ctenidium takes in oxygen from the current of water and gives out carbon dioxide which diffuses into water.

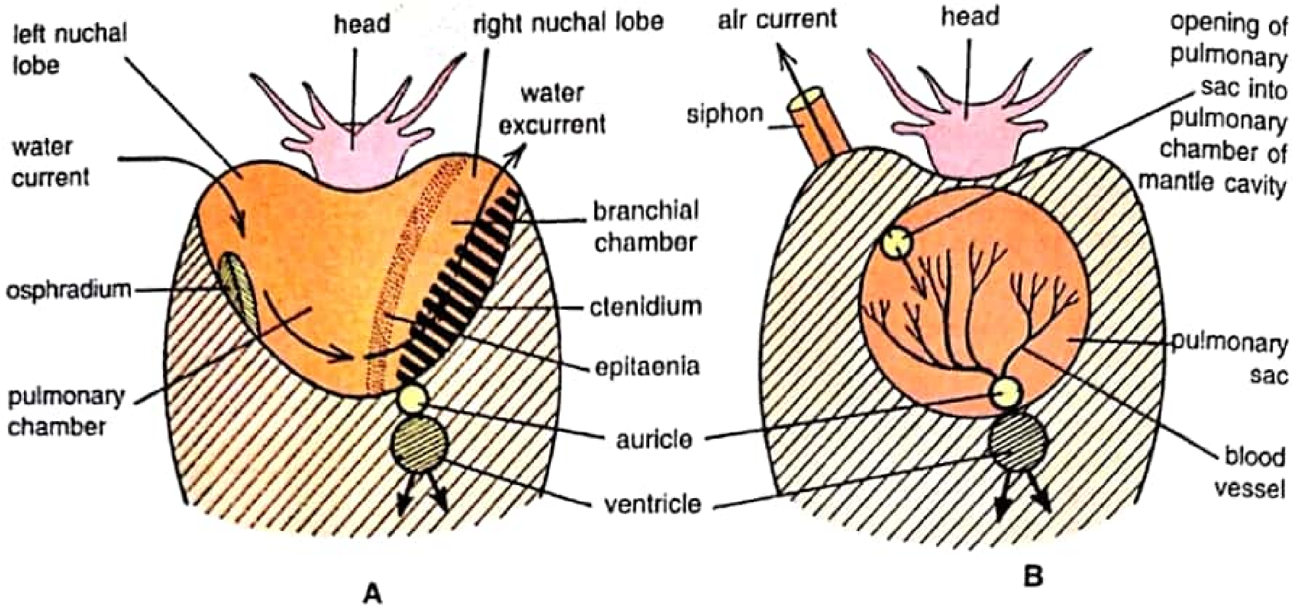

Fig. 60.16. *Pila globosa. Diagrams showing mechanism of respiration. A—During aquatic respiration;* B—During aerial respiration.

(ii) Aerial respiration. The pulmonary sac or lung is used in aerial respiration in two ways. When the snail comes to the surface of water its left nuchal lobe projects as a tube above the water and air is drawn into it, the air goes to the pulmonary chamber and then into the lung ; the branchial chamber being shut off by the epitaenia pressing against the mantle. When the snail comes on land it takes in air directly into its lung through the mantle cavity and no siphon is formed by the left nuchal lobe. In both types of aerial respiration alternate contractions and relaxations of the muscles of the lung walls take place, when the muscles contract the floor of the lung gets arched increasing its cavity and air is drawn into the lung, when the muscles relax the cavity of the lung decreases and air is expelled, inward and outward movements of the head and foot also help in the process of taking in air. The blood vessels in the lung take in oxygen from the air and give out carbon dioxide (Fig. 60.16 B). *Pila* also respires by its pulmonary sac during aestivation period by means of the air already imprisoned in the pulmonary sac.

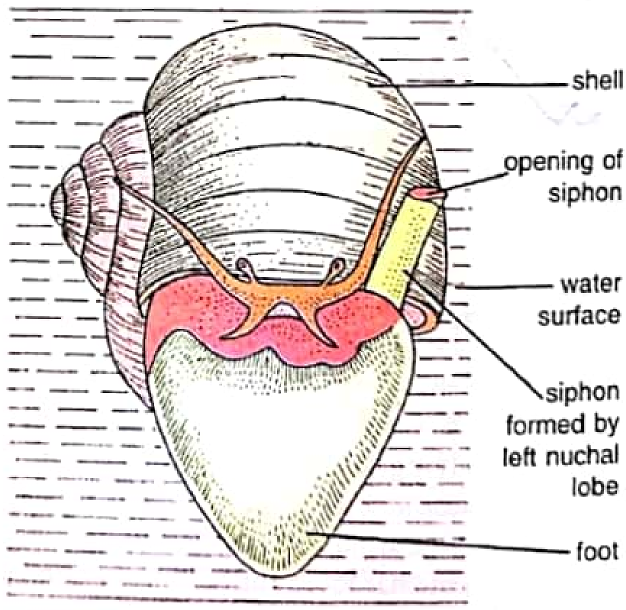

Fig. 60.17. *Pila globosa* with its siphon up for breathing air.

BLOOD VASCULAR SYSTEM

Due to double mode of respiration the blood vascular system of *Pila* has become very much complicated. It is of open type. It consists of (i) **pericardium**, (ii) **heart**, (iii) **art**[illegible] (iv) **sinuses**, and (v) **veins**, through which the blood flows.

