

CORE COURSE-II

INVERTEBRATA-II

(ANNELIDA – ECHINODERMATA)

(Based on Bharathidasan University Syllabus)



Compiled by

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This note is written in simple and easy English to facilitate students studying Zoology as a main subject and as allied subject under the Bharathidasan University syllabus.

This book written based on Bharathidasan University syllabus

I hope this notes will be committed to the intellectual life of the students.

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2. *Invertebrata –II*
3. *Chordate*
4. *Biology of Invertebrates and Chordates (Allied)*
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9. *Invertebrate I and Invertebrate II - (Practical Manual)*
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11. *Chordata and Cell and Molecular Biology (Practical Manual)*

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UNIT-I
ANNELIDA

General Characteristics of Phylum Annelida

- (Annelus: little ring)
- Habitat: Mostly aquatic, few are terrestrial
- Habit: free living
- Symmetry: ***bilateral symmetry***
- Coelom: ***Coelomate***
- Body is ***metamerically*** segmented
- Grade of organization: organ system grade
- Germ layer: ***Triploblastic***
- Body can be separate 3 sections there are ***prosomium, trunk*** and ***pygidium***.
- Digestive system: Complete and developed
- Respiration by general body surface
- Nervous system with an anterior nerve ring, ganglia and a ventral nerve chord.
- Circulatory system: closed circulatory system.
- Excretion by ***nephridia***
- Reproduction: Sexual and gonochoristic or hermaphroditic.
- Fertilization: Internal or external
- Development: direct some (Animal has larval stage)

Class 1 Polychaeta (Polys: many; chaete:hair)

- Habitat: They are marine, terrestrial, and freshwater.
- Archetypical protosome development (schizocoely).
- True coelomates (schizocoelomates).
- Bilaterally symmetry, segmented worms.
- Complete digestive system.
- Closed circulatory system.
- Well-developed nervous system.
- Excretory system: Both metanephridia and protonephridia.
- Lateral epidermal setae with each segment.
- Dioecious or hermaphroditic.
- Fertilization: external
- Examples: *Nereis* (sandworm), *Syllis*, *Sabella*

Class 2 Oligochaeta (Oligos: few, chaete: hair)

- Habitat: mostly terrestrial and few are freshwater
- Body metamerically segmented
- Clitellum present
- Hermaphrodite but cross fertilization occur
- Fertilization: external
- Cocoon formation occur
- Examples: *Pheretima posthuma* (Earthworm), *Lumbricus*, *Stlaria*, *Tubifex*

Class 3 Hiradinea (Hirudo: leech)

- Habitat: primarily freshwater annelids but some are marine, terrestrial and parasitic
- The body has definite number of segments.
- The tentacles, parapodia and setae are totally absent.
- They are hermaphrodite.
- Fertilization: internal and a larval stage is absent.
- Examples: *Hirudinaria* (Leech)

Class 4 Archannelida (Arch: first)

- Habitat: They are strictly marine
- The body is long and worm like.
- The setae and parapodia normally absent.
- They may be unisexual or hermaphrodite.
- The development: indirect forming trochophore larva.
- Examples: *Protodrillus*, *Dinophilus*, *Protodrilus*

Class 5. Echiuroidea

- Exclusively marine forms found in mud and sand
- Body more are less cylindrical and covered with small papillae.
- Trace segmentation in adult.
- Anus is terminal
- Parapodia are absent
- Sexes are separate
- Larvae is trochopore

Class 6. Sipunculoidea

- It is found in sand, mud and coral of sea.
- Parapodia and seate absent
- Anus located on near anterior end.
- Sexes are separate
- Larvae is similar to trochopore

Class 7. Priapulida

- It is found in sand, mud of sea.
- Sexes are separate
- Mouth is anterior and anus is posterior.
- Development unknown.

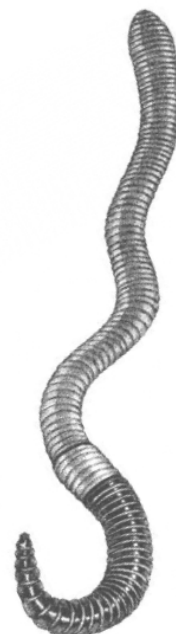
EARTH WORM

Classification

Phylum	:	Annelida
Class	:	Oligochaeta
Order	:	Neo oligochaeta

General characters of earthworm

- It is worm like metamerically segmented animal
- Habitat: Moist place like soil, organic matters.
- Habit: **free living**
- They are burrowing animal



- They are **detritus**(waste matters) feeder
- Body cylindrical and elongated
- Anterior end is pointed and posterior end is blunt
- It is grown to about 15 cm
- They body divided into 100-200 segments are called Metameres.
- External metamere marked is called Annuli and internal metamere is called *septa*.
- It has no head; the first segment is called *Peristomium*.
- Peristomium has mouth and *Prostomium*.
- The last segment is called anal segment or *pygidium*.
- The adult earth worm has 14-17th segments swollen into ring like structure called *Clitellum*.
- The clitellum divide in to 3 parts

1. *Pre-clitellor region* 2. *Clitellor region* 3. *Post clitellor region*

Apertures of earthworm

- **Mouth**: Located at anterior region of peristomium
- **Anus**: Located at posterior region of the anal segment
- **Female genital pore**: Located at ventral side of the 14th segments.
- **Male genital pore**: Located at ventral side of the 18th segments.
- **Spermalthecal opening**: Three pair of opening present from 6-9th segment
- **Nephridiopore**: The tiny opening presented in all over the body
- **Dorsal pore**: It is located between dorsal side of 10th and 11th segment.

Body wall

- The body wall of earthworm is called dermo-muscular (well developed skin)
- The body wall is *triploblastic*
- Its body wall consist cuticle, epidermis, circular muscle, longitudinal muscle and coelomic epithelium

Coelom or body cavity

- Coelom refers to body cavity lying between the body wall and the gut. It is true coelom.
- The coelom filled with a fluid is called coelomic fluid.

Locomotion

- Earthworm moves with help of muscles and setae.

Digestive system

- The digestive system consists of *alimentary canal* and *digestive glands*.
- *Mouth*
- *Buccal Cavity*
- *Pharynx*
- *Esophagus*
- *Gizzard*
- *Intestine*
- *Anus*

Alimentary canal

- It is straight tube, starts from mouth (1).
- Mouth leads to buccal cavity (2), the buccal cavity leads into pharynx (3-4).
- The pharynx leads to oesophagus (5), the oesophagus leads to gizzard (6).
- The gizzard followed by intestine, it is long and straight and it extends up to the anal segments.

Gizzard

- It is oval, hard, thick walled, highly muscular organ, which extends up to 9th segment. It helps to grind the food particles.

Typhlosole

- The dorsal wall of the intestine has a fold which projects into the lumen of the intestine are called typhlosole. It is increase area of absorption.
- The undigested waste material open outside by the anus.

Digestive gland

- *Pharangeal* gland
- It is locate around the pharynx.
- It secrete *proteolytic* enzyme.

Intestinal gland

- It is locate wall of the intestine.
- It does secrete *Proteolytic*, *Lipolytic* and *amylolytic* enzyme.
- Feeding
- Earthworm feed on the dead organic matter in the soil (detritus)

Digestion

- An earthworm follows Intra and inters cellular digestion.
- Intra cellular digestion take place in epithelial cells of intestine
- Inter cellular digestion take place in intestine.

Absorption

- Absorption takes place in the posterior parts of the intestine.
- *Typhlosole* increase the digestion

Egestion

- The undigested organic matters and soil passed out through the anus in the form of worm casting.

Circulatory system

- Closed type of circulatory system
- Circulatory system formed by three components there are *Blood, blood vessels and hearts*.

Blood

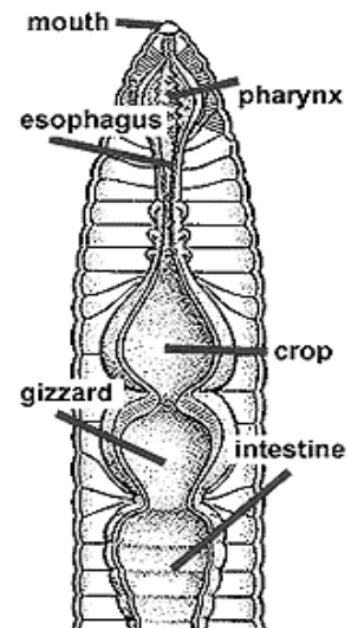
- Blood has plasma, haemoglobin and corpuscles

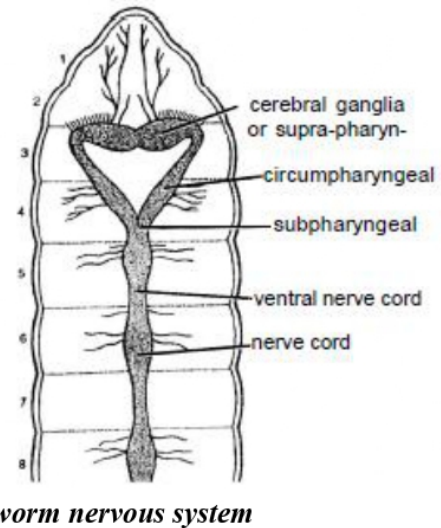
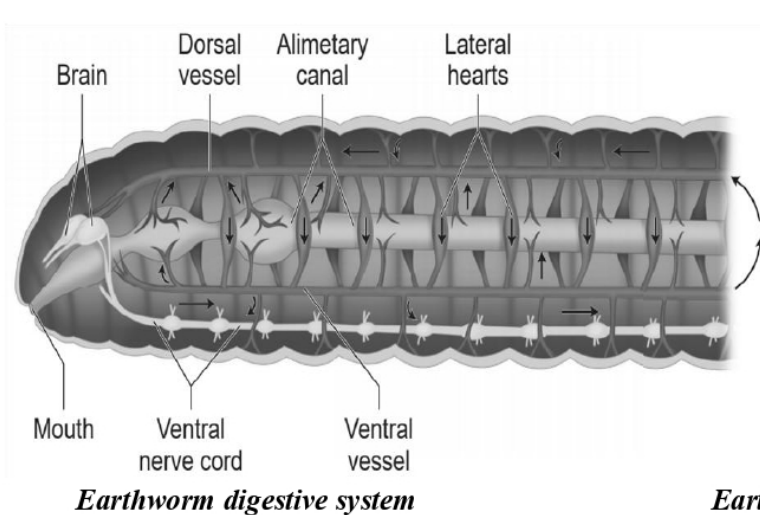
Blood vessels

- Two main vessels *1. Dorsal vessel 2. Ventral vessel*
- Dorsal vessel : it s found above the alimentary canal and blood passes forward
- Ventral vessel: it is found below the intestine, blood flow backward.

Heart

- Earthworm has 8 pair of hearts
- Hearts are muscular pumping organ
- Hearts located from 6th -13th segments
- Nature of the hearts is muscular and contractile.





Respiration

- Respiration organ is absent
- Respiration take place through the skin it is called *cutaneous respiration*

Excretion

- Excretion is carried out by coiled ducts called nephridia. They are arranged segmental so we call segment organ.
- Nephridia one end open in to the coelom by nephrostome, the another end open into outside by nephridio pore
- Earth worm has three types of nephridia
 1. *Meganephridia*
 2. *Micronephridia*
 3. *Pharyngeal nephridia*

Nervous system

- It has brain, that brain formed by 2 ganglia called cerebral ganglia.
- The two ganglia fused together to form bilobed mass they are situated above the pharynx is called supra pharyngeal ganglia.
- Below the pharynx ganglia is called sub pharyngeal ganglia
- Supra pharyngeal ganglia and sub pharyngeal ganglia connect together to form circumpharyngeal connectives
- From the sub pharyngeal ganglia arises a double nerve called ventral nerve cord.
- From the ventral nerve cord arise segmental ganglia

Reproductive system

Male reproductive system

Male reproductive system consists of *testes, Seminal Vesicle, Seminal funnel, Vas deferens and Prostate Gland.*

Testes

- There are two pairs of testes. One pair is situated at 10th segment and another pair at the 11th segment.
- Each testis consists of 4 to 8 digits.
- Function – They synthesis sperm.

Seminal Vesicle

- There are two pairs of seminal vesicles.
- One pair is situated at 9th and 12th segment.
- Each seminal vesicle communicates with testes sac.
- Function - Maturation of sperm takes place in seminal vesicles.

Seminal Funnel

- There are two pairs of the seminal funnel.
- One pair is found in the 10th segment and another pair in 11th segment.
- They are ciliated and found below tests.
- Function- Mature sperms from seminal vesicles move back to the testes sac and pass through the spermiducal funnel into vasa differentia.

Vas deferens

- Earthworm has two vas deferens. It is open into male genital aperture.

Penial setae

- It is used for copulation

Prostate Gland

- (i) A pair of Prostate gland found in 18th segment,
- (ii) Prostate gland produces a fluid function of which is not known. Few zoologists believe secretion is useful for activation of sperms.

Female reproductive system

- Female reproductive system consists of ovaries, oviduct and spermatheca.

Ovaries

- A pair of ovaries located at 13th segment.
- It is produced ova.

Oviduct

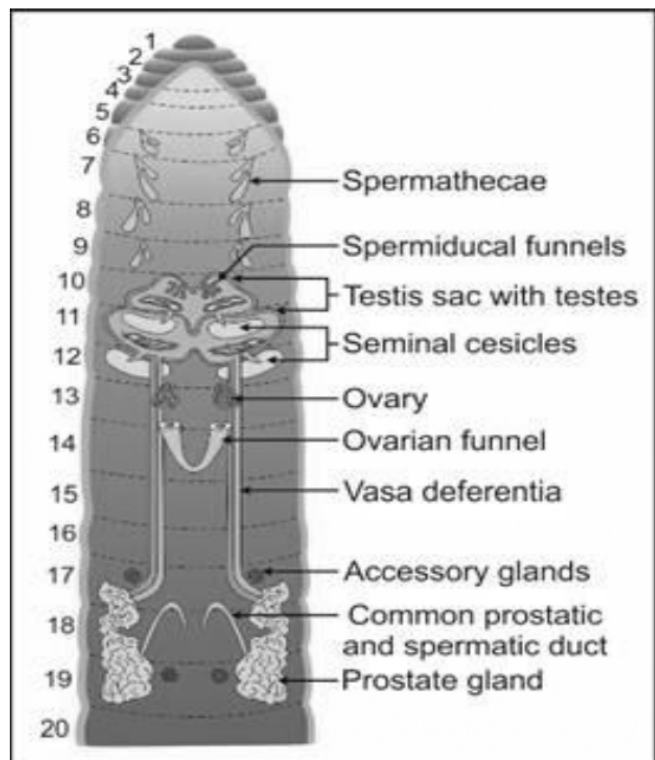
- A pair of oviducts located at 14th segments. One end of the oviduct open into 13th segment is called oviduct funnel and another end open in to out site on the 14th segment by a female genital aperture.

Spermatheca

- Three pairs of spermatheca locate at 7,8 and 9 segments it is sac like structure
- The spermatheca stores the spermatozoa.

Copulation

- Copulation takes place in two earthworms. Two earthworms attach themselves opposite site in ventral surface.
- The male genital pores of one earthworm come to lie exactly against the spermathecal opening of another earthworm.
- The spermatozoa move into the spermathecae. After the copulation earthworm separated.
- Finally the clitellar glands secrete a membranous bag around the clitellar

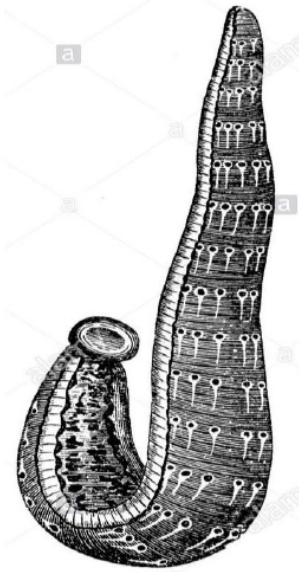


segments. The bag become call as cocoon.

- Ova and albumen are released into the cocoon.
- The earthworm wriggles out of the cocoon backward the spermatozoa are released into the cocoon. After that the cocoon released from the animal.

Development

- Fertilization is external, direct development
- One or two eggs are develop into earthworms remain the eggs used as food for the developing embryo.
- The young earthworm comes out by the rapture of the cocoon



LEECH

Classification

- Phylum** : Annelida
- Class** : Hirudinea
- Order** : Gnathobdellida

General characters of hirudinaria

- Hirudinaria is commonly called *cattle leech*.
- Size: 33 cm
- It is *ectoparasite* of man and animals.
- Habit: It is feed s on blood so it is called *sanguivorous*.
- Habitat: ponds, tanks, lakes, rivers and commonly found forest areas.
- It is a *multicellular, bilateral symmetry, coelomate, triploblastic animal*.
- It is a *metamerically* segmented (33) worm like animal.
- Each segment provide ring like structure is called *annuli*.
- 1 - 2 -1 annulus
- 3 - 2 annulus
- 4-6 - 3 annulus
- 7-22 - 5 annulus
- 23 - 3 annulus
- 24-26 - 2 annulus
- Leech antero-posteriorly elongated and elastic in nature.
- It can be extended (ribbon shaped) and contract in nature (cylindrical).
- Anterior end lobe like structure called prostomium.

Suckers

- Leech has two suckers, one is anterior sucker (5) and another one is posterior sucker (7) ends.

Eyes

- Leech has five pairs of eyes. They are situated anterior region each segment has two eyes.

Receptors

- Each segmented has numbers of projections called receptors.
- **1. Segmental receptors 2. Annulus receptors**

Segmental receptors

- 4 pairs are dorsal side

- 3 pairs are ventral side

Annulus receptors

- 36 receptors located in each segmented of these 18 pairs dorsal side, 18 pairs ventral side.

Mouth

- Situated at middle of anterior sucker.

Anus

- Situated at posterior sucker.

Nephridiopores

- 17 pairs of nephridiopore
- Situated at 6 to 22 segments.

Male genital pore: located at 10th segment.

Female genital pore: located at 11th segment.

Haemocoel

- Leech contain haemocoelomic canal, this canal filled with haemocoelomic fluid. This type of coelom is called haemocoel.

Body wall

Body wall consist of 5 layers

1. Cuticle 2. Epidermis 3. Dermis 4. Muscular layer 5. Botryoidal tissues.

Cuticle

- It is thin and transparent outer layer.

Epidermis

- It is present below the cuticle.
- It is formed by columnar cells.
- Many epidermis cells are glandular and secrete the mucous.

Dermis

- Below the epidermis lies dermis. This layer formed of connective tissues.

Botryoidal tissues

- It is special types of tissues present between body wall and gut.

Locomotion

- Leech move two ways.
- **1. Looping or crawling movement. 2. Swimming movement**

Looping or crawling movement

- This movement contract and relaxation of muscles.
- Two suckers involve movements.
- Animal fixes it posterior sucker on the substratum.
- Body gradually extends forwards and holds the anterior sucker.
- The fixed its posterior sucker it releases and brings closes behind the anterior sucker.
- Here the posterior sucker fixed, and then the anterior sucker is released and movement is released.

Digestive system of leech

- Digestive system consists of **1. Pre oral chamber and mouth 2. Buccal cavity 3. Pharynx 4. Oesophagus 5. Crop 6. Stomach 7. Intestine 8. Rectum 9. Anus.**

Pre oral chamber and mouth

- It is cup like structure on ventral side of anterior sucker.
- Its roof is formed by a membrane like velum bearing a triradiate mouth in the middle.

Buccal cavity

- Mouth leads into buccal cavity.
- The inner wall of buccal cavity contains 3 jaws, one is mid-dorsal another two are ventrolateral in position.
- Teeth are present on the edge of the jaws.
- Jaws have 42-54 button-like salivary papillae.
- Mouth and buccal cavity present the 1-5 segments.

Pharynx

- Buccal cavity leads to pharynx
- Pharynx present at 5-8 segments.
- Pharynx surrounded by salivary glands, that glands secrete **Hirudin** which prevents the coagulation of blood.

Esophagus

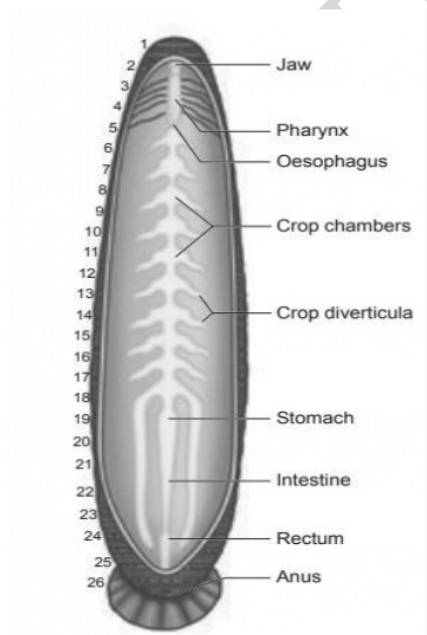
- It is short and narrow

Crop

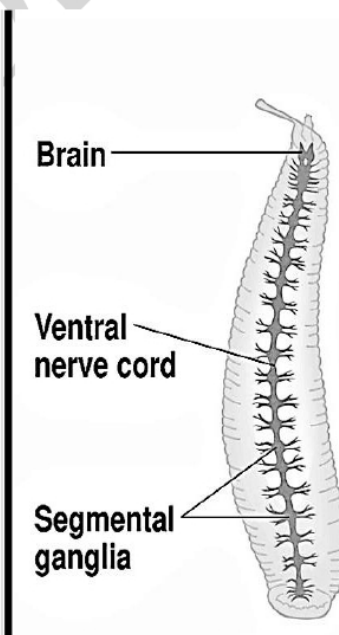
- Oesophagus leads to crop
- It is an extension chamber from 9-18 segments.
- Each chamber arises a pair of caeca.
- The last caeca is largest extending up to 22th segments.
- The crop stores enormous quantity of blood.

Stomach

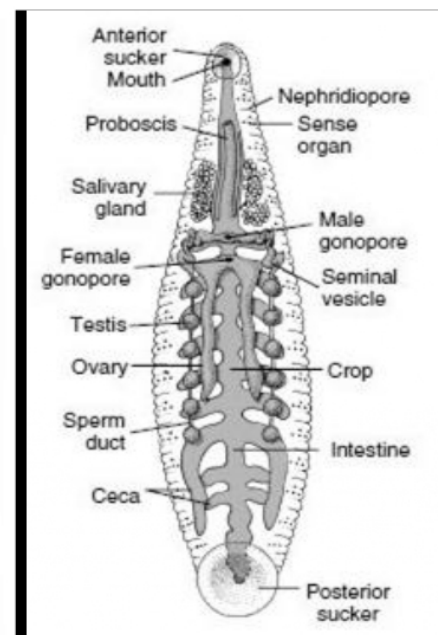
- Last chamber of the crop ends in a funnel-shaped tube called stomach.
- It is located at 19th segment.



Digestive system



Nervous system



Reproductive system

Intestine

- Stomach leads to intestine.
- It is thin walled narrow tube
- It is located at 19-22th segments.

Rectum

- The intestine ends in a region called rectum situated from the 23th to 26th segments.

Anus

- The rectum opens to the outside by anus.

Food

- The leech has a *sanguivorous*.

Digestion

- The blood sucked by the leech is stored up in the crop.
- The blood is passed drop by drop in to the stomach.
- The blood digested by *peptolytic* enzymes.

Absorption

- Digested blood absorbed slowly by the intestine
- The complete digestion take about a year or even more.

Respiration

- There is no special respiratory organ
- The skin serves as respiratory organ
- Gases exchange take place by diffusion.

