PHYLUM : MOLLUSCA

General characters

Widely distributed over the world. Mostly aquatic (marine and few are fresh-water) and some are terrestrial living in damp soil.

- Body is soft and unsegmented (except Neopilina).
- Bilaterally symmetrical except gastropodas (asymmetrical) because the shell is coiled.
- Schizocoel or Haemocoel cavity found as coelom.
- Body wall is Triploblastic
- Organ system level of body organization.
- Body is divisible into head (absence in pelecypoda and scaphopoda), dorsal visceral mass,ventral muscular foot and mantle.
- Body is covered by a hard calcareous structure, made up of calcium carbonate, called shell. In some molluscus, it is internal or reduced or even absent (oplacophora).
- Locomotion takes place by ventral muscular foot.
- Digestive system is well developed with a hard chitinous structure, called radula.
- Respiration takes place through one or more gills or ctenidia, lungs (pulmonary sac) or general body surface in the terrestrial forms.
- Circulatory system is closed or open type.
- Head consists tentacles and compound eyes. Presence of one pair tentacles except octopus where tentacles are modified into arm.
- Excretion takes place by paired metanephridia (kidney).

- Nervous system consists of many paired ganglia, connectives and nerves.
- Sense organs are eyes, tentacles, osphradium and statocyst.
- Sexes are usually separate but some are monoecious.
  Pila- sexual dimorphism.
  Limax- hermaphrodite
  Helix- hermaphrodite
- Fertilization is external (in sessile group such as in oyster) or internal.
- Development may be direct or indirect. Larva is trochopore or veliger or parasitic stage called glochidium larva. Eg. Pila, Sepia, Snail etc

Classification of mollusca

Class: Monoplacophora

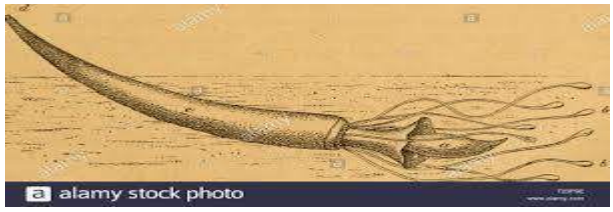
- Body is bilaterally symmetrical and unsegmented.
- Mantle dome-shaped.
- The shell comprises a **single piece** or valve.
- Flattened limpet-shaped shell with spirally coiled Protoconch.
- Head without eyes and tentacles.
- Mantle encircles the body as a circular fold of the body.
- Foot broad and flat, with 8 pairs of pedal retractor muscles.
- Gills external. 5 pairs of gills in pallial grooves.
- 6 pairs of nephridia, two of which are gonoducts.
- Radula in a radular sac; intestine much coiled.
- Heart of 2 pairs of auricles and a single ventricle.
- Nervous system with longitudinal pallial and pedal cords.
- Sexes separate **(dioecious)**
- Examples: *Neopilina galatheae*.

Class: Amphineura

- These are marine, attached on rocks
- Body is bilaterally symmetrical
- Dorso-ventrally flattened body; no distinct head
- No eyes and tentacles.
- Radula, mantle, foot and external gills present.
- Posterior mantle cavity.
- Shell is calcareous with 8 calcareous dorsal plates. Eg- Chiton

Class: Scaphopoda

- Exclusively marine.
- The body is bilaterally symmetrical, elongated and enclosed in a tusk-shell opens at both ends.
- No head; mouth with tentacles; no eyes.
- Conical foot, radula present; no gills.
- Mantle tubular completely enclosing the body.
- Mouth surrounded by lobular processes or outgrowths.
- Heart rudimentary.
- Kidneys paired; gonad single.
- Sexes separate**(dioecious).**
- Trochophore larva.
- Examples: *Dentalium*, *Cadulus*, *Pulsellum*.



Class:Gastropoda

- Marine, freshwater, terrestrial and few parasitic on echinoderms.
- Body unsegmented, asymmetrical typically with nivalve, **spirally coiled**
- Head distinct bearing tentacles, eyes, and mouth.
- The foot is ventral, broad, flat and muscular forming the creeping sole and often bearing dorsally a hard piece, the **operculum** on its posterior end.
- **Torsion** (coiling) of body mass at sometimes in development.
- The mantle is a collar-like fold of body wall lining the body leaving a space, the **mantle cavity**, between itself and the body.
- The buccal cavity contains an **odontophore** with a radula bearing rows of chitinous teeth.
- The digestive system comprises muscular pharynx, long esophagus, stomach, long coiled intestine, and anteriorly placed anus.
- Respiration by **gills (ctenidia)** in most forms, through the wall of the mantle cavity in some forms and by pulmonary chamber
- The open circulatory system and heart is enclosed in a pericardium.
- The excretory system comprises metanephridia (kidney) which are paired in primitive forms and reduced to a single nephridium in most forms.
- The nervous system comprises distinct cerebral and pleural besides buccal, pedal, parietal and visceral ganglia.
- Sexes separate (dioecious) in most forms while in some forms united.
- The development includes **trochophore** and **veliger larva**
- **Examples:** Pila globosa, Land Snail-Limnaea



Class:Pelecypoda

- Aquatic, mostly marine, some freshwater forms.
- The body is bilaterally symmetrical and laterally compressed.
- Bivalve shells hinged together and mid-dorsally.
- Head is not distinct; pharynx, jaws, radula, and tentacles
- The foot is ventral, muscular which is ploughshare.
- **Mantle** bilobed, consisting of paired, right and left lobes.
- **Gills** or **ctenidia** are paired, one on each side.
- The coelom is reduced to a dorsally placed pericardium.
- The alimentary canal is coiled with large paired digestive glands.
- The heart is contained within the pericardium and comprises a median ventricle and two auricles.
- The excretory organ is paired nephridia or kidneys opens at one end into pericardium at the other end to the exterior.
- The nervous system consists typically of 4 pairs of ganglia i.e. cerebral, pleural, pedal and visceral.
- Cerebral and pleural of each side usually fused into a single Cerebro-pleural ganglion.
- Sense organs are statocyst and osphradia.
- Sexes are separate or united.
- Mostly filter-feeding.
- Development is accompanied by **metamorphosis** which usually includes a **trochophore larva.**
- **Examples:** Freshwater mussel, Mytilus etc.

Class: Cephalopoda

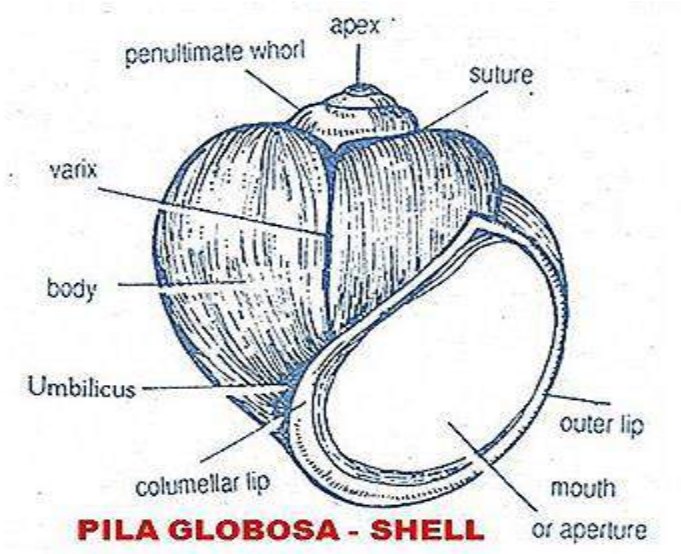
- Marine and free-swimming.
- The body is bilaterally symmetrical with head and trunk.
- Body elongated dorso-ventrally.
- Shell external, internal or absent.
- Head distinct and large with well-developed eyes and mouth.
- The trunk consists of the symmetrical and **uncoiled** visceral mass.
- Mantle encloses posteriorly and ventrally a large mantle cavity.
- Foot altered into a series of **suckers bearing arms** or tentacles encircling the mouth.
- Mouth bears jaws and radula.
- 2 or 4 pairs of bipectinate gills.
- Circulatory system **closed**, heart with 2 or 4 auricles.
- The excretory system comprises 2 or 4 pairs of nephridia.
- The nervous system is highly developed and the principal ganglia are concentrated around the esophagus.
- Sexes are separate.
- Development meroblastic without metamorphosis.
- Examples: Sepia. Loligo, Nautilus etc

PILA GLOBOSA: APPLE SNAIL

External morphology

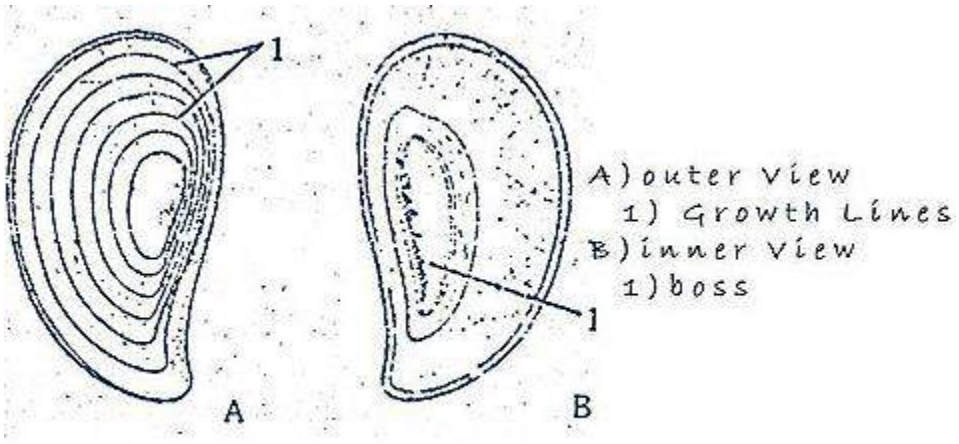
SHELL:

- Shellof Pila is a single piece and hence it is called univalvia.
- It protects the body of the animal.
- The shell shows an axis called columella.
- It is hollow Around this columella the shell is coiled.
- The shell shows 61/2 coils. The coils are separated by suture lines.
- The apex of the shell is first formed part. The last whorl is the biggest.
- It is called body whorl in which the body of the animal lies.
- This body whorl will open out through the mouth. It shows Hps.
- Near this mouth the columella opens out through umbilicus.
- Hence this shell is called umbiiicated shell or perforate shell.
- On this body whorl vertical lines are present .
- They are growth lines. They are called varices.
- If the mouth of the shell is on the right side of the observer when the apex of the shell is upwards, it is called dextral shell.
- If the mouth is on the left side it is called sinistral shell.



OPERCULUM :

- The mouth of the shell is covered by operculum.
- This is a plate like structure secreted by foot glands.
- On the inner side of this operculum a bulge is present.
- It is called Boss.Foot muscles are attached to it.



PILA GLOBOSA - OPERCULUM

Microscopic structure of the shell :

In the section of the shell 3 layers can be seen.

1) Periostracum : It is brown in colour. It is made by conchiolin. It is produced by the glands present on the margin of the mantle.

2) Ostracum : It is the middle layer. It is made by alternate layers of $CaCO_3$,and conchiolin. It is also called prismatic layer.

3) Mother of pearl layer (or) Nacreous layer :

It is made by $CaCo_3$. It is white in colour. It is shining layer. The shell is secreted by the Mantle layer.

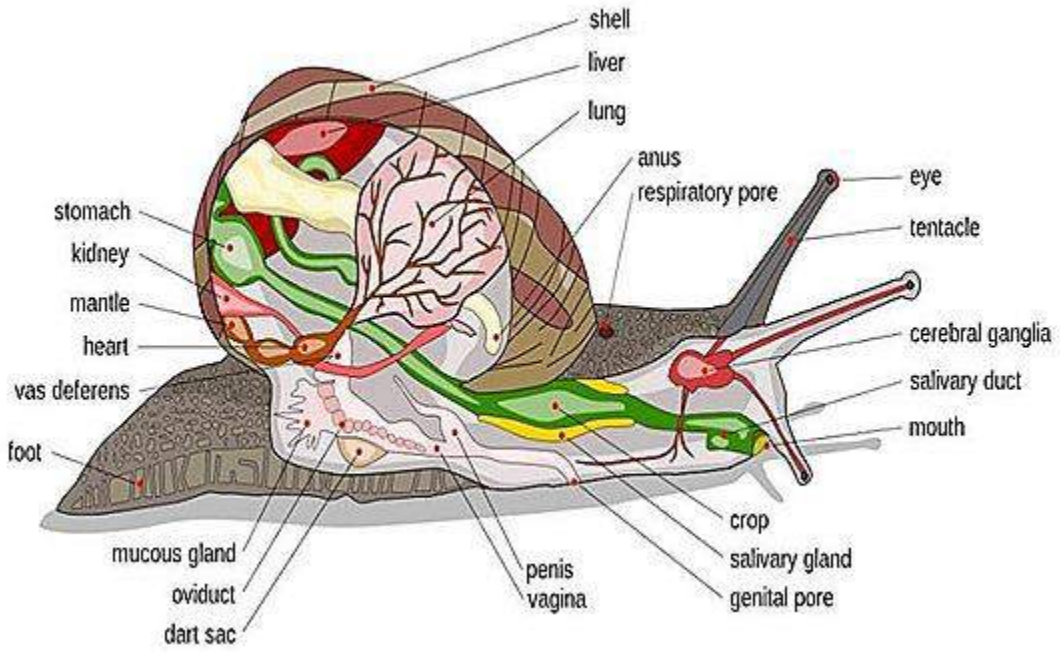
Inner soft parts:

When shell is removed the inner soft parts can be seen clearly. They are head, foot and visceral mass. They are covered by protected by Mantle

1. Head: It is present on the dorsal side of the foot. It shows the following parts

a) Two pairs of Tentacles : The first pair of tentacles are present on the mouth. They are called cephalic tentacles. The second pair of tentacles shows contraction and expansion The second pair tentacles are considered as true tentacles.

b) Eye Stalks : Behind the second pair of tentacles eye stalks are present They bear eyes. These are called ommatophores.



c) Mouth : At the apex of the head mouth opening is present.

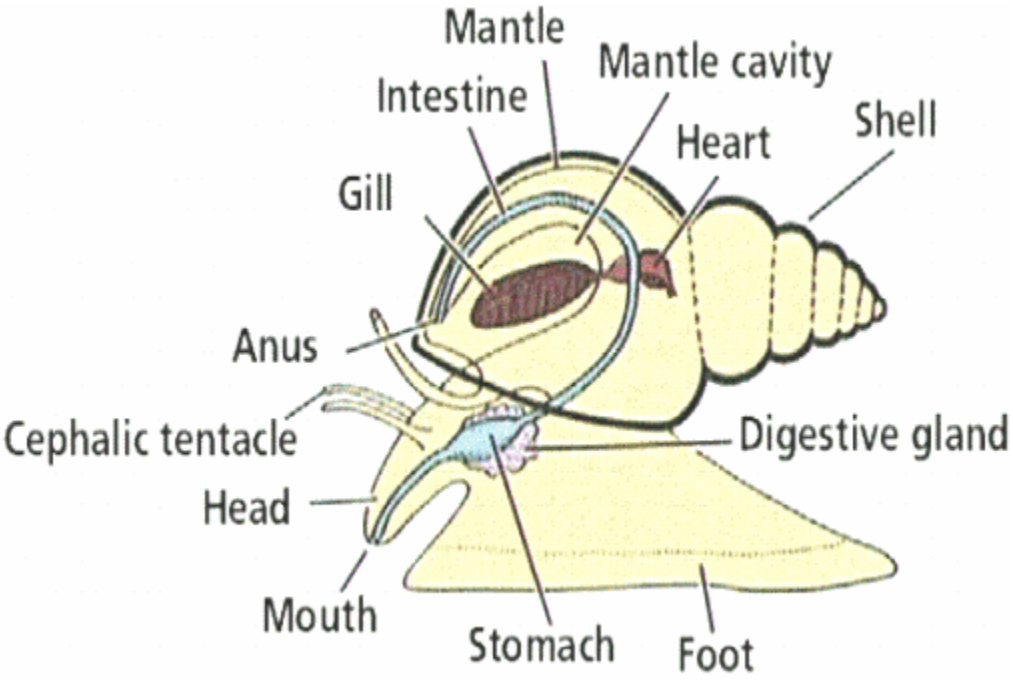
d) Pseudepipodia or Nuchal lobes On either side of the head two pseudepipodia are present. They are present on the left and right sides of the head. They are helpful to draw in water into the mantle cavity and to send that water outside.

2. Foot: On the ventral side of the body foot is present. It is broad and sole like. It has longitudinal and transverse muscles. Their contractions will bring locomotion. The foot shows mucus glands. They secrete mucus which will help the animal to creep on the land without friction.

MANTLE CAVITY - PALLIAL COMPLEX :

In between the mantle and body a cavity is present called mantle cavity. It has the following structures.

Epitaneal ridge : Starting near the right pseudepipodium a thick ridge will travel upto the posterior end of the mantle cavity. It is chitinous ridge. It will divide the mantle cavity into right branchial chamber and left pulmonary chamber.



Branchial Chamber : It contains the following structures.

1. Ctenidium : It is a monopectinate gill. It is like a comb. All the lamellae are present on one side of the axis. It helps in branchial respiration.

2. Rectum : It is present on the left side of the gill. It opens out through anus on anal papilla.

3. Genital duct: On the left side of the rectum genital duct is present. (In male vas deferens in female oviduct will be present). This duct will open out through genital pore. In the male pila near the male genital pore penis is present.

4. 0sphradium: Near the left pseudepipodium, attached to the pulmonary chamber wall a leaf like osphradium is present. It will test the purity of water.

Pallial Complex in the Apple Snail:

In between the mantle and body a cavity is present called mantle cavity. It has the following structures.

Epitaneal ridge: Starting near the right pseudepipodium a thick ridge will travel upto the posterior end of the mantle cavity. It is chitinous ridge. It will divide the mantle cavity into right branchial chamber and left pulmonary chamber.

Branchial Chamber: It contains the following structures.

1. **Ctenidium:** It is a monopectinate gill. It is like a comb. All the lamellae are present on one side of the axis. It helps in branchial respiration.
2. **Rectum:** It is present on the left side of the gill. It opens out through anus on anal papilla.
3. **Genital duct:** On the left side of the rectum genital duct is present. (In male vas deferens in female oviduct will be present). This duct will open out through genital pore. In the male pila near the male genital pore penis is present.
4. **Osphradium:** Near the left pseudepipodium, attached to the pulmonary chamber wall a leaf like osphradium is present. It will test the purity of water.

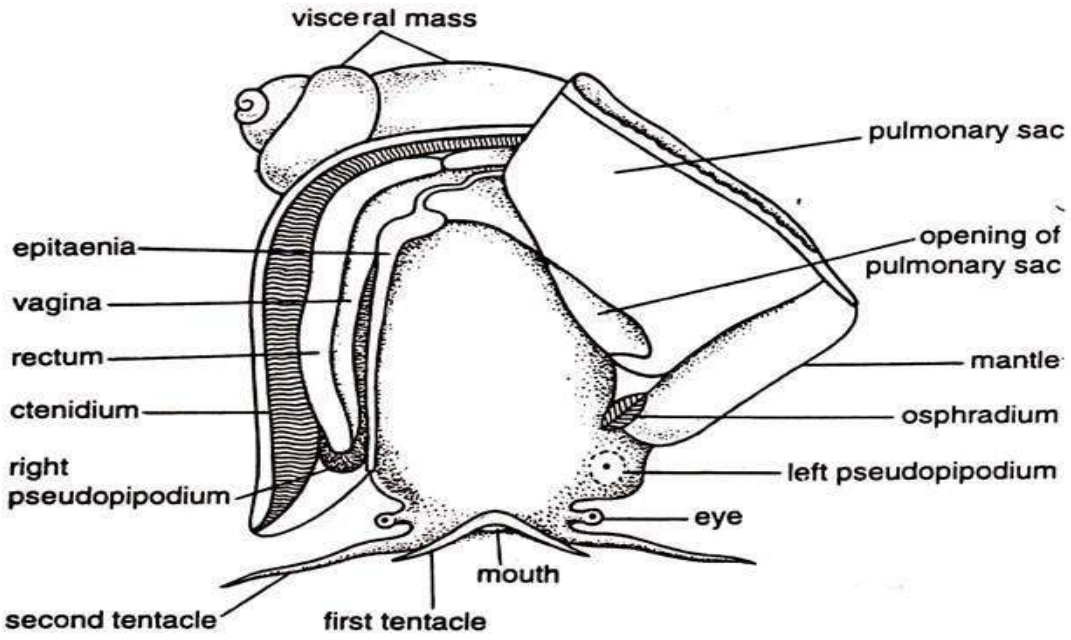


Fig. 26.13. Pila sp. Female. Pallial complex. (The mantle cut and turned right)

Digestive System of Pila:

Pila is herbivorous and it lives primarily on aquatic vegetation. Its digestive system comprises of a tubular digestive canal and digestive glands

Digestive canal is made up of three distinct regions: (i) fore gut, (ii) mid gut and (iii) hind gut. The fore gut and hind gut develop from the embryonic ectodermal layer, while the mid gut is endodermal in origin.

(i) Fore Gut:

The fore gut includes the buccal mass and the esophagus. Mouth is a vertical slit which leads into the anterior end of the digestive tract which becomes greatly swelled to form an oval buccal cavity. The buccal cavity is enclosed by a strong thick- walled muscular structure called buccal mass. Many workers consider the buccal mass as the pharynx

The entrance of the mouth is guarded by a pair of chitinous jaws projecting from the roof of the buccal cavity (Fig. 1.84A). At the floor of the buccal cavity, is present a chitinous ribbon-like structure called radula or lingual ribbon .

It is an elongated structure bearing transverse rows of serrations. Each transverse row contains about seven teeth — two marginals and a lateral on either sides of a median rachidian tooth, forming the formula 2, 1, 1, 1, 2 = 7. The radula is movably placed by muscles upon a large outgrowth of the floor of the buccal cavity called tongue mass or odontophore, which is made up of muscle with cartilaginous support.

The entrance of the mouth is guarded by a pair of chitinous jaws projecting from the roof of the buccal cavity (Fig. 1.84A). At the floor of the buccal cavity, is present a chitinous ribbon-like structure called radula or lingual ribbon .

It is an elongated structure bearing transverse rows of serrations. Each transverse row contains about seven teeth — two marginals and a lateral on either sides of a median rachidian tooth, forming the formula 2, 1, 1, 1, 2 = 7. The radula is movably placed by muscles upon a large outgrowth of the floor of the buccal cavity called tongue mass or odontophore, which is made up of muscle with cartilaginous support.

The odontophore has an anteriorly placed subradular organ, which is more or less a rounded structure. It is divided into two by a median furrow. A small, pouch-like sublingual cavity is present beneath the subradular organ. The radula at the posterior end enters into a radular sac which supplies new teeth to the radula.

The radula is pushed forward by muscles from behind and it works as a file for rasping food materials. Dorso-laterally in the anterior region of the roof of the buccal mass lies a pair of jaws. The jaws are flexible.

Its anterior cutting edge is truncated and serrated, bearing numerous small and two or three large teeth-like processes. The jaws help to cut the aquatic vegetation upon which Pila feeds. The buccal cavity receives the secretion of two salivary glands, situated on its posterior side.

The buccal cavity leads into a long, narrow oesophagus. The oesophagus, just after its origin from the buccal mass, gives out on each side, small outpushings called oesophageal pouch. The oesophagus leads into the stomach.

(ii) Mid Gut:

The mid gut consists of the stomach and the intestine. It is red in colour and is situated on the lower part of the visceral mass just below the pericardium. It is a large sac, bent on itself to form a 'U'-tube, one limb of which receives the oesophagus and the other leads into the intestine.

