CLASSIFICATION OF LIVING THINGS

KINGDOM PLANTAE

Is a kingdom in which all plants are grouped.

Plants: are multi-cellular eukaryotic organisms with ability to manufacture their own food by using energy from the sun through the process of photosynthesis.

DIVISION OF KINGDOM PLANTAE

Kingdom Plantae is made up of the following divisions:-

i) Division bryophyta e.g. Moss plants.
ii) Division filicinophyta or pteridophyta. E.g. Fern plants.
iii) Division coniferophyta e.g. Pines, cypress
iv) Division angiospermophyta e.g. Maize, beans

GENERAL AND DISTINCTIVE FEATURES OF KINGDOM PLANTAE

(i) They are multi-cellular.
(ii) Their cell walls made of cellulose.
(iii) They are eukaryotic organisms.
(iv) They have chlorophyll
(v) They are autotrophs.
(vi) They reproduce both sexually and asexually.
(vii) They store food as starch.
(viii) Their cells are organized into tissues, organs and organ systems.
(ix) They show limited movement, for example opening and closing of flower petals.

(I) DIVISION CONIFEROPHYTA (Gymnosperms)

This division is made up of the cone-bearing plants, hence the name conifers.

◊ The members of this division are called **conifers.**
◊ **Conifers** are plants that have needle-shaped leaves and almost all green.

They include plants such as pines, spruces, cedar, red wood, cypress and juniper.

GENERAL CHARACTERISTICS OF DIVISION CONIFEROPHYTA

The following are the general characteristics of conifers.

(i) They have cones.
(ii) They neither have flowers nor fruits.
(iii) They are wind pollinated.
(iv) They are vascular, i.e. they have phloem and xylem tissues.

(v) Their seeds are not enclosed in an ovary, but in cones.

(vi) They reproduce sexually by seed.

(vii) They do not need water for fertilization.

(viii) Their leaves are needle-like, linear or scale-like.

(ix) They have alternation of generation.

NB: Some species of conifers have male and female cones on the same individual tree while other species have plants with only male or female cones.

DISTINCTIVE FEATURES OF DIVISION CONIFEROPHYTA

(i) Conifers are non-flowering but seed producing plants.

(ii) They have seed born in cones shaped structure rather than in fruits.

(iii) Their leaves are needle- shaped and have a thick cuticle for protection and to decrease water loss.

(iv) They are gymnosperms which means naked- seed

(v) Their leaves are needle-like

(vi) Their seeds are enclosed in cones.

(vii) They have cones. The female cones contain ovules while the male cones produce microspores known as pollen.

THE STRUCTURE OF PINUS

Pinus are coniferous, evergreen resinous trees which belongs to genus Pinus

- ◊ Pinus are evergreen, with needle-like leaves
- ◊ Most of pinus have thick and scaly bark, only few species have thin and flaking bark.
- ◊ Pinus grow about 15 to 45 metres tall
- ◊ Most of pinus have female and male cones on the same trees
- ◊ Branches of pinus arise from the same point on the tree.

ADVANTAGES AND DISADVANTAGES OF THE DIVISION CONIFEROPHYTA

QN: Explain the advantages and disadvantages of the division coniferophyta

ADVANTAGES OF CONIFERS

(i) Conifers are source of timber.

(ii) Some conifers are used for decoration.eg Christmas trees

(iii) Some conifers are source of wood pulp which is used to manufacture papers.

(iv) Some conifers are source of food. E.g. Pine leaves are used as food for some insects

(v) and timber, as well as cedar which many people use for their homes because of its beauty and

(vi) Some conifers are used as medicine. E.g. Pines and cypress are rich in vitamin; their branches cones and oils can be extracted and used as nutrient supplements.

(vii) Conifers are source of habitat for many birds and animals.

(viii) Some conifers are source of firewood and charcoal.

(ix) Conifers form a large arena for Biological research and Ecological studies.

(x) Thick forests of conifers form green belts that modify the climate.

(xi) Some conifers are source of useful chemical substances such as resins.

DISADVANTAGES OF CONIFERS

(i) Conifers have low reproduction rate since they rely on wind pollination and seed dispersal.

(ii) Conifers act as a habitat for dangerous animals such as snake etc.

(iii) Conifers prevent other plants from growing as they completely shade the ground below.

(iv) Wood products from conifers are soft and easily attacked by terminates.

(II) DIVISION ANGIOSPERMOPHYTA

This division includes all flowering plants such as mango trees, hibiscus flowers, maize, beans etc.

◊ Plants which are found in division angiospermophyta are called **angiosperms**

ANGIOSPERMS

These are flower and seed bearing vascular plants.

GENERAL FEATURES OF ANGIOSPERMS

(i) They bear flowers which are reproductive structures.

(ii) They produce seeds enclosed in an ovary.

(iii) They have well developed vascular system for transporting water and dissolved substances.

(iv) They have alternation of generation

DISTINCTIVE FEATURES OF ANGIOSPERMS

(i) They bear flowers which are reproductive structures.

(ii) They bear seeds enclosed in an ovary.

(iii) They have endosperm produced after fertilization to nourish the embryo.

(iv) Their haploid gametophyte is confined inside the ovary or anther of the flower.

(v) They have double fertilization

- ◊ Double fertilization is the process whereby one sperm fertilizes the egg cell to form the diploid zygote, while the other sperm fertilizes the central polar cell to form triploid endosperm.

CLASSES OF THE DIVISION ANGIOSPERMOPHYTA AND THEIR DISTINCTIVE FEATURES

Division Angiosperms is divided into two classes, namely:

(i) Class Monocotyledonae

(ii) Class Dicotyledonae

CLASS MONOCOTYLEDONAE

This consists of plants whose seed are made up of only one cotyledon.

- ◊ Members of class monocotyledonae are called **monocots**

Example of monocots

- ◊ Maize plant
- ◊ Grasses
- ◊ Palm trees
- ◊ Sugarcanes

DISTINCTIVE FEATURES OF CLASS MONOCOTYLEDONAE

(i) Monocots have one cotyledon

(ii) Monocots have narrow leaves with parallel venation.

(iii) Monocots have fibrous root systems.

(iv) Floral parts are in 3, or multiple of 3.

(v) Monocots have no cambium hence there is no secondary growth.

(vi) Monocots have scattered vascular bundles in their stems.

DIAGRAM OF MONOCOT STEM AS SEEN UNDER A LIGHT MICROSCOPE

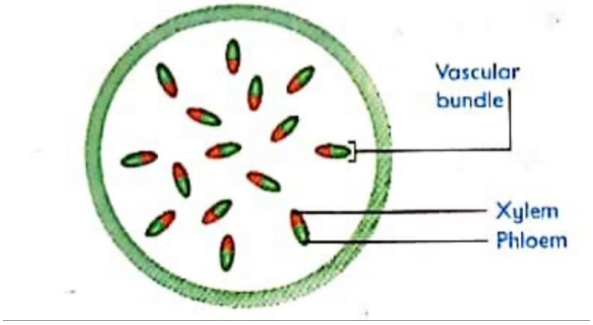
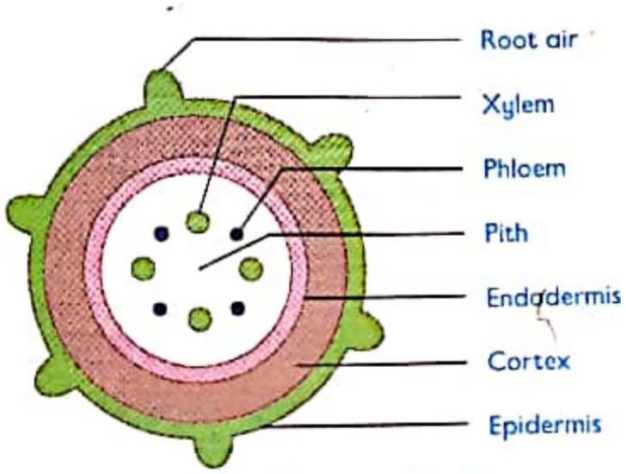


DIAGRAM OF MONOCOT ROOT AS SEEN UNDER A LIGHT MICROSCOPE



CLASS DICOTYLEDONAE

This consists of plants whose seeds are made up of two cotyledons.

- Members of class dicotyledonae are called **dicots**

Example of dicots

- Bean plants
- Groundnuts
- Peas
- Sunflowers
- Hibiscus

DISTINCTIVE FEATURES OF CLASS DICOTYLEDONAE

(i) Dicots have two cotyledons

(ii) Dicots have broad leaves with net-like venation.

(iii) Dicots have tap root system

(iv) Floral parts are in 4 or 5 or multiple of 4 or 5.

(v) Dicots have vascular cambium which brings about secondary growth.

(vi) Vascular bundles in dicot stem are arranged in a ring form.

DIAGRAM OF DICOT STEM AS SEEN UNDER A LIGHT MICROSCOPE

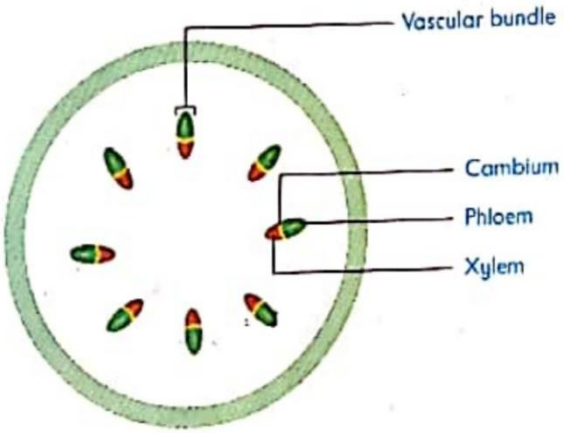
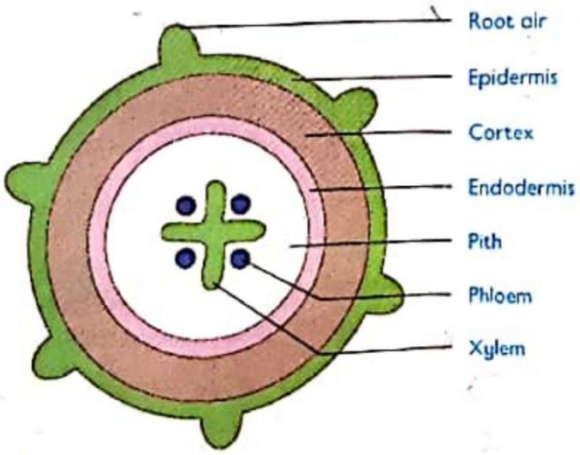


DIAGRAM OF DICOT ROOT AS SEEN UNDER A LIGHT MICROSCOPE



DIFFERENCES BETWEEN MONOCOTS AND DICOTS

MONOCOTS E.g. **Maize plants**	**DICOTS** E.g. **Bean plants**
(i) Have seeds with two cotyledon	Have seeds with two cotyledons
(ii) Have leaves with parallel venation	Have leaves with net-like venation
(iii)Have fibrous root system	Have tap root system
(iv)Have long and narrow leaves	Have short and broad leaves
(v) Have no cambium	Have cambium
(vi)Vascular bundles in stem are scattered	Vascular bundles in stem are arranged in a ring
(vii) Floral parts are in 3, or multiple of 3.	Floral parts are in 4 or 5 or multiple of 4 or 5.

ADVANTAGES AND DISADVANTAGES OF DIVISION ANGIOSPERMOPHYTA

QN: Explain advantages and disadvantages of division angiospermophyta

ADVANTAGES OF ANGIOSPERMS

(i) Angiosperms are source of food to other living organisms such as human being.

(ii) Angiosperms provide different varieties of wood for furniture, paper and building materials.

(iii) Some angiosperms are used to make medicine.

(iv) Angiosperms are source of oxygen which is used for cellular respiration.

(v) Angiosperms are source of raw materials for textile industry. E.g. cotton

(vi) Angiosperms are used to modify climate.

(vii) Angiosperms provide a wide range of habitats for different species of organisms.

DISADVANTAGES OF ANGIOSPERMS

(i) Some angiosperms are poisonous when eaten they cause death to human and other animals. E.g. Some cassavas have cyanide acid that inhibits cellular respiration.

(ii) Some angiosperms are drugs that can be abused when taken. E.g. Marijuana, cocaine, tobacco, caffeine.

(iii) Some angiosperms are bad weeds, they reduce crop yields. E.g. Cuscuta kilimanjari is parasitic to coffee plantations.

SIMILARITIES OF DIVISION CONIFEROPHYTA AND DIVISION ANGIOSPERMOPHYTA

(i) Both are seed producing plants

(ii) Both have true roots, stems and leaves

(iii) Both have vascular bundles

DIFFERENCES BETWEEN DIVISION CONIFEROPHYTA AND DIVISION ANGIOSPERMOPHYTA

ANGIOSPERMS	GYMNOSPERM
(i) They produce fruits that contain seeds	They produce cones that contain seeds
(ii) They are flowering plants	They are non-flowering plants
(iii) Their seeds are enclosed in an ovary	Their seeds are enclosed in cones
(iv) Their reproductive structures are flowers	Their reproductive structures are cones

ECONOMIC IMPORTANTCE OF KINGDOM PLANTAE

(i) Plants give out oxygen which is used for cellular respiration.

(ii) Plants are source of fuel to man e.g. Charcoal and firewood

(iii) Plants are source of food to man and herbivorous animals,

(iv) Some plants are used to make medicine. E.g. quinine, moarobaini etc

(v) Plants provide shade and good habitat for wildlife and birds.

(vi) Plants beautify and decorate the environment

(vii) Leguminous plants add nitrate nutrients in the soil.

(viii) Some plants provide raw materials used in textile industries

(ix) Some plants are source of timber.

(x) Some plants are drugs that can be abused when taken. E.g. Marijuana, cocaine, tobacco, caffeine.

(xi) Some plants are poisonous when eaten they cause death to human and other animals. E.g. Some cassavas have cyanide acid that inhibits cellular respiration.

REVISION QUESTION

1. Choose the correct answer from the choices given

   (i) Absence of flowers and fruits is a characteristics of_____

   A. Monocots
   B. Dicots
   C. Conifers
   D. Vascular plants

   (ii) One of the following is a similarity between Gymnosperms and Angiosperms

   A. They reproduce sexually by seeds
   B. They are wind pollinated
   C. They have cones
   D. They have seeds with cotyledons

   (iii)Plants are said to be vascular if_____

   A. They contain phloem
   B. They contain cambium
   C. They contain xylem
   D. They contain xylem and phloem

(iv) In flowering plants, seeds are enclosed in_____

A. Ovules
B. Ovaries
C. Fruits
D. cones

(v) An example of the most important drug extracted from the angiosperms is_____

A. Penicillin
B. Magnesium
C. Quinine
D. All the above

2. State whether each of the following statements is true or false
   (i) Most coniferous tree(evergreen plants) have needle leaves throughout the whole year___
   (ii) Conifers are seedless plants_____
   (iii) Angiosperms are not flowering plants_____
   (iv) Cones produce a sweet scent during winter_____
   (v) Monocots have fibrous root system_____
   (vi) Dicots have seeds with only one cotyledon_____
   (vii) The phloem in both dicots and monocots functions as a conductor of organic nutrients from one part of the plant to another_____
   (viii) Angiosperms do not provide food for man or animal_____
   (ix) Monocots stem vascular bundles is in a ring-form
   (x) All dicots and monocots are flowering plants_____
   (xi) In most dicots, their roots develop from the lower end of the embryo at the radical_____
3. Explain the general and distinctive features of the division coniferophyta.
4. Describe the structure of Pinus.
5. What is the advantage of conifers having needle-like leaves?
6. How useful is division Coniferophyta to human beings?
7. Explain the general and distinctive features of the division Angiospermophyta
8. (a) Give three similarities of division Coniferophyta and division Angiospermophyta
   (b) How is division coniferophyta different from division Angiospermophyta?
9. What are the characteristic differences between monocots and dicots?
10. (a) Draw well labeled diagrams of monocots and dicot stems as seen under a light microscope.
    (b) How different is the arrangement of vascular bundles in monocot and dicot stems?
11. State the economic importance of division Angiospermophyt

MOVEMENT AND LOCOMOTION

MOVEMENT

Is the act of changing positions or postures by the part or the whole of an organism.

- ◊ Movement occurs both in plants and animals
- ◊ Movement in plants mainly involves growth towards or away from certain environmental factors.

LEVELS AT WHICH MOVEMENT OCCURS

Movement can occur at various levels, namely:

(i) Cellular level

(ii) Organ level

(iii)Organism level

CELLULAR LEVEL

At this level, movement is by cytoplasmic streaming e.g. In amoeba and swimming of male gametes such as sperms.

ORGAN LEVEL

In animal, movement of organs is brought about contraction and relaxation of muscles. For example contraction of biceps muscles and relaxation of triceps muscles in human arm cause arm to be raised.

ORGANISM LEVEL

At this level the whole organism moves from one place to another

LOCOMOTION

Is the change in position of the whole organism from one place to another.

- ◊ Locomotion occurs in animals and in some protoctists.

DIFFERENCES BETWEEN MOVEMENT AND LOCOMOTION

	MOVEMENT	LOCOMOTION
1	It involves only part of an organism	It involves the whole organism
2	Occurs in both plants and animals	Occurs in animals and some protoctists

IMPORTANCE OF MOVEMENT AND LOCOMOTION TO ANIMALS AND PLANTS

(i) Enables organisms to escape from danger.

(ii) Enables organisms to locate food and water.

(iii) To move to better climatic conditions. For example birds migrate during extreme cold weather or drought.

(iv) Brings together organisms or reproductive cells for reproduction.

(v) Enables organisms to find good habitats

(vi) To aid in insect pollination.

TYPES OF MOVEMENT

There four main types of movements, namely:-

(i) Amoeboid movement

(ii) Ciliary movement

(iii) Flagella movement

(iv) Muscular movement

(I) AMOEBOID MOVEMENT

Is the movement shown by amoeba and white blood cells by using locomotory structures called pseudopodia.

(II) CILIARY MOVEMENT

Is the movement shown by paramecium and larvae of some aquatic animals by locomotory structures called cilia.

(III) FLAGELLA MOVEMENT

Is the movement shown by euglena, trypanosoma, some bacteria and sperm by using locomotory structures called flagella

◊ Flagella are tail- like projection on a cell surface.

(IV) MUSCULAR MOVEMENT

Is movement shown by vertebrate animals such as mammals, birds, fish and insects move by using muscles aided by skeleton.

FORMS OF LOCOMOTION

The following are various forms of locomotion exhibited by animals:-

(i) Walking
(ii) Running
(iii) Leaping
(iv) Hopping
(v) Crawling
(vi) Swimming
(vii) Flying

(I) WALKING

Is a form of locomotion shown by human beings and some animals by using two or four legs.

BIPEDAL

Are organisms that walk on two legs.

- ◊ Example of bipedal includes;
  - ─ human being
  - ─ kangaroo
  - ─ chimpanzees
  - ─ birds

QUADRUPEDS

Are organisms that walk on four limbs.

Example of quadrupeds includes:

- ─ dogs
- ─ cows
- ─ Goats
- ─ Elephants
- ─ zebras

(II) SWIMMING

Is a form of locomotion exhibited by aquatic animals such as fish, whales and seals by using fins and fat tissues.

(III) FLYING

Is a form of locomotion shown by birds, bats and winged insects moving through air by using wings.

(IV) LEAPING

Is moving by jumping from one place and landing onto another place.

- ◊ Example of leaping animals:
  - ─ Frogs
  - ─ Toads

(V) HOPPING

Is a form of locomotion shown by insects such as grasshopper moving by making quick short jumps.

(VI) CRAWLING

Is a form of locomotion shown by Earthworms, snails and millipedes moving with the body resting on the ground.

MOVEMENT OF THE HUMAN BODY

SKELETON

Is a rigid framework of cartilage and bones to which soft tissues, organs and muscles are attached.

OR is a framework of tissues supporting a human or an animal body.

TYPES OF SKELETON

There are three types of skeletons animals.

(i) Hydrostatic skeleton
(ii) Exoskeleton
(iii)Endoskeleton

(I) THE HYDROSTATIC SKELETON

Is a skeleton found in animals with soft bodies like earthworms.

- ◊ Hydrostatic skeleton is made up of a fluid which acts as a skeleton

Hydrostatic skeleton is found in the following organisms

- ◊ Earthworms
- ◊ Jelly fish
- ◊ Leech

Role of hydrostatic skeleton

- ◊ Helps animals such as the earthworms to move and burrow in the soil

(II) EXOSKELETON

Is the hard outer skeleton that covers bodies of insects and arthropods.

- ◊ It is called exoskeleton because it is found outside the body of an organism.
- ◊ Exoskeleton is made up by a mixture of protein and chitin.
- ◊ Exoskeleton is covered with cuticle that is slippery and water proof therefore preventing loss of water from insect's body.
- ◊ Exoskeleton is made of plates called sclerites which are hard enabling insects to move.

Exoskeleton is found in the following organisms

(i) Insects such as grasshopper, houseflies and butterflies
(ii) Arthropods such as crabs, prawns, centipedes and millipedes.

(III) THE ENDOSKELETON

Is a skeleton which found inside the body of an organism.

(i) Endoskeleton is made up of bone and cartilage

Endoskeleton is found in the vertebrates such:-

- ─ Fish
- ─ Cow
- ─ Dog
- ─ Human being
- ─ Birds
- ─ Reptiles

DIFFERENCES BETWEEN ENDOSKELETON AND EXOSKELETON

ENDOSKELETON	EXOSKELETON
(i) It is found inside the body of an organism	It is found outside the body of an organism
(ii) It is made of bones and cartilage	It is made up of chitin
(iii) It is found in vertebrate animals like birds, fish and human beings.	It is found in insects like grasshoppers and other arthropods like crabs
(iv) it grow with the rest of the body	It does not grow because it is dead material
(v) it is living	It is non living

FUNCTIONS OF SKELETON

(i) Provides the site for muscles and body organs attachment.
(ii) It protects delicate organs such as brain, heart, lungs and kidney,
(iii) It supports and gives the body its shape.
(iv) Enables the organism to move from one place to another
(v) It store minerals such as calcium and phosphorus.
(vi) Provides a rigid framework which supports softer parts of the body
(vii) Helps in the formation of blood cells such as RBCs and WBCs. E.g. endoskeleton

THE HUMAN SKELETON

The human skeleton consists of bones and joints

(I) BONE

Is a hard and tough connective tissue composed of minerals such as calcium and phosphate.
(ii) A human being has a total of 206 bones.

FUNCTIONS OF BONES

(i) Provides a rigid framework which supports to the softer parts of the body.
(ii) Protects the delicate organs of the body.
(iii) Helps in blood cells formation in the body.
(iv) Stores mineral salts in the body such as calcium.

LIGAMENT, TENDON AND CARTILAGE

LIGAMENT

Is a fibrous tissue which joins bone to bone.

Function of ligament

(i) It is elastic to allow movement at joint
(ii) It makes joints more stable.

TENDON

Is a tough connective tissue that joins muscle to the bone.

FUNCTION OF TENDON

(i) It is inelastic to join muscles to the bones.

CARTILAGE

Is a skeletal connective tissue which is softer than bone.

(iii)Cartilage is found at the end of the bones especially at joints

FUNCTION OF CARTILAGE

(i) It supports the trachea, nose, oesophagus and pinna of the ear.

(ii) Reduces friction at the joints.

NECTA 2003

Question 4 (c) What is the difference between the functions of a ligament and a tendon.

THE STRUCTURE OF THE HUMAN SKELETON

Structurally, the human skeleton is divided into two parts (components) namely;-

(i) Axial skeleton

(ii) Appendicular skeleton

AXIAL SKELETON

The axial skeleton consist of bones that form axis of the body

Components of the axial skeleton

Axial skeleton is made of four parts (components), namely:

(i) The skull
(ii) The vertebral column
(iii)Sternum
(iv) Ribs

Function of the axial skeleton

◊ It supports and protects the organs of the head, neck and trunk.

APPENDICULAR SKELETON

Appendicular skeleton is made of forelimbs (arms), hind limbs (legs), pelvic girdle and pectoral girdle.

Components of appendicular skeleton

Appendicular skeleton is made of the following components:

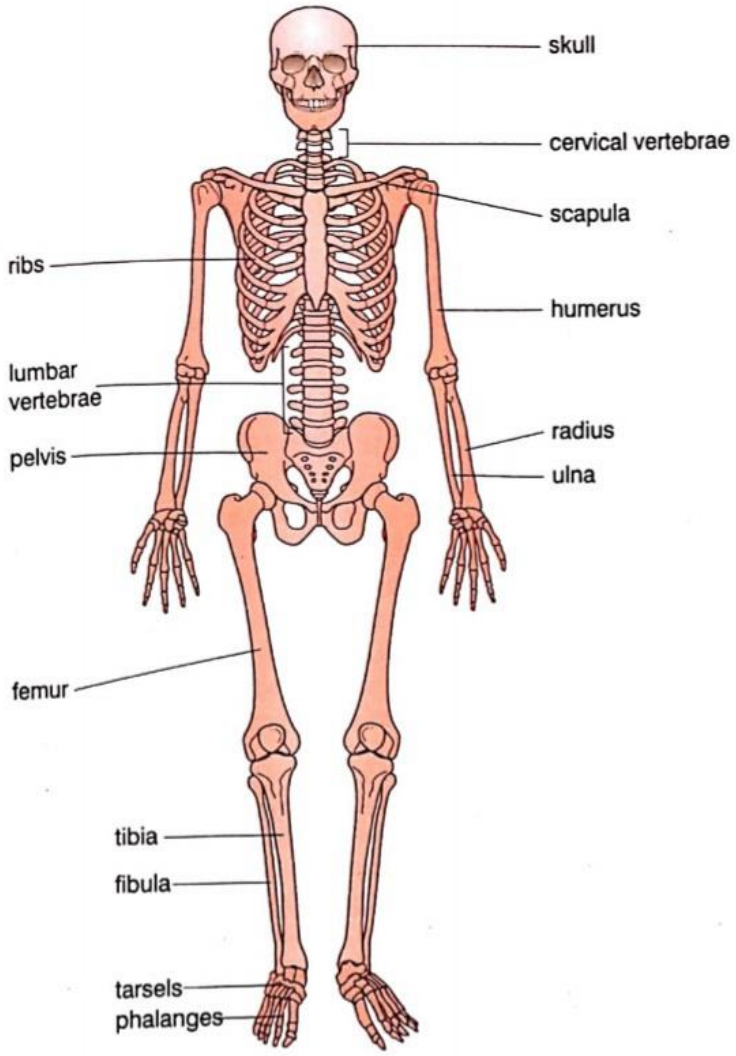
(i) The arms

(ii) Legs

(iii) Pectoral girdle

(iv)Pelvic girdle.

THE DIAGRAM OF HUMAN SKELETON



FUNCTIONS AND ADAPTIONS OF THE COMPONENTS OF THE AXIAL SKELETON

1. THE SKULL

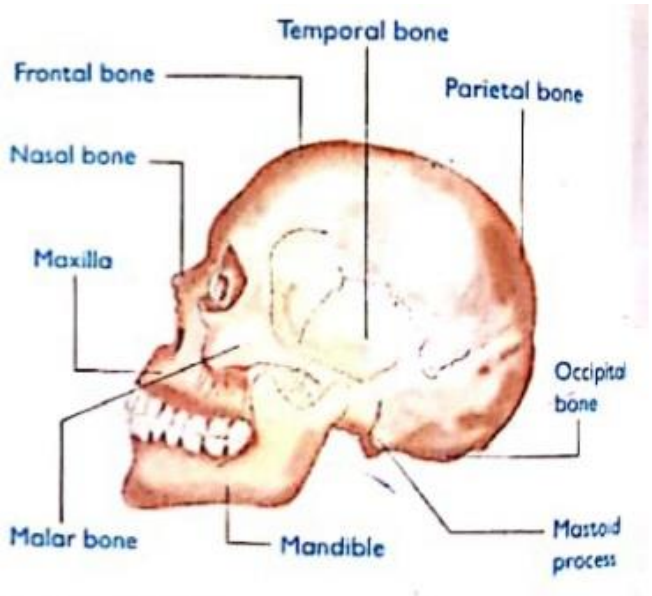
Is the bony framework of the head.

- ◊ The skull is made of cranial bones and facial bones
- ◊ 8 Cranial bones joined by immovable joints called **sutures** to form cranium
- ◊ Cranium houses (covers) the brain, middle ear and part of the ear
- ◊ Facial bones make up the upper jaw (maxilla) and lower jaws (mandible)

FUNCTIONS OF THE SKULL

(i) It protects the brain, olfactory organs, the eyes and the middle and inner ear.
(ii) It gives shape of the head.

THE DIAGRAM OF HUMAN SKULL



2. THE RIBS

Are thin, flat curved bones that form a protective cage around the organs in upper body.

- ◊ Ribs comprise 24 bones which are arranged in 12 pairs.
- ◊ The union between the ribs, vertebral column and the sternum makes the **ribcage**

Functions of the ribs

(i) To give the chest its shape.

(ii) To protect the heart, lungs, spleen and kidney against injuries and shock.

(iii) Helps in breathing by expanding to let air in and contract to let air out.

Adaptations of the ribs

(i) Ribs have long shaft for attachment of intercostal muscles

(ii) Ribs have tuberculum and capitulars for articulation with tubercular and capitulars facets of the thoracic vertebrae.

(iii) Ribs have curved shaft to provide a long surface area for attachment of intercostal muscles.

(iv) Ribs have hard shaft for support and protection of delicate organs of thoracic cavity from mechanical damage.

TYPES OF RIBS

Ribs are of three categories namely;-

(i) True ribs

(ii) False ribs

(iii) Floating ribs

TRUE RIBS

These are the first 7 pairs of ribs, at the back they are connected to the backbone.

- ◊ At the front they are connected to the breast bone or the sternum.

FALSE RIBS

These are the next 3 pair of ribs.

- ◊ They are slightly shorter than the true ribs.
- ◊ At the back they are connected to the backbone, in the front they are not connected to the sternum, instead they are connected to the lowest rib.

FLOATING RIBS

These are the last 2 pairs of ribs.

- ◊ They are the smallest of all.
- ◊ They are attached to the backbone at the back but are not attached to anything in the front, hence the name floating ribs.

NB: The first seven ribs are attached directly to the sternum ventrally while the next three ribs are joined together ventrally to form costal cartilage which is then attached to the sternum.

- ◊ The sternum is composed of small bone known as **sternabrae**

3. VERTEBRAL COLUMN

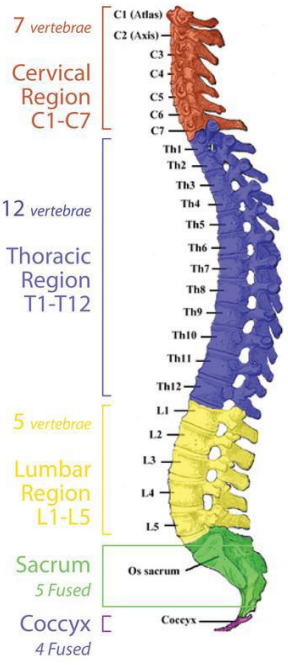
Is a series of 33 bones called vertebrae.

◊ Vertebral column is also called the **spine, backbone** or **spinal column**.

Functions of vertebral column

(i) Protects the spinal cord
(ii) Supports the body trunk

DIAGRAM OF VERTEBRAL COLUMN



TYPES OF VERTEBRAE

Vertebral column has five types of vertebrae, namely:

(i) The cervical vertebrae

(ii) Thoracic vertebrae

(iii) Lumbar vertebrae

(iv) Sacral vertebrae

(v) Caudal vertebrae

Each vertebra is separated by an intervertebral disc of cartilage.

Function of intervertebral disc

(i) Prevents wearing out of vertebrae during locomotion.

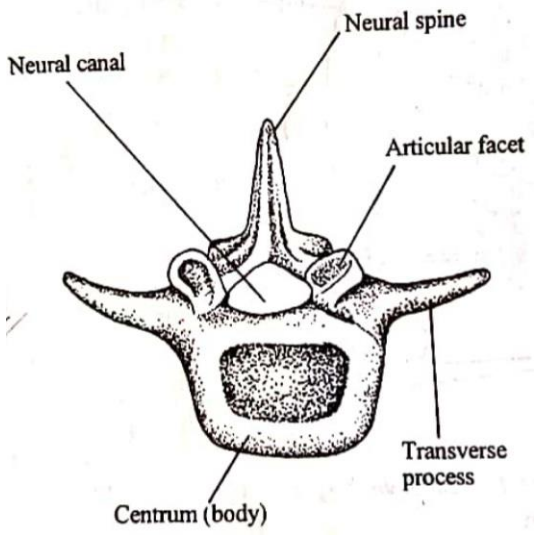
(ii) Acts as a shock absorber

STRUCTURE OF THE VERTEBRAE

Each vertebra has the following parts:

PARTS	DESCRIPTION	FUNCTION
1. CENTRUM	◊ Is the main body of the vertebra	◊ Holds and supports other parts of the vertebra
2. NEURAL CANAL	◊ Is the hollow part just above the centrum	◊ Allows passage of the spinal cord
3. NEURAL ARCH	◊ Is the part surrounding the neural canal	◊ Protects the spinal cord ◊ Projects to form processes for muscles attachment.
4. TRANSVERSE PROCESSES	◊ These are lateral projections on the neural canal	◊ Offers surface area for muscles attachment
5. NEURAL SPINE	◊ Projection from the back of the neural arch	◊ Offers surface area for muscles attachment
6. ARTICULAR FACETS	◊ These are articulating surfaces include prezygapophysis and postzygapophysis	◊ Offers articulation surface with adjacent bones and vertebrae

DIAGRAM OF THE BASIC STRUCTURE OF VERTEBRA



THE CERVICAL VERTEBRAE

These are short bones found in the neck region

◊ They are seven in man.

◊ The first two cervical vertebrae are known as ATLAS and AXIS

◊ Axis fits into the ventral part of the neural canal of the atlas

◊ Atlas and axis have wing-like transverse processes.

FUNCTION OF ATLAS AND AXIS

(i) They permit movement of the head.

For example

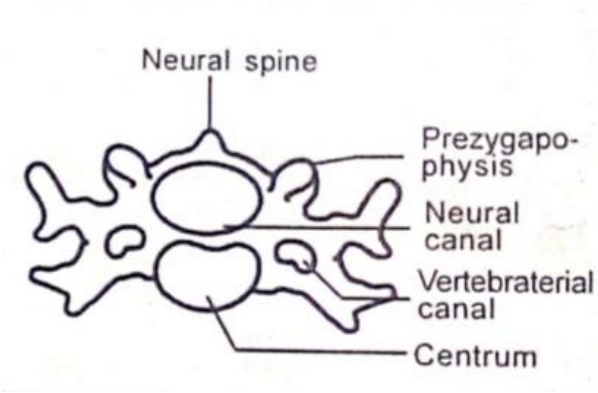
◊ The joint between the atlas and skull allows up and down (nodding) movements of the head

◊ The joints between the atlas and axis allow turning or sideways movements of the head.

DIFFERENCES BETWEEN ATLAS AND AXIS

ATLAS	AXIS
(i) Has no centrum	Has a wide centrum
(ii) Has no odontoid process	Has the odontoid process (projection of centrum)

DIAGRAM OF CERVICAL VERTEBRAE



Functions of cervical vertebrae

(i) They provide the site for neck muscles to attach

(ii) They support the skull or weight of the head.

(iii) They allow free rotation/nodding of the skull on vertebral column

Adaptations of cervical vertebrae

(i) They have vertebraterial canal for passage of vertebral artery and vertebral nerves.

(ii) They have wing-like transverse processes for neck muscles attachment.

(iii) They have short neural spine for attachment of neck muscles.

(iv) They have large and wide neural canal for passage of spinal cord.

(v) The atlas has facets that articulate with the skull to allow nodding movement.

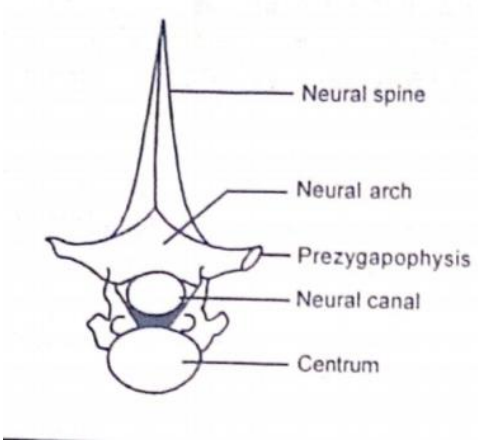
(vi) Axis has odontoid process to permit turning of the head

THE THORACIC VERTEBRAE

These are found in thorax region articulating with ribs.

◊ They are 12 in man and 13 in rats.

DIAGRAM OF THORACIC VERTEBRAE



Function of thoracic vertebrae

◊ They provide the site for muscles in the thorax to attach

Adaptations of thoracic vertebrae

(i) They have long neural spine which offers a large surface area for the attachment of back muscles.

(ii) They have short transverse processes for articulation with the ribs.

(iii) They have prominent centrum to support the weight of the vertebrae above them.

(iv) They have wide neural canal for passage of spinal cord.

(v) They have facets for articulation with ribs

(vi) They have articular surfaces (pre- and post-zygapophysis) covered with cartilage which is found between adjacent vertebrae. Cartilage reduces friction between adjacent bones.

THE LUMBAR VERTEBRAE

Are vertebrae between the lower end of the rib and waist.

◊ Lumbar vertebrae found in the lumbar region of the body.

◊ Most of mammals have 7 but man has 5 lumbar vertebrae.

Distinctive features of lumbar vertebrae

(i) They have short and broad neural spine

(ii) They have long transverse processes e.g. Extra transverse processes.

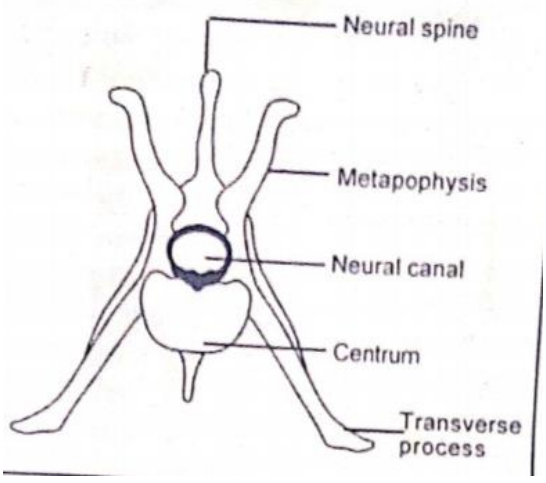
(iii) They have large and enlarged centrum with a D-shaped neural canal.

Function of lumbar vertebrae

(i) Provides site for abdominal muscles to attach

(ii) Permits bending, sideways movements and rotation of the trunk

DIAGRAM OF LUMBAR VERTEBRAE



Adaptations of lumbar vertebrae

(i) They have short and broad neural spine for attachment of powerful back muscles.

(ii) They have long, large and well developed transverse processes for abdominal muscles to attach.

(iii) They have projections (metapophysis and anapophysis) for increasing the surface area for muscles to attach.

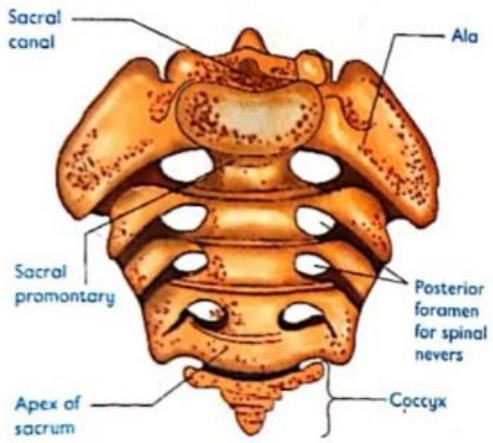
(iv) They have large and thick centrum for supporting the upper body weight.

THE SACRAL VERTEBRAE

These are situated in the sacral region (between the waist and tail).

◊ They are three in most mammals but are 5 in man, all fused together to form sacrum.

DIAGRAM OF SACRAL VERTEBRAE



Distinctive features of sacral vertebrae

(i) They have short neural spine.

(ii) The sacrum is broader on the front side and narrow towards the tail.

(iii) They have a small neural canal.

(iv) The transverse processes of first sacral vertebrae are large and wing- like for articulation with pelvic girdle.

(v) They have pairs of holes.

Adaptations of sacral vertebrae

(i) Anterior vertebrae have a well- developed transverse process which are fused to the pelvis girdle or articulate with pelvic girdle.

(ii) The sacral vertebrae are fused for strength and transmit weight of the stationary animal to the rest of the body.

(iii) Sacrum has broad base and short spine for attachment of back muscles.

THE CAUDAL (COCCYGEAL) VERTEBRAE

Caudal vertebrae are found in the tail region.

◊ Their numbers differ from animal to animal depending on the animal's size of the tail.

◊ Since man has no external tail there are only four caudal vertebrae which are fused together to form the coccyx known as a vestigial tail.

Distinctive features of caudal vertebrae

(i) They have reduced transverse processes

(ii) They have reduced neural spines and zygapophysis.

(iii)They lack a neural arch.

THE APPENDICULAR SKELETON

The appendicular skeleton comprises the upper extremity and the lower extremity.

◊ The upper extremity consists of following parts:

- Forelimbs (arms)
- Pectoral girdle

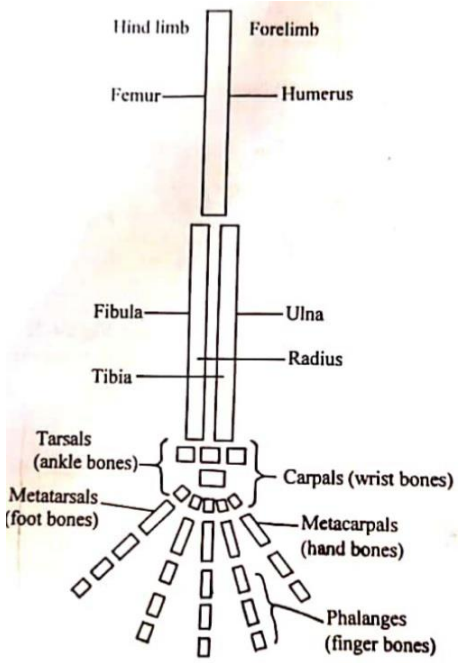
◊ The lower extremity consists of the following parts:

- Hind limbs(legs)
- Pelvic girdle

NB: All mammals have limbs which are designed in the same plan of pentadactyl limb plan.

◊ **Pentadactyl limb** means each limb ends with five digits (fingers or toes).

DIAGRAM TO SHOW PENTADACTYL LIMB PLAN



1. FORELIMBS (arms)

These are attached to the axial skeleton to the anterior part of the body.

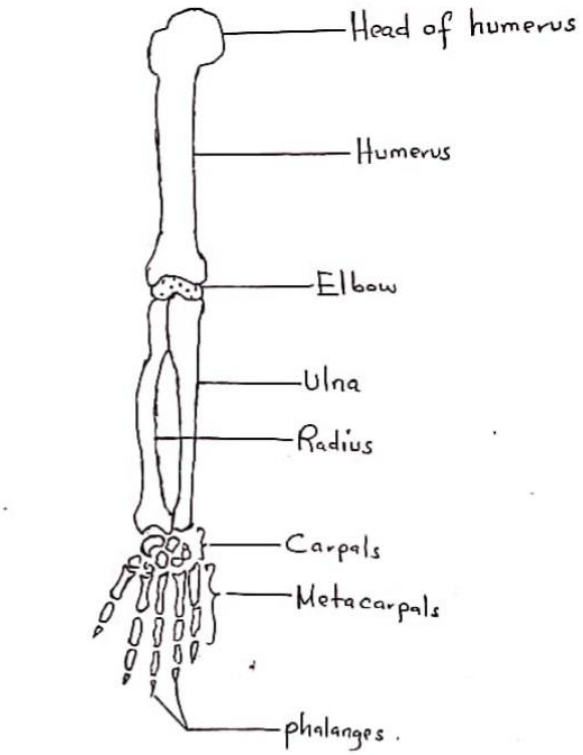
Forlimbs comprises the following parts

(i) Humerus

(ii) Radius and ulna

(iii)Carpals, metacarpals and phalanges

DIAGRAM TO SHOW THE FORELIMB



THE HUMERUS

Is a single long bone found in the upper arm.

◊ It lies between the shoulder and the elbow

FUNCTIONS OF HUMERUS

◊ Used for attachment of biceps and triceps muscles.

ADAPTATIONS OF HUMERUS

(i) Has a round head that articulates with the glenoid cavity of the scapula forming a ball and socket joint.

(ii) Has two rough projections, the greater and lesser taberosities near the head for muscles attachment.

(iii) Has depression called bicipital groove between the two tuberosities for muscle attachment

(iv) Has trochlea with a deep groove that fits in the sigmoid notch of ulna to form a hinge joint at elbow.

RADIUS AND ULNA

These are bone found in the forearm and are usually fused in rabbits.

◊ Radius is on the side of the thumb while the ulna is on the side of the small finger.

◊ Ulna has a projection called olecranon process, which has a sigmoid notch for articulation with humerus.

FUNCTION OF RADIUS AND ULNA

(i) They support the carpals, metacarpals and phalanges.

(ii) They provide surface area for attachment of muscles of the arm.

CARPALS, METACARPALS AND PHALANGES

Carpals

Are small bones which form the wrist

◊ They articulate with radius and ulna at the upper and metacarpal at the lower end.

◊ They are 8 in man an 9 in rabbit

Metacarpals

Are small bones which found in the palm

◊ They are longer than the carpals.

◊ They are 5 in man, 3 in each finger and 2 in the thumb

Phalanges

These are the finger bones.

◊ They are 14 in man

2. THE PECTORAL GIRDLE

This is also called the shoulder girdle

◊ It is made up of two separate halves

◊ Each half is made up of three bones that are attached to the vertebral column by ligaments and muscles.

Three bones of the pectoral girdle are:

a) Scapula
b) Coracoids
c) Clavicles

a) THE SCAPULA

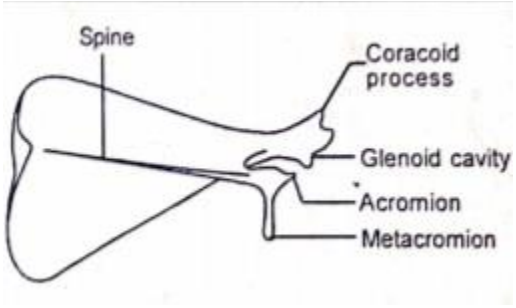
Is a large triangular flat bone on the side of the rib cage.

- ◊ It is also known as a shoulder blade.
- ◊ The scapula has a concave depression called the **glenoid cavity**
- ◊ Glenoid cavity articulates with the head of humerus to form a **ball and socket joint**.

FUNCTIONS OF THE SCAPULA

- ◊ Provide site for attachment of muscles that move the arms.
- ◊ It also connects the arm to the axial skeleton.

DIAGRAM OF SCAPULA



ADAPTATIONS OF THE SCAPULA

(i) They have the glenoid cavity, a socket which articulates with the humerus forming a ball and socket joint at the shoulder.
(ii) They have acromium and metacromium for muscles attachment
(iii) The socket (glenoid cavity) has cartilage. These are the smooth surfaces to reduce friction.
(iv) They are broad and flattened to increase the surface area for muscles attachment.
(v) They are hard to provide support.

b) CORACOID

Is the bone of the pectoral girdle that is found at the apical end of the scapula

- ◊ This bone is formed by coracoids process of the scapula.

c) THE CLAVICLES

These are also called the collar bone.

- ◊ It is slender and s-shaped.
- ◊ It connects the upper arm to the trunk of the body and has a shoulder joints.
- ◊ They articulate anteriorly with the sternum and posteriorly with the acromion processes of the scapulate.

FUNCTIONS OF THE CLAVICLES

(i) They provides site for muscles attachment.

(ii) They also aid in movement of the arm.

3. THE PELVIC (HIP) GIRDLE

This consists of two hip bones known as pubic bones

- ◊ Pubic bones fused ventrally to form pubis symphysis.

Parts of pubic bones

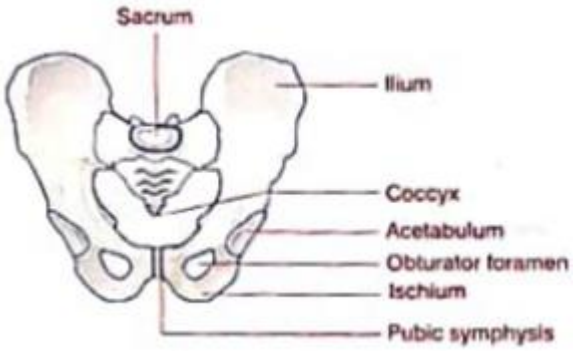
Each pubic bone comprises of three bones:

(i) Pubis

(ii) Ischium

(iii) Ilium

DIAGRAM OF PELVIC GIRDLE



NB: These bones are completely fused together in adult.

- ◊ The pelvis has a socket called the **acetabulum** which articulates with the femur to form the hip joint
- ◊ The size of pubic cavity is very important in females during birth
- ◊ During birth a hormone known as **relaxin** cause relaxation of the pubis symphysis thus expanding the size of the pelvic cavity.

FUNCTIONS OF PELVIC GIRDLE

(i) It supports the weight of the body from the vertebral column

(ii) It support and protects organs in the lower body such as the urinary bladder and the reproductive organs.

(iii)It protects the developing foetus in a pregnant woman.

(iv) Provides a large surface area for attachment of muscles that move the leg.

4. THE HIND LIMBS

These are attached to the axial skeleton to the posterior part of the body.

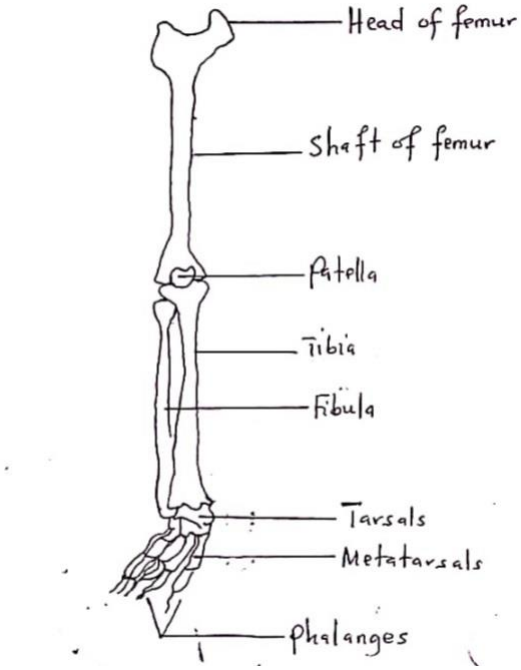
Hind limbs comprises of the following parts:

a) Femur (thigh bone)

b) Tibia and fibula

c) Tarsal, metatarsals and phalanges

DIAGRAM OF HINDLIMB



a) THE FEMU

Is the longest, largest and strongest bone found in the thigh between the hip and the knee.

◊ On the upper end, femur has a round head which fits into the acetabulum of the pelvic girdle to form a ball and socket joint of the hip.

◊ The lower end of femur possesses two curved convex surfaces called condyles for articulation with tibia and fibula to form a hinge joint at the knee.

FUNCTIONS OF FEMUR

(i) The femur supports the upper part of the body.

(ii) Its shaft provides surface for attachment of thigh muscles.

KNEE CAP

This is a large, triangular bone between the femur and tibia.

◊ Its main function is to protect the knee joint.

b) TIBIA AND FIBULA

These are bones that form the skeleton of the lower hind limb.

- ◊ They are found between the knee and the ankle.
- ◊ The fibula is fused to the tibia on the lower part of the leg

TIBIA	FIBULA
(i) It is large and bears most of weight	It is small and serves as an area for muscles attachment
(ii) It is found in front (ventral) ◊ It is found on the side of the big toe	It is found behind (dorsal)

ADAPTATION OF TIBIA AND FIBULA

(i) Tibia has two slight depressions at the upper end, for articulation with the condyles of the femur.

(ii) They have medial and lateral malleolus on the posterior end for articulation with tarsals bones.

(iii)They are hard and strong shaft to support the body weight.

A MALLEOLUS

Is the bony prominence on each side of the human ankle.

There are two types of malleolus namely:

(i) Medial malleolus

(ii) Lateral malleolus

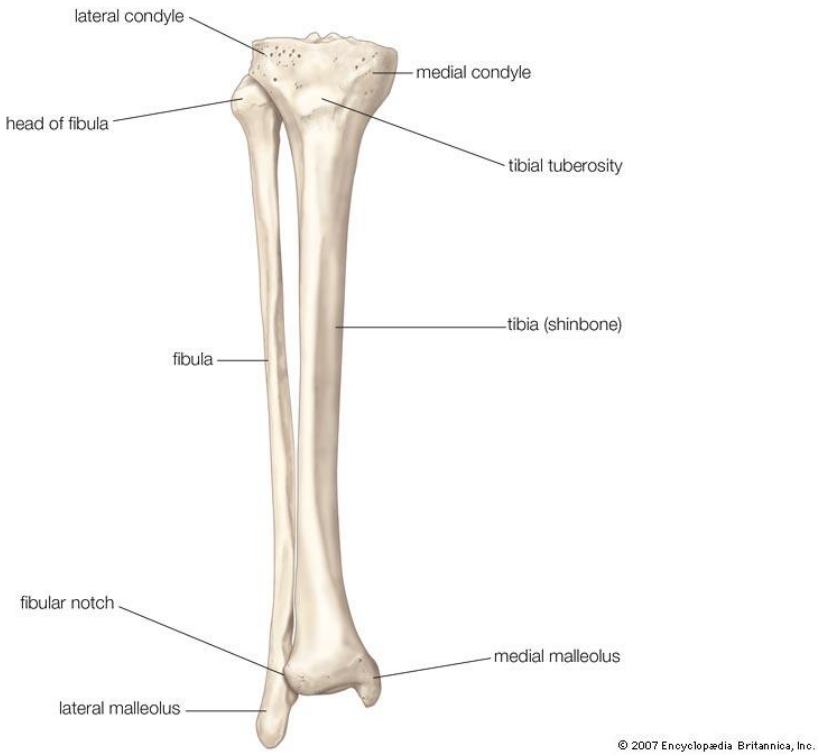
MEDIAL MALLEOLUS

Is the prominence on the inner side of the ankle, formed by the lower end of the tibia.

LATERAL MALLEOLUS

Is the prominence on the outer side of ankle, formed by the lower end of the fibula.

DIAGRAM OF TIBIA AND FIBULA



c) TARSALS, METATARSALS AND PHALANGES

Tarsals

◊ Are small bones which articulate with tibia and fibula to form the ankle joint

Metacarpals

◊ Are small bones which articulate with metatarsals to form the foot.

Phalanges

◊ Are small bones which articulate with metatarsals to form toes.

NB: Metatarsal and phalanges are similar in number and position to those of the hand.

ADAPTATIONS OF THE HUMAN SKELETON FOR CARRYING OUT ITS FUNCTION

Function	Adaptation
Support	◊ Firm and strong framework which maintains the shape of the body
Protection	◊ Presence of endoskeleton which is hard and firm. E.g. skull protects the organ in the head
Locomotion	◊ Presence of joints and muscles.
Synthesis of red and white blood cells	◊ Presence of bone marrows

Questions: Explain how skeleton is adapted for the following functions.

a) Locomotion
b) Synthesis of blood cells
c) Protection

JOINT

is the point where two or more bones meet.

◊ Joints are very important for movement and locomotion as they allow freedom of movement between bones

TYPES OF JOINTS

There are three types of joints namely;-

(i) Immovable/fixed joints
(ii) Gliding /slightly movable joints
(iii)Free movable/synovial joints

IMMOVABLE JOINTS

These are joints that do not allow any movement.

◊ Immovable joints are also called **fixed joints**
◊ They have no cartilage in them but bones are held closely together by short connective tissue fibres.

Example of immovable joints

◊ Sutures the joints that found in the skull (cranium joints)
◊ The joints between the bones of the

GLINDING JOINTS

These are joints that allow little movement.

◊ Gliding joints are also called slightly movable joints or sliding bones
◊ In this type of joint, short bones glide or slide over each other to bring about movement
◊ Gliding joints have no fluid between them instead they have a large cartilage between them known as intervertebral disc which reduces friction during movement

Examples of gliding joints

◊ Joints that occur between the vertebrae.
◊ Joints found at the wrist and ankle

FREELY MOVABLE JOINTS

These are joints that allow a large degree of movement.

- ◊ Freely movable joints are also called **synovial joints**
- ◊ They have a slippery fluid secreted by synovial membrane called a **synovial fluid**

Function of synovial fluid

(i) It reduces friction by lubricating the bones

(ii) Acts as a shock absorber during movement.

TYPES OF MOVABLE JOINTS

There are three types of synovial joints, namely:

a) Ball and socket joints

b) Hinge joints

c) Pivot joints

a) BALL AND SOCKET JOINTS

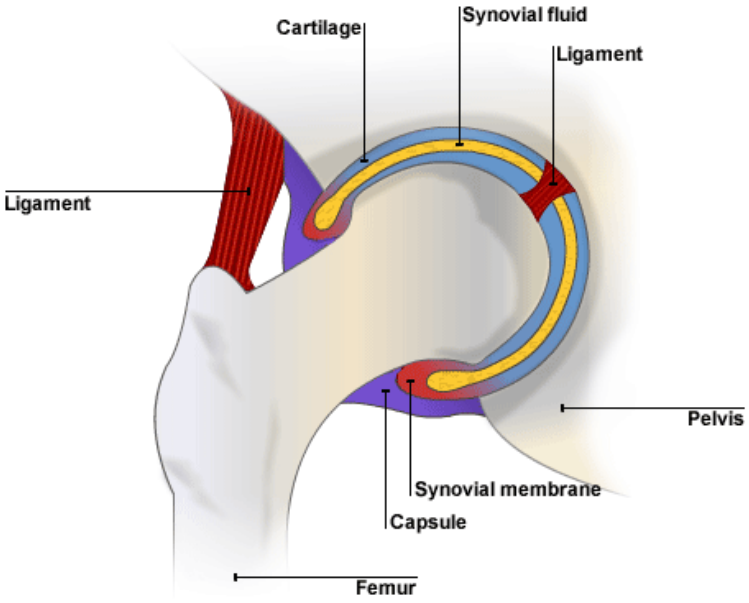
These types of joint allow movement in all directions.

- ◊ These joints involve two bones, one with a rounded head and the other with a depression into which the head of the first bone fits and move freely.

Examples of ball and socket joints

- ◊ **Hip joint** (a joint found between the femur and the pelvic girdle)
- ◊ **Shoulder joint** (a joint found between the humerus and the pectoral girdle)

DIAGRAM OF BALL AND SOCKET JOINT



b) HINGE JOINTS

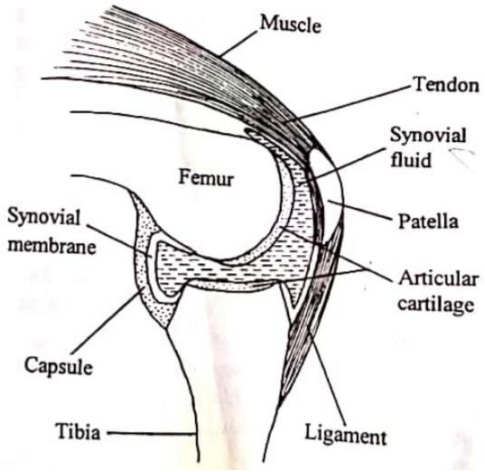
These are the joints that allow movement in one direction only

- ◊ Hinge joints look like the door.

Examples of hinge joints

- ◊ Elbow joint
- ◊ Knee joint

DIAGRAM OF HINGE JOINT



c) PIVOT JOINT

Is the joint which allows movement in several directions.

- ◊ In this type of joint one bone form a peg that enters into a cavity in the other bone.
- ◊ The peg acts as a pivot over which the other bone rotates.

Example of pivot joint

- ◊ Joint found between the atlas and the axis of the cervical vertebrae.

  NB: Odontoid process of the axis fits into the neural canal of the atlas to form a pivot joint which allows rotational movements of the head.

MUSCLES

Muscle is a contractile tissue specialized for contraction and relaxation to bring about movement in the body.

- ◊ Muscles tissue covers the skeleton.
- ◊ Muscles are responsible for locomotion and any other type of movement in animals.
- ◊ A muscle is a specialized tissue consisting of sheets of cells referred to as muscle fibres.

◊ Muscles are capable of contraction so as to produce about movement or tension in the body.

TYPES OF MUSCLES

In the human body there are three types of muscle. These are;-

(i) Cardiac muscles

(ii) Smooth muscles

(iii) Skeletal muscles

CARDIAC MUSCLES

These are muscles that are found only in the heart.

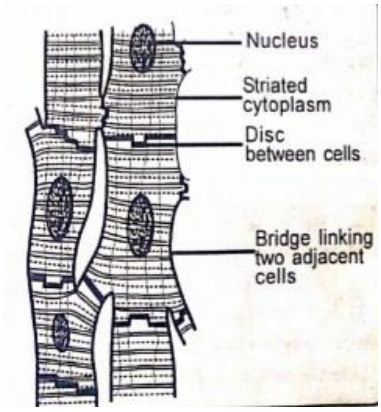
◊ Their cells have a single nucleus

◊ These muscles are controlled by involuntary nervous system.

Question: Why the heart beats continuously throughout the life of an organism?

Answer: Due to the presence of cardiac muscles that contract without suffering from fatigue

DIAGRAM OF CARDIAC MUSCLES



APTATIONS OF CARDIAC MUSCLES

(i) They have abundant mitochondria to provide adequate ATP for contraction.

(ii) They are myogenic to contract and relax without nervous stimulation.

(iii) They are branched and interconnected to provide a large surface area for contraction and relaxations.

(iv) They are multinucleated for better coordination of its contractile activities.

(v) They are striated to allow for contraction and relaxation in short intense bursts

(vi) They are elastic to allow for contractions and relaxation.

(vii) They have intercalated disc to allow the cardiac potential to travel across them, making it easier for electric impulses to move quickly.

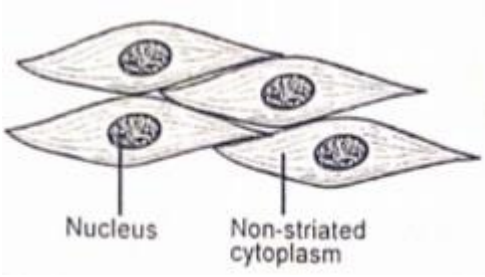
(viii) Intercalated disc also acts as shock absorber to protect the myocorolium from mechanical shock.

SMOOTH MUSCLES

These are the muscles found in the walls of organs such as alimentary canal, the blood vessels and the bladder

- ◊ Smooth muscles also reffered to as **involuntary muscles**. This is because their activity is not under the control of the will.
- ◊ They are made up of cells which are long and spindle-shaped
- ◊ The cells have one central nucleus

DIAGRAM OF SMOOTH MUSCLES



ADAPTATIONS OF SMOOTH MUSCLES

(i) They are connected by autonomic nervous system (involuntary nervous system) hence involved in involuntary actions.

(ii) They have numerous mitochondria to provide ATP energy for contractions.

(iii)They have spindle –shaped cells to allow smooth uniform contractions.

(iv)They have elastic myofibrils to allow for contraction and relaxation.

SKELETAL MUSCLES

These are muscles attached to skeleton

- ◊ Skeletal muscles are also known as voluntary muscles
- ◊ Skeletal muscles are responsible for locomotion and other voluntary movement of the body.

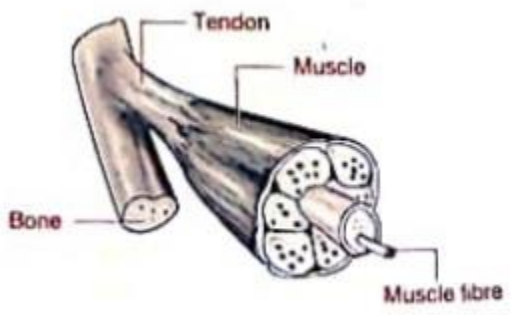
ADAPTATIONS OF SKELETAL MUSCLES

(i) They are multi-nucleated to allow for better control of contractile activities.

(ii) They are long to offer a large surface for contraction and relaxation.

(iii) They are striated to allow contractions and relaxations on short intense bursts for efficient locomotion.

DIAGRAM OF SKELETAL MUSCLE



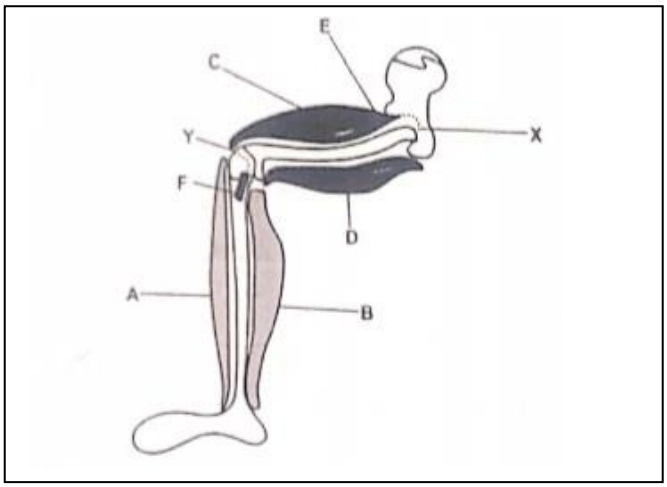
MUSCLES AND MOVEMENT

Skeleton on its own cannot bring locomotion or any movement without the help of muscles.

GROUPS OF MUSCLES IN HINDLIMBS AND FORELIMBS

The hind limb has seven groups of muscles which are responsible for a wide range of movement of the legs. These are:

(i) Protractor muscles
(ii) Retractor muscles
(iii) Adductor muscles
(iv) Abductor muscles
(v) Rotator muscles
(vi) Flexor muscles
(vii) Extensor muscles



(i) Protractor muscle

These muscles pull the base of the leg forward.

(ii) Retractor muscles

These muscles pull the base of the leg backwards

(iii) Adductor muscles

These muscles pull the leg inwards towards the body.

- ◊ Adductor muscles are also known as depressor muscles

(iv) Abductor muscles

These muscles pull the leg outwards away from the body.

- ◊ Abductor muscles are also known as levators

(v) Rotator muscles

These muscles are responsible for rotating either the whole leg or a part of the leg at a joint.

(vi) Flexor muscles

These muscles pull two parts of the leg towards each other.

(vii) Extensor muscles

These muscles pull two parts of the leg away from each other.

The forelimb has two groups of muscles which bring about movement. These are:

(i) Biceps
(ii) Triceps

(i) Biceps

These muscles are also known as flexor muscles

- ◊ Biceps is responsible for bending of the arm by pulling the radius and ulna upward.

(ii) Triceps

These muscles are also known as extensor muscles

- ◊ Triceps is responsible for strengthening of the arm by pulling two limb bones away from each other.

HOW MUSCLES FACILITATING MOVEMENT

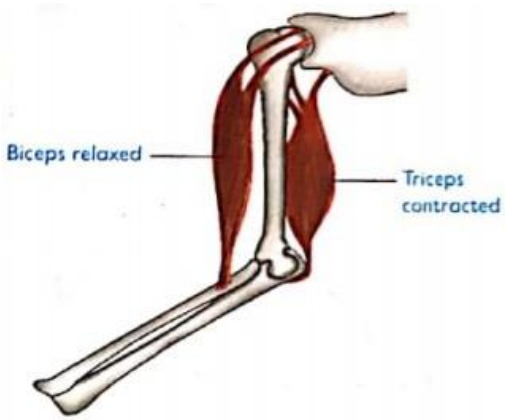
- ◊ Muscles work in an **antagonistic fashion** means they work oppositely to each other.
- ◊ When one muscle contracts the other muscle relaxes
  For example: When the biceps muscles contract, triceps muscles relax, radius and ulna are moved upwards, causing the arm to bend.
- ◊ Biceps and triceps are known as **antagonistic muscles** because they work oppositely to each other.

ROLES OF MUSCLES IN MOVEMENT OF ARM

(i) Strengthening of the arm (downward movement)

- ◊ The triceps muscles contract hence shortening
- ◊ Biceps muscles relax (extends).
- ◊ Radius and ulna moves downwards, and the arm straightened.

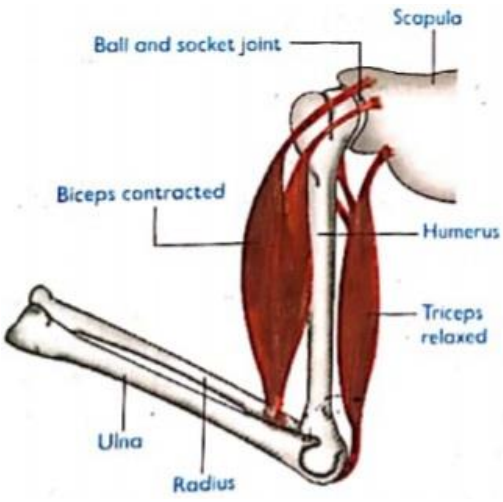
DIAGRAM SHOWING MUSCLES DURING STRENGTHENING OF THE ARM



(ii) Bending of the arm (upward movement)

- ◊ Biceps muscles contract
- ◊ Triceps muscles relax
- ◊ Radius and ulna are moved upwards, causing the arm to bend.

DIAGRAM SHOWING MUSCLES DURING BENDING OF THE ARM



GENERAL ADAPTATIONS OF THE MUSCLES

(i) They are very elastic for stretching or contracting of muscles
(ii) They are supplied with blood vessels for nutrients supply and carrying wastes away from the muscles.
(iii)Their cells produce ATP energy for the muscles to function

MUSCLE CRAMPS

Muscle cramp is an involuntary contraction of the skeletal muscles.

- ◊ Muscle cramp is often painful and can last from seconds to 10 minutes.
- ◊ Muscle cramp may involve part of a muscle or an entire muscle.

CAUSES OF MUSCLE CRAMPS

The following are some common causes of muscle cramps:

(i) Vigorous activity

- ◊ The vigorous use of a muscle in sports or in any other physical activity may cause muscle cramps during the activity or even hours later.

(ii) Injury

- ◊ A muscle cramp may occur as a protective mechanism following an injury such as broken bone. This occurs to minimize movement and stabilize the area of injury.

(iii)Dehydration

- ◊ When one loses more body fluids and salts, mostly water than the amount that is taken in, muscle crap may occur.

(iv)Muscle fatigue

- ◊ When the muscle contract powerfully may result muscles fatigue very quickly hence muscle cramp may occur.

(v) Lack of magnesium or calcium in the body

- ◊ Magnesium and calcium are important in muscle contraction and therefore lack of them they lead to muscle cramps.

(vi)Lack of oxygen in the muscles (inadequate of oxygen muscles).

EFFECTS OF MUSCLE CRAMPS

(i) Muscle cramps cause a lot of pain.
(ii) Leads to tenderness and firmness of the involved muscles
(iii)May disrupt the functioning of the involved body organ. For example when a muscle cramp occurs in the foot it can cause difficult in walking.

PREVENTION OF MUSCLE CRAMPS

Muscle cramps may be prevented through;-

(i) Stretching the affected muscle more often. E.g. standing up and walking around can stop cramps in the leg.
(ii) Gently massaging the muscle so as to relax it.
(iii) Drinking a lot of water before, during and after the activity.

(iv) Taking of salt in solution form or licking to replace the amount of salt lost in the body.
(v) Rapid breathing as well as stretching the muscles can improve cramps from lack of oxygen.
(vi) To do a lot of physical exercise before engaging in sports or other physical activity.
(vii) Exercise activity especially during warm weather should be avoided.
(viii) Applying warmth from a warm cloth could also be a quick remedy.

MOVEMENT IN PLANTS

Movement in most plants is very slow thus unnoticeable.

- ◊ Most plant movements are growth movements and these movements are reffered to as **growth curvature** or **movement of curvature**.

Movement of curvature

Is movement that involves certain parts of the plant while the plant is fixed on its position

Parts of the plant that show movement

- ◊ Leaves
- ◊ Stems
- ◊ Roots

NB: These parts they move when they grow and enable plants to obtain their requirements such as water and light.

Question: Explain why plants do not need to locomote as animals?

Answer: Plants do not need to locomote as animal because:-

(i) They obtain water and nutrients from the soil through their roots.
(ii) They are capable of manufacturing their own food through photosynthesis.
(iii) Most perennial plants can survive harsh conditions such as drought by shedding their leaves or having deep roots to absorb water in deeper soils
(iv) Fertilization is aided by pollination through wind insects.

TYPES OF GROWTH MOVEMENT IN PLANTS

Growth movement in plants is divided into two categories, namely:-

(i) Autonomic movement
(ii) Paratonic movement

(i) AUTONOMIC MOVEMENT

These are self-controlled growth movements.

Example of automic movement

- ◊ Growth in the meristematic region, i.e. tips of shoots and roots.

(ii) PARATONIC MOVEMENT

These are the plant growth movements induced by external stimuli such as light, moisture, gravity, temperature, touch and chemicals.

TYPES OF PARATONIC MOVEMENT

Paratonic movement is divided into two categories, namely:

a) Tropic movement
b) Nastic movement

TROPIC MOVEMENTS

These are the plant growth movements in response to the stimuli.

- ◊ Tropic movement is also called **tropism.**

Tropism is the directional growth of a plant organ in response to an external stimulus such as light.

- ◊ The plant moves either towards or away from the stimulus.
  - — If the movement is towards the stimulus, it is called **positive tropism.**
  - — If the movement is away from the stimulus, it is called **negative tropism**.

TYPES OF TROPIC MOVEMENTS

The following are types of tropic movement

(i) Phototropism
(ii) Hydrotropism
(iii)Geotropism
(iv)Thigmotropism
(v) Chemotropism

(i) **Phototropism** is the plant growth movement in response to the source of light.

(ii) **Hydrotropism** is the plant growth movement in response to the source of water.

(iii)**Thigmotropism** is the plant growth movement in response to the source of touch.

(iv)**Chemotropism** is the plant growth movement in response to the source of chemicals.

(v) **Geotropism** is the plant growth movement in response of the source of gravity.

(vi)**Thermotropism** is the plant growth movement in response to the source of heat.

NASTIC MOVEMENT

These are non-directional movement of plant organs in response to diffuse stimuli

- ◊ Nastic movements are independent of external stimuli

Example of nastic movement

- ◊ Folding of leaves in warm weather conditions
- ◊ Opening and closing of flowers in response to intensity of light.
- ◊ Closing of leaves when attached.

COORDINATION

Concept of Coordination

COORDINATION

Is the working together of different parts of the body in an orderly and organized manner

- ◊ Without coordination the body becomes disorderly and it may fail to function properly.

IMPORTANCE OF COORDINATION

(i) Coordination ensures survival of organisms.

(ii) Coordination enables organism to detect their life necessities such as food for heterotrophs, detection of light by autotrophs.

(iii) Coordination helps living organism to respond to their stimuli.

IRRITABILITY OR SENSITIVITY

Is the ability to perceive, interpret and respond to changes in the internal and external environment.

External environment

This is outside surrounding of whole organisms.

Components of external environment

The following are components of external environment:

- ◊ Light
- ◊ Sound
- ◊ Pressure
- ◊ Gravity
- ◊ Chemicals
- ◊ Water
- ◊ Food

Internal environment

This is the surrounding at cells within the body of an organism.

Components of internal environment

The following are components of internal environment:

- ◊ Water
- ◊ Glucose
- ◊ Minerals
- ◊ Ions
- ◊ pH
- ◊ Temperature.

COMPONENTS OF COORDINATION

There are five components of coordination namely:

(i) Stimulus
(ii) Receptors
(iii) Coordinators
(iv) Effectors
(v) Response

STIMULUS (plural: Stimuli)

Is the change in the environment of an organism

TYPES OF STIMULI

There are two types of stimuli, namely:-

(i) External stimulus
(ii) Internal stimulus

EXTERNAL STIMULUS

Is the stimulus which is associated with the surrounding environment

Example of external stimuli

- ◊ Heat
- ◊ Wind
- ◊ Pressure
- ◊ Chemicals
- ◊ Water
- ◊ Food
- ◊ Light

INTERNAL STIMULUS

Is the stimulus which occurs within the organism

Example of internal stimuli

- ◊ Water
- ◊ Glucose
- ◊ Mineral ions
- ◊ pH
- ◊ Temperature

RECEPTORS

Are the specialized cells that detect stimulus

- ◊ In animals receptors are located in specialized organs known as **sense organs.**

Example of receptors

- ◊ Receptor for pain, touch, heat, and cold-are located in the skin
- ◊ Receptors for taste-located in the tongue
- ◊ Receptors for light-located in the eye

- ◊ Receptors for sound-located in the ear
- ◊ Receptors for smell-located in the nose
    - ─ When a receptor detects stimuli, it creates impulses which are transmitted to the coordinating system through nerve cells.

NERVE IMPULSE

Is a slight electric charge which travels along a nerve cell

A COORDINATOR

Is an organ that receives messages from the receptors, translates them and sends the information back to effectors for action.

Example of coordinators

(i) The brain
(ii) Spinal cord

EFFECTORS

Are the parts of the body that respond to the stimuli.

Example of Effectors

(i) Muscles
(ii) Glands
(iii) Cilia
(iv) Flagella

A RESPONSE

Is a behavioural, physiological or muscular activity initiated by a stimulus

OR

Is the change shown by an organism in reaction to a stimulus

- ◊ Examples of response
    - ─ Blinking when an insect lands on the eye
    - ─ Dropping a hot object.

The table below shows the relationship between some stimuli, receptor, effectors and response

Stimuli	Receptors	Effectors	Responses
Heat	Skin	Skin	Secretion of sweat, sweating
Cold	Skin	Skeletal muscles	Uncontrolled contraction and relaxation of skeletal muscles, shivering
		Skin	Formation of goose pimples.
Taste	Tongue	Salivary glands	Secretion of saliva, salivation
Pain	Skin	Skeletal muscles	Contract, move organs away from source of pain
Sound	Ear	Ear drum	Hearing of noise, music or sound.

The sequential order of transmissions of a nerve impulse from a sensory organ to the organism's response is

Stimulus → Receptors → Coordinators → Effectors → Response

The Ways in Which Coordination is Brought About

Coordination is controlled or effected by two major systems, namely:

(i) Nervous system

(ii) Hormonal system called endocrine system

◊ The coordination in simple multi-cellular animals is controlled by **nervous system only**.

◊ The coordination in higher animals called vertebrates (including human beings) is controlled by **nervous system and endocrine system**.

◊ Coordination in plants is under the control of **hormones**.

NERVOUS COORDINATION IN HUMAN, NEURONES

NEURONES

Are cells which carry electrical impulses from the central nervous system to all parts of the body

◊ Neurone is the basic unit of the nervous system.

◊ Neurones are also called **nerve cells**

STRUCTURE AND FUNCTIONS OF THE NEURONE

Each neurone consists three basic features, namely;-

(i) The cell body

(ii) Dendrites

(iii)The axon

Other parts/features of the neurone are:

(i) Dendrons

(ii) Myelin sheath

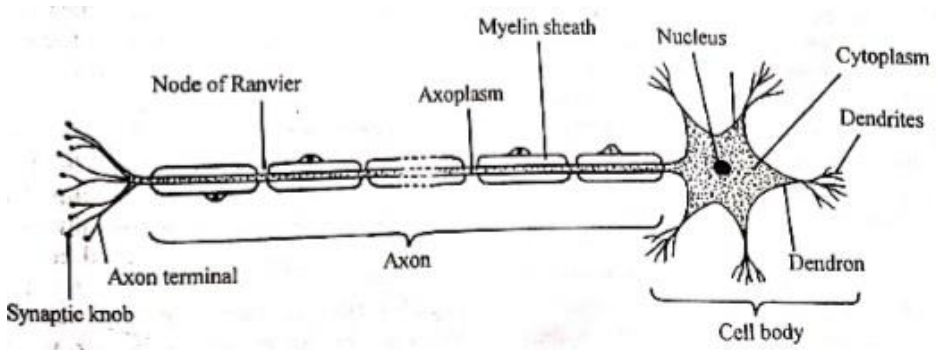
(iii)Schwann cells

(iv)Node of Ranvier

(v) Axoplasm

(vi)Neurilemma

DIAGRAM OF NEURONE



1. **CELL BODY**

   Is the main part of the nerve cell

   Function of the cell body

   ◊ It gives rise to other parts of the nerve cell

   ◊ It is the main control centre of the nerve cell

   Components of the cell body

   The cell body has the following components:

   (i) **Cytoplasm**- enclosing the nucleus.

   (ii) **Nucleus**- which control all activities

   (iii)**Mitochondria**- that provide energy for metabolic processes.

2. **DENDRITES**

   Are short numerous fibres which receive nerve impulses from other neurones and transmit them to the cell body.

3. **THE AXON**

   Is the elongated fibre that extends from the cell body

   ◊ The longer the axon, the faster it transmits information.

   The role of axon

   ◊ It transmits nerve impulses away from the cell body.

4. **MYELIN SHEATH**

   Is a fatty layer that covers axon for protection and insulation

   Function of myelin sheath

   ◊ Protects the neuron and allow impulses to travel faster.

   ◊ It insulates the axon

5. **SCHWANN CELLS**

   Are cells found on the surface of myelin sheath

   Function of Schwann cells

   ◊ They secrete the myelin sheath

6. **NODES OF RANVIER**

   Are constrictions which interrupt myelin sheath at exactly one millimeter interval

   Role/function of node of ranvier

   ◊ Used to speed up the transmission of impulses.

7. **DENDRONS**

   Are extensions of the cell body

   ◊ They form branches known as dendrites

   Function of Dendrons

   ◊ They transmit impulses towards the cell body

8. AXOPLASM

Is a specialized type of cytoplasm which is continuous with the cytoplasm in the cell body

Function of axoplasm

◊ It is a part through which nerve impulses travels

9. NEURILEMMA

Is a layer of cells which encloses the myelin sheath

ADAPTATION OF NEURONES TO THEIR FUNCTION

(i) They have numerous mitochondria for energy supply during conduction of impulses
(ii) They are long so as to enables transmission of impulses to long distance in the body.
(iii) They have node of Ranvier to increase the speed of impulse transmission
(iv) They are supplied with denser network of blood capillaries for supply of food and oxygen
(v) They are numerous for effective transmission of impulses along the whole body.
(vi) They are covered with fatty myelin sheath for protection and insulation.
(vii) They have numerous dendrites for connectivity with other neurons.
(viii) They have Schwann cells that secrete myelin sheath.
(ix) They have elongated axons which help in quick transmission of impulses.

NB: The axon terminates into synaptic knobs.

◊ These knobs have vesicles containing a chemical transmitter substance, for example acetylcholine.
◊ The axon of one neuron and the dendrites of the next neuron do not actually touch each other.
◊ The gap between neurons is called the synapse

A SYNAPSE

Is a junction between two neurones

Function of synapse

◊ It enables impulse to be passed from one neurone to another.
◊ It ensures that impulses are transmitted in one direction only.

THE TRANSMISSION OF NERVOUS IMPULSES ACROSS A SYNAPSE

The transmission of nervous impulses across a synapse is mediated by chemical substances called **neurotransmitter**

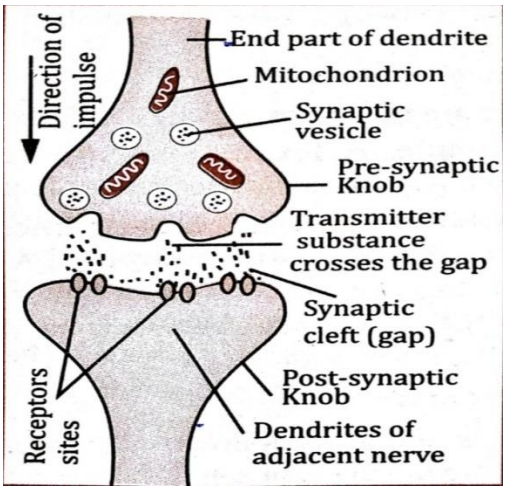
Example of neurotransmitters

(i) Acetylcholine
(ii) Noradrenaline

The transmission of nervous impulses across synapses occurs as follows:

(i) When an impulse reaches the synaptic knob of the pre-synaptic neurone, synaptic vesicles discharge the neurotransmitter into the synaptic cleft.
(ii) Where it diffuses across the cleft and binds to specific receptors on the post-synaptic membrane.

(iii)This leads to generation of action potential in the post-synaptic membrane.
(iv)The result is the transmission of an impulse along the post-synaptic neurone.



QUESTION: Why the nerve impulse travels only in one direction?

REASON: This is because the neurotransmitters are found only on the pre-synaptic knob meaning that impulses can only travel from the pre-synaptic neuron to the post-synaptic neuron.

TYPES OF NEURONES

There are three types of neurons, namely:

(i) Sensory neurons
(ii) Motor neurons
(iii)Relay (intermediate) neurons

◊ Each of these neurons has a different structure and performs different functions.

SENSORY NEURONES

Are nerve cells that transmit impulses from the sensory receptors to the central nervous system.

◊ Sensory neurones have their cell bodies off the axon and outside the central nervous system.
◊ Sensory neurons are also called **afferent neurones**

Function of sensory neurones

◊ They transmit impulses from a receptors to the central nervous system

DIAGRAM OF SENSORY NEURONE

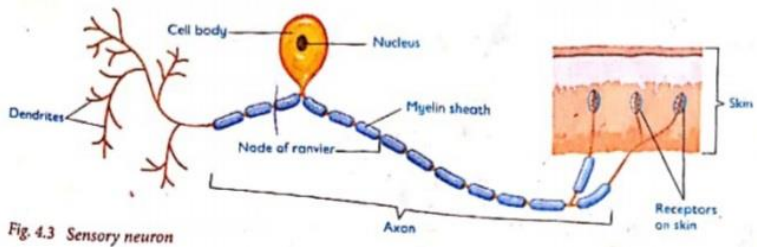


Fig. 4.3 Sensory neuron

TYPES OF SENSORY NEURONES

There are two types of sensory neurons, namely:

(a) **Visceral sensory neurones**: are those neurones that transmit nerve impulses from internal organs

(b) **Somatic sensory neurones**: are those neurones that transmit impulses from the skin, skeletal muscles, joints and bones

RELAY NEURONES

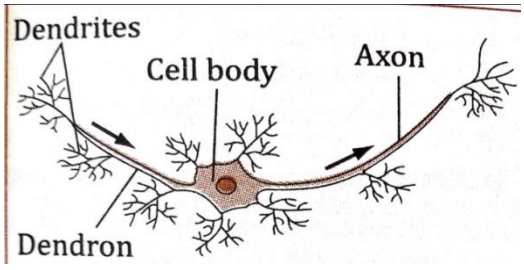
Are nerve cells that connect sensory neurone and motor neurone in the central nervous system

- ◊ Relay neurons are located in the central nervous system between the sensory and the motor neurons.
- ◊ Relay neurones are also called **intermediate neurones**

Function of relay neurones

- ◊ To convey messages between neurones in the central nervous system.

DIAGRAM OF RELAY NEURONE



TYPES OF RELAY NEURONES

(i) **A unipolar neurone:** is a type of neurone that has its axon extending from its cell body.

(ii) **A bipolar neurone:** is a type of neurone that has an axon and dendrons extending in two different directions from the cell body.

(iii)**A multi-polar neurone:** has one axon and several dendrons extending from the cell body in different directions.

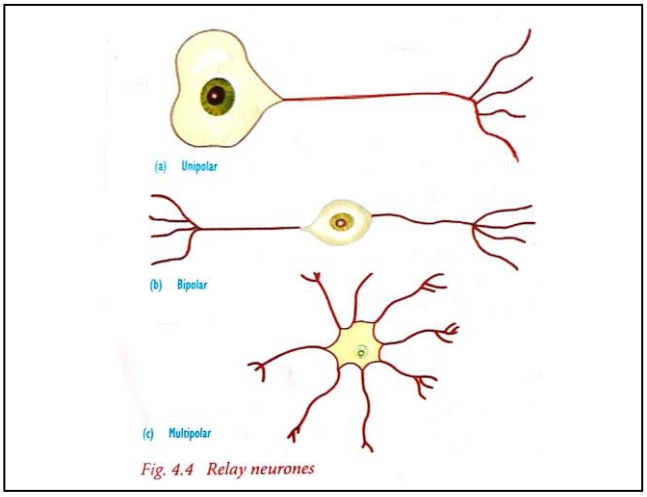


Fig. 4.4 Relay neurones

NB: The axon extends to the motor neuron

MOTOR NEURONES

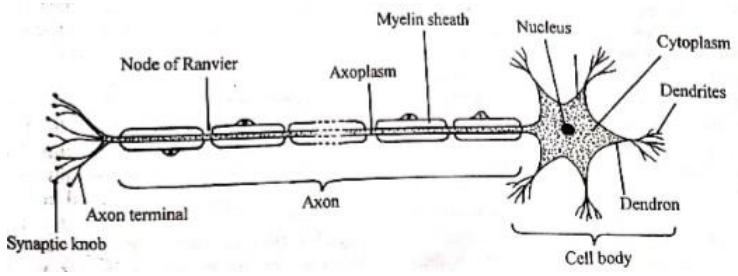
Are nerve cells that transmit impulses from the central nervous system to the effectors

- ◊ The cell body of a motor neurone is at one end of the neurone and lies entirely within the central nervous system.
- ◊ It has tiny branches at each end (dendrites) and a long fibre (axon) that carries the signals or nervous impulses.
- ◊ Motor neurones are also called **efferent neurones**

Function of motor neurones

- ◊ To transmit impulses from the central nervous system to the effectors.

DIAGRAM OF MOTOR NEURONE



STRUCTURAL DIFFERENCES BETWEEN MOTOR AND SENSORY NEURONES

MOTOR NEURONE	SENSORY NEURONE
(i) The cell body is located at one end of the neurone	The cell body located near one end of the neurone
(ii) It is multipolar	It is unipolar
(iii)Has a large and irregular cell body	Has small and definite cell body
(iv)Has dendrites surrounding cell body	Has no dendrites which surround cell body

NERVOUS SYSTEM

This system is made up of the brain, spinal cord and nerves.

Parts of the nervous system

Nervous system is divided into two parts, namely:

(i) Central nervous system

(ii) Peripheral nervous system

CENTRAL NERVOUS SYSTEM (CNS)

Is the part of the nervous system consisting of the brain and spinal cord.

◊ It coordinates all the neural functions.

THE COMPONENTS OF THE CENTRAL NERVOUS SYSTEM AND THEIR FUNCTIONS

The central nervous system has two main components, namely:

(i) The brain

(ii) Spinal cord

THE BRAIN

Is a delicate organ enclosed within a body structure called the skull or cranium.

◊ Brain is the master control of the body.

◊ Brain is covered by a system of membrane called **meninges**.

◊ The brain is the main centre for integrating and coordinating impulses.

Function of human brain

(i) The human brain is a specialized organ that is ultimately responsible for all thought and movement that the body produces.

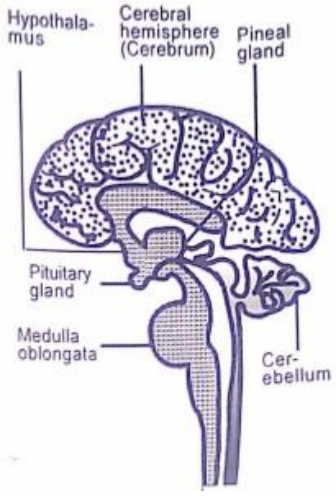
(ii) It allows humans to successfully interact with their environment, by communicating with others and interacting with inanimate objects near their surroundings. For example If the brain is not functioning properly, the ability to move, generate accurate sensory information or speak and understand language can be damaged as well.

PARTS OF THE HUMAN BRAIN

The human brain is divided into three parts, namely:

1. Fore brain 2. Mid brain 3. Hind brain

DIAGRAM OF HUMAN BRAIN



1. FORE BRAIN

Is the anterior portion of the brain

- ◊ The outer portion is grey hence called grey matter and inner portion is whitish hence called white matter.
- ◊ Fore brain is responsible for voluntary actions

Fore brain is made up of:

(a) Cerebrum.
(b) Hypothalamus
(c) Thalamus
(d) Pituitary gland
(e) Olfactory lobes

(a) CEREBRUM

Is the largest part of the human brain

- ◊ Cerebrum is covered by a thin layer of grey matter called **cerebral cortex**

Functions of the cerebrum

The cerebrum has the following functions:

(i) It is responsible for reasoning and intelligence.
(ii) It is involved in learning, imagination and creativity.
(iii) It is the memory centre.
(iv) It is responsible for personality or character.
(v) It controls voluntary body movement such as walking and dancing.
(vi) It is responsible for sight, hearing, taste, smell and speech.

Parts of the cerebrum

Cerebrum is divided into two parts (cerebral hemispheres), namely:

(i) Right hemisphere
(ii) Left hemisphere

Right hemisphere

Is the part of the cerebrum which sends and receives impulses from the left side of the body

Left hemisphere

Is the part of the cerebrum which sends and receives impulses from the right side of the body

(b) HYPOTHALAMUS

This part is concerned with body temperature and osmoregulation.

- ◊ It contains osmoreceptors and thermoreceptors that detect changes in osmotic pressure and internal body temperature respectively.
- ◊ It has a very rich blood supply

Function of the hypothalamus

- ◊ It coordinates and controls the autonomic nervous system
- ◊ It has centres that control appetite, thirst and sleep.
- ◊ It also controls the activities of pituitary gland.
- ◊ It acts as an endocrine gland.

(c) PITUITARY GLAND

This is the master of endocrine glands.

Function of pituitary gland

◊ It secretes hormones which control osmoregulation, growth, metabolism and sexual development.

(d) OLFACTORY LOBES

Is the part of fore brain that receives impulses of smell via olfactory nerves from the nose.

Function of olfactory lobes

◊ It is concerned with the sense of smell.

2. MID BRAIN

Is the smallest part of the brain which found between the fore brain and hind brain.

◊ The mid brain consists of the optic lobes, which are the main area for audio and visual processing.

Functions of the midbrain

(i) To relay information between the fore brain and hind brain.
(ii) To relay information between fore brain and the eye through optic nerves.
(iii) It is responsible for the movement of the head and trunk.

THALAMUS

The thalamus is located in the middle part of the brain.

(i) It helps to control the attention span, sensing pain.
(ii) It monitors input that moves in and out of the brain to keep track of the sensations the body is feeling.
(iii) It contains the centre for the integration of sensory information.

3. HIND BRAIN

It is made up of **cerebellum** and the **medulla oblongata**

(a) CEREBELLUM

Is located in front of medulla oblongata

◊ The cerebellum controls essential body functions such as balance, posture and coordination, allowing humans to move properly and maintain their posture.

Functions of the cerebellum

(i) It maintains posture, movement and balance
(ii) It ensures that all muscles work together to produce smooth coordinated voluntary movement.
(iii) It assists in the learning of new motor skills like playing the piano, swimming and riding a bicycle.

NB: Damage to the cerebellum results in uncoordinated movements

(b) MEDULLA OBLONGATA

This is the central part of the autonomic nervous system

Function of medulla oblongata

(i) It controls all unconscious activities of the body e.g. Breathing, heartbeat, digestion, dilation and contraction of blood vessels, secretion of juices from glands and temperature regulation

(ii) It contains a number of reflex centre for regulating heartbeat, breathing, blood pressure.
(iii) It controls swallowing, salivation, vomiting, coughing, and sneezing.

The diagram below shows and summarizes the basic functions of different parts of the brain.

SPINAL CORD

Is a part of the central nervous system and is posterior to the brain.

- ◊ The spinal cord extends from the base of the brain into the inside of vertebral column.
- ◊ It is enclosed in meninges and protected by the vertebral column

THE STRUCTURE OF THE SPINAL CORD

Structurally the spinal cord consists of the following parts:

(i) Grey matter
(ii) white matter
(iii) Dorsal root
(iv) Ventral root

GREY MATTER

Is the central part of the spinal cord

- ◊ It surrounds the central canal which is filled with **cerebrospinal fluid**
- ◊ Grey matter consists of relay neurones which relay information between the afferent and efferent neurones.
- ◊ The grey matter has cell bodies, dendrites and synapses

CEREBROSPINAL FLUID (CFS)

Is a clear watery fluid secreted from the blood

- ◊ It is similar to lymph whose normal contents include glucose, salts, enzymes, and some white blood cells (but no red blood cells).

Function of cerebrospinal fluid

(i) Provides nourishment to brain tissues
(ii) Serves as a shock absorber

WHITE MATTER

Is the outer part of the spinal cord surrounding the grey matter.

- ◊ White matter consists of axon of sensory and motor neurones.

VENTRAL ROOT

This is a part of the spinal which carries motor nerve fibres.

DORSAL ROOT

This is a part of the spinal which carries sensory nerve fibres.

THE STRUCTURE OF SPINAL CORD

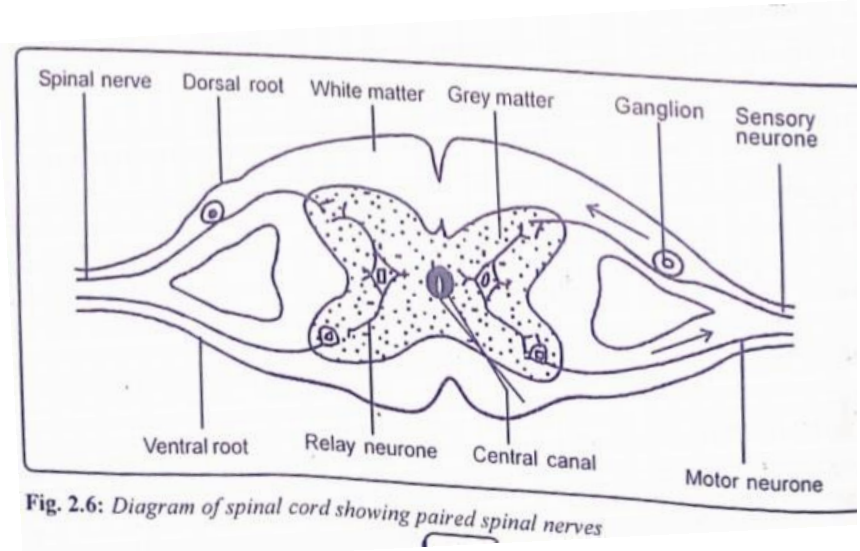


Fig. 2.6: *Diagram of spinal cord showing paired spinal nerves*

FUNCTIONS OF THE SPINAL CORD

(i) Conducts sensory nerve impulses from the receptors to the sense organs to the brain
(ii) Conducts motor nerve impulses from the brain to the effectors
(iii) Enables animals to attain an upright posture through the maintenance of muscle tone
(iv) It serves as the reflex centre for all spinal reflexes.

PERIPHERAL NERVOUS SYSTEM (PNS)

Is a system which is made up of a network of nerves linking various parts of the body to the brain and spinal cord

◊ It links the CNS with the receptors and effectors

THE COMPONENTS OF THE PERIPHERAL NERVOUS SYSTEM AND THEIR FUNCTIONS

The peripheral nervous system (PNS) is divided into two parts (components):

(a) The somatic nervous system
(b) The autonomic nervous system

(a) **THE AUTONOMIC NERVOUS SYSTEM**

This comprises of nerves that control the involuntary activities of the body.

◊ The autonomic nervous system is also called **involuntary nervous system**
◊ The autonomic nervous system has sensory and motor neurons running between the central nervous system and various internal organs, for example the heart and lungs.

Example of involuntary activities of the body

◊ gut movements
◊ beating of the heart
◊ secretion of glands

Function of the autonomic nervous system

- ◊ It is responsible for involuntary control of internal organs, blood vessels and smooth muscles.

The autonomic nervous system is divided into:

(i) Sympathetic nervous system.
(ii) Parasympathetic nervous system.

THE SYMPATHETIC NERVOUS SYSTEM

This system normally produces effects that prepare the animal for emergency.

- ◊ It activates the fight or flight' response under sudden or stressful circumstances.

Example of effects produced due to sympathetic stimulation

- ◊ Increasing the heart rate
- ◊ Dilating the pupils
- ◊ Increasing blood pressure
- ◊ Glucose formation in the liver

THE PARASYMPATHETIC NERVOUS SYSTEM

This system normally produces effects that aimed at energy conservation.

- ◊ It helps the body to return to normal activity after an emergency

Example of effects produced during parasympathetic stimulation

- ◊ Decreasing the heart rate
- ◊ Constricting the pupils
- ◊ Decreasing blood pressure
- ◊ Stimulation of the digestive tract

NB: Together, these two systems regulate homeostasis within the body - one preparing the body for action, and the other repairing the body afterward.

(b) **THE SOMATIC NERVOUS SYSTEM**

This comprises of nerves that control voluntary activities of the body.

- ◊ The somatic nervous system is also called **voluntary nervous system**
- ◊ The somatic system has neurones connected with voluntary skeletal muscles and sense organs.

  Example of somatic nervous system

  - ─ Nodding of the head
  - ─ Raising the leg

Function of the somatic nervous system

- ◊ It is responsible for the voluntary control of the skeletal muscles, bones and sense organs.
- ◊ It is composed of afferent nerves that carry information to the central nervous system (spinal cord) and efferent nerves that carry neural impulses away from the central nervous system.

Peripheral nervous system consists of the following nerves:

(i) Cranial nerves
(ii) Spinal nerves

CRANIAL NERVES

These nerves arise from the brain and link the brain to the structures in the head, neck and upper of the trunk.

- ◊ There are 12 pairs of cranial nerves.

Function of cranial nerves

- ◊ They transmit impulses to the sense organ and muscles of the head and neck.

Examples of cranial nerves

- ─ The optic
- ─ Auditory
- ─ Olfactory nerves.

SPINAL NERVES

These arise from the spinal cord.

- ◊ They are associated with receptors and effectors in the trunk for example the arms and legs.
- ◊ In humans, there are a total of 31 pairs of spinal nerves.
- ◊ Each spinal nerve has two roots namely: **dorsal root** and **ventral root**

REFLEX ACTION

Is a rapid involuntary response to a certain stimulus

- ◊ Reflex actions are rapid and happen without us thinking.

Example of reflex action

- ◊ The withdrawal of the hand from a hot or sharp object
- ◊ Sneezing in response to a foreign body in the nose
- ◊ Blinking of the eye incase an object passes close to it.
- ◊ Salivation
- ◊ Swallowing
- ◊ Secretion of tears when an onion is cut
- ◊ Enlargement of pupil in different light intensities

THE NEURONIC PATHWAY (REFLEX ARC) OF A REFLEX ACTION

REFLEX ARC

Is the route that is followed by impulses during a reflex action

OR

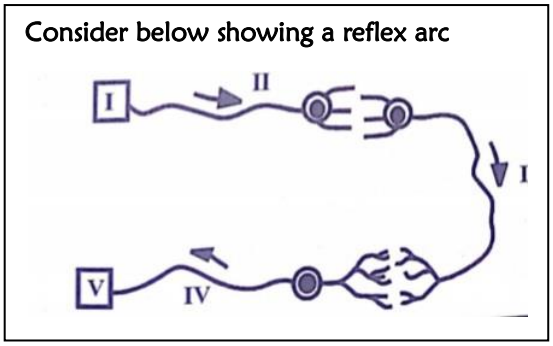
Is the path taken by impulses involved in the reflex action

Components of a reflex arc (neuronic pathway)

A reflex arc consists of the following components;

(i) Sensory receptor
(ii) Sensory neurone
(iii) Relay neurones
(iv) Motor neurone
(v) Effectors e.g. muscle or gland

NB: Relay neurone is within the central nervous system (CNS)



Sequence of a reflex action

- ◊ The receptors in the sense organs are stimulated by the stimulus and sensory nerve impulse is generated. The impulse is transmitted through a sensory nerve fibre to the central nervous system.
- ◊ The nerve impulse is received by the intermediate neurones within the central nervous system (CNS)
- ◊ The motor nerve impulse is transmitted to the effectors through a motor nerve fibre from the central nervous system.
- ◊ Then the effectors respond.

TYPES OF REFLEX ACTION

Basically there are two types of reflex action, namely

(i) Simple reflex
(ii) Conditioned reflex.

SIMPLE REFLEX ACTION

Is a quick involuntary response to stimulus.

- ◊ It occurs without conscious thought and does not need to learn.

Example of simple reflex actions

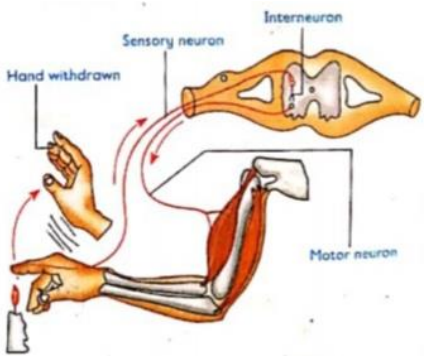
- ◊ Blinking
- ◊ Salivation
- ◊ Coughing
- ◊ knee jerk
- ◊ Sneezing
- ◊ Dropping a hot object.

QUESTION: What will happen when a person touches a hot object?

ANSWER: When a person touches a hot object, simple reflex action occurs without conscious thought as follows:

- ◊ The heat from a hot object stimulates pain receptors in the skin. This generates an impulse which is transmitted by the sensory neurone to the spinal cord.
- ◊ In spinal cord, the impulse is integrated and interpreted then the impulse is transmitted to the motor neurone via the relay neurone.
- ◊ The impulse travels along the motor neurone to the biceps of the arm, which contracts resulting in withdrawal of the hand from the hot object.

The diagram below shows a simplified reflex arc of this situation



CONDITIONED REFLEX ACTION

Is a learned response resulting from a stimulus from a past experience which was originally ineffective in producing a specific response

- ◊ This response develops over a period of time.

Example of conditioned reflex action

- ◊ Seeing a banana may not have any effect on someone who has never seen a banana before. But after one has eaten several bananas and found them to be sweet, seeing a banana will cause salivation.

The conditioned reflex was first described experimentally by Ivan Pavlov a Russian scientist using dogs as follows:

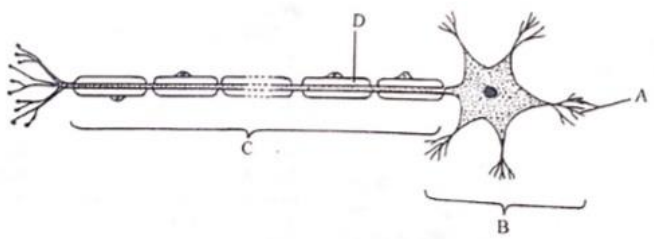
- ◊ He observed the sight or smell of food initiates salivation in dogs. This is a normal reflex called the salivation reflex
- ◊ He rang a bell whenever he was feeding his dogs. He continued doing this for several weeks. Later on, he rang the bell in absence of food. He found that this stimulated salivation in the dogs. Thus, the original stimulus (sight or smell of food) was replaced by a different and unrelated stimulus (ringing the bell) through learning.
- ◊ Conditioned reflexes are mediated by the brain through previous experience.
- ◊ In case of Pavlov's experiment, the dogs had learnt to associate ringing of the bell with the presence of food.
- ◊ Therefore, ringing the bell initiated the same response as the presence of food.
- ◊ Conditioned reflexes can also be unlernt. If ringing of the bell is continued but this time in absence of food, dogs will stop salivating on hearing it.

DIFFERENCE BETWEEN SIMPLE REFLEX AND CONDITIONED REFLEX ACTION

SIMPLE REFLEX ACTION	**CONDITIONED REFLEX ACTION**
(i) It is inborn response to external stimuli	It is a learnt response
(ii) Does not involve the brain directly	It involves the brain directly
(iii) It is the same in all members of a species	It differs among members of a species
(iv) Single stimulus brings about response	Combined stimuli (related and unrelated stimuli) brings about response
(v) Initiated by a related stimuli	Initiated by an unrelated stimuli
(vi) It is always constant	It can be reinforced through rewards and punishment

REVISION QUESTIONS

1. (a) Distinguish between neurones and nerves.
   (b) Name the three types of neurones found in vertebrates and state their functions.
   (c) List three features which show that neurones are similar to other cells.
   (d) Mention the main components of nervous coordination
2. The diagram below shows the structure of a motor neurone.

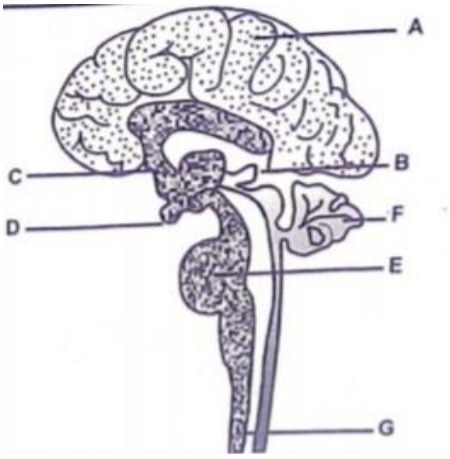


(a) Name the parts labeled A-D
(b) State the adaptations that enable the neurone to carry out its functions efficiently.
(c) State whether the axon of this neuron transmits impulses away from the cell body or towards the cell body.
(d) State two features that would distinguish a sensory neurone from this neurone.

