**FORM I TOPICS**

1. **a) Define biology**

    a. the study of life/living things
    b.

b) **List the branches of biology**

- Zoology (study of animals)
- Botany (study of plants)
- Microbiology (study of microorganisms)

c) **Explain the importance of biology**

- helps to solve environmental problems
- Helps to learn scientific skills
- For entry into other professions/careers
- To apply knowledge to everyday life situations
- To classify organisms into their right groups
- understanding living organisms

d) **State the characteristics of living organisms**

- feeding/nutrition
- Growth and development
- respiration (to produce energy)
- sensitivity/irritation/response
- excretion (getting rid of metabolic waste material)
- movement/locomotion
- reproduction

**e) State the main differences between plants and animals**

| **Animals** | **Plants** |
|---|---|
| Specialized excretory organs | No specialized excretory organs |
| Respond to stimulus quickly | Slow respond to stimulus |
| All body parts grow equally(intercalary) | Grow at shoot tip and root tip only |
| Move around to look for food | Stationery |
| Heterotrophic | Autotrophic |
| Cells have no cell walls | Cells have cell wall made of cellulose |
| No chlorophyll | Contain chlorophyll |
| Give parental care to young | Plants don't care for their young |

2. **a) i) What is a hand lens?**

- Convex lens mounted on a frame and used to magnify small objects for viewing.
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**ii) How is a hand lens used?**

- place the lens a short distance from the eye
- Bring the object to be viewed near the lens until an enlarged and clear image can be seen.
-

**ii) When is a hand lens used?**

- For reasonably sized objects such as insect wing, leg, flower parts.
- Cannot be used for small objects such as cells, stomata.
-

**iv) Explain how to calculate drawing magnification**

- drawing magnification equals to length of drawing divided by length of object or image length divided by actual length i.e. $\frac{\text{length of drawing}}{\text{Length of object}}$ or $\frac{\text{image length}}{\text{actual length}}$

**b) i) what is classification?**

- Orderly arrangement of living organisms into various groups according to their similarities.

**ii) List the external features used to classify plants**

- rhizoids(e.g. mosses)
- frond (e.g. ferns)
- roots e.g. taproot, fibrous roots, modified roots
- flowers
- leaves
- buds
- seeds
-

**iii) List the external features used to classify animals**

- horns e.g. cattle, goat, sheep, deer, gazelle etc
- hooves e.g. cattle, sheep, donkey
- mammary glands e.g. cattle, dog, sheep, cat
- hair e.g. human, cat
- Shell e.g. snail, Tortoise
- spines e.g. hedge hog, porcupine

**c) Give the reasons why classification is important**

- Placing/grouping living organisms into correct groups called taxa
- Identification
- arrange information about living organisms into orderly and sequential manner i.e. it is easy to study organisms in groups
-helps in understanding evolutionary relationships
- monitoring disappearance and appearance of organisms i.e. predict characteristics of organisms

**d) i) Name the taxonomic units of classification in descending order**

- Kingdom (largest unit)
- Phylum (animals)/division (plants)
- Class
- Order
    - Family
    - Genus
    - Species(smallest unit)
    -

**ii) What is a species?**

- all organisms which can interbreed and give rise to fertile (viable) offspring

**iii) Name the major kingdoms used in classification**

-monera
-protoctista/protista
-fungi
-plantae
-animalia

**e) i) Define the term binomial nomenclature**

- a scientific system of naming organisms using the generic/genus and specific/species names
- e.g. for humans, Homo sapiens

**ii) State the principles followed during binomial nomenclature**

- the first (generic) name should begin with a capital letter while the rest are small letters
- the two names are printed in italics and if handwritten should be underlined each separately
-

**iii) Give the advantages of using binomial nomenclature**

- no confusion about which organism is referred to
- names are internationally accepted regardless of language
- shows evolutionary relationship hence easy to understand
- useful in naming many species unlike use of common names

**iv) Name the types of classification**

- traditional (using common names)
- scientific(using binomial nomenclature)

3. **a) i) Define the term cell**

- it is the basic unit of organization of an organism i.e. the basic functional and structural unit of an organism.

**ii) What is cell biology?**

- study of structure and functioning of a cell
- also called cytology

**b)i) What is a microscope?**

- an instrument used to magnify objects and make them appear bigger.

**ii) Name the types of microscope**

- the light microscope
- the electron microscope
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iii) **State the purpose of using a light microscope**

- it magnifies and reveals the structure details of tiny objects such as the cell, that cannot be seen by the human eye directly
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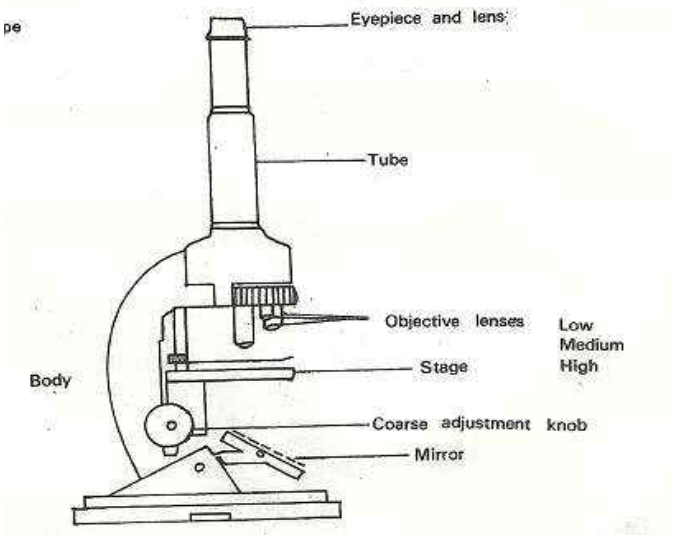
**iv) Draw a labeled sketch of a light microscope**




**v) State the functions of the labeled parts**

a.) **Eyepiece** used to look through and to magnify the object
b.) **Course adjustment knob** raises or lowers body tube and focuses object roughly
c.) **Fine adjustment knob raises** or lowers body tube by small distances to bring image into fine focus
d.) **objective lens** brings image into focus and also magnifies object/image

- **stage** is a platform where object or specimen on slide is placed
- **mirror** reflects light through condenser and directs it to objective lens
- **clips** hold glass slide in position
- **body tube** holds eyepiece and revolving nose piece which has objective lenses
- **limb** or base support whole instrument

- **arm** for holding when carrying instrument
- **revolving nose piece** holds objective lens in place enabling change from one objective lens to another

**e) i) Explain the procedure followed when using a microscope**

- put the microscope on the bench with the stage facing away from you (viewer)
- turn the lower power objective to click in line with the eyepiece
- Ensure that the diaphragm/iris is fully open
- Adjust the mirror until the stage is illuminated with enough light
- Place the slide containing the specimen on the stage for magnification
- Draw the image and indicate magnification of the drawing.

**ii) State the precautions that are necessary when handling a microscope**

- always use two hands when carrying it
- never place a microscope too close to the edge of the bench or table
- do not touch the mirror and lens with wet or dirty hands
- clean dirty lenses using a special lens cleaning cloth
- clean other parts using a soft cloth or tissue paper
- low power objective must click into position before and after use.
- Do not wet any part of the microscope
- Clean and store well after use

**d) i) What is magnification?**

- The power of making an image larger

**ii) Give the formula used to calculate magnification in a light microscope**

- eyepiece lens magnification x objective lens magnification

**iii) Give the reasons for each of the following steps when preparing a cross-section of a stem or leaf for examination under the microscope**

**cutting very thin sections**

- thin sections allow light to pass through making it easy to observe the tissue

**Using a sharp razor blade during the cutting**

- sharp blade does not damage, deform, destroy or distort the surface of cell or tissue
- it makes thin sections

**Placing sections in water**

- to maintain turgidity hence maintain shape of cell
- it prevents drying of the section

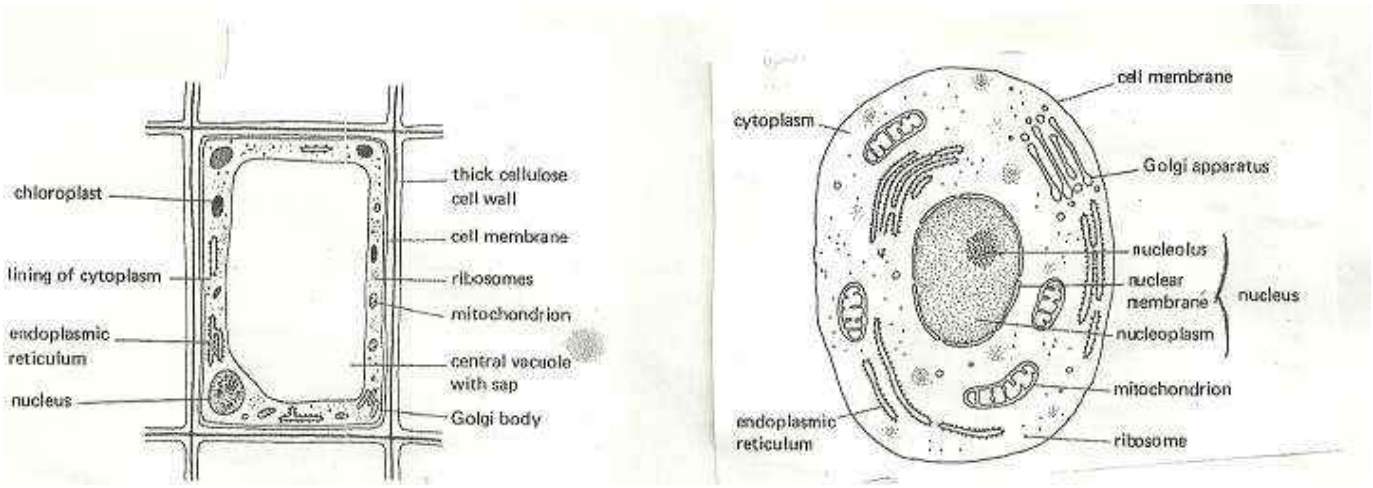
**Staining the sections with iodine before observing**

- To make chloroplasts, starch containing structures, granules or plastids distinct.

**e) i) List the parts of a cell that can be seen under a light microscope**

a cell membrane
b cytoplasm
c cell wall
e nucleus
d vacuole

**ii) Draw the general structure of a plant and animal cell**




**iii) List the parts of a cell that can be seen under an electronic microscope and state the functions of each part.**

**Cell wall**

- found in plant cells in addition to cell membrane
- made of cellulose which makes the plant tough
- allows gases, water and other substances to pass through

**Cell membrane**

- permeable/selective to control movement of materials in and out of cells
- bound/encloses the cell contents
- also called plasma membrane or plasmallema

**Cytoplasm**

- fluid medium where chemical reactions occur
- also where cell organelles are suspended

**Nucleus**

- controls cell activities

**Nucleolus**

- synthesizes DNA

**Vacuole**

- sacs filled with fluid called cell sap
- large in plants but small in animals
- act as reservoirs for food and harmful wastes which would otherwise interfere with the metabolism in cytoplasm

**Lysosomes**

- store hydrolytic enzymes
- destroy worn out cell organelles, cells, pathogens
- digestion of food in unicellular organisms
- autolysis

**Golgi apparatus**

- processing/packaging of synthesized materials
- transporting/secretion of packaged materials/cell materials e.g. glycoproteins and mucus
- production of lysosomes

**Ribosomes**

- where protein synthesis takes place

**Mitochondrion**

- synthesis of ATP/energy

**Chloroplasts**

- where photosynthesis takes place

**Endoplasmic reticulum**

- transport of cell secretions
- can be rough or smooth

**iv) State the functions of cell sap**

stores chemical substances, sugar, salts

- maintains shape of the cell/provides mechanical strength
- plays a role in osmoregulation by creating an osmotic gradient that brings about movement of water
-

**e) Compare plant and animal cells**

- plant cells have chloroplasts lacking in animals
- animal cells have many small vacuoles while plant cells have a large central vacuole
- plant cell have cellulose cell walls lacking in animal cells
- cytoplasm in plant cell is in the periphery but in animal cell it is centrally placed
- plants store starch, oil and protein while animals store gats and glycogen
- animal cells have centrioles which plant cells do not have

**f) Explain the meaning of each of the following**

**i) Cell**

- Basic unit of organization in an organism
- Specialized animal cells include sperm, ovum muscle

Specialized plant cells include epidermal, guard cell and palisade cell

**ii) Tissue**

- these are cells of a particular type grouped together to perform a certain function
- animal tissues include epithelium, blood, nerves, muscle, skeletal and connective tissues
- plant tissues include epidermal, photosynthetic, vascular, strengthening tissues

**iii) Organ**

- tissues combine together to form organs
- an organ is a complex structure with a particular function
- animal examples include heart, liver, kidney, lungs, brain, blood vessels, muscles, skeleton
- Plant organs include leaves, roots, flowers, and stem.

**iv) Organ system**

- organs are grouped together to form systems also called organ systems
- animal systems include excretory, digestive, respiratory, nervous, circulatory, endocrine(hormones/glands), skeletal systems
- plant systems include transport system

**g) i) Name the structures which are present in plant cells but absent in animal cells**

- Chloroplast
- Cell wall

**ii) Name the structures which are present in animal cells but absent in plant cells**

- Lysosomes
- Centrioles
- Pinocytic vesicles
-

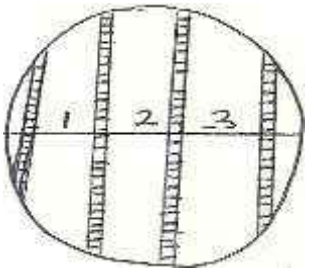
**h) Explain how to estimate cell size**

**i) Materials**

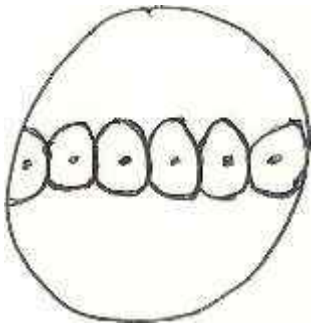
- cell sizes are measured in units known as micrometers (my)
- required is a transparent ruler marked in millimeters
- $1m\mu = \frac{1\ mm}{1000}$

**ii) Procedure**

- Click to low power
- place transparent ruler with its millimeter marks on the stage
- focus so that the millimeter marks can be seen as thick dark lines
- estimate the diameter of field of view by counting the one millimeter spaces between the first mark and the last one across the field of view as shown below




- the diameter of the field of view above is estimated as 3.2 mm
- convert the diameter of the field of view from millimeters to micrometers i.e. 3.2/1000
- Estimate the fraction of the field of view occupied by the cell. This is done by estimating the number of cells places end to end that would fill the diameter of the field of view as shown below

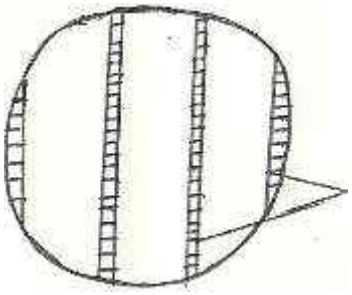


- in the figure above, it is estimated that approximately six cells will occupy the diameter of the field of view
- therefore, one cell will occupy 1/6 of the field of view
- its diameter is calculated as 1/6 times the diameter of the field of view

**i) i) In a drawing of a giraffe, the height of the head from the ground was recorded as 10cm. the drawing also showed a magnification of 0.02. calculate the actual height of the giraffe**

$$\frac{\text{Drawing height}}{\text{Magnification}} = \frac{10\text{cm}}{0.02} = 500\text{cm}$$

ii) **In a class experiment to estimate sizes of cells a student observed and obtained millimeter marks on the field of view of a microscope as shown in the diagram below**.



Millimeter marks

- If the student counted 40 cells on the diameter of the field of view, what was the approximate size of the each cell in micrometers?

$$\frac{\text{Diameter of field of view}}{\text{Number of cells}} = \frac{3 \times 1000}{40} = 75\ m\mu$$

**iii) Under which of the following light microscope magnifications would one see a larger part of the specimen? X40 or x400? Give a reason**

- x40
- Smaller magnification gives a wider field of view hence a larger part seen.

**e.) a) i) Define cell physiology**

- the study of the functions of a cell in relation to their structure

**ii) State the functions of the cell**

- exchange of materials between the cell and the external environment
- physiological reactions e.g. photosynthesis
- production of energy through mitochondria

**b) i) Describe the structure of cell membrane**

- made up of three layers
- Lipid portion sandwiched between two protein layers
- Lipid portion enhances penetration of oil soluble substances

Pores present to facilitate inward and outward movement of water soluble substances

**iii) Give the properties of cell membrane**

- semi-permeable
- sensitive to changes in temperature and pH
- Possesses electric charges.

**c) i) What is diffusion?**

- movement of substances/molecules/particles/ions from a region of high concentration to a region of low concentration (until equilibrium is reached)

**ii) State the factors affecting diffusion**

- diffusion gradient/concentration gradient
- surface area to volume ratio
- temperature
- size of molecules
- state of the diffusing substance
- thickness of membrane and tissues

**iii) Explain the roles of diffusion in living organisms**

- gaseous exchange
- absorption of digested food in intestines
- movement of salts in plants
- movement of materials between blood capillaries and tissues
- removal of waste materials from bodies of small organisms
- air movement in intercellular spaces in plants

**iv) Suggest an experiment to demonstrate diffusion**

- to a beaker of water, drop crystals of potassium permanganate or copper sulphate
- leave to stand in a place without disturbing
- observe the spreading of molecules
- liquid is coloured uniformly due to diffusion

**d) i) What is osmosis?**

- Movement of water or solvent molecules from a dilute/hypotonic solution to a more concentrated/hypertonic solution across a semi-permeable membrane.

**OR**

- movement of solvent molecules from a region of <u>their higher</u> concentration to a region of <u>their lower</u> concentration through a semi-permeable membrane

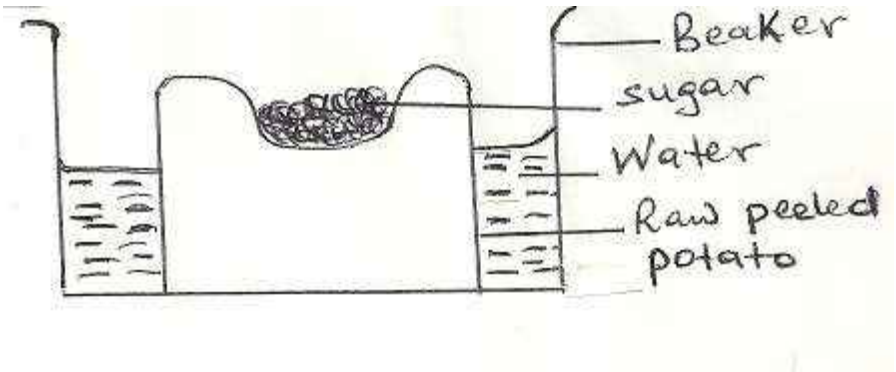
**ii) State the factors affecting osmosis**

- concentration of the solution
- concentration gradient
- temperature

**iv) Explain the roles of osmosis in living organisms**

- helps to draw water into roots of plants
- helps in the passage of water from one living cell to another in the plant
- helps to keep plant cells turgid increasing support
- Helps in opening and closing of stomata.
- Folding of leaves in ***Mimosa pudica*** when touched
- Feeding in insectivorous plants

**v) A group of students set up an experiment to investigate a certain physiological process. The set up is as shown in the diagram below.**



After some time they observed that the level of sugar had risen.
What was the physiological process under investigation?

- Osmosis

**Why was there a rise in the level of sugar solution?**

- sugar solution is more concentrated than cell sap osmosis
- those cells become more concentrated and therefore draw water from neighbouring cells
- this process continues until the cells in contact with the water in the container draw it up causing a rise in the level of the sugar solution

**Suggest the results that the students would obtain if they repeated the experiment using cooked potato**

- The level of sugar solution will not rise.

**What is the reason for your suggestion?**

- boiling kills/destroys cells making them osmotically inactive

**vi) Explain the following terms**

**Hypnotic**

- a solution whose concentration is lower than that of the cell

**Isotonic**

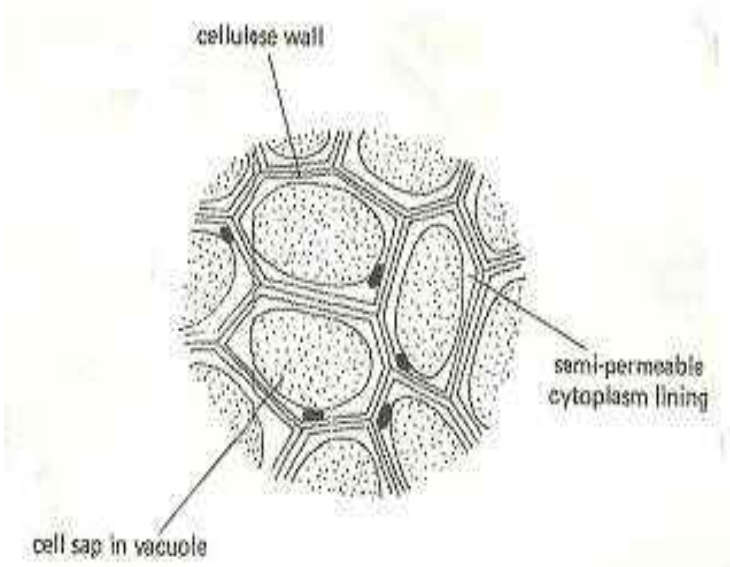
- a solution whose concentration is the same as that of the cell

**Hypertonic**

- a solution whose concentration is higher than that of the cell

**Turgor pressure**

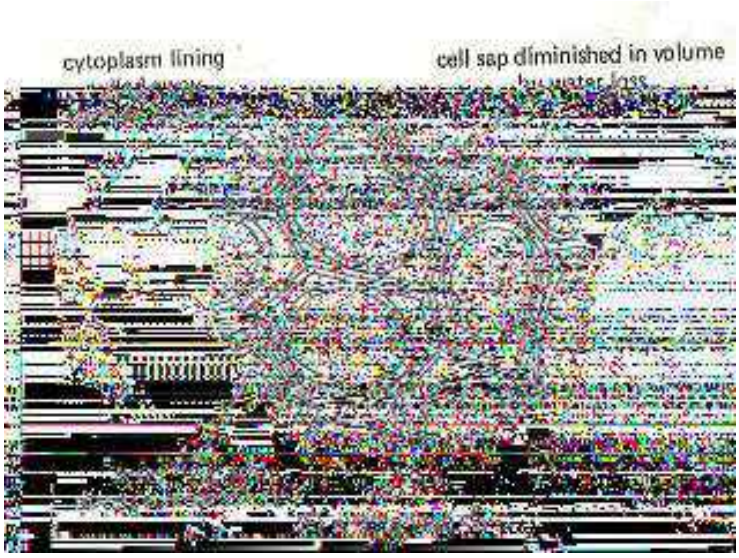
- As a cell gains water, its vacuole enlarges and exerts an outward pressure called turgor pressure.




(a) turgid cells

**Plasmolysis**

- if a plant is placed in a hypotonic solution if loses water
- the protoplasm shrinks to an extent that it pulls away from the cellulose cell wall



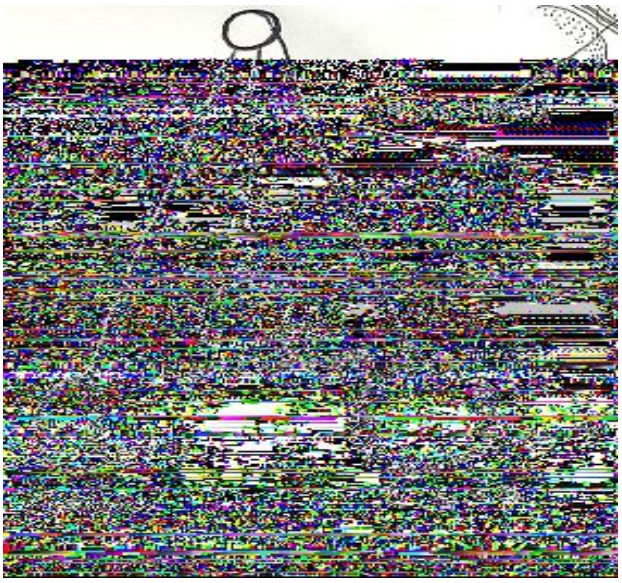

**Wilting**

- when a plant is turgid it can stand upright
- however, if the cells lose a lot of water, turgidity is reduced
- the plant then droops because the cells are flaccid
- the plant is said to wilt

**Haemolysis**

- if red blood cells are placed in distilled water, the cells take up water by osmosis, swell and burst
- this is because it does not have any mechanism like the cellulose cell wall to prevent overstretching nor any means of removing excess water
- this is called haemolysis

**e) A form one student placed red blood cells in different salt concentrations and obtained the following**
**results:-**
There was a gain (+) no change (0 zero) and a loss (-) in the volume of the cells as show below:-



**Briefly explain the results of the experiment**

- in the first solution , red blood cell absorbed water by osmosis, swell and burst (haemolysis) hence the solution is hypotonic
- in the second solution, there was no change in size or structure as it was isotonic hence no osmotic gradient
- in the third solution the red blood cell lost water to shrink hence became crenated as the solution was hypotonic to the cell cytoplasm.

**f) i) What is active transport?**

- movement of molecules and ions against a concentration gradient
- the substances move from a lower to a higher concentration gradient by use of energy

**ii) State the factors affecting active transport**

- oxygen concentration
- temperature
- change in pH
- glucose concentration
- enzyme inhibitors

**iii) Why is oxygen important in the process of active transport?**
- Oxygen is required for respiration, which produces energy necessary for the process to occur.

**2.0 ) the factors that affect the rates of the following process in living organisms.**

a.) **DIFFUSION.**

**- Diffusion gradient** which refers to the difference in concentration of molecules between the region of high concentration and the region of low concentration. Increasing the concentration gradient causes an increase in rate of diffusion and vice versa.
**-Surface area to volume ratio .**is the ratio of total surface area exposed by an organism compared to its body volume. Small sized living organisms have a large surface area to volume ratio. The larger the surface area to volume ratio ,the high the rate of diffusion and vice versa. Small organisms like amoeba and paramecium can hence rely on diffusion for transport of substances into and within its body and removal of waste products
**-thickness of membranes.** Molecules take longer to diffuse across thick membranes than across thin membranes hence the thin the membrane the higher the rate of diffusion.
**-Temperature.** Increasing temperature increases the kinetic energy of diffusing molecules making them to spread faster. Increasing temperature increases the rate of diffusion and vice versa
**-size of molecules/molecular weight.**Small sized molecules/molecules of low molecular weight move/diffuse faster hence the rate of diffusion is high where the molecules involved are small or have low molecular weight and vice versa**.**

**B.)OSMOSIS**

**-Temperature.** Increasing temperature increases the kinetic energy of water molecules making them to spread faster. Increasing temperature increases the rate of osmosis and vice versa
**-concentration gradient/diffusion pressure deficit.** Refers to the difference in concentration on either side of a semi-permeable membrane. The higher the osmotic pressure difference the higher the rate of osmosis.

**C.) ACTIVE TRANSPORT**

**OXYGEN CONCENTRATION.** It is required for respiration/to oxidize respiratory substrates to release energy required for active transport. an increase in oxygen concentration causes a simultaneous increase to the rate of active transport upto a certain level.
**$P^H$** Enzymes being protein in nature are $P^H$ specific. Extreme change in $P^H$ affect the rate of respiration which is controlled by enzymes and may denature the enzymes reducing the rate of active transport.
**-GLUCOSE CONCENTRATION.** is the main respiratory substrate for energy production. An increase in glucose concentration in cells increase the rate of respiration and hence the rate of active transport is increased upto a certain optimum level beyond which any additional increase in glucose concentration has no effect.
**TEMPERATURE.** The process of respiration by which energy for active transport is generated is controlled by enzymes. Enzymes work best at temperatures of between $35^0$c-$40^0$c,usually called optimum temperature ranges. At very low temperatures enzymes are inactive lowering the rate of respiration hence low rates of active transport . increase in temperature above optimum ( above $40^0$c)denatures enzymes slowing down respiration and ac tive transport until it finally stops.

**ENZYMES INHIBITORS.** They are substances which slow down (by competing with the enzyme for the active sites in the substrate) or stop ( by blocking the active sites of the enzyme) the activity/funtioning of enzymes .this slows down or stops respiration and so is active transport.
**CONCENTRATION OF CARRIER MOLECULES IN THE CELL MEMBRANE.** They are substances that bind to the ions being transported actively and carrying them across the membrane . increase in concentration of carrier molecules increases the rate of active transport upto a certain level and vise versa.

4.) explain briefly the role of osmosis in living tissues.
In plants:
Osmosis facilitates the absorption of water from the soil by plant roots, water is required for the process of photosynthesis.
Turgidity of cells contributes to support in herbaceous plants and helps plant to maintain shape.
Helps in closing and opening of stomata regulating the process of gaseous exchange and transpiration.
It facilitates feeding in insectivorous plants like venus fly trap.
In animals:
Enables reabsorption of water from the kidney tubules back to blood stream facilitating the process of osmoregulation.
It enables organisms in fresh water bodies like amoeba to absorb water.
it is applied in food preservation.

5.) explain what happens when plant and animal cells are put in hypotonic and hypertonic solutions.

**a.** i)**plant cells in hypotonic solution.**

The concentration of the plant cell sap is hypertonic to the solution/water medium. the cell draws in water by osmosis through the cell wall, cell membrane into the cell cytoplasm. Water enters the cell vacuole by osmosis; it enlarges and exerts an outward pressure on the cell wall called turgor pressure. Increased turgor pressure pushes the cell cytoplasm against the cell wall until the cell wall cannot stretch any further. The cell becomes firm or rigid and is said to be turgid. As the cell wall is being stretched outwards, it develops a resistant inwards pressure that is equal and opposite to the turgor pressure and this is called wall pressure.

ii.) **Plant cells in hypertonic solution.**

The plant cell sap is hypotonic to the solution medium. Water molecules are drawn out of the plant cells by osmosis into the hypertonic solution through the semi-permiable membrane of the plant cells. As a result the plant cell will start to shrink/less rigid and become flabby. The cell membrane/plasma membrane is pulled away from the cell wall and the cell is said to be flaccid. this process by which a plant cell lose water, shrink and become flaccid is called plasmolysis. However the shape of the plant cell is maintained by the tough rigid cellulose cell wall which prevents crenation in plant cells.

b.i) **Animal cells in hypotonic solution.**

The concentration of water in the cytoplasm of the plant cells is hypertonic to the solution medium in the test. Water molecules are then drawn into the animal cell cytoplasm from the surrounding medium by osmosis through the semipermiable membrane. the cell swells as water is drawn into them by osmosis .as water continues to enter into the cell,the weak animal cell membrane bursts a process called lysis. in red blood cells this process is called haemolysis. However in unicellular organisms like amoeba and paramecium,bursting of their cells does not take place because they have specialized organelles called contractile vacuoles for removal of exces water out of their bodies/cells.

**ii.) animal cells in hypertonic solution.**

The concentration of the animal cells cell cytoplasm is hypotonic to the solution medium in the test. the surrounding hypertonic solution will draw water out of the animal cells by osmosis through the semi-permeable membrane. Continued loss of water causes the cells to be smaller in size and their membranes become wrinkled. This process will continue until the concentration of the cell sap and the surrounding medium is equal i.e isotonic.the process by which animal cells lose water and shrink is called crenation.

6.) **Explain briefly the role of active transport in living organisms.**

It is involved in active reabsorption of glucose and mineral salts in kidney tubules during formation of urine. it enables the absorption of digested food from the alimentary canal/small intestines into the blood stream. Excretion of waste products from body cells for eventual removal. Involved in transmission of nerve impulses within the nerve cells through the sodium pump which maintains a balance between sodium and potassium ions. It facilitates accumulation of substances in the body cells to offset osmotic pressure of organisms in dry and marine environment allowing them to absorb water by osmosis and avoid desiccation. In plants it enables plant roots to absorb water from the soil against the concentration gradient. It's involved in translocation of manufactured food in the phloem tissue within the plant body. It's involved in the opening and closing of the stomata through the sodium-potassium pump mechanism.

**iv) Outline the roles of active transport in living organisms**

- mineral salt intake by plants
- selective reabsorption of glucose and some salts by kidney tubules
- absorption of digested good by small intestines
- excretion of waste products from body cells
- reabsorption of useful materials in the blood stream or at the tissue fluid
- sodium pump mechanism in the nerve cells/neurons

**f.) a) i) Define nutrition**

- the process by which living organisms obtain and assimilate nutrients
-

**ii) State the importance of nutrition**

- for respiration to get energy
- for growth
- for development
- to repair and replace worn out and damaged parts and tissues

**b) Differentiate the various modes of feeding**

**i) Autotrophism**

- manufacturing food from simple organic substances
- types are photosynthesis and chemosynthesis

**ii) Heterotrophism**

- obtaining food from autotrophes and other organic substances
- types are holozoic, saprophytic and parasitic

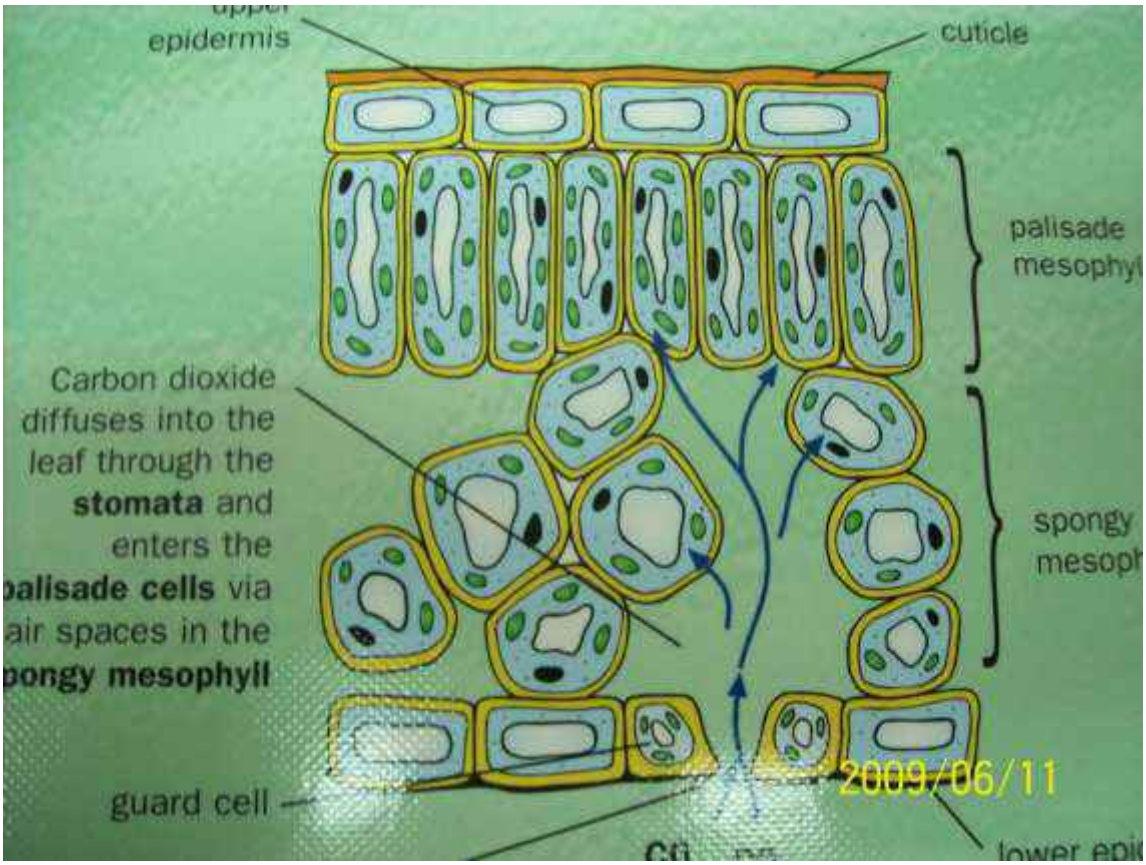
**g.) a) i) Define photosynthesis**

- the process by which green plants build up organic compounds from carbon IV oxide and water in the presence of sunlight

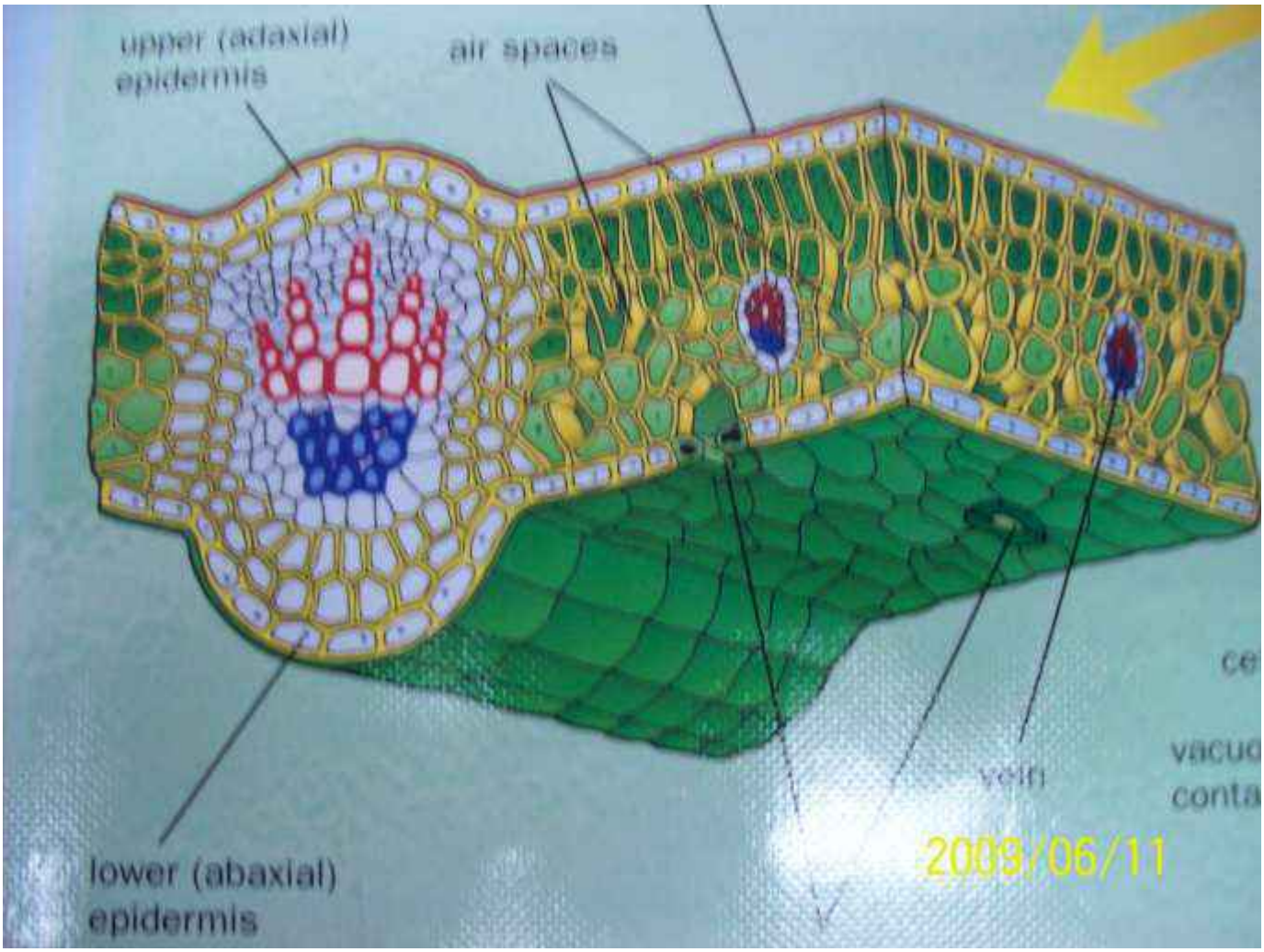
**ii. State the importance of photosynthesis**

- formation of sugars/glucose which is a source of energy
- purification of air($CO_2$ is used, $O_2$ is released)
- storage of energy to be used later in respiration
- stores energy in wood, coal, oil to be used later to run industries

**Structural adaptation of the leaf to its function**

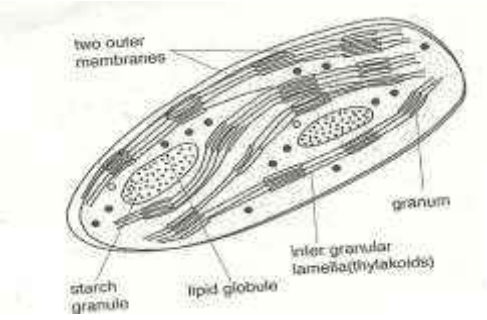


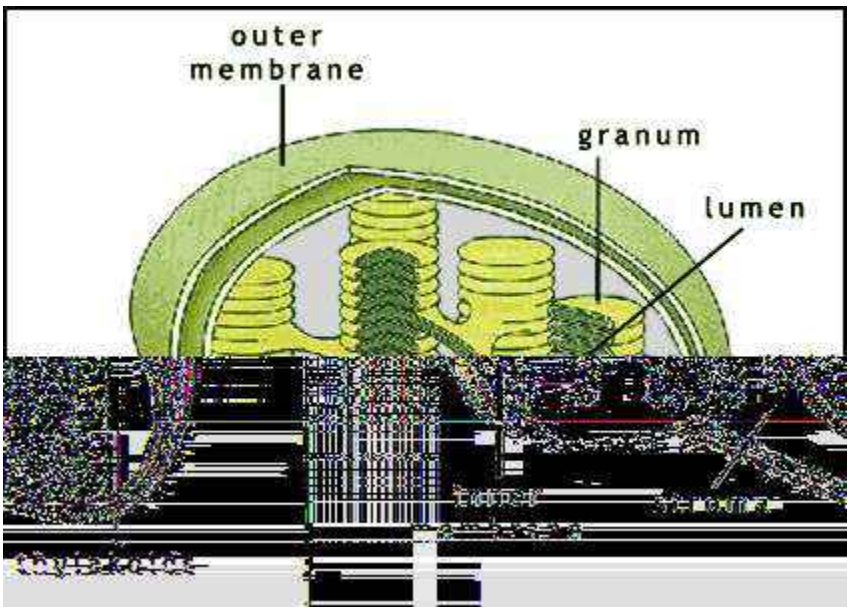
The leaf has a broad and flattened lamina to provide a large surface area for trapping optimum light for photosynthesis and allow maximum gaseous exchange.
The leaf epidermis is thin ( one cell thick) to reduce the distance across which diffusion of carbon (iv) oxide gas to palisade cells and oxygen gas from palisade cells takes place.
The leaf has numerous stomata that allows easy diffusion of gases into and out of the palisade tissue.
The leaf cuticle and epidermis are transparent to allow easy penetration of light to the photosynthetic tissue.
The palisade cells are numerous,elongated and contain numerous chloroplasts to trapping optimum light for photosynthesis.
The palisade tissue is just beneath the upper epidermis exposing them to trap optimum light for photosynthesis.
The leaf has numerous leaf veins consisting of a.) xylem vessels and tracheids for transporting water and dissolved mineral salts from the soil to the photosynthetic tissue
b.) phloem tissue for translocation of of manufactured food from the leaf to storage organs and other parts of the plant .
Numerous and large air spaces in the spongy mesopyl layer for optimum gaseous exchange with the photosynthetic tissue.
Phylotaxy which is regular arrangement of leaves on the stem minimizes overshadowing and overlapping exposing all leaves to light for photosynthesis.
The prominent midrib and leaf veins reduces chances of rolling of leaves maintaining a large surface area for trapping optimum light for photosynthesis.




**C) Describe the structure and function of chloroplast**

**i) Structure**






**ii) Function**

- structure in which photosynthesis takes place

**iii) Adaptations**

- has numerous/many grana to provide large surface area for packing many chlorophyll pigments
- have numerous chlorophyll pigments which trap sunlight/light for photosynthesis
- has stroma/third matrix which contain certain enzymes that catalyze photosynthetic reactions

**d) i) Give a word equation for photosynthesis**

Carbon (iv)Oxide + water $\xrightarrow[\text{Chlorophyll}]{\text{sunlight}}$ sugar + oxygen

NB $6CO_2 + 6H_2O \longrightarrow C_6H_{12}0_6 + 6O_2$

**.) describe briefly the process of photosynthesis in plants.**

The process of photosynthesis takes place in green plants allowing them to make their own food. The process is controlled by enzymes and involves a series of reactions that take place in chloroplasts. The raw materials required are water and carbon (iv) oxide.the process takes place in two consecutive stages i.e

**Light reaction stage.**

It's also called the light dependent stage as it requires light energy . the reactions take place in the granna of the chloroplast. light energy from the sun is trapped by chlorophyll in the chloroplast and converted into chemical energy. This energy splits water molecules into hydrogen ions and oxygen atoms a process is called photolysis. The oxygen atoms are released as aby product or used up in the process of respiration. The hydrogen ions formed are used in the dark stage of photosynthesis.

Water ⟶ hydrogen ions + oxygen atoms

$2H_2O$ ⟶ $4H^+$ + $o_{2\,g}$

Some of the light enrgy is used to combine a molecule called adenosine diphosphate(ADP) with a phosphate group to form the rich energy molecules called adenosine Tri-Phosphate(ATP)

ADP + P ⟶ ATP

**Dark reaction stage.**

It's also called the light independent stage of photosynthesis since light is not required because it can take place both in presence and absence of light. the reactions are controlled by enzymes. the hydrogen atoms released in the light stage are combined with carbon(iv)oxide to form simple sugars mainly glucose. The process uses energy from ATP. This is reffered to as carbon (iv) oxide fixation. The reactions take place in the stroma of chloroplast. The excess glucose is converted into starch or lipids for storage.