The portion at which the oesophagus ends is called the cardiac chamber, while the other end is called the pyloric chamber. The cardiac chamber constitutes the main part of the stomach. The wall of the cardiac chamber is corrugated while that in the pyloric part exhibits transverse folds.

The pyloric stomach is followed by a long narrow intestine that forms 2.5-3 coils. The posterior part of the intestine is nearly straight and turns to the anterior direction when it ends into the rectum.

(iii) Hind Gut:

It includes the rectum which is a thick-walled tube. It lies on the floor of the right side of the mantle cavity and finally opens to the exterior through a small anus. Anus is situated near the mouth within the right mantle opening.

Digestive glands include the salivary gland and the hepatic gland/digestive gland liver. There are two salivary glands situated on each side of the oesophagus. The two ducts of the salivary glands run anteriorly to open into the buccal cavity.

Their secretion consists of mucus and a starch digesting enzyme. The hepatic gland is black in colour and constitutes the main bulk of the visceral hump. It gives out two ducts which unite to form a common duct that opens into the stomach.

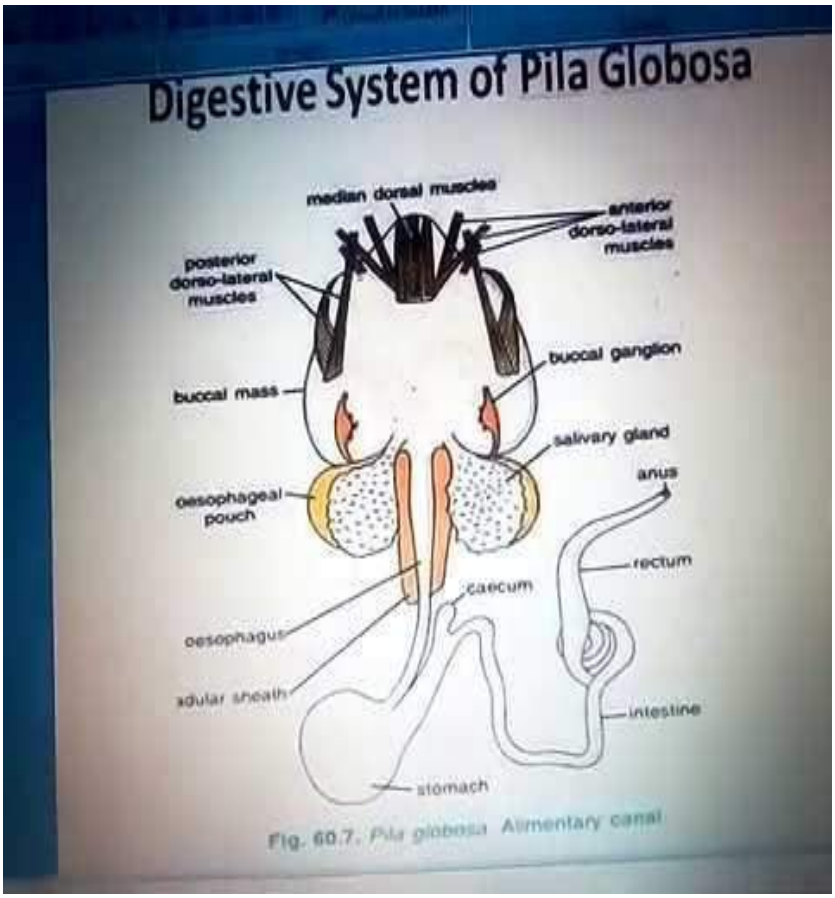


Fig. 60.7. *Pila globosa*. Alimentary canal.

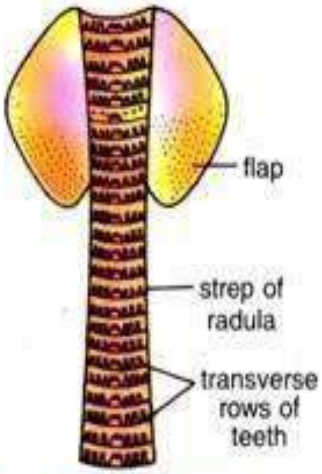


Fig. 60.10. *Pila globosa*. The radula.

Pila commonly known as pond snail or apple snail is a gastropod mollusc. They inhabit fresh water pond and lake. They live most of the time in water but can also thrive well on land. So they are really amphibious in nature and exhibit double mode of respiration i.e., absorb oxygen from water during aquatic respiration and utilize atmospheric air while living on land.

Pila performs aquatic respiration by gill.

Gill:

In Pila a single ctenidium is situated on the dorsolateral wall of the branchial or right chamber of the mantle cavity.The gill consists of numerous triangular lamellae or leaflets, arranged in a single row running parallel to one another along the central axis of the gill. This type of gill is called monopectinate type.

The basal end of each lamella is attached to the pallial epithelium of the mantle wall and the other end hangs freely in the branchial chamber. In the middle of the gill, the lamellae are large in size, while it decreases towards the two ends

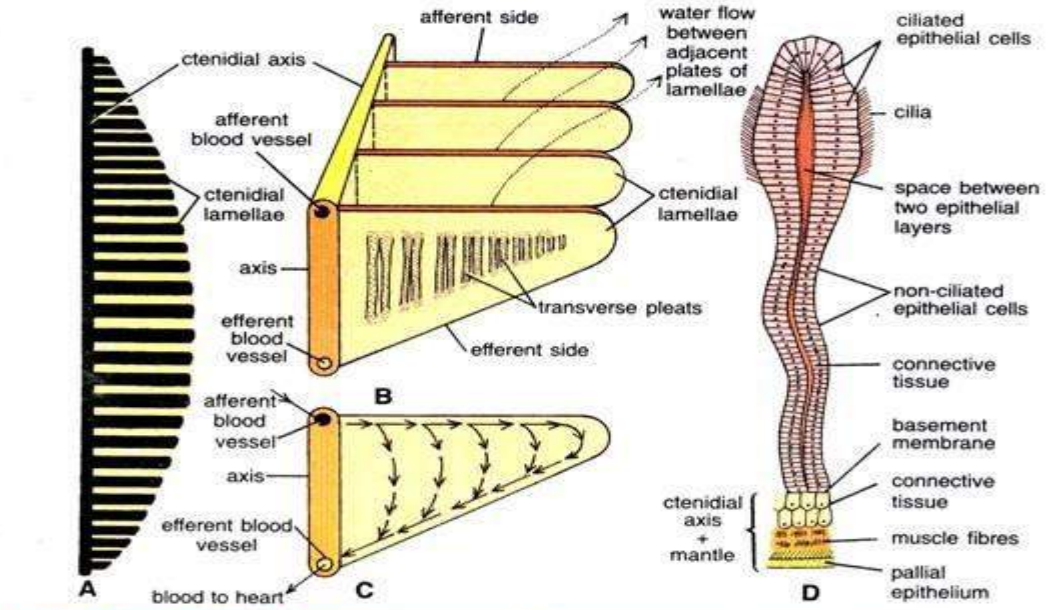


Fig. 60.14. *Pila globosa*. Respiratory organs. A—A monopectinate ctenidium; B—Stereogram to show water current through gill-lamellae; C—A single lamella to show flow of blood within it; D—A lamella in T.S.

Histologically each branchial lamella is composed of two layers of epithelia supported by muscle fibres and connective tissues.

Both afferent and efferent blood vessels lying along the axis of the gill supply blood to the gill lamellae through fine vessels and capillaries. The efferent vessel carries oxygenated blood to the heart.

Mechanism of Aquatic Respiration in Pila:

In aquatic respiration, a current of water containing oxygen is drawn in by the left siphon .into the mantle cavity. The water then flows over the gill by the help of ciliated epithelia. Exchange of gases take place between the water and the blood vessels of gill.

