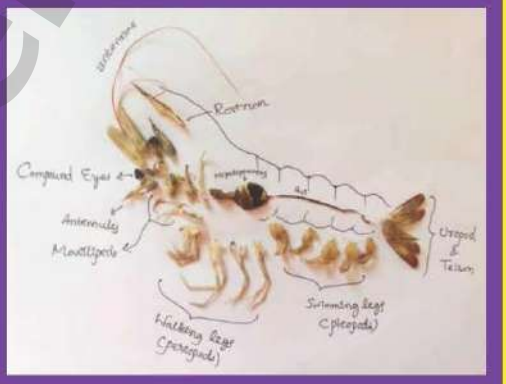
Practical Manual

Anatomy and Biology of Shellfish

Bachelor of Fisheries Science (B. F. Sc.)

1st Year 2nd Semester; Course No.: CC-FSP214

Credit: 2(1+1)



Department of Fisheries Science

School of Agriculture and Allied Sciences (SAAS)

The Neotia Uniersity

Jhinga, P.O.- Amira, Diamond Harbour Road,

District- 24 Pgs (S); Pin- 743368;

West Bengal

ज्ञानम् आत्म प्रदीपाय

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(Certificate)

This is to certify that- this is a bonafide record of practical work done by Mr./ Ms. _____
Regd. No. _____ in B. F. Sc. degree programme, Course No. CC-FSP214 entitled "Anatomy and Biology of Shellfish" during 2nd semester.

Date :…….. ***Signature of Faculty In charge***
Place:……..

Evaluation System

Anatomy and Biology of Shellfish
Course No.: CC-FSP214
Credit: 2(1+1)
1st Year 2nd Semester

Sl. No.	*Marks distribution*	*Total marks*	*Marks obtained*
1.	Record		
2.	Attendance		

.....

Signature of Faculty In-charge

"The true laboratory is the mind, where behind illusions we uncover the laws of truth."

-------Sir Jagadish Chandra Bose

"For the beginners, practical knowledge is purely based upon sound theoretical knowledge. The laboratory is the scientific workshop where the truth of ideas is tested."

---------- (Nanda and Ghosh, 1995).

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Practical: 1

❖ *General concept of Anatomy practical:*

Aim of practical class:

The students generally acquire theoretical knowledge in the class room. But in order to gather practical knowledge, a student of fishery science should verify and learn the structural arrangements of cells, organs and systems of the fishes as far as possible in the laboratory.

Guidelines for the students:

1. Students should come to the practical class in time.
2. One should not be remained absent in the practical class.
3. While coming for the practical class, they must bring the necessary articles.
4. Be seated in the seat allotted.
5. Maintain silence and discipline in the laboratory.
6. Students should listen to the teacher carefully and do the work accordingly.
7. Work with full concentration and confidence without disturbing others.
8. If face any difficulty, consult the teacher concerned.
9. Do not borrow or lend any of the requirements to or from nearby friends.
10. Handle the instruments carefully.
11. Be economic and careful while using the chemicals.
12. Clean your hands and instruments with soap and apply grease to the dissecting instruments after finishing your practical work.
13. Before leaving the laboratory, check up your instruments.
14. Always come prepared with the assignments given for the practical class.

Requirements of practical class:

For practical class, every student must possess the following articles.

1. Apron white in colour.
2. Practical record.
3. Rough practical note book.
4. A set of dissecting instruments (Fig.-1).
5. Grease
6. Pencil and pencil cutter.
7. One eraser.
8. One scale of twelve inches length.
9. Thread of one meter.

Fig-1

How to maintain the Anatomy practical record:

The student of fishery sciences is advised to remember the following points for the maintenance of Anatomy practical record as shown in Fig.-2.

1. A hard bound practical record containing loose drawing sheets tied with a tape, so that extra sheets can be included if necessary.
2. Always draw the diagram of the dissection or the slide or specimen studied in the middle of the front side of the drawing sheet. The back side of the drawing sheet should remain blank.
3. The notes are written on a plain white paper of size of the drawing sheet and write notes on its back side only. The arrangements of the plain white paper containing notes must be in such a way that the description will be on the left side and the corresponding diagram in the drawing sheet will be on the right side.
4. Always draw the diagrams with pencil.
5. Never use coloured or copying pencil or ink for the drawing.
6. Draw only one diagram of the dissection done in each drawing sheet.
7. Maximum two diagrams should be drawn in a drawing sheet.
8. Avoid shading the diagram.
9. Diagram should not be too large or too small but should be of moderate size.
10. The diagrams must be scientific rather than artistic.
11. Each diagram dust be labelled neatly with capital letters in pencil. The labelling should be on the right side of the diagram.
12. In the left hand corner at the top, write the laboratory assignment number and date in pencil according to the practical class.

13. At the bottom and towards the right hand corner, put your full signature, roll number and group number in ink.
14. Do not trace the diagrams form the book or from the records of the practical book.
15. Keep the record up to date and get it corrected and signed by the concerned teacher in each and every practical class.

Instruments used for microscopic study:

Students of fishery sciences are to study the details of minute organisms and the muscles, cells etc. of different fishes with the help of microscopes. For such studies, two different microscopes are generally used in the undergraduate laboratory namely, I) Simple dissection microscope II) Compound microscope and III) Table lens.

1. Simple dissection microscope (Fig.-2)

It is provided with a single lens system and consists of the following parts

a. Base or foot
b. Stand
c. Reflecting mirror
d. Glass stage
e. Adjustment screw
f. Two stage clips for keeping the slide in position
g. Folded arm
h. Convex lens (eye piece).

Winkel-Zeiss 2 Simple, Dissecting Microscope (circa 1927)

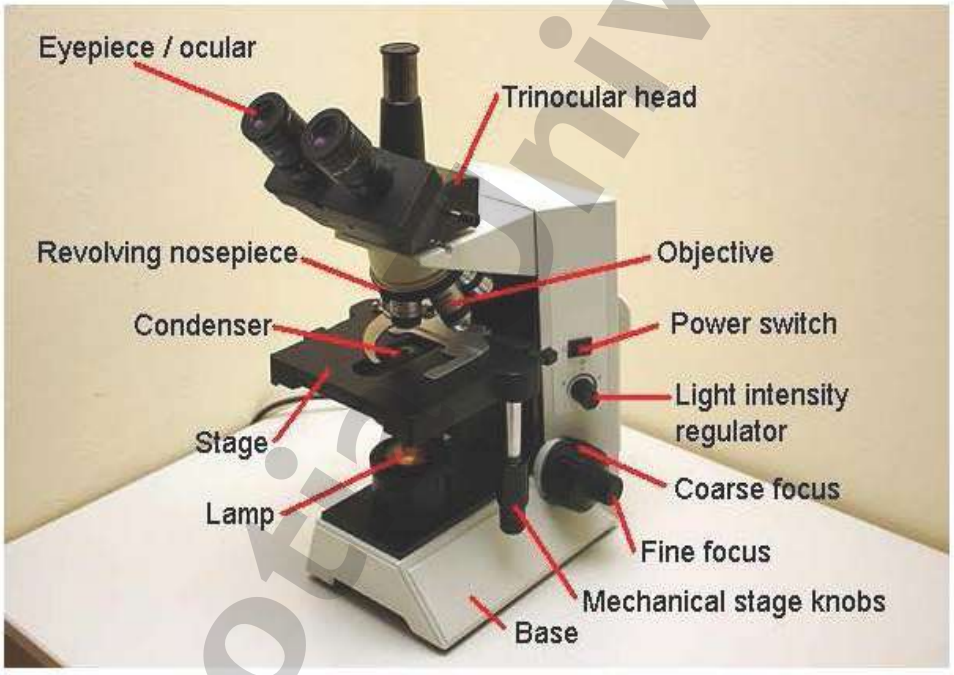
Operation: During operation of this type of microscope, the material on a slide is to be kept on the glass stage. Then one of the eyes is to fixed just above the lens and the light is to be adjusted by turning the mirror. Now the material should be brought to the focusing range and finally by rotating the adjustment screw the material can be viewed clearly. By this type of microscope an object can be magnified from 4 to 40 times depending upon the magnification of the lens.

Precautions:

i. The microscope is to be displayed carefully and it should be kept at least four inches away from the edge on the table.
ii. Direct sun light should not fall on the mirror.
iii. Water or chemicals should not adhere to any part of the microscope.
iv. Before use, the lens and mirror should be cleaned by means of silk cloth.

2. Compound microscope (Fig.-3)

It is provided with a double lens system (objective and eye piece). By this type of microscope, using the same eye piece, various magnifications can be achieved by using objective of different powers. Generally in the laboratory low power and high power objectives are used.



Parts: The compound microscope consists of the following parts:

a. Base or foot
b. A mirror (one surface is flat and the other is concave)
c. Inclination point
d. Arm
e. Iris diaphragm
f. Stage
g. Two stage clips
h. Three objectives (different powers)
i. Nose piece
j. Body tube
k. Draw tube
l. Coarse adjustment

m. Fine adjustment
n. Eye piece

Operation:

1. The microscope is to be kept on the table at a distance of about four inches from the edge of the table with the arm facing the user.
2. The body tube is to be raised for more than an inch above the stage by rotating the coarse adjustments.
3. Then the low power objective is to be brought in line with the body tube by rotating the nose piece.
4. Now light is to be focused by looking through the eye piece and simultaneously turning the mirror.
5. The slide containing the material (with a cover slip on it) should be placed on the stage and then the material is to be brought to the focus of light which passes through the central hole of the stage.
6. The body tube is to be lowered by rotating the coarse adjustment until the objective comes closer to the cover slip.
7. Finally, by looking through the eye piece and rotating the fine adjustment, the material can be viewed clearly.

   To get a clear picture of the material under high magnification, firstly it should be viewed under low power objective and later high power objective is to be brought over the material by rotating the nose piece. Now the material can be viewed by rotating the fine adjustment.

   An object can be magnified form 60 to 100 times by the low power objective and from 200 to 400 times by the high power objective.

Precautions:

1. While displacing the microscope one must hold its arm with one hand and its base or foot should be supported by other hand.
2. The microscope should not be tilted unless instructed by the teacher.
3. Direct sun light should not fall on the mirror.
4. Plain mirror should be used for natural day light and concave mirror for the artificial light.
5. Water or chemicals should not adhere to any part of the microscope.
6. The objective must not touch the cover slop on the slide.
7. Before use, the lenses and mirror should be cleaned by means of silk cloth.

3) Table lens (Fig.-4)

The table lens is used for observing smaller part of the fishes such as fins, scales, teeth etc.

Parts: It consists of following parts-

a. Base or foot
b. Stand
c. Handle
d. Lens

For dissecting smaller fishes, the base or foot should be kept by the side of the dissection tray and the lens should be fixed sufficiently above the water surface. Then by looking through lens and rotating the screw, the distance between the water surface and the lens is to be adjusted to the dissecting materials can be viewed clearly.