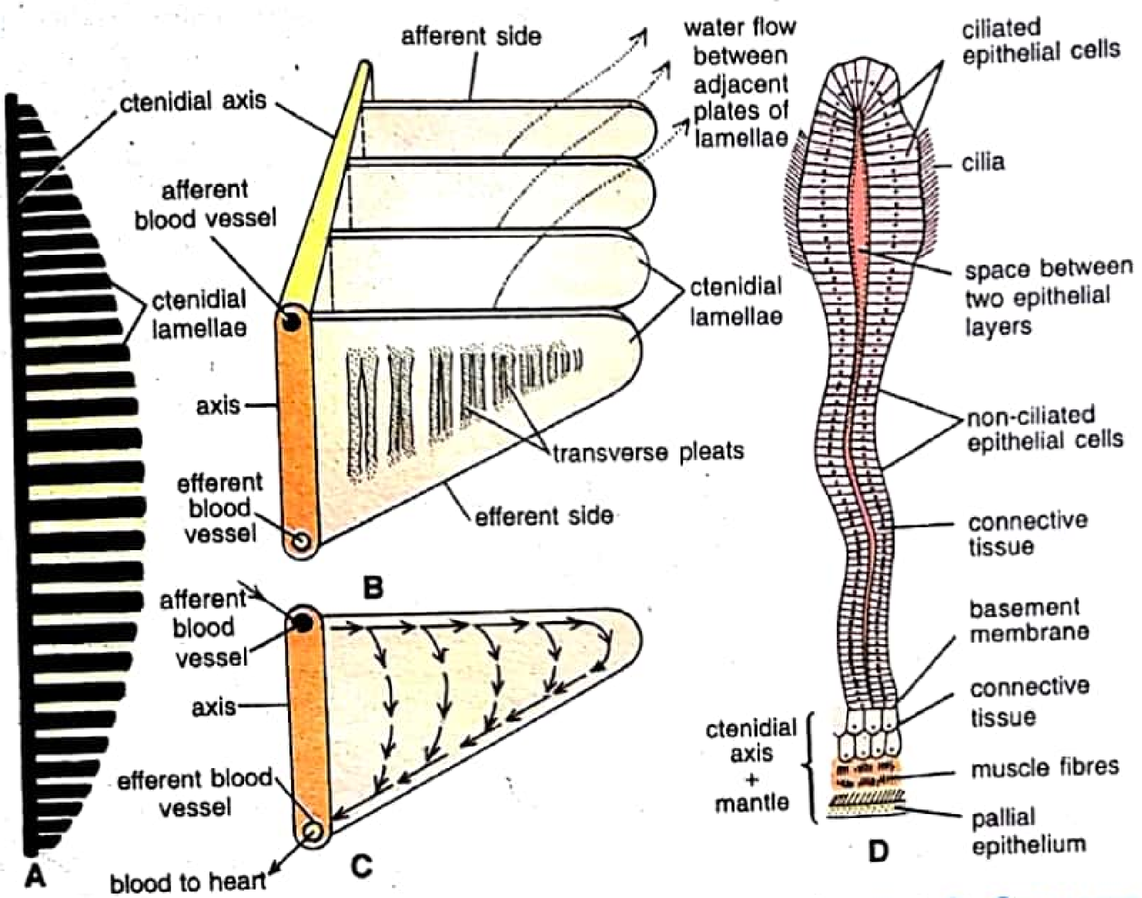

Fig. 60.14. *Pila globosa*. Respiratory organs. A—A monopectinate ctenidium; B—Stereogram to show water current through gill-lamellae; C—A single lamella to show flow of blood within it; D—A lamella in T.S.

3. Nuchal lobes. The right and left pseudepipodia or nuchal lobes are fleshy and highly contractile processes of the mantle on either side of the head. They form elongated funnels or siphons during respiration for the entry and exit of water.

Mechanism of respiration. There are two types of respiration in *Pila* which are as follows:

(i) Aquatic respiration. True aquatic respiration takes place when the snail lies at the bottom of a pond or aquarium, when it is floating or lying suspended in mid-water and when it is attached to plants or weeds in water. At this time the head and foot is fully extended and the two nuchal lobes further increase in size and the left lobe takes the form of a distinct gutter in which a current of water flows. In aquatic respiration a current of water enters the left nuchal lobe and first comes in contact with the osphradium which tests the nature of the water. It enters the mantle cavity and passes over the epitaenia into the branchial chamber to bathe the ctenidium, then the current passes out through the right nuchal lobe (Fig. 60.16 A). The

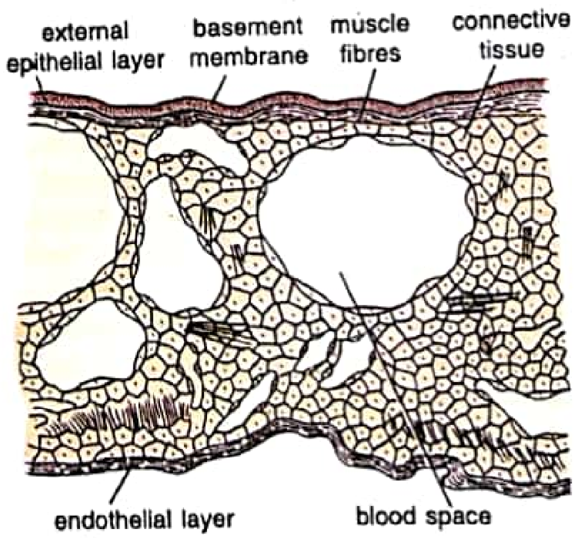

Fig. 60.15. *Pila globosa*. T.S. of a portion of the outer wall of the pulmonary sac.

Food and Feeding

The food consists of aquatic plants of succulent nature like *Vallisneria* and *Pistia* which are cut by jaws and the odontophore, then the radula moves forwards and backwards filing the food into small particles exactly like the chain-saw mechanism. Thus, the food is cut up and masticated inside the buccal cavity.

Digestion

The salivary glands pour their secretion by means of their ducts into the buccal cavity where it mixes with the food. It helps in digesting the starch by converting it into sugar. In the stomach the food is digested by the secretion of digestive gland. Secretion of digestive gland digests various kinds of food but cellulose is digested inside the resorptive cells only. Thus, both extracellular and intercellular digestion occur. The stomach is the site of extracellular digestion and the digestive gland is the site of intracellular digestion and absorption, this is characteristic of Mollusca. Absorption of digested food takes place mainly in the digestive gland and some in the intestine.

RESPIRATORY SYSTEM

Pila leads an amphibious life and, therefore, it exhibits dual modes of respiration, *i.e.*, **aquatic** and **aerial**. For these, it possesses a **ctenidium** or **gill** (for aquatic respiration) and a **pulmonary sac** or **lung** (for aerial respiration).

Respiratory Organs

The respiratory organs consist of a single **ctenidium** or **gill**, a **pulmonary sac** or **lung** and a pair of **nuchal lobes**.

1. Ctenidium or gill. The ctenidium or gill is the organ of aquatic respiration. The ctenidium is situated on the dorso-lateral wall of the branchial chamber of the mantle cavity. It is composed of a long series of thin triangular leaflets or **lamellae**, lying parallel to each other, which are attached to the mantle wall by their broad bases but have their apices hanging free in the branchial chamber. The line of attachment of the lamellae to the wall of the mantle forms the **ctenidial axis**. The ctenidial axis is provided with an **afferent blood vessel** (carrying deoxygenated blood) and an **efferent blood vessel** (carrying oxygenated blood) from gills to heart. All the gill lamellae are not of the same size; these are largest in the middle and gradually smaller towards the two ends. Such a gill is known as **monopectinate gill**. Each lamella bears transverse ridges or **pleats** on both

2. Midgut. The midgut includes the stomach and intestine.

(i) Stomach. The stomach begins on the left side just below the pericardium and runs backwards as a blind pouch on the postero-lateral sides of the main whorl of the visceral mass. It is a rectangular sac of dark red colour having a broad U-shaped internal cavity of rose-red colour. The stomach is differentiated into two chambers—**cardiac chamber** and **pyloric chamber**. The cardiac chamber is rounded in appearance and possesses longitudinal folds on its inner surface. The oesophagus opens into it. The pyloric chamber is tubular and has transverse folds on its inner surface. From the pyloric chamber arises a short bag-like **caecum** but it has no crystalline style as found in many gastropods. The duct of digestive gland opens into the stomach at the junction of its two chambers.