The water is expelled from the mantle cavity through the right siphon. Two fleshy projections over the foot, called nuchal lobes form the respiratory siphon during aquatic respiration in Pila

Aerial Respiration in Pila:

If the oxygen concentration of water gets reduced, Pila comes out of water and respire by taking in air with the help of pulmonary sac. A comb-like sense organ called osphradium, close to the left nuchal lobe helps the animal to estimate the oxygen concentration in water.

Pulmonary Sac:

The pulmonary sac is a closed cavity hanging from the dorsal wall of the mantle in the pulmonary chamber or left chamber of mantle cavity. The sac has an opening called the pneumostome in the pulmonary chamber — which is guarded by two valves.

The dorsal wall of the pulmonary sac is highly vascular and helps directly in gaseous exchange. Histologically, the sac is composed of outer epithelial layer, middle muscular and vascular connective tissue layers and inner endothelial layer .

Mechanism of Aerial Respiration:

It takes place in two ways:

(i) In Water:

Pila can respire through the pulmonary sac while it remains in water. To inhale the atmospheric air, it comes to the surface of the water. It then expands the size of the left nuchal lobe, both in length and breadth and rolls up to form an elongated respiratory tube.

The outer end of the tube extends beyond the level of water and sucks in air from the atmosphere. The inner end of the tube comes in contact with the opening of the pulmonary sac. The alternate contraction and dilation of the mantle wall and the pulmonary sac help in the process of respiration.

Following the exchange of oxygen and carbon dioxide, from air to the blood vessels of pulmonary sac and from blood vessels to air, the expelled air goes out of pulmonary chamber through the respiratory tube. During this exchange, the branchial chamber remains completely separated from the pulmonary chamber by the epitaenia which comes in contact with the roof of the mantle (Fig. 2.64).

(ii) On Land:

During dry season, when the water level gets reduced, or while living on land, Pila does not use any respiratory tubes or siphons. The pulmonary sac directly becomes filled up with atmospheric air to facilitate aerial respiration.

The shell remains closed completely with the help of operculum during the time of aestivation, when Pila respires with the little amount of stored air kept in the pulmonary sac. Hemocyanin, dissolved in plasma acts as the respiratory pigment in Pila.

Excretory System of Pila:

The excretory organ in Pila is the kidney. It consists of two renal chambers — one anterior and the other posterior (Fig. 1.88). It is coelomic in origin, being a true coelomoduct, opening at one end, into the coelom (pericardial cavity) and at the other, to the exterior (mantle cavity).

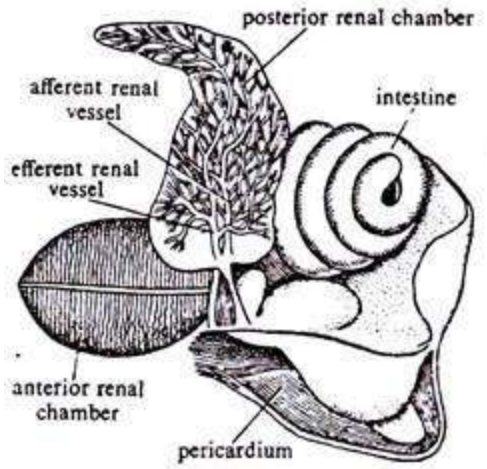


Fig. 1.88 : Kidney of *Pila*.

In pila a big kidney will work as an excretory organ. It is called organ of Bojanus. It is present on the left side. It opens to the exterior.

It has two chambers. One is on the right anterior side and the second one is at the left posterior side. The second side opens in the posterior chamber

A. Right anterior chamber ; It is oval in shape. It is red in colour. It is present anterior to the pericardium. It opens into the branchial cavity of palial complex.

The cavity in this chamber is reduced. It shows a number of lamella. They are supplied with blood They take excretory wastes from blood and send ink branchial cavity.

B. Left Posterior Chamber : It is broad lobe. It is brown in colour. It is present on the left side of Hepato-pancreas. It has big lumen. Its one end opens into pericardium through reno-pericardial-aperture. The other end is connected withanterior chamber.

Mechanism of excretion : The two chambers will absorb nitrogenous waste materials present in the blood supplied to them. Thus collected r.it-ogenous waste materials will be sent into branchial chamber and finally sent :'

Pila excretes ammonia It is ammenotelic animal. When pila is moving on land it will excrete urea it is called ureotelic animal.

Sense Organs of Pila Globosa:

In Pila Globosa, the special organs of sense are a single osphradium, paired eyes, statocysts, and tentacles.

1. Osphradium:

Osphradium hangs from the mantle near the left pseudepipodium. It is oval with 22 to 28 fleshy leaflets arranged on the sides of a central axis. It is a chemoreceptor and tests the current of water which enters the mantle cavity through the left pseudepipodium, it also exercises selection over the food taken in.

The evolution of gastropod osphradium parallels that of ctenidia, in primitive forms an osphradium is present for each ctenidium, in prosobranchs which have one ctenidium there is only a single osphradium; the osphradium disappears in those gastropods which have lost the ctenidia, or have a reduced mantle cavity, or have become pelgic.

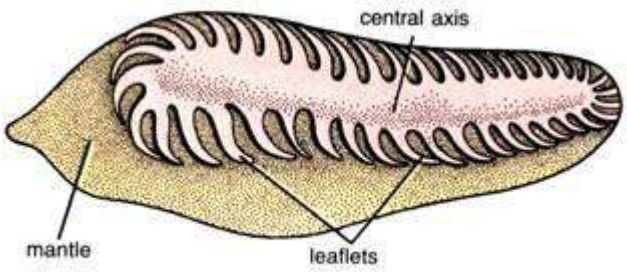


Fig. 60.24. *Pila globosa*. Osphradium.

2. Statocysts:

Located in the foot near each pedal ganglion lies a statocyst in a depression. It is a round capsule lined with epithelial cells and surrounded by connective tissue. In the cavity of the capsule are small calcareous statoconia. The statocysts receive nerves from pedal and cerebral ganglia, they are organs of equilibrium and regulate the position of the snail.

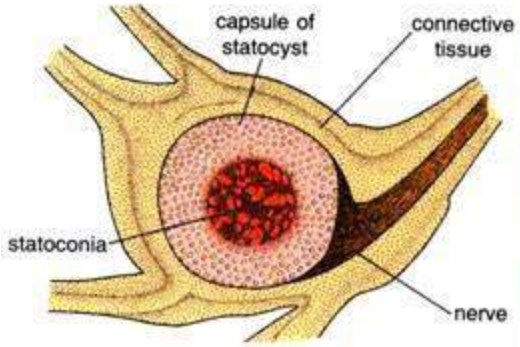


Fig. 60.26. *Pila globosa*. Statocyst.

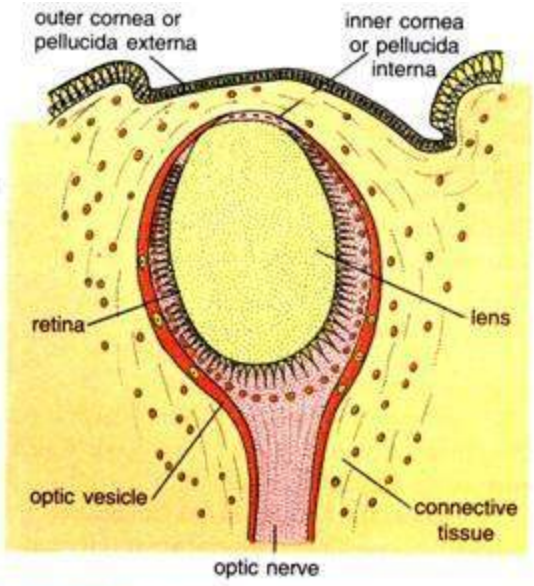


Fig. 60.27. *Pila globosa*. Horizontal longitudinal section of the eye.

3. Eyes:

There is a pair of eyes, each borne on an ommatophore. An eye is an oval capsule, its wall is the retina made of pigmented sensory cells, it is continued in front as a thin, non-pigmented, transparent cornea. The overlying epidermis is transparent; in the interior of the capsule is a clear ovoidal lens surrounded by a dense vitreous body. An optic nerve innervates the retinal cells. Eyes are sensory to light.