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Dissection tools: https://www.youtube.com/watch?v=EZWApd9zgf0
https://www.youtube.com/watch?v=4AophuoO8Ec

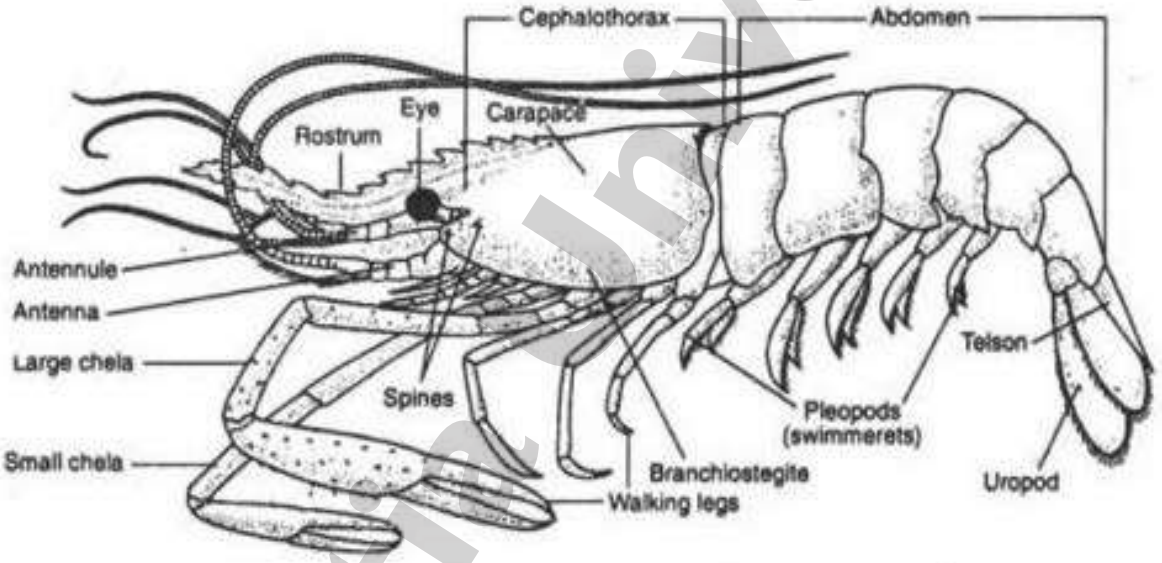
Parts of Microscope:
https://www.youtube.com/watch?v=hMncjPw6MPo

https://www.youtube.com/watch?v=mjE1Abpx2Og

Practical: 2

❖ *Study of External Morphology of Prawn*

The fresh specimen is slightly bluish in colour. The entire outer surface of the body is covered by hard exoskeleton. The body is distinctly divided into two parts— **cephalothorax and abdomen**. Both these parts bear on their ventral surfaces paired appendages, which are specialised for different functions.



Cephalothorax:

Cephalothorax is the broad, un-segmented and cylindrical anterior part. It is formed by the fusion of head and thorax. A continuous shield-like exoskeletal covering, called carapace, encloses the cephalothorax. On both the ventrolateral sides, the carapace-hangs freely over the gill-chamber as gill-cover or branchiostegite.

Following structures are present on the cephalothoracic region:

(1) Rostrum:

On the dorsal and median surface, the carapace is drawn into a long serrated projection towards the anterior end. This is defensive in function.

Draw the diagram:

Prawn: external morphology:

https://www.youtube.com/watch?v=E1_kbXflKfU

https://www.youtube.com/watch?v=myEAm2Bjc8s

https://www.youtube.com/watch?v=iqrVmz625WA

(2) Eye:

Near the base of the rostrum and on each side of the carapace is placed an eye. Each eye is black and hemispherical and made up of several visual elements. It is thus called compound eye and it is mounted on a movable and jointed stalk. It is responsible for detecting light.

(3) Spines:

These are small pointed structures, present in pairs on each lateral side of the carapace and posterior to each eye. The anterior pair is known as antennal spines and the short posterior pair is the hepatic spines.

(4) Appendages:

Thirteen pairs of appendages are present on the ventral side of prawn. The close apposition of these appendages speaks about the fusion of cephalothoracic segments.

The first five pairs, i.e. First antenna or Antennule, Second antenna, Mandible, First maxilla or Maxillula and Second maxilla are known as cephalic appendages. The remaining eight pairs are called thoracic appendages or periopods, which include three pairs of Maxillipeds and five pairs of walking legs.

(a) First antenna:

First antenna is also known as antennules. It is placed near the base of the eye stalk. It carries olfactory setae, probably for determining smells and the balancing organ, called statocyst.

(b) Second antenna:

It is situated immediately after the first antenna. The coxa contains a specialized organ, called green gland, or antennal gland (or maxillary gland), which serves as excretory organ.

(c) Mandible:

It is placed on the outer side of the mouth and is responsible for crushing the food.

(d) First maxilla or Maxillula:

This crown-shaped smallest appendage is placed slightly posterior to the mouth. It consists of three small leaf-like plates carrying sensory setae in their margins. The first maxilla is responsible for pushing the food inside the mouth.

(e) Second maxilla:

It is fan-shaped and placed immediately after the first maxilla. The second maxilla serves double functions— food getting producing constant water current within the gill chambers.

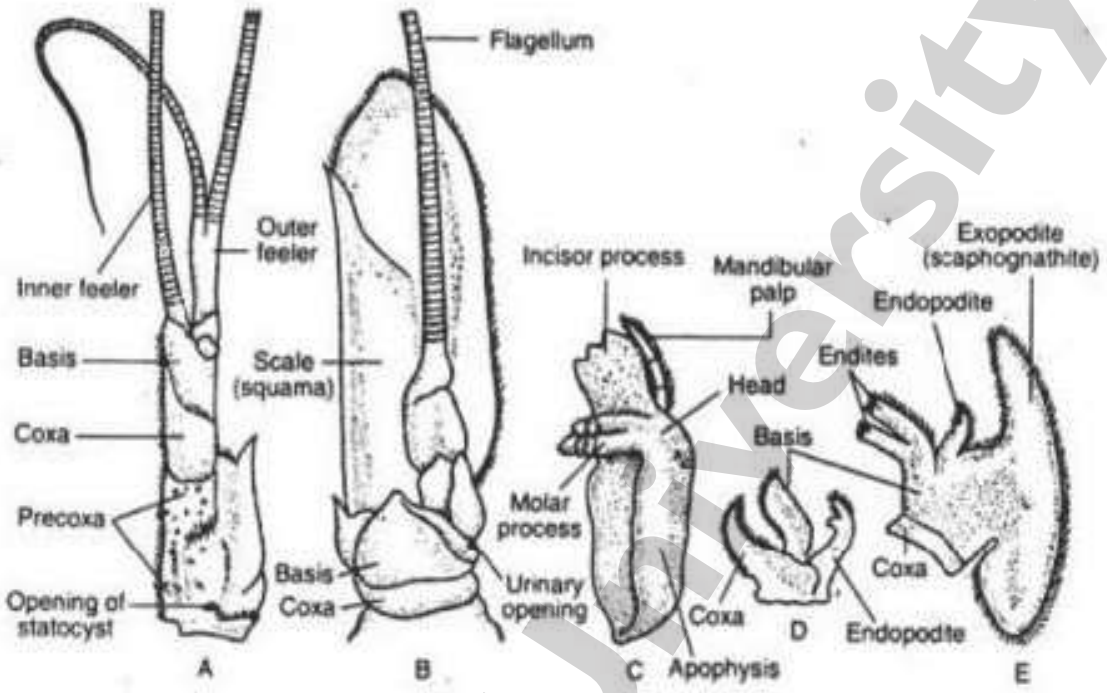


Fig. 18.3: Cephalic appendages of prawn (*Palaemon*). A. Antennule or First antenna. B. Second antenna. C. Mandible. D. First maxilla or Maxillula. E. Second maxilla.

(f) First maxilliped:

The coxa and basis of the protopodite are flattened to become jaws and bear stiff setae on their inner margins. In addition to short endopodite and long exopodite, the coxa bears a bilobed epipodite. The exo and endopodite parts of coxa together with basis help in the in pushing of food. The epipodites help in respiration.

Draw the diagram:

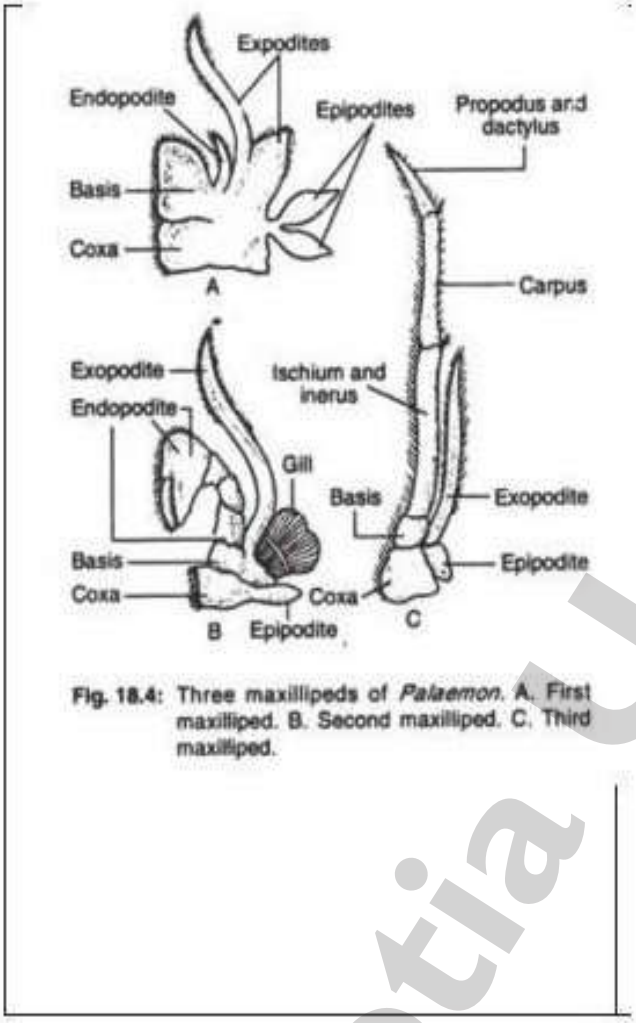


Fig. 18.4: Three maxillipeds of *Palaemon*. A. First maxilliped. B. Second maxilliped. C. Third maxilliped.

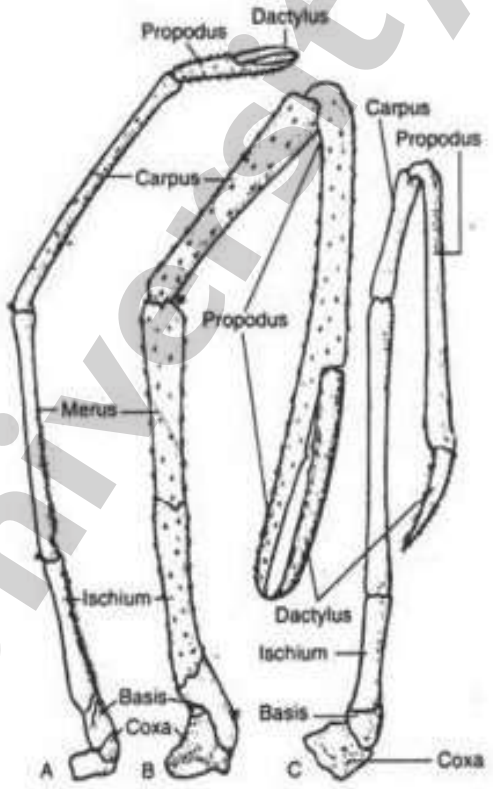


Fig. 18.5: A. First walking leg. B. Second walking leg. C. Third walking leg of *Palaemon*. Note that the prawn has five pairs of walking legs of which only the first and second pairs of legs are provided with spincers. The remaining three pairs are without spincers and resemble the third walking leg.

(g) Second maxilliped:

Here the short coxa carries on its outer margin a small epipodite and a gill. The inner margin is lined with numerous setae. The exopodite is long and un-jointed but the endopodite is made up of five segments— ischium, merus; carpus, propodus and dactylus. The last two segments are curved backwards to form a knife-like structure.

(h) Third maxilliped:

This appendage is leg-like and its coxa carries a thin epipodite on the outer side. The exopodite is thin and un-jointed but the endopodite has three segments— proximal, middle and distal. The proximal segment is formed by the fusion of ischium and merus, middle is carpus and the distal segment is formed by the fusion of propodus with dactylus.

Draw the diagram:

(i) Walking legs:

There are five pairs of walking legs for crawling. Each leg has a short protopodite with distinct coxa and basis and a prominent five segmented endopodite. These endopodite segments are ischium, merus, carpus, propodus, and dactylus. The first and second legs possess pincers formed by the attachment of dactylus on propodus and are called chelate legs, while the rest are known as non-chelate legs.

Abdomen:

The abdomen is composed of six distinct segments and a posterior-most triangular telson. Each abdominal segment is laterally compressed and is bounded by a ring-like exoskeletal piece, called the sclerite. Each sclerite consists of a ventral plate-like sternum and a dorsal arch-shaped tergum. The tergum suspends freely on the lateral sides as pleuron. The pleuron is connected with the appendage of the corresponding side by a small plate-like epimeron. Each abdominal segment carries a pair of appendages on its ventral sides. These appendages are called pleopods and the last pair is modified and known as uropods.

