# Minor course practical:

## Paper code: ZOUAMNL1:

## Paper name: Animal diversity of non-chordates (Coelomates)

1. Study of following specimens:

**Annelids:** Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria etc.

**Arthropods**: Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta, termites and honey bees etc.

**Onychophora:** Peripatus

**Molluscs:** Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus etc.

**Echinodermates:** Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria and Antedon etc.

2. Study of digestive system of earthworm.

3. Study of septal nephridia and pharyngeal nephridia of earthworm.

4. T. S. through pharynx, gizzard, and typhlosolar intestine of earthworm.

5. Mount of mouth parts and dissection of digestive system of Periplaneta

6. Dissection of nervous system of Periplaneta

7. To submit a project report on any related topic to larval forms (crustacean, mollusc and echinoderm)

**Suggested readings:**

1. Ruppert and Barnes (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Barnes RSK, Calow P, Olive PJW, Golding DW and Spicer JI (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science.
3. Barrington EJW (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson.
4. Nigam (1997). Biology of Chordates, S. Chand.
5. Kotpal, Modern text book of Zoology: Vertebrates, Rastogi Publication.

# Phylum Annelida

## *Nereis*

**Systematic position:**

**Phylum:** Annelida

**Class:** Polychaeta

**Order:** Errantia

**Genus:** *Nereis*

**Comments:**

1. *Nereis* is commonly called rag worm.
2. The body is long, slender, elongated, dorso-ventrally flattened segmented and is divisible into head, trunk and pygidium.
3. Head consists of two parts, the prostomium and peristomium. Prostomium bears a pair of tentacles, two pairs of eyes and a pair of short two jointed palps. Peristomium bears four tentacles and a slit-like mouth.
4. Trunk is made up of several segments, each bearing a pair of lateral parapodia which are locomotory organs. Setae project beyond the outer margin of each parapodium.
5. Pygidium or anal segment is without parapodia but bears a pair of appendages known as anal cirri and a terminal anus.
6. Respiration happens via blood capillary network of parapodia.
7. Alimentary canal is straight and extends from mouth at the anterior end to the anus at the posterior end.
8. Sexes separate. Fertilization is external.
9. The sexual phase of Nereis is known as Heteronereis.
10. **Habit and habitat:** Nereis is found in burrows in sand or rocks in intertidal and shallow marine waters.
11. **Distribution:** Nereis is cosmopolitan in distribution and found in coastal waters of Europe, North Atlantic, Pacific oceans and U.S.A.

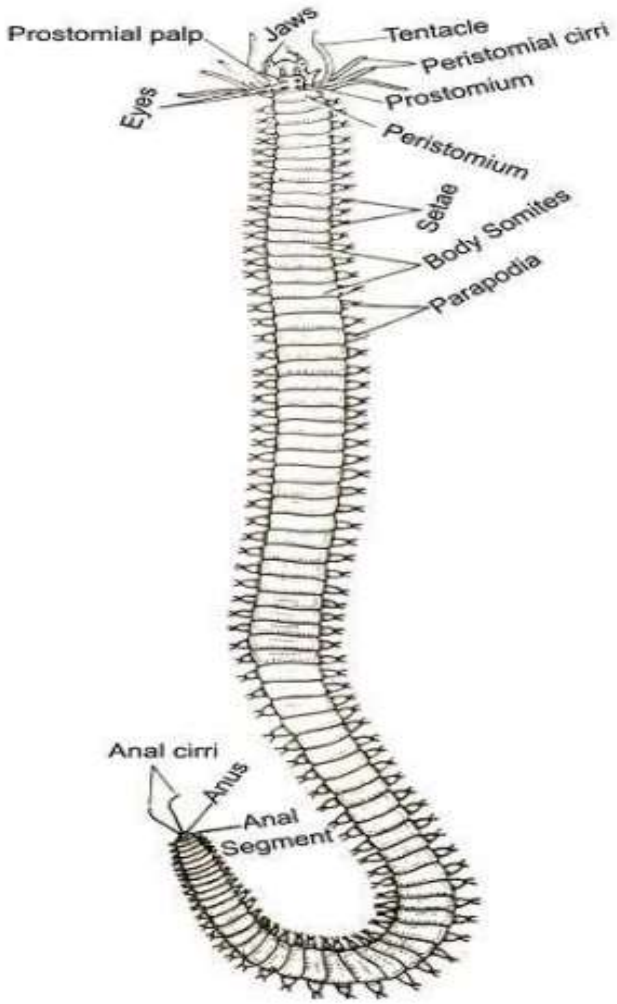



**Figure:** ***Nereis***

# *Heteronereis*

**Systematic position:**

**Phylum:** Annelida

**Class:** Polychaeta

**Order:** Errantia

**Genus:** Heteronereis

**Comments:**

1. Heteronereis is the sexual phase of Nereis.
2. The body of Heteronereis is divisible into an anterior atoke or asexual region and a posterior epitoke or sexual region.
3. It comes out to the water surface and leads an active free swimming life.
4. Eyes become greatly enlarged and highly sensitive to light.
5. The peristomial cirri become longer.
6. Parapodia become enlarged, develop additional foliaceous outgrowths and setae become oarshaped which help in active swimming.
7. Due to excessive development of gonads, the muscles and alimentary canal are reduced.
8. There is no marked sexual dimorphism in most species.
9. Habit and habitat: Heteronereis is a free-swimming worm found in sea.

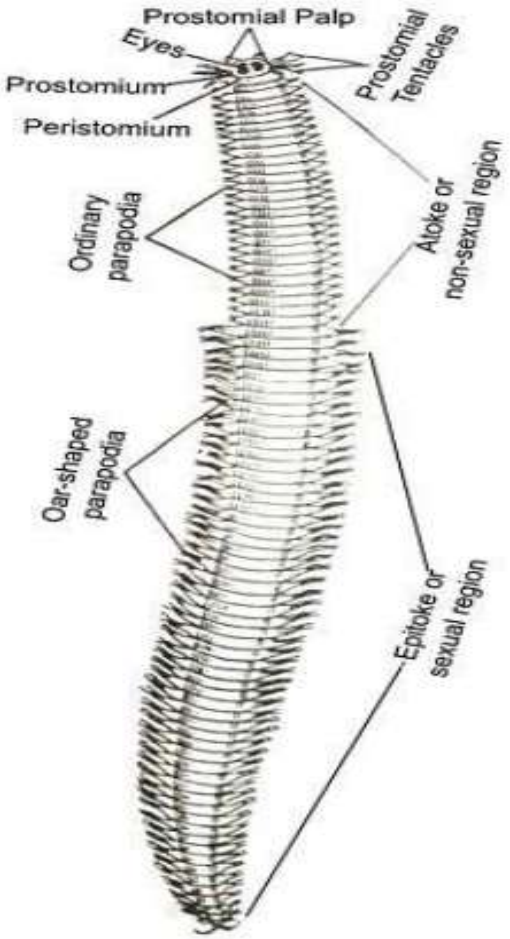



**Figure:** ***Heteronereis***

# *Hirudinaria*

**Systematic position:**

**Phylum:** Annelida

**Class:** Hirudinea

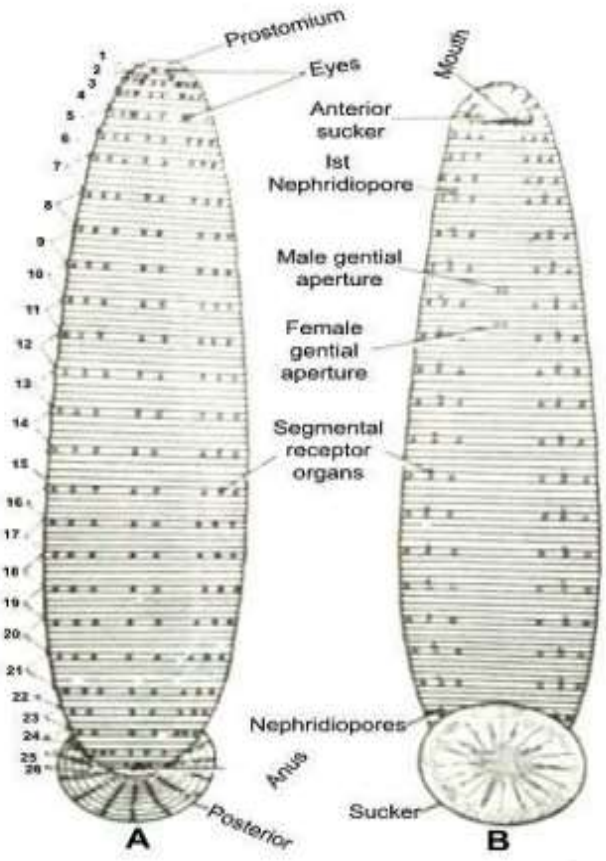
**Order:** Gnathobdellida

**Genus:** Hirudinaria

**Comments:**

1. Hirudinaria granulosa is commonly called Indian cattle leech.
2. Body is soft, elongated, vermiform and bilaterally symmetrical with dorsal surface green and ventral surface orange yellow in colour.
3. During extension of the body is dorso-ventrally flattened while during contraction it is cylindrical.
4. Body of leech is divided into 33 segments. The segments are further divided into annuli or rings.
5. Anterior and posterior suckers are well developed. Anterior sucker is oval bearing triradiate mouth and is formed by the fusion of prostomium with a few somites of anterior region. The posterior sucker is circular in outline and forms a muscular disc at the posterior end. Both the suckers serve as powerful organs of adhesion and locomotion.
6. Five pairs of eyes are present on the dorsal side.
7. No special respiratory organs. Respiration happens via skin.
8. Locomotion by creeping/crawling on the surface.
9. Alimentary canal is a straight tube extending from mouth to anus. Small aperture or anus is situated middorsally on the 26th segment at the root of the posterior sucker.
10. Excretory system consists of segmentally arranged seventeen pairs of nephridia arranged from six to twenty-two segments, opening by nephridiopores on the ventral surface.
11. Hermaphrodite.
12. Male genital aperture is situated mid-ventrally in the second and third annuli of 10th segment and female genital aperture between second and third annuli of 11th segment.
13. Sexual reproduction is common.

14. Habit and habitat: Hirudinaria is found in freshwater tanks, ponds, lakes, slow streams and swamps. It is sangivorous (blood sucking) in habit. Distribution: Hirudinaria has cosmopolitan or worldwide distribution specially found in India and Myanmar.




A. Dorsal view B. Ventral view

**Figure: *Hirudinaria***

# *Pheretima*

**Systematic position:**

**Phylum:** Annelida

**Class:** Oligochaeta

**Order:** Neooligochaeta

**Genus:** Pheretima

Comments:

1. Pheretima is commonly called earthworm.
2. Body is bilaterally symmetrical, narrow, long, elongated and cylindrical measuring upto 150 mm in length.
3. Anterior end is tapering and posterior end is blunt.
4. Body is divided into 100-120 ring-like segments by a distinct series of annular grooves.
5. Each segment is provided with setae arranged in a ring with each setae arising from a setigerous sac of the skin. The setae help in locomotion by holding the earth.
6. Mouth is crescentic aperture situated just below the prostomium.
7. The clitellum is a circular band of glandular tissue which completely surrounds the segments from 14th to 16th segment.
8. Hermaphrodite.
9. A pair of male genital pore is situated ventrally in the eighteenth segment while female genital pore are situated at the ventral surface of fourteenth segment.
10. Anus is situated at the terminal end of the last body segment called anal segment.
11. Reproduction is usually sexual.
12. Development takes place in cocoons.
13. Earthworm is used as bait in fishing and as food by many uncivilized people. It also has use in medicines, education, experiments and in agriculture as producer of organic fertilizer.

14. **Habit and habitat:** Pheretima are burrowers found in the soil rich in decaying organic matters usually in pastures, lawns, gardens, irrigated farm lands, near the banks of ponds, lakes and rivers.
15. **Distribution:** Found all over world.

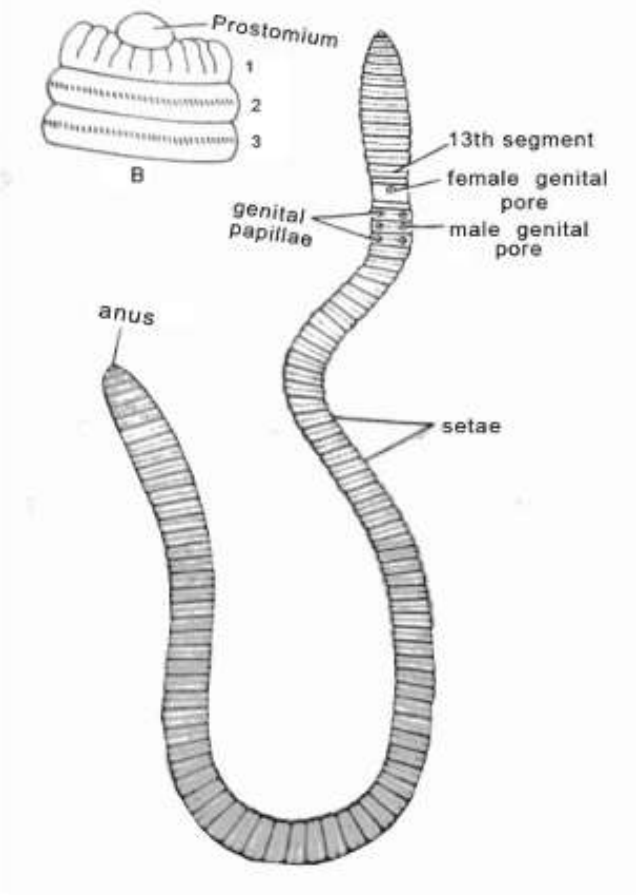



**Figure:** ***Pheretima***

# Aphrodite

**Systematic position:**

**Phylum:** Annelida

**Class:** Polychaeta

**Order:** Errantia

**Genus:** Aphrodite

**Comments:**

1. Aphrodite is commonly called as sea mouse.
2. It measures about 12 cm in length.
3. Body is short, oval and dorso-ventrally flattened.
4. Ventral surface is flat, segmented and forms a creeping sole.
5. Stiff setae and hollow bristles are present on the dorsal surface.
6. Segments clearly visible on the underside.
7. Head is small, situated anteriorly beneath the dorsal felt and bears a single small median tentacle and two large lateral palps.
8. Intestine is characterized by long branching segmental caeca which digest minute food particles.
9. Respiration takes place through dorsal body surface.
10. Anus is situated at the posterior extremity on the dorsal surface.
11. Sexes are separate and fertilization is external.
12. Habit and habitat: Aphrodite is a marine burrowing form found just below the intertidal zone usually on sandy muddy bottoms.
13. Distribution: It is found in both sides of Atlantic and in the Mediterranean Sea.