4. Tentacles:

The tentacles and foot are liberally supplied with nerves, they are sensory to contact, tentacles contain both tactile and chemoreceptor cells and probably gustatory also. The first pair of tentacles are olfactory.

Reproductive System of Pila Globosa:

In Pila Globosa, the sexes are separate, i.e., dioecious and there is a definite sexual dimorphism. The shell of the male is usually smaller in size and less swollen than the female. There is a well developed copulatory organ in the male but it is quite rudimentary in the female.

(i) Male Reproductive Organs of Pila Globosa:

The male reproductive organs consist of:

1. Testis with its fine vasa efferentia

2. Vas deferens with the vesicula seminalis and the terminal glandular part of the vas deferens

3. Penis with its sheath

4. Hypobranchial glands.

1. Testis:

It is a flat plate-like whitish structure, more or less triangular in outline, situated in the upper part of the first 2½ – 3 whorls of the shell. It lies closely attached to the digestive gland along its upper and inner or columellar edge and is separated from the shell by a thin cutaneous membrane.

The cream-coloured testis is easily distinguished from the digestive gland which is brownish or dirty green. Minute ducts the vasa efferentia lead downwards from the different parts of the testis and may unite with one another before opening into the vas deferens.

2. Vas Deferens:

From the posterior end of testis arises a thin vas deferens.

It consists of three distinct parts:

(i) Proximal thin tubular portion leading from the testis,

(ii) Vesicula seminalis and

(iii) Thick glandular portion which opens into the mantle cavity near the anal opening. The vas deferens starts from the posterior end of the testis and runs immediately beneath the skin along the inner or columellar edge up to the postero-renal chamber. It then turns to the left and on reaching the level of the pericardium turns upwards and to the right to open into the vesicula seminalis on its ventral side.

The vesicula seminalis lies to the right of the pericardium immediately below the line of junction of the anterior and posterior renal chambers. It is slightly curved and has a flask-shaped appearance with its posterior blind end broadly rounded.

The vesicula seminalis opens on the left side into the terminal glandular part of the vas deferens. In the mantle-cavity, the vas deferens lies closely attached to the left side of the rectum and ends in a prominent claw- shaped structure the genital papilla having the male genital aperture a little behind the anus.

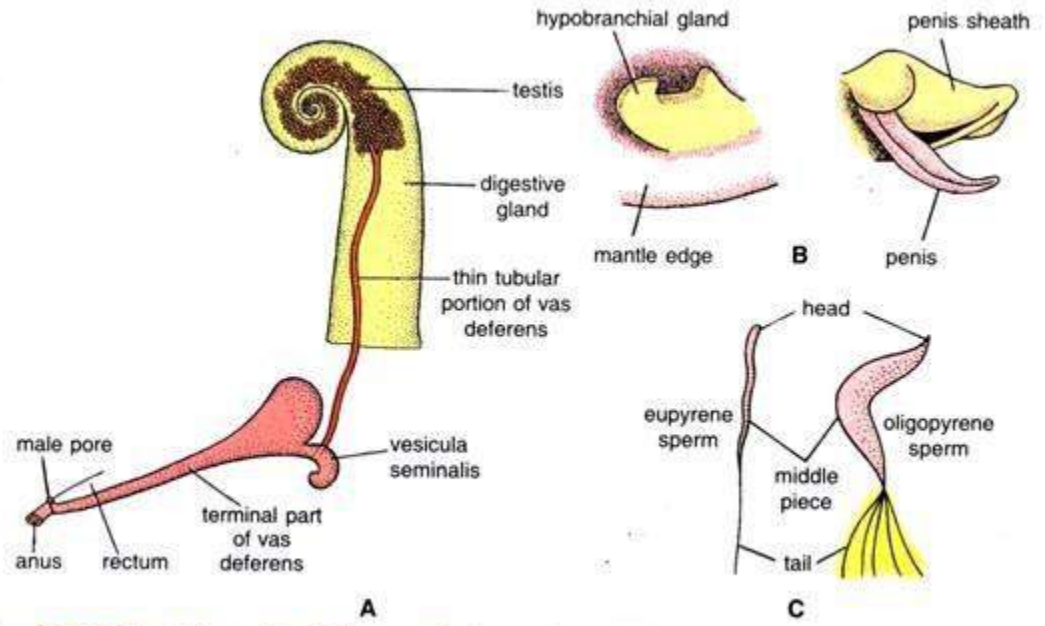


Fig. 60.28. *Pila globosa.* A—Male reproductive organs; B—Male copulatory organs in surface and ventral view; C—Sperms.

3. Penis Sheath and Penis:

The edge of the mantle bears on its inner surface a thick glandular flap of a yellowish colour. The flap is attached on its right-side but is free on its left; its edges are slightly rolled in to form a spout-like sheath, penis sheath for the penis. The penis is a long and stout flagellar structure, about half an inch long arising from the attached right side of the flap of the mantle.

It is seen as a slightly curved structure lying within its sheath. It is swollen at its point of attachment but gradually tapers to the free tip, bearing a deep groove all along its length on its inner surface. The penis is capable of extension.

4. Hypobranchial Gland:

At the base of penis sheath is an oval hypo-branchial gland. It consists of tall cells containing small basal nuclei. The surface of the glandular area is somewhat pleated but there is no duct and the secretions of the gland cells are apparently poured directly on the surface.

The spermatogenesis of Pila globosa has been worked out by Sharma, G. P., Gupta, Brij Lal, and Mital, O.P. (1959) and they have reported that the spermatozoa of Pila are of two kinds:

(i) Eupyrene sperms and

(ii) Oligopyrene sperms.

The eupyrene sperms are hair-like having an elongated spirally twisted nucleus with a small conical acrosome in front, and a mitochondrial middle piece behind, followed by the end piece in the form of a long vibrating tail.

The anterior and posterior limits of middle piece are marked by the proximal ring-shaped centrosome and distal granular centrosome respectively. The axial filament springs up from the proximal centrosome; in the region of the middle piece the axial filament is enseathed by the mitochondrial material, but in the end piece the filament is naked.

These sperms move actively forward in a spiral course, measure about 25 μ in length and 1.2 μ in breadth and they can only fertilise the eggs. The oligopyrene sperms on the other hand, have a very sluggish and serpent-like movement.

The acrosome is poorly developed, the nucleus is elongated, broad and curved but not spirally coiled ; the middle piece is short and the number of axial filaments varies from 4—8. These sperms measure about 32.5 μ in length and 3 μ in width and they cannot fertilise the eggs; these are probably having some secondary function.

(ii) Female Reproductive Organs:

The female reproductive organs consist of:

Ovary:

The ovary in the female lies in the same position as the testis in the male but it is not so extensive. It occupies the upper and inner surfaces on the first 2 – 2½ whorls and is covered over by a thin but stout skin-coat. Ovary is a much branched structure of a light orange colour which becomes darker in fully mature individuals.

The branches of ovary consist of single-layered acini which are more or less flask-shaped, with their closed rounded ends directed outwards and the elongated necks of the flasks descending to meet those of the adjacent acini to form minute ducts which in their turn open into the main oviduct.

Oviduct:

The narrow and transparent oviduct originates from about the middle of the ovary. It runs anteriorly just below the skin along the inner margin of the digestive gland. Near the renal organ it turns downwards and then upwards to enter the receptaculum seminis.

Receptaculum Seminis:

It is a bean-shaped structure, lying in the cavity of the posterior renal chamber closely attached to the uterus. A thin-walled pouch arises directly from the wall of the uterus and is called the pouch of the receptaculum.

Uterus:

It is a large pear-shaped structure, deep-yellow in colour. It lies inside the body whorl below the intestine and the right of the renal chambers. The apex of the uterus points forwards and is continued as the vagina, while its basal portion is broad and rounded and is connected on its outer side with the receptaculum seminis.