The general process of photosynthesis can be summarized by the following word and chemical equitions.

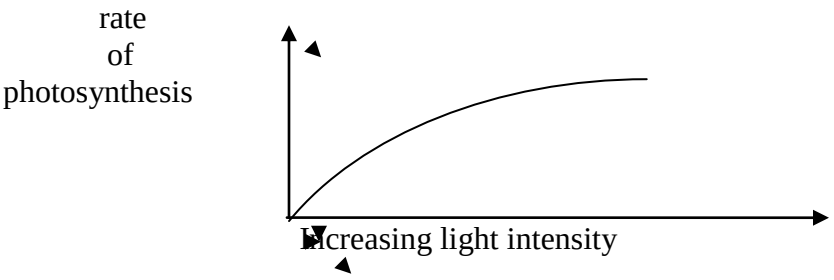
Water + carbon (iv) oxide $\xrightarrow{\text{light \& chlorophyll}}$ glucose + oxygen

$6H_2o + 6co_2 \longrightarrow C_6H_{12}O_6 + 6O_2$

**9.) factors that cause high rate of photosynthesis.**

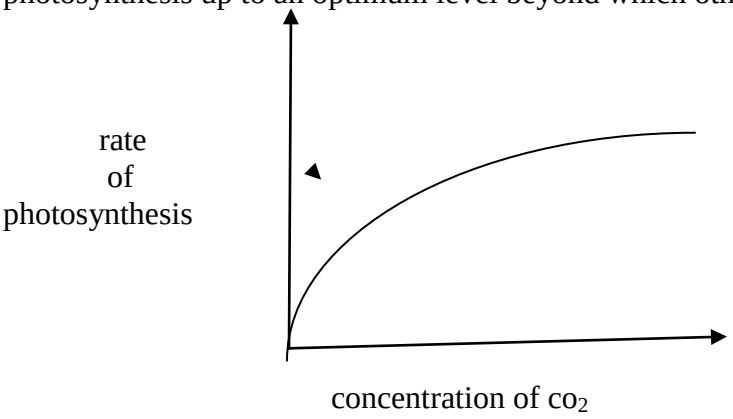
<u>High water availability in the soil</u>. Water a raw material for photosynthesis is split in presence of light to provide the hydrogen ions required in carbon (iv) fixation. When water is readily available more hydrogen ions are produced hence high rate of photosynthesis.

High light intensity. Light splits water molecules to hydrogen ions and oxygen atoms. Increasing light intensity increases the rate of photosynthesis up to a certain level beyond which other factors become limiting and rate of photosynthesis becomes constant.




Day length. Long day length especially at high latitudes (temperate regions) provides more light for photosynthesis causing an increase in the rate of photosynthesis.

Light quality. The preferred wavelengths for photosynthesis range between 400nm-700nm. the rate of photosynthesis is higher in red and blue light and lower in all other types of light.
Concentration of carbon (iv) oxide. It's a raw material required to combine with hydrogen ions to form simple carbohydrate molecules. Increasing the concentration of carbon (iv) oxide increases the rate of photosynthesis up to an optimum level beyond which other factors limit the rate of photosynthesis.




**f) Give the differences between the light and dark reactions during photosynthesis**

| **Light reactions** | **Dark reactions** |
|---|---|
| • occurs in grana | • occurs in stroma |

**h.) a) i) What are chemicals of life?**

- substances which make up cells, tissues and organs of the living system
- they combine to form organic compounds

**ii) What are organic compounds?**

- compounds that contain the element carbon

**iii) List the organic compounds**

- proteins
- carbohydrates
- lipids(fats and oils)
- vitamins
- enzymes
- nucleic acids(DNA and RNA)

**b) i) What are carbohydrates?**

- Compounds of carbon, hydrogen and oxygen

- The elements are in the ratio of I carbon: 2 hydrogen: 1 oxygen

**ii) Name the groups of carbohydrates**

- monosaccharides (simple carbohydrates) e.g. glucose, fructose and galactose
- disaccharides ( formed when two monosaccharides combine) e.g. maltose, sucrose, lactose
- polysaccharides (composed of many monosaccharides and disaccharides) e.g. starch, glycogen, cellulose

**iv) State the general functions of carbohydrates**

- production of chemical energy
- storage of starch(plants) and glycogen (animals)
- commercial uses e.g. manufacture of paper, textiles

**c) i) what are proteins?**

- compounds of carbon, hydrogen and oxygen and in addition nitrogen, and sometimes sulphur and or phosphorus
- building blocks are called amino acids

**ii) Name the types of amino acids**

- essential amino acids which must be supplied in food since they body cannot synthesize them
- Non-essential amino acids which body can synthesize.

**iv) State the classes of proteins**

- first class proteins which supply all the essential amino acids
- second class proteins which lack at least one amino acid

**v) Give the functions of proteins**

- structural compounds e.g. muscles, hair, hooves, and feathers
- as enzymes e.g. pepsin, trypsin
- hormones e.g. insulin and glucagons
- antibodies
- part of haemoglobin molecule
- actin and myosin in muscles
- collagen in bones and cartilage
- pigments in rods and cones for coordination
- components of blood i.e. plasma proteins

**d ) i) What are lipids**

- Fats and oils

- They contain carbon, hydrogen and oxygen
- However, they contain a higher proportion of carbon and hydrogen but less oxygen that in carbohydrates

**ii) Name the types of lipids**

- oils(liquid under room temperature)
- fats (solid under room temperature)

**iii) What are the building blocks of lipids?**

- fatty acids and glycerol

**v) State the functions of lipids**

- production of energy
- source of metabolic water
- structural compound

**e) i) What are enzymes?**

- a chemical compound, protein in nature, which acts as a biological catalyst

**ii) State the properties of enzymes**

- are highly specific in nature
- they are not used up during chemical reactions
- work within specific range of temperature
- work within specific range of pH
- enzyme controlled reactions are reversible

**iii) State the factors that affect enzyme action**

- temperature
- substrate concentration
- pH of the medium
- enzyme concentration
- presence of inhibitors and co-factors

**v) Name the types of enzyme inhibitors**

- competitive inhibitors
- non- competitive inhibitors

**vi) What are the functions of enzymes?**

- enable cellular reactions to take place at a reasonably faster rate
- Control cell reactions therefore no violent incidences occur in cells that might burn them.

**i.) a) Explain the various types of heterotrophic nutrition**

**i) Holozoic**

- Mode of feeding by animals where solid complex food substances are ingested, digested and egested.

**ii) Saprophytism**

- feeding on dead organic matter

**iii) Parasitism**

- feeding from another organism but not killing it

**iv) Symbiosis**

- an association in which organisms of different species derive mutual benefit from one another

**b) Differentiate between omnivorous, carnivorous and herbivorous modes of nutrition**

**i) Herbivorous**

- herbivores feed exclusively on vegetation

**ii) Omnivorous**

- omnivores are animals which feed partially on plant materials and partially on flesh e.g pigs

**iii) Carnivorous**

- Carnivores feed on flesh alone e.g. lion

**c) i) What is dentition?**

- Refers to the number, arrangement and kind of teeth in an animal

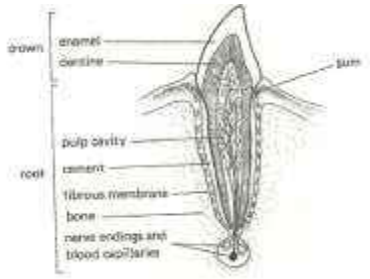
**ii) Distinguish between the terms homodont and heterodont**

- homodont have same kind , type, shape and size of teeth which perform similar function e.g. fish, reptiles and amphibians
- Heterodont have different kind, type, shape and size of teeth which perform different functions as those found in mammals.

**iv) Name the types of teeth found in mammals**

- Incisors
- Canines
- Pre-molars
- Molars

**d) Describe the adaptations and functions of various types of mammalian teeth**

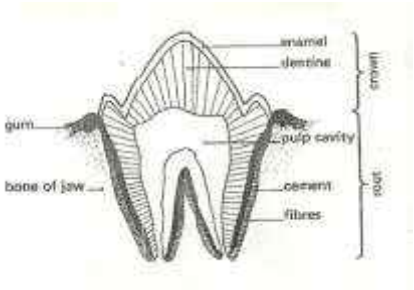



**Incisors**

- chisel shaped/wedge shaped
- found in the front of the buccal cavity
- used for cutting

**i) Canines**

- next to incisors
- very sharp and pointed
- located at the sides of jaws
- used for tearing food



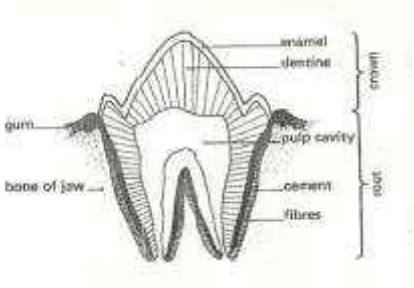

**ii) Premolars**

- next to canines but before molars
- have cusps and ridges on their surface
- used for crushing and grinding

**iii) Molars**

- found at the back of the jaw
- have cusps and ridges on their surface
- absent in young mammals but appear later when permanent teeth grow
- used for grinding and crushing
-

**e) i)Draw a labeled diagram to represent internal structure of a mammalian tooth.**




**ii) State the functions of the labeled structures labeled**

**Dentine**

- main constituent of teeth
- like bone in structure but contains no cells

**Enamel**

- protects tooth from mechanical/physical injury
- the hard covering of the exposed part of teeth

**Crown**

- portion of tooth above the gum
- covered with dentine

**Root**

- part imbedded in the jaw below the gum
- covered by substances called cement
- cement is hard and bone-like

**Cement**

- bone-like substance covering root and enamel of mammalian tooth

**Neck**

- region at the same level with the gum
- forms a junction between the crown and root
- covered by enamel

**Pulp cavity**

- at centre of tooth within dentine
- has blood vessels for transporting nutrients/food and gases
- has nerves for sensitivity

**f) i) What is dental formula?**

- formula indicating the number of each kind of teeth for a given species of mammal
- only half the jaw is included
- the number in the upper jaw of one side is written above that in the lower jaw of one side
- the categories of teeth are given in the order incisors, canines, pre-molars, molars

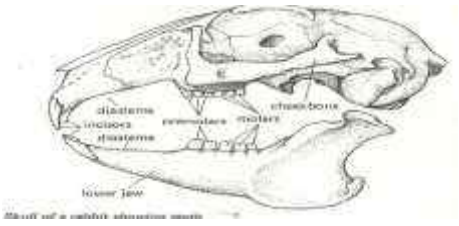
**ii) Give examples of dentition in named mammals**

- carnivore e.g. dog $i^2/_3$ , $c^1/_1$, $pm^2/_3$, $m^2/_3$ = 42
- herbivore e.g. sheep $I^0/_3$, $c^0/_1$, $pm^2/_3$, $m^3/_3$ = 30
- Omnivore e.g. human $I^2/_2$. $c^1/_1$, $pm^2/_2$, $m^3/_3$ = 32

**iii) How would one use dental formula to identify the following?**

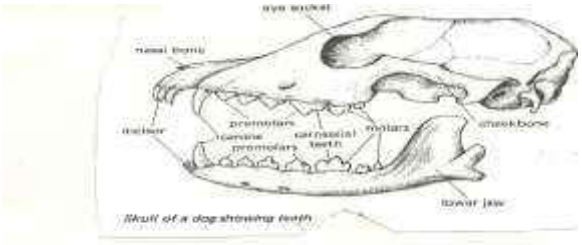
**Herbivores**

- presence of diastema/gap between incisors and premolars
- free movement of tongue
- absence of incisors in upper jaw
- absence of canines
- presence of hard pad
- closely packed molars




**Carnivore**

- presence of canines
- presence of carnassial teeth
- presence of incisors in upper jaw/absence of diastema/gap between incisor and premolar




**iv) State the functions of the following structures in mammals**

**Carnassials**

- tearing flesh from bones

Pad of gum

- provides grasping surface for lower incisors

**g) Name the common dental diseases**

- dental caries
- periodontal (pyorrhea and gingivitis)

**j.) a) i) What is digestion?**

- breakdown of complex food particles by enzymes to simple substances which can be absorbed

**ii) Explain the types of digestion**

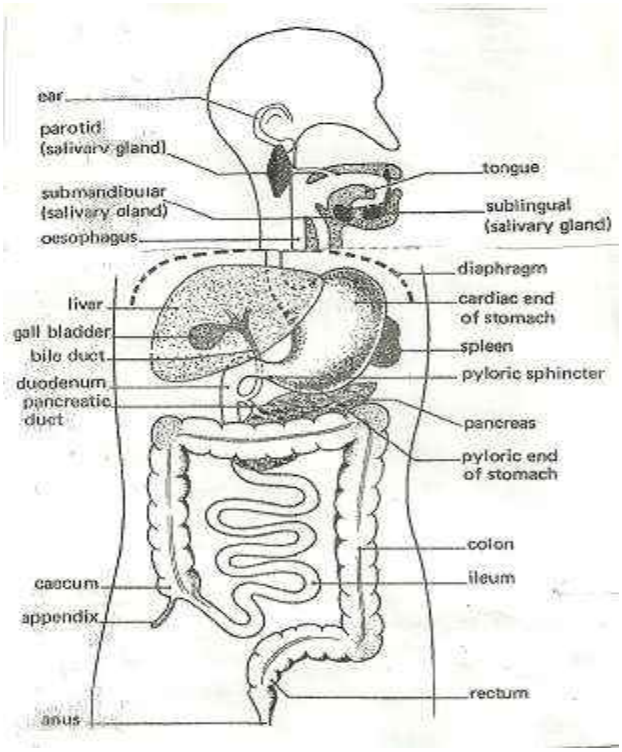
**Intercellular**

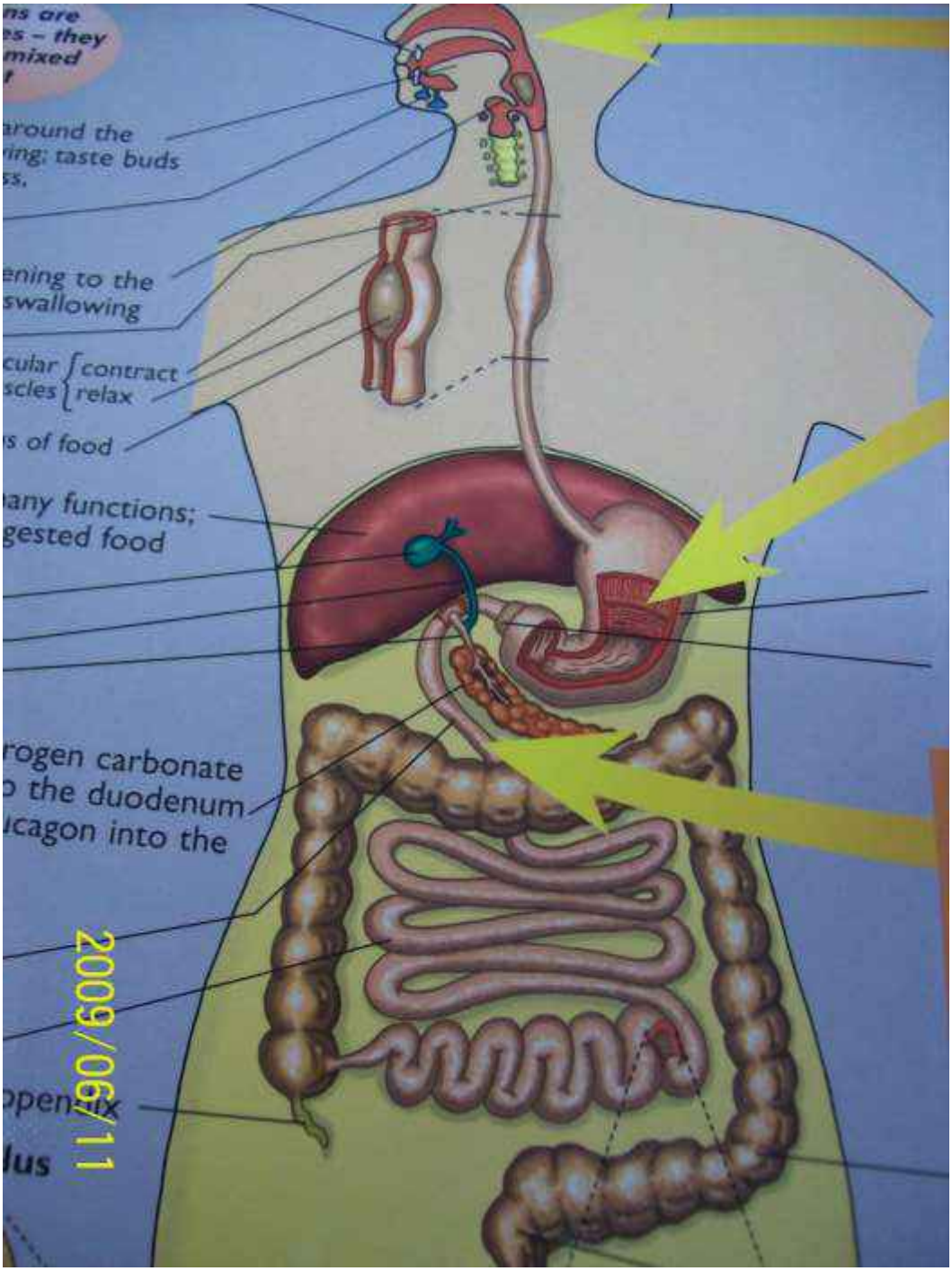
- Digestion that takes place in food vacuoles inside cells.

**Extra cellular**

- digestion that takes place outside cells e.g. in the digestive tract

**b) i) Draw human digestive system**






**ii) Describe the process of digestion in the various parts of the human digestive system**

**Mouth**

- contains teeth for chewing
- has tongue for mixing food with saliva
- has salivary glands for chemical digestion, secretion of enzymes and mucus secretion
- starch is acted on by salivary amylase enzymes to produce maltose
- the tongue rolls food into a bolus which is carried into the stomach by peristalsis
- peristalsis is movement of food along the gut by waves of contraction
- it facilitates rapid digestion due to its mixing action

**Oesophagus**

- also called gullet
- forms a passage for food by peristalsis
- connects the mouth to the stomach

**Stomach**

- has gastric glands which secrete gastric juices
- these juices contain hydrochloric acid(HCL), mucus, and the enzymes pepsin, rennin and lipase
- HCL produces an acidic medium for enzyme action
- Proteins are acted upon by pepsin to produce peptides
- Caseinogen is acted upon by rennin to produce casein
- Fats are acted upon by lipase to produce fatty acids and glycerol
- Mucus lubricates the stomach and prevents autolysis of stomach (mucus protects stomach)

**Duodenum**

- the first u-shaped part of the small intestine
- food in the stomach is now in a semi-liquid form called chime
- chime leaves the stomach by peristalsis into the duodenum
- there, the liver produces bile pigments, bile salts and sodium hydrogen carbonate
- the stomach is usually alkaline to neutralize chime which is acidic
- bile salts emulsify fats
- bile comes from the gall bladder through the bile duct
- sodium hydrogen carbonate provides the correct pH/alkaline
- pancreatic juices are released by pancreas into the duodenum
- the juices  contain trypsin, chemotrypsin, amylase, lipase and protease
- proteins are acted upon by trypsin to form polypeptides and amino acids
- starch is broken down to maltose by amylase

**Ileum**

- produces intestinal juices
- Intestinal juice contains maltase, sucrase, lactase, erepsin, lipase, and several other peptidases
- Maltose is broken down to glucose and galactose by lactase
- Sucrose is acted upon by sucrase to glucose

Polypeptides are broken down into amino acids by erepsin

- Mucus secretion is to protect the ileum wall from digestion/autolysis

**Colon**

- Commonly called the large intestine
- Wider than the ileum
- has several mucus-producing cells

Highly folded for water absorption

- Also prepares food for egestion
- egestion is the process by which the insoluble parts of food are discharged from the body in form of faeces.

**Rectum**
- Muscular and enlarged
- it produces mucus
- used for storage and removal of faeces

**Anus**

- found at the exterior end of the rectum
The rectum opens into the anus
- The anus has anal sphincter to control egestion
- Anus is used for egestion of faeces

**c) Explain how mammalian intestines are adapted to perform their function**
-
The mammalian intestines are relatively long and coiled. This allows food enough time and increases surface area for digestion and absorption of products of digestion
- The intestinal lumen (inner wall) has projections called villi to increase surface area for absorption
- The villi have projections called micro-villi which lead to further increase of surface area for absorption
- The walls have glands which secrete enzymes for digestion e.g. maltase, sucrase, lactase, peptidase and enterokinase.
- Goblet cells (mucus secreting cells or glands) produce mucus which protects the intestinal wall from being digested and reduces friction.
- Intestines have openings of ducts which allow bile, a pancreatic juice into the lumen
- The intestines have circular and longitudinal muscles whose contraction and relaxation (peristalsis) leads to mixing of food with enzymes (juices) helps push food along the gut.
- The intestines are well supplied with blood vessels that supply oxygen and remove digested food.
- Intestines have lacteal vessels for transport of lipids (fats and oils)
- Intestines have thin epithelium to facilitate fast/rapid absorption/diffusion

**d) What is the function of hydrochloric acid in digestion?**
- kills bacteria
- activates trypsinogen to trypsin which digests proteins to peptones and peptones to soluble amino acids
- provides acidic medium for gastric enzymes

**e) i) What is assimilation?**
- The process by which digested food is taken up by cells and used in the body for various purposes.

**ii) State the uses of digested food in the bodies of animals**
- Protection
- Repair
- Growth
- Energy production

**f) Name the types of food substances in the food that do not undergo digestion in human digestive system**

- mineral salts
- water
- roughage
- vitamins

**k.) Explain the importance of the following food substances in human nutrition**

**Vitamins**

- are organic chemical compounds essential for a healthy body
- are obtained from fresh fruits and vegetables
- some are synthesized in the body e.g. vitamin K
- they are destroyed by overcooking food
- they protect the body against diseases, play regulatory mechanisms in the body and act as co-enzymes
- insufficient amounts lead to deficiency diseases e.g. rickets, scurvy, beriberi

**a) Mineral salts**

- are important in organic compounds containing elements which are essential for normal body metabolism
- those required in large quantities are called macro-nutrients while those required in small quantities are called micro-nutrients or trace elements
- They are used in bone and teeth formation. In osmotic balance and neurotransmission
- insufficient amounts lead to anaemia, rickets, goiter
- Excess amounts lead to high blood pressure, and dental disorders.

**b) Roughage**

- composed of cellulose and plant fibers
- digested by cellulose contained by gut microorganisms
- provides grip essential for peristalsis
- lack of roughage leads to slow movement of food leading to constipation
- roughage adds bulk to food for peristalsis to take place

**c) Water**

- used in transport in the body, universal solvent, hydrolysis
- insufficient leads to dehydration

**l.) Explain the factors that determine energy requirements in humans**

**a) Basal Metabolic Rate (BMR)**

- this is the energy required when the body is completely at rest
- used to carry out breathing, heartbeat, circulation of blood and other basic reactions
- also used in maintaining body temperature at constant
- all movements or physical work e.g. walking, eating required more energy.

**b) Occupation**

- means activity occurring everyday
- everyday activity determines energy requirement
- People doing heavy work like digging require more energy than office workers.

**c) Age**

- children carry out many activities and also have more cell division than adults
- their BMR is therefore higher than for adults
- as they grow older, they become less active and their energy requirements decrease

**d) Body size**

- small bodied people have a large surface area to volume ratio
- their bodies lose more heat energy to the surrounding
- they therefore require more energy-giving foods
- this is the opposite for big bodied people

**e) Sex**

- most males are more muscular than females
- they also do heavier work than females hence require more energy
- females do lighter work hence require less energy

**f) Climate**

- in warm climate the body requires less energy
- in low temperatures the body requires more energy to maintain body temperature

**m.) Explain various tests carried out on food**

| Test | Procedure | Observation | Conclusion |
|---|---|---|---|
| Starch | - add iodine solution | - colour changes to blue black/dark blue | Present |
| Reducing sugar | Benedicts solution heat/boil/warm in hot water bath | - colour changes to Green to yellow to orange to brown to red | Present |
| Non-reducing sugar | Dilute HCL, $NaHCO_3$, heat/boil, warm in hot water bath | - colour changes to Green to yellow to orange to brown to red | Present |
| Proteins | 1% $CuSO_4$, 5% NaOH | -- colour changes to purple/violet | Present |
| Ascorbic acid (Vitamin C) | DCPIP drop wise | DCPIP decolorized | Present |
| Fats/oils (lipids) | - rub on filter paper<br>- ethanol | - translucent mark<br>- white emulsions | present |

**FORM TWO TOPICS**

1. **a) i) Define transport**

- movement of substances from one part of the body to another

**ii) Explain the necessity of transport in plants and animals**

- make nutrients move from one point to another
- movement of respiratory gases i.e. oxygen and carbon IV oxide
- elimination of metabolic wastes
- movement of hormones
- movement of water
- movement of salts
- movement of enzymes

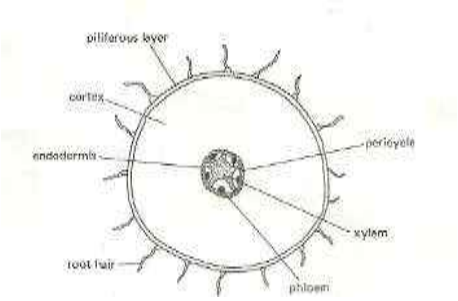
**b) i) Describe the structure and function of root hair**

- root hairs are found near the root tip
- they are cells with elongated finger-like projections which are in contact with soil particles
- they are permeable to water and mineral salts hence are used to absorb water and mineral salts
- There large number offers a large surface area for absorption of water and mineral salts.

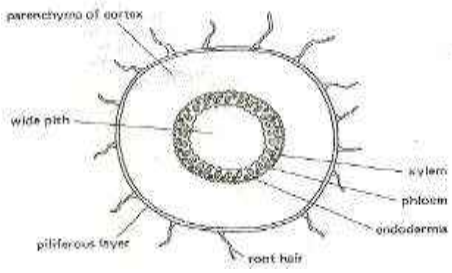
**ii) State ways in which the root hairs are adapted to their functions**

- the root hair is long/narrow/numerous to increase surface area for absorption of water and mineral salts
- many mitochondria in cytoplasm to supply energy for active transport of mineral salts
- are thin walled to speed up rate of absorption of water and mineral salts

**c) i) Compare the internal structure of a dicotyledonous root and a monocotyledonous root**
**Dicot root**




**Monocot root**



**ii) State the similarities and differences between a dicotyledonous and monocotyledonous root**
**Similarities**

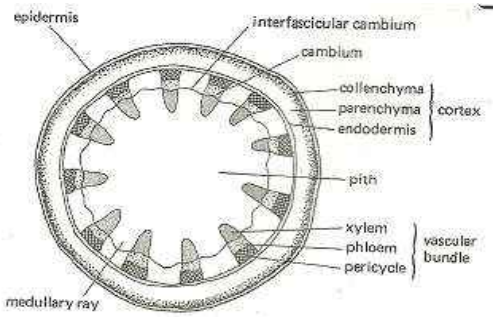
- both used for anchorage and absorption of water and mineral salts
- both have root hairs, epidermis, pericycle, cortex, endodermis and vascular bundles (xylem and phloem)
- both may be used to store food/storage organs
-

**Differences**

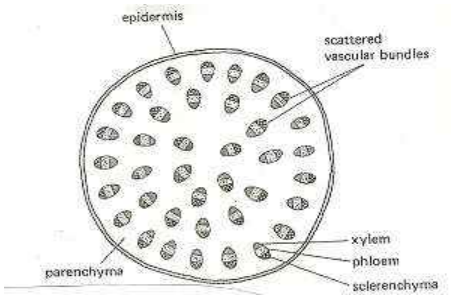
| Monocotyledonous | Dicotyledonous |
|---|---|
| • phloem and xylem are arranged in ring form alternately<br>• pith present | • phloem lies between radial rays of central xylem(star shaped)<br>• pith absent |

i**ii) Compare the internal structure of a monocotyledonous and dicotyledonous stem**

Monocotyledonous




Dicotyledonous




**v) Give the similarities and differences between a monocotyledonous and dicotyledonous stem**

**Similarities**

- both are used for protection
- both conduct water, salts and food
- both have epidermis, cortex, pericycle and vascular bundles

**Differences**

| Monocotyledonous | Dicotyledonous |
|---|---|
| • vascular bundles are many and scattered<br>• some have hollow pith or pith is absent<br>• no cambium layer therefore cannot undergo secondary growth<br>• very little cortex | • vascular bundles are few and arranged in a concentric ring near the epidermis<br>• pith large and well developed<br>• presence of cambium therefore undergoes secondary growth<br>• cortex has several layers of cells |

**v) State the differences between the internal structure of a root and a stem.**

| Root | Stem |
|---|---|
| • has root hairs<br>• no cuticle<br>• xylem and phloem arranged alternately<br>• in xylem, the small vessels are towards the outside<br>• cortex is the widest tissue | • no root hairs<br>• cuticle present<br>• xylem and phloem arranged on the same radii<br>• in xylem, the smallest vessels are towards the inside<br>• pith is the widest tissue |

c**) i) Name the transport structures of a flowering plant**

- xylem vessels and tracheids transport water and mineral salts from the soil
- Phloem vessels translocate manufactured food from leaves to other parts of the body.

**ii) State the ways in which xylem vessels are adapted to their function**

- lignified/thickened to prevent collapsing
- narrow to facilitate capillary
- no cross walls for continuous flow/column of water
- have bordered pits for lateral movement of water

**d) i) Why do flowering plants need water?**

- photosynthesis
- transport
- turgidity which helps in plant support
- solvent i.e. medium for chemical reactions
- cooling effect during transpiration
- seed germination

**ii) Describe the movement of water from the soil to the leaves of a tall plant**

Soil

- water exists as a thin film in the soil, between soil particles
- the concentration of cell sap of root hair is greater than that of the surrounding solution in the soil, thus drawing the water molecules across the cell wall and cell membrane into the root hair by osmosis
- water drawn into the root hair cell dilutes the cell sap making it less concentrated than that in the adjacent cortex cells of the root
- due to osmotic gradient water moves from the root hair cells into the cortex by osmosis, from cell to cell by osmosis, across the endodermis by active transport into xylem vessels of the root that conduct water into xylem vessels of the stem into xylem vessels of the leaves

Stem

- Once in the stem water moves up the plant aided by the narrowness of the xylem vessels (capillary), root pressure, attraction of water molecules to each other (cohesion). Attraction of water molecules to the walls (adhesion)

- from the stem water enters the xylem of leaves
- water moves in the xylem vessels of the stem in a continuous (uninterrupted) water column up to the tree leaves

Leaves

- once in the leaves water moves into the mesophyll cells by osmosis
- as water vaporizes from the spongy mesophyll cells their sap becomes more concentrated than the adjacent cells
- as the result water flows into the cell from other surrounding cells which in turn takes in water from xylem vessels within the leaf veins
- this creates a pull(suction force) called transpiration pull that pulls a stream of water from xylem vessels in the stem and roots
- The transpiration pull maintains a continuous column of water from the roots to the leaves.

**iii) Name the process by which mineral salts enter into a plant**

- active transport
- diffusion

**vi) Explain the forces that make water and mineral salts move through a plant**

- mineral salts are taken up due to diffusion because of the concentration gradient between the mineral ions in sap and those in soil solution
- active transport involves energy in form of ATP due to respiration which forces mineral salts through a plant against a concentration gradient
- water moves by osmosis through a semi-permeable membrane of root hairs and between cells of stem
- in stem water moves by cohesion(attraction of water molecules to each other)
- it also moves by adhesion(attraction of water molecules to walls)
- capillarity is due to narrowness of xylem vessels
- transpiration pull occurs when water vapour evaporates from sub-stomatal chambers into the air
- root pressure is a force that pushes water up the stem from the roots and causes guttation /exudation

**vii) Explain the uptake of mineral salts by plants**

- plants require mineral salts for metabolism and proper functioning of their bodies
- mineral salts are taken up from the soil into the root hairs in form of solution by active transport which requires energy
- active transport involves substances called carriers taken up together with water and are then carried to the stems and leaves
- the main process involved in uptake and movement of mineral salts is active transport

**e) i) What is transpiration?**

- loss of water from plant to the atmosphere

**ii) Name the sites through which transpiration takes place in a plant**

- stomata (stomatal transpiration)
- lenticels (lenticular transpiration)
- cuticle(cuticular transpiration)

**iii) State the importance of transpiration to plants**

- cooling the plant
- transport of water
- transport of mineral salts
- excretion of excess water from plants
- excess transpiration causes wilting

**v) Explain the structural factors that affect the rate of transpiration in plants**

- number of stomata i.e. the more the stomata the higher the rate and vice versa
- turgidity of the guard cells which control the opening and closing of stomata when they are open transpiration rate is high
- size of leaves where the larger the surface area the higher the rate of transpiration
- leaf fall leads to lower rate of transpiration and also drying of leaves reduces rate of transpiration
- Thin cuticle reduces distance through which water vaporizes hence increase transpiration rate. Absence of cuticle also increase rate of transpiration

**vi) explain the environmental factors that affect rate of transpiration in plants**

- high temperature increases rate of transpiration and low temperature reduces the rate
- humidity when high increases rate and when low reduces the rate
- transpiration rate is higher in moving air (wind) than in still air
- high light intensity increases internal temperature hence higher rate of evaporation leading to higher rate of transpiration
- availability of water in the soil leads to more absorption hence more loss to the atmosphere
- atmospheric pressure when high leads to more evaporation and when low leads to low rate evaporation of water

**vii) State the structural differences between xylem vessels and sieve tubes**

- sieve tubes have cross wall while xylem vessels have none
- xylem vessels are lignified while sieve tubes are not
- Sieve tubes have cytoplasm elements while xylem vessels have none.

**viii) State the adaptations of plants which enable them to reduce water loss**

- thick waxy cuticle
- reduced leaf size/thorns/spines
- shedding of leaves
- Sunken stomata. Water vapour accumulates in the depression of stomata lowering the water vapour concentration gradient leading to lower rate of evaporation
- rolling of leaves

**ix) State the factors that cause increase in the rate of transpiration from leaves**

- increased light intensity
- low relative humidity
- temperature

**x) Explain how drooping of leaves on a hot sunny day is advantageous to a plant**

- reduces surface area exposed to sun reducing cuticular transpiration

**f) Explain how aquatic and terrestrial plants are adapted to deal with problems of transpiration**

a. Mesophytes

- they grow in soils with enough water
- water loss is perfectly balanced by absorption of more from the soil
- no special adaptations

b. Xerophytes

- they grow in dry conditions
- root grow very deep to absorb water
- succulent/fleshy leaves to store water
- few stomata which are sunken
- thickened waxy cuticle
- leaves are hairy and often folding
- some leaves are needle-like/spines or scales
- leaf surfaces are reduced i.e. small leaves
- all these adaptations are to reduce water loss

c. Hydrophytes

- plants that grow in water
- presence of sclereids
- leaves are broad
- leaves have many stomata on upper side only (none on the lower surface)
- some leaves float on water
- absence or reduced leaf cuticle
- large air spaces
- some leaves are submerged
- poorly developed or reduced vascular bundles

**g) i) What is translocation**

- transfer of manufactured food substances to the parts where they are required

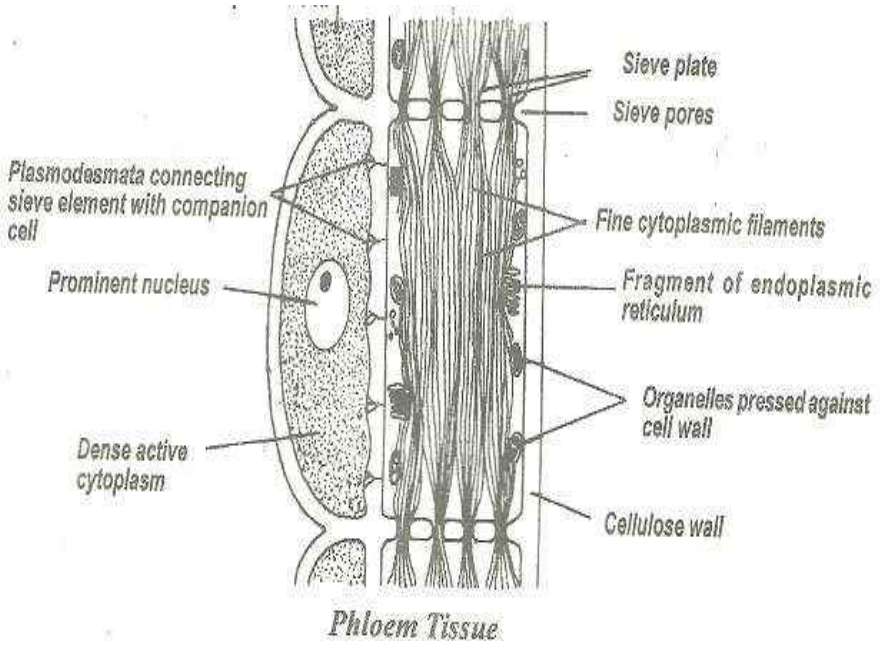
ii) **Name the tissue which is responsible for translocation of manufactured food in flowering plants**

- phloem tissue

**iii) Name the processes that bring about the translocation of manufactured food**

-active transport
Diffusion
Mass flow
Cytoplasmic streaming

**iv) Draw a labeled diagram to represent phloem tissue**



Phloem Tissue

**vi) State the functions of the labeled structures**
**cytoplasmic strands**

- translocation

**Companion cell**

- supply nutrients to sieve tube element
- supply energy for translocation
- regulates activities of tube cells/elements

**Sieve tubes element**

- conduct food down the stem

**vii) name the compounds that are translocated in phloem**

- sugars
- amino acids
- hormones e.g auxins
- oils/lipids
- resins
- vitamins

**Describe an experiment you would carry out in order to demonstrate that phloem transports manufactured food substances in a plant**

a. Ringing experiment

- cut a ring in the bark including the phloem from the stem of a woody plant
- phloem is found next to or just beneath the bark
- observe daily for some time(more than three weeks)
- a swelling of the bark appears above the ring
- this is due to accumulation of food from leaves
- the bark of a second similar plant is removed carefully leaving the phloem intact
- a swelling does not appear

**ii) Use the radio-active tracers**

- plant is exposed to carbon containing radio-active carbon C14
- C14 is found in the end products of photosynthesis
- It is finally detected in phloem
- C14 is found to move in both directions

**iii) Collecting exudate from stylets of aphids**

- aphids feed on certain plant phloem using their stylets
- aphid mouthparts are dissected using a sharp razor
- exudates from the mouthparts are collected and then analyzed
- sucrose is found to be a major component of the exudates
- this proves that phloem translocates manufactured food substances

**h) Describe an experiment you would carry out to demonstrate that xylem transports water**

i. Either

- cut a stem of a young plant or twig of a tree under water
- or else uproot a young herbaceous plant and wash the soil gently
- put some water in a beaker and add a dye i.e. eosin or red ink and place the cut stem or young plant in a beaker
- leave for time e.g. between 20 minutes and one hour
- cut a thin section of stem or leaf
- mount it on a slide and examine under a microscope
- observe and note the distribution of the dye or ink
- the dye appears only in the xylem vessels

ii. OR

- use radio-active tracers, C14 in form of carbon
- ring a plant then put it in a container containing radio-active phosphorous solution
- The radio-active phosphorus is later detected in the leaves.

