

UNIT-1V

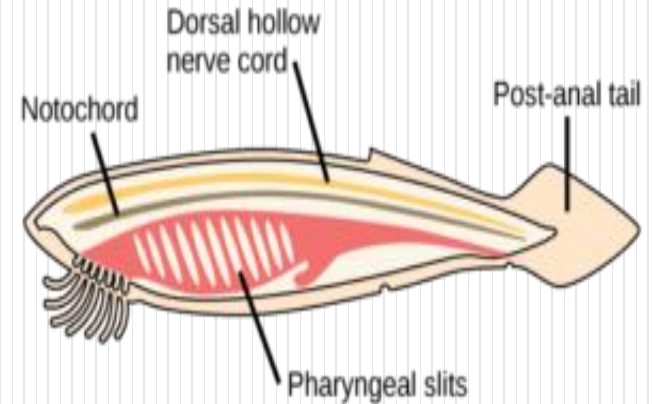
**Protochordata:- Hemichordata- Balanoglossus ,
Urochordata-Salpa and Cephalochordata-
Amphioxus. Organization, phylogenetic
considerations. General characteristics of
vertebrates and classification up to classes. Pisces:-
Definition, general characters, classification,
structural and functional adaptations of fishes.**

Phylum Chordata

- ✓ A chordate is an animal that belongs to the *phylum* Chordata, which is part of the Deuterostomes *kingdom*.
- ✓ Organisms in the Deuterostomes kingdom have a distinct characteristic: their anus develops before their mouth in early embryonic stages.
- ✓ The phylum Chordata includes a wide range of organisms, as it is comprised of all *vertebrates*, which are organisms with a backbone, and many *invertebrates*; organisms that don't have a backbone.
- ✓ Chordates have all of these characteristics, at least at some point in their lives. In many cases, these characteristics only appear during embryonic development

Notochord

- ✓ It is a longitudinal rod that is made of cartilage and runs between the nerve cord and the digestive tract.
- ✓ Its main function is to support the nerve cord.
- ✓ In Vertebrate animals, the vertebral column replaces the notochord.



Dorsal Nerve Cord

- ✓ This is a bundle of nerve fibres which connects the brain to the muscles and other organs.

Post-anal tail

- ✓ This is an extension of the body beyond the anus.
- ✓ In some chordates, the tail has skeletal muscles, which help in locomotion.

Pharyngeal slits

- ✓ They are the openings which connect the mouth and the throat.
- ✓ These openings allow the entry of water through the mouth, without entering the digestive system.

Characteristic Features of Phylum Chordata

- ✓ They are bilaterally symmetrical and triploblastic.
- ✓ Chordates are coelomate and show an organ system level of organisation.
- ✓ They have the characteristic notochord, dorsal nerve cord, pharyngeal slits. Also have a post-anal
- ✓ In this phylum, the nervous system is dorsal, hollow and single.
- ✓ The heart is ventral, with a closed circulatory system.
- ✓ The habitat of these animals is widespread in the marine environment, fresh waters as well as terrestrial environments.

Phylum chordata

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graph TD; A[Phylum chordata] --> B[Lower chordates: protochordata/acraniata (without cranium)]; A --> C[Higher chordates: Euchordata/craniata (cranium is present)]; B --> D[Sub phylum I Hemichordata (Eg: Balanoglossus)]; B --> E[Sub phylum II Urochordata/tunicata (notochord is present only in larval tail) (Eg: Salpa)]; B --> F[Sub phylum III Cephalochordata (notochord extends from head to tail region) (Eg: Amphioxus)];
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Lower chordates:
protochordata/acraniata
(without cranium)

Higher chordates:
Euchordata/craniata
(cranium is present)

Sub phylum I
Hemichordata

Eg: Balanoglossus

Sub phylum II
Urochordata/tunicata

(notochord is present
only in larval tail)

Eg: Salpa

Sub phylum III
Cephalochordata

(notochord extends from
head to tail region)

Eg: Amphioxus

Protochordata

- ✓ Protochordates are commonly called **lower chordates**.
- ✓ Protochordates are marine animals in which heterogeneous group of animals of phylum Chordata, related to the vertebrates
- ✓ They lack a head and a cranium, so they are also known as **Acraniata**.
- ✓ It resemble in possessing gill slits, noto-chord, and dorsal hollow nerve cord.
- ✓ Protochordates consists of three sub-phyla based on the property of notochord.
 - **Hemichordata**
 - **Urochordata** and
 - **Cephalochordata**.

General Characters Of Protochordata

- ✓ They are marine, small & primitive chordates
- ✓ Live singly & Feed on microbes or particulate matter
- ✓ Head, Skull & Cranium are absent
- ✓ Body covered by single transparent layer called Tunic.
- ✓ The body cavity is enterocoelic.
- ✓ They are jaw less animal.
- ✓ Pharynx with pharyngeal gill slits.
- ✓ Circulatory system includes blood without erythrocytes, heart, vessels and sinuses.
- ✓ Body bears protonephoric kidney.
- ✓ Nervous system is primitive .
- ✓ Sexes are separated or hermaphrodite.
- ✓ Development indirect with larval stage.

Hemichordata

- ✓ All hemichordates are **marine**.
- ✓ Some are **solitary** and slow moving, others are **sedentary** and **colonial**.
- ✓ It refers to the presence of a short notochord.

General Characters Of Hemichordate

- ✓ Solitary or colonial mostly marine tubicolous , soft and fragile animal.
- ✓ Body is divided in to 3 regions: **proboscis, collar and trunk**.
- ✓ Soft bodied, vermiform, triploblastic, bilaterally symmetrical unsegmented animal.
- ✓ Body wall with single layered epidermis lower layer dermis is absent.
- ✓ Body cavity is true coelom, divided into 3 parts i.e. **protocoel, mesocoel and metacoel**.

- ✓ Complete digestive tract straight with terminal anus.
- ✓ Gill slits are present or absent if present then number varies.
- ✓ Buccal diverticulum wrongly named as notochord, is present.
- ✓ Closed circulatory system is present.
- ✓ Blood is colorless without blood cell.
- ✓ Excretory system consist of the glomerulus and a proboscis gland lies in proboscis.
- ✓ Nervous system is primitive consist of intra-epidermal nerve plexus.
- ✓ Reproduction is sexual: sexes are separated or hermaphrodite.
- ✓ Gonids one or many pairs.
- ✓ Fertilization is external.
- ✓ They feed on micro-organism and debris by ciliary mechanism.
- ✓ There are about 70 species.

Classification of Phylum Hemichordata

✓ Phylum Hemichordata is again divided into two classes:

Enteropneusta:

- ✓ This class includes acorn worms.
- ✓ They have a vermiform body and are found on sandy beaches near seas in warm climates.

Pterobranchia:

- ✓ They have a tube-dwelling and live in deep sea waters.
- ✓ They are bottom dwellers who attached to other organisms for their survival.