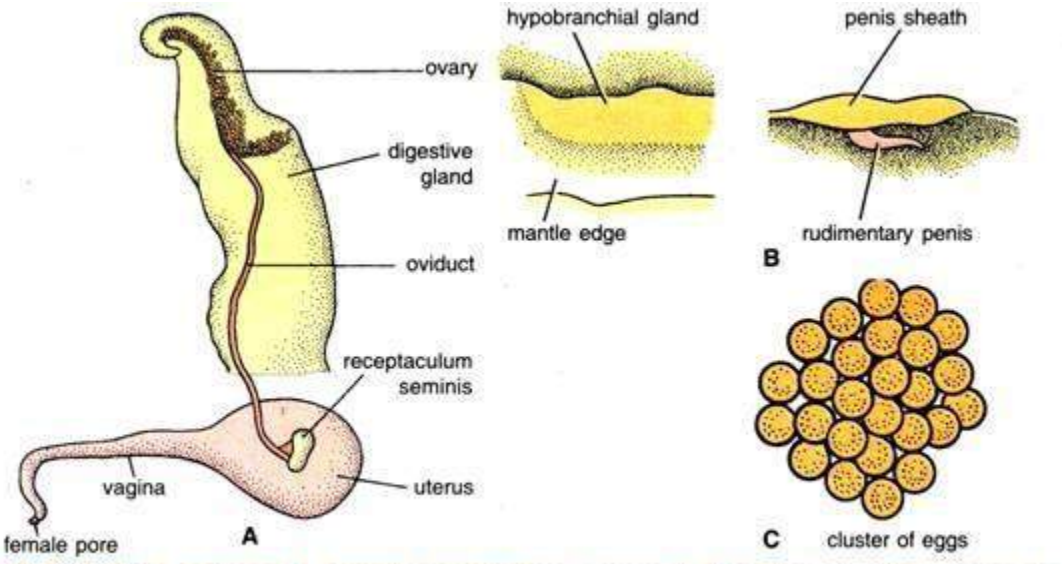


Fig. 60.29. *Pila globosa.* A—Female reproductive organs; B—Female copulatory organs in surface and ventral view; C—Eggs.

Vagina:

The vagina is a white or cream coloured, band-like structure lying immediately beneath the skin. It extends from the uterus to the upper end of the columellar muscle. The vagina enters the mantle cavity at its right posterior corner and continues forwards to the female genital aperture situated on a small papilla, a little behind the anus.

Hypobranchial Gland:

The hypobranchial gland of female is poorly developed. There is a rudimentary glandular thickening in the area of hypobranchial gland.

Copulatory Apparatus:

The female has a rudimentary penis lying beneath the glandular fold at the edge of the mantle. It is a thin flagellar structure with a rudimentary groove along its inner surface. The flagellum is about a quarter of an inch in length and has nearly the same thickness throughout except the tip where it is slightly pointed. There is no trace of the folding's of the penis sheath.

Copulation in Pila Globosa:

Copulation in Pila globosa occurs either in water or on land, it lasts for 3 hours. Male and female Pila come together facing each other.

The penis of the male is expanded and gets attached to the genital papilla by its base. Then the penis and its sheath are inserted into the mantle cavity of the female. The tip of the penis is put into the female genital aperture and spermatozoa are transferred through the vagina into the receptaculum seminis.

Fertilisation and development of Pila Globosa:

Ferilisation is internal, eggs are fertilised in the uterus and oviposition starts a day or two later. The fertilised eggs are laid in masses of 200 to 800 in moist earth near ponds and lakes. The ndevelopment is direct, the ferilised eggs hatch out into young ones which resembles adult.

Circulatory system

The blood vascular system cf Pila includes sinuses and blood vessels. This system contains

1) Blood

2) Heart, Pericardium

3) Arteries

4) Veins

5) Sinuses

1) Blood :

1) It is liquid tissue. It contains plasma and amoeboid cells.

2) It is bluish liquid.

3) In the plasma "haemocyanin" is dissolved.

4) The amoeboid cells will work as phagocytes. They also absorb nitrogenous waste metrials

Functions of blood :

It will distribute digested food to all body parts

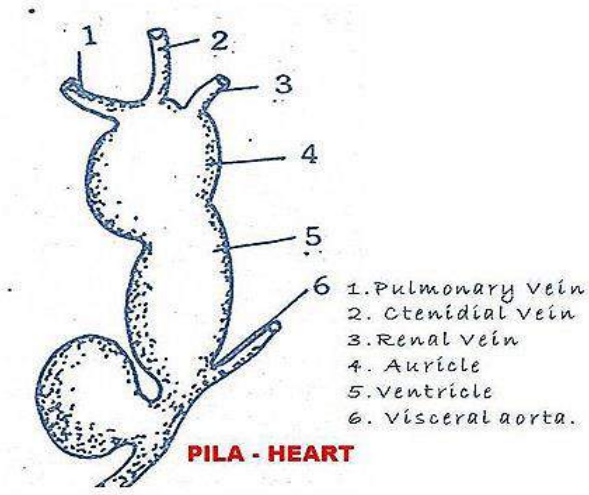
2) It will distribute $0_2$to the tissue.

3) It will cany excretory wastes to the excretory organ.

2) Heart & Pericardium :

In visceral mass at the anterior end on the stomach a heart is present. It is covered by pericardium.

In the heart two chambers are present,



a) auricle : It is made by thin walls. It is triangular. It shows contractions and relaxations.

b) Ventricle : Its walls are thick. It is muscular. Its inner walls are spongy in nature.

c) In between the auricle and ventricle a auriculo - ventricular opening is present.

d)At this opening a pair of semilunar valves are present. They will allow the blood to flow in a single direction.

3) Arteries : From the ventricle a aorta will arise. It will divide into cephalic aorta an visceral aorta.

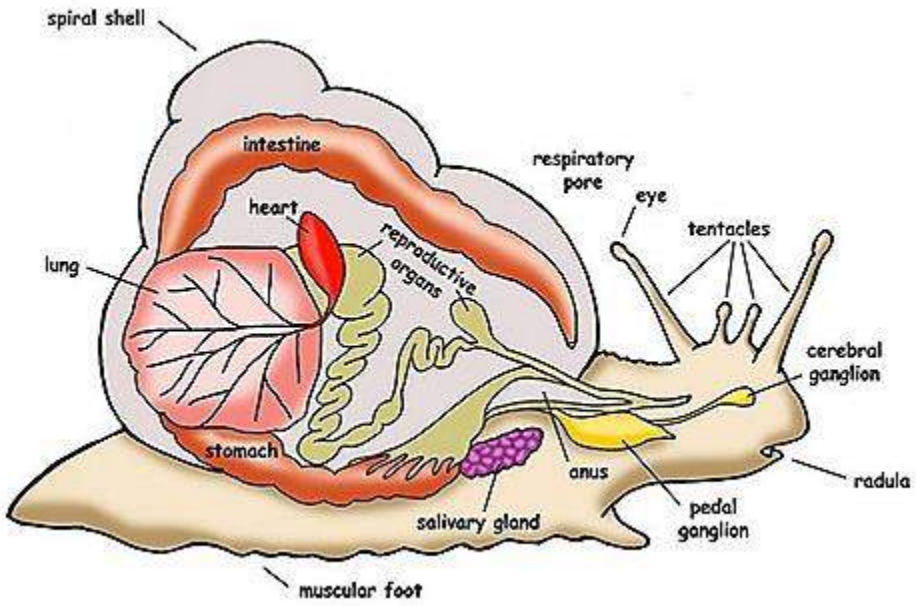
a. Cephalic aorta : It will travel anteriorly. At its base a vesicle is present. It is called aorta vesicle. Its contractions help in blood circulation. This aorta gives the following branches

1. Cutaneous artery - to skin

2. Oesophageal artery - to oesophagus.

3. Left pallial artery - to the left pallium.

4. Pericardial artery - It enters into pericardium.



The pericardial artery will finally reach the renal sacs. After giving these branches the cephalic aorta will travel to the left of the oesophagus and give the following branches.

1. Radular artery - to radula.

2. Retinal artery - to eye.

3. Tentacular artery - to the tentacles.

4. Pedal artery - to the foot.

b. Visceral aorta : It will travel to the posterior end. It supplies blood to the visceral mass. It gives the following arteries.

