

ZOOLOGY
VOLUME-01
THEORY



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1.1.1.1 TABLE OF CONTEXT

1) Origin and evolution.....	02
2) Introduction to phylum	13
3) Phylum porifera.....	15
4) Phylum cnidaria.....	20
5) Phylum Platyhelminthes	24
6) Phylum Aschelminthes.....	28
7) Phylum Annelida.....	32
8) Phylum Mollusca.....	37
9) Phylum Arthropoda.....	42
10) Phylum Echinodermata.....	49
11) Phylum Hemi/Chordata.....	55
12) Plasmodium	62
13) Earthworm.....	65
14) Frog.....	82



ENTRANCE MASTER

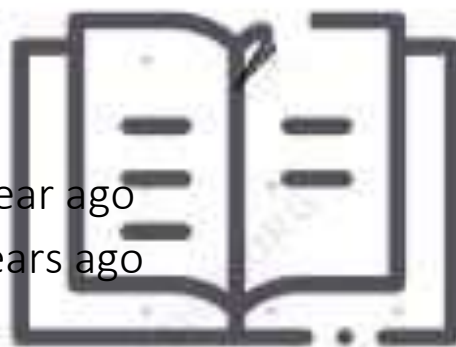
EVOLUTION

- The change in living organism (flora and fauna) that have occurred over the millions of years on earth
- Unit of evolution= population
- Evolution is directionless and indetermination
- Evolution is slow, gradual, and irreversible
- It is a stochastic process based on change
- Depends on lifespan/lifecycle of organism.

{Lifespan or lifecycle is inversely proportional to evolution rate.}

BIG-BANG THEORY

- Most accepted theory
- Explained origin of universe
- Occurred about 20 billion year ago
- Origin of earth 4.5 billion years ago



PRIMITIVE EARTH

- Origin = 4.5 billion years ago
- Temperature was high (5000-6000 ° c)
- Reducing temperature
- Volcanic storm was high
- Ozone layer was absent
- Atmosphere mostly contained H₂O, CO₂, NH₃, CH₄

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THEORIES OF ORIGIN OF EVOLUTION

➤ Special creation theory

❖ This theory has three connotations

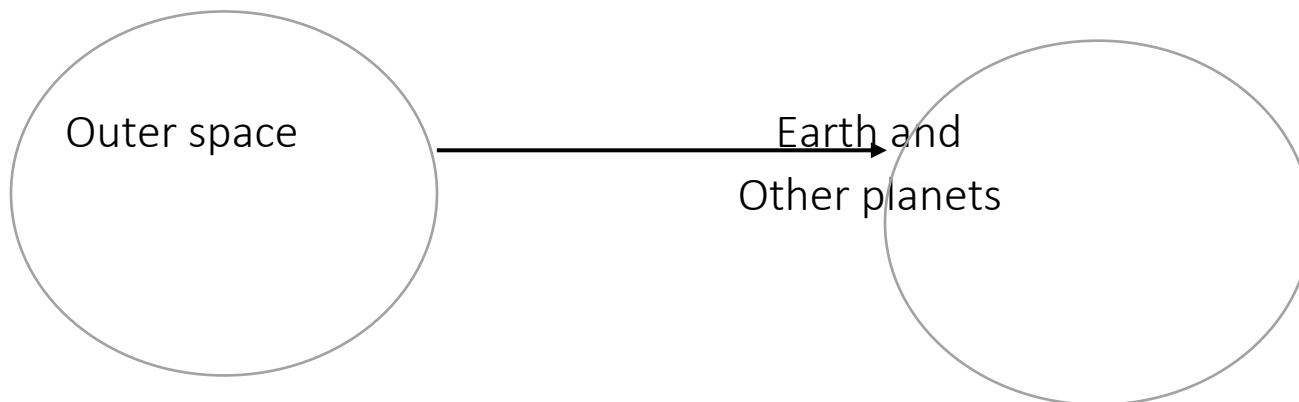
- 1) All the living organism (species or types) that we see today were created by super natural force

- 2) The diversity was always the same since creation and will be the same in the future also
- 3) Earth is about 4000 years old

Discarded by Darwin in 19 century

➤ PANSPERMA THEORY

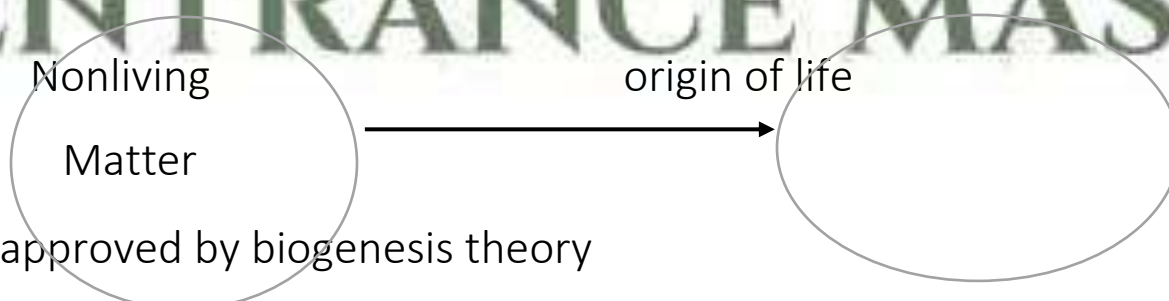
- Proposed by Arrhenius in 1980



- Unit of life= spore
- It was discarded because living matter couldn't survive extreme cold, dryness and UV rays.

➤ SPONTANEOUS THEORY/ ABIOGENESIS THEORY

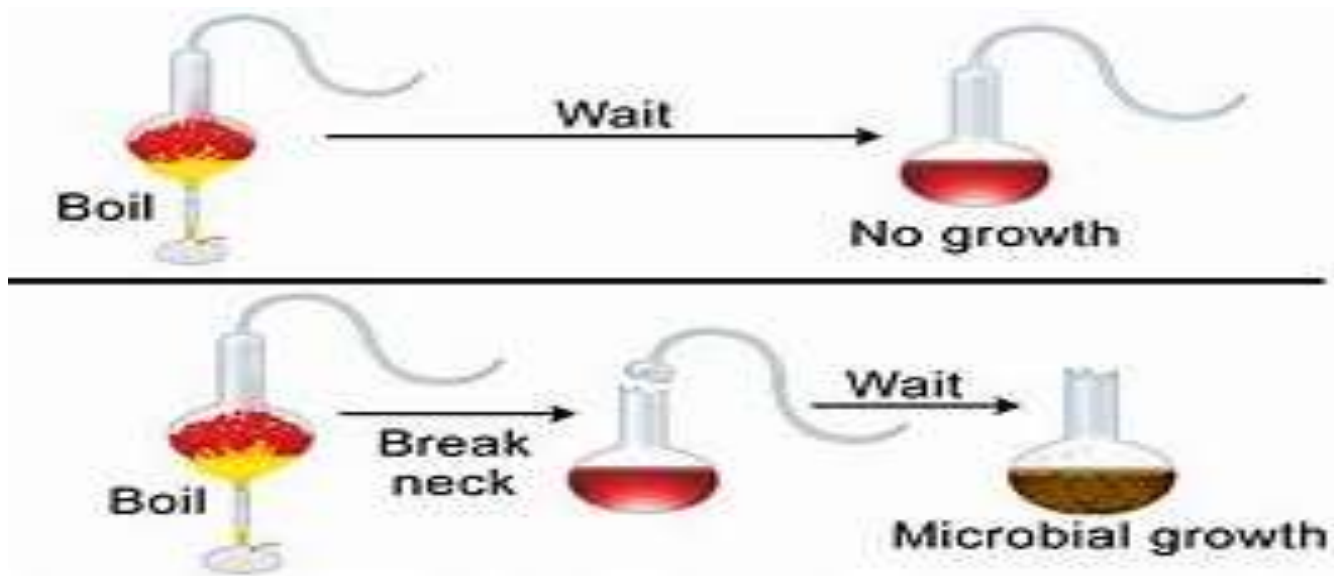
- Also called abiogenesis, autobiogenesis or autogenesis.
- Proposed by Anaximander.
- According to this theory the evolution was sudden change.



- Disapproved by biogenesis theory

➤ BIOGENESIS THEORY

- Given by "Huxley and Harvey"
- Supported by Redi, Spallanzani & Louis pasture.
- "**Omnis Vivo Ex vivo**" it state that, "the other living organism evolved from the pre-existing living cell"



LOUIS PASTURE EXPERIMENT

- Discarded: because it didn't prove how organism was actually evolved.

➤ OPARIN AND HALDANE THEORY

- It is also called chemical evolution theory.
- It is most accepted theory
- Oparin wrote the book known as "origin of life"

primitive earth

inorganic compound
present

non- living organic compound
(RNA, Protien, polysaccharide ..)

chemoheterotrophic
organism

chemoautotrophic
organism

non-oxygenic
photoautotrophic

oxygenic
photoautotrophs

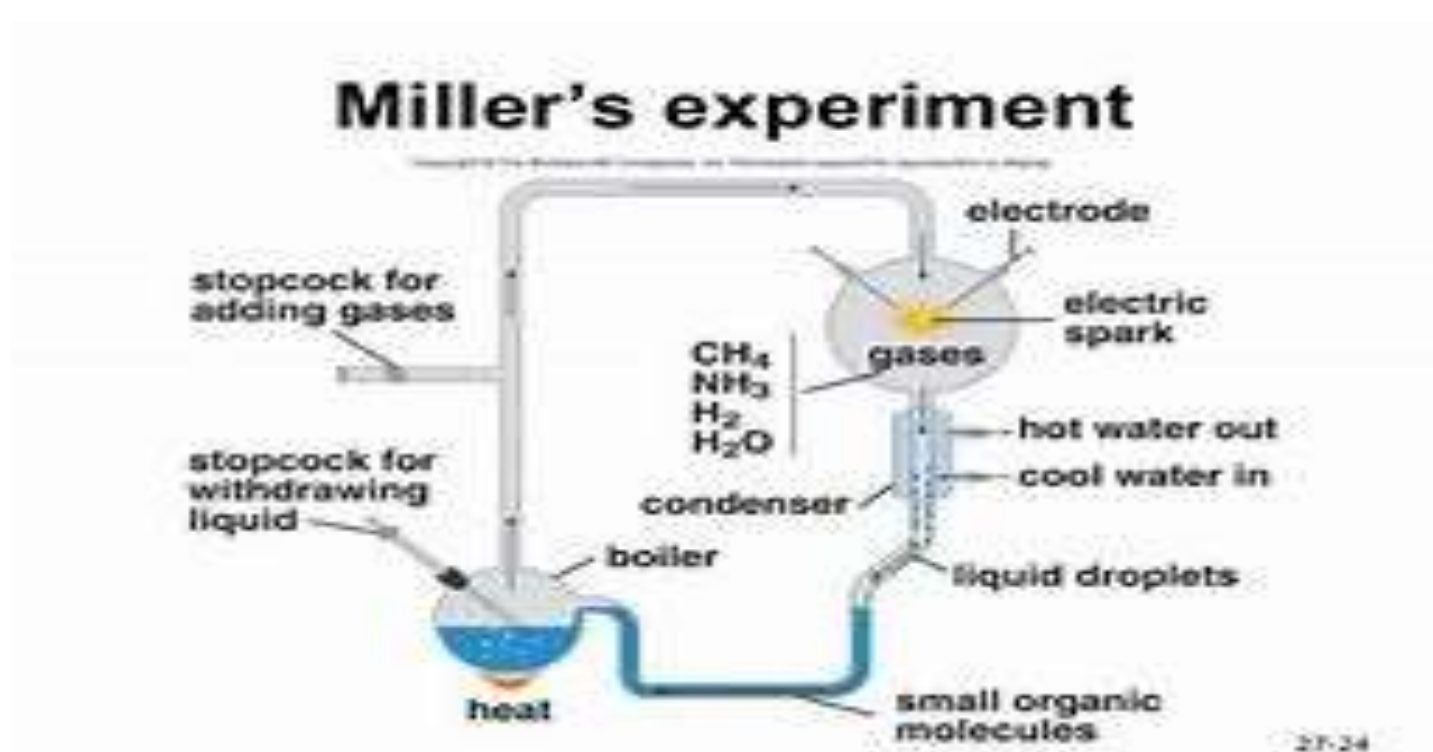
- ✓ First living organism in the earth was prokaryotic organism

- ✓ Cyanobacteria produced the first oxygen product on the earth

❖ EVIDENCE OF CHEMICAL EVOLUTION

1) MILLER EXPERIMENT

The Miller-Urey experiment was a test tube earth experiment that recreated the reducing primordial atmospheric conditions thought to have been present during the origin of life on earth. The experiment successfully produced simple organic molecules such as amino acids from inorganic components thought to have been present on prebiotic earth. The experiment proved that organic molecules could have been synthesized under the abiotic (life-free) conditions of early Earth, which has many applications to evolution



2) OTHER SIMILAR EXPERIMENT

- Other observed, formation of sugar, nitrogen base, nitrogen base, pigments and fats.

3) ANALYSIS OF METERITE CONTENT

- Also revealed similar compounds indicating that similar processes are occurring in else space

❖ EVIDENCES OF ORGANIC EVOLUTION

(a) PALAEONTOLOGICAL EVIDENCE

Fossils: remains of hard part of past organism found in rocks.

- Fossils are found in sedimentary rocks
- They provide one of the most acceptable evidence
- Most common fossils found “Petrified fossils”

(b) EVIDENCE FROM COMPARATIVE MORPHOLOGY AND ANATOMY

1) **Homologous organ:** appearance is different but function is same.