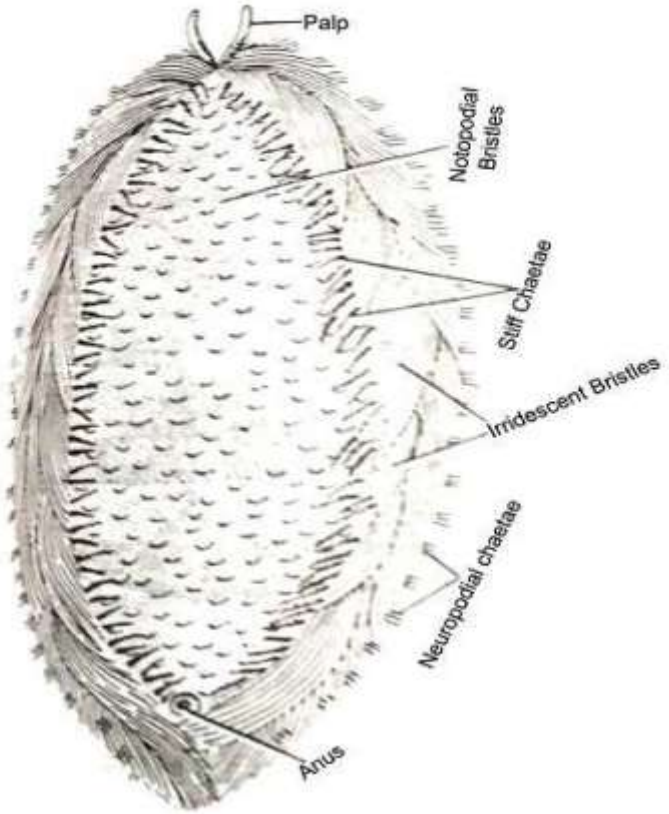



**Figure: Aphrodite**

# Phylum: Arthropoda

**Systematic position:**

**Phylum:** Arthropoda

**Class:** Merostomata

**Genus:** Limulus

**Comments:**

1. Limulus is commonly known as king crab.
2. It is bilaterally symmetrical, triploblastic metamerically segmented animal with jointed appendages.
3. Body is divided into anterior prosoma, posterior opisthosoma and a spine like tail or telson.
4. Prosoma is covered by a horse-shoe shaped carapace. It bears a pair of simple eyes and a pair of compound eyes. It bears 6 pair of appendages surrounding the mouth. The first pair of chelicerae is small, trisegmented and chelate. Rest of the five appendages consists of four pairs are chelate legs and a last pair of non-chelate leg.
5. Opisthosoma is hexagonal and movably articulated with prosoma. It consists of 6-segmented mesosoma and 3-segmented metasoma. It bears six pairs of appendages, the first pair is fused and forms the genital operculum and the remaining five pairs of appendages are flap like and membranous and are used for respiration.
6. The telson is used to flip itself over if stuck upside down and to steer in the water.
7. Excretion takes place through coxal glands.
8. Sexes are separate. Fertilization is external.
9. Habit and habitat: Limulus is marine form and found in shallow waters along sandy and muddy shores of sheltered bays and estuaries. It feeds on molluscs, annelid worms and other benthic invertebrates.
10. Distribution: It is found along the eastern coast line of Asia, Gulf of Mexico and North America.

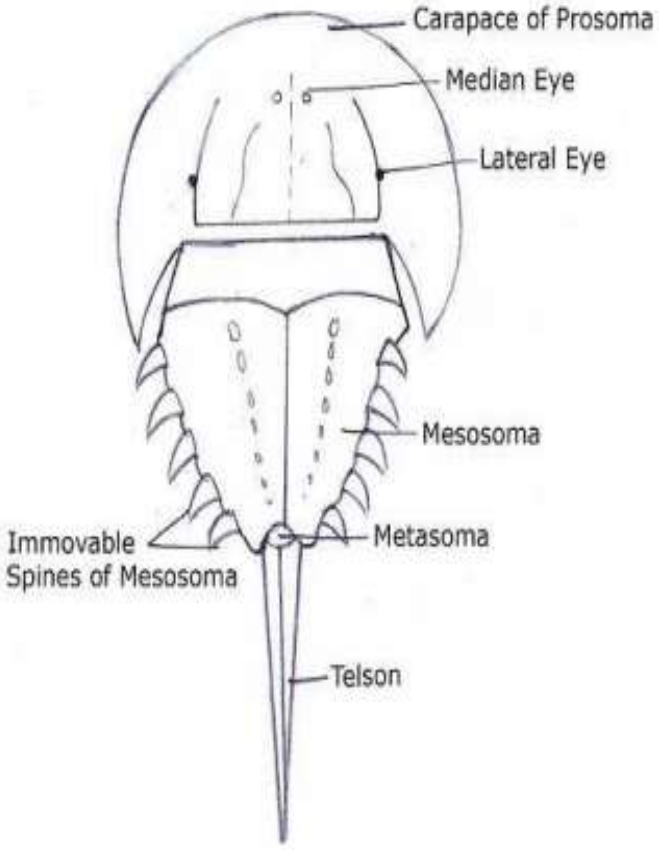



**Figure: Limulus**

# *Palamnaeus*

**Systematic position:**

**Phylum:** Arthropoda

**Class:** Arachnida

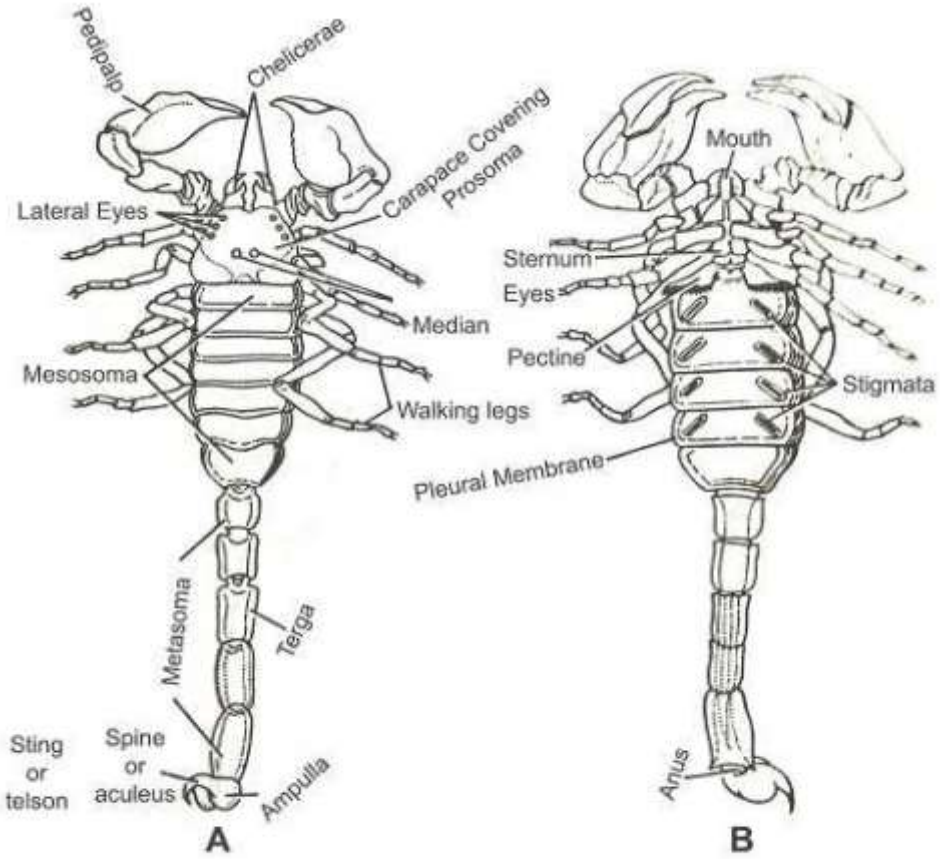
**Order:** Scorpionidea

**Genus:** Palamnaeus

**Comments:**

1. Palamnaeus is commonly known as scorpion.
2. Body is bilaterally symmetrical, triploblastic, coelomate, metamerically segmented animal with jointed appendages.
3. Body is differentiated into anterior prosoma, middle mesosoma and posterior metasoma.
4. Prosoma is covered by carapace that bears a pair of median eyes and 2-5 pairs of lateral eyes. It has six segments, each with a pair of appendages, i.e., one pair of chelicerae, one pair of pedipalp and four pairs of walking legs.
5. Opisthosoma consists of two parts anterior mesosoma and posterior metasoma.
6. Mesosoma is seven segmented, the first segment bears genital operculum, the second segment bears a pair of pectines and each of the third, fourth, fifth and sixth segments have a pair of stigmata. The seventh segment is without any appendages.
7. Metasoma is tail like and comprises five caudal segments and a last segment or telson bearing the sting.
8. Sexes are separate.
9. Viviparous.
10. Palamnaeus are harmful to mankind; its sting can cause swelling at the sting site, extreme pain, fever and in some cases collapse.
11. Habit and habitat: Palamnaeus is nocturnal, carnivorous and secretive animal. It is found in sand or under stones.

12. Distribution: Palamnaeus are found on the land masses the world over except Antarctica.




A. Dorsal View B. Ventral View

**Figure**: **Palamnaeus**

# *Palaemon*

**Systematic position:**

**Phylum:** Arthropoda

**Class:** Crustacea

**Order:** Decapoda

**Genus:** Palaemon

**Comments:**

1. Palaemon is commonly known as prawn.
2. Body is elongated, spindle shaped and bilaterally symmetrical.
3. Palaemon species are of pale-yellow, pale-blue and greenish color with brown tinge or with orange-red patches. Preserved specimens become deep orange-red.
4. The body can be divided into two regions, anterior cephalothorax and posterior abdomen.
5. Cephalothorax is a large, rigid, unjoited, immovable and cylindrical structure. It consists of 13 segments, 5 of the head region, and 8 of the thorax region.
6. Abdomen is rounded, jointed and compressed laterally. It consists of 6 movable segments and a terminal conical structure, called telson. Each abdominal segment bears a pair of jointed appendages called pleopods or swimmerets.
7. The prawn uses its walking legs for movement at the water-bed.
8. Respiration happens via gills, epipodites and lining of branchiostegites.
9. Excretion through a pair of antennary or green glands, a pair of lateral ducts, an unpaired renal or nephroperitoneal sac and the integeument.
10. Sexes are separate. Sexual dimorphism is well developed.
11. Habit and habitat: Palaemon is found in freshwater ponds, lakes, streams, ditches and rivers. It is a nocturnal creature. It hides at the bottom during the day and comes to the surface at night in search of food. It feeds mainly on algae, moss and other aquatic weeds.
12. Distribution: Palaemon is commonly found in India.

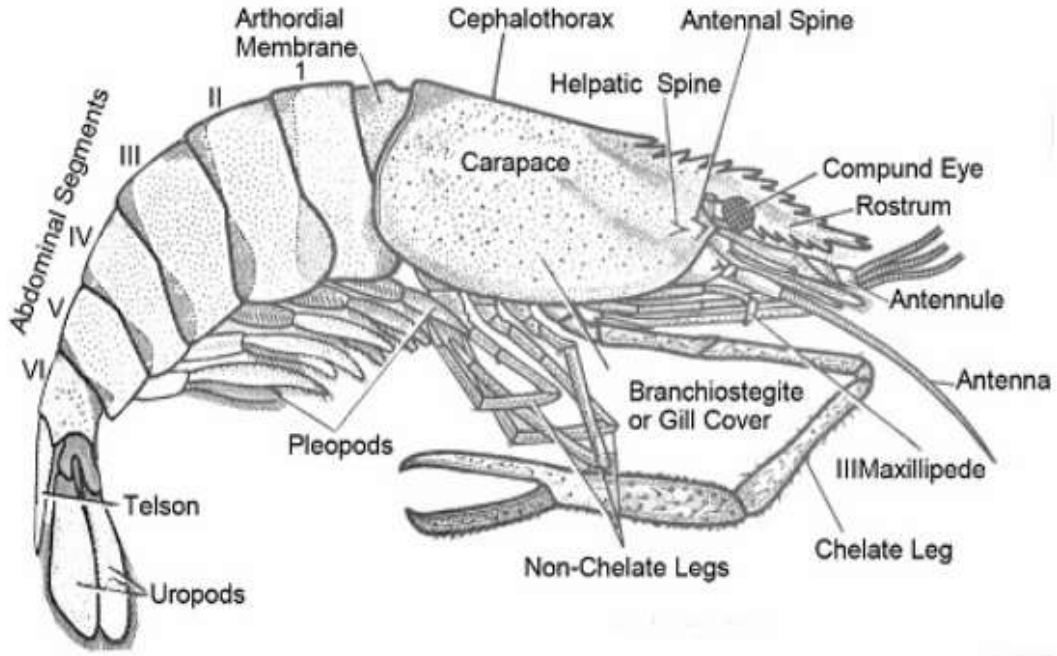



**Figure: Palaemon**

# *Balanus*

**Systematic position:**

**Phylum:** Arthropoda

**Class:** Crustacea

**Order:** Thoracica

**Genus:** Balanus

**Comments:**

1. Balanus is commonly called as rock barnacle or acorn barnacle.
2. Body is bilaterally symmetrical, triploblastic metamerically segmented animal with jointed appendages.
3. Body is surrounded by a calcareous shell consisting of six plates: an unpaired rostrum, an unpaired carina and two pairs of carino-lateral plates.
4. A four-fold cover, consisting of two scuta and two terga covers the shell opening.
5. Six pairs of thoracic legs are provided that can protrude out of the shell opening to collect food particles.
6. Hermaphrodite. Development is indirect involving a nauplius larva. Habit and habitat: Balanus is found attached to rocks and molluscan shells.
   Distribution: Balanus is cosmopolitan in distribution. It is mainly found along North Atlantic coast, Pacific coast, West Indies and Washington to Alaska.