Eg: Balanoglossus (the acorn worm)

Balanoglossus (the acorn worm)

Classification:

Phylum: Hemichordata

Class: Enteropneusta

Scientific Name: *Balanoglossus gigas*

Common Name: Acorn Worm

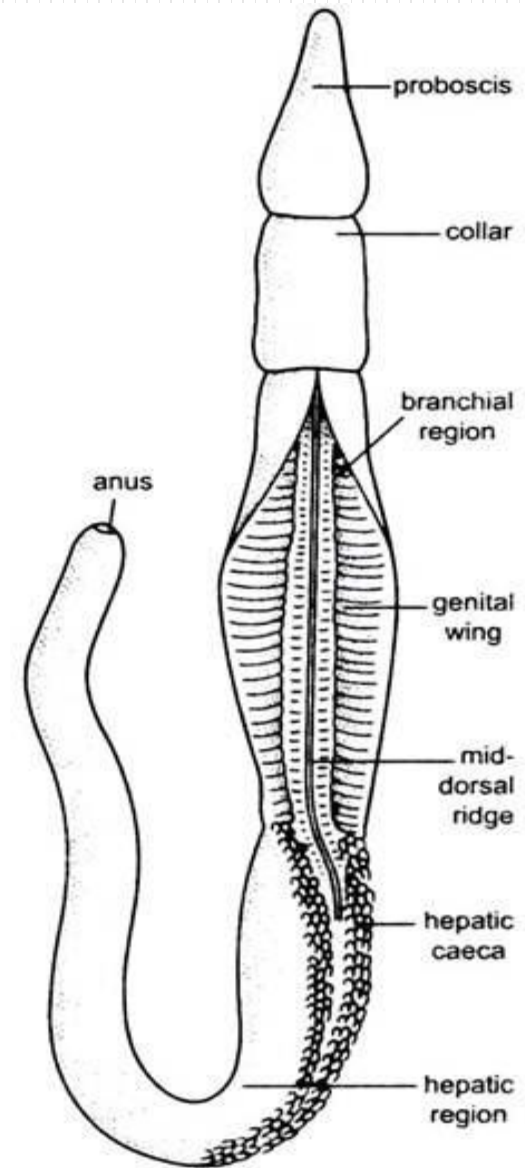
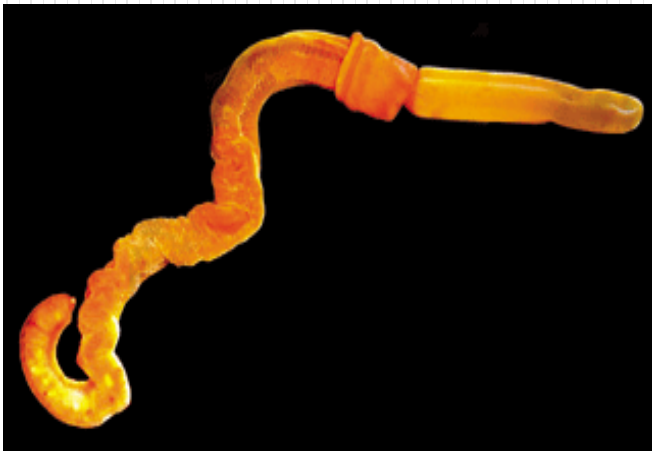


Fig. 2.2. *Balanoglossus*. External features in dorsal view.

Body structure

- ✓ Body is stout and unsegmented, and has a **worm-like** or **vase-like**
- ✓ Three distinct regions namely **proboscis**, **collar** and **trunk** are present.
- ✓ They are bilaterally symmetrical and triploblastic.
- ✓ They have **organ-system** level of organization.

Appendages:

- ✓ There are no locomotory appendages.
- ✓ The collar may bear **arms** and **tentacles**.
- ✓ Body wall consists of single layered epidermis and musculature of smooth longitudinal fibres.
- ✓ Their body consists of a **true coelom** with 3 parts corresponding to the 3 body divisions: an unpaired proboscis coelom, a paired collar coelom and a paired trunk coelom.

Digestive tract and respiration

- ✓ Digestive tract is complete.
- ✓ Proboscis contains a hollow out growth from the gut, called the **buccal diverticulum or stomochord** and was regarded as notochord in the past.
- ✓ All feed on microorganisms and debris by filtering or **ciliary mechanism**.
- ✓ Respiration occurs by a pair to numerous pairs of gill slits or through the general body surface.

Circulatory system

- ✓ Circulatory system includes a dorsal heart, two main **longitudinal vessels**; a dorsal and a ventral, interconnected by small lateral vessels and sinuses.
- ✓ Blood is **colorless** and **without corpuscles**.

Nervous system and excretory system

- ✓ Nervous system is **diffuse** consisting of an **epidermal plexus** of nerve cells and nerve fibers.
- ✓ Excretory system comprises of a proboscis gland, or glomerulus, situated in the proboscis and connected with the blood vessels.

Reproduction

- ✓ Sexes are separate or united.
- ✓ The gonads may be in several pairs or only one in pair.
- ✓ Fertilization is external or internal. Asexual reproduction may occur.
- ✓ Development may include a free-swimming **tornaria larva**.

Urochordata

- ✓ Urochordata refers to the presence of a notochord in the tail region.
- ✓ The notochord is restricted to the tail region of the larval forms of urochordates and is absent in the adults.
- ✓ Tunicata is the other name of this subphylum Urochordata, due to the presence of an outer leathery covering called tunic or test in the adult (tunica- outer covering).

General Characters of Urochordate

- ✓ All are exclusively marine and occur in all the seas at level of 5 km depths from surface water.
- ✓ They are either solitary or colonial.
- ✓ Majority of them are sedentary few are free swimming and pelagic.

- ✓ They possess the ability of de-differentiation (grow small during starvation and develop again on normalization of condition)
- ✓ Body covered with cuticular tunic or test in adult.
- ✓ Body without head varies in size, form, Colour.
- ✓ Notochord present in tail of larva and not in adult.
- ✓ Body divided into trunk and tail without appendages.
- ✓ There is no coelom.
- ✓ Alimentary canal is complete with large pharynx perforated by two or numerous gill slits for respiration.
- ✓ Circulatory system is open type with ventral heart.

- ✓ Excretion is carried out by nephrocytes cell pyloric or neural gland.
- ✓ They are hermaphrodite ,fertilization is external.
- ✓ Asexual reproduction by budding is common.
- ✓ Development include a minute free swimming tadpole larva with tail with dorsal nerve cord notochord restricted to tail region only.
- ✓ About 2200 Urochordata are known Ex. *Salpa*, *Hard mania*, *doliolum*, *ascidia* etc.

Classification:

Phylum: Urochordata

Class: Thaliacea

Order: *Salpida*

Family: *Salpidae*

Class — Thaliacea:

General Characters:

1. These are free-living pelagic urochordates.
2. The tunic is transparent and thin.
3. They possess encircling circumferential bands of muscles within the walls of the test.
4. Incurrent and ex-current siphons are present at opposite end of the body.
5. A few pharyngeal gill slits are present.
6. In the life-cycle polymorphism and clear alternation of generations are evident.