(ii) Intestine. From the pyloric chamber arises an intestine which runs along its anterior edge and further along the digestive gland beneath the posterior renal chamber. It then turns upwards and backwards in the visceral mass where it forms 2½ or 3 coils between the gonad in front and the digestive gland behind, before joining the rectum.

3. Hindgut. The **rectum** or terminal part of the alimentary canal is a thick-walled tube. It enters the mantle cavity and passes downwards to open by an anus on the right of the head.

Salivary glands. The two salivary glands lying one on each side of the posterior limit of the buccal mass and partially cover the oesophagus. The surface and margins of each gland are greatly cut up, giving it the appearance of a somewhat branched type of gland. The duct of each gland begins near its internal anterior corner and immediately enters the muscles of the buccal mass and opens into the buccal cavity. The secretion of salivary glands contains mucus and an enzyme which digests starch. The mucus lubricates the radula and helps in the transport of food.

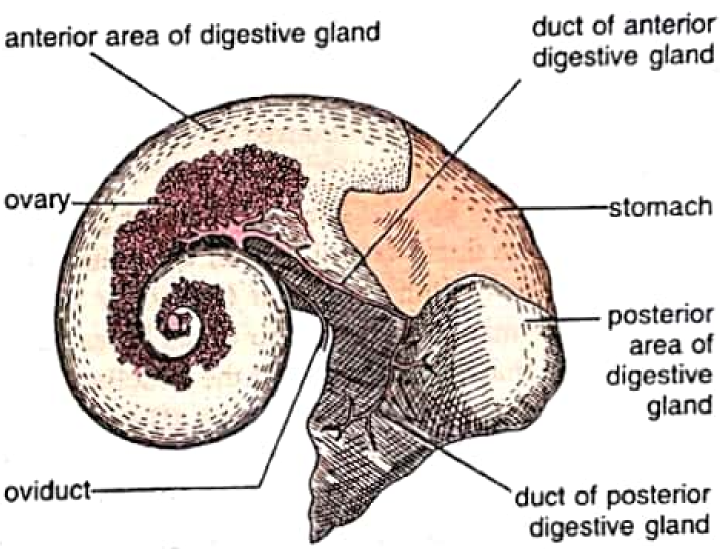

Fig. 60.13. *Pila globosa.* Digestive gland and associated structures seen from inner side.

Digestive gland. The digestive gland, often referred to as **liver or hepatopancreas**, of *Pila* is a somewhat triangular plate or cone with a very convex outer and more or less flattened inner surface. The cone is spirally coiled from the tip inwards and downwards following the whorls of the shell. The gland is of a brownish to dirty green colour and is quite soft when fresh. Two main ducts arise from the two main lobes of the digestive gland; these ducts unite just before reaching stomach to open into it by a common aperture. The digestive gland is made up of a number of fine tubules bound together by connective tissue. These tubules unite with one another to form larger tubules which terminate in two main ducts corresponding to two main lobes of the gland. The terminal part of each tubule is glandular, called the **alveolus** and the rest of the tubule is ciliated. The alveoli have three kinds of cells, they are **secretory**, **resorptive** and **calcareous cells** or **lime** ... produce a brown liquid containing an enzyme which dissolves cellulose

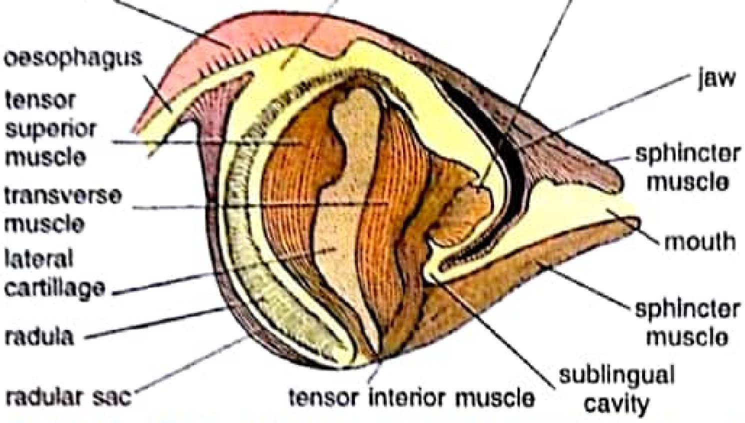

Fig. 60.8. *Pila globosa.* Vertical longitudinal section of the buccal mass about the middle.

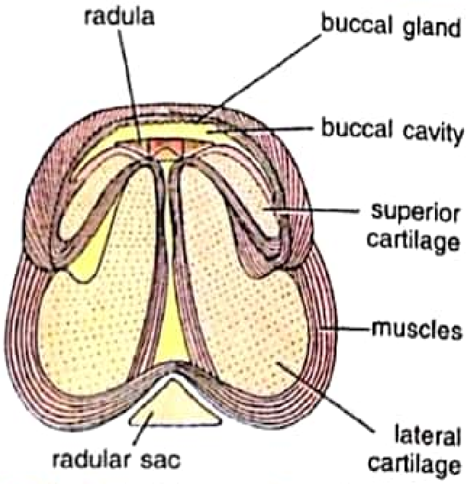

Fig. 60.9. *Pila globosa.* Buccal mass in T.S.

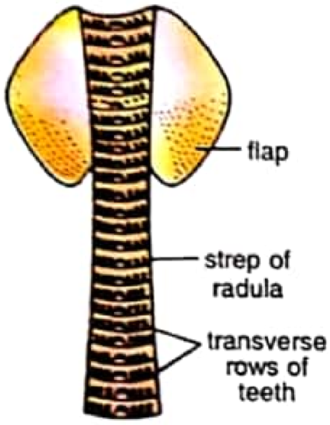

Fig. 60.10. *Pila globosa.* The radula.

adontoblasts. In side the radular sac is a **radula** which is characteristic of Mollusca. The radula is made of many transverse rows of horny teeth. Each row has seven teeth, two marginal and one lateral tooth on each side and a **central** or **rachidian** tooth in the middle, thus, giving a formula 2,1,1,1,2. The radula moves forward and backward on the odontophore for rasping food particles; these movements of radula are called **chain saw movements**. The teeth are made of chitin which is reinforced by hardened protein, they have sharp cutting projections which act like a file and rasp vegetable food. The teeth of the radula are worn off in front and new teeth are formed all the time by odontoblasts. On the roof of buccal cavity, above the radula, is a pair of grooved **buccal glands** which are digestive.