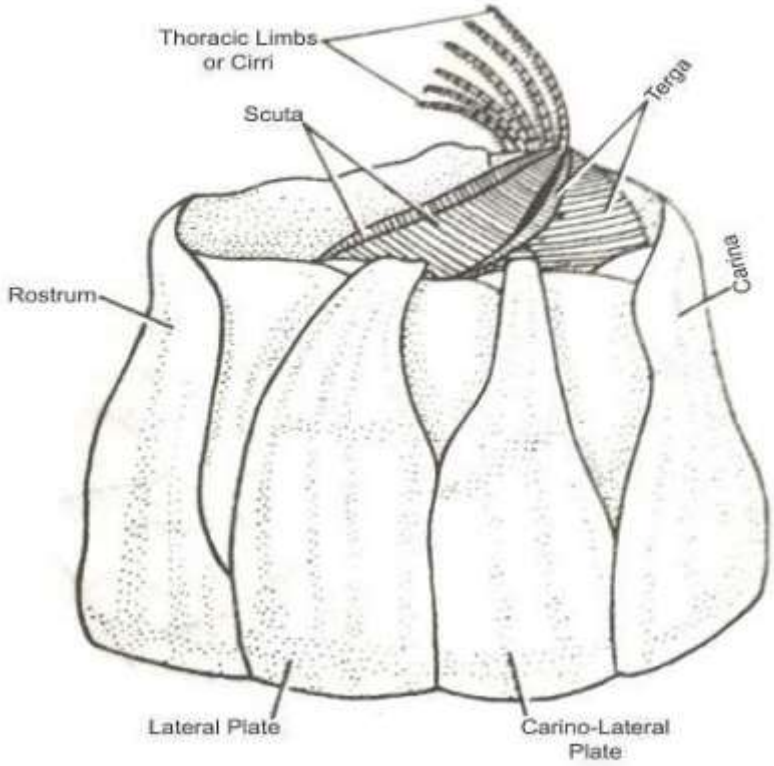



**Figure**: **Balanus**

# *Sacculina*

**Systematic position:**

**Phylum:** Arthropoda

**Class:** Crustacea

**Order:** Rhizocephala

**Genus:** *Sacculina*

**Comments:**

1. Sacculina is commonly known as root-headed barnacle.
2. It lives as a parasite on crab's abdomen.
3. The body is made up of two parts- a thin sac and a peduncle. The sac appears like a fleshy tumour attached to the abdomen by a peduncle. The peduncle consists of numerous root-like filaments which protrude body of the host to derive nutrition.
4. Appendages, segmentation, alimentary canal and anus are absent.
5. Hermaphrodite, i. e. sexes united.
6. Larva is cirripede-nauplius.
7. The female Sacculina, attached to male crab, causes hormonal imbalance in the crab that makes it infertile (parasitic castration).
8. Habit and habitat: Sacculina live in marine environment.
9. Distribution: Sacculina is cosmopolitan.

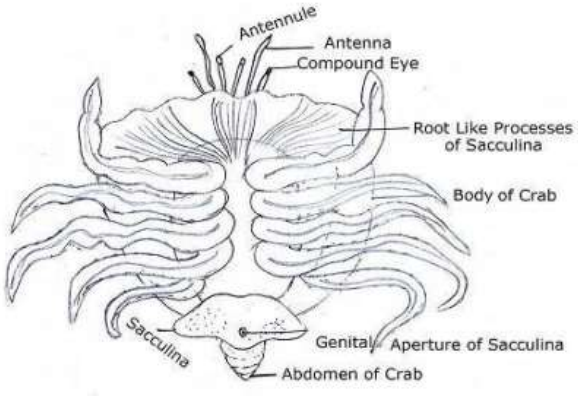



**Figure**: **Sacculina**

# *Eupagurus*

**Systematic position**

**Phylum:** Arthropoda

**Class:** Crustacea

**Order:** Decapoda

**Genus:** Eupagurus

**Comments:**

1. Eupagurus is commonly known as hermit crab.
2. Body is asymmetrical, elongated and divisible into cephalothorax and abdomen.
3. Body is extremely modified in order to live inside the molluscan shells.
4. Cephalothorax is broad and flattened.
5. Head bears a pair of compound eyes, a pair of large antennae and a pair of short antennules. Thorax bears five pair of legs. First, fourth and fifth pair of legs are chelate whereas rest of the legs are non-chelate. Front two legs are of different sizes the large left claw is used for defense purpose and the smaller right claw is used for scooping food and water.
6. Abdomen is soft and is spirally twisted.
7. Abdominal appendages of the left side are reduced while those of the right side are absent.
8. Habit and habitat: Eupagurus inhabits the abandoned shells of gastropods. It is a nocturnal creature, generally silent during the day. It leads a commensal life.

9. Distribution: Eupagurus is cosmopolitan. It is found at Bombay and Goa beaches, from Alaska to Lower California and Florida.

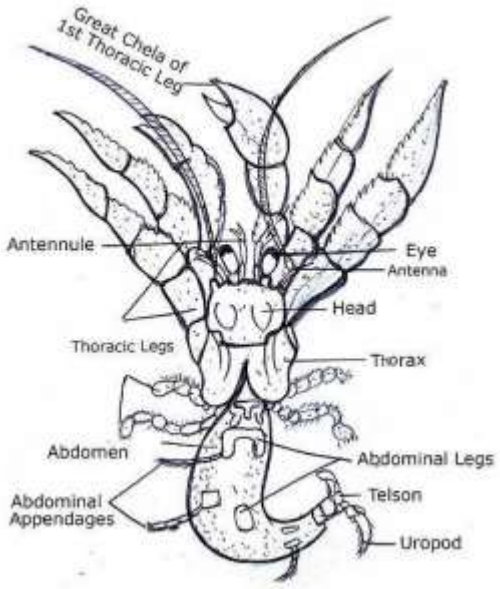



**Figure**: **Eupagurus**

# *Scolopendra*

**Systematic position**

**Phylum:** Arthropoda

**Class:** Myriapoda

**Order:** Chilopoda

**Genus:** Scolopendra

**Comments:**

1. Scolopendra is commonly known as centipede.
2. Body is elongated and dorsoventrally flattened with numerous segments.
3. Body is divided into small head and a long trunk.
4. Head bears a pair of antennae, eyes, a pair of mandibles and two pairs of maxillae.
5. Trunk has 22 identical segments each (except first) has a pair of walking legs.
6. First pair of trunk appendages or maxillipedes bears a sharp claw through which opens the poison gland.
7. Sexes are separate.
8. It is nocturnal and mostly carnivorous.
9. Scolopendra is harmful to mankind because of their venomous bite.

   Habit and habitat: Scolopendra commonly occurs under stones, in rotten logs and in houses in damp places.

   Distribution: Scolopendra is found in India and U.S.A.

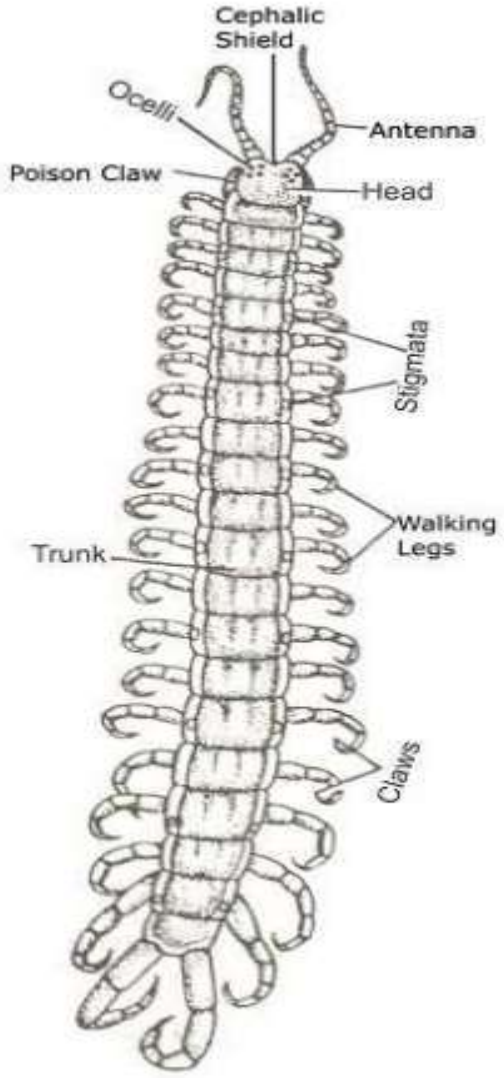



**Figure:** ***Scolopendra***

# *Julus*

**Systematic position**

**Phylum:** Arthropoda

**Class:** Myriapoda

**Order:** Diplopoda

**Genus:** Julus

**Comments:**

1. Julus is commonly called millipede or wire worm.
2. Body is elongated, cylindrical and consists of a large number of segments.
3. Body is divided into head, thorax and abdomen.
4. Head contais a pair of large mandibles, eyes and a pair of antennae having seven joints.
5. Thoracic segments each having a pair of legs, while abdominal segments bear two pairs of legs each.
6. Microscopic holes called ozopores (Stink glands) present along the sides of the body, secreting noxious substance as a defence mechanism.
7. Sexes are separate.
8. Habit and habitat: Julus is found hidden usually in dark and damp places under stones or wood or in decaying leaves. It feeds on decomposing vegetation faeces and organic matter mixed with soil.
9. Distribution: Julus is cosmopolitan in distribution; found in India, Europe and U.S.A.

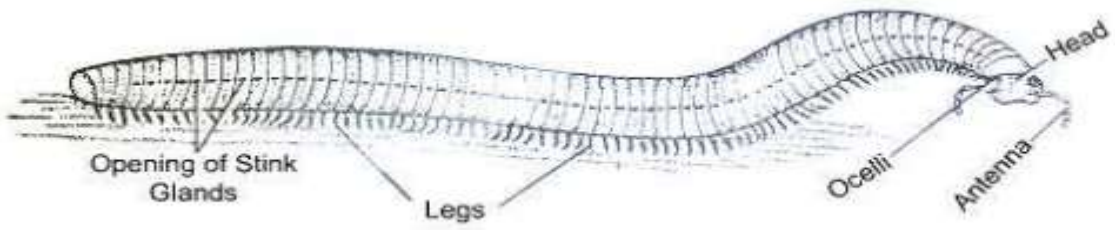



**Figure: *Julus***

# *Bombyx*

**Systematic position**

**Phylum:** Arthropoda

**Class:** Insecta

**Order:** Lepidoptera

**Genus:** Bombyx

**Comments:**

1. Bombyx is commonly called as silk moth.
2. Body consists of head, thorax and abdomen.
3. Head bears a pair of plumed antennae and a pair of compound eyes.
4. Thorax bears three pairs of legs and two pairs of wings which are covered with scales.
5. Hindwing is smaller than forewing.
6. The abdomen is consists of ten segments.
7. Mouthparts are siphoning type.
8. Moths are nocturnal. They come on the light during the rainy season.
9. Habit and habitat: Bombyx is reared for silk. The adults have a short lifespan and don not feed.
10. Distribution: Bombyx are cosmopolitan in distribution.

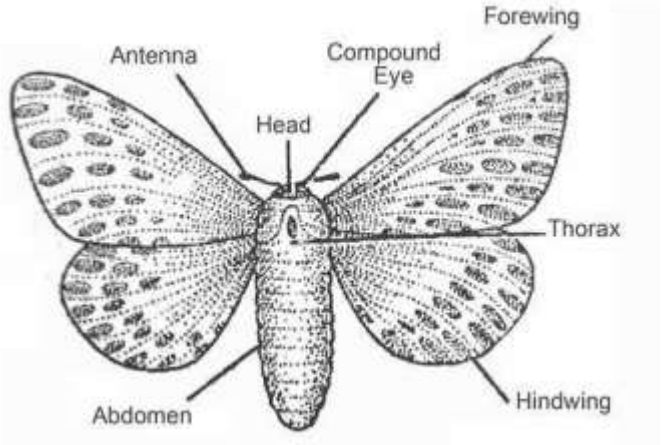



**Figure:** ***Bombyx***

# Cockroach

**Systematic position**

**Phylum:** Arthropoda

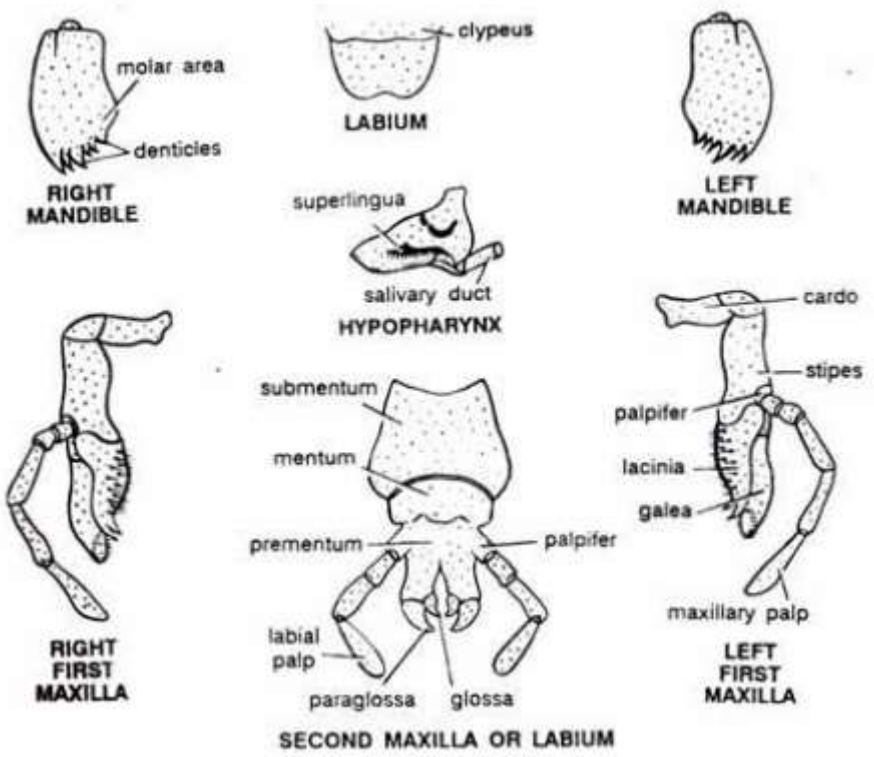
**Class:** Insecta

**Order:** Orthoptera

**Genus:** Cockroach

**Comments**

1. It contains chewing mouth parts.
2. Head is dorso-ventrally elongated and is composed of antennae, large compound eyes and mouth parts.
3. Mouth parts consist of (i) labrum, (ii) mandibles and (iii) maxillae.
4. Labrum protects the mouth. Mandibles are simple and toothed.
5. Maxilla has two part-cardo and stipes. Stipes contains internally lacinia, medially galea and extemally maxillary palp.
6. Labium is composed of submentum, postmentum and prementum.
7. Prementum carries glossa internally, Paraglossa medially and palpiger externally.
8. Maxillary and labial palps are tasting organs.
9. **Identification**: Since the mount shows definitely arranged various parts especially labium maxilla and all above features, hence it is mouth parts of cockroach.




**Cockroach Head and Mouth parts**

# *Odontotermes*

**Systematic position**

**Phylum:** Arthropoda

**Class:** Insecta

**Order:** Isoptera

**Genus:** Odontotermes

**Comments:**

1. Odontotermes is commonly called as termite.
2. Body is soft, elongated and cylindrical and has three distinct regions: head, thorax and abdomen.
3. Head and thorax are small as compare to abdomen.
4. Head bears a pair of compound eyes, a pair of antennae and the mouth. 5. Thorax bears three pairs of walking legs.
5. Abdomen bears of ten segments. The ninth segment bears a pair of anal cerci. It is swollen to accommodate the large number of fertilized eggs. 6. Mouth parts are biting type.
6. Social and polymorphic insects. They live together in large communities.
7. Colony consists sexually mature males and females (kings and queens), sterile workers, soldiers and nasutes.
8. Wings are well developed.
9. Termites are known to cause huge economic loss they damage the household furniture and other materials made up of wood.
10. **Habit and habitat:** Termite is nocturnal, and lives in tunnels constructed inside wood and earth. Some termites make huge mounds using excavated mud, wood and excreta mixed with saliva. They feed upon vegetation, wood, faecal matter of termites and the dead of the colony.
11. **Distribution:** Termites are found all over the world.

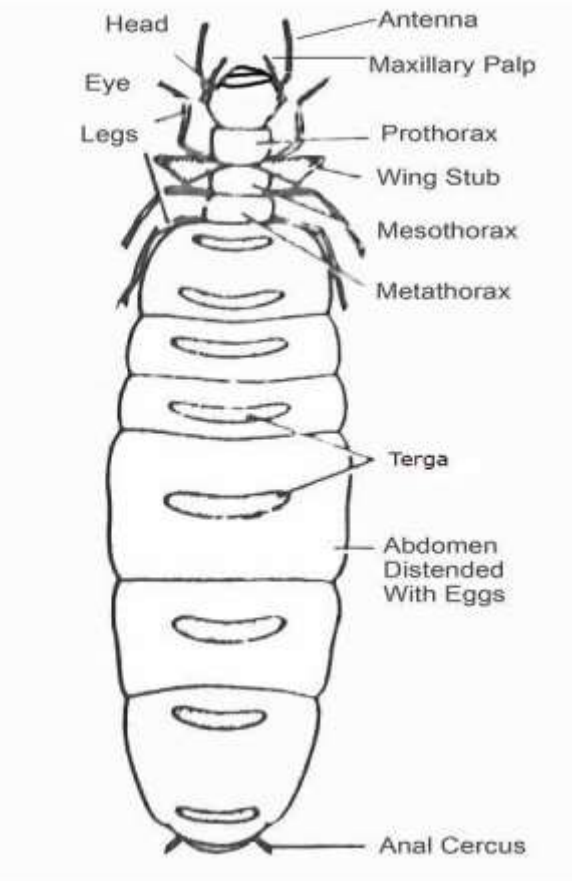



**Figure: Termite**

# *Apis*

**Systematic position**

**Phylum:** Arthropoda

**Class:** Insecta

**Order:** Hymenoptera

**Genus:** Apis

**Comments:**

1. Apis is commonly known as honey bee.
2. Apis is a social insect and lives in a highly organized petennial colony in bee hive.
3. The body is divided into three distinct regions; head, thorax and abdomen.
4. Head contains mouth, compound eyes and a pair of antennae. Mouth parts are chewing and lapping type.
5. Thorax contains three pairs of legs and two pairs of wings.
6. Abdomen is segmented and contains spiracles for breathing.
7. Honey bee colony consists of a queen, male drones and sterile female workers.
8. Female worker bees have the ovipositor modified to form sting.
9. Female worker bees do duties like - food collection, bringing nectar, making wax cells, looking after the young ones, building and cleaning the hive, etc.
10. The queen is larger in size than workers and drones. It has a longer abdomen and its duty is to lay eggs only.
11. The drones are the male members of the colony, without stings. They mate with queen and die after mating.
12. The honey bees are economically important insects as they are the source of honey and bees wax.
13. Bee keeping is called apiculture.
14. Habit and habitat: Apis lives in colonies of couple of thousands bees. A colony consists of a single egg laying female or queen, several hundred male drones and thousands of sterile female workers. The worker bees collect nectar from the nectaries of flowers.
15. Distribution: Cosmopolitan. Honeybee is commonly found in India, Europe and Africa.

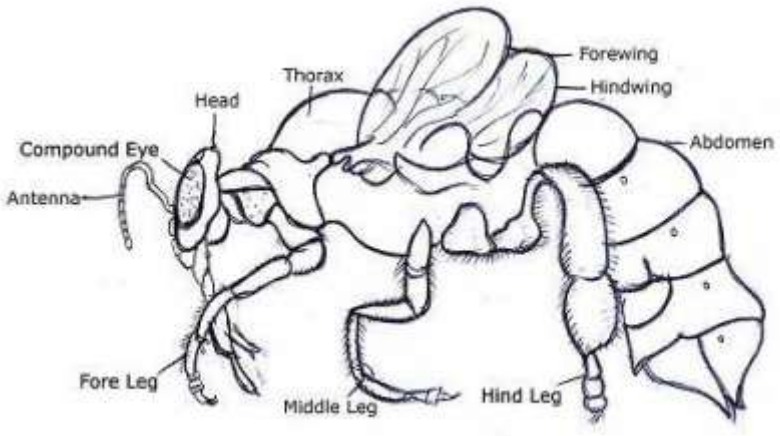

Forewing
Thorax
Hindwing
Head
Abdomen
Compound Eye
Antenna
Fore Leg
Middle Leg
Hind Leg

**Figure:** ***Apis***

# Phylum: *Onychophora*

## Peripatus

**Systematic position**

**Phylum:** Onychophora

**Genus:** Peripatus

**Comments**

1. It is a soft bodied, worm like animal. It grows up to 1 to 2" in length.
2. The soft body shows deep black colour on the dorsal side and light red colour on the ventral side.
3. The skin is soft and bears many minute papillae and bristles along the mid-dorsal line of the body. It produces slimy secretion which is protective and helps in capturing the food organisms.
4. It is a connecting link between annelids and arthropods.

The body is divisible into two parts.

1. Head: Head is composed of three segments. They are fused. It has a pair of antennae. Each antenna shows a large number of segments. On the ventral side of the head mouth is seen. The mouth is surrounded by a lip which has ridges. A pair of jaws with teeth surrounds the mouth. A tongue is also seen in the mouth. A pair of oral papillae will be present. Each oral papilla contains the openings of slime glands. On the dorsal side of the head a pair of simple eyes will be seen.

2. Trunk: It contains 14-42 segments arragned serially. All the segments are alike. Each segment shows a pair of appendages. The anus is terminal and it is present at the posterior end of the body. On the ventral side below the anus the genital pore is present.

Appendages: Each segment contains a pair of appendages. Each appendage shows 2 parts. 1) A conical proximal leg. 2) A short distal foot with a pair of horny claws. The leg shows 2 spiniferous pads at its distal end. The leg bears rigns of papillae with bristles. The foot is attached to the distal end of the leg. All the appendages are hollow.

Habit and habitat

Peripatus is terrestrial animal. It lives under stones; bark of trees and in shady places. It is nocturnal in habit.

Distribution:

Peripatus is seen in neotropical regions like West Indies, America, Congo, Australia, Tasmania, New-Zealand, Malayasia etc.

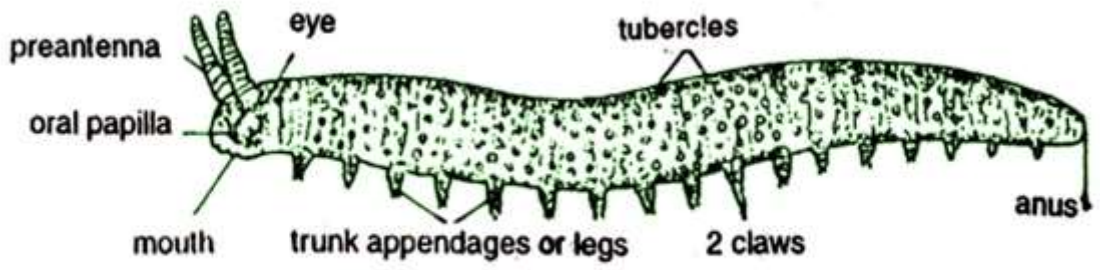



**Figure: *Peripatus***

# Phylum *Mollusca*

## *Chiton*

**Systematic position:**

**Phylum:** Mollusca

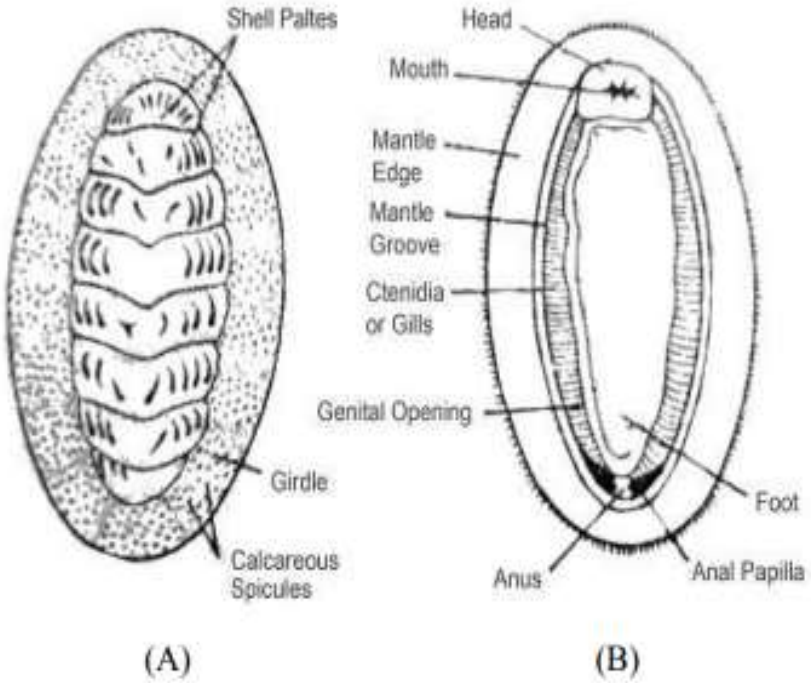
**Class:** Amphineura

**Order**: Chitonida

**Genus:** Chiton

**Comments:**

1. Body of Chiton is bilaterally symmetrical, unsegmented and dorso-ventrally compressed.
2. It consists of shell, foot, mantle and the visceral mass.
3. Shell is calcareous and is present on the dorsal side and is composed of eight overlapping plates.
4. Head is not distinct. Eyes and tentacles are absent.
5. Foot is ventral, broad, sole-like and muscular, adapted for creeping and adhering.
6. Mantle covers greater part of body and partly covers the edges of the shell plates.
7. Mouth and anus are at opposite ends.
8. Sexes are separate; gonad is single and is located in the front of the heart.
9. Excretory system consists of two nephridia.
10. Development is indirect through trochophore larva.
11. Chitons are eaten as food and their shells are used for decoration.
12. Habit and habitat: Chiton is marine animal found attached to the rocks and corals between tide marks. It creeps along slowly on a muscular foot.
13. Distribution: Chiton is found all over the world.




Dorsal Ventral

**Figure: Chiton**

# *Dentalium*

**Systematic position:**

**Phylum:** Mollusca

**Class:** Scaphopoda

**Genus:** Dentalium

**Comments:**

1. Dentalium is commonly known as tusk shell.
2. It measures 2-5 cm in length.
3. It lies in a tubular, bilaterally symmetrical shell open at both ends.
4. Head and foot project out from the anterior aperture of the shell. Head bears a mouth surrounded by filiform tentacles called captacula. Eyes and osphradium are absent.
5. Mantle is entirely within the shell.
6. The foot is long pointed, spade-like and highly extensible adapted for digging and burrowing.
7. Sexes are separate.
8. Development is indirect and includes a veliger larva.
9. Shell of Dentilium is used for ornamental purposes. Its shells were once used by Red Indians of America as currency.
10. Habit and habitat: Dentalium is marine and found in the sand at great depth. It feeds on microscopic organisms, detritus and foraminifera.
11. Distribution: They are found in all seas except polar.

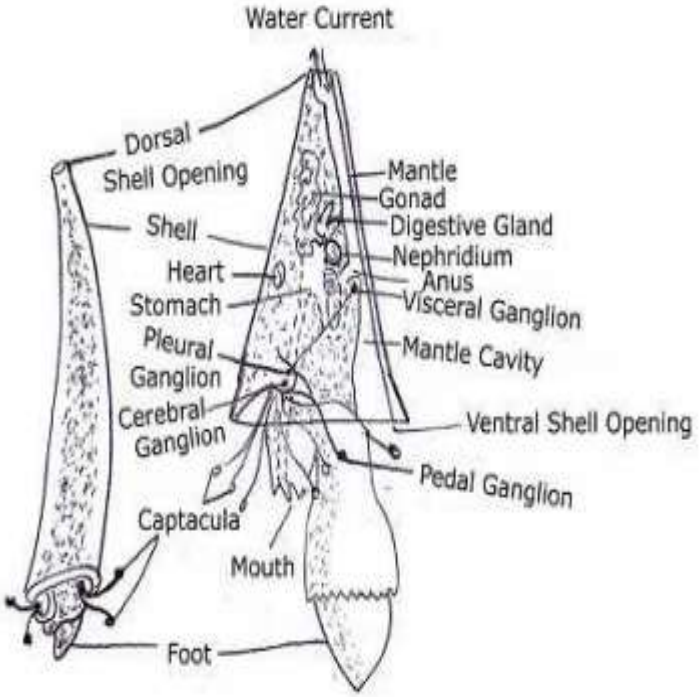



**Figure:** ***Dentalium***

# *Pila*

**Systematic position**

**Phylum:** Mollusca

**Class:** Gastropoda

**Order:** Mesogastropoda

**Genus:** Pila

**Species:** globosa

**Comments:**

1. Pila gobosa is commonly called apple snail.
2. Shell is univalve and coiled around a central axis in a right handed spiral.
3. Operculum is well developed and closes the aperture or the mouth of the shell.
4. The body is soft and is enclosed in a shell. It consists of head, foot and visceral mass.
5. Head is the anterior fleshy part of the body overhanging the foot. It bears mouth, two pairs of contractile tentacles and a pair of eyes.
6. Foot is the locomotory organ of Pila and lies below the head.
7. All visceral organs are contained in this lump like structure that lies above the head-foot complex.
8. Skin of the visceral mass forms a thin and delicate covering called the mantle.
9. Respiratory organs consist of a single ctenidium or gill, a pulmonary sac or lung and a pair of nuchal lobes. Aquatic respiration by ctenidium and aerial respiration by pulmonary chamber.
10. Sexes are separate but without sexual dimorphism.
11. It is found in large numbers in those areas which are rich in aquatic plants like Vallisneria and Pistia.
12. Habit and habitat: Pila is commonly found in freshwater ponds, lakes, tanks, pools, marshes, paddy fields, streams and rivers of Northern India. They are amphibious being adapted for life in water and on land. It creeps slowly using its ventral muscular foot.
13. Distribution: Pila is confined to the Oriental and Ethiopian regions.

