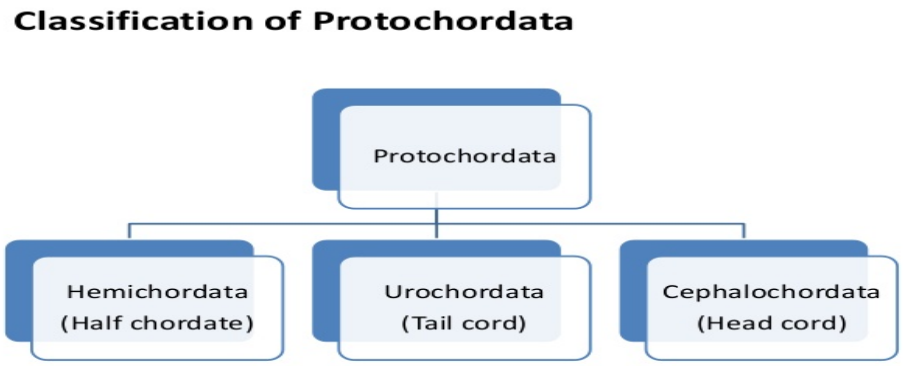
Lesson 18

ZOO 202
Mid Term Notes

Q.1 Why are protochordates not classified as true Chordata?

Like the remaining subphylum of the chordates, the Vertebrata, the protochordates have;

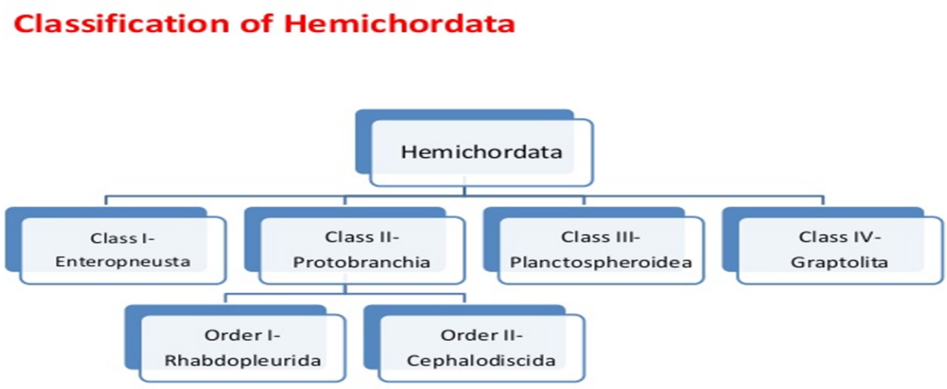
- A hollow dorsal nerve cord
- Gill slits,
- A stiff supporting rod,
- The notochord,
- The forerunner of the backbone.
- The protochordates differ chiefly from the vertebrates in **not having a backbone**.
- The organisms belonging to the Protochordata are generally known as the lower chordates.
- They don't form a "proper" taxonomic group and are only classified as such for convenience purposes.
- However, they do form a major division of Chordata.
- They are also known as Acraniata because they lack a true skull.
- They are generally found in marine water.
- Their body is bilaterally symmetrical, triploblastic, and coelomated.
- At a certain stage of their lives, their body develops a long, rod-like structure for support called notochord.
- They exhibit organ system level of organization.
- Eg., Herdmania, Amphioxus.



(…..First classification of protochordata…..) Hemichordata

Q.2 What is Hemichordata (Tunicates & Amphioxus)?

- Marine, Solitarily
- **Deuterostomate** animals with a body divided into three regions: proboscis, collar, and trunk; coelom divided into three cavities
- Body is divided into **proboscis, collar, and trunk**.
- Bilaterally symmetrical
- Primitive notochord restricted to proboscis only, thus called **stomochord**.
- Triploblastic
- True coelom present
- Straight or U shaped gut with anus
- Nervous system normally diffuse and variable
- Open circulatory system
- Blood has no color and corpuscles.
- Excretory organ- Glomerulus
- Filter feeding
- Four classes- Enteropneusta, Pterobranchia, Planctosphaeroidea, Graptolita
- Eg., Cephalodiscus, Rhabdopeura



Q.3 ExplainClass I – Enteropneusta (Acorn worms) ?