3. A person had a car accident that damaged one part of his brain but left the rest of it unaffected. Complete column B of the table by filling in the of the brain whose damage would correspond to the symptom shown in column A.

Column A	Column B
(i) Inability to regulate body temperature	
(ii) Loss of memory	
(iii) Irregular heart beat and breathing movements	
(iv) Inability to maintain proper body balance and posture	

4. The figure below shows the major parts of a mammalian brain and part of the spinal cord.



(a) Name the part labeled A to G and state the function of each part.
(b) Which of the labeled parts is most development is man.

5. (a) What is a reflex action?
(b) With the use of relevant examples, distinguish between a simple reflex and a conditioned reflex
(c) Complete the following table with the words, response, stimulus, effector and receptor

(i) Olfactory cells	
(ii) Salivary glands	
(iii) Smell of food	
(iv) Salivation	

6. (a) List the following in the order in which they are involved in a simple reflex: Motor neurone, effector neurone, stimulus, intermediate neurone, receptor, sensory neurone, impulse.
   (b) Give three examples of reflex actions
   (c) If somebody accidentally puts a finger on a hot object, the hand is rapidly withdrawn away from the source of heat. Explain the process involved.
7. A hand is withdrawn from a hot object before one becomes consciously aware of the pain. Explain why this is so.
8. (a) State four factors on how the nerve cell structure is suited to its function of impulse transmission.
   (b) State four structural differences between motor and sensory neurone
9. (a) Define the term "reflex arc" as used in coordination.
   (b) State the function of the following parts of the brain.
      (i) Cerebrum
      (ii) Cerebellum
      (iii)Medulla oblongata
10. Magao was making some tea for her mother. She accidentally touched the pan while switching off the stove. She pushed away the pan and poured all the tea.
      (a) What action did Magao exhibit?
      (b) Give other examples of such types of action.
      (c) How useful is such an action?
      (d) Which part of the CNS is concerned with such type of action?

SENSE ORGANS

Sense organ

Is a complex specialized organ or structure where sensory neurones are concentrated and function as a receptor to specific stimuli.

TYPES OF SENSE ORGANS

In mammals, there are five main sense organs, namely:-

(i) The eye – for sight
(ii) The ear – for hearing
(iii)The nose – for smell
(iv)The skin – for pressure, touch, temperature and pain
(v) The tongue – for tasting

THE SENSORY RECEPTORS

These are specialized cells that detect stimulus

Types of sensory receptor

According to their location, there are two types of sensory receptors, namely:

(a) Interoreceptors
(b) Exteroreceptors

(a) **INTERORECEPTORS**

Are sensory receptors which are located within the body

- ◊ They respond to stimulus from within the body.

Example of interoreceptor

- ─ Osmoreceptors

(b) **EXTERORECEPTORS**

Are receptors which are located near the body surface

- ◊ They respond to stimulus from the external environment

Example of exteroreceptor

- ─ Mechanoreceptors

TYPES OF RECEPTORS

According to the stimulus which responds to, there are several types of receptors, namely:

(i) Photoreceptors
(ii) Thermoreceptors
(iii) Chemoreceptors
(iv) Pain receptors
(v) Mechanoreceptors
(vi) Osmoreceptors

(i) Photoreceptors: are cells sensitive to light

(ii) Mechanoreceptors: are cells sensitive to pressure and vibration

(iii) Thermo receptors: are cells sensitive to temperature

(iv) Chemoreceptors: are cells sensitive to chemical substance

(v) Pain receptors: are cells sensitive to pain on the surface and in the body.

(vi) Osmoreceptors: are cells sensitive to osmotic pressure

1. THE TONGUE

Is an organ responsible for taste

- ◊ It has a specialized group of sensory cells called **taste buds.**
- ◊ Test buds are also called **gustatory cells**
- ◊ In mammals, taste buds occur on raised portions of the upper surface of the tongue called **lingual papillae** while in other vertebrates, they are distributed on the walls of buccal cavity.
- ◊ They have hair-like processes projecting above the surface of the papillae.
- ◊ The tongue is kept moist by saliva, and is richly supplied with nerves and blood vessels.

Role of test buds

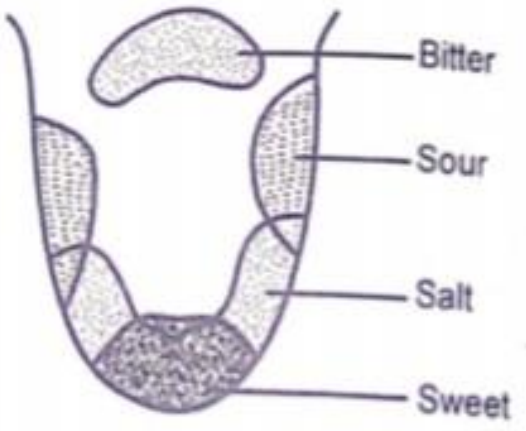
- ◊ Helps in taste detection of the food taken.

MAIN TASTES THAT THE HUMAN TONGUE IS ABLE TO DETECT

There are four main tastes that the human tongue is able to detect. These are:

a) **Sweet:** detected at the tip of the tongue.
b) **Sour:** detected at the sides of the tongue.
c) **Bitter:** detected at the back of the tongue.
d) **Salt:** detected all over the tongue.

DIAGRAM OF THE TONGUE SHOWING THE ZONES ASSOCIATED WITH THE FOUR TASTE SENSATIONS



ADAPTATIONS OF THE TONGUE TO ITS FUNCTIONS

The tongue is adapted to its functions by possessing the following features:

(i) The tongue has taste buds which help it to respond the stimuli such as sweet, bitter, sour and salt.
(ii) At the base of each taste bud there is a nerve that sends the sensations to the brain.

MECHANISM OF FOOD TASTE DETECT IN THE TONGUE

◊ When the food is in the mouth, taste buds become stimulated by the chemicals dissolve on the moist surface of the tongue and therefore generate a nerve impulse.
◊ The nerve impulse generated is taken to the brain via sensory fibres and produce sensation of taste such as sweet.

NB:

◊ The tongue is always moist to dissolve the incoming chemicals from food for sensation of taste.
◊ The sensory fibres are found at the base of the taste buds and connect the taste buds to the brain
◊ The combined activity of taste buds and smell receptors gives the sensation of flavor.

Importance of sensation of taste

(i) It helps animals to distinguish between suitable from unsuitable substances for ingestion
(ii) It stimulates the salivary glands to secrete saliva containing enzymes and stomach walls to secrete the gastric juice containing digestive enzymes.
(iii) It helps one to enjoy good food and to reject bad food.

2. THE HUMAN NOSE

The nose: is an organ responsible for the sense of smell.

- ◊ It has a specialized group of sensory cells called **olfactory cells** located in the upper part of the nasal cavity.
- ◊ Nasal cavity is an air filled space found inside the nose

Olfactory cells are cells sensitive to smell

- ◊ They are also called olfactory bulb
- ◊ The olfactory cells secrete mucus that moistens the nostrils.

THE MECHANISM OF SMELLING OCURS AS FOLLOWS:

- ◊ When a substance dissolves in moisture caused by mucus in the olfactory region, the olfactory cells are stimulated and an impulse is sent to the olfactory lobes of the brain via the olfactory nerve. The nerve impulse is interpreted as smell.

QUESTIONS

Question 1: Why when we have the cold we lose sense of smell?

Answer: Because the olfactory surfaces become dry.

Question 2: Why hot food often has more taste than cold food?

Answer: This is because it activates more the taste buds and the smell receptors.

Question 3: Why we cannot taste foods smell when suffering from cold?

Answer: This is because the nasal passages are inflammed and coated with mucus. The smell receptors are essentially non- functional.

ADAPTATIONS OF THE NOSE IN CARRYING OUT ITS FUNCTIONS

The nose able to carry out its functions due to the following features

(i) It is made up of cartilage to allow flexibility of the nose during blowing or sneezing thus removing dust, particulate matter or microorganisms.
(ii) It has sinuses containing mucous secreting cells for mucus secretion
(iii) It has mucus produced by mucous secreting cells which keeps the inner surface of the nose moist and traps unwanted substances.
(iv) It has olfactory nerve which sends impulses to the brain enabling us to sense smell.

The major functional differences between the taste receptors and smell receptors

- ◊ **Smell receptors** are cells specialized for detecting vapour coming to the organism from distant source while **taste receptors** are cells specialized for detection of chemical present in the mouth.
- ◊ **Smell receptors** are much more sensitive than taste receptors while **taste receptors** are much less sensitive than smell receptors

3. THE HUMAN SKIN

Is the largest organ in the body

- ◊ As a sense organ, the skin senses touch, pressure, pain, heat and cold.
- ◊ It protects us from microbes and the elements
- ◊ Helps to regulate body temperature and permits the sensations of touch, heat, and cold.

THE STRUCTURE OF THE SKIN

Structurally, the mammalian skin is made of two main layers, namely:

(i) **Epidermis**
(ii) **Dermis**

1. THE EPIDERMIS

Is the outer layer of the skin which contains melanin

- ◊ Melanin is a pigment which determines the colour of the skin and protects the body against ultra violet radiations.
- ◊ It contains dead cells that protect the body against bacterial invasion and reduces loss of water through evaporation.

The epidermis is made up of three layers, namely:

(a) Cornified layer
(b) Granular layer
(c) Malpighian layer

(a) CORNIFIED LAYER

Is the outermost layer of the epidemis

- ◊ It is made up of keratinised dead cells that prevent entry of bacteria, physical damage and loss of water through evaporation.

(b) GRANULAR LAYER

Is the middle layer of the epidermis.

- ◊ It is made up of living cells that give rise to the cornified layer.

(c) MALPIGHIAN LAYER

Is the innermost part of the epidermis

- ◊ It is made up of actively dividing cells that give rise to new epidermal cells.
- ◊ It contains melanin pigment.

Function of melanin pigment

(i) Determines the colour of the skin

(ii) Protects the inner layers of the skin against ultra violet radiations.

2. THE DERMIS

Is the inner layer of the skin

- ◊ It is made up of collagen fibres and elastic fibres which gives the skin toughness and flexibility and fat cells which store energy and provide thermal insulation.
- ◊ It is comparatively thicker than the epidermis.

The dermis contains the following structure:

(a) Sweat glands

(b) Blood capillaries

(c) Nerve ending

(d) Sensory cells.

(a) SWEAT GLANDS

These are coiled tubules which have long ducts opening to the surface through the pores.

Function of sweat glands

- ◊ They secrete sweat through pores in the skin surface.

The way on how sweat glands produce sweat

- ◊ The secretory cells in sweat glands absorb excess water, mineral salt, traces of urea, lactic acid and carbon dioxide from the blood capillaries, and then secrete them as sweat into the surface of the skin.

(b) BLOOD CAPILLARIES

These are blood vessels which supply the skin with nutrients and oxygen and remove excretory products.

(c) NERVE ENDINGS

These consist of sensory nerve cells that detect changes from the external environment.

- ◊ They are sensitive to touch, pressure, cold, heat and pain.

(d) HAIR FOLLICLES

These are lined with granular and malpighian layers of the epidermis.

- ◊ The hair follicles hold the hair fibre
- ◊ They are supplied with sensory nerves to increase sensitivity of the skin.
- ◊ The base of each hair follicle is connected to the epidermis by an erector Pilli muscles which contract to make hair stand and relax to make hair lie.

(e) SEBACEOUS GLANDS

Are glands that produce an oily chemical substance called **sebum**

◊ They are attached to the hair follicles and drain their contents into the hair follicle.

Function of sebum

(i) Acts as antiseptic to bacteria therefore, it protects the skin against disease causing microorganisms (pathogens).

(ii) It keeps the hair and epidermis supple, flexible and water proof.

(f) SUBCUTANEOUS LAYER

This is a fat layer that lies beneath the dermis.

◊ It is also known as adipose tissue.

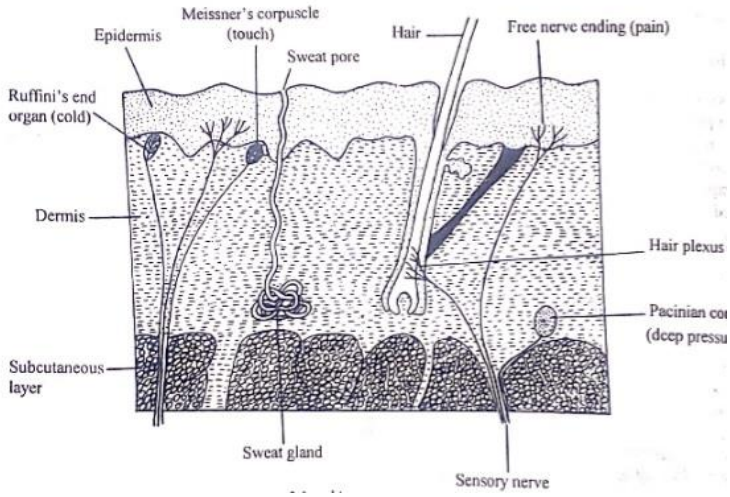
Function of subcutaneous layer

(i) It acts as heat insulating layer

(ii) It provides a channel for blood vessels and nerves to the skin.

(iii) It acts as a storage region for fats and food reserves.

THE STRUCTURE OF THE SKIN



FUNCTIONS OF SKIN

(i) Protects the underlying tissues from physical damage and prevents the entry of microorganisms.

(ii) It helps in body temperature regulation

(iii) It helps in excretion of excess water mineral salts and traces of urea through sweat

(iv) It synthesizes vitamin D through the action of sunlight. Ergosterol in the fatty layer of the skin converts into vitamin D under the influence of sunlight.

(v) Responds to external stimuli such as heat, cold, pain and touch.

(vi) Prevents excessive loss or absorption of water since it is water proof.

(vii) Produces melanin pigment that protects the body from ultra violet radiations.
(viii) The skin acts as sensory organ due to the presence of various nerve endings.
(ix) It prevents micro-organism and other foreign materials from entering the body.
(x) It acts as a storage organ for fats in the body.

ADAPTATIONS OF THE SKIN TO ITS FUNCTIONS

(i) It has cornified layer made up of dead cells to prevent entry of bacteria, physical damage and desiccation.
(ii) It has granular layer made up of living cells that give rise to cornified layer.
(iii) It has melanin pigment in the malphigian layer which protects the body against ultra violet
(iv) It has blood vessels in the dermis which supply oxygen and nutrients to tissues of the skin and remove excretory products
(v) It has sebaceous glands to produce sebum which is antiseptic to bacteria
(vi) It has the hair erector muscles which controls whether the hair stands erect or lies down depending on the temperature of the surrounding.
(vii) It is supplied with nerves which convey impulses to the central nervous system to be interpreted.
(viii) It has blood vessels in the dermis which dilate when the body temperature is high to facilitate heat loss by radiation and constrict when the temperature is low to reduce heat loss.
(ix) It has sweat glands to produce sweat which helps to cool down the body.
(x) It has sensory cells which are sensitive to touch, pressure, cold enable response to environmental changes.
(xi) It has subcutaneous fat or adipose tissue which acts as heat insulating layer.
(xii) It has sweat glands to secrete sweat which contain water, sodium chloride, uric acid and urea through pores in the skin surfaces hence acts as an excretory organ.

SKIN AS A SENSE ORGAN

Skin as a sense organ is composed of the following sensory receptors:

NB: The skin contains sensory nerve endings which are receptors.
They are sensitive to pain, pressure, touch, heat and coldness.
When the nerve endings are stimulated they set up nervous impulses which are sent to the spinal cord or brain to be interpreted.

(i) Touch receptors
(ii) Pressure receptors
(iii) Pain receptors
(iv) High temperature receptors
(v) Cold receptors

Skin receptors are more complex consisting of nerve endings called **encapsulated nerve endings** surrounded by a connective tissue.

Function of the connective tissue

- ◊ It protects the nerve ending from mechanical damage
- ◊ It helps in generation of a nerve impulse.

The encapsulated nerve endings include:

(i) Meissner's corpuscles – respond to touch
(ii) Krausser's end organs – respond to cold
(iii) Ruffini's end organ – respond to pain
(iv) Pacinian corpuscles – respond to pressure
(v) End bulls corpuscles – respond to heat

Below is a table summarizes the functions and locations of receptors in the skin

RECEPTOR	LOCATION	FUNCTION
Touch receptors	On the superficial part of the skin	Sensitive to touch
Pressure receptors (Pacinian corpuscles)	In the lower part of the dermis	Sensitive to pressure
Pain receptors	Free nerve ending below the epidermis	Sensitive to pain thus protects the body against potential harm by initiating reactions such as reflex action.
High temperature recptors	In the middle of the dermis	Sensitive to temperatures between 30°C to 43°C
Cold receptors	At the base of dermis	Sensitive to temperatures between 20°C to 30°C

NECTA PRACTICAL 2A (2020) question

1. You are provided with a tooth pick, piece of cotton wool, methylated spirit and samples labelled A and B which are stimuli of receptors in your body. Carry out the experiments in term (i) – (iv) and then answer the questions that follow:
   - ◊ Sample A- Sands
   - ◊ Sample B- wheat flour

   (i) Look at your body and observe the sense organ that covers the whole hands.
   (ii) Take a tooth pick and prick slightly the upper part of your hand and note the feeling.

(iii) Touch each of the samples A and B and feel their coarseness
(iv) Take cotton wall and soak into methylated spirit. Rub it on your hand and observe what is happening.

QUESTIONS

(a) (i) Give the name of the sense organ that covers your hands
    (ii) Explain four functions of the sense organ mentioned in (a) (i)
(b) (i) What did you feel when you pricked the upper part of your hand with a tooth pick?
    (ii) What type of sensory receptors responsible for the feeling in (b) (i)?
(c) (i) Identify the coarseness felt in each of the sample A and B.
    (ii) What types of sensory receptors responsible for the feeling in (c) (i)?
(d) (i) What did you feel when you rubbed methylated spirit on your skin?
    (ii) Give two types of sensory receptors responsible for the feeling in (d) (i)
(e) What was the aim of the experiment
(f) Explain the roles of hair and sweat pores on the sense organs covering your hands

4. THE MAMMALIAN EYE

Is a complex light sensitive organ specialized for sight

- ◊ It is spherical in shape
- ◊ It contains numerous light sensitive cells called **photoreceptors** in a specialized region known as **retina**
- ◊ The eyeball is located in a cavity in the skull called **orbit** or **eye socket.**

FUNCTION OF ORBIT

(i) It offers protection of eyeball against physical damage.
(ii) It has thick layer of fat deposited around the eyeball, which serves as a shock absorber.
- ◊ The eyeball is attached to the walls of the socket by a pair of antagonistic muscles that control its movement.

MUSCLES THAT CONTROL MOVEMENT OF EYEBALL

There are two pairs of antagonistic muscles that control movement of eyeball, namely:

(i) Superior and inferior oblique muscles – moves the eyeball left and right.
(ii) Superior and inferior rectus muscles – moves the eyeball up and down.
- ◊ These muscles can move the eyeball in many directions to increase the field of view.

PARTS ASSOCIATED WITH THE EYE

a) EYELIDS

These are two thin folds of the skin found in front of the eyeball.

- ◊ The movement of the eyelids is known as blinking.
- ◊ Blinking keeps the surface of the eye moist.
- ◊ The eyelids have **tear glands** or **lacrimal glands**

There are two types of eyelids namely

(i) Upper eyelids
(ii) Lower eyelids

Function of eyelids

- ◊ They protect the external surface of the eye.

TEAR GLANDS

They are found below the upper eyelid of each eye

Function of tear glands

- ◊ They secrete a saline liquid (tears)

A tear is a solution of sodium chloride and hydrogen carbonate.

- ◊ Tears contain enzymes which kill microorganisms and protect the eyeball from infection.
- ◊ Tears drain into the nose through small tubes at the corner of the eye called **canaliculi** into the pharynx.
- ◊ Blinking washes this liquid across the surface of the eyeball.

Function of tears

(i) To keep the surface of the eyeball moist.
(ii) To prevent the eyeball from friction.
(iii)To protect the eyeball from infection.

b) EYE LASHES

These are relatively many long hairs found on the edge of the eyelids.

Function of eye lashes

- ◊ They protect the eyeball from foreign particles such as dust and insects.

c) EYEBROWS

These are hairs above the eyelids that prevent sweat from the forehead and dust from entering the eye.

Function of eyebrows

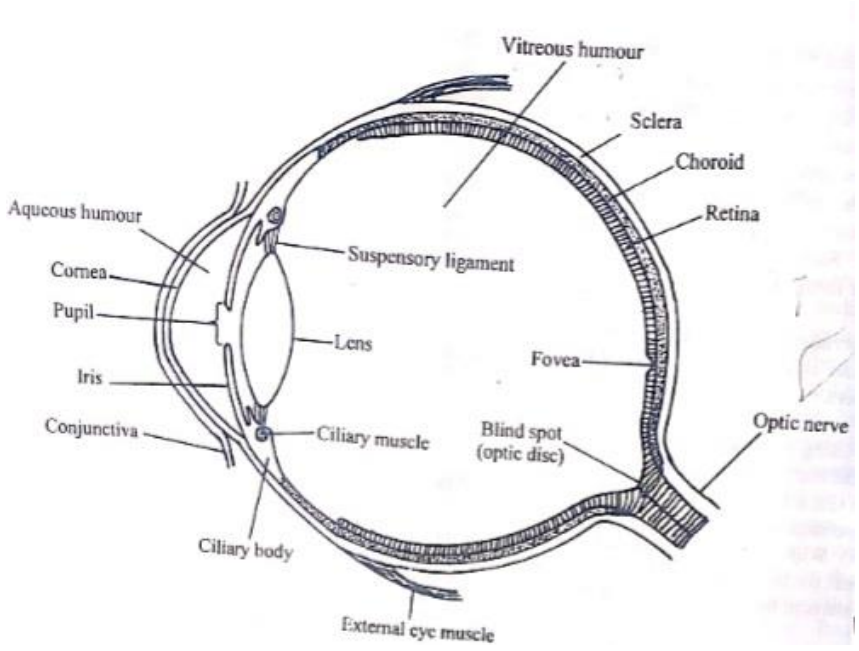
- ◊ They prevent the entry of dust particles and sweat into the eye.

STRUCTURE OF THE EYE

The eye is made up of the following parts

(i) Sclera
(ii) Cornea
(iii) Conjunctiva
(iv) Choroid
(v) Ciliary body
(vi) Iris
(vii) Pupil
(viii) Lens
(ix) Aqueous humour
(x) Vitreous humour
(xi) Suspensory ligaments
(xii) Retina
(xiii) Optic nerve
(xiv) Blind sport

THE INTERNAL STRUCTURE OF THE EYE



FUNCTIONS AND ADAPTATION OF PARTS OF THE EYE

1. SCLERA

Is the outermost layer of the eye

- ◊ Sclerotic layer is white in colour and is composed of elastic connective tissues.
- ◊ It is the tough opaque layer of the eye
- ◊ It is made of dense collagen fibres.

Function of the sclera

(i) It protects the eye
(ii) It supports and maintains the shape of the eyeball.

NB: Sclera continues and becomes transparent layer at the front of the eye to form cornea.

2. CORNEA

Is the transparent front part of the sclera that allows light into the eye

- ◊ Cornea is covered by a thin membrane known as **conjunctiva.**

Function of cornea

(i) It is convex (curved) to refract light.
(ii) It is transparent to allow light to pass through.

3. CONJUNCTIVA

Is a thin transparent membrane that covers cornea

- ◊ It lies in the inner surface of the eyelids

Function of the conjunctiva

(i) It is transparent to allow the light to enter the eye.
(ii) It is tough to protect the inner parts of the eye from mechanical damage.

4. CHOROID

Is a layer in the eye between the sclera and the retina

- ◊ It is heavily pigmented layer
- ◊ Choroid extends to the front of the eye to form the ciliary body and iris.

Function of the choroid

(i) It has a dark pigment which prevents internal reflection in the eye by absorbing scattered light ray
(ii) It contains a dense network of blood vessels, which supply oxygen and nutrients to the eye and remove metabolic waste products.

5. IRIS

Is a ring of contractile muscles which is continuous with the ciliary muscles.

◊ It is the coloured visible part of the eye

Iris has two sets of muscles namely:

(i) Circular muscles
(ii) Radial muscles

NB: Contraction and relaxation of the circular and radial muscles control the size of the pupil by dilation and constriction thus controlling the amount of light entering the eye

Function of the iris

(i) Controls the amount of light entering the eye.
(ii) Its pigment absorbs light to prevent blurred vision
(iii)Its pigment determines the colour of the eye.

6. CILIARY BODY

Is made of contractile muscles which control the shape and curvature of the lens so as to improve focusing.

◊ The contraction and relaxation of the ciliary muscles changes the shape of the lens.

Functions of ciliary body

(i) They have glandular cells which secretes the aqueous humour
(ii) They control the shape and curvature of the lens

7. PUPIL

Is the hole in the centre of the iris through which light enters into the eye

Function of the pupil

(i) It allows light to enter the eye.

NB: In dim light, the pupil dilates to allow more light into the eye while in bright light the pupil constricts to allow less light into the eye.

8. LENS

Is a transparent biconvex elastic structure filled with a jelly like substance

- ◊ It is attached to the ciliary body by suspensory ligaments.

Function of the lens

(i) It is transparent to allow light to pass through.
(ii) It is biconvex to refract light onto the retina.
(iii) It is elastic in nature to allow it to change shape when the eye focusing on near and far objects.
(iv) It separates the aqueous humour from the vitreous humour

9. AQUEOUS HUMOUR

Is the watery transparent fluid found between the cornea and the lens.

Function of aqueous humour

(i) It refracts light onto the retina
(ii) It is transparent to allow light to pass through
(iii) It maintains the shape of the eyeball
(iv) Oxygen and nutrients diffuse from the blood vessels to nourish the cornea and the lens

10. VITREOUS HUMOUR

Is a dense clear gel that fills the posterior chamber of the eye between the lens and retina.

Function of vitreous humour

(i) It maintains the shape of the eyeball.
(ii) It is transparent to allow light to get to the retina

11. SUSPENSORY LIGAMENTS

Are inelastic structures that hold the lens in position

Function of suspensory ligaments

(i) They attach the lens to the ciliary muscles
(ii) Hold the lens in position

12. RETINA

Is the innermost part of the eye which contains light sensitive cells called photoreceptor cells.

Function of retina

- ◊ It is a layer of the eye where the image is formed.
- ◊ It is a part of the eye where light is detected

Types of photoreceptor cells found in the retina

Retina has two types of photoreceptor cells namely:

(i) Cones
(ii) Rods

CONES

Are cells sensitive to light of high intensity

- ◊ Cones contain a photochemical pigment (light-sensitive pigment) called **iodopsin**
- ◊ **Iodopsin** is adapted for bright light vision and colour vision.
- ◊ Cones are able to detect colour
- ◊ Cones are densely packed together in a certain region of the retina known as the **fovea or yellow spot**.

RODS

Are cells sensitive to light of low intensity

- ◊ Rods contain a photochemical pigment known as **rhodopsin**
- ◊ **Rhodopsin** is adapted for dim light vision and does not detect colour
- ◊ Rods are able to detect black and white colours only.
- ◊ Rods are scattered all over the retina but are more numerous on the periphery. Because of this, one can see an object better in dim light if he looks at it from the corner of the eye.

DIFFERENCES BETWEEN CONES AND RODS

CONES	RODS
(i) They are sensitive to light of high intensity	They are sensitive to light of low intensity
(ii) They have pigment known as iodopsin	They have pigment known as rhodopsin
(iii)They are used for colour vision	They are used for night vision
(iv)Found in fovea	Found in other parts of retina. Not found in fovea

QUESTION: Explain why nocturnal animals are able to see properly during night than during the day?

ANSWER: Because they have large number of rods in their retina which enable them o see clearly during night.

13. FOVEA

Is a small depression on retina that has cones only

- ◊ Fovea is also called a **yellow spot**

Function of fovea

- ◊ It a region for colour detection

14. BLIND SPOT

Is an area in the retina through which optic nerve leaves the eyeball.

- ◊ Blind spot has neither rods nor cones, so image from objects falling on the blind spot cannot be perceived by the brain.

QUESTION: Why the blind spot is not sensitive to light?

ANSWER: Blind spot is not sensitive to light because it has no rods or cones.

Differences between the fovea and blind spot of the eye

FOVEA	BLIND SPOT
(i) It has cones	It has no cones
(ii) It is sensitive light	It is not sensitive to light

14. OPTIC NERVE

Is a cranial nerve which contains sensory neurons.

- ◊ The neurons transmit impulses from rods and cones on the retina to the brain for interpretation
- ◊ Optic nerve leaves the eye at the blind spot

ACCOMMODATION OF THE EYE

Accommodation

Is the ability of the eye to focus both near and distant objects.

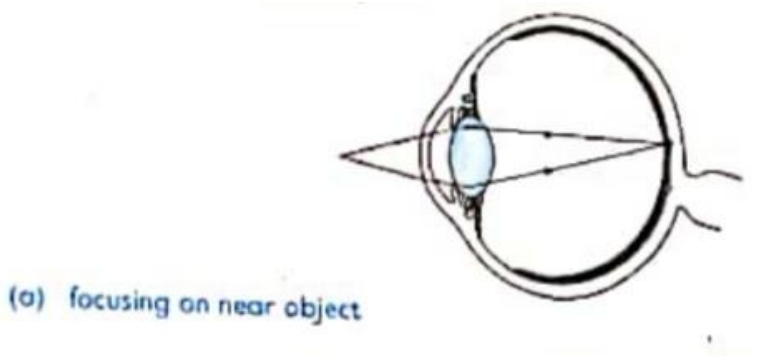
- ◊ It is a reflex mechanism which enables the eye to adjust and bring an image from a far or near object to focus on the retina.
- ◊ Accommodation ensures that clear images of objects are formed.

MECHANISM OF ACCOMODATION

Accommodation of the eye is accomplished through a change in the shape of the lens

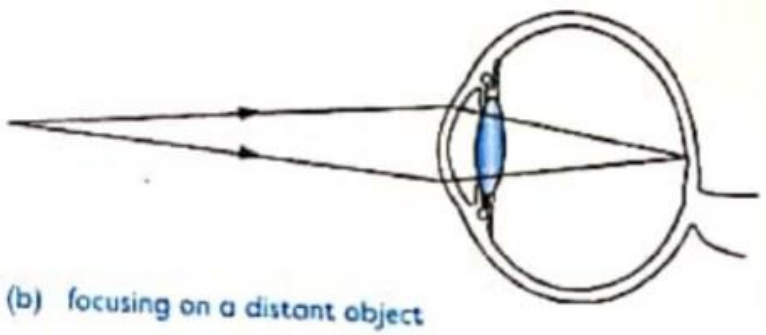
- ◊ **When the eye is focusing on a near object,** the ciliary muscles contract while the suspensory ligaments relax, the lens becomes thick and allows light rays from near objects to be focused on the retina.

Consider the diagram below



- ◊ **When the eye is focusing on a distant object,** the ciliary muscles relax while the suspensory ligaments contract. The lens becomes thin, light rays from far object are less refracted and hence focused on the retina.

Consider the diagram below

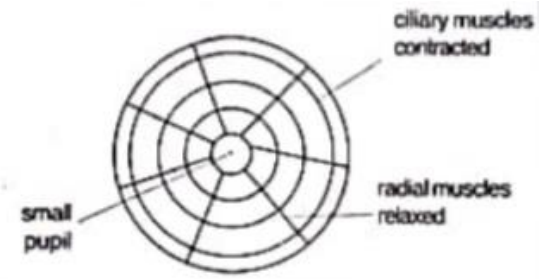


RESPONSE TO LIGHT INTENSITY

The amount of light entering the eye is determined by the size of the pupil

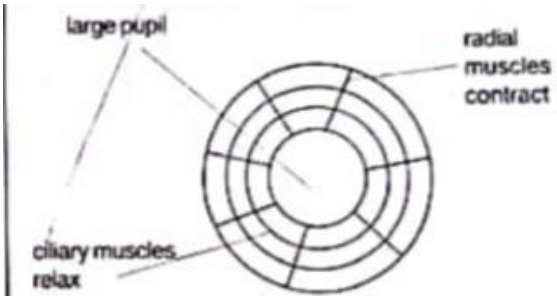
- ◊ **In bright light,** the circular muscles of the iris contract while radial muscles relax reducing the size of pupil. This limits the amount of light entering the eye.

  Consider the diagram below



- ◊ **In dim light,** the radial muscles of the iris contract while circular muscles relax increasing the size of pupil thus allowing more light to enter the eye.

  Consider the diagram below



BILOGICAL SIGNIFANCE OF THE ABOVE RESPONSE

(i) It protects the retina from damage by excessive light.
(ii) It improves visibility in dim light

Questions:

1. (a) Explain how the iris regulates amounts of light entering into the eye. Or explain how the iris of the eye responds to light of varying intensity.
   (b) What is the purpose of the response you have described in (a) above

IMAGE FORMATION AND INTERPRETATION

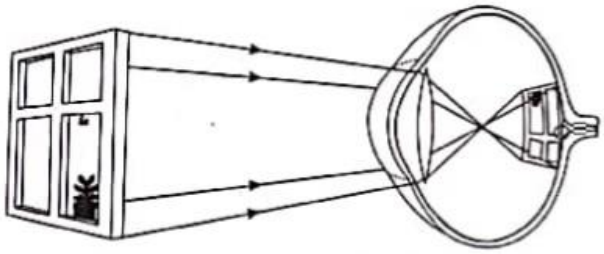
An image is formed on the retina when the photoreceptors (rods and cones) are stimulated.

Mechanism of image formation

- ◊ When light falls on an object, it is reflected. Some of the reflected rays fall on the eye. The light from the object is refracted by cornea, aqueous humour, lens and vitreous

humour, focusing it on the retina. The image formed on the retina is upside down and smaller than the object. The image on the retina stimulates the photoreceptor cells causing the generation of impulses in neurones. Impulses are then transmitted to the brain through the optic nerve for interpretation. A normal size, upright and coloured image is formed.

Consider the diagram below



ADAPTATIONS OF THE EYE

(i) It has conjunctiva which protects the eyeball from mechanical damage and also helps the eyeball to move/ rotate easily by secreting mucus.
(ii) It has cornea which is transparent to allow light into the eye and refracts the light entering the eye.
(iii) It has aqueous and vitreous humours which are thin aqueous jelly- like fluids to allow light to pass through and refract it. They contain solutions of salts, sugar and proteins to provide nourishment to the eye.
(iv) It has iris which is opaque and contractile for controlling the amount of light entering the eye by controlling the size of the pupil.
(v) It has ciliary body contains ciliary muscles for controlling the shape and curvature of the lens
(vi) It has suspensory ligaments to hold the lens in position.
(vii) It has a transparent biconvex lens which allows light to pass through and to refract light onto the retina.
(viii) It has retina which contains photoreceptor cells for image formation.
(ix) It has rods which contain rhodopsin pigment for dim light vision.
(x) It has cones which contain iodopsin pigment for colour vision, bright light and light of high intensity.
(xi) It has fovea centralis with a high concentration of cones for accurate vision.
(xii) It has the choroid layer to provide nourishment (oxygen and nutrients) to the eye.
(xiii) Choroid also has black pigments to stop or reduce light reflection and absorb stray light.
(xiv) It has a sclerotic layer to protect the inner more delicate parts of the eye and to give shape to the eye.

(xv) It has optic nerves contain sensory neurones for transmission of impulses from retina to the brain for interpretation

(xvi) It has pupil which is a gap between upper and lower iris through which light enters the eye.

(xvii) An external eye muscle is contractile to move the eyeball (within the socket).

(xviii) Eyelashes prevent dust and hazardous particles from reaching the conjunctiva.

COMMON DEFECTS OF THE MAMMALIAN EYE AND THEIR CORRECTION

Defects of the mammalian eye are structural deviations of the eye which alter the focusing mechanism of the eye.

There are two common eye defects, namely:

(i) Short-sightedness (myopia)

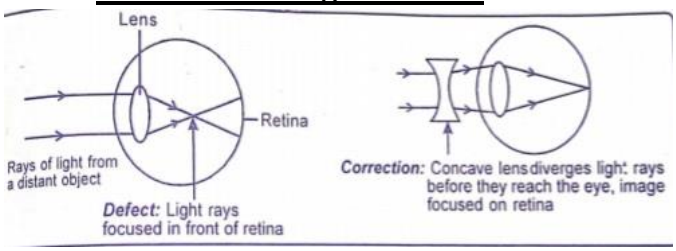
(ii) Long-sightedness (Hypermetropia)

1) SHORT-SIGHTEDNESS (MYOPIA)

Is the eye defect whereby a person cannot focus distant objects properly

- ◊ A person is able to focus only near objects.
- ◊ The myopia is caused by long eyeball which results the image to be formed in front of the retina.
- ◊ Myopia can be corrected by using spectacles with concave lens (diverging lens).
- ◊ Concave lenses diverge the light rays before they reach the eye.

Consider the diagram below

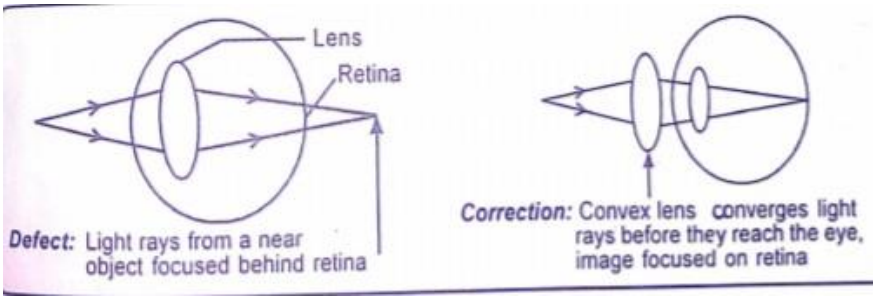


2) LONG-SIGHTEDNESS (HYPERMETROPIA)

Is an eye defect whereby a person cannot focus near objects properly.

- ◊ A person is able to focus only distant objects.
- ◊ Hypermetropia is caused by short eyeball which results the image to be formed behind the retina.
- ◊ Hypermetropia can be corrected by using spectacles with convex lenses.
- ◊ Convex lenses converge the light rays before they reach the eye.

Consider the diagram below



3) OLD SIGHTEDNESS (PRESBYOPIA)

Is a defect caused by loss of flexibility or elasticity of the lens and weakening of ciliary muscles.

- ◊ Person cannot focus near objects properly.
- ◊ The defects can be corrected by using spectacles with bifocal lenses.

4) ASTIGMATISM

Is a condition in which the cornea or lens is uneven such that images are not focused properly on the retina.

- ◊ The defect can be corrected by using spectacles with special cylindrical lenses.

5) CATARACTS

Is a worm disease in which worms invade the lens

- ◊ The lens becomes cloudy such that light cannot pass through easily and the person cannot see properly.
- ◊ It is curable at early stage but if it is chronic lens may have to be removed by operation and can be replaced by a plastic lens inside the eye or a good eye from a donor.

6) CLAUCOMA

Is the eye defect caused by pressure in the eye

- ◊ It is more common in old people
- ◊ A person with this defect forms blurred images.

7) COLOUR BLINDNESS

Is the genetic disorder in which a certain colour cannot be distinguished by man.

- ◊ A common type of colour blindness is red- green blindness, individual is not in position to determine/distinguish between red and green colour.

8) TRACHOMA

Is a viral disease which affects the lining of the eyelids.

- ◊ Trachoma can be transmitted from one person to another through contact
- ◊ If not treated, trachoma can cause blindness

5. THE HUMAN EAR

Is a specialized organ responsible for hearing and maintaining body balance.

- ◊ The ear contains specialized sensory cells (receptors) that are sensitive to sound and the position of head with respect to gravity.

FUNCTION OF THE EAR

The mammalian ear performs two main functions

(i) Hearing (detection of sound waves)

(ii) Maintenance of body balance and posture

THE STRUCTURE OF THE EAR

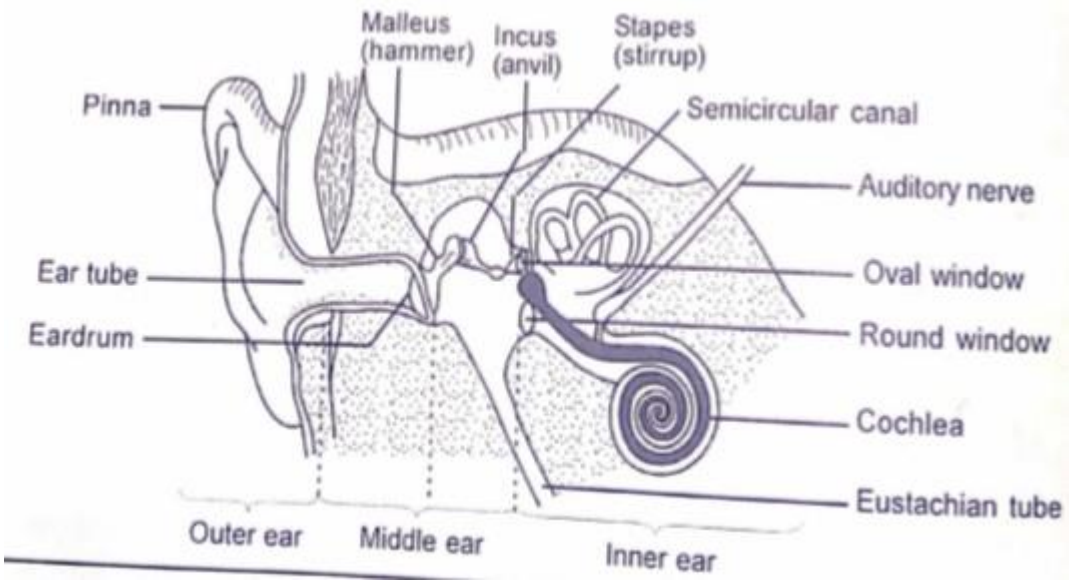
Structurally the ear is divided into three main parts (chambers), namely:-

(i) The outer ear

(ii) The middle ear

(iii)The inner ear

Consider the diagram below showing the parts of ear



1. THE OUTER EAR

Is the external part of the ear filled with air

The outer ear is made up of the following parts

(a) Pinna

(b) Auditory canal

(c) Eardrum

(a) **PINNA**

Is the outermost part of the ear and is made up of cartilage.

- ◊ It is a funnel-shaped flap

Function of pinna

(i) It collects sound waves and directs them into the ear canal.

(ii) It helps some animals to determine the direction of sound. E.g.cattles

(b) **EXTERNAL AUDITORY CANAL (EAR CANAL)**

Is a tube that directs sound waves to the eardrum.

- ◊ Ear canal is also known as **meatus**

Functions of auditory canal

(i) It is a tube through which sound waves travel.

(ii) It has hairs and secretes wax, which help to trap dust and micro-organisms thus protecting the eardrum.

(iii)It has sebaceous glands that secretes sebum in its lining to moisten the eardrum and lining of the canal

(c) **EARDRUM (TYMPANIC MEMBRANE)**

Is a thin double membrane that forms the boundary between the outer and middle ears

- ◊ It vibrates when hit by sound waves.

Functions of eardrum

(i) It converts the sound waves into vibrations and transmits them to the ear ossicles.

2. THE MIDDLE EAR

Is an air-filled cavity in the skull.

The middle ear is made up of the following parts:

(a) Ear ossicles

(b) Oval window

(c) Round window

(d) Eustachian tube

(a) **EAR OSSICLES**

Are three small tiny bones that link the eardrum with the oval window.

- ◊ They are named according to their shape
  - (i) Malleus (hammer)
  - (ii) Incus (anvil)
  - (iii)Stapes (stirrup)

Function of ear ossicles

- ◊ Used to amplify the vibrations
- ◊ Used to transmit amplified vibration of sound from the eardrum to the oval window
- ◊ Used to connect the eardrum to the oval window

(b) **OVAL WINDOW**

Is a flexible membrane that covers a small hole leading to the inner ear.

Function of oval window

- ◊ It transmits vibrations to the inner ear.

(c) **EUSTACHIAN TUBE**

Is a narrow tube that connects the middle ear to the pharynx (mouth cavity).

Function of Eustachian tube

(i) It allows air to get in and out of the middle ear

(ii) It equalizes the air pressure between the middle and the outer ear hence preventing distortion (rupture) of the eardrum.

NB: The Eustachian tube is normally closed, but opens during swallowing, chewing and yawning.

3. THE INNER EAR

Is a fluid filled cavity consisting of a series of chambers and canals embedded in the bone of the skull.

- ◊ The fluid in the inner ear is called **perilymph**

The following are chambers and canal in the inner ear

(i) Semicircular canals, Utricle and Saccule

(ii) Cochlea

(i) SEMICIRCULAR CANALS

Are fluid filled tubular cavities and each has a swelling known as ampulla at one end.

- ◊ Semicircular canals, utricle and saccule are also called **vestibular apparatus**

Function of semicircular canals, utricle and saccule

- ◊ Help to maintain body balance and posture

(ii) COCHLEA

Is a coiled tube filled with liquid called endolymph

- ◊ Cochlea contains sensory cells which are connected to the brain through the auditory nerves
- ◊ The part of cochlea that responds to sound is called **organ of corti**

Function of cochlea

(i) It is the structure responsible for sense of hearing.

(ii) It is coiled to offer a large surface area for attachment of sensory cells responsible for hearing.

(iii)It has sound receptors in the organ of corti to detect sound vibrations (hearing)

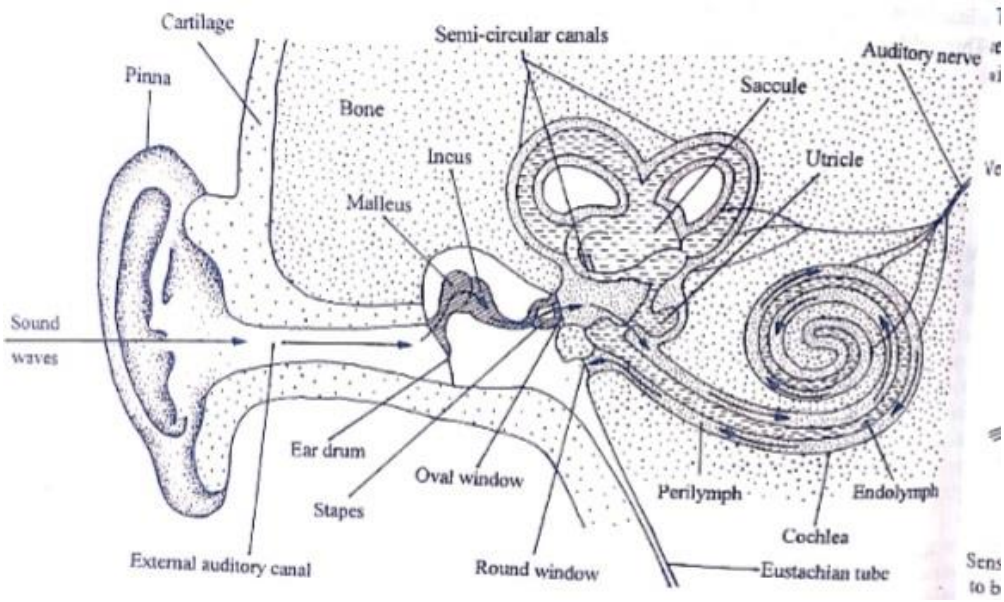
Function of organ of corti

- ◊ It is a part of cochlea that responds to sound

MECHANISM OF HEARING

◊ The pinna collects and directs sound waves into the auditory canal. From the auditory canal, the sound waves are passed on to the eardrum causing it to vibrate. The vibrations from the eardrum picked by malleus, incus and then to the stapes. The stapes passes the vibrations to the oval window which amplifies the sound waves 22 times. When the oval window vibrates, it causes the fluid in the inner ear and in the cochlea to move hence stimulates the sensory hair cells in the organ of corti. When the sensory hair cells become stimulated they generate nerve impulse. The impulse generated is transmitted to the brain via the auditory nerve. The brain interprets the impulse as sound of specific pitch and loudness.

Consider the diagram below



BALANCE AND POSTURE

◊ The semi-circular canals, utricle and saccule are the structures concerned with animal's sense of balance and position in space. The canals are filled with fluids which moves as the body moves or as the head changes position. The movement of the fluid stimulates sensory nerves in the canals and impulses are sent to the brain. The brain then sends impulses that affect an appropriate posture.

ADAPTATIONS OF THE MAMMALIAN EAR TO ITS FUNCTIONS

The ear is adapted to its functions by possessing the following features:

(i) It has pinna which collects sound waves and directs them into the inner ear via the auditory canal.

(ii) It has ear drum which converts the sound waves into vibrations and transmits them to the ear ossicles.
(iii) The lining of auditory canal contains wax-secreting cells which produce wax to protect the inner delicate parts of an ear from mechanical damage.
(iv) It has ear ossicles which amplify and transmit vibrations to the oval window.
(v) It has Eustachian tube which allows air in and out of the middle ear to equalize the air pressure between the middle and the outer ear hence preventing rupturing of the eardrum.
(vi) It has cochlea which is coiled to increase the surface area for sound reception.
(vii) Presence of fluid-filled vestibular apparatus in the inner ear which facilitate balancing of sound when fluid is displaced.

DRUGS AND DRUG ABUSE IN RELATION TO NERVOUS COORDINATION

Drugs are chemical substance which when taken into the body alter the structure or functioning of the body.

Examples of drugs

- ◊ Cocaine
- ◊ Heroine
- ◊ Tobacco
- ◊ Marijuana

PSYCHOACTIVE DRUGS

Are the drugs that affect the central nervous system.

- ◊ Psychoactive drugs produce a false sense of well-being and relieve someone from tension, anxiety, stress and pain.

TYPES OF PSYCHOACTIVE DRUGS

(a) STIMULANTS

Are drugs which stimulate the nervous system.

- ◊ They speed up brain activities and also the body processes.

Example of stimulants

- ─ Cocaine
- ─ Heroine
- ─ Nicotine
- ─ Caffeine from coffee, tea

(b) SEDATIVES (DEPRESSANTS)

Are sleep- inducing drugs.

- ◊ They slow brain activities and evoke sleep. E.g. alcohol,

(c) PAINKILLERS

Are drugs immobilize or suppress pain centre in the brain

- ◊ Painkillers are only prescribed by the doctors on inevitable cases because they cause brain damage.

(d) INHALANTS (VOLATILE SOLVENTS)

These include compounds like glue, kerosene, toluene and petroleum.

- ◊ Other inhalants such as chloroform and industrial solvents are used as intoxicating drugs.

(e) HALLUCINOGENS

Are drugs that distort the way the brain interprets impulses from the sensory organs.

- ◊ These distortions may take one or two of the following forms
  - ─ The brain may alter the massage about something real, producing **Illusion**
  - ─ The brain may produce images with no basis in reality called **hallucinations**

Example of hallucinogens

◊ Marijuana.

NB: Users of hallucinogens drugs may show signs of mental illness with confusion, violence and depression.

(f) NARCOTICS

These drugs dull the senses and relieve pain by depressing the cerebral cortex in the brain.

◊ Narcotics also affect the thalamus, the body's mood-regulating center.

Example of narcotics

- ─ Codeine
- ─ Morphine
- ─ Heroine
- ─ Opium

FORMS OF DRUG TAKING

(i) **Intravenous**: this is injecting a chemical substance into the blood system through a vein.
(ii) **Inhalation:** some people prefer to inhale volatile solvents such as petrol, glue or paint.
(iii)**Oral:** some other drugs like marijuana are smoked
(iv)**Sniffing:** some drugs like cocaine are sniffed through the nose.

PROPER WAYS OF HANDLING AND USING DRUGS

(i) Avoid taking any drug without diagnosing the disease and prescription by the doctor.
(ii) Always stay away from peer pressures and drug addicts to avoid copying their bad habits.
(iii) Keep yourself busy with a number of activities such as sports and games, reading books, etc.
(iv) Report any case of drug abuse or trafficking to concerned authorities.
(v) Form a counselling club to advise people especially youths on how to keep off from drugs.

(vi) If one feels addicted, s/he should seek advice from health officials.
(vii) Never take a dose more or less that what has been prescribed by the doctor.
(viii) Complete the prescribed dose even after you start feeling well or after the symptoms of the disease has disappeared.9. Keep all drugs out of reach of children and drug addicts.

DRUG ABUSE

Is the misuse of drugs for the reasons other than the medical reasons.
OR is the use of a drug for any purpose other than what it was intended for.

◊ When drugs are used regularly, they can cause a stable of dependence called **addiction**.

DRUG ADDICTION

Is a habitual and uncontrollable behaviour involving the use of drugs.
OR is a state of over dependence of drugs so that life becomes unbearable without it.

CAUSES OF DRUG ABUSE

(i) Desire to satisfy curiosity about the effects of drugs.
(ii) Sense of belongingness to a certain group.
(iii) Desire to have a new life experiences.
◊ Some people just take drugs as an experiment to find out the experience the drug users feel, but badly end up becoming drug addicts.
(iv) To escape from life realities such as poverty, hunger, family quarrels.
(v) Peer pressure from peer groups.
◊ Peer pressure leads people to drug so as to create a sense of belonging and fitting in the peer group. It‘s often said that teens use drugs when their friends do.
(vi) Lack of education or ignorance
(vii) Lack of employment
(viii) Lack of family upbringing
(ix) For recreational purposes and excitements.
◊ Drug users believe that taking drugs make them feel better and lively.
(x) To do away with unpleasant feelings and memories.
◊ Some people take drugs as a way to forget problems and life hardships they experienced in life. Some people take drugs to avoid physical or emotional pain, discomfort, stress, boredom, anxiety and depression.

EFFECTS OF DRUG ABUSE

Excessive use of drugs can cause:
(a) Health hazards
(b) Social hazards

(a) **HEALTH EFFECTS OF DRUG ABUSE**

(i) Cigarette smoking can lead to lung cancer and other heart diseases
(ii) Bhang affects the reproductive system by slowing down the rate of sperm production
(iii) Alcohol causes brain damage, liver cancer and gastric diseases

(iv) Drugs e.g. miraa causes ulcers and rotten teeth
(v) Many drugs affect the brain and give a false sense of happiness which is short lived.
(vi) Spread of diseases such as HIV/AIDS
(vii) Cocaine cause high blood pressure, heart failure and can lead death
(viii) Misuse of drugs weakens the body immune system

(b) **SOCIAL EFFECTS OF DRUG ABUSE**

(i) Students drop out of school
(ii) Marriage breakdown
(iii) Poverty
(iv) Failure to concentrate at work
(v) Increases of crime and violence
(vi) Leads to irresponsible sexual behaviours
(vii) Leads to accidents, loss of properties and death

PREVENTIVE AND CONTROL MEASURES OF DRUG ABUSE

(i) Avoid taking any form of drug without prescription from the doctor
(ii) Keep off from peer pressure and people who are addicted to drugs
(iii) Provision of education to the community about the problems of drug abuse.
(iv) Enforcement of laws, rules and regulation for the control and supply of drugs.
(v) Avoid emotional pain and stress by engaging in creative activities such as sports and games
(vi) The youth should be motivated to get involved in the fight against drug abuse.
(vii) Early detection, treatment and rehabilitation of drug addicts can help minimize the problem.
(viii) Various effects of drug addiction must be advertised through newspapers, radio, television, magazine, social media, and many other media so as to make the problem known to as many people as possible.
(ix) Parents should set a warm and friendly atmosphere at home so that the drug users can feel easy to cooperate with.
(x) Motivation of the addicts to make up for detoxification.
(xi) The experience of drug users can be advertised to the people through media to make the general public aware of the effects of drugs so as to discourage those who might think of starting taking drugs.

THE HUMAN ENDOCRINE SYSTEM

The human endocrine system consists of a number of glands that secrete hormones into the blood stream.

◊ Endocrine system is also called **hormonal coordination**
◊ Endocrine system is in charge of all processes that happen slowly, such as cell growth

ENDOCRINE GLANDS

Are the parts of the endocrine system which are responsible to secrete hormones

- ◊ They are ductless glands (they have no ducts).
- ◊ They release their secretion into the blood stream where they are carried to the target organs to bring an effect.

HORMONE

Is a chemical substance produced in one part of the body and transported by blood to another part where it brings a response.

- ◊ Hormones are produced by endocrine glands and transported by the blood to the target organs where they bring their effects.
- ◊ Hormones regulate physiological activities in the body such as metabolism, growth and development.

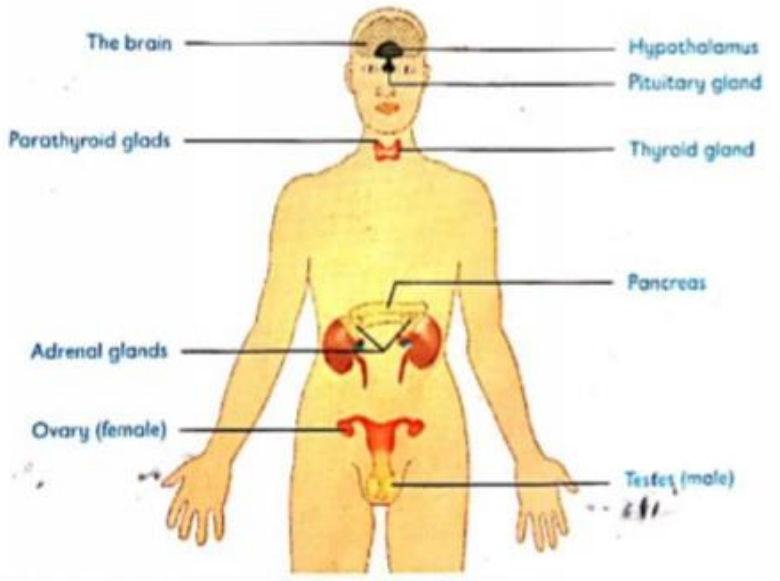
TARGET ORGANS

Are the parts of the body of an organism that are influenced by the hormones.

The following are glands/parts of the endocrine system:

(i) Pituitary gland
(ii) Thyroid gland
(iii) Adrenal gland
(iv) Parathyroid gland
(v) Pancrease
(vi) Gonads (Testes and Ovaries)

DIAGRAM OF HUMAN ENDOCRINE SYSTEM



◊ Endocrine system works together with nervous system to help the body to function properly.

SIMILARITIES BETWEEN THE ENDOCRINE SYSTEM AND THE NERVOUS SYSTEM

(i) They both require a stimulus to trigger a certain response.
(ii) They both provide a means of communication within the body of an organism.
(iii) They both require a transporting medium.
(iv) They both bring about responses that enable an organism to survive in an environment.
(v) They both work to regulate the activities of cells, tissues, organs and organ systems in relation to internal and external changes.

THE DIFFERENCE BETWEEN NERVOUS SYSTEM AND HORMONAL SYSTEM

NERVOUS SYSTEM	HORMONAL SYSTEM
(i) Electrical impulses are transported by blood.	Hormones are transported by blood.
(ii) Response is fast	Response is slow.
(iii) Effects are short-lived	Effects are long-lasting.
(iv) Usually specific	May affect more than one target organ
(v) Electrical signals are sent through nervous impulses	Chemical substances (hormones) evoke a response.
(vi) May be voluntary or involuntary	Always involuntary.

POSITION OF ENDOCRINE GLAND IN HUMAN BODY

1. PITUITARY GLAND

It is located at the base of the fore brain and connected to the hypothalamus by nerve centre.

◊ It has been called the **master gland**

ROLES OF PITUITARY GLAND

(i) Regulates the activities of the other endocrine glands.
(ii) It controls the functioning of the body directly by producing its own growth hormone.
(iii) It controls the production of Thyroxin hormone in the thyroid gland.

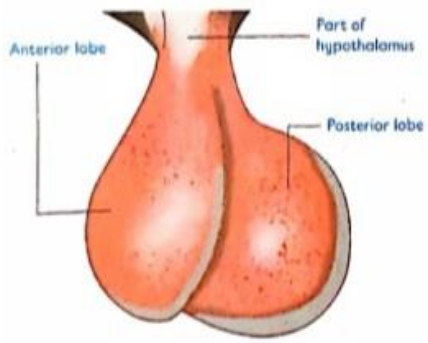
QUESTION: Why the pituitary gland is also known as a master gland?

ANSWER: Because it regulates the activities of the other endocrine glands.

The pituitary gland consists of two different lobes namely:-

(a) The anterior lobe
(b) The posterior lobe

Consider the diagram below showing the anterior and posterior lobes



(a) THE ANTERIOR LOBE

This lobe secretes stimulating hormones collectively known as **trophic hormones**

- ◊ Anterior lobe also secretes **growth hormones** and **prolactin**

TROPHIC HORMONES

Are hormones which activate other endocrine glands to secrete hormones.

Examples of trophic hormones

(i) Adrenocorticotrophic hormones (ACTH) – causes the adrenal cortex to secrete cortical hormones
(ii) Thyroid stimulating hormones (THS) – causes the thyroid gland to secrete thyroxine hormone.
(iii) Gonadotropin hormones e.g. luteinizing hormones (LH) and follicle stimulating hormones (FSH)

- ◊ **Follicle stimulating hormone** stimulates the growth of the Graafian follicle in females and causes sperm production in males.
- ◊ **Luteinizing hormone** brings about ovulation in female

GROWTH HORMONES

Growth hormones stimulate the body growth.

Effects of growth hormones

(i) Over secretion of growth hormones cause **gigantism**
(ii) Under secretion of growth hormones cause **dwarfism**

PROLACTIN HORMONE

◊ This hormone causes mammary glands to secrete milk in lactating mammals.

(b) **THE POSTERIOR LOBE**

This lobe secretes antidiuretic hormone and oxytocin

◊ **Antidiuretic hormone (ADH) or vasopressin** – causes reabsorption of water in the kidneys.
◊ **Oxytocin hormone**– brings about contraction of the uterus at birth

Effects of antidiuretic hormone and oxytocin

◊ Under secretion of antidiuretic hormone cause **Diabetes insipidus.**
◊ Hypo secretion of oxytocin cause **delayed birth**
◊ Over secretion of oxytocin cause **premature birth**

2. **THYROID GLAND**

It is located on the surface of the trachea in the neck

◊ It produces **thyroxine hormone**

Thryroxine hormone: is an iodine containing hormones.

Its function

◊ It rises the metabolic rate by stimulating metabolism of carbohydrates, proteins and lipids

Effects of thyroxine hormone

(i) Under secretion of thyroxine hormone during infancy cause **cretinism**
(ii) Under-secretion of thyroxine hormone in adult causes **myxoedema.**
(iii) Deficiency of iodine in the diet cause a disease called Goitre
(iv) Over secretion of thyroxine hormone causes exopthalmic goitre.

CRETINISM

Is a condition characterized by slow physical growth and mental retardation.

MYXOEDEMA

Is a condition characterized by slow physical activity which results in weight gain.

These individuals have a low metabolic rate which is expressed by reduced heartbeat and breathing rate and low body temperature.

GOITRE

Is a disease which is characterized by enlargement of the thyroid gland.

- ◊ Goitre is an indication of myxoedema in adults.

EXOPTHALMIC GOITRE

The condition is characterized by increase in metabolic rate, causes underweight, restlessness and mental instability.

- ◊ Also the person becomes thin, excitable and sweats a lot, the eye protrude and the thyroid gland swell.

3. PARATHYROID GLAND

It is found within the thyroid gland.

- ◊ It produces **parathormone**
- ◊ Parathormone is produced in response to a lack of calcium in the blood resulting increased absorption.

Its function

- ◊ It controls concentration of calcium and phosphate ions in the blood.

4. ADRENAL GLANDS

There are two adrenal glands each located above the kidneys.

- ◊ The adrenal glands consist of an outer layer, the adrenal cortex and an inner layer, the adrenal medulla.

THE ADRENAL CORTEX

Adrenal cortex produces two classes of hormones, namely:

(i) Glucocorticoids e.g. cortisol
(ii) Mineralocorticoids eg **Aldosterone**

- ◊ **Cortisol** stimulates glucose formation from non-carbohydrates sources e.g. Proteins.
- ◊ **Aldosterone** stimulates the reabsorption of sodium ions in the kidney.

Effect of Failure of the adrenal cortex to function properly

- ◊ Leads to **Addison's disease** which is characterized by decrease in blood glucose, loss of sodium chloride and a lot of water in urine.

THE ADRENAL MEDULLA

Adrenal medulla secretes the **adrenaline hormone**

ADRENALINE HORMONE

Is the hormone for fight or flight

- ◊ It is produced when an animal is faced with an emergency situation, during anxiety and excitement.

Its function

(i) It prepares the body for a **fight or flight action** in an emergency
- ◊ It prepare the body for emergency by rising blood pressure, increasing heart beat and breathing rates, increasing blood sugar levels and increasing supply of blood to the muscles.

5. PANCREASE (Islets of Langerhans)

Is a compound gland in that it has both exocrine and endocrine portions.

- ◊ The exocrine portion produces **digestive enzymes**.
- ◊ The endocrine portion produces two hormones namely:
  (i) **Insulin**
  (ii) **Glucagon.**

Function of insulin

- ◊ Promotes the conversion of glucose to glycogen by the liver.

Effects of insulin

- ◊ Under secretion of insulin causes **Diabetes Mellitus**
- ◊ Over secretion of insulin causes **hypoglycaemia**

Function of glucagon

- ◊ Promotes the conversion of glycogen to glucose in the liver cell.

Effects of glucagon

- ◊ Under secretion of glucagon causes **hypoglycaemia**
- ◊ Over secretion of glucagon causes **hyperglycaemia**

6. TESTES

They produce male sex hormone collectively known as androgen.

- ◊ Example of androgen is **testosterone hormone**

Function of testosterone

(i) Regulates the growth, maturation and maintenance of the male reproductive organs.
(ii) It is responsible for sperm production
(iii) It is responsible for the development of male secondary sexual characteristics. E.g. Beards, deep voice, pubic hairs.

7. OVARY

Is a female organ which is responsible to produce female sex hormones called **oestrogens** and **progesterones**

Function of oestrogen

- ◊ It promotes development of female secondary characteristics. Eg rounded body, growth of breasts
- ◊ It controls pregnancy by promoting thickening of the uterus
- ◊ Promotes growth, maturation and maintenance of the female reproductive tract.

Function of progesterone

(i) It controls the menstrual cycle
(ii) It supports pregnancy
(iii)It encourages the development of the uterus lining after ovulation.
(iv) It inhibits ovulation and prevents the uterus from contracting during pregnancy.

- ◊ Relaxin is also produced by ovaries begins as the time of birth approaches. This hormone causes the ligaments between the pelvic bones to loosen providing a more flexible passage for the baby during birth

COORDINATION IN PLANTS

Plants perceive and respond to a variety of stimuli that are important to their survival.

- Most plant responses are very slow and unnoticeable and normally **growth movement**

Types of plant responses

(i) Tropic response
(ii) Tactic response

TROPIC RESPONSE

Is the growth movement that is caused by a wide range of stimuli.

- Plant grows either towards or away from the stimulus
  - If the movement is towards the stimulus, it is called **positive tropism.**
  - If the movement is away from the stimulus, it is called **negative tropism**.
- Tropic movements are mediated through **plant hormones**

PLANT HORMONES

Plant responses are controlled by the following hormones

(i) Auxins
(ii) Gibberellins
(iii) Cytokinins
(iv) Ethylene
(v) Abscisic acid

AUXINS

Are a group of plant hormones that influence growth

- The main auxin made in plants is the indole acetic acid (IAA)
- Auxins are produced in buds, root and shoot tips, young leaves, seeds, embryos and developing fruits.
- These hormones play an important role in plant tropism.

ROLES OF AUXINS

(i) Promote cell elongation.
(ii) Promote differentiation of vascular tissues.
(iii) Enhance the formation and growth of adventitious roots. This is the reason why stem cuttings grow roots after being put in water containers or soil.
(iv) Inhabits development of side branches leading to apical dominance.
(v) Promotes formation fruits and elongation of young leaves.
(vi) High concentration of auxins stimulates growth of the shoot but inhibits root growth.

NB: **Apical dominance** is a condition where some plants grow very tall but with few branches.

- This can be avoided by cutting the apex of such plants, thus allowing growth of the branches.

EFFECTS OF AUXINS CONCENTRATION ON GROWTH

Experiments have revealed that:

- High concentration of auxins stimulates growth in shoots
- Low concentration of auxins stimulates growth in roots
- Amount of auxins which stimulate shoot growth, normally inhibit root growth.

TROPISM

Is the growth movement by plant organs in response to a unilateral stimulus.

- Direction of the plant organ movement is related to the direction of the stimulus coming from one direction.

TYPES OF TROPISM

The following are types of tropism

(i) Phototropism
(ii) Hydrotropism
(iii) Geotropism
(iv) Thigmotropism
(v) Chemotropism

THE IMPORTANCE OF TROPIC AND NASTIC RESPONSES

PHOTOTROPISM

Is the plant growth movement in response to light.

- Most plant shoots are said to be positively phototropic because they tend to grow towards light.
- Most roots are negatively phototropic because they grow away from light.

Importance of phototropism to plants

(i) It places the leaves in a position to maximize light absorption, thereby enhancing photosynthesis.
(ii) Etiolation enables seedlings germinating in dark areas to grow fast and reach for light before exhausting their stored food reserves.

EFFECTS OF AUXINS ON PHOTOTROPISM

In an experiment it was revealed that:

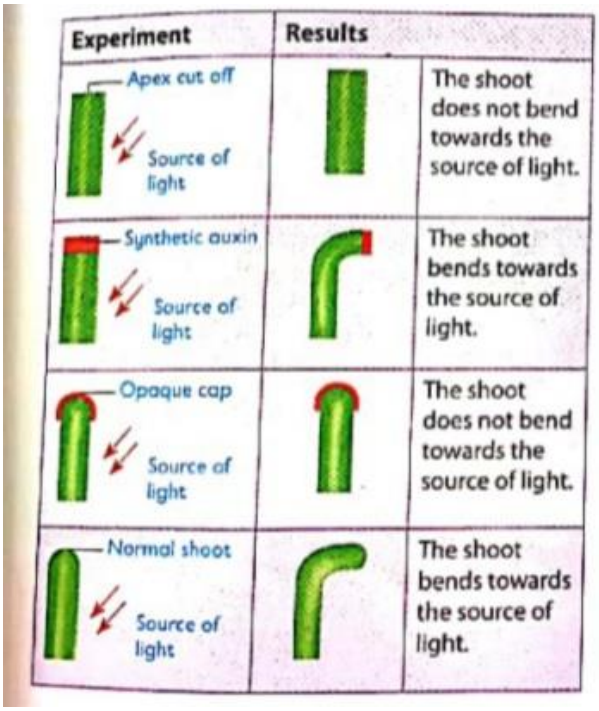
- If a shoot is exposed to light from one direction only, the shoot bends towards the source of light because light detected at the shoot apex causes unequal distribution of auxins. Light causes auxins to migrate to the dark side. Auxins on the dark side become more

concentrated than on the side where the light is coming from. The cells on the dark side grow faster and elongate than the ones on the side where the light is coming from. As a result, the shoot bends towards light

NB: Light stimulus is detected at the shoot apex because of the presence of auxins.

- If a shoot is exposed to the place where there is equal distribution of light, it grows straight upwards because auxins produced at the shoot apex migrate uniformly down the shoot. Hence, promote equal growth rate of `8all cells in the zone of elongation, bringing about normal increase in the height of the shoot.
- If a shoot whose apex has been cut or covered with aluminium foil or opaque cap is exposed to unilateral light, the shoot grows straight upwards because shoot whose have been cut or covered does not respond to light.
- Plants grow taller and faster in the dark because auxins are not destroyed by light.
- Plants which have long weak stems, small leaves and lack chlorophyll is said to be **etiolated**
- **Etiolation:** is a condition resulted from a plant growing in insufficient light, and is yellow, thin and taller than normal.

THE TABLE BELOW DEMONSTRATING EFFECT OF LIGHT ON A PLANT SHOOT



Question: Why plants grow taller and faster in the dark area?
Answer: Because auxins are not destroyed by light.

GEOTROPISM

Is the growth movement in response to the force of gravity.

- Most roots grow towards the direction of the force of gravity and are said to be **positively geotropic.**
- Most shoots grow away from the force of gravity and are said to be **negatively geotropic.**

Importance of geotropism to plants

(i) It enables plant roots to absorb water and mineral salts from the soil.

(ii) It ensures anchorage of the plant in soil to prevent it from falling over or being swept away.

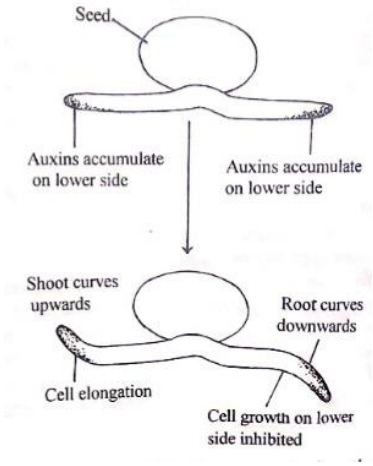
(iii) It enables the shoot to grow upwards in order to exposes the plant leaves to sufficient light for photosynthesis.

EFFECTS OF AUXINS ON GEOTROPISM

In an experiment it was revealed that:

- When a seedling is placed horizontally, auxins accumulate on the lower side due to the force of gravity.
- The lower side of the root and shoot have more auxins than the upper side,
- High concentrations of auxins stimulate growth of the shoot but inhibit growth of the root.
- The lower side of the shoot elongates more than the upper side and the shoot curves upwards.
- The upper side of the root grows faster than the lower side and the root curve downwards.
- Hence, the root is positively geotropic while the shoot is negatively geotropic.

Consider the diagram below showing geotropism response

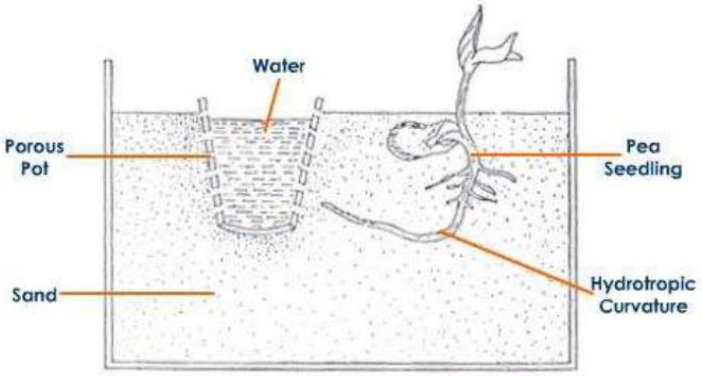


HYDROTROPISM

Is the growth movement in response to water or moisture.

- Roots grow towards moisture and are said to be **positively hydrotropic.**
- When seed planted near a water source such as porous pot or river, the roots of the seedling will always grow towards water.

- Auxins at the tip of the root influence growth towards moisture as shown in the figure below:-



Plant roots growing towards water

IMPORTANCE OF HYDROTROPISM

(i) It enables the plants to absorb dissolved minerals and water.

Water is necessary for various functions such as:

- Photosynthesis
- Numerous physiological reactions that take place within plant cells.
- Turgor pressure, which aids in plant support.
- Dissolution of mineral salts.

CHEMOTROPISM

Is the growth movement in response to a unilateral source of chemicals.

- Example, during the process of fertilization the pollen tube grows through the style towards the ovule

IMPORTANCE OF CHEMOTROPISM

(i) It enables plants to absorb mineral salts from the soil when the roots grow towards beneficial chemicals such as fertilizers.

(ii) It facilitates the fertilization process in flowering plants.

THIGMOTROPISM OR HAPTOTROPISM

Is the response of plant organs to the stimulus of touch.

- It is mostly exhibited by weak-stemmed plants. Example passion fruits and morning glory
- The tendrils of climbing plants bend or twine round a support as a positive response to touch.
- The leaves of Mimosa pudica close in response to touch.
- Root tips grow away from stones or other obstacles. This is negative haptotropism.

Importance of thigmotropism

(i) It helps climbing plants to expose their leaves to sunlight for optimum photosynthesis.
(ii) Enables plants with weak stems to obtain mechanical support.
(iii)It enables the insectivorous plants such as the Venus flytrap to trap insects and digest them to obtain nutrients.

EFFECTS OF AUXINS ON THIGMOTROPISM

- When tendrils or stems of climbing plants come into contact with a suitable hard object, the contact causes them to curve and coil round the object.
- Contact influences the migration of auxins from the contact surface.
- The side in contact with object has less auxins so the cells on that side undergo less elongation and therefore less growth.
- The outer side away from the point of contact has a higher concentration of auxins, promoting faster growth.
- This causes the shoot to continue coiling round the object.

Consider the diagram below showing a climbing plant coiled around a support

NASTIC MOVEMENT

These are non-directional movement of plant organs in response to diffuse stimuli

- ◊ Nastic movements are independent of external stimuli
- ◊ Nastic movements occur as a result of changes in turgor pressure in a certain cells.

Example of nastic movement

- ◊ Folding of leaves in warm weather conditions
- ◊ Opening and closing of flowers in response to intensity of light.
- ◊ Closing of leaves when touched

TYPES OF NASTIC RESPONSE

(i) **Nyctinasty or thermonasty** – is a plant movement in response to temperature changes.

(ii) Photonasty – is the plant movement in response to light intensity changes.

(iii) **Seismonasty** – is the plant movement in response to shock or vibrations

(iv) **Hydronasty** – is the plant movement in response to changes in atmospheric humidity.

(v) **Haptonasty** – is the plant movement in response to contact. E.g. Mimosa pudica respond to touch

(vi) **Chemosnasty** – is the plant movement in response to chemicals

TACTIC MOVEMENT

Is the movement of a whole organism in response to an external directional stimulus.

- Tactic movements are known as **taxis**

TYPES OF TACTIC RESPONSES

(i) **Phototaxis** – is the locomotary response to light

(ii) **Chemotaxis** – is the locomotary response to chemicals

(iii) **Aerotaxis** – is the locomotary response to variations in oxygen concentration

(iv) **Rheotaxis** – is the locomotary response to direction of water currents

(v) **Magnetotaxis** – is the locomotary response to magnetic field

(vi) **Thermotaxis** – is the locomotary response to temperature changes

(vii) **Osmotaxis** – is the locomotary response to variations in osmotic pressure

OTHER PLANT HORMONES

GIBBERELLINS

These are mixture of chemical compounds which have an effect on plant growth.

Example of gibberellins

- Gibberellic acid

Roles of gibberellins

(i) Promotes cell elongation and differentiation

(ii) Promotes fruit formation and growth

(iii) Breaks seed dormancy

(iv) They stimulate rapid growth in dwarf varieties of a certain plants.

CYTOKININS

These are active growth substances which promote growth in plants in the presence of auxins.

- They are widely distributed within plants especially in roots.

Roles of cytokinins

(i) Promote cell division by inducing growth of roots.
(ii) They break seed dormancy
(iii) Stimulate opening of stomata
(iv) Promote cell enlargement

ETHYLENE

Is a gaseous hormone and the only hormone in gaseous state in plants.

- It is produced by fruits when it is about to ripen.

Roles of ethylene

(i) Promotes ripening of fruits
(ii) Inhibits stem growth
(iii) Break bud dormancy

ABSCISIC ACID

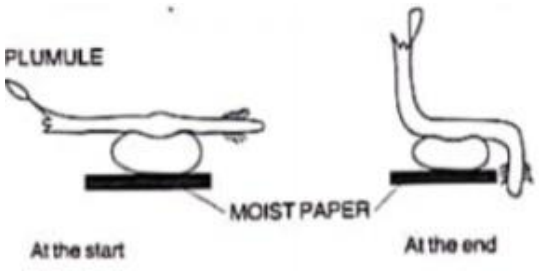
Is a hormone which inhibits growth in plants

Roles of abscisic acid

(i) It promotes falling off of leaves and fruits a process called abscission
(ii) Promotes aging
(iii) When applied to seeds causes natural dormancy in seeds.

REVISION QUESTIONS

1. An experiment was set up a shown below:

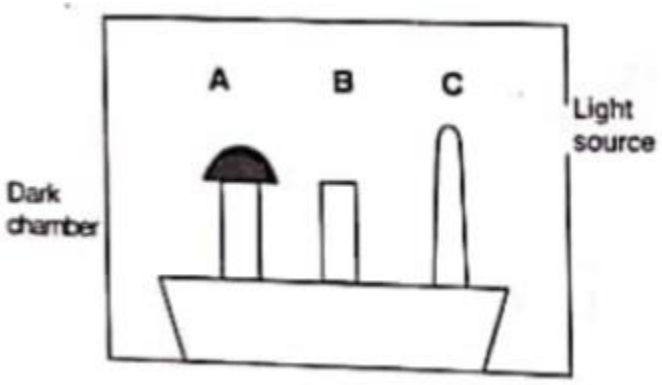


a) Suggest a possible aim of this experiment
b) State the response shown by:-
    (i) Plumule
    (ii) Radicle
c) Account for the response in b (i) and (ii)

2. The diagram below shows a stem of a plant growing round a tree trunk

a) State the name given to this type of response

3. The diagrams below represents three seedlings grown in a dark chamber with unilateral light source



A had the shoot covered with a tin cup while B had the apex cut off and C was left intact. State the results on shoots A, B and C by the end of the experiment and give reasons for your answer

4. Explain the following observations
    a) Lighting a shoot from one side makes it bend towards light.
    b) The shoot of a seedling kept in dark placed sideways (horizontal) grows upwards while its roots grow downwards.

EXCRETION

Excretion

Is the removal of metabolic waste products from the body of an organism.

Egestion (defecation)

Is the removal of undigested food from the alimentary canal through anus.

QUESTION: Why defecation is not excretion?

Answer: Because it involves the removal of undigested food materials from the body which are not metabolic wastes as excretion.

Secretion

Is the production and release of useful material in the body of an organism.

Example of useful material

- Enzymes
- Hormones
- Mucus

IMPORTANCE OF EXCRETION

(i) It helps to remove waste product and toxic materials e.g. urea, carbon dioxide gas etc.

(ii) It eliminates the excess materials from our body, like, soluble vitamins, drugs.

(iii) Maintain the pH of body fluids by removing excess bile pigment through liver.

(iv) Maintains water balance in the body. Excess water is removed as sweat or urine.

(v) Regulation of blood pressure by removing excess salt and water in the body.

(vi) It gives chance for absorption of other materials.

(vii) Regulates the salt content in the body.

EXCRETORY PRODUCTS

Are the waste products produced from metabolic activities of the body.

THE MAJOR EXCRETORY PRODUCTS

The major excretory products are;-

(i) Carbon dioxide

(ii) excess water

(iii) Nitrogenous compounds like ammonia, urea, uric acid, etc.

Other excretory products include:

- chemicals from medicines
- toxic substances
- Hormones

THE TABLE BELOW DESCRIBE VARIOUS EXCRETORY PRODUCTS ELIMINATED BY ORGANISMS

◊ **Carbon dioxide**

This is a by-product of respiration of both plants and animals.

◊ It is excreted through stomata in plants

◊ In man, carbon dioxide is eliminated from the body by **lungs**

◊ **Excess Water:**

Excess water is lost from the surface of gaseous exchange in both plants and animals.

◊ In mammals, water is also lost through **sweat, water vapour or urine**

◊ **Nitrogenous wastes**

Are wastes formed from the breakdown of excess proteins and amino acids.

- Amino acids cannot be stored in the body because their accumulation is toxic.
- **Deamination** is the process whereby excess proteins and amino acid are broken down in the liver to form ammonia.

FORMATION OF AMMONIA AND UREA

(i) Amino group is removed from amino acid to form ammonia

(ii) Ammonia formed combine with carbondioxide from respiration to form urea($CO(NH_2)_2$).

TYPES OF NITROGENOUS WASTE

The main nitrogenous wastes excreted by living things are:

(i) Ammonia

(ii) Urea

(iii)Uric acid.

(I) AMMONIA

This waste is the results of broken down proteins and amino acid in the liver.

- Ammonia is high toxic and soluble in water
- It requires a large amount of water to be eliminated.
- Ammonia is excreted mostly by aquatic organisms e.g. fish, amphibians

NB: Organisms that excrete ammonia are called **ammoniotelic**

(II) UREA

Isthe nitrogenous waste formed when ammonia combine with carbon dioxide in the liver.

- Urea is less toxic and less soluble in water.
- It does not require a large amount of water to be eliminated.
- Urea is excreted by many aquatic and terrestrial animals. Eghuman being.

(III) URIC ACID

Is a major nitrogenous waste of terrestrial animals such as birds, reptiles, and insects.

- Uric acid is much less toxic and insoluble in water.
- It requires less amount of water to be eliminated

NB: Animals that excrete uric acids as their waste product are called **uricotelic animals**

EXCRETION IN HUMAN

In human, the removal of excretory products is done through excretory organs.

EXCRETORY ORGANS

Are special organs concerned with removal of excretory products.

The following are excretory organs in an animal's body:

(i) The kidney
(ii) The skin
(iii) The lungs
(iv) The liver.

The table below shows excretory organs and its corresponding excretory products

ORGAN	EXCRETORY PRODUCT
LUNGS	(i) Carbon dioxide
	(ii) Excess water
KIDNEYS	(iii) Urea and salts, excess water
SKIN	(iv) Excess water, urea and mineral salts like NaCl
LIVER	(v) Urea and bilirubin(bile) or bile pigments from breakdown haemoglobin

THE ROLE OF THE SKIN, LIVER AND KIDNEYS IN EXCRETION

Functions of the skin in excretion

(i) It has **sweat glands** which excrete excess water, minerals salts, and traces of urea.

Functions of the liver in excretion

(i) Detoxification
(ii) Deamination

NB: Detoxification: is the process whereby toxic and harmful substances are made harmless by the liver cells.

Other functions of the liver

(i) Production of bile
(ii) Storage of vitamins. E.g. fat-soluble vitamins A,D, E and K
(iii) Carbohydrate metabolism
(iv) Production of heat

(v) Hormone breakdown
(vi) Breakdown of red blood cells
(vii) Storage of blood

Function of the lungs in excretion

(i) It helps in the removal of carbon dioxide from the body through **exhalation**.

URINARY SYSTEM AND ITS ADAPTIVE FEATURES

THE URINARY SYSTEM

Is a system concerned with production, storage and removal of urine.

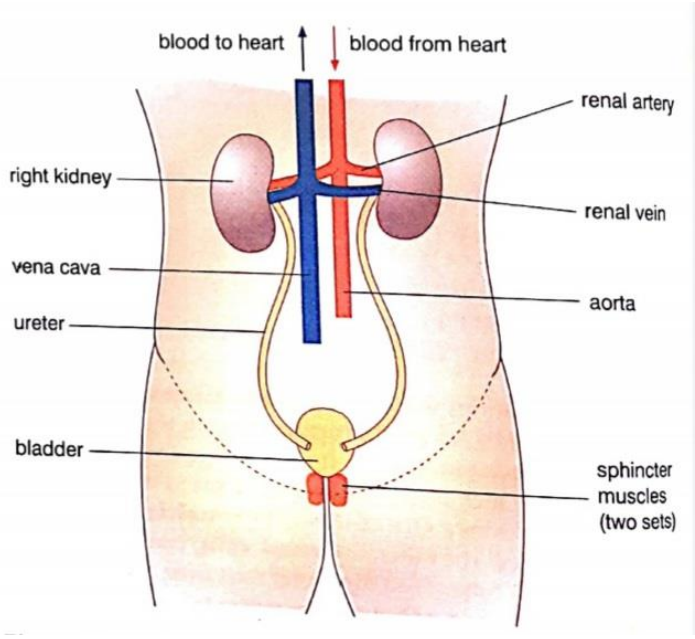
FUNCTIONS OF THE URINARY SYSTEM

(i) Excretion of nitrogenous metabolic waste products such as ammonia and urea.
(ii) Regulates the concentration of salts in the body fluids.
(iii) Maintains balance of water in the blood.
(iv) Plays a role in controlling blood composition, blood pressure and volume of plasma.

Components of the urinary system

(i) Kidneys
(ii) Ureters
(iii) Blood vessels
(iv) Urinary bladder
(v) Urethra
(vi) Sphincter muscles

DIAGRAM OF HUMAN URINARY SYSTEM



1. URETERS

Is the pair of ducts or tubes that carries urine from the kidneys to the bladder.

- ◊ Ureters wall consist of smooth muscles which contract to force urine downward, away from the kidneys.

2. URINARY BLADDER

Is the muscular sac that stores urine temporary before excreted out of the body.

3. SPHINCTER MUSCLES

Are the circular muscles that help to keep urine from leaking by closing tightly around the opening of the bladder

4. URETHRA

Is a tube which carries urine from the bladder to outside the body.

- ◊ **In female**, urethra carry urine outside the body
- ◊ **In male**urethra carry urine and sperm outside the body.

5. KIDNEYS

Are the bean-shaped organs which help the body to eliminate urea in form of urine.

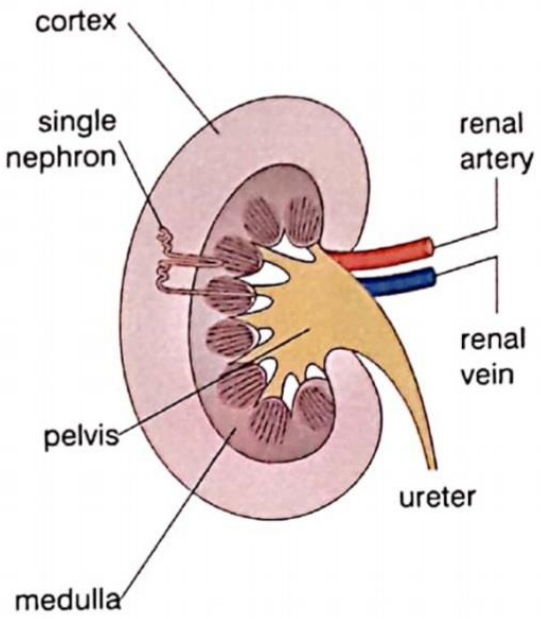
- ◊ The kidneys are the main organs of excretion.
- ◊ Each kidney is enclosed in a thin, fibrous covering called the **capsule**.

LAYERS OF THE INTERNAL STRUCTURE OF THE KIDNEYS

The kidney has three distinct regions, namely;-

(i) The **cortex**
(ii) The **medulla**
(iii)The **pelvis**

DIAGRAM OF THE INTERNAL STRUCTURE OF THE KIDNEY



THE CORTEX

Is the outermost layer of the kidney.

- ◊ It contains billions of **glomeruli** where blood is filtered.

THE MEDULLA

Is the middle layer of the kidney, normally red in color

- ◊ It consists of billions of **loops of Henle** where the amount of salt and water are controlled.
- ◊ The surface of medulla is folded to form projections called **pyramids.**

THE PELVIS

Is the space inside the kidney which collects the urine and leads it to the ureter.

FUNCTIONS OF THE KIDNEY IN EXCRETION

(i) They help to remove excess water and dissolved urea in form of urine from the blood.
(ii) They maintain appropriate water-salt balance in the blood.
(iii) They are important in regulation of blood pressure.
(iv) They filter blood to remove wastes and reabsorb useful substances such as water and salts.
(v) Absorbing minerals.

6. RENAL ARTERY

Is the blood vessel that carries blood from aorta to the kidneys.

- ◊ Blood carried toward the kidneys contains more urea than that blood carried away from the kidneys

7. RENAL VEIN

Is the blood vessel that carries blood away from the kidney where waste products have been removed

Some animals do not have a well developed kidney, they have structures called **nephridia.**

- ◊ **Nephridia** have the same role as the nephron in the kidneys.

Example of animals that use nephridia as their excretory organ

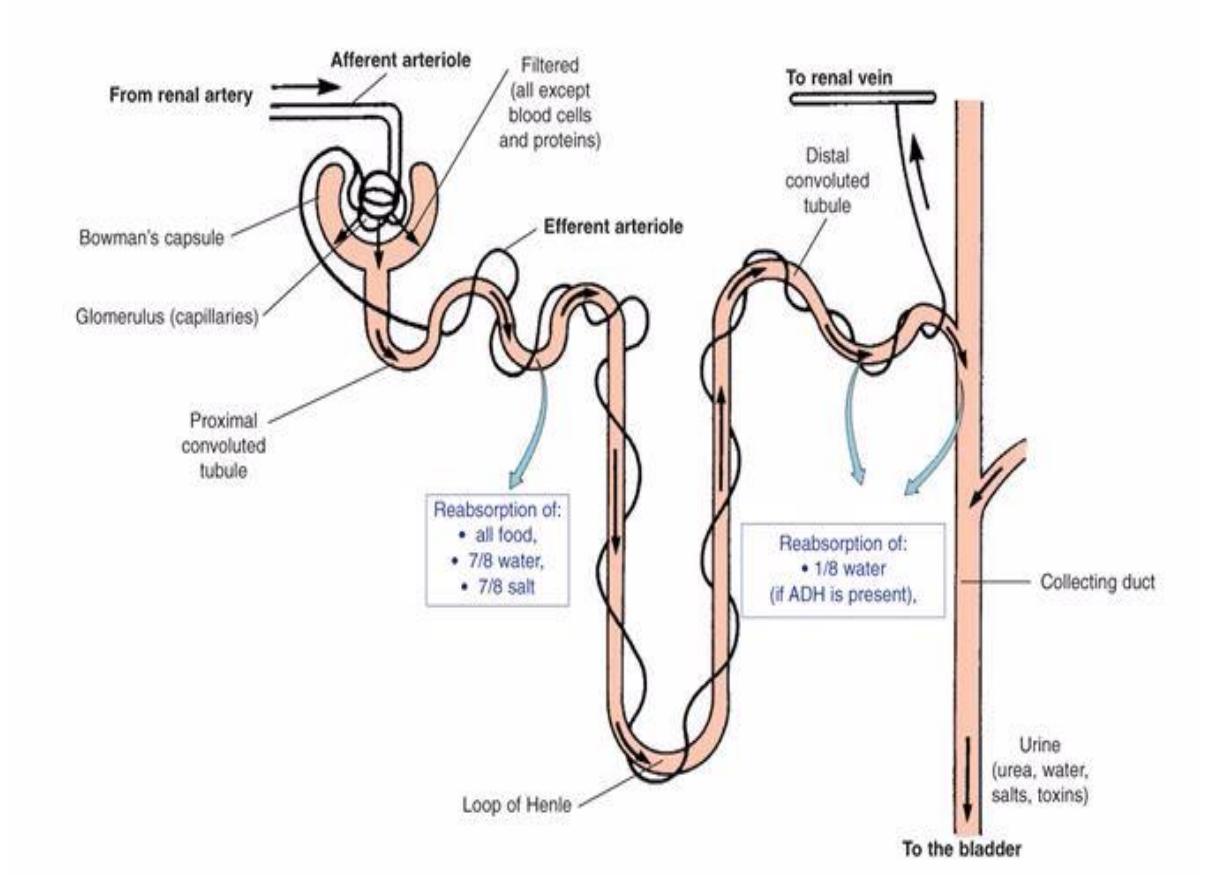
- ─ Earthworm

NEPHRON

is the structural and functional unit of the kidney.

- ◊ It act as filters and remove the waste products from blood and forms urine.
- ◊ Each kidney possesses a large number of nephrons approximately one million.

DIAGRAM OF NEPHRON



PARTS OF NEPHRON

Each nephron is divided into two portions.

(a) Malpighian body or organ

(b) Renal tubules.

(a) **MALPIGHIAN ORGAN**

Is the anterior rounded part of the nephron.

- ◊ Malpighian organ is formed of two parts, namely:
  - (i) Glomerulus
  - (ii) Bowman's capsule

NB: Glomerulus and Bowman's capsule together are called **Malpighian body or Malpighian Organ.**

(i) GLOMERULUS

Is a fine interconnected network of blood capillaries enclosed by Bowman's capsule.

Functions/Roles of glomerulus

- ◊ It receives and filters blood from afferent arteriole.

AFFERENT ARTERIOLE

Is the branch of renal artery which carries blood to the glomerulus

Function of afferent arteriole

- ◊ Carries blood to the glomerulus

EFFERENT ARTERIOLE

Is the branch of renal artery which carries blood away from the glomerulus to different part of the body.

Function of efferent arteriole

- ◊ Carries bloodwith large particles away from the glomerulus to different part of the body.

(ii) BOWMAN'S CAPSULE

Is a round cup-shaped structure that encloses the glomerulus.

Function/role of Bowman's capsule

- ◊ It serves as a filter to remove organic wastes, excess inorganic salts, and water.

RENAL TUBULE

Is the duct like tubule behind the Bowman's capsule

- ◊ The renal tubule is divided into four regions, namely;
  - (i) Proximal convoluted tubules
  - (ii) Loop of Henle
  - (iii) Distal convoluted tubule
  - (iv) Collecting duct

(i) **PROXIMAL CONVOLUTED TUBULE**

Is highly coiled tubule that extends from Bowman's capsule to the descending loop of Henle.

Function/Role of proximal convoluted tubule

- ◊ It helps in reabsorption of **glucose**, **amino acid**, **potassium** and **calcium ions**.

(ii) **LOOP OF HENLE**

Is the U-shaped part of the nephron.

Function/Role of loop of Henle

- ◊ It helps to reabsorb water and salt (Nacl).

NB:

- ◊ Animals with long loop of Henle store large amount of water in their body for long period of time.
- ◊ It is one of the adaptivefeature for animals living in desert area.

PARTS OF LOOP OF HENLE

Loop of Henle is divided into two parts namely:

(i) Descending loop of Henle
(ii) Ascending loop of Henle.

(i) **DESCENDING LOOP OF HENLE**

This part is permeability to water.

Function

- ◊ To reabsorb water

(ii) **ASCENDING LOOP OF HENLE**

This part is permeability to sodium ions.

Function

- ◊ To reabsorb sodium ions

(iii)**DISTAL CONVOLUTED TUBULE**

Is more highly coiled tubule that extends from the loop of Henle to the collecting duct.

Function/Role of distal convoluted tubule

- ◊ To reabsorb sodium ions and water

(iv)**COLLECTING DUCT**

Is tube that directs urine into the renal pelvis of the kidney for drainage into the ureter.

ROLES OF THE NEPHRON IN EXCRETION

(i) At the distal convoluted tubule and collecting duct water re- absorbed under the influence of ADH.
(ii) The afferent arteriole entering the Bowman's capsule is wider than the efferent arteriole leaving it. This creates high pressure at the glomerulus.
(iii) Used in the process called ultrafiltration. Whereby liquid part of the blood with dissolved substances (urea, glucose, salts and amino acid) forced out into the cavity of Bowman's capsule.
(iv) Reabsorption of salts such as Na+ ions and water at the loop of Henle under the influence of the aldosterone hormone.

ADAPTATIONS OF THE URINARY SYSTEM TO ITS FUNCTIONS

(i) The urinary system has a large afferent arteriole, and narrow efferent arteriole, which allows build up of pressure, thus facilitating ultra-filtration.
(ii) The glomerulus capillaries are highly coiled and semi permeable, causing a build up of pressure in the glomerulus hence ultra filtration.

(iii) The glomerular capillaries are semi permeable to allow selective movement of materials in and out of the nephron (selective reabsorption).

(iv) The tubules' epithelium is thin (1 cell thick) to reduce diffusion distance for faster passage and hence reabsorption of materials; and they are and leakier than normal capillaries.

(v) It is connected to a collecting duct, which channels the filtrate (urine) out of the nephron to the ureter to allow for continous functioning of the nephron.

(vi) The proximal convoluted tubule and the distal convoluted tubule are coiled so as to increase the nephrons's length and hence more surface area for efficient reabsorption to take place.

(vii) The Bowman's capsule is cup-shaped to provide maximum surface area for filtration.

(viii) The tubule is supplied with a network of blood capillaries for maximum reabsorption.

(ix) The nephrons are numerous in number for efficient excretion of waste products.

THE PROCESS OF URINE FORMATION

The process of urine formation in the body involves three steps, namely:

1. Ultrafiltration
2. Selective reabsorption
3. Removal of urine

1. ULTRAFILTRATION (GLOMERULAR FILTRATION)

This involves forcing out liquid part of the blood into the cavity of Bowman's capsule.

The process occurs as follows

- ◊ The blood from renal artery carrying the urea, plasma, proteins, mineral ions, blood cells, dissolved food substances, hormones and oxygen enters the nephron through the afferent vessel.
- ◊ The afferent vessel entering the glomerulus is wider than the efferent vessel leaving the glomerulus.
- ◊ The narrowness of efferent vessel produces a resistance to blood flow and hence creating a high pressure in the glomerulus.
- ◊ Due to the high pressure in the glomerulus the liquid part of the blood and dissolved substances of small molecular sizes such as urea, glucose, amino acids, salts, uric acid, vitamins, and hormones are forced out of the glomerulusinto the Bowman's capsule.
- ◊ The large sized molecules such as proteins and blood cells are not filtered because the walls of the capillaries of the glomerulus and Bowman's capsule have very small pores.
- ◊ The filtrate formed during this process is called glomerular filtrate.

NB: The blood that remains rich in plasma proteins and blood cells has very little water.

2. SELECTIVE REABSORPTION

This involvesturning back ofuseful substances into the blood capillaries.

- During this process as the glomerular filtrate is flowing along the renal tubule, most of the filtered substances which are useful in the body are selected and reabsorbed back into the blood.

Selective reabsorption occurs along the renal tubules as follows

- ◊ The glomerular filtrate from the Bowman's capsule enters the proximal convoluted tubule whereby all Glucose, amino acid, vitamins, hormones and 80% of water and salts are reabsorbed through the process of active transport.
- ◊ From the proximal convoluted tubule, the glomerular filtrate flows into the loop of Henle whereby 5% of water and most salts are reabsorbed through the process of osmosis and active transport.
- ◊ From the loop of Henle, the filtrate moves to distal convoluted tubule where most of salts and water are reabsorbed.
- ◊ The remaining filtrate is now called urine.

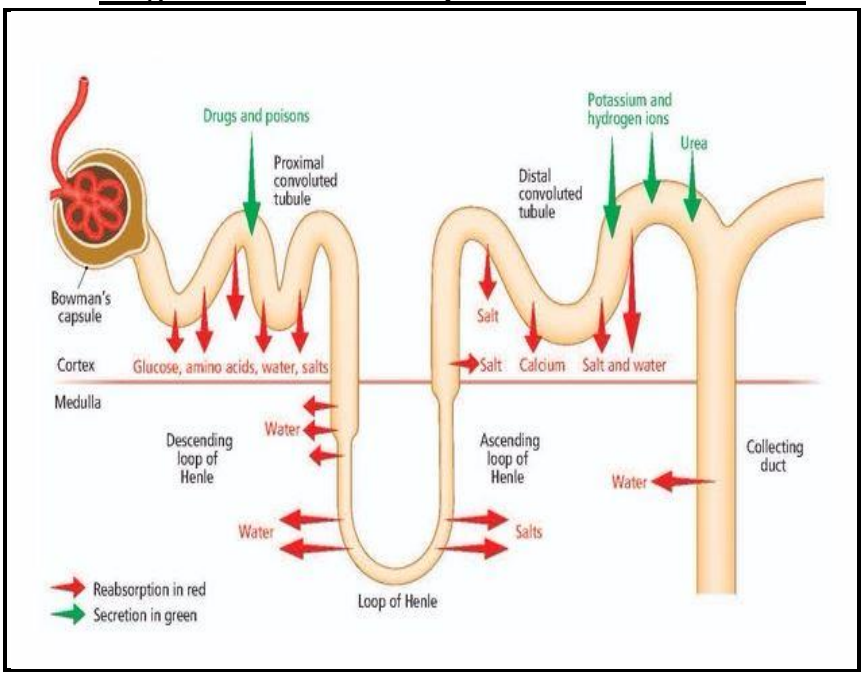
3. SECRETION

- ◊ The process where substances move out of the blood into the renal tubules (nephron).
- ◊ Secretion takes place at distal convoluted tubule where potassium and acid in the form of hydrogen ions, are removed from the blood by the distal convoluted tubule, and are then added to the urine.

REMOVAL OF URINE

- ◊ From the distal convoluted tubule, the urine moves to the collecting tubules.
- ◊ From the collecting tubules the urine flows down into the collecting duct where it joins urine from collecting tubules of other nephrons.
- ◊ The urine then flows into the pelvis via the pyramids and is finally emptied into the urinary bladder via the ureter.
- ◊ When the bladder is full, the sphincter muscles relaxes and urine is allowed to pass out of the body via urethra.

Diagram to illustrate the process of urine formation



NB:

- ◊ The process by which urine is passed out from the body is known as urination.
- ◊ Human produce approximately 1.5 litres of urine per daily but may vary depending on the amount of liquid taken.

COMPONENTS OF URINE

Components	Amount in %
Water	95%
Urea	2%
Salts	1.4%
Creatinine	0.1%
Ammonia	0.04%
Uric acid	0.003%

POSSIBLE EXAMINATION QUESTIONS

1. Explain why:
   (i) Desert animals have a long loop of Henle and fewer glomeruli.
   (ii) Proximal convoluted tubule is coiled.
2. Describe how the following are excreted from plants
   (i) Carbon dioxide
   (ii) Oxygen
   (iii)Water

3. The following table shows the approximate concentration of a certain substance in blood plasma, glomerular filtrate and urine. Study the table below carefully and answer the questions that follow.

Substance	%inbloodplasma	% in glomerularfiltrate	%in urine
Water	90	90	94
Protein	6.5	0	0
Urea	0.03	0.08	1.8
Glucose	0.1	0.1	0
Blood cells	7.0	0	0

(a) Briefly explain why the concentrationof protein and blood cells in glomerular filtrate and urine is zero?

- ◊ Because protein and blood cells are not filtered due to their large molecule size
- ◊ Because the walls of the capillaries of the glomerulus and Bowman's capsule have very small pores.

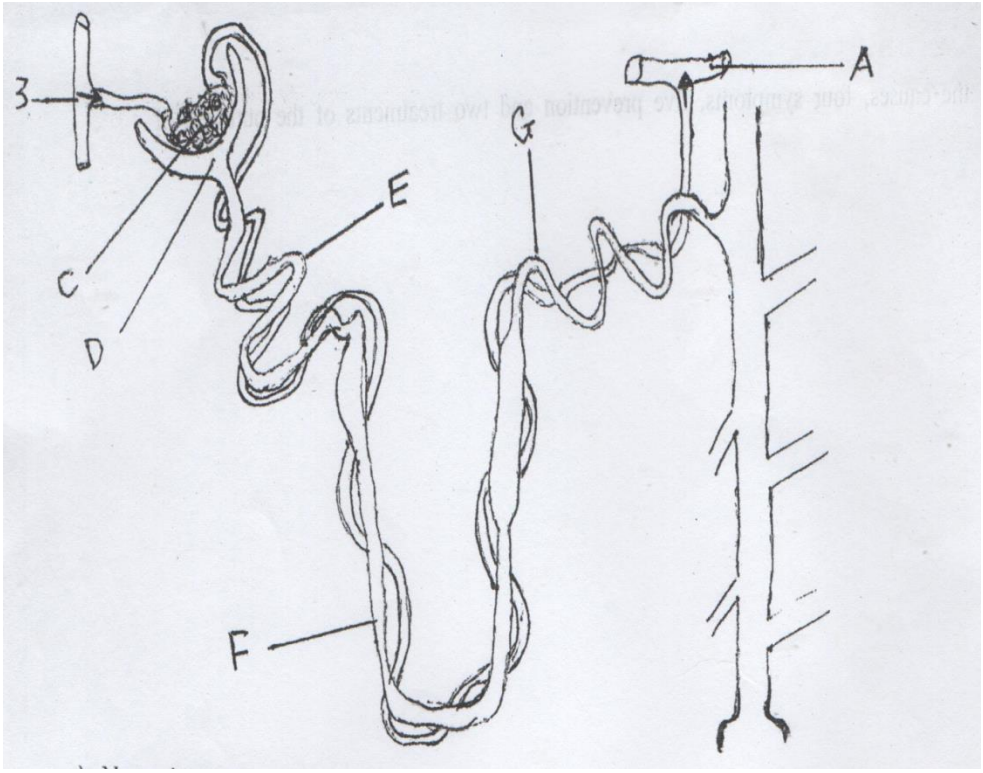
(b) Briefly explain why there is no glucose in urine?

- ◊ Becausein proximal convoluted tubule all glucose are reabsorbed into blood capillaries.

(c) By how many times is urea ore concentrated inurin ethane glomerular filtrate?

