Contents

BIOLOGY HANDBOOK

ALLEN CAREER INSTITUTE KOTA (RAJASTHAN)

PLANT KINGDOM

CHAPTER - 1 : LIVING WORLD

- **Earnst Mayr** has been called as "The Darwin of 20th century" He worked on Taxonomy, Zoogeography, Evolution, Systematics and History & Philosophy of biology. He gave the biological concept of species.
- The number of species that are known and described ranges between 1.7 – 1.8 million
- **ICBN** – International Code of Botanical Nomenclature
- **ICZN** – International Code of Zoological Nomenclature
- Each biological name is made up of two components, generic name and specific epithet. This system is called as bionomial system.
- Biological names are generally in Latin and written in italics. They are latinised or derived from Latin irresepective to their origin.
- Both the words in a biological name, when handwritten, are separately underlined, or printed in italics to indicate their Latin origin.
- Classification is the process by which any thing is grouped into convenient categories based on some easily observable characters.
- The group included in taxonomic categories is called as taxon.
- Characterisation, identification, nomenclature and classification are the processes that are basic to taxonomy.
- Category is a part of overall taxonomic arrangement and all categories together constitute the taxonomic hierarchy.
- As we go higher from species to kingdom the number of common characteristics goes on decreasing.
- **Herbarium** is a store house of collected plant specimens that are dried, pressed and preserved on sheets.
- **Keys :** The keys are based on the contrasting characters generally in a pair called couplet. Each statement in the key is called a lead.
- Keys are generally analytical in nature.
- **Flora** : It contains the actual account of habitat and distribution of plants of a given area. These provide the index to the plant species found in a particular area.
- **Monograph :** It contains complete informations on any one taxon.

CHAPTER - II : BIOLOGICAL CLASSIFICATION

- Aristotle was the earliest to attempt a more scientific basis for classification.
- **Aristotle** divided animals into two groups (1) Having red blood cells and (2) Do not having red blood cells.
- **R.H. Whittaker's Classification** is phylogenetic classification.
- Archaebacteria differ from other bacteria in having a different cell wall sturcture and this feature is responsible for their survival in extreme conditions.
- Some cyanobacteria can fix atmospheric N_2 in their specialised cells called heterocysts. eg. ***Nostoc*** & ***Anabaena***.
- In diatoms the cell walls form two thin overlapping shells, which fit together as in a soap box.
- The cell wall of diatoms (chrysophytes) are embedded with silica and thus the walls are indestructible.
- **Red dinoflagellates** undergo very rapid multiplication so they make the sea appear red, called as red tides.
- The cell wall of fungi is composed of chitin and polysaccharides.
- Some fungi can live as symbionts in association with algae (lichen) and with roots of higher plants as mycorrhiza.
- In fungi the sexual cycle involves.

  (1) Plasmogamy (2) Karyogamy (3) Meiosis.
- Phycomycetes are found in aquatic habitats, on decaying wood on moist or damp places or as obligate parasites on plants.
- In ascomycetes and basidiomycetes dikaryotic (n + n, two nuclei per cell) condition is also found called as dikaryophase.

- Many members of ascomycetes like morels and buffles are edible fungi.
- Members of basidiomycetes are mushrooms, bracket fungi and puffballs. They produce basidiospores exogenously on their basidium (pl. basidia). Some times basidia are arranged in fruiting bodies called basidiocarp.
- **Deuteromycetes :** they are commonly known as imperfect fungi because they reproduce only by asexual or vegetative reproduction, not by sexual reproduction. They produce septate and branched mycelium. Some members are saprophytes or parasites while a large number of them are decomposers of litter and help in mineral cycling.

CHAPTER - III : PLANT KINDGOM

- Kingdom plantae includes all eukaryotic chlorophyllous autotrophic organisms. A few members are partially heterotrophic such as insectivorous plants or parasites. Bladderwort and venus fly trap are examples of insectivorous plants and ***Cuscuta*** is a parasite.
- The **artificial system** gives equal weightage to vagetative and sexual characteristics, this is not acceptable since the vegetative characters are more easily effected by envirnoment.
- **Natural classification** is based on natural affinities among the organisms and consider not only the external features but also internal features.
- The phylogenetic systems are based on evolutionary relationships between the various organisms.
- **Numerical taxonomy** is based on all observable characters. Number and codes are given to all the characters and these data are made and processed by the help of computer for making the numerical taxonomy.
- **Cytotaxonomy :** cytotaxonomy is based on cytological informations like chromosome number, structure and behaviour.
- **Chemotaxonomy :** Chemotaxonomy uses the chemical constituents of the plant.

ALGAE

- Algae are highly variable in form and size, they are unicellular (microscopic), colonial, filamentous, and also form massive plant bodies (kelps)
- **Isogamy :** Fusion of similar gametes in size is isogamy. These gametes may be motile (***Ulothrix***) or nonmotile (***Spirogyra***).
- **Anisogamy :** Fusion of two gametes dissimilar in size is anisogamy eg. some species of ***Chlamydomonas***.
- **Oogamy :** Fusion between one large, nonmotile (static) female gamete and a smaller, motile male gamete is termed as Oogamy. eg. ***Volvox, Fucus.***
- At least a half of the total CO_2 fixation on earth is carried out by algae through photosynthesis.
- Many species of ***Porphyra***, ***Laminaria*** and ***Sargassum*** are among the 70 species of marine algae used as food.
- Many algal products like algin (from brown algae) and carrageen (red algae) are used commercially. Agar-agar (from ***Gelidium*** and ***Gracillaria***) are used to grow microbes and preparation of ice creams and jellies.
- ***Chlorella*** and ***Spirullina*** are unicellular algae, rich in proteins and are used as food supplements even by space travellers.

CHLOROPHYCEAE (Green algae)

- Most of the members of chlorophyceae have one or more storage bodies called pyrenoids located in chloroplasts. Pyrenoids contain protein besides starch.
- In green algae the cell wall is made of inner layer of cellulose and an outer layer of pectose.

PHAEOPHYCEAE : (Brown algae)

- The members of brown algae show great variation in size and form. They range from simple branched, filamentous forms to profusely branched form, which may reach a height of 100 meters.
- Their cellulosic cell wall is covered on outside by a gelatinous coating of algin.
- Food is stored in them as complex carbohydrate, laminarin or mannitol.

- The gametes of these algae are pyriform (pear shaped) and bear two laterally attached flagella.
- Common members of phaeophyceae are – ***Ectocarpus***, ***Dictyota***, ***Laminaria***, ***Sargassum*** & ***Fucus***.

RHODOPHYCEAE (Red algae)

- Majority of red algae are found in marine water with greater concentrations in warmer areas.
- The reserve food in red algae is **floridean starch** which is very similar to amylopectin and glycogen.
- Sexual reproduction in red algae is Oogamous and accompanied by complex post fertilisation developments.
- Examples of red algae are ***Polysiphonia***, ***Porphyra***, ***Gracillaria***, ***Gelidium***.

BRYOPHYTA

- Bryophytes lack true roots, stem or leaves. They may possess root like, stem like or leaf like structures.
- Main body of **bryophytes** is made of haploids cells and it produces gametes hence is called as **gametophyte.**
- Sporophyte in them is not free living, but attached to the photosynthetic gametophyte and derives nourishment from it.
- ***Sphagnum*** provides peat that have long been used as fuel and also used as packing material for trans-shipment of living material because of its high water holding capacity.
- Mosses along with lichens are the first organisms to colonies rocks and hence are of great ecological importance.
- Mosses form dense mats on the soil, they reduce the impact of falling rain and prevent soil erosion.

LIVER WORTS :

- The plant body of liver wort is thalloid and the thallus is dorsiventral and closely appressed to the substratum.
- The leafy members of liverworts have tiny leaf like appendages in two rows on the stem like structures.
- Asexual reproduction in liverworts takes place by fragmentation of thalli or by the formation of specialised structures called gemmae (gemma-singular). Gemmae are green multicellular, asexual buds, which develop in small receptacles called gemma cups.
- The sporphyte is differentiated into a Foot, Seta and Capsule (***Marchantia***). After meiosis spores are produced within the capsule.

MOSS

- The gametophyte body of moss is made up of two stages.
  (i) Protonema – first stage produced from spore.
  (ii) Leafy stage – The second stage produced from buds of protonema.
- Vegetative reproduction in mosses is by fragmentation and budding in the secondary protonema.
- Common example of mosses are ***Funaria***, ***Polytrichum*** and ***Sphagnum***.

PTERIDOPHYTA

- In pteridophytes the main plant body is sporophyte which is differentiated into root, stem & leaves. They have well differentiated vascular tissues.
- The leaves in pteridophyta are small (microphylls) as in ***Selaginella*** or large (macrophylls) as in ferns.
- Only few genera of pteridophytes show heterospory; they produce two types of spores, Macrospores (large) and Microspores (small).
- In heterosporous pteridophytes the female gametophytes are retained on the parent sporophyte for variable period. The development of zygote into young embryo takes place within the female gametophytes. This is precursor to the seed habit, considered as an important step in evolution.

GYMNOSPERMS

- In gymnosperms ovules are not enclosed in ovary walls and remain exposed both before and after fertilisation, so they produce naked seeds.
- Gymnosperms are medium sized trees or tall trees and shrubs.
- The giant redwood tree ***Sequoia*** is one of the tallest tree species.
- In gymnospemrs the stem may be unbranched (***Cycas***) or branched (***Pinus***, ***Cedrus***)

- The leaves may be simple or pinnately compound.
- The leaves in gymnosperms are well adapted to withstand extremes of temperature, humidity and wind. In conifers, the needle like leaves reduce the surface area. Their thick cuticle and sunken stomata also help to reduce water loss. These are the xerophytic characters in gymnosperms.
- The male and female cones (strobili) may be produced on the same tree (***Pinus***) or on different trees (***Cycas***)
- In Gymnosperms the male and female gametophytes do not have an independent free living existence.

Lichens :

- Lichens are symbiotic associations between algae and fungi.
- The algal component of lichen is known as **phycobiont** and fungal component is known as **mycobiont.**
  - → Algal component – Autotrophic
  - → Fungal component – Heterotrophic
- In lichens algae prepare food for fungi and fungi provide shelter and absorb mineral nutrients and water for algae.
- Lichens are very good pollution indicators, they do not grow in polluted areas.

→ Most of the lichens are **ascolichen** (on the basis of fungal component).

→ Most common phycobiont in Lichens :- ***Trebouxia***

→ *Parmelia* species are used as a curry powder in India.

→ *Cetaria islandica* is used as laxative.

→ *Cladonia rangiferina* is commonly known as reindeer moss.

Viruses :

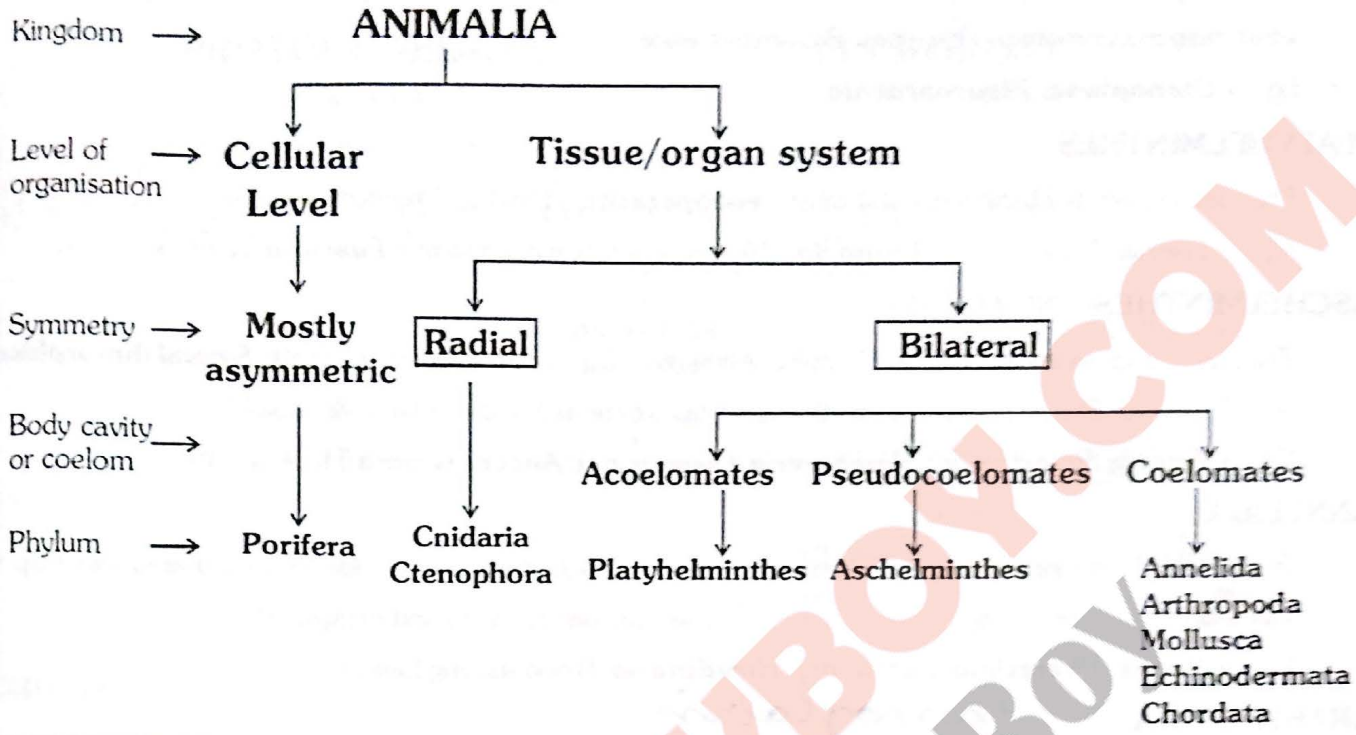
- The viruses are non-cellular organisms that are characterised by having an inert crystalline structure outside the living cell.
- The name virus that means *venom* or *poisonous* fluid was given by Pasteur.
- Viruses are obligate parasite.
- Viruses are inert outside their specific host cell.
- In addition to proteins viruses also contain genetic material that could be either RNA or DNA.
- Generally, plant viruses are single stranded RNA viruses.
- Bacteriophages are generally double stranded DNA viruses.
- The protein coat of virus is called *Capsid* made of small subunits called capsomeres. These capsomeres are arranged in helical or polyhedral geometric forms.