Circulatory system

- There is no true blood vessel.
- The blood vessels are replaced by canal is called *haemocoelic canal*. This canal filled with haemocoelic fluid.
- There are four longitudinal canals
- One is dorsal side above the alimentary canal. Another one ventral side below the alimentary canal there are no contact in nature. Remaining two located at lateral either side of alimentary canal. This is contract in nature.
- The four canals are connected together at the posterior end.
- There is no heart but the lateral canals serve as heart. They have valve in side. This is contract in nature.
- Dorsal and ventral channels distribute the haemocoelic fluid, but the lateral channels distribute and collect the haemocoelic fluid.
- Haemocoelic fluid flows forwards in the dorsal and lateral channels. But ventral channels fluid flow backwards and the numbers of branches arise from this channel and distribute the fluid all over the body.

Nervous system

- A **brain** located at above the pharynx it is formed a pair of *supra pharyngeal ganglia*.
- *Sub- pharyngeal ganglia* located at below the pharynx. It is formed by four pairs of ganglia.
- A pair of circumpharyngeal connects the brain and *Sub- pharyngeal ganglia*.
- A double ventral nerves cord arising from *Sub- pharyngeal ganglia*. This nerves cord connects the all segmental ganglia from 6-26 segments. The last segment is much larger than the rest.

Excretory system

- Excretory system formed by 17 pairs of nephridia.
- Each nephredia arranged from 6-22 segments.
- There are two types
- **1. Testicular and 2. pre testicular nephridia**

1. Testicular

- These nephridia are connected with the testis.
- These are located from 12-22 segments.
- Each nephridia has following parts
1. Initial lobe 2. Apical lobe 3.Inner lobe 4. Main lobe 5.Vesiculr duct 6. Vesicle 7. Nephriopore.
- The nephridium horse shoe shape.
- It has two limbs one is anterior another one is posterior
- The posterior limbs passes into a thick lobe called apical lobe.
- Between the two limbs there is inner lobe .this inner lobe finished at the testis sac.
- Inner side of the anterior lobe arise a duct called vesicular duct.
- Vesicular duct open in to vesicle. The vesicles open into **nephridiophore** through excretory duct.

2. Pre testicular nephridia

- These nephridia resemble the testicular nephridia but there are not connected with the testes.

Reproductive system of Leech

- It is hermaphrodite animal

Male reproductive system

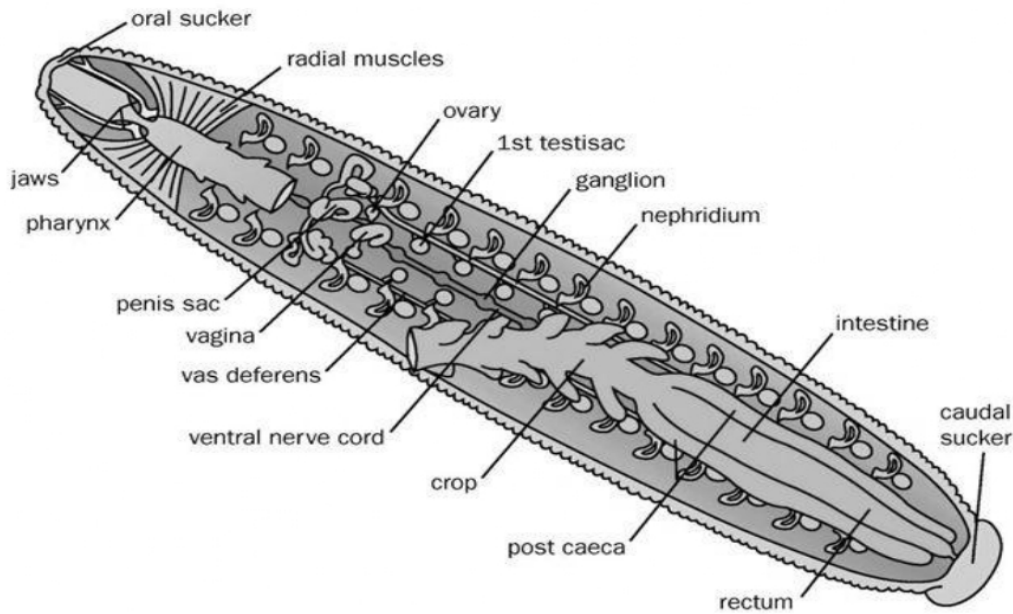
- Reproductive system consist of **testes, vasa efferentia, vasa deferentia, epididymis, ejaculatory duct, atrium**

Testes

- It has 11 pairs of testes located at 12-22 segments.
- It is sac like structure.
- From the testis arises a short duct is vas efferens
- Vas efferens join to the vas deferens
- The 10th segment vas deferens becomes convolute to form the **epididymis** or sperm vesicle.
- The epididymis leads to ejaculatory duct.
- The two ejaculatory ducts join and make atrium.
- During copulation the sperm passed by penis in to vagina.

Female reproductive system

- It is consist of **ovaries, oviducts, common oviduct, and vagina.**
- A single pair of ovaries found in 11th segment
- Ovaries enclosed by ovisacs
- Ovaries released ova.
- From the ovaries a tube aeries is called oviduct.
- The ovum reach vagina through oviduct and common oviduct.



Copulation

- Cross fertilization
- During copulation two leeches come together and contact (join)
- The penis of one leech enters another female reproductive aperture.

Fertilization

- Internal fertilization
- Further development take place in cocoon.

Formation of cocoon

- The cocoon is secreted in the form of snow white **frothy girdle** from 9-11 segments.
- The clitellar glands secrete an aluminous fluid, which is deposited in the cocoon with the fertilized ova.
- Finally the leech removes the entire cocoon.
- Development takes place inside the cocoon.
- Finally cocoon rupture young leech released.
- The process of development takes about 15 days.

METAMERISM IN ANNELIDA

- The linear arrangement of segments one by one (behind the other). These compartment are called **segments or somites or metameres**. The arrangement of segments is called metamerism.
- The animals exhibiting metamerism are called metamericly segmented. Eg Annelida
- In metamerism, each segment is a mirror image of the other segment
- Each segment contains nephridia, blood vessels, reproductive organs, nerves, muscles etc
- The segments work in co-operation with all other segments. They are integrated into a single functional unit.
- The metamerisms in animals are classified into 8 types. They are as follows:
- **1. True metamerism 2. Pseudometamerism 3. Homonomous segmentation 4. Heteronomous segmentation 5. External metamerism 6. External and internal metamerism 7. Complete metamerism and 8. Incomplete metamerism**

1. True metamerism

- In true-metamerism, the segmentation of the body is based on the segmentation of the mesoderm. Eg. Annelida
- New segments develop at the posterior end older segments occur at the anterior end.
- The segments work in co- operation

2. Pseudometamerism

- Pseudometamerism is exhibited by tape- worms
- The segmentation is based on the segmentation of the ectoderm
- New segments develop at the anterior end. Hence the youngest segments occur at the anterior end and the old segments occur at the posterior end
- The segments work as independent units. There is no co-operation between the segments

3. Homonomous metamerism

- In homonomous segmentation, all the segments of an animal are identical. Eg. Nereis. Here the anterior segments are specialized to form the head. This specialization is called cephalization

4. Heteronomous metamerism

- In heteronomous segmentation, the segments are dissimilar. Eg. Arthropoda

5. External metamerism

- In external metamerism, the metamerism marked only externally. Eg. Arthropoda.

6. External and internal metamerism

- The segmentation is marked externally as well as internally. Eg. Annelida. Internally the segments are separated by transverse partitions called septa.

7. Complete metamerism

- In complete metamerism, each segment has all the organs

8. Incomplete metamerism

- In incomplete metamerism the segmentation is not seen in all organs

Origin of Metamerism

There are many theories to explain the origin of metamerism.

- *Corn or fission theory*
- *Pseudometamerism theory*
- *Locomotory metamerism theory.*

Corn or fission theory

- According to this theory, a segmented animal is really a chain of individual zooids.
- Each zooid represents a single segment. These zooids are formed by repeated transverse fission of an unsegmented ancestor.
- The zooids fail to detach themselves and are united end to end.
- These segments gradually become integrated morphologically as well as physiologically and merged into one complex individual

Pseudometamerism theory

- According to this theory, the ancestor was unsegmented. It contained body systems spread out along the length of the body. This unsegmented body became segmented by the development of septa

Locomotory Metamerism theory

- According to this theory, metamerism is formed by the breaking up of the body into segments, as a result of serpentine swimming movements.

Significance of Metamerism

- Metamerism gives many advantages for the animals. They are as follows:
- It facilitates locomotion
- Metamerism offers division of labour.

COELOM

- The cavity located between the *body wall* and the *alimentary canal* is called *Coelom*.

Types of coelom

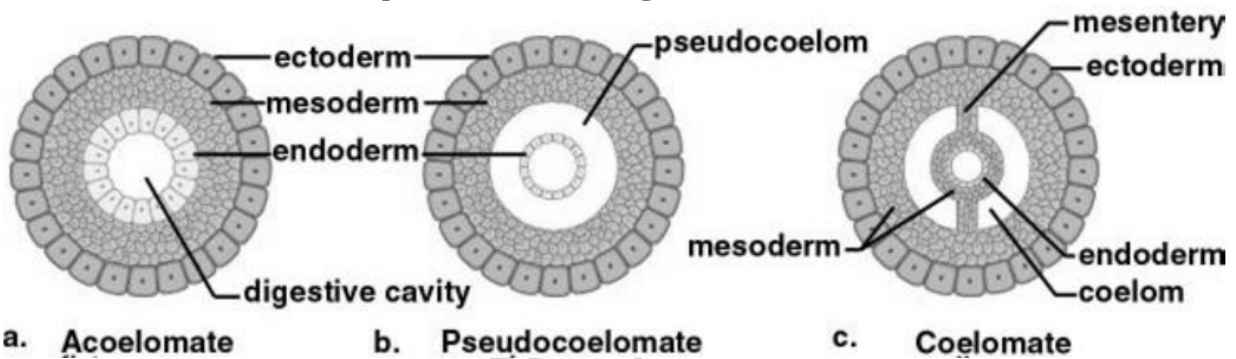
1. *Acoelom* 2. *Pseudocoelom* 3. *Eucoelom* 4. *Haemocoelom*

1. Acoelom

- Some animal has parenchyma cells present between the body wall and alimentary canal this condition is called *Acoelom*. E.g: *Platyhelminthes*

2. Pseudocoelom

- Pseudocoelom or false coelom , the body cavity present between body wall and gut. There is no coelomic epithelium.
- Pseudocoelom filled with pseudocoelic fluid. E.g: *Nematoda*



3. Eucoelom

- It is true coelom
- Coelom located between the body wall and the gut
- Coelom filled with coelomic fluid
- E.g: *Annelida, Arthropoda, Mollusca, Echinodermata and Chordata*
- Eucoelom has two types

1. *Enterocoelom* 2. *Schizocoelom*

1. Enterocoelom

- Coelom developed from **gut** region E.g: *Echinodermata and Chordata*.

2. Schizocoelom

- Coelom developed from **mesoderm** region E.g: *Annelida, Arthropoda, Mollusca*.

4. Haemocoelom

- Some animal coelom reduced in size and the coelom filled with haemocoelic fluid.
- This condition is called **haemocoelom**. E.g: *Annelida (Leech), Arthropoda, Mollusca*.

Origin of Coelom

1. *Enterocoelic origin* 2. *Schizocoeloc origin*

1. Enterocoelic origin

- The coelom arising from the gut is called **enterocoelom**.

2. Schizocoelic origin

- The coelom arising from the mesoderm is called *schizocoelic*.

ADAPTIVE RADIATION IN ANNELIDA

Adaptive radiation is the evolution of a group of organism, along a number of different lines involving adaptation to a variety of ecological niches (Places).

Adaptive radiation in Polychaeta**Free swimming form**

- These form of animal swimming in water or crawling in the sea bottom
- It is locomotory organ is *parapodia*.

Burrowing polychaetes

- These polychaetes are variously modified for a *burrowing mode* of life.
- Eg: *Glycera, Arenicola*

Glycera

- The prostomium conical in shape and it has short tentacles.

Arenicola

- It is live in 'J' shaped burrows.

Tubicolous polychaetes

- These polychaetes live in tubes.
- The tubes are various length, shape and material.
- Eg: *Chaetopterus, Amphirrite, Terebella, Pectinaria, Sabella* and *Serpula*.

Chaetopterus

- It is live in 'U' shaped tubes.

Amphirrite

- It is live in a tube.
- The head bear many tentacles.

Terebella

- It is live in sandy tube.

Pectinaria

- It carries the tube from place to place.

Sabella

- It is brilliantly coloured. Hence it is called peacock worm.
- It is live in membranous tube.

Serpula

- It is live in a hard calcareous tube.
- The tube is attached to shell or other marine objects.

Parasitic polychaetes

- Myzostoma is an ectoparasite on echinoderms.

Adaptive radiation of oligochaetes

- Oligochaetes live in vertical burrows of soil.
- It is elongated cylindrical body with setae.
- Setae used for burrowing life.
- Eg: *Earthworm, Tubifex*

UNIT- II
ARTHROPODA

General Characteristics of Phylum Arthropoda

1. Arthros; Jointed, podos; Foot)
2. Kingdom: Animalia
3. All arthropods are segmented, joined leg and chitinous exoskeleton.
4. Habitat: mostly terrestrial and aquatic
5. It is largest phylum about 80% known species.
6. Body has Three-part: **head, thorax, and abdomen.**
7. Body is metamericly segmented
8. Compound eyes which contain several thousand lenses leading to a larger field of vision.
9. They possess two antennae.
10. Symmetry: bilateral
11. Germ layer: triploblastic
12. Grade of organization: organ system grade
13. Coelom: haemocoel
14. Chitinous (hard) exoskeleton, no bones or a skeleton
15. Respiratory system: by general body surface, by gills, tracheae or book lungs
16. Circulatory system: open type with dorsal heart.
17. Excretion: **malpighian tubules** or **green gland**
18. Nervous system: dorsal brain with ventral nerve cord
19. Sexes are separate. Sexually dimorphism is present
20. Fertilization: internal.
21. Development: direct or indirect with larval stages.

Classification

- Arthropoda is classified into five classes on the basis of body divisions, body appendages, habitat, and organs of respiration and modes of excretion.

Class: 1 Merostomata

- Habitat: aquatic or marine
- The abdominal appendages are modified into gills.
- Abdominal end is a telson
- Lateral compound eyes are present.
- Ex: **Horseshoe crab**

Class: 2 Arachnida (Arachne: spider)

- Habitat: mostly terrestrial and rarely aquatic
- Body is usually divided into **cephalothorax** and **abdomen.**
- There are four pairs of legs attached to the cephalothorax.
- Respiration: by **tracheae** or **book lungs or gills.**
- Excretion: by **malpighian tubules** or **coxal gland or both.**
- Examples: *Aranea* (Spider), *Palamnaeus* (Scorpion), *Limulus* (King Crab),

Class: 3 Crustacea (Crusta: shell)

- Habitat: They are mostly aquatic, few are terrestrial and very few are parasitic.
- Cephalothorax: Head is often fused with thoracic segments to form cephalothorax.

- Thorax and abdomen have a pair of biramous appendages in each segment.
- Respiration: through the gills or general body surface.
- Excretory organs are modified coelomoducts which may either maxillary glands or antennary glands.
- Examples: *Cancer* (crab), *Palaemon* (Prawn), *Daphnia* (water flea) etc.

Class: 4 Myriapoda (Myrios: ten thousand; podos: foot)

- Habitat: Mostly terrestrial.
- Many appendages: Body is long with numerous segments each having one or two pairs of legs.
- Head is distinct with antennae, a pair of eyes and two to three pairs of jaws.
- Excretion: by malpighian tubules.
- Respiration: by trachea.
- Examples: *Julus* (Millipede), *Scolopendra* (Centipede), *Spirobolus* etc

Class 5 Insecta (Insectus: divided)

- Habitat: Mostly terrestrial and rarely aquatic
- Body divided into three regions: head, thorax and abdomen.
- Thorax has three segments, each bearing a pair of leg and a pair of wings found on second and third segments.
- Abdomen has 7-11 segments without appendages.
- Respiration: by tracheae, gills etc.
- Excretion: usually by malpighian tubules.
- Examples; *Pieris* (Butterfly), *Periplaneta* (Cockroach), *Tabernus* (Housefly), Mosquitoes, Ants, etc.

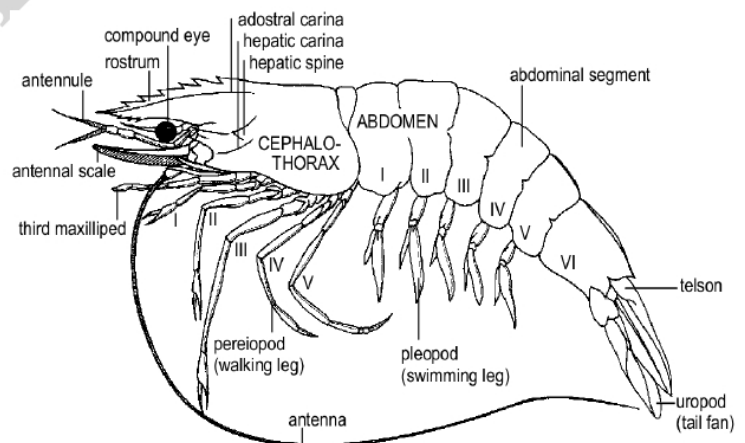
PRAWN

Classification

Phylum : Arthropoda
 Class : Crustacean
 Order : Decapoda

General characters of prawn

- Habitat: marine form segmented and joint leg animal.
- Habit: Omnivorous
- Body cover by *chitin*
- ***Chitin is very hard and*** its form exoskeleton
- This exoskeleton protects the body.
- Each segment exoskeleton dorsal piece is tergum and ventral piece is sternum.
- Cephalothorax covers by ***carapace*** or ***dorsal shield***.
- Anterior carapace produced a spine is called rostrum.
- It is serrate in nature.
- Mouth located between the mandibles.
- Anus is located posterior end.
- Body has 19 segments
- Body has two regions



1. Anterior - *cephalothorax* – 13 segments join in nature
2. Posterior- *abdomen*- 06 segments free in nature

Cephalothorax

- It is formed by the fusion of two regions
 1. Head (*5 segments*)
 2. Thorax (*8 segments*)
- Each segment has a pair of appendages presented in ventral side.
- Last projection is called **telson**
- Prawn has two compound eyes.

Appendages of prawn

- Cephalic appendages – 5 segments
- Thoracic appendages – 8 segments
- Abdominal appendages – 6 pairs

1. Antennules 2. Antenna 3. Mandible. 4-5. I and II Maxillae, 6-8. I,II,III Maxillipedes, 9-13. I-V walking legs, 14-18. Pleopods, 19.Uropod.

- Each appendages formed many segments called *podomeres*.
- **Each** appendages do various function like sensory, feeding, locomotion, respiration, copulation etc.,
- Appendages consist of a basal region called *protopodite* made up of two segments namely coxa and basis.
- The protopodite has two fingers like processes called exopodite and endopodite.
- Exopodite larger than endopodite
- This type of appendages is called biramous.

Cephalic appendages – 5 segments

1. Antennules 2. Antenna 3. Mandible. 4-5. I and II Maxillae

1. Antennules

- It is first pair of appendages
- It is present below the eye
- Protopodite consist of three podomeres **1.Pre coxa 2. Coxa. 3. Basis**
- Endopodite and exopodite modified into flagella.
- Function: sensory

2. Antenna

- The protopodite shows coxa and basis.
- Endopodite is long feeler like structure, which is a tactile sense organ.
- The exopodite is plate like and it is called Squama.
- It works as a balancer during swimming.
- At the base of the coxa renal opening is present.
- Antenna is sensory, excretory and balancing in function.

3. Mandibles

- They are present on either side of the mouth.
- The basal part of coxa is divided into two parts, it shows a mandibular and incisor process.
- The mandibular process shows 5 or 6 dental plates.
- The incisor process shows 3 teeth. On the outer margin of the head a mandibular palp is present, which represents the basis and endopodite.
- The exopodite is absent. The mandibles are masticatory in function.

4. I Maxillae or Maxillula

- The protopodite is 2 lobed. They are called Gnathobases.
- The endopodite is slender. Exopodite is absent.
- It helps in the manipulation of the food.

5. II Maxillae

- The protopodite is fan and is divided into 4 lobes.
- Endopodite is small and unsegmented.
- The exopodite is broad, and plate like structure.
- It is called Scaphognathite or baler. It is useful to bring in water into the branchial region.
- It is helpful for respiration and manipulation of food.

Thoracic appendages

- They have 8 pairs of appendages.
- The first 3 pairs are Maxillipedes.
- The remaining 5 are walking legs.

I Maxillipede

- They are thin and leaf like.
- Protopodite is 2 segmented. The endopodite is short.
- Exopodite is present.
- It is bilobed. Epipodite is respiratory in function.
- It is present on the outer side of coxa.

II Maxillipede

- It has 2 segmented protopodite.
- Coxa bears a conical epipodite and a gill Endopodite is 5 segmented.
- The five segments are ischium, merus, carpus, propodus and dactylus. Exopodite is long and unsegmented.

III Maxillipede

- It looks like a walking leg. It has 3 segmented endopodite.
- The basal segment corresponds to ischium and merus.
- The apical segment is fused and corresponds to propodus and dactylus.
- The middle one is carpus.

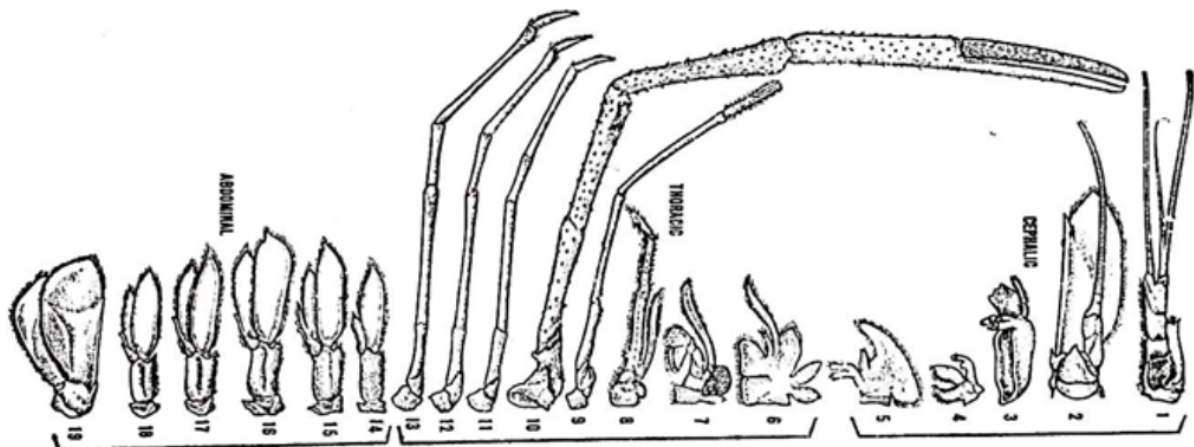
Walking legs

- They have 5 pairs of walking legs.
- The first 2 pairs are chelate and the other 3 pairs are nonchelate.
- They are useful for walking.
- The typical walking leg has a two jointed protopodite and 5 jointed endopodite.
- The protopodite has two segments, coxa and basis.
- The endopodite has ischium, merus, carpus, propodus and dactylus.
- In the first and second pairs of legs propodus is prolonged beyond its articulation with dactylus and it looks like a chela or pincer.