(a) Pleopods or Swimmerets:

One pair of pleopods is present in each of the first five abdominal segments. In each pleopod the protopodite has a longer basis than the coxa. The exopodite is longer than the endopodite. Both the exo and endopodites bear tactile setae but the former is larger.

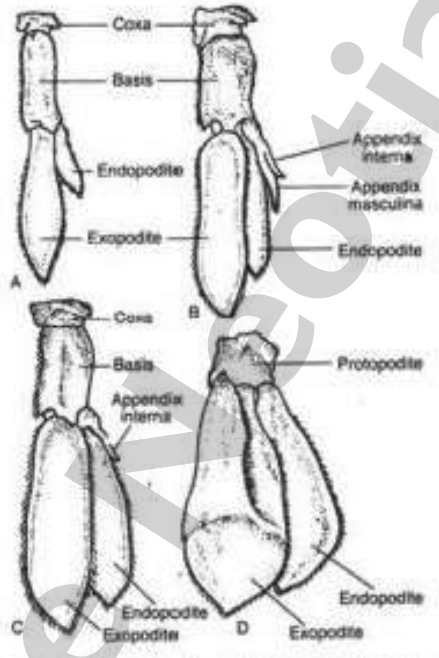


Fig. 18.7: A. First swimmeret, B. Second swimmeret, C. Third swimmeret and D. Uropod of *Palaemon*. Note that a male *Palaemon* can be distinguished from a female one by the presence of appendix interna.

The second pleopods of the male prawn have an additional process which is known as appendix masculina. The pleopods are primarily meant for swimming.

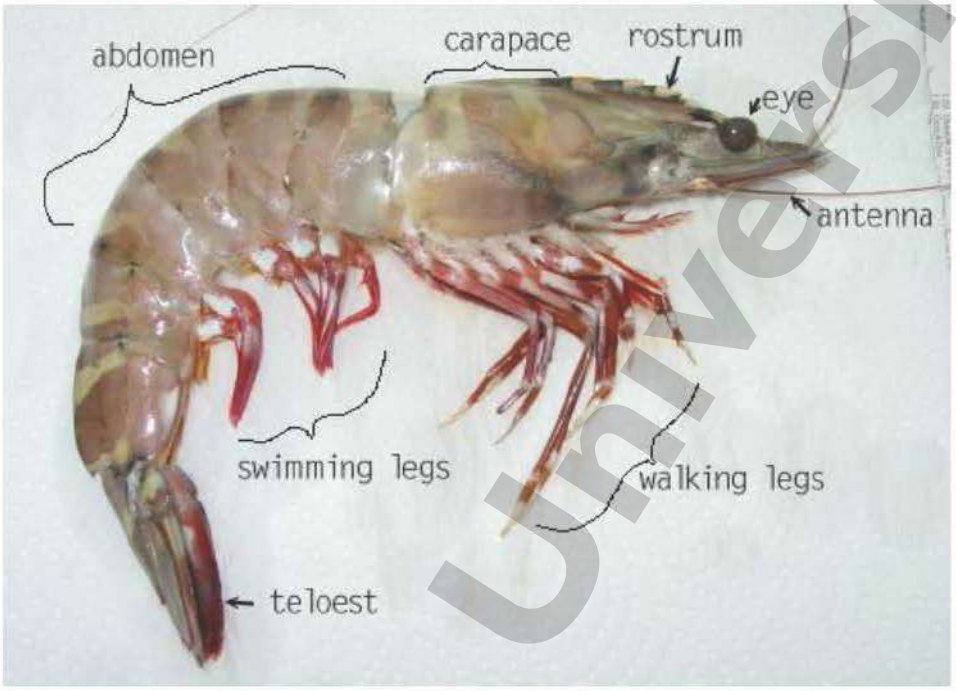
(b) Uropod:

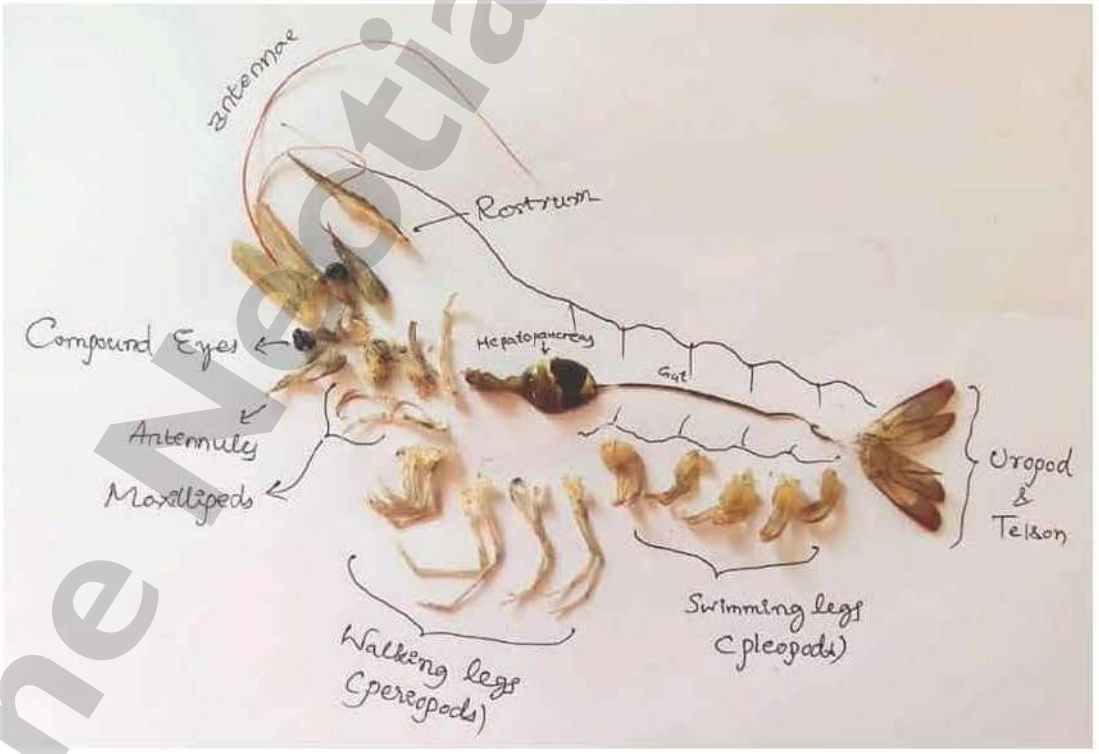
One pair of uropods is present in the last segment, one on each side of the telson. The protopodite is one segmented but the exo- and endopodites are large and fan-shaped.

Draw the diagram:

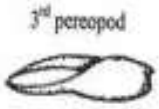
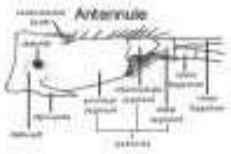
Practical: 3

Study of External Morphology of Shrimp





Differences between Penaeids and Non-penaeids

Sl. No.	Penaeids	Non-Penaeids
1.	Pleura on either side of the exoskeleton of the second abdominal segment overlap only the third segment 	Pleura on either side of the exoskeleton of the second abdominal segment overlap the pleura of the first and third segments 
2.	The first three walking legs are chelated 	Only the first two walking legs (pereopods) are chelated 
3.	Antennules with two flagella 	Antennules with three flagella 
4.	Male possesses "Petasma" for transferring sperm and female possesses "thelycum" for storing the sperm	Such organs for transferring and storing are not present
5.	Females lay eggs individually in water	Females carry eggs between their pleopods as a cluster

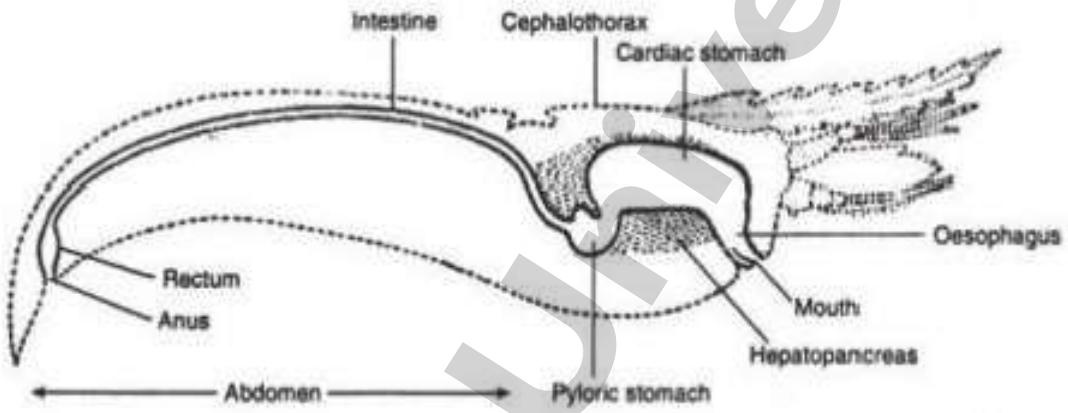
SHRIMP DISSECTION:
https://www.youtube.com/watch?v=2daMyqfd73E&t=67s

Practical: 4

❖ Study of Digestive system of Prawn

Digestive System of Prawn:

The digestive system of Prawn consists of (A) Alimentary canal and (B) Digestive glands.



A. Alimentary canal:

The alimentary canal of Prawn is distinctly divisible into three parts—fore gut, mid gut and hind gut.

1. Fore gut:

It is internally lined by thick cuticle and consists of following parts:

(a) Mouth:

It is a broad opening on the ventral side of the cephalothorax between the third and fourth segments. It is bordered anteriorly by shield-like labrum, posteriorly by two-lobed labium and laterally by the incisor processes of the mandibles.

(b) Buccal cavity:

A small antero-posteriorly flattened chamber between the mouth and oesophagus. It has an irregularly folded lining of cuticle.

(c) Oesophagus:

It runs vertically upwards as a broad tube from the buccal cavity and leads to the stomach.

Draw the diagram:

Prawn digestive system dissection:
https://www.youtube.com/watch?v=nepU67zG5rY
https://www.youtube.com/watch?v=uPeRNw2FicQ&t=19s

(d) Stomach:

This is the longest part of the fore gut which is placed longitudinally within the cephalothorax. **It is divided into two parts:**

(i) Cardiac stomach: It is large, spacious and bag-like anterior part of the stomach. Its inner cuticular wall is provided with ridges having minute bristles. The posterior part of the hastate plate is depressed and reaches up to the cardio-pyloric opening.

ii) Pyloric stomach:

The cardiac stomach opens within the next part, pyloric stomach through a narrow, X shaped cardio-pyloric opening. The opening is guarded by one anterior, one posterior and two lateral valves. The pyloric stomach is much smaller and narrower than cardiac stomach. It receives the duct from the digestive gland, hepatopancreas.

2. Mid gut:

It is the narrow and elongated part of the' intestine, which begins from the dorsal chamber of pyloric stomach and runs along the mid-dorsal line up to the sixth abdominal segment. Its internal epithelial lining at the posterior part is folded. Thus the space within the tube is reduced.

3. Hind gut:

It is also lined by thick cuticle and consists of following parts:

(a) Rectum:

It is the swollen muscular region of the last part of intestine having number as internal folds.
(b) Anus:

This is the aperture through which the alimentary canal opens to the exterior. It is a ventrally placed longitudinal slit-like opening, present near the base of the telson on a raised papilla.