- Homology indicates common ancestor.
- Homology is the result of divergent evolution
- E.g. (i) forelimbs of mammals
(ii) Mouth parts of insects
(iii) Similarities in proteins and genes performing a given function among diverse organisms give clue to common ancestor.

2) **Analogous organ:** embryonic development and functional structure are different but appearance/function is same

- Analogy doesn't indicate common ancestor
- Analogy is result of convergent evolution
- E.g. wings of butterfly and birds, flippers of penguins and dolphin, sweet potato and potato. Etc.

(c) EVIDENCE FROM EMBRYOLOGY

- Biogenetic law of Ernst Haeckel {"ontogeny recapitulate phylogeny"}
- It means any organism shows its ancestral adult stage during its embryonic development.
- E.g. Development of vestigial gills slit behind the head but it is a functional organ only in fish and not found in any other adult stage.
- Disapproved by- Von Bear

❖ THEORIES OF ORGANIC EVOLUTION

1) **Lamarckism:**

- Theory of inheritance of acquired character
- Proposed by a French naturalist

Basic concept of Lamarckism

- Internal vital force
- Effect of environment and new needs
- Use and disuse of organs
- Inheritance of acquired character
- It was disapproved.

2) **Darwinism/Theory of natural selection :**

- Book of Darwin: "origin of species" (1859)

Two key concepts of Darwinian Theory:

- a) Branching descent
- b) Natural selection

Observation of Darwin:

- i) Over population :



- ii) Struggle for existence:

Types of struggle

- (a) Intraspecific struggle → (Most dangerous) fight between the own species
- (b) Interspecific struggle : it is a fight between important force for organic evolution
- (c) Environment struggle : natural climatic condition make animals to mutate

- iii) Variations and heredity:

The fittest among the group will acts as a leader who will protect all the species. E.g. 1 lion is king among a group of lions

- iv) Natural selection/ survival of fittest:

Natural selection was given by Darwin and survival of fittest was given by Herbert spencer. According to this theory the fittest one gets survive as it can bear the various change/mutation (it is similar to the variation and heredity)

- v) Origin of new species

3) Mutation theory:

This theory was given by Hugo de varies based on his work on evening primrose (Oenothera Lamarckism)

4) Neo-Darwinism/ modern synthetic theory:

Since Darwin didn't have the key concept about the gene that theory was modified slightly and new theory Neo-Darwinism was made. It has two key concept;

- a) Natural selection
- b) Reproductive isolation

Features of Neo-Darwinism

- i) Over production
- ii) Struggle for existence
- iii) Variation and heritance → all germinal variation are inheritable

→ sources of origin of variations.

- (a) Mutation
- (b) Gene recombination
- (c) Hybridization and nonrandom mating
- (d) Gene migration and gene flow
- (e) Genetic drift
- iv) Natural selection
- v) Reproductive isolation
- vi) Origin of new species
- vii) *And this is the one of the most accepted theory.*

GEOLOGICAL TIME SCALE

I have provided all the mnemonics for this please refer to +2 book for details about it.

→ ERA

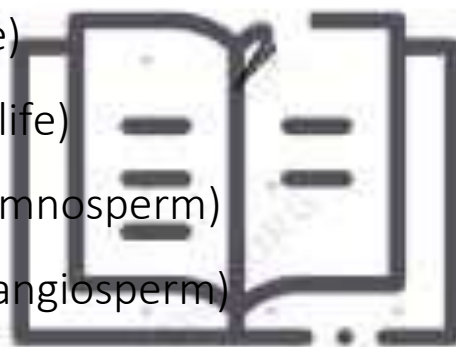
Press the **pale** button to the **message** the **center**.

Precambrian (the era of early life)

Paleozoic (the era of ancient life)

Mesozoic (Age of reptiles and gymnosperm)

Cenozoic (Age of mammals and angiosperm)



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→ PERIODS

Camel often **sit** **d**own **care**fully, **per**haps their joint **creak**.

Cambrian

Ordovician (the age of invertebrate)

Silurian

Devonian (The age of fishes, abundance of tree ferns)

Carboniferous (The age of amphibians, 1st seed plant)

Perman (Origin of conifers)

Triassic

Jurassic (Age of reptile's, dominance of gymnosperm)

Cretaceous (dominance of flowering plant)

→ EPOCHS OF THE CENOZOICS ERA

Put **e**gg on **m**y **p**late **p**lease **h**oney

Paleocene

Eocene

Oligocene

Miocene

Pliocene

Pleistocene

Holocene

HUMAN EVOLUTION

I have provided all the mnemonics for this please refer to +2 book for details about it.

Dr Ram and **h**anuman **ja-pa-n** (japan) **car** sey Gaye

Dr – Dryopithecus

Ram- Ramapithecus

A- Austriopethecius

H- Homo habilus

Ja- java men

Pa-pecking man

N-Nederthal man

Cr- Cro-Magnons

S-Homo sapiens

→ **Dryopithecus**

- Common ancestor to ape and man
- Arboreal and herbivorous

→ **Shivapithecus**: Fossils found in Shavlik hills of India

→ **Ramapithecus**

- first erect on his hind leg
- jaws and teeth similar to human

→Australopithecus

- also known as southern ape man
- first fully erect
- Cranial capacity of 500-700c.c.

→Homo habilis [h= Homohabillus, H= handy man]

- tool maker, skillful man
- Cranial capacity of 700-800 c.c.
- carnivorous, nut cracker

→java man [@ java loves lava]

- first to use fire and rudimentary languages
- Cranial capacity of 800-1000 c.c.

→ Pecking man

- Cranial capacity of 900-1250 c.c.
- Omnivorous and carnivorous like Java man.

→Nederthal man

- Believed in immortality of soul
- Built- hut
- Cranial capacity of 1300-1600 c.c.

→Cro-Magnons [C= Cro-Magnons, C= cave dwellers]

- Cave-painting
- Direct ancestor to modern man
- Cranial capacity of 1600-1650 c.c.

→Homo sapiens

- Modern man
- Cranial capacity of 1400 -1500 c.c.
- Appeared around 10,000 years ago in Capsin Sea and Meditarin Sea.

TIPS:

[Don't get confused with the first fully erect on his hind legs, and first fully erect men]



CHAPTER-02

INTRODUCTION TO PHYLUM

LEVEL OF ORGANIZATION



Number of level of organization:

- 1. Cellular level
- 2. Tissue level
- 3. Organ level

- 1) Porifera →(1) → cellular level of organization
- 2) Coelenterate
- 3) Ctenophora (2) Tissue level of organization
- 4) Platyhelminthes
- 5) Aschelminthes
- 6) Annelida
- 7) Arthropoda
- 8) Mollusca (3) →organ-system organization
- 9) Echinodermata
- 10) Hemi-Chordata
- 11) Chordata

SYMMETRY

1. Radial symmetry

- Cnidaria
- Ctenophora
- Echinodermata

2. Bilateral symmetry

- All other phylum shows Bilateral symmetry.

NOTE: porifera shows various symmetry & Larval stage of Echinodermata shows bilateral symmetry.

3. SEGMENTATION

- Above Aschelminthes they are *Acoelomate*,
- Aschelminthes is *Pseudo coelomate*,
- After Aschelminthes remaining all are coelomate.

FIRST TIME APPEARANCE

- Digestive system was first seen from Aschelminthes.
- Circulatory system was first seen from Annelida.
- Respiratory system was first seen from Arthropoda.



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Study tips: Remember all phylum name in sequence it will be much easier to rem

Chapter-03

PHYLUM PORIFERA

- porifera means pore bearer.
- Member of this phylum are commonly known as sponges.
- Body is perforated with many pores called ostia,
- ostia are the mouth let and allow the entry of water,
- a large apertures called osculum allows exits of water,
- Commonly porifera are marine but few are also a fresh water {e.g. spongilla}

HABIT AND HABITAT

- These animals are generally marine and mostly asymmetrical.
- Some sponges are also fresh water like spongilla
- Adult sponges are sessile or sedimetary (which can't move) but their larvae are motile
- Study of sponges are known as parazology.
- These are primitive multicellular animals and have cellular level of body organization.
- Sponges are on a blind branch of evolutionary tree.
- Sponges have evolved from colonial choanoflagellates.
- the connecting link between Protozoa and porifera is proterospongia.

BODY STRUCTURE

- Body wall has two layers
 - Outer pinacoderm
 - Inner choandoderm
- In between these layer, a non-cellular jelly like layer called mesenchyme is present.
- Body cavity is called Spongocoel or paragastric cavity or atrium.

Q) Why can't water enter through the osculum?

🌀 Water only enters through ostia and exit through osculum this is because of the repeated biting movement of flagella (coenocyte's cells).

- Pinacoderm has pinacocytes.
- Choandoderm has Coenocyte's.

→ choanocytes are also known called collared flagellated cells.

→ These line the Spongocoel and the canals.

GAS EXCHANGE:

→ All the body system are absent in porifera.

→ Gas exchange occurs through the general body surface.

→ there are no specialized organ for respiration.

EXCRETION SYSTEM

→ Excretion occurs through general body surface.

→ specialized excretory system is absent.

→ Excretory product is ammonia (Ammonotellic)

NOTE: sponges are not found in cold water they flourish best in warm water.

FOOD AND FEEDING

→ These are microphages animals.

→ These feed on microscopic food particles like bacteria, protozoans etc.

→ Digestion is intra-cellular.

→ Food is captured by flagella of coenocyte's which digest partially.

→ partially digested food is passed on to trichocyte's which digests completely and distribute it.

SKELETON SYSTEM

→ the body is separated by a skeleton system made up of spicules or sponging fibers.

→ Spicules are small needle like structure which are of two types

- Calcareous spicules (made up of CaCO_3)
- Siliceous spicules (made up of silica)

NERVOUS SYSTEM

→ there are no Neuron but these are sensitive to external environment.

→ Pinacocytes are contractile cells.

→ These can increase decrease overall surface area of sponge body.

CANAL SYSTEM

→ Sponges have a water transport system or canal system.

→ It is also called aquifers system.

→ It is a lifeline of sponges.

→ Water enters through minutes pore called ostia in the body wall into central cavity, Spongocoel (paragastric cavity) from where it goes out through the osculum.

→ flow of water:

H₂O → Ostia → spongocel → Osculum

→ It is the system of pores, chambers and canal through which water circulates.

→ This pathway of water transport is helpful in,

- Food gathering
- Respiratory exchange
- Removal of waste
- Reproduction

REPRODUCTION SYSTEM

→ sexes are not separate. [♀ & ♂ are not separate]

→ These are hermaphrodite's animals. {Egg & sperm are produced by the same individuals}

→ Reproduction is asexual as well as sexual.

→ Asexual reproduction is by:

- Fragmentation
- Budding
- Branching
- Gemmule formation.

→ Sexual reproduction is by formation of gametes.

FERTILIZATION AND DEVELOPMENT

→ Fertilization is internal

→ Scypha sponge is protogynous (ova mature earlier than sperm)

→ Flagella of chonatocytes capture sperm and possess it to ova developing in mesenchyme.

→ Development is indirect (having larval stage) which is morphologically distinct from adult.

→ Larvae are ciliated and free swimming.

→Larval stage are:

- Amphiblastula
- Parenchyma
- Rhagon

→Examples are:

- Spongilla (fresh water sponges)
- Euspongilla (Common bath sponges)
- Sycon (Crown sponge or urn sponges)
- Cliona (boring sponges or Sulphur sponge's → produces sulphuric acid →harmful to pearl industry)
- Hyalonema (Glass rope sponge)
- Euplectella- Venus's flower basket [It is given as a wedding gift in Japan]



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CHAPTER-04

PHYLUM CNIDARIA (COLEENTERATA)

→The term cnidaria is derived from Cnidoblast or cnidocytes.

→These contains siting capsule or nemtoblast.

→These are present on the tentacles and the body.

→Cnidoblast are used for

- Anchorage
- Defense
- Food capturing.

→Hypnotoxin poison are present in few of the cnidarian.

→ All the cnidarian are aquatic (Mostly marine & some fresh water form too)

→Sessile (Lobelia) as well as free swimming (Aurelia) forms are present

Example of fresh water → hydra.

BODY SYMMETRY

→Mostly radial symmetrical animals.

→Anthozoans (sea anemone) have biradial symmetry

LEVEL OF ORGANIZATION

→Cnidarian's exhibit's tissue level of organization.

→Connective tissue is absent.

GERM LAYERS

→They are diploblastic animals.

→body develops from two germ layers .i.e.

- Ectoderm
- Endoderm

BODY WALL

→It consist of two distinct layers, .i.e.

- Outer epidermis [Pinacoderm]
- Inner epidermis [Choanoderm]

→In between these two layers, there is a sheet of gelatinous materials called Mesoglea.

BODY PLAN

→Blind sac type of body plan s present.

→Mouth is present but anus is absent.

→Undigested Food is passed out through Mouth.

METAGENESIS

→It is alternation of generation between polyp and medusa in some cnidarian.

→Both polyp and medusa are diploblastic.

→Polyp produces medusa asexually and medusa from the polyp sexually (e.g. obelia {sea fur})

POLYMORPHISM

→It is the phenomenon of division of labor in which different functions are assigned to different individual colony.

→Members of colony are called zooids.

Gastrozooids (Nutrition)

Gonozooids (reproduction)

Dactylozooids (defense)

SKELETON

→The soft body may be supported by calcareous exoskeleton.

