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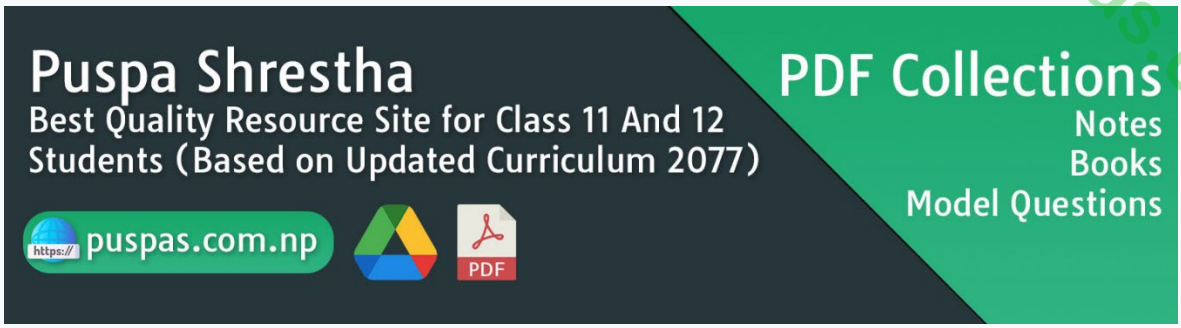

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MODEL QUESTION - ANSWER

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Section A (Botany)

1. Answer any seven questions in very short. [7x1=7]

a. Write the function of xylem?

The main functions of xylem are

i. Conduction of water and minerals from root to leaves.

ii. Provide the mechanical support.

b. Name the components of a nucleotide?

The main components of nucleotide are: Pentose sugar, Nitrogenous Base and Phosphate molecules.

c. Give one example of polygenic inheritance.

The best example of polygenic inheritace is human skin colour.

d. Define genetic code.

A code which is formed by combination of three nitrogenous bases and it represents a particular amino acid. e.g AUG is a genetic code that represent amino acid methionine.

e. What is polyploidy?

The organisms which have more than two sets of chromosomes are called polyploids and phenomenon is called polyploidy.

f. Mention two importance of vegetative propagation.

Importance of Vegetative propagation are:

i. It is the only means of reproduction in species which are seedless or which usually do not produce viable seeds, such as banana, figs, pineapple, and chrysanthemum.

ii. It is rapid, easier and cheaper compared to production of plants by seeds.

g. Give two examples of entomophilus plants.

Two examples of entomophilous plants are: Rose and Mustard.

h. Define genetic engineering.

Branch of biology which deals with study about a selective alternation of genetic make up of an organism by introducing foreign gene.

i. Define tissue culture.

Tissue culture is a techniques of growing cells, tissues and organs in a artificially prepared nutrient medium under aseptic conditions.

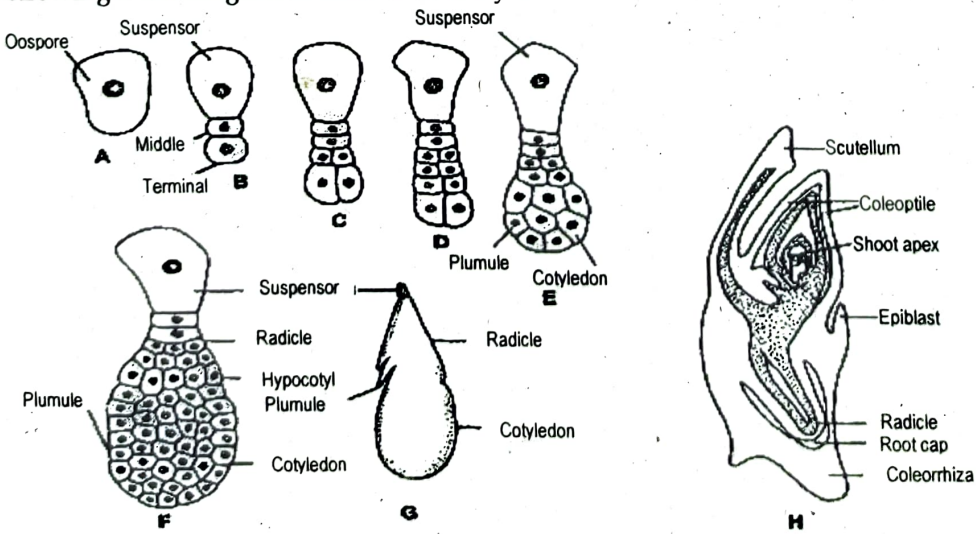
j. What is the main source of green manures?

The main sources of green manures is root nodules of leguminous plants.

2. Answer any five questions in brief. [5x3=15]

a. Give the well-labelled diagram of monocot embryo Description is not required.

Following is the diagram of monocot embryo:



A–G, Stages in development of a monocot embryo. H, a monocot embryo of a grass.

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b. What are the differences between dicot stem and monocot stem?

➢ The differences between dicot stem and monocot stem are follows;

Dicot stem	Monocot Stem
Hypodermis is made up of collenchymatous tissue.	Hypodermis is made up of sclerenchymatous tissue.
Ground Tissue is heterogenous which is made up of cortex, endodermis, pericycle, pith and pith rays.	Ground Tissue is homogenous which is not differentiated into cortex, endodermis, pericycle, pith and pith rays.
Vascular bundles are arranged in concentric ring.	Vascular bundles are Scattered.
Vascular bundles are conjoint, collateral and open type.	Vascular bundles are conjoint, collateral and closed type.
Water cavity is absent.	Water cavity is present.

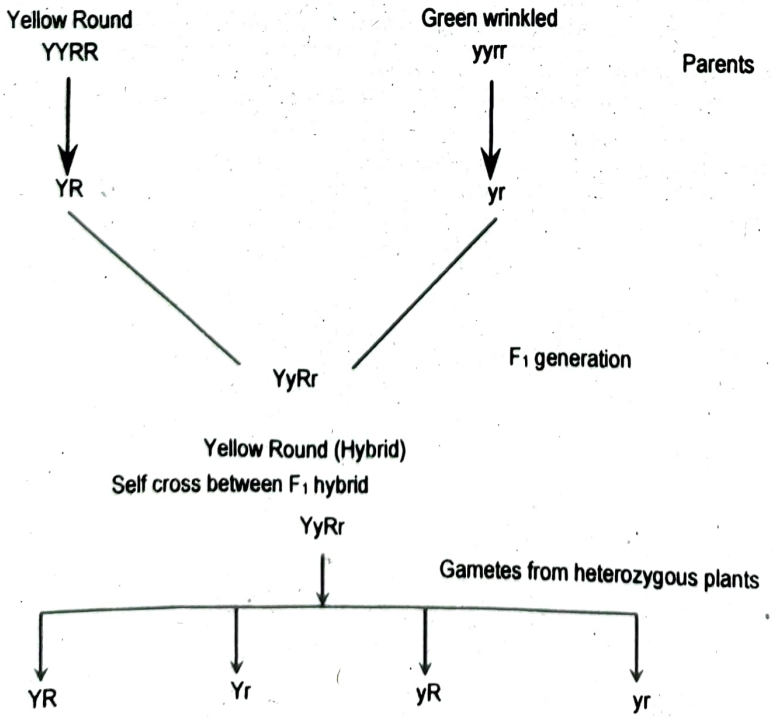
c. Differentiate between phenotype and genotype.

➢ Differentiate between phenotype and genotype are follows:

Genotype	Phenotype
It is gene complement of an individual.	It is morphological appearance of organism.
Genotype remains the same throughout the life of an individual.	It can be change with time e.g infant, adolescent, young.
It is not influenced by phenotype.	Genotype establishes the boundaries within which phenotype can be expressed.
Genotype cannot be studied directly. It can be known through the study of ancestors, and offspring.	It can be known through direct observation.
Individuals with different genotypes may have similar phenotype e.g tallness for TT, and Tt	Individuals with similar phenotypes may not belong to same genotype.

d. What did you understand by Mendel's 9:3:3:1 ratio?

➢ A 9:3:3:1 ratio is at ratio of phenotypes among offspring (Progeny) that results when two dihybrids make. It can be more understood by a cross is made between yellow round seed (YYRR) with green wrinkled seed (yyrr).



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♀ \ ♂	YR	Yr	yR	yr
YR	YYRR Yellow round	YYRr Yellow round	YyRR Yellow round	YyRr Yellow round
Yr	YYRr Yellow round	YYrr Yellow wrinkled	YyRr Yellow round	Yyrr Yellow wrinkled
yR	YyRR Yellow round	YyRr Yellow round	yyRR Green round	yyRr Green round
yr	YyRr Yellow round	Yyrr Yellow wrinkled	yyRr Green round	yyrr Green wrinkled

Phenotypic ratio = 9 : 3 : 3 : 1

Yellow Round Yellow Wrinkled Green Round Green Wrinkled

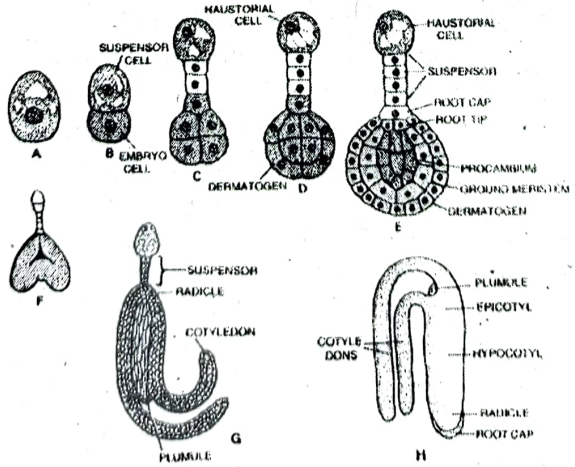
Genotypic ratio = 1:2:2:4:1:2:1:2:1

e. Differentiate between self and cross fertilization.

Differences between self and corss fertilization are follows:

Self pollination	Cross Pollination
It is the transfer of pollen grains from anther to the stigma of either the same or genetically similar flower.	Cross pollination involves the transfer of pollen from anther of one flower to the stigma of a genetically different flower.
Self pollination can occur even in closed flower.	It occurs when the flowers are open.
External agency is not required for self pollination, except in case of geitonogamy.	An external agent is essential for carrying the pollen grains from anthers to the stigma.
The plants ultimately become homozygous.	The plants remain heterozygous.
Highly useful characters are preserved by self pollination	Cross pollination is unable to preserve all the highly useful characters since they tend to get diluted.
Adaptability to changed environment is absent as self pollination does not produce variability.	Plants are better adapted to changed environment and struggle for existence due to introduction of variations.
It does not help in producing new races, varieties and species.	Cross pollination is a mechanism of producing new races, varieties and even species.
Self pollination produces pure lines.	It give rise to offspring having variations among themselves.

f. Show with the diagrams the development of dicot embryo (no description).



Stages in the development of a dicot embryo

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g. Mention the applications of genetic engineering.

Genetic engineering is the branch of biology which deals with the study about the alternation of genetic make up of organism by the introduction of foreign gene. When conducting genetic engineering the organisms that have their genetic make up altered are referred to us genetically modified organisms or GMOS. During the process DNA are altered to change a characteristic about the organism. Nowadays genetic engineering techniques have been used in various fields like in agriculture, in production of different types of modern medicine. Some these importances are

Application of genetic engineering in medicine.

Genetic engineering can be used in the various field of medicine like:

i. Gene therapy
ii. Production of human insulin
iii. Production of interferon
iv. Production of human growth hormone (somatotrophin)
v. Production of vaccines
vi. Diagnosis of infections disease
vii. Production of Transgenic animals
viii. Production of antibiotics

3. What is secondary growth? Discuss the activity of cambium in secondary growth of dicot stem. [7.5]

The increase in thickness or girth due to the activity of the cambium and the cork cambium is known as secondary growth. In a typical dicot stem secondary growth starts in the interstellar region and extends towards extra-stellar region. In the stellar region it starts owing to the activity of cambium and in extra- stellar region due to cork cambium.

Secondary Growth in Dicot Stem: On the basis of the activity of cambium and cork cambium, secondary growth in stem can be explain in following heading

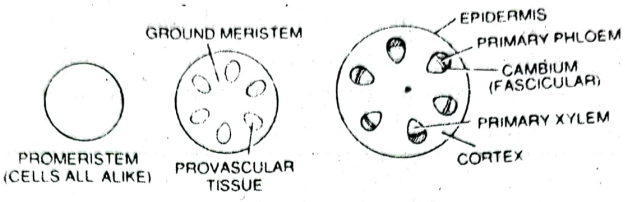
1. Activity of the cambium

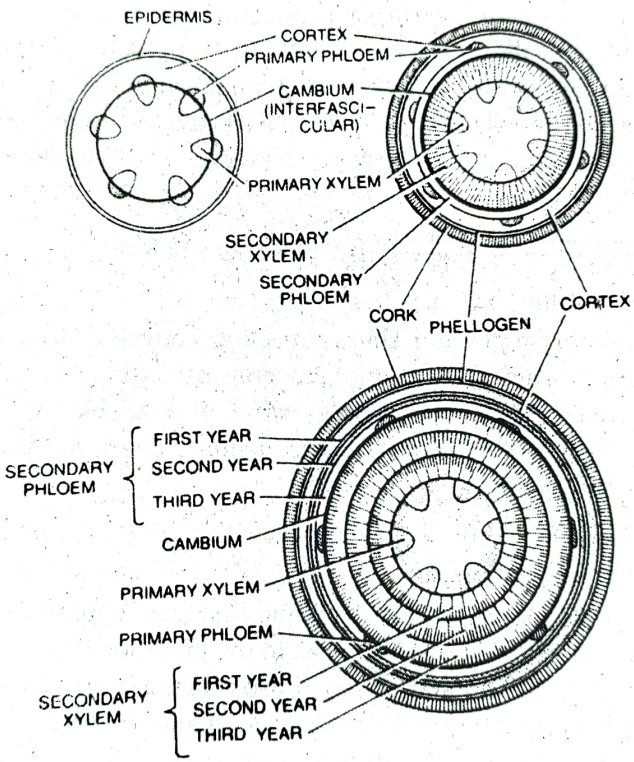
a. **Formation of cambium Ring:** The vascular bundles of dicot stem have strips of cambium in between xylem and phloem which are known as intrafascicular cambium. During secondary growth the cells of medullary rays in a line with the intrafasicular cambium develop meristematic activity and form strips of cambium called interfesicular cambium. The intra and interfesicular cambium unite to form a complete ring called the cambial ring. The activity of the cambial ring gives rise to secondary growth. The cambium has two types of cells (i) the fusiform initials which are elongated and form fibers, sieve cells, sieve tubes, tracheids (ii) ray initials which produce parenchymatous cells of the rays in wood and phloem.

b. **Formation of Secondary Tissues:** The cambium ring becomes active as a whole and starts cutting off new cells. The cells cut off on the outer side get differentiated into phloem and are called secondary phloem. The cells cut off on the inner side are modified into the elements of xylem which constitute secondary xylem. The secondary phloem consists of sieve tubes, companion cells, phloem fibers and phloem parenchyma. Secondary xylem consists of pitted vessels, tracheids, xylem fibers and xylem parenchyma. The activity of cambium ring is more on the inner side than on the outer with the result of that xylem increases more rapidly in bulk than the phloem. Due to increasing pressure, the primary phloem is completely crushed and is represented by small patches. The xylem is pushed towards the pith and remains more or less intact. The bulk of the trunk of a tree consists of secondary xylem.

c. **Formation of Secondary medullary Rays:** Ray initials of the cambium ring form some narrow bands of parenchymatous cells. These cells extend radially from the pith to the phloem. These are called secondary medullary rays or vascular rays. The rays present in xylem are called xylem rays and rays present in phloem are called phloem rays.

d. **Formation of Annual Rings:** The activity of vascular cambium is greatly affected by the variations in the climate. It is more pronounced in temperate regions. The cambium stops dividing in winter. In the spring season or early summer, the cambium becomes more active and produces a large number of vessels with wider lumen. These are called spring wood or early wood. During the autumn or winter season, the cambium becomes less active and produces vessels with narrow lumens. Tracheids and wood fibers are formed in large numbers. These woods are called autumn wood or late wood. Hence the annual rings are formed after year. In the oldest part of the tree, annual rings can be used in determing the age of a tree. In tropical regions the climate is more or less uniform. Therefore the annual rings are not well developed and do not correlate with the age of tree.





Sapwood and Heartwood: In older stems, the woody trunk is differentiated into two regions. The outer light coloured region is called sap wood or laburnum and central dark colored region is called heart wood or duranum. The cells of sapwood are living and functional. They take part in conduction of water and storage of food. The heartwood consists of dead cells. During the growth process the ring of sap wood gradually process, the rings of sap wood gradually convert into heartwood. The living cells of sapwood lose their protoplast and water content. The lumen of the xylem vessels get blocked by the ingrowth of the parenchymatous cells. The adjacent parenchyma tissue enters through the pits of vessels and gradually enlarges to form a ballon like structure, which is called tyloses. The heartwood is stronger and more durable than sapwood. The heartwood becomes resistant to the attacks from bacteria and fungi due the presence of antiseptic oils.

Activity of the cork cambium (Secondary growth in the cortex): It is the result of the activity of a secondary meristem called cork cambium, which appears between hypodermis and primary cortex. Some of the parenchyma cells in the peripheral layers of cortex undergo dedifferentiation and become meristematic. These cells now represent the cork cambium or phellogen. The cork cambium starts exhibiting mitotic activity on both the sides, just as the cambial ring in the stele.

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The mitotic activity on the inner surface of the cork cambium results in the formation of cells, which undergo differentiation into a living tissue, called secondary cortex or phelloderm, just above the primary cortex. The mitotic activity on the outer surface results in the formation of cells, which undergo differentiation into a dead tissue, called cork or phellem, just below the epidermis. The cork covers and masks the hypodermis. The tissue resulting from secondary growth in the cortex the cork, the cork cambium and the secondary cortex together represent a region called periderm.

The periderm along with the primary cortex represents the bark. In several dicot plants, the bark peels off regularly. Due to the formation of periderm, the epidermis is subjected to pressure and as a result it breaks at several places to form opening called **lenticels**. The lenticels, also known as aerating pores, enclose a group of living cells called **complementary cells**. Through these cells exchange of respiratory gases and to some extent transpiration take place. Thus secondary growth in the cortex results in the formation of periderm. Due to the addition of this region there is an increase in the girth of the girth.

OR

Describe the light dependent steps of photosynthesis.

Photosynthesis (G.K. Photo - light, synthesis-production) is the anabolic process in which green plants produce their food in the presence of sunlight and chlorophyll and produce glucose and oxygen. The volume of oxygen released during photosynthesis is coequal to the volume of carbondioxide absorbed. The released oxygen is exclusively formed from water and not from carbondioxide. The process of photosynthesis can be represented by following chemical equation.

$$6CO_2 + 12\,H_2O \xrightleftharpoons[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

The overall reaction is not single and simple reaction between carbondioxide and water but a highly complex process in which a number of reactions occur. In it the radiant energy absorbed by chlorophyll is transferred in to chemical energy which is available for all vital activities of living cells. Photosynthesis consists of oxidation and reduction. The overall process of photosynthesis is completed in to two main phases.

i. Light reaction or Hill reaction

ii. Dark reaction or Blackman reaction

Light dependent steps of photosynthesis: It is the first step of photosynthesis which takes place during day time. It occurs in grana of chloroplast in the presence of light. Light reaction was first of all studied by Robert Hill 1937 so this reaction is also called hill reaction or photochemical reaction. In light reaction solar energy is trapped by chlorophyll and stored in the chemical energy of ATP and as reducing power in NADPH. Oxygen is evolved in the light reaction by splitting of water. When a photon is absorbed by a molecule, an electron is boosted to a higher energy level. To boost an electron a photon must have a certain minimum quantity of energy, hence the term quantum. A molecule that has absorbed a photon is in an energy rich excited state. When the light source is turned off the high energy electrons return rapidly to their normal low energy orbital's as the excited molecule reverts to its original stable condition, called the ground state.

Photochemical Reaction Centre and Photo system: The light absorbing pigments are located in the thylakoid membranes. Situated in these membranes are clusters of chlorophyll and accessory pigments along with special type of chlorophyll molecules P_{680} and P_{700}. P_{680} and P_{700} molecules form the reaction centers or photo centers. The accessory and the other chlorophyll molecules harvested solar energy and pass it on the reaction centers. These are called light harvesting or antenna molecules. They function to absorb light energy, which they transmit at a very high rate to the reaction centre where the photochemical act occurs. In each reaction center two types of phosystem are exist known as phtosystem I and Phosystem II. Photosystem I absorb light above the wavelength of 700nm and photosystem II absorb light at or below 680 nm. The overall process of light reaction is completed into following steps.

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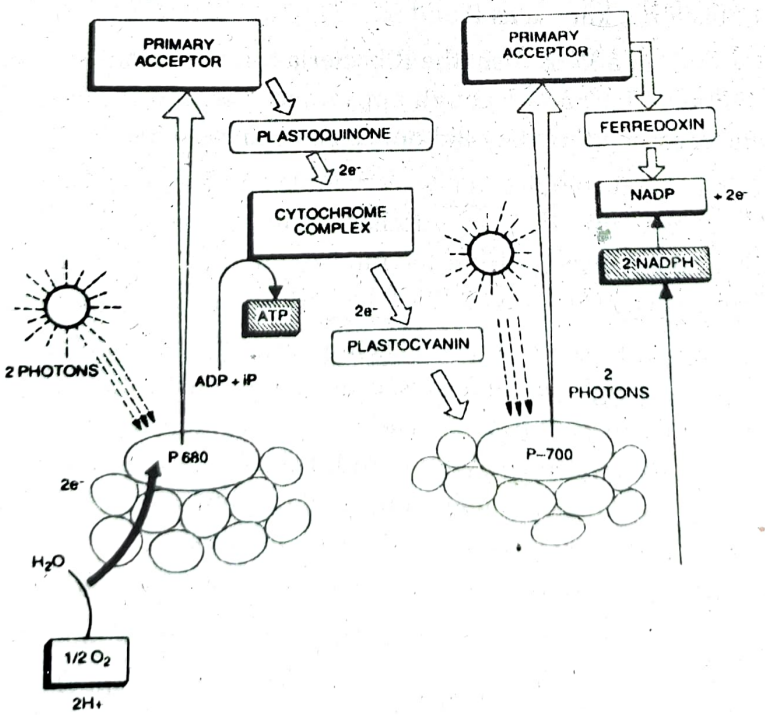
1. **Photo-excitation of Chlorophyll molecules:** Chlorophyll molecules absorb light energy in the form of photon. When it absorbs light energy it become and activated. The activated chlorophyll molecule release one electron and develops a positive charge. This type of chlorophyll is called ionized chlorophyll molecule. The released electrons contain a huge mass of energy which is utilized in the further process of photosynthesis i.e. photolysis of water and photophosphorylation.
2. **Photolysis of Water or Oxidation of water molecule:** During this step the water molecules split into H^+ and OH^- In the presence of light and chlorophyll. OH^- reunites and form water and molecular O2. This process takes place in PSII.

$$4H_2O \longrightarrow 4OH^- + H^+$$

$$4OH^- \longrightarrow 2H_2O + O_2$$

3. **Photophosphorylation:** Photosynthetic phosphorylation is the process of phosphate group transfer into ADP to synthesize energy rich ATP molecule making use of light as external energy source. During photosynthetic electron transport, hydrogen protons H+ accumulate in the thylakoid space, due to splitting of water and transport between PQH_2 to Cytf. Increase in te number of hydrogen protons in the thylakoid space results in increase of proton gradient. Down flow of protons from high to low concentration along H^+concentration gradient through ATPase complex provides the energy that allows an ATP synthase enzyme to produce ATP from ADP+Pi. Formation of ATP in the chloroplasts takes place in two different forms.

Non- Cyclic Photophosphorylation: The electron lost by P_{680} (PSII) is taken up by P_{700} (PSI) and donot get back to P_{680} i.e unidirectional and hence it is called non-cyclic photophosphorylation. The electron pass through the primary acceptor, plastoquinone, cytochrome complex, plastocyanin and finally to P700. The electron given out by P700 is taken up by primary acceptor and is ultimately passed on to NADP. The electron combines with H+ and reduces NADP to $NADPH_2$. The hydrogen ions also called protons are made available by splitting up of water. Non-cyclic phtophosphorylation needs a constant supply of water molecules. The net result of this cycle is the formation of oxygen, NADPH and ATP molecules. Oxygen is produced as a waste product of photosysnthesis. It occurs in palnts.



Cyclic Photophosphorylation: The electron released by P_{700} of PSI in the presence of light are taken up by the primary acceptor and are then passed on to ferredoxin, plastoquinone, cytochrome complex, plastocyanin and finally back to P_{700} i.e electron come back to the same molecule after cyclic movement. It occurs in photosynthetic bacteria.

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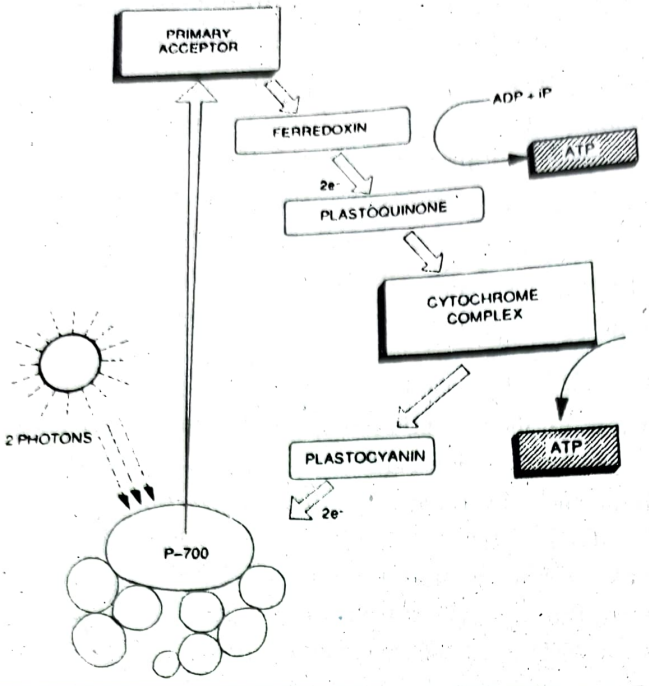

4. "DNA is the hereditary material", explain it with an experiment. **[8]**

DNA is Genetic Material

DNA is polyoxyribonucleotide which is responsible to transfer of traits from parents to their offsprings, so it is act as a genetic material that can be proved experimentally by bacterial transformation method and virus transduction method.

Frederick Griffith: Bacterial transformation

In 1928, British bacteriologist Frederick Griffith conducted a series of experiments using *Streptococcus pneumoniae* bacteria and mice. Griffith wasn't trying to identify the genetic material, but rather, trying to develop a vaccine against pneumonia. In his experiments, Griffith used two related strains of bacteria, known as R and S.

R strain. When grown in a Petri dish, the R bacteria formed colonies, or clumps of related bacteria, that had well-defined edges and a rough appearance (hence the abbreviation "R"). The R bacteria were nonvirulent, meaning that they did not cause sickness when injected into a mouse.

S strain. S bacteria formed colonies that were rounded and smooth (hence the abbreviation "S"). The smooth appearance was due to a polysaccharide, or sugar-based, coat produced by the bacteria. This coat protected the S bacteria from the mouse immune system, making them virulent (capable of causing disease). Mice injected with live S bacteria developed pneumonia and died.

As part of his experiments, Griffith tried injecting mice with heat-killed S bacteria (that is, S bacteria that had been heated to high temperatures, causing the cells to die). Unsurprisingly, the heat-killed S bacteria did not cause disease in mice. The experiments took an unexpected turn, however, when harmless R bacteria were combined with harmless heat-killed S bacteria and injected into a mouse. Not only did the mouse develop pnenumonia and die, but when Griffith took a blood sample from the dead mouse, he found that it contained living S bacteria.

Diagram illustrating Frederick Griffith's experiment with S and R bacteria.

1. **Rough strain (nonpathogenic):** When this strain is injected into a mouse, the mouse lives.
2. **Smooth strain (pathogenic):** When this strain is injected into a mouse, the mouse gets pneumonia and dies.
3. **Heat-killed smooth strain:** When heat-killed smooth cells are injected into a mouse, the mouse lives.
4. **Rough strain & heat-killed smooth strain:** When these two types of cells are injected into a mouse as a mixture, the mouse gets pneumonia and dies.

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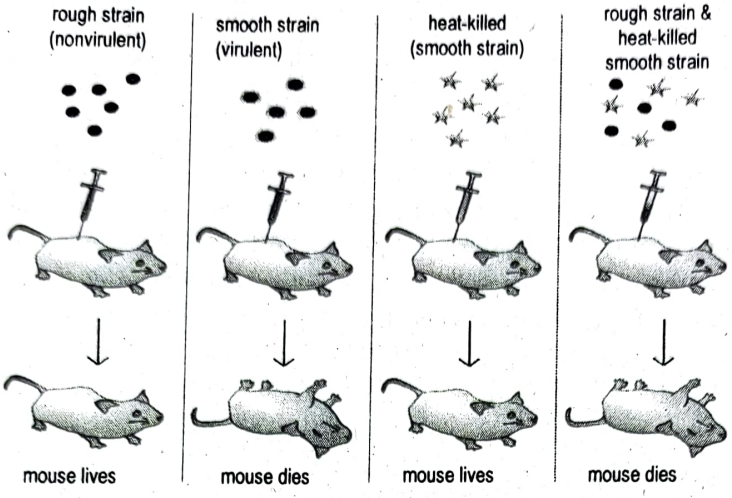
Griffith concluded that the R-strain bacteria must have taken up what he called a "transforming principle" from the heat-killed S bacteria, which allowed them to "transform" into smooth-coated bacteria and become virulent.



In 1944, O. T. Avery, McCleod and McCarty repeated the experiments of Griffith and found that when living R cells were mixed with the capsule of heat killed S type and infected into mice, there was no disease. But when they injected a mixture of R cells and the chromosome of S-bacteria into mice, the mice developed pneumonia and died. This led to the conclusion that the chromosome of S-bacteria causes the transformation and not the capsule.So they announced that bacterial transformation involves transfer of a part of DNA from the dead bacterium (donor) to the active living bacterium (recipient), which expresses the character of the donor cell, and so is called a recombinant.

R-Type Bacteria + Polysaccharides of heat killed S-Type Bacteria

Inject into mice → Mice Survived

R-Type Bacteria + Protein of heat killed S-Type Bacteria

Inject into mice → Mice Survived

R-Type Bacteria + DNA of heat killed S-Type Bacteria

Inject into mice → Mice died

R-Type Bacteria + DNA of heat killed S-Type Bacteria+ Deoxyribonuclease

Inject into mice → Mice Survived

Form these two experiments they concluded that polysaccharides and proteins of heat killed S-type bacteria can not transfer the disease pneumonia in mice after mixing of with living R-type. DNA of heat killed S-type transfer the disease pneumonia in mice after mixing with living R-type. This proved DNA is a genetic material.

Transduction method (Hershey and Chase Method)

In 1952, Alfred Hershey and Martha Chase took an effort to find the genetic material in organisms. Their experiments led to an unequivocal proof to DNA as genetic material. Bacteriophages (viruses that affect bacteria) were the key element for Hershey and Chase experiment. The virus doesn't have their own mechanism of reproduction but they depend on a host for the same. Once they attach to the host cell, their genetic material is transferred to the host. Here in case of bacteriophages, bacteria are their host. The infected bacteria are manipulated by the bacteriophages such that bacterial cells start to replicate the viral genetic material. Hershey and Chase conducted an experiment to discover whether it was protein or DNA that acted as the genetic material that entered the bacteria.

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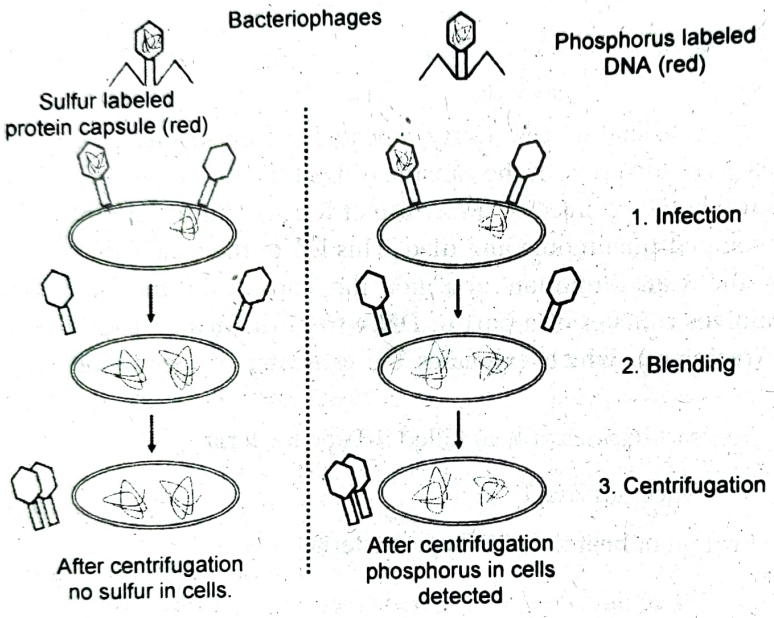
DNA as Genetic Material

Experiment: The experiment began with the culturing of viruses in two types of medium. One set of viruses (A) was cultured in a medium of radioactive phosphorus whereas another set (B) was cultured in a medium of radioactive sulfur. They observed that the first set of viruses (A) consisted of radioactive DNA but not radioactive *proteins*. This is because DNA is a phosphorus-based compound while protein is not. The latter set of viruses (B) consisted of radioactive protein but not radioactive DNA. The host for infection was *E.coli* bacteria. The viruses were allowed to infect bacteria by removing the viral coats through a number of blending and centrifugation.

Observation: *E.coli* bacteria which were infected by radioactive DNA viruses (A) were radioactive but the ones that were infected by radioactive protein viruses (B) were non-radioactive.

Conclusion: Resultant radioactive and non-radioactive bacteria infer that the viruses that had radioactive DNA transferred their DNA to the bacteria but viruses that had radioactive protein didn't get transferred to the bacteria. Hence, DNA is the genetic material and not the protein.



Section B (Zoology)

1. Answer any seven questions in very short. **[7x1=7]**

a. In which kind of animal tissue you find the mast cells?

Mast cells are found in the matrix of areolar connective tissue of chordates.

b. Name the two sexes linked diseases in human.

The two sexes linked diseases in human are Haemophilia A and B and Duchenne Muscular Dystrophy.

i. Haemophilia impairs the body's ability to make blood clots

ii. Duchenne Muscular Dystrophy (DMD) is characterized by rapid progression of muscle degeneration, eventually leading to loss of skeletal muscle control, respiratory failure and death. Both are x-linked recessive diseases.

c. Define gametogenesis.

Gametogenesis is defined as a biological process by which diploid or haploid precursor cells undergo cell division and differentiation to form mature haploid gametes. It is the formation of spermatozoa in adult male and ovum in adult female.

d. Name any two enzymes which are responsible for protein digestion.

The two main enzymes which are responsible for protein digestion are pepsin in stomach and trypsin in intestine.

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e. Define the term 'deamination'.

Deamination is the removal of amino group from an amino acid. Deamination takes place in liver, which converts them into harmless products.

f. Which part of human brain is the centre of intelligence?

Cortex of the cerebrum of the human brain is regarded as the centre of intelligence.

g. Name the causative agent of typhoid fever.

Salmonella typhi, a rod-shaped, flagellated, aerobic, gram-negative bacterium, is the causative agent of typhoid fever.

h. What does ISD cause?

ISD (Inhibited Sexual Desire) is caused by various drugs like hallucinogens, sedatives, etc, by alcoholism and by smoking acts.

i. What is the role of surrogate mother in test tube baby?

The role of surrogate mother is to bear a child on behalf of another woman, either from her own egg fertilized by the other woman's husband, or form the implantation in her uterus of a fertilized egg from the other woman.

j. Differentiate between heterograft and autograft.

An autograft is defined as any tissue transferred from one site to another in the same individual. A heterograft is a type of tissue graft in which the donor and recipient are of different species. Heterograft is also known as xenograft.

2. Answer any five questions in brief. [5x3=15]

a. Describe the structure of aerolar fissure.

Areolar tissue is a loose connective tissue that consists of a meshwork of collagen fibres, elastic fibres, and reticular fibres. It is the most common type of connective tissue in vertebrates. It is so named because its fibres are far enough apart to leave ample open space for interstitial fluid in between (areola-Latin-open space). It consists of three components – Fibres, cells and matrix.

1. **Types of Fibres:**
   - i. White collagen fibres, composed of collagen protein, are found in bundles called fasciae (singular fascia). They are wavy in nature. They strengthen the tissue.
   - ii. Yellow elastic fibres, composed of elastin protein, are found singly. They are straight and branched. Due to their stretchable nature they provide elasticity to the tissue.
   - iii. Reticular fibres, composed of one or more types of very thin and delicately woven stands build a highly ordered cellular network and provide a supporting network. They provide support in walls of blood vessels, and skeletal and smooth muscle fibres. They help to form the basement membranes and the framework (stroma) of many soft organs such as lymph node, red bone marrow and spleen.

2. **Types of Cells:** There are seven types of cells found embedded in the matrix. They are as follows:
   - i. Fibroblasts: They are elongated or tapered, flattened cell that form the collagen and elastin protein fibres and ground substance.
   - ii. Macrophages or Histocytes – These are amoeboid or fixed phagocytic cells derived from monocytes of the blood. Macrophages play a role in phagocytosis and thereafter enter the lymphatic system to aid in activation of immune response.
   - iii. Leucocytes – These are white blood cells. They are blood borne defensive cells that leave the vascular system during inflammatory events to patrol adjoining tissue spaces. Most are neutrophils and lymphocytes.
   - iv. Plasma cells – They are white blood cells derived from B-lymphocytes. They produce antibodies. They are spherical shaped with rounded nuclei.
   - v. Mast cells (Mastocytes) – they are key cells involved in inflammation. They release histamine, heparin and serotonin. These chemical agents induce the vascular response that cause inflammation.
   - vi. Adipocytes – These are fat cells that store fats or triglycerides. They are spherical and appear as empty cells with nucleus pushed to the periphery.
   - vii. Mesenchyma cells – They are embryonic stem cells that divide to form new cells of all connective tissue types. They are precursors to fibroblasts, chondroblasts and osteoblasts.

3. **Matrix:** Matrix is the ground substance, where all the types of fibres and cells are embedded.

b. If a red-eyed male Drosophila is mated with a white-eyed female, what will be the pheno type of male and female in F1 progeny?

Eye colour in Drosophila was one of the first x-linked traits to be identified, and Thomus Hunt Morgan mapped this trait to the X chromosome in 1910.

In Drosophila, the wild type eye colour is red (X^W) and is dominant to white eye colour (X^w) because this eye colour gene is located on the X-chromosome only, reciprocal crosses do not produce the same offspring ratios. Males are said to be hemizygous, because they have only one allele for any X-linked characteristic. Hemizygosity makes the descriptions of dominance and recessiveness irrelevant for XY males beacuse each male has only one copy of the gene. Drosophila males lack a second allele copy on the Y -chromose; their genotype can only be X^WY or X^wY.

In contrast, females have two allele copies of this gene and can be X^WX^W, X^WX^w or X^wX^w.

After crossing between white eyed female (X^wX^w) with red eyed male (X^WY) , in the F_1 generation all the female flies will be red eyed and all the males will be white-eyed.

Red-eyed Male White-eyed Male

Male Gametes \ Female Gametes	X^W	X^w
X^W	X^WX^W	X^WX^w
Y	X^WY	X^wY

All female offspring have red eyes

All male offspring have white eyes

c. How is the notochord formed in the embryo of frog?

The study of mode of development of the notochord in chordates is known as notogenesis. The notochord is a flexible rod made out of a material similar to cartilage.

After formation of three germinal layers some mesodermal cells at the roof of archenteron separate from other mesodermal cells. They form a rod-like structure, which is the beginning of notochord. A thin membrane develops around the rod-like structure known as notochordal sheath. Finally rod-like structure and notochord sheath form the notochord. Notochord modifies into vertebral column as well as other skeletons in the course of development. Hence, notochord is mesodermal in origin.

d. What is vitamin? Mention functions of fat - soluble vitamins.

Vitamins are a group of organic compounds which are essential for normal growth and maintaining good health and are required in small quantities in the diet because they cannot be synthesized by the body.

Vitamins are classified by their solubility, or, in other words, the vitamin's ability to dissolve into another substance. Accordingly two groups of vitamins are present – water soluble vitamins and fat-soluble vitamins.

For instance, fat-soluble vitamins are vitamins that dissolve in fat. Because fat is easily stored in body, fat-soluble vitamins can be stored within the fat they can accumulate and be saved for later use.

The fat-soluble vitamins are A, D, E and K.

1. **Functions of Vitamins A (Retinol):** Vitamin A is a collective form of retinol, retinal, retinoic acid and B-carotene. It is found in diets like liver, orange, ripe yellow fruits, leafy vegetables, carrot, pumpkin, squash, spinach, fish, soya milk and milk.

Vitamin A has multiple functions:

i. **Vision –** Vitamin As is required for maintenance of normal vision. In the eyes, a form of vitamin A called retinal is combined with a protein called opsin to give rhodopsin, an essential light absorbing molecule for seeing in dim light.

ii. **Immune system –** Vitamin A is essential for maintaining impaired response to infection.

iii. **Cell growth –** One form of vitamin A, retinoic acid is a key hormone –like growth factor for epithelial cells and other cell types in the body.

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iv. **Gene transcription and protein formation:** Retinoic acid is essential for gene transcription. Retinol is taken up by the cell where it is oxidized to retinaldehyde which is taken oxidized to give retinoic acid. Retinoic acid functions as ligand for nuclear receptors. Retinoic acid binds to these nuclear receptors in order to regulate gene transcription.

v. **Skin health** – Retinoic acid also maintains skin health by activating genes that cause immature skin cells to develop into mature epidermal cells.

2. **Functions of Vitamins D (Calciferol):** Vitamin D are obtained by consuming fish, eggs, liver and mushrooms. On human, the most important compounds in this group are vitamin D_3 (Cholecalciferol) and vitamin D_2 (ergocalciferol). Vitamin D is sometimes called "sunshine vitamin" because it is produced in the skin in response to sunlight.
   - The most vital function is the regulation of absorption of calcium and phosphorus and facilitating normal immune system.
   - Vitamin D is important for normal growth and development of bones and teeth.
   - Research has shown that vitamin D might play an important role in regulating mood and warding off depression.
   - Adding vitamin D supplements in diet prevent heart disease.

3. **Functions of Vitamin E:** Vitamin E refers to tocopherols and tocotrienols. Tocopherol is the most common form of vitamin E. It is found in corn oil, soyabean oil, margarine and sunflower oils.
   - Vitamin E is an antioxidant. It protects body tissue from damage caused by substances called free radicals, which can harm cells, tissues and organs.
   - Vitamin E help to keep the immune system strong against viruses and bacteria.
   - Vitamin E is important in the formation of red blood cells and it helps the body to use vitamin K.

4. **Functions of Vitamin K:** Vitamin K is obtained by eating spinach, mustard, turnip, broccoli, cabbage and asparagus. Three types of vitamin K are found. They are vitamin K_1 or Phylloquinone, Vitamin K_2 or Meanquinone and Vitamin K_3 or menadione.
   - Vitamin K is needed for blood clotting, which means it helps wounds heal properly. It helps in the formation of blood clothing factors II, VIII, IX and X.
   - Vitamins K helps to build strong bone, especially important in the elderly who are prone to bone fractures and osteoporosis.

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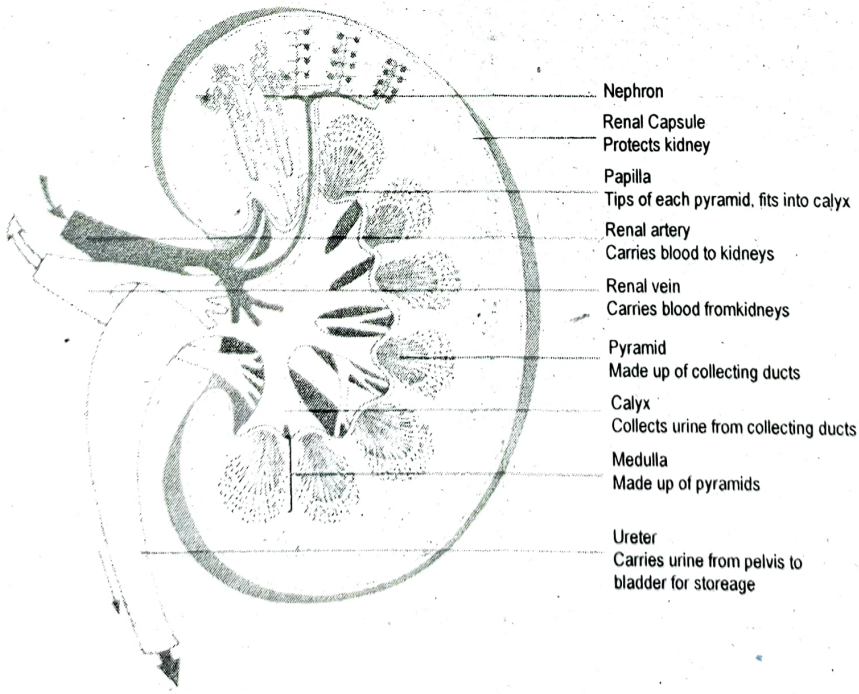
e. **Draw a labeled sketch of internal structure of human kidney.**

Following is the structure of human kidney:



Structure of human kidney

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f. What will be the problems of over human population? Suggest some measures to control over population.

Overpopulation is the state where by the population rises to an extent exceeding the carrying capacity of the ecological setting. In an overpopulated environment, the numbers of people might be more than the available essential materials for survival such as transport, water, shelter, food or social amenities. This regularly contributes to environmental deterioration, worsening in the quality of life, or even the disintegration of the population.

It is estimated that about 81 million people are added to the existing world's population annually. Currently the world's population stands more than 7 billion. (2017)

Causes of overpopulation: Overpopulation is caused by numbers of factors, which are as follows:

1. Reduced mortality rate due to medical facilities.
2. High fertility rate due to modern advancement in reproductive sector and fertility treatment.
3. Eradication of several infectious diseases like malaria, kala-azar, tuberculosis, etc.
4. Immigration influx of people in certain places due to better facilities.
5. Lack of family planning.
6. Lack of education
7. Traditional belief of having more children as gods gifts.
8. Early marriage.
9. Advancement is agricultural technology.
10. Better food storage facilities.

Consequences of overpopulation: The consequences or effects of overpopulation are listed below:

1. Depletion of natural resources and degradation of Environment.
2. Conflicts and wars on limited natural resources like river, lakes, fuels, etc.
3. Poverty and high cost of living.
4. Lack of better public health, medical care, housing, shelter, etc.
5. Emergence of new diseases.
6. Rise in unemployment, crimes and accidents.
7. Low quality of living standard
8. Lack of better education
9. Mass extinction of species
10. Loss of fresh water.
11. Unhygienic environment due to pollution.
12. Lower life expectancy.

Control measures or solution of overpopulation

1. Better education and spread of public awareness about over population.
2. Making people aware of family planning.
3. Tax benefits or concessions.
4. Knowledge of sex education
5. Enacting birth control measures and regulations.
6. End gender bias through law.
7. Offer education to women and girls.
8. Offer employments
9. Concept of small family should be encouraged.

g. Define amniocentesis. Mention its negative & positive effects?

Amniocentesis is a medical procedure used in prenatal diagnosis of chromosomal abnormalities and fetal infections, and also for sex determination, in which a small amount of amniotic fluid, which contains fetal tissues, is sampled from the amniotic sac surrounding a developing fetus, and then the fetal (Foetal) DNA is examined for genetic abnormalities. Amniocentesis is performed when a women is between 14 and 16 weeks gestation.

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Although amniocentesis offers many advantages there are also various other disadvantages, which are given below:

Advantages of Amniocentesis (merits):

It has several benefits for the mother who are expecting.

Amniocentesis identifies several genetic disorders such as Down's Syndrome, Edward syndrome or Patau's Syndrome, Sickle cell disease, thalassaemia, cystic fibrosis and muscular dystrophy in the growing foetus. Neural tube defects such as spina bifida and anencephaly are also detected in the growing foetus. The most common defect is the Down's syndrome. The accurate result accounts for 99% of the total examined. It also helps to know, whether the foetus lungs are mature enough for an early delivery if the mother appears to be in premature labour. This test has become more popular among the ladies who opt for the test to ensure whether they have a healthy growing baby in their womb or not. By knowing the needs of the unborn baby parents can be informed, they can arrange best for him/her. Amniocentesis is an important test for mothers to have that have already had a child with a birth defect.

Disadvantage of Amniocentesis (Demerits):

Disadvantage of amniocentesis include preterm labour and delivery, respiratory distress, postural deformities, chorioamnionitis (inflammation of foetal membrane due to bacterial infection), foetal trauma, etc. There is a risk of miscarriage but very low-around 1 in 200 (0.5%).

Besides the health risk, this has also become a very controversial topic from ethical perspective. Women who have the test done and receive results that their baby has a chromosornal or genetic disorder are making decisions that are to many, unethical choices. Currently, more and more data has evolved about healthy babies being misdiagnosed are killed by abortion. Another ethical disadvantage is the use of this test along with others to find the sex of the foetus. Some couples who find the sex of the baby is not what they desired have resorted to abortion. Many unwanted baby girls by their parents are killed before birth.

Explain the structure and function of human brain. **[8]**

The brain is one of the most complex and magnificent organs in the human body. The human brain is the "master organ" or "command center" of the body because it controls all the other organs and systems of the body. The brain interprets information from the outside world and embodies the essence of the mind and soul. Intelligence, creativity, emotion and memory are a few of the many things governed by the brain. In fact, the human brain is so complicated that it remains an exciting frontier in the study of the body.

- Brain is protected within the skull.
- The human brain is the largest brain of all vertebrates relative to body size.
- It weighs about 3.2 lbs (1.4 kilograms)
- The brain makes up about 2 percent of a human's body weight.
- It contains about 75 billion nerve cells or neurons.
- The brain is covered by a protective connective tissue called meninges.
- The brain consists of fluid filled cavities called ventricles.
- The brain and spinal cord together form the central nervous system.

Parts of Human Brain

Forebrain (Prosencephalon)	Midbrain (Mesencephalon)	Hindbrain (Rhombencephalon)
1. Olfactory lobe	1. Crura cerebri	1. Cerebellum
2. Cerebrum	2. Corpora Quadrigemina	2. Pons Varolii
3. Diencephalon		3. Medulla Oblongata

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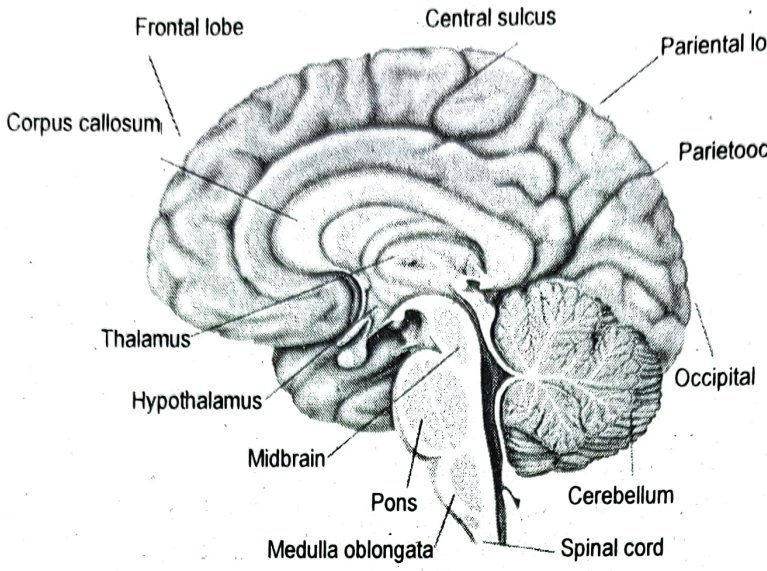
Human brain is composed of three parts: forebrain or pronsencephalon, midbrain or mesencephalon, and hindbrain or rhombencephalon.



Structure of brain

I. **Forebrain (Prosencephalon) – Center for processing sensory information**

Forebrain constitutes the largest part of the brain. It has three components: olfactory lobe, cerebrum and diencephalon.

1. **Olfactory lobes:** Olfactory lobes are a pair of lobes that rest on the lower surface of the cerebrum. Each lobe consists of an olfactory bulb and olfactory tract. It receives neural input from the nasal cavity, thus processing the sense of smell. The nasal cavity's smell receptors are connected to the olfactory bulb through axons. Olfactory lobes are not much developed in human beings.

2. **Cerebrum (Telencephalon):** Cerebrum is the largest part of human brain. A deep furrow known as the longitudinal fissure runs midsagitally down the centre of the cerebrum, dividing the cerebrum into the left and right cerebral hemisphere. A band of nerve fibres or white matter called corpus callosum connects the left and right cerebral hemisphere. Each hemisphere controls the opposite side of the body. Two fluid filled lateral ventricles, termed as 1st and 2nd ventricles are present in the cerebrum. The ventricles are filled with cerebrospinal fluid (CSF).

Histologically, cerebrum is composed of two layers:

i. **Outer layer, cerebral cortex:** The cerebral cortex is the surface layer of the cerebrum. It is composed of gray matter, which consists of cell bodies, dendrites and unmyelinated neurons. The cerebral cortex is a highly convoluted structures consisting of several bulgings and depressions. The bulges are called gyri (singular: gyrus), and the depressions are called Sulci (singular: Sulcus). The folding of cortex increases the brains surface and allows more neurons to fit inside the skull and enable higher functions. Cerebral cortex contains nearly 75% of the total neuron cell bodies.

ii. **Inner layer, cerebral medulla:** Cerebral medulla lies deep to the cerebral cortex. It consists of white matter which contains mainly myelinated neurons. The white matter acts as the information highway of the brain to speed the connection between distant parts of the brain and the body.

The cerebral cortex of each cerebral hemisphere is divided into four lobes:

a. **Frontal lobe and its functions:**

- Personality, behaviour, emotions
- Judgement, planning, problems solving
- Body movement
- Intelligence, concentration and self awareness.

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b. **Parietal lobe and its functions**

- Interprets language, words
- Sense of touch, pain, temperature
- Interprets signals form vision, hearing, motor, sensory and memory.
- Spatial (relating to the position or area) and visual perception.

c. **Occipital lobe and its functions**

- Interprets vision (colour, light, movement)

d. **Temporal Lobe and its functions**

The temporal lobe includes hippocampus end amygdala. Amygdala is a powerful structure, the size and shape of an almond, responsible for sex drive, emotional reactions such as anger and fear. Amygdala has also been associated with a range of mental conditions including depression to even autism. Amygdala are two in number, one on each cerebral hemisphere.

Temporal lobes have many functions such as:

- Understanding language (speech)
- Memory
- Hearing
- Sequencing and organization
- Sense of smell

Functions of cerebrum: Cerebrum is the centre of intelligence.

3. **Diencephalon:** Diencephalon is the posterior part of the forebrain. Main structures of the diencephalon include the epithalamus, thalamus, hypothalamus, subthalamus, pineal gland and third ventricle filled with cerebro–spinal fluid.

i. **Epitahlamus –** Posterior part of the diencephalon that includes the pineal gland. It aids in sense of smell and help to regulate sleep –wake cycles with the help of melatonin hormone secreted by pineal gland.

ii. **Thalamus –** These are two egg shaped structures, composed of large mass of gray matter, located in the dorsal part of the diencephalon. It is critically involved in a number of functions including relaying sensory and motor signals to the cerebral cortex and regulating consciousness, sleep and alertness.

iii. **Hypothalamus –** It lies below the thalamus and is part of limbic system. It is an integral part of the endocrine system, with the key function of linking the nervous system to the endocrine system via the pituitary gland. The hypothalamus has a central neuroendocrine function.

- It synthesizes and secrete neurohormones called releasing hormones and these in turn stimulate or inhibit the secretion of pituitary hormones.
- Responsible for production of oxytocin and anti-diuretic hormone (ADH).
- Neural part control includes control of body temperature, hunger, attachment behaviour, thirst, water balance, fatigue, sleep and circadian rhythm.

iv. **Subthalamus (Ventral thalamus) –** It is located ventral to thalamus and lateral to the hypothalamus. It assists in motor control.

II. **Midbrain (Mesencephalon) Mediating between Hindbrain and Forebrain**

The mesencephalon or midbrain is the portion of the brainstem that connects forebrain and the hindbrain. It is the smallest portion of the brain. It lies in between the cerebrum above and pons varolli below. Midbrain consists of corpora quadrigemina and crura cerebrii.

1. **Corpora Quadrigemina:** The corpora quadrigemina (quadruplet bodies) are four solid lobes on the dorsal side of the cerebral aqueduct, where the superior posterior pair are called superior colliculi and the inferior posterior pair are called the inferior colliculi.

i. The superior colliculus is often referred to as the tectum. It is involved in preliminary visual processing and control of movements of eyes.

ii. The interior colliculus is also called tectum. It is involved in auditory processing. It receives input from various brain stem nuclei and projects to the thalamus, which relays auditory information to the auditory cortex.

2. **Crura Cerebrii or Cerebral Peduncles:** The cerebral peduncles are structures at the front of the mid brain which arise from the front of the pons varolii and contain the large ascending (sensory) and descending (motor) nerve tracts that run to and from the cerebrum and the pons. The three common areas that give rise to the cerebral peduncles are the cerebral cortex, the spinal cord and the cerebellum. These peduncles help refine our movements.

III. **Hindbrain (Rhombencephalon): Control centre for visceral functions**

It is the posterior most part of the brain. Hindbrain has three parts: (1) Cerebellum, (2) Pons Varolii and (3) Medulla oblongata

1. **Cerebellum:** The cerebellum or "Little brain" is similar to the cerebrum, in that it has two hemisphere and has a highly folded surface or cortex. It is the second largest part of the brain and is located posterior to the brain and inferior to the cerebrum. The outer layer is called cerebellar cortex made up of gray matter. The cerbellar hemispheres are connected by a central vermis. Deep to the cerebellar cortex is a tree shaped layer of white matter called the arbor vitae. The arbor vitae connects the processing regions of cereberallar cortex to the rest of the brain and body.

The cerebellum helps to control motor functions such as balance, posture, and coordination of complex muscles activities. The cerebellum receives sensory inputs from the muscles and joints of the body and uses this information to keep the body balanced and to maintain posture. The cerebellum also controls the timing and finesse of complex motor actions such as walking, writing and speech.

2. **Pons Varolii:** Pons varolii is the region of the brainstem found superior to the medulla oblongata, inferior to the mid brain, and anterior to the medulla. Pons act as the bridge for nerve signals travelling to and from the cerebellum and carries signals between the superior regions of the brain and the medulla and spinal cord.

3. **Medulla oblongata:** Medulla oblongata is a roughly cylindrical mass of nervous tissue that connects to the spinal cord on its inferior border and to the Pons on its superior border. The medulla contains mostly white matter that carries nerve signals ascending into the brain and descending into the spinal cord. Within the medulla are several regions of gray matter that process involuntary body functions related to homeostasis. The cardiovascular centre of the medulla monitors blood pressure and oxygen levels and regulate heart rate to provide sufficient oxygen supplies to the body's tissues. The medullary rhythmicity center controls the rate of breathing to provide oxygen to the body. Vomiting, sneezing, coughing and swallowing reflexes are coordinated in this region of brain as well.

The medulla oblongata is the most important part of the brain. Any injury or shock to the medulla oblongata may cause death of the individual. Medulla oblongata continues below into spinal cord as it emerges out of the cranial cavity through foramen magnum. The mid brain, Pons varolii and medulla oblongata together constitute the brainstem.

Function of brain:

It controls most of the activities of the body, processing, integrating and coordinating the information it receives from the sense organs and making decisions as to the instructions sent to the rest of the body.

Or

Explain the respiratory organs of human being.

Respiration is an essential physiological activity during which the organic compounds are oxidized within the cell with the release of energy.

Human beings exhibit pulmonary respiration i.e., breathing by the lungs. The organs concerned with respiration in man are as follows:

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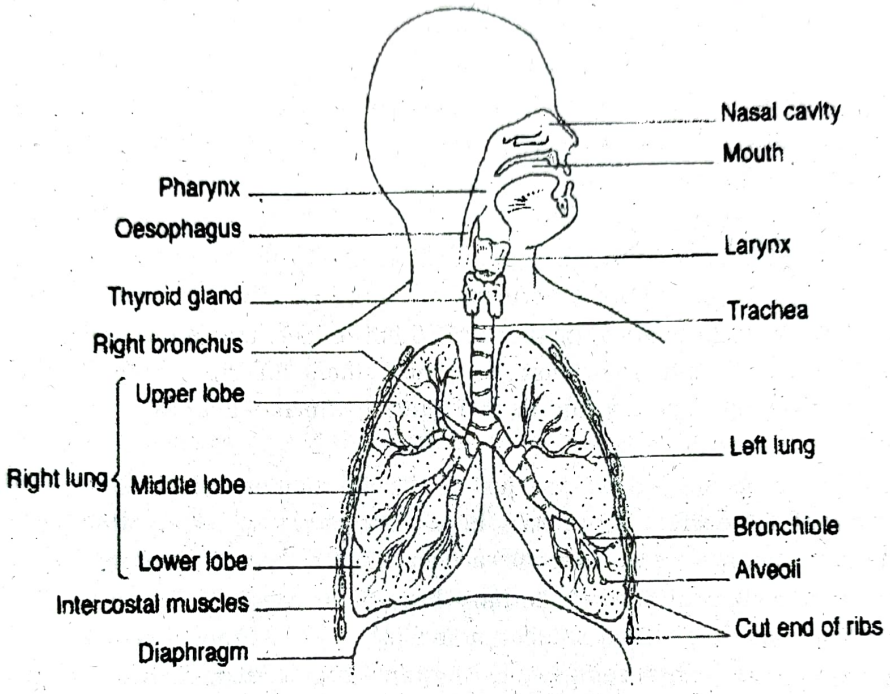
1. **External Nares:** These are a pair of openings situated just above the month. The two nostrils are separated by a nasal septum, the anterior part of which is cartilogenous and the posterior is bony.
2. **Nasal chambers:** The external nares leads to two nasal chambers or nasal cavities. They lie above the soft palate and open posteriorly into the nasopharynx through the internal nares. They are lined with vascular ciliated mucosa epithelium. The nasal cavities are divided into several bony shelves called turbinates, which provide a large surface area.

There are air cavities associated with nasal cavities. These cavities are called paranasal sinuses which are found in the bones of face and the cranium. They are lined with mucous epithelium and produce mucus which drain into the nasal cavities, and make the skull light.



Resperatory organs of human

Functions of Nasal cavities:

i. The upper one third part of the mucosa is olfactory area which contains olfactory cells and are involved in sense of smell.

ii. The lower two third part of the mucosa is the respiratory area, which acts as air conditioner. It moistens the air and warms the air before entering to the lungs.

iii. The vibrissae or hairs present in the nasal chambers prevent the entry of dust particles into the lung.

iv. The ciliated epithelium traps the microorganisms and prevents infection.

3. **Internal Nares and Pharynx:** Posteriorly, the nasal chambers open through the internal nares into pharynx, which is a crossing of both the air passage and the food passage. The pharynx is divided into three regions: the nasopharynx, oropharynx, and the laryngopharynx. The inhaled air form the nasal cavities passes into the nasopharynx and then to the oropharynx, and finally descends into the laryngopharyx, where it is diverted into the opening of the larynx by the epiglottis. The epiglottis is a flap of elastic cartilage that acts as a switch between the trachea and the oesophagus. Because the pharynx is also used to swallow food, the epiglottis ensures the air passes into the trachea by covering the opening to the oesophagus.
4. **Larynx:** The glottis opens into the larynx. It is the modified part of the pharynx. It lies in front of the food pipe (oesophagus) at the level of 3rd, 4th, 5th and 6th cervical verrtebrae. The larynx is also the body's "voice - box" as it contains the vocal folds that produce the sounds of speech and singing. Until puberty, there is no difference in the size of the lanynx between males and females. Thereafter, it grows larger in males, generally with deeper voice and is called 'Adam's apple'.

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The larynx is a short, epithelium lined tube formed of nine pieces of cartilage and several ligaments that bind them together.

The superior most region of the larynx is the epiglottis. Inferior to the epiglottis is the glottis region of the larynx, which contains the vocal folds. The largest cartilage in the larynx, the thyroid cartilage, supports the glottis.

5. **Trachea (Windpipe):** The larynx continues posteriorly into a long tube called trachea. It is about 12 cm long and 2.5 cm wide. It runs through the neck lying in front of the oesophagus. It is also known as windpipe. It extends from cervical vertebrae 6th to 5th throacic vertebrae. Externally, it is supported by 16-20 C-shaped incomplete hyaline cartilaginous rings, lying one above another. The rings are incomplete posteriorly. These rings prevent collapse of the trachea. Internally, the trachea is line with pseudo-stratified ciliated epithelium consisting of mucus secreting goblet cells. The secretion of mucus cells keeps the wall of the tube moist and traps dust particles.

Trachea is an integral part of the body's airway and has the vital function of providing air flow to and from the lungs for respiration.

6. **Bronchi (Singular: Bronchus)**

On entering the thoracic cavity, the trachea divides into the right and left bronchi. The trachea bifurcates at the level of 5th thoracic vertebra.

The right main bronchus is wider, shorter (2.5 cm longer) and more vertical than the left main bronchus. The right main or primary bronchus enters the right lungs and divides into three secondary bronchi: the superior, middle and inferior, which deliver oxygen to the three lobes of the right lung.

The left primary bronchus is 5 cm long, just double the right one and is narrower than the right one. It enters the roof of the left lung opposite the sixth thoracic vertebra and divides into two secondary brochi: the superior and inferior bronchi, each entering the superior and inferior lobes of left lung.

The secondary bronchi divide into tertiary bronchi or segmental bronchi. The tertiary bronchi divide further in another three smaller branchings called bronchioles. The bronchioles further divide into even smaller branchings called terminal bronchioles, each of which then gives rise to several respiratory bronchioles, which go on to divide into two to eleven alveolar ducts. Each alveolar duct again gives off smaller sacs called the alveolar sacs, which finally end in alveoli (sing. Alveolus). Alveolus is the structural and functional unit of gas exchange in the lung. Internally, the bronchi are lined by pseudo-stratified ciliated columnar epithelium.

∴ Trachea → Primary bronchus → Secondary bronchus → Tertiary bronchus → Bronchioles → Terminal bronchioles → Respiratory bronchioles → Alveolar duct → Alveolar Sac (Alveolus)

In each lung, there are about 150 million alveoli, constituting about 50 m^2 when the lung have been breathed out, and upto 150 m^3 when they breathe in. The alveoli are surrounded by a dense network of blood capillaries. The alveoli look like a bunch of grapes. The walls of the alveolus are lined with simple squamous epithelial cells known as alveolar cells. A thin layer of connective tissue underlies and supports the alveolar cells. Capillaries surround the connective tissue on the outer border of the alveolus. The respiratory membrane is formed where the walls of capillary touch the wall of an alveolus. At the respiratory membrane, gas exchange occurs freely between the air and blood through the extremely thin walls of the alveolus and capillary.

Septal cells and macrophages are also found inside the alveoli. Septal cells produce alveolar fluid that coats the inner surface of the alveoli. Alveolar fluid is extremely important to lung function, as it is a surfactant that moistens the alveoli, helps maintain the elasticity of the lungs, and prevents the thin alveolar walls from collapsing. The septal cells are squamous cells.

Macrophages in the alveoli keep the lungs clean and free of infections by capturing and phagocytizing pathogens and other foreign matters that enter the alveoli along the inhaled air.

7. **Lungs:** The lungs are a pair of large, spongy organs found in the thorax lateral to the heart and superior to the diaphragm. They are pink coloured and highly vascular organs.

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Each lung is surrounded by a double layered epithelium called the pleura. The outer layer is called the parietal pleura and the inner layer is called the visceral pleura. The visceral pleura covers the outer surface of the lung. Between the parietal and visceral pleura is the pleural cavity, which is filled with a serous fluid called the pleural fluid. The pleural fluid is secreted by the pleural layers. The pleural fluid lubricates the inside of the pleural cavity to prevent irritation of lungs during breathing. It also provides space to expand while the lung distend.

Each lung is cone-shaped, with the superior part forming a cone, called the apex. while the inferior part forming a base, resting on a dome-shaped diaphragm. Lungs are slightly different in size and shape due to the heart pointing to the left side of the body. The left lung is, therefore, slightly smaller than the right lung and is made up of two lobes while the right lung has three lobes. The left lung contains the cardiac notch, an indentation in the lungs that surrounds the apex of the heart. The lungs together weigh approximately 1.3 kgs, and the right is heavier. Both lungs have a central recession called the hilium at the root of the lung, where the blood vessels and airways pass into the lungs. Blood is supplied to the lungs by a pairs of pulmonary veins to be conveyed to the heart. They receive vagus nerve from the parasympathetic nervous system. The bronchial arteries supply oxygenated blood to the lungs.

Each lung has distinct lobes. The right lung has three lobes - the superior, the middle and inferior lobes. The horizontal fissure separates the superior lobe from the middle lobe, while the right oblique fissure separates the middle lobe and inferior lobes. The left lung has only two lobes: Superior and inferior separated by the left oblique fissure.

Internally, each lung is composed of about 150 million airsacs or alveoli, which are the primary structures that facilitate the exchange of gases.

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4. What are communicable diseases? Discuss the causative agents, symptoms, effects and control measures of any one communicable disease you have studied. [7.5]

Communicable disease are disease that are transmitted through close contact with humans or animals. Some examples are influenza, measles and tuberculosis.

Tuberculosis (TB) is an infections or communicable disease caused by the bacterium *Mycobacterium Tuberculosis* (MTB). Tuberculosis generally affects the lungs, but can also affect other parts of the body. Most infections do not have symptoms, in which case it is known as latent tuberculosis. About 10% of latent infections progress to active disease which, if left untreated, kills about half of those infected.

In Nepal it is very common in rural areas. About 15000 people die due to TB in Nepal every year.

Causative Agent: Tuberculosis is caused by *Mycobacterium tuberculosis* which is a small rod shaped acid fast bacteria measuring 1 to 4 μm in length. It attacks and multiply in any parts of the human body and destroys the tissue. The tissue destruction is due to a toxin called tuberculin and formation of tubercles. As this bacteria prefers oxygen, it generally attacks the lungs where oxygen concentration is high.

There are two types of Tuberculosis on the basis of site of infection:

Pulmonary TB: The infection sites are the lungs. It is the most common types of TB (i.e. about 90% of cases)

Extra-pulmonary TB: In 15 - 20% of active cases, the infection spreads outside the lungs, causing other kind of TB. These are collectively denoted as "extra-pulmonary tuberculosis". Extra pulmonary TB occurs move commonly in immune-suppressed persons and young children. In those with HIV, this occurs in more than 50% of cases. Notable extra pulmonary infection sites include the pleura, the central nervous system (in tuberculosis meningitis), the lymphatic system, the primogenital system, and the bones and joints.

Mode of Transmission: TB is spread from person to person through the air i.e. air borne disease. When people with active pulmonary TB cough, sneeze, speak sing, or spit, they expel infectious

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aerosol droplets 0.5 to 5 μm in diameter. A single sneeze can release upto 40,000 droplets. Each of these droplets may transmits the disease since the infectious dose of tuberculosis is very small.

People with prolonged, frequent, or close contact with TB are at particularly high risk of becoming infected, with an estimated 22% infection rate. A person with active TB but untreated TB may infect 10 to 15 other people per year.

About one-third of the world's population has latent TB, which means people have been infected by TB bacteria but are yet not ill with the disease and connot transmit the disease. Persons with compromised immune systems, such as people living with HIV, malnutrition or diabetes, or people who use tobacco, have a much higher risk of falling ill.

Incubation period: The incubation period of an infection is defined as the time interval between initial infection and disease onset.

In most healthy people, the immune system is able to destroy the mycobacterium. The incubation period of TB ranges from few weeks to years. This usually happens either within the first year or two of infection, or when the immune system is weakened – for example, if someone is having chemotherapy treatment for cancer.

Symptoms of TB: The classical clinical symptoms and signs of pulmonary TB may include the following:

- Fever
- Night sweats
- Cough (often chronic)
- Haemoptysis (coughing up bloody sputum)
- Decrease or loss of appetite.
- Weight loss and muscle loss
- Fatigue or malaise
- Chest pain while breathing
- Shortness of breath
- Swollen lymph nodes

Extra pulmonary TB often have symptoms that are non-specific but frequently localized to the involved site. The following includes the signs and symptoms of extra pulmonary TB.

- Skeletal TB (Pott's disease): spinal pain back stiffness, paralysis is possible.
- TB meningitis: Headache, mental changes, coma.
- TB arthritis: Usually pain in a single joint (hips and knee most common)
- Genitourinary TB: Dysuria (painful urination), flank pain.
- Gastrointestinal TB: Difficulty swallowing, non-healing ulcers, abdominal pain, diarrhea (may be bloody)
- Pleural TB: Empyema or pleural effusions.

Diagnosis: Because TB may occur as either as latent or active form, the definite diagnosis of active tuberculosis depends on the culture of mycobacteria from sputum or tissue biopsy.

Several test are used to diagnose tuberculosis, depending on the type of TB suspected. For active form of TB, following tests are done.

1. For pulmonary TB–TB that affects the lungs – one may have a chest x–ray.
2. For extra pulmonary TB- TB that occurs outside the lungs–one may have CT scan, MRI Scan or ultrasound scan of the affected part of the body. Biopsy, Urine tests and blood tests are also carried out for other forms of TB.

Testing for latent TB: The Mantoux test is widely used test for latent TB– where one have been infected with TB bacteria, but do not have any symptoms. The Mantoux test involves injecting a

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small amount of a substance called pps tuberculin into the skin of the suspected person's arm. It is also called the Tuberculin skin test (TST). If one have the latent TB infection, the skin will be sensitive to PPD tuberculin and a small, hard red bump will develop at the site of the infection, usually within 48 to 72 hours of testing. If one have a very strong skin reaction, he/she may need a chest x-ray to confirm whether she/he have active TB disease.

Control of Tuberculosis:

Control of Tuberculosis involves treatment of TB and prevention form TB.

1. **Treatment of TB:** DOTS (Directly Observed Treatment Short-Course), also known as TB-DOTS, is the name given to the Tuberculosis control strategy recommended by the World Health organization (WHO). TB is completely curable through short-course chemotherapy. Treating TB cases who are sputum-smear positive (who can spread the disease to others) at the source, it is the most effective means of eliminating TB from a population. DOTS has been recognized as a highly efficient and cost -effective strategy. It involves a regular, uninterrupted supply of high quality anti-TB drugs. DOTS helps to ensure the right drugs are taken at the right time for the full duration of treatment. For active TB, it will require several drugs at once. The most common medication used to treat TB includes: Isoniazid, Rifampin, Ethambutol and Pyrazinamide.

2. **Prevention from TB:**

i. BCG vaccination: The vaccine called Bacillus Calmette Guerin (BCG) is the most widely used vaccine. It reaches more than 80% of all new born children and infants. The BCG vaccine has been shown to provide children with excellent protection against the TB.

ii. TB Education: People with TB need to know how to take their drugs properly. They also need to know how to make sure they do not pass TB on the other people.

iii. Preventing TB Transmission in Households:

In order to reduce exposure in households where some one has infections TB, the following actions should be taken whenever possible:

- Houses should be adequately ventilated.
- Anyone who coughs should be educated on cough etiquitte and respiratory hygiene, and should follow such practices at all times.
  - Spend as much time as possible outside;
  - Sleep alone in a separate, adequately ventilated room;
  - Spend as little time as possible in public transport;
  - Spend as little time as possible where large numbers of people gather together.

"Fight Before it starts. Test for TB"

❐

Section A: Botany

Unit 1

ANATOMY AND PHYSIOLOGY OF ORGANISMS

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A. ANATOMY OF ORGANISMS

VERY SHORT ANSWER QUESTIONS [1 MARK]

1. 2076 Set B Q.No. 1f **Define tissue.** [1]

Tissue is a group of similar or dissimilar cells having common origin, similar structure and common methods of development as well as similar set of function. In plant two types of tissues are found known as meristematic tissues and permanent tissues.

2. 2076 Set C Q.No. 1a **What is apical meristem?** [1]

The mersitematic tissues which are located at the growing point of main and lateral shoots is called apical meristems.

3. 2075 GIE Q.No. 1a **Give any two names of xylem elements.** [1]

Two elements of xylem bundle

i. Xylem vessel ii. Xylem tracheids

4. 2075 Set A Q.No. 1b **Mention the function of sclerenchyma.** [1]

The function of sclerenchyma is to provide mechanical support.

5. 2075 Set A Q.No. 1h **What is function of lenticel?** [1]

It functions as a pore, providing a pathway for the direct exchange of gases between the internal tissues and atmosphere through the bark, which is otherwise impermeable to gases.

6. 2075 Set B Q.No. 1a **Define meristematic tissue.** [1]

The group of cells which have the capacity of division is called meristematic cells e.g. cells of apical region of plants.

7. 2074 Supp Q.No. 1a **Define phloem.** [1]

The vascular tissue in plants which conducts sugars and other metabolic products downwards from the leaves. It is made up of four elements called companion cell, sieve element, phloem parenchyma and phloem fibres.

8. 2074 Set A Q.No. 1a **What is sclereids?** [1]

Sclereids are highly thickened dead sclerenchymatous tissue. They are also called stone cells. Sclereids provide strength and hardiest to stony fruits like almond, coconut etc.

9. 2074 Set B Q.No. 1a **What is the function of xylem?** [1]

Please refer to Model (Botany) Q.No. 1a

10. 2073 Supp Q.No. 1a **Mention the two names of permanent tissue.** [1]

The two names of permanent tissue are: Xylem and Phloem.

11. 2073 Supp Q.No. 1b **Define the role of cambium.** [1]

Undifferentiated meristematic tissue present between xylem and phloem in dicot stem is called cambium. It helps in secondary growth.

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12. 2073 Set C Q.No. 1a **What is permanent tissue?** [1]

Those tissues which lost their dividing capacity permanently or temporarily and attained a definite shape, size and functions are called permanent tissues. e.g. parenchyma, collenchyma, xylem, phloem etc.

13. 2073 Set D Q.No. 1a **Define meristematic tissue.** [1]

Please refer to 2075 Set B Q.No. 1a

14. 2072 Supp. Q.No. 1a **Mention two elements of xylem.** [1]

Please refer to 2075 GIE Q.No. 1a

15. 2072 Set C Q.No. 1a **What is apical meristem?** [1]

The meristematic tissues which are located at the growing point of main and lateral shoots is called apical meristems.

16. 2072 Set D Q.No. 1a **What is the role of sclerenchymatous tissue?** [1]

The main roles sclerenchymatous tissues are

i. It is responsible for providing the mechanical strength to plant cells.
ii. It prevents the plant from adverse effects of environment.
iii. It provides grittiness in the pulp of fruits.

17. 2072 Set E Q.No. 1a **What is the function of phloem?** [1]

The main functions of phloem are

i. Conduction of organic food from leaves to different parts of plants.
ii. Phloem fibers provide the mechanical support to plants.

18. 2071 Supp. Q.No. 1b **Function of collenchyma?** [1]

The main functions of collenchyma are

i. It provides mechanical strength to young stem, leaves and petioles.
ii. It provides the elasticity to the growing regions.
iii. It prevents leaf from tearing.

19. 2071 Set C Q.No. 1 a **Mention two elements of phloem.** [1]

The two elements of phloem are: Sieve element and Companion cells.

20. 2071 Set D Q.No. 1 a **Define chlorenchyma.** [1]

A parenchymatous tissue which contain chlorophyll is called chlorenchymatous tissue. These tissues are present in leave and green parts of plants and helps in photosynthesis.

21. 2071 Set D Q.No. 1 c **Define secondary growth.** [1]

Increase in the thickness of stem and roots due to formation of secondary tissues is called secondary growth.

22. 2070 Supp. Q.No. 1 a **What does it mean by meristematic tissue?** [1]

Please refer to 2075 Set B Q.No. 1a

23. 2070 Set C Q.No. 1 a **What do you mean by chlorenchyma?** [1]

A parenchymatous tissue which contains chlorophyll is called chlorenchymatous tissue. These tissues are present in leaves and green parts of plants and help in photosynthesis.

24. 2070 Set D Q.No. 1 a **What is sclereids?** [1]

Please refer to 2074 Set A Q.No. 1a

25. 2069 Q.No. 1a **Define permanent tissue.** [1]

Please refer to 2073 Set C Q.No. 1a

26. 2069 Q.No. 1b **Mention the role of cuticle?** [1]

The main roles of cuticle are

i. It prevants the internal tissue from mechanical injury.
ii. It helps in the transpiration particularly in herbaceoous plants.

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27. **2068 Q.No. 1a Define sclerenchyma.** [1]

Sclerenchyma is simple types of permanent tissue which contain highly thickened cell wall due to deposition of lignin. These tissues provide mechanical support.

28. **2067 Q.No. 1a What is sclerenchyma?** [1]

Please refer to 2068 Q.No. 1a

29. **2066 Q.No. 1 a What are annual rings?** [1]

Formation of concentric ring of spring wood and autumn wood in a single year in plant stem (dicot stem) is called annual rings. It helps to determine the age of plant.

30. **2065 Q.No. 1 a Name thin walled cells with chloroplast.** [1]

Thin walled cells with chloroplast are

i. Palisade cells ii. Spongy cells

31. **2065 Q.No. 1 d Define cambium.** [1]

Please refer to 2073 Supp Q.No. 1b

32. **2064 Q.No. 1a Name two elements of xylem bundle.** [1]

Please refer to 2075 GIE Q.No. 1a

33. **2064 Q.No. 1b What is semipermeable membrane?** [1]

A membrane which helps in movement of solvent only is called Semi- permeable membrane e.g. egg membrane, animal bladder etc.

34. **2062 Q.No. 1a Name two complex permanent tissues.** [1]

Two examples of complex permanent tissues

i. Xylem or Wood ii. Phloem or Bast

35. **2062 Q.No. 1c What is the role of chlorenchyma?** [1]

The main role of chlorenchyma is photosynthesis due to presence of chlorophyll. It is present in green parts of plants.

36. **2062 Q.No. 1e Write full form of T.S. and L.S.** [1]

Full form of T.S - Transverse section Full form of L.S - Longitudinal section.

37. **2061 Q.No. 1a Name two elements of phloem bundle.** [1]

The two elements of phloem are

i. Sieve element ii. Companion cells

38. **2061 Q.No. 1c What is the function of cortex?** [1]

The functions cortex is

i. Storage of food material ii. In stem it act as protective tissue.

39. **2060 Q.No. 1h What do you mean by apical meristem?** [1]

Please refer to 2076 Set C Q.No. 1a

40. **2059 Q.No. 1a Name any one plant with exarch Xylem.** [1]

Exarch xylem found in root of dicot plant like Gram.

41. **2058 Q.No. 1a Give one example of stem with conjoint and collateral vascular bundle.** [1]

Stem with conjoint and collateral vascular bundle is dicot stem e.g. sunflower.

42. **2057 Q.No. 1a Give one example with scattered vascular bundle in the stem.** [1]

Scattered vascular bundle is found in maize stem.

ANSWER IN BRIEF [3 MARKS]

1. **2076 Set B Q.No. 2b Describe the tunica and corpus theory.** [3]

According to this theory, shoot apex is dome shaped in outline and protected by young leaf called leaf primordial. It has two parts: outer mantle like tunica and inner mass of cells called corpus. Cells of tunica are smaller. They undergo anticlinal divisions and form the protoderm which later differentiates into epidermis. Cells of corpus are comparatively larger. They divide in all planes and form ground meristem and procambium. This theory is only applicable for differentiation of shoot ap...

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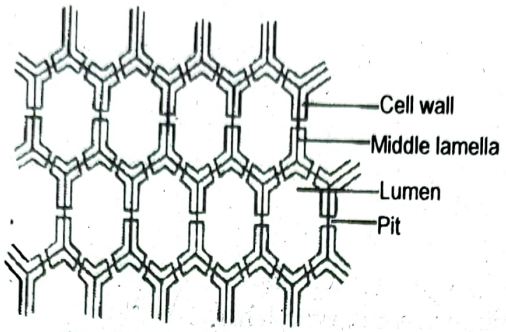
2. 2076 Set C Q.No. 2a 2074 Supp Q.No. 2a **Structure and function of sclerenchyma.** [3]

Following are the structure and functions of sclerenchyma.

i. It is a long, elongated cell with narrow and pointed ends.
ii. It is lignified and thick walled dead cell that does not perform metabolism.
iii. It is develops either from procambium or from secondary larenchyma
iv. It contains deposition of different types of lignin with pits.
v. This is a supporting tissue that with stands various strains which result from stretching and bending of plant organs without any damage.
vi. Most commonly, the sclerenchyma cells are grouped into fibres and sclereids



T.S of Sclerenchyma Tissue

Functions

The main functions sclerenchymatous tissues are

i. It is responsible for providing the mechanical strength to plant cells.
ii. It prevents the plant from adverse effects of environment.
iii. It provides grittiness in the pulp of fruits.

3. 2076 Set C Q.No. 2b **Collateral vascular bundle.** [3]

In collateral vascular bundle, xylem and phloem lie together on the same radius, xylem being internal and phloem external in position. In this case the phloem occurs on one side of the xylem strand. In a dicot stem the collateral vascular bundle contains a strip of cambium between xylem and phloem such vascular bundles are called open vascular bundles. However, the cambium strip is not found in the vascular bundle of monocot stem. Such vascular bundles are called closed vascular bundles. Thus, the vascular bundle in dicot stem is conjoint collateral and open and in monoct stem it is conjoint, collateral and closed.

4. 2075 Set A Q.No. 2d **Complex permanent tissues.** [3]

It is heterogenous system of cells. It consists of more than one type of cells working together as a unit. It consists of parenchymatous and sclerenchymatous cells. They are also known as conducting tissues because they are involved in the conduction of water, minerals and food material inside the plant body. The most important complex tissues are - xylem and phloem.

1. Xylem (wood): Xylem is a conducting tissue which conducts water and mineral nutrients upward from the root to the leveas. The xylem is composed of different kinds of elements. They are (a) tracheids (b) fibres, (c) vessels or tracheae (d) wood parenchyma

a. **Xylem tracheids**

- These are elongated; tube like cell having tapering, rounded or oval ends.
- The walls are lignified
- It is without protoplast and non-living on maturity
- The secondary wall layers are deposited in different manner, thus the wall shows various types of thickening - annular (thickening in the form of ring), spiral (thickening in the form of spiral), reticulate (thickening in the form of network), scalariform (thickening in the form of ladder) and pitted (thickening on entire inner cell wall.
- It conducts the water and mineral.

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b. Xylem vessels / Tracheae

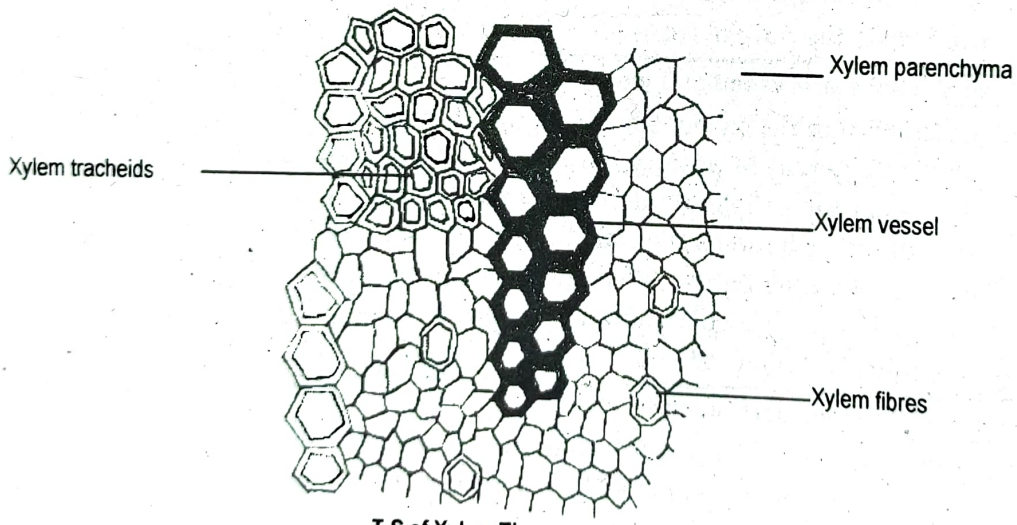
- These are rows of elongated tube like dead cells.
- The characteristics are perforation plate at their ends walls and joined end to end to form chain of cells called vessels.
- Tracheae are formed by the dissolution of ends walls of developing vessel members.
- It is shorter and boarder than tracheids.
- Xylem with smaller vessels is called protoxylem and xylem with larger vessels is called metaxylem.

c. Xylem parenchyma

- The parenchyma cells which frequently occur in the xylem of most plant are called xylem parenchyma
- The walls of xylem parenchyma are thin and made up of cellulose.
- These cells are noted for storage of food in the form of starch, fat, tannin, crystals and various other substances also occur in xylem parenchyma cells.
- These cells assist directly or indirectly in the conduction of water upward through the vessels and tracheids.

d. Xylem fibres

- These are also called as wood fibres.
- They are common in secondary xylem.
- They are made up of sclerenchymatous cells.
- The cells of xylem fibres contain thick lignified walls and narrow lumen.
- The cells are dead as that of tracheids and vessels.
- These are the principle supporting component of xylem, which provide mechanical strength to the plant parts.



T.S of Xylem Tissue

2. **Phloem (Bast):** The phloem is a specialized complex permanent tissue. It is mainly concern for the conduction to organic food synthesized by leaves to the different parts of plant. Phloem is composed of different kinds of elements. They are (a) sieve elements (b) companion cells (c) phloem fibres (d) phloem parenchyma.

a. Sieve elements

- The conducting elements of the phloem are collectively known as sieve elements.
- They may be segregated into the less specialized sieve cells and they make specialized sieve tube.
- They are elongated tube like cells. Their walls are thin and made of cellulose.

b. Companion cells

- These are specialized thin walled parenchymatous cells found to be associated with sieve tube.

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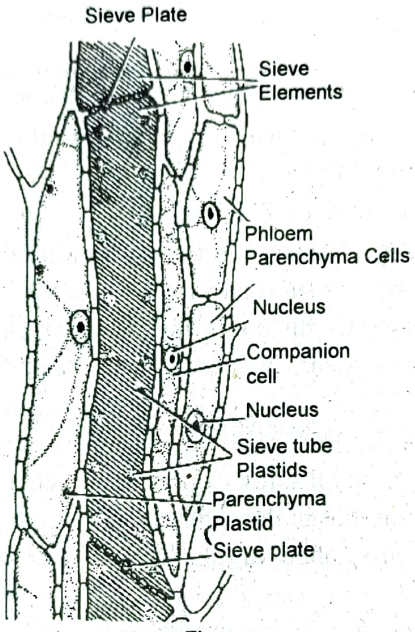
- They are thin walled and contain dense cytoplasm and prominent nucleus.
- Nuclei of companion cells control the metabolic activities of sieve tube and pteridophyte.
- The companion cells are found in angiosperms only. In gymnosperm, no companion cells are found, but there are some special parenchymatous cells called albuminous cells.

c. Phloem Parenchyma

- These are thin walled living parenchymatous cells.
- They are absent in most of monocots and herbaceous plants.
- The cells contain cytoplasm and nucleus.
- They store food material in the form of starch, fat and other organic substances.

d. Phleom fibres

- These are made up of thick sclerenchymatous cells.
- In many flowering plants, fibres form a prominent part of both primary and secondarey phloem.
- They serve to the mechanical strength of phloem and plant body as a whole.



L.S of Phloem Tissue

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5. 2075 GIE Q.No. 2a | 2074 Set B Q.No. 2a | 2071 Set C Q.No. 2a **Structure and function of collenchyma.** [3]

i. It is simple non-lignified living mechanical tissue with or without intercellular spaces and originated from the ground meristem.

ii. It is polygonal, spherical or elongated with pointed or rounded ends.

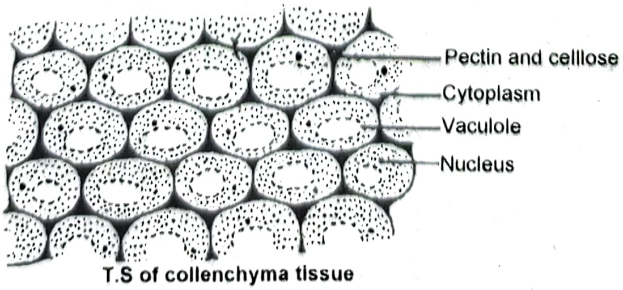
iii. The cell walls unevenly thicken and rich in pectin and hemicellulose.

iv. It is found in hypodermis of herbaceous stem and dicot leaf.

v. It may contain chloroplast and perform photosynthesis.

vi. Depending on deposition of pectin in a intercellular space collenchyma may be angular (stem of *Tagetus*), lamellar (stem of *Helianthus*) and Lacunar or tubular (e.g. stem of *Curcurbita*)

vii. It provides mechanical support to stem and provide flexibility of organs (e.g. tendrils).



T.S of collenchyma tissue

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6. 2074 Set A Q.No. 2a | 2070 Set C Q.No. 2a **Structure and function of parenchyma.** [3]

i. It consists of isodiamatric, thin walled living cells with intercellular space.

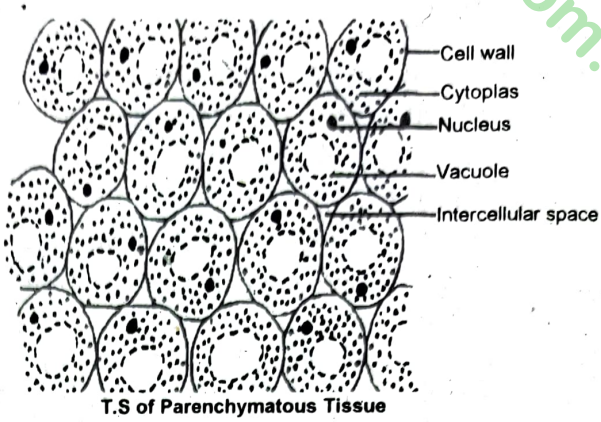
ii. Each cell is bounded by a cellulosic cell wall with centrally located large vacuole and Peripheral cytoplasm having nucleus.

iii. It is found almost all parts of plants su stem, root leaf, flowers, and fruit.

iv. The main function is storage of material.

v. It is modified into following types on specific function such as

- Prosenchyma
- Chlorenchyma
- Aerenchyma
- Xylem Parenchyama
- Phloem Parenchyama



T.S of Parenchymatous Tissue

7. 2073 Set C Q.No. 2a **Structure and function of conjoint vascular bundle.** [3]

In this case xylem and phloem are present in a same bundle. They combine together in a single bundle. Conjoint vascular bundles are of three types.

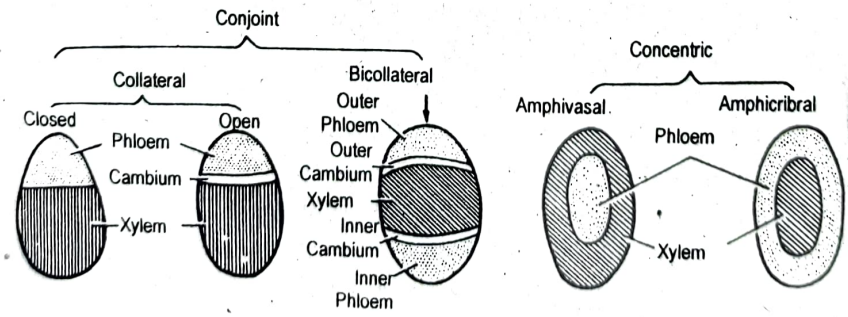
a. **Collateral vascular bundle:** Please refer to 2076 Set C Q.No. 2b

b. **Bicollateral vascular bundle:** In bicollateral vascular bundle, the phloem is present on both outer and inner sides of xylem. A strip of cambium is also found on both outer and inner sides of xylem. The sequences of vascular tissues are the outer phloem, outer cambium, xylem, inner cambium and inner phloem. These are always open - Bicollateral vascular bundles are found in the members of cucurbitaceae family.

c. **Concentric vascular bundle:** In this case one kind of vascular tissue (xylem and phloem) completely encircles the other from all sides. Concentric vascular bundles are of two types.

i. **Amphivasal:** When phleom lies in the centre and the xylem completely surrounds the phloem such vascular bundles are called amphivasal. It is found in *Dracaena, Yucca* and other monocots and some dicot.

ii. **Amphicribal:** When xylem lies in the centre and the phloem completely surrounds the xylem such vascular bundles are called amphicribal. It is found in ferns. Such vascular bundles are always closed.



Various Types of Conjoint Vascular Bundles

8. 2072 Supp. Q.No. 2a **Structure and function of aerenchyma.** [3]

Aerenchyma is a spongy tissue that forms spaces or air channels in the leaves, stems and roots of some plants, which allows exchange of gases between the shoot and the root. The channels of air-filled cavities provide a low-resistance internal pathway for the exchange of gases such as oxygen and ethylene between the plant above the water and the submerged tissues. Aerenchyma is also widespread in aquatic and wetland plants which must grow in hypoxic soils.

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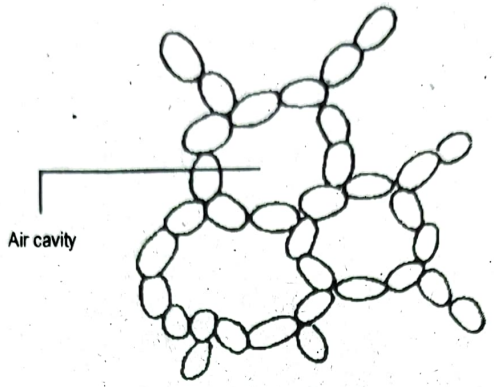
Functions

1. The large air-filled cavities provide a low-resistance internal pathway for the exchange of gases between the plant organs above the water and the submerged tissues.
2. This allows plants to grow without incurring the metabolic costs of anaerobic respiration.
3. Some of the oxygen transported through the aerenchyma leaks through root pores into the surrounding soil.
4. The resulting small rhizosphere of oxygenated soil around individual roots supports microorganisms that prevent the influx of potentially toxic soil components such as sulfide, iron and manganese.



Aerenchyma Tissue

9. 2072 Set D Q.No. 2a **Structure and function of conjoint vascular bundle.** [3]

Please refer to 2073 Set C Q.No. 2a

10. 2072 Set E Q.No. 2a **Write short notes on sclerenchyma tissue.** [3]

Please refer to 2076 Set C Q.No. 2a

11. 2071 Supp. Q.No. 2a **Describe complex tissue and its function.** [3]

Please refer to 2075 Set A Q.No. 2d

12. 2071 Set D Q.No. 2a **Structure and function of phloem tissue.** [3]

The phloem is a specialized complex permanent tissue. It is mainly concerned for the conduction to organic food synthesized by leaves to the different parts of plant. Phloem is composed of different kinds of elements. They are (a) sieve elements (b) companion cells (c) phloem fibres (d) phloem parenchyma.

a. **Sieve elements**

- The conducting elements of the phloem are collectively known as sieve elements.
- They may be segregated into the less specialized sieve cells and the make specialized sieve tube.
- They are elongated tube like cells. Their walls are thin and made of cellulose.

b. **Companion cells**

- These are specialized thin walled parenchymatous cells found to be associated with sieve tube.
- They are thin walled and contain dense cytoplasm and prominent nucleus.
- Nuclei of companion cells control the metabolic activities of sieve tube.
- The companion cells are found in angiosperms only. In gymnosperm, no companion cells are found, but there are some special parenchymatous cells called albuminous cells.

c. **Phloem Parenchyma**

- These are thin walled living parenchymatous cells.
- They are absent in most of monocots and herbaceous plants.
- The cells contain cytoplasm and nucleus.
- They store food material in the form of starch, fat and other organic substances.

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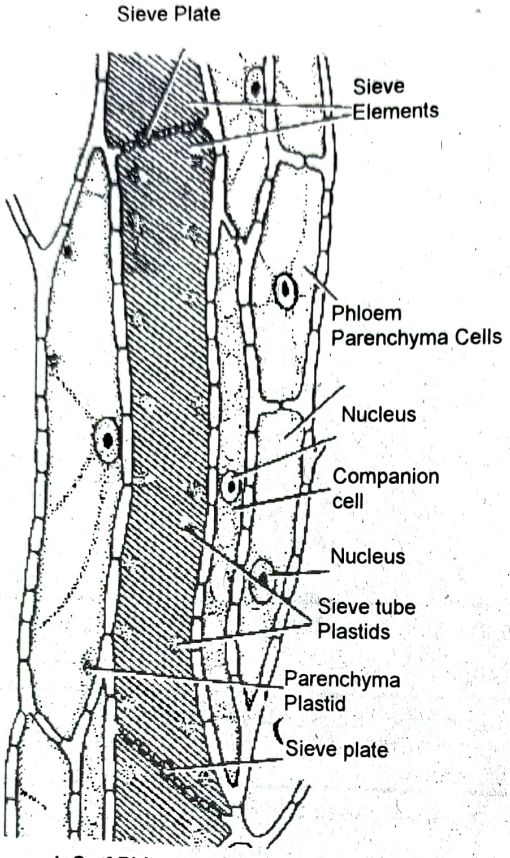
d. Phleom fibres

- These are made up of thick sclerenchymatous cells.
- In many flowering plants, fibres form a prominent part of both primary and secondary phloem.
- They serve to the mechanical strength of phloem and plant body as a whole.



L.S of Phloem Tissue

13. 2070 Set D Q.No. 2a Differentiate between spongy and palisade parenchyma. [3]

Difference between spongy parenchyma and palisade parenchyma are as follows:

Spongy Parenchyma	Palisade Parenchyma
It is found towards the lower epidermis	It is found below the upper epidermis
Cells are with large intercellular space	Cells are compactly arranged at right angle to the epidermis
It contain chloroplast molecules but lesser in number	It contain chloroplast with high quantity
Possess elongated columnar cells	Possess irregular or isodiametrical cells.
Non living inclusions are completely absent	Non living inclusion are found in this layer

14. 2069 Q.No. 2b Structure and function of sclerenchymatous tissue. [3]

Please refer to 2076 Set C Q. No. 2a

15. 2068 Q.No. 2a Structure and function of collenchymatous tissue. [3]

Following are the function of collenchymatous tissues:

Please refer to 2075 GIE Q. No. 2a

16. 2067 Q.No. 2a Describe in detail about the types and functions of parenchymatous tissue. [3]

Following are the functions of parenchymatous tissue:

Please refer to 2074 set A Q. No. 2a

17. **2065 Q.No.2a Differentiate between xylem and phloem tissues.** [3]

Difference between xylem and phloem are as follows:

Xylem	Phloem
Xylem is usually found towards inner sides of plant.	Phloem is usually situated towards outer sides of plant.
The conducting cells are dead.	The conducting cells are living.
It conducts water and minerals.	It conducts organic food.
It contain four element tracheids, vessels, fibres, and parenchyma.	It contain four element sieve element, companion cells, fibres and parenchyma.
Conducting elements are lignified.	Conducting elements are non lignified.

18. **2064 Q.No.2a Differentiate between the collenchyma and sclerenchyma.** [3]

Difference between collenchyma and sclerenchyma are as follows:

Collenchyma	Sclerenchyma
Collenchyma is living tissue.	Sclerenchyma is dead tissue.
It is thin walled tissue.	It is thick walled tissue.
Cell wall is made up of cellulose.	Cell wall is made up of cellulose and lignin.
It is found in soft parts of plant.	It is found in hard parts of plant.
It can help in secondary growth.	It cannot help in secondary growth.
It stores food and provide mechanical support.	It has no role in storage of food involved in mechanical support.

19. **2062 Q.No.2d What are the roles of meristem?** [3]

The main functions of meristematic tissue are as follows:

i. Meristematic tissues are actively dividing tissues of the plant.
ii. They are responsible for primary and secondary growth of the plant.
iii. All new organ and their growth occur by the division of meristematic tissue.
iv. Secondary tissue such as wood, cork is also formed due to activity of meristematic tissue.
v. It helps in the formation of reproductive shoot.
vi. Apical meristem of stem produces new leaves and branches.

20. **2062 Q.No.2h How xylem differs from phloem? Discuss.** [3]

Please refer to 2065 Q.No.2a

21. **2061 Q.No.2c What is simple permanent tissue of plants?** [3]

A simple tissue which is made up of similar types of cells forming a uniform or homogenous mass of cells. They may be living or dead. The common examples are parenchyma, collenchyma and sclerenchyma.

a. **Parenchyma** : Please refer to 2074 Set A Q. No. 2a
b. **Collenchyma** : Please refer to 2075 GIE Q. No. 2a
c. **Sclerenchyma** : Please refer to 2076 Set C Q. No. 2a

22. **2059 Q.No.2a Give the meaning of secondary growth with one example.** [3]

The increase in thickness or growth due to the activity of the cambium and the cork cambium is known as secondary growth. In a typical dicot stem secondary growth starts in the interstellar region and extends towards extra-stellar region. In the stellar region it starts owing to the activity of cambium and in extra- stellar region due to cork cambium.

Example;

Secondary growth in Dicot Stem

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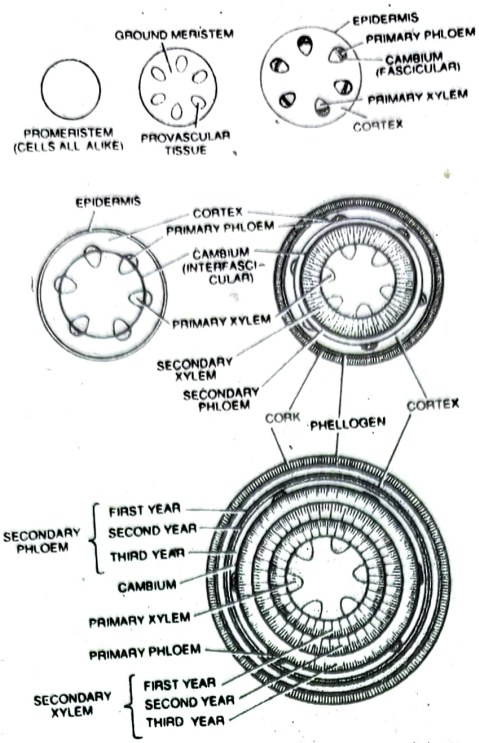


Secondary growth in dicot stem

23. 2058 Q.No.2j **Write about the permanent tissues of plant.** [3]

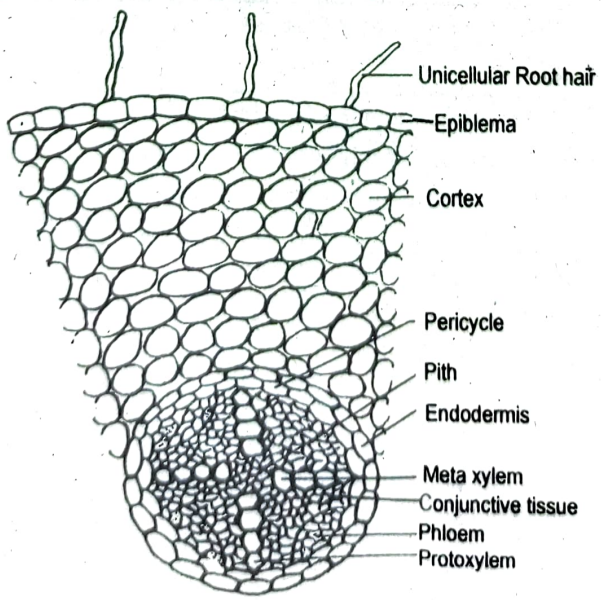
Please refer to 2061 Q.No.2c

LONG ANSWER QUESTIONS

1. 2076 Set B Q.No. 3 **Describe the anatomical structure of dicot root and compare it with monocot root.** [7.5]

Dicot Root:

1. **Epiblema or epidermis or piliferous layer:** It is outermost unilayered with several unicellular root hairs. It consists of thin walled, compactly arranged living parenchymatous cells. Epiblema of a root differs from the epidermis of the stem in being devoid of distinct cuticle and stomata. Due to presence of unicellular root hairs it also helps in absorption of water and minerals from soil.
2. **Cortex:** It lies below the epiblema. The cortex is made up of many layers (6-8) of thin walled oval, rounded, or angular parenchyma cells with intercellular spaces for exchange of gases. The cells of cortex store food. They also conduct water from the epiblema to the inner tissues.



T.S of Dicot Root

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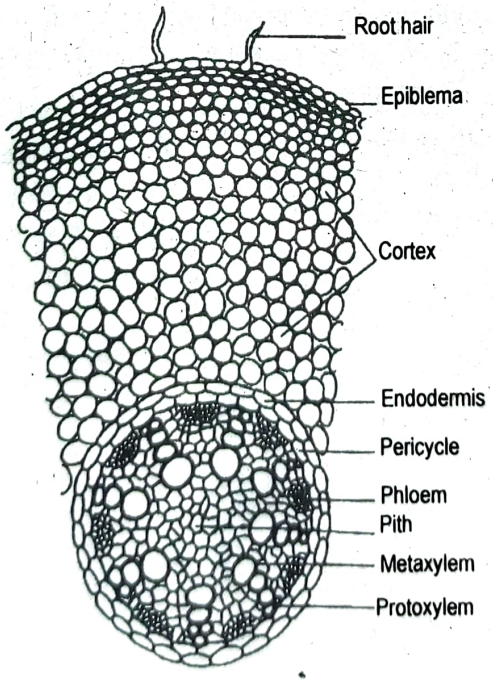
3. **Endodermis:** It is the innermost layer of cortex and covers the stele. It consists of compactly arranged barrel shaped parenchyma cells without intercellular spaces. Most of the cells are characterized by the presence of special thickening of suberin and lignin on their radial and tangential walls and called casparian strips. Some endodermal cell near protoxylem has no casparion strips and called passage cells or transfussion cells. These cells allow radial diffusion of water and minerals through the endodermis.
4. **Pericycle:** The layer next to the endodermis is known as pericycle. The cells of pericycle are thin walled and parenchymatous without intercellular spaces. Pericycle helps in the formation of lateral meristem. At the time of secondary growth it produces secondary cambium or phellogens.
5. **Vascular bundle:** Vascular bundles are two to eight in number, radial and arranged in ring. Xylem and phloem bundles are separated from each other by parenchymatos cells called conjunctive or complementary tissues. Xylem is exarch and consists of tracheids, vessels, parenchyma and fibres. Phloem consists of sieve tubes, companion cells and phloem parenchyma. Usually phloem fibres are absent of reduced.
6. **Pith:** It is feebly developed and centrally located. It consists of thin walled, polygonal parenchymatous cells without intercellular spaces. In dicot roots, it may be reduced or absent. It helps in storage of food material.

Monocot root

1. **Epidermis or Epiblems:** The epidermis or outermost layer is commonly known as epiblema or piliferous layer. It is uniseriater and composed of compact tubular cells having no intercellular spaces among them. The outer regions of epiblema contain unicellular root hairs which help in absorption of water and minerals from soil.
2. **Cortex:** Immediately beneath the epidermis a massive cortex lies consisting of thin walled parenchyma cells having intercellular spaces. Usually in an old root a few layers of cortex immediately beneath the epiblema undergo suberisation and give rise to a single or multilayered zone of exodermis. This is a protective layer which protects internal tissues from outer agencies.



T.S of Monocot Root

3. **Endodermis:** It is the innermost layer of cortex and covers the stele. It consists of compactly arranged barrel shaped parenchyma cells without intercellular spaces. Most of the cells are characterized by the presence of special thickening of suberin and lignin on their radial and tangential walls and called casparian strips. Some endodermal cell near protoxylem has no casparian strips and called passage cells or transfussion cells. These cells allow radial diffusion of water and minerals through the endodermis.

4. **Pericycle:** It lies just below the endodermis and is composed of thin walled parenchymatous cells without intercellular space (sometime patches of sclekenchymatous cells are also found. Several lateral roots arise from this layer.
5. **Vascular bundle:** Vascular bundle is radial, arranged in a ring. Xylem and phloem are present in separate bundle and are numerous and referred as polyarch. Phloem bundle consists of sieve tubes, companion cells and phloem parenchyma. Xylem bundle consists of protoxylem which lies towards periphery and met xylem towards the connected by parenchymatous tissue called conjunctive tissues.
6. **Pith:** Pith is large, well developed portion of monocot roots. It occupies the central portion and made from thin walled parenchymatous tissues with intercellular spaces. It contain abundant amount of starch grains.

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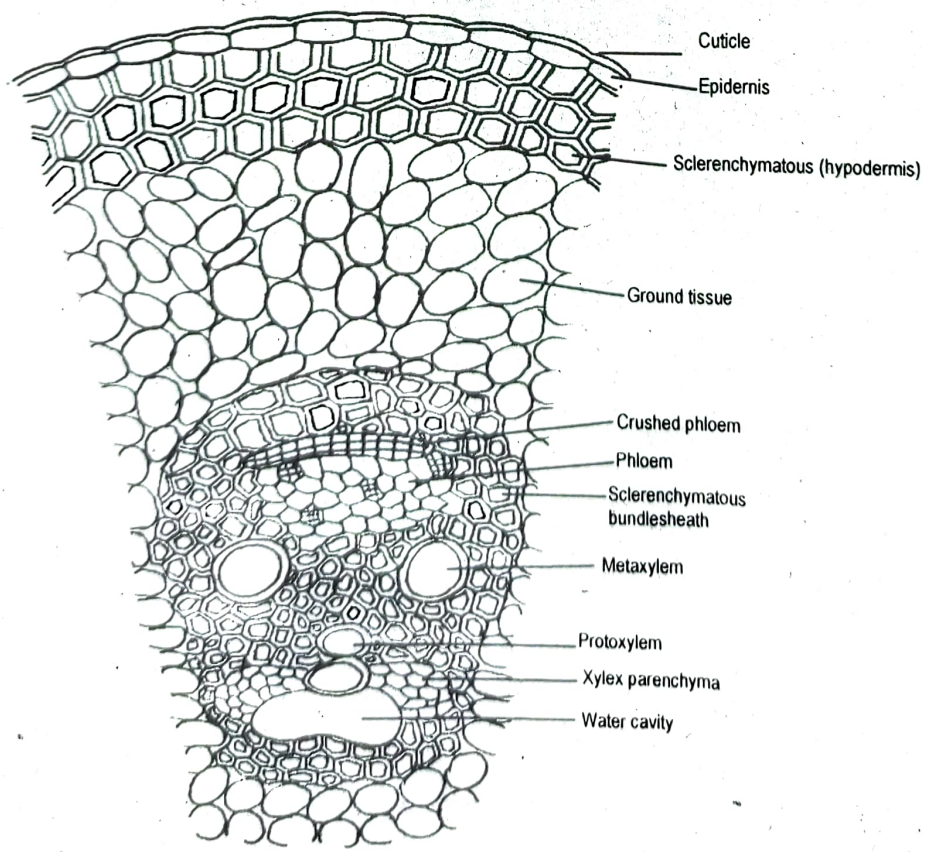
2. 2075 GIE Q.No. 3 **Define tissue and describe in detail about structure and function of complex permanent tissues with suitable diagrams.** [7.5]

Tissue is a group of similar or dissimilar cells having common origin, similar structure and common methods of development as well as similar set of function. In plant two types of tissues are found known as meristematic tissues and permanent tissues.

Monocot Stem:

1. **Epidermis:** It is outermost single layer of compactly arranged elongated barrel shaped, transparent parenchymatous tissues without intercellular spaces. Externally it is covered by cuticle. At some places the epidermis contains stomata for gaseous exchange. Each stoma has two dumb- bell shaped guard cells.
2. **Hypodermis:** It is 2-3 layered thick, dead lignified sclerenchymatous tissue lies below the epidermis. It provides rigidity and mechanical strength to the stem.
3. **Ground tissues:** It has no differentiation of cortex, endodermis, pericyle, pith, and medullary rays (except Asparagus). It is parenchymatous and occupies the whole stem interior. The cells are small and angular towards the hypodermis and become large and oval in inner region. The ground tissue store food. Some cells involve in photosynthesis due to presence of chloroplast in them.



T.S. of Monocotstem

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4. **Vascular strand:** Vascular bundles are scattered in ground tissue. They are collateral and closed type. The bundles towards periphery are greater in number and smaller in size than those towards centre. Each vascular bundle is surrounded by a sheath of slerenchyma called bundle sheath. The bundle sheath is more conspicuous towards upper and lower side of the bundles. Vascular bundle consists of phloem towards outer side and xylem towards of pitched and bigger vessels of metaxylem and smaller and annular or spinal vessels of protozylem. Some of the protozylem vessels and xylem parenchyma cells dissolve and form a cavity that generally stores water and called water cavity or lysogenous cavity.
5. **Medullary rays:** It is absent in monocot stem
6. **Pith:** It is not well marked

Why secondary growth does not take place.

Normally the vascular bundles of the monocotyledons stems are closed ones. Thus due to absence of the cambium they lack secondary growth in thickness and the vascular system is wholly composed of primary tissues. The bundles remain irregularly scattered in the ground tissues, forming an atactostele, where the limits of cortex and other ground tissues can be hardly discerned.

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3. 2075 Set A Q.No. 3 **Define secondary growth. Explain the process of secondary growth in dicot stem with necessary diagrams.** **[7.5]**

Please refer to Model (Botany) Q. No. 3

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4. 2075 Set B Q.No. 3 **Define permanent tissue and discuss the structure and function of simple permanent tissues in detail.** **[7.5]**

Permanent tissue is composed of cells which have lost the power of division. It is of three types: simple permanent tissue, complex permanent tissue and special tissue.

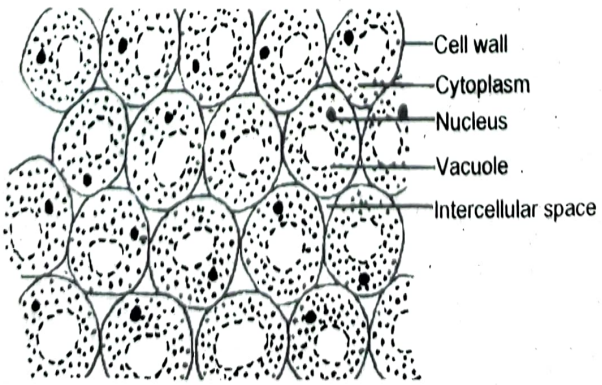
Simple permanent tissues

A simple tissue which is made up of similar types of cells forming a uniform of homogenous mass of cells. They may be living or dead. The common examples are parenchyma, collenchyma and sclerenchyma.

a. **Parenchyma**

i. It consists of isodiamatric, thin walled living cells with intercellular space.
ii. Each cell is bounded by a cellulosic cell wall with centrally located large vacuole and Peripheral cytoplasm having nucleus.
iii. It is found almost all parts of plants such as stem, roo,t leaf, flowers, and fruit.
iv. The main function is storage of food material.
v. It is modified into following types based on specific functia such as

- Prosenchyma
- Chlorenchyma
- Aerenchyma
- Xylem Parenchyama
- Phloem Parenchyama



T.S of Parenchymatous Tissue

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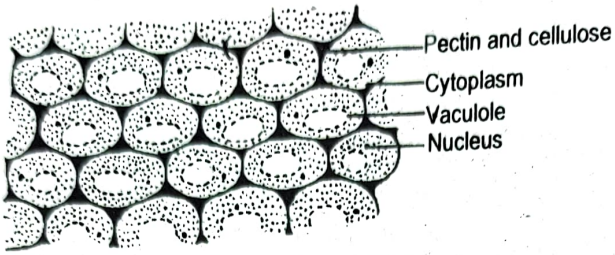
b. Collenchyma

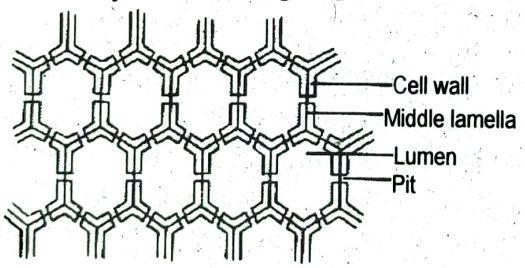
i. It is simple non-lignified living mechanical tissue with or without intercellular spaces and originated from the ground meristem.
ii. It is polygonal, spherical or elongated with pointed or rounded ends.
iii. The cell walls unevenly thicken and rich in pectin and hemicellulose.
iv. It is found in hypodermis of herbaceous stem and dicot leaf.
v. It may contain chloroplast and perform photosynthesis.
vi. Depending on deposition of pectin in a intercellular space collenchyma may be angular (stem of *Tagetus*), lamellar (stem of *Helianthus*) and Lacunar or tubular (e.g. stem of *Curcurbita*)
viii. It provides mechanical support to stem and provide flexibility of organs (e.g. tendrils).



T.S of Collenchyma Tissue

c. Sclerenchyma

i. It is a long, elongated cell with narrow and pointed ends.
ii. It is lignified and thick walled dead cell that does not perform metabolism.
iii. It is developed either from procambium or from secondary parenchyma.
iv. It contains deposition of different types of lignin with pits.
v. This is a supporting tissue that with stands various strains which result from stretching and bending of plant organs without any damage.
vi. Most commonly, the sclerenchyma cells are grouped into fibres and sclereids.



T.S of Sclerenchyma Tissue

5. 2074 Supp Q.No. 3 **Describe the process of secondary growth in dicot stem with necessary diagrams.** [7.5]

Please refer to Model (Botany) Q.No. 3

6. 2074 Set A Q.No. 3 **Define Secondary growth and discuss how meristems are responsible for increase in thickness of dicot stem.** [7.5]

Please refer to Model (Botany) Q.No. 3

7. 2074 Set B Q.No. 3 **Define secondary growth and describe the process involved in dicot stem with figure.** [7.5]

Please refer to Model (Botany) Q.No. 3

8. 2073 Supp Q.No. 3 OR **Describe the T.S. of monocot and dicot leaf with necessary diagrams.** [7.5]

Please refer to 2075 GIE Q.No. 3

9. 2073 Set C Q.No. 3 **Describe and compare the anatomical structure of dicot and monocot stem with neat and clean diagrams.** [7.5]

Please refer to 2075 GIE Q.No. 3

10. 2073 Set D Q.No. 3 **Describe and compare anatomical structure of dicot and monocot root with neat and clean diagrams.** [7.5]

Please refer to 2076 Set B Q.No. 3

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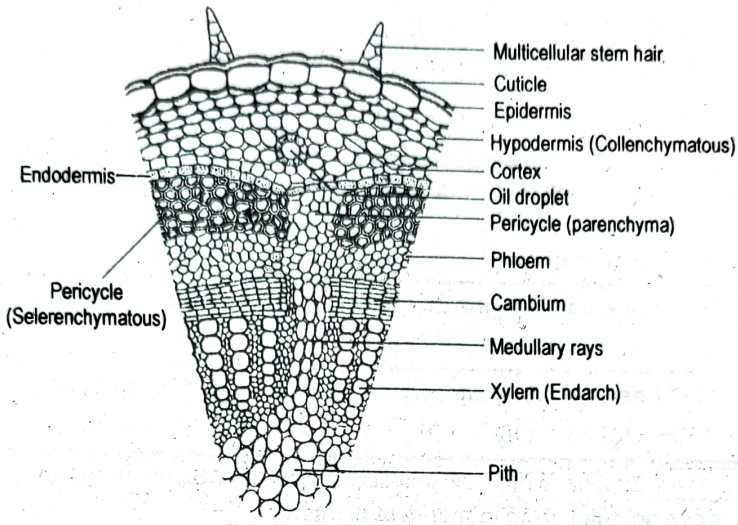
11. **2072 Set C Q.No. 3** **Describe the T.S. of dicot stem with well labelled diagrams and compare it with monocot stem also.** **[7.5]**

Following are the features of typical dicot stem:

1. **Epidermis:** It is upper most single layer of the stem made up of compactly arranged, thin walled parenchy matous cells. The epidermis is externally covered by thin or thick cuticle. The epidermis of sunflower contains several unbranched multicellular hairs and few stomata. The various functions of epidermis are protection of internal tissues, exchange of gases through stomata etc.



T.S. of Dicot Stem (Detail portion)

2. **Hypodermis:** It is present below the epidermis and consists of 3-5 layers of collenchymatous tissues with lamella ion thickening. The cells are living and may contain some chloroplasts which may functions as photosynthetic cells.
3. **Cortex:** It is a few to several cells in thickness. The cortex is made up of thin walled parenchymatous cells. They enclose intercellular space. Its cells may contain some chloroplasts which may function as assimilatory cells.
4. **Endodermis:** It is a wavy layer of one cell in thicker. The endodermis lies at the innermost boundary of cortex. It is made up of barrel shaped cells which do not enclose intercellular spaces. The endodermis cells contain starch grains as reserve food. Therefore, the endodermis is also called as starch sheath.
5. **Pericycle:** It is a few layered regions lies inner to the endodermis and outside the vascular bundle. The pericycle is made up of both parenchyma and sclerenchyma. Sclerenchyma lies above the phloem in the form of semicircular patches hence also called bundle cap. Parenchyma pericycle is present outside medullary rays. The sclerenchyma pericycle provides mechanical strength to the young stem while parenchymatous Pericyle stored food.
6. **Vascular bundle:** The vascular strand is in the form of vascular bundle present around the central pith and inner to the Pericycle. The vascular bundles are wedge shaped. Each vascular consists of primary phloem on the outside, primary xylem towards the inside and a strip of cambium in between the two. Phloem and xylem tissues lie on the same radius. Such vascular bundles are called conjoint (with both xylem and phloem), collateral (with phloem and xylem on the same radius), and open (with a strip of cambium in between phloem and xylem). Xylem consists of two parts, smaller protoxylem and larger metaxylem. Protoxylem lies at the tip of metaxylem towards the pith. Therefore xylem is endarch.
7. **Medullary or pith rays:** They are the radial strips of parenchyma which are present between adjacent vascular bundles. The medullary rays connect the pith with pericycle and cortex.
8. **Pith or medulla:** It forms the centre of the stem. It is made up of oval or rounded parenchyma cells which enclose intercellular spaces. The pith cells store food.

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Differences between dicot and monocot stem

Dicot stem	Monocot Stem
Hypodermis is made up of collenchymatous tissue.	Hypodermis is made up of sclerenchymatous tissue.
Ground Tissue is heterogenous which is made up of cortex, endodermis, pericycle, pith and pith rays.	Ground Tissue is homogenous which are not differentiated into cortex, endodermis, pericycle, pith and pith rays.
Vascular bundles are arranged in concentric ring.	Vascular bundles are Scattered.
Vascular bundles are conjoint, collateral and open type.	Vascular bundles are conjoint, collateral and closed type.
Water cavity is absent.	Water cavity is present.

12. 2072 Set D Q.No. 3 **What is secondary growth? Describe the process involved in dicot stem with necessary diagrams.** [7.5]

Please refer to Model (Botany) Q.No. 3

13. 2072 Set E Q.No. 3 **What is secondary growth? Describe the process of secondary growth in dicot stem.** [7.5]

Please refer to Model (Botany) Q.No. 3

14. 2072 Supp. Q.No. 3 OR **Describe T.S. of monocot and dicot leaf with necessary diagrams.** [7.5]

Please refer to 2073 Supp Q.No. 3 OR

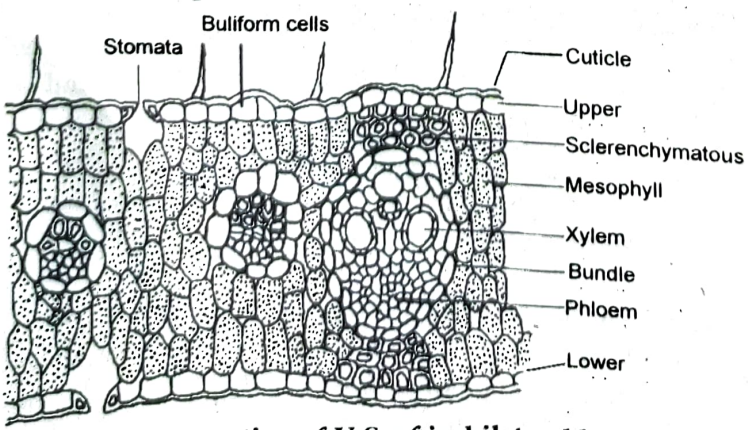
15. 2071 Supp. Q.No. 3 or **Explain with well labelled figure of T.S. of monocot stem and discuss why secondary growth does not take place in monocot plants.** [7.5]

Please refer to 2073 Supp Q.No. 3 OR

16. 2071 Set C Q.No. 3 OR **Describe the T.S. of monocot and dicot leaf with necessary diagram.** [7.5]

Dicot leaf or dorsiventral leaf: It is arranged usually at right angle to rays of sun. Its dorsal surface receives much light than ventral surface. To study the anatomy of the dicoty ledonous leaf, several vertical sections passing through the mid rib are required. The internal structure of dicot leaf shows following anatomical characters.

1. **Epidermis:** In dicot leaf epidermis is present on both side known as upper epidermis and lower epidermis.
   a. **Upper epidermis:** This is the outermost layer made up of single layered parenchyma cells attached to one another. The outer walls of the cells are cuticularized. Stomata and chloroplasts are absent. The cuticle prevents excessive transpiration and helps in binding the cells together. It also helps to protect the epidermal cells from mechanical injury.
   b. **Lower epidermis:** This is like the upper epidermis but contain stomata. There are no chloroplasts but they are found in guard cells of stomata (Kidney shape). Just below the stomata a cavity called sub-stomata cavity is present. This helps in exchange of gases and loss of water in the form of vapour.



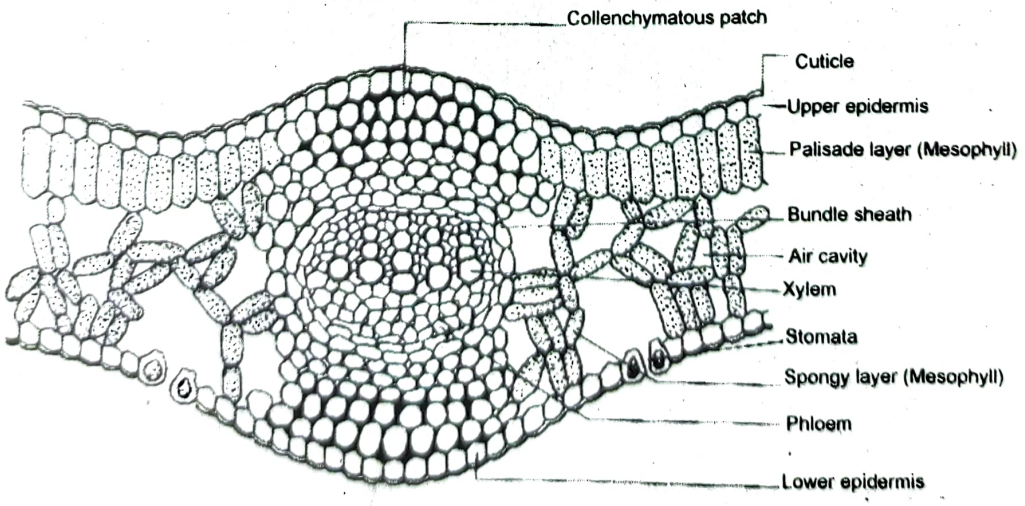
A portion of V.S. of isobilateral leaf

2. **Mesophyll:** It lies between upper and lower epidermis. It is differentiated into palisade and spongy parenchyma in the wing region. Palisade parenchyma lies below the upper epidermis. It consists of 1-2 layers of vertically elongated cells without intercellular spaces. They contain abundant chloroplast. Spongy parenchyma lies between palisade parenchyma and lower epidermis. The cells may be oval rounded, cylindrical or irregular in outline. They have few chloroplasts. They enclose large intercellular spaces. As the chloroplasts are denser in the palisade tissue than the spongy tissue the upper surface of the leaf appears to be deeper green than the lower surface.
3. **Vascular bundle:** The vascular bundles are conjoint, collateral and closed. Xylem lies towards the upper and phloem towards the lower epidermis. The xylem is present in exarch condition. Each vascular bundle is surrounded by a parenchymatous bundle sheath cells. A large mid-vein vascular bundle and several small lateral bundles are found in the leaf. They are uniformly present in the same plane and lie embedded in mesophyll tissue. Mesophyll is absent in the region of midrib and other larger veins. Sclerenchyma or collenchyma cells occur on outer and inner sides of the vascular bundle up to the upper and lower epidermis. These cells are called bundle sheath extension.