Ex: Salpa

Salpida

- ✓ Salpa is found in almost all seas as a free-swimming pelagic animal.
- ✓ It occurs in two phases- an asexual oozoid or solitaria form and a sexual blastozoid or gregaria form.
- ✓ The body is cylindrical. The muscle bands are incomplete, i.e., the muscle bands do not form complete rings as seen in Doliolum.
- ✓ It is present in coastal to deeper zone of 4,500 feet depth.
- ✓ The first gill-slit forms a large opening in adults.
- ✓ The larval stage is lacking. **Example: Salpa**

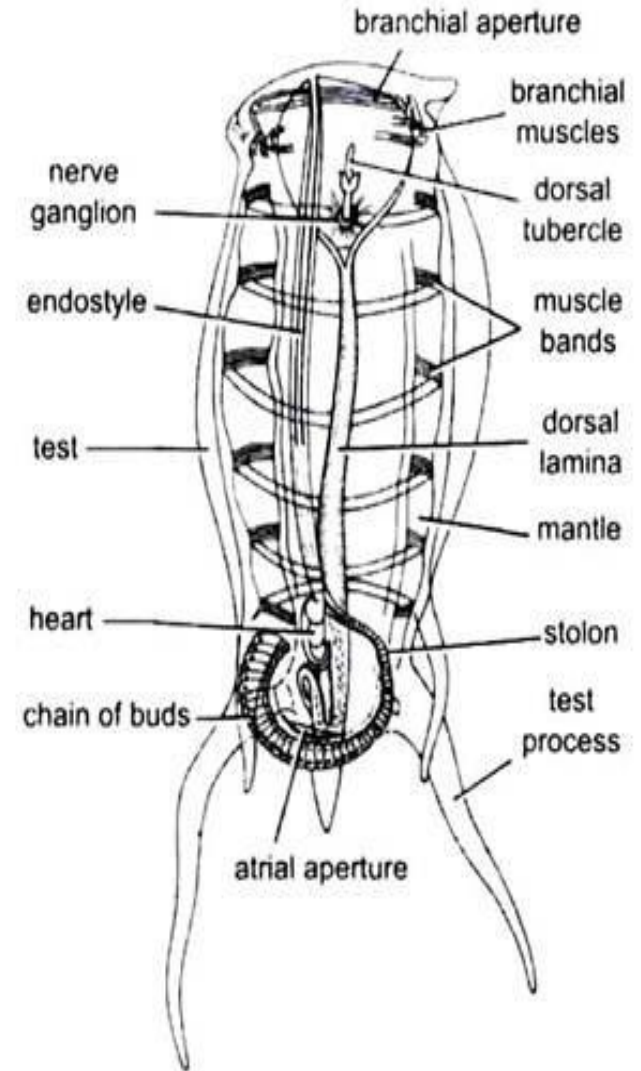


Fig. 5.10. *Salpa*. (Asexual or solitaria phase).

Structure of Salpa:

- ✓ Salpa is a transparent, small pelagic marine creature.
- ✓ Its body is covered by a soft gelatinous test closely attached with the mantle.
- ✓ The body is ovoidal having branchial and atrial apertures at the opposite ends.
- ✓ The nucleus is opaque which contains the heart and the alimentary canal.
- ✓ Muscles bands are six to nine C-shaped, incomplete ventrally.
- ✓ Atrial band is complete, while the oral band is prolonged into lips and acts as sphincter.
- ✓ Their contractions eject water through the atrial aperture and the animal is propelled forwards.

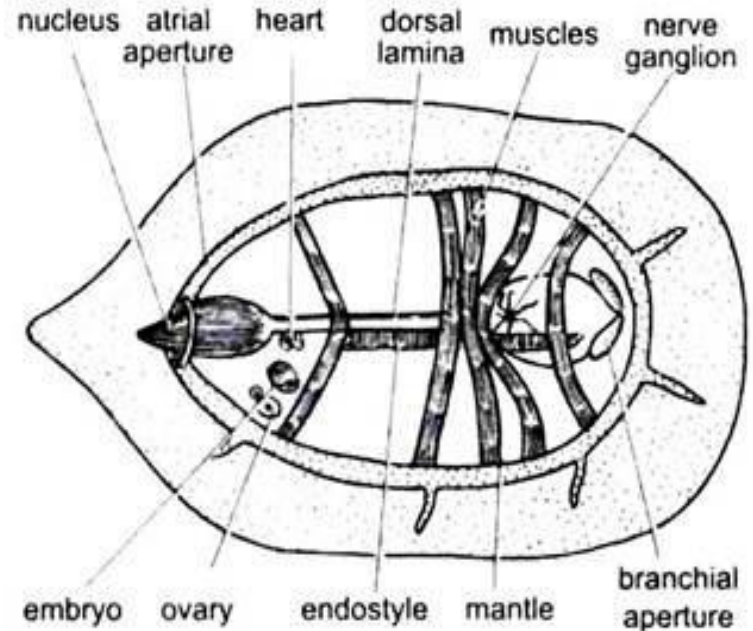


Fig. 5.11. *Salpa*. (Sexual or gregaria phase).

Digestive System:

- ✓ Branchial aperture is wide and guarded by movable upper and lower lips.
- ✓ It leads into a tubular buccal cavity which is followed by prebranchial zone of pharynx and then large elongated pharynx.
- ✓ It has a dorsal lamina and a central endostyle.
- ✓ The side walls of pharynx have no stigmata and freely communicate with the atrial cavity on each side.
- ✓ Dorsal tubercle is located near the tentacular languet formed by the anterior end of dorsal lamina.
- ✓ Beneath it lies two sub-neural glands which open independently into the pharynx. Above these is present the nerve ganglion.
- ✓ Rest of the alimentary canal includes the oesophagus, saccular stomach having two lateral caeca, looped intestine and rectum opening into atrium through anus.

Nervous System:

- ✓ Nerve ganglion lies near the anterior end gill and gives off many nerves.
- ✓ Above the nerve ganglion is present a U-shaped pigmented ridge-like eye.
- ✓ In some species one or more lateral ocelli are also present.

Heart:

- ✓ It is present near the stomach.
- ✓ It gives off many vessels to the various organs of the animal.
- ✓ Branchial sac receives many transverse vessels from the dorsal and central aorta.

Reproduction:

- ✓ The asexual oozoid has no gonads, but it has a stolon arising from near the endostyle.
- ✓ The stolon elongates and segments into a chain of buds, which break off in groups to form the sexual blastozooids or gregaria stage which later separate.

Fertilisation:

- ✓ Fertilisation is internal.
- ✓ Before fertilisation the stalk-like oviduct shortens and draws the ovary towards the dorsal side of the nucleus.
- ✓ The ovary is now enclosed in a lumen having a relation with the atrium.
- ✓ Fertilisation of a single ovum occurs within this lumen.
- ✓ After fertilisation the oviducal opening becomes closed and ovarian epithelium forms a sac-like structure around the ovum.

Development:

✓ Development is direct and takes place within the body of the parent.

✓ Cleavage is holoblastic.

✓ The developing embryo projects into the branchial cavity.

✓ The nourishment of embryo occurs by the formation of a diffusion placenta through which a close union is brought about between the vascular system of the parent and that of the embryo.

✓ The placenta of *Salpa* is partly formed from follicle cells and ectoderm cells of the embryo, and partly from the cells of oviduct.