→Corals secrete a skeletal of CaCO_3 around their body.

GAS EXCHANGE

→IT occurs by diffusion of gases through general body surface.

→Specialized Respiratory structure are absent.

EXCRETORY

→It occurs by diffusion through general body surface.

→Specialized excretory structure are absent.

→Excretory product is mainly ammonia.

→Cnidarians are ammonotelic.

CIRCULATION

- Body cavity is coelenteron.
- It is also called gastrovascular cavity.
- It helps in digestion as well as distribution of food
- Body cavity also acts as hydro skeleton.

NERVOUS SYSTEM

- It contains networks of nerve cells and their processes.
- Sensory cells are also present.
- Statocysts maintain balance and equilibrium in free-swimming form.

DIGESTIVE SYSTEM

- Body cavity is coelenteron (gastrovascular cavity) with a single opening.
- Mouth is situated on a conical projection called hypostome.
- Digestion is first extracellular in the gastrovascular cavity and then intracellular.



REPRODUCTIVE SYSTEM

- Mostly hermaphrodite animals.
- Reproduction is usually asexual (budding) in polyp form and sexual in medusa form.

FERTILIZATION

- Fusion of gametes may be external or internal.

DEVELOPMENT

- Development is indirect.
- Free-swimming larval stages are present. Larval stages are:

- Planula
- Hydrula
- Scyphistoma
- Ephyra

NOTE: Hydra doesn't have free-swimming larval stage.

UNIQUE FEATURE

- Tissue level of organization.
- Special stinging cells, the cnidocytes or cnidoblasts for defense and offence.
- Epitheliomuscular cells with dual role of epithelium and musculature.
- Incomplete digestive tracts bounded by body walls.
- A simple nervous system in the form of a network of nerve cells and fibers.

EXAMPLES

- Hydra (Fresh water polyp)
- Obelia (Sea fur)
- Aurelia (Jelly Fish)
- Adamsia (sea anemone)/Sea flower.

Chapter-05

PHYLUM PLATYHELMINTHES

- They have dorsoventrally flattened body hence are called flatworm.
- It may be leaf-like or Ribbon like.
- True segmentation is absent. [E.g. planaria (free-living)]
- Cephalization is present.

HABIT AND HABITAT

- These are mostly endoparasite found in animals including human beings. E.g.
 - Tenebrio Solium (pork tapeworm)
 - Fasciola Hepatica (sheep liver fluke)

BODYPLAN

- Blind sac type of body plan.
- Mouth present but anus is absent.

BODY SYMMETRY

- Flatworm are bilaterally symmetrical animals.

LEVEL OF ORGANIZATION

→Organs level of organization.

→Hooks and suckers are present in parasitic forms

→They show beginning of cephalization (head formation).

GERM LAYER

→These are triploblastic animals

→Body develops from three germ layers

- Ectoderm
- Mesoderm
- Endoderm

BODY WALL

→Body is enclosed by single layers of epidermis or by a firm teguments and muscle layers.

GAS EXCHANGE

→It occurs by diffusion of gases through general body surface.

→specialized respiratory structure are absent.

EXCRETION

→Specialized cell called flame cell helps in osmoregulation and excretion.

→Excretory product is ammonia (ammonotelic).

CIRCULATION

→circulatory system is undeveloped.

→Body cavity is filled with characteristic connective tissue called parenchyma.

NERVOUS SYSTEM

→It is ladder like.

→It comprise brain and two main longitudinal nerve cord connected at intervals by transverse commissures.

DIGESTIVE SYSTEM

→Digestive tract if present is incomplete as in cnidarians.

→Parasitic forms absorb nutrients from the host directly through their body surface.

→Indigestible remains of food are passed out through mouth.

REPRODUCTIVE SYSTEM

- Sexes are not separate.
- Mostly hermaphrodite animals.
- copulatory apparatus is present.
- Fertilization is internal.

DEVELOPMENTS

- Development is indirect and includes many larval stage.

UNIQUE FEATURES

- Organ level of organization
- Some members like planari have high regeneration capacity.
- Triploblastic body condition.
- Presence of Muscle layers.
- Beginning of Cephalization.
- flame cells as excretory organs.



EXAMPLES

- 1) Planaria (Dugesia)
- 2) Fasciolopsis hepatica (sheep liver fluke)
- 3) Fasciolopsis Buski (Blood fluke)
- 4) Taneia Solium (pork worm)
- 5) Taneia saginata (Beef tape worm)
- 6) Echinococcus granulosus (Dog tapeworm)

→Commonly known as Roundworm.

HABIT AND HABITAT

→They may be free living, aquatic and terrestrial or parasitic in plants and animals.

BODY FORM

→Body is slender, Vermiform, unsegmented, flat or cylindrical.

→Their body is circular in cross-section, Hence the name Roundworm.

→Bilaterally symmetrical animals.

LEVEL OF ORGANIZATION

→Organ system level of body organization.

GERM LAYER

→Triploblastic

→Body develops from three germ layers;

- Ectoderm
- Mesoderm
- Endoderm



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BODY WALL

→The body wall consist of firm, non-living, resistant cuticle, epidermis and Muscle layers.

→Epidermis is syncytial without cilia.

→Epidermis is externally covering with thick cuticle of scleroproteins.

→Cuticle is moulted four times during growth period.

MUSCULATURE

→Musculature includes mostly longitudinal muscle fibers.

SKELETON

→There is no mineralized skeleton.

→High fluid pressure pseudocoelom Maintains body shape (hydro skeleton)

BODY CAVITY

→A cavity is present between body wall and digestive tract.

→It is not lined by mesoderm, so it is called Pseudocoelom.

→It has pseudocoelomic fluid.

DIGESTIVE SYSTEM

→Digestive canal is complete with mouth and specialized Muscular pharynx.

→Intestine is straight, non-muscular with posterior anus.

GAS EXCHANGE

→Specialized respiratory system is absent.

→Gases exchange through general body surface.

CIRCULATORY SYSTEM

→Circulatory system is absent.



EXCRETORY SYSTEM

→An excretory tube (H-shaped) also known as Renate cells removes body waste from the body cavity through the excretory pore.

→Excretory product is ammonia (Ammonotellic).

NERVOUS SYSTEM

→It consist of cerebral ganglia, circumcentric nerve ring with anterior and posterior nerve.

REPRODUCTIVE SYSTEM

→Sexes are separate (dioecious/unisexual) i.e. male and female are separate.

→Often, females are longer than male.

→Egg are with chitinous shell.

DEVELOPMENT

→Development may be direct (the young ones resemble the adults) or indirect.

[Rhabditiform larva]

UNIQUE FEATURES

→Syncytial epidermis.

→Body wall musculature of longitudinal fibers only.

→Presence of pseudocoelom.

EXAMPLES

- Ascaris lumbricoides (Roundworms)
- Wuchereria bancrofti (Filarial worm)
- Ancylostoma duodenale (hook worm)
- Enteriobius vermicularis (pinworm/seatworm/threadworm)
- LoaLoa (Eye worm)
- Drancunculus medinesis (Guinea worm)



ENTRANCE MASTER

CHAPTER-07

PHYLUM ANNELIDA

HABIT AND HABITAT

→They may be aquatic (marine/fresh water) or terrestrial; free-living and some parasitic form.

BODY FORM

→Body is soft, elongated, cylindrical or flattened.

→Body is divided into segments or metameres by ring like grooves (annuli)

BODY SYMMETRY

→These are bilaterally symmetrical animals.

LEVEL OF ORGANIZATION

→Organ-system level of organization.

HEAD

→Anterior end of body often forms a distinct head with sense organs as well.

APPENDAGES

→Many annelids have simple unjointed locomotary appendage called Para podia.

GERM-LAYER

→These are triploblastic animals.

→Both develops from three germ layers:

- Ectoderm
- Mesoderm
- Endoderm

BODY WALL

→It consist of thin, moist cuticle, Single layered epidermis and well developed Musculature.

→Minute bristle like chitinous structure called Setae are present.

MUSCULATURE

→Muscles are of two types

- Circular muscle
- Longitudinal muscles

SKELETON

→There is no mineralized skeleton

→fluid present in coelom serves as hydrostatic skeleton.

BODY CAVITY

→It is true coelom lined by mesodermal coelomic epithelium.

→It is divided by transverse septa into compartments

→It is filled with coelomic fluid.

DIGESTIVE SYSTEM

→Digestive tract is straight, complete and extends throughout the body.

→There is tube within tube of body plan.

→Digestion is completely extracellular.

GAS EXCHANGE

→It occurs through moist skin (Cutaneous Respiration)

→Some annelids (e.g. Amphitrite) have external gills also for branchial respiration.

CIRCULATORY SYSTEM

→Blood vascular system is closed-type.

→Some blood vessels are enlarged and acts as heart.

→Blood is red in color with hemoglobin dissolved in plasma.

→Some annelids have erythrocrutorin pigments.

EXCRETORY SYSTEM

→It consist of coiled tubules called nephridia.

→These helps in excretion as well as osmoregulation.

→Excretory materials is

- Ammonia in aquatic form
- Urea in terrestrial form

NERVOUS SYSTEM

- It consists of paired cerebral ganglia (brain) and a solid, double mid-ventral nerve cord.
- Sense organs like taste buds, photoreceptors cells, statocyst etc. are also present

REPRODUCTIVE SYSTEM

- Sexes may be separate (dioecious) or united (monoecious).
- Nereis is unisexually whereas earthworm and leech are bisexual.

FERTILIZATION

- It is external (earthworm) in some forms and internal other (leech).

DEVELOPMENT

- Life history may include trochophore larva in some parts/forms.

UNIQUE FEATURE

- Metameric segmentation.
- Nephridia for excretion and Osmoregulation.
- Closed circulation system with respiratory pigments in plasma.
- Setae in the body walls in most forms.

ADVANCEMENT OVER ASCHELMENTHIS

- Metameric segmentation
- Head, appendages and respiratory organs (gills) in some cases.
- True coelom
- Circulatory system often with the red blood.
- Circular and longitudinal muscles in both body wall and gut

EXAMPLES

- Nereis (Sand worm)
- Pheretima (Earthworm)
- Hirudinaria (blood sucking leech) [These release Hirudin which prevents the clotting of blood]



ENTRANCE MASTER

CHAPTER-08

PHYLUM MOLLUSCA

- These are soft bodies' animals.
- Body may be covered by a shell.
- Shell may be external or internal.

HABIT AND HABITAT

- Molluscan occupy all the possible habitat, except aerial.

BODY FORM

- The body has a variety of shapes and is usually unsegmented.
- Neopilina is only segmented mollusca.
- It is connecting link between Annelida & mollusca.

BODY SYMMETRY

- The symmetry is generally bilateral in mollusca.
- Some are secondarily asymmetrical (snail) due to torsion (twisting) during growth.

LEVEL OF ORGANIZATION

- The molluscan have organ-system of level of organization.

BODY-PART

- The body is usually differentiated into three regions
 - Anterior head with sense organ.
 - Dorsal visceral mass containing organ-systems.
 - Ventral foot for locomotion.

MANTLE (PALLIUM)

- A thin, fleshy fold or outer growth of dorsal body wall more or less covers the body.
- This fold is called mantle or pallium.
- It enclosed a space called Mantle or pallia cavity, between itself and the body.

GERM LAYERS

- These are triploblastic animals.

→Body develops from three germ layers.

- Ectoderm
- Mesoderm
- Endoderm

BODY WALL

→Epidermis is one layers and usually ciliated.

→Muscles are unstriped and occur in bundle.

BODY CAVITY

→Coelom is greatly reduced.

→It is greatly reduced/represented by cavities in the pericardium, kidneys and gonads.

SHELL

→The mantle usually secretes an external slimy shell

→The shell may be internal (cuttle fish) reduced and even absent (octopus).

DIGESTIVE SYSTEM

→The digestive tract is complete.

→Buccal cavity often contains a rasping organ, the radula, with transverse rows of teeth.

→Anus opens into the mantle.

GAS EXCHANGE

→Respiratory usually take place by:

- Gills, called ctenidia, located in the mantle cavity.
- Body-surface
- Mantle
- Lungs (pulmonary sac)

CIRCULATORY SYSTEM

→The circulatory is mostly open.

→It include dorsal pulsatile heart and a few arteries that open into sinuses.

→Blood often has a copper-containing, blue respiratory pigments called haemocyanin.

→The cephalopods have closed circulatory system

e.g. (octopus-Devilfish)

EXCRETORY SYSTEM

→The excretory system includes one or two pairs of sac –like kidneys, which opens into the mantle.

→The excretory system is mainly ammonia (Ammonotellic)

NERVOUS SYSTEM

→The nervous system typically comprises three paired ganglia

- Cerebral above the mouth.
- Pedal in the foot
- Visceral in the visceral mass.

→Ganglia are inter connected by commissure and connectives.

→Octopus has highly developed brain.

→A commissure joins similar ganglia.

→A connective link dissimilar ganglia

→Sense organs include:

- Eyes
- Statocyst for equilibrium
- Osphradia for testing chemical and physical nature of water.

REPRODUCTIVE SYSTEM

→Sexes are usually separate.

→Gonads have ducts.

→Asexual reproduction is absent.

FERTILIZATION

→Fertilization may be external or internal.

DEVELOPMENT

→Life history may be direct or with the larva named glochidium or veliger.

UNIQUE FEATURES

→Three body regions: head, visceral mass and foot.