Monocots leaf or isobilateral leaf

Most of monocot leaves are nearly erect and more or less both surfaces usually receive direct and equal amount of sunlight. The internal structure of monocot leaf shows following anatomical structure.

1. **Epidermis:** The epidermis is found on both upper and lower surfaces of the leaf. The epidermal layers are umiseriate and composed of more or less oval cells. The outer wall of the epidermis contain cuticle. Stomata are equally distributed on both the epidermal layers. Hence the leaf is amphistomatic type. Some cells of upper epidermis remain thin-walled and uncutinised. They become large and empty. These are called bulliform or motorcells. These cells are help in rolling of leaves in dry weather.
2. **Mesophyll:** As the leaf is isobilateral, the mesophyll is not differentiated into palisade and spongy tissues. It is composed of compactly arranged thin walled, diametric chlorophyllus cells having well developed intercellular spaces among them.
3. **Vascular bundles:** Several vascular bundles are present in isobilateral leaf. Each vascular bundle is surrounded by parenchymatous bundle sheath. They are conjoint, collateral and closed. Xylem consists of vessels, tracheids and xylem parenchyma. Lysogenous cavity is found above vessels. The phloem lies towards inner side. It consists of sieve tube and companion cells. A band of sclerenchyma is present inner to upper and lower epidermis instead of mesophyll around larger vascular bundle.



A portion of V.S. of dorsiventral leaf

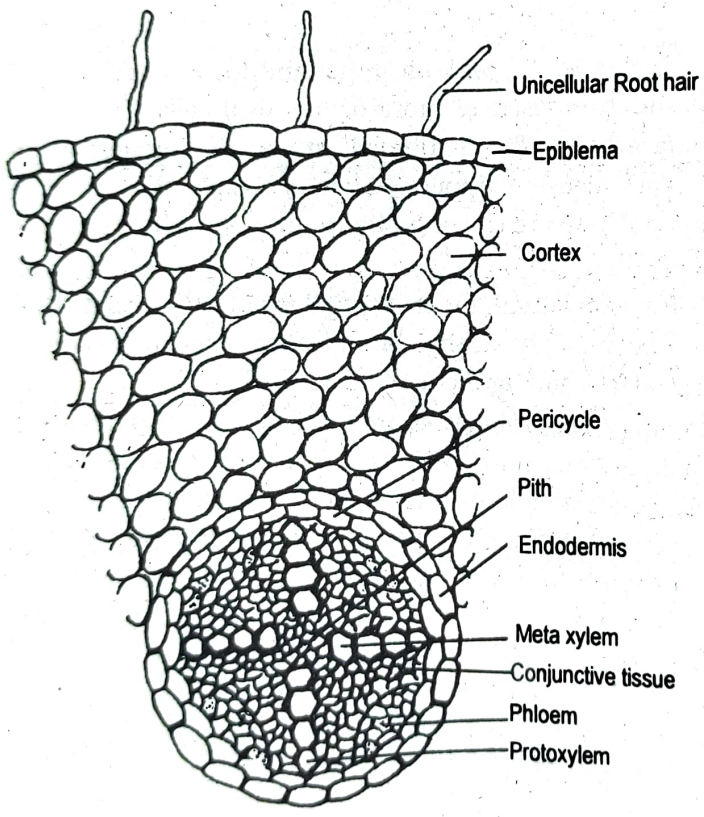
17. 2071 Set D Q.No. 3 **Draw a well labeled diagram of T.S. of morfocot stem and point out its differences with dicot stem.** **[7.5]**

Please refer to 2073 Supp Q.No. 3 OR

18. 2070 Supp. Q.No. 3 2070 Set C Q.No. 3 **Describe the T.S. of monocot ~~stem~~ root with well labelled diagram and point out its differences with that of dicot ~~stem~~ root.** [7.5]

Following are the anatomical structure of dicot root:

1. **Epiblema or epidermis or piliferous layer:** It is outermost unilayered with several unicellular root hairs. It consists of thin walled, compactly arranged living parenchymatous cells. Epiblema of a root differs from the epidermis of the stem in being devoid of distinct cuticle and stomata. Due to presence of unicellular root hairs it also helps in absorption of water and minerals from soil.
2. **Cortex:** It lies below the epiblema. The cortex is made up of many layers (6-8) of thin walled oval, rounded, or angular parenchyma cells with intercellular spaces for exchange of gases. The cells of cortex store food. They also conduct water from the epiblema to the inner tissues.
3. **Endodermis:** It is the innermost layer of cortex and covers the stele. It consists of compactly arranged barrel shaped parenchyma cells without intercellular spaces. Most of the cells are characterized by the presence of special thickening of suberin and lignin on their radial and tangential walls and called casparian strips. Some endodermal cell near protoxylem has no casparian strips and called passage cells or transfussion cells. These cells allow radial diffusion of water and minerals through the endodermis..



T.S of Dicot Root

4. **Pericycle**: The layer next to the endodermis is known as pericycle. The cells of pericycle are thin walled and parenchymatous without intercellular spaces. Pericycle helps in the ormation of lateral meristem. At the time of secondary growth it produces secondary cambium or phellogens.
5. **Vascular bundle:** Vascular bundles are two to eight in number, radial and arranged in ring. Xylem and phloem bundles are separated from each other by parenchymatos cells called conjunctive or complementary tissues. Xylem is exarch and consists of tracheids, vessels, parenchyma and fibres. Phloem consists of sieve tubes, companion cells and phloem parenchyma. Usually phloem fibres are absent of reduced.
6. **Pith:** It is feebly developed and centrally located. It consists of thin walled, polygonal parenchymatous cells without intercellular spaces. In dicot roots, it may be reduced or absent. It helps in storage of food material.

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Differentiation between Dicot root with Monocot root

Dicot root	Monocot root
Cortex is comparatively narrower.	Cortex is comparatively wider
Vascular bundles are normally 2-6.	Vascular bundles are more than 6 (polyarch).
Conjunctive tissues are parenchymatous.	Conjunctive tissue may be parenchymatous or sclerenchymatous.
Pith is either absent or very small.	Pith is well developed
Secondary growth takes place.	Secondary growth is absent.

19. 2070 Set D Q.No. 3 OR **Describe the T.S. of monocot stem with well labelled diagram and point out its differences with that of dicot stem.** [7.5]

Please refer to 2070 Supp Q.No. 3

20. 2069 Q.No. 3 **Define secondary growth and describe its processes involved in dicot stem with necessary figures.** [7.5]

Please refer to Model (Botany) Q.No. 3

21. 2068 Q.No. 3 **Draw a well labeled diagram of T.S. of dicot stem and point out its differences with monocot stem.** [7.5]

Please refer to 2072 Set C Q.No. 3

22. 2067 Q.No. 3a **Draw a well labelled diagram of T.S. of dicot root and point out its differences with that of monocot root.** [7.5]

Please refer to 2070 Supp Q.No. 3

23. 2066 Q.No. 3 **Describe the internal structure of the monocot stem with the help of a well labelled diagram.** [7.5]

Please refer to 2073 Supp Q.No. 3 OR

24. 2065 Q.No. 4 **Draw a neat, well labelled diagram of T.S. of dicot stem and point out its differences with that of monocot stem.** [8]

Please refer to 2072 Set C Q.No. 3

25. 2064 Q.No. 3 **What is secondary growth? Describe the process of secondary growth in dicot stem.** [7.5]

Please refer to Model (Botany) Q.No. 3

26. 2063 Q.No. 3 OR **What is secondary growth? How the meristems are responsible for secondary growth? Discuss.** [7.5]

Please refer to Model (Botany) Q.No. 3

27. 2062 Q.No. 3 **Describe and compare the anatomical structures of dicot and monocot roots.** [7.5]

Please refer to 2076 Set B Q.No. 3

28. 2061 Q.No. 3 **Discuss the anatomical structure of dicot stem.** [7.5]

Please refer to 2072 Set C Q.No. 3

29. 2060 Q.No. 3 **Discuss the anatomical structure of dicot root. Point out the nature of its vascular bundle.** [7.5]

Please refer to 2070 Supp Q.No. 3 (first part)

30. 2059 Q.No. 3 **Discuss anatomical features of a typical dicot stem and point out any four important differences with the monocot type.** [5+2]

Please refer to 2072 Set C Q.No. 3

31. 2057 Q.No. 3 **What do you mean by permanent plant tissues? Discuss the structure and functions of simple permanent tissues.** [1+3+3]

Please refer to 2075 Set B Q.No. 3

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B. PHYSIOLOGY OF ORGANISMS

VERY SHORT ANSWER QUESTIONS [1 MARK]

1. 2076 Set B Q.No. 1a **What is the major product of C3 cycle?** [1]

The major product of C3 cycle is glucose.

2. 2076 Set B Q.No. 1j **Define turgor pressure.** [1]

When a living plant cell is kept in water or hypotonic solution, water enters into the cell sap by osmosis. The entry of water into the cell sap, a pressure is created which presses the protoplast against the cell wall as a result cell become turgid and this pressure is called turgor pressure (T.P)

3. 2076 Set C Q.No. 1b **Define plasmolysis.** [1]

Loss of water from a turgid cell when it kept in hypertonic solution is called plasmolysis.

4. 2076 Set C Q.No. 1c **Where does auxin synthesize?** [1]

Auxins are synthesized in the shoot tips and young leaves from where they are transported to the base of plant.

5. 2075 GIE Q.No. 1b **Define diffusion.** [1]

Movement of molecules from their higher concentration to their lower concentration until their equilibrium state is called diffusion. e.g. Aroma of flower, spreading of scent in room etc.

6. 2075 GIE Q.No. 1c **What is geotropism?** [1]

Geotropism means movement of plant in response to gravitational force.

7. 2075 Set A Q.No. 1a **Define transcription.** [1]

Formation of RNA from DNA during the time of protein synthesis is known as transcription.

8. 2075 Set A Q.No. 1c **What is imbibition?** [1]

Imbibition is a special type of diffusion when water is absorbed by solids-colloids causing an enormous increase in volume. Examples include the absorption of water by seeds and dry wood.

9. 2075 Set B Q.No. 1b **What is imbibition?** [1]

Please refer to 2075 Set A Q.No. 1c

10. 2075 Set B Q.No. 1c **Mention the two names of plant hormone.** [1]

There plants hormones are:

i. Cytokinins ii. Auxins iii. Gibberallins

11. 2074 Supp Q.No. 1b **What is phosphorylation?** [1]

A biochemical process that involves the addition of phosphate to an organic compound. Examples include the addition of phosphate to glucose to produce glucose monophosphate and the addition of phosphate to adenosine diphosphate (ADP) to form adenosine triphosphate (ATP).

12. 2074 Supp Q.No. 1c **Mention about auxin.** [1]

A plant hormone which causes the elongation of cells in shoots and is involved in regulating plant growth.

13. 2074 Set A Q.No. 1b **Define ATP?** [1]

Adenosine triphosphate; an adenosine-derived nucleotide that supplies large amounts of energy to cells for various biochemical processes, including muscle contraction and sugar metabolism through its hydrolysis to ADP.

14. 2074 Set A Q.No. 1c **What dose it mean by photoperiodism?** [1]

Photoperiodism refers to the response of plants to the lengths of dark and light periods. Many angiosperms, or flowering plants, have a protein that can sense seasonal changes in light. A plant will flower depending on these changes in light levels. Each plant has a different photoperiod that it requires to flower and propagate. Plants generally fall into three photoperiod categories: long-day plants, short-day plants, and day-neutral plants.

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15. **2074 Set B Q.No. 1b Define glycolysis.** [1]

Glycolysis is the process in which glucose change into pyruvic acid. It occurs in cytoplasm during aerobic and anaerobic respiration it is also called EMP pathway.

16. **2074 Set B Q.No. 1c What do you mean by phototropism?** [1]

Phototropism means movement of plant in response to light.

17. **2073 Supp Q.No. 1c What do you mean by phototropism?** [1]

Please refer to 2074 Set B Q.No. 1c

18. **2073 Set C Q.No. 1b Define transpiration.** [1]

Removal of excess amount of water from the certain parts of plants in the form of water vapours is called transpiration.

19. **2073 Set C Q.No. 1c What is the role of hormone?** [1]

Hormones control all the physiological aspects of plant like formation of flowers and seed, etc. These are chemical compound e.g. Auxin ,cytokinins etc.

20. **2073 Set D Q.No. 1b What is turgidity?** [1]

Turgidity is essential in plant cells to make them keep standing upright plant cells that lose much water haves less turger pressure, and tend to be come flaccid.

21. **2073 Set D Q.No. 1c Give two names of plant hormone.** [1]

Two plant hormones are

i. Auxins ii. Cytokinins

22. **2072 Supp. Q.No. 1b Define aerobic respiration.** [1]

Respiration in which complete oxidation of organic food in the presence of oxygen in to carbodioxide and energy is called areobic respiration. It can be summarized by following chemical equation.

23. **2072 Supp. Q.No. 1c What do you mean by chemotropism?** [1]

Chemotropism means movement of plant in response to chemical compounds.

24. **2072 Set C Q.No. 1b Define phototropism.** [1]

Please refer to 2074 Set B Q.No. 1c

25. **2072 Set C Q.No. 1c What does it mean by deplasmolysis?** [1]

Entry of water in plasmolysed cell due to endosmosis is called deplasmolysis.

26. **2072 Set D Q.No. 1b Define geotropism.** [1]

Please refer to 2075 GIE Q.No. 1c

27. **2072 Set D Q.No. 1c What does it mean by plasmolysis?** [1]

Please refer to 2076 Set C Q.No. 1b

28. **2072 Set E Q.No. 1b What is ascent of sap?** [1]

Upward movement of sap from the root to tip of plant is called ascent of sap.

29. **2071 Supp. Q.No. 1a What is light reaction?** [1]

A reaction which takes place in the grana of chloroplast in the presence of light is called light reaction. Light reaction takes place during day time in plant. During this reaction CO_2 change into organic compounds in the presence of light and chlorophyll.

30. **2071 Supp. Q.No. 1d What is osmosis?** [1]

Movement of molecules from their higher concentration to their lower concertration of solute through semi-Permeable membrane until their equilibrium state is called osmosis.

31. **2071 Set C Q.No. 1 b Define transpiration.** [1]

Loss of excess amount of water from the upper parts of plants in the form of vapour is called transpiration.

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32. 2071 Set C Q.No. 1 c **What do you mean by hydrotropism?** [1]

Hydrotropism means movement of plants in response to water.

33. 2071 Set D Q.No. 1 b **What is diffusion?** [1]

Movement of molecules from their higher concentration to their lower concentration until their equilibrium state is called diffusion. e.g. Aroma of flower, spreading of scent in room, etc.

34. 2070 Supp. Q.No. 1 b **Define turgidity.** [1]

Please refer to 2073 Set D Q.No. 1b

35. 2070 Supp. Q.No. 1 c **Mention two plant hormones.** [1]

Please refer to 2073 Set D Q.No. 1c

36. 2070 Set C Q.No. 1 b **Define osmotic pressure.** [1]

Osmotic pressure can be defined as the pressure that develol's coher a solution is separated from its pure solved by a Semi-Permeable membrane.

37. 2070 Set C Q.No. 1 c **What is hormone?** [1]

Hormones control all the physiological aspects of plant like formation of flowers and seed, etc. These are chemical compound e.g. Auxin, cytokinins etc.

38. 2070 Set D Q.No. 1 b **Define ascent of sap.** [1]

Please refer to 2072 Set E Q.No. 1b

39. 2070 Set D Q.No. 1 c **Mention two plant hormones.** [1]

Please refer to 2073 Set D Q.No. 1c

40. 2069 Q.No. 1c **What does it mean by osmosis?** [1]

Movement of molecules from their high concentration to their lower concentration of solute through semi-permeable membrane until their equilibrium state is called osmosis.

41. 2068 Q.No. 1b **What is plasmolysis?** [1]

Loss of water from a turgid cell when it kept in hypertonic solution is called plasmolysis.

42. 2068 Q.No. 1c **What is the function of hydathode?** [1]

Function of hydathodes

i. Hydathodes are special water secreting pores which exude water in the liquid form.

43. 2067 Q.No. 1b **Define the term diffusion?** [1]

Please refer to 2075 GIE Q.No. 1b

44. 2067 Q.No. 1c **What is phototropism?** [1]

Please refer to 2074 Set B Q.No. 1c

45. 2066 Q.No. 1 b **Define phototropism.** [1]

Please refer to 2074 Set B Q.No. 1c

46. 2066 Q.No. 1 e **Write full form of NADP.** [1]

Full form of NADP is Nicotinamide Adenine Dinucleotide Phosphate.

47. 2065 Q.No. 1 b **What happens when a turgid cell is placed in hypertonic solution?** [1]

If the turgid cell is placed in hypertonic solution exosmosis takes place.

48. 2065 Q.No. 1 c **What are different types of photosynthetic pigments?** [1]

Different types of photosynthetic pigment are chlorophyll, carotenoids etc.

49. 2064 Q.No. 1c **Write full form of ATP.** [1]

Full form of ATP is Adenosine Tri-phosphate.

50. 2064 Q.No. 1d **What is parthenocarpic fruit?** [1]

A fruit which develop with out fertilization is called parthenocarbic fruit. Therefore fruits are seeds less.

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51. 2062 Q.No. 1b **What is the role of ethylene?** [1]

Role of ethylene

i. Ethylene helps ripening of fruits.

ii. Application of ethylene used to break dormancy of buds and seeds.

52. 2062 Q.No. 1o **What is the role of guard cell?** [1]

Role of guard cells are

i. Opening of stomata in day time.

ii. Helps in removal of excess amount of water.

53. 2061 Q.No. 1 b **What is apical dominance?** [1]

Apicul dominance means dominancy of apical bud by the inhibitio- of lateral buds due to presence of auxius on apical buds.

54. 2061 Q.No. 1o **What is the role of hydathode?** [1]

Role of hydathodes is follow:

i. Hydathodes are special water secreting pores which exude water in the liquid form.

55. 2060 Q.No. 1i **What is photophosphorylation?** [1]

Photophosphorylation is the process in which light energy is converted in to chemical energy in the form of ATP.

56. 2060 Q.No. 1j **Where do auxins are synthesized?** [1]

Auxins are synthesized in the shoot and root apices and young leaves.

57. 2060 Q.No.2i **How does transpiration differ from guttation?** [1]

Differences between transpiration and guttation are follows:

Transpiration	Guttation
Water lost in the form of vapour.	Water lost in the form of liquid.
It takes place by stomata.	It takes place by hydathode.

58. 2058 Q.No. 1c **Name the plant hormone affecting seed germination.** [1]

Plant hormone affecting seed germination are

i. Gibberellins ii. Cytokinins

59. 2058 Q.No. 1h **Mention the function of lateral meristem.** [1]

The main function of lateral meristem is increase in thickness of the plant part.

60. 2057 Q.No. 1c **Which plant hormone promotes leaf and fruit fall?** [1]

Plant hormones which promotes the leaves and fruit fall Abscisis acid and ethylene.

ANSWER ALL IN BRIEF [3 MARKS]

1. 2076 Set B Q.No. 2a **Significances of respiration.** [3]

Respiration transforms the energy stored in foods eaten by an organism into energy that can be used for metabolic processes that sustain the organism's life. The importance of the respiratory system is critical; organisms can endure many days without food and sometimes a few without water, but cannot survive for more than a few minutes if respiration ceases. Plants respire, but they predominantly engage in a process called photosynthesis. This shares characteristics with respiration, except with the relevant chemical reactions running in the reverse direction. Because respiration and photosynthesis complement each other across the planet's ecosystems, respiration is as vital to plants indirectly as it is to organisms that rely on respiration directly. The most important functions of respiration are

1. Cellular respiration is a set of metabolic reactions and processes that take place in the cells of organisms to convert biochemical energy from nutrients to ATP.
2. Cellular respiration is one of the key ways a cell releases chemical energy to fuel cellular activities.
3. The chemical energy stored in ATP is used to drive processes requiring energy including biosynthesis, locomotion or transport across cell membranes.

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2. 2075 GIE Q.No. 2b **Factors affecting respiration.** [3]

Most cell activity requires chemical energy. Respiration is the cellular process of releasing energy from food. Aerobic respiration releases fifteen times more energy than fermentation. The following eight points will highlight the eight major factors affecting aerobic respiration in Plants. (1) Oxygen Content of the Atmosphere (2) Effect of Temperature (3) Effect of Light (4) Effect of Water Contents (5) Effect of Respirable Material (6) Effect of Carbon Dioxide Concentration (7) Protoplasmic Conditions and (8) Other Factors.

1. **Oxygen Content of the Atmosphere:** The percentage of oxygen in the surrounding atmosphere greatly influences the rate of respiration. But reduction of the oxygen content of the air, however, causes no significant lowering in the respiratory rate until the percentage drops to about 10%. At 5% oxygen definite retardation of respiration occurs.
2. **Effect of Temperature:** Like most chemical reactions, the rate of respiration is greatly influenced by temperature. Estimation of Q 10 of the process for a rise in temperature from 8° to 18 °C gives a Q 10 of 2, indicating a chemical reaction. If the rise is at a much higher starting temperature, say between 20° and 30°C, then the Q 10 may fall below 2. It should be borne in mind that different plants or plant parts may show considerable variation in regard to optimum temperature for respiration.
3. **Effect of Light:** Light has indirect effects on the rate of respiration. With the increase in light intensity, the temperature of the surrounding atmosphere also increases thus affecting the rate of respiration. Secondly, the quantity of respirable material in the plant largely depends upon the rate of photosynthesis which is directly influenced by light and thirdly, stomata remain open during daylight and hence rapid exchange of gases takes place through them.
4. **Effect of Water Contents:** Over a certain range, water content of the plant tissue greatly influences its rate of respiration. In most of the storage able seeds the moisture content is kept below the point which allows a rapid respiration. With the increase in moisture content, the rate of respiration is likely to go up with the result a rapid loss of viability will occur and at the same time the temperature will also rise and the grain may be spoiled.
5. **Effect of Respirable Material:** Amount and kind of respirable material present in the cells greatly affect the rate and course of respiration. It has been shown that plants respire more rapidly after having been exposed to conditions favorable for photosynthesis during which carbohydrates are synthesized. Increase in respiration has also been observed to be associated with increase in soluble sugars.
6. **Effect of Carbon Dioxide Concentration:** The rate of respiration is normally not affected by increase of carbon dioxide concentration in the surrounding atmosphere up to 19%, but as the concentration increases from 10% to 80%, a progressive decrease in respiration occurs.
7. **Protoplasmic Conditions:** The young growing tissues which have greater amount of protoplasm as compare to older tissues, show higher rate of respiration. Their higher rate of respiration supports the meristematic activities of the cells by supplying large amount of energy. The degree of hydration of the protoplasm in the cells affects the rate, and mechanical injury to plant tissues will accelerate respiration.
8. **Other Factors:** Various chemicals, such as cyanides, azides and fluorides, have been reported to possess respiration retarding properties through their effect on respiratory enzymes. Respiration rate may likely be accelerated by low concentrations of the compounds like ethylene, carbon monoxide, chloroform and ether.

3. 2075 Set A Q.No. 2e **Stomatal transpiration.** [3]

The process of the loss of water in the form of vapours through the stomata present on the epidermal surface of the leaf, green stem, etc. is called stomatal transpiration. It is most common types of transpiration. It is about 50-97% of total transpiration. It occurs during day time until the stomata open. During the process of stomatal transpiration, the mesophyll tissues lying in the leaves loose water to the intercellular spaces. So the mesophyll tissues become unsaturated and

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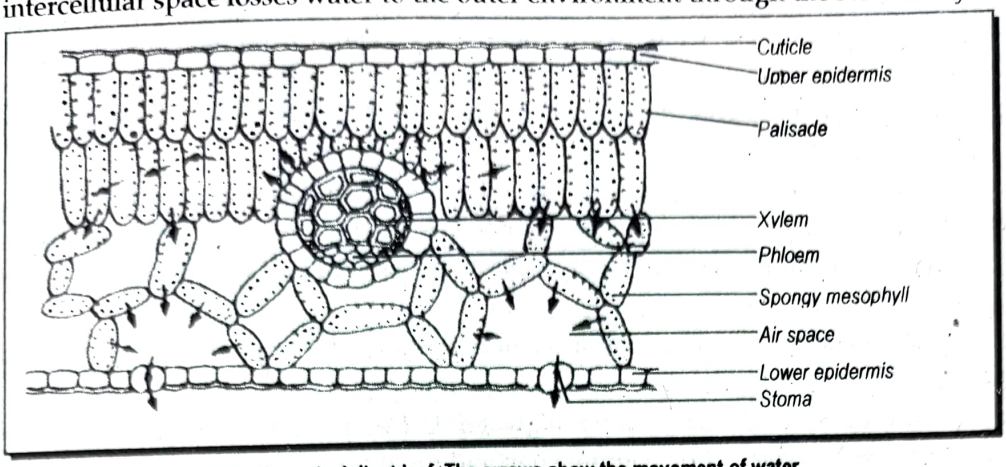
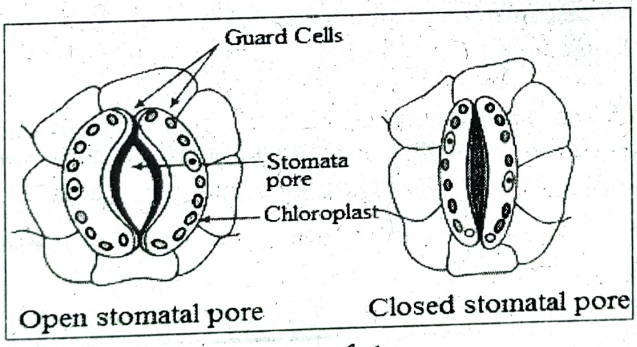
draw water from the adjacent mesophyll tissues which also absorb water from the xylem tissues of the leaves. The intercellular spaces become saturated after getting water from the mesophyll tissues. Then intercellular space losses water to the outer environment through the stomata by diffusion.



V.S. of a typical dicot leaf. The arrows show the movement of water

4. 2075 Set A Q.No. 2g 2075 Set B Q.No. 2a **Structural and functional aspects of stomata.** [3]

A stoma is a minute pore on the epidermis of aerial parts of plants through which exchange of gases and transpiration take place. Each stoma is surrounded by a pair of kidney shaped guard cell (in dicot) and dumbbell shaped guard cell (in monocot). Each guard cell is a modified epidermal cell showing a prominent nucleus, cytoplasm and plastids. The wall of the guard cell is differentially thickened. The inner wall of each cell facing the stoma is concave and thick and rigid. The outer wall is convex and is thin and elastic. The guard cells are surrounded by a variable number of epidermal cells called subsidiary cell or accessory cells. Average length of stomata is 20 to 28μm and breadth 5 μm.



Structure of stoma

Mechanism of Opening and Closing of Stomata: Opening and closing of stomata occurs due to turgor changes in guard cells. Due to endoosmosis an increase in turgor of the guard cells takes place which finally results in stretching and bulging out of their outer thin walls. This result in the pulling apart of the opposed inner thicker walls creating an opening or pore in guard cells of stomata. When the turgor pressure of guard cells decreases inner walls sag, leading to closure of space between them. This is due to the loss of water from guard cells, resulting in thicker walls to move closer and finally shut the opening.

Functions of Stomata

i. Evaporation of excess amount of water during transpiration.
ii. Absorption of carbon dioxide from atmosphere.
iii. Release of oxygen in atmosphere.

5. 2075 Set B Q.No. 2b **Kinds of transpiration.** [3]

Most of the water absorbed is lost through the aerial parts of the plants into air by the process called transpiration. Very little water (less than 2%) is used up in various metabolic activities of plants. Most of the transpiration takes place through leaves known as foliar transpiration.

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Types of transpiration

Transpiration may occur through the cuticle, lenticles stomata and sometime bark and according it is called. Cuticular, lenticular, stomatal and bark transpiration.

a. **Cuticular Transpiration:** It is the loss of water in the vapour from the general surface (leaves and young stems) through the layer of cuticle. Cubicula transpiration is appreciable only in case the cuticle is thin as in entophytic plants growing in humid areas. It is continues throughout day and night.

b. **Stomata Transpiration:** It is the loss of water in vapor from the stomata present on the surface of leaves and to a lesser present on the surface of leaves and to a lesser extent on the surface of flowers and young stem. It is the major part of transpiration (80-90%) it however, occurs only when stomata are open.

c. **Lenticular Transpiration:** This is loss of water in vapors from lenticels or aerating poxes present in the bark of stems.

d. **Bark Transpiration:** A small quantity of water is lost from the corky bark of the stem. Both lenticular and bark transpiration continue day and night time.

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6. **2074 Supp Q.No. 2b Anaerobic respiration.** [3]

Anaerobic respiration is the process of producing cellular energy without oxygen. Anaerobic respiration is a relatively fast reaction an process 2 ATP which is far fewer than aerobic respiration. Anaerobic respiration happens in the cytoplasm where glycolysis release energy from glucose and fermentation recycles NADH back to NAD^+. Anaerobic respiration takes in two different ways in plant and animals.

i. **In animals:** Our muscles used oxygen and glucose to respire anaerobically and produce the energy they require. These are carried to the muscle via blood. However if we were to carry out vigorous exercise our heart and lungs would not be able to get sufficient oxygen to our muscles in order for them to respire. In this case muscles carry out anaerobic respiration. The chemical equation is

$$C_6H_{12}O_6 \rightarrow \underset{\text{Lactic acid}}{C_3H_6O_3} + 120KJ/Mol$$

ii. **In plants:** The oxygen supply to plants can also runout, this happens for examples if the soil gets waterlogged. In this case they have to obtain their energy via anaerobic respiration. The chemical equation is

$$C_6H_{12}O_6 \rightarrow \underset{\text{Ethanol}}{C_2H_5OH} + CO_2 + \text{energy}$$

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7. **2074 Set A Q.No. 2b Factors affecting transpiration.** [3]

The external factors of transpiration are

i. Atmospheric humidity	ii. Wind	iii. Atmospheric pressure
iv. Soil temperature	v. Soil water	vi. Temperature of air
vii. Concentration of CO_2	viii. Intensity of light	

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8. **2074 Set B Q.No. 2b Stomata and its functions.** [3]

Please refer to 2075 Set A Q.No. 2g

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9. **2073 Supp Q.No. 2a Structure and function of Hydathode.** [3]

A hydathode is a type of pore, commonly found in angiosperms, that secretes water through pores in the epidermis or leaf margin, typically at the tip of a marginal tooth or serration. Hydathodes occur in the leaves of submerged aquatic plants such as Ranunculus fluitans as well as herbaceous plants of drier habitats such as Campanula rotundifolia. They are connected to the plant vascular system by a vascular bundle. Hydathodes are commonly seen in water lettuce, water hyacinth, rose, balsam, and many other species. Hydathodes are made of a group of living cells with numerous intercellular spaces filled with water, but few or no chloroplasts, and represent modified bundle ends. These cells open out into one or more sub-epidermal chambers. These, in turn, communicate

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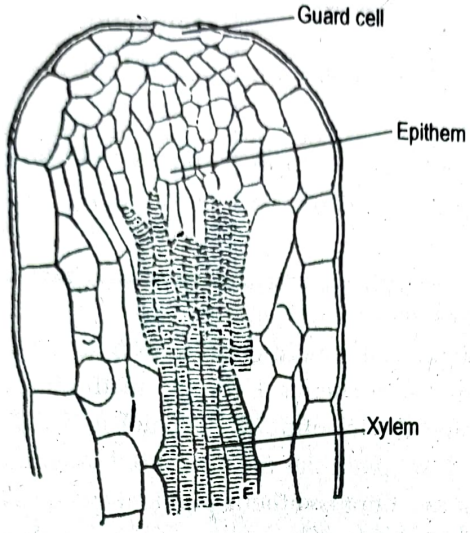
with the exterior through an open water stoma or open pore. The water stoma structurally resembles an ordinary stoma, but is usually larger and has lost the power of movement. Hydathodes are involved in the process of guttation, in which positive xylem pressure (due to root pressure) causes liquid to exude from the pores. Some halophytes possess glandular trichomes that actively secrete salt in order to reduce the concentration of cytotoxic inorganic ions in their cytoplasm; this may lead to the formation of a white powdery substance on the surface of the leaf.



Structure of Hydathodes

Functions of Hydathodes:

The main functions of hydathode are:

i. It is a specialized structure involved in the guttation.

ii. They are the permanent opening present on the tip, margins. Adaxial as well as the abaxial surfaces.

iii. Some hydathode are actively involved in the exuding the fluids while some others passively exudes the fluids.

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10. 2073 Supp Q.No. 2b Characteristics of C_3 plants with examples. [3]

The characters of C_3 plants are:

1. Only one type of chloroplast is found.
2. It is photosynthetically less efficient.
3. It is characterized by the absence of bundle sheath cells.
4. The plants donot show Kranz anatomy.
5. Calvin cycle enzymes are present in the chloroplast of mesophyll cells.
6. The carbondioxide fixing enzyme is RUBP carboxylase.
7. Common examples are wheat, oats, barley, rice, cotton, beans, etc.

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11. 2073 Set C Q.No. 2b Significance of photosynthesis. [3]

The main significance of Photosynthesis are:

i. It is only process by which organic food can be prepared from the inorganic compounds in the presence of light, chlorophyll and carbon dioxide.

ii. It helps to absorption of atmospheric carbondioxide with evolution of O_2.

iii. It helps to reduce global temperature by reduction of CO_2 from atmosphere.

iv. All fossils fuels like coal, petroleum, gases, etc. are photosynthetic products.

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12. 2073 Set D Q.No. 2a 2072 Set C Q.No. 2a Structure and function of stomata. [3]

Please refer to 2075 Set A Q.No. 2g

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13. 2073 Set D Q.No. 2b External factors of transpiration. [3]

Please refer to 2074 Set A Q.No. 2b

14. 2072 Supp. Q.No. 2b **Differentiate between osmosis and diffusion.** [3]

Difference between osmosis and diffusion are follows:

Osmosis	Diffusion
It can occur only in liquid medium.	It can occur in any type of medium.
It is biological process.	It is physical process.
Semi-permeable membrane involved.	Semi-permeable does not involved.
It involves the movements of solvent molecules only.	It involves the movement of solid, liquid and gases.
Sweating from body, releasing water form cucumber by adding salts are some common examples.	Release of aroma of flower, spreading of perfumes in rooms are some examples.

15. 2072 Set C Q.No. 2b **Light reaction.** [3]

Light reactions receive sunlight. In the light dependent reactions, energy from sunlight is absorbed by chlorophyll and converted into chemical energy, in the form of the electron carrier molecule NADP (nicotinamide adenine dinucleotide phosphate) and ATP (Adenosine triphosphate). The light dependent reactions take place in the thylakoid membranes in the granum within the chloroplast. In light reaction two photosynthetic pigment systems are involved called photosystem I (PSI) and Photosystem II (PSII). Each photosystem carries numbers of chlorophyll molecules which absorb light energy and produce energized electrons. These electrons are the power of light reaction. These two photo system absorb different light with different wave light PSI absorb 700 nm wavelength of light and PSII absorb 680 nm wave length of light. The overall process of light reaction is completed into following steps.

1. Photo-excitation of Chlorophyll molecules:
2. Photolysis of Water or Oxidation of water molecule:
3. Photophosphorylation:

a. Non- Cyclic Photophosphorylation:
b. Cyclic Photophosphorylation:

16. 2072 Set D Q.No. 2b **Anaerobic respiration.** [3]

Please refer to 2074 Supp Q.No. 2b

17. 2072 Set E Q.No. 2b **Discuss the physiological significance of auxins.** [3]

Following are the significance of auxins:

i. The primary physiological effect of auxin in plants is to stimulate the elongation of cells in shoot.
ii. It helps in apical dominance.
iii. It involves in root initiation.
iv. Natural auxin has controlling influence on the abscission of leaves, fruits, etc.
v. Auxins can induce the formation of parthenocarpic fruits.
vi. It helps in vascular differentiation.

18. 2071 Supp. Q.No. 2b **What is the function of Gibberellin in plant?** [3]

Functions of gibberellins are given below;

1. **Stem elongation**

Gibberellins cause stem elongation and leaf expansion. It is believed that certain types of dwarfness are due to gibberellin deficiency. But it has no effect on roots.

2. **Bolting**

Gibberellin induces stem elongation in rosette plants. Cabbage is a rosette plant with profuse leaf growth and retarded internodal length. Just prior to flowering, internodes elongate enormously.

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This is called bolting. Bolting needs either long days or cold nights. When a cabbage head is kept under warm nights, it retains its rosette habit. Bolting can be induced artificially by the application of gibberellins under normal conditions.

3. **Seed Germination**
Gibberellins promote seed germination in lettuce, cereals.

4. **Breaking of seed dormancy**
Gibberellins break dormancy of buds and tubers. But in root tubers it inhibits the development of the root tuber.

5. **Parthenocarpy**
Gibberellins cause parthenocarpy in apple and pear.

6. **Increasing Fruit Size**
Gibberellins along with auxin, control the growth and development of fruits.

7. **Flowering and sex expression**
Gibberellins control flowering in long day plants. Gibberellins promote the production of male flowers, either in place of female flowers in monoecious plants or in genetically female plants such as cucurbits.

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19. **2071 Set C Q.No. 2b Characteristics of C_4 plants with examples.** [3]

Characteristics of C_4 plants

1. The C_4 process is also known as the Hatch-Slack pathway and is named for the 4-carbon intermediate molecules that are produced, malic acid or aspartic acid.
2. C_4 has one step in the pathway before the Calvin Cycle which reduces the amount of carbon that is lost in the overall process.
3. The carbon dioxide that is taken in by the plant is moved to bundle sheath cells by the malic acid or aspartic acid molecules (at this point the molecules are called malate and aspartate).
4. The oxygen content inside bundle sheath cells is very low, so the RuBisCO enzymes are less likely to catalyze oxidation reactions and waste carbon molecules.
5. The malate and aspartate molecules release the carbon dioxide in the chloroplasts of the bundle sheath cells and the Calvin Cycle begins.
6. Bundle sheath cells are part of the Kranz leaf anatomy that is characteristic of C_4 plants.
7. The most common examples are sugarcane, maize, *Euphorbia, Amaranthus* etc.

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20. **2071 Set D Q.No. 2b Describe the use of cytokinis.** [3]

Following are the uses of cytokinin:

i. Cytokinins are essential for tissue culture besides cell division. They are also involved in morphogenesis.
ii. Application of cytokinins to marketed vegetables can keep them fresh for several days.
iii. Cytokinins application is helpful to plants in developing resistance to pathogens and extreme of temperature
iv. Cytokinins delay sensecence of intact plant parts.
v. Cytokinin promotes femaleness in flowers.

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21. **2070 Supp. Q.No. 2a Structure of stomata and its mechanism.** [3]

Please refer to 2075 Set A Q.No. 2g

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22. **2070 Supp. Q.No. 2b Steps of dark reaction.** [3]

The light reactions of photosynthesis transform the energy of light into high energy compound ATP and NADPH. The dark reaction reduced CO_2 to from carbohydrates. These reactions are called dark reactions because these reactions do not directly depend on photons of light. The process of dark reaction is completed in to following steps.

1. **Calvin Cycle or C_3 cycle:** This cycle was invented by Melvin Calvin and his colleayues. They were investigating CO_2 fixation in C_3 plants (chlorella a green algue) by using radioactive isotope of carbon 14c. During Calvin cycle atmospheric CO_2 fix and formed 3 carbon compound called phosphoglyaric acid (PGA) in the presence of RUBP. The released PGA is then changed in to glucose. The overall process of Calvin cycle can be represented by following equation

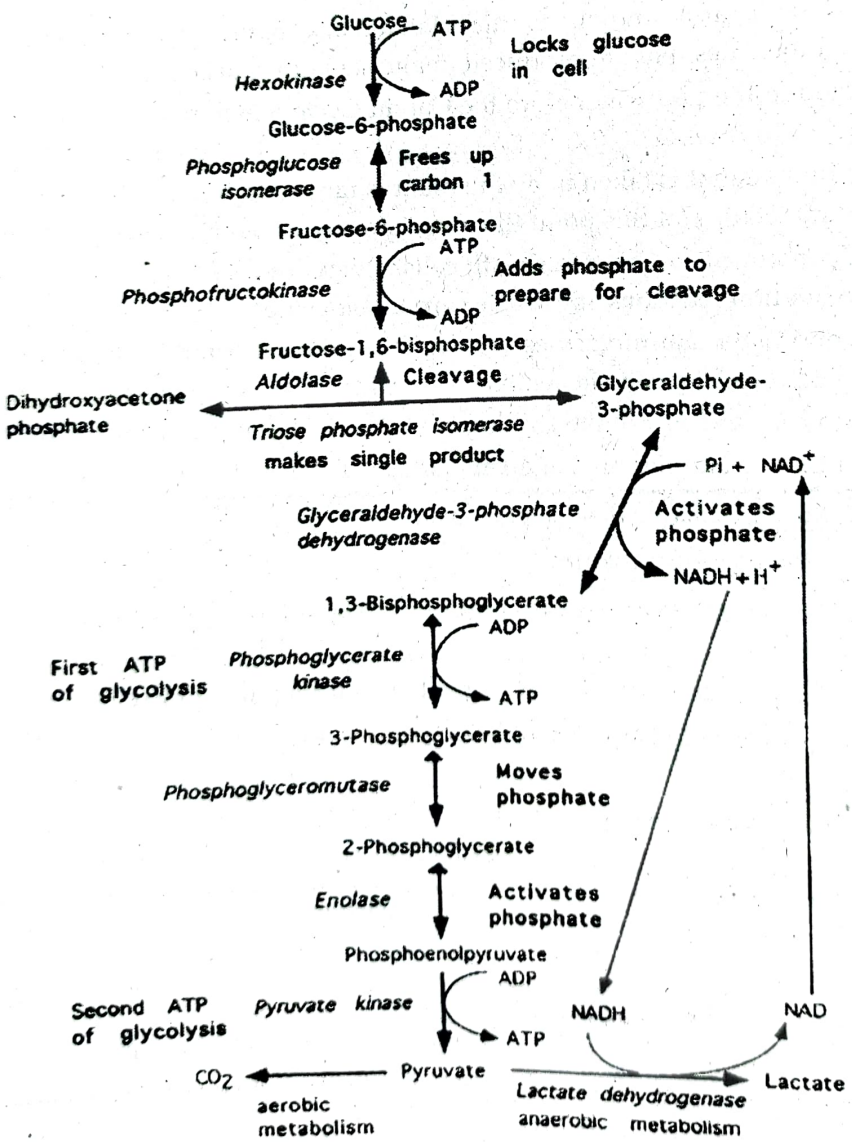
$$6CO_2 + 6RUBP + 12NADPH + 12\,H^+ + 18ATP + 12H_2O \longrightarrow$$
$$C_6H_{12}O_6 + 12NADP + 18ADP + 18iP + 6RUBP + 12H_2O$$

2. **Hatch and slack cycle/ C_4 Cycle:** In several plants like *Zea mays, Euphoprbia, Amaranthus,* and *Chenopodium* first stable products for initial CO_2 fixation, in dark reactions are oxaloacetic acid, aspartic acid and malic acid. They are also known as C_4 plants because all are four carbon compounds. During dark phase CO_2 combines with phosphoenol pyruvic acid to form oxaloacetic acid in nesophyll chloroplasts. It is further reduced to malic acid; malic acid is transferred to chloroplasts in bundle sheath. Where liberated CO_2 come in contact with RUBP to undergo calvin cycle.

[3]

23. **2070 Set D Q.No. 2b Process of glycolysis.**

It is also called EMP pathway because its details were given by Embden, Meyerhof and Paranas. It is a stepped process by which one molecule of glucose breaks in to two molecules of pyruvic acid. It occurs in cytoplasm it is common to both aerobic and anaerobic respiration. The steps are:



Process of glyoclysis

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24. **2069 Q.No. 2c External factors affecting the photosynthesis.** [3]

The main external factors affecting rate of photosynthesis is light, temperature, carbon dioxide, water, oxygen and mineral elements.

1. **Carbon Dioxide**

The atmosphere is the chief source of carbon dioxide. It contains only 0.03 % of the gas by volume. It is very small amount. Therefore, CO, remain a limiting factor. The increase in the amount of carbon dioxide increases the photosynthesis. This increase is more rapid up to 1% of carbon dioxide concentration. But it slows down beyond this point. Higher concentrations have an inhibitory effect on photosynthesis. It is clear that increase in concentration of CO, increases the yield of plant

2. **Light**

Both quality and intensity of light influence the rate of photosynthesis.

As the intensity of light increases, the rate of photosynthesis also increases. At a very high light intensity the rate of photosynthesis decreases as chlorophyll itself is destroyed due to high intensity. This phenomenon is called as photooxidation as it occurs in the presence of O_2.

In moderate light intensities the rate of photosynthesis is directly proportional to irradiance.

High light intensity

Beyond saturation point, light intensity reduces photosynthesis. This effect is called solarization. It can be caused by photo-inhibition and photo-oxidation.

Photo-inhibition

Highlight intensity increases the rate of transpiration and reduction in hydration of green cells. Stomata may close. Photo inhibition is not influenced by O_2 concentration and temperature.

Photo-oxidation

Due to O_2 there occurs destruction or oxidation of photosynthetic pigments and intermediate.

Wavelength of light

Wavelength of light between 400 nm and 700 nm is most effective for photosynthesis. This light is called photosynthetically active radiation (PAR).

Comparatively more photosynthesis occurs is red and blue regions though others have significant net photosynthesis. Light has maximum efficiency in red and minimum in blue region. In both these regions light is absorbed by chlorophylls. Red light favours more carbohydrate accumulation while blue light favours more protein synthesis.

Duration of light

If light intensities are not otherwise harmful, continuous photosynthesis can be sustained throughout 24 hours.

3. **Temperature**

Overall, the process of photosynthesis is sensitive to higher temperatures. This is because the enzymes involved in photosynthesis become inactive at higher temperatures. Low temperatures also inactivate the enzymes. Thus an optimum temperature is preferred.The optimum temperature lies between 15° - 35° C.

4. **Water**

If water availability in the soil decreases, plants undergo water stress. Under the condition of water stress, the rate of photosynthesis declines, as Stomata fail to open and leaf water potential decreases. It is observed that the rate of photosynthesis is reduced with the decrease hydration of the leaves.

5. Oxygen

25. **2068 Q.No. 2b Describe the anaerobic respiration.** [3]

Please refer to 2074 Supp Q.No. 2b

26. **2067 Q.No. 2b Describe the uses of cytokinin.** [3]

Please refer to 2071 Set D Q.No. 2b

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27. 2066 Q.No. 1 d **Highlight the importance of osmosis.** [3]

Following are the importance of osmosis:

i. It is a mean by which plant cells maintain their water content despite the loss of water to the air that is constantly occurring.

ii. It helps the absorption of water by roots hairs from the soil.

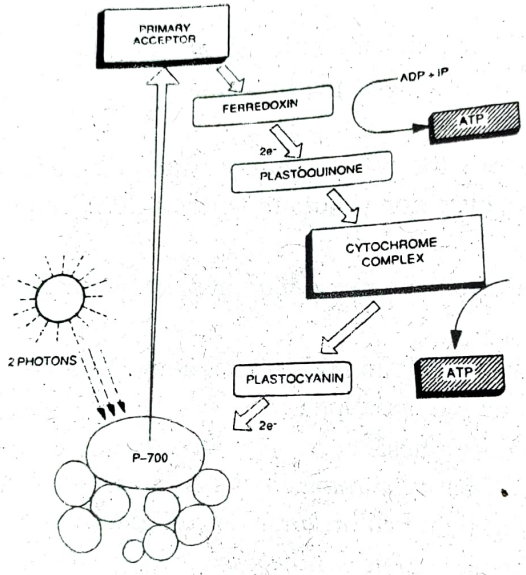
iii. Cell to cell diffusion of water is also affected by osmosis.

iv. Higher osmotic pressure of the cells provides resistance to the plants against drought injury.

v. It controls opening and closing of stomata during transpiration through its regulation of the turgidity of guard cells.

28. 2065 Q.No.2 b **Cyclic phosphorylation.** [3]

In this type of phosphorylation the initial donor and final accepter of electron is the same, chl- a' of PSI. Hence, the movement of electron is cyclic such type of phosphorylation. Occur in bacteria (Photosynthetic bacteria only) in this phosphorylation production of O_2 and only ATP is synthesized.



Process of cyclic phosphorylation

29. 2064 Q.No.2b **What are the differences between transpiration and guttation.** [3]

Difference between transpiration and guttation are follows:

Transpiration	Guttation
It occurs during day time.	It usually occurs in the night.
Water lost in the form of vapour.	Water lost in the form of liquid.
Water is pure.	Water mixed with minerals.
It takes place through stomata, lenticel or cuticle.	It occurs through lenticles.
It is a controlled process.	It is an uncontrolled process.

30. 2064 Q.No.2h **Differentiate between active absorption and passive absorption.** [3]

Active absorption	Passive absorption
It occurs due to the activity of roots and particularly root hairs.	It occurs due to the activity of shoot and leaves.
It is due to osmotic and non-osmotic mechanism.	It is due to active transpiration in the upper part.
Active absorption involves symplast movement of water in root hairs.	In passive absorption water moves probably through the free spaces or apoplast of root.

31. **2062 Q.No.2c Elaborate about glycolysis.** [3]

Please refer to 2070 Set D Q.No. 2b

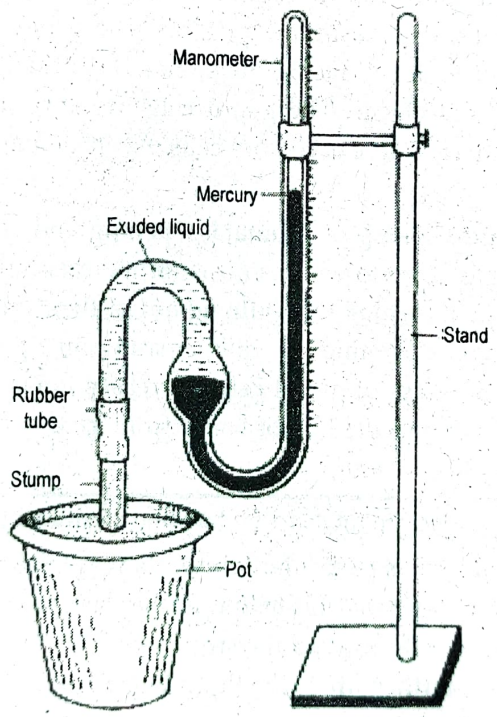
32. **2062 Q.No.2f Discuss an experiment to demonstrate the root pressure.** [3]

Demonstrate the process of root pressure

Apparatus required: A well watered herbaceous plant, a knife, a rubber tube, a narrow glass tube and colored water, manometer etc.

Theory: Root pressure is defined as hydrostatic pressure developed in the root due to accumulation of absorbed water. If the pressure exerted on the liquid contents of the cortical cells of the roots, under fully turgid condition this root pressure pushes the water up the xylem vessels to the aerial parts. It shows that water absorption is an active process.

Procedure: Water a potted herbaceous plant. Keep it over night. Next morning, cut off the stem a few centimeters above the soil level or near to the root. Fix a long and narrow glass tube to the cut end of the stump with the help of rubber tubing. Pour a little colored water in the glass tube and mark its level. The glass tube is connected to a manometer and whole setup is then left for observation.



Demonstration of root pressure

Observation: After some time the level of the colored water rises in the tube. And rise in the level of the mercury of the manometer shows the measurement of root pressure.

Result and conclusion: A rise in the level of water in the glass tube is due to the pressure exerted by water exuded from the cut part of the stem. The exuding of water from the cut end of the stem is called bleeding. The flow of water from the cut surface or bleeding when measured by mercury manometer is estimated to 3-5 atmospheres only.

Precautions:

i. The plant should be well watered but the soil should not be flooded
ii. The soil should not be deficient in minerals,
iii. Place the apparatus in cool and humid environment.
iv. Evaporation from the open end of the tube is prevented by using non-drying oil or petridish.
v. The plant should be vigorously growing.

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33. 2062 Q.No.2i **Differentiate between transpiration and guttation.** [3]

Please refer to 2064 Q.No.2b

34. 2062 Q.No.2h **Explain the process of grafting with its importance.** [3]

Grafting and budding are horticultural techniques used to join parts from two or more plants so they appear to grow as a single plant. In grafting the upper part (scion) of one plant groups on the root system (stock) of another plant. The main advantages of grafting are:

i. It is quicker than growing whole new plants saving even more time as well as money and space.
ii. Grafting repair damage parts of plants.
iii. It helps to produce disease resistant varieties.
iv. It is applicable for quick fruiting in plants.

35. 2061 Q.No.2b **How pyruvic acid is formed in glycolysis?** [3]

Please refer to 2070 Set D Q.No. 2b

36. 2060 Q.No. 1f **What cell controls the opening and closing of stomata?** [3]

A stoma is a minute pore on the epidermis of aerial parts of plants through which exchange of gases and transpiration take place. Each stoma is surrounded by a pair of kidney shaped guard cell (in dicot) and dumbbell shaped guard cell (in monocot). Each guard cell is a modified epidermal cell showing a prominent nucleus, cytoplasm and plastids. The wall of the guard cell is differentially thickened. The inner wall of each cell facing the stoma is concave and thick and rigid. The outer wall is convex and is thin and elastic. The guard cells are surrounded by a variable number of epidermal cells called subsidiary cell or accessory cells. Average length of stomata is 20 to 28μm and breadth 5 μm.

Mechanism of Opening and Closing of Stomata: Opening and closing of stomata occurs due to turgor changes in guard cells. Due to endoosmosis an increase in turgor of the guard cells takes place which finally results in stretching and bulging out of their outer thin walls. This result in the pulling apart of the opposed inner thicker walls creating an opening or pore in guard cells of stomata. When the turgor pressure of guard cells decreases inner walls sag, leading to closure of space between them. This is due to the loss of water from guard cells, resulting in thicker walls to move closer and finally shut the opening.

37. 2060 Q.No.2g **Describe how auxins are related with bending of shoots towards light.** [3]

The growth of plants toward light is particularly important at the beginning of their life cycle. Many seeds germinate in the soil and get their nutrition in the dark from their limited reserves of starch and lipids even mature plants bend toward the strongest light. They do this by elongating the cells of the stem on the side that is farthest from the light. This phenomenon is called phototropism. The substance responsible for cell elongation is auxin. This hormone is formed in cells at the tip of the shoot and is then passed from cell to cell. As such the hormone is shuttled through many cells of the plant before it reaches its final destination. Export and import proteins push the auxin out of one cell into the intercellular space and then into the next cell and so on until the auxin eventually reach its target site.

38. 2059 Q.No.2b **Mention the physiological effects of gibberellins in plant growth.** [3]

Physiological effects of gibberellins are:

i. Elongation of intact stems.
ii. Help to formation of dwarf shoots.
iii. It over come the natural dormancy of buds.
iv. It helps in seeds germination.
v. Helps in fruit development.
vi. They promote flowering in long day plants.

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39. **2058 Q.No.2a Describe biological role of gibberallic acid in plants.** [3]

Please refer to 2059 Q.No. 2a

40. **2058 Q.No.2d Describe an experiment showing Oxygen is evolved during photosynthesis.** [3]

Requirements:

Apparatus: Beaker, test tube, funnel, glass rod etc.

Materials: An aquatic plant e.g. *Hydrilla*, matchstick

Chemical: Water, sodium bicarbonate, pyrrogalic solution,

Theory: Photosynthesis (G.K. Photo - light, synthesis-production) is the anabolic process in which green plants produce their food in the presence of sunlight and chlorophyll and produce glucose and oxygen. The volume of oxygen released during photosynthesis is coequal to the volume of carbondioxide absorbed. The released oxygen is exclusively formed from water and not from carbondioxide. The process of photosynthesis can be represented by following chemical equation.

$$6CO_2 + 12\,H_2O \xrightleftharpoons[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

The overall reaction is not single and simple reaction between carbondioxide and water but a highly complex process in which a number of reactions occur. In it the radiant energy absorbed by chlorophyll is transferred in to chemical energy which is available for all vital activities of living cells. Photosynthesis consists of oxidation and reduction. The overall process of photosynthesis is completed into two main phases.

i. Light reaction or Hill reaction

ii. Dark reaction or Blackman reaction

Procedure: A few branches of an aquatic plant, *Hydrilla* are kept in a big beaker full of the same pond water. There after, the branches are covered with a glass funnel, and a test tube full of water is inverted at the end of the funnel. If rewired a small quantity of sodium bicarbonate may be added in water. So that the supply of carbon dioxide may become adequate for photosynthesis. Now, the apparatus is kept in the sun light.

Observation: The gas bubbles may be observed from the ends of the *Hydrilla* branches kept under the glass funnel in the beaker. These gas bubbles are accumulated in the end of the test tube inverted over the end of the funnel, and the water within the tube goes downward.

Test of oxygen Gas: Presence of oxygen gas can be tested by introducing a few drops of pyrogallate solution into the test tube. The pyrogallate solution absorbs oxygen immediately and the tube gets refilled with water. It can also be tested by introducing a burning stick.

Result and conclusion: The pyrogallic acid has property of absorbing oxygen gas. When pyrogallic acid introduced into the test tube, it absorbs oxygen gas collected at the top of test tube creating a partial vacuum and water up filing the vacuum. It concluded that the released gas during photosynthesis is oxygen.

Precautions:

i. Set up should be kept in sunlight.

ii. Plant should be completely dipped in water.

iii. The inverted test tube should be completely filled with water.

iv. The funnel should be raised from the bottom of beaker by keeping wooden support to maintain the flow of CO_2 source.

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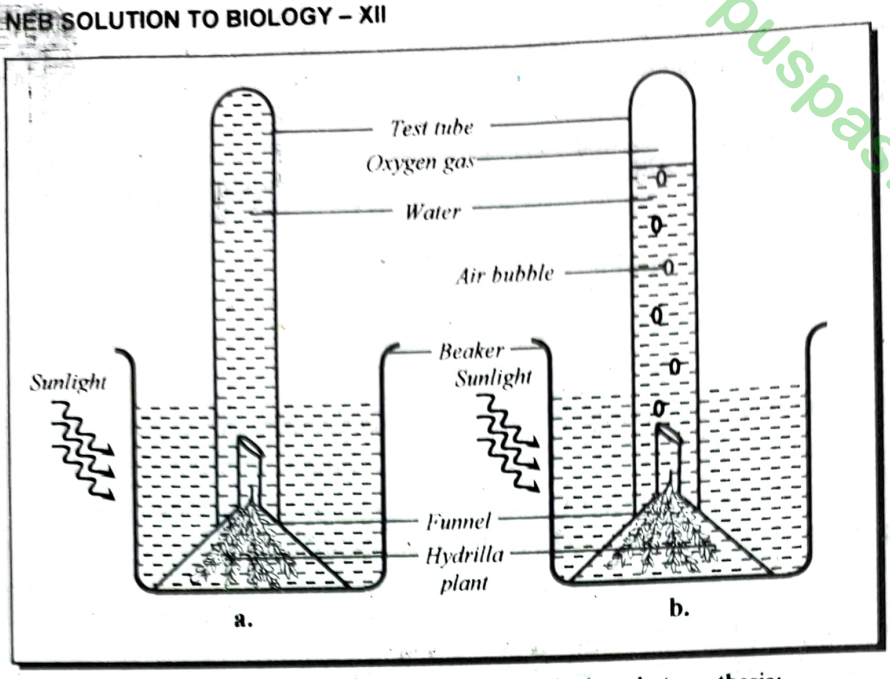

Demonstration showing evolution of oxygen during photosynthesis: a. at the beginning of the experiment; b. At the end of the experiment

41. 2058 Q.No.2i **Explain the significance of carboxylation in Calvin cycle.** [3]

The light independent reactions or dark reactions of photosynthesis are chemical reactions that convert CO_2 and other compounds into glucose. These reactions occur in the stroma, the fluid filled area of a chloroplast outside of the thylakoid membrances. These reactions take the products of light dependent reactions and perform further chemical process on them. There are three phases to the light dependent reactions, collectively called the Calvin cycle. The first step of Calvin cycle is carboxylation in which CO_2 molecule combines with a fire carbon molecules called ribulose, 1.5 biphoshate (RUBP) and produce a six carbon containing compound that split into two molecules of a three carbon compound 3 phosphoglyceric acid (3-PGA). This reaction is catalyzed by the enzyme RUBP carboxylase.

42. 2057 Q.No.2b **What are the physiological effects of cytokinins on plants?** [3]

Please refer to 2071 Set D Q.No. 2b

43. 2057 Q.No.2a **Discuss the role of light in photosynthesis.** [3]

Photosynthesis is the process in which light energy is converted into chemical energy using the energy of light, carbohydrates such as sugars are synthesized from CO_2 and H_2O. The process of photosynthesis occur when green plants use the energy of light to convert carbondoxide and water into carbonhydrates. Light energy is absorbed by chlorophyll, a photosynthetic pigment of the plant, while air containing carbon dioxide and oxygen enters the plant through the leaf stomata. An extremely important by product of photosynthesis is oxygen, on which most organism depend. The overall process of photosynthesis can be summarized by

$$6CO_2 + 12\,H_2O \xrightleftharpoons[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

44. 2053 Q.No.2c **Name any three plant hormones.** [3]

Please refer to 2075 Set B Q.No. 1c

MARK (√) THE CORRECT CHOICE [1 MARK]

1. 2056 Q.No. 1c **Rooting hormones are-** [1]

(i) Auxins (ii) Gibberllins
(iii) Kinetins (iv) Ethylene

Ans: Auxins

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2. **2055 Q.No. 1b Falling of leaves from plants is due to:**

(i) Excess of auxins in the leaf (ii) High concentration of ABA in the leaf
(iii) Due to cytokinins (iv) Due to gibberellin [1]

Ans: Due to cytokinins

3. **2054 Q.No. 1a Growth inhibiting hormone in plant is:**

☐ Abscisic acid ☐ Auxin
☐ Cytokinin ☐ Ethane [1]

Ans: Auxin

DIFFERENTIATE BETWEEN THE FOLLOWING PAIR OF WORDS [2 MARKS]

1. **2056 Q.No. 4f Auxins and gibberlins.** [2]

Differences between auxins and gibberlins are folllows:

Auxins	Gibberlins
They are mostly found in higher plants.	They are mostly found in fungi and few higher plants.
Auxin promotes growth in shoot segments.	Gibberallin promotes growth in intact shoot.
There is little effect on leaf growth.	Leaf growth is enhanced.
It does not cause bolting in rosette plants and root croops.	It bring about elongation of stem or bolting in rosette plants and root crops.

2. **2055 Q.No. 4 a Auxins and cytokinins** [2]

Differences between auxins and cytokinins are folllows:

Auxins	Cytokinins
It is produced in the shoot apex and leaf primodio.	It is found in the endosperm and embryo of seeds in fruits and roots.
It promotes the growth of apical bud.	It promotes the growth of lateral buds.

SHORT ANSWER QUESTIONS [2 MARKS]

1. **2053 Q.No. 3c What is plant growth inhibitor? Why is it necessary in plants?** [2]

Chemical substances which retard such processes as root and stem elongation, seed germination, and bud opening. These regulators actively depress growth of isolated stem sections and act as antagonists to the plant hormones such as auxin, gibberallin, and cytokinin. The most common example of plant inhibitors hormones are abscisic acid and ethylene.

2. **2052 Q.No. 3e Name any four growth hormones found in plant.** [2]

Following are the four growth hormones found in plant:

i. Auxins ii. Gibberellins iii. Cytokinin iv. Ethylene

LONG ANSWER QUESTION

1. **2076 Set B Q.No. 3 OR Describe an experiment to demonstrate light is necessary for the process of photosynthesis with clean diagram.** [7.5]

Apparatus and materials required: A healthy potted plant, a petri dish, a beaker containing water, forceps, a water bath, a piece of wire gauze, a tripod, a burner, a box of matches, alcohol a strip of black paper, iodine solution and clips.

Theory: Photosynthesis is a biochemical process by which green plants synthesize simple sugar in the presence of sunlight using carbon dioxide from the atmosphere and water from the soil. This simple sugar (glucose) is later converted to starch.

$$6CO_2 + 12H_2O \xrightarrow{\text{Chlorophyll/Sunlight}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

The most important factor for photosynthesis is light. The rate of photosynthesis depends on the quantity and quality of light. The chlorophyll molecule in green leaves absorb light; get excited and

emit electrons. The emitted electrons are used in the production of adenosine triphosphate (ATP). Finally the solar energy is converted into chemical energy and stored in the glucose produced.

The rate of photosynthesis is the maximum in the presence of red and blue lights, while in green light the rate is minimum because green light is reflected by the chlorophyll molecules.

Procedure:

1. Take the potted plant and keep it in a dark place for 2-3 days so that the leaves get destarched.
2. Cover a part of one of its leaves with the strip of black paper. Make sure that you cover both the sides of the leaf.
3. Now place this plant in sunlight for 3—4 hours.
4. Pluck the selected covered leaf and remove the black paper covering it.
5. Place this leaf in the beaker containing water and boil it for about 10 minutes.
6. Take out the leaf and now boil it in alcohol, using the water bath, for 10 minutes. This removes the chlorophyll.
7. Take out the leaf and wash it under running water.
8. Place this leaf in the Petri dish and put a few drops of iodine solution on it. Now observe the change in colour.

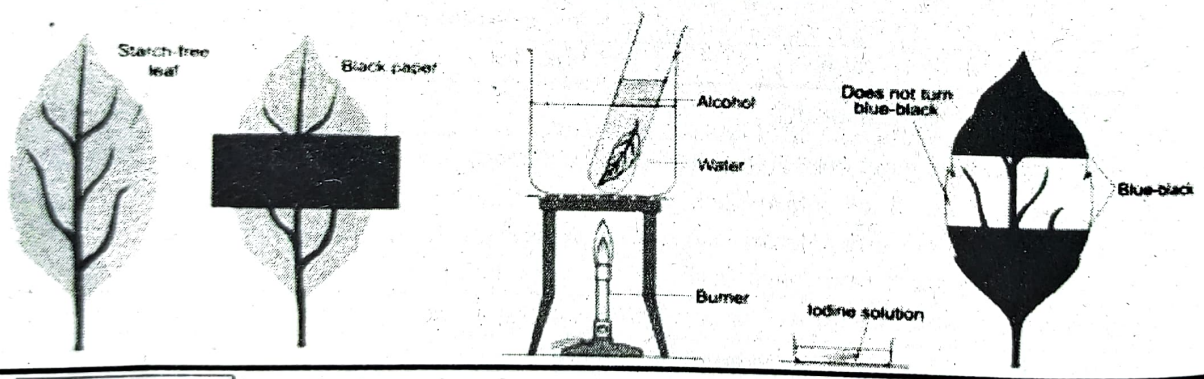
Observations:

The leaf turns blue-black except in the covered region. As this covered region did not receive light, photosynthesis did not occur. Hence no starch was formed there. The uncovered region received light and starch was formed there due to photosynthesis.

Result: Light is essential for photosynthesis.

Precautions:

1. Before starting the experiment, the leaf must be distracted.
2. The leaf must be covered with black paper properly to prevent the entry of light.
3. Boiling the leaf in alcohol should be done in the water bath.



2. **2076 Set C Q.No. 3 Describe the various factors that influence the photosynthesis in plants.** [7.5]

Photosynthesis (G.K. Photo - light, synthesis-production) is the anabolic process in which green plants produce their food in the presence of sunlight and chlorophyll and produce glucose and oxygen. The volume of oxygen released during photosynthesis is coequal to the volume of carbondioxide absorbed. The released oxygen is exclusively formed from water and not from carbondioxide. The process of photosynthesis can be represented by following chemical equation.

$$6CO_2 + 12\,H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

The overall reaction is not single and simple reaction between carbondioxide and water but a highly complex process in which a number of reactions occur. In it the radiant energy absorbed by chlorophyll is transferred in to chemical energy which is available for all vital activities of living cells. Photosynthesis consists of oxidation and reduction. The overall process of photosynthesis is completed into two main phases.

1. Light reaction or Hill reaction.
2. Dark reaction or Blackman reaction.

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Factors Affecting Photosynthesis

Like other physiological process, photosynthesis is also affected by a number of factors. These factors are

1. **Temperature:** When CO_2, like and other factors are not limiting, the rate of photosynthesis increases with a rise in temperature, over a range from 6°C to about 37°C. Above this temperature there is an abrupt fall in the rate and the tissue dies at 43°C. High temperatures cause the inactivation of enzymes and therefore affect the enzymatically controlled dark reactions of photosynthesis.
2. **Carbon Dioxide Concentration:** Nearly 0.032% by volume of CO_2 is present in the atmosphere and at this low level it acts as a limiting factor. Under laboratory conditions when light and temperature are not limiting factors, increase in CO_2 concentration in the atmosphere from 0.03%-1% raises rate of photosynthesis.
3. **Light:** The photosynthetically active region of the spectrum of light is at wavelength from 400-700nm. Green light (550nm) plays an important role in photosynthesis. Light supplies energy for the process. Light varies in intensity, quality and duration.
4. **Concentration of Oxygen:** O_2 has been shown to inhibit photosynthesis in C_3 plants while C_4 plants show little effect. It is suggested that C_4 plants have photorespiration and high O_2 stimulates it. The rate of photosynthesis increase by 30-50% when the concentration of O_2 in air is reduce from 20-0.5% and CO_2, light and temperature are not limiting factors.
5. **Water:** Water is an essential raw material in carbon assimilation. Less than 1% of the water absorbed by a plant is used in photosynthesis. The decrease in water contents of the soil from field capacity to the permanent wilting point results in the decreased photosynthesis.
6. **Mineral Elements:** Several mineral are essential for plant growth. These include Mg, Fe, Cu, Ci, Mn, P and are closely associated with reactions of photosynthesis.
7. **Air Pollutants:** Gaseous and metallic pollutants decrease photosynthetic activity. These include ozone, SO_2, oxidants, hydrogen fluorides, etc.
8. **Chlorophyll Content:** Chlorophyll is one of the important essential components required for the process of photosynthesis. It always takes place in green part of plants but never in non green parts.
9. **Anatomy of Photosynthetic parts:** The rate of photosynthesis gets influenced greatly by the structure of photosynthetic parts. Just like thickness of cuticle and epidermis, and distribution of stomata, chlorophyllous and non-chlorophyllous mesophyll tissues, etc. influence the rate of photosynthesis.
10. **Age of Leaf:** The rate of photosynthesis increases up to maturation of leaf. But the rate of photosynthesis may decrease in an aging leaf.

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3. 2076 Set C Q.No. 3 OR **Describe the various factors that affect the process of respiration in plants.** [7.5]

Most cell activity requires chemical energy. Respiration is the cellular process of releasing energy from food. Aerobic respiration releases fifteen times more energy than fermentation. The following eight points will highlight the eight major factors affecting aerobic respiration in Plants. (1) Oxygen Content of the Atmosphere (2) Effect of Temperature (3) Effect of Light (4) Effect of Water Contents (5) Effect of Respirable Material (6) Effect of Carbon Dioxide Concentration (7) Protoplasmic Conditions and (8) Other Factors.

1. **Oxygen Content of the Atmosphere:** The percentage of oxygen in the surrounding atmosphere greatly influences the rate of respiration. But reduction of the oxygen content of the air, however, causes no significant lowering in the respiratory rate until the percentage drops to about 10%. At 5% oxygen definite retardation of respiration occurs.
2. **Effect of Temperature:** Like most chemical reactions, the rate of respiration is greatly influenced by temperature. Estimation of Q 10 of the process for a rise in temperature from 8° to 18 °C gives a Q 10 of 2, indicating a chemical reaction. If the rise is at a much higher starting temperature, say between 20° and 30°C, then the Q 10 may fall below 2. It should be borne in mind that different plants or plant parts may show considerable variation in regard to optimum temperature for respiration.
3. **Effect of Light:** Light has indirect effects on the rate of respiration. With the increase in light

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intensity, the temperature of the surrounding atmosphere also increases thus affecting the rate of respiration. Secondly, the quantity of respirable material in the plant largely depends upon the rate of photosynthesis which is directly influenced by light and thirdly, stomata remain open during daylight and hence rapid exchange of gases takes place through them.

4. **Effect of Water Contents:** Over a certain range, water content of the plant tissue greatly influences its rate of respiration. In most of the storage able seeds the moisture content is kept below the point which allows a rapid respiration. With the increase in moisture content, the rate of respiration is likely to go up with the result a rapid loss of viability will occur and at the same time the temperature will also rise and the grain may be spoiled

5. **Effect of Respirable Material:** Amount and kind of respirable material present in the cells greatly affect the rate and course of respiration. It has been shown that plants respire more rapidly after having been exposed to conditions favorable for photosynthesis during which carbohydrates are synthesized. Increase in respiration has also been observed to be associated with increase in soluble sugars.

6. **Effect of Carbon Dioxide Concentration:** The rate of respiration is normally not affected by increase of carbon dioxide concentration in the surrounding atmosphere up to 19%, but as the concentration increases from 10% to 80%, a progressive decrease in respiration occurs.

7. **Protoplasmic Conditions:** The young growing tissues which have greater amount of protoplasm as compare to older tissues, show higher rate of respiration. Their higher rate of respiration supports the meristematic activities of the cells by supplying large amount of energy. The degree of hydration of the protoplasm in the cells affects the rate, and mechanical injury to plant tissues will accelerate respiration.

8. **Other Factors:** Various chemicals, such as cyanides, azides and fluorides, have been reported to possess respiration retarding properties through their effect on respiratory enzymes. Respiration rate may likely be accelerated by low concentrations of the compounds like ethylene, carbon monoxide, chloroform and ether.

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4. **2075 GIE Q.No. 3 OR Define respiration and describe the various steps involved in Kreb's cycle.** [7.5]

Respiration is the physiological process in which complete and incomplete oxidation of organic food takes place. In respiration the oxidation of various organic food substances like carbohydrates may take place. The process of respiration occurs in all living cells of plants and animals and generally called cellular respiration. The energy which produced during the process is used in all the life activities of the organisms. It is a catabolic process occurs in mitochondria and cytoplasm of the cell and represented by the following chemical equation.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + H_2O$ + Energy (2868KJor 686Kcal)

The main facts associated with respiration are

1. Consumption of atmospheric oxygen.
2. Release of energy by break down of organic food.
3. Liberation of carbon dioxide and a small quantity of water.
4. Oxidation and decomposition of reserve food.

Types of respiration: Based on availability of oxygen during the process, respiration can be classified into two types.

a. **Aerobic respiration:** Respiration which occurs in the presence of oxygen and organic food material is completely oxidised into CO_2 and H_2O with release of energy is called aerobic respiration.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + H_2O$ + Energy (2868KJor 686Kcal)

b. **Anaerobic respiration:** The respiration which occurs in the absence of oxygen and the organic food material is incompletely oxidised into ethyl alcohol and CO_2 with little amount of energy is called anaerobic respiration. It occurs in cytoplasm of a cell. Such type of respiration generally occurs in lower organisms like bacteria and fungi. It also occurs in many tissues of higher plants, seeds in storage, fleshy fruits, and muscles of animals. This process of incomplete oxidation is known as fermentation in the case of bacteria and fungi.

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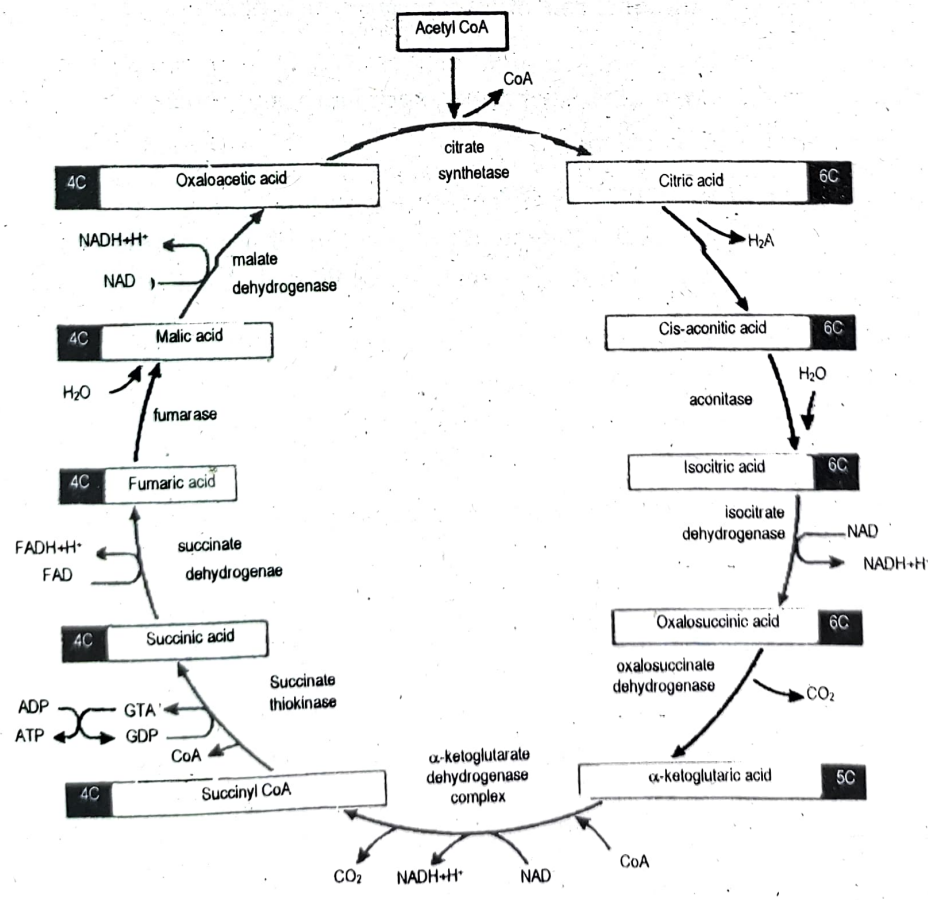
$C_6H_{12}O_6 \rightarrow CO_2 + C_2H_5OH + 5Okcal$

Kreb's Cycle (TCA-Cycle)

It occurs inside the mitochondrial matrix of inner chamber. Its details were given by Sir Hans Kreb's (1948). It is also called citric acid cycle (because the first stable product is citric acid) or Tricarboxylic Acid (because citric acid contain three 3-COOH groups). Kreb's Cycle is completed in eight successive steps.

Steps	Substrates	Enzyme	End-Products
1. **Condensation**	Acetyl-CoA+Oxaloacetic acid+H_2O	Citric acid synthetase	Citric acid +CoenzymeA(6C)
2. **Rearrangement**	It is again completed in two steps a) citric acid b) Cis-aconitic acid +H_2O	 Aconitase Aconitase	 Cis-Aconitic acid +H2O Iso-citric acid
3. **Dehydrogenation** (-2H)	Isocitric acid +NAD (H-acceptor)	Isocitrate dehydrogenase	Oxalosuccinate+NADH+H^+ (6C)
4. **Decarboxylation** (-CO_2)	Oxalosuccinate	Oxalosuccinate decarboxylase	α-ketoglutaric acid+CO_2 (5C)
5. **Oxidative Decarboxylation** (-2H) (-CO_2)	It also completed in two steps a) α-ketoglutarate + NAD +Coenzyme A b) Succinyl –CoA GDP+Pi	 α-ketoglutarate dehydrogenase complex Succinic thiokinase	 Succinyl-CoA+NADH+H^++CO_2 (4C) Succinate+Coenzyme-A+GTP (4C)
6. **Dehydrogenation** (-2H)	Succinate +FAD (H-acceptor) (FAD=Flavin Adenine Dinucleotide)	Succinate dehydrogenase	Fumarate+$FADH_2$ (4C)
7. **Hydration** (+H_2O)	Fumarate +H_2O	Fumarase	Malate(4C)
8. **Dehydrogenation** (-2H)	Malate+NAD (H-acceptor)	Malate dehydrogenase	Oxaloacetic acid+NADH+H^+ (4C)

Various Steps involved in Kreb's Cycle



Krebs cycle (TCA Cycle) and its detail reactions

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5. **2075 Set A Q.No. 3 OR** **Describe various steps of light reaction of photosynthesis.** [7.5]

✍ Please refer to Model (Botany) Q.No. 3

6. **2075 Set B Q.No. 3 OR** **Describe the experiment to demonstrate that light is necessary for the process of photosynthesis.** [7.5]

✍ Please refer to 2076 Set B Q.No. 3 OR

7. **2074 Supp Q.No. 3 OR** **Define transpiration and discuss the process of unequal transpiration in dicot leaf.** [7

✍ Most of the water absorbed is lost through the aerial parts of the plants into air by the process called transpiration. Very little water (less than 2%) is used up in various metabolic activities of plants. Most of the transpiration takes place through leaves known as foliar transpiration.

Types of transpiration: Transpiration may occur through the cuticle, lenticles stomata and sometime bark and according it is called. Cuticular, lenticular, stomatal and bark transpiration.

1. **Cuticular Transpiration:** It is the loss of water in the vapour from the general surface (leaves and young stems) through the layer of cuticle. Cubicula transpiration is appreciable only in case the cuticle is thin as in entophytic plants growing in humid areas. It is continues throughout day and night.
2. **Stomatal Transpiration:** It is the loss of water in vapour from the stomata present on the surface of leaves and to a lesser present on the surface of leaves and to a lesser extent on the surface of flowers and young stem. It is the major part of transpiration (80-90%) it however, occurs only when stomata are open.
3. **Lenticular Transpiration:** This is loss of water in vapours from lenticels or aerating poxes present in the bark of stems.
4. **Bark Transpiration:** A small quantity of water is lost from the corky bark of the stem. Both lenticular and bark transpiration continue day and night time.

Demonstrate the process of unequal rate of transpiration in a dorsiventral leaf.

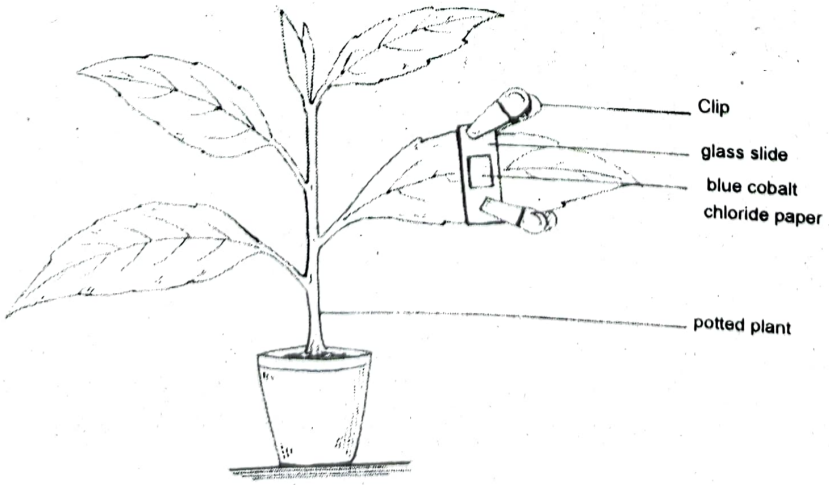
Requirements:

Apparatus: Two glass slide, two clips, filter paper, sprit lamp, and forceps.

Materials: Dorsiventral plant with leaf

Chemical: 5% Cobalt chloride solution, Vaseline

Theory: Same as back side and add a statement. But the rate of transpiration from the two surfaces of dorsiventral leaf is not same due to the unequal number of stomata per unit area on the two surfaces.



At the beginning of experiment

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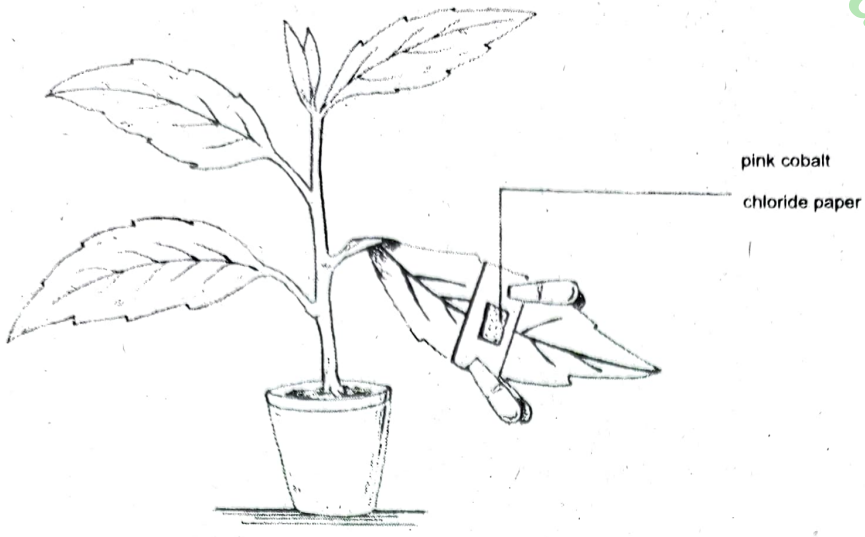

At the end of experiment

Procedure: Prepare 5% cobalt chloride solution by dissolving 5mg of anhydrous cobalt chloride in to 100ml distilled water. Take a healthy potted plant with elongated dorsiventral leaf. Wipe the leaf with the help of dry cotton. Take two pieces of filter paper of equal size. Soak pieces of filter paper in cobalt chloride solution. The moistened filter paper appears pink colour. Dry the pink coloured filter paper with the help of sprit lamp until it turns blue. Place blue filter paper on both the surfaces of dorsiventral leaf. Cover the pieces of blue filter paper with dry and clean glass slides. Tie slides with clips. Apply Vaseline over the edges of slide to make air tight. Place the experimental setup in sunlight and observe continuously.

Observation: The blue colour of cobalt chloride paper on the lower surface starts to change into pink colour within a few minutes while the paper on the upper surface takes some more time to turn into pink colour.

Result and conclusion: The change in colour of filter paper on both surfaces of leaf from blue to pink is due to the effect of the moisture which comes out from the leaf. Since the numbers of stomata are more in the lower surface of leaf, colour of filter paper changes from blue to pink quickly due to vigorous transpiration. On the other hand the change in colour of filter paper on the upper surface of leaf is slow due to less number of stomata. This concludes the unequal rate of transpiration two surfaces of dorsiventral leaf.

Precautions:

1. Potted plant should be healthy and well watered.
2. Indicator paper should be in equal size.
3. Moist filter paper should be dried completely.
4. Experimental leaf should be wiped and dried.
5. Vaseline should be applied on the edges of glass slide properly.

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8. 2074 Set A Q.No. 3 OR **What is photosynthesis? Discuss the experiment to demonstrate that co_2 is necessary for photosynthesis.** **[7.5]**

Photosynthesis (G.K. Photo - light, synthesis-production) is the anabolic process in which green plants produce their food in the presence of sunlight and chlorophyll and produce glucose and oxygen. The volume of oxygen released during photosynthesis is coequal to the volume of carbondioxide absorbed. The released oxygen is exclusively formed from water and not from carbondioxide. The process of photosynthesis can be represented by following chemical equation.

$$6CO_2 + 12\,H_2O \xrightarrow[\text{Chlorophyll}]{\text{Light}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

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The overall reaction is not single and simple reaction between carbondioxide and water but a highly complex process in which a number of reactions occur. In it the radiant energy absorbed by chlorophyll is transferred into chemical energy which is available for all vital activities of living cells. Photosynthesis consists of oxidation and reduction. The overall process of photosynthesis is completed into two main phases.

1. Light reaction or Hill reaction
2. Dark reaction or Blackman reaction

Demonstrate that carbondioxide is necessary for photosynthesis by Moll's half leaf experiment.

Requirements:

Apparatus: A wide mouthed bottle, split cork, petridish, beaker, test tube, sprit lamp.

Material: Destarch plant with healthy leaf.

Chemicals: Water, alcohol, iodine solution, Vaseline, KOH.

Theory:

Photosynthesis (G.K. Photo - light, synthesis-production) is the anabolic process in which green plants produce their food in the presence of sunlight and chlorophyll and produce glucose and oxygen. The volume of oxygen released during photosynthesis is coequal to the volume of carbondioxide absorbed. The released oxygen is exclusively formed from water and not from carbondioxide. The process of photosynthesis can be represented by following chemical equation.

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1. Light reaction or Hill reaction
2. Dark reaction or Blackman reaction

Procedure: A wide mouthed bottle with split cork in two equal halves is taken. The bottle is partially filled up with concentrated KOH solution. A leaf detached from the plant previously kept in darkness at least 48 hours is pressed in between the two halves of the cork of the bottle so that half the leaf remains within the bottle and the other half outside the bottle. The Petiole of the leaf remains outside which is kept in water filled beaker. So that the leaf may not become dry soon. The apparatus is made air tight by applying Vaseline so that the atmospheric air may not enter the bottle. There after the apparatus is kept in the sunlight for photosynthesis.

Test for Starch: Boil the experimental leaf in a test tube containing alcohol for five minutes to decolorize the leaf by making water bath. Wash the leaf with water to remove alcohol. Place the leaf on a petridish containing iodine solution.

Observation: After starch test, the portion of leaf outside the bottle turns blue black in colour and the colour remain unchanged in the portion of leaf that kept inside the bottle.

Result and conclusion: The carbon-dioxide within the bottle is absorbed by KoH solution and in the absence of CO_2, the photosynthesis does not take place and the starch is not formed. The portion of the leaf which remained outside the bottle could receive all the necessary factors for photosynthesis and the photosynthesis did take place in this portion forming starch. This portion of leaf gives positive starch test and becomes blue-black in contact of iodine solution. This way this experiment proves that CO_2 is necessary for the process of photosynthesis.

Precautions:

1. Leaf should be destarched.
2. The mouth of bottle should be sealed completely.

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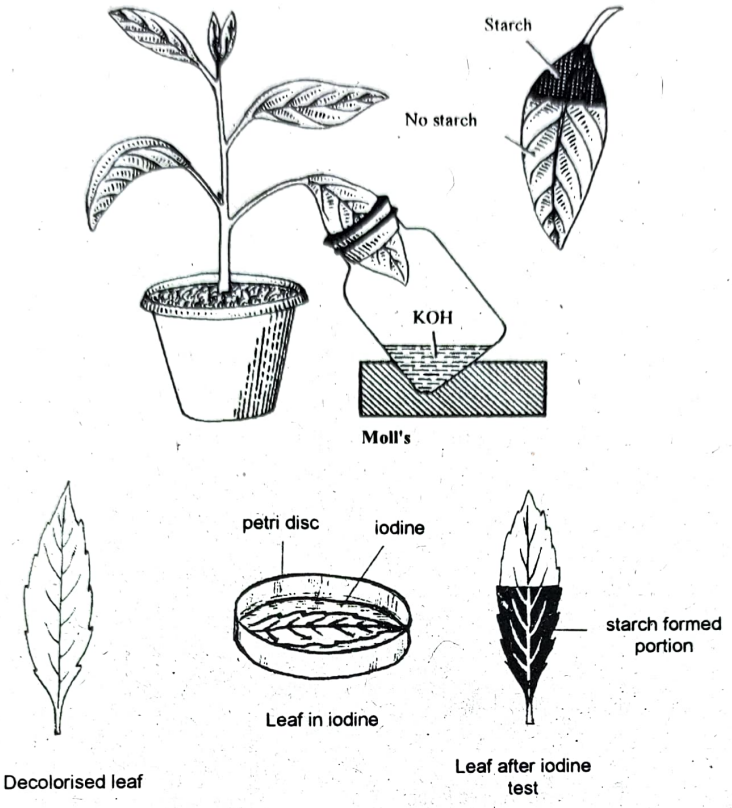
3. The portion of leaf inside the bottle should not touch KOH solution.
4. Setup should be placed in a light.
5. The decolorized leaf should be washed with water before iodine test.



9. **2074 Set B Q.No. 3 OR What is transpiration? Discuss the process of transpiration by bell jar method. [7.5]**

Respiration is the physiological process in which complete and incomplete oxidation of organic food takes place. In respiration the oxidation of various organic food substances like carbohydrates may take place. The process of respiration occurs in all living cells of plants and animals and generally called cellular respiration. The energy which produced during the process is used in all the life activities of the organisms. It is a catabolic process occurs in mitochondria and cytoplasm of the cell and represented by the following chemical equation.

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The main facts associated with respiration are

1. Consumption of atmospheric oxygen.
2. Release of energy by break down of organic food.
3. Liberation of carbon dioxide and a small quantity of water.
4. Oxidation and decomposition of reserve food.

Demonstrate the process of transpiration of bell jar method

Requirements:

Apparatus: Glass bell jar, wooden plate, polythene bag, thread,

Materials: Healthy potted plant

Chemical: Vaseline

Theory: Most of the water absorbed is lost in the form of vapour through the aerial parts of the plants in to the air by the process called transpiration. Very little water (Less than 2%) is used up in various metabolic activities of plants. Most of the transpiration takes place through the leaves known as foliar transpiration. Transpiration may occur through the cuticle, lenticels, stomata and sometime bark in some species of plants.

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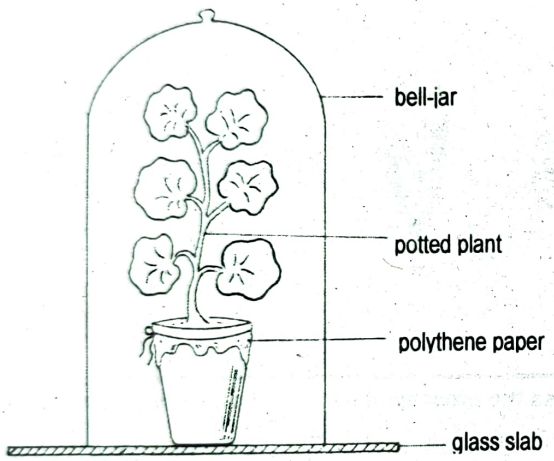
Procedure: A healthy potted plant is taken for this purpose. Now the soil surface of pot is be covered by the polythene bag so that there is no evaporation of water from the moist surface of soil. There after the potted plant is kept on a wooden plate is being covered over by a ball jar. margins of the bell jar are vase lined, so that the atmospheric air may not entry the bell jar. N covered potted plant is kept at contact to sunlight.

Observation: After sometime, the droplets, of water vapour appear on the inner surface of the bell j

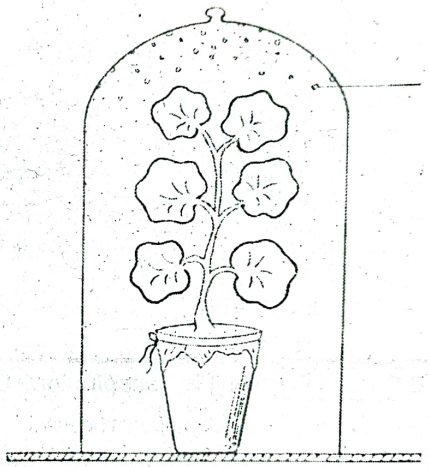
Result and conclusion: Since the bell jar and pot is sealed completely with Vaseline and polyth bag, there is no possibility of water vapour coming inside the apparatus from outer environm and soil. Thus, the only source of water accumulated on the inner side of bell jar is the wa escaping through the aerial parts of plant kept under bell jar. This concludes that water escapes through aerial parts of plant in the form of water vapour.

Precautions:

1. The soil surface of pot should be covered properly.
2. The edge of bell jar should be sealed properly with the help of Vaseline.
3. Experimentive plant should be healthy and well watered.
4. The setup should be kept in contact of sunlight.



At the beginning of experiment



At the end of experiment

10. **2073 Supp Q.No. 3 Describe an experiment to show the O_2 is evolved during photosynthesis with clear diagrams.** [7.5]

Please refer to 2058 Q.No. 2d

11. **2073 Set C Q.No. 3 OR What is respiration? Describe the various steps involved in Kreb's cycle.**

Please refer to 2075 GIE Q.No. 3 OR

12. **2073 Set D Q.No. 3 OR What is ascent of sap? Discuss the various theories involved in this phenomenon.** [7.5]

The upward movement of water or sap from the soil by root hairs and distributed to all parts of plants is called ascent of sap. This upward movement of sap takes place with the help of xylem tracheids and xylem vessels.

Theories for Ascent of Sap

Based on force responsible for ascent of sap there are three different theories

1. **Vital Force Theory:** A common vital force theory about the ascent of sap was given by J.C Bose (1923). It is called pulsation theory. The theory believes that the innermost cortical cells of the root absorb water from the outer side and pump the same into xylem channels. However living cells do not seem to be involved in the ascent of sap as water continues to rise upward in the plant in which roots have been cut or the living cells of the stems are killed by poison or heat.
2. **Root Pressure Theory:** The theory was put forward by Priestley (1916). Root pressure is a positive pressure that develops in the xylem sap of the root of same plant. It is a manifestation of active

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water absorption. Root pressure is observed in certain seasons which favor optimum metabolic activity and reduce transpiration. It is maximum during rainy season in the tropical countries and during spring in temperate habitats. Root pressure is retarded or becomes absent under conditions of starvation, low temperature, drought and reduced availability of oxygen. There are three view points about the mechanism of root pressure development

a. **Osmotic:** Tracheary elements of xylem accumulate salts and sugars. High solute concentration causes withdrawal of water from the surrounding cells as well as from the normal pathway of water absorption. As a result a positive pressure develops in the sap of xylem.

b. **Electro-Osmotic:** A bioelectric potential exists between the xylem channels and surrounding cells which favour the passage of water into them.

c. **Nonosmotic:** Differentiating xylem elements produce hormones that function as metabolic sinks and cause movement of water toward them. The living cells surrounding xylem can actively pump water into them.

3. **Physical Forces Theories:** Physical force theories suggest that as ascent of sap takes place through the dead xylem vessels, the mechanism is entirely physical and living cells are not involved. These theories are

a. **Boehm's Theory or Capillarity theory:** Boehm's (1809) suggested that the xylem vessels behave like the capillary tubes. He believed that this capillarity of the vessels and the normal atmospheric pressure are responsible for the ascent of sap. The vessel capillaries exert some force which helps to raise the water up to certain height of the stem.

b. **Imbibition Theory:** Sachs (1878) believed that water is imbibed through the cell wall materials and translocated upwards. So the theory states that ascent of sap takes place through the wall, but it is evident that water is translocated through the lumen of the vessels.

c. **Cohesion-Tension Theory or Transpiration Pull Theory:** This theory was given by Dixon in 1894. It was further improved by Dixon in 1914. It is also called cohesion and transpiration pull theory or Dixon theory of ascent of sap. It is most accepted theory. The main features of this theory are as follows:

i. **Cohesion Force:** Water molecules are held together by strong cohesion force which is due to hydrogen bonds amongst them. There is another force of adhesion which holds water to the walls of xylem channels.

ii. **Continuous Water Column:** A continuous column of water is present in the xylem channels of plant.

iii. **Transpiration Pull:** Loss of water from the aerial parts in transpiration causes a suction pressure in the water column of the plant. It is known as transpiration pull. Transpiration pull lifts the water in the water column of the plant. It is known as transpiration pull. Transpiration pull lifts the water upwardly. The continuity of water column does not break due to cohesion force between two water molecules.

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13. 2072 Supp. Q.No. 3 **What is transpiration? Describe an experiment to show the unequal rate of transpiration with clear diagrams.** **[7.5]**

Please refer to 2074 Supp Q.No. 3 OR

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14. 2072 Set C Q.No. 3 OR **Define respiration and explain the experiment to demonstrate the aerobic respiration with well labelled diagrams.** **[7.5]**

Respiration is the physiological process in which complete and incomplete oxidation of organic food takes place. In respiration the oxidation of various organic food substances like carbohydrates may take place. The process of respiration occurs in all living cells of plants and animals and generally called cellular respiration. The energy which produced during the process is used in all the life activities of the organisms. It is a catabolic process occurs in mitochondria and cytoplasm of the cell and represented by the following chemical equation.

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b. **Anaerobic respiration:** The respiration which occurs in the absence of oxygen and the organic food material is incompletely oxidised into ethyl alcohol and CO_2 with little amount of energy is called anaerobic respiration. It occurs in cytoplasm of a cell. Such type of respiration generally occurs in lower organisms like bacteria and fungi. It also occurs in many tissues of higher plants, seeds in storage, fleshy fruits, and muscles of animals. This process of incomplete oxidation is known as fermentation in the case of bacteria and fungi.

$C_6H_{12}O_6 \rightarrow CO_2 + C_2H_5OH$ + 5Okcal

Demonstrate the process of evolution of carbon dioxide during aerobic respiration by using gagong's respiroscope.

Requirements: Apparatus: Ganong's respirocope, beaker, clamped, stand, forceps, small test tube, thread.

Material: Germinating seeds of gram.

Chemicals: Water, KOH solution.

Theory: Respiration is the physiological process in which complete and incomplete oxidation of organic food takes place. In respiration the oxidation of various organic food substances like carbohydrates may take place. The process of respiration occurs in all living cells of plants and animals and generally called cellular respiration. The energy which produced during the process is used in all the life activities of the organism's. It is a catabolic process occurs in mitochondria and cytoplasm of the cell and represented by the following chemical equation.

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$C_6H_{12}O_6 \rightarrow CO_2 + C_2H_5OH$ + 5Okcal

Procedure: Take a respiroscope having a bulb with a long bent tube. Remove the seed-coat from the germinating seeds. Place them into the bulb through its open end. Dip the bent tube into the beaker containing water. Hang a small test tube containing KOH solution with a thread inside the bulb.

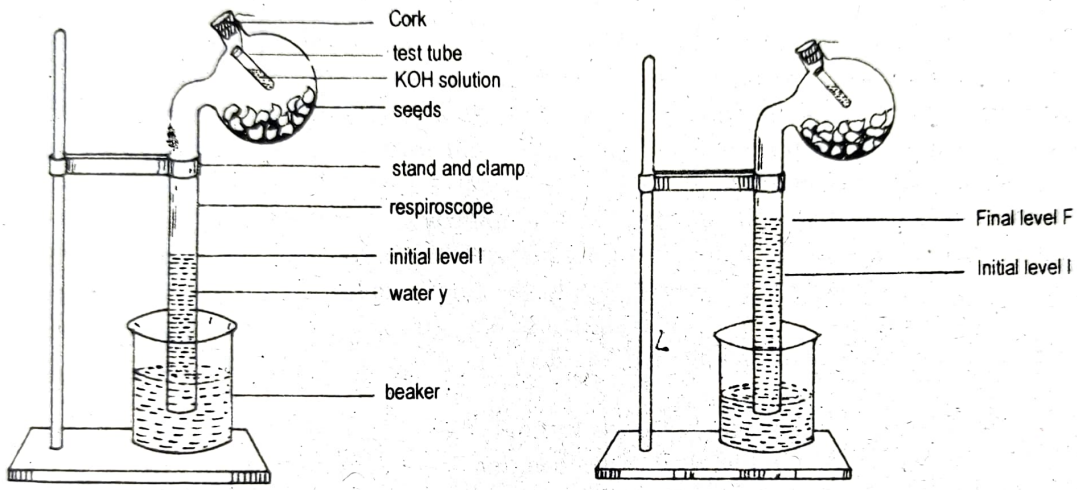
Close the open and tight with a cork. Fix the apparatus in a vertical position using the clamp and stand. Take an initial reading in the bent tube. Allow the set up to remain untouched for a few hours.

Observation: After few hours there is increase in the level of water in vertical graduated tube of respiroscope.

Result and conclusion: The germinating gram seeds placed in the bulb of respiroscope respire by utilizing oxygen present in the bulb releasing CO_2. The released CO_2 is absorbed by KOH and creates a partial vacuum in the bulb. The vacuum acts as suction pump and pulls water upwards from the beaker. Thus water rises up in the vertical tube to fill the vacuum. Since KOH absorbs only CO_2 gas, the evolved gas during respiration confirms CO_2.

Precautions:

1. Germinating seeds should be used without seed coat.
2. The respiroscope should be that properly.
3. The end of vertical tube should be dipped in water.
4. Level of water in the graduated tube should be taken carefully.



At the beginning of experiment

At the end of experiment

15. **2072 Set D Q.No. 3 OR Define photosynthesis and describe the experiment to demonstrate that CO_2 is necessary for photosynthesis (Moll's apparatus). [7.5]**

Please refer to 2074 Set A Q.No. 3 OR

16. **2072 Set E Q.No. 3 OR Describe in brief about the various factors that influences the photosynthesis in plants. [7.5]**

Please refer to 2076 Set C Q.No. 3

17. **2071 Supp. Q.No. 3 What is photosynthesis? Describe an experiment to show the process by moll's apparatus method. [7.5]**

Please refer to 2074 Set A Q.No. 3 OR

18. **2071 Set C Q.No. 3 Define photosynthesis and describe any experiment regarding the photosynthesis studied by you. [7.5]**

Please refer to 2074 Set A Q.No. 3 OR

19. **2071 Set D Q.No. 3 OR Define transpiration, and describe an experiment to show the rate of transpiration by Ganong's photometer. [7.5]**

Most of the water absorbed is lost through the aerial parts of the plants into air by the process called transpiration. Very little water (less than 2%) is used up in various metabolic activities of plants. Most of the transpiration takes place through leaves known as foliar transpiration.

Types of **transpiration**

Transpiration may occur through the cuticle, lenticles stomata and sometime bark and according it is called. Cuticular, lenticular, stomatal and bark transpiration.

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1. **Cuticular Transpiration:** It is the loss of water in the vapour from the general surface (leaves and young stems) through the layer of cuticle. Cuticular transpiration is appreciable only in case the cuticle is thin as in entophytic plants growing in humid areas. It is continues throughout day and night.
2. **Stomata Transpiration:** It is the loss of water in vapour from the stomata present on the surface of leaves and to a lesser present on the surface of leaves and to a lesser extent on the surface of flowers and young stem. It is the major part of transpiration (80-90%) it however, occurs only when stomata are open.
3. **Lenticular Transpiration:** This is loss of water in vapours from lenticels or aerating pores present in the bark of stems.
4. **Bark Transpiration:** A small quantity of water is lost from the corky bark of the stem. Both lenticular and bark transpiration continue day and night time.

Demonstrate the process of water up-take during transpiration by ganong's potometer.

Requirements:

Apparatus: Ganongs photometer, Cork with hole, beaker, Dropper.

Material: A helathy leafy shoot

Chemical: Vaseline

Theory: Most of the water absorbed is lost in the form of vapour through in the aerial parts of the plants in to the air by the process called transpiration. Very little water (Less than 2%) is used up in various metabolic activities of plants. Most of the transpiration takes place through the leaves known as foliar transpiration. Transpiration may occur through the cuticle, lenticels, stomata and sometime bark in some species of plants.

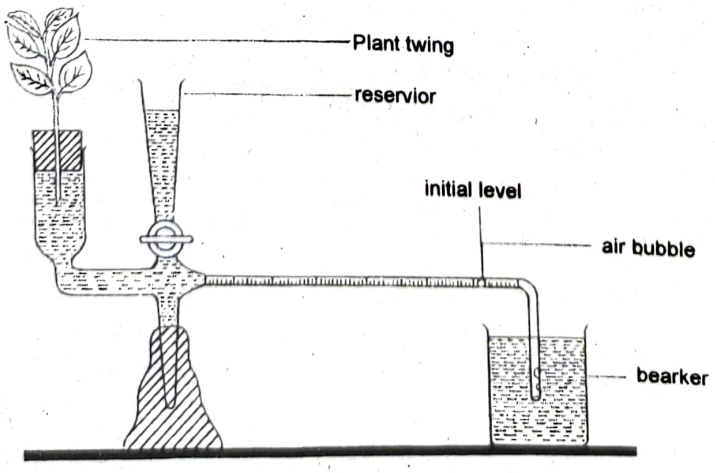
Procedure: Taka a Ganong's photometer. Fill it completely with water through reservoir. Cut a leafy twig under water and fix it in the shoot chamber with the help of a cork with hole. Dip the distal end of tube in a beaker containing water. Apply vaseline on the edge of the shoot chamber and hole of cork to make the setup air tight. Introduce air bubble through bent tube with the help of dropper, note the initial position of air bubble in graduated tube. Keep the experimental setup in sunlight for some time.

Observation: The air bubble slowly travels through the horizontal tube of potometer towards the plant. Mark the point where the air bubbles has finally reached and note the time taken to travel that distance.

Result and conclusion: The water escapes from the leaves of twig in the form of water vapour During transpirations a sunction force is created in the leafy twig. The sunction force leads the leafy twig to absorb water from horizontal tube of potometer. As a result of which the air bubble moves towards the twig in order to make continuity of water column in the plant.

Precautions:

1. The apparatus should be air tight
2. The plant twig should cut under water to avoid blockage in xylem vessel.
3. Only one air bubble should be entered in the capillary tube.



At the beginning of experiment

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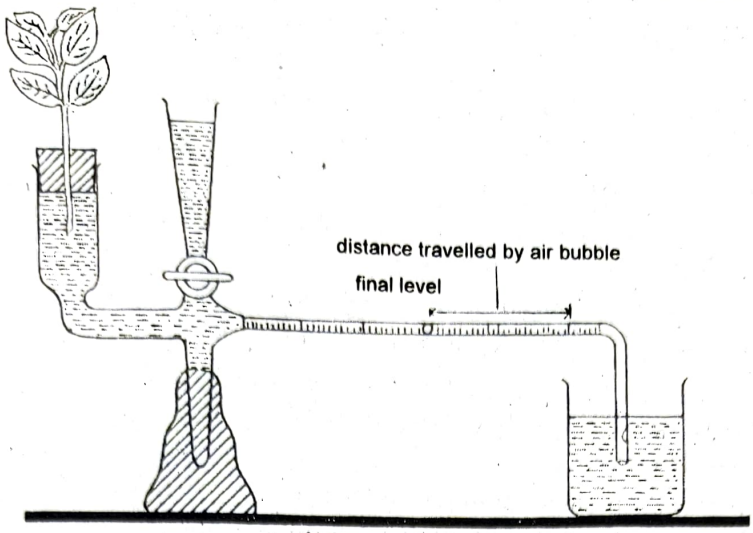

Experiment showing water uptake during transpiration by Ganong's potometer

20. **2070 Supp. Q.No. 3 OR Define respiration. Describe in detail the experiment to demonstrate the aerobic respiration with clean diagrams.** **[7.5]**

Respiration is the physiological process in which complete and incomplete oxidation of organic food takes place. In respiration the oxidation of various organic food substances like carbohydrates may take place. The process of respiration occurs in all living cells of plants and animals and generally called cellular respiration. The energy which produced during the process is used in all the life activities of the organisms. It is a catabolic process occurs in mitochondria and cytoplasm of the cell and represented by the following chemical equation.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + H_2O$ + Energy (2868KJor 686Kcal)

The main facts associated with respiration are

1. Consumption of atmospheric oxygen.
2. Release of energy by break down of organic food.
3. Liberation of carbon dioxide and a small quantity of water.
4. Oxidation and decomposition of reserve food.

Types of respiration: Based on availability of oxygen during the process, respiration can be classified into two types.

a. **Aerobic respiration**

Respiration which occurs in the presence of oxygen and organic food material is completely oxidized into CO_2 and H_2O with release of energy is called aerobic respiration.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + H_2O$ + Energy (2868KJor 686Kcal)

b. **Anaerobic respiration:** The respiration which occurs in the absence of oxygen and the organic food material is incompletely oxidised into ethyl alcohol and CO_2 with little amount of energy is called anaerobic respiration. It occurs in cytoplasm of a cell. Such type of respiration generally occurs in lower organisms like bacteria and fungi. It also occurs in many tissues of higher plants, seeds in storage, fleshy fruits, and muscles of animals. This process of incomplete oxidation is known as fermentation in the case of bacteria and fungi.

$C_6H_{12}O_6 \rightarrow CO_2 + C_2H_5OH$ + 5Okcal

Mechanism of respiration: The breakdown of organic food materials into carbondioxide and water with release of energy is complete in following steps.

1. Glycolysis
2. Oxidative decarboxylation
3. Kreb's cycle
4. Electron transport system / Terminal oxidation

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Demonstrate that carbon dioxide is evolved during fermentation

Requirements:

Apparatus: Glass rod, cotton, Kuhne's fermentation tube, beaker, forceps, etc

Material: Yeast powder.

Chemical: Sugar, water, KOH solution

Theory: Fermentation is an anaerobic respiration in which incomplete oxidation of organic food material into an ethylalcohol, carbondioxide with little amount of energy. It is an enzymatic process. The enzymes are produced by the metabolic activities of microorganisms such as bacteria and fungi (yeast). Alcoholic fermentation is a type of fermentation in which sugar is converted into ethyl alcohol and CO_2 with the help of enzyme zymase produced by yeast. The overall process of fermentation can be represented by following chemical equation.

$C_6H_{12}O_6 \rightarrow CO_2 + C_2H_5OH + 5Okcal$

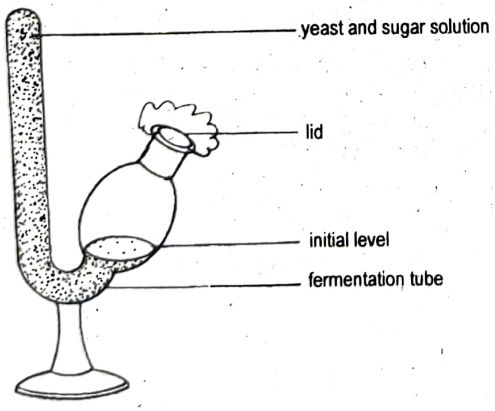
Procedure: Prepare 10% of sugar solution in beaker mix yeast powder in sugar solution. Stir the mixture with the help of glass rod to make homogenous mixture. Fill the vertical tube of fermentation tube fully and bulb partially. Note the initial position of mixture in the bulb. Cover the mouth of bulb with cotton plug place the experimental set up in a warm place for few hours.

Observation: After few hours gas starts collecting the solution downwards. The solution level in the bulb rise. The mixture emitting an alcoholic smell. After addition of KOH in the mixture, the solution resumes the original level in both vertical tube and bulb.

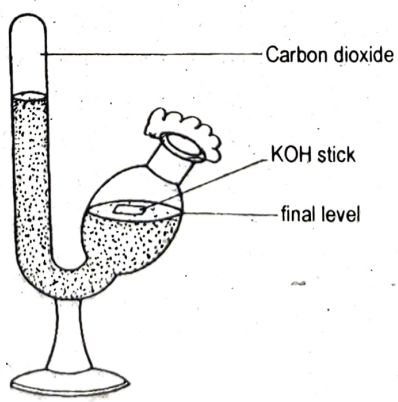
Result of conclusion: In the homogenous mixture of sugar solution and yeast, yeast cells produce enzymes that cause fermentation of sugar by converting it into alcohol and carbon dioxide. The released CO_2 is collected at the top of vertical tube, causes the rise in the level of mixture in the bulb. The collected gas is absorbed by KOH and partial vacuum is created in the tube. The vacuum acts as a suction pump and pulls the mixture from bulb, resulting in the fail of mixture in the bulb and fills the empty space of tube by solution. This confirms the evolved gas during fermentation carbon dioxide.

Precaution:

1. Sugar and yeast powder should be mixed homogeneously.
2. Vertical tube of fermentation tube should be filled completely by mixture of sugar solution and yeast.



At the beginning of experiment



At the end experiment

Experiment showing evolution of carbon dioxide during fermentation

21. **2070 Set C Q.No. 3 OR** **Define respiration. Describe in detail the experiment to demonstrate the anaerobic respiration with clean diagram.** [7.5]

Please refer to 2070 Supp. Q.No. 3 OR

22. **2070 Set D Q.No. 3** **What is transpiration? Discuss the experiment in detail to demonstrate the unequal transpiration with clean diagram.** [7.5]

Please refer to 2072 Supp. Q.No. 3

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23. **2069 Q.No. 3 OR Describe the experiment (Moll's apparatus) in detail showing the necessity of carbon dioxide during photosynthesis.** [7.5]

Please refer to 2074 Set A Q.No. 3 OR

24. **2068 Q.No. 3 OR What is transpiration? Describe an experiment to show the rate of transpiration by Ganong's potometer.** [7.5]

Please refer to 2071 Set D Q.No. 3 OR

25. **2067 Q.No. 3a OR What is transpiration? Describe an experiment to show the unequal transpiration.** [7.5]

Please refer to 2072 Supp. Q.No. 3

26. **2066 Q.No. 3 OR Define aerobic respiration and highlight major steps of this process.** [7.5]

Respiration is the physiological process in which complete and incomplete oxidation of organic food takes place. In respiration the oxidation of various organic food substances like carbohydrates may take place. The process of respiration occurs in all living cells of plants and animals and generally called cellular respiration. The energy which produced during the process is used in all the life activities of the organisms. It is a catabolic process occurs in mitochondria and cytoplasm of the cell and represented by the following chemical equation.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + H_2O$ + Energy (2868KJor 686Kcal)

The main facts associated with respiration are

1. Consumption of atmospheric oxygen.
2. Release of energy by break down of organic food.
3. Liberation of carbon dioxide and a small quantity of water.
4. Oxidation and decomposition of reserve food.

Types of respiration: Based on availability of oxygen during the process, respiration can be classified into two types.

a. **Aerobic respiration:** Respiration which occurs in the presence of oxygen and organic food material is completely oxidized into CO_2 and H_2O with release of energy is called aerobic respiration.

$C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + H_2O$ + Energy (2868KJor 686Kcal)

Steps in Aerobic Respiration: Aerobic respiration is a biological process that takes energy from glucose and other organic compounds to create a molecule called ATP. ATP is then used as energy by nearly every cell in the body. Aerobic respiration has four stages: glycolysis, formation of acetyl coenzyme A, the citric acid cycle, and the electron transport chain.

Step 1: **Glycolysis:** The first step of aerobic respiration is glycolysis. This step takes place within the cytoplasm of the cell, and is actually anaerobic, meaning it does not need oxygen. During glycolysis, break down of glucose take place in to pyruvic acids with release of energy in the form ATP and NADH molecule.

Step 2: **Formation of Acetyl Coenzyme A:** The next step in aerobic respiration is the formation of acetyl coenzyme A. In this step pyruvate is brought into the mitochondria to be oxidized, creating a 2- carbon acetyl group. This 2- carbon acetyl group then binds with coenzymes A, forming acetyl coenzyme A. The acetyl coenzyme A is then brought back into the mitochondria for use in the next step.

Step 3: **Kreb's Cycle or Citric acid cycle:** The third step of aerobic respiration is called the citric acid cycle. It is also called Kreb's cycle. Here oxaloacetate combines with the acetyl coenzyme A, creating citric acid. Two turns of the citric acid cycle are required to break down the original acetyl coenzyme A from the single glucose molecule. These two cycles create an additional two ATP molecules, as well as six NADH and two FADH molecules, all which are used later.

Step 4: **Electron Transport Chain:** The final step in aerobic respiration is the electron transport chain. In this phase, the NADH and FADH donate their electrons to make large amount of ATP. One molecule of glucose creates a total of 34 ATP molecules.

27. **2065 Q.No. 4 OR Give an experiment to show that CO_2 is essential for photosynthesis.** [8]

Please refer to 2074 Set A Q.No. 3 OR

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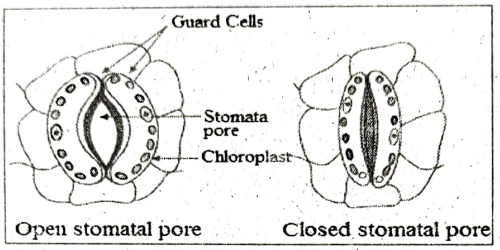
28. 2064 Q.No. 3 OR **Describe briefly the various influencing factors of photosynthesis.** [7.5]

Please refer to 2076 Set C Q.No. 3

29. 2063 Q.No. 3 **Give an account of the structure of stomata and its working mechanism during transpiration.** [7.5]

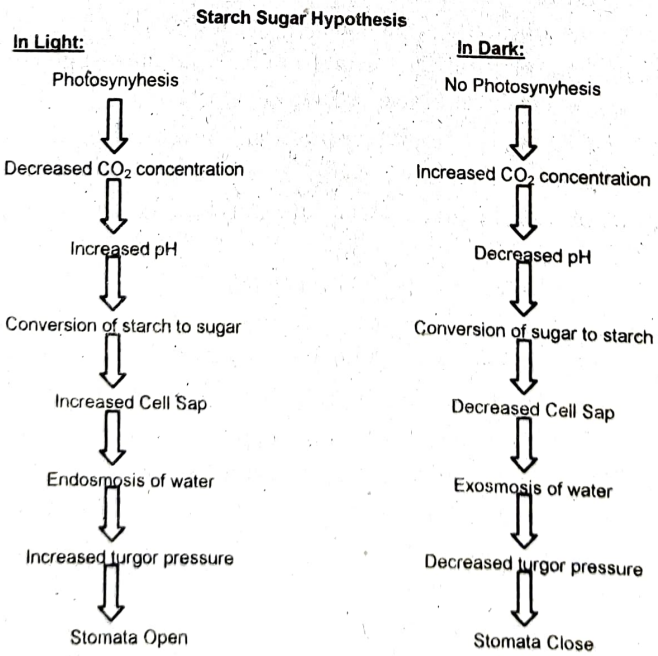
A stoma is a minute pore on the epidermis of aerial parts of plants through which exchange of gases and transpiration take place. Each stoma is surrounded by a pair of kidney shaped guard cell (in dicot) and dumbbell shaped guard cell (in monocot). Each guard cell is a modified epidermal cell showing a prominent nucleus, cytoplasm and plastids. The wall of the guard cell is differentially thickened. The inner wall of each cell facing the stoma is concave and thick and rigid. The outer wall is convex and is thin and elastic. The guard cells are surrounded by a variable number of epidermal cells called subsidiary cell or accessory cells. Average length of stomata is 20 to 28μm and breadth 5 μm.



Mechanism of Opening and Closing of Stomata

Opening and closing of stomata occurs due to turgor changes in guard cells. Due to endoosmosis an increase in turgor of the guard cells takes place which finally results in stretching and bulging out of their outer thin walls. This result in the pulling apart of the opposed inner thicker walls creating an opening or pore in guard cells of stomata. When the turgor pressure of guard cells decreases inner walls sag, leading to closure of space between them. This is due to the loss of water from guard cells, resulting in thicker walls to move closer and finally shut the opening. There are different theories to explain the opening and closing of stomata. Two of them are

1. **Starch Sugar Inter-convertible theory**

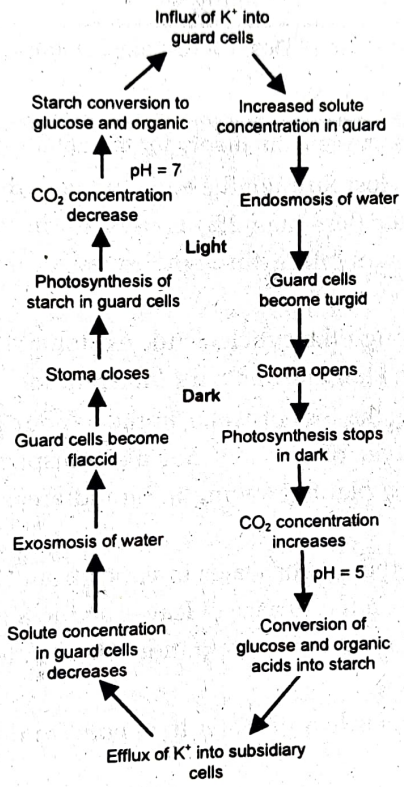


This theory was developed by Lioyd (1908) and later expended by Sayere (1926). According to this theory closing and opening of stomata depends upon turgidity of guard cells and turgidity always depends upon inter conversion of starch and sugar. During light utilization of CO_2 takes place during photosynthesis which decreases CO_2 concentration in leaf cells and increases PH. In high PH

starch converts into sugar which increases osmotic pressure of guard cells and withdraw water from surrounding cells. Due to which turger pressure of guard cellsincreases and stomata open. But during night time accumulation of CO_2 in protoplast of guard cell of stoma takes place due to lack of photosynthesis. It leads to decrease PH in guard cell due to formation of carbonic acid. The low PH converted sugar into starch which decreases osmotic pressure of gurad cells. Then water present in guard cell is transferred to subsidiary cells. As a result turger pressure of guard cells decrease and stomatal aperture close.

2. **Malate Or active Potassium ion (K+) transportation hypothesis**

This theory was proposed by Fujino (1959). It is also called K+ ions transport and hormonal regulation theory. According to this hypothesis the accumulation of K+ ion in guard cells bring the opening of stomata and loss of K+ ions causes closing of stomata. Overall process can be represented as



Active K^+ transport mechanism

30. **2062 Q.No. 3 OR What is respiration? Discuss the mechanism of anaerobic respiration.** [7.5]

2074 Set B Q. No. 3 OR (first part)

Anaerobic respiration

The respiration which occurs in the absence of oxygen and the organic food material is incompletely oxidised into ethyl alcohol and CO_2 with little amount of energy is called anaerobic respiration. It occurs in cytoplasm of a cell. Such type of respiration generally occurs in lower organisms like bacteria and fungi. It also occurs in many tissues of higher plants, seeds in storage, fleshy fruits, and muscles of animals. This process of incomplete oxidation is known as fermentation in the case of bacteria and fungi.

$C_6H_{12}O_6 \rightarrow CO_2 + C_2H_5OH + 5Okcal$

Mechanism of Anaerobic respiration

Anaerobic respiration involves glycolysis in which one molecule of glucose (6C) is degraded into two molecules of pyruvic acid (3C). Pyruvic acid acts as H-acceptor. Depending upon the metabolic pathways the end product of anaerobic respiration is either ethanol and carbon dioxide or lactic acid and not water.

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(a) Alcoholic Fermentation

This process is involved in brewing industry for producing bewerages like beer, rum, whiskey etc. It is done by brewing yeast. It involves following steps

1. Decarboxylation of pyruvic acid in the presence of enzyme pyruvate decaroxylase co-enzyme thiamine pyrophosphats and ZN^{++} as cofactor. It produces acetaldehyde.
2. Acetaldehyde accepts 2H atoms from $NADH_2$ in the presence of enzyme ethanol dehydrogenase and changes into ethanol.
3. Ethanol is lost so large amount of energy goes waste.
4. Accumulation of alcohol formed by fermentation in a culture of yeast cells stops multiplication of yeast cells and may even lead to the death of cells.

Alcohol fermentation is also used in baking industry in which CO_2 produced causes doughing of wheat flour. It occurs in the presence of baking yeast.

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31. 2061 Q.No. 3 OR What is transpiration? Describe an experiment to show an unequal transpiration. [7]

✍ Please refer to 2072 Supp. Q.No. 3

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32. 2060 Q.No. 3 OR Discuss cohesion-tension theory for the uptake of water. [7]

✍ Most of the water absorbed is lost through the aerial parts of the plants into air by the process called transpiration. Very little water (less than 2%) is used up in various metabolic activities of plant. Most of the transpiration takes place through leaves known as foliar transpiration. Types of transpiration

Transpiration may occur through the cuticle, lenticles stomata and sometime bark and according it is called. Cuticular, lenticular, stomatal and bark transpiration.

1. **Cuticular Transpiration:** It is the loss of water in the vapour from the general surface (leaves and young stems) through the layer of cuticle. Cubicula transpiration is appreciable only in case the cuticle is thin as in entophytic plants growing in humid areas. It is continues throughout day and night.
2. **Stomata Transpiration:** It is the loss of water in vapor from the stomata present on the surface of leaves and to a lesser present on the surface of leaves and to a lesser extent on the surface of flowers and young stem. It is the major part of transpiration (80-90%) it however, occurs only when stomata are open.
3. **Lenticular Transpiration:** This is loss of water in vapors from lenticels or aerating poxes present in the bark of stems.
4. **Bark Transpiration:** A small quantity of water is lost from the corky bark of the stem. Both lenticular and bark transpiration continue day and night time.

Cohesion-Tension Theory or Transpiration Pull Theory

This theory was given by Dixon in 1894. It was further improved by Dixon in 1914. It is also called cohesion and transpiration pull theory or Dixon theory of ascent of sap. It is most accepted theory. The main features of this theory are as follows:

i. **Cohesion Force:** Water molecules are held together by strong cohesion force which is due to hydrogen bonds amongst them. There is another force of adhesion which holds water to the walls of xylem channels.

ii. **Continuous Water Column:** A continuous column of water is present in the xylem channels of plant.

iii. **Transpiration Pull:** Loss of water from the aerial parts in transpiration causes a suction pressure in the water column of the plant. It is known as transpiration pull. Transpiration pull lifts the water in the water column of the plant. It is known as transpiration pull. Transpiration pull lifts the water upwardly. The continuity of water column does not break due to cohesive force between two water molecules.

33. **2059 Q.No. 3 OR Describe the light dependent steps of photosynthesis. How are they linked to the dark reaction? Discuss.** **[5+2]**

Please refer to Model (Botany) Q.No. 3 OR

Process of cyclic phosphorylation

The light reactions result in the production of reducing power, which reduce NADP and in the production of ATP. In the dark reaction these agents are used to reduce CO_2.

34. **2057 Q.No. 3 OR What are the types of transpiration? Explain the factors affecting the rate of transpiration.** **[1.5+5.5]**

Most of the water absorbed is lost through the aerial parts of the plants into air by the process called transpiration. Very little water (less than 2%) is used up in various metabolic activities of plants. Most of the transpiration takes place through leaves known as foliar transpiration.

Types of transpiration

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4. **Bark Transpiration:** A small quantity of water is lost from the corky bark of the stem. Both lenticular and bark transpiration continue day and night time.

Transpiration is affected by several external and internal factors:

i. **Light:** This is the most important factor affecting the rate of transporation. Transpiration not only accelerated by the direct sunlight but also by the diffused sunlight. Light affects transpiration in two ways. Firstly it increases the transpiration by raising the transpiration of leaves. Secondly there is close relationship between the opening and closing of stomata in the presence of stomata.

ii. **Humidity of Air:** Low and high humidity affects the transpiration. When the humidity low, air become drier and receives moisture readily. On the other hand when humidity increases air becomes moist or saturated. It receives less water vapors, thereby decreasing the rate of transpiration.

iii. **Temperature:** Rate of transpiration is directly affected by temperature increase temperature increase transpiration at certain limitation.

iv. **Available of soil water:** The rate of transpiration also depends on the amount of water absorbed by the roots. If absorption lags behind the rate of transpiration also diminishes.

v. **Leaf area:** Increase leaf area increase rate of transpiration because large leaf contain large number of stomata.

vi. **Leaf Structure**

vii. **Root-shoot ratio**

viii. **Velocity of wind**

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Unit 2

GENETICS

Very Short Answer Questions [1 mark]

1. **2076 Set B Q.No. 1b What do you mean by master strand?** [1]

Master strand means strand which helps to produce single strand of mRNA during the time of protein synthesis.