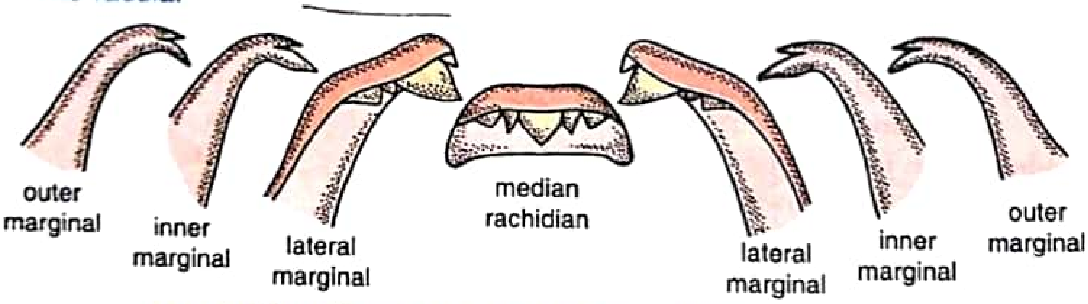

Fig. 60.11. *Pila globosa.* A single row of radular teeth.

(iii) Oesophagus. The buccal mass leads into a long narrow oesophagus. From near the origin of the oesophagus arise a pair of round, whitish **oesophageal pouches**. They arise by short ducts and lie below the salivary glands. They are prolongations of the oesophagus, they probably secrete digestive enzymes. Oesophageal pouches serve for a temporary storage of food and digestion begins in them. Some extracellular digestion is brought about in the stomach by the enzymes produced by the salivary glands and oesophageal pouches.

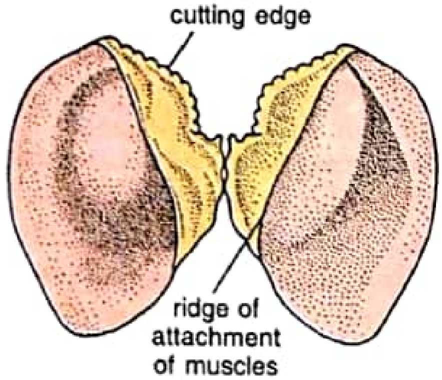

Fig. 60.12. *Pila globosa.* Jaws.

reddish mass near the posterior end of the epitaenia. Near the left pseudepipodium is a fleshy **osphradium** a typical molluscan sense organ.

COELOM

The coelom is reduced to unpaired cavities of pericardium, kidney and gonad. The renal and pericardial cavities communicate, but the cavity of gonad is unconnected. The visceral organs are surrounded by means of sinuses or spaces containing blood. These blood-filled spaces constitute the **haemocoel.**

DIGESTIVE SYSTEM

The digestive system of *Pila* comprises 1. a tubular alimentary canal, 2. a pair of salivary glands and 3. a large digestive gland.

Alimentary Canal

The alimentary canal is distinguished into three regions, *viz.*, 1. the **foregut** or **stomodaeum** including the buccal mass and oesophagus, 2. the **midgut** or **mesenteron** consisting of stomach and intestine, and 3. the **hindgut** or **proctodaeum** comprising the rectum. The midgut alone is lined by endoderm, while the other two are lined by ectoderm.

1. Foregut. The foregut includes the mouth, buccal mass and oesophagus.

(i) Mouth. The mouth is a narrow vertical slit situated at the end of snout. There are no true lips but the plicate edges alone serve as secondary lips.

(ii) Buccal mass. The mouth leads into a large cavity of buccal mass or pharynx having thick walls with several sets of muscles. The anterior part of the cavity of buccal mass is **vestibule.** Behind the vestibule are two jaws hanging from the roof of the buccal mass. The jaws bear muscles and their anterior edges have teeth-like projections for cutting up vegetable food.

Buccal cavity. Behind the jaws is a large buccal cavity. On the floor of the buccal cavity is a large elevation called **odontophore.** The front part of odontophore has a furrowed **subradular organ** which helps in cutting food. The odontophore has protractor and retractor muscles and two pairs of cartilages, a pair of triangular **superior cartilages** which project into the buccal cavity, and a pair of large S-shaped lateral cartilages.

Radula. Above and behind the odontophore is a bag-like **radular sac** which is a diverticulum of the buccal cavity. The radular sac has transverse rows of cells called

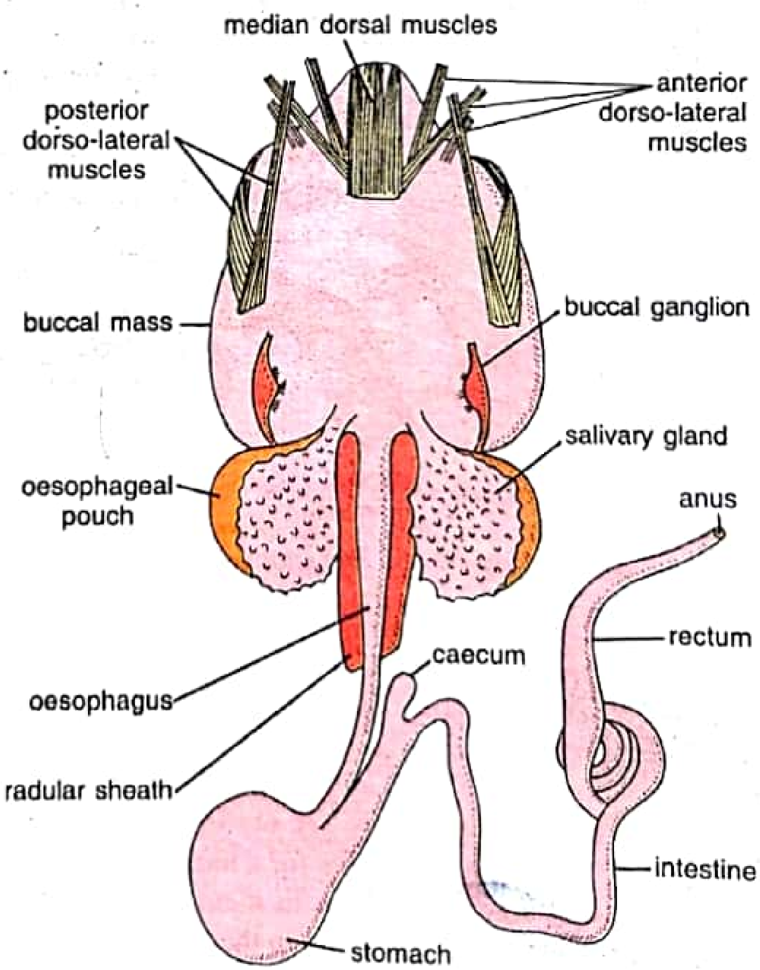

Fig. 60.7. *Pila globosa*. Alimentary canal.

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.

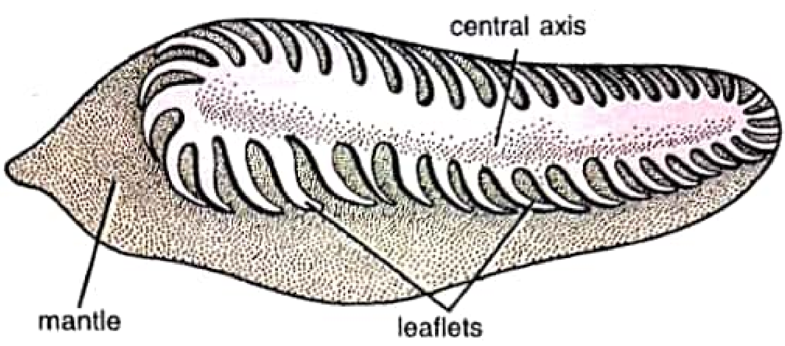

Fig. 60.24. *Pila globosa.* Osphradium.

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.

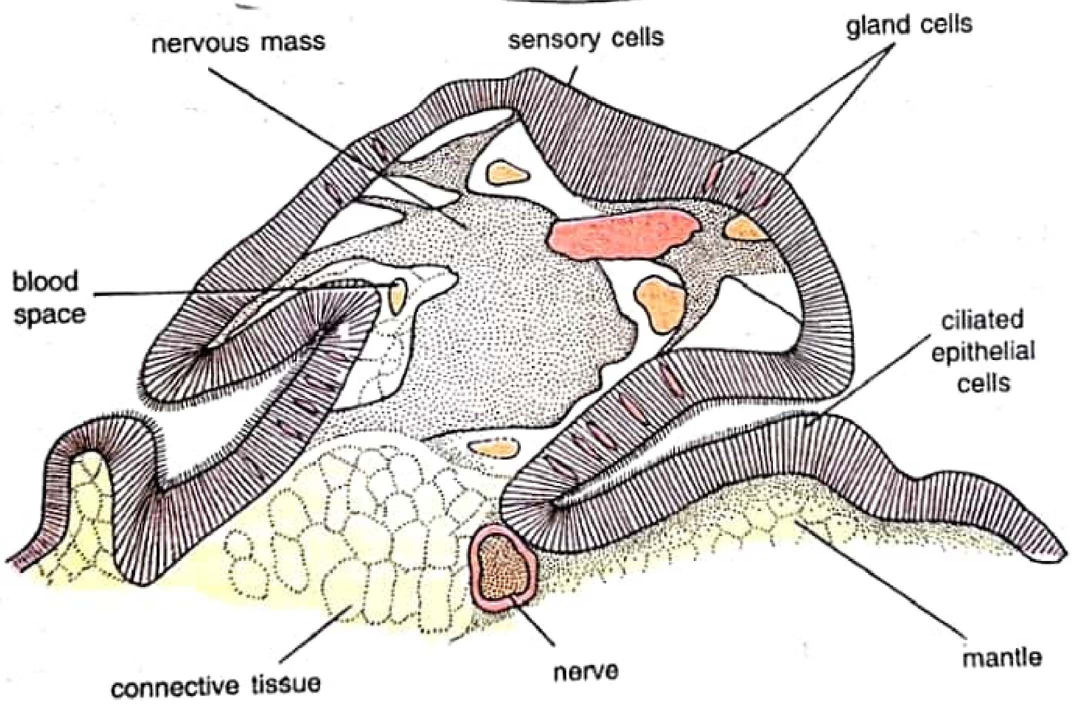

Fig. 60.25. *Pila globosa.* T.S. of osphradium.

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.

? taste

supra-intestinal ganglion by a stout **supra-intestinal** or **left visceral connective.** It is further connected with the fused right pleural and infra-intestinal ganglion through the **infra-intestinal** or the **right visceral connective.**

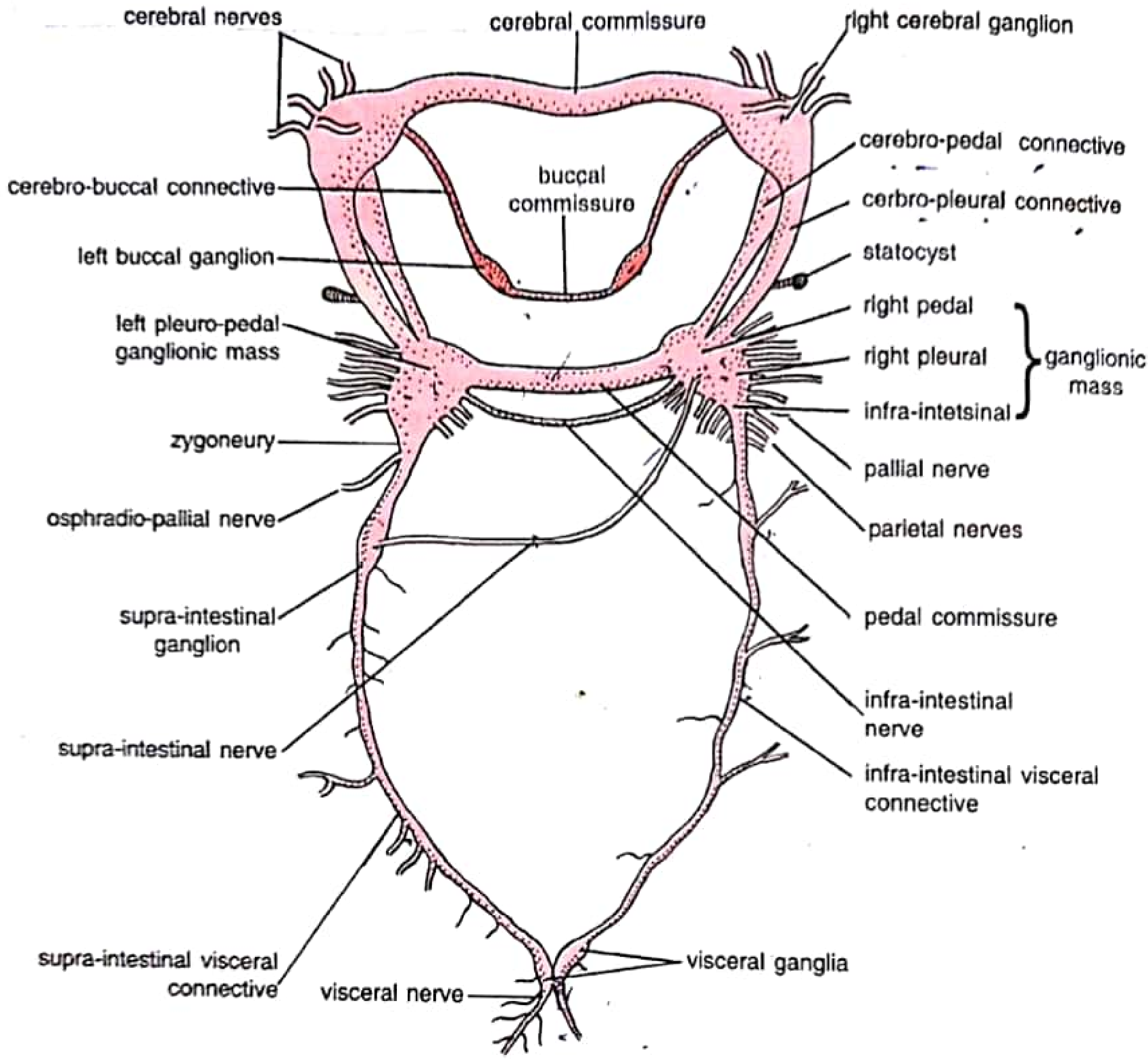

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Fig. 60.23. *Pila globosa.* Nervous system.