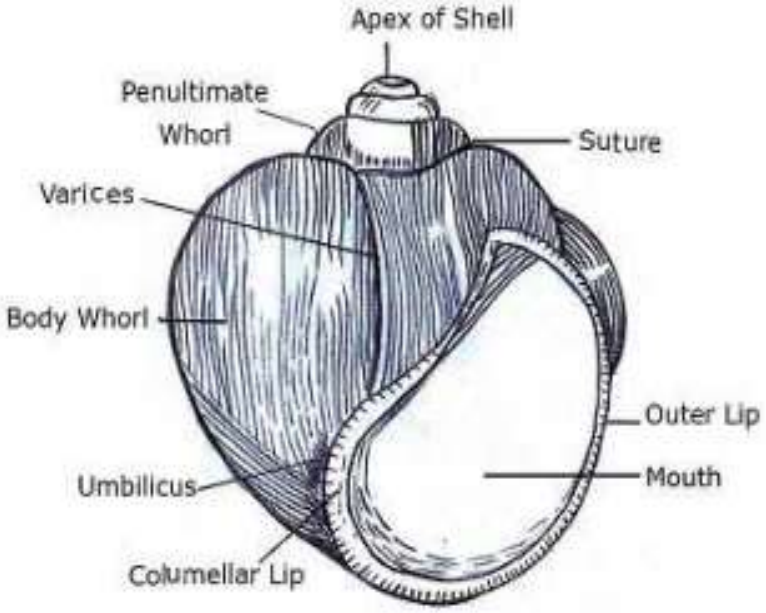

Apex of Shell
Penultimate
Whorl
Suture
Varices
Body Whorl
Outer Lip
Mouth
Umbilicus
Columellar Lip

**Figure: Pila**

# Helix

**Systematic position**

**Phylum:** Mollusca

**Class:** Gastropoda

**Order:** Stylommatophora

**Genus:** Helix

**Comments:**

1. Helix is commonly called garden snail.
2. Body is enclosed in a shell and divisible into head, foot and visceral hump.
3. Shell is thin and bears prominent lines of growth.
4. Head bears two pairs of tentacles, the smaller pair bears smell organs and the larger pair bears a pair of simple eyes.
5. Mouth is located underneath the head.
6. Foot possesses a flat ventral surface and used for creeping.
7. Respiration by pulmonary sac or lung.
8. Hermaphrodite.
9. Some snails may live more than 30 years but most live less than 8 years. Snails are eaten the world over. Snail eggs are a speciality food in certain European countries.
10. **Habit and habitat:** Helix is terrestrial rather than marine. It is generally herbivorous however there are some species that are carnivorous or omnivorous. In winter it hibernates in the soil.
11. **Distribution:** Helix is found in Palearctic region.

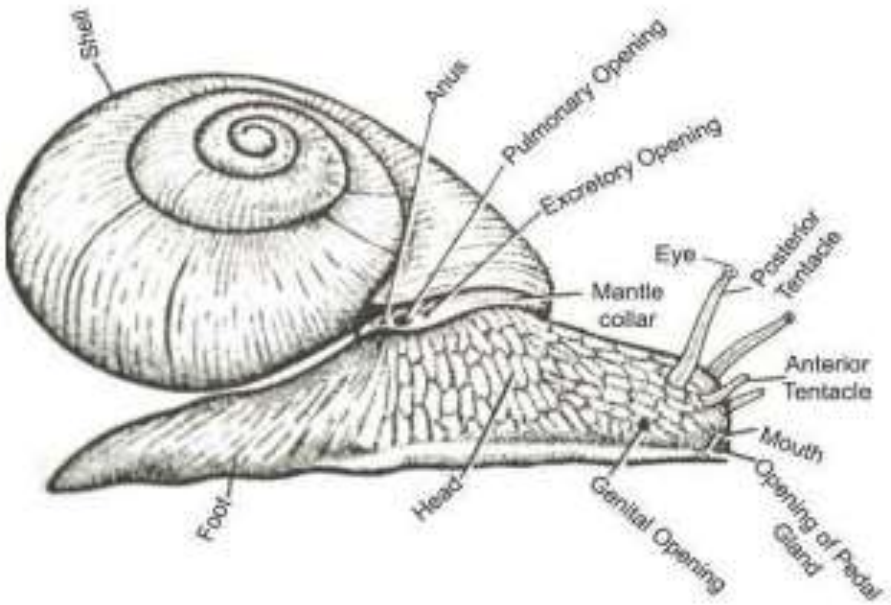



Figure: ***Helix***

# *Sepia*

**Systematic position:**

**Phylum:** Mollusca

**Class:** Cephalopoda

**Order:** Decapoda

**Genus:** Sepia

**Comments:**

1. Sepia is commonly called cuttle fish which is a misnomer because it is actually a mollusc and not a fish.

2. Body is soft, unsegmented and bilaterally symmetrical. It is divisible into a large head, a small neck or collar and trunk.

3. The head is well developed, bears a pair of eyes and 10 oral arms which are a modification of foot. 8 oral arms are smaller while two are longer and are called tentacles.

4. Collar is constricted and connects the head with the trunk.

5. The trunk extends into flaps called lateral fins on either side that help the animal in swimming.

6. It is covered by a thick muscular mantle, enclosing a large mantle cavity, on the ventral side which contains viscera.

7. It has a life expectancy of 1-2 years.

8. The Sexes are separate and reproduction is sexual.

9. Ornament makers use cuttle bones as moulds for casting small objects.

Habit and habitat: Sepia is a marine animal that resides shallow to mid water and is often associated with coral reefs. It is carnivorous, feeds on crustaceans, small fishes and other animals.

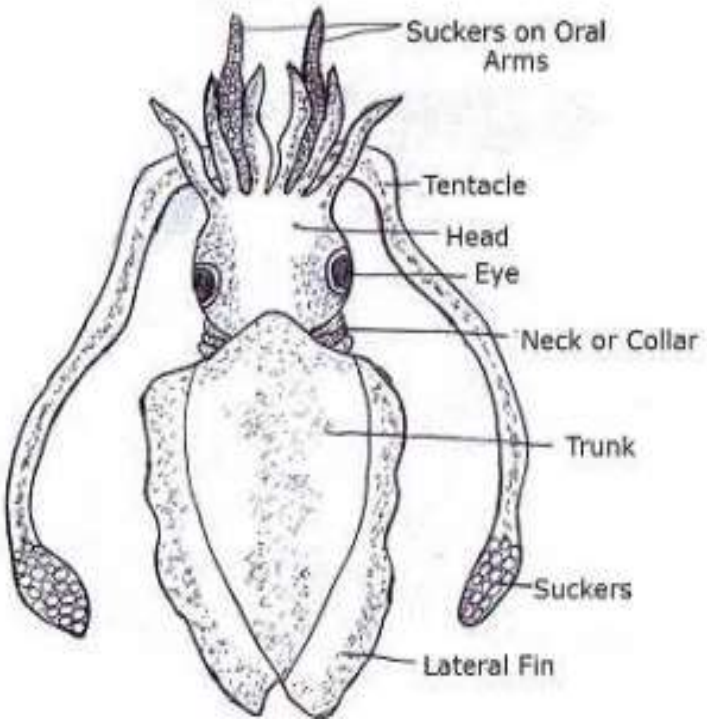



**Figure: *Sepia***

# *Octopus*

**Systematic position:**

**Phylum:** Mollusca

**Class:** Cephalopoda

**Order:** Octopoda

**Genus:** Octopus

**Comments:**

1. An Octopus is commonly called devil fish.

2. The body is unsegmented, symmetrical and soft bodied animals.

3. The head bears a pair of eyes. The mouth is surrounded by eight elongated equal arms usually bearing suckers.

4. Shell is absent.

5. It moves around by crawling or swimming.

6. For defence it ejects ink from the ink-gland into the surrounding water, producing a smoky cloud.

7. In males one of the arms, called hectocotylized arm, bears a spoon shaped organ at its end. The arm is used to caress the female and deposit spermatophores beneath its mantle.

8. Sexes are separate.

9. Development is direct.

10. It feed upon crabs, bivalves and fishes etc.

11. **Habit and habitat:** Octopus is a nocturnal marine creature inhabits many diverse regions of the ocean, including coral reefs, pelagic waters and the ocean floor.

12. **Distribution:** Octopus is cosmopolitan in distribution. It is generally found in Europe, India, Pacific and Atlantic coasts.

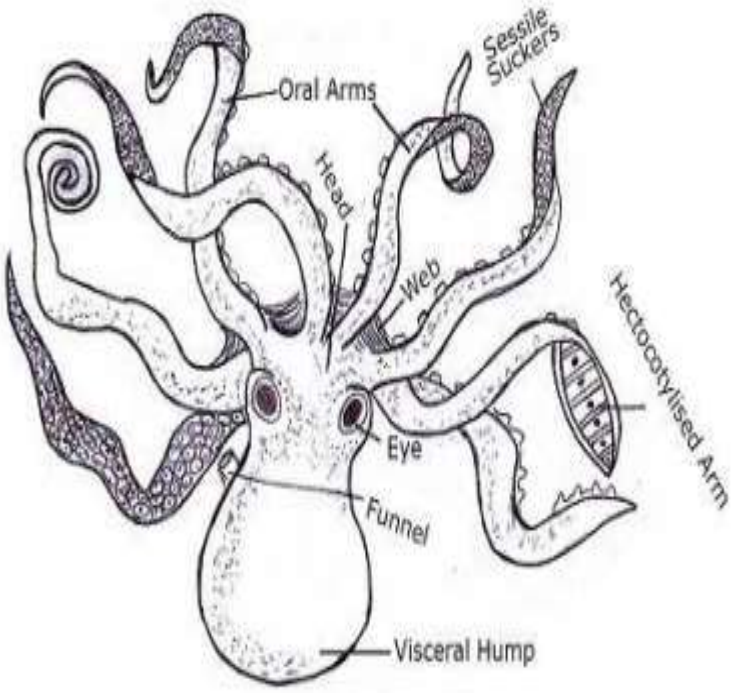



**Figure:** ***Octopus***

# Phylum: *Echinodermata*

***Pentaceros***

**Systematic position:**

**Phylum:** Echinodermata

**Class:** Asteroidea

**Order:** Phanerozonia

**Genus:** Pentaceros

**Comments:**

1. Pentaceros is known as sea pentagon.
2. The body is very thick and regular star-shaped and has a diameter of about 25 cm.
3. Central disc is large and the five arms are short and tapering.
4. Aboral surface is convex and bears rows of definitely arranged spines. Oral surface is concave, having a central mouth, communicating with five ambulacral groves, each bearing two double rows of tube feet.
5. Pedicellariae is small and valvate type.
6. Sexes are separate.
7. Development indirect which includes bipinnaria larva.
8. Pentaceros is very harmful to pearl industry as it feeds on pearly oysters.
9. Habit and habitat: Pentaceros is marine. It feeds on oysters, thus, it is very harmful to the pearl industry.
10. Distribution: Pentaceros is found commonly in the Indo-Pacific Ocean and around the West Indies; in the Bay of Bengal and Arabian Sea.

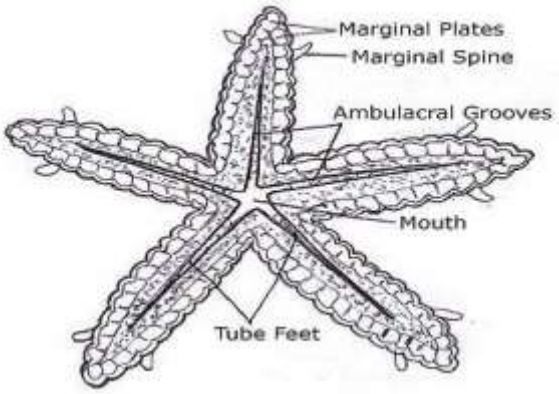



**Figure:** ***Pentaceros***

# *Asterias*

**Systematic position:**

**Phylum:** Echinodermata

**Class:** Asteroidea

**Order:** Forcipulata

**Genus:** Asterias

**Species:** rubens

**Comments:**

1. Asterias is commonly known as starfish or sea star.
2. Average size of Asterias ranges from 10 to 25 cm in diameter.
3. The body is star shaped, consisting of a central disc with five radiating arms which are broad at their base and tapering towards their extremities.
4. Mouth is pentagonal and lies in the centre of the disc on oral surface.
5. Aboral surface bears a number of short, stout spines arranged in irregular rows, numerous dermal branchiae among spines and a smaller aperture, the anus which is situated near the centre.
6. Pedicellariae are very small, microscopic bodies scattered all over the body.
7. Water vascular system is well developed.
8. Sexes are separate. Fertilization is external.
9. Development includes a free swimming bippinnaria larva.
10. Habit and habitat: Asterias are free-living marine animals that can be found at all water depths as well as crawling over rocks and shells Asterias is a marine form and found in the sandy and rocky parts of the sea.
11. Distribution: Asterias is found in shallow water in North Temperate seas and found abundantly on North-Atlantic coast. It is found in abundance in India and U.S.A.

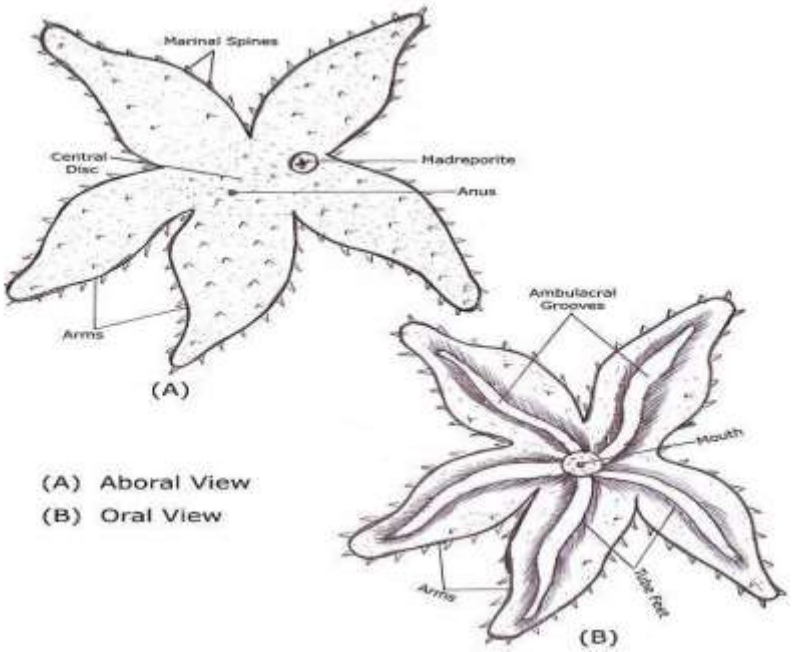



**Figure:** ***Asterias***

# *Echinus*

**Systematic position:**

**Phylum:** Echinodermata

**Class:** Echinoidea

**Order:** Camarodonta

**Genus:** Echinus

**Comments:**

1. Echinus is commonly called sea-urchin.
2. It has a globe-shaped body enclosed within a shell or corona and having very long movable spines. The surface of corona is divided into five ambulacral regions alternating with five interambulacral regions. In each ambulacral region, there are two rows of tube feet.
3. Mouth is present on oral surface and is surrounded by peristome. The chewing apparatus or Aristotle's lantern projects from the mouth. Anus is surrounded by a periproct and is present in the centre of the aboral surface.
4. Water-vascular system is well developed.
5. Development is indirect and involves free swimming echinopluteus larva.
6. Sexes are separate. Gonads are five large masses.