1. Small Pericardial artery - to the pericardium.

2. Big Gastric artery - to the stomach

3. Many Intestinal arteries- to the intestine.

4. Many Renal arteries- to the kidney.

5. Big Mesentric artery - to the intestine.

6. Many Gonidial arteries - to the gonads.

At the end the visceral aorta end as branches on the rectum wall.

4) **Sinuses** : Arteries will supply blood to all body parts. This blood will enter into small sinuses. All these sinuses will unite to form big sinus. It is called Haemocoel. From this big sinus the blood will enter into veins. These sinuses are **4** in number.

a. Perivisceral sinus : It is present around the oesophagus at the anterior and.

b. Periintestinal sinus : It is present around the intestine at its posterior end.

c. Branchio- renal sinus : It is present around the ctenidium.

d. Pulmonary sinus : It is present around the pulmonary sac.

These sinuses are connected with veins.

5) Veins : From the sinuses veins will arise. They carry blood to the heart.

a. Efferent pulmonary vein: It will collect blood from puimonary sac and carry to heart.

b. Afferent ctenidial vein : It will carry blood to ctenidium.

c. Efferent ctenidial vein : It will collect blood from ctenidium and carry it to heart.

d. Afferent renal vein : It will supply blood to kidneys.

e. Efferent renal vein : It will collect blood from kidneys and carry it to heart **Blood Circulation** : Blood from ventricle will go to aorta. It will supply blood to all body parts. From the body parts sinuses will collect blood. From sinuses veins will arise They bring blood back to heart.

a. From pulmonary sac pure blood is carried to heart by efferent pulmonary vein.

b. From ctenidiun pure blood is carried to heart by efferent ctenidial vein.

c. From kidneys the blood is carried to heart by efferent renal vein.

TORSION IN MOLLUSCA (GASTROPDA)

Torsion (twisting) is the rotation of visceral organs in anticlockwise direction through an angle of 180° on the rest of the body during larval development. The phenomenon takes place in the free-swimming (veliger) larva of gastropods and converts the symmetrical larva into an asymmetrical adult.

Conditions before Torsion:

1. The mantle cavity is situated at the posterior side containing the pallial complex.

2. The ctenidia and two nephridiopores are located posteriorly.

The alimentary canal is straight with the mouth at the anterior side and anus at the posterior side.

4. The auricles are placed behind the ventricle.

5. The nervous system is bilaterally symmetrical.

6. Firstly, the embryo is bilaterally symmetrical in the veliger stage when foot and a planospiral shell are formed first in this stage.

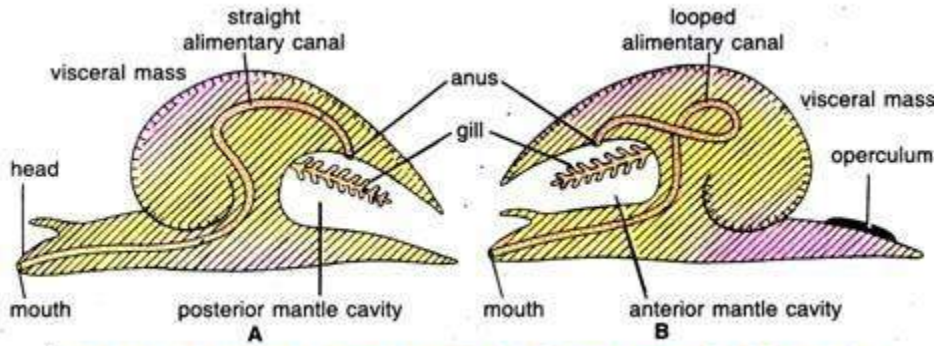


Fig.63.2. A gastrpod showing torsion. A—Before torsion; B—After torsion.

How Torsion Occurs:

1. The morphological phenomenon of bending on the ventral side which takes place in an antero-posterior sagittal plane about a transverse axis of the animal results.

(a) Firstly, the displacement of the mantle cavity towards the right side and then to the anterior end of the body but the head and foot remain fixed (Fig, 16.72).

(b) The looping of the digestive tract and approximation of mouth and anus take place.

The original saucer-shaped visceral mass and the shell become cone- shaped and finally become spirally coiled.

2. Simultaneous coiling up of these structures results in an exogastric coil.

3. Ventral portion of the visceral mass and mantle rotate about 180° or little more.

4. Twisting of dorsal mass occurs in such a manner that organs such as right gill and right auricle remain and corresponding parts on the left side are often lost.

During the completion of metamorphosis there is a lateral torsion subsequent to primitive ventral plexus with the result that the original coil of the visceral sac and the shell which was originally dorsal or exogastric becomes ventral or endogastric. So the lateral torsion leads to the attainment of condition of gastropods following certain changes in original organisation.

Events in torsion

Displacement of mantle cavity:
The mantle cavity was originally posterior in position but after torsion the mantle cavity opens just behind the head and its associated parts shifted forward.

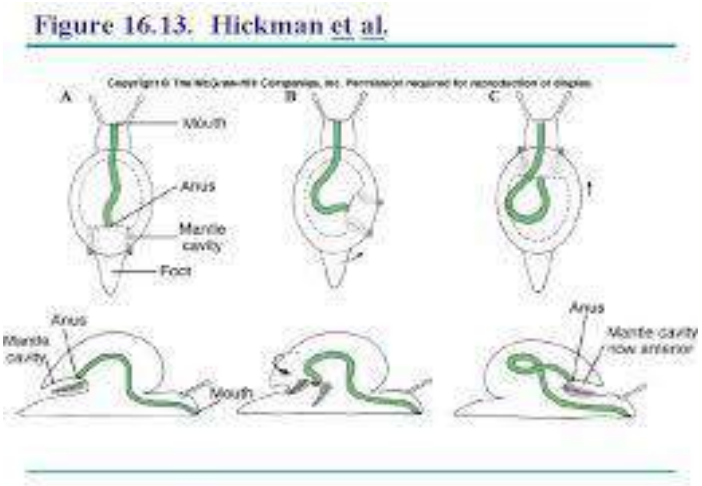
Changes in relative position:
Before torsion the anus and ctenidia are pointed backwards and auricles are situated behind the ventricle. After torsion the anus and ctenidia come forward and the auricles come to lie in front of ventricle.

Twisting of alimentary canal:
The alimentary canal which was primarily straight is twisted in the form of a loop and approximation of mouth and anus takes place.

Origin of chiastoneury:
Crossing of the pleuro-visceral connectives is due to the fact that the pallial complex must have changed its position from the posterior to the anterior part of the body arid become twisted in the form of 8. The right connective with its parietal ganglion passes over the intestine called the supraintestinal and the left connective passes below the intestine called the infraintestinal.

Endogastric coil:
The coil of visceral sac which was primarily dorsal or exogastric becomes ventral or endogastric after torsion. The coiling of the shell is not associated with the torsion and was a separate evolutionary event and the shell remained a symmetrical spiral.

Loss of symmetry:
It is due to displacement of anus towards right side of the mantle cavity and loss or reduction of paired parts of the primitively left or topographically right side.



Detorsion:
Acquisition of secondary symmetry observed in some Opisthobranch Gastropod is regarded as the result of detorsion. The distortion means the reversion to the changes that have occurred during torsion. As a result of detorsion the pallial complex travels towards the posterior end along the right side.

The ctenidia are pointed backwards and the auricles come behind the ventricle. The visceral loop becomes untwisted and symmetrical. In this way a secondary external symmetry is established again. Detorsion is always associated with the loss of shell and the liberation of gills (ctenidia) from their enclosing case.

The gills become exposed and subjected to external current. Different gradations of detorsions are encountered in the different members of opisthobranchs. In Acteon and Bulla detorsion is partial, and complete detorsion is observed in Aplysia. In some nudibranchs (e.g., Doris, Apolidia, etc.), the shell and mantle cavity are absent and the body becomes secondarily bilaterally symmetrical.