ACCESSORY RESPIRATORY ORGANS IN FISHES

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Accessory Or Extrabranchial Respiration In Fishes

- Mainly fishes are gill breathers, Under exceptional environmental condition when branchial respiration insufficient. In case fishes are adopt aerial respiration.
- But in other case fishes are use accessory respiratory organ to increase the availability of oxygen.
- The usage of accessory respiratory organ prevent death during aestivation.
- Mostly air-breathing organs are present in fresh water fishes.

The Commonest Air-Breathing Structures Found Among Fishes

- Skin
- Branchial Epithelium Or Branchial Diverticulam
- Pharyngeal Epithelium Or Pharyngeal Diverticulam
- Air-Filled Branchial Chamber
- Gas bladder And Lung
- Stomach And Intestine

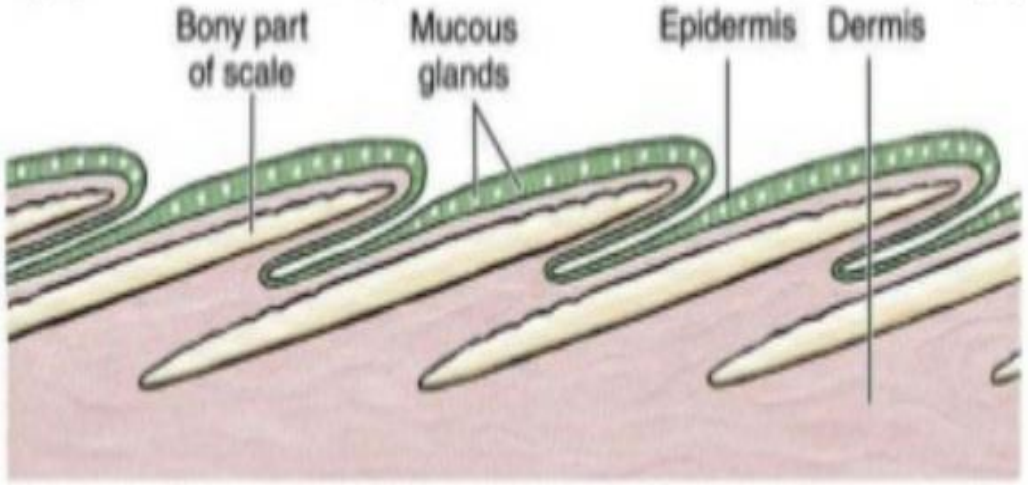
Cutaneous Respiration By Skin

- Simplest Form Of Aerial Respiration.
- In this case the skin is thin , moist , glandular and richly vascular.
- The embryos and larvae of many fishes breathe by skin , until gills become functional.
- Acipenser and some catfishes , the highly vascular opercular fold serve as an accessory respiratory structure.
- Eg:Anguilla ,Periophthalmus ,Boleophthalmus.

ACIPENCER

Doras

SKIN



Anguilla

Periophthalmus

Boleophthalmus

Bucco-Pharyngeal Respiration

- Buccal and pharyngeal epithelia are richly vascular they may serve as a respiratory surface for gas exchange.
- Fish may keep its branchial chamber water filled ,while going out of water, gill respiration to continue.
- Eg :Periophthalmus,Monopterus,Electrophorus

Periophthalmus

Monopterus

Electrophorus

Pharyngeal Air Sacs

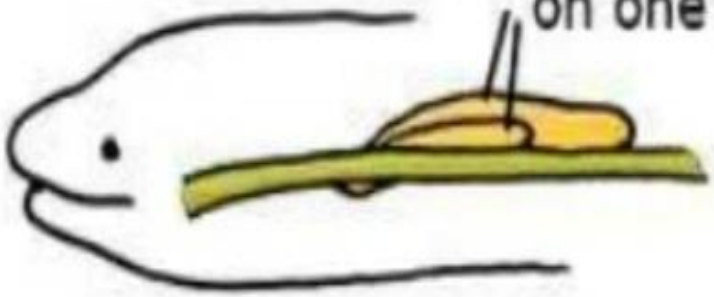
- The accessory respiratory organs are a pair of lungs like pharyngeal pouches . extension of the pharynx .
- They are lined by a thick vascular membrane. this membrane provides the respiratory surface for gas exchange.
- In amphipnous a pair of blind sac like pharyngeal diverticulam ,sac are lined by the richly vascular pharyngeal epithelium.

Eg:Channa , Amphipnous

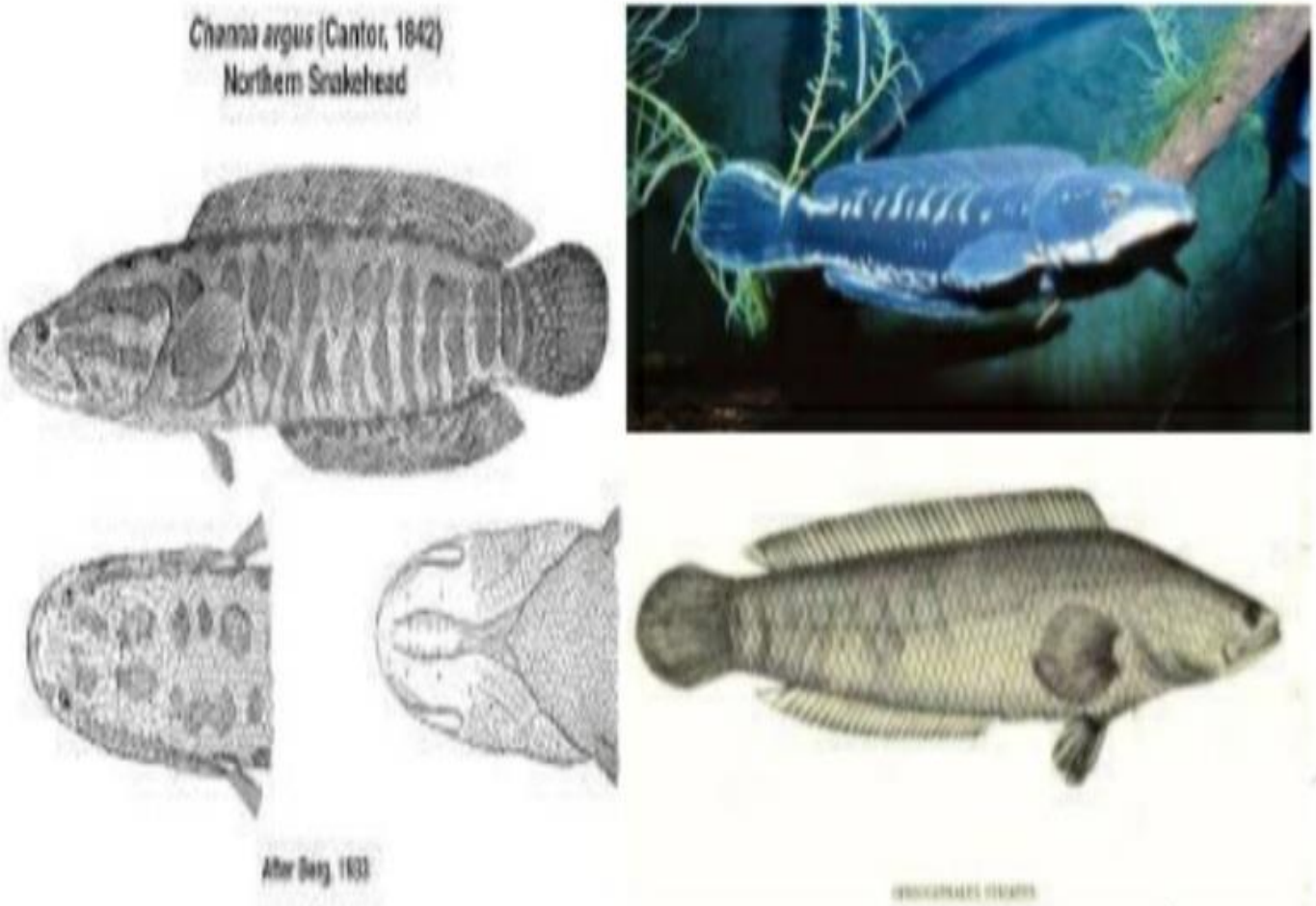
Pharyngeal Air Sacs

Lungfish

paired air sacs, but on one side

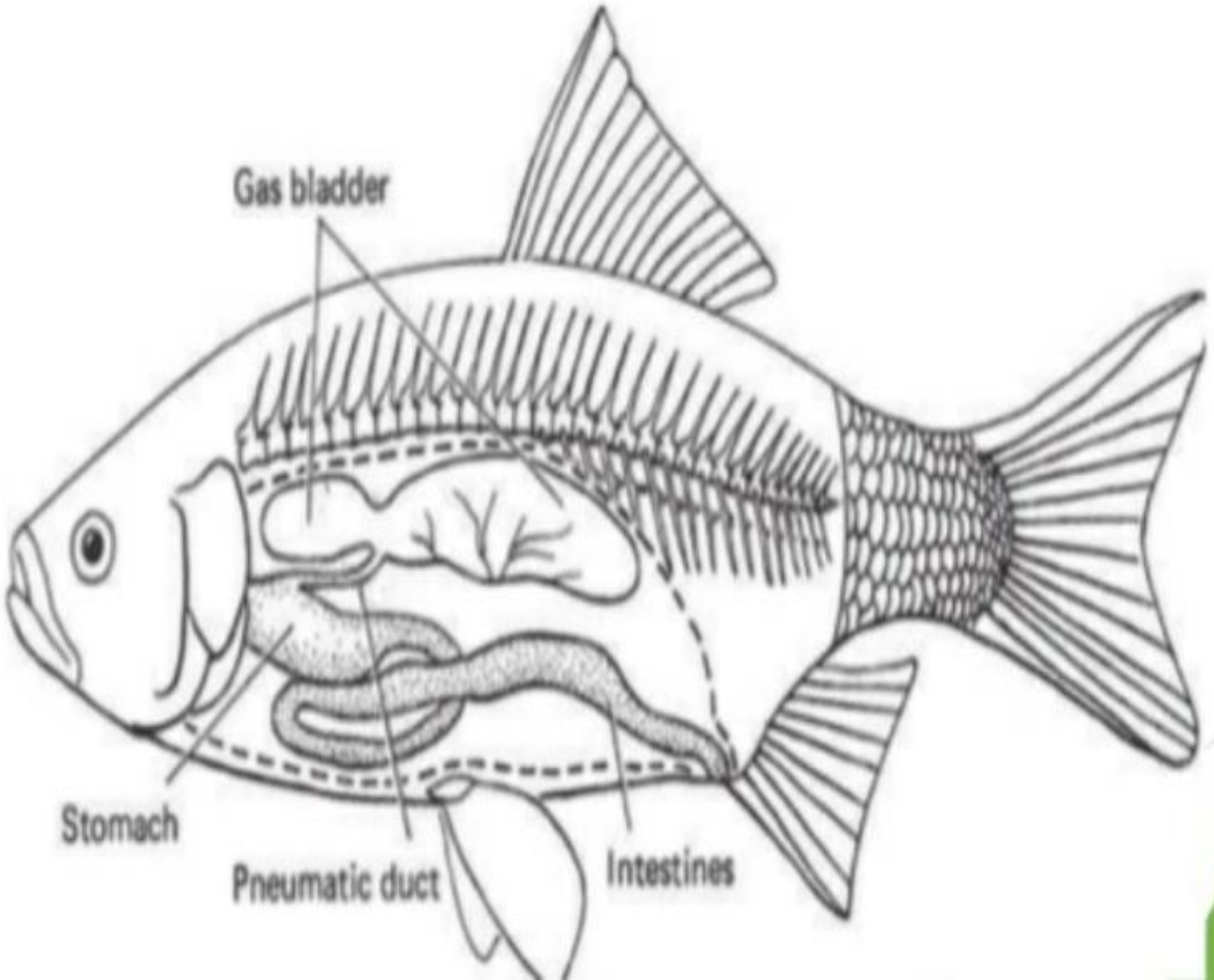


Channa

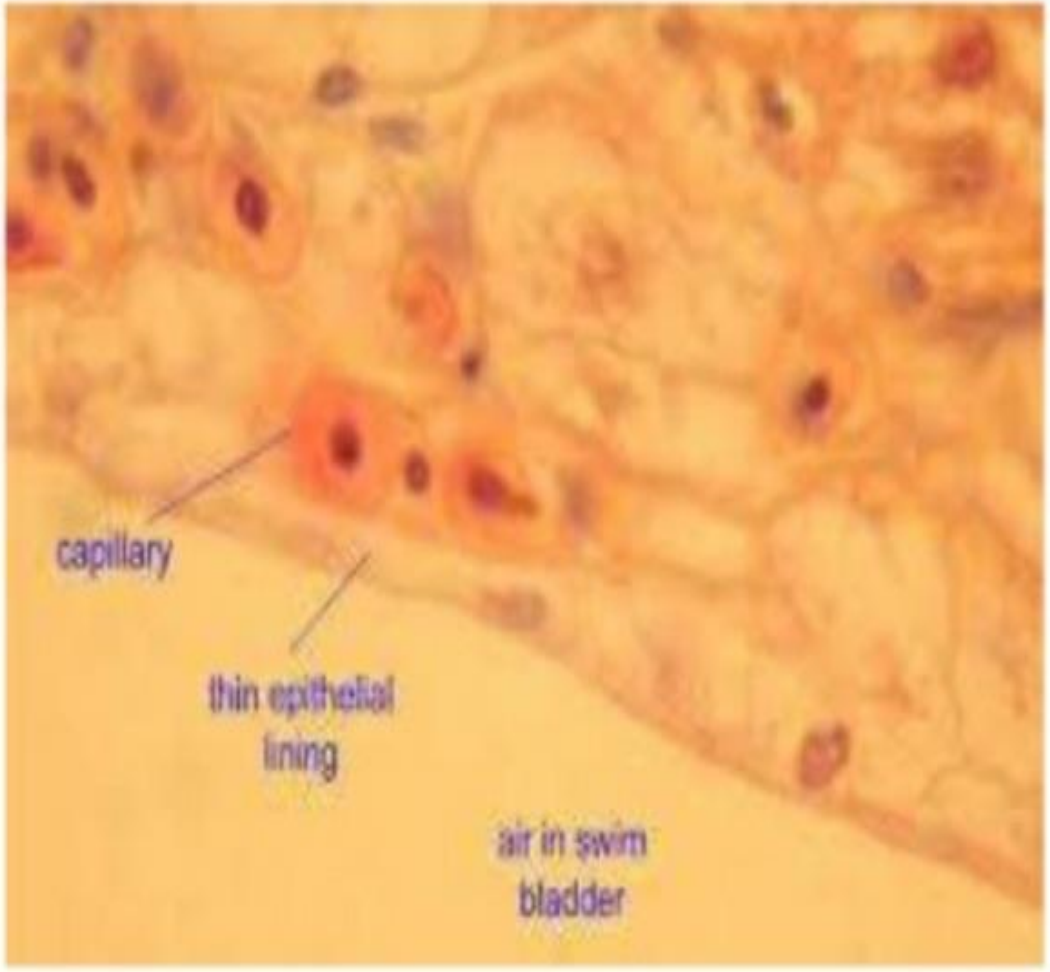

Channa argus (Cantor, 1842)
Northern Snakehead
After Berg, 1933

Amphipnous

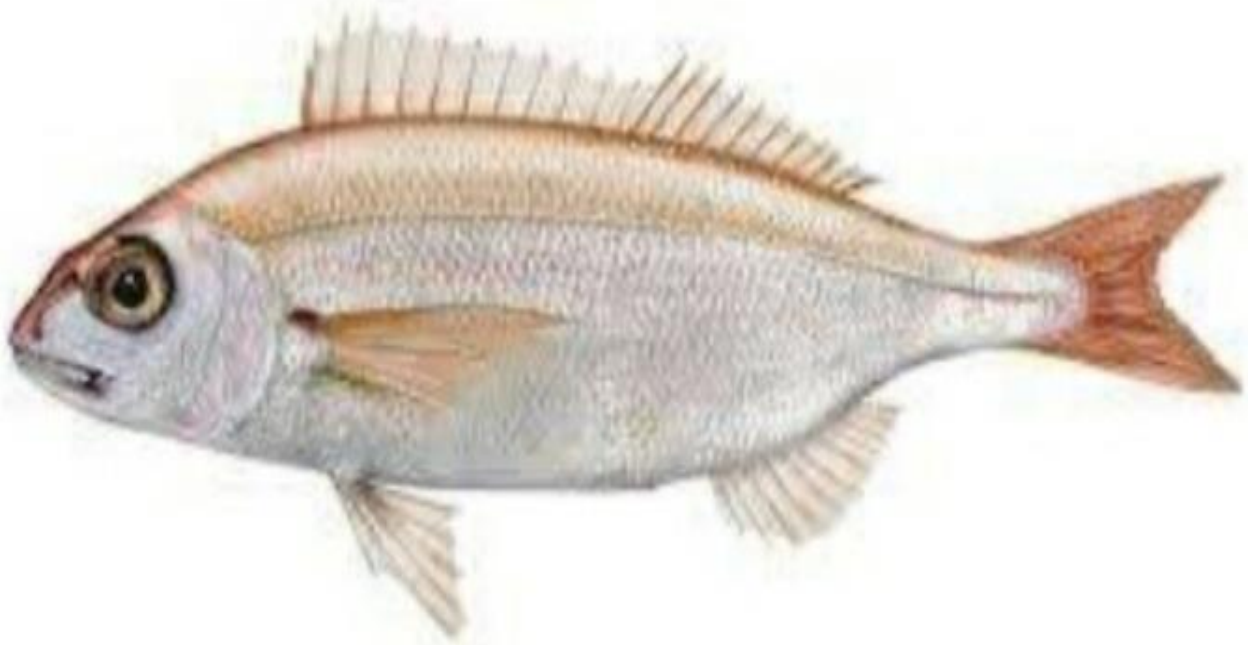
Gas bladder



Gas bladder



Erythrinus



Polypterus

Lung fishes eg:Protopterus

Respiration Through Air Reservoirs

- In a number of fishes accessory respiratory organs are air sacs or air reservoirs.
- It specialized air storage and gas exchange.
- They may extensions or outpushing of the branchial chamber, buccal cavity ,pharynx, stomach or intestine

The commonest type of air reservoirs

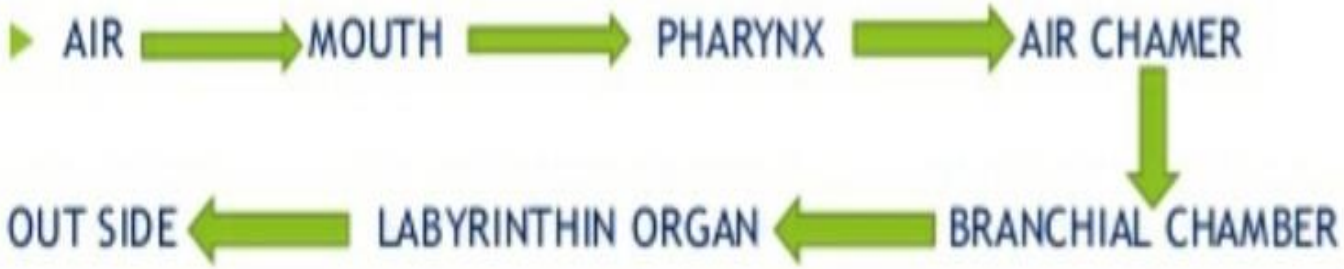
- labyrinthine organs
- branchial air tubes
- intestinal air reservoirs

arborecent or dendriform organs

pharyngeal air sacs

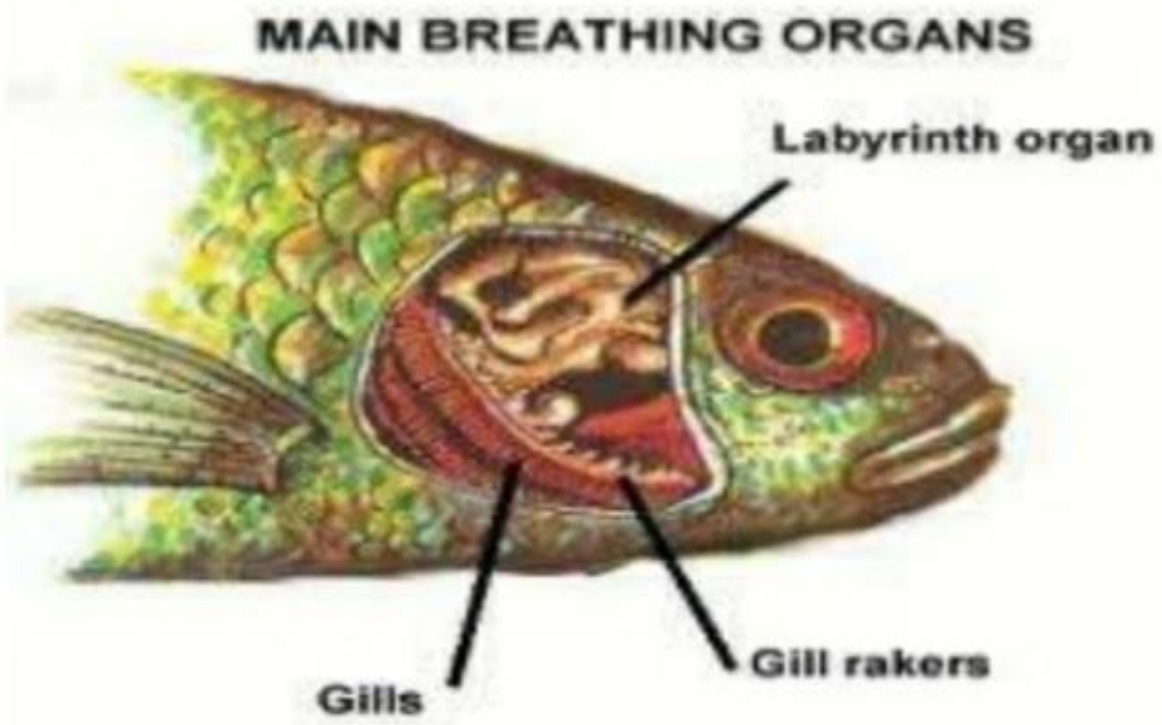
Labyrinthine organs

- Accessory respiratory organs are labyrinthine like structure.
- It develop from branchial epithelium.
- Mainly it located one on each side above the gills.

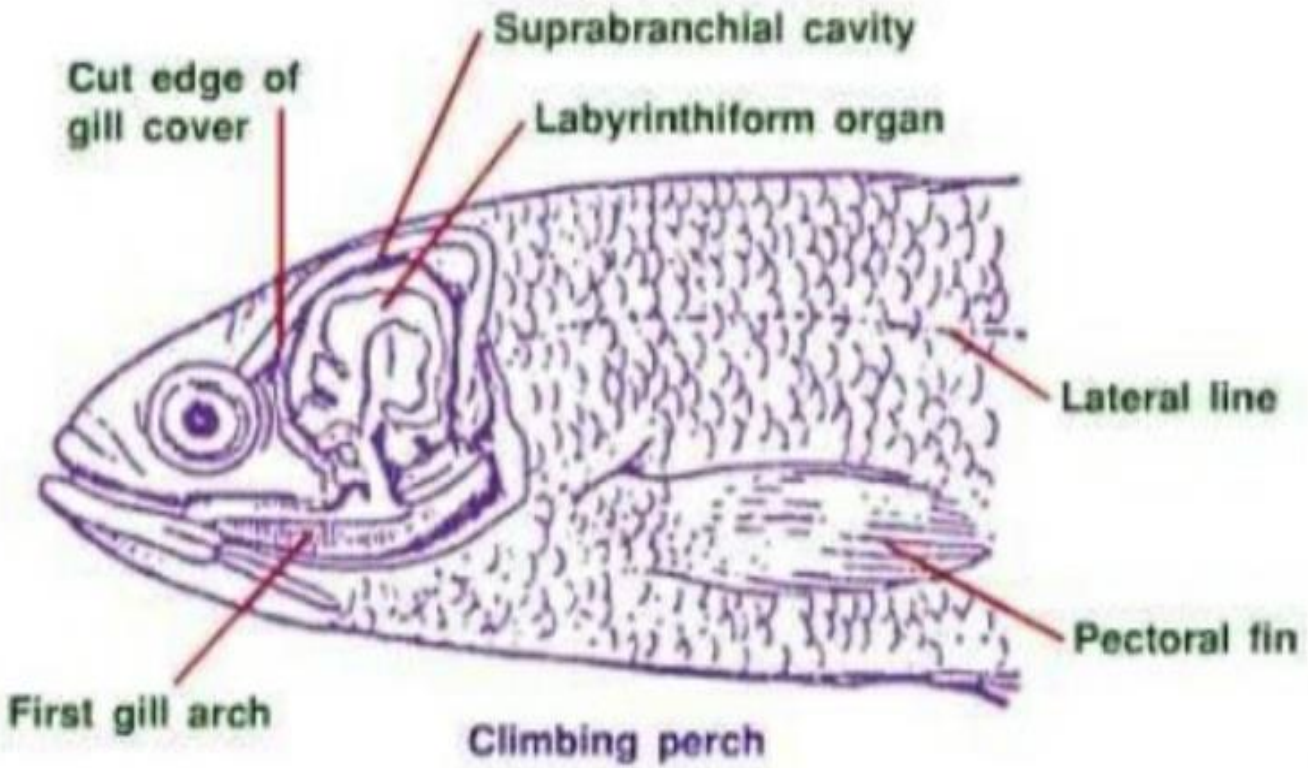


Eg: Anabas , Osphronemus, Macropodus , Betta

Labyrinthine Organ



Labyrinthine Organ



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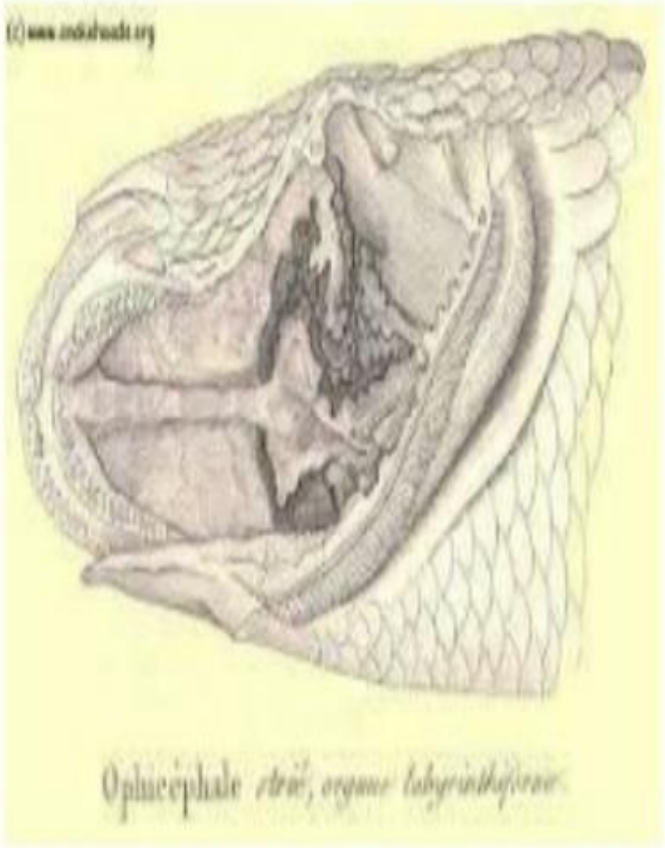
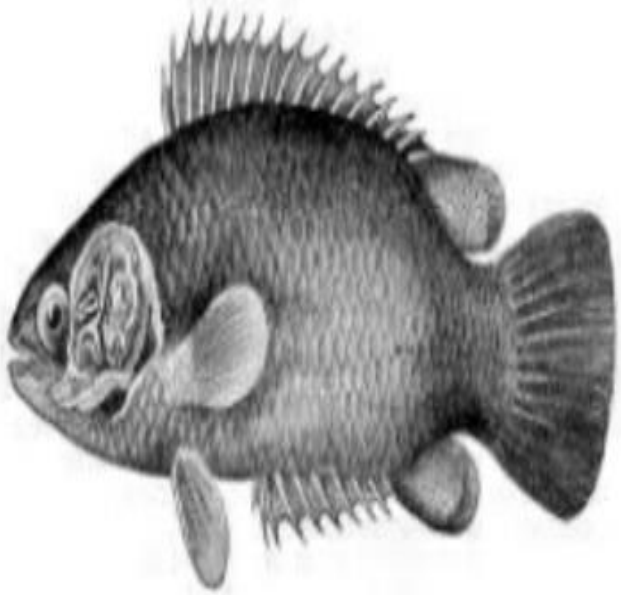
Labyrinthine organ in fishes



Labyrinthine organ fishes

Anabas



Osphronemus

Osphronemus

Labyrinthine organ in fishes

Macropodus

Betta

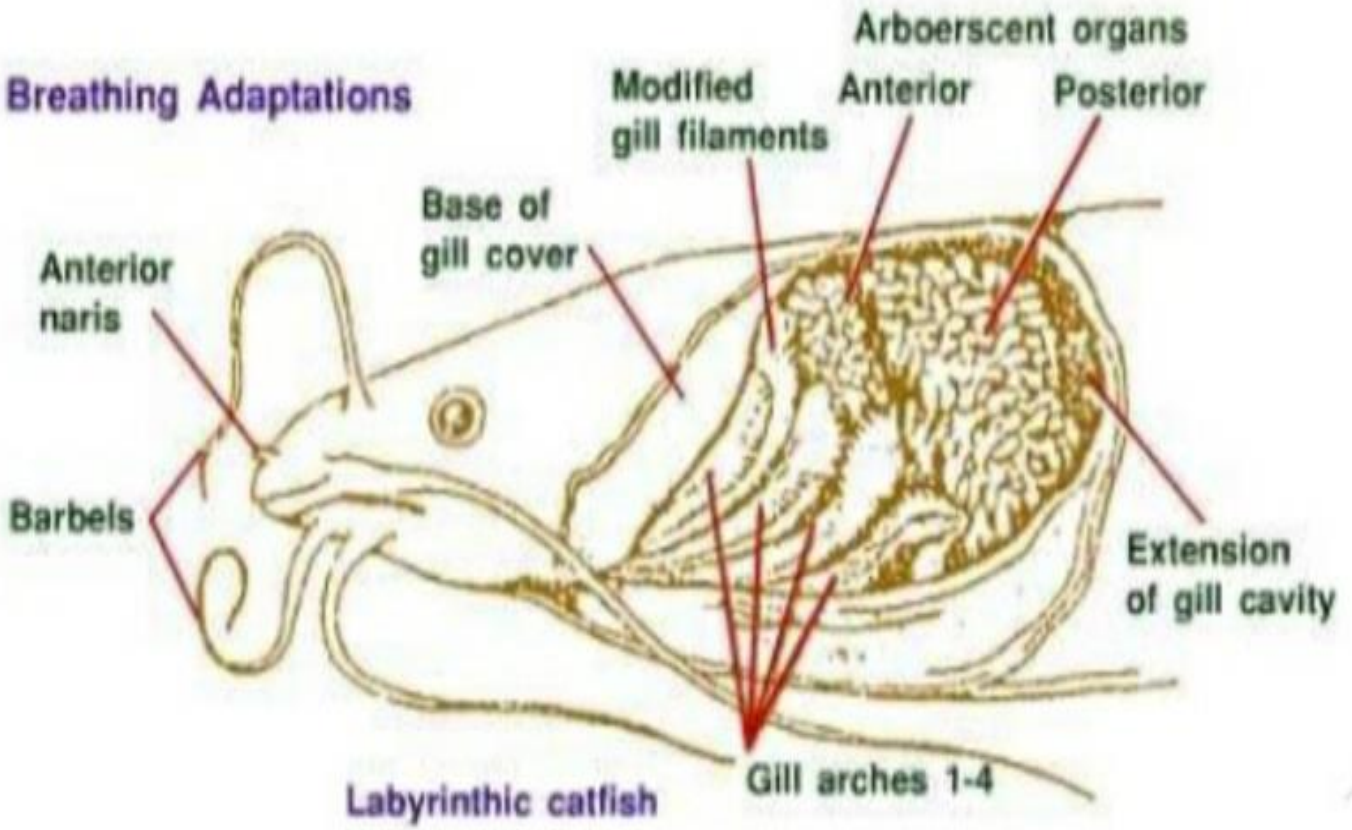
Betta

Arborescent Organs or Dendriform Organs

- It is an two air chambers which are extensions of the branchial cavities.
- The air chamber contains two richly vascular branching structures, called as dendriform organs or arborescent organs.
- The surface of arborescent organs covered by vascular fold of branchial epithelium .The organs provide a respiratory surface for gas exchange.

Eg: Some cat fish Clarias, Heterobranchus

Arborescent organ



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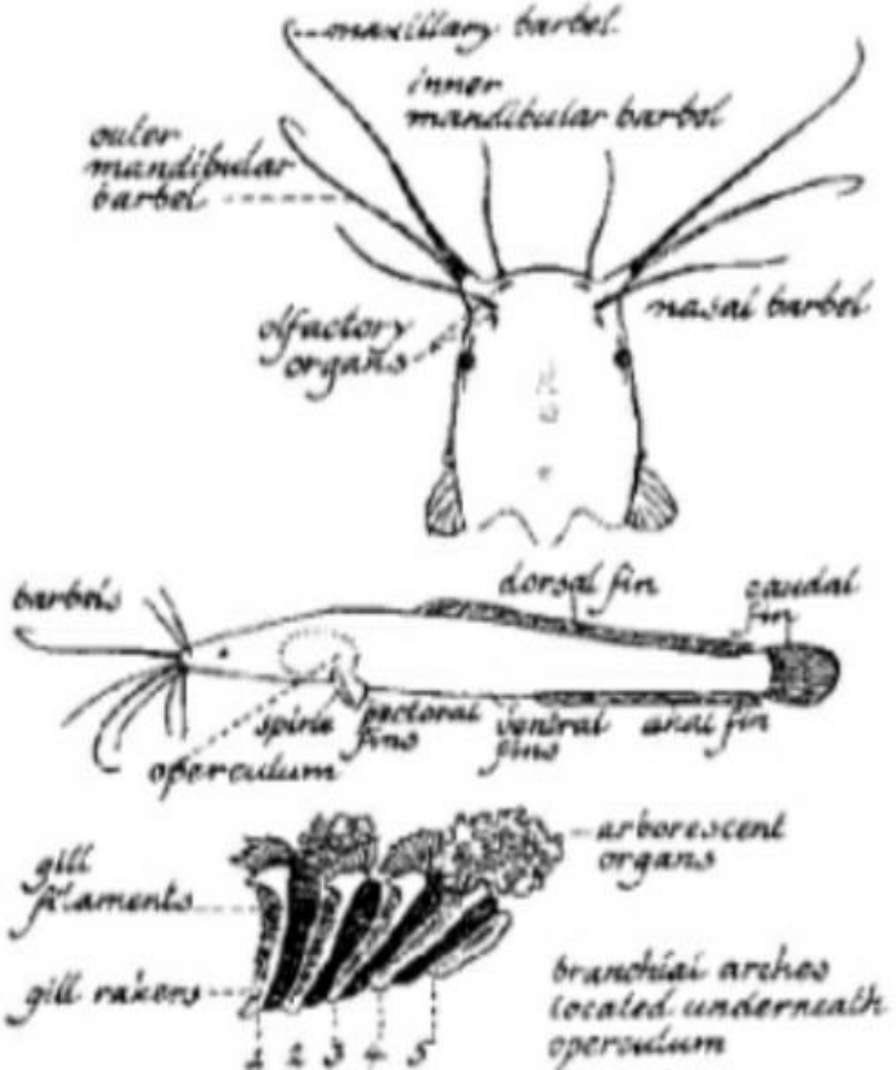
Arborescent organs



Clarias

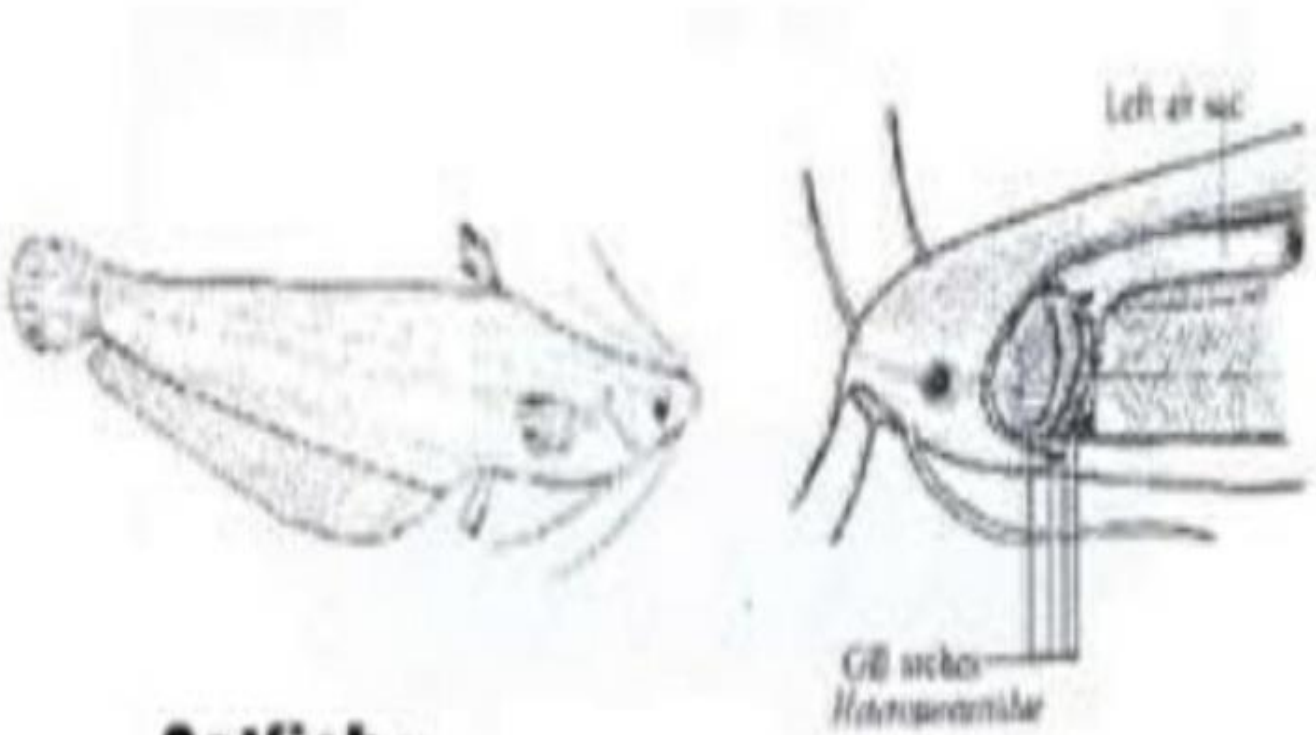
Heterobranchus

Branchial Air Tubes

- It is an long lung like air tubes
- The tube situated one on each side of the vertebral column.
- They are extension of the branchial chamber and extentend middle of tail .It provides a respiratory surface for gas exchange.

Eg : Heteropneustes

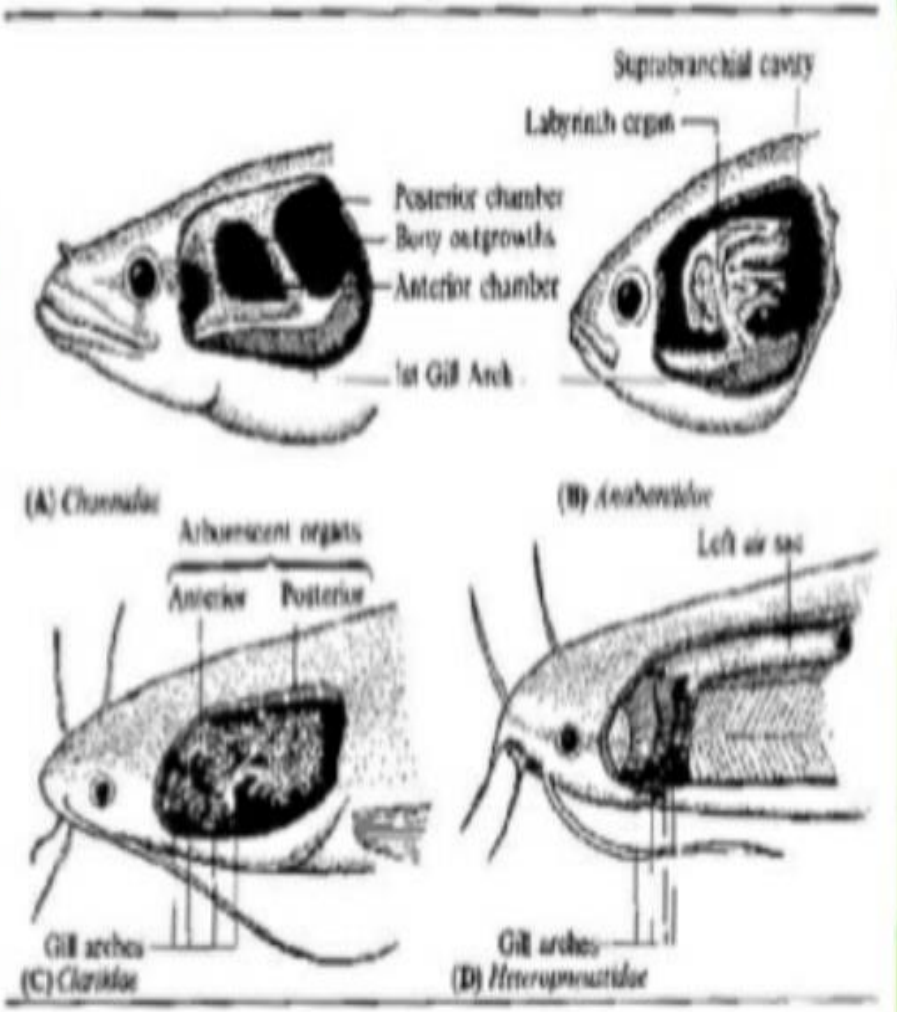
BRANCHIAL AIR TUBE



Catfish.ir

Branchial Air Tube

- A--- AIR SAC
- B---LABYRINTHINE ORGAN
- C---ARBORESCENT ORGAN
- D---BRANCHIAL AIR TUBE



Heteropneustes

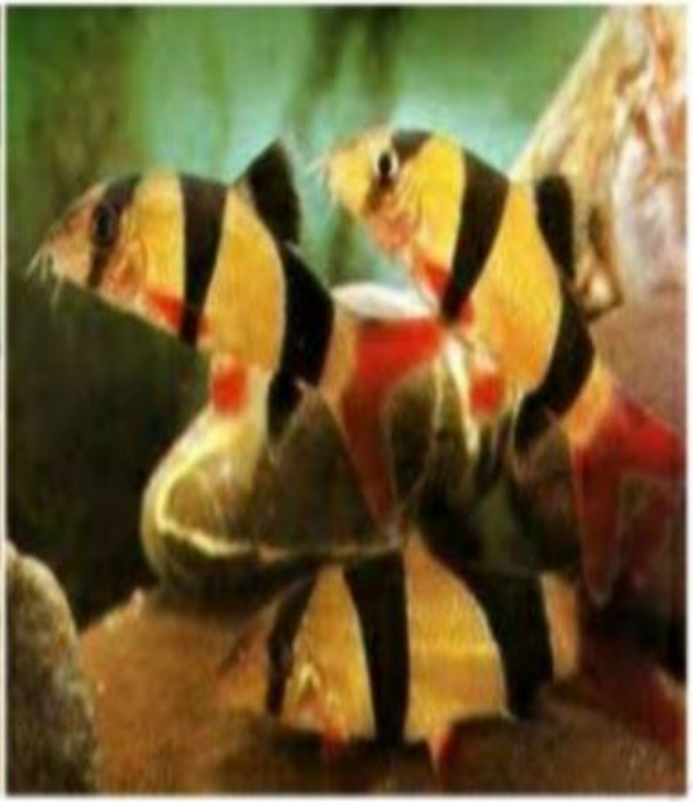
Intestinal Air Reservoirs

- unusual method of air breathing ,specialized vascular pouch present on intestine Eg: Cobitidae,Doras
- rectum is used as an air reservoirs

Eg: Cat Fish Callichthys

CALLICHTHYS

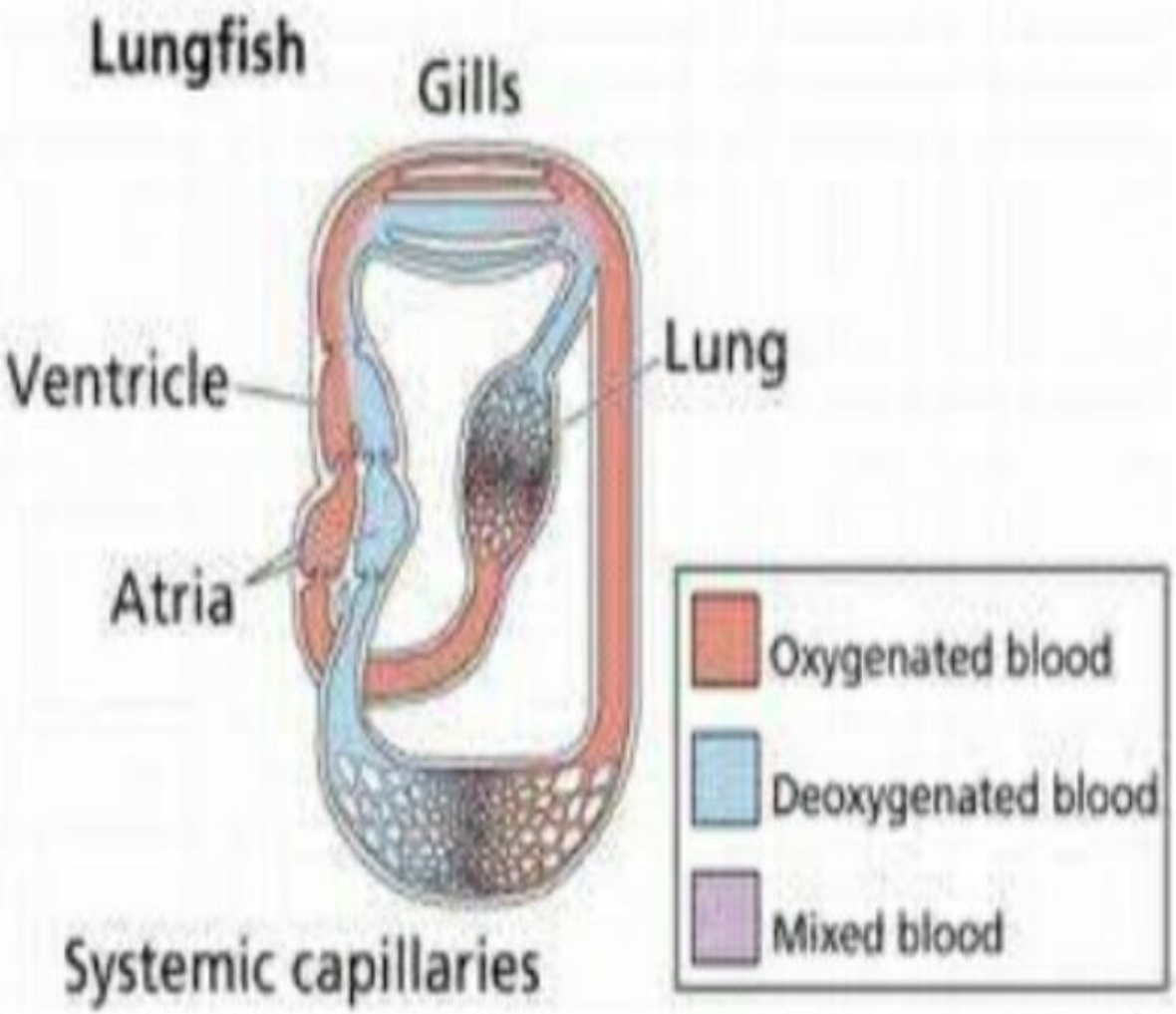
COBITIDAE



Pulmonary Respiration By Gas Bladder And Lung

- some surviving primitive fishes use lungs as air breathing organ.(eg:Amia,Lepidosteus,Polysterus)
- The gas bladder of some teleosts play important role in air-breathing.(eg:Erythrinus,Umbra,Gymnarch)

Circulation Of Blood



Amia

Affinities of Branchiostoma | Zoology

Affinities # Branchiostoma with Mollusca:
Molluscs and Branchiostoma differ widely. Superficial resemblances in ciliary feeding and respiratory mechanism (no gill slits in molluscs) have no phylogenetic significance.

Affinities # Branchiostoma with Echinodermata:
Similarities:
1. Early development cleavage, gastrulation and mesoderm formation.

2. Three separate enterocoelic cavities.

3. The pores of the calyx of some fossil carpoid echinoderms are similar to the gill slits of Branchiostoma.

4. Presence of creatin phosphate and phosphagens.

At present, the echinoderms are not considered as an ancestor of chordates. The similarity is presumably due to a remote common origin of both the groups.

Affinities # Branchiostoma with Hemichordata:
Similarities:
1. Pharyngeal apparatus.

2. Feeding and respiratory mechanism.

3. Origin and development of enterocoelic coelomic pouches.

Affinities # Branchiostoma with Urochordata:
Similarities:
(Tadpole larva and branchiostoma):
1. Body shape and a fin-bearing tail.

2. Notochord extends nearly whole body length.

3. A hollow nerve cord above notochord.

4. Pharynx with endostyle, pharyngeal and epipharyngeal grooves.

5. Feeding and respiratory mechanism.

Affinities # Branchiostoma with Cyclostomata:
Similarities:

(Branchiostoma and ammocoete larva):
1. Body elongated bearing a continuous dorsal.

2. Presence of an oral hood.

3. Velum guards the mouth.

4. Presence of endostyle.

Affinities # Adult Branchiostoma and Cyclostomata:
Similarities:
1. Presence of myotomes.

2. Presence of gill slits.

Dissimilarities:
1. Absence of vertebral column and paired sense organs in Branchiostoma.

Affinities # Branchiostoma with Vertebrata:
Similarities:

1. Presence of pharyngeal gill slits.

2. Presence of notochord.

3. Presence of dorsal, hollow, tubular nerve cord.

4. Presence of phosphocreatin and phosphoarginine, the sources of energy supply for muscular activity.

The old concept that Branchiostoma is a recent derivative of ascidians has been abandoned. Alternatively, Acrania may be a specialised and degenerate descendant of the Agnatha.

The evidence as to the real position of acrania is still insufficient, but investigations tend to bring them nearer to the crariiates. It is probable that the Branchiostoma and its allies, fish-like creatures existed in Silurian seas, and the vertebrates evolved from animals of that kind.

AMPHIOXUS (BRANCHIOSTOMA)

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External features

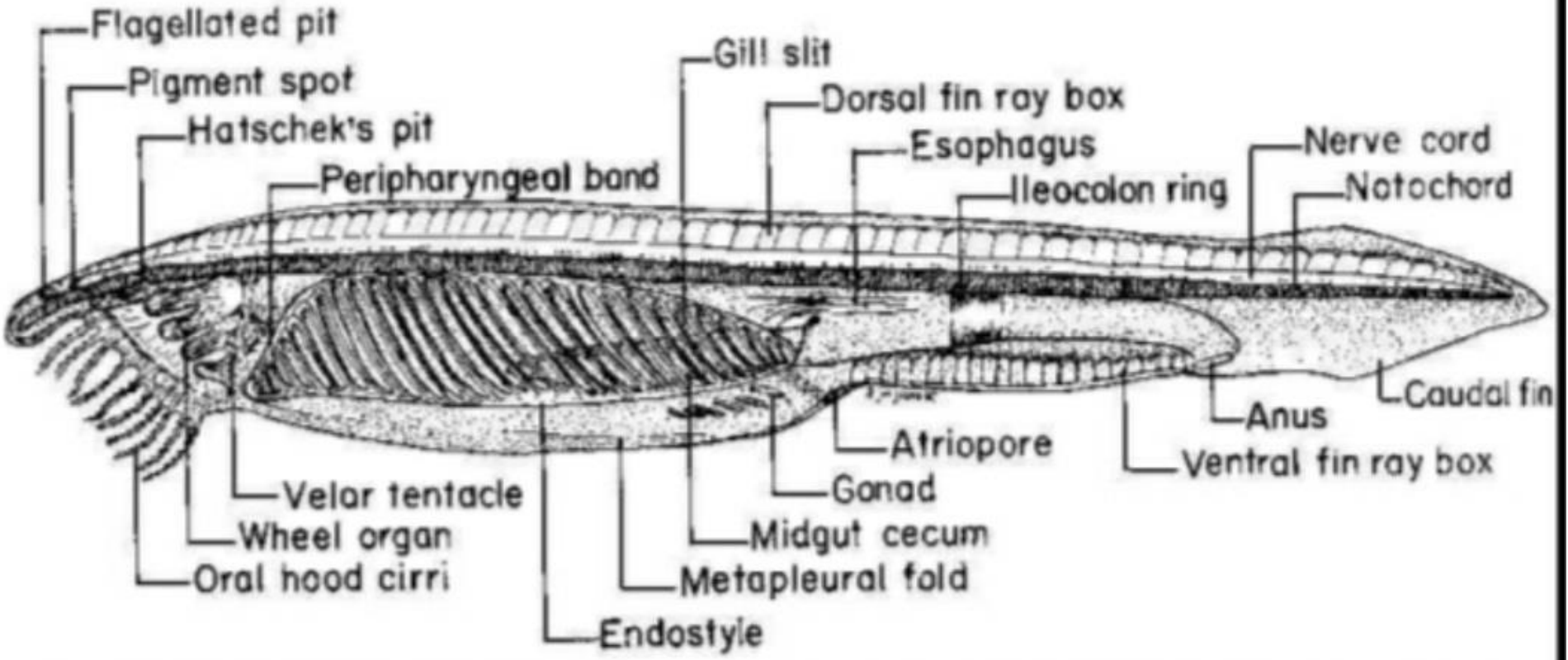


Figure 1–4. A lateral view of a whole mount slide of a young specimen of *Amphioxus*.

External features

- **Myotomes and Gonads :**
  - On each lateral side of the body a series of < shaped muscle bands, called the myotomes are present.
  - Below the myotome, Between mouth and atriopore a series of gonads are found on either side.
- **Body wall :**
  - Body wall includes from outside
    - A thin, delicate and transparent **skin** (Integument)
    - A well developed **musculature** and
    - A parietal **peritoneum**

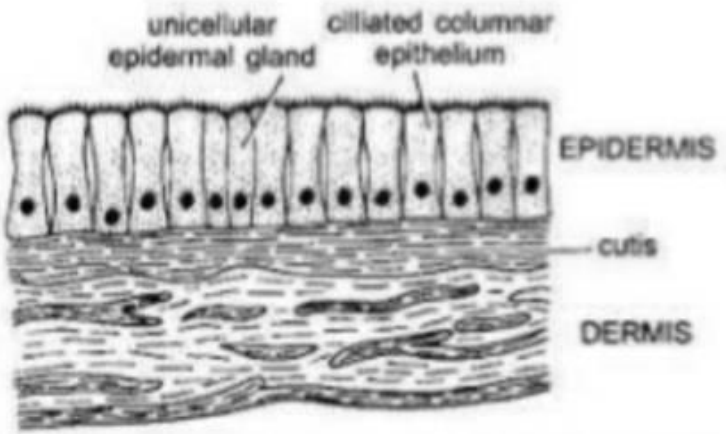


Fig. 41.10. V.S. of skin of a young *Amphioxus*.

External features

- **Skeleton :**
  - Exoskeleton absent
  - Endoskeleton present but they are neither bony not cartilagenous
  - **Notocord** : Chief axial endoskeleton, structurally it is elongated, narrow, cylindrical and rod like
  - **Other skeletal structures** : fin ray boxes supporting fins, oral ring supporting oral hood, gill rods supporting gill slits
- **Coelom :**
  - True coelomate
  - Enterocoelomate filled with coelomic fluid
- **Atrium :**
  - Space formed by metapleural folds one on either side of gill slits of embryo
  - **Gill slits opens directly into atrium**

Digestive system

- Complete type, consist of Alimentary canal and digestive glands
- **Alimentary canal :**
  - Mouth
  - Oral hood
  - Buccal cavity
  - Pharynx
  - Oesophagus
  - Intestine
  - Anus

Digestive glands :

Mid gut diverticulum (Liver)

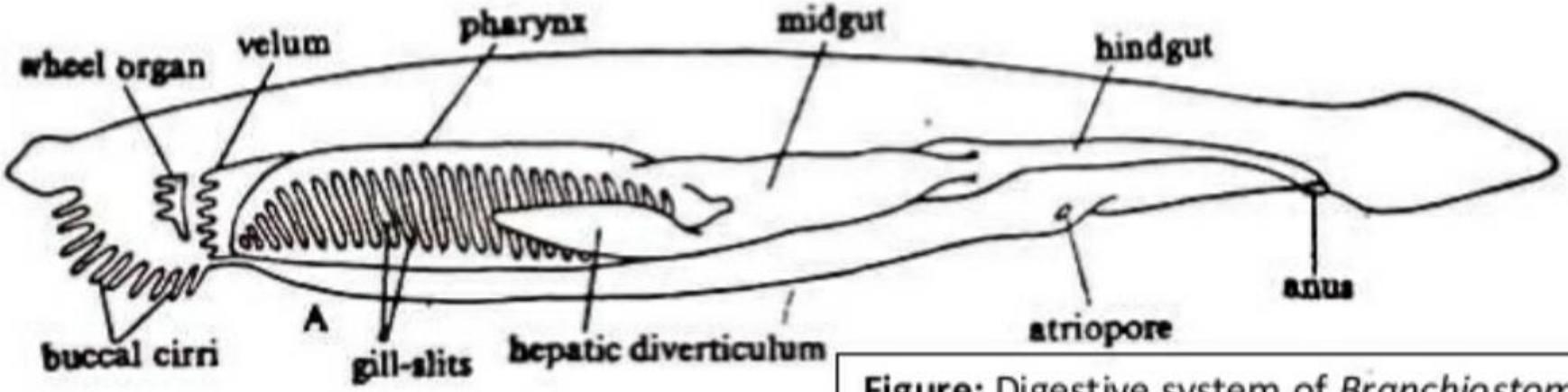


Figure: Digestive system of *Branchiostoma*

Digestive system

- **Physiology of digestive system:**
  - **Food**: Microphagus
  - **Feeding** : Ciliary or filter feeder
  - **Digestion** : Digestion starts in midgut. Midgut diverticulum and midgut epithelium secretes digestive enzymes like amylase, lipase and protease. Digested food is absorbed in midgut and hindgut and undigested food is thrown out of anus.

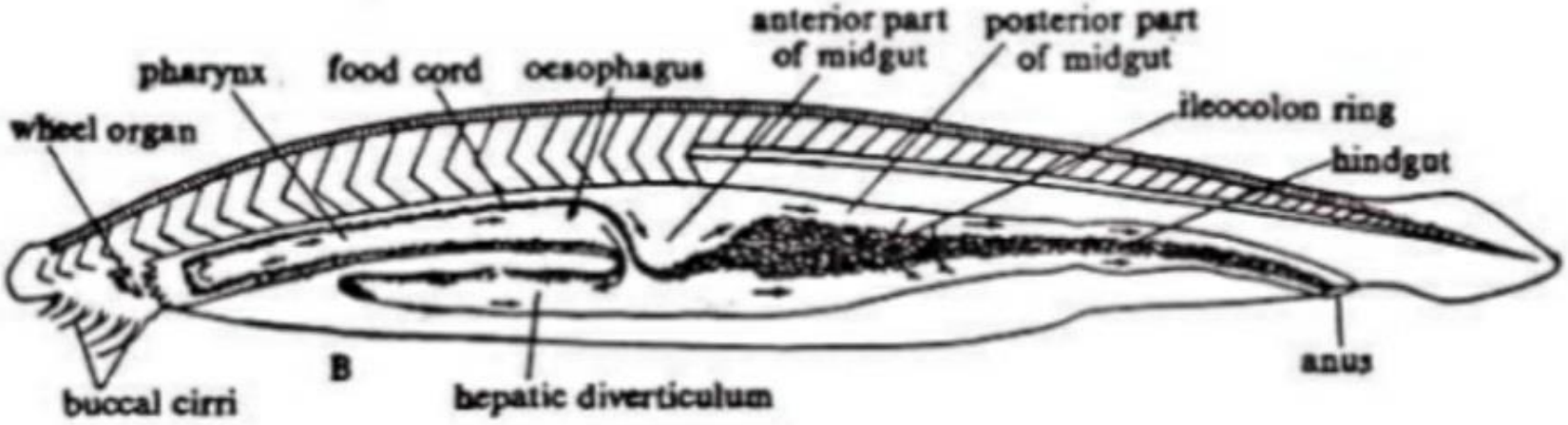
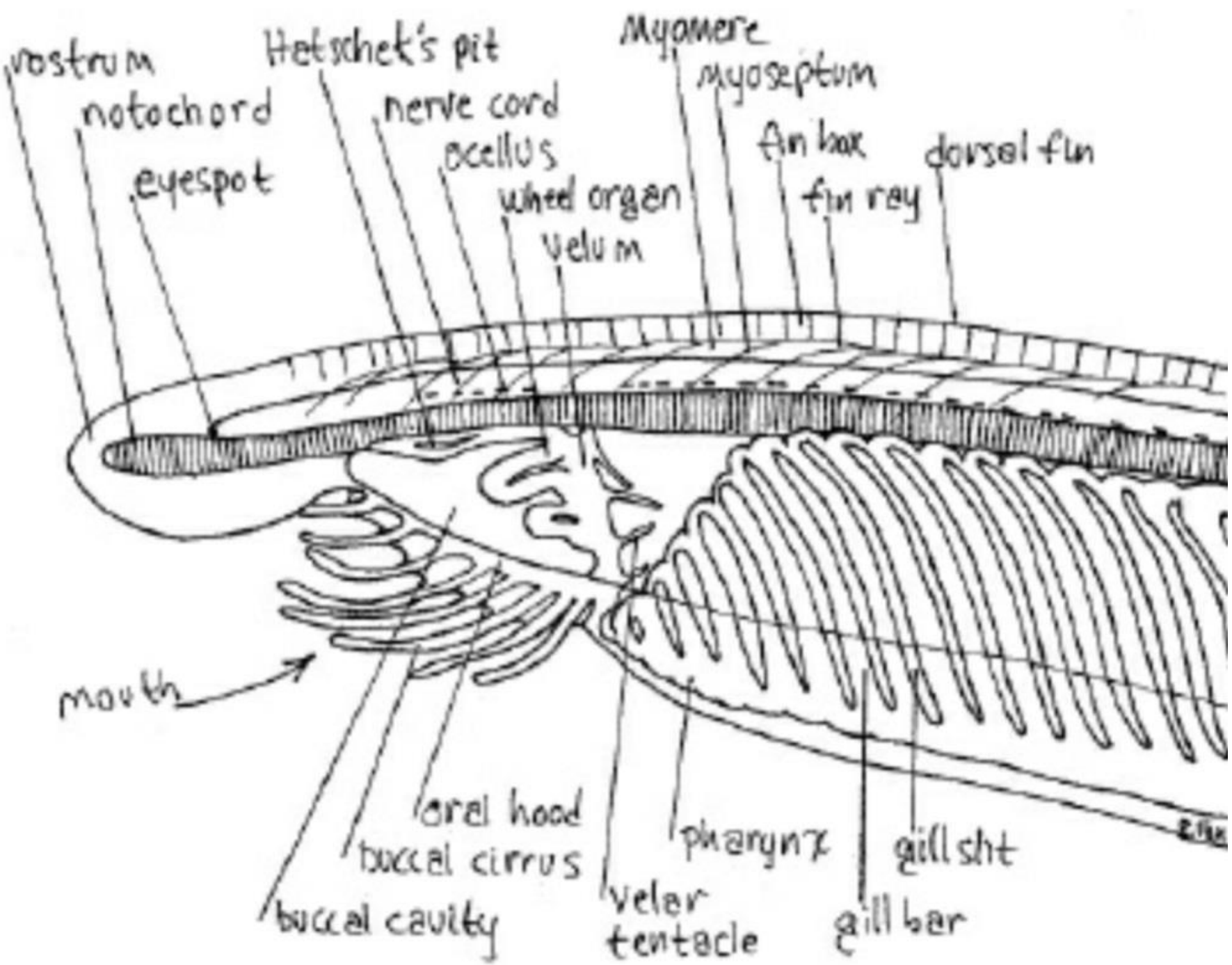
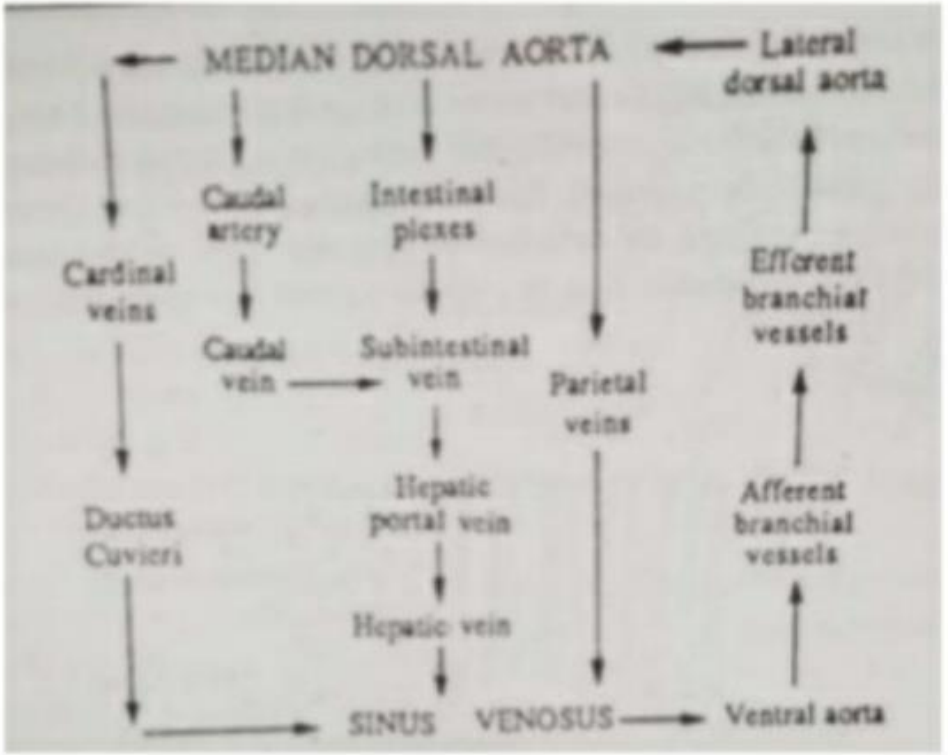


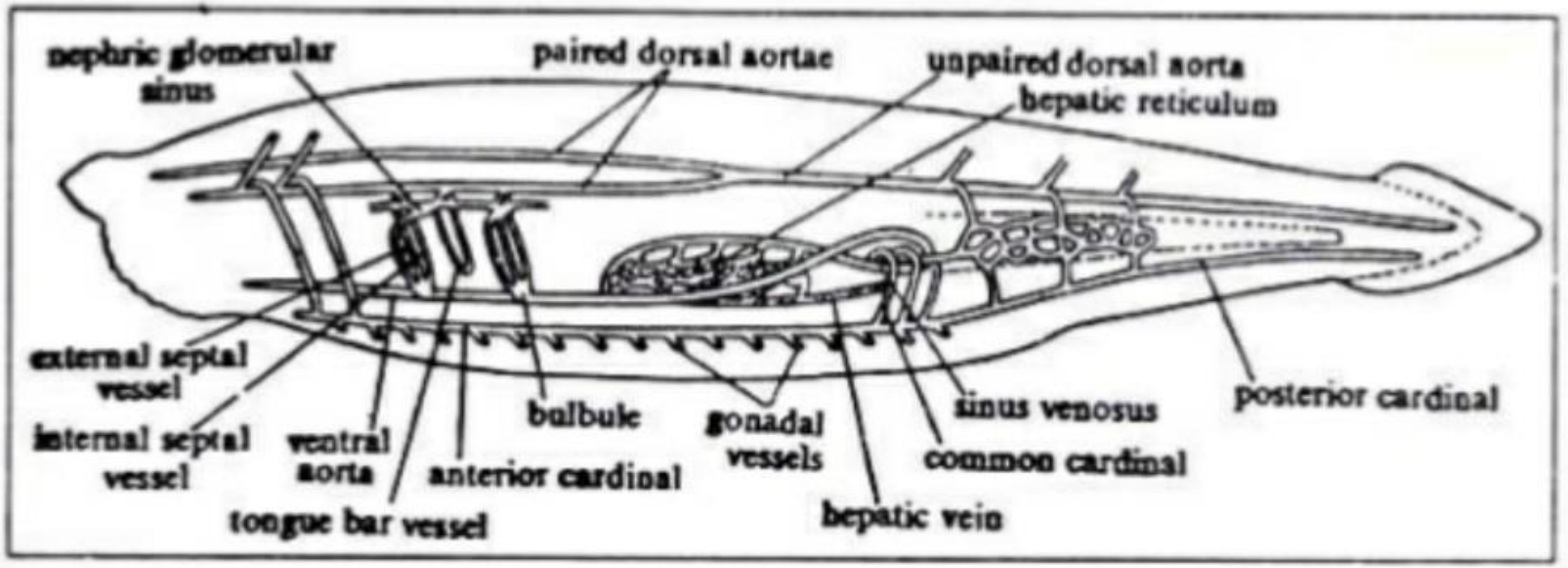
Figure: Schematic representation of feeding current through the gut


rostrum
notochord
eyespot
Hetschek's pit
nerve cord
ocellus
wheel organ
velum
Myomere
myoseptum
fin bar
fin ray
dorsal fin
mouth
buccal cavity
oral hood
buccal cirrus
velar
tentacle
pharynx
gill slit
gill bar

Circulatory system

- **Coarse of circulation :**





Circulatory system

- **Principle vessels and their branches**

1. **Sinus venosus :** blood from different parts of the body is collected into large sac called sinus venosus
2. **Ventral aorta :** From sinus venosus a large median artery extend forward and runs mid ventrally
3. **Dorsal aorta :** From the gill bars the blood is collected by the paired right and left lateral dorsal aorta
4. **Sub intestinal vein :** the blood from tail region is collected in sub intestinal vein
5. **Hepatic portal system :** The sun intestinal vein continues at the hepatic portal vein
6. **Cardinal veins :** the blood from ventro lateral region is collected by an anterior and posterior cardinal vein
7. **Parietal veins :** Blood from dorsal body wall is collected by a pair of parietal vein

Circulatory system

- Closed type
- Colorless blood due to lack of blood pigment
- Role of blood is to transport food and excretory waste.
- Heart is absent and blood is present in blood vessel and lymph vessel
- It consist of following vessels : Sinus venosus, Ventral aorta, Dorsal aorta, Sub intestinal vein, Hepatic portal system, Cardinal veins and Parietal veins

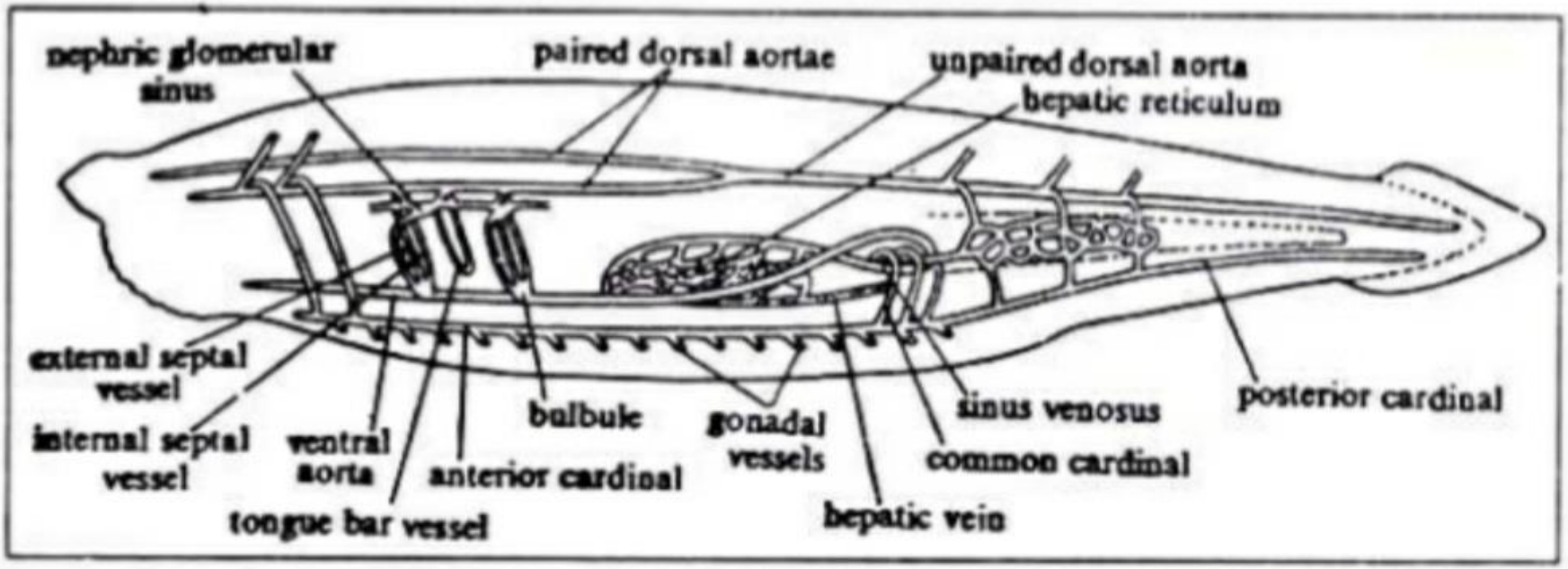
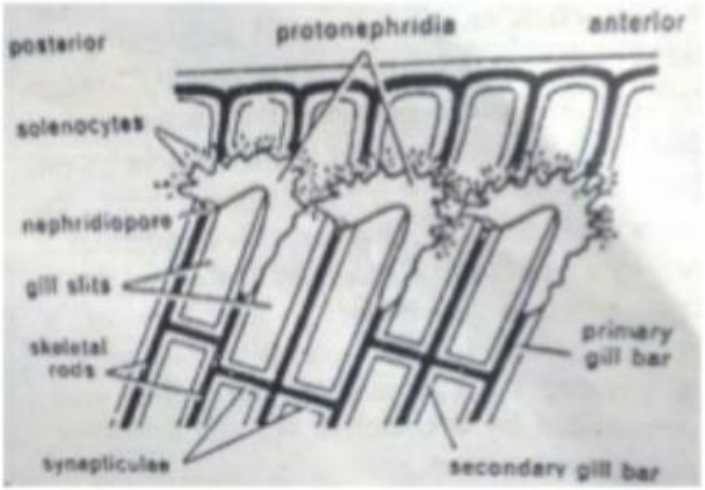


Fig. 3.17 : Diagrammatic view of the circulatory system of *Branchiostoma* (after Jollie, 1962).

Excretory system

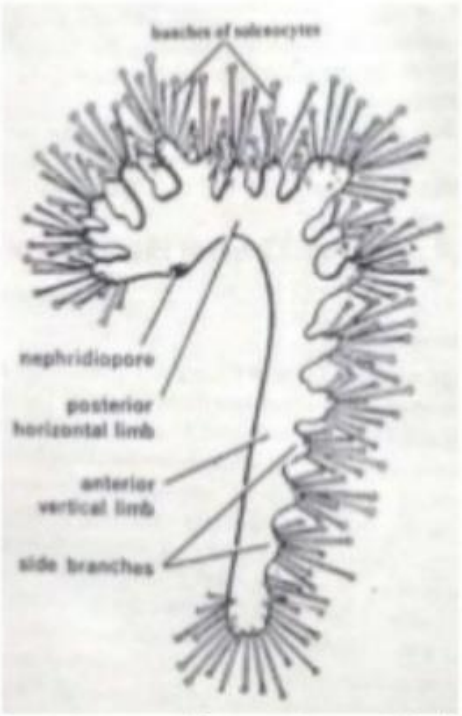
- Lacks kidney
- Excretion occurs through solenocytes
- Solenocytes of Amphioxus are closely resemble the protonephridia of flatworm or annelids **(Parallel evolution)**



Position of nephridia on pharyngeal wall

1. Protonephridia :

- Simple, closed, ciliated sac like and thin walled ectodermal tubules present on pharyngeal wall on each gill.
- It is bent forming posterior horizontal and anterior vertical limb.
- Vertical limb is blind while horizontal limb opens into atrium through nephridiophore
- It gives several small branches, called flame cells or solenocytes.



Structure of protonephridia

2. **Hatschecks nephridium :**

- A single long and straight tube, called the nephridium of hatschecks lies in the roof of oral hood slightly towards left and ventral to notochord.
- Supplied blood by the dorsal aorta
- Structure basically like protonephridia and extracting nitrogenous wastes

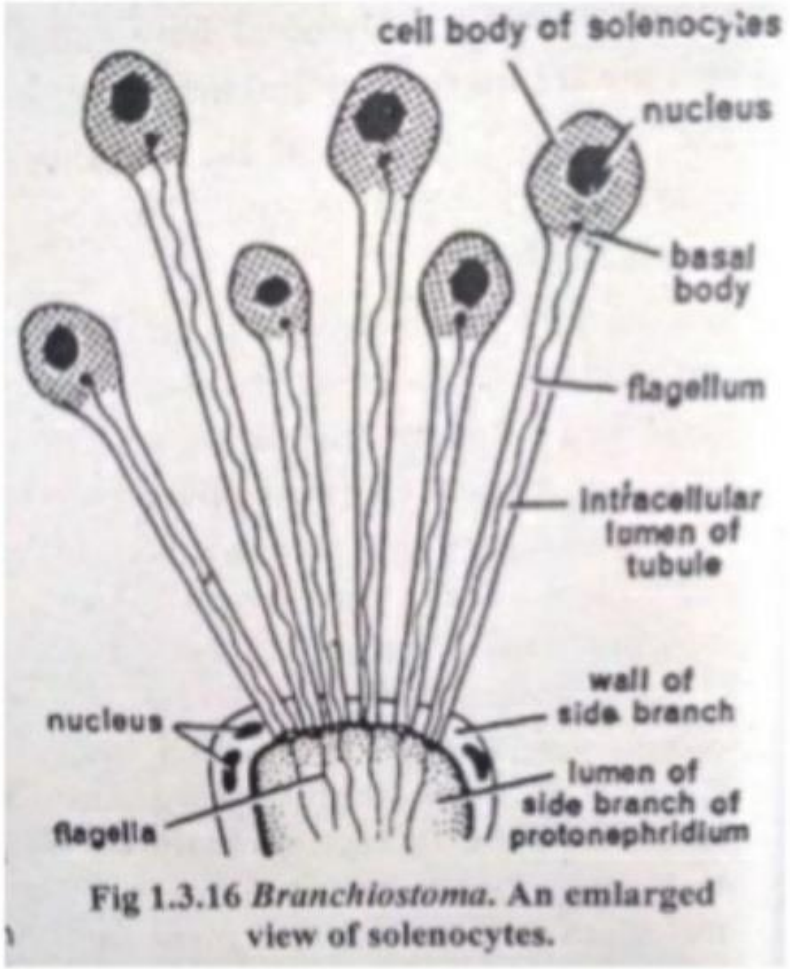
3. **Brown funnel :**

- Two sac like brown funnels are situated dorsally upon the posterior end of pharynx.
- It is excretory

4. **Renal papillae :**

- Group of cells present on the flow of atrial cavity form renal papillae which are probably also excretory in function

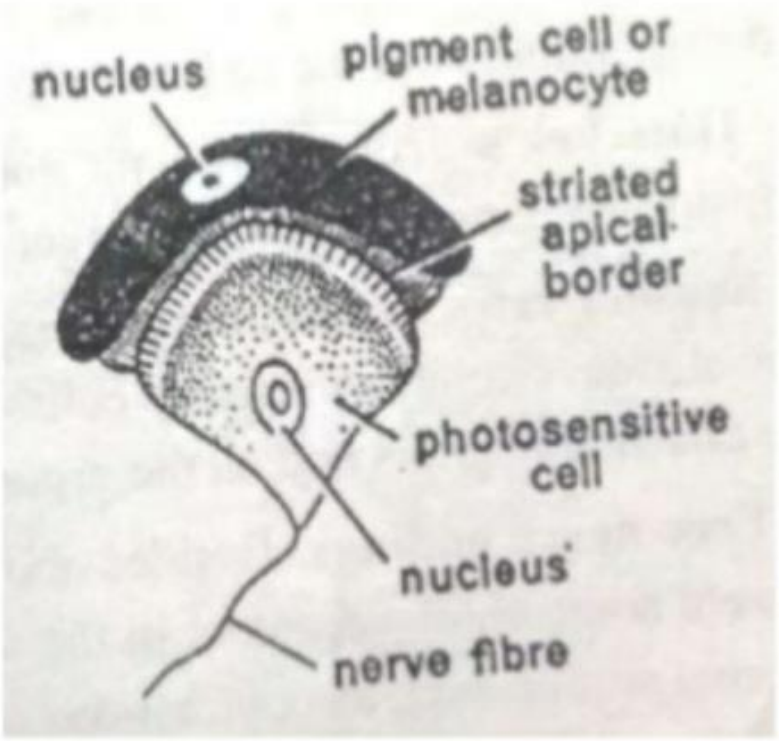
- **Solenocytes** : Nephridium bears about 500 solenocytes, consisting of tiny rounded nucleated cell body and a long hollow stalk or tubule
- Nephridia are richly supplied with blood vessel and solenocytes freely project into coelomic fluid
- Excretion occurs by simple diffusion
- Nitrogenous wastes are extracted by solenocytes from blood, discharged by nephridiophore into the atrium and passed out of body through atriophore with the outgoing water current



Structure of Solenocytes

Sense Organs (Receptors)

- **Eye spots or ocelli :** Photoreceptors distributed on the ventro-lateral sides of nerve cord. Made up of two types of cells an outer pigment cell or melanocyte and an inner photosensitive cell.
- **Cephalic pigment spot :**
- **Infundibular organ :**
- **Kollichers pit :**
- **Hatscheks groove :**
- **Sensory cells and papillae :**
- **Free nerve endings :**



Eye spots or ocelli