Viroids : ~ SSRNA

- Discoverer – T.O. *Diener*
- They have only low molecular weight RNA, no protein coat.
- *Potato spindle tuber disease* is caused by potato spindle tuber viroid.

Note : Viruses, Viroid and Lichens are not included in five kingdom system of classification.

ANIMAL KINGDOM



INTRODUCTION

Animals show different types of of body organisation

(i) Protoplasmic level Eg. – **Protozoa**

(ii) Cellular level Eg. – **Porifera**

(iii) Tissue level Eg. – **Coelenterata** & **Ctenophora**

(iv) Organ/organ system level Eg. – **Platyhelminthes** onwards to **Chordata.**

Animals can be Asymmetric, Radial and Bilateral symmetric.

Most of the animals are **triplobastic**.

Flatworms are **Acoelomate**, Round worms are **pseudocoelomate** where as rest of the animals are **coelomates.**

Digestive tract is **incomplete** in coelenterata, ctenophora and platyhelminthes where as it is **complete** in rest of the phyla.

Modes of respiration can be Body surface, cutaneous branchial and pulmonary.

Circulatory system is **open** in Arthropoda, Mollusca, Echinodermata, Hemichordata and in Urochordata where as it is **closed** in annelida and rest of the chordates

Modes of Excretory system includes Flame cells, Nephridia, Malpighian tubules, Green glands and Kidneys in animals.

PORIFERA

Mostly marine, cellular level body organistation with **water transport system / Canal system** having ostia, osculum and choanocytes (Collar cell) etc.

Sponges are **hermaphrodite** and their Fertilization is **internal.**

Eg. – **Sponges,** Like – ***Sycon*** (Scypha), ***Spongilla*** (Fresh water sponge), ***Euspongia*** (Bath spange)

COELENTERATA

Mostly marine, radially symmetrical with stinging cell known as ***Cnidoblast***. Mainly two forms i.e. **polyp** & **medusa** which exibit alternation of generation **(Metagenesis)**

Eg. – ***Hydra Aurelia*** (Jelly Fish), ***Adamsia*** (Sea anemone), ***Pennatula*** (Sea pen), ***Gorgonia*** (Sea Fan), ***Meandrina*** (Brain coral), ***Physalia*** (Partuguese man-of-war).

CTENOPHORA

Exclusively **marine** popularly known as sea walnuts or **comb jellies** due to presence of 8-cillary comb plates which help in locomotion. They show Bioluminescence.

Eg. → ***Ctenoplana, Pleurobrachia***

PLATYHELMINTHES

They are known as **Flatworms** and mostly **endoparasitc**. Hooks and suckers are found.

Eg. → **Taenia,** (Tape worms), ***Planaria,*** *(High regeneration of capacity),* ***Fasciola*** (Liver Fluke), etc.

ASCHELMINTHES / NEMATODA

They are known as **round worm.** Complete Alimentary Canal with muscular Pharynx. **Sexual dimorphism** is well marked. Often male is small with curved tail where as Female is large & straight.

Eg. → ***Ascaris*** (Round worm), ***Wuchereria*** (Filaria worm), ***Ancyclostoma*** (Hook worm).

ANNELIDA

Body surface with **segments** or **metamere**. Possess Longitudinal and circular muscles. Parapodia help in swimming. In Nervous system, nerve cord is double, mid ventral, solid and gangliated

Eg. → ***Nereis, Pheretima*** (Earthworm), ***Hirudinaria*** (Blood sucking Leech).

ARTHROPODA

Arthropoda is the **largest** phylum with **jointed appendages** and chitinous exoskeleton. Mainly body is divided into **head, Thorax** and **Abdomen**. Few Arthropods have economic importance and few are vectors for various pathogens statocysts balance organs are present.

Eg. (i) Economically important insects – ***Apis,*** Bombyx, Laccifer

(ii) Vector – Anopheles, Culex, Aedes.

(iii) Gregarious pest – ***Locusta*** (Locust)

(iv) Living fossil – ***Limulus*** (king crab)

MOLLUSCA

It is the **second largest** phylum. Basically they are **soft body** and hence covered with calcareous shell. Normally body is divided into **Head, muscular foot** and **visceral hump**. Spongy fold **mantle** and rasping organ for feeding-**radula** is also found

Eg. ***Pila, Pinctada, Sepia, Loligo, Octopus, Aplysia, Dentalium, Chaetopleura*** (Chiton)

ECHINODERMATA

An exclusively **marine phylum** and having **spiny body.** Their larva is **bilateral** symmetrical where are adult is **radially symmetrical.** They have an endoskeleton of calcareous ossicus.

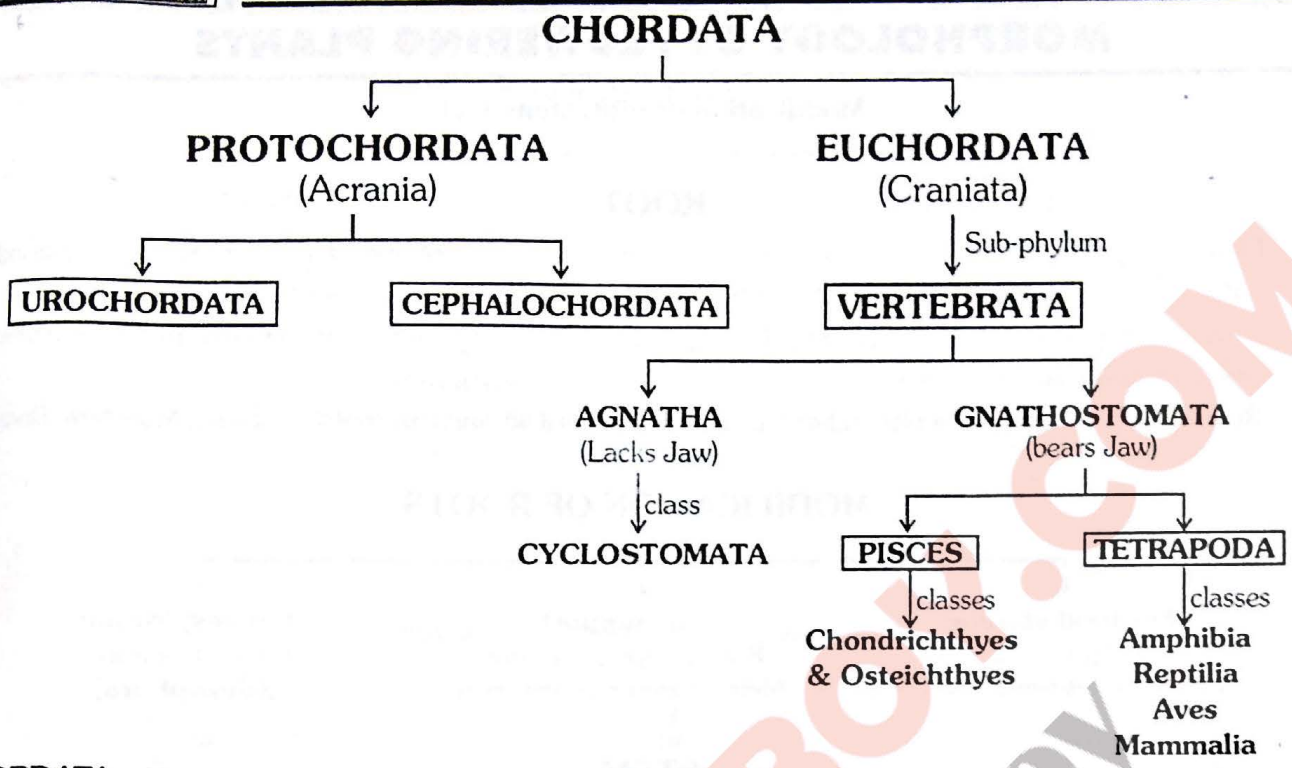
Unique **water vascular system** helps in locomotion, nutrition and respiration

Eg. ***Asterias*** (Star fish), ***Echinus*** (Sea urchin) ***Antedon*** (Sea lily), ***Cucumaria, Ophiura*** (Brittle star)

HEMICHORDATA

Earlier considered as sub-phylum of chordata. Body is divided into **proboscis, collar** & **Trunk.** Animals are worm like

Eg. → ***Balanoglossus, Saccoglossus.***



CHORDATA

Chordata are fundamentally characterised by presence of **Notochord, dorsal hollow Nerve** cord and **paired pharyngeal gills slits.**

- There are three sub-phylas of chordata –
  - (i) **Urochordata** – Eg. ***Herdmania, Ascidia, Salpa***
  - (ii) **Cephalochordata** Eg. ***Amphioxus*** or ***Branchiostoma*** (Lancelet)

    Urochordata and Cephalochordata are also known as **Protochordata**.
  - (iii) **Vertebrata** - This subphylum is divided as **Agnatha** and **Gnathostomata.**
- Agnatha do not possess jaw where as Gnathostomata **possess** Jaw.
- Cyclostomata are agnatha and considered as most primitive vertebrates. Gnathostomata has two super classes **Pisces** & **Tetrapoda**
- Class chondrichthyes (**Cartilaginous**) and osteichthyes (**Bony**) are pisces classes and bear **fins** for locomotion.
- **Tetrapoda** divides into four classes - **Amphibia, Reptilia, Aves** and **Mammalia.** They have **two pairs** of Limbs and thus grouped under tetrapoda.
- **Amphibian** have adapted for both on Land and water where as **reptiles** are characterised by the presence of **dry** and **cornified** skin and thus considered as **successful terrestrial animals**.
- Fishes, Amphibians and Reptiles are **poikilothermic** (cold blooded) where as Aves and mammals are **Homothermic** (warm blooded). Birds with **feathers** on their bodies.
- Their fore limbs modified into **wings** where as hind limb are adapted for **walking, swimming** and **clasping.**
- The most unique mammalian charateristic is the presence of **mammary glands**. Skin is **hairy** and presence of **diaphragm** are salient features of mammals. **Pinna** are also present. All are **homeothermic animals**.

★ Torpedo – Electric ray

MORPHOLOGY OF FLOWERING PLANTS

Modification of root, stem, leaf

ROOT

- Direct elongation of the radicle leads to the formation of primary root and lateral roots are called secondary tertiary roots, (are collectively called tap root system). eg most of the dicot plants (Mustard).
- In monocots primary root is replaced by the large numbers of roots which is originated from the base of stem called fibrous roots. eg – wheat
- Roots arise from parts of the plant other than radicle are called adventitious roots. eg. Grass, Monstera, Banyan.

MODIFICATION OF ROOTS

For food storage	For support	For respiration
Carrot, Turnip (Tap root)	Banyan tree (Prop root)	Pneumetophores
Sweet Potato (Adventitious roots)	Maize, sugarcane (stilt root)	**(Rhizophora)**

STEM

It develops from the plumule. The main function of the stem is spreading out branches bearing leaves, flowers and fruits.

MODIFICATIONS OF STEM

(1) **For food storage-underground stem** (Potato, ginger, turmeric, zaminkand, Colocasia)

(2) **Stem tendrils** – Help plants to climb
e.g.– Gourds (Cucumber, Pumpkins, Watermelon) and grapevines

(3) **Thorns** – Protect plants from browsing animals
e.g – **Citrus, Bougainvillea.**

(4) **Phylloclade** – Perform photosynthesis
e.g. – **Opuntia (Flat), Euphorbia (Cylindrical)**

(5) **Offset** – Pistia, Eichhornia

(6) **Sucker** – Banana, Pineapple, Chrysanthemum

LEAF

Leaves originate from shoot apical meristem and are arranged in an acropetal manner.

The leaf is attached to the stem by leaf base and may bear two lateral small leaf like structures called stipules.

Swollen leaf bases are called pulvinus. e.g. Some leguminous plants.

Venation – Arrangement of veins and veinlets in the lamina of leaf its termed as venation

VENATION

Reticulate	Parallel
Veinlets form network	Vein run parallel to each other
(Dicots)	(Monocots)

TYPES OF LEAVES

- **Simple**
  Incision do not touch the mid rib
- **Compound**
  Incisions reach up to the mid rib and breaking it into leaf lets
  - **Pinnately**
    Leaflets are Present on the rachis
    (Neem)
  - **Palmately**
    Leaf lets are attached at the tip of Petiole
    (Silk cotton)

Phyllotaxy (Arrangement of leaves on stem or brach)

- **Alternate**
  Single leaf arises at each node
  (China rose, mustard, Sunflower)
- **Opposite**
  A pair of leaves arise at each node
  (Calotropis, Guava)
- **Whorled**
  More than two leaves arise at each node
  (Alstonia)

Modification of leaves :

(i) **Tendril** – for climbing (Pea)

(ii) **Spine** – For defence (Cacti)

(iii) **Food storage** – Onion, Garlic

(iv) **Petiole Performs photosynthesis** - Australian acacia

(v) **To trap the insect** – Pitcher plant, Venus fly trap.

INFLORESCENCE

(Arrangement of flowers on the floral axis)

- **Racemose**
  main axis continues to grow flowers are borne in an acropetal manner
- **Cymose**
  main axis terminates in a flower, flowers are born in basipetal manner

FLOWERS

- Swollen end of pedicel is called thalamus.
- Bisexual flower (Flower has both stamen and carpel)
- Unisexual flower (Flower having either stamen or carpel)

SYMMETRY

- **Actionomorphic (Radial)**
  Eg- Mustard, Datura, Chilli
- **Zygomorphic (Bilateral)**
  Eg- Pea, Gulmohur, Bean, Cassia
- **Asymmetric (Irregular)**
  Eg- Canna

Types of flower on the basis of Position of ovary

- **Hypogynous** (ovary superior) Eg- Mustard, Chinarose, Brinjal
- **Perigynous** (ovary half inferior) Eg- Plum, Rose, Peach
- **Epigynous** (ovary inferior) Eg-Guava, Cucumber Ray florets of sunflower

Calyx

- Gamosepalous (Sepals united)
- Polysepalous (sepals free)

Corolla

- Gamopetalous (Petals united)
- Polypetalous (Petals free)

AESTIVATION –

Mode of arrangement of sepals or petals in floral bud with respect to the other members of the same whor

TYPE OF AESTIVATION

- **Valvate** (Calotropis)
- **Twisted** (China rose, Lady's Finger, Cotton)
- **Imbricate** (Cassia, Gulmohur)
- **Vexillary** or **Papilionaceous** (Pea, Bean)

ANDROECIUM

(i) **Epipetalous** (Stamens are attached to the petals) Eg– Brinjal
(ii) **Epiphyllous** (Stamens are attached to the perianth) Eg – Lily
(iii) **Polyandrous** (Stamens remain free)
(iv) **Monoadelphous** (Stamens united into one bundles) Eg- China rose
(v) **Diadelphous** (Stamens united into two bundles) Eg- Pea
(vi) **Polyadelophous** (Stamens united into more than two bundles) Eg- **Citrus**
(vii) **Variation** in the length of filaments within flower eg. Salvia, Mustard.
(viii) Sterile stamen is called staminode.

PLACENTATION

Arangement of ovules within the ovary

- **Marginal** Pea
- **Parietal** Mustard **Argemone**
- **Axile** China rose Tomato Lemon
- **Free central** Dianthus Primrose
- **Basal** Sunflower Marigold

GYNOECIUM

Apocarpous - eg. Rose, Lotus, michelia.

Syncarpous - eg. Mustard, Tomato

FRUIT

- Mature or ripened ovary is called fruit. If fruit is formed without fertilisation of ovary is called parthenocarpic fruit.
- Drupe fruits eg. Mango (Mesocarp edible), Coconut (Mesocarp fiberous)

ANATOMY OF FLOWERING PLANTS

- Axillary bud is derived from shoot apical meristem.
- Both apical meristem and intercalary meristem are primary meristem, because they appear early in life of a plant and contribute to the formation of the primary plant body.
- Lateral meristems are cylindrical.
- Intrafascicular cambium is an example of primary lateral meristem.
- Interfascicular cambium and cork cambium (phellogen) are examples of secondary lateral meristem.
- In the dicot stem, vascular cambium is partly primary and partly secondary in origin.
- In the dicot root, vascular cambium is completely secondary in origin.
- Parenchymatous cells are generally isodiametric.
- Collenchymatous cells are much thickened at the comers, due to deposition of pectin, cellulose and hemicellulose.
- Collenchyma is present below epidermis either as a homogenous layer or in patches in herbaceous dicotyledonae stem.
- Cell walls of sclerenchymatous cells are thick and lignified.
- Sclereids are commonly found in the fruit wall of nuts, pulp of fruits like guava, pear & sapota, seed coats of legumes and leaves of tea.
- Tracheids are unicellular, whereas vessels are multicellular.
- Vessel is a long cylindrical tube-like structure made up of many cells called vessel elements.
- Xylem fibres have highly thickened walls and obliterated central lumens.
- The radial conduction of water takes place by the ray parenchymatous cells.
- In stems, the primary xylem is endarch, whereas in roots, the primary xylem is exarch.
- Gymnosperms have albuminous cells and sieve cells. They lack sieve tube and companion cells.
- The companion cells are specialised parenchymatous cells, which are closely associated with sieve tube elements.
- The companion cells help in maintaining the pressure gradient in the sieve tubes.
- Phloem parenchyma is absent in most of the monocolyledonae.
- Phloem fibres (Bast fibres) are generally absent in primary phloem.
- Enucleate condition is found in mature sieve tube element and in mature vessel element.
- Protophloem has narrow sieve tubes, whereas metaphloem has bigger sieve tubes.
- Jute, flax and hemp fibres are used commercially.
- Tissue systems are of three types on the basis of their structure, location and function.
- Epidermal cells are parenchymatous.
- Cuticle is absent in roots.
- The stomatal aperture, guard cells and surrounding subsidiary cells are together called stomatal apparatus.
- The root hairs are unicellular elongations of epidermal cells.
- The trichomes in the shoot system are usually multicellular.
- The ground tissue system consists of parenchyma, collenchyma and sclerenchyma.

- Radial vascular bundles are found in roots.
- Endodermal cells of roots are barrel-shaped having Casparian strips on radial and tangential walls. These strips are of a waxy-material-suberin.
- In dicot root, pith is small or inconspicous, whereas in monocots roots pith is large and well developed.
- In roots conjunctive tissue is present between the xylem and the phloem. It is made up of parenchyma.
- Dicot roots are usually diarch to Tetrarch (Rerely hexarch), whereas monocot roots are usually polyarch.
- In dicotyledonous stem, endodermis is called starch sheath.
- In dicot stem, hypodermis is collenchymatous, whereas in monocot stem hypodermis is sclerenchymatous.
- In dicot stem (for ex. sunflower stem) pericycle is present above the phloem in the form of semi lunar patches of sclerencyhyma.
- In dicot stem, vascular bundles are arranged in a ring, whereas in mococot stem vascular bundles are scattered in ground tissue,
- In monocot stem, each vascular bundle is surrounded by sclerenchymatous bundle sheath.
- Type of vascular bundle in dicotyledonae stem ⇒ Conjoint, collateral & open
- Type of vascular bundle in monocotyledonae stem ⇒ Conjoint, collateral & closed
- In a dorsiventral leaf,mesophyll is differentiated into palisade parenchyma (towards adaxial) & spongy parenchyma (towards abaxial).
- In grasses, certain adaxial epidermal cells along the veins modify themselves into large, empty and colourless cells. These cells are called bulliform cells.
- The primary and earlier secondary phloem get gradually crushed due to the continued formation and accumulation of secondary xylem. The primary xylem however remains more or less intact in or around the centre.
- By the activity of vascular cambium ring formation of secondary xylem (towards centre), secondary phloem (towards periphery) and secondary medullary rays (passes through the secondary xylem and the secondary phloem in the radial direction) takes place. Secondary medullary rays are parenchymatous.
- In temperate region, the climatic conditions are not uniform throughout the year.
- In the spring season vascular cambium is very active, whereas in winter it is less active.
- The cork is impervious to water, due to suberin deposition in the cell wall.
- Phellem (cork), Phellogen (cork cambium) and phelloderm (secondary cortex) are collectively known as periderm.
- Complimentary cells of lenticels are derived from phellogen.
- Bark is a non-technical term that refers to all tissues exterior to the vascular cambium, therefore including secondary phloem.
- Secondary phloem and periderm are included in bark.
- Lenticels occur in most woody trees.
- Lenticels are lens shaped openings.
- In the begining vascular cambium is wavy, which later becomes circular in the dicot root.

ANIMAL TISSUE

- A tissue is defined as group of cells along with intercellular substance having similar origin and performing similar function.

EPITHELIUM TISSUE

- Epithelium tissue has a free surface, which faces either a body fluid or the out side environment.
- Epithelium is of two type : simple and compound epithelium.
- Simple epithelium is made up of a single layer of cells and functions as a lining for body cavities, ducts and tubes. The compound epithelium consists of two or more cell layers and has protective function.
- Simple squamous epithelium is made of a single layer of flattened cell with irregular boundaries. Found in blood vessel and inner lining on lungs and are involved in forming a diffusion boudary.
- The cuboidal epithelium is commonly found in ducts of glands and tubular part of nephrons and its main function is secretion and absorption.
- The columnar epithelium is made up of pillar shaped cells in which nucleus is located at the base. When free surface has microvilli, found in the lining of stomach and intestine.
- When their free surface has cilia they are called as ciliated epithelium, found in the lining of bronchioles and fallopian tubes.
- Compound epithelium has a limited role in secretion and absorption. Their main function is to provide protection against chemical and mechanical stresses. They cover the moist surface of buccal cavity, pharynx, inner lining of ducts of salivary gland and of pancreatic ducts.
- Some of columnar or cuboidal cells get specialised for secretion and are called as glandular epithelium. They are mainly of two types, unicellular (goblet cells) and multicellular (salivary glands)
- On the basis of mode of pouring their secretion glands are exocrine and endocrine.
- Three types of cell junctions are found in epithelium : Tight junction (help to stop substances from leaking across a tissue) Adhering junctions (perform cementing - to keep neighbouring cells together) Gap junction (for rapid transfer of ions, small molecules and some times big molecules)

Simple squamous epithelium	Filtration, diffusion, osmosis	Air sacs of lungs, walls of capillaries, lining of blood and lymph vessels.
Simple cuboidal epithelium.	Secretion, absorption	Surface of ovaries, lining of kidney tubules, and lining of ducts of certain glands
Simple columnar epithelium	Protection, secretion, absorption	Lining of uterus and organs of the digestive tract
Pseudostratified columnar epithelium	Protection, secretion, movement of mucus and cells	Lining of respiratory passages and reproductive tract
Stratified squamous epithelium	Protection	Outer layer of skin, lining of oral cavity, throat, vagina, and anal canal
Stratified cuboidal epithelium	Protection, secretion	Male urethra, parts of the pharynx
Transitional epithelium	Distensibility, protection	Inner lining of urinary bladder and passageways of urinary tract

- Their special function are linking and supporting other tissues/organs of the body.
- In all connective tissues except blood the cells secret fibres like collagen, elastic and reticular.
- These cells also secrete modified polysaccharides which accumulate between cells and fibres which acts as matrix (ground substance).

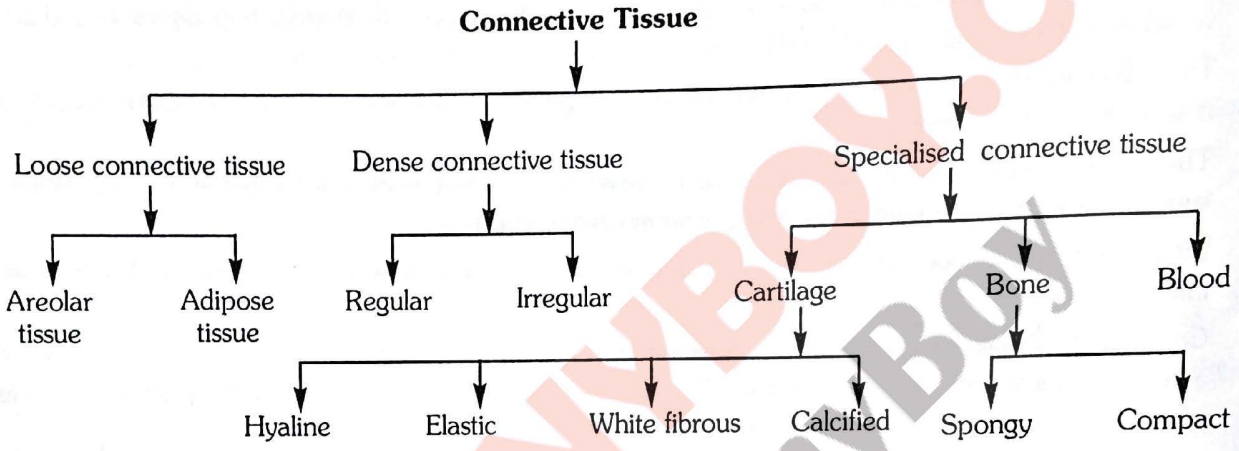
Connective tissue

- Connective tissues are classified into three types

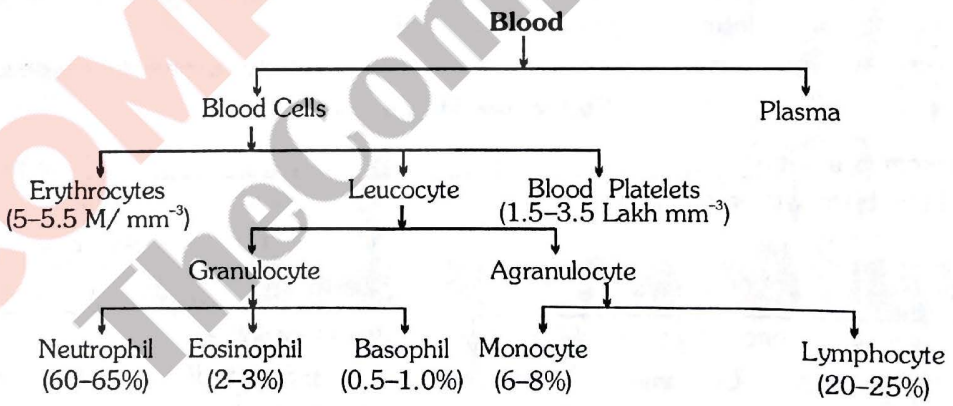
  (i) Loose connective tissue.