**2. a) i)List the components of animal transport systems**

- system of blood vessels in which materials are circulated round the body
- blood, a fluid medium which contains dissolved substances and cells
- the heart, a pumping mechanism which keeps blood in circulation

**ii) Distinguish between closed and open circulatory systems**

- closed system has blood vessels through which blood moves eg vertebrates
- open system has no blood vessels hence blood is in direct contact with tissues e.g arthropoda

**iii) What are the advantages of the closed circulatory system over open circulatory system?**

- Closed system has continuous vessels hence able to generate high pressure
- Circulates blood over longer distance
- Circulates blood at a faster rate
- Efficient transport of nutrients and waste products
- Animals are more active

**iv) Distinguish between single circulatory system and double circulatory system**
**Single circulatory**

- blood passes through the heart once in a complete circuit of the body

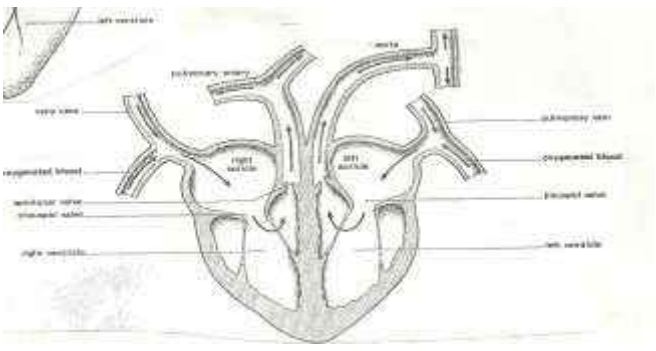
**Double circulation**
-blood enters the heart twice in a complete circulation
- Pulmonary circulation from the heart to lungs and back
- Systemic circulation from the heart to body systems and back

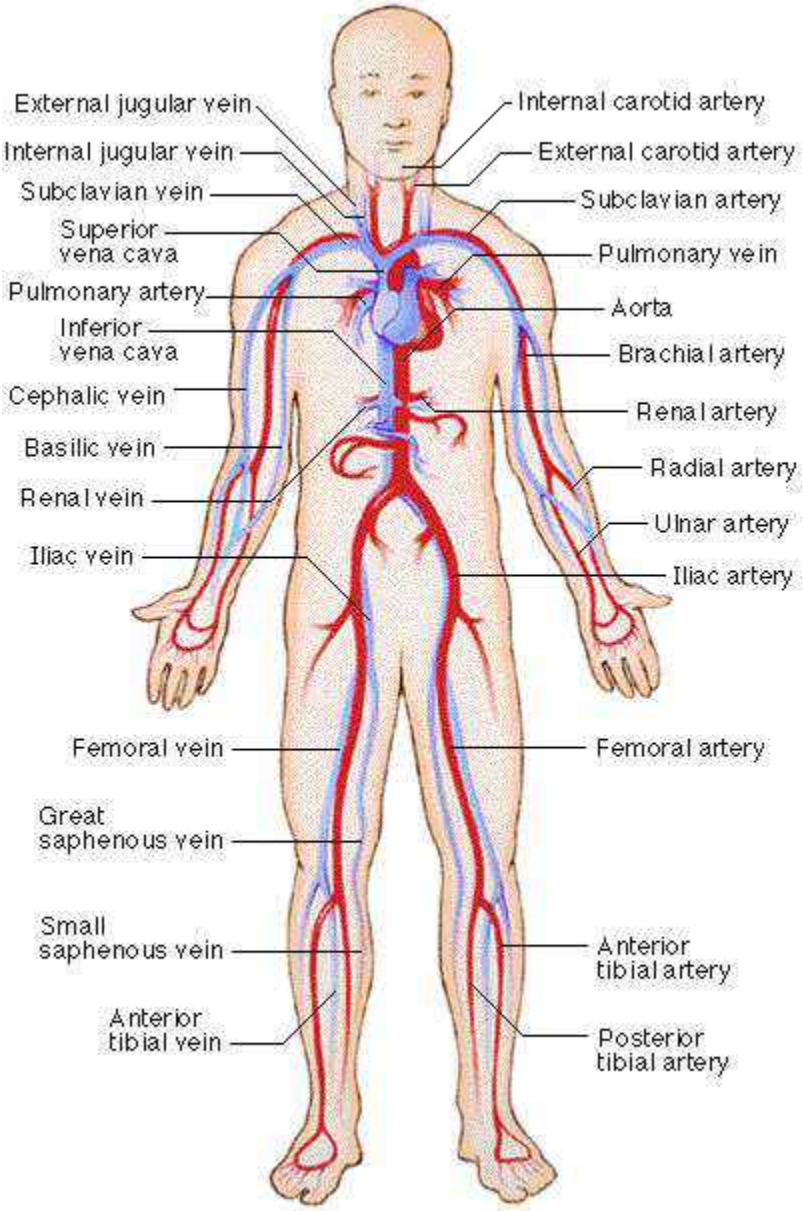
**b) i) describe the general layout of the transport system in mammals**

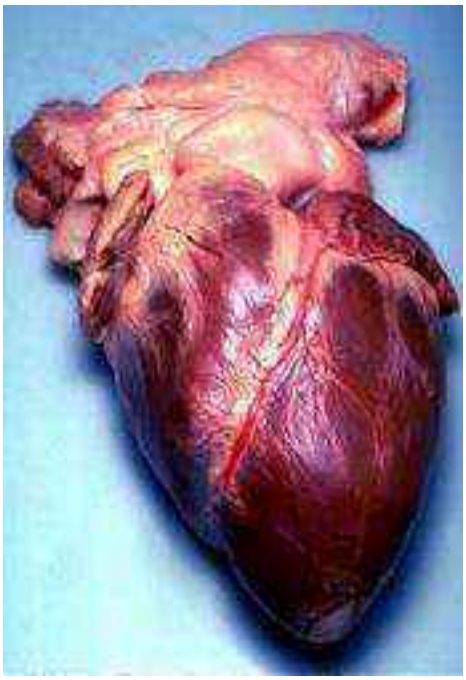
- blood which is a fluid tissue of the body carrying food substances, oxygen, carbon IV oxide and metabolic wastes
- arteries which are elastic tubes carrying blood from the heart to cells
- veins which are blood vessels carrying blood away from the cells to the heart
- capillaries which are extremely numerous and are microscopic channels connecting arteries to veins

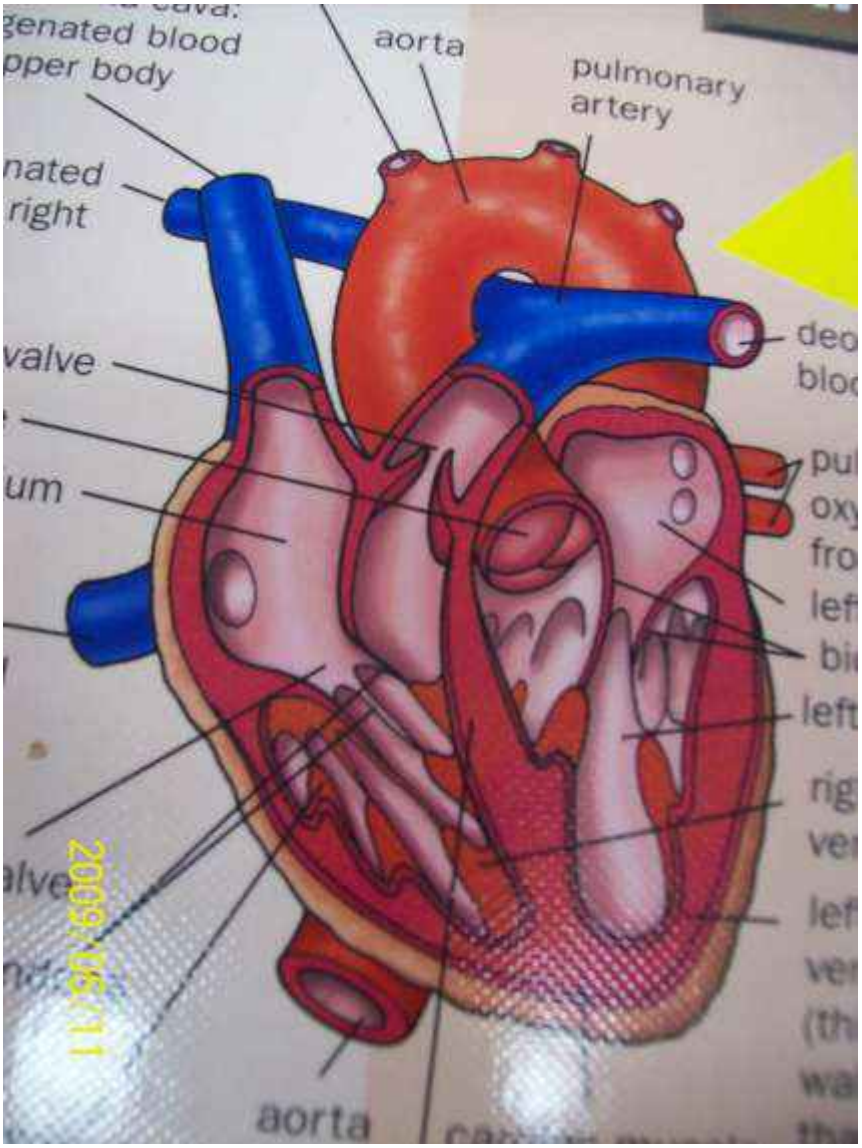
**ii) Describe the structure and function of the mammalian heart**

- the heart is a four-chambered hollow muscle located in the thoracic cavity
- it consists of two small receiving chambers, the atria(auricles) and two larger pumping chambers, the auricles




External jugular vein
Internal jugular vein
Subclavian vein
Superior vena cava
Pulmonary artery
Inferior vena cava
Cephalic vein
Basilic vein
Renal vein
Iliac vein
Femoral vein
Great saphenous vein
Small saphenous vein
Anterior tibial vein
Internal carotid artery
External carotid artery
Subclavian artery
Pulmonary vein
Aorta
Brachial artery
Renal artery
Radial artery
Ulnar artery
Iliac artery
Femoral artery
Anterior tibial artery
Posterior tibial artery






- the left ventricles is the most powerful and has the thickest walls
- this is because it is the chamber which pumps blood throughout the body
- each time it contracts, blood is forced out into the elastic arteries(aorta)
- blood moves on to the capillaries
- from capillaries blood moves to veins and back to the heart through the vena cava
- from vena cava it enters into right auricle which contracts and pumps blood into the right ventricle
- right ventricle pumps blood into the lungs through the pulmonary artery
- blood releases carbon IV oxide to  lungs and picks oxygen then returns to left auricle
- left auricle pumps blood into left ventricle
- left ventricle then pumps blood into the aorta and into arteries, starting the process all over again
- both auricles contract simultaneously while both

**iii) Explain how the mammalian heart is adapted to performing its functions**

- the heart is made of muscles that contract and relax synchronously without requiring nervous stimulation
- nerve supply however, determine contraction strength and frequency
- the heart is divided into four chambers
- The right atrium is connected to the right auricle. It receives blood from the whole body.
- The blood is pumped from the left atrium to the right ventricle
- To avoid flow back into the right atrium, a valve is present between the two chambers – the tricuspid valve
- The right ventricle pumps blood to the lungs
- This is facilitated by the presence of pulmonary artery
- A valve is also present to avoid blood flowing back from the pulmonary artery to the right ventricle
- Blood from the lungs enters the heart through the pulmonary vein into the left atrium.
- When the left atrium contracts, blood flows into the left ventricle
- Blood will not flow back into the left atrium because of the presence of bicuspid valve(mitral)
- The left ventricle is connected with the aorta and when it contracts, blood flows into the aorta for distribution into the whole body
- The heart muscle surrounding the left ventricle is thicker than that surrounding the right ventricle to be able to generate enough pressure to push blood to the whole body
- A pace-maker is present in the heart muscle to initiate and synchronise contractions.
- For the heart muscle to be well nourished and be provided with enough oxygen and carbon IV oxide removal, it is supplied with blood by the coronary arteries and drained by the coronary veins

**iv) Explain why blood leaving the lungs may not be fully oxygenated**

- under ventilation of the lungs
- blockage of alveoli (air sacs)
- high cardiac frequency i.e. high rate of pumping of blood in the heart

**e) Describe the structure and functions of the blood vessels**

**i. Arteries**

- carry away blood from the heart
- carry oxygenated blood except pulmonary artery which takes blood from the heart to lungs for oxygen
- have thick, muscular walls
- are elastic
- have narrow lumen
- all these adaptations are required to withstand high pressure caused by heartbeat

**ii. Capillaries**

- link arterioles and venules to arteries and veins
- small in diameter to increase pressure resistance for materials to filter out
- thin walled as they consist of a single layer of cells to allow diffusion of substances e.g leucocytes to tissues
- thin walled to allow presence of intercellular spaces
- large number i.e. numerous to provide a large surface area for exchange of materials
- have sphincter muscles at the junction of the arterioles and capillaries to control movement of blood into them
- lie close to the body for easy exchange of materials

**iii. Veins**

- carry blood back to the heart
- all carry deoxygenated blood except pulmonary vein that carries blood from the heart to lungs
- have thinner walls than arteries
- have valves to prevent backflow of blood
- have wide lumen

**g) i) State the ways in which the composition of blood in the pulmonary arterioles differs from that in the pulmonary venules**

| Pulmonary arterioles | Pulmonary venules |
|---|---|
| • deoxygenated<br>• high carbon IV oxide<br>• low oxygen<br>• more nutrients | • oxygenated<br>• low carbon IV oxide<br>• high oxygen<br>• less nutrients |

**ii) Give the reasons why pressure of blood is greater in the arterioles than I the veins of mammals**

- blood is pumped to the arteries by the heart at high pressure
- blood pressure in veins is reduced by capillary resistance
- arteries have narrow lumen which maintains high pressure/veins have wide lumen which reduces pressure
- arteries have more/thicker muscular walls which generate pressure/veins have less/thinner muscular walls which reduce pressure

**iii) Name the common heart diseases in humans**

- thrombosis
- antheroma
- arteriosclerosis
- varicose veins
- cerebral vascular thrombosis
-

**h) i) State the functions of mammalian blood**

- transport of substances
- defense against diseases
- clotting
- temperature regulation

**ii) Describe how mammalian blood components carry out their functions**

**Plasma**

- transport dissolved food substances like glucose, amino acids, fatty acids and glycerol from small intestines to liver and other body tissues
- transports hormones, enzymes from secretory glands to tissues when required
- transports carbon IV oxide to lungs and urea from tissues to the kidneys
- distributes heat
- bathes the tissues allowing for exchange of materials
- contains protein fibrinogen and pro-thrombin which take part in blood clotting

**Red blood cells (Erythrocytes)**

- transports oxygen from the lungs to body tissues in form of haemoglobin
- transport carbon IV oxide from body tissues to the lungs in form of bicarbonates

**White blood cells (leucocytes)**

- engulf foreign bodies
- produce antibodies for defense against disease
- produce antitoxins which neutralize bacterial toxins

**Blood platelets (thrombocytes)**

- produce an enzyme called thrombokinase/thromboplastin necessary for blood clotting
- prevents loss of blood, water and mineral salts

**iii) State the ways in which the red blood cells are adapted to their functions**

- many per unit volume hence carry more oxygen and carbon IV oxide
- biconcave in shape to provide large surface area for absorption of oxygen and carbon IV oxide
- absence of nucleolus hence more haemoglobin to carry sufficient oxygen and carbon IV oxide
- alter shape to be able to pass through the narrow lumen of capillaries to deliver or supply oxygen and carry away carbon IV oxide
- have haemoglobin with high affinity for uptake of oxygen and carbon IV oxide

**iv) State the structural differences between a red blood cell and a white blood cell.**

| Red blood cells | white blood cells |
|---|---|
| • has haemoglobin | - not pigmented |
| • smaller size | - larger size |
| • lacks nucleus | - nucleated |

**v) State the functional differences between a red blood cell and a white blood cell**

| **Red blood cell** | **White blood cell** |
|---|---|
| - Transports oxygen and carbon IV oxide | - protects body against harmful pathogens |

**vi) How does the heart increase blood flow to some parts of the body during exercise**

- stronger contractions
- faster contractions/heartbeat

**Explain how oxygen and carbon Iv oxide are transported in the blood**

**Oxygen**

- oxygen concentration is higher in lungs(alveoli) that in blood
- oxygen in the alveoli dissolves in the film of moisture and diffuses through thin epithelial and capillary walls into plasma and red blood cells
- the oxygen combines with haemoglobin to form oxyhaemoglobin
- blood then becomes oxygenated
- blood from lungs then travels to all body tissues where the oxyhaemoglobin breaks down to form oxygen and haemoglobin
- haemoglobin is transported back to the lungs to collect more oxygen while the oxygen in capillaries diffuses into body cells for respiration
- respiration produces carbon IV oxide

**Carbon IV oxide**

- carbon IV oxide produced during respiration diffuses out of cells into blood plasma and red blood cells due to concentration gradient
- carbon IV oxide and water form carbonic acid carbamino compounds with haemoglobin
- in the presence of carboxyl anhydrase enzyme, hydrogen carbonate is carried in blood to the lungs
- in the lungs the hydrogen carbonate dissociates to liberate carbon IV oxide which diffuses into alveolar cavity due to concentration gradient
- from alveolar space carbon IV oxide is expelled during expiration

**Most carbon IV oxide is transported from tissues to lungs within the red blood cells and not in the blood plasma. Give the advantages of this mode of transport.**

- PH of blood is not altered/homeostasis is maintained
- Within the red blood cell is an enzyme, carbonic anhyrase which helps in fast loading(combining) and offloading of carbon Iv oxide

**i) i) what is blood clotting?**

- process in which blood components clump together to prevent loss of blood from an injured/cut vessel

**ii) Name a protein, vitamin, an enzyme and a mineral element involved in blood clotting**

Protein – fibrinogen/prothrombin
Vitamin - k/quinine
Enzyme – thrombokinase/thromboplatin/thrombin
Mineral element – calcium

**iii) describe the blood clotting process**

- enzyme thromboplastin produced in the platelets of damaged tissues converts plasma protein prothrombin into thrombin in the presence of calcium ions
- thrombin converts another plasma protein fibrogen into fibrin in the presence of vitamin K
- fibrin is insoluble
- fibrin forms fibres which form a meshwork that forms a clot
- prothrombin thromboplastin thrombin
  calcium ion

Fibrinogen thrombin fibrin clot
vitamin K

**iv) State the role of blood clotting on wounds**

- prevents blood/body fluids from being lost
- conserves water and salts
- prevents entry of microorganisms/pathogens
- regulates body temperature
- enables wound to heal faster

**v) Explain why blood flowing in blood vessels does not normally clot**

- Presence of anticoagulant in blood

**j) i. list the major types of human blood groups**

- O, with neither B nor A antigen
- AB, with both A and B antigens
- A, with type A antigen
- B, with type B antigen

**iii. explain the meaning of :**

**Universal donor**

- a person who can donate blood to any other blood group without agglutination/clumping
- this is usually blood group O
- however this person cannot receive blood from other blood groups except group O

**Universal recipient**

- can receive blood from all blood groups without agglutination
- this is usually blood group AB
- however, can only donate blood to group AB

**iii) What is the difference between rhesus positive and Rhesus negative blood samples?**

- rhesus positive blood has the Rhesus (Rh) antigen
- rhesus negative lacks the Rhesus antigen

**vi) What is blood transfusion?**
- Introduction of blood from one person to another

**v) Under what conditions would blood transfusion be necessary in people?**
- during accidents
- during surgery in hospitals
- bleeding mothers when giving birth

**vi) How can low blood volume be brought back to normal?**
- transfusion
- taking fluids
- eating iron rich food/taking iron tablets

**How may excessive bleeding result in death?**
- Anaemia/low blood volume/loss of iron/low red blood cells count/low haemoglobin leading to low oxygen, loss of nutrients and dehydration.

**State the precautions that must be taken before blood transfusion**
- blood must be disease free
- sterilized equipment must be used
- blood of the recipient and that of the donor must b compatible to both ABO and rhesus factor
- Fresh blood must be used.

**j) i) What is immunity?**
- Resistance to disease by organisms

**ii) Distinguish between natural and acquired immunity**
- natural immunity is inherited/transmitted from parent to offspring/inborn/innate
- Acquired immunity is developed after suffering from a disease or through vaccination.

**iii) What are allergic reactions?**
- Excessive sensitivity and reaction of an individual to certain substances in environment e.g. dust, pollen, perfumes, smoke etc.

**vi) How does an allergic reaction occur?**
- the substances act as antigens
- an antigen-antibody reaction occurs on surface of cells
- the cells release a substance called histamine
- the histamine causes irritation, itching and may stimulate nasal discharge

**v**
**ii) State the role of vaccination against certain diseases**
- protect body against infectious diseases
- prevent spread/transmission of certain diseases
- diseases for which vaccination is given include tuberculosis, poliomylitis,measles, whooping cough, diphtheria

**3. a) i) What is gaseous exchange?**

- The continous exchange of oxygen and carbon Iv oxide between the organism and environment.

**ii) Why is gaseous exchange important to organisms?**

- to supply oxygen necessary for energy production
- to remove carbon IV oxide produced during respiration
- To remove water vapour.

**b) i) name the structure used for gaseous exchange by plants**

- stomatal pores/stomata
- lenticels
- cuticle
- pneumatophores

**ii) Briefly describe the structure of stomata**

- are minute pores found in leaf epidermis
- each consists of a slit-like opening
- Each is bordered by two large, bean-shaped guard cells.
- Guard cells contain chloroplasts, unlike the other epidermal cells which enable photosynthesis to occur
- Inner walls of guard cells are thicker than the outer cells

**iii) State the factors which affect stomatal opening**

- water which when low stomata close and when high stomata keeps open
- light as stomata open in bright light and close in darkness
- temperature

**iv) Name the theories suggesting the mechanism of opening and closing of stomata**

- interconversion of starch and sugar
- pH theory
- mineral ion concentration

**v) Describe the mechanism of opening and closing of stomata**

- stomata close at night and open during daytime
- This comes about due to changes in turgidity as a result of pH changes in guard cells.
- In the dark carbon Iv oxide accumulates in the intercellular spaces
- This raises concentration of carbonic acid
- The pH drops (pH lowered)
- Enzymes convert sugar into starch in guard cells
- Osmotic pressure in guard cells is lowered
- Water moves out of guard cells by osmosis making cells lose turgidity hence become flaccid
- The stomata close
- During day time there is photosynthesis hence the production of sugar, carbon IV oxide concentration is lowered, pH increases, guard cells become turgid causing stomata to open.

- During the day potassium ions concentrate in guard cells, raising their osmotic pressure and causes then to open
- In the night the concentration of potassium ions decreases increasing osmotic pressure in guard cells therefore causes stomata to open.

**vii) What is the advantage of having stomata open during daytime and having them closed at night?**

- opening in the daytime allows diffusion of carbon IV into the leaf for photosynthesis to take place and allows diffusion of oxygen out of the leaf
- transpiration also takes place, thus cooling the leaf and facilitating uptake of water and mineral slats
- Closing in the night is to conserve water in the plant especially when there is not enough water available in the soil.

**c) i) State the ways in which leaves of plants are adapted to gaseous exchange**

- presence of stomata for faster gaseous exchange
- intercellular spaces/air spaces in the leaf for movement/circulation of air
- film of moisture around the surface of cells for easy diffusion
- broad/flattened shape to increase surface area
- thin lamina to reduce distance of diffusion
- exposed to air for easy diffusion

**ii) Describe how gaseous exchange takes place in terrestrial plants**

- Gaseous exchange takes place in spongy mesophyll
- During the day air diffuses into large air spaces of spongy mesophyll through stomata
- The carbon iv oxide in the air diffuses into the photosynthesis oxygen is produced
- Some of the oxygen diffuses out of the leaf through stomata
- During the night air diffuses out of air spaces of spongy mesophyll
- The air dissolves into film of moisture
- The oxygen in the air diffuses into cells and is used in respiration during which carbon iv oxide is produced
- The carbon iv oxide diffuses out of the leaf through stomata due to diffusion/concentration gradient
- At night carbon iv oxide accumulates in the leaf since photosynthesis does not take place
- Some gaseous exchange also takes place through cuticle
- Gaseous exchange occurs through epidermis of young leaves and stems
- The cork cells at lenticels are loosely packed
- Gaseous exchange takes place between cork and atmosphere within the loosely packed cells

**iii) State the ways in which floating leaves of aquatic plants are adapted to gaseous exchange**

- stomata found only on upper dermis to allow efficient gaseous exchange
- presence to aerenchyma tissues/large air spaces to enable it float/buoyancy/storage of air
- absence of cuticle to enhance gaseous exchange

**iv) How is aerenchyma tissue adapted to its function?**

- has large airspaces which store gases/for gaseous exchange/buoyancy

**v) Explain stomatal distribution in plants of different habitats**

- land plants have their stomata mainly on the lower side to reduce water loss but if on both sides then upper side has very few
- water plants, floaters, have stomata on upper side to enhance water loss
- in dry areas, plants have leaves with sunken stomata to reduce water loss by transpiration
- Plants in wet areas have stomata equally distributed on both sides.

**d) i) List the types of respiratory surfaces of animals**

- cell membrane in unicellular organisms e.g. amoeba
- gills in fish
- tracheal system
- skin, buccal cavity and lungs in amphibians
- lings in mammals

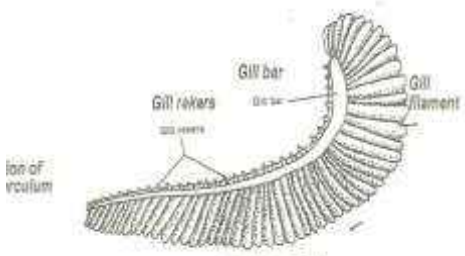
**ii) State the characteristics of respiratory surfaces in animals**

- moist
- thin walled/thin membrane/thin surface
- Highly/richly vascularised/numerous blood vessels/well supplied with blood vessels.
- Large surface area

**iii) Describe gaseous exchange in protozoa**

- example is amoeba
- small and have large surface area
- oxygen diffuses into the organism and carbon IV oxide diffuses out into water
- simple diffusion of gases is enough to meet its respiratory requirements

**e) i) Make a labeled drawing of a fish gill**



A gill of a fish

**ii) How is a fish gill adapted to its function?**

- large surface area due to many filaments
- extensive vascularisation due to capillaries, for gaseous exchange
- thin filaments to facilitate diffusion of gases
- presence of rakers to filter solid particles
- gill bar is bony, hard and firm to support the filaments and rakers and for attachment of filaments and rakers

**iii) Discuss gaseous exchange in bony fish**

- example is tilapia
- the mouth opens and the floor of the mouth is lowered so that the volume in the mouth is increased and pressure is lowered
- water then enters into the mouth cavity
- the mouth is closed and the floor of the mouth raised so that the volume is reduced
- this raises the pressure, forcing water over gills and out through the operculum
- As water passes over the gills oxygen diffuses due to concentration gradient (partial pressure) into the blood stream.
- In the body tissues, carbon IV oxide diffuses into the blood (due to concentration gradient, and is transported to the gills and diffuses out into the water.

**iv) What is counter-flow system?**

- Where water in which the fish lives flows in opposite direction across the gill.

**vi) What is the advantage of counter-flow system?**

- maintains a diffusion gradient so that there is maximum uptake of oxygen
- oxygen continues diffusing into blood and carbon iv oxide into water

**f) i) Describe the mechanism of gaseous exchange in terrestrial insects**

- example is cockroach
- air in the atmosphere contains oxygen
- air is drawn into the body of the insect through the spiracles due to movement of abdominal muscles
- these movements cause the opening of spiracles
- air moves through the trachea to tracheoles
- oxygen moves from the tracheoles into body cells by diffusion due to concentration gradient
- carbon iv oxide in the tissues diffuses into tracheoles due to concentration gradient
- From tracheoles carbon IV oxide moves into trachea and out through the spiracles into the air.

**ii) State how traceholes are adapted to gaseous exchange**

- thin walls of tracheoles
- moist surface
- large surface area due to numerous tracheoles

**g) i) What is breathing?**

- Any process which speeds up the rate of gaseous exchange between an animal and its surrounding.

**ii) Name the structures in humans that are used in gaseous exchange**

- nose
- larynx
- epiglottis
- trachea
- lungs
- pleural membrane
- pleural cavity
- diaphragm muscles

**iii) Describe the mechanism of gaseous exchange in a mammal**

Breathing in

- external intercostals muscles contract while internal intercostals muscles relax, raising the ribcage upwards and outwards
- muscles of the diaphragm contract hence it flattens
- the volume of the thoracic cavity increases while pressure decreases
- higher air pressure in the atmosphere forces air into lungs through the nose

Breathing out

- external intercostals muscles relax while internal intercostals muscles contract, moving the ribcage downwards and inwards
- muscles of the diaphragm relax hence the diaphragm assumes dome shape
- the volume of the thoracic cavity decreases while pressure increases
- the higher pressure forces air out of the lungs through the nose

**iv) Explain how mammalian lungs are adapted to gaseous exchange**

- large number of alveoli that increase surface area
- moist inner surface of alveoli for dissolving oxygen/gases to facilitate exchange of gases through alveolar cavities and blood
- thin walls of alveoli to allow efficient/faster diffusion of gases
- rich capillary/blood supply on alveolar surface to transport oxygen away from the lungs and carbon IV oxide to the lungs

**v) Name the features of alveoli that adapt them to their function**

- have large surface area/spherical shaped
- numerous/many to increase surface area
- one cell thick
- moist surface for air to diffuse
- highly vascularised/numerous capillaries

**vii) How is the trachea of a mammal suited to its function?**

- has a ring of cartilage which keeps it open at all times
- cilia that move mucus/particles to the top of the trachea i.e. into larynx for removal
- mucus to trap dust, solid particles and microorganisms
- hollow for passage of air

viii) **State the advantages of breathing through the nose rather than through the** mouth

- nose has hairs to filter solid particles
- it has mucus lining to trap dust particles
- the nose has cells sensitive to smell for survival
- it warms the air before it reaches the lungs

**ix) Give the conditions under which the carbon iv oxide level rises above normal in mammalian blood**

- vigorous exercise
- emotions/stress
- disease infection

**x) Explain the physiological changes that occur in the body to lower the carbon iv oxide level back to normal when it rises**

- heartbeat/cardiac frequency increases to pump blood faster carbon iv oxide from the tissues and supply more oxygen
- ventilation rate/rate and depth of breathing increases to take more oxygen and remove carbon iv oxide from the lungs
- arterioles to take in more oxygen and remove carbon iv oxide from the lungs
- arterioles dilate leading to faster flow of blood to and from body tissues

**h) i)Describe the factors which control the rate of breathing in humans**

- breathing movements usually occur unconsciously
- it is controlled by the medulla oblongata part of the brain situated at the breathing centre
- medullar oblongata is in the brain
- respiratory centre transmits impulses to the diaphragm through phrenic nerves
- carbon iv oxide concentration in the blood determines the breathing rate
- if carbon iv oxide is less, the brain is triggered to decrease breathing rate
- cardiac frequency decreases and the arterioles constrict
- therefore carbon iv oxide level is raised
- this brings back to normal level of breathing and carbon iv oxide level increases/is more the brain is triggered to increase breathing rate
- cardiac frequency is increased
- there is vasodilation of arterioles
- carbon iv oxide level falls
- therefore the normal level is attained and carbon iv oxide is removed faster

**ii) Name the respirator diseases**

- asthma
- bronchitis
- whooping cough
- pneumonia
- tuberculosis

**4. a) i) Define respiration**

- the oxidation/breakdown of food within cells to release energy

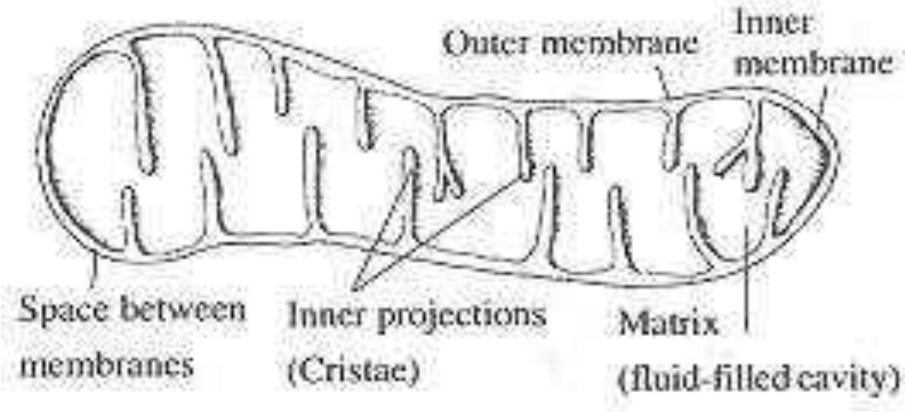
**ii) Explain the significance of respiration in living organisms**

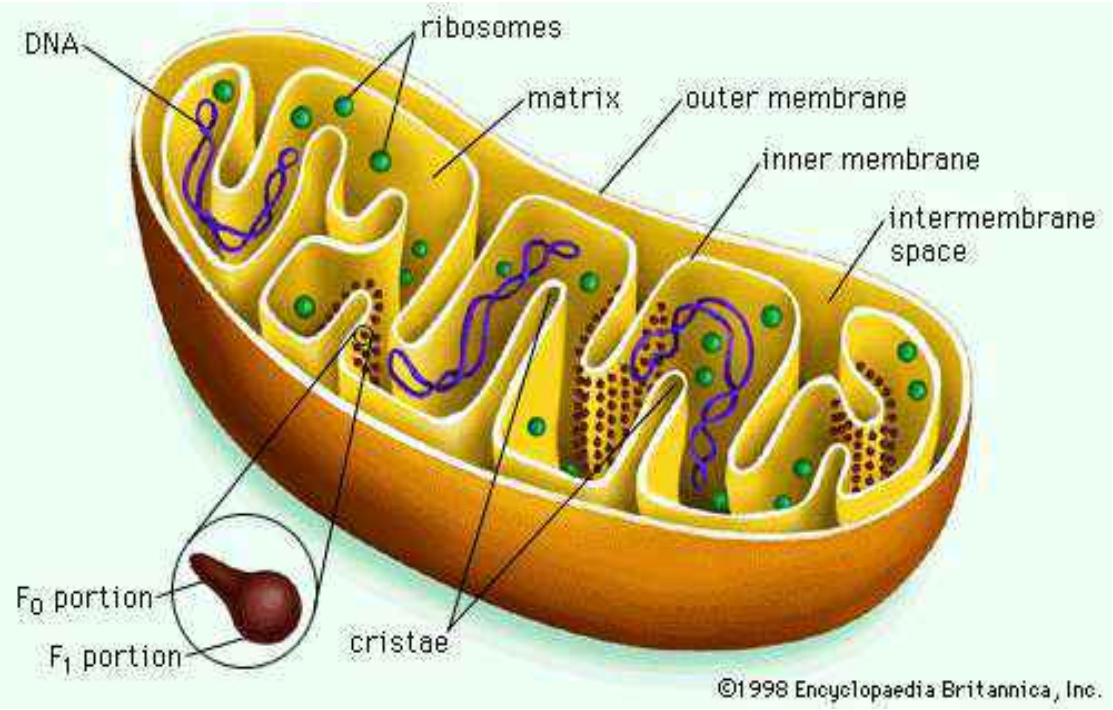
- it yields energy (ATP)
- this energy enables organisms to move, grow, excrete and reproduce

iii) Where does respiration take place?

- in the mitochondria

**b) i) Draw and label a mitochondrion**



**ii) State the most important function of mitochondria**

- to produce Adenosine triphosphate (ATP) which is the energy source of the whole cell

**iii) Give the functions of the labeled parts**

**Outer membrane**

- controls what enters and what leaves mitochondrion

**Cristae**

- also called inner membrane
- increase surface are for attachment of enzymes
- this is where cellular oxidation reactions occur

**Matrix**

- enzymes are located here
- other reactions occur here

**c) explain the roles of enzymes in respiration**

- they catalyse reactions i.e. speed up respiration

**d) i) What is aerobic respiration**

- respiration in the presence of oxygen

**ii) Give a word equation for aerobic respiration**

- glucose + oxygen - water + carbon iv oxide + energy

**iii) What are the end products of aerobic respiration?**

- energy
- carbon iv oxide
- water

**e) i) What is anaerobic respiration**

- occurs in the absence of oxygen
- e.g. yeast and certain bacteria release energy in the absence of oxygen

**ii) What are obligate anaerobes?**

- are completely independent of oxygen

**iii) What are facultative anaerobes?**

- can survive both in the presence and absence of oxygen
- also called partial anaerobes

**iv) State the word equation representing anaerobic respiration in plants**

- Glucose ethanol + carbon iv oxide + energy

**v) Name the end products of anaerobic respiration in plants**

- alcohol/ethanol
- carbon iv oxide
- energy

**g) i) Give a word equation of anaerobic respiration in animals**

- Glucose lactic acid + energy

**ii) Name the end products of respiration in animals when there is insufficient oxygen supply**

- lactic acid
- energy

**iii) Why is there a high rate of lactic acid production during exercise?**

- the demand for oxygen is more than supply leading to anaerobic respiration

**iv) Why does lactic acid level reduce after exercise?**

- lactic acid is oxidized to form carbon iv oxide and water
- some is converted to glucose
- some is converted into glycogen

**v) State why accumulation of lactic acid during vigorous exercise lead to an increase in heartbeat**

- lactic acid is poisonous to tissues and must be removed
- to increase supply of oxygen to tissues

**State the economic importance of anaerobic respiration**

- brewing of alcohol
- biogas production
- compost manure formation
- silage formation
- baking bread
- production of dairy products
- fermentation of milk
- sewage treatment
- Fermentation of tea in industries.

**What is oxygen debt?**

- amount of oxygen required to convert accumulated lactic acid to water, carbon IV oxide and energy

**h) i) What is respiratory quotient(RQ)?**

- ration of carbon IV oxide produced to oxygen consumed

$$RQ = \frac{\text{volume of } CO_2 \text{ produced}}{\text{Volume of oxygen consumed}}$$

**ii) Why are respiratory quotient important**

- their calculation assists in identifying the kind of substrate being used in respiration

**iii) Name the respiratory substrates**

- carbohydrates
- fats
- proteins

**iv) Why does anaerobic respiration of a given substrate yield a smaller amount of energy than aerobic respiration?**

- Some energy locked up in intermediate products like ethanol in plants and lactic acid in animals
    - substrate is completely oxidized in aerobic respiration

**iv) Explain the disadvantages of anaerobic respiration**

- Less energy produced in anaerobic respiration since food is partially oxidized while in aerobic respiration food is completely oxidized.
- Some metabolic wastes accumulate in cells affecting cellular functions
- Ethanol produced in plants poisons the tissues while lactic acid produced in animals causes muscle fatigue/muscle cramp and may stop muscle contraction
- Such intermediate wastes are not produced in aerobic respiration

**v) Mention the types of experiments carried out for respiration**

- germinating seeds which yield energy in form of heat
- animals produced heat when they respire
- yeast cells respire to produce heat

**5. a) i) Define the following terms**

**Excretion**

- the process by which organisms get rid of waste products which result from chemical process which occur in living cells

**Secretion**

- the process by which organisms produce substances which are useful to the body, by glands

**Egestion**

- removal of indigestive materials from the body

**Homeostasis**

- maintenance of constant internal environment

**ii) Explain why excretion is necessary in plants and animals**

-products of excretion are usually harmful while some are toxic
- if allowed to accumulate in the cells they would destroy tissues and interfere with normal metabolism
- They are therefore removed through excretion

**b) i) Describe how excretion takes place in green plants**

- carbon IV oxide, oxygen and water diffuse through the stomata, lenticels and hydathodes
- some toxic wastes are converted into non-toxic substances
- these are deposited in certain tissues of the plant or stored in aging structures
- resins and tannins are exuded through the bark of stem or lost during leaf fall

**ii) Why do plants lack complex excretory structures like those of animals?**

- plants have lower rates of metabolism
- plants excrete non-poisonous products derived from carbohydrate metabolism unlike animals which produce toxic wastes derived from protein metabolism
- plants re-use some of their wastes like nitrogenous wastes used in protein synthesis
- plants store waste products in roots, fruits and leaves

**ii) State the excretory products of plants and some of their uses to humans**

- **caffeine** from tea and coffee is used in medicine and as a stimulant which is harmful to humans
- **quinine** used for treating malaria
- **cocaine** derived from leaves of cocoa plant used as a stimulant by addicts or as a local anesthesia, also causes damage to the brain, may cause addiction if not well used and is an illegal drug
- **Tannins** derived from barks of acacia (wattle bark) trees are used to make ink and tanning (softening) of leather.
- **Nicotine** got from leaves of tobacco plant stimulates the central nervous, may cause addiction if much is used or consumed. It is used to make cigarettes, cigars and is poisonous. It is a precursor of lung cancer
- **Cannabis sative(**bhang) is used to make drugs
- **Gum** derived from glues is used for sticking substances and making certain jellies
- ***Rubber***, a product of latex, got from rubber plant is sued to make tyres and synthetic fibres
- **Morphine** from opium poppy plant is a narcotic and illegal drug as it causes addiction
- **Khat and miraa** are used as stimulants
- **Colchicines** used in inducing polyploidy, cancer therapy, treatment of gouts in small quantities
- **Papain** used as meat tenderizer

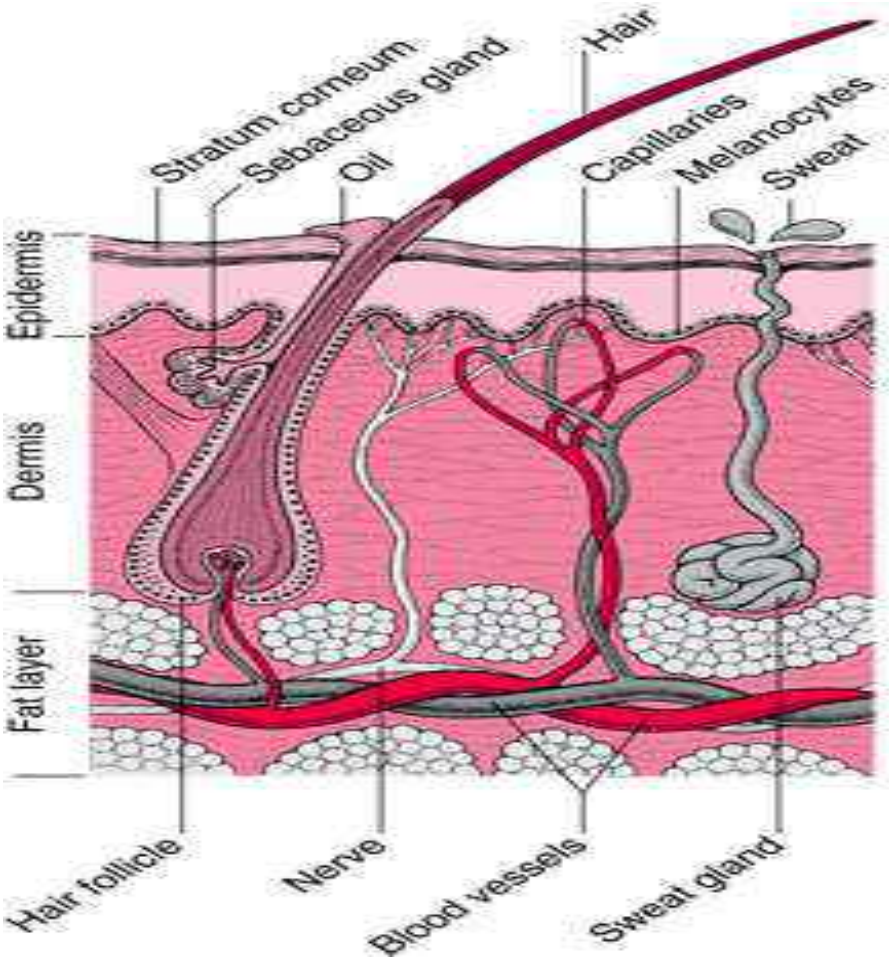
**c) i) Describe excretion in unicellular organisms**

-examples are amoeba and paramecium
-They have to remove waste products such as carbon IV oxide and nitrogenous substances e.g urea and ammonia
- These diffuse from the body surface into the surrounding water
- Diffusion is due to large surface area

**ii) List excretory organs and products of mammals**

- kidney excretes urea, water and salts
- skin excretes water, slats and urea
- lungs excrete carbon IV oxide and water
- liver excretes bile salts

**d)i) Draw and label a mammalian skin**




**ii) Explain how the mammalian skin is adapted to its functions**

- the skin is made up of dermis and epidermis

**Epidermis**

- it is made up of three layers
- the outermost layer, cornified layer is made up of dead cells that prevent entry of microorganisms, prevent physical damage and dessication
- granular layer made of living cells gives rise to cornified layer
- malpighian layer is made up of actively dividing cells that give rise to new epidermal cells/granular layer it contains melanin that protects the body against ultra violet rays(radiations)

**Dermis**

- has several components
- Has sweat gland which produce sweat through sweat pores on the skin and the sweat evaporates cooling the body by lowering body temperature. When it is cold, no sweat is produced, conserving water
- sweat contains water, sodium chloride, uric acid and urea hence the skin acts as an excretory organ
- Has hair. The hair stands erect to trap air when temperature is low to reduce loss/insulation. It lies flat to allow heat loss when temperature is high.
- Has nerve endings which are sensitive to stimuli such as heat, cold, pain, pressure and touch
- Has subcutaneous fat/adipose fat that insulates the body against heat loss
- Has arteries and capillaries (blood vessels) that supply food and oxygen and remove excretory products. Arterioles vasodilate when temperatures are high to lose heat by radiation, and convention. Arterioles constrict when temperatures are low to conserve heat i.e. reduce heat loss
- Has sebaceous glands which secrete sebum, and antiseptic and water repellant that prevents drying and cracking the skin by making the skin supple

**e) What is the role of lungs in excretion?**

- during respiration oxygen is used up in the body cells to produce energy
- carbon IV oxide is produced as a by-product
- the carbon IV oxide must be eliminated from the body
- elimination is through the lungs
- also, water vapour is formed and must be removed
- this removal is through the lungs
- the lung is therefore considered as an excretory organ as it removes carbon IV oxide and water vapour which are by-products of respiration

**f) State the functions of the liver**

**i. Excretion**

- in this function the liver is aided by the kidney
- deamination i.e. excess amino acids converted into urea and uric acid which is transported to skin and kidney for removal
- detoxification where harmful substances are converted into harmless ones in the liver and transported to kidneys for removal
- breakdown of worn out blood cells and haemoglobin and the residue excreted through the kidney to give urine a yellow tinge
- Breakdown of sex hormones after they have performed their function and the wasted are released through the kidney and bile.