General Characters

- Marine worms
- Usually range in size between 10 and 40 cm
- More than 70 species
- most occupy U-shaped burrows in sandy and muddy substrates between the limits of high and lo**w tides.**

Proboscis is a short, conical projection at the worm's anterior end.

A **ring like collar** is posterior to the proboscis

An **elongate trunk** is the third division of the body

A **ciliated epidermis** and **gland cells** cover acorn worms. The **mouth** is located ventrally between the proboscis and the collar.

- A variable number of **pharyngeal slits**, from a few to several hundred, are positioned laterally on the trunk.

- Pharyngeal slits are openings between the anterior region of the digestive tract, called the pharynx, and the outside of the body.

Enteropneusta : Feeding, Digestion and Nervous system:

Enteropneusta : Feeding

- **Cilia** and **mucus** assist acorn worms in feeding.
- Detritus and other particles adhere to the mucus-covered proboscis. Tracts of cilia **Ciliary tracts** converge near the mouth and form a mucoid string that enters the mouth.
- Acorn worms may reject some substances trapped in the **mucoid string** by pulling the proboscis against the collar.
- **Ciliary tracts** of the collar and trunk transport rejected material and discard it posteriorly.

Enteropneusta : Digestion

- The digestive tract of enteropneusts is a simple tube.
- Food is digested as diverticula of the gut, called hepatic sacs, release enzymes.
- The worm extends its posterior end out of the burrow during defecation. At low tide, coils of fecal material, called castings, lie on the substrate at burrow openings.

Enteropneusta : Nervous system

- The nervous system of enteropneusts is **ectodermal in origin**
- Lies at the base of the ciliated epidermis.
- Consists of dorsal and ventral nerve tracts
- and a network of epidermal nerve cells, called a **nerve plexus**.
- There are **no major ganglia**.
- **Sensory receptors** are unspecialized and widely distributed over the body.

Enteropneusta : Excretion

- Excretory wastes may be filtered through the glomerulus, into the coelom of the proboscis,

- Later on release to the outside through one or two pores in the wall of the proboscis.

- The blood of acorn worms is colorless, lacks cellular elements, and distributes nutrients and wastes.

Enteropneusta : Reproduction and Development

Enteropneusts are dioecious.

Two rows of gonads lie in the body wall in the anterior region of the trunk, and each gonad opens separately to the outside.

Fertilization is external.

Spawning by one worm induces others in the area to spawn—behavior that suggests the presence of spawning pheromones.

- Enteropneusts normally reproduce sexually via external fertilization, and develop either directly or via **tornaria larvae**.

- The indirect developers, including **Balanoglossus** and **Ptychodera species**, are in the majority.

- These species develop from egg to planktonic tornaria larva to adult form.

- The tornaria larvae eventually become **sessile**, with the burrow-dwellers Developing tails behind the anus that they use to anchor themselves in their mucus-lined tunnels.

- Direct developers, on the other hand, hatch into adult animals, by passing the planktonic phase.

- An example is Saccoglossus kowalevskii.

Q.4 Phylum Chordata……

Explain about chordates and its characteristics?

Chordates:

- The earliest tetrapod's are the amphibians, with fossils dating back to the Devonian period
- Shortly thereafter, reptile-like tetrapods arose.

- It was some time after the appearance of reptiles, approximately 80 million years, that mammals entered the scene. The first mammalian fossils date back to the Triassic period, about 208 million years ago.
- Finally, bird fossils appear 146 million years ago in the Jurassic period.

Chordate Characteristics:

- Bilaterally symmetrical
- deuterostomate animals
- Four unique characteristics present at some stage in development: notochord, pharyngeal slits or pouches, dorