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BY	DR ANUPAM DUBEY

DIGESTIVE SYSTEM

DR ANUPAM SIR

The digestive system of ***Herdmania*** **includes the** ***alimentary canal*** and the ***digestive glands***.
[I] Alimentary canal-The digestive tract of Herdmania is coiled and complete, beginning at the mouth and terminating at the anus.
The following part forms the alimentary canal.

1. Mouth.

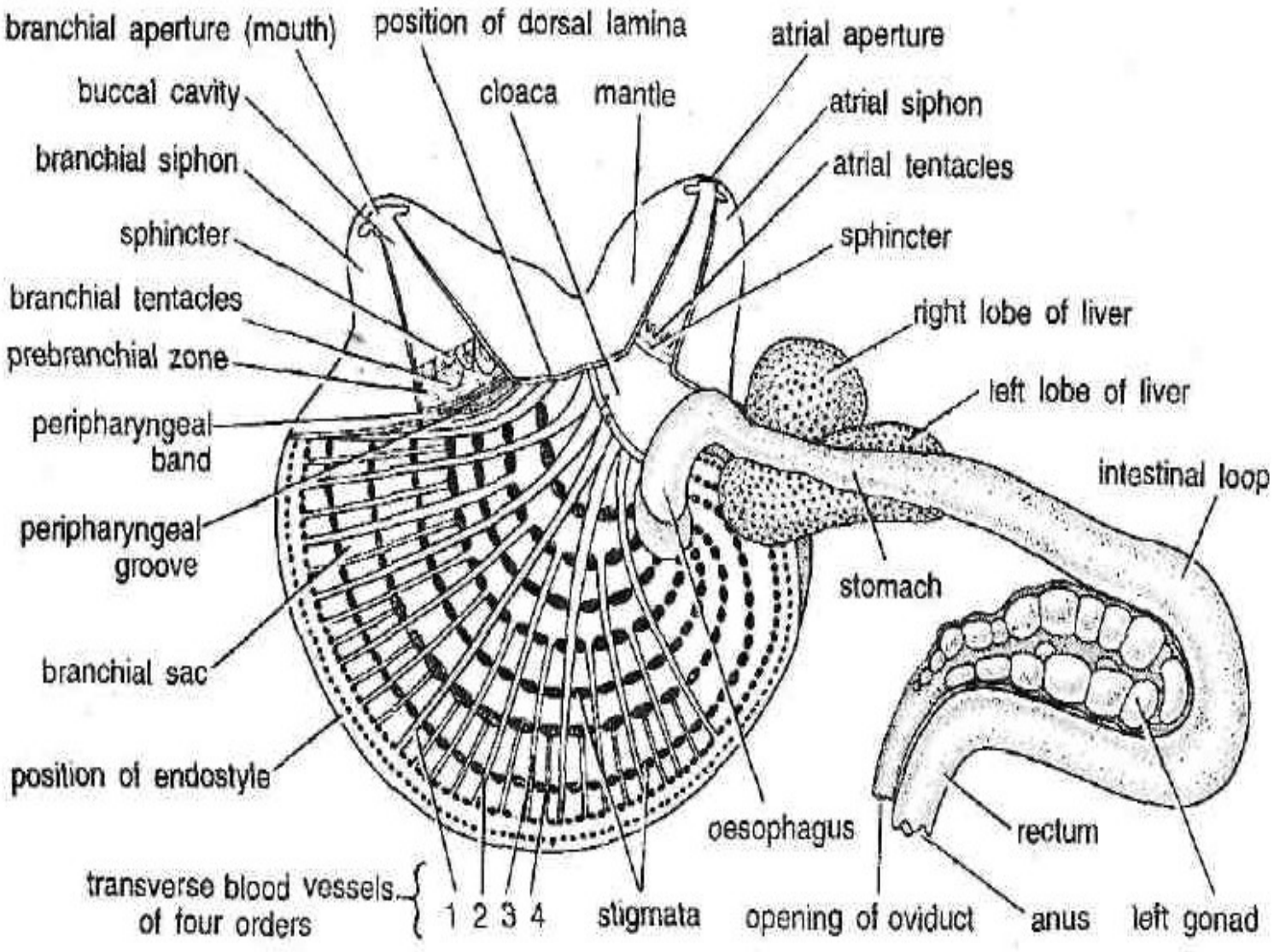
- The mouth or branchial aperture opens on the top of the branchial siphon marking the anterior end of the body.
- It is bordered by four lips or lobes formed by the test and leads into the bronchial siphon.

2. Buccal cavity.

- The short narrow and laterally compressed cavity of bronchial siphon, lined by epidermis, is called the stomodaeum or buccal cavity.
- A strong bronchial sphincter present near the base of the siphon regulates its opening.
- The base of the siphon is provided with a circlet of highly branched, delicate bronchial tentacles richly supplied with nerves.
- Their number is about **64 which are broadly** in four sizes, such as 8 large (5 mm), 8 medium (2.5 mm), 16 small (1.5 mm) and 32 very small (0.5 mm).
- A bronchial tentacle is sickle-shaped, attached by its broad base. Its upper and thicker border bears numerous paired lateral branches, called tentaculets, each in turn bearing smaller secondary and tertiary branches.
- The lower border of tentacle is **thin, lobed, notched and covered by glandular epithelium**.
- The free ends of tentacles meet at the centre forming a sort of strainer which prevents entry of larger food particles into pharynx.

3. <u>Pharynx.</u>

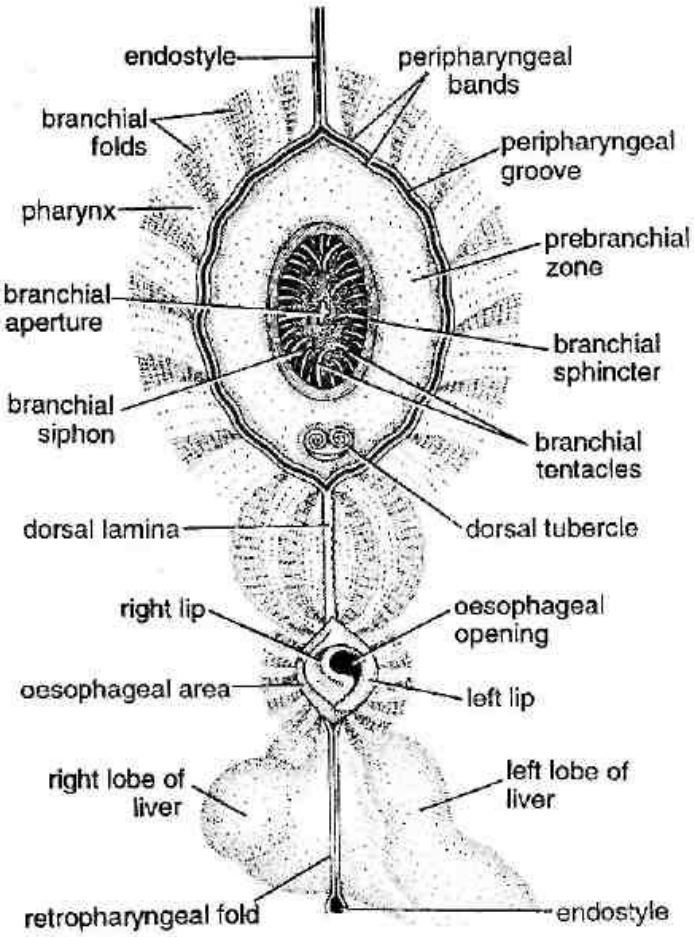
- Buccal cavity or branchial siphon is followed by the pharynx.
- It occupies the major part of the body or atrial cavity.
- It is differentiated into a prebranchial zone and a branchial sac.



Herdmania. Alimentary canal in left view, after removal of test and mantle.

(a) Pre-branchial zone.

- It is the smaller anterior region having smooth **walls without folds,cilia and stigmata or gill-slits**.
- It is demarcated from the branchial sac by two circular, thin, parallel and ciliated ridges, called anterior and posterior **peripharyngeal bands**, enclosing a narrow ciliated **peripharyngeal groove**.
- The **two bands** bear larger cilia while the groove has **smaller cilia**.
- The anterior **peripharyngeal band** is a complete ring and middorsally in front of it lies a swollen dorsal tubercle made of two spiral coils.
- The **posterior peripharyngeal** band is interrupted mid-dorsally by the dorsal lamina and mid-ventrally by the **endostyle**.



Herdmania. Diagram showing relations of branchial, siphon branchial folds, peripharyngeal bands with groove, oesophageal area, dorsal lamina and endostyle.