2. **2076 Set B Q.No. 1c Write the name of purine bases.** [1]

Purine bases are a dicyclic compound present in the form of Adenine and Guanine both in DNA and RNA.

3. **2076 Set C Q.No. 1d Mention about dominant allele.** [1]

Out of two alleles of hybrid one allele expresses its effect is called dominance e.g. Tt is a tall and tall is dominance character.

4. **2076 Set C Q.No. 1e Define heredity.** [1]

The process of transmission of characters from parents to offspring in successive generation is called inheritance.

5. **2075 GIE Q.No. 1d What do you mean by genotype?** [1]

The genetic make up of an organism is called genotype. e.g. The genotype of pure tall plant is TT and hybrid tall plant is Tt.

6. **2075 GIE Q.No. 1e Illustrate about recessive.** [1]

The character which fails to express it self in the presence of dominant gene is called recessiveness e.g in hybrid tall pea plant (Tt) T is dominant while t is recessive.

7. **2075 Set A Q.No. 1d What do you mean by genotype?** [1]

Please refer to 2075 GIE Q.No. 1d

8. **2075 Set A Q.No. 1i What do you understand by multiple allelism?** [1]

Phenomenon in which single character control by more than two alternative forms of gene present on the same locus. The best example is blood group of human being.

9. **2075 Set A Q.No. 1j Give significance of linkage.** [1]

The main significances of linkage are

i. Linkage plays an important role in determining the nature of scope of hybridization and selection programmes.

ii. Linkage reduces the chance of recombination of genes and thus helps to hold parental characteristics together. It thus helps organism to maintain its parental, racial and other characters.

10. **2075 Set B Q.No. 1d What do you mean by gene pool?** [1]

Total variety of gene existing in a sexually reproducing organism is called gene pool.

11. **2075 Set B Q.No. 1e Elaborate offspring.** [1]

Please refer to 2075 GIE Q.No. 1e

12. **2074 Supp Q.No. 1d What do you mean by genetic material?** [1]

A material which helps to transmission o characters from parents to their offspring's is called genetic material e.g. DNA and RNA act as genetic material in entire living being on earth surface.

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13. **2074 Supp Q.No. 1e Elaborate backcross.** [1]

The cross of F_1 hybrid with any of two parents is called back cross. It is used to identify the hidden recessive alleles

14. **2074 Set A Q.No. 1d State about synapsis.** [1]

Synapsis is an event that occurs during meiosis in which homologous chromosomes pair with their counterparts and remain bound due to the exchange of genetic information. During meiosis, homologous chromosomes are paired and then separated to reduce the genetic content of the resulting gamete cells. Synapsis does not occur during mitosis, because homologous chromosomes do not pair with their counterparts. Synapsis starts when proteins connecting the various chromosomes to the nuclear membrane start to migrate. The proteins move around until their counterpart is found, and the synaptonemal complex is formed. The synaptonemal complexes consist of protein and RNA, and hold the homologous chromosomes together.

15. **2074 Set A Q.No. 1e What do you mean by gene pool?** [1]

Please refer to 2075 Set B Q.No. 1d

16. **2074 Set B Q.No. 1d What does it mean by heredity?** [1]

Please refer to 2076 Set C Q.No. 1e

17. **2074 Set B Q.No. 1e What is genotype?** [1]

Please refer to 2075 Set A Q.No. 1d

18. **2073 Supp Q.No. 1d What does it mean by allele?** [1]

Alternative form of gene is called alleles.

19. **2073 Supp Q.No. 1e Illustrate about DNA.** [1]

DNA is a type of nucleic acid formed by the combination of thousands of nucleotide called deoxyribonucleotide. It acts as a genetic material in all kinds of living organism including some virus.

20. **2073 Set C Q.No. 1d What does it mean by monohybrid cross?** [1]

Please refer to Please refer to 2075 Set A Q.No. 1d

21. **2073 Set C Q.No. 1e Write the full form of t RNA and m RNA.** [1]

Full form of tRNA is Transfer RNA and mRNA is Messenger RNA

22. **2073 Set D Q.No. 1d What does it mean by gene?** [1]

Gene is a smallest DNA segment of which responsible for characters of an organism's.

23. **2073 Set D Q.No. 1e Elaborate test cross.** [1]

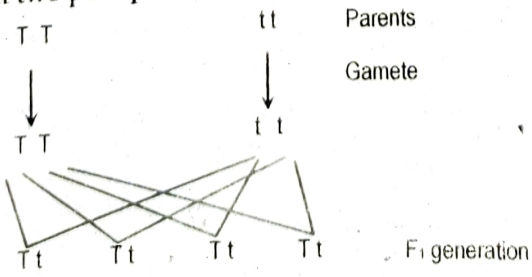
The cross of F_1 hybrid with recessive parent is called test cross it is used to determine the genotype of unknown individual.

24. **2072 Supp. Q.No. 1d What does it mean by heterozygote?** [1]

The individual with two different alleles of the same gene is called heterozygous. e.g. Tt. (Hybrid tall)

25. **2072 Supp. Q.No. 1e Illustrate about F_1 generation.** [1]

Offspring produce from two pure parental stocks, is called F_1 generation.



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26. **2072 Set C Q.No. 1d What is genetic material?**

Please refer to 2072 Set D Q.No. 1d [1]

27. **2072 Set C Q.No. 1e Define offspring.**

Please refer to 2075 Set B Q.No. 1e [1]

28. **2072 Set D Q.No. 1d What is homozygous?**

The individual which have identical alleles of same gene are called homozygous e.g. TT, tt. [1]

29. **2072 Set D Q.No. 1e Define recessiveness.**

Please refer to 2075 GIE Q.No. 1e [1]

30. **2072 Set E Q.No. 1c Differentiate dominance and epistasis.**

Difference between dominance and epistasis are follows; [1]

Dominance	Epistasis
It involves a single pair of alleles.	It involves two pairs of alleles.
Dominance occurs due intragenic.	Epistasis occurs due to intergenic gene interaction.

31. **2072 Set E Q.No. 1j State law of independent assortment.**

Law of independent assortment state that factors (gene) for each characters assorted independently from one generation to another generation. [1]

32. **2072 Set E Q.No. 1d Define gene mutation.**

Mutation which occurs due to nitrogenous is called gene mutation it also called point or micromutation. [1]

33. **2071 Supp. Q.No. 1c Define phenotype?**

The morphological appearance of an organism is called phenotype e.g. The genotype of a hybrid tall is Tt and its phenotype is tall. [1]

34. **2071 Supp. Q.No. 1e Define trait.**

Traits are the characters of an organism which are determined by gene e.g. tall, dwarf, Red green etc are the traits of plant. [1]

35. **2071 Set C Q.No. 1d What does it mean by trait?**

Please refer to 2071 Supp. Q.No. 1e [1]

36. **2071 Set C Q.No. 1e Illustrate about RNA.**

RNA is a type of nucleic acid which act as genetic material in some virus and also involved in protein synthesis. It is made up Purine, pyrimidine, Ribose sugar and phosphate molecules. [1]

37. **2071 Set D Q.No. 1d What does it mean by muton?**

A segment of DNA which can under goes to mutation is called muton. [1]

38. **2071 Set D Q.No. 1 e Define homozygous.**

Please refer to 2072 Set D Q.No. 1d [1]

39. **2070 Supp. Q.No. 1 d What is genetic material?**

Please refer to 2072 Set D Q.No. 1d [1]

40. **2070 Supp. Q.No. 1 e What do you mean by dominance?**

Please refer to 2076 Set C Q.No. 1d [1]

41. **2070 Set C Q.No. 1 d What does it mean by homozyous?**

Please refer to 2072 Set D Q.No. 1d [1]

42. **2070 Set C Q.No. 1 e Elaborate the offspring.**

Please refer to 2075 GIE Q.No. 1e [1]

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43. **2070 Set D Q.No. 1 d What does it mean by homozygous?** [1]

Please refer 2067 Q.No. 1e

44. **2070 Set D Q.No. 1 e What do you mean by recessive?** [1]

Please refer 2070 Set C Q.No. 1e

45. **2069 Q.No. 1d Define polyploidy.** [1]

Please refer to Model (Botany) Q.No. 1e

46. **2069 Q.No. 1e What do you mean by test cross?** [1]

The cross of F_1 hybrid with the recessive parent is called test cross. This is used to determine the genotype of an unknown individual.

47. **2068 Q.No. 1d Define inheritance.** [1]

Please refer 2076 Set C Q.No. 1e

48. **2068 Q.No. 1e What is variation?** [1]

The difference which occurs in offspring of same parent is called variation.

49. **2067 Q.No. 1d What is heredity?** [1]

Please refer to 2076 Set C Q.No. 1e

50. **2067 Q.No. 1e What is homozygous?** [1]

Please refer to 2072 Set D Q.No. 1d

51. **2066 Q.No. 1 c What is a heterozygous organism?** [1]

Please refer to 2072 Supp. Q.No. 1d

52. **2065 Q.No. 1 e What is a backcross?** [1]

Please refer to 2074 Supp Q.No. 1e

53. **2065 Q.No. 1 f Write chemical differences between DNA and RNA.** [1]

Differences between DNA and RNA are follows:

DNA	RNA
It is made up of Deoxyribose sugar.	It is made up of Ribose sugar.
It consists of nitrogenous base in the form of A, C, T, G.	It consists of nitrogenous base in the form A, C, G,U.

54. **2065 Q.No. 1 g Define polyploidy** [1]

Please refer to Model (Botany) Q.No. 1e

55. **2063 Q.No. 1n What do you understand by the term allele?** [1]

Please refer to 2073 Supp Q.No. 1d

56. **2063 Q.No. 1c What do you mean by the term anemophily?** [1]

Pollination which takes place with the help of air is called anemophily.

57. **2063 Q.No. 1o Define gene-pool.** [1]

Please refer to 2075 Set B Q.No. 1d

58. **2062 Q.No. 1d What does it mean by monohybrid cross?** [1]

Cross between single pair of contrasting characters is called monohybird cross. For example cross between tall pea plants with dwarf pea plants. Here tall and dwarf is the single contrasting of plant height.

59. **2061 Q.No. 1d What does it mean by genotype?** [1]

Please refer to 2075 GIE Q.No. 1d

60. **2061 Q.No. 1e Write full form of t RNA and m RNA.** [1]

Full form of tRNA is Transfer RNA and mRNA is Messenger RNA

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61. **2060 Q.No. 1g What is polyploidy?** [1]

Please refer to Model (Botany) Q.No. 1e

62. **2060 Q.No. 1m What is a regulator gene?** [1]

The gene that controls the activity of structural gene by formation of repressor protein is called regulator gene.

63. **2059 Q.No. 1c Give one example of co-dominance.** [1]

Example of co-dominance is human blood group AB'.

64. **2059 Q.No. 1d Mention the nitrogen bases present in pyrimidine.** [1]

Nitrogenous base present in pyrimidine are: Thymine, Cytosine and Uracil.

65. **2058 Q.No. 1d Write two examples of polyploidy.** [1]

Two examples of polyploidy are: Modern variety of wheat (*Triticum aestivum*) and *Brassica napu.*

66. **2058 Q.No. 1e What is punnett square?** [1]

It is a mathematical table with vertical and horizontal columns in which all gametes from female parent are entered on the left hand vertical side and all gametes from male parent are entered on top horizontal side.

67. **2058 Q.No. 1i Define linkage.** [1]

Linkage is the association of gene in a chromosome.

68. **2058 Q.No. 1m Give the significance of polygenic trait.** [1]

It helps to know the frequency distribution of genotype for showing continuous variation.

69. **2057 Q.No. 1e Define allele.** [1]

Please refer to 2073 Supp Q.No. 1d

70. **2057 Q.No. 1g Give one example of polygenic inheritance.** [1]

Please refer to Model (Botany) Q.No. 1c

71. **2057 Q.No. 1n Define genetic code.** [1]

Please refer to Model (Botany) Q.No. 1d

72. **2053 Q.No. 3e Why is the phenotypic ratio 3 : 6 : 3 : 1 : 2 : 1 obtained?** [1]

The classical or Mendelian phenotypic ratio of 9:3:3:1 is obtained only when the alleles at both gene loci display dominant and recessive relationships. If one or both gene loci have incompletely dominant alleles, or codominant alleles or lethal alleles, the dihybrid ratio becomes modified variously, such as follows: 1. 3: 6 : 3 : 1 : 2 : 1 ratio When the dihybrid parents have dominant and recessive alleles at one gene locus and codominant alleles at second gene locus, the F_2 9 : 3 : 3 : 1 Phenotypic ratio becomes 3: 6: 3: 1: 2: 1.

73. **2052 Q.No.2d List the characters of identification of genetic disorder.** [1]

List of identification of genetic disorder are

i. The parents have another child with genetic disorder.
ii. There is a family history of a genetic disorder.
iii. One parent has a chromosomal abnormality.
iv. The fetus has abnormalities seen o- ultrasound.

Answer all in brief [3 marks]

1. **2076 Set B Q.No. 2c Structure of RNA.** [3]

RNA is typically stranded and is made of ribonucleotides that are linked by phosphodiester bonds. A ribonucleotide in the RNA chain contains ribose sugar, one of the four nitrogenous bases (A, U, G and C) and a phosphate group. The structure of RNA contain following characters.

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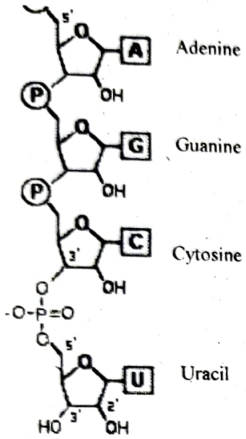
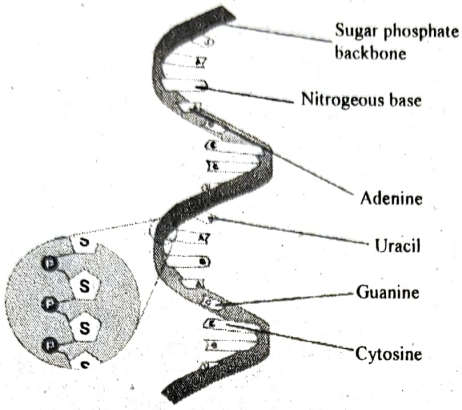
i. It is also a macro molecules made up of thousands of polynucleotide.
ii. It is single stranded which run 5-3 direction.
iii. Each nucleotide consists of a ribose sugar, phosphate, and one of the four nitrogen bases. The nucleotides of RNA are called ribonucleotide.
iv. RNA contains nitrogenous base in the form of G, C, A, U.
v. On the absis of molecular size and functions RNA can be classified into 3 types. i.e. t-RNA, m-RNA, r-RNA.



Chemical structure of RNA



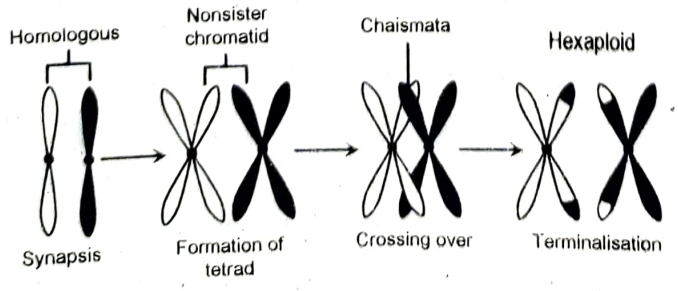
Structure of RNA

2. **2076 Set B Q.No. 2d Mechanism of crossing over.** **[3]**

Crossing over is the exchange of homologous segments between non sister chromatids of homologous chromosomes. Due to the process of crossing over new genetic combination take place among the species. it take place during pachytene sub stage of meiosis first.

Mechanism of crossing over: Crossing over is a physical process due to which production of new or non parental combination produces. The process of crossing over involves the following stages.

1. **Synapsis:** The pairing between homologous chromosomes during zygote sub stage of meiosis is called synapsis. The pairing starts at one or more points and proceeds through their entire length. The paired homologous chromosomes are called bivalents synapsis occurs in the presence of synaptinemal complex.
2. **Formation of Tetrad:** The synapsis is followed by duplication of chromosomes. After duplication of chromosomes each of the homologous chromosome in a bivalent split longitudinally into two sister chromatids and formed four chromatids is known as tetrad.
3. **Formation of chiasmata and crossing over:** The non-sister chromatids twist over each other at one or more points called chiasmata. The segments of chromatids break at corresponding point and exchange their genetic material which is called crossing over. The process of crossing over and chiasmata formation take place in pachytene and diplotene sub stage of meiosis.
4. **Terminalization:** The homologous chromosomes are attached at multiple points in order for recombination before diakinesis. During diakinesis these attachments start moving towards the edge of the chromosome and thus the non-sister chromatids are separated from each other which is called treminalization.



Process of crossing over

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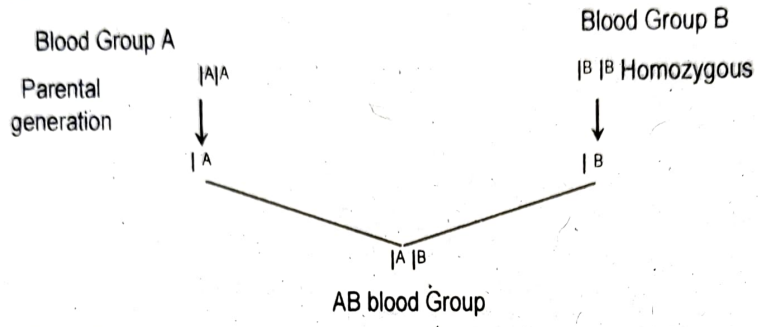
3. **2076 Set B Q.No. 2g Describe the co-dominance with suitable example.** [3]

A form of dominance in which the alleles of a gene pair in a heterozygote are fully expressed. The resulting offspring is neither dominant nor recessive. The best example of co-dominance can be seen in blood group AB.

Example

There are four phenotypic classes of human blood types. These are A, AB and o. These blood types are due to the action of three alleles of the blood group gene I. The alleles IA and IB both are dominant over alleles Io and are co-dominant with each other also. A cross between IAIA and IBIB will result in the hybrid with AB blood group which is different from A or B. so here is a case of a gene having more than two alleles, called multiple alleles in which two alleles (I^A and I^B) are co-dominant and the third alleles I^O is recessive to both I^A and I^B.



4. **2076 Set C Q.No. 2c Difference between homozygous and heterozygous.** [3]

Difference between heterozyous and homozygous;

Homozygous	Heterozygous
It is pure for a trait and breed true. i.e give rise to similar homozygous individuals.	Heterozygous individual is seldom pure and produces offspring with different genotypes on selfing e.g TT, Tt, and tt on selfing of Tt individuals.
Both the alleles of a trait are similar e.g TT, tt.	It carries dissimilar alleles. e.g Tt
It produces one type of gametes.	It produces two types of gametes.

5. **2076 Set C Q.No. 2d Structure of RNA.** [3]

Please refer to 2076 Set B Q.No. 2c

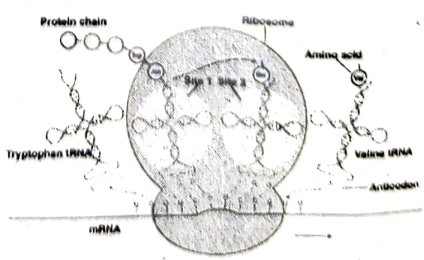
6. **2076 Set C Q.No. 2e Process of translation.** [3]

It is a process of formation of protein from RNA. It is also a process of translating the language of nucleotide sequence of mRNA into the amino acids sequences. It occurs by the formation of peptide bonds between amino acids where order is specified by mRNA.

The process of translation is completed into following steps.

1. Activation of amino acids
2. Attachment of activate amino acid to t-RNA
3. Initiation protein syntheses
   a. Formation of 40S ribosomal complex
   b. Formation of 80S ribosomal complex
4. Elongation of polypeptide Chain
   a. Binding of amino acid to 'A' site of ribosome
   b. Formation of Peptide Bond
   c. Translocation of t-RNA from 'A' site to 'P' site of ribosome
5. Termination of Protein synthesis
6. Modification of released protein

Protein Synthesis



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7. **2075 GIE Q.No. 2c Significance of crossing over.** [3]

Please refer to 2076 Set B Q.No. 2d

8. **2075 GIE Q.No. 2d Characteristic features of genetic code.** [3]

The main characteristics of genetic code are

1. Genetic code is triplet code
2. Genetic code is comma less
3. Genetic code is non-overlapping
4. Genetic code is Degenerate
5. Genetic code is Non-ambiguous
6. Genetic code is universal
7. Genetic code has initiation code
8. Genetic code has non-sense code
9. Genetic code has fix polarity

9. **2075 GIE Q.No. 2e Chromosomal aberration.** [3]

Mutations that arise due to change in morphological structure is called chromosomal aberrations. Chromosomal aberrations are of following types.

1. **Deficiency:** It is a aberration in which a segment of chromosomes breaks and los. Lost of segments of chromosomes May terminal or intercalary. e.g

   A B C D E F G – Original sequence of chromosome

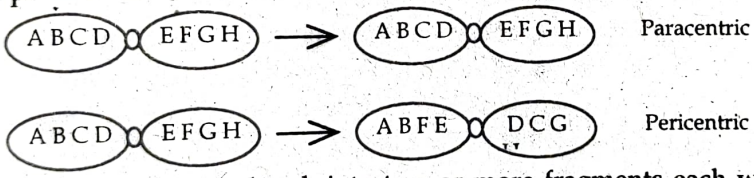
   A B E F G – After deficiency (missing C, D)

2. **Duplication:** It is a aberration in which a segment or a part of the chromosome gets repeated in the same chromosome. e.g

   A B C D E F G H - Original sequence of chromosome

   A B C D D E F G G H – After duplication (Duplication of DD, GG)

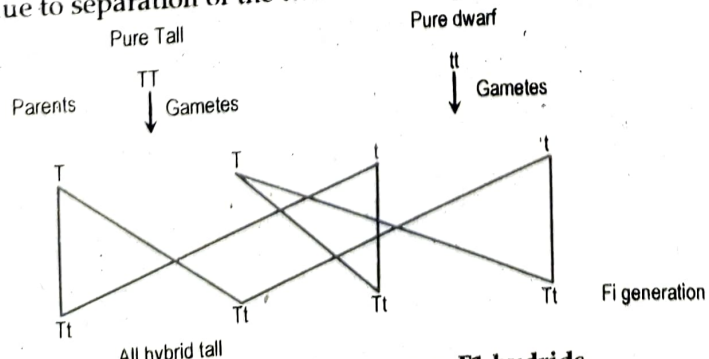
3. **Inversion:** Inversion is an intrachromosomal aberration characterized by inversion or reversal of a chromosome segment and gene sequence contained there in relative to the standard chromosome. It occurs in intercalary segment o the chromosome. There are two types of inversion called paracentric and pericentric inversion.



4. **Translocation:** Chromosome may break into two or more fragments each with a raw end. These segments may reunite and during reunion either the piece of the same chromosome or the piece of the non-homologous chromosomes may be used. It may be of two types' simple translocation and reciprocal translocation.

10. **2074 Supp Q.No. 2c Monohybrid cross with chart.** [3]

Cross between signal pair of contrasting characters is called monohybird cross. For example cross between tall pea plants with dwarf pea plants. Here tall and dwarf is the single contrasting of plant height. When homozygous tall (TT) and homozygous dwarf (tt) pea plant are crossed all the plants in Fi generation are the tall (Tt). On self pollination of F_1 hybrid in F2 generation tall and dwarf plants are obtained in the ration 3:1. The reappearance of dwarfness which had remained hidden in F_1 generation is due to separation of the two contrasting allelic factors (T and t) present in F_1 hybrid.



Self Pollination between F1 hydrids

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F_2 generation

♀ \ ♂	T	t
T	TT (Tall)	Tt (Tall)
t	Tt (Tall)	Tt (Dwarf)

11. **2074 Supp Q.No. 2d Chromosomal aberration.** [3]

Please refer to 2075 GIE Q.No. 2e

12. **2074 Supp Q.No. 2e Structure of RNA and its types.** [3]

Please refer to 2076 Set B Q.No. 2c

13. **2074 Set A Q.No. 2c Dihybird cross with chart.** [3]

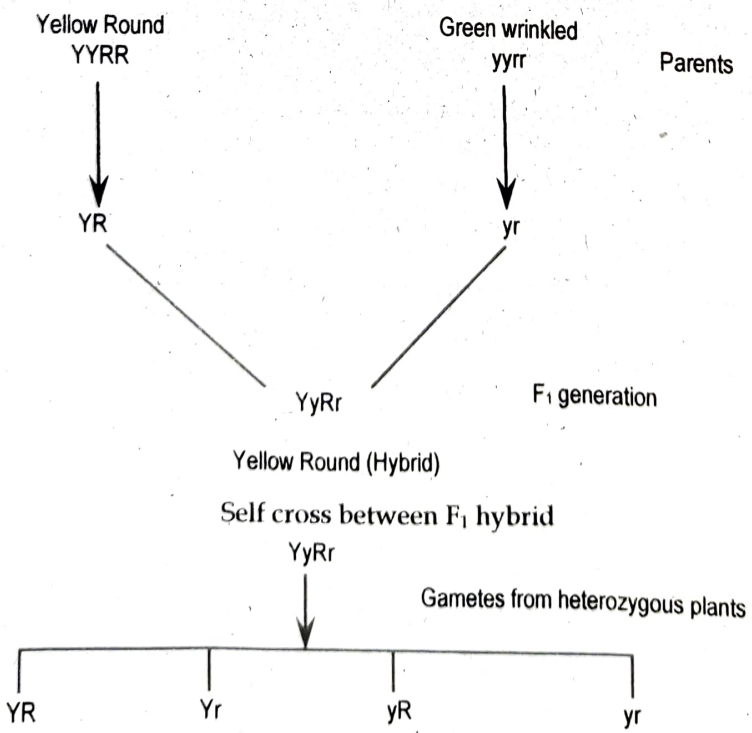
A dihybrid cross is a breeding experiment between parental generation that differ in two traits. The individuals in this type of cross are homozygous for a specific trait. Traits are characteristics that are determined by segments of DNA called genes. Diploid organism inherits two alleles for each gene. An allele is an alternate version of gene that is inherited during sexual reproduction.

Example:

Dihybrid cross can be understand by a cross is made between seed color and seed shape. One plant is homozygous for the dominant traits of yellow seed color (YY) and round seed shape (RR). The genotype can be expressed as (YYRR). The other plants have (yyrr).

The resulting offspring (F_1 generation) are all heterozygous for yellow seed color and round seed shape (YyRr).

Self pollination in the F_1 generation plants results in offspring (F_2 generation) hat exhibit a 9:3:3:1 Phenotypic ratio in variations of seed color and seed shape. In the F_2 generation, about 9116 of the plants have yellow seeds with round shapes 3116 (green seed color and round shape), 3116 (Yellow seed color and wrinkled shape) and 116 (green seed color and wrinkled shape). The F_2 progeny exhibit four different phenotypes and nine different genotypes. It is the inherited genotype that determines the phenotype of the individual. For example, plants with genotypes (YYRR, YYRr YyRR or YyRr) have yellow seeds with round shapes. Plants with genotypes (yyRR or yyRr) have green seeds and round shapes, while plans with the genotype (yyrr) have green seeds and wrinkled shapes.



♀ \ ♂	YR	Yr	yR	yr
YR	YYRR Yellow round	YYRr Yellow round	YyRR Yellow round	YyRr Yellow round
Yr	YYRr Yellow round	YYrr Yellow wrinkled	YyRr Yellow round	Yyrr Yellow wrinkled
yR	YyRR Yellow round	YyRr Yellow round	yyRR Green round	yyRr Green round
yr	YyRr Yellow round	Yyrr Yellow wrinkled	yyRr Green round	yyrr Green wrinkled

Phenotypic ratio = 9 : 3 : 3 : 1

Yellow Round, Yellow Wrinkled, Green Round, Green Wrinkled

Genotypic ratio = 1:2:2:4:1:2:1:2:1

14. **2074 Set A Q.No. 2d Gene mutation.** [3]

Gene mutations happen when there are changes in the nucleotide sequence that makes up the strand of DNA. This can be caused by random mistakes in DNA replication or even an environmental influence like UV rays or chemicals. The changes at the nucleotide level then influence the transcription and translation from gene to protein expression. Changing even just one nitrogen base in a sequence can change the amino acid that is expressed by that DNA codon which can lead to a completely different protein being expressed.These mutations range from being non-harmful all the way up to causing death. It can also classified in to following types

15. **2074 Set A Q.No. 2e Nucleoside and nucleotide.** [3]

Nucleotide: A nucleotide is a compound containing a nitrogenous base and a phosphate group attached to a pentose sugar, which can be either a ribose or a deoxyribose. One to three phosphate groups can be attached to the 5′ carbon of the pentose sugar. The nitrogenous base can be either a purine or pyrimidine. Purine bases are adenine and guanine and pyrimidine bases are cytosine, uracil, and thymine. Examples for nucleotides are AMP, ADP, ATP, dAMP, dADP, dATP, ddATP, GMP, GDP, GTP, dGMP, dGDP, dGTP, an ddGTP, CMP, CDP, CTP, dCMP, dCDP, dCTP and ddCTP, TMP, TDP, TTP, dTMP, dTDP, dTTP and ddTTP

Nucleoside: A nucleotide without any phosphategroupbound to the 5′ carbon of the pentose sugar is known as a nucleoside. That means, nucleotide is composed of a nucleoside, which binds with one to three phosphate groups. Hence, a nucleoside is composed of a nitrogenous base and a pentose sugar. Nitrogenous bases and the pentose sugars of a nucleoside are same as in the nucleotide. Adenosine, thymidine, uridine, guanosine, cytidine and inosine are examples for nucleosides. The nitrogenous base is bound to the 3′ position of the pentose sugar via a beta-glycosidic bond.

16. **2074 Set B Q.No. 2c Reasons of choosing pea plants in Mendel experiment.** [3]

Dihybrid Cross

A dihybrid cross is a breeding experiment between parental generation that differ in two traits. The individuals in this type of cross are homozygous for a specific trait. Traits are characteristics that are determined by segments of DNA called genes. Diploid organism inherits two alleles for each gene. An allele is an alternate version of gene that is inherited during sexual reproduction.

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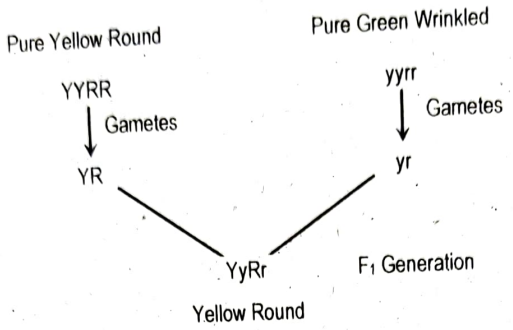
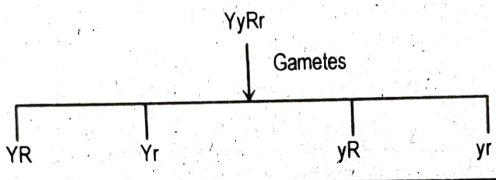
Self pollination in the F_1 generation plants results in offspring (F_2 generation) hat exhibit a 9:3:3:1 Phenotypic ratio in variations of seed color and seed shape. In the F_2 generation, about 9116 of the plants have yellow seeds with round shapes 3116 (green seed color and round shape), 3116 (Yellow seed color and wrinkled shape) and 116 (green seed color and wrinkled shape). The F_2 progeny exhibit four different phenotypes and nine different genotypes. It is the inherited genotype that determines the phenotype of the individual. For example, plants with genotypes (YYRR, YYRr, YyRR or YyRr) have yellow seeds with round shapes. Plants with genotypes (yyRR or yyRr) have green seeds and round shapes, while plans with the genotype (yyrr) have green seeds and wrinkled shapes.



Self Pollination between F_1 hybrids



♀ \ ♂	YR	Yr	yR	yr
YR	YYRR Yellow round	YYRr Yellow round	YyRR Yellow round	YyRr Yellow round
Yr	YYRr Yellow round	YYrr Yellow wrinkled	YyRr Yellow round	Yyrr Yellow wrinkled
yR	YyRR Yellow round	YyRr Yellow round	yyRR Green round	yyRr Green round
yr	YyRr Yellow round	Yyrr Yellow wrinkled	yyRr Green round	yyrr Green wrinkled

Phenotypic ratio = 9 : 3 : 3 : 1
(Yellow Round, Yellow Wrinkled, Green Round, Green Wrinkled)

Genotypic ratio = 1:2:2:4:1:2:1:2:1

17. **2074 Set B Q.No. 2d Significance of polyploidy.**

Following are the significance of polyploidy:

1. It helps in evolution. The artificially induced polyploids as well as natural polyploids can evolve new species.
2. It helps to increased size, hardness and resistance to disease.
3. Disease resistance and high yielding plants can be producing by polyploidy.
4. Helps to produce seedless variety of plants like to mate watermelon etc.
5. Polyploidy plants have better adaptability, receptivity and yielding.
6. It may increase immunity of organism.

18. **2074 Set B Q.No. 2e Structure of DNA.**

Structure of Deoxyribonucleic acid (DNA)

James Watson and Francis Crick (1953) proposed the helical structure of DNA for which they were awarded with Nobel Prize. According to Watson and Crick DNA shows following structure.

i. DNA is along chain polymer of over millions of deoxyribonucleotide (e.g 3.4 million base pairs in *Escherichia coli*, 65 million base pair in humans).

ii. DNA has two complementary and spirally coiled unbranched strands. The two strands are not coiled upon each other but the double strand is coiled upon itself or around a common axis like a spiral stair case with base pairs forming steps and back bones of two strands forming railings. Two strands of DNA is made up of phosphate and sugar molecules which joined together by phosphodiester bond.

iii. The two strands are antiparallel to each other i.e. one chain runs in 5-3 direction and other in 3- 5 direction.

iv. The two strands of DNA are held together by the weak hydrogen bond between specific base sequences.

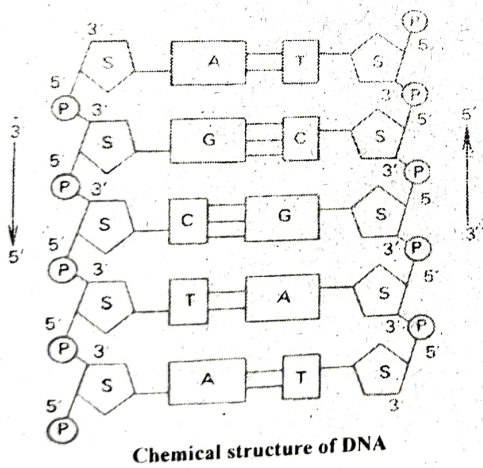
v. These base sequences are attached to helix sugar with the help of glycosidic linkage.

vi. The base pairing are always specific it means guanine (G) always combine with cytosine(C) with three hydrogen bond and adenine(A) always combine with Thymine(T) with two hydrogen bond.

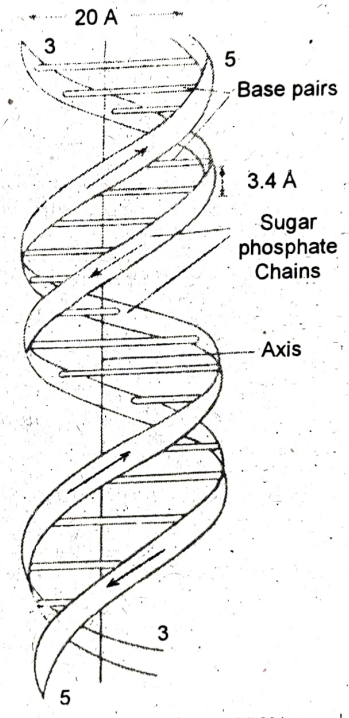
vii. The distance between two strands is about 20Å

viii. One turns of helix measures about 34Å

ix. The distance between two nitrogenous base in a helix is about 3.4Å



Chemical structure of DNA



Helical structure of DNA

Functions of DNA

1. DNA is a genetic material because it helps in the inheritance of characters from parents to their offspring.
2. It helps to synthesizes RNA by the process of transcription.
3. DNA is indirectly involved in protein synthesis and controls the metabolic activities of a cell.
4. It controls the growth and development of organisms.
5. DNA gives new combinations during meiosis by crossing over.
6. Changes in sequences and number of nucleotides produce mutation that is a raw material of evolution.

2073 Supp Q.No. 2c Cause of selecting Drosophila in experiments. [3]

The main cause to select Drosophila in experiments are

1. It can be easily cultured under normal condition in jar containing suitable medium.
2. Drosophila is harmless and does not spread any diseases.

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3. Large number of specimens can be accommodated in a small place.
4. These are less expensive to culture.
5. It breeds throughout the year.
6. Its life cycle is short and completed in 10-14 days, so that the result of controlled breeding are quickly available.
7. It can express the characters very quickly.

20. **2073 Supp Q.No. 2d Significance of mutation.** [3]

Mutation is a sudden heritable change in the content of genetic material of organisms. Mutation can cause by different types of chemical as well as physical component. Some of these are

i. Ionizing radiation
ii. UV light
iii. Different chemical compound including nitrous acid, mustard gas, colchicines, ethyl ethane sulphonate etc.

Role of mutation

1. It is the basis of heredity.
2. It provides raw material for evolution.
3. Mutation helps in better adaptability for organism in changing environment.
4. It helps to create new species in environment.
5. It helps in hybrid vigour or heterosis.
6. It allows breeders to improve races of useful plants and animals for better yield, quicker growth and less input.

21. **2073 Supp Q.No. 2e Differentiate between incomplete and codominance.** [3]

Following are the difference between incomplete and codominace:

Incomplete Dominance	Co-Dominance
Effect of one of the two alleles is more conspicuous.	Effects of both alleles are equally conspicuous.
It produces a fine mixture of the expression of two alleles.	There is no mixing of the effect of the two alleles.
The effect in intermediate of the two alleles	Both the alleles produce their effect independently.
The expressed phenotype is new. It has no allele of its own.	The expressed phenotype is combination of two phenotypes and their alleles.
Common example: flower color in Mirabillis Jalapa.	Common example: AB blood group in human beings.

22. **2073 Set C Q.No. 2c Mechanism of crossing over.** [3]

Please refer to 2076 Set B Q.No. 2d

23. **2073 Set C Q.No. 2d Codominance** [3]

Please refer to 2076 Set B Q.No. 2g

24. **2073 Set C Q.No. 2e Characteristic of genetic code.** [3]

Please refer to 2075 GIE Q.No. 2d

25. **2073 Set C Q.No. 2g Advantages of polyploidy.** [3]

Please refer to 2074 Set B Q.No. 2d

26. **2073 Set D Q.No. 2c Law of segregation.** [3]

The law of segregation state that the factors (gene) for each character segregate (separate) at the time of gamets formation. The character never mixes or contaminate with each other. They remain together for long time and separate at the time of gametogenesis.

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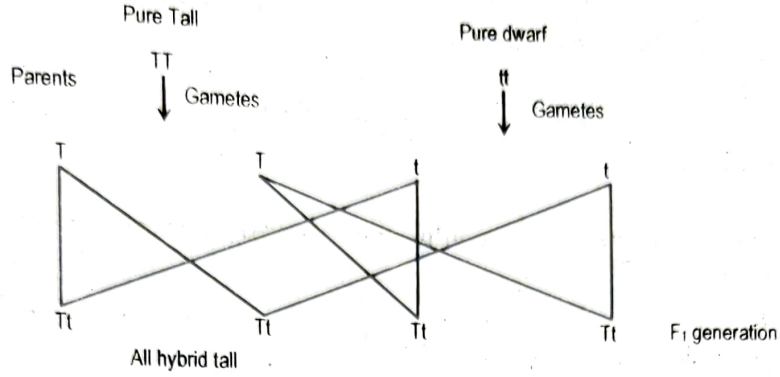
For example; When homozygous tall (TT) and homozygous dwarf (tt) pea plant are crossed all the plants in F1 generation are the tall (Tt). On self pollination of F1 hybrid in F_2 generation tall and hidden in F_1 generation is due to separation of the two contrasting allelic factors (T and t) present in F_1 hybrid.



Self Pollination between F_1 hybrids

F_2 generation

♀ \ ♂	T	t
T	TT (Tall)	Tt (Tall)
t	Tt (Tall)	Tt (Dwarf)

27. **2073 Set D Q.No. 2d Characteristics of genetic code.** [3]

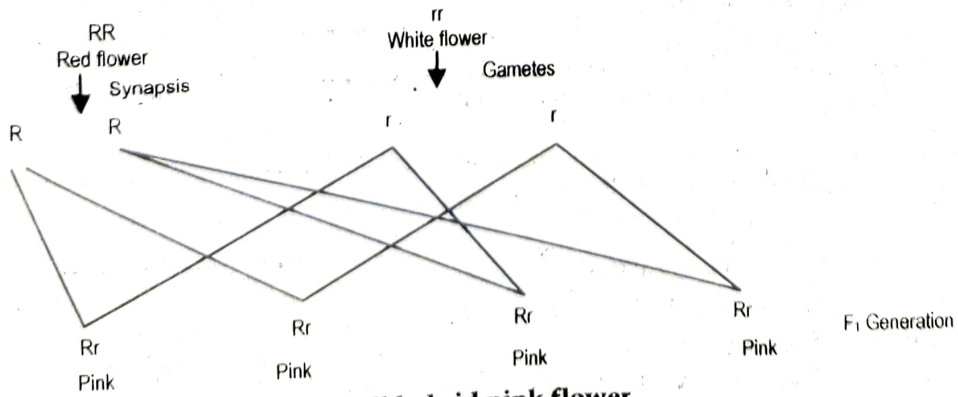
Please refer to 2075 GIE Q.No. 2d

28. **2073 Set D Q.No. 2e Incomplete dominance with examples.** [3]

It is a Post Mendelian discovery. Incomplete dominance is the Phenomenon of neither of the two alleles being dominant so that expression in the hybrid is a fine mixture or some what intermediate between the expression of two alleles of a gene in their homozygous states. It is not blending effect because Parental characters reappear in F_2 Generation.

Example:

The best example of incomplete dominance can be seen in the four O'clock plant (*Mirabilis Jalapa*). This plant produces two types of flowers, red flowered and white Flowered. When these two plants are crossed produce all hybrid pink plants in F_1 generation. On selfing them, F_2 generation has 1 red: 2 pink: 1 white flowered plant with phenotypic ratio being similar to genotypic ratio. Appearance of pink flower is due to incomplete dominance of red flower trait over white flower trait.



All hybrid pink flower

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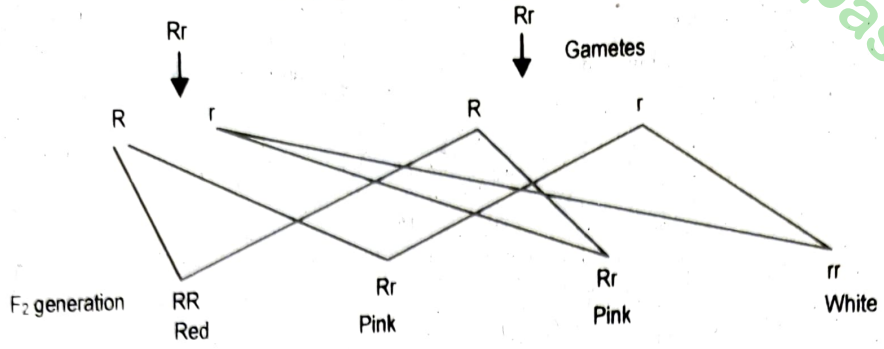

Phenotypic ratio = 1 : 2 : 1

Genotypic ratio = 1 : 2: 1

29. **2072 Supp. Q.No. 2c Law of segregation.** [3]

Please refer to 2073 Set D Q.No. 2c

30. **2072 Supp. Q.No. 2d Significance of polyploidy with examples.** [3]

Please refer to 2074 Set B Q.No. 2d

31. **2072 Supp. Q.No. 2e Criss-cross inheritance with its importance.** [3]

The transmission of a character from father to grandson through his daughter is called criss cross inheritance. It is also called zig-zag inheritance. In this pattern the character appears in alternative generation only. The sex linked characters exhibit criss-cross inheritance. E.g. Haemophilia, Colorblindness etc.

Importance

1. Discovery of criss cross inheritance proved that genes are located on chromosomes.
2. A trait showing criss cross inheritance is Sex-linked.
3. Information about criss cross inheritance is useful for knowing inheritance of sex-linked disorders.

32. **2072 Set C Q.No. 2c Process of crossing over** [3]

Please refer to 2076 Set B Q.No. 2d

33. **2072 Set C Q.No. 2d Reason of pea plant selection for Mendel's experiments.** [3]

There are following reasons to choose pea plant by Mendel for his experiments. Some of these are

i. Pure varieties of Pea were available.
ii. Pea plants are easy to cultivate.
iii. Life cycle of pea plant is of a few months so that results can be got quite early.
iv. Large number of seeds is borne by a plant.
v. The plant is a small herbaceous climber but the flowers are quite large.
vi. The flowers can be cross – pollinated.
vii. The hybrids are fertile.

34. **2072 Set C Q.No. 2e Law of dominance.** [3]

Mendel's law of dominance states that in a heterozygote, one trait will conceal the presence of another trait for the same characteristic, rather than both alleles contributing exclusively. The expression of dominant factors dur to the synthesis of polypeptide chain but recessive factors cannot synthesis zed polypeptide chain. Therefore, they became unable to express themselves in F_1 generation.

Example: When a cross is made between pure tall Pea plants (TT) with dwarf pea plant (tt), only tall plants (Tt) appear in F_1 generation, although they contain both alleles for tallness and dwarfness. Thus, tallness as it express it in F_1 generation is called dominant character and the dwarfness as it remains unexpressed is called recessive.

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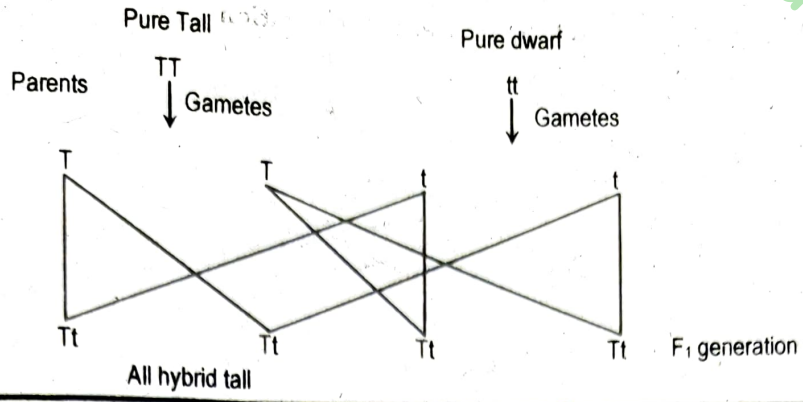

35. **2072 Set D Q.No. 2c Law of segregation.** [3]

Please refer to 2073 Set D Q.No. 2c

36. **2072 Set D Q.No. 2d Importance of polyploidy.** [3]

Please refer to 2074 Set B Q.No. 2d

37. **2072 Set D Q.No. 2e Chromosomal aberration.** [3]

Please refer to 2075 GIE Q.No. 2e

38. **2072 Set E Q.No. 2c Differentiate genotypes and phenotypes.** [3]

Following are the differences between genotype and phenotype:

Genotype	Phenotype
It is gene complement of an individual.	It is morphological appearance of organism.
Genotype remains the same throughout the life of an individual.	It can be change with time e.g infant, adolescent, young.
It is not influenced by phenotype.	Genotype establishes the boundaries within which phenotype can be expressed.
Genotype cannot be studied directly. It can be known through the study of ancestors, and offspring.	It can be known through direct observation.
Individuals with different genotypes may have similar phenotype e.g tallness for TT, and Tt	Individuals with similar phenotypes may not belong to same genotype.
It is not influenced by environment.	It is easily influenced by environment.

39. **2072 Set E Q.No. 2d Describe about the process of crossing over.** [3]

Please refer to 2076 Set B Q.No. 2d

40. **2072 Set E Q.No. 2e Explain sex-linked inheritance of colour blindness in man.** [3]

Colours blindness is a x-linked recessive inheritance. X –linked recessive inheritance is a mode of inheritance in which a mutation in a gene on the x-chromosome causes. The phenotype to be express in males and in females who are homozygous for the gene mutation. X-linked inheritance means that the gene causing the trait or the disorder is located on the X-chromosomes. Females have two X chromosomes, while males have one X and one Y chromosome. So in female it can express only in homozygous condition, but in males it can expressed in heterozygous condition because Y chromosome is genetically inert. Red-green colour blindness a very common trait in humans and frequently used to explain X-linked disorders. About 1% of male and less than 1% female affected by this disease throughout the world. Affected person cannot differentiate red and green colour. Gene near to X-chromosome therefore colour blindness is also a sex-linked inheritance.

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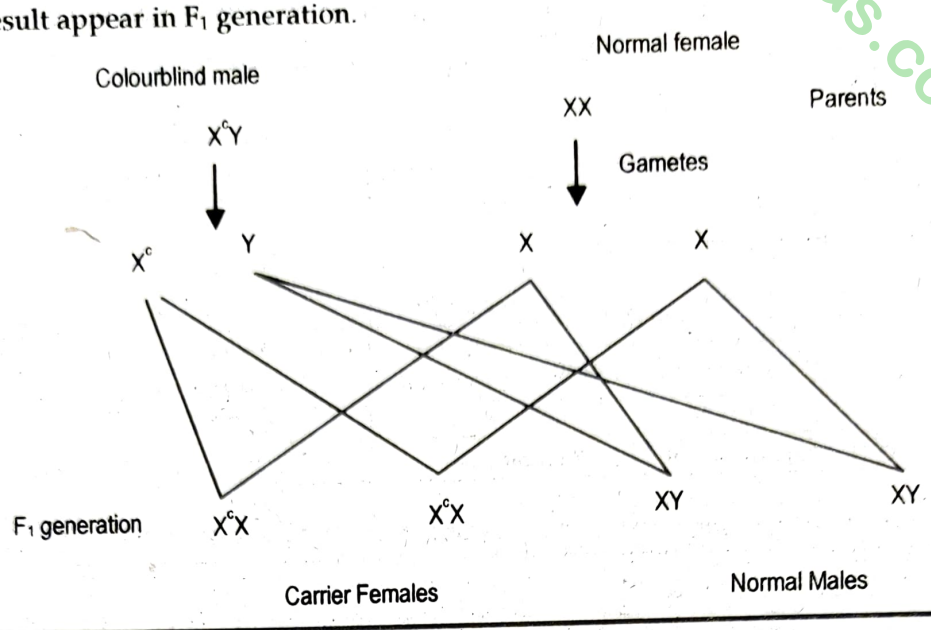
Example: When a cross is made between colour blind male (X^cY) with normal female (XX). The following result appear in F_1 generation.



41. **2071 Supp. Q.No. 2c Explain the chromosomal mutation.** [3]

Please refer to 2075 GIE Q.No. 2e

42. **2071 Supp. Q.No. 2d Discuss the crossing over.** [3]

Please refer to 2076 Set B Q.No. 2d

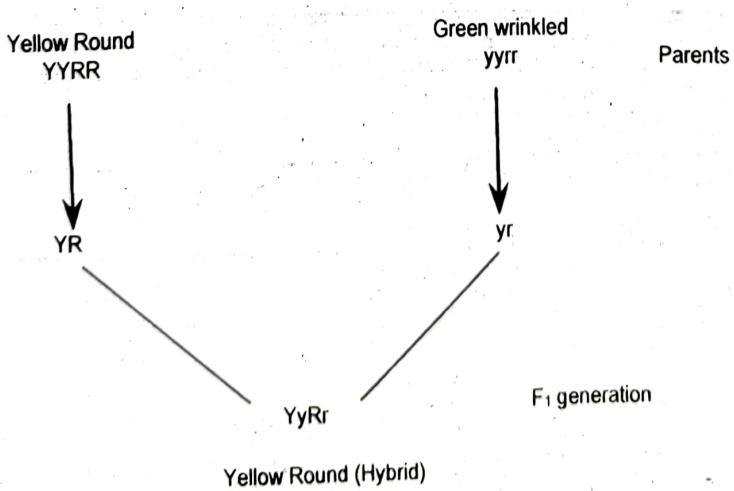
43. **2071 Supp. Q.No. 2e Describe the law of dominance.** [3]

Please refer to 2072 Set C Q.No. 2e

44. **2071 Set C Q.No. 2c Law of independent assortment.** [3]

Mendel formulated the third law of inheritance based on his dihybrid cross. This law state that the factors for different characters are inherited independently from generation to generation. i.e. They do not remain linked in the offspring's but are assorted independently. For example, when homozygous Pea plants having Yellow Round Seed (YYRR) and green wrinkled (yyrr) are crossed, in F_1 generation all plants having yellow round seeds (YyRr). On self pollination plants with yellow round, yellow wrinkled, green round and green wrinkled seeds are obtained in the ratio of 9:3:3:1. This proves that the inheritance of the pair of contrasting characters called shape is independent of inheritance of another pair of contrasting characters called colour of seed.

Example:



Self cross between F_1 hybrid

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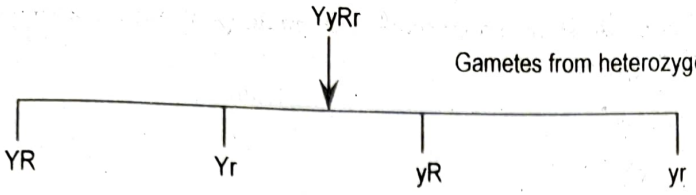

♀ \ ♂	YR	Yr	yR	yr
YR	YYRR Yellow round	YYRr Yellow round	YyRR Yellow round	YyRr Yellow round
Yr	YYRr Yellow round	YYrr Yellow wrinkled	YyRr Yellow round	Yyrr Yellow wrinkled
yR	YyRR Yellow round	YyRr Yellow round	yyRR Green round	yyRr Green round
yr	YyRr Yellow round	Yyrr Yellow wrinkled	yyRr Green round	yyrr Green wrinkled

Phenotypic ratio = 9 : 3 : 3 : 1

Yellow Round, Yellow Wrinkled, Green Round, Green Wrinkled

Genotypic ratio = 1:2:2:4:1:2:1:2:1

45. **2071 Set C Q.No. 2d** **Significance of polyploidy with examples.** **[3]**

Please refer to 2074 Set B Q.No. 2d

46. **2071 Set C Q.No. 2e** **Difference between incomplete and codominace.** **[3]**

Please refer to 2073 Supp Q.No. 2e

47. **2071 Set D Q.No. 2c** **Differentiate between DNA and RNA.** **[3]**

DNA	RNA
Usually occurs inside nucleus and some cell organelles like mitochondria and chloroplast.	It usually occurs inside the nucleus, most of it is found in the cytoplasm.
It is double stranded with exception of some viruses (e.g. 0 × 174).	It is single stranded with exception of some virus (Reovirus).
Sugar is deoxyribose type	Sugar is ribose type.
The base present in DNA are A, G, T and C.	The base present in RNA are A, G, U, C.
It replicates to from new DNA molecules.	It cannot normally replicate itself.
Puriues are phyrimidines are in equal ratio.	They may not occur in equal ratio.

48. **2071 Set D Q.No. 2d** **Describe the law of dominance.** **[3]**

Please refer to 2072 Set C Q.No. 2e

49. **2071 Set D Q.No. 2e** **Describe in detail about chromosomal mutations.** **[3]**

Please refer to 2075 GIE Q.No. 2e

50. **2070 Supp. Q.No. 2c** **Types of DNA and its function.** **[3]**

DNA duplex model proposed by Watson an Crick s right handed spiral and is called B-DNA (Balanced DNA). In the model the base pairs lie at nearly right angles to the axis of helix. Another right handed duplex model is A-DNA (Alternate DNA). Here, a single turn of helix has 11 base pairs. The base pairs lie 20° away from perpendicular to the axis. C-DNA has base pairs per turn of spiral while in D-DNA the number is only 8 base pairs. Both are right handed. Z-DNA (Zigzag DNA) is left –handed double helix with Zigzag back bone, alternate purine and pyrimidine bases, single turn of 45 A lengths with 12 base pairs and a single groove.

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Functions:

i. DNA act a genetic material in all living organism's including virus.
ii It helps to synthesize RNA by the process of transcription.
iii. It involves in protein synthesis and control all the metabolic activities of cell.
iv. DNA helps in recombination of gene during meiosis by crossing over.

51. 2070 Supp. Q.No. 2d **Law of dominance with examples.** [3]

Please refer to 2072 Set C Q.No. 2e

52. 2070 Supp. Q.No. 2e **Semiconservative method of DNA replication.** [3]

Formation of new DNA stands from pre exiting DNA is called replication of DNA. DNA replication occurs during S-phase of interphase during cell division. There are three method of DNA replication.

Semi – Conservative Replication

This was proposed by Watson and Crick in 1953 on the basis of their model of DNA molecule. It is most accepted model of replication. During this replication the two parental strands separate and each makes a copy of itself. After one round of replications the two daughter molecules each comprises one old and one new strand. Note that after two rounds two of the DNA molecules consist only of new material, while the other two contain one old and one new strand.

It occurs in the following steps:

1. The strands of DNA get separated by the breakage of hydrogen bond between two nitrogenous base and formed two template DNA strands.
2. Complementary bases from nucleoplasm place opposite the exposed bases on each stand by base pairing, that is A with T and C with G.
3. Hydrogen bond formation take place which helps to hold complementary bases in place in newly synthesized DNA.
4. Each new DNA molecule contains one old polynucleotide stand and one ne strand. So this method of replication is known as semi-conservative replication.

53. 2070 Set C Q.No. 2c **Structure and function of RNA.** [3]

Please refer to 2076 Set B Q.No. 2c

Functions

1. It acts as a gentic material in some virus like TMV, HIV etc.
2. It involve in protein synthesis.

54. 2070 Set C Q.No. 2d **Law of segregation.** [3]

Please refer to 2073 Set D Q.No. 2c

55. 2070 Set C Q.No. 2e **Semi-conservative method of DNA replication.** [3]

Please refer to 2070 Set C Q.No. 2c

56. 2070 Set D Q.No. 2c **Types of RNA and its functions.** [3]

Types of RNA

On the basis of molecular size and functions there are three major types of RNA

1. **Ribosomal RNA(r-RNA):** It is most abundant and stable types of RNA comprising 70-80% of total RNA. It has 40000 to 1000000 Dalton molecular weight. r-RNA is present in the ribosome and regulate the process of protein synthesis. r-RNA is synthesized from the DNA of nucleolus. It regulate the process of protein synthesis.
2. **Messenger RNA (m-RNA):** It is the most heterogenous in size and stability. It has 500000-1000000 dalton molecular weight. It carries the genetic information specifying the amino acids sequence in a protein to ribosome. It comprises only 5-10% of total RNA. It is formed from the sense strand of DNA. It helps to carry genetic information from DNA.

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3. **Transfer RNA (t-RNA):** It is second most stable type of RNA. It comprises 10-15% of total RNA. Each t- RNA molecules is made up of 75 nucleotide sequences. It is folded in a specific manner and formed clover leaf like structure. It consists of five different arms in which four arms are called recognition site and one non recognition site. It helps to transfer amino acids to ribosome to synthesiszed a protein

57. **2070 Set D Q.No. 2d Reasons for the selection of pea plant on the Mendal's experiment.** [3]

Please refer to 2072 Set C Q.No. 2d

58. **2070 Set D Q.No. 2e Semi-conservative method of DNA replication.** [3]

Please refer to 2070 Set C Q.No. 2c

59. **2069 Q.No. 2d Characteristics of genetic code.** [3]

Please refer to 2075 GIE Q.No. 2d

60. **2069 Q.No. 2e Process of crossing over.** [3]

Please refer to 2076 Set B Q.No. 2d

61. **2069 Q.No. 2f Mendel's dihybrid cross.** [3]

Please refer to 2074 Set A Q.No. 2c

62. **2068 Q.No. 2c Describe the structure of DNA.** [3]

Please refer to 2074 Set B Q.No. 2e

63. **2068 Q.No. 2d Discuss the incomplete dominance with examples.** [3]

Please refer to 2073 Set D Q.No. 2e

64. **2068 Q.No. 2e 2067 Q.No. 2e Describe the types of mutations.** [3]

Mutation is a sudden heritable change in the content of genetic material of organisms. The substance which responsible to cause mutation is called mutagen. Hugo de Vries (1901) coined the term of mutation. The result of mutation are;

1. A genetic disorder is a disease caused by a mutation in one or a few genes. A human example is cyctic fibrosis. A mutation in a single gene causes the body to produce thick sticky mucus that clogs the lung and blocks ducts in digestive organs.
2. Cancer is a disease in which cells grow out of contro and form abnormal masses of cells. It is generally caused by mutation in genes that regulate the cell cycle. Because of mutation cells with damaged DNA are allowed to divide without limits. Cancer genes can be inherited.
3. Mutation can provide raw material for evolution.
4. It can help to create new species in environment.

65. **2067 Q.No. 2c Describe the structure of DNA.** [3]

Please refer to 2074 Set B Q.No. 2e

66. **2067 Q.No. 2d Describe in detail about the incomplete dominance with examples.** [3]

Please refer to 2073 Set D Q.No. 2e

67. **2066 Q.No. 1 a Explain the Mendel's law of segregation.** [3]

Please refer to 2073 Set D Q.No. 2c

68. **2066 Q.No. 1 b Describe the significance of polyploidy.** [3]

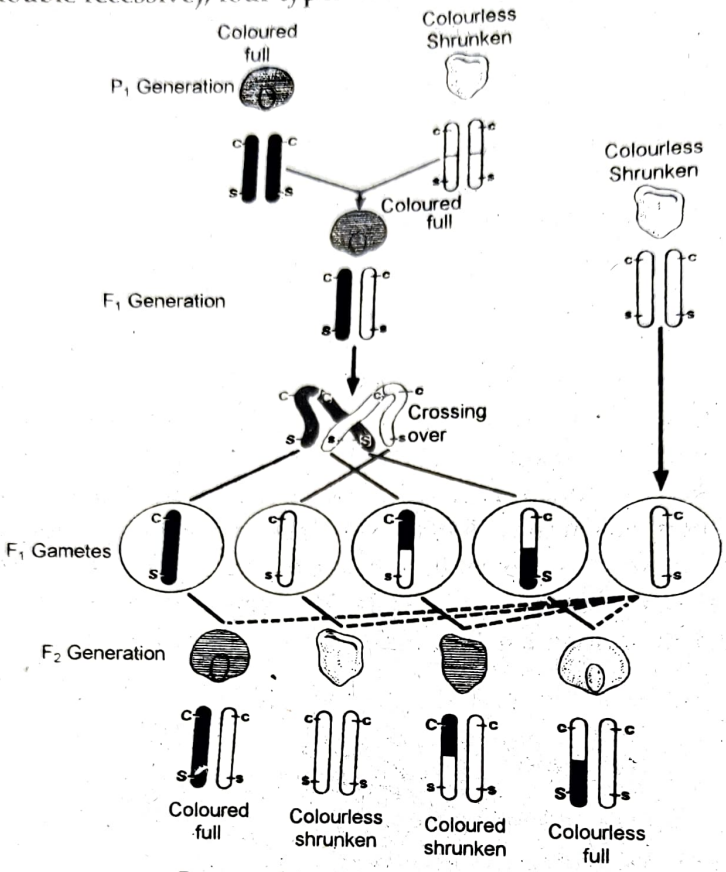
Please refer to 2074 Set B Q.No. 2d

69. **2065 Q.No.2 c Incomplete linkage in maize.** [3]

Incomplete linkage is exhibited by those genes which produce some percentage of non-parental combinations. Such genes are located distantly on the chromosome. It is due to accidental or occasional breakage of chromosomal segments during crossing over. The genes that show incomplete linkage is called incomplete linked. The distance between two incomplete linked genes is more than 50mu (map unit)

Example. Incomplete Linkage in Maize Plant

Maize provides a good example of linkage. Hutchinson crossed a variety of maize having coloured and full seed (CCSS) with a variety having colourless and shrunken seeds (ccss). The gene C for colour is dominant over its colourless allele c and the gene S for full seed is dominant over its shrunken allele s. All the F_1 plants produced coloured and full seed. But in a test cross, when such F_1 females (heterozygous) are cross pollinated with the pollen from a plant having colourless and shrunken seeds (double recessive), four types of seeds are produced.



Incomplete linkage in maize

From the above stated result it is clear that the parental combinations are more numerous (96.4%) than the new combination (3.6%). This clearly indicates that the parental characters are linked together. Their genes are located in the same chromosome and only in 3.6% individuals these genes are separated by crossing over. This is an example of incomplete linkage.

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70. 2064 Q.No.2c **Show the dihybrid cross on Punnett Square Method.** [3]

Please refer to 2074 Set B Q.No. 2c

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71. 2063 Q.No.2i **Discuss the relationship between variation and heredity.** [3]

Heredity may be defined as the transmission of characters from one generation to successive generations or from parents to their offspring. Thus heredity is the cause of similarities between the offspring's, so that the individuals of the same parents resemble each other in many aspects. Heredity involves the transfer of genetic characters from parents to the offspring via egg and sperm. Heredity takes place in both asexual as well as sexually reproducing organism. Individual produce from asexually is called clone and organisms produce from sexually is called offspring. Clones are not the basis of variation and evolution of life. So clones are basis of heredity but not the basis of variation offspring's are the basis of heredity as well as variation.

Though offsprings receive all the characters from their parents, they are not exactly alike. Differences are found even between the offsprings of the same parents. It is difficult to find out the identical individuals. The progeny differs not only in itself but also with the parents. These differences are called variation. Variation takes place in both somatic cells and reproductive cells. Variation which occurs in somatic cells and such types of variation is non heritable variation and not the basis of heredity. Variation which occurs in reproductive cells is heritable and basis of heredity.

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72. **2063 Q.No. 2j What are the causes and roles of mutation?** [3]

Please refer to 2073 Supp Q.No. 2d

73. **2062 Q.No.2a Elaborate about the incomplete dominance.** [3]

Please refer to 2073 Set D Q.No. 2e

74. **2061 Q.No.2a Describe semi-conservative mode of replication of DNA.** [3]

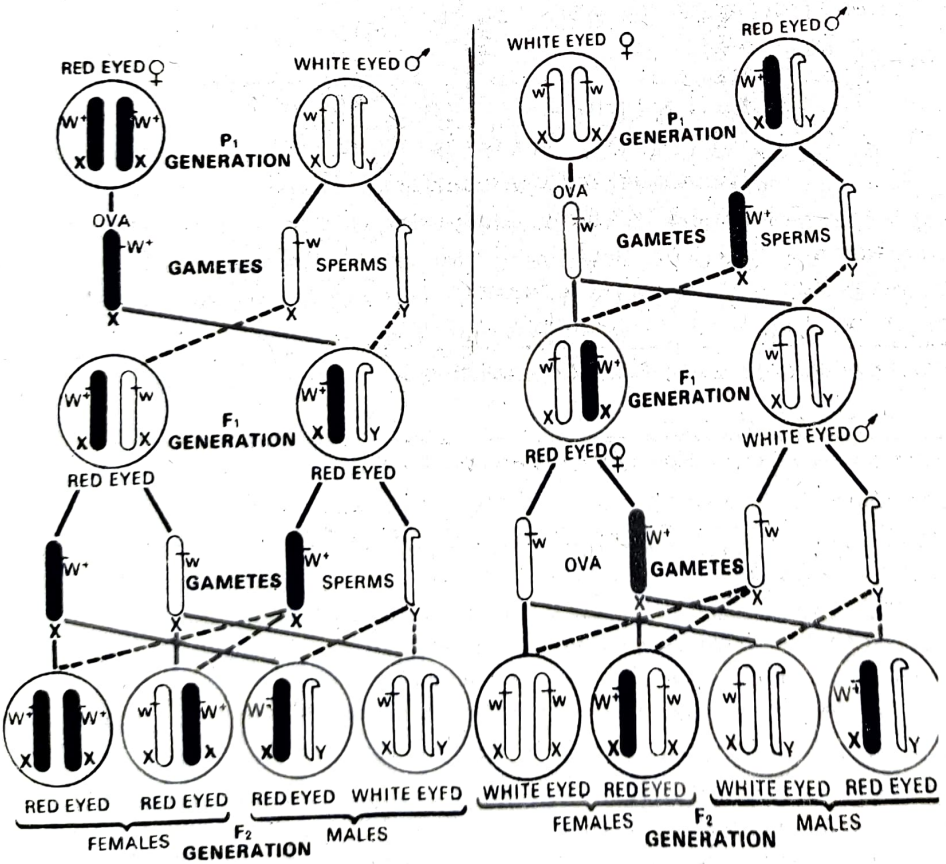
Please refer to 2070 Supp. Q.No. 2 e

75. **2061 Q.No.2e Discuss about sex-linked inheritance in *Drosophila*.** [3]

The chromosomes present in the diploid cells of the majority of the sexually reproducing animals are of two types: autosomes bearing genes for somatic characters and sex chromosomes bearing genes for sex. Sex chromosomes also carry some genes for non –sexual characters such colour blindness, haemophilia (Human being), and eye color in *Drosophila*. Such genes which are always associated with sex chromosomes are called sex-linked genes. In man and Drosophila the sex chromosome (X and Y) are unequal in size and shape, X being larger and rod shaped whereas Y is small and slightly curved.

Sex-linkage in *Drosophila*

T.H. Morgon (1910) for the first time discovered sex-linkage in *Drosophila melanogaster*. Morgon when experimenting noted the sudden appearance of one white eyed male (mutant form) in the culture of normal red-eyed Drosophila. This white eyed male was crossed with red eyed female. The F_1 flies (Both male and female) where all red eyed indicating that white eye color is recessive to the normal red eye color. When these F_1 flies were inter-crossed freely, the red and white eyed flies appeared in the ratio 3:1 in the F_2 generation. White eyed flies were male. Among the red eyed flies two third were female and one third were male. The female were all red eyed whereas 50% males were white eyed and the remaining 50% males were red eyed genetically they are heterozygous (W^+ w)



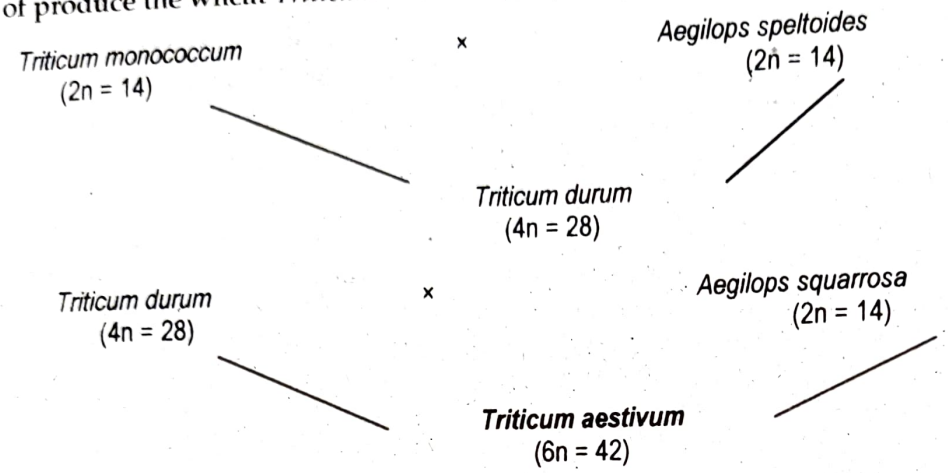
Eye colour in *Drosophila melanogaster*

76. **2061 Q.No.2f Elaborate about the dominance.** [3]

Please refer to 2072 Set C Q.No. 2e

77. **2060 Q.No.2h How is the wheat variety developed?** [3]

A hexaploid species of wheat was artificially synthesized in 1946 by the cross between *Triticum monococcum*. *Triticum durum* with wild grass *Aegilops speltoides* and *Aegilops squarrosa*. When a cross is made between *Triticum monococum* (2n = 14) a with wild grass *Aegilops speltoides* (2n = 14) to produce a different speices ofwheat called emmer wheat *Triticum durum* (4n = 28) a tetraploid condition. Emmer wheat is again crossed with another species of wild grass *Aegilops Squarrosa* (2n = 14) of produce the wheat *Triticum aestivum* (2n = 42), a hexaploid (6n) condition.



Modern variety of Wheat

78. **2059 Q.No.2d Differentiate between genotype and phenotype.** [3]

Please refer to 2072 Set E Q.No. 2c

79. **2059 Q.No.2e Write a short account of crossing over.** [3]

Please refer to 2076 Set B Q.No. 2d

80. **2058 Q.No.2e Why is a man unable to pass on a sex-linked gene to his son?** [3]

A particularly important category of genetic linkage has to do with the X and Y sex chromosomes. These not only carry the genes that determine male and female traits but also those for some other characteristics as well. Genes that are carried by either sex chromosome are said to be sex linked. In human being male normally have X and Y combination of sex chromosomes, while women have two XX chromosomes. Since only male inherit Y chromosomes, they are the only ones to inherit Y linked traits. Men and women can get the X-linked ones since both inherit X chromosomes so man can only transmit sex linked trait to his daughter because X linked gene in male always come from his mother.

81. **2058 Q.No.2h Write the semi-conservative mode of replication of DNA.** [3]

Please refer to 2070 Supp. Q.No. 2 e

82. **2057 Q.No.2c What do you understand by Mendel's 9:3:3:1 ratio?** [3]

Please refer to Model (Botany) Q.No. 2d

83. **2057 Q.No.2d Define mutation. What is the result of mutation?** [3]

Please refer to 2068 Q.No. 2e

84. **2054 Q.No. 3a Prove 9 : 3 : 3 : 1 phenotypic ratio of dihybrid cross.** [3]

Please refer to Model (Botany)Q.No. 2d

85. **2054 Q.No. 3e Define mutation theory.** [3]

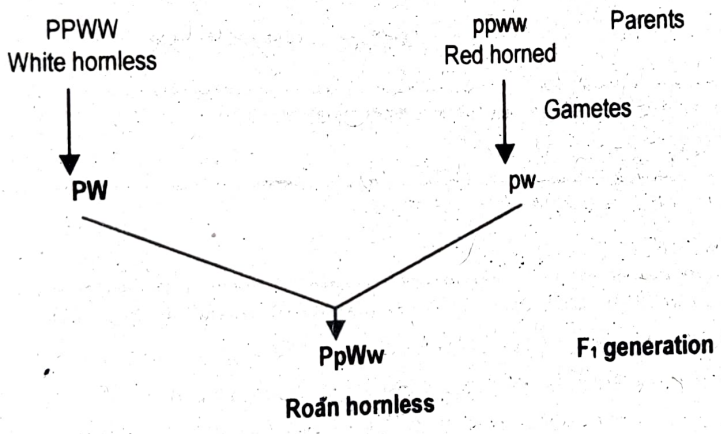
Mutation theory, idea that new species are formed from the sudden and unexpected emergence of alterations in their defining traits. Advanced at the beginning of the 20th century by Dutch botanist and geneticist Hugo de Vries in 1901-1903, the mutation theory. This theory joined two seemingly opposed traditions of evolutionary thoughts. First its mutationists accepted the primary contention

of saltationist theory, which argued that new species are produced rapidly through discontinuous transformations. Saltationist theory contradicted Darwinism, which held that species evolved through the gradual accumulation of variation over vast epoch. Second mutationsists tended to hold the strict Darwinian line that all differention is for the god of he species, which differed from the saltationist idea that some organismic variations are inherently undesirable. The second argument was premised on the belief that more variation provided better opportunities for adaptation to a variable environment.

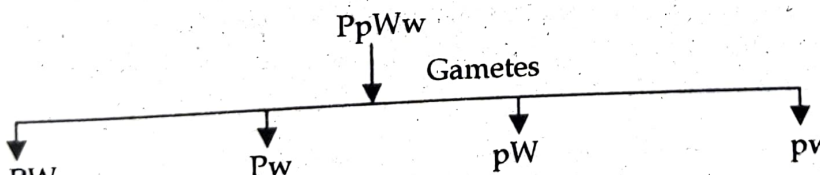
86. **2053 Q.No. 3e Why the phenotypic ratio 3:6: 3 : 1 : 2 : 1 obtained?** [3]

The classical or Mendelian phenotypic ratio of 9:3:3:1 is obtained only when the alleles at both gene loci display dominant and recessive relationships. If one or both gene loci have incompletely dominant alleles, or codominant alleles or lethal alleles, the dihybrid ratio becomes modified variously, such as follows: 1. 3: 6 : 3 : 1 : 2 : 1 ratio When the dihybrid parents have dominant and recessive alleles at one gene locus and codominant alleles at second gene locus, the F2 9 : 3 : 3 : 1. Phenotypic ratio becomes 3: 6: 3: 1: 2: 1.

Example: In cattles, hornless (P) condition is dominant to horned (p) condition, and white (W) coat color id codominant to red color (w). The mating of a homozygous white, hornless cattle (PPWW) with a homozygous red horned cattle (ppww). In F_1 generation heterozygous hornless, roan and genotype of PpWw. These hornless roan F_1 heterozygotes produce a F_2 progeny in the ratio of 3:6:3:1:2:1.



Self-mating between F_1 hybrids



F \ M	PW	Pw	pW	pw
PW	PPWW White Hornless	PPWw Roan Hornless	PpWW White Hornless	PpWw Roan Hornless
Pw	PPWw Roan Hornless	PPww Red Hornless	PpWw Roan Hornless	Ppww Red Hornless
pW	PpWw White Hornless	PpWw Roan Hornless	ppWW White Horned	ppWw Roan Horned
pw	PpWw Roan Hornless	Ppww Red Hornless	ppWw Roan Horned	ppww Red Horned

Phenotypic Ratio: 3: 6: 3: 1: 2: 1.

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87. 2053 Q.No. 2f What is dihybrid cross? [3]

Please refer to 2074 Set A Q.No. 2c

88. 2052 Q.No. 2b What is the basis of Mendelian genetics? Explain the law of segregation of characters. [3]

The main basis of Mendelian genetic are

1. The behaviour of chromosomes during mitotic prophase
2. The behaviour of chromosomes during meiotic cell division.
3. Fertilization of gametes.

Law of segregation : Please refer to 2073 Set D Q.No. 2c

Mark (√) the correct choice [1 mark]

1. 2056 Q.No. 1d The probability of appearance of tall characters on pea plants in F_2 generation of a Mendeian experiment is- (i) 100% (ii) 50% (iii) 75% (iv) 25% [1]

Ans: 75%

2. 2055 Q.No. 1d Agents that cause mutations are called:

(i) Mutagens (ii) Mutants (iii) Chromosomes (iv) Genes [1]

Ans: Mutagens

3. 2053 Q.No. 1a Genetic make up of an individual is called . . . . .

☐ Phenotype ☐ Genotype

☐ Recessive ☐ None [1]

Ans: Genotype

4. 2053 Q.No. 1e The mutation theory was proposed by . . . .

☐ Devries ☐ Charles Darwin

☐ Lamark ☐ A.R. Wallace [1]

Ans: Charles Darwin

5. 2052 Q.No. 1ii An organism having similar genes is called:

a. Genotype b. Dihybrid c. Homozygous d. Linkage [1]

Ans: Homozygous

6. 2052 Q.No. 1iii The theory of mutation was given by:

a. Darwin b. Cuvier c. Devries d. Lamarck [1]

Ans: Charles Darwin

Differentiate between the following terms [3 marks]

1. 2075 Set A Q.No. 2a Differentiate between RNA and DNA. [3]

Differentiation between DNA and RNA are explained below:

DNA	RNA
i. DNA found in nucleus.	i. RNA found in cytoplasm little amount found in nucleolus and nucleplasn.
ii. DNA is Double stranded.	ii. RNA is single stranded.
iii. Sugar is of deoxyribose type.	iii. Sugar is Ribose type.
iv. Nitrogenous base are G, CA, T.	iv. Nitrogenous base are G, C, AU.
v. It act as a genetic material in most of the living beings including virus.	v. It act as genetic material in some virus.
vi. Puriues and pyrimidine are in equal ratio.	vi. They may not occur in equal ratio.
vii. It can self replicate.	vii. It cannot self replicate.

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2. **2075 Set A Q.No. 2c Law of independent assortment.** [3]

Please refer to 2071 Set C Q.No. 2c

3. **2075 Set A Q.No. 2f Describe the properties of genetic code.** [3]

Some of the most important properties of genetic codes are as follows:

- The code is a triplet codon
- The code is non-overlapping
- The code is commaless
- The code is non-ambiguous
- The code has polarity
- The code is degenerate
- Some codes act as start codons
- Some codes act as stop codons

4. **2075 Set B Q.No. 2c Law of dominance.** [3]

Please refer to 2072 Set C Q.No. 2e

5. **2075 Set B Q.No. 2d Semi conservative method of DNA replication.** [3]

Please refer to 2070 Supp. Q.No. 2 e

6. **2075 Set B Q.No. 2e Incomplete dominance.** [3]

Please refer to 2073 Set D Q.No. 2e

7. **2056 Q.No. 4d Phenotype and genotype.** [3]

Please refer to Model (Botany) Q.No. 2c

8. **2055 Q.No. 4c Dominant and recessive characters** [3]

Difference between dominant and recessive characters are follows;

Dominant	Recessive
Dominance allele it is able to express itself even in the presence of is recessive allele.	Recessive allele is unable to express its effect in the presence of dominant allele.
It does not require another similar allele to produce its effect on the phenotype e.g Tt is tall.	It produces allele its phenotypic effect only in the presence of similar allele e.g tt is dwarf.

9. **2053 Q.No. 4a Euploidy and Aneuploidy.** [3]

Difference between euploidy and aneuploidy are follows;

Euploidy	Aneuploidy
Euploidy is a variation of a chromosomal set of a cell or organism.	Aneuploidy is a variation in total chromosome number of a cell or organism.
The number of chromosomes sets is changed.	The number of chromosomes set is not changed.
It occurs due to fertilization of one ovum with two sperms etc.	It occurs due to non disjunction in meiosis 1 and 2 and mitosis.

10. **2053 Q.No. 4b Dominance and Recessive** [3]

Please refer to 2055 Q.No. 4C

11. **2052 Q.No. 4a Heterozygous and Homozygous** [3]

Please refer to 2076 Set C Q.No. 2c

12. **2052 Q.No. 4b Phenotype and genotype** [3]

Please refer to Model (Botany) Q.No. 2c

Long Questions

1. **2076 Set B Q.No. 4 What is DNA? Describe the process of semi conservative method of DNA replication with good diagrams.** [8]

Deoxyribonucleic acid (DNA) is a chemical compound which responsible to transmit the genetic characters from one generation to another generation. DNA is act as a genetic material in all kinds of living beings including some viruses. It is a polynucleotide sequence present in nucleus, mitochondria and chloroplast.

Semi-Conservative Mode of DNA Replication

In this process both the strands of DNA separate. Each strand act as template strand and will synthesize its complementary strand. As a result in each daughter DNA, one strand has old strand while the other strand has new strand.

Mechanism of Semi-Conservative Mode of DNA Replication

During replication the weak hydrogen bonds between the nitrogenous bases of the nucleotides are separated. So that the two polynucleotide chains of DNA also separate and uncoil. Because of the specificity of base pairing, each nucleotide of separated chains attracts its complementary nucleotide from the cell cytoplasm. A pairs with T and T with A; C pairs with G and G with C. Once the nucleotides are attached by their hydrogen bonds, their sugar radicals unite through their phosphate components, completing the formation of a new polynucleotide chain. The entire process of semi conservative replication involves following steps.

1. **Origin of Replication:** Prokaryotic and Viral DNA has only one replication unit called replicon. Eukaryotic DNA has a number of replication or replicating units. Each replicon has a particular region where replication starts. It is called origin of replication or ori. In the region of ori there is a particular nucleotide sequence called automatic replicating sequence or ARS. Replication proceeds bidirectional from each ori. A replication fork is produced on each side of ori. Replication will continue till a replication fork meets another replication fork. The area is often called termination point.
2. **Activation of Deoxyribonucleotides:** The deoxyribonucleoside monophosphate (AMP, GMP, CMP, TMP) occur in the nucleoplasm. These are activated into triphosphate (ATP, GTP, CTP, and TTP) by combing with ATP and enzyme phosphorylase the process of phosphorylase.
3. **Unwinding of DNA:** Replication of DNA begins at a specific point called origin of replication or initiation point. The unwinding enzymes helicase bind to the points of origin of replication on the double helical DNA and initiate unwinding of its strands. The enzyme topoisomerase helps in making a nick in the DNA molecule at the origin. The two strands of DNA start separating by the breakdown of hydrogen bonds between paired nucleotides exposing their nitrogenous bases, so that each can serve as template for the synthesis of a new strand. In viruses and bacterial DNA there is only one origin of replication, where replication begins. Since bacterial and viral Chromosomes are circular and small, replication ends at the same point where it started. Thus complete molecule of circular DNA is one unit of replication. It is called a replicon. In eukaryotes the DNA molecules are large. They have several origins of replication and an equal number of replicons. The point of origin is marked as replication fork in the replicating molecule. The origin of replication consists of a sequence of 100 to 200 base pairs. Specific initiator proteins recognize the initiation point on DNA. These along with DNA directed RNA polymerase initiate synthesis of RNA primer for the formation of DNA chain.
4. **Formation of RNA Primer:** The DNA directed RNA polymerase synthesizes a short primer strand of RNA on the DNA template. This RNA primer is formed because enzyme RNA polymerase cannot initiate synthesis of new DNA strand but it can polymerise the growth of DNA chain. It consists of about 50-100 nucleotide. Enzyme primase brings about polymerization of RNA primer on template DNA strand.

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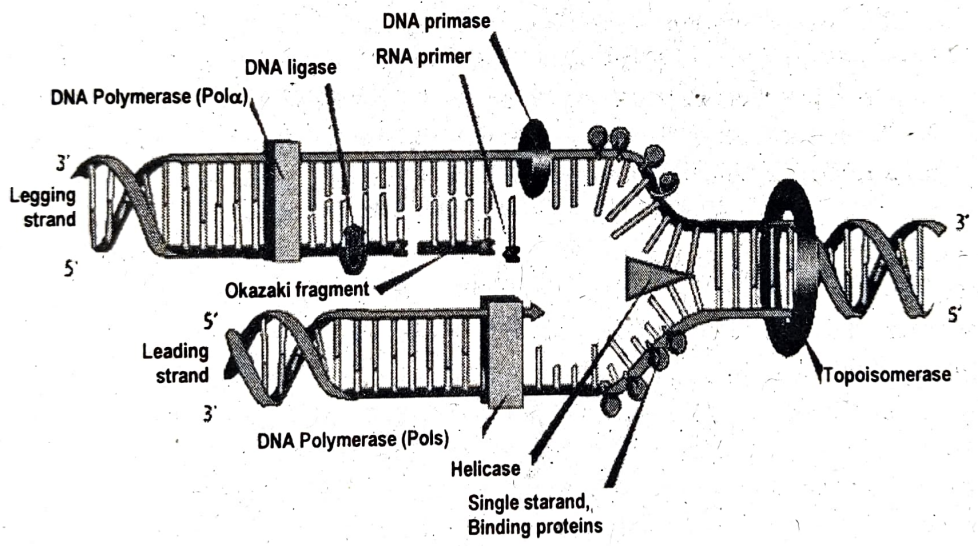
5. **Elongation of New DNA Strand:** The enzyme DNA polymerase can polymerise the nucleotides only in 5′⟶3′ direction. DNA polymerase is responsible for the template directed condensation of deoxyribonucleotide triphosphatases. Synthesis of new complementary strand proceeds from the 3′OH terminus of the primer causing extension or growth in 5′⟶3′ direction. Because the two strands of DNA are in antiparallel direction, the two strands have to be synthesized by growth occurring in opposite direction. The addition of deoxyribonucleotides is done by DNA polymerase in the presence of ATP. The enzyme synthesize a new strand in a continuous piece in 5′⟶3′ direction and is called leading strand. On the other strand of DNA the enzyme forms DNA fragments in small pieces again in 5′⟶3′ direction initiating from RNA primer. The primer is formed with the help of primase enzyme. The small segments are called lagging strand or okazaki strand (name after the Japanese scientist Okazaki). They are joined together to produce a continuous daughter strand with the help of DNA ligase. Once the small pieces of Okazaki fragments have been formed, RNA primer is removed from 5′ end one by one by the exonuclease activity of DNA polymerase.

6. **Proof reading and DNA repair:** The specificity of base pairing ensures exact replication. Somehow it is possible that wrong bases may get in at a rare frequency of one in 10000. These wrongly introduced bases can be removed by the activity of enzyme DNA polymerase. Even the wrong bases entered into helix of DNA polymerase. Even the wrong bases entered into helix of DNA by mutation (escaped by proof reading mechanism of DNA) can be identified and corrected by repair enzymes. These repair enzymes cut off the defection segment of DNA and introduce and join the normal correct segment with the help of enzyme ligase.



Mechanism of DNA replication

2. **2076 Set C Q.No. 4 Define genetic material and describe the process involved in semi-conservative method of DNA replication with neat and clean diagram.** **[8]**

Please refer to 2076 Set B Q.No. 4

3. **2075 GIE Q.No. 4 Define crossing over and describe its mechanism and significance with necessary diagrams.** **[8]**

Crossing over is the process of exchange of genetic material or segments between non-sister chromatids of two homologous chromosome.

Mechanism of Crossing Over: The entire process of crossing over take place during pachytene but it starts and ends in zygotene and diakinesis subtage of meiosis I. Mechanism of crossing over is completed into following steps.

1. **Synapsis:** Crossing over starts at pachytene but is visible at the time of zygotene substage. During this subtage homologous chromosome come in contact and pair along their length called synapsis. At this substage each homologous chromosome is made up of two chromatids which remain

attached together by the centromere. The resultant pairs of homologous chromosomes are called bivalents. During synapsis there is a formation of molecular complex of protein and nucleic acid called synaptinemal complex. This complex helps to pairing of homologous chromosome.

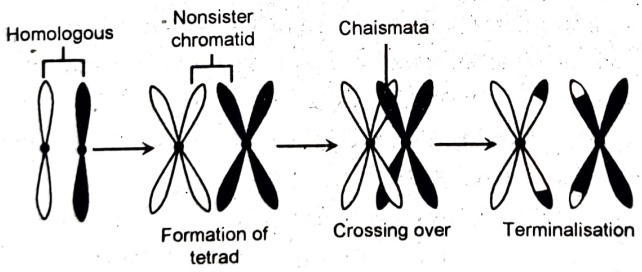
2. **Formation of Tetrad:** The synapsis is followed by duplication of chromosomes. During this substage each homologous chromosome of bivalents splits longitudinally and forms two identical sister chromatids which remain held together by an unsplitted centromere. The longitudinal splitting of chromosomes is achieved by the separation of already duplicated DNA molecules. At this stage each bivalent contains four chromatids, so it is known as tetrad.

3. **Formation of chaismata and crossing over:** The process of crossing over take place during pachytene subtage in tetrad stage of chromatids. Non sister chromatids first break at the corresponding points due the activity of enzyme endonuclease. Then a segment on one side of each break connects with a segments on the opposite side of the break, so that the two non-sister chromatids cross each other. The fusion of chromosomal segments with opposite one takes place due to ligase. The crossing of two chromatids in known as chaisma formation. The crossing over thus includes the breaking of chromatids segments, their transposition and their fusion.

4. **Terminalization:** After the occurance of process of crossing over the non sister chromatids start to repal each other because the force of synapsis attraction between them decreases. The chromatids separate progressively from the centromere towards the chaisma and the chaisma itself moves in a zipper fashion towards the end of the tetrad. The movement of chaisma is known as terminalization. Due to terminalization the homologous chromosomes are separated from each other.

Significance of crossing over

1. It produces new combination of gene and trait.
2. It increases variability of organism which is useful for natural selection.
3. Due to crossing over useful recombination can occur that can be used by breeder to produce useful new varieties of plants and animals.
4. It helps in construction of linkage map or genetic map.
5. It increases immunity of organisms.
6. Crossing over is a source of raw material for evolution.



Mechanism of crossing over

4. 2075 Set A Q.No. 4 **What is sex-linked inheritance? Explain it with reference to eye colour of *Drosophila* (Fruit fly).** [8]

Criss-cross inheritance is the transmission of a gene from mother to son or father to daughter. Those patterns of inheritance are called crisscross inheritance or skip generation inheritance, in which a character is inherited to the second generation through the carrier of first generation.

Sex chromosomes(X and Y) besides carrying sex determining genes also bear few genes for somatic characters. Such genes are called sex linked gene and their inheritance pattern is called sex linked inheritance. The genes present on X- chromosome are called X-linked and those present on Y are called Y-linked genes. In this type of inheritance results of reciprocal crosses are not identical. If a gene is X-linked, it is transmitted to both male and female offspring's by mother, but from father it goes to daughters and not to the sons. For the expression of X-linked character the females' offspring's shall receive the recessive gene from both the parents. In male offspring's the X is received from the mother and the single recessive gene expresses itself. This is called hemizygous condition. For this reason X-

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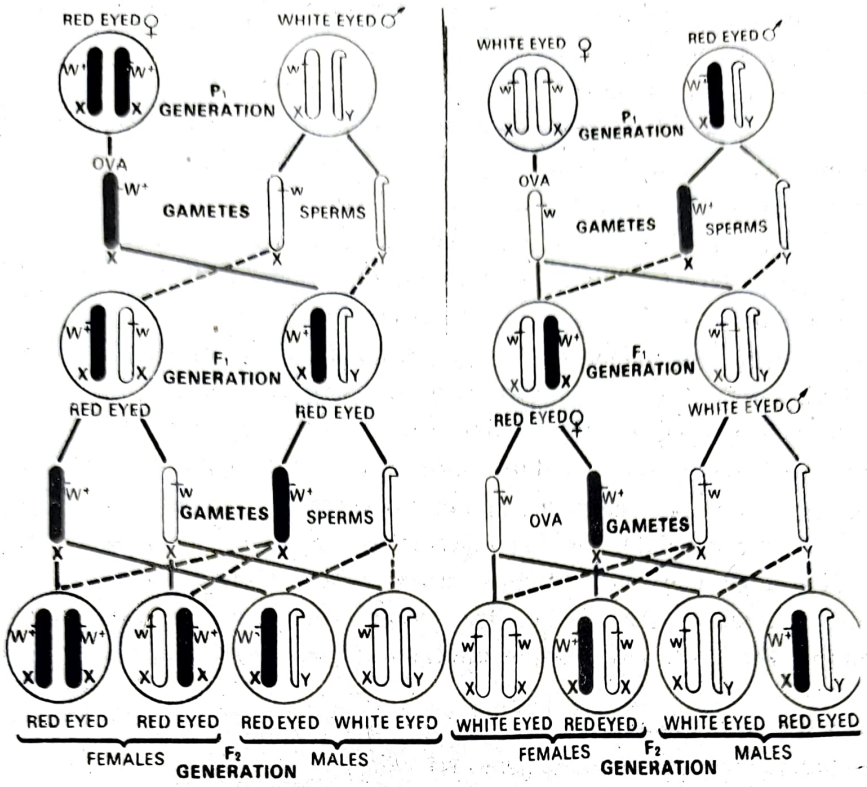
linked characters are more common in male than females. Y- linked genes are called holandric gene. These are inherited from male to male. Female does not receive Y-linked genes.



Sex Linked Inheritance in Drosophila melanogaster

Sex linkage was discovered by Thomas H. Morgan 1910 while working on *Drosophila melanogaster*. Morgan noted the sudden appearance of one white eyed male in the culture of red eyed *Drosophila*. This white eyed male was mated with red-eyed females. The F1 flies (both male and female) were all red eyed, indicating that white eye mutation (w) is recessive to red eye color (W^+). When F1flies mated freely, the red and white eyed flies appeared in the ratio of 3:1. But all white-eyed flies were male. The red eyed and white eyed males were in 1:1 ratio in the progeny. The females were all red eyed. In this cross white eyed females did not appear. The inheritance of white eye colour in Drosophila can be explained by assuming that

1. Gene for white eye color is located in the X- chromosome and Y-chromosome is empty, carrying no normal allele for eye color.
2. The white- eyed female possesses gene for white eye color (w) on both of its X-chromosomes. It transmits one gene for white eye color (w) to each offspring.
3. The white eyed males receive X-chromosome with w gene from the mother and Y-chromosome with no such gene from father. Therefore recessive w gene in homozygous state produces white eye color in all the male offspring's.
4. The daughter receives one X- chromosome with w gene from mother and one X-chromosome with dominant W- gene for red eye color from father. Therefore all of them are red eyed phenotypically but genetically they are heterozygous (W^+ w)

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5. 2075 Set B Q.No. 4 **Describe in detail about Mendel's law of independent assortment up to F_2 generation.** **[8]**

Please refer to 2071 Set C Q.No. 2c

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6. 2074 Supp Q.No. 4 **What is DNA and describe the process of DNA replication found in semi-conservative method with neat and clean diagrams.** **[8]**

Deoxyribonucleic acid, a self-replicating material which is present in nearly all living organisms as the main constituent of chromosomes. It is the carrier of genetic information.

Remaining portion: Please refer to 2076 Set B Q.No. 4

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7. **2074 Set A Q.No. 4** **Define sex linked inheritance and describe the process found in fruit fly.** [8]

Please refer to 2076 Set B Q.No. 4

8. **2074 Set B Q.No. 4** **What is sex linked inheritance? Discuss it with special reference to eye colour of fruit fly.** [8]

Please refer to 2076 Set B Q.No. 4

9. **2073 Supp Q.No. 4** **Define crossing over and describe its mechanism with necessary diagrams along with its significance.** [8]

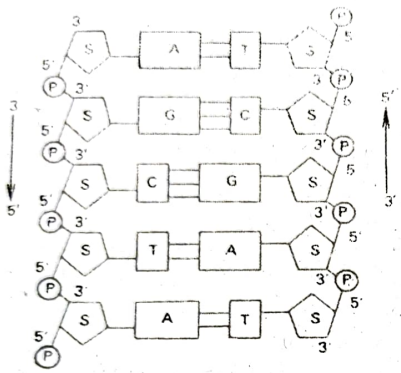
Please refer to 2075 GIE Q.No. 4

10. **2073 Set C Q.No. 4** **What is genetic material? Describe the structure and function of DNA.** [8]

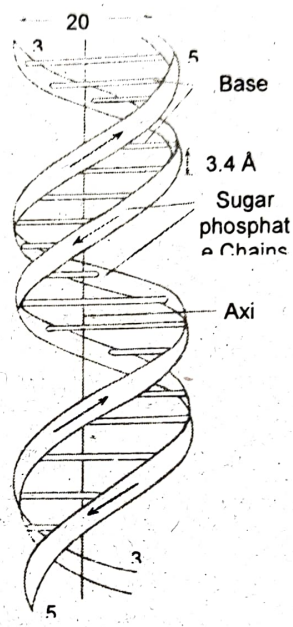
Genetic Materials

The material used to store genetic information in the nuclei or mitochondria of an organism's cells either in the form of DNA and RNA is called genetic material.

Structure and function of DNA



Chemical structure of



Helical structure of DNA

Deoxyribonucleic **acid (DNA)**

DNA is a long spirally coiled chain macromolecule which is formed by polymerization of large number of repeated units called deoxyribonucleotides. It represents the genetic material of organisms and is the molecular basis of heredity in all kinds of organism's including some viruses. In prokaryotes DNA lies coiled in the cytoplasm. In eukaryotes most of the DNA occurs inside the nucleus. It is the main component of chromatin fibers which later on form chromosomes. A small quantity of DNA occurs in the mitochondria and chloroplasts. The DNA which is found in prokaryotes, mitochondria and chloroplast is generally circular without histone protein and DNA present in nucleus is linear and is associated with histone protein.

James Watson and Francis Crick (1953) proposed the helical structure of DNA for which they were awarded with Nobel Prize. According to Watson and Crick DNA shows following structure.

i. DNA is a long chain polymer of over millions of deoxyribonucleotide (e.g 3.4 million base pairs in *Escherichia coli*, 65 million base pair in humans).

ii. DNA has two complementary and spirally coiled unbranched strands. The two strands are not coiled upon each other but the double strand is coiled upon itself or around a common axis like a spiral stair case with base pairs forming steps and back bones of two strands forming railings. Two strands of DNA is made up of phosphate and sugar molecules which joined together by phosphodiester bond.

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iii. The two strands are antiparallel to each other i.e. one chain runs in 5-3 direction and other in 3-5 direction.

iv. The two strands of DNA are held together by the weak hydrogen bond between specific base sequences.

v. These base sequences are attached to helix sugar with the help of glycosidic linkage.

vi. The base pairing are always specific it means guanine (G) always combine with cytosine(C) with three hydrogen bond and adenine(A) always combine with Thymine(T) with two hydrogen bond.

vii. The distance between two strands is about 20A^{o}

vii. One turns of helix measures about 34A^{o}

ix. The distance between two nitrogenous bases in a helix is about 3.4A^{o}

Functions of DNA

1. DNA is a genetic material because it helps in the inheritance of characters from parents to their offspring.
2. It helps to synthesizes RNA by the process of transcription.
3. DNA is indirectly involved in protein synthesis and controls the metabolic activities of a cell.
4. It controls the growth and development of organisms.
5. DNA gives new combinations during meiosis by crossing over.
6. Changes in sequences and number of nucleotides produce mutation that is a raw material of evolution.

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11. 2073 Set D Q.No. 4 **Define genetic material and describe the process of semi-conservation mode of replication of DNA with neat and clean diagrams.** **[8]**

✍ Please refer to 2073 Set C Q.No. 4

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12. 2072 Supp. Q.No. 4 **Define crossing over and describe its mechanism with necessary diagrams along with its significance.** **[8]**

✍ Please refer to 2075 GIE Q.No. 4

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13. 2072 Set C Q.No. 4 **Define sex-linked inheritance and discuss it with special reference to eye colour of Drosophila melanogaster (fruit fly).** **[8]**

✍ Please refer to 2076 Set B Q.No. 4

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14. 2072 Set D Q.No. 4 **Define DNA and describe the process involved in the semi-conservative mode of replication of DNA with necessary neat and clean diagrams.** **[8]**

✍ Please refer to 2076 Set B Q.No. 4

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15. 2072 Set E Q.No. 4 **What are genetic materials? Discuss the double helical structure of Watson and Crick's model of DNA with necessary diagrams.** **[8]**

✍ Please refer to 2073 Set C Q.No. 4

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16. 2071 Supp. Q.No. 4 **What is dihybrid cross? Mention diagrammatic account of dihybrid cross of Mendel's experiment and discuss.** **[8]**

✍ A dihybrid cross is a breeding experiment between parental generation having two contrasting characters. The individuals in this type of cross are homozygous for a specific trait. Traits are characteristics that are determined by segments of DNA called genes. Diploid organisms inherit two alleles for each gene. An allele is an alternate version of a gene that is inherited (one from each parent) during sexual reproduction. Based on this cross Mendel formulated the law of independent assortment.

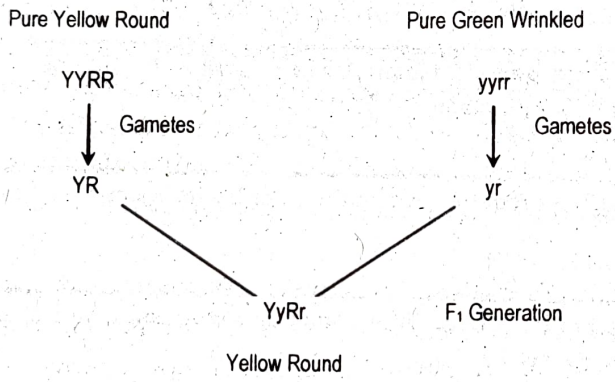
In a dihybrid cross, the parent organisms have different pairs of alleles for each trait being studied. One parent possesses homozygous dominant alleles and the other possesses homozygous recessive alleles. The offspring, or F^1 generation, produced from the genetic cross of such individuals are all heterozygous for the specific traits. This means that all of the F1 individuals possess a hybrid genotype and express the dominant phenotypes for each trait.

Example: The two different phenotypes in the dihybrid cross are seed color and seed shape. One plant is homozygous for the dominant traits of yellow seed color (YY) and round seed shape (RR). The genotype can be expressed as (YYRR). The other plant displays the homozygous recessive traits of green seed color and wrinkled seed shape (yyrr).

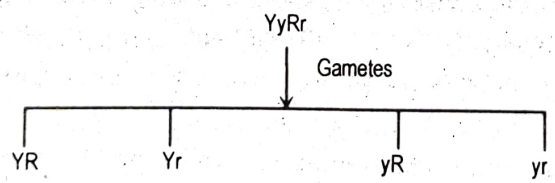
When a true-breeding plant with yellow seed color and round seed shape (YYRR) is cross-pollinated with a true-breeding plant with green seed color and wrinkled seed shape (yyrr), the resulting offspring (**F1 generation**) are all heterozygous for yellow seed color and round seed shape (YyRr).

Self pollination in the F1 generation plants results in offspring (**F2 generation**) that exhibit a 9:3:3:1 phenotypic ratio in variations of seed color and seed shape.

This ratio can be predicted by using a Punnett square to reveal the possible outcomes of a genetic cross based on probability. In the F2 generation, about **9/16** of the plants have yellow seeds with round shapes, **3/16** (green seed color and round shape), **3/16** (yellow seed color and wrinkled shape) and **1/16** (green seed color and wrinkled shape). The F2 progeny exhibit four different phenotypes and nine different genotypes. It is the inherited genotype that determines the phenotype of the individual. For example, plants with genotypes **(YYRR, YYRr, YyRR, or YyRr)** have yellow seeds with round shapes. Plants with genotypes **(YYrr or Yyrr)** have yellow seeds and wrinkled shapes. Plants with genotypes **(yyRR or yyRr)** have green seeds and round shapes, while plants with the genotype **(yyrr)** have green seeds and wrinkled shapes



Self Pollination between F_1 hybrids



♀ \ ♂	YR	Yr	yR	yr
YR	YYRR Yellow round	YYRr Yellow round	YyRR Yellow round	YyRr Yellow round
Yr	YYRr Yellow round	YYrr Yellow wrinkled	YyRr Yellow round	Yyrr Yellow wrinkled
yR	YyRR Yellow round	YyRr Yellow round	yyRR Green round	yyRr Green round
yr	YyRr Yellow round	Yyrr Yellow wrinkled	yyRr Green round	yyrr Green wrinkled

Phenotypic ratio = 9 : 3 : 3 : 1

Yellow Round Yellow Wrinkled Green Round Green Wrinkled

Genotypic ratio = 1:2:2:4:1:2:1:2:1

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17. **2071 Set C Q.No. 4** **Define crossing over and describe its mechanism with necessary diagrams along with its significance.** [8]

Please refer to 2075 GIE Q.No. 4

18. **2071 Set D Q.No. 4** **Describe the process of crossing over and its significances.** [8]

Please refer to 2071 Set C Q.No. 4

19. **2070 Supp. Q.No. 4** **What is Mutation? Describe its various types and its significance.** [8]

Mutation is a sudden heritable change in the content of genetic material of an organism. The substance which rwsponsible to cause mutation is called mutagen. Hugo De Vries (1901) coined the term of mutation.

Types of mutation

Mutation can be classified in to following types on the basis

1. **On the basis of cell affected:** Based on cell affected mutation can be classified into two types i.e. somatic mutation and germinal mutation. Somatic mutation affect somatic cell and such mutation do not play any role in evolution. On the other hand germinal mutation affects in germ cell and play important role on evolution.
2. **On the basis of where mutation occurs:** Based on the place of mutation occur, mutation can be divided into two types

i. **Gene Mutation/Point/Micro mutation:** Gene mutations happen when there are changes in the nucleotide sequence that makes up the strand of DNA. This can be caused by random mistakes in DNA replication or even an environmental influence like UV rays or chemicals. The changes at the nucleotide level then influence the transcription and translation from gene to protein expression. Changing even just one nitrogen base in a sequence can change the amino acid that is expressed by that DNA codon which can lead to a completely different protein being expressed.These mutations range from being non-harmful all the way up to causing death. It can also classified in to following types.

1. **Frame Shift Mutations:** Frame shift mutations are much more serious and deadly than point mutations. Even though only one nitrogen base is affected just like in point mutations, this time the single base is either completely deleted or an extra one is inserted into the middle of a DNA sequence. This change in sequence causes the reading frame to shift, hence the name frame shift mutation. A reading frame shift changes the three letter long codon sequence for messenger RNA to transcribe and translate. Not only is that amino acid changed, all subsequent amino acids are changed. This significantly changes the protein and can cause severe problems and even possibly death. It is of two types

a. **Insertions:** One type of frame shift mutation is called an insertion. Just as the name implies, an insertion occurs when a single nitrogen base is accidentally added in the middle of the sequence. This throws off the reading frame of the DNA and the wrong amino acid is translated. It also pushes the entire sequence down by one letter, changing all codons that come after the insertion and therefore completely altering the protein.

Even though inserting a nitrogen base makes the overall sequence longer, that does not necessarily mean the amino acid chain length will increase.

In fact, it could seriously shorten the amino acid chain. If the insertion causes a shift in the codons to create a stop signal, a protein may never be made. Otherwise, an incorrect protein will be made. If the protein that has been changed was essential for life, then most likely the organism will die.

b. **Deletions:** The other type of frame shift mutation is called a deletion. This happens when a nitrogen base is taken out of the sequence. Again, this causes the entire reading frame to change. It changes the codon and will also affect all amino acids that are coded for after the deletion. Nonsense and stop codons may also appear in the wrong places, much like an

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insertion.

ii. **Silent Mutation:** A protein is a string of amino acids which is encoded in a string of 3 base codons of DNA (one codon encodes one amino acid). For instance ATG encodes the amino acid methionine (all proteins in all living cells on earth begin with a methionine because all genes in all living cells on earth begin with ATG). However most amino acids can be encoded by more than one codon

iii. **Non-Sense mutation:** Non-sense mutation is a point mutation in a sequence of DNA that results in a premature stop codon, or a *nonsense codon* in the transcribed mRNA, and in a truncated, incomplete, and usually nonfunctional protein product

DNA:	5' -	ATG	ACT	CAC	TGA	GCG	CGA	AGC	TGA – 3'
	3' -	TAC	TGA	GTG	ACT	CGC	GCT	TCG	ACT – 5'
mRNA:	5' -	AUG	ACU	CAC	UGA	GCG	CGU	AGC	UGA – 3'
Protein:		Met	Thr	His	Stop				

iv. **Substitution:** A substitution is a mutation in which there is an exchange between two bases (i.e. a change in a single "chemical letter" such as switching a T to a C). Such a substitution could change a codon to one that encodes a different amino acid and cause a change in the protein produced. Sometimes substitutions may not effects the protein structure, such mutations are called silent mutations and sometimes they may change an amino-acid-coding codon to a single "stop" codon and cause an incomplete protein. This can seriously affect the protein structure which may completely change the organism. **Sickle Cell Anaemia** is caused by substitution mutation, where in codon (**GAG mutates to --> GTG**) and leads to (**Glu --> Val**) change.

a. **Transition:** A **transition** is a point mutation that changes a purine nucleotide to another purine (A ↔ G) or a pyrimidine nucleotide to another pyrimidine (C ↔ T).

b. **Transversion: Transversion**, in molecular biology, refers to the substitution of a (two ring) purine for a (one ring) pyrimidine or *vice versa*.

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20. 2070 Set C Q.No. 4 **Describe the sex linked inheritance with special examples to the eye colour of *Drosophila melanogaster* (fruit fly).** [8]

➴ Please refer to 2076 Set B Q.No. 4

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21. 2070 Set D Q.No. 4 **Describe the sex linked inheritance with special reference to the eye colour of *Drosophila melanogaster* (fruit fly).** [8]

➴ Please refer to 2076 Set B Q.No. 4

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22. 2069 Q.No. 4 **What is mutation? Describe its various types and its significance.** [8]

➴ Please refer to 2070 Supp. Q.No. 4

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23. 2068 Q.No. 4 **What is criss-cross inheritance? Discuss about the sex-linked inheritance with special reference to the eye colour of *Drosophila*.** [8]

➴ Please refer to 2075 Set A Q.No. 4

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24. 2067 Q.No. 4 **Describe the six linked inheritance with the reference of *Drosophila* (fruit fly)** [8]

➴ Please refer to 2075 Set A Q.No. 4

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25. 2066 Q.No. 4 **What do you mean by linkage? Describe its types with examples.** [8]

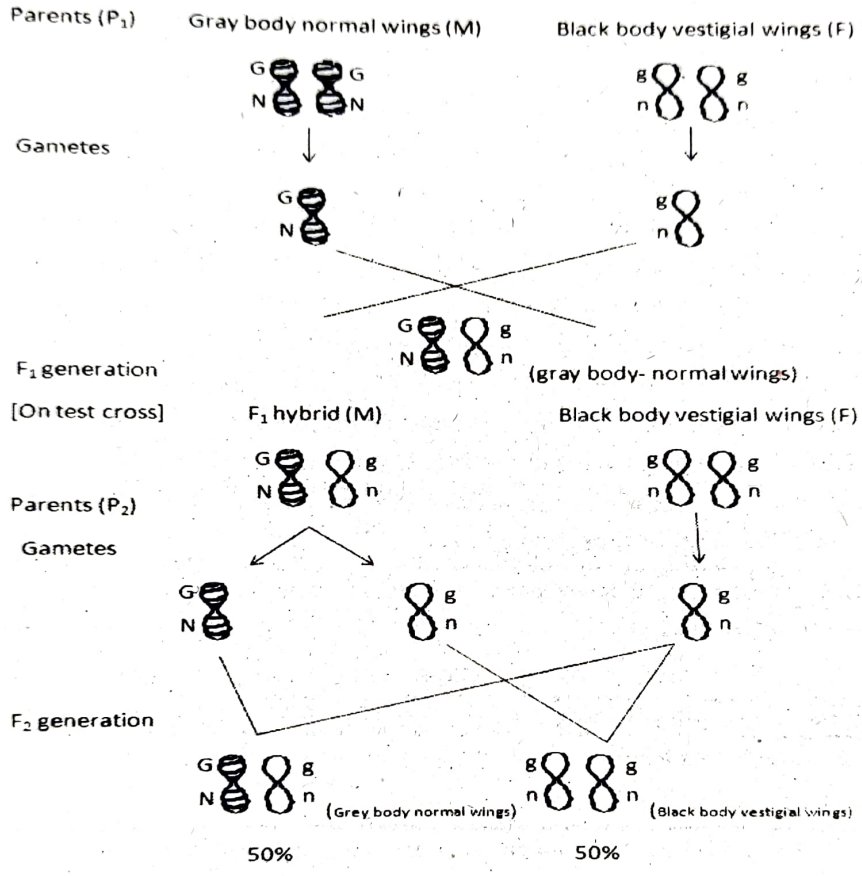
➴ A gene is basic unit of heredity. Genes control various characters existing in an organism's and these genes are located in specific pattern on chromosomes. Chromosomes contain a number of genes for different characters. Linkage is a phenomenon of persistent or permanent association of genes that can be inherited in successive generations in same position and proportion without any changes or separations. The genes located in the same chromosome are inherited together called linked genes and the characters controlled by these genes called linked characters. The distance between the linked genes is measured in map units or morganoid. There is no crossing over between the linked genes of having distance less than 50mu. In the distance less than 50mu of linked genes, there is no formation of any non-parental combinations. But the distance between the

linked genes is more than 50mu units are responsible for formation for some non-parental characters along with parental characters which is due to chance of crossing over.

Types of Linkage

Depending upon the presence or absence of new combinations or non-parental combinations, linkage can be of two types:

i. **Complete Linkage:** If two or more characters are inherited together and consistently appear in two or more generations in their original or parental combinations, it is called complete linkage. These genes do not produce non-parental combinations. Such types of genes are called complete linked genes. The distance between the complete genes is less than 50mu. Genes for grey body and normal wings in male Drosophila show complete linkage.



Complete linkage in *Drosophila*

ii. **Incomplete Linkage:** Incomplete linkage is exhibited by those genes which produce some percentage of non-parental combinations. Such genes are located distantly on the chromosome. It is due to accidental or occasional breakage of chromosomal segments during crossing over. The genes that show incomplete linkage is called incomplete linked. The distance between two incomplete linked genes is more than 50mu.

Example. Incomplete Linkage in Maize Plant

Maize provides a good example of linkage. Hutchinson crossed a variety of maize having coloured and full seed (CCSS) with a variety having colourless and shrunken seeds (ccss). The gene C for colour is dominant over its colourless allele c and the gene S for full seed is dominant over its shrunken allele s. All the F_1 plants produced coloured and full seed. But in a test cross, when such F_1 females (heterozygous) are cross pollinated with the pollen from a plant having colourless and shrunken seeds (double recessive), four types of seeds are produced.

From the above stated result it is clear that the parental combinations are more numerous (96.4%) than the new combination (3.6%). This clearly indicates that the parental characters are linked together. Their genes are located in the same chromosome and only in 3.6% individuals these genes are separated by crossing over. This is an example of incomplete linkage.

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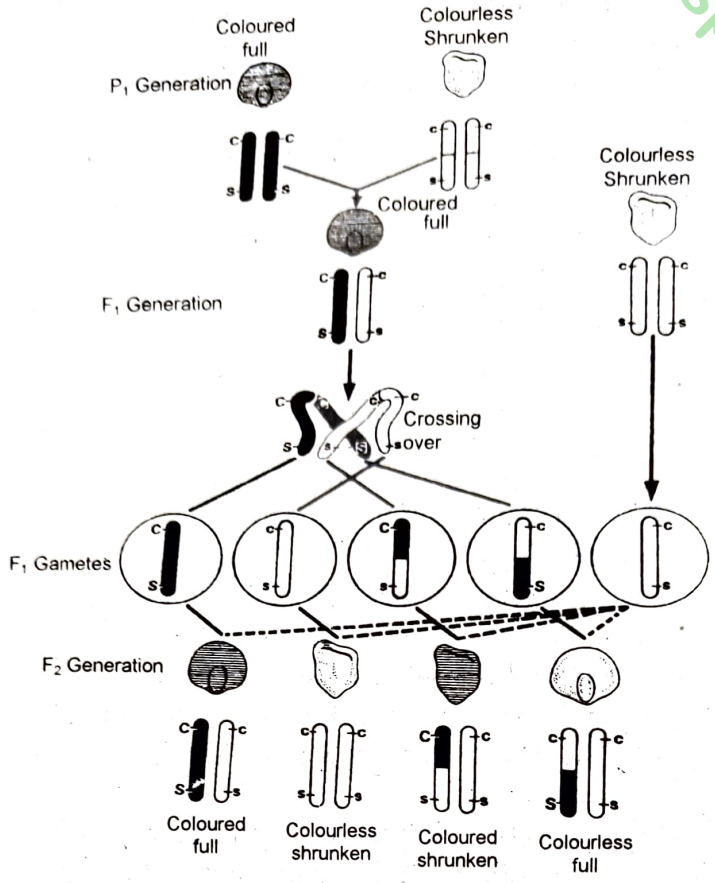

Incomplete linkage in maize plant

Significance of Linkage:

i. Linkage plays an important role in determining the nature of scope of hybridization and selection programmes.

ii. Linkage reduces the chance of recombination of genes and thus helps to hold parental characteristics together. It thus helps organism to maintain its parental, racial and other characters. For this reason plant and animal breeders find it difficult to combine various characters.

26. 2065 Q.No. 3 **Explain the mechanism of DNA replication and mention its significance.** [7.5]

Please refer to 2076 Set B Q.No. 4

27. 2064 Q.No. 5 **Describe in detail about the process of semi-conservative method of DNA replication.** [7]

Please refer to 2076 Set B Q.No. 4

28. 2063 Q.No. 4 **Discuss the mechanism of DNA replication and state its functions.** [7]

Please refer to 2076 Set B Q.No. 4

29. 2062 Q.No. 5 **What is criss-cross inheritance? Discuss about the sex-linked inheritance with special reference to the eye colour of *Drosophila*.** [7]

Please refer to 2075 Set A Q.No. 4

30. 2061 Q.No. 5 **Describe the double helical structure of Watson & Crick's model of DNA.** [7]

Please refer to 2073 Set C Q.No. 4

31. 2060 Q.No. 5 **What is mutation? Explain gene mutation in brief.** [7]

Please refer to 2070 Supp. Q.No. 4

32. 2059 Q.No. 5 **What are genetic materials? Describe the structure and function of DNA.** [1+4+2]

Please refer to 2073 Set C Q.No. 4

33. 2058 Q.No. 4 **Describe the Mendel's Law of inheritance.** [10]

Based on the result of monohybrid and dihybrid cross Mendel formulated law of inheritance of Mendelism. These laws's are:

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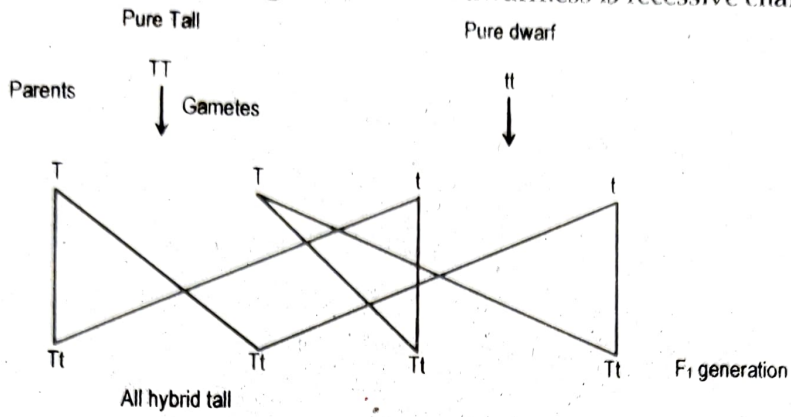
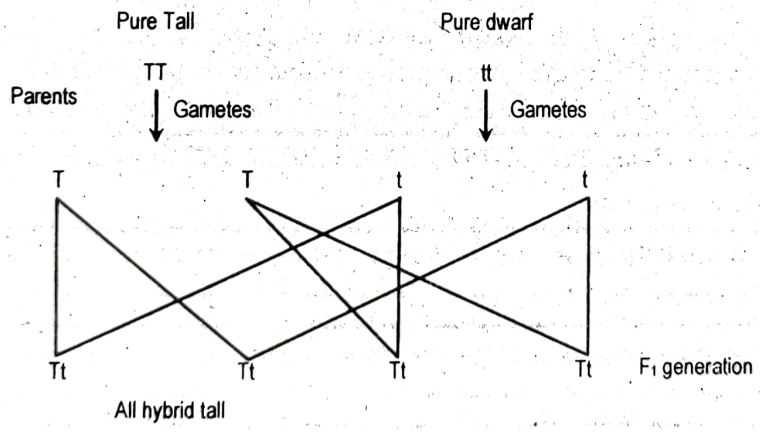
i. **Law of dominance:** Law of dominance state that when two homozygous parental stocks with contrasting characters are crossed, only one form of character appear in F_1 generation and other remain unexpressed. The character which is expressed is called dominant characters while the one which is not expressed is called recessive characters. For example when homozygous tall (TT) and homozygous dwarf (tt) Pea Plant are crossed all the plants in F1 generation are tall (Tt). Thus Tallness is dominant character in Fi generation and dwarfness is recessive character.



ii. **Law of segregation or Purity of Gametes:** The law of segregation state that the factors (gene) for each character segregate (separate) at the time of gamets formation. The character never mixes or contaminate with each other. They remain together for long time and separate at the time of gametogenesis.

For example; When homozygous tall (TT) and homozygous dwarf (tt) pea plant are crossed all the plants in Fi generation are the tall (Tt). On self pollination of F1 hybrid in F_2 generation tall and dwarf plants are obtained in the ration 3:1. The reappearance of dwarfness which had remained hidden in F_1 generation is due to separation of the two contrasting allelic factors (T and t) present in F_1 hybrid.



Self Pollination between F_1 hybrids

F_2 generation

♀ \ ♂	T	t
T	TT (Tall)	Tt (Tall)
t	Tt (Tall)	Tt (Dwarf)

Phenotypic ratio = 3: 1, Genotypic ratio = 1:2:1

iii. **Law of independent assortment:** Mendel formulated the third law of inheritance based on his dihybrid cross. This law state that the factors for different characters are inherited independently from generation to generation. i.e. They do not remain linked in the offspring's but are assorted independently. For example, when homozygous Pea plants having Yellow Round Seed (YYRR) and green wrinkled (yyrr) are crossed, in F_1 generation all plants having yellow round seeds (YyRr). On

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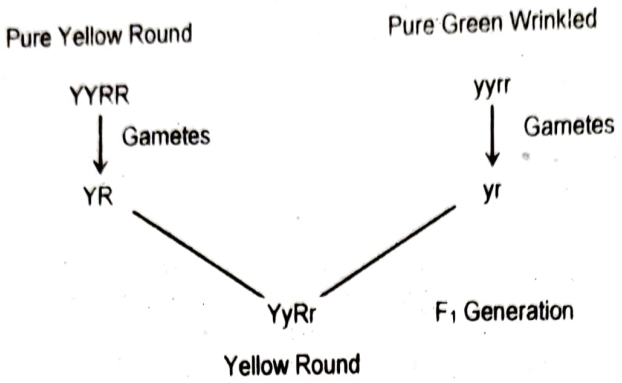
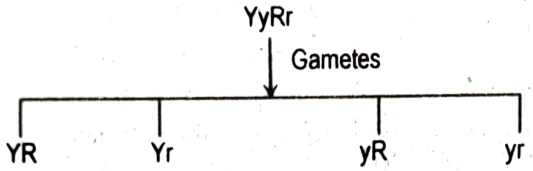
self pollination plants with yellow roud, yellow wrinkled, green round and green wrinkled seeds are obtained in the ratio of 9:3:3:1. This proves that the inheritance of the pair of contrasting characters called shale is independent of inheritance of another pair of contrasting characters called colour of seed.



Self Pollination between F_1 hybrids



♀ \ ♂	YR	Yr	yR	yr
YR	YYRR Yellow round	YYRr Yellow round	YyRR Yellow round	YyRr Yellow round
Yr	YYRr Yellow round	YYrr Yellow wrinkled	YyRr Yellow round	Yyrr Yellow wrinkled
yR	YyRR Yellow round	YyRr Yellow round	yyRR Green round	yyRr Green round
yr	YyRr Yellow round	Yyrr Yellow wrinkled	yyRr Green round	yyrr Green wrinkled

Phenotypic ratio = 9 : 3 : 3 : 1

Yellow Round, Yellow Wrinkled, Green Round, Green Wrinkled

Genotypic ratio = 1:2:2:4:1:2:1:2:1

34. **2057 Q.No. 5 Discuss the mechanism of DNA reclication.** [7]

Please refer to 2076 Set B Q.No. 4

35. **2053 Q.No. 6 Discuss the Law of Independent Assortment.** [10]

Please refer to 2058 Q.No. 4

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Unit 3

DEVELOPMENTAL BIOLOGY

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Answer all in very short [1 mark]

1. 2076 Set B Q.No. 1d **What do you mean by scion and stock?** [1]

Scion: Scion is the part of plant which is grafted on the stock.
Stock: Stock is the plant selected for root system during grafting.

2. 2076 Set B Q.No. 1h **Define megasporogenesis.** [1]

The process which helps in the formation of megaspore with in the sporangium or embryo sac called megasporogenesis.

3. 2076 Set B Q.No. 1i **What do you mean by chiropterophily?** [1]

Pollination which takes place with the help of bat like in plant Anthocephalous kadamba is known as chirepterophily.

4. 2076 Set C Q.No. 1f **What does it mean by scion?** [1]

A detached living portion of a plant (such as a bud or shoot) joined to a stock in grafting and usually supplying solely aerial parts to a graft.

5. 2076 Set C Q.No. 1g **What is microspore?** [1]

Microspores are land plant spores that develop into male gametophytes, whereas megaspores develop into female gametophytes. The male gametophyte gives rise to sperm cells, which are used for fertilization of an egg cell to form a zygote.

6. 2076 Set C Q.No. 1h **State about cleistogamy.** [1]

Cleistogamy is a type of automatic self-pollination of certain plants that can propagate by using non-opening, self-pollinating flowers. Especially well known in peanuts, peas, and pansy this behavior is most widespread in the grass family.

7. 2075 GIE Q.No. 1f **Mention about vegetative propagation.** [1]

Propagation which takes place by any vegetative parts of plants like root, stem and leave is called vegetative propagation.

8. 2075 GIE Q.No. 1g **What is pollen tube?** [1]

Pollen tube a tube like structures which is formed during fertilization and contain tube nucleus and male sperm.

9. 2075 GIE Q.No. 1h **Define autogamy.** [1]

It is a type of pollination pollen grains are transferred to stigma of same flower. It can occurs by three methods i.e Cleistogamy, Homogamy, and Geitonogamy.

10. 2075 Set A Q.No. 1e **What is the advantage of cross pollination?** [1]

Following is the advantages of cross pollination:

1. It helps in mixing of traits, i.e. it helps in bringing about variations.
2. Variations help in better sustainability and viability of the species.
3. Undesirable characters of the plant can be eliminated.

11. 2075 Set B Q.No. 1f **What is grafting?** [1]

Grafting is the technique of transplanting a part of one plant to other plant of closely related variety or species.

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12. 2075 Set B Q.No. 1g **What does it mean by microsporogenesis?** [1]

It is the process of formation of microspore within the sporangium or pollen sac.

13. 2075 Set B Q.No. 1h **Define anemophily.** [1]

It is a types of cross pollination which occurs by wind is called anemophilly. Like *Pinus*.

14. 2074 Supp Q.No. 1f **What does it mean by layering?** [1]

A method of propagating a plant in which roots are induced in the stem while it is still attached to parental plant. It is of two types' i.e air layering and mound layering.

15. 2074 Supp Q.No. 1g **State about angiosperm.** [1]

A plant of a large group that comprises those that have flowers and produce seeds enclosed within a carpel, including herbaceous plants, shrubs, grasses, and most trees.

16. 2074 Supp Q.No. 1h **Define hydrophilly.** [1]

Hydrophily is a fairly uncommon form of pollination whereby pollen is distributed by the flow of waters, particularly in rivers and streams. Hydrophilous species fall into two categories: those that distribute their pollen to the surface of water, and those that distribute it beneath the surface. The most common examples are *Hydrilla Vallisneria* etc.

17. 2074 Set A Q.No. 1f **What is tuber?** [1]

A much thickened underground part of a stem or rhizome, e.g. in the potato, serving as a food reserve and bearing buds from which new plants arise.

18. 2074 Set A Q.No. 1g **Mention about pollen grains.** [1]

Pollen is a fine to coarse powdery substance comprising pollen grains which are male microgametophytes of seed plants, which produce male gametes (sperm cells). Pollen grains have a hard coat made of sporopollenin that protects the gametophytes during the process of their movement from the stamens to the pistil of the ovary.

19. 2074 Set A Q.No. 1h **Define fertilization.** [1]

Fusion of male and female gametes inside the ovary called is fertilization.