B. Digestive gland:

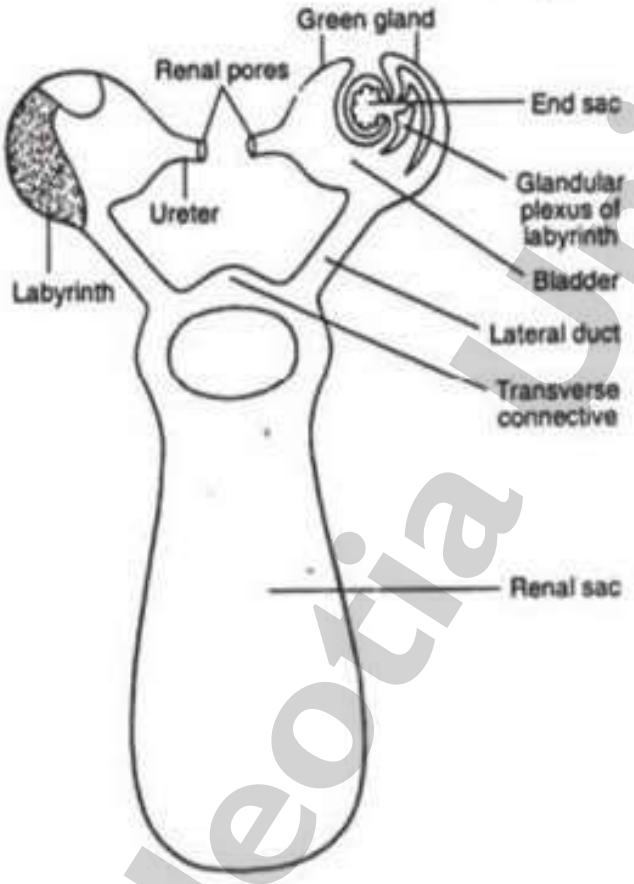
Only one digestive gland, hepatopancreas, is present. It is an orange-yellow coloured, loosely arranged bilobed organ which encircles completely the pyloric stomach, part of the intestine and partly the cardiac stomach.

The hepatopancreas in its role as digestive gland serves as liver, pancreas and intestine of higher animals. In addition, it absorbs digested food and can store it for future use. Thus, this organ serves double functions— digestion and storage.

Practical: 5

❖ *Study of Excretory system of Prawn*

Excretory organs of Prawn are known as green glands or antennal glands. They are called green glands for their colour and antennal gland for the location at the base of the second antennae. .



The organ consists of following parts:

(A) End sac:

This small bean-shaped part contains a blood lacuna. Its wall is two- layered, the inner layer is of epithelial cells having excretory function and the outer thick connective tissue layer has minute lacunae.

Draw the diagram:

Excretory System in Palaemon (Prawn):
https://www.youtube.com/watch?v=URXYRcHBCOY

(B) Labyrinth:

Present outside the end sac and contains many narrow, branched and coiled excretory tubules. Each tubule communicates with the end sac by a single opening but opens within the bladder through several apertures. A single epithelial cell layer having excretory function lines each tubule.

(C) Bladder:

It is a thin-walled sac with an epithelial lining. It communicates with the exterior through a small ureter.

(D) Excretory opening:

It is present on the base of each second antenna. Both the green glands are connected with a common large thin-walled transparent and centrally placed sac, called the renal sac. It is present between the cardiac stomach and the carapace and it communicates with the bladder of each green gland by a separate lateral duct. The two lateral ducts are interconnected by a transverse connective.

8. Physiology of Green Glands of Prawn:

The green glands perform two important functions:

1. Elimination of nitrogenous waste products:

End sac and the labyrinth are the two regions responsible for extracting urine from the blood. The most nitrogenous products include ammonia, a major excretory product in all crustaceans (the ammonia compounds are excreted by end sac in only aquatic crustaceans), and also urea and uric acid.

The excretory products are conveyed by the excretory ducts of the labyrinth from the surrounding blood of the haemocoel. Ultrafiltration of the blood takes place across the wall of the end sac. The labyrinth walls are folded and glandular which are considered as the site of selective reabsorption. The primary urine is modified when it passes through the parts of the excretory system. The urine remains temporarily stored within the bladder and is periodically expelled through renal pore.

2. Maintains the osmotic equilibrium.

The excess water which enters the body is separated from the body fluid by the green glands to maintain osmotic equilibrium and volume regulation of the body fluid is achieved.

In addition to green glands, gills and integumental covering are also responsible for excretion. The exoskeleton at the time of its periodic replacement carries a large quantity of excretory products.

❖ *Study of Circulatory system of Prawn*

Circulatory System of Prawn:

In Palaemon, the blood vascular system is of open type. It comprises: **1. pericardium, 2. Heart, 3. Sinuses or blood-lacunae, and 5. blood channels.** There are no veins and capillaries in Palaemon.

1. Pericardium or pericardial sinus: It is a wide spacious sinus lying just below the dorsal wall of the thorax and above the reproductive organs and hepatopancreas. The heart is enclosed within the pericardium.

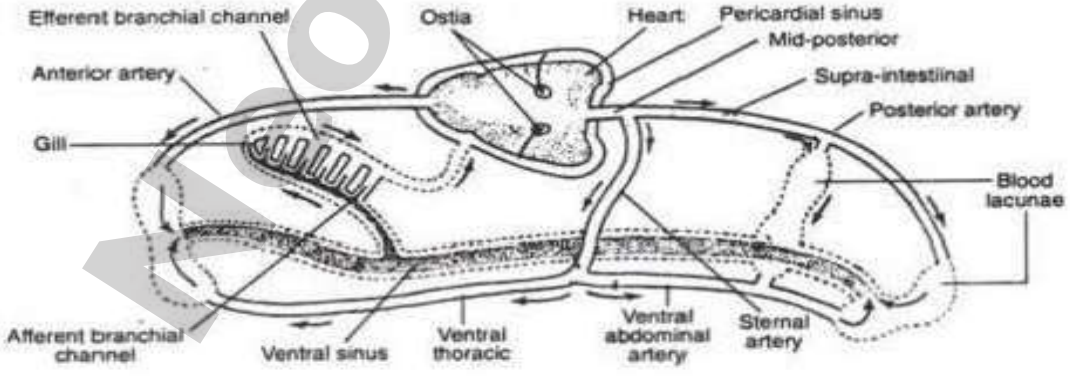
2. Heart: The heart is muscular, triangular structure, perforated by five pairs of apertures or ostia.

3. Arteries: The oxygenated blood flows from the pericardial sinus in to the heart. When heart contracts, it pumps out all of its blood in to narrow, strong and muscular tubes called arteries.

4. Blood sinuses or lacunae: The arteries open in to the blood sinuses or lacunae. All the sinuses of the body eventually connect together to form a pair of ventral sinuses, situated below the hepatopancreas.

5. Blood channels: From each ventral sinus blood is carried to the gill of that side by means of six afferent branchial channels. The oxygenated blood will be carried to pericardial sinus by another series of six efferent branchial channels.

- In *Palaemon*, the blood is colourless, thin, watery fluid containing floating colourless leucocytes or the white amoeboid corpuscles, which are phagocytic in nature. The respiratory pigment is **haemocyanin** which is dissolved in the plasma of the blood.
- Haemocyanin is composed of copper and protein. The blood has the power of coagulation.



➢ *Prawn - Blood Circulatory System* -চিংড়ির রক্ত সংবহনতন্ত্র পর্যবেক্ষণ

https://www.youtube.com/watch?v=K-xDscVnLXU

Practical: 7

❖ *Study of Nervous System of Prawn*

Nervous System of Prawn:

Nervous system resembles the annelidan pattern but shows considerable advancement. **It is divisible into:**

(A) Central nervous system

(B) Peripheral nervous system

(C) Autonomic nervous system.

It also includes several sense organs to permit the entry of different messages from outside.

A. Central nervous system:

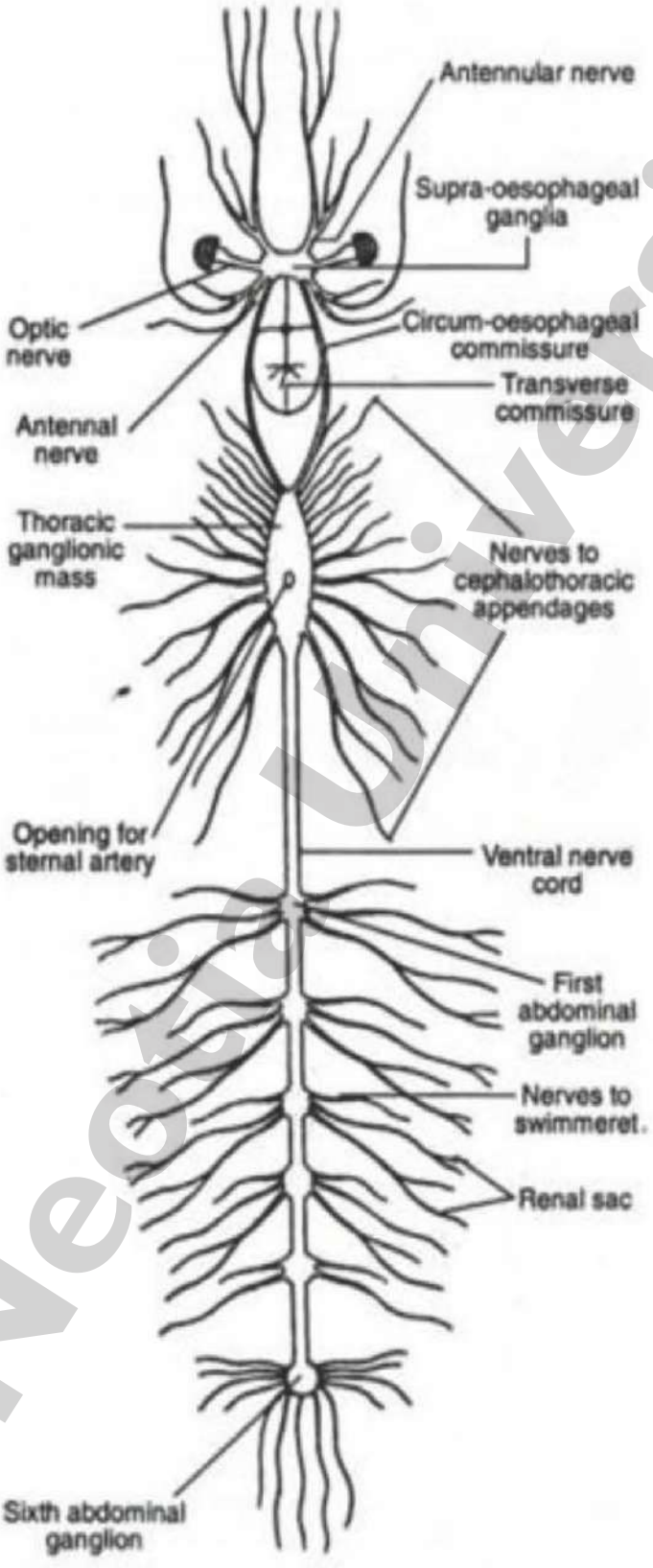
The central nervous system runs from anterior to posterior end and contains following structures:

1. Brain:

It is made up of a pair of supraoesophageal ganglia which are placed dorsally and near the base of the rostrum. It sends a number of peripheral nerves to the different organs at the anterior end of the cephalothorax.

2. Circumoesophageal connectives:

These are a paired cord, each of which begins from the supraoesophageal ganglion of one side and runs posteriorly along the ventrolateral wall of the cephalothoracic cavity. A small ganglion is present in each commissure to supply nerve to the mandibles.



The two cords are connected by a thin nerve, called transverse loop, which is present immediately after the oesophagus. The two connectives ultimately unite at the floor of the thoracic cavity with a large ganglion, called the thoracic ganglionic mass.

3. Thoracic ganglionic mass:

A large ventral elongated mass is formed by the fusion of eleven pairs of ganglia. Two circumoesophageal connectives are united with it at the anterior end. This ganglionic mass is pierced by the sternal artery. It sends eleven pairs of peripheral nerves.

4. Ventral nerve cord:

From the posterior end of the thoracic ganglionic mass originates ventral nerve cord which runs up to the posterior-most segment. The cord appears to be single but in reality it is formed by the fusion of two separate cords.

The ventral nerve cord along its course bears a ganglion in each segment. The last ganglion or 6th ganglion is the largest of all the abdominal ganglia and known as stellate ganglion.

B. Peripheral nervous system:

The peripheral nerves are given off from the different parts of the central nervous system. Each peripheral nerve contains two kinds of fibres—motor and sensory. The motor fibres carry instructions from the central nervous system to different parts and the sensory fibres are meant for bringing messages from different corners of the body.

Following peripheral nerves are seen in prawn:

1. Optic nerve:

From each lobe of brain, an optic nerve enters within the eye to innervate the retinal layer.

2. Antennular nerve:

From each lobe of brain an antennular nerve is given within the first antenna or antennule to supply statocyst and various other structures present in the first antenna.

3. Antennary nerve:

From the posterior side of each lobe of brain, antennary nerve originates and runs posteriorly to take a quick turn towards the anterior dissection to supply the various parts within second antenna including green gland.