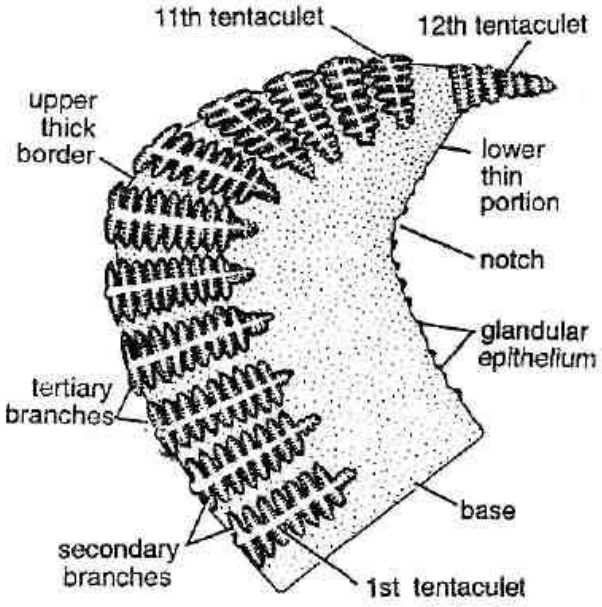
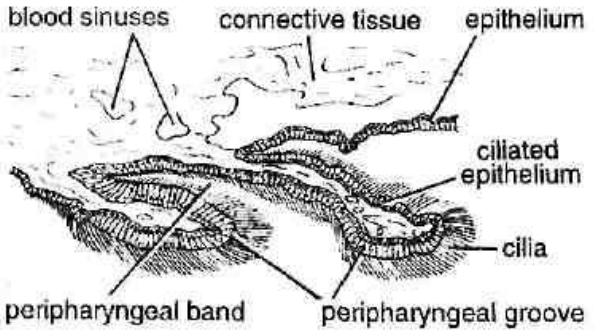
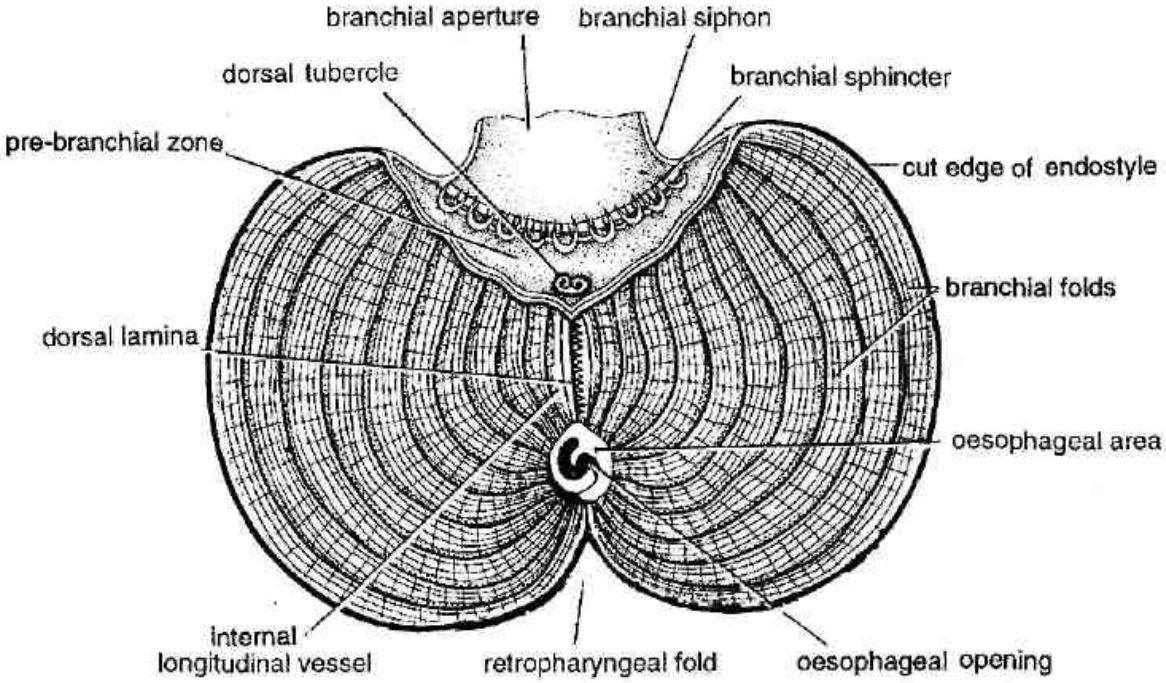


Fig. 10. *Herdmania.* A branchial tentacle in side view.



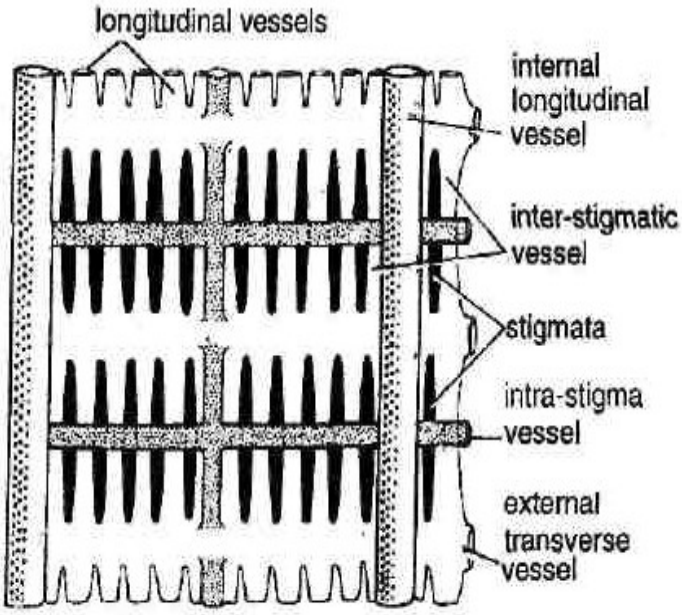
Herdmania. Peripharyngeal bands and groove in T. S.