20. 2074 Set B Q.No. 1f **State about cutting.** [1]

A plant cutting is a piece of a plant that is used in horticulture for vegetative (asexual) propagation. A piece of the stem or root of the source plant is placed in a suitable medium such as moist soil.

21. 2074 Set B Q.No. 1g **Mention about gymnosperm.** [1]

Gymnosperm are naked seed bearing plants on earth. e.g. pinus, cycas

22. 2074 Set B Q.No. 1h **Elaborate entomophilly.** [1]

Pollination which take place with the help of insects called entomophilly e.g. Mustard.

23. 2073 Supp Q.No. 1f **Define grafting.** [1]

Please refer to 2075 Set B Q.No. 1f

24. 2073 Supp Q.No. 1g **Elaborate megasporogenesis.** [1]

Please refer to 2076 Set B Q.No. 1h

25. 2073 Supp Q.No. 1h **What is pollination?** [1]

Transfer of pollen from anther to stigma is known as pollination. Pollination may be cross and self.

26. 2073 Set C Q.No. 1f **Define the role of rhizome.** [1]

Rhizome is a thick and fleshy underground stem which grows horizontally near the soil surface it contain auxiliary buds which helps in vegetative propagation.

27. 2073 Set C Q.No. 1g **State about microgametogenesis.** [1]

The process which helps in the formation of male gamete from microspore or pollen grains.

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28. **2073 Set C Q.No. 1h What is pollen tube?** [1]

Please refer to 2075 GIE Q.No. 1g

29. **2073 Set D Q.No. 1f Define vegetative propagation.** [1]

Please refer to 2075 GIE Q.No. 1f

30. **2073 Set D Q.No. 1g Mention about anther.** [1]

Anther is the fertile part of androecium that helps in dispersal of microspore or pollen grains.

31. **2073 Set D Q.No. 1h State about double fertilization.** [1]

After discharge of male sperm inside embryos sac one of the male gametes fuse with egg and form zygote called syngamy and second male sperm fuse with secondary nuclei and forms a triploid endosperm. This process is called triple fusion. Here both of the male gametes take part in fertilization. This is called double fertilization or syngamy and triple fusion.

32. **2072 Supp. Q.No. 1f Define gootee.** [1]

Gootee is air layering technique in which roots are developed in hard and aerial healthy branch by using grafting clay.

33. **2072 Supp. Q.No. 1g Elaborate gametogenesis.** [1]

Gametognesis is a process of formation of gametophyte. In angiosperm gametogenesis is two type's microgametogenesis (Male gamete) and megagametogenesis (Female gamete).

34. **2072 Supp. Q.No. 1h What is double fertilization?** [1]

Please refer to 2073 Set D Q.No. 1h

35. **2072 Set C Q.No. 1f Mention about gootee.** [1]

It is method of development of root in the hard branches of plant that lie far away from the root.

36. **2072 Set C Q.No. 1g What is pollen tube?** [1]

Please refer to 2075 GIE Q.No. 1g

37. **2072 Set C Q.No. 1h Illustrate about entomophily.** [1]

Please refer to 2074 Set B Q.No. 1h

38. **2072 Set D Q.No. 1f Write about cutting.** [1]

Please refer to 2074 Set B Q.No. 1f

39. **2072 Set D Q.No. 1g What is entine?** [1]

Intine is the inner smooth protective layer of microspore which is made up cellulose.

40. **2072 Set D Q.No. 1h Illustrate about megagametogenesis.** [1]

The process which helps in the formation of megaspore with in the sporangium or embryo sac called megagametogenesis.

41. **2072 Set E Q.No. 1e Define embryo sac.** [1]

It is the female gametophyte of angiosperm having egg cell, two synergids, three antipodal cells, and two polar nuclei.

42. **2072 Set E Q.No. 1f Write any two advantages of vegetative propagation.** [1]

Please refer to Model (Botany) Q.No. 1f

43. **2072 Set E Q.No. 1g What is the difference between stock and scion?** [1]

Difference between stock and scion is follows:

Stock	Scion
Stock is the plant selected for root system during grafting.	Scion is the part of plant which is grafted on the stock.

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44. 2071 Supp. Q.No. 1g **Define megasporogenesis?** [1]

Please refer to 2076 Set B Q.No. 1h

45. 2071 Supp. Q.No. 1h **What is cross pollination?** [1]

Transfer of pollen- grains from the anther of a flower to the stigma of another flower borne of different plants.

46. 2071 Set C Q.No. 1f **Define vegetative propagation.** [1]

Formation of new individual from any vegetative parts of plants is called vegetative propagation.

47. 2071 Set C Q.No. 1g **Elaborate microsporogenesis.** [1]

It is the process of formation of microspore within the sporangium or pollen sac.

48. 2071 Set C Q.No. 1h **What is fertilization?** [1]

Please refer to 2074 Set A Q.No. 1h

49. 2071 Set D Q.No. 1f **What is grafting?** [1]

Please refer to 2075 Set B Q.No. 1f

50. 2071 Set D Q.No. 1g **Define megasporogenesis.** [1]

Please refer to 2076 Set B Q.No. 1h

51. 2071 Set D Q.No. 1h **What is self pollination?** [1]

Transfer of pollen grains from the anther of a flower to the stigma of same flower or different flower of same plant.

52. 2070 Supp. Q.No. 1f **Elaborate the benefit of vegetative propagation.** [1]

Please refer to Model (Botany) Q.No. 1f

53. 2070 Supp. Q.No. 1g **Elaborate about angiosperm.** [1]

Angiosperms are highly evolved groups of plant existing on earth it bears flower which helps in reproduction. Seeds are covered by seed coat.

54. 2070 Supp. Q.No. 1h **Define the benefit of pollination.** [1]

The benefit of pollination is transfer of male gametes towards female gametes for the formation of zygote.

55. 2070 Set C Q.No. 1f **Define asexual reproduction.** [1]

A reproduction which occurs without the fusion of male and female gametes is called asexual reproduction.

56. 2070 Set C Q.No. 1g **Mention about male gametophyte.** [1]

The process which helps in the formation of male gamete from microspore or pollen grains.

57. 2070 Set C Q.No. 1h **Point out fertilization.** [1]

Please refer to 2074 Set A Q.No. 1h

58. 2070 Set D Q.No. 1f **Define sexual reproduction.** [1]

A reproduction which occurs due to fusion of male and female gametes is called sexual reproduction.

59. 2070 Set D Q.No. 1g **Elaborate about female gametophyte.** [1]

The process which helps in the formation of female gamets with in the ovary in angiosper

60. 2070 Set D Q.No. 1h **Point out about anemophily.** [1]

Please refer to 2075 Set B Q.No. 1h

61. 2069 Q.No. 1f **What do you understand by the asexual reproduction?**

Please refer to 2070 Set C Q.No. 1f

62. **2069 Q.No. 1g What is exine?** [1]

Outer layer of pollen grain which protects male gametes is called exine.

63. **2069 Q.No. 1h Write the meaning of anemophily.** [1]

Please refer to 2075 Set B Q.No. 1h

64. **2068 Q.No. 1f What does it mean by vegetative reproduction?** [1]

Please refer to 2075 Set B Q.No. 1f

65. **2068 Q.No. 1g Define megasporogenesis?** [1]

Please refer to 2076 Set B Q.No. 1h

66. **2068 Q.No. 1h What is entomophilly?** [1]

Please refer to 2074 Set B Q.No. 1h

67. **2067 Q.No. 1f What is vegetative reproduction?** [1]

Please refer to 2075 Set B Q.No. 1f

68. **2067 Q.No. 1g Define microsporogenesis?** [1]

Please refer to 2075 Set B Q.No. 1g

69. **2067 Q.No. 1h What is self pollination?** [1]

Transfer of pollen grains from the anther of a flower to the stigma of same flower or different flower of same plant.

70. **2066 Q.No. 1 f Where are the microspore mother cells found in an angiospermic plant?** [1]

In angiosperm microspore mother cells are found inside the anther covered by nourishing layer called tapetum.

71. **2064 Q.No. 1f What is vegetative reproduction?** [1]

Please refer to 2075 GIE Q.No. 1f

72. **2063 Q.No. 1a Define vegetative reproduction.** [1]

Please refer to 2075 GIE Q.No. 1f

73. **2063 Q.No. 1j What is grafting?** [1]

Please refer to 2075 Set B Q.No. 1f

Very Short Answer Questions [2 marks]

1. **2062 Q.No. 1f What do you mean by fertilization?** [2]

Fusion of male and female gametes inside the ovary called fertilization.

2. **2061 Q.No. 1f What is the role of fragrance in pollination?** [2]

The role of fragrance is to attract pollinator for pollination.

3. **2057 Q.No. 1d Give two examples of entomophilus plants.** [2]

Please refer to Model Q.No. 1g

4. **2054 Q.No.2e What is double fertilization? Give example.** [2]

The process in which the two sperm nuclei of a pollen grain unite with nuclei of the embryo sac of an angiosperm plant. One sperm nucleus unites with the egg to form the diploid zygote, from which the embryo develops. The other sperm unites with the two nuclei located in a single cell at the center of the embryo sac. Together these nuclei form the triploid nucleus of the cell from which the endosperm develops. Double fertilization in this form is unique to the angiosperms.

5. **2052 Q.No. 3a How does endosperm in Angiosperms become triploid?** [2]

The process of fertilisation observed in angiosperms is called as double fertilisation. It is the combination of syngamy and triple fusion. Events during fertilisation are elucidated. As the pollen

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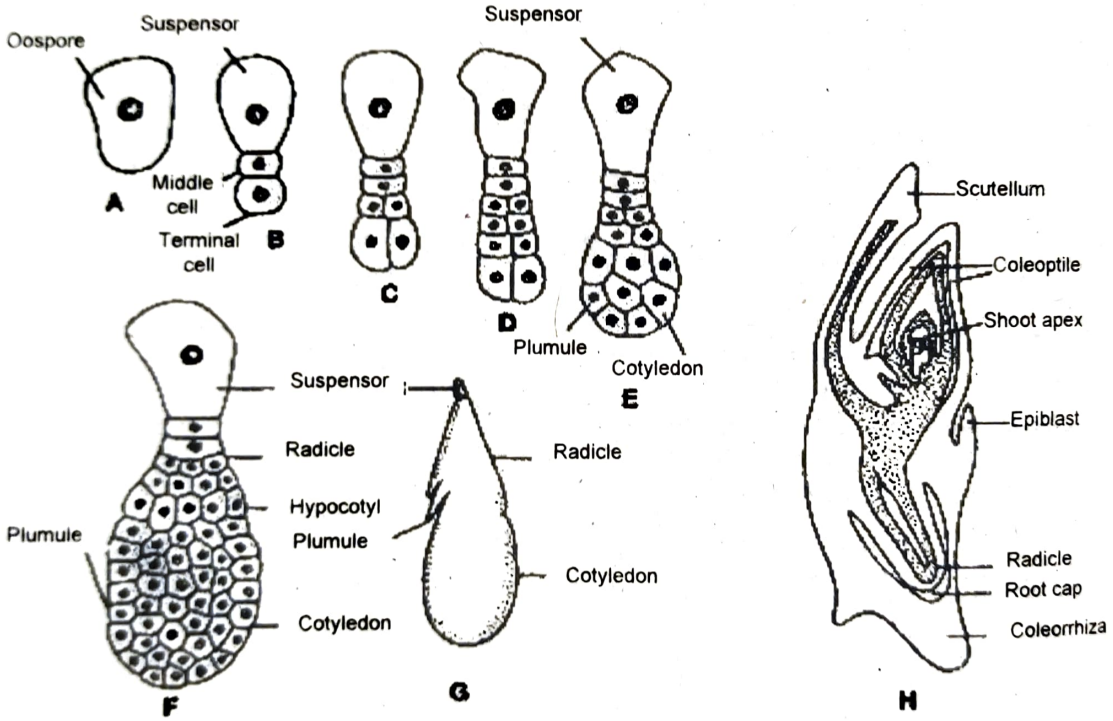
grain falls on the stigma of the flower, it germinates and forms a pollen tube. Pollen tube is guided by the secretions of the ovule. Pollen tube enters the micropylar region of the ovule. Embryo sac inside an ovule consists of antipodals, synergids, egg cell, a central cell with two polar nuclei. Pollen tube releases two male gametes into synergids cytoplasm. One of the male gametes fuses with the nucleus of egg cell by the process of syngamy to form diploid zygote(2n). The other male gamete fuses with the central cell and forms primary endosperm nucleus (PEN). This fusion is called as triple fusion. Hence, endosperm is triploid in nature.

Describe in brief [3 marks]

1. 2076 Set C Q.No. 2f **Development of monocot embryo.** [3]

The zygote or oospore elongates and then divides transversely to form basal and terminal cells. The basal cell (towards micropylar end) produces a large swollen, vesicular suspensor cell. It may function as haustorium. The terminal cell divides by another transverse wall to form two cells. The top cell after a series of divisions forms plumule and a single cotyledon. Cotyledon called scutellum, grows rapidly and pushes the terminal plumule to one side. The plumule comes to lie in a depression. The middle cell, after many divisions forms hypocotyl and radicle. It also adds a few cells to the suspensor. In some cereals both plumule and radicle get covered by sheaths developed from scutellum called coleoptile and coleorhiza respectively.

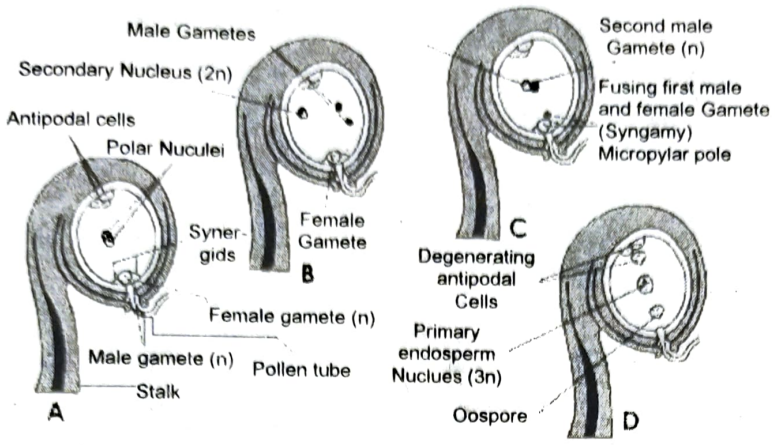


A–G, Stages in development of a monocot embryo. H, a monocot embryo of a grass.

2. 2075 GIE Q.No. 2f **Double fertilization.** [3]

Fertilization in flowering plants involves the fusion of the male and female gametes. Pollinators such as butterflies, bees and birds, pollinate the ovum or egg and transfer the male gametes to a flower's female reproductive organs. Pollination occurs between two flowers of the same or different plants or within one flower only. The male component of fertilization in flowering plants is pollen. It consists of two or three gametophytes containing the tube cell and germ cell. The tube cell grows into a pollen tube, while the germ cell divides through mitosis. Pollination brings the male pollen into the female stigma of a flower with the help of pollinators. Large flowers mostly attract insect pollinators, while smaller flowers use the wind to pollinate. The pollen is then transferred into the pistil or gynoecium, which contains the stigma, receptacle, ovary and style. Its tube cell sticks to the receptive stigma and starts to develop into a pollen tube. The male germ cell releases two sperm cells that travel to reach the flower's ovum. While the male cell grows, the

female cell in the ovule develops. One of the sperm cells fuses with the egg, while the other forms an endosperm tissue, which serves to nourish the growing zygote or seed. After fertilization occurs, the ovary wall becomes a fruit.

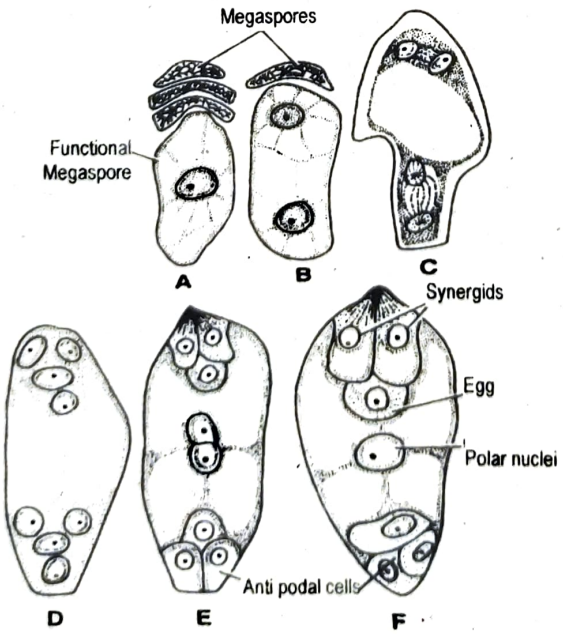


Porcess of Double fertilization

3. 2074 Supp Q.No. 2f **Megagametogenesis.** [3]

Megaspore represents first stage of the female gametophyte. It develops to form the female gametophyte. The female gametophyte is also called embryosac. The megaspore enlarges and its nucleus divides mitotically to form two nuclei. A vacuole appears between these two nuclei and pushes the nuclei toward the opposite poles of the cell. Both nuclei divide mitosis division to form eight nuclei, four at micropylar end and four at the chalazal end. This is followed by cellular organization of the embryo sac.

One nucleus from each pole moves towards the centre of the embryo sac and fuse to form a polar nucleus or secondary nucleus. The remaining three nuclei at the micropylar end organise into egg apparatus. The egg apparatus consists of two lateral synergids and a medium large egg cell or female gamete. Similarly three nuclei of the chalazal end form the antipodal cells. These cells help to provide nutrition for embryo sac. A mature female gametophyte before fertilization has seven nuclei (3 in egg apparatus, 3 in antipodal cell and a diploid polar nucleus). The egg apparatus and antipodal cells are haploid in nature. The formation of female gametophyte is followed by fertilization of the egg cell and the secondary nucleus.



Development of female gametophyte

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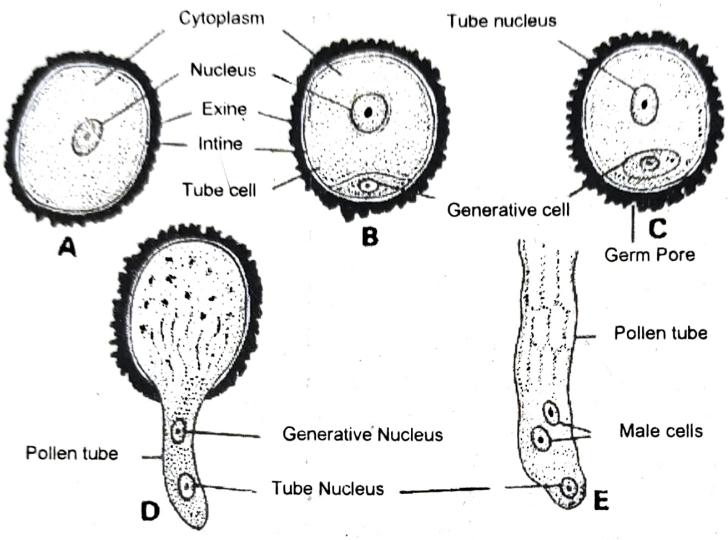
4. **2074 Set A Q.No. 2f Microgametogenesis.** [3]

A newly formed pollen grain possesses a very dense cytoplasm with a central nucleus. As the cell increases in size the vacuole develops and the nucleus is shifted at the side adjacent to the wall. The nucleus divides into two smaller generative towards the wall and larger vegetative nucleus towards centre. After this generative nucleus divides into nucleus stage. These are called sperms nuclei or male gametes. At the three celled stage normally on stigma the exine of pollen grain rupture at the germ pore and the intine in squized out with its contents. A tube like structure is formed called pollen tube. The tube nucleus enters into the pollen tube and two male gametes follow the tube nucleus. As pollen tube contains the enzymes like amylase, invertase, phosphotase, pectinase, lipase etc. it can degrade the chemicals contained in style and grows toward ovary. In this way a mature male gametophyte contains pollen tube with a tube nucleus and two male gametes.



Structure of male gametophye

Structure and germination of pollen grain in angiosperms. A, uninucleate pollen grain; B. pollen grain with generative cell and tube nucleus; C. generative cell lies free in tube cell; D. Pollen tube has developed and the generative cell and tube nucleus have migrated into it; E. generative nucleus has divided into two male gametes.

5. **2074 Set B Q.No. 2g Double fertilization.** [3]

Please refer to 2075 GIE Q.No. 2f

6. **2073 Supp Q.No. 2f Development of dicot embryo.** [3]

Please refer to Model (Botany) Q.No. 2f

7. **2073 Set C Q.No. 2f Process of fertilization.** [3]

Please refer to 2075 GIE Q.No. 2f

8. **2073 Set D Q.No. 2f Monocot embryo.** [3]

Please refer to 2076 Set C Q.No. 2f

9. **2072 Supp. Q.No. 2f Anemophilous pollination and its concerned plant's characteristics.** [3]

Anemophilous flowers are those flowers whose pollens are transferred by wind from the anthers to the stigmas of the same or a different plant. Here are some of the characteristic features of anemophilous flowers that have been identified by botanists:

1. They are often small and inconspicuous and are usually developed well before the foliage, so that this does not interfere with the free circulation of air around the flowers.
2. They do not develop nectarines nor are they scented.
3. The male parts tend to produce very large quantities of pollen by comparison with entomophilous flowers. This compensates for the indirect and somewhat risky means of transport. The greater the

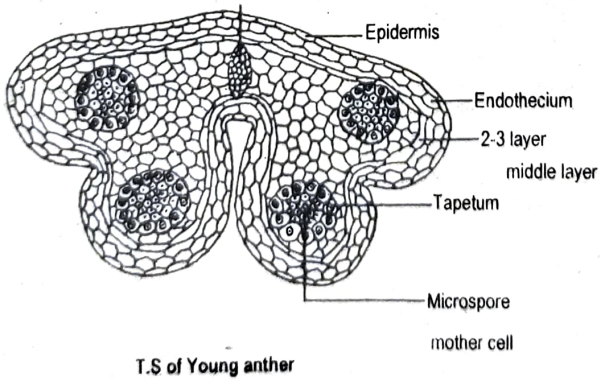
quantity of pollen, the greater is the chances of pollination. The aggregation of many male flowers into flexible catkins is common among trees, and clouds of pollen can be seen as it is shed from the hazel, oak and other trees.

4. The stigmas are often large, feathery and very sticky, and extend well outside the flower. Thus the pollen is more likely to reach them.
5. To remain airborne as long as possible, the pollen grains are usually very tiny, smooth-walled, dry and light; sometimes they have air-bladders.
6. Plants with anemophilous flowers are either trees or herbaceous plants with flowers high above the foliage. Thus there is less interference with pollen dispersal or pollen capture by the stigmas.

10. 2072 Set C Q.No. 2f Process of microsporogenesis. [3]

Formation of microspores or pollen grain within an anther is called microsporogenesis or microgametogenesis. A typical anther is bilobed structure. Young anther contains homogenous mass of meristematic cells. During development it assumes four lobed structures. Few cells of hypodermis at each lobe become more distinct than others due to larger size, distinct nucleus and dense cytoplasm. Such cells are called archesporial cells. These cells are divide periclinally (used to describe a type of cell division in a layer of cells that occurs parallel to an adjacent layer of cells) into two layers outer primary parietal layer and inner primary sporogenous layer. Primary parietal layer divides periclinally as well as anticlinally(Used to describe a type of cell division in a layer of cells that occurs perpendicular to the adjacent layer of cells) to form 2-5 concentric layers of anther wall which includes epidermis, endothecium, middle layers, and tapetum.

Primary sporogenous layer either directly function as microspore mother cell or they undergo one or more mitotic divisions to form microspore mother cells. A microspore mother cell divides meiotically into 4 haploid microspores. Aggregation of 4 microspores is called microspore tetrad. Separated microspores are called pollen grains. Each pollen grain has two walls outer thick exine and inner thin intine. It contains haploid nucleus with some cytoplasm. Exine at some points is thinner such points are called germ pore.Microspore or pollen grain represents the beginning of the male gametophyte. Pollen grains are of various shapes but commonly they are globular. They are unicellular uninucleated with two layered wall. The outer layer is called exine and made up of hard polymer of carotenoids (sporopollenin). The inner layer is called intine which made up of cellulose and pectin.



T.S of Young anther

11. 2072 Set D Q.No. 2f Development of male gametophyte. [3]

Please refer to 2074 Set A Q.No. 2f

12. 2072 Set E Q.No. 2f What is anemophily? Describe the features of anemophilous flowers. [3]

Please refer to 2072 Supp. Q.No. 2f

13. 2071 Supp. Q.No. 2f Elaborate the development of dicot embryo. [3]

Please refer to Model (Botany) Q.No. 2f

14. 2071 Set C Q.No. 2f Development of monocot embryo. [3]

Please refer to 2076 Set C Q.No. 2f

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15. **2071 Set D Q.No. 2f** **Describe the development of dicot embryo.** [3]

Please refer to Model (Botany) Q.No. 2f

16. **2070 Set C Q.No. 2f** **Development of male gametophyte.** [3]

Please refer to 2074 Set A Q.No. 2f

17. **2070 Set D Q.No. 2f** **Development of female gametophyte.** [3]

Please refer to 2074 Supp Q.No. 2f

18. **2069 Q.No. 2a** **Advantages of vegetative propagation.** [3]

Following are the advantages of vegetative reproduction:

1. The offsprings are genetically identical and therefore advantageous traits can be preserved.
2. Only one parent is required which eliminates the need for special mechanisms such as pollination, etc.
3. Many individual may be produced from a single plant.
4. Many plants are able to tide over unfavorable conditions. This is because of the presence of organs of asexual reproduction like the tubers, corm, bulbs, etc.
5. Vegetative propagation is especially beneficial to the agriculturists and horticulturists.

19. **2068 Q.No. 2f** **Elaborate the double fertilization.** [3]

Please refer to 2075 GIE Q.No. 2f

20. **2067 Q.No. 2f** **Discuss the process of double fertilization with necessary figures.** [3]

Please refer to 2075 GIE Q.No. 2f

21. **2066 Q.No. 1c** **Write the advantages of vegetative reproduction.** [3]

Please refer to 2069 Q.No. 2a

Differentiate between the following [3 marks]

1. **2076 Set B Q.No. 2f** **Process of male gametogenesis.** [3]

Please refer 2072 Set C Q.No 2f

2. **2075 Set A Q.No. 2b** **The development of monocot embryo.** [3]

Please refer to 2071 Set C No. 2f

3. **2057 Q.No.2e** **Differentiate between self and cross Pollination?** [3]

Please refer to Model (Botany) Q.No. 2e

4. **2053 Q.No. 4e** **Autogamy and Allogamy**

Please refer to 2057 Q.No. 2e

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Unit 4

APPLICATION OF BIOLOGY

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Answer all in very short [1 mark]

1. 2076 Set B Q.No. 1e **Define biofertilizer.** [1]

The living organisms which are used as fertilizers to improve the fertility of soil are called biofertilizers like. *Rhizobium leguminosarum* is a bacterium which can be commonly used as biofertilizer.

2. 2076 Set B Q.No. 1g **What is callus culture?** [1]

The callus is wound tissues composed of undifferenatiate, vacuolate and unorganized mass of cells.

3. 2076 Set C Q.No. 1i **Illustrate about callus culture.** [1]

Please refer to 2076 Set B Q.No. 1g

4. 2076 Set C Q.No. 1j **Define biotechnology.** [1]

Biotechnology is the branch of biology which deals with the study about different techniques for living organisms in the production of useful substances.

5. 2075 GIE Q.No. 1i **Illustrate about tissue culture.** [1]

Please refer to Model (Botany) Q.No. 1i

6. 2075 GIE Q.No. 1j **What does it mean by farmyard manure?** [1]

Manure which is produced by a mixture of dung and crop residues is called farmyard manures.

7. 2075 Set A Q.No. 1f **Give two scientific names of plant that are used as green manure.** [1]

Two plants which are of manure value are;

i. *Lens esculenta* (Masur) ii. *Vigna unguiculata* (Cow pea)

8. 2075 Set A Q.No. 1g **Define tissue culture.** [1]

Please refer to Model (Botany) Q.No. 1i

9. 2075 Set B Q.No. 1i **Mention about green manure.** [1]

Green manure is the type of fertilizer obtained from highly nutritive, quick growing green crops like leguminous plant. Green manures helps to increase soil fertility.

10. 2075 Set B Q.No. 1j **Illustrate about vaccine.** [1]

Vaccines are liquid chemical substances, which is used to stimulate an immune response in the body.

11. 2074 Supp Q.No. 1i **What is hybridization?** [1]

Hybridization is a technique to produce hybrid varieties of plants and animals.

12. 2074 Supp Q.No. 1j **Illustrate the importance of yeast.** [1]

The role of yeast is conversion of carbohydrat into alcohol by the process of fermentation in the presence of enzymes zymase.

13. 2074 Set A Q.No. 1i **Illustrate GMO.** [1]

Genetically Modified Organisms are being created and grown across the globe. Genetic modification occurs when the DNA of one living thing is added into the DNA of another so that a 'desirable' trait becomes part of the new, modified, organism. These modifications can alter or introduce particular traits in the organism. For example, a corn plant can be bred to resist herbicides that will kill the weeds growing around it that would compete for nutrients and light. In

this module, we'll discuss the most frequently modified crops.

14. **2074 Set A Q.No. 1j State about genetic engineering.** [1]

Please refer to Model (Botany) Q.No. 1h

15. **2074 Set B Q.No. 1i Define biofertilizer.** [1]

Please refer to 2076 Set B Q.No. 1e

16. **2074 Set B Q.No. 1j What is the role of yeast?** [1]

Please refer to 2074 Supp Q.No. 1j

17. **2073 Supp Q.No. 1i What do you mean by shoot culture?** [1]

In this method apical shoot can be used as explants for tissue culture. This explants is cultured in nutritive media to develop plant directly.

18. **2073 Supp Q.No. 1j Mention about green manure.** [1]

Green manure is the type of fertilizer obtained from highly nutritive, quick growing green crops like legumes plant. Green manures helps to increase soil fertility.

19. **2073 Set C Q.No. 1i What do you mean by biotechnology?** [1]

Please refer to 2076 Set C Q.No. 1j

20. **2073 Set C Q.No. 1j Mention about biofertilizer.** [1]

Please refer to 2076 Set B Q.No. 1e

21. **2073 Set D Q.No. 1i What is callus culture?** [1]

Please refer to 2076 Set B Q.No. 1g

22. **2073 Set D Q.No. 1j What do you mean by fermentation?** [1]

Incomplete oxidation of sugar into alcohol and CO_2 is called fermentation it is an extra cellular activities of organisms like Yeast.

23. **2072 Supp. Q.No. 1i What do you mean by embryo culture?** [1]

Embryo culture is a technique of development of plants after keeping embryo in nutritive media in aseptic condition.

24. **2072 Supp. Q.No. 1j Mention about farmyard manure.** [1]

Please refer to 2075 GIE Q.No. 1j

25. **2072 Set C Q.No. 1i Define tissue culture.** [1]

Please refer to Model (Botany) Q.No. 1i

26. **2072 Set C Q.No. 1j Elaborate about bio-fertilizer.** [1]

Please refer to 2076 Set B Q.No. 1e

27. **2072 Set D Q.No. 1i Define biotechnology.** [1]

Please refer to 2076 Set C Q.No. 1j

28. **2072 Set D Q.No. 1j Elaborate about farmyard manure.** [1]

Please refer to 2075 GIE Q.No. 1j

29. **2072 Set E Q.No. 1h Define fermentation.** [1]

Incomplete oxidation of sugar into alcohol and CO_2 is called fermentation it is a extra cellular activities of organism's like least.

30. **2072 Set E Q.No. 1i What do you mean by biofertilizer?** [1]

Please refer to 2076 Set B Q.No. 1e

31. **2071 Supp. Q.No. 1f What is callus?** [1]

Please refer to 2076 Set B Q.No. 1g

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32. **2071 Supp. Q.No. 1i Define the function of green manure?** [1]

Please refer to 2073 Supp Q.No. 1j

33. **2071 Supp. Q.No. 1j What is the role of insecticides?** [1]

The main role of insecticide is to kill the insect in crop plants. The most common insecticides used in crop land are natural insecticides (Neem leaf) and artificial insecticides like DDT.

34. **2071 Set C Q.No. 1i What do you mean by callus culture?** [1]

Please refer to 2076 Set B Q.No. 1g

35. **2071 Set C Q.No. 1j Mention about bio-fertilizer.** [1]

Please refer to 2076 Set B Q.No. 1e

36. **2071 Set D Q.No. 1i What is tissue culture?** [1]

Please refer to Model (Botany) Q.No. 1i

37. **2071 Set D Q.No. 1j Define vaccines.** [1]

Please refer to 2075 Set B Q.No. 1j

38. **2070 Supp. Q.No. 1i Point out the concept of disease resistant plants.** [1]

Please refer to 2070 Set C Q.No. 1i

39. **2070 Supp. Q.No. 1 j What does it mean by genetic engineering?** [1]

Please refer to Model (Botany) Q.No. 1h

40. **2070 Set C Q.No. 1i Elaborate the concept of disease resistant plant.** [1]

The plant species which can not be easily harmed by pathogens are called disease resistant plants.

41. **2070 Set C Q.No. 1j What do you mean by genetic engineering?** [1]

Please refer to Model (Botany) Q.No. 1h

42. **2070 Set D Q.No. 1i Significance of green manure.** [1]

Green manure is the type of fertilizer obtained from highly nutritive, quick growing green crops like legumes plant. Green manures helps to increase soil fertility.

43. **2070 Set D Q.No. 1j Mention about genetic engineering.** [1]

Please refer to Model (Botany) Q.No. 1h

44. **2069 Q.No. 1i Mention the fields of biotechnology.** [1]

The main fields of biotechnology are

i. Tissue culture
ii. Protoplast culture
iii. Genetic engineering
iv. Hybridoma Technology

45. **2069 Q.No. 1j State the meaning of tissue culture.** [1]

Please refer to Model (Botany) Q.No. 1i

46. **2068 Q.No. 1i Define biotechnology.** [1]

Please refer to 2076 Set C Q.No. 1j

47. **2068 Q.No. 1j What is vaccine?** [1]

Vaccines are liquid chemical substances, which is used to stimulate an immune response in the body.

48. **2067 Q.No. 1i Define tissue culture.** [1]

Please refer to Model (Botany) Q.No. 1i

49. **2067 Q.No. 1j What is an antibiotic?** [1]

Antibiotics are the chemical compounds produced from some microorganisms and acts as a toxin against other organisms by inhibiting their growth.

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50. 2066 Q.No. 1 g **Define a callus.** [1]

Please refer 2076 Set B Q.No. 1g

51. 2064 Q.No. 1e **What is hybridization?** [1]

Please refer to 2074 Supp Q.No. 1i

52. 2064 Q.No. 1g **What is biofertilizer?** [1]

Please refer to 2076 Set B Q.No. 1e

53. 2064 Q.No. 1o **What is herbal therapy?** [1]

The use of plants or plant extracts for medicinal purposes is called herbal therapy.

54. 2063 Q.No. 1f **What is callus?** [1]

Please refer to 2076 Set B Q.No. 1g

55. 2063 Q.No. 1h **Define inbreeding.** [1]

Inbreeding is a kind of breeding in which two individual with similar phenotypes are crossed.

56. 2063 Q.No. 1k **Define fermentation.** [1]

Please refer to 2072 Set E Q.No. 1h

57. 2062 Q.No. 1g **What is farmyard manure?** [1]

Please refer to 2075 GIE Q.No. 1j

58. 2062 Q.No. 1n **How alcohol is formed?** [1]

Alcohol is formed from incomplete oxidation of sugar during the process of fermentation. It is an extracellular process.

59. 2061 Q.No. 1j **What are vaccines?** [1]

Please refer to 2068 Q.No. 1j

60. 2061 Q.No. 1g **What is the role of root nodules?** [1]

The main function of root nodules to contain nitrogen fixing bacteria called *Rhizobium leguminosarum*.

61. 2060 Q.No. 1k **Which is callus?** [1]

Please refer to 2076 Set B Q.No. 1g

62. 2060 Q.No. 1n **Define fermentation.** [1]

Incomplete oxidation of sugar into alcohol and CO_2 is called fermentation it is a extra cellular activities of organism's like yeast.

63. 2059 Q.No. 1j **Name any two plants which are of manure value.** [1]

Please refer to 2075 Set A Q.No. 1f

64. 2059 Q.No. 1o **Give two applications of genetic engineering.** [1]

Two applications of genetic engineering are;

i. Application of genetic engineering in the production of human insulin.

ii. Application of genetic engineering in the production of Antibiotics.

65. 2058 Q.No. 1k **Name two types of fermentation processes.** [1]

Two types of fementation processes are;

1. Alcoholic Fermentation 2. Antibiotic Fermentation

66. 2058 Q.No. 1f **Define genetic engineering.** [1]

Please refer to Model Q.No. 1h

67. 2057 Q.No. 1j **Give any two plant names which are used as green manures.** [1]

Two plant names which are used as green manures are;

i. *Lens esculenta* (Masur) ii. *Vigna unguiculata* (Cow pea)

68. 2057 Q.No. 1o **Which organisms cause fermentation for alcohol?** [1]

Saccharomyces cerevisiae (Yeast)

Answer all in brief. [3 marks]

1. 2076 Set B Q.No. 2e **Application of plant tissue culture.** [3]

Tissues culture is a technique of growing cells, tissues and organs in an artificially prepared nutrient medium under aseptic conditions.

Application of tissues culture

Some important applications of tissues culture are

1. Multiple shootlet production
2. Production of disease free plants
3. Production of androgenic haploids
4. Getting pure line
5. Haploid plants are useful in for mutation breeding
6. Induction and selection of mutants
7. Embryo rescue
8. Somaclonal variation
9. Production artificial seeds.

2. 2076 Set C Q.No. 2g **Possible danger of genetic engineering.** [3]

List of possible dangers of genetic engineering

i. Genetic engineering is mainly concerted with manipulation of gene which may also form harmful combination of genes.

ii. There is an out risk of creation of drug resistance germs and out break of disease in against which there is no known prevention.

iii. It helps to creates new disease in organism's

iv. In the context of application of genetic engineering in human life, misuses of this technology in the production of biological war face or weapons are a very major disadvantage.

3. 2075 GIE Q.No. 2g **Application of biotechnology.** [3]

Importance of biotechnology

Now a day, biotechnology is used in various purposes for benefit of human being directly or indirectly in the different sectors.

1. In the **field of agriculture:** Different technique of biotechnology has been used in the field of agriculture for increasing productivity of cross. Some of these applications are:
   a. Micro propagation
   b. Production of disease free plants.
   c. Improvement of variety
   d. Development of transgenic plants and animals.
2. In the **field of medicine**: The concept of biotechnology has been used in the production of medicine, cure of different disease and preventing the human beings from untimely death of these applications are:
   a. Gene therapy
   b. Production of antibiotics
   c. Production of vaccines
   d. Hybridoma technology

4. 2075 Set B Q.No. 2f **Significance of fermentation technology.** [3]

Following are the significance of fermentation technology:

1. It is used in food industries such as dairy, sugarcane, and confectionary.
2. In pharmacy and biotech industry for synthesis of enzyme and other chemicals.
3. In beverages and distilleries for preparation of all types of alcohols and other liquids.
4. It helps in the Process of conversion of sugar to convert into cellular energy.
5. Biological enrichment of food substrates with protein, essential amino acids, essential fatty acids, and vitamins

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5. 2075 Set B Q.No. 2g **Application of genetic engineering in agriculture.** [3]

A number of food crops like potato, tomato, soybean, rice, wheat, etc. have now been genetically altered to enhance their qualities and quantities. Genetic engineering has important contribution in the field of agriculture like:

a. **Development of resistant varieties of plants:** Various genes that increase resistivity against diseases and adverse environmental conditions have been identified, cloned and manipulated into another species. For example, Bt gene is isolated from a bacterium Bacillus thuringiensis which is cloned and then manipulated it into rice or maize to increase resistivity. Similarly Agrobacterium has been used to introduce a gene from TMV into tobacco plant to increase resistivity against virus.

b. **Nitrogen fixation in non-leguminous cereals:** The transfer of nif genes from bacterium to the non-leguminous crops helps in nitrogen fixation that increases fertility of soil and then productivity of crops. This method is also helps to increase protein content of plants.

c. **Development of transgenic plants, animals and microbes:** The transgenic or genetically modified organism (GMO) is an organism carrying foreign genes or foreign DNA.

i. **Transgenic plants:** Plant having foreign genes or foreign DNA is called transgenic plant.

Transgenic plant	Advantage
Tomato	- To increase life of fruits (undergo slow ripening)
Golden Rice (miracle rice)	- To increase vitamin A
Potato	- To increase protein content

ii. **Transgenic animals:** Animal having foreign genes or foreign DNA is called transgenic animal.

Transgenic animal	Advantage
Cow, sheep and goat	- Production of huge amount of proteins in milk
Mice	- Study of technique of cloning
Chicken	- Production of vaccines for influenza, measles and mumps

iii. **Transgenic microbes (bacteria and fungi):** Micro-organism having foreign genes or foreign DNA is called transgenic microbes.

Transgenic microbe	Advantage
E. coli	- Production of human insulin (humulin)
Rhizobium meliloti	- Bio-fertilizer for nitrogen fixation
Yeast	- Production of vaccines for hepatitis B

6. 2074 Supp Q.No. 2g **Possible danger of genetic engineering.** [3]

Please refer to 2076 Set C Q.No. 2g

7. 2074 Set A Q.No. 2g **Application of plant tissue culture.** [3]

Please refer to 2076 Set B Q.No. 2e

8. 2074 Set B Q.No. 2f **Importance of genetic engineering in medicine.** [3]

Please refer to Model Q.No. 2g

9. 2073 Supp Q.No. 2g 2073 Set D Q.No. 2g **Application of genetic engineering in agriculture.** [3]

Genetic engineering is the branch of biology which deals with the study about the alternation of genetic make up of organism by the introduction of foreign gene. When conducting genetic engineering the organisms that have their genetic market altered are referred to as genetically modified organisms or GMOS. During the process DNA are altered to change a characteristic about the organism. Nowadays genetic engineering techniques have been used in various fields like in agriculture, in production of different types of modern medicine.

Some of these importances are

Application of genetic engineering in medicine.

Genetic engineering can be used in the various field of medicine like.

1. Gene therapy

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2. Production of human insulin
3. Production of interferon
4. Production of human growth hormone (somatotrophin)
5. Production of vaccines
6. Diagnosis of infections disease
7. Production of Transgenic animals
8. Production of antibiotics

Application of genetic engineering in agriculture

A number of food crops like potato, tomato, soyabea, rice, wheat, etc have now been genetically modified to enhance their qualities and quantities. Some of these contributions are.

i Development of disease resistant varieties of plants
ii. Development of biofertilizer (NIF gene)
iii. Increase protein content in different crops
iv. Development of transgenic plants, animals and microbes.

10. **2072 Supp. Q.No. 2g Genetic engineering and its possible danger.** [3]

Please refer to 2076 Set C Q.No. 2g

11. **2072 Set C Q.No. 2g Possible dangers of genetic engineering.** [3]

Please refer to 2076 Set C Q.No. 2g

12. **2072 Set D Q.No. 2g Application of biotechnology in agricultural sciences.** [3]

Please refer to 2073 Set D Q.No. 2g

13. **2072 Set E Q.No. 2g Discuss the importance of biotechnology.** [3]

Please refer to 2075 GIE Q.No. 2g

14. **2071 Supp. Q.No. 2f Discuss the biofertilizer and its application.** [3]

The living organism's which are used as fertilizers to improve the fertility of soil are called biofertilizers like *Rhizobium leguminosarum* is a bacteria which can be used as biofertilizer.

1. They are cheap
2. They lead to soil enrichment
3. They improve soil aeration and water holding capacity of soil.
4. They help in high quality yield
5. They do not possesses any hazard to human health
6. Some biofertilizer excrete antibiotics which act as pesticides.

15. **2071 Set C Q.No. 2g Application of genetic engineering in medicine.** [3]

Please refer to Model (Botany) Q.No. 2g

16. **2071 Set D Q.No. 2g Elaborate the fermentation technology and its application.** [3]

Incomplete oxidation of sugar into alcohol and CO_2 is called fermentation. The process of fermentation is extra cellular process which takes place by groups of microorganism like yeast. Fermentation is one of the most important food processing technologies. Many fermented products are preserved with extension of shelf life. In addition to being more shelf - stable products and removal of antinutritional components, all fermented foods have aroma and flower characteristics that result directly or indirectly from the fermenting microorganisms. The most common groups of microorganisms involved in food fermentation are bacteria, yeasts, and molds. Microbial enzymes also play an important role in food fermentation. Fermented foods play an important role in improving food security, increasing income and employment, enhancing livelihoods and improving the nutrition and social well - being of millions of people around the world, and others. Fermentation is influenced by numerous factors, including moisture, temperature, dissolved O_2 concentration, and dissolved CO_2. Variation of these factors may affect the rate of fermentation, the organoleptic properties of the product, nutritional quality, and other physicochemical properties. Fermentation preserves perishable raw materials.

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17. **2070 Supp. Q.No. 2f Importance of biofertilizer.** [3]

Please refer to 2071 Supp. Q.No. 2f

18. **2070 Supp. Q.No. 2g Benefit of fermentation technology.** [3]

Please refer to 2071 Set D Q.No. 2g

19. **2070 Set C Q.No. 2g Tissue culture and its application.** [3]

Please refer to 2076 Set B Q.No. 2e

20. **2070 Set D Q.No. 2g Fermentation technology and its significances.** [3]

Please refer to 2071 Set D Q.No. 2g

21. **2069 Q.No. 2g Genetic engineering and its application.** [3]

Please refer to 2073 Set D Q.No. 2g

22. **2068 Q.No. 2g Discuss the green manure and its application.** [3]

Green manure is the type of fertilizer obtained from highly nutritive, quick growing green crops like legumes plant. Green manures helps to increase soil fertility.

Application of Green Manure

1. They help to improve aeration of the soil
2. They help's to increase crops productivity from 30-50%
3. Green manures, helps to increase nitrogen contents in soil particularly by leguminous plant.
4. Green supply essential nutrients to the soil
5. They are cheap and easily available.

23. **2067 Q.No. 2g Discuss green manure and its application in agriculture.** [3]

Please refer to 2068 Q.No. 2g

24. **2066 Q.No. 1e Discuss the industrial application of fermentation technology.** [3]

Please refer to 2071 Set D Q.No. 2g

25. **2065 Q.No.2d Application of micropropagation in agriculture.** [3]

Micropropagation is the practice of rapidly multiplying stock plant material to produce a large number of progeny plants, using modern plant tissue culture methods. Micropropagation is used to multiply plants such as those that have been genetically modified or bred through conventional plant breeding methods. It is also used to provide a sufficient number of plantlets for planting from a stock plant which does not produce seeds, or does not respond well to vegetative reproduction.

Application of micropropagation in agriculture

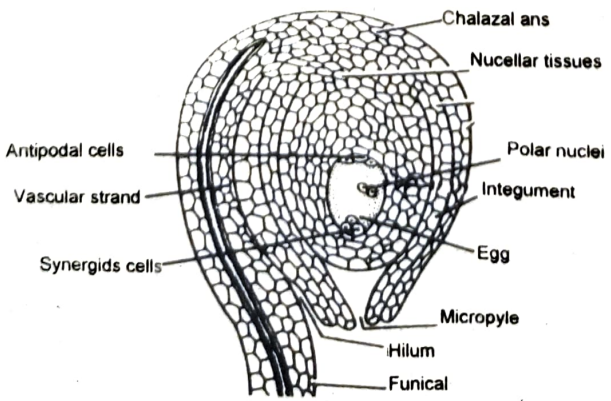
Please refer to 2076 Set B Q.No. 2e

26. **2065 Q.No.2e Advantages of green manure over chemical fertilizers.** [3]

Please refer to 2068 Q.No. 2g

27. **2064 Q.No.2d Draw a L.S. of well labelled diagram of typical ovule. (No description).** [3]

Following is the structure of L.S. of Ovule:



L.S. of Ovule

28. **2064 Q.No.2e Mention briefly about the importance of plant tissue culture in agriculture.** [3]

Please refer to 2076 Set B Q.No. 2e

29. **2063 Q.No.2d Write down the applications of biotechnology.** [3]

Please refer to 2075 GIE Q.No. 2g

30. **2062 Q.No.2b Explain about the green manure with examples.** [3]

Green manure is the type of fertilizer obtained from highly nutritive, quick growing green crops like legumes plant. Green manures helps to increase soil fertility.

e.g. *Trifolium repens* - Tinlate Jhar
Lathyrus satives - Khesari
Lens esculenta - Musuro
Vigna umbrellata - Masyang

31. **2061 Q.No.2d Discuss the significance of biotechnology.** [3]

Please refer to 2075 GIE Q.No. 2g

32. **2061 Q.No.2g Write down the prospects of genetic engineering.** [3]

Please refer to 2073 Set D Q.No. 2g

33. **2060 Q.No.2a What are the objectives of plants breeding? Explain.** [3]

The phenomenon of the development of improved and new agricultural and horticulture crop varieties that are far better than original varieties is called plant breeding. The objectives of plants breeding are

1. Production of disease and rest resistance plants
2. Production of crops whose products have high nutrient content
3. Production of different varieties of plants that are resistant to environmental hazards like drought frost salinity of soil etc.
4. Production of high yielding varieties
5. Production of fast growing plants.

34. **2060 Q.No.2b What is the importance of manures in agriculture?** [3]

Please refer to 2068 Q.No. 2g

35. **2060 Q.No.2d Discuss in brief the methods of plant tissue culture.** [3]

Methods of plant tissues cultural involved following steps.

1. Constituents of tissue culture media

Tissue culture media consists of following types of ingredient inorganic elements, organic compounds, vitamins, semi-synthetic substance, growth hormones etc.

2. Preparation of tissue culture media.
3. Selection of tissue culture media
4. Sterilization
5. Micropropagation

36. **2059 Q.No.2i State the advantages and disadvantages of outbreeding.** [3]

Advantages of out breeding

i. It results in the increase in the size of plants.
ii. It induces resistance to disease and pest.
iii. It helps to creates the vitality of different plants.
iv. It helps to increase size and number of fruit.
v. It helps to increase fertility of plants.
vi. It helps to increase yield of crops.

Disadvantages of out breeding

i. Sometimes it introduces harmful characters to the organisms.

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ii. Some very good characters of a variety are likely to be spoiled.
iii. It decreases the reproductive ability of organisms.

37. 2059 Q.No.2j **Explain the principles of fermentation technology.** [3]

➢ Please refer to 2071 Set D Q.No. 2g

38. 2057 Q.No.2j **What are the advantages of green manures over chemical fertilizers?** [3]

➢ Please refer to 2068 Q.No. 2g

39. 2055 Q.No. 6 **Discuss the basic concept of genetic engineering. Explain its practical applications.** [3]

➢ Please refer to 2073 Set D Q.No. 2g

40. 2052 Q.No. 7 OR **Discuss briefly about the alcoholic fermentation.** [3]

➢ Alcoholic fermentation is a type of cellular respiration which does not requires oxygen (anaerobic respiration) and involves the breaking down of glucose to pyruvic acid and then finally ethanol. The basic equation for alcohol fermentation shows that yeast starts with glucose, a type of sugar, and finishes with carbon dioxide and ethanol. However, to better understand the process, we need to take a look at some of the steps that take us from glucose to the final products.

The process of alcohol fermentation can be divided into two parts. In the first part, the yeast breaks down glucose to form 2 pyruvate molecules. This part is known as glycolysis. In the second part, the 2 pyruvate molecules are converted into 2 carbon dioxide molecules and 2 molecules of ethanol, otherwise known as alcohol. This second part is called fermentation.

The main purpose of alcohol fermentation is to produce ATP, the energy currency for cells, under anaerobic conditions. So from the yeast's perspective, the carbon dioxide and ethanol are waste products. That's the basic overview of alcohol fermentation.

$C_6H_{12}O_6 \rightarrow CO_2 + C_2H_5OH + 50kcal$

Write short notes on the following [4 marks]

1. 2056 Q.No.2f **Genetic engineering** [4]

➢ Please refer to 2073 Set D Q.No. 2g

Discuss the following [4 marks]

1. 2055 Q.No.2b **The advantages of out-breeding** [4]

➢ **Advantages of out breeding**

i. It results in the increase in the size of plants.
ii. It induces resistance to disease and pest.
iii. It helps to creases the vitality of different plants.
iv. It helps to increase size and number of fruit.
v. It helps to increase fertility of plants.
vi. It helps to increase yield of crops.

Attempt the following questions [2 marks]

1. 2054 Q.No. 3b **What is green manuring? Give example.** [2]

➢ They are highly nutritive quick growing green crops that are cultivated in fields. These crops that are ploughing under soil before maturation for increasing soil fertility and improvement of crops some common examples are Dhaincha, sunnhemp etc.

Differentiate between the following pair of words [2 marks]

1. 2055 Q.No. 4f **Inbreeding and outbreeding** [2]

➢ Inbreeding is the production of offspring from the mating of individuals that are closely related genetically.

Outbreeding is the production of offspring from the mating of two genetically distinct individuals.

❐

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Section B: Zoology

Unit 1

ANIMAL TISSUES

Very Short Answer Questions [1 mark]

1. 2076 Set C Q. No. 1a **Name main component of matrix.** [1]

The extracellular matrix has three main components:

i. Highly viscous proteoglycans (heparin sulfate, keratin sulfate and chondriotin sulfate)
ii. Insoluble collagen fibres, which provide strength and resilence
iii. Soluble multiadhesive proteins (fibronectin and laminin)

2. 2075 GIE Q. No. 1g **Mention the functions of the lymph.** [1]

The lymph has three main functions:

i. The removal of excess fluids from the body tissues
ii. Absorption of fatty acid and subsequent transport of fats to the circulatory system
iii. Production of immune cells such as lymphocytes, monocytes, plasma cells, etc.

3. 2075 Set A Q.No. 1a **What is the plastic epithelium?** [1]

Plastic epithelium, also known as transitional epithelium, is a type of stratified epithelium or tissue consisting of multiple layers of epithelial cells which can contract and expand as needed. They are found in the urothelium, including that of renal pelvis, urinary bladder, the ureters, urethra, prostrate and the ejaculatory ducts.

4. 2075 Set B Q.No. 1b **Mention the total amount of blood in an average person.** [1]

An average adult person with a weight of 150 to 180 pounds will contain approximately 4.7 to 5.5 litres of blood circulating inside their body. Blood accounts for roughly 7 to 8 percent of a person's body weight.

5. 2073 Supp Q.No. 1a **Which epithelium lines the blood vessel?** [1]

A single layer of squamous epithelium known as endothelium lines the blood vessels.

6. 2073 Set C Q.No. 1a **Which protein is present in white fiber?** [1]

Collagen protein is found in white fiber.

7. 2073 Set C Q.No. 1c **What do you understand by yellow spot?** [1]

Yellow spot is an oval yellow area near the centre of the retina of the human eye.

8. 2073 Set D Q.No. 1a **Write the functions of heparin and histamine.** [1]

Heparin prevents the formation of clots within the blood. During injury histamine dilates the blood vessels (i.e, vasodilator) causing the interior of the blood vessels to widen and allows white blood cells to move easily to the site of infection.

9. 2072 Supp. Q.No. 1a **Why are bones brittle in old age?** [1]

In old age, lack of calcium causes the bone being brittle.

10. 2072 Set C Q.No. 1a **What is matrix?** [1]

Matrix is the material or ground substance in animal cells or tissue, in which specialized structures are embedded.

11. 2072 Set D Q.No. 1f **Squamous epethelium is called pavement tissue. Why?** [1]

Squamous epithelium is called pavement tissues because the squamous cells fit together like irregular pavement stones seen from above.

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12. **2072 Set E Q.No. 1a Write down the role of mast cell.** [1]

Mast cells play an important protective role as well, being intimately involved in wound healing, immune tolerance, defense against pathogen's blood-brain barrier function.

13. **2071 Supp. Q.No. 1a Mention the basic function of epithelial tissue.** [1]

The basic functions of epithelial tissues are as follows: Protection, secretion, absorption and excretion.

14. **2071 Set C Q.No. 1a Name the tissue whose cells divide throughout the life.** [1]

The stem cells of the blood, epithelium of skin and alimentary canal divide continuously throughout their lives.

15. **2071 Set D Q.No. 1a Where does the mast cells are located?** [1]

Please refer to Model (Zoology) Q.No. 1a

16. **2070 Supp. Q.No. 1a Name the tissue that connect bones with bone and muscle.** [1]

The tissue which connect bones with bone are called ligaments. The tissue that connect bones with muscle are called Tendons.

17. **2070 Set C Q.No. 1a Name the tissue that connects muscles with the bone.** [1]

Tendon is the tissue that connects muscles with bone.

18. **2070 Set D Q.No. 1a What is ligament?** [1]

A ligament is a short band of tough, flexible fibrous connective tissue, which connects two bones or cartilages or hold together a joint.

19. **2069 Q.No. 1a What is periosteum?** [1]

Periosteum is a dense layer of vascular connective tissue, composed of white collagen fibres, that envelops the bone except at the surfaces of the joints.

20. **2069 Q.No. 1e What do you understand by the term census?** [1]

A census is the procedure of systematically acquiring and recording information about the members of a given population.

21. **2069 Q.No. 1g Write the effects of increased secretion of sex corticoids in women.** [1]

Excess of sex corticoids in female develop male secondary sexual characters such as beard, moustaches and hoarse voice resulting in a disease called Adrenal virilism.

22. **2069 Q.No. 1i Define immunity.** [1]

Immunity is a balanced state of having adequate biological defenses to fight infection, disease, or other unwanted biological invasion, while having adequate tolerance to avoid allergy, and autoimmune diseases.

23. **2067 Q.No. 1h What is keratoplasty?** [1]

Keratoplasty is a surgical procedure, where a damaged or diseased cornea is replaced by donated corneal tissue. It is also termed as corneal transplantation or corneal grafting.

24. **2066 Q.No. 1 a What is mast cell?** [1]

Mast cells are white blood cells that are derived from haematopoietic progenitor cells. Mast cells are important immune effector and modulatory cells that help to link innate and adaptive immunity in the fight against pathogens.

25. **2065 Q.No. 1 a Define a ligament.** [1]

Ligament is a flexible dense connective tissue that connects bone with bone or bone with cartilages.

26. **2062 Q.No. 1m Which cell is the longest cell of the body?** [1]

The longest cell in the body is nerve cell or neuron.

27. **2062 Q.No. 1l What is Osteocyte?** [1]

An osteocyte, is a mature cell found in bone.

28. **2060 Q.No. 1a Which is the hardest tissue in the body?** [1]

Bone is the hardest tissue in the body.

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29. 2059 Q.No. 1b **Mention the human body parts where you find unstriated muscles.** [1]

In human body unstriated muscles are found within the walls of oesophagus, stomach, intestines, bronchi, uterus, urethra, bladder, blood vessels, arrector pilli of skin, the ciliary muscles and iris of eye.

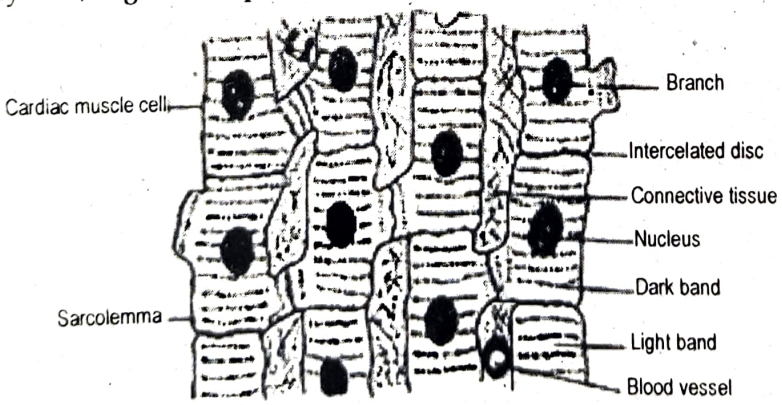
Answer all in brief [3 marks]

1. 2076 Set B Q. No. 2a **Cardiac muscle.** [3]

Cardiac muscle is one of the three types of vertebrate muscles, with the other two being skeletal and smooth muscles. Cardiac muscle tissue, also known as myocardium, is a structurally and functionally subtype of muscle tissue located in the heart, that has actually the characteristics from both skeletal and smooth muscle tissue. It is composed of individual heart cells (cardiomyocytes) joined together by intercalated discs. It is capable of strong, continuous, and rhythmic contractions that are automatically generated. The contractility can be altered by autonomic nervous system and hormones. This muscle has high metabolic, energy, and vascular demand. Four characteristics define cardiac muscle tissue cells: they are involuntary and intrinsically controlled, striated, branched, and single nucleated. The striation is due to the arrangement of actin and myosin protein into regular myofibrils. The presence of myofibrils and many mitochondria in cardiac muscle cells provide them with great strength and endurance to pump the blood throughout an entire life.

Cardiac muscle fibres are cylinder-like and extensively branched, and are connected to one another at their ends by intercalated discs. An intercalated disc allows the cardiac muscle cells to contract in a wave-like pattern so the heart can work as a pump. The intercalated disc contains two structures important in cardiac muscle contraction: gap junction and desmosomes. A gap junction forms channels between adjacent cardiac muscle fibres that allow depolarizing current produced by cations to flow from one cardiac muscle to the next. This joining is called electric coupling, and in cardiac muscle it allows the quick transmission of action potentials and the coordinated contraction of the entire heart. This network of electrically connected cardiac muscle cells creates a functional unit known as a syncytium. The remainder of the intercalated disc is composed of desmosomes. A desmosome is a cell structure that anchors the ends of cardiac muscle fibres together so the cells do not pull apart during the stress of individual fibres contracting.

Contraction of the heart (heartbeat) is controlled by specialized cardiac muscle cells called pacemaker cells. The wave of contraction that allows the heart to work as a unit, known as a functional syncytium, begins with pacemaker cells.



Cardiac muscle fibres

2. 2076 Set C Q. No. 2a **Write short note on lymph.** [3]

Lymph is a clear and colorless fluid which flows through the lymphatic system of the body and takes part in transportation.. Lymph is formed by the seepage of blood plasma, proteins and few blood cells through the pores of capillaries. This fluid transports protein, fats and other nutrients from the digestive system. Lymph also collects bacteria and other pathogens from the bloodstream and brings to the lymph nodes to destroy them. Lymph mainly contains blood plasma with some white blood cells, the lymphocytes and macrophages. Unlike the cardiovascular system, the lymphatic system is not closed and has no central pump. Lymph movement occurs despite low

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pressure due to peristalsis, valves, and compression during contraction of adjacent skeletal muscle and arterial pulsation. Lymph is transported through larger lymphatic vessels to lymph nodes, where it is cleaned by lymphocytes, before emptying ultimately into the right or the left subclavian vein, where it mixes back with the blood.

Composition of the Lymph: Lymph consists of the following components:

i. Water - 94%
ii. Nitrogenous substance
iii. Glucose
iv. Lymphocytes
v. Proteins like albumin, globulin and fibrinogen
vi. Fats
vii. Urea, uric acid and creatinine
viii. Chlorides
ix. Enzymes

Functions of the Lymph: The functions of the lymph are as follows:

1. It is used to supply nutrients to the body.
2. It is used to remove the metabolic wastes from the tissue cells.
3. It is used in maintaining the composition of tissue fluid.
4. It helps in invading the entry of pathogenic infections caused by microorganisms.
5. It is used in absorbing the fats from the small intestine through lymphatic vessels.

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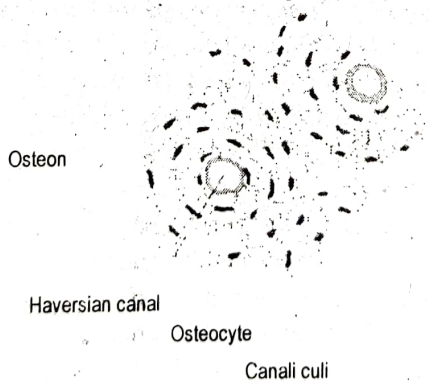
3. 2075 GIE Q. No. 2a **Write a short note on Haversian canal.** [3]

A series of microscopic tubes in the outermost region of the compact bone is called Haversian canals. They allow nerves and blood vessels to pass through them. Each Haversian canal generally contains one or two capillaries and nerve fibres. The concentric layers known as lamellae form these canals. They surround blood vessels and nerve cells throughout bones and communicate with bone cells or osteocytes through connections called canaliculi. Haversian canals are contained within Haversian system or Osteon , which are typically arranged along the long axis of the bone in parallel to the surface. The haversian canal and it surroundings together constitute the structural and functional units of long bone called Haversian System or Osteon.



Haversian canal with its associates

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4. 2075 Set A Q.No. 2a **The structure and functions of columnar epithelial tissue.** [3]

Columnar epithelial tissue is one of the three basic types of epithelial tissue based on shape-the other two being cuboidal and squamous epithelial tissue.

The columnar epithelal tissue or epithelium has cells taller than they are wide i.e. column - shaped. Their nuclei, are elongated and are usually located near the base of the cells.

On the basis of number of laryers, columnar epithelium is classified into two types- Simple columnar epithelium and stratified columnar epithelium.

1. **Simple columnar epithelium:** It is single - layered. It is found in the linings of alimentary canal including the stomach and intestine and in the uterus and oviduct.

Simple columnar is further divided into two categories: ciliated and non-ciliated.

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i. Ciliated columnar epithelium is found in the bronchioles of the respiratory tract, the fallopian tubes, uterus, and the central part of the spinal cord. Their main functions include movement of mucus, propel of egg towards the uterus, etc.

ii. Non-ciliated columnar epithelium is found in the lining of gastrointestinal tract and may be brush - bordered.

The ciliated columnar cells consist of microvilli for maximising the surface area for absorption and these microvilli may form a brush border. Their main functions are secretion of mucus. Some columnar cells are modified for sensory reception such as in the nose, ears and the taste buds.

2. **Stratified Columnar Epithelium:** This epithelium is multilayered; the upper layer contains columnar cells, middle and lower cells may be cuboidal or squamous. These are found in the conjunctiva of the eye, pharynx, anus, uterus, male urethra, vas deferens, lobar ducts in salivary glands, respiratory tract, ureters and oviducts.

The cells function in secretion and protection.

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5. 2075 Set B Q.No. 2a **Give an account of areolar tissue.** [3]

Areolar tissue is a loose connective tissue that consists of a meshwork of collagen fibres, elastic fibres, and reticular fibres. It is the most common type of connective tissue in vertebrates. It is so named because its fibres are far enough apart to leave ample open space for interstitial fluid in between (areola-Latin-open space). It consists of three components – Fibres, cells and matrix.

I. Types of Fibres:

- White collagen fibres, composed of collagen protein, are found bundles called fasciae (singular fascia). They are wavy in nature. They strengthen the tissue.
- Yellow elastic fibres, composed of elastin protein, are found singly. They are straight and branched. Due to their stretchable nature they provide elasticity to the tissue.
- Reticular fibres, composed of one or more types of very thin and delicately woven stands build a highly ordered cellular network and provide a supporting network.

II. Types of Cells: There are seven types of cells found embedded in the matrix. They are as follows:

1. **Fibroblasts:** are elongated or tapered, flattened cell that form the collagen and elastin protein fibres and ground substance.
2. **Macrophages or Histocytes**: These are amoeboid or fixed phagocytic cells derived from monocytes of the blood. Macrophages play a role in phagocytosis and thereafter enter the lymphatic system to aid in activation of immune response.
3. **Leucocytes:** These are white blood cells. They are blood borne defensive cells that leave the vascular system during inflammatory events to patrol adjoining tissue spaces. Most are neutrophils and lymphocytes.
4. **Plasma cells:** They are white blood cells derived from B-lymphocytes. They produce antibodies. They are spherical shaped with rounded nuclei.
5. Mast cells **(Mastocytes):** They are key cells involved in inflammation. They release histamine, heparin and serotonin. Theses chemical agents induce the vascular response that cause inflammation.
6. **Adipocytes:** these are fat cells that store fats or triglycerides. They are spherical and appear as empty cells with nucleus pushed to the periphery.
7. **Mesenchyma cells:** They are embryonic stem cells that divide to form new cells of all connective tissue types. They are precursors to fibroblasts, chondroblasts and osteoblasts.

III. Matrix: Matrix is the ground substances, where all the types of fibres and cells are embedded.

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6. 2074 Supp Q.No. 2b **Write short note on WBC.** [3]

White Blood Corpuscles or Cells (WBCs), also called Leucocytes, are the cells of the immune system that are involved in protecting the body against both infectious disease and foreign invaders. All the white blood cells are produced and derived from multipotent cells in the bone marrow known as haematopoietic stem cells. Leucocytes are found throughout the body, including the blood and lymphatic system. The formation of leucocytes in the bone narrow is termed as leucopoiesis.

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WBCs are colourless, irregularly shaped and bigger sized cells than the Red Blood Corpuscles. WBCs contain nucleus. The numbers of WBCs are between 5000 to 11000 per cubic millimeter of blood. Their life span is estimated as four days or more and varies under different conditions and environment. WBC is rich in nucleoprotein and contains certain fats, glycogen, cholesterol, vitamin – C and variety of enzymes.

The average rate of WBC: RBC is 1 : 700. They are constantly changing their shapes and resemble *Amoeba*. Consequently, their movement is called amoeboid movement. They are capable of moving from one place to another and even getting out through the thin walls of the smallest blood vessels.

There are several varieties of WBC, each type possessing characteristics structure and staining property. They are divided into two main groups: Granulocytes and Agranulocytes.

a. **Granulocyes:** These cells have granules in their protoplasm. They make up about 72% of the total leucocytes. These granules may take either of the three different stains– neutral (Purple), acid (red) or basic (blue).

Granuloagles are classified according to their staining properties and they are as follows:

i. **Eosinophils or Acidophils:** They take acid stains such as Eosin very readily. They have bilobed nucleus. They constitute 2 to 4 % of the total WBCs. They play important role in detoxification or neutralizing the toxins in the body.

ii. **Basophils:** They react with basic stains such as methylene blue and give blue colour. They make up 0.5% of the total WBCs. They have S-shaped nucleus. Basophils release heparin, histamine and serotonin. Heparin prevents blood clotting (anti-coagulant). Histamine dilates the blood vessels (vasodilator) and induces inflammation. Serotonin acts as neurotransmitter.

iii. **Neutrophils:** They are most abundant type of WBCs. They make up 68% of the total WBCs. The have multilobed nucleus. They can absorb both acid and alkaline dyes and give purple colour. They are highly motile and phagocytic i.e, engulf bacteria, foreingn bodies and dead cells.

b. **Agranulocyes:** They do not have granules in their protoplasm. They constitute 28% of the total WBCs. They are classified into two:

i. **Lymphocytes:** They are 24% of the total WBCs. They are the smallest sized WBCs. They have oval or rounded nucleus. Lymphocytes are further classified into three major types: T cells, B cells and natural killer cells. T-cells are involved in cell mediated immunity, whereas B cells are primarily responsible for the production of antibodies. Natural killer cells play a major role in defending the host from tumours and virally infected cells.

ii. **Monocytes:** They are the largest sized leucocytes and form 4% of the total WBCs. They have a horse-shoe shaped nucleus. They are the most powerful phagocytes and act, mostly as scavengers. They have bean or kidney-shaped nucleus.

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7. **2074 Set A Q.No. 2b Explain the types and functions of connective tissue.** [3]

➢ Please refer to 2071 Set C Q.No. 2a

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8. **2074 Set B Q.No. 2a Differentiate between striated and unstriated muscles.** [3]

➢ The differences between striated muscle and unstraiated muscle are as follows:

Striated Muscle	Unstriated Muscle
Presence of alternately arranged light and dark bands. i.e. striations present.	Light band and dark bands are absent so there is no striation.
It is voluntary in action.	It is involuntary in action.
The muscle fibres are long and cylindrical with blunt ends.	The muscle fibres are long spindle shaped with pointed ends.
The fibres are multinucleated.	The fibres are uninucleated.
Sarcoplasmic reticulum is well developed.	Sarcoplasmic reticulum is poorly developed.
Numerous mitochondria and glycogen granules are present.	Less mitochondria and glycogen granules are present.
They are attached to skeleton and therefore, called skeletal muscles. e.g. Muscles of limbs, face, neck, thorax, etc.	They have no connection with skeleton. i.e. non-skeletal muscles. e.g. Muscle so intestine, blood vessels, urinary tract, etc.

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9. **2073 Supp Q.No. 2a Describe Haversian Canal System.** [3]

Haversian systems are units of structure within mature bone. The systems run parallel to the long axis of bones. Each cylindrical unit within compact bone is an entire Haversian system. The Haversian system includes lamellae, osteocytes, lacunae, canaliculi and a Haversian canal. They are present in bones of mammals, some birds, reptiles and amphibian species.

A Haversian system, also known as osteon, is a series of concentric rings or circles called lamellae. Down the middle of each of these systems is a hollow tube or Haversian's canal that holds a blood vessel. Each compact bone in the human body has many Haversian system that line up next to each other, creating a dense structure. Within the lamellae of each Haverisan system are series of spaces called lacunae. The lacunae hold the osteocyltes or bone cells. This osteocyte, along with the collagen and calcium phosphate that make up the matrix of the lamellae, ensure that compact bone is very strong. There are osteoblasts or young bone cells in the area that become osteocytes. The blood vessels that runs down the middle of a Haversian system provides nutrients to the living bone tissue.Nerve and lymph vessels are also found in the Haversian's canal. The space between osteons are connected to each other by oblique in the compact bone of the shaft of long bones of human. Haversian system is named after the English Physician Clopton Havers (1657-1702).

10. **2073 Set C Q.No. 2a Differentiate between cartilage and bone.** [3]

The differences between cartilage and bones are given below:

Cartilage	Bone
It is soft, elastic and flexible	It is hard, inelastic and tough
Cells are called chondrocytes.	Cells are called osteocytes.
Matrix is a non-vascular.	Matrix is vascular.
Matrix is a homogenous mass without lamellae.	Matrix occurs in lamellae.
Matrix has a protein called chondrin.	Matrix has a protein called ossein.
Each lacuna has 2-3 chondrocytes.	Each lacuna has only one osteocyte.
Bone marrow is absent.	Bone marrow is present.

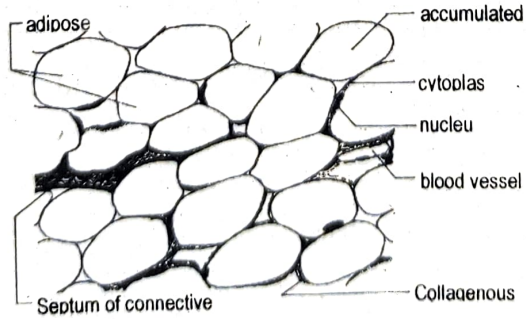
11. **2073 Set D Q.No. 2a Describe Haversian Canal System.** [3]

Please refer to 2073 Supp Q.No. 2a

12. **2072 Set C Q.No. 2a Describe Adipose tissue.** [3]

Adipose tissue is a loose fibrous connective tissue that is packed with many fat cells called "adipocytes". Adipose tissue is the modified form of areolar tissue.

Structure: Adipose tissue is specialized for storage of triglycerides, which are referred to as "fats". Each adipocyte is filled with a large droplet of triglyceride (fats). As this occupies most of the volume of the cell, its cytoplasm, nucleus and other components are pushed towards the edge of the cell.



Location of Adipose Tissue

Adipose tissue forms a thick layer in the given locations:

- Sub cutaneous layer deep to skin
- Around the heart and kidney
- Yellow marrow of the long bones

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- Paddings around the joints.
- Inside the eye-socket, posterior to eye ball.

Functions:

The primary functions of adipose tissue are listed as follows:

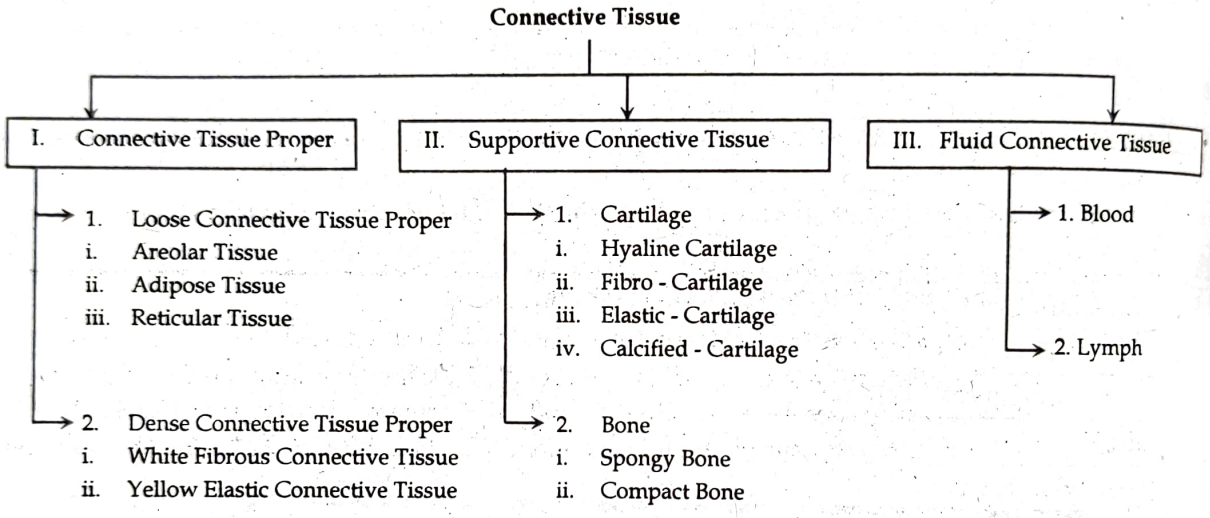
1. Adipose tissue acts as an insulating layer helping to reduce heat loss through the skin.
2. It has a protective function, providing mechanical protection (padding) and support around some of the major organs such as kidneys, eye ball, etc.
3. Adipose tissue is a means of energy storage. Food that is excess to requirement is converted into fats and stored within adipose tissue in the body.

13. **2071 Supp. Q.No. 2a How striated muscle differ's from unstriated muscle.** [3]

Please refer to 2074 Set B Q.No. 2a

14. **2071 Set C Q.No. 2a Mention the types and functions of connective tissue.** [3]

The main types of tissues are listed as follows:



The functions of connective tissue are listed as follows;

1. Areolar tissue is a binding and packing material whose main purpose is to provide support to hold other tissues and organs in place.
2. Adipose tissue provides padding, absorbs shocks and insulates the body to slow heat loss.
3. The white fibrous tissue makes a strong covering of various organs, such as kidneys, heart, brain, bones, etc.
4. The dense regular white fibrous tissue forms tendons and ligaments. The tendons bind muscle to bone while ligaments join bone together.
5. Cartilages provide support and cushioning. It acts as a cushion between joints to prevent the bones from rubbing against each other.
6. Blood transports substances like digested food, respiratory gases, waste materials and hormones from one part of the body to another.

15. **2071 Set D Q.No. 2a Describe the structure of areolar tissue.** [3]

Please refer to 2075 Set B Q.No. 2a

16. **2070 Supp. Q.No. 2a Functions of connective tissue.** [3]

The functions of connective tissues are as follows:

1. Connective tissue binds together and support various tissues and organs in the body.
2. It forms sheath around the organs like a packing material.
3. It provides insulation around the organ and slow heat loss.
4. It provides a supportive framework for the body.
5. It forms a cushion around various soft organs and act as shock – absorber to protect them. e.g. around eyes, kidneys, etc.

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6. It produces blood.
7. It transport food materials, respiratory gases, waste materials and hormones from one part to other part within the body.
8. It fight against various pathogens and keep one free of diseases.

17. **2069 Q.No. 2e Functions of epithelial tissue.** [3]

The functions of epithelial tissues are as follows:

1. Epithelial tissue covers the outside of the body and lines organs, blood vessels, lymph vessels and cavities.
2. The cells in epithelial tissue are very closely packed together and joined with little space between them. With its tightly packed structure, epithelial tissue serve some type of barrier and protective in function.
3. Epithelial tissue helps to protect against microorganism. The skin is the body's first line of defence against bacteria, viruses and other microbes.
4. Epithelial tissue functions to absorb, secrete and excrete substances. In the intestine, it absorbs nutrients during digestion. Epithelial tissue in glands secrete hormones, enzymes and other substances. Epithelial tissue in the kidneys excrete wastes and in the sweat glands excrete perspiration.
5. Epithelial tissue has a sensory function as it contains sensory nerves in areas such as the skin, tongue, nose and ears.
6. Ciliated epithelium or tissue found in the female reproductive tract helps to proper ova in propel direction.

18. **2069 Q.No. 2g The trends of human population growth.** [3]

Population growth is the increase in the number of individuals in a population.

Global human population growth amounts to around 75 million annually, or 1.1% per year. The world population has grown from 1 billion in 1800 to 7 billion in 2012. It is expected to keep growing, and estimates have put the total population at 8.4 billion by mid- 2030 and 9.6 billion by mid - 2050.

It took hundreds thousands of year for the world population to grow to 1 billion. Then in just another 200 years or so, it grew seven fold. Today (2017) it stands at about 7.5 billion.

Population		
Years Passed	**Year**	**Billion**
	1800	1
127	1927	2
33	1960	3
14	1974	4
13	1987	5
12	1999	6
12	2011	7
14	2025*	8
18	2043*	9
40	2083*	10

The recent past has seen enormous change in fertility rates and life expectancy. In the early 1970s, women had an average 4.5 children each. By 2014 the total fertility of the world had fallen to around 2.5 children per woman. Meanwhile, average global lifespan have risen, form 64.8 years in the early 1990s to 70 years in 2014.

In addition, the world is seeing high levels of urbanization and accelerating migration. 2007 was the first year in which more people lived in urban areas than in rural areas, and by 2050 about 66 percent of the world population will be living in cities.

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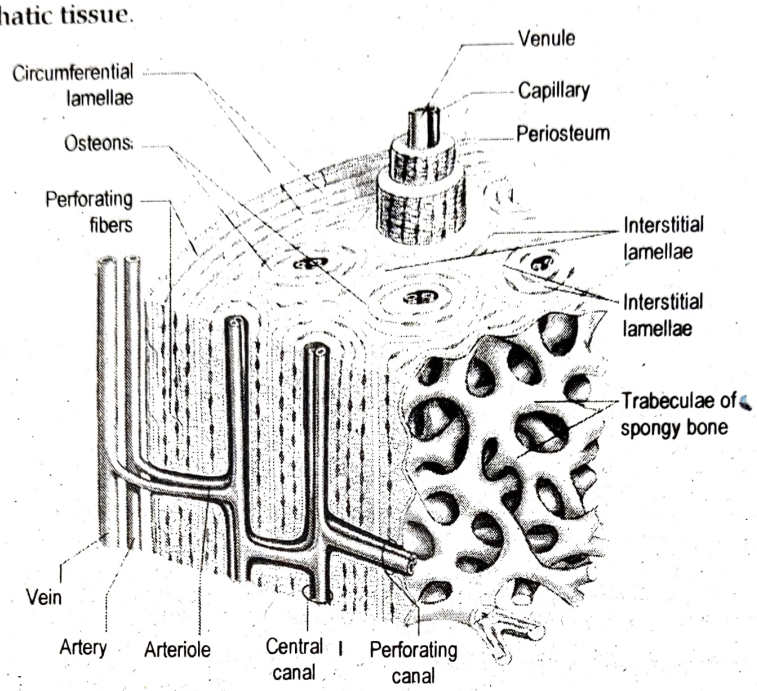
19. **2068 Q.No. 2a** **The structure of bone.** [3]

T.S. of a decalcified long bone shows the following structures.

i. **Periosteum:** Periosteum is a dense fibrous highly vascular membrane that covers the bone. Periosteum is permiated with the nerves and blood vessels that innervate and nourish underlying bone. Periosteum allows for attachment for muscle tissue to the bone and provide pathways for blood and lymphatic tissue.



The organization of osteons and lamellae in compact bone

ii. **Outer layer of osteoblast:** It lies just below the periosteum. The osteoblast layer secretes ossein protein and give rise to oesteocytes.

iii. **Matrix:** Matrix lies immediately below the outer layer of osteoblasts. Bone matrix is an intracellular substance of bone tissue consisting of collagen fibres, ground substance, and inorganic bone salts. Matrix is made up of several thin layer of lamellae arranged in a concentric manner around the central marrow cavity of the bone. A lacuna encloses a single bone cell or osteocyte. The lacunae are linked together by minute channels called canaliculi. These canaliculi provide routes by which nutrients can reach the osteocytes and waste products can leave them.

iv. **Haversian's Canals:** There are several microscopic narrow tubes or channels within the bone containing blood vessels and nerves. These channels are called Haversian's canals They run parallel to the long axis of the bone. The channels are formed by concentric layers called lamellae (Singular lamella).

The arrangements of the Haversian's canal along with their surrounding lamellae are collectively called Haversian's system or Osteon. Osteon is the basic central structural or fundamental unit of compact bone. Osteons are connected to each other and the periosteum by oblique channels called the Volkmann's Canals. Volkmann's Canal transmit blood vessels from the periosteum into the bone.

v. **Inner layer of osteoblast or Endosteum:** Inner layer to the matrix is called endosteum. Endosteum is a thin vascular membrane of connective tissue that lines the inner surface of the bone tissue that forms the medullary cavity of the long bones. Endosteum has osteogenic properties contributing directly to the process of bone growth and repair.

vii. **Bone marrow:** Bone marrow is the spongy tissue inside the long bone. Bone marrow contains immature cells, called stem cells. Stem cells stay in the bone marrow while they develop into blood cells. Then, once fully mature, the blood cells are released into the bloodstream. Bone marrow is soft gelatinous tissue that fills the medullary cavities – the centres of long bones. There are two types of bone marrow: red bone marrow (also known as myeloid tissue) and yellow bone marrow (fatty tissue).

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20. **2067 Q.No. 2a Differentiate between simple and compound epithelium.** [3]

The main differences between simple and compound epithelium are listed as follows:

Simple Epithelium	Compound Epithelium
The cells are arranged in a single layer and rest on basement membrane.	The cells are arranged in multiple layers. The inner most layer of cells rest on basement membrane.
They are present in secretory and absorptive surface.	They are not involved in secretory and absorptive function.
Simple epithelium has less thickness.	Compound epithelium has more thickness.
It is not protective as it cannot resist the damage due to mechanical or chemical abrasions.	Because of multilayered structure they help in protection of tissue below them.
May be simple squamous or simple cuboidal or simple columnar.	May be stratified squamous or stratified cuboidal or stratified columnar or transitional epithelium.
Germinal epithelium is absent.	The lowermost layer is called germinal epithelium.
Found in the lining of body cavities, blood vessels, ducts and tubules or reproductive parts, etc.	Found in buccal cavity lining, oesophagus lining, stomach and intestinal lining, Urethra, Uterus, Urinary bladder, etc.

21. **2066 Q.No. 2a Describe the Adipose tissue.** [3]

Please refer to 2072 Set C Q.No. 2a

22. **2065 Q.No. 2a Internal structure of bone** [3]

Please refer to 2068 Q.No. 2a

23. **2064 Q.No.2f Describe briefly about the importance of microelements.** [3]

The importance of different microelements are as follows:

1. Iron: It is an essential element, which is a component of haemoglobin in blood. Iron transports oxygen from the lungs to different parts of the body. Iron is also essential for synthesis of DNA.
2. Iodine: It is critical for the formation of thyroid hormones. Its deficiency causes enlargement of the thyroid gland, also known as goiter, while its deficiency during pregnancy can cause irreversible brain damage in newborns.
3. Fluoride: It is responsible for bone and teeth formation. It hardens tooth enamel, reduce incidence of tooth decay and prevent bone loss.
4. Copper: It prevents damage to cells due to its antioxidant action, and as a component of many enzymes. It helps in production of energy from carbohydrate, protein and fats. It is also essential for formation of bone, connective tissue and red blood cells.
5. Zinc: It improves immune function, helps to clot blood, maintain sense of taste and smell, keeps skin healthy and enables normal growth and development.
6. Manganese: It is necessary for formation and activation of enzymes. It works as an antioxidant, helps to develop bone and heals would by increasing collagen production.

24. **2060 Q.No.2f How is oxygen transported in the blood and released in the tissue?** [3]

Oxygen is transported in the blood in two forms:

1. In dissolved form: About 1.5% blood is carried by plasma in dissolved form.
2. In the form of oxyhaemoglobin: Most of the oxygen, (98.5%) is carred in the form of oxyhaemoglobin. One gram of haemoglobin (Hb) carries 1.34 ml of oxygen. 100 ml of blood (with Hb concentration of 15%) contains about 20ml of oxygen.

At high oxygen concentrations oxyhaemoglobin is formed.

$Hb_4 + 4O_2 \rightleftharpoons Hb_4O_8$ (Oxyhaemoglobin)

The binding of oxygen is a reversible reaction. The oxygen is carried in the form of oxyhaemoglobin by the blood to all the tissues and cells of the body. As soon as the oxyhaemoglobin reaches the tissue, the oxyhaemoglobin dissociates into free oxygen and haemolglobin. The partial pressure of oxygen is less in the body tissue. Therefore, the haemoglobin releases oxygen into the tissue. The oxygen than diffuses into the cells for oxidation of food.

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Unit 2

DEVELOPMENTAL BIOLOGY

Very Short Answer Questions [1 mark]

1. **2076 Set C Q. No. 1b What is organogenesis?** [1]

Organogenesis is the process by which the three germ tissue layers of the embryo, which are the ectoderm, mesoderm, and endoderm, develop into the internal organs of the organism. E.g. the ectoderm forms the neural tube, which eventually develops into the brain and spinal cord.

2. **2075 Set A Q.No. 1b Mention the role of acrosome during fertilization.** [1]

Acrosome release a chemical substance called sperm lysine, which help in penetrating the membrane of an ovum during fertilization.

3. **2074 Supp Q.No. 1a What is the function of acrosome?** [1]

Please refer to 2075 Set A Q.No. 1b

4. **2074 Supp Q.No. 1b Define holoblastic cleavage.** [1]

Holoblastic cleavage is a stage of embryonic development where the whole egg is completely divided into distinct and separate blastomere.

5. **2074 Set A Q.No. 1i Differentiate between spermatogenesis and oogenesis.** [1]

Difference between spermatogenesis and oogenesis is given below:

Spermatogenesis	Ooogenesis
The process of formation of haploid spermatozoa from diploid spermatogonia inside the testes of male.	The process of formation of functional haploid ova from the diploid geneminal cells in the ovary of female.

6. **2074 Set B Q.No. 1h Which stage of egg is laid by frog?** [1]

Female adult frog lays egg in the form of secondary oocyte.

7. **2073 Supp Q.No. 1b Define spermatogenesis.** [1]

The process of formation of haploid spermatozoa from diploid spermatogonia inside the testes of male is known as spermatogenesis.

8. **2073 Set C Q.No. 1b Mention the role of acrosome.** [1]

Please refer to 2075 Set A Q.No. 1b

9. **2073 Set D Q.No. 1b Define gametogenesis.** [1]

Please refer to Model (Zoology) Q.No. 1c

10. **2072 Supp. Q.No. 1b Define cleavage.** [1]

Cleavage is the repeated mitotic division of zygote to form a solid ball of cells called morula which later changes into a hollow ball of cells called blastula.

11. **2072 Set C Q.No. 1b Define gastrulation.** [1]

Gastrulation is a phase in the embryonic development of most animals during which the single layered blastula is reorganized into a three -layered structure called gastrula.

12. **2071 Supp. Q.No. 1b What is yolkplug?** [1]

Yolk plug is the remaining patch of endodermal cells that is created during the formation of the dorsal lip of blastopore.

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13. **2071 Set C Q.No. 1b Differentiate between animal pole and vegetal pole of Frog's egg.** [1]

Difference betweeen animal pole and vegetal pole of frog's egg is as follows:

Animal pole	Vegetal pole
Upper dark brown pole of the embryo.	Lower yolky pole of the embroyo

14. **2071 Set D Q.No. 1b Define spermiogenesis.** [1]

The transformation of spermatids into highly motile mature spermatozoa is called spermiogenesis.

15. **2070 Supp. Q.No. 1b Define epiboly.** [1]

Epiboly is a stage in gastrulation, in which the micromeres of animal hemisphere divide and redivide to form a large number of micromeres that spread all over the macromeres of the vegetal pole enveloping it form all the sides and leaving only a small area.

16. **2070 Set C Q.No. 1b What is cleavage?** [1]

Please refer to 2072 Supp. Q.No. 1b

17. **2070 Set D Q.No. 1g What is sperm lysin?** [1]

Sperm lysine is a protein, produced by spermatozoa of male vertebrates, that creates a hole in the envelope of the egg thereby allowing the sperm to pass through the envelope and fuse with the egg.

18. **2068 Q.No. 1b What is spermiogenesis?** [1]

Please refer to 2071 Set D Q.No. 1 b

19. **2065 Q.No. 1 d What is the function of acrosome found is sperm cell?** [1]

Please refer to 2075 Set A Q.No. 1b

20. **2065 Q.No. 1 e Define the term blastulation.** [1]

Blastulation is a phase of embryonic development of vertebrates, in which the morula is transformed into blastula having a fluid filled cavity called blastocoel.

21. **2064 Q.No. 1i What is cleavage?** [1]

Please refer to 2072 Supp. Q.No. 1b

22. **2063 Q.No. 1d What is holoblastic cleavage?** [1]

Please refer to 2074 Supp Q.No. 1b

23. **2061 Q.No. 1m Define cleavage.** [1]

Please refer to 2072 Supp. Q.No. 1b

24. **2059 Q.No. 1e Give reason why micromere cells in frog's embryo are fast dividing.** [1]

The micromeres divide faster than the megamere in frog's embryo due to large quantity of non-living inert yolk present in the vegetal hemisphere.

Mark (√) the correct choice [1 mark]

1. **2052 Q.No. 1i Cleavage in frog is:**

a. Holoblastic and unequal b. Holoblastic and equal
c. Centrolecithal d. None of them [1]

Holoblastic and equal

Answer all in very short [3 marks]

1. **2076 Set B Q. No. 2b The process of neurulation.** [3]

Neurulation is the formation of the neural tube from the ectoderm of the embryo.

Neurulation, in frog, takes place after gastrulation i.e. formation of three germinal layers - ectoderm, mesoderm and endoderm. Following steps are observed during neurulation in frog:

1. Some ectodermal cell situated near the notochord modify into neural plate. The notochord stimulates neurulation in the ectoderm after its development. The neural plate is also called medullary plate.

2. Neural plate slowly forms a depression called neural groove, whose edges are called ne folds.
3. Some ectodermal cells are scattered near neural fold.
4. The neural fold come close to each other and finally coincides and form separate neural and ectodermal layer.
5. Cavity of the neural tube is called neurocoel.
6. The neural tube separates from the endodermal layer and moves downward just below ectoderm.
7. The neural tube remains open at the front end for a while through an aperture ca neuropure. Neuropore connects the neural tube with the exterior.
8. On the posterior side neural tube communicates with archenteron through neurenteric ca for sometime.
9. Later on, the anterior part of neural tube becomes the brain, while posterior part forms spinal cord. Nerves are developed from neural crest. In this way nervous system is form from neural tube or ectoderm.
10. Neurulation process starts after 50 hours of fertilization and completed in 67 hours a fertilization.

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2. **2076 Set C Q. No. 2b Write down the fate of mesoderm.**

Ans During the embryonic development of the chordates gastrulation results in the formation of th germ layers: ectoderm, mesoderm and endoderm. Each germ layer gives rise to specific tiss organs and organ-systems by a process called organogenesis. The mesoderm forms the mid layer of the early trilaminar embryo germ layers.

The mesoderm later on gives rise to the following organs and tissues:

- Dermis of skin,
- Muscles except iris and ciliary muscles,
- Connective tissues,
- Kidneys,
- Gonads
- Notochord,
- Heart, blood and lymph vessels,
- Urinary and reproductive ducts,
- Most of skeleton,
- Coelomic epithelium,
- Pericardium and pleura,
- Dentine of teeth,
- Cortex of adrenal gland,
- Mesenteries,
- Sclera and choroid of eyes,
- Wall of the gut except its lining.

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3. **2075 GIE Q. No. 2b How coelom is formed during development of frog?**

Ans A coelom is a fluid-filled body cavity that is completely lined by tissue created from the mesod The steps involved in the formation of coelom in the embryo of frog can be illustrated through following points.

1. After the formation of three germinal layer, the mesodermal layer splits into two thin layer name
   i. outer somatic or parietal layer, and
   ii. inner visceral or splanchnic layer.
2. A cavity is formed in between the somatic and visceral layer and it is called splanchnocoel, wh extends down ward and outside below the gut.

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The splenchnocoel assumes u-shaped cavity.
3. The somatic layer fuses with ectoderm to form body wall or somatopleure.
4. The inner viscelar layer fuses with endoderm to form splanchnopleure or gut wall.
5. Hence, coelom is mesodermal in origin and such type of coelbum is called schizocoel.
6. This clarifies, that coelom is the cavity between body wall and gut wall.
7.

2075 Set A Q.No. 2b The formation of coelom in the embryo of frog. [3]

4. Please refer to 2075 GIE Q. No. 2b

2075 Set B Q.No. 2b How is gastrula formed during the development of frog? [3]

5. Gastrulation is an early phase of embryonic development of frog during which the single -layered blastula is reorganized into a trilaminar (three-layered) structure known as gastrula. These three germ layers are known as the ectoderm, mesoderm and endoderm. Followings are the stages of gastrulation in frog:

1. **Epiboly:** The continuous and rapid division of micromeres results in the migration from the animal pole towards the vegetal pole. It completely encloses the megamers except in the region of yolk plug. The process of overgrowth of micromere is called epiboly.
2. **Formation of Blastopore:** A small crescentric groove is formed on the postero-dorsal side of blastula, a little behind the edge of grey crescent in the presumptive endoderm. The groove is the beginning of the archenteron (gastrocoel) and its anterior margin is the dorsal lip of blastopore. Its backwardly projecting lateral horns are called the lateral lips which finally meet below forming the ventral lip. Thus the crescentric groove becomes a complete circle, or blastopore, through which is visible a tiny spot of Yolky endodermel cells, the Yolk plug.
3. **Invagination of Endoderm:** As the prospective endoderm cells or micromeres advance, the future endoderm cells or megameres gradually migrate towards blastopore and gradually sink inside.
4. **Formation of Archenteron:** The archenteron gradually increases in size, becoming firstly tubular, then bag like, as more vegetalpole cells are rolled in from the blastopore tip and cells of the animal pole are rolled inwards at the anterior margin of the dorsal lip. This active migrations turn a simple groove into a large cresentric mark of the dorsal lip of blastopore, its edges swing laterally. The advancing archenteron pushes the floor of the blastocoel, which rises upward, the rise begins on the dorsal side nearest the dorsal lip. Ultimately the blastocoel is nearly replaced by archenteron.
5. **Involution:** The advancing future notochord cells, continue to roll-in or involute till all the prospective chordal cells have disappeared from the surface. They extend beneath the neural plate cells which however remain on the surface. With the formation of lateral lips of blastopore, the future mesoderm cells also roll inside over the lateral lips. Internally they occupy positions on either side of chordal cells between the surface epidermis and endoderm.

Thus, formed three layers: the ectoderm, mesoderm and endoderm, also called primary germ cell, give rise to several organs of the larval body. Gastrulation starts after 26 hours from fertilization of egg and completed in 42 hours after fertilization.

6. **2074 Supp Q.No. 2a What is spermatogenesis? Elaborate it.** [3]

Spermatogenesis is the process by which haploid spermatozoa develop from germ cells in the semiferous tubules of the testis. Spermatogenesis is the male version of gametogenesis. Spematogenesis produces mature male gametes, commonly called sperm but more specifically known as spermatozoa, which are able to fertilize the counterpart female gamete, the oocyte, during conception to produce a single-called individual known as a zygote.

Spermatogenesis can be divided into three phases, each of which is associated with different germ cell types:

1. Proliferative phase: Spermatogonia ⟶ spermatocytes
2. Meiotic phase: Spermatocytes ⟶ spermatids
3. Differentiation phase (Spermiogenesis): Spermatids ⟶ Spermatozoa

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a. **Proliferative phase:** Stem or A spermatogonia located in the basal region of the tubular epithelium undergo mitosis. The progeny of these divisions maintain their own numbers as well as giving rise to several interconnected B Spermatogonia. B Spermatogonia divide to give rise to primary spermatocytes, which are the largest cells in the spermatogenic series.

b. **Meiotic Phase:** Each primary spermatocyte divides to give rise to two short-lived secondary spermatocytes, which in turn give rise to two spermatides each. The spermatid contains a haploid number of chromosomes. This cell division is meiosis.

c. **Differentiation phase:** This phase is also known as spermiogenesis. Spermatids undergo transformation into spermatozoa. Many changes occur within the cells, the three major ones being

i. Formation of the acrosome, which covers the cranial part of the head. The acrosome will contain hydrolytic enzymes to allow fusion of sperm and egg for fertilization.

ii. Condensation of nuclear chromation in the head to form a dark-staining structure.

iii. Growth of the tail opposite the acrosome, and loss of excess cytoplasmic material which is shed as a residual body.

Spermatogenesis is controlled by a complex of feedback mechanism involving the hypothalamus, anterior pituitary and testes. The hormones involved in spermatogenesis are Gonadotrophin releasing hormone (GnRH), Follicle stimulating hormone, (FSH), Luteinising hormone (LH), and other androgens.

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7. **2074 Set A Q.No. 2a Describe the formation of nervecord in the embryology of frog.** [2]

Please refer to 2076 Set B Q. No. 2b

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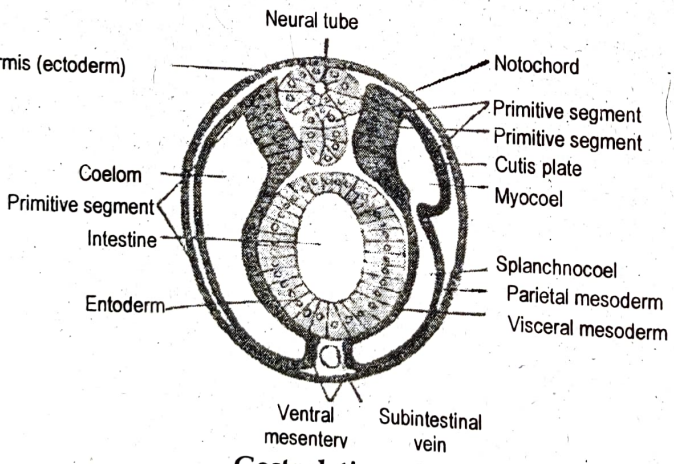
8. **2074 Set B Q.No. 2d What is gastrulation? Discuss the process of gastrulation during the development of frog with diagrams.** [2]

Please refer to 2075 Set B Q.No. 2b



Gastrulation of frog

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9. **2073 Supp Q.No. 2b Explain about the formation of notochord in the embryo of frog.** [5]

The notochord is a flexible rod made out of a material similar to cartilage.

After formation of three germinal layers some mesodermal cells at the roof of archenteron separate from other mesodermal cells. They form a rod-like structure, which is the beginning of notochord. A thin membrane develops around the rod-like structure known as notochordal sheath. Finally rod like structure and notochord sheath form the notochord. Notochord modifies into vertebral column as well as other skeletons in the course of development. Hence, Notochord is mesodermal in origin.

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10. **2073 Set C Q.No. 2b Discuss Gastrulation in Frog.** [5]

Please refer to 2075 Set B Q.No. 2b

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11. **2073 Set D Q.No. 2b Explain briefly about the coelom formation in frog.** [5]

Coelom is also known as body cavity. It is the cavity between body wall and gut wall. The fluid inside coelom is called coelomic fluid. Frog is schizocoelomate.

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After the formation of three germinal layer, splitting starts in the lateral mesoderm. Therefore, coelom is mesodermal in origin. After splitting two different layer of mesoderm are formed i.e;

1. Outer somatic or patietal mesoderm located beneath the skin.
2. Inner visceral or splanchnic mesodermal layer, around the wall of archenteron.

In between these two layers, a u-shaped cavity called splanchnocoel is formed. It is the beginning of formation of coelom. The size of splanchnocoel increases and somatic mesoderm fuses with ectoderm to form the body wall or somatopleure. Similarly, the visceral mesoderm fuses with endoderm to coelom form gut wall or splanchnopleure. Thus, coelom is formed. Hence, coelom is made up of mesodermal layer only and such type of coelm is termed as schizocoel. It clarifies that coelom is the cavity between body wall and gut wall.

12. **2072 Supp. Q.No. 2g Describe the formation of notochord in the embryo of frog.** [3]

Please refer to 2073 Supp Q.No. 2b

13. **2072 Set C Q.No. 2b Discuss the formation of coelom in the embryo of frog.** [3]

Please refer to 2075 Set A Q.No. 2b

14. **2072 Set D Q.No. 2f The coelom formation in frog.** [3]

Please refer to 2075 Set A Q.No. 2b

15. **2072 Set E Q.No. 2g The neurulation process in frog's embryo.** [3]

Please refer to 2076 Set B Q. No. 2b

16. **2071 Supp. Q.No. 1b The cleavage in the fertilized egg of frog.** [3]

Cleavage is the process of cell division in the early embryo. The frog zygote undergoes rapid mitotic cell divisions just after two or three hours of fertilization. The cleavage is holablastic i.e. division furrows divides cell completely but the cleavage in unequal due to moderate amount of Yolk.

The process of cleavage in frog is described below:

1. The first cleavage occurs shortly after the zygote nucleus is formed. A furrow appears that runs longitudinally through the poles of the egg, passing through the point at which the sperm entered and bisecting the grey crescent. The first cleavage is meridional or vertical. Cleavage starts from animal pole to the vegetal pole. This divides the egg into two halves forming the two-celled stage.
2. The second cleavage is meridional or vertical, but at right angle to the first furrow. The second cleavage forms the four-celled stage.
3. The furrow in the third cleavage runs horizontally or latitudinally but in a plane closer to the animal pole than to the vegetal pole. It produces the eight-called stage; the upper four being called micromeres and the lower four cells containing yolk being called macromeres. The macromeres are larger in size than micromeres.
4. The fourth cleavage is meridional like that of first cleavage. It results in 16 blastomeres; eight cells are micromeres and remaining eight cells are macromeres.
5. The fifth cleavage is latitudinal or horizontal resulting in 32 blastomeres. Among them sixteen cells are Megameres and sixteen cells are micromeres.

17. **2071 Set C Q.No. 2b Explain the process of neurulation.** [3]

Please refer to 2076 Set B Q. No. 2b

18. **2071 Set D Q.No. 2b How is the notochord formed in embryo of frog?** [3]

Please refer to 2073 Supp Q.No. 2b

19. **2070 Supp. Q.No. 2b Morula and blastula stage of frog.** [3]

In the embryonic development of frog, the zygote nucleus undergoes a series of mitotic cell division and formation of 32- celled stage takes place. After the 32- celled stage, cleavages become less regular and difficult to follow. Micromeres divide faster than megameres because yolk present in the vegetal pole interferes in the division process. Due to this irregular division of cells, the dividing zygote appears like a mulberry shaped solid ball of cells called morula. The upper

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hemisphere of morula contains a large number of small, black and Yolk-free cells called micromeres. The lower hemisphere of morula consists of smaller number of larger, white but yolk-laden cells called megameres. According to some authors, a true solid ball-like morula stage does not occur in frogs.

Very soon the morula stage give rise to a stage called blastula, which is a hollow ball like structure. Blastula formation starts after 4.5 hours of fertilization of egg and completed in 26 hours of fertilization.

Blastula stage: As the division continues, the blastomeres arrange at the periphery and a small central fluid filled space appears within the embryo. This is called segmentation cavity or blastocoel. This stage of the embryo is called blastula stage and this process is called blastulation. The blastocoel is composed of numerous small pigmented, black micromeres while its floor contains large yolk-laden megameres.

20. 2070 Set C Q.No. 2e **Give an account of the formation of coelom in the embryo of frog.** [3]

Please refer to 2075 Set A Q.No. 2b

21. 2070 Set D Q.No. 2g **Blastula formation of frog.** [3]

Blastula is the early developmental stage of an animal, following the morula stage and consisting of a single, spherical layer of cells enclosing a hollow cavity.

At the end of cleavage, the solid ball of cells give rise to blastula which consists of a number of blastomeres. The characteristic feature of the blastula is the presence of a cavity called blastocoel. The process of the formation of blastula is called blastulation.

Following events are observed during blastula formation.

1. Blastula is a single layered embryo with cavity inside known as blastocoel.
2. The cavity or blastocoel lies almost entirely in the upper half of the embryo.
3. As the segmentation proceeds further, the blastocoel increases considerably in size and filled with a fluid.
4. Blastula is apparently a hollow spherical ball almost indistinguishable from the fertilized egg, begin almost the same size.
5. The floor of blastocoel is composed of several layer of yolk laden cells while the roof is composed of small pigmented cells.
6. The entire animal pole of the blastula represents the presumptive or prospective ectoderm which is further divided into presumptive epidermis and presumptive neural plate.
7. A small area near the vegetal pole represents the presumptive notochord
8. The presumptive mesoderm lie in the region of gray crescent and the vegetal pole represents the presumptive endoderm.
9. Formation of blastula starts after 4.5 hours of fertilization of egg and completed in 26 hours after fertilization.

22. 2069 Q.No. 2a **Formation of nervecord.** [3]

Please refer to 2076 Set B Q. No. 2b

23. 2068 Q.No. 2b **About the coelom formation in frog.** [3]

Please refer to 2075 Set A Q.No. 2b

24. 2067 Q.No. 2b **Discuss the fate of ectoderm.** [3]

The fate of ectoderm is explained through following points:

i. Epidermis of skin, epidermal derivatives like epidermal glands, hair, nails, etc.
ii. Entire Nervous system including the brain, spinal cord and neurons.
iii. Medulla of adrenal gland, pineal gland, posterior and intermediate lobes of pituitary gland.
iv. Internal ear
v. Nasal and olfactory epithelia

vi. Enamel of teeth
vii. Lining of mouth cavity and cloaca
viii. Cranial cartilages and cartilages of visceral arches.
ix. Some glands – Sweet glands, oil glands, mammary glands, salivary glands and lacrimal glands.

25. **2059 Q.No.2c Describe the structure of frog's gastrula.** [3]

During embryonic development of frog, a single-celled zygote undergo multiple rounds of cleavage, or cell division, in order to produce a ball of cells called the blastula. The blastula later on modifies into a structure called gastrula. The process of migration and rearrangement of cells present in the blastula is termed as gastrulation.

I. **Structure of early Gastrula:**

1. Early gastrula is a small rounded ball-like structure made up of micromeres and megameres.
2. A well-defined cavity, called the blastocoel, is present on the upper half (animal hemisphere) of the embryo. Blastocoel is surrounded by micromeres and megameres.
3. A small depression appears on the dorsolateral side towards the posterior vegetal pole, and this depression is called blastopore.

II. **Structure of late Gastrula:**

1. The blastopore opens into a spacious cavity called archenteron.
2. The archenteron grows inside in size and reduces the blastocoel size as a narrow cavity.
3. Only two layers are formed initially.
4. Complete gastrula has three layers: ectoderm, mesoderm and endoderm,
5. Ectoderm is formed from the outer layer of micromeres
6. Endoderm layer is found between the blastocoel and archenteron.
7. Mesoderm is formed in the posterior side near the yolk plug.
8. The macromeres project outside as Yolk plug in the region of blastopore.
9. The notochord and neural plate are well-defined and situated in the dorsal side.

26. **2052 Q.No.2f List the process of segmentation of the egg of frog.** [3]

After fertilization of egg of frog, a zygote is formed. The zygote nucleus and zygote now divides which is called cleavage or segmentation. The division is mitosis and end up in the formation of three germ layers or gastrula.

The list of process of segmentation of the egg of frog embryo includes:

1. Cleavage:

Cleavages has following stages:

i. **Two-celled stage** - The first division of cleavage which is vertical or meridional
ii. **Four -celled stage** - The second cleavage division, which is also vertical but at right angle to the first cleavage division.
iii. **Eight-celled stage** - The third cleavage is horizontal passing about the equatorial line or plane. Eight unequal blastomeres are formed. Upper four are smaller called micromeres and lower four are larger called megameres.
iv. **Sixteen-celled stage** - The fourth and fifth cleavage are again vertical and sixteen calls are formed -8 micromeres and 8 megamere.
v. **32 celled stage** - The sixth and seventh cleavage are latitudinal forming 32 cells - 16 micromeress and 16 megameres.

2. **Morula state** – Mulberry shaped ball of cells. Micromeres are more in number than megamere because megameres divide slowly due to the presence of Yolk in vegetal pole.
3. **Blastula stage** – The process of formation of blastula is called blastulation. Blastula is a hollow ball of cells, consisting of a cavity called blastocoel.
4. **Gastrulation** – The blastula later on converts into gastrula. Which consists of three germinal layers - ectoderm, mesoderm and endoderm.

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Long Questions

1. 2066 Q.No. 3 Describe the formation of coelom during the development of frog. [7.5]

Coelom is the main body cavity in most vertebrates including frogs and is positioned inside the body and contain the digestive tract and other organs. Coelom is mesodermal in origin i.e. it is formed by the splitting of the mesoderm during the development of the frog.

Coelom formation begins in the gastrula stage. According to schizocoel theory (Clark, 1964), the coelom has been evolved by the splitting of mesodermal plates. The steps involved in the formation of coelom in the embryo of frog can be illustrated as given by:

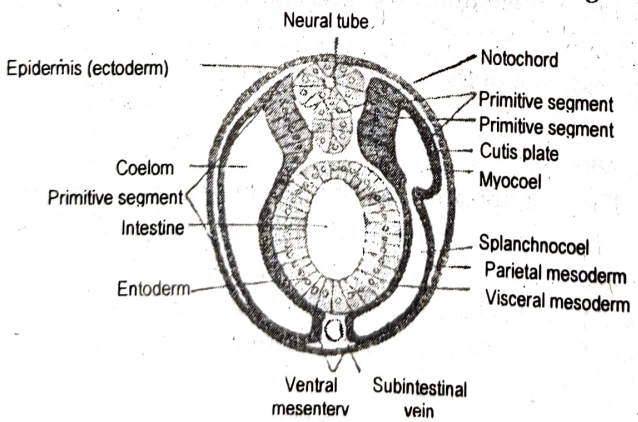
1. After the formation of three germinal layers, the mesodermal layer splits into two thin layers namely:
   i. Outer somatic or Parietal layer, and
   ii. Inner visceral or Splanchnic layer.
2. A cavity is formed in between te somatic and visceral layer and it is called splanchnocoel, which extends downward and continues to the outside below the gut.
3. The splanchnocoel assumes U-shaped cavity.
4. The somatic layer fuses with ectoderm to form body wall or somatopleure.
5. The inner visceral layer fuses with endoderm to form splanchnopleure or gut wall.
6. Hence, coelom is mesodermal in origin and such type of coelum is called schizocoel.
7. This clarifies, that coelom is the cavity between the body wall and gut wall.

2. 2065 Q.No. 3 Describe the changes taking place during gastrulation in frog. [7.5]

Gastrulation is the process of highly integrated cell and tissue migrations of prospective endodermal and mesodermal areas to their definite positions into the interior of the embryo. These movements are self determined and interdependent and are termed morphogenetic movements creating new relationships and ultimately a triploblastic embryo. The cellular preparations for these movements take place during cleavage.

Gastrulation results in the formation of three- layered gastrula from a single - layered blastula. These three layers are ectoderm (outer, mesoderm (middle) and endoderm (Inner).

Following changes occurs during the process of gastrulation in frog:



1. **Epiboly:** Epiboly is the continuous and rapid division of micromeres results in the migration from the animal pole towards the vegetal pole. It completely encloses the megameres except in the region of yolk plug. The process of overgrowth of micromere is called epiboly.
2. **Formation of Blastopore:** After some time, a small crescentic groove is formed on the posterior dorsal side of blastula, a little behind the edge of grey crescent in the presumptive endoderm. This groove is the beginning of the archenteron (gastrocoel) and its anterior margin is the dorsal lip of balstopore. Its backwardly projecting lateral horns are called the lateral lips which finally meet below forming the ventral lip. Thus the crescentric groove becomes a complete circle, or blastopore through which is visible or tiny spot of yolky endodermal cells, the yolk plug.

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3. **Invagination of Endoderm:** As the prospective endoderm cells or micromeres advance, the future endodermal cells or megameres gradually migrate towards blastopore and gradually sink inside.

4. **Formation of Archenteron:** The archenteron gradually increases in size, becoming firstly tubular, then bag-like, as more vegetal pole cells are rolled in from the blastopore tip and cells of the animal pole are rolled inwards at the anterior margin of the dorsal lip. This active migration turn a simple goove into a large cresentric mark of the dorsal lip of blastopore, its edges swing laterally. The advancing archenteron pushes the floor of the blastocoel, which rises upward, the rises begins on the dorsal side nearest the dorsal lip. Ultimately the blastocoel is nearly replaced by archenteron.

5. **Involution:** The advancing future notochord cells, continue to roll-in or involute till the prospective chordal cells have disappeared from the surface. They extend beneath the neural plate cells which however remain on the surface. With the formation of lateral lips of blastopore, the future mesoderm cells also roll inside over the lateral lips. Internally they occupy positions on either side of chordal cells between the surface epidermis and endoderm.

Thus formed three layers: the ectoderm, mesoderm and endoderm, also called primary germ cells, give rise to several organs of the larval body. Gastrulation starts after 26 hours from fertilization of eg and completed in 42 hours after fertilization. Gradually the gastrula undergoes the process of tabulation or neurulation to become a neurula.

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3. **2064 Q.No. 6 What are germinal layers? How they are formed in the embryo of frog?** **[6]**

A germinal layer is a group of cells in an embryo that interact with each other as the embryo develops and contribute to the formation of all tissues and organs.

Fertilization leads to the formation of a zygote. During the next stage, cleavage, the mitotic cell divisions transform the zygote into a hollow ball of cells, the blastula. The blastula undergoes gastrulation, forming a gastrula with three layers in frog. During the process the blastoderms begin to move. They wander and occupy their prospective organs forming zones.

At a specific region below the equator the blastoderm cells assume an elongated bottle like shape. They move towards the interior of the blastula. As the cells moves further inside, an invagination happens. A deepening of the invagination results in a cavity called the archenteron or gastrocoel. The opening of the archenteron on the surface of the blastula is called the blastopore. The blastopore gradually assumes a crescentric shape and finally it becomes circular. The region dorsal to the blastopore is called the "dorsal lip" and the lower ridge is called "ventral lip."

The surface cells representing several prospective zones of the embryo begin to wander inside through the blastopore. The inwarding of cells is called involution. The involution results in the positioning in the chorda-mesodermal cells and pharyngeal endodermal cells. The mesodermal cells occupy the region between inner endodermal and outer ectodermal cells. While the exterior chorda-mesodermal cell involute inside, their pale is aken up by the ectoderm. The expanison of the ectoderm is called epiboly.

Epiboly causes overlapping or 'the roofing over' of the gastrula by the ectoderm.

The blastopore is gradually covered by certain endodermal cells. The closing cells of the blastopore constitute the Yolk plug. The Yolk plug then continues to shrink as ectodermal epiboly progresses and is eventually absorbed into the embryo. The mesoderm constitutes the region between the superficial ectoderm and the internal endoderm, and lines the upper part of the archenteron. At the end of gastrulation, the frog embryo becomes a gastrula. It has ectoderm as its outer layer, mesoderm as its middle layer and an endoderm as is inner layer. The endoderm and mesoderm line the archenteron of the gastrula.

Gastrulation is crucial to the proper development of frogs, which have complex tissue structure. Each of these primary germ layer gives rise to the following organs:

1. **From ectoderm:** Skin, brain, spinal cord, all the neurons, sense receptors, epithelium of conjunctiva of eye, iris, lining of buccal cavity, stomadeum and proctodeum, rectum, lens, cornea and retina, enamel of teeth, pituitary gland and pineal gland.

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2. **From mesoderm:** Notochord, bones and cartilage, Dermis of the skin, Pericardium and peritoneum muscles, all the types of connective tissue such as areolar tissue, adipose tissue and blood, coelom and its lining, artery, veins, heart and lymphatic system, excretory system, sex organs, sclera and choroid of eye, spleen, etc.
3. **From Endoderm:** Epithelium of digestive tract, gastric and intestinal glands, Liver and hepatic duct, Pancreas and Pancreatic duct, Pharynx, tonsils, Eustachian tubes, Thymus and thyroid gland, tongue, lungs and gills, etc.

4. **2063 Q.No. 6 Describe embryonic development of frog up to formation of blastula stage.** (8)

The female frog releases many egg cells in water. The eggs are laid in secondary oocyte form and contains first polar body in the animal pole. Usually only one sperm penetrate each ovum i.e. monospermy. Penetration is always taking place in the pigmented area of the ovum. A small raised area called the cone of reception is the entry print of the sperm into the egg. The sperm acrosome release a proteolytic enzyme called the sperm lysin which dissolves the vitelline and plasma membrane in order to enter the egg. As soon as the sperm head penetrates it, the vitelline membrane of the egg becomes the fertilization membrane, which checks the entry of a second sperm. Meanwhile, the second maturation division takes place in ovum with the formation of second polar body. The male leaves the tail behind, and only the head and the neck remains. It is now called male pronucleus resulting in the formation of zygote nucleus restoring diploid chromosome number which is 26 pairs. The fusion of male and female pronuclei is called amphimixis. There are regions in the zygote- an upper pigmented animal hemisphere, a pale yolky vegital pole and a grey crescent with almost no pigment.

About two to three hours after fertilization, the fertilized egg begins to divide. The division is repeated frequently and mitotic. The division is termed as cleavage.

The division is called holoblastic i.e., complete, but the cells are unequal due to moderate quantity of yolk. The cleavage can be described as follows:

i. **The first** cleavage is vertical. It starts from the animal pole and gradually extends downwards to the vegetal pole. The furrow divides zygote into similar blastomeres.
ii. **The second** cleavage is also vertical but a right angle to the first cleavage plane forming four equal blastomeres.
iii. **The third** cleavage is horizontal, but just above the equatorial plane. This results in the formation of eight blatomeres. Upper four smaller cells are called micromeres, while the lower larger ells are called megameres.
iv. **The fourth** cleavage is vertical but at double plane resulting in the formation of 16 called stage - eight are micromeres and the other eight are megameres.
v. **The fifth** cleavage is two horizontal division or latitudinal division, which result in 32 called stage - the upper sixteen cells are called micromeres, and the lower sixteen larger sized cells are called megameres.

After 32-called stage, the embryo appears like a mulberry-shaped solid ball of cells called the morula.

After 32-called stage, cleavages become less regular. Micromeres divide faster than the megameres because there is enough amount of yolk in this region and it interferes the division process. As the cell division proceeds the morula transforms into a blastula.

As the micromeres divide faster than the megameres, the micromeres become numerous than megameres. As the division continues, the blastomeres are arranged at the periphery and soon a large cavity is formed inside the morula. This cavity is called blastocoel or segmentation cavity. The cavity is filled with albuminous fluid secreted by the surrounding blastomere. The fluid contains albumin and carbohydrate which provide nutrition to the cell of embryo. This stage of embryo is called blastula and the process is called blastulation. A fully formed blastula is a hollow-ball like structure. The blastocoel lies in the upper animal pole. It's roof is formed by numerous small pigmented, black micromeres while its floor is composed of large, Yolk laden, white megameres.

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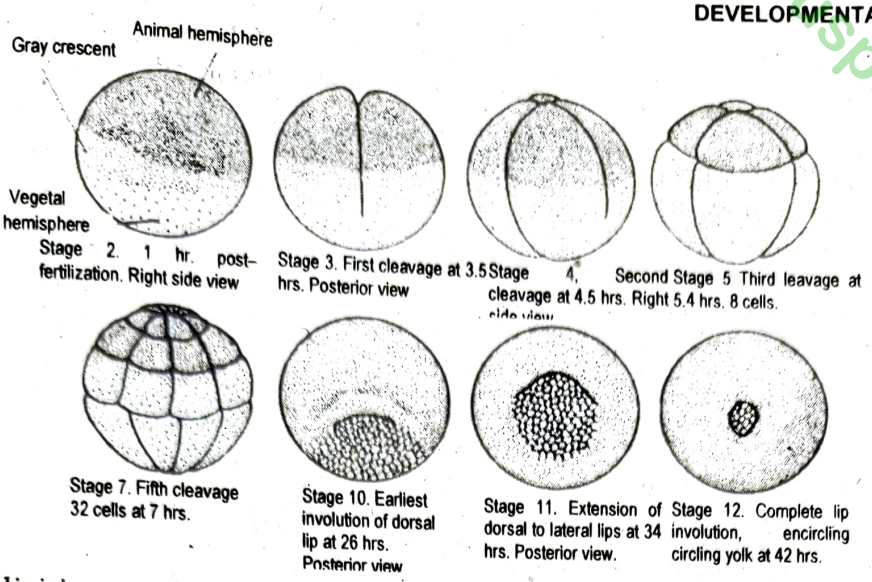

As the cell divisions continue, the blastula stage converts into gastrula. The whole process is called gastrulation. It involves mass migration and rearrangement of cells of blastula. The series of changes that take place in blastula are completed in four major steps:

i. **Epiboly:** The epiboly is the overgrowth of micromere of the animal pole. The micromeres of animal pole divide and redivide in large number and spread all over the megameres of the vegetal pole enveloping it from all sides and leaving only a small area which is not covered by blastomeres. This blastomere free area is called yolk plug.

ii. **Imboly:** Imboly is the impushing of the outer cells of the blastula forming a canal or sheath inside it. It begins with the formation of a small groove which is extended further to form a cavity called the archenteron, the opening of which is termed as blastopore. Blastopore is the precursor of anus. As the archenteron increases in size, the blastocoel decreases in size and finally disappears. Ultimately, the blastopore becomes guarded by dorsal lip, ventral lip and two lateral lips.

iii. **Migration of Micromeres:** The roof forming cells of the archenteron are differentiated into the chordamesoderm while the floor and the lateral sides of the archenteron are the endoderm. Due to the migration of the micromeres some Yolk filled megameres called Yolk plug come out through the blastopore.

iv. **Rotation of gastrula:** As the archenteron enlarges in size, the blastocoel gradually displaces towards the vegetal pole. The changes shift the centre of gravity of the embryo. The embryo freely swings once about 90° so that the blastopore comes near the original vegetal pole of the embryo. The dorsally situated archenteron is now uppermost. The antero-postrior axis of the embryo now becomes horizontal and parallel to the water surface having the animal pole in the front and the blastopore at the back.

5. **2062 Q.No. 6 How does fertilization take place in frog? Describe its development up to the formation of gastrula.** **[6]**

Please refer to 2063 Q.No. 6

6. **2061 Q.No. 6 What is coelom? Describe its formation in the development of frog.** **[6]**

Please refer to 2066 Q.No. 3

7. **2060 Q.No. 6 Describe the development of frog upto the formation of 3 germinal layers.** **[6]**

Please refer to 2064 Q.No. 6

8. **2058 Q.No. 6 What is coelom? How is it formed in the development of frog?** **[1+3+2]**

Please refer to 2066 Q.No. 3

9. **2057 Q.No. 6 What are germinal layers? How they are formed in frog's embryo?** **[1+5]**

Please refer to 2064 Q.No. 6

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Unit 3

HUMAN BIOLOGY AND HEALTH

A. Anatomy and Physiology

Very Short Answer Questions [1 mark]

1. **2076 Set B Q. No. 1a Name the place where actual exchange of gases takes place inside the lung.** [1]

The actual exchange of oxygen and carbon dioxide occurs in the lung between the alveoli and a network of tiny blood vessels called capillaries, which are located in the wall of the alveoli.

2. **2076 Set B Q. No. 1b What is double circulation?** [1]

Double circulation is a type of circulatory system that occurs in mammals, in which the blood passes through the heart twice before completing a full circuit of the body.
It includes two steps:

i. **Pulmonary circulation:** The circulation of blood between the heart and lungs.
ii. **Systemic circulation:** The circulation between the heart and other organs and tissue of the body.

3. **2076 Set B Q. No. 1c Which hormone controls osmoregulation?** [1]

Anti-diuretic Hormone (ADH) or Vasopressin, secreted by the pituitary gland, controls osmoregulation.

4. **2076 Set B Q. No. 1d Define nerve impulse.** [1]

Nerve impulse is defined as the sum total of physical and chemical disturbances created by a stimulus (electrical, chemical or mechanical) in a neuron which results in a movement of a wave along the nerve fibre. Nerve impulse is an electrical impulse generated by neurons that allows them to rapidly signal throughout the body.

5. **2076 Set B Q. No. 1i Why do drug addicts suffer from AIDS?** [1]

HIV is virus which spreads through blood or other body fluids. Drug addicts are at high risk of getting infected by HIV primarily in two ways:

i. If a needle has been used by a HIV positive person, infected blood can be injected into the person who uses that needle.
ii. When drugs impair judgment and people have unprotected sex with an HIV positive partner.

6. **2076 Set C Q. No. 1c What is meant by dead space?** [1]

Dead space means the volume of air that enters the airways and lungs, but does not take part in the gas exchange. The inhaled air either remains in the conducting airways, or reaches the alveoli that are poorly supplied with blood vessels.

7. **2076 Set C Q. No. 1d Why is ultra-filtration called so?** [1]

In the process of glomerular filtration all compounds such as amino acids, salts glucose and water are separated from the blood. The pure blood remains. That is why it is called ultrafiltration.

8. **2076 Set C Q. No. 1e In which part of oviduct fertilization occurs?** [1]

Fertilization takes place in the ampullary region (ampulla) of the oviduct (Fallopian tube) in mammals.

9. **2075 GIE Q. No. 1a Name the muscles involved in breathing.** [1]

The muscles involved in breathing are as follows:

i. External intercostals muscles
ii. Internal intercostals muscles
iii. Diaphragm

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10. 2075 GIE Q. No. 1b **Why the ventricles have thicker wall than that of auricles?** [1]

The ventricles have thicker walls than that of auricles because the ventricles need to pump the blood out of the heart at greater pressure compared to auricles.

11. 2075 GIE Q. No. 1c **What is pellagra?** [1]

Pellagra is a systemic disease that results from severe Vitamin B-3(Niacin) deficiency. It is characterized by three Ds – Dementia, Diarrhoea and Dermatitis.

12. 2075 GIE Q. No. 1d **Name the fluid present inside the internal ear.** [1]

The fluid present inside the internal ear is called Perilymph, which consists of Sodium as major components.

13. 2075 GIE Q. No. 1e **What is the term for one contraction phase and one relaxation phase of heart?** [1]

One contraction phase (systole) and one relaxation phase (diastole) of heart is termed as Cardiac Cycle.

14. 2075 GIE Q. No. 1f **Name the part of retina where sharp image is formed.** [1]

The part of retina where sharp image is formed is known as Fovea Centralis.

15. 2075 Set A Q.No. 1c **Define natural pace-maker.** [1]

Natural pacemaker is defined as a group of cells in the heart, which generates electrical impulses and conducts them throughout the muscles of the heart, stimulating the heart to contract and pump blood. The natural pace-maker is the sinoatrial node (SA Node), located at the top of the heart's right atrium, near the entrance of the superior venacava.