Nerves from the cerebral ganglia go to the head, tentacles and eyes. The buccal ganglia send nerves to the buccal mass. Nerves from the pedal ganglia innervate the foot, and those from the pleural ganglia go to the mantle, ctenidium and siphons. From the visceral ganglion nerves go to the intestine, kidney and gonads. These nerves constitute the peripheral nerves.

Characteristics of nervous system. The nervous system of *Pila* shows two characteristics, firstly most of the ganglia, except the visceral, are concentrated near the buccal mass, secondly the visceral loop is twisted into a figure of 8 due to torsion. The twisted condition of the nervous system is a primitive feature, because in most gastropods there is a secondary bilateral symmetry shown by the ganglia and connectives.

SENSE ORGANS

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

the pallial cavity through the external renal opening. The kidney is a coelomoduct communicating at one end with the coelom (pericardium) and at the other end with the exterior (mantle cavity). The kidney removes nitrogenous waste from the blood, waste is discharged into the mantle cavity. Excretory matter contains mostly ammonia, and some ammonium compounds, urea and uric acid. In order to conserve water ammonia is converted into the relatively insoluble uric acid. This adaptation for water conservation is particularly striking in *Pila* which is seasonally amphibious, during its aquatic phase it excretes ammonium compounds, but during its terrestrial phase it excretes uric acid.

In most Gastropoda the **digestive gland** plays a role in excretion because it contains some excretory cells that take up waste which is eliminated by way of the stomach and intestine.

NERVOUS SYSTEM

The nervous system of *Pila* consists of paired and unpaired **ganglia** with their **commissures and connectives**. The commissures are the nerves which establish connections between similar ganglia, while connectives are the nerves which connect two dissimilar or different ganglia. However, the paired ganglia of *Pila* are **cerebral**, **buccal**, **pleural**, **pedal** and **visceral**, while unpaired ganglia are **supraintestinal** and **infraintestinal**. These ganglia with their commissures and connectives are described below :

1. Cerebral ganglia. There are two triangular **cerebral ganglia**, one on each side above the buccal mass, they are connected to each other by a thick cerebral commissure running transversely above the buccal mass, and by a thin **labial commissure** lying below the buccal mass. Each cerebral ganglion is further connected with the buccal ganglion of its side through a very slender **cerebro-buccal connective**. Thick band-shaped **cerebro-pleural** and **cerebro-pedal** connectives serve to connect each cerebral ganglion with the corresponding pleural and pedal ganglia. Each cerebral ganglion gives off several nerves supplying anteriorly the skin of snout, the tentacle and the buccal mass; and posteriorly the tentacle, the eye and the statocyst.

2. Buccal ganglia. At the junction of the buccal mass and oesophagus are two **buccal ganglia**. They are connected to each other by a transverse **buccal commissure**. They are also connected to the cerebral ganglia by a **cerebro-buccal connective** on each side, the connectives lie above the buccal mass. Nerves from each buccal ganglion supply the buccal mass, radular sac, salivary glands, oesophagus and the oesophageal pouches.

3. Pleuro-pedal ganglionic mass. In fact, the pleural and pedal ganglia of each side join together to form a **pleuro-pedal ganglionic mass** situated below the buccal mass. In a pleuro-pedal ganglionic mass, the pleural ganglion is placed towards the outer side and the pedal ganglion to the inner side. The pleuro-pedal ganglionic mass is connected to the cerebral ganglion of its side by a **cerebro-pleural connective** and **cerebro-pedal connective**. The two pedal ganglia are connected to each other by two **pedal commissures** lying closely parallel to each other. The right pleuro-pedal mass has an **infra-intestinal** or a **sub-intestinal ganglion** also fused with it. A slender, loop-like **infra-intestinal nerve** behind the pedal commissure, connects the pleural ganglia of both the sides. A statocyst is connected by a band of connective tissue, to each pedal ganglion.

4. Supra-intestinal ganglion. The supra-intestinal ganglion is a slightly swollen, more or less fusiform ganglion lying in a sinus about a quarter of an inch behind the pleuro-pedal mass of the left side. It is connected with the pleuro-pedal mass by a stout connective, called **zygoneury**. It gives off on the inner side a thin **supra-intestinal nerve** which runs anteriorly above the intestine to the right side to join the right pleural ganglion. The supra-intestinal ganglion also sends off posteriorly a branch, the **left visceral connective** which connects it with the visceral ganglion.

5. Visceral ganglion. The visceral ganglion is formed by the fusion of two spindle-shaped ganglionic masses. It lies near the base of the visceral mass close to the anterior lobe of the digestive gland and to the right of the pericardium. The visceral ganglion is connected with the large quantities of food in Europe. Shells of freshwater mussels are used in the pearl button industry in all parts of the world, they are made from the nacreous layer of shells, no other material stands laundering as these buttons. Shells of oysters are mixed with tar for making roads in America and lime from these shells is used in feeding poultry for formation of their egg shells. Lime is also used in buildings. In many parts of the world molluscan shells are used for making ornaments and jewellery, in some parts shells of *Cypraea* (cowrie) are used as money and as ornaments. Many freshwater clams and marine oysters produce pearls, but the most valuable natural pearls are produced by pearl oysters *Pinctada margaritifera* and *Pinctada mertensi* which inhabit the warmer parts of Indian and Pacific Oceans along the coasts of China, India, Sri Lanka and Japan. A pearl is made when a small foreign object, such as a particle of sand or a parasite, lodges between the shell and the mantle. The foreign object becomes a nucleus around which concentric layers of nacreous are laid by the mantle, in this manner a pearl is formed. But pe are also produced by most pelecypods including freshwater clams. In Japan pearl cultu practised by artificially introducing a small solid or liquid irritant below the mantle of the oyste, the resultant one year old pearl is then transplanted to another oyster, a pearl of good size is obtained in three years after transplanting. 3

IMPORTANT QUESTIONS

Long Answer Questions

1. Give an account of torsion and detorsion in Gastropoda.
2. What is pearl ? How is the pearl formed ?
3. How are molluscs important to mankind ? Discuss.

Short Answer Questions

1. Write short notes on :
   (*i*) Archimollusc; (*ii*) Pearl formation; (*iii*) Economic importance of Mollusca.
2. Write important characteristic features of Archimollusc.
3. Write a short note on torsion in Gastropoda.
4. What is the economic importance of Mollusca ?
5. Give a brief account of pearl formation.

Very Short Answer Questions

1. What is archimollusc ?
2. How does torsion occur ?
3. What is the name of common Indian pearl oyster ?
4. What is detorsion ?
5. Give names of some molluscs used as human food.

Multiple Choice Questions

1. Pearl is produced by
   (*a*) *Oyster* (*b*) *Nautilus*
   (*c*) *Doris* (*d*) *Chiton*.
2. Which one of the following molluscan groups is primarily used in the pearl formation?
   (*a*) Monoplacophorans
   (*b*) Cephalopods
   (*c*) Gastropods
   (*d*) Pelecypods.
3. Pearl producing species of mollusc is
   (*a*) *Tridacna maxima* (*b*) *Solen kempi*
   (*c*) *Pinctada vulgaris* (*d*) *Mytilus viridus*.
4. The most primitive mollusc is
   (*a*) *Patella* (*b*) *Chiton*
   (*c*) *Dentalium* (*d*) *Neopilina*.
5. A pearl oyster secretes pearl to
   (*a*) Regenerate injured parts
   (*b*) Protect itself against invading parasites
   (*c*) Harden its mantle cavity
   (*d*) Isolate damaged tissues of the body.
6. Whose secretion forms the pearl?
   (*a*) Prismatic layer
   (*b*) Columnar epithelial cells of mantle
   (*c*) Ciliated epithelial cells of mantle
   (*d*) Connective tissue of mantle.
7. Which of the following genera produces the most valuable kind of pearl of Eastern Asia?
   (*a*) *Meleagrina* (*b*) *Mytilus*
   (*c*) *Pinctada* (*d*) *Ostrea*.
8. Nucleus of pearl is
   (*a*) Outer material of normal shell which is secreted by the animal around some foreign particle
   (*b*) Artificial nucleus inserted by scientists inside pearl
   (*c*) Pearl oyster
   (*d*) None of the above.
9. Malacology is the study of
   (*a*) Mollusca (*b*) Mantis
   (*c*) Shell of Mollusca (*d*) Marine animal.

In Cephalopoda the body has become greatly elongated along the dorso-ventral axis, and a result of change in the method of locomotion this axis has become the functional antero-poster axis. A ring of tentacles lies at the anterior end of the body and the visceral hump is posterior, t original mantle cavity has become ventral.

PEARL FORMATION

Pearl is a valuable gem known to mankind since ancient times. The pearl, in fact, is of anim origin and produced by certain **bivalves** of Mollusca. The pearl producing bivalves are mari oysters of the genus *Pinctada*, though some freshwater bivalves of the genus *Unio* and *Anodon* also produce pearl but of inferior quality and rarely of any use. Today, Japan produces the bulk pearl in the world by using pearl culture technique. However, the culture of pearl, its fishing ar its commercialisation, etc., constitute a separate story. Here we are concerned only with the way of the formation of pearl in the body of a bivalve.

The pearl is secreted by the **mantle** as a protective measure against foreign objects like sand particles, parasites, small larvae or any object of organic and inorganic origin. In fact, as soon as a foreign object, somehow, enters the body of a bivalve in between the shell and mantle, the mantle immediately gets irritated and at once encloses it like a sac. The mantle wall then starts secreting layers of **nacre** around the foreign object from defence point of view. Thus, mantle wall secretes continuously several layers of nacre aroun the foreign object and finally pearl is formed. The value of pearl depends upon its size, quality, etc Now a days, the pearl producing bivalves are reared and pearls are produced artificially by introducing some foreign objects between the mantle and shell in the different parts of the world Japan has surpassed all other countries in this field.

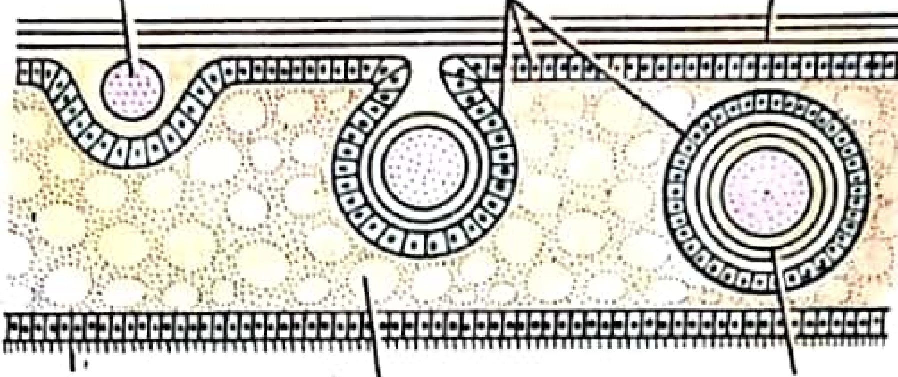

Fig. 63.3. Stages in pearl formation.

Detorsion.

Monitoring pearl quality.

Teredo, the shipworm burrows.

Unio pearl (inferior quality).

resorption to be confined to a dorsal digestive gland or liver, the liver undergoes growth to for projection which grows so much that it falls over to one side causing a **coiling** of the alimen canal into a visceral hump. The visceral hump grows faster on one side than on the other, so that it is twisted into a compact spiral which is directed posteriorly to keep the balance of the animal, the shell is also coiled. With this spiral coiling one may confuse another process called torsion of the visceral mass, but this coiling evolved before torsion.

The visceral hump behind the head includes the visceral mass, mantle, mantle cavity, and foot; it rotates in a counter-clockwise direction through an angle of 180° on the rest of the body by contraction of an asymmetric retractor muscle which arises from the right side of the larval shell, passes over the body and gets inserted to the left side of the head. This rotation is known as **torsion** which is distinct from coiling and is a much more drastic change, it occurs after coiling of the visceral hump. In torsion only a narrow part of the body and the organs which pass through it are twisted, it is that small part which lies between the visceral hump and the rest of the body. Torsion changes the orientation of the mantle cavity and its organs, and the organs of the left side tend to be reduced or even lost.

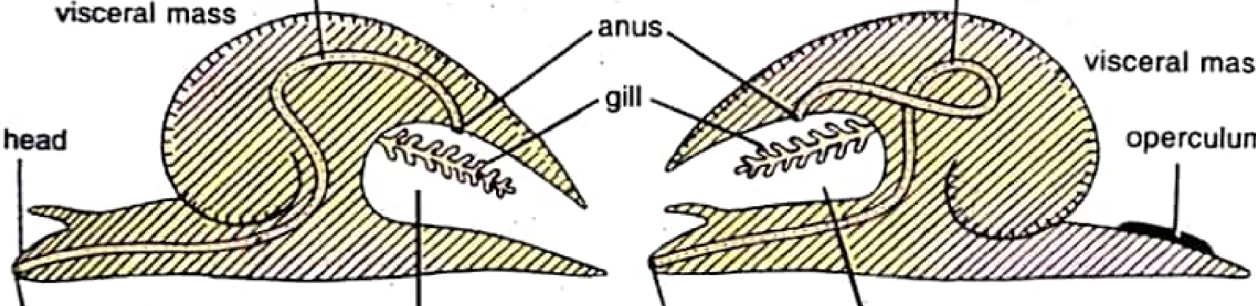

Fig.63.2. A gastrpod showing torsion. A—Before torsion; B—After torsion.