4. Cephalothoracic nerves:

Eleven pairs of cephalothoracic nerves originate from the thoracic ganglionic mass to supply different muscles and appendages in that region.

5. Abdominal nerves:

From each abdominal ganglion two 'pairs of peripheral nerves are given off to the corresponding segments to supply muscles and appendages. The stellate ganglion in addition to these two pairs sends several more branches to telson, rectum and other adjoining structures.

C. Autonomic nervous system:

It includes a few minute ganglia and slender nerves which are present over the cardiac stomach to supply involuntary parts of the body.

D. Sense organs:

1. Tactile organs:

These sense organs are present along the margin of antenna and other appendages. These are responsible for the sensation of touch.

2. Olfactory setae:

These organs are present on the small inner branch of the outer feeler of the first antenna. These are responsible for smell.

3. Statocyst:

Inside the base (pre-coxa) of each antennule, the statocyst is present as a small, white and spherical cuticular sac. In the central part of the sac, elongated and slender sensory setae are elliptically arranged. Finer branches of statocyst nerve carry the information from each seta to the brain and the animal corrects its loss of equilibrium.

4. Eye:

Each movable and stalked eye is compound in nature, i.e., made up of several simple visual units' Each unit is called an ommatidium or ocellus.

Each ommatidium is divisible into two parts —outer dioptrical region for focussing the light rays falling from the object and inner retinal part or receptor region for receiving light stimuli and serves to form the image.

➢Dissection of prawn | Nervous system|
https://www.youtube.com/watch?v=qGblNki4cAc

➢Nervous System of Prawn - চিংড়ি এর স্নায়ুতন্ত্র পর্যবেক্ষণ
https://www.youtube.com/watch?v=TPdqtymVtx0

Practical: 8

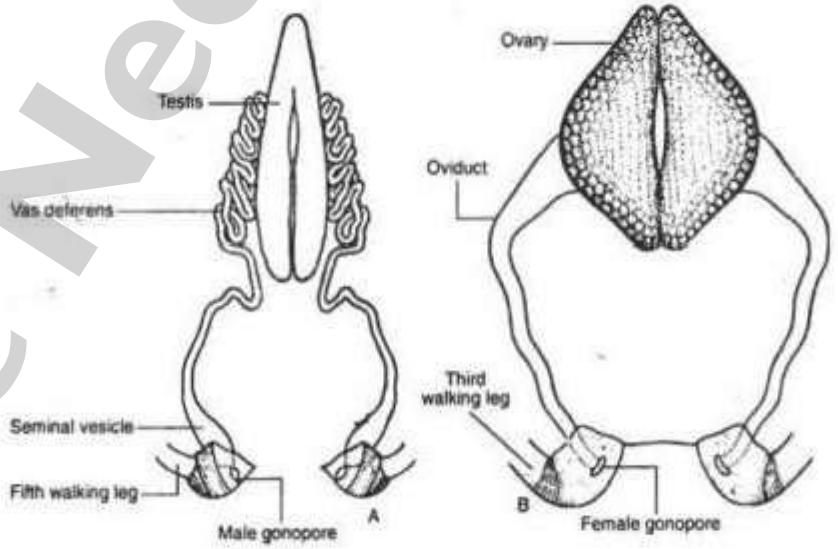
❖ *Study of Reproduction System of Prawn*

Reproductive System of Prawn:

Sexes are separate in prawn and sexual differences (i.e., sexual dimorphism) are prominent. The gonads are of different shapes and both occupy similar position.

DIFFERENCES BETWEEN A MALE AND A FEMALE PRAWN

Male	Female
1. Among the specimens of same age, the size is large.	1. Size is comparatively smaller.
2. Abdomen is narrow.	2. Abdomen is proportionately broad.
3. Walking legs are closely set.	3. Walking legs are set apart.
4. Second walking leg is strongly developed and with numerous spines.	4. Second walking leg is moderately developed.
5. **Appendix masculina** is present in the second pleopod.	5. Absent.
6. Testes are elongated with a long median gap for cardio-pyloric strand. Posterior ends are free.	6. Two ovaries are fused at both the ends and the median gap is short.
7. First part of the reproductive duct, **vas deferens**, is coiled.	7. The oviducts are straight.
8. Reproductive openings or **gonopores** are present near the base of **fifth** walking legs.	8. Gonopores are present near the base of **third** walking legs.



Male reproductive system:

1. Testes:

These paired, soft and white organs are present above the hepatopancreas and beneath the heart. Anterior ends of the two testes are united but the posterior ends are free. Each testis includes numerous minute tubes, called seminiferous tubules, which remain enclosed within connective tissue. Each tubule has an inner lining of a single layer of epithelial cell which transforms into spermatozoa.

2. Vas deferens:

From the posterior end of each testis, a long much-coiled duct, called vas deferens, originates

3. Seminal vesicles:

Each vas deferens near the base of the fifth walking leg is swollen as seminal vesicle. It serves as a chamber in which sperm cells are temporarily stored and transformed into small packets, called spermatophores.

4. Male gonopore:

The base of each fifth walking leg contains a small opening, called male gonopore, through which the seminal vesicle of the corresponding side opens. The gonopore is guarded by a small cuticular lid.

Female reproductive system:

1. Ovaries:

These paired white and compact organs are placed above the hepatopancreas and beneath the heart. The two ovaries are united at their both ends. Each ovary is bounded by a hard capsule within which egg cells or ova remain serially arranged. The matured eggs remain near the margin and the immature eggs occupy the centre.

2. Oviducts:

From the outer border and from near the middle of each ovary originates a short and wide oviduct which runs straight downwards to the third walking leg.

3. Female gonopore:

Present one on the inner side of each third walking leg as a small aperture is called the female gonopre or reproductive opening. It acts as an outlet of oviducts.

Prawn reproductive system:
https://www.youtube.com/watch?v=oThQ9eriQbI

Practical: 9

❖ *Study of External Morphology of Pila* sp.

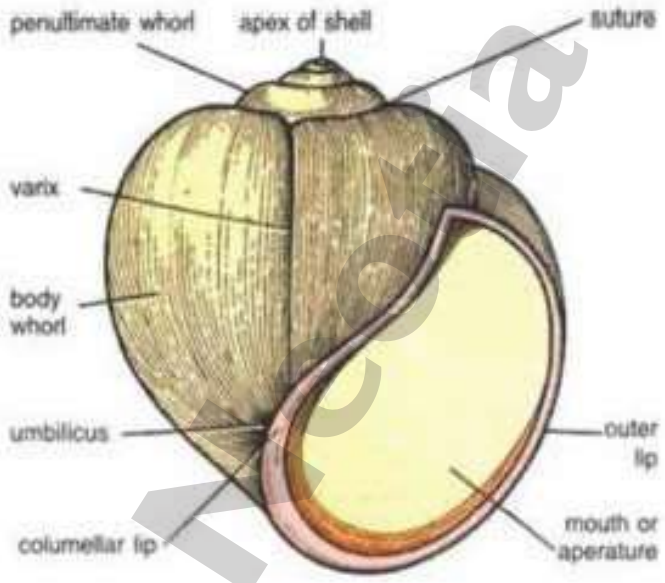
Shell of *Pila*:

The shell of *Pila globosa*, as in other Gastropoda, is univalve but coiled around a central axis in a right-handed spiral.

The top of the shell is the apex which is formed first and growth of shell takes place from it, the apex contains the smallest and the oldest whorl. Below the apex is a spire consisting of several successively larger whorls or coils followed by penultimate whorl and the largest whorl or body whorl which encloses most of the body.

The lines between the whorls are called sutures. Internally all the whorls of the shell are freely communicated with one another; such a shell is called unilocular. The body whorl has a large mouth or opening, which the head and the foot of the living animal can protrude.

The mouth lies to the right of the columella and the shell is spiralled clockwise. The outer margin of the mouth is called an outer lip, and the inner margin as inner or columellar lip.



In the centre of the shell runs a vertical axis or columella around which the whorls of the shell are coiled; the columella is hollow and its opening to the exterior is known as an umbilicus. The lines of growth of shell are visible, some of them appear as ridges known as varices. The shell of *Pila globosa* varies in colour from yellowish to brown or even blackish.

Operculum of *Pila Globosa*:

Fitting into the mouth of the shell is a calcareous operculum, its outer surface shows a number of rings of growth around a nucleus; the inner surface has an elliptical boss for attachment of muscles, the boss is cream- coloured and is surrounded by a groove. The operculum is, in fact, secreted by the glandular cells of the foot.

Microscopic Structure of Shell:

The shell of *Pila globosa* consists of an outermost pigmented layer called periostracum made of a horny organic conchiolin, below this is a prismatic layer made of crystalline calcareous plates running vertically, the innermost nacreous layer is made of calcareous plates running longitudinally. Inside the shell is the mantle which secretes the shell.

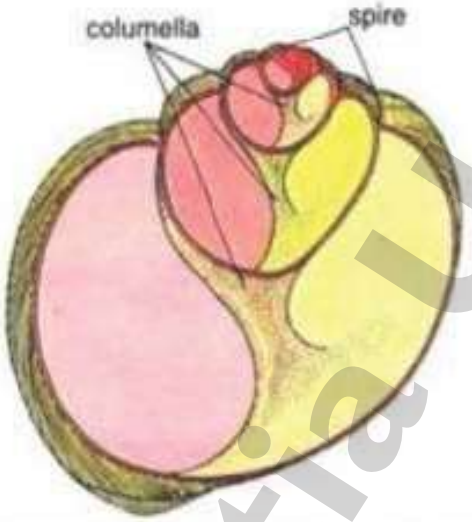


Fig. 60.2. *Pila globosa*. Shell seen from dorsal surface.

Body of *Pila*:

The body consists of a head, a foot and a visceral surface, mass. In an expanded animal the head and foot come out of the shell-mouth but the visceral mass lies inside the shell whorls. A collumellar muscle arises from the foot and is inserted in the columella, it attaches the body to the shell and it withdraws the animal inside and closes the operculum.

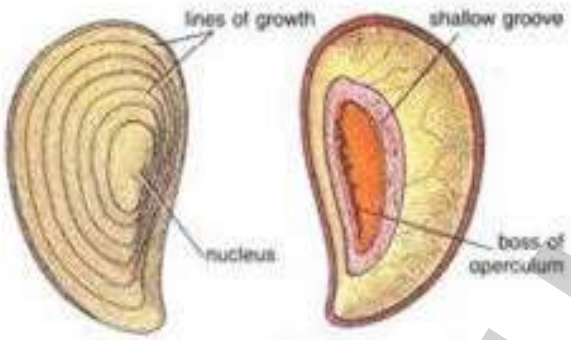
(i) Head:

There is a distinct head produced into a snout, the head bears two pairs of tentacles. The first pair of tentacles or labial palps are small and lie in front, behind them there is a second pair of

tentacles which are long. The tentacles are hollow and capable of much extension and contraction. Behind the tentacles the head has a pair of eyes borne on stalks or ommatophores.

(ii) Foot:

Below the head is a large muscular foot, its lower surface is gray and flattened sole. It is triangular with the apex pointing backwards, it is used for creeping; its upper surface is spotted and the dorsal posterior surface bears the operculum.