16. 2075 Set A Q.No. 1d **Mention the function of pons-varolii.** [1]

The pons-varolii is involved in several functions of the body including:

- Acting as a bridge or highway for relay of many signals to and from the cerebrum and the cerebellum.
- Autonomic Function: Breathing Regulation.
- Sensation of hearing, taste and balance.
- Regulation of deep sleep.

17. 2075 Set B Q.No. 1a **Name the covering of lungs.** [1]

Pleural membrane or pleura is the outer covering of the lungs. It has two layer: the outer layer is called the parietal layer, and the inner layer is called the visceral layer.

18. 2075 Set B Q.No. 1c **What do you mean by auditory meatus?** [1]

The auditory meatus refer to external auditory meatus and internal auditory metus.

- The external auditory meatus, also called ear canal, is a tube running from the outer ear to the middle ear. It is about 2.5 cm in length and 0.7 cm in diameter.
- The internal auditory meatus is a canal within the petrous part of the temporal bone of the skull between the posterior cranial fossa and the inner ear.

19. 2075 Set B Q.No. 1d **What is PEM?** [1]

The full form of PEM is protein - energy malnutrition, which refers to a form of malnutrition, that develops in children and adults whose consumption of protein and energy is insufficient to satisfy the body's nutritional need. Kwashiorkor and marasmus are the types of PEM.

20. 2075 Set B Q.No. 1e **Which structure is called pace maker of the heart?** [1]

The pacemaker of the heart is called the sino-atrial node (SA Node), which is located at the top of the heart's right atrium, near the opening of superior venacava.

21. 2075 Set B Q.No. 1f **Which pigment enables us to see in the dark?** [1]

Rhodopsin pigment (Retinal - Vitamin A + Opsin protein) enables us to see in the dark.

22. 2075 Set B Q.No. 1g **Mention the importance of Rh factor.** [1]

Rh or the rhesus factor is a hereditary trait pertaining specificially to protein found in the surface of red blood cells. An individual may either be Rh positive or Rh negative. A person who is Rh positive has sufficient protein on his or her RBCS. On the contrary, a person who is Rh negative does not.

By knowing the Rh factor of the individuals, they can avoid complications from a blood transfusion.

Similarly, Rh factor is one important consideration to be taken by mothers during pregnancy. By knowing the Rh factor, the couple can avoid erythroblastosis fetalis, a haemolytic disease of the newborn, which can be fatal to the fetus.

23. **2074 Supp Q.No. 1c Define vital capacity.**

Vital capacity (VC) is the maximum amount of air a person can expel from the lungs after maximum inhalation. It is equal to the sum of inspiratory reserve volume, tidal volume, and expiratory reserve volume. A normal human adult has a vital capacity between 3 and 5 litres.

24. **2074 Supp Q.No. 1d Name the HCl secreting cells of stomach.**

The Hydrochloric Acid (HCl) secreting cells of stomach are called the parietal cells (also known as Oxyntic cells).

25. **2074 Supp Q.No. 1e Name two neurotransmitter.**

Acetylcholine and nor–epinephrine are two neurotransmitters.

26. **2074 Supp Q.No. 1f Which minerals are required for development of bone and teeth?**

For the growth of bone and teeth calcium and phosphorus are needed.

27. **2074 Supp Q.No. 1g Which hormone is called birth hormone?**

Oxytocin is called the birth hormone. This hormone is released by the adenohypophysis of the pituitary gland and is associated with the contraction of labor and birth in all mammalian species.

28. **2074 Supp Q.No. 1j Define Rh-factor.**

Rhesus (Rh) factor is an inherited antigen found on the surface of red blood cells. If the blood has the antigen, it is termed as Rh positive and if the antigen is absent, then it is termed as Rh negative. Rh positive is the most common blood type (Around 85% people).

29. **2074 Set A Q.No. 1a Which pigment is responsible for night vision?**

Rhodopsin is the photopigment found in the rod cells within the retina of our eye that help us to see at night.

30. **2074 Set A Q.No. 1h What are neurotransmitters? Give an example.**

Neurotransmitter, also called chemical transmitter or chemical messenger, any of a group of chemical agents released by neurons (nerve cells) to stimulate neighbouring neurons or muscles or gland cells, thus allowing impulse to be passed from one cell to the next throughout the nervous system.

Acetylcholine, a substance synthesized by the neuron, is the primary neurotransmitter.

31. **2074 Set A Q.No. 1j Define ultrafiltration.**

Ultrafiltration is defined as a process in which the high hydrostatic pressure forces small molecules in a tubular fluid such as water, glucose amino acids, sodium chloride and urea through the filter from the blood in the glomerular capsule across the basement membrane of the Bowman's capsule and into the renal tubules.

32. **2074 Set B Q.No. 1a Differentiate between chyme and chyle.**

Chyme is a semifluid mass of partly digested foods and stomach fluids, and is acidic in nature. In the small intestine chyme mixes with intestine juice and bile and converts into a milky fluid known as Chyle. It contains emulsified fat and other products of digestion.

33. **2074 Set B Q.No. 1b What is Hamberger shift?**

The phenomenon of chloride ion diffusing into the erythocytes to maintain the ionic balance is called Hamburger's phenomenon or chloride shift.

34. **2074 Set B Q.No. 1c Define Rh-factor?**

The Rh-factor is a type of protein found on the surface of red blood cells.

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35. **2074 Set B Q.No. 1d What is barr-body?** [1]

Barr body is a condensed, inactive X chromosome present in most female mammal in the nuclei of the somatic cells (Except the germ cells). It is also called sex chromatin. It is regarded as diagnostic of genetic femaleness. In sports competitions, it is used to verify that an individual is genetically female.

36. **2074 Set B Q.No. 1e Give the name of one mixed and motor nerves.** [1]

Name of one mixed and motor nerves are:

i. Vagus Nerve (Cranial Nerve X) = Mixed Nerve

ii. Oculomotor Nerve (Cranial Nerve III) = Motor Nerve.

37. **2074 Set B Q.No. 1f Write the possible blood groups of children when parents blood group are A and AB.** [1]

The possible blood groups of children when parents blood group are A and AB are A, B and AB.

38. **2074 Set B Q.No. 1g What causes the characteristic smell of urine?** [1]

The characteristic smell of urine is due to a chemical substance called Urinod (C_6H_8O)

39. **2074 Set B Q.No. 1i Define the term deamination.** [1]

Please refer to Model (Zoology) Q.No. 1e

40. **2074 Set B Q.No. 1j Give the Dental formula of an adult man.** [1]

The dental formula of adult man is given by:

Incisor (I) $\frac{2}{2}$, Canine (C) $\frac{1}{1}$, Premolar (PM) $\frac{2}{2}$, Molar (M) $\frac{3}{3} \times 2 = 32$

41. **2073 Supp Q.No. 1c What are two diseases caused by the deficiency of vitamin A?** [1]

The two diseases caused by deficiency of vitamin A are given below:

i. Nyctalopia or Night blindness in which the person cannot see at night (due to disorder in rod cells of retina).

ii. Xerophthalmia in which the eyes fail to produce tears (due to dryness of conjuctiva and cornea).

42. **2073 Supp Q.No. 1d What is the most toxic excretory product produced in the body?** [1]

Ammonia is the most toxic excretory product produced in the human body.

43. **2073 Supp Q.No. 1f What is chloride shift?** [1]

Please refer to 2074 Set B Q.No. 1b

44. **2073 Supp Q.No. 1g Where is the location of bicuspid valve?** [1]

The bicuspid valve lies between the left atrium and the left ventricle of the mammalian heart.

45. **2073 Set C Q.No. 1d State Ionic Theory.** [1]

Ionic theory states that nerve impulse is an electro-chemical event governed by differential permiability of neurilemma of neuron to Na^+ and K^+ which in turn is regulated by the electric field.

46. **2073 Set C Q.No. 1e Write the meaning of arteriosclerosis.** [1]

Arteriosclerosis is the thickening, hardening and loss of elasticity of the walls of arteries. This process gradually restricts the blood flow to one's organs and tissue and lead to severe health risk.

47. **2073 Set C Q.No. 1f Which hormone is called emergency hormone and why?** [1]

Adrenaline hormone secreted by adrenal medulla of adrenal gland is called the emergency hormone because it initiates quick reaction which makes the individual to think and respond quickly to the stress.

48. **2073 Set D Q.No. 1c Name two enzymes responsible for protein digestion.** [1]

Please refer to Model (Zoology) Q.No. 1d

49. **2073 Set D Q.No. 1d What is deamination?** [1]

Please refer to Model (Zoology) Q.No. 1e

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50. 2073 Set D Q.No. 1f **What are the essential enzymes to digest oil?** [1]

Pancreatic Lipase (Steapsin) and intestinal lipase are the essential enzymes that digest oil.

51. 2073 Set D Q.No. 1g **Where lies the organ of corti?** [1]

The organ of corti lies on the basilar membrane of cochlea of internal ear.

52. 2072 Supp. Q.No. 1d **When does menopause occur?** [1]

Menopause occurs when women's menstrual period or vaginal bleeding stops permanently. Menopause typically occurs between 45 and 55 years of age.

53. 2072 Supp. Q.No. 1e **What is safe period?** [1]

Safe period is the period during the menstrual cycle of the human female when conception is considered least likely to occur. It comprises approximately the 10 days after menstruation starts and 10 days preceding menstruation.

54. 2072 Supp. Q.No. 1h **Name the endocrine part of pancreas.** [1]

Islets of Langerhans are the endocrine parts of pancreas.

55. 2072 Set C Q.No. 1c **What do you mean by dead space?** [1]

Dead space is the volume of air which is inhaled that does not take part in the gaseous exchange because it remain in the conducting airways, or poorly perfused (diffused)

56. 2072 Set C Q.No. 1d **Write the full form of FSH and LH.** [1]

The full form of the following are:

FSH= Follicle stimulating Hormone

LH= Leutinizing Hormone

57. 2072 Set D Q.No. 1a **Why blind spot of retina cannot form image?** [1]

Blind spot is the area on the retina without receptors that respond to light. Therefore, an image that falls on this region will not be seen. It is in this region that the optic nerve exits the eye on it way to the brain.

58. 2072 Set D Q.No. 1c **Write down the function of somatostatin.** [1]

In the hypothalamus, somatostatin regulates the secretion of hormones coming from the pituitary gland, including growth hormones and thyroid stimulating hormone. In the pancreas somatostation inhibits the pancreatic hormones including glucagon and insulin.

59. 2072 Set D Q.No. 1d **Name sensory cranial nerves.** [1]

The sensory cranial nerves are: CNI- Olfactory Nerve, CN II- Optic Nerve and CN VII- Vestibulo-Cochlear Nerve.

60. 2072 Set D Q.No. 1i **Mention the role of acrosome during fertilization.** [1]

The role of acrosome is to produce and release digestive protein called sperm lysine which helps the spermatozoa to penetrate the membranes of ovum for fertilization.

61. 2072 Set E Q.No. 1b **Name the minerals needed for proper growth of teeth and bone.** [1]

Calcium and phosphorus are needed for proper growth of teeth and bone.

62. 2072 Set E Q.No. 1c **What are Haemopoietic organs?** [1]

Haemopoietic organs are those organs where blood corpuscles: erythrocytes, Leucocytes and thrombocytes are formed. In adult mammals and human begins, the principle haemopoietic organ is the bone marrow.

63. 2072 Set E Q.No. 1d **What do you mean by deamination?** [1]

Please refer to Model (Zoology) Q.No. 1e

64. 2072 Set E Q.No. 1e **What is the role of eustachian tube?** [1]

The Eustachian tube controls the pressure within the middle ear, making it equal with the air pressure outside the body.

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65. **2072 Set E Q.No. 1j What is gluconeogenesis?** [1]

Gluconeogenesis is a process by which the liver converts non-carbohydrates such as fats, amino-acids, glycerol, lactic acid, etc, into glucose. The purpose is to regulate the blood sugar in the body.

66. **2071 Supp. Q.No. 1c Define reabsorption.** [1]

Reabsorption is the process in which the kidney selectively reabsorbs substances, it has already secreted into the renal tubules, such as glucose, protein and sodium. These reabsorbed substances are returned to the blood.

67. **2071 Supp. Q.No. 1d What do you mean by synapse?** [1]

Synapse is a junction across which a nerve impulse passes from axon terminal to another neuron, a muscle cell or a gland cell.

68. **2071 Set C Q.No. 1c Define the term peristalsis.** [1]

Peristalsis is the involuntary contraction and relaxation of the muscles of the alimentary canal or other canal, creating a wave - like movements which push the contents of the canal forward.

69. **2071 Set C Q.No. 1d What is chloride shift?** [1]

Please refer to 2074 Set B Q.No. 1b

70. **2071 Set C Q.No. 1e Name the fluid in which the membranous labyrinth floats.** [1]

Perilymph is the fluid in which the membranous labyrinth of the inner ear floats.

71. **2071 Set C Q.No. 1f Which pigment enables us to see in dark?** [1]

Rhodopsin pigment of rod cells, a photoreceptors of the retina, enables us to see in dark.

72. **2071 Set D Q.No. 1c Mention any two enzymes for protein digestion.** [1]

Please refer to Model (Zoology) Q.No. 1d

73. **2071 Set D Q.No. 1d Define the term deamination.** [1]

Please refer to Model (Zoology) Q.No. 1e

74. **2071 Set D Q.No. 1h Name three auditory ossicles.** [1]

The three auditory ossicles are Mallaeus, Incus and stapes that are found in the tympanic cavity of middle ear.

75. **2070 Supp. Q.No. 1e What is homeostasis?** [1]

The maintenance of relatively stable, internal physiological environment in higher animals under fluctuating environmental condition is called homeostasis. e.g Acid - Base balance, Body temperature, Glucose concentration, calcium level, fluid volume, etc.

76. **2070 Supp. Q.No. 1f Define synaptic vessicle.** [1]

Synaptic vesicle is a small secretory vesicle that contains a neurotransmitter and found inside an axon near the presynaptic membrane, and releases its contents, into the synaptic cleft after fusing with the membrane.

77. **2070 Supp. Q.No. 1h Define interferon.** [1]

Interferons (IFN_s) are a group of signalling protein made and released by host cells in response to the presence of several pathogens, such as viruses, bacteria, parasites and also tumor cells. These protein molecules are used for communication between cells to trigger the protective defenses of the immune system that help eradicate pathogens.

78. **2070 Set C Q.No. 1i What are narcotics?** [1]

Narcotics are a group of drugs, which when administered in the animal body, in mild doses dull the senses, relieves pain, and induce profound sleep but in excessive doses cause stupor, coma or convulsions. e.g. opium, morphine, heroine, etc.

79. **2070 Set C Q.No. 1c Which mineral is required for the growth of bone and teeth?** [1]

Please refer to 2074 Supp Q.No. 1f

80. **2070 Set C Q.No. 1e Differentiate between hormones and enzymes.** [1]

The difference between hormones and enzymes are listed below:

Hormones	Enzymes
Hormones are chemical messengers secreted by endrocrine glands such as pituitary gland, thyroid gland, adrenal gland etc. e.g Insulin, Thyroxine, growth hormone, etc	Enzymes are biological catalysts released by exocrine glands like salivary gland, digestive gland, etc. e.g. Amylase, trypsin and lipase

81. **2070 Set D Q.No. 1b Name the pigments found in bile.** [1]

There are two pigments called bilirubin and biliverdin found in bile.

82. **2070 Set D Q.No. 1c What is the location of Adam's apple?** [1]

Adam's apple, a chunk of bony cartilage, is found wrapped around the larynx (neck) in men.

83. **2070 Set D Q.No. 1d Which hormone is useful for retaining salt in body?** [1]

Aldosterone hormone, the main minerlocorticoid and steroid hormone, produced by the zone glomerulosa of the adrenal cortex of the adrenal gland is useful for retaining salt in the body.

84. **2070 Set D Q.No. 1e Name two neurotransmitters.** [1]

Please refer to 2074 Supp Q.No. 1e

85. **2070 Set D Q.No. 1f Which system of body is affected by Tuberculosis?** [1]

Respiratory system is affected by Tuberculosis.

86. **2070 Set D Q.No. 1h Why is ultrafiltration called so?** [1]

Please refer to 2076 Set C Q. No. 1d

87. **2070 Set D Q.No. 1i What is glycogenolysis?** [1]

Glycogenolysis is a process by which glycogen, the primary carbohydrate stored in the liver and muscle cells of animals, is broken down into glucose to provide immediate energy and to maintain blood glucose during fasting. Glycogenesis occurs primary in the liver and is stimulated by the hormones glucagon and epinephrine.

88. **2069 Q.No. 1b Name the main steps of nutrition.** [1]

The main steps in nutrition are in the orders:

1. Ingestion
2. Digestion
3. Absorption
4. Assimilation
5. Egestion.

89. **2069 Q.No. 1c What do you mean by myogenic heart?** [1]

The type of heart, where contraction is initiated by a special modified heart muscle known as sino atrial node (SA-Node) located in the right atrium, is called myogenic heart. e.g. The heart o vertebrates including human beings.

90. **2069 Q.No. 1d Which part of the retina has only cones?**

Fovea centralis of macula lutea of the retina has only cone cells.

91. **2069 Q.No. 1f Name the endocrine part of pancreas.**

Islets of Langerhans is the endocrine part of pancreas.

92. **2069 Q.No. 1h What is antibody?**

Antibody is a blood protein recruited by the immune system to identify and neutralize foreig objects like bacteria and viruses. Each antibody has a unique target known as antigen present on th invading organism, just like every lock has a signal key. An antibody has a signal antigen key.

93. **2069 Q.No. 1j Define the term sexing.**

Sexing is a process, through which the sex of live stock and other animals are determined. e.g chicken sexing is necessary in the poultry farming.

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94. **2068 Q.No. 1a In what form is oxygen transported to tissues?** [1]

Oxygen is transported to tissue in the form of oxyhaemoglobin. The red blood cells contain a pigment called hemoglobin, each molecule of which binds four oxygen molecules.

95. **2068 Q.No. 1c Define the carrying capacity of the environment.** [1]

The carrying capacity of a biological species in an environment is the maximum population size of the species that the environment can sustain indefinitely, given the food, habitat, water, and other necessities available in the environment.

96. **2068 Q.No. 1d What is most toxic excretory product produced in the body?** [1]

Ammonia is the most toxic excretory product produced in the body.

97. **2068 Q.No. 1e Name the hormone secreted by corpus luteum.** [1]

The corpus luteum secretes a steroid hormone called progesterone, which is responsible for the development and maintenance of endometrium of the mammalian uterus.

98. **2068 Q.No. 1f What are narcotics?** [1]

Please refer to 2070 Set C Q.No. 1i

99. **2068 Q.No. 1g What do you understand by Rh-factor?** [1]

Please refer to 2074 Supp Q.No. 1j

100. **2067 Q.No. 1a Mention the location and important feature of cardiac muscle.** [1]

Cardiac muscle is specialized tissue that is found only in the heart. They are self-contracting, automatically regulated and must continue to contract in rhythmic fashion for the whole life of the organism.

101. **2067 Q.No. 1b What is Hamburger's phenomenon?** [1]

Please refer to 2074 Set B Q.No. 1b

102. **2067 Q.No. 1c Why blood group A person can not donate blood to Blood group B person?** [1]

Blood group A and Blood group B are incompitable. If a person having blood group A donate blood to person having blood group B, the donor cells will be attacked by the receiver's immune system, which may cause shock, kidney failure and death of the receiver.

103. **2067 Q.No. 1d Name the pigment needed for vision in dim light.** [1]

Rhodopsin is the pigment needed for vision in dim light.

104. **2067 Q.No. 1e Mention the functions of human ear.** [1]

Human ear has two functions:

i. Hear the sound around us.

ii. Assist with our balance (sense of equilibrium)

105. **2066 Q.No. 1 b Which pigment is responsible for night vision?** [1]

Rhodopsin pigment (Retinal- Vitamin A+ opsin protein) is responsible for night vision.

106. **2066 Q.No. 1 c What do you understand by stroke volume?** [1]

Stroke volume is the amount of blood pumped by the left ventricle of the heart in one contraction. It is about 70 ml/heart beat.

107. **2066 Q.No. 1 d Mention the role of hemoglobin.** [1]

The role of haemoglobin (found in red blood cells) is to transport oxygen from the lungs to the body tissues and then transport carbondioxide out of the tissue. Each RBC contain approximately 280 million haemoglobin molecules. Haemoglobin is popularly known as oxygen carrier.

108. **2066 Q.No. 1 e What is chloride shift?** [1]

Please refer to 2074 Set B Q.No. 1b

109. **2065 Q.No. 1 b What are the vitamins produced in human colon with the help of bacteria?** [1]

The vitamins produced in human colon with the help of bacteria are vitamin K, vitamin B_{12} (cobalamin), vitamin B_1 (Thiamine) and B_2 (Riboflavin).

110. 2065 Q.No. 1 c **Mention the function of hypothalamus.** [1]

Hypothalamus, a neuroendocrine part of the brain links the nervous system to the endocrine system via the pituitary gland. It synthesize and secretes certain neurohormones, called releasing hormones or hypothalamic hormones, which stimulate or inhibit the secretion of pituitary hormones.

111. 2064 Q.No. 1h **What is the function of lung?** [1]

Absorbing from the air through the process of inhalation, the lungs bring oxygen in to the blood stream, which carries oxygen to the rest of the body. The cells of the body release Co_2 as they use oxygen. This is carried back to the lungs by the blood. The carbon dioxide (Co_2) leaves the lungs when the lung exhale.

112. 2064 Q.No. 1j **What is malnutrition?** [1]

Malnutrition is the condition that develops when the body does not get right amount of vitamins, minerals, protein, carbohydrate and other nutrients it needs to maintain healthy tissue and organ function. Malnutrition occurs in people who are either under nourished or over nourished.

113. 2064 Q.No. 1k **Mention the role of molars.** [1]

The role of molars is to chew and grind the food into smaller pieces.

114. 2064 Q.No. 1l **What do you mean by capillaries?** [1]

Capillaries are the smallest blood vessels which serve to distribute oxygenated blood from arteries to the tissues of the body and to feed deoxygenated blood from the tissues back in to the veins. In other word, capillaries are any of the tiny blood vessels that connects the smallest arteries (arterioles) to the smallest veins (venules).

115. 2064 Q.No. 1m **What is middle ear?** [1]

Middle ear is the air filled central cavity of the ear, behind the tympanic membrane. It consist of the three auditory ossicles: Mallaeus, Incus and stapes. It is sound conducting part of the ear.

116. 2063 Q.No. 1b **Mention the role of acrosome.** [1]

The role of acrosome is to release enzymes like hyluronidase and acrosin, which break down the outer membrane of the ovum, called the zona pellucida, allowing the haploid nucleus in the sperm cell to join with the haploid nucleus in the ovum.

117. 2063 Q.No. 1e **Name the enzyme which curdles milk.** [1]

Rennin, also called chymosin, a protein digesting enzyme curdles milk by transforming caseinogen into insoluble casein.

118. 2063 Q.No. 1g **What do you mean by Rh factor?** [1]

The Rh factor is a protein (antigen) found on the surface of red blood cells of the human beings & other primates.

119. 2063 Q.No. 1i **What are neurotransmitters?** [1]

Neurotransmitters are brain chemicals that communicate information throughout our body. They relay signals between nerve cells. (neurons). e.g. Dopamine, somatostatin, etc.

120. 2062 Q.No. 1h **What is the function of liver?** [1]

The primary functions of the liver are: bile production and excretion of bilirubin, cholesterol, hormones and drugs.

121. 2062 Q.No. 1i **What is ventricle?** [1]

Ventricles are lower chambers of the heart, that are involved in pumping blood. The right ventricle pumps blood into the lungs to receive oxygen.

122. 2062 Q.No. 1j **What is pulmonary respiration?** [1]

Respiration through the lungs is called pulmonary respiration.

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123. 2062 Q.No. 1m **What is the role of veins?** [1]

The role of veins is to carry deoxygenated blood from the tissues and organs to the heart, and to carry oxygenated blood from the lungs to the heart.

124. 2061 Q.No. 1h **What is the function of kidney?** [1]

The kidneys extract waste or toxic substances from blood, balance body fluids, form urine and aid in other important functions of the body.

125. 2061 Q.No. 1i **What is the role of arteries?** [1]

Arteries, the blood vessels, carry blood away from the heart under pressure.

126. 2061 Q.No. 1k **Mention the types of respirations.** [1]

There are two types of respiration:

i. Aerobic respiration, which requires oxygen and releases lots of energy.

ii. Anaerobic respiration. which does not require oxygen but releases much less energy.

127. 2061 Q.No. 1n **Define permanent teeth.** [1]

Permanent teeth are the second set of teeth, which replace the temporary milk teeth or deciduous teeth and last for most of mammal's life.

128. 2060 Q.No. 1c **Define the term 'deamination'.** [1]

Please refer to Model (Zoology) Q.No. 1e

129. 2060 Q.No. 1d **Which pigment gives colour to urine?** [1]

Urochrome or urobilin is the pigment that gives the yellow colour to urine.

130. 2060 Q.No. 1e **What do you mean by uterus?** [1]

The uterus, also commonly called womb, is a hollow muscular organ of the female reproductive system of mammal's that is responsible for the development of the embryonated fetus during pregnancy.

131. 2060 Q.No. 1f **Which pigment enable us to see in the dark?** [1]

Rhodopsin pigment enables us to see in dark.

132. 2059 Q.No. 1g **Name the thoracic muscles involving in inspiration process of man.** [1]

The thoracic muscles involved in the inspiration process of man are diaphragm, external intercostal muscles and internal intercostal muscles that run between the ribs.

133. 2059 Q.No. 1h **Mention the hormone when abnormally secreted results simple goiter.** [1]

Thyroid hormone when secreted abnormally (too much or too less) results simple goitre. This hormone is secreted by thyroid gland.

134. 2059 Q.No. 1i **Write the dental formula of adult man.** [1]

Please refer to 2074 Set B Q.No. 1j

135. 2059 Q.No. 1j **Define ultrafiltration.** [1]

Ultrafiltration is how urea, salt, water and glucose are taken out of the blood in the kidneys. This is a step in the formation of Urine.

136. 2059 Q.No. 1k **Name the photoreceptor cells in the human eye.** [1]

There are two types of photoreceptor cells in the retina of human eye: rod cells and cone cells.

137. 2058 Q.No. 1b **Define 'atrial systole'.** [1]

Atrial systole is the contraction of the atria of heart by which blood is forced into the ventricles.

138. 2058 Q.No. 1g **What is grey matter?** [1]

Grey matter is a major component of the central nervous system (The brain and the spinal cord) which consists of neuronal cell bodies (cytons), dendrites, unmyelinated axons, glial cells, synapses and capillaries. The grey matter includes regions of the brain involved in muscle control, sensory perception such as seeing and hearing, memory, emotions, speech, decision making, and self-control.

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139. **2058 Q.No. 1n Give the role of ACT hormone.** [1]

Adrenocorticotropic hormone (ACTH), produced by the pituitary gland, stimulates the cortex of the adrenal gland to release cortisol hormone, a key carbohydrates, sodium, potassium and protein as well as blood pressure.

140. **2058 Q.No. 1o Name two proteolytic enzymes present in the intestinal juice.** [1]

Two of the many proteolytic enzymes found in the intestinal juice are dipeptidase and aminopeptidase.

141. **2057 Q.No. 1b Where do you find "Adam's apple"?** [1]

Please refer to 2070 Set D Q.No. 1 c

142. **2057 Q.No. 1f What is the structure of lens in human eye?** [1]

The lens is a transparent, biconvex structure in the eye, that along with the cornea, helps to refract light to be focused on the retina.

143. **2057 Q.No. 1h Which artery supplies the blood to the shoulder?** [1]

The brachial artery (axillary artery), a branch of sub clavian artery, supplies blood to the shoulder.

144. **2057 Q.No. 1i Mention the function of bile.** [1]

Bile has three main functions:

i. Bile breaks down the large fats particles into smaller fat droplets i.e. emulsification, which aids in the process of digestion of fats.

ii. Serves as route of excretion for billirubin, a byproduct of red blood cells recycled by the liver.

iii. Neutralize any excess stomach acid in the small intestine.

145. **2057 Q.No. 1k Which hormone results the growth of human body?** [1]

Growth hormone, also called somatotropin, a peptide hormone, secreted by pituitary gland stimulates growth of human body.

146. **2057 Q.No. 1m Which part of human brain is the centre of intelligence?** [1]

Please refer to Model (Zoology) Q.No. 1f

Mark (√) the correct choice [1 mark]

1. **2056 Q.No. 1a Nitrogen is the constituent of- (i) Carbohydrate (ii) Lipid (iii) Protein (iv) Organic acid** [1]

Nitrogen is the constituent of protein.

2. **2054 Q.No. 1c Both exocrine and endocrine secretion is found in the gland:**

☐ **Parathyroid** ☐ **Thymus** ☐ **Pancreas** ☐ **Adrenal** [1]

Both exocrine and endocrine secretion is found in the gland: **Pancreas.**

3. **2052 Q.No. 1iv Pancreas is: a. Exocrine b. Endocrine c. Gonads d. None of them** [1]

Pancreas is None of them.

Answer in very Brief [3 marks]

1. **2076 Set B Q. No. 2c The role of Vitamins.** [3]

Vitamins are micronutrients synthesized by plants. When plants like fruits and vegetables are eaten by us, the vitamins are absorbed into our body. Other animals have the same ability to absorb vitamins from plants, so some vitamins are obtained second hand by eating animal products such as eggs, fish or meat. Vitamins are organic compounds that are needed in small amount for healthy functioning of the body.

Vitamins are classified as fat – soluble and water-soluble. Fat soluble vitamins are vitamin A, D, E and K. Water soluble vitamins are vitamins B and C. Thirteen important vitamins are required in the body.

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I. **Importance of Fat soluble vitamins**

i. Vitamin A or Retinol is used for bone development, functioning of all tissues, prevents respiratory diseases, improves vision and prevent cancer.

ii. Vitamin D or Calciferol is responsible for healthy bone and teeth, strong joints and helps protect the nervous system.

iii. Vitamin E or Tocopherol relieves fatigue, prevents and dissolves blood clots, protects the lung against pollution, help to heal burn wounds and prevents cramps.

iv. Vitamin K or Menadione is used to form proteins and aids blood clotting.

II. **Importance of water soluble vitamins**

1. Vitamins B or B – complex

It consists of eight vitamins and they are as follows:

i. Vitamin B_1 or thiamine is used to control mood and humor, helps the nervous system, promotes memory and concentration, helps growth, aids digestion of fats and sugars.

ii. Vitamin B_2 or Riboflavin is responsible for proper growth, maintains healthy skin, nails, hair and mucous membranes and to improve vision.

iii. Vitamin B_3 or Niacin or Nicotinic Acid serves to preserve the cells, aids in the production of substances needed by the body, maintains healthy skin, aids in digestion.

iv. Vitamins B_5 or Pantothenic acid helps converts fats and sugars into energy, to form cells for growth, heal wounds and prevent fatigue.

v. Vitamin B_6 or Pyridoxine helps growth, makes antibodies and red blood cells, prevents nervous and skin, helps in the formation of other vitamins.

2. Vitamin C or Ascorbic Acid allows for growth, repair of tissue cells, gums, blood vessels, bone and teeth, protects against infectious diseases and cancer; helps in wound healing, prevents from cold and respiratory illness.

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2. **2076 Set B Q. No. 2d The role of Bile in the fat digestion.** **[3]**

Bile or gall is a dark green fluid produced by the liver of human being that aids the digestion of fats in the small intestine. In humans, bile is produced continuously by the hepatocytes of the liver, and stored and concentrated in the gall bladder. After eating, the stored bile is discharged into the duodenum. Bile is composed of water, bile acids, cholesterol, sodium, potassium and bilirubin (a waste product formed from the breakdown of red blood cells). Bile is slightly alkaline with a pH of about 7.5 to 8. Adult humans produce 400 to 800 ml of bile daily. Initially, hepatocytes secrete bile into the canaliculi, from which it flows into the bile ducts. The hepatic bile contains large quantities of bile acids, cholesterol and other organic molecules. As the bile flow through the bile duct it is modified by addition of watery, bicarbonate-rich secretion from the ductal epithelial cells. The amount of bile secreted into the duodenum is controlled by the hormones cholecystokinin, secretin, gastrin, somatostatin and also by the vagus nerve.

When the chyme reaches the duodenum, the upper portion of the duodenum and the muscle of the gall bladder wall begin to contract. This rhythmic contraction releases bile into the common bile duct, the passageway that connects the gall bladder to the small intestine. In addition to the bile, the pancreas releases lipases, which are digestive enzymes that are vital to fat digestion.

$$\text{Fats} \xrightarrow[\text{Bile Salts}]{\text{Emulsification}} \text{Fat globules}$$

(Sodium glycolate + sodium taurocholate)

The pancreatic lipase (Steapsin) and intestinal lipase converts the fats into fatty acids and glycerol.

$$\text{Emulsified Fats} \xrightarrow[\text{Intestinal lipase}]{\text{Pancreatic lipase/}} \text{Fatty acids + Glycerol}$$

Fats are hydrophobic, i.e., they do not dissolve in water. Without proper digestive juices, small molecules of fat would combine together to form one large molecule of fat. Bile prevents this from happening. Bile molecules contain a hydrophobic end, as well as a hydrophilic, or water-absorbent, end. When bile enters the small intestine, bile molecules attach to the fat molecule. The fat molecule absorbs the hydrophobic end of the bile molecule, allowing the hydrophilic end to protrude from

the fat molecule like a tail. This hydrophilic end repels other fat molecules, preventing them from combining together. These coated fat molecules become a particle known as micelles. Once the fat molecules are converted into micelles, the lipase enzymes from the pancreas begin to break down the fat molecules into fatty acids and monoglycerides. These substances are able to pass through the wall of small intestine, where they enter intestinal epithelial cells and then to the lymphatic system and finally to the bloodstream.

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3. 2076 Set B Q. No. 2e Distinguish between endocrine and exocrine glands. [3]

Differences between Exocrine and Endocrine Glands

Exocrine Glands	Endocrine Glands
They have ducts, i.e., they are ducted glands.	They are ductless glands, i.e., they do not have ducts.
They secrete enzymes, mucus, milk, sweat, oil, and other substances.	They secrete hormones.
They are located near the action sites	They may be either near or far away from the action sites.
They are generally simple in structure.	They are generally complex in structure.
Their secretions are secreted in moderate to maximum quantity.	Their secretions are secreted in minimum quantity.
They influence short term or daily activities such as digestion, respiration, excretion, etc.	They influence long term activities such as body growth, reproduction, menstrual cycle, etc.
Examples are liver, lachrymal gland, mammary gland, sebaceous gland, goblet cells, etc.	Examples are pituitary gland, thyroid gland, adrenal gland, thymus gland, pineal gland, etc.

4. 2076 Set C Q. No. 2c Discuss CO_2 transport. [3]

Gaseous carbon dioxide is produced in large quantities by metabolically-active tissues and diffuses into the blood stream where it is transported to the lungs for elimination.

Carbon dioxide molecules are transported in the blood from body tissues to the lungs by one of three methods:

a. **Dissolution directly into the blood:** Several properties of carbon dioxide in the blood affect its transport. First, carbon dioxide is more soluble in blood than is oxygen. Roughly 5-10% of carbon dioxide is transported from tissues to the lungs in a simple dissolved form. In this process metabolically-generated carbon dioxide gas simply diffuses into local capillaries, travels to the lungs via venous blood, and is exhaled

b. **Carried as Bicarbonate ions:** Transport of carbon dioxide in a chemically-modified form accounts for nearly 70% of total carbon dioxide transport and is achieved by carbon dioxide conversion to bicarbonate. The processes which are responsible for this transport require multiple steps as detailed below.

   i. Gaseous CO_2 derived from metabolically-active cells diffuses in a dissolved state into the cytosol of erythrocytes present in local capillaries. Erythrocytes possess large amounts of carbonic anhydrase which catalyze reaction of the diffused CO_2 with a molecule of H_2O to form carbonic acid (H_2CO_3). It should be pointed out that generation of carbonic acid from carbon dioxide and water is a normally very slow kinetic process and requires catalysis by erythrocyte carbonic anhydrase to achieve rates viable for carbon dioxide transport. Once generated, carbonic acid spontaneously dissociates into a free hydrogen ion (H^+) and bicarbonate (HCO_3^-).

   ii. The resultant free hydrogen ions appear to be absorbed by the erythrocytic hemoglobin molecule which may promote enhanced oxygen unloading in the periphery. The resultant bicarbonate ion is transported across the erythrocyte membrane into the plasma in exchange for a chloride ion using an electroneutral Bicarbonate-Cl Antiporter. Bicarbonate then travels in venous plasma to the lungs where the above reactions occur in reverse, leading to generation of gaseous CO_2 which is exhaled. Reversal of these reactions in the lungs is enhanced by the presence of high oxygen partial pressures.

c. **Binding to Haemoglobin:** Carbon dioxide can bind to plasma proteins or can enter red blood cells and bind to hemoglobin. This form transports about 10 percent of the carbon dioxide. When carbon dioxide binds to hemoglobin, a molecule called carbamino aemoglobin is formed. Binding of carbon dioxide to hemoglobin is reversible. Therefore, when it reaches the lungs, the carbon dioxide can freely dissociate from the hemoglobin and be expelled from the body.

5. **2076 Set C Q.No. 2d Explain working of Heart.** [3]

The human heart is an organ that pumps blood throughout the body via the circulatory system, supplying oxygen and nutrients to the tissues and removing carbon dioxide and other wastes. The heart is a muscle whose working mechanism is made possible by the many parts that operate together. The organ is divided into several chambers that take in and distribute oxygen-poor or oxygen-rich blood. These chambers are accompanied by veins and arteries that facilitate the same function. With all of its parts working together towards the same goal, the heart successfully pumps blood with ease.

The heart muscle contracts in two stages to squeeze blood out of the heart. This is known as systole.

- In the first stage, the upper chambers (atria) contract at the same time, pushing blood down into the lower chambers (ventricles).
- Blood is pumped from the right atrium down into the right ventricle and from the left atrium down into the left ventricle.
- In the second stage, the lower chambers contract to push this blood out of the heart to either the body via your main artery (aorta) or to the lungs to pick up oxygen.

The heart then relaxes – known as diastole. Blood fills up the heart again, and the whole process, which takes a fraction of a second, is repeated.

The different sides of the heart have different functions:

- On the right side, the upper chamber fills with oxygen-depleted blood from your body and pushes it via the lower chamber and the pulmonary artery back to the lungs. Here blood picks up oxygen and releases carbon dioxide.
- On the left side, the upper chamber fills with oxygen-rich blood from the lungs. This is pumped via the lower chamber into the aorta and out to the body to provide cells with the crucial oxygen they need.

6. **2076 Set C Q. No. 2e Differentiate between sympathetic and parasympathetic nervous system.** [3]

The sympathetic and parasympathetic nervous system are the parts of autonomic nervous system (ANS). The autonomic nervous system controls the activity of the organs, glands and various involuntary muscles. The sympathetic and parasympathetic nervous system are antagonist in functions. The differences between these two are as follows:

Sympathetic Nervous System	Parasympathetic Nervous System
Originated from the thoracic and lumbar regions of the spinal cord (Thoracic – lumbar outflow)	Originated from the cranial and sacral region of the spinal cord (cranio-sacral outflow)
It is close to the spinal cord, away from the effector.	It lies away from the spinal cord, closed to the effector.
It consists of a paired chains of sympathetic ganglia.	Chains of parasympathetic ganglia are absent.
Pre-garglionic fibres are shorter.	Pre-ganglionic fibres are longer.
Post ganglionic fibres are longer.	Post-ganglionic fibres are shorter.
Number of post ganglionic fibres are large in number.	Number of post ganglionic fibres are few.
The post garglionic fibres are adrenergic i.e. the relaeaed neutransmittor are noradrenaline (norepinephrine)	The postganglionic fibres are cholinergic i.e. they release neurotransmitor as acetylcholine.
It controls the body's "flight or fight" responses or how the body reacts to perceived danger.	It controls the "rest and digest functions" of the body i.e. works when the body is at rest.

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7. **2075 GIE Q. No. 2c Significance of ovarian cycle.** [3]

The ovarian cycle, also called menstrual cycle, is the scientific term for the physiological changes that occurs in fertile woman for the purpose of sexual reproduction. In other words, the ovarian or menstrual cycle is the monthly series of changes a sexually matured woman's body goes through in preparation for the possibility of pregnancy. Each month, one of the ovaries releases an egg - a process called ovulation. At the same time hormonal changes prepare the uterus for pregnancy. If ovulation takes place and the egg is not fertilized, the lining of uterus sheds through the vagina. This is called menstrual period, which is characterized by loss of blood through the vagina (Menses).

In human female it begins at the age of 12-14 years and continues till the age of 50-55 years. The first menstrual cycle or bleeding is called menarche while the cessation of ovulation and permanent stoppage of menstrual cycle is called menopause. The menstrual cycle is governed by hormonal changes. The average length of the menstrual cycle in 28 days.

The ovarian cycle has following four phases:

1. **Follicular phase or proliferative phase:** This phase involves the maturation of ovarian follicles and rapid proliferation of endometrial cells of uterus.

i. **Changes in the ovaries or ovarian cycle:** Follicular phase is the first part of ovarian cycle. During this phase, the ovarian follicles mature and get ready to release an egg.

ii. **Changes in the uterus or uterine cycle:** The Graafian follicular cells secrete increased amount of Oestrogen. It's level increases gradually maximum on 12th day of the cycle. The oestrogen initiates the formation of a new layer of endometrium in the uterus. Endometrium lining becomes 2 - 3 mm thick. This phase is therefore, called proliferative phase.

Both the phase lasts for 9-10 days. i.e. from 5th day to the 14th day.

2. **Ovulation:** Ovulation is the second phase of the ovarian cycle. Ovulation is the release of a mature egg from the ovary. This phase occurs mid-cycle around two weeks or so before menstruation starts. During this phase, the anterior lobe of pituitary gland produces raised level of Luteinizing Hormone (LH) and FSH. The process of production of high amount of LH is called LH surge. The release of LH matures the egg and weakens the wall of the follicle in the ovary, causing the fully developed follicle to release its secondary oocyte. The secondary oocyte promptly matures into an ootid and then becomes mature ovum (diameter 0.2mm). After being released from the ovary, the egg is swept into the fallopian tube by frimbae, which is the finger – like projection at the end of each fallopian tube.

3. **Luteal phase or secretory phase**

Ovarian cycle – The luteal phase is the final phase of the ovarian cycle. It is the period between ovulation and onset of menstruation lasting usually for 14 days i.e. from 15th day to 28th day of the cycle. The pituitary hormones FSH and LH cause the remaining part of the dominant follicle to transform into the corpus luteum, a golden coloured structure, which produces a hormone called progesterone. Hence, this phase of ovary is called luteal phase. The progesterone also induces the production of small amount of oestrogen hormone from the adrenal glands. The hormones produced by the corpus luteum also suppress production of the FSH and LH. Cosequently, the level of FSH and LH fall quickly overtime and the corpus luteum subsequently atrophies (Wastes away). If pregnancy does not occur, the corpus lutum withers and die.

Uterine cycle – The secretory phase is the final phase of the uterine cycle and it corresponds to luteal phase of the ovarian cycle. During secretory phase the corpus luteum produces. Progesterone hormone, which play a vital role in making the endometrium receptive to implantation of the blastocyst and supportive of the early pregnancy, by increasing blood flow and uterine secretions and reducing the contractility of the smooth muscles of the uterus.

4. **Menstruation:** If the egg is fertilized in the fallopian tube, the resulting embryo attached to the lining of the uterus. If the egg is not fertilized, it wil not attached to the lining of uterus. In such case, the corpus luteum stops secreting progesterone and the soft tissue of the uterine lining are

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shed off. These tissue along with the unfertilized egg are discharged. This is called menstruation or menses during which mild bleeding (haemorrhage) occurs due to casting off the uterine epithelium and rupturing of blood vessels. It usually occurs at 28 days. The bleeding lasts for about 3-5 days. The FSH and LH level become very low. About 50-100 ml of blood is lost through the vaginal orifice. This is also called weeping of uterus for the lost ovum.

8. **2075 GIE Q. No. 2d Write about neurotransmitters used by sympathetic and parasympathetic nervous system.** **[3]**

Neurotransmitters are referred to as the body's chemical messengers. They are the molecules used by the nervous system to transmit messages between neurons, or from neurons to muscles. Neurotransmitters are synthesized by neurons and are stored in vesicles, which typically are located in the axon's terminal end, also termed as presynaptic terminal.

The chief neurotransmitters of sympathetic nervous system are epinephrine(adrenaline) and norepinehrine (noradrenaline).Hence, the neurons of sympathetic nervous system are regarded as adrenergic. Both also serve as hormones and belong to a class of compound known as catecholamines. They influence different parts of our body and stimulate the central nervous system. Chemically, epinephrine and norepinephrine are very similar. However, epinephrine works on alpha and beta receptors, while norepinephrine only works on alpha receptor. Alpha receptors are only found in the arteries. Beta receptors are found in the heart, lungs, and skeletal muscles. Both neurotransmitters are found in the postganglionic fibres of sympathetic nervous system.

Epinephrine has powerful effects in the body. These include:

i. increased blood sugar levels
ii. increased heart rate
iii. relaxation of smooth muscle in the airways to improve breathing.

These effects are designed to provide the body with extra energy. When the body is in stress flood of epinephrine is released in the body. This is known as fight-or-flight response, or adrenaline rush. Norepinephrine has effects similar to those of epinephrine. Norepinephrine can also cause the blood vessels to narrow, which increase blood pressure.

Acetylcholine is the main neurotransmitter of parasympathetic nervous system. Acetylcholine is stored in the cholinergic neurons. It is the most abundant neurotransmitter in the body. Acetylcholine assists in carrying signals across the nerve synapse. Acetylcholine functions in the peripheral and central nervous system both as an activator and inhibitor. Acetylcholine influences a large part of body systems counting the cardiovascular system by playing a role of a vasodilator, by lessening cardiac rate, and by lessening cardiac contraction; the gastrointestinal system by means of augmenting peristalsis in the stomach and by raising the number of digestive contractions; and ultimately, the urinary tract by lessening the aptitude of the bladder and increasing the voiding process. In addition to these, acetylcholine influences the respiratory system and facilitates secretion by all glands, which respond to parasympathetic nerve impulses. Also, acetylcholine is involved in cardiac, skeletal, and smooth muscles' contraction. It is involved in rapid eye movement sleep. It assists in learning, memory, arousal, and neuroplasticity.

9. **2075 GIE Q. No. 2e How the foods are digested in human intestine?** **[3]**

The acidic semi-digested food or the chyme leaves the stomach in small squirts rather than all at once. The small intestine is the site where most of the chemical and mechanical digestions take place.

When the chyme reaches the duodenum, the first part of small intestine, it acts as stimulant for the release of hormones such as Secretin and Cholecystokinin, which are secreted by the duodenal wall. Cholecystokinin stimulates the emptying of bile in the gall bladder and secretion of pancreatic juice from the pancreas. Similarly, Secretin stimulates the pancreas to release pancreatic juice. The bile neutralizes the acidic chyme for the action of pancreatic juice. Pancreatic juice consists of three powerful enzymes: pancreatic amylase, pancreatic lipase and trypsinogen.

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1. **Digestion of carbohydrate:** The pancreatic amylase converts the carbohydrate into glucose and maltose.

$$\text{Carbohydrate or starch} \xrightarrow{\text{Amylase}} \text{Glucose (Diasachharides)}$$

Succus entericus or intestinal juice from the duodenum contains several enzymes. The enzymes maltase, lactase and sucrase convert the maltose, lactose and sucrose into glucoses. In this way, carbohydrate is digested in the duodenum.

2. **Digestion of protein:** The semi-digested proteins or polypeptides are completely digested in the small intestine. The proenzyme trypsinogen is converted into active trypsin by the action of Enterokinase released by the intestinal wall. The trypsin converts the proteoses and peptones into peptides and amino acids.

$$\text{Trypsinogen} \xrightarrow{\text{Enterokinase}} \text{Trypsin}$$

$$\text{Proteoses and Peptones} \xrightarrow{\text{Trypsin}} \text{Aminoacids + dipeptides + polypeptides.}$$

The final step of protein digestion occurs in the ileum by the action of intestinal juice or Succus entericus. The intestinal juice contains proteolytic enzymes such as aminopeptidase and dipeptidase.

Aminopeptidase converts remaining polypeptides to small peptides and free amino acids.

$$\text{Polypeptides} \xrightarrow{\text{Aminopeptidas}} \text{Small peptides + Amino acids}$$

Similarly,

$$\text{Dipeptides} \xrightarrow{\text{Di-peptidase}} \text{Amino acids}$$

$$\text{Tripeptides} \xrightarrow{\text{Tri-peptidase}} \text{Amino acids}$$

In this way, complete digestion of protein takes place in ileum.

3. **Digestion of Fats/Lipids:** Bulk of fat digestion occurs in the small intestine due to pancreatic lipase. Bile aids in the digestion of lipids, primarily triglycerides, through emulsification. Emulsification is the process in which large lipids globules are broken down into several small lipid globules.

$$\text{Fats} \xrightarrow[\text{Bile Salts}]{\text{Emulsification}} \text{Fat globules}$$

(Sodium glycolate + sodium taurocholate)

The pancreatic lipase (Steapsin) and intestinal lipase converts the fats into fatty acids and glycerol.

$$\text{Emulsified Fats} \xrightarrow[\text{Intestinal lipase}]{\text{Pancreatic lipase/}} \text{Fatty acids + Glycerol}$$

Nucleases convert nucleic acids into nucleotides.

Nuclease

$$\text{Nucleic acids} \xrightarrow{\text{Nuclease}} \text{Nucleotides.}$$

Nucleosidases convert purine and pyramidine nucleosides into purine or pyramidine bases + pentose phosphates.

$$\text{Purine or pyramidine nucleosides} \xrightarrow{\text{Nucleosidases}} \text{Purines or pyramidine bases + pentose phosphates}$$

10. **2075 Set B Q.No. 2c How carbohydrate is digested in human digestive tract?** [5]

The main function of carbohydrate is to provide the body with energy to support muscular work, brain activity, breathing and other important activities. Carbohydrates are made up of made up of sugars known as saccharides or glucose. Most carbohydrate foods contain many saccharides or glucose linked together, which are called polysaccharides. Carbohydrate digestion begins in the mouth and is complete when the polysaccharides are broken down into single sugar or monosccharides which can be absorbed by the body.

The digestion of carbohydrate in the human body can be summarised as follows:

1. **Digestion in the mouth:** Carbohydrate digestion starts in the mouth or buccal cavity. The salivary glands in the mouth secrete saliva, which helps to moisten the food. The food is then chewed while

the salivary glands release the enzyme salivary amylase or ptyalin. Ptyalin canverts the carbohydrate or starch into disaccharides such as dextrin, maltotriose and maltose.

Carbohydrate $\xrightarrow{\text{Ptyalin}}$ Dextrin, maltoriose, maltose.

Saliva in the mouth accounts for 30% of initial carbohydrate digestion.

2. **Digestion in the stomach:** There is no digestion of carbohydrate in the stomach because the stomach does not contain carbohydrate digesting enzyme. The food is crushed into a semisolid Chyme in the stomach.

3. **Digestion in the small Intestine:**

Digestion of carbohydrate predominantly occur in the small intestine. The acidic chyme enters the duodenum from the stomach. In response to chyme being in the duodenum, the pancreas releases the enzyme pancreatic amylase or amylopsin, which breaks down the polysaccharides into disaccharide, a chain of two glucose linked together.

Carbohydrate $\xrightarrow{\text{Pancreatic Amylase}}$ Maltose/Sucrose/Lactose

The small intestine then produces enzymes called lactase, sucrase and maltase, which break down the diasccharides such as lactose, sucrose and maltose into glucose.

Lactose $\xrightarrow{\text{Lactase}}$ Glucose (monosaccharide) + Galactose

Sucrose $\xrightarrow{\text{Sucrase}}$ Glucose + Fructose

Maltose $\xrightarrow{\text{Maltase}}$ Glucose

In this way, carbohydrate digestion is completed in the ileum. The glucose or monosccharides are then absorbed in the ileum (small intestine).

11. 2075 Set B Q.No. 2d **The role of graafian follicle.** [3]

Graafian follicle is a structure in the ovary of a female mammal, consisting of an oocyte surrounded by granular follicle cells which enclose a large, fluid – filled cavity, the whole structure being encased in a wall of connective tissue.

In other words, Graafian follicle is a small sac, embedded in the ovary that encloses an ovum.

It is named after Dutch physician and anatomist Reinier de Graaf (1641-1673).

At puberty each ovary has a large number of immature follicles or primordial follicles, each of which contains an underdeveloped egg cell. About every 28 days between puberty and the onset of menopause, one of the follicles develops to maturity, or ripens, into a graafian follicles or vesicular ovarian follicle under the influence of follicle stimulating hormone (FSH).

- It provides for the maturation and release of a fertilized oocyte.
- It forms the corpus luteum, which promotes and maintains implantation of the embryo.

The graafian follicle has two major functions.

As the Graafian follicle ripens, it increases in size. The ovum within becomes large, the follicular wall becomes thicker, and fluid collects in the follicle and surrounds the ovum. The follicle secretes estradiol, the hormone that prepares the endometrium to receive a fertilize egg. As the follicle matures it moves to the surface of the ovary and forms a projection. When fully matures, the Graafian follicle breaks open and release the ovum, which passes into the fallopian tubes. This release of the ovum is called ovulation. It occurs midway in the menstrual cycle, generally about 14 days after the commencement of the menstrual flow. Meanwhile, the empty graafian follicle in the ovary becomes filled with cells containing a yellow substance, the corpus luteum. The corpus luteum secretes progesterone hormone that causes further change in the endometium, allowing it to provide a good milieu (environment) in which the fertilized egg or zygote can grow through the stages of gestation to become a fetus.

12. 2075 Set B Q.No. 2e **How impulse transmitted through a nerve fibre?** [3]

The transmission of the nerve impulse along a neuron from one end to the other occurs as a result of electrical changes across the membrane of the neuron.

The following events characterize the transmission of a nerve impulse:

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1. **Resting Potential:** The resting potential describes the unstimulated, polarized state of a neuron (at about - 70 mv). There is a difference in electrical charge between the outside and inside of the membrane. The inside is negative and the outside is positive.
Of the many kinds of ions present in the nerve cells and the surrounding fluid, sodium (Na^+) and potassium (K^+) ions are the most important. Sodium ions are tenfold higher in concentration outside than inside the membrane surface, whereas potassium ions are more than twenty times more concentrated inside than outside. A certain amount of sodium and potassium is always leaking across the membrane through leakage channels, but sodium-potassium pumps in the membrane actively restore the ions to the appropriate side.
The main contribution to the resting membrane potential (a polarized nerve) is the difference in permeability of the resting membrane to sodium versus potassium ions. Other ions, such as large, negatively charged proteins and nucleic acids, reside within the cell. It is these large, negatively changed ions that contribute to the overall negative charge on the inside of the cell membrane as compared to the outside. There are ion voltage gated channels in the membrane and they open in response to neurotransmitters, changes in membrane potential, or other stimuli.
2. **Action potential or Depolarization:** When the nerve is stimulated, the sodium channels open and sodium rushes into the axon. Now the inside of the membrane becomes positively charged and outside become negatively charged. This reverse polarity of the membrane is called depolarization. The electrical potential difference is about + 40 millivolts, at the point of stimulation. In this manner, the action potential travels down the length of the axon.
3. **Repolarization:** As soom as depolarization is complete, the voltage gated sodium channels are closed. Just after the sodium channels close, the potassium channels open wide, and potassium exit the axon, so the charge across the membrane is brought back to its resting potential. This is called repolarization. This process continues as a chain-reaction along the axon. The potential difference again becomes - 70 mv.
4. **Sodium–potassium exchange pump or refractory period:** The membrane is polarized, but the Na^+ and K^+ are on the wrong sides of the membrane. To re-establish the original distribution of these ions, the Na^+ and K^+ are returned to their resting potential location by sodium - potassium exchange pumps in the cell membrane. Two potassium ions move inside for every three sodium ions, that move outside. Once these ions are completely returned to their resting potential location, the neuron is ready for another stimulus.

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13. 2074 Supp Q.No. 2c **Define portal vein. Describe hepatic portal system with its significance.** [3]

A portal vein or hepatic portal vein is a blood vessel that carries blood from the gastrointestinal tract, gallbladder, pancreas, and spleen to the liver.

The hepatic portal system is the venous system that returns blood from the digestive tract and spleen to the liver, where raw nutrients in blood are processed before the blood returns to the heart. It is part of the body's filtration system. Its main function is to deliver de-oxygenated blood to the liver to be detoxified further before it returns to the heart.

The hepatic portal system consists of:

1. **Hepatic portal vein:** This is the main vein connected to the liver. It is formed at the connection of the inferior and superior mesenteric veins.
2. **Inferior mesenteric vein:** This vein opens into the spleenic vein. It collects blood from the colon and the rectum.
3. **Superior mesenteric vein:** This vein collect blood from the ileum (small intestine) and some part of colon, and connects with the hepatic portal vein.
4. **Gastrosplenic vein:** This tributary is formed by the union of the splenic vein from the splean and the gastric vein from the stomach. It joins the mesenteric vein inside the pancreas.
5. **Cystic vein:** It collects blood from the gall bladder.

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Significance of hepatic portal system:

All the nutrients and other substances absorbed from the intestine are carried to the liver before they enter general circulation.

1. The excess glucose in the blood is converted into glycogen and stored in the liver for future use (Glycogenesis). When there is fall in the glucose level in blood, the glycogen is broken down into glucose and drain into the blood (Glycogenolysis).
2. The highly toxic ammonia produced during the protein metabolism are converted into less toxic urea, which is carried to the kidney (Deamination).
3. The ingested toxins are detoxified by the hepatocytes before they are released in the systemic circulation.

14. 2074 Supp Q.No. 2d **What is micturition? Describe its process.** [3]

Micturation is the release of urine from the urinary bladder through the urethra to the outside of the body. It is the urinary's form of excretion. It is also known as urination or voiding. It is colloquially known as peeing and pissing. It is normal for adult humans to urinate upto seven times during the day.

Process of Micturation

Urine produced in the Kidneys travel down the ureters into the urinary bladder. The bladder expands like an elastic sac to hold more urine. As it reaches capacity, the process of micturation begins. Involuntary muscle movements send signals to the nervous system, putting the decision to urinate under conscious control. Micturation or urination can be described by the following process:

1. **The two uretheral sphincters maintain urinary continence:** The internal urethral sphincter and external sphincter both provide muscle control for the flow of urine. The internal sphincter is involuntary. It surrounds the opening of the bladder to the urethra and relaxes to allow urine to pass. The external sphincter is voluntary. It surrounds the urethra outside the bladder and must be relaxed for urination to occur.
2. **The Bladder expands as it is filled with Urine:** The bladder is shaped like a pyramid when empty, it becomes more oval as it fills with urine and expands. A smooth muscle called the detrusor surrounds the bladder, and folds called rugae line the interior wall. These structures give the bladder elasticity and allow it to expand. The floor of the bladder includes a funnel - like region called the trigone, formed by the two urethral orifices- like region called the trigone, formed by the two urethral orifices and the internal urethral sphincter. Urine flows into the bladder via the ureteral orifices and out through the internal sphincter.
3. **Muscles of Micturation: The Detrusor and Uretharal Sphincter:** When the bladder is full of urine, stretch receptors in the bladder wall trigger the micturation reflex. The detrustor muscle that surrounds the bladder contracts. The internal urethral sphincter relaxes, allowing for urine to pass out of the bladder into the urethra. Both of these reactions are involuntary. It must be relaxed for urine to flow through the urethra and outside the body.
4. **How Full Does the Bladder Get Before Urination?:** The bladder expands as urine flows in from the ureters, but there is a limit to the volume it can contain. At about 200 ml of urine, the detrusor muscle begins to contract and the internal urethral sphinctor muscle begins to relax. This sends signals through the nervous system and creates the "urge" to urinate. If this urge is ignored, continence may be threatened. At about 500 ml, detrusor muscle contractions begin to force open the internal urethral opening. Unless the external urethral sphincter is powerful enough to prevent it, micturation will occur involuntarily.

15. 2074 Supp Q.No. 2e **Enlist about ear ossicles and their roles.** [3]

The ear ossicles are the three bones in either middle ear that are among the smallest bones in the human body. They serve to transmit sounds from the air to the fluid filled labyrinth (cochlea). The ear ossicles are also called auditory ossicles. These three ossicles are named as mallaeus, incus and stapes. Each bone is named in Latin for its shape.

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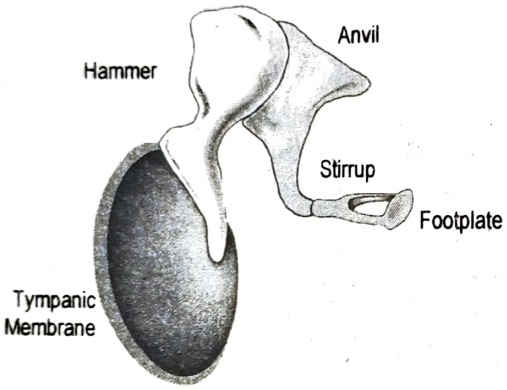
i. Mallaeus means hammer or mallet
ii. Incus means anvil
iii. Stapes means stirrup

The Mallaeus is the most lateral of the ossicle that articulates with the incus through incudomalleolar joint and is attached to the tympanic membrane (eardrum). It has a large rounded head on its superior end, which tapers to a narrow neck and handle on its inferior end. It forms a synovial joint with the incus at the head.

The anvil-like Incus is the middle ossicle that forms synovial joints with the malleus and on its lateral side and the stapes on its medial side. The incus is widest where it meets the malleus and tapers to a thinner projection known as the lenticular process where it meets the stapes.

The stirrup shaped stapes is the smallest ossicle with a hollow space in the middle. It is also the smallest bone in the human body. It articulates with the incus through the incudostapedial joint.

The stapes is loosely attached to the oval window of the cochlea, allowing it to move in and out like a piston. The piston - like action generates vibrations in the fluid-filled inner ear that are used to signal the brain of a sound event. The extent of the movements of the ossicles is controlled by two muscles attached to them and they are tensor tympani and stapedius.



Ear ossicles

Role or function of Ear ossicles: The main function of the auditory ossicles is the conduction of sounds to the inner ear where they are transduced into nerve signals and sent onward to the brain. The ossicles act as a compound lever which achieves a multiplication of force. This lever action is thought to achieve an amplification. The lever is adjustable under muscle action.

As sound waves vibrate the tympanic membrane (eardrum), it in turn moves the nearest ossicle, the malleus, to which it is attached. The malleus then transmits the vibrations, via the incus, to the stapes and so ultimately to the membarane of fenestra ovalis, the opening of the inner ear. The ossicles give the eardrum a mechanical advantage via lever action and a reduction in area of force distribution. This reduction in the area of force application allows a large enough increase in pressure to transfer most of the sound energy into the liquid. The increased pressure will compress the fluid found in the cochlea and transmit the stimulus.

16. 2074 Set A Q.No. 2e Explain the protein digestion in human alimentary canal. [3]

During digestion the protein are broken down into their basic units, called the amino acids. A large protein breaks down via a few intermediate steps, in the stomach, and in the small intestine, before it becomes the tiny amino acids. The enzymes which break down peptide bonds are called peptidases.

Protein digestion begins in the stomach, where the acidic environment favors protein denaturation. When the food that contains protein reach the stomach, the oxyntic cells of the stomach wall release hydrochloric acid. It makes the food acidic. Then, the zymogen cells or chief cells or peptic cells release an inactive pro-enzyme called pepsinogen. The pepsinogen is converted into active pepsin with the help of HCl.

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Digestion of protein in the intestine: When the semi-digested food i.e. chyme reaches the duodenum, the first part of intestine, it is acted upon by various protein digesting enzymes,

The protein digesting enzymes come from pancreas and intestine itself.

The acidic chyme is acted upon by bile secreted by the liver and converted into slightly alkaline semi-digested food.

As soon as the acidic food is neutralized the pancreas releases pancreatic juice, which consists of protein-digesting enzymes: the trypsionogen, chymotrypsinogen and elastase. The inactive trypsinogen is converted into active trypsin with the help of enterokinase enzyme relaeased by duodenum. Similarly, chymotrypsinogen is also converted into active chymotrypsin with the help of trypsin.

Trypsin converts proteoses and peptones or polypeptides into amino acids and some to tripeptides and dipeptides.

- Trypsinogen $\xrightarrow{\text{Enterokinase}}$ Trypsin (Active)
- Chymotrypsinogen $\xrightarrow{\text{Trypsin}}$ Chymotrypsin (Active)
- Proteins, proteoses, peptones or polypeptides $\longrightarrow$ $\xrightarrow{\text{Trypsin/Chymotrypsin}}$ Amino acids + Tripeptides + Dipeptides.
- Proelastase (Inactive) $\xrightarrow{\text{Trypsin}}$ Elastase (Active)
  Elastase converts the elastin protein into dipeptides and amino acids
- Elastin $\xrightarrow{\text{Elastase}}$ polypeptides $\xrightarrow{\text{Elastase}}$ Dipeptides+ Aminoacids
  Similarly, inactive procarboxy peptidase is converted into active carboxypeptidase A and B, which then digest the polypeptides into small peptides and amino acids.
- Procarboxypeptidase $\xrightarrow{\text{Trypsin}}$ carboxypeptidase A and B
- Polypeptides $\xrightarrow{\text{carboxypeptidase A \& B}}$ small peptides + amino acids
  The final step of protein digestion occurs in the ileum by the action of intestional juice or succus entericus. The intestinal juice contains proteolytic enzymes such as aminopeptidase and dipeptidase.
  Aminopeptidase converts remaining polypeptides to small polypeptides to small peptides and free aminoacids.
- Polypeptides $\xrightarrow{\text{Aminopeptidase}}$ small peptides + Amino acids similarly,
- Dipeptides $\xrightarrow{\text{Di-peptidase}}$ Amino acids
- Tripeptides $\xrightarrow{\text{Tri-peptidase}}$ Amino acids

In this way, complete digestion of protein takes place in the ileum (small intestine)

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17. **2074 Set A Q.No. 2f Draw a well labelled diagram of human ear. Discuss the physiology of hearing.** [3]

Physiology of hearing: The ear is the sensory organ of sound. The sense of hearing is sensitive to the sound stimuli. The three main parts of the ear are very important.

1. **The outer ear or external Ear:** The outer ear has pinna, a flap like organ made up of cartilage and skin, and is funnel - like shape. It collects and directs sound into the ear canal and finally into the tympanic membrane or eardrum.
2. **Sound transmission through the middle ear:** The sound from the external ear strikes the tympanic membrane, which is semi-transparent thin fibroelastic connective tissue membrane, covered by epidermis from outer side and a cuboidal mucous epithelium from inner side. It vibrates and transmits sound waves to the ear ossicles. Ossicles are made up of three small bones, which is the hammer (Mallaeus), the anvil (Incus) and the strirrup (stapes). It intensifies the vibration of the sound waves by 22 times before transmitting to the oval window. Eustachian tube, a narrow tube that joins the middle ear to the throat balances the air pressure at both sides of the eardrum. The oval window transmits the sound vibrations from the middle ear to the inner ear.

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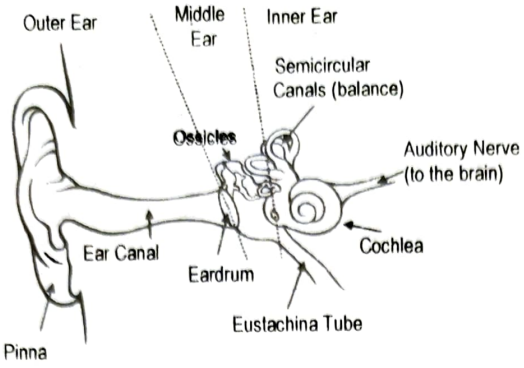

3. **Sound Transmission through the inner ear:** The ossicular chain transfer energy from a solid medium to the fluid medium of the inner ear via the stapes. The stapes is attached to the oval window. Movement of the oval window creates motion in the cochlear fluid and along the basilar membrane. Motion along the basilar membrane excites frequency specific areas of the organ of corti, which in turn stimulates a series of nerve ending.

4. **Sound transmission to the Brain:** With the initiation of the nerve impulses, another change in medium occurs; from fluid to neural. Nerve impulse are relayed through the vestibulo-cochlear nerve (CN VII), through various nuclei along the auditory pathway to areas to the brain. It is the brain that interprets the nerve impulses and create a thought, picture, or other recognized symbol. In the cerebral cortex (Auditory area), the nerve impulse is interpreted as sound.

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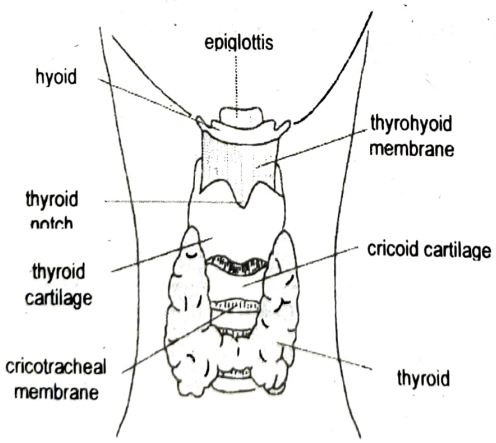
18. **2074 Set A Q.No. 2g Describe the structure and functions of thyroid gland in brief.** [3]

The thyroid gland is an endocrine gland, which is found at the front of neck, below the Adam's apple.

The thyroid gland is a butterfly- shaped organ which is composed of two lobes, left and right connected by a narrow isthmus. The thyroid weight 25 grams in adults, with each lobe being about 5 cm long, 3cm wide and 2 cm thick, and the isthmus about 1.25 cm in height and width. The gland is usually larger in women, and increases in size in pregnancy. The thyroid gland is brownish red in colour due to high number of blood vessels.



Thyroid gland

Anatomy: At the microscopic level, there are three primary features of the thyroid gland-follicles, follicular cells and parafollicular cells.

1. **Follicles:** Thyroid gland is encased by a thin connective tissue capsule that enters the substance of the lobes to further subdivide the gland into irregular lobular units. Each labule contains a cluster of follicles, which are the structural and functional units of the thyroid gland – The follicle is surrounded by columnar, or cuboidal or squamous epithelial cells depending upon the level of activity of the follicle. When they are active they appear cuboidal to columnar but when they are inactive they are sqnamous. Follicular cells are responsible for producing Thyroglobulin (an iodine rich inactive form of the thyroid hormones), which is then stored as a semi-solid substance (Colloid) in the lumen of the follicles. They consist of a rim that has a rich blood supply, nerve and lymphatic presence.

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Follicular cells: When stimulated the follicular cells secrete the thyroid hormones T3 and T4. They do so by transporting and metabolising thyroglobulin contained in the colloid.

Parafollicular cells: Scattered among follicular cells and spaces between the spherical follicles are another type of thyroid cells, the parafollicular cells. These cells secrete the hormone, Thyroalcitionin (calcitonin)

Functions of Thyroid gland:

The normal thyroid produces about 80% T4 (Tetra-iodothyronin) and about 20% T3 (Tri-iodothyronin), however, T3 possesses about four times the hormone strength as T4.

The thyroid hormones main functions include:

1. **Metabolic:** The thyroid hormones increase the basal metabolic rate (BMR) and have effect on almost all body tissues. They increase the absorption in the gut generation, uptake by cells, and breakdown of glucose.
2. **Cardiovascular:** The hormones increase the rate and strength of the heartbeat.
3. **Development:** Thyroid hormones are important for normal development. They increase the growth rate of the young people, and cells of the developing brain are a major target of T3 and T4.
4. The thyroid hormones also play a role in maintaining normal sexual function, sleep, and thought patterns, and menstrual cycle in adult females.

19. **2074 Set B Q.No. 2b Discuss about the hormones secreted by thyroid gland.** [3]

Please refer to 2074 Set A Q.No. 2g

20. **2074 Set B Q.No. 2g Write down the differences between sympathetic and parasympathetic nervous system.** [3]

Please refer to 2076 Set C Q. No. 2e

21. **2073 Supp Q.No. 2c Give a brief account of the action of different proteolytic enzymes.** [3]

Proteloytic enzyme, also known as protease, proteinase or peptidase, any of a group of enzymes that break the long chain like molecules of protein into shorter fragments (peptides) and eventually into their components amino acids.

Here are different types of proteolytic enzymes, which are classified according to sites at which they catalize the cleavage of protein.

The action of proteolytic enzymes in the digestive tract is described as below:

1. **Action of Proteolytic Enzymes in the Stomach:** During digestion, when the food reaches the stomach, the gastric gland becomes stimulated and secretes gastric juice, which contains various enzymes that digest the food. Among them is initially released an inactive proenzyme or precursor, the pepsinogen. Pepsinogen is converted to active pepsin by hydrochloric acid (HCl) secreted by the oxyntic cells of gastric gland. Pepsin cleaves protein into proteoses and peptones.

Pespsinogen $\xrightarrow{HCl}$ Pepsin (Active)

Proteins $\xrightarrow{Pepsin}$ proteoses and peptones

In the stomach of infants, proteolytic enzyme called Rennin or Chymosin digests the milk protein. It is secreted as prorennin which is converted to rennin by HCl. In presence of calcium, rennin coverts the casein of mik into paracasien. The paracasein is converted to proteoses and peptones by the action of pepsin.

Prorennin (Inactive) $\xrightarrow{HCl}$ Rennin (Active)

Casein (Milk protein) $\xrightarrow{Rennin}$ Paracasein

Paracasein + Ca^{++} $\longrightarrow$ Calcium paracaseinate

Cal. Paracaseinate $\xrightarrow{Pepsin}$ Proteoses and peptones

2. **Action of Proteolytic Enzymes in Small Intestine:** The pancreatic juice contains proteolytic proenzyme or precursors such as Trypsinogen, Chymotrypsinogen, Proelastase and Procarboxypeptidase.

i. Trypsinogen is transformed to an edopeptidase called Trypsin by an enzyme called Enterokinase secreted from the walls of small intestine. Trypsin converts proteoses and peptones or ploypeptides into amino acids and some to tripeptides and dipeptides.

∴ Trypsinogen (inactive) $\xrightarrow{\text{Enterokinase}}$ Trypsin (Active)

∴ Proteins, proteoses, peptones or polypeptides $\xrightarrow{\text{Trypsin}}$ amino acids + Tripeptides + Dipeptides

The Trypsin also converts the precursors like chymotrypsinogen, proelastase and procarboxypeptidase into their active forms.

ii. The chymotrypsinogen is converted into active chymotrypsin by the help of Trypsin.

∴ Chymotrypsinogen (Inactive) $\xrightarrow{\text{Trypsin}}$ Chymotrypsin (Active)

The chymotrypsin converts the proteins and polypeptides into amino acid, Tripeptides and dipeptides.

∴ Protein, Proteoses, Peptones, Polypeptidase $\xrightarrow{\text{Chymotrypsin}}$ Amino acid + Tripeptides + dipeptides.

iii. Proelastase is converted to elastase by the action of trypsin. The elastase converts the elastin protein to ploypeptides and dipeptides.

∴ Proelastase (Inactive) $\xrightarrow{\text{Trypsin}}$ Elastase (Active)

∴ Elastin $\xrightarrow{\text{Elastase}}$ Polypeptides $\xrightarrow{\text{Elastase}}$ di-peptides.

iv. Procarboxypeptidase is transformed into carboxypeptidase A and B with the help of Trypsin. The carboxypeptidase A and B convert polypeptides to small peptides and amino acids.

∴ Procarboxypeptidase $\xrightarrow{\text{Trypsin}}$ Carboxypeptidase A and B

∴ Polypeptides $\xrightarrow{\text{Carboxypeptidase A and B}}$ small peptides + amino acids.

3. **Action of Proteolytic Enzymes of Intestinal juice:** The final step of protein digestion occurs in the ileum by the action of intestinal juice or succus entericus secreted by the intestinal gland. The intestinal juice contains proteolytic enzymes such as amino peptidase and dipeptidase.

i. Aminopeptidase converts remaining plypeptides to small peptides and free amino acids.

∴ Polypeptides $\xrightarrow{\text{Aminoepeptidase}}$ small peptides + Amino acids.

ii. Dipeptidase transforms di-peptides into amino acids.

∴ Di- peptides $\xrightarrow{\text{Di - peptidase}}$ Amino acids.

iii. Tripeptiase Cleaves tri-peptides into amino acids.

∴ Tri- peptides $\xrightarrow{\text{Tri - peptidase}}$ Amino acids.

These are all about the actions of proteloytic enzymes in the digestive tract.

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22. **2073 Supp Q.No. 2d Explain the functions of medulla oblongata.** [3]

The medulla oblongata is the most important part of the brain. One would not be able to live without medulla oblongata because of the myriad of crucial task it performs including regulating blood pressure and breathing. It is the portion of the hindbrain and lower most part of the brainstem. It sits below the pons and above the spinal cord and is a major relay point for information going to and form the brain and spinal cord.

The functions of medulla oblongata refer to several functions of the autonomous nervous system (ANS) which include:

1. **The control of venlitation:** Via signals form the carotid and aortic bodies. Respiration is regulated by groups of chemoreceptors. These sensors detect changes in the acidity of the blood, thus if the blood is considered too acidic, the medulla oblongata releases electrical signals which are sent to intercostal and phrenic muscle tissue increasing their contraction rate in order to reoxygenate the blood.

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2. **Cardiovascular centre:** Medulla regulates the rate of heartbeat
3. **Vasomotor centre:** Medulla regulates blood pressure and other homeostatic processes.
4. **Reflex centre:** Medulla is the reflex centre of vomiting, coughing, sneezing and swallowing.

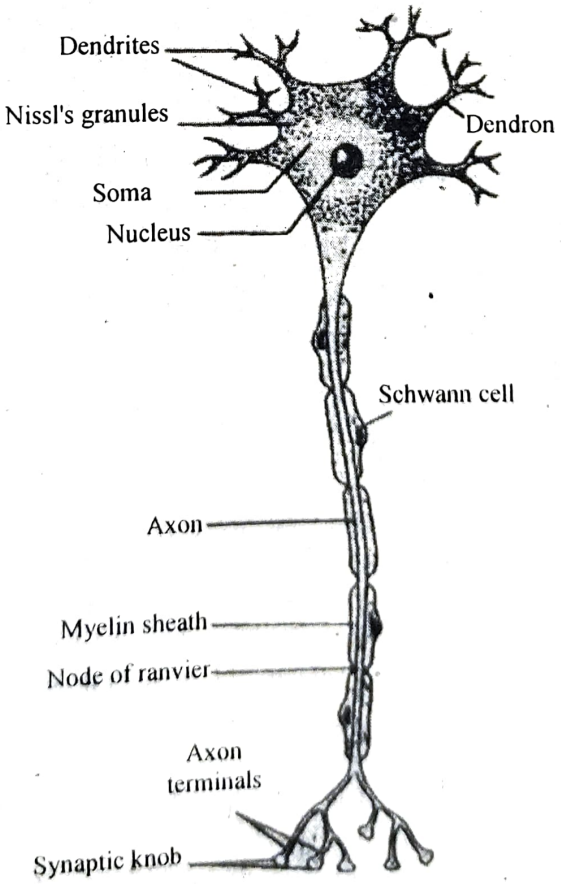
23. **2073 Set C Q.No. 2c Write short note on Natural Pacemaker.** [3]

The natural pacemaker of the heart is the sinus node, one of the major elements in the cardiac conduction system, the system that controls the heart rate. This stunningly designed system generates electrical impulses and conducts them throughout the muscles of the heart. Stimulating the heart to contract and pump the blood as necessary. The sinus node consists of a cluster of cells that are situated in the upper part of the wall of the right atrium near the entrance of superior venacava. The electrical impulses are generated here. The sinus node is also called sinu-atrial/auricular node or, for short, the SA node. The electrical signal generated by the SA node moves from the cell to cell down through the heart until it reaches the atrio-ventricular node (AVnode),a cluster of cells situated in the centre of the heart between the atria/auricles and ventricles. The AV node checks the signal and sends it through the muscle fibres of the ventricles, causing them to contract. The SA node sends electrical impulses at a certain rate, but the heart rate may still change depending upon physical demands, stress, or normal factors. Sometimes the SA node does not work properly, causing the heart to beat too fast, too slow or irregularly. In other cases, the heart's electrical pathways are blocked, which can cause an irregular heart rhythm. The autonomic nervous system controls the firing of the SA node to trigger the start of the cardiac cycle. The autonomic nervous system can transmit a message quickly to the sinus node or SA node. So it in turn can increase the heart rate to twice the normal within 3 to 5 seconds. The quick response is important during exercise when the heart has to increase its beating speed to keep up with the body's increase demand for oxygen.

24. **2073 Set C Q.No. 2d Explain ovarian cycle.** [3]

Please refer to 2075 GIE Q. No. 2c

25. **2073 Set D Q.No. 2c Draw a neatly labelled diagram of a neuron.** [3]



Structure of Neuron

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26. 2073 Set D Q.No. 2d **Differentiate between Hyperthyroidism and Hypothyroidism.** [3]

The differences between Hyperthyroidism and Hypothyroidism are follow:

Hypothyroidism	Hyperthyroidism
The thyroid gland does not make enough thyroid hormone for the body needs.	This condition occurs when thyroid gland produces too much of its hormone i.e. Thyroxine.
The thyroid gland is underactive.	The thyroid gland is overactive.
The whole body metabolism slows down. e.g. The intestinal tracts becomes sluggish and less production of heat.	All the body functions tend to speed up like a racing car. i.e., fast metabolism.
The heart rate is slower than the normal i.e., Brady-cardia	Elevated heart rate and palpitations i.e., Tachy-cardia.
Fatigue or tiredness is experienced. Depression is observed.	Anxiety as opposed to depression is observed.
Lack of appetite.	Increased appetite.
Less dangerous than hyperthyroidism.	More dangerous than hypothyroidism.

27. 2072 Supp. Q.No. 2a **Describe Haversian Canal System.** [3]

The Haversian Canal system or simply Haversian system (Name after British Physician Clopton Havers, 1657-1702) or osteon is the faundamental functional unit of a compact bone comprising a Haversian Canal and its concentrically arranged lamellae, Osteons are roughly cylindrical structures that are typically several millimeters long and around 0.2 mm in diameter. They are present in many bones of most mammals, some birds, reptiles and amphibian species. Osteons tend to run parallel to the long axis of a bone.

Osteons are formations characteristic of mature bone and take shape during the process of bone remodeling or renewal. New bone may also take this structure as it forms in which case the structure is called primary osteon. The process of formation of osteons and their accompanying Haversian Canal begins when immature woven bone and primary osteons are destroyed by large cells called osteclasts, which hollow out a channel through the bone, usually following existing blood vessels. Layers of bone forming cells or osteoblasts, follow the osteoclasts and lay down new bone on the sides of the channel, the layer of bone, built up in this way slowly narrow the channel until a tunnel not much larger than a central blood vessel remains. The blood supply for the osteocycles then passes through these channel, the Haversian's Canal. The space between adjacent osteons are filled with interstitial lamellae, layers of bone that are often remnants of previous Haversian systems. Transverse vessels, which run perpendicular to the long axis of the cortex, are called Vokmann's canals. Volkmann's canal connects adjacent osteons and also connect the blood vessels of the Haversian Canals with the periosteum, the tissue covering the bone's outer surface. Each Haversian canal is surrounded by varying number (5-20) of concentrically arranged lamellae of bone matrix. Near the surface of the compact bone, the lamellae (singular –lamella) are arranged parallel to the surface, these are called circumferential lamellae. Some of the osteoblast develop into osteocytes, each living within its own space, the lacuna.

Osteocytes make contact with the cytoplasmic processes of their counterparts. via a network of small transverse canals. The canaliculi (singular – canaliculus). This network facilitates the exchange of nutrients and metabolic waste.

28. 2072 Supp. Q.No. 2b **Discuss the action of proteolytic enzymes.** [3]

Please refer to 2073 Supp Q.No. 2c

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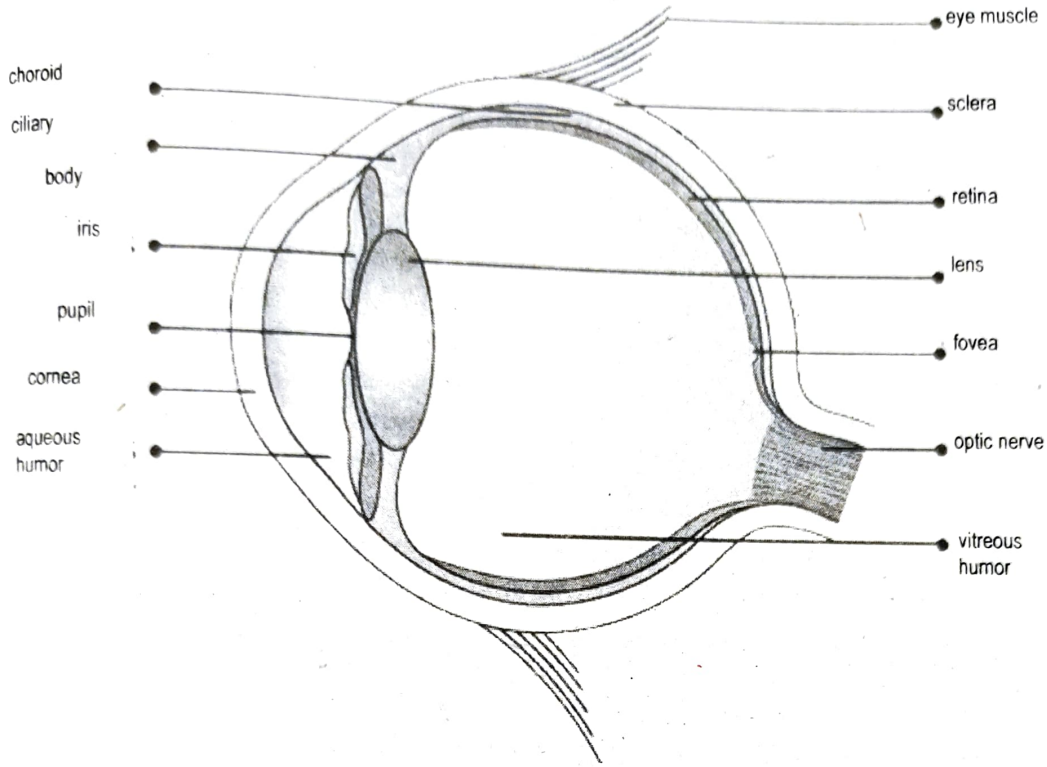
29. **2072 Supp. Q.No. 2e Draw a neat and labelled diagram of section of eye (No. description is required)** [3]



V.S. of Human eye

30. **2072 Set C Q.No. 2d Describe the structure and function of cochlea.** [3]

The cochlea is the main structure of the human auditory system. It is not actually an organ itself, but a bony structure in the inner ear.

Structure of cochlea: Cochlea is a fluid-filled spirally coiled bony tubes about 20-30 mm long. In human, the cochlea makes 2.5 turns around its axis.

When cut in T.S., the cochlea show three chambers or scalae separated by two thin membrane. The Reissner's membrane separates the scala vestibuli from scala media and basilar membrane separate scala tympani form sacla media.

1. **Upper scala vestibule** – It is the upper chamber of cochlea and is connected to the tympanic cavity through fenestra ovalis. It is filled with a specific fluid called perilymph, which has high concentration of sodium ions.
2. **Lower Scala Tympani** – It is the lower chamber of cochlea which communicates with the middle ear through fenstra rotunda i.e. round window. It is also filled with perilymph.
3. **Scala Media** – It is the middle chamber of cochlear duct. It is filled with a specific fluid called endolymph which has high concentration of potassium ions and secreted by the cochlea itself.

The basilar membrane is a mechanically somewhat stiff membrane, supporting the receptor organ of hearing, the organ of corti, and determines the mechanical wave propagation properties of the cochlear system. The organ of corti is the sensory epithelium, a cellular layer on the basilar membrane, in which sensory hair calls are powered by the potential differences between the perilymph and the endolymph. The organ of corti is formed of 54000 receptor or sensory auditory cells. The hairs present in the sensory cells in the organ of corti is called stereocilia.

Function of cochlea: The cochlea is the auditory centre of the inner ear, that translates the vibrations of the auditory sound into impulses the brain can understand.

31. **2072 Set C Q.No. 2e Mention the functions of fat soluble vitamins.** [3]

Please refer to Model (Zoology) Q.No. 2d

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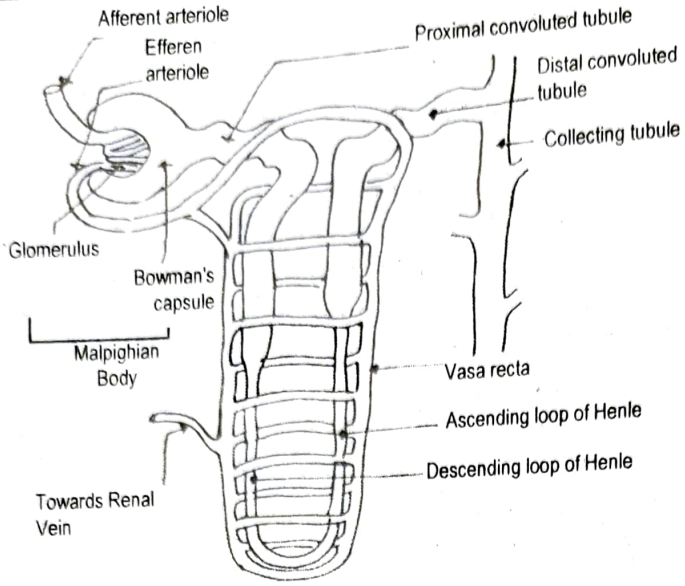
32. **2072 Set C Q.No. 2f** **Draw a neatly labelled sketch of a nephron. (No description required)** [3]



Structure of Nephron

33. **2072 Set D Q.No. 2a** **Mechanism of hearing.** [3]

➢ Please refer to 2074 Set A Q.No. 2f

34. **2072 Set D Q.No. 2c** **The sources and functions of vitamin A.** [3]

➢ **The Sources of Vitamin A (Retinol) is listed as follows;**

Vitamin A is available in food in two forms:

i. The vitamin A form found in food that come from animal is retinol, which is also called preformed Vitamin A, a yellow fat-soluble vitamin, and the precursor to the most active form of vitamin A (Retinoic Acid) used in the body. Vitamin A from animal sources are liver, milk, butter, cheese, whole egg, cream, cod liver oil, kidney, etc.

ii. The vitamin A form found in fruits and vegetable is called 'Provitamin A carotenoid'. The most common type of Pro-viamin A is Beta-carotene.

Sources of Beta-carotene include:

- Bright yellow and orange fruits such as cantaloupe, pink grape fruit and apricots.
- Vegetables such as carrots, pumpkin, sweet potatoes, and winter squash.
- Other sources are broccoli, spinach and most dark green, leafly vegetables.

The Functions of Vitamin A are as follows:

i. **Vision:** The most well known role of vitamin A is vision. Retinol is transported to the retina, located at the back of the eye, where it is oxidized to retinal. When needed, retinal can be transported to the rod cells (Photoreceptors) where it binds to a protein called opsin to form the visual pigment 'rhodopsin'.

ii. **Regulation of gene expression:** Once retinol has been taken up by a cell it can be oxidized to retinal, which can be oxidized to retinoic acid. Retinoic acid can bind to different nuclear receptor to initiate or inhibit gene expression.

iii. **Normal functioning of immune system:** Retinol is necessary to maintain integrity and function of skin and mucosal cell (lining of airways, digestive and urinary tract), acting as a barrier and forming the body's first line of defense against infection.

iv. **Embryonic development:** During fetal development, it functions in limb development and formation of the heart, eyes and ears.

v. Vitamin A is required for normal development of precursor cells (stem cells) into red blood cells.

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5. **2072 Set D Q.No. 2d The pancreas as Heterocrine gland.** [3]

The pancreas is classified as heterocrine gland because it contains both endocrine and exocrine glandular tissue.

Exocrine part: The exocrine tissue makes up about 99% of the pancreas by weight. The exocrine tissue is arranged into small masses known as pancreatic lobules or acini (singular – acinus). Acini are small raspberry – like clusters of exocrine cells that surround tiny ducts. The exocrine cells in the acini produces pancreatic juice which contains digestive enzymes, that enter the duct. The ducts of many acini run into the larger pancreatic duct. The pancreatic duct pours digestive enzymes into the duodenum. Just before entering the duodenum the pancreatic duct joins with the common bile duct coming from the liver to form a hepato-pancreatic duct.

ii. **Endocrine part:** The endocrine tissue makes up 1% of the pancreas by weight. The endocrine portion is made of small bundles of cells called Islets of Langerhans or Pancreatic Islets. (Named after German pathologist anotmist Pal Langerhans, 1869). There are about one million islets distributed throughout the pancreas of a healthy human. Hormones produced by these islets are directly poured into the blood by four types of cell.

- Alpha cells producing glucagon (20% of total islet cells)
- Beta cells producing insulin (70%)
- Delta cells producing somatostatin (< 10%)
- PP cells (gamma cells) producing pancreatic polypeptide (< 5%)

Role **as heterocrine gland**

a. Role **as exocrine gland:** The pancreatic acini secretes pancreatic juice. The pancreatic juice is strongly alkaline (PH_8). It consists of water, mineral salts and several enzyme which are as follows.

i. Trypsin
ii. Chymotryypsin
iii. Peptidases
iv. Amylase
v. Pancreatic lipase or steápsin
vi. Sucrase
vii. Maltase
viii. Lactase
ix. Ribo and deoxyribonucleases

b. Role as **endocrine gland:** The islets of largerhan secrete pancreatic hormones. The main function of the pancreatic hormones is to maintain blood glucose level. Glucagon increases blood glucose level while insulin decreases blood glucose level. They have antagonist actions. The normal blood glucose level is 45mg to 95 mg /100 ml of blood.

36. **2072 Set D Q.No. 2e Differentiate between sympathetic and parasympathetic nervous system.** [3]

Please refer to 2076 Set C Q. No. 2e

37. **2072 Set E Q.No. 2a Role of fats in body.** [3]

Role of fats in the body is described below:

i. **As a source of energy:** Although the main source of energy for the body is carbohydrate, fat is used as a source of backup energy in cases when carbohydrates are not available. Fat is a concentrated energy source. One gram of fat has 9 calories, which is more than double the amount of calories from carbohydrate and protein. Based on an 1800- calorie diet, this recommendation amounts to 40 to 70 daily grams of fat.

ii. **Vitamin Absorption:** Some types of vitamins rely on fat for absorption and storage. Fat –soluble vitamins such as vitamins A, D, E and K can not function without adequate daily fat intake. These vitamins are essential parts of our daily diet.

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iii. **As reserve food material:** The excess calories after consumption are stored for future use in special fat cells, (adipose tissue) under the skin as subcutaneous fat. In hibernating animals, the store fats provide energy.

iv. **Insulation:** Fat cells, stored in adipose tissue, is designed to insulate the body keeping heat inside and therefore, helping us maintain the proper body temperature. In addition to insulating, the fat layer protect the inner core from extreme temperature changes. This is because when the skin temperature significantly drop, the fat deposit will generate and then release heat which helps increase the temperature.

v. **Protection:** The fat layer that is surrounding the major organs such as the brain, the heart, nerves, tissues and bones are designed to act like a protective cushion. During a sudden impact or even trauma, the fat layer will absorb as much as the shock as it can so it can protect these essential organs and structures from being significantly damaged.

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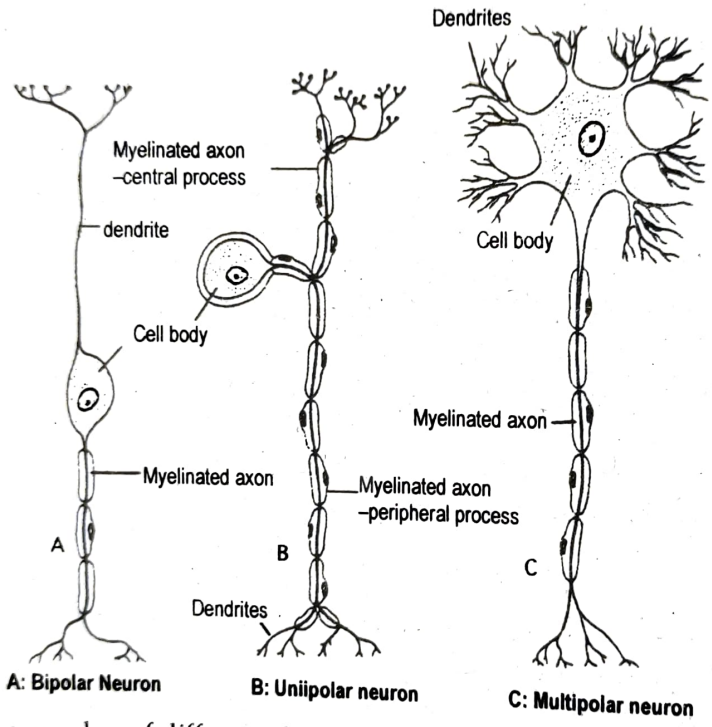
38. 2072 Set E Q.No. 2b **Types of neurons.** [3]

Neurons are the structural and functional units of the nervous system.



Neurons exist in a number of different shapes and sizes and can be classified by their morphology and function.

The neurons are classified in two ways:

I. **Structural classification – Types on the basis of structure:** On the basis of structure, neurons are of three types, which are as follows:

1. **Unipolar Neuron:** The neuron which has only protoplasmic process extending from the cell body is called unipolar neuron. Unipolar neurons are common in insects.
2. **Bipolar Neuron:** Neurons that have two cytoplasmic extensions attached to their cell body or cyton or soma are structurally classified as bipolar. One process serves as the axon and the other as the dendrite. Both processes often have many smaller branches.
   Bipolar neurons are found in the retina of the eye, root of the nasal cavity, and inner ear. These neurons are the part of the sensory pathways for smell, sight, taste, hearing, and vestibular functions.
3. **Multipolar Neuron:** A multipolar neuron is a a type of neuron that possesses a single axon and many dendrites allowing for the integration of a great deal of information from other neurons. The processes are projected from the cell body. Multipolar neurons constitute the

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majority of neurons in the central nervous system.

Functional classification of Neuron: Based on function, the neurons are classified into three types.

1. **Sensory or afferent neurons:** Sensory neurons are unipolar, bipolar or multipolar neurons that conduct impulse form receptors (e.g. eyes, ears, mouth and nose) to the brain and spinal cord.
2. **Motor or efferent neurons:** Motor neurons are nerve cells that carry information from the central nervous system (brain and spinal cord) to muscles and organs throughout the body.
3. **Interneurons:** Interneuron is a neuron found between the primary afferent neuron and the final motor neuron. They have processes which are entirely confined within a specific area as within the olfactory lobe.

39. **2072 Set E Q.No. 2e The pancreas as compound gland.** [3]

Please refer to 2072 Set D Q.No. 2d

40. **2072 Set E Q.No. 2f The menstrual cycle.** [3]

Please refer to 2075 GIE Q. No. 2c

41. **2071 Supp. Q.No. 1c Role of diaphragm in respiration.** [3]

Thoracic diaphragm or simply diaphragm is sheet of internal skeletal muscle that extends across the bottom of the thoracic cavity. The diaphragm separates the thoracic cavity from the abdominal cavity. Diaphragm performs an important function in respiration. As the diaphragm contract the volume of the thoracic cavity increase and the air is drawn into the lungs. Diaphragm is dome shaped and attached to the base of the sternum, the lower part of the rib cage, and the spine. The lungs are enclosed in the rib cage from the sides and diaphragm from the bottom.

The lungs do not have ability to expand or relax on their own. In order to pump air in and out of the lungs the rib cage and the diaphragm work together to expand and contract the thoracic cavity, causing the lungs to expand and contract. The diaphragm does the vast majority of the breathing work.

The diaphragm is under involuntary control. The diaphragm is the main respiratory muscles that allow us to inhale and exhale. This is done by the contraction and relaxation of the muscle creating a vacuum that sucks air into the lungs through the mouth and noses.

During inhalation or inspiration, the diaphragm contracts and flattens out resulting in the decreased air pressure in the thoracic cavity. When the air pressure falls, air will rush into the respiratory tract and finally into the lungs.

When we are ready to exhale the air back out, the diaphragm will relax and go back to its normal dome shape, thereby pushing up on the bottom of the lungs. The pushing of the bottom of the lungs forces the air back out of the lung causing us to exhale.

This is how the diaphragm normally functions.

42. **2071 Supp. Q.No. 1d What are islets of Langerhan's, name the cells involved with them and give their functions.** [3]

Islets of Langerhans are the endocrine part of the heterocrine pancreas. They are also called pancreatic islets. The normal human pancreas consist of about 1 million islets. The islets of Langerhans constitute 1 to 2% of the pancreatic volume. The combined mass of the islets is 2 grams. These islets are irregularly shaped patches of endocrine tissue and are scattered throughout the pancreas. The islets are surrounded by blood vessels. The islets are spherical in shape and consists of four major types of endocrine cells which produces hormones.

The cells present in the islets of Langerhans are as follows:

i. Alpha cells or α - cells making up to 20% of the cell of the endocrine part of pancreas. α-cells secretes the hormone glucagon.

ii. Beta cells or β-cells making up 65% to 70% of the cells in the islets of Langerhans. These cells produce insulin hormone.

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iii. Delta cells or δ-cells constituting less than 10% of the cells of pancreatic islet. δ-cells produce the hormone somatostatin.

iv. PP cells or gamma cells contributing less than 5% of the cells of islets. They release pancreatic polypeptides.

1. **Functions of Beta cell and its hormone:** The main function of Beta cell is to produce hormone insulin. Insulin controls the blood glucose level in human body thus preventing hyperglycemia. When there is excess glucose in the blood stream. Insulin encourages the storage of glucose as glycogen in the liver, muscles and fat cells. The process of conversion of glucose into glycogen is called glycogenesis.

2. **Functions of Alpha cell and its hormone:** The function of Alpha cells is to produce the hormone, glucagon. The main function of glucagon is to prevent the blood glucose levels dropping too low in the body. To do this, it acts on the liver. It stimulates the conversion of stored glycogen (in the liver) to glucose which can be released into the bloodstream. This process is called glycogenolysis.

3. **Functions of Delta cell and its hormone:** The functions of delta cells is to produce somatostatin hormone. The pancreatic somatostatin inhibits the secretion of insulin and glucagon hormones.

4. **Functions of PP cells and its hormone:** The PP cells secretes the pancreatic polypeptide. It consists of 36 amino acids. Pancreatic polypeptide secretion in human is increased after a protein meal, fasting, exercise and acute hypoglycemia.

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43. **2071 Supp. Q.No. 1e Ear ossicles and their roles.** [3]

✎ Please refer to 2074 Supp Q.No. 2e

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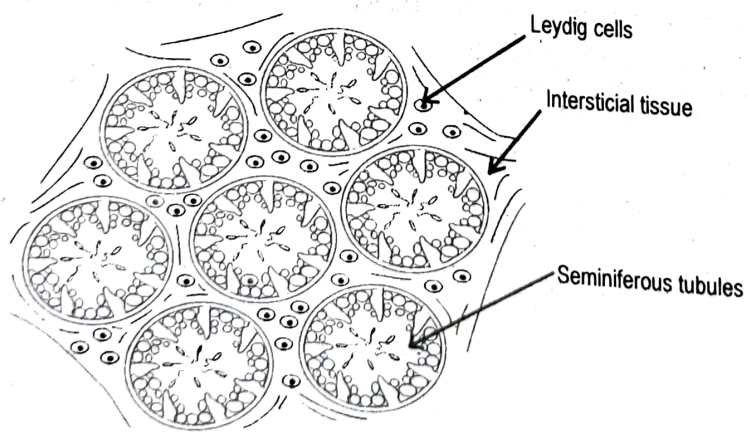
44. **2071 Supp. Q.No. 1f About the leydig cells.** [3]

✎ Leydig cells or interstitial cells are small groups of large polygonal found in the connective tissue present between the seminiferous tubules. Leydig cells are the endocrine part of the testis. Each cell has a large prominent nucleus, an eosinophilic cytoplasm and numerous lipid-filled vesicles. The cell consists of large number of smooth endoplasmic reticulum (SER) and scattered patches of rough endoplasm reticulumic (RER). Several mitochondria are also found in the cytoplasm.

Leydig cells secrete androgens the male sex hormone. Testosterone is one of the many androgenic hormones. The other hormone is dehydrotestosterone (DHT).

In male, the Interstitial Cells Stimulating Hormone (ICSH), or luteinizing hormone (LH) stimulates the Leydig cells of the testis to produce male sex hormones.

The functions of testosterone are given below:



1. Testosterone initiates the development of the male internal and external reproductive organs during foetal development.
2. The androgens are responsible for the maturation of seminiferous tubules and production of sperm.
3. Androgens like testosterone in boys are responsible for the development of secondary sexual characters like the growth of hair on face, chest, abdomen and pubis. It also initiates the enlargement of the larynx and deepening of the voice in male. Low testosterone in male causes a decrease in sex drive, reduced sperm count, poor erections and enlarged breast.

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45. **2071 Set C Q.No. 2e Describe kidney as a homeostatic organ.** [3]

The kidneys are responsible for maintaining homeostasis by following ways:

1. **Osmolarity regulation:** Osmolarity regulation means maintaining water and salt level of the body. This regulation is brought about by changing the permeability of distal convoluted tubules and collecting ducts. The change in permeability is affected by antidiuretic hormone (ADH) or vasopressin released from the posterior lobe of the pituitary. When the amount of water decreases in the blood plasma, it stimulates the secretion of ADH and more water is reabsorbed from the filtrate in the collecting duct. In contrast, when the amount of water increases, it inhibits the secretion of ADH and so, less water is absorbed from the filtrate.

Regulation of different salts in the blood is under the influence of aldosterone hormone of the adrenal cortex. When there is decrease in the sodium concentration in the blood, the aldosterone makes the wall of the renal tubule and collecting duct highly permeable to sodium, potassium and chloride ion. As a result, all Na^+, K^+ and Cl^- ions are reabsorbed from the filtrate into the blood.

2. **Excretion of wastes:** The kidneys excrete a variety of waste product produced by metabolism into the urine. These include the nitrogenous wastes urea from protein catabolism and uric acid from nucleic acid metabolism.

3. **Reabsorption of vital nutrients:** Vital macromolecules such as glucose and amino acids are reabsorbed in the proximal tubule of the kidney.

4. **Acid - base homeostasis:** The kidneys play two important roles in maintaining the acid-base balance: to reabsorb and regenerate bicarbonate from urine, and to excrete hydrogen ions into the urine. The kidneys excrete non-volatile acids, such as lactic acids, ketones, sulphuric acid, etc.

5. **Blood pressure regulation:** Although the kidneys cannot directly sense blood, long-term reugalation of blood pressure depends upon the kidney. This primarily occurs through maintenance of the extracellular fluid compartment, the size of which depends on the plasma sodium concentration.

6. **Production of Hormones:** The kidneys secrete a variety of hormones; including erythropoietin, and the enzyme renin. The erythropoietin stimulates the bone marrow for the production of red blood cells or erythrocytes (i.e. process called erythropoiesis).

46. **2071 Set D Q.No. 2c What is vitamin? Mention the functions of fat soluble vitamins.** [3]

Please refer to Model (Zoology) Q.No. 2d

47. **2071 Set D Q.No. 2d Draw a well labelled diagram of internal structure of kidney.** [3]

Please refer to Model (Zoology) Q.No. 2e

48. **2070 Supp. Q.No. 2c An artificial respiration.** [3]

Artificial Respiration is defined as the process of forcing air into the lungs of a person who has stopped breathing by blowing into their mouth or nose in order to make them start breathing again. Artificial respiration can save a life whenever breathing has stopped but heartbeat has not, as in near-drowning, electric shock, choking, gas poisoning, drug poisoning, injury to the chest, or suffocation from other causes. It is also administered along with other procedures in cases of cardiac arrest.

To be effective, artificial respiration must be begun immediately. At the same time artificial respiration has begun someone should call for emergency medical assistance. Any obstruction must be removed from the victim's mouth that would interfere with the passage of air, such as mud, sand, chewing gum, or displaced false teeth. Once begun, artificial respiration should be continued until the victim begins to breathe regularly by himself/herself.

It is reported that victims have recovered as long as four hours after artificial respiration was started.

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Four types of artificial respiration are in medical use. They are as follows:

1. **Cardiopulmonary Resuscitation (CPR)**
   Cardiopulmonary resuscitation (CPR) is an emergency procedure that combines chest compressions often with artificial respiration in an effort to manually preserve intact brain function until further measures are taken to restore spontaneous blood circulation and breathing with breathing or abnormal breathing. CPR is applicable to adults, children and infant but not newborns.

   CPR can keep oxygenated blood flowing to the brain and other vital organs until more definitive medical treatment can restore a normal heart rhythm. When the heart stops, the lack of oxygenated blood can cause brain damage in only a few minutes. A person may die within eight to ten minutes.
2. **Mouth – to – Mouth Breathing:** Mouth – to – Mouth resuscitation is a part of most protocols performing CPR. In some case, mouth – to – mouth resuscitation is performed separately, for instance near drowning and opiate overdoses.
3. **Oxygen Therapy:** Oxygen therapy is a treatment that deliver oxygen gas for the patient to breathe. The victim receives oxygen therapy form tubes resting in the nose, a face mask, or a tube placed in the victim's trachea, or windpipe. This treatment increases the amount of oxygen the victim's lungs receive. Oxygen therapy may be prescribed when the patient's blood oxygen level goes too low. Low blood oxygen may make the person feel short of breath, tired or confused and can damage the body.
4. **Mechanical ventilation:** It can be used as a short – term measure for example during an operation or critical illness. The common method is by insertion of a tube into the trachea (i.e, tracheal intubation), which provides a clear route for the air. This can be either an endotracheal tube inserted through the natural openings of mouth or nose or a tracheostomy inserted through an artificial opening in the neck. Mechanical ventilators machines are used for this process. They may be transport ventilator's intensive – care ventilators, Neonatal ventilators or positive airway pressure ventilators (PAP).

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49. 2070 Supp. Q.No. 2d **Antagonistic effects of insulin and glucagon.** [5]

Maintaining homeostasis often requires conditions to be limited to a narrow range. When conditions exceed the upper limit of homeostasis, a specific action, usually the production of a hormone, is triggered. When conditions return to normal, hormone production is discontinued. If conditions exceeds the lower limit of homeostasis, a different action, usually the production of a second hormone, is triggered. Hormones that act to return body conditions to within acceptable limits form opposite extremes are called antagonist hormones.

The regulation of blood glucose concentration (through negative feedback) illustrates how the endocrine system maintains homeostasis by the action of antagonistic hormones. Bundles of cells in the pancreas called Islets of Langerhans contain two kind of cells, alpha cells and beta cells. These cells control blood glucose concentration by producing the antagonistic hormone insulin and glucagon. Beta cells of islets of Langerhans secrete the hormone insulin. When the concentration of blood glucose raises such in after eating, beta cells secrete insulin into the blood. Insulin stimulates the liver and most other body cells to absorb glucose. Liver and muscle cells convert glucose to glycogen. In response, glucose concentration decreased in the blood and insulin secretion discontinues through negative feedback from declining levels of glucose.

Alpha cells secrete glucagon when the concentration of blood glucose drops such as during exercise or fasting, alpha cells secrete glucagon into the blood. Glucagon stimulates the liver to release glycogen. The glucose in the liver originates from the breakdown of the glycogen. Glucagon also stimulates the production of ketone bodies from amino acids and fatty acids. Ketone bodies are an alternative energy source to glucose for normal, glucagon secretion discontinues through negative feedback.

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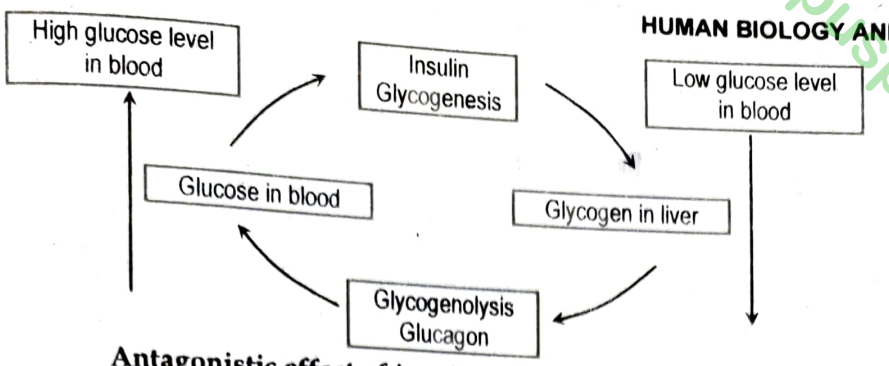

Antagonistic effect of insulin and glucagon in blood.

0. **2070 Supp. Q.No. 2e The role of iris in image formation.** **[3]**

The iris is the part of the eye and is located in front of the eye in its anterior compartment where it sits between the crystalline lens and the cornea. It is the diaphragm of the eye. The iris is the frontal extended modified part of the choroid, the middle layer of the eye. The iris is composed of two different types of smooth muscles: the outer circular muscles and the inner radial muscles. The muscles are arranged like the spokes of a bicycle wheel. In the center of iris is a round opening which is known as the pupil. The iris muscles regulate the size of the pupil either by dilating (widening) or constricting (narrowing) according to the intensity of light. The contraction of circular muscles reduces the size of the pupil and contraction of radial muscles widens the aperture of the pupil.

The pupil is under the control of autonomic nervous system (ANS). The sympathetic nervous system is responsible for the dilation of the pupil where as the constriction of pupil is controlled by parasympathetic nervous system.

During image formation, the iris provides the pathway early of light through it. The iris divides the space in between the cornea and the lens into two – the anterior chamber and the posterior chamber.

Human iris can be compared to the diaphragm of the camera and the pupil analogous to the aperture of the camera. The irises help in focusing on objects at different distances by a method called accommodation. The pupil size varies depending on which the eyes are focusing. It helps in keeping the image formed on the retina sharp.

The contraction and dilation of the pupil is related to the amount of light in the environment. At night, the muscles will dilate the pupil so there is sufficient light in the eye. When it is too bright outside, the pupil will contract to allow less light into the eyes and prevent damaging the retina.

51. **2070 Supp. Q.No. 2f About menopause.** **[3]**

Menopause is the time in all women's lives when menstrual periods stops permanently and is no longer able to get pregnant naturally. Menopause typically occurs between 45 to 55 years of age. Menopause occurs when a women has no any vaginal bleeding for a year. Menopause is usually a natural change and a result of aging.

Symptoms of menopause

Menopause occurs when periods stop. However, it is rare that monthly menstrual bleed ceases suddenly. Most commonly the menstrual cycle becomes irregular with a tendency towards heavy prolonged or painful periods. This usually marks the start of the first stage of the menopause and is known medically as peri-menopause.

Symptoms of the menopause can vary considerably form one person to the next. Common symptoms include:

A. **Physical Symptoms**

i. Hot flushes and night sweats – it is experienced by 80% of the women going through the menopause. This problem arises as changes in hormone levels upset the temperature regulating part of the brain. Hot flushes can be described as sudden feeling of warmth or heat in the body. Hot flushes are accompanied by night sweats or excessive sweating during the day.

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ii. Change in menstrual cycle – the menstrual cycles becomes irregular and finally ceases.
iii. Vaginal dryness and discomfort during sexual intercourse.
iv. Difficulty in sleeping or disturbed sleep.
v. Menopause headache
vi. Muscle and joint pain – e.g. Breast pain and back pain.
vii. Low mood, irritability and anxiety due to decreasing level of hormones, which affect the brain functions.
viii. Breast enlargement
ix. Heart palpitations
x. Digestive problem – Less able to function properly and bloating may be experience.

B. **Psychological symptoms**

Psychological symptoms include

i. Poor memory
ii. Depressive mood.
iii. Irritability
iv. Reduce sex drive (Libido)

Cause of Menopause:

i. Ageing – As the women grow in age the hormones decline and eggs are not produced by the ovaries.
ii. Known causes of premature ovarian failure include autoimmune disorder, thyroid diseases, diabetes mellitus, chemotherapy, genetic, radiotherapy, cancer of reproductive organs, cigarette smoking, higher body mass index, surgical removal of the ovaries or the removal of uterus.

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52. 2070 Set C Q.No. 2a **Describe the structure of a neuron.** [5]

Neuron or nerve cell is the structural and functional unit of the nervous system. In other words, any of the impulse – conducting cells that constitute the brain, spinal cord and the nerves in vertebrates are called neurons. Each neuron has two properties: excitability and conductivity. These cells are highly specialized cells that generate and transmit bio-electrical impulse from one part of the body to other.

There are about 100 billion neurons in human body. Neurons are the largest and longest cells in the body.

Neuron, once formed never die. It persists throughout one's life.

1. **Cell body or Cyton:** The cell body or Cyton has a star – shaped body covered by a cell membrane. It is also called Soma or Perikaryon. The cyton consists of fair concentration of cytoplasm and a centrally placed nucleus. The cell nucleus is a key feature of the soma. The nucleus contains genetic material (chromosomes) including information for cell development and synthesis of protein necessary for maintenance and survival.

It has all the cell organelles, which are as follows:

i. **Nucleus** – Produces ribosomes necessary for translation of genetic information into proteins.
ii. **Nissl Bodies** – They are large granular bodies composed of rough endoplasmic reticulum (RER) and free ribosomes. Nissl bodies are the most striking feature of neuron. It is responsible for protein synthesis.
iii. **Endoplasmic reticulum (ER)** – System of tubes for transport of materials within cytoplasm. They may have ribosomes (Rough ER) or no ribosomes (Smooth ER) With ribosome the ER is important for protein synthesis.
iv. **Golgi Apparatus** – Membrane bound structure important in packaging peptides and proteins (including neurotransmitters) into vesicles.
v. **Mitochondria** – Produce energy to fuel cellular activities. The cell body constitutes the grey matter of the brain and spinal cord. (In brain, it is located in the periphery while in the spinal cord it is located centrally.)

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Cytoplasmic extension or nerve processes: The cyton give rises to two types of fine cytoplamic extensions or nerve processes: They are (i) Dendron and dendrites and (ii) Axon.

Dendron and dendrites: The cyton gives off several larger sized fine branches called Dendron (i.e. trees). The dendrons break up into smaller fine branches called dendrites. They are afferent in nature i.e., dendrites act to propagate the electrochemical stimulation received from other neural cells to the cell body of the neuron. They have Nissl's bodies and neurofibrils.

Dendrites play a critical role in integrating the synaptic inputs and in determining the extent to which action potentials are produced by the neuron.

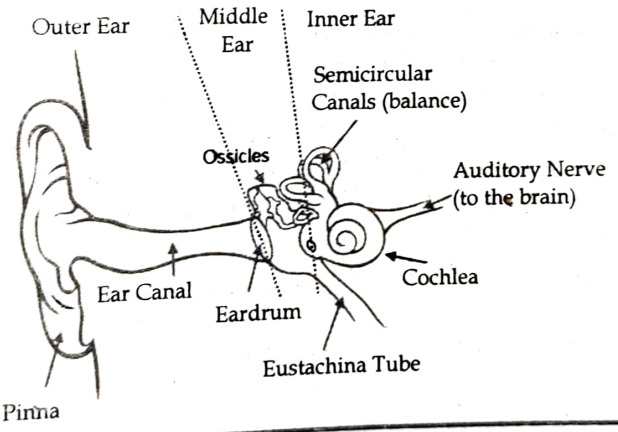
Axon: One of the protoplasmic extensions of the cyton becomes enlarged and long and unbranched to form an axon. It is long, single and cylindrical. The axon arises from the cell body at a specialized place called the axon hillock.

Axons are covered by a membrane known as axolemma. The cytoplasm of axon is called axoplasm. There are two types of axon in the peripheral nervous system and the central nervous system: a) Myelinated Axon and (b) Unmyelinated axon.

The myelinated axon consists of a myelin sheath, a layer of a fatty insulating substance, which is formed by two types of glial cells: Schwann cell ensheathing peripheral neurons and oligodendrocytes insulating those of the central nervous system. Along myelnated axon, gaps in the myelin sheath known as Nodes of Ranvier occur at evenly spaced intervals. The myelinaton enables and especially rapid mode of electrical impulse propagation called saltatory conduction. The myelin sheath acts as insulator.

The axon does not have Nissl's bodies and golgi apparatus. The axoplasm consists of large number of fine thread like neurofibrils.

53. 2070 Set C Q.No. 2d **Draw a neatly labelled sketch of human ear (No description is required).** [3]



54. 2070 Set D Q.No. 2a **Working mechanism of human eye.** [3]

The human eye is an organ which reacts to light and pressure. As a sense organ, the human eye allows vision. Human eyes help provide a three dimensional, moving image, normally cloloured in daily. The human eye can differentiate between about 10 million colours.

The eye works on the same principle as that of the camera. The light rays from the object pass through the conjunctiva cornea, aqueous humour, lens and vitreous humor in the order. All these structures refract the light such that it falls on the retina.

Light from the sun or an artificial light, travels in a straight line and enters the eye. Light is focused primarily by the cornea, the clear front surface of the eye, which acts like a camera lens.

The iris works like a shutter in a camera. It has the ability to enlarge and shrink, depending on how much light is entering the eye. The iris controls the amount of light reaching the back of the eye by automatically adjusting the size of the pupil, centre aperture of iris. This is to prevent damage to the eyes, by stopping too much light entering the eye when it is bright, and maximizing the amount of light entering the eye when it is dark.

The light then passes through the lens. The lens focuses light through the vitreous humor, a clear gel -like substance, that fills the back of the eye and supports the retina. The retina receives the

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image that the cornea focuses through the eye's internal lens. Depending on how far the object is the lens changes shape to keep the light focused on the retina. This is called accommodation. A fatter lens bends more light than a flatter lens. When a far object has to be looked, the light does not need to bend a lot to converge on the retina, so the suspensory ligaments pull the lens to make it flat. When a near object has to be looked the light has to bend more to converge on the retina, so the suspensory ligaments pull less, allowing the lens to become a fatter shape.

In retina, which sits at the back of the eye, is a thin layer of tissue that contains millions of tiny light sensing nerve cells. These nerve cells are rods and cones because of their distinct shapes.

Cones are concentrated in the centre of the retina, in an area called the macula. When there is bright light, cones provide clear, sharp central vision and detect colours and fine details.

Rods are located outside the macula and extend all the way to the outer edge of the retina. They provide peripheral or side vision. Rods also allow the eyes to detect motion and help us see in dim light and at night. The absorbed light activates the pigments present in the rods and cones. The pigments are present on the membranes of the vesicles. Thus, the light is then converted into action potentials in the membranes of the vesicles. These travel as nerve impulse through the rod and cone cells and reach the synaptic knobs. From there the impulses are transmitted to the bipolar neurons, and then to the ganglia and finally to the optic nerves. Thus the nerve impulse generated in the retina are carried to the brain by millions of neurons of the optic nerve. The vision is controlled by the occipital lobe at the back of the brain. The information received is processed and the person is able to see the image. The image formed on the retina is inverted. However, the brain corrects the image upright and real image is sensed.

55. **2070 Set D Q.No. 2c** **Differentiate between inspiration and expiration.** [3]

The two lungs are the primary organs of the respiratory system. The process of breathing (respiration) is divided into two distinct phases: inspiration (inhalation) and expiration (exhalation). The differences between inspiration and expiration are listed below:

Inspiration	Expiration
It is an active process	It is a passive process
Contraction of external intercoastal muscles and relaxation of internal intercoastal muscles occur.	Relaxation of external intercoatal muscles and contraction of internal intercoastal muscles occur.
Ribcage move forward and outward.	Ribcage move downward and inward.
Diaphragm contracts and becomes flattened.	Diaphragm relaxes and becomes original dome shaped.
Increase in the volume of thoracic cavity.	Decrease in the volume of thoracic cavity.
Air pressure in lung is less than atmospheric pressure.	Air pressure in lung is higher than atmospheric pressure.
Intake of air into lungs.	Expulsion of air form the lungs.
Oxygen is taken to lungs.	Carbondioxide is expelled through the nose.

56. **2070 Set D Q.No. 2e** **Natural pacemaker.** [3]

Please refer to 2073 Set C Q.No. 2c

57. **2069 Q.No. 2b** **Importance of vitamins.** [3]

Please refer to 2076 Set B Q. No. 2c

58. **2069 Q.No. 2c** **The role of graafian follicle.** [3]

Please refer to 2075 Set B Q.No. 2d

59. **2069 Q.No. 2d** **Exchange of gases in the lung.** [3]

Gas exchange is the delivery of oxygen from the lungs to the blood stream, and the elimination of carbondioxide from the blood stream to the lungs. Gas exchange is the part of respiration and is a biological process by which gases more passively by diffusion across a surface. It occurs in the lungs between the alveoli and a network of tiny blood vessels called capillaries, which are located in the walls of the alveoli. These alveoli provide a massive surface area through which gases can

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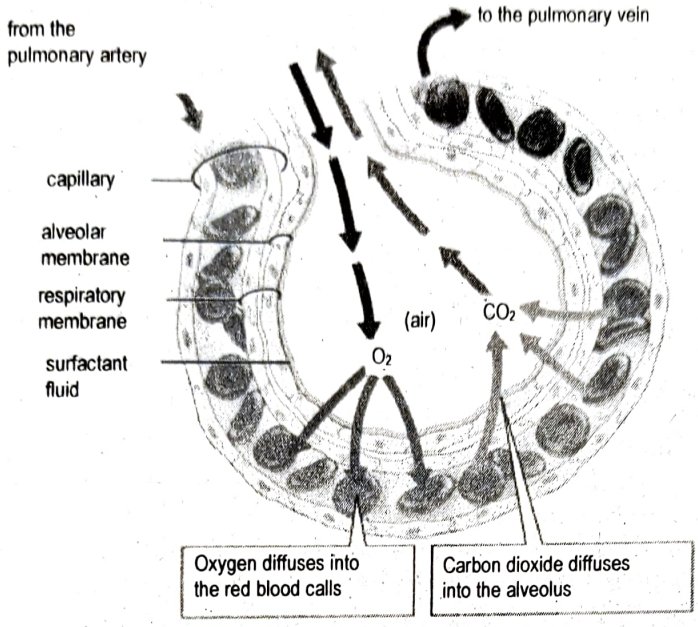
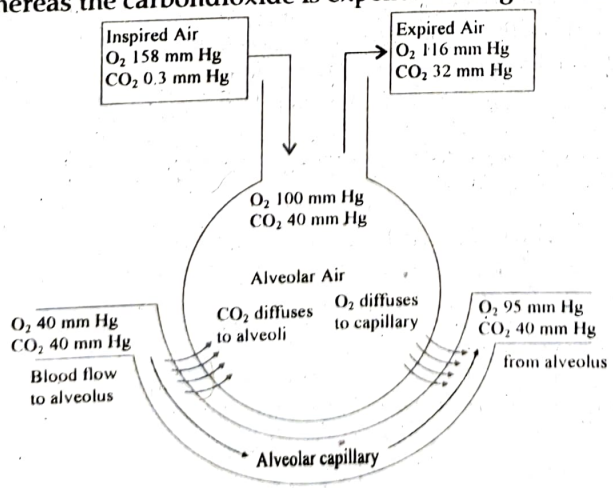
diffuse. These alveoli (singular –alveolus) are the structural and functional units of lungs. The alveoli are also called air sacs. These gases diffuse a very short distance between the alveolus and the blood because the lining of the lung and the capillary are both only one cell thick.



The exchange of gases in the lung is called pulmonary gas exchange or external respiration as it involves the respiratory processes that have contact with the external environment.

The oxygen and carbondioxide each have a partial pressure related to their concentration within the gas mixture. These individual pressures are termed partial pressure. Differences in the partial pressure between the gases in the alveoli and blood create a pressure gradient across the respiratory membrane (membrane separating the alveoli and blood capillaries).

Gases move from an area of high concentration (high pressure) to an area of low concentration (low pressure). The partial pressure of oxygen (PO_2) is about 100 mm Hg in the alveoli and 40 mm Hg in the alveolar capillary blood. The partial pressure of carbondioxide (PCO_2) is about 44 to 46 mm Hg in the alveoli and 47 mm Hg in the alveolar capillary blood. Therefore the oxygen diffuses from the alveoli to the capillary blood and carbondioxide diffuses from the capillary blood to the alveoli. The oxygen then binds to the haemoglobin of the red blood cells and transported to all the tissues and cells of the body whereas the carbondioxide is expelled through the nose.



Gases exchanges betweeen alveoli and blood capillary

60. **2068 Q.No. 2c Action of different proteolytic enzymes.** **[3]**

Please refer to 2073 Supp Q.No. 2c

61. 2068 Q.No. 2d **Give an account of adrenal cortex.** [3]

Adrenal cortex is a part of adrenal gland. Adrenal glands are two in number in each human being and they are the major endocrine glands.

The adrenal glands are two, triangular shaped organs that measure about 1.5 inches in height and 3 inches in length. Each adrenal gland weighs about 5 grams. They are located on top of each kidney. Their names are directly related to their locations (ad-near or at; reneskidneys). They are often referred to as supra-renal glands.

Histologically each adrenal gland is comprised of two distinct structures – outer part, the cortex and the inner part, the medulla.

The adrenal cortex is derived from the mesoderm, whereas the adrenal medulla is derived from the neural crest i.e., ectodermal in origin. The adrenal cortex is controlled by Adrenocorticotrophic Hormone (ACTH) secreted by the anterior lobe of pituitary gland.

The adrenal cortex is composed of smaller cells and comprises three zones or layers:

1. **Zona glomerulosa:** Zona glomerulosa of the adrenal gland is the most superficial layer of the adrenal cortex, lying directly beneath the renal capsule. Its cells are ovoid and arranged in clusters or arches. This part secretes mineralo corticoid hormones.
2. **Zona fasciculata:** Zona fasciculata constitutes the middle and also the widest zone of the adrenal cortex, sitting directly beneath the zona glomerulosa. The cells are arranged in bundles or fascicles. This layers secretes glucocorticoid hormones.
3. **Zona reticularis:** Zona reticularis is the innermost layer of the adrenal cortex lying deep to the zona fasciculata and superficial to adrenal medulla. The cells are arranged in chord-like fashion projecting indifferent directions giving a net like appearance. (Latin reticulum – net) this layer secretes sex-corticoid hormones.

62. 2068 Q.No. 2g **Differentiate between sympathetic and parasympathetic nerves.** [3]

Please refer to 2076 Set C Q. No. 2e

63. 2067 Q.No. 2d **Describe the function of liver.** [3]

The liver performs many essential functions related to digestion, metabolism, immunity and storage of nutrients within the body. These functions makes the liver a vital organ without which the tissues of the body would quickly dies from lack of energy and nutrients. Hence, liver is also known as the master laboratory of the body.