  (ii) Dense connective tissue.

  (iii) Specialised connective tissue.
- Loose connective tissue consists of Areolar and Adipose tissue, present beneath the skin.
- In Dense connective tissue fibres and fibroblasts are compactly packed.
- Dence connective can be regular namely Tendon and Ligament where as irregular are oriented differently in the skin.

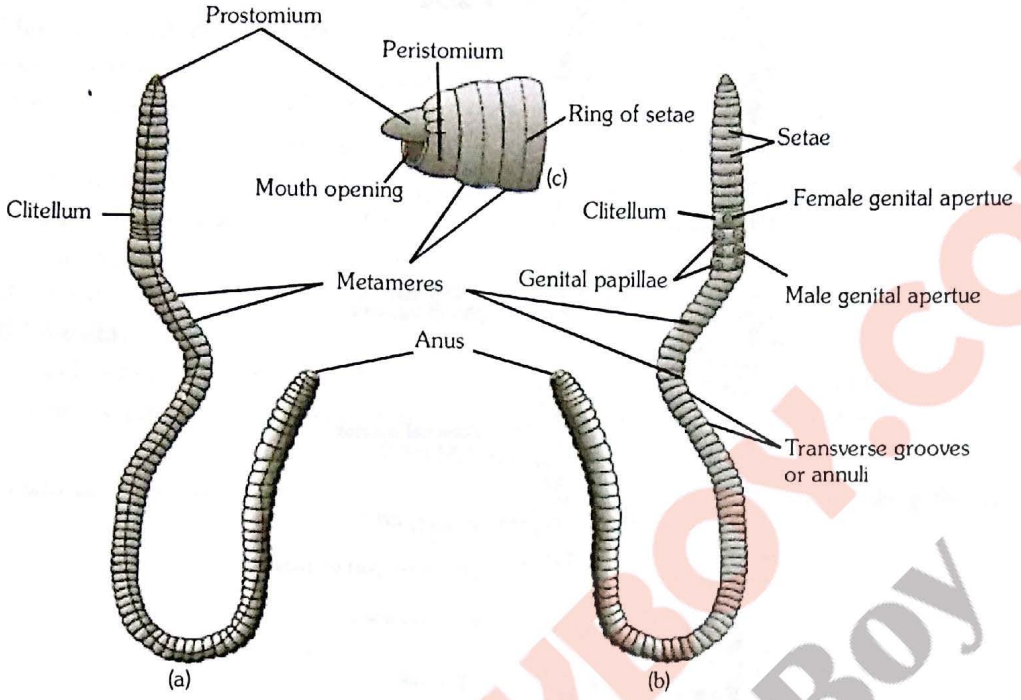


- In cartilage intercellular material is solid and pliable e.g.– tip of nose, ear pinna etc.
- Bone have a hard and non-pliable ground substance rich in calcium salt. Bone cells (osteocytes) are present in the Lacunae. The bone marrow in some bone is the site of production of blood cells.



- Blood is fluid connective tissue containing plasma, RBC, WBC and platelets. It is main circulating fluid that helps in the transport of various substances.

EARTHWORM (PHERETIMA POSTHUMA)



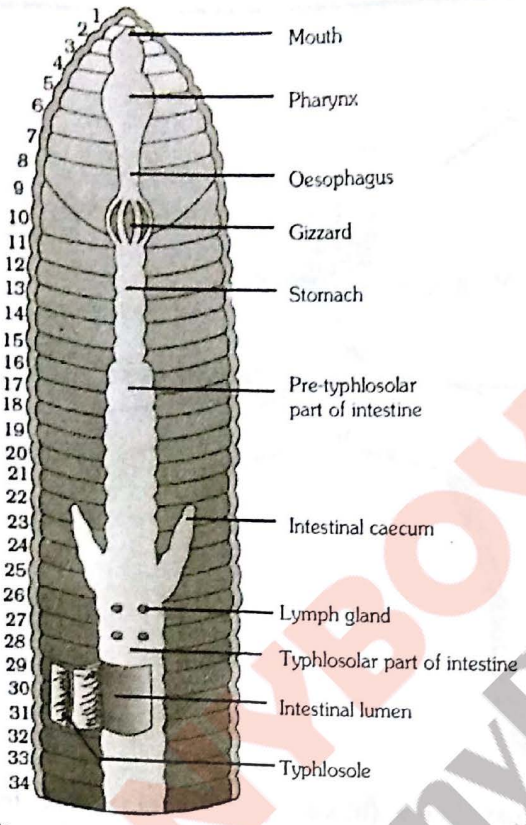
Body of earthworm : (a) dorsal view (b) ventral view (c) lateral view showing mouth opening

- Earthworms have long cylindrical body.
- Body is divided into 100 – 120 segments.
- Anterior end consists of the mouth and the *Prostomium*. A lobe which serves as a covering for the mouth and as a wedge to froce open cracks in the soil into which the earthworm may crawl.
- The prostomium is sensory in function.
- The first body segment is called the *peristomium* (buccal segment)
- In a Mature worm, segments 14 – 16 are covered by a prominent dark band of glandular tissue called →clitellum.
- 4 Pair of spermathecal apertures are situated on the ventro-lateral sides of the intersegmental grooves in 5^{th} to 9^{th} segments.
- A single female genital pore is present in the mid-ventral line of 14^{th} segment.
- A pair of male genital pores are present on the ventro-lateral sides of the 18^{th} segment.
- Numerous minute pores called nephridio-pores open on the surface of the body.
- In each body segment except the first last and clitellum there are rows of s-shaped setae.
- Setae help in locomotion.

BODY WALL

- Body wall of earthowrm is consits of cuticle, epidermis, muscular layers and coelomic epithelium.
- Epidermis consists of tall, columnar cells of four types:
  (i) Supporting cells (major Part)
  (ii) Glandular cells (Goblet and albumin)
  (iii) Basal cells
  (iv) Sensory cells
- Circular and longitudinal muscle layers are present in the muscle layer they are help in locomotion.

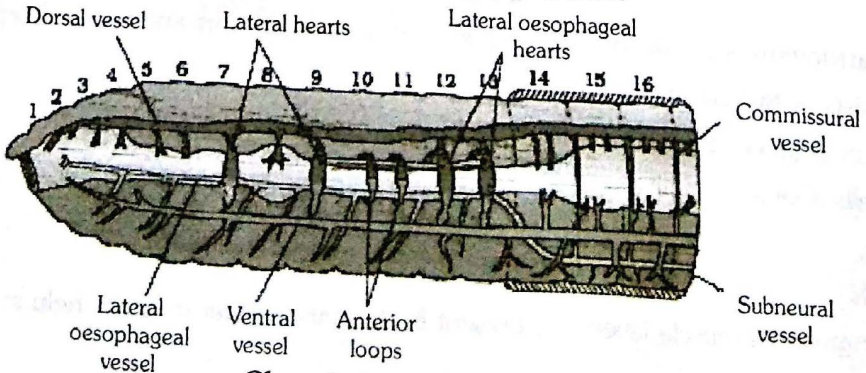
ALIMENTARY CANAL



Alimentary canal of earthworm

- Earthworm has a straight alimentary canal, representing a "tube with in a tube Plan"
- Location of different parts of alimentary canal are:
  (i) Buccal chamber (1 – 3 segments)
  (ii) Pharynx (4 – 5 segments)
  (iii) Oesophagus (6 – 7 segments)
  (iv) Gizzard (8 – segment)
  (v) Stomach (9 – 13/14 segment)
  (vi) Intestine (15 to last)
- Mouth present in first segment (Peristomium)
- Mouth open into buccal cavity which leads in to muscular pharynx.
- Roof of pharynx contains pharyngeal glands containing chromophil cell. Secreting mucus and proteases.
- Gizzard is a thick muscular organ, cavity lined by tough cuticle for grinding.
- Wall of stomach contains 'Calciferous glands' the secretion of which neutralizes the acidity of soil.
- Intestin has three regions:
  (i) Pretyphlosolar region,
  (ii) Typhlosolar region and
  (iii) Post-typhlosolar region.
- Typhlosole is a highly glandular, vascular longitudinal ridge increasing The are for absorption of digested food
- Earthworm are omnivorous, undigested particles as faeces are called as '***Casting***'.
- Casting Improve the fertility of soil.

BLOOD VASCULAR SYSTEM



Closed circulatory system

- Blood vascular system of earthworm is closed type.
- Blood is red in colour, respiratory pigment haemoglobin is dissolved in the blood plasma.
- Blood vascular system is different in first 13 segments as regards to number arrangement and nature of blood vessels.
- The Main longitudinal vessel are:
  (i) Dorsal blood vessel (ii) ventral blood vessel
  (iii) Lateral oesophageal vessels (Paired) (iv) subneural vessel and
  (v) supraoesophageal vessel (smallest)
- Important transverse vessels in first 13 segments are:
  (i) Lateral hearts (Segments 7 and 9)
  (ii) Anterior loops (Segments 10 and 11)
  (iii) Lateral oesophageal hearts (segments 12 and 13)

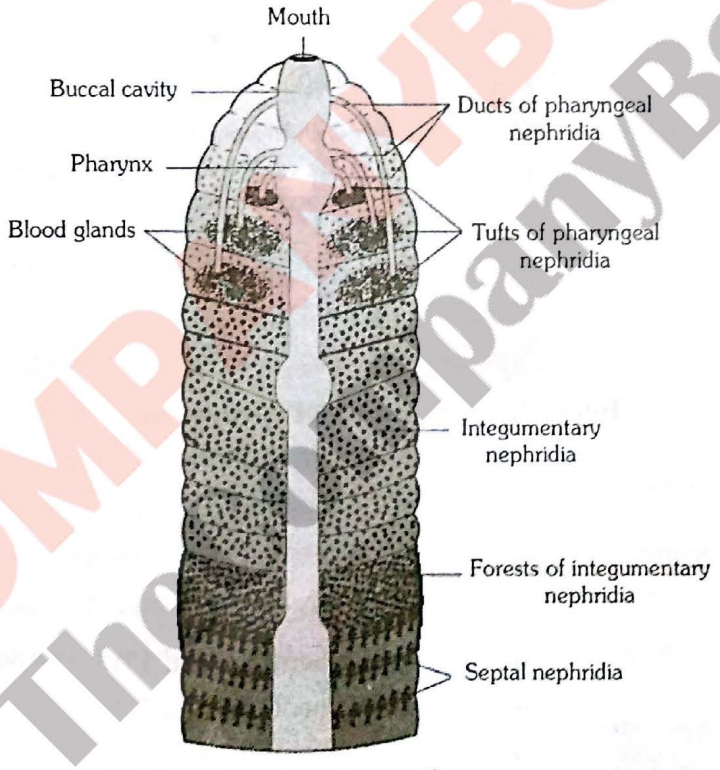
Blood Glands:

- Blood glands are located in the segments 4, 5 and 6 above the pharyngeal mass.
- Blood glands serve for the manufacture of blood corpuscles and haemoglobin.

RESPIRATORY SYSTEM

- Earthworm respires but has no respiratory organs, exchange of gases takes place through moist skin.

EXCRETORY SYSTEM



Nephridial system in earthworm

- Excretory organs of earthworm are segmental nephridia of ectodermal in origion, analogns to vertebrate kidney.
- Septal nephridia are enteronephric finally excretory products are poured into intestine.
- Enteronephric condition is an adaptation for the conservation of water.
- The nephridia extract water and excretory substances from both blood and coelmic fluid by ultrafiltration.
- Excretory products of earthworm are urea (about 50%) ammonia (about 40%) and traces of creatitine.
- Earthworms are mainly ureotelic.

NERVOUS SYSTEM

- Earthworms has a well developed nervous system. It has a brain but no head.
- Brain lies above Pharynx, made up of a pair of suprapharyngeal (cerebral) ganglia.
- A solid ventral nerve cord arises from subpharyngeal ganglion.
- Neurons in earthworm are motor, sensory and adjustor type.