(d) Explainwhythereisgreatconcentrationofureainurinethaninglomerularfiltrate

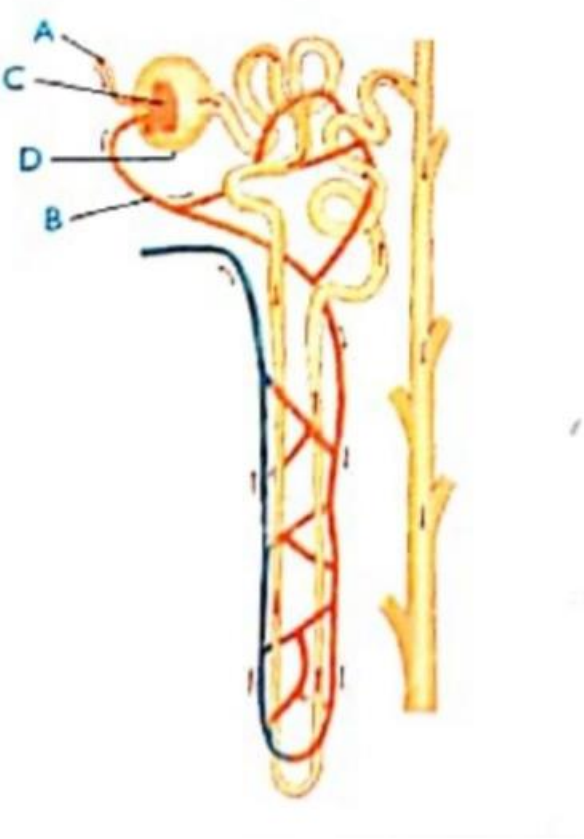
4. Study the diagram below and answer the questions that follow:



a) Name the part A to G
b) Name the process which takes places between C and D
c) Name three materials reabsorbed at E and two at G
d) What is the function of F during urine formation

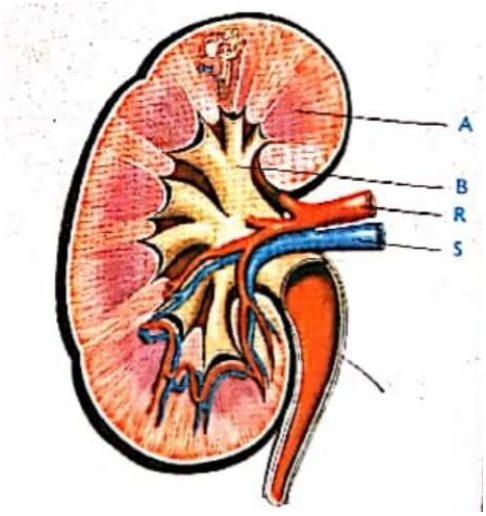
5. Explain what happens to excess amino acids in the liver.
6. Draw a well labelled diagram of human urinary system and state the function of each part.
7. Explain what will happen to a human being if:
   (i) Glomeruli are reduced to only few.
   (ii) The pores of the skin are blocked
   (iii)The pancreas does not produce enough insulin.

8. The diagram represents the nephron. Use it to answer the questions that follow;



   (i) Name the parts labelled A, B, C and D
   (ii) Name the fluids founds in C and D
   (iii)What eventually happens to the fluid in D?

8. Explain how the urinary system is able to carry out its functions
9. The diagram below represents a mammalian kidney. Study it carefully and answer the questions that follow.



(a) Before the drains into the ureter, it is collected at part…….
(b) Blood vessel R carries blood from……. to ……..
(c) Blood vessels S is called……..

10. Define the term
    (i) Excretion
    (ii) Secretion
    (iii) Deamination
    (iv) Nephron

COMPLICATIONS AND DISORDERS OF THE EXCRETORY SYSTEM

The following are the common complications and disorders of the excretory system

1. Gout
2. Kidney failure
3. Kidney stone
4. Urinary tract infections (UTIs)
5. Liver cirrhosis
6. Hepatitis
7. Bladder Cancer

1. KIDNEY (RENAL) FAILURE

Is the failure of the kidney to function adequately due to partial or entire destruction of nephrons

Causes of kidney failure

- ◊ Damage to the kidney due to accident or complications during surgery
- ◊ Low blood volume due to excessive bleeding
- ◊ Poor intake of fluids
- ◊ Medication, for example, diuretics ("water pills") may cause excessive water loss
- ◊ Obstruction of renal artery, causing blocking of blood flow to the kidneys
- ◊ Kidney stones

- ◊ Chronic diseases that gradually cause the kidneys to stop functioning
- ◊ Dehydration from loss of body fluid (for example, vomiting, diarrhoea, sweating, fever)
- ◊ Prostate cancer may block the urethra and prevent the bladder from emptying

Symptoms of kidney failure

- ◊ Oedema (swelling of the legs, ankles, feet, face or hands due to excess fluids)
- ◊ High levels of urea in blood leading to vomiting, nausea, weight loss, blood in urine or difficulty in urinating.
- ◊ Loss of appetite
- ◊ Shortness of breath

Effects of kidney failure

- ◊ Bone damage
- ◊ Muscle paralysis
- ◊ Abnormal heart rhythm
- ◊ Loss of memory
- ◊ Pain in the back or side
- ◊ If not treated earlier, can lead to death if it involves both kidneys

Prevention/treatment of kidney failure

- ◊ Avoid potassium-rich foods like citrus fruits, bananas, instant coffee, peanuts and chocolate
- ◊ May require a kidney transplant.
- ◊ Medications e.g. phosphorus-lowering medications.
- ◊ Dialysis-The use of semi-permeable membrane to separate large molecules from small ones, used in kidney dialysis machines to remove urea from blood

2. KIDNEY STONES

Are small, hard mineral deposits that form in the pelvis region of the kidneys which can obstruct the flow of urine.

Causes of kidney stones

- ◊ Inadequate intake of water
- ◊ Certain types of drugs
- ◊ Lack of vitamins
- ◊ Dehydration from loss of body fluid (for example, vomiting, diarrhoea, sweating, fever).
- ◊ Decrease in urine volume and/or an excess of stone-forming substances in the urine.
- ◊ Infection in the urinary tract gradually cause the kidneys to stop functioning
- ◊ Obstruction to the flow of urine
- ◊ Prostate cancer may block the urethra and prevent the bladder from emptying.

Symptoms of kidney stones

- ◊ Extreme pain and difficulty in urination
- ◊ Pain in the low back and/or side, groin, or abdomen

- ◊ Blood in the urine due to damage of the inside walls of the kidney, ureter or urethra
- ◊ Nausea and vomiting
- ◊ Chills and fever

Effects of kidney stones

- ◊ May lead to kidney failure
- ◊ Toxicity due to urine staying in the body for a long time.
- ◊ Severe back pain
- ◊ Surgery and medications are expensive.

Prevention/treatments of kidney stones

- ◊ Taking a balanced diet that is low in protein, nitrogen and sodium
- ◊ Drinking plenty of water
- ◊ Avoid beverages that contain caffeine like coffee.
- ◊ Surgical treatment to remove the stones
- ◊ May require kidney transplant
- ◊ Medications (painkillers).

3. URINARY TRACT INFECTIONS (UTIs)

Is an infectionof the urinary system. This type of infection can involve urethra, kidney, bladder and ureters.

- ◊ Most infection involves the lower urinary tract such as bladder and urethra.
- ◊ Women are at greater risk of developing a UTI than men.

Causes of urinary tract infections

- ◊ Bacterial infection in the urinary tract

Symptoms of urinary tract infections

- ◊ Frequent feeling to urinate
- ◊ Pain during urination
- ◊ Cloudy urine
- ◊ Passing frequent, small amounts of urine.
- ◊ Strong-smelling urine.

Effects of urinary tract infections

- ◊ Medications are expensive.
- ◊ Pain and nuisance due to urge to urinate frequently.

Prevention/treatment of urinary tract infections

- ◊ Drinking a lot of fluids
- ◊ Maintaining toilet hygiene
- ◊ Complete urination
- ◊ Cleanse genital area before sex
- ◊ Urinate after sex to flush away any bacteria that may have entered your urethra
- ◊ Keep genital area dry by wearing cotton underwear and loose-fitting clothes

4. LIVER CIRRHOSIS

Is a condition in which liver cells degenerate and are replaced by scar tissue, causing the liver to shrink, harden, become fibrous and fail to function normally.

Causes of liver cirrhosis

- ◊ Alcohol and viral hepatitis B and C
- ◊ Attack by bacteria and viruses
- ◊ Parasites such as liver flukes and schistosoma
- ◊ Obstruction of the gall bladder
- ◊ Exposure to chemical poisons such as silica and asbestos

Symptoms of liver cirrhosis

- ◊ Loss of weight
- ◊ Poor appetite
- ◊ Abdominal pain
- ◊ Blood stained vomit

Effects of liver cirrhosis

- ◊ Severe cirrhosis is fatal
- ◊ Easy bruising, yellowing of the skin (jaundice), itching, and fatigue.
- ◊ Oedema, ascites (accumulation of fluid in the abdominal cavity), and liver cancer

Prevention/treatment of liver cirrhosis

- ◊ Avoiding excess consumption of alcohol
- ◊ Avoiding fatty food
- ◊ Low salt intake
- ◊ Eating varied, easily digestible food
- ◊ Plenty of rest
- ◊ Medical treatment
- ◊ Liver transplant in case of severe cirrhosis

5. HEPATITIS

Is an inflammation of the liver caused by viruses

- ◊ Hepatitis is of the three forms, Hepatitis A, Hepatitis B and Hepatitis C

Causes of Hepatitis

- ◊ It is caused by virus

Mode of transmission of Hepatitis

- ◊ Viruses are transmitted through body fluids such as saliva, blood and semen.

Symptoms of Hepatitis

- ◊ Nausea
- ◊ Loss of appetite
- ◊ Fatigue
- ◊ Abdominal discomfort

- ◊ Jaundice
- ◊ Dark brown urine and whitish faeces.

Effects of Hepatitis

- ◊ May lead to liver failure
- ◊ If not treated early may lead to death

Prevention/treatments of Hepatitis

- ◊ Hygienic processing of food
- ◊ Proper disposal of sewage
- ◊ Treatment of water
- ◊ Proper handling of blood
- ◊ Screening blood before transfusion
- ◊ Using sterilized needles and syringes

6. BLADDER CANCER

Causes

- ◊ Not yet very clear but number of reasons such as
- ◊ Smoking
- ◊ Radiation
- ◊ Parasitic infection
- ◊ Exposure to chemicals (carcinogens) may cause the disease.

Symptoms

- ◊ Blood in urine.
- ◊ Frequent urinary tract infections, painful urination and urge to urinate without actual flow.
- ◊ Weight or appetite loss.
- ◊ Abdominal or back pain, persistent raised temperature or anaemia.

Effects

- ◊ Expenses on medication.
- ◊ Pain - reduces the quality of life.

Prevention/treatment

- ◊ Stop smoking.
- ◊ Avoid exposure to industrial chemicals.
- ◊ Eat healthy foods-choose low-fat, low-cholesterol diet that includes plenty of fruits and vegetables.
- ◊ Avoid dehydration by increasing your fluid intake, particularly water. Water dilutes cancer-causing chemicals.

7. GOUT

Causes

- ◊ Abnormal metabolism of uric acid, either producing too much or having difficulty excreting it.
- ◊ Eating too much meat and alcohol worsens it.

Symptoms

- ◊ Tender, swollen joints
- ◊ Red or purplish skin and warmth around the affected joint.
- ◊ Pain due to the formation of crystals in the joints.
- ◊ Difficulty in walking.

Effects

- ◊ Inability to walk
- ◊ May lead to arthritis hence bone erosion
- ◊ May lead to kidney stones

Prevention/treatment

- ◊ Diet low in protein, especially avoiding red meat.
- ◊ Drinking plenty of water.
- ◊ Treatment using prescribed drugs.

EXCRETION IN PLANTS

In plants, breakdown of substances is much slower than in animals. Plants do not have specialized excretory organs for the removal of metabolic wastes.

QUESTION: Why plants do not have specialized excretorysystem like in animals?

ANSWER

Plants do not need a specialized excretory system like in animals because:-

(i) The rate of producing waste products in plants is much lower.
(ii) Most excretory products from plants are removed by diffusion through the stomata or lenticels.
(iii) Some major excretory products of plants are recycled after being released. E.g. carbon dioxide used in photosynthesis, oxygen used in respiration and water used in water cycle.
(iv) Plants produce less poisonous substances compared to the nitrogenous wastes produced by animals.
(v) Plants have large vacuoles which store waste substances often accumulating at concentrations that lead to crystal formation in form of oil droplets or granules.
(vi) Plants store the waste products in organs that are destined to fall or die off. E.g. leaves

Plants eliminate some waste through diffusion.

TYPES OF EXCRETORY PRODUCTS ELIMINATED BY PLANTS

The following are common excretory products eliminated by plants

(i) Alkaloids
(ii) Resins
(iii) Gums
(iv) Latex
(v) Rubber
(vi) Excess oxygen produced by photosynthesis during a day.
(vii) Carbon dioxide produced by respiration
(viii) Excess water throughtranspiration.

ALKALOIDS

Are nitrogenous excretory products in plants and occur in various forms.

- **Examples of common alkaloids:**
  - Caffeine and theophilinet
  - Quinine
  - Cocaine
  - Cannabis
  - Opiates(morphine)
  - Nicotine
  - Colchicine
  - Pyrethrins
  - Khat (miraa) mirungi)

THE IMPORTANCE OF COMMON EXCRETORY PRODUCTS OF PLANTS

The table below shows functions of some plant waste products.

Product (waste)	Plant source	Uses and effects
1. Tannins	Dead tissues of plants such as acacia, conifers and mangroves	◊ It is used in the manufacture of inks and dyes. ◊ Treatment/ tanning of hides and skins into leather. I.e. it combines with animal proteins to form a complex compound which is not easily broken down by animal proteases.
2. Caffeine and theophilinet	Coffee fruits and tea leaves	◊ Mild stimulants to increase mental activity and reduce fatigue. Note; excessive intake of caffeine may cause heart and kidney damage.

3. Quinine	Bark of cinchona tree.	◊ A drug for the treatment of malaria. ◊ An additive in drinks to act as a stimulant.
4. Cocaine	Leaves of coca plant	◊ A very expensive drug for local anaesthetics. ◊ A painkiller and also gives great mental and physical strength. ◊ Note: Overdose may lead to hallucinations,anxiety and even death.
5. Cannabis	Fruits, flowers and leaves of cannabis sativa (bhang or marijuana)	◊ Manufacture of drugs such as painkillers. ◊ Results in relation, talkativeness, and greater appreciation of sound and colour. ◊ Decreased performance in concentration, intellectual and manual tasks. ◊ Overdose effects are similar to that of cocaine.
6. Opiates(morphine)	Opium poppy	◊ Manufacture of drugs like morphine and codeine both of which are effective painkillers, muscle relaxant, cough suppressants, and anti-diarrhoeal.
7. Nicotine	Tobacco leaves.	◊ Manufacture of insecticides and narcotic drugs (drugs that stimulate sleep or stimulate a feeling of relaxation and mask the sensation of pain). ◊ A common cause of respiratory and cardiac diseases, due to tar from its smoke.
8. Papain	Epicarp of pawpaw fruits (especially raw).	◊ Has proteolytic activity hence used as a meat tenderizer.
9. Colchicine	Roots of the crocus plant.	◊ Interferes with the process of cell division resulting into mutations; and thus useful in plant breeding. ◊ It is also carcinogenic (cancer–causing).
10. Pyrethrins	Flowers of pyrethrum	◊ Making of insecticides
11. Khat(miraa) mirungi)	Leaves and twigs of the “khat” plat	◊ Used as a stimulant.

12. Latex	Rubber tree -Sapodilla	◊ Used to produce gloves and clothing. Manufacture of shoe soles, tyres, etc. ◊ Manufacture of chewing gum.
13. Gums	Different plants such as Arabic ghath and carob, acacia tree, etc.	◊ Most are edible and thus used to thicken foodsand creams. ◊ Gum from sapodilla is used to make chewing gum. ◊ Agar extract (a gum) from algae is used as a growth medium to culture microorganisms. ◊ It is also used to make cough medicine
14. Anthocyanins	Petals and leaves of various plants, and are mostly red, blue or purple.	◊ Extracted for making dyes. ◊ Used in making PH indicators.
15. Digitalis glycosides	Foxglove	◊ Manufacture of drugs used for treatment of heart diseases such as digitoxin
16. Rennin	Certain tree stems like the casuarina tree	◊ Manufacture of varnish and gum.
17. Oil	Flowers or leaves of certain trees.	◊ Manufacture of perfume and ointment for insect bites.

QUESTIONS:

1. Describe how the following are excreted from plants
   ii. Carbon dioxide
   iii. Oxygen
   iv. Water
2. What is the role of the following in excretion in plants
   i. Stomata
   ii. Vacuoles
   iii. Lenticels
3. Plants do not need an elaborate excretory system like that of animals. Explain.
4. Draw a well labelled diagram of human urinary system and state the function of each part.
5. Give two ways in which each of the following contributes to homeostasis:
   (i) Kidney
   (ii) Skin
   (iii) Liver
6. (a) Name five excretory products from plants that are useful to human.
   (b) State the importance of each excretory product you mentioned in (a) above

Urine is a waste product of metabolism formed in the structural and functional units of the kidneys called nephrones. Blood at high pressure travels into these tubules by the tube of blood capillaries and walled glomerulus.
The following steps are involved in the process of urine formation:

Ultra filtration, blood enters the glomerulus through the afferent arterioles, it passes under pressure that result in filtration of blood, water and small molecules are forced out of glomerular capillary walls and Bowman's capsule. Large molecules remain in the blood of the glomerulus.

Selective reabsorption, some molecules are selectively reabsorbed into the blood. The glomerular filtrate flows through the proximal convoluted tubule, the U-shaped loop of Henle and distal convoluted tubule. The useful substances present such as glucose, amino acids and salts are reabsorbed by active transport. The filtrate now contains more urea, some salts and water. Reabsorption of solutes increases the water concentration of the filtrate. The water is reabsorbed into blood by osmosis.

Tubular secretion, some nitrogenous waste products like creatinine and some other substances like K^+ ions are removed from blood by distal convoluted tubules are added to urine. The urine formed is collected in the urinary bladder.

REGULATION

The Concept of Regulation

REGULATION

Is the maintenance of a relatively constant body internal environment.

OR is the process of controlling the internal body environment and needs.

- ◊ Cells will only function properly if there is little or no fluctuation in the conditions of their immediate environment.

HOMEOSTASIS

Is the process of maintaining a constant internal environment in living organisms

IMPORTANCE OF REGULATION

Reasons that show importance of regulation:-

(i) Ensuring survival of the organisms

(ii) Maintaining favorable condition such as pH and required ionic concentration for the functioning of cells, tissues and organs.

(iii) Enabling organisms to get rid of body wastes and useless materials for example excess water and salts

(iv) Enabling organisms to get rid of excess materials for example excess water and salts

- ◊ NB: To understand the mechanism of regulation there is a great need to distinguish between **two aspects of the environment** to the organism these are:
  (a) Internal environment
  (b) External environment

(a) INTERNAL ENVIRONMENT

Is an immediate surroundings of the cells comprising of interstitial (Intracellular), intercellular or tissue fluid.

- ◊ The tissue fluid contains dissolved food, dissolved gases and chemical ions

(b) EXTERNAL ENVIRONMENT

Is an immediate surroundings of the organism

- ◊ It may be aquatic (water) or terrestrial (land).

FORMATION OF TISSUE FLUID

TISSUE FLUID

Is the medium from which cells obtain their requirements and through which cells discharge their waste products.

- ◊ Tissue fluid is formed from the blood by the process called **ultra – filtration.**
- ◊ The ultra – filtration occurs due to the pumping of the heart and the narrowness of the capillaries that causes the build up of pressure on the arteriole side of the capillaries that forces water and low molecular weight component of blood out of the capillaries into the intercellular spaces hence tissue fluid is formed.

Components of tissue fluid

- ◊ Tissue fluid contains the same composition as blood but lacks cells and plasma proteins.
- ◊ The same composition of tissue fluid and blood are:
  - ◊ Glucose
  - ◊ Amino acids
  - ◊ Fatty acids
  - ◊ Oxygen
  - ◊ Hormone e.g. nutshell fluids.

Main function of tissue fluid

- ◊ Provides the condition where cells absorb nutrients and oxygen and shed into it waste materials such as carbon dioxide and urea when flow in intercellular space.
- ◊ Bathes the cells and eventually find its way back into the blood.

NB: Excess fluid is drained into the lymphatic vessels to form **Lymph.**

Lymph is an excess tissue fluid in lymphatic vessels that the lymph has no cells and plasma protein while the blood has cells and plasma protein.

- ◊ The similarity between the lymph and blood is that both they have glucose, amino acids, oxygen and hormones.

MECHANISM OF REGULATION

Mechanism of regulation is known as ***Homeostatic regulatory mechanism***

- ◊ This mechanism enables organism to adjust fairly quickly to any slightly changes.

The process of regulation or homeostasis works on a feedback mechanism as follows:

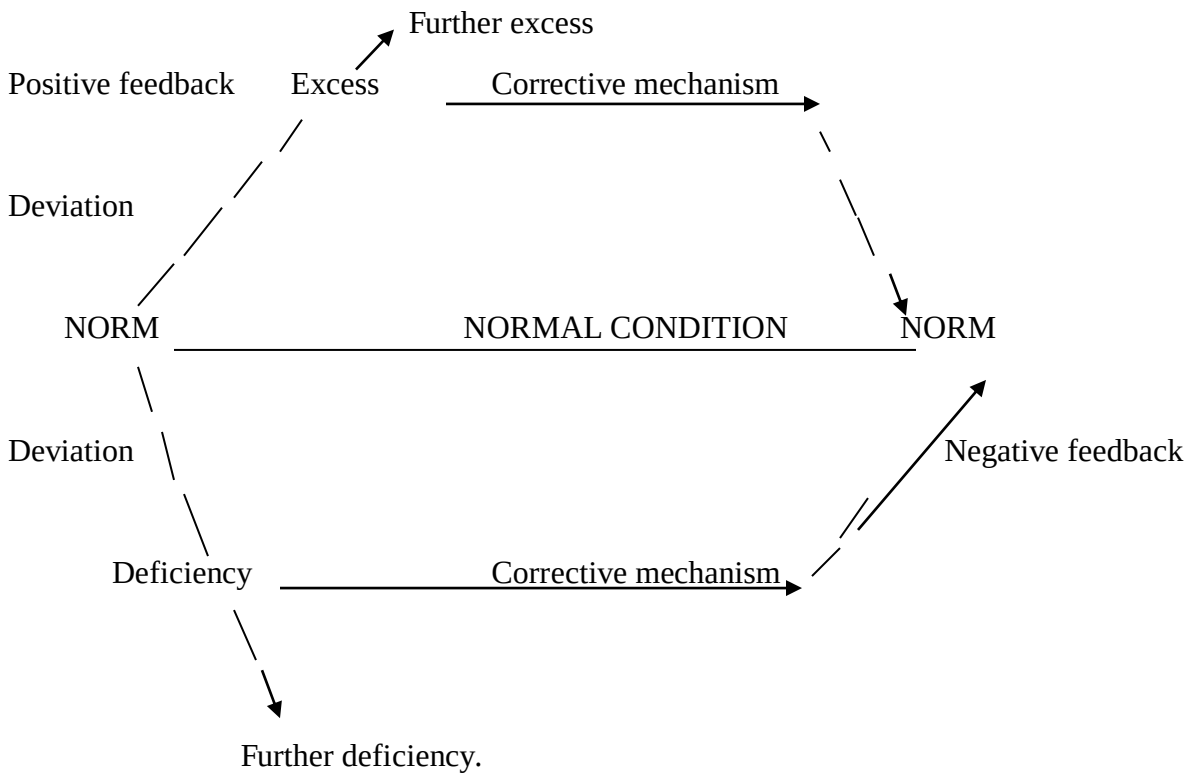
- ◊ When a factor in the body such as blood sugar level drops or rises above normal, it is detected and then corrective action is taken to bring it back to normal. Such a response is called **NEGATIVE FEEDBACK.**

BUT

- ◊ If the change below or above the normal is not corrected but instead there is further deviation, this is called **POSITIVE FEEDBACK.**

Consider the figure below showing the mechanism of regulation

THE FIGURE OF GENERALIZED MECHANISM OF REGULATION



NOTE: The feedback mechanism is divided into two types, namely:

(i) Negative feedback mechanism.
(ii) Positive feedback mechanism.

Negative feedback mechanism: is the mechanism through which the effectors restore the normal condition.

Positive feedback mechanism: is the mechanism that fails or break down any deviation from the normal leads to further deviation.

TYPES OF REGULATION

There are various types of regulation in the animals' bodies. These are:-

(i) Temperature regulation (thermoregulation)
(ii) Blood sugar regulation
(iii)Osmoregulation

THERMOREGULATION

Is the maintenance of a relatively constant body temperature.

- ◊ A constant body temperature favours efficient enzymes activities.
- ◊ Thermoregulation is very important because:
  - ─ The high temperature denatures or destroys the enzymes
  - ─ Low temperature inactivates the enzymes by slowing down or stopping enzyme catalyzed reactions.
- ◊ The external temperature affecting the body is detected by **thermo receptors** in the skin.
- ◊ The thermo receptors relay information to the **temperature regulation centre** in the hypothalamus in the brain through sensory nerves.
- ◊ The internal temperature is detected by the **hypothalamus** as the blood flows in the brain.

HYPOTHERMIA

Is the condition that occurs when the body temperature falls than the normal

- ◊ Hypothermia cause permanent damage to the brain.
- ◊ Hypothermia is a risk for mountaineers since they are exposed to low temperatures and wind.
- ◊ It is also risky to swimmers, since water conducts heat away from the body
- ◊ Also elderly who tend to be less active thus they generate less heat from the activity of muscles.

HYPERTHERMIA

Is the condition which occurs when the body temperature increases above normal

CATEGORIES OF THERMOREGULATION

Thermoregulation can be categorized into two groups, namely:

(a) Homoiothermic
(b) Poikilothermic

(a) **HOMOIOTHERMIC THERMOREGULATION**

Is the type of thermoregulation where by animals are able to maintain constant internal body temperature even when the surrounding temperature changes.

- ◊ Animals which are able to maintain constant internal body temperature even when the surrounding temperature changes are called **homoiothermic animals.**
- ◊ Homoiothermic animals are also called **warm blooded animals, homoiotherms or endotherms.**

Example of homoiothermic animals

- ◊ Mammals
- ◊ Birds.

ADVANTAGES OF HOMOIOTHERMY

(i) Enables animals to exploit a wide range or geographical habitats
(ii) Homoiotherms have high metabolic rate, hence remain active throughout.
(iii) Endotherms are independent of external temperature.
(iv) Helps animals to respond faster to stimuli
(v) Homoiothermic organisms have a greater survival value.
(vi) Enzyme controlled reactions proceed without interruptions.

DISADVANTAGES OF HOMOIOTHERMY

(i) They need food with high calorific value such as fat in order to maintain their body temperature especially during cold.
(ii) Endotherms consume a lot of food to be in position to generate heat internally.
(iii) They have a problem of overheating in tropics and hot desert areas.

PAIKILOTHERMIC

Is the type of thermoregulation where some animals change their body temperature with change in the external environment temperature

- ◊ Animals whose body temperatures change with change in the surrounding temperature are called **Poikilothermic animals**
- ◊ Poikilothermic animals are also called **cold blooded animals, poikilotherms or ectotherms.**

Example of poikilothermic animals

- ◊ Amphibians e.g. frogs
- ◊ Reptiles e.g. lizards and snakes
- ◊ Fishes e.g. sharks, tilapia

ADVANTAGE OF POIKILOTHERMY

(i) They have a lower food consumption as they do not generate heat internally i.e. consume little amount of food.

(ii) Poikilotherms found in tropics and hot desert do not have a problem of overheating because there is no heat generated internally.

(iii) Ectotherms need food with low calorific value.

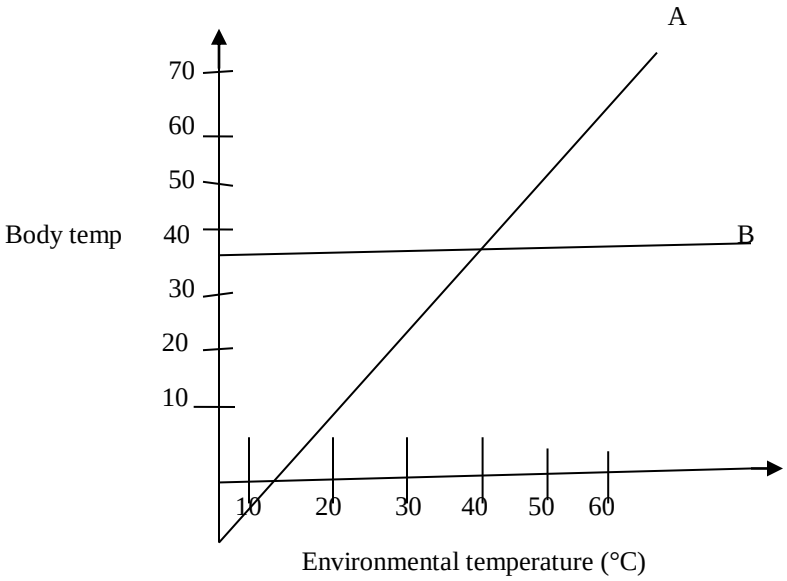
DISADVANTAGES OF POIKILOTHERMY

(i) They have low metabolic rate and therefore sluggish when external temperature are low and can be preyed upon easily.

(ii) Due to over reliance on external temperature ectotherms take time to respond to stimuli.

(iii) During low temperature, poikilotherms may go to hibernation and may even die.

QUESTION: The graph below shows the relationship between environmental temperature and body temperature in two different animals A and B.



(a) What happens to the body temperature of **animal A** as the external temperature increases.

ANSWER: The body temperature of **animal A** increases as the external temperature increases.

(b) What term is used to describe :

(i) Animals of type A

(ii) Animals of type B

ANSWERS

(i) Animals of type A are poikilotherms/ectotherms

(ii) Animals of type B are Homoiotherms / endotherms

(c) State, giving reasons, which type of animal you would expect to be more widely distributed.

ANSWERS: The animals of **type B** can be more widely distributed

The animals of **type B** can be more widely distributed due to the following sreasons:

(i) Endotherms are independent of external temperature
(ii) Endotherms can respond faster to stimuli
(iii) Endotherms have a high metabolic rate.

METHODS OF HEAT GAIN AND HEAT LOSS IN ANIMALS

Animals gain or lose heat to the environment through the following methods:

(i) Conduction
(ii) Radiation
(iii) Evaporation
(iv) Convection.

Conduction

Is the transfer of heat energy from one body to another through direct contact with each other.

- ◊ For example when a person takes a cold shower on a hot day, he/she loses heat to the surrounding thus cooling his/her body temperature.
- ◊ The same applies when he/she sits on a cold object like a chair. He/she will feel the coldness of the chair due conduction.

Radiation

Is the transfer of heat energy from one body to another without the bodies being in contact with each other.

- ◊ The transfer of heat energy is usually through infra-red waves.
- ◊ Up to 60% of heat lost by a person sitting in a room at 21˚C may be due to radiation.

Evaporation

Is the change of a liquid to a vapour.

- ◊ Evaporation is accompanied by cooling.
- ◊ That is why sweating provides a cool effect and accounts for up to 25% of the total heat energy lost by a person.

Convection

Is the movement of air resulting from pockets of warm air being replaced by cooler air and vice versa.

MECHANISM FOR TEMPERATURE REGULATION

◊ For temperature to be kept constant endotherms have developed special mechanisms that help them lose and or gain heat.

Body temperature is regulated through:-

(a) Physiological means
(b) Behavioural means

PHYSIOLOGICAL MEANS

This occurs under the control of the nervous system.

◊ In physiological means, body temperature regulation is done through the following methods:

(i) Sweating
(ii) Panting
(iii) Shivering
(iv) Vasodilation
(v) Vasoconstriction
(vi) Contraction and relaxation of hair erector Pilli muscles.
(vii) Change of metabolic rate

(i) **Sweating**

This occurs when animal lose water vapour from their body surface.

◊ Latent heat of vaporization is lost from the body as sweat evaporates.

(ii) **Panting**

Is the process of hanging out of tongue to allow heat loss through evaporation

◊ Panting is mostly done by dogs and cats as a way cooling their bodies because they have no sweat glands except in the pads of the paws.

(iii)**Vasodilation**

Is the increase of diameter of arterioles near the surface of the skin

◊ This enables more blood to flow near the surface of the skin and more heat is lost to the surrounding by conduction, convection and radiation.

(iv)Vasoconstriction

Is the decrease of arterioles diameter near the skin surface.

◊ This decrease blood flow near the skin surface hence less heat is lost to the surrounding by conduction, convection

(v) Shivering

Is an involuntary rhythmic contraction of muscles which serves to generate heat during cold weather.

(vi) Change of metabolic rate

This involves the increase of metabolic rate during cold weather and the decrease of metabolic rate during hot weather.

MECHANISM OF TEMPERATURE REGULATION THROUGH PHYSIOLOGICAL MEANS

Through physiological means homoiotherms are able to regulate their body temperature as follows:

During hot weather condition

During hot weather condition organisms keep their body temperature constant through the following methods:

(i) Sweating

When sweat evaporates on the skin, it produces a cooling effect on the body thereby lowering the body temperature.

(ii) Panting

Dogs and cats cool their bodies through hanging out of their tongues to allow heat loss through evaporation.

(iii) Relaxation of erector Pilli muscles

During hot weather condition, erector Pilli muscles relax making the hair to lie flat on the skin surface to encourage loss of heat from the body by radiation and convection.

(iv) Vasodilation of arterioles

The diameter of arterioles near the surface of the skin becomes wider. Therefore more blood flow near the skin surface hence more heat is lost to the surrounding by conduction, convection and radiation.

(v) Decrease in metabolic rate

During hot weather condition metabolic rate decrease therefore less heat is generated and hence the body temperature falls.

During cold weather condition

During hot weather condition organisms keep their body temperature constant through the following methods:

(i) Shivering

This is an involuntary rhythmic contraction of skeletal muscles, which serves to generate heat during cold weather.

(ii) Contraction of erector Pilli muscles

During cold weather condition, erector Pilli muscles contract making hairs on the skin surface to rise. This causes more air to be trapped between the hairs, making it an insulator thus preventing heat loss from the body to the surrounding.

- ◊ In human, contraction of the erector pilli muscles causes ‘goose pimples’ since there is very few hair on the skin. When this happens, the sweat pores close up thus no sweat is lost through evaporation.

(iii) Vasoconstriction of arterioles

The diameter of arterioles near the skin surface becomes narrower. Therefore the blood supply to the skin surface is reduced and less heat is lost to the surrounding.

(iv) Increase metabolic rate

During cold weather condition metabolic rate increase therefore more heat is generated and hence the body temperature rises.

A SUMMARY OF BODY TEMPERATURE REGULATION BY PHYSIOLOGICAL MEANS

When the body temperature rises above normal (during hot)	When the body temperature drops below normal
◊ Hypothalamus detects change in temperature. ◊ Signals are sent to the tissues which respond by — Increasing sweating — Vasodilation — Relaxation of hair erector pilli muscle ◊ Reduced metabolism ◊ No shivering	◊ Hypothalamus detects the change. ◊ Signals are sent to the body tissues which responds by — Reducing sweating — Vasoconstriction — Contraction of hair erector pilli muscles ◊ Increase metabolism ◊ Shivering.

BEHAVIOURAL MEANS

This occurs under the organism's will

◊ In behavioural means, body temperature regulation is done through the following methods:

(i) Moving to a shaded place.
(ii) Wearing of a coat
(iii) Migration
(iv) Clustering
(v) Coiling
(vi) Hibernation
(vii) Aestivation
(viii) Basking

(i) Migration

This is the movement of animals covering a long distances in order to avoid harsh environmental temperature.

(ii) Clustering

This involves grouping together of animals to share warmth in order to raise body temperature

- ◊ Example: bees cluster together

(iii)**Coiling**

This is the process whereby animals are rounding into a series of circle.

(iv)**Hibernation**

This is a behavioural pattern where an organism goes into a deep sleep to avoid cold weather conditions.

(v) **Aestivation**

This is a behavioural pattern where an organism goes into a deep sleep to avoid warm weather conditions.

(vi)Basking

This is a behavioural pattern where an organism moves in the sun to raise the body temperature

- ◊ Snakes, lizards and chameleons bask in the sun to raise their body temperature

MECHANISM OF TEMPERATURE REGULATION THROUGH BEHAVIOURAL MEANS

Through behavioural means homoiotherms and poikilotherms are able to regulate their body temperature as follows:

During hot weather condition	During cold weather condition
◊ Some organisms move into the shade. ◊ Humans wear light clothing ◊ Other drinks cold water to cool down their bodies. ◊ Some roll in water or splash water to cool off. ◊ Some burrow underground ◊ Some organism aestivate	◊ Some organisms hibernate. ◊ Humans wear more clothing. ◊ Some organism cluster together in groups to share warmth. ◊ Some organism spend most of the day in deep burrow ◊ Some organisms bask in the sun

RELATIONSHIP BETWEEN BODY SKIN AND HEAT LOSS IN ORGANISMS

- ◊ Small animals have a large surface area to volume ratio. They therefore lose heat faster which makes them to eat more food to cater for their high metabolism.
- ◊ Large animals have small surface area to volume ratio. They therefore lose heat at a slower rate.

TEMPERATURE REGULATION IN ANIMALS LIVING IN COLD CLIMATE

Animals living in very cold climate such as **polar bears** have the danger of suffering hypothermia. Therefore, they are adapted to avoid heat loss by having the following features;-

(i) Thicker hair (fur) which is better in holding air around the body thus acts as an insulator to prevent heat loss to the surrounding.
(ii) They have a thick layer of fat beneath the dermis that prevents heat loss.
(iii) Large body shape compared to their counterpart living in hot or temperate climate. Large bodies means small surface are to volume ration thus reduced heat loss.

OSMOREGULATION

Is the maintenance of relatively constant osmotic pressure of body fluids
OR is the control of the water content and salt concentration in the body of an organism.

- ◊ The osmotic pressure of the body fluids (the blood and tissue fluid) is determined by the concentration of various solutes such as sugar, salts and chemical ions.

IMPORTANCE OF OSMOREGULATION

(i) Ensures proper functioning of the cells.

NB:

- ◊ If there is too much water in the blood, the osmotic pressure increase, water will move from blood into the cells causing cells to swell even burst and disrupt metabolic activities.
- ◊ If there is too little water in the blood, the osmotic pressure decreases, water will move from cells into the blood by osmosis causing cells to shrink and disrupt metabolic activities as well

FACTORS THAT AFFECT THE CONTENT OF SALT AND WATER IN THE BODY

Content of salt and water in the blood is affected by the following factors:

(i) Amount of water taken in the body

Large intake of water causes blood to have too much water while fewer intakes causes less water in the blood. It is advised to take two liters equivalent to eight glasses of water per day for the body to function properly.

(ii) Climatic condition

During hot weather there is increased sweating which cause loss of water by evaporation thus reduced amount of water in the blood. The vice versa occurs during cold weather.

(iii)Amount of salt taken into the bod

Putting less salt in food causes reduced salt in the blood while putting too much salt in food causes increased amounts of salt in the blood. Moderate amounts of salt should be taken too much salt is not healthy as it may lead to high blood pressure.

(iv)Hormonal Abnormalities

When less Antidiuretic hormone (ADH) is produced it leads to increased content of water in the blood and vice versa.

THE MECHANISM OF OSMOREGULATION

Osmoregulation is controlled by the hypothalamus and the pituitary gland working together with the kidneys.

- ◊ When the osmotic pressure of the body fluids rises as a result of dehydration or excessive intake of salts, osmoreceptors in the hypothalamus of the brain are stimulated. These cells relay information to the pituitary gland which is stimulated to secrete a hormone known as vasopressin (Antidiuretic hormone) into the blood. Antidiuretic Hormone stimulates the kidney tubules to become more permeable to water to increase the water content in the blood hence osmotic pressure falls to normal level.
- ◊ If the osmotic pressure falls below normal due to large intake of water the pituitary gland is less stimulated and less ADH is produced hence the kidney reabsorbs less water and the osmotic pressure rises to normal results to the production of large volume of dilute urine.

DIABETES INSPIDUS

This is a disease that results from the failure of the pituitary glands to produce sufficient antidiuretic hormone (ADH).

Causes of diabetes inspidus

- ◊ Inability of the pituitary gland to produce ADH

Symptoms of diabetes inspidus

- ◊ Diuresis
  Is a condition of producing large amount of dilute urine.

Effects of diabetes inspidus

- ◊ Dehydration.
- ◊ A patient required to takes a lot of water.

BLOOD SUGAR REGULATION

This is the regulation of the amount of glucose in the blood.

- ◊ In human beings, the normal blood sugar concentration at a steady state is about **90mg per 100ml** of blood.
- ◊ The maintenance of a relatively constant blood glucose level is carried out by two pancreatic hormones namely, **Insulin** and **Glucagon**
- ◊ These hormones are secreted by a specialized group of pancreatic cells called **islets of Langerhans**.

Insulin

Is the hormone produced by **beta cells** in the islets of Langerhans

Roles of insulin in regulation

(i) To promote the conversion of glucose to glycogen and stored in the liver and skeletal muscles.
(ii) To promotes the uptake of glucose from the blood by muscles cells
(iii)Increases protein synthesis in some cell.

Glucagon

Is the hormone produced by **alpha cells** in the islets of Langerhans

Role glucagon in regulation

(i) To promote the conversion of glycogen to glucose in the liver cell.
(ii) Glucagon stimulates absorption of glucose from the ileum.

MECHANISM OF BLOOD SUGAR REGULATION

◊ When there is excess glucose in the blood, the beta cells in the islets of Langerhans produce more insulin and less glucagon. The insulin produced stimulates the liver cells to convert excess glucose to glycogen. Hence, the blood sugar level falls to normal level.

Glucose (Excess) —Insulin→ Glycogen (Normal)

◊ On other hand, when there is low blood glucose in the blood. The alpha cells in the islets of Langerhans produce more glucagon and less insulin. The glucagon produced stimulates the liver cells to convert glycogen to glucose. Hence, blood sugar level is raised back to normal level.

Glucagon

Glycogen ⟶ Glucose

(Excess) (Normal)

The whole process is summarized in the table below

When the blood sugar (glucose) rises above the normal.	When the blood sugar (glucose) drops (falls) below the normal.
◊ Beta cells produce more insulin and less glucagon ◊ Insulin causes the liver cells to: – Convert excess glucose to glycogen. – Convert excess glucose to fats for storage. – Increase oxidation of excess glucose to energy, CO_2 and water. ◊ Normal glucose level is restored.	◊ Alpha cells produce more glucagon hormone and less insulin. ◊ Glucagon causes the liver to:- – Convert stored glycogen to glucose. – Convert stored fats to glucose – Reduce oxidation of glucose. ◊ Normal glucose level is restored.

EFFECTS OF HIGH AND LOW SUGAR LEVEL

(i) HYPERGLYCAEMIA

Is a condition which occurs due to failure of pancreas to produce insulin.

(ii) HYPOGLYCAEMIA

Is a condition in which glucose concentration in the blood is far much below the normal range of corrective mechanism.

DIABETES MELLITUS

This is a disease caused by a failure of pancreas to secrete insulin or produces little amounts of insulin.

◊ Diabetes mellitus is Greek word means "**sweet urine**".

TYPES OF DIABETES

There are two forms of diabetes, namely:

(i) Type I diabetes

(ii) Type II diabetes

Type I diabetes

This occurs when the cells from the immune system attack beta cells in the islets of Langerhans making beta cells to produce very little or no insulin at all leading to a glucose build up in the blood.

Type II diabetes

This occurs in adulthood

- ◊ In this type of diabetes, either the pancreas produces too little insulin or produces adequate amounts but the cells do not respond to insulin causing glucose to build up in the blood.

SYMPTOMS OF DIABETES MELLITUS

- ◊ Passing out urine frequently
  - ─ A condition of passing urine frequently is called **polyuria**
- ◊ Presence of glucose in the urine
  - ─ A condition of passing urine which contain glucose is called **glycosuria**
- ◊ Extreme thirst and hunger
- ◊ Weight loss
- ◊ Numbness in hands and feet
- ◊ Extreme fatigue
- ◊ Dry, itchy skin
- ◊ Slow healing of wounds
- ◊ Blurred vision.

EFFECTS OF DIABETES MELLITUS

- ◊ Coma (becoming unconscious for a long time)
- ◊ Death
- ◊ Slow healing of wounds
- ◊ Lowered body immunity leading to frequent infections.

CONTROL/ TREATMENT OF DIABETES MELLITUS

- ◊ Administration of insulin
- ◊ Limit carbohydrate intake
- ◊ Physical exercise.

FACTORS INVOLVED IN THE DEVELOPMENT OF DIABETES

(i) Age

Type II diabetes is more common in people aged above 40 years.

(ii) Obesity

Excess body fat reduces cell responsiveness to insulin. Obesity is a major risk factor for type II diabetes

(iii)Physical inactivity

Staying idle or doing work that does not require much energy and lack of physical exercise may lead to obesity hence diabetes.

(iv)Family history of diabetes

People whose family members have had diabetes can be in danger of becoming diabetic.

REPRODUCTION

Concept of Reproduction

Reproduction

Is the process by which organisms g` ive rise to new members that are similar to their parents.

IMPORTANCE OF REPRODUCTION

Reproduction is an important process because;

(i) It ensures the continuity of the species.
(ii) It is a means of passage of characters from one generation to another
(iii) It increasing and maintaining population size
(iv) Sexual reproduction is a means of genetic variation among individuals

TYPES OF REPRODUCTION

Thereare two types of reproduction,namely: -

i) Sexual reproduction
ii) Asexual reproduction

SEXUAL REPRODUCTION

Sexual reproduction involves fusion of male and female gametes in the process of fertilization.

GAMETES

Are male and female reproduction cells.

◊ Male gamete is called **sperm**
◊ Female gamete is called **ovum or egg**

These two gametes differ in form and function and each is produced from a different organ.

◊ In animals the gametes producing organs are called **gonads.** These include the ovaries and testes.
◊ In flowering plant structures concerned with the production of gametes are the ovaries and anthers.
◊ The testes and anthers produce the male gametes while ovaries produce the female gametes.

FERTILIZATION

Is the fusion of male and female gametes to form zygote.

Types of fertilization

There are two types of fertilization

(i) External fertilization
(ii) Internal fertilization

External fertilization

Is the type of fertilization takes place outside the body of the female

Example of organisms that show external fertilization

- ◊ Frogs
- ◊ Some fish

Internal fertilization

Is the fertilization takes place inside the body of the female.

Example of organisms that show internal fertilization

- ◊ Mammals
- ◊ Birds
- ◊ Reptiles

ZYGOTE

Is a fertilized Ovum which eventually develops into a new organism

HERMAPHRODITE ORGANISM

Is an organism which posses both male and female reproductive structures

- ◊ Hermaphrodite organism is also known as **Bisexual organism**

CHARACTERISTICS OF SEXUAL REPRODUCTION

The following are the main characteristics of sexual reproduction:

(i) It always involves two parents, a male and a female parents
(ii) The parents must produce gametes.
(iii) Normally neither a male gamete nor a female gamete can develop into a new organism.

ADVANTAGES (MERITS) OF SEXUAL REPRODUCTION

(i) It brings about variation among living organism of the same species and therefore the undesirable character cannot pass from one generation to another.
(ii) It produces individual that grow slowly, hence cannot result into competition and overpopulation.
(iii) Due to combination of factors from the two parents, the organism may develop resistance to diseases and hence reducing the chance of wiping the whole population.

DISADVANTAGES (DEMERITS) OF SEXUAL REPRODUCTION

(i) It involves fertilization and pollination which are energy consuming process.
(ii) Offspring takes a long time to mature.
(iii) It involves two parents, hence cannot take place in the absence of the second parent.
(iv) Since it brings variation among organism of the same species, hence the desirable characters cannot be maintained.

ASEXUAL REPRODUCTION

Isa type of reproduction in which new individualsare reproduced from a single parent without the formation of gametes.

- ◊ There is no fusion of gametes butan individual separates itself from the parent and grows into a similar individual.
- ◊ In this kind of reproduction, in some organisms, body part such as roots, stems or leaves may become reproductive body organs.

  Examples of organisms that reproduce asexually:
  - ◊ Amoeba
  - ◊ Bacteria.
  - ◊ Some plants

CHARACTERISTICS OF ASEXUAL REPRODUCTION

(i) It involves only one parent.
(ii) It does not involve the fusion of gametes.
(iii) Desirable characteristics are maintained
(iv) No change of genetic materials passed from a parent to an offspring since asexual reproduction involves only one individual organism.

ADVANTAGES (MERITS) OF ASEXUAL REPRODUCTION

(i) It has a faster rate of reproduction.
(ii) Nutrients are provided by parents, thus increasing the chances of survival of the offsprings.
(iii) Beneficial characteristic of parents such as resistance to disease and high yield are maintained in their offsprings
(iv) It involves only one parent and therefore no need of looking for another parent for producing a new individual.
(v) It does not involve pollination and fertilization and therefore saves the energy loss.
(vi) Its offspring matures faster than sexually reproduced organisms

DISADVANTAGES (DEMERITS) OF ASEXUAL REPRODUCTION

(i) Organisms maintain their genetic materials, therefore there is no variation.
(ii) Undesirable characteristics such as low yield and vulnerability to diseases are passed on to the offsprings.
(iii) Rapid rate of growth of the organisms could deplete resources such as nutrients because of competition.

DIFFERENCES BETWEEN SEXUAL AND ASEXUAL REPRODUCTION

SEXUAL REPRODUCTION	ASEXUAL REPRODUCTION
(i) Two parents are involved.	Single parent is involved.
(ii) Involves fertilization	Does not involve fertilization
(iii)Gametes are produced by gametogenesis	No gametesproduced
(iv)Involves zygote formation	No zygote formation
(v) There is variationin offsprings	Offsprings are identical to the parents
(vi)Meiosis is essential for gamete formation	Mitosis is essential for spore formation and cell division.
(vii) Not rapid	Its rapid in fovourable conditions
(viii) Population number increase slowly	Population number increase rapidly

FORMS OF ASEXUAL REPRODUCTION

There are various forms of asexual reproduction in which includes:-

(a) Fission
(b) Spore formation(Sporulation)
(c) Budding
(d) Fragmentation
(e) Vegetative propagation.

(a) FISSION

Is a type of asexual reproduction in which an organism divides into two or more parts of equal size

◊ Fission is the simplest form of **asexual reproduction.**

TYPES OF FISSION

Fission is divided into two categories, namely:-

(i) Binary fission
(ii) Multiple fission

(i) BINARY FISSION (SPLITTING)

Is a type of fission in which an organism divides into only two equal parts to form two complete organisms.

Example of organisms which reproduce by binary fission:-

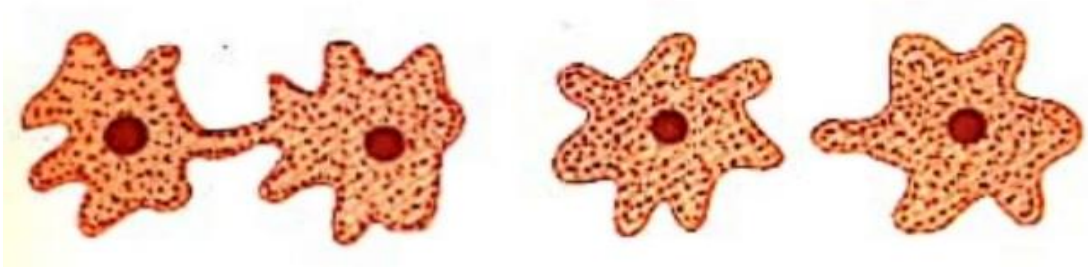
◊ Amoeba
◊ Bacteria
◊ Paramecium
◊ Euglena

Process on how binary fission occurs

(i) Mother cell expands, nucleus divide into two equal parts through mitosis

(a)Mother cell (b) Nucleus divided into two equal parts

(ii) The cytoplasm separates and each part forms a cell membrane and become a new organism.



(c) Mother cell dividing (d)Two daughter cells

(ii) MULTIPLE FISSION

Is a type of fission in which an organism divides into several parts.

Example of organisms which reproduce by multiple fission

- ◊ Plasmodium
- ◊ Parasitic protoctists

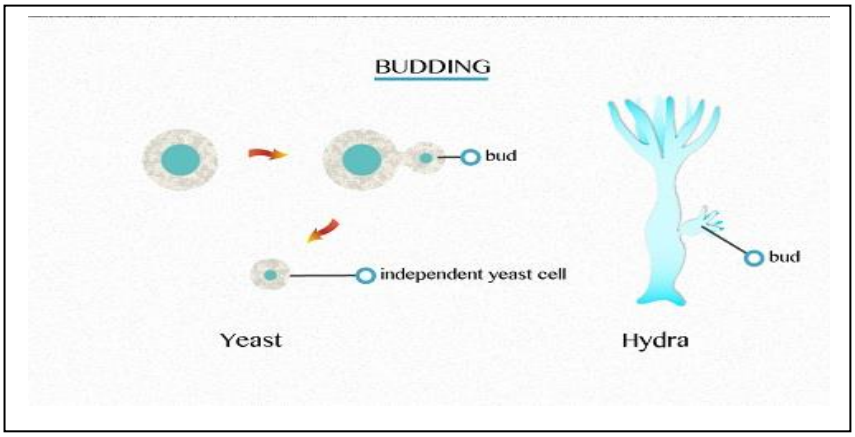
(b) BUDDING

Is a type of asexual reproduction in which a new organism is derived from an outgrowth (bud) thatbecomes detached from the parent.

- ◊ The bud later separates from the parent and grows to become an independent organism to attain the size of the parent.

Example of organisms which reproduce by budding

- ◊ Yeast
- ◊ Hydra
- ◊ Certain flatworms
- ◊ Several annelids



(c) FRAGMENTATION

Isa form of asexual reproduction in which a parent organism breaks into two or more parts.

- ◊ Fragments grow and develop into a new organism with identical features as the parent.

Example of organisms which reproduce by fragmentation

- ◊ Worms such as:
  - — **Nematodes (tapeworms)**
  - — **Flat worms.**

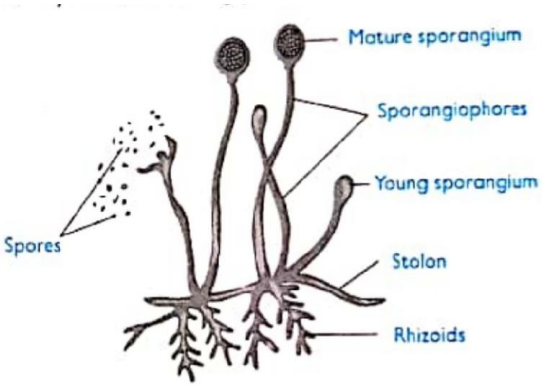
(d) SPORE FORMATION(SPORULATION)

Spores are single celled bodies capable of giving rise to an individual.