The various functions of liver are summarized as follows:

1. **Secretion of Bile:** The liver cells or hepatocytes synthesize bile. The bile juice is a dark green or golden yellow coloured alkaline fluid.
2. **Metabolism of carbohydrate, lipid, protein, vitamins and minerals:**
   i. **Glycogenesis** – Liver converts the excess of glucose into glycogen with the help of insulin hormone secreted by pancreas.
   ii. **Glycogenolysis** – It is the breakdown of glycogen into glucose molecules. It is done in presence of glucagon hormone of the pancreas, by the liver. It takes place when there is less glucose in blood. The combined action of glycogenesis and glycogenolysis maintains the sugar level in blood.
3. **Protective functions:** The Kupffer's cells of liver perform phagocytosis to eliminate foreign compounds.
   i. **Detoxification** – Liver converts the toxic substances into less toxic substances (e.g. Methylation).e.g. Drugs, poisons are detoxified.
   ii. **Phagocytosis** – Liver consists of kupffer's cells, which engulf harmful microorganisms and foreign materials.
   iii. **Excretion** – Liver helps to remove unwanted substances such as carbolic acid, indol, cresol, etc. from the blood coming from the alimentary canal.
4. **Production of RBCs** – Liver produces red blood cells in the foetus of animals.
5. **Production of blood clotting factors** – Liver synthesizes blood clotting factors or proteins like fibrinogen and prothrombin.
6. **Synthesis of anti-blood clotting factor** – Liver also produce anti-coagulant called heparin, which prevents blood clotting inside the body.

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7. **Destruction of RBCs** – The old red blood corpuscles are broken down in the liver cells. The non-functional haemoglobin is splitted into bile pigments- bilirubin and biliverdin.

64. **2067 Q.No. 2g Describe the role of pituitary gland in Endocrinology.** [3]

The pituitary gland is called the "Master gland" of the body because it secretes stimulating hormones which control the secretion of most of the endocrine glands of the body.

The role of pituitary gland is illustrated by the functions of different hormones produced by adenohypophysis and neurohypophysis.

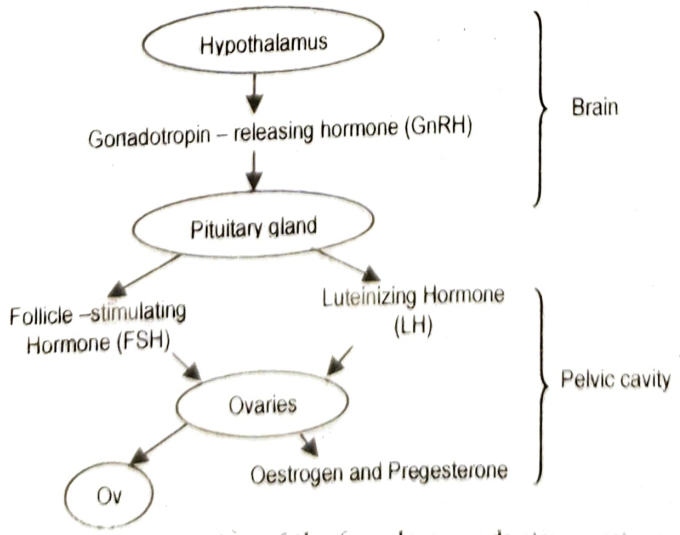
I. **Hormones of Adenohypophysis and their role:** Anterior pituitary or Adenohypophysis secretes six different hormones, which are as follows:

1. **Growth Hormone or Somatotropin Hormone (S.T.H.):** Growth hormone target various body cells. It stimulates the growth and division of body cells especially to that of bones and skeletal muscles.
2. **Thyroid stimulating Hormone or Thyrotropin:** Thyroid Stimulating Hormone (TSH) stimulates the thyroid gland to secrete the hormones tetraiodothyronin (T_4) or thyroxin and triiodothyronine (T_3)
3. **Adrenocorticotropic Hormone (ACTH):** ACTH stimulates the adrenal cortex to produce mineral corticoids, glucocorticoids and androgens.
4. **Gonadotropic Hormones (GTH):** These hormones control various activities of the gonads (i.e., testes and ovaries) and the sexual cycle. These are of two types: (i) Follicle stimulating Hormone (FSH), and (ii) Luteinizing Hormone (LH) or Interstitial cells Stimulating Hormone: In females, LH along with FSH is responsible for the final maturation of the ovarian follicles and ovulation. After ovulation, LH alone promotes the formation of corpus luteum and the secretion of another female sex hormone, the progesterone.
5. **Lactogenic Hormone (LTH) or Prolactin:** Prolactin, also known as luteotropic hormone or luteotropin, is a protein that is best known for its role in enabling mammalian females to produce milk. Prolactin targets the mammary gland.
6. **Melanocyte – Stimulating Hormone:** This hormone targets the melanocytes of the skin and the skin release melanin which is responsible for the colour of skin.

65. **2066 Q.No. 2c List the hormones required for proper functioning of male and female reproductive organs.** [3]

I. **List of hormones required for proper functioning of female reproductive organs are given below:**

1. Gonadotropin Releasing Hormone (GnRH)
2. Follicle Stimulating Hormone (FSH)
3. Luiteinizing Hormone (LH)
4. Oestrogen
5. Progesterone



Hormonal regulation of the female reproductive system.

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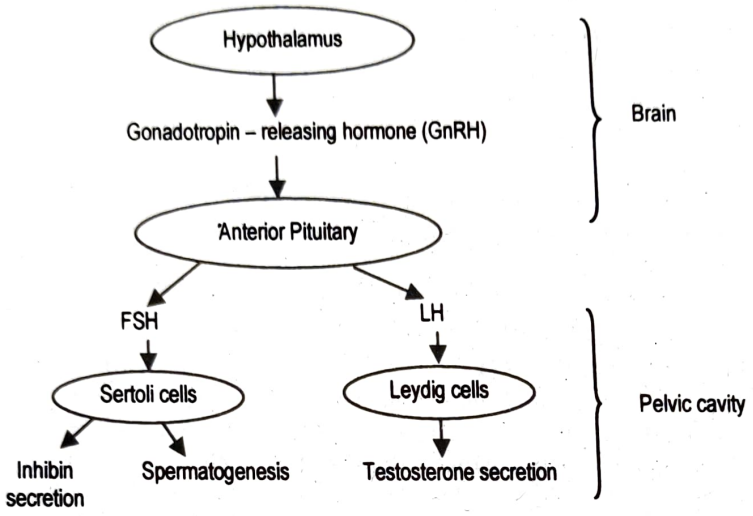
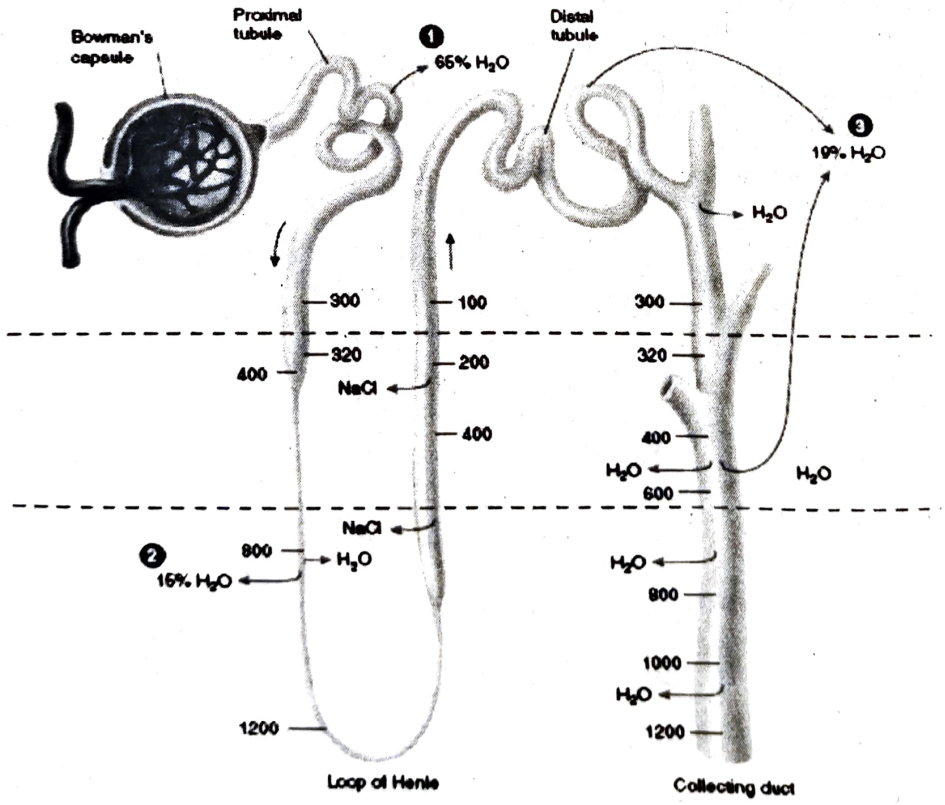
II. List of Hormones required for proper functioning of male reproductive systems are given below:

1. Gonadotropin -Releasing Hormone (GnRH)
2. Follicle - Stimulating Hormone (FSH)
3. Luteinizing Hormone (LH)
4. Testosterone
5. Inhibin



Hormonal Regulation of male reproductive system

66. 2066 Q.No. 2d Draw a neatly labelled diagram of a nephron. (No description is required.) [3]



L.S of human kidney

67. 2065 Q.No. 2b Structure and function of cochlea.

Please refer to 2072 Set C Q.No. 2d

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68. **2065 Q.No. 2c Symptoms and causes of anemia** [3]

Anemia also spelled as Anaemia, is defined as a decreased in the total amount of red blood cells (RBCs) or haeomoglobin in the blood. Haemoglobin is a main part of RBCs and bind with oxygen. If haemoglobin is low than the body will not get enough oxygen.

Initially, anemia can be so mild that it goes unnoticed. But as the body becomes more deficient in RBCs or haemoglobin, the anemia worsen, the sign and symptoms intensity.

The sign and symptoms of anemia include

- Extreme fatigue
- Weakness
- Pale skin
- Chest pain, fast heartbeat or shortness of breath
- Headache, dizziness or lightheadedness
- Cold hands and feet
- Inflammation or soreness of tongue

Causes of Anemia:

There is no single cause of anemia. Due to the great number of anemia type, it can sometimes be difficult to pinpoint the exact cause.

Below is a general overview of common causes of three main groups of anemia.

i. **Anemia caused by blood loss:** The most common type of anemia – iron deficiency anemia often falls into this category. In this case, the disorder is brought on by as shortage of iron, most often caused by blood loss.

ii. **Anemia caused by decreased or faulty red blood cell productions:**

iii. **Anemia caused by the destruction of red blood cells:**

69. **2064 Q.No. 2g Sketch the well labelled diagram of L.S. of human kidney.** [3]

Please refer to Model (Zoology) Q.No. 2e

70. **2063 Q.No. 2a What are vitamins? Why they are essential?** [3]

Please refer to 2076 Set B Q. No. 2c

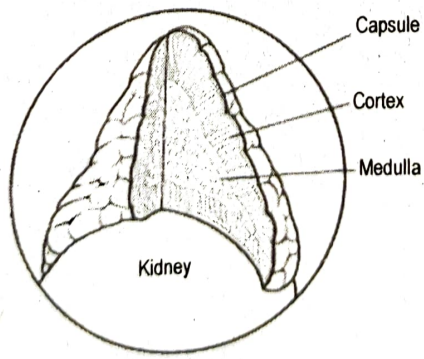
71. **2063 Q.No. 2b Write a note on an artificial respiration.** [3]

Please refer to 2070 Supp. Q.No. 2 c

72. **2063 Q.No. 2e Describe structure and function of adrenal gland.** [3]

The adrenal glands are a pair of endocrine glands that rest on the upper poles of the kidneys, one on each kidney. The right adrenal is pyramidal, whereas the left one is more crescentric. Due to its location, each adrenal gland is also called supra renal gland. They are highly vascularize. Each adrenal gland has a size of 5 cm long and 3 cm wide and 5 grams in weight.

Histologically, each adrenal gland is composed of two distinct parts: the adrenal cortex and the adrenal medulla. The cortex is controlled by the pituitary gland (anterior lobe) and the medulla is controlled by autonomic nervous system (ANS).



L.S of adrenal gland

Adrenal cortex: The adrenal cortex is affected by Adrenocorticotrophic Hormone (ACTH) secreted by anterior lobe of pituitary gland. The cortex makes up 90 percent of the weight of adrenal gland.

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The adrenal cortex consists of three concentric zones of steroid producing cells. They are follows;

1. **Zona Glomerulosa, Its hormones and their functions:** The outermost layer of adrenal cortex is the zona glomerulosa.

   This region secretes the hormones mineralocorticoids. The main meneralocorticoid is aldosterone, which maintains sodium and potassium levels in the body.

2. **Zona fasciculata, Its Hormone and their role:**

   Zona reticularies releases the hormones glucocorticoids. The glucocorticoids targets the kidney for various metabolic functions. They are in three forms: Cortisol, cortisone and corticosterone. Cortisol is the most abundant about 95% of total corticoids.

   The glucocorticoids has given functions

   i. Utilization of carbohydrate, fat and protein by the body.
   ii. Normal response to stress.
   iii. Anti-inflammatory effects.
   iv. Promotes normal cell function and promotes the conversion of fats and some proteins into glucose (the process being called gluconeogenesis), For this reason they are sometimes called hyperglycemic hormones.

3. **Zona Reticularis, Its Hormones and Functions:** It is the innermost cortical layer lying directly adjacent to the medulla. Its cells form irregular cords and clusters, separated by capillaries and connective tissue. This region secretes sex corticoid hormone ,the Dehydroepiandrosterone (DHEA).

II. **Adrenal Medulla:** The adrenal medulla is controlled by an autonomic nervous system (ANS). It is the central part of the adrenal gland. It is surrounded by adrenal cortex. The cells of medulla are called chromaffin cells, which are neuroendocrine in functions. These cells are larger and granular. This region is in connection with the sympathetic nervous system. Therefore, it is also known as sympathetico adrenal system.

Hormones of Adrenal medulla and their functions:

Medulla secretes two hormones – Adrenaline and nor adrenaline

Functions of Adrenaline

Adrenaline prepare the body for "Fright, fight or Flight" and has many effects:

- Action of heart increased.
- Rate and depth of breathing increased. Increase the conversion of glycogen to glucose to provide energy to the tissue when needed.
- Onset of muscular fatigue delayed.
- Dilates the blood vessel i.e. vasodilator used in the treatment of asthma.
- Blood supply to the bladder and intestine reduced their muscular wall relax, the sphincters contracts.

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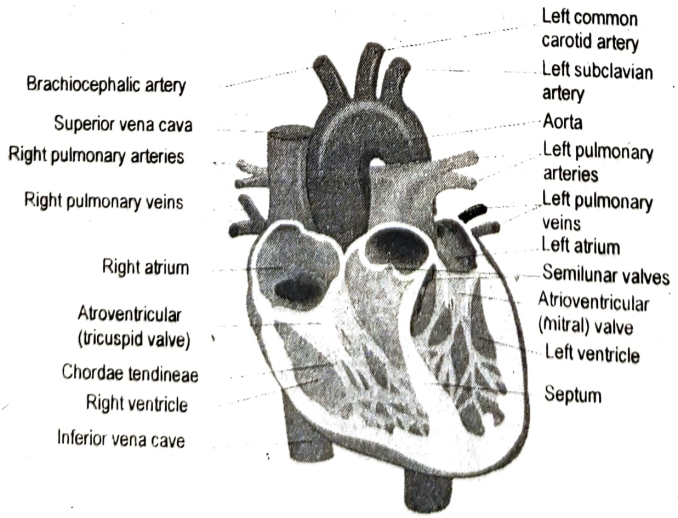
73. 2062 Q.No. 2f **Show the internal structure of human heart (diagrammatically).** [3]



V.S of Human heart

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74. **2061 Q.No. 2i Draw a labeled V.S. of human eyes.** [3]

Please refer to 2072 Supp. Q.No. 2e

75. **2061 Q.No. 2j What is the function of endocrine glands?** [3]

The endocrine system is made up of a network of gland. These glands secrete hormones to regulate many bodily functions including growth and metabolism. The hormones are directly secreted into the blood stream. Hormones are the chemical substances that affect the activity of another part of the body i.e. target site. In essence, hormones serve as messengers, controlling and coordinating activities throughout the body.

The different endocrine glands, their hormones and their effect are as follows:

1. Hypothalamus: It is the part of the brain and the control and relay centre of the endocrine system.
2. Pituitary Gland: It is the "Master gland" of the body because it releases several hormones which control all the other glands of the body. Hormones secreted by the pituitary gland and their functions are as follows:

i. Oxytocin: Stimulates urine contraction and breast contraction for milk release.

ii. Anti-diuretic Hormone (ADH) or vasopressin: Stimulates re-absorption of water from kidney tubules.

iii. Prolactin (PRL): Stimulates production of breast milk.

iv. Human growth Hormone (HGM): Stimulates growth of the body.

v. Thyroid stimulating Hormone (TSH): Stimulates the thyroid gland to release thyroxin hormone.

3. Pineal gland: It release melatonin hormone which regulate sleep cycle i.e., Synchronize the body to the 24 hours day/night rhythm, thus informing the brain when it is day and when it is night.
4. Thyroid gland: Thyroid gland release thyroxin which regulate Basal Metabolic Rate (BMR). Another hormone of thyroid gland is Calcitonin, which uptake the calcium to the bone.
5. Parathyroid gland: It is associated to release parathormone, responsible for the growth of muscle and bone; distribution of calcium and phosphate in the body.
6. Thymus gland: It release thymosin, that activates the immune system by activating the T-killer cells, T-helper cells and T-memory cells .
7. Pancreas: The endocrine part, Islets of langerhans, of the pancreas secretes insulin, glucagons and somatostatin which regulate the blood glucose level of the body.
8. Adrenal gland: The adrenal cortex of adrenal gland release glucocorticoids, mineralo-corticoids and sex-corticoid. The glucocorticoids help to utilize carbohydrate, fat and protein by the body.
9. Ovaries: Ovaries releases estrogen and progesterone break down uterine wall, builds up and maintains the uterus wall for embedding fertilized egg.
10. Testis: Testes release Testosterone which stimulates the development and function of male sex organs.

76. **2060 Q.No. 2e Draw a labeled L.S. of human kidney.** [3]

Please refer to Model (Zoology) Q.No. 2e

77. **2060 Q.No. 2f What are heart sounds? How are they produced?** [3]

Heart sounds are the noises generated by the beating heart and the resultant flow of blood through it

Some of the common mechanisms by which heart sounds are generated include:

1. Operating or closure of the heart valves.
2. Flow of blood through the valve orifice.
3. Flow of blood into the ventricular chambers.
4. Rubbing of the cardiac surfaces:

The distinctive sound of a heartbeat - lub-dub, lub-dup, lub-dup-comes from the two pairs of valves that are closing in the chambers of our heart. The valves are like turnstiles, allowing blood to move in one direction through heart and keep it from backing.

1. **The first heart sound (S_1):** The first heart sound, or S_1, forms the "lub" of the "lub-dub" and is caused by turbulence caused by the closure of mitral valve (bicuspid valve) and tricuspid valve at the beginning of ventricular contraction or systole. During the systole the mitral and tricuspid valves are closed and the blood tries to flow back to the atrium back bulging the AV valves. But the chordae tendinae stop the back bulging and causes the blood to flow forward. This will cause vibration of the valves, blood and the wall of the ventricles which is presented as the 1st heart sound.
It is low-pitched and a relatively long sound (0.15 sec).
2. **The second heart sound (S_2):** The second heart sound, or S_2, forms the "dub" of "lub-dub" and is produced by the closure of aortic valve and pulmonary valves at the end of systole.
During diastole, blood in the blood vessels tries to flow back to the ventricles and causes the semi lunar valve to bulge. But the elastic recoil of the arteries causes the blood to bounce forward which vibrates the blood, the valves and the ventricle wall. It is high-pitched, louder, sharper and relatively shorter than S_1 (0.12 Sec)
3. **Third heart sound (S_3):** Rarely, there may be a third heart sound also called the prodiastolic gallop or ventricular gallop. It occurs at the beginning of diastole after S_2 and is lower in pitch and is not vulvular in origin. S_3 is created when the ventricles relax and pressure from the filling blood rapidly distends the ventricle. When the stiff, Non-compliant ventricular wall reaches its physical limits, it suddenly tenses, and the S_3 sound is created. It is typically very faint and difficult to hear.
S_3 is normal in young but suggestive of heart failure in people over 40 years of age.
4. **Fourth heart sound (S_4):** The fourth heartsound (S_4) is a late diastolic sound that corresponds to late ventricular filling through active atrial contraction. It is also called prestylic or atrial gallop. It is a very low frequency and of very short duration (0.05 sec). It is normal in children but rarely normal after age 20. It is a sign of pathologic state, usually a failing or hypertonic left ventricle.

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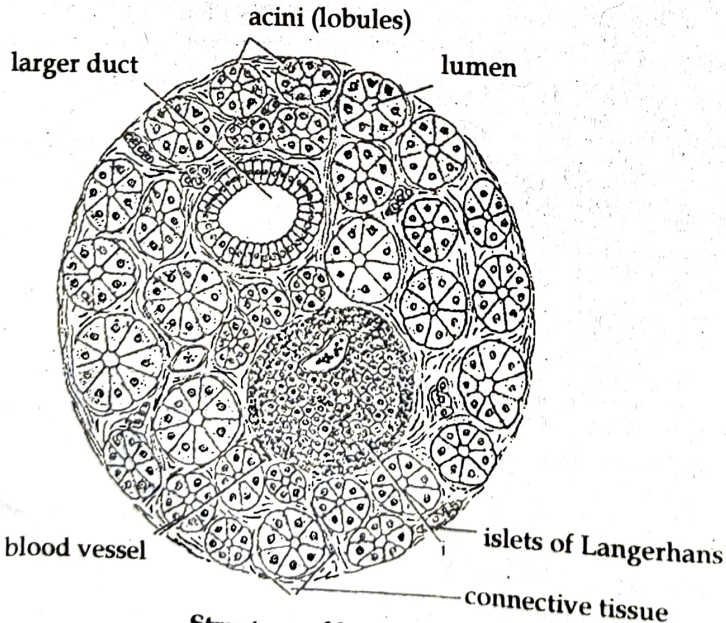
78. **2059 Q.No. 2f Discuss the histological structure of human pancreas.** [3]

The pancreas is the main enzyme producing accessory gland of the digestive system. It is a heterocrine gland i.e. it has both exocrine and endocrine functions. It is located in the abdominal cavity behind the stomach. It is about 15 cm long.
The exocrine part is called pancreatic acini and the endocrine part is called Islets of Langerhans.



Structure of human pancreas

1. **Histological structure of pancreatic Acini:** The pancreatic acinar cell is the functional unit of the exocrine pancreas. It synthesizes, stores and secretes digestive enzymes. The acini are grape-like structures composed of pancreatic acinar cells and ducts. It comprises about 95 percent of total pancreatic volume.

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The acine are serous type. The connective tissue is very little between two acini. Each acinus consists of a group of pyramidal cells with their apical tips towards the lumen. The cells rest upon the basal lamina. Each cell has a basal spherical nucleus and one or two nucleoli. Half of the cells towards the lumen contain numerous zymogen granules in the cytoplasm. The basal zone contains endoplasmic reticulum and elongated mitochondria. The apical region of the cells show irregular microvilli. The acinar cells or secretory cells of each acinus surround a small intercalated duct. The intercalated ducts drain into the interlobular ducts.

The ducts are lined by a single layer of columnar epithelium. The pancreatic ducts carry pancreatic juice, and pour into the duodenum.

2. **Histological structure of Islets of Langerhans:** Islets of Langerhans are the structural and functional units of endocrine pancreas. They appear as rounded clusters of cells within exocrine pancreatic tissue. There are about one million pancreatic islets (Islets of Langerhans) distributed in the pancreas. It comprises only five percent of the total mass of pancreas.

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79. **2059 Q.No. 2g Draw a labelled sketch of internal ear of man.** [3]

Please refer to 2070 Set C Q.No. 2 d

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80. **2059 Q.No. 2h Name the hormones produced by adrenal gland and state their functions.** [3]

Adrenal gland has two parts: adrenal cortex and adrenal medulla. These two parts secrete different hormones.

1. **Hormones of Adrenal cortex:** Adrenal cortex has three regions arranged in order from outer to inner: Outer zona glomerulosa, middle zona fasciculata and inner zona reticularis.

The hormones and their functions are as follows:

i. **Glucocorticoids:** These hormones are secreated by zona fasciculata.

Glucocorticoids includes cortisol, cortisone and corticosterone. Cortisol is the most abundant; about 95% of total glucocorticoids.

Its functions are as follows:

- Utilization of carbohydrate, fat and protein by the body.
- Normal response to stress.
- Anti-inflammatory effects.

ii. **Mineralocorticoid:** These are secreted by zona glomerulosa. The main Mineralocorticoid is aldosterone. Its functions are as follows:

- Regulation of salt and water balance.
- Regulation of sodium and potassium ions in the blood and extra cellular fluid.

iii. **Sex corticoids:** These hormones are secreted by zona fasciculata and zona reticularis. Their main functions are as follows:

- Proper functioning of sex organs
- Development of secondary sexual characters in growing male and female.

The male adrenal sex corticoids are testosterone and that of female are estrogen and progesterone.

2. **Hormones of Adrenal Medulla:** The adrenal medulla occupies the central portion of the adrenal gland. It releases two hormones – Adrenaline and Nor-adrenaline.

Functions of adrenaline (Epinephrine): Adrenalin, also called Epinephrine, prepares the body for "Fright, fight or flight" and has many effects:

- Action of heart increases.
- Rate and depth of breathing increases.
- Force of muscular contraction improves.

i. **Functions of Nor-adrenaline (Nor-Epinephrine):** It has similar effect to adrenalin:

- Constriction of small blood vessels leading to increase in blood pressure.
- Increases blood flow through the coronary arteries and slowing of heart rate.
- Relaxation of the smooth muscles in the intestinal walls.

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81. **2058 Q.No. 2b** **Explain the phenomenon of reflex action.** [3]

Reflex action is defined as the involuntary functioning or movement of any organ or body part in response to a particular stimulus. The function or action occurs immediately, without the involvement of the will or consciousness.

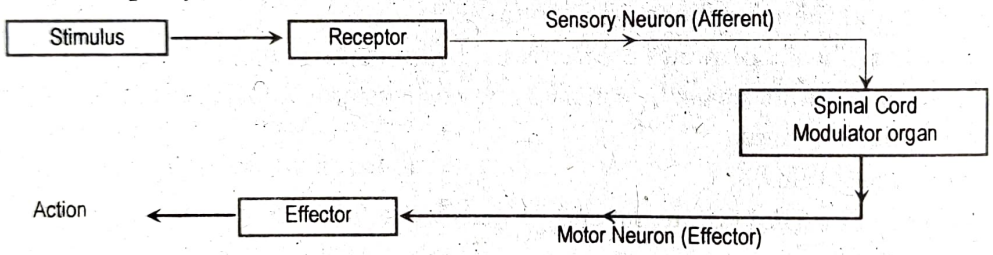
Reflex actions in human are controlled by the reflex arc. When the safety of an organism demands a very quick response, the signals may be passed directly from a sensory neuron, via a relay neuron, to a motor neuron for instant, unthinking action. This is reflex action.

A reflex arc is the nerve pathway which makes such a fast automatic response possible. It is an innate behaviour and all the human beings behave in the same way.

For example: When a person accidently touches a hot object, he or she automatically jerk his/her hand away without thinking.

In higher animals, most sensory neurons do not pass directly into brain, but synapse in the spinal cord. This characteristic allows reflex actions to occur relatively quickly by activating spinal motor neurons without the delay of routing signals through the brain, although the brain will receive sensory input while the reflex action occurs.

Most reflex arcs involve only three neurons. The stimulus, such as a needle stick, stimulates the pain receptors of the skin, which initiate an impulse in a sensory neuron. This travels to the spinal cord where it passes, by means of a synapse, to a connecting neuron called the relay neuron situated in the spinal cord. The relay neuron in turn makes a synapse with one or more motor neurons that transmit the impulse to the muscles of the limb causing them to contract and pull away from the sharp object. Reflexes do not require involvement of the brain.



A Reflex Arc

The reflexes shown by humans are blinking of eyes, sneezing, coughing, hunger, salivation in mouth at the sight of tasty food, knee jerking, etc. Knee jerking is the simplest reflex. Reflex action reduces the over loading of the brain.

82. **2058 Q.No. 2c** **List the functions of human kidney.** [3]

The kidneys are the chief excretory organs of the body. The function of the human kidney are listed as follows:

1. **Removing wastes from the Blood:** Filtering the blood is the primary function of the kidney. Everyday the kidneys process about 190 litres of blood and filters out 2.237 litres of waste products and extra water. To effectively handle this volume of blood, the kidneys are equipped with lots of blood vessels.
2. **Excretion of wastes:** The kidneys excrete a variety of waste product, produced by metabolism into the urine. These include the nitrogenous wastes urea, from protein catabolism and uric acid, from nucleic acid metabolism.
3. **Reabsorption of vital nutrients:** Glucose, amino acids, bicarbonates, sodium, chloride, phosphate and water are reasbsorbed by the nephrons of the kidneys.
4. **Maintain acid-base balance:** Normal metabolism produces large quantities of acid, mainly Sulphuric acid, resulting from protein metabolism. Kidney excrete this acid. The kidney reabsorps and regenerate bicarbonate from the urine and excrete hydrogen ions and fixed acids into the urine.
5. **Regulation of water volume:** Regulating the body's water volume is another important function of the kidney. Our body is made up of approximately 50 –60% water. Having too much or too little of water can cause serious problems. The kidneys are equipped to regulate the correct volume of water in the body.

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6. **Regulating Blood Pressure:** Blood pressure is, to a large extent, controlled by the kidneys, via the production of the proper balance of the vasoconstrictive and vasodilatory chemicals and by maintaining normal salt and water balance.
7. **Production of Hormones:** Kidneys secrete a hormone called erythropoietin. It plays a key role in the production of red blood cells in the bone marrow.
8. **Processing vitamin D :** The kidneys convert calcidiol to calcitriol, which is an active form of vitamin D. In this active form, vitamin D promotes calcium absorption by the small intestine and makes it available for bone development.

83. 2058 Q.No. 2f Distinguish between antigen and antibody. [3]

Differences between antigen and antibody are follows:

Antigen	Antibody
An antigen is a foreign particle that can create an immune response within a person's body.	Antibodies are also known as immunoglobulins and these proteins are created by the body.
Antigens are mostly made up of proteins, but they may also be nucleic acids, lipids or carbohydrates.	Antibodies are always proteins.
Antigens are typically divided into self and non-self antigens. Self antigens, like cancer, come from within the body. Non-self antigens come from outside the body. They stimulate our immune system to produce more antibodies.	There are a total of five types of antibodies. They are IgA, IgE, EgG, IgM and IgD.
Antigens are "hooks" on the surface of cells and are found in nearly every cell.	Antibodies are found in the eyes, vagina, ears, digestive tracts, respiratory passage, tears, blood, mucus, saliva, lungs, lymph and body fluid.
Antigens cause disease or allergic reaction.	Protects the system by immobilization or lysis of antigenic material.

84. 2057 Q.No. 2f How human heart beating starts? [3]

The heart depends on its electrical system to deliver signals and make the heartbeat normally.

The heart beat is triggered by electrical impulses that travel down a special pathway through the heart. An electrical stimulus is generated by the sinoatrial node (SA node) or sinus node, which is a mass of specialized tissue located in the right atrium of the heart. The SA node is known as the heart's natural pacemaker. The SA node generates an electrical stimulus regular i.e. 60-100 times per minute under normal conditions. This electrical stimulus travels down through the conduction pathways. The electrical activity spreads through the wall of the atria and causes them to contract. This forces the blood into the ventricles.

The electrical impulse travels from the SA node to the atrioventricular node (AV node). The AV node is a cluster of cells in the centre of the heart between the atria and ventricles, and acts like a gate that slows the electrical signal before it enters the ventricles. This delay gives the atria time to contract before the ventricles do.

The electrical impulse continues down to the atrioventricular bundle or bundle of His, the only muscular connection between atria and ventricles. The bundle of His divides into right and left pathways and descend downward along the interventricular septum. The right and left branches divide into smaller brances, called Purkinje fibres. The Purkinje fibres form a network of fibres which spread to all the parts of ventricular myocardium. Thus the impulse form the SA node reaches the ventricular muscles and cause the contraction of the heart. Each contraction of the ventricles represents one heartbeat. The adult human heart beats about 72 times per minute. When the ventricle contracts the blood is forced out of the heart to the lungs and body.

The SA node fires another impulse and the cycle begins again.

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85. 2057 Q.No. 2h **What is the structure of adrenal gland? Name the hormones it produces.** [3]

The adrenal glands are endocrine gland found in the abdominal region. Human body has two adrenal glands and one sits on top of each human kidney, therefore, referred to as suprarenal glands. Each adrenal gland weight 4 - 5 grams in an adult. The adrenal gland measures approximately 3 cm in width, 5 cm in length and 1 cm in thickness. These glands are yellowish in colour.

The adrenal glands are surrounded by a fatty capsule and lie within adrenal fascia (connective fissue), which also surrounds the kidneys. A weak wall of connective tissue separates the glands from the kidneys.

Each adrenal gland has two distinct parts, each with a unique function, the outer adrenal cortex and the inner medulla, both of which produce hormones.

The adrenal cortex is divided into three separate zones; the outer zona glomerulosa, the middle zona fasciculata and inner zona reticularis. Each zone is responsible for producing specific hormones.

The adrenal medulla is located inside the adrenal cortex in the contre of an adrenal gland. It produces several "Stress hormones".

The name of the normones secreted by adrenal glands are as follows:

1. **Mineralocorticoids:** These hormones are produced by zona glomerulosa. The main mineral corticoids are aldosterone.
2. **Glucocorticoids:** These are secreted by zone fasciculata. Glucocorticoids includes the hormones cortisol, cortisone and corticosterone.
3. **Androgens:** These are produced by zone reticularis. The androgens are dehydroepiandrosterone (DHEA) and Androstenedione (The precursor of testosterone). These hormones are converted to more potent androgens such as **testosterone or oestrogens in the gonads.**
4. **Catecholamines:** The adrenal medulla secretes catecholamines which include the following hormones:
   i. Adrenaline or Epinephrine
   ii. Nor-adrenaline or nor-adrenaline
   iii. Dopamine in small amount

86. 2054 Q.No. 2b **Mention the function of pitutaries.** [3]

Please refer to 2067 Q.No. 2g

87. 2053 Q.No. 3a **Justify pancreas as exocrine and endocrine gland.** [3]

Please refer to 2072 Set D Q.No. 2d

88. 2053 Q.No. 3b **Mention the function of male sex hormone.** [3]

Testosterone is the male sex hormone that is important for sexual and reproductive development. Testosterone belongs to a class of male hormones called androgens, which are sometimes called steroids or anabolic steroids.

In men, testosterone is produced mainly in the testes, with a small amount made in the adrenal glands. The brain's hypothalamus and pituitary gland control testosterone production.

Testosterone has following functions or involved in:

1. Development of male sex organs before birth.
2. Development of secondary sex characteristics at puberty, such as voice deepening, increased penis and testes size, and growth of facial and body hair.
3. Plays a role in sex drive.
4. Spermatogenesis i.e. sperm production.

89. 2052 Q.No. 3c **What is endocrine gland? Give the list of major endocrine glands.** [3]

Endocrine gland is a ductless gland that produces and secretes hormones into the blood or lymph nodes, affecting metabolism and other body process.

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The list of major endocrine glands are as follows:

1. Hypothalamus – Situated in the brain
2. Pituitary gland – located in the base of the brain
3. Pineal gland – located in the epithalamus of the brain
4. Thyroid gland – found at the front of the neck.
5. Parathyroid gland – situated in the neck and adjacent to the thyroid glands
6. Thymus gland – situated in the sternum.
7. Adrenal gland – Found above the kindneys
8. Endocrine pancreas (Islets of langerhans) – found in the abdominal cavity behind the stomach.
9. Ovaries (In Female) – Located in the pelvic region.
10. Testes (In male) – Located; outside abdomen.

Differentiate between following [3 marks]

1. **2054 Q.No. 4d Thyroid gland and Thymus gland** **[3]**

The differences between thyroid gland and thymus gland are as follows:

Thyroid gland	Thymus gland
Thyroid gland is located in the neck, below the thyroid cartilage.	Thymus gland is located in the upperchest.
It is larger in adults than in children.	It is larger in children than in adults.
Thyroid gland produces thyroid hormones including thyroxine (Tetraidothyronine or T_4)	Thymus glands mature T-lymphocytes, and hormones including thymosin and thymopoietin.
Thyroid remains throughout the life.	Thymus starts to degenerates after reaching adulthood.
It regulates the rate of metabolism, protein synthesis and the responsiveness of the body to other hormones.	Thymus provides an environment for the maturation of T-lymphocytes. It is a part of immune system.
Thyroid is the gland of the endocrine system.	Thymus is an organ or gland of the lymphatic system.

Discuss the following [4 marks]

1. **2056 Q.No. 3f Thyroxine hormone triggers the rate of metamorphosis.** **[4]**

Thyroxine, also known as tetraiodothyronine (T_4), is a hormone produced and secreted by thyroid gland. Thyroxine controls the amphibian metamorphosis– the process by which a tadpole turns into a frog.

In amphibians, metamorphosis is generally associated with the changes that prepares an aquatic organism for a primary terrestrial life.

The control of metamorphosis by thyroxine (T_4) was experimented in tadpoles. It was discovered that tadpoles metamorphosed prematurely when fed powdered sheep thyroid gland. It was found that when the thyroid gland was removed or destroyed from the early tadpoles, the larvae never metamorphosed. The larva instead become a giant tadpole, but not a frog. The tail degeneration is clearly associated with increasing level of thyroxine.

This experiment proves that thyroximne triggers metamorphosis in amphibians.

2. **2055 Q.No.2a Structure of the Thyroid gland.** **[4]**

The thyroid gland is a highly vascular brownish red gland located anteriorly in the lowerneck, extending from the level of the 5th cervical vertebra down to the 1st thoracic vertebra.

The thyroid gland is a butterfly shaped organ consisting of two lobes connected by an isthmus. The lobes are regarded as left and right lobes. The thyroid weights 25 grams in adult, with each lobe being about 5 cm long, 3 cm wide and 2 cm thick and the isthmus is about 1.25 cm in height and width. The gland is usually larger in women, and increases in size in pregnancy.

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The thyroid sits near the front of the neck, lying against and around the front of the neck, lying against and around the front of the larynx and trachea. The thyroid cartilage and cricoid cartilage lie just above the gland, below the Adam's apple. The thyroid gland is covered by a thin fibrous capsule. The thyroid is supplied with arterial blood from the superior thyroid artery, a breach of the external carotid artery.

At a microscopic level, there are three primary features of the thyroid-follicles, follicular cells and parafollicular cells.

1. **Thyroid follicles:** Thyroid follicles are small spherical grouping of cells that play the main role in thyroid function. They consist of a rim that has a rich blood supply, nerve and lymphatic presence, that surrounds a core of colloid that consists mostly of thyroid hormone precursor proteins called thyroglobulin, an iodinated glycoprotein.
2. **Follicular cells:** The core of a follicle is surrounded by a single layer of follicular cells When stimulated by thyroid stimulating hormone (TSH), these secrete thyroid hormones T_3 and T_4. Follicular cells vary in shape from flat to cubidal to columnar, depending on how active they are.
3. **Parafollicular cells:** Scattered among follicular cells and in spaces between the spherical follicles are parafollicular cells. These cells secrete calcitonin or c-cells.

Explain the following, each one in a short paragraph [4 marks]

1. **2055 Q.No. 3a Pituitary gland is referred to as "Master Gland". Why?** [4]

Pituitary gland is often called the "master gland" because the hormones it secretes play an active part in controlling the activities of all the endocrine glands.

The pituitary gland lies below the hypothalamus of the brain. Pituitary gland is composed of anterior and posterior lobe, both of which secrete different hormones that controls the other endocrine glands to release their respective hormones.

The pituitary hormones regulate other endocrine glands, one affects the adrenal glands, one the thyroid and the other remaining the gonads i.e. testes in male and ovaries in female.

1. TSH, the Thyroid-stimulating hormone, also known as thyrotrophin, causes the thyroid gland to produce its hormone, thyroxine.
2. ACTH, the adrenocorticotrophic Hormone affects the production of hormones by the adrenal cortex of adrenal glands.
3. FSH, the follicle stimulating hormone, spurs production in women of oestrogen, a sex hormone produced by the ovaries; and in men, of sperm by the testes. FSH stimulates the production of Graafian follicles, which contain egg, in the ovaries of female.
4. LH, the Luteinizing hormone, transforms a Graafian follicle to corpus luteum, a special tissue which secretes a hormone called progesterone. Progesterone prepares the mucous membrane lining the uterus to receive a fertilized egg.
5. LTH, the lactogenic hormone, or luteotrophin, stimulates the mother's mammary glands to produce milk.

Long Answer Questions

1. **2076 Set B Q. No. 3 Describe the structure and functions of different parts of human brain.** [7.5]

Please refer to Zoology Model (Zoology) Q. No. 3

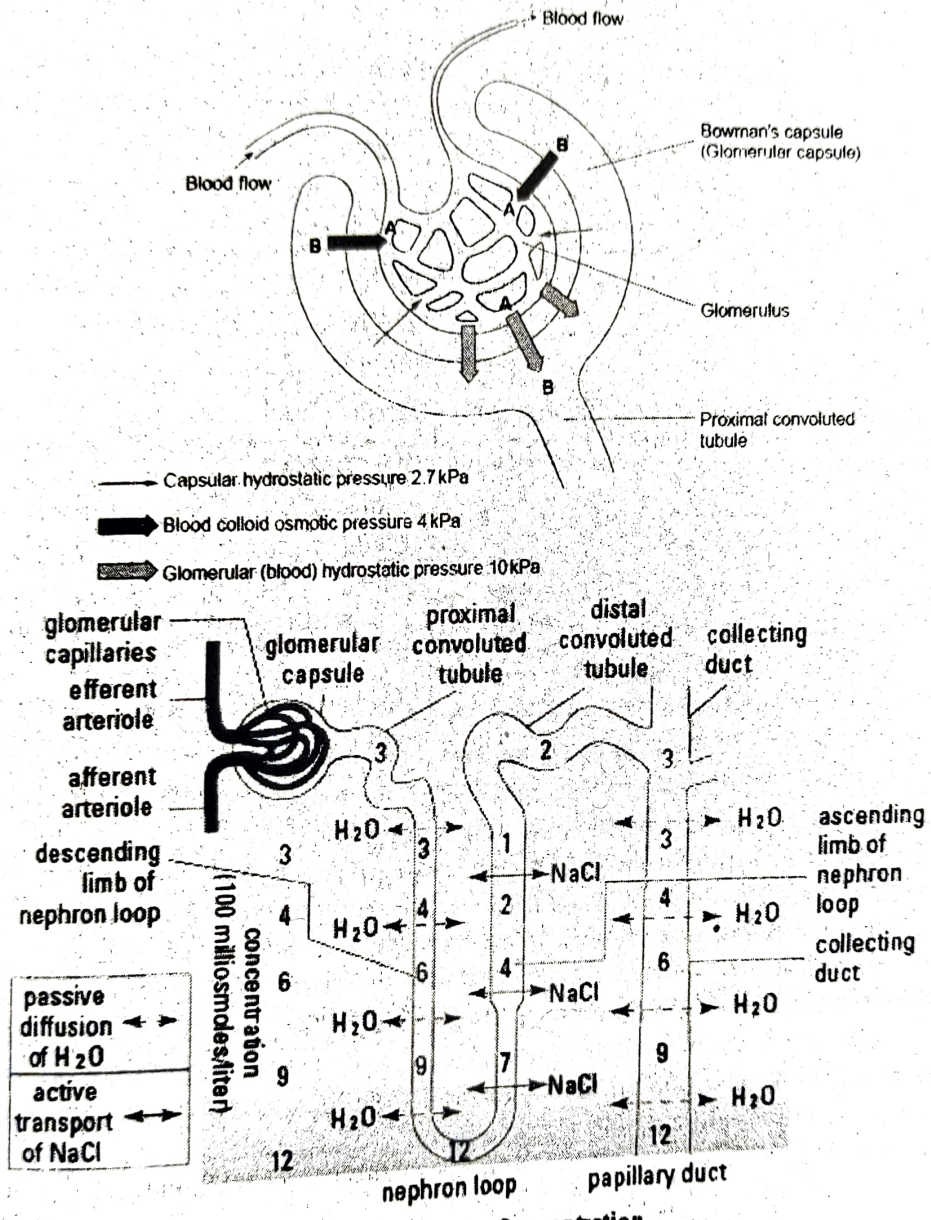
2. **2076 Set B Q. No. 3 OR Give an account of the process of urine formation in human being.** [7.5]

Human beings are ureotelic i.e., they excrete their nitrogenous waste products mainly in the form of urea. The urea is produced in the liver and reaches the kidneys through blood circulation and excreted in the form of watery solution called urine.

Urine is a waste by-product formed form excess water and metobolic waste molecules during the process of renal filtration system. The primary function of the renal system is to regulate blood volume and plasma osmolarity, and waste removal via urine is essentially a convenient way that the body performs many functions using one process.

Urine formation is a very sophisticated process that takes place in the kidney. This important process provides a mechanism for the body to get rid of metabolic wastes and toxins, which can be deadly if allowed to accumulate in the body. There are two kidneys in human being and each kidney has about one million nephrons, where urine formation takes place.

At any given time, about 20 percent of the blood is going through the kidneys to be filtered so that body can eliminate waste and maintain hydration, blood pH and proper levels of blood substances.



Regulation of Urine Concentration

There are three main steps of urine formation:

1. **Glomerular filtration or Ultratiltration:** The functional unit of kidneys, the nephron bears a "Bowman's capsule" which serves as an ultrafilter. The glomerulus is a capillary tuft that receives its blood supply from an afferent arteriole and flows into the glomerulus. Blood in the glomerulus has filterable blood components. Filterable blood components move towards the inside of the glomerulus while non-filterable blood components bypass the filtration process by existing through the efferent arteriole.

The diameter of the afferent arteriole entering the glomerulus is greater than that of the efferent arteriole which leaves it. More blood enters than can leave, so that the blood in the glomerulus is under great hydrostatic pressure. This is the main driving force that tends to move the fluid out of the glomeruli. This pressure is about 55 to 70 mm Hg.

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The filtration is assisted by the difference between the blood pressure in the glomerulus and the pressure of the filtrate in the glomerular capsule. The pressure exerted by the blood in the glomerulus is called glomerular hydrostatic pressure which is about 55 mm Hg. The glomerular hydrostatic pressure is opposed by the osmotic pressure of the blood (30 mm Hg) and by the filtrate hydrostatic pressure (15 mm Hg) in the glomerular capsule. Since the filtration membrane limits the size of particles crossing the membrane, the osmotic pressure inside the glomerular capillary is higher than the osmotic pressure in the Bowman's capsule. The cells and the medium-to-large proteins cannot pass between the podocyte proceses or through the fenestrations of the capillary endothelial cells.

This means that red and white blood cells, platelets, albumins, and other proteins are too large to pass through the filter and remain in the capillary, creating an average colloid osmotic pressure of 30 mm Hg within the capillary.

The net filtration pressure (NFP) is given by:

NFP = Glomerular Blood Hydrostatic Pressure (GBHP) – [Capsular Hydrostatic Pressure (CHP) + Blood Colloid Osmotic Pressure (BCOP)]

$\therefore$ NFP = 55 – [15 + 30] = 10 mm Hg.

This physical phenomenon is called ultrafiltraion. The filtered out blood is called glomelular filtrate or capsular filtrate, which contains water, urea, glucose, amino acids, vitamins, hormones, uric acids, creatinine, sodium and potassium ions, drugs, slats, etc. The useful substances are reabsorbed in the capillaries in later process. The volume of filtrate formed by both the kidneys per minute is termed as eh glomerular filtration rate (GFR). The heart pumps about 5 litres blood per minute under resting condition. Approximately 20 percent or one litre enters the kidney to the filtered. On average, this litre results in the production of about 125 ml per minute in adult human being. This amount equates to a volume of about 180 litres per day. Ninety-nine percent of this filtrate is returned to the circulation by reabsorption so that only about 1 to 2 litres of urine are produced per day.

2. **Selective reabsorption:** This is the second step in urine formation. It takes place in proximal convoluted Tubules (PCT) and Henle's Loop. PCT is the longest and widest part of the nephron. It contains many brush bordered microvilli for absorption of filtrate.

The glomerular filtrate contains both useful and harmful substances. The useful substances such as glucose amino acids, vitamins, minerals salts, Na^+, K^+ are absorbed in the blood from the tubules by the process called selective reabsorption. For this the efferent arteriole forms a network of capillaries around the neck and the body of nephron.

- Glucose, amino acids, vitamins and hormones are reabsorbed into PCT by active transport.
- About 80% inorganic salts like sodium, potassium, chloride and bicarbonate are selectively absorbed from the filtrate to the blood capillary at different regions of PCT by both passive and active transport mechanism. Some amount of salts are absorbed in the distal convoluted tubules (DCT).
- 50% of urea of the filtrate diffuses back in the blood capillaries.
- 99% water is absorbed at many levels including the Loop of Henle by osmosis.
- The remaining constituents in the filtrate are the waste product to be excreted.
- Sodium reabsorption also occurs in the collecting tubules.

The absorption process is regulated by certain hormones as:

- Parathormone from parthyroid gland and calcitonin from thyroid gland together regulate reabsorption of calcium and phosphate.
- Anti-diuretic hormone (ADH) or Vasopressin from the posterior lobe of pituitary gland affects the permeability of the distal convoluted tubules and collecting tubules for increasing water reabsorption.
- Aldosterone (Mineralocorticoid) hormone secreted by the cortex of adrenal gland increases the reabsorption of sodium and excretion of potassium.

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3. **Tubular secretion:** It is the final step in urine formation. It takes place in distal convoluted tubules and collecting duct of nephron. The blood flowing through the efferent vessel also contain unwanted substances like hydrogen ions, creatinine and drugs not cleared by the process of filtration. These substances are secreted into the lumen of Distal Convoluted Tubule (DCT) by a process called tubular secretion.

At the same time, sodium, chloride and calcium are moved from the urine into blood in order to regulate the concentration of ions in plasma.

The substance, thus formed in the tubule after selective reabsorption and tubular secretion is called the urine. The urine passes into the collecting tubule and then into the pelvis from where it passes on to the urinary bladder through the ureters. The urinary bladder acts as reservoir for urine. As the bladder fills with urine, the body of the bladder expands. Bladder can collect about 300 ml of urine. At last the urine is thrown outside the body through the urethra. The elimination of urine from the urinary bladder is called micturation.

Urine is a pale yellow transparent fluid containing different excretory product. It is slightly acidic in nature with pH around 6. The yellow colour of the urine is due to urochrome pigment, a product of bilirubin and urobilin. The bad smell of urine is due to urinod (C_6H_8O).

The composition of urine is as follows:

95% = water

2% = Urea

0.3% = Uric acid

1.7% = Creatinine, Ammonia, Sodium, Potassium, Chlorides, Phosphates, Sulphates, Oxalates

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3. **2076 Set C Q.No. 3 Describe the structure and function of uriniferous tubule with labeled diagram. [7.5]**

Each nephron in the human is a long tubule, or extremely fine tube, about 30-55 mm (1.2 - 2.2 inches) long. A nephron has the following parts:

1. **The Renal Corpuscle or Malpighian's Body:** It is the head of the nephron and it is where urine first forms. The renal corpuscle is the site of the filtration of blood plasma. The renal corpuscle filters out large solutes from the blood, delivering water and small solutes to the renal tubule for modification. The renal corpuscle is also known as Malpighian's body. It has two components: the glomerulus, and the Bowman's capsule. The renal corpuscle has two poles - a vascular pole and a urinary pole.

   i. **Glomerulus:** The glomerulus is a capillary tuft that receives its blood supply from an afferent arteriole of the renal circulation. The glomerular blood pressure provides the driving force for water and solutes to be filtered out of the blood plasma, and into the space in Bowman's capsule called Bowman's space. Only about a fifth of the plasma is filtered in the glomerulus. The rest passes into an efferent arteriole. The diameter of the efferent arteriole is smaller than that of the afferent, and this difference increases the hydrostatic pressure in the glomerulus. The capillaries consist of a tube lined by endothelium or endothelial cells with a central lumen. The walls have a unique structure: there are pores between the cells that allow water and soluble substances to exit, and after passing through the glomerulus basement membrane, and between podocyte foot processes, enter the capsule as ultrafiltrate.

   ii. **Bowman's capsule:** The Bowman's capsule, also called the glomerular capsule, surrounds the glomerulus. It is composed of visceral inner layer formed by specialized cells called podocytes, and a parietal outer layer composed of simple squamous epithelium. Fluids from blood in the glomerulus are filtered through the visceral layer of podocytes, resulting in the glomerular filtrate. The glomerular filtrate next moves to the renal tubule, where it is further processed to form urine. The different stages of this fluid are collectively known as the tubular fluid.

2. **Renal Tubule:** The renal tubule is the portion of the nephron containing the tubular fluid filtered through the glomerulus. After passing through the renal tubule, the filtrate continues to the collecting duct system.

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The components of the renal tubules are:

i. **Proximal convoluted Tubule (PCT):** The proximal convoluted tubule (PCT) is divided into an anterior convoluted portion and a posterior straight descending portion. Fluid in the filtrate entering the PCT is reabsorbed into the peritubular capillaries, including approximately $\frac{2}{3}$ of the filtered salts and water all filtered organic solutes such as glucose and amino acids.

ii. **Loop of Henle:** The Loop of Henle is a U-shaped tube that extends from the proximal tubule. It consists of a descending limb and ascending limb. It begins in the cortex, receiving filtrate from the PCT, extends into the medulla as the descending limb, and then returns to the cortex as the ascending limb to empty into the distal convoluted tubule (DCT). The primary function of Loop of Henle is to concentrate the salt in the interstitium, the tissue surrounding the loop.

   a. **Descending limb:** It is permeable to water but completely impermeable to salt. As the filtrate descends deeper into the hypertonic interstitium of the renal medulla water flows freely out of the descending limb by osmosis until the tonicity of the filtrate and interstitium equilibrate.

   b. **Ascending limb:** The ascending limb of Loop of Henle is impermeable to water, a critical feature of the countercurrent exchange mechanism employed by the loop. The ascending limb actively pumps sodium out of the filtrate, generating the hypertonic interstitium that drives countercurrent exchange. In passing through the ascending limb, the filtrate becomes hypotonic since it has lost much of its sodium context. The hypotonic filtrate is passed to the distal convoluted tubule in the renal cortex.

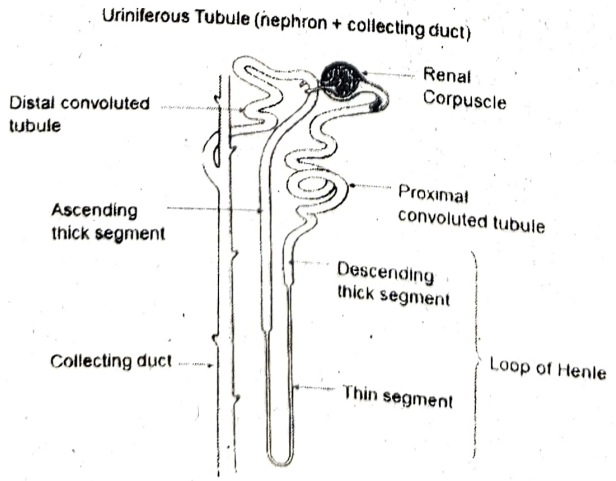
iii. **Distal Convoluted Tubule (DCT):** The distal convoluted tubule is not similar to the proximal convoluted tubule in structure and function. Cells lining the tubule have numerous mitrochondria to produce enough ATP for active trnasport to take place. Much of the ion transport taking place in DCT is regulated by the endocrine system.

After travelling the length of the distal conoluted tubule, only about 1% of water remains, and the remaining salt context is negligible.

iv. **Collecting Tubule (CT):** Each DCT delivers its filtrate to a system of collecting ducts, the first segment of which is the connecting tubule. It is present in the medulla. The collection of collecting tubule is called ducts of Bellini (formerly called) and open into the renal pelvis. These ducts pour all the urine into the renal pelvis.

The functions of Nephrons is listed below:

- It regulates salt and water balance in the blood. (e.g. Sodium)
- It reabsorbs what is needed and excretes the rest as urine.
- It eliminates wastes from the body.
- It regulates blood volume and pressure.
- It controls the level of electrolytes and metabolites.
- It regulates the blood pH.



Uriniferous Tubule or Nephron of Human Being

2076 Set C Q. No. 3 OR Describe the structure of female reproductive organs with menstrual cycle in human being. [7.5]

Female reproductive system is made up of internal organs and external structures. Its function is to enable reproduction of the species. Sexual maturation is the process that this system undergoes in order to carry out its role in the process of pregnancy and birth.

The female reproductive system has three parts: External genitalia or vulva, Internal reproductive organs and Accessory glands

External Genitalia or Vulva: The vulva is the collective name for the external female genitalia located in the pubic region of the body. The vulva surrounds the external ends of the urethral opening and the vagina and includes the Mons pubis, labia majora, labia minora, clitoris and hymen.

Mons Pubis: The mons pubis is the rounded portion of the vulva where sexual hair development occurs at the time of puberty. It is a raise layer of adipose tissue between the skin and the pubic bone that provide cushioning to the vulva.

Labia Majora: These are two marked folds of skin that extend from the mons pubis downward and backward to merge with the skin of perineum. They form the lateral boundaries of the vulval or peduncal cleft, which receives the openings of the vagina and the urethra. They consists of sebaceous glands and sweat glands.

Labia Minora: The labia mionra are two folds of skin, lacking fatty tissue that extends backward on each side of the opening into the vagina. They lie inside the labia majora and are some 4 cm in length.

Clitoris: The clitoris is a small erectile structure at the bottom of mons pubis that covered by the labia minora. It possesses a sensitive tip of spongy erectile tissue, the glans clitoridis. The glans clitoridis contains many nerve endings for sensing sexual pleasure.

Vestibule: It is a cleft between the labia minora into which the urethra and vagina open. It extends to the posterior fourchette. The external opening of the urethra is some 2.5 cm behind the clitoris and immediately in front of the vaginal opening.

Hymen: A thin piece of tissue that covers the opening of vagina is called hymen. It has one or more holes in it. Sometimes a hymen may be stretched or torn during a sexual experience. If it does tear, it may bleed a little bit.

Internal Reproductive Organs: Internal sex organs include vagina, uterus, Fallopian tubes and ovaries.

Vagina: The vagina is an elastic, muscular tube that connects the cervix of the uterus to the exterior of the body. It is located within the pelvis, anterior to the rectum and posterior to the urinary bladder. The vagina lies at a 90° angle in relation to the uterus. The vagina is held in place by endopelvic fascia and ligaments. The vagina is lined by rugae, which are situated in folds throughout. The orifice of the vagina is guarded by hymen. It is 10 to12 cm long. The vagina has a mucous membrane and an outer smooth muscle coat closely attached to it.

The vagina's functions are as follows:

- As the receptacle for the penis during sexual intercourse.
- Carries sperm to the uterus and fallopian tubes.
- Serves as the birth canal by stretching to allow delivery of the foetus during childbirth.
- During menstruation, the menstrual flow (blood) exits the body via the vagina.

Uterus: The uterus is hollow, muscular, pear shaped organ located posterior and superior to the urinary bladder. Uterus is commonly known as womb and is a major female reproductive organ. It is a hollow, muscular organ with thick walls, and it has a glandular lining called endometrium. In the adult female, the uterus is 7.5 cm long, 5 cm in width and 2.5 cm thick, but it enlarges to four to five times this size in pregnancy. The narrower, lower end is called the cervix; this project into the vagina. The cervix is flexible so it can expend to let a baby pass through during childbirth. The cervix is also

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called the neck of the uterus. The external opening of cervix into the vagina is called external OS and the internal opening into the endometrial cavity is termed as internal OS. The average length of cervix is 3 to 5 cm.

The two fallopian tubes enter the uterus at opposite sides, near its top. The part of the uterus above the entrances of the tubes is called the Fundus; the part below is termed as the body.

The uterus is supported and held in position by the other pelvic organs, by the muscular floor or diaphragm of the pelvis, by certain fibrous ligaments, and by folds of peritoneum.

The uterus is composed of three layers of tissue: outer serous coat the peritoneum, middle muscular myometrium and inner mucous membrane called endometrium. The endometrium contains numerous uterine glands, blood vessels and lymphatic spaces. The appearances of the endometrium vary considerably at different stages in reproductive life. It begins to reach full development at puberty and thereafter exhibits dramatic changes during each menstrual cycle.

Uterus surrounds and supports the developing foetus during pregnancy. i.e., uterus is the home to a developing foetus.

3. **Uterine Tubes of Fallopian Tubes:** The fallopian tubes are two tubes leading from the ovaries to the uterus. Three sections of the tubes are distinguished:

   i. The funnel–shaped outer end, or infundibulum

   ii. The expanded and thin–walled intermediate portion, or ampulla

   iii. The cord–like portion, the isthmus, that opens into the uterus.

   The infudibulum is fringed with irregular projection's called frimbriae. The frimbriae are attached to the ovary. The firmbriae swipe over the outside of the ovaries to pick up released ova and carry them into the infundibulum for transport to the uterus. The inside of each fallopian tube is covered in cilia that work with the smooth muscles of the tube to carry the ovum to the uterus.

   Fallopian tubes primary function is to transport sperm towards the egg, which is released by the ovary, and then to allow passage of the fertilized egg back to the uterus for implantation. Fertilization occurs in fallopian tubes.

   The uterine tubes exit the uterus through an area known as the cornua and form a connection between the endometrial and peritoneal cavities. Each tube is approximately 10 cm in length and 1 cm in diameter and is situated within apportion of the broad ligament called the mesosalpinx.

4. **Ovaries:** A pair of ovaries are located on either side of uterus. Ovaries are the female gonads, or primary sex organs, and are two in number. Each is suspended by a mesentery, or fold of membrane, from the back layer of the broad ligament of the uterus.

   The ovaries are responsible for housing and releasing the ova, or eggs, necessary for reproduction. At birth, a female has approximately 1 to 2 million eggs. But only 300 of these eggs ever mature and are release for fertilization. Once a month, the ovaries release only one egg or ovum. This is called ovulation.

   The ovaries are small and oval shaped. The actual size of ovaries depends on a woman's age and hormonal status. The ovaries are 3 to 5 cm in length during child bearing age but became smaller once menopause occur.

   Several ligaments supports the ovary. The ovarian ligament connect the uterus and ovary. The posterior portion of the broad ligament forms the mesovarium, which supports the ovary. The suspensory ligament of the ovary, a peritoneal fold overlying the ovarian vessels, attaches the ovary to the pelvic side wall.

   The ovaries release oestrogen and other hormones which cause female to start getting period. i.e. menstruating.

   The surface of the ovary is smooth and is covered by cubical cells and this layer is called germinal epithelium. Below the epithelial layer, the substance of the ovary is divided into an outer cortex and an inner medulla. Below the germinal epithelium is a thin connective tissue zone, the tunica albuginea. The rest of the cortex consists of stromal or framework cells, contained in a fine network of fibres and also the follicles and corpora lutea.

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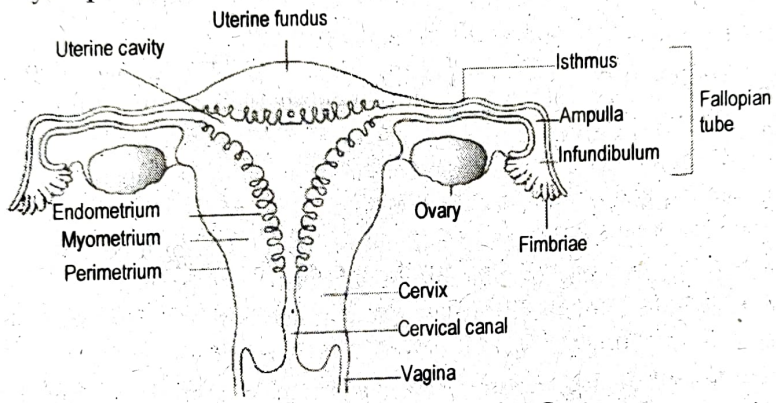
The ovarian follicle or graafian follicles, are rounded enclosures for the developing ova in the cortex near the surface of ovary. Each follicle contains an ovum. As many as 700,000 primary follicles are contained in the two ovaries of a young female. Most of these degenerate before or after puberty.

The ovum after release travels from the ovary to the fallopian tube, where it is fertilized before reaching the uterus.

III. **Accessory Glands:**

1. **Bartholin's Gland:** These glands are located beside the vaginal opening and produce a fluid (mucus) secretion.
2. **Breasts and Mammary Glands:** The breasts are specialized organs of the female body that contains mammary glands, milk ducts and adipose tissue. The two breasts are located on the left and right side of the thoracic region of the body. The mammary glands released milk when the pigmented nipple is stimulated.

For menstrual cycle please refer to 2075 GIE Q. No. 2c



Human Female Reproductive System

5. **2075 GIE Q. No. 3 Describe the structure and functions of pituitary gland.** [7.5]

The pituitary gland is called the "Master Gland" of the body because it secretes stimulating hormones which control the secretion of most of the endocrine glands of the body.

Structure

The pituitary gland is also known as Hypophysis and this endocrine gland is about the size of a pea weighing 0.5 gram in humans. The pituitary gland rests upon the hypophysial fossa of the sphenoid bone in the centre of the middle cranial fossa and is surrounded by a small bony cavity called Sella turcica. It lies underneath the brain and behind the bridge of the nose. Located above the pituitary gland is the hypothalamus. The hypothalamus decides which hormones the pituitary should release by sending it either hormonal or electrical messages.

The pituitary gland is composed of three lobes: anterior, intermediate, and posterior.

Anterior lobe

The anterior pituitary arises from an invagination of the oral ectoderm and forms Rathke's pouch. The anterior lobe is further divided into the pars tuberalis and pars distalis that constitute 80% of the pituitary. Between the pars tuberalis and pars distalis lies pars intermedia, the intermediate lobe. The anterior lobe and the pars intermedia together constitute the adenohypophysis.

Posterior lobe

The posterior lobe is actually the extension of the hypothalamus. The hormones of posterior lobe are produced by the cell bodies of the hypothalamus. The posterior lobe is called neurohypophysis which is connected to the hypothalamus by a pituitary stalk or infundibulum.

Functions of pituitary

The role of pituitary gland is illustrated by the functions of different hormones produced by adenohypophysis and neurohypophysis.

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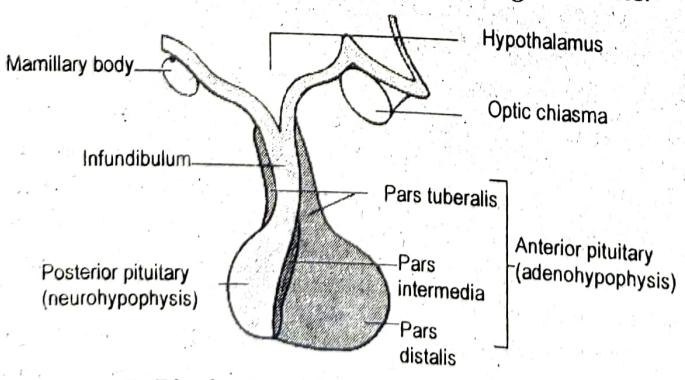
a. **Hormones of Adenohypophysis and their functions:** Adenohypophysis secretes six different hormones, which are as follows:

1. **Human Growth Hormone (HGH) or Somatotropin Hormone (STH):** Growth hormone targets various body cells. It stimulates the growth and division of the body cells especially to that of bones and skeletal muscles.
2. **Thyroid Stimulating Hormone or Thyrotropin (TSH):** Thyroid stimulating hormone stimulates the thyroid gland to secrete Tetraiodothyronin (T4) and Triiodothyronin (T3), which in turn stimulate metabolism in other cells throughout the body.
3. **Adrenocorticotropic Hormone (ACTH):** ACTH stimulates the adrenal cortex to produce mineralocorticoids, glucocorticoids, and sex corticoids or androgens.
4. **Gonadotropic Hormone (GTH):** These hormones control various activities of the gonads (i.e., testes and ovaries) and the sexual cycle. These are of two types :
   i. **Follicle Stimulating Hormone (FSH):** stimulates ovarian follicle to produce eggs in women; stimulates sperm production in men.
   ii. **Luteinizing Hormone (LH):** stimulates ovaries to produce estrogen in women; stimulates the Leydig cells to produce testosterone in men.
5. **Prolactin or Lactogenic Hormone:** Prolactin, also known as luteotropic hormone or luteotropin, stimulates breast tissue in nursing mothers to produce milk.
   i. **Melanocte Stimulating Hormone (MSH):** MSH is produced by the intermediate lobe of pituitary gland. MSH acts on cells in the skin (i.e.,melanocytes) to stimulate the production of melanin, which darkens the colour of the skin.

b. **Hormones of Neurohypophysis and their functions:** The posterior lobe contains the ends of nerve cells coming from the hypothalamus. The hypothalamus sends hormones directly to the posterior lobe via these nerves, and then the pituitary gland releases them. The neurohypophysis secretes only two hormones:

1. **Antidiuretic Hormone (ADH) or Vasopressin:** ADH stimulates the kidneys to reabsorbs fluid and produce less urine and is therefore important in maintaining water balance in the body. It also controls blood pressure.
2. **Oxytocin :** Oxytocin causes the uterus to contract during childbirth and is therefore called birth hormone. It also stimulates contraction of the milk ducts in the breast, which move milk to the nipple in lactating women. Hence it is called milk ejecting hormone.



Pituitary Gland and Its' Lobes

6. 2075 GIE Q. No. 3 OR **Give an account of the process of urine formation in human being.** [7.5]

Please refer to 2076 Set B Q. No. 3 OR

7. 2075 Set A Q.No. 3 **Define homeostasis. Explain the mechanism of urine formation in human body.** [7.5]

Homeostasis is defined as the phenomenon of maintenance of relatively stable, internal physiological environment in higher animals under fluctuating environmental condition. e.g Acid - base balance, body temperature, glucose concentraion calcium level, fluid volume, etc.

For the explanation of the mechanism of urine formation in human body,

Please refer to 2076 Set B Q. No. 3 OR

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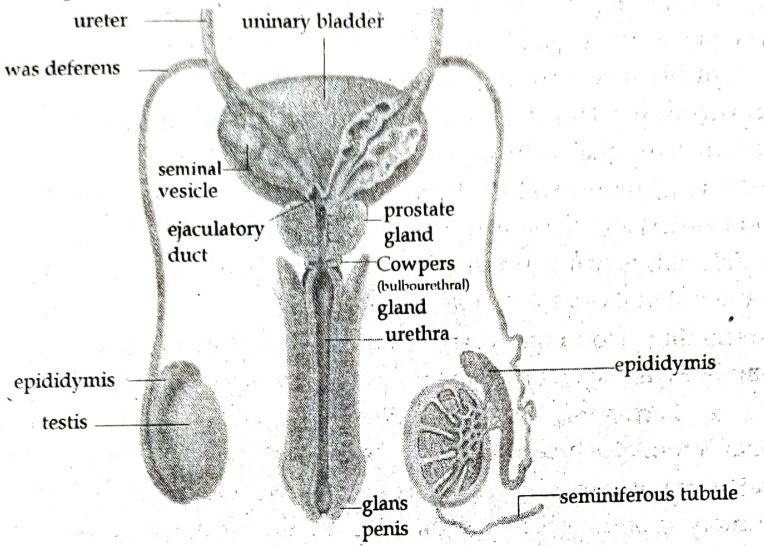
8. **2075 Set A Q.No. 3 OR Give a detailed account of male reproductive organ of man.** [7.5]

The male reproductive organs are located outside the body and within the pelvis. Male reproductive system has two main parts: External male genitalia and internal male reproductive organs.

I. **External male sex organs:** The external structures include the penis, scrotum and testicles or testes.



1. **Penis:** Penis is the male organ used in sexual intercourse. It has three parts: the root, which attaches to the wall of the abdomen; the body, or shaft; and the glans, also called the head of the penis, is covered with a loose layer of skin called foreskin. The opening of the urethra, the tube that transports semen and urine, is at the tip of the penis. The glans of the penis contains a number of sensitive nerves. The base of the glans penis is called the corona.

The penis includes three cylindrical spaces (sinuses) of erectile tissue. The two larger ones, the corpora cavernosa, occur side by side.

The third sinus, the corpus spongiosum, surrounds most of the urethra. When these spaces are filled with blood, the penis becomes large and erect.

Semen, which contains sperm, is expelled through the end of the penis when the man reaches sexual climax (orgasm). When the penis is erect, the flow of urine is blocked form the urethra, allowing only semen to be ejaculated at organism.

2. **Scrotum:** The scrotum is a sac–like organ made of skin and muscles that houses the testes. It is located inferior to the penis in the pubic region. The scrotum is made up of two side – by – side pouches with a testis located in each pouch. The main function of the scrotal sac is to keep the testes cooler than 37°c. It acts as a "climate control system" for the testes. For normal sperm development, the testes must be at a temperature slightly cooler than body temperature. Special muscles in the well of scrotum allow it to contract and relax, moving the testicles closer to the body for warmth or farther away from the body to cool the temperature.

3. **Testes (singular Testis):** The two testes, also known as testicles, are the male gonads responsible for the production of sperm and testosterone. The testes are ellipsoid glandular organs around 1.5 to 2 inches long and an inch in diameter, and 10 to 15 grams each in weight. Each testis is found inside its own pouch on oneside of the scrotum and is connected to the abdomen by a spermatic cord and cremaster muscle. The cremaster muscles contract and relax along with the scrotum to regulate the temperature of the testes.

The inside of the testes is divided into small compartments known as lobules. Each lobule contains a sections of seminiferous tubule lined with epithelial cells. The epithelial cells contain many stem cells that divide and form sperm cells through the process of spermatogenesis. Interstitial cells, called cells of leydig, are found in between the seminiferous tubules and secrete testosterone. Sertoli cells are also found.

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II. Internal Male Reproductive organs:

1. **Epididymis:** The seminiferous tubules join together to become the epididymis. The epididymis is a tube that is about 2 inches long and coiled at posterior end. Within the epididymis the sperms complete their maturation. It also stores and nourishes sperms. The smooth muscle in the wall of the epididymis propels the sperm into the duetus deferens. Vasa efferentia from the rete-testis open into the epididymis.

   The epididymis has three parts:

   i. Head or caput epididymis – proximal part of epididymis
   ii. Body or corpus epididymis – Highly convoluted middle part
   iii. Tail or cauda epididymis – distal part of epididymis, which carry the sperms to the vas deferens.

   The cauda epididymis continues to form less convoluted vas deferens. The total lenth of epididymis is almost 20 feet or 6 meters long.

2. **Ductus Deferens:** Also known as vas deferens, the ductus deferens is a thin tube approximately 30 cm long that starts from the epididymis to the pelvic cavity. It carries the spermatozoa from the epididymis to the ejaculatory duct.

3. **Ejaculatory Duct:** The ductus deferens passes through the prostrate gland and joins with the urethra as a structure known as ejaculatory duct. The ejaculatory duct contains the ducts from the seminal vesicles as well. During ejaculation, the ejaculatory duct opens and expels sperm and the secretions from the seminal vesicles into the urethra.

4. **Urethra:** Semen passes from the ejaculatory duct to the exterior of the body via the urethra, an 8 to10 inch long muscular tube. The urethra passes through the prostrate gland and ends at the external urethral orifice located at the tip of the penis. The urethra serves a dual function in males. This channel is the part of the urinary tract that transport urine from the bladder and the part of the reproductive system through which semen is ejaculated. When the penis is erect during sex, the flow of urine is blocked from the urethra, allowing only semen to be ejaculated at orgasm.

   Accessory Reproductive Organs of male human

   The seminal vesicles, prostrate glands and bubourethral glands constitute the asessory organs of male human.

5. **Seminal vesicles:** The seminal vesicles are a pair of lumpy exocrine glands that store and produce some of the liquid portion of the semen. The seminal vesicles are 2 inches in length and located posterior to the urinary bladder and anterior to the rectum. The liquid produced by the seminal vesicles contains proteins and mucus and has an alkaline p^H to help sperm survive in the acidic environment of the vagina. The liquid also contains fructose to feed sperm cells so that they survive long enough to fertilize the oocyte. The duct of each seminal vesicle joins the ductus deferens on that side to form the ejaculatory duct.

6. **Prostate Gland:** The prostate is a walnut – sized exocrine gland and surrounds the urethra. The prostate produces a large portion of the fluid that makes up semen. The fluid is milky white in colour and contains enzymes, protein, and other chemicals to support and protect sperm during ejaculation. The prostate also contains smooth muscle that can constrict to prevent the flow of urine or semen.

7. **Bulbourethral Glands or Cowper's Glands:** The bulbourethral or Cowper's glands are a pair of pea–sized exocrine glands located inferior to the prostate and anterior to the anus. The Cowper's glands secrete a thin alkaline fluid into the urethra that lubricates the urethra and neutralizes acid from urine remaining in the urethra after urination. This fluid enters the urethra during sexual arouse prior to ejaculation to prepare the urethra for the flow of semen.

9. 2075 Set B Q.No. 3 Describe the structure and functions of an adrenal gland. [7.5]

The adrenal glands are endocrine glands found in the abdominal region. Human body has two adrenal gland and one sits on top of each human kidney, therefore, referred to as suprarenal gland.

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Their name directly relates to their location (ad-near or at; renes - kidneys). They are yellowish in colour and highly vascularized. They lie beneath the peritoneum i.e., they are retroperitoneal. Each adrenal gland weight 4/5 grams in an adult. The adrenal gland measures approximately 3 cm in width, 5 cm in length and 1 cm in thickness.

The adrenal glands are surrounded by a fatty capsule and lie within drenal fascia (connective tissue), which also surrounds the kidneys. A weak wall of connective tissue separates the glands form the kidneys. The right adrenal is pyramidal whereas the left one is more crescentric.

Histologically, each adrenal gland is composed of two distinct parts:

1. the adrenal cortex, and
2. the adrenal Medulla.

The adrenal cortex is the outer part, which constitute 90% of the total volume of the adrenal gland, while the inner part is called the adrenal medulla, which comprises 10% of the adrenal gland's volume. The two parts differ in embryological origin; structure and function. Both cortex and medulla secrete their specific hormones. The adrenal cortex is controlled by the anterior lobe of the pituitary gland, while the medulla is controlled by the autonomic nervous system (ANS).

1. **Adrenal (Cortex):**

The adrenal cortex is affected by Adreno-corticotrophic Hormone (ACTH) secreted by the adrenal cortex to produce its hormones. The adrenal cortex is derived from the mesodrem of the embryo i.e. mesodermal in origin. The adrenal cortex is devoted to the synthesis of corticosteriod hormones from cholesterol. All the hormones secreted by adrenal cortex are steroids.

The adrenal cortex is composed of three structurally different concentric zones. From the outside in, they are as follows:

i. Zona glomerulosa
ii. Zona fasciculate
iii. Zona reticularis.

i. **Zona glomerulosa, It's hormones and their functions**: Zona glomerulosa is the outermost layer of adrenal cortex. It constitute about 15% of the gland. Its cells are closely packed and arranged in spherical clusters and arched columns which secrete hormones called mineralo-caorticoids because they affect mineral homeostasis.

- The zone glomerulosa produces aldosterone, which is the main mineralocotricoid. It acts on the kidney to conserve salt and water.
- Aldosterone's functions are associated with the maintenance of water and electrolyte balance in the body.
- It is secreted when the sodium level is low in the blood.
- It acts on the kidneys to cause more sodium to be returned to the blood and more potassium to be excreted.

As the sodium concentration in the blood increase, water follows it by osmosis, thereby, increasing blood volume and blood pressure.

- The blood potassium level regulates the amount of aldosterone produced by the adrenal cortex. When the blood potassium level rises, more aldosterone is secreted.
- Angiotensin also stimulates the secretion of aldosterone. When renal blood flow is reduced or blood sodium level fall, the enzyme renin is secreted by kidney cells. Renin converts the plasma protein angiotensionogen, produced by the liver, to angiotensin I. Angiotensin converting enzyme (ACE), formed in small quantities in the lungs, proximal kidney tubules and other tissue converts angiotensin I into angiotensin II, which stimulates the secretion of aldosterone.

ii. **Zona fasciculate, its horomes and functions:**

This is the middle zone and the widest one among the three zones. It constitutes about 50% of the gland. It consists of the cells arranged in long, straight columns. The cells of this zone secrete glucocorticoids, which are named because they affect glucose homeostasis. The glucocorticoids

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target the kidney for various metabolic functions. They are in three forms: Cortisol, cortisone, and corticosterone. Cortisol is the most abundant about 95% of total corticoids.

The glucocorticoids has given functions:

- The glucocorticoids target the liver and stimulates it to synthesize glucose from non-carbohydrates such as amino acids and glycerol. This process is called gluconeogenesis. Breakdown of triglycerides into fatty acids and glycerol energy production is called lipolysis.
- Cortisol is anti-inflammatory and help in reducing pain. It retards phagocytic activities of white blood cells and thus suppresses "inflammation reaction'. Due to this, they are often given to patients with inflammatory diseases such as rheumatoid arthritis and asthma.
- Glucocorticoids also reduce the function and action of the immune system, making them useful for protecting against transplant rejection and ameliorating autoimmune and allergic disease.
- Cortisol has the capacity to cope with stress by elevating blood pressure. That is why it is called stress hormone.

iii. **Zona reticularis, its hormone and functions:**

It is the innermost cortical layer directly adjacent to the medulla. It cells form irregular cords and clusters, separated by capillaries and connective tissue. They usually targets the gonads i.e. testes in males and ovaries in female. Small amounts of male and female sex hormones called sex - corticoids or gonado corticoids are released by this zone. However, their impact are usually overshadowed by the greater amounts of hormones released by the ovaries or testes. More sex corticoids are released than female sex corticoids.

- The more male sex corticoids are called androgens. The androgens include Dehydroepiandrosterone (DHEA) and Androstenedione, which are the precursor of testosterone. Although the genetic sex is determined by the chromosomes in a fertilized egg, a male foetus develops normal male characteristics only if the foetal gonads and adrenals produce sufficient quantities of androgens. The androgens stimulate the production of male secondary sexual characters like growth of hair, enlargement of larynx, etc.
- Similarly, the female sex hormones like oestrogen maintain the development of female secondary sexual characters.

2. **Adrenal Medulla:**

The adrenal medulla is embedded in the centre of the cortex of each adrenal gland. It is small, making up only about 10% of the total adrenal weight. The adrenal medulla develops from the neuroectoderm of the embryo. The adrenal medulla consists of rounded groups of relatively large and granular cells, known as chromaffin cells. These cells are modified postganglionic cells of the sympathetic nervous system, which have lost normal processes and have acquired a glandular function. These cells are connected with the preganglionic motor fibres of the sympathetic nervous system. Indeed, the adrenal medulla is an integral part of the sympathetic nervous system, a major subdivision of the autonomic nervous system. The sympathetic nervous system and the adrenal medulla are collectively known as the sympatho-adrenal system.

The medulla of adrenal glands secretes two hormones

i. Adrenaline or Epinephrine

ii. Non-adrenaline of Non-epinephrine.

The adrenaline has a greater effect on the heart and metabolic processes where as noradrenaline has more influence on blood vessels.

i. **Function of Adrenaline:**

Adrenaline prepare the body for "Fright, fight of flight" and has many effects. They are also called "emergency hormones"

- This hormone rapidly responds to stress by increasing the heart rate and rushing blood to the muscles and brain.
- Increase the conversion of glycogen to glucose in the liver to provide energy to the tissue when needed. This process is called glycogenesis.

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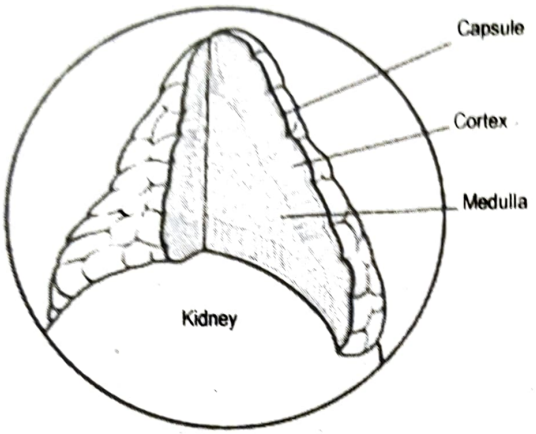
- Metabolic rate increases
- Rate and depth of breathing increases
- Force of muscular contraction improves
- Onset of muscular fatigue is delayed.
- Blood supply to the bladder and intestine is reduced, their muscular walls relax, the sphincters contract.
- Dilates the blood vessel i.e. vasodilator, used in the treatment of asthma.



L.S of adrenal gland

ii. **Function of Non-adrenaline**

It has similar effects to adrenaline:

- Constriction of small blood vessels leading to increase in blood pressure.
- Increased blood flow through the coronary arteries and slowing of heart rate
- Relaxation of the smooth muscle in the intestinal wall.

Conclusion: The adrenal glands have a multiple functional role in the endocrine system.

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10. 2075 Set B Q.No. 3 OR **Describe the structure of a nephron giving its working mechanism.** **[7.5]**

Each of the two human kidneys consists of over a million nephrons. Nephrons are the microscopic structural and functional units of the kidney. It produces urine in the process of removing waste and excess substances from the blood. There are two types fo nephrons according to their locations in the kidney: Cortical nephrons lying in the cortex of kidney and juxtamedullary nephrons lying in the medulla of the kidney.

Structure of a nephron:

Each nephron in the human kidney is a long tubule, or extremely fine tubule, about 30 to 55 mm (1.2 to 2.2 inches) long. Each nephron is composed of two parts:

i. Renal corpuscle: The initial filtering components
ii. Renal tubule: That processes and carries away filtered fluid.

i. **Renal Corpuscle:**

- This is the head of the nephron and it is where urine first forms.
- It consists of glomerulus, which is surrounded by Bowman's capsule.
- The glomerulus is like a network of capillaries. The Bowman's capsule, around the glomerulus, shapes like a funnel.
- Blood is filtered across the glomerular, capillaries into bowman's space. This is the first step of urine formation. filtrates than exits the Bowman's space into the renal tubule
- Each renal corpuscle has two poles:

a. **Vascular pole:** This is where afferent arteriole enters the glomerulus and where efferent arterioles leave the glomerulus.

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b. **Urinary pole**: This is where filtrates produced by the glomerulus exit and enter the first part of tubule.

- Bowman's capsule is composed of a visceral inner layer formed by specialized cells called podocytes, and a parietal layer composed of simple squamous epithelium.

ii. **Renal Tubule:**

- Filtrates from the glomerulus enters the tubule where urine continually forms. The renal tubules functions in reabsorption, secretion and excretion.
- The components of the renal tube are as follows:

a. **Proximal Convoluted Tubule (PCT):**

This is the first part of the renal tubule and lies in the cortex of the kidney, close to the renal corpuscle. Fluid that is filtered from the Bowman's capsule enters the proximal tubule. It consists of brush-bordered cuboidal epithelium.

Working mechanism of PCT:

- PCT reabsorbs two-third of the filtered sodium (65 – 80% of sodium) and water.
- It reabsorbs all the glucose, amino acids. Glucose is reabsorbed via sodium - Glucotransporter.
- It reabsorbs a fraction of the bicarbonate, potassium, phosphate and calcium.
- It secretes ammonia, which functions as a buffer for hydrogen ions.
- Hydrogen ions, uric, acid and drugs are secreted form the blood into the PCT.
- After filtrates leave the PCT, it enters into proximal straight tubule and finally into the loop of Henle.

b. **Loop of Henle:**

It is U-shaped and lies in the medulla of the kidney. It has different segments, which perform different functions.

i. **Thin Descending Loop (TDL)**

- It is highly permeable to water. Water is reabsorbed here by osmosis.
- It is impermeable to sodium.
- It allows the urine to be concentrated. The urine in TDL is hypertonic.

ii. **Ascending Limb of loop of Henle**

The ascending limb of loop of Henle is divided into two segments: 1. Thin ascending limb of loop of Henle 2. Thick ascending limb of loop of Henle.

- The lower end of ascending limb is very thin and is lined by simple squamous epithelium.
- The distal portion of ascending limb is thick and is lined by simple cuboidal epithelium, where sodium, potassium and choloride are actively reabsorbed, while it is impermeable to water. This segment makes the urine less concentrated or hypotonic.
- The loop of Henle reabsorbs 10 – 20% sodium and chloride and 10% of the filtered water.

c. **Distal convoluted Tubule (DCT):**

- This segment of renal tubule lies behind the thick ascending loop of Henle.
- It is lined with simple cuboidal epithelium.
- It actively reabsorbs sodium and chloride.
- It is relatively impermeable to water, but in presence of antidiuretic hormone (ADH), it becomes permeable to water and the urine becomes concentrated
- It secretes ammonia and hydrogen ions.

d. **Collecting Tubule and Duct**

Collecting tubule is the final segment of the renal tubule before it enters the collecting duct system.

- The collecting duct runs through the cortex into the medulla and opens into the renal papilla. It consists of cuboidal and columnar epithelium.
- It has two types of cells:

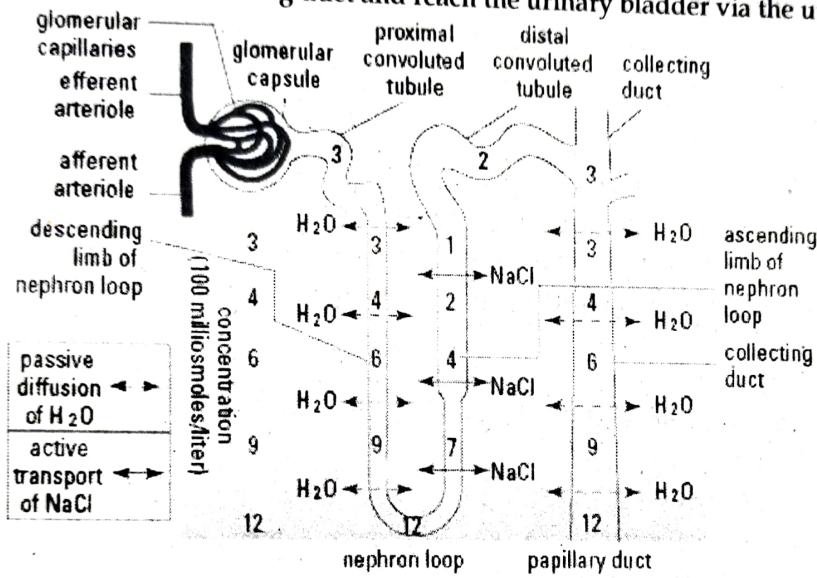
1. **Principle cells:**
   - Reabsorbs sodium and water, and sent to the blood.
   - Secretes potassium

These functions are regulated by ADH and aldosterone.

Aldosterone increases sodium reabsorption and increase potassium secretion. ADH enhances water reabsorption into the blood. When high amount of ADH is secreted, more water is reabsorbed and sent to the blood, resulting in low volume of urine excretion. Decrease ADH results in diluted high urine volume excretion. ADH increase water permeability of the ducts.

2. **Intercalated calls:**
   - Secretes hydrogen ions
   - Reabsorbs potassium

The final components of urine are water, sodium chloride, calcium, potassium, bicarbonate, creative and urea. Urine leaves the collecting duct and reach the urinary bladder via the ureter.

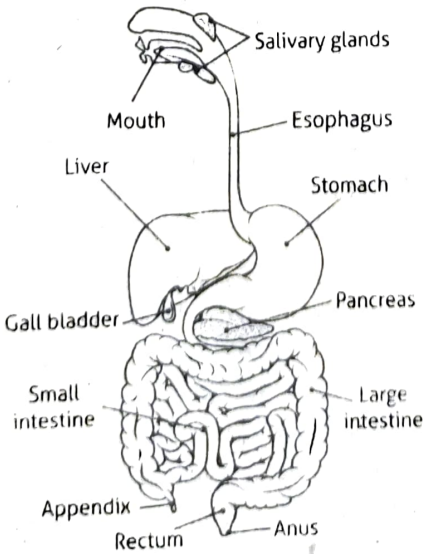


Regulation of Urine Concentration

1. **2074 Supp Q.No. 3 Give an account on human alimentary canal.** **[7.5]**

Alimentary canal, also called digestive tract is a pathway by which food enters the body and the solid wastes are expelled. The alimentary canal is a partially coiled long tube which starts at the mouth, runs through the stomach and intestine and finishes at the anus. It is part of the digestive system. In human, it measures 8 to 10 meters in length.

Main regions of the alimentary canal are follows:



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1. **Mouth:** Mouth is actually the name for the opening of the alimentary canal. It is bounded by lips and cheeks. It is a transverse slit. Through the mouth food is ingested. Mouth leads into buccal cavity.
2. **Buccal Cavity:** Buccal cavity is also called oral cavity. It has three parts: palate, tongue and teeth.
   i. **Palate:** It forms the roof of the oral cavity. Anterior part is called hard palate and posterior part is called soft palate. Hard palate consists of transverse ridges called rugae, which help to hold the food during mastication. The hinder part of the soft palate is called uvula, which is a small muscular flap.
   ii. **Tongue:** It is a muscular and glandular structure attached to the base of the buccal cavity. On the upper surface it has a V–shaped furrow called sulcus terminalis. It divides the tongue into the anterior oral part and posterior pharyngeal parts. Its upper surface consists of tiny projections called lingual papillae. Lingual papillae are of three kinds in humans:
      a. Vallate or Circumvallate papillae – Having gustatory receptors to sense taste.
      b. Filliform papillae – smallest and contain touch receptors.
      c. Fungiform papillae – Rounded and mostly present at the tip of the tongue.

      The tongue tastes food and moves it to the pharynx.
   iii. **Teeth:** Human teeth are said to be thecodonot (embedded in the socket of jaw), heterodont (of different types) and diphyodont (erupt twice in whole life).

      Therefore, humans have two sets of teeth – temporary or deciduous or milk teeth and the permanent teeth.

      Four types of permanent teeth are found in human:
      i. Incisors for cutting
      ii. Canines for tearing
      iii. Premolars for chopping
      iv. Molars for grinding
3. **Pharynx:** The oral cavity opens into a 5 inched long pharynx. It has three parts: nasopharynx, oropharynx and laryngopharynx. The swallowing mechanism guides the masticated food through the pharynx into a tube called oesophagus.
4. **Oesophagus (Food pipe):** Oesophagus is a muscular tube lined with mucous membrane which stretches from the lower limit of pharynx to the cardiac orifice of the stomach. It is about 25cm long and 2.5cm in diameter. It is sharphy bent at the point at which it meets the stomach. This prevents the backward movement of food from the stomach into it.

   The alimentary canal has layers of muscle in its wall throughout its entire length. These layers of smooth muscle can contract and relax in an antagonistic fashion to push the bolus (food) along the tube. There are two main types of smooth muscles in the wall of the alimentary canal: circular muscle fibres are arranged around the circumference of the tube and longitudinal muscle fibres are arranged along the length of the tube. The muscular walls of the oesophagus move in a rhythmic wave like manner, which carries the food down to the stomach. This involuntary muscular movement is called peristalsis. Food passes from the mouth to the stomach through the oesophagus.
5. **Stomach:** The stomach is an irregularly pear–shaped bag, situated in upper and left part of the abdomen. The stomach is a muscular storage organ that keeps food in it for around 3–4 hours before pushing it into the duodenum. It lies just behind the left lobe of the liver. It is about 25 cm in length and has a capacity of about 2 litres in adult.

   The stomach has four parts – cardiac part, fundus, body and pyloric part.
   i. Cardiac part: it is so called because it is present close to the heart. The opening of oesophagus to the stomach is regulated by the cardiac sphincter.
   ii. Fundus: Fundus is dome–shaped and is usually filled with air.
   iii. Body: It is the main part of the stomach and also the middle part of the stomach.
   iv. Pyloric part: The posterior part of the stomach is called pyloric part. The opening of pylorus into small intestine is regulated by pyloric sphincter.

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Internally, the mucosa of an empty stomach is thrown into numerous folds, called gastric rugae, which flatten when the stomach is distended. The inner wall of the stomach lining has columnar cells and sunken pits. Each pit constitutes a gastric gland. The cells lining a gastric pit, or glands are of three kinds.

i. Mucous cells, which secrete mucus.
ii. Parietal or oxyntic cells, secreting hydrochloric acid.
iii. Chief cells or zymogen cells, secreting inactive enzyme pepsinogen.

The muscle layers in the stomach wall churn the food and mix it with the secretions of the stomach lining. These secretions are called gastric juice, which contains a mixture of hydrochloric acid, mucus and pepsinogen. About 3 litres of gastric juice is produce per day. The acid makes the gastric juice overall very acidic around p^H 1.5. This acidity forms part of the non–specific defences of the body against bacteria as the extreme p^H kills almost all bacteria in the food. The mucus protects the cells, lining the stomach from acidity. Hydrochloric acid converts the inactive pepsinogen to active pepsin, a protein digesting enzyme. Digestion of protein and fats begin in the stomach. Pepsin breaks down proteins into peptones, and gastric lipase breaks down lipids.

6. **Small Intestine:** The small intestine is about 6 meters in length and 2.5 cm in thickness. There are three divisions of the small intestine: Duodenum, Jejunum and Ileum.

i. **Duodenum:** It is the first part of the small intestine. It begins with pyloric stomach, and is C-shaped. It is 25 cm long in adult humans. In the middle o the duodenum, two different ducts open through a common aperture. One duct is called common bile duct and the other is the pancreatic duct. Together they are called hepato pancreatic duct.

The common bile duct carry a yellow greenish alkaline juice called bile from the liver and pours down into the duodenum. Similarly, the pancreatic duct carry pancreatic juice from the pancreas and drain into the duodenum. The opening of common bile duct is guarded by sphincter of Oddi. Pancreatic juice contains a number of digestive enzymes such as amylase, trypsinogen, lipase, etc.

Duodenum is the site of digestion. The inner wall of duodenum has crypts of lieberkuhn and Brunner's glands.

ii. **Jejunum:** Jejunum is the middle part of the small intestine and measures about 2.5 m in length. It is thick – walled and more vasculature.

iii. **Ileum:** Ileum is the lower part of the small intestine. It is 3.5 meter long and opens into caecum of large intestine. Ileum is the site of food absorption. It has payer's patches in its inner wall.

7. **Large Intestine:** It is located just behind the ileum. The large intestine is divided into three major parts: anteriorly placed caecum; middle part, the colon, and posteriorly placed rectum.

i. **Caecum:** It lies in between the ileum and colon. It measures about 6cm long and 7.5cm broad. The caecum ends in the vermiform appendix, which is a vestigial organ. Vermiform appendix is an 8 cm long blind tube, which sometime becomes a source of trouble.

ii. **Colon:** It is about 1.3cm long and divided into four regions: (a) ascending colon, (b) transverse colon (c) descending colon, and (d) sigmoid colon.

The wall of colon contains thickened bands of muscles called the taeniae coli. The sacculations of the wall of colon are called haustra. Colon is the home to varied population of bacteria, called the gut–flora. Few minerals and vitamins are absorbed in the colon.

iii. **Rectum:** Rectum is the distal part of the large intestine. It is found just behind the sigmoid colon. It is about 12 cm long. Rectum is involved in storing faecal matter before defaecation. Water is absorbed in the rectum and it synthesizes vitamin K.

8. **Anal Canal:** It is the last part of the digestive tract. It is 3.8cm long. It has two anal sphincter – external and internal anal sphincters. Anal canal lining contains several vertical folds called the anal columns. Anal canal opens outside into anus.

9. **Anus:** It is the termination of alimentary canal. It is an aperture from where the undigested food is thrown outside.

12. 2074 Supp Q.No. 3 OR **What is cancer? Discuss the cause and treatment of cancer.** [7.5]

Cancer is a group of diseases involving abnormal cell growth with the potential to invade or spread to other parts of the body. There are over 100 different types of cancer, and each is classified by the type of cell that is initially affected. They form a subset of neoplasms. A neoplasm or tumor is a group of cells that thave undergone unregulated growth and will often form a mass or lump, but may be distributed diffusely. The pathological process in tumor formation is called neoplasia.

Cancer can start almost anywhere in the human body, which is made up of trillions of cells. Normally human cells grow and divide to form new cell as the body needs them. When cells grow old and become damaged, they die, and new cells take their place. When cancer develops, however, this orderly process breaks down. As cells become more and more abnormal, old and damaged cells survive when they should die, and new cells form when they are not needed. These extra cells can divide without stopping and may forms growths called tumors.

Many cancers are in solid forms or tumors, which are the masses of tissue. Cancer of blood and lymph generally do not from solid tumors.

Causes of cancer: Cancer is ultimately the result of cells that uncontrollably grow and do not die. Normal cells in the body follow an orderly path of growth, division, and death. Programmed cell death is called apoptosis, and when this process breaks down, cancer begins to form. Unlike regular cells, the cancer cells do not experience programmed death and instead continue to grow and divide and leads to the mass of abnormal cells that grow out of control. The normal cells mature into a very distinct types of cells with specific functions, whereas cancer cells do not. This is the one reason, unlike normal cells, cancer, cells continue to divide without stopping.

In addition, cancer cells are able to ignore signals that normally tell cells to stop dividing, or apoptosis, which the body uses to get ride of unneeded cells.

Cancer cells may be able to influence the normal cells. molecules, and blood vessels that surround and feed a tumor. Cancer cells are also often able to evade the immune system, a network of organs, tissues, and specialized cells that protect the body from infections and other conditions. The process by which cancer cells spread to other parts of the body is called metastasis.

How Cancer Arises?

Cells can experience uncontrolled growth if there are mutations to DNA, and therefore, alternations to the genes involve in cell division.

There are certain "Drivers of cancer". The genetic changes that contribute to cancer tend to affect there main types of genes–

1. Proto-oncogene, 2. Tumor suppressor genes, 3. DNA repair genes. These changes are called "Drivers" of cancer.

Proto-oncogene are involved in normal cell growth and division. However, when these genes are altered in certain ways or more active than normal, they may become cancer-causing genes (or oncogenes), allowing cells to grow and survive when they should not.

Tumor suppressor genes are involved in controlling cell growth and division. Cells with certain alterations in tumor suppressor genes may divide in an uncontrolled manner.

DNA repair genes are involved in fixing damaged DNA. Cells with mutations in these genes tend to develop additonal mutations in other genes. Together there mutations may cause the cells to become cancerous.

Causative Agents of Cancer: Any substance that causes cancer is called carcinogen or carcinogenic agent. In other words, carcinogens are a class of substances that are directly responsible for damaging DNA, prompting or aiding cancer. Tobacco, asbestos, arsenic, radiations such as gamma and x-rays, the sun, and compounds in vehicles exhaust fumes are all examples of carcinogens. When our bodies are exposed to carcinogens, free radicals are formed that try to steal electrons from other molecules in the body. These free radicals damage cells and affect their ability to function normally. The exact cause of cancer is still unknown. The development of cancer depends upon multiple factors.

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The carcinogens may be physical, chemical or biological.

A. **Physical carcinogenic Agents**

Physical carcinogenic agents include the followings:

1. **Radiations:** Higher - energy radiation, including ultraviolet radiations (present in sunlight), x-rays, and gamma ray, generally is carcinogenic, if received in sufficient doses. Ultraviolet rays from sunlight is the most common cause of skin cancer. In Australia, where people with pale skin are often exposed to strong sunlight, melanoma is the most common cancer diagnosed in people aged 15 - 44 years.
2. **Physical Irritation or Injuries:** Constant irritation or injuries which continues for a long time may produce cancer in that area. For example; The edge of a broken tooth rubbing against the tongue may cause cancer of the tongue at the point of irritation.

B. **Chemical carcinogenic Agents**

1. **Tobacco smoking:** Tobacco smoke contain over fifty known carcinogens, including nitrosomines and polycyclic aromatic hydrocarbons. Tobacco smoking is related to cancer in the lungs, larynx, head, neck stomach, bladder, kidney, oesophagus and pancreas. Tobacco is responsible for about one in five cancer death worldwide.
2. **Chewing of Tobacco:** Chewing of tobacco can cause oral cancer, throat cancer, lip cancer, gum cancer, stomach cancer, etc.
3. **Alcoholism:** Excess alcohol drinking for a long time may cause cancer of liver and digestive tract.
4. **Contaminated water:** Drinking water contaminated by arsenic and its compounds may cause gastro-intestinal cancer. Taking bath with water containing arsenic may cause skin cancer. Inhaling arsenic and its compounds through herbicides, fungicides and pesticides may cause lung cancers.
5. **Over exposure to benzene:** Constant inhalation of benzene through light fuel oil, printings, lithography, paint, rubber, dry cleaning, adhesives, coatings and detergent may cause cancers of blood (leukemia) and lymph (Hodgkin's lymphoma)
6. **Processed food:** Chemicals like nitrites used as food preservatives in cured meat such as bacon have been noted to cause colon cancer.
7. **High salt diet:** Gastric cancer is more common in Japan due to its high salt diet.

C. **Biological Carcinogenic Agents**

1. **Infections:** Approximately 15% of cancer deaths are related to infections disease, globally. Viruses are the usual infections agents that cause cancer but bacteria and parasites may also have an effect.

   A virus that can cause cancer is called oncovirus. These include human papilloma virus (cervial carcinoma), Kaposi's sarcoma herpvirus (Kaposi's sarcoma), Hepatitis B and Hepatitis C viruses (Hepato cellular carcinoma), and Human T-cell Leukemia virus-1 (T-cell Leukemia).

   Bacterial infection may cause gastric carcinoma. Parasitic infections may cause squamous cell carcinoma of bladder (i.e. schistosoma haematobium).
2. **Lack of physical exercise and obesity:** Physical inactivity is believed to contribute to cancer not only through its effect on body weight but also through negative effects on immune system and endocrine system. Obesity may cause colon cancer.
3. **Heredity:** The vast majority of cancers are non-hereditary. Heredity cancers are primarily caused by an inherited genetic defect. Less than 0.3% of the population are carriers of a genetic mutation which has a large effect on cancer risk. e.g. Breast and ovarian cancer.
4. **Hormones:** Some hormones play role in the development of cancer by promoting cell proliferation. Higher level of Oestrogen and Progesterone hormones in adult female human may, results in the development of breast cancer. Similarly, higher level of testosterone in adult male has higher chance of developing prostate cancer. Higher level of growth hormone may promote osteosarcoma.
5. **Ageing:** Ageing is another fundamental factor for the development of cancer. The incidence of cancer rises dramatically with age. The overall risk accumulation is combined with the tendency for cellular repair mechanisms to be less effective as a person grows older.

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Cancer is a leading cause of death world wide, accounting for 8.8 million death in 2015.

Cancer Treatment: There are many types of cancer treatment. The types of treatment depend on the type of cancer and how advanced it is. Some people with cancer will have only one treatment. But most people have a combination of treatments, such as surgery with chemotheapy and/or radiation therapy.

Following are the most common methods for the treatment of cancer:

1. **Surgery:** In surgery, the tumor is removed by physical operation. It is only applicable for small cancer and localized cancer. When the cancer has metastasized, it is impossible.
   The goal of surgery can be either the removal of only the tumor, or the entire organ. Surgery is used for the treatment of cancers of breast, prostate, lung, liver brain, etc.
2. **Radiation Therapy:** Radiation Therapy (also called Radiotherapy) is the use of ionizing radiation to kill cancer cells and shrink tumors. Radiotherapy is used to treat almost every type of solid tumor, including cancers of the brain, breast, cervix, larynx, liver lung, pancreas, prostrate, skin, stomach, uterus, or soft tissue sarcomas. Radiation is also used to treat fluid cancers like leukemia (blood cancer and lymphoma (lymph cancer).
3. **Chemotherapy:** Chemotherapy is the treatment of cancer with anticancer drugs, that can destroy cancer cells. Chemotherapy drugs interfere with cell division in various possible ways e.g. with the duplication of DNA or the separation of newly formed chromosomes. The treatment of leukemias and lymphomas requires the use of high-dose chemotherapy.
4. **Targeted Therapy:** This therapy is used to cure breast cancer.
5. **Immunotherapy:** Cancer immunotherapy refers to a diverse set of therapeutic strategies designed to induce the patients own immune system to fight the tumor. Vaccines are given to the patients to generate specific immune responses to tumors. This therapy is carried out to cure cancers of bladder, renal cells (kidney), skin and prostate.
6. **Hormonal Therapy:** The growth of some cancers can be inhibited by providing or blocking certain hormones. Common examples are hormone sensitive tumors i.e. breast and prostate cancers.

Prevention of cancer: Seven Tips To Reduce The Risk

1. **Do not use tobacco**
2. **Eat a healthy diet**
   - Eat plenty of fruits and vegetables, Avoid obesity, Limit processed foods and meats.
3. **Maintain a healthy weight and be physically active**
4. **Protect yourself from the sun**
   - Avoid midday sun, Stay in the shade, Cover exposed areas of the body, Avoid tanning beds and sun lumps.
5. **Get immunized**
   - Hepatitis B vaccine, Human palillomavirus (HPV) vaccine.
6. **Avoid Risky behaviours**
   - Practice safe sex, Not sharing needles.
7. Do regular medical care

"The best protection from cancer is early detection"

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13. 2074 Supp Q.No. 4 **Describe the physiology of respiration.** [8]

Aerobic respiration is the process of producing cellular energy involving oxygen. Cells break down food in the mitochondria in a long, multistep process that produce 38 ATP molecules. In complete oxidation of one molecule of glucose, 686 K cal of energy is produce and the energy is utilized according to the need of the cell.

Aerobic respiration can be represented as:

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6O_2 + 6H_2O + \text{energy (686 K cal)}$$

(Glucose)

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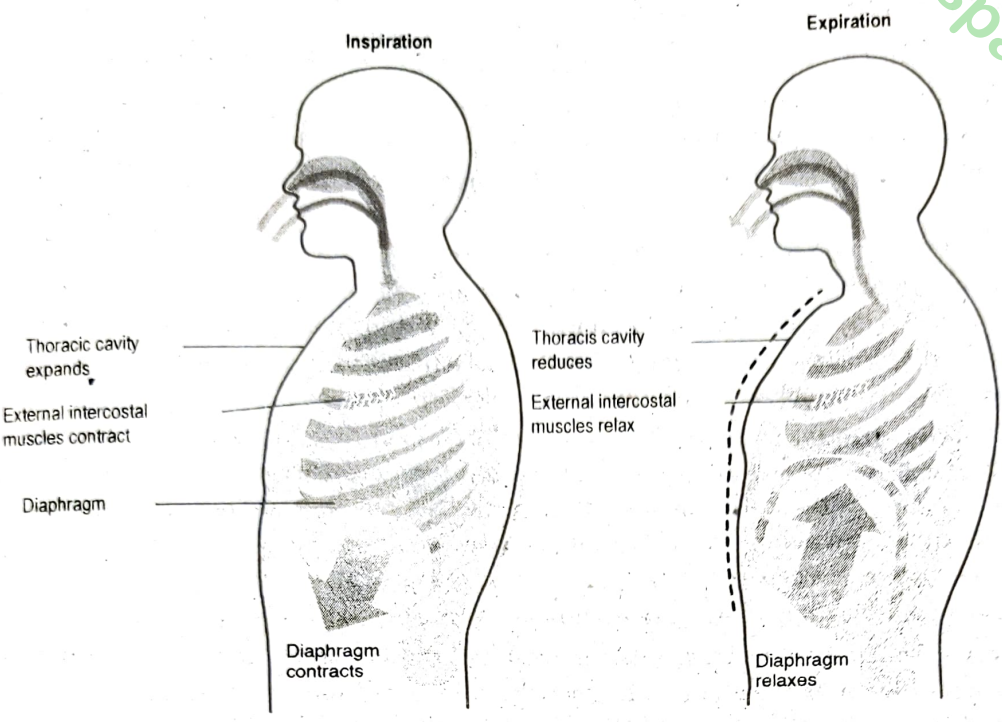
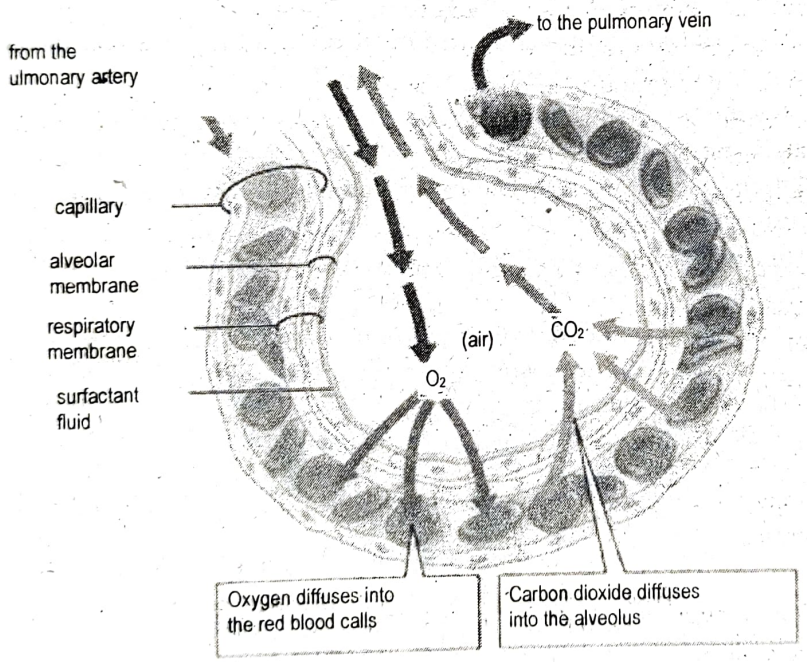


Pulmonary ventillation



Exchange of gases

Respiration through a pair of lungs is called pulmonary respiration.

The human pulmonary respiration is studied under the title: Human Respiratory System and its mechanism.

The human respiratory system consists of a pair of lungs and a series of air passages leading to the lungs. The entire respiratory tract (passage) consists of the nose, pharynx, larynx, trachea, bronchi and bronchioles. Air enters the nose through the nostrils. When air passes through the nose, it is warmed, moistened and filtered. The hair present in the nose filter out particles in the incoming air. The air is moistened by the mucus present in the nose and it is warmed by the blood flowing through the capillaries in the nose.

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The respiratory tract from the nose to the bronchioles is lined by mucous membrane and cilia. The mucus membrane and cilia act as additional filters.

Behind the nose lies the pharynx (throat). There are two passages here –one for food and the other for air. The air passes from the pharynx to the larynx, the opening of which is called the glottis. The glottis is protected by a lid called epiglottis, which prevents food from entering the passage to the lungs.

From the larynx the air goes to the trachea, or the windpipe. The trachea is about 11cm long. It is guarded by 16–20 C–shaped tracheal rings, which prevent the trachea from collapsing. The trachea divides into two tubes called bronchi. Each bronchus divides and branches out into thinner tubes called bronchioles. The bronchioles enter the lungs and further divides into even smaller branches called alveolar ducts. These open into extremely thin-walled, grape–shaped air sacs called alveoli, each of which is covered by a web of blood capillaries.

The lungs are a pair of spongy organs lying in the chest cavity, formed by the ribs. The exchange of gases between the air and the body takes place in the capillary–covered alveoli inside the lung. Here, oxygen from the air in the alveoli goes into the blood, and the carbondioxide in the blood goes out. The oxygen binds to the haemoglobin molecules present in the red blood corpuscles and is taken to different parts of the body. There are millions of alveoli in the lungs.

Mechanism of Pulmonary Respiration: The main purpose of respiratory system is to provide oxygen to the tissues and to remove carbondioxide from them. This entire process is achieved through the following steps:

1. **Breathing or Pulmonary Ventilation:** There are two main types of breathing: Inspiration and expiration.

   i. **Inspiration (Inhalation or Intake of air):** Inspiration is the process of breathing in, by which air is brought into the lungs.

   Inspiration involves the following steps:

   a. A muscular dome shaped diaphragm is present at the base of the lungs. On contraction it becomes flattened and lowered. The lower surfaced of lungs is pulled downwards and the volume of lungs increases.

   b. External intercostals muscles present between the ribs contract, the rib cage moves outwards and upwards.

   c. These contractions together increase the volume of the chest cavity, lower the air pressure within the lungs and the atmosphere air rushes in filling the lungs with fresh air. Thus inspiration is an active phase of breathing.

   ii. **Expiration (Release of Air):** It involves following steps:

   a. The external intercostals muscles relax and the internal intercostals muscles contract.

   b. As a result, the rib cage lowers and moves inward.

   c. The diaphragm relaxes and rises to its original dome shaped position.

   d. This decreases the volume of the chest cavity, thus, increasing the air pressure within the lungs and the air, which is laden with CO_2 and is forced out.

2. **Exchange of gases at the alveolar surface:** Blood is the medium for the transport of oxygen form the lungs to the different tissues and carbon dioxide from tissues to the lungs. The deoxygenated blood is brought to the lungs by pulmonary artery which divides into fine capillaries that surround alveoli. Both alveoli and capillaries are made up of thin walled single layer of epithelial cells and, therefore, allow gaseous exchange easily. There are more oxygen in alveolar air and more carbondioxide in the capillaries.

   Due to the pressure difference of oxygen and carbondioxide between the alveoli and blood capillaries, the oxygen diffuses from the alveolar air into the blood capillaries. At the same time carbondioxide diffuses form blood capillaries into the alveolar air.

   Gaseous exchange in the lungs is referred to as external respiration. Each gas diffuses down its own partial pressure gradient, i.e., form a high to low partial pressure. The partial pressure of oxygen is 100 mm Hg in the alveolar air compared to only 40 mm Hg in the blood entering the lungs. The

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partial pressure of carbondioxide is 40 m Hg in the alveolar air and 45 mm Hg in the blood entering the lungs. The partial pressure gradient of each gas equilibrates as blood flows through the pulmonary capillaries. Therefore, the partial pressure of oxygen is 100 mm Hg and partial pressure of carbondioxide is 40 mm Hg in the blood leaving the lungs. This oxygen rich blood will then be delivered to the tissues, where oxygen is needed to make ATP as a source of energy.

3. **Transport and exchange of gases in the tissues:** Efficient transport of oxygen is by a complex blood protein called haemoglobin. This iron rich protein is packed in Red Blood Corpuscles (RBCs) giving blood a red colour. About 97% of the total oxygen is transported from lungs to the tissues in combination with haemoglobin. Only 3% of oxygen is transported in dissolved form by plasma.

Oxygenation of blood takes place in lungs. Four molecules of oxygen form reversible bond with haemoglobin forming the compound oxyhaemoglobin.

$$Hb + 4O_2 \underset{\text{Active tissue}}{\overset{\text{Lung Alveoli}}{\rightleftharpoons}} Hb(4O_2)$$

(Haemoglobin) (Oxyhaemoglobin)

When the oxygenated bloods reaches the tissue surface there is high concentration of CO_2 in the tissues, oxygen having been used up and low concentration of O_2. As a result the bonds holding oxygen and haemoglobin in oxyhaemoglobin become unstable and blood release oxygen and takes up CO_2.

4. **Internal Respiration in Metablolizing Tissues or Cellular Respiration:** Gases exchange in the metabolizing tissues is referred to as internal respiration. Compared with external respiration, the gases now move in opposite directions i.e., oxygen diffuses out of the blood into the tissues, and carbondioxide diffuses out of the tissue into the blood. Just like in the lungs, partial pressure gradients drive gas exchange in the tissues. The oxygen rich blood in the capillaries has PO_2 of about 100 mm Hg, compared to only 40 mm Hg in the metabolizing cells. Oxygen diffuses into the cells and does so until equilibrium is achieved across the respiratory membrane. Therefore, the PO_2 in the blood drops to 40 mm Hg as the blood flows through the capillary.

Oxygen taken in the blood is utilized in all the living cells during cellular respiration. It is a complex process that is completed in mitochondria. During cellular respiration, glucose is oxidized to release energy. Energy released is stored in ATP (Adenosine Triphosphate) molecules and is readily available for cell use.

During aerobic respiration, 38 molecules ATP are released on oxidation of one glucose molecule.

5. **Transport of Carbon dioxide from Tissues to Lungs:** Blood transports carbondioxide with comparative ease because of its highly solubility. CO_2 is transported to the lungs in three ways.

i. CO_2 is physically dissolved in blood plasma. (Only 5–7% of the total CO_2 transported)

ii. CO_2 directly combines with haemoglobin of RBCs to form Carbaminohaemoglobin (About 21 – 23%).

iii. As bicarbonate it is dissolved in plasma but produced in RBCs catalyzed by the enzyme carbonic anhydrase and then diffuses into plasma (largest fraction of CO_2, about 70 to 75%) to be transported in this manner.

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14. **2074 Set A Q.No. 3 Define aerobic respiration. Explain the mechanism of respiration in human being.[7.5]**

Please refer to 2074 Supp Q.No. 4

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15. **2074 Set A Q.No. 3 OR What is myogenic heart? Describe the internal structure of human heart with labelled diagram. [7.5]**

Myogenic heart

The type of heart, where the muscles of the heart are stimulated to contract by nerve impulse generated by the Sino Atrial (SA) Node. It is a cluster of cells, which are the part of heart muscles. The muscles of the heart can contract on their own, wihtout any external electrical stimulus from the brain or spinal cord. Examples are hearts of mammals including human.

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For internal structure of human heart

The heart is a muscular organ in humans, which pumps blood through the blood vessels of the circulatory system. Blood provides the body with oxygen and nutrients, as well as assists in the removal of metabolic wastes. In humans, the heart is located between the lungs, in the middle compartment of the chest, at the level of thoracic vertebrae $T_5 - T_8$.

The heart is cone – shaped, with its base positioned upwards and tapering down to the apex. An adult heart has a mass of 250–350 grams. The heart is typically the size of a fist: 12 cm long and 8 cm wide, and 6 cm in thickness.

A double membraned sac called pericardium surrounds the heart and attaches to the mediastinum. The pericardium has two layers– outer parietal layer and inner visceral layer that surrounds the heart. There is a pericardial fluid between these two layers and protects the heart from mechanical shock.

The heart wall is made up of three layers: the inner endocardium, middle myocardium and outer epicardium. These are surrounded by pericardium. The endocardium is composed of simple squamous epithelium and covers the heart chambers and valves. The endocardium secretes endothelins, which regulates the contraction of myocardium. The middle layer myocardium is composed involuntary striated muscle tissue surrounded by a framework of collagen. The outer layer is called epicardium or visceral layer.

Chambers of Heart: The heart has four chambers, two upper atria, the receiving chambers, and two lower ventricles, the discharging chambers. The auricles or atria are separated with each other by interatrial septum, while the ventricles are separated by interventricular septum. The atria open into the ventricles via the atrioventricular valves, present in the atrioventricular septum. This distinction is visible also on the surface of the heart as the coronary sulcus. The interventricular septum is visible on the surface of the heat as the anterior longitudinal sulcus and the posterior interventricular sulcus. The interventricular septum is much thicker than the interatrial septum, since the ventricles need to generated greater pressure when they contract.

Valves of Heart: The heart has four valves, which separate its chambers. One valve lies between each atrium and ventricle, and one valve rests at the exit of each ventricle.

The valves between the atria and ventricles are called atrioventricular valves. Between the right atrium and the right ventricle is the tricuspid valve, which has three cusps. These three cusps are connected to chordate tendinae and three papillary muscles named the anterior, posterior, and septal muscles, after their relative positions. The mitral valve or bicuspid valve lies between the left atrium and left ventricle. It has two cusps, an anterior and a posterior cusp, which are attached via chorade tendinae to two papillary muscles projecting from the ventricular wall.

The papillary muscles extend from the walls of the heart to valves by cartilaginous connections called chordate tendinae. These muscles prevent the valves form falling too far back when they close. During the relaxation phase of the cardiac cycle, the papillary muscles are relaxed and the tension on the chordate tendineae is slight. As the heart chambers contract, so do the papillary muscles. This creates tension on the chordate tendineae, helping to hold the cusps of the Atrioventriular (AV) valves in place and preventing them from being blown back into the atria.

There are two semi–lunar valves at the exit of each of the ventricles. There is pulmonary valve located at the base of the pulmonary artery. It has three cusps and has no connection with papillary muscles. When the ventricle relaxes blood flows back into the ventricle form the artery and this flow of blood fills the pocket–like valve, pressing against the cusps which close to seal the valve. Another valve called the aortic semi–lunar valve is located at the base of the aorta and is not attached to papillary muscles. This valve has three cusps which close with the pressure of the blood flowing back from the aorta.

The right atrium receives blood almost continuously form the body's two major veins, the superior and inferior venacava. A small amount of blood from the coronary circulation also drains into the right atrium via the coronary sinus, which is immediately above and to the middle of the opening

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of the inferior venacava. In the wall of the right atrium is an oval –shaped depression known as the fossa ovalis, which is a remnant of an opening in the fetal heart known as the foramen ovale.

The right ventricle's wall are lined with trabeculae carneae or columnae carnae, ridges of cardiac muscle covered by endocadium. The right ventricle tapers into the pulmonary trunk, into which it ejects blood contracting. The pulmonary trunk branches into the left and right pulmonary arteries that carry the blood to each lung.

The left atrium receives oxygenated blood back from the lungs via the four pulmonary veins.

The left ventricle is much thicker than the right ventricle, because the left ventricle has to pump the blood with great force to the entire body. The left ventricle pumps blood to the body through the aortic valve and into the aorta. Two small openings above the aortic valve carry blood to the heart itself, the left main coronary antery and the right coronary artery.

Working Mechanism of Human Heart: The heart's main function is to pump blood to the circulation. This is accomplished by a series of contractions (systole) and relaxation (diastole) of the heart muscle, which occurs in a rhythmic or cyclic pattern.

The following sequences describes the cardiac cycle.

Stage 1 – Atrial systole/ventricular diastole: The right atrium, which has been filled with blood from the circulation, contracts and empties blood into the relaxed right ventricle, with the tricuspid valve open. Almost at the sametime, blood from the left atrium, which has come from the lungs, empties into the left ventricle, through the open mitral valve. During this time, the valves in the venacava and the pulmonary vein are closed to prevent the backflow of blood.

Stage 2 – Ventricular systole/Atrial Diastole: After contraction, the atria relax, the atrioventricular valves close, and the ventricles simultaneously contract with a higher pressure to pump blood into the lungs, via the pulmonary artery, and the systemic circulation, via the aorta.

Stage 3 – Ventricular diastole/ Atrial systole: After pumping out blood, the ventricles relax and the pulmonary and aortic valves close to prevent backflow. Refilling of the right and left atria occurs as they relax and start the whole cycle again.

The cardiac cycle produces a heartbeat, which usually takes less than a second. The whole sequence is termed as heart beat.

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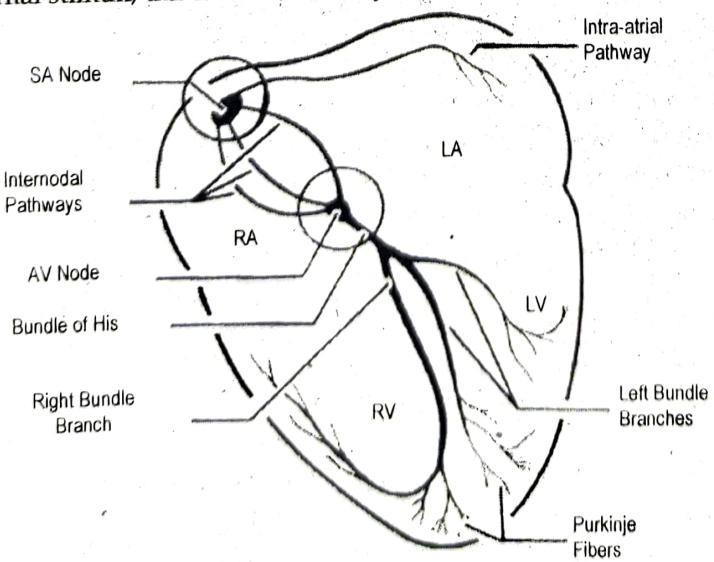
16. **2074 Set B Q.No. 3 Describe the origin and conduction of heart beat with necessary diagram.** **[7.5]**

The type of heart which contracts or beats from an electrical impulse within a muscle is termed as myogenic heart. Such types of hearts are found in vertebrates. The heart is an electrically controlled muscular pump which sucks and pumps blood. The electrical signals which controls the heart are generated within the heart itself. The heart is, therefore, capable of beating rhythmically in the absence of external stimuli; this is called autorhythmicity.



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The parts of the heart normally beat in orderly sequence: contraction of the atria or auricles (atrial systole) is followed by contraction of the ventricle (ventricular systole) and during diastole all the four chamber are relaxed. The heart beat originates in a specialized cardiac conduction system and spread via this system to all parts of the myocardium. The structures that make up the conduction system are the Sino–atrial node (SA–node), the intermodal atrial pathways, the atrio–ventricular node (AV Node), the bundle of his and its branches, and the Purkinje system.

The pumping of the heart, or the heartbeat is caused by alternating contraction and relaxation of the myocardium. Excitation of the heart arises in the pacemaker cells in the sino – atrial node (SA – Node). SA – Node is called the natural pacemaker and is located in the upper right atrium, close to where the superior venacava enters the right atrium. Electrical signals arising in the SA – node stimulate the two auricles to contract forcing blood into the ventricles. The electrical signal then travels through the atrial path way to the atrio-ventricular node (AV – node) which is located in the interatrial septum. A bundle of fibres originates from the AV– node and this is called Bundle of His or Purkinje's fibres. The impulse after passing through the AV – node passes along Bundle of His, which happens to be the only direct muscular communication between the auricles and ventricles. At the tip of inter–ventricular septum the bundle of His divides into right and left bundle branches which are distributed respectively to the right and left ventricle. The bundle branches terminate in thin fibres called the Purkinje's fibres through which the impulses reach the ventricular muscles.

The sino–auricular node sends out intermittent impulse. Each impulse initiates a wave of contraction, which causes their contraction. When this wave of contraction along with the impulse reaches the auriculo – ventricular node, it is also stimulated. The impulse from it makes the ventricles contract. When the ventricle contracts, the auricle relaxs. The sequence is repeated.

Heart rate is driven by the SA – node, and is mainly influenced by the Autonomic Nervous System (ANS). Parasympathetic stimulation decreases the heart rate, while sympathetic stimulation increases the heart rate.

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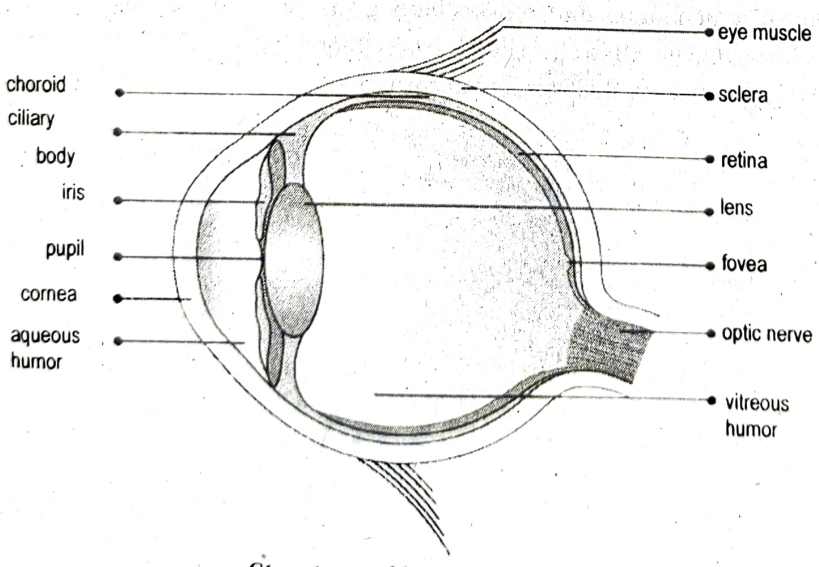
17. **2074 Set B Q.No. 3 OR** **Describe the structure of human eye with well labelled diagram.** **[7.5]**

The eye is the organ which regulates the sense of sight, allowing human beings to interpret the shapes, colours and dimensions of the surroundings by processing the light they reflect or emit.