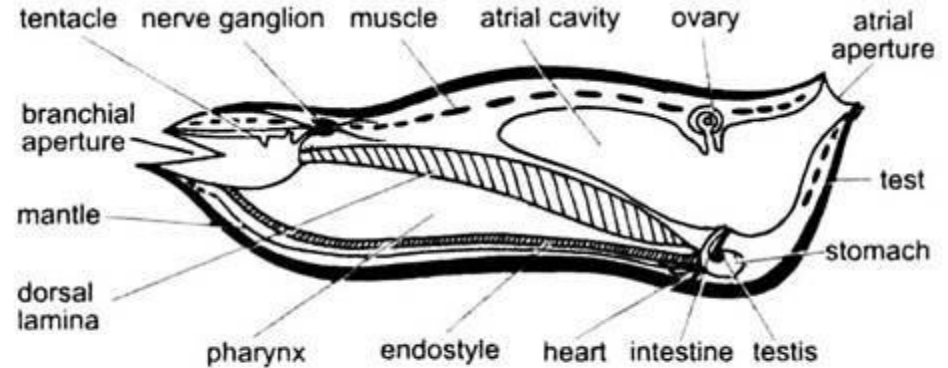


Fig. 5.12. *Salpa*. Diagrammatic sagittal section.

- ✓ Segmentation is complete.
- ✓ During segmentation there is a migration inwards of some of the cells of the follicle and of the wall of the oviduct.
- ✓ These cells enter the segmenting ovum and pass among the blastomeres.
- ✓ These cells are called kalymnocytes and possibly they carry nourishment to the developing embryo.
- ✓ These are broken up and eventually completely absorbed.
- ✓ There is no tailed larval stage.
- ✓ The embryo develops the muscle bands and all the characteristic parts of the adult while present within the parents body.

- ✓ The sexually produced embryo grows into a solitary asexual oozoid which escapes from the parent and becomes free-swimming.
- ✓ After a time there grows a stolon, on the surface of which are formed a number of bud-like projections.
- ✓ These increase in size as the stolon elongates and each takes the form of a sexual Salpa.
- ✓ The chain of zooids formed on stolon breaks off in groups and swim as such while reproductive organs develop in each.
- ✓ Salpa, dimorphic and it exhibits an alternation of generations in its life history.

Cephalochordata

- ✓ Cephalochordates are small fish like animals which show Chordate characters.
- ✓ The notochord extends the entire length of the body.
- ✓ They show a dorsal, tubular neural tube without a definite brain.
- ✓ It includes two genera
 1. Asymmetron and
 2. Branchiostoma (Amphioxus).

General Characters of Cephalochordata

- ✓ Body is fish like and is useful for burrowing and swimming.
- ✓ It has a head and a tail.
- ✓ Appendages are absent.
- ✓ Dorsal, caudal and ventral fins are present.
- ✓ Body- wall shows one- cell thick, non-ciliated epidermis, dermis, connective tissue, striated muscle and parietal peritoneum.
- ✓ It has no exoskeleton.
- ✓ Notochord extends from the anterior end to posterior end.
- ✓ Enterocoelic coelom is present. However, reduced in the pharyngeal region by atrium.

- ✓ Alimentary canal is long. It includes a large pharynx with many gill-slits ciliary mode of feeding is developed. Gills will perform respiration.
- ✓ Circulatory system is closed.
- ✓ Heart and respiratory pigments are absent.
- ✓ Hepatic portal system is present.
- ✓ Excretory system shows paired protonephridia with solenocytes.
- ✓ Brain is not present
- ✓ Two pairs of cerebral and several pairs of spinal nerves are present.
- ✓ Sexes are separate. Gonads are metamerically arranged and with out gonoducts.
- ✓ Asexual reproduction will not take place.
- ✓ Fertilization is external.

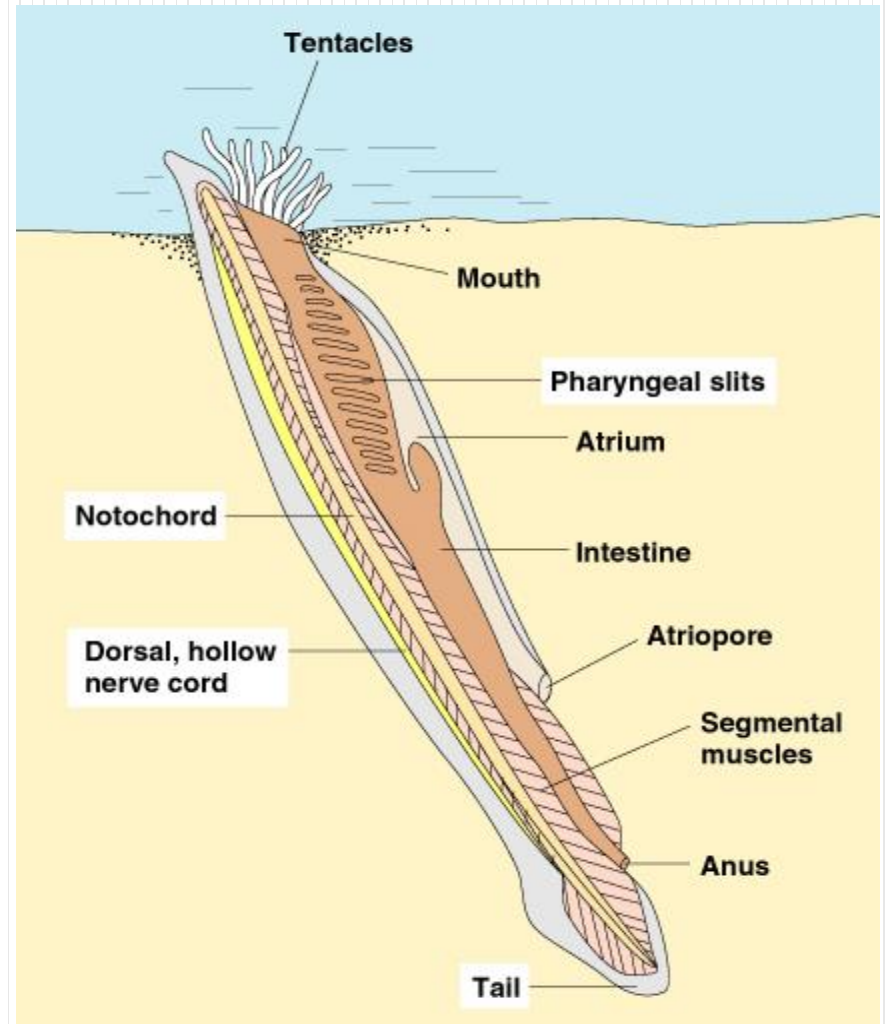
For ex: Amphioxus

CEPHALOCHORDATA : (AMPHIOXUS)

- ✓ Amphioxus belongs to Cephalochordate.
- ✓ Amphioxus lives in shallow marine waters and burrows in sand. It is commonly seen in the Indian ocean.
- ✓ Most of its body is buried. Only its anterior part is left outside.
- ✓ It is active during night It is 3.5 to 6cms, in length Its body is whitish in colour.
- ✓ Presence of dorsal tubular nerve cord.
- ✓ Presence of a long notochord from anterior end to posterior end on the dorsal side. Because, it extends to the cephalic region. Hence it is called Cephalochordata

- ✓ Gill slits are present in the
- ✓ Presence of post anal tail.
- ✓ The presence of liver diverticulum.
- ✓ The development of hepatic portal system.
- ✓ Presence of Myotomes and which are useful for locomotion.
- ✓ The presence of dorsal, caudal and ventral fins.

In these characters Cephalochordata resembles chordates.