SENSE ORGANS

- Sense organs in earthworm are quite simple three types are:

  (i) Epidermal receptor (tangoreceptors)

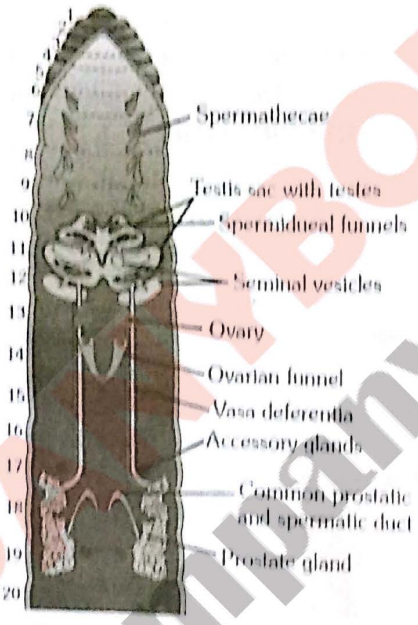
  (ii) Buccal receptors (gustatory and olfactory)

  (iii) Photoreceptors

  On the surface of skin on dorsal side.

- Earthworm has no eyes, photoreceptors are used to judge intensity and duration of light, donot have the capaci of vision.

REPRODUCTIVE SYSTEM



Reproductive system of earthworm

- Earthworms do not reproduce asexually.
- Earthworms are monoecious or hermaphrodites.
- They are protandrous, there is no self-fertilization.
- **Male Organs :**

  (i) Testes two pairs → (Segments 10 and 11)

  (ii) Seminal vesicles → (Segments 11 and 12)

  (iii) Accessory glands → (Segments 17 and 19)

  (iv) Genital papillae → (Segments 17 and 19)

  (v) Male genital apertures → (Segments 18)

  (vi) Prostate gland → (Segments 17 – 20)

- **Female Organs :**

  (i) Ovary one pair → (Segment 13)

  (ii) Female genital Pore → (Segment 14)

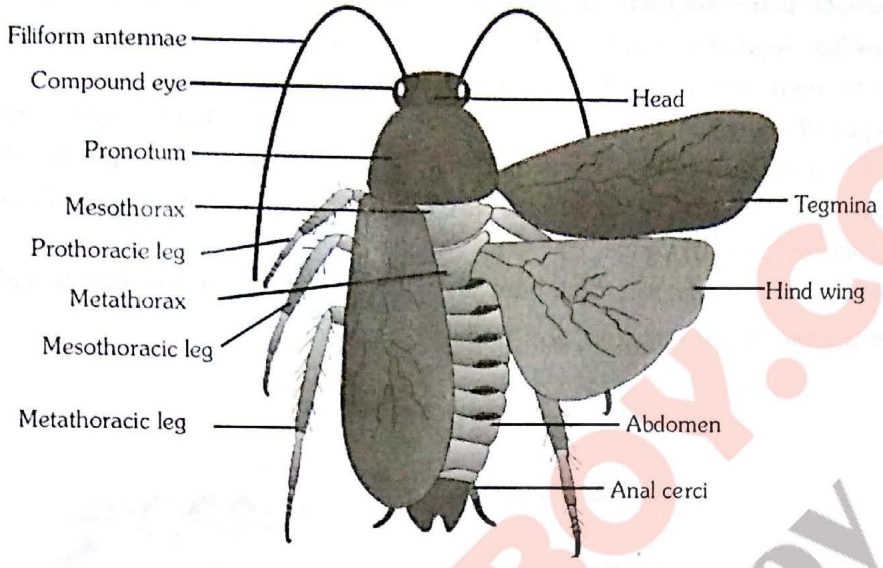
  (iii) Spermatheca 4 pairs → (Segments 6, 7, 8, 9)

- Spermatheca are used to store and transfer of sperms after copulation.
- Cocoons are formed by glandular *clitellum*.
- Fertilization is external and occurs in cocoon.
- Metamorphosis does not occur in earthworm.

COCKROACH (PERIPLANETA AMERICANA)

In India – Periplaneta americana and Blatta orientalis

[External features of cockroach]

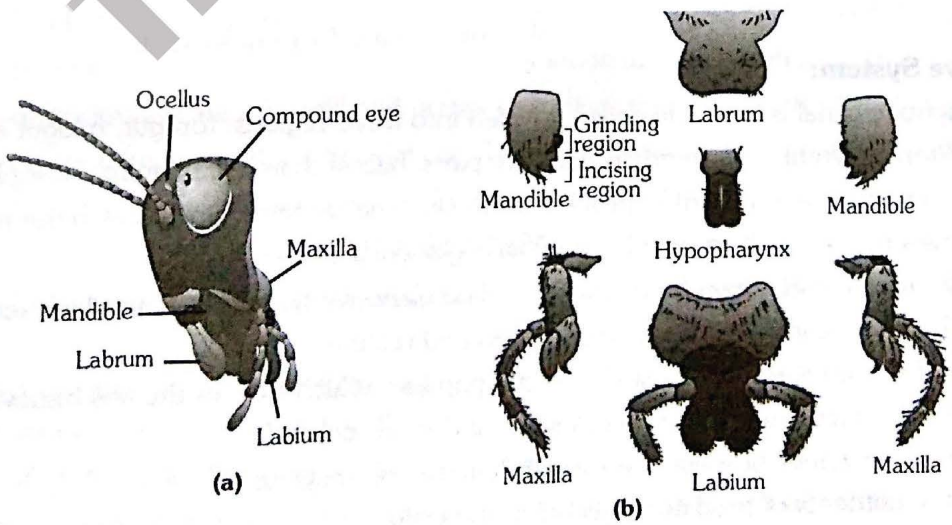


External features of cockroach

- Cockroaches belong to the class insecta of the phylum arthropoda.
- Their size ranges from 1/4 inches to 3 inches (0.6 – 7.6cm) and have long antenna, legs and flat extension of the upper body wall that conceals head.

MORPHOLOGY

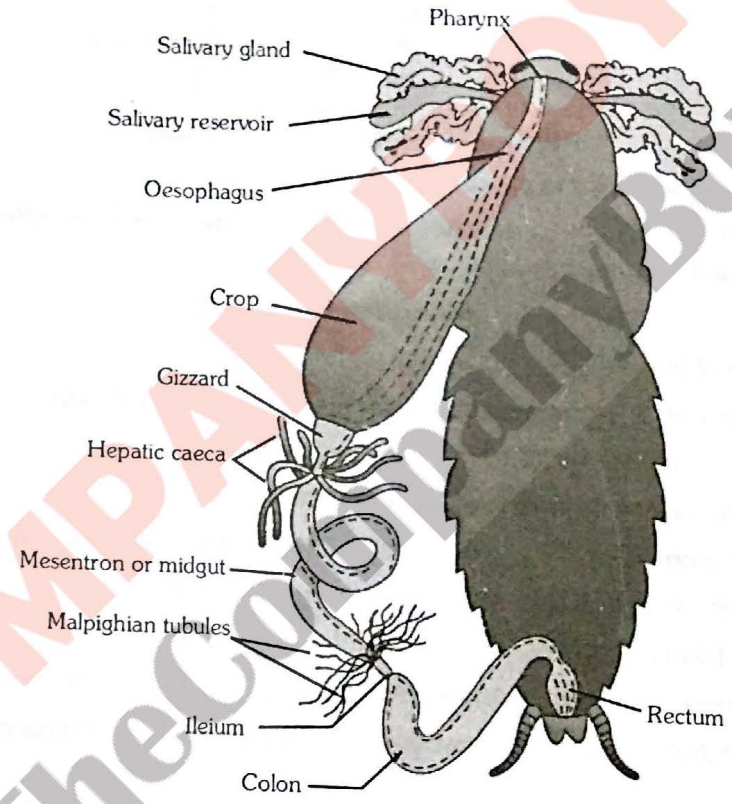
- Cockroach are cursorial (running) and noctumal.
- The body of the cockroach is segmented and divisible into three distinct regions-head, thorax and abdomen.
- Body is covered with chitinous exo skeleton of scalerites.
- Head is derived by the fusion of six embryonic segments.
- Head bears a pair of long antennae a pair of ocelli or fenestrae and a pair of compound eyes.
- Antennae have sensory receptors that help in monitoring the environment.
- The thorax consists of three segments; Prothorax, Mesothorax and metathorax.
- Thorax bears three pairs of jointed appendages and two pairs of wings on mesothorax and metathorax.
- Abdomen is the largest and broadest part consisting of ten segments (11 segments in embryo) without appendges.



Head region of cockroach : (a) parts of head region (b) mouth parts

- Mouthparts of cockroach are mandibulate type or bitting and chewing type.
- Mouth parts consitsts of labrum (upper lip), labium (lower lip), maxillae (segmented and resemble to a leg), mandibles and hypo pharynx (tongue).
- The main structures of mastication (chewing) are mandibles which are short with teeth.
- Leg of cockroach is five segmented, these segments are, coxa, trochanter, femur, tibia and tarsus.
- The most swollen segment in the leg of cockroach is coxa.
- The longest segment in the leg of cockroach is tibia.
- Anal cerci, a pair of many jointed structure are present on the tergite of 10^{th} segment in male and female cockroach.
- Anal styles, a pair of small, spine-like unjointed structures are present on sternite of 9^{th} segment in males only.
- Anal cerci bear minute sensory hairs which are sensitive to sound and other vibrations.
- Cockroach has two pairs of wings.
- The first pair (mesothoracic) are thick hard and leathery protective in function called tegmina (elytra).
- Second Pair (metathoracic) are thin, soft and membranous.

ANATOMY

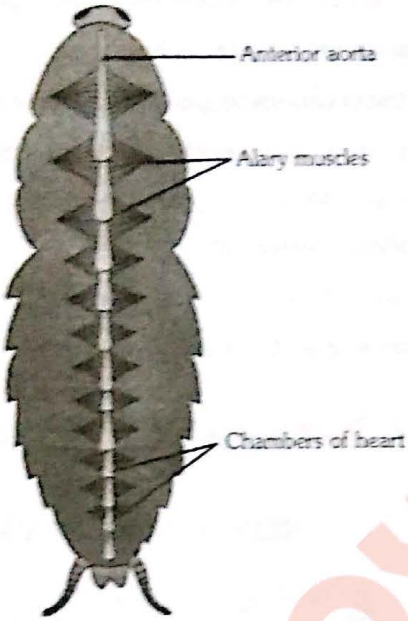


Alimentary canal of cockroach

Digestive System:

- The alimentary canal is long and coiled, divided into three regions: foregut, midgut and hindgut.
- Foregut (stomodaeum) is differentiated into five parts: buccal chamber, pharynx, oesophagus, crop and gizzard.
- Gizzard is muscular and internally provided with six cuticular teeth which crush the food.
- Midgut (mesenteron) is short, tubular lined with glandular endoderm.
- At anterior end of mesentron there are eigth blind glandular hepatic caecae which secrete digestive enzymes.
- Hindgut (proctodaeum) comprises ileum, colon and rectum.
- The wall of rectum is provided with six rectal papillae, which help in the absorption of water and salts.
- Cockroach is omnivorous: it feed on all sorts of organic debris.
- The digestive enzymes of saliva are mainly Zymase and amylase.
- Most of the nutrients of food are digested in the crop.
- Absorption of digested food takes place in mesenteron.

CIRCULATORY SYSTEM



Open circulatory system of cockroach

- Circulatory system of cockroach is open type.
- The blood of cockroach flows through haemocoelic system.
- Haemocoel is divided into a dorsal pericardial sinus, a middle perivisceral sinus and a ventral perineural sinus by two perforated diaphragms.
- The heart is longitudinally beaded with 13 chambers perforated by ostia having valves.
- The blood circulation is maintained by 13 pairs of wing shaped involuntary alary muscles
- Heart of cockroach is neurogenic.

RESPIRATORY SYSTEM

- Respiratory system of cockroach consists of tracheal system.
- The tracheal system opens outside by ten pairs of spiracles (two pairs thoracic and eight pairs of abdominal). The spiracles are with valves.
- The first thoracic and first abdominal spiracles remain open all the times.
- Ventilation of tracheal system is by alternate contraction and relaxation of abdomen.

EXCRETORY SYSTEM

- Excretory organs of cockroach are malpighian tubules open at the junction of midgut and hindgut (ileum).
- Malpighian tubules absorb excretory substances from haemolymph and fat bodies and pass into the proctodaeum.
- Malpighian tubules are concerned with homeostasis osmoregulation and excretion.
- Excretory products of cockroach are uric acid and urates of sodium and potassium so they are uricotelic.
- Fat body of cockroach contains mainly four types of cell. Trophocytes mycetocytes oenocytes and urate cells.
- Fat body of cockroach is functionally **analogous to liver of vertebrates.**

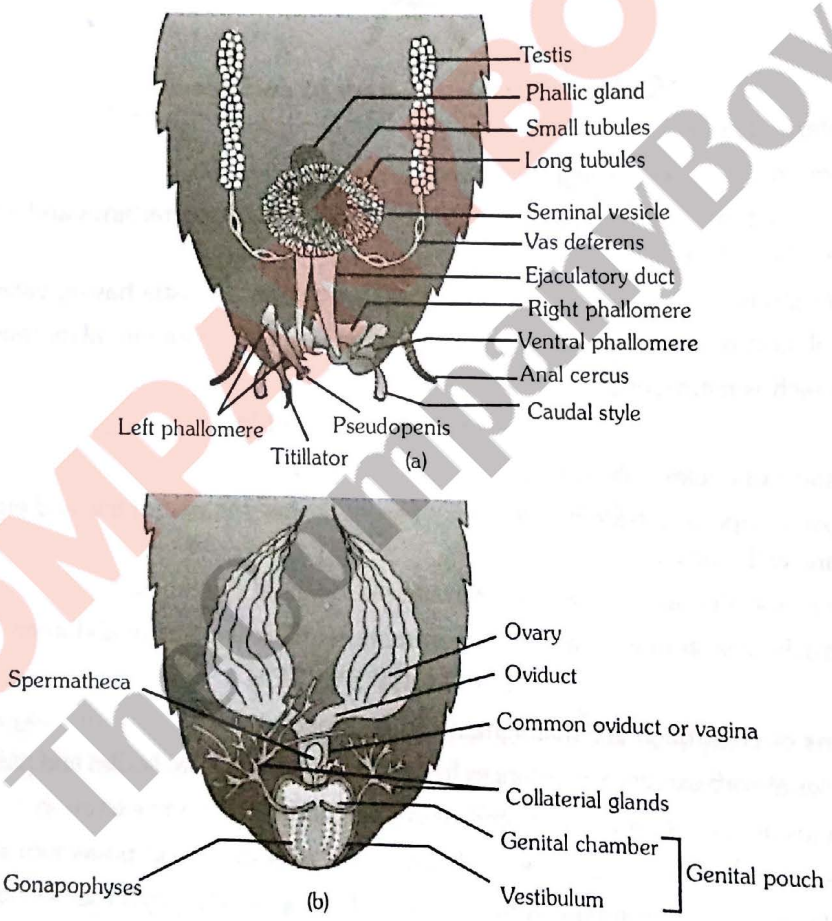
NERVOUS SYSTEM

- Cockroach has a well developed nervous system with central, peripheral and sympathetic (autonomous) nervous system.
- Central nervous system consists of cerebral or supraoesophageal ganglion (brain), suboesophageal ganglion paired circumoesophageal connective double ventral nerve cord with three thoracic and six abdominal ganglion.
- Nerves given off to all parts of the body constitute the peripheral nervous system.
- Autonomic or stomatogastric nervous system include five ganglia namely frontal (pharynx),hypocerebral (oesophagus), visceral or ingluvial (crop) and proventricular (gizzard).

ENDOCRINE SYSTEM

- Endocrine system of cockroach consists of corpora allata, corpora cardiaca and prothoracic gland.
- Intercerebral glands in brain secrete the brain hormone.
- Brain hormone stimulates the prothoracic glands to secrete a moulting hormone called ecdysone.
- Corpora allata are neurosecretory and secrete juvenile hormone or neotinin.
- Sense organs in cockroach are: Photoreceptors (compound and simple eyes), thigmoreceptors (antennae), chemoreceptors (on maxillary and labial palps, labium and hypopharyns) and auditory receptors on anal cerci
- Each compound eye of cockroach is composed of about 2000 visual units called ommatidia.
- There are two types of vision in insects mosaic vision or appostion image during day time and superposition or dull image in dim light.
- But in cockroach, pigment sheath of ommatidia is non-contractile so capable of only mosaic vision even during night.

REPRODUCTIVE SYSTEM



Reproductive system of cockroach : (a) male (b) female

Male reproductive system

- In cockroach, sexes are separate so dioecious.
- **Male organs** consist of testes vasadifferentia, ejaculatory duct, mushroom or utricular gland, phallic or conglobate gland and male gonapophyses. and anal styles
- Testes of cockroach are located in the abdominal segments 4, 5 and 6
- Mushroom glandconsists of two types of tubules, the

(i) long slender tubules, the utriculi majores or peripheral tubules,and

(ii) Short tubules, the utriculi breviores, making up of the major part of the gland.

- small seminal vesicles are also found associated with mushroom gland.
- All sperms of a seminal vesicle are glued together into a large bundle called spermatophore.
- Spermatophore has three-layered wall: Inner layer secreted by utriculi majores; middle layer secreted by ejaculatory duct and outer layer secreted by phallic gland.

Female reproductive system

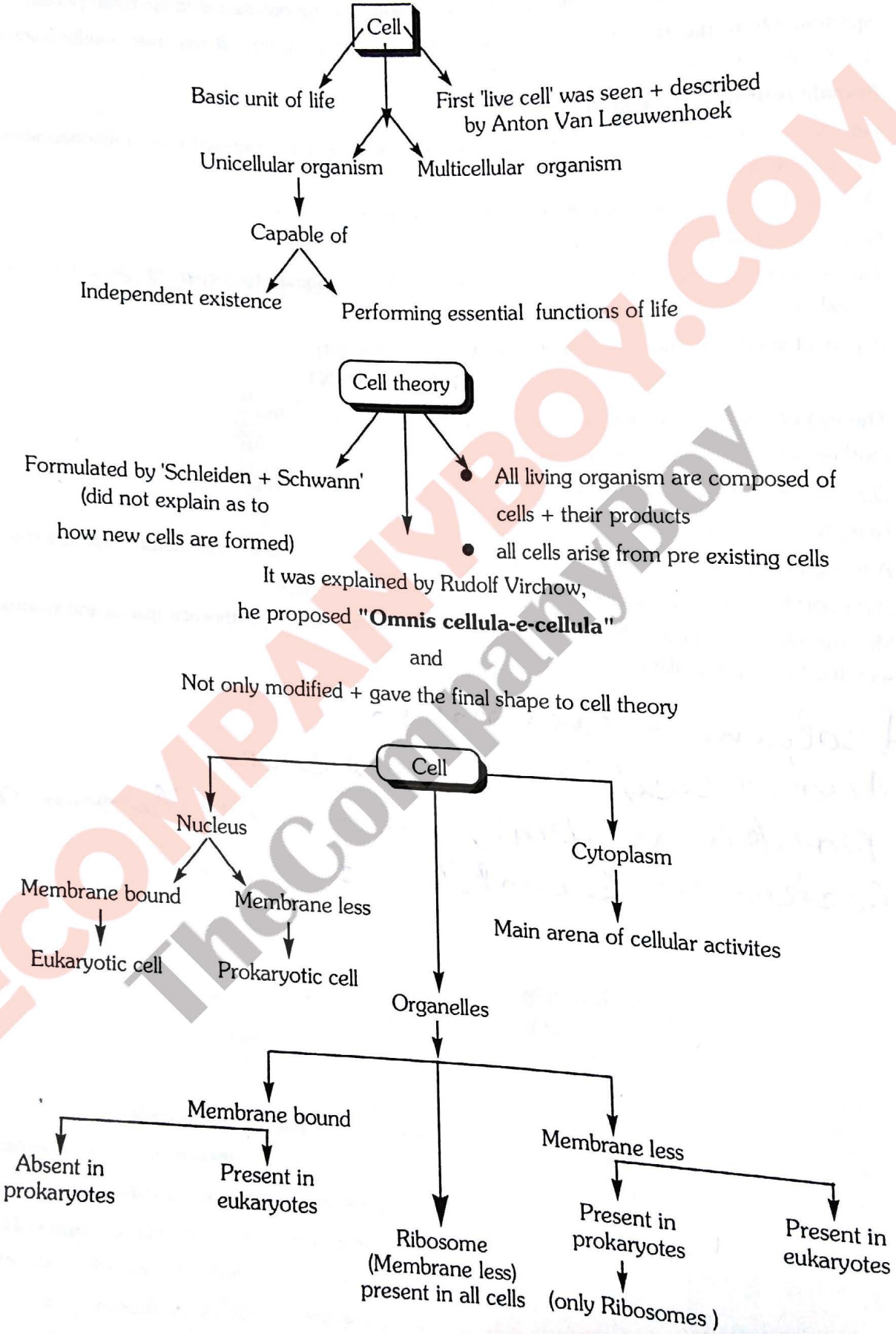
- Female organs consist of ovaries,oviducts, Vagina,genital chamber, spermathecae,colleterial gland and female gonapophyses.
- Ovaries of cockroach are located in the abdominal segments 2 to 6.
- Each ovary consists of eight ovarioles.
- Two oviducts from each side open into a common oviduct or vagina which open into genital chamber by female genital pore.
- A pair of spermathecae are present near female genital pore.

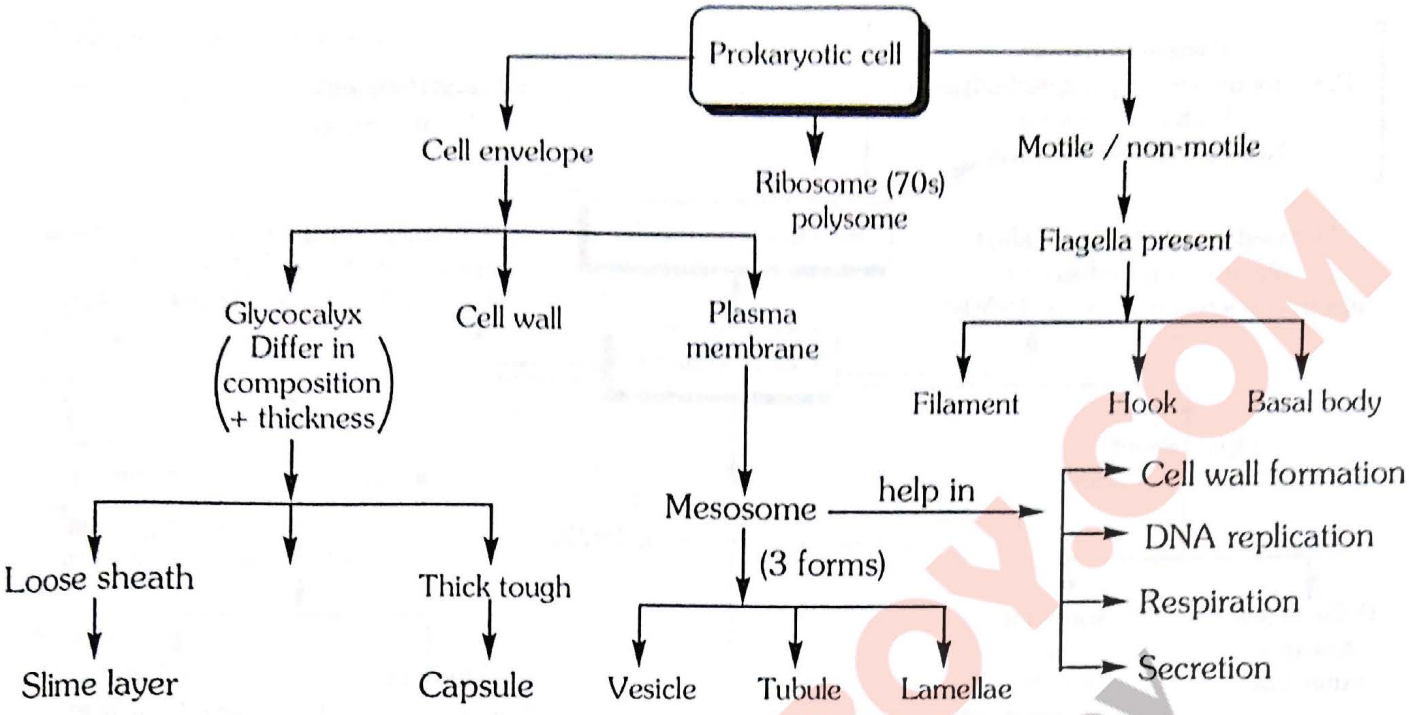
DEVELOPMENT

- The egg of cockroach is centrolecithal type yolk being in the centre.
- Ootheca of cockroach contains sixteen fertilized eggs.
- Ootheca of cockroach is formed of a protein secreted by colleterial glands.
- Nymph of cockroach emerges out form Ootheca
- A nymph resembles the adult in general structure but lackes the wings and mature reproductive organs.
- Metamorphosis in cockroach is incomplete or paurometabolus type.
- Metamorphosis is regulated by two hormones ecdysone. Secreted by prothoracic glands and juvenile hormone secreted by corpora allata.