→A glandular fold, the mantle, over the body.

→Mantle cavity with anal, excretory and genital apertures in it.

→Calcereous shell around the body in most cases.

→A rasping organ, the radula in the buccal cavity.

EXAMPLES

→Mussels

→Oysters

→Snails

→Slugs

→Squids

→cuttle-fish

CHAPTER-09

PHYLUM ARTHROPODA

GENERAL CHARACTERS

→It is largest phylum of an animal kingdom with Maximum numbers of species.

→Over two thirds of all named species on the earth are Arthropods.

HABIT AND HABITAT

→They may be aquatic (marine/fresh water) or terrestrial: free living or sometime parasitic.

→Some are gregarious and few are colonial with social life of high order.

→Some arthropod's shows parental care and also parthenogenesis, i.e. development of unfertilized eggs into an offspring.

→Fossils arthropods are called trilobites.

BODY FORM

→The body is variously shaped.

→It is segmented externally to varying degree.

→The segments are grouped into three regions called tagmata

→There may be two tagmata:

- Head and trunk
- Cephalothorax and abdomen.

- Some forms may have three tagmata. I.e. Head, thorax and abdomen.
- The segments are not separated internally by septa unlike in the annelids.

BODY SYMMETRY

- These are bilaterally symmetrical.

LEVEL OF ORGANIZATION

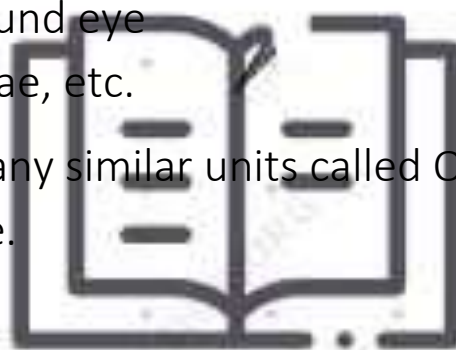
- They have organ-system of level of organization.

HEAD

- Anterior part of the body forms a distinct head.
- It consist of many fused segments.
- It bears well-developed sense organs such as:

- Simple eye
- Compound eye
- Antennae, etc.

- A compound eye consist of many similar units called Ommatidia, each having a lenses and capable of forming an image.



APPENDAGES

- Some or all the segments bears appendages.
- The appendages are jointed.
- This character gives the phylum its name.
- This appendages are variously modified for;

- 1) Feeding and walking
- 2) Jumping and swimming
- 3) Clinging, sensory reception, copulation and defense.

GERM LAYERS

- These are triploblastic animals.
- Body develops from three germ layers:

- Ectoderm
- Mesoderm
- Endoderm

BODY WALL

- It consist of thick, chitinous cuticle and a single layered epidermis.
- The hard cuticle resist growth and is periodically changed during growth.
- The process is called Moulting or ecdysis.
- Muscles do not form a continuous layer internal to the epidermis
- These are arranged in bundle, each specialized to move a particular segment of the body.
- All muscles are striated.

BODY CAVITY

- Body cavity around the viscera contains blood and is called haemocoel.
- True coelom is reduced to cavities in the reproductive organs.

DIGESTIVE SYSTEM

- Digestive tract is complete and has striated muscles.
- It has 3 distinct region:
 - Anterior stomodaeum
 - Middle mesenteron
 - Posterior Proctodaeum
- Stomodeum & Proctodaeum are lined by ectodermal epithelium covered by cuticle.
- Mesenteron is lined by endodermal epithelium.
- Mouth is provided with moveable appendages called mouth parts.
- These are variously adapted for:
 - Biting and chewing
 - Piercing and sucking
 - Sponging
 - Lapping
- Digestion is completely extracellular.

GAS EXCHANGE

- These are variety of respiratory structure in different arthropod's groups

1) Insects	Tracheal tubes
2) Crustaceans	Gills
3) Arachnids	Book lungs
4) King crabs	Book gills

CIRCULATORY SYSTEM

- The circulatory system is of open types.
- Blood flows in haemocoel instead of blood vessels.
- Blood is called hemolymph and it is colorless with white corpuscle.
- A dorsal pulsatile, 1 to many-chambered tubular heart is present.

EXCRETORY SYSTEM

- | | | |
|----------------|-------|---------------------------------|
| 1) Insects | _____ | Malpighian Tubules |
| 2) Crustaceans | _____ | Green glands / Antennary glands |
| 3) Arachnids | _____ | Coxal glands |
| 4) King crabs | _____ | Coxal glands |

→Excretory materials is

- Ammonia in aquatic forms (Ammonotelism)
- Uric acid in landforms (Uricotelism)

NERVOUS SYSTEM

→It comprises a circumcentric ring and a double, solid, mid-ventral nerve cord.

- Eye (Simple and compound)
- Chemoreceptor
- Tactile receptor
- Statocyst

REPRODUCTIVE SYSTEM

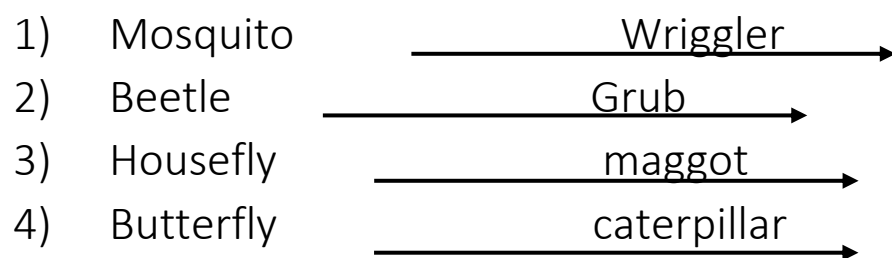
- Sexes are separate (Dioecious).
- Gonads have ducts.
- Asexual reproduction is absent.
- Most arthropod's are oviparous (egg laying).
- A few are ovoviviparous (direct birth giving).

FERTILIZATION

→Fertilization is external in a few aquatic form but is internal in the majority.

DEVELOPMENT

→Life history usually include larval form, which undergoes varying degree of metamorphosis to become adult.



UNIQUE FEATURES

- Jointed appendages modified for a variety of function.
- Tough, jointed, exoskeleton of chitinous plates.
- Tracheae for respiration in majority of cases.
- Compound eye in majority of cases.
- Malpighian tubules for excretion in majority of cases.
- Power of flight in most of the insects.
- Many release Pheromones into environment.
- Cilia and flagella are absent.

ADVANCEMENT OVER ANNELIDS

- Distinct head in all species.
- Joined appendages serving a variety of functions.
- Joined exoskeleton for protection and muscle attachment.
- Striped muscles arranged in bundles for moving particular parts.
- Special respiratory organs & well developed sense organ.
- Endocrine glands and pheromone secretion for communication.

EXAMPLES

- Economically important insect-Apis (Honeybee)
- Bombyx (silkworm), prawn.
- Vectors: Anopheles, culex, Aedes...etc.
- Gregarious pest: - locustae (Locust) Living fossils; Limulus (king crab)

CHAPTER-10

PHYLUM ECHINODERMATA

GENERAL CHARACTERSTIC

→This phylum includes spiny skinned animals.

HABIT & HABITAT

→They are exclusively marine animals.

BODY FORMS

→The body have various shapes:

- Star-like
- Cylindrical
- Melon-like
- Disc-like
- Flower-like

→It is unsegmented.

BODY SYMMETRY

→The symmetry is radial in adults and bilateral in the larvae.

→The radial symmetry of the adults is pentamerous, i.e. body parts are arranged in five or multiple five.

LEVEL OF ORGANIZATION

→The echinoderms have organ-system of organization.

→All system have radial arrangements.

HEAD

→The body lacks head in all echinoderms.

APPENDAGES

→Peculiar tube feet (podia) are developed for locomotion.

→The tube feet generally protrude out through special radial ambulacra.

→They are extended and retracted in hydraulic pressure of fluid in them and by contraction of their muscles.

GERM-LAYERS

→These are triploblastic animals.

→Body develops from three germ layers:

- Ectoderm

- Mesoderm
- Endoderm

BODY WALL

- Epidermis is single-layered and ciliated.
- It overlies a thick dermis containing Mesodermal Endoskeleton of calcareous plates.
- The latter often have spines, hence Echinodermata.
- Muscles are smooth and lie below dermis.
- Mouth pincer-like structure, called pedicellariae, project through skin in many.
- They keep the body surface clear of debris and organism by opening and closing.

BODY CAVITY

- A true coelom lined by ciliated Mesothelium is present.
- It is enterocoelous and contains a fluid with free amoeboid cells called coelomocytes.

WATER VASCULAR SYSTEM

- A part of the larval coelom is modified into a unique water-filled ambulacra or water vascular system with tube feet to help in locomotion.
- A perforated plate, termed madreporite, permits entry of water into the ambulacra system.

ENTRANCE MASTER

DIGESTIVE SYSTEM

- The digestive tract is usually complete.
- It is incomplete in brittle stars.

GAS EXCHANGE

- There are variety of respiratory structures.
 - Gills called dermal branchiae, or papulae in starfish
 - Genital bursae in brittle stars.
 - Cloacal trees in sea-cucumbers.
 - Tube-feet's in all.

CIRCULATORY SYSTEM

- The circulatory system is greatly reduced and is of open type.
- Blood often lacks a respiratory pigments.

- There is no heart or pumping vessels.
- The circulatory system has little role in gas transport.

EXCRETORY SYSTEM

- There is no specialized excretory organs.
- Nitrogenous waste is ammonia (Ammonotelism).
- It diffuses out via gills, bursae, respiratory trees and tube feet.

NERVOUS SYSTEM

- The nervous system includes a nerve ring and radial nerve cords.
- There is no brain.
- Sense organs are simple.

REPRODUCTIVE SYSTEM

- Sexes are separate.
- Males and female are alike externally.
- Copulation does not occur.



FERTILIZATION

- Fertilization is generally external.
- Many echinoderms have good power of regeneration.

ENTRANCE MASTER

DEVELOPMENT

- Life history includes a ciliated, bilaterally symmetrical larva that undergoes metamorphosis to change into a radial adults.
- Larva is named:
 - Bipinnaria in starfishes,
 - Ophiopluteus in brittle stars,
 - Echinopluteus in sea-urchins,
 - Auricularia in sea –cucumbers,
 - Crinoidea in feather starts.

UNIQUE FEATURES

- Bilateral symmetry in the larva and radial symmetry in the adults.
- Demarcation of the body surface into alternating ambulacral and interambulacral areas.

- Mesodermal endoskeleton of calcareous plates, usually with spines.
- Modification of a part of the coelom into a water vascular system for aid in locomotion.
- Characteristic tube feet for locomotion.
- Peculiar pedicellariae for cleaning the body surface.
- Anus is dorsal and mouth is ventral in position.

EXAMPLES

- Starfish (Asterias)
- Brittle fish (Ophiura)
- Sand dollar (Echinarachnius)
- Sea urchin (Echius)
- Sea urchin (Echinus)
- Sea cucumber (cuncumaria)
- Sea lilly (Antedon)



ENTRANCE MASTER

General characters

- These are usually described as primitive chordates or invertebrates chordates.
- Earlier, these were included under phylum Chordata.

HABIT AND HABITAT

- Exclusively marine, solitary or colonial, mostly tubicolous

BODY FORM

- Body is soft and unsegmented.
- Body is worm-like or vase-like with three distinct regions
 - Proboscis
 - Collar
 - Trunk



BODY SYMMETRY

- Body is bilaterally symmetrical.

LEVEL OF ORGANIZATION

- Hemi-chordates have organ-system level of organization.

ENTRANCE MASTER

GERM LAYERS

- These are triploblastic animals.
- Body develops from three germ layers.
 - Ectoderm
 - Mesoderm
 - Endoderm

BODY WALL

- The body wall consists of a single-layered epidermis and musculature of smooth muscle fibers.
- Epidermis has mucous glands.

BODY CAVITY

→Body cavity is a true coelom with 3 parts corresponding to the 3 body divisions:

- An unpaired proboscis coelom (protocoel)
- An paired collar coeloms (Mesocoel)
- An paired trunk coeloms (metacoel)

DIGESTIVE SYSTEM

→Digestive tract is proboscis contains a hollow outgrowth from the gut called buccal diverticulum or stomochord

(Earlier regarded as notochord)

GAS EXCHANGE

→Respiration occurs by gill slits or through the general body surface.

CIRCULATORY SYSTEM

→Circulatory system is open type and includes:

- Dorsal heart
- Two main longitudinal vessels (dorsal & ventral)
- Small lateral vessels and sinuses.

→ Blood is colorless and without corpuscles.

EXCRETORY SYSTEM

→Excretory system comprises a proboscis gland or glomerulus, situated in the proboscis and connected with blood vessels.

NERVOUS SYSTEM

→Nervous system is diffuse, consisting of an epidermal plexus of nerve cells and nerve fibers.

REPRODUCTIVE SYSTEM

→Sexes are usually separate.

→Gonads may be in several pairs or only in one pairs.