Eyes are also known as photoreceptor organs. In human, there is a pair of eyes, located one on either side of the face in a bony socket known as orbital cavity or eye orbit. Each eye is a hollow spherical body.



Structure of human retina

The transverse size of a human adult eye is approximately 24.2mm and the sagittal size is 23.7mm with no significant difference between sex and age groups. Each eye ball is 7.5grams in weight. By age 13, the eye attains its full size.

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The eye is arguably the most complicated organ in the human body, with a number of parts fitted together in a near spherical structure. Each part in the system is responsible for a certain action which is a part of the functions of the eye. It is amazing that so small eye can have so many parts. Eye is natural optical instrument.

The details of the human eye is studied by taking a vertical section (V.S.). Its wall is composed of three layers or coats:

1. **The outer Fibrous Coat:** It has three components: Sclera, cornea and conjunctiva

   i. **Sclera:** The sclera also known as the "white of the eye", is the opaque, fibrous, protective, outer layer of the eye containing collagen and elastic fiber. In human the whole sclera is white. It is continuous with the duramater and the cornea. It occupies $\frac{5}{6}$ part of the fibrous coat and is avascular.

   Sclera protect and maintains the shape of the eyeball, offering resistance to internal and external forces and provide and attachment for extra ocular muscles insertions.

   ii. **Cornea:** Cornea is a transparent portion that forms the anterior $\frac{1}{6}$ of the eyeball. Cornea is actually the modified part of sclera. The cornea is avascular (i.e. getting no blood supply). It absorbs oxygen from the air. Oxygen is dissolved in tears and then diffuses through the cornea to keep it healthy.

   At the junction of sclera and cornea there is a structure called the "canal of schlemn". From the anterior chamber the aqueous humour, which is continuously produced, is drained off into the canal of schlemn and then into the blood. Cornea forms a slight bulge at the front. The cornea allows the rays of light to pass through it and converge the light to the retina by refraction.

   iii. **Conjunctiva:** It is a thin transparent circular membrane, which covers the sclera and lines the inside of the eyelids. It is composed of stratified squamous epithelium, goblet cells and stratified columnar epithelium. Conjunctiva is highly vascularized i.e., having blood supply. Conjunctiva helps lubricate the eye by producing mucus and tears, and protects the cornea.

2. **Middle vascular layer:** It has 3 components: Choroid, Ciliary bodies and Iris.

   i. **Choroid:** This is the middle layer of the wall of eyeball and has high number blood vessels. It is dark in colour due to the presence of melanin pigment. The pigmented cells absorb light and prevent it from being reflected within the eyeball so that blurring image is not formed. The blood vessels supply nutrients and oxgen to the tissues of choroid.

   ii. **Ciliary bodies:** The ciliary body extends downwards the inside of the eye from the choroid coat. It is composed of the ciliary muscles and the ciliary processes. The ciliary processes secrete aqueous humour. The ciliary muscles are smooth muscles and are of two types: circular and meridional. Attached to the ciliary body are the suspensory ligaments, which are in turned attached to the capsule that surrounds the lens of the eyes. The capsule and ligaments, together with the ciliary body hold the lens in place.

   iii. **Iris:** The iris is a circular muscular diaphragm containing the pigment giving eye its colour. It separates the aqueous humour region into anterior and posterior chambers. It extends from the ciliary bodies across the eyeball infront of the lens. It has an opening in the centre called pupil. It is actually the frontal modification of choroid. It contains two types of smooth muscles: circular muscles and radial muscles.

   The iris controls the amount of light entering the eye by the radial muscles contracting in dim light and the circular muscles contracting in bright light. Both the sets of muscles are under the control of the autonomic nervous system. Sympathetic stimulation causes the radial muscle to contract and the pupil to dilate, while the parasympathetic stimulation causes the circular muscles to contract and the pupil to constrict. Iris is found in different colors like brown, black, blue, green, etc.

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3. **The inner neural coat – The Retina:** Retina is the inner most layer of the wall of the eyeball. The retina is the neural and sensory layer of the eye ball. Its external surface is in contact with the choroid and its internal surface with the vitreous humour. A small oval, yellowish area of the retina lying exactly opposite the centre of the cornea is named as the macula lutea or yellow spot, which has at its middle a shallow depression, the fovea centralis. The fovea centralis has cone cells only and is the place of most distinct vision. In the retina, nerve fibres from the light sensitive cells leave the eyeball to form the optic nerve.

An artery and vein pass through the optic disc. This area is called the blind spot because it is devoid of receptor cells. Ora serrata (ora terminals) is a special structure which demarcates the sensitive part of retina from its non sensitive part.

The retina consists of the following layer:

i. **Layer of Rods and Cones:** The rod cells and cone cells are photoreceptor cells.

   a. **Rod cells:** There are about 90 million rod cells in human retina. The rods contain a photosensitive pigment called rhodopsin (visual purple), which is composed of opsin and retinine. The opsin is a protein and retinine is an aldehyde of vitamin A retinal. The rods make the animal to see in the darkness.

   b. **Cone cells:** There are about 6 to 7 million cone cells in human retina. The photosensitive pigments in the cones are of three types namely: porpyrosin, iodopsin and cyanopsin which give response to red, green and blue light respectively. The sensation of different colours are produce by various combinations of these three types of cones and their photo pigments. The protein in cone pigment is photopsin. The pigments are also called erythrolabe (red), chlorolabe (green) and cyanolabe (blue).

ii. **External Nuclear Layer:** This layer contains the cell bodies and nuclei of rod and bone cells.

iii. **Internal Nucleic layer:** This layer consists of cell bodies and nuclei of three types of neurons: (a) Bipolar Neurons, (b) Horizontal neurons and (c) Amacrine cells.

iv. **Layer of Ganglion Cells:** This layer contains the cell bodies of ganglionic cells. Axon of each ganglion cell gives rise to a fibre of the optic nerve.

v. **Layer of Optic Nerve Fibre:** This layer is made up of axons of ganglion cells that form the optic nerve. The optic nerve are connected with the brain. The nerve fibres from all parts of the retina converge to leave through a blind spot (optic disc) which contain no rods and cones, therefore, no image is formed. The optic nerve is regarded as cranial nerve II (i.e. CNII).

Contents of the Eye Ball

1. **The Lens:** The lens is a transparent, biconvex, elastic structure that bends light waves as they pass through its surface. Its diameter is 8mm. The lens separtates the aqueous and vitreous humours. It is composed of epithelial cells that have large amount of clear cytoplasm in the form of fibres.

   The lens is covered by a transparent elastic capsule – the lens capsule. The lens capsule is suspended by suspensory ligament made up of yellow elastic fibres. The lens can change shape according to the distance of the object and focuses light waves into the retina.

2. **Aqueous Humour:** The space between the cornea and the lens is called aqueouschamber, which contains a thin watery fluid called aqueous humour. It consists of amino acids, glucose, ascorbic acids and respiratory gases. The epithelium of the ciliary process continuously secretes the aqueous humour.

   The aqueous humour helps to maintain the shape of the front part of the eye and provides nutrients to the lens and cornea. The aqueous humour is continuously drained off into canal of schlemn and then into the blood. The pressure in the eye, called intraocular pressure is produced by aqueous humour.

3. **Vitreous Humour:** The space between the lens and retina is called vitreous chamber, which is filled with a transparent gel – like vitreous humour. It is also called "Wharton's Jelly". It consists of water, salts, hyaluronic acid and mucoproteins.

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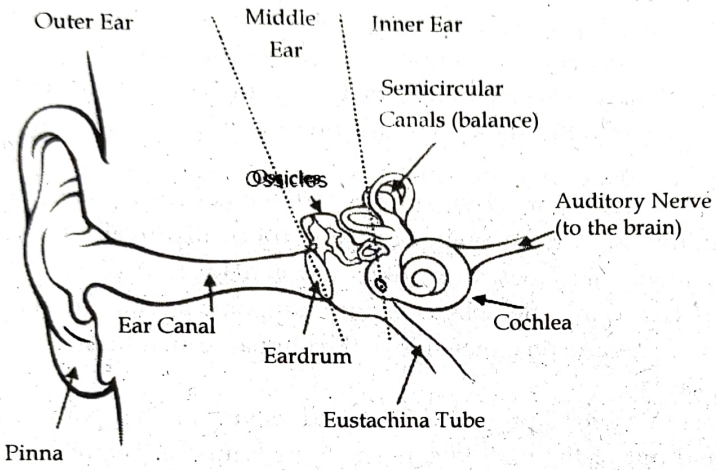
It helps to maintain the shape of the eyeball and also contribute to intraocular pressure. It acts as hydroskeleton and supports the retina and lens. Unlike the aqueous humour, the vitreous humour cannot be replaced in any significant quantity. Therefore, in puncture, wounds of the eye, it is important to prevent the escape of vitreous humour.

18. **2073 Supp Q.No. 3 Give an account of the structure and function of human ear.** **[7.5]**

Human ear, is the organ of hearing and equilibrium that detects and analyses noises by transduction (or the conversion of sound waves into electrochemical impulses) and maintains the sense of balance (equilibrium). Human ear are two in number and situated one on each side of the head. Ear is also called stato–acoustic organ or phonoreceptor organ. Human ear remains connected to the brain with the vestibulo–cochlear nerve or 8th cranial nerve (CNVIII).



Human ear has external, middle and inner portions, accordingly, human ear is divisible into three main parts:

Among them the external ear is located outside while the other two parts are situated and protected inside the temporal bone of the skull.

1. **External Ear:** External ear is the visible part of human ear. It comprises a pinna, external auditory meatus and tympanic membrane.
   - i. **Pinna:** The pinna is a projecting elastic cartilage covered with skin. The pinna consists of the curving outer rim called helix, which is the most prominent outer ridge. The inner curve rim is called the ante–helix. The pinna is also known as auricle. It is sensitive as well as effective in collecting sound waves.
   - ii. **External Auditory Meatus:** It is a tubular passage supported by cartilage in its exterior part and by bone in its inner part. It is also called ear canal and stretches for about 2.5cm(1 inch). It is slightly curve, which makes the foreign particles difficult to reach the eardrum. The meatus is internally lined by hairy skin composed of stratified epithelium and ceruminous gland (wax glands). The ceruminous glands are modified sweat glands which secrete a waxy substance – the cerumen (ear wax) that prevents the foreign bodies entering the ear. The sebaceous glands secrete sebum. The eardrum transmits sound from the pinna to the eardrum.
   - iii. **The Tympanic Membrane (Tympanum):** The tympanic membrane or eardrum, is a membrane at the end of the auditory canal and marks the beginning of the middle ear. The eardrum is extremely sensitive and pressure from sound waves makes the eardrum vibrate. The central part of the tympanum is called umbo. The tympanum has three layers – outer stratified epithelial layer, middle fibro – elastic layer and inner cuboidal epithelium.
2. **Middle Ear:** The middle ear lies between the outer ear and the inner ear. It consists of tympanic cavity, ear ossicles, skeletal muscles and windows.

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i. **The tympanic cavity:** It is filled with air and connected with the nasopharynx through the Eustachian tube (auditory tube), which serves to equalize the air pressure in the tympanic caving with that on the outside.

ii. **Ear ossicles:** There is a small flexible chain of three small bone called ear ossicles – the mallaeus (hammer shaped), the incus (anvil shaped) and the stapes (stirrup shaped). The mallaeus is attached to the tympanum on one side and to the incus on the other side. The incus is connected with the stapes, which is attached to the oval membrane covering the fenestra ovalis (oval window) of the inner ear. Malleus is the largest and stapes is the smallest ossicle. Stapes is also the smallest bone in the body.

The three ossicles function together to receive, amplify, transmit the sound from the eardrum to the inner ear. The mallaeus receives vibrations from sound pressure on the eardrum. It transmits vibrations to the incus, which in turn transmits the vibrations to the stapes. The wide base of the stapes rest on the fenestra ovalis. As the stapes vibrates, vibrations are transmitted through the oval window, causing movement of fluid within the cochlea.

iii. **Skeletal muscles:** Two skeletal muscles, the tensor tympani attached to the mallaeus and the stapedius attached to the stapes are also present in the middle ear. Stapedius is the smallest muscle in the body.

iv. **Windows:** The middle ear is connected with the inner ear through two small openings closed by the membranes. These openings are fenestra ovalis (oval window) and fenestra rotunda (round window). The fenestra ovalis is covered by foot plate of the stapes. The fenestra rotunda is enclosed by a flexible secondary tympanic membrane. The latter is responsible for equalizing the pressure on either side of the tympanic membrane.

Function of middle ear:

a. Due to pressure changes produced by sound waves, the tympanic membrane vibrates, i.e., it moves in and out of the middle ear. Thus, the tympanic membrane acts as a resonator that reproduces the vibration of sound.

b. It transmits sound waves from external to the internal ear through the chain of ear ossicles.

c. The intensity of sound waves is increased about twenty two times by the ear ossicles.

3. **Internal Ear:** The inner ear sits within the temporal bone in a complex cavity called the bony labyrinth. Another labyrinth called the membranous labyrinth is contained within the bony labyrinth. The bony labyrinth consists of a fluid called perilymph in which the membranous labyrinth floats.

The bony labyrinth is made up of three parts: one vestibule, three semicircular canal and one cochlea.

i. **Semi –circular Ducts:** There are present three semicircular ducts; the anterior, the posterior and the lateral semicircular ducts. They arise from the utriculus. The anterior and posterior semicircular ducts arise from crus commune.

Each semicircular duct is enlarged at one end to give rise to a small rounded ampulla. The anterior and lateral semicircular ducts bear ampullae at their anterior ends, while the posterior duct contains an ampulla at its posterior end.

Each ampulla contains a sensory patch of cells, the crista. Each crista consists of two kinds of cells, the sensory and supporting cells. The sensory cells bears log sensory hairs at their free ends and nerve fibres at the other end. The sensory hairs are partly embedded in a gelatinous mass, the capula. The cristae are concerned with balance of the body.

ii. **Vestibule:** The vestibule is a sac– like structure which is further divided into two parts – the larger dorsally placed utriculus, and the small ventral chamber as sacculus.

a. **Utriculus:** The utriculus or utricule is dorsally placed structure to which all the three semicircular ducts are connected.

b. **Sacculus:** The sacculus or saccule is a ventrally situated structure which is joined with utriculus by a narrow utriculo –sacular duct. Form this duct along tube, the ductus endolymphaticus arises which ends blindly ad the saccus endloymphaticus.

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Both utriuclus and sacculus contain sensory patches, the maculae. A macula comprises sensory and supporting cells similar to that of the crista. The hairs are not actually motile and are embedded in a gelatinous membrane, the otolith membrane in which there are also found very small crystals of calcium carbonate, the otolith. The cristae and maucale are the receptors of balance.

iii. **Cochlea:** The cochlea is the main hearing organ, located in the temporal bone. It is a spiral shaped cavity in the bony labyrinth making 2.5 turns around its axis, the modiolus. A core component of the cochlea is the organ of corti, the sensory organ of hearing. It is spirally coiled that resembles a snail shell in appearance. It is 20–30 mm in length. It tapers from a broad base to an almost printed apex.

Internally, it consists of three fluid filled chambers or canals, the upper scala vestibuli, lower scala tympani, and the middle scala media (cochlearduct). Both scala vestibuli and scala tympani are filled with a fluid called perilymph. However, scala media is filled with endolymph. Both the scala vestibuli and scala tympani are connected with each other at the apex of the cochlea by a small canal, the helicotrema. The base of scala vestibule is in contact with the fenstra ovalis, while the lower end of scala tympani is in connection with the fenestra rotunda.

The scala media is the most important canal of the cochlea. It bears an upper membrane, the Reissner's membrane and the lower membrane called the basilar membrane. On the basilar membrane, a sensory ridge, the the organ of Corti is present. The organ of corti consists of outer hair, inner hairs, inner pillar cells, outer pillar cells, tunnel of corti, phalangeal cells, cells of Hensen and cells of Claudius. The sensory hairs project form the outer ends of the hair cells into the scala media, while from the inner end of the cells nerve fibres arise, which unite to form a cochlear nerve. The tectorial membrane over hangs the sensory hair in the scala media. It is properties are to determine the patterns of vibration of sound waves.

19. **2073 Supp Q.No. 3 OR Describe female reproductive system in human being.** **[7.5]**

Please refer to 2076 Set C Q. No. 3 OR

20. **2073 Set C Q.No. 3 What is aerobic respiration? Describe pulmonary respiration in human with suitable diagram.** **[7.5]**

Please refer to 2074 Supp Q.No. 4

21. **2073 Set C Q.No. 4 Describe the structure and function of human brain with well labelled diagram.** **[8]**

Please refer to Model (Zoology) Q.No. 3

22. **2073 Set D Q.No. 3 Describe the structure of human eye.** **[7.5]**

Please refer to 2074 Set B Q.No. 3OR

23. **2073 Set D Q.No. 3 OR Describe female reproductive system in human.** **[7.5]**

Please refer to 2073 Supp Q.No. 3 OR

24. **2072 Supp. Q.No. 3 Explain the structure of human ear.** **[7.5]**

Please refer to 2073 Supp Q.No. 3

25. **2072 Supp. Q.No. 3 OR Describe the structure and function of human heart.** **[7.5]**

Please refer to 2074 Set A Q.No. 3 OR (second part)

26. **2072 Set C Q.No. 3 Give a detailed account of male reproductive organs of man.** **[7.5]**

Please refer to 2075 Set A Q.No. 3 OR

27. **2072 Set C Q.No. 3 OR What are myogenic hearts? Explain origin and conduction of heart beat in human being.** **[7.5]**

Please refer to 2074 Set B Q.No. 3

28. **2072 Set D Q.No. 3 Describe the alimentary canal of Human with labelled diagram.** **[7.5]**

Please refer to 2074 Supp Q.No. 3

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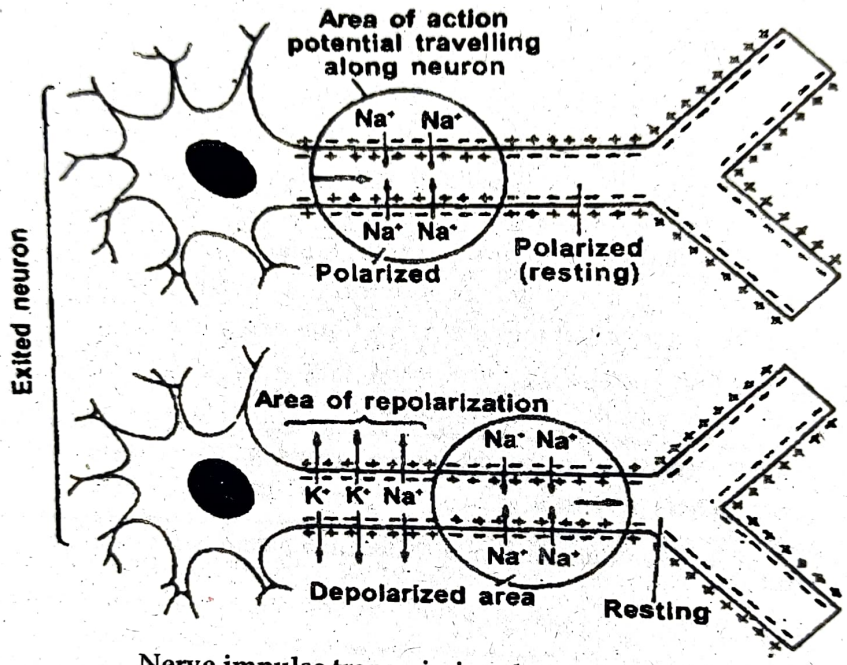
29. **2072 Set D Q.No. 4 Discuss the transmission of nerve impulse with well labelled diagram.** [8]

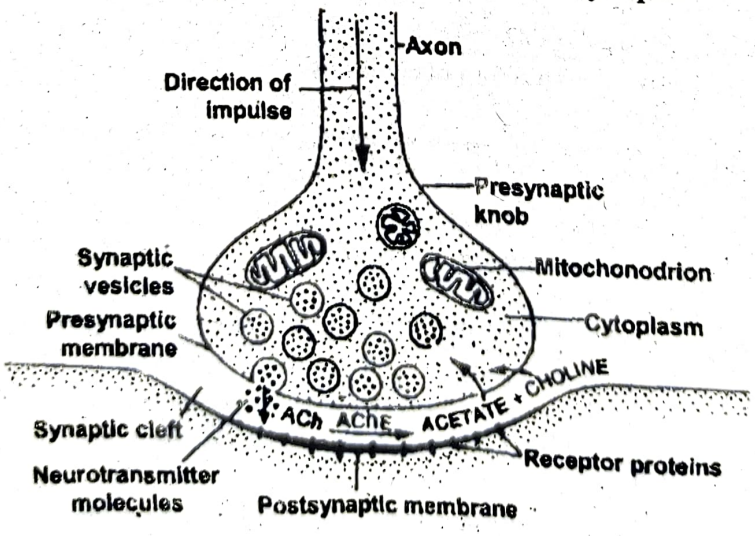
✎ All the nerve fibres carry information in the form of nerve impulse. Nerve impulse is the sum total of physical and chemical disturbances created by a stimulus (electrical, chemical or mechanical) in a neuron which result in the movement of a wave along the nerve fibre.

The nerve fibre or axon is like a cylinder, the interior of which is filled with axoplasm (i.e., the cytoplasm of the neuron) and the exterior of which is covered with a thin membrane, the axon membrane or axolemma, The axon is immersed in the extracellular fluid (ECF). Through axolemma, movement of solute takes place between the axoplasm and ECF. Generally, the solutes in ECF and axoplasm are in ionic form. In the axoplasm positively charged protein molecules are present which are neutralized due to the presence of large amount of potassium ions. In the ECF the negatively charged chloride ions are neutralized by the presence of positively charged sodium ions.

Nerve impulse transmission has following two main events:



Nerve impulse transmission through synapse



I. **Transmission of Nerve Impulse along the nerve fibre (axon):** Nerve impulse transmission along the axon has following steps:

1. **Polarization or Resting Potential: Sodium is on outside and Potassium is on inside:** Signals are transmitted from neuron to neuron via an action potential, when axon membrane rapidly depolarizes and repolarizes.

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Different types of ion channels are present on the neural membrane of axolemma or axon membrane. These ion channels are selectively permeable to different ions. When a neuron is not conducting any impulse i.e., resting, the axon membrane is comparatively more permeable to potassium ions (K^+) and nearly impermeable to sodium ions (Na^+). Similarly, the membrane is impermeable to negatively charged proteins and nucleic acids present in the axoplasm. Consequently, the axoplasm inside the axon contains high concentration of K^+ ions and negatively charged proteins and nucleic acids, and low concentration of Na^+ ions and thus form a concentration gradient. The concentration of sodium ions is 14 times more in ECF (outside) and that of potassium ions is 28–30 times more in the axoplasm (inside). It is the large negatively charged protein and nucleic acids that contribute to the overall negative charge on the inside of the cell membrane. The outside of the neural membrane is positively charged.

The ionic gradients across the resting membrane are maintained by the active transport of ions by the sodium– potassium pump which transport three sodium ions outside and two potassium ions inside the cell. The electrical potential difference across the resting plasma membrane is called resting membrane potential. The resting potential ranges from – 40 to –90 millivolts (mV), and – 70 mV on average.

Thus, inactive and polarized neuron is said to be at its resting potential. It remains in this way until a stimulus comes along. Resting potential gives neuron a break.

Depolarization or Action Potential: Sodium ions more inside the membrane and the charges are reversed: Action potentials are formed when a stimulus causes the cell membrane to depolarize past the threshold of excitation, causing all the sodium gated ion channels to open.

When a stimulus (may be mechanical, electrical or chemical) is applied to the membrane of nerve fibre, its permeability changes and sodium–potassium pump stop operating. The voltage gated sodium ion channels open suddenly and rapid influx of Na^+ takes place followed by the reversal in the polarity at that site i.e, the outer surface of the axon membrane becomes negatively charge and the inner side becomes positively charged. The polarity of the membrane is, thus, reversed and this phenomenon is called depolarization or action potential, which is in fact termed as nerve impulse. The electrical potential difference is about + 40 mV at the point of stimulation. This in turn stimulates neighbouring sodium gates, further down the axon to open. In this manner, the action potential travels down the length of the axon as opened Na^+ gates stimulate neighbouring Na^+ gates to open.

Repolarization: Potassium ions move outside and sodium ions stay inside the membrane; outer surface is positively charged and inner surface is negatively charged again: As soon as depolarization is complete, the cell "Resets" its membrane voltage back to the resting potential. The Na^+ gates close and voltage gated potassium channels open, allowing K^+ ions to leave the cell. As K^+ ions leave the cell, the membrane potential once again becomes negative i.e., – 70 mV. With K^+ ions moving to the outside, the membrane repolarization restores electrical balance, although it is opposite of the initial polarized membrane that had Na^+ on the outside and K^+ in the inside.

Hyperpolarization: More potassium ions are outside than there are more sodium ions on the inside: When the potassium gates finally close, the neuron has slightly more potassium ions on the outside than it has sodium ions on the inside. This causes the membrane potential, and the membrane is said to be hyperpolarized because it has a greater potential (about – 80 mV).

Refractory period or sodium–potassium exchange pump: Refractory period puts everything back to normal: Potassium returns to inside, sodium returns to outside: With the passage of the action potential, the cell membrane is in unusual state of affairs. The membrane is polarized but the Na^+ and K^+ are on the wrong sides of the membrane.

During the refractory period, the axon will not respond to a new stimulus. To re–established the original distribution of these ions, the Na^+ and K^+ are returned to their resting potential location by sodium – potassium – exchange pump in the cell. This is run by an enzyme called sodium potassium – ATPase. For every two K^+ ions that are actively transported inward, three Na^+ ions are

pumped out. So inside become more negative than outside of neural membrane. The large negative organic ions such as proteins, organic acids, etc. are more inside the membrane than outside where they are only in negligible concentration. This makes the inside the neuron membrane more negative. The nerve fibre stays in the resting potential until another impulse comes along.

The velocity of conduction of nerve impulse of mammal is 120 meters per second.

II. **Transmission of Nerve Impulse along the Synapse:** A nerve impulse is transmitted from one neuron to another through junctions called synapse. A synapse is formed by the membranes of a pre–synaptic neuron and a post –synaptic neuron, which is separated by a gap called synaptic cleft that consists of extra –cellular fluid (ECF). Chemicals called neurotransmitters are involved in the transmission of impulses at their synapses. There are two types of neurotransmitters called nor-adrenaline and acetylcholine.

The transmission cross a cholinergic synapse, which uses acetylcholine as neurotransmitter, can be summarized in following steps.

1. First, an action potential arrives at the pre–synaptic neuron.
2. This changes the voltage in the neuron causing the voltage–gated calcium channels on the pre–synaptic neuron to open.
3. Calcium ions then diffuse into the pre–synaptic membrane or neuron.
4. The increased concentration of calcium in the neuron then causes synaptic vesicles, containing the neurotransmitter acetylcholine, to move towards the membrane on the pre–synaptic neuron.
5. The vesicles fuse to the membrane and the neurotransmitter is released into the gap between the two neuron (known as synaptic cleft).
6. The acetylcholine neurotransmitter then diffuses across the synaptic cleft towards the post–synaptic neurons membrane.
7. The acetylcholine neurotransmitter then binds to the complimentary receptors on the post –synaptic neuron's membrane.
8. The increase in concentration of the neurotransmitter causes ligand (chemical) gated sodium channels in the post –synaptic neuron membrane to open, allowing sodium to diffuse into post–synaptic neuron.
9. The increased concentration of sodium ions now in the post –synaptic neuron depolarize the neuron's membrane causing excitatory post–synaptic potentials (EPSPs)
10. If these EPSPs reach a certain threshold, then an action potential is initiated in the post–synaptic neuron and the impulse has been successfully transmitted from one neuron to the next.

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30. **2072 Set E Q.No. 3 Describe the structure and function of Human Heart with labelled diagram.** [7.5]

Please refer to 2074 Set A Q.No. 3 OR (second part)

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31. **2072 Set E Q.No. 3 OR Describe the physiology of digestion in Human being.** [7.5]

Digestion is the process by which humans break down food into componet molecules that are absorbed and utilized by the body to build structures and promote vital functions. Food supplies humans with macromolecules like proteins, lipids and carbohydrates, as well as vitamins and minerals. Before food can be used it has to be mechanically broken down into tiny pieces, then chemically broken down so nutrients can be absorbed.

In humans, proteins need to be broken down into amino acids, carbohydrates and starches into glucose and fats into fatty acids and glycerol. This mechanical and chemical breakdown encompasses the process of digestion.

These twin processes are;

1. **Mechanical digestion:** Larger pieces of food get broken down into smaller pieces while being prepared for chemical digestion; this process starts in the mouth and continues in the stomach.

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2. **Chemical digestion:** Several different enzymes break down macromolecules into smaller molecules that can be absorbed. This process starts in the mouth and continues in the intestines.

In humans, digestion is extracellular and it occurs in the human of various parts of the alimentary canal.

Physiology of digestion in humans includes the following steps:

I. **Ingestion:** Ingestion is the process by which the food is taken into the alimentary canal. It includes the processes that take place while food is in the mouth, such as chewing and grinding using the teeth (mastication), the lubrication and chemical effects of saliva released from the salivary glands, and swallowing of the food which sends it down the digestive tract.

II. **Digestion:**

1. **Digestion in the mouth:** Carbohydrate digestion starts in the buccal cavity by an enzyme called salivary amylase or ptyalin present in the saliva, which is slightly acidic in nature. Ptyalin converts starch into disaccharides such as Dextrin, Maltotriose and Maltose (simple sugars).

$$\text{Starch} \xrightarrow{\text{Ptyalin}} \text{Dextrin, Maltotriose, Maltose}$$

Saliva in the mouth accounts for 30% of initial starch digestion. About three litres of saliva is produced per day.

Similarly, digestion of fats also starts in the buccal cavity by an enzyme called lingual lipase present in the saliva. Lignal lipase converts the fats into fatty acids and glycerol.

$$\text{Fats or Lipids} \xrightarrow{\text{Lipase}} \text{Fatty acids + glycerol.}$$

After undergoing masticating and starch/lipids digestion, the food will be in the form of a small, round slurry mass called a bolus. It will then travel down the oesophagus and into the stomach by the action of peristalsis. Peristalsis is a muscular wave that travels the length of the alimentary canal, moving partially digested food a short distance down the tract.

No chemical digestion of protein occurs in the mouth.

2. **Digestion in the stomach:** As the bolus enters the stomach starch digestion stops. After receiving the bolus (chewed food) the process of peristalsis is started; mixed and churned with gastric juices the bolus is transformed into a semi–liquid substances called chyme. Stomach muscles mix up the food with enzymes and acids to make smaller digestible pieces.

The surface of the inner lining of the stomach contains gastric glands, which are composed of three types of cells: mucous cells, chief cells and parietal cells. A hormone called gastrin stimulates the gastric gland to secrete their fluids.

There is no chemical digestion of carbohydrates in the stomach. Gastric enzymes are secreted by the chief cells, while hydrochloric acid is secreted by the parietal cells. The combination of mucus, HCl and enzyme is referred to as gastric juice.

i. **Digestion of Protein:** The gastric gland secretes pepsinogen and HCl. Pepsinogen is activated by HCl to become active pepsin that starts hydrolysis of protein. Pepsin changes proteins into proteoses, peptones and polypeptides.

$$\text{Pepsinogen} \xrightarrow{\text{HCl}} \text{Pepsin (active)}$$

$$\text{Proteins} \xrightarrow{\text{Pepsin}} \text{Proteoses} \xrightarrow{\text{Pepsin}} \text{Peptones} \xrightarrow{\text{Pepsin}} \text{Polypeptides}$$

In human infants, milk protein called casein is digested by the help of an enzyme called rennin. Rennin is secreted as precursor called prorennin, (which is inactive), by the fundus of stomach. Prorenin is converted to active rennin by the help of HCl secreted by oxyntic cell. In presence of calcium, rennin converts the casein of milk to a paracasien. Paracasein is then acted upon by pepsin.

$$\text{Prorennin} \xrightarrow{\text{HCl}} \text{Rennin (active)}$$

$$\text{Casein (milk protein)} \xrightarrow{\text{+Rennin}} \text{Paracasein} + Ca^{++} \longrightarrow \text{calcium paracaseinate}$$

∴ Calcium paracaseinate + Pepsin ⟶ Proteoses + peptones.

Stomach pepsin digests about 20% of the proteins.

ii. **Digestion of Lipids/fats:** The gastric juices contain small amount of gastric lipase, which begins the breaking down of specific lipids.

Gastric lipase converts the fats into fatty acids and glycerol.

∴ Fats $\xrightarrow{\text{Gastric lipase}}$ Fatty acids + glycerol

The HCl destroys the micro organisms present in the food. The semi-fluid chyme enters the duodenum through the pyloric sphincter.

3. **Digestion in the duodenum and small intestine:** The chyme leaves the stomach in small squirts rather than all at once. The small intestine is the site where most of the chemical and mechanical digestion is carried out.

When the acidic chyme enters the duodenum, it acts as a stimulant for the release of secretin and cholecystokinin which are released by the epithelial cell walls of the duodenum. This in turn acts as a signal for the release of bile from the liver and digestive enzymes from the pancreas, and are eventually poured into the duodenum.

Secretin signals the secretion of sodium bicarbonate in the pancreas and it stimulates the secretion of bile in the liver. This hormone responds to the acidity of the chyme.

Similarly, cholecystokinin (CCK) stimulates the release of the digestive enzymes in the pancreas and stimulates the emptying of bile in the gall bladder.

Gastric inhibitory peptide (GIP) is in the duodenum and decreases stomach churning in order to slow the emptying of stomach.

The bile neutralizes the acidic effect of chyme and makes the food alkaline so that pancreatic juice from pancreas can function.

i. **Digestion of carbohydrate:** Pancreatic juice contains three powerful enzymes called pancreatic amylase, pancreatic lipase and trypsinogen (precursor).

Pancreatic amylase splits molecules of starch and glycogen into diasaccharides and maltose.

∴ Starch or Carbohydrate $\xrightarrow{\text{Amylase}}$ Glucose (Diasaccharides)

Enzymes released by the walls of the small intestines break down the diasaccharide into monosaccharide. The enzymes are collectively called intestinal juice secreted by Brunner's gland and crypts of Lieberkuhn.

The carbohydrate digesting enzymes of intestine include maltase, lactase and sucrase which converts the maltose, lactose and sucrose into glucose.

In this way starchs/ carbohydrates are completely digested in the duodenum.

ii. **Digestion of Protein:** A large part of protein digestion takes place in the stomach. The enzymes pepsin of stomach plays an important role in the digestion of nine amino acids. In the duodenum, other enzymes trypsin, elastase, and chymotrypsin – act on the peptides, reducing them to smaller peptides. These enzymes are produced by the pancreas and released into the duodenum where they act upon chyme. Further breakdown of peptide to single amino acids is aided by enzymes called peptidases.

Action of proteolytic enzymes of succus entericus (Intestinal Juice)

The final step of protein digestion occurs in the ileum by the action of intestinal juice or succus entericus. The intestinal juice contains proteolytic enzymes such as aminopeptidase and dipeptidase.

Aminopeptidase converts remaining polypeptides to small peptides and free amino acids.

∴ Polypeptides $\xrightarrow{\text{Aminopeptidase}}$ small peptides + amino acids

Similarly,

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$$\text{Dipeptides} \xrightarrow{\text{Di–peptidase}} \text{Amino acids}$$

$$\text{Tripeptides} \xrightarrow{\text{Tri–peptidase}} \text{Amino acids}$$

In this way, complete digestion of protein takes place in ileum.

iii. **Digestion of Fats/ Lipids:** Bulk of fats digestion occurs in the small intestine due to pancreatic lipase. Bile aids in the digestion of lipids, primarily triglycerides, through emulsification. Emulsification is the process in which large lipids globules are broken down into several small lipid globules.

$$\text{Fats} \xrightarrow{\text{Emulsificaiton}} \text{Fat globules}$$

The pancreatic lipase (Steapsin) and intestinal lipase converts the fats into fatty acids and glycerol.

$$\text{Lipids / Fats} \xrightarrow[\text{Bile salts}]{\text{Pancreatic lipase / intestinal lipase}} \text{Fatty acids + Glycerol}$$

(sodium glycolate + sodium tauro cholate)

4. Neucleases converts nucleic acids into nucleotides.

$$\text{Nucleic acids} \xrightarrow{\text{Nuclease}} \text{Nucleotides.}$$

5. Nucleosidases convert purine and pyramidine nucleosides into purine or pyramidine bases + pentose phosphates.

$$\text{Purine or pyramidine nucleosides} \xrightarrow{\text{Nucleosidases}} \text{Purines or pyramidine bases + pentose phosphates.}$$

32. **2071 Supp. Q.No. 3 Describe the process of food digestion in human beings.** [7.5]

Please refer to 2072 Set E Q.No. 3 OR

33. **2071 Supp. Q.No. 4 Give the account of the structure and working mechanism of human heart.** [8]

Please refer to 2074 Set A Q.No. 3 OR (second part)

34. **2071 Set C Q.No. 3 OR Describe female reproductive system of human being.** [7.5]

Please refer to 2073 Supp Q.No. 3 OR

35. **2071 Set C Q.No. 4 Given the structure and working mechanism of human heart.** [8]

Please refer to 2074 Set A Q.No. 3 OR (second part)

36. **2071 Set D Q.No. 3 Describe the structure and functions of brain.** [7.5]

Please refer to Model (Zoology) Q.No. 3

37. **2071 Set D Q.No. 3 OR Discuss about the male reproductive organs of human being.** [7.5]

Please refer to 2075 Set A Q.No. 3 OR

38. **2070 Supp. Q.No. 3 Discuss about the structure and working of human heart.** [7.5]

Please refer to 2074 Set A Q.No. 3 OR (second part)

39. **2070 Supp. Q.No. 4 Give an account of digestive system of man.** [8]

The digestive system is a group of organs working together to convert food into energy and basic nutrients to feed the entire body. Food passes through a long tube inside the body known as the alimentary canal or the gastro intestinal tract (GI tract). The alimentary canal is made up of oral cavity, pharynx, oesophagus, stomach, small intestine, large intestine and anus. In addition to the alimentary canal, there are several important accessory organs that help the body to digest food but do not have to food pass through them. Accessory digestive organs are salivary glands, liver gall bladder and pancreas. To achieve the goal of providing energy and nutrients to the body, six major functions take place in the digestive system: 1. Ingestion 2. Secretion 3. Mixing and movement 4. Digestion 5. Absorption 6. Elimination.

The digestive system is concerned with the breakdown of complex food substances and its conversion into simpler components, its absorption through the blood stream and assimilation in

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the cells and tissues producing desired effects of growth etc. The digestive system in man comprises of different components each assigned with a specific function.

The digestive system in human body comprises of the following:

1. **Mouth:** Mouth is bounded by the upper and lower lip and is the initiation of the digestive system in the human body.
2. **Buccal cavity:** Mouth leads into a spacious buccal cavity or oral cavity. The buccal cavity is provided with three pairs of salivary glands, namely parotid, sublingual, and submaxillary (submandibular) that produce saliva. The floor of the buccal cavity is provided with the muscular tongue with tastebuds that help in tasting and mastication of the food. Man is heterodont and has incisors (2), canine (1), premolar (2) and molar teeth (3) in each half of the jaw. The last of the molar teeth is called wisdom teeth.

Dental formula for adult human:

$$[I = \frac{2}{2}, C = \frac{1}{1}, PM = \frac{2}{2}, M = \frac{3}{3}] \times 2 = 32$$

Dental formula for children

$$[I = \frac{2}{2}, C = \frac{1}{1}, PM = \frac{0}{0}, M = \frac{2}{2}] \times 2 = 20$$

In the mouth, the food is ingested, and masticated, mixed with saliva and converted into bolus for swallowing. Pharynx is the region where both the digestive tract and the respiratory tracts join together. The opening of the trachea is provided with an opening called glottis which gets enclosed by the membranous epiglottis during swallowing. It prevents entry of food particles in the trachea. If it enters accidently, cough reflex is initiated.

3. **Oesophagus:** The oesophagus is a tubular pathway leading form the mouth to the stomach and is involved in transport of bolus by means of involuntary peristalsis. It is an alternate contraction and relaxation of the circular and longitudinal muscles that forces the food downwards. Oesophagus is 25cm long and 2.5cm wide in adults. The oesophagus enters the stomach at the cardiac end through the cardiac sphincter.
4. **Stomach:** The stomach is a larger sac–like organs with a J–shaped structure. It is 25cm long. It is the widest part of the digestive tract. The stomach is divided into four regions: Cardia, surrounding the lower oesophageal sphincter; fundus–rounded portion above and to the left of the cardia; body–large central portion below the fundus, and the narrow inferior region called pylorus.

The inner lining of stomach consists of gastric glands which consists of four types of cells.

i. Zymogenic or peptic or chief cells, producing a proenzyme called pepsinongen.
ii. Parietal cells or oxyntic cells produce hydrochloric acid, instrinsic factor.
iii. Mucous cells produce mucus.

All the above substances together form the gastric juice.

The enteroendocrine cells produce stomach gastric hormone, which stimulates oxyntic cell to release HCl. The HCl acidifies the bolus.

The stomach has both the mechanical and chemical function in digestion. The upper part of the stomach has involuntary smooth muscle, which relaxes to allow a large volume of food to be stored. The lower muscle then contracts in a rhythmical manner to churn the food inside and mix it together with the HCl and digestive enzymes pepsin and lipase which break it down further. The stomach then empties its contents into the small intestine.

5. **Small intestine:** It initiates from the pyloric end of the stomach and consists of anteriorly placed duodenum, middle part, the jejunum and terminal ileum. This region is specialized by the presence of numerous finger– like projections called villi with blood vessels that serve in absorption. Small intestine is more than 6 meter long. Whilst in the small intestine the food is subjected to yet more enzymes, those from the pancreas and from the glands within the intestine walls which break down carbohydrates and proteins. It is also mixed with the bile, the product of liver. Bile is

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temporarily stored in the gall bladder found underneath the liver. Bile works to dissolve fats (emulsification) so that it can be digested by the other enzymes. Rhythmic smooth muscle contraction continues within the small intestine and pushes through its narrow tube. Once the food is completely broken down into its individual components it is absorbed through the intestinal wall, into the blood flow of the capillaries which surround the intestine. The villi vastly increase the surface area of the intestine wall for molecules of digested food to pass through.

Duodenum is the main site of digestion, and jejunum and ileum are the site of absorption. Duodenum is 25cm long; jejunum is 2.5meter long and ileum is 3.5 meter long.

6. **Large Intestine:** The large intestine initiates after the ileum and consists of ascending colon, transverse colon, descending colon, sigmoid colon and the rectum. The ileum and colon is guarded by the ileocaecal sphincter. The large intestine continues the food's journey and is the body's last chance to absorb any water and minerals still remaining. The rest of the contents of the large intestine is waste such as undigested pieces of food and fiber. This is passed through to the rectum where it is stored until one go to the toilet.

The caecum consists of vermiform appendix, a 9–12 cm long vestigial organ in human. Large intestine is 1.5 meter long.

7. **Anus:** Anus is the terminal aperture of the digestive tract. Through the anus, the faecal matter or stool is thrown outside.

The accessory digestive glands includes the liver and pancreas.

1. **Liver:** Liver is the largest digestive gland (i.e. 1.5kg) occupying most of the right half of the abdomen below the diaphragm. It is divided into two major lobes: the larger one is right lobe and the smaller one is left lobe. Both the lobes are separated from one another by falciform ligament. The bile canaliculi merge to form the right and left hepatic ducts that unite to form the common hepatic duct. It joins the cystic duct coming from the gall bladder and the two together forms the common bile duct, which enters the duodenum by ampulla of vater or hepato –pancreatic ampulla. Liver consists of numerous liver cells called hepatocytes which produce bile.

Bile neutralizes the acidic chyme and breaks down the larger fats into fat droplets (i.e. emulsification).

2. **Pancreas:** The pancreas is an oblong heterocrine gland (12.5cm × 2.5cm) located posterior to the greater curvature of the stomach and is usually connected to the duodenum by two ducts. It has a head, body and tail. The head is expanded and near the C– shaped curve of the duodenum.

Histologically, the pancreas has two types of cells – the pancreatic acini and the pancreatic islets or Islets of langerhans. The pancreatic islets possess the α, β and δ cells that secretes glucagon, insulin and somatostatin, respectively. Insulin and glucagon hormones together regulate the glucose level in blood. The pancreatic acini produce pancreatic juice, which consists of pancreatic amylase, pancreatic lipase and trypsin for the digestion of starch, fats and protein, respectively.

40. **2070 Set C Q.No. 3 Describe the respiratory organs of man** [7.5]

Please refer to Model (Zoology) Q.No. 3 OR

41. **2070 Set C Q.No. 3 or Give an account of Alimentary canal of man.** [7.5]

Please refer to 2074 Supp Q.No. 3

42. **2070 Set D Q.No. 3 Describe the respiration in human beings with suitable diagrams.** [7.5]

Please refer to 2074 Supp Q.No. 4

43. **2070 Set D Q.No. 4 Discuss the physiology of digestion in human beings.** [8]

Please refer to 2072 Set E Q.No. 3 OR

44. **2069 Q.No. 3 Describe the structure and functions of human brain.** [7.5]

Please refer to Model (Zoology) Q.No. 3

45. 2069 Q.No. 4 **Give an account of the process of Urine formation in human being.** [8]

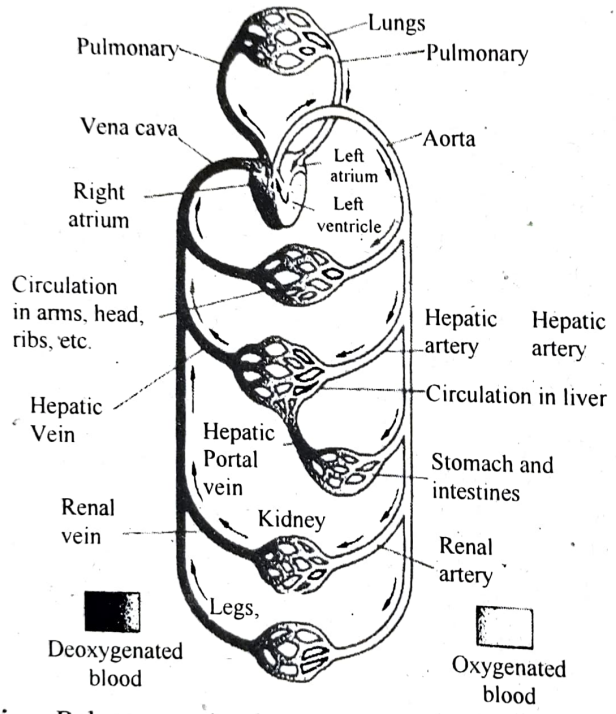
Please refer to 2076 Set B Q. No. 3 OR

46. 2068 Q.No. 3 **Explain the course of blood circulation in the human heart with the help of neat and well labeled diagram.** [7.5]

Heart is a pumping station and it pumps the blood in the body. It is composed of cardiac muscle and beats automatically without fatigue throughout the lives.

The human blood circulation is closed type, i.e., the blood travels in blood vessels. There are two separate chambers for oxygenated and deoxygenated blood. Deoxygenated blood passes into the right side of the heart (right auricle and right ventricle) and is pumped to the lungs where it picks up oxygen and release carbondioxide. Oxygenated blood returns to the left chambers of heart (left auricle an left ventricles) to be pumped to all the parts of the body except the lungs. There is no chance of mixing of blood.

Human have double circulation in which blood passes through the heart twice during each complete circuit of the body. This can be described in terms of two circuits through the heart.



1. **Pulmonary circulation:** Pulmonary circulation is pumping of deoxygenated or oxygen poor blood from the heart to the lungs and returning of oxygenated blood to the heart from the lung. The pulmonary circulation is described as follows:

i. **Deoxygenated Blood (Oxygen -Poor Blood)**

- Deoxygenated blood leaves the right ventricle (RV) of the heart via the pulmonary artery.
- The pulmonary artery divides into two main branches, the right pulmonary artery and left pulmonary artery, which carry deoxygenated blood to the right and left lungs respectively. In both cases the deoxygenated blood is taken to the alveolar capillaries of the lungs via networks of arteries and arterioles in each lung.
- While blood is flowing through the alveolar capillaries gaseous exchange takes place. During this process, Carbondioxide leaves the blood and oxygen enters the blood. Therefore, when the blood moves on from the alveolar capillaries it is oxygenated blood or more accurately "oxygen - rich blood".

ii. **Oxygenated Blood (Oxygen-rich blood)**

- The newly oxygenated blood in the alveolar capillaries flows on into venules leading to pulmonary veins.

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- Pulmonary veins from each lung return oxygenated blood to the left atrium (LA) of the heart.
- From the left atrium of the heart, blood passes through the bicuspid valve into the left ventricle (LV) of the heart, then on to the systemic circulation part of the cardiovascular system.

Systemic Circulation:

The circulation of blood between the heart and body organs (except lungs) is called systemic circulation.

The systemic circulation can be described as follows:

i. **Oxygenated Blood**

- Oxygenated blood leaves the lung and enters the left Atrium (LA) of the heart via the pulmonary veins.
- This oxygenated blood is then pumped from the left atrium to the left ventricle (LV) of the heart.
- From the left ventricle, the oxygenated blood leaves the heart via the Aorta, a major artery, and goes to the body tissues.
- The Aorta divides into other arteries that serve different parts of the body. These can be separated into two categories: blood supply to the upper-body, and blood supply to the lower-body.

a. **Blood supply to the Upper-body:**

The Aorta leads to the Subclavian arteries that take blood to the arms, and also to the carotid artery that carry blood to the head.

b. **Blood supply to the Lower-body:**

- The Aorta leads to the Hepatic artery that carries blood to the liver.
- The Mesenteric artery that carries blood to the small intestines.
- The Renal arteries that carry blood to the kidneys.
- The Iliac arteries that carry blood to the legs.

ii. **Deoxygenated Blood**

- Blood is deoxygenated when it leaves the tissues and organs it has supplied with oxygen and other nutrients, to return back to the pulmonary circulation.

  This can be described for the upper-body and lower-body separately:

a **Returns of Blood from the Upper-Body**

- Blood return from the head via Jugular veins
- Blood return from the arm via the Subclavian veins.
- All of the blood in the major veins of the upper body flows into the superior Venacava, which returns the blood to the right ventricle of the heart.

b. **Return of Blood from the Lower-Body**

- Blood return from the small intestine by passing through the Hepatic Portal Vein to the liver. Blood returns from the liver via the Hepatic Vein.
- Blood returns from Kidneys via the renal veins.
- Blood returns from the legs via the iliac veins.
- All the blood in the major veins of the lower body flows into the Inferior Venacava, which returns the blood to the right ventricle of the heart.

- After re-entering the right atrium of the heart via the superior Venacava and the Inferior Venacava, deoxygenated blood is pumped into the right ventricle of the heart through the tricuspid valve, and then out of the heart to the lungs via the pulmonary artery.
- Deoxygenated blood enters the lungs and is oxygenated before leaving the lungs (as oxygenated blood) and the cycle begins again..

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The whole course of circulation can be summarized as:

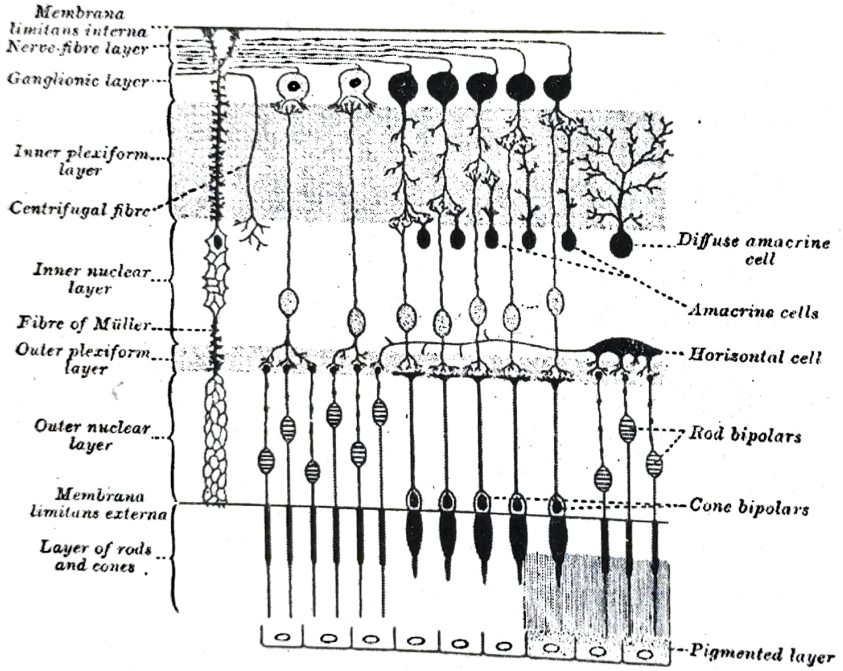
Organs → Venous capillaries → Venules (Deoxygenated blood) → Veins → Superior and Inferior Venacava → Right Auricle → Right Ventricle → Pulmonary Aorta → Lungs (Oxygenation occurs) → Pulmonary Veins → Left Auricle (Oxygenated Blood) → Left ventricle → Systemic Aorta → Arterioles → Arterial capillaries → Organs.

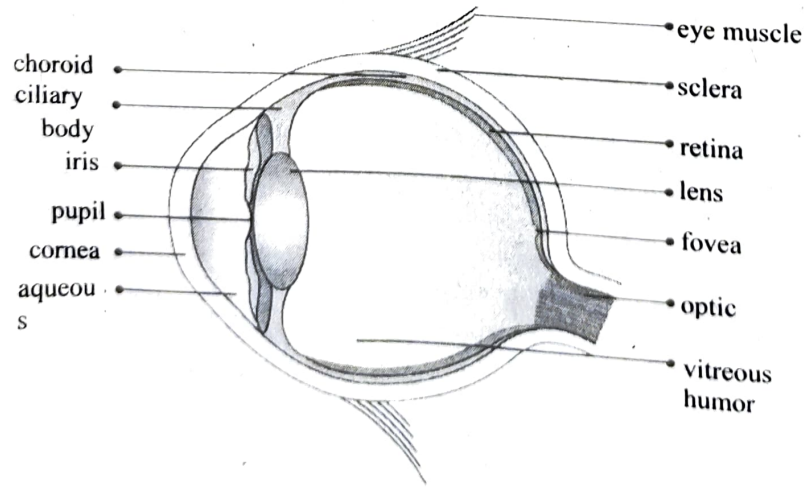
47. 2068 Q.No. 4 **Give an account of the retina in human eye, and mention its working mechanism.** [8]

Retina is the innermost coat of the posterior part of the eyeball that contains cells which are sensitive to light and which trigger nerve impulses that pass via the optic nerve to the brain, where are visual image is formed.

Retina is a layer of nervous tissue that covers the inside of the eyeball, in which stimulation by light occurs, initiating the sensation of the vision. The retina is actually an extension of the brain, formed embryonically from neural tissue and connected to the brain by the optic nerve.

Neural retina typically refers to three layers of neural cells: Photoreceptor cells - rods and cones, bipolar neurons, and ganglionic cells within the retina, while the entire retina refers to these three layers plus a layer of pigmented epithelial cells. The only neurons that are directly sensitive to light are the photoreceptor cells.





V.S of human eye

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Structure of Retina

The human retina has ten distinct layers as seen under electron microscope. From closest to farthest from the vitreous body:

1. **Inner limiting membrane or Membrane limitans interna** is the retinal layers located nearest to the center of the eyeball in contact with the hyaloid membrance of the vitreous humour.
2. **Nerve fibre layer** - axons of the ganglion cell nuclei
3. **Ganglion cell layer** - contains nuclei of ganglion cells, the axons of which become the optic nerve fibres for messages and some displace amacrine cells.
4. **Inner plexiform layer** - contains the synapse between the bipolar axons and the dendrites of the ganglion and amacrine cells.
5. **Inner nuclear layer** - contains the nuclei and surrounding cell bodies of the amacrine cells, bipolar cells and horizontal cells.
6. **Outer flexiform layer** - projections of rods and cones ending in the rod spherule and cone pedicle, respectively. These make synapses with dendrites of bipolar cells. In the macular region, this is known as the fibre layer of Henle.
7. **Outer Nuclear layer** - cells bodies of rods and cones.
8. **External limiting membrane** - layer that separates the inner segment portions of the photoreceptors from their cell nucleus.
9. **Layer of rods and cones** - layer of rod cells and cone cells (photosensitive cells).
10. **Retinal pigmented epithelium** - single layer of cuboidal cells. This layer is close to the choroid.

The rod cells are rod shaped and contains round nucleus and a pigment called rhodopsin, made up of proteins like opsin and retinine and vitamin A. There are about 10-20 million rods in retina. Rod cells are responsible for night vision or they function in dim light. It is bleached and consumed or destroyed in light. But it is soon reformed in dark by vitamin A, the deficiency of which causes night blindness.

The cone cells are cone-shaped and are very sensitive to bright light. They are responsible for colour vision. Cone cells are about 7 million in human retina. Cone cells are shorter than rods but wider and tapered. They contain violet pigment called iodopsin. There are three types of iodopsins: erythrolabe, chlorolabe, and cyanolabe, which are sensitive to red, green and blue light, respectively. They have oval nucleus.

There is a spot called the Yellow spot or macula lutea in the retinal wall. There is a central depression in the macula lutea, known as fovea centralis, which consist of cone cells only. Most light rays are focused here. It forms the sharpest and acute vision.

The nerve which carries inpulses from the retina to the brain is called optic nerve. A point where the optic nerve enters the retina is called blind spot. It does not contain any rods or cones so it is least sensitive to light and no image is formed here. The retina works much like the film of a camera.

The retina processes light through a layer of photoreceptor cells. These are essentially light-sensitive cells, responsible for detecting qualities such as colour and light-intensity The retina processes the information gathered by the photoreceptor cells and send this information to the brain via the optic nerve. The brain interprets the message and visual is perceived.

48. **2067 Q.No. 3 Describe the pulmonary respiration and mechanism of breathing in human being.** [7.5]

Please refer to 2074 Supp Q.No. 4

49. **2067 Q.No. 4 Give an account of structure and functions of a nephron in human being.** [8]

Please refer to 2076 Set C Q. No. 3

50. **2066 Q.No. 4 Give an account of the structure and function of human brain.** [8]

Please refer to Model (Zoology) Q.No. 3

51. **2065 Q.No. 4 Describe the digestive organs of man with the help of well labelled diagram.** [8]

Please refer to 2070 Supp. Q.No. 4

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52. 2064 Q.No. 4 **Explain the course of blood circulation in the human heart with well labelled diagram.** [10]

➢ Please refer to 2068 Q.No. 3

53. 2063 Q.No. 4 **Discuss the processes of urine formation in a nephron.** [8]

➢ Please refer to 2076 Set B Q. No. 3 OR

54. 2063 Q.No. 4 OR **Give an account of the structure and functions of human ear.** [10]

➢ Please refer to 2073 Supp Q.No. 3

55. 2062 Q.No. 4 **Describe the human alimentary canal and process of digestion with neat diagram.** [10]

➢ **Human alimentary canal** : Please refer to 2074 Supp Q.No. 3

Process of digestion : Please refer to 2070 Set D Q.No. 4

56. 2061 Q.No. 4 **What is respiration? Describe the respiratory system of human being.** [10]

➢ Please refer to Model (Zoology) Q.No. 3 OR

57. 2060 Q.No. 4 **Write an account of the structure and working of human heart.** [10]

➢ Please refer to 2074 Set A Q.No. 3 OR (second part)

58. 2059 Q.No. 4 **Discuss the internal structure of human lung and mention its working mechanism.** [5+2]

➢ The human lungs are a pair of large cone-shaped spongy and pinkish structures or organs in the thoracic cavity and are optimized for gas exchange between the blood and air. Human body require oxygen to survive. The lungs provide us with that vital oxygen while also removing carbondioxide before it can reach hazardous levels. They have narrow rounded apex at the top, and a broad concave base that rests on the convex surface of the diaphragm.

The left lung is smaller than the right one and has a concavity, the cardiac notch, where the heart lies. The left lung has two lobes: superior lobe and inferior lobe, which are divided by the oblique fissure. The right lung has three lobes: superior lobe, middle and inferior lobe. A horizontal fissure separates the superior lobe and middle lobe, and a oblique fissure separates the middle and lower lobe.

If the inner surface of the lungs could be stretched out flat, they would occupy an area of about 80 to 100 square meter - about the size of half of tennis court. Therefore, lungs are one of the largest organs in the body.

Each lung receives air from a single, large primary bronchus. As the primary bronchus enters the lung, it branch off into smaller secondary bronchi that carry air to each lobe of the lung. Thus, the right bronchus gives off three secondary bronchi while the left bronchus gives off two secondary bronchi. The secondary bronchi further divide into many smaller tertiary bronchi within each lobe. The secondary and tertiary bronchi improve the efficiency of the lung by distributing air even by within each lobe of the lungs.

The pseudostrafied epithelium that lines the bronchi contain many cilia and goblet cells. The goblet cells produce mucus to coat the lining of the bronchi. Cilia move together to push mucus away from the lung. Particles of dust and pathogens like viruses, bacteria and fungi in the air entering lungs stick to the mucus and are carried out of the respiratory tract. In this way mucus helps to keep the lungs clean and free of disease.

The tertiary bronchi branch off into many small bronchioles. Bronchioles are made of elastin fibres and smooth muscle tissue. The bronchioles further branch off into many tiny terminal bronchioles. Terminal bronchioles are the smallest air tubes in the lungs and terminate at the alveoli of the lungs. The terminal bronchioles are elastic, capable of dilating and contracting to control airflow into the alveoli. The terminal bronchioles give off respiratory bronchioles.

Alveoli are the functional units of the lungs that permit gas exchange between the air in the lungs and the blood in the capillaries of the lungs. Alveoli are found in small clusters called alveolar sacs at the end of the terminal bronchiole. Each alveolus is a hollow cup-shaped cavity surrounded by many tiny capillaries. Each lung consists of about 150 million alveoli.

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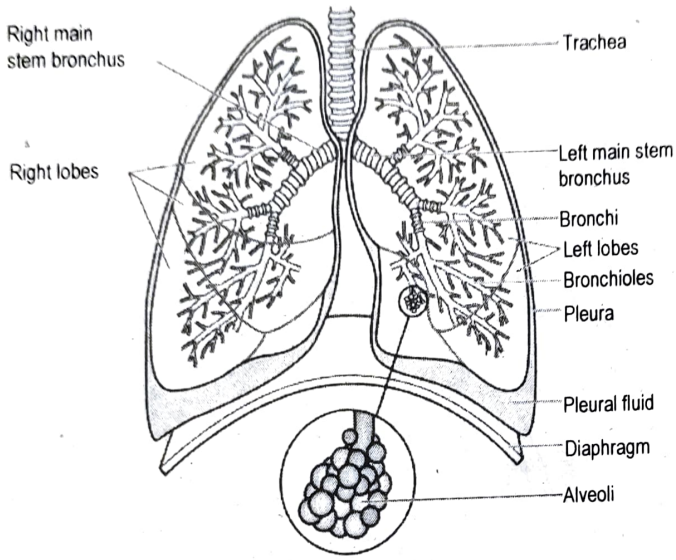
The wall of the alveolus are lined with simple squamous epithelium on alveolar cells. A thin layer of connective tissue underlines and support the alveolar cells. Capillaries surround the connective on the outer border of the alveolus. The respiratory membrane is formed where the walls of the capillaries touch the walls of an alveolus. At the respiratory membrane, gas exchange occurs freely between the air and blood through the extremely thin walls of the alveolus and capillary.

Septal cells and macrophages are also found inside the alveoli. Septal cell produce alveolar fluid that coats the inner surface of the alveoli. Alveolar fluid is extremely important to lung function, as it is a surfactant that moistens the alveoli, help maintain the elasticity of the lungs, and prevents the thin alveolar walls from collapsing. Macrophages in the alveoli keep phagocytizing pathogens and other foreign matter that enter the alveoli with inhaled air.



L.S of Human lungs

Working mechanism of lungs: The lungs are like bellows. When they expand, they pull air into the body. When they compress, they expel carbondioxide, a waste gas that bodies produce. The diaphragm and rib cage essentially pump the lungs.

- **Pulmonary ventilation:**

Human lung receive air from the external environment through the process of negative pressure breathing. Negative pressure breathing requires a pressure differential between the air inside the alveoli and the atmospheric air.

Muscles surrounding the lungs, such as the diaphragm, intercostals muscles, the abdominal muscles, expand and contract to change the volume of the thoracic cavity. Muscles expand the thoracic cavity and decrease the pressure inside the alveoli to draw atmospheric air into the lungs. This process of drawing air into the lungs is known as inhalation or inspiration. Muscles can also contract the size of the thoracic cavity to increase the pressure inside the alveoli and force out of the lungs. This process of pushing air out of the lungs is known as exhalation or expiration.

The process of intake of atmospheric oxygen into the lungs (inspiration) and throwing of carbondioxide from the lungs (expiration) is termed as breathing or pulmonary ventilation. Adult human beings typically take 15 to 12 breaths a minute, which comes to around 20,000 breaths a day.

59. 2058 Q.No. 3 **Describe the fertilization process in human beings.** [7]

Human fertilization is the union of a human egg and sperm, usually occuring in the Ampulla of the Fallopian tube of the human female. The result of this union is the production of a zygote cell, or fertilized egg, initiating prenatal development.

The process of fertilization involves a sperm fusing with an ovum. The most common sequence begins with ejaculation during copulation, follows with ovulation, and finishes with fertilization. Various exceptions to this sequence are possible, including artificial insemination, in-vitro

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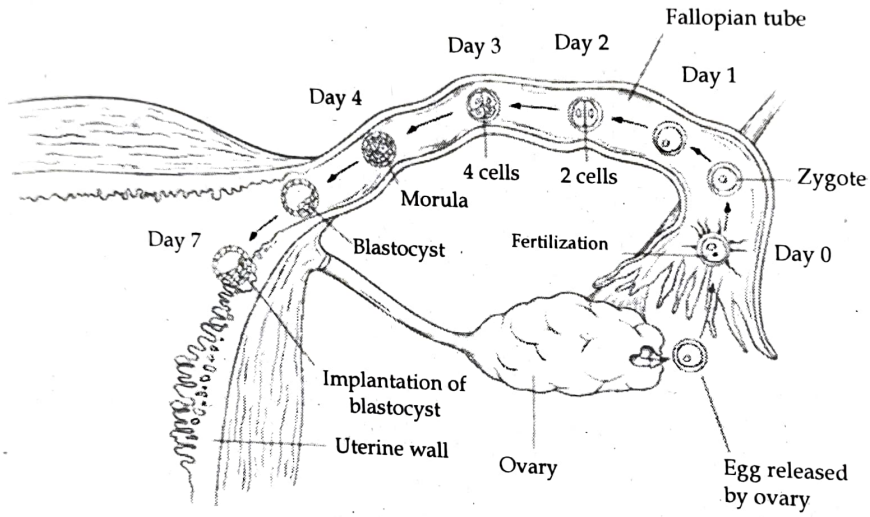
fertilization, external ejaculation without copulation, or copulation shortly after ovulation. Upon encountering the secondary oecyte the acrosome of the sperm produces enzymes which allow it burrow through the outer jelly coat of the egg. The sperm plasma then fuses with the egg's plasma membrane, the sperm head disconnects from its flagellum and the egg travels down the fallopian tube to reach the uterus.

During intercourse, a man ejaculate about 3.5 ml of seminal fluid or semen into the women's vagina. There are upto 150 million sperm in the semen in a single ejaculation. This process is called insemination.

In overview, fertilization in human can be described as the following steps:

1. **Movement of the sperm towards the egg:** The sperm travel to the Fallopian tube to meet the egg, however the sperm have some big challenges ahead to complete this journey. For instance, the sperm have to complete this journey within 12 to 48 hours of the eggs being ovulated, or else they will die.



Process of fertilization in human female

About 85% of the sperm are not properly structured for travel. This leaves only about 15% of the sperm to complete the journey to the egg. The remaining sperm will follow chemical signals given by the vagina and cervix, the opening of the uterus. The chemical signals will guide the sperm through the cervical mucus and up the lining of the uterus. The uterus is known as the womb and is where the baby will develop after fertilization.

Only about 1,000 sperm are left. After the sperm make it through the uterus, they face the challenge of picking up the right fallopian tube. There are two fallopian tubes, and only one contains the egg. The sperm that choose the correct fallopian tube will finally reach the egg. This process from ejaculating to the remaining sperm reaching the egg, takes about 20 minutes. At this point, there are only a few dozen sperm left that actually make it to the egg. The remaining sperm begin to surround the egg, and they race to be the first and only sperm to actually fertilize the egg.

Sperm mobility is aided by the muscular contractions of the wall of the uterus and the oviducts; and the secretion of a viscous liquid from the secretory cells of the epithelial lining of oviductal mucosa.

2. **Sperm capacitation:** Freshly ejaculated sperm are unable or poorly able to fertilize. Rather, they must undergo a series of changes known collectively as capacitation. Capacitation is associated with the removal of adherent seminal plasma proteins, reorganization of plasma membrane lipids and proteins. Capacitation is required to render the spermatozoa competent to fertilize an oocyte. This results in more fluid membrane with an increased permeability to Ca^{++}. An influx of Ca^{++} produces increased intracellular CAMP (Cyclic Adenosine Monophosphate) levels and thus, an increase in motility.

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3. **Sperm-Zona Pellucida Binding:** The sperm generally comes in contact with the ovum at the animal pole. Only one of the few dozen sperms fuses with the egg and this is called monospermy fertilization.

The sperm binds through the corona radiata, layer of follicle cells on the outside of the secondary oocyte. After binding with the corona radiata the sperm reaches the zona pellucida, which is a glycoprotein layer surrounding the plasma membrane of mammalian oocyte. The zona pellucida first appears as unilaminar primary follicles. The zona pellucida is surrounded by the cumulus oophorus, a clustur of cells. The innermost layer of cumulus oophorus is called zona radiata. The cumulus is composed of cells that care for the egg when it is emitted from the ovary.

The zona pellucida binds spermatozoa, and is required to initiate the acrosome reaction.

4. **The Acrosome Reaction:** Binding of sperm to the zona pellucida is an easy part of fertilization. The sperm then faces the daunting task of penetrating the zona pelucida to get to the oocyte. Evolution's response to this challange is the acrosome - a huge modified lysosome that is packed with zona-digesting enzyme and is located around the anterior part of the sperms' head - just where it is needed.

The acrosome reaction provides the sperm with an enzymatic drill to get through the zona pellucida. The acrosomal reaction normally takes place in the ampulla of the fallopian tube when the sperm penetrates the secondary oocyte. The same zona pellucida protein that serves as a sperm receptor also stimulates a series of events that lead to many areas of fusion between the plasma membrane and outer acrosomal membrane. Membrane fusion (actually an exocytosis) and vesiculation expose the acrosomal contents, leading to leakage of acrosomal enzymes from the sperm's head.

As the acrosome reaction progresses and the sperm passes through the zona pellucida, more of the plasma membrane and acrosomal contents are lost. By the time, the sperm traverses the zona pellucida, the entire anterior surface of its head, down to the inner acrosomal membrane, is denuded (i.e. to strip of all covering or surface layers). Sperm that lose their acrosomes before encountering the oocyte are unable to bind to the zona pellucida and thereby unable to fertilize.

5. **Penetration of the Zona-Pellucida:** The constant propulsive force from the sperm's flagellating tail in combination with acrosomal enzymes, allow the sperm to create a tract through the zona pellucida.

6. **Cortical reaction:** The entry of the sperm head into the egg brings about several changes in the egg surface. These are the cortical changes and the development of the fertilization membrane. Once the sperm cells find their way past the zona pellucida, the cortical granules inside the secondary oocyte fuse with the plasma membrane of the cell, causing enzymes inside these granules to be expelled by exocytosis to the zona pellucida. This in turn causes the glyco-proteins in the zona pellucida to cross-link with each other, making the whole matrix hard and impermeable to sperm. This layer which prevents the entry of other sperms is called fertilization membrane. The cortical reaction and acrosome reaction are both essential to ensure that only one sperm will fertilize an egg.

7. **Activation of the ovum:** The penetration of the sperm activates the egg and initiates a series of changes in the egg cortex and in the egg cytoplasm. Ovulation in the human female occurs at the secondary oocyte stage in which Meiosis - I has been completed and the first polar body has been released but second meiotic division has yet to be completed. When the sperm lysin dissolves the egg membrane, the ovum is activated to release second polar body and begin cleavage. This results in a mature ovum.

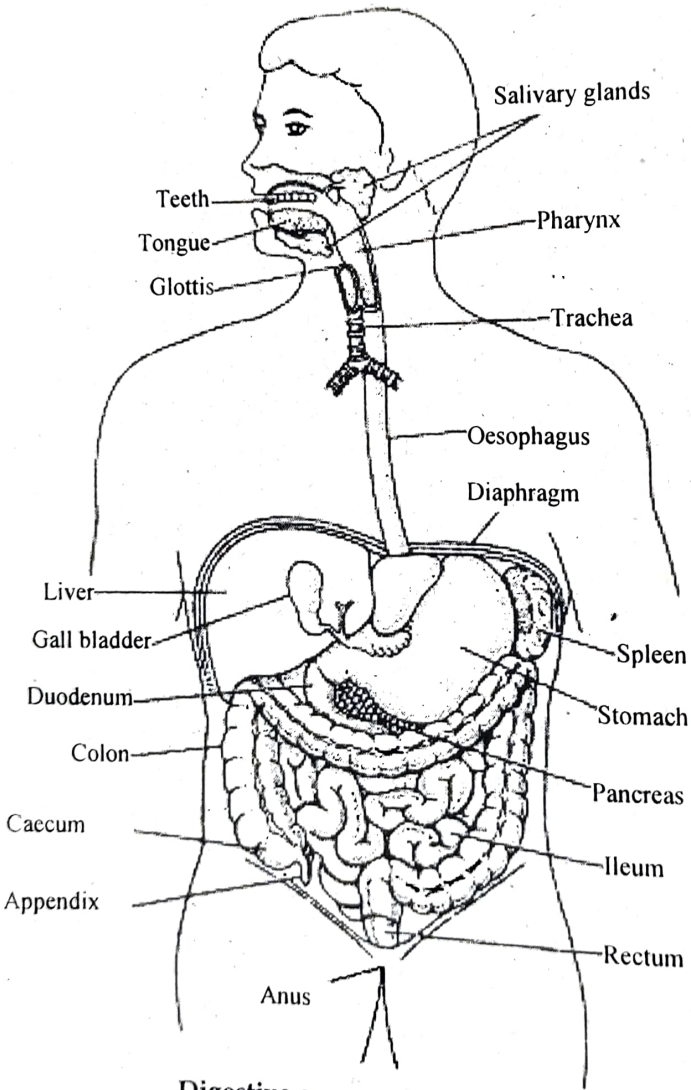
8. **Fusion of Male and Female Pronuclei (Amphimixis):** In this process there is fusion of the male and female nuclei. Initially the two nuclei remain close together and at the point of contact the nuclear membranes disappear and the chromosomes come to lie on the equator. Finally the nuclear fusion is completed and it becomes zygote nucleus. The egg is said to have been fertilized and it becomes a zygote. The fusion of male and female nuclei is called amphimixis. This restores the original diploid

condition in the zygote nucleus. Moreover it brings about the intermingling of the paternal and maternal hereditary material so that the resulting offspring receives both paternal and maternal characteristics. Now the zygote is ready to undergo cleavage to develop into the embryo.

60. 2058 Q.No. 3 OR **Write the basic features of digestive system in mammals. Draw a well labeled diagram of alimentary canal of man.** [5+2]

The mammalian digestive system consists of the alimentary canal and various accessory glands that secret digestive juices into the canal through the ducts. The food is moved along the tract by the contraction of smooth muscles in the wall of the canal. These rythmic contraction waves are called peristalsis. The regulation of passage of material from one chamber to another within the canal is controlled by ring -like valves called sphincters.

The accessory glands of the mammalian digestive tract are three pairs of salivary glands, the pancreas, the liver and its storage organ the gall bladder.



Digestive organs of Human

1. **The Oral cavity - Mouth:** Physical and chemical digestion of food begin in the mouth. During chewing, the food is made easier to swallow. The presence of food in the mouth triggers a nervous reflect that causes the salivary glands to secret saliva into the mouth. The tongue located in the oral cavity helps to manipulate the food during chewing and shapes the food into a ball called the bolus, which it pushes to the back of the mouth and into the pharynx.

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2. **The Pharynx:** Mouth leads to pharynx which leads to both the oesophagus and the windpipe (trachea). The bolus moves towards the oesophagus as a flap of cartilage called epiglottis blocks the food from entering the trachea.

3. **The oesophagus:** The oesophagus channels food from the pharynx to the stomach. The muscles in the walls move the food.

4. **The Stomach:** The stomach is located on the left side of the abdomen; just below the diaphragm. Since its walls are elastic, the stomach can hold upto 2 liters of food and water. The wall of the stomach secret gastric juices, a digestive fluid that mixes with the food. The fluid is highly acidic and its p^H is about 2. The acid kills the bacteria in the food.

The gastric juice also contains pepsin, which breaks down the protein into peptide bonds. The goblet cells of the stomach wall secrete mucus which prevent the erosion of stomach wall by the action of HCl.

The stomach is closed off at both ends. The opening from the oesophagus to the stomach is called the cardiac orifice. This opening will open when a bolus is ready to pass. The opening from the stomach to the small intestine is the pyloric sphincter. This opening regulates the passage of chyme in the small intestine. This happens as a squirt at a time, taking about 2-6 hours to empty the stomach after a meal.

5. **Small Intestine:** The small intestine is the major organ of digestion and absorption. The small intestine is the longest section of the digestive tract and is more than six meters in length. Most of the digestion and absorption occurs here. The pancreas, liver and gall bladder participate in digestion.

The first part of small intestine is the duodenum, which is 25 cm long. This is where the chyme from the stomach mixes with the digestive juices from the pancreas, liver, gall bladder and glands from the intestinal wall. The liver produces bile which is stored in the gall bladder. Bile does not contain digestive enzymes. It contains bile salts which help in the absorption of fats. Bile also carries waste from the liver. Bile helps in the neutralization of acidic food.

The middle part of the small intestine, the jejunum does not take part in digestion.

Most of the absorption of glucose, amino acids, fatty acids and glycerol takes place in the ileum. The wall of the small intestine has many foldings called the villi and each of the cells of the villi has microvilli. These microvilli absorb nutrients and are then transported across the capillary membranes.

6. **Large Intestine:** The ileum is connected to the large intestine at a T-shaped junction where a sphincter regulates the movement of materials. The part of the large intestine connected to the ileum is called the caecum. The caecum has a finger like projection called vermiform appendix, which is vestigial in carnivores. But the vermiform appendix are enlarged and functional in herbivores and used in the digestion of cellulose. The caecum is connected to the colon which is 1.5 meter long. It has four parts from front to back-ascending colon, transverse colon, descending colon, and sigmoid colon. The main function of the colon is to reabsorb water. The colon harbors many beneficial bacteria, called the microflora or gutflora, e.g. E. Coli, that help in the production of vitamin K, which is used in blood clotting. The terminal portion of the colon is called rectum, where the undigested food or faeces are stored until they are eliminated.

The terminal opening of the alimentary canal from where the undigested food in eliminated is called the Anus. Between the rectum and the anus are two sphincters, one involuntary and one voluntary. Once or more a day, a strong contractions of the colon create an urge to defaecate.

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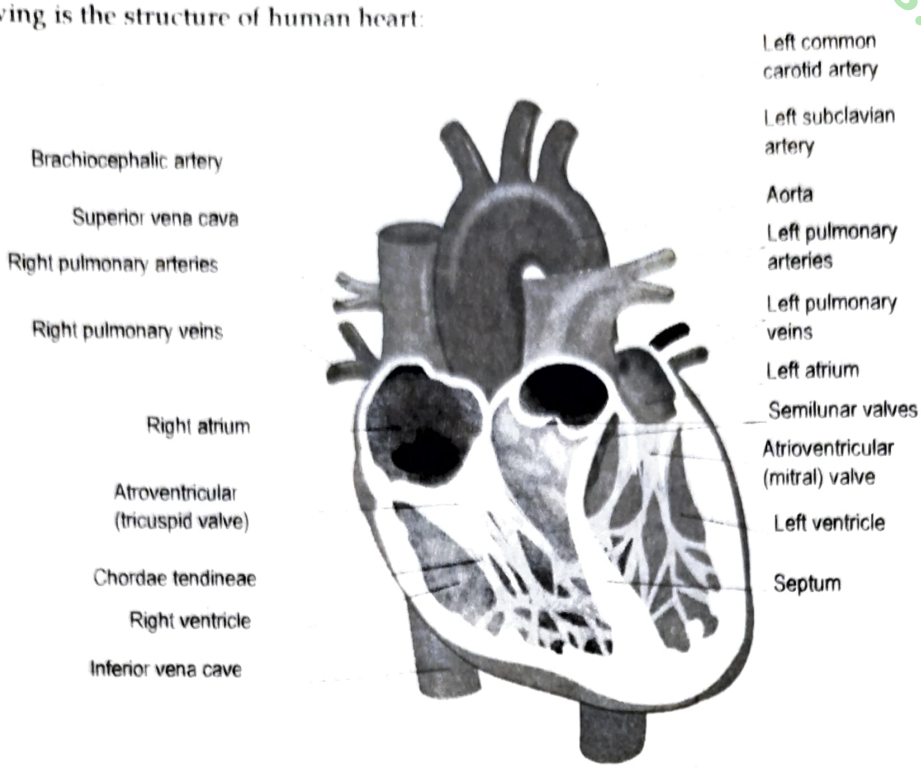
61. 2058 Q.No. 5 **Draw a well-labeled sketch of structure of human heart.** [7]

Following is the structure of human heart:



V.S of human heart

62. 2057 Q.No. 4 **Write an account of the structure of mammalian kidney. How it acts as homeostatic organ?** [5+5]

The kidneys, in mammals, are a pair of bean-shaped structures that are located just below and posterior to the liver in the peritoneal cavity. Kidneys filter blood and purify it. All the blood in the mammalian body is filtered many times a day by the kidneys; these organs use up almost 25 percent of the oxygen absorbed through the lungs to perform this function. The filtrate coming out of the kidneys is called urine.

Kidney structure:

The size of the kidney varies in different mammals. In human, each kidney is 11.5 cm long, 5 to 7 cm broad and 3 cm thick and weighs 150 gm in male and 135 gm female. The right kidney lies slightly lower than the left kidney due to the space occupied by the liver on the right side. The kidneys are reddish brown in colour.

Externally, the kidneys are surrounded by three layers collectively called as renal coverings. The outermost layer is a tough connective tissues layer called the renal fascia. The second layer is called perirenal fat capsule, which helps anchor the kidney in place. The third innermost layer is the renal capsule. The layers protects the kidney from injury. The outer side of the kidney is convex and the inner side deeply concave bearing a pit or depression called the Hilum, through which renal vessels and ureter enter or leave the kidney. The kidney is supplied by renal artery and drained by renal vein.

Internal structure of kidney

Internally, the kidney has three regions - an outer cortex, the middle medulla, and the inner pelvis in the region called the hilium of the kidney, when cut in longitudinal section.

1. **Cortex:** The cortex is the outer part of the kidney and constitutes $\frac{1}{3}$ part of the kidney tissue. It is light pink in colour. It is granular due to the presence of nephrons - the functional unit of the kidney. It contains Bowman's Capsule, and proximal and distal convoluted tubules of nephrons.

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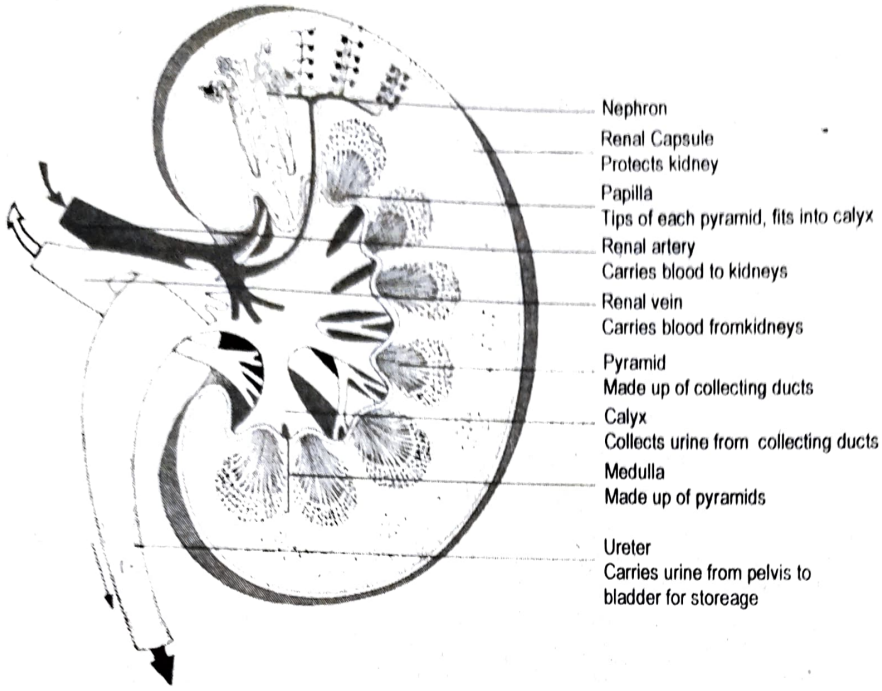

L.S. of human kidney

2. **Medulla:** The renal medulla constitute $\frac{2}{3}$ part of the kidney. It is darker in colour and contains loop of Henle and collecting tubules. The medulla consists of multiple pyramidal tissue masses, called the renal pyramids. In between the pyramids are spaces called renal columns of Bertini through which the blood vessels pass. The tips of the pyramids, called renal papillae, point towards the renal pelvis. There are on average, eight renal pyramids in each kidney. The renal pyramids along with the adjoining cortical region are called the lobes of the kidney.
3. **Renal Pelvis:** Renal Pelvis is a large funnel-shaped space towards the hilum of the kidney. The renal pelvis branches out into two or three extensions called the major calyces, which further branch into the minor calyces. The renal pelvis leads to the ureter on the outside of the kidney. The ureters are urine-bearing tubes that exit the kidney and empty into the urinary bladder.

Each kidney is composed of about one million nephrons, held together by connective tissue. The nephrons are the structural and functional unit of kidney.

There are two parts of kidney nephron: the Renal corpuscles or Malpighian's body and the Renal Tubule.

Kidneys act as Homeostatic Organ

Homeostasis refers to the ability of the body or cell to seek and maintain a condition of equilibrium or stability within its internal environment when dealing with external changes.

The kidneys are responsible for maintaining homeostasis by following ways:

1. **Osmolarity regulation:** Kidney maintains salt-water balance in the body. This regulation is brought about by changing the permeability of distal convoluted tubules and collecting ducts.
2. **Excretion of wastes:** The kidney excrete a variety of waste product produced by metabolism in the urine. These include the nitrogenous wastes urea from protein metabolism and uric acid from nucleic acid metabolism.
3. **Reabsorption of vital nutrients:** Vital macromolecules such as glucose and amino acids are reabsorbed in proximal convoluted tubule in the kidney.
4. **Acid-Base Homeostasis:** The kidneys plays two important roles in maintaining the acid-base balance; to reabsorb and regenerate bicarbonate from urine, and to excrete hydrogen ions into the

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urine. Kidneys excrete non-volatile acids such as lactic acids, ketones, sulphuric acid, etc. In other words, the kidney maintains the p^H of the body.

5. **Blood Pressure Regulation:** Although Kidneys cannot directly sense blood, long term regulation of blood pressure depends upon the kidney. This primarily occurs through maintenance of the extracellular fluid.
6. **Heat loss:** Some amount of heat is lost form the body during micturation.
7. **Production of Hormone:** The kidneys produce erythropoietin hormone which stimulate bone marrow to produce more red blood cells. Thus, they regulate the RBC count in blood.

B. Human Population

Very Short Answer Questions [1 mark]

1. 2073 Set D Q.No. 1e **How would you define psychotropic drugs?** [1]

Psychotropic drugs are chemical substances, when taken into the body, change brain function and result in alteration in perception, mood, or consciousness. e.g. opium, narcotics, stimulants, etc.

2. 2072 Set E Q.No. 1f **Give full form of IUD.** [1]

The full form of IUD is Intra Uterine Device. It is a small T-Shaped birth control device that is inserted in to a woman's uterus to prevent pregnancy.

3. 2070 Set C Q.No. 1d **Define population.** [1]

Population is defined as the number of all the organisms of the same group or species, which live in a particular geographical area, and have the capacity of interbreeding.

4. 2060 Q.No. 1o **What do you mean by natality rate?** [1]

Natality rate, also called birth rate, are the annual number of birth during a year per 1,000 persons in the population at mid year.

5. 2058 Q.No. 1j **What is demography?** [1]

Demography is the study of statistics such as births, deaths, income, or the incidence of diseases, which illustrate the changing structure of human population. In other words, Demography is the scientific study of population.

Answer all in brief [3 marks]

1. 2076 Set B Q. No. 2g **Population growth curves.** [3]

A population growth curve is a graphical representation of how a particular population increases over time. Growth curves are used in statistics to determine the type of growth pattern of the population – be it linear, exponential or cubic.

Two types of population growth patterns may occur depending on specific environmental conditions:

i. An exponential growth pattern (J curve) occurs in an ideal, unlimited environment
ii. A logistic growth pattern (S curve) occurs when environmental pressures slow the rate of growth

Exponential Growth (J-shaped Curve)

- Exponential population growth will occur in an ideal environment where resources are unlimited.
- In such an environment there will be no competition to place limits on a geometric rate of growth
- Initially population growth will be slow (lag phase) as there is a shortage of reproducing individuals that may be widely dispersed
- As population numbers increase the rate of growth similarly increases, resulting in an Exponential (J-shaped) curve
- This maximal growth rate for a given population is known as its biotic potential.

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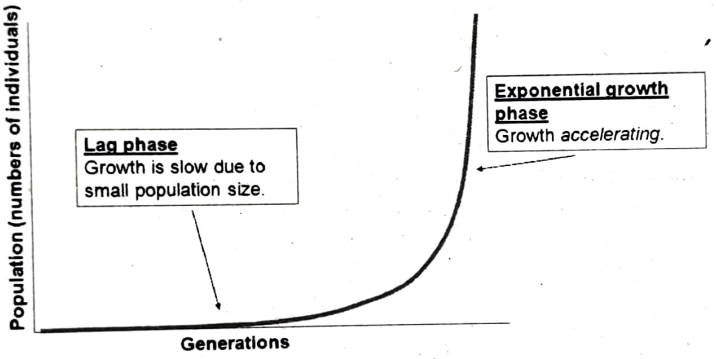
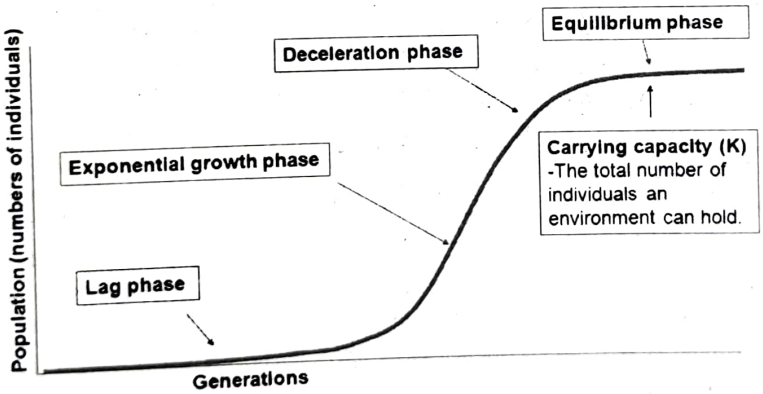
- Exponential growth can be seen in populations that are very small or in regions that are newly colonised by a species
- Examples: 'boom and bust cycle' of some insects and algal blooms.

Logistic Growth (S-shaped Curve)

- Logistic population growth will occur when population numbers begin to approach a finite carrying capacity.
- The carrying capacity is the maximum number of a species that can be sustainably supported by the environment
- As a population approaches the carrying capacity, environmental resistance occurs, slowing the rate of growth
- This results in a Sigmoidal (S-shaped) growth curve that plateaus at the carrying capacity (denoted by κ)
- Logistic growth will eventually be seen in any stable population occupying a fixed geographic space
- Examples: most of the animals and plants including human beings.





Limiting Factors

Limiting factors are environmental conditions that control the rate at which a process (e.g. population growth) can occur

- Population growth can be determined by density-dependent or density-independent factors

Density dependent environmental factors are influenced by the relative size of a population

- These factors include predator numbers, availability of food and other resources and the spread of pathogenic diseases

Density independent environmental factors are **not** influenced by the relative size of a population

- These factors include weather and climate conditions, as well as the occurrence of natural disasters (e.g. earthquakes)

2. **2075 GIE Q. No. 2f The problems of population growth.** **[3]**

Please refer to 2075 Set B Q.No. 2f

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3. 2075 Set B Q.No. 2f Various problems of over population. [3]

Overpopulation can have a number of negative effects, some of which are discussed below:

1. **Depletion of natural Resources:** As human population keeps on enlarging, exhaustible natural resources such as arable land, fresh water, coral reef, fossil fuels, and wildnerness forests continue to drop sharply.
2. **Accelerated Habital loss:** The increased loss of the ecosystems including wetlands, wildlife, rainforests, coral reefs, aquatic life forms, and grasslands are highly influenced by overpopulation.
3. **Amplified climatic change and global warming:**
   The largest human influence has been the emission of greenhouse gases such as carbon dioxide, methane and nitrous oxide. Anticipated effects include warming global temperature, rising sea levels, changing precipitation, and expansion of deserts.
4. **Loss of biodiversity and mass Extinction of species:**
   Overpopulation has seen continued encroachment into frontier forest, heightened pollution, and destruction of natural ecosystem that has greatly contributed to the mass extinction of species.
5. **Lack of fresh water:** Overpopulation creates greater demand on the world's freshwater supplies. As only roughly 1% of the world's water is fresh and accessible.
6. **Lower life expectancy and diminished quality of life:** Overpopulation lowers the standard of living since it creates stress on the vital resources for survival. This creates problems in consistent supply of food, water, energy, health, security and shelter. Consequently people opt for low standard of life. It results in lower life expectancy.

4. 2074 Set A Q.No. 2c Enlist the control measures of human population growth. [3]

Some of the control measures or strategies that could put human population on and environmentally sustainable path are outlined as follows:

1. **Provide universal access to safe and effective contraceptive options for both sexes:** With nearly two in five pregnancies reported as mistimed or never wanted, lack of access to good family planning services is among the biggest gaps in assuring that each baby will be wanted and welcomed in advance by its parents.
2. **Guarantee education through secondary school for all especially girl:** In every culture surveyed to date, women who have completed at least some secondary school have fewer children an average, and have children later in life than do women who have less education.
3. **Eradicate gender bias from law, economic opportunity, health and culture:** Women who can onherit, own, and manage property; divorce; obtain credit, and participate in civic and political affairs on equal terms with men are more likely to postpone child bearing and to have lower children compared to women who are deprived of these right.
4. **Offer age appropriate sexuality education for all students:** Various studies have suggested that exposure to comprehensive programmes that detail puberty, intercourse, options of abstinence and birth control and respecting the sexual rights and decisions of individuals, can help prevent unwanted pregnancies and hence reduce birth rates.
5. **Integrate lessons on population, environment, and development into school curricula at multiple level:** Refraining from advocacy or propaganda, school should educate students to make well-informed choices about the impacts of their behavior, including childbearing, on the environment.

5. 2074 Set B Q.No. 2c What is Malthus theory of human population? Discuss the consequences of overpopulation. [3]

Malthus theory of human population

Thomas Robert mathus (1766–1834), an English cleric and scholar, was the key figure to analyse the population statistics. His formulation on population was a landmark in the history of population theories. He generalized the relationship between population factors and social change.

In his essay on the Principle of population (1798) Malthus urged that because of the strong attraction of the two sexes, the population could increase by multiples, doubling in every twenty

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five years. He contented that the population would eventually grow so large that food production would be insufficient.

The Malthusian doctrine is stated as follows:

1. There is a natural sex instinct in human beings to increase at a fast rate. As a result, population increases in geometrical progressing and if unchecked doubles itself in every 25 years.
2. On the other hand, the food supply increases in a slow arithmetical progression due to the lack of constant supply of land.
3. Since population increases in geometrical progression and the food supply in arithmetical progression, population tends to outrun food supply. Thus an imbalance is created which leads to over-population.
4. To control over-population resulting from the imbalance between population and food supply, Malthus suggested preventive checks and positive checks.

The preventive checks are applied by a man to control the birth rate. They are foresight, late marriage, celibacy (the state of abstaining from marriage and sexual relations), moral restrainst, etc. If people fail to check growth of population by the adoption of preventive checks, positive check oprate in the form of vice (criminal activities), misery (state of suffering from poverty), famine, war, disease, flood and other natural calamities, which tend to reduce population and thereby bring a balance with food supply. According to Malthus, preventive checks are always in operation in a civilized society, for positive checks are crude.

Discuss the consequences of overpopulation

Please refer to 2075 Set B Q.No. 2f

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6. 2073 Supp Q.No. 2g **Describe the measures of family planning.** [3]

Family planning is the practice of controlling the number of children in a family and their intervals between their births. Family planning involve consideration of the number of children a woman wishes to have, including the choice to have no children, as well as the age at which she wishes to have them.

Family planning methods are grouped into two main categories: Natural and artificial.

1. **Natural method of family planning:**

No artificial equipments are used for family planning. Some of the natural methods are as follows:

i. **Delayed marriage** - Ensures the birth of less number of children

ii. **Behavioral methods** - Abstinence is the best way to prevent pregnancy

iii. **Fertility Awareness** - Method of birth control that does not use any drugs or devices. It combines the calender/rhythm method, the basal body temperature, and the cervical mucus method. This method determines the days of month the woman is most likely to get pregnant. The objective of fertility awareness is to become familiar with the menstrual cycle and begin charting fertility pattern.

iv. **Prolonged lactation** - But not reliable

2. **Artificial methods of family planning:** External objects are used in artificial methods. Artificial methods of family planning is grouped into two: Temporary and permanent.

i. **Temporary methods** - It works for short time only.

a. **Barrier methods** - Barrier methods of birth control physically stop the sperm from getting to the egg. These are available for both male and female. The instruments are

- Condoms - rubber or plastic membrane easy to use and most used device.
- Diaphragms - fit in the neck of the adult female and prevent the sperm reaching the ovum.

b. Spermicidal **agents** - These substances kill the sperm cell. These are found in the forms of foams, tablets or creams that are inserted within the vagina before sexual intercourse. These include $KMnO_4$, $ZnSo_4$, Lactic acid, Citric acid, etc. In Nepal, Kamal Chakki is the most famous foaming tablets.

c. **Chemical /Hormonal methods:** Some birth control works by altering the woman's hormones to make pregnancy unlikely or impossible. Birth control pill or oral contraceptive pills usually consist of mixture of oestrogen and progesterone hormone. Both these hormones prevent ovulation, if taken in sufficient amount. e.g. Nilokan, Gulaf Chakki, Kanchan, Mala-D, are famous contraceptive pills of Nepal.

d. **Intra-Uterine Devices (IUDS):** These are tiny plastic and metal (Copper) loops or coils, which are inserted into the uterus of female. It prevents fertilization by interfering with the implantation of the fertilized egg into the lining of the uterus. e.g. Copper T- 200 in Nepal.

e. **Depo-provera:** An injection of progesteron injected in the body of female within seven days after menstruation in every three months.

f. **Norplant:** Norplant is a set of six small (3-4 cm long) flexible tubes, which are inserted under the skin of the upper arm through a minor surgery. Once administered, it is effective for five years. Nor plant is a progesteron that thickness the cervical mucus, which prevent the sperms from meeting the egg.

ii. **Permanent Method:** These are surgical method and include:

a. **Vasectomy:** It makes the male permanently incapable of fertilization. The spermatic ducts are cut and prevent the sperms from coming out during ejaculation.

b. **Tubectomy:** The fallopian tubes are cut and tied in females, Laparoscopy is commonly used for this purpose.

c. **Abortion:** Undesired pregnancies may be terminated by surgical process called abortion. It is normally used only in pregnancies not older than 3 months.

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7. 2072 Supp. Q.No. 2d **Write down the causes of population growth.** [3]

The rapid growth of the world's population over the post one hundred years result from the difference between the rate of birth and rate of death. This is due to decline in death rate and rise in the birth rate.

The causes of population growth can be summarized as follows:

1. **Advancement in civilization and science and Technology:** In due course of time human have learned to live and became more civilized. Progress in science and technology enabled them to eliminate many factors that resist environment.
2. **Advancement in Agricultural technology:** Due to advancement in science and technology farmers are able to increase food production geometrically. In more recent years, the technology has produced a broader variety of techniques: new kind of seed, chemical fertilizers, pesticides and sophisticated machinery.
3. **Improvement in public Health:** Better medical facilities have made people live longer than before. Greater medical attention to all has resulted in increase in life expectancy.
4. **Conquest of Diseases:** Scientists have learned a great deal about the way to prevent and cure many types of disease. Otherwise, millions of people who would have died of disease a century ago. The most effective tools in the conquest of diseases have been improved knowledge about nutrition, vaccination, better public health practices and the development of new medicines.
5. **Technology advancement in fertility treatment:** With latest technological advancement and more discoveries in medical science, it has become possible for couple who are unable to conceive to undergo fertility treatment methods and have their own hoby.
6. **Lack of family planning:** Most developing nations have large number of people who are illiterate and have little knowledge about family planning.

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8. 2071 Supp. Q.No. 1g **Malthus theory of population growth.** [3]

Please refer to 2074 Set B Q.No. 2c (first part)

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9. 2071 Set D Q.No. 2e **Discuss on problems of over human population.** [3]

Please refer to 2075 Set B Q.No. 2f

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10. **2070 Supp. Q.No. 2g The various factors controlling population growth.** [3]

The various factor that controls or affect population growth are as follows:

1. **Birth rate Natality rate:** Natility rate is the rate at which new individuals are added to a particular population by reproduction. It is generally expressed as number of births per 1,000 individuals of a population per year. Higher birth rate increase the population size.
2. **Death rate or mortality rate:** Mortality rate is the rate at which the individuals die or get killed. It is opposite of natality rate. It is generally expressed number of death per 1,000 individuals of a population per year. High mortality rate decrease population growth.
3. **Immigration:** Immigration is the permanent entry of new individuals of same species into a population from outside. It increases the size of local population.
4. **Emigration:** Emigration is the permanent movement or departure of individuals of same species out of the local population due to several reasons such as lack of food, scarcity of space (over-crowding), etc. Emigration decreases the size of local population. But the species spread to new areas.
5. **Carrying capacity (Resources):** Population density of an area is largely determined by available resources like food, water and space in the region. The maximum number of individuals of a population, which can be provided with necessary resources for healthy living, is called carrying capacity of the habitat. Size of population increases till it reaches the carrying capacity of the habitat.
6. **Natural calamities:** A drastic changes in the environment destabilized or event exterminates a population. Natural calamities such as earthquake, volcanic eruptions, etc cause drastic changes in the environment leading to the destruction of the resources.
7. **Biotic factors:**
   - i. Food - more food, more population.
   - ii. Predators - more predators, less population growth.
   - iii. Competitors - more competitors, less population.
   - iv. Parasites - more parasites cause disease and slow down the growth and reproductive rate of organism within a population.
8. Abiotic factors:
   - i. **Temperature** - Higher temperatures speed up enzyme catalyzed reactions and increases growth.
   - ii. **Oxygen availability** - affects the rate of energy production by respiration.
   - iii. **Light availability** - Light may also control breeding cycles in human.
   - iv. **Toxins and pollutants** - Reproductive success may be affected by low oestrogen secretion. This decrease of oestrogen is due to pollutants like sulpher dioxide.

11. **2070 Set C Q.No. 2c Discuss the control measures of over population.** [3]

Please refer to 2074 Set A Q.No. 2c

12. **2067 Q.No. 2c Write short note on control measures of human population growth.** [3]

Please refer to 2074 Set A Q.No. 2c

13. **2066 Q.No.2 b Write the consequences of overpopulation.** [3]

Please refer to 2075 Set B Q.No. 2f

14. **2065 Q.No.2e Meaning of carrying capacity and causes of population growth.** [3]

Carrying capacity is defined as the maximum number of individuals of a population that can be supported indefinitely in a defined habitat without permanently damaging the ecosystem upon which it is dependent. There are limits to the life - sustaining resources earth can provide us.

The causes of population growth can be listed as follows:

1. **Decline in Death Rate:** The fall in death rates is one fundamental cause to population growth. During to the advancements in medicine, man has found cures to the previously fatal diseases.

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2. **Rise in Birth rate:** New discovery in nutritional science have boosted the reproductive rate of human being. These are medicines and treatments, which can help in conception. Thus, science has led to an increase in birth rate.
3. **Lack of education:** Lack of education results in failing to understand the need to prevent excessive growth of population. They are unable to understand the harmful effects of overpopulation.
4. **Early marriage:** Child marriage in some communities of developing countries like India, Pakistan, Bangladesh, Nepal, etc. is very common. It increases the chance of producing more children.
5. **Better medical facilities:** Medical science has made many discoveries thanks to which they are able to defeat a whole range of diseases. Antibiotics and vaccines have saved millions of lives till now.

15. 2064 Q.No.2i **Differentiate between J-shaped and S-shaped curves.** [3]

The growth of population is measured as increase in its size over a period of time and population show characteristic pattern of growth with time. These patterns are known as population growth forms. There are two population growth forms.

1. J-shaped population growth form (J-curve)
2. S-shaped population growth form (S-curve)

The differences between J-shaped curve and S-Shaped curve are as follows:

J-Shaped Curve	S-Shaped Curve
J- curve represents population growth with no restriction.	S-curve represents population growth with a restricting factor.
It consists of two phases -lag phase and exponential or log phase.	It consist of lag phase, exponential (log phase) and stationary phase.
It denotes growth in J-shaped manner.	It denotes the growth in the letter 'S' shaped manner.
Finally J-shaped curve shows rapid increase in mortality rate.	Finally s-shaped curve shows zero growth rate as birth rate equals to death rate.
Shows as boom and bust pattern.	Starts with exponential growth but latter on stabilizes at the carrying capacity of the environment.
Examples-Lemming (rodents) of Tundra, some insects and all annual plants.	Examples – Human population, Yeast cells and most of the organisms.

16. 2062 Q.No.2g **What are the disadvantages of over population?** [3]

Overpopulation is the condition of having a population so dense as to cause environmental deftorioration, an impaired quality of life, or a population crash.

The disadvantage of overpopulation is that population growth puts tremendous pressure on economic and ecological resources. In long term, the world will have to come to terms with the fact that humans are consuming at a faster rate than the nature is to produce right now.

The disadvantage of over population can be listed as follows:

1. Depletion of Natural Resources
2. Degradation of Environment
3. Conflicts and wars for limited natural resources.
4. More mouths to feed and fewer natural resources on hand can have a devastating effect on the economy.
5. Lower standard of living
6. Poverty
7. Overcrowded cities
8. Sickness and spreading of diseases
9. Insufficient natural resources to provided adequate goods and services.

17. **2061 Q.No.2g Discuss about the over population of human beings.** [3]

Overpopulation is the state where by the population rises to an extent exceeding the carrying capacity of the ecological setting. In an overpopulated environment, the numbers of people might be more than the available essential materials for survival such as transport, water, shelter, food or social amenities. This regularly contributes to environmental deterioration, worsening in the quality of life, or even the disintegration of the population.

It is estimated that about 81 million people are added to the existing world's population annually. Currently the world's population stands more than 7 billion. (2017)

Causes of overpopulation

Overpopulation is caused by factors, which are as follows:

1. Reduced mortality rate due to medical facilities;
2. High fertility rate due to modern advancement in reproductive sector and fertility treatment;
3. Eradication of several infections diseases like malaria, Kala-azar tuberculosis, etc;
4. Immigration, influx of people in certain places due to better facilities;
5. Lack of family planning;
6. Lack of education;
7. Traditional belief of having more children as gods gifts;
8. Early marriage;
9. Advancement is agricultural Technology;
10. Better food storage facilities.

Consequences of overpopulation

The consequences or effects of overpopulation are listed below:

1. Depletion of Natural resources and degradation of Environment;
2. Conflicts and wars on limited natural resources like river, lakes, fuels, et;
3. Poverty and high cost of living;
4. Lack of better public health, medical care, housing, shelter, etc;
5. Emergence of new diseases;
6. Rise in unemployment, crimes and accidents;
7. Low quality of living standard;
8. Lack of better education;
9. Mass extinction of species;
10. Loss of fresh water;
11. Unhygienic environment due to pollution;
12. Lower life expectancy.

Control measures or solution of overpopulation

1. Better education and spread of public awareness about over population.
2. Making people aware of family planning.
3. Tax benefits or concessions.
4. Knowledge of sex education
5. Enacting birth control measures and regulations.
6. End gender bias through law.
7. Offer education to women and girls.
8. Offer employment
9. Concept of small family should be encouraged.

18. **2057 Q.No. 2g Discuss the consequences of over human population.** [3]

Please refer to 2075 Set B Q.No. 2f

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Long Questions

1. 2071 Set C Q.No. 3 | 2060 Q.No. 4 OR **Discuss about the human population growth, problems of over population and control strategies.** [7.5]

Human population growth

Pleaser refer to 2072 Supp. Q.No. 2d

Problems of over population and control strategies

Please refer to 2061 Q.No. 2g

C. Disease

Very Short Answer Questions [1 mark]

1. 2076 Set B. Q. No. 1j **Hepatitis is more dangerous than AIDS, why?** [1]

The causes of spread of hepatitis are more than what they are for HIV/AIDS. Hepatitis spreads rather more easily. This is why hepatitis is more dangerous than AIDS. Hepatitis kill the infected person earlier than the AIDS does.

2. 2076 Set C. Q. No. 1f **Write full form of ELISA.** [1]

The full form of ELISA is Enzyme-Linked Immunosorbent Assay. It is a test that detects and measures antibodies or infectious agents in a blood sample of the person.

3. 2076 Set C Q.No. 1f **Why and when was TB declared as world emergency?** [1]

In 1993, World Health Organization(WHO) declared Tuberculosis(TB) as global emergency because TB is the leading cause of death worldwide from a single infectious agent and three million people die from it each year, although drugs which cure it are readily available and cheap.

4. 2075 GIE Q. No. 1i **Give the meaning of "window period" in AIDS.** [1]

The 'Window Period" is the time between potential exposure to HIV infection and the point when the test will give an accurate result. During the windov· period a person can be infected with HIV and be very infectious but still test HIV negative.

5. 2075 Set A Q.No. 1e **Define the term drug abuse.** [1]

Drug abuse is defined as the use of drug without medical justification. Drug abuse is a patterned use of a drug in which the user consumes the substance in amounts or with methods which are harmful to themselves or others.

6. 2075 Set A Q.No. 1j **Write the full form of LSD and COPD.** [1]

The full form of the following:

LSD = Lyserdic Acid Diethylamide (a psychedelic drug)

COPD = Chronic Obstructive Pulmonary Disease (Lung disease)

7. 2074 Set A Q.No. 1f **Which disease is caused due to deficiency of vitamin C?** [1]

The disease caused due to deficiency of Vitamin is called Scurvy. It can lead to anemia, debility, exhaustion, spontaneous bleeding, pain in the limbs, and especially the legs, swelling in some parts of the body, and sometimes ulceration of the gum and loss of teeth.

8. 2074 Set A Q.No. 1g **Define passive smoking.** [1]

Passive smoking is the inhalation of smoke, called second hand smoke (SHS), or environmental tobacco smoke (ETS), by persons other than the intended "active" smoker. It occurs when tobacco smoke permeates any environment causing its inhalation by people within that environment.

9. 2073 Supp Q.No. 1e **How would you define narcotics?** [1]

Narcotics are a group of drugs that in moderate doses dull the senses, relieve pain, and induce sleep but in excessive doses cause stupor, coma or convulsions. Examples are Opium, Heroin, Codein and Morphine.

10. **2073 Set C Q.No. 1g What is carcinogen? Give two examples.** [1]

Cancer causing agents are called carcinogens. Two example of carcinogens are as follows:

i. Radiocative substances like gamma rays and alpha particles, which cause skin cancer.

ii. Polycyclic aromatic hydrocarbons like benzo (a) Pyrene and Benzo (b) Aanthracene Florence obtained from tobacco, smoke which causes lung cancer.

11. **2073 Set C Q.No. 1h What is vaccine?** [1]

A vaccine is a liquid biological preparation, which when administered in the animal body including man provide active acquired immunity to a particular disease. e.g. Polio vaccine.

12. **2073 Set D Q.No. 1i What is pathogen?** [1]

Pathogen is a bacterium, virus or other micro-organism, nematode or arthropod that can cause disease.

13. **2072 Supp. Q.No. 1c Give the causative agent of Typhoid fever.** [1]

Please refer to Model (Zoology) Q.No. 1g

14. **2072 Supp. Q.No. 1f What are psychedelic drugs?** [1]

Psychedelic drugs are substances that have hallucinogenic, perception-altering effect when taken into human body. e.g. Lysergic Diethylamide (LSD)

15. **2072 Supp. Q.No. 1g Define immunosuppressant.** [1]

Immunosuppressant is an agent that can suppress or prevent the immune response. It is used to prevent rejection of a transplanted organ. e.g. Azathioprine and dactinomycin.

16. **2072 Set C Q.No. 1f Mention the incubation period of Hepatitis 'B'.** [1]

The incubation period of Hepatitis B is 1.5 months to 6 months (average 4 months). According to WHO, the incubation period of hepatitis B virus is 75 days on average, but can vary from 30 to 180 days.

17. **2072 Set C Q.No. 1h How would you define drug?** [1]

A drug is any substance, which, when inhaled, injected, smoked, consumed, absorbed via a patch on the skin, or dissolved under the tongue causes physical and mental change of the individual. e.g. Cocaine, Heroin, etc.

18. **2072 Set C Q.No. 1i Name a drug that gives boundless energy.** [1]

Cocaine, a form of stimulants, gives boundless energy.

19. **2072 Set D Q.No. 1b Which drugs are obtained from hemp plant?** [1]

The drugs obtained from hemp plant are Marijuana and Hashish.

20. **2072 Set D Q.No. 1g Name carcinogen present in tobacco.** [1]

The carcinogens present in tobacco are cyanide, benzene, formaldehyde, methanol, Acetylene, etc. These are collectively called as tar.

21. **2072 Set E Q.No. 1g What is metastasis?** [1]

Metastasis is the spread of cancer cells to news areas of the body often by way of the lymph system or bloodstream.

22. **2071 Supp. Q.No. 1e Why a drunk person should not drive?** [1]

Vehicle accidents are the primary danger associated with drinking and driving. When your reaction times are slower because of alcohol, you might not hit the brakes soon enough, which cause serious accidents. This is because drinking alcohol causes no co-ordination between body and mind.

23. **2071 Set D Q.No. 1i Give the cause of myopia.** [1]

Myopia or short-sightedness occurs when the eyeball is too long, relative to the focusing power of the cornea and the lens of the eye. This causes light rays to focus at a point in front of the retina, rather than directly on its surface.

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24. **2071 Set D Q.No. 1e Name the causative agent of typhoid.** [1]

Please refer to Model (Zoology) Q.No. 1g

25. **2070 Supp. Q.No. 1c Give the mode of transmission of hepatitis B.** [1]

Hepatitis B is spread when blood, semen, or other body fluid infected with the Hepatitis B virus enters the body of a person who is not infected. People can become infected with the virus during activities such as spread from an infected mother to her body during birth, sex with an infected partner, etc.

26. **2070 Set C Q.No. 1g Define malignant tumor.** [1]

Malignant tumor is a type of tumors that invades surrounding tissues, is capable of producing metastases, may recur after attempted removal, and is likely to cause death unless adequately treated. In other word, malignant tumor is called cancerous tumor.

27. **2070 Set C Q.No. 1h What is the incubation period of hepatitis 'A'?** [1]

The average incubation period of hepatitis A is 28 days. The range is 15-50 days.

28. **2068 Q.No. 1h Name two diseases caused by deficiency of vitamin A.** [1]

Two diseases causes by deficiency of vitamin A are:

i. Night blindness (Nyctalopia): Person connot see at night.

ii. Xerophthalmia: dryness in conjunctiva and cornea.

29. **2067 Q.No. 1j Why in Hepatitis dangerous than AIDS?** [1]

Please refer to 2076 Set B. Q. No. 1j

30. **2067 Q.No. 1i What is Toxoid? Give example.** [1]

Toxoid is a toxin of a pathogenic organism treated so as to destroy its toxicity but leave it capable of inducing the formation of antibodies on injection. These are used as vaccines to induce immunity. e.g. Diptheria Toxoid and Tetanus Toxoid.

31. **2064 Q.No. 1n What is the full form of AIDS?** [1]

AIDS stands for Acquired Immune Deficiency Syndrome.

32. **2062 Q.No. 1i What are the causative agents of tuberculosis?** [1]

The causative agents of tuberculosis are bacterial species: *Mycobacterium tuberculosis* and *Mycobacterium bovis*.

33. **2061 Q.No. 1i What are the causative agents of typhoid?** [1]

Please refer to Model (Zoology) Q.No. 1g

34. **2058 Q.No. 1i What are psychotropic drugs?** [1]

Psycho tropic drugs are chemical substances which when administered in the body change brain function and results in alterations in perception, mood, or consciousness. They are called mood-altering drugs.

Answer in Brief [3 marks]

1. **2076 Set C Q. No. 2g Write down the mode of transmission of Hepatitis B.** [3]

Hepatitis B is a potentially life-threatening liver infection caused by the hepatitis B virus (HBV). It is a major global health problem. It can cause chronic infection and puts people at high risk of death from cirrhosis and liver cancer. Hepatitis B can range from a mild illness lasting a few weeks to a serious, lifelong illness.

The hepatitis B virus is spread when blood, semen, or other body fluid infected with the hepatitis B virus enters the body of a person who is not infected. People can become infected with the virus from:

- Birth (spread from an infected mother to her baby during birth)
- Sex with an infected partner

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- Sharing needles, syringes, or drug preparation equipment
- Sharing items such as toothbrushes, razors or medical equipment such as a glucose monitor with an infected person
- Direct contact with the blood or open sores of an infected person
- Exposure to blood from needle sticks or other sharp instruments of an infected person

Hepatitis B virus is not spread through food or water, sharing eating utensils, breastfeeding, hugging, kissing, hand holding, coughing, or sneezing.

2. **2074 Set A Q.No. 2d Discuss the reasons of drug abuse and control measures to prevent it.** [3]

The reasons of drug abuse may be followings:

1. **Legality:** Nicotine and alcohol are legal and, therefore, many people do not understand how addictive they can be.
2. **Prescribed medication:** Some people think that because their doctor gives them prescription, the medications are safe. But whenever misused, drugs like heroin and cocaine can be addictive.
3. **Fitting in:** This is most common among young adults and teenagers. They start to use drugs because they want to fit in. A lot of cases young adults and teenagers do not fully understand the severity of drug use and addition.
4. **Depression:** One reason why an individual uses drugs is because they are lonely. They think that, if they use drugs, they will be happy and that using drug will fill that void that is inside them. This is dangerous time. Then the user will continue to take more and more to get that effect.
5. **Peer pressure:** Young adults and teenagers are most often associated with peer pressure, but it can happen to anyone, at any age. It is hard to resist feeling pressured when surrounded by others who are using drugs.
6. **To feel Good:** People start to abuse drugs because they think, if they begin using drugs, they will forget their problems. But eventually, they cannot live without drugs.
7. **Availability:** Prescription drugs, street drugs and nicotine are always available.
8. **Gateway:** For many addiction starts with alcohol, but when the effects of alcohol are no longer enough, they turn to harder and stronger drugs.
9. **Experimenting:** A curious person may try drugs as an experiment and later on becomes addict.
10. **Self Medicating:** Some people start using drugs to help with side effects of undiagnosed or untreated illness.
11. **To enhance performance:** Many sport persons or players start to use drugs to boost their performance but end up becoming addicts.

Control measures to prevent drug Abuse

Following measures should be followed to prevent oneself from drug abuse:

1. Abstinence i.e., Not to use drug.
2. Take tie for oneself - e.g. Travelling and Listening to music.
3. Live a healthy, well-balanced life.
4. Learn coping mechanism such as reading, writing, exercising, etc.
5. Spend time with the right friends and family.
6. Learn to handle peer pressure.
7. Education about the right use of drugs.
8. Engage in Mindfulness Activities such as meditation and yoga.
9. Use medication only as prescribed.
10. Seek help
11. Strong law enforcement against drug dealing.

3. **2074 Set B Q.No. 2f Define addiction. Discuss the different types of drugs and their effects.** [3]

Addiction is defined as the state of being enslaved to a habit or practice or to something that is

psychologically or physically habit - forming. Examples are drug addiction, alcohol addiction, shopping addiction, sex addiction, gambling, etc.

Drugs are natural or synthetic substances which when taken into the living body affects its functioning or structure, and are used in the diagnosis, mitigation, treatment or prevention of a disease or relief of discomfort.

A. Psychotropic Drugs

- Alter the behaviour, consciousness and capacity of perception.
- Also called mood-altering drugs.
- Classified into tranquilizers, opiate narcotics and stimulants.

1. Sedative and Tranquilizers:

- Depress the activities of central nervous system (CNS)
- Produce the feeling of calmness, relaxation or drowsiness in the body.
- Reduce tension worry and anxiety.
- Higher doses of sedatives induce sleep, therefore, sedatives are called sleeping pills.
- Examples are Barbiturates, Benzodiazepines, alcohol and Gamma Hydroxybutyrate (GHB)

2. Opiate Narcotics

- Pain releiving drugs, therefore, called Narcotic Analgesics.
- Also called "Pain Killers".
- Suppress the brain activities.
- Examples are Opium, Morphine, Codein and Heroin
- Opium reduces respiratory and cardiovascular activity, causes nausea vomiting, higher doses may cause death.
- Morphine suppresses brain activity, provides relief from severe or intense pain.
- Codeine is a mild analgesic and used in cough syrups.
- Heroin (Diamorphine) causes anxiety, fever, chills and painful gastro-intestinal sensation. It is highly addictive and is the strongest opiate narcotics. They are also called brown sugars or smacks.

3. Stimulants

- Stimulates the nervous system
- Increases mental alertness and self confidence temporarily.
- Produces the feeling of excitement, a sense of well being and flow of new idea.
- Also called mood elevators or antidepressants.
- Examples are Caffeine, Amphetamines, Cocaines and Nicotine.
- Caffeine are found in coffee tea and coca plant. It causes mental alertness, reduces appetite and restlessness.
- Nicotine is found in tobacco. It causes masculature relaxation, increases blood pressure and heart rate.
- Cocaine causes pleasure and mental alertness, reduces sleep and appetite, may cause hallucination.
- Amphetamine causes similar effect to that of cocaine but effect last longer; reduces sleep, therefore, called anti-sleeping pills or tablets.

B. Psychedelic Drugs

- Also called Hallucinogens because they cause optical or auditory hallucination, i.e., illusion, perception of external objects or sound actually not present.
- Also called vision-producing drugs.
- Most dangerous forms of drugs.
- Causes alterations in perception (usually visual), mood and thought).
- These drugs include LSD and products of Hemp plants (cannabis).

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Lysergic Acid Diethylamide (LSD)

- Cause hallucination; may cause to hear or see things that do not exist or imagine situation that are not real.
- Long term uses cause nightmares, flashbacks, chronic psychosis, serious damage to CNS leading to suicide.
- Overdoses may causes coma and even death.

Products of Hemp plants (Cannabis)

- Obtained from hemp plant (Cannabis species)
- Examples are Mescaline, Hashish, Bhang, Charas and Ganja.
- Dilates eye pupil, may increase blood sugar level, frequent urination, extreme anxiety or sadness, psychosis, etc.
- Impaired co-ordination and memory.
- Amotivational syndrome (Having no interest in any activities)

2073 Set C Q.No. 2e Write on control and prevention of smoking. [3]

Given that cigarette smoking is such a major threat to global health, controlling the worldwide epidemic of cigarette smoking would lead to enormous public health benefits. Some of the strategies to control smoking include:

1. **Smoking cessation interventions:** It is the best method of control of smoking. Quitting smoking means no disease. It can be done in several ways such as taking medicines that prevent the withdrawal symptoms; taking alternative habits of chewing gums, etc.
2. **School and college based educational interventions:** It is effective among the students. Since habit of smoking starts at early age, providing informations about the bad effects of smoking at the school and college level, contribute a lot in minimizing the effect of smoking.
3. **Mass media/public education:** Mass media strategies have been used for broad based public education regarding variety of public health issues, including tobacco use prevention and control. Mass media efforts are viewed as particularly appropriate for reading youth, who are often heavily exposed to and greatly interested in media message.
4. **Tobacco Advertising Restrictions:** Of all consumer products, cigarettes are the most heavily advertised and marketed. Restrictions on cigarette advertising on television and other media are important.
5. **Youth access restrictions:** Minors, under 18 years of age, should be restricted from tobacco access. Rules should be made to restrict sale of tobacco to minors.
6. Heavy taxation on tobacco products discourage smoking.
7. Smoking should be banned in public places, duty stations, bus stops, temples, hotels restaurants, cinema hall, public transportations. Smoking zones should be allocated at fixed places.

Following are control measures of smoking

1. Banning on smoking in public areas.
2. Banning on sales of tobacco products.
3. Restriction of selling tobacco products to people below 18 years of age.
4. Heavy taxation on tobacco products.
5. Allocate smoking zone in fixed places.
6. Banning on advertisement of tobacco products.

2073 Set D Q.No. 2f Write a note on hepatitis. [3]

Hepatitis is the term used to describe inflammation of the liver. It is usually the result of viral infection or liver damage caused by drinking alcohol.

Viral hepatitis is classified as Hepatitis A,B,C,D, E and G. A different type of virus is responsible for each type of virally transmitted hepatitis.

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1. **Hepatitis A:** It is caused by an infection with the hepatitis A virus (HAV). This types of hepatitis is most commonly transmitted by consuming food or water contaminated by faeces from a person infected with hepatitis A.
2. **Hepatitis B:** It is transmitted through contact with infectious body fluids, such as blood, vaginal secretions or semen, containing hepatitis B virus (HBV). Injection drug use, having sex with an infected partner, or sharing razors with an infected person increase the risk of getting hepatitis B. It is the most dangerous and infectious hepatitis. About 350 million people world wide are living with this disease (WHO, 2015).
3. **Hepatitis C:** It comes from the hepatitis C virus (HEV) Hepatitis C is transmitted through direct contact with infected body fluids, typically through injection drug use and sexual contact. It is second most dangerous and infectious viral hepatitis.
4. **Hepatitis D:** It also called delta hepatitis, is caused by hepatitis D virus (HDV). HDV is contracted through direct contact with infected blood. Hepatitis D is a rare from of hepatitis that only occurs in conjunction with hepatitis B infections. The hepatitis D cannot multiply without the presence of hepatitis B.
5. **Hepatitis E:** It is a water borne disease caused by hepatitis E virus (HEV). It is more common in areas with poor sanitation and typically results from ingesting fecal matter that contaminates the water supply. It is very common in Asia and Africa.
6. **Hepatitis G:** It is the recent discovered form of Hepatitis, caused by Hepatitis G virus (HGV). It is not fully understood.

The common symptoms of all forms of hepatitis include fatigue; flu-like symptoms, dark urine, pale stool, abdominal pain, loss of appetite, unexplained weight loss, yellow skin and eyes, which may be the sign of jaundice.

Hepatitis are diagnosed through blood test; physical test such as gently pressing the abdomen, detecting the colour of eye and skin, ultrasound or liver biopsy.

Treatment include the taking of different medicines. The control and prevention of hepatitis includes personal hygiene, not sharing drug needles, razors, tooth brush, not touching spilled blood.

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6. 2072 Supp. Q.No. 2f **Give a brief account of 'Kala-Azar'.** [3]

Kala-Azar or Visceral Leishmaniasis is a chronic and potentially fatal parasitic disease of the viscera i.e. the internal organs, particularly the liver, spleen, bone marrow and lymph nodes, due to the infection by the parasitic protozoa *Leishmania donovani*. It is transmitted from one person to other by the bite of infected female sand fly (Phlebotomine sandflies)

Kala azar is also called black fever or Dum dum fever. This disease is the second largest parasitic killer in the world (after malaria), responsible for an estimated 200,000 to 400,000 infections every year worldwide. Kala azar is endemic in many countries with approximately 200 million people at the risk of infection. About 90 percent patient are from India, Bangladesh, Nepal, Sudan and Brazil.

The sand flies feed on animals and human for blood, which they need for developing their eggs. If blood containing *Leishmania* parasites is drawn from animal or human the next person to receive a bite will then become infected and develop leishmaniasis.

The most typical symptoms of Visceral Leishmaniasis are fever and the enlargement of the spleen, and enlargement of the liver sometimes. Initially, *Leishmania* parasites causes skin sores or ulcers at the site of bite. If the disease progresses, it attacks the immune system. Kala-azar also increases the risk of other secondary infections. If not treated in time, the patient dies.

Kala-azar can be diagnosed by microscopical examination of the patient. Examination of white blood cells count shows decrease of neutrophils but increase in lymphocytes and monocyles.

There are no vaccines or preventive drugs for Visceral Leishmaniasis. The traditional treatment is with pentavalent antimonials such as sodium stibogluconate and meglumine antimone. Resistance

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is now common in India and Nepal. Millefosine is the first oral treatment for the disease.
The most effective method to prevent infection is to protect from sand fly bites.
To decrease the risk of being bitten, these precautionary measures are suggested:

- Avoid outdoor activities, when sand flies generally are most active. Wearing long-sleeved shirts, long pants and socks minimize the amount of exposed skin.
- Use of insect repellents
- Stay in well-screened or air conditioned areas.
- Spraying of insecticides
- Destruction of breeding place of sandfly.

7. **2072 Set E Q.No. 2c The short and long term effects of use of tobacco.** [3]

Smoking or chewing of tobacco is the number one socially significant disease worldwide. The use of tobacco has both short and long term effects.

I. **The short term-effects of smoking are as follows:**

- Bad breath, Bad taste in mouth, Smelly hair and clothes, Addiction to nicotine, Decreased lung capacity, Yellow or brown stain on teeth, Loss of athletic ability, Damage to the respiratory system, Elevated heart rate, Chronic cough and Increased incidence of bronchitis and asthma, etc.