- ◊ The spore develops from single cell as a result of mitosis, forming a structure known as sporangium.
- ◊ When the sporangium is truly developed, the wall bursts to release the spores which when placed in suitable area they germinate into new organisms.

Example of organisms which reproduce by spores

- ◊ Fungi such as mucor and rhizopus
- ◊ Bacteria
- ◊ Protozoa
- ◊ Many non-flowering plants such as ferns and mosses



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Spore formation in rhizopus

(e) VEGETATIVE PROPAGATION

Is the form of asexual reproduction in plants where parts of the plant become detached and develop into new independent individuals

OR

Is the process whereby new individuals are formed or grow from parts of the parent plants which are not associated with reproductive organs.

- ◊ Vegetative reproduction is also called **vegetative reproduction**

TYPES OF VEGETATIVE REPRODUCTION

There are two types of vegetative reproduction, namely:-

i) Natural vegetative reproduction.
ii) Artificial vegetative reproduction.

NATURAL VEGETATIVE REPRODUCTION

Is a type of vegetative reproduction in which new plants develop from part of a parent plant such as stem, leaves or roots.

- ♦ In this type, reproduction occurs without the intervention of man
- ♦ Detached portions of the parent plant such as roots, leaves and stems of some plants will grow naturally and develop into new plants.

GROUPS OF NATURAL VEGETATIVE PROPAGATION

Vegetative propagation is normally grouped on the basis of the part of the plant involved. These are:

(i) Propagation by modified stems
(ii) Propagation roots
(iii)Propagation by leaves

(i) PROPAGATION BY MODIFIED STEMS

These include:

(a) Rhizomes
(b) Stolons
(c) Stem tubers
(d) Bulbs
(e) Corms
(f) Suckers

(a) RHIZOMES

These are horizontal underground stems with scale leaves, axillary buds, terminal buds on one end and adventitious roots.

- ♦ The stem acts as a food reserve.
- ♦ During favourable conditions the axillary bud develops into the aerial part of the plant.
- ♦ Rhizomes are able to survive in unfavourable environmental conditions such as drought, which kills the aerial part.

Example of plants that develop rhizomes

- ♦ Ferns
- ♦ Lilies
- ♦ Coach grass
- ♦ Morning glory

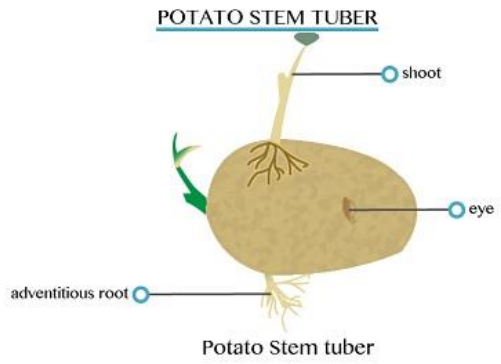
(b) STEM TUBERS

These are short swollen underground stems filled with food reserves such as starch.

- Stem tubers bear scale leaves, axillary buds and lenticels.

Example of stem tubers

- Irish potatoes



Potato Stem tuber

(c) STOLONS

These are slender stems that grow horizontally along the ground surface.

- Stolons have terminal buds, scale leaves, nodes and internodes.
- Aerial shoots and underground adventitious roots develop at the axillary buds

Examples of plants that develop stolons

- Strawberries
- Oxalis
- Wandering jew
- Kikuyu grass

(d) BULBS

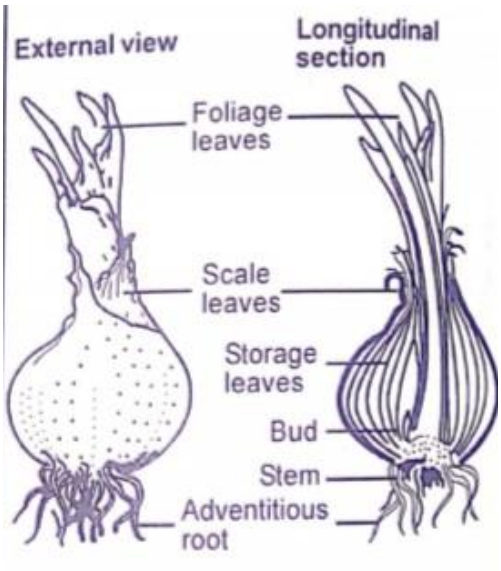
These modified swollen underground shoots with thick fleshy leaves.

- A longitudinal section through an onion bulb show overlapping leaves closely packed together originating from a stem.
- The outer leaves are dry and scaly
- They protect the inner thick, soft and fleshy leaves that containstored food

Example of bulb

- An onion

BULB IN ONION



(e) CORMS

These are short swollen underground stems with stored food.

- They have a flat base, axillary buds, nodes, internodes, apical buds and adventitious roots

Examples of corms

- Cocoyams
- Yams
- Crocus gladiolus
- caladium

(f) SUCKERS

These are short vertical stems, which arise from the main stem just below the ground surface.

- Each sucker can separate from the mother plant and develop into an independent plant.

Example of plants that develop suckers

- Bananas
- Pineapples
- Sisal

(ii) VEGETATIVE PROPAGATION BY ROOTS

These include:

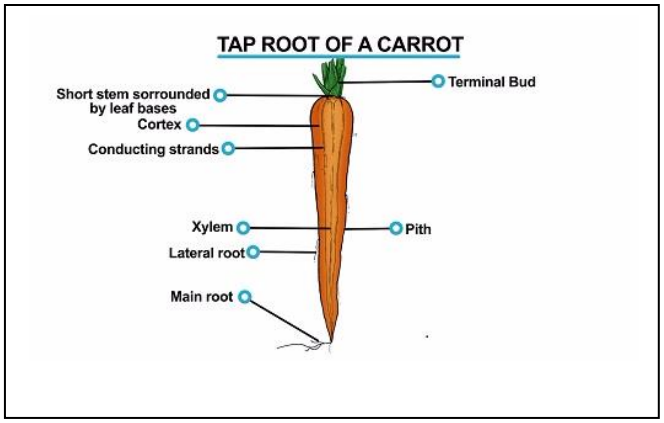
(a) Tap root
(b) Root tubers

(a) TAP ROOT

Is a long swollen underground root which acts as storage organs.

Examples of plants that develop tap roots

- Carrots
- turnips



(b) ROOT TUBERS

These are swollen adventitious underground roots.

- Some of the adventitious roots swell forming underground storage organs
- Root tubers do not bear leaves or bud.

Example of root tubers

- Cassava
- Sweet potatoes

(iii)VEGETATIVE PROPAGATION BY LEAVES

Leaves are not commonly used as means of propagation like stems and roots.

- Several species of plant propagate vegetatively by means of leaves.
- When detached from the parent plant, the leaf fall off, develops adventitious roots and bud.
- These structures will develop into mature plants.

Example of plants that propagate vegetatively

- Cactus
- Begonia
- Leaf of bryophyllum

ARTIFICIAL VEGETATIVE REPRODUCTION

Is a type of vegetative reproduction where reproduction occurs with the intervention of man.

- ◊ Man can learn from plants' natural vegetative propagation and can intervene and make propagation of plants artificially.

METHODS OF ARTIFICIAL VEGETATIVE REPRODUCTION

Artificial vegetative reproduction involves the following methods:

i) Cutting
ii) Grafting
iii) Layering

(i) CUTTING

In this method,a part of a plant such as a stem is cut and planted into a new place and watered.

- It grows into a new complete independent plant

Example of plants reproduced by cutting

- Cassava
- Sugarcane
- Sweet potatoes
- Lemon

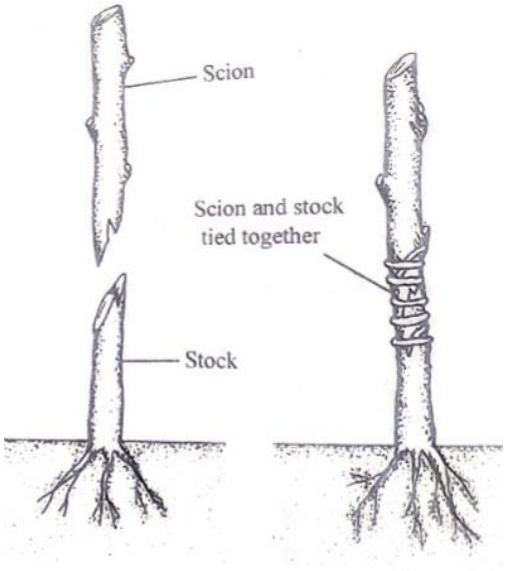
NB: Cassava, sugarcane and sweet potatoes are propagated by stem cuttings while lemon is propagated by root cuttings

(ii) GRAFTING

This method involves inserting a scion with the desired qualities into a closely related plant stock without the desired qualities.

- Grafting is done commercially to get varieties of fruits like, oranges, lemons etc.
- **Scion** is the cut shoot which is inserted into stock.
- **Stock** is the stem onto which the scion is inserted

A figure below shows grafting method



(iii)LAYERING

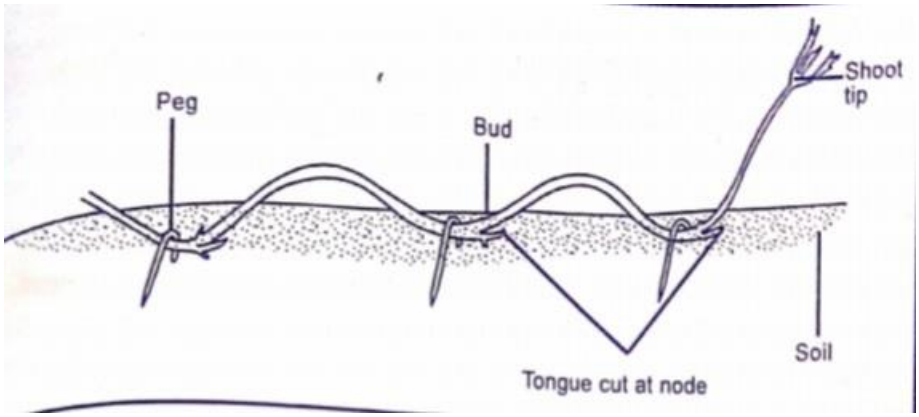
Is the pegging down of a branch of a plant without breaking it and covering it with moist soil.

- After some time the portion of the pegged branch in the soil grows adventitious roots
- Once the roots are fully developed, the branch is cut off from the parent plant.
- The new plant may be left to grow on its own to avoid overcrowding.

Example of plants reproduced by layering

- Avocados
- Rose
- Gooseberry

Diagram showing layering method



ADVANTAGES OF VEGETATIVE PROPAGATION

(i) Vegetative propagation is independent of processes of pollination, fertilization and dispersal.
(ii) Fruit trees grown from seed take several years before they mature. Fruit trees grown from cutting or grafting mature in one to two seasons.
(iii) New plants formed have the same genetic constitution like their parents except in cases of mutation. Any desirable characteristics of the parent will reappear in the offspring. Good qualities in parent plants are retained
(iv) Vegetative propagation makes possible the propagation of plants like bananas and seedless fruits that do not have capacity for sexual reproduction. Other plants produce very small quantities of seeds and are best propagated vegetatively.
(v) Cutting and grafting generally need less care than seedlings while becoming established.
(vi) A large area is covered within a short period of time in some of the cases e.g. runners

ADVANTAGES OF VEGETATIVE PROPAGATION IN AGRICULTURE

(i) Offspring have the same genetic constitution like the parent plant. Therefore if the parent is susceptible to a certain disease, its occurrence may lead to destruction of the whole crop.
(ii) If the parent is susceptible to a certain pest, it will be destroyed wholly.
(iii)In case of unfavorable weather conditions the whole plant would be wiped off.

EXAMINATION QUESTIONS

NECTA 2016

10. (a) Give the meaning of the following terms:
    (i) Vegetative propagation
    (ii) Gametes
    (b) Explain the merits and demerits of asexual reproduction in plants
    (c) Explain the merits and demerits of Vegetative propagation in agriculture.

CELL DIVISION

Is the process whereby a mature cell divides into two or more daughter cells.

- ◊ Reproduction involves the multiplication of cells.
- ◊ In order for cells to multiply, they undergo cell division where one cell divides into two, two to four, four into eight, and so on.

TYPES OF CELL DIVISION

Basically, there are two types of cell division, namely:

(i) Meiosis
(ii) Mitosis

MEIOSIS

Is a type of cell division that gives riseto four reproductive cells each with half number of chromosomes of the parent cell

- ◊ This type of cell division, which occurs in the reproductive organs to produce sex cells known as gametes.
- ◊ In this type of cell division the parent cells has diploid number of chromosomes.
- ◊ However the daughter cell arising from the cell division has a **haploid state.**
- ◊ Therefore meiosis reduces the chromosomes number into half means from 2n to n.

TERMS USED IN MEIOSIS

1) HAPLOID STATE

Is a condition in which the daughter cellsarising from the division have the half number of chromosomes found in the parent cell.

2) DIPLOID STATE

Is a condition in which chromosomes in each cell except gametes occur in pairs.

- ◊ Example, in man there are 23 pairs of chromosomes in each cell (46 chromosomes).

3) CROSSING OVER

Is the exchange of genetic material between the homologous chromosomes.

4) CENTRIOLES

Are structures found in animal cells that seem to act as an orientation device during cell division.

5) CHROMOSOMES

Are long thread-like structures found in the nucleus of animal and plant cells.

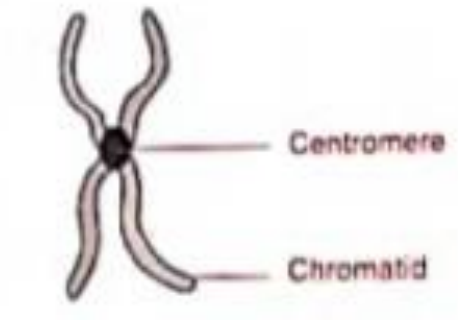
Function of chromosomes

- ◊ Carries the genes that determine an individual's characteristics.

STRUCTURE OF THE CHROMOSOME

- ◊ Chromosome is made up of two parallel strands called **chromatids**
- ◊ Each pair of chromatids is joined at one point by a structure called **centromere**

Consider the diagram below showing a diagram of chromosome



6) CENTROMERE

Is a structure whereby each pair of chromatids joined at one point.

7) HOMOLOGOUS CHROMOSOMES

Are chromosomes having the same structural features and carry gene for similar characteristics in the same position

8) SYNAPSIS

Is the process whereby the pair of homologous chromosomes lies adjacent to each other to form bivalent.

9) CHIASMA (CHIASMATA)

Is the point where homologous chromosomes are joined.

- ◊ It is the point at which homologous chromosomes exchange genetic **materials.**

STAGES OF MEOSIS

Meiosis consists of two successive divisions (meiotic division), namely:

(i) Meiosis I

(ii) Meiosis II

NB: Both meiosis I and meiosis II progress through the stages of prophase, metaphase, anaphase and telophase.

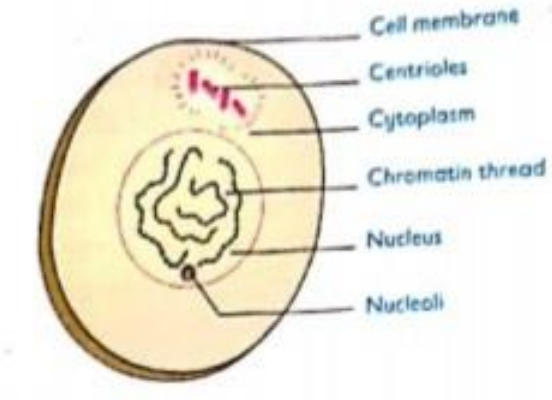
INTERPHASE

Is the phase just before meiosis begins.

Events occur during interphase:-

(i) The chromosomes appear as thin chromatin threads within the nucleus.
(ii) Centrioles and mitochondria replicate.
(iii)The cell grows and carries out normal life function.

Consider the diagram below showing interphase stage



NB: The interphase was wrongly named as a **resting phase**, but actually it is not a resting phase just because during this phase, many activities occur inside the cell like replication of cell organelles.

MEIOSIS I (FIRST MEIOTIC DIVISION)

Is the first division which involves duplication of the chromosomes and separation of the homologous chromosomes.

Meiosis I consist of the following phases:

(i) Prophase I
(ii) Metaphase I
(iii)Anaphase I
(iv)Telophase I

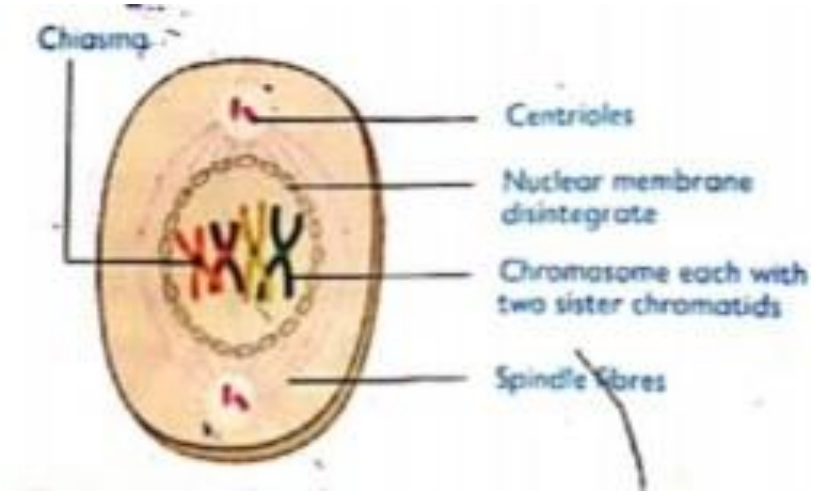
PROPHASE I

During prophase I the following events occur:

◊ Chromosomes shorten, thickenand become more visible
◊ Nucleolus disintegrate and disappear

- ◊ Homologous chromosomes come together forming a bivalent. This process is called **synapsis.**
- ◊ Chromatids cross over by chiasmata which results into exchange of genetic materials.

Consider the diagram below showing prophase I



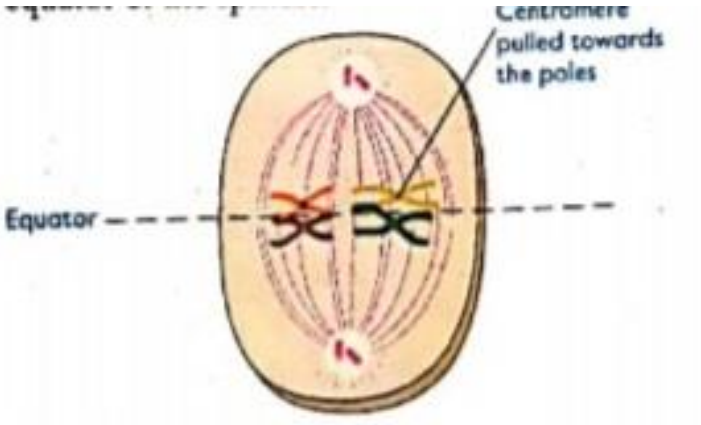
METAPHASE I

During metaphase I the following event occur:

(i) Spindle fibres forms

(ii) Bivalent homologous chromosomes moves to the equator of the spindle

Consider the diagram below showing metaphase I



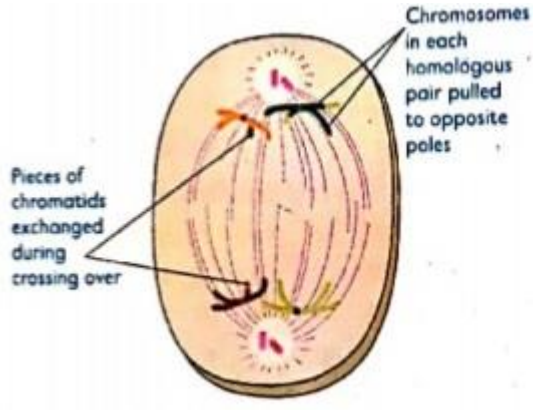
ANAPHASE I

During anaphase I the following events occur:

(i) The two homologous chromosomes separate and migrate to opposite poles of the spindle fibres.

(ii) The spindle fibres attached to the centromere shorten, pulling the homologous chromosomes to the opposite poles.

Consider the diagram below showing anaphase I



TELOPHASE I

During telophase I, the following events occur:

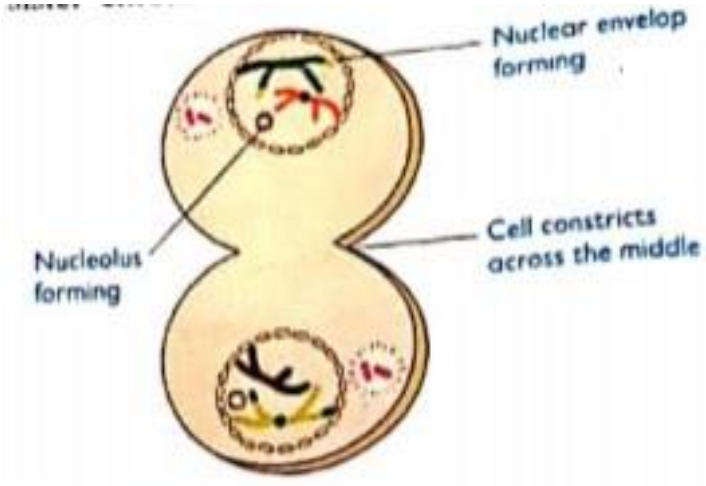
(i) The chromosomes reach their destination

(ii) The spindle apparatuses breaks down and disintegrates

(iii) Then the nucleus membrane reforms around each set of chromosomes

(iv) The cell constricts across the membrane and divides into two

Consider the diagram below showing anaphase I



QUESTION: Why first meiotic division is referred to as Reduction division?

ANSWER: Because at the end of prophase I the number of chromosomes in each cell is half the chromosomes number cell.

In animal cells before prophase II

- ◊ Centrioles are replicated,
- ◊ Nucleotides do not replicate since all genetic material was already formed during interphase.
- ◊ This brief phase sometimes reffered to as **interphase II**.

BUT

- ◊ In plant cells, telophase I is followed by the prophase II.

MEIOSIS II (SECOND MEIOTIC DIVISION)

Is a second division of meiosis which involves the separation of sister chromatids**.**

- ◊ At the end of meiosis II, four daughter cells are formed from one parent cell.
- ◊ The daughter cells formed at the end of meiosis II are called**gametes.**
- ◊ Each daughter cell (gamete) has half number of chromosomes (haploid) of the parent cell.

Meiosis II progress through the following phases

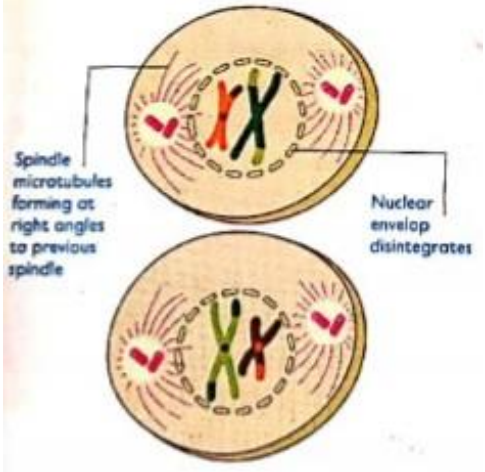
(i) Prophase II
(ii) Metaphase II
(iii)Anaphase II
(iv)Telophase II

PROPHASE II

During prophase II the following events occur:

(i) Centrioles replicates
(ii) New spindle fibres are formed.
(iii)The nucleolus disintegrates. In plant cells, the nucleolus does not disintegrate, it persists.
(iv)The nuclear membrane dissolves.

Consider the diagram below showing prophase II

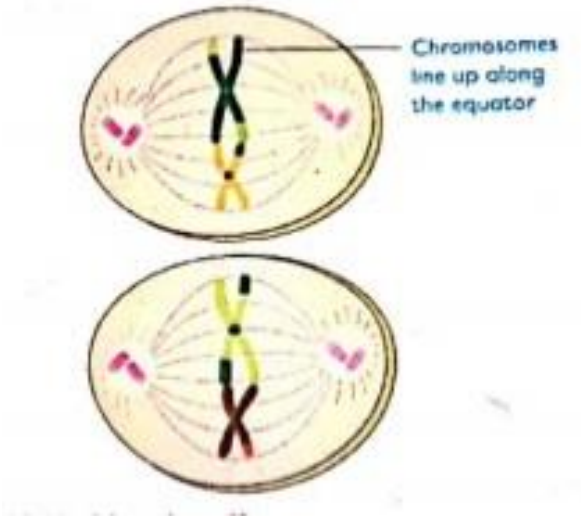


METAPHASE II

During prophase II the following events occur:

- ◊ Chromosomes migrate to the equator of the spindle.

Consider the diagram below showing metaphase II

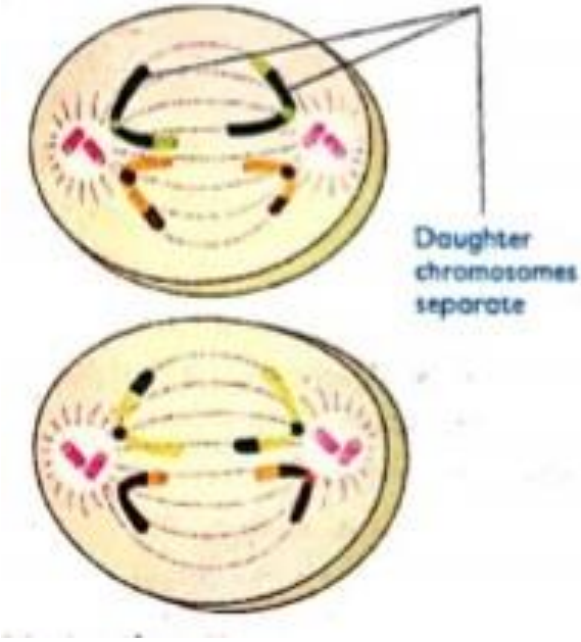


ANAPHASE II

(i) Sister chromatids separate from each other at the centromere.

(ii) The spindle fibres attached to the centromere contract, pulling the sister chromatids to the opposite poles.

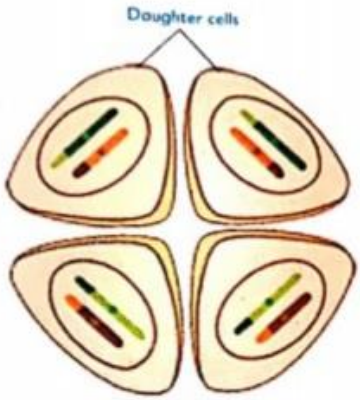
Consider the diagram below showing anaphase II



TELOPHASE II

(i) The chromosomes lengthen and become thin.
(ii) The spindle fibres disintegrate and disappear.
(iii) The nucleolus reappears.
(iv) The nuclear membrane is formed around each set of chromosomes.
(v) **In animal cells,** the cytoplasm constricts, resulting in the formation of four daughter cells, each daughter cell having the haploid number of chromosomes.

Consider the diagram below showing telophase II



In plant cells

- ◊ A cell plate develops along the equator of the spindle fibres.
- ◊ New cell walls are formed to enclose the four daughter cells.

In plant cells

- ◊ A cell plate develops along the equator of the spindle fibres.
- ◊ New cell walls are formed to enclose the four daughter cells.

A cell plate: is a structure formed from vesicles at the end of mitosis that separates the cytoplasm of two daughter cells.

DIFFERENCES BETWEEN THE MEIOSIS IN ANIMAL AND MEIOSIS IN PLANT

MIOSIS IN ANIMAL	MEIOSIS IN PLANT
It occurs in testes for male animals and in ovaries of female.	It occurs in anthers of male and in ovaries ofa female.
Gametes are producesdirectly	Gametes are not produced directly

THE SIGNIFICANCE OF MEIOSIS IN RELATION TO REPRODUCTION

(i) It helps in the formation of gametes (reproductive cells such as ova and sperms)
(ii) It brings variation through crossing over action
(iii) It ensures a constant number of chromosomes in organism of the same species by reducing the doubling number of chromosomes.

SIMILARITIES AND DIFFERENCES BETWEEN MITOSIS AND MEIOSIS

Similarities between mitosis and meiosis

(i) Their DNA replicate once.
(ii) They involve nuclear divisions.
(iii) They follow through the same steps i.e. interphase, metaphase, anaphase and telophase
(iv) Their homologous chromosomes align at the equator during metaphase

DIFFERENCES BETWEEN MITOSIS AND MEIOSIS

MITOSIS	MEIOSIS
(i) Involved in asexual reproduction	Involved in sexual reproduction
(ii) Crossing over does not take place	Crossing over takes place
(iii) Occurs as a one division process	Occurs as a two division process, meiosis I and II
(iv) A single cell divides into two daughter cells	A single cell divides into four daughter cells
(v) Daughter cells have diploid number of chromosomes	Daughtercells havehaploid number of chromosomes.
(vi) Occurs in somatic cells leading to growth	Occurs only in reproductive cells leading to gamete formation

REPRODUCTION IN FLOWERING PLANTS, THE STRUCTURE OF THE FLOWER

◊ In flowering plants (angiosperms) sexual reproduction is carried out by specialized structures known as **flowers.**

FLOWER

Is a reproductive organ of plant

◊ It is a modified part of the stem or side branch in which sexual reproduction occurs

◊ The male gametes are produced in the **anthers** while the female gametes are produced in the **ovary**

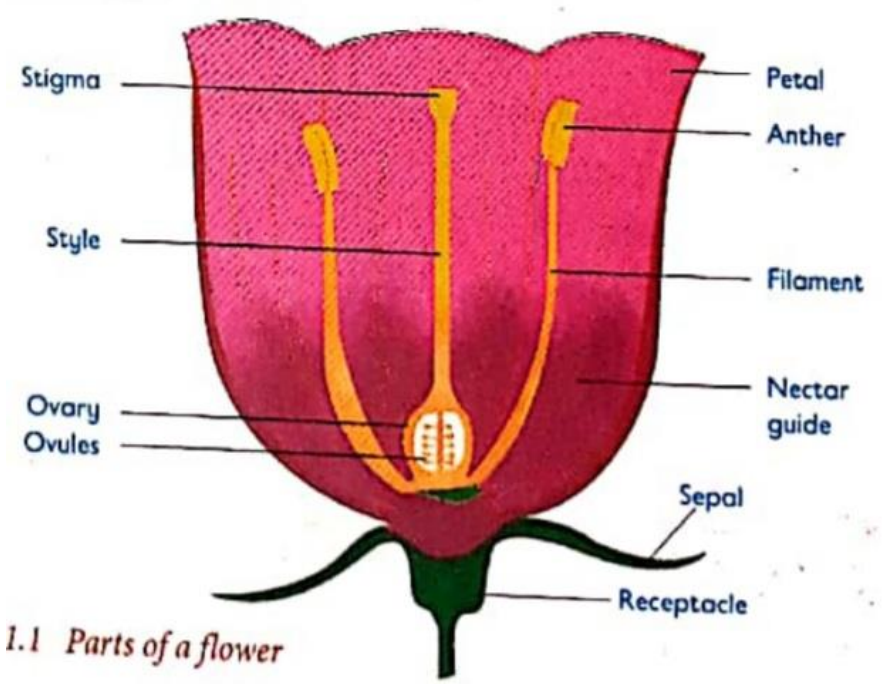
STRUCTURE AND FUNCTIONS OF A FLOWER

A flower consists of the following parts:

(i) Flower stalk/pedicel
(ii) Receptacle
(iii) Sepals/calyx
(iv) Petals/corolla
(v) Stamens
(vi) Pistil/Carpels

◊ The parts of the flower are arranged in four circles called **whorls** and are attached to a **receptacle**.

DIAGRAM OF A FLOWER



1.1 Parts of a flower

1) FLOWER STALK/PEDICEL

Is the part through which the flower is attached to the stem.

◊ **Sessile flowers:** are flowers which have no stalk and are directly attached to the stem of the plant

Function of flower stalk

◊ It is the part where floral parts are attached onto it.

2) RECEPTACLE

Is a swelling that develops at the tip of the flower stalk into which the floral parts are attached in ring or whorls.

◊ It is the axis (stem) to which the floral organs are attached

3) SEPALS (calyx)

Are the outermost parts of a flower and they are mostly green in colour.

◊ Sepals are collectively referred to as the **calyx**.

◊ Some flowers have sepal-like structures beneath the calyx known as **epicalyx**, for example the hibiscus flower.

Function of sepals

◊ They protect the young flower while in the bud stage.

4) PETALS (corolla)

Are brightly coloured leafy structures of a flower.

- ◊ Petals of insect-pollinated flowers aredelicate, brightly coloured and scented.
- ◊ The colour and scent attracts the agents of pollination such as birds and insects.
- ◊ Petals are collectively called the **corolla.**
- ◊ Sepals and petals are collectively referred to as the **perianth**.

Function of petals

(i) They attract pollinating agents such as insects and birds

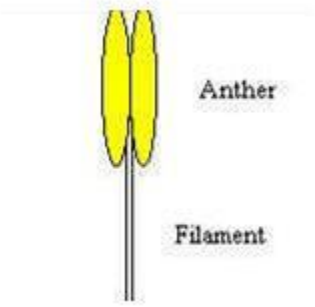
(ii) They protect the reproductive organs of the flower

5) STAMENS

Are the male reproductive parts of a flower

- ◊ The stamen is made up of **filaments** and **anthers.**
- ◊ The male reproductive structures are collectively referred to as the **androecium**.

Consider the diagram below showing male reproductive structures



(a) FILAMENT

Is a slender stalk that supports the anther.

- ◊ The filament may arise from the receptacle or the petals
- ◊ The filaments of some flowers are fused to form a tube-like structure called the staminal tube

Function of filament

- ◊ It supports anthers

(b) ANTHER

Is a two-lobed upper part of the stem.

- ◊ Each lobe has two pollen sacs within which pollen grains develop.

Pollen grains

Are the male gametesof flowering plants.

Function of anther

- ◊ It produces male gametes known as pollen grains

6) PISTIL (Carpel)

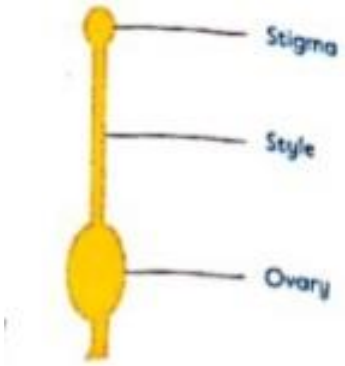
Is the female reproductive structure of a flower.

- ◊ It isthe female part of a flower
- ◊ The female reproductive structures are collectively referred to as the **gynoecium**

Each carpel consists three parts, namely:

(a) Stigma
(b) Style
(c) Ovary

Consider the diagram below showing parts of carpel



(a) OVARY

Is a female reproductive organ which contains ovules.

Ovules: are unfertilized female gametes.

- ◊ After fertilization ovary develops into **a fruit** while ovules develop into **seeds**

Function of ovary

- ◊ It is a part where ovules are produced

TYPES OF OVARY

There are two types of ovary in relation to the position of the receptacle, namely:

(i) Superior ovary
(ii) Inferior ovary

(i) Superior ovary

Is one that is positioned above the receptacle.

Exampleof superior ovary

- ◊ Ovary of a bean flower
- ◊ Apple

(ii) Inferior ovary

Is one that is positioned below or enclosed within the receptacle.

Example of inferior ovary

- ◊ Ovary of Hibiscus flower
- ◊ Ovary of Rose flower
- ◊ Ovary of Black jack flower.

(b) STYLE

Is the hollow connecting ovary and stigma

- ◊ In maize plants, the style and the stigma hang out of the flower.

Function of style

- ◊ It connects the stigma to ovary.

(c) STIGMA

Is a small swelling found at the tip of the style

- ◊ It is glandular sticky structure at the top of the carpel.
- ◊ The branches of the stigma correspond to the number of carpels.
- ◊ Five branches of the stigma indicate the presence of five carpels

Function of stigma

- ◊ Itreceives pollen grains during pollination.

7) NECTAR GUIDES

Are streaks of deep pigmentation (colour) originate from the bases of the petal

Function of nectar guide

- ◊ Used to direct the insects to the nectarineswhere nectar is secreted.

Nectarines

Are swelling at the base of the petal

Function of nectarines

- ◊ Produces nectar which attracts pollinating agents.

TERMS USED TO DESCRIBE DIFFERENT TYPES OF FLOWERS

1) COMPLETE FLOWER

Is a flowerwithall floral parts that is sepals, petals, stamens and carpels.

Example of complete flower

- ◊ Hibiscus flower

2) INCOMPLETE FLOWER

Is aflowerwith one or more floral parts missing.

Example of incomplete flower

- ◊ Clemantis

3) BISEXUAL FLOWER

Is a flower with bothstamen and carpel

- ◊ It is a flower with two sex (male and female sex)

Example of bisexual flower

- ◊ Hibiscus flower

4) UNISEXUAL FLOWER

Is an incomplete flower with either stamens or carpel only

- ◊ It is a flower with one sex only

Example of unisexual flower

- ◊ Pawpaw flower

5) PISTILLATE FLOWER

Is an incomplete flower that has carpels only.

- ◊ It is a female flower

6) STAMINATE FLOWER

Is an incomplete flower that has stamens only.

- ◊ It is a male flower

7) POLYSEPALOUS

Is a flower whose sepals are free.

8) GAMOSEPALOUS

Is a flower whose sepals are fused

9) MONOECIOUS PLANT

Is a plant in which both male and female flowers are borne

Example of monoecious plant

- ◊ Maize

10) DIOECIOUS PLANT

Is a plant which has male or female flowers only.

- ◊ Pistillate flowers and staminate flowers are borne in different individual plants

Example of dioecious plant

- ◊ Pawpaw tree

11) ACTINOMORPHIC FLOWER

Is a flower that can be divided into two equal halves by any vertical section passing through the center

- ◊ Actinomorphic flower is also called regular flower
- ◊ It is radially symmetrical

12) ZYGOMORPHIC FLOWER

Is a flower that can be divided into two equal halves in only one particular plane passing through the center.

- ◊ Zygomorphic flower is also called irregular flower
- ◊ It is bilaterally symmetrical

13) INFLORESCENCE FLOWERS

Are many flowers that borne on the same branch or on closely associated branches

Example of inflorescence flowers

- ◊ Sunflowers

QUESTIONS

1. Why the stamens and carpels are known as the essential parts of a flower?
2. Why the sepals and petals are known as the accessory parts of a flower?

ANSWER

1. Because they contain the male and female reproductive structures that play part in reproductive process.
2. Because they do not play a direct role in the reproductive process but they aid in the process by protecting the essential parts and by attracting pollinating insects

EXPERIMENT 1

Aim: to investigate the structure of a flower

Materials: Hibiscus flowers, hand lens, razor blade, a notebook.

Procedure:

1. Carefully observe the hibiscus flower you have picked.
2. Identify the different parts of the flower.
3. Describe the floral parts, noting their numbers, colour and structure.
4. Cut the flower longitudinally using a sharp new razor blade into two identical halves. Then draw a net, well labelled diagram of one half of the flower.

POLLINATION

Pollination: is the transfer of pollen grains from the anthers to the stigma of a flower.

- ◊ Pollen grains from anthers are carried to the stigma by the agents of pollination such as wind, insects or birds.

TYPES OF POLLINATION

There are two mainly types of pollination, namely:

(i) Self-pollination

(ii) Cross pollination

SELF POLLINATION

Is the transfer of pollen grains from the anther to the stigma of the same flower or another flower of the same plant.

Example:

- ◊ Include garden peas.

CROSS POLLINATION

Is the transfer of pollen grains from the anther of one flower to the stigma of another flower of the same species.

OR

Is the transfer of pollen grains from the anther to the stigma of a flower of another plant but of the same species.

Example of cross pollination

- ◊ Include maize.

Factors that favours cross pollination and hinder self-pollination

- ◊ **Dioecious plants**: Some plants have flowers that are only male - they have only **stamen**. Other plants of the same species have flowers that are only female - they have only **carpels**.
- ◊ **Monoecious plants**: Some flowers on a plant are only male and other flowers on the same plant are only female. So, self-pollination is avoided by a difference in the timing of their development.

- ◊ **Protandry**: Anthers on some plants mature first. Pollination of immature stigma on the same plant is therefore not possible.
- ◊ **Protogyny**: The stigmas mature first.
- ◊ **Self-incompatibility**: Pollination can occur but the pollen tube doesn't grow well, if at all, so no fertilization takes place.

DIFFERENCES BETWEEN SELF-POLLINATION AND CROSS- POLLINATION

Self pollination	**Cross pollination**
(i) External pollinating agents are not required	External pollinating agents are required
(ii) Involves a single plant	Involves two different plants of the same species
(iii) Produces a small number of pollen grains	Produce a large number of pollen grains
(iv) Occurs only in perfect flowers	Occurs both in perfect or imperfect flowers
(v) Produces homozygous offsprings	Produces heterozygous offsprings
(vi) Does not brings about variation	It brings about variation
(vii) Both anthers and stigmas mature at the same time	Anthers and stigmas mature at different time

Importance of pollination

(i) It enables flowering plants to reproduce and produce enough seeds for dispersal
(ii) It enables flowering plants to maintain genetic diversity within a population.
(iii) It enables flowering plants to develop adequate fruits
(iv) The plants produced through pollination are more resistant to diseases.
(v) It reduces chances of harmful recessive genes to express themselves,

AGENTS OF POLLINATION

Agents of pollination: are the carriers of pollen grains from the anther to the stigma.

- ◊ Agents of pollination can either be organisms such as insects and birds or physical conditions such as wind and water.

THE MAIN AGENTS OF POLLINATION

The following are the main agents of pollination, namely:

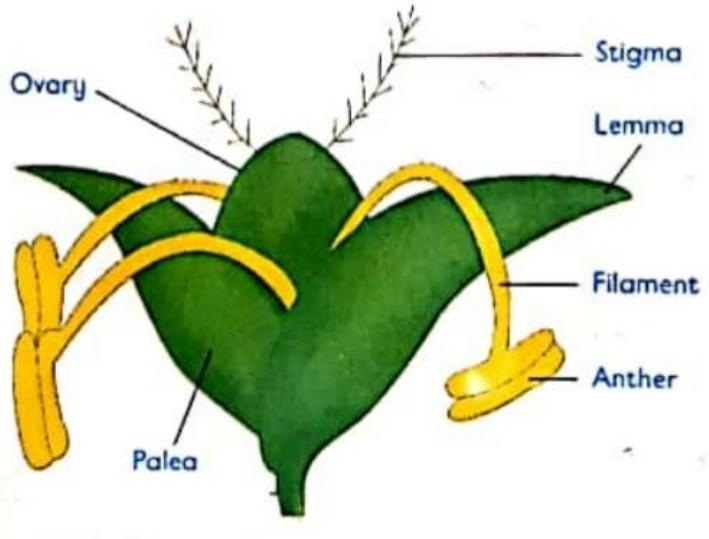
(i) Wind
(ii) Insects
(iii) Birds

WIND POLLINATED FLOWERS

Areflowers in which pollination occurs through wind

- ◊ Wind pollinated flowers are also referred to as anemophilous flowers.
- ◊ The term anemophilous is derived from the word ***anemo***which refers to as wind.

Structure of a wind-pollinated flower (flower of rye grass plant)



ADAPTATION OF THE WIND POLLINATED FLOWERS TO THEIR MODE OF POLLINATION

(i) The anthers and stigmas are exposed to make it easy for wind to blow the pollen that can then easily land on the stigma.

(ii) The pollen grains are small and light hence easily carried in the air by wind.

(iii) They have smooth and dry pollen grains that can easily be picked by wind.

(iv) They have large anthers which produce large amounts of pollen grains to increase the chances of pollination.

(v) Their anthers are loosely attached to the filaments and hang freely to allow the anthers to be easily shaken by wind.

(vi) They have a sticky stigma that traps pollen grains

(vii) They have a long hairy style to expose the stigma out of the flower

(viii) It has lemma that encloses the immature stamens and carpels and protects the florets of grasses.

CHARACTERISTICS OF WIND POLLINATED FLOWERS

Flowers that depend on wind for pollination have the following features:

(i) They have no nectarines

(ii) They are scentless.

(iii) They have small petals with exposed anther and stigma.

(iv) They are mostly unisexual. Example in maize, the maize cob is pistillate while the tassel is staminate.

(v) They have dull- coloured petals that do not attract insects and birds.

(vi) They have long, hairy style to expose the stigma outside the flower.

(vii) They have large anthers which produce large amounts of pollen grains.

(viii) The pollen grains are small and light. Hence easily carried in the air by wind.

(ix) They have large feathery stigmas outsides the flower to trap pollen grain.

(x) They have smooth and dry pollen grains that can easily picked by wind.

(xi) They have a sticky stigma that traps pollen grains.

INSECT POLLINATED FLOWERS

Are flowers in which pollination occurs through insects.

◊ Insect pollinated flowers are also referred to as entomophilous flowers.

◊ The term entomophilous is derived from the word entomophily which means to be carried by insects.

Example of insect pollinated flowers

◊ Mango flower

◊ Roses

CHARACTERISTICS OF INSECT POLLINATED FLOWERS

(i) They have large brightly-coloured petals which attracts insects.

(ii) They are scented to attract insects for pollination.

(iii) They have nectarines which contain nectar.

(iv) The pollen grains are large, heavy and sticky.

(v) Theiranthers are small in size and produce few but large pollen grains.

(vi) The stigma and anther are held firmly in position within the flower.

(vii) Insect pollinated flowers are mostly bisexual

DIFFERENCES BETWEEN WIND AND INSECT POLLINATED FLOWERS

WIND POLLINATED FLOWERS	INSECT POLLINATED FLOWERS
(i) They have no scent	They have scent
(ii) They have no nectarines.	They have nectarines which contain nectar.
(iii)They have dull- coloured petals	They have large brightly-coloured petals
(iv)They have large anthers which produce large amounts of pollen grains.	They have smallanthers which produce fewpollen grains.
(v) Their pollen grains are small, light and smooth.	Their pollen grains are large, heavy and sticky.

CLASS WORK

1. Give the similarities between wind and insect pollinated flowers
2. Give four differences between wind and insect pollinated flowers

FERTILIZATION IN FLOWERING PLANTS

Fertilization: is the fusion of the male and female gamete nuclei to form a zygote

- ◊ Fertilization in plants takes place in the embryo sac
- ◊ Double fertilization is unique feature of flowering plants.
- ◊ Fertilization in plant takes place slowly.

DOUBLE FERTILIZATION

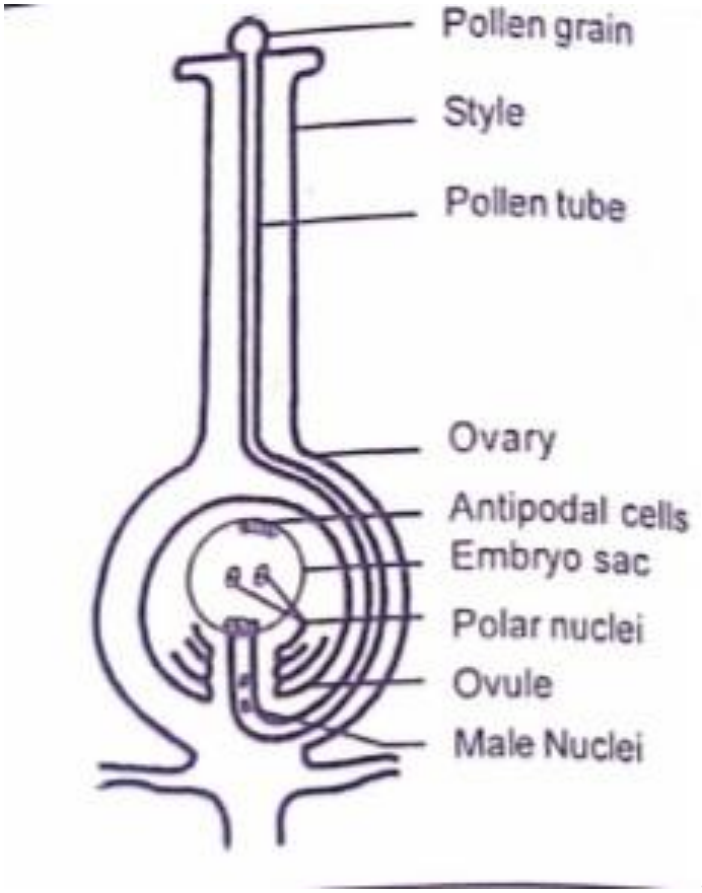
Is the process by which one male nucleus fuses with the functional egg to form a diploid zygote and the other male nucleus fuses with the polar nuclei to form the primary triploid or endosperm nucleus

PROCESS OF FERTILIZATION IN FLOWERING PLANT

- ◊ Pollen grains land and sticks on the stigma and germinates. A pollen tube develops from the pollen grain and grows down the style to the ovary. It obtains nourishment along the style. The tube nucleus leads the way and the generative nucleus follows close behind it. As the tube grows downwards, the generative nucleus divides by mitosis to form two male nuclei. The pollen tube breaks through the ovary wall and enters the ovule through the micropyle. The tube nucleus disintegrates giving clear way for the two male nuclei.

The male nuclei enter the embryo sac where oneof the male nuclei fuses with the egg nucleus to form a diploid zygote. The other male nucleus fuses with the two polar nuclei to form a triploid nucleus known as the primary endosperm.This is known as **double fertilization.**

The diagram below showing germination of the pollen grain and growth of the pollen tube



STRUCTURE OF THE MATURE OVULE

Mature ovule consisting the following parts:

(i) Functional female gamete– is the egg cell at the micropyle end of the ovule used in fertilization process.

(ii) Synergid – are two non-functional eggs at the micropyle end and they eventually disintegrate after fertilization

(iii)Antipodal cells – are the three non-functional cells at the furthest end of the micropyle and they eventually disintegrate after fertilization

(iv) Polar nuclei – are two nuclei formed when one nucleus from each group moves to the centre of the embryosac

(v) The funicle – is a stalk which the ovule uses to attach to the placenta on the ovary wall.

(vi) Embryosac – is a cytoplasm of an ovule

THE CHANGES THAT OCCUR IN FLOWER AFTER FERTILIZATION

After fertilization, the following changes occur in flower

(a) SEED FORMATION

After fertilization, the fertilized ovule develops into a seed

- ◊ Fertilization leads to the formation of seeds

(b) FRUIT FORMATION

After fertilization, the fertilized ovary develops into a fruit

- ◊ In most cases the development of the fruit is stimulated by fertilization.

PARTHENOCAPY

Is the process by which fruits develop without fertilization taking place

- ◊ Parthenocarpic fruits such as pineapples, bananas, guavas lack seeds.

(c) EMBRYO FORMATION

After fertilization, the zygote undergoes mitosis and becomes an embryo with three parts namely, plumule, radicle and cotyledon.

(d) FORMATION OF THE TESTA (seed coat)

After fertilization, the integuments develop into seed coat or testa.

- ◊ The testa has one scar called hilum that mark the point where the ovule was attached to the placenta

The seed coat is made up of two layers

(i) Outer seed coat (testa) – forms the hard thick testa

(ii) Inner seed coat (tergmen) – remains thin and transparent.

FUNCTIONS OF TESTA

(i) Protects the seed against dehydration, physical damage and invasion of microorganisms

(ii) Permits oxygen and water enter into the seed during germination.

(e) FORMATION OF PERICARP

After fertilization, the ovary wall becomes the pericarp

- ◊ The pericarp is often the edible layer in fruits.

The pericarp is made up of three layers namely:

(i) Exocarp – is the outermost layer

(ii) Mesocarp – is the middle layer

(iii)Endocarp – is the inner layer

(f) DISINTEGRATION OF THE FLORAL PARTS

After fertilization, the stamens, sepals, petals, stigma and style wither, dry up and fall off.

- ◊ In some cases, some of the floral parts may become fleshy and form part of the fruit.
- ◊ The fruit retains scars at the points of attachment to the pedicel and style.

TYPES OF FRUITS

Fruits are classified into three main groups, namely:

(a) Simple fruits

(b) Aggregate fruits

(c) Multiple fruits

REPRODUCTION IN MAMMALS

In mammals reproduction occurthrough an elaborate system called **reproductive system**

HUMAN REPRODUCTIVE SYSTEM

Is one of the body systems made up of specialized organs such as ovaries, testes and uterus.

- ◊ Its role is to produce offspring.

REPRODUCTIVE ORGANS

Are specialized organsfor reproduction to take place

Example of reproductive organs

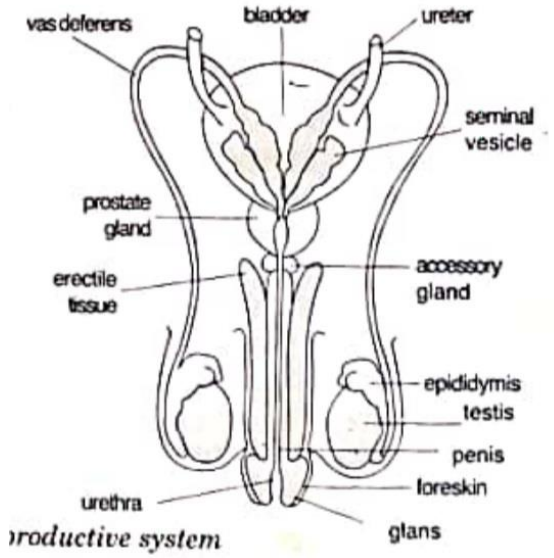
- ◊ Testes
- ◊ Ovaries
- ◊ Uterus
- ◊ Penis
- ◊ Vagina

THE MALE REPRODUCTIVE SYSTEMS

The male mammal reproductive system consists of the following structures

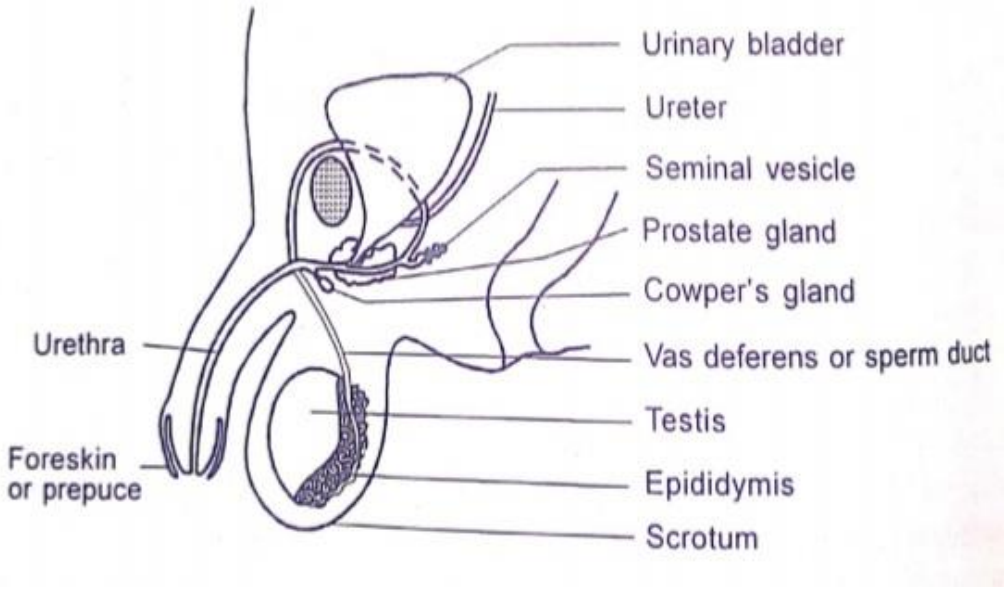
(i) Testes
(ii) Epididymis
(iii) Vas deferens
(iv) Urethra
(v) Penis
(vi) Accessory glands
(vii) Scrotum
(viii) Seminiferous tubules

THE FRONT VIEW DIAGRAM OF MALE REPRODUCTIVE SYSTEM



roductive system

THE SIDE VIEW DIAGRAM OF MALE REPRODUCTIVE SYSTEM



1) TESTES (singular: Testis)

Are two oval-shaped structures that lie outside the body cavity in a special sac called **scrotum**

- ◊ They hang outside the body cavity to ensure their temperature is lower than that of the body.
- ◊ Sperm develop best at lower temperature than that of the body.