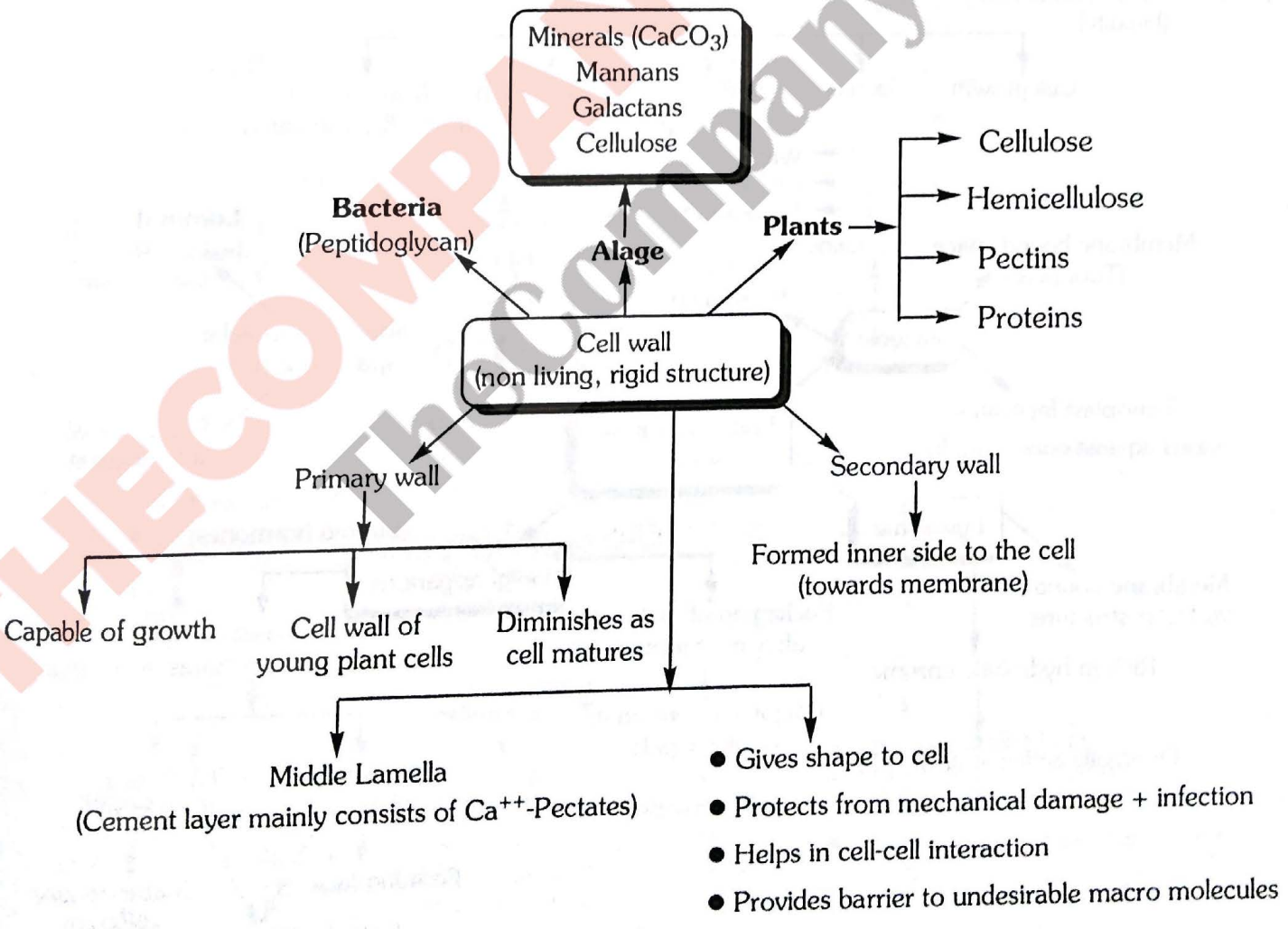
★ Aroluim – locomotion
★ Audioreceptor – anal cerci
★ Double, ventral, solid – earthworm, cockroach
★ Cockroch – Sexual dimorphism

CELL : THE UNIT OF LIFE

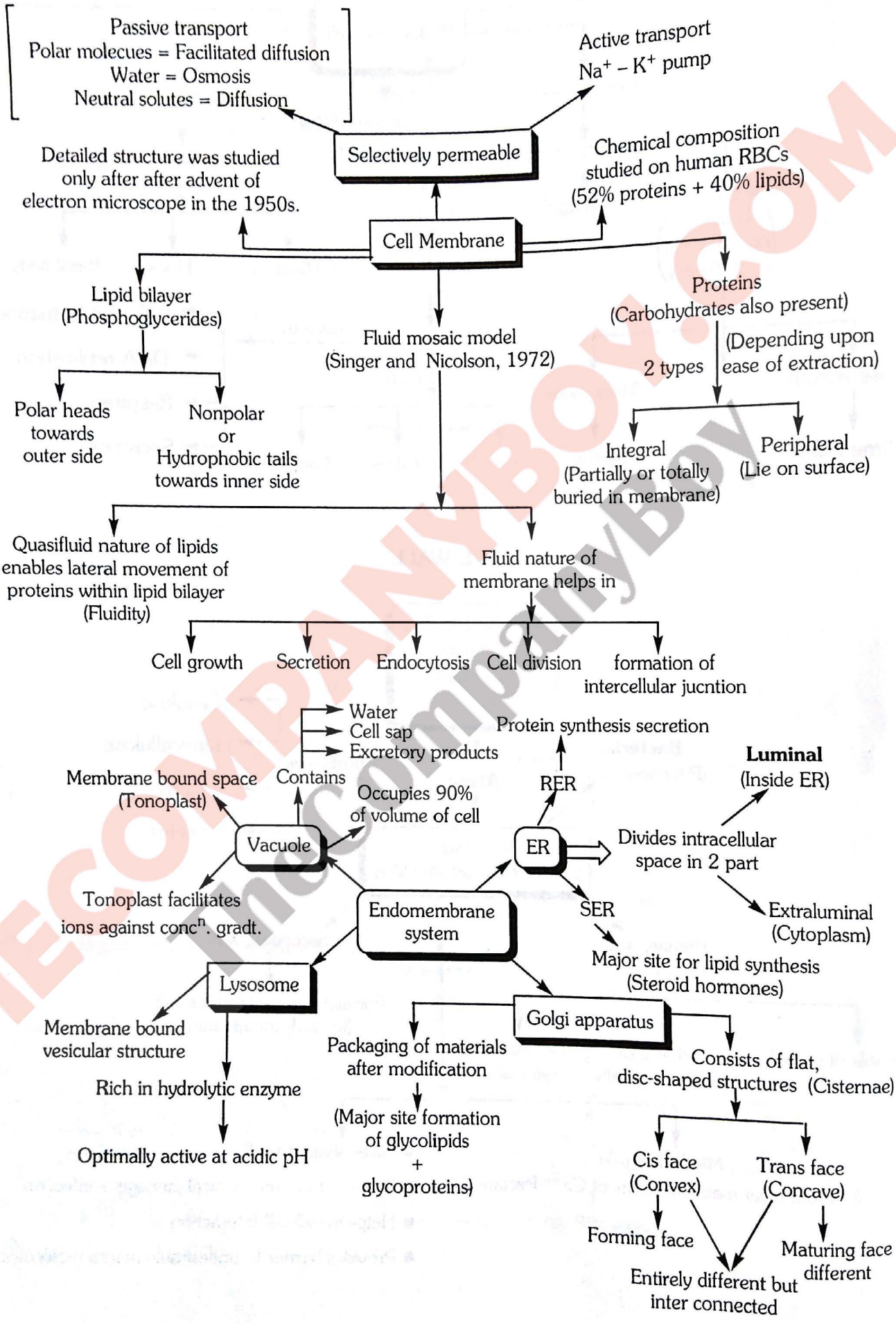




CELL WALL



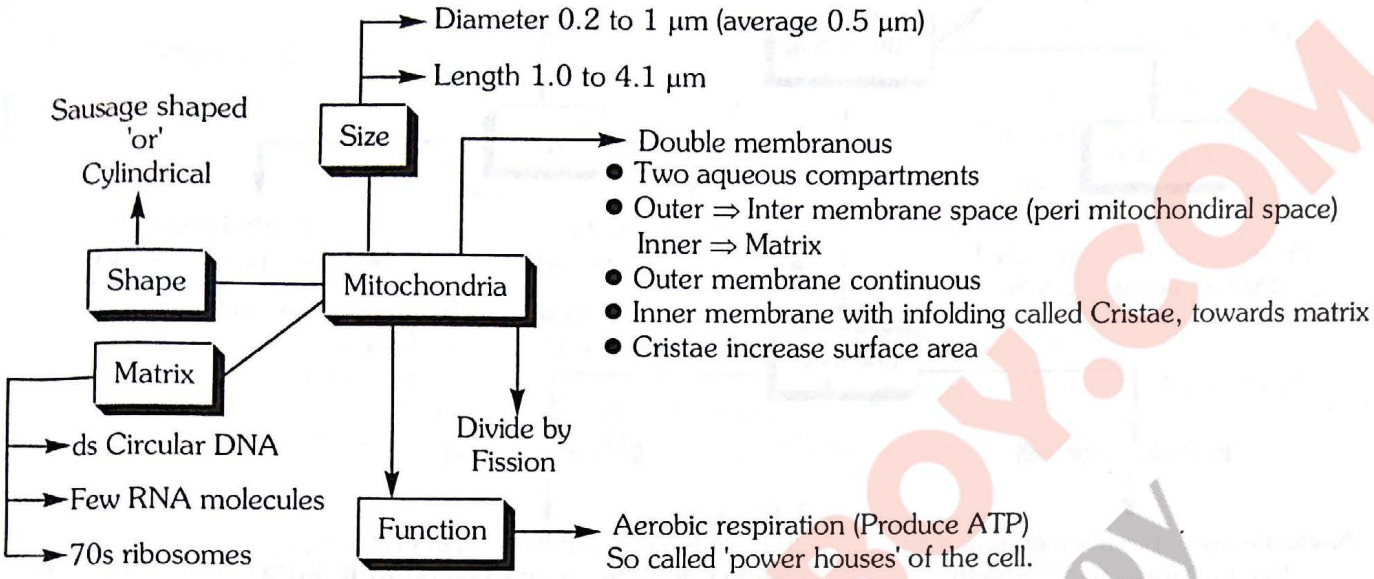
CELL MEMBRANE



MITOCHONDRIA

⇒ Visible under the microscope only after specific staining.

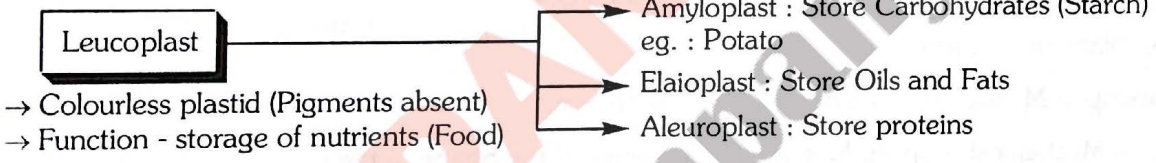
⇒ Number per cell is variable, **depending on the physiological activity of the cells.**

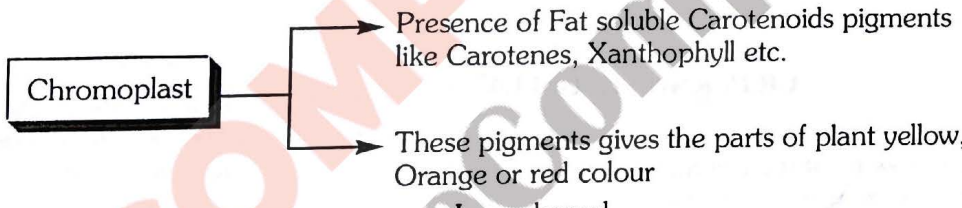


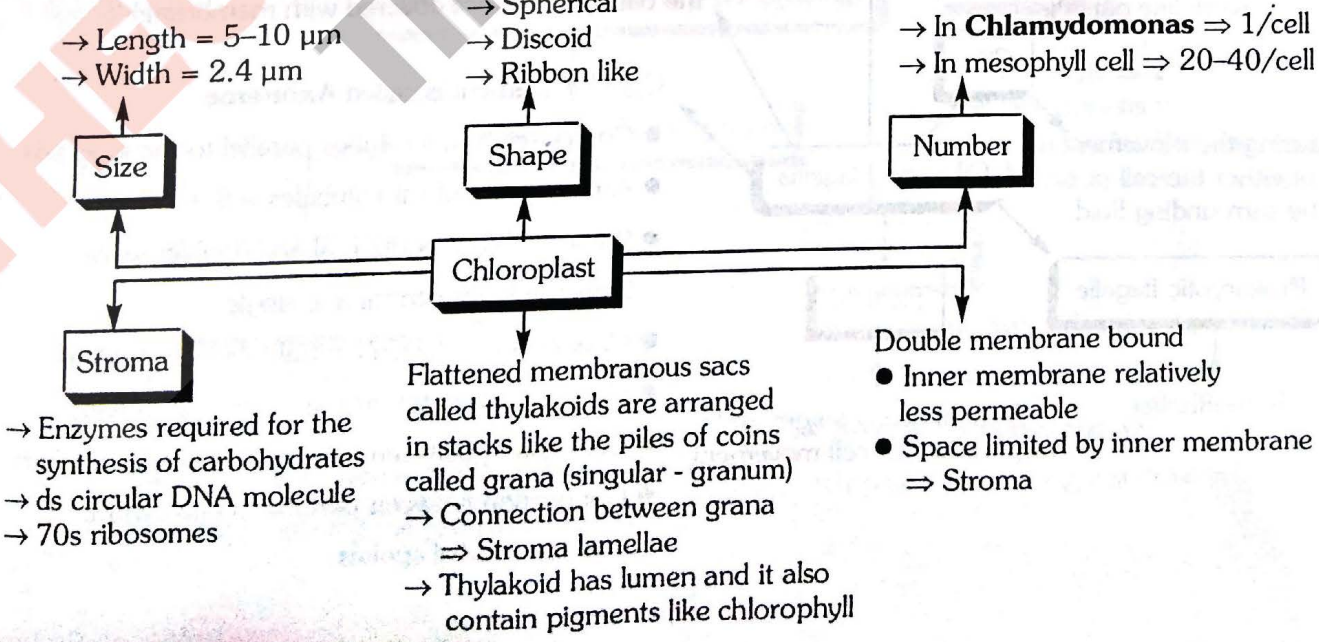
PLASTIDS

→ On the basis of presence or absence of pigments and types of pigments, plastids are of 3 types.