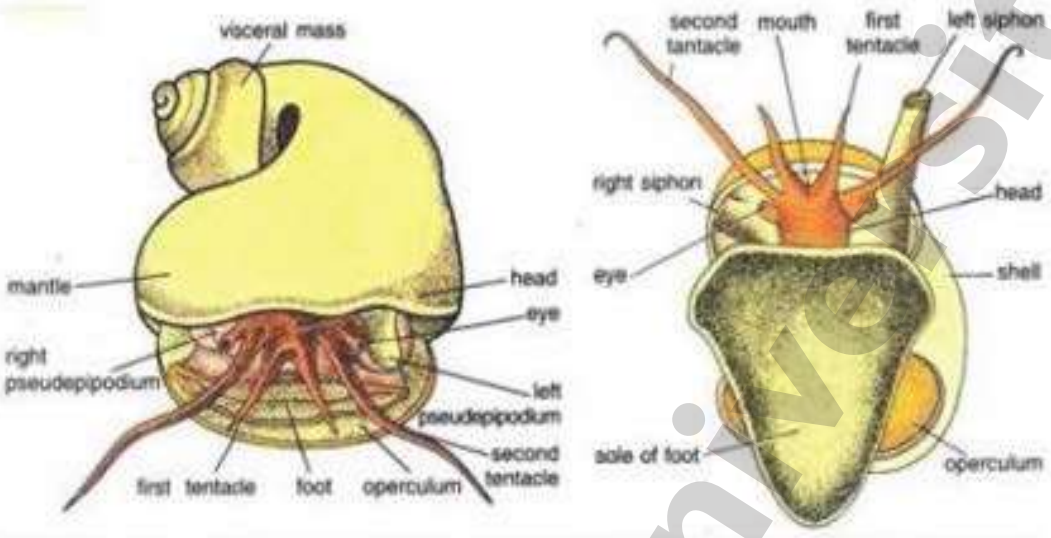
When the foot is withdrawn the operculum closes the mouth of the shell. In the foot is a pedal mucous gland which forms a slime trail during locomotion. Waves of contraction which sweep from the anterior to the posterior end of the foot provide the main power for locomotion. In fact, the head and the foot together constitute the head-foot complex which is connected to the visceral mass by an inconspicuous neck.

(iii) Visceral Mass:

Above the head-foot complex is a visceral mass containing the main organs, it fills all the whorls of the shell and it is spirallycoiled like the shell. The visceral mass exhibits the phenomenon of torsion which is distinct from coiling. It is soft and grey to dark brown in colour.

(iv) Mantle:

The mantle, also referred to as pallium, covers the visceral mass and it forms a hood over the animal when it is withdrawn. The edge of the mantle is thick and contains shell glands which secrete the shell, above the thickened edge there is a supra-marginal groove.



The mantle also has two fleshy lobes called nuchal lobes or pseudepipodia which are joined on either side of the head. The left pseudepipodium forms a long tubular respiratory siphon for aerial respiration and a respiratory current enters, through it, the right pseudepipodium is less developed and not a regular tube, respiratory current passes out through it.

Mantle Cavity and Pallial Complex:

In the anterior part there is a large space between the mantle and the body, this is a mantle or pallial cavity which has been shifted to the front by a process of torsion. It encloses a number of organs and the head can be withdrawn into it. The mantle or pallial cavity encloses within it a number of important organs which are collectively known as pallial complex. Near the right pseudepipodium is a prominent ridge or epitaenia which runs backwards up to the end of the mantle cavity, it divides the mantle cavity into a right branchial cavity and a left pulmonary sac.

In the branchial cavity or chamber lie a single gill or ctenidium, rectum and anus, the genital aperture and the anterior chamber of the kidney as a reddish mass near the posterior end of the epitaenia. Near the left pseudepipodium is a fleshy osphradium a typical molluscan sense organ.

Draw the diagram:

https://www.youtube.com/watch?v=MOPBzJ8IGfY
https://www.youtube.com/watch?v=DiCRj0zOFxk
https://www.youtube.com/watch?v=JN1zKIRD1xY

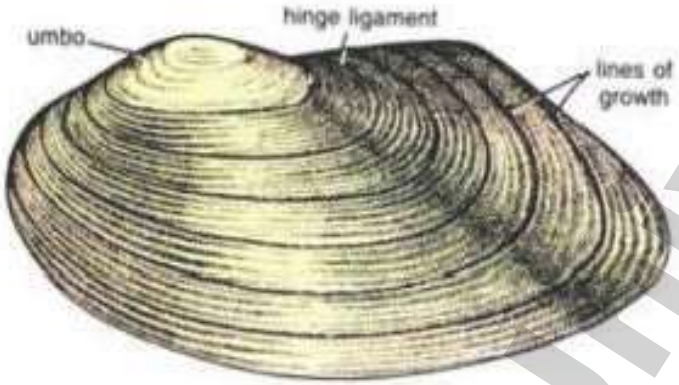
Practical: 10

❖ *Study of External Morphology of Unio* sp.

External Features of Unio:

(i) Shape and Size:

The body is laterally flattened. The anterior side of the body is roughly oval in outline and the posterior end is slightly narrower. Lamellidens has a bilaterally symmetrical body.



(ii) Shell:

The soft body of Unio is completely enclosed by a hard calcareous shell. Shell is composed of two symmetrical and equal halves called valves and known as right and left valves.

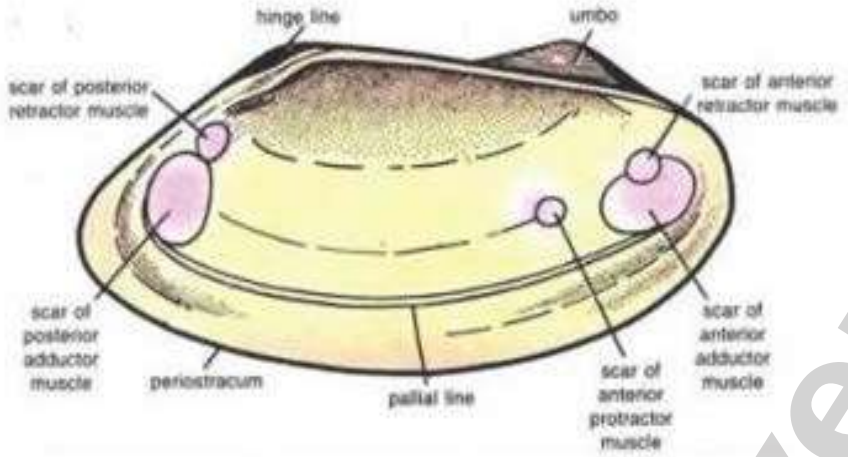
The two valves are united by a dorsal elastic band called a hinge ligament which is continuous with the two shell valves but is made of un-calcified conchiolin, it is elastic and causes the valves of the shell to open.

At the anterior end of the hinge ligament on each side, is a swelling called umbo which is the oldest part of the shell and is first formed in a young animal. Below the umbo are concentric lines of growth of the shell valves.

But in some oysters, the upper or left valve is always larger than right valve by which the animal is attached.

If a shell valve is removed from the mantle lobes, its inner surface is seen which shows marks of insertion of muscles running transversely between two valves.

The insertion of the edge of the mantle marks a pallial line. Anteriorly is an impression of an anterior adductor muscle, posteriorly is a larger impression of a posterior adductor muscle; close to these impressions are marks of an anterior retractor muscle and a posterior retractor muscle. Near the anterior adductor is also an impression of a protractor muscle.



The adductor muscles close the shell valves tightly by pulling them together, the retractors pull in the foot, and the protractor pushes out the foot. The hinge ligament acts antagonistically to the adductor muscles and causes the shell valves to open when the adductors relax.

Draw the diagram:

https://www.youtube.com/watch?v=WIzuSBKrtaY
https://www.youtube.com/watch?v=ADGkuX8IL9c&t=70s

Practical: 11

❖ *Study of External Morphology of Crab*

- Body is flat and covered by a carapace. It is comprised of a cephalothorax of 13 segments and abdomen is curved below the cephalothorax.
- The cephalothorax is comprised of 13 (5 + 8) segments of cephalic and thoracic region, is much broader then its length and is covered over by a carapace.
- The cephalothorax bears a pair of stalked compound eyes, a pair each of small antennule and antennae.
- Mouth parts (mandible, first maxillae and second maxillae) and first two maxillepedes are exceedingly small and are covered over by third maxillepede which acts as operculum or cover.
- Of the five pairs of walking legs, first pair is chelate and is largest. The second to fifth pairs are non-chelate and sufficiently developed and clawed.
- Abdomen is reduced, flattened and is curved permanently in a groove below cephalothorax. It is comprised of six segments with a telson.
- Two pairs of copulatory stylets formed by 1st and 2nd pleopods are seen in the males. In females, four pairs of pleopods form an egg carrying basket. Thus in a crab, well-developed locomotor appendages like swimmerets of prawn are not seen in the abdomen. Anus is present at the terminal end of last abdominal segment.

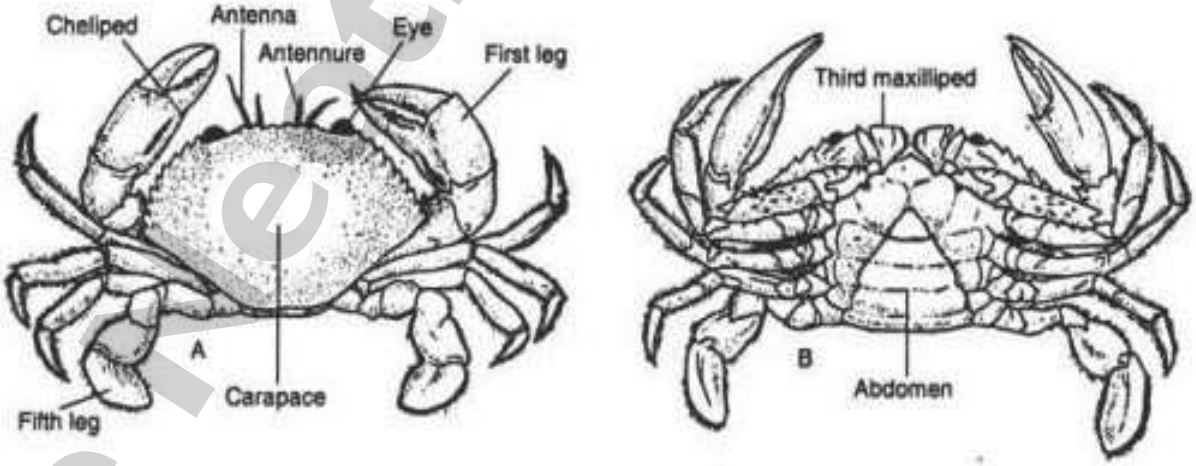


Fig. 18.18: External features of a true crab. A. Dorsal view. B. Ventral view.

Draw the diagram:

https://www.youtube.com/watch?v=stUjTosyTPE
https://www.youtube.com/watch?v=u7jyRDn99jY

Practical: 12

❖ *Study of External Morphology of Cephalopods*

Loligo:

1. It is a marine mollusc commonly called squid.

2. Body is long, slender, pigmented and tapering behind.

3. A fin is present along its postero-lateral edges.

4. The shell is internal, feather-like and membranous.

5. The body is divisible into head, collar (neck) and trunk.

6. Head bears a pair of large bulging eyes 4 pairs of thick and small arms and a pair of long, slender and clubbed tentacles.

Octopus:

1. It is commonly called as **"sea-devil"** and is a marine and cosmopolitan animal.
2. It is normally found in holes or crevices or under stones along sea bottom.

3. Body globular and is divided into visceral hump and head. The head is comparatively small and undifferentiated.

4. Foot modified Into 8 small and thick arms which are all arranged around mouth.

5. Head bears a pair of large conspicuous eyes.

6. Each arm is beset with two rows of large cuplike suckers all along its length.

7. The third right arm of male is modified into a spatulate structure for transfer of spermatophores into the female.

8. Shell and tentacles are altogether absent.

9. Between head and visceral hump, at the lower side, is present a conical funnel at the base of which lies an ink gland which helps in its escape from enemy.

Cuttlefish:

1. It is a marine mollusc commonly called cuttle-fish and is commonly used as food.

2. Body bilaterally symmetrical, somewhat ovoid and dorsoventrally flattened.

3. Body is distinguished into head, neck (collar) and trunk (body).

4. Head is round and bears two large and bulging eyes, 4 pairs of small straight and forwardly directed arms and a pair of long, curved and clubbed tentacles.