   Habit and habitat: Echinus is marine, found in the sea in the rocky places.

   Distribution: Echinus is widely distributed in the Atlantic, Mediterranean and Pacific Oceans.

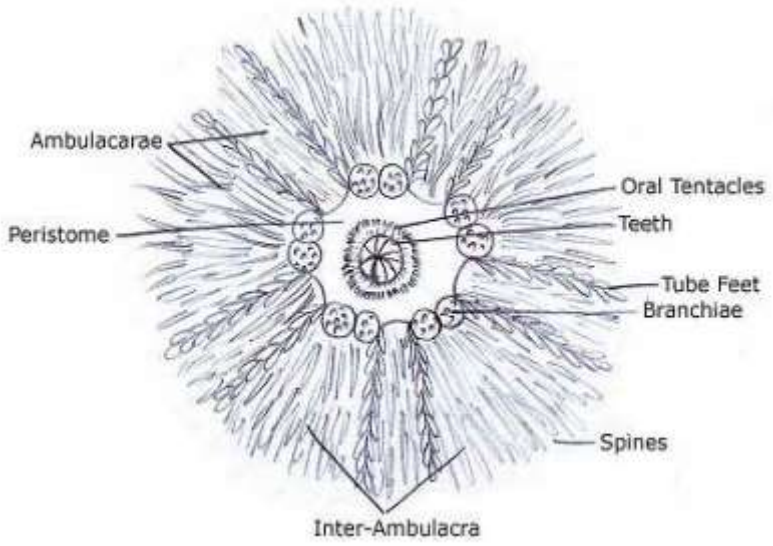



**Figure: Echinus**

# *Antedon*

**Systematic position:**

**Phylum:** Echinodermata

**Class:** Crinoidea

**Order:** Articulata

**Genus:** Antedon

**Comments:**

1. Antedon is commonly known as feather star.
2. Body consists of a central disc or calyx and a series of five radiating arms.
3. It has a central leathery disc covered with bony plates with oral and aboral surfaces.
4. Each arm is divided at its base into two, so that there are ten long slender flexible arms, bearing lateral pinnules.
5. Tube feet without suckers present along the edges of ambulacral grooves.
6. Sexes are separate.
7. It has an amazing power of regeneration.
8. Development includes a pentacrinoid larva with jointed stalk. Habit and habitat: It is cosmopolitan marine animal that occurs in shallow as well as deep waters. They are gregarious forms and feed on microscopic living organisms.

   Distribution: Antedon is worldwide in distribution, found in all seas. It is commonly found along Atlantic Coast.

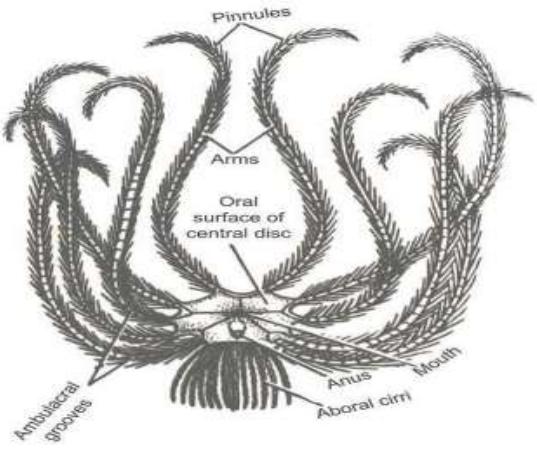



**Figure: Antedon**

## 2. Study of digestive system of earthworm

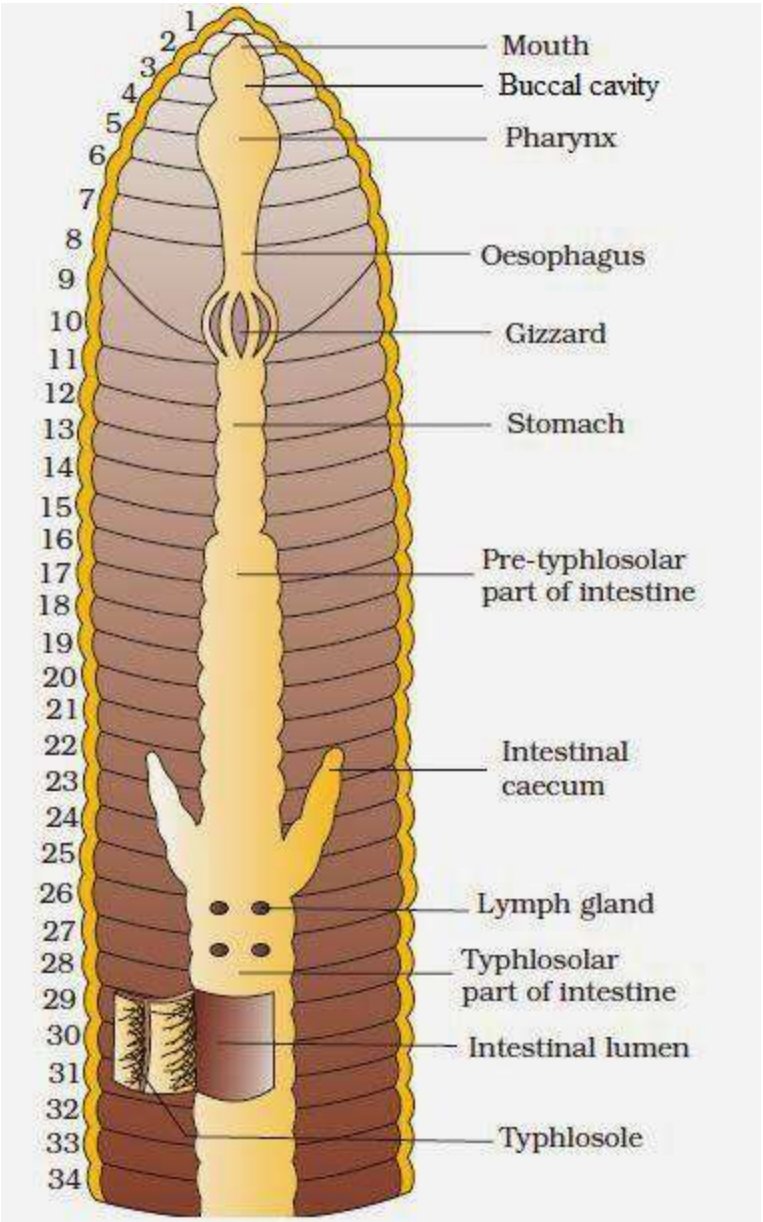



**Fig. Alimentary canal of earthworm**

Digestive system of earthworm mainly contains alimentary canal and digestive glands.

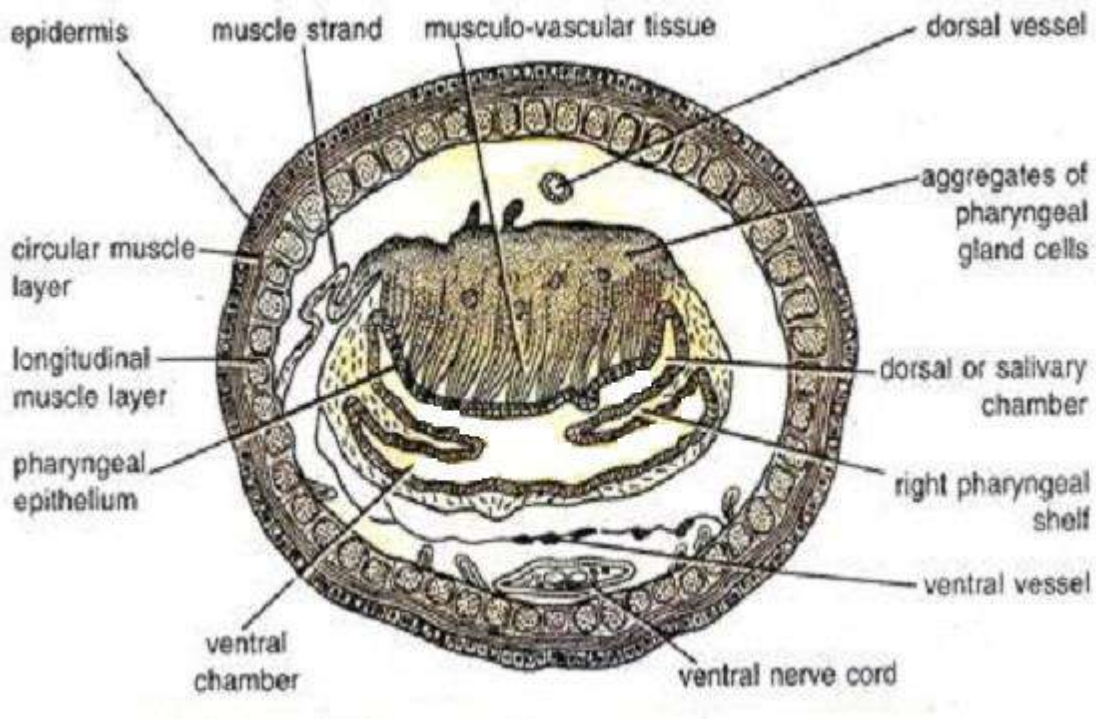
[I] **Alimentary canal:** It runs as a straight tube throughout the length of the body from the mouth to the anus. The parts are as follows:

**1. Mouth and Buccal Chamber:**

The mouth is a crescentic aperture lying below the prostomium. The mouth leads into a short, thin-walled tube called buccal chamber or buccal cavity running up to the 3rd segment. The lining of the buccal cavity is folded and it is surrounded by muscular strands. The buccal cavity can be protruded through the mouth with the help of special muscles that run backwards from the buccal chamber to the body wall.

**2. Pharynx:**

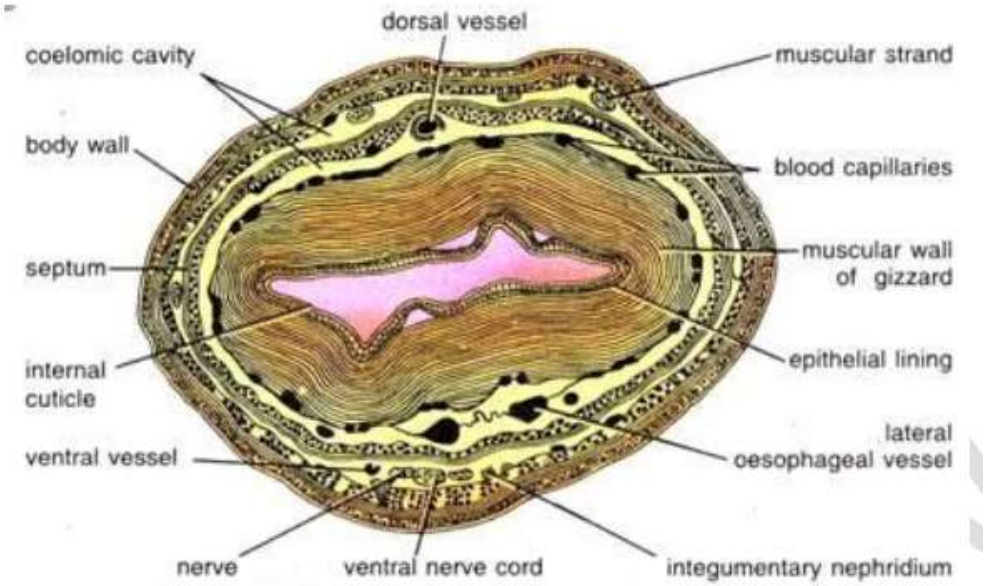
The buccal chamber is followed by the pharynx which extends up to the 4th segment. It is a pear-shaped broad and muscular structure separated from the buccal cavity by a groove. The roof of the pharynx is very thick and projects into the pharyngeal cavity as pharyngeal bulb, its lateral walls internally form two horizontal folds or shelves, one on each side, which divide the lumen of the pharynx into two chambers—the dorsal salivary chamber and the ventral conducting chamber.




**[T.S. through pharynx of earthworm]**

The roof of the pharynx is lined by ciliated epithelium, above which are many muscles with connective tissues and blood vessels and outside these are the pharyngeal or salivary glands. These are groups of small, whitish unicellular glands of chromophil cells.

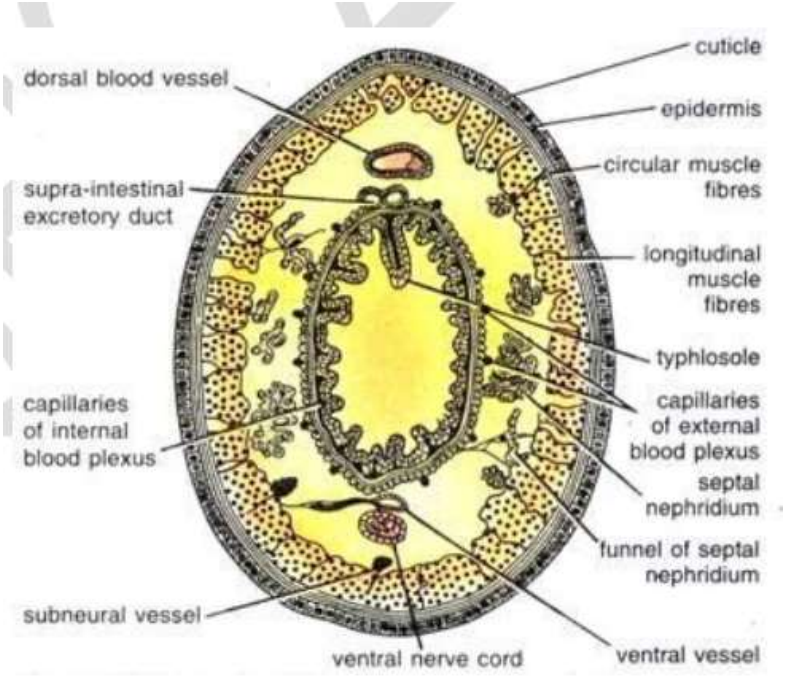
These glands open into the salivary chamber of the pharynx through their fine ducts. They secrete mucin for lubrication of food and also a proteolytic enzyme for the digestion of proteins. The ventral conducting chamber of the pharynx serves as the passage for the ingested materials.




[T.S. through gizzard of earthworm]

**Intestine:**

The stomach is extending from 15th segment up to the anus. It has a beaded appearance due to constrictions corresponding to septa but bulging in each segment. The lining of intestine has ciliated and glandular cells. The intestinal lining is folded to form villi, one of these villi becomes larger and well developed than the others to form the typhlosole. The typhlosole, thus, hangs in the lumen of intestine and runs mid-dorsally from 26th segment up to the last except posterior 24, 25 segments.