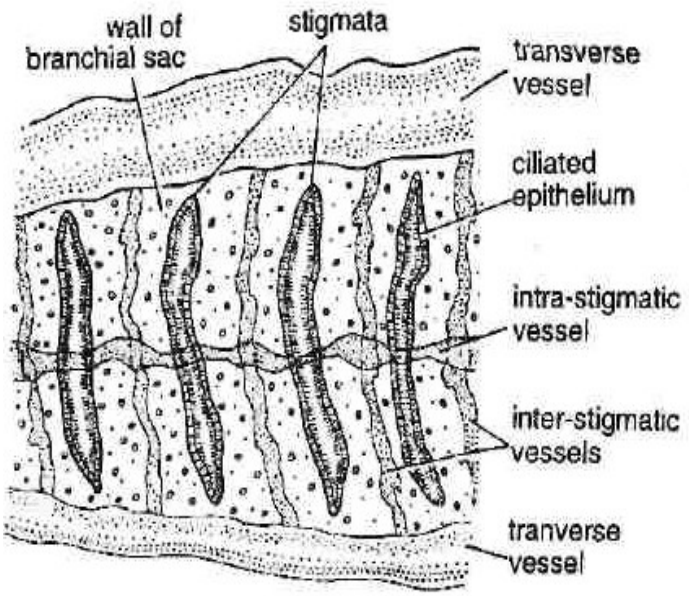
Herdmania. Pharynx cut longitudinally along mid-ventral line (endostyle) to show internal structure.

(b) Branchial sac.

- It is the larger posterior region **of pharynx**.
- It is also known as **the branchial basket** because of its looks, as its lateral walls are perforated by numerous elongated gill-slits of stigmata through which the cavity of pharynx communicates with the atrial cavity.
- Each side of **branchial sac** bears about **200,000 stigmata** arranged in several transverse rows.
- The epithelium lining the stigmata bears long cilia, called lateral cilia.
- The pharyngeal wall is richly vascular and the bars contain their corresponding blood vessels, i.e., internal longitudinal and **external transverse vessels**.
- The adjacent stigmata are also separated from each other by thin longitudinal intersegmental **bars and vessels.**
- Besides, a thin transverse **intrastigmatic** bar and vessel transversely cross through each row of **stigmata** .



Herdmania. Plan of branchial vessels and four stigmatic areas in a portion of pharyngeal wall.



Herdmania. One stigmatic area enlarged to show ciliation.

(i) Trabeculae.

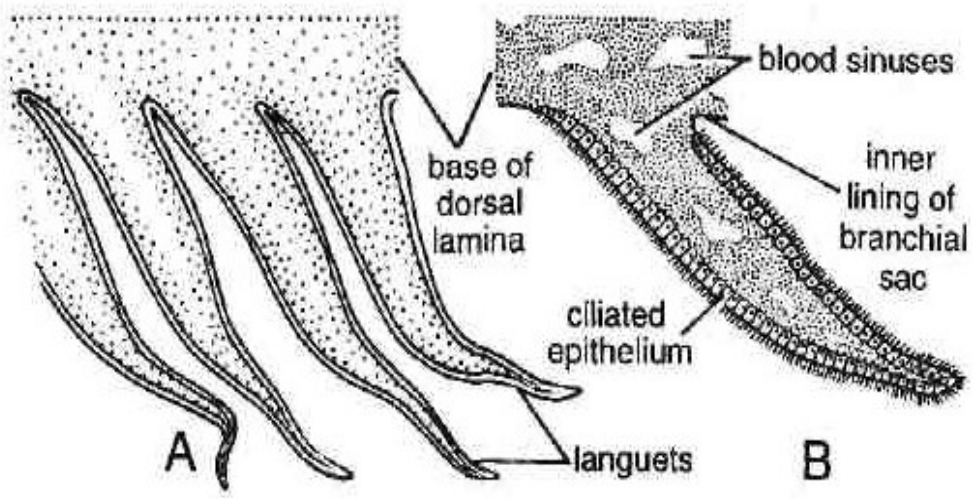
- The inner wall of branchial sac becomes folded longitudinally to **increase its surface area**.
- The number of branchial folds **is 9 or 10 on either side**.
- The inner surface is **nonciliated.**
- The outer wall of branchial sac is connected to mantle by several hollow strands, called **trabeculae,** each containing a blood vessel.

(ii) Dorsal lamina,:

- A thin **flap or fold, 1 to 1.5** cm long, is suspended from the short mid-dorsal border of the roof of branchial sac.
- It is called the **hyperpharyngea**l band or dorsal lamina.
- It extends from the posterior **peripharyngeal band** to the right lip of **oesophageal opening**.
- A row of **20 to 30 conical**, tapering tongue-like processes, the languets, hang down from dorsal lamina into the

cavity of the branchial sac.

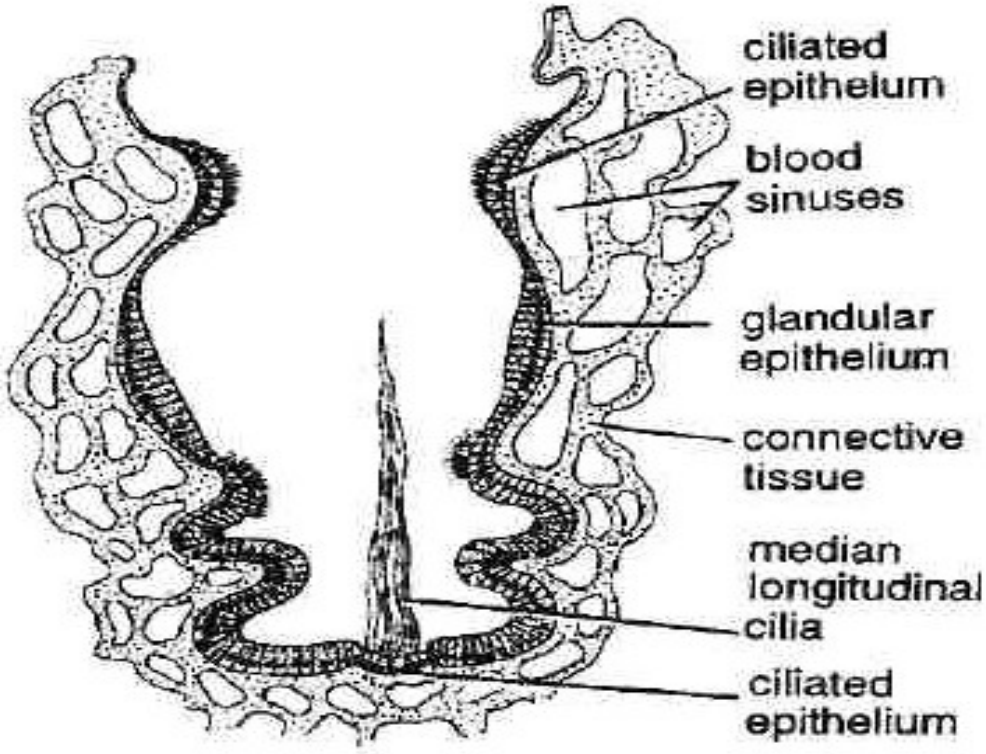
- The languets are covered by ciliated epithelium.
- In the living animal, the dorsal lamina and its languets are bent to the right side forming a sort of gutter for conducting food .



Herdmania. A — Part of dorsal lamina. B — One languet in section.

(iii) Endostyle.

- **Similarly,** a shallow longitudinal mid-ventral groove, **called endostyle**, is present on the floor of the branchial sac.
- Anteriorly, the endostylar groove is continuous with the **peripharyngeal groove**, while the marginal **folds of endostyle merge** with the **posterior peripharyngeal band**.
- Posteriorly, the groove **terminates** before reaching oesophageal opening, while its folds reach up to **oesophageal** opening as thin retropharyngeal folds
- Structurally, endostyle consists of five longitudinal ciliary tracts (**1 median, 2 lateral pairs**) alternating with four longitudinal tracts of mucus-secreting glandular cells.
- The cilia of the median tract are the longest of all.
- The **endostyle of urochordates** is homologous with the **hypopharyngeal groove** of cephalochordates and thyroid glands of vertebrates.



Herdmania. Endostyle in T. S.

(iv) **Oesophageal area**.

- The posteriormosl region of branchial sac has a small circular oesophageal area made of two semicircular lips guarding the oesophageal opening.
- This area is **devoid of blood vessels, folds are stigmata**.

4. Oesophagus.

- The branchial sac **postero-dorsally** leads into the o**esophagus** which is a very short, curved and thick-walled tube **opening into stomach**.
  - Its narrow lumen is produced into four longitudinal ciliated grooves for the passage of food .

5. Stomach.

- It is wider than oesophagus **thinwalled, sphinctered** at both ends, has a **smooth inner surface**, and is surrounded on either side by the **right and left lobes of liver**.

6. Intestine.

- The stomach leads into the i**ntestine** which is **a thin-walled, U-shaped** tube formed by a proximal, ventral or descending limb and a distal, dorsal or **ascending limb**, both united anteriorly.
- The **intestinal loop**, thus formed encloses the **left gonad** (

7. Rectum.

- Posteriorly the terminal part of intestine leads into a short, narrow tube, **the** *rectum,* internally lined by cilia.
- It curves dorsally to open into the atrium or ***cloaca* t**hrough the *anus* which is

bounded by four lips.

8. Cloaca.

- The **atrial cavity or cloaca** leads dorsally into the atrial **siphon** which opens to the outside through the atrial aperture.
- The atrial siphon is lined internally by ectoderm and thus represents the **proctodaeum.**

[II] Digestive glands

1. Liver.

- Liver of **Herdmania** is a large dark brown bilobed digestive gland made of a larger left lobe and a smaller right lobe attached on either side of the stomach.
- Liver is composed of a large number of tubules or caeca embedded in a connective tissue matrix containing **blood sinuses.**
- Tubules unite to form **11 or 12 hepatic** ducts which open independently into the stomach.
- Liver secretion contains a strong amylase, a protease and a mild lipase.

2. Pyloric gland.

- **It** consists of a large number of branching tubules in the walls of stomach and intestine.
- They open by a single duct into the middle of the proximal limb of intestine.

o The pyloric gland of Herdmania probably performs a dual function, that of a vertebrate pancreas and of an excretory organ.

[III] Food, feeding and digestion

1. Food.

- Due to sedentary habit, Herdmania is a ciliary or **filter feeder.**
- The food consists of microscopic **planktonic organisms such as algae, diatoms, infusorians,** etc.

2. Feeding or food collection.

- Outward beatings of lateral **cilia lining**, the stigmata set up a **constant water current** which enters through the mouth and buccal cavity into the pharynx, passes through stigmata into the atrial cavity and leaves the body **through atrial siphon (cloaca) and atrial aperture**
- . The branchial tentacles, forming a sort of sieve or strainer, prevent larger particles but allow minute food particles to enter the pharynx along with the water current.
- The tentacles probably also act as chemoreceptors and keep out the impurities present in sea water.

- The larger particles and impurities are thrown out of the mouth by producing a strong reverse current.
- The lateral cilia of stigmata retain the food particles inside the branchial sac, which settle on its wall.
- **Enormous quantity** of viscid mucus secreted by the gland cells of **endostyle** is whipped up along the inner lateral walls of branchial sac by the lashing movements of **the endostyiar cilia.**
- The food particles entangled with this mucus are also shifted dorsally by the frontal cilia that beat upwards.
- The food-laden mucus finally reaches the dorsal lamina, **rolled up into a cylindrical mass**.
- Here, it is driven backwards by ciliary action in the form of a string or.cord, in the groove formed by the curved languets of dorsal lamina and passes into the oesophagus aided by the **oesophageal lips.**
- From oesophagus the food **passes into the stomach**.

3. Digestion.

- **In** stomach, food is digested by the enzymes present in the liver secretion.
- Amylase hydrolyses starch into maltose, protease breaks down **proteins, and lipase acts on fats**.
- Secretion of pyloric gland probably has an accessory digestive function similar to that of pancreas.
- Digestion is completed and the digested **food absorbed in the intestine**.
- The undigested food material passes into rectum and driven out by rectal cilia into cloaca through anus as a much coiled **faecal cord with mucus.**
- It is expelled out forcefully up to a distance of **10-12 cm through** atrial aperture by the sudden contractions of the body.
- Reserve food in the form of concentrically striated starch-like granules is present in the liver and the walls of oesophagus, **stomach and intestine**.

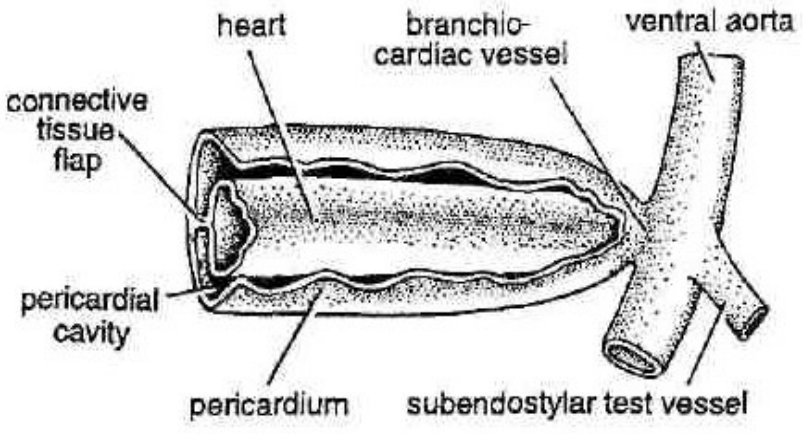
BLOOD VASCULAR SYSTEM

DR ANUPAM SIR

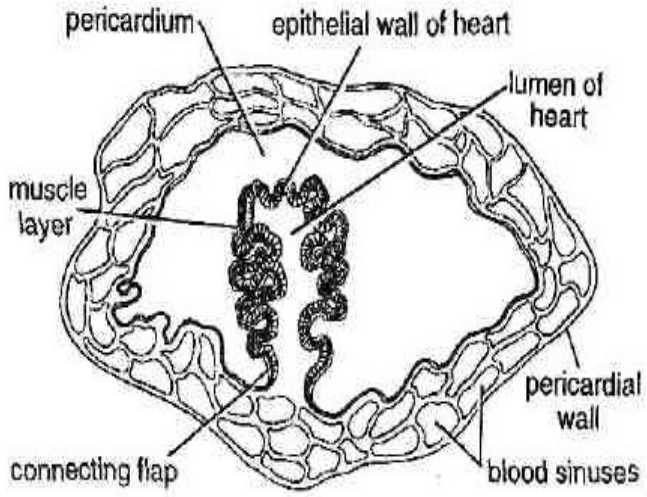
- The circulatory system of Herdmania is well developed and greatly modified.
- It includes :
  (i) Heart and pericardium,
  (ii) Blood vessels,
  (iii) Blood.

1. Heart and pericardium:-

- The pericardium is a noncontractile, elongated and transparent tube about 7 cm long and 3 mm wide, running obliquely below the right gonad.
- It is closed at both the ends and filled with a colourless pericardial fluid with corpuscles similar to those of blood.
- Its thick wall is made of **connective tissue**, contains **blood sinuses** and is internally lined by **squamous epithelium.**



Herdmania. Pericardium cut open to show the attachment of the heart.



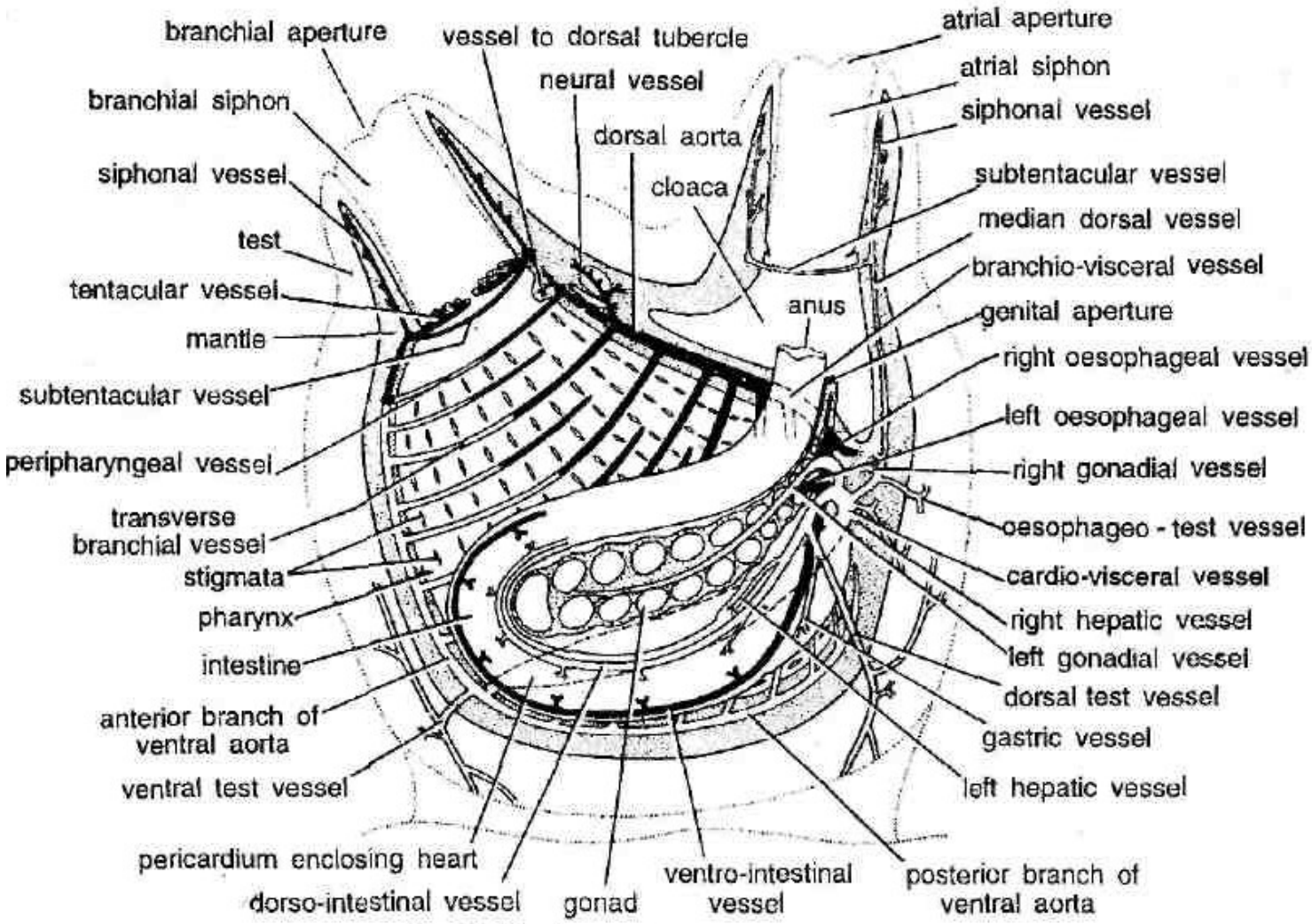
Herdmania. Heart and pericardium in T.S.

- The heart is enclosed within the **pericardium** and attached to its wall along its entire length by a thin **mesentery**-like **connective tissue flap**.
- It is a cylindrical highly contractile and thin-walled structure with **striated muscles**.
- It is formed by an infolding of the **pericardium**.
- Both ends of heart are open.
- There are no **valves** but a **pear-shaped body** present midway in the pericardial body probably regulates the **flow of blood in the heart**.

2. Blood vessels:-

- Blood vascular system is elaborate.
- While the major **blood vessels** have definite walls, the smaller ones lack them.

- The larger blood vessels and their branches are as follows:



Herdmania. Heart and blood vessels.

(a) Ventral aorta:-

- The ventral or **subendostylar vessel** is the largest vessel of the body, arising from the ventral end of the heart.
- At its point of origin, it first gives out a stout ventral test vessel, supplying the ventral side of the test, and then bifurcates into an anterior and a posterior **hypobranchial branch** running first below the entire length of the **endostyle.**
- Both, the branches give off several paired transverse vessels (40 to 56 pairs) to the wall of **branchial sac** between rows of **stigmata**, and numerous fine vessels to the **endostyle** and **mantle**.
- The anterior branch joins **two** circular vessels at the base of **branchial siphon**—
  (i) A peripharyngeal vessel that runs below the peripharyngeal groove, and
  (ii) A **subtentacular vesse**l that runs below the bases of branchial tentacles.
- The latter sends a **tentacular branch** in each tentacle and 6-8 **siphonal vessels** into **the branchial siphon.**
- The posterior branch of ventral aorta sends a minor vessel to **oesophageal area**.

(b) Dorsal aorta

- It is a stout vessel lying mid-dorsally, just above dorsal lamina in the dorsal wall of **branchial sac.**
- It is not connected to the **heart** but communicates with the ventral vessel through 5-7 pairs of transverse vessels of the **branchial sac**, and the circular **peripharyngeal** and **subtentacular vessels**.
- From its middle portion, a **neural vessel** is given into the neural complex.
- The anterior end of dorsal aorta also sends a small branch to **dorsal tubercle** and 6-8,, **siphonal vessels** into the **mantle** of **branchial siphon**.

(c) Branchio-visceral vessel

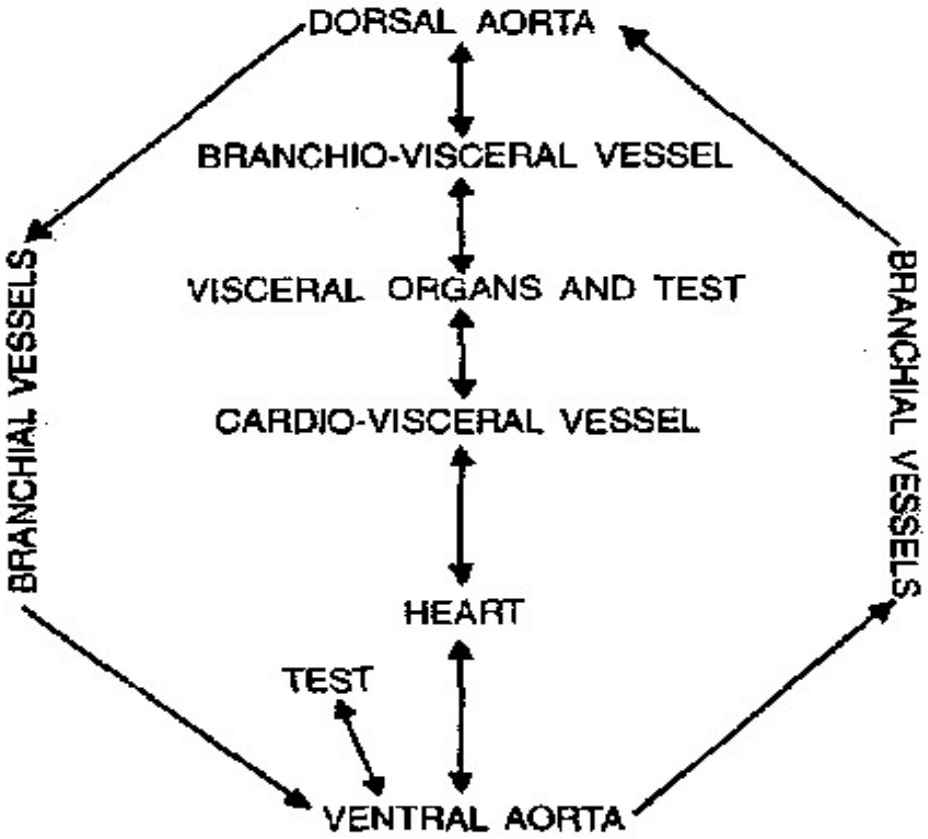
- It is a very short vessel in posterior continuation of **dorsal aorta**.
- It immediately divides into two branches.
- The right branch or right **oesophageal vessel** is short and supplies the right liver lobe and right side of **oesophagus**.
- The left branch or **ventro-intestinal vessel** is stout, long and supply blood to left side of **oesophagus, stomach, intestine, rectum**, **left gonad** and **left liver lobe**.

(d) Cardio-visceral vessel

- It arises from the dorsal end of the heart and supplies blood to several organs through different branches.
- Immediately near origin, it sends a right **hepatic vessel** to right liver lobe and an **oesophageo-test vessel** to oesophagus and test,
  - (i) The main dorsal branch sends a test vessel, a left **oesophageal** and a right **gonadial** to respective organs.
    -It further extends to form a circular **subtentacular vessel** at the bases of **atrial tentacles** and 6-8 **siphonal vessels** into the wall of **atrial siphon**.
  - (ii) The main middle branch or left **gonadial vessel** passes obliquely into the **left gonad**,
  - (iii) The main ventral branch soon divides into a **dorso-intestinal vessel** to left liver lobe, **stomach** and **intestine**, a **gastric vessel** to **stomach** and a **dorsal test vessel** to **test**.

3. Blood

- Blood is slightly **reddish**, **transparent** and **hypertonic** to **sea water**.
- It contains a few **colourless amoeboid leucocytes**, 6 or 7 types of coloured corpuscles with or without nucleus and without or with one, few or several vacuoles and the **nephrocytes** having **vacuoles** and **colloidal cytoplasm**.
- The **pigment** found in corpuscles may be **orange**, **yellowish-brown** or **yellowish-green**, **but never red.**
- Most **tunicates** can extract the rare metal **vanadium** from sea water and store it in green blood corpuscles called **vanadocytes**.
- But its oxygen absorbing power is very low and real function is uncertain.
- Some tunicates, including Herdmania, can not extract vanadium from sea water.
- In ascidians capillaries are absent but sinuses are present.
- Therefore, there is no distinction between blood and tissue fluids due to free intermixing.



Herdmania. Course of blood circulation.