5. Each arm, along its inner concave surface, bears four rows of large and distinct suckers.

6. The tentacles bear suckers along their free clubbed end.

7. Collar is reduced and is hidden beneath the trunk.

8. Trunk bears a thick and broad lateral fin, all along its length.

9. External shell absent but a greatly reduced and calcareous. Internal shell is present below the dorsal skin.

10. In male the left tentacle is hectocotelyzed and is used for copulation.

11. The arms and tentacles are modifications of foot.

12. An ink gland is present which ejects ink-like fluid as a device to escape from the enemy.

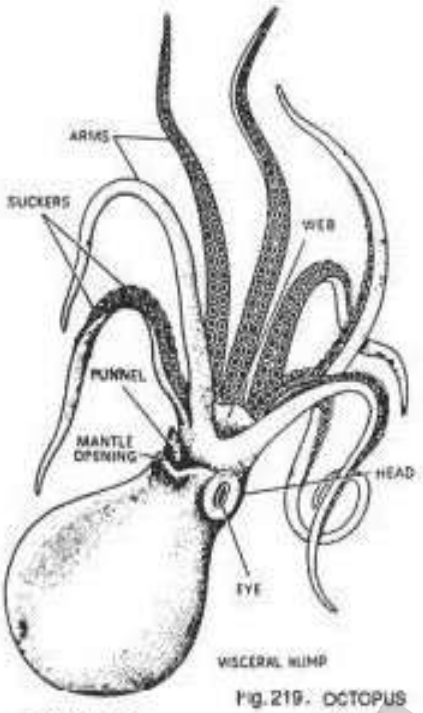


Fig. 219. OCTOPUS

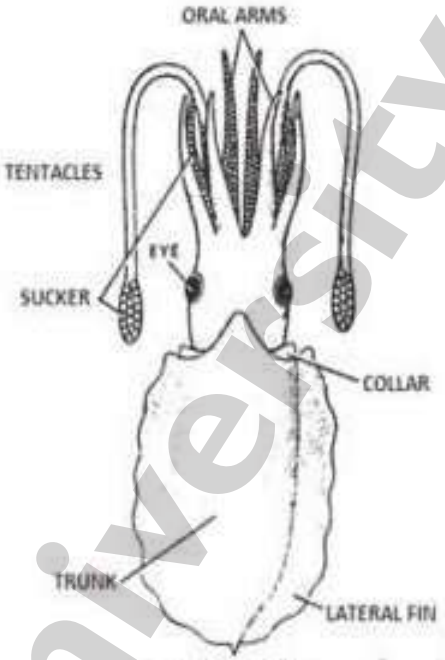


Fig. 217. SEPIA

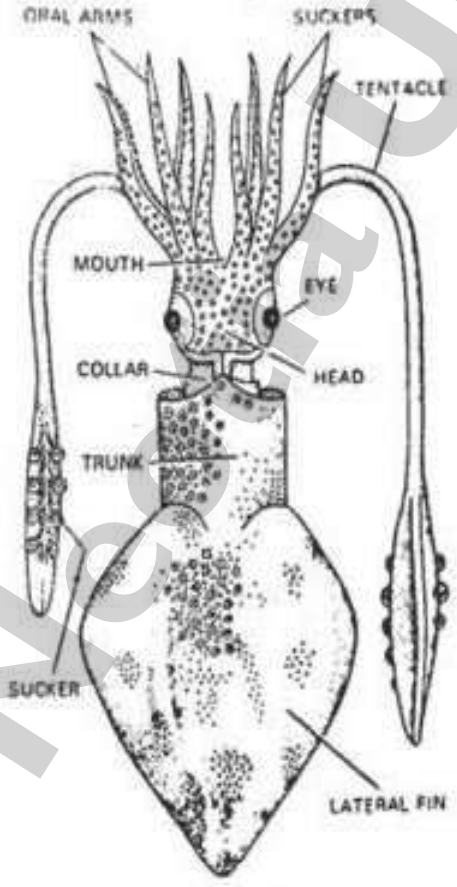


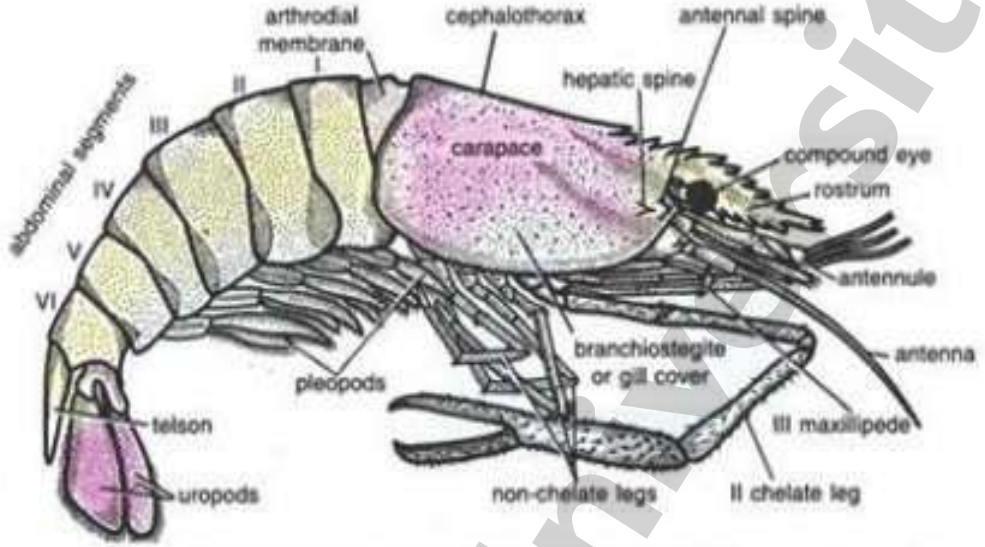
Fig. 218. LOLIGO

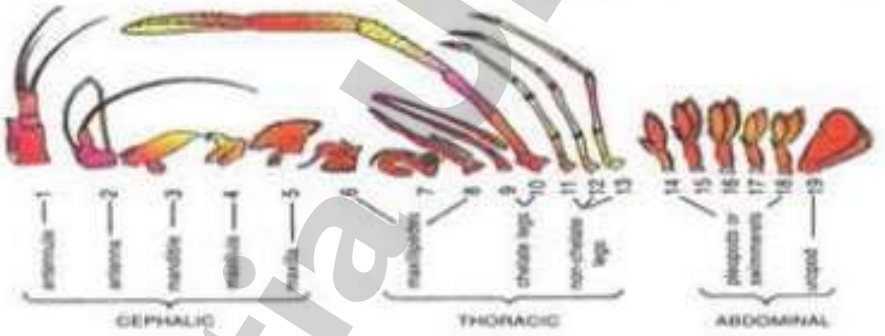
Draw the diagram:

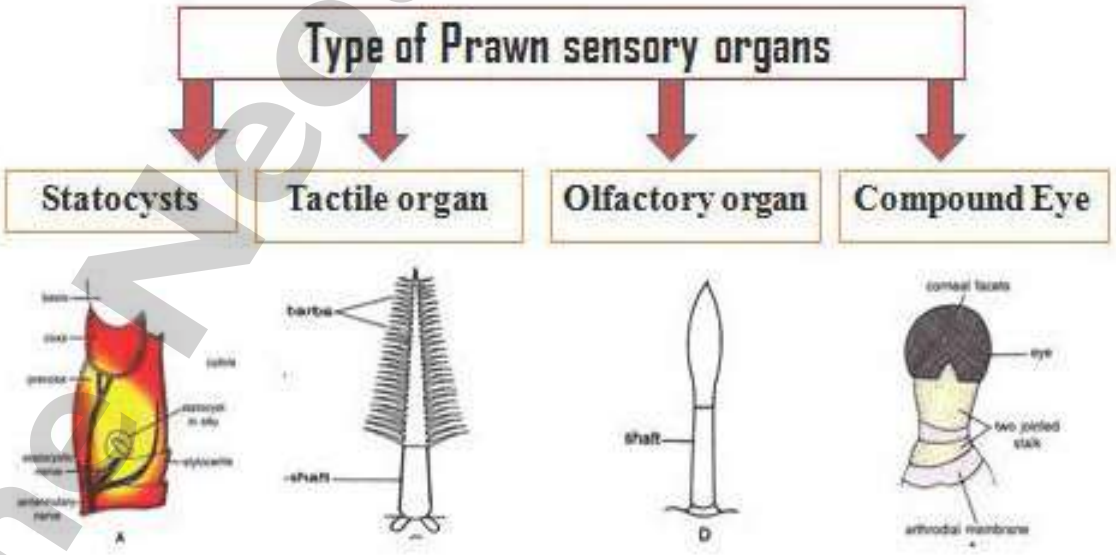
https://www.youtube.com/watch?v=r-2iYtqS_EM
https://www.youtube.com/watch?v=elw_Tcw0G0c&t=57s
https://www.youtube.com/watch?v=UiXA54Z_TVo&t=50s

Practical: 13

❖ *Sensory organs of Prawn*





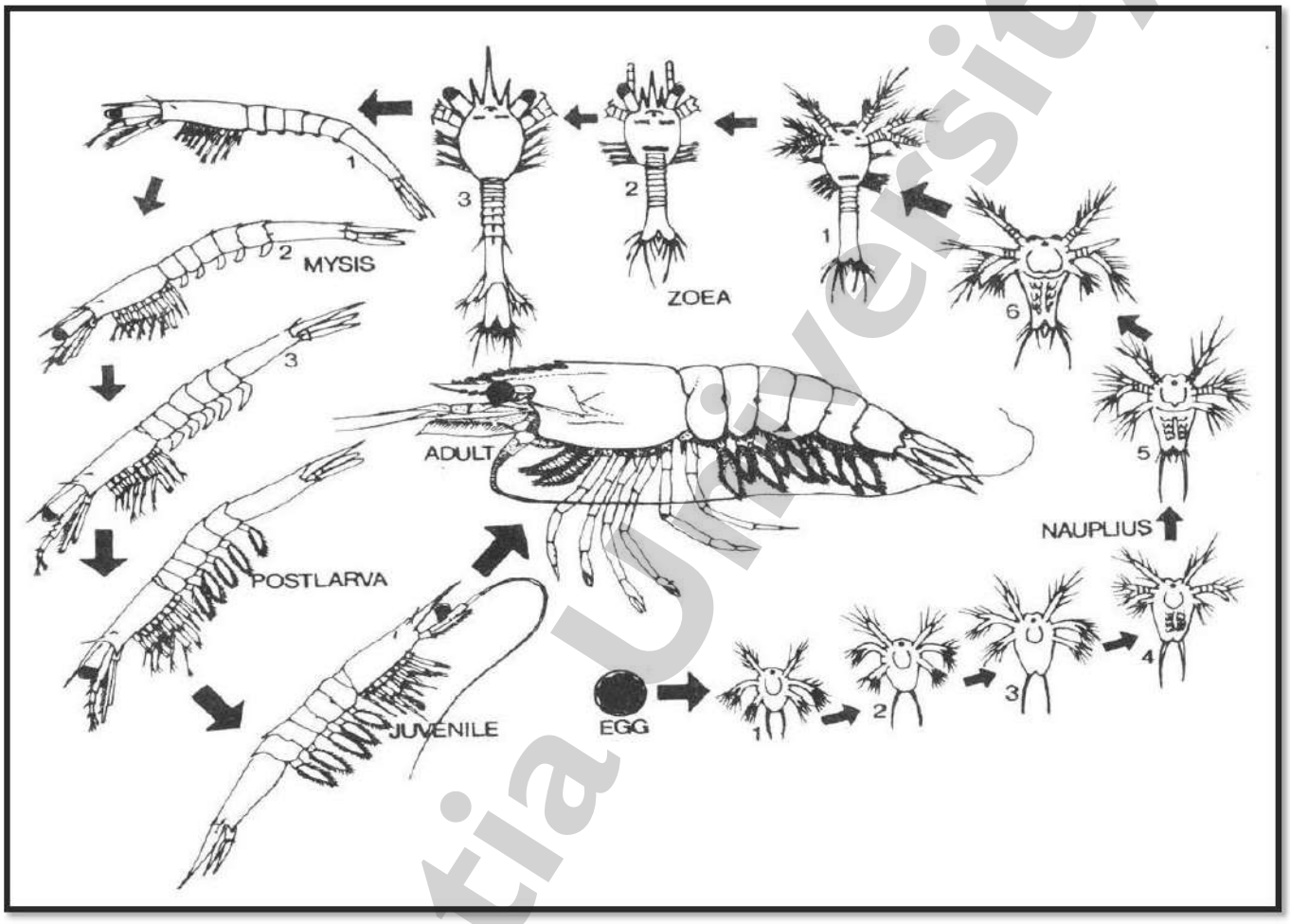


Draw the diagram:

https://www.youtube.com/watch?v=h0GsXi9mw_I
https://www.youtube.com/watch?v=9rNI6MO6X2c

Practical: 14

❖ *Larval stages of shrimp*



Life cycle of *P. monodon*

Egg

↓

Nauplius larvae (6 stages)

↓

Protozoea (3 stages)

↓

Mysis (3)

→ Larval stages (12)

↓

Post larvae

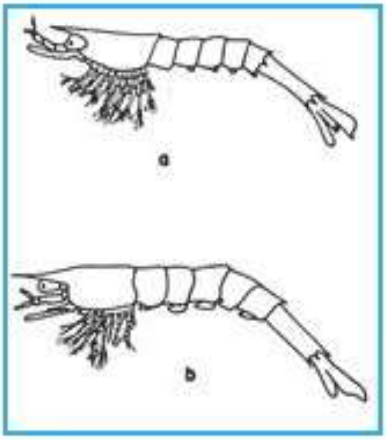
↓

Adult

- The first larval stage is known as **nauplius**. The unsegmented body which is pyriform in shape possesses three pairs of appendages. The nauplius undergoes six moltings within 50 hours into a protozoea.