Before torsion the mantle cavity opens posteriorly, ctenidia point backwards, the auricles are behind the ventricle, the nervous system is bilaterally symmetrical, and the mouth and the anus are at opposite ends. After torsion the mantle cavity opens in front just behind the head, ctenidia come to lie in front and point anteriorly, the ctenidium of the right side comes to lie on the left and that of the left side on the right, the auricles become anterior to the ventricle, the auricle of the right side comes to lie on the left and vice versa, the nervous system is twisted into a figure of 8 by the crossing of the two long nerve connectives running to the viscera, and the digestive system becomes U-shaped so that the anus comes to lie in front near the mouth. The entire process of torsion generally takes only a few minutes.

In primitive Gastropoda there are two ctenidia, two auricles and two kidneys, but in more specialised forms the real left but topographically right ctenidium, right auricle and the right kidney fail to form; this absence of organs of the right side is a consequence of torsion. The number of auricles is directly related with the number of ctenidia present, and the loss of one gill leaves only one auricle. It is not clear whether torsion is an advantage or not to the animal, or if it has any evolutionary significance, but it takes place during the embryological development of gastropods, the larva is a first bilaterally symmetrical, then quite suddenly it undergoes torsion.

In some forms after the coiling of the visceral hump, torsion occurs by rotation only through 90°, so that the ctenidia and anus point laterally.

Detorsion. In some forms the changes brought about by torsion are reversed to a certain extent, while in others, *e.g.*, *Aplysia* a complete reversal of torsion takes place which is known as detorsion, this occurs when the shell is lost or much reduced, the ctenidia liberated from their enclosing case point posteriorly again, their anterior position being of no advantage, and the visceral hump gets completely untwisted.

3. There was no trace of segmentation but it had an anterior mouth and a posterior anus.

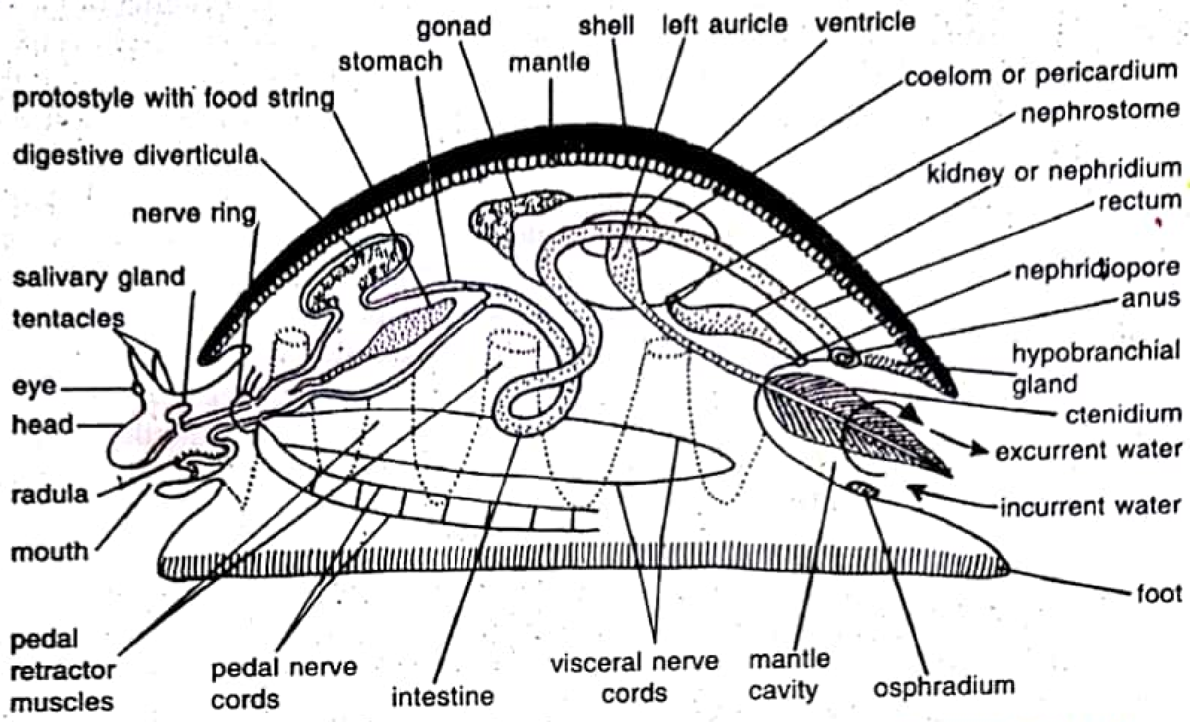

Fig. 63.1. Schematic lateral view of an archimollusc (hypothetical molluscan ancestor).

4. It had a distinct **head**, situated antero-ventrally, with a pair of **tentacles** and a pair of **eyes**.

5. It had a large, muscular ventral **foot**; its edges were provided with small delicate tactile tentacles.

6. Its postero-dorsal part was raised into a **hump**.

7. Its **visceral mass** was covered in **pallium** or **mantle**.

8. Dorsally, it had an oval, convex **shell** secreted by the mantle.

9. **Mantle cavity** lying between the visceral mass and mantle was in direct communication to external environment.

10. Respiration was performed by one or more pairs of **ctenidia or gills**.

Pearls

11. An olfactory organ, **osphradium** was present close to gills.

12. Its **alimentary canal** was somewhat straight; pharynx had horny **jaws, odontophore** was present which had chitinous **radula**.

13. It was **microphagous** and **herbivore**.

14. Its **heart** was three chambered, having one mid-dorsal **ventricle** and two ventro-lateral **auricles**.

15. The body cavity was **haemocoel** and original coelom in the form of pericardium and gonocoel.

16. It had a pair of tubular **nephridia** or **kidneys** for excretion.

17. Its nervous system was very simple; nerve ring around oesophagus, visceral and pedal nerve cords.

18. Paired tentacles, eyes, osphradium, statocysts were the sensory organs.

19. Sexes were separate and fertilisation was external.

20. A free swimming **trochophore larva** developed during development which metamorphosed directly into adult without undergoing in **veliger** stage.

TORSION IN GASTROPODA

Mollusca are typically bilaterally symmetrical animals but this symmetry is lost in Gastropoda due to two processes called **coiling** and **torsion**. There is a tendency for digestion and