FERTILIZATION

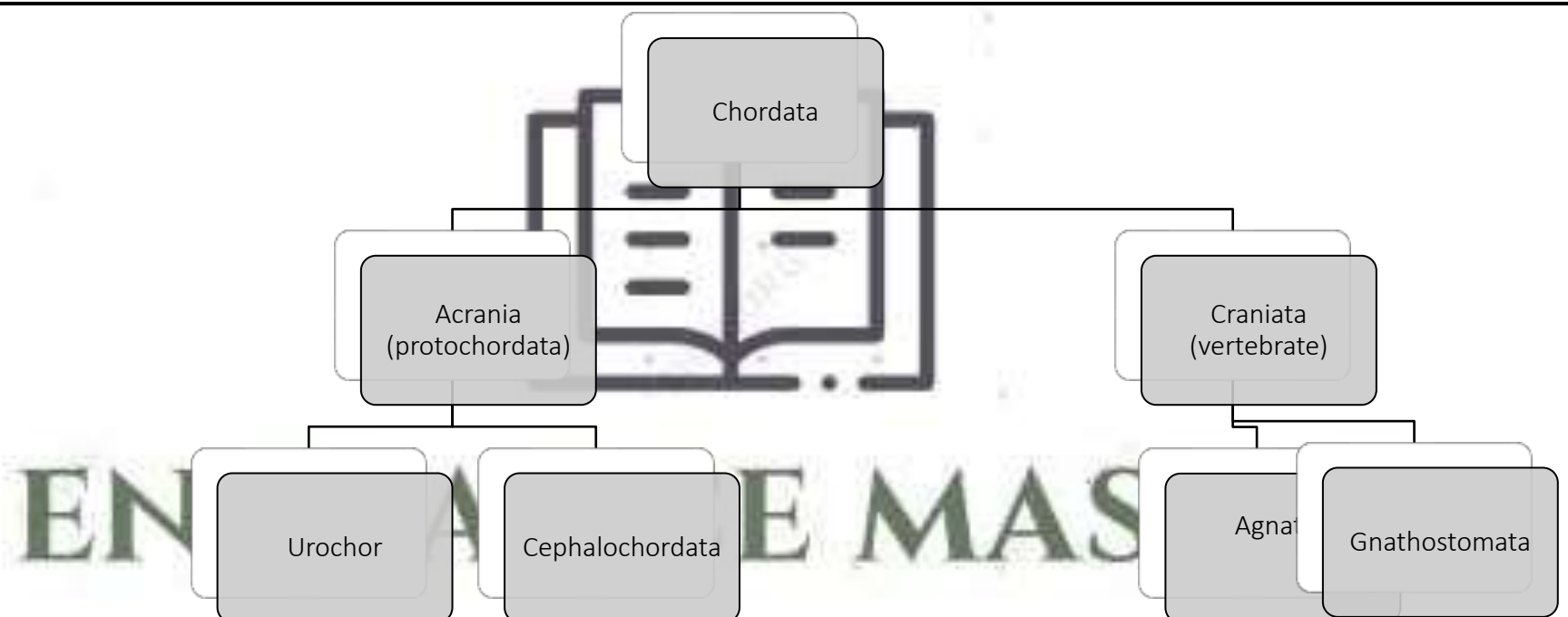
- Fertilization is external in sea water.
- Asexual reproduction occurs in some species

DEVELOPMENTS

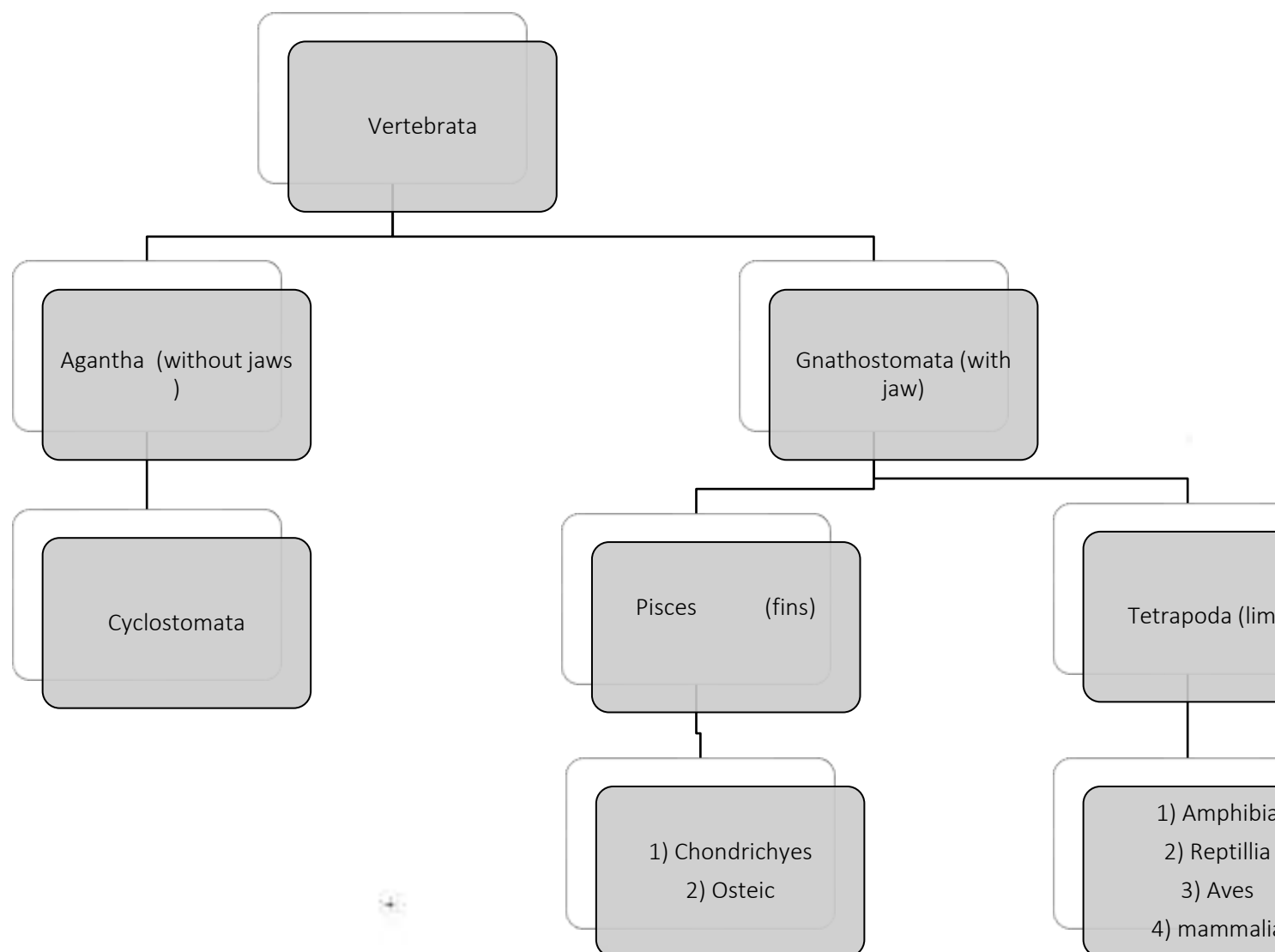
- Development may include a free swimming tornaria larva.

EXAMPLES

- Balanoglossus (Acron worm or tounge worm)
- Saccoglossus
- Cephalodiscus
- Rhabdopleura



Note: All the vertebrate are chordates but all the chordate are not vertebrate

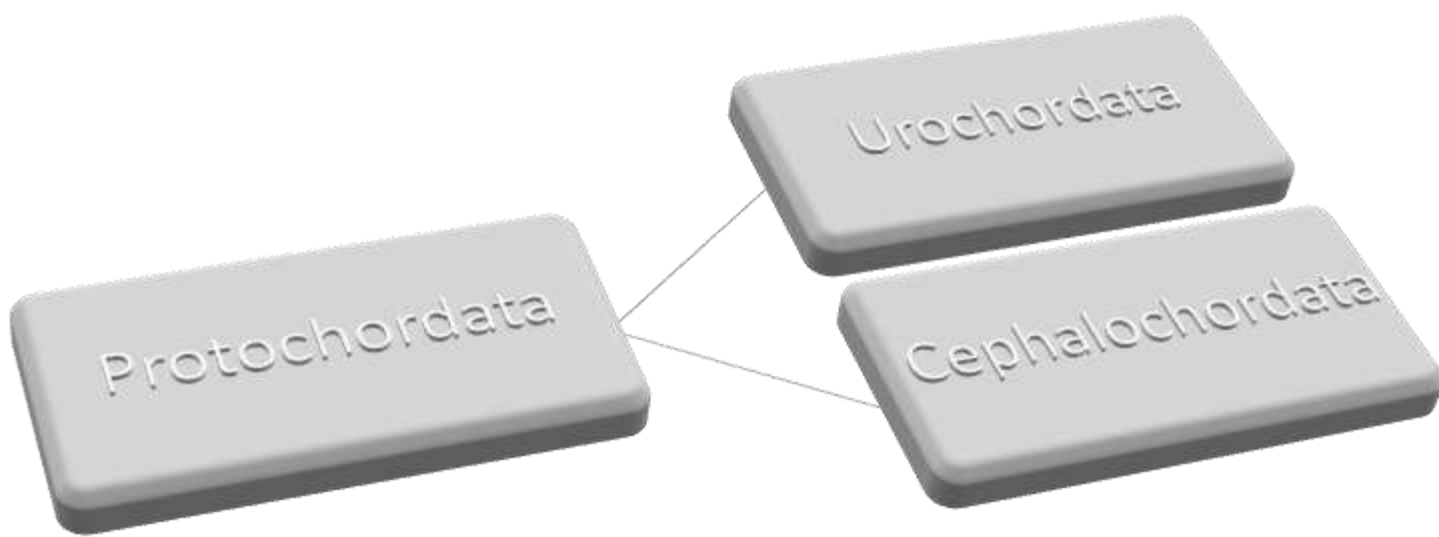


DIAGNOSTIC CHARACTERS OF CHORDATES

- Notochord
- Dorsal hollow nerve cord
- Pharyngeal gill slits
- Post anal tail (if present)

ADVANCEMENTS

- Living endoskeleton which grows with the body.
- More efficient respiratory organs (gills and lungs)
- With enormous surface area for rapid exchange of gases.
- Efficient circulatory system with well-developed heart.
- Better sense organ.
- Well developed endocrine glands.



UROCHORDATA

- These are exclusively animals
- These are more sessile, filter-feeding animals.
- Body is generally enclosed in leathery test (Tunic) composed largely of tunicin (also called animal cellulose).
- Notochords occurs only in the tails of larva and diapers in adults
- Nerve cord is present in the larva, but is replaced by a single dorsal ganglion in the adults.
- Pharyngeal are numerous, persist in the adults, and open into an ectoderm-lined cavity, the atrium.
- There are no gills.
- Lava is called tadpole and it changes into a degenerate adult.
- This transformation is called retrogressive metamorphosis.

EXAMPLES

- Herdmania- Sea squirt,
- Doliolum (Solitary, free swimming, barrel- like form)
- Pyrosoma (Colonial phosphorescent form)
- Oikopleura (Tailed form living in a self-Secreted house)
- Salpa
- Ascidea

CEPHALOCHORDATA

- Exclusively marine, filter-feeding animals
- Nerve chord persists throughout life.

→Notochord extends are numerous and persist in the adults.

→Examples: Branchiostoma (Amphioxus) - lancelet

CHAPTER-12



PLASMODIUM

RECAP TO PHYLUM PROTOZOA

→Based on locomotory organ, it has 4 classes i.e. Rhizopoda, flagellate, sporozoa & ciliata.

→Simplest & most primitive of all animals.

→Cellular level of body organization.

→Nutrition holozoic, halophytic, saprophytic... etc.

→Digestion is intracellular.

→Trypsin present.

PLASMODIUM;

→Discovered by **Charles Laveran** in RBCs of man.

→**Ronald Ross** discovered the Oocyst in the gut wall of mosquito and established malarial parasite and mosquito relationship.

→**Grassi** discovered/described the digenetic life cycle of plasmodium.

→There are 92 species of plasmodium known till now & only four species causes different types of malaria in man.

PLASMODIUM VIVAX;

- Causes Benign, tertian malaria,
- Fever is caused in every alternative days,
- Schuffner's granules/dots.

PLASMODIUM MALARIAE

- Causes Benign Quartan malaria,
- Fever after 72 hours,
- Ziemann's dots.

PLASMODIUM FALCIPARUM

- Causes malignant tertian malaria/cerebral malaria/Black water fever,
- No regularity of fever on it,
- Mayers dots.

PLASMODIUM OVALE

- Causes benign tertian malaria,
- symptoms seen after 48 hours,
- James's dots/ Schiffer's dots.



ENTRANCE MASTER

KEY POINT:

- 1) All plasmodium causes Benign except Falciparum (causes malignant).
- 2) All plasmodium causes tertian except malaria (causes Quartan).

FEW IMPORTANT POINTS:

- Plasmodium Falciparum has no exo erythrocytic cycle.
- Longest incubation period is 28 days of plasmodium malariae.
- Malaria day is celebrated on 25th April & mosquito day is celebrated on 20th August.
- Active feeding stage is trophozoite & Infective stage is sporozoite.
- Relapsing malaria is due to plasmodium Ovale & plasmodium Vivax.
- Chloroquine is given for treating malaria.



CLASSIFICATION

- Kingdom Animalia
- Sub-kingdom Invertebrate
- Phylum Annelida
- Class Oligochaete
- Genus Pheretima
- Species Posthuma

Note: Earthworm is also called metaphire Posthuma.

HABIT AND HABITAT

- It is burrowing animals (Fossorial animals), nocturnal animals.
- They show '-' photo taxis.
- It feed upon moist soil having rich of organic substance which is called humus.
- Copulation takes place during night and rainy season.