- Such legs are called chelate legs. They catch the food and push it into the mouth.
- The second chelate, leg in male is larger and powerful than in females.
- The 3rd, 4th and 5th walking legs are non chelate.
- In female the 3rd walking leg bears a female reproductive opening on the inner side of coxa.
- In the male the genital opening is present on the arthrodial membrane between the thorax and 5th walking leg.

Abdominal Appendages

- Abdomen bears six pairs of appendages.
- Each appendage is biramous. These are called pleopods or swimmerets.
- The protopodite has *coxa and basis*. The basis bears two flat leaves like *exopodite* and *endopodite*.
- From the inner margin of the endopodite a small appendix interna arises.
- In the females during breeding season the appendix interna of opposite appendages unite and carry eggs.
- In a uropod the coxa and basis fuse together to form a triangular sympod. It bears exo and endopodites.



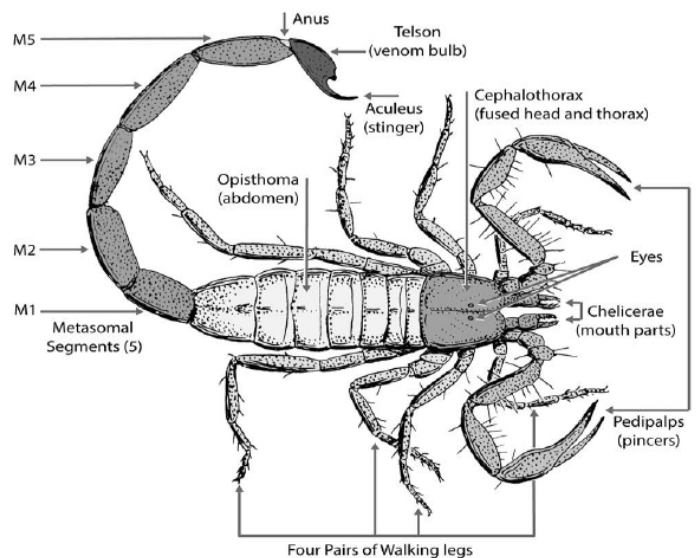
Appendages of Prawn

SCORPION

Kingdom : Animalia
 Phylum : Arthropoda
 Class : **Arachnida**
 Order : Scorpionida

General characters of scorpion

- Habitat: Terrestrial animal.
- It is *first land arthropods*.
- They live without any changes from the day of origin. Hence they are called *living fossils*.
- It is nocturnal animal.
- It is live under the *stone, logs, dries leaves and hills region*.



- It is carnivorous in habit

Morphology

- **Body elongated and dorsoventrally flattened body.**
- It is **bilateral symmetry**
- Body covered exoskeleton formed of **chitin**.
- Body consist of **18 segments**
- Body divided in to 3 regions
1. Prosoma 2. Mesosoma 3. Metasoma

1. Prosoma

- It is anterior region or **cephalothorax**.
- It is consist of **6 segments**.
- Prosoma covered by carapace.
- It has **4 pairs of eyes**.
- One pair of eyes present in **dorsally (larger in size)** and remaining 3 pairs of eyes located **laterally (smaller in size)**
- Each segment has a pair of appendages (leg), namely **chelicerae, pedipalpi** and **walking legs**.

Chelicere

- It is a first pair of appendages.
- It is small and locates sides of the mouth.
- It is used to hold the food.

Pedipalpi

- It is second pair of appendages.
- It is large leg called **chelate**
- Chelate made up of 6 segments (join) namely
1. Coxa 2. Trochanter 3. Humerus 4. Branchium 5. Hand 6. Fingers.
- It is used to seize the prey.

Walking leg

- 4 pairs of walking legs located at 3-6 segments.
- Each segment has legs. These legs have 7 segments or join namely;
1. Coxa 2. Trochanter 3. Femur 4. Patella 5. Tibia 6. Profarus 7. Tarsus
- The tarsus has a pair of claws.

2. Mesosoma

- **It is a middle region**
- **It has six segments**
- Each segment consist of **dorsal tergum** and **ventral sternum**
- **Tergum** and **sternum** connected **Pleural membrane**.
- The sternum of the first mesosomal segment has **genital operculum**.
- The second sternum has comb like structure called **Pectines**
- The pectines consist of shaft, fulcra and teeth.
- The pectine is a tactile function.
- The remaining four pair of mesosomal segments bears 4 pair of laterally arranged opening called **stigmata**

- These are the openings of book lungs.

3. Metasoma

- It is a posterior region
- It is consist of 6 segments.
- The last segment of metasoma has sting
- The sting is formed of a swollen part called a *vesicle* and *pointed spine*.
- The inside of the vesicle has two poison glands opens into the spine.
- Mouth is a small opening at the ventral side.
- Anus located at the base of sting ventrally.

Body cavity

- The body cavity is the *haemocoel*. It is filled with *haemocoelic fluid*.

Endoskeleton

- The endoskeleton located between at *prosoma* and *mesosoma* it is called *endosternite*.

Digestive System

It is formed of the *alimentary canal* and the *digestive glands*.

Alimentary Canal

- The alimentary canal is formed of four regions, namely the *pre-oral cavity*, *the fore gut*, *the mid-gut* and *the hind-gut*.
- *Pre-oral cavity* is a large cavity located in front of the mouth.
- *The fore-gut* is formed of the mouth, the pharynx and the oesophagus.
- *The mid-gut* consists of the *stomach* and the *intestine*.
- *The oesophagus* leads into a tubular stomach. The stomach extends up to the diaphragm.
- The stomach followed by the intestine. It is long and wide. It extends upto the fifth segment of the metasoma.
- Two pairs of malpighian tubules are attached to the intestine in the middle.
- *The hind-gut* is short and occupies the last segment of metasoma.
- It opens to the outside by the anus located at the base of the sting

Digestive glands

- Scorpion has two types of digestive glands, namely the *stomach glands* and the *hepatopancreas*.

1. **Stomach glands:** These glands are located around the stomach. They open into the stomach by a pair of ducts.

2. **Hepatopancreas:** It is a brownish gland located around the intestine in the mesosoma.

It is formed of many lobes. It opens into the intestine by five pairs of hepatic ducts.

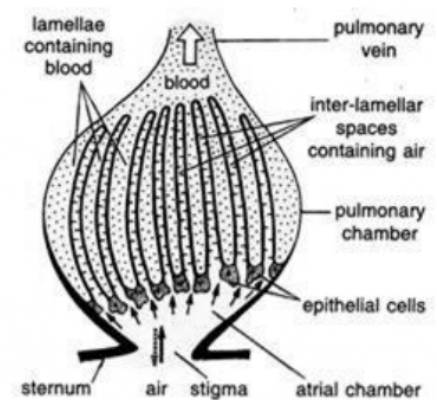
- Its function is not clearly known.

Feeding

- Scorpion is carnivorous. It feeds on insects, spiders, etc.
- It also exhibits cannibalism.
- The prey is captured by the *pedipalpi*.
- The sting paralyses or anesthetic the prey.
- The *chelicerae* tear the prey into pieces.
- *Absorption* takes place in the intestine.
- The undigested food is sent out through the anus.

Circulatory system

- It has open type of circulatory system.



- It is consist of *Heart, Arteries, Sinuses* and *Veins*.

Heart

- Heart is tubular structure, located at Mesosoma.
- It is covered by Pericardium membrane.
- Heart is formed 7 chambers.
- Each chamber has a pair of *ostia* and a pair of *systemic aorta*.
- Heart anteriorly leads to *anterior aorta* and posteriorly leads to *posterior aorta*.
- Heart function is contraction and relaxation (Peristaltic movement).

Arteries

- Heart has three types of arteries there are
 1. *Anterior aorta* 2. *Posterior aorta* 3. *Lateral aorta*.

1. Anterior aorta

- It is arises from anterior end of the heart
- It is runs forward and supplies blood to the prosoma.

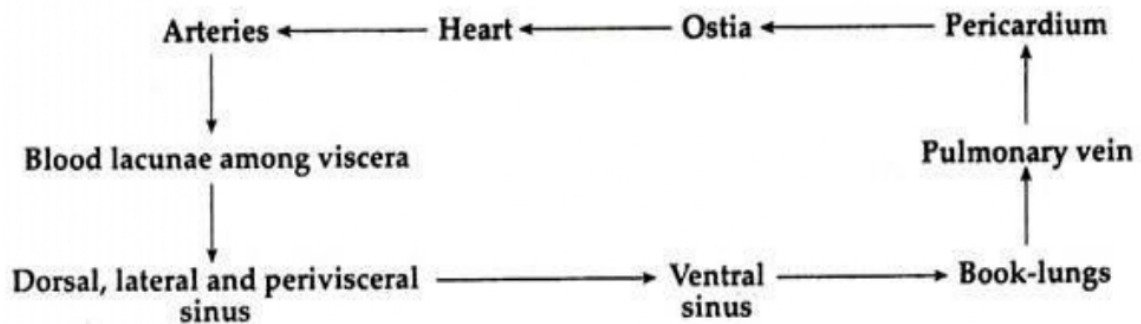
2. Posterior aorta

- It is arises from posterior end of the heart
- It is runs backward and supplies blood to the metasoma.

3. Lateral aorta

- It is arises from side of the heart
- One pair of aorta arises from each chamber of heart
- It is supply the blood to the mesosoma.

Diagrammatic representation of course of the blood circulation in scorpion :



3. Sinuses

- The aorta breaks in to small vessels. The blood collected from them and makes a small space is called *lacunae*. The lacunae open into large space called *sinuses*.

Vein

- Blood passes from the ventral sinus to the book lungs for oxygenation.
- The oxygenated blood is carried to the pericardial sinus by pulmonary veins.

Course of circulation

- Heart contract, the blood sent to various organs by arteries.
- The impure blood collected from lacunae
- The blood stream ventral sinuses to book lungs for oxygenation.
- Then the oxygenated blood move to heart through pericardial sinus, pulmonary vein and ostia.

Respiration

- Respiratory organ is four pairs of book lungs.
- They are found in 8,9,10 and 11 segments.
- The book lungs open out by stigma.
- The cavity of book lungs lined by cuticle.
- The book lungs contain numbers of fold is called *lamellae*. They contain blood.
- Each stigma leads into a small chamber is called atrial chamber, the atrial chamber leads in to large pulmonary chamber.

Excretory system

The excretion is carried out by the following organs

1. Coxal glands 2. Malpighian Tubules 3. Hepatopancreas.

1. Coxal glands

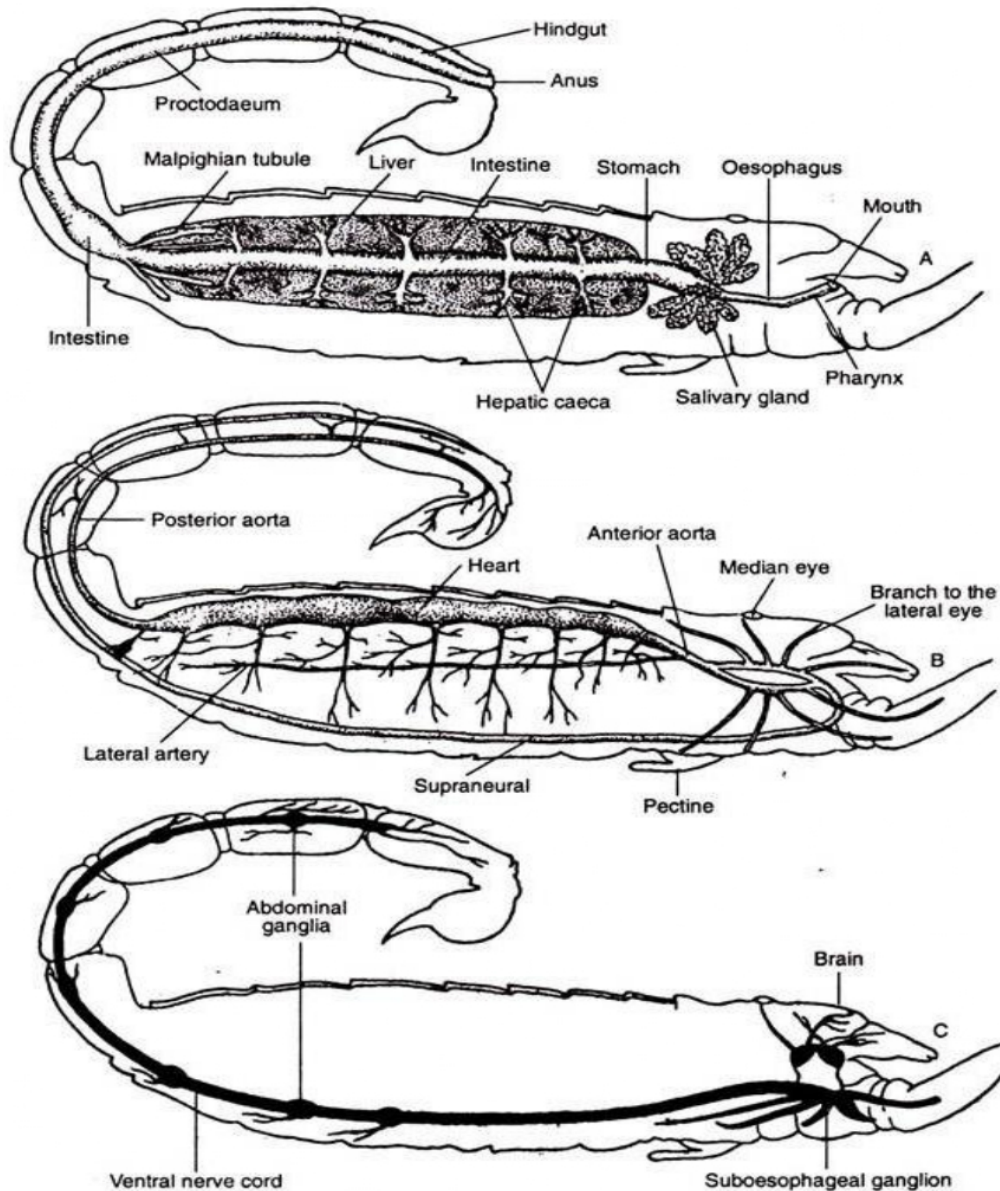
- Scorpion has a pair of coxal glands.
- They situated at the third walking leg.
- Each gland is a modified coelomoduct.
- It is consist of large end sac, coiled labyrinth and bladders.
- The sac and labyrinth filter the nitrogenous waste.
- The bladder open outside by excretory pore.

2. Malpighian Tubules

- Scorpion has two pairs of malpighian tubules.
- One end attached to the mid gut and another end freely floats at the blood.
- Nitrogenous waste is collected from the blood into the lumen and passed into the gut.

3. Hepatopancreas

- It is located around the intestine
- It is open into gut by five pair of duct.
- It is believed as excretory function.



18.112: Internal structures of scorpion. A. Alimentary system (lateral view). B. Heart and arterial system (lateral view). C. Nervous system (lateral view).

Nervous system

- Nervous system consists of the brain, sub-oesophageal ganglia, nerve ring, and double ventral nerve cord.

Brain

- It is located in the prosoma and nerve ring, sub-oesophageal ganglia are located first six pair of appendages.

Ventral nerve cord

- It arises from the sub-oesophageal ganglia
- It has seven ganglia.
- The first ganglia located at 4th segment of mesosoma.
- The remaining ganglia located up to 4th segments of metasoma.

Sense organ

1. Sensory setae
2. Median eyes
3. Lateral eyes
4. Pectines

1. Sensory setae

- They are out growth of body wall.
- They are tactile sense organ.

2. Median eyes

- Median eyes located dorsal side of the scorpion.
- They are sensitive the light cannot produce image.

3. Lateral eyes

- They have three pair of lateral eyes located on the dorsal side of the carapace.

4. Pectines

- It is a comb like structure located at ventral side of the scorpion.
- It is formed shaft, fulcra and teeth.

Reproductive system

- Sexes are separate, Sexual dimorphism, Male smaller than female.

Male reproductive system

- A pair of testes located at mesosoma.
- Each testis has three squares.
- A small tubes arises from anterior part of the testis is called vas deferens.
- It is run forward.
- Vas deferens become wider is called seminal vesicle.
- Seminal vesicle leads to ejaculatory ducts and open into the genital atrium.

Female reproductive system

- A single ovary located at mesosoma
- It is consist of three squares.
- Oviduct arises from ovary and it is open into common gonopore.

Copulation

- Fertilization internal, Development internal
- During copulation male digs a hole and copulation is complete with in it.
- After the copulation a female eats the male.
- Scorpion is 'viviparous'
- The young ones resemble the adults and they undergo several moults before growing into adult.

LARVAL FORMS OF CRUSTACEA

- In Crustaceans, the development is direct or indirect.
- In direct development, the egg hatches in to a young one resembling the adult.
- In indirect development, the egg hatches in to a larva.

The following larvae occurs in the life cycle of Crustaceans

1. *Nauplius*
2. *Metanauplius*
3. *Cypris*
4. *Kentrogen larva*
5. *Zoea*
6. *Alima*
7. *Megalopa*
8. *Mysis*
9. *Phyllosoma*

1. Nauplius

- It is the first larva hatched from the egg in most of the Crustaceans.
- It is minute and microscopic and free swimming larva
- It is oval in shape; the anterior end is broad and the posterior end is narrow.
- The body has three regions, namely the anterior head, the middle trunk and the posterior anal region
- The head has a simple median eye on the dorsal side
- It has three pairs of appendages. The first pairs of appendages are **uniramous** and are called **antennule**. The second and third pairs of appendages are **biramous** and are called **antenna** and **mandible**. The mandible has no teeth.
- The posterior end has a caudal fork.
- The nauplius larva grows and under goes several moults and finally develops into the next larva called metanauplius

2. Metanauplius

- It is the second larva of *Penaeus*.
- It develops from the nauplius.
- The body has an anterior cephalothorax and a posterior abdomen.
- The abdomen ends in a caudal fork.
- The anterior end has a pair of frontal sense organs.
- The larva has three pairs of appendages
- It has a median eye.

3. Cypris

- It is the larva of *Sacculina*, *Balanus* and *Lepas*
- It develops from **nauplius**.
- It is a free swimming larva.
- It is triangular in shape.
- The larva has seven pairs of appendages, namely a pair of antennules and six pairs of thoracic appendages
- The abdomen has a pair of caudal spines
- The terminal ends of antennules are hooked
- A median eye is present
- After a short free swimming life, the Cypris larva is attached to a crab with the help of its hooked antennules and develops into the next larva called **Kentrogen larva**.

4. Kentrogen Larva

- It is the larva of *Sacculina*
- Kentrogen larva is attached to the body of a crab
- It looks like a sac covered with a cuticle
- The bag encloses a mass of germ cells.
- Inside the body of the crab the Kentrogen larva develops into the next larva the ***Sacculina interna***

5. Zoea

- Zoea develops from the *metanauplius*.
- It is free swimming larva.
- It is minute and microscopic.

- Body is divisible into *cephalothorax* and *abdomen*.
- Cephalothorax covered by *carapace*.
- Thorax the 3 pairs of maillipedes and abdomen has six segments.

6. Alima larva

- It is the larva of **Squilla**.
- It is a modified zoea larva.
- It is a pelagic larva, having a glass-like transparency and occurring in large numbers in the plankton.
- It has a slender form, and a sort and broad carapace. All the head appendages are present. But only is 6-segmented, having 4 or 5 pairs of pleopods.

7. Megalopa larva

- It is the larva of *crab*.
- It is develops from *Zoea*.
- It is a pelagic larva.
- The body is divisible into a *cephalothorax* and an *abdomen*.
- All the appendages, eyes are well developed.
- The Megalopa developed into the *crab*.

8. Mysis

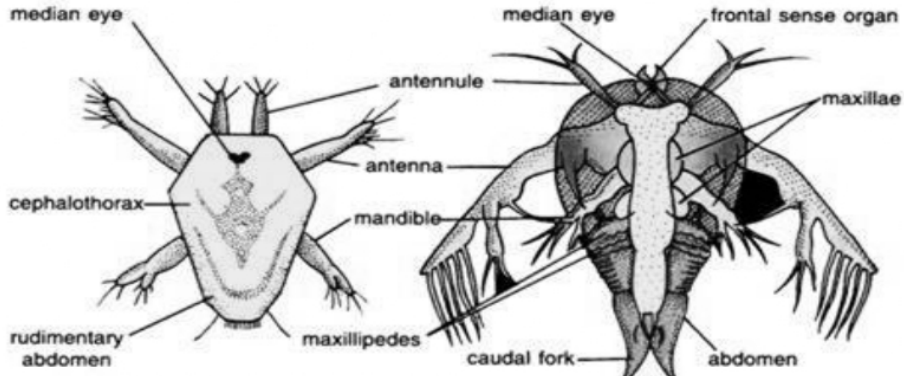
- In some crustaceans like *Prawns*, the *Zoea* larva develops into the *Mysis*.
- It is elongated, body divisible into a *cephalothorax* and an *abdomen*.
- Cephalothorax covered by *carapace*.
- Anterior the carapace is produces into a spine called *rostrum*.
- All the appendages, eyes are well developed.

9. Phyllosoma

- It is the larvae of rock-lobster.
- It is commonly called *glass-crab*.
- It is a pelagic larva.
- Body divisible into a *cephalothorax* and an *abdomen*.
- Cephalothorax covered by *carapace*.
- Thorax has four appendages, abdomen has no appendages.
- *Phyllosoma* develops in to the adult.

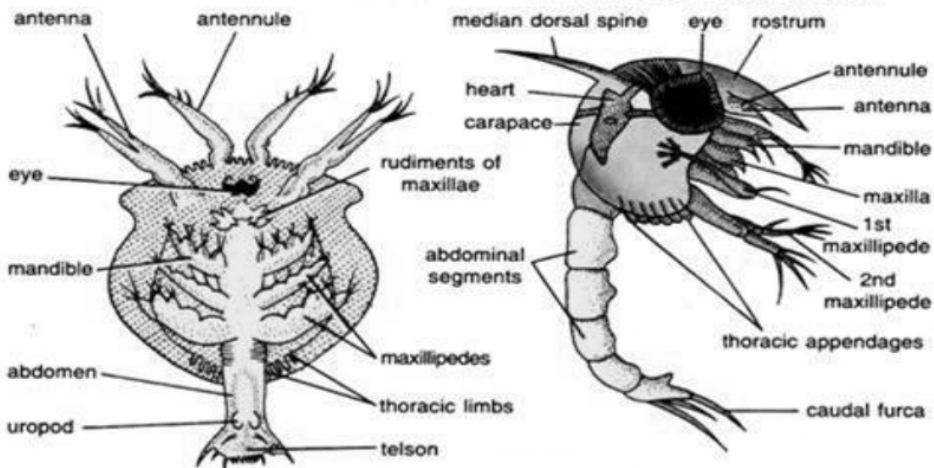
Significances

- They help in the dispersal of species.
- They help to study the relationship between the different groups of crustaceans. The closely related groups have similar larvae
- The larvae help to finalize the systematic position of certain disputed Crustaceans.
- It is believed that all crustaceans might have evolved from a common ancestor resembling the nauplius larva.



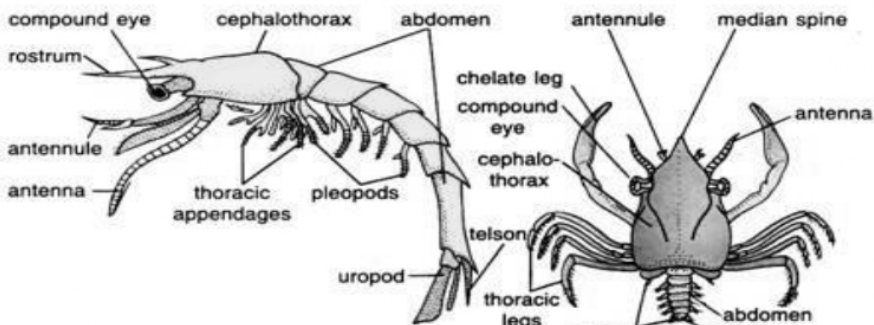
NAUPLIUS LARVA OF CYCLOPS

METANAUPLIUS LARVA OF APUS



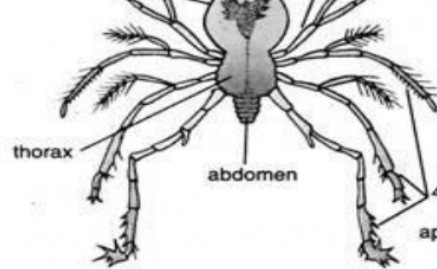
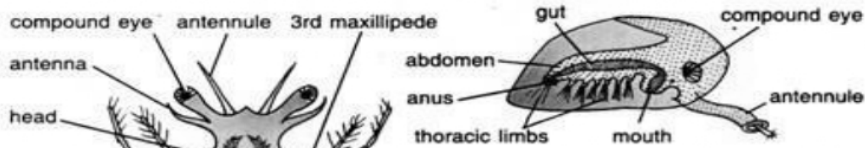
PROTOZOAEA LARVA OF EUPHAUSIA

ZOEAE LARVA OF CRAB

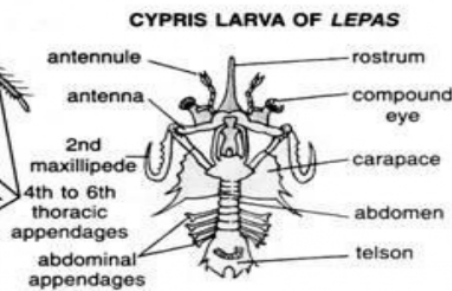


MYSIS LARVA OF PENAEOUS

MEGALOPA LARVA OF CRAB



PHYLLOSOMA LARVA OF PALINURUS



ALIMA LARVA OF SQUILLA

PERIPATUS

- Peripatus is the only genus existing under the class *Onychophora* of phylum *Arthropoda* and it retains many ancestral characters. Hence it is called a living *fossil*. It is a connecting link between *Annelida* and *Arthropoda*.
- It exhibits discontinuous distribution and is found in warmer parts of the world, namely Africa, Australia, New Zealand, Central America, Mexico, West Indies, India and Malaya.

Salient Features

1. Peripatus is a terrestrial animal. It lives in the moist and shady places under the bark of dead trees.
2. It is nocturnal and insectivorous in habit.
3. It looks like a caterpillar growing to a length of 1.5 cm to 15 cm.
4. The body is unsegmented, but the parts of the body are segmentally arranged.
5. The body consists of a head and a trunk.
6. The head bears a pair of antennae, a pair of eyes, a pair of oral papillae and a mouth.
7. The trunk bears 14 to 43 pairs of legs. The legs are unsegmented and each leg bears a pair of claws.
8. The anus is situated at the posterior end of the trunk.
9. The body is covered by a *soft, velvety skin*. The skin shows many transverse wrinkles and numerous conical papillae.
10. The mouth is surrounded by a pair of *chitinous jaws*.
11. The body wall is *dermomuscular*.
12. The body cavity is a *haemocoel*.
13. The alimentary canal is a *straight tube*.
14. A pair of salivary glands is connected with the alimentary canal.
15. A pair of *slime glands* is located inside the body. The ducts of slime glands open at the tip of oral papilla. The prey is captured by spurting mucous from the slime gland.
16. Respiration is carried out by *trachea* with *spiracles*.
17. Excretion is carried out by segmentally arranged *metanephridia*.
18. It excretes *uric acid*. Hence Peripatus is a uricotelic animal.
19. The heart is in the form of a long tube extending the whole length of the body. It is surrounded by a pericardial sinus. The heart opens into the pericardial sinus by paired ostia.
20. The nervous system is ladder-like.
21. The sexes are separate.

Affinities

- Peripatus was first described by *Guilting in 1825*. He placed it in the phylum Mollusca because of its slug-like appearance.
- In *1874 Mosely* placed it under the phylum Arthropoda. It is a connecting-link between *Annelida* and *Arthropoda*.
- It exhibits Annelidan characters, Arthropodan characters and unique characters of its own.

1. Annelidan Characters

1. The *segmentation* is more or less *homonomous*
2. The body is *vermiform*.
3. The body wall is *dermomuscular*.
4. The legs are hollow and unjointed like those of *parapodia*.
5. The eyes are simple.
6. The nephridia are segmentally arranged,
7. Genital ducts are ciliated.
8. Alimentary canal is straight.

2. Arthropodan Characters

1. The antennae are jointed and are similar to those of arthropoda.
2. The jaws are the modified appendages.
3. *Haemocoel* is present in both the groups.
4. The heart is provided with lateral ostia.
5. Respiration is carried out by the *tracheal system*.
6. Salivary glands are connected with the digestive system.
7. The body is covered with a chitinous cuticle.
8. The appendages are provided with claws.
9. The development is like that of *arthropods*.

Unique Features of Peripatus

1. Segmentation is not distinct.
2. The stigmata are arranged in a *scattered pattern*.
3. The nervous system is ladder-like and without segmental ganglia.
4. The skin is soft, velvety with many transverse wrinkles and numerous papillae.
5. There is only one pair of jaws.

Conclusion

- Peripatus shows both Annelidan and Arthropodan characters. So it forms a connecting *link between Annelida and Arthropoda*.
- It gives an idea that arthropods might be originated from an annelid-like ancestor.

ECONOMIC IMPORTANCE OF INSECTS

- Insects constitute the largest group in the animal kingdom. Insects are closely associated with man like his domestic animals.
- They live on and around human beings. They are inseparable from human lives. On the basis of their importance to man, insects are classified into two groups, namely

1. Beneficial insects 2. Harmful insects**1. BENEFICIAL INSECTS**

- Beneficial insects are useful to man and they promote the economic growth of the world.
 - The beneficial insects are classified into two groups, namely
- 1. Productive insects 2. Helpful insects***
- Insects which yield useful products are called productive insects. The useful products of insects are the following:

1. Honey:

- Honey is produced by honey bees.
- It is the nectar of flowers collected, processed and stored by honey bees.
- Honey is used as a natural sweet and medicine.
- Honey is intensively produced by apiculture.

2. Bee-wax:

- It is the secretion of hypo-dermal glands located on the abdomen of bees.
- It is used by bees for the construction of bee-hives.
- The wax of bee-hives is extensively used by man

3. Silk

- Silk is a protein fibre secreted by the larva of silk-moth for the construction of cocoon. Silk is intensively produced by sericulture, the rearing of silk-worms.

4. Lac

- Lac is secreted by the lac insect *Laccifer lacca*.
- It is used for the manufacture of *shellac*.

5. Galls

- Galls are peculiar growths produced by gall insects.
- Galls are used for the preparation of tannin, inks and dyes.
- Tannin is used in the process of tanning hides

6. Cochineal dye

- It is manufactured from the dried bodies of scale insects *Coccus cacti*, *Dactylopius*, etc.

7. Cantheridine

- Cantheridine is a medicine prepared from the dried elytra of blister beetles, *Lytha* and *Mylabris*.

8. Insect-food

- Certain insects are used as food.
- Greeks prepare a kind of flour by grinding grasshoppers.
- Insects form the main source of food for frogs, lizards, snakes, fishes, birds, moles, shrews and ant eaters

9. Medicines

- Many products of insects are used as medicine. Honey is used as an antibiotic.
- The bee venom is used to cure rheumatism.

2. HELPFUL INSECTS

- These insects do favorable and beneficial works for man.

1. Pollination

- Certain insects act as pollinating agents. Bees, wasps, butterflies, etc. are the important insects acting as pollinators.
- They transfer pollen grains from one flower to another while collecting nectar

2. Predators

- Some insects help man by killing and eating harmful insects.
- Dragon flies eat Mosquitoes. The nymphs of dragon flies eat mosquito larvae.
- The larvae of lady-bird beetles feed upon aphids infecting cotton plants.
- The larvae of blister beetles bore through the egg-capsules of locusts and destroy them.

3. Scavengers

- Carrion beetles bury human faeces and cattle dung in the ground.
- The flesh flies lay eggs in animal carcasses which are completely eaten up by their maggots in all time.
- Ants dispose all kinds of decaying organic matter.

4. Parasitic Insects

- Certain insects are parasitic on harmful insects and destroy them.
- The insect *Lydella stabulus* is parasitic on corn borer.
- The wasp *Megarhyssa lunator* is parasitic on wood-boring caterpillars

5. Soil Fertility

- Insects promote soil fertility by making burrows in it and by adding their faeces and dead bodies to it.

6. Ornaments

- Brightly coloured part of insects are used as ornaments in trays, rings and necklaces

7. Entertainment

- Crickets are reared as pets by Orientals.
- Certain insects create inspiration for composing poems, music, etc.

8. Scientific Study

- *Drosophila melanogaster* is intensively used in genetical study.
- Cockroaches are used for laboratory dissections.
- **Grasshoppers** are used forr studying meiosis.
- *Chironomous* larva is used for the study of giant chromosomes.

SOCIAL LIFE IN INSECTS

Numerous members of the same species live together and cooperate with each other in an organised way to form societies and colonies, this is called social life. Social life is well developed in insects.

Insects Exhibiting Social Life by the following

1. Bees -*Apis indica*, *A. dorsata*, *A. mellifera*, etc
2. Ants
3. Termites
4. Wasps.

1. Large Population

- Social life is characterised by large population. Each colony is formed of thousands of individuals.
- For example a honey-bee society is formed of 50,000 to 80,000 honey bees. In red ants, the population contains about 5,00,000 individuals

2. Co-operation

- The members of the colony co-operate with each other for food, shelter, protection, etc.

3. Polymorphism

- The phenomenon of the existence of several morphological forms in a species is called **polymorphism**.
- In honey-bees, there are three types of bees, namely queen, drones and workers. They are morphologically different.

4. Caste-system

- In an insect colony, there are three or four types of insects doing different functions. This phenomenon is called caste-system and each type is called a caste.
- Honey bee colony has three castes, namely queen, drones and workers
- The ant society has four types of castes namely gynes (queens), anes (kings), workers and soldiers.
- In termites, there are six types of castes, namely
 - *Macropterous forms* - These are the true kings and queens of termite colony
 - *Brachypterous forms* - These are substitute kings and queens of termite colony. Substitute kings and queens.
 - *Apterous forms* - These are worker like substitute kings and queens of termites

- *Workers* - These are sterile females.
- *Soldiers* - These are found in termite and ant-colonies. They are concerned with offense and defence
- *Nasutes* - These are like soldiers.

5. Division of Labour

In social life, each caste is doing a specific function. This phenomenon is called division of labour. The following are the works of the different castes in social insects:

Queens

- The fertile female of the bee-colony is queen.
- The main function of the queen is to lay eggs.
- Hence she is called the veritable egg-laying machine.
- All the members of colony are queen's own daughters and Sons.
- The queen can live for 15 or more years.
- The bee colony has only one queen. But there are many queens in ants and termites.

Drones

- These are fertile males. Their main function is to mate with the queen and fertilize the eggs.

Workers

- These are sterile females.
- They live only for a few weeks.
- They do all the functions of the colony.
- They collect nectar store honey, feed young ones and queens, build new combs, repair old combs, clean the comb ventilate the comb by fanning wings and protect the colony

Nasutes: These are like soldiers.

- They are found in termite colonies.
- The anterior end of the head is prolonged into a pointed structure called rostrum.
- A frontal gland opens at the tip of the rostrum.
- The secretion of the frontal gland is used to attack the enemies and is used to dissolve hard substances like concrete.

6. Houses

- Social insects construct architectural nests in which they live. The nests are in the form of **comb** or **hive**, **termitarium** and **formicaries**.

Comb or Hive

- The nest of honey-bee is called comb or hive.
- It is made of wax. It consists of five types of chambers, namely queen cells, drone cells, worker cells, storage cells and brood cells.
- There are one or two queen cells in a comb.
- The queen lives inside the queen cells

Termitarium

- The nest of the termite is called termitarium.
- It consists of a number of underground tunnels and chambers and a mound on the surface of the earth.
- Certain termitaria are huge and reach a height of 25 feet. The termitarium is built of sand particles cemented together by saliva and faecal matter

Formicaries

- These are the nests of ants.
- These are of three types, namely subterranean nests, mound nests and suspended nests.
 - Subterranean nests:** These are formed of a network of galleries and chambers beneath the surface of the earth
 - Mound nests:** These are mounds on the surface of the ground. They are constructed out of soil, leaves, straws, twigs, etc. The mounds contain galleries. These galleries are continuous with the underground tunnels and chambers
 - Suspended nests:** These nests are hanging from the branches of trees. They are made of leaves include together by saliva or silk

7. Parental Care

In social insects parental care is well developed.

1. The eggs are removed from the queen chambers and are deposited in the brood chambers
2. The young ones are fed by the workers,
3. The queen is fed by the workers.
4. The young ones and the queen are cleaned by the workers.
5. The workers keep the chambers cool in summer by fanning their wings.
6. In winter the workers cling and cluster around the queen.

8. Progressive Provisioning

- The young ones are fed till they reach adulthood. This is called progressive provisioning

9. Mass Provisioning

In stingless bees and potter wasps, when the eggs are laid, sufficient food is stored at the same time for the complete development of the larvae. This is called mass provisioning.

10. Trophallaxis

- The mutual exchange of food between insects is called trophallaxis.
- Ants feed one another from mouth to mouth.

11. Swarming

- The mass flight of insects in air is called **swarming** or **nuptial flight**.
- This occurs for two purposes, namely mating and dispersal of colonies.

12. Development of New Colonies**Formation of New Colony in Bees**

- In the case of honey-bee, when the colony is over populated, the queen leaves the hive accompanied by some drones.

- They swarm and mate in the air.
- They select a suitable place and start a new colony.
- In the old colony a new queen develops

Formation of New Colony in Termites

- In the case of termites, new colony is formed during rainy seasons.
- **Macropterous** forms swarm out. After a brief flight they alight on the ground.
- The wings are shed. A male and female join together and they mate on the ground.
- They form the queen and the king excavates a small burrow called nuptial chamber. The queen attains huge size. She lives for several years. It lays millions eggs per year.
- The eggs hatch into new members of the colony.

Formation of New Colony in Ants

- The males and females develop wings.
- They swarm together in large numbers in the air. Mating takes place in the air.
- The males die after mating. The females alight on the ground and they shed their wings.
- They excavate a small chamber in the ground and they lay eggs.
- A colony may contain many queens. The eggs hatch into new members of the colony.

UNIT-III
MOLLUSCA

General Characteristics of Phylum Mollusca

1. (Molluscs: soft)
2. Habitat: Mostly aquatic and few are terrestrial
3. Body is soft *without segmentation*
4. Grade of organization: Organ system grade
5. Germ layer: *Triploblastic*
6. Symmetry: *Bilaterally symmetry*
7. The body is divided into *head, muscular foot* and *visceral mass*.
8. The body is covered by a mantle and a shell
9. Respiration: by gills (ctinidia) in the mantle cavity. lungs in terrestrial forms
10. Digestive system: Complete and developed
11. Circulatory system: Closed type
12. Heart consists of one or two auricle and one ventricle
13. Excretion: A pair of *Metanephridia* (Kidney)
14. Nervous system: consists of three pair of ganglia
15. Sexes: Dioecious and few are hermaphrodite
16. Reproduction: Gamatic fusion
17. Fertilization: *External or internal*
18. Development: Direct or indirect

Class 1 Aplacophora (A=Without, Placophora=A sheet of wood)

- They are worm like mollusc, body covered by cuticle. Absence of shell.
- Foot absent or reduced to a ventral ridge.
- Mantle thick, with minute calcareous spicules.
- Head poorly marked and without eyes or sensory tentacles.
- There are no excretory organs. Examples: *Neomenia*

Class 2 Monoplacophora (Mono=one, Placophora=A sheet of wood)

- Habitat: Exclusively marine
- Head is present without eyes and tentacles
- Gills are external
- Excretion by nephridia . Examples: *Neopilina galathea*

Class 3 Polyplacophora(Poly=Many, Placophora=A sheet of wood)

- Body oval to somewhat elongated and dorsoventrally flattened.
- Dorsal surface covered by eight shell plates. The surrounding mantle forms a thick ‘girdle’, the cuticle.
- A broad muscular creeping foot is present on the ventral surface.
- Between the foot and mantle cavity, in the pallial groove lies a number of gills.
- Head is poorly developed. Eyes and tentacles are absent.
- Radula is large and bears many teeth.
- Ex: *Chiton, Cryptochiton*

Class 4 Gastropoda (Gastros=stomach, podas=foot)

- Habitat: These are either aquatic or terrestrial
- They possess a spiral shell.
- The foot is large and flat.
- Head is well developed with tentacles and eyes.
- Examples: *Hilex* (Snail), *Limax* (Slug), *Pila* (Apple snail).

Class 5 Scaphopoda (Tusk shell) (skepha= a boat, podas=foot)

- Habitat: marine
- Body is bilateral symmetry elongated and enclosed in tusk shell
- Foot is reduced
- Excretion: a pair of Kidney
- Examples: *Cadulus*, *Dentalium*

Class 6 Pelecypoda or Bivalvia (bi=two, valve=folding door)

- Habitat: mostly marine
- They burrow in mud and sand.
- Symmetry: bilateral and the body is laterally compressed.
- No distinct head
- Examples: *Mussels*, *Unio*, *Mytilus*.

Class 7 Cephalopoda (cephalo=head, podos=foot)

- Habitat: mostly marine.
- They are adapted for swimming.
- The foot is modified into eight to ten long tentacles in the head region.
- The shell is either external, internal or absent.
- Examples: *Octopus*, *Loligo*, *Sepia*, *spirula*, *Nautilus*

PILA

Classification

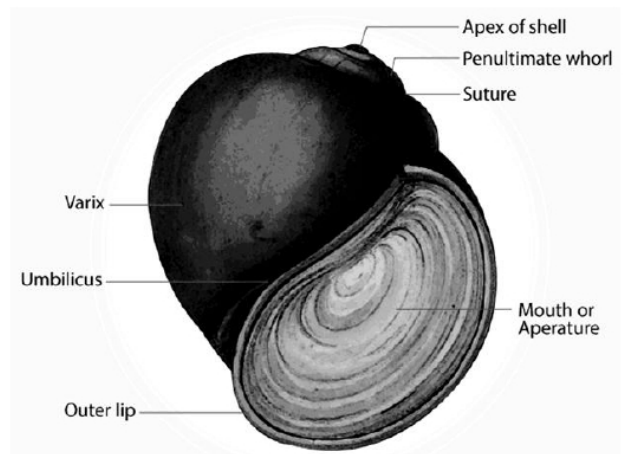
Phylum : Mollusca
 Class : Gastropoda
 Order :Pectinibranchia

General characters

- *Pila* is commonly called **apple snail**.
- It has a soft, unsegmented body covered by a **mantle** and a **shell**.
- It is an asymmetrical animal with a spirally coiled shell. It appears to walk on foot.
- *Pila* is a freshwater animal. It lives in ponds, tanks, lakes, rivers, wells and paddy fields.
- It can also live on land. So it is an amphibious animal. It creeps on the sub-stratum.
- It is **herbivorous** in habit some time carnivorous

Shell

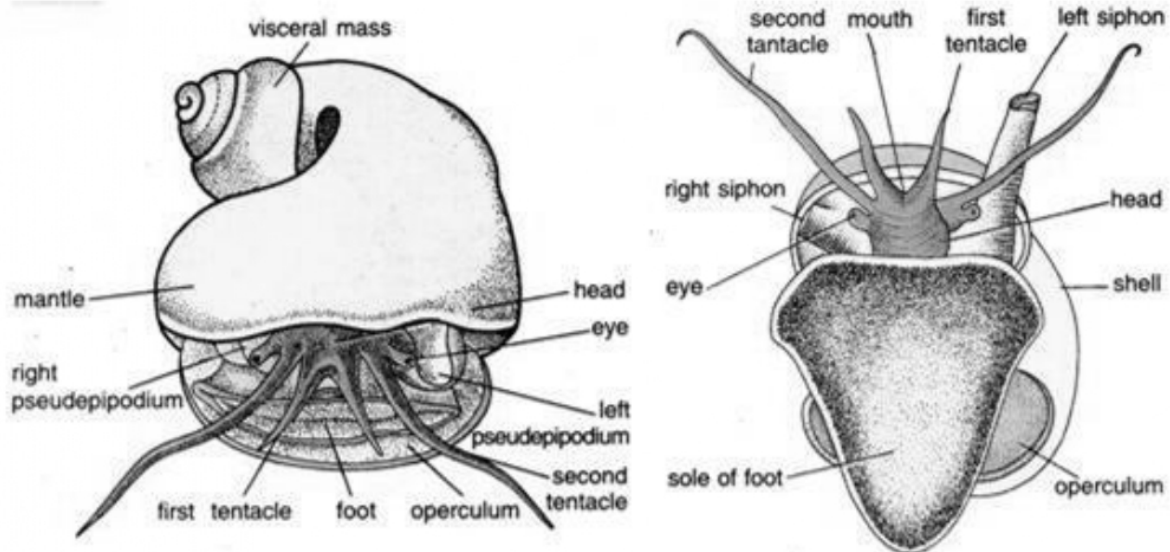
- The soft body of the *Pila* is covered by a shell. It is spirally coiled. The coils are called whorls.
- The upper whorl is small and is called apex. It is located at the top of the shell and it is old.
- The lower most whorls are larger and it is called body whorl. It is the youngest whorl



- The mouth is directed towards the right side. Hence the shell is *dextral*.
- Very rarely, the mouth is directed towards the left side. This type of shell is called *sinistral*.
- The mouth of the shell is closed by a lid called *operculum*.
- The outer surface of the operculum bears concentric lines called lines of growth.
- The shell is formed of three layers, namely an outer *periostracum*, a *middle ostracum* and an *inner hypostracum*.
- The periostracum is formed of a chitinous substance called conckiolin.
- The ostracum and hypostracum are made of calcium carbonate and conckiolin.

Body Organization

- The body of Pila is soft.
- It is divisible into three parts, namely head, foot and visceral mass.



Digestive System

- The digestive system is formed of the alimentary canal and the digestive glands.

Alimentary Canal

- The alimentary canal is well developed. It consists of the mouth, the buccal mass, the oesophagus, the stomach, the intestine, the rectum and the anus.
- The mouth is located below the anterior tentacles.
- The mouth leads into the buccal mass.
- The radula is elongated and ribbon-shaped and it lies on an elevated ridge known as odontophore on the floor of the buccal mass
- The radula is formed of **7 teeth**.
- buccal mass leads into the oesophagus. It is a straight tube. It opens into the stomach.
- The stomach is located on the left side of the visceral mass and is divisible into two parts, namely a sac-like cardiac region and a tubular pyloric region.
- A small rounded caecum arises from the pyloric region. The pyloric region leads into the intestine.
- The intestine is long and coiled. It elongates into the rectum, which lies in the mantle cavity.
- The rectum opens into the mantle cavity by the anus.

Digestive Glands

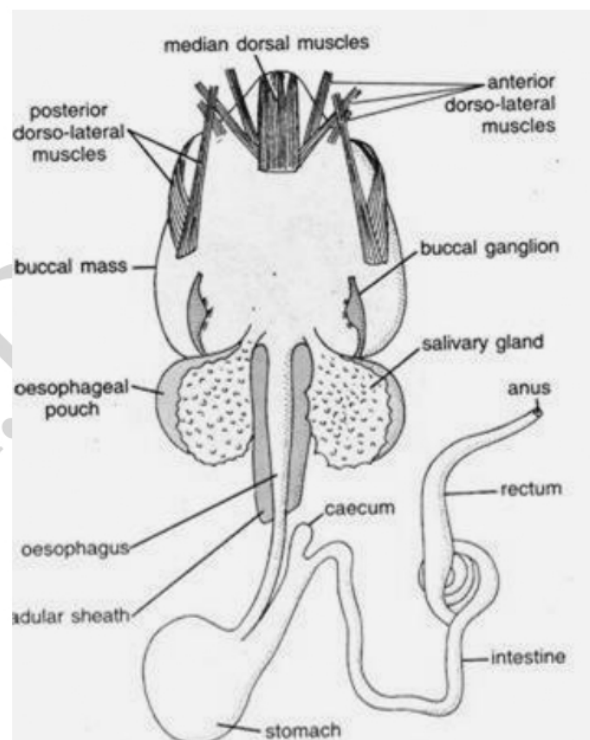
- Pila has two types of digestive glands.
- They are the salivary glands and the hepatopancreas.

Salivary glands

- Pila has a pair of salivary glands.
- They are located on the dorsal side of oesophageal pouches.
- From each gland arises a duct called salivary duct.
- The salivary glands open into the buccal cavity.
- The salivary secretion contains mucous and enzymes.

Hepatopancreas

- It lies in the visceral mass. It is brownish in colour.
- It is formed of two main lobes. Each lobe is formed of minute tubules.
- The tubules of each lobe unite together to form a large duct.
- The two ducts join together to form a common duct called hepatic duct.
- It opens into the stomach at the junction of cardiac and pyloric regions.
- The hepatopancreas is formed of three types of cells, namely secretory cells, resorptive cells and lime-containing cells.
- The secretory cells secrete enzymes. The resorptive cells digest proteins intracellularly. The lime containing cells store calcium carbonate.



Feeding and Digestion

- Pila is a herbivore.
- The food consists of aquatic plants.
- They are cut into pieces by the jaws.
- They are made into small particles by the rasping activity of the radula.
- The secretion of the salivary glands is poured into the buccal cavity and the food is mixed up with the secretion.
- It helps in digesting starch.
- Further digestion takes place inside the stomach by the secretion of the digestive gland.
- After the digestion of cellulose some amount of food passes through the hepatic duct and is absorbed by the resorptive cells of hepatopancreas.
- These cells digest the food by intracellular method.
- The digested food diffuses into the blood.
- From the stomach the food enters the intestine.
- The absorption of digested food takes places mainly in the intestine.

- The undigested food is passed into the mantle cavity through the anus.
- From the mantle it is passed out through the outgoing water.

Respiratory System

- Pila is an amphibious animal. It has two modes of respiration.
- They are aquatic respiration and pulmonary respiration.

Aquatic Respiration

- When Pila is in the water, aquatic respiration takes place.
- The respiratory organ for aquatic respiration is the gill or ctenidium.
- Pila has a single gill. It is located in the branchial chamber of the mantle cavity
- The axis bears a single row of triangular plates called lamellae.

Mechanism of Aquatic Respiration

- When Pila is in the water, aquatic respiration takes place.
- The cilia of the ctenidium and the continuous rise and fall of the floor of the mantle cavity create water current.
- The ctenidium is bathed in water.
- The exchange of gases takes place between the blood of ctenidium and water.

Pulmonary Respiration

- It occurs when Pila is on land. The respiratory organ is the lung or pulmonary sac.
- It is located in the pulmonary chamber of the mantle cavity.
- The pulmonary sac is in the form of a bag hanging from the roof of the mantle.

Mechanism of Pulmonary Respiration

- In pulmonary respiration air is used. The left pseudopodium is used as the respiratory siphon.
- Air enters the pulmonary chamber through the left pseudopodium.
- The pulmonary sac exhibits rhythmic contraction and relaxation.
- During relaxation, the air from the pulmonary chamber enters the pulmonary sac through the pulmonary aperture.
- During contraction, the air passes into the pulmonary chamber from the pulmonary sac.
- The blood of the pulmonary sac takes in O_2 , from the air and gives out CO_2 .

Circulatory System

- The circulatory system is open type. It consists of blood, pericardium, heart, arteries sinuses and veins.

Blood

- The blood is blue in colour. It contains plasma and corpuscles. The plasma contains a blue pigment called haemocyanin.
- This gives the blue colour to the blood. The corpuscles are colourless

Pericardium

- Pericardium is an oval sac. It encloses a cavity called pericardial cavity.
- The heart found in the pericardial cavity.

Heart

- The heart is formed of two chambers, namely an auricle and a ventricle.
- The auricle is posterior in position.
- It is thin-walled and triangular in shape.
- It opens into the ventricle through an auriculoventricular aperture.
- It is guarded by a pair of semi lunar valves.
- The auricle receives pure blood from the following three veins
 - *Blood from the gill*
 - *Blood from the lung.*
 - *Blood from posterior end of the renal chamber.*

Arteries

- A large artery arises from the ventricle is called aortic trunk.
- It divides into two branches, namely an anterior cephalic aorta and a posterior visceral aorta.
- **The cephalic aorta:** It is supply the blood to mantle, the pseudopodium, oesophagus, skin, head and foot.
- **The visceral aorta** divides into many branches and they supply blood to the stomach, the intestine, the liver, the gonad and the pericardium.

Sinuses

- The impure blood from the various parts of the body is collected into small spaces called lacunae. These spaces join together to form large spaces called sinuses.
- These sinuses represent the haemocoel.
- There are four main sinuses.
- **Peri-visceral sinus:** It is located below the mantle cavity. It surrounds the oe- sophagus and buccal mass.
- **Peri-intestinal sinus:** It lies around the intestine.
- **Branchio-renal sinus:** It lies along the right side of the anterior renal chamber.
- **Pulmonary sinus:** It is located in the walls of the pulmonary sac

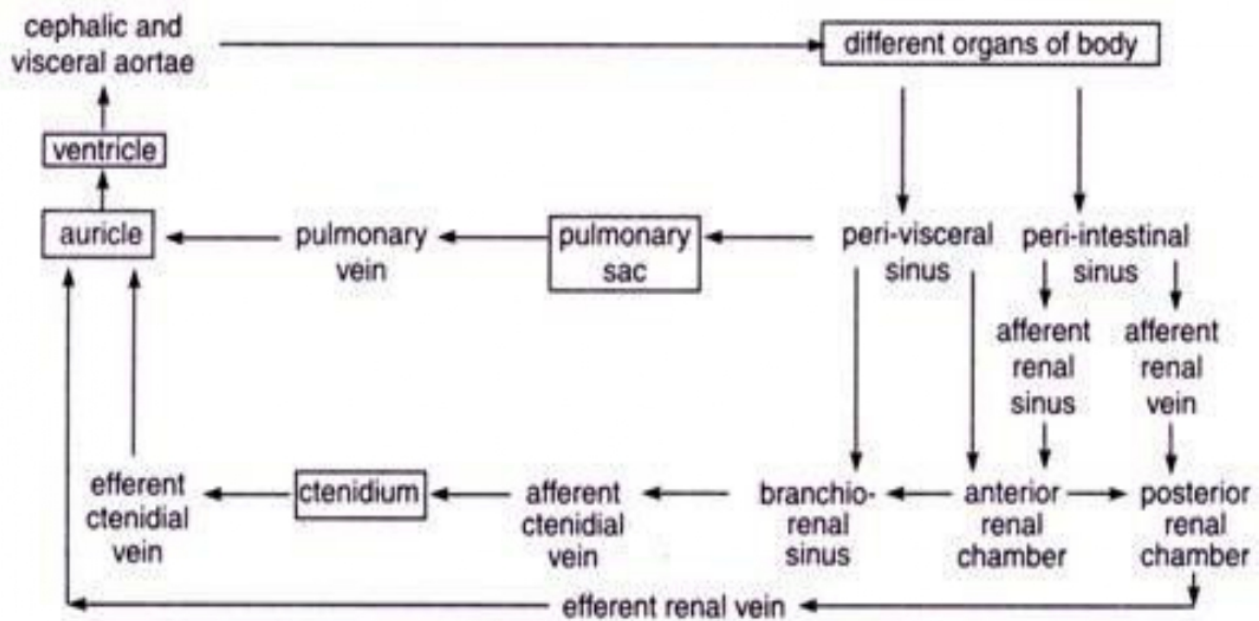
Veins

- The veins transport blood from the various parts of the body. There are five main veins.
- **Afferent ctenidial vein:** It transports blood from the perivisceral sinus to the ctenidium
- **Efferent ctenidial vein:** It carries blood from the ctenidium to the auricle.
- **Afferent renal vein:** It carries blood from the peri intestinal sinus to the posterior renal chamber.
- **Efferent renal vein:** It transports blood from the posterior renal chamber to the auricle.
- **Pulmonary vein:** It carries blood from the pulmonary sac to the auricle

Course of Circulation

- The blood from the heart is supplied to all the organs of the body through the branches of the cephalic and visceral aorta.
- The blood is then collected in the perivisceral and peri-intestinal sinuses.
- From the perivisceral sinus, the blood passes into the branchiorenal sinus.
- During aquatic respiration, the blood from the branchiorenal sinus passes into the ctenidium through the afferent ctenidial vein.
- After the exchange of gases, the blood from the ctenidium passes through the efferent ctenidial vein into the auricle.

- During aerial respiration, the blood from the perivisceral sinus passes into the pulmonary sinus. After the gaseous exchange it enters the auricle through the pulmonary vein.
- From the peri-intestinal sinus the blood enters the anterior and posterior renal chambers.
- After the removal of excretory waste materials inside the renal organ, the blood from the posterior renal chamber enters the auricle through the efferent renal vein.
- The blood from the anterior renal chamber goes to the ctenidium.
- After the gaseous exchange, the pure blood enters the auricle. Thus the auricle receives both the pure and impure blood.



Excretory System

- The excretory system is formed of a single *renal organ* or *kidney* lying nearer to the pericardium.
- The kidney consists of an anterior chamber and a posterior chamber
- The anterior chamber opens into the mantle cavity by the renal aperture.
- The posterior chamber opens into the pericardium by the *renopericardial aperture*.
- It also opens into the anterior renal chamber.
- The afferent and efferent renal veins repeatedly branch into the roof of this chamber.
- The two renal chambers are supplied with blood from which the nitrogenous waste materials are separated.
- When the animal is inside water, it excretes ammonia and when it is on land it excretes uric acid.

Nervous System

- It has two special features. They are as follows: form of a ring around the buccal mass form the figure 8.
- The nervous system of Pila is well developed.
- The nervous system of Pila has the following ganglia:
- **Cerebral ganglia:** These are a pair of ganglia located beneath the buccal mass near its anterior end.
- **Pleural ganglia:** These are a pair of ganglia situated beneath the buccal mass at its posterior end.

- **Pedal ganglia:** Pila has a pair of pedal ganglia. They are situated on the inner side of the pleural ganglia. They are partly fused with the pleural ganglia.
- **Supra intestinal ganglion:** It is a single ganglia located behind the left pleural ganglia
- **Visceral ganglia:** These are a pair of ganglia located in the visceral mass. They are fused together.
- **Buccal ganglia:** These are paired ganglia located beneath the junction of the buccal mass and the oesophagus.

Commissures

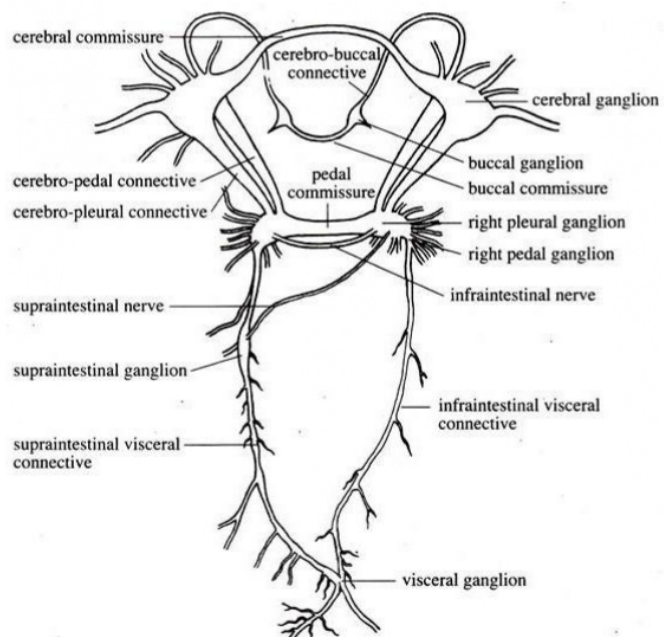
- The nerves connecting similar ganglia are called commissures. Pila has the following commissures
- **Cerebral commissure:** It is a nerve connecting the two cerebral ganglia.
- **Pedal commissure:** It is a nerve connecting the two pedal ganglia.
- **Buccal commissure:** The buccal ganglia are connected together by a buccal ganglia.

Connectives

- The nerves connecting two dissimilar ganglia are called connectives. Pila has the following connectives:
- **Cerebro-pleural connectives:** The nerves connecting cerebral ganglia with the pleural ganglia are called cerebro pleural connectives
- **Cerebro-pedal connectives:** They connect the cerebral ganglia with the pedal ganglia.
- **Cerebro-buccal connectives:** They connect the cerebral ganglia with the buccal ganglia.
- **Left visceral connective:** It connects the supra intestinal ganglion with the visceral ganglion.
- **Right visceral connective:** It connects the visceral ganglia with the right pleural ganglion.

Nerves

- **Infra-intestinal nerve:** It connects the two pleural ganglia. It runs below the oesophagus.
- **Supra-intestinal nerve:** It connects the supra-intestinal ganglion and the right pleural ganglion. It runs above the oesophagus
- **Osphradial nerve:** It supplies the osphradium. It arises from the supra-intestinal ganglion



Sense organ

Eyes, Statocyst, Osphradium and Tentacles

Eyes

- The head has two pairs of tentacles and a pair of eyes.
- The eyes cannot form image but detect the light.

Statocyst

- It has two statocyst
- It is located near the ganglia.
- It is maintaining equilibrium.

Tentacles

- Two pair of tentacles located at head region.
- It is a sense organ.

Reproductive system

- Sexes are separate
- Female larger than male

Male reproductive system

- It is formed by *testis, vasa efferent, vas deferent, seminal vesicle, copulatory organ* and *hypobranchial glands*.

Testis

- A single testis located at the whorls of the shell.
- It is closely attached to the digestive glands.
- Number of *vasa efferentia* arises from the testis and formed a single vas deference
- It is formed by three portions there are
 1. *Tubular portion*
 2. *Seminal vesicle*
 3. *Glandular portion*
- The copulatory organ is penis.

Female reproductive system

- It is formed by *ovary, oviduct, seminal receptacle, uterus, vagina and genital aperture*.
- Ovary dark in colour
- Oviduct arises from the ovary. It is open into seminal receptacle.
- Seminal receptacle leads in to uterus it is continues into vagina which is open into genital aperture.

Fertilization and Development

- At the time of copulation the sperms are introduced into the seminal receptacles of female
- Fertilization is internal
- The eggs are released on the safe place.
- The young ones resemble the adult hence development is direct.

LAMELLIDENS (FRESH WATER MUSSEL)Classification

Kingdom	:	Animalia
Phylum	:	Mollusca
Class	:	Bivalvia
Order	:	Eulamellibranchiata

General character of Lamellidens (Fresh water mussel)

- It is live in fresh water.
- It is commonly called freshwater mussel.
- It's anterior broad and posterior narrow
- Body covered mantle and shell.
- It is bilateral symmetry.
- Shell made up of two piece hence it is called bivalvia.
- Filler feeding and omnivorous animal.

Shell

- The shell made up of calcium carbonate and horny substance.
- It is made up of three layers there are;
 1. *Perostracum* - Outer layer
 2. *Prismatic* - Middle layer
 3. *Nacreous* - Inner layer (It is mother of the pearl layer)

Body organization

- Body soft and enclosed by shell.
- Body consist of Mantle, Visceral mass and foot.
- The body covered by skin called *mantle*.
- *Visceral mass* includes all the internal organs.
- Foot is *wedge* shaped.
- Internally foot contain intestine, digestive glands and gonads.
- Foot is used for burrowing.

Musculature

- The two shell valves are operated by two large musculature called anterior and posterior (*Adductor*) muscles.
- Shell valve open the muscles are relax when the contract the valves are close.

Respiration

- It is follow two types of aquatic respiration
 1. *Mantle respiration*
 2. *Gill respiration*

1. Mantle respiration

- It is a fold of skin covering the soft body below the shell.
- It is formed two lobes on either side.
- It has richly blood supply and continuously *bathed in water*.
- Exchange of gases occurs between the blood of mantle and water.

2. Gill respiration

- This type of respiration carried by *gills or ctenidia*
- Gills are out growth of skin.
- Two gills located one on either side of the body and inside the mantel cavity.
- Gills have plate like structure is called *laminae*.
- Gills are ‘W’ shape and covered with cilia.

Mechanism of respiration

- When the cilia beats the water moves from *inhalant siphon* to *infrabranchial chamber*.
- Then the water moves from *infrabranchial chamber* to *ostia* then moves to *water tube*.
- Then the water moves from *water tube* to *suprabranchial chamber*.
- Then the water passes out through the *exhalent siphon*.
- Gas exchanges occur over the mantle and the gills.

Digestive system

- It is firmid by *alimentary canal* and *digestive system*

1. Alimentary canal

- It is formed *Mouth, Oesophagus, Stomach, Intestine, Rectum* and *Anus*.

Mouth

- It is located anterior region.
- Mouth region has number of cilia presented. It is help to food moves towards mouth.

Oesophagus

- It is short tube arises from the mouth

Stomach

- Oesophagus leads to stomach.
- It looks like large sac structure. It is completely surrounded by the liver.

Crystalline style

- The stomach produced into outgrowth called *crystalline sac*.

Intestine

- It is coiled in shape
- It contains a pair of folds inside called *typhlosole*.
- Absorption takes place intestine.

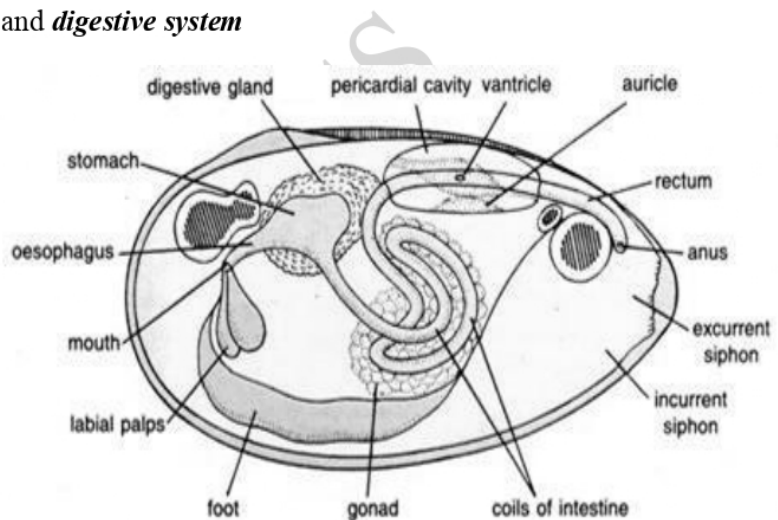
Rectum

- It is arises from intestine
- Rectum passes undigested food to anus through *cloaca*.

Digestive glands

Liver

- It is secretes digestive enzyme.



- It is absorb carbohydrate
- It is breaks the solid food particles.

Food

- It is filter feeding omnivorous.
- It is feed minute plants and animals *Digestive system of lamellidens*

Digestion

- Intra cellular and inter cellular digestion.

Circulatory system

- Open types of circulatory system
- It is consist of *Blood, Heart, Arteries, Sinuses* and *Veins*.

Blood

- Blood is blue colour because it has *Haemocyanine* blood pigments.
- Blood formed of plasma and corpuscles.

Heart

- Heart covered by pericardium.
- It is formed by three chambers.
- One is ventricle and two are auricles.
- An auricle opens into ventricle by *Auriculoventricular* aperture.

Arteries

- From the ventricles two blood vessels are arise. These are *anterior aorta* and *posterior aorta*.

Anterior aorta

- Anterior aorta divides into many arteries and they supply the blood to all anterior body region.

Posterior aorta

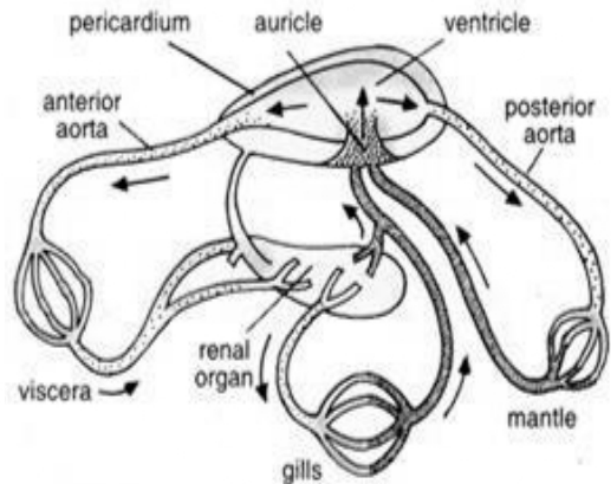
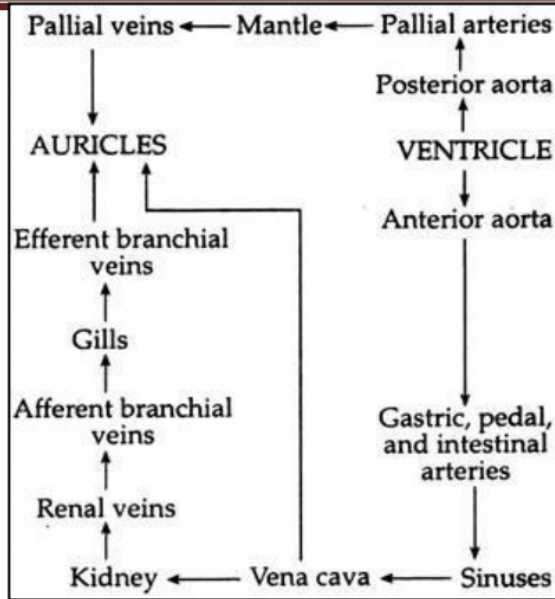
- Posterior aorta divides into many arteries and they supply the blood to all posterior region.

Sinuses

- The blood collected small spaces called *lacunae*. The lacunae open into large space called *sinuses*.

Vein

- Blood from the sinuses is collected in to a large vein is called *vena cava*
- The vena cava sends the blood to kidney through *afferent renal vein*.
- Kidney removes nitrogen waste from the blood.
- The blood collected from kidney through *efferent renal vein*
- *Efferent renal vein* sends the blood to gills for oxygenation through *Afferent ctenidial vein*.
- The oxygenated blood received auricles from *Efferent ctenidial vein*.



Circulatory system of lamellidens

Excretory organ

1.Organ of Bojanus or Kidney 2.Keber's organ

1.Organ of Bojanus or Kidney

- First observed by *Bojanus* and hence the name *Organ of Bojanus*.
- They are kidneys.
- Kidneys are 'U' shaped and two limbs.
- It is located beneath of pericardium.

2.Keber's organ

- It is located front of the pericardium
- It is *reddish-brown glands*.
- Keber's glands discharge nitrogenous waste into pericardial fluid.
- The fluid enters to the kidney proper.
- From the kidney proper the waste product collects and sent to urinary bladders.
- The urinary bladder opens into *supra branchial chamber* by *renal aperture*.
- Kidney also plays as osmoregulation.

Nervous system

- Nervous system consists of *three pair of ganglia, connectives, and small nerves*.

1. Cerebro-pleural ganglia

- It is located above the mouth
- The two ganglia connect by *cerebro-pleural connectives*.

2. Pedal ganglia

- It is located in the foot.
- It is connected cerebral ganglia by a pair of *cerebro-pedal connectives*.
- It gives blood to the *foot, statocyst*.

3. Visceral ganglia

- A pair of visceral ganglia located at visceral mass.
- The visceral ganglia connected to the *cerebro-visceral connectives*.

Sensory organ

- Sensory organ poorly developed. It has three types of sensory organ there are;

*1. Statocyst 2. Sensory cells 3. Osphradia***1. Statocyst**

- A pair of statocyst located in the foot.
- It is function as organ of *equilibrium*.

2. Sensory cells

- Sensory cells are scattered epithelial cells.
- The function as photo receptor

3. Osphradia

- A pair of osphradia located surface of visceral ganglia.
- It is chemoreceptor.

Reproduction

- Sexes are separate but there is no sexual dimorphism.

Male reproductive system

- A pair of branched, coiled testes located the intestine.
- Each testis arises, a short vas deferens.
- It is open into mantle cavity by genital aperture.

Female reproductive system

- A pair of large branched ovary located the intestine.
- Each ovary arise a short oviduct which is open into mantle cavity by female genital aperture.

Fertilization

- Sperm shed and passed out by the water.
- The sperm reach female through inhalant siphon of female.
- Fertilization takes place in cloaca.
- Glochidium larvae development takes place in lamelle

Glochidium larvae

- Glochidium is fresh water mussel larvae.
- It is very minute microscopic (0.1-0.5mm)
- It is covered by shell, it has two valves.
- The shell valves operate by adductor mussel.
- A byssus glands is located near the adductor mussel, the byssus gland secrete provisional byssus it is thread like.
- Finally mature larvae passed out the water.
- Further development takes place in the fish.
- The larva attached to the fish hence it is ectoparasite life.
- This life is going ten weeks.

Advantages of parasitic life

- Larvae protected from predator.
- Get food from fish.
- Transport to different places.
- Pearl is a natural creation of molluscs.
- It consists of nacre or mother of pearl.

PEARL OYSTER CULTURE**Types of Pearls**

Pearls are of seven types. They are the following:

1. *Lingha pearl*: This is the best quality pearl obtained from marine oysters.

2. **Seed pearls:** The small pearls are called seed pearls.
3. **Baroque pearls:** These are spherical pearls form inside the body.
4. **Blister pearls:** These are pearls attached to the shell. They are half-spherical in shape.
5. **Oriental pearls:** These are true pearls with a great lustre, beauty and a smooth surface.
6. **Natural pearls:** These are the pearls obtained from pearl oysters of deep oceans.
7. **Cultured pearls:** These are the pearls obtained from cultivated species of pearl oysters.

Composition of Pearl

The pearl is formed of nacre. The nacre is formed of two substances, namely a calcium carbonate which is in the form of *aragonite* or *calcite* and an *albuminoid* substance called *conchiolin*.

Pearl oyster culture

- Pearls are intensively produced by cultivating pearl oyster.
- It is sedentary animal attached to rocks.

Culture of pearl

1. *Collection of oyster*
2. *Preparation of graft tissue*
3. *Preparation of nucleus*
4. *Implantation*
5. *Rearing of oyster*
6. *Harvesting*

1. Collection of oyster

- Collected from bottom of the sea
- Spats (Young oyster) collected by cage.
- Pearl oysters youngones are getting from laboratory.

2. Preparation of grafting tissue

- The piece of tissue which is inserted to the oyster is called graft tissue.
- The graft is 2×2 mm in size.

3. Preparation of nucleus

- The nucleus is foreign material which is inserted into the oyster.
- It is 2mm in diameter
- It is shell of mollusc.

4. Implantation

- A small incision is made on the foot.
- The graft tissue placed followed by nucleus placed on the graft tissue.
- Then the oyster released in cage.

5. Rearing of oyster

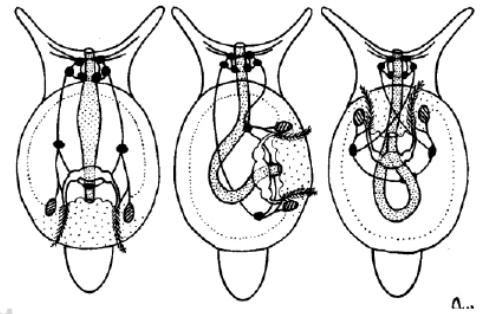
- The operated oysters are placed in cage.
- This type of oyster culture is called raft culture.

6. Harvesting

- Pearls attain their maximum size in three years.
- After three years, the pearl oysters are removed from the cage and pearl is taken out.

TORSION IN MOLLUSCS

- Torsion is the *rotation of the visceral organs* during development to an angle of 180° in the anticlockwise direction in gastropod molluscs.
- It occurs in the larva of *gastropods*.
- It covers the *symmetrical larva* into an *asymmetrical adult*.
- The gastropods exhibiting torsion are included in the group *Streptoeura* Eg. *Pila*.
- The larva of gastropod is *symmetrical*.
- The alimentary canal is straight with the mouth at the anterior and the anus at the posterior end.
- The mantle cavity is located in the *posterior side*.
- The ctenidia are located posteriorly.
- The nervous system is *bilaterally symmetrical*.
- The auricles lie posterior to the ventricle.
- The larva develops torsion in order to become the adult.



Ventral flexure

- First of all a ventral flexure appears in the larva.
- It converts the straight alimentary canal into a loop.
- The shell and visceral mass become cone shaped.
- Finally they become spirally coiled.

Differential growth

- The growth is retarded on the right side of the larva.
- On the left side of the larva growth is accelerated.

Anti-clockwise rotation

- The mantle and the pallial complex rotate to an angle of 180° in the anticlockwise direction.
- This process shifts the organs from the left side to the right side.

Events in torsion

- * Looping of alimentary canal.
- * Anus is brought close to the mouth.
- * Twisting of nervous system.
- * Displacement of mantle cavity.
- * Change in the position of ctenidia.
- * Displacement of auricles.
- * Coiling of shell and visceral mass.
- * Degeneration of structures on the left side
- * Loss of symmetry.

Detorsion

- In some gastropods, there is a reversion of torsion after torsion. The reversion of torsion is called *detorsion*.
- During detorsion, the visceral mass shifts to an angle of 180° in the clock wise direction.
- The mantle cavity is brought forward.
- The alimentary canal is untwisted.
- The anus is brought backward.
- Detorsion occurs in Euthyneura Eg. *Aplysia*.

Advantages of torsion

- By torsion, the animal gets the privilege of using pure water for respiration.
- The respiratory current coincides with the locomotory current preventing hindrance to locomotion.
- Anteriorly placed osphradium helps the animal's sensation to test the suitability of water lying ahead.

Disadvantages of torsion

- Torsion brings the anus close to mouth giving sanitation problems.
- The faecal matter released forward gives impure water for respiration.

ECONOMIC IMPORTANT OF MOLLUSCA

- The phylum mollusc represented more than 1, 00,000 living species.
- The mollusc plays a major role in the life of man.

1. Beneficial molluscs 2. Destructive molluscs

1. BENEFICIAL MOLLUSCS

- It is useful for various ways. They promote economic values for human.

1. Food

- Oyster, sea mussels, squid, pila, cuttle fish used for food.

2. Bait

- It is excellent bait for fishes.

3. Buttons

- Shells of gastropods used for manufacturing buttons.

4. Pearls

- Pearls are one of the costliest gems obtained from the pearls oyster, it is natural jewellery.

5. Ornamentation

- Gastropods and tusk shells are manufacturing fancy articles.

6. Dye and ink

- *Tyrian purple* is obtained from the juice of *Nucella* and *Murex*
- Cuttle fish contain a brown pigment which is used as ink.

7. Medicine

- Cuttle bones are used as medicine and food supply calcium to the pet birds.

8. Cradle

- The shells of giant clam are used as cradle for babies.

DESTRUCTIVE MOLLUSCS

- Another group of molluscs damage to other animals ad wooden structures.

1. Herbivorous

- Slugs and snail damaged plants and garden, green house and the decorate plants and vegetable.

2. Carnivorous

- Some molluscs feed on another organism.

3. Destruction pelecypods

- It is commonly ship worm.
- They damage ship and make hole wooden structure.

4. Parasite

- These are the molluscs that are parasitic on other organisms
- Gastropods parasites are common among bivalves, polychaetes and echinoderms.

5. Intermediate hosts

- The freshwater snails, like *Limnaea* and *Planorbis* act as intermediate host for the flat worms such as *Fasciola* and *Schistosoma*.

UNIT-IV
ECHINODERMATA

General Characteristics of Phylum Echinodermata

- (Echinos: Spines; derma: Skin)
- Habitat: These are exclusively marine
- Grade of organization: organ system of organization.
- Germ layer: Triploblastic
- Symmetry: Adults are radially symmetrical while the larvae are bilaterally symmetrical.
- Coelom: Present (coelomate)
- Body without segmentation
- The shape of the body is flat, star like, spherical or elongated.
- Head is absent
- Presence of tube feet
- Presence of water vascular system
- Mouth is present on ventral side while anus is present on dorsal side
- Respiration by papule, gills or cloacal respiratory tree
- Nervous system: Absent, they are brainless organism.
- Circulatory system is reduced, heart is absent
- Blood has no pigment.
- Digestive system: Complete
- Excretory system: Absent
- Sexes: Mostly dioecious, rarely monocious
- Reproduction: Sexual and asexual
- Fertilization: External
- Development: Indirect with larvae

Classification of echinoderms

- *Asteroidea*
- *Ophiuroidea*
- *Echinoidea*
- *Holothuroidea*
- *Opiochistioidea*

Class 1 Asteroidea

- Body is flattened star shaped with five arms
- They possess tube feet with a sucker
- Presence of calcareous plates and movable spines.
- Respiratory organ: papulae
- Examples: *Asterias* (Star fish), *Astropecten*, *Zoraster*, *Oreaster*

Class 2 Ophiuroidea

- Body is flat with pentamerous disc
- They possess a long arm which is sharply demarcated from the central disc.
- They possess tube feet without sucker

- Anus and intestine are absent
- Respiratory organ: Bursae
- Examples: *Ophiderma*, *ophiothrix*, *Astrophyton*, *Amphuria*, etc

Class 3 Echinoidea

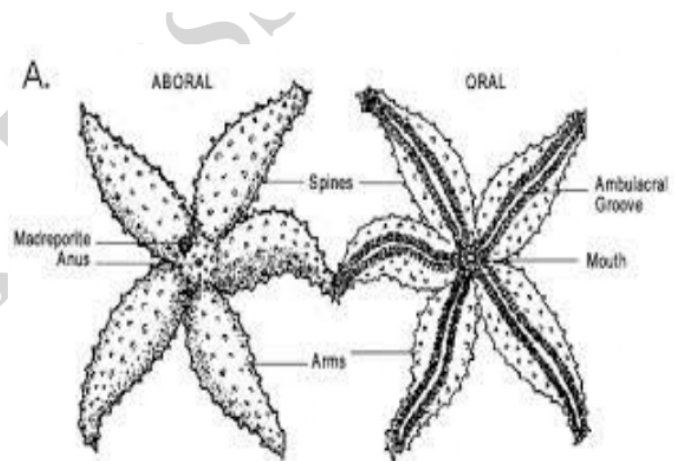
- Body is disc-like hemi-spherical
- They are devoid of arms or free-rays.
- They possess tube feet with a sucker.
- They possess compact skeleton and movable spines.
- Examples: *Echinus* (Sea urchin), *Cidaris*, *Arbacia*, *Echinocardium*, *Diadema*

Class 4 Holothuroidea

- Body is elongated in the oral-aboral axis and it is like cucumber.
- They have no arms, spines and pedicellariae.
- The tube feet are sucking type which is modified into tentacles and form a circle around mouth.
- Respiratory organ: cloacal respiratory tree
- Examples: *Cucumaria* (Sea cucumber), *Holothuria*, *Mesothuria*, etc

Class 5 Opiochistioidea

- The class includes fossil echinoderms.
- The body enclosed by theca
- Arms bifurcated, with two pinnules.
- They have tube feet without suckers
- Examples: *Eothuria*, *Sollasina*, *Eucladia*., etc



STAR FISH

Classification

Phylum	: Echinodermata
Class	: Asteroidea
Order	: Forcipulata

General characters

- Star fish or Sea star is common echinoderm in the sea water. Its Zoological name is *Asterias rubens*. It belongs to the genus *Asterias* is represented by 100 species,
- Star fish dwells on the bottom of the sea.
- It is a benthonic form.
- They are more common on hard rocky sea bottom; Star-fish is a carnivorous animal.
- It creeps slowly on the sea bottom.
- It can bend or twist in many ways.
- It has the power of autotomy (Self amputation).

External Features: The body of *Asterias* is star shaped and looks like a sea star.

Shape

- The body is compressed on oral-aboral axis.
- It shows a central disc. From this disc five arms will project.
- They are symmetrically arranged.
- The arms are board proximally and are free at the distal end.
- The arms occupy the radial axis.

Size

- The smallest star fish is one cm in diameter, where as the largest one is 200 cm in diameter.
- The average size varies from 10 to 20 cm.

Colour

- Star fish show brilliant colours. Yellow - brown or orange colours are common.

Surface of the Body

- The body shows two surfaces.
- **Oral and Aboral.**
- The oral surface faces the bottom of the sea.
- The centre of the oral surface contains mouth.
- The aboral surface is directed upwards. It is slightly convex.
- The oral and aboral surfaces are not dorsal and ventral sides of the body, but right and left sides of a bilaterally symmetrical animal.

Mouth

- It is round opening.
- It is present in the centre of the oral surface of the central disc.
- The mouth is also called Actinosome.
- It is surrounded by peristomial membrane, which is soft.
- Mouth is surrounded by five groups of oral spines.

Ambulacral grooves

- From the comers of the mouth five ambulacral grooves will start and run along the middle of the arms.

Tube feet or Podia

- Each ambulacral groove contains 4 rows of tube feet.
- They are soft and extensible tubular processes.
- Each tube feet end in a sucker.
- The tube feet are useful for locomotion and food collection.

Ambulacral spines

- Each ambulacral groove is guarded on each side by 2 or 3 rows of spines.
- These are movable. These spines are aggregated into five groups called Mouth papillae.

Eye

- The eye is small and bright red spot.
- It is present at the end of each arm. It is light sensitive.

Tentacle

- At the end of each arm a small non-retractile tentacle is present. It is olfactory in function.

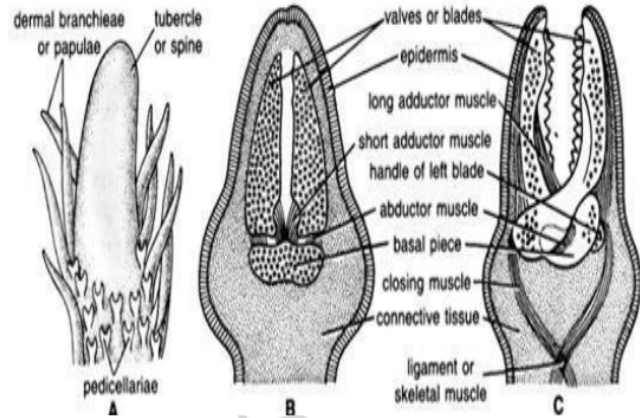
Anus: It is a small opening. It is nearly in the middle of aboral surface.

Pedicellariae

Pedicellariae are scattered all over the body. These are present in between the spines of the aboral surface. On the oral surface they are present attached to the bases of the spines.

Structure of a Typical Pedicellaria

- A pedicellaria consists of a stalk and 3 ossicles (calcareous plates).
- The stalk is flexible. One end of the stalk is embedded the skin.
- The free end of the stalk bears 3 ossicles.
- Of these 3 ossicles, one lies horizontally at the apex of the stalk and it is called basal piece. It is immovable.
- The other two ossicles are movable.
- The jaws can be opened and closed.
- The jaws work like a forceps and hence this type of pedicellaria is called forcipulate pedicellaria.
- The pedicellariae are of two types.



They are 1. *Pedunculate pedicellaria* and 2. *Sessile pedicellaria*

Pedunculate Pedicellaria

- Pedunculate pedicellaria have a stalk. They are also called stalked pedicellaria.
- In Asterias, all the pedicellaria are pedunculate type.
- The pedunculate pedicellaria has a stalk and 3 ossicles, namely a basal piece and two jaws.
- The pedunculate pedicellaria is further classified into two types, namely **straight type** and **crossed type**.

Straight pedicellaria:

- In straight pedicellaria, the two jaws remain straight on the basal piece. The jaws work like a forceps.

Crossed pedicellaria:

- In crossed pedicellaria, the basal part of the jaws are curved and they cross each other. They work like scissors.

Sessile Pedicellaria

- The sessile pedicellaria has no stalk.
- Sessile pedicellariae are not found in Asterias; but they are found in Oreaster, a sea star, allied to Asterias.

Functions of Pedicellaria

- The pedicellaria function as organs of offense and defense.
- They help to clean the surface of the body of debris, sand grains, etc.
- They are used to capture small prey.
- They protect the papulae.

Digestive system

- Digestive system formed by alimentary canal and digestive glands.

Alimentary canal

- It is formed by mouth, oesophagus, stomach, intestine, rectum, Anus

Mouth

- Mouth located at oral surface.
- Mouth followed by oesophagus it is short.
- Mouth leads to stomach.

Stomach

- Stomach consist of two region
- **1. Cardiac stomach and 2.Pyloric stomach.** (It has glad cells which secrete mucous).
- Pyloric stomach leads upwards in to intestine.
- The intestine leads to rectum.
- The rectum opens into outside by anus.

Digestive glands

- Digestive gland is pyloric caeca
- They are 5 pairs of pyloric caeca one pair in each arm.
- Each pyloric caeca has two rows of glandular pouches.
- The glandular pouches open into median duct.
- Median ducts unite together formed common duct is called pyloric ducts.
- The pyloric duct opens into stomach.

Feeding and Digestion

- Starfish is carnivorous and it feeds on crustaceans, molluscs and fishes.
- It captures the prey with help of flexible arms, tube feet and suckers.
- When the digestion is completed, the cardiac stomach is withdrawn into the body.
- Thus digestion is extracellular
- Digested food is absorbed into the pyloric caeca.
- Here the digested particles are digested by intracellular digestion.
- The undigested food is passed out through the anus.

Respiration

- Respiration is carried out by thousands of dermal branchiae or papulae.
- The dermal branchiae are simple, transparent, hollow outgrowths of the skin.
- They are present on the aboral surface.
- O₂ dissolved in sea-water is extracted by these gills in exchange of CO₂.
- The thin walls of the tube foot may also serve for exchange of gases

Water-Vascular System

- Water vascular system otherwise called the *ambulacral system*.
- It is peculiar to echinoderms and not present in any other animal group.
- This is a system of canals filled with a fluid consisting of sea-water and certain corpuscles.

- The essential parts of the system are the *madreporite, stone canal, ring canal, radial canals, Tiedmann's bodies, polian vesicles, lateral canals and tube feet*.

Madreporite

- It is a hard rounded and calcareous plate lying on the aboral surface.
- It is situated in the inter radial position.
- The surface of the madreporite is provided with a number of radiating grooves or furrows.
- The bottoms of these furrows are perforated by minute pores, so that the whole plate looks like a sieve. Each pore leads into a pore canal and all the pore canals merge into collecting canals.
- The collecting canals converge into a small bag-like ampulla beneath the madreporite.
- The ampulla opens into a stone canal.

Stone Canal

- It is an S-shaped canal. The walls are formed by calcareous rings and hence the name.
- Internally the stone canal is lined with cilia,
- One end of the tube opens to the outside through the madreporite.
- The other end opens into a ring canal.

Ring Canal

- It is a wide pentagonal ring-like vessel lying around the mouth.

Tiedmann's Bodies

- The ring canal gives off inner surface 10 small yellowish rounded glandular bodies called Tiedmann's bodies.
- In Asterias only 9 Tiedmann's bodies occur, the position of the 10th being occupied by the stone canal.

Polian Vesicles: The ring canal bears on its outer side five pear-shaped structures called polian vesicles.

Radial Canals: From its outer surface the ring canal gives off five radial canals, one entering each arm.

Lateral Canals: Each radial canal gives off many paired lateral canals on both the sides, which lead to a tube foot or podium.

Tube Feet: The tube-foot is a hollow elastic thin walled closed cylinder.

It consists of an upper sac-like ampulla, a middle tubular podium and a terminal disc-like sucker.

Functions of the Water Vascular System

- Locomotion
- Food capture and
- Attachment

Locomotion

- Starfish exhibits creeping movement.
- It creeps on the tube feet.
- It can move at a speed of 15 cm per minute
- The water vascular system helps in locomotion.
- The water vascular system sets up a hydraulic pressure mechanism which brings about the locomotion.
- In the direction of movement, one or two arms are slightly raised from the substratum.
- The suckers are released and the tube feet are raised and moved forward to repeat the process.

Food capture

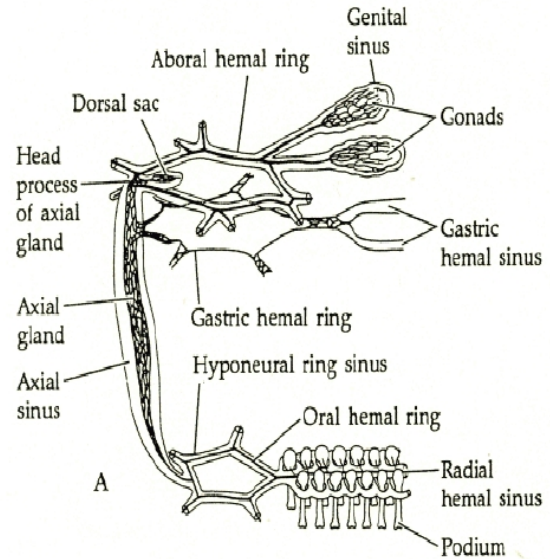
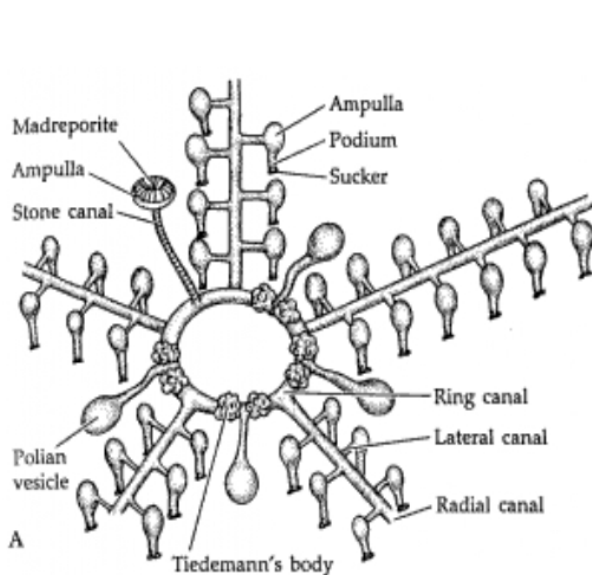
- The tube-feet are used to capture the prey. The suckers are used to open the shells of molluscs

Attachment

- The star fish can be attached to the rocks by the tube feet.

Water vascular system

Circulatory system



Circulatory System

- Circulatory system of star fish is of open type. It is formed of two systems, namely

1. Perihaemal system 2. Haemal system

Perihaemal System

- It is a system of channels derived from the coelom.
- Like the true coelom
- It is formed of aboral ring sinus, genital sinus, oral ring sinus, axial sinus, radial perihaemal sinus, lateral channels, marginal sinuses and peribranchial sinuses.
- **Aboral ring sinus:** It is a pentagonal tube lying around the intestine
- **Genital sinus:** The aboral ring sinus produces a pair of tubes called genital branches from its corner. Each branch ends in a sac called genital sinus. It encloses the gonad.
- **Oral ring sinus:** It is a circular channel lying around the mouth in the central disc.
- Internally, it is divided into two channels by aseptum called haemal strand.
- The two channels are outer oral ring sinus and inner oral ring sinus.
- **Axial sinus:** It is a vertical tubular sinus. It encloses the axial gland and stone canal. The axial sinus, axial gland and stone canal are together called axial complex.
- **Radial perihaemal sinus:** It lies in the arm. It arises from the outer oral ring sinus. It extends upon the tip of the arm
- **Lateral channels:** These arise from the radial perihaemal sinuses on either side. They supply the tube-feet.
- **Marginal sinuses:** In each arm, there are two marginal sinuses lying in the margins. They are connected with the radial perihaemal sinuses by the lateral channels.

2. Haemal System

- This is the blood lacunar system.

- It is open type
- It is similar to the haemocoelic system of leech, arthropods and molluscs.
- The haemal system is formed of oral haemal ring, aboral haemal ring and axial gland
- **Oral haemal ring:** It lies around the mouth.
- It is located in the haemal strand.
- It gives off five radial haemal sinuses entering the arms.
- The radial haemal sinus gives off lateral branches to the tube feet.
- **Aboral haemal ring:** It lies inside the aboral perihemal ring sinus.
- **Axial gland:** It is elongated and spongy in nature.
- It is formed of a network of connective tissue and amoebocytes and has a covering of coelomic epithelium.
- The oral end of the axial gland is
- connected with oral haemal ring and the aboral
- The axial gland produces the sex cells

Nervous system

It consists of four types

1. Ectoneural nervous system

- It consists of central circum oral nerve ring enclosing the mouth.
- The system arises from ectoderm hence it is called ectoneural nervous system.
- It is sensory in function.

2. Deep Oral Nervous System

- It is developed from the mesoderm.
- It is motor in function.
- oral nerve ring around the mouth.

3. Aboral or Coelomic Nervous system

- It is formed of an aboral anal nerve ring
- It is mesodermal in origin and motor in function

4. Endodermal nervous system

- This system is a continuation of the ectoneural system.
- It is located in the wall of the alimentary canal and is sensory in function.

Sense Organs

- Star fish contains two types of sensory organs.
- They are *Neurosensory cells and Eyes*

Neurosensory cells:

- It is specialized sensory cells distributed throughout the epidermis
- They are abundant in the tentacles, tube feet and the bases of pedicellariae.
- They may be tactile or olfactory in function.

Eyes

- Star fish has five eyes. They are situated at the terminal end of the arm beneath the tentacle.
- Each eye is made up of numerous eye *pits or ocelli*. Each eye-pit is cup-shaped.
- The eye cannot form image; but it detects changes in light intensity

Reproductive System

- In star fish, sexes are separate.
- There is no sexual dimorphism.
- It has five pairs of gonads, one pair in each arm at its base. The gonad is enclosed in a genital sinus.
- From each gonad arises a gonoduct
- This opens to the outside on the aboral surface by a minute gonopore.
- The gametes originate in the axial gland and later they migrate into the gonads.

Life Cycle

- Star fish is a marine sedentary animal.
- The development is indirect as there are larval forms

Fertilization

- The fertilization is external. It occurs in the sea. The fertilized egg is called zygote.

Cleavage

- The segmentation is holoblastic, equal and indeterminate.
- It is a rapid process.
- The cleavage converts the zygote into a blastula in one day

Blastula

- It is spherical and ciliated.
- It is hollow and hence called coeloblastula.
- It is surrounded by a layer of ciliated cells.
- The blastula swims freely water.

Gastrulation

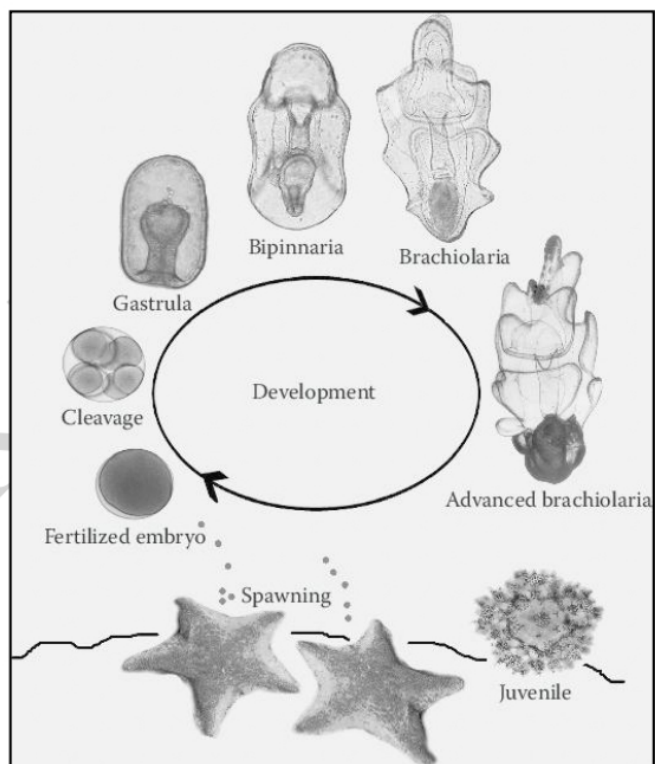
- The blastula invaginates to form a double layered cup called gastrula.

Gastrula

- Gastrula is in the form of a double-layered cup.
- The two layers are the outer ectoderm and the inner endoderm.
- The cavity of the gastrula is called archenteron. It opens to the outside by an opening called blastopore.
- These cells from the mesoderm.
- The gastrula swim in water.
- After some time, it develops into a larva called dipleurula larva.

Dipleurula Larva

- This larva develops from the gastrula.
- Dipleurula is the fundamental larva of the echinoderms.
- It is the first larva in the life cycle.
- It is microscopic.
- It is a free swimming larva.
- It is bilaterally symmetrical



- It is oval in shape.
- It has a gut formed of the mouth, the oesophagus, the intestine, the stomach and the anus.
- It feeds on diatoms.
- The dipleurula develops into the bipinnaria larva.

Bipinnaria Larva

- It is the second larva of star fish.
- It develops from dipleurula larva.
- It is minute and microscopic.
- It swims freely on the surface of water.
- It is bilaterally symmetrical
- It has a straight alimentary canal with a mouth at the anterior end and an anus at the posterior end
- bipinnaria larva after a short free swimming life, is transformed into the **brachiolaria larva**.

Brachiolaria larva

- The preoral region of this larva has three processes called brachiolar arms. These three arms are tipped with suckers. It swims and feeds like a bipinnaria.

Metamorphosis

- Metamorphosis occurs in the following
- The brachiolaria larva sinks to the bottom of the sea.
- It gets attached to the substratum with the help of brachiolar arms.
- The mouth, anus and the ciliary bands disappear.
- A new mouth is formed on the left side of the larva.
- A new anus is formed on the right side of the larva.
- The mouth represents the oral side and the anus represents the aboral side.

SEA URCHIN (*Salmacis bicolor*)

Classification

Kingdom	:	Animalia
Phylum	:	Echinodermata
Class	:	Echinoidea

General characters

- Its common name is '*sea urchin*'
- Body covered by spines.
- It is a marine animal. Lives in a rocky place.
- It moves slowly with the help of feet and spines.
- It is 6-12 cm in diameter.
- Body divided into oral and aboral surface.
- Mouth surrounded by a membrane is called peristome.
- It has five pairs of teeth, buccal cavity and branched tubes.

Pedicellariae

- They are found all over the body.
- Each pedicellariae consists of a stalk and jaws.

- It had four types of pedicellaria

1. Gemmiform pedicellariae

- It is long and curved.

It has poison gland, the poison paralysed the pray.

2. Tridentate pedicellariae

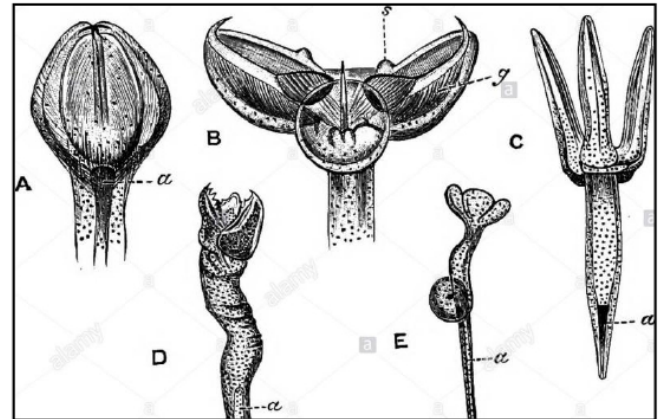
- It is long, triangular with teeth.
- It is used for capture the small organism

3. Trifoliate pedicellariae

- It is leaf like structure without teeth.
- It is used for cleaning the body surface.

4. Ophiocephalous type

- It is broad blade contain teeth.
- It is used seize the prey.



Pedicellariae

Test

- The shell *exoskeleton* covered the body or *corona*.
- The test consists of 20 rows of plates.
- They are arranged ten sections of these five Ambulacral zones remaining five inter ambulacral zones.

Digestive system

- It is consist of *mouth, pharynx, Aristotle lantern, oesophagus, stomach, intestine, rectum* and *anus*.
- Mouth opens into the pharynx.
- The pharynx surrounded by the chewing apparatus called *Aristotle lantern*
- Pharynx followed by oesophagus, the oesophagus lead to stomach.
- Stomach followed by intestine and rectum.
- The rectum runs upwards and opens into the anus.

Aristotle's lantern

- It is formed five jaws joined together.
- Jaws are triangular in shape.
- It has long pointed tooth. It is movable.
- It is made up of two ossicles know as *alveoli*.

Water vascular system

- Water vascular system consist of *ring canal, five radial vessels, transverse vessels, tube feet, madreporide, polian vesicle* and *tiemann bodies*.

Ring canal

- It is encircle the pharynx.

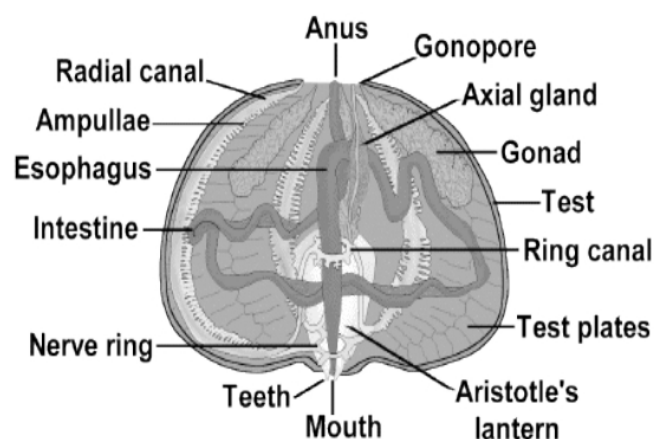
Radial vessels

- Radial vessels arises from ring canal
- It is located ambulacral area.

Transverse vessels

- It is arises from radial vessels and terminate in tube feet.

Stone canal



- It is arises from ring canal
- It is run upwards upto mandreporite.

Polian vesicles

- The ring canal has five polian vesicles.

Function

- It is helps in locomotion.
- It is maintain hydrostatic pressure.

Respiratory system

- Respiratory system consists of tube feet, dermal branchiae, accessory intestine.
- O₂ present the sea water.
- O₂ enters to stalks through tube feet then water moves ampullae then coelomic fluid and all over the body.
- Accessory intestine also involve respiration.

Blood vascular system

- It is formed *perahaemal* and *haemal system*.

Perihaemal system reduced in size and it has no perahaemal ring.

Haemal system

- It has haemal ring
- From the haemal ring arise five radial sinuses.
- It is run along the ampulacral vessels.
- It is also gives two vessels it is run dorsal and ventral alimentary canal.

Nervous system

1. *Ecto neural nervous system* 2. *Deep oral nervous system*

1. Ecto neural nervous system

- It is consist of circumoral ring.
- It is encircle the pharynx
- It gives five radial nerves along ampulacral zones.
- It supply the blood to feet, spine, pedicellariae

2. Deep oral nervous system

- It is poorly development.
- It is formed five nerve patches.
- This system supplies nerves to the Aristotle's lantern.

Reproduction

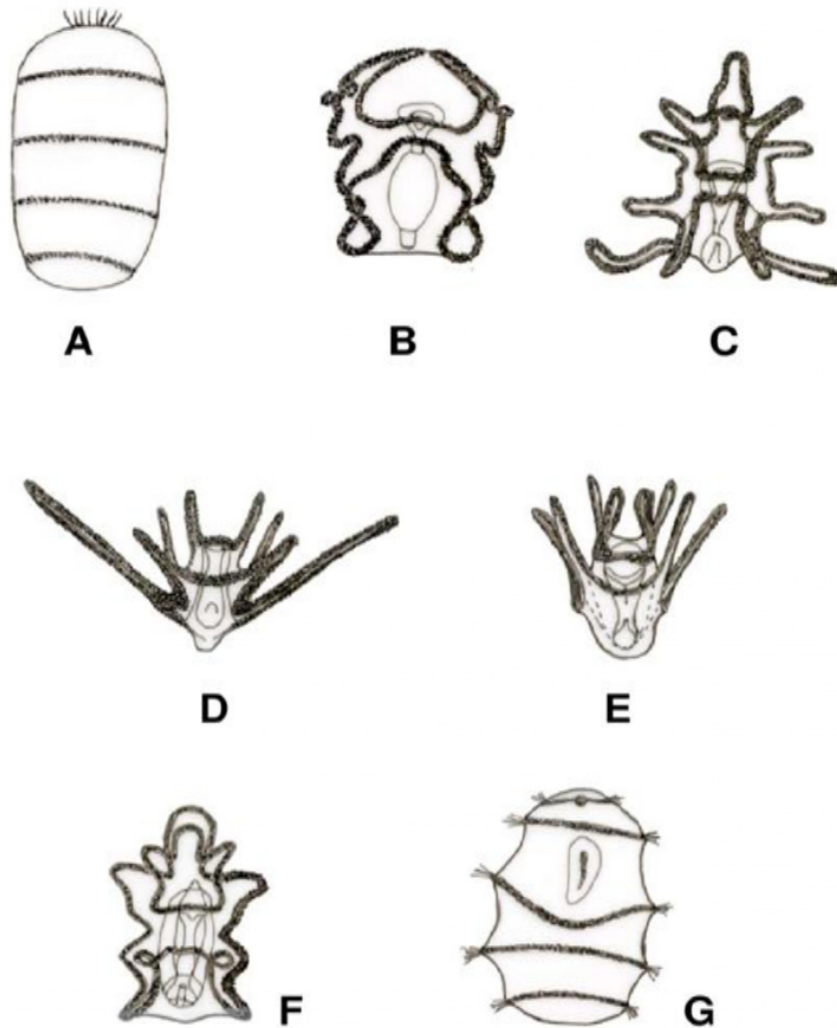
- It is diocious animal (sexes are separate).
- It is consist of five gonads.
- Gonads located at aboral region.
- Mature female gonads orange in colour.
- Mature male gonads white in colour.

Development

- Ova and sperm released into the water, fertilization takes place.
- The fertilized egg hatches out into an *echinopluteus larvae*.
- It is plankton larva, bilateral symmetrical.
- Later, it metamorphoses into an adult.

LARVAL FORMS OF ECHINODERMS

- In echinoderms development may be direct or indirect.
- In direct development there is no larva
- In direct development is seen in only Arctic and Antarctic water.
- In indirect development the life cycle includes one or more larvae
- They are
 - *Dipleurula larva*
 - *Bipinnaria larva*
 - *Brachiolaria larva*
 - *Ophiopluteus*
 - *Echinopluteus*
 - *Auricularia larva*
 - *Doliolaria of Holothuroidea (pupa)*
 - *Doliolaria of Crinoidea*
 - *Pentacrinoid larva*



A: *Dipleurula larva*, **B:** *Auricularia larva*, **C:** *Brachiolaria larva* **D:** *Ophiopluteus* **E:** *Echinopluteus* **F:** *Bipinnaria larva* **G:** *Doliolaria*

Dipleurula Larva

- This larva develops from the gastrula. It has the following salient features:
- Dipleurula is the fundamental larva of all echinoderms.
- It is microscopic.
- It is a free-swimming larva.
- It is bilaterally symmetrical.
- It is oval in shape.
- It has a gut formed of the mouth, the oesophagus, the intestine, the stomach and the anus.
- It feeds on diatoms.
- The dipleurula develops into the bipinnaria larva.

Bipinnaria Larva

- It is the second larva of starfish. It develops from dipleurula larva.
- It is minute and microscopic.
- It swims freely on the surface of the water
- It is bilaterally symmetrical.
- It has a straight alimentary canal with a mouth at the anterior end and an anus at the posterior end
- The body has a number of outgrowths called arms. The arms are covered by ciliated bands and are used for locomotion.

Brachiolaria Larva

- It is third larva of star fish.
- It develops from Bipinnaria Larva
- It is swim and feeds like Bipinnaria Larva

Ophiopluteus

- It is the larva of Ophiuroidea.
- The preoral lobe is small
- The ciliated band is single.
- The arms are supported by calcareous rods
- The larva has a pair of pre oral arms, a pair of post oral arms, a pair of postero dorsal arms and a pair of postero lateral arms
- The postero lateral arms are always longer and directed forward, so that the larva appears like a V

Echinopluteus

- It is the larva of Echinoidea.
- It has a small pre-oral lobe and a single ciliary band.
- The arms are supported by calcareous rods.
- The larva is provided with a pair of preoral arms, a pair of post oral arms, a pair of antero lateral arms, a pair of antero dorsal arms, a pair of postero dorsal arms, a pair of postero lateral arms and a median posterior arm.
- The postero lateral arms are very short and directed backwards.

Auricularia Larva

- It is the larva of Holothuroidea
- There is a well developed pre-oral lobe.
- Ciliated band is single.

Doliolaria of Holothuroidea (Pupa)

- In Holothuroidea (sea-cucumber), the auricularia larva develops into doliolaria larva.
- This larva is also called a pupa.
- It is a free-swimming larva.
- It is barrel-shaped.
- The calcareous skeleton is in the form of spheres.
- The ciliated bands are broken into pieces.
- Metamorphosis begins during free swimming life. After metamorphosis, the larva sinks into the bottom to become the adult.

Doliolaria of Crinoidea

- It is the larvae of Antedon
- It is a free swimming larvae.
- It is bilateral symmetry.
- It is barrel shaped.
- It has 4 or 5 ciliated bands.

Pentacrinoid Larva

- It is the second larva of Antedon.
- It develops from Doliolaria larva.
- It looks like a sea-lily.
- It has a stalk.
- The stalk develops from the pre-oral lobe of Doliolaria.

Metamorphosis

- During metamorphosis, the bilaterally symmetrical larvae become transformed into Radially symmetrical adults.
- In all these larval forms during metamorphosis, there is alteration of the position of the mouth.

Significance

- All the larvae of echinoderms have a bilateral symmetry. Hence it is believed that the ancestor of echinoderms was a bilaterally symmetrical animal.
- According to Bather (1900) this ancestor was called dipleurula. But according to Semon (1888) this ancestor was called pentactula.
- The pentactula ancestor was universally accepted. The radial symmetry of echinoderm is secondary: But the radial symmetry exhibited by Coelenterata and Porifera is primary.
- The radial symmetry in echinoderms is only superficial, concealing the true bilateral symmetry.

UNIT-V
MINOR PHyla

General characters of minor phyla

The invertebrate phyla are divided into major and minor phyla, based on the number of species and individual and their participation in ecological communities.

- The animal grouped under minor phyla are comparatively few in number, small in size.
- They are unimportant as source of food or disease of man.

CTENOPHORA

- All the ctenophores are marine
- They are solitary in pelagic.
- They are transparent.
- They have tissue grade of organization.
- They have bilateral symmetry.
- They are unsegmented.
- The gastro vascular system is well developed.
- Two anus opening are present.
- Excretion and respiration are carried out by diffusion.
- Nervous system formed by nerve net.
- Cilia are used for locomotion.
- They are hermaphrodites.

Resemblance of Coelenterates

- Radial symmetry
- Tissue grade of organization.
- Absence of coelom.
- Diploblastic body wall.
- Presence of statocyst.

Differences from Coelenterate

- Absence of nematocyst.
- Presence of aboral sense organ.
- Presence of two tentacles.

Resemblance of platyhelminthes

- Dorso-ventrally flatted
- Ciliated ectoderm.
- Crawling mode of life.
- Determinate development.

ROTIFERA

- The rotifers are wheel animalcules.
- They are microscopic animals.
- They live in freshwater. Example: Brachionus.
- They are related to Platyhelminthes and Aschelminthes.
- They may be free or attached, solitary or colonial, creeping or swimming or pelagic.
- Some of them are epizoic or parasitic.
- The rotifers vary from 0.04 to 3 mm.in length.
- The body is divided into an anterior head a trunk and a posterior tail.
- The mouth is present on the ventral side
- An eye is present at the anterior end
- The tail is wrinkled and movable.
- It ends in two finger-like projections, the toes.
- The toes contain a pair of cement or pedal glands, the secretion of which serves for attachment
- The body cavity is a pseudocoel.
- The mouth leads into a buccal tube.
- buccal tube leads to pharynx or Mastax
- The mastax leads into an oesophagus.
- Oesophagus open in to stomach
- Stomach is followed by an intestine which opens into the cloaca.
- A pair of coiled nephridial tubes occurs on either side of the alimentary canal.
- Cerebral eye with red pigments is present.
- Papillae with sensory hairs called antennae or palps are present.
- They are tactile in function.
- They exhibit sexual dimorphism.
- The males are smaller than females.
- Reproduction takes place in two ways, by parthenogenesis and by sexual methods.

Affinities

- Rotifers have relationship with arthropods annelids and platyhelminthes.

Affinities with Arthropods

- The affinity towards arthropods was based on certain resemblances such as
- Cuticle
- Apparent segmentation
- Presence of jaws
- The bristle bearing arms of Pedalion suggest the resemblance to a crustacea.

Affinities with Annelida

- Some rotifers show a close resemblance with the swimming trochophore larva.

Affinities with Platyhelminthes

- The protonephridial system with flame cells is identical with that of the rhabdocoel.
- The division of female gonad into a vitellarium and germarium is similar to flatworms.

CHAETOGNATHA

- It is commonly known as arrow worm.
- They are plankton
- The body divided into head, trunk and tail
- The anterior end forms a head bearing a pair of eyes.
- Mouth is a slit-like opening located on the ventral side of the head.

- An unique feature of the chaetognaths is the hood, a fold of body wall, containing a coelomic space, that can be drawn over the head.
- The alimentary canal is straight. It consists of the mouth, pharynx, oesophagus and an intestine which terminates in the anus.
- A pair of lateral diverticula is present at the beginning of the intestine
- There are no specialized respiratory, circulatory and excretory systems.
- The nervous system includes a large cerebral ganglion dorsal to the pharynx, a ventral sub-oesophageal ganglion near the middle of the body.

Sense Organs

- A pair of eyes is present on the head dorsally. Each eye consists of five pigmented cups or ocelli.

Affinities

- They show affinities to Mollusca, Nematoda, Annelida, Arachnida, Crustacea, Hemichordata and even to Chordata.

Affinities with Annelida

- Large coelom is found in both with longitudinal septum.
- Muscle fibres occur in bundles.
- Teeth and jaws of Chaetognatha resemble the chaetae of Chaetopoda.
- Nervous system is annulate.

Affinities with Aschelminthes

- The entire construction is of pseudocoelomate
- The wall lacks one of the two muscle layer.
- Straight alimentary canal.

SIPUNCULIDA

- The sipunculida are unsegmented, vermiform and coelomate protostome animals
- They are commonly called peanut worms.
- The phylum includes about 200 known species belonging to about 13 genera.
- The common examples are Sipunculus, Dendrostomum, Phascolion, etc.
- It is a burrowing animal.
- The size varies from 2mm to about 60cm in length.
- The body has two distinct regions an anterior introvert and a posterior trunk
- The alimentary canal is long, U' shaped and much coiled.
- The mouth leads into the alimentary canal which is not divided into distinct regions.
- It runs up to the hind-end of the body where it bends forwards and extends to the anus.

Affinities of Annelids

- Dermo-muscular body wall.
- Central nervous system is of the annelidan type.
- Spiral cleavage.
- Presence of nephridia.
- Origin of coelom.
- Presence of trochosphere larva.
- But sipunculids exhibit the following differences from the annelida:
- Both the adult and larva lack the body segmentation.
- Presence of introvert with tentacular fold.
- Single ventral nerve cord is without ganglia.
- Only one pair of nephridia

- Anus is dorsal in position near the oral end.
- Parapodia and setae are absent.

Vocabulary English	சொல்லகராதி தமிழ்
Aboral	வாய்க்கு எதிர்புறம்
Absorption	உறிஞ்சுதல்
Acoelom	உடற்குழி அற்றவை
Adaptation	தகவமைப்பு (இசைவாக்கம்)
Affinities	ஈர்ப்புகள் அல்லது தொடர்பு
Amphibious	நிலம் நீர் இரண்டிலும்
Ampulla	விரிமுனை
Annelida	வளைத்தசை புழு
Apex	உச்சி
Appendages	இணையுறுப்புகள்
Arms	கை
Arrow worm	அம்பு புழு
Artery	தமனி
Blastula	கருக்கோளம்
Blood vessel	இரத்த நாளம்
Book lungs	புத்தக நுரையீரல்
Burrow	வளை
Burrowing	நிலத்தில் உள்ள வளை
Cannibalism	தன் இனத்தையெ உண்ணும் உயிரி
Carnivorous	இறைச்சி உண்பவை
Carnivorous	மாமிசம் உண்பவை
Cephalothorax	தலைமார்புப் பகுதி
Chamber	அறை
Chitin	ஒருவகை பாதுகாப்பு உறை
Circulatory system	சுற்றோட்ட அமைப்பு
Cleavage	பிளவி பெருக்கம்

Clitellum	புணர்தடிப்பு
Clitellum	புணர்வளைத் தடிப்பு
Cocoon	கூடு
Coelom	உடல்குழி
Comb	சீப்பு அல்லது தேன் கூடு
Compound eye	கூட்டு கண்
Copulation	புணர்தல்
Cosmopolitan	உலகப்பொதுகுடியிருப்பாக விளங்குகிறது
Crawling	ஊர்ந்து
Dermal pores	உட்தோலுக்குரிய துளைகள்
Detritus	கழிவு
Digestion	செரிமானம்
Dioecious	தனி பால் உயிரி
Ducts	குழாய்கள்
Echinodermata	முட்தோலிகள்
Ectoparasite	வெளிப்புற ஒட்டுண்ணி
Egestion	செரிக்கப்படாத உணவு வெளியேற்றல்
Elongate	நீள்தன்மையுடைய
Epidermis	மேல்தோல்
Excretion	கழிவுகற்றல்
Exoskeleton	புற உடற்கூடு
Filter feeding	வடிகட்டி உணவு
Foot	பாதம்
Formicaries	எறும்பு புற்று
Ganglia	செல்திரள் அல்லது நரம்பு திரள்
Gastropoda	சங்கு இனம்
Gastrula	ஈரடுக்கு கருக்கோளம்
Genital pore	பிறப்புறுப்பு துளை
Groove	பள்ளம்
Haemocoel	இறத்தக்குழி
Herbivorous	தாவர உண்ணி

Ligaments	தசைநார்கள்
Locomotion	இடப்பெயர்ச்சி
Looping	மடக்குதல் அல்லது வளைதல்
Mantle	மூடகம்
Mantle	மூடகம் அல்லது கவசம்
Metamerism	சீரமைப்புக் கண்டம்
Metamorphosis	வளர்உருமாற்ற
Minor phyla	சிறிய தொகுது
Mollusca	மெல்லுடலிகள்
Mucous	சளி போன்ற
Nocturnal	இரவு நேரங்களில்
Nuptial flight	திருமண ஓட்டம்
Omnivorous	அனைத்துண்ணிகளாகும்
Operculum	மூடியுடன்
Oral	வாய்பகுதி
Oral disc	வாய்வழி வட்டு
Oral surface	வாய் மேற்பரப்பு
Ornaments	அழகு, ஆபரணங்கள்
Parasite	ஒட்டுண்ணி
peanut worm	வேர்க்கடலை புழு
Peanut worm	வேர்க்கடலை புழு
Pedal glands	பெடல் சுரப்பிகள்
Peritoneum	வயிற்றறை உறையின்
Plankton	மிதவை உயிரி
Poda	கால்கள்
Pollination	மகரந்த சேர்க்கை
Polymorphism	பல உருதன்மை
Pseudocoelom	போலி உடல்குழி
Pulmonary	நுரையீரல்
Radial canal	ஆரக்கால்வாய்
Ring canal	வளைய கால்வாய்

Rotifer Wheel animalcules	சக்கர விலங்குகளின்
Sanguivorous	இரத்தத்தை உணவாக எடுத்துக்கொள்பவை
Scavenger	துப்புறவு செய்பவர்
Segments	கண்டங்கள்
Sense organ	உணர்வு உறுப்பு
Sessile	ஒட்டிவாழ்பவை
Setae	சீட்டாக்கள்
Shaft	தண்டு
Shell	ஓடு
Snail	நத்தை
Spine	முள்
Stalk	தண்டு
Sternum	மார்பெலும்பு
Sting	கொடுக்கு
Sucker	உறிஞ்சுதல்
Suture	பிளவு
Tentacle	நீட்சி
Tentacles	உணர் உறுப்பு
Tergum	காப்பு
Termitarium	கறையான் புற்று
Thorax	மார்புப் பகுதி
Toes	கால்விரல்
Torsion	திருகு
Vascular system	வாஸ்குலர் அமைப்பு
Vein	சிரை
Water vascular system	நீர் சுற்றோட்ட மண்டலம்
Wedge	ஆப்பு
Whip	சாட்டை போன்ற
Whorls	சுருள்கள்

QUESTION BANK
UNIT - I
PHYLUM: ANNELIDA

I. Two mark questions**1. What are the classes of phylum Annelida?**

- Class 1 Polychaeta (Polys: many; chaete:hair)
- Class 2 Oligochaeta (Oligos: few, chaete: hair)
- Class 3 Hirudinea (Hirudo: leech)
- Class 4 Archiannelida (Arch; first)
- Class 5. Echiuroidea
- Class 6. Sipunculoidea
- Class 7. Priapulida

2. Clitellum

The adult earth worm has 14-17th segments swollen into ring like structure called *Clitellum*.

3. Body seta

Body seta presents on the surface Earthworm its helps to movement

4. Peristomium

The first segment of the earthworm is called *Peristomium*.

5. Prostomium

Peristomium has mouth and *Prostomium*.

6. Metamerism

The linear arrangement of segments one by one (behind the other). These compartment are called *segments or somites or metameres*. The arrangement of segments is called metamerism.

7. Nephridia

Nephridia is a excretory organ of Mollusca

8. Sangivorous

Some animal feeds on blood so it is called *sangivorous*.

9. Hirudin

Leech Pharynx surrounded by salivary glands, that glands secrete **Hirudin** which is prevent the coagulation of blood.

10. Coelom and their types

The cavity located between the *body wall* and the *alimentary canal* is called *Coelom*.

Types of coelom

1. Acoelom 2. Pseudocoelom 3. Eucoelom 4. Haemocoelom

11. Adaptation

- Fitness of an organism to its environment
- It is the characteristic which results in suitable and convenient morphological and functional correlation between an organism and its environment

UNIT-II
PHYLUM: ARTHROPODA

I. Two mark questions**1. What are the classes of phylum Arthropoda?**

Class: 1 Merostomata

Class: 2 Arachnida (Arachne: spider)

Class: 3 Crustacea (Crusta: shell)

Class: 4 Myriapoda (Myrios: ten thousand; podos: foot)

Class 5 Insecta (Insectus: divided)

2. Arthropoda

- Arthropods are joint leg animal (Arthros; Jointed, podos; Foot)
- All arthropods are segmented, jointed leg and chitinous exoskeleton.
- Habitat: mostly terrestrial and aquatic

3. Cephalothorax

It is formed by the fusion of two regions namely Head and Thorax is called cephalothorax.

4. Appendages of prawn

Prawn has totalt 19 appendages there are

- Cephalic appendages – 5 segments
- Thoracic appendages – 8 segments
- Abdominal appendages – 6 pairs

1. Antennules 2. Antenna 3. Mandible. 4-5. I and II Maxillae, 6-8. I,II,III Maxillipedes, 9-13. I-V walking legs, 14-18. Pleopods, 19.Uropod.

5. Prosoma, Mesosoma, Metasoma.

Prosoma :It is anterior region of scorpion it is formed totally 6 segments

Mesosoma, :It is a middle region of scorpion it is formed totally 6 segments

Metasoma :It is a posterior region of scorpion it is formed totally 6 segments

6. Book lungs

- Book lungs respiratory organ of scorpion.
- They are found in 8,9,10 and 11 segments.
- The book lungs open out by stigma.

7. Coxal glands

- Coxal glands are excretory organ of scorpion
- Scorpion has a pair of coxal glands.
- They situated at the third walking leg.

8. Hepatopacreas

- Hepatopacreas are excretory organ of scorpion
- It is located around the intestine
- It is open into gut by five pair of duct.
- It is believed as excretory function.

9. Green glands

Green glands are excretory organs of some arthropods like crustaceans. They are also called antennal glands because these glands are located near antenna.

10. Trophallaxis

- The mutual exchange of food between insects is called trophallaxis.
- Ants feed one another from mouth to mouth.

11. Malpighiantubules

- Malpighiantubules are excretory organ of scorpion
- Scorpion has two pairs of malpighian tubules.
- One end attached to the mid gut and another end freely floats at the blood.

UNIT-III
PHYLUM: MOLLUSCA

I. Two mark questions

1. Mollusc

Mollusk refers to soft body animal t *without segmentation* (Molluscs: soft) Habitat: Mostly aquatic and few are terrestrial

2. What are the classes of phylum molluca?

Class 1 Aplacophora (A=Without, Placophora=A sheet of wood)

Class 2 Monoplacophora (Mono=one, Placophora=A sheet of wood)

Class 3 Polyplacophora(**Poly=Many**, Placophora=A sheet of wood)

Class 4 Gastropoda (Gastros=stomach, podas=foot)

Class 5 Scaphopoda (Tusk shell) (skepha= a boat, podas=foot)

Class 6 Pelecypoda or Bivalvia (bi=two, valve=folding door)

Class 7 Cephalopoda (cephalo=head, podos=foot)

3. Redulla

It is an anatomical structure used to feeding for some molluscan, some time compared to a tongue.

5. Statosyst

- Satosyst is a sensory organ of pila
- It has two statocyst
- It is located near the ganglia.
- It is maintaining equilibrium.

6. Osphridium

- Osphridium is a sensory organ of fresh water mussel
- A pair of osphradia located surface of visceral ganglia.
- It is chemoreceptor.

7. Tentacles

- Tentacles are sensory organ of pila
- Two pair of tentacles located at head region.

8. Sinuses

- The impure blood from the various parts of the body is collected into small spaces called lacunae. These spaces join together to form large spaces called sinuses.
- These sinuses represent the haemocoel.

9. Bojanus organ or Kidney

- It is a excretory organ of fresh water mussel
- First observed by *Bojanus* and hence the name *Organ of Bojanus*.
- They are kidneys.
- Kidneys are 'U' shaped and two limbs.
- It is located beneath of pericardium.

10. Keber's gland

- It is a excretory organ of fresh water mussel
- It is located front of the pericardium
- It is *reddish-brown glands*.
- Kidney also plays as osmoregulation.

11. Glochidium larvae

- Glochidium is fresh water mussel larvae.
- It is very minute microscopic (0.1-0.5mm)
- It is covered by shell, it has two valves.
- The larva attached to the fish hence it is ectoparasite life.
- This life is going ten weeks.

12. Torsion

- Torsion is the *rotation of the visceral organs* during development to an angle of 180° in the anticlockwise direction in gastropod molluscs.

13. Detorsion

- In some gastropods, there is a reversion of torsion after torsion. The reversion of torsion is called *detorsion*.

14. Spats

- Spats (Young oyster) collected by cage.

UNIT-IV
PHYLUM: ECHINODERMATA

I. Two mark questions**1. Echinodermata**

Echinoderm mean spiny skin animal found in only marine

2. What are the classes of phylum Echinodermata?

- *Asteroidea*
- *Ophiuroidea*
- *Echinoidea*
- *Holothuroidea*
- *Opiochistioidea*

3. Pedicellaria and their types

Pedicellariae are scattered all over the body. These are present in between the spines of the aboral surface. On the oral surface they are present attached to the bases of the spines.

- The pedicellariae are of two types.
They are 1. *Pedunculate pedicellaria* and 2. *Sessile pedicellaria*

4. Diplural larva

- It is the first larva of star fish.
- It is microscopic.
- It is a free swimming larva.
- It is bilaterally symmetrical
- It is oval in shape.

5. Bipinnaria larva

- It is the second larva of star fish.
- It develops from dipleurula larva.
- It is minute and microscopic.
- It swims freely on the surface of water.
- It is bilaterally symmetrical

6. Branchiolar larva

- The preoral region of this larva has three processes called brachiolar arms. These three arms are tipped with suckers. It swims and feeds like a bipinnaria.

7. Metamorphosis

Metamorphosis is a biological process by which an animal physically develop after birth or hatching.

8. Aristotle's lantern

- It is formed five jaws joined together.
- Jaws are triangular in shape.
- It has long pointed tooth. It is movable.
- It is made up of two ossicles know as *alveoli*.

9. Test

- The shell *exoskeleton* covered the body or *corona*.
- The test consists of 20 rows of plates.

- They are arranged ten sections of these five Ambulacral zones remaining five inter ambulacral zones.

UNIT-V
MINOR PHYLA

I. Two mark questions

1. Wheel animalcules

- The rotifers are wheel animalcules.
- They are microscopic animals.
- They live in freshwater. Example: Brachionus.
- They are related to Platyhelminthes and Aschelminthes.
- They may be free or attached, solitary or colonial, creeping or swimming or pelagic.

2. Ctenophora

- All the ctenophores are marine
- They are solitary in pelagic.
- They are transparent.
- They have tissue grade of organization.
- They have bilateral symmetry.

3. Minor phyla

- The invertebrate phyla are divided into major and minor phyla, based on the number of species and individual and their participation in ecological communities.
- The animal grouped under minor phyla are comparatively few in number, small in size.
- They are unimportant as source of food or disease of man.

4. Sipunculida

- The sipunculida are unsegmented, vermiform and coelomate protostome animals
- They are commonly called peanut worms.
- The phylum includes about 200 known species belonging to about 13 genera.
- The common examples are Sipunculus, Dendrostomum, Phascolion,
- It is a burrowing animal

5. Chaetognatha

- It is commonly known as arrow worm.
- They are plankton
- The body divided into head, trunk and tail
- The anterior end forms a head bearing a pair of eyes.
- Mouth is a slit-like opening located on the ventral side of the head.

QUESTION BANK
UNIT - I
PHYLUM: ANNELIDA

I. Two mark questions

1. What are the classes of phylum Annelida?
2. Clitellum
3. Body seta
4. Peristomium
5. Prostomium
6. Metamerism
7. Nephridia
8. Sangicorous
9. Hirudin
10. Coelom and their types
11. Adaptation

II. Five mark questions

12. Analyze the general characters of Annelida up to class.
13. Explain – Digestive system of earth worm.
14. Examine the course of circulation in earthworm
15. Explain – Respiratory system of earth worm
16. Write a note on the reproductive system of earthworm
17. Explain – Digestive system of leech
18. Examine the course of circulation in leech
19. Write a note on the reproductive system of leech.

III. Ten mark questions

20. Discuss the metamerism in annelids.
21. Discuss the adaptive radiation of annelids
22. Give a detailed account of coelom and their types.

UNIT-IIPHYLUM: ARTHROPODA**I. Two mark questions**

1. What are the classes of phylum Arthropoda?
2. Arthropoda
3. Cephalothorax
4. Appendages of prawn
5. Prosoma, Mesosoma, Metasoma.
6. Book lungs
7. Coxal glands
8. Hepatopacreas
9. Green glands
10. Trophallaxis
11. Mulpigiantubules

II. Five mark questions

12. Analyze the general characters of Arthropods up to class.
13. Explain – Digestive system of scorpion
14. Examine the course of circulation in scorpion
15. Explain – Respiratory system of scorpion
16. Write a note on the reproductive system of scorpion

III. Ten mark questions

17. Write an essay on Social life in insects
18. Explain - Peripatus and its affinities.
19. Give an account on economic importance of insects.
20. Enlist the appendages of prawn.

UNIT-III
PHYLUM: MOLLUSCA

I. Two mark questions

1. Mollusc
2. What are the classes of phylum mollusca?
3. Redulla
4. Kidney
5. Stosyst
6. Osphridium
7. Tentacles
8. Sinuses
9. Bojanus organ
10. Keber's gland
11. Glochidium larvae
12. Torsion
13. Detorsin
14. Trochophore larva
15. Spats
16. Gastropoda

II. Five mark questions

17. Analyze the general characters of mollusca up to class.
18. Explain – Digestive system of *Pila*.
19. Examine the course of circulation in *Pila*
20. Explain about aquatic respiration in *Pila*.
21. Write a note on the reproductive system of *Pila*
22. Explain – Digestive system of *Lamdliidens marginalis*.
23. Examine the course of circulation in *Lamdliidens marginalis*.
24. Explain – Respiratory system of *Lamdliidens marginalis*.
25. Write a note on the reproductive system of *Lamdliidens marginalis*.

III. Ten mark questions

26. List out the economic importance of mollusc
27. Write an essay on torsion in Mollusca.
28. Give an account on pearl oyster culture.

UNIT-IVPHYLUM: ECHINODERMATA**I. Two mark questions**

1. Echinodermata
2. What are the classes of phylum Echinodermata ?
3. Pedicellaria and their types
4. Diplural larva
5. Bipinnaria larva
6. Brenchiola larva
7. Meta morphosis
8. Aristotle's lantern
9. Test

II. Five mark questions

10. Describe the morphology of sea urchin.
11. Explain-life cycle of star fish
12. Give short notes on nervous system of star fish
13. Classify phylum Echinodermata upto class level

III. Ten mark questions

14. Elucidate the structure of water vascular system in star fish.
15. Elucidate the larval forms of echinoderms.
16. Give a detailed account on water vascular system in echinoderms.

UNIT-V
MINOR PHYLA

I. Two mark questions

1. Wheel animalcules
2. Ctenophora
3. Minor phyla
4. Sipunculida
5. Chaetognatha

II. Five mark questions

6. Write the characters and features of ctenophore.
7. Write the characters and features of Minor phyla
8. Discuss the affinities and systematic position of Ctenophore.

III. Ten mark questions

9. Write an essay on Rotifera.
10. Write a detailed note on characters and affinities of Sipunculida
11. Discuss the affinities and systematic position of Chaetognatha

UNIVERSITY QUESTIONS

S.NO: 1751F

Subject Code: 16SCCZO2**B., SC DEGREE EXAMINATION – APRIL-2019****Part III – Zoology-Major****INVERTEBRATA-II (ANNELIDA-ECHINODERMATA)****Time: Three Hours****Maximum: 75 marks****SECTION A- (10×2=20)***Answer ALL questions*

Explain / Define the following:

1. Polychaeta
2. Superficial metamerism
3. Trophallaxis
4. Coxal glands
5. Trochophore larva
6. Spats
7. Pedicellaria
8. Aristotle's lantern
9. Wheel animalcules
10. Ctenophora

SECTION-B (5×5=25)*Answer ALL questions, choosing either (a) or (b)*

11. a). Give an account of adaptive radiation in Annelida. **(OR)**
b). Write a note on the morphology of leech.
12. a). Enlist the thoracic appendages of prawn. **(OR)**
b). Examine the course of circulation in a scorpion.
13. a). Discuss the pallial complex of *Pila*. **(OR)**
b). List out the economic importance of mollusc.
14. a). Elucidate the structure of water vascular system in star fish. **(OR)**
b). Specify the morphology of sea urchin.
15. a). Explain the general characters of Sipunculida. **(OR)**
b). Describe the affinities of Chaetognatha with other phyla.

SECTION-C (3×10=30)*Answer any THREE questions*

16. Discuss the metamerism in annelids.
17. "Peripatus is a connecting link between Annelida and Arthropoda"- Justify.
18. Analyze the mechanism of respiration in *Lamdillidens marginalis*.
19. Elucidate the larval forms of echinoderms.
20. Write an essay on Rotifera.

S.NO: 5751F

Subject Code: 16SCCZO2B., SC DEGREE EXAMINATION – NOVEMBER-2019Part III – Zoology-MajorINVERTEBRATA-II (ANNELIDA-ECHINODERMATA)

Time: Three Hours

Maximum: 75 marks

SECTION A- (10×2=20)Answer ALL questions

Explain / Define the following:

1. Coelom
2. Leech
3. Arthropoda
4. Prawn
5. Pearl oyster culture
6. Gastropoda
7. Star fish
8. Pedicellaria
9. Chaetognatha
10. Minor phyla

SECTION-B (5×5=25)Answer ALL questions, choosing either (a) or (b)

11. a). Describe the morphology of earthworm with a neat diagram. **(OR)**
b). Analyze the general characters of Annelida.
12. a). Discuss the significance of *Peripatus*. **(OR)**
b). Give an account on economic importance of insects.
13. a). Explain about aquatic respiration in *Pila*. **(OR)**
b). Write a note on general characters of Mollusca.
14. a). Classify phylum Echinodermata upto class level. **(OR)**
b). Describe the morphology of sea urchin.
15. a). Write a note on Sipunculida. **(OR)**
b). Analyze the general characters of Rotifera.

SECTION-C (3×10=30)Answer any THREE questions

16. Discuss about metamerism in annelids.
17. Analyze the social life of insects.
18. Write an essay on torsion in Mollusca.
19. Explain the larval forms of echinoderms.
20. Write a detailed note on characters and affinities of Ctenophora.

தேடிச் சோறுனிதந் தின்று - பல

சின்னங் சிறுகதைகள் பேசி - மனம்

வாடித் துன்பமிக உழன்று - பிறர்

வாடப் பலசெயல்கல் செய்து - நரை

கூடிக் கிழப்பருவ மெய்தி - கொடுங்

கூற்றுக் கிரையெனப் பின்மாயும்,,,,,,