II. **The long term health consequences of smoking or chewing tobacco are as follows:**

1. **Tobacco kills:** Tobacco kills people through heart disease and stroke. In United States alone, about 181,000 people die each year from smoking related heart disease and heart.
2. **Heart diseases:**
   - Hypertension (High blood pressure)
   - Congestive heart failure - ineffective pumping of the heart leads to an accumulation of fluid in the lungs.
   - Coronary heart disease - Narrowed arteries lead to heart attack and death.
   - Blocked blood vessels
   - Strokes – Blocked blood flow to the brain or bleeding in the brain. Stroke is a major killer.
3. **Cancers:** Smoking and chewing of tobacco causes cancers of lung, respiratory tract, larynx, mouth, stomach, pancreas, bladder, cervix, throat etc.
4. **Lung diseases:**
   - Emphysema - The very small airways (bronchioles) that join the tiny air sacs (alveoli) in the lungs lose elasticity. Patient loses ability to exhale fully and chemical balance in the body is disturbed.
   - Chronic Bronchitis – The airways of the lungs change shape and size and the mucous glands are enlarged, causing coughing and production of sputum.
5. **Reproductive defects:**
   - Abnormal sperm cells, Impotence, Difficulty maintaining pregnancy, Menstrual disorders and early menopause
6. **Birth defects:**
   - Miscarriage or stillbirth, Low birth weight, premature birth
   - Sudden infant death syndrome (SIDS)- Seemingly healthy babies die without warning.
7. **Other damages:**
   - Prematurely wrinkled skin, Permanent gum and teeth loss, Weakened immune system, Stomach ulcers and Unwanted weight loss.

8. **2071 Set C Q.No. 2c Write the effects of hypothyroidism.** [3]

Hypothyroidism is a condition where the thyroid gland is underactive. Thyroid gland cannot produce enough thyroid hormone and affect the whole body. Thyroid hormones regulate the metabolic activities of the body.

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The general effect of hypothyroidism in human is as follows:

1. Low blood pressure and decreased heart rate; risk of hardening of the arteries or heart attack.
2. Cholesterol problem
3. Affect nervous system - tingling, numbness, weakness, burning pain, etc.
4. Difficulty in thinking or a feeling of fatigue known as brain fog. This mental cloudiness can lead to forgetfullness or difficulty completing task.
5. Are likely to develop depressive symptoms
6. Slows the metabolic rate. Low thyroid hormone affect the production of key stomach hormone gastrin. Low gastrin hormone levels can lead to heartburn, ulcers, reflux, bloating and inflammation.
7. Leads to higher risk of bone fracture.
8. Can cause an increase in gallstones
9. Can cause eyebrow hair become thin.
10. Inability to handle cold temperatures, triggering dry and waxy skin.
11. When thyroid is sluggish blood sugar control becomes more difficult.
12. Cretinism: Low secretion of thyroid hormone during childhood leads to a disorder called cretinism. This leads to poor mental and physical growth in child. It results in mental retardation.
13. Myxoedema: Low secretion of thyroid hormone in adulthood results in a condition called myxoedema, which is characterized by decreased metabolic rate, fatigue, lethargy, constipation, heavy menstrual periods, slowed thinking, etc.
14. Goitre: The deficiency of iodine in diet leads to the low production of thyroid hormone. It leads to the enlargement of the gland and swelling of the neck.

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9. **2071 Set C Q.No. 2d Discuss different diseases caused by malnutrition.** [3]

Malnutrition is a serious condition that occurs when a person's diet does not contain the right amount of nutrients. It refers to

- under nutrition - not getting enough nutrients
- over nutrition - getting more nutrients than you need.

Malnutrition leads to several abnormal conditions and diseases with are discussed below:

1. **Protein – Energy Malnutrition (PEM):** PEM refers to a form of malnutrition where there is inadequate calorie or protein intake. PEM has two forms - Kwashiorkor and marasmus.

i. **Kwashiorkor –** It is a severe form of malnutrition. It is most common in developing regions of the world where babies and children have a diet that lacks protein and other essential nutrients.

The main sign of kwashiorkor is too much fluid in the body's tissues, which causes swelling under the skin (oedema). It usually begins in the leg, but can involve the whole body, including the face.

Symptoms of kwashiorkor include:

- loss of muscle mass, an enlarged tummy (pot belly),
- regular infections, or more serious long lasting infections than usual
- red, inflamed patches of skin that darken and peel or split open
- dry, brittle hair that falls out easily and may lose its colour.
- failure to grow in height
- Tiredness and irritability.

Kwashiorkor can be fatal if it is left untreated for a long time because children become very vulnerable to infections.

ii. **Marasmus:** Marasmus is a severe form of protein energy malnutrition caused by shortage of protein and calories in the body. Without these vital nutrients, the body becomes dangerously low in energy and important functions begin to stop. Children of developing countries are mostly affected. It is estimated that 20 million children under the age of five have developed marasmus, according to UNICEF. About 5,00,000 to 2 million children die as a result of it.

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There are several symptoms of marasmus; that include:

- Thin face, Ribs and shoulders clearly visible through the skin
- Very loose skin, persistent dizziness
- Sunken eyes, Diarrhoea, Irritable behaviour
- Frequent dehydration

It not treated in time, it leads to death.

2. **Other diseases related to malnutrition**

Deficiencies

a. Osteoporosis – lack of calcium
b. Rickets – Vitamin D deficiency leads to bone tenderness, muscle weakness, dental problems, growth disturbance, etc.
c. Tetany – Lack of calcium and excess of phosphate leads to involuntary contraction of muscles (tetany seizure)
d. Goitre – Caused by iodine deficiency leads to enlargement of thyroid gland and swelling of neck.
e. Anaemia – Caused by iron deficiency leads to several diseases.
f. Beriberi – Deficiency of vitamin B_1 (Thiamine) causes weight loss, weakness, pain in the limbs, oedema impaired sensory perception.
g. Pellagra – Deficiency of vitamin B_3 (Niacin) causes inflamed skin, diarrhea, dementia (gradual loss of ability to think and remember) and sores in the mouth.
h. Scurvy – Deficiency of vitamin C leads to fatigue, curly hair, decreased RBCs, gum disease, bleeding from the skin and sore arms and legs.

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10. **2071 Set C Q.No. 2f Give the symptoms and control methods of tuberculosis.** **[3]**

Tuberculosis is a highly infections disease caused by the bacterium *Mycobacterium tuberculosis* (MTB). Tuberculosis or TB generally affects the lungs, but can affect other parts of the body, including abdomen , bones and nervous system.

The symptoms of tuberculosis (TB)vary depending on which part of the body is affected. TB usually develops slowly, and it may take several weeks for you to become aware that you are unwell.

General symptoms of TB:

- lack of appetite and weight loss,
- a high temperature (fever),
- night sweats,
- extreme tiredness or fatigue.

According to the site of infection TB is of two types:

1. **Symptoms of pulmonary TB:** Most TB infections affects the lungs, which can cause:
   - Persistent cough that lasts more than there weeks and usually brings up phlegm (mucus), which may be bloody.
   - breathlessness that gradually gets worse.
2. **Symptoms of extra-pulmonary TB:** Less commonly, TB infections develop in areas outside the lungs, such as the small glands that form part of the immune system (lymph nodes), the bones and joint, the digestive system, the bladder, the reproductive system, the brain and nerve.
   - Persistently swollen glands and abdominal pain
   - Pain and loss of movement in an affected bone or joint.
   - Confusion, a persistent headache and seizures

Control measures of Tuberculosis: TB prevention consists of several main parts. The first part of TB prevention is to stop transmission of TB from one adult to another. This is done through firstly, identifying people with active TB, and then curing them through provision of drug treatment.

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1. **BCG vaccination:** It is one of the most widely used of all current vaccines, and it reaches more than 80% of all new born children and infants where it is part of the national childhood immunization programme.
   The BCG (Bacille Calmette Guerin) vaccine has been shown to provide children with excellent protection against disseminated forms of TB.
2. **TB education:** TB education is necessary for people with TB. People with TB need to know how to take their TB drugs properly. They also need to know how to make sure that they do not pass TB on to other people. TB education is also necessary for general public. The public need to know basic information about TB.
3. **TB Treatment as TB prevention:** TB drug treatment for the prevention of TB, also known as chemoprophylaxis, can reduce the risk of a first episode of active TB occuring in people with latent TB. The drugs that cure TB includes isoniazid (INH), rifampin (RIF), Ethambutol (EMB) and pyrazinamide (PZA)
4. **Preventing TB Transmission in Households:** In order to reduce exposure in households where someone has infectious TB, the following actions should be taken whenever possible
   - Adequately ventilated Houses
   - While smear positive, TB patient should
     - Spend as much time as possible outdoors.
     - If possible, sleep alone in a separate, adequately ventilated room.
     - Spend as little time as possible on public transport.
     - Avoid as little time as possible on public areas where numbers of people gather.
   - Children below five years of age should spend as little times as possible in the same living spaces as culture positive TB patients
   - Use of mask
   - Personal hygiene.

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11. 2071 Set D Q.No. 2g **Write notes on hepatitis B.** [3]

Hepatitis B is an infection of the liver caused by a virus that is spread through to blood and body fluid. It is the most widespread form of hepatitis worldwide. The causative agent is hepatitis B virus (HBV).

An estimated 257 million people are living with HBV infection. In 2015, Hepatitis B resulted in 887,000 death worldwide.

Hepatitis B is a potentially life threatening liver infection. It can cause chronic infection and puts people at high risk of death from cirrhosis and liver cancer. Hepatitis B is 50 to 100 times more infections than HIV. HBV is also known as blood borne virus (BBV).

Mode of Transmission

1. By contact with blood form an infected person – transfusion of infected blood and blood products or by contaminated needle used by drug addicts, tattooists or acupuncturists.
2. By sexual contact with an infected person.
3. From an infected pregnant women to her child around the time of delivery.
4. The virus can be contracted by a person, mostly health care workers, accidently pricking themselves with a contaminated needle.
5. By sharing personal items like razors, toothbrushes with an infected person.

Risk Groups:

- Drug users or drug abusers.
- Homosexual men and heterosexuals having multiple sex partners.
- Baby born form infected mother
- Health workers such as doctor and nurses.

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Symptoms of Hepatitis B

- Feeling very tired, mild fever, headache, not wanting to eat, vomiting, acute abdominal pain, tan coloured stool, dark urine, yellowish eyes and skin (Jaundice) and liver failure/liver cancer, etc.

Diagnosis:

Diagnosis is done by blood test, liver biopsy, etc

Treatment: Acute hepatitis B infection does not usually require treatment and most adults clear the infection spontaneously. On the other hard, Chronic Hepatitis B infection requires treatment. There are seven medication licensed for treatment of hepatitis B infection. These include antiviral drugs lamivudine, adefovir, tenofovir, telbivudine, entecavir, interferon alpha-2a and PE gylated interferon alpha – 2a.

Prevention

To avoid getting or spreading the virus to others:

- Use of condom while having sex, not sharing needles, wearing gloves before touching blood in hospitals.
- Not Sharing common items like, toothbrushes, razors, combs, etc
- Not to get a tattoo as far as possible.
- Avoid pregnancy during Hepatitis B infections.
- Avoid multiple sex partners.
- Blood screening before transfusion.

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12. **2070 Set C Q.No. 2g Mention the health hazards of tobacco smoke.** [3]

No matter how we smoke it, tobacco is dangerous to our health. There is no safe substance in any tobacco product, from acetone and tar to nicotine and carbon monoxide.

Smoking can lead to a variety of ongoing complications in the body, as well as long-term effects in the body system.

The effects of tobacco smoking on various system of the body are given below:

I. **Effect on Respiratory System:**

Smoking causes:

1. Chronic obstructive pulmonary disease (COPD) a disease that gets worse over time and causes wheezing, shortness of breath, chest lightness, etc,
2. Emphysema, a condition in which the walls between the airsacs in the lungs loss their ability to stretch and shrink back. The lung tissue is destroyed, making it difficult to breath.
3. Chronic bronchitis, which causes swelling on the lining of the bronchial tubes. This leads to less air how to and from the lungs.
4. Pneumonia
5. Asthma
6. Tuberculosis (TB)

II. **Effect on circulation**

The chemicals in tobacco smoke harm the blood cells and damage the function of the heart. This damage increase risk for:

1. Atherosclerosis, a disease in which a waxy substance called plaque builds up in the arteries
2. Aneurysms, which are bulging blood vessels than can burst and cause death.
3. Cardiovascnlar disease (CVD), which includes:
   i. Coronary heart disease (CHD), narrow and blocked arteries around the heart.
   ii. Heart attack and damage to the arteries.
   iii. Heart -related chest pain
   iv. High blood pressure.
4. Stroke, which is sudden death of brain cells caused by blood clots or bleeding.
5. Tobacco smoke can change blood chemistry and damage blood vessels.

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III. **Effect on digestive system**

i. Gastritis and stomach ulcers.

iii. Weakens the muscle that controls the lower end of the gullet and allow acid from the stomach to travel in the wrong direction back up in the gullet, a process known as reflux.

IV. **Effect on Bones:** Recent studies show a direct relationship between tobacco use and decreased bone density. Smoking form an early age puts women at even higher risk for osteoporosis.

V. **Effect on vision:** Research has linked to an increased risk of developing age related macular degeneration, cataract and optic nerve damage, all of which can lead to blindness.

VI. **Effect on Central Nervous System:** One of the ingredients in tobacco is a mood-altering drug called nicotine. Nicotine reaches the brain in mere seconds and makes one feel more energized for a while. But as that effect wears off, one feel tired and crave more. Nicotine is extremely habit forming, which is why people find smoking so difficult to quit.

Physical withdrawal from nicotine can impair cognitive functioning and make one feel anxious, irritated, and depressed. Withdrawal can also cause headaches and sleep problems.

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13. **2070 Set D Q.No. 2b Ill effects of alcohol on health.** [3]

A glass a day may do little harm to the overall health. But if the habit grows or if someone find himself/herself having a hard time stopping after just one glass, the culminative effects can add up. Here is how the alcohol can affect our body.

1. **Ill-effect of alcohol on Nervous system**

Consuming alcohol immediately affects the brain. Alcohol acts as depressant on the brain and other nerve tissue.

Short term effect of Alcohol use results in:

- Slurring of speech, Slow reaction time, Drowsiness, Memory loss, Emotional change, Black outs, Sleep disruption and Temporary loss of consciousness.

Long term Effect: Chronic or severe alcohol abuse can also cause permanent brain damage. This can lead to Wernicke - Korsa-Koff syndrome, a brain disorder that affects memory. Long term drinking results in alcohol dependence or alcoholism. Alcoholism leads to psychosis, neuritis, depression and suicides.

2. **Ill-effect of Alcohol on Digestive system**

i. Drinking too much alcohol initially causes fat deposits to develop in the liver. With continued excessive drinking, the liver may become inflammed, causing alcoholic hepatitis, which can result in liver failure and death, Alcoholism can permanently scar and damage the liver, resulting liver cirrhosis and liver cancer. Women are particularly susceptible to the effect of alcohol on the liver. Liver is the most affected organ due to alcoholism.

ii. Alcoholism can lead to stomach ulcers, internal bleeding and cancer. Alcohol can cause the stomach to become inflamed i.e. gastritis.

3. **Ill- effect of alcohol on circulatory system:** People who are chronic drinkers of alcohol have a higher risk of heart - related issues than people who do not drink. Woman who drink are more likely to develop heart disease than men who drink.

While under the influence of alcohol, the circulating system experiences: decreased blood pressure, slower pulse and more difficult respiration.

4. **Ill-Effect of alcohol on kidneys:** Chronic drinking can cause liver disease. This adds to the kidney's job. The kidneys of heavy drinkers have to work harder. Alcohol causes changes in the functions of kidneys and makes them less able to filter blood. This leads kidney failure.

5. **Ill-effect of alcohol on sexual and reproductive Health:** In male, heavy drinking causes erectile dysfunction and low sexual desire (libido)

Women who drink too much may stop menstruating and leads to infertility. Pregnant female who drinks heavily have higher risk of premature delivery, miscarriage or, still birth. Another serious case is fatal alcohol syndrome disorders (FASD).

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6. **Ill-effect of alcohol on skeletal and muscle system:** Can cause the bone to become thinner and increase risk of bone fracture, and fracture may heal slowly.
   - Drinking alcohol may leads to muscle weakness, cramping, and eventually atrophy (waste away)
7. **Other ill-effect of alcohol on health**
   - Diabetic, complication – low blood sugar level causes hypoglycaemia
   - Low immune system
   - Risk taking behaviour
   - Personality disorder
   - Schizophrenia – mental disorder characterized by abnormal social behaviour and failure to understand what is real.
8. **Cancers:** Cancers of mouth oesophagus, stomach, liver pancreas, etc.

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14. **2066 Q.No. 2e Write a note on smoking.** [3]

Smoking refers to the process of burning a substance (tobacco, drugs, etc) and inhaling the resultant smoke.

The major forms of smoking tobacco includes cigarette, smoking pipes, cigars, etc.

Smoking is the number one socially significant disease.

Smoking tobacco is the most popular form of enjoyment being practiced by over one billion people globally, of whom majority are in the developing countries. Smoking is one of the leading causes of preventable death globally.

Those who undergo this habit are called direct smokers where as those who have to swallow the venomous smoke coming out of the smokers mouth are called passive smokers. The latter are as affected as the former.

Tobacco smoke contains more than 5,000 chemicals. About 70 of them are known to cause cancer. Smoking cigarettes is the number one risk factor for lung cancer. A large number of people die every year due to smoking effect.

Effect of Smoking Tobacco

In the smoke, there are gas elements such as hydrogen cyanide, carbon monoxide, etc. Smoke has a black substance called tar. The main drug of tobacco is nicotine, which is highly addictive.

There are several harmful effects of smoking. It affects the human body a numerous way

1. Smoking kills people at early ages.
2. It causes heart attack, stroke, high blood pressure, hypertension, anxiety, etc.
3. Smoking causes asthma, bronchitis, emphysema, pneumonia, tuberculosis, etc.
4. Smoking increases the chance of lung cancer, throat cancer, oral cancer, stomach cancer, etc.
5. It affects the digestive system - gastritis, anorexia (loss of appetite), bloating, etc.
6. It causes bad breadth, low stamina, irritability, Yellow teeth, cough, etc.
7. It affects pregnant female: Low birth weight of the baby, premature birth, still birth are common events.

Causes of smoking

1. **Fun and curiosity:** Young people first begin smoking to get fun of it. There is a curiosity among young adult and teenagers about the taste of a cigarette.
2. **Peer pressure:** Friends and same age group people force the non-smoker to take cigarette.
3. **Advertisement:** Glamorous way of advertising smoking attracts the people to smoke.
4. Minors or younger ones imitate the elders and start smoking.
5. Smoking by cinema heroes, heroines, and actors attracts the younger ones to smoke.
6. To get instant relief.

Control measures: Please refer to 2073 Set C Q.No. 2e (second part only)

Conclusion – "Say no to smoking"

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15. 2064 Q.No. 2j **Elaborate about the control of smoking.** [3]

Please refer to 2073 Set C Q.No. 2e (first part only)

16. 2063 Q.No. 2c **Differentiate between benign and malignant tumour.** [3]

Differences between benign and malignant tumor are as follows:

Benign Tumor	Malignant Tumor
It is enclosed in the connective tissue.	It is not enclosed in any specific tissue.
It remains confined to the site of its origin.	It is not confined to the site of its origin.
It may grow in size but does not spread to other parts of the body.	The cancerous cells are carried by blood or lymph to other parts of the body where they spread secondary cancersous metallic.
It is not fatal but may cause pain.	It is usually fatal as the cancerous cells destroy other normal cells.
They are not cancerous.	They are cancerous.
Examples: Adenomas, Lipomas, Moles, Fibroma.	Examples: Leukemia, Lung, Cancer, Myoma, Carcinomas, etc.

17. 2062 Q.No. 2j **Elaborate about the causes of typhoid.** [3]

Typhoid fever is an acute illness associated with fever caused by the bacterium *Salmonella typhi*. It can also becaused by *Salmonella paratyphi*, a related bacterium that usually causes a less server illness.

Typhoid fever is contracted by drinking or eating the bacteria in contaminated food or water. People with acute illness can contaminate the surrounding water supply through stool, which contains a high concentration of the bacteria. Contamination of the water supply can, in turn, taint the food supply.

Less commonly, the *Salmonella typhi* bacteria can be passed out in an infected person's urine. If an infected person handles food without washing their hands properly after urinating, they can spread the infection to someone else who eats the contaminated food.

In parts of the world with poor sanitation, infected human waste can contaminate the water supply. People who drink contaminated water or eat food washed in contaminated water can develop typhoid fever.

Using a toilet contaminated with bacteria and touching the mouth before washing the hands can cause typhoid. The majority of people in developing countries pick up typhoid bacteria while travelling and spread it to others through the faeco-oral route.

18. 2060 Q.No. 2c **"AIDS is very common among drug addicts." Discuss.** [3]

Although HIV/AIDS can affect anyone, the risk of infection is significantly higher in patients suffering from drug abuse, whether the risk is of direct exposure through needles or increased likelihood of higher risk behaviour due to loss of judgement. Drug abuse is of primary concern to HIV/AIDS by promoting actions which increase the initial risk of infection.

HIV is a virus that is transmitted in body fluids (Blood and lymph) often by sharing a used needle. HIV prevalence amount people who inject drugs (PWID) is 28 times higher than among the rest of the population.

It is estimated that there are 11.7 million people who inject drugs worldwide, and 14% of them are through to be living with HIV. Three countries - China, Russia and USA account for nearly half of all people who inject drugs globally.

Morever, almost one third of global HIV infections outside of Sub - Saharan Africa are caused by injecting drugs. In Eastern Europe and central Asia, which saw a 57% increase in new HIV infections between 2010 and 2015, the burden is particularly high among people who inject drugs.

Despite the increased risk of HIV for people who inject drugs they are among those with the least

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access to HIV prevention, treatment and healthcare. This is because drug abuse is often criminalized and stigmatised.

Why are people who inject drugs at risk of HIV transmission? The answer in sharing needle. If a needle has been used by an HIV positive person, infected blood in the needle can be injected into the person who uses that needle. Furthermore, drug addicts are more likely to test for HIV late, increasing the chance of onward HIV transmission.

Other reasons for needle sharing are that it is part of a social and cultural norm among people who inject drugs, and that it can acts as a form of bonding.

In many cases, women are more susceptible to HIV infection because of gender-based violence (GBV). Women may be pressured to share needles and engage in high risk sexual activities.

Drugs can change the way the brain works, disrupting the parts of the brain that people use to weigh risks and benefits when making decisions. This is partly due to the addictive and intoxicating affects of many drugs. It can lead to unsafe sexual practices, which put people at risk for getting HIV or transmitting it to someone else.

Biological effects of drugs: Drug abuse and addiction can affect a person's overall health, altering susceptibility to HIV and progression of AIDS. Research has shown that HIV causes greater injury to cells in the brain among drug addicts than among HIV patients who do not abuse drugs.

19. **2058 Q.No. 2g Explain the major causes of cancer.** [3]

Most cancers are related to environmental, lifestyle, or behavioural exposures.

It is nearly impossible to prove what caused a cancer in any individual, because most cancers have multiple possible causes.

At a microscopic level, cancer is caused by changes (mutations) to the DNA within cells. Any agent that causes cancers are called carcinogens.

The major causes of cancer are discussed below:

1. **Smoking:** Smoking is by far the biggest preventable causes of cancer. Chemicals in cigarette smoke enter the blood stream and can then affect the entire body. Smoking causes at least fourteen types of cancers such as cancer of lungs, mouth, pharynx, nose, sinuses, larynx, oesophagus, liver, pancreas, stomach, kidney, bowel, ovary, cervix, bladder and some types of leukaemia. Tobacco smoking causes 80% of lung cancer. Tobacco is responsible for about one in three of all cancer deaths in the developed world, and about one in five worldwide.
2. **Obesity and weight:** Research has shown that many types of cancer are more common in people who are overweight or obese, including cancers of the breast (In women after the menopause), bowel, womb, oesophagus, pancreas, kidney, liver, upper stomach, gallbladder, ovary, thyroid gland, myeloma (blood cancer type) and meningioma (brain tumor). The most common types of cancer are breast and bowel cancer.
3. **Alcohol:** Drinking alcohol regularly can increase the risk of seven different cancers. Cancers linked to alcohol include: mouth cancer, pharyngeal cancer, oesophageal cancer, laryngeal cancer, breast cancer, bowel cancer and liver cancer.
4. **Physical Inactivity:** Physical activity makes the body cope with every form of physical disorders. In contrast, physical inactivity raises the level of hormones like oestrogen and insulin. High level of oestrogen increases the risk of breast and womb cancer. Being inactive causes obesity and inflammation in the bowel and leads to bowel cancer.
5. **Unhealthy diet and eating:** Diets that are low in vegetables, fruits, and whole grains, and high in processed or red meats are linked with a number of cancers. A high – salt diet is linked to gastric cancer; contaminated food to liver cancer and chewing betel nut to oral cancer. Unhealthy diet can also causes colon cancer.
6. **Radiation:** Up to 10% invasive cancers are related to radiation exposure, including both ionizing radiation and non-ionizing ultra-violet radiation.

7. **Pollution:** Air pollution is a mixture of many different substances which have been shown to increase the risk of cancer. Second head smoking affects children the most. Pollutants cause lung cancer.

Long Answer Questions

1. **2076 Set B Q. No. 4 What is addiction? Discuss the symptoms, effects and control measures of alcohol addiction in detail.** [8]

Addiction is a condition that results when a person ingests a substance (e.g., alcohol, cocaine, nicotine) or engages in an activity (e.g., gambling, sex, shopping) that can be pleasurable but the continuation of which becomes compulsive and interferes with ordinary responsibilities and concerns, such as work, relationships or health. People who have developed an addiction may not be aware that their behaviour is out of control and causing problems for themselves and others.

Alcohol addiction, also know as alcoholism, is marked by a craving for alcohol and the inability to stop drinking even when it causes extreme person and social harm.

In other words, the physical and mental dependence of the user to alcoholic drinks like beer, wine and whisky is tremed as alcohol addiction.

Signs of an alcohol addiction include frequently drinking more than intended, wanting to stop drinking but being unable to, developing a tolerance to alcohol, feeling symptoms of withdrawal when stopping, letting personal and professional responsibilities flounder in favour of drinking and spending an extreme amount of time trying to get and drink alcohol. Alcoholics rarely recognize they have problem until they face severe alcohol related consequences.

When consumed, ethanol acts as a depressant that alters brain chemistry, causing side effects such as slurred speech, difficulty walking, impaired motor skills, and a greater willingness in risky behaviour. This is called intoxication.

Sign and Symptoms of Alcohol Addiction

Unlike cocaine and heroin, alcohol is widely available and accepted in many cultures. It is often at the centre of social situations and closely linked to celebrations and enjoyment. Symptoms of Alcohol Use Disorder include:

1. **Mood/Psychological symptoms:**
   - The person uses alcohol for longer periods of time or in greater amounts than they intended.
   - The individual has the desire to cut down on alcohol use but unable to do so.
   - The person spends a lot of time obtaining, using or recovering form alcohol.
   - The person fails to fulfill major role obligations due to alcohol use.
   - The individual recognizes that alcohol use is leading to or worsening psychological or mood related problems but continue to use anyway.
   - Alcohol use required in order to relax, feel happy, sleep, cope with difficulties or just feel "normal".
2. **Behavioral Symptoms:**
   - The person no longer takes part in important activities due to alcohol use.
   - Knowingly uses alcohol repeatedly in dangerous situations.
   - Drinking in secret to avoid negative judgments from others.
3. **Physical symptoms:**
   - Alcohol craving,
   - The individual recognizes that alcohol use is leading to or worsening physical problems but continue to use anyway,
   - Tolerance,
   - Need for significantly larger amounts of alcohol to become intoxicated or to achieve the desire sensation,
   - Significantly decreased effect from the same amount of alcohol use,

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- Slurring speech and difficulty walking,
- Impaired vision,
- Slow reaction time,
- Suffering from blackouts after some one have been drinking.

4. **Withdrawal symptoms**
   - Alcohol used to avoid withdrawal symptoms,
   - Negative physical or psychological effects resulting following cessation of alcohol use.

Effects of Alcohol Addiction

The effects of alcohol can be summarized as follows:

A. **Effect on the individual's Health**

1. **Effect on Nervous System**
   - Slurred speech,
   - Memory imparing,
   - Seizure causing disorder,
   - Wernicke – Korsakoff Syndrome (WKS), a brain disorder,
   - Night terrors, Delusions and Hallucinations, Delirium,
   - Increased levels of both aggression and depression,
   - Neuritis (inflammation of nerve fibres) leading to numbness of hand and feet,
   - Insomnia, Coma and even death, Black out i.e. not remembering past events, and
   - Suicidal tendency.

2. **Effect on Digestive system**
   - Liver damage because liver is the most affected organ due to alcoholism, other effects include,
   - Fatty liver syndrome, Hepatitis and, Liver cirrhosis,
   - Damage of tissue in the digestive tract and prevent the intestine from digesting food and absorbing nutrients vitamins. As a result, malnutrition may occur,
   - Gassiness and bloating, a feeling of fullness in the abdomen,
   - Diarrhoea or painful stool, Internal bleeding, Ulcers, Dehydration and Constipation,
   - Cancer of mouth, throat, oesophagus, colon and liver.

3. **Effect on circulatory system**
   - High blood pressure, Irregular heartbeart, Difficulty pumping blood through the body, Stroke, Heart attack, Heart disease, Heart failure, Hypothermia and Cardiomyopathy

4. **Effect on sexual and Reproductive Health**
   - Erectile Dysfunction in Men,
   - Low libido,
   - Heavy bleeding during menstruation in female who drinks too much,
   - Women who drink heavily during pregnancy have a higher risk of premature delivery, miscarriage or stillbirth,
   - Fetal alcohol syndrome disorder (FASD) is a serious concern in women who drink too much alcohol,
   - Increased breast cancer in women who drink too much.

5. **Effect on skeletal and muscle systems**
   - Osteoporosis, excessive drinking causes thinning of bones and increase the risk of bone fractures if someone falls, and fractures may heal slowly.
   - Drinking alcohol may also lead to muscle weakness, cramping and eventually atrophy.

6. **Effect on pancreas**
   - Excessive alcohol use is a common cause of pancreatitis, or inflammation of the pancreas, and it is the major risk factor for pancreatic cancer.
   - Impairs pancreas's ability to produce insulin, which can lead to diabetes.

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7. Effect on immune system

- Excessive drinking reduces the body's natural immune system
- Prone to develop pneumonia or tuberculosis. About 10% of all TB cases worldwide can be tied to alcohol consumption.

B. Effect of Alcoholism in Drinker's Family

- Marital conflict which always leads to divorce.
- Domestic violence usually spouse abuse or child abuse.
- Frustration, feeling of insecurity to the alcoholic's children.
- Children are at increased risk for alcohol abuse, drug abuse, mood disorder and anxiety disorder.
- Leads to poverty, child neglet, unemployment, loss of sexual relationship between husband and wife.

C. Effect of Alcoholism on Society

- Loss of respect from others and social withdrawl,
- Increased risk of vehicle accidents, theft, rape, murder, and violence.
- Increased risk of fire related cases; about 50% traffic death are related to alcohol abuse.
- It promotes smuggling.
- Loss of national manpower because alcoholics do not participate in nation building programs.

Control Measures of Alcohol Addiction

It involves treatment and prevention

A. Treatment:

- Hospitalization of alcohol addict
- Detoxification and long term rehabilitation.
- Medicines that recover the damage parts of the body are given to the alcoholics.
- Counselling
- Nutritional change

B. Prevention

- Effective laws, rules and regulation should be enforced to control production and control of alcohol consumption.
- Heavy taxes on alcoholic drinks
- Drunk driving should be penalized
- Public awareness about the bad effect of alcoholic drinks.
- Encouragement to make alcohol free environment.
- Minors should not be allowed to drink alcohol.

"Let's make An Alcohol Drink – Free Environment"

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2. 2076 Set C Q. No. 4 Describe the causative agent, mode of transmission, symptoms, control and prevention of Typhoid. [8]

Typhoid fever is a bacterial infection that can spread throughout the body, affecting many organs. Without prompt treatment, it can cause serious complications and can be fatal. The bacteria are present in many Southeast Asian countries as well as in Africa, Central and South America, and Western Pacific countries in areas where there is poor water and sewage sanitation. Floods in these regions can also quickly spread the bacteria. All travellers going to endemic areas are at risk, especially long-term travellers, adventure travellers, humanitarian workers, and those visiting friends or relatives in areas with poor sanitation. Typhoid fever is very common in urban areas of Nepal. Typhoid remains a serious health threat in the developing world, especially for children.

Causative Agent

Typhoid Fever is a gastrointestinal infection caused by *Salmonella enterica typhi* bacteria. The bacteria multiply in the intestinal tract and can spread to the bloodstream. Paratyphoid fever, a similar illness, is caused by *Salmonella enterica paratyphi A, B, and C.*

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Modes of transmission:

The bacterium lives in the intestines and bloodstream of humans. No animals carry this disease, so transmission is always human to human. Typhoid fever is contracted by drinking or eating the bacteria in contaminated food or water. The transmission is through faecal-oral route. People with acute illness can contaminate the surrounding water supply through stool, which contains a high concentration of the bacteria. Contamination of the water supply can, in turn, taint the food supply. The bacteria can survive for weeks in water or dried sewage.

About 3%-5% of people become carriers of the bacteria after the acute illness. Others suffer a very mild illness that goes unrecognized. These people may become long-term carriers of the bacteria -- even though they have no symptoms -- and be the source of new outbreaks of typhoid fever for many years.

The *Salmonella typhi* bacteria will be in the stools of an infected person after they have been to the toilet.

If they don't wash their hands properly afterwards, they can contaminate any food they touch. Anyone else who eats this food may also become infected.

Less commonly, the *Salmonella typhi* bacteria can be passed out in an infected person's pee (urine).

Again, if an infected person handles food without washing their hands properly after peeing, they can spread the infection to someone else who eats the contaminated food.

In parts of the world with poor sanitation, infected human waste can contaminate the water supply. People who drink contaminated water or eat food washed in contaminated water can develop typhoid fever.

Other ways typhoid fever can be contracted include:

- using a toilet contaminated with bacteria and touching your mouth before washing your hands
- eating seafood from a water source contaminated by infected stool or urine
- eating raw vegetables that have been fertilized with human waste
- contaminated milk products
- having oral or anal sex with a person who's a carrier of Salmonella typhi bacteria

Symptoms

After the ingestion of contaminated food or water, the Salmonella bacteria invade the small intestine and enter the bloodstream temporarily. The bacteria are carried by white blood cells in the liver, spleen, and bone marrow, where they multiply and reenter the bloodstream. People develop symptoms, including fever, at this point. Bacteria invade the gallbladder, biliary system, and the lymphatic tissue of the bowel. Here, they multiply in high numbers. The bacteria pass into the intestinal tract and can be identified in stool samples. If a test result isn't clear, blood or urine samples will be taken to make a diagnosis.

Generally, the progression of untreated typhoid fever is divided into four distinct stages, each lasting about a week. Over the course of these stages, the patient becomes exhausted and emaciated.

- In the first week, the body temperature rises slowly, and fever fluctuations are seen with relative bradycardia, malaise, headache, and cough. A bloody nose (epistaxis) is seen in a quarter of cases, and abdominal pain is also possible. A decrease in the number of circulating white blood cells (leucopenia) occurs with eosinopenia and relative lymphocytosis; blood cultures are positive for *Salmonella enterica* subsp. enterica or *S. paratyphi*. The Widal test is usually negative in the first week.
- In the second week, the person is often too tired to get up, with high fever in plateau around 40 °C (104 °F) and bradycardia. Delirium can occur, where the patient is often calm, but sometimes becomes agitated. Rose spots appear on the lower chest and abdomen in around a third of patients. The abdomen is distended and painful in the right lower quadrant, where a

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rumbling sound can be heard. Diarrhea can occur in this stage, but constipation is also common. The spleen and liver are enlarged (hepatosplenomegaly) and tender. The Widal test is strongly positive. Blood cultures are sometimes still positive at this stage. The major symptom of this fever is that it usually rises in the afternoon up to the first and second week.

- In the third week of typhoid fever, a number of complications can occur:
  - Intestinal haemorrhage due to bleeding in congested Payer's patches occurs; this can be very serious, but is usually not fatal.
  - Intestinal perforation in the distal ileum is a very serious complication and is frequently fatal.
  - Encephalitis
  - Respiratory diseases such as pneumonia and acute bronchitis
  - The fever is still very high and oscillates very little over 24 hours. Dehydration ensues, and the patient is delirious (typhoid state). One-third of affected individuals develop a macular rash on the trunk.
  - Platelet count goes down slowly and the risk of bleeding rises.
  - By the end of third week, the fever starts subsiding.

Control (Treatment)

Typhoid fever can be treated with antibiotics. As resistance to antibiotics has emerged including to fluoroquinolones, newer antibiotics such as cephalosporin and azithromycin are used in the affected regions. In more severe cases, where the bowel has become perforated, surgery may be required. Those who become chronically ill (about 3%-5% of those infected), can be treated with prolonged antibiotics. Often, removal of the gallbladder, the site of chronic infection, will provide a cure.

Even when the symptoms go away, people may still be carrying typhoid bacteria, meaning they can spread it to others through their faeces.

It is important for people being treated for typhoid fever to do the following:

- Take prescribed antibiotics for as long as the doctor has prescribed.
- Wash their hands with soap and water after using the bathroom, and do not prepare or serve food for other people. This will lower the chance of passing the infection on to someone else.
- Have their doctor test to ensure that no *Salmonella typhi* bacteria remain in their body.

Prevention

Typhoid fever is common in places with poor sanitation and a lack of safe drinking water. Access to safe water and adequate sanitation, hygiene among food handlers and typhoid vaccination are all effective in preventing typhoid fever.

Two vaccines have been used for many years to protect people from typhoid fever:

- an injectable vaccine based on the purified antigen for people aged over 2 years
- a live attenuated oral vaccine in capsule formulation for people aged over 5 years

These vaccines do not provide long-lasting immunity and are not approved for children younger than 2 years old.

A new typhoid conjugate vaccine, with longer lasting immunity, was prequalified by WHO in December 2017 for use in children from the age of 6 months.

The following recommendations will help ensure safety while travelling:

- Use the mantra *Boil it, Cook it, Peel it, or Forget it!*
- Ensure food is properly cooked and still hot when served.
- Avoid raw milk and products made from raw milk. Drink only pasteurized or boiled milk.
- Avoid ice unless it is made from safe water.
- When the safety of drinking water is questionable, boil it or if this is not possible, disinfect it with a reliable, slow-release disinfectant agent (usually available at pharmacies).

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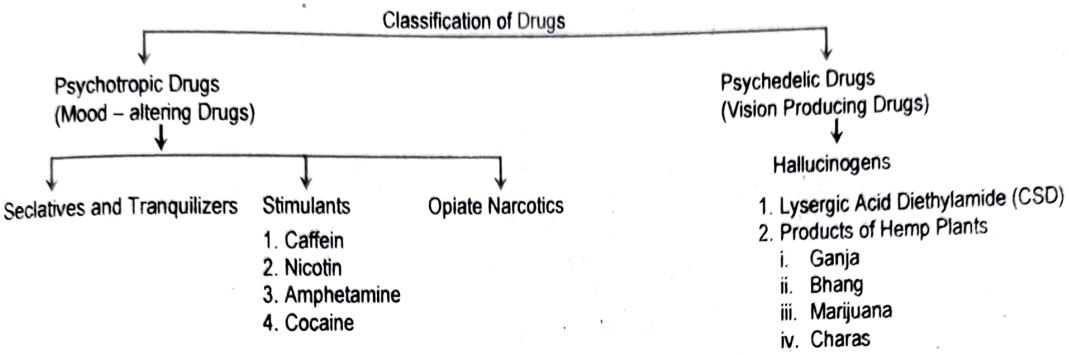
- Wash hands thoroughly and frequently using soap, in particular after contact with pets or farm animals, or after having been to the toilet.
- Wash fruits and vegetables carefully, particularly if they are eaten raw. If possible, vegetables and fruits should be peeled.

3. **2075 GIE Q. No. 4 Explain sources and biological effects of different categories of drugs.** [8]

Classification of Drugs by their effect on central nervous system.



Drugs are natural or synthetic substances which when taken into the living body affects its functioning or structure, and are used in the diagnosis, mitigation, treatment or preventing of a disease or relief of discomfort. The study of drugs is called pharmacology.

Drug are obtained from six major sources:

1. Plant sources
2. Animal sources
3. Mineral/Earth sources
4. Microbiological sources
5. Semi-synthetic or synthetic sources
6. Recombinant DNA technology

Types of drugs, their sources and effect on health are given below:

Drugs are categorized into two main classes on the basis of their effect on CNS: Psychotropic drugs and psychedelic drugs.

I. **Psychotropic Drugs:**

- These drugs alter the behaviour, consciousness and capacity of the perception of the users.
- Also called mood-altering drugs because they are capable of affecting the mind and emotions.
- Psychotropic drugs are classified as sedatives and tranquilizers, opiate narcotics and stimulants.

1. **Sedatives and Tranquilizers:**

Sources: Barbuturic acid

Examples: Barbiturates, Benzoziazepines, Gamma Hydroxy-butyrate (GHB) and alcohol.

i. **Sedatives:** These drugs have depressing effect on the central nervous system. They produce the feeling of calmness, relaxation or drawsiness in the body. Hence, they are called depressants. They reduce worry and anxiety. Higher doses of sedative induce sleep so they are called sleeping pills.

ii. **Tranquilizers:** These have similar effect to that of sadatives. However, it differ from sedatives in that it does not induce sleep.

Higher does of both sedatives and tranquilizers may result in slurred speech, staggering gait, poor judgement, and slow uncertain reflexes. Higher doses of sedative may cause death.

2. **Opiate Narcotics:**

Sources: Poppy plants (*Papever somniferum*).

Narcotics are the oldest, and the strongest drugs known to mankind. A narcotic is a central nervous system depressant. These are called pain releiving drugs or narcotic analgesics. They are popularly known as pain killers".

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Opitate narcotics are classified into the following types:

i. **Opium:**

Source: Extracted from unripe capsule of poppy plant.

- Extremely habit forming, sometime even causing addiction in as little as three days.
- Reduces respiratory and cardiovascular activity, causes nausea, vomiting, higher doses may cause death. Can be smoked, eaten, drunk, injected or taken as pills.
- Cause feelings of instense pleasure and euphoria.

ii. **Codein:**

Source: Opium

- Mild analgesic; used as cough medicine and for diarrhoea
- Greater benefit may occur when combined with paracetamol (acetaminophen) or a nonsteroidal) anti-inflammatory drugs such as aspirin or ibuprofen.
- Overdoses may cause vomiting, constipation, drowsiness, itchiness, lightheadedness, etc. Frequent uses may cause addiction.

iii. **Morphine:**

Source: Extracted from opium:

It acts directly on the CNS to decrease the feeling of pain. It can be taken to get relief from both acute and chronic pain. It is frequently used for pain from myocardial infarction and during labour. It can be given by mouth, by injection into a muscle, by injecting under the skin, intravenously, etc. Effect duration is usually 3 to 7 hours. Morphine has high potential for addiction.

Common effect of morphine include euphoria, pain relief, drowsiness and reduction in anxiety. Over dosing or morphine can lead to unconsciousness, coma or slowed breathing to the point of death.

iv. **Heroin:**

Source: Morphine

Heroin is the strongest opiate narcotic. It is highly addictive. They are commonly called brown sugars or smacks. They are eaten, inhaled or injected.

The general effects of using heroin include: contentment, reduced anxiety, relieved tension, drowsiness and apathy. Signs of overdose of heroin include shallow breathing, dry mouth, tongue discoloration, very small pupils, slow pulse and bluish lips. It may cause sensations of disorientation, feeling of constipation and vomiting.

3. **Stimulants or Anti-depressants:**

These drugs increase the activity of the CNS. They increase mental alertness and self confidence temporarily. They produce the feeling of excitement, a sense of wellbeing and flow of new idea. Hence, they are called mood elevators or antidepressants.

Stimulants are classified into the following types:

i. **Caffeine:**

Sources: Leaves of tea plant (*Thea sinensis*), seeds of coffee plants (*coffea arabia*) and seeds of cacao plants (*Theobroma cacao*)

- Mild stimulants and taken as beverages.
- Causes mental alertness, reduces appetite and restlessness.
- Higher doses may cause insomnia.

ii. Nicotine:

Sources: Obtained from tobacco plants (*Nicotiana tobaccum* and *Nicotiana rustica*)

- Inhaled as smokes.
- Repeated use can cause addiction.
- Affects nervous impulses, musculature relaxation, blood pressure and heart rate.
- Higher doses may cause insomnia and loss of appetite.

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iii. **Amphetamines:**

Sources: Synthetic drugs

- Commonly called anti-sleeping drugs because they reduce sleep.
- It is snorted or ingested. It effects on human body include feeling of wakefulness, increased confidence and increased physical and mental activities.
- Generally taken by students, night guards, long distance vehicle drivers athletes to increase physical performance.
- Overdoses may lead to seizures and death.

iv. **Cocaine:**

Source: Cocoa plants

- Strongest stimulants and highly addictive:
- Causes pleasure and mental alertness, reduce sleep and appetite.
- May cause hallucination
- Commonly snorted, inhaled as smoke or as a solution injected into a vein.
- Mental effects may include loss of contract with reality, an intense feeling of happiness, or agitation. Physical symptoms include a fast heart rate, sweating, and large pupil.
- Higher doses may cause death by sudden cardiac arrest.

II. **Psychedelic Drugs:**

These drugs are called hallucinogens because they cause optical or auditory hallucination, i.e, illusion, perception of external objects or sound actually not present. They are called vision producing drugs, because their effect last long.

These drugs are categorized into two broad classes:

LSD and products of hemp plants.

1. **Lysergic Acid Diethylamide (LSD)**

Source: Derived from a fungus - Ergot (*Claviceps purpurea*), parasite over rye or wheat plant.

- Causes hallucination. It is the most dangerous from of hallucinogens.
- Long term use cause nightmares, horrible dreams,
- Flashbacks, chronic psychosis, serious damage to CNS leading to suicide.
- Overdoses may cause coma or even death.

2. **Products of Hemp plants:**

These hemp plants are generally regarded as cannabis plants. Their derivatives are called cannabis.

The cannabis plants are *Cannabis sativa* and *Cannabis indica*

The products are called Marijuana, Hashish, Bhang, Charas and Ganja. All these forms have similar effects.

- Dilates the pupil, increase blood pressure, blood sugar lever, frequent urination, extreme anxiety or sadness, abnormal laughter, psychosis.
- Impaired co-ordination and memory.
- Cause amotivational syndrome (Having no interest in anything)
- Lowered immunity to illness
- Impaired sense of time.
- It taken with alcohol, it may cause death of the user.
- They are the second most widely abused drugs after alcohol.
- Taken as smoke, vapourizer, canabis tea and as ingredients of food. e.g Bhang.

4. 2075 Set A Q.No. 4 **Define AIDS? Mention its causative organism, mode of transmission, symptoms, diagnosis treatment and preventive measures.** **[8]**

HIV stands for human immunodeficiency virus, which is the virus that causes HIV infection. HIV attacks and destroys the infection-fighting CD4 cells or T-Helper cells of the immune system. The loss of T-Helper cells makes it difficult for the body to fight infections and certain cancers. Without

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treatment, HIV gradually destroys the immune system and advance to AIDS.

AIDS stands for acquired immunodeficiency syndrome. AIDS is the most advanced stage of HIV infection. AIDS is a set of symptoms or syndrome caused by HIV. If left untreated AIDS leads to death of the patient.

Causative Agent of HIV infection: The human immunodeficiency virus (HIV) is a lentivirus (a subgroup of retrovirus) that causes HIV infection and overtime acquired immuno-deficiency syndrome (AIDS). AIDS is a condition in humans in which progressive failure of the immune allows life-threatening oppurtunistic infections and cancer to thrive.

Mode of Transmission: HIV is transmitted through the following body fluids:

1. Blood, Semen, Pre-cum, Rectal, Vaginal fluids and Breast milk.

HIV is transmitted by three main routes: 1. Sexual contact, 2. Significant exposure to infected body fluids or tissues, 3. Mother to child during pregnancy, delivery, or breast feeding.

There are several ways this can happen.

- Sexual contact with an infected person, when the mucous membrane lining the mouth, vagina, penis, or rectum is exposed to body fluids such as semen or vaginal fluids that contain HIV, as occurs during unprotected sexual intercourse.
- Sharing needles, syringes or other injection equipments with someone who is infected.
- Transmission in health care settings. Health care professionals have been infected with HIV in the work place, usually after being acciendently pricked by contaminated needle or stuck with contaminated sharp object (containing HIV-infected blood)
- Transfer from an infected mother to a child before birth, during birth, or after birth through the mother's milk.
- Medical procedures, such as tranfusion of blood that contains HIV, procedures done with inadequately sterilized instruments, or transplantation of an infected organs or tissues.

Treatment

There is currently no cure or effective HIV vaccine. Treatment consists of highly active antiretroviral therapy (HAAPT) which slows progression of the disease. As of 2010 more than 6.6 million people were taking them. Some of the drugs approved by the U.S. Food and Durg Administration (FAD) has approved a number of drugs for treating HIV and AIDS.

1. **Neocleoside Reverse Transcriptase Inhibitors (NRTI):** These drugs interrupt the virus from duplicating, which may slow the spread of HIV in the body. They include:
   - Abacavir, Stavudine, Didanosine,Tenofovir, Emtricitabine, Zalcitabine, Lamivadine, Zidovudine
2. **Protease Inhibitors (PI):** These FDA – approved drugs interrupt virus replication at a later step in virus life. Protease inhibitor include:
   - Amprenavir, Lopinavir, Atazanavir, Ritonavir, Fosamprenavir, Saquinavir and Indinavir
3. **Non-Nucleoside Reverse Transcriptase Inhibitors (NNRTI):** NNRTIs block the infection of new cell by HIV. These drugs may be prescribed in combination with other anti-retroviral drugs. NNRTs include:
   - Delvaridine, Efravirenz, Nevirapine.

Prevention: HIV prevention refers to practices done to prevent spreadness of HIV/AIDS. The best way is to protect oneself from infection.

- Have safe sex –use of condom everytime you have sex.
- Avoid multiple sex partner.
- Avoid unnatural sex practice like oral sex and analsex.
- Avoid homosexuality.
- Screening of blood before transfusion
- Avoid intravenous drug use

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- Sterilization of needle, syringe and sharp object before use.
- Avoid breastfeeding by the infected mother.
- Eat healthy diet
- Do regular exercise
- Regular medical check up including blood test.
- Avoid pregnancy by the infected mother.

For symptoms

When people get HIV and do not receive treatment, they will typically progress three stage of disease.

Stage 1: Acute HIV Infection

- Appears within 2 to 4 weeks of infection with HIV.
- Flu-like illness, which may last for few weeks.
- People with acute HIV infection are often unaware that they are infected because they may not feel sick.

Stage 2: Clinical Latency (HIV inactivity or dormancy)

- Also called Asymptomic HIV infection or chronic HIV infection.
- Without treatment, this stage last for 3 to 20 years.
- Typically no symptoms at first, near the end of this stage many people experience fever, weight loss, gastrointestinal problem and muscle pains.
- Development of generalized lymphadenopathy i.e. enlargement of lymph nodes.

Stage 3: Acquired Immuno- Deficiency Syndrome (AIDS)

- Most severe and last stage of HIV infection.
- Damaged immune system
- In absence of specific treatment, around half of people infected with HIV develop AIDS within 10 years.
- Without treatment, people with AIDS typically survive about 3 years.
- AIDS patient suffers from opportunistic diseases like Kaposi sarcoma, lymphoma, cervical cancer, tuberculosis, pneumonia, typhoid, common cold, etc.
- Diarrhoea without explanation
- Unexplained weight loss
- Weakness
- Chill

Diagnosis of HIV/AIDS:

HIV is mostly diagnosed by testing the blood or saliva for antibodies to the virus. There are two main and commonly used techniques for the diagnosis of HIV/AIDS:

i. **ELISA:** HIV testing is initially done using an enzyme - linked immunosorbent assay (ELISA) to detect antibodies to HIV. Specimens with a non-reactive result from the ELISA are considered HIV-Negative

ii. **Western blot:** Specimens with a reactive ELISA result have to undergo confirmatory testing called the western blot, which detects specific protein in a sample of tissue. Only specimens that are repeatedly reactive by ELISA or reactive by western blot are considered HIV-Positive and indicate HIV infection.

To be reconstructed.

5. **2075 Set B Q.No. 4 Explain the sources and effects of different types of drugs on health.** **[8]**

Please refer to 2075 GIE Q. No. 4

6. **2074 Set A Q.No. 4 What are communicable diseases? Discuss the causative agent, mode of transmission, incubation period, symptoms, diagnosis, control and preventive measures of tuberculosis.** **[8]**

Please refer to Model (Zoology) Q.No. 4

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7. **2074 Set B Q.No. 4** **Discuss the different stages, causative agents, symptoms, treatment and types of cancer.** [8]

➢ Please refer to 2074 Supp Q.No. 3 OR

8. **2073 Supp Q.No. 4** **Give a detailed account of any bacterial disease you have studied.** [8]

➢ Please refer to Model (Zoology) Q.No. 4

9. **2073 Set C Q.No. 3 OR** **Discuss the causative agent, mode of transmission, symptoms, control and prevention of Ascariasis in the context of Nepal.** [7.5]

➢ Ascariasis is an intestinal infection caused by a parasitic roundworm or helminth, *Ascaris Lumbricoides*.

Ascariasis is often found in developing countries, including Nepal, with poor sanitary conditions or in areas where human stool is used as fertilizer. Ascariasis is the most common intestinal worm infection.

In Nepal, *Ascaris* has remained as a leading human parasite (known as 'Golo Juka" locally). In some rural area of Nepal, over seventy five percent people are infected with this parasite. However, the death rate is quite low in Nepal.

Kids are more likely than adults to develop gastrointestinal symptoms with an ascariasis infection because their smaller intestines are at greater risk for intestinal blockage. The greater the number of worms involved, the more severe the symptoms are likely to be.

Causative Agent: The causative agent of ascariasis is a roundworm, *Ascaris lumbricoides*. The roundworms range in size from 5.9 to 9.8 inches for adult males and 9.8 to 13.8 inches for adult females. The worms can grow to be as thick as a pencil and can live for 1 to 2 years.

Mode of Transmission: The mode of transmission is faeco-oral. The infective stage to man is embryonated eggs of roundworms.

The source of infection is from objects which have been contaminated with faecal matter containing embryonated eggs. Ingestion of infective eggs from soil contaminated with human faeces or contaminated vegetables and fruits, and water is the primary route of infection. Infections eggs may occur on other objects such as hands, money and furniture. Transmission from human to human by direct contact is impossible.

In many developing countries, human faeces are used for fertilizer, or poor sanitary facilities allow human waste to mix with soil in yards, ditches and fields. Children are particularly susceptible to ascariasis because they tend to put things in their mouth, including dirts, and they often have poorer hygiene habit than adults.

People can accidently ingest contaminated soil through hand-to-mouth contact or by eating uncooked fruits or vegetables that have been grown in contaminated soil.

Symptoms: Most people infected with ascariasis have no symptoms. Moderate to heavy infestations cause various symptoms, depending on which part of the body is infected.

1. **In the Lungs:** After the *Ascariasis* eggs are ingested, they hatch in the small intestine and the larvae migrate through the blood stream or lymphatic system into the lungs. At this stage, the human experience signs and symptoms similar to asthma or pneumonia, including:
   - Persistent cough
   - Shortness of breath
   - Wheezing

   After spending six to 10 days in the lungs, the larvae travel to the throat, where they are coughed up and then swallowed.
2. **In the Intestines:** The larvae mature into adult worms in the small intestine and the adult worms typically live in the intestine unit they die. In mild or moderate ascariasis, the intestinal infestation can cause:
   - Vague abdominal pain
   - Nausea and Vomiting
   - Diarrhoea or bloody stools.

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It large number of adult worms are present in the small intestine, then the patient might have:

- Severe abdominal pain
- Fatigue
- Vomiting
- Weight loss or malnutrition, anaemia, etc.
- Worms in vomit or stool.
- Intestinal blockage and perforation causing internal bleeding (haemorrhage) or appendicitis.
- Blockage of narrow ducts of liver or pancreas.

Treatment:

i. **Medications:** Medications that are used to kill roundworms are called ascaricides. Those recommended by WHO for ascariasis are: Albendazole, Mebendazole, Levamisole and Pyrantal Pamoate. Other effective agents many include Tribendimidine and Nitazonanide.

ii. **Surgery:** In cause of heavy infestation, surgery may be necessary to remove worms and repair damage they have caused. Intestinal obstruction or perforation, bile duct obstruction, and appendicitis are complications that may require surgery.

Prevention: The best defense against ascariasis is a good hygiene and common sense. Followings are the tips to avoid ascariasis infections:

- Safe and sanitary disposal of human faeces.
- Cleaning toilet properly.
- Thoroughly cooking all food.
- Cleaning fruits and vegetables with a proper iodine solution.
- Sterilization of any contaminated clothing and beddings.
- Having pets checked for worms regularly.
- Washing hands properly before eating with hands.

These practices are recommended for all children.

- Try as much as possible to keep kids from putting things in their mouth.
- Teach kids to wash their hands well and often, especially after using bathroom and before eating. "Avoid contaminated Food and Water"

10. **2073 Set D Q.No. 4 Discuss causative agent, symptoms, method of diagnosis, mode of infection and preventive and control measures of Tuberculosis.** **[8]**

Please refer to Model (Zoology) Q.No. 4

11. **2072 Supp. Q.No. 4 What is cancer? Discuss its causes, types, symptoms, control measures, diagonosis and treatment.** **[8]**

Please refer to 2074 Supp Q.No. 3 OR

12. **2072 Set C Q.No. 4 Discuss the causative agent, mode of transmission, symptoms, diagnosis and control measures of Tuberculosis.** **[8]**

Please refer to Model (Zoology) Q.No. 4

13. **2072 Set D Q.No. 3 OR Describe Tuberculosis as world emergency with causative agent, mode of transmission, symptoms and control measures.** **[7.5]**

Please refer to Model (Zoology) Q.No. 4

14. **2072 Set E Q.No. 4 Describe the causative agent, epidemiology, symptoms and control of Tuberculosis.** **[8]**

Please refer to Model (Zoology) Q.No. 4

15. **2071 Supp. Q.No. 4 What is AIDS? Write what you know about the AIDS.** **[8]**

Please refer to 2075 Set A Q.No. 4

16. **2071 Set D Q.No. 4 What are communicable diseases? Describe the causative agents, symptoms, effects and control measures of any one communicable disease you have studied.** **[8]**

Please refer to Model (Zoology) Q.No. 4

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17. 2070 Supp. Q.No. 4 OR **Describe the causes and symptoms of the following diseases: Typhoid, Tuberculosis, Cancer and AIDS.** [8]

I. Typhoid: Typhoid is a bacterial infection caused by *Salmonella typhi*

Causes of Typhoid

Typhoid is usually transmitted by water or food. The route is faeco-oral or urino-oral. Typhoid fever is contracted by drinking or eating bacteria in contaminated food or water. People with acute illness can contaminate the surrounding water supply through stool and urine. Contamination of the water supply can, in turn, taint the food supply. The bacteria can survive for weeks in water or dried sewage. Also it can be spread directly from person to person via contaminated fingers.

Symptoms: Classically, the course of untreated typhoid is divided into four distinct stages, each lasting about a week. Over the course of these stages, the patient becomes exhausted and emaciated.

- In the first week, the body temperature rises slowly, and fever fluctuations are seen with relative bradycardia, malaise, headache and cough. A bloody nose (Epistaxis) is seen in a quarter of case, and abdominal is also possible. A decrease number of white blood cells (Leukopenia) occurs.
- In the second week, the person is often too tired to get up, with fever in plateau around 40°C (104°F) and bradycardia. Delirium (acute confusional state) is frequent. Rose spots appear on the lower chest and abdomen in most patients. The abdomen is distended and painful in the right lower quadrant, where borborygmi (stomach rumble) occurs. Diarrhoea can occur in this stage: six to eight stools in a day. Constipation is frequent. The spleen and liver are enlarged (Hepatosplenomegaly).
- In the third week of typhoid fever, a number of complications can occur.
  - Intestinal haemorrhage due to bleeding in peyer's patches.
  - Intestinal perforation in the distal ileum, and usually fatal.
  - Encephalitis
  - Respiratory disease such as pneumonia and acute bronchitis.
  - Neuropsychiatric symptoms e.g. Delirium.
  - Dehydration.
  - Platelet count goes down slowly and risk of bleeding rises.

II. Tuberculosis (TB): Tuberculosis (TB) is a multisystemic infections disease caused by *Mycobacterium tuberculosis* a rod-shaped bacterium. There are two main types of TB: Pulmonary TB and Extra-Pulmonary TB. Pulmonary TB primarily affects the lungs, while the extra-pulmonary TB affects the pleura, the Central Nervous System, the lymphatic system, the genitourinary system, and the bones and joints.

Causes: Tuberculosis is an air borne disease. When people with active pulmonary TB cough sneeze, speak, sing, or spit, they expel infectious aerosol droplets. A single sneeze can release upto 40,000 droplets. Each of these droplets may transmit the disease, since the infections dose of tuberculosis is very small.

People with prolonged, frequent, or close contact with people having TB are at particularly high risk of becoming infected. A person with active but untreated tuberculosis may infect 10 to 15 other people per year.

Symptoms: Although there are number of TB types, pulmonary tuberculosis in responsible for the majority (About 85%) of TB infections.

The classical clinical symptoms and signs of pulmonary TB may include the following:

- Fever
- Night sweats

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- Cough (often chronic)
- Haemoptysis (coughing up bloody sputum)
- Decrease or loss of appetite
- Weight loss and/or muscle loss (unintentional)
- Fatigue or malaise
- Chest pain (Pain while breathing)
- Shortness of breath
- Swollen lymph nodes.
- Pneumonia (In elders)

Extra pulmonary TB have symptoms that are non specific but frequently localized in the involved site. The following includes the signs and symptoms of additional types of TB:

- Skeletal TB: Spinal pain, back stiffness, paralysis is possible.
- TB meningitis : Headaches, mental changes and coma
- TB Arthritis: Usually pain in a single joint (hips and knees)
- Genitourinary TB: Dysuria (painful urination), abdominal pain, bloody diarrhoea.
- Pleural TB: Empyema and pleural effusions.

III. **Cancer:** Cancer is a group of disease involving abnormal growth of cells with the potential to invade or spread to other parts of the body. Cancer is also called malignant neoplasm. Cancer is the number one non communicable disease in terms of number of people killed every year.

Causes: Cancer is ultimately the result of cells that uncontrollably grow and do not die. Normal cells follow the pattern of programmed death or apoptosis. If there is mutation to DNA, the abnormal cells begin to multiply rapidly and unfollows the apoptosis. This leads to mass of abnormal cells that grows out of control.

The mutation of DNA is caused by various factors called carcinogens or carcinogenic agents. Some of the cancer causing factors are as follows:

1. Genetic make up
2. Smoking – cancer of lung, oral, throat, kidney and bladder.
3. Alcoholism – Cancer of liver, stomach and intestine
4. Sun and Uv exposure – cancer of skin
5. Radiation exposure – Cancer of skin
6. Previous cancer treatment–
7. Junk or processed food
8. Obesity and physical inactivity
9. Heredity – cancer of breast, uterus and blood.

Symptoms: According to American Cancer Society, there are seven classical clinical symptoms of different forms of cancer.

1. Change is bowel or bladder habits.
2. A sore that does not heal.
3. Unusual bleeding or discharge
4. Thickening of lump in the breast, testicles or elsewhere
5. Indigestion or difficulty in swallowing
6. Obvious change in the size, colour, shape, or thickness of a wart, mole, or mouth sore.
7. Nagging cough or hoarseness.

IV. **HIV/AIDS:** HIV is a virus spread through certain body fluids that attacks the body's immune system, especially the CD4 cells, often called T-cells, a form of white blood cells. Over time, HIV can destroy so many of these cells that body cannot fight off infections and diseases. These special cells help the immune system fight off infections. Untreated, HIV reduces the number of T-cells in

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the body. This damage to the immune system makes it harder and harder for the body to fight off infections and some other diseases. Opportunistic infections or cancers take advantage of a very weak immune system and signal that a person has AIDS. HIV stands for human immunodeficiency virus. It is the virus that leads to acquired immunodeficiency syndrome or AIDS if not treated. AIDS is the final stage of HIV infections.

Causes

HIV is transmitted by three main routes: Sexual contact, significant exposure to infected body fluids or tissues and from mother to child during pregnancy, delivery, or breastfeeding.

1. **Sexual:** The most frequent mode of transmission of HIV is through sexual contact with an infected person.
2. **Body Fluids:** The most frequent mode of HIV transmission is via blood and blood products. Blood borne transmission can be through needle - sharing during intravenous drug use, needle stick injury, transfusion of contaminated blood or blood product, or medical injections with unsterilized equipment.
3. **Mother – to – child:** HIV can be transmitted from mother to child during pregnancy during delivery, or through breast milk resulting in the infection in the baby. This is the third most common way of HIV transmission.

Symptoms

When people get HIV and do not receive treatment, they will typically progress three stage of disease.

Stage 1: Acute HIV Infection

- Appears within 2 to 4 weeks of infection with HIV.
- Flu-like illness, which may last for few weeks.
- People with acute HIV infection are often unaware that they are infected because they may not feel sick.

Stage 2: Clinical Latency (HIV inactivity or dormancy)

- Also called Asymptomic HIV infection or chronic HIV infection.
- Without treatment, this stage last for 3 to 20 years.
- Typically no symptoms at first, near the end of this stage many people experience fever, weight loss, gastrointestinal problem and muscle pains.
- Development of generalized lymphadenopathy i.e. enlargement of lymph nodes.

Stage 3: Acquired Immuno- Deficiency Syndrome (AIDS)

- Most severe and last stage of HIV infection.
- Damaged immune system
- In absence of specific treatment, around half of people infected with HIV develop AIDS within 10 years.
- Without treatment, people with AIDS typically survive about 3 years.
- AIDS patient suffers from opportunistic diseases like Kaposi sarcoma, lymphoma, cervical cancer, tuberculosis, pneumonia, typhoid, common cold, etc.
- Diarrhoea without explanation
- Unexplained weight loss
- Weakness
- Chill

18. 2070 Set C Q.No. 4 **Discuss causative agent, incubation period, affected organs, mode of transmission, symptoms, prevention and control measures of AIDS.** [8]

Please refer to 2075 Set A Q.No. 4

19. 2070 Set D Q.No. 3 OR **Write, what you know about the AIDS?** [7.5]

Please refer to 2075 Set A Q.No. 4

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20. 2069 Q.No. 4 OR **Write an essay on socially significant diseases.** [8]

A disease is an abnormal condition of an organism that impairs the organism's function in whole or in part and is identified by characteristic signs and symptoms.

Any abnormal change that causes distress and discomfort to the lives of both the concerned person and the people around him/her is termed as socially significant disease.

There are three alarming socially significant diseases at present. They are listed below:

1. **Drug Abuse and Addiction:** Drug addiction is a chronic, often relapsing brain disease that causes compulsive drug seeking and use, despite harmful consequences to the drug addicts and those around them. Drug addiction is a brain disease because the abuse of drugs leads to the changes in the structure and function of the brain. Although the initial decision to take drug is voluntary, overtime the changes in the brain caused by repeated drug abuse can impair a person's self control and ability to make sound decision, and at the same time create an intense impulse to take drugs.

Drugs are chemicals that tap into brain's communication system and disrupt the way nerve cells normally send, receive, and process information.

In 2015, around 29.5 million people were engaged in drug abuse and suffered from drug use disorder.

Types of Drugs commonly used

i. **Amphetamines:** Overdose of these substances can result in seizure and death.

ii. **Anabolic steroids:** A group of substances that is most often abused by body builders and other.

iii. **Caffeine:** While it is consumed by many coffee, tea, and soda drinkers.

iv. **Cannabis:** More usually called marijuana, the scientific name being Tetrahydrocannabinol (THC). Marijuana is the most commonly used illicit drug.

v. **Cocaine:** A drug that tends to stimulate nervous system. It can be snorted in powder form, smoked or injected when made into a liquid.

vi. **Hallucinogens:** Examples include lysergic acid diethylamide (LSD) and Mescaline. They alter the perception of the users.

vii. **Nicotine:** The addictive substance found in tobacco. It is one of the most addictive substances.

viii. **Opiates:** This group is also called narcotics and include drugs like heroin, codeine, hydroquinone, morphine, methadone, vicodin, oxycontin, percocet and percoden.

ix. **Sedatives:** Also known as hypnotic or antanxiety drugs. They are the second most commonly used drugs. They are the second most commonly used drugs.

Causes of Drug abuse: No single factor can predict whether or not a person will become addicted to drugs. Risk for addiction is influenced by person's biology, social, environment, and age or stage of development. The more risk factors in individual has, the greater the chance that taking drugs can lead to addiction. For example:

i. **Biology:** The genes that people are born with in combination with environment influences – account for about half of their addiction vulnerability. Additionally, gender, ethnicity, and the presence of other mental disorders may influence risk for drug abuse and addiction.

ii. **Environment:** A person's environment includes many different influences–from family and friends to socioeconomic status and quality of life in general. Factors such as peer pressure, physical and sexual abuse, stress, and parental involvement can greatly influence the course of drug abuse and addiction in a person's life.

iii. **Development:** Genetic and environmental factors interact with critical development stages in a person's life to affect addiction vulnerability, and adolescents experience a double challange. Although taking drugs at any age can lead to addiction, the earlier that drug use begins, the more likely it is to progress to more serious abuse. And because adolescent's making, judgement, and self-control, they are especially prone to risk taking behaviours, including trying drugs of abuse.

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Effect of Durg abuse or Drug Addiction

i. **Injuries:** Drug abusers or Drug addict are prone to inintentinal injuries, accidents, risk of domestic violence, medical problems and deaths.

ii. **Health problems:** The impact of drug abuse and addiction can be far reaching, affecting almost every organ in the human body.

Drug use can:

- Weaken the immune system, increasing susceptibility to infections.
- Cause cardiovascular conditions ranging from abnormal heart rate to heart attacks. Injected drugs can lead to collapsed vein and infections of the blood vessels and heart vessels.
- Cause nausea, vomiting and abdominal pain.
- Cause the liver to work harder, possibly causing significant damage or liver failure.
- Cause seizures, stroke and widespread brain damage that can impact all aspects of daily life by causing problems with memory, attention and decision – making, including sustained mental confusion and permanent brain damage.

iii. **Behavioural problem include**

- Paronoia, Aggressiveness, Suicidal tendency, Amotivational syndrome, Hallucianation, Addiction, Impaired judgment, Impulsiveness and Loss of self control

iv. **Birth defects:** Nearly 4 percent of pregnant women in the United States use illicit drugs such as marijuana, cocaine, amphetamines and heroin. Some of these drugs may cause baby to be born very small or too soon.

v. **Family and social problems**

- Poverty or financial crisis, Domestic violence, Marital conflict and divorce, Child neglet, Feeling of insecurity to the abuser's or addict's child/children
- Theft, burglary, murder, fire related incidences etc.
- Smuggling

Drug use disorders Symptoms

- Having blackout or loss of memory
- Mood irritability, sadness, or mood swings
- Repeated argument with loved ones
- Repeatedly using drugs to cope with problems
- Physical symptoms when abstaining from drug use.
- Continuous craving for drugs
- Lack of motivation
- Slurring speech
- Becoming absent from duty stations (e.g. school. office, etc)
- Sharp decline in academic performance.

Treatment of drug dependency

- Hospitalization of the abusers or addicts
- Rehabilitation of the addicts
- Drug Detox
- Holistic Therapy including Yoga, acupuncture and meditation.
- Motivational enhancement Therapy
- Psychodynamic therapy

Prevention

Drug abuse is a preventable disease. Drug abuse can be prevented by the following activities.

- Public awareness about the bad effect of drug abuse.
- Presentation programs that involve the family, schools, communities, and the media.
- Strong penalties for drug dealers.
- Common sense.

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2. **Alcoholism**

Alcoholism is the most severe form of alcohol abuse and involves the inability to manage drinking habits. It is also called alcohol used disorder.

Warning Sings of Alcoholism

Common signs of alcoholism include:

- Being unable to control alcohol consumption.
- Craving alcohol when you are not drinking.
- Putting alcohol above personal responsibilities.
- Feeling the need to keep drinking more.
- Spending a substantial amount of money on alcohol.
- Behaving differently after drinking.

Reasons why people drink

While there are various reasons as to why people start drinking, some of the most common are to:

- to relieve stress
- to feel good
- to cope with loss e.g. losing relatives or friends
- to overcome anxiety
- to gain courage
- to peer pressure
- to social culture and traditions

Health complications from alcohol abuse

Drinking too much - on a single occasion or long term - can take a serious toll on your health. Some effects of alcohol have minor effect on your health, while others can be severe or life threatening.

I. **Short -term effects of alcohol abuse:**

- Slow reaction time
- Poor reflexes
- Reduce brain activity
- Lower inhibitions
- Blurred vision and slurring speech
- Difficulty in breathing
- Restlessness

II. **Long-term effects of alcohol-abuse**

- Brain defects including Wernicke-korsakoff Syndrome
- Liver disease/liver cancer
- Diabetes complications
- Heart problems
- Increased risk of cancer
- Vision damage
- Bone loss/osteoporosis

Treatment for Alcoholism

Alcohol treatment is divided into three sections, consisting of

1. Detoxification: Drugs are given to alcoholic person to overcome alcoholism.
2. Rehabilitation: Alcoholic person involves in recovery programs
3. Maintenance: Therapy after rehab. It may entails support groups, counselling and other recovery resources.

3. **Smoking:** Smoking is a practice in which a substance is burnt and the resulting smoke breathed in to be tasted and absorbed into the bloodstream. Most commonly the substance is the dried leaves of the tobacco plant.

Smoking generally have negative health effects, because smoke inhalation inherently poses challanges to various physiological process such as respiration. Smoking caused over five million death in 2015 (WHO). Smoking is very common is Nepal.

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Smoking and increased Health Risks

i. **Cardiovascular diseases– Smoking**
- Causes stroke and coronary heart disease
- Damages blood vessels and makes them thicken and narrower.
- Makes heart beat faster.
- Blood clot blocks the flow of blood to skin and legs.

ii. **Respiratory diseases:**
- Lung diseases caused by smoking is chronic obstructive pulmonary diseases (COPD) including emphysema and chronic bronchitis.
- Lung cancer
- Asthma

iii. **Cancer:** Smoking can cause cancer almost anywhere in your body. Cancers of bladder, blood (Acute Myeloid Leukemia), cervix, colorectal, oesophagus, kidney and ureter, larynx, liver, mouth, tongue, lip, gum, palate, tonsils, pancreas, stomach, trachea, bronchus and lung.

iv. **Reproductive system complications and birth defects**
- Preterm (early) delivery
- Still birth (Death of the baby before birth)
- Low birth weight
- Sudden Infant Death Syndrome (SIDS)
- Facial clefts in infants
- Reduce fertility in male
- Increase risk of miscarriage

Control measures of smoking
- Quit smoking
- Avoid smoking
- Public awareness programs about the bad effects of smoking
- Heavy taxation on tobacco products
- No smoking in public places

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21. **2068 Q.No. 4 OR What is cancer? Discuss its types, causes, symptoms, control measure, diagnosis and treatment.** [8]

➢ Please refer to 2074 Supp Q.No. 3 OR

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22. **2067 Q.No. 3a OR Describe the causative agent, mode of transmission and control measure of typhoid.** [4]

➢ Typhoid or Typhoid fever is an acute illness associated with fever caused by bacteria. The acute illness is characterized by prolonged fever, headache, nausea, loss of appetite, and constipation or sometimes diarrhoea. Without prompt treatment, it can cause serious complications and can be fatal.

Typhoid fever is highly contagious. An infected person can pass the bacteria out of their body in their stool (faeces) or, less commonly in their urine.

Causative Agent: Typhoid fever is caused by a type of bacteria known as *Salmonella typhi*. The bacterium lives in the intestines and bloodstream of human. It invades the Peyer's patches (a lymphoid tissue) of ileum of small intestine and grow there.

Salmonella typhi enters the human body through the mouth and spends 1 to 3 weaks in the intestine. After this time, it makes its way through the intestinal wall and into the bloodstream. From the blood stream, it spreads into other tissues and organs.

A similar but often less sever disease, paratyphoid fever, is caused by *Salmonella paratyphi* A, B or C.

Mode of Transmission

Typhoid is transmitted via the faeco-oral router or urino-oral route.

No animals carry these disease, so transmission is always human to human. It is spread between human individuals by direct contact with the faeces or urine of an infected human.The human waste can contaminate the water supply.

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Following are the methods of transmission of typhoid:

- Using a toilet contaminated with bacteria and touching the mouth before washing hands.
- eating seafood from a water source contaminated by infected faeces or urine
- eating raw vegetables that have been fertilized with human waste.
- contaminated milk products.

Control Measures

The control measures of typhoid fever includes treatment and prevention.

A. **Treatment:**

The only effective treatment for typhoid is antibiotics. Antibiotics such as ampicillin, chloramphenicol, trimethoprim- sulfamethazole, amoxicillin, and ciprofloxacin are effective against typhoid.

Surgery is usually indicated in cases of intestinal perforation.

B. **Prevention:**

Proper sanitation, Proper disposal of human excreta, Purification of water before drinking or cooking, Practice of hygiene and cleanliness, Adequate medical care, Washing hand before eating or preparing food, Avoid raw fruits and vegetables, Choosing hot food and Vaccination.

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23. 2066 Q.No. 4 OR **What is DOTS? Discuss the causative agent, symptoms, effect and control measures of tuberculosis.** [8]

DOTS or Directly Observed Treatment Short course is the internationally recommended stategy for TB control that has been recognized as a highly efficient and cost-effective strategy. DOTS is a standardized short-course anti-TB treatment given under direct and supportive observation. It helps to ensure the right drugs are taken at the right time for full duration of treatment. It also ensures the regular, uniterrupted supply of high quality anti-TB drugs.

Introduction to Tuberculosis

Tuberculosis or TB is a contagious infection that usually attacks the lungs. It can also spread to other parts of the body, like the brain and spine.

Causative Agent:

Tuberculosis is caused by the bacterium *Mycobacterium tuberculosis*. It is an obligate pathogeric bacterial species.

It generally attacks the lungs. It passes from person to person through the air.

The Symptoms of tuberculosis is given below:

1. **Pulmonary TB:** The classical symptoms of pulmonary TB includes: a cough that last more than 3 weeks, chest pain, coughing up blood (Haemoptysis), feeling tired all the time, chills, night seats, fever, loss of appetite and weight loss.
2. **Extra pulmonary TB:** Extra pulmonary TB often have symptoms that are non-specific but frequently localized to the involved site. The following includes the signs and symptoms of extra pulmonary TB:

- **Skeletal TB (Pott's Disease):** Spinal pain, back stiffness, paralysis is possible
- **TB Meningits:** Headache, mental changes and coma.
- **TB Arthritis:** Usually pain in a single joint (hips and knees most common)
- **Genito-urinary TB:** Dysuria (Painful urination), flank pain.
- **Gastro-intestinal TB:** Difficulty swallowing, non-healing ulcers, abdominal pain, diarrhoea (may be bloody)
- **Pleural TB:** Empyema or pleural effusion.

Effect of TB:

It left untreated, TB can cause severe effects on health.

- **Lung damage and Death:** Lungs is so damaged that one cannot breath properly.
- **Meningitis:** It affects the brain and its functions.
- **Arthritis:** The muscles around the joint may experience spasms and may atrophy over time.
- **Milliary TB:** Another rare type of TB is milliary TB, in which the infection spreads through out the body. The name milliary arose because the millions of infected sports throughout the body are roughly the same size as millet.

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Control Measures: The control measures of TB includes the treatment and prevention.

A. **Treatment of TB:** DOTS (Direct Observed Treatment Short course), also known as TB-DOTS, is the name given to the tuberculosis control stategy recommended by the WHO. TB is completely curable through short course chemotherapy. Treating TB cases who are sputum- smear positive (who can spread the disease to other) at the source, it is the most effective means of eliminating TB from a population. DOTS has been recognized as a highly efficient and cost-effective strategy. It involves a regular uniterrupted supply of high quality anti-TB drugs. DOTS helps to ensure the right drugs are taken at the right time for the full duration of treatment. For active TB, it will require several drugs at once. The most common medication used to treat TB includes: Isoniazid, Rifampicin, Ethambutol and Pyrazinamide.

Prevention from TB

1. **BCG Vaccination:** The vaccine called Bacillus Calmette Guerin (BCG) is the most widely used vaccine. It reaches more than 80% of all new born children and infants. The BCG vaccine has been shown to provide children with excellent protection against the TB.
2. **TB Education:** People with TB need to know how to take their drugs properly. They also need to know how to make sure they do not pass TB on to other people.
3. **Preventing TB transmission in Households:** In order to reduce exposure in households, where someone has infectious TB, the following actions should be taken whenever possible:
   - Houses shows be adequately ventilated
   - Anyone who coughs should be educated on cough etiquitte and respiratory hygiene, and should follow such practices at all times.
   - While smear positive, TB patients should;
   - Spend as much time as possible outside;
   - Sleep alone in a separate, adequately ventilated room;
   - Spend as little time as possible in public transport;
   - Spend as little time as possible, where large numbers of people gather together.

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24. **2065 Q.No. 4 OR** **What is AIDS? Mention its causative organism, mode of transmission, symptoms, diagnosis, treatment and preventive measures.** **[8]**

✍ Please refer to 2075 Set A Q.No. 4

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25. **2064 Q.No. 4 OR** **What are communicable diseases? Elaborate about the causative agents, symptoms, effects and controlling measures of tuberculosis.** **[10]**

✍ Please refer to Model (Zoology) Q.No. 4

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26. **2062 Q.No. 4 OR** **What is cancer? Discuss the causes and treatment of cancer and also mention one major cancer in man and woman each.** **[10]**

✍ Please refer to 2074 Supp Q.No. 3 OR

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27. **2061 Q.No. 4 OR** **Define AIDS, and elaborate about its origin, causative agents, mode of transmission and controlling measures.** **[10]**

✍ Please refer to 2075 Set A Q.No. 4

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28. **2059 Q.No. 4 OR** **What is addiction? Discuss the symptoms, effects and control measures of alcohol addition.** **[10]**

✍ Please refer to 2076 Set B Q. No. 4

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29. **2058 Q.No. 4 OR** **What is 'DOTS'? Describe causal organism, symptoms, transmission and preventive measures of tuberculosis.** **[1+1+2+2+4]**

✍ Please refer to 2066 Q.No. 4 OR

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30. **2057 Q.No. 4 OR** **What are communicable diseases? Discuss the causative agents, symptoms, effects and control measures of any one communicable disease you have studied.** **[2+1+2+2+3]**

✍ Please refer to Model (Zoology) Q.No. 4

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Unit 4

APPLICATION OF BIOLOGY

Very Short Answer Questions [1 mark]

1. **2076 Set B Q. No. 1e What is vaccine? Name their types.** [1]

Vaccine is a preparation of suspension or extract of dead or attenuated germs of a disease which on inoculation into a healthy person provides temporary or permanent, active or passive immunity by inducing antibodies formation.

According to WHO, there are five major types of vaccines:

i. Live-attenuated vaccines
ii. Killed or Inactivated vaccines
iii. Toxoid vaccines
iv. Subunit vaccines
v. Conjugate vaccines

2. **2076 Set B Q. No. 1f Give limitations of organ transplantation.** [1]

The limitations of organ transplantation are as follows:

i. Shortage of organs
ii. Very expensive
iii. Prolonged suffering of the recipient
iv. Possible transplant rejection
v. Possible surgery complication

3. **2076 Set B Q. No. 1g What is a fingerling?** [1]

Fingerling is a young fish, especially less than a year old and about the size of a finger.

4. **2076 Set B Q. No. 1h What are pullets?** [1]

Pullets are young hens, especially one less than one year old.

5. **2076 Set C. Q.No. 1h What do you mean by allograft?** [1]

Allograft is the transplant of an organ or tissue between two genetically different members of the same species. Examples are transplant of kidney, liver, cornea, etc.

6. **2076 Set C Q. No. 1i Who invented the first Antibiotics?** [1]

Sir Alexander Fleming, a British Bacteriologist, invented the first Antibiotics, the Penicillin, in 1928 at St. Mary's Hospital in London.

7. **2076 Set C Q. No. 1j What are pullets?** [1]

Please refer to 2076 Set B Q. No. 1h

8. **2075 GIE.Q. No. 1h Differentiate between vaccine and injection.** [1]

A vaccine is a biological preparation that provides active acquired immunity to a particular disease. e.g. Polio vaccine.

An injection is the introduction of a drug, vaccine, contraceptive or other therapeutic agent into the body using a needle or syringe. Injections are health care procedures.

9. **2075 GIE Q. No. 1j Define the term 'rejection'.** [1]

Rejection is defined as a process in which a transplant recipient's immune system attacks the transplanted organ or tissue. When a person receives an organ from someone else during transplant surgery, that person's immune system may recognize that it is foreign.

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10. 2075 Set A Q.No. 1f **What is antigen?** [1]

An antigen is a molecule capable of inducing an immune response on the part of the host organism. They cause an immune system to produce antibodies against it.

11. 2075 Set A Q.No. 1g **What is a Down's syndrome?** [1]

Down syndrome is a congenital disorder arising from a chromosome defect, causing intellectual impairment and physical abnormalities including short stature and a broad facial profile. It arises from a defect involving chromosome 21, usually and extra copy (trisomy – 21)

12. 2075 Set A Q.No. 1h **What do you mean by exotic fish?** [1]

Exotic fishes are those species which are not native and introduced from foreign or other countries to the local areas. Example of exotic fish reared in Nepal is Japanese rainbow trout.

13. 2075 Set A Q.No. 1i **Differentiate between autograft and isograft.** [1]

Differences between Autograft and Isograft is given below:

Autograft	Isograft
The tissue transplanted from one part of the body to another in the same individual. Exanrple: Bone autograft.	The tissue or organ transplanted from one member of a species to another genetically identical member. Example: kidney transplantation between identical twins

14. 2075 Set B Q.No. 1h **What is prophylaxis?** [1]

A prophylaxis is the prevention of a specific disease, as by studying the biological behaviour, transmission, etc. of its causative agent and applying a series of measures against it.

15. 2075 Set B Q.No. 1i **Give any two applications of vaccines.** [1]

The two main applications of vaccines are as follows:

1. Vaccines are used to develop immunity against specific infections such as tuberculosis, typhoid, polio, tetanus, diphtheria, measles, hepatitis B, cholera, etc.
2. Vaccines destroy or kill the infectious agents.

16. 2075 Set B Q.No. 1j **What are immunosuppressants?** [1]

Immunosuppressants are drugs or medicines that can supress or prevent the immune response. Immunosuppresants are used to prevent rejection of a transplanted organ and to treat autoimmune diseases such as rheumatoid arthritis, Crohn's disease (Chronic inflammatory gastrointestinal disease) and psoriasis (skin disease). Examples are Imuran and Cyclosporine.

17. 2074 Supp Q.No. 1h **What is IVF technology?** [1]

IVF Technology is a medical procedure in which the spermatozoa and ova are fertilized outside the body, in a laboratory dish, and then implanted it in a woman's uterus. This technology help woman become pregnant. Test tube babies are born through this technology.

18. 2074 Supp Q.No. 1i **What is meant by broad spectrum antibiotics?** [1]

Broad spectrum antibiotics refer to an antibiotic that acts on two major bacterial groups, gram-positive and gram-negative, or any antibiotic that acts against a wide range of disease-causing bacteria. Examples of broad-spectrum antibiotics are Ampicillin, Amoxicillin, Tetracyclines, Cholramphenicol, Aminoglycosides, etc.

19. 2074 Set A Q.No. 1b **Mention two main properties of antibiotics.** [1]

Two main properties of antibiotic are as follows:

i. Antibiotics are selective in their effect on different micro organisms. Some of these agents act mainly on gram-positive bacteria, while other inhibit only gram-negative one.

ii. The mode of action of antibiotics upon organism varies. Some interfere with growth and cell division. Others affect microbial respiration or the utilization of essential metabolites and kill them (bactericidal).

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20. **2074 Set A Q.No. 1c What is erythroblastosis fetalis?** [1]

Erythroblastosis fetalis, also called hemolytic disease of the newborn, a type of anemia in which the red blood cells or erythrocytes of the fetus are destroyed in a maternal immune reaction resulting from a blood group incompatibility between the fetus and its mother. Symptoms of erythroblastosis fetalis range from mild to serve; sometime death of the fetus or newborn.

This commonly happens when a woman with Rh- negative blood becomes pregnant by a man with Rh-positive blood and conceives a baby with Rh-positive blood. Red blood cells from the baby can leak across the placenta into the mother's bloodstream during pregnancy and delivery. This causes the mother's body to make against the Rh factor of the baby.

21. **2074 Set A Q.No. 1d How is ammnicentesis misused?** [1]

Amniocentesis is a pre-natal diagnostic test based on the chromosomal pattern of the cells in the amniotic fluid that surrounds the developing foetus in the womb. It is misused to detect the sex of pre-born child that leads to female foeticide (killing) in the case of girl-child.

22. **2074 Set A Q.No. 1e Name any two indigenous fish of Nepal.** [1]

The main indigenous fish species of Nepal are:

i. *Labeo rohita* (Rohu) ii. *Catla catla* (Bhakur)

23. **2073 Supp Q.No. 1h Give the meaning of surrogacy.** [1]

Surrogacy is a method or agreement whereby a woman agrees to carry a pregnancy for another person or persons, who will become the new born's parent(s) after birth. There are two types of surrogacy: Traditional surrogacy and gestational surrogacy.

24. **2073 Supp Q.No. 1i What do you mean by Antibiotics?** [1]

Antibiotics, also called antibacterials, are a type of antimicrobial drug used in the treatment and prevention of bacterial infections. They may either kill or inhibit the growth of bacteria. Examples are Penicillin and Cephalosporin.

25. **2073 Supp Q.No. 1j Name two commercially produced fish varieties.** [1]

Please refer to 2074 Set A Q.No. 1e

26. **2073 Set C Q.No. 1i What is xenograft? Mention its use.** [1]

Xenograt is a graft of tissue or organs transplanted between animals of different species. Xenografts are widely used in research in connection with disorders, or the functioning. of the human being.

27. **2073 Set C Q.No. 1j What do you mean by poultry farming?** [1]

Poultry farming is the process of raising domesticated birds such as chicken, ducks, turkeys, geese, quails, and ostriches for the purpose obtaining meat or eggs for food.

28. **2073 Set D Q.No. 1h What do you mean by IVF Technology?** [1]

Please refer to 2074 Supp Q.No. 1h

29. **2073 Set D Q.No. 1j What are two popular varieties of fishes in Nepal?** [1]

Please refer to 2074 Set A Q.No. 1e

30. **2072 Supp. Q.No. 1i What is test tube baby?** [1]

When a woman becomes unable to become pregnant by normal process, the ovum is withdrawn from her ovary and fused with spermatozoa in a laboratory dish. The zygote, thus formed is implanted in a woman's uterus. After nine month she delivers a baby. Such baby is called test tube baby.

31. **2072 Supp. Q.No. 1j Define about the significance of poultry farming.** [1]

Poultry farming or raising of birds domestically or commercially, is primarily for meat, eggs, feathers, manures and cash income.

32. **2072 Set C Q.No. 1e What is antibiotics?** [1]

Please refer to 2073 Supp Q.No. 1i

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33. 2072 Set C Q.No. 1g **Why is amniocentesis banned?** [1]

Amniocentesis is a process in which doctor will study the foetus and will determine the sex of the unborn baby. If the sex will come out to be female then female foeticide is most probable to happen. That is why amniocentesis is banned world wide.

34. 2072 Set C Q.No. 1j **Define significance of poultry farming.** [1]

Poultry farming plays very important role mankind through food supply, income and employment generation, providing raw materials to some industries, facilitating research works, etc.

35. 2072 Set D Q.No. 1e **Which analysis is carried out to find the sex of unborn baby?** [1]

Chromosomal analysis of amniocentesis is carried out to find the sex of unborn body.

36. 2072 Set D Q.No. 1h **What is xenograft?** [1]

The tissue or organ which is transplanted between the animals of different species called xenograft. e.g. Pig heart valves in human.

37. 2072 Set D Q.No. 1j **Why is surrogacy banned in some countries?** [1]

Surrogacy is banned in some countries because they think renting of uterus is against the religion and ethics.

38. 2072 Set E Q.No. 1h **How is test tube baby different from normal baby?** [1]

A normal baby is born via a natural fertilization process i.e. fertilization inside the body. Test tube baby is born through Invitro Fertilization (IVF) method i.e. fertilization outside the female body i.e. in a laboratory dish.

39. 2072 Set E Q.No. 1i **Name two indigenous fishes found in Nepal.** [1]

Please refer to 2074 Set A Q.No. 1e

40. 2071 Supp. Q.No. 1f **Give the reason to develop test-tube baby technique.** [1]

When a baby is not conceived by natural way, test-tube baby technique is applied.

41. 2071 Supp. Q.No. 1g **Name the first antibiotic.** [1]

Penicillin is the first antibiotic discovered in 1928 AD.

42. 2071 Supp. Q.No. 1h **Define second generation vaccines.** [1]

The vaccines which are prepared with the help of genetic engineering technique are called second generation vaccines. e.g. Hepatitis B vaccine, Herpes vaccine, etc.

43. 2071 Supp. Q.No. 1i **Define genograft with example.** [1]

Xenogroft is a tissue or organ transplanted between the individuals of different species e.g. use of pig heart valves in humans.

44. 2071 Supp. Q.No. 1j **Give two advantages of amniocentesis technique.** [1]

Amniocentesis has many advantages for the mother's who are expecting babies. The two advantages are as follows:

i. Amniocentesis identifies several genetic disorders like, Down syndrome and Edward syndrome, in the growing foetus.

ii. Amniocentesis can indicate whether the baby is at risk of spina bifida or anencephaly. Parents are able to prepare before the birth to meet the particular needs of the child.

45. 2071 Set C Q.No. 1g **Who extracted penicillin for the first time?** [1]

Sir Alexander Fleming, a British Biologist, discovered the first antibiotics, Penicillin, in 1928.

46. 2071 Set C Q.No. 1h **Define the term immunity.** [1]

Immunity is the capacity of organisms to resist a particular disease especially through preventing development of a pathogenic microorganism or by counteracting the effects of its products.

47. **2071 Set C Q.No. 1i What do you mean by extensive fish farming?** [1]

Extensive fish farming generally refers to fish farming conducted in medium to large sized ponds or water bodies. The fish production relies merely on the natural productivity of the water.

48. **2071 Set C Q.No. 1j What are pullets?** [1]

Please refer to 2076 Set B Q. No. 1h

49. **2071 Set D Q.No. 1f Differentiate between autograft and heterograft.** [1]

Please refer to Model (Zoology) Q.No. 1j

50. **2071 Set D Q.No. 1g What is the role of Surrogate mother?** [1]

The role of surrogate mother is to serve as host animal or animal incubator and to deliver offspring after normal gestation period.

51. **2071 Set D Q.No. 1j What is integrated fish farming?** [1]

Integrated fish farming is a process of farming where fishes are produced in combination with other farm products and livestock, centered around the fish farm. Animal manure is shed directly into fish pond as fertilizer and support the growth of photosynthetic organism.

52. **2070 Supp. Q.No. 1d At what stage an embryo is implanted in the uterus to apply the test-tube baby technique.** [1]

Blastocyst (32-64 celled stage) stage of embryo is implanted in the uterus to apply the test-tube baby technique.

53. **2070 Supp. Q.No. 1g Who discovered the first antibiotic?** [1]

Please refer to 2071 Set C Q.No. 1 g

54. **2070 Supp. Q.No. 1i Define allograft with example.** [1]

Allograft is a tissue or organ that is transplanted between the donor and recipient of the same species but are genetically different. e.g. Kidney and heart transplantation in humans.

55. **2070 Supp. Q.No. 1j Name first test-tube baby with date.** [1]

The first test tube baby is a female named Louise Joy Brown, who was born on 25th July 1978, at Oldham General Hospital, Oldham, England.

56. **2070 Set C Q.No. 1f What is antigen?** [1]

Please refer to 2075 Set A Q.No. 1f

57. **2070 Set C Q.No. 1j What do you mean by vaccination?** [1]

Vaccination is the administration of antigenic material i.e. a vaccine to stimulate an individual's immune system to develop adaptive immunity to a pathogen. e.g. Polio vaccination, Tetanus toxoid vaccination, etc.

58. **2070 Set D Q.No. 1j What do you mean by vaccination?** [1]

Please refer to 2070 Set C Q.No. 1j

59. **2068 Q.No. 1i What is called brooding?** [1]

Brooding is the management of chicks from one day old to about 8 weeks of age, and it involves the provision of heat and other necessary care during chicks early growing period.

60. **2068 Q.No. 1j What do you mean by surrogate mother?** [1]

Surrogate mother is a woman who bears a child on behalf of another woman, either from her own egg fertilized by other woman's partner or from the implantation in her uterus of a fertilized egg from the other woman. She may or not be the biological mother of the growing foetus.

61. **2067 Q.No. 1f Who invented penicillin and when?** [1]

Sir Alexander Fleming, a British biologist, invented Penicillin in 1928 A.D.

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62. 2067 Q.No. 1g **What do you understand by poultry farming?** [1]

Poultry farming is the raising of various types of domestic birds such as chicken, ducks, geese, quails, ostriches, turkeys, etc., for the purpose of meat, eggs and feather production.

63. 2067 Q.No. 2e **Give brief account of antibiotics.** [1]

Antibiotics are powerful medicines that fight certain infections and can save life when used properly. Antibiotics are prepared from the chemical substances extracted from bacteria or fungi.

64. 2067 Q.No. 2f **Discuss the significance of Amniocentesis in brief.** [1]

The significance of amniocentesis is that early diagnosis of genetic disorders or metabolic disorder of the growing foetus is done. The abnormal foetus can be aborted.

65. 2066 Q.No. 1 f **At what period amniocentasis is done?** [1]

Amniocentesis is carried out when a women is between 14 and 16 weeks pregnant.

66. 2066 Q.No. 1 g **What is the role of immunosuppresant in organ transplantation?** [1]

When an organ is transplanted in recipient body, the recipient's body knows that the new organ is foreign and try to destroy it. The immunosuppressant drugs suppress the body ability to do so. The role of immunosuppressant is to prevent rejection.

67. 2065 Q.No. 1 f **What is ELISA test?** [1]

ELISA or Enzyme-Linked Immunosorbent Assay is a test which is used to determine if some one has antibodies related to certain infectious condition's. An ELISA test is primarily use to diagnose HIV which causes AIDS.

68. 2065 Q.No. 1 g **Write the meaning of surrogate mother.** [1]

Please refer to 2068 Q.No. 1j

69. 2062 Q.No. 1k **What is antigen?** [1]

Antigen is a toxin or other foreign substance which induces an immune response in the body, especially the production of antibodies.

70. 2059 Q.No. 1m **Give the meaning of amniocentesis.** [1]

Amniocentesis is a medical procedure used in prenatal diagnosis of chromosomal abnormalities and fetal infections, and also for sex determination, in which a small amount of amniotic fluid, which contains fetal tissue, is sampled from the amniotic sac surrounding a developing fetus, and then the fetal DNA is examined for genetic abnormalities.

71. 2059 Q.No. 1n **Mention any two chief properties of antibiotics.** [1]

Please refer to 2074 Set A Q.No. 1b

72. 2057 Q.No. 1l **Mention any two chief uses of antibiotics.** [1]

The two chief uses of antibiotics are listed as belows:

i. Antibiotic are medicines used to treat infectious diseases caused by bacteria (e.g. Pneumonia, Urinary tract infections, etc)

ii. Antibiotics are administered in low dose in animal feed, which improves growth rate, reduces mortality and morbidity, and improves reproductive productivity.

Answer all in brief. [3 marks]

1. 2076 Set B Q. No. 2f **The role of surrogate mother in a test tube baby.** [3]

Surrogate motherhood is one of the many currently available forms of Assisted Reproductive Technologies (ARTs) that have developed in response to the increasing number of individuals or couples who find themselves unable to conceive a child on their own. Surrogate motherhood involves the service of a woman who agrees to carry or gestate a child for the express purpose of surrendering that child to the intending couple upon the birth of the child. The demand for surrogate motherhood is created by a diagnosis of female infertility, although women need not to be infertile in order to employ the services of a surrogate.

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A woman who agrees, usually for pay, to give birth to a child resulting from artificial insemination or the implantation of an already fertilized egg and who surrenders any parental rights to a third party is called surrogate mother. The surrogate mother, usually gestational surrogate mother, acts as a substitute mother. She does not contribute any thing in terms of genetic make up to the growing child.

In Vitro Fertilization (IVF) and Uterine Embryo Transfer (UET) is a widely accepted assisted reproductive treatment for infertile couples worldwide. And the surrogate mother serves as animal incubator to deliver baby after normal gestation period. The baby born in such a way is called test-tube baby, which are as normal as other traditionally born children.

2. **2076 Set C Q.No. 2f Discuss significance of surrogacy.** [3]

Surrogacy is a method of assisted reproduction where intended parents work with a gestational surrogate who will carry and care for their baby(ies) until birth. Intended parents use surrogacy to start or grow their families when they can't do so on their own.

Intended parents come from all different backgrounds – many are same-sex couples or hopeful single parents who are ready to start a family, while others have struggled for years with infertility and have exhausted their fertility treatment options. However, all of these intended parents have one thing in common: a strong desire to add to their families. For these couples and individuals, surrogacy makes this dream possible.

The advantages of surrogacy are clear to the hundreds of families who have been created in this special way. Here are just a few surrogacy benefits that intended parents enjoy:

- Surrogacy allows infertile couples and singles to become parents when they may not be able to have children otherwise.
- In most cases, gestational surrogacy allows one or both parents to be biologically related to their child.
- Surrogacy gives hopeful parents the opportunity to raise a child from birth.
- Intended parents are involved throughout the pregnancy experience and are generally able to be present for many key milestones, from the embryo transfer to their baby's birth.
- Surrogacy gives intended parents the opportunity to know and form a special bond with their surrogate and her family.
- Intended parents may face fewer restrictions with surrogacy than with adoption; those who cannot adopt due to agency restrictions on factors like age can still pursue surrogacy.
- Surrogates have already carried other pregnancies and have a proven uterus, increasing their chances of successfully carrying a surrogate pregnancy. This may make surrogacy more likely to be successful than fertility treatments for intended parents.
- Surrogacy gives intended parents more control and peace of mind throughout the pregnancy than they usually have with fertility treatments or adoption.

While surrogacy is not without its challenges for intended parents, it is often the answer to years of hard work and frustration for hopeful couples and individuals who have tried unsuccessfully to add to their families.

3. **2075 GIE Q. No. 2g The advantages of poultry farming.** [3]

Poultry farming means 'raising various types of domestic birds commercially for the purpose of meat, eggs and feather production'. The most common and widely raised poultry birds are chicken.

Poultry farming business has numerous benefits which are described below:

1. The main benefit of poultry farming is, it does not require high capital for starting.
2. Poultry farming does not require big space. Poultry birds can be raised in small confined areas.
3. Commercial poultry farming business ensure high return of investment within a very short period of time. Some poultry birds like broiler chickens take shorter duration of time to mature and generating profit.
4. Poultry farm structures do not require high maintenance. Diseases are less common in some poultry birds like turkeys and quails.

5. Poultry provides fresh and nutritious food and has a huge global demand. Poultry products are not much expensive and most of the people can afford those.
6. Marketing poultry products is very easy. Farmers can easily sell the products in their local market.
7. Poultry farming creates income and employment opportunities for the people. Women and students can also do this business along with their daily activities.

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4. 2075 Set A Q.No. 2f **Vaccine and their types.** [3]

Vaccine is a preparation of suspension or extract of a dead or attenueted germs of a disease which on inoculation (injection) into a healthy person provides temporary or permanent active or passive immunity by inducing antibodies formation. Thus, antibodies provoking agents are called vaccines. The administration of vaccines into the body is called vaccination. Due to vaccination, immunisation against a particular disease is achieved. The principle of immunization or vaccination is based on the property of 'memory' of immune system.

Types of vaccines

There are many types of vaccines, categorized by the antigen used in their preparation, their formation's affect, how they are used, how they are stored and how they are administered. According to WHO, there are five major types of vaccine, which are as follows:

1. **Live, Attenuated Vaccines:** Live, alternated vaccines contain a version of the living microbe that has been weakened in the lab so it cannot cause disease. Because a live, attenuated vaccine is the closest thing to a natural infection, these vaccines are good "teacher" of the immune system. They elicit strong cellular and antibody responses and often confer lifelong immunity with only one or two doses. The attenuated virus cannot replicate in the human cell, to cause illness, but will still provoke an immune response that can protect against future infection. They need to be refrigerated.

   Live, attenuated vaccines list:

   - Vaccines (small pox)
   - Measles, mumps, rubella (MMR combined vaccine)
   - Varicella (Chicken pox)
   - Influenza (Nasal spray)
   - Rotavirus (Against diarrhea in babies and children)
   - Baccile Calmette Guerin, BCG (Tuberculosis)
   - Oral Polio Vaccine, OPV (Polio)
   - Yellow Fever
   - Zoster (Shingles) – Painful skin with blister.

2. **Killed or Inactived Vaccines:** These vaccines contains killed disease causing microbes. The microbes are killed by chemicals such as formaldehyde or formalin or by using heat, or radiation. The dead microbes cannot mutate back to their disease-causing state. Inactive vaccines usually do not require refrigeration, and they can be easily stored and transported. Most inactive vaccines however, stimulate a weaker immune system response than live vaccines do. So it would likely to take several additional doses, or booster shots, to maintain a person's immunity.

   This could be a drawback in areas where people do not have regular access to health care centres and cannot get booster shots on time.

   The list of inactive or killed vaccines:

   i. **Viral:**
   - Polio Vaccine (Salk Vaccine)
   - Influenza Vaccine.

   ii. **Bacterial:**
   - Typhoid Vaccine
   - Cholera Vaccine
   - Plague Vaccine
   - Pertusis Vaccine

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3. **Toxoids:** Some bacterial diseases are not directly caused by a bacterium itself, but a toxin produced by the bacterium. For example – Tetanus is not caused by the clostridirium tetani bacterium, but by a neurotoxin it produces (Tetanospasmin). Immunization for these types of pathogens can be made by inactivating the toxin that causes symptoms. This can be done via treatment with chemical such as formalin, or by using heat or other methods. Such vaccines are called toxoids.

Examples of Toxoids are: - Tetanus Toxoid (TT)

Diphtheria Toxoid

4. **Subunit Vaccines:** Instead of the entire microbe, subunit vaccines include only the antigens that best stimulate the immune system.

Examples of these vaccines: Hepatitis B Vaccine.

5. **Conjugate Vaccines:** A conjugate vaccine is created by covalently attaching a poor antigen to a strong antigen thereby eliciting a stronger immunological response to the poor antigen.

Most commonly, the poor antigen is a polysaccharide that is attached to strong protein antigen. However, peptide /protein and protein /protein conjugates have also been developed.

The list of these vaccines:

- Haemophilus influenzae type b (Hib), Meningococcal vaccine, Pneumococcal vaccine

6. **Experimental vaccines:** A number of innovative vaccines are also in development. These include:

- Dendritic cell vaccines, Recombinant vector vaccines, DNA vaccine, T-cell receptor vaccine

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5. 2075 Set A Q.No. 2g **Poultry farming in Nepal.** [3]

The poultry farming mainly refers to chicken farming in Nepal. Chicken raised for eggs are usually called layers while chickens raised for meat are often called broiler.

A Nepali eats 4.1 kg chicken and 44 eggs annually, well below the global average (Report CBS, Nepal 2014–15).

Commercial production of chicken meat in Nepal stands at 114,058 tonnes annually, while egg output amount to 1.2 billion sets annually, the CBS, Nepal report said.

Nepal's poultry industry has an annual turnover of Rs. 33.72 billion. Chitwan is the largest producer of poultry products in the country.

The GSP (Gross Domestic Production) contribution of the poultry farming sector stands at around 4 percent. Poultry production is carried all around Nepal. The surge in the scope and the size of the business is due mainly to opening of big poultry farms, hatcheries and feed industries in poultry hub of chitwan and other emerging new markets. Lower cost coupled with nutritional value of poultry products and their growing popularity among consumers has unleashed a huge potential for business expansion across the country. That is why there is an upward trend in opening new farms and expands existing ones.

It is estimated that over 1594,400 households are rearing poultry birds (CBS, Nepal, 2010). The poultry population is growing by 5% each year and estimated production of egg for local is 40 and 280 for pure bred hen. According to the latest data collected the total number of laying hens and total egg production is highest in the hilly region of Nepal. Similarly the total number of laying has and total egg production is more in the central development Region.

Three types of poultry breeds are raised in Nepal.

- Local bread: Shakini, Ghanti Khuile, Pwankh Ulte.
- Pure breed, and
- Synthetic breed

Now Hampshire, Rhode Island red, white phymouth rock. single comb white leghorns, Australop, Giri Raja, etc are exotic breeds of poultry raised in Nepal. Some are raised for meat while other are raised for dual purpose: Meat and egg. Poultry manure is regarded as very productive and it is extensively used by the farmers to grow crops.

The production of poultry has not been well sufficient to fulfil the national demand, production by small holders being a major limiting factor. Production of high quality forages and the feed

ingredients can play supportive role to improve the total production. In addition, planned and genetic engineering tools increase the production of population of poultry. The products of poultry have always been playing in uplifting the life standard of small holder and total GDP of Nepal.

6. 2075 Set B Q.No. 2g **Advantages of fish farming.** [3]

The advantages of fish farming can be discussed as follows:

1. Fish farming provides a source of needed protein without affecting the water resources. Fishes contain essential nutrients, with a high protein value and low to moderate fat in comparison to terrestrial animals.
2. Market demand and price is always high for fish and fish-related products worldwide.
3. Fishes can be placed almost everywhere. Fish farms can be built in virtually any location. As long as there is a natural setting, an artificial setting can be created where the fish can be cared for just like any other form of livestock.
4. Fish farming provides a large and consisteht supply of fish compared to natural fisheries by growing fish more quickly than natural fisheries. Further more, natural fisheries have restriction on the quantity of fish that can be caught.
5. Fish growth in ponds can be controlled. The farmers themselves select the fish they wish to raise.
6. Fish in ponds are usually close at hand.
7. Can revive endangered and rare species of fish,
8. Easily maintained, requires much less attention than cattle and other farm animals.
9. It is an artificial balanced ecosystem where there is no waste.
10. Waste land or unproductive lands can be used for fish farming ponds.
11. Provides a good source of income and employment and raises the socio-economic status of weaker section of the society.

7. 2074 Supp Q.No. 2f 2070 Set C Q.No. 2 b **Write note on poultry farming.** [3]

Poultry farming is the process of raising domesticated births such as chickens, ducks, turkeys and geese for the purpose of meat or eggs for food and feather for other purpose. The most common and widely raised poultry birds are chicken. It requires small capital investment and provides additional income and job opportunities to a large number of rural populations in the shortest possible time. It gives quick return within one to six month of investments, is easily manageable and requires less space and labour. Poultry birds and their eggs are a rich sources of nutrients.

The different breeds of chicken reared are Plymouth rock, Rhode Island Red, New Hampshire, Single comb white Leghorn, Brahma, cochin, Langshan, Cornish, Australop, Sussex, Aseel, Bursa, Sakhini, etc. More than 50 billion chicken are raised annually as a source of food, for both their meant and their eggs. Chicken raised for eggs are called layers while chickens raised for meat are often called broilers.

Commercial hens usually begin laying eggs at 16-20 weeks of age. Some commercial breeds of hen can produce over 300 eggs a year.

Poultry production systems should be provided fresh air, clean feed, water, shelter and protection against predators. Poultry farming system are as follows:

i. Deep litter system in which birds are fully confined within a house but can move around freely. The floor is covered with a deep litter of grain husk (maize or rice), straw, wood shaving, etc.

ii. Battery cage system in which laying birds are kept in a small cage throughout their productive life.

iii. Free-range system, where the chickens are allowed to pasture an open land.

Following are poultry farm activities:

1. Preparing the chicken house for the arrived of chicks.
2. Feeding the chickens

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3. Monitoring the conditions inside the chicken houses, including temperature, humidity, and air quantity.
4. Monitoring the feed and water lines to make sure they are providing the chicks with plenty of fresh water and chicken feed.
5. Monitoring the health of the chickens.
6. Clearing the chicken houses or coops.
7. Collecting eggs (for laying hens)
8. Loading chickens onto trucks for moving to chicken slaughter houses for meat.

Poultry farming has played a great role in uplifting the socio-economic status of economically poor people. Besides chicken meat and eggs are rich source of protein and contributing a lot in minimizing protein energy malnutrition.

8. **2074 Supp Q.No. 2g What is vaccination? Describe their types.** [3]

Please refer to 2075 Set A Q.No. 2f

9. **2074 Set B Q.No. 2e Define organ transplantation and discuss its different types.** [3]

Organ transplantation is medical procedure in which an organ is removed from one body and placed in the body of a recipient, to replace damaged or missing organ. Organs Transplant is needed when an organ has failed to perform because of illness or injury. Organs that have been successfully transplanted include heart, kidneys, liver, pancreas, intestine, thymus and lungs. Tissues include bones, tendons, cornea, skin, heart valves, nerves and veins. Worldwide kidneys are the most commonly transplanted organs, followed by the liver and then the heart. Cornea is the most commonly transplanted tissue.

Organ donors may be living, brain dead and dead via circulatory death.

Types of Transplant

Based on relationship between the recipient and donor, transplantation is following four types:

1. **Autograft or Auto transplantation:** Autograft are the transplant of tissue to the same person. A common example is the removal of a piece of bone (Usually form the hip) and it being ground into paste for the reconstruction of another portion of bone. It is also called auto transplantation. There is no transplant rejection and hence, it is 100% successful.
2. **Allograft and Allotransplantation:** It is the transplant of an organ or tissue between two genetically non-identical members of same species. Most human tissue and organ transplant are allograft. Due to the genetic difference between the organ and the recipient, the recipient's immune system will identify the organ as foreign material and attempt to destroy it, causing transplant rejection. Examples of allograft are transplantation of kidney, liver, lungs, pancreas, cornea, etc.
3. **Isograft:** It is the transplant of tissue or organ between two genetically identical individual. e.g. Between twins. There is no transplant rejection because both have similar genetic composition. e.g. Kidney transplantation.
4. **Xenograft and Xenotransplantation:** A transplant of organs or tissue from one species to another is called xenograft. An example is transplant of pancreatic islets tissue between fish and primates. It is extremely dangerous due to rejection. It is mainly carried out for different researches.

Advantages of transplantation

1. Saves life
2. Second chance at life
3. Offer consolation or reduce grieves
4. Provide opportunities for medical research

Disadvantages of transplantation

1. Prolonged suffering of the family of donor
2. Prolonged suffering of the recipient
3. Possible transplant rejection
4. Possible surgery complication
5. Very expensive

10. **2073 Supp Q.No. 2e Discuss the scope of fish farming in Nepal.** [3]

Please refer to 2073 Set C Q.No. 2g

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11. 2073 Supp Q.No. 2f Write a short note on vaccins. [3]

A vaccine is a biological preparation that provides active acquired immunity to a particular disease. A vaccine typically contains an agent that resembles a disease causing micro-organism and is often made from weakened or killed forms of the microbe, its toxins or one of its surface protein. The agent stimulates the body's immune system to recognize the agent as a threat, destroy it, and recognize and destroy any of these micro-organisms that is later encounters.

Vaccines can be prophylactic (preventing from future infections) or therapeutic (vaccines against cancers). The administration of vaccine is called vaccination.

The term vaccine was first used by a British Physician Edward Jenner in 1778 (Latin: Vacca means cows)

The principle of immunisation or vaccination is based on the property of memory of the immune system. Vaccines also generate memory B and T cells that recognise the pathogen quickly. When the vaccinated person is attacked by the same pathogen, the existing memory, T or B cells recognise the antigen quickly and attack the invaders with a massive production of lymphocytes and antibodies.

There are several basic types of vaccines. Some vaccines are as follows:

1. **Attenuated vaccines:** Contain live weakened micro organism. Many of these are active viruses that have been cultivated under conditions that disable their virulent properties. Examples are vaccines against Yellow fever, measles, rubella, mumps, chicken pox, small pox, small pox, polio, etc.
2. **Killed vaccines:** Consisting of virus, bacteria or other pathogens that have been grown in culture and then killed using a method such as heat or formaldehyde. e.g. Vaccines against typhoid, cholera, plague and pertusis. The pathogen particles are destroyed and cannot divide, but the pathogens maintain some of their integrity to be recognized by the immune system and evoke an adaptive immune response.
3. **Toxoids:** Toxoids are vaccines made from inactivated toxic compounds that cause illness rather than the micro-organism. e.g. Tetanus and Diphtheria vaccines.
4. **Subunit:** Protein subunit – rather than introducing an attenuated or killed microorganism to an immune system, a fragment of it can create an immune response. e.g. Vaccine against Hepatitis virus.
5. **Conjugate:** Certain bacteria have polysaccharide outer coats that are poorly immunogenic. e.g. Haemophilus influenza type B vaccine.

There are three classes of vaccines.

i. First generation vaccines are live or attenueted or killed pathogens. e.g. Polio and BCG (against TB) vaccines.

ii. Second generation vaccines are prepared by genetic engineering method which contain sub section as protein form or toxoid in case of bacteria. e.g vaccines against Hepatitis B virus and Herpus.

iii. Third generation vaccines are artificially synthesized. It can be recombinant vector vaccines where antigen is a sub unit of pathogen and is integrated into another virus. e.g. Leukemia and Ebola vaccines.

Advantages of Vaccination

i. Protects individuals against disease.

ii. Prevents epidemics and pandemics.

iii. Prevents spreading the disease the others.

iv. Prevents the potential greater cost treating infected patients

12. 2073 Set C Q.No. 2f Discuss methods of control of over population. [3]

Followings are the effective methods which can be employed to control population growth:

1. **Family planning method:** Family planning is used to ensure that a woman gets a child when she actually wants one. It reduces accidental pregnancies and ensures a controlled family size. This

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method implies family by choice and not by change. This method is extensively used, success of this method depends on the availability of cheap contraceptive devices for birth control. "Hurry for the first child, Delay the second child and Avoid the third."

2. **Late marriage:** As for as possible, marriage should be solemnized at the age of 30 years. This will reduce period of reproduction among the females bringing down the birth rate.
3. **Self control:** Self control is one of the most powerful methods to control the population. It is an ideal and healthy approach and people should be taught to follow.
4. **Public Awareness programmes:** Media like television, radio, and newspapers are good means to propagate the benefits of the planned family to the uneducated and illiterate people.
5. **Spread of education:** The spread of education changes the outlook of people. The educated main prefer to delay marriage and adopt small family norms. Educated women are health conscious and avoid frequent pregnancies.
6. **Social security:** More and more people should be covered under social security schemes so that they do not depend upon others in the event of old age, sickness, unemployment, etc. With these facilities they will have no desire for more children.
7. **Raising the cost of bringing up children:** Measures aimed at imposing greater burden on those with more children can be introduced. Those with children could be taxed according to the number of children they have. Maternity or paternity leaves could be denied. In addition, higher school fees, medical care fees, etc. could be imposed on those with more than the stated number of children.

13. **2073 Set C Q.No. 2g Explain advantages of fish farming in Nepal.** **[3]**

As Nepal is rich in water resource and has suitable climate for the development of various breeds of fishers, fishery has a great scope in Nepal. There has been a steady growth in the fish production in the last 15 years.

Commercial fish farming in Nepal provides many profitable opportunities; farmers are raising and selling the fish on commercial basis. There are about more than 6000 rivers, fresh water resources suitable for fish farming in Nepal.

Consumption of fish products in Nepal is increasing rapidly because fish is a healthy food, low in calories and choleslerol level, but rich in protein. Different varieties of fishes like common carp, grass carp, rohu, Japanese Trouts, Naini, big head carp, silver carp, etc are reared in large quantity. Climate and nature of the soil is suitable to construct the fish ponds in different parts of Nepal.

The advantages of fish farming in Nepal can be summarized as follows:

1. About 6,00,000 Nepalese are involved in fish farming in part time or full time scale.
2. Over the past ten years intensive fish culture systems have played an increasing role in Nepal's total agricultural production.
3. The abundant availability of water resources makes Nepal a country with potential for fish farming.

Fish-farming sector has played and important role in providing local and national food security, fighting protein related malnutrition, reduction of poverty by supplementing family income and creating additional gainful employment opportunities in rural areas of Nepal, and improving the environment by harvesting holding and proper use of the water resources in Nepal.

14. **2073 Set D Q.No. 2e Give a short note on poultry farming in Nepal.** **[3]**

Please refer to 2075 Set A Q.No. 2g

15. **2073 Set D Q.No. 2g Discuss the merits and demerits of amniocentesis.** **[3]**

Please refer to Model (Zoology) Q.No. 2g

16. **2072 Supp. Q.No. 2c Mention the scope of fish farming.** **[3]**

The scope of fish farming can be elaborated as follows:

1. **Fish as a source of food:** Fish and fish products has a huge demand worldwide. Fish is one of the most common and favourite items in food menu. Fishes in general are a much healthier source of protein compared to livestock commonly consumed. Fish farming plays an important role in effort to stamp out malnutrition by providing an adequate supply of protein rich in omega- 3 oils and other essential nutrients required by the human body.

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2. **As a source of Income:** Fish business is really very profitable and risk-less business. Commercial fish growing can create new income and employment opportunities. Unemployed educated young people can start fish farming. People with other occupation can also start fish farming business without impacting their regular work.
3. **Fish growth in ponds can be controlled:** The farmers themselves select the fish species they wish to raise.
4. **Effective land use**
5. **Reviving endangered species**
6. **Scientific Research**

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17. **2072 Set C Q.No. 2c Explain the role of surrogate mother.** [3]

➴ Please refer to 2076 Set B Q. No. 2f

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18. **2072 Set C Q.No. 2g Discuss the advantages of fish farming.** [3]

➴ Please refer to 2075 Set B Q.No. 2g

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19. **2072 Set D Q.No. 2g The advantages of pisciculture in Nepal.** [3]

➴ Please refer to 2073 Set C Q.No. 2g

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20. **2072 Set E Q.No. 2d Note on vaccine.** [3]

➴ Please refer to 2073 Supp Q.No. 2f

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21. **2071 Set D Q.No. 2f Define amniocentesis, mention its merits and demerits too.** [3]

➴ Please refer to Model (Zoology) Q.No. 2g

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22. **2071 Set C Q.No. 2g Discuss the advantages and drawbacks of test tube baby.** [3]

➴ Since In-vitro Fertilization (IVF) was pioneered by Sir Robert Edwards and Patrick Steptoe in 1978, IVF has helped million of people become parents. The baby born through IVF method is called test-tube baby. Test-tube baby and IVF are synonyms.

Advantages of IVF or Test-tube Baby

1. IVF helps many patients who would be otherwise unable to conceive. The ultimate advantage of IVF is achieving a successful pregnancy and a healthy baby. IVF can make this a reality for people who would be unable to have a baby otherwise. Women suffering form blocked fallopian tubes, older patients/patients with a low ovarian reserve can conceive through IVF method.
2. It can help single women and same sex couples. For single women or same sex couples who wish to have a child, IVE can provide a great opportunity for helping them to become parents.
3. Unused embryos can be donated to research or another couple.
4. Embryos can be used to screen for inherited diseases.
5. It is a great achievement to medical science.

Disadvantages of IVF Test tube Baby

1. As a medical treatment, IVF comes with a small chance of developing side effect, the most server of these being ovarian hyper-stimulation syndrome (OHSS).
2. In IVF treatment, there is often more than one embryo put back into the uterus, and this leads to a likelihood of multiple pregnancy. Around 20 – 30% of IVF pregnancies results in multiple pregnancies.
3. There is evidence that high oestrogen levels associated with high stimulation IVF and can increase the risk of prematurely and low birth weight in babies.
4. IVF treatment is expensive.
5. Some patients may be concerned about ethical issues such as the right over the baby.

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23. **2070 Set C Q.No. 2f Discuss the benefit of organ transplantation.** [3]

➴ Organ transplantation is often the only treatment for end stage organ failure, such as liver, kidney and heart failure. Organ transplantation is a medical procedure in which an organ is removed from one body and placed in the body of a recipient, to replace a damaged or missing organ.

The benefits of organ transplantation can be discussed as follows:

1. Someone who will surely die receives a new organ and has a chance at life. Under some circumstances, one death might result in the continued life of several people.

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Sometimes relatives of the donor feel that if the organs go into young, deserving people, then their loss was not in vain. It helps the grieving process. A single organ donor can save upto eight lives.

It is probably clear that an increased life span is one of the major benefits of organ transplantation.

Transplantation improves the quality of life. Even for a recepient who is not at risk of death, an organ transplant a better quality of life. A transplant may allow someone to live medication-free for the first time since being diagnosed. There are always certain recepient's benefits from specific types of donations.

- Eye and tissue transplantation can allow someone to see again.
- Bone transplant transplants may be the only hope for children with leukemia and other deadly diseases.
- Heart valve transplants are used for babies, who are born with heart defects.

This can be best witnessed in patient who is suffering from kidney failure. A kidney transplant means a completely new and healthy kidney in the patient's body.

5. Organ transplantation saves money. It helps to reduce the medical cost. Organ transplantation can allow an individual to live without long-term, costly treatments that have been necessary to have a high quality of life. The transplant may seems expensive when one actually gets it done, but in the long run, it saves a lot of money that would have otherwise been spent on treatment such as kidney dialysis, which demands heavy expenses time to time.
6. Organ transplantation provides material for medical research.

24. 2070 Set D Q.No. 2d The importance of poultry farming in Nepal. **[3]**

Poultry farming is the process of keeping different types of birds for food or sale. It is regarded as one of the important occupations in Nepal. Poultry sector is an emerging industry in Nepal with two distinct pattern of poultry production - intensive and scavenging. The scavenging poultry is widely prevalent in the rural areas and nearly 45% of total poultry population comprises the native flock and 55% of poultry birds accounts for commercial poultry.

The importance of poultry in Nepal can be elaborated as follow:

1. It is estimated that 1594,400 households aree rearing poultry bird in Nepal (Centre Bureau of Statistic, Nepal, CBS, 2010)
2. It is found to be a profitable occupation in Nepal.
3. Even if the birds need to fed with grain, the turn-over ratio is higher than with other livestock animals.
4. Poultry has become an important source of animal protein, which could add significantly to household protein intake.
5. Research has fould that poultry birds in the household has significant effect on household income level and welfare. Thus, poultry farming has been found to have strong poverty –alleviating effects.
6. Other benefits like manure production in the form of poultry litter, and scavenging insects and worms from the soil may benefit agriculture enterprise.

25. 2070 Set D Q.No. 2f Advantages of organ transplantation. **[3]**

Please refer to 2070 Set C Q.No. 2f

26. 2069 Q.No. 2f Advantage and disadvantage of amniocentesis. **[3]**

Please refer to Model (Zoology) Q.No. 2g

27. 2068 Q.No. 2e What are vaccines? Describe their types. **[3]**

Please refer to 2075 Set A Q.No. 2f

28. 2068 Q.No. 2f About the scope of fish farming in Nepal. **[3]**

Please refer to 2073 Set C Q.No. 2g

29. 2065 Q.No. 2d Amniocentesis. **[3]**

Please refer to Model (Zoology) Q.No. 2g

30. 2062 Q.No.2e Write a note on amniocentesis. **[3]**

Amniocentesis is a medical procedure used in prenatal diagnosis of chromosomal abnormalities and fluid from amniotic sac of pregnant woman is sampled, which contains foetal tissues, and the foetal DNA is examined to find out genetic abnormalities.

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Amniocentesis was first introduced by American obstetrician Fritz Friedrich Fuchs and Danish gastroenterologist Polv Riis in 1956. Amniocentesis can be used for prenatal sex discernment and hence this procedure has legal restrictions in many countries.

Those with a higher risk of giving birth to children with a serious health condition or abnormality include:

- Women aged over 35 years.
- Women with a medical history of an inherited condition such as sickle cell anaemia or muscular dystrophy.
- Women who have undergone a previous pregnancy with genetic problem such as Down's Syndrome.

The amniocentesis test is 98 to 99 percent accurate for testing chromosomal abnormalities, neural tube defects and genetic disorders. Amniocentesis is often carried out between 15 and 18 weeks of gestation.

Before the start of the procedure, a local anesthetic can be given to the mother in order to relieve pain felt during the insertion of the needle used to withdraw the fluid. After the local anesthetic is in effect, a needle is usually inserted through the mother's abdominal wall, then through the wall of the uterus, finally into the amniotic sac. With the aid of ultrasound guidance, a physician punctures the sac in an area away from the foetus and extract approximately 20 ml of amniotic fluid. The foetal cells are separated from the extracted sample. The cells are grown in a culture medium, then fixed and stained. Under microscope the chromosomes are examined for abnormalities. The most common abnormalities are Down Syndrome (Trisomy 21), Edward Syndrome (Trisomy 18), and Turner Syndrome (Monosomy X). Other foetal problems include Neural tube defects. Such as anencephaly and spina bifida, infant respiratory distress syndrome.

Advantages of Amniocentesis

1. **Genetic Diagnosis:**
   - Down syndrome
   - Fragile X
   - Rare, inherited metabolic disorders
   - Neural tube defects

If the doctor diagnoses a problem at this stage, it may be possible to treat it before the foetus leves the womb.

2. **Determination of sex of the foetus.**

Drawbacks of Amniocentesis

i. Amniocentesis is performed between 15th to 18th week of pregnancy; performing this test may result in fetal injury.
ii. Complications of amniocentesis include preterm labour and delivery.
iii. Chance of miscarriage
iv. Risks to the another include puncture of uterine blood vessels with subsequent hemorrhaging, infection within the uterine blood vessels, infection within the uterine cavity, premature rupture of the membranes allowing leaking of amniotic fluid.
v. It is an expensive process.
vi. Ethical problems arise when parents decide for an abortion following the test results when there is a baby girl in the womb of mother.

31. 2061 Q.No. 2h What is the benefit of organ transplantation? [3]

Please refer to 2070 Set C Q.No. 2f

32. 2057 Q.No.2i Write a note on organ transplation. [3]

Please refer to 2074 Set B Q.No. 2e

33. 2056 Q.No.2b Monoclonal antibody [4]

An antibody produced by the fusion of myeloma cells (cancer cells) with antibody producing white blood cell (B Lymphocytes). The resulting hybrid cell is called hybridoma. The hybridoma cells can be selected and grown to produce a single, specific antibody which is called monoclonal antibody.

❑