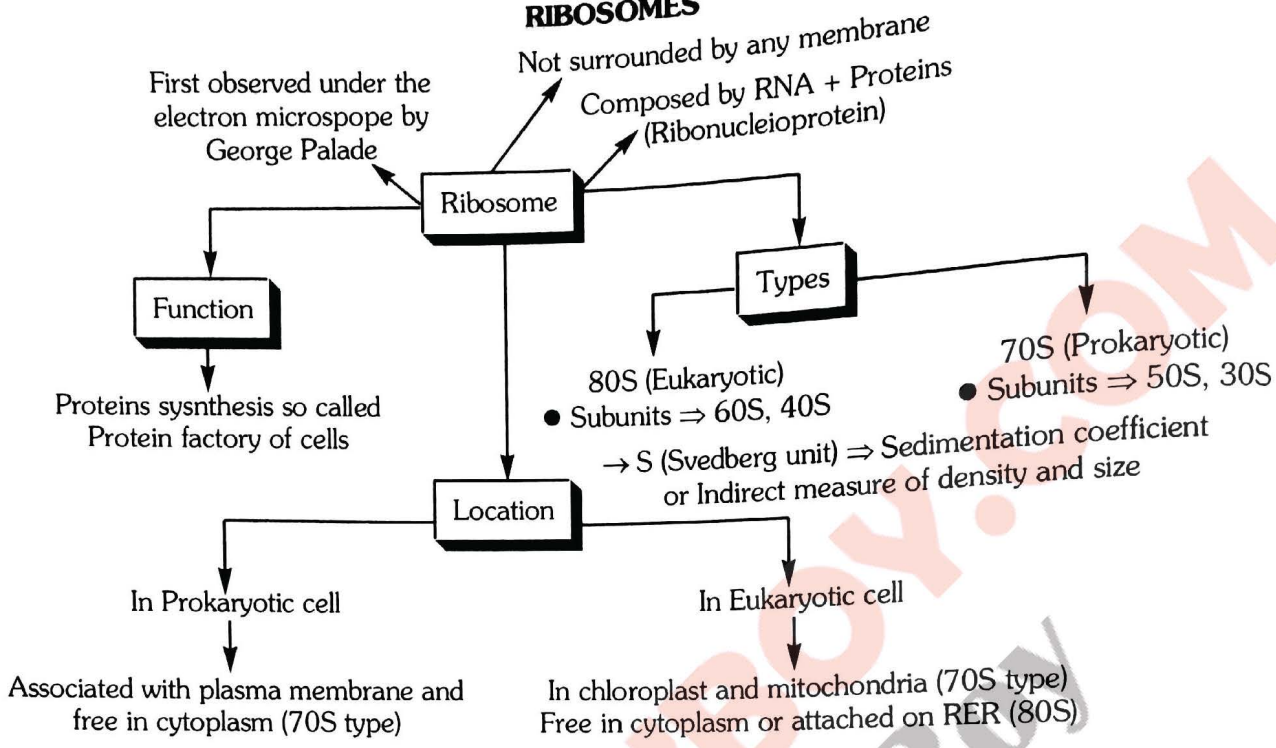
(i) Leucoplast (ii) Chromoplast (iii) Chloroplast







RIBOSOMES

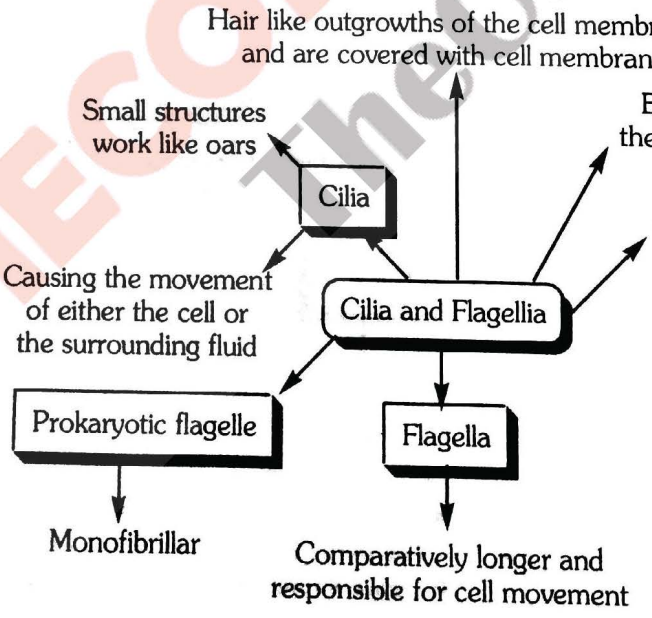


CYTOSKELETON

→ Network of filamentous proteinaceous structures.
(Microfilaments + Microtubules + ER) present in cytoplasm.

→ Functions → Mechanical support, Motility, Maintenance of the Shape of the cell.

CILIA AND FLAGELLA

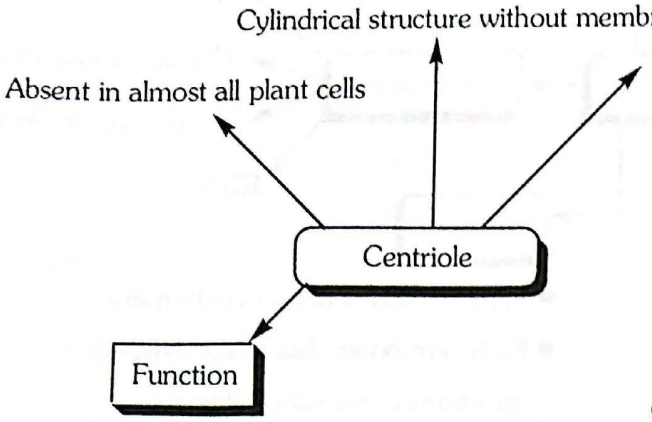


Core 'or' filament is called **Axoneme**

- Composed of microtubes parallel to the long axis.
- Arrangement of microtubules = 9 + 2
- 9 microtubules peripheral and doublet while 2 microtubules central and single
- Connection between central tubules = bridges
- Covering of central tubules = central sheath
- Connection between peripheral tubules = Linkers
- Connection between peripheral and central tubules = radial spokes

CENTROSOME AND CENTRIOLES

→ Centrosome = 2 centrioles (Perpendicular to each other) + Surrounding amorphous pericentriolar material.



In transverse section appear as cartwheel

- Composed of 9 peripheral microtubules of fibrils of tubulin protein
- Peripheral tubules ⇒ Triplets
- Central proteinaceous part = Hub
- Connection between hub and peripheral tubules = radial spokes
- Arrangement of microtubules = 9 + 0

- Formation of basal body of Cilia and Flagella
- Helps in formation of Spindle fibres during cell division in animal cells

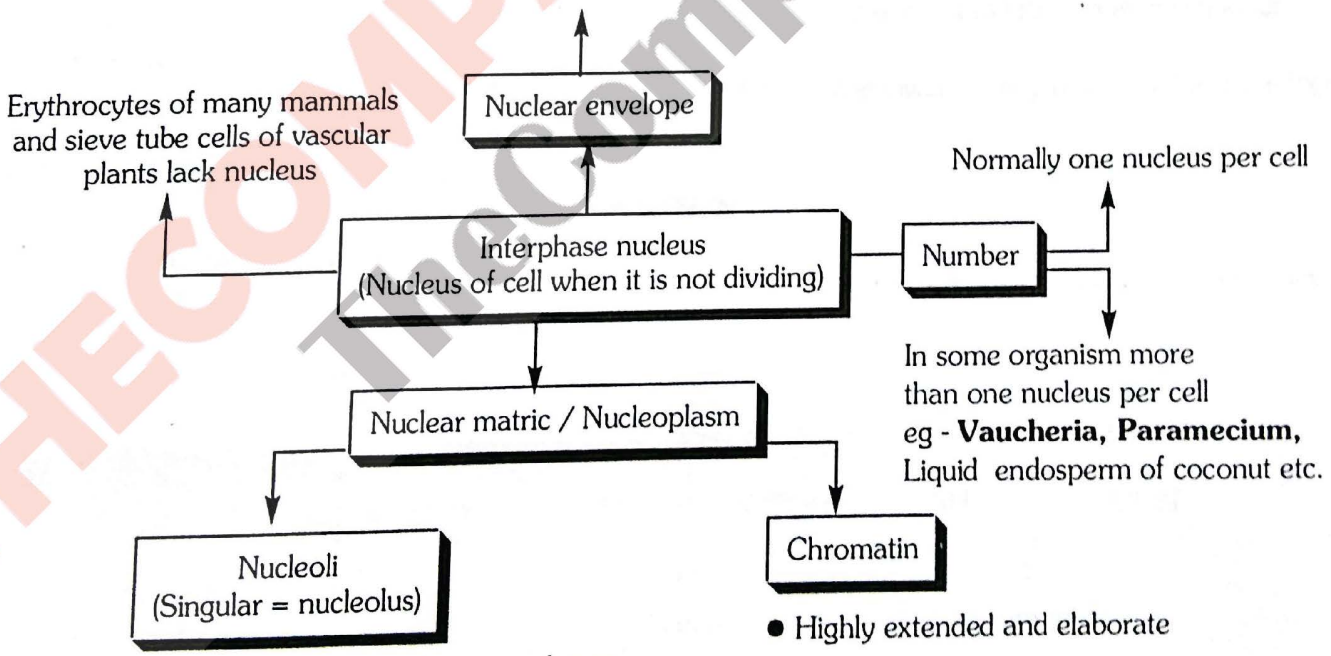
NUCLEUS

→ First described by Robert Brown.

→ Term "Chromatin" was given by Flemming.

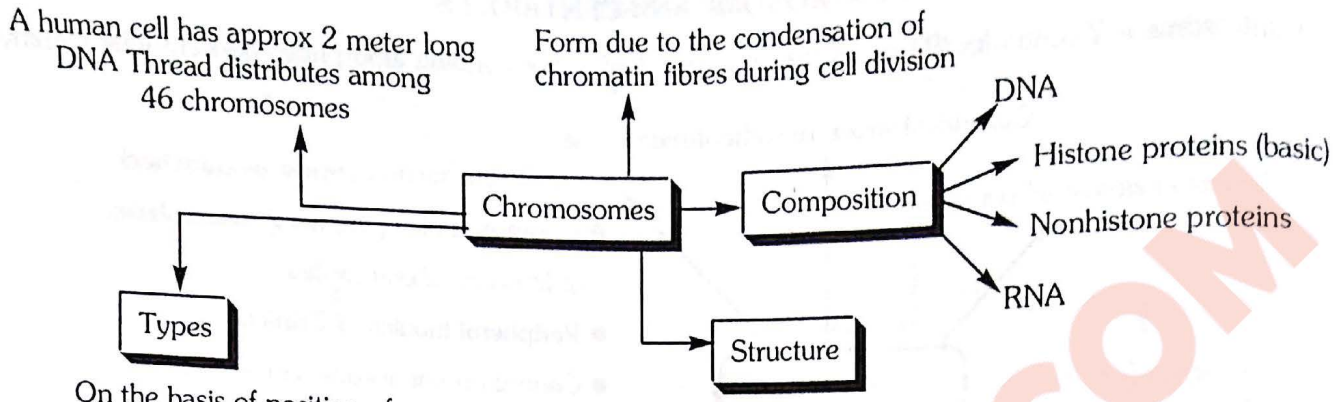
→ Staining of chromatin = by basic dyes

- Consist of two parallel membranes
- Space between both the membranes ⇒ Perinuclear space (10 – 50nm)
- Nuclear envelope is interrupted by minute pores formed by fusion of both the membranes
- Through pores movement of RNA and proteins takes place between cytoplasm and nucleus.
- Outer membrane remain continuous with ER



- Spherical structure without membrane
- Site for ribosomal RNA (r – RNA) synthesis
- Larger and more in number in cells those activity carrying out protein synthesis

- Highly extended and elaborate nucleoprotein fibres
- Become condense and form chromosomes during cell division



On the basis of position of centromere

- Metacentric – centromere in middle
- Submetacentric – Centromere slight away from middle
- Acrocentric – Centromere close to the end of chromosome
- Telocentric – Centromere at terminal position

- Primary constriction or centromere
- Each centromere has to disc shaped structures called Kinetochores
- Few chromosomes have secondary constriction at constant location
- Fragment or part of chromosome after secondary constriction = Satellite

MICROBODIES

→ Membrane bound minute vesicles contain enzymes.
→ Present in both plant and animal cells.
→ Ex. Pexoxisome, Glyoxysome, Sphaerosome etc.