[T.S. through typhlosolar nephridia of earthworm]

**The typhlosole divides the intestine into three regions:**

**(i) Pre-typhlosolar Region:**

The first part of intestine lying between 15th to 26th segments constitutes the pre-typhlosolar region. In this region the intestinal lining is folded to form villi which are highly vascular, no typhlosole is found in this region. In the 26th segment, two short and conical outgrowths, one on either side, are given off from the intestine. These are called intestinal caeca.

They are extended anteriorly up to 22nd segment and have a special blood supply; internally the caeca have many longitudinal folds which appear as villi in transverse sections, the epithelial cells being highly vascularized and filled with secretory granules.

Chen and Puh (1941) believe that these caeca are digestive glands and secrete an amylolytic enzyme for the digestion of starch. Usually active digestion occurs in this region.

**(ii) Typhlosolar Region:**

This is the second part of intestine lying between 26th to the last segment except posterior 24, 25 segments.

This region is provided with an internal median fold of the dorsal wall of intestine called the typhlosole, which is in fact, a well developed intestinal villi. The typhlosole increases the

absorptive surface of the intestine. The process of digestion is probably completed in this region, hence, it is the major site of absorption.

**(iii) Post-typhlosolar Region:**

The intestine, in the last 24, 25 segment, has no typhlosole. It is the third region of intestine and is called the rectum. It is thin-walled, vascularised without villi and glandular cells. It contains small pellets of mud which are passed out from the anus as faeces at the opening of burrows. These are actually the castings of Pheretima.

**Anus:** It is a small circular opening placed at terminal end in the centre of the last or anal segment of the body.

**3. Study of septal and pharyngeal nephridia of earthworm**

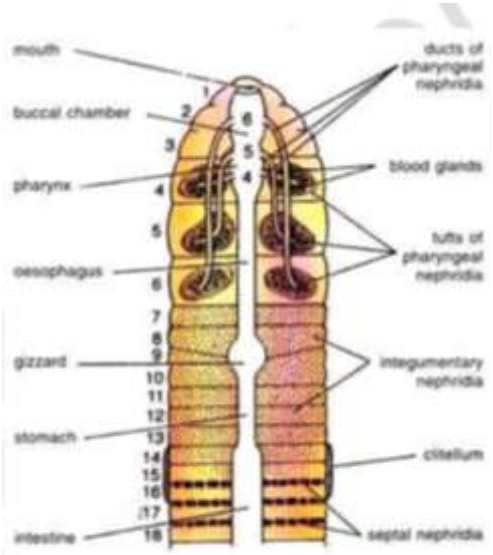
**II] Digestive Glands of Earth Worm:**

The pharyngeal or salivary gland cells, glandular cells of stomach, intestine and the intestinal caeca are supposed to be the various digestive glands which secrete the digestive enzymes for the digestion of food.

Septal and Pharyngeal nephridia of earthworm

**1. Septal Nephridia:**

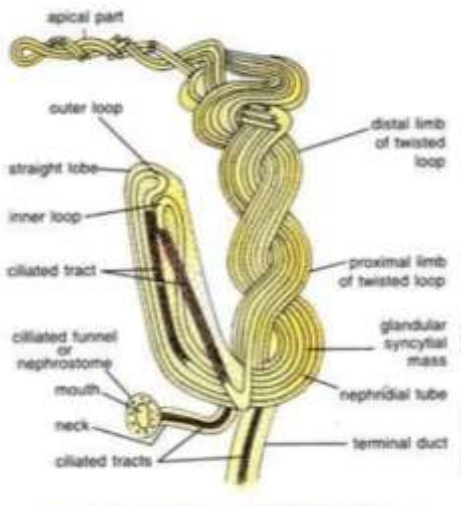
These are found situated on the inter-segmental septum between 15th and 16th segments to the posterior side of the body. Each septum bears nephridia on both the surfaces arranged in semicircles around the intestine, two rows in front of the septum and two behind it. Each septum has about 40 to 50 nephridia in front and the same number behind, so that each segment possesses 80 to 100 septal nephridia except the 15th segment which has only 40 to 50 nephridia. These are not found in the segments up to 14th.




[Different types of nephridia in earthworm]

**Structure:**

The septal nephridia may be considered typical of all the nephridia of Pheretima. Each septal nephridium (Fig.) consists of nephrostome, neck, body of nephridium and the terminal duct.




[A septal nephridium]

**(i) Nephrostome:**

It is also known as ciliated funnel or nephridiostome. It is the proximal flattened funnel-shaped structure of the nephridium lying in the coelom.

It has an elliptical mouth-like opening leading into an intracellular canal of the large central cell, the margins of the opening are surrounded by a large upper lip and a smaller lower lip. The lips are provided with several rows of small ciliated marginal cells and the central canal is also ciliated.

**(ii) Neck:**

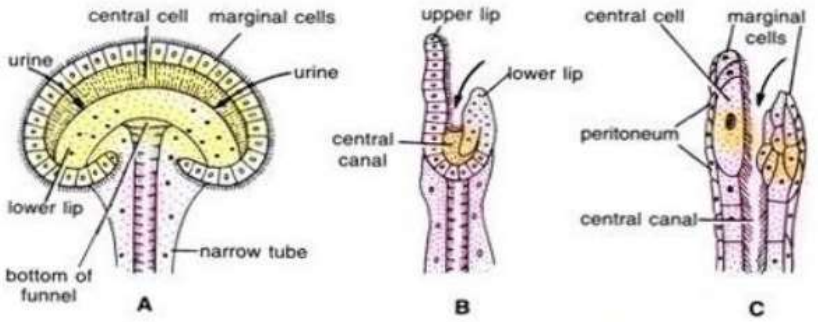
The nephrostome leads into a short and narrow ciliated canal forming the neck. It joins the nephrostome to the body of nephridium.

**(iii) Body of Nephridium:**

The body of nephridium has two parts a short straight lobe and a long twisted loop. The loop is formed by two limbs— the proximal limb and the distal limb.



Both these limbs are twisted spirally around each other, the number of twists varies from nine to thirteen. The neck of nephridium and the terminal duct join together and remain connected with the proximal limb of the twisted loop, while the distal limb becomes the straight lobe.




[Nephrosotme of earth worm : A – whole, B,C – T.S.]

Internally the nephridium is made of a connective tissue matrix having long coiled nephridial duct forming loops. There are four such canals in the straight lobe, three in the lower part and two in the upper part of the limbs of twisted loop. Two canals of the straight lobe out of the four are ciliated like the ciliated canal of the neck.

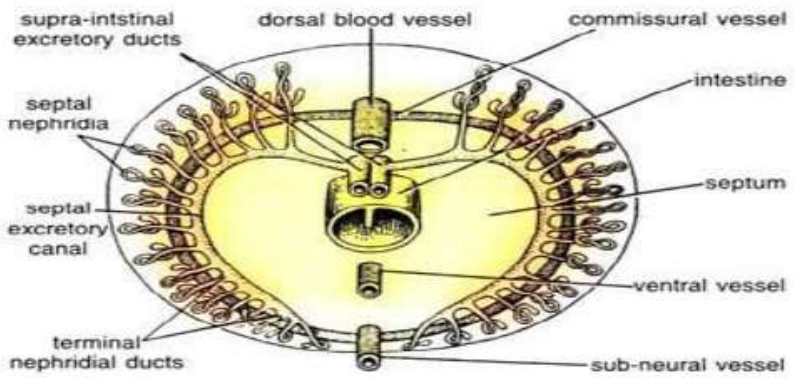
**(iv) Terminal Duct:**

It is short and narrow with a terminal excretory duct. It joins the nephridium with septal excretory canal.

**Relation of septal nephridia with intestine:**

The nephridia hang freely in the coelom and are attached only by their terminal ducts. They open by their terminal ducts into two septal excretory canals lying on the posterior surface of the septum, one on each side of the intestine, each begins ventrally but dorsally it opens in the supra-intestinal excretory duct of its own side.

The supra-intestinal excretory ducts are two parallel longitudinal canals lying above the gut and below the dorsal vessel. These excretory ducts begin from the 15th segment and run to the last segment, they communicate- with each other for a short space behind each septum, then either the right or the left duct opens by a ductule into the lumen of the intestine near the septum. Thus, each segment has one such opening into the intestine of either the left or the right supra-intestinal excretory duct. The waste collected by the nephridia is discharged through the excretory canals and ducts into the lumen of the intestine. Such nephridia opening into the intestine are called enteronephric nephridia.




[Septal nephridia in intestinal region]

**Pharyngeal Nephridia:**

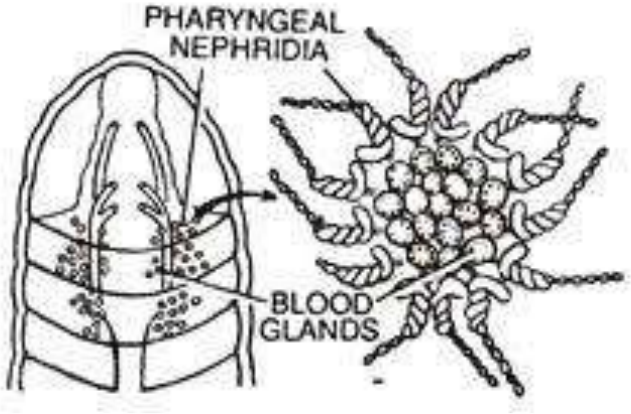
These nephridia lie in three paired tufts, one on either side of the anterior region of the alimentary canal in the segments 4th, 5th and 6th. The tufts of pharyngeal nephridia also contain blood glands.

Each pharyngeal nephridium is about the size of a septal nephridium but it is of the closed type having no funnel or nephrostome. It has a short straight lobe and a spirally twisted loop, its lumen has ciliated canals. Ductules arise from each nephridium and unite to form a single thick-walled duct on each side in each segment.

The two ducts of nephridia of segment 6th open into the buccal cavity in segment 2nd and the paired ducts of nephridia of segments 4th and 5th open into the pharynx in segment 4th.

These nephridia also discharge their wastes into the alimentary canal and are, therefore, enteronephric but such enteronephric nephridia which open into the anterior region of the alimentary canal (buccal cavity and pharynx) are called peptonephridia because they may have taken the function of digestive glands.

Recently it has been reported that the pharyngeal nephridia of P. posthuma produce a variety of enzymes like amylase, chimosin, prolinase, prolidase, dipeptidases, aminopeptidase, lipase, etc., which hydrolyse various foodstuffs. Thus, such nephridia work like the salivary glands.




{pharyngeal nephridia of earthworm]

5. **Mounting of Cockroach Mouth Parts**

**Aim: Mounting of Cockroach Mouth Parts**

**Comments:**

Cockroaches are insects which come under the order **blattaria**. Cockroach is a nocturnal and omnivorous animal. It feeds on any kind of organic matter. It has a dorso ventrally flat and compressed body which is covered by a hard and chitinous exoskeleton.

The cockroach's body is segmented into three portions namely, **head**, **thorax** and **abdomen**. The mouth part is attached to ventral side of the head and surrounds the oral cavity which faces downwards.

The mouthparts of the cockroach includes the following parts, namely, labrum, mandibles, maxillae and labium.

Labrum, the upper lip is a broad which is roughly rectangular in shape. It hangs from the frontal edge of the head in the lower side. It covers the mouth and mandibles. Hypo pharynx is a tongue-like structure present on the floor of the mouth. The salivary gland discharges saliva through it.

Mandibles is a pair of hard, large, strong, dark coloured triangular structure found one on either side with a jagged inner edges. They tend to move in horizontal motion and crushes the food present in-between them.

Maxillae is a pair of structures which lies outside and behind the mandibles. Each of it consists of three parts known as protopodite, endopodite and exopodite. Protopodite has stipes and cardo. Exopodite has 5 segements and is concerned with taste. It is also termed as maxillary palp and endopodite is made of inner lacina and outer galea. Maxillae is used to manipulate the food particles before entering the mouth.

Labium is formed by the fusion of second pair of maxillae. The labium forms the broad median of lower lip and has 3 pairs of segmented labial palps on either side which functions in sensory. The labial palps and maxillae have sense organs which helps them to choose suitable food. The maxillae and mandibles grinds the food by moving them laterally. The labrum and labium helps to hold the food between the maxillae and the mandibles.

**Aim:**

To dissect & identify the mouth parts of cockroach

**Requirements:**

Cockroach, petridish, slides, cover slips, dissecting & compound microscope and dissection box.

**Procedure:**

1) Hold the head of the cockroach in between the thumb & the index finger & take out the labrum with the help of forceps.

2) Lift up the antennae & hold them in between the thumb & index finger. Insert a pin at the base of the labium & separate it from the tissue that lies underneath it. Remove the labium with the help of forceps by cutting it at its base with angular scissors.

3) Catch hold of the cordo & remove the first maxilla with the help of forceps.

4) Cut the membrane below the mandibles and take them out.

5) Observe a small flap like tongue in the centre. Hold it with forceps and remove it intact.

6) Place all the parts on a slide and add a few drops of dilute KOH solution to dissolve the muscles.

7) Arrange the mouth parts onto a slide.

8) Observe the prepared slide under a dissecting microscope.

**Observation:**

The following mouth parts were observed and recorded

(i) The labrum,

(ii) A pair of mandibles

(iii) A pair of first maxillae

(iv) A pair of second maxillae and

(v) A Hypopharynx.