FUNCTIONS

(i) They produce the male gametes (sperms)

(ii) They secrete male sex hormone called testosterone.

Scrotum: is the sac that enclosesthe testes

Function of scrotum

(i) It supports and protects the testes

SEMINIFEROUS TUBULES

Arelong narrow tubes in found in each testis

- ◊ Seminiferous tubules are lined with cells that develop into sperms.
- ◊ The cells between seminiferous tubules are referred to as **interstitial cells** and they secrete androgens such as testosterone.

Function of seminiferous tubules

(i) It is a site where spermatogenesis occurs.

2) EPIDIDYMIS

Is a long coiled tube that stores the sperm made in the seminiferous tubules.

- ◊ One end of epididymis is attached to the testis and the other to the sperm duct.
- ◊ The lining of the epididymis has cilia which propel the sperm forward.
- ◊ The contraction of the walls of the epididymis also aids in the movement of sperms through the sperm the sperm duct during ejaculation.
- ◊ Sperm stored in the epididymis may be reabsorbed in the body if ejaculation does not occur within four weeks.

Function of epididymis

- ◊ Epididymis used to store sperms.

3) VAS DEFERENS (SPERM DUCT)

Is a duct through which semen is carried from epididymis to urethra.

- ◊ The duct has a narrow lumen and muscular walls which, when they contract during ejaculation, propel sperms towards the urethra.

Function of vas deferens

- ◊ It carries sperms from the epididymis to the urethra.

4) EJACULATORY DUCT (URETHRA)

Is atube that directs sperms from the vas deferensout of male body

- ◊ Ejaculatory duct is also called urethra

Functions of ejaculatory duct (urethra)

(i) It carries sperms out of male body from the vans deferens

(ii) It carries urine out of male body from the urinary bladder

5) PENIS

Is a copulatory organ which is used to introduce sperms into the vaginaduring sexual intercourse or copulation.

- ◊ The penis is made of sponge tissue muscles and blood vessels.
- ◊ The head of the penis is called the **glans** and is covered by a fold of skin, called **prepuce** or **foreskin.**
- ◊ The **glans** contains highly sensitive sensory nerve endings.
- ◊ During sexual excitement, the erectile tissue fills with blood, making the penis firm and erect.
- ◊ During sexual intercourse (copulation) the erect penis is inserted into the female's vagina. Stimulation of the sensory nerve endings results in a reflex rhythmical contraction of various tubes in the male reproductive tract, which propels semen into vagina. This process is known as **ejaculation**

EJACULATION

Is the process by which sperms are released into the vagina during sexual intercourse

- ◊ During ejaculation, contraction of the urethra muscles propels semen out of the erect penis.
- ◊ Semen is made up of sperm and fluid from various glands in the male reproductive system also referred to as seminal fluid.

Function of penis

◊ Used to introduce sperms into female reproductive system.

6) ACCESSORY SEX GLANDS

These include:

(a) Cowper's gland
(b) Prostate gland
(c) Seminal vesicles.

◊ Accessory sex glands produce the fluid which mixes with sperms to form **semen.**

Function of fluid secreted by accessory sex glands

(i) It provides alkaline medium for the sperm to swim in.

(ii) It provides nutrients for the sperms

(iii)It provides protection to the sperms.

FUNCTIONS PERFORMED BY ACCESSORY GLANDS

ACCESSORY GLANDS	FUNCTION
(a) COWPER'S GLANDS OR (BULBO-URETHRAL GLAND)	◊ They secrete mucus which lubricates the urethral walls providing a conclusive surface for swimming of sperms.
(b) **PROSTATE GLANDS** ◊ Located at the junction of urinary bladder and urethra.	◊ Secretes an alkaline buffer that protects sperm cells against the acidic vaginal environment.
(c) **SEMINAL VESICLES**	◊ Secretes a fluid that provides a favourable medium

◊ Located below the urinary bladder.	for mobility of the sperms. ◊ Secretion contains sucrose and prostaglandins.Sucrose provide glucose that is used in respiration for ATP energy for swimming.

ADAPTATIONS OF MALE REPRODUCTIVE SYSTEM

(i) Testes occur in a pair, this increase the surface area for sperm production.

(ii) The presences of highly coiled seminiferous tubules increase the surface area for sperm production.

(iii) The scrotum offers protection from mechanical damage of the testes.

(iv) The testes are located outside the body to provide low temperature adequate for sperm formation.

FEMALE REPRODUCTIVE SYSTEM

The female reproductive system is made up of the following organs:

(i) The ovaries

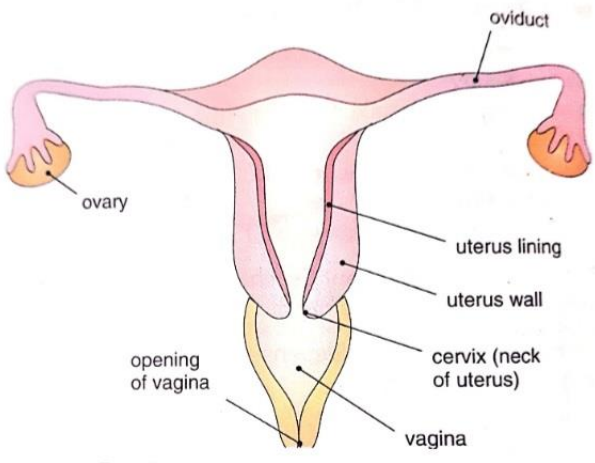
(ii) Fallopian tube (Oviduct)

(iii) Uterus or womb

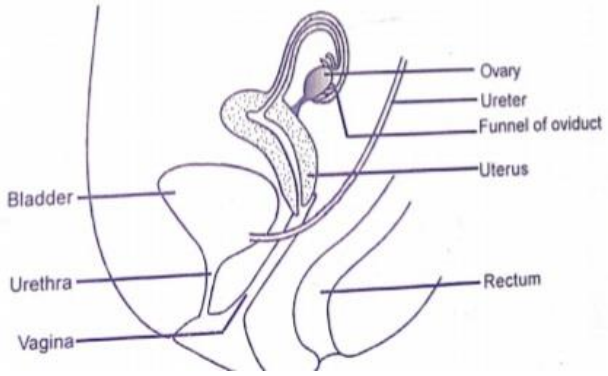
(iv) Cervix

(v) Vagina or birth canal

DIAGRAM OF FEMALE REPRODUCTIVE SYSTEM



FRONT VIEW



SIDE VIEW

1) THE OVARIES

These are two oval-shaped cream coloured structures that lie on the lower part of the abdomen below the kidney.

◊ Ovaries are attached to the uterus by a membrane.

Function of ovary

(i) It is the organ where ova or female gametes are produced

(ii) It produces female sex hormones (oestrogen and progesterone.

LAYERS OF OVARY

Each ovary has two layers, namely:

(i) Outer cortex

(ii) Inner medulla

(i) **AN OUTER CORTEX**

This layer has follicles which give rise to ova.

◊ Each follicle consists of an immature ovum surrounded by epithelial cells.

◊ A girl is born with up to 400,000 immature ova but only about 400 mature.

(ii) **AN INNER MEDULLA**

This layer has blood capillaries, nerve fibres and smooth muscles.

2) FALLOPIAN TUBE (OVIDUCT)

Is the tubethroughwhich the ovum moves from the ovary to uterus.

◊ Fallopian tube or oviduct is a funnel shaped opening.

◊ Its inner lining has cilia which help to propel the ovum towards the uterus.

◊ Fallopian tube consists finger like projections called **fimbriae**which used to pick the ovum during ovulation

Function of fallopian tube

◊ It is the site where fertilization takes place.

◊ It passes down the ovum from the ovary to the uterus.

3) UTERUS (WOMB)

Is a chamber between the oviduct and the vagina.

◊ It is the organ where zygote develops during pregnancy.

◊ The lining of the uterus is called **endometrium.**

- ◊ Endometrium thickens every month in the preparation for pregnancy but peel off if fertilization does not occur.

Function of uterus

(i) It is the organ where zygote develops during pregnancy.

(ii) It is a region where implantation takes place.

- ◊ Its walls are thick and elastic to accommodate the growing foetus.

4) CERVIX

Is the muscular ring found between uterus and vagina

- ◊ It is a neck of the uterus.
- ◊ It is the point where the vagina is linked to the uterus.

Functions of cervix

(i) It separates the uterus from the vagina.

(ii) It allows the menstrual blood to flow out of the uterus and the sperms to get into the uterus.

(iii) It is narrow to ensure that the embryo does not leave the uterus before the right time.

(iv) Itexpands to allow the baby to pass through into the vagina during birth.

(v) It has mucus plug that seals it during pregnancy to prevent microorganisms from entering the uterus.

5) VAGINA

Is a muscular tubular structure that links the uterus to outside of the body.

- ◊ It is also called a **birth canal**
- ◊ It has elastic walls that stretch during sexual intercourse and during birth
- ◊ The mouth of the vagina is surrounded by flaps of tissue called labia which form the external genitalia.

Function of vagina

- ◊ It is a region where sperms are deposited during sexual intercourse.

6) VULVA

Is the external opening of the vagina.

- ◊ It is a region containing the female external genitalia.
- ◊ The walls of the vulva contain**vestibule glands** which release mucus when the female is sexually aroused and helps to lubricate the penis during sexual intercourse.

Parts of vulva

Vulva is made up of the following structures:

(i) Labia majora

(ii) Labia minora

(iii)Clitoris

(i) LABIA MAJORA

Is the large lips protector for the other external reproductive organs.

◊ It contains sweat and oil-secreting glands.

◊ After puberty are covered by hair.

(ii) LABIA MINORA

Is the small lips lie inside the labia majora and surrounded the openings to the vagina and urethra.

(iii)CLITORIS

Is the female equivalent to male penis.

◊ It engages with blood during sexual arousal (stimulation) which makes it to erect as penis.

GAMETOGENESIS (GAMETE FORMATION)

Is the process by which reproductive cells or gametes are formed.

TYPES OF GAMETOGENESIS

There are two types of gametogenesis, namely:

(i) Spermatogenesis (ii) Oogenesis

(i) SPERMATOGENESIS

Is the process of sperm cells formation.

◊ Spermatogenesis occurs in the seminiferous tubules in the testes.

◊ The outer layer of seminiferous tubules is called the **germinal epithelium**.

◊ The germinal epithelium has sortoli cells at intervals.

PROCESS OFMALE GAMETE FORMATION (SPERMATOGENESIS)

◊ The diploid germinal epithelial cells called primordial germ cells undergo mitosis to form large diploid cells called spermatogonia.

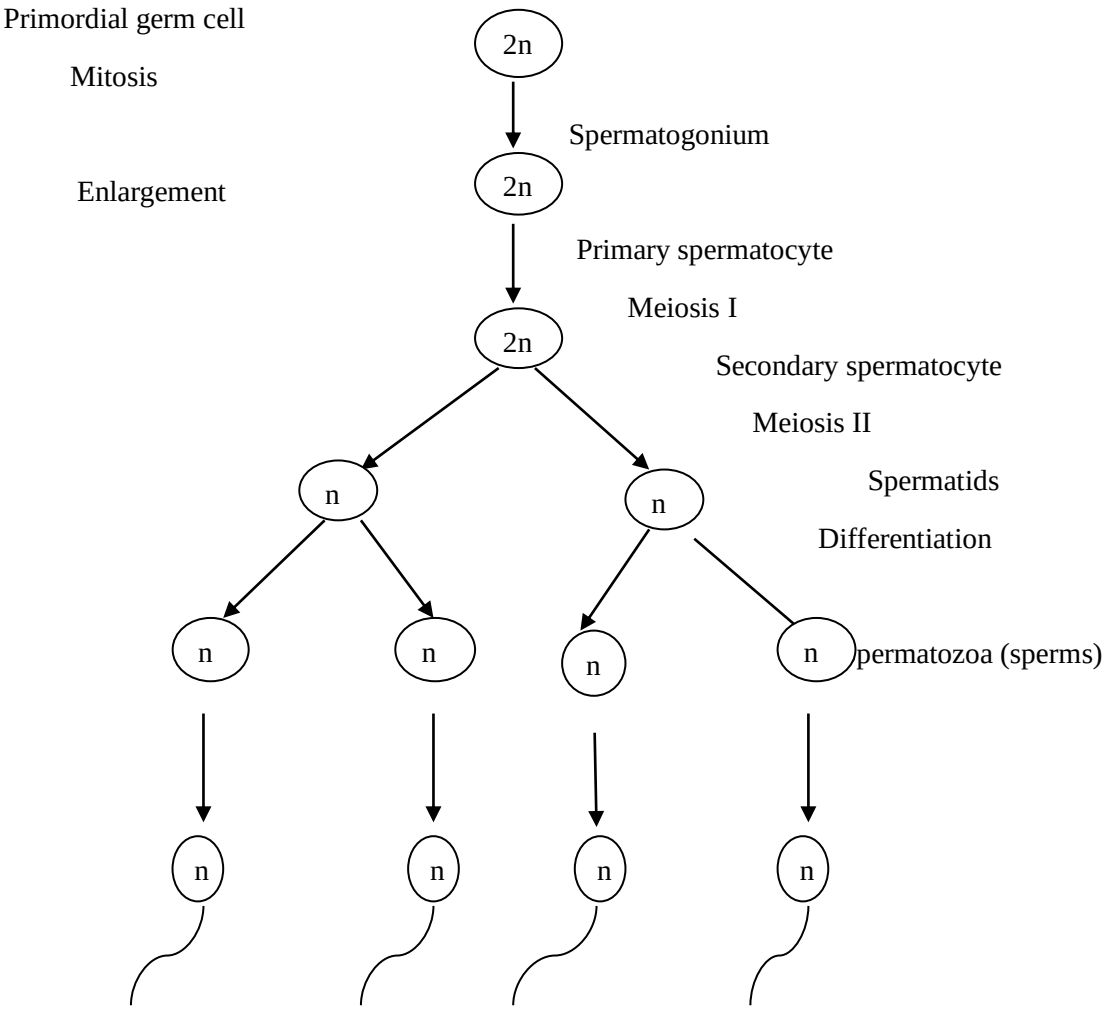
◊ The spermatogonia enlarge to form the primary spermatocytes.

◊ The primary spermatocytes undergofirst meiotic division to form secondary spermatocytes.

◊ The Secondary spermatocytes undergo second meiotic division to form spermatids.

◊ The spermatids attach to sertoli cells and then undergo differentiation to form spermatozoa (mature sperm).

Consider the chart below showing the process of male gamete formation (spermatogenesis)



NB: **2n** – Indicates a diploid cell

n – Indicates a haploid cell

THE SPERM

Is the male reproductive gamete.

Function of the sperm

- ◊ It fertilizes the ovum to form zygote

Structure of the mature sperm

The mature sperm is made up of the following parts:

(a) Head

(b) Neck – contains centriole

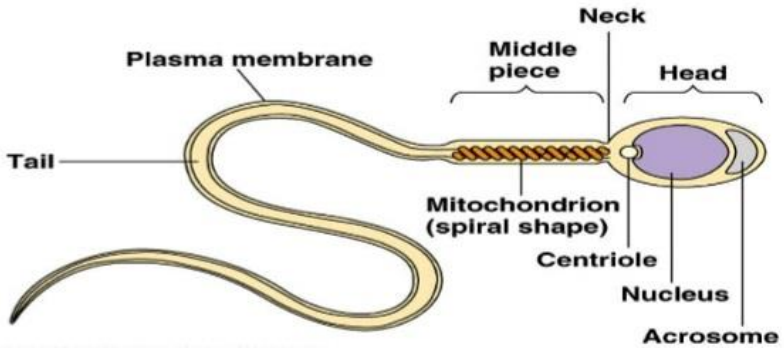
(c) Middle piece

(d) Tail

NB:

- ◊ The sperm head contain:
  - (i) **Large nucleus**
  - (ii) **Acrosome**
- ◊ The middle piece of the sperm contain
  - (i) **Mitochondria**

Consider the diagram below showing a structure of a human sperm cell



FUNCTION OF EACH PART OF THE SPERM

Part of the sperm	Function
Acrosome	◊ It contains lytic enzymes used to dissolve egg membrane during fertilization
Nucleus	◊ It carries genetic materialswhich has haploid number of chromosomes
Mitochondria	◊ Used to provide energy needed for swimming (propulsion).

Tail	◊ Used for swimming of the sperm.
Centriole	◊ Used to form the sperm flagellum and sperm movement ◊ Used for the development of embryo after fertilization

ADAPTATIONS OF THE SPERM

(i) It has a long tail used for swimming

(ii) It has a large nucleus that helps the sperm cells to carry a lot of genetic information.

(iii) It has numerous mitochondria that help to provide enough energy needed for sperm swimming

(iv) It has lytic enzymes in the acrosome which help to digest the egg membrane to facilitate fertilization.

(v) They are produced in large numbers to increase chances of survival.

OOGENESIS

Is the process of eggs/ova formation.

◊ It occurs in the ovary.

◊ The outer surface of the ovary consists of a layer of diploid cells, the **germinal epithelium.**

PROCESS OF FEMALE GAMETE FORMATION (OOGENESIS)

◊ The diploid germinal epithelial cells called primordial germ cells undergo mitosis to form daughter cells called oogonia.

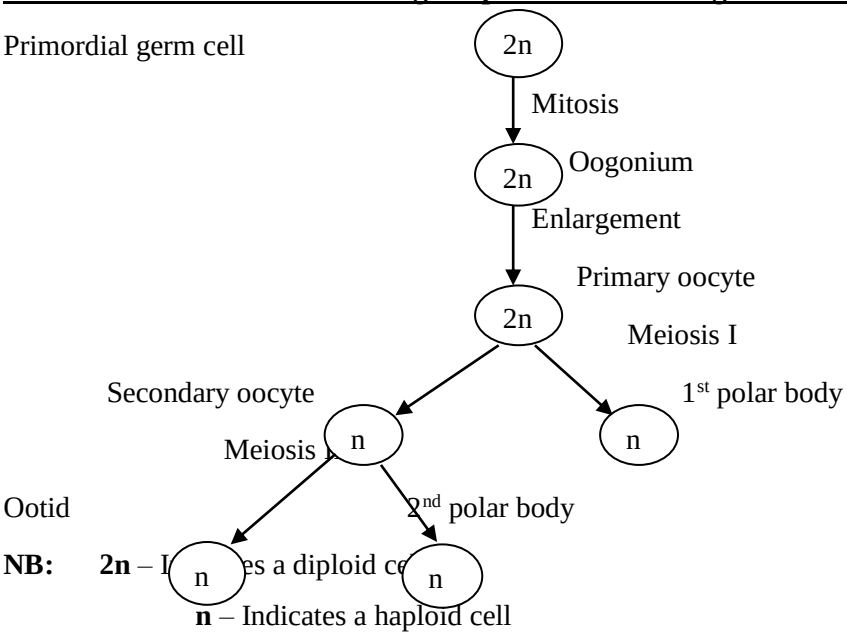
◊ The oogonia enlarge to form the primary oocytes.

◊ During every menstrual cycle, one of the primary oocyteundergoes first meiotic division to form haploid secondary oocyte (immature ovum) and smaller polar body. This takes place just before ovulation.

◊ The secondary oocytes undergo second meiotic division to form ootid (mature ovum) and a second polar body. This takes place after the sperm penetrated the egg.

◊ The polar bodies receive the half chromosomes and have no further function hence they degenerate immediately after fertilization.

Consider the chart below showing the process of female gamete formation (oogenesis)



Spermatozoa (sperms)

THE EGG (OVUM)

Is female reproductive gamete

◊ The human ovum is a large cell of about 0.1mm in diameter

Parts of the ovum

(i) It has haploid large nucleus which contains genetic materials

(ii) It has a large cytoplasm which contains yolk droplets.

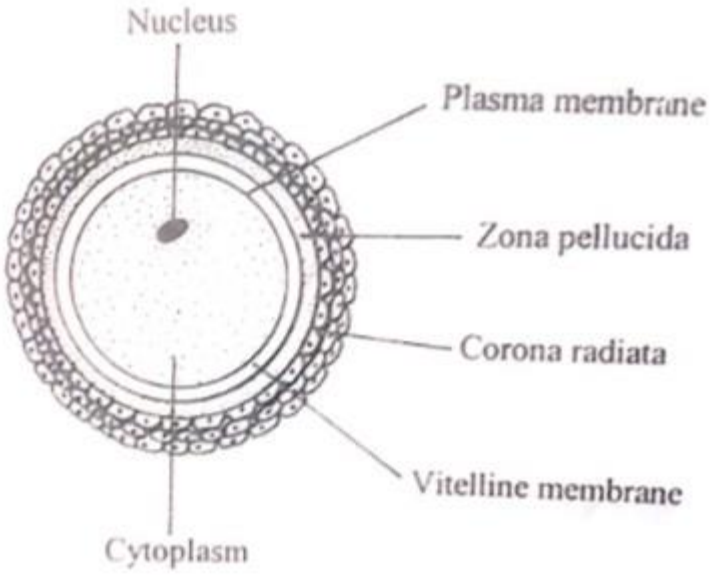
— Yolk droplets consist of food materials such as proteins and fats used to provide the embryo with nourishment during the early stages of its development.

(iii) It has outer membrane called **vitelline membrane**andinner membrane called **plasma membrane**used to enclose and protect theinner parts of the ovum.

(iv) It has jelly-like layer called zona pellucid above the **vitelline membrane.**

(v) It has **corona radiata** beyond the zona pellucida

Diagram below shows the structure of an ovum



ADAPTATIONS OF THE EGG TO ITS FUNCTIONS

(i) It secretes the chemicals which attract sperm to move towards it.
(ii) It has a receptor site where the sperm bind before entering the egg cells.
(iii) It has food reserves in the cytoplasm used during development of zygote before the placenta is formed.
(iv) It has microvilli which increases surface area for absorption of nutrients

DIFFERENCES BETWEEN SPERMATOZOA AND EGG CELL

SPERMATOZOA	EGG CELL
It is small in size	It is larger in size than a sperm
It has a large nucleus	It has a small nucleus
It has a very small amount of cytoplasm	It has a very large amount of a cytoplasm.
It does not stores food	It stores large amount of food.
It has acrosome	It has no acrosome
It has numerous mitochondria.	It has few mitochondria
It has flagellum	It lacks flagellum
It is motile	It is non motile
It has no microvilli	It has microvilli
It is single layered	It is multi layered.

DIFFERENCE BETWEEN OOGENESIS AND SPERMATOGENESIS

SPERMATOGENESIS	OOGENESIS
(i) It occurs in testes	It occurs in ovaries
(ii) Four sperms are produced from one spermatogonium	Only one ovum is produced from one oogonium.
(iii) Spermatozoa are produced in large number.	Ova are produced in small number.
(iv) Spermatozoa are minute yolkless and motile.	Ova are much large, often with yolk and non-motile.

Qn. Summarize the similarities and differences between

(i) Spermatogenesis and oogenesis

(ii) Spermatozoa and an egg cell

THE PROCESSES OF OVULATION AND MENSTRUATION

OVULATION

Is the process by which the egg is released from the ovary.

- ◊ Ovulation is controlled by Luteinizing Hormone (LH).
- ◊ An ovum can remain in the oviduct for 72 hours from the time of their release from the ovary.

MENSTRUAL CYCLE

Is a reproductive cycle marked by the flow of blood from the uterus after a period of time.

- ◊ Menstrual cycle is also called **oestrus cycle.**
- ◊ Menstrual cycle begins on the first day of menstruation and lasts approximately 28 days.
- ◊ The menstrual cycle starts after a female puberty.
- ◊ The first onset of menstrual cycle is called **menarche.**

PHASES OF MENSTRUAL CYCLE

Menstrual cycle involves four phases, namely:

(a) Healing and repair of the uterine lining

(b) Ovulation

(c) Thickening of the uterine lining in preparation for implantation

(d) Menstruation repeats itself.

(a) HEALING AND REPAIR OF THE UTERINE WALL

Events occur during this phase:

- ◊ The follicle stimulating hormone from the pituitary gland stimulates the development of follicles in the ovary to Graafian follicle.
- ◊ The Graafianfollicle formed starts to secrete oestrogen hormone.
- ◊ The oestrogen hormone induces the healing and repair of the uterine wall after menstruation.

(b) <u>OVULATION</u>

Events occur during this phase:

- ◊ The oestrogen hormone produced by the Graafian follicle stimulates the pituitary gland to produce the luteinizing hormone (LH).
- ◊ The luteinizing hormone produced by the pituitary gland causes ovulation).
- ◊ The Luteinizing hormone causes the Graafian follicle to change to a yellowbody called corpus luteum

(c) <u>THICKENING OF THE UTERINE WALL (ENDOMETRIUM) IN PREPARATION FOR IMPLANTATION</u>

Events occur during this phase:

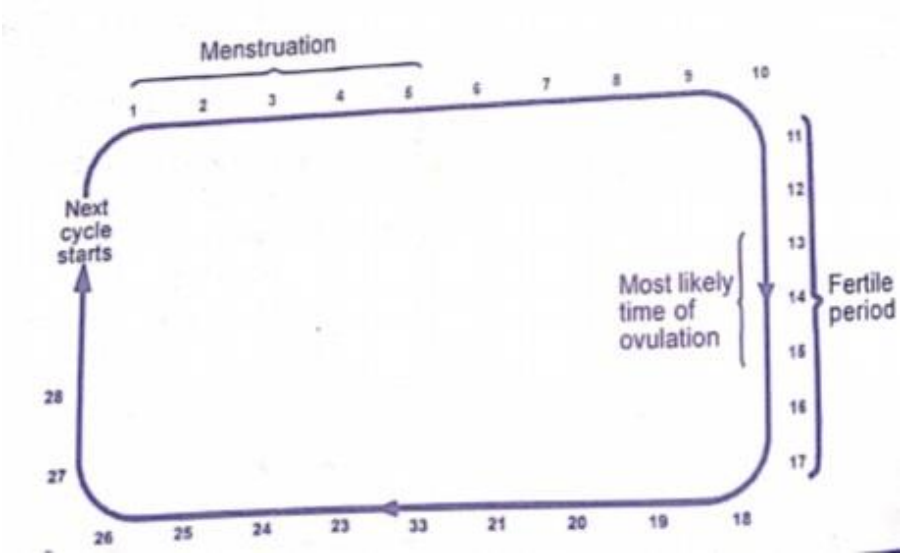
- ◊ The corpus luteum produces progesterone hormone.
- ◊ The progesterone causes the wall of the uterus to thicken in preparation for pregnancy.
- ◊ Progesterone and oestrogen inhibit the secretion of Follicle stimulating hormone and Luteinizing hormone
- ◊ If fertilization occurs progesterone hormone inhibits the production ofFollicle stimulating hormone and Luteinizing hormone as a result the Graafian follicle does not develop and ovulation does not occur.

(d) <u>MENSTRUATION REPEATS ITSELF</u>

Events occur during this phase:

- ◊ If fertilization does not occur, progesterone stimulates disintegration of the corpus luteum
- ◊ Disintegration of corpus luteum leads to a drop in the level of progesterone hormone
- ◊ Decrease in the level of progesterone hormone causes the endometrium to disintegrate and menstruation takes place.
- ◊ Menstruation in turn leads to a decrease in the concentration of oestrogen.
- ◊ The inhibition of FSH and LH ceases.
- ◊ The level of these hormones starts to rise and a new cycle begins.

<u>Diagram showing menstrual cycle of 28 days</u>



HORMONES THAT REGULATES THE MENSTRUAL CYCLE

Menstrual cycle is regulated by the following hormones:

(i) Follicle stimulating hormone (FSH)
(ii) Oestrogen
(iii) Luteinizing hormone (LH)
(iv) Progesterone

FUNCTION OF HORMONES THAT REGULATES THE MENSTRUAL CYCLE

HORMONES	FUNCTION
Follicle stimulating hormone (FSH)	◊ It stimulates the development of a Graafian follicle from primary follicle. ◊ It stimulates secretion of oestrogen.
Luteinizing hormone (LH)	◊ It stimulates the maturation of a Graafian follicle ◊ It promotes ovulation ◊ It stimulates corpus luteum to secrete progesterone.
Progesterone	◊ It stimulates the thickening of the endometrium. ◊ It stimulates increased blood supply to the endometrium.
	◊ It inhibits production of FSH and LH
Oestrogen	◊ It stimulates the pituitary gland to produce the luteinizing hormone. ◊ It stimulates the repair and the healing of endometrium after menstruation.

MENSTRUATION

Is the discharge of blood and tissue debris from the uterus through the vigina.

◊ Menstruation occurs when fertilization did not take place and it can last among 3-5 days
◊ Menstruation is also known as **menses**, **menstrual flow** or **period.**

- ◊ During menstruation the dead ovum together with the lining of the uterus and quantity of the blood are passed out of the body through the vagina.

MENARCHE

Is the first period or menstruation.

DYSMENORRHEA

Is the severe pain caused by the contraction of the uterine muscles during menstruation to get rid of tissue debris and the unfertilized egg.

MONOPAUSE

Is the period in woman's life during which her menstruation becomes irregular and subsequently stops.

- ◊ Menopause occurs between 45 and 55 years of age.
- ◊ During menopause the ovaries stop releasing ova and producing hormones.

ENDOMETRIUM

Is the lining of the uterus

- ◊ It thickens every month in the preparation for pregnancy.

FACTORS AFFECTING THE ONSET AND DURING OF MENSTRUATION

(i) Diseases
(ii) Stress
(iii) Anxiety
(iv) Drugs
(v) Foods
(vi) Hormonal contraceptives

COPULATION

Is the insertion of an erect penis into the vagina of the femaleand move back and forth.

- ◊ Sperms are deposited in the upper region the vagina.
- ◊ Sperms can remain alive in the oviduct up to 48 hours from the time of their deposition.

FERTILIZATION

Is the fusion of nucleus of male and female gametes to form a zygote.

- ◊ It takes place in the oviduct (fallopian tube).
- ◊ The time of fertilization is likely to occur is called **fertile period** of the woman and normally is between the 11^{th} and the 17^{th} days after menstruation.

TYPES OF FERTILIZATION

Fertilization may occur externally or internally

(i) EXTERNAL FERTILIZATION

Is the type of fertilization that takes place outside the body of female animals.

- ◊ Here the female animal lay eggs in water and the male sheds sperms over the laid eggs to fertilize them.

External fertilization occurs in the following animal:

- ◊ Fish
- ◊ Amphibians such as frogs

(ii) INTERNAL FERTILIZATION

Is the type of fertilization that takes place inside the body of the female animal.

- ◊ Here the sperms are deposited by the male's penis into the female's tube like structure called vagina.

Internal fertilization occurs in the following animals:

- ◊ Reptiles
- ◊ Birds
- ◊ Mammals

NB: After fertilization, the fertilized egg (zygote) develops into a young one withinor outside the body of the females.

OVIPAROUS ANIMALS

Are animals in which fertilization occurs internally but the fertilized egg develops outside the female body.

OR

Oviparous animals:are animals which lay eggs

EXAMPLES OF OVIPAROUS ANIMALS

- ◊ All birds.
- ◊ Most reptiles
- ◊ Most arthropods.
- ◊ Marine invertebrates
- ◊ Some fishes
- ◊ Certain type of mammals e.g. Duck billed platypus.

OVIVIPAROUS ANIMALS

Are animals whose zygote develops internally but nourishes itself like zygote that develops externally.

- ◊ Oviviparous female keep their zygotes in their bodies but they do not nourish them,
- ◊ They only offer protections.

Example of oviviparous animals includes:

- ◊ Reptiles
- ◊ Some fishes
- ◊ Certain insects

Oviviparity: is a condition in which the zygote develops internally but nourishes itself like zygote that develops externally.

VIVIPAROUS ANIMALS

Are the animals whose zygote develops within the maternal body and gets its nourishment from maternal body.

Viviparity: Is a condition whereby a zygote develops within the maternal body and gets its nourishment from maternal body.

THE PROCESS OF FERTILIZATION AND PREGNANCY

The process of fertilization and pregnancy occur as follow:-

- ◊ During sexual intercourse the urethra muscles in the penis contract to release semen into the vagina during ejaculation.
- ◊ After the sperm are deposited in the upper region of the vagina they swim through the cervix to the uterus and then enter the oviducts.
- ◊ After ovulation, the ovum moves into the oviduct where it fuses with the sperm to form a zygote.
- ◊ The zygote formed undergoes cell division to form a hollow mass of cell called a **blastocyst** or **blastula**.
- ◊ The zygote moves in the oviduct towards the uterus and is implanted in the endometrium.
- ◊ Cilia and contractions of the oviduct walls propel the zygote towards the uterus.
- ◊ This movement can take up to a week.

IMPLANTATION

Is the process by which the zygote is attached to the uterine wall.

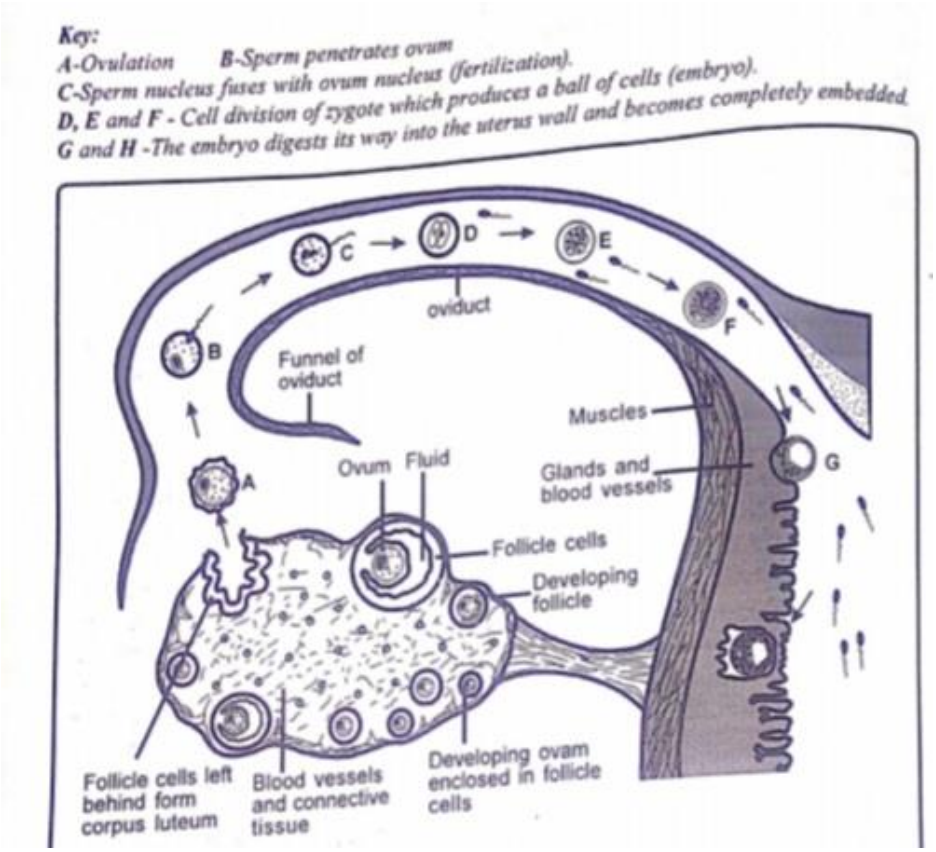
- ◊ It occurs between six to nine days after fertilization.
- ◊ Implantation is completed about 11 to 12 days after conception.

THE PROCESS OF ZYGOTE IMPLANTATION

- ◊ After fertilization, the formed zygote travel from the fallopian tube to the uterine wall
- ◊ The outer cells of the zygote release hydrolytic enzymes that digest the epithelium of the uterine wall hence making a cavity on it.

- ◊ After formation of cavity on the uterine wall, the zygote sinks into that cavity and gets established.
- ◊ After implantation is completed the zygote undergoes further cell division to form an **embryo**.
- ◊ The out layer of the embryo's cells develops finger like projection called **villi.**
- ◊ The villi extend into the lining of the uterus and form part of the placenta.
- ◊ After eight weeks, the embryo is called **foetus.**

DIAGRAM BELOW ILLUSTRATE OVULATION, FERTILIZATION AND IMPLANTATION PROCESSES



EMBRYO

Is a plant or animal as it develops from a fertilized egg.

- ◊ The embryo is attached to the placenta by a tube like structure called **umbilical cords**.
- ◊ Umbilical cord has two arteries and one vein.

FUNCTIONS OF THE UMBILICAL CORD

(i) It connects the foetusto the placenta

(ii) Umbilical arteries carry deoxygenated blood from the foetus to the placenta.

(iii) Umbilical vein, carries blood rich in nutrients, antibodies and oxygen from the placenta to the foetus.

PLACENTA

Is a temporary organ joining the mother to the foetus in the uterus.

- ◊ It is the point at which close association develops between maternal and foetal circulation.
- ◊ The placenta is formed from the embryo and part of the endometrium of the uterus
- ◊ The placenta begins to carry out its functions 12 weeks after implantation.

FUNCTIONS OF PLACENTA

(i) It allows carbon dioxide and nitrogenous wastes like urea to diffuse from the foetus to the mother.
(ii) It allows oxygen, water, glucose, acid vitamin and mineral salt to diffuse from the mother's blood to the foetus.
(iii) It allows the antibodies from the mother to pass to the foetus. These antibodies provide protection to the foetus against disease such as tetanus measles and small pox
(iv) It prevents disease causingmicroorganisms and their toxins from themother to the foetus
(v) It performs endocrine function by secreting hormones such as oestrogen and progesterone.
(vi) It is the site of gaseous exchange between the mother and the foetus.
(vii) It allows maternal and foetal blood circulation to flow in different directions. This is called **counter-current flow**.
(viii) It allows the maternal and foetal circulation to be at different pressures.

QUESTION. Why are the maternal (mother) and fetal (foetus) blood do not allowed to mix?

Answer. Maternal and fetal blood do not mix due to the following reasons:

(i) Maternal blood flows under higher pressure compared to the fetal blood, this could damage the delicate blood vessels of the foetus.
(ii) If two bloods were mix, the fetal blood could be recognized as foreign by the maternal blood, hence the maternal blood immune system could respond by killing the foetus.
(iii) Half of the genetic materials come from the father and so the fetal cells are not identical to those of the mother.

ADAPTATIONS OF PLACENTA TO ITS FUNCTIONS

(i) It contains villi which increase the surface area over which exchange of substances takes place.
(ii) Have thin membrane to reduce the distance across which exchange of substances occurs.
(iii) It is rich in blood vessels to enable greater exchange of substances across the placenta.

PLACENTAL EXCHANGE

(a) Materials (substances) allowed to pass from the mother to the foetus through the placenta.

(i) Oxygen
(ii) Water
(iii) Digested food substances e.g. Glucose
(iv) Amino acids
(v) Vitamins
(vi) Mineral salts
(vii) Antibodies which provide protection against diseases such as tetanus, measles and small pox

(b) Materials allowed to pass from the foetus to the mother through the placenta.

(i) Carbon dioxide
(ii) Nitrogenous waste products e.g. urea

(c) Material not allowed to pass through the placenta.

◊ All the body cells
◊ Plasma proteins
◊ Pathogens

Layers developed after implantation.

During the process of implantation three membranes develop, namely:

(a) Amnion
(b) Chorion
(c) Allantois

(a) AMNION

Is the membrane that enclose amniotic cavity

Function of amnion

— It surrounds the embryo and creates amniotic cavity

◊ Amniotic cavity is filled with a fluid known as **amniotic fluid**.

FUNCTION OF AMNIOTIC FLUID

(i) Protects the embryo against shock since it is shock absorber.
(ii) Protects the embryo against injury and physical damage.
(iii) Keeps the embryo moist.
(iv) Maintains the external temperature of the foetus.

(b) **CHORION**

Is the membrane which surrounds the amnion

Function of chorion

— It surrounds the amnion

◊ Chorion forms finger- like projections called **chorion villi.**

Function of chorion villi

◊ Used to supply nutrients to the embryo.

(c) ALLANTOIS

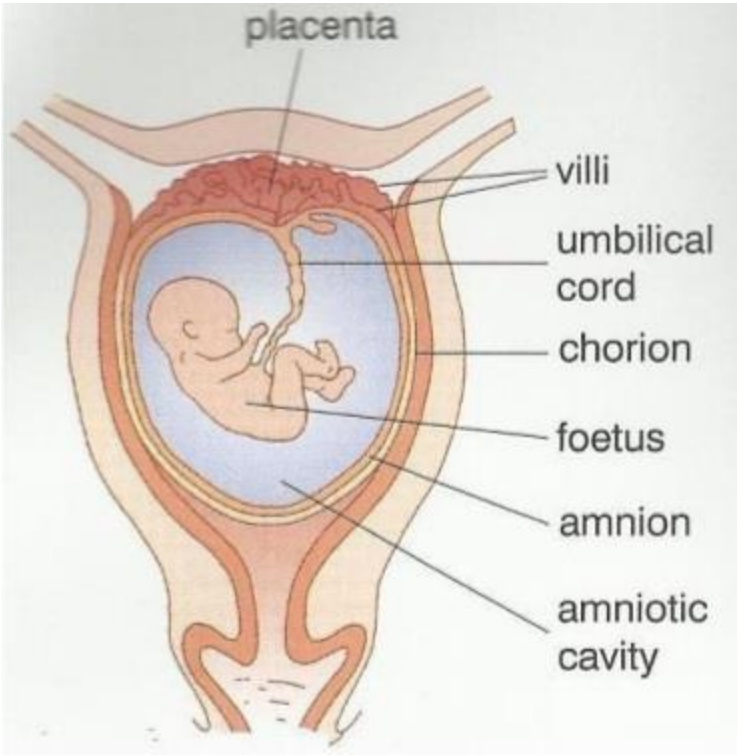
This membrane is present only for a short time.

Function of allantois

— It removes and stores the waste products of the embryo.

NB: Allantois later becomes the umbilical cord while chorion forms the placenta.

DIAGRAM OF AN ENBRYO AND ITS PLACENTA



GESTATION

Is the period between fertilization and birth.

◊ In humans, the gestation period is referred to as **pregnancy.**

◊ Pregnancy lasts 9 months or 40 weeks in humans.

Different mammals have different gestation periods as shown in the table below

Mammals	Duration
Mammals such as cow, human being, gorilla	9 months
Elephant	18-22 months
Cat and dog	63 days
Giraffe	16 months
Mice	22 days
Rabbit	31 days
Whale	15 months

NB:

- ◊ During the gestation period, the zygote develops into an embryo, then a foetus.
- ◊ The heart of the human embryo starts to beat in the seventh week.
- ◊ By the 26^{th} week, the foetus is full formed and has high chances of surviving if it is born prematurely.

CHILD BIRTH

Is the end of a pregnancy with the birth of one or more babies.
OR is the process by which the full formed foetus is expelled out from the mother's womb after gestation period is completed.

THE PROCESS OF CHILD BIRTH

This process occurs after 9 months in human being.

- ◊ Child birth starts with the rhythmic contractions of the uterine muscles.
- ◊ Birth is triggered by the fall in the level of oestrogen and progesterone in the maternal blood.
- ◊ The fall in the level of oestrogen and progesterone and subsequent release of oxytocin cause the periodic contractions of the muscular wall of the uterus.
- ◊ The release of oxytocin occur in waves.
- ◊ The uterine contractions are the ones, which cause pains known as labour pains.
- ◊ Labour pains are accompanied by the dilation of the cervix, and the rapture of the amnion and chorion releasing amniotic fluid.
- ◊ At this juncture uterine concentrations become frequent and powerful pushing the baby downwards, head first through the enlarged cervix and widened birth canal and the baby is born.
- ◊ Immediately after birth the umbilical cord is tied (ligatured) and cut to separate the baby from the placenta.
- ◊ The final stage of birth is the expulsion of the placenta as an after birth.

INDUCED BIRTH

When pregnancy lasts for more than 38 weeks or when examination shows that the placenta is not coping with the needs of the foetus, birth can be induced either by:

(i) Carefully breaking the membrane of the amniotic sac.
(ii) Injecting oxytocin hormone helps to rupture the amnion.

CAESARIAN DELIVERY

Is the removal of the baby by surgical means through incision of the abdominal and uterine walls.

CAESARIAN SECTION (CS)

Is an operation to remove the baby from the uterus.

Caesarian section it be carried out due the following complications:

- ◊ Narrow birth canal (vagina)
- ◊ When the umbilical cord coils around the baby's neck.
- ◊ Where the mother cannot push the baby.
- ◊ When the baby's head is too big
- ◊ If the baby is in an abnormal position.

COMPLICATIONS OF PREGNANCY

The following are complications which prevent full-term development of a foetus.

(a) Ectopic pregnancy
(b) Stillbirths
(c) Abortion
(d) Miscarriage
(e) Preterm (pre- mature) babies
(f) Preeclampsia

(a) ECTOPIC PREGNANCY

Is a situation where the fertilized egg does not move to the uterus and is implanted in the fallopian tube

- ◊ Ectopic pregnancy is caused by blockage of the fallopian tube due to infections, diseases or other factors

(b) STILLBIRTHS

Is the situation where a foetus dies while still in the uterus.

OR Is the giving birth to a dead baby.

The following are possible causes of still birth

- ◊ High blood pressure
- ◊ Preeclampsia
- ◊ Drugs
- ◊ Alcohol
- ◊ Pharmaceutical drugs
- ◊ Bacterial infection
- ◊ diabetes in the mother
- ◊ Exposure to radiations
- ◊ Physical trauma and rhesus diseases.

(c) ABORTION

Is the purposeful removal of the foetus from the womb before it has developed enough to survive on its own.

OR Is the removal of the foetus before it is fully developed by either physical or chemical means.

- ◊ Abortion is usually done before the end of the third month or by the 24^{th} week of pregnancy.

TYPES OF ABORTION

There are two types of abortion

(i) Spontaneous abortion

(ii) Induced abortion

(i) SPONTANEOUS ABORTION

This occur when the foetus is expelled from the womb without being induced in any way.

(ii) INDUCED ABORTION

Is the deliberate ending of pregnancy due to medical reasons.

- ◊ Abortion can be carried out with the purpose of saving mother's life if the foetus is found to be developing in an abnormal way.

(d) MISCARRIAGE (spontaneous abortion)

Is the loss or termination of a pregnancy before 20-24 weeks.

- ◊ It is referred to as miscarriage because the foetus is not fully developed and hence cannot survive on its own.
- ◊ The first sign of a miscarriage is bleeding which sometimes associated with pain.

The following are possible causes of miscarriage

- ◊ Poor nutrition of the mother.
- ◊ Exposure to chemicals
- ◊ Psychological trauma and medications.
- ◊ Uncontrolled diabetes
- ◊ High blood pressure
- ◊ Cigarette smoking
- ◊ Chromosomal abnormalities in the developing foetus.

(e) PRE-TERM BABIES OR PRE- MATURE BABIES

Are those babies born before 37 weeks

- ◊ Usually a baby is born after about 40 weeks.
- ◊ Premature babies born with less than 2.5 kilograms, very small, weak and need special care.
- ◊ Pre-mature babies must be kept in a special machine called an **incubator** until they can support themselves because they have difficulties in breathing, sucking and maintaining their body temperature.

(f) BREECH BIRTH

Is a situation where the baby is born legs first

- ◊ Normally, babies are born head first.

(g) PREECLAMPSIA

Is a condition of pregnancy characterized by high blood pressure and protein in the uterine.

A woman with preeclampsia experiences the following symptoms:

- ◊ Sudden weight gain
- ◊ Swelling of the face and hands.
- ◊ Severe headache.
- ◊ Abdominal pain
- ◊ Blurred vision.
- ◊ If not treated, it can develop into eclampsia.

NB: **Eclampsia:** is a very serious condition which is characterized by seizures and if not treated may be **fatal**

WAYS OF MINIMIZING COMPLICATIONS OF PREGNANCY

The following are proper measures that should be taken to prevent complications of pregnancy:

(i) Visiting a parental clinic as early as possible once a woman discovers that she is pregnant.
(ii) Improveyour nutrition and maintain a balance diet.
(iii) Prevent sexually transmitted diseases and cure them properly if contracted.
(iv) Avoid giving birth at home especially when there is no certified and qualified midwife.

FACTORS THAT HINDER FERTILIZATION

The following are the factors which may hinder fertilization:

(i) Blockage of the fallopian tube
(ii) Low sperm count
(iii) Unhealthy gametes
(iv) Use of contraceptives
(v) Diseases
(vi) Premature ejaculation
(vii) Impotence
(viii) Hormonal abnormalities

(i) BLOCKAGES OF THE FALLOPIAN TUBE

Sperms do not find their way to the ovum when the fallopian tube is blocked.The blockage of fallopian tube can be caused by factors such as sexually transmitted diseases or some contraceptive methods.

(ii) LOW SPERM COUNT

Low sperm count minimizes the chances of fertilization, hence infertility.

Causes of low sperm count

- ◊ Excessive use of alcohol, drugs, and smoking
- ◊ hormonal abnormities and sexually transmitted diseases.

Sperms count: is a measure of mount of sperms in a man's ejaculate

- ◊ For a man to fertilize an egg, at least 20 million sperms must be produced so as to increase the chances of fertilization.

(iii) UNHEALTHY GAMETES

Production of unhealthy gametes in one or both male and female that cannot be viable to form a zygote minimizes the chances of fertilization

Causes of unhealthy gametes

- ◊ Poor health due to poor diet or disease.
- ◊ Exposure to strong radiations

(iv) USE OF CONTRACEPTIVES

◊ Some contraceptives used by women produce thick mucus that prevents sperm from reaching the ovum.

◊ Some even kills the sperm before reaching from the ovum.

(v) DISEASES

◊ Some diseases such as Sexually transmitted diseases block the fallopian tube or the epididymis hence blocking the sperm from reaching and fertilizing an egg.

◊ Prostate cancer and inflammation may also hinder sperm formation hence no fertilization.

(vi) PREMATURE EJACULATION

Is a situation where by a man reaches orgasm before he inserts his penis into a vagina.

- ◊ Premature ejaculation prevents the sperms from getting into the female reproductive system for fertilization to occur

(vii) HORMONAL ABNORMALITIES

- ◊ Hormonal problems in females may hinder ovulation. When this occurs fertilization will not take place because the ovum may be immature or may not have been produced at all.
- ◊ In male hormonal abnormalities may lead to low sperm count or failure to produce sperm.

(viii) IMPOTENCE

Is a condition in which a man fails to achieve an erection or achieves it but cannot maintain it.

Causes of impotence

- ◊ Anxiety
- ◊ Depression
- ◊ Chronic diseases like diabetes
- ◊ Prostate cancer.

ARIFICIAL INSEMINATION

Artificial insemination: is a technique whereby sperm from a donor is artificially inserted through the cervix of the mother-to-be.

◊ Insemination is done in humans but more widely used in farm animals such as cattle.

IMPORTANCE OF ARTIFICIAL INSEMINATION

◊ **In humans**

(i) It enables couples or women whose partners cannot make them pregnant, to be able to give birth by being fertilized by sperms from a donor.

(ii) It enables man to preserve sperms so that their wives can conceive when they are away from home along period even after the husband dies.

(iii) The woman has a chance to choose the father of her child as she can select semen from different men.

◊ **In agriculture (farms)**

(i) It enables farmers to get desired characteristics for their animals, such as resistance to diseases or high milk production.

(ii) It provides a rapid means of spreading the beneficial characteristics of a particular male throughout the stock.

(iii) Semen can be transported far distances even where there are no males.

(iv) Many females can use semen from one male. For example, the semen from a single bull can be used to sire as many as 90000 cattles a year.

(v) It allows cross bleeding which brings about variation.eg a Fresian cow can be mated by a Jersey bull.

TEST TUBE BABIES

Are babies whose fertilization is carried out in the test tubes by suckling the ovum from woman and sperm from man by syringe.

◊ After fertilization to take place then the zygote is inserted into the woman's womb where there is a chance of implantation and development of the embryo.

◊ Woman who are unable to conceive because their fallopian tubesare blocked can use this technique.

SURROGATE MOTHER

Is a woman who allow uterus to be used to carry artificially fertilized ovum to birth.

◊ After birth the baby is given to the woman who donated the ovum.

FERTILITY DRUGS

Are synthetic hormones administered to women who cannot conceive because their ovaries do not release ova

MULTIPLE PREGNANCIES

Multiple pregnancy: refers to a situation when more than one foetus is carried in a single pregnancy.

◊ Multiple pregnancies result into birth of two, three, four, or up to eight offspring at a time.

CAUSES OF MULTIPLE PREGNANCIES

(i) Genetic factors

(ii) The use of fertility drugs - which may cause several eggs to be produced at the same time.

(iii) More than one ovum released into the reproductive track

(iv) One fertilized ovum splitting up into more than one embryo resulting to twins.