**ii) Homeostasis**

- regulation of blood glucose
- the normal amount of glucose in blood is about 90mg/100
- increase in blood sugar is detected by cells of the pancreas which secrete insulin
- insulin stimulates the liver to convert excess glucose to glycogen
- further excess glucose is converted to fats until the normal blood sugar level is attained
- Excess glucose is oxidized to carbon IV oxide, water and energy. Excess glucose is also used in respiration
- decrease in blood sugar level below normal level is detected by the pancreas, which secretes glucagon which stimulates the liver to convert glycogen to glucose until the normal sugar level is attained
- fats, amino acids are converted to glucose
- it also leads to reduced oxidation of glucose

**Deamination**

- excess amino acids are deaminated by the removal of amino group
- the amino group is converted to ammonia
- ammonia combines with carbon IV oxide to form urea
- urea is excreted in urine through the kidney

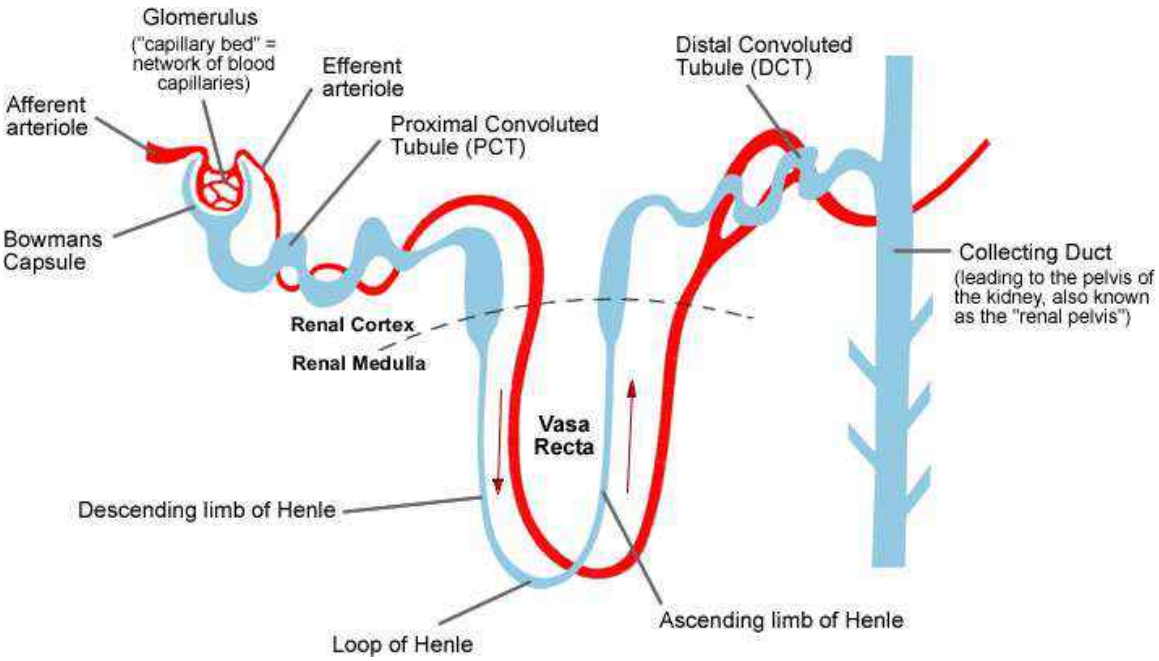
**Detoxification**

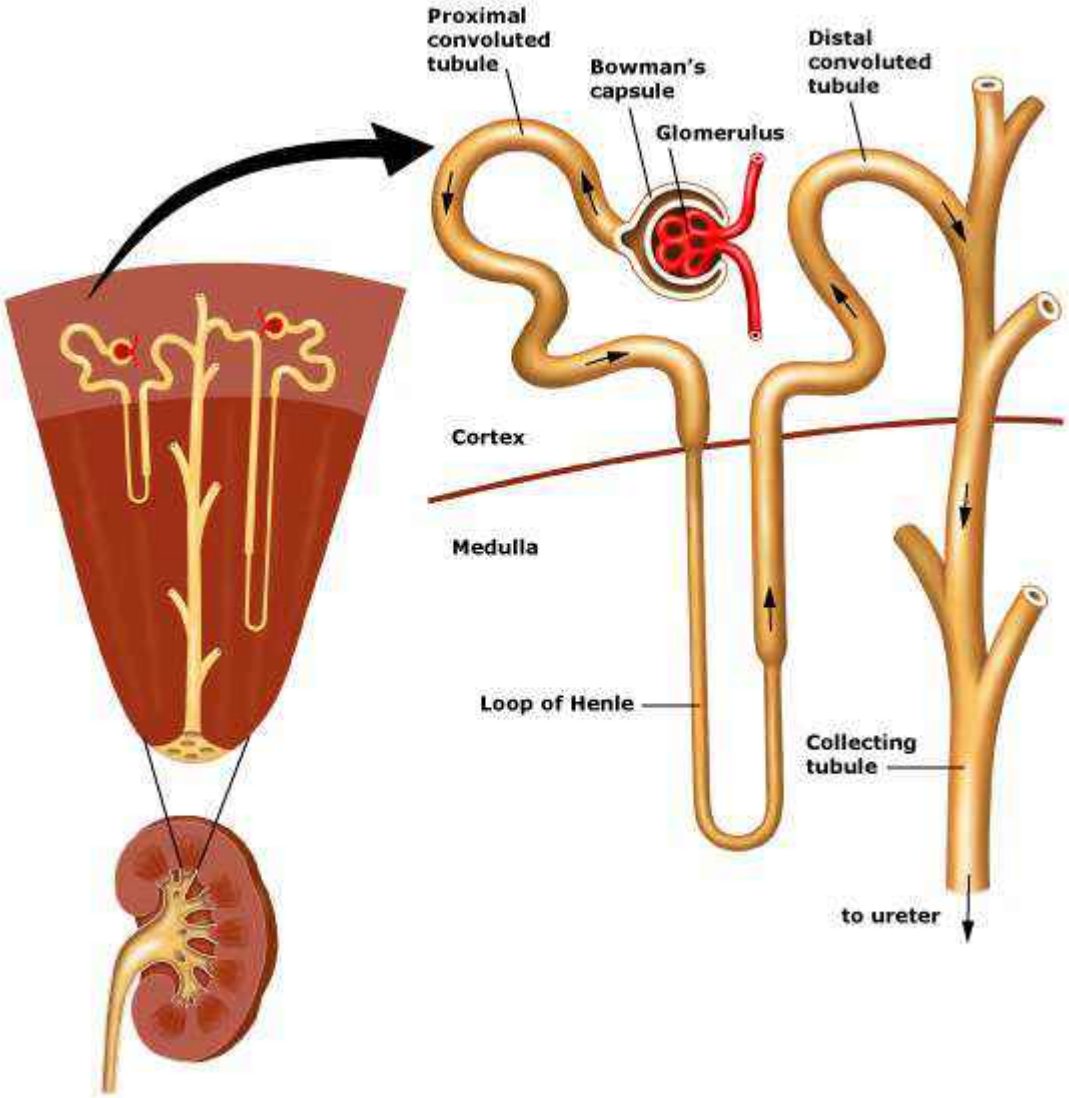
- poisonous substances are converted to less harmful compounds

**Thermal regulation**

- maintenance of body temperature
- heat is generated in the liver by chemical activities
- the heat is distributed

**g) i) Draw a labeled diagram of mammalian nephrone**




Proximal convoluted tubule
Bowman's capsule
Glomerulus
Distal convoluted tubule
Cortex
Medulla
Loop of Henle
Collecting tubule
to ureter

**ii) Describe how the human kidney functions**

- the afferent arterioles, which is a branch of the renal artery, supplies blood to the glomerulus
- the afferent arteriole has a wider diameter than the efferent arteriole
- this difference in diameter of afferent and efferent vessels causes high pressure leading to ultra filtration
- the walls of the blood capillaries are one cell thick hence glucose, amino acids, vitamins, hormones, salts, cratinine, urea and water filter into Bowman's capsule to form glomerular filtrate
- white blood cells, red blood cells, plasma proteins (such as globulin) and platelets are too large to pass through the capillary walls hence remain in blood capillary
- the filtrate flows into proximal convoluted tubule where amino acids, vitamins and all glucose are selectively reabsorbed back into the blood stream
- many mitochondria provide energy for reabsorption of these substances against a concentration gradient by active transport
- the glomerular filtrate flows into the loop of Henle
- water in the descending loop moves by osmosis into the blood capillaries
- sodium chloride is actively pumped from the ascending arm of the loop of Henle into the blood capillaries
- the glomerular filatrate flows into the distal convoluted tubule
- water and salts are reabsorbed from distal convoluted tubule into blood capillaries
- the glomerular filtrate flows into collecting tubule (duct) from where more water is reabsorbed into blood stream
- antiduretic hormone influences the amount of water reabsorbed depending on osmotic pressure of blood
- the glomerular filtrate from collecting duct, now referred to as urine, is emptied into pelvis and ureter into bladder and out of body through urethra
- urine consists of excess water, slats and nitrogenous wastes

**iii) State the adaptations of proximal convoluted tubule to its function**

- folded to increase surface area for absorption
- thin epithelium to reduce distance of diffusion
- micro-villi on inner lining to increase surface area for absorption
- folded to reduce speed of flow for efficient absorption
- numerous mitochondira to provide energy for reabsorption
- dense capillary network to transport reabsorbed products

**iv) Name the common kidney diseases**

- nephritis
- kidney stones(renal calculi
- cystitis
- oedema
- kidney failure

**6. a) i) Why is homeostatic control necessary?**

- this provides a constant internal environment so that the cells of the body have the optimum (best) condition for their survival

**ii) What is internal environment?**

- immediate surrounding of body cells
- refers to tissue fluid within an organism

**b) i) Why is constant body temperature maintained by mammals?**

- most enzymes in the body function within a narrow range of temperature
- high temperature denatures enzymes
- low temperature inactivates and inhibits enzymes

**ii) Explain the advantage gained by possessing a constant body temperature**

- animals remain active despite fluctuations in environmental temperature
- higher chances of survival in various environments ie they colonize various environments
- chemical processes in their body continues at an optimum rate

**iii) How do mammals regulate body temperature?**

- the body temperature of a mammal is kept constant
- to maintain this temperature the mammal must be able to balance its heat loss against the heat gain
- body temperature is controlled by the hypothalamus, a specialized part of the brain
- changes in the temperature within the body and the surrounding are detected by the hypothalamus
- it transmits impulses to the skin and the blood stream in response to temperature changes
- hypothalamus acts as a thermostat for the body
- a mammal loses heat by breathing out, urine, feaces, skin by radiation and by evaporation of sweat.
- A mammal generates heat by the activity of its muscles, by general metabolism in respiration, or chemical activities
- In hot conditions the hypothalamus stimulates responses that increase heat loss from the body hence lowering the body temperature
- Such responses include sweating, vasodilation, keeping its hair flat on the surface of skin and reduction of metabolic rate
- In cold conditions the hypothalamus stimulates responses that generate heat gain in the body and reduce heat loss to the environment
- Such responses include shivering, vasoconstriction, raising its hair to trap a layer of air around the skin because still air is a good insulator of heat and by generation of heat by increasing metabolic rate.

**iv) Why does body temperature of a healthy person rise up to $37^{o}$C on a hot humid day?**

- sweat evaporation is reduced hence cooling is less therefore more heat is retained in the body causing temperature to rise

**v) Name the structures in the human body that detect external temperature changes**

- temperature receptors (end bulb corpuscles e.g. bulb of Krause (warmth) and organ of Ruffinni (cold)
- heat (thermal) receptors

**vi) State the advantages that organisms with small surface area to volume ratio experience over those with larger**

- heat loss slow hence their body temperature can increase to intolerable levels
- Heat gain from surrounding slower hence may remain inactive for a long time.
- Need specialized and complex transport system and also gaseous exchange system

**Explain why individuals with smaller sizes require more energy per unit body weight than those with larger sizes.**

- surface area to volume ratio is higher in smaller individuals than larger ones, therefore smaller heat is lost faster by smaller ones than larger ones
- they therefore require more energy per unit body weight to maintain body temperature

**c) i) What is the meaning of osmoregulation?**

- mechanism which regulates osmotic pressure of internal environment of an organism
- the regulation/maintenance of salt/solute-water balance of an internal environment

**ii) State the importance of osmoregulation**

- Maintenance of constant level of water and slats (osmotic pressure) for optimum/suitable conditions for metabolism suitable for cellular functions

**iii) State the ways by which desert mammals conserve water**

- fewer glomeruli
- longer loop of Henle
- excretion of dry feaces or concentrated urine
- hump for fat to be metabolized to give metabolic water for use
- nocturnal, burrowing, aestivate or hibernate
- sweat glands few or absent
- more ADH (vasopressin)

iv**) Explain why some desert animals excrete uric acid rather than water**

- uric acid is less toxic than ammonia, hence elimination of uric acid requires less water than ammonia therefore more water conserved
- uric acid being less toxic is safer to excrete where there is less water/desert

v**) Explain why eating a meal with too much salt leads to production of a small volume of concentrated urine**

- the concentration of salts in the blood rises leading to production of more ADH hence higher rate of water reabsorption by kidney tubules

**vi) Explain how marine fish regulate their osmotic pressure**

- swallow plenty of sea water to increase amount of water in the body
- have chloride excretory cells in their gills to remove excess salts
- eliminate nitrogenous wastes in form of trimethalamine oxide which requires little water for elimination
- few/small glomeruli thus slow filtration rate in the kidneys
- retain nitrogenous wastes in form of urea to raise osmotic pressure of body fluids

**d) i) What is the biological significance of maintaining a relatively constant sugar level in a human body?**

- body cells are surrounded by tissue fluids that are isotonic/same osmotic pressure as cytoplasm
- if sugar level is high/hypertonic, cell will lose water by osmosis to the surrounding, thus increasing the concentration of the contents
- this changes the physiology of the cell
- if the blood sugar is lower than the normal, the cytoplasm gains water by osmosis, diluting the cell contents, thus altering the physiology of the cell

**ii) Discuss the role of the following hormones in blood sugar control**

**Insulin**

- insulin is produced when there is increase in blood sugar concentration
- it converts glucose to glycogen which is in the liver or muscle thus lowering sugar level

**Glucagon**

- when glucose level decreases glucagon is produced, which causes the breakdown of glycogen to glucose thus raising blood sugar level

**e) Explain the part played by antidiuretic hormone in homeostasis**

- Produced when there is less water (high osmotic pressure above normal level of salt concentration) in the blood.
- It acts on kidney tubules (nephron) thus increasing water reabsorption from tubules to the blood stream, thus restoring osmotic pressure
- When there is more water(lower osmotic pressure) or decreased salt concentration in blood, little or no ADH is produced, less water reabsorbed hence water loss in urine (more dilute urine) hence raising the osmotic pressure in body fluids/blood

**f) What is the role of blood clotting in homeostasis?**

- when a blood vessel is cut, there is exposure of blood platelets to the air
- this triggers fibrinogen to be converted to fibrin
- the fibrin forms a clot that prevents body fluids e.g. blood from being lost
- therefore the clot conserves water and salts in the body

**g) Describe the role of the following hormones in homeostasis**

**i. Aldosterone**

- concerned with regulation of ionic balance
- secreted by the cortex of adrenal glands
- it increases sodium ion uptake by the gut and promotes the reabsorption of sodium ions (and therefore water) in the kidneys)
- this is accompanied by elimination of potassium ions
- this raises the overall level of sodium and lowers the overall level of potassium in the blood
- as sodium ions are absorbed in the blood, chlorine ions follow so as to neutralize the effect of sodium ions
- the production of aldosterone is regulated by the concentration of sodium ions which has an inhibiting effect, and a fall in sodium ions has a stimulating effect on the adrenal cortex
- the flow of aldosterone is stimulated by the adreno-cortic-tropic hormone (ACTH) produced in the anterior of the pituitary gland
- however, the main method of control is dependent on the fact that adrenal cortex itself is somehow sensitive to the relative concentration of potassium and sodium in the blood

**ii. Adrenaline**

- produced by adrenal glands
- in high concentrations, it increases hydrolysis of glycogen and increases blood sugar
- it is usually released in emergency cases to increase glucose level for respiration
- this releases energy for the emergency

**h) i) Distinguish between diabetes mellitus and diabetes insipidus**

- diabetes mellitus is a condition resulting from insufficient production of insulin causing hyperglucaemia and presence of glucose in urine
- diabetes insipidus is a condition whereby less or no antidiuretic hormone is secreted hence a high volume of water is passed out in urine in a condition called diuresis

**ii) How can high blood sugar level in a person be controlled?**

- administer insulin

**iii) Why does glucose not normally appear in urine even though it is filtered in the mammalian Bowman's capsule?**

- glucose molecules are actively reabsorbed in the proximal convoluted tubules

**iv) When is glycogen which is stored in the liver converted into glucose and released into the blood?**

- after activity/when blood sugar (glucose) falls below normal
- when glucagon
- stimulates the liver/when glucagon is produced
- after strenuous/vigorous activity
- during starvation

**v) How would one find out from a sample of urine whether a person is suffering from diabetes mellitus?**

- test or react urine in Benedict's solution
- positive result i.e. orange or red precipitate
- Positive result is an indication of diabetes mellitus.

# FORM III TOPICS

**1. a) i) What is meant by the term binomial nomenclature?**

- scientific system of naming organisms using the generic(genus) and specific (species) names

**ii) State briefly the general principles of classification of living organisms**

- scientific names must be in Latin or should be latinised
- family names are formed by adding the suffix "idea" to the stem of the genus e.g. the genus Rana become Ranaidea
- generic names should be a single unique name

**b) State the main characteristics of the five kingdoms of organisms**

**i. Monera**

- e.g. bacteria
- unicellular (single celled)
- prokaryotic (genetic material not surrounded by membrane)
- cell wall without cellulose
- lack most organelles
- small in size (microscopic)

**ii. Protista(protoctista)**

- single celled(unicellular)
- eukaryotic (most cell organelles present)
- when cell walls are present have no cellulose
- e.g. protozoa and algae
- usually microscopic

**iii. Fungi**

- have hyphae (which form mycelia)
- absence of chlorophyll
- have rhizoids (lack roots, leaves, stem)
- have spore forming structures (sporangia)
- e.g. mucor, rhizopus

**iv. Plantae**

- most are green/contain chlorophyll
- autotrophic/feed by photosynthesis
- cells have cellulose cell walls
- respond slowly to stimuli (tropism)
- lack locomotion (are stationary)
- indefinite growth (at meristems)
- lack specialized excretory structures

**v. Animalia**

- cells do not have cell walls
- most carry out locomotion
- heterotrophic
- fast response to stimuli (tactic)
- have specialized excretory structures

**c) Describe the economic importance of:**

**i. Fungi**

- some cause decay to our food
- some cause diseases to humans and animals e.g. ringworms
- may be used as food e.g. mushrooms, yeast
- some are used in production of antibiotics e.g. penicillin, chloromycin, streptomycin
- yeast is used in brewing industry, baking and source of vitamin B
- many cause diseases to our crops e.g. late blight
- important in recycling nutrients in soil since they cause decay of organic matter
- mycorrhizal association in forest development may help in water intake/absorption
- help in nitrogen fixation

**Bacteria**

- are useful in the manufacture of antibiotics
- silage formation,
- fermentation of cheese, butter, milk yoghurt
- curing of tea, tobacco and retting flax
- formation of vitamin B12 and K
- enzymes such as amylase and invertase
- hormones such as insulin
- vinegar, acetic acid, lactic acid, citric acid
- in septic tanks and modern sewage works make use of bacteria
- biogas production
- saprophytic bacteria are used in compost decomposition or cause decay
- symbiotic bacteria are used in compost decomposition or cause decay
- symbiotic bacteria in herbivores/ruminants help in digestion
- some diseases in animals/humans and plants are caused by bacteria
- many bacteria cause food spoilage/decay
- nitrifying and nitrogen fixing bacteria increase soil fertility/make nitrates available
- denitrifying bacteria reduce soil fertility/convert nitrates into nitrogen/reduce nitrates

**d) State the main characteristics of the following division of kingdom plantae**

**i. Bryophyte**

- e.g. mosses and liverworts
- presence of rhizoids
- lack of vascular tissues (lack phloem and xylem)
- body parts not differentiated into root, stem, leaves
- capsule or seta
- gametophyte generation dominant.

**ii. Pteridophyta**

- e.g. ferns
- has true roots, stems and leaves
- fond with sori on under-surface
- vascular tissues present
- sporophyte generation is dominant

**iii. Spermatophyte**

- photosynthetic
- well differentiated into roots, stems and leaves
- well developed vascular system
- seed bearing plants

**e) Name sub-divisions of spermatophyte and state the characteristics of each class**

**i. Gymnospermae (cornifers)**

- naked seeds (exposed
- are all woody trees
- reproduce by means of cones
- show xerophytic characteristics
- xylem have tracheids but lack vessels
- phloem lacks companion cells
- single fertilization
- pollen lands directly on ovules

**ii. Angiospermae (flowering plants)**

- reproduce by flowers
- seeds enclosed (in fruits)
- flowers bisexual hence double fertilization
- herbaceous
- pollen grains land on stigma of pistil
- xylem contains vessels
- phloem contains companion cells
- ovules contained in ovary

**iii. Name the classes and state characteristics of angiospermae**

**Dicotyledonae**

- two seed leaves
- network venation of leaves
- regularly arranged vascular bundles
- tap root system
- broad leaves
- secondary growth occurs

**Monocotyledonae**

- one seed leaf
- parallel venation of leaves
- irregularly arranged vascular bundles
- fibrous root system
- narrow leaves
- sheath like leaf stalk (petiole)
- no secondary growth

**iv) State the importance of plants**

- balancing carbon IV oxide and oxygen in the atmosphere during photosynthesis and respiration
- influence water cycle
- reduce soil erosion by bind soil particles together
- useful products e.g. food, medicine, timber, paper and clothing
- habitat ( e.g. forests and grassland) for animals which may also be tourist attraction
- earn money from sales of products
- aesthetic value/beauty e.g. flowers, shade/shelter, live fences, windbreaks
- Some are harmful e.g. poisons, weeds, injurious (stinging nettles, thorns), water hyacinth.

**f) i) Give the general characteristics of phylum arthropoda**

- jointed appendages
- presence of exoskeleton
- triploblastic and coelomate
- segmented body
- bilateral symmetry (similar halves)

**ii. State the characteristics of the following classes of arthropoda**

**Diplopoda**

- the millipedes
- two pairs of legs per segment
- many segments
- terrestrial habitat
- body cylindrical and long
- herbivorous
- one pair of antennae

**Chilopoda**

- the centipedes
- one pair of legs per segment
- many segments
- terrestrial habitat
- body long and ventro-dorsally flattened
- carnivorous
- last pair of legs pointing backwards with poison claws called maxillipedes
- one pair of antennae

**Insecta**

- three body parts i.e. head thorax, abdomen
- six legs/three pairs of legs
- a pair of compound eyes
- presence of wings
- a pair of antennae

**Crustacean**

- two body parts
- segmented body
- have pincers (modified legs) to catch prey
- have hard exoskeleton
- a pair of compound eyes

**Arachnida**

- body divided into two parts( abdomen and cephalothorax)
- simple eyes
- eight legs (four pairs of legs)

**iii) State the economic importance of insects**

**Beneficial effects**

- food supply
- important in food chains
- pollinators
- biological control of pests and other organisms
- aesthetic value
- contribute to decomposition e.g. litter feeders like beetles

**Harmful effects**

- pests
- vectors
- dirt and disease carriers
- injurious e.g. stings and bites

**g) i) State the general characteristics of chordate**

- notochord
- dorsal slits (pharyngeal cleft during development)
- bilateral symmetry
- triploblastic (three layer body-ectoderm, mesoderm and endoderm)
- clear cut head formation
- multilayered epidermis
- post anal tail
- closed circulatory system
- segmented muscle blocks(myotomes)
- single pair of gonads

**Give the characteristics of the following classes of chordate**

**Pisces**

- presence of fins for locomotion
- two chambered heart
- presence of overlapping scales
- presence of gills or operculum for gaseous exchange
- presence of lateral line for protection
- streamlined body
- poikilothermic (body temperature varies with that of environment)

**Amphibian**

- partially live in fresh water and partially on land
- poikilothermic
- pentadactylous with two pairs of limbs
- webbed feet for locomotion in water
- body streamlined
- heart is three chambered
- moist skin for gaseous exchange

**Reptilia**

- scales on body
- poikilothermic
- homodont teeth except tortoise and turtle
- all have limbs except snakes
- skin is dry
- oviparous (lay eggs)
- no pinna (external ear)
- three chambered heart 9crocodile has four chambers)
- skin not glandular
- no mammary glands

**Aves**

- the birds
- homoeothermic (constant body temperature)
- four chambered heart
- streamlined body for locomotion in air
- skin dry and covered by feathers
- scales on legs
- hollow bones
- oviparous (lay eggs)
- mouths modified into beaks

**Mammalian**

- hair on the body
- homoeothermic
- viviparous (give birth to live young) except a few
- have mammary glands
- glandular skin e.g. sweat glands, sebaceous glands
- four chambered heart
- pinna (external ear)
- two pairs of pentadactyl limbs
- presence of diaphragm
- have salivary glands

**i) i) What is a dichotomous key?**

- A biological device (tool) which enables one to identify an organism by progressively opting between two alternative observable characteristics

**ii. State the necessity of using a dichotomous key**

- used to identify organisms quickly and accurately
- by following the statements in the key we are able to identify each organism on the basis of a characteristic which is not to be found in other specimens

**iii. List the rules followed in constructing a dichotomous key**

- use observable characteristics only
- start with major characteristics, placing organisms into two groups at each stage
- use a single characteristics at a time
- use contrasting characteristics at each stage e.g 1(a) short, 1(b) tall
- avoid repeating the same characteristics

**iv) Describe the procedure of using a dichotomous key. Make a list of major features of the characteristics to be identified**

- look at the features of similarities
- look at the features of differences between the organisms
- we can then be able to identify the organisms by distinguishing one from another
- the key uses a method of elimination by following statements that are correct only for the organism

**iv You are provided with a specimen kale leaf. Use the dichotomous key below to identify the taxonomic group to which the specimen belongs. Show the steps (number and letter) in the key that you followed to arrive at the identify of the specimen**

| | |
|---|---|
| 1 a) leaf broad | go to 2 |
| b) leaf narrow | Araicaria |
| 2 a) leaf parallel veined | Cynodon |
| b) leaf net-veined | go to 3 |
| 3 a) leaf with one lobe (simple) | go to 4 |
| b) leaf with many lobes (compound) | Grevellea |
| 4 a) leaf fleshy | Kalanchoa |
| b) leaf not fleshy | go to 5 |
| 5 a) leaf petiole modified to form sheath | go to 6 |
| b) leaf petiole not modified to form sheath | Brassica |
| 6 a) leaf purple | Tradescantia |
| b) leaf green | Commelina |

steps – 1a, 2b, 3a, 4b, 5b
Identify – Brassica

v) **You have been provided with four animals labeled K (mature adult housefly), L (mature adult grasshopper, M(maize flour beetle) and N(worker termite) use the dichotomous key below to identify the specimens. Write down in the correct order, the steps (number and letter) in the key that you followed to arrive at your answer.**

Dichotomous key

| | |
|---|---|
| 1 a) animal with wings | go to 2 |
| b) animal without wings | go to 7 |
| 2 a) with two pairs of wings | go to 3 |
| b) with one pair of wings | Diptera |
| 3 a) with membranous wings | go to 4 |
| b) hind pair of membranous wings | go to 6 |
| 4 a) with long abdomen | Odontata |
| b) medium sized abdomen | go to 5 |
| 5 a) wings with coloured scales | Lepidoptera |
| b) wings without scales | hymenoptera |
| 6 a) forewings hard and shell-like | coleopteran |

b) forewings hard but not shell-like Orthoptera

7 a) body horizontally flattened Isoptera
b) body laterally flattened Symphonoptera

**Identify the orders o the various specimens as per the table below**

| Specimen | Order | Steps followed |
|---|---|---|
| K-housefly | Diptera | 1a,2b |
| L- grasshopper | Orthoptera | 1a, 2a, 3b, 6b |
| M- beetle | Coleoptera | 1a, 2a, 3b, 6a |
| M-termite | Isoptera | 1b, 7a |

**2 a) Define the following ecological terms**

**i. Ecology**

- study of the interrelationships between organisms and their environment

**ii. Environment**

- surrounding of the organism i.e. biotic or a biotic factors

**iii. Habitat**

- A specific locality (home) of a living organism with a set of factors (conditions) in which an organism lives.

**iv. Ecological niche**

- Role of an organism in its habitat e.g. feeding relationship

**v. Population**

- Number (group) of organisms of a species occupying a given habitat

**vi. Community**

- Refers to different species of (plants and animals) organisms in a given habitat (area) co-existing or interacting (living) with each other and the environment in which they live

**vii. Ecosystem**

- A community of organisms interacting with one another and the environment in which they live

**viii. Biosphere**

- The earth and its atmosphere where living organisms are found

**ix. Autecology**

- Study of a single (individual) species of plants or animals within a community, ecosystem, habitat or environment.

**x. Synecology**

- Study of natural communities (plants and animals) or populations interacting within an ecosystem.

**xi. Carrying capacity**

- maximum number of organisms an area can support without being depleted

**xii. Biome**

- geographical area with particular climatic conditions and flora and fauna
- it constitutes many ecosystems

**xiii. Biomass**

- dry weight (mass) of a living organism in a given area
- units of measurement are kg/m2/year

**b) i) What are abiotic factors?**

- non-living components of the ecosystem

**ii) Explain how abiotic factors affect living organisms**

**Wind**

- this influences rate of water evaporation from organisms

- therefore it affects distribution of organisms e.g. wind increases rate of transpiration and evaporation of water from the soil
- wind is an agent of soil erosion, may break and uproot trees
- may aid in the formation of sand dunes which can form habitats for some desert plants
- wind disperses fruits, seeds, spores
- wind forms waves in lakes and oceans which enhances aeration of water which replenishes oxygen concentration necessary for life
- wind is an agent of pollination

**Temperature**

- influences rate of enzyme action in photosynthesis and other metabolic reactions in plants and animals
- organisms function within a narrow range of temperature
- it affects distribution of organisms
- changes in temperature affect rate of photosynthesis and biochemical reactions e.g. metabolism and enzyme reaction
- temperature increases rate of transpiration

**Light**

- needed by green plants and photosynthetic bacteria which are primary producers
- animals depend on plants directly or indirectly for food
- main source of light is the sun
- light is necessary for synthesis of vitamin D in certain animals
- some plants need light for flowering
- seeds like lettuce need light for germination

**Humidity**

- amount of water vapour held by the air
- affects the rate at which water is lost from organisms body by evaporation and stomatal transpiration
- when humidity is low the rate of transpiration increases
- humidity influences distribution of organisms

**PH**

- each plant requires a specific PH in which to grow (acidic, neutral or alkalinic)
- pH affects enzyme reaction in metabolism

**Salinity**

- some ions are needed for plant and animal nutrition
- osmoregulation implants and animals is affected by salinity

**Topography**

- altitude affects light, atmospheric pressure and light
- Slope influences surface runoff, wind erosion, etc.
- mountains affect distribution of organisms which differs in leeward side and windward side
- mountains affect distribution of organisms which differ on lowlands and on highlands
- mountains also form physical barriers to migration of organism and may cause isolation of species
- background may offer camouflage to some organisms hence protection from enemies

**Rainfall (water) or precipitation**

- amount and distribution of rainfall affect vegetation type
- this consequently affects distribution of animals e.g. polar region water frozen hence only well adapted organisms survive
- fewer organisms found in deserts where rainfall is less
- Water is required for seed germination, raw material for photosynthesis, solvent for mineral salts. Provides turgidity for plant support, medium for transport, disperses fruits, seeds and spores

**Pressure**

- the weight atmosphere exerts upon the earth
- varies with altitude 9the higher the altitude the less the pressure
- this variation implies change in density which directly means less oxygen for respiration and less carbon iv oxide for photosynthesis and this affects distribution of organisms

**Mineral salts (trace elements)**

- these affect distribution of plants in the soil
- plants thrive best where elements are available
- Plants living in soil deficient in a particular element must have special methods of obtaining it.
- They harbor nitrogen fixing bacteria and others have carnivorous habit
- Plant distribution influences animal distribution

**c) i) What are biotic factors?**

- refers to living organisms in an area
- biotic environment of an organism constitutes all organisms around it, which it relates or interacts with in various ways

**ii) Give examples of biotic factors affecting ecosystems**

- feeding relationships
- predation
- competition
- diseases and pests
- human activities

**d) Discuss how the various biotic factors affect living organisms**

**i. Competition**

- organisms compete with one another for food, light, water, mates and shelter
- organisms must live together for competition for available resources
- those which cannot cope either structurally or behaviorally will migrate or die
- those remaining, due to better adaptations will increase in population
- competition between members of the same species is called intra-specific competition e.g. for mates
- Competition between members of different species is inter specific competition e.g. for food and space.

**ii. Predation**

- this is predator-prey relationship
- predator feeds on prey hence both control the other's population
- Distribution of predator and prey is important as predator cannot survive without prey
- It there is no predator the prey will increase in population beyond carrying capacity hence die due to environment depletion

**iii. Parasitism**

- an association where an organism lives in or on another living organism obtaining food(and other benefits) from it, causing harm to it (without necessary killing it)
- parasites may kill host
- they deprive host of food
- make host weak by introducing diseases
- make reproductive ability of host low hence host becomes susceptible to predation

**iv. Diseases and parasites**

- make organisms weak and susceptible to predation
- kill organisms and reduce their population

**v. Symbiotic**

- and association of organisms of different species where both benefit from the association i.e. there is mutual benefit

**vi. Human activities**

- these are human factors which have an influence on the biosphere
- examples are road construction, industrialization, deforestation, agriculture, pollution, poaching, fishing conservation, population control
- affect ecosystem and balance of nature

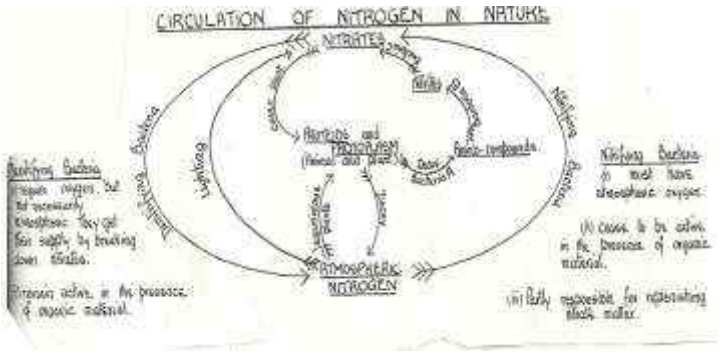
**Saprophytism**

- saprophytes are organisms which obtain organic matter in solution from dead and decaying tissues of plants and animals
- they include saprophytic bacteria and fungi
- they make available carbon, nitrogen and other elements form dead to living organisms
- they are useful in recycling nutrients in nature

**e)i) What is nitrogen cycle?**

- The process by which nitrogen in the air is made available plants and animals and eventually returns to the air.

**ii) Draw a simplified diagram representing the nitrogen cycle**




**iii) Describe the nitrogen cycle**

- during thunderstorms/lightning nitrogen gas combines with oxygen to form nitrogen oxides
- nitrogen oxides dissolve in water to form nitric acid
- acid is deposited in the soil by rain
- nitric acid combines with chemical substances to form nitrates or nitric acid dissociates to form nitrates which are absorbed by plants
- symbiotic bacteria (Rhizobium) which are found in root nodules of leguminous plants fix free nitrogen to nitrates
- free living bacteria (clostridium and Azotobacter) fix nitrogen to nitrates
- nostoc algae (Anabaema chlorella) fix nitrogen to nitrates
- plants use nitrates to form plant proteins
- animals feed on plants and convert plant proteins into animal proteins
- plants and animals die and are decomposed by putrefying bacteria, fungi(saprophytes)
- decomposing plants, animals and nitrogenous wastes release ammonia which is converted to nitrites by Nitrosomonas and nitrococcus bacteria

- nitrites are converted to nitrates by nitrobacter bacteria
- nitrates in the soil can be converted to free nitrogen (denitrification) by some fungi, pseudomonas and theobaccilus bacteria generally called denitrifying bacteria

**iii. Nitrogen in the atmosphere cannot be directly utilized by plants. State two ways by which this nitrogen is made available for plant use**

- fixation by microorganisms (Rhixobium, Axotobacter)
- fixation by electrical discharge in atmosphere i.e. conversion by thunderstorm or lightning

**f) i) Describe how energy flows from the sun through the various trophic levels in an ecosystem**

- energy from the sun is trapped by green plants during photosynthesis, producing chemical energy9food or carbohydrates
- green plants are producers and occupy the first trophic level
- green plants are eaten by herbivores called primary producers as they occupy the second trophic level
- herbivores are eaten by carnivores, secondary consumers, which occupy the third trophic level
- when organisms 9plant and animals) die, fungi and bacteria which are saprophytic organisms feed on them thus causing them to decompose into simple substances e.g. mineral salts
- these organisms are called decomposers and detrivores
- decomposer feed on dead organic matter hence cause decomposition and decay which releases nutrients for plants, linking biotic and a biotic components
- at all levels energy is lost through respiration

**Give the reasons for loss of energy from one trophic level to another in a food chain**

- insufficient utilization of food resources(wastage) e.g by defalcation
- through respiration
- through excretion e.g. urination and sweating

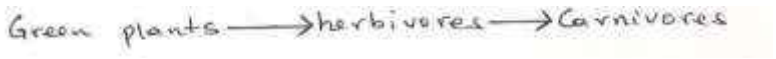
**Why are green plants referred to as primary producers in an ecosystem?**

- They utilize the energy from the sun to manufacture food for themselves and for subsequent trophic level (consumers) and other organisms

vi**. Explain the following terms giving suitable examples**

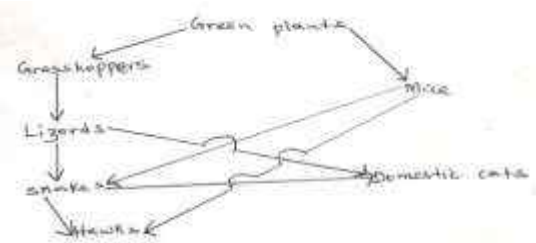
**Food chain**

- a nutritional sequence between producers and consumers through which energy flows in a straight line i.e. linear representation of feeding relationship between different organisms in an ecosystem
- if one consumer or the producer is removed the food chain is broken
- arrow points to the direction of energy flow e.g. green plant herbivore carnivore decomposer

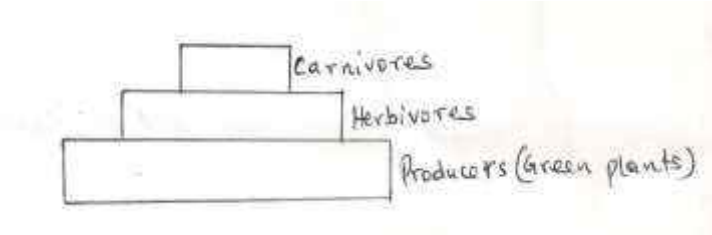


**Food web**

- complex feeding relationship where a consumer feeds on more than one type of food while several herbivores feed on one type of plant
- it is an interrelationship of many food chains
- consumers are usually fewer than producers to ensure survival of both

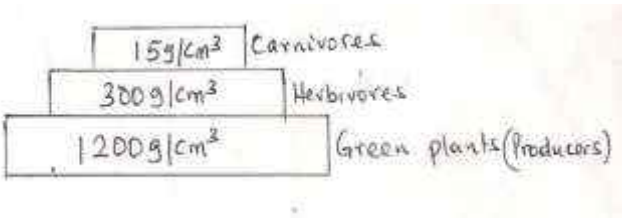



**Pyramid of numbers**




- this is a diagrammatic representation of numbers of organisms at each trophic level in a food chain
- usually there are more producers than consumers
- hence producers herbivores carnivore
- the reason for the pyramid is because herbivores feed on many plants (producers) as carnivores feed on many herbivores
- sometimes this may not be true e.g. when many caterpillars feed on one tree or parasites on a herbivore
- this gives an inverted pyramid of numbers

**Pyramid of biomass**




- refers to diagrammatic representation total dry weight of organisms at different trophic levels in a food chain
- producers have greater biomass than any level of consumers progressively
- size of organisms in successive e trophic levels increases
- amount of individuals decreases in successive levels

**Account for the decrease of biomass in the successive trophic levels**

- fixed energy which supports living matter decreases at each successive trophic level since energy is lost by respiration and indigested (unconverted) materials hence less biomass supported at each level

**h) i) Describe the three characteristics of a population growth**

- increase in numbers
- decrease in numbers/growth rate
- change in numbers

**Dispersion**

- spread or distribution of organisms in a habitat

**Density**

- the number of individuals per unit area

**ii) Explain how the following methods are used to estimate population of organisms**
**quadrat method**

- identify the study area
- throw or mark out the quadrat in the area of study at random
- identify or label the various species of plants in the quadrat
- count plants of each species
- record the numbers
- repeat the process
- work out the average per quadrat for each species
- calculate the total number of different species in the area or calculate the population for the total area of habitat

**Line transect**

- a string is stretched along an identified area
- all plants touching the string are counted

**Belt transect**

- preliminary study of the study area to estimate size or make a sketch map
- two parallel lines (strings or ropes) running for a determined distance and width
- count the number of organisms in the transect
- calculate the area covered by the transect
- calculate the number of organisms being investigated per unit area
- repeat this process at least three times in other parts of the study area
- find the mean number of organisms per unit area from all the belt transects
- from this figure calculate the total population of the desired organisms in the study area.

**Capture-recapture method**

- e.g. grasshoppers or fish
- capture the grasshoppers
- count and mark using permanent ink
- record
- release and allow time
- recapture and count the marked and unmarked
- total population is equal to the number of marked and unmarked grasshoppers in the second sample multiplied by the number of marked grasshoppers in the first sample divided by number of grasshoppers marked in the second sample that were recaptured

**2. a) Describe the adaptations of plants to various habitats**

**i. Xerophytes**

- grow in areas with scarcity of water
- roots grow deeply and extensively (widely spread) to ensure access to water
- thick succulent stems, roots and leaves for water storage
- photosynthetic stems take place of leaves which would lose a lot of water
- Leaves are needle-like (reduced to spines), scaly, have sunken stomata. Some have curled (rolled) leaves. Some have thick waxy cuticle, reduced number of stomata to reduce water loss by transpiration
- some shed leaves during dry season to reduce water loss
- presence of thorns for protection
- short life cycle to ensure survival
- reversed stomatal rhythm

**ii. Hyrophytes**

- grow in places with plenty of water(waterlogged)
- aerenchyma a tissue (airspaces) and large intercellular spaces and long fibrous roots for buoyancy (floating in water)
- poorly developed support tissues (sclerenchyma) because water provides the necessary support
- upper epidermis of leaves have more stomata than lower epidermis for gaseous exchange or for increased rate of transpiration
- poorly developed conducting tissues (xylem and phloem) because plants obtain water by diffusion

**iii. Mesophytes**

- grow in well watered soils (common plants)
- no special adaptations, but depending on particular habitat, may have some adaptations
- in forests they grow fast, tall to capture light. Have climbers while some are adapted to carry out photosynthesis in low light intensities (those that form undergrowth)
- in places with adequate water they form broad leaves, thin cuticle and many stomata on both leaf surfaces
- in direr regions they possess more stomata on the lower leaf surface and are deep rooted
- some are shallow rooted and develop buttress and prop roots for support
- some have waxy or glossy surface to reflect sun rays and drip off rain water

### iv. Halophytes

- plants that grow in very salty soil where the salt concentration is higher than that in the plant
- have root cells which concentrate a lot of salts in them and enable then to take in water by osmosis
- succulent roots to store water
- have pneumatophores (breathing roots) to take in oxygen
- some have buttress roots for support
- secrete excess salt by use of salt glands
- have large airspaces in leaves and stems for buoyancy and to store air
- capable of photosynthesis at low light intensities
- e.g. mangrove

**b) i) What is pollution?**

- any process which leads to adverse or harmful changes in the environment

**ii) Explain the various human activities that have caused pollution**
**Causes and effects of air pollution**

- sulphur iv oxide, hydrogen sulphide, chlorine, oxides of nitrogen produced by industries, sewage, decomposing organic matter and fumes affect gaseous exchange, makes acid rain and damage plant leaves
- aerosols, herbicides, insecticides (agrochemicals), paint spays, acaricides and CFC's sprayed to control diseases, pests and weeds affect respiratory organs of animals. The chemicals are residual and persistent (not easily broken down) and bring depletion of the ozone layer
- smoke and fumes produced in areas with heavy industries, motor vehicles, fires which burn fuel, oil, wood and coal cause carbon ii oxide, poisoning affect respiratory systems and affect visibility
- particles in smoke and fumes settle on leaves and stop photosynthesis
- carbon iv oxide causes green house effect which causes temperature inversion as a result of heating the lower layers of atmosphere
- sound and noise produced incessantly by machines, aeroplanes and heavy vehicles affect hearing in animals
- dust from cement factories, quarries, dust roads settles on leaves limiting photosynthesis
- removal of vegetation interferes with carbon cycle
- radio-active emissions from nuclear reactors, mines and bombs cause cancer, mutations and death.

**Control of air pollution**

- use of lead free petrol in motor vehicles, air craft, aeroplanes and petroleum engines
- uses of smokeless fuels and electricity
- filtration, dissolution and use of chemicals to remove harmful gases
- factories should be erected far away from residential areas
- use of tall chimneys
- reduce volume or intensity of sound e.g. by use of ear muffs
- concords should fly at higher altitudes and aeroplanes to fly high up

**State the causes, effects and methods of controlling and prop roots for support water pollution**
**Causes and effects**

- agrochemicals e.g. fertilizers cause eutrophication leading to increase in animal population
- Silting makes water surfaces shallow and silt clogs stomata and gills of fish reducing rates of photosynthesis and gaseous exchange. It also leads to reduction of algae which causes reduction of consumers i.e. animal population
- industrial and domestic wastes contain toxic materials which kill producers and other organism while oily substances in wastes may clog gills of fish and may change pH of water oxygen solubility is also reduced by oily surfaces
- Untreated sewage and effluents where decomposition or organic matter in sewage reduces oxygen supply and sewage provides food for bacteria increasing their population and demand for oxygen thus depriving fish of oxygen.
- Human feaces causes eutrophication, carbon IV oxide produced by decomposition of faecal matter changes pH of water interferes with photosynthesis and may clog fish gills or block light penetration which interferes with producers thereby decreasing productivity.
- Dumping of chemicals from industries with toxic pollutants which kill organisms
- Spillage of oil and chemicals block oxygen and kill organisms
- Discharge of water from industries into water body where high temperatures reduce amount of oxygen in the water causing organism to suffocate and die
- Untreated sewage may lead to outbreak of epidemics

**Control of water pollution**
-pollution caused by domestic effluents may be controlled by treating domestic waste, using biotechnology, banning the use of phosphate-based detergents, using plastic pipes instead of those made from lead, recycling gabbage, using biodegradable detergents.
Pollution caused by industrial waste may be controlled by treating/cooling industrial waste, carrying out environmental impact assessment before establishing industries
Oil spillage may be controlled by cleaning spilled oil biotechnology and penalizing the industry individual or companies which cause oil spills/water pollution
Pollution caused by agrochemicals may be controlled by using mechanical control of weeds, biological control of weeds and pests, biodegradable organic fertilizer herbicides, insecticides pesticides, organic farming educate farmers on the use of correct amount of agrochemicals

- silting may be controlled by appropriate farming practices, contour farming, reafforestation, building gabions and terracing

**iv) State the causes /effects and control methods of soil pollution**
**Causes and effects**

- Air pollutants e.g. sulphur IV oxide fumes form sulphuric acid with rain water. The acid rain alters soil pH therefore affecting plants that cannot tolerate acidic soil
- most aerosols sprayed to control pests and diseases precipitate in the soil and are taken up by plants which make its concentration many times higher, increasing the toxicity in the plants which absorb them
- petroleum products due to spillage by oil tankers making it impossible for plant roots to obtain oxygen in oil saturated soils, therefore plants are killed
- agrochemicals and inorganic fertilizers contain heavy metals that are not used up by plants and eventually soil microorganisms cannot inhabit the soils
- organic matter slows down, life ceases and soil becomes exhausted
- community, household wastes and industrial wastes disposal is a major problem in big towns and cities. commodities packaged in metal tins, rubber, plastic containers, scrap metal, glass bottles, different types of paper are nuisance to the environment, rendering it useless for agricultural purposes

**Control of soil pollution**

- use of organic farming techniques
- biological control of pests, diseases, parasites
- recycling of non-degradable containers or burying them safely after use
- controlled burning of garbage
- treatment of human and industrial waste for safe disposal
- avoid spilling chemicals and oil when used

**v) Define biological control give suitable examples**

- using a living organism to regulate, control or reduce the population of another organism e.g beetles to feed on water hyacinth, fish to feed on mosquito larvae.