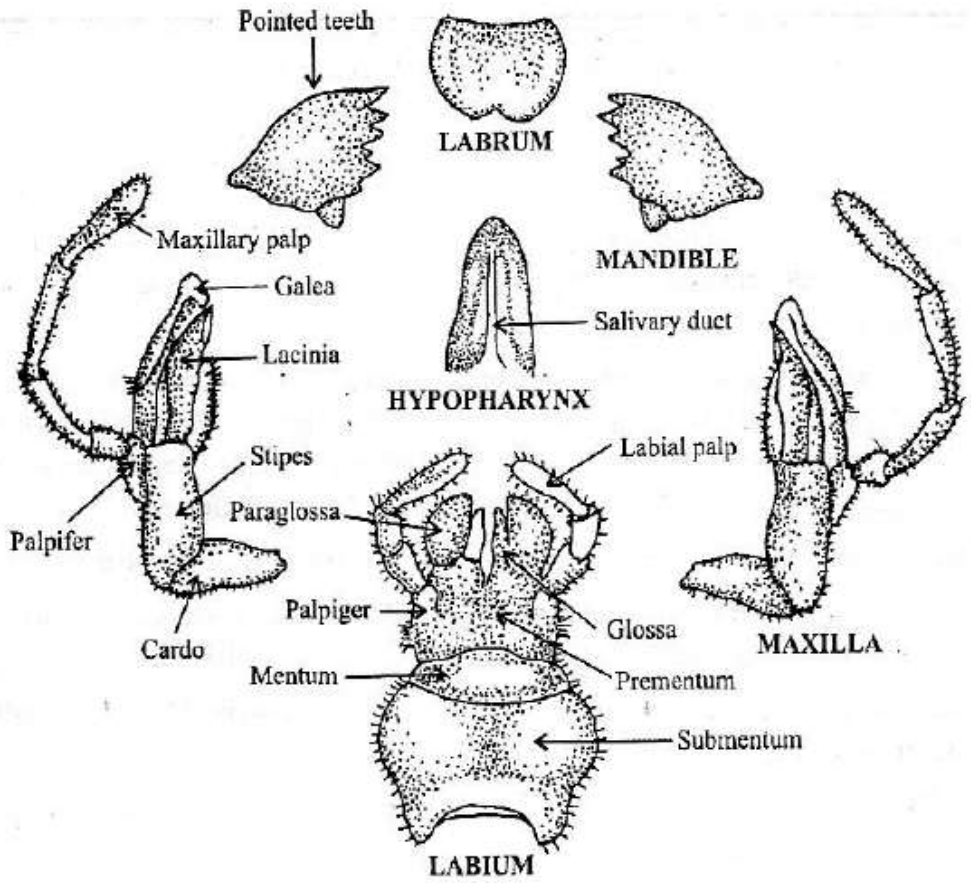



Fig.6. Mouthparts of Cockroach

## 6. Dissection of digestive system of cockroach

**Aim:** To dissect the digestive system of Cockroach.

**Materials Required:** Dissection box, chloroform, wooden board and dissection tray.

**Procedure: (i) Killing of Cockroach:** The cockroach is usually killed with chloroform. It can be killed successfully by drowning in water.

**(ii) Dissection of Cockroach:** Hold the specimen with your left hand and clip the wings. Fix the specimen in a dorsal position on a dissecting tray with the help of pins passing through abdominal sterna and coxa of legs. Cut the lateral membrane (pleura) between the terga and sterna of the thorax and abdomen with a pair of fine scissors.

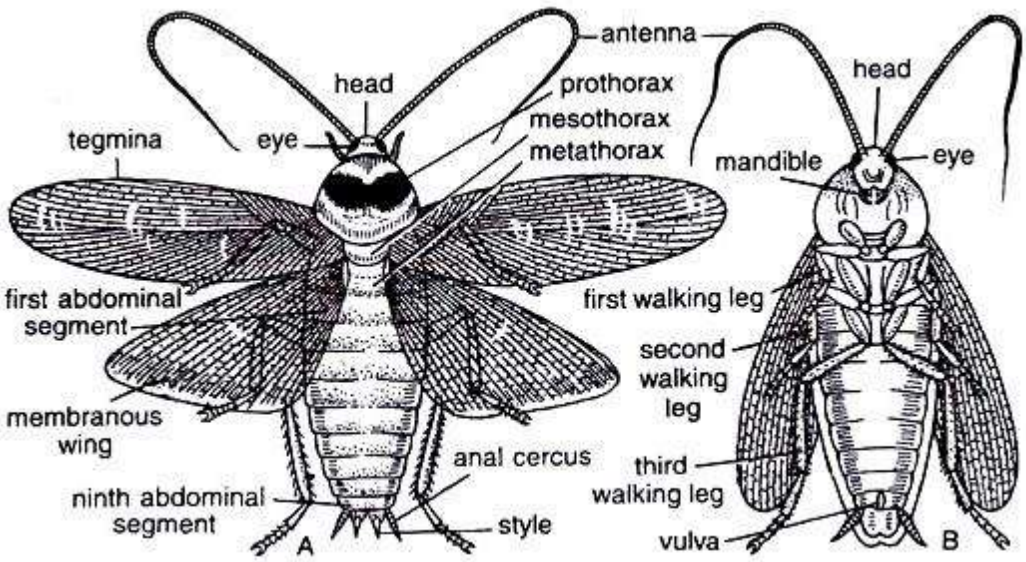



**Fig.1. External feature of Cockroach**

Posteriorly the two incisions should meet at the hindmost end of the abdomen. Proceed forward up to the anterior end of the thorax.

Give a transverse incision along the anterior border of the first thoracic segment and carefully remove the terga. The thoracic and the abdominal cavity are exposed. Put clear water in the tray. Remove fat bodies and tracheae to expose internal organs.

**Observation:** Carefully uncoil the intestine and stretch the alimentary canal to one side. Prevent it from coming back to the original position by pushing down a pin in the wax between the gut and the specimen.

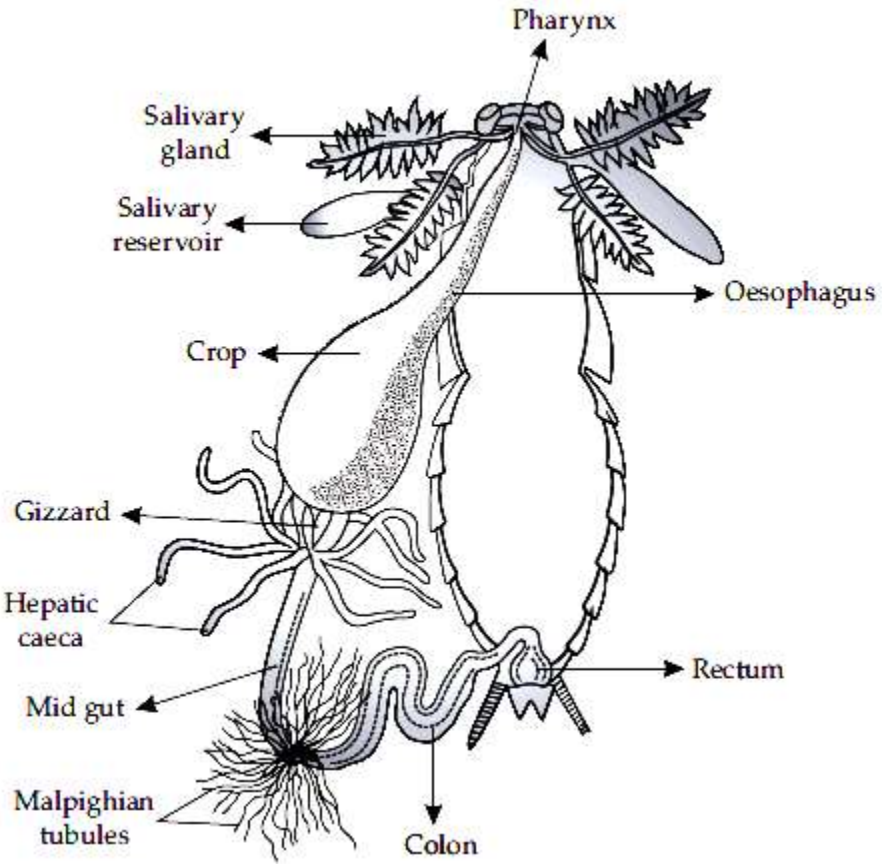



**Fig.2. Digestive system of Cockroach**

**Mouth:** The mouth is located ventrally at the base of buccal cavity.

**Buccal cavity:** An ill-defined chamber, bounded anteriorly by epipharynx and labrum; posteriorly by hypo-pharynx and labium; laterally by two mandibles.

**Pharynx:** A short, vertically oriented tube opening into the oesophagus.

**Oesophagus:** A short tube running posteriorly in the thorax.

**Crop:** There is no demarcation between the oesophagus and the crop. In fact, the crop is a large sac-like dilatation of the oesophagus. It extends into the abdomen.

**Gizzard or proventriculus:** A round, thick walled muscular structure, posterior to the crop. The gizzard has two parts, they have contain six chitinous teeth in the inner side of the wall and the posterior has two circular hairy cushion.

**Mesenteron or mid gut:** A narrow tube runs from the gizzard to the hindgut and a 7 to 8 hepatic caeca present at the junction of gizzard and mid gut.

**Proctodaeum or hind gut:** A narrow tube, divisible into 3 zones – ileum, colon and rectum. The junction of the mid and hind gut is marked by 60 to 70 extremely fine, yellowish Malpighian tubules (The tubules are excretory in function.). The rectum opens through the anus.

**Salivary glands:** Two in number. The glands and the receptacles lie on the dorsolateral aspects of the crop. The ducts of the glands and receptacles run forward by the sides of the crop. The ducts from the two glands unite and those from the receptacles also unite to form two common ducts, which again unite and give rise to an efferent salivary duct opening on the ventral side of the hypo-pharynx.

**SCAN TO VIEW DISSECTION OF DIGESTIVE SYSTEM OF COCKROACH**

## 7. Dissection of nervous system of cockroach

**Aim:** To dissect the digestive system of Cockroach.

**Materials Required:** Dissection box, chloroform, wooden board and dissection tray.

**Procedure:**

**i) Killing of Cockroach:** The cockroach is usually killed with chloroform. It can be killed successfully by drowning in water.

**ii) Dissection of Cockroach:** Hold the specimen with your left hand and clip the wings. Fix the specimen in a dorsal position on a dissecting tray with the help of pins passing through abdominal sterna and coxa of legs. Cut the lateral membrane (pleura) between the terga and sterna of the thorax and abdomen with a pair of fine scissors.

Posteriorly the two incisions should meet at the hindmost end of the abdomen. Proceed forward up to the anterior end of the thorax.

Give a transverse incision along the anterior border of the first thoracic segment and carefully remove the terga. The thoracic and the abdominal cavity are exposed. Put clear water in the tray. Remove fat bodies and tracheae to expose internal organs.

**Observation:** Fix the head of the specimen by pinning through the mandibles. The rest of the body should be fixed to the wax of the dissecting tray in the way already described. Carefully remove the epicranial plate of the head capsule and expose the cerebral ganglia.

Cut the pharynx and pull it out with the oesophagus. Remove the viscera and the ventral nerve cord is exposed. Expose the roots of the circumoesophageal connectives on the lateral sides of the brain and trace them to the points where they meet the sub-oesophageal ganglia.

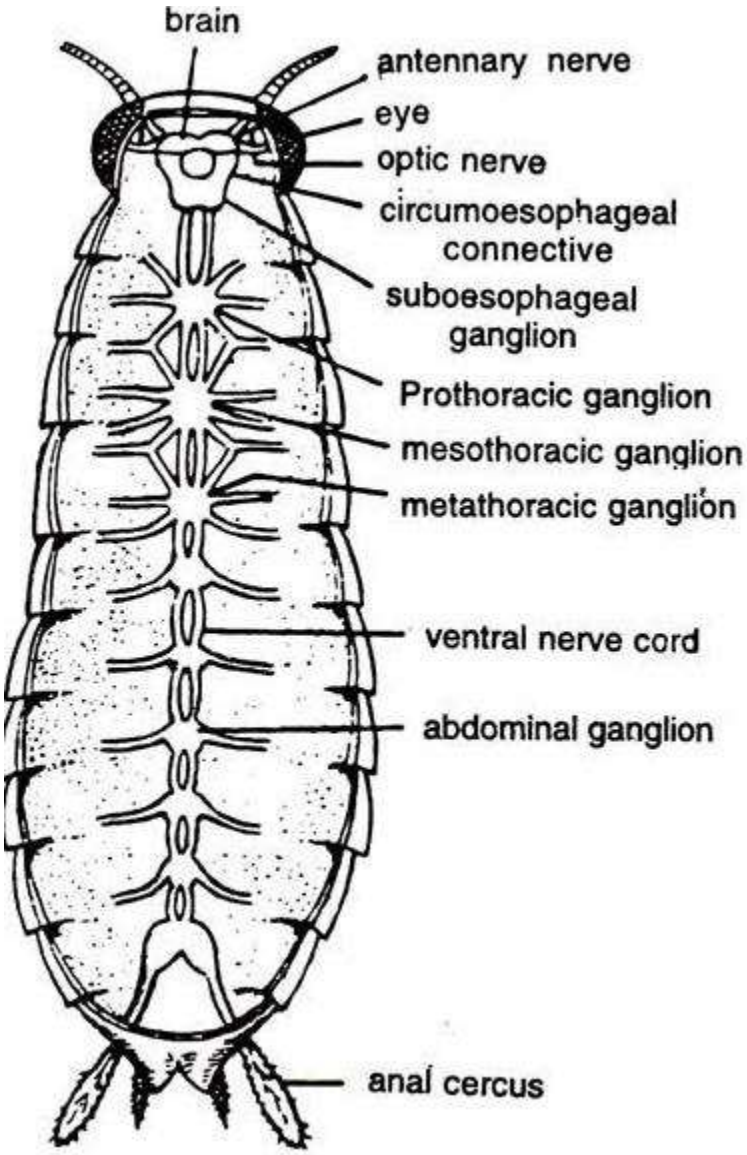



**Fig.3. Nervous system of Cockroach**

**Cerebral ganglia or brain:**

The two fused to form a mass. A number of nerves arise from the ganglionic mass, which innervate eyes, antennae and the adjacent structures.

**Circumoesophageal connectives:**

Arising from the brain two short and broad nerves run around the oesophagus to meet the sub-oesophageal ganglia.

**Sub-oesophageal ganglia:**

It is formed by the fusion of two ganglia and located in the mid-ventral region of the head just ventral to the oesophagus. Nerves arising from sub-oesophageal ganglia end in labrum,

mandible and both pairs of maxillae. A pair of connectives run backward from the ganglia and join the first thoracic ganglion, (prothoracic ganglion).

**Ventral nerve cords:**

These are two solid nerves and run along the mid-ventral line of the thorax and abdomen. The nerve cords are connected by nine ganglia, three thoracic and six abdominal.

The three thoracic ganglia and the last abdominal ganglion are large in size. Nerves emanating from the thoracic ganglia innervate the musculature and structures of the thoracic region. Those from the abdominal ganglia send nerves to the structures in the abdominal region.

**Stomatogastric or Anterior Sympathetic Nervous System:**

It consists of a median frontal ganglion, hypo-cerebral ganglion, oesophageal and ingluvial ganglion.

**i. Frontal ganglion:** Situated in front of brain, on the oesophagus, median in position. Connected to tritocerebral lobes of brain by a pair of frontal connectives.

**ii. Hypo-cerebral ganglion:** Situated on the oesophagus below the brain. Recurrent nerve connects frontal and hypo-cerebral ganglion.

**iii. Oesophageal or pharyngeal or occipital ganglion or corpora cardiacum:** Situated on both sides of oesophagus slightly above the hypo-cerebral ganglion. From hypo-cerebral ganglia nerves go to corpora cardiaca or oesphageal ganglia. From corpora cardiaca of each side nerve connects ventrally to another ganglia corpora allatum.

**iv. Ingluvial or Stomachic ganglion:** Situated on the posterior end of the foregut. Nerves from hypo-cerebral ganglion connect the ingluvial or stomachic ganglion. The nerves from ingluvial ganglion innervates the neighbouring regions of the stomodaeum.

**SCAN TO VIEW DISSECTION OF NERVOUS SYSTEM OF COCKROACH**