The terms used to describe multiple births are derived from Latin words for numbers as follows:

(i) **Twins**- Two offspring

(ii) **Triplets**- Three offspring

(iii) **Quadruplets** - Four offspring

(iv) **Quintuplets** - Five offspring

(v) **Sextuplets**-Six offspring

(vi) **Septuplets** -Seven offspring

(vii) **Octuplets** - Eight offspring

◊ The most common form of multiple pregnancies is birth of twins.

◊ Quadruplets develop when an egg divides into two and again each half further divides into two.

◊ More divisions my result in up to eight offspring.

TWINS

Are two babies born at the same time one after another by the same mother.

TYPES OF TWINS

There are two common types of twins, namely:

(a) Identical twins

(b) Non-identical twins or fraternal twins

(a) **IDENTICAL TWINS**

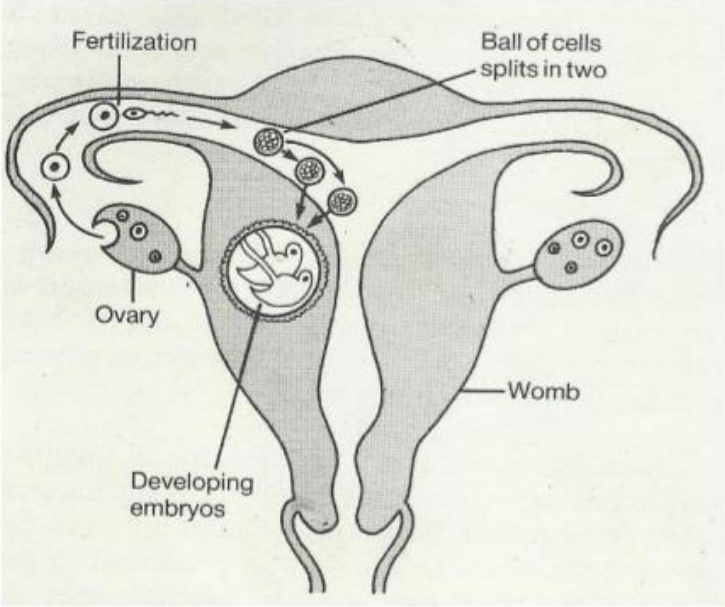
Are twins arise from a single fertilized egg, that splits into two parts and each part develop into a complete individual.

◊ Identical twins are also known as **uniovular twins or monozygotic twins**

Characteristics of identical twins

(i) They are of the same sex.
(ii) They are very much alike (similar)
(iii) They are genetically identical
(iv) Only one sperm fertilizes the egg
(v) They arise from a single egg (ovum)
(vi) They are closed in the same membrane and share the same placenta.

Consider the diagram below illustrating the formation of identical twins



SIAMESE TWINS

Are identical twins who develop without separating completely and born attached to one another.

Causes of Siamese twins

◊ Failure of a complete division of the zygote.
◊ It is an abnormality.
◊ The zygote starts dividing into two but stops at a point.

(b) NON-IDENTICAL TWINS

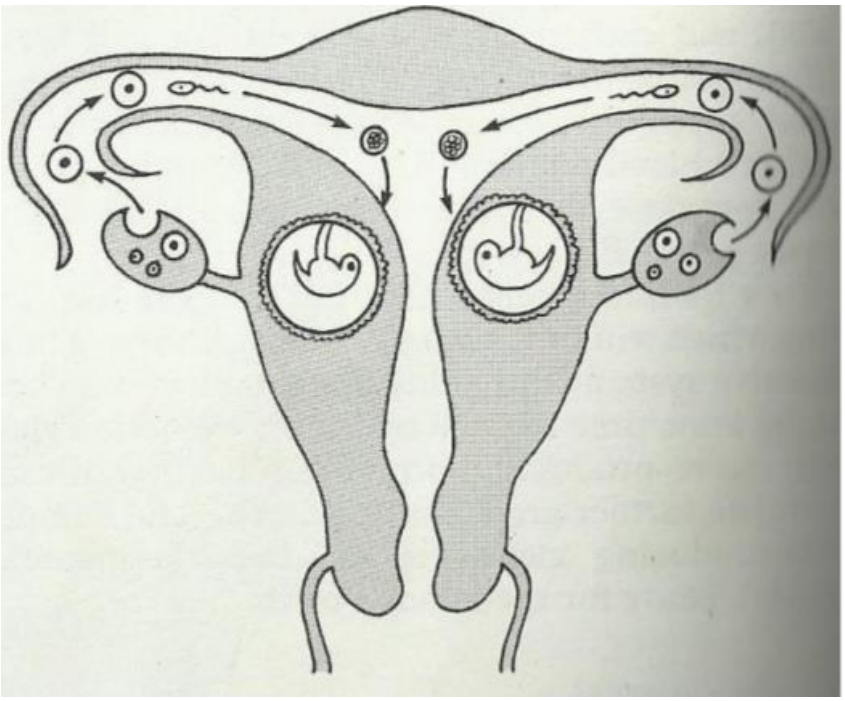
These twins develop when two eggs are released from the ovaries at the same time.

◊ Identical twins are also called **fraternal twins** or **binovular twins** or **dizygotic twins**

Characteristics of fraternal twins

(i) The twins may be of the same or of different sex.
(ii) Each egg is fertilized by a different sperm.
(iii) The twins do not look alike.
(iv) They are genetically different but have a degree of resemblance.
(v) They arise from a two eggs released from the ovaries at the same time.

Consider the diagram below illustrating the formation of fraternal twins



DIFFERENCE BETWEEN IDENTICAL TWINS AND FRATERNAL TWINS.

IDENTICAL TWINS	**FRATERNAL TWINS (NON-IDENTICAL TWINS)**
(i) The twinsare of the same sex.	The twinsmay be of the same or of different sex
(ii) Only one sperm fertilizes the egg	Each egg is fertilized by a different sperm.
(iii) They are very much alike	The twins do not look alike.
(iv) They are genetically identical	They are genetically different.
(v) They arise from a single egg	They arise from two eggs

DISORDERS OF REPRODUCTIVE SYSTEM

The following are disorders that affect both male and female reproductive systems.

(a) Infertility
(b) Pelvic inflammatory Disease (PID)
(c) Sexual Transmitted Infections (STI's)
(d) Impotence
(e) Blockage of fallopian tubes.
(f) Blockage of the sperms duct,
(g) Cancer
(h) Congenital Malformation
(i) Hormonal abnormalities
(j) Vaginal discharges
(k) Fibroids

(l) Premature ejaculation

THE CAUSES, EFFECTS AND POSSIBLE REMEDIES (TREATMENTS) OF THE REPRODUCTIVE SYSTEM DISORDERS

(a) INFERTILITY

Is the inability to conceive.

Or is the situation where a woman is unable to carry a pregnancy to full term.

- ◊ Infertility can occur to both male and female.

Causes of infertility

(i) Diseases. Example chlamydia, gonorrhea and syphilis cause blockage of the fallopian tubes and sperm ducts leading to infertility.
(ii) Low sperm count thus reducing chance of fertilization
(iii) Removal of the uterus due to cancer.
(iv) Failure to ovulate because the ovaries are not producing eggs
(v) Low sperm motility that is, the inability of sperms to swim and reach the eggs.

Effects of infertility

(i) Failure of a couple to have children.
(ii) Leads to broken marriages especially when one partner blame the other.

Possible treatment (remedies) of infertility

(i) Use of medications such as fertility drugs.
(ii) One can carry out an operation on blocked fallopian tubes and sperm ducts
(iii) Use of artificial insemination to enable a couple have children
(iv) Avoiding the risks of contracting STI's
(v) Avoiding smoking
(vi) Avoiding exposure to chemicals
(vii) Seeking for medical help

(b) PELVIC INFLAMMATORY DISEASE (PID)

Is an infection that lead to the inflammation of the uterus, fallopian tubes and other reproductive parts.

◊ Pelvic inflammatory diseaseoccurs in women.

Causes of pelvic inflammatory disease

◊ Untreated STIs like gonorrhea and chlamydia in which the bacteria travel up into the uterus, oviduct, ovaries and pelvic cavity.

Effects of pelvic inflammatory disease

(i) Lead to blockage of the fallopian tubes hence infertility in women.
(ii) Lead to ectopic pregnancy and chronic pelvic pain.
(iii) Cause scars to nearby tissues and organs.

Possible treatments or remedies for pelvic inflammatory disease

(i) Pelvic inflammatory diseasecan be treated by taking antibiotics.
(ii) Abstaining from sex and practicing safe sex.

(c) CANCER

Is a disease characterized by abnormal and uncontrolled growth of cells.

◊ Cancer can occur anywhere in the body including the reproductive system.

Types of cancer which occur in the reproductive system

The following are types of cancer that affect the reproductive system

(i) Prostate cancer
(ii) Cancer of the testes in male
(iii) Cancer of the ovaries
(iv) Cancer of the uterus (uterine cancer)
(v) Cervical cancer in females.

CERVICAL CANCER

Is cancer of the cervix and it attacks women.

Causes of cervical cancer

The main cause of cancer is unknown but there are factors that increase the risk of getting cancer include:

◊ Risk factors such as STIs. About 80% of cervical cancer is associated with STIs
◊ Other factors such as smoking and exposure to chemicals. About 20 %of cervical cancer is associated with these factors.

Effects of cervical cancer

(i) It may cause heavy, long and abnormal menstrual flow.
(ii) Lead to infertility
(iii) Can lead into death.

UTERINE CANCER

Is cancer of the uterus and it attacks women.

Causes of uterine cancer

(i) Risk factors such as prolonged exposure to oestrogen.
(ii) Early onset of menstruation
(iii) Late menopause
(iv) Never getting pregnant and obesity.
(v) These risk factors are also associated with ovarian cancer.

Effects of uterine cancer

(i) Causes strong abdominal pain.
(ii) It causes heavy, long and abnormal menstrual flow.
(iii) Infertility
(iv) If not early can lead to death.

PROSTATE CANCER

Is the cancer of prostate gland, a gland found in male reproductive organs.

◊ It is mostly attacks men over 50 year of age.

Causes of prostate cancer

◊ Maintaining a diet high in fat and red meat
◊ Alcohol consumption
◊ Inactivity
◊ Obesity and aging.
◊ Food preservatives and addictive
◊ Viruses and UV rays.

Effects of prostate cancer

(i) Difficulty in erection.
(ii) Surgery to remove the prostate gland may lead to permanent impotence.
(iii) Problems with controlling and passing urine since the grown prostate tissue may have pressed on the urethra.
(iv) Decreased sexual desire
(v) Painful ejaculation

Possible remedies for cancer

(i) Avoid smoking
(ii) Control weight and avoid diet rich in fat and red meat.
(iii) Eat balanced diet low in fat and rich in fruits, vegetables and fish.
(iv) Exercise regularly
(v) Regular screening at least once a month since early stages of cancer can be treated through surgery.
(vi) Surgery can cure cancer completely if the cancer is found before it spreads to other organs or tissue.

(d) ENDOMETRIOSIS

Is the condition whereby the tissue lining the uterus (endometrium) grows in other areas of the body.

- ◊ This occurs in the tissue around the pelvic area.
- ◊ Endometriosis causes a lot of pain in the abdomen, and may lead to infertility.
- ◊ If not treated, can block oviducts and cause infertility.
- ◊ It is important to take regular checkups and early treatment once endometriosis is discovered.

(e) CONGENITAL MALFORMATION

- ◊ Absence of the uterus, ovary or fallopian tube
- ◊ Some women are born with blocked oviduct or with no uterus

(f) FUNCTIONAL DISORDERS

Is the inability of the woman to experience sexual pleasure and satisfaction during the sexual act.

Causes of functional disorders

- ◊ Emotional problems
- ◊ Feeling of guilt
- ◊ Trauma

SEXUALITY AND SEXUAL HEALTH AND RESPONSIBLE SEXUAL BEHAVIOUR

Sexuality

Refers to anything that has to do with being male and female.

- ◊ It involves sexual orientation
- ◊ Sexuality is the function of whole personality begins at birth and end at death

Sexuality includes various aspects such as:

- ◊ Being biologically male or female
- ◊ Having masculine or feminine behavior
- ◊ Sexual functioning
- ◊ How one is interested and experiences sexual activity
- ◊ How he/she is attracted to others.

SEXUAL BEHAVIOURS

Isthe way people express their sexuality.

Types of sexual behaviour or practice

The following are types of sexual behaviour

(i) Acceptable sexual behavior or responsible sexual behaviour

(ii) Unacceptable sexual behavior or irresponsible behaviour

RESPONSIBLE SEXUAL BEHAVIOURS

Are sexual behaviours, which are normal and accepted in the societies.

Examples of responsible behaviours

- ◊ Marriage
- ◊ Heterosexuality

NB: Heterosexuality is the sexual practice between members of the opposite sex

- ◊ It is also called **vaginal sex**

IRRESPONSIBLE SEXUAL BEHAVIOURS

Are sexual behaviours which are not accepted by the family as well as societies.

- ◊ Irresponsible sexual behaviors are also called **sexual deviations**

Examples of irresponsible sexual behaviours

- ◊ Use of alcohol and drug abuse
- ◊ Prostitution
- ◊ Homosexuality
- ◊ Erotic fantasy
- ◊ Masturbation
- ◊ Celibacy
- ◊ Anal sex
- ◊ Oral sex
- ◊ Watching pornography
- ◊ Bisexuality
- ◊ Rape

EROTIC FANTASY

Is a situation whereby a person creates imaginary thoughts like making love to an opposite partner while he/she is not.

MASTURBATION

Is the sexual behaviour in which one attains sexual arousal and orgasm through self-stimulation.

- ◊ The stimulation may be brought about by touching or rubbing genitals, against objects such as hand fingers, pillow or special devices.

CELIBACY

Is when a person abstains continuously from sexual activity.

- ◊ **People may practice celibacy due to the following reasons:**
  - (i) Health problems
  - (ii) Religious beliefs
  - (iii) Avoiding diseases like AIDS

ANAL SEX

Is a sexual practice whereby an erect penis is inserted into the anus of a man or woman.

- ◊ Anal sex is also known as sodomy

ORAL SEX

Is a sexual practice whereby an erect penis is inserted into the mouth rather than the vagina.
Or is a sexual practice whereby lips and tongues are used to stimulate the genitals of the partner

PROSTITUTION

Is the exchange of sexual services for money.

- ◊ A person who practices prostitution is called a **prostate**.
- ◊ A prostitute can be a man, woman or even children.

PORNOGRAPHY

is obscene literature, art or movies that show sexual acts and images in a way that is intended to make people feel sexually excited or aroused.

- ◊ Some people enjoy watching pornographic movies or magazines and get aroused and end up masturbating or having sex.

HOMOSEXUALITY

Is a sexual practice between members of the same sex

- ◊ Such people are called **homosexuals**
- ◊ Male homosexuals are called **gays**
- ◊ Female homosexuals are called**lesbians**

BISEXUALITY

Is a sexual practice where people are sexually attracted towards members of the same sex and of the opposite sex.

- ◊ Such people are called **bisexuals.**

RAPE

Is the use of force or threats to have sex with someone against his/her will.

INCEST

Is a sexual practice with a close relative. E.g. father and daughter

CAUSES OF IRRESPONSIBLE SEXUAL BEHAVIOURS

(i) Poverty
(ii) Lack of proper counselling and guidance
(iii) Peer pressure and influence
(iv) Mass media
(v) Moral decay
(vi) Marriage breakdown
(vii) Poor parenting
(viii) Drug addiction
(ix) Globalization and advancement of science and technology
(x) Personal behavior

POVERTY

Some people may practice unaccepted sexual behavior like prostitution due to poverty. Such people practice prostitution as a source of income.

PERSONAL BEHAVIOR

Some people practice certain sexual behavior because they just enjoy doing it. For example some people practice prostitution simply because they enjoy doing it not because they need money.

LACK OF EDUCATION

Some people practice unaccepted sexual behaviours because they because they do not have the right information about sexuality.

MORAL DECAY

Due to moral degradation some people practice unacceptable sexual behaviours like rape, having sexual intercourse with relatives, parents, homosexuality, bisexuality and prostitution.

POOR PARENTING

Some peopleend up practicing unacceptable sexual behavior because they did not get proper guidance from their parents when they were younger.

GLOBALIZATION AND ADVANCEMENT OF SCIENCE AND TECHNOLOGY

Globalization has made people capable of accessing sexual practices acceptable and practiced in other countries and adopting them even though some may not be acceptable in one's society.

EFFECTS (CONSEQUENCES) OF IRRESPONSIBLE SEXUAL BEHAVIOUR

(i) Spread of sexually transmitted diseases. E.g. syphilis, HIV/AIDS, gonorrhea.
(ii) Early and unexpected pregnancies.
(iii) Family and marriage breakdown.
(iv) Reproductive disorders such as infertility.
(v) Physiological trauma.
(vi) Death. E.g. after a rape
(vii) Getting a responsibility of caring for a family at an early age.
(viii) It can degrade the personality of a person. For example, prostitutes or rapists have no place to put their faces in some societies
(ix) Lead to conflict in the family or marriage
(x) It leads to authorities spending so much money to treat patients who have contracted STDs.
(xi) Increasing the level s of crimes.
(xii) Increasing illiteracy rate.

WAYS OF ERADICATING IRRESPONSIBLE SEXUAL BEHAVIOURS

The following are some measures that can be taken to prevent irresponsible sexual behaviours in the family and community:

(i) Avoiding all practices that can lead to sexual excitement such as taking alcohol, watching pornography, meeting in dark and guest places.
(ii) Being faithful to your partners.
(iii) Impose strict government laws. E.g. against rape

(iv) Following religious teachings on sexuality.
(v) Offering guidance and counseling services about sexuality.
(vi) Close supervision and guidance of children. E.g. protection of children from media coverage scary events such as wars, bombings, or shootings.
(vii) Providing education to the people about sexuality.
(viii) Controlling emotions and desires by being involved in age-appropriate activities. E.g. Sports.

FAMILY PLANNING AND COTRACEPTION

FAMILY PLANNING

Refers to taking action so that only the required numbers of babies are born.

- ◊ Family planning is also called **birth control**

CONTRACEPTION

Refers to the prevention of pregnancy intentionally.

Importance of family planning and contraception.

The following are reasons, why family planning and contraception is very important to the mother, the family and community:

(i) It allows a couple to have a baby only when they want it.
(ii) It allows a couple to have the number of children they are able to take care of.
(iii) It gives the mother time to work and carry out economic activities instead of spending their entire time caring for children.
(iv) It ensures parents are able to provide enough food and give the children enough attention and care such that they can grow in a healthy way.
(v) It enables the mother to have enough time for her body to recover before having another baby.
(vi) It enables a government to have population that it can support and develop.

SOCIAL PRACTICES (METHODS) WHICH ENHANCE FAMILY PLANNING

The following are contraceptive methods which enhance family planning. These methods are grouped into two groups, namely

(a) Natural methods
(b) Artificial methods.

(a) NATURAL METHODS

Are methods that is carried out without the use of device or chemicals.

The following are natural methods which enhance family planning and contraception

(i) Abstinence
(ii) Calendar method
(iii) Withdrawal method
(iv) Cervical mucus method

ABSTINENCE

Is where a person totally refrains from sexual intercourse.

Advantages of abstinence method

- ◊ It is 100%effective

Disadvantage

- ◊ It is not easy especially for married couples.

WITHDRAWAL METHOD

Is a method whereby the male withdraws his penis from the vagina before ejaculation.

- ◊ Withdrawal method is also called **coitus interrupts**

Advantagesof withdrawal method

- ◊ It is costless
- ◊ It is reliable when effectively carried out.

Disadvantages of withdrawal method

- ◊ There is a likelihood of sperm leakage from semen that could escape from the sperm duct just before ejaculation.

CALENDAR METHOD

Is the method where by intercourse only takes place on days considered 'safe' within the menstrual cycle.

- ◊ Calendar method is also called **rhythm method**

Advantages

- ◊ It is uncostly and it can be best practiced by married couples.
- ◊ It enables a woman to recorganize when she is fertile and when she is not.

Disadvantages

- ◊ It is very unreliable especially for women with irregular periods.
- ◊ It needs constant recording of the date the menstrual period starts, failure to do that may lead to conception.

CERVICAL MUCUS (BILLING) METHOD

Is the natural method which involves the observation of the mucus in the vagina.

- ◊ During fertile period the mucus gets thinner and becomes clear while during the infertile period, the mucus gets thicker and sticky.

Advantage

- ◊ It is costless.

Disadvantages

- ◊ It is not reliable as sperms can survive for 3 to 7 days and conception can thus occur.
- ◊ It is not suitable for women with irregular cycles.

(b) ARTIFICIAL METHODS

Are those methods which involve the use of device or chemical substances

Artificial methods include:

(i) Condoms

(ii) Diaphragm

(iii) Implants
(iv) Contraceptive pills
(v) Mini pills
(vi) Intra-uterine device (IUD)
(vii) Male sterilization
(viii) Female sterilization

CONDOMS (SHEATH)

◊ **Male condom** is a thin rubber sheath worn by a man over an erect penis to collect sperms so that they are not released into the vagina
◊ **Female condom** is a loose rubber fitting with two flexible plastic rings on either end
◊ It is inserted into the vagina before intercourse.

Advantage

◊ It is simple to use
◊ It is 98% effective if used properly.
◊ It offers protection against sexually transmitted diseases

Disadvantages

◊ If not used properly it can tear, releasing semen into the vagina.
◊ Semen may also overflow leading to conception.
◊ Female condoms are expensive.

DIAPHRAGM

is a flexible dome shaped rubber fitted into the cervix

◊ It is used with sperm killing chemicals (spermicides) preventing the sperm from fertilizing the egg.
◊ It remains in the cervix for about six hours after intercourse to prevent conception.

Advantages

◊ It is 92% effective if used properly.

Disadvantages

◊ It may cause pain or abrasions during fitting.
◊ It requires reapplication of jelly for each intercourse.

IMPLANTS

Are thin flexible tubes that contain progesterone which prevents ovulation.

◊ The tubes are inserted under the skin on the underside of the upper arm and hormone is slowly released into the blood stream.
◊ It also causes thickening of the mucus in the cervix thus preventing sperm from reaching the egg.

Advantages

◊ Very effective (over 99%)
◊ Fertility is restored immediately after removal of the implants.

Disadvantages

- ◊ It requires specialized trained personnel to insert them.
- ◊ They are expensive
- ◊ Makea woman uncomfortable when they are touched.

CONTRACEPTIVE PILLS (COMBINED PILLS)

Are pills containing progesterone and oestrogen.

- ◊ The pills are taken orally on daily basis to prevent ovulation.

Advantages

- ◊ Easy to use, does not require regular check ups
- ◊ Very effective when properly used (over 99%)

Disadvantages

- ◊ They may cause nausea, headache and weight gain
- ◊ Failure to take the pills even for a day may lead to conception.

MINI PILLS

Are pills containing only progesterone which makes the lining of the uterus unfavourable for implantation of the fertilized egg.

Advantages

- ◊ Very effective when properly used.

Disadvantages

- ◊ They may cause weight gain and headaches

INTRA-UTERINE DEVICE

Is a small device made of plastic and copper that is inserted in the womb thus preventing the sperm from reaching the egg or the fertilized egg from reaching uterus for implantation.

- ◊ It can stay in the womb between 3 to 10 years.

Advantages

- ◊ Very effective (98 to 99%)
- ◊ It is easy to fit

Disadvantages

- ◊ Must be inserted and removed only by a trained professional
- ◊ May cause heavy menstrual flow, back pain and PID

MALE STERILIZATION (VASECTOMY)

Is a minor operation that involves cutting off or blocking of the sperm ducts

Advantages

- ◊ It is very effective (more than 99%)

Disadvantages

- ◊ It is irreversible if it happens that a couple need to have a baby later.
- ◊ The sperm ducts in some rare cases may rejoin thus causing conception and infection may occur.

FEMALE STERILIZATION

Is a minor operation in which the fallopian tubes are blocked or cut so that sperms never meet the egg.

Advantages

- ◊ Very effective (99.5%)

Disadvantages

- ◊ It is irreversible

IMPORTANCE OF MALE INVOLVEMENT IN FAMILY PLANNING

(i) They can both agree on which method they find suitable.

(ii) Involving the male partner is also important when there are complications regarding the use of contraception.

(iii) To avoid misunderstanding and breakage of marriages.

SOCIAL-CULTURAL FACTORS AFFECTING FAMILY PLANNING AND CONTRACEPTION

The following are social-cultural factors affecting Family planning:

(i) Customs and traditions
(ii) Religious beliefs
(iii) Economic status
(iv) Maternal health
(v) Education level

CUSTOMS AND TRADITIONS

In some societies a woman is not allowed to have sexual intercourse while breastfeeding. Therefore, a woman will abstain until she stops breastfeeding.

RELIGIOUS BELIEFS

Some religion such as a section of Christians and in Islam, the use of condoms is not advocated thus increasing the chances of conception.

ECONOMIC STATUS

People tend to be more conscious of having a large number of children for the fear of not being able to take care of them due to their economic status.

MATERNAL HEALTH

A woman may be forced to become sterile due to health problems, for example a woman with ovarian cancer may be forced to undergo surgery to remove the uterus thus making her unable to have more children.

EDUCATION LEVEL

Couples who are more educated tend to be more conscious on the number of children to have than those who a less educated.

MATERNAL AND CHIRD CARE

Are the special services provided to the mother and the baby in order to improve their well-being and prevent complications that may affect their health.

ANTENATAL CARE

Are special services provided to the mother before the baby is born

- ◊ Antenatal care involves health care.

The following are antenatal care provided to the mother before the baby is born:

- ◊ A healthy diet
- ◊ Weight check-ups
- ◊ Blood group testing
- ◊ Rhesus factor testing
- ◊ Amount of haemoglobin testing
- ◊ HIV, blood pressure and STIs check up
- ◊ Rest
- ◊ Exercise
- ◊ Love and support
- ◊ Preparing the mother for delivery.

IMPORTANCE OF ANTENATAL CARE

(i) It ensures the baby is developing well and if not, proper measures can be taken immediately to prevent any danger to the mother and the baby.

(ii) Any signs of infections or abnormalities in the developing baby are detected and taken care of.

(iii) It reduces complications during pregnancy such as ectopic pregnancy.

(iv) It prevents mother to child transmission of diseases like HIV.

(v) It enables the expectant mother to get nutritious food and food supplements such as acid for proper development of the baby.

NATAL CARE

Are special services provided to the mother during delivery in orderto ensures safe delivery.

Example of natal care

- ◊ Being kind and gentle to her during delivery.
- ◊ Helping the expectant mother to give birth
- ◊ Relieving her pain through comforting or medication

Importance of natal care

- ◊ Ensures safe delivery

POST -NATAL CARE

Are special services provided to the mother and the baby after birth.

- ◊ **Post means after and natal means birth,**

Example of post-natal care:

- ◊ A healthy diet
- ◊ Rest
- ◊ Exercise
- ◊ Immunization of the child
- ◊ Breastfeeding
- ◊ Love and support
- ◊ Good shelter
- ◊ Child health clinic visits
- ◊ Warmth
- ◊ Protection and hygiene

IMPORTANCE OF POST-NATAL CARE

(i) To help the mother recover quickly

(ii) To maintain good health. Since a healthy mother produces enough milk to feed her baby so that it grows healthy.

NB: Mothers should breast-feed the child whenever possible

QUESTION: Why mother's milk is better than any other food?

Answer: Mother's milk is better than any food due to the following reasons:

(i) It contains antibodies that are much needed to the child

(ii) It contains much proteins and vitamins which are very important for the child's growth

(iii) Breast milk is easily digested than bottled milk. Therefore, children who take milk from their mother rarely suffer from constipation

(iv) Breast milk is free from contamination

(v) It contains some chemicals which help in development of the nervous system of the child

(vi) Does not need any preparations

SOCIAL-CULTURAL FACTORS WHICH AFFECT MATERNAL AND CHILD CARE IN THE FAMILY AND COMMUNITY

The following are social-cultural factors which affect maternal and child care in the family and community:

(i) Female genital mutilation

(ii) Local belief

(iii) Working

(iv) Alcohol consumption during pregnancy

FEMALE GENITAL MUTILATION (FGM)

Is the practice of circumcising women.

- ◊ The practice is said to have effects during childbirth. It causes women to experience pain, bleeding, and shock and may lead to infection.

LOCAL BELIEF

These are certain local beliefs and taboos such as banning women to eat certain types of foods such as protein rich foods, which could help to build their health and that of the child.

WORKING

Hard work such as cultivation may cause several problems to the pregnant woman such as miscarriage or pain.

ALCOHOL CONSUMPTION DURING PREGNANCY

In most cultural practices taking alcohol is considered as a normal behavior. But alcohol during pregnancy affects both the health of the mother and that of the child.

APPROPRIATE WAYS OF PROVIDING MATERNAL AND CHILD CARE FOR PEOPLE LIVING WITH HIV/AIDS(PLWHA)

These following are appropriate ways of providing maternal and child care for People Living with HIV/AIDS:

(i) To ensure frequent medical checkup and ARVs when necessary for both maternal and child.
(ii) To ensure they get well balanced diet
(iii) Avoid sharing sharp objects like razor blades
(iv) Counseling in order to help them deal with their feelings of loss and grief
(v) To avoid discrimination for people living with HIV/AIDS
(vi) Ensure the use of polite language when providing care to them
(vii) Wearing of gloves when cleaning their bodies and clothes

REVISION QUESTIONS

1. Choose the correct answer

(i) The term parturition means:

A. Birth
B. Gestation
C. Implantation
D. Ovulation

(ii) A woman gives birth and produces twins, a boy and a girl because:

A. One egg was fertilized and then divided into two
B. The uterus was large enough for two embryos to develop
C. Her ovaries produced two eggs, which were both fertilized
D. Twins were produced in her family history

(iii) Which one of the following is the correct order of events?

A. Fertilization –implantation-ovulation
B. Ovulation – fertilization - implantation
C. Implantation – ovulation –fertilization
D. Fertilization – ovulation – implantation

(iv) Shortly after an egg is fertilized the product is known as: -

A. Zygote
B. Embryo
C. Foetus
D. Young baby

(v) In human beings fertilization takes place in the: -

A. Vagina
B. Uterus
C. Oviduct
D. Cervix

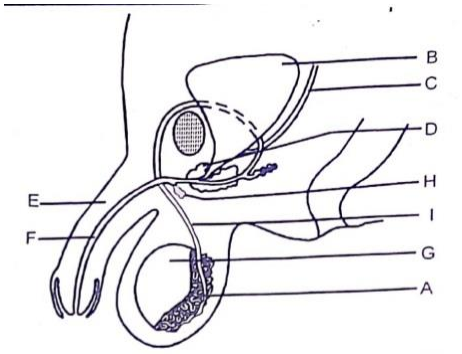
(vi) Animals which have the organs of the both sexes are correctly known as: -

A. Bigamous
B. Hermaphrodite
C. Bisexual
D. Parthenogenic

(vii) Which one of the following does not pass across the placenta from the mother to the foetus?

A. Oxygen
B. Antibodies
C. Red blood cells
D. Water

(viii) In the figure below sperm are produced in: -



A. G
B. D
C. E
D. F

(ix) which gland is marked H in the figure shown in (viii) above?
A. Seminal vesicle
B. Prostate gland
C. Cowper's gland
D. Pituitary gland

(x) Sperm are stored in
A. D
B. C
C. B
D. A

(xi) Which structure contains spaces, which fill with blood during sexual excitement?
A. D
B. E
C. F
D. G

(xii) Which two numbered parts both contribute to the composition of semen?
A. H and G
B. A and G
C. H and D
D. A and D

(xiii) The male sterilization operation known as vasectomy is carried out by: -
A. Blocking I
B. Tying and cutting I
C. Collapsing B
D. Removing E

(xiv) In a female mammal, fertilization normally occur in the: -
A. Uterus
B. Vagina
C. Ovary
D. Oviduct

(xv) Identical twins develop from two: -
A. Having of an egg fertilized by two sperms
B. Eggs fertilized by the same sperm
C. Having of a fertilized egg
D. Eggs released by the same ovary

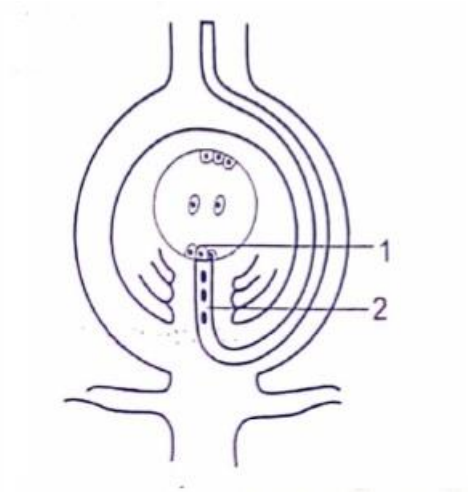
(xvi) Sexual reproduction involves the fusing together of: -
A. Oogonia
B. Ova
C. Gametes
D. Zygotes

(xvii) After ovulation, the cells of the follicle proliferate to form a solid body called the corpus luteum. This released a hormone called: -

A. Progesterone
B. Oestrogen
C. Luteinizing hormone
D. Oxytocin

(xviii) In the figure below the part marked 1 is the: -

A. Pollen tube
B. Embryo sac
C. Egg nucleus
D. Tube nucleus



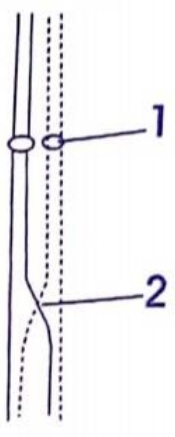
(xix) In the figure above the part marked 2 is the: -

A. Embryo sac
B. Egg nucleus
C. Integuments
D. Pollen tube

(xx) Contraction of uterus before and during birth is brought about by the means of a hormone produced by the posterior lobe of the pituitary gland called: -

A. Antidiuretic hormone
B. Oxytocin
C. Vasopressin
D. Oestrogen

(xxi) Figure below is a diagram showing what happens during crossing over of homologous chromosomes. The part marked 1 is: -



A. Nucleus
B. Chiasma
C. Tetrad
D. Centromere

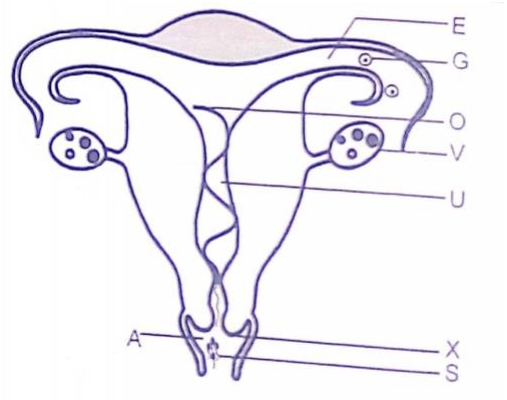
(xxii) Part 2 in the figure shown above in (xxi) is: -

A. Nucleus
B. Chiasma
C. Tetrad
D. Centromere

(xxiii) If menstruation occurs on days 4 to 9 of a month what would be the date of the ovulation in a menstrual cycle of 28 days.

A. 17th
B. 14th
C. 21st
D. 28th

(xxiv) The diagram below shows an intra- uterine device in position in a woman's uterus. The part marked V is:



A. Egg
B. Ovary
C. Uterus
D. Vagina

(xxv) The part E in the figure shown above in (xxiv) is: -

A. Fallopian tube
B. Egg
C. Ovary
D. Uterus

(xxvi) Which parts unite during fertilization in the figure above?

A. G and O
B. E and S
C. S and G
D. A and S

(xxvii) What is part O in the figure above?

A. Tube
B. Uterus
C. Vagina
D. Loop

(xxviii) Which of following is the correct statement about pollen grains?

A. Pollen attracts insects to the flower
B. Pollen grains are the male gametes
C. Pollen grains contain the male and female gametes
D. Pollen grains give a sweet smell to the flower

(xxix) Which of the following statements about fertilization in plants and animals is not true?

A. A zygote is produced by the fusion of male and female gametes
B. No new living organism can be produced without fertilization
C. A female gamete is bigger than a male gamete
D. A reproductive cell is a gamete

(xxx) In the process of plant grafting, two parts are involved, these are: -

A. Scion and stock
B. Scion and roots
C. Stock and a mature tree
D. Buds and leaves

(xxxi) Budding and grafting involves growing the desired plant on a vigorous wild plant of the same or closely related special. In these methods of propagation1 the:

A. Wild plant supplies the scion
B. Wild plant supplies the stock
C. Desired or required plant supplies the stock
D. Source of the stock or scion is not important

(xxxii) Contrary to what some people believe that the male reproductive organs (male genitalia) are external as compared to the female genitalia, most of the parts of the male genitalia are internal. Which of the following sets includes entirely internal male genitalia?

A. Testis, prostate gland, scrotum and prepuce
B. Seminal vesicles, testis, prostate gland and scrotum
C. Prostate gland, spermatic cord, testis and prepuce
D. Spermatic cord prostate gland and seminal vesicle

(xxxiii) Select the correct statement from the following: -

A. The release of an ovum from an ovary and the preparation of uterus to receive a fertilized egg to develop into a zygote are called fertilization.
B. The process of passing out dead unfertilized ovum and uterine lining in women is called menstruation
C. The embryo receives food from the placenta
D. After fertilization, the ovum dies and is released during menstruation.

(xxxiv) In which of following stages of meiosis do chromosomes appear as thin chromatin threads?

A. Interphase I
B. Interphase II
C. Anaphase I
D. Telophase II

(xxxv) Chromosomes become more visible during_____

A. Telophase I
B. Interphase II
C. Prophase I

D. Anaphase

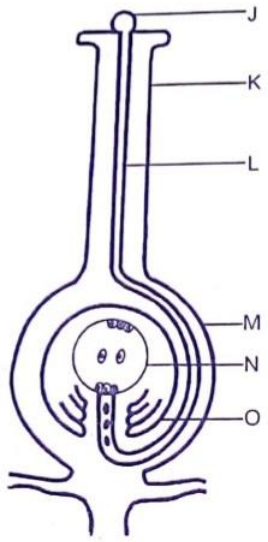
(xxxvi) At this stage of meiosis, new spindle fibres are formed at right angles to those formed during meiosis I.

A. Prophase I
B. Anaphase II
C. Anaphase I
D. Prophase II

(xxxvii) Crossing over occurs during_____

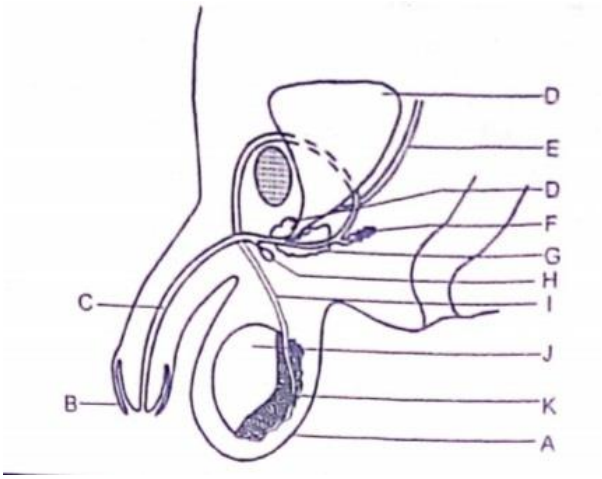
A. Interphase I
B. Metaphase II
C. Prophase I
D. Anaphase II

2. Study the diagram below and answer the question that follow:



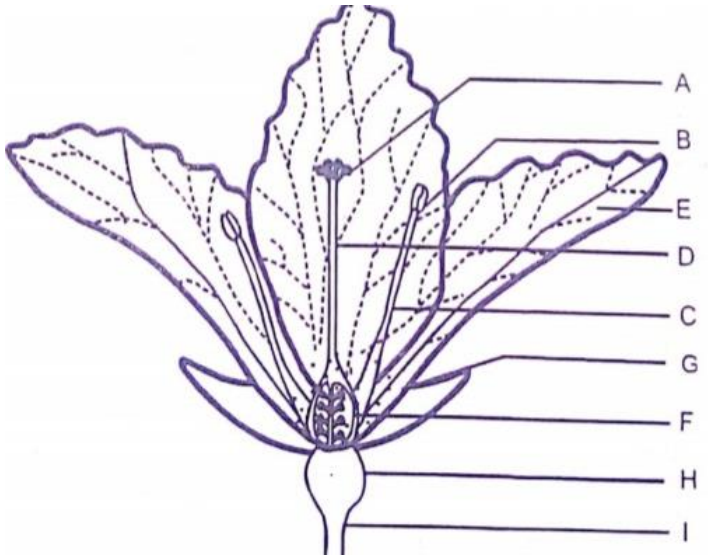
(a) Name the parts labelled J, K, L, M, N and O
(b) What does the diagram represent?
(c) What is the origin of the endosperm tissue in seeds?
(d) What is the outcome of the following structures after fertilization?
  (i) Structure K
  (ii) Structure M
  (iii) Structure O

3. The diagram below is of a human male urino-genital system. Study it and answer the questions that follow.



(a) Name the parts labelled A, B, C, D, E, F, G, H, I, J and K
(b) Which two of the above named parts are not parts of the reproductive system?
(c) Vasectomy is a method of birth control involving an operation on part of the male reproductive system. Discuss
(d) During circumcision which part is removed?
(e) Between the fore skin and the glans of the penis accumulates a whitish substance known as----------
(f) Where are the sperms made?
(g) Where are the sperms stored?

4. The figure below shows a longitudinal section through a flower. Study the diagram and answer the questions that follow.

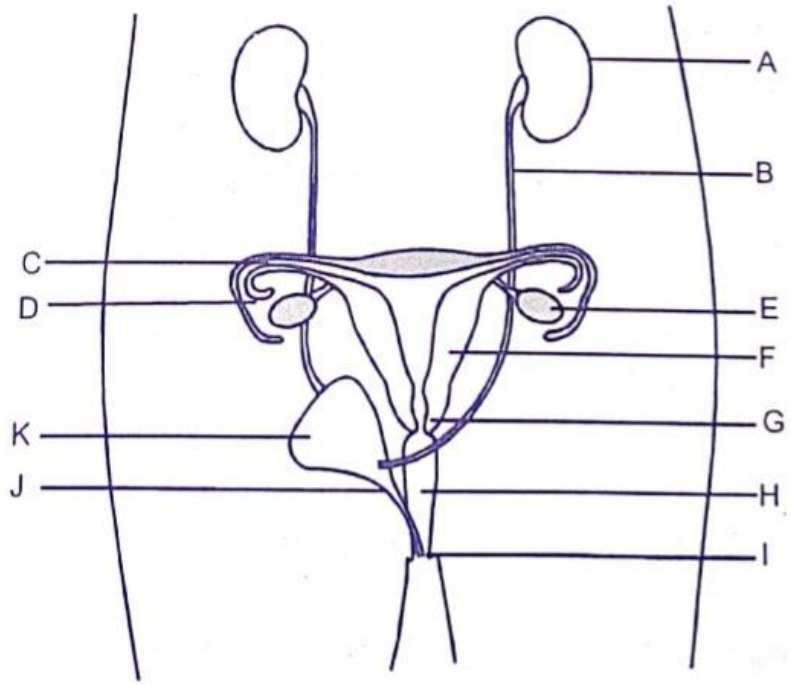


(a) Name all the labelled parts A- I
(b) Which of the labelled parts of the constitute the gynoecium of the flower?
(c) The flower has both stamens and carpels. What term is used to describe such a flower?
(d) What do you understand by the term pollination?
(e) The type of the ovary represented in the diagram is?
(f) Which part protects the flower in bud stages?

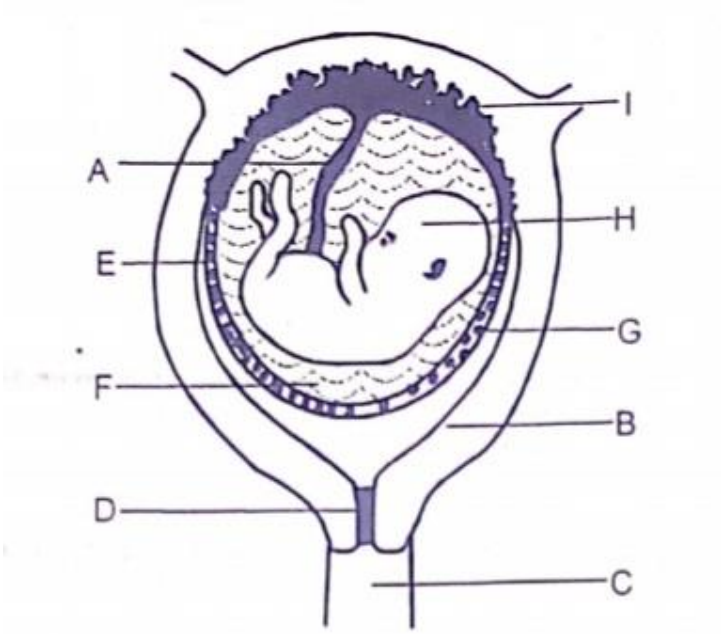
5. (a) Define the following terms.
    (i) Spermatogenesis
    (ii) Oogenesis
   (b) Where do spermatogenesis and oogenesis processes occur in the human body?
   (c) What is the main difference between the two processes in (a) above?
6. Briefly explain the meaning of the following terms in human reproduction.
    (a) Fertilization
    (b) Implantation
    (c) Gestation period
    (d) Ovulation
    (e) Parturition
7. (a) Name the hormones, which control the following processes in the human body.
    (i) Development of female secondary sexual characteristics
    (ii) Preparation of the uterus for pregnancy
    (iii) Production and secretion of milk by mammary glands
    (iv) Contraction of uterus wall during birth
   (b) State the functions of the following hormones: -
        (i) Follicle stimulating hormones
        (ii) Luteinizing hormone
        (iii) Androgen
8. State the function of each of the following structures: -
    (a) Placenta
    (b) Vas deferens
    (c) Epididymis
    (d) Prostate gland
9. (a) distinguish between external and internal fertilization and give two examples of organism in which they occur
   (b) What are advantages of internal fertilization over external fertilization?
10. (a) Why is maize grain considered as a fruit and not as a seed?
    (b) What is the role of the fruit in the development of angiosperm seed??
11. With specific examples distinguish between oviparous and viviparous?
12. (a) Describe how fertilization occurs in a named flower?
    (b) How are seeds formed?
    (c) What are the differences between a seed and a fruit?
13. (a) What are the characteristics of an insect-pollinated flower?
    (b) Define the term cross-pollination
    (c) Mention three agents of pollination.
14. Describe the part played by each of the following in reproduction.
    (a) Androecium
    (b) Gynoecium
    (c) Corolla
15. Discuss how fruits/seeds are adapted for dispersal
16. (a) Briefly explain with reasons why vegetative propagation can be of an advantage to a farmer or gardener compared to reproduction by seeds.

(b) List the characteristics of wind pollinated flowers.

17. In a maternity ward, a baby born with the hands and feet having a blue colouration. The baby died after a few minutes.
    (a) Name the disorder from which the baby was likely to have been suffering from.
    (b) Explain how the disorder occurred.
    (c) What measures could have been taken to save the baby?
18. The diagram below shows a female reproductive system.

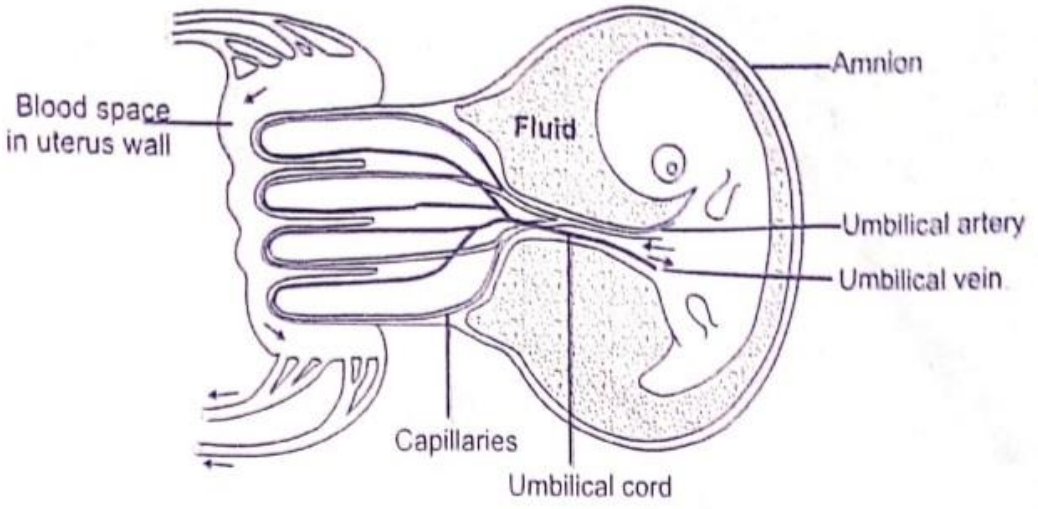


    (a) Name the parts labelled: A, B, C, D, E, F, G, H, I, J and K
    (b) Where are sperms deposited?
    (c) Where does fertilization normally occur?
    (d) Which part releases the ovum?
    (e) During birth control method i.e. tubal ligation, which part is tied and cut?
    (f) Which parts are not associated with the reproductive system?
    (g) Briefly explain the functions of the parts labelled C, D, E, F, G, H and I
19. The diagram below shows a foetus in the uterus.



(a) Identify the parts labelled A, B, C, D, E, F, G, H and I
(b) Briefly explain the functions of the amniotic fluid during the development of the foetus.
(c) Which hormone is produced by the part I during the last six months of the pregnancy?
(d) What is the role of the hormone you mentioned in (c) above?

20. Briefly define the following terms:
    (a) Ectopic pregnancy
    (b) Still birth
    (c) Miscarriage
    (d) Premature
    (e) Abortion
    (f) Breech birth
21. (a) Precisely explain the term sexual deviations.
    (b) Give a brief account on the various sexual deviations in the society.
22. (a) What do you understand by the term family planning?
    (b) Briefly mention five methods of family planning.
23. The diagram below shows an embryo and its placenta during the early stages of development.



(a) Briefly list down the materials allowed to pass from the mother to the foetus.
(b) Briefly list down the materials not allowed to pass from the mother to the foetus.
(c) What materials does the foetus release to the mother's blood?
(d) (i) Which blood vessel (umbilical artery or umbilical vein) has greater concentration of amino acids?
(ii) Give reasons for your answer in (i) above.
(e) Which blood vessel (umbilical artery or umbilical vein) has greater concentration of carbon dioxide?
(f) Explain how oxygen in the maternal in the blood passes into the foetus blood supply.
(g) Precisely describe which change occur in the circulatory system of the foetus soon after birth.

24. (a) What are sexually transmitted diseases?
(b) Name five sexually transmitted diseases.
(c) Outline ways of controlling and preventing the spread of HIV/AIDS
25. (a) Define fertilization
(b) Why happens to the ovum after fertilization takes place?
(c) Where does fertilization occur in mammals?
(d) What is the fate of the endometrium if fertilization does not occur?
26. (a) Draw a male gamete
(b) State ways in which the male gamete is adapted to movement towards the ovum.

27. (a) Name the accessory glands of the male reproduction system.
(b) What is the role of the glands in reproduction?
28. The female normally releases one ovum in each reproductive cycle.
(a) At which stage of life does the female reproduction cycle commence and does it end?
(b) (i) Give the average number of days of the reproductive cycles in females.
(ii) Name the episode that marks the start and end of each reproductive cycle.
(c) What is the role of the umbilical cord during pregnancy?

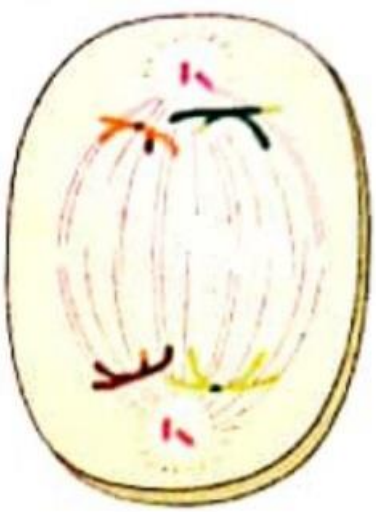
29. (a) Name the organ through which substances are passed from the mother to the foetus.
    (b) How is the organ named in (a) above adapted to its functions?
30. (a) What is the role of the following parts of the male reproductive system?
        (i) Testes
        (ii) Epididymis
        (iii) Vas deferens
    (b) State the effect of testosterone in reproduction.
31. The diagram below shows a process in reproduction.

    (a) (i) Name the process.
        (ii) Name the hormone that causes the process given in (i)
    (b) What is the role of the Graafian follicle?
32. Explain how each of the following can help to minimize complications of pregnancy:
    (a) Visiting clinic as early as possible once a woman discovers the she is pregnant.
    (b) Improved nutrition
    (c) Avoiding sexually transmitted diseases.
    (d) Avoiding giving birth at home.
33. Explain the dangers of the following unacceptable sexual behaviours to an individual.
        (a) Anal intercourse
        (b) Prostitution
        (c) Watching pornography
        (d) Rape
34. (a) Define reproduction
    (b) Why is reproduction very important to living organisms?

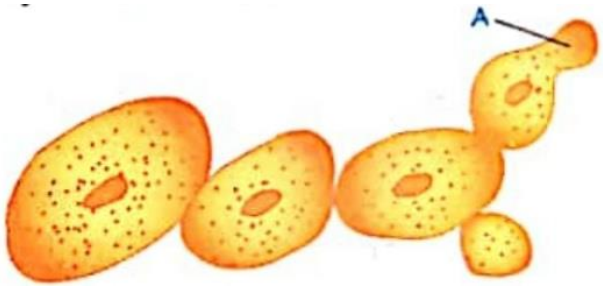
35. (a) Distinguish between:
        (i) Meiosis I and meiosis II
        (ii) Binary fission and multiple fission
    (b) Give examples of organisms that reproduce by each of the following ways:
            (i) Fusion of gametes
            (ii) Cutting
            (iii) Spore formation
            (iv) Budding
36. (a) Explain how binary fission occurs
    (b) Give advantages and disadvantages of sexual and asexual reproduction.

(c) Explain how sexual reproduction brings about variation among organisms of the same species.

37. Meiosis is a backbone of sexual reproduction. Explain
38. State the importance of each of the following processes:
    (a) Reproduction
    (b) Crossing over
    (c) Formation of spindle fibres.
39. The diagram below shows a cell undergoing a stage in cell division.



    (a) With reasons, identify this stage.
    (b) Draw a diagram to show the next stage of cell division.
40. The diagram below shows asexual reproduction in yeast cells.



    (a) Name the type of reproduction shown in the diagram.
    (b) Identify the structure labelled A
    (c) State the biological importance of A.

41. (a) What type of reproduction does amoeba undergo?
    (b) Explain how such type of reproduction takes place.