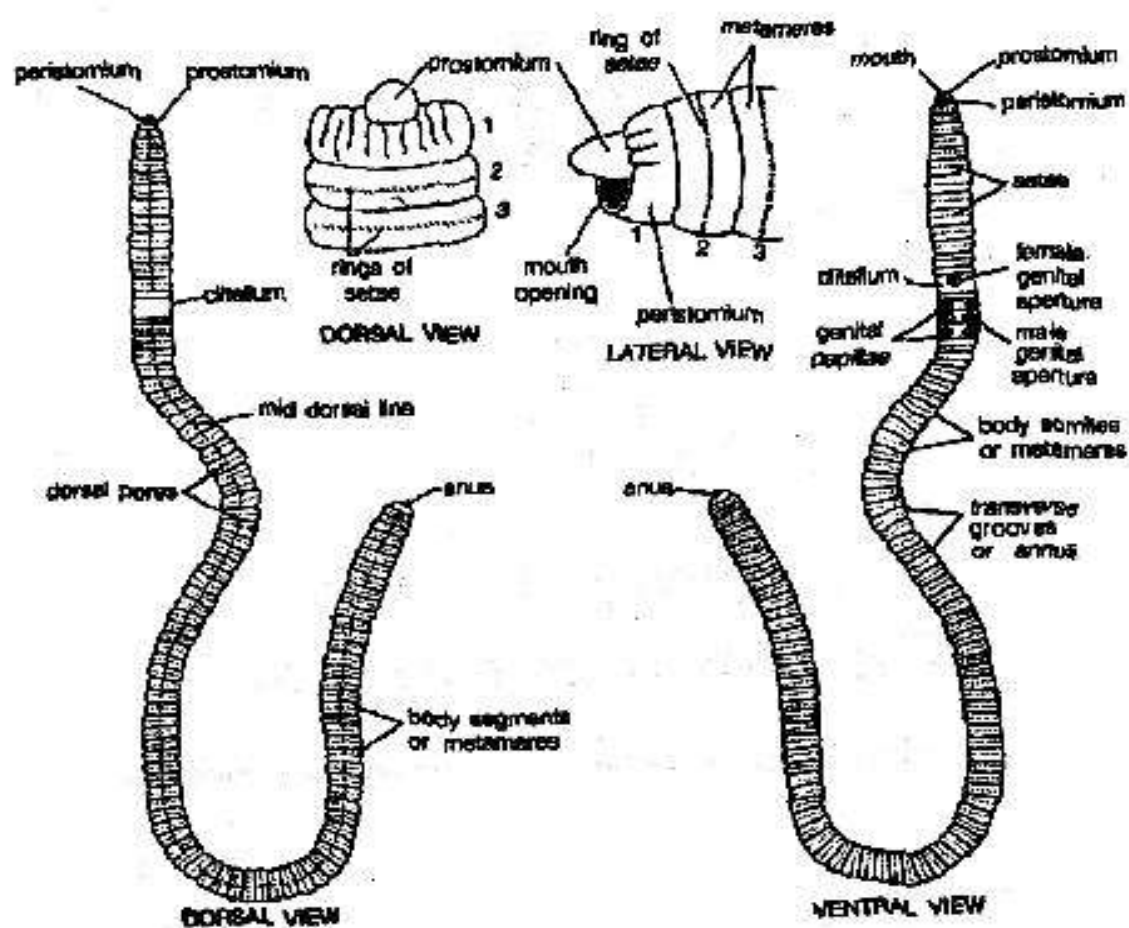
MORPHOLOGY OF EARTHWORM

- It is cylindrical, segmented and bilaterally symmetrical body having size 150mm length and 3-6 mm width.
- They are brown color due to the presence of pigment called porphyrin.



SEGMENTATION

- Segmentation of earthworm is known as metamerer, hence known as metameric Posthuma.
- There are total 100-120 segments/metamerer in the earthworm starting from mouth (peristomium) to anus (pygidium).
- The glandular segment present in 14, 15 & 16th segment is clitellum.
- Metamerically segmentation occurs mainly in the body but 1st four unsegmented while pseudo segmentation (incomplete septa) part is 8-9 as well as 14-16th segments.



Segmentation of earthworm

- 1st segment → Mouth (peristomium)
- 2nd-3rd segment → Buccal cavity
- 4th segment → Pharynx
- 4th, 5th, 6th segment → Pharyngeal segments
- 7th & 9th segment → Lateral heart
- 5/6, 6/7, 7/8, 8/9th segments → Spermathecal opening
- 5th-7th segment → Oesophagus
- 6th, 7th, 8th, 9th segments → Spermatheca (stores sperm)
- 8th segments → Gizzard (Muscular organ)
- 10/11th segments → Testes or testes sac
- 12th segments → Seminal vesical
- 12th & 13th segments → Lateral oesophageal heart
- 9th-14th segment → Stomach
- 14th segment → Oviduct & Female genital pore
- 14th, 15th, 16th segments → Clitellum
- 21th to 16th segment → Prostate gland
- 15th to last → Intestine
 - 17th & 19th segment → Male genital papillae (Accessory gland)
- 18th segments → Male genital pore

→ Externally segmented by – Annulus or Groove.

→ Internally segmented by- Septa (Absent in 1st four segment, between 9th & 10th segments & clitellar region)

CLITELLUM

→ Also known as Cingulum.

→ It consists of two kinds of glands.

→It has albuminous and chitinous gland which secrete albuminous and chitinous membrane during cocoon formation. (Glandular organ helps in cocoon formation)

→It is also known as forest of nephridia.

COLORATION

→It's body is dark brown in color due to presence of porphyrin pigment which is located in the circular muscle on the dorsal side of the body, which is manufactured by chlorophyll contained in humus.

→It protects against the UV rays.

→Hemoglobin is present as the respiratory pigment, which is dissolved in plasma.

→Oxyhemoglobin directly diffuses from plasma.

COELOM

→The space between body wall and wall of alimentary canal is called coelom.

→It is not a continuous cavity but is divided into the compartments by transverse partitions → septa.

→In Pheretima Posthuma, Schizocoel acts as coelom (the branch of eucoelomate)

→Its origin is mesodermal and is lined by two layers of Mesodermal layers.

→It is analogous to liver of vertebrates.

→Function of coelomic fluid is to:

- Acts as hydrostatic skeleton to facilitate locomotion.
- Helps in respiration to exit dorsal pore
- Because of this fluid the body of the earthworm is lustrous.

BODY WALL

→Body wall is derived from ectoderm and somatic mesoderm.

→Body wall consists of cuticle, epidermis, muscular layer and parietal peritoneum (coelomic epithelium).

→The cuticle present on it is thin, delicate, non-cellular and chitinous.

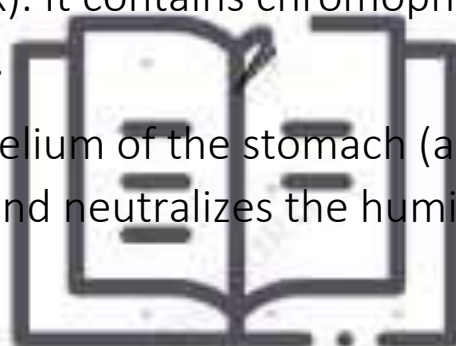
→Epidermis lies below the cuticle and consists of supporting cells, glandular cells, basal cells, receptor cells and septal cells.

→Muscular cells consist of an outer thin layer of circular muscle and inner thick layer of longitudinal muscles. {Just opposite to the human}

Note: parietal peritoneum is the innermost layers of the body wall and forms outer boundary of coelom, which secretes coelomic fluid.

DIGESTIVE SYSTEM

- Alimentary canal of Pheretima Posthuma is complete and straight tube.
- Digestion is extracellular,
- It is functionally designated into various parts, i.e. buccal cavity, Pharynx, Oesophagus, gizzard, stomach, intestine, and anus.
- The peristomium (mouth) leads to the buccal cavity which extends from 1st to 3rd segments.
- Oesophagus extends from 5th to 7th segments and gizzard is on 8th segments.
- Gizzard has a thick layer of circular muscle and is lined internally by the cuticle.
- Gizzard is also called grinding machine of earthworm because it crushes down the food into soluble/fine particle.
- Stomach of earthworm extends from 9th segments to 14th segments.
- The intestine of the earthworm are well-known into pre-typhlosolar region (15th to 26th segments), typhlosolar region (from 27th to 35th segments before the anus) and post-typhlosolar region (in last 23rd to 25th segments).
- The glands associated with the alimentary canal for the digestion include: Pharyngeal gland (present in roof of pharynx). It contains chromophil cells which secrete saliva [saliva consist of mucus and proteases].
- Glandular cells of gastric epithelium of the stomach (also called calciferous glands), which secretes calcium oxalate and neutralizes the humic acid of soil.



PHYSIOLOGY OF THE DIGESTION

Earthworm feeds on dead and decaying organic matter present in the soil, which is known as humus. The digestion in the earthworm is an extracellular process.

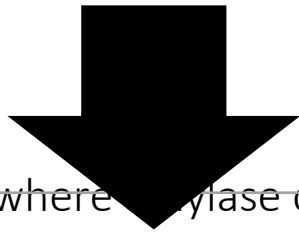
Physiology of digestion involves,

The mouth and the buccal cavity takes part in the ingestion process, where many chemo receptor are present which helps earthworm to identify the food.

Food particles eaten by the earthworm are pushed into the buccal cavity when the pharyngeal cavity is enlarged by the contraction of muscle that extends from pharynx to the body wall

The proteolytic enzyme present in pharynx act upon food which hydrolyses protein and mucin help in the lubrication of the food

The food then comes to gizzard which grinds the food into minute particles by squeezing and rolling action, then the food enters the stomach where calciferous glands help neutralizing the acidic food



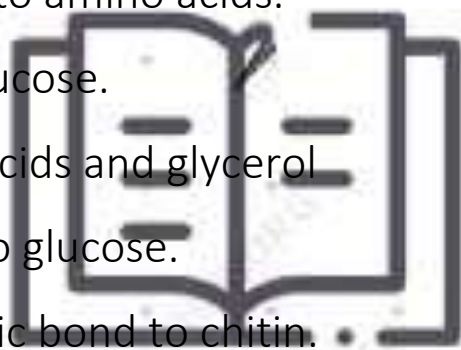
Then the food enters the intestine where amylase converts starch into the glucose. The complete digestion of food takes place in the intestine where various enzymes of intestine act on food and digested food gets absorbed (the typhlosole increases the absorption surface of the intestine)



The undigested food passes to the rectum where water gets absorbed and the undigested food is thrown out through the anus in the form of casting

ENZYME PRESENT IN THE INTESTINE AND THEIR FUNCTION:-

- Protease = converts proteins to amino acids.
- Amylase = convert starch to glucose.
- Lipase = convert fats to fatty acids and glycerol
- Cellulase = convert cellulose to glucose.
- Chitinase = Hydrolyse glycosidic bond to chitin.



EXCRETORY SYSTEM

→ The process of removal of harmful toxin and undigested food from the body is called excretion & the organ related to excretion is called excretory organ. The excretory organ of the earthworm is nephridia. Nephridia are the porous, long, thin and coiled tube which are found in all the segments except first three segments and cillateral region. {The nephridia of earthworm is analogous to the kidney in vertebrates}. On the basis of their position there are three types of nephridia in earthworm. They are;

1) **Septal nephridia**

→ The septal nephridia are the largest nephridia and a well-developed nephridia, which is found attached to both sides of each intersegmental septum behind the 15th segment.

→ It is an Enteronephric nephridia and remove metabolic wastes from blood and coelomic fluid.

2) **Pharyngeal nephridia**

→ The pharyngeal nephridia are similar to septal nephridia but lack nephrostome.

→ The pharyngeal nephridia is enteronephric nephridia that removes waste from blood only and occurs in the 4th, 5th and 6th segment; lies on side of gut in 3 paired and closed internally.

3) **Integumentary nephridia**

- The integumentary nephridia are attached to the inner side of the body wall, closed internally without nephrostome and are the smallest nephridia.
- They occur in all segments except first two (or 15th to last depends on the option) and removes waste from the blood only.

Some valuable point:

- Chloragogen cell which is present in coelomic fluid also serves the function of excretion (they excrete silicates consumed by the earthworm).
- Septal and Pharyngeal nephridia opens into the alimentary canal and are enteronephric type (*spent*).
- Largest nephridia is septal nephridia and the smallest and most numerous nephridia is Integumentary nephridia.

CIRCULATORY SYSTEM

- It is closed type. I.e. vessels present.
- There is no RBCs but hemoglobin is dissolved in plasma.
- There are 4 pairs of tubular heart with valve.
 - 1) **Lateral heart:** 7th& 9th segment (Each consisting of 4 valve)
 - 2) **Lateral oesophageal heart :** 12th & 13th segments (Each consisting of 3 pair of valve)
 - 3) **Total heart:** 8 (4-pairs)

→Blood vessels are:

Longitudinal vessels	Transverse vessels
-Dorsal blood vessel	-Anterior loops (10 and 11)
-Ventral blood vessels	-Commissural vessel (14 th to last)
-Supra oesophageal	-Dorso- intestinalis vessel (15 th -last)
-Lateraloesophageal vessel (paired)	-Ventro-intestinalis vessel (15 th to last)
-Sub neural vessel	-Ventro–tegumentaries vessel (1 st -last)

DORSAL BLOOD VESSELS

- It is the largest blood vessels running mid-dorsally above the alimentary canal from 1st to last segments. (In first 13th segments it acts as collecting vessels where it collects blood from intestine and sub neural vessels)
- It has valve on each segments after the 14th segments.
- The flow of blood is: posterior to anterior direction (Forward direction)
- It is also known as true heart of earthworm.

VENTRAL BLOOD VESSEL

- Found below the alimentary canal.
- It is the main distributing vessel.
- The flow of blood is anterior to the posterior direction.

SUPRA-OESOPHAGEAL BLOOD VESSEL

- It lies in the 9th to 13th segments.
- It is a short collecting vessels lying mid dorsally above the stomach.

LATERAL OESOPHAGEAL BLOOD VESSELS

- It lies in the 1st to 13th segments.
- They are paired and present on lateral side of alimentary canal.
- They are collective vessels which collect blood from seminal vesicle (11th & 12th segments).
- After the 13th segment these unite to form sub-neural blood vessels.

SUB-NEURAL BLOOD VESSEL

- It lies after 14th segments to the last segments.
- It is a collecting vessels present beneath ventral nerve cord.
- From SNV one pair of commissural vessel comes out from each segment which collects blood from septa and septal nephridia and supplies to dorsal vessels.

REPRODUCTIVE SYSTEM

- Earthworm are monoecious but they cannot self –fertilize their own eggs as they are protandrous (the male reproductive organ develops earlier than female), so cross-fertilization occurs.

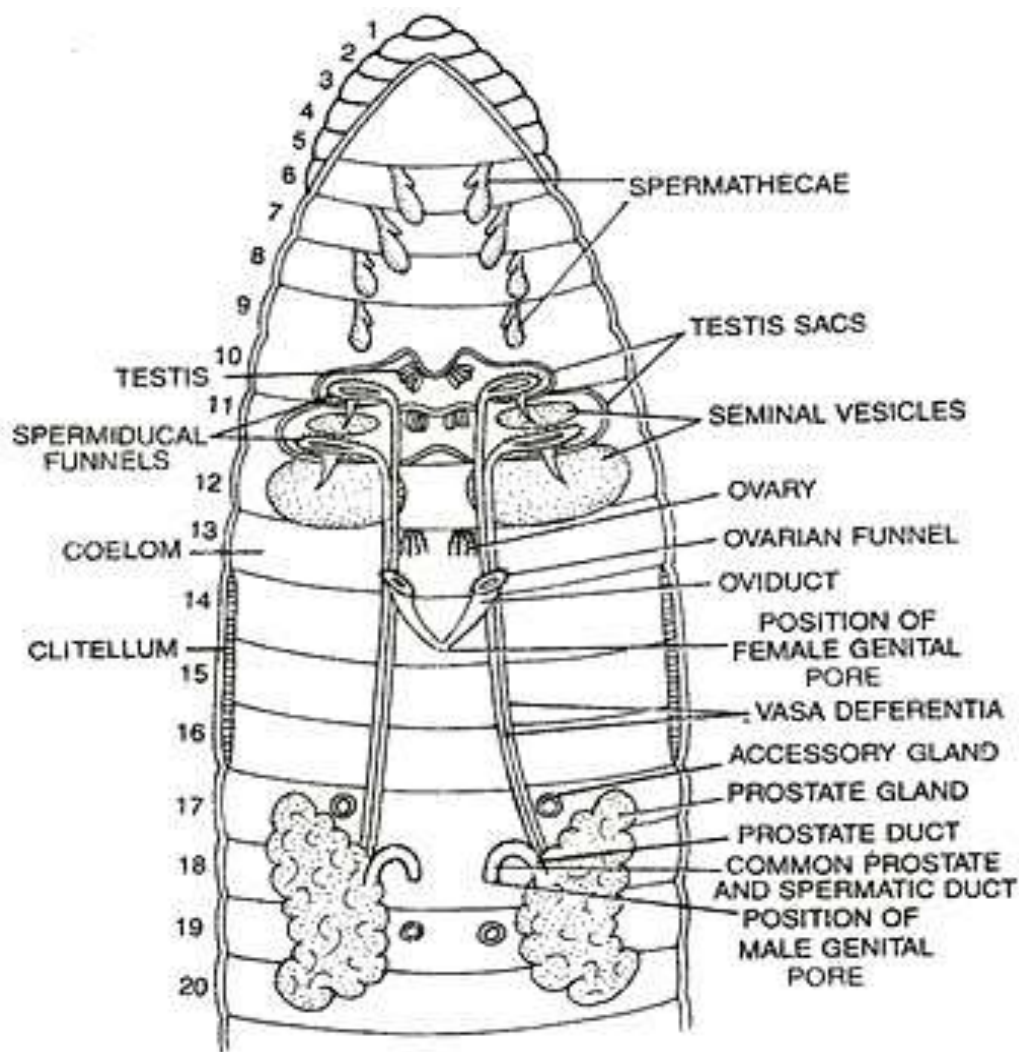
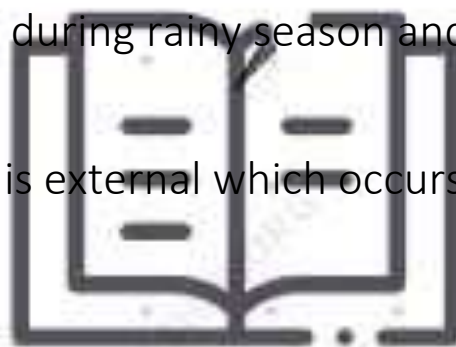


Fig: Reproductive system of earthworm

→The copulation occurs at night during rainy season and the time of copulation is one hour.

→The fertilization in earthworm is external which occurs in cocoon.



ENTRANCE MASTER

MALE REPRODUCTIVE ORGAN

→The male reproductive organs includes testes, testes sac, seminal vesicle, vasa efferentia, prostate glands and accessory gland.

→**The testes** are the small 2 pairs of finger like projection containing spermatogonia present in 10th & 11th segment lying Vento-laterally beneath the alimentary canal, on either side of nerve cord which produce spermatozoa.

→**The testes sac** are of 1 pair (2) which are found in 10th (small and encloses testis and spermiducal funnel) & 11th segments (large and encloses testis, spermiducal funnel and seminal vesicle).

→**The seminal vesicle** also known as septal pouch are of two pairs present in 11th (enclosed by testis sac) & 12th segments (free) which receives spermatozoa produced by testes through the testis sac. They help in the maturation of the spermatozoa. [The sperm receive food (fructose) from seminal vesicle].

→**The vasa efferentia** are the two pairs structure present in 10th to 18th segments which helps in conduction of sperm.

→**The prostate gland** (also known as dirty or creamy structure) extend from 17th to 20th segments, whose secretion serves as a medium for transfer of sperm and helps in activation of sperm.

→**The accessory glands** (also known as male genital papillae) are of 2 pairs found in 17th & 19th segments. They help in attachments of two worms during copulation.

FEMALE REPRODUCTIVE ORGAN

→The female reproductive organ consists of ovaries, oviduct and Spermatheca.

→**The ovaries** (1 pair) are attached to the posterior surface of septum present between 12th and 13th segment which produces ova. (Exactly the ovary is found in 13th segments).

→**The oviducts** are the two short tubes each lying immediately behind the respective ovary and open to outside by female genital pore.

→Four pairs of **the Spermatheca** found in 6th, 7th, 8th & 9th segments opens to outside through spermathecal pores situated Ventrally. They receive & temporarily store sperm received from another earthworm during copulation.

→ **Cocoon (ootheca)** are formed by clitellum which is unicellular mucus gland that secretes cocoon. The cocoon of earthworm contains many zygotes i.e. fertilized egg but only one zygote undergoes development and one earthworm develops.

ENTRANCE MASTER

NERVOUS SYSTEM

→The nervous system of earthworm is well developed and consists of central, peripheral and autonomic nervous system.

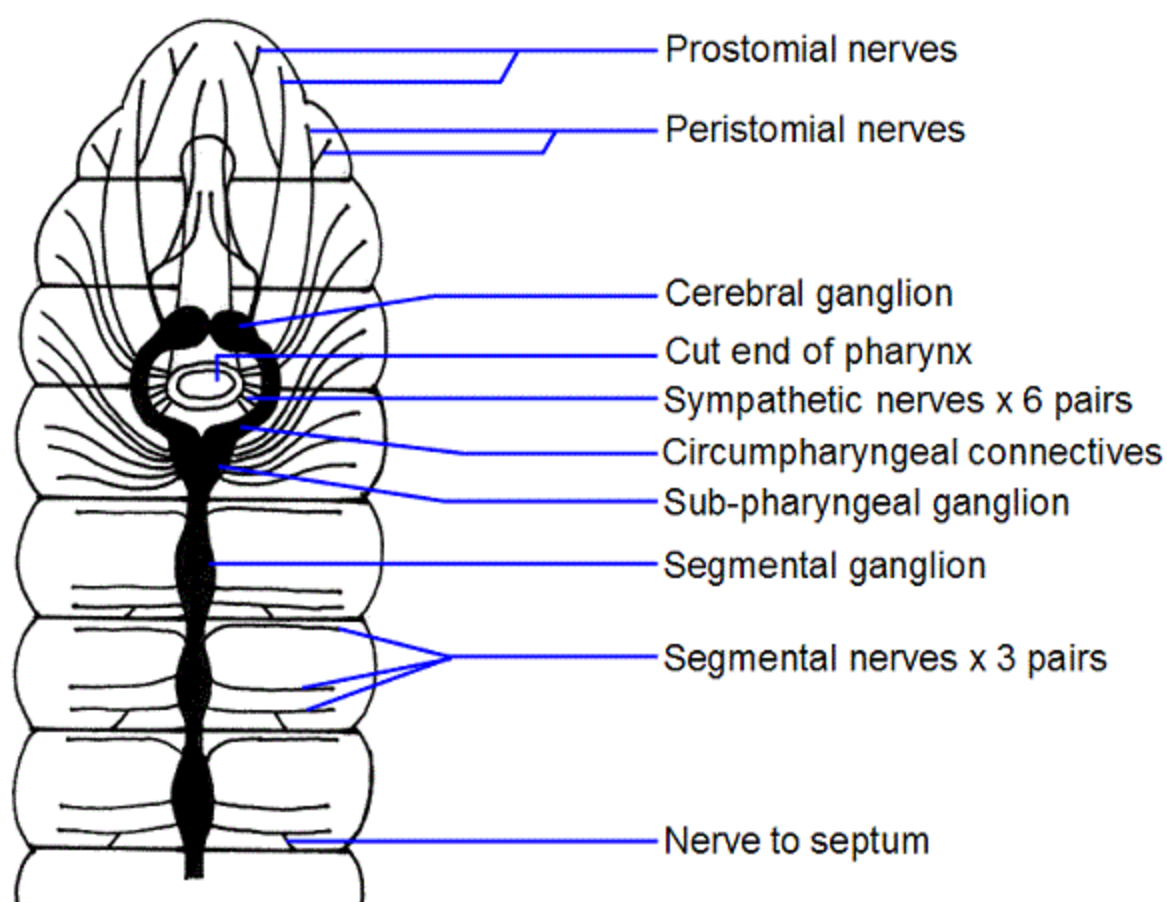


Fig: Nervous system of the Earthworm

→ Central nervous system consist of:

- Supra-pharyngeal** (cerebral) ganglia or brain (3rd segments at dorsal surface of pharynx)
- A pair of **peripharyngeal** or circumpharyngeal connectives, (3rd and mainly 4th segments)
- A pair of **sub-pharyngeal** ganglia (double, ventral and solid)

→ Ventral nerve cord has segmental ganglia (a swollen structure in each segments from 5th segments onwards)

→ Nerve arising from CNS and supplying various body parts constitute peripheral Nervous system.

PERIPHERAL NERVOUS SYSTEM

→ Supra-pharyngeal nerve gives out 8-10 pairs of nerve.

→ Peripharyngeal connectives gives 2 pairs of nerve.

→ Sub-pharyngeal ganglia gives 3 pairs of nerves.

→ Nerve cord gives 3 pairs of nerve in each segments that arises as 2 pairs from ganglia and 1 pairs directly form nerve cord.

→ **Autonomic nervous system** consist of an extensive nerve plexus situated beneath epidermis within the muscle of body wall and on alimentary cannal.

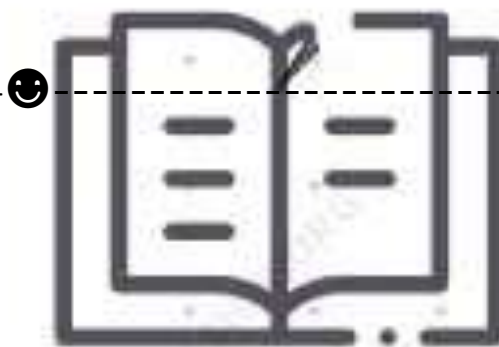
Important points

- Earthworm has brain but no head and eye.

- Sub-pharyngeal connective is also known as nerve ring or brain ring because it encircle around pharynx in 3rd and 4th segments.
- Neuron in earthworm are –motor, sensory and adjustor (associated neuron)
- All the neuron present in the worm are of mixed types.

Receptor are of 3 types:

- Epidermal receptor:** In Epidermis –tango receptor & tactile receptor is present.
- Buccal receptor:** In buccal cavity; chemo-receptors (olfactory + Gustatory)
Earthworm lacks eye but it has photoreceptor.
- Photo receptor:** Each photo receptor has single large optic cell. Inside optic cell there is an “L” shaped **lens orphaosome or optics organelles in cytoplasm**. It cannot form image but earthworm uses it to judge intensity and duration of light. It is present maximum in prostomium & peristomium on dorsal surface. A network of nerve fiber is associated to lens. This network is known as “**retinella**”.



ENTRANCE MASTER

Classification of frog:

Phylum	Chordata
Group	Craniata
Phylum	Vertebrata
Division	Gnathostomata
Super class	Terapoda
Class	Amphibia
Order	Anura
Genus	Rana
Species	Tigrina
Common name	Indian bull frog

MAJOR DIFFERENCE BETWEEN FROG AND TOAD

FROG	TOAD
They are mainly aquatic.	They lives on land
There are Diurnal.(active during the days)	They are Nocturnal.
Omosterum is present.	Omosterum is absent.
Internal vocal sac is present	Internal vocal sac is absent.
Their skin is smooth.	Their skin is rough and dry.
Parotid gland (poison gland) is absent.	Parotid gland (poison gland) is present.

HABIT AND HABITAT

- Frog are amphibious (which lives both in land and water) in nature.
- They travels towards water resources mainly in the breeding season for the copulation and deposition of egg.
- The larva (tadpole) is herbivores and the adult is carnivores.
- [The adult frog are also cannibal organism (animal which feed on own species)].
- Frogs belong to Phylum Chordata, class Amphibia. They can live in freshwater as well as on land. Rana Tigrina is the species of frog that is most commonly found in India. Their body temperature is not constant. Hence, they are called poikilotherms or cold blooded animals. They are capable of camouflage, that is, they can change their color when on dry land or in grasses for their protection from enemies. This coloration which is for their

own protection is known as mimicry. During extreme cold and heat, they take protect themselves by taking shelter in deep burrows. This is referred to as hibernation (winter sleep) and aestivation (summer sleep).

MORPHOLOGY

→Frog are bilaterally symmetrical, somehow dorsoventrally flattened & Streamlined with bluntly pointed ends.

→Frogs have mucus present on their skin that makes it slippery and smooth. A moist condition is always maintained on skin. Generally, their body's dorsal side is olive green in color and has irregular dark spots. On the other hand, there is a uniform pale yellow color on the ventral side. The intake of water in frogs occurs as absorption through skin.

→Frogs' body has a head and trunk. They do not have a tail (in adults) and neck. A pair of nostrils is found above the mouth.

→The head of frog is triangular & pointed. Their mouth is large terminal & semi-circular which is bounded by hard immovable lips.

→They have bulgy eyes and a nictitating membrane covers their eyes that protects their eyes in water.

→Head contains slightly light colored spot which is called Brown spot. Brown spot is also called third eye which is possessed by remote ancestor of frog.

→Sound signals are received by the ear (a membranous tympanum) present on eyes' either side.

→They have hind limbs and forelimbs that help them in burrowing, leaping, walking and swimming. Webbed digits are found their feet for swimming.

SKIN

→The skin of frog is smooth (lacks scale), slippery (mucus gland).

→They show protective Phenomenon called metachrosis that helps them to match the surrounding.

→It is divided into 2 regions: Epidermis and Dermis.

EPIDERMIS

→It is the outer layer, non-vascularized which consist of two layers; they are:

- i. **Stratum corneum**
- ii. **Stratum germinativum or malpighian layer**

i) **Stratum corneum**

- It is the outer layer and consist of flattened squamous epithelial cells (4 layers).
- First layer of squamous epithelium consist of completely dead keratinized cells which undergoes moulting or ecdysis.

ii) **Stratum germinativum or malpighian layer**

- They are the inner layer, columnar cells (single cells) resting on the basement membrane.
- Keratins are actually deposited on the stratum corneum due to division of these cells (columnar cells)
- The cells continually divide and add cells to outer layers which under goes keratinization. This leads to acquire keratohyaline which dissolves into protoplasm, forms shiny, semi-transparent, water proof, Eleidin which harden forming keratin

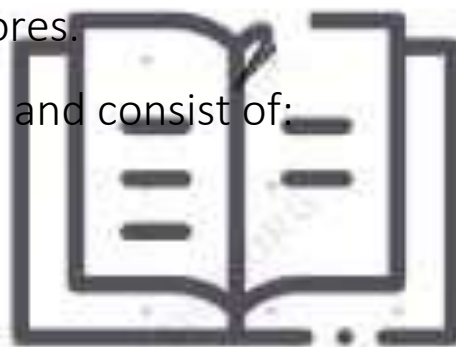
DERMIS:

→It is the inner layer of the skin, vascularized, thick.

→It consist of connective tissue, muscle fibers, nerve fiber, blood vessels, capillaries, cutaneous gland and chromophores.

→They are mesodermal in origin and consist of:

- i) **Stratum spongiosum.**
- ii) **Stratum compactum.**



- **Stratum spongiosum**

→It consist of connective tissue, fiber, blood vessels, lymph space, nerve fiber, cutaneous gland & chromatophores.

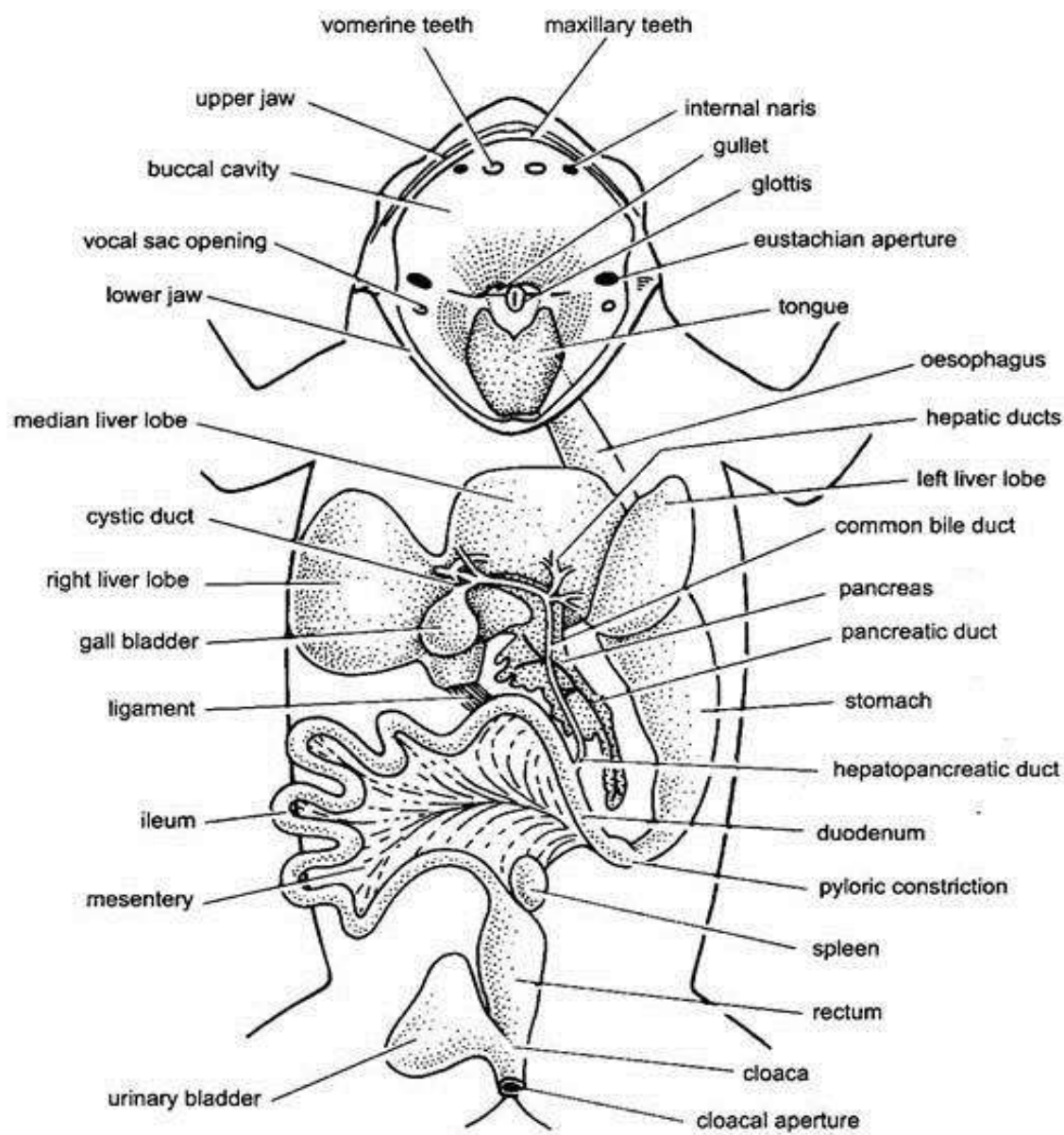
→Cutaneous gland include mucous & poison gland, chromatophores provides coloration to skin.

- **Stratum compactum**

→It is made of muscle fibers and connective tissue.

DIGESTIVE SYSTEM

→The digestive system includes alimentary canal & associated digestive glands.



Digestive system of frog

(1) Mouth, buccal cavity & pharynx

→The mouth of frog is wide, terminal, and bounded by upper and lower jaw where only lower jaw is movable.

→Dentation of frog are Acrodont, Homodont and Polyphyodont

→Teeth present in the frog are pre-maxillary, maxillary and vomerine teeth.

[The teeth of frog are not meant for chewing, cutting and mastication rather used for preventing the prey to escape]

→The tongue of frog is large, muscular, sticky, protrusible, retractile and bifitted. It is attached anteriorly and free posteriorly where taste papillae are present but taste bud are absent.

→The darting movement of tongue is due to the presence of protractor and retractor hypoglossal muscle and presence of lymph in sublingual lymph sinus.

→Pharynx bears opening of Eustachian tubes, Gullet (for Oesophagus) and glottis (for respiratory passage).

(2) Oesophagus

→The Oesophagus is short & broad tube whose wall secrete an inactive enzyme called pepsinogen (whose function takes place in mouth).

(3) Stomach

→It is long curved muscular sac of about 5-6 cm whose anterior part is cardiac and posterior part is pyloric with sphincter.

→It's wall consist of large number of gastric glands, they are:

- (a) Peptic or zymogen glands or chief cells: it secretes pepsinogen.
- (b) Oxyntic cells: it secretes HCl.
- (c) Mucous gland: It secrete Mucin.

Function of stomach:

→storage of food.

→Mechanical mixing of food.

→Chemical modification of food.

(4) Small intestine

→Small intestine consist of two part. They are

(i) Duodenum (present anterior)

→It is u- shaped structure which receives hepatopancreatic duct in proximal region.

(ii) Ileum (Present posterior)

→In ileum villi is present for increasing absorption surface area.

→The wall of ileum consist large number of intestinal glands which secrete succus entericus.

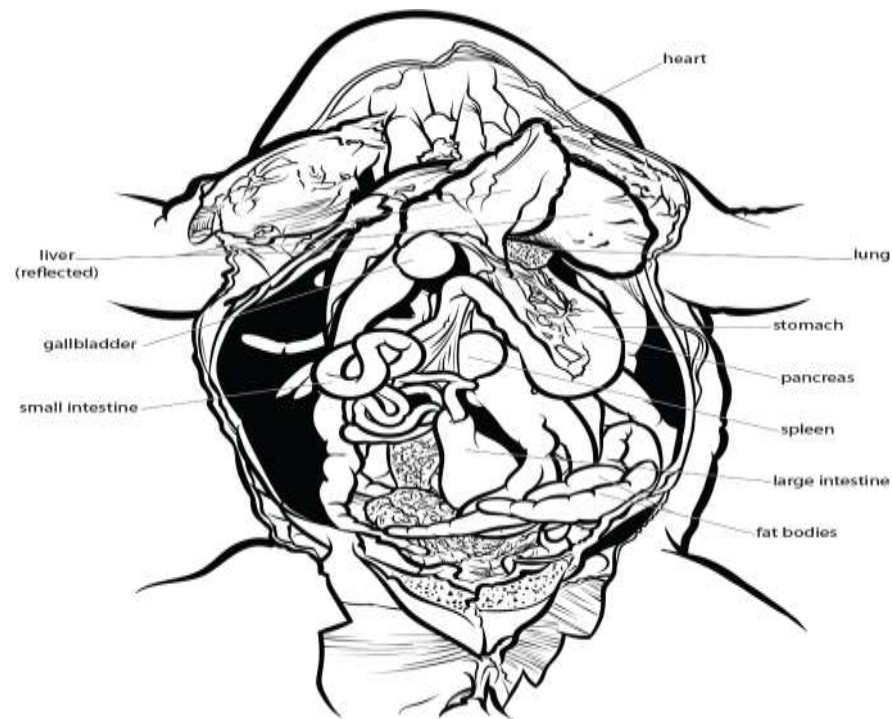
(5) Rectum (large intestine)

→It involve in absorption of water, ions, salts, etc.

(6) Cloaca

→It is the common opening where rectum, ureter, oviduct, urinary bladder open.

→The opening occurs in cloaca from rectum called anus which is guarded by anal sphincter.



Internal organ of frog

Associated digestive glands are:

1) Liver

→The liver of frog is three lobe and it secretes salts and pigments.

2) Pancreas

→It is a heterocrine gland which secretes both enzyme and hormone.

→The enzyme secreted by pancreas are:-

- i) Trypsin (Activated by enterokinase)
- ii) Amylase
- Lipase [ATAL]

→Hormone secreted by pancreas are:-

- i) Insulin
- ii) Glucagon

RESPIRATORY ORGAN