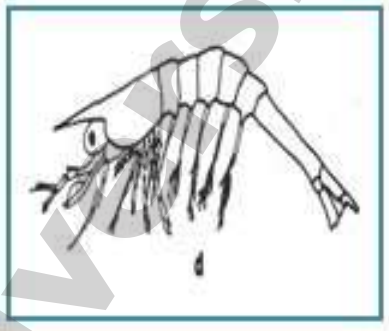
- The body becomes elongated with a distinct cephalothorax. The early **protozoea** stage has a pair of protruded compound eyes, the next stage is characterized by the presence of a rostrum and the late protozoea stage has a pair of uropods.

- After 4–6 days, the protozoea finally metamorphoses into a **mysis**. (Fig.a-b). At this stage, the larvae assumes the form of a juvenile shrimp at which the pleopods are to develop. At this stage, tiny protrusion known as pleobases are seen on the ventral side of the abdominal segments.



- The next stage is marked by the devlopment of first segment of the pleopods development. The mysis remain drifting in the water column until they metamorphose into post larvae within 10–12 days.

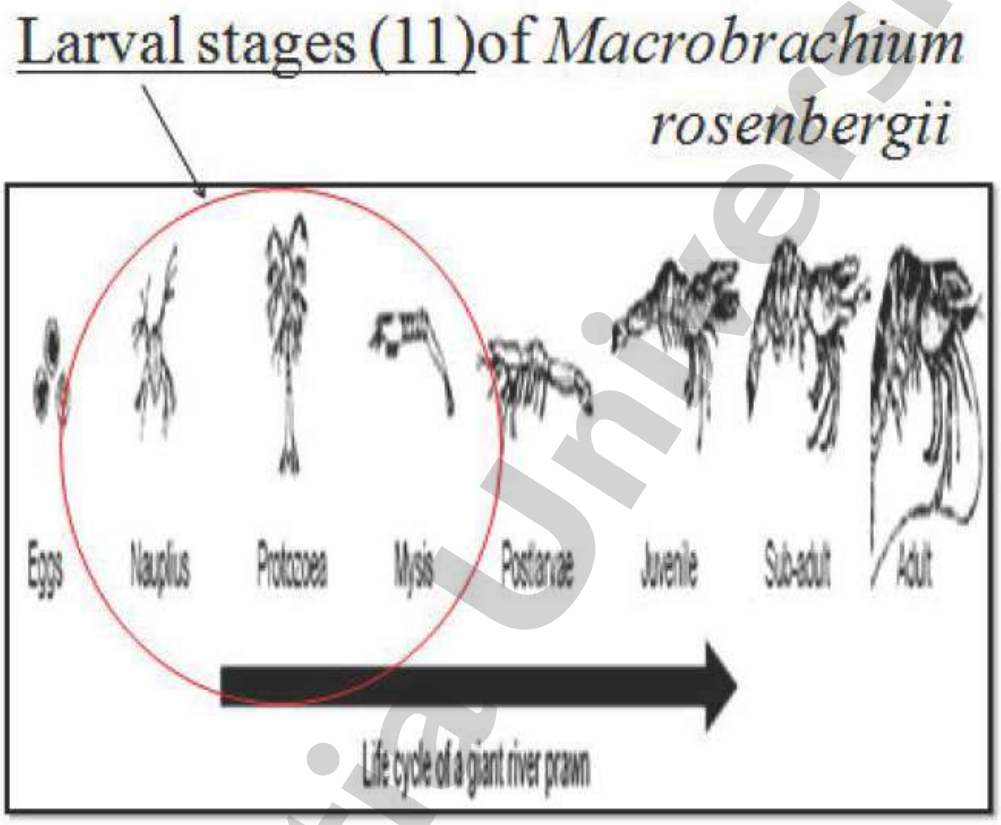
- At **post larval stages**, the pleopods become fully developed and functional and attains sexual maturity.
- They spend their juvenile, adolescent and sub-adult stages in estuarine waters and then gradually move toward deeper water as they grow and eventually returning to offshore water when they attain sexual maturity.
- The shrimp begin to grow as they settle into the salt waters of the estuaries. They feed on algae, small animals and debris. But as they grow, they also become prey for small fish living in the waters. Juvenile stay in these areas for two to three months.



https://www.youtube.com/watch?v=ATs9gSlfAh0
https://www.youtube.com/watch?v=HjnpXF5uVv0&t=56s

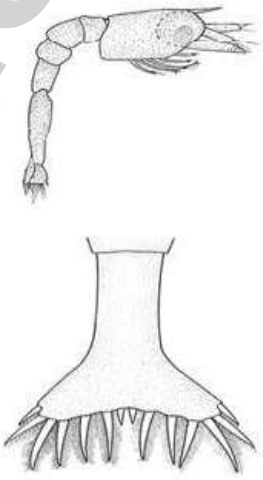
Practical: 15

❖ *Larval stages of prawn*



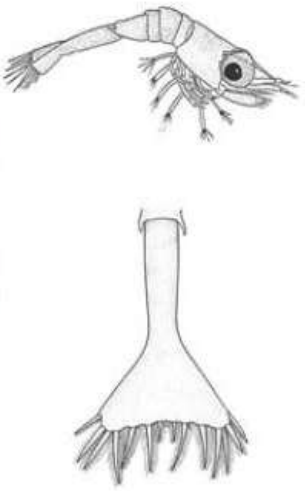
ZOEA-I

Carapace smooth; anterolateral edge produced into a small pterygostomial spine; rostrum slender, pointed, eyes large, sessile; abdomen 6-segmented; telson not demarcated from the 6th abdominal segment and bears seven pairs of spines.



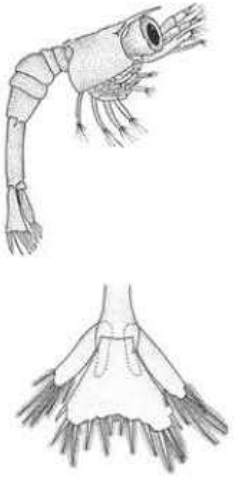
ZOEA-II

Carapace with prominent supra-orbital and branchiostegal spines, eyes stalked, a pair of prominent lateral spines present on the 5th abdominal segment and telson with eight pairs of spines.



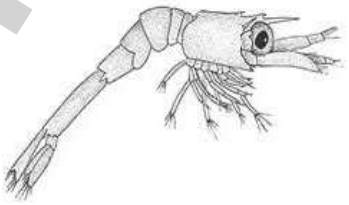
ZOEA-III

Characteristics : Rostrum with epigastric spines, carapace with well defined supra-orbital, brachiostega and pterygostomial spines, biramous buds of third and uniramous bud of fifth pereopo developed, articulation of telson with sixth abdominal somite is defined, and uropd developed and biramous with exopod bearing six long plumose setae and endopod bare.



ZOEA-IV

Characteristics : Larvae with third and fifth pereopods developed, rostrum with two dorsal teeth, endopod of uropod with plumose setae.



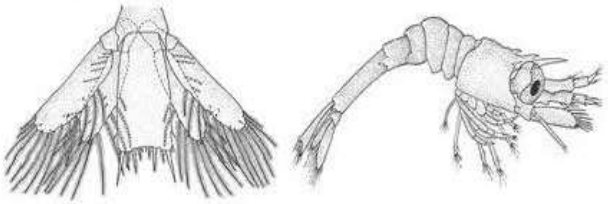
ZOEA-V

Characteristics :

Biramous buds of fourth pereopod developed, telson rectangular, posterior margin with five spines on either side, distal portion of lateral margin with three spines, endopod of the uropod with more than six plumose setae.

ZOEA-VI

Characteristics : Fourth periopod fully developed and thus in this stage all the periopods are fully developed, no pleopod buds telson slightly tapering towards the posterior end and endopod of uropod bearing more than eleven plumose setae.



ZOEA-VII

Characteristics : Rostral teeth serrated on the ventral surface, three plumose setae under the second teeth, uniramous buds of pleopods developed; telson narrow posteriorly, tip with ten spines, outermost ones longest and cospicuous.

ZOEA-VIII

Characteristics : Buds of pleopods are biramous, without any setae, tip of the telson pointed, endopod of uropod with more than 18 plumose setae.

ZOEA-IX

Characteristics : First and second pereopods chelate, exopod of third and second pleopods atleast with and endopod bare.

ZOEA-X

Characteristics : Appendix interna developed on second to fifth pleopods, outer spine on tip of telson very long.

FIRST POSTLARVAE

Characteristics : Except for the size first post larvae has most of the characteristics of adult, pleopods have become functional and pereopods have become uniramous; carapace with branchiostegal and antennal spine only, rostrum long with 8-9 teeth on the dorsal side and at least a single tooth on the ventral Side.

SECOND POSTLARVAE

Characteristics : Rostrum at least with ten dorsal teeth and two ventral teeth, ploeopods have become fully functional with exopod and endopod bearing long plumose setae, telson with sharply pointed tip bearing four spines and two setae, anterior two pairs of lateral spines movable and have shifted toward the dorsal aspect of the telson.

https://www.youtube.com/watch?v=RDIfHS0VNXQ

https://www.youtube.com/watch?v=_7bVy1hghAA

Practical: 16

❖ *Larval stages of crab*

Life cycle of *scylla serrata*

Egg

Zoea (5 stage) → LARVAL STAGES

Megalopa

Juvenile

Crab 1 / 1st instar

Zoea-1

➢Abdominal segments are 5.
➢Telson is with 3+3 spines.
➢Eyes are sessile.

Zoea II

➢Eyes are stalked.
➢Abdominal segments are five.
➢Telson has 4+4 spines

Zoea III

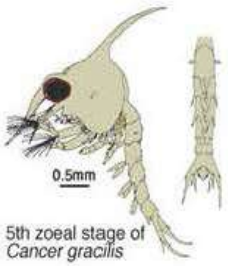
There are five abdominal segments.

Zoea IV

Pleopods buds appear in abdominal segments and rudiments of remaining thoracic appendages also appear.

Zoea V

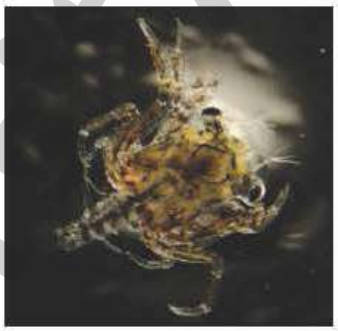
➢Setae are present in pleopods.
➢Telson with 5+5 spines.
➢Rest of thoracic appendages develop.



5th zoeal stage of *Cancer gracilis*

Megalopa

➢Carapace length is more than width.
➢Abdomen with five pairs of pleopods.
➢A pair of chelipeds and four pairs of legs are seen.



Adult

➢Carapace with nine anterio lateral spines on either side .
➢First pair of cheliped and three pairs walking legs, fifth pairs of legs has paddle shaped dactylus.
➢sexual maturity is reached after 18 to 20 postlarval molts, at the age of 1 to 1½ years.
➢Males continue to molt and grow after they reach sexual maturity.
➢females cease to molt and grow (terminal molt) when they mature and mate.

https://www.youtube.com/watch?v=7isXWEe4YTA

https://www.youtube.com/watch?v=8Z-LvzYGIjc
https://www.youtube.com/watch?v=DN164hYstlM