Phylum: Chordata
Class: Leptocardii
Scientific Name: *Amphioxus*
Common Name: Lancelet

AMPHIOXUS - FINS:

- ✓ On the dorsal side dorsal fin is 'present.
- ✓ It is connected with a caudal fin.
- ✓ Caudal fin is connected with ventral fin which extends up to atriopore.
- ✓ The dorsal and ventral fins are supported by small rectangular fin- ray boxes
- ✓ There is a single row of Fin ray box in the dorsal fin.
- ✓ Two rows are present in the ventral fin.
- ✓ Ventral surface of the anterior two-thirds of the trunk is nearly flat and
- ✓ Its lateral margins are produced into a pair of thin folds, the meta pleural folds or lateral fins.

Section of Body -wall of Amphioxus

AMPHIOXUS - BODY WALL:

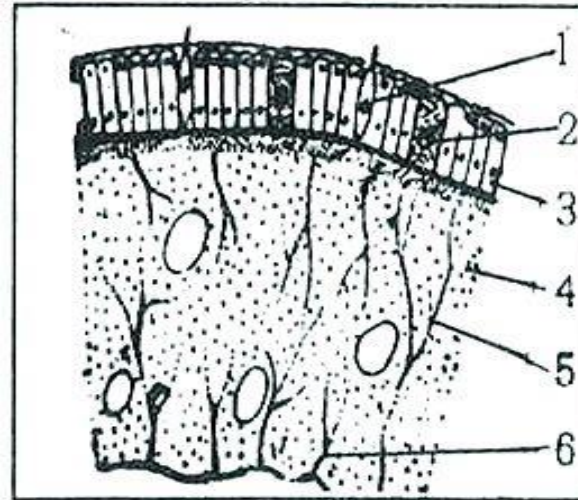
- ✓ The body is covered by skin.
- ✓ It has two regions,
 - a) Epidermis
 - b) Dermis.

a) Epidermis:

- ✓ The epidermis is very thin layer of the cells. it is single layered.
- ✓ The epidermal cells are columnar and present on a basement membrane.
- ✓ They are ciliated or non ciliated. it has an outer cuticle covering.
- ✓ The cuticle is made of a substance resembling chitin. The epidermis contains mucous cells and sensory cells.

b) Dermis:

- ✓ It is composed of connective tissue
- ✓ it shows an outer thin layer with fibres and an inner thick spongy layer with connective tissue, blood vessels and nerve fibres.



- 1) Sensory cell
- 2) Gland cell
- 3) Epidermis
- 4) Inner spongy layer
- 5) & 6) Fibres.

Myotomes:

- ✓ The myotomes are thick and are in the dorsal and dorso-lateral regions.
- ✓ They are arranged in a linear series.
- ✓ They are V shaped blocks.
- ✓ There are about 60 pairs of myotomes.
- ✓ The myotomes of the left side alternate with those of the right side.
- ✓ Each myotome is covered by connective tissue, called myocommata.

AMPHIOXUS - OPENINGS ON THE BODY:

There are 3 openings on the body of Amphioxus.

- ✓ Mouth
- ✓ Atriopore
- ✓ Anus

Mouth:

- ✓ The mouth is very wide and lies at the anterior end of the trunk.

Atriopore:

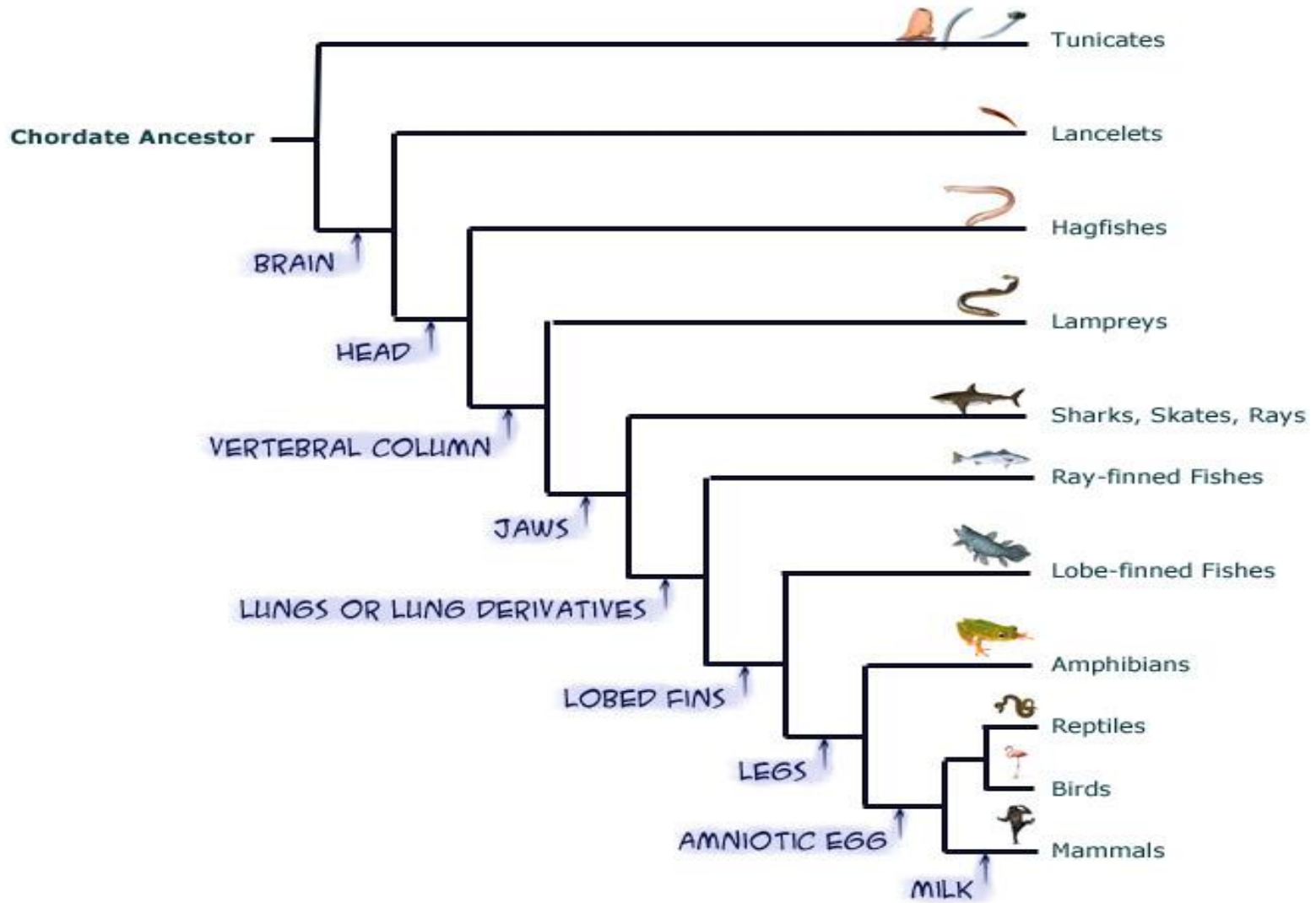
- ✓ The atriopore is a small aperture situated in front of the ventral fin.

Anus:

- ✓ The anus lies at the base of caudal fin on the ventral side.

Organization and Pylogenetic Relationships

The tree showing the relative relationships of different well known chordates.



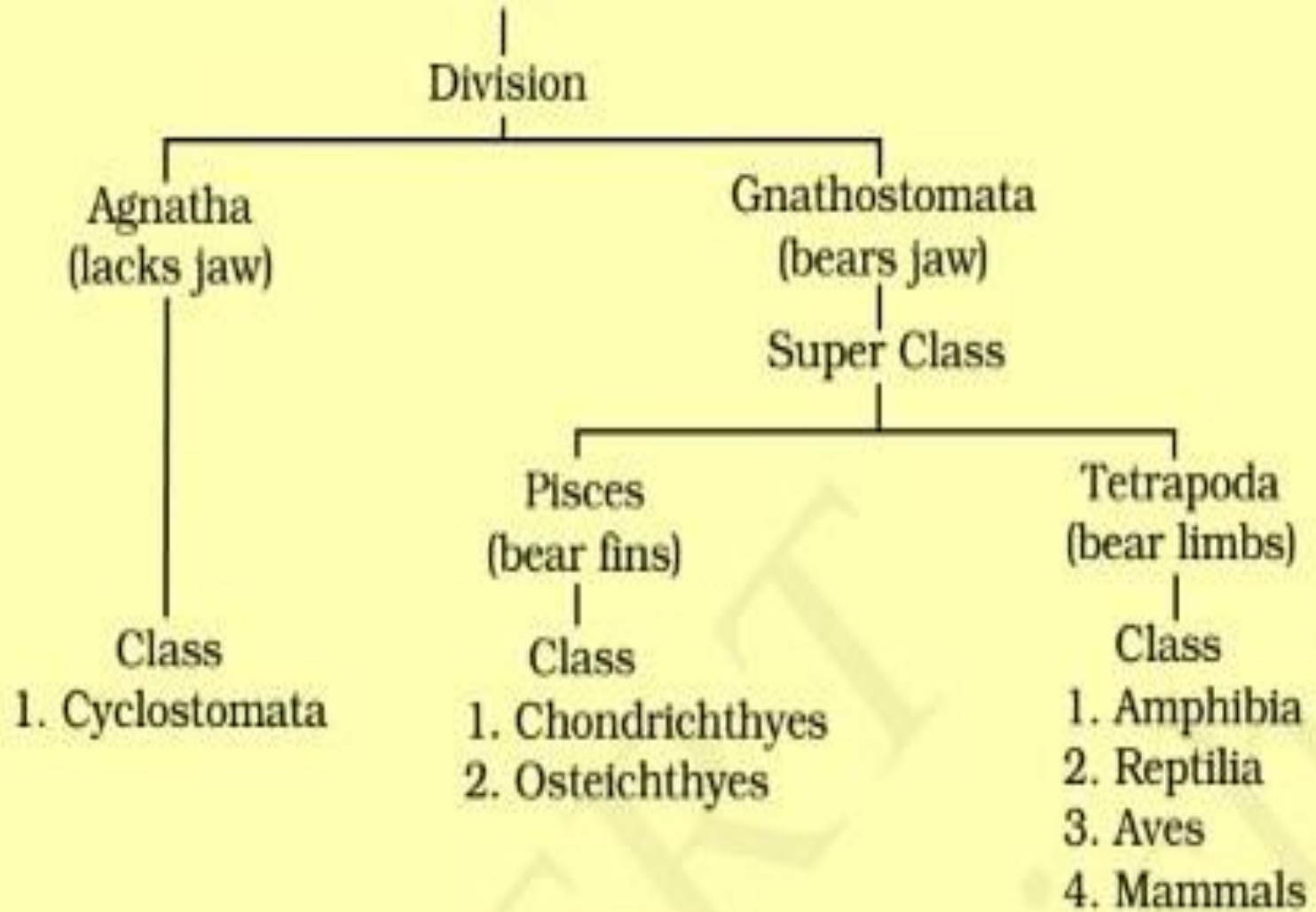
Vertebrate

- ✓ Vertebrates are the animals belonging to the sub-phylum Vertebrata. They belong to the Phylum Chordata.
- ✓ The characteristics of phylum chordata is the presence of notochord, a dorsal hollow nerve cord and paired pharyngeal gill slits.
- ✓ The members of subphylum Vertebrata possess notochord during the embryonic period.
- ✓ The notochord is replaced by a cartilaginous or bony vertebral column in the adult.
- ✓ All vertebrates are chordates but all chordates are not vertebrates.
- ✓ Special characteristics of vertebrates other than the vertebral column are, they have a muscular heart which is two, three or four chambered.
- ✓ For excretion they have kidneys and appendages that are paired which may be fins or limbs.

General characteristics of Vertebrates

- ✓ They have notochord in their developmental stages at their dorsal side
- ✓ They are bilaterally symmetrical
- ✓ They have visceral clefts
- ✓ The heart is ventrally located
- ✓ They have closed circulatory system
- ✓ They have internal skeleton.
- ✓ They possess post anal tail although rudimentary in some.
- ✓ They have segmented muscle blocks known as myotomes on either side of the body.

Vertebrata



Cyclostomata

✓ The living members of this class are all ectoparasites on some fishes. They have an elongated body.



Figure 4.18 A jawless vertebrate - *Petromyzon*

- ✓ They bear 6-15 pairs of gills through which they respire.
- ✓ The mouth of the cyclostomes is sucking circular mouth without jaws.
- ✓ They do not have body scales and paired fins.
- ✓ The vertebral column and the cranium is cartilaginous.
- ✓ Circulation is closed type.
- ✓ These are marine organisms but they migrate to fresh water for spawning. After metamorphosis their larvae return to the ocean.

Example: Petromyzon (Lamprey), and Myxine (Hagfish).

Pisces

✓ These are fishes. A number of fishes have Skelton made up cartilage and others made up of bone. They include catfish, Nile perch, lungfish, rayfish and dogfish.

General characteristics of Pisces

- ✓ They have gills for gaseous exchange. Movement is by means of gills
- ✓ Their bodies are covered with scales and have streamlined body.
- ✓ They don't posses middle or external ear.
- ✓ Their heart consists of two main chambers , the auricle and ventricle with single circulatory system.
- ✓ Body temperature changes according to the temperature of the environment.
- ✓ Eyes covered with nictating membrane.They poses a lateral line system for sensitivity.

PISCES-CLASSIFICATION

- ✓ The super class Gnathostomata includes craniates, in which one pair of the visceral arches is modified into this jaws.
- ✓ The super class is divided into, two groups.

1) Pisces and

2) Tetrapoda.

Pisces include three classes.

✓ *Placodemi,*

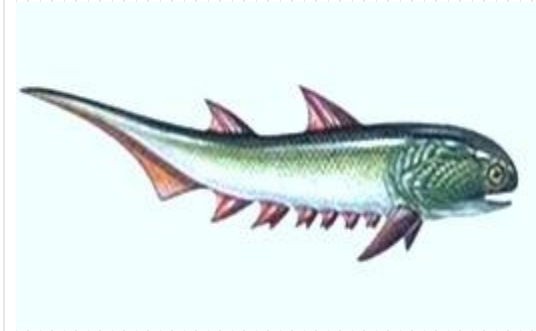
✓ *Elasmobronchi (Chondrichthyes),*

✓ *Osteichthyes*

Placodermi (Aphstohyoids)

- ✓ It includes extinct fishes.
- ✓ They are all armored fishes.
- ✓ Their exoskeleton is in the form of bony plates or shields.
- ✓ Their endoskeleton is bony:
- ✓ The hyoidean gill-slits are complete. It is not reduced.
- ✓ The autodiastylic jaw suspension is seen in these fishes.
- ✓ Heterocercal caudal fin is seen.
- ✓ Hyoid arch will not support the jaws.
- ✓ Primitive jaws are seen.
- ✓ They survived up to Permian period of Paleozoic era.

Ex: Climatius, Bothriolepis.



Climatius



Bothriolepis

Chondrichthyes/ Elasmobranchi

(Cartilaginous Fishes)

General characters:-

- ✓ Mostly marine and predaceous.
- ✓ Body fusiform or spindle shaped.
- ✓ Fins both median and paired, all supported by fin rays.
- ✓ Skin tough containing minute placoid scales and mucous glands.
- ✓ Endoskeleton entirely cartilaginous, without true bones
- ✓ Notochord persistent.
- ✓ Respiration by 5 to 7 pairs of gills.
- ✓ Heart 2-chambered (1 auricle and 1 ventricle).
- ✓ Kidneys opisthonephric. Excretion is ureotelic.
- ✓ Brain with large olfactory lobes and cerebellum. Cranial nerves 10 pairs. **Example: Scoliodon, Pristis, Trygon.**

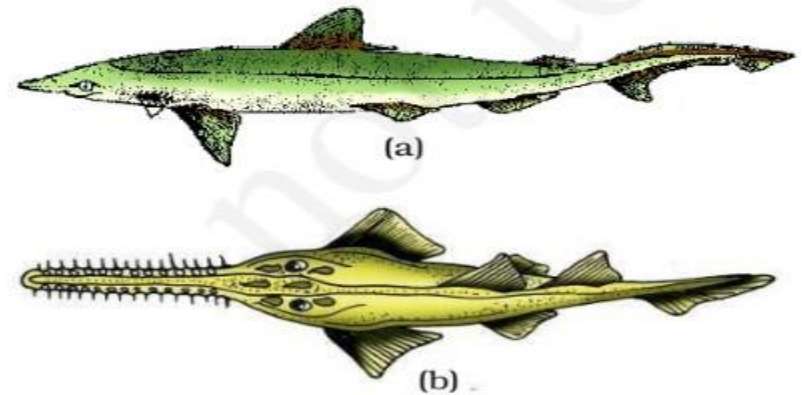


Figure 4.19 Example of Cartilaginous fishes :
(a) *Scoliodon* (b) *Pristis*

The Class **Elasmobranchi** is divided into two sub-classes.

1.Sub-class Selachi :-

- ✓ In these fishes the pectoral fin has cartilagenous rods.
- ✓ Fins are well developed.
- ✓ The caudal fin is hetetocercal.
- ✓ This subclass has four orders in which only two are living.

Order 1. Protoselachl

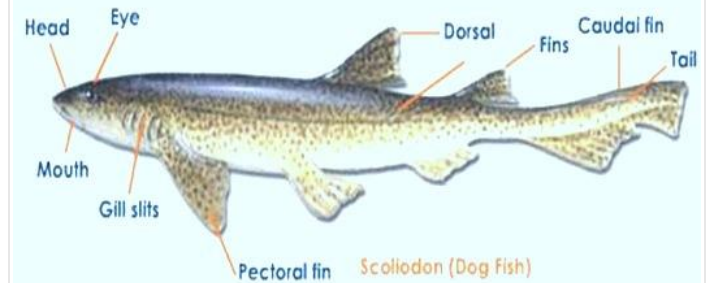
- 1) Jaws show many pointed teeth.
- 2) Nasal openings are paired.
- 3) Hyostylic or Axnphistylic jaw suspension.

It is represented by few living species.

Ex :Heteroloatas

Order 2. Euselachi

- 1) Skin contains placoid scales.
- 2) These fishes are exclusively marine.
- 3) 5 pairs of gill slits. They open separately.



It is divided into two

1. Sub-order . Pleurotremata:

- 1) Gill slits on the lateral sides of the body.
- 2) Pectoral fins are distinct.
- 3) It includes sharks and dog fishes.

Ex :- Scoliodon, Sphyrna (Hammer headed shark), Stegostoma (Tiger shark).

2. Sub-order Hypotermata:

- 1) It includes skates And Rays.
- 2) The body is flattened dorso-ventrally.

3) Pectoral fins are enormously expanded anteriorly and posteriorly and gill openings are ventral and five in number.

4) Dorsal fins, if present are seen on the tail.

Ex :- Pristis (Saw fish), Rhinobatus (Guitar fish), Torpedo (Electric ray), Raja (Skates), Trygon (sling rays), Myliobatis (Eagle rays)

Sub-Class 2; Bradyodonti

It includes fossil and modern chimaeras.

1. Mouth is small and bounded by lips.
2. Holostylic jaw suspension is seen.
3. Gill opening are enclosed in boneless operculum.
4. Male possesses a frontal clasper on the head.

It is divided into 2 orders

Order 1. Eubradodonti: 'It includes Helodus'.

Order 2. Holocephali: It includes chimaera. These are called devil fishes. Chimaera also called king of herrings. Chimara



Osteichthyes (Bony fishes)

General Characters

- ✓ Inhabit all sorts of water-fresh, brackish or salt; warm or cold.
- ✓ Body spindle-shaped and streamlined.
- ✓ Fins both median and paired, supported by fin rays of cartilage or bone.
- ✓ Skin with many mucous glands, usually with embedded dermal scales of 3 types; ganoid, cycloid or ctenoid.
- ✓ Endoskeleton chiefly of bone and Respiration by 4 pairs of gills on body gill arches
- ✓ Ventral heart 2-chambered (1 auricle + 1 ventricle).
- ✓ Adult kidneys mesonephric. Excretion is ureotelic.
- ✓ Brain with very small olfactory lobes, small cerebrum and well developed optic lobes and cerebellum and Well developed lateral line system.

Example: Hippocampus, Clarias.

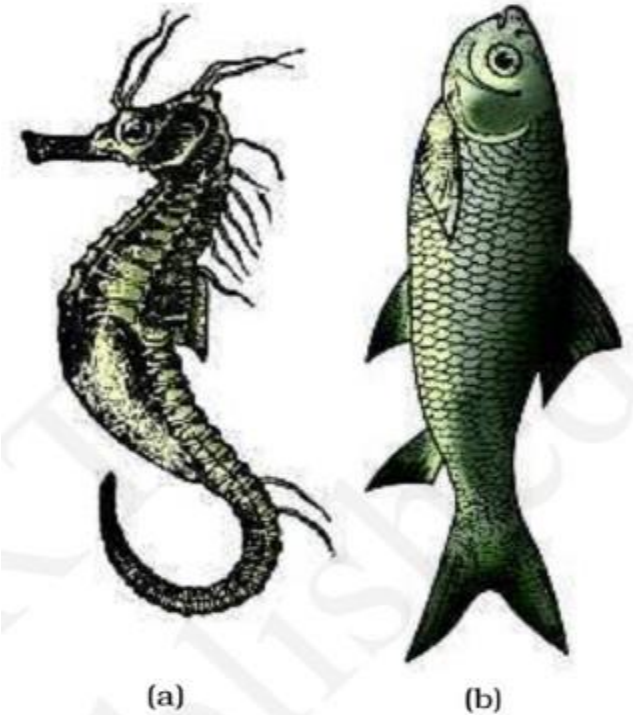


Figure 4.20 Examples of Bony fishes :
(a) *Hippocampus* (b) *Catla*

This class is divided into two sub-classes.

**Sub-Class I. Crossopterygii,
Sub-Class II. Actinopterygii,
Sub-Class-I: Crossopterygii**

In this sub-class bony fishes are included which show lobed and massive fins. The sub-class includes two orders,

Order - 1 Rhipidistia

- ✓ This order includes extinct fishes. But in 1938 one coelacanth fish was caught.
- ✓ This was identified as, Rhipidistian fish by Miss. Latimer.
- ✓ The fish is called Latimeria. It is the oldest living fossil.

Ortler -2. Dipnoi

This order Includes living fishes. In the present day only 3 genera are living. They show discontinuous distribution.

- Ex:*
- 1. Neoceratodus (Australian lung fish),*
 - 2. Protopterus (African lung fish),*
 - 3. Lepidosiren (South American lung fish).*

Sub-class II Actinopterygii

These fishes will live in fresh water or marine water. They not show internal nostrils. This subclass is divided into three super orders.

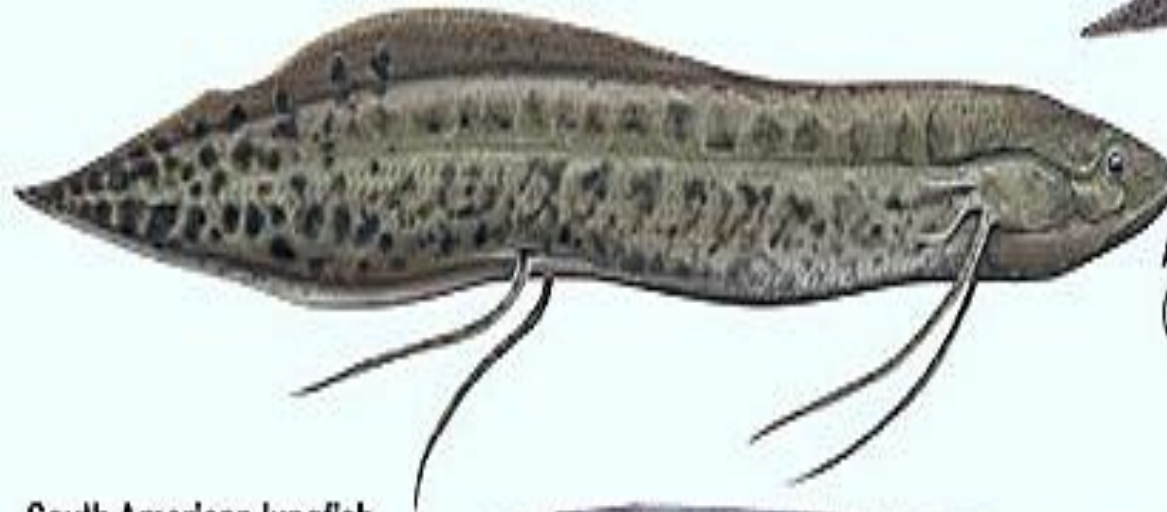
Super order I: Chondrostei

This super order includes 3 orders, only fishes of one order or surviving

Order polypteriformes :-

The fishes with ganoid scales Caudal fin is symmetrical. Dorsal fin has many peculiar fin-lets. *Ex:Polypterus.*

Australian lungfish
(*Neoceratodus forsteri*)



African lungfish
(*Protopterus annectens*)

South American lungfish
(*Lepidosiren paradoxa*)



Super order II: Holostel:

This include 2 orders.

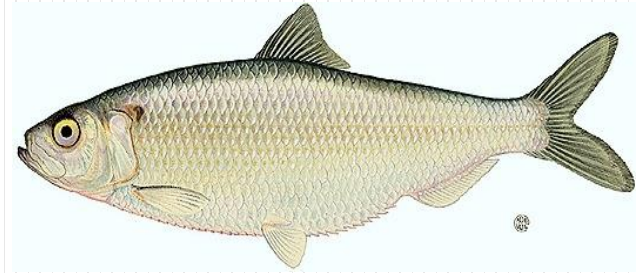
Order 1. Amiiformes.

Caudal fin is heterocercal. Ex Antia (Bowin).

Order 2. Lepidoeteiformes:

Nasal opening at the end of the much elongate snout. Caudal fin is abbreviate heterocercal.

Ex: Lepidosteus (Gar pike).



Super order III. Telosteti :

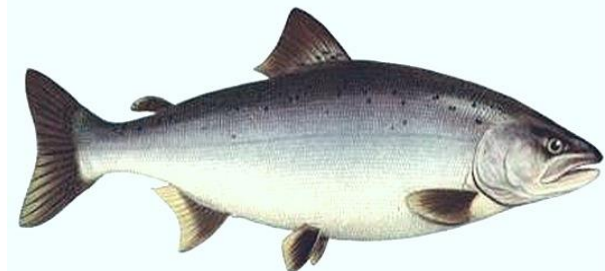
This is a very important super order. It includes nearly 25,000 species.

They are divided into many orders.

Order I. Clupeiformes :

Caudal fin is homocercal.

Ex: 1. Hilsa hilsa (Herrings). 2. Salmon.



Order 2. Cypriniformes:

Weberian ossicles connecting the ear with air bladder is present. Bladder is connected with duct to the alimentary canal

Ex : Carps. (Labeo, Cinhina, Barbus).

Order 3. Anguilliformes. :

Body eel like, air-bladder, If present connected with intestine by a duct.

Ex: Anguilla.

Order 4. Beloniformes :

Physoclistic fishes in which fins are without spines.

Ex : Exocoetus, (flying fish)., Cypsilurus

Order-5. Syngnathiformes:

Physoclistic fishes In which the first dorsal fin, If present, Is spinous.

Ex: Hippocampus (Sea horse). Syngnathus (Pipe-fish)

Order 6: Syinbranehiformes:

Eel like body, air-bladder is absent spines absent In fins.

Ex Asnphinuous.

Order 7. Psrciformes:

Physoclistic fishes fins usually with spines. Usually two dorsal fins.

Eg: Fierasfer, Anabas (Climbing perch).

Order 8. Pleuronectiformes.

Both eyes are situated on one side skull is asymmetrical. Fins usually without spine. Adults without air bladder.

Ex :Cynogiossus

Order 9. Echenelformes

The spinous dorsal fin is t into an adhesive disc placed on the head. Air bladder is absent.

Ex: Echenis (Sucker fish).

Order 10. Ophiocephaliformes:

Physoclistic fishes in which are Without spine, scales are cycloid, air bladder is very long.

Ex: Channa or opiocephalus.

Order 11. Tefradontiformes :

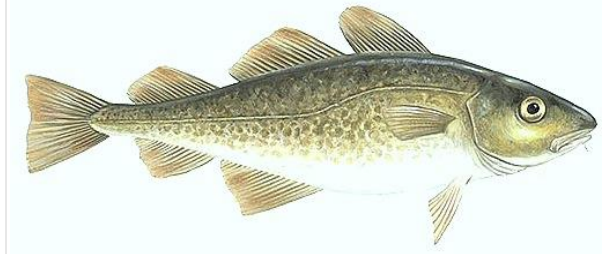
Gill openings restricted air bladder is present or absent.

Ex: Tetradon, Diodon (Porcupine fish).

Order 12. Gadiformes:

Physoclistic fishes in which fins are without spines, scales cycloid.

Ex: Gadus (cod).



*Thank
you*