**vi) What is eutrophication?**

- enrichment of water bodies with nutrients due to discharge of sewage leading to rapid growth of surface plants

**viii) What are the effects of eutrophication?**

- enrichment of water bodies with nutrients due to discharge of sewage leading to rapid growth of surface plants

**vii) What are the effects of eutrophication?**

- The plants block light from reaching plants underneath hence no photosynthesis
The plants die and decompose leading to lack of oxygen hence animals also die

**c) Describe the symptoms, mode of transmission and control of cholera, typhoid malaria and amoebic dysentery in humans**

| Disease | Causative agent | Transmission | Symptoms | Control |
|---|---|---|---|---|
| Cholera | Vibrio cholerae(bacterium) | Contaminated food or water<br>Spread by flies form faeces | Intestinal pain<br>Diarrhea<br>Vomiting<br>Dehydration | Proper hygiene e.g. boiling drinking water<br>Vaccination |
| Typhoid | Salmonella typhi (bacterium) | • contaminated food or water<br>• spread by flies from faeces | • fever<br>• rashes<br>• diarrhea + blood from bowels | • proper sanitation<br>• vaccination |
| Malaria | Plasmodium (protozoa) | - bite by infected female anopheles mosquito | - fever<br>Joint pains<br>Vomiting<br>Headache<br>Anaemia | • killing mosquito<br>• killing the mosquito larvae<br>• draining stagnant water<br>• clearing bushes<br>• treatment<br>• sleep under mosquito net |
| Amoebic dysentery (amoebiasis) | Entamoeba hystolytica (bacterium) | - contaminated food or water due to improper disposal of faeces | - intestinal pain<br>Diarrhea<br>Vomiting<br>Dehydration | • sanitation<br>• personal hygiene<br>• cook food well<br>• treatment using drugs |

**d) Discuss Ascaris lumbricoides under the following sub-headings**

**i. Mode of transmission**

- through ingestion of contaminated food
- live in intestines

**ii. Effects of parasite on the host**

- inflammation of lungs
- pneumonia
- produce toxic substances
- intestinal obstruction

**iii. Adaptations**

- thick cuticle which protects it against digestion
- lays many eggs to ensure survival
- mouthparts for sucking partly digested food
- lack of elaborate alimentary canal
- tolerant to low oxygen concentration
- two hosts to ensure survival
- eggs have protective cover to ensure survival in adverse environments

**iv. Control and prevention**

- proper sanitation
- wash hand after defaecation and before eating

**e) Discuss schistosoma under the following sub-headings**

**i. Mode of transmission**

- through contaminated water in swamps, etc

**ii. Effects on host**

- bleeding in lungs
- blood stained urine
- unthriftiness

**iii. Adaptations**

- has two hosts to increase chances of survival
- eggs have a hook like structure which raptures the walls of intestine or bladder
- lay large number of eggs to ensure survival
- larvae have a sucker for attachment on human skin which it digests
- larva has a tail which it swims with in search of host in water
- prolonged association between male and female to ensure that fertilization takes place
- adults can tolerate low oxygen concentration (in the animal tissues)
- adult worm secretes chemicals against antibodies
- larvae and eggs (have glands that) secrete lytic enzymes to soften the tissues that ease penetration
- larvae are encysted so as to survive adverse conditions

**iv) Control and prevention**

- proper use of toilet facilities
- boiling water before use
- avoid bathing/washing in infected water
- Use of molluscicides (chemicals that kill snails/biological control/clearing water weeds on which snails feed.
- Drainage of stagnant water
- Wearing gum/rubber boots

**3. a) i) What is reproduction?**

- process by which living organisms give rise to new members of their own species which resemble the parents

**ii) Why is reproduction important?**

- for continuity of species/ to ensure survival of species
- maintaining life of species
- replace dead individuals

**iii) Name the types of reproduction**

- sexual which involves fusion of male and female gametes
- asexual in which no gametes are involved but parts of a mature organism develops into new individuals

**b) i) What is cell division?**

- process by which cells are formed from pre-existing cells

**ii) What are chromosomes?**

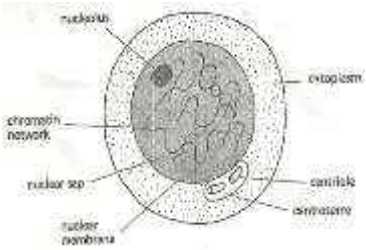
- Threadlike structures found in nucleus of a cell.
- The units called genes
- Genes are factors that cause inheritance or determine characteristics of offspring

**c) i) What is mitosis?**

- A type of cell division that occurs during growth leading to increase in number of cells
- all cells maintain the same chromosome constitution i.e. the diploid state

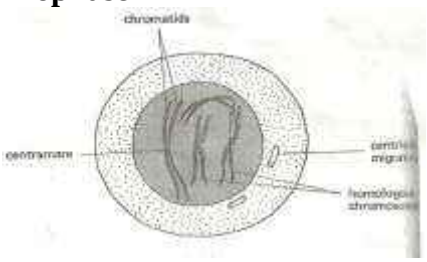
**ii) Describe the five stages of mitosis**

**Interphase**




- replication of organelles
- duplication of DNA
- production of energy (ATP) for cell division

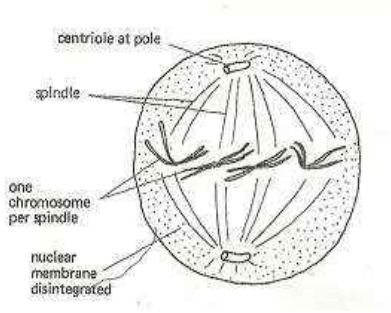
**Prophase**



- stage of dehydration
- chromosomes shorten and thicken
- chromosome replicates into two chromatids
- chromatids joined at centromere
- formation of spindle fibers

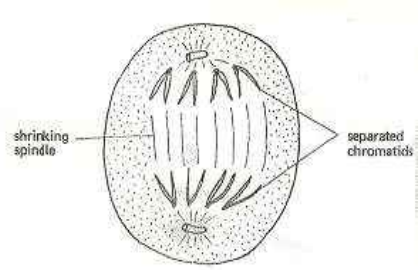
**Metaphase**

- chromosomes move to equator (early metaphase)
- chromosomes line up at the equator
- homologous chromosomes do not associate

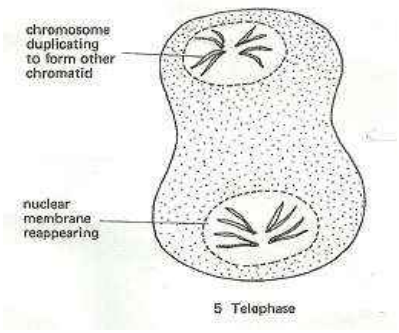



**Anaphase**

- chromatids separate
- move to opposite ends (poles) of the cell



Telophase




- chromatids reach the poles
- formation of two daughter cells occurs i.e. cytoplasmic division

**ii) State the significance of mitosis**

- ensures each daughter cell has same number and kinds of chromosomes as daughter cells
- gives rise to new cells (responsible for growth)

**d) i) What is meiosis?**

- division of diploid cells to form gametes which are haploid

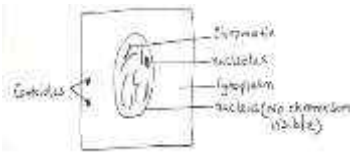
**ii) State the significance of meiosis**

- gives rise to gametes
- source of variation

**iii) Give a summary of the stages of meiosis**
**First meiotic division**

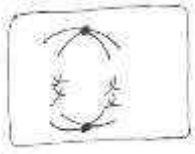
**Interphase**

- cell is in non-dividing condition
- chromosomes appear threadlike



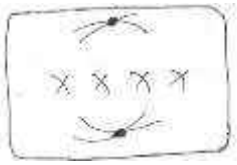
**Prophase I**

- chromatic material shorten and thicken
- double stranded chromosomes appear (bivalent)
- double stranded chromosomes pair and twist round each other (synapsis)
- point of contact of chromosomes is called chiasma



**Metaphase I**

- paired homologous chromosomes line up at the equator

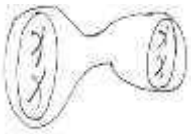


**Anaphase I**

- paired homologous chromosomes move to the poles

**Telophase I**

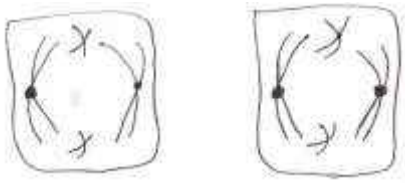
- paired homologous chromosomes reach the poles
- two new nuclei are formed



**Second meiotic division**

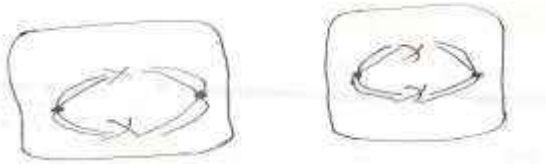
**Prophase II**

- chromosomes shorten, thicken and become visible,
- stage of dehydration



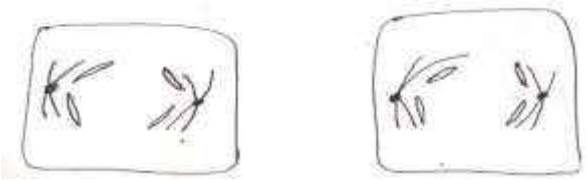
**Metaphase II**

- movement of chromosomes to equator



**Anaphase II**

-chromatids of each chromosome separate to the poles



**Telophase II**

- reach the poles
- four haploid daughter cells are formed

**iv) Give the similarities between mitosis and meiosis**

- both take part in cells
- both involve division (cell multiplication)

**v) What are the differences between mitosis and meiosis?**

| Mitosis | Meiosis |
|---|---|
| • maintenance of chromosome number (diploid)<br>• takes place in somatic cells/growth<br>• no crossing over/no variations<br>• results into 2 daughter cells<br>• no pairing/no synapsis/no bivalent formed<br>• a one division process of four stages | • reduction/halving of chromosomes (haploid<br>• occurs in reproductive cells/gonads/produces gametes<br>• crossing over takes place/variation occurs<br>• results into 4 daughter cells<br>• there is paring/synapsis/bivalent<br>• a two division process of four stages each |

**d) i) What is asexual reproduction**

- formation of new individuals as a result of the fusion of two gametes
- fusion is called fertilization

**ii) What is the significance of sexual reproduction in living organisms?**

- leads to genetic variation e.g. cross breeding which gives rise to hybrids

**iii) State the advantages of sexual reproduction**

- genetic variation
- greater adaptability to environment by offspring
- few bad or good traits inherited/retained
- greater amount of dispersal is possible
- may result in stronger offspring

**iv) Give the disadvantages of sexual reproduction**

- less certainty in egg and sperm meeting
- low rate of survival
- sex-linked diseases easily transmitted

**e) i) What is asexual reproduction?**

- formation of new organisms without fusion of gametes
- occurs with only one parent
- parts of organism develop into new individual

**ii) State the advantages of asexual reproduction**

- retention of useful characteristics/genes/traits
- offspring establish faster/shorter life cycle
- better chances of survival because of suitable environment

**iii) Give the disadvantages of asexual reproduction**

- lack of genetic variation
- lowered resistance to disease
- loss of hybrid vigor
- competition for resources due to overcrowding

**iv) Explain how reproduction occurs by the following methods of asexual reproduction**
**Sporulation**

- formation of spores
- spores are small haploid cells produced by plants
- spores give rise to new haploid organisms
- includes moulds, ferns, bryophytes, pteridophytes

**Budding**

- where an outgrowth arises from a parent and drops off to develop into a new organisms
- hereditary material in the daughter cell and parent are exactly the same
- occurs in organisms such as hydra, jelly fish, sea anemones, yeast and some fungi

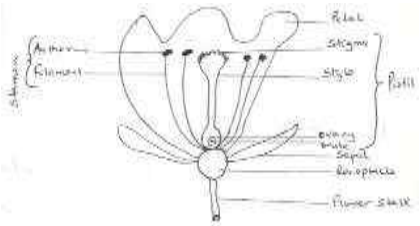
**Binary fission**

- a cell splits into two new cells of equal size
- each daughter cell grows into anew organism
- Occurs in organisms such as amoeba, euglena, paramecium, some fungi and bacteria.

**f) i) What is a flower?**

- this is the reproductive structure which bears the reproductive parts of a plant
- it produces seeds and fruits

**ii) Draw a longitudinal section of a labeled diagram of a flower**




**iii) Give the functions of the parts of a flower**

**Receptacle**

- expanded end of stalk which bears floral parts

**Calyx**

- consists of sepals
- usually green
- protect flower in bud

**Corolla**

- consist of petals
- often colored or scented to attract insects

**Androecium**

- male part of flower
- consist of stamens
- each stamen consists of an anther containing pollen sacs
- anther produces pollen grains which contain male gametes

**Gynaecium**

- female part of flower
- consists of one or more carpels
- each carpel contains one or more ovules in an ovary
- style bearing a stigma extends from ovary
- ovary contains female gametes which when fertilized become seeds

**iv) What is inflorescence?**

- a group of flowers borne on the same branch (main stalk)

v**) Explain the meaning of the following terms which describe flowers**

**Hermaphrodite**

- one with both stamen and carpel
- most flowers are hermaphrodite/bisexual

**Unisexual**

- have only one of carpel or stamen i.e. either male or female

**Carpelate**

- also called pistilate
- contains only carpels hence a female flower

**Staminate**

- also called male flower
- contains only stamens

**Dioecious plants**

- have pistilate and staminate flowers on different plants e.g. pawpaw

**Monoecius plants**

- have pistilate and staminate on one plant
- however, pistilate and staminate occur at different plants e.g. maize

**Complete flower**

- Has all four parts i.e. Calyx, corolla, androecium and gynoecium

**Incomplete flower**

- does not have all four parts
- at least one is missing

**vi) Explain the meaning of the following types of ovary**

**Superior**

- ovary occurs above other floral parts on the receptacle

**Inferior (epigynous)**

- other floral parts arise above ovary on the receptacle

**g) i) What is pollination?**

- transfer of pollen grains from anther of a stamen to stigma of a flower

**ii) Explain the types of pollination**

- self pollination takes place when mature pollen grains of a flower fall on the stigma of the same flower
- cross pollination takes place when pollen grains of a flower fall on the stigma of another flower of the same species

**iii) State the advantages of pollination**

- healthy offspring
- leads to variation
- greater chances of dispersal

**iv) List the agents of pollination**

- wind
- water
- insects

**v) How are flowers adapted to wind and insect pollination?**

**Insect pollinated flowers (entomophilus)**

- are scented to attract insects
- have stick stigma for pollen grains to stick on
- are brightly coloured to attract insects
- presence of nectar to attract insects
- have nectar guides to guide insects to the nectarines
- have nectarines to secrete nectar
- stigma/ anthers located inside the flower/tubal/funnel shaped corolla to increase chances of contact by insects
- sticky/spiny/spiky pollen grains which stick on the body of insects and on stigma
- large/conspicuous flowers easily seen by/attract insects
- anthers firmly attached to the filament for insects to brush against them
- landing platform to ensure contact with anthers and stigma
- mimicry to attract (male) insects

**Wind pollinated flower (anemophilus)**

- anthers/stigma hang outside the flower to increase chances of pollination
- the style/filament is long to expose stigma/anthers
- stigma is hairy/feathery/branched to increase surface area over which pollen grains land/to trap pollen grains
- pollen grains are smooth/dry/light/small to be easily carried by wind
- large amount of pollen grains to increase chances of pollination
- anthers loosely attached to filaments to enable them to sway to release pollen grains
- pollen grains may have structures which contain air to increase buoyancy
- flowers have long stalks holding them out in the wind

**vi) State the ways in which plants prevent self-pollination**

- protandry(anthers/stamens mature first)
- protagyny (pistils mature first)
- monoecism (where male and female parts are on same plant but different parts)
- dioecism(where male and female parts are on different plants)
- incompatibility (self sterility)
- heterostyly (styles at different heights)

**vii) Give the characteristics that ensure cross pollination takes place in flowering plants**

- presence of special structures that attract agents of pollination
- protandry/dichogamy
- protagyny/dichogamy
- monoecism
- self sterility
- heterostyly

**viii State the advantages of cross pollination**

- hybrid vigour
- less prone to diseases
- promotes genetic variation
- greater evolutionary potential

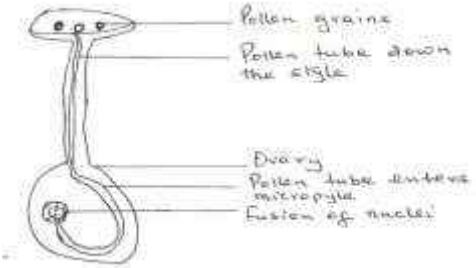
**h) i) What is fertilization?**

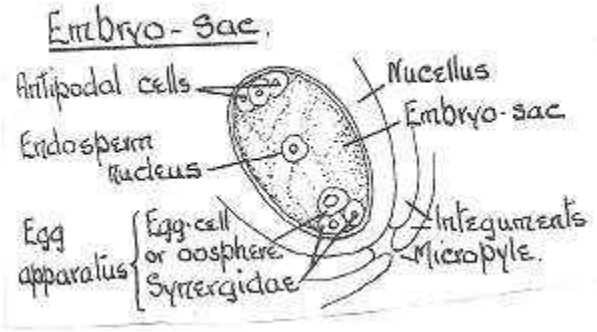
- Fusion of male and female gametes to form a zygote

**ii) Describe how fertilization takes place in a flower**

- this follows pollination
- pollen grain is deposited on the stigma
- pollen grain sticks to the surface of the stigma
- the surface of the stigma produces a chemical substance which stimulates the pollen grain to produce a pollen tube/to germinate
- the pollen tube grows through the style tissues on which it feeds until it enters the ovary
- the generative nucleus divides into two giving two male nuclei
- embryo sac contains eight nuclei i.e. two synergids, egg cell, two polar nuclei and three antipodal cells
- the pollen tube enters the embryo sac through the micropyle and one of the male nucleus fuses with the egg cell/ovum to form a zygote

- the other male nucleus fuses with the two polar nuclei to form the triploid nuclei/endosperm)food storage used by developing embryo)
- the pollen tube nucleus in the pollen tube disintergrates soon afterwards
- this process is referred to as double fertilization
- zygote grows into an embryo containing plumule, radicle and cotyledons




**iii) What is double fertilization?**

- there are two male nuclei entering embryo sac
- one fuses with the ovum to form a zygote, while the other fuses with the polar nuclei to form a triploid primary endosperm nucleus
- therefore there are two fusions at fertilization

**iv) Name the changes that Occur in a flower after fertilization**

- petals, stamen, calyx and style wither
- ovary wall changes into pericarp
- intergument changes into seed coat/testa
- zygote changes into embryo (by mitosis)
- primary endosperm nucleus changes into endosperm
- whole ovule changes into seed
- ovary develops and grows into fruit(under the influence of gibberrellic hormone)

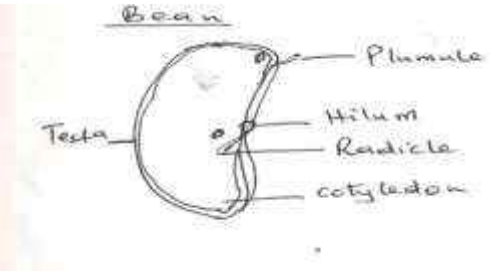
**j) i) Distinguish between a fruit and a seed**

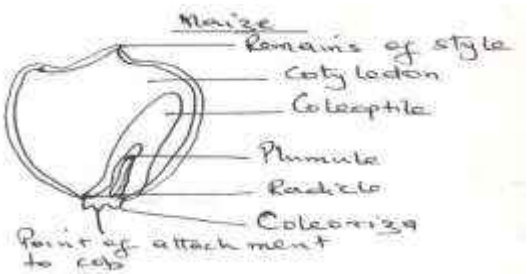
- a fruit is a fertilized ovary and has two scars
- a seed is a fertilized ovule and has one scar

**ii) How is a seed formed?**

- after fertilization, zygote grows into an embryo, primary endosperm nucleus developed into endosperm, interguments harden to form testa, hence the whole ovule becomes the seed
- the seed loses water to become drier
- the seed has plumule, radicle, seed leaves called cotyledons, a microphyle and a scar

**iii) Draw a labeled diagram of a seed**



**iv) Describe the main parts of a seed**

**Testa**

- also called seed coat
- a tough outer covering which protects the seed from insects, bacteria etc
- segment is the membrane inside the testa

**Hilum**

- a scar
- spot where the seed was attached to the fruit or pod

**Micropyle**

- small hole through which water and air enter the seed

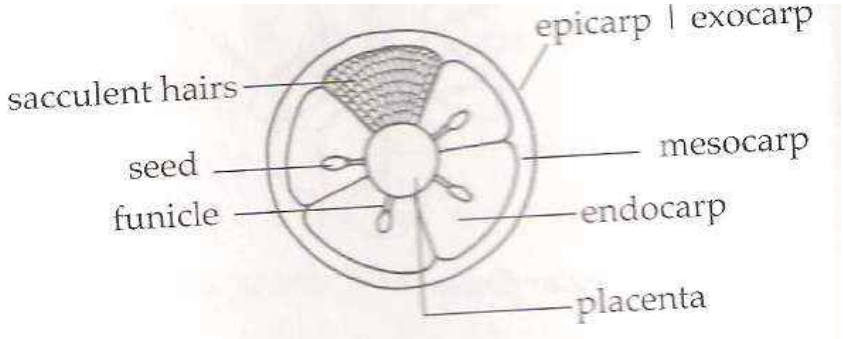
**Radicle**

- embryonic root
- grows into the shoot system

**Cotyledons**

- embryonic leaves
- store food for the germinating seed i.e. for plumule and radicle
- when plumule and radicle grow, they use food stored in the cotyledon
- in some seeds food is stored in the endosperm

**v) Draw a labeled diagram of a fruit**




**vi) How is a fruit formed?**

- one of the organs that remains on the plant after pollination and fertilization is the ovary
- within the ovary, the developing embryo produces special chemical substances that stimulate the young ovary
- these substances also signal the start of the formation of the fruit, which is a mature ovary
- the fruit may contain one or more seeds
- during fruit formation the ovary increases in size while ripening or maturing
- a true fruit is  formed from the ovary of a flower after fertilization
- it has two scars(style scar and stalk scar) and contains seeds
- some seeds are not formed from the ovary of a flower
- some other parts of a flower develop to form a fruit
- such fruits are called false fruits

**vii) Explain the importance of fruits in the survival of plants**

- protect the seed against dessication, predators and adverse conditions
- aid in seed dispersal by attracting agents of dispersal
- stores food for the plant

vii. **Distinguish between parthenogenesis and** parthenocarpy

- parthenogenesis is development of new animals from unfertilized eggs
- parthenocarpy is development of a fruit without fertilization

**iv) State the differences between a seed** and fruit

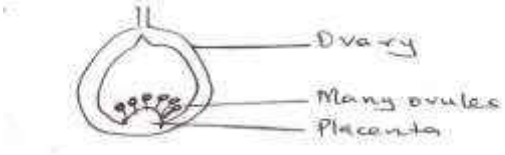
| **Seed** | **Fruit** |
|---|---|
| • fertilized ovule<br>• attached to placenta through funicle<br>• one scar called hilum<br>• has seed coat/testa<br>• seed wall undifferentiated | • fertilized ovary<br>• attached to branch through a stalk<br>• two scars (style scar and stalk scar)<br>• has fruit wall/pericarp<br>• fruit wall is differentiated |

**j. i) What is placentation?**

- arrangement of ovules within the plant ovary

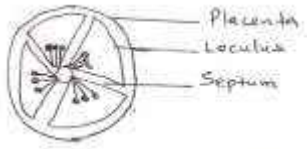
**ii) Explain the following types of placentation**

**Marginal**



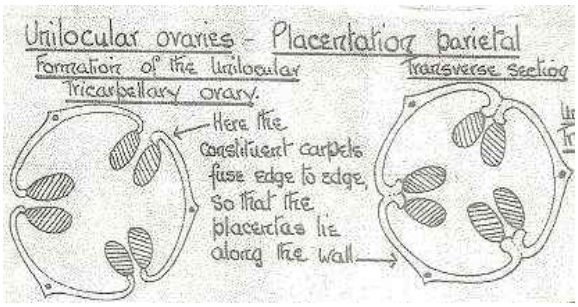

- placenta appears as one ridge on ovary wall
- ovules are attached to placenta in rows e.g. peas in a pod

**Basal**



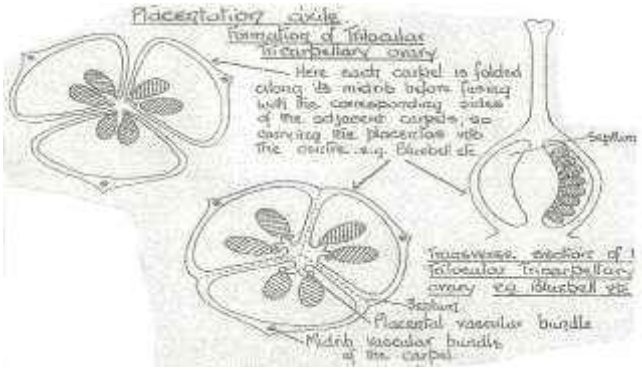

- placenta formed at the base of the ovary with numerous ovules attached to it

**Parietal**



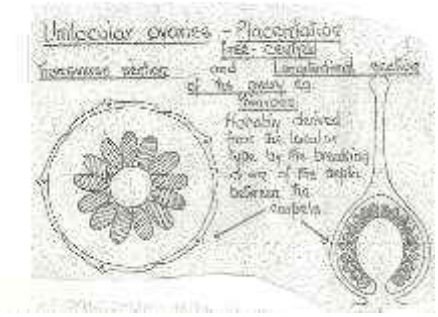
- edges of carpels fuse together
- dividing walls disappear, leaving one loculus
- have numerous seeds e.g. passion fruit
- placenta of each carpel appears as ridges on ovary wall

**Axile**




- edges of carpels fuse together to form a single central placenta
- numerous ovules arranged on placenta
- ovary divided into a number of loculi by walls of the carpel e.g.

**Free central placentation**




- edges of carpels fuse together
- dividing was disappears leaving one loculus
- placenta appears at base of ovary
- has numerous ovules

**k) i) How are fruits grouped?**

**Simple fruits**

- formed from a single flower or one ovary e.g. mango

**Aggregate fruits**

- consists a group of ovaries that appear on a common receptacle e.g. strawberry

**Multiple (compound) fruits**

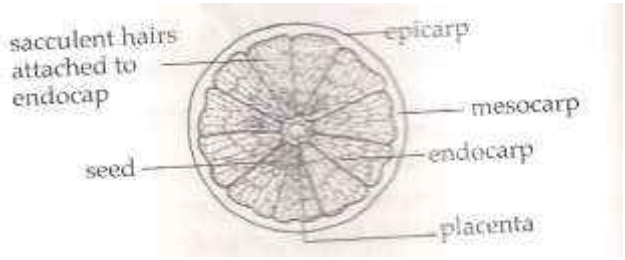
- formed from several flowers whose ovaries fuse together after fertilization
- form a bunch e.g. pineapple, figs
- are always false fruits

**ii) What are succulent fruits?**

- also called fleshy fruits
- all or part of pericarp (fruit wall) becomes juicy

**iii) Give types of juicy fruits**

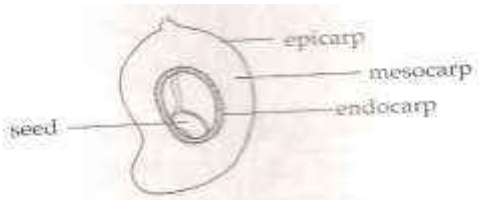
**-Berry**




- has many seeds
- whole pericarp is succulent e.g. orange, tomato, pawpaw

**Drupe**

- only one seed
- pericarp divided into three layers i.e. epicarp, mesocarp(juicy) and endocarp(hard)
- e.g. mango and coconut




**Pome**

- juicy part is swollen receptacle
- is usually a false fruit
- example is a pear

**iv) What are dry fruits?**

- have a pericarp that is dry, hard and woody
- either dehiscent or indehiscent
- called dry because they are not succulent

**v) What are dehiscent fruits?**

- split open when ripe to release seeds
- contain many seeds

**vi) Give types of dehiscent fruits**

**Legumes**

- split along two edges
- are usually pods e.g. beans, peas, crotolaria

**Follicle**

- split on one side only e.g. Sodom apple

**Capsule**

- has several lines of weakness/sutures
- open in many places e.g. castor oil, cotton

**vii) What are indehiscent fruits?**

- non-splitting fruits
- usually one seeded only

**ix) Give main types of indehiscent fruits**

**Nut**

- pericarp woody, hard and thick e.g. cashew

**Achene**

- has thin, tough pericarp e.g. sunflower

**l) i) What is seed and fruit dispersal?**

- spreading of seeds and fruits away from parents so as to settle where conditions are suitable for their germination

**ii) Why is dispersal of seeds and fruits necessary?**

- prevent overcrowding
- reduces competition for space, nutrients and light
- colonization of new areas is made possible
- to increase chances of survival
- to prevent inbreeding
- to avoid extinction due to over competition for the necessities

**iii) Explain how seeds and fruits are adapted to various methods of dispersal**

**Adaptations for wind dispersal**

- they have wings, feathers or hair-like structures to increase surface area for wind to carry them easily/buoyancy
- seeds/fruits are loosely attached on the stalks so that they can easily be released and carried away by wing
- seeds/fruits are generally light and small sized to be easily carried by wind
- some seeds/fruits have parachute-like structures to be easily carried b wind
- some have censor mechanism where seeds and fruits are borne on long stalks that are loosely attached which allows swaying so that movements of capsule by wind releases the seeds

**Water dispersal seeds**

- seed/ mesocarp has air spaces thus light/buoyant to float hence carried by water
- they have waterproof cover and tough pericarp protects seeds from getting soaked
- fibrous and spongy mesocarp to easily float

**Animal dispersal seeds**

- presence of hooks for attachment to animals thus carried to other parts
- fruits are brightly coloured, succulent and scented to attract animals
- seed coats are hard and resistant to digestive enzymes hence seeds are dropped away from mother plant
- large in size or borne on clusters to be easily seen

**Self dispersal/explosive**

- self opening seeds
- they have lines of weakness called sutures for violent opening thus scattering seeds away from parent plant

**5. a) i) Distinguish between external and internal fertilization in animals**

- in external fertilization fusion of the male and female gametes takes place outside the body of the female e.g. amphibians and fish
- in internal fertilization union of gametes occurs inside the body of the female

**ii) State the advantages and disadvantages of external fertilization**

**Advantages**

- large numbers produced therefore many offspring per breeding season
- female does not suffer gestation stress
- mother does not need to care for the young except in a few species
- the surviving individuals are highly selected for better survival

**Disadvantages**

- many predators surround the eggs before and after fertilization
- fewer chances of fertilization/a lot of gametes wasted
- embryo development at mercy of environment
- large numbers of female gametes are required therefore female gets much exhausted

**iii) State the advantages and disadvantages of internal fertilization**

**Disadvantages**

- number of gametes fewer hence less number of offspring
- less adapted for sudden change of environment after birth
- in mammals females suffer gestation stress

**Advantages**

- more chances of fertilization
- fewer predators of oval/fertilized egg protected in females body
- stable internal environment
- fewer gametes required

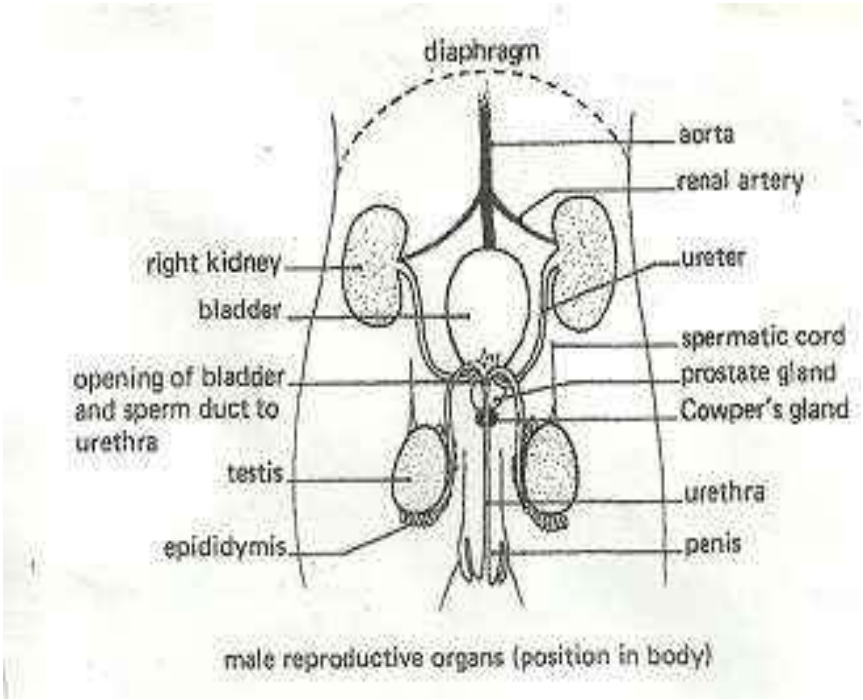
**iii) Give a reason why it is necessary for frogs to lay many eggs**

- to increase chances of survival/fertilization

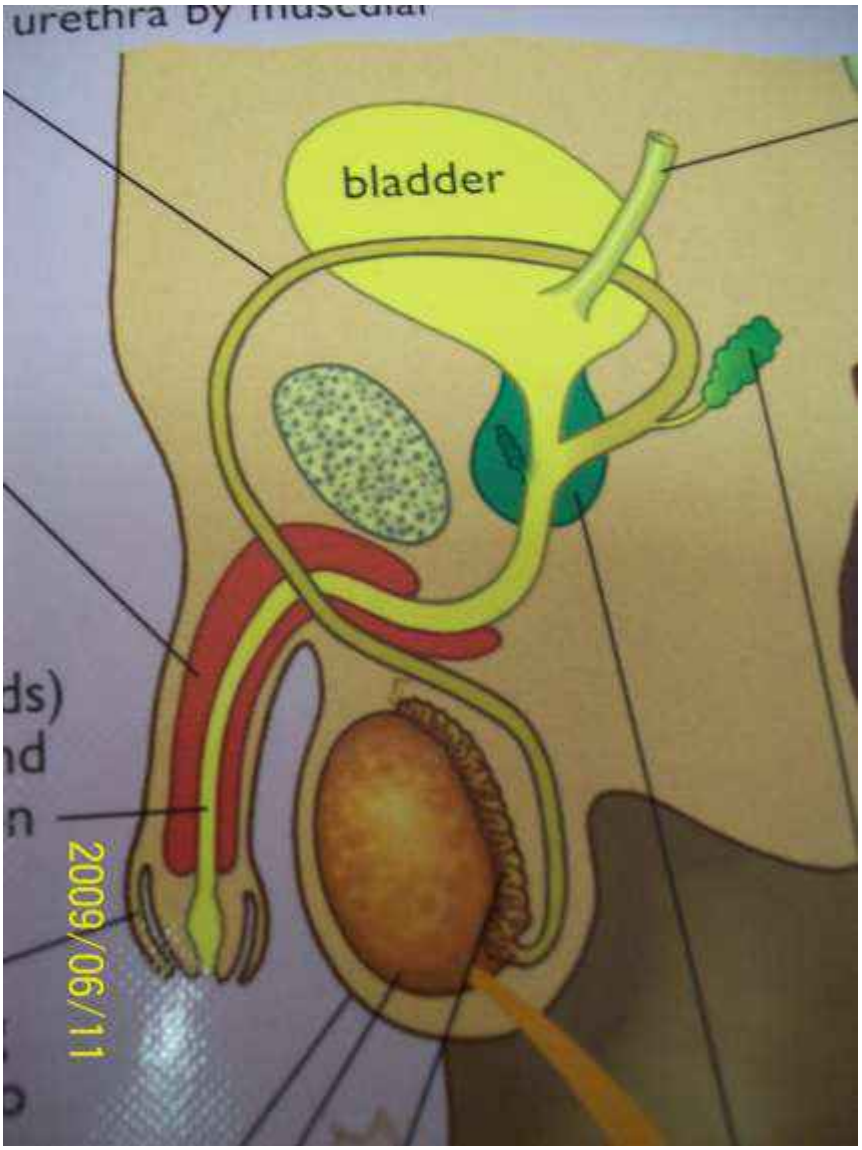
**iv) Compare external and internal fertilization**

| External | Internal |
|---|---|
| • occurs in water outside the bodies of animals<br>• many eggs are laid<br>• usually less contact between male and female<br>• both fertilized eggs exposed to danger | • occurs inside the body of the female animal<br>• fewer eggs released from ovary<br>• very close contact in form of copulation between male and female<br>• Fertilized eggs are enclosed hence highly protected inside females' body. |

**b) i) Draw and label the human male reproductive system**



male reproductive organs (position in body)


urethra by
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**ii) Describe how the mammalian male reproductive system is adapted to perform its functions**

**Penis**

- is highly vascularised/spongy
- has a sensitive glands
- becomes erect to allow entry into the vagina

**Scrotum**

- contains the testes outside the body on whose walls the process of spermatogenesis takes place
- the process is favored by lower temperature
- it contains sertoli cells which nourish sperms until they are mature

**Epididymis**

- long and coiled for the purpose of sperm storage

**Vas deferens**

- muscular
- upon contraction pushes sperms out and allows ejaculation

**Gametes**

- produced in large numbers to increase chances of fertilization
- the sperms have a tail for swimming/large number of mitochondria to provide energy/allow swimming to reach the egg

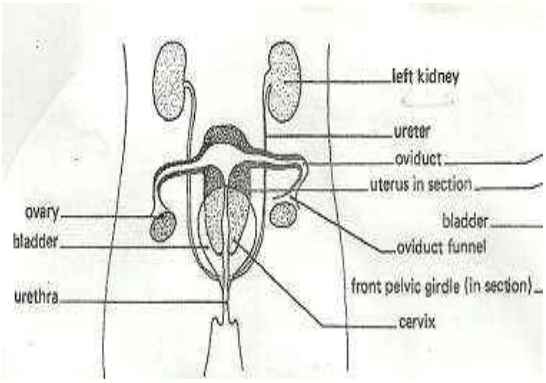
**Accessory glands**

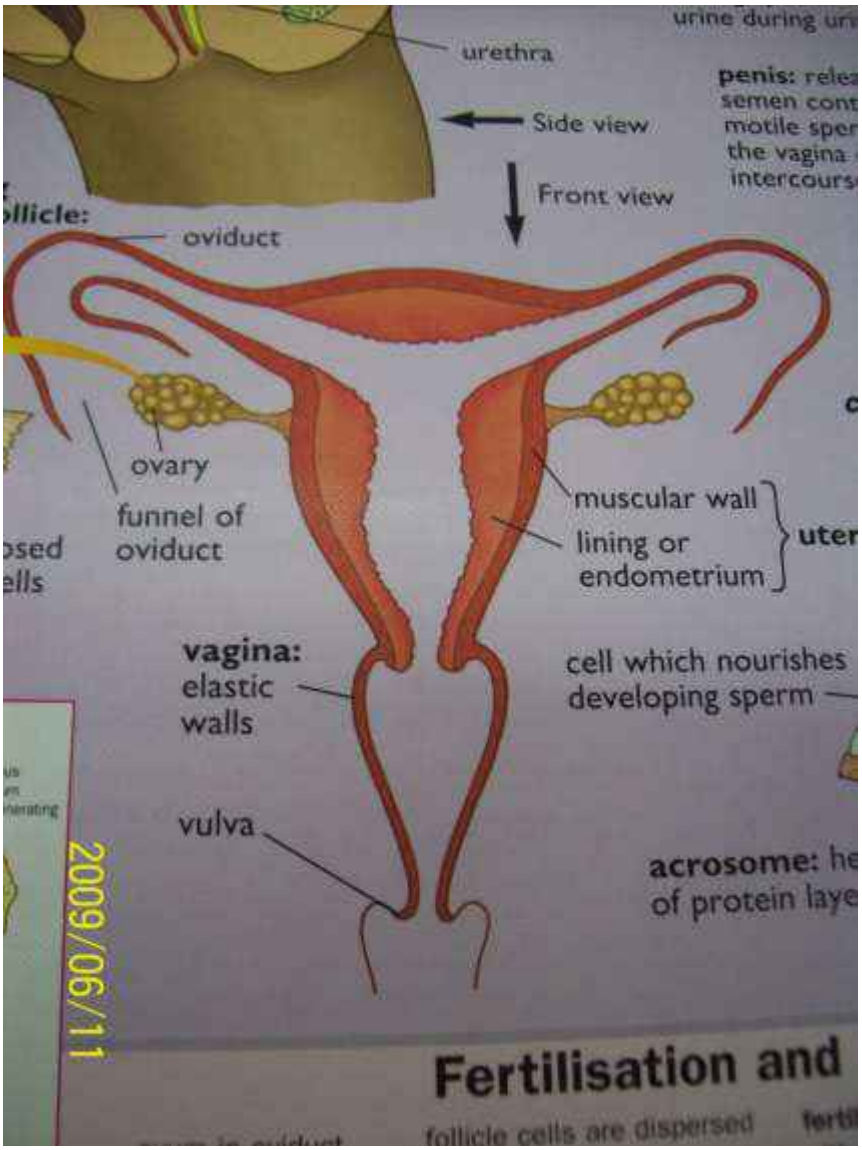
- are seminal vesicle, Cowper's gland and prostate gland
- they produce seminal fluid to provide a medium/ nutrients for sperms to swim

**iii) How is the sperm adapted to perform its function?**

- acrosomes contain enzymes to digest egg membrane
- nucleus contains genetic material
- mitochondria produce energy to move the tail back and forth
- the lashing movement of the tail enables the sperm to move/propulsion in fluid medium towards the egg
- it is streamlined for faster/easier movement/swimming to meet the egg

**c) i) Draw and label the human female reproductive system**




urethra
Side view
Front view
oviduct
ovary
funnel of oviduct
muscular wall
lining or endometrium
vagina: elastic walls
cell which nourishes developing sperm
vulva
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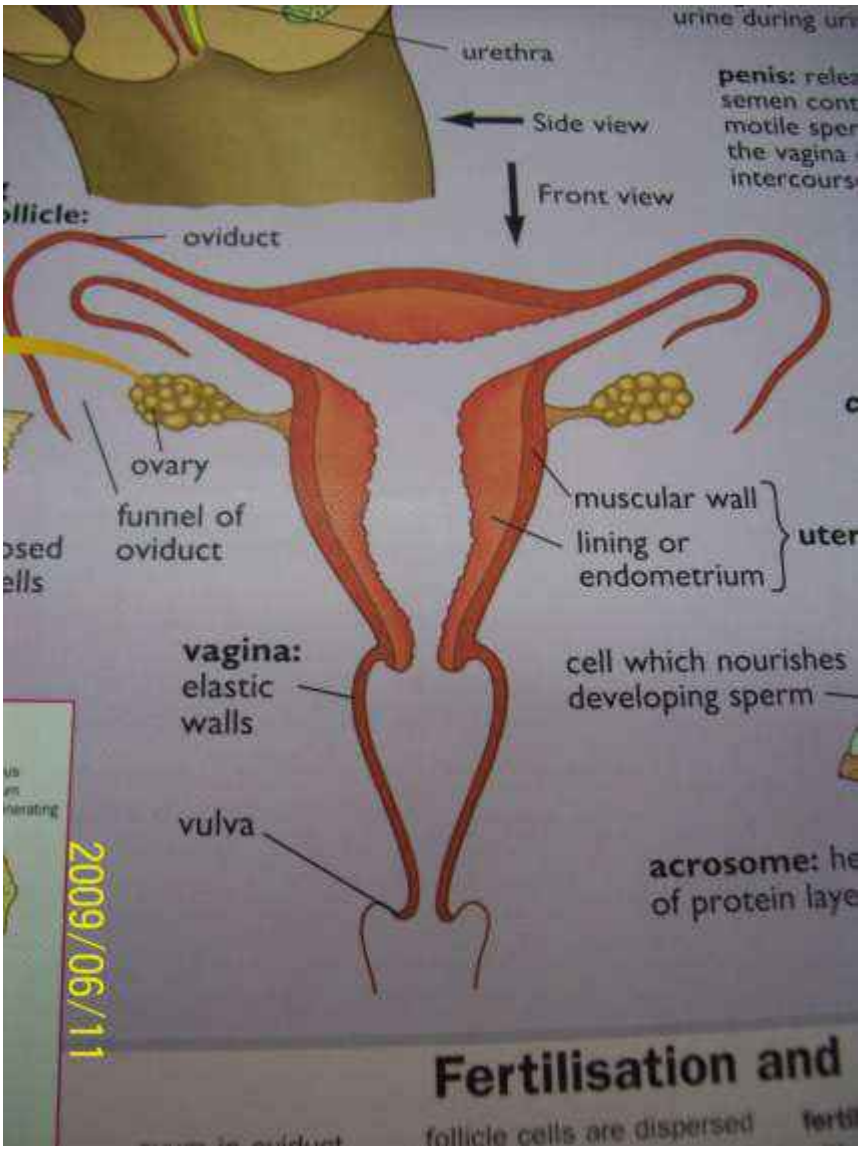
Fertilisation and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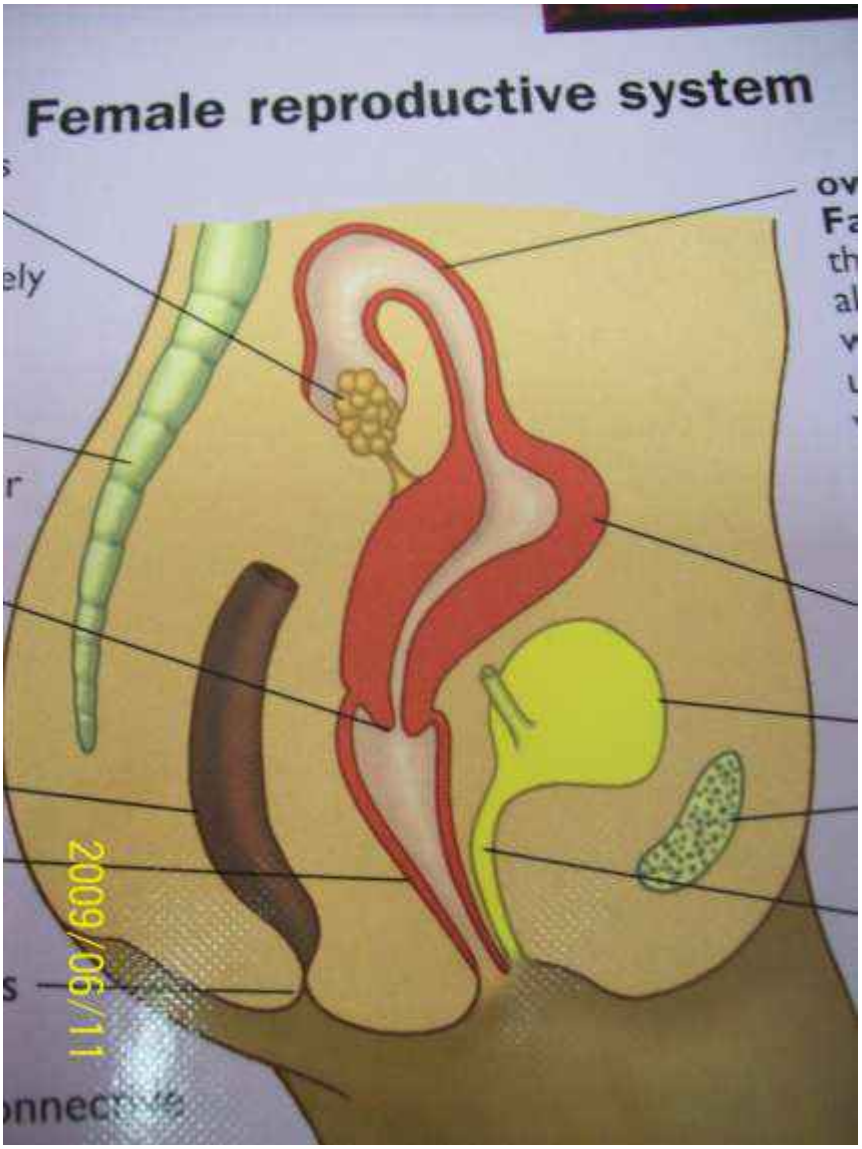



**ii) Describe how the various structures of the human female reproductive system are adapted to their function**

**Ovaries**

- have several graafian follicles that develop and burst open to release/produce mature ova
- secretes sex hormones)oestrogen) which initiate/control development of secondary sexual characteristics
- produce hormones oestrogen and progesterone which prepare the uterus for implantation and subsequent nourishment of the embryo

**Oviducts (fallopian tube)**

- are thin narrow and tubular to increase flowing speed of semen containing sperms
- are funnel shaped on the end next to ovary which enables them to receive the ovum
- their lining contains cilia which propel the ovum towards the uterus
- has peristaltic muscles that enable movement of zygote/ovum to the uterus for implantation
- is fairly long to increase surface area for fertilization

**Uterus**

- is muscular for protection of developing embryo
- has elastic wall that allows growth and development of foetus/embryo
- has a highly vascularised endometrium that provides nutrients/gaseous exchange to developing embryo

**Cervix**

- has valves that close the lower end of the uterus to ensure continued pregnancy during gestation period
- is capable of dilating
- has narrow entrance/neck-like entrance to uterus that enables quick swimming of sperms to uterus
- has suction mechanism that draws up/pulls sperms into uterus
- has a "W" shape that fits well with the glands of the penis to ensure sperms are deposited at the right point

**Vagina**

- is elastic and muscular to enable good accommodation or penetration of the penis thus proper deposition of sperms and for easy parturition
- allows menstrual flow
- has sensitive labial walls which secrete/produce lubricating substances that ensure/enable/facilitate good coition
- capable of considerable enlargement, due to elastic muscles, to accommodate baby during parturition

**Clitoris**

- has sensitive cells for orgasm

**iii) Explain how the ovum is adapted to its function**

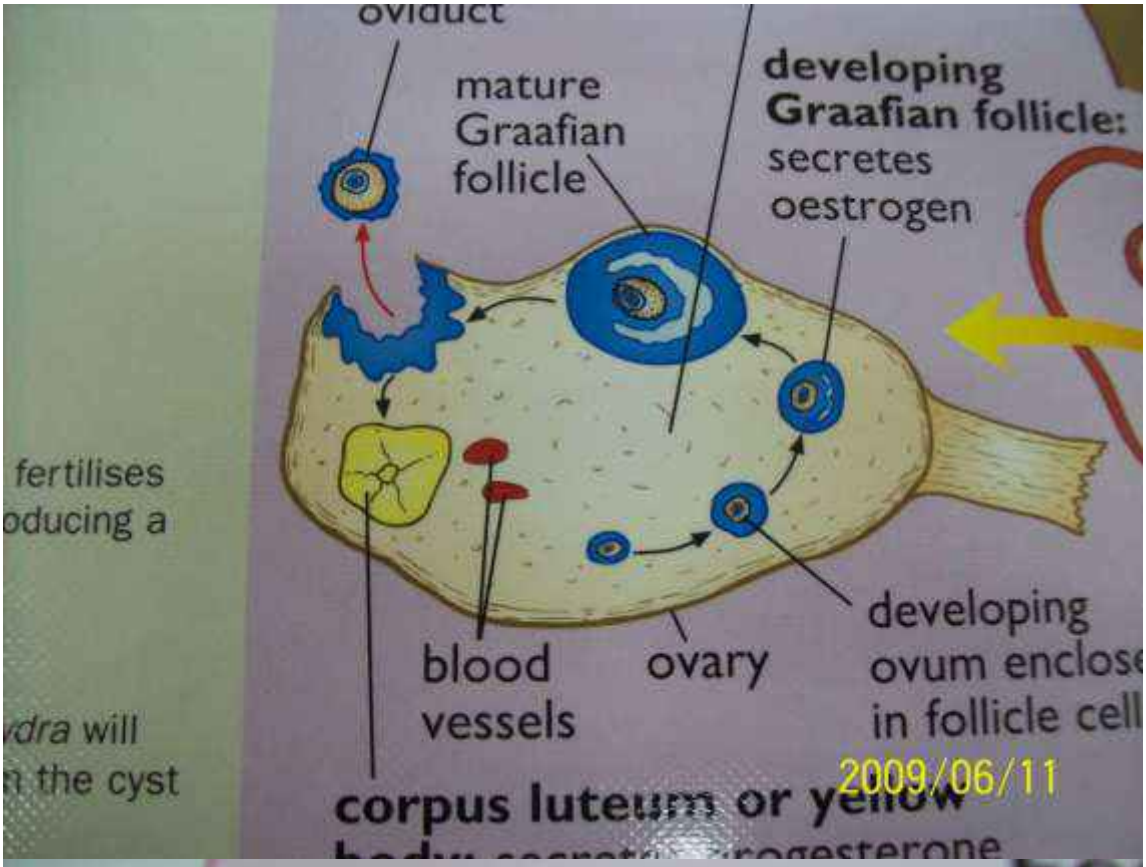
- nucleus contains genetic material
- ventelline membrane encloses plasma membrane which encloses yolky cytoplasm
- yolky cytoplasm provides nourishment
- jelly coat protects ovum against dehydration

**iv) Explain the differences between sperm and ovum**

| **Sperm** | **Ovum** |
|---|---|
| • long with a tail and head<br>• small<br>• locomotory<br>• stores little food<br>• has acrosome (tip with lytic enzymes)<br>• nucleus prominent but cytoplasm negligible | • spherical<br>• large<br>• stationary<br>• a lot of food stored in yolky cytoplasm<br>• lacks acrosome<br>• a lot of cytoplasm |

**d) i) Explain the process of fertilization**

- a process whereby the egg and sperm are brought together and fuse to form a zygote
- occurs in the fallopian tube after copulation
- sperm head penetrates the outer coat of the ovum while the tail remains outside
- penetration is due to reaction of acrosome
- acrosome digests the vitelline membrane
- thereafter a zygote is formed
- zygote which is diploid undergoes rapid cell division to form a mass of cells called blastocyst
- after fertilization a membrane forms around the ovum to prevent further entry of sperms
- blastocyst eventually develops into an embryo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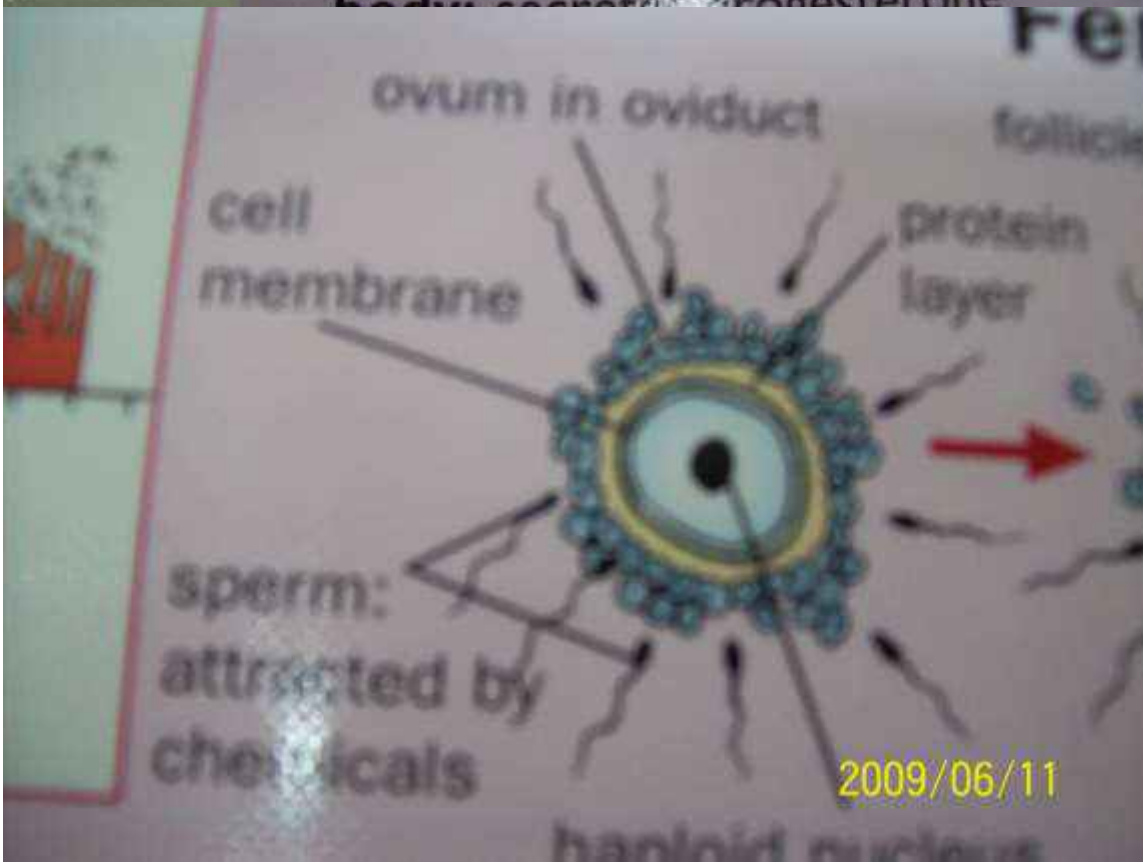
ovum in oviduct
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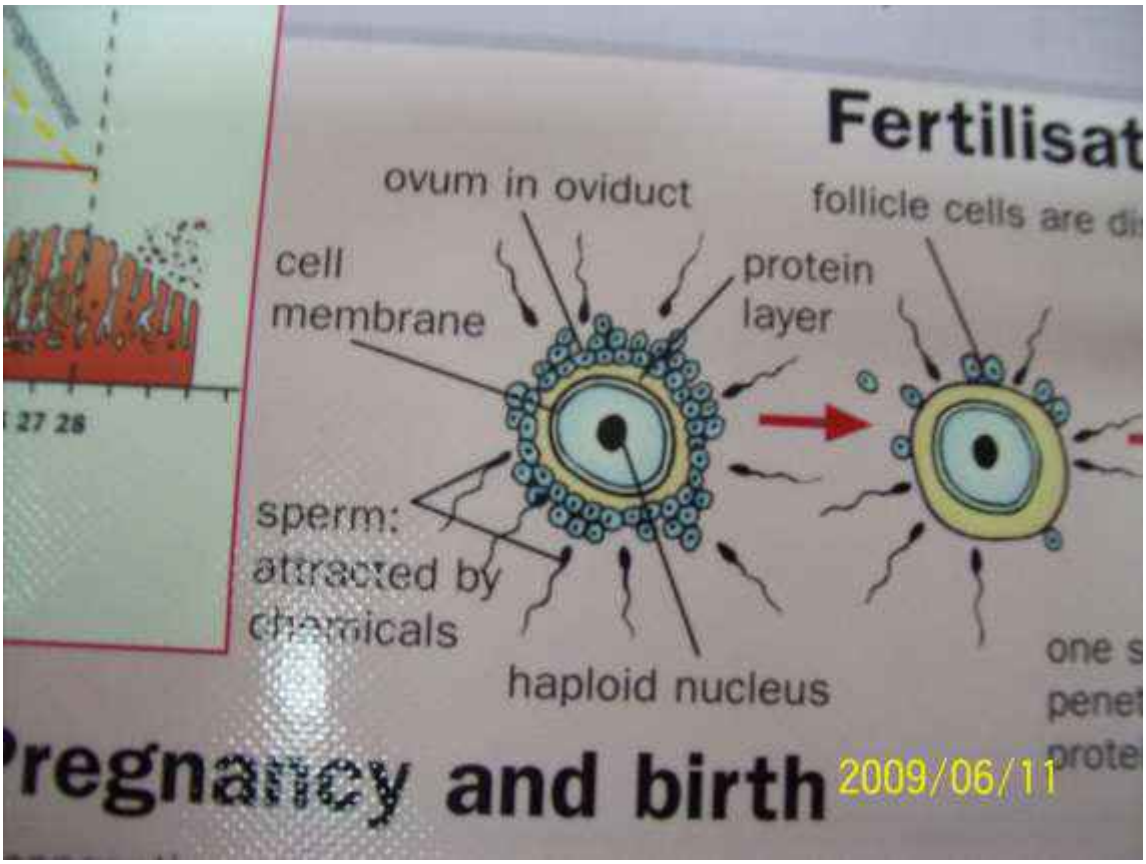
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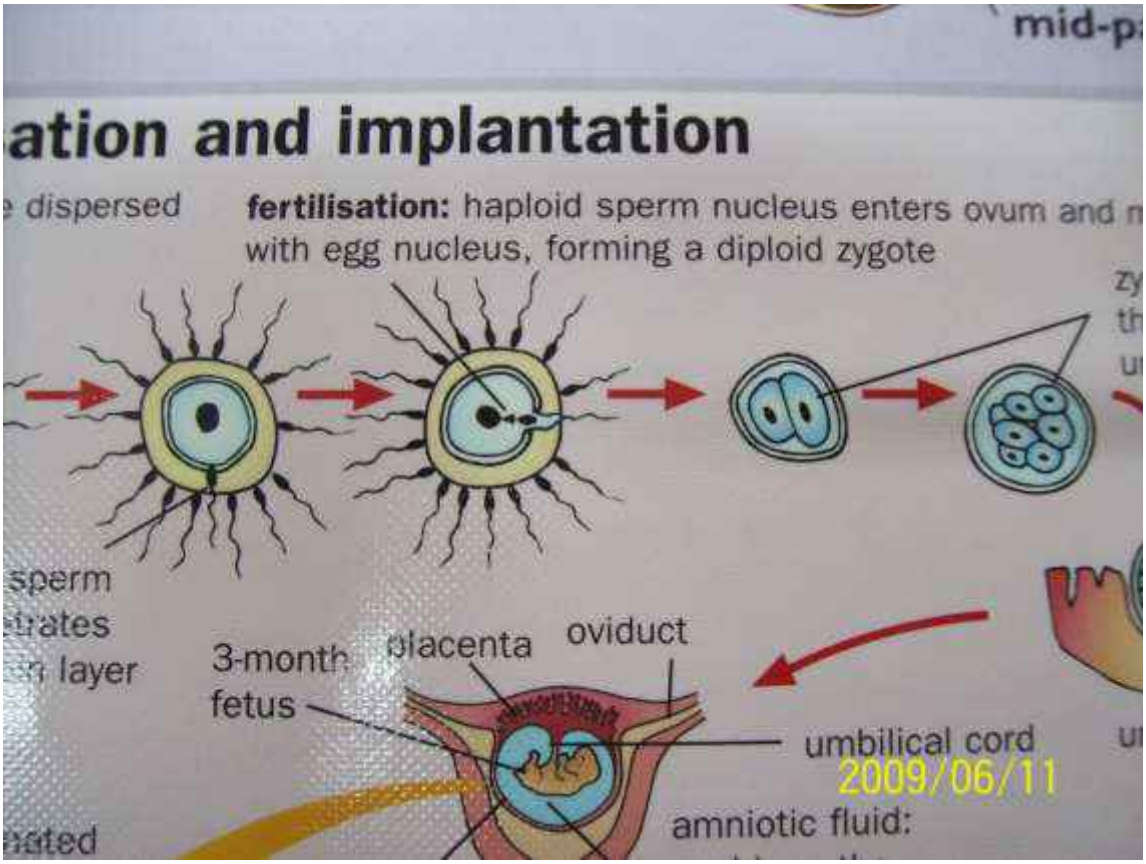
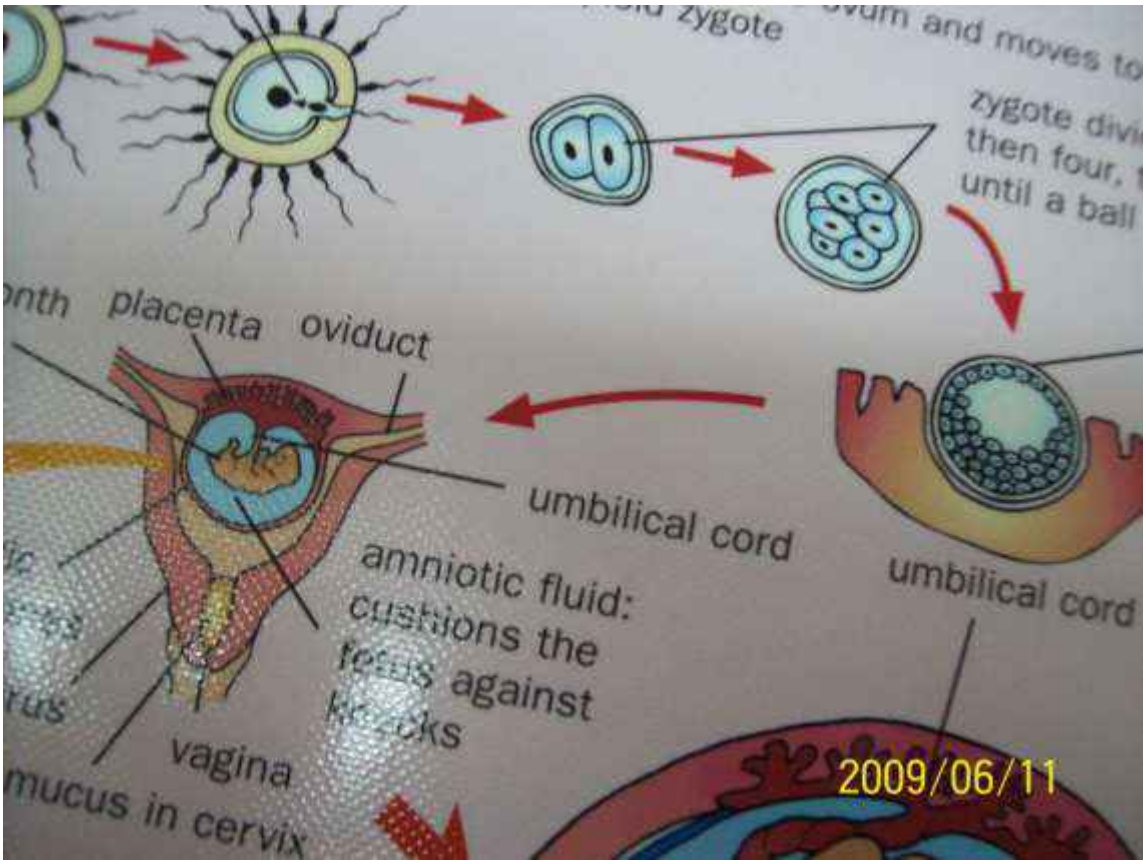



**i) Explain the process of implantation**

- this is the embedding and attaching of the embryo in the uterine wall/endometrium
- implantation marks the beginning of pregnancy
- sometimes implantation occurs in the oviduct wall which is abnormal and results in ectopic pregnancy which is fatal
- the outer wall of the blastocyst develops fingerlike projections which project into the uterine wall for attachment
- the projections are called villi
- the villi and endometrium develop into an organ that is called the placenta
- the embryo is attached to the placenta through a cord called the umbilical cord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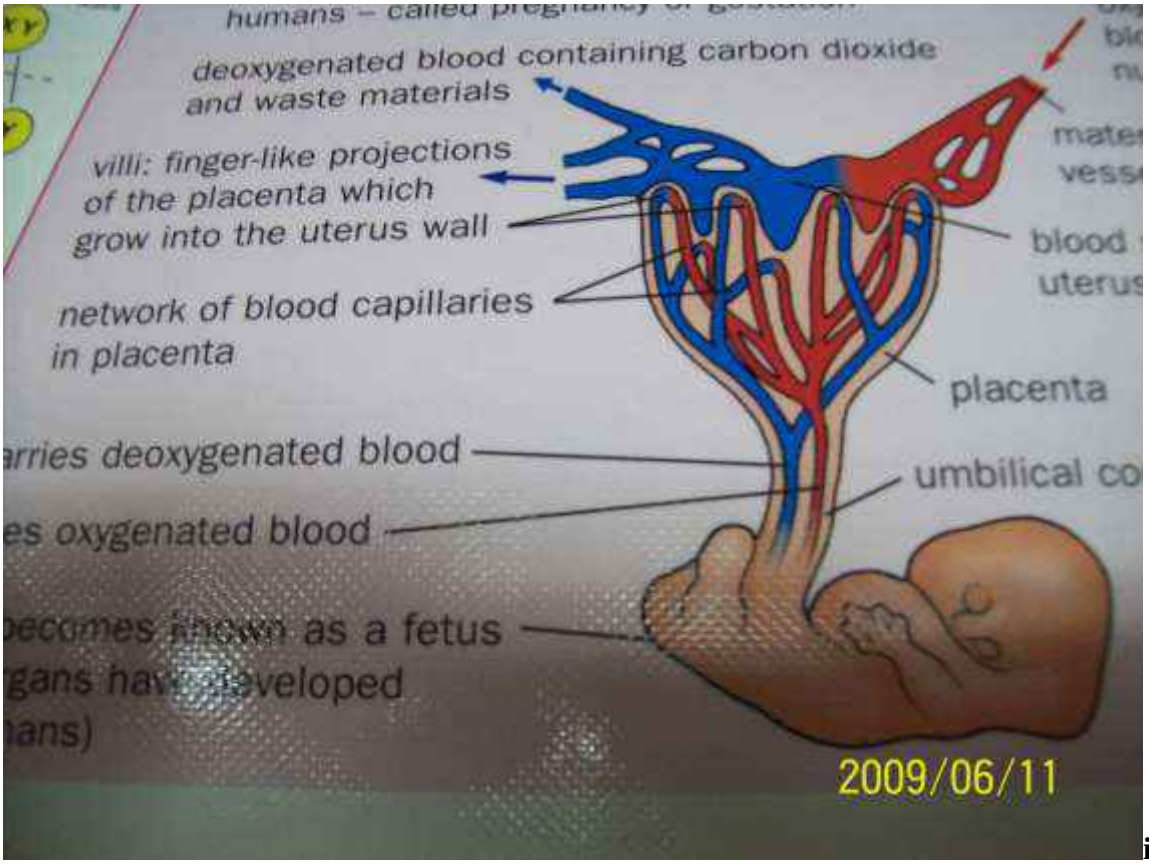
humans – called pregnancy or gestation
deoxygenated blood containing carbon dioxide and waste materials
villi: finger-like projections of the placenta which grow into the uterus wall
network of blood capillaries in placenta
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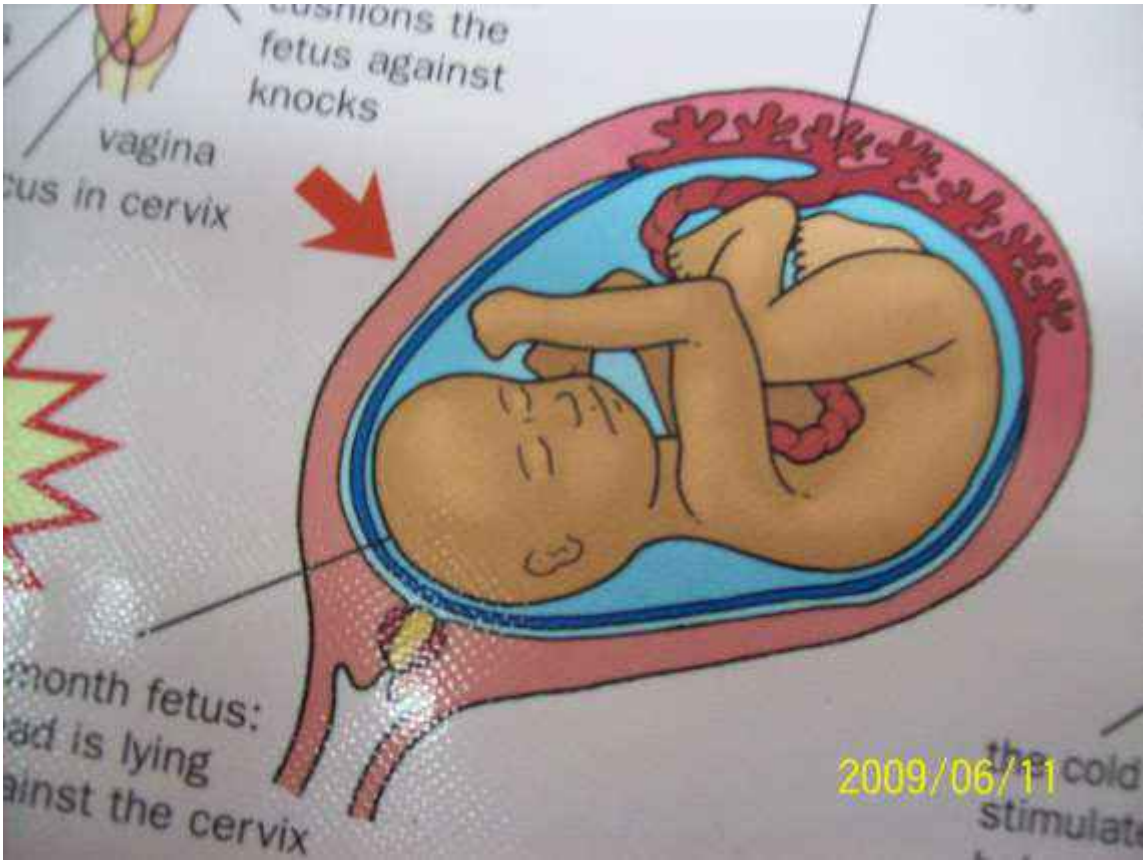
**iii)**




**State the functions of umbilical cord**

- it contains blood vessels umbilical artery, iliac arteries and umbilical veins)
- it joins the placenta to the embryo
- passage for nutrients from the mother
- passage of excretory substances from foetus to mother for final discharge
- gaseous exchange
- passage of antibodies from mother to foetus, for protection of foetus against diseases

**iv) State the role of placenta**

- exchange of gases between mother and foetus
- exchange of nutrients and nitrogenous wastes
- anchorage/attachment of foetus
- produces hormones (oestrogen and progesterone)

**e) i) What is gestation period?**

- time taken from fertilization to birth/pregnancy

**ii) Explain the functions of the membranes associated with placenta**

**Chorion**

- surrounds the embryo
- has fingerlike projections that attach embryo to the uterus

**Amnion**

- contains amniotic fluid
- fluid surrounds embryo
- protects embryo from mechanical injury by acting as shock absorbers
- fluid also protects embryo from dehydration
- distributes pressure equally over embryo

**Yolk sac**

- surround the yolk
- produces blood cells for embryo until its own liver is able to perform the task

**Allantois**

- present only for a short time
- removes and store waste material
- it eventually becomes the umbilical cord

**iii) Explain the events that take place to facilitate parturition**

- near birth the placenta produces less progesterone
- oxytocin hormone is produced by posterior lobe of pituitary gland
- because progesterone level has decreased the uterus becomes sensitive to oxytocin
- oxytocin causes the contraction of the uterus (myometrium)
- these contractions are called labour pains
- just before parturition the head turns downwards
- the contractions eventually push the baby through the vagina
- amnion breaks and amniotic fluid is released
- oxytocin dilates the cervix
- foetus is expelled through cervix with head coming out first
- finally the whole infant comes out
- the umbilical cord is cut and the placenta is expelled as afterbirth

**iv) State the reasons why later in pregnancy the ovary will b e removed without disturbing the pregnancy**

- corpus luteum in the ovary secretes progesterone which maintains pregnancy and development of foetus after conception
- after four months pregnancy is maintained by progesterone from the placenta

**f) i) What are secondary sexual characteristics**

- Characteristics (physiological and anatomical) that start developing at puberty due to the influence of male and female hormones

**ii) State the main secondary changes in**

**Boys**

- deepening of the voice
- growth of hair on face, pubic part, chest, legs
- penis and testes become bigger
- muscular development
- sperm production begins at puberty and may continue throughout life

**Girls**

- growth of hair on pubic part and armpits
- widening/enlargement of hips
- development of breasts
- menstrual cycle starts as ovaries mature
- body acquires extra fat

**iii) Describe the role of hormones in secondary sexual characteristics in**

**Boys**

**Follicle stimulation hormone (FSH)**

- from pituitary
- stimulates production of androgens(male hormones) mainly testosterone by testis

**Testosterone**

- secondary sexual characteristics

**Girls**

**FHS**

- from pituitary
- development of follicles
- stimulates oestrogen production by ovary

**LH**

- from pituitary
- ovulation
- stimulates release of progesterone by ovary

**Oestrogen**

- stimulates release of LH
- secondary sexual characteristics

**Progesterone**

- also from placenta
- sustains pregnancy as it inhibits prolactin and oxytocin during pregnancy

**Prolactin**

- milk formation

**Oxytocin**

- parturition
- milk ejection

**g) i) What is menstruation?**

- vaginal discharge due to disintegration of endometrium

**ii) Describe the role of hormones in the human menstrual cycle**

- it is controlled by sex hormones which are responsible for the onset of secondary sexual characteristics and also control of the menstrual cycle
- the onset is signaled by discharge of blood/menses 14 days following the start of menstruation
- anterior lobe of pituitary gland secretes follicle stimulating hormone(FSH)
- Follicle stimulating hormone causes graafian follicle to develop in the ovary. It also stimulates tissues of the ovary/wall (theca) to secrete oestrogen
- oestrogen causes repair/healing of uterine wall
- oestrogen stimulates anterior lobe of pituitary to produce luteinising hormonge (LH)
- LH causes ovulation. It also causes graafian follicle to change into corpus luteum. LH stimulates corpus luteum to secrete progesterone
- Progesterone causes proliferation/thickening of uterine wall
- Oesterogen/progesterone inhibits the production of FSH by anterior lobe of pituitary, thus no more follicles develop and oestrogen production reduces
- In the next two weeks progesterone level rises and inhibits production of LH from anterior lobe of pituitary
- The corpus lutetium stops secreting progesterone and menstruation occurs when the level of progesterone drops
- Anterior lobe of pituitary starts secreting FSH again.

**iii) What is menopause?**

- end of ovulation in women
- occurs after age of 45 years
- does not occur in males

**h) Explain the symptoms, methods of transmitting and prevention (control) of the following sexually transmitted diseases**

**i) Gonorrhea**

- caused by a bacterium called neisseria gonorrhea
- transmitted through sexual intercourse,
- infects urethra and vaginal tract (epithelia)
- Symptoms include pain, discharge of mucus and bad smell (females)
- Effects include sterility, heart diseases, blindness of foetus and arthritis
- Treatment by antibiotics
- Control and prevention by proper sexual conduct

**ii) Herpes**

- notably Herpes simplex and H. genitalis
- caused by virus which attacks genitalia
- symptoms are painful sores in genitalia, skin lesions
- transmitted in saliva, sexual intercourse and injection by drug addicts
- no treatment

**iii) Syphilis**

- caused by bacterium called Treponema palladium
- symptoms are painless wounds in genitalia
- attack genitalia, nervous system, lips
- treated by antibiotics

**iv) Trichomoniasis**

- caused by plasmodium called trichomonas
- attacks reproductive tract
- symptoms are itching and discharge of pus from the genitals
- treated by antibiotics

**v) Hepatitis**

- Viral disease

Affects the liver
Transmitted through sexual intercourse
No known treatment

**vi) Candidiasis**

- caused by fungus called candida albicans
- transmitted through sexual intercourse
- symptoms include itching urethra, and vaginal discharge (odourless)
- controlled by personal hygiene, early treatment and responsible sexual behavior

**vii) HIV/AIDS**

- caused by HIV virus
- transmitted by sexual intercourse, blood transfusion, sharing piercing instruments from infected mother to foetus, infant and baby
- symptoms include fever, swollen lymph nodes, night sweating, cough, weight loss, fatigue, loss of appetite, diarrhea, headache, a opportunistic infections and tumors
- Control by responsible sexual behaviour, education, screening blood for transfusion and using sterile piercing instruments.

**6. a) Define the terms**

**i) Growth**

- an irreversible change in size of a cell, organ or whole organism
- growth is due to synthesis of protoplasm or extracellular substances

**ii) Development**

- refers to a series of changes which an organism goes through in its lie cycle
- during development both qualitative and quantitative changes take place(involves differentiation)

**iii) Differentiation**

- refers to changes in which the cells of the body undergo and become specialised to perform specific functions

**b) i) Differentiate growth in plants and animals**

| Plants | Animals |
|---|---|
| • confined to shoots/root tips (apical)<br>• have definite growth regions(meristems)<br>• often indefinite/continuous<br>• growth results in branching<br>• affected by light, auxins, hormones and temperature | • occurs all over the body(intercalary)<br>• different parts grow at different rates(allometric)<br>• maximum growth on maturity(definite)<br>• no branching<br>• affected by nutrients |

**ii) List the processes involved in growth**

- assimilation
- cell enlargement
- cell division(by mitosis)

**iv) List the parameters used to measure growth**

- height/length
- dry weight
- number of individuals
- volume
- leaf area of plant

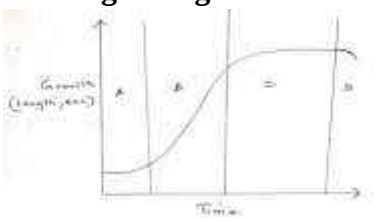
**iv) Name the patterns of growth in organisms**

- allometric and isometric
- limited and unlimited
- discontinuous growth

**c) i) Name the different types of growth curves**

- sigmoid curve(normal growth curve)
- intermittent growth curve

**ii) Draw a sigmoid growth curve and explain its different phases/stages**



**A-lag phase**

- Slow growth rate at first

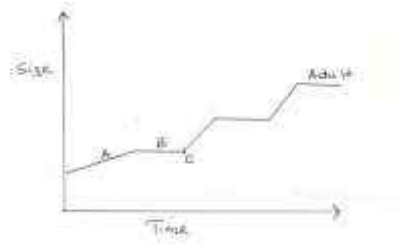
Organism adapting to the environment

**B-exponential phase**

- organisms already adapted
- first growth due to birth rate that is higher than death rate

**C- Stationery phase (plateau)**
- Birth rate equals death rate (equilibrium)
Lack of nutrients, accumulation of toxic waste products
**D-phase of decline**
- due to depletion of nutrients, accumulation of toxic wastes, lack of space
- some individuals old hence not reproducing
- death rate higher than birth rate

**iii) Draw an intermittent curve and explain the various stages**




A-growth
B-no growth
C- moulting/ecdysis
- seen in arthropods
- growth in  in arthropods is intermittent(takes place during some time only because their hard cuticles (exoskeleton) does not expand to cause growth
- the cuticle must be shed off first to allow further growth
- the shedding is called ecdysis or moulting
- when moulting has taken place animal grows but growth stops when the exoskeleton hardens again

**d) i) What is seed dormancy?**
- A state where a viable seed is incapable of germinating when all conditions are favourable.

**ii) State the biological importance of seed dormancy**
- gives embryo time to reach maturity
- gives time for dispersal
- allows plant to survive adverse conditions

**iii) State the factors which cause seed dormancy**
**Internal factors**
- presence of abscisic acid/ABA/ presence of germination inhibitors
- embryo not fully developed
- absence of hormones/enzymes/inactivity of hormones/enzymes/gibberellins/cytokinins
- impermeability of seed coat

**External factors**
- unsuitable temperature
- absence of light
- lack of oxygen
- lack of oxygen
- lack of water

**iv) Give the conditions necessary to break seed dormancy**

- scarification/scratching to make seed coat impermeable
- vernalisation/cold treatment in some seeds like wheat
- burning/nicking/expose to heat e.g. wattle seeds
- destruction of germination inhibitors

**e) i) What is seed germination?**

- process by which a seed develops in a seedling

**ii) What is viability**

- ability of a seed to germinate

**iii) Discuss the various conditions necessary for the germination of seeds**

**Water**

- medium for enzymatic activity
- hydrolysis of food into simpler substances
- medium of transport
- softens the seed
- acts as a solvent

**Air**

- in form of oxygen
- oxygen is used for respiration/oxidation of food to release energy

**Suitable (optimum) temperature**

- activates enzymes involved in mobilization of food reserves

**Enzymes**

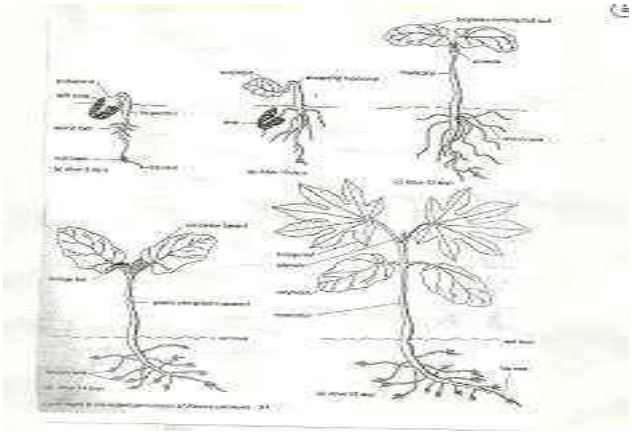
- breakdown and subsequent oxidation of food
- conservation of hydrolyzed food products into new plant tissues

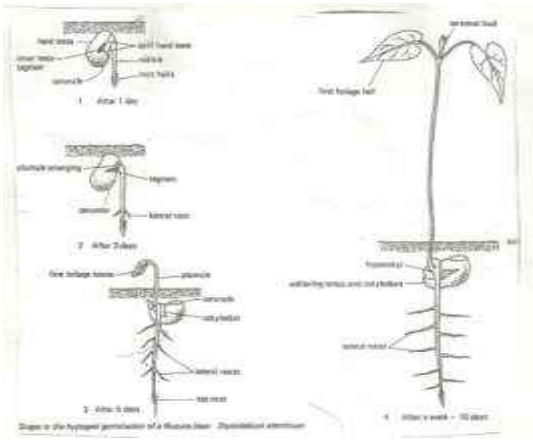
**Viability**

- only viable seed are able to germinate and grow

**iv) Name and describe the types of germination**

**Epigeal**





cotyledons are brought above the ground level during germination due to elongation of hypocotyls

**Hypogeal**

- the cotyledons remain below the surface during germination due to elongation of epicotyl e.g. maize

**v) Name the part of the bean seed that elongates to bring about epigeal germination**

hypocotyl

**vi) Account for the loss in dry weight of cotyledons in a germinating bean seed**

- food stored is mobilized/used up for respiration and growth

**vii) Describe the physiological changes that occur in a seed during germination**

- in presence of oxygen, optimum temperature and water, food reserves in the seed are hydrolysed or broken down into soluble diffusible form by enzymes
- soluble food diffuses to the growing embryo
- oils and carbohydrates provide energy
- simple sugars converted to cellulose to form cell wall
- amino acids make protoplasm
- seed develops plumule and radicle hence germinates

**viii) Explain the biological significance of cotyledons being brought above the ground in epigeal germination**

- cotyledons have inadequate food
- they are brought above the ground to acquire chloroplasts to carry out photosynthesis before the formation of foliage leaves to supplement food supply required for growth during germination

**f) i) Distinguish between primary and secondary growth**

**Primary growth**

- occurs at the apical (shoot and tip) apices regions where meristematic cells occur
- causes plant elongation since cells divide by mitosis

**Secondary growth**

-occurs at the cambium meristems

Increases width (girth) of the stem

**ii) What are meristems**

- dividing cells
- meristem means they are dividing

**iii) State the characteristics of meristematic cells**

- dense cytoplasm
- thin cell walls
- absence of vacuoles/cell sap

**iv) State the location and function of the following meristematic tissues**

**Apical meristem**

- located at tips of roots and shoots
- increase length of stem and roots/primary growth

**Intercalary meristem**

- found at bases of internodes
- responsible for elongation of internodes and increase in leaf sheath in grasses

**Lateral meristems**

- found near the periphery of stem and root
- responsible for secondary growth/growth in girth of stem and root/lateral growth
- called cambium and constitute vascular and cork cambium

**v) Describe primary growth**

- occurs at tips of shoots and roots in the meristematic tissues of apical meristem
- at the apex there is a zone of cell division/mitosis
- cells elongate at elongation zone
- the elongated cells differentiate at the region of differentiation resulting in increase in size
- in the stems meristems give rise to leaf premodia which envelop the apex to form a bud
- the bud protects the delicate inner cells
- in roots the meristem is protected by root cap
- after cells differentiate the form permanent tissues

**vi) Describe secondary growth in plants**

- also called secondary thickening
- only occurs in dicotyledonous plants that have cambium
- monocotyledonous plants do not undergo secondary growth because they lack intervascular cambium
- cambium cells divide to produce more cells on either side of the cambium
- cells produced to the inside become secondary cambium
- cells produced to the outside become secondary phloem
- division of cambium cells occurs yearly producing new rings of secondary phloem and secondary xylem each year
- intervascular cambium(cambium between vascular bundles) divide to form secondary parenchyma, thereby increasing growth of medullary rays
- much more xylem is formed than phloem, thus pushing phloem and cambium ring outward
- the rate of secondary growth is depended on seasons(rains) resulting in annual rings
- cork cambium is located beneath epidermis ad is responsible for secondary thickening of the bark of perennial plants
- cork cambium divides to form new cork(bark) tissues to accommodate increased growth on outside and secondary cortex on the inside
- Cork cells (cells of the bark) are loosely parked at some points to form lenticels for gaseous exchange.

**vii) State the significance of secondary growth**

- increase girth or circumference of trees
- annual rings which show seasonal growth can be used to tell the age of trees

**g) i) Describe one method which can be used to measure the average growth rate of a single leaf of a plant**

**EITHER**

- chose/identify a young leaf(just unfolded)
- use the same leaf throughout
- measure (total) length of (whole) leaf
- record
- repeat at regular intervals until no more change occurs/constant length
- average rate of growth is equal to total increase in length divided by the period taken to achieve full length

Average rate of growth = $\frac{\text{total increase in length}}{\text{period taken to achieve full length}}$

**OR**

- choose/identify a young leaf(just unfolded)
- use the same leaf throughout
- trace the outline on a graph paper and work out the area
- record
- repeat at regular intervals until regular area
- average rate of growth equals to total increase in area divided by the period of time taken to achieve full area

Average rate of growth = $\frac{\text{total increase in area}}{\text{period of time taken to achieve final area}}$

**i**

**i) Describe how the growth of a root can be determined**

**Materials**

- fine thread, marking ink, germinating bean seedlings, blotting paper, ruler marked in millimeters, pins, cork, a boiling tube and moist cotton wool

**Procedure**

- dry seedlings using blotting paper
- place inside against the ruler marked in mm
- dip the fine thread in waterproof ink
- mark the radicle at equal intervals
- pin the seedling to the cork
- suspend the seedling into the boiling tube containing moist cotton wool
- allow the seedling to grow for two days/some time observe the intervals with the marks
- record your observations the widest intervals are found in the region just behind the tip indicating/showing region of greatest growth

**iii) A boy hammered a nail in the bark of a tree at a height of 1.5metres above the ground. Four years later, the nail was found at the same height although the tree had grown 3 meters taller. Explain the above observation**

The nail was hammered at a point where vertical growth had stopped/further growth was confined to increase in width/diameter.

Vertical growth is confined to tips/apex/vertical apical meristem

**h) i) Describe the role of hormones in growth and development of plants**
indole acetic acid/IAA/ auxins
Cell division/increase in cell division
Tropic responses
Cell elongation/increases in ell elongation
Development of abscision layer
Growth of ovaries into fruits/parthenocarpy/initiates flowers
Inhibits growth of lateral buds/produces apical dominance
Stimulates adventitious/lateral roots
Gibberellins (Gibberellic acid/GA3

Promote cell elongation/rapid cell division/increase in length of the internodes
Promote fruit formation without fertilization/parthenocarpy
Reduces root growth
Breaks seed dormancy/promotes germination

**Cytokinnins (Kinnins/Kinnetin/Zeatin)**
- breaks dormancy
- promotes flowering
- promotes cell division
- stabilizes protein and chlorophyll
- promotes root formation on a shoot
- low concentration encourages leaf senses
- normal concentration increases cell enlargement in leaves
- stimulates lateral bud development

**Ethylene (ethynel$C_2H_4$)**
- accelerates ripening in fruits
- encourages fruit fall/leaf fall
- induces thickening in stern/inhibits stem elongation
- promotes flowering (in pineapples)
- promotes germination in certain seeds

**Abscisic acid (ABA) abscisin hormone/dormin)**
- causes bud dormancy
- encourages fruit/leaf fall
- high concentration causes closing of stomata
- causes seed dormancy
- inhibits cell elongation

**Traumatin**
- heals wounds by callous formation

**Florigen**
- promotes flowering

**ii) State the applications of plant hormones in agriculture**

- induce root growth in stem cuttings
- selective weed killers
- encourage sprouting of lateral buds
- breaking seed dormancy
- induce parthenocarpy
- accelerate ripening of fruits
- promote flowering
- cause dormancy

**iii) Explain apical dominance**

- a phenomenon whereby production of auxins by a growing apical bud of a shoot inhibits growth of lateral buds
- this inhibition is due to high concentration of auxins (indoleacetic acid/IAA) in apical bud
- removal of terminal/apical bud causes development and sprouting of several buds which later develop into branches
- applied in pruning coffee, tea and hedges
- this leads to more yield

**iv) Describe the role of hormones in the growth and development of animal**
**somatotrophin (growth hormones)**

- from anterior pituitary
- promotes cell division
- overproduction causes gigantism
- underproduction causes dwarfism

**Thyroxine**

- promotes growth and metamorphosis
- underproduction leads to a child becoming a cretin (mentally retarted)

**Androgens**

- in males
- growth of male reproductive organs

**Oestrogen**

- in females
- growth of female reproductive organs

**Ecdysone**

- in arthropods
- moulting (ecdysis)

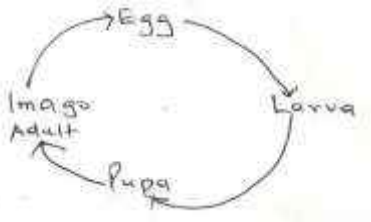
**t) i) What is metamorphosis?**

- change in form during which there are changes in structure and function in body of organism
- prepares organism for life in a different habitat

**ii) Explain complete metamorphosis**

radical changes in the body during the life cycle of an organism
called holometabolous development

example is egg larva pupa adult (imago)
occurs in animals such as butterfly and bee



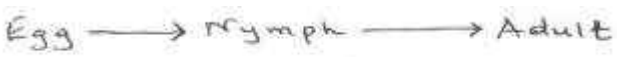

**iii) What is the significance of each of the four stages in complete metamorphosis?**

**Larval stage**
- feeding takes place
- larva is quite different from adult
- larva sheds its cuticle (exoskeleton) several times to emerge as pupa
- dispersal stage avoids overcrowding

**Pupa**
- enclosed in a case called puparium (cocoon)
- no feeding
- organ formation takes place

**Adult**
- emerges from puparium
- reproductive stage of the life cycle

**iv) Describe incomplete metamorphosis**
- called hemimetabolous development
- changes are gradual
- eggs develop into nymphs which develop into adults
- nymph resembles adult but are sexually immature
- a nymph moults several times as some parts develop before it becomes an adult
- stage of development between one moult and another is called instar
- occurs in insects such as locust and cockroach




**v) Name the hormones that control metamorphosis in insects**
- brain hormone responsible for moulting because it simulates production of ecdyson (moulting hormone)
- ecdysone(moulting hormone) causes moulting
- juvenile hormone causes moulting in larvae

**vi) State the advantages of metamorphosis in the life of insects**

- the adult and larvae exploit different niches
- do not compete for food
- pupa cam survive adverse pupa can survive adverse conditions  eg-feeding stage
- dispersal prevents overcrowding

## FORM IV TOPICS

1. **a) i) Define the term genetics**

- the study of heredity(inheritance) and variation or study of mechanisms by which characteristics are passed from parents to offspring

**iii) List some characteristics which are inherited**

- size
- height/length
- colour/type
- shape
- yield

**iii) State the importance of genetics**

- helps to explain differences between organisms of the same species
- helps to explain the transmission of characters from generation to generation
- improvement in livestock
- improvement in crops
- can be used to treat some difficult diseases

**b) i) Explain the meaning of the following terms**

**Heredity**

- the resemblance among individuals related by descent
- transmission of traits from parents to offspring

**Trait**

- also called character
- A character of the organism e.g. type of ear, colour of eyes, height, yield etc.

**Gene**

- unit of inheritance
- it is the heredity factor which transmits traits from parents to offspring
- genes are located at fixed points on chromosomes
- each point is called a locus (loci)

**Allele**

- genes can exist in a series of alternative forms at a particular locus
- allele refers to alternative forms of genes controlling a particular characteristic

**Chromosomes**

- threadlike structures found in nuclei of all plants and animals
- they carry genes which are hereditary materials
- they consist of substances called DNA and proteins called histosones

**DNA**

- deoxyribonucleic acid
- substances that make up chromosomes
- double helix(strand) molecule that contains genes
- DNA consists of nucleotides
- A nucleotide consists of an inorganic phosphate, ribose sugar and a base

- There are four bases in a DNA molecule i.e. Adenine(A), guanine(G), thymine(T) and cystosine (C)
- Ribose sugar has four bases attached to it i.e. adenine, cystosine, guanine and thymine
- Adenine pairs with thymine while guanine pairs with cystosine
- Nucleotide initiates and controls protein synthesis

**ii) List the types of chromosomes**

- somatic (body) chromosomes also called autosomes
- sex chromosomes (related to reproduction)

**c) i) What is variation?**

- sequence of differences occurring among individuals of the same species

**ii) State the causes of variation in organisms**

- random assortment of genes during meiosis
- crossing over
- fertilization
- doubling of chromosome numbers(mutation)
- environmental conditions

**iii) Name the types of variation**

- Continuous variation (differences not clear cut) e.g. height, length, weight, skin colour, intelligence etc. They are quantitative and show intermediates
- discontinuous variation(differences are clear cut) e.g. ability to roll tongue, ABO blood grouping system, RH factor, patterns of fingerprints, and ability to taste PTC. They are qualitative and have no intermediates

**iv) Explain the following terms**

**Acquired characteristics**

- they are as a result of adaptations due to the environment and are not inherited

**Inherited characteristics**

- are passed down to offspring during sexual reproduction

**Genotype**

- genetic constitution of an individual/genetic makeup

**Phenotype**

- characteristics of an individual observed or discernible by other means i.e. observable character

**Dominant gene (character)**

- expressed in the phenotype when homozygous or heterozygous

**Recessive gene**

- only expressed in homozygous state

**Homozygous**

- when two alleles are identical e.g. LL,ll

**Heterozygous**

- when two alleles are different at a particular locus e.g. Ll

**F1 and F2**

- F1 means first filial generation i.e. the first generation produced when two varieties can be crossed
- F2 means second generation i.e. product of offspring or from F1 generation

**d) i) Explain Mendels first law of inheritance**

- also called law of segregation
- it states that genes are responsible for the development of individual characters
- these characters are transmitted individually without any alterations
- Only one character from a contrasting pair can be carried in a gamete, hence only one character can be inherited.

**ii) Give an example of this law**

- In an experiment, Drosophila (fruit fly) with long wings were crossed with those having short wings. Assume letter L denotes gene for wing size. The gene for long wings is dominant to that for short wings
- the genes for dominant are LL and for recessive ll.
- State the expected results for the first cross

**iii) What is monohybrid inheritance?**

- when inheritance of one character is studied one at a time e.g. wing size only
- the F2 generation (when selfed) always gives a phenotypic ratio of 3:1 and a genotypic ratio of 1:2:1 in a complete dominance

**v) What is complete dominance?**

- refers to where only one dominant character is expressed while the other character which is recessive is not expressed in the heterozygous state e.g. the case of wing size above

**e) i) What is meant by co dominance?**

- When genes produce independent effects when heterozygous/none of the genes is dominant over the other/where two or more alleles does not show complete dominance/recessiveness due to the failure of any allele to be dominate in a heterozygous condition.

**ii) Give an example of co dominance**

In a certain plant species, some individual plants may have only white, red or pink flowers. In an experiment a plant with white flowers was crossed with a parent with red flowers. Show results of F1 generation. Use letter R for red gene and W for white gene.

**If the plants form F1 were selfed, work out the phenotype ratio for the F2 generation**

Phenotypic ratio 1red:2pink:1white
Genotypic ratio 1:2:1

**f) i) What is a test cross?**

- A cross between an individual showing a character for a dominant gene(that is homozygous or heterozygous) with a homozygous recessive individual

**OR**

- a cross between individual(organism) of unknown genotype with a homozygous recessive individual

**ii) State the importance of a test cross in genetics**

- helps in determining the genetic constitution/genotype of an organism

**iii) What are multiple alleles?**

- a set of more than two alleles that may determine a character
- example is blood group which can be determined by any two of three alleles i.e. A,B and O

**iv) Explain the inheritance of ABO blood groups**

- in humans blood groups are determined by three alleles i.e. A,B and O
- it is only possible to have two genes at a time
- genes A and B are co-dominant while gene O is recessive to genes A and B

**Give a worked example using parents with heterozygous blood groups AO and BO**

**vi) Explain the inheritance of Rhesus factor (Rh) in human beings**

- in humans blood is either Rh positive or Rh negative
- people who have Rh antigen are Rh(+ve) while those without Rh antigen in their blood are Rh(-ve)
- Rh(+ve) is due to a dominant gene while the recessive gene causes lack of Rh factor. When a person who is homozygous dominant marries a person who is homozygous recessive the result is as shown below

Let the gene for dominant Rh factor be R while gene for recessive be r

**vii) How is sex determined in human beings?**

- there are two sex chromosomes in humans, x and y
- males are xy and females are xx
- in females all ova have x chromosome
- in males 50% of sperms contain x chromosomes while 50% of sperms contain y chromosome
- when a sperm containing x chromosome fuses with an ovum this results into a girl
- when a sperm containing y chromosome fuses with an ovum the result is a boy
- an example is given below

**g) i) What does the term linkage mean?**

- These are genes which occur together on a chromosome and are passed to offspring without being separated

**ii) Define the term sex-linked genes**

- genes carried in the sex chromosome that are transmitted along with genes that determine sex

**iii) What is meant by the term sex linkage?**

- genes are located on the sex chromosome
- they are transmitted along with those that determine sex

**iv) Name the sex-linked traits in humans**

- colour blindness
- haemophilia
- Hairy ears. pinna, nose
- Baldness
- Duchene muscular dystrophy (DMD) muscular wasting

**v) Give an example of a sex linked trait in humans on:**

**Y Chromosome**

- tuft of hair sprouting from pinna/baldness

**X Chromosome**

- colour blindness/haemophilia

**vi) In humans red-green colour blindness is caused by a recessive gene C, which is sex-linked. A normal man married to a carrier woman transmits the trait to his children. Show the possible genotypes of the children.**

Let C represent the gene for normal colour vision (dominant)
Let c represent the gene for colour blindness
Parental phenotype Norman man x carrier woman

**viii) State the importance of sex linkage**

- possible to determine sex of day old chicks

**ix) Haemophilia is due to a recessive gene. The gene is sex-linked and located on the x chromosome. The figure below shows sworn offspring from phenotypically normal parents**

What are the parental genotypes?

- XY and $X^hX$

Work out the genotypes of the offspring

**h) i) What is mutation?**

- sudden change in the structure of DNA at a particular locus/chromosome/gene

**ii) Describe how mutations arise**

- mutations arise due to alterations in normal number of chromosomes
- change in a portion of a chromosome affecting one or more genes
- by chromosomal aberration e.g. dleltion/duplication/substitution/inversion/translocation/crossing over
- caused by mutagenic agents e.g. radiation (x-rays, ultra violet light, gamma rays) and chemicals e.g. mustard gas/colchicines

**iii) State the factors that may cause mutation**

- these are chemicals and radiations

| **Radiations** | **Effects** |
|---|---|
| X-rays | gene/chromosome alteration |
| Ultra violet rays | structural distortion of DNA |

| **Chemicals** | **Effect** |
|---|---|
| - colchicines | prevents spindle formation |
| Cyclamate | chromosome aberrations |
| Mustard gas | chromosomes aberrations |
| Nitrous acid | adenine in DNA is deaminated so behaves like guanine |
| Acridone orange | addition and removal of bases of DNA |
| Formaldehyde | |

**iv) State the characteristics of mutations**

- arise suddenly
- are unpredictable
- random
- generally rare
- may breed true
- some are desirable while others are lethal

**v) Explain chromosomal mutation**

- Change in nature, structure or number of chromosomes

**vi) Explain how the following types of chromosomal mutations occur**

**Duplication**

- a section of a chromosome is repeated/replicates
- therefore genes are repeated

**Inversion**

- occurs when chromatids break at 2 places and when rejoining the middle piece rotates and joins in an inverted position

**Deletion**

- portion of a chromosome is left out after it breaks off
- alters number and sequence of genes

**Translocation**

- occurs when a section of a chromatid breaks off and becomes attached to another chromatid of another chromosome

Non-disjuntion
Failure of homologous chromosomes/sister chromatids to separate/segregate during meiosis

**Polyploidy**

- where number of chromosomes double or triple
- beneficial in plants due to the following
- increased yields/hybrid vigour//heterosis
- resistance to pests
- early maturity
- resistance to drought
- resistance to diseases

**vii) What are gene mutations**?

- an alteration in the structure of a gene
-

**vii) Explain how the following occur during gene mutation**

**Deletio**n

- some bases/nucleotides of a gene are removed

**Inversion**

- the order of some bases/nucleotides of a gene is reversed

**Insertion**

- addition of a base between two existing bases

**Substitution**

- a portion of a gene is replaced by a new portion

viii) **Name the disorders in humans caused by gene mutation**

- albinism
- sickle cell anaemia
- achondroplasia/chondordystorphic dwarfism
- haemophilia
- colour blindness
- phenylketonuria

**I. State the practical applications of genetics**

**i. Breeding programmes (research)**

- high yielding/hybrid vigour/heterosis
- resistance to diseases
- resistance to drought/salinity
- early maturing

**ii. Genetic engineering**

- genetic manipulation to produce desired characteristics

**iii. Law**

- legal questions of paternity knowledge of blood groups or blood transfusion

iv) Genetic counseling

- aimed at reducing harmful traits e.g. albinism, congenital idiots, colour blindness e.t.c

**v) Others**

- Pre-sex determination

Understanding human evolution and origin of other species.

**2. a) i) Explain the meaning of evolution**

- a gradual change in living organisms from simple life forms to more complex forms over a long period of time.

**ii) Differentiate organic evolution from chemical evolution as theories of origin of life**

- organic evolution refers to the emergence of present forms of organisms gradually from pre-existing forms (some of which no longer exist)
- chemical evolution explains the origin of life as having occurred when simple chemical compounds reacted to form the simplest life forms

**iii) What is special creation?**

- maintains that the whole universe and all living organisms came into being due to the act of a supernatural being

**b) Discuss the various kinds of evidence for evolution**

**i) Fossils**

- fossils are remains of organisms preserved in naturally occurring materials for many years
- they give evidence of types of plants/animals that existed at certain geological age/long ago/millions of years ago
- gives evidence of morphological/anatomical/structural changes that have taken place over a long period of time e.g. human skull, leg of horse

**ii) Comparative anatomy**

- gives evidence of relationship among organisms/gives evidence of a common ancestry of a group of organisms
- organisms have similar structures/organs performing the same function e.g. digestive system/ urinary system/nervous system/vestigial structures and vertebrate heart
- Divergence where the basic structural form is modified to serve different functions e.g. vertebrate forelimb/beak structure in birds/birds feet/parts of a flower. These are called homologous structures
- homologous structures have a common embryonic origin but are modified to perform different functions e.g. the pentadactyl limb
- adaptive radiation is a situation where organism have a homologous structure with common embryonic origin which is modified to perform different functions to adapt organisms to different ecological niches/habitats e.g. beaks of Darwinian finches(birds)

- Convergence is where different structures are modified to perform a similar function e.g. wings of birds and insects/eyes of humans and octopuses. These are called analogous structures
- Vestigial structures are greatly reduced in size and have ceased to function e.g. human appendix/caecium/coccix in humans, wings of kiwi (flightless bird), presence of hind limb pad in python, halters in insects, human hair nictitating membrane in human eye, human ear muscle, pelvic girdle in whale and third digit of wing of bird.

**iii) Comparative embryology**

- some embryos of different animals appear very similar thus showing relationship and possibility of a common ancestry
- e.g. different classes of vertebrates larvae of annelida and mollusca are similar (tocophere)

**iv) Comparative serology/physiology**

- these show biochemical and immunological comparisons of blood groups/components to show immunological similarities of tissues therefore showing relatedness of different organisms
- e.g. antigen antibody reactions, human blood groups/Rh factor reveal some phylogenic relationship among organisms/common ancestry

**v) Geographical distribution**

- organisms differ in various geographical regions
- present continents are thought to have been a large land mass joined together/pangea/Eurasia/Gondwanaland
- present continents drifted apart from one land mass/continental drift
- as a result of continental drift isolation of organisms occurred bring about different patterns of evolution
- organisms in each continent evolved along different lines hence emergence of new species/divergence/convergence

**Examples**

- marsupials in Australia
- illama, jaguar, panther in S. America
- lion, camel in Africa
- tiger in Asia

**vi) Cell biology (cytology)**

- structures and functioning of cells are similar
- occurrence of organelles e.g. mitochondria in all cells/both plant and animal cells
- these point at a common ancestry

**c) i) State the evolutionary characteristics that adopt human beings to the environment**

- Brain
- Eyes
- Upright posture/bipedal locomotion
- prehensible arm/hand
- Speech

**ii) State the ways in which <u>Homo</u> <u>sapiens</u> differs from <u>Homo</u> <u>habilis</u>**

- standing upright/erect posture
- intellectual capacity/higher thinking capacity/bigger brain/higher brain capacity
- communication through language/speech

**d) i) Explain Larmarck's theory of evolution**

- Inheritance of acquired characteristics/environment induces production of a favorable trait which is then inherited
-

**ii) Explain why Lamarck's theory of evolution is not accepted by biologists today**

- evidence does not support Lamarck's theory
- acquired characteristics are not inherited/inherited characteristics are found in reproductive cells only
-

**iii) Explain Darwin's theory of evolution**

- inheritance of genetically acquired characteristics
- a character happens to appear spontaneously which gives advantage to an organism therefore adapted then inherited through natural selection
-

**e) i) What is natural selection?**

- Organisms with certain characteristics are favoured by the environment
Such organisms tend to survive and produce viable offspring
Others not favored are eliminated from subsequent generations

**ii) With examples, explain how natural selection takes place**

- organism with certain characteristics are favored by their environment
- such organisms tend to survive and produce viable offspring
- others not favored are eliminated from subsequent generations
- as the environmental conditions change the survival value of a character may alter with time so that characteristics which were favored may no longer have advantage and other characters may then become favorable
- if a favorable character is inherited, then offspring produce generations which are better adapted to survive in a population
- more offspring are produced than can survive which results in struggle for survival
- the fittest survive

**iii) State the advantages of natural selection to organisms**

- assist to eliminate disadvantageous characteristics/perpetuates advantageous characteristics
- allows better adapted organisms to survive adverse changes in the environment/less adapted organisms are eliminated

**iv) State the ways in which sexual reproduction is important in the evolution of plants and animals**

- brings about useful variations/desirable characters
- variations make offspring better adapted for survival/more resistant to diseases
- may lead to origin of new species

**v) Explain the significance of mutation in evolution**
- Mutation bring about variation which can be inherited
- Some of these variations are advantageous to the organism
- Others are disadvantageous
- The advantageous variations favour the organism to compete better in the struggle for survival
- This results into a more adapted organism to its environment or new species/varieties
- Those with disadvantageous characters will be discriminated against therefore eliminated from the population/death/perish

**vi) Plain why it is only mutations in genes of gametes that influence evolution**
- gametes form the new offspring

**vii) How would you prove that evolution is still taking place?**
- resistance of organism to antibiotics, pesticides and drugs
- new varieties of bacteria are resistant to certain antibiotics such as penicillin
- houseflies and mosquitoes are resistant to DDT

**vii) Explain why some bacteria develop resistance to a drug after they have bee subjected to it for some time**
- bacteria mutates/develops a new strain/chemical composition is altered hence is able to produce enzymes/chemicals which degrade the drug rendering it non-susceptible to the drug
- the new strain is favoured by selection pressure/ natural selection

**f) How has industrial melaninism i.e. peppered moth contributed towards the mechanism of evolution**

- This is an example of natural selection
- The peppered moth exists in two distinct forms, the speckled white form (normal form) and a melanic form (the black/dark)
- They usually rest on leaves and barks of trees that offer camouflage for protection
- Originally the "speckled white" form predominated the unpolluted area of England
- This colouration offered protection against predatory birds
- Due to industrial pollution tree barks have blackened with soot
- The white form underwent mutation
- A black variety/mutant emerged suddenly by mutation
- It had selective advantage over the white forms that were predated upon in the industrial areas
- The speckled white form is abundant in areas without soot/smoke

**3. a) i) Define irritability, stimulus and response irritability**
-also called sensitivity
- Responsiveness to change in environment

**Stimulus**
A change in the environment of organism which causes change in organism's activity
**Response**
- change in activity of an organism caused by a stimulus

**ii) State importance of irritability to living organisms**
- Adjusting to environmental conditions. Sensitive/defect/responding

**iii) List the examples of external stimuli to organisms**

- air/oxygen (aero)
- light(photo)
- osmotic pressure (osmo)
- current (Rheo)
- chemical concentration (chemo)
- \water/moisture (hydro)
- Touch/contact (hapto/thigmo)
- Gravity/soil (geo)
- Temperature (thermo)
-

**b) i) What are tactic responses?**

- response in which whole organism or its motile parts move e.g. gamete

**ii) What causes tactic responses?**

- caused by unidirectional stimulus
- usually doesn't involve growth
- response is either positive or negative
- named according to source of stimulus
- e.g phototaxis, aerotaxis, chemotaxis

**iii) State the importance of tactic response to:**

**Members of kingdom protista**

- move towards favorable environment/move away from unfavorable environment
- move towards their prey/food

Microscopic plants

- escape injurious stimuli/seek favorable habitats

**iv) Name the type of response exhibited by:**

Euglena when they swim towards the source of light

- phototaxis
- sperms when they swim towards the ovum
- chemotaxis

**v) State the advantages of tactic responses to organisms**

- to avoid unfavorable environment/injurious stimuli
- escape from predators
- to seek favorable environment
- to seek for food/prey

**c) i) Define the term tropism**

- growth movement of plants in response to external unilateral/unidirectional stimuli

**ii) Explain the various types of tropism in plants**

**Phototropism**

- growth movements of plant shoots in response to unilateral sources of light
- the tip of the shoots produce auxins down the shoot
- light causes auxins to migrate to outer side/darker side causing growth on the side away from light hence growth curvature towards source of light roots are negatively phototrophic

**Geotropism**

- response of roots/parts of a plant to the direction of force of gravity
- auxins grow towards the direction of force of gravity causing positive geotropism in roots while shoot grows away from force of gravity (negatively geotrophic)
-

**Thimotropism/Haptotropism**

- growth response of plant when in contact with an object
- contact with support causes migration of auxins to outer side causing faster growth on the side away from contact surface
- this causes tendrils/stem to twin around a support
-

**Hydrotropism**

- growth movement of roots in response to unilateral source of water/moisture
- the root grows towards the source of water/ positively hydrotropic while leaves are negatively hydrotropic
-

**chemostropism**

- growth movement of parts of plant to unilateral source of chemicals
- the chemicals form a gradient between two regions e.g. pollen tube growing towards the ovary through the style
-

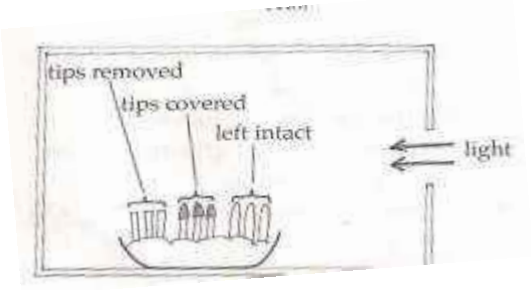
**iii) State the ways in which tropisms are important to plants**

- expose leaves/shoots in positions for maximum absorption of sunlight for photosynthesis
- enables roots of plants to seek/look/search for water
- enables plant stems/tendrils to obtain mechanical support especially those that lack woody stems
- enables roots to grow deep into the soil for anchorage
- enables pollen tube grow to embryo sac to facilitate fertilization

**iv) Explain the differences between tropic and tactic responses**

| **Tropisms** | **Taxes** |
|---|---|
| - growth curvature in response<br>- slow<br>- influenced by hormones | - locomotory response<br>- fast<br>- external influence |

**d) The diagram below represents growing seedlings which were subjected to unilateral light at the beginning of an experiment**




R

**i) State the results of P, Q and R after 5 days**

- P will bend/grow towards light
- Q will remain straight/have little or no growth
- R will remain/grow straight/grow upwards

**ii) Account for your results in (i) above**

P- Growth substance/growth hormone/IAA/auxin are produced by the stem tip

- they move (downwards and get distributed) to the side away from light where they cause rapid/more growth/cell division/elongation that results in bending

Q- Source of auxin has been removed

R- The auxins cannot be affected by light because the tip has been covered

**iii) If the tin foil were removed from the tip of seedling R, what results would be observed after two days**

- it will bend/grow towards light

**iv) State the expected results after 3 day is if the box were removed**

- all seedlings will grow straight/upwards

e) **In an experiment to investigate a certain aspect of plant response, a seedling was placed horizontally as shown in diagram I below. After seven days the appearance of the seedling was as shown in diagram 2**

**Account for the curvature of the shoot and root after the seven days**

**i) Shoot**

- auxins accumulate on the lower side of the seedling due to gravity
- high concentration of auxins in shoot stimulates faster growth causing more elongation on the lower side than the upper side hence curvature occurs upwards

**ii) Root**

- the high concentration of auxins inhibits growth hence the upper side with less auxins grows faster than the lower side therefore the curvature occurs downwards

**f) What is etiolation?**

- phenomenon exhibited by plants when grown in darkness
- such plants are pale yellow due to absence of chlorophyll, have small leaves, long stems/hypocotyle and slender stems
- plants exhibit etiolation to reach light/obtain light
- this is a survival response

**4. a) i) What is coordination in animals**

- The linking together of all physiological activities that occur in the body so that they take place at the right time and in the correct place

**ii) Name the main systems for coordination in animals**

- Nervous system/sensory system
- Endocrine (hormonal system)

**iii) List the components of the mammalian sensory system**

- Central nervous system (CNS), brain & spinal cord
- Peripheral nervous system (PNS) cranial and spinal nerves
- Sense organs
- Autonomic nervous system (ANS) nerve fibers and ganglia

**iv).Explain the terms receptors, conductors and effectors**

- Receptors are structures that detect stimuli i.e. sense organs
- Conductors transmit impulses from receptors to effectors e.g. neurons
- Effectors are the responding parts e.g. muscles, glands

**v) What are the functions of the central nervous system?**

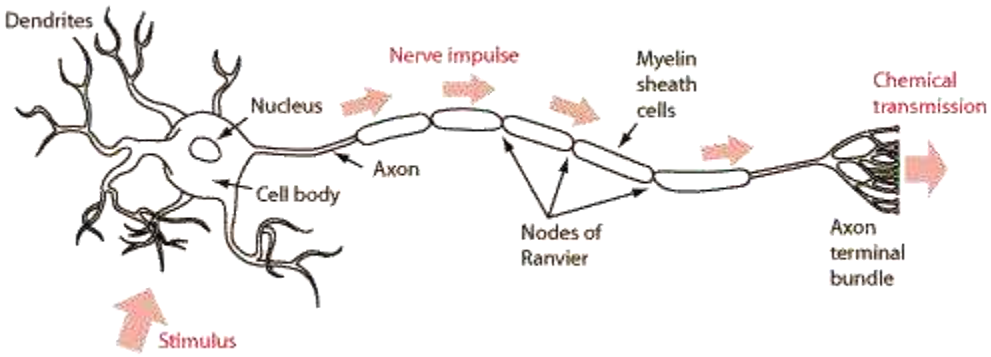
- provides a fast means of communication between receptors and effectors
- coordinates the activities of the body

**vi) State the differences between somatic and autonomic systems of peripheral nervous system**

- Somatic is concerned with controlling the conscious or voluntary actions of the body i.e. skin, bones, joints and skeletal muscles
- the autonomic (automatic) nervous system controls involuntary actions of internal organs, digestive system, blood vessels, cardiac muscles and glandular products.

**b) i) What is a neurone?**

- the basic unit of the nervous system
- also called nerve cell
- conducts impulses
- include monitor sensory and relay neurons



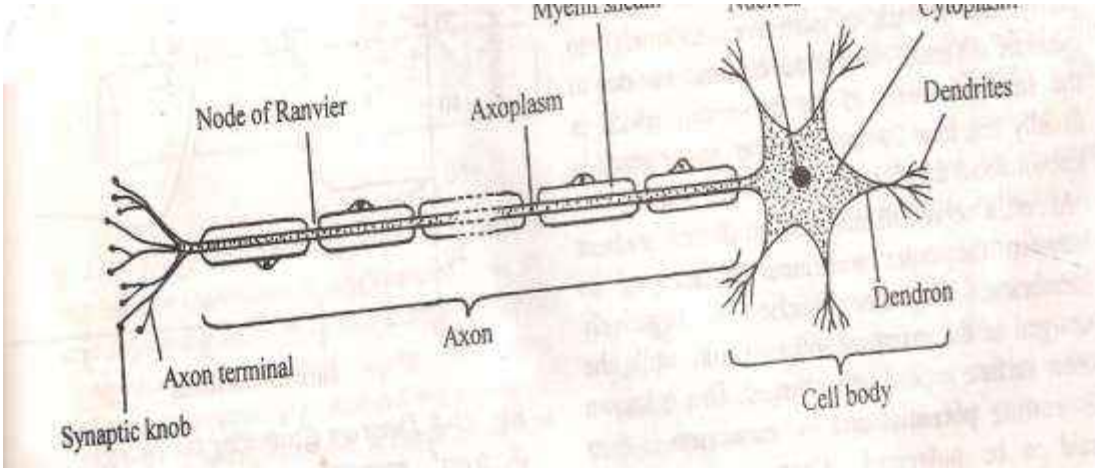

**ii) Name the parts of a typical neurone and state the functions of each part**

- cell body/centron contains nucleus and cytoplasm
- axon transmits impulses away from cell body
- dendrites relays impulses across adjacent neurons
- myelin sheath insulates axon and speeds up transmission of impulses
- schwan cells forms myelin sheath and aid in nutrition and regeneration of axon

- node of ranvier occur between schwan cells, where axon is not covered, speeds up impulse transmission
- nissils granules contain mitochondria that provide cell body with energy for metabolic process

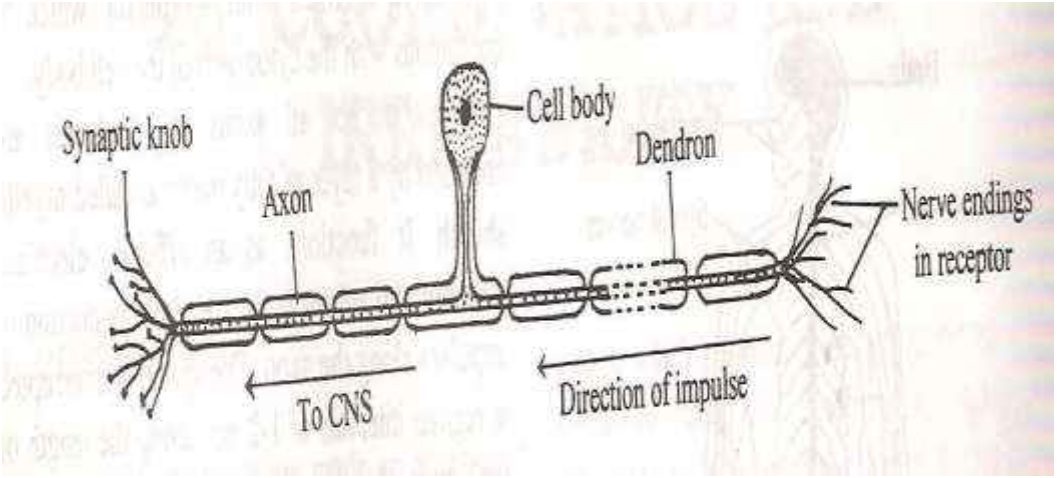
i) **Describe the structure and function of a motor neurone**

- motor neurone relays impulses from CNS (brain/spinal cord) to effectors ( muscles/glands)



**ii) Describe the structure and function of sensory neurone**

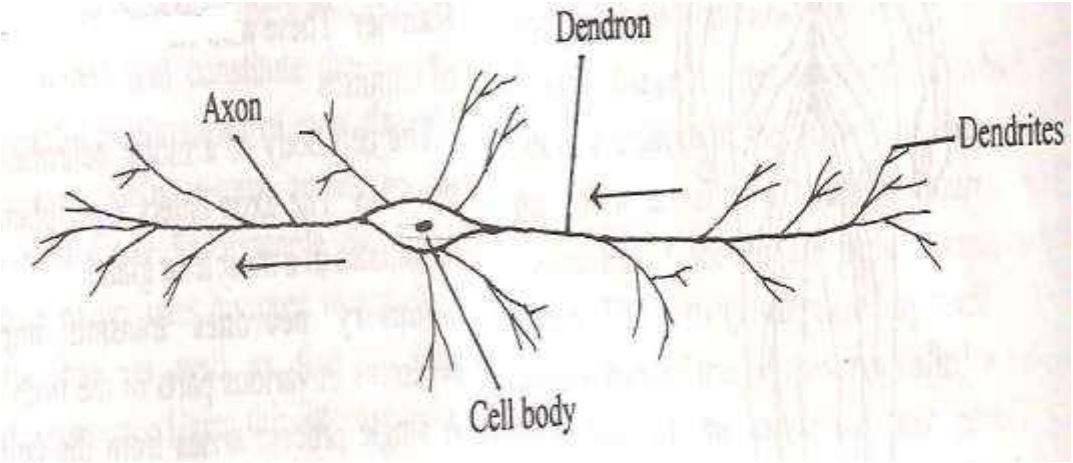
- sensory neurone relays impulses from receptors (sense organs) to CNS




**iii) State structural differences between motor and sensory neurons**

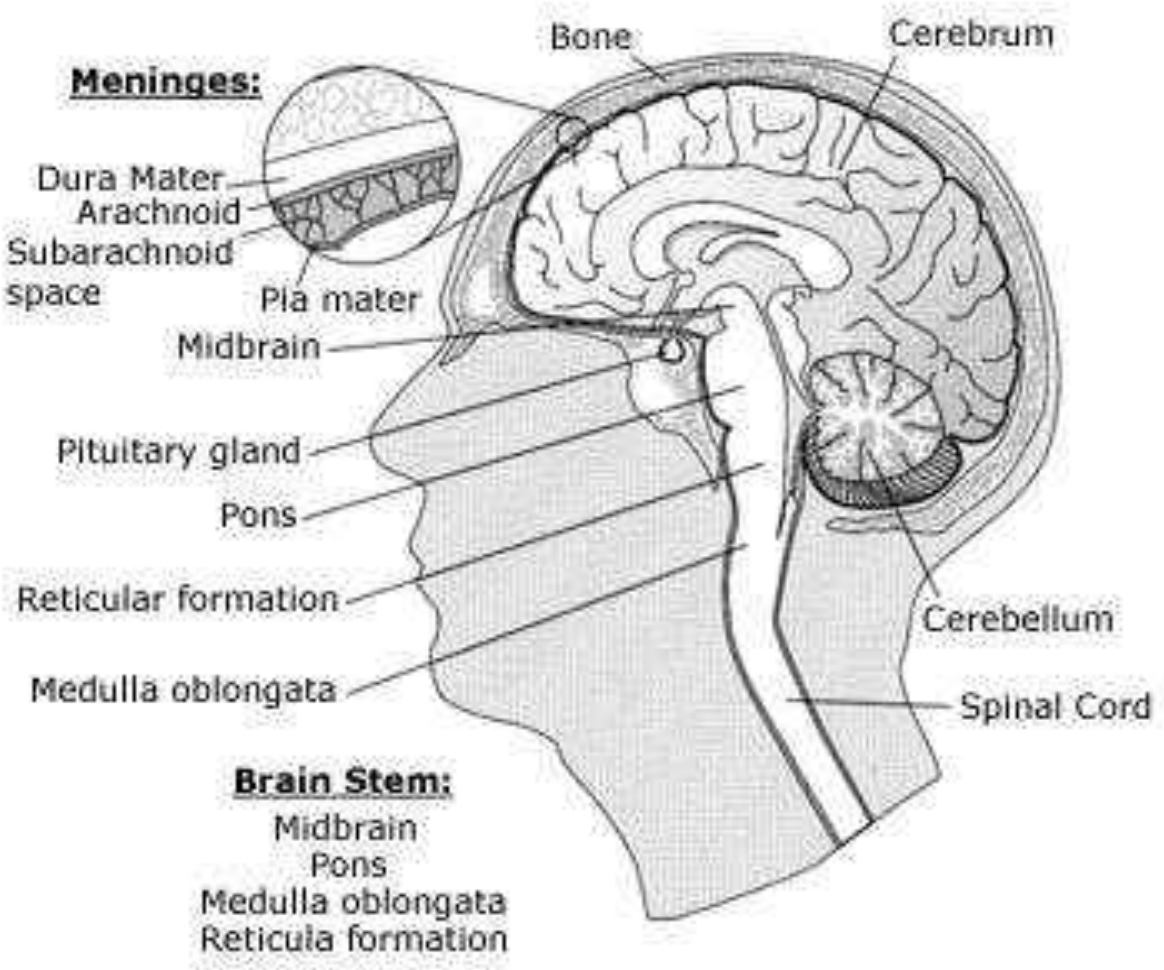
- Cell body in motor neurone is terminal (at the end) and inside central nervous system.
- Cell body in sensory neurone is terminal but has axon at both ends (bipolar)

**iv) Describe the structure and function of a relay neurone**




- also called intermediate/internuncial/associate/connector/interneurone
- locate inside central nervous system and spinal cord
- usually lack myelin sheath

**c) State the functions of the major parts of the human brain**




**i) Cerebrum**

- called forebrain
- occupies most of the brain
- consists of four lobes each with specific function
- temporal lobe controls taste smell hearing learning and memory
- partial lobe controls sensory output and touch
- occipital lobe controls vision, motor output and speech
- frontal lobe controls personality, learning thought and speech
- also has parts called thalamus and hypothalamus
- thalamus helps to sort sensory information
- hypothalamus controls hunger, heartbeat body temperature and aggression

**ii) Mid brain**

- quite small in humans
- relay centre for audio and visual information
- also involves in some sight, hearing and orientation responses

**i) Hind brain**

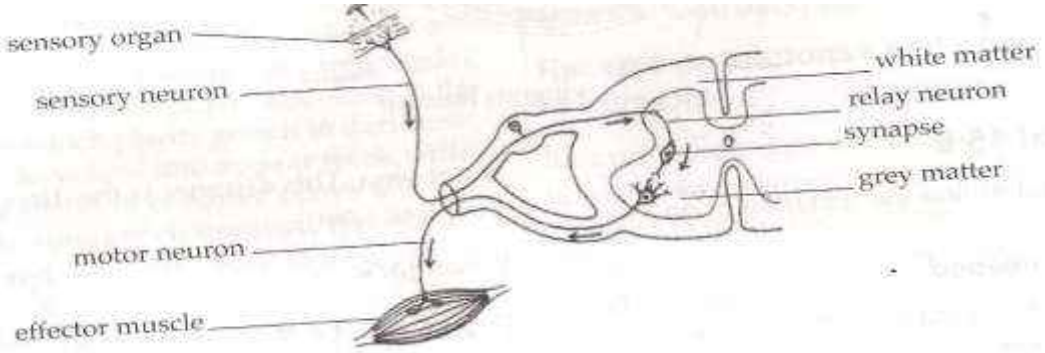
- consists of cellebral and medulla oblongata
- cerebellum is responsible for coordinating impulses, posture and balance, motor coordination and muscle tone
- medulla oblongata controls heartbeat, blood pressure breathing rate, coughing and sneezing

**a) i) What is reflex action?**

- an automatic response to an external stimulus e.g. sneezing or withdrawing hand from a hot object

**ii) Describe a reflex action that will lead to the withdrawal of a hand from a hot object**

- Receptors in the skin respond to stimuli. Are stimulated
- an impulse is transmitted through the sensory neurone, across a synapse to the central nervous system (white matter), through the relay neurone into grey matter, then to the motor neurone and finally to the effect muscle which contracts
- the hand is then withdrawn




**iii) Explain how an impulse is transmitted across the synapse (gap)**

- impulse initiates release of transmitter substance acetylcholine at the end of the sensory neurone
- acetylcholine diffuses across the synapse and generates an impulse in the next neurone

**ii) Briefly describe the transmission of a nervous impulse across a neuro-muscular junction**

- impulse arrives at synoptic knob and causes vesicle to move to the pre-synaptic membrane
- vesicle discharges transmitter substance into synaptic cleft
- transmitter substance/acetylcholine diffuses across the cleft and attaches to post-synaptic membrane
- the membrane is depolarized, generating the action potential

**iii) What are the functions of a synapse?**

- allows transmission of nerve impulses from neurone to neurone
- ensures nerve impulses travel in only one direction
- in the brain they store information/memory

**b) i) What is a conditioned reflex?**

- A response caused by a unilateral stimulus (associated stimulus) which substitutes the normal stimulus

**ii) Explain a conditioned reflex**

- it is automatic
- it involves the spinal cord
- it is usually learned e.g. writing, cycling, dancing
- it involves the interaction of highly specialized centers of the brain with a large number of neurone necessary to bring about conditioning
- example is experiments carried out by Pavlov using dogs

**iii) Compare a simple reflex action with a conditioned reflex**

| **Simple reflex** | **Conditioned reflex** |
|---|---|
| • independent of experience<br>• one stimulus to evoke response<br>• some sensory and motor neurons used<br>• reflex is simple | • dependent on experience<br>• both substitute and original reflex evoke response<br>• sensory component replaced but motor remains unchanged<br>• reflex is modified |

**c) i) What are endocrine glands?**

- ductless glands that produce hormones in animals
- hormones are chemical substances which help to coordinate the functions of the body

ii**) State the functions of hormones in animals**

- regulate growth and development
- control behavior during breeding
- proper functioning of cells
- regulate metabolic activities

**iii) Name the main endocrine glands, their secretions and functions in the human body**

| Gland | Hormone | Functions |
|---|---|---|
| Thyroid | Thyroxine | Increases rate of metabolism |
| Parathyroid | Parathyroid hormone | Regulates calcium and phosphate levels |
| Pituitary | Hormone growth | Regulate growth of body |
| | Gonadotrophic hormone | Stimulates the development of male and female sex organs |
| | Lactogenic hormone (prolactin) | Stimulates secretion of milk after child birth |
| | Thyrotropic hormone(TSH) | - proper functioning of thyroid gland/thyroxine production |
| | Adrenocorthicotropic hormone (ACTH) | - stimulates release of adrenal cortex hormone |
| | Oxytocin | • regulates blood pressure<br>• stimulates smooth muscles<br>• stimulates contraction of uterus during childbirth<br>• aids in flow of milk from mammary glands |
| | Follicle stimulating hormone(FSH) | • causes maturation of egg in females<br>• stimulates sperm production in males |
| | Vasopressin (ADH) Antiduretic hormone | - regulates water balance by kidneys |
| Adrenal | Adrenaline (epinephrine) | • for emergency<br>• prepares body to cope up with stress |
| | Aldosterone | - maintains balance of salt and water in blood |
| | Cortisone | • breaks down stored proteins to amino acids<br>• aids in breakdown of adipose tissue<br>• regulates sugar level in blood<br>• prevents inflammation |

| | | |
|---|---|---|
| | | |
| | Sex hormones | • supplements sex hormones produced by gonads<br>• promotes development of sexual characteristics |
| Pancrease | Insulin | • regulates level of sugar in blood<br>• enables liver to store sugar |
| | Glucagons | • regulates level of sugar in blood |
| Ovaries | Oestrogen | • causes sexual secondary characteristics in females<br>• prepares uterus for pregnancy |
| | Progesterone | • growth of mucus lining of uterus<br>• maintains uterus during pregnancy |
| Testes | Androgens(testosterone) | • causes secondary sexual characteristics in males |
| Stomach cells | Gastrin | • stimulates release of gastric juice |
| Intestinal cells | Secretin | • stimulate release of pancreatic juice |

**iv) Give the differences between nervous and endocrine (hormonal) communication**

| Nervous | Hormonal (endocrine) |
|---|---|
| Response confined to effector organs (localized targets) | Response more widespread (various targets) |
| Speed of response is rapid | Response less rapid |
| Nervous impulse thro\\ugh nerves/nerve cell/neurons | Hormones transferred through blood |
| Duration of response is short | Persist for long |
| Speed of transmission is rapid | Speed of transmission is slower |
| Transmission is electrical | Transmission is chemical |
| | |

**v) State the effects of over secretion and under secretion of adrenaline and thyroxine in humans**

| Hormone | Over secretion | Under secretion |
|---|---|---|
| Adrenaline | • thin toneless muscles<br>• high blood pressure<br>• weak bones<br>• obesity<br>• early onset of sexual development | • low blood pressure<br>• inability to withstand stress<br>• fatigue<br>• muscular weakness<br>• muscle wasting<br>• increased dark pigmentation of skin |
| Thyroxine | • increased metabolism<br>• increased heartbeat<br>• physical restlessness<br>• mental restlessness<br>• protruding eyeballs<br>• enlarged thyroid gland | • cretinism(retarded growth and low mental development<br>• lowered metabolism<br>• low ventilation rate of lungs<br>• low body temperature<br>• lowered mental activity<br>• coarse hair<br>• puffy eyes<br>• enlarged thyroid gland |

**g) i) Define the following terms**

**Drug**

- a substance that causes a change in body function

**Drug abuse**

- indiscriminate use of drugs without minding their side effects
- misuse or wrong use of drugs

**ii) State the types of drugs, examples and side effects**

**Sedatives**

- also called depressant
- a drug that decreases the action of the central nervous system
- reduce anxiety, and tension, induce sleep and act as muscle relaxants
- when abused they cause withdrawal effects such as anxiety, delirium and death
- includes barbiturates, other sedatives, tranquilizers and alcohol

**Pain-killers**

- suppress centers of pain in the brain

**Hallucinogens**

- given to people with hallucination or mentally ill patients to calm then down
- when abused they lead to a feeling of confusion, agitation, depression and violent behavior that can lead to murder or suicide
- examples include valium, LSD, bhang, narcotics and cannabis

**Stimulants**

- drugs that temporarily increase the action of the central nervous system
- they create a feeling of alertness, wakefulness, a sense of self confidence and well being
- used to decrease fatigue and mild depression
- when abused they cause feelings of persecution, hallucination and addiction
- include amphetamines, cocaine, caffeine, miraa and nicotine

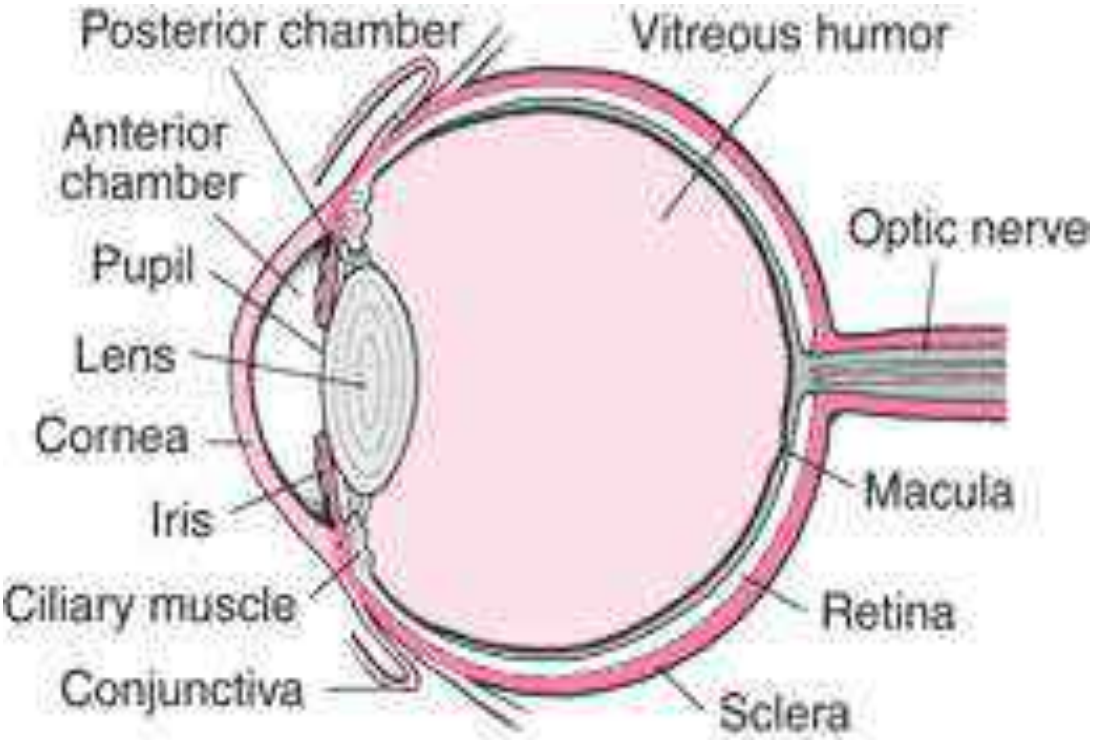
**iii) State the general effects of drug abuse on human health**

- damage to body organs e.g. liver cirrhosis
- drug addiction
- impaired judgment resulting in clumsiness
- socio-economic problems e.g. crime, loss of jobs, divorce, prostitution, HIV/AIDS
- may cause poor health

**h) i) List the special sense organs in mammals and the major function of each**

- Eye for sight
- Ear for hearing and balance
- Nose for smell
- Skin for touch, temperature detection, pain detection

**iii) How is the human eye adapted to its function?**



- conjunctiva is thin/transparent/tough to allow light to pass through/to protect the eye
- Sclerotic layer is made up of (collagen) fibers/fibrous. It maintains shape of the eyeball/protects the eye
- cornea is transparent/curved thus refracts light rays/allows light to pass through
- Choroid is a layer of tissue with black pigment/dark pigment. Prevents internal reflection of light in the eye/contains blood vessels that supply oxygen/nutrients/remove (metabolic) wastes from the eye
- retina has cones/rods for bright colour vision/low light vision
- yellow spot has a high concentration of cones for accurate vision/visual acuity
- Blind spot has no cones and rods. Place where optic nerve leaves/enters the eye
- optic nerve has (sensory) nerve fibers for transmission of impulses to the brain (for interpretation)
- Lens is biconvex/made up of elastic material/transparent. Adjust focus on far or near objects allow light to pass through/for refraction of light rays
- ciliary body is made up of muscle fibers/glandular which contract/relax to change shape
- suspensory ligaments are inelastic to hold lens in position/attach it to ciliary body
- iris(is the coloured part of the eye it) has radial and circular muscles which control size of pupil
- pupil is the small hole at the centre of iris through which light passes into the eye
- aqueous humor is a fluid through which oxygen/nutrients pass to the cornea/lens/maintains shape of the eyeball/refracts light rays
- vitreous humor is a fluid which maintains shape of eye/refracts light rays

**iii) What is accommodation of the eye?**

- ability of the eye to adjust to bring an image from a near or far object into sharp focus on the retina

iv) **Explain how an eye viewing a near object adjusts to viewing a far object**

- ciliary muscles relax
- suspensory ligaments become taut/tight
- lens decreases curvature/becomes thinner
- radial muscles relax
- circular muscles contract
- size of pupil decreases to reduce amount of light

v) **What changes occur in the eye if it changes from observing an object at a distance to one at a closer range?**

- ciliary muscles contract
- Tension in suspensory ligaments reduces/relax/ slackens
- Lens bulges/thickens/increases curvature
- Radial muscles contract
- Circular muscles relax
- Size of pupil becomes large to allow in more light.

**viii) State the changes which would take place in the eye if a person in a dark room had lights switched on**

- circular muscles contract and radial muscles relax
- pupil becomes small to allow less light into the eye

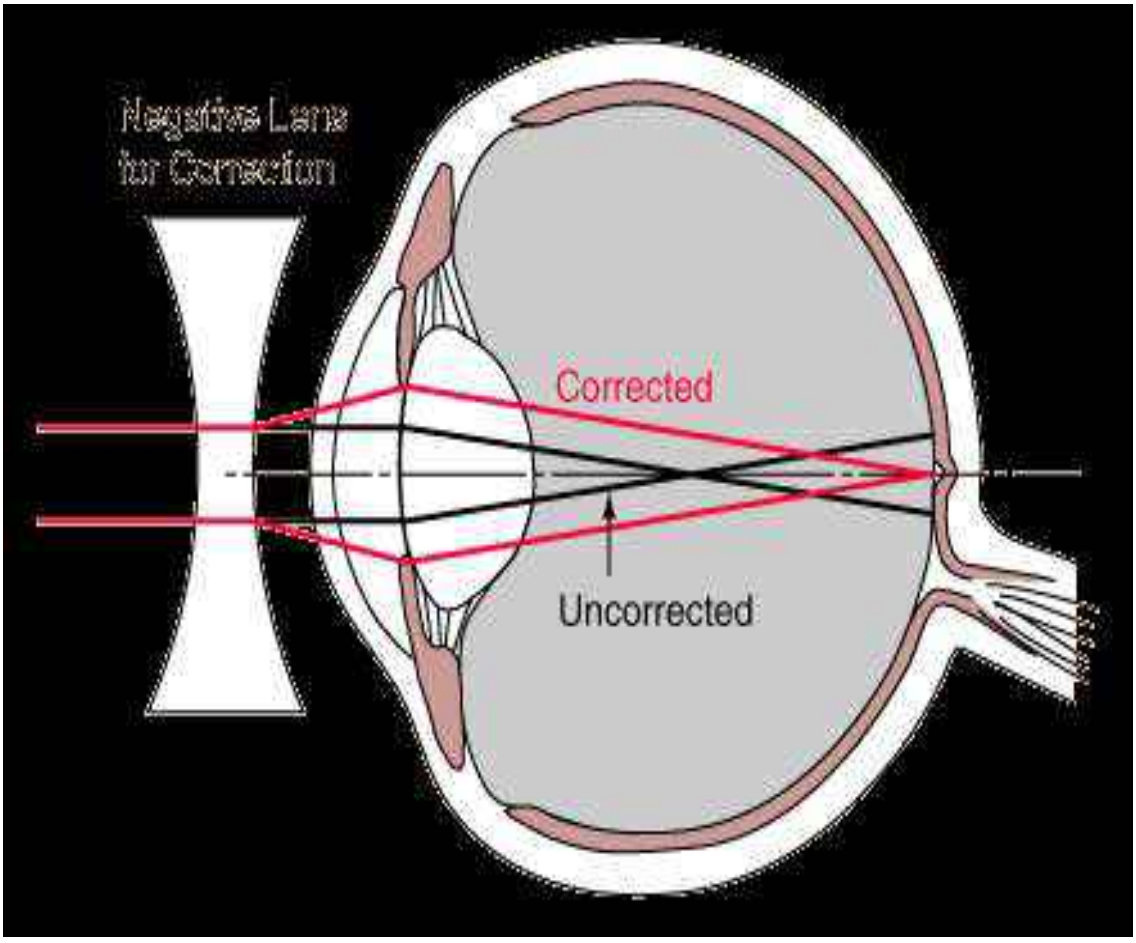
**ix) Explain how the eye forms an image**

- the mammalian eye works like a camera
- light rays enter the cornea pass through the pupil, aqueous humor, lens and vireous humor
- light rays are refracted by the aqueous and humor and lenses
- finally light falls on the retina to form an image
- the image is real and inverted and smaller than object, back to front/reversed
- Retina forms a fine image when light rays reach it.

x) **Name the defects of the eye and state how they can be corrected**

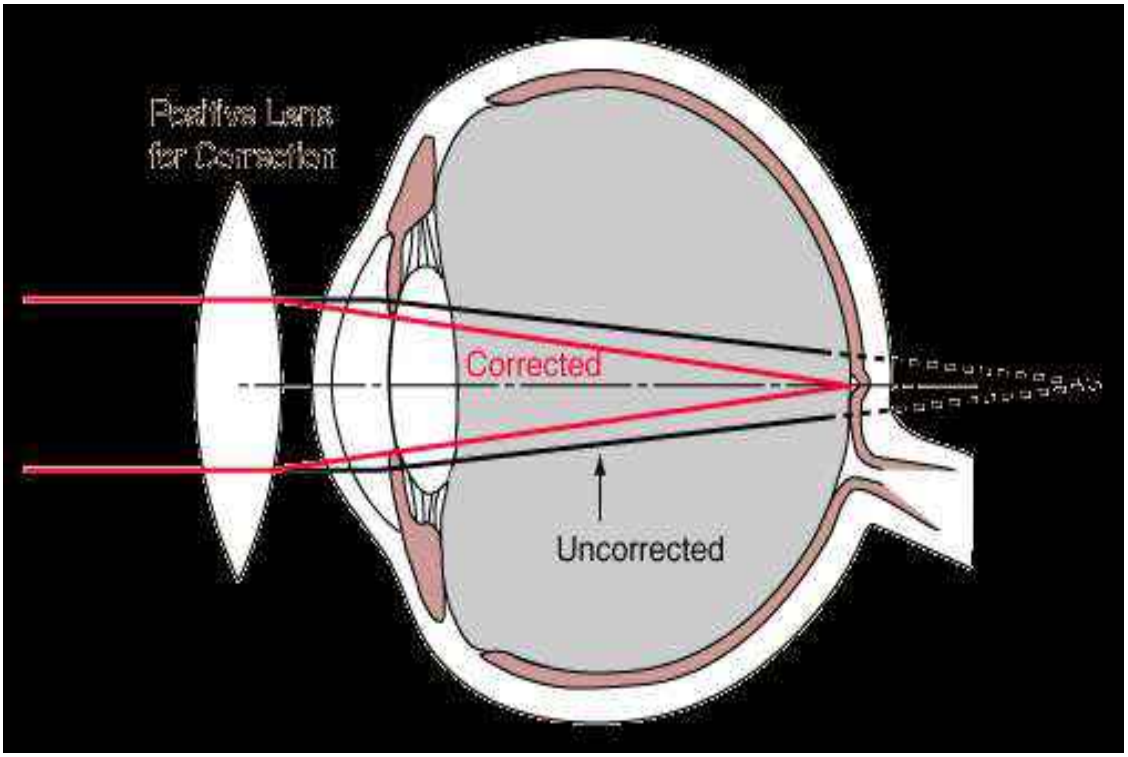
**Short sight (Myopia)**

- eye cannot focus on far objects
- image is formed in front of the retina because light rays converge in front of retina
- the lens is too thick, curve and eyeball too long
- corrected by wearing concave/biconcave/lenses
- these lenses diverge light rays onto retina



**Long sight (Hypermetropia)**

- eye lenses are unable to focus because they are flat, thin and weak hence unable to focus image on the retina
- they are unable to accommodate/change the focal length
- near image is formed behind the retina but a distant one is correctly focused on the retina
- corrected by wearing convex/biconvex/converging lenses




**Presbyopia**

- occurs in old age hence called old sight
- caused due to loss of elasticity of lenses, weakness of ciliary muscles hence lack of focus of light rays
- this causes long sight
- corrected by wearing biconvex/convex/converging lenses

**Squinting**

- eyeballs are uncoordinated/do not turn at the same time
- eye muscles move in different directions
- this makes accommodation and focusing difficult
- corrected through surgery

**Astigmatism**

- surface of cornea is uneven
- leads to weak focus of light raise on retina
- corrected by using cylindrical lenses/lenses with combined curvature

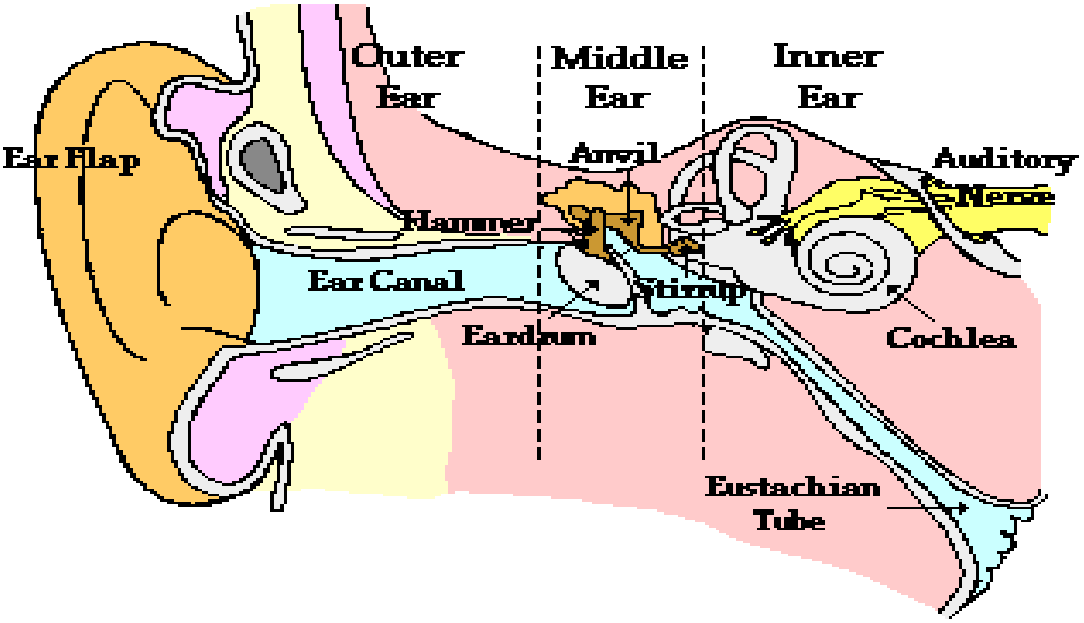
**xi) State the advantages of having two eyes in human beings**

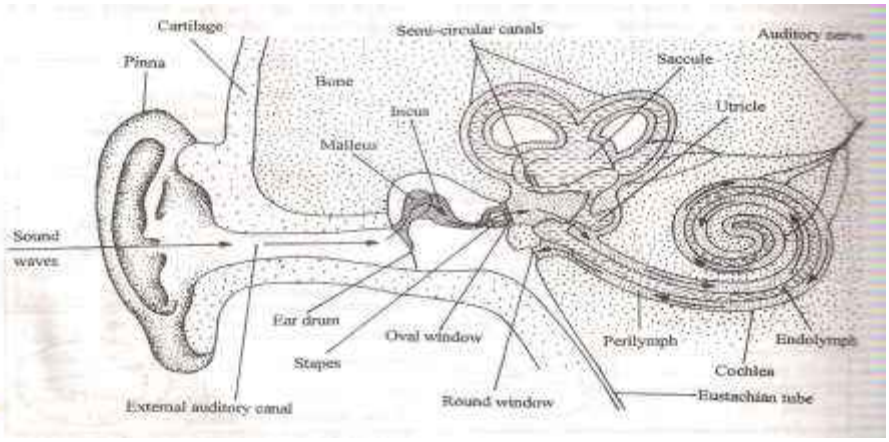
- stereoscopic vision
- gives a wider angle of binocular vision
- if one is damaged human is not blinded

**I i) What are the functions of the human ear?**

- hearing
- balancing

**iv) How are the structures of the human ear suited to perform the function of hearing?**



- shape of the external ear/pinna allows collection of sound waves and channels them down the auditory canal/auditory mateus
- auditory canal is a tube that concentrates and directs sound waves to tympanic membrane/ tympanum/eardrum
- Eardrum is thin and tight. It sets into vibration/vibrates/converts sound waves into vibrations
- the vibrations are transmitted to the ear ossicles/malleus, incus and stapes that amplify the sound vibrations
- the vibrations are then transmitted to the fennestra ovalis/oval window
- Oval window is a membrane which amplifies/transmits vibrations to the fluids (perilymph and endolymph) then to cochlea.
- The cochlea is coiled to occupy a small space and accommodate a large number of sensory cells
- The sensory cells/hairs (in the cochlea) are set into vibrations/stimulated producing nerve impulses in the auditory nerve
- Impulses in the auditory nerve are transmitted to the brain for interpretation for hearing
- Eustachian tube connects the inner ear to the throat. It equalizes air pressure in the middle ear with the atmospheric air pressure (in outer ear)
- Fennestra rotundus/round window dissipates/discharges/discards vibrations from inner ear to middle ear

**iii) Explain how the structure of the human ear performs the function of balancing**

- there are three semi-circular canals/utriculus/succulus/vestibular apparatus arranged in planes at right angles to each other
- at the end of each canal is a swelling called ampulla which contains receptors
- the movement of the head causes movement of the fluid/endolymph in at least one canal
- the fluid movement causes stimulation of the receptors/sensory hairs
- sensory impulses are generated
- the auditory nerve transmits the impulses to the brain for interpretation for the position of body/posture/balance

**iv) State what would happen if the auditory nerve was completely damaged**

- deafness
- loss of body balance
- impulse not transmitted to the brain

**7. a) i) What is support?**

- to support is to carry part of the weight/mass of an organism

**ii) What is locomotion?**

- progressive change in the position of an organism

**iii) State the importance of support systems in living organisms**

- they provide a framework for the body of organisms and help to determine their shape
- provide land animals with means for support to their weights against gravity
- organs are attached to the skeleton for support and stability to avoid entanglement and crushing each other
- they protect very important and delicate organs whether inside or outside the body e.g. eyes, heart
- in large plants the rigid trunks of trees support the greater mass of leaves and fruits

**iv) State the importance of locomotion in animals**

- in search of food
- search for mates
- escaping predators

**b) i) Name the tissues in higher plants that provide mechanical support**

- sclerenchyma
- collenchyma (not lignified)
- xylem/tracheids and vessels

**ii) State the importance of support in plants**

- exposing the surface area of leaf to sunlight for photosynthesis
- ensure flowers are exposed to pollination agents
- expose fruits and seeds to agents of dispersal
- to resist breakages due to their own weight and that of other organisms
- for proper transport and translocation of materials

**iii) Name the types of plant stems**

- herbaceous e.g. shrubs
- woody e.g. trees
- weak stems in creepers, twining plants and plants bearing tendrils

**iv) Name the tissues in plants that are strengthened with lignin**

- sclerenchyma
- xylem vessels/tracheids/xylem

**v) What makes young herbaceous plants remain upright?**

- turgidity
- presence of collenchyma

**vi) State the ways by which plants compensate for lack of ability to move from one place to another**

- ability to pollinate
- response to nastic and tropic movement
- ability to exploit localized nutrients
- ability to disperse seed or fruit propagation

c) **i) Explain the ways in which erect posture is maintained in a weak herbaceous stem**

- This is the function of turgidity and presence of collencyma

Cells take in water and become turgid

**ii) Explain how support in plants is achieved**

- Turgor pressure due to absorption of water keeps cells firm hence hold herbaceous plants upright
- collenchyma and clerenchyma tissues are closely packed in stem and roots to provide support
- inelastic cuticle on epidermis is covered by a waxy layer hence keeping shape of plant and setting inward pressure against turgid cells and this causes a force to hold plant upright
- xylem vessels and tracheids are lignified to provide support to stems, roots and leaves
- climbing plants obtain mechanical support from other plants and objects
- they have climbing structures like tendrils which hold on to other objects

**d) i) Give the reasons why support is necessary in animals**

- for attachment of muscles
- For attachment of other body organs
- to protect delicate body organs
- to maintain body shape/form
- to enable movement/locomotion

**ii) Why is movement necessary in animals?**

- enables animals to search for food
- enables animals to search for shelter
- enables animals to escape predators/harmful conditions
- enables animals to search for water
- enables animals to search for mates
- enables animals to search for breeding sites

**e) i) Name the organ used for support by animals**

- Skeleton

**ii) Name the different types of skeletons in animals, giving an example of an animal for each type of skeleton named**

- exoskeleton e.g. arthropoda (crab, insect)
- endoskeleton e.g. chordata (cat, fish)

**iii) State the difference between exoskeleton and endoskeleton**

- endoskeleton is a rigid framework covered by body tissues of an animal
- exoskeleton is a rigid framework found on the surface of an animal

**iv) State the advantages of having an exoskeleton**

- supports/protects delicate inner parts
- water proof/prevents drying up of body
- provided surface for muscle attachment

**v) Explain the importance of having an endoskeleton**

- support the body
- give body its shape
- protect delicate organs e.g. skull, brain, ribs
- used in locomotion e.g. bones serve as levers
- red blood cells are formed in bone marrow
- minerals are stored in bones e.g. calcium and phosphorus

**f) i) Explain how a fish is adapted to living in water**

- streamlined body for easy movement in water
- swim bladder controls depth of swimming
- fins for movement, balance, direction and stability
- gills for gaseous exchange in water
- presence of lateral line to sense vibrations
- scales provide protection
- colour which offers camouflage against predators

**ii) Explain how a finned fish is adapted to locomotion in water**

- streamlined body to reduce resistance/friction )to swim smoothly)
- the vertebral column consists of a series of vertebrae held together loosely so that it is flexible
- myotomes/muscles associated with vertebral column produce movement
- the sideways and backwards thrust of the tail and body against water results in resistance of water pushing the fish sideways and forwards in a direction opposed to thrust
- heat not flexible so as to maintain forward thrust
- presence of fins help in propulsion/balance/paired fins (pectoral and pelvic) for controlling pitch and slow down movement/unpaired fins (dorsal, ventral, anal) for yawing and rolling (caudal) for swimming/propulsion and steering/change of direction
- presence of swim bladder to make fish buoyant
- scales tip towards the back to provide smooth surface
- body covered with mucus to reduce friction
- flattened surface for easy floating

**g) i) Name the main parts of the vertebral column giving the types of bones found in each part**
**Axial skeleton**

- forms the main axis of the body
- formed by the skull, sternum, ribs and vertebrae

**Appendicular skeleton**

- composed of limbs and girdles
- the forelimbs are connected to the trunk by the pectoral girdles (shoulder bones)
- hind limbs are connected to the pelvic girdle (hips)
- bones are scapular, clavicle, humerus, ulna, femur, tibia, fibula, metacarpals, carpals, tarsals, metatarsals, phalanges, ilium, ischium and pubis

**ii) What are the vertebrae?**

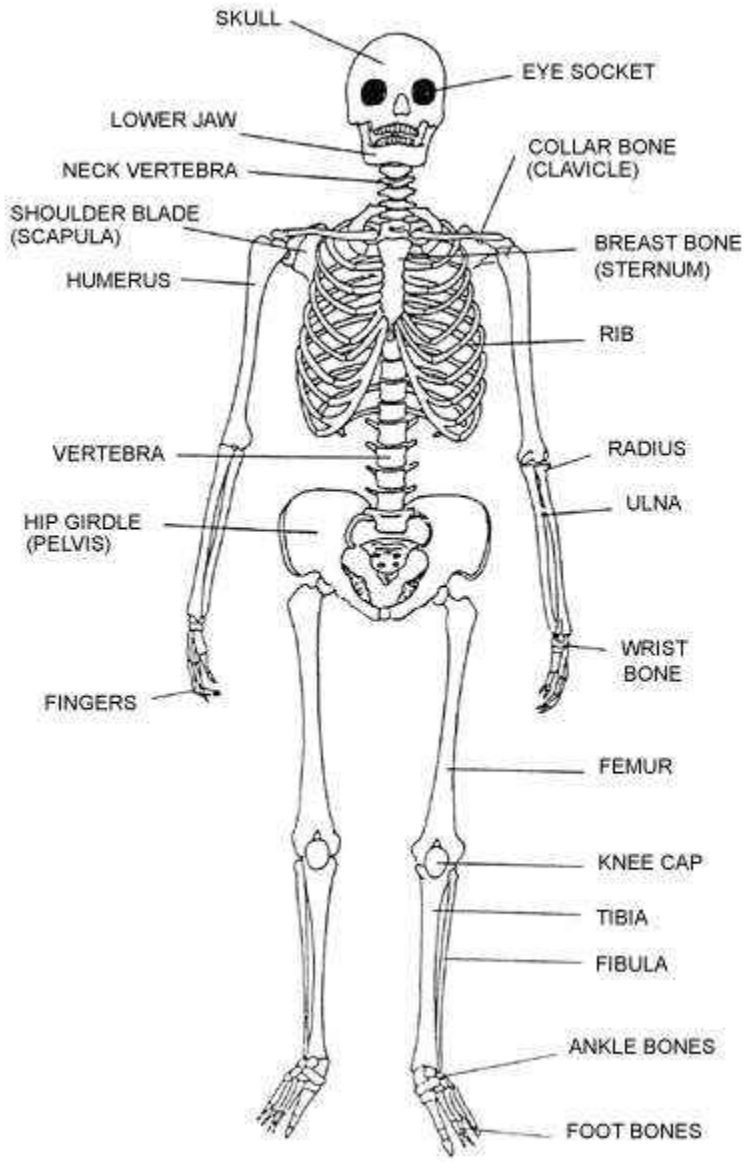
- bones of the vertebral column

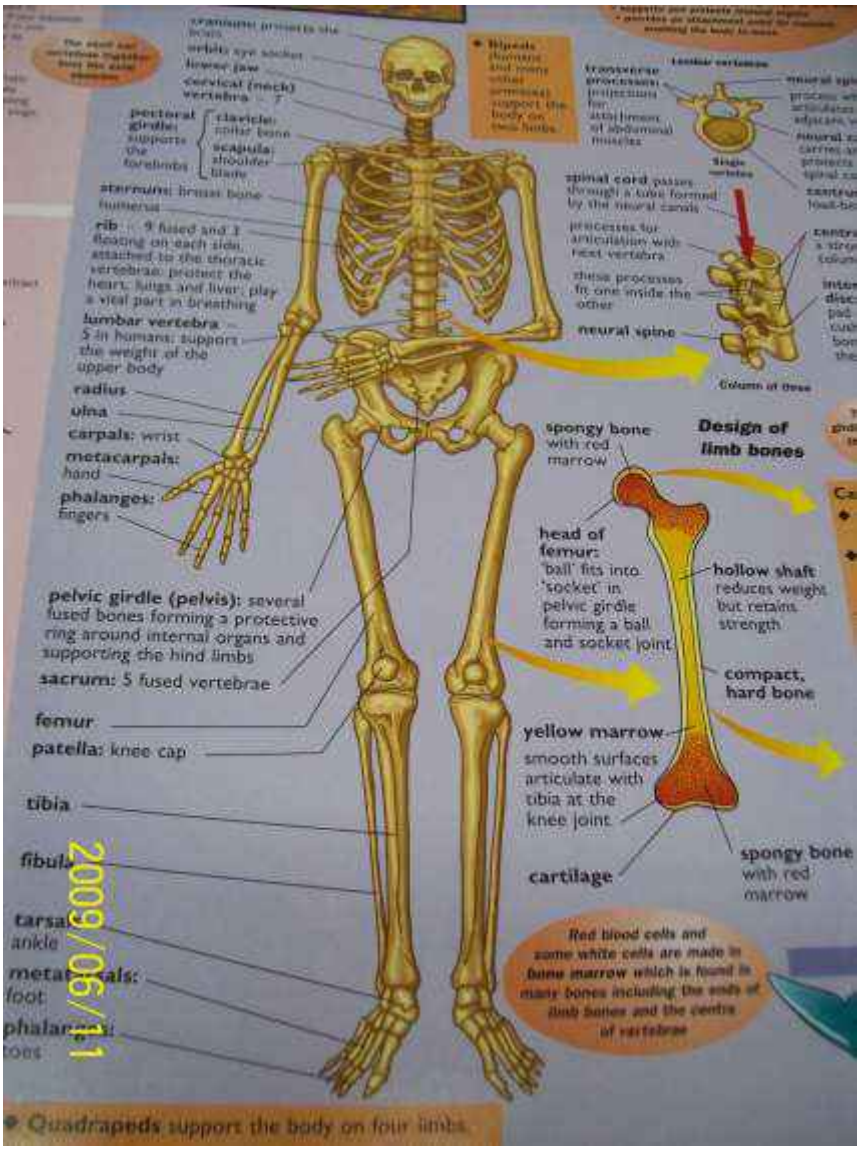
**iii) State the functions of the vertebral column**

- gives flexibility
- absorbs shock
- protects spinal cord
- supports weight of body
- provide surface for muscle attachment
- between the vertebrae are soft discs which offer cushioning called interverterbral discs

**iv) State the general characteristics of vertebrae**

- have solid structure called centrum to support weight of body
- has transverse process lateral to centrum for muscle attachment
- neural spine is dorsal to centrum and provides surface area for muscle attachment
- neural canal a passage for spinal cord and offers protection to it
- has facets for articulation with other vertebrae
- neural arch encloses neural canal




cranium: protects the brain
orbits: eye sockets
lower jaw
cervical (neck) vertebra – 7
pectoral girdle: supports the forelimbs
clavicle: collar bone
scapula: shoulder blade
sternum: breast bone
humerus
rib – 9 fused and 3 floating on each side, attached to the thoracic vertebrae; protect the heart, lungs and liver; play a vital part in breathing
lumbar vertebra – 5 in humans; support the weight of the upper body
radius
ulna
carpals: wrist
metacarpals: hand
phalanges: fingers
pelvic girdle (pelvis): several fused bones forming a protective ring around internal organs and supporting the hind limbs
sacrum: 5 fused vertebrae
femur
patella: knee cap
tibia
fibula
tarsals: ankle
metatarsals: foot
phalanges: toes
Quadrapeds support the body on four limbs
transverse processes: projections for attachment of abdominal muscles
thoracic vertebra
lumbar vertebra
spinal cord passes through a tube formed by the neural canals
processes for articulation with next vertebra
these processes fit one inside the other
neural spine
Column of three
Design of limb bones
spongy bone with red marrow
head of femur: 'ball' fits into 'socket' in pelvic girdle forming a ball and socket joint
hollow shaft reduces weight but retains strength
compact, hard bone
yellow marrow
smooth surfaces articulate with tibia at the knee joint
cartilage
spongy bone with red marrow
Red blood cells and some white cells are made in bone marrow which is found in many bones including the ends of limb bones and the centre of vertebrae
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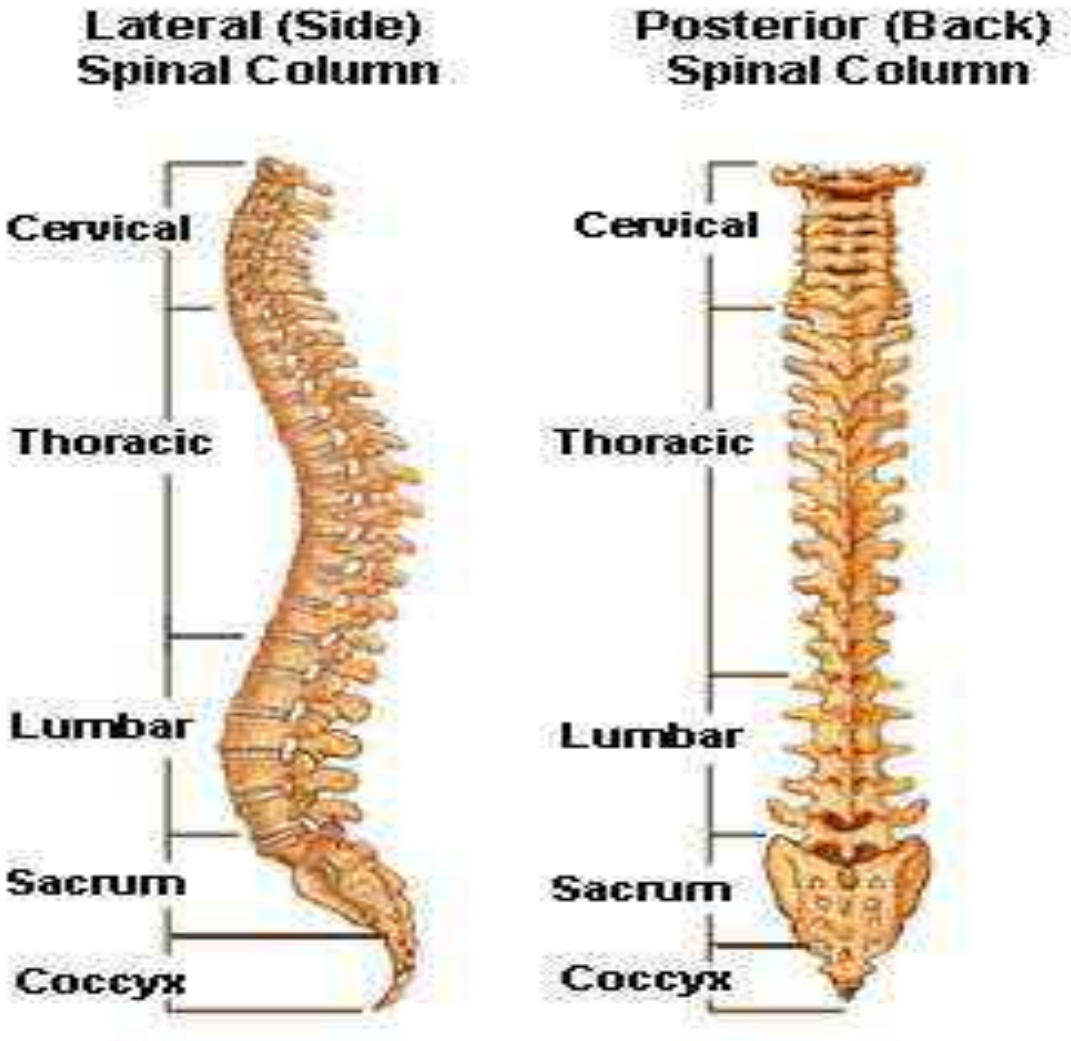
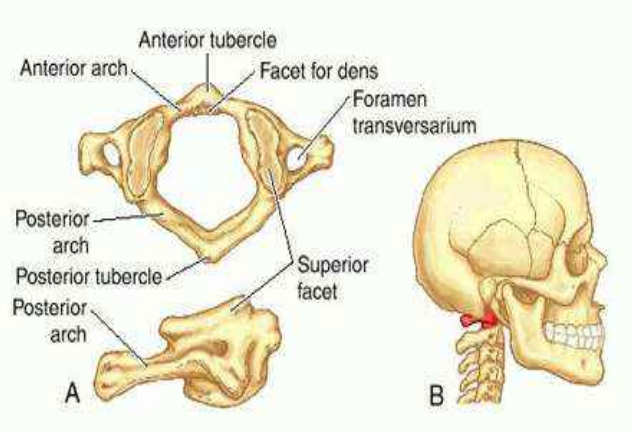
**v) Name the bones of the vertebral column**

- Cervical vertebra
- Thoracic vertebra
- Lumbar vertebra
- Sacral vertebra
- Caudal vertebra



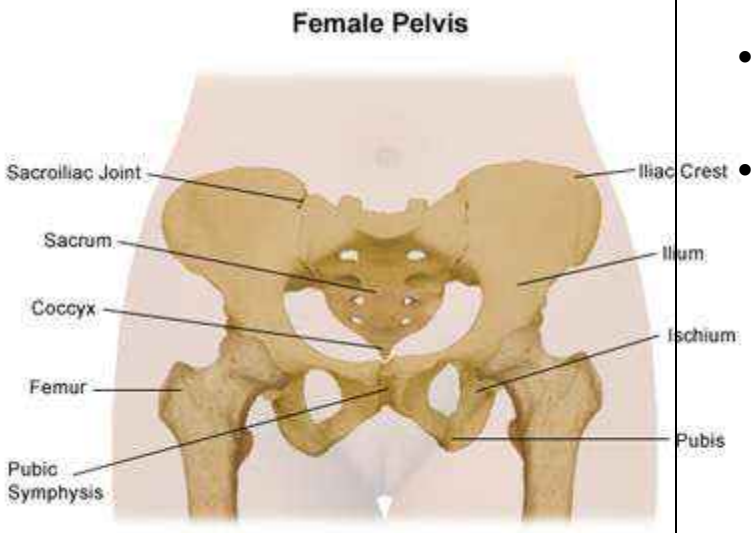
**vi) Describe how the various vertebrae are adapted to their functions**

| Bone | Structure | Function |
|---|---|---|
| Skull<br>  | • cranium and jaw bones<br>• made of several bones joined together<br>• large box called cranium and smaller paired boxes for eyes, ears, nose, jaws<br>• has large hole called foramen magnum for the passage of spinal cord | • attachment of jaws<br>• protect brain and other delicate parts |
| Cervical region<br>Atlas (first cervical) | • ring shaped<br>• no Centrum<br>• broad, flat transverse processes<br>• vertebraterial canal for passage of vertebral artery<br>• facet for articulation of condyles of skull | • protect spinal cord<br>• attachment of muscles<br>• allow nodding of head |
| Axis (second cervical) | • adontoid peg projects from Centrum<br>• large flattened neural spine<br>• vertebrasterial canal<br>• small transverse process | • allows head to rotate<br>• protects spinal cord<br>• provides surface for muscle attachment |
| Cervical (others) | • short neural spine<br>• branched transverse process for neck muscles<br>• vertebraterial canals<br>• wide neural canal | • support weight of head<br>• protect spinal cord<br>• neck muscle attachment |

| | | |
|---|---|---|
| Thoracid | • long backward pointing neural spine<br>• transverse process that points sideways<br>• facets for articulation of ribs<br>• notch for spinal nerves to pass through | • forms rib cage<br>• articulation with one end of a rib<br>• protects, spinal cord<br>• muscle attachment |
| Lumbar | • short neural spine<br>• long transverse process pointing towards abdomen<br>• large Centrum<br>• extra processes e.g. prezygapophysis, hypapophysis, anapophysis, metapophysis | • protect organs of abdomen<br>• support upper part of body<br>• protect spinal cord<br>• muscle attachment |
| Sacral | • fused bones to form sacrum<br>• well developed transverse process of first vertebra<br>• vertebraterial canals<br>• short neural spine | • protects alimentary canal<br>• attachment of hip girdles<br>• protect spinal cord<br>• muscle attachment |
| Rib | • long<br>• flattened<br>• attached to sternum from front | • protect internal organs<br>• muscle attachment |

**vii) Describe the bones that form the appendicular skeleton**

| Bone | Structure | Function |
|---|---|---|
| Pectoral girdle scapular (shoulder bone) | • Broad i.e. Flattened blade<br>• glenoid cavity to articulate with humerus<br>• metacromion/acromion for muscle attachment<br>• hard to provide support<br>• socket with cartilage/smooth surface to reduce friction | Support<br>Muscle attachment<br>Articulates with humerus |
| Humerus | • long shaft for muscle attachment<br>• round head to articulate with glenoid cavity<br>• trochlea for articulation with ulna<br>• olecranon fosa to prevent arm bending the other way | • movement<br>• muscle attachment |
| Ulna and radius | • ulna longer and on side of little finger<br>• has sigmoid notch and olecranon process to form hinge joint with humerus<br>• radius is smaller and lies along thumb side and does not join ulna<br>• allows articulation with wrist bones | • movement<br>• muscle attachments |

| | | |
|---|---|---|
| | | |
| Pelvic girdle(hip bone)<br>  <br> | • composed of three fused bones (ilium, ischium, pubis)<br>• upper end fused to sacrum<br>• lower end has acetabalum for articulation with femur<br>• has abturator foramen for passage of nerves and blood vessels | • movement<br>• muscle attachment<br>• support<br>• absorbs pressure exerted by ground when animal moves |
| Femur | • rounded head to fit in acetabulum of pelvis<br>• projections called trochanter for attachment of thigh muscles<br>• condyles at lower end for articulation with tibi<br>• patella that covers knee and prevents leg from bending backwards | • movement<br>• muscle attachment |
| Tibia and fibula | • tibia is longer than fibula<br>• tibia is outer bone and fibula is inner bone<br>• tibia lies on side of large toe<br>• fibula is fused to tibia (on outer side) | • movement<br>• muscle attachment |

**8. a) What is a joint?**

- the point where bones meet

**ii) State the functions of joints**

- provide a point of articulation between bones

**iii) Name the main types of joints**

- immovable joints e.g. skull, pelvic girdles and sacrum
- slightly movable joints e.g. between vertebrae
- Freely movable joints e.g. knee, elbow

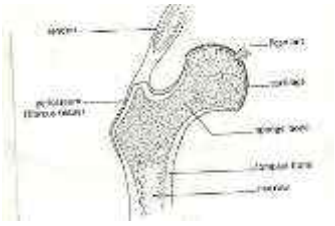
**iv) Give the features of movable joints**

- ends of bones covered with articular cartilage
- ends bound by capsules of ligaments
- have joint cavity filled with lubricating fluid called synovial fluid secreted by synovial membrane
- they are called synovial joints

**b) Describe the synovial joints**

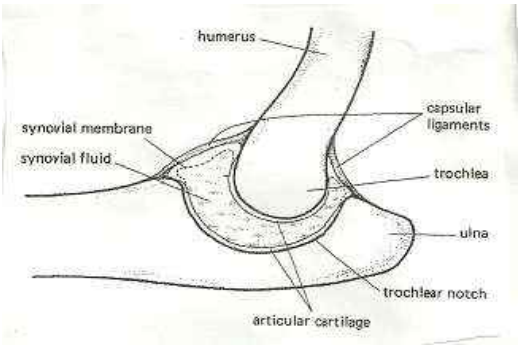
**iv) Ball and socket**

- allow movement in all planes /directions i.e. $360^{o}$
- rounded end of bone fits into a rounded cavity in another bone
- e.g. shoulder joint and hip joint



**v) Hinge joint**

- convex surface of one bone fits into the concave surface of another bone
- this allows movement in only one plane/direction 180o
- e.g. elbow joint and knee joint




**vi) Pivot joint**

- allows rotation e.g. where atlas pivots on olecranon process of axis

**c) i) What is synovial fluid?**

- lubricating fluid produced by synovial membrane at movable joints

**ii) State the functions of synovial fluid**

- absorbs shock
- reduces friction/gives lubrication
- nourishment
- distributes pressure

**d) Explain the following terms**

**v) Ligament**

- connective tissue joining one bone to another

**vi) Cartilage**

- supporting soft tissue found at joints
- they cushion the bones and absorb shock

**vii) Tendon**

- tissue that connects muscle to bones

**9. Muscles**

**e) i) What is a muscle?**

- fleshy part of body
- composed of long cells enclosed in a sheath
- specialized cells capable of contracting

**ii) State the functions of muscles**

- cover the skeleton
- provide shape
- contract and relax to enable body to move

**f) Describe the structure and function of various types of muscles**

**i) skeletal muscles**

- also called voluntary/striated/stripped muscles
- they are attached to skeleton
- they consist of striated, multinucleated, ling fibers and are cylindrical shaped
- found on legs, arms, eyes, neck where they cause movement

**ii) Involuntary muscles**

- also called smooth/visceral/unstriated/unstripped
- their movement is not controlled by the will
- they are unstriated, nucleated, short fibred and spindle shaped
- are found in alimentary canal, blood vessels, secretory glands, other tubular visceral organs, bladder, uterus, urinary tract, reproductive system, respiratory tract, ciliary body, iris

**iii) Cardiac muscles**

- also called myocardium
- found in the walls of the heart
- are not under control of the will
- composed of long cylindrical cells with special junctions
- myogenic i.e. generate their own contraction
- they are not fatigued
- their function is contraction of the heart to pump blood

**g) Explain how muscles cause movement of the human arm**

- the muscles which bring about these movements are called biceps and triceps
- biceps are attached to scapula and radius for bending
- triceps are attached to scapula, humerus and ulna for stretching
- when the biceps contracts, it pulls the radius (forearm) and the hand bends
- the triceps relaxes at the same time
- when the triceps contracts and biceps relaxes(extends) the arm is stretched
- biceps flexes the arm (flexor) and triceps extend(extensor muscle) the arm

**h) i) State the structural differences between skeletal muscles e.g. biceps and smooth muscles e.g. gut muscle**

| **Skeletal (biceps)** | **Smooth (gut) muscle** |
|---|---|
| • multinucleated<br>• striated/stripped<br>• long muscle fibers<br>• block/cylindrical | • uninucleated<br>• unstriated<br>• short muscle fibers<br>• spindle shaped |

**ii) Name the cartilage found between the bones of the vertebral column**

- intervertebral disc

**iv) What are the functions of the cartilage named in (d) ii) above**

- acts as a cushion/absorbs shock
- reduces friction
- flexibility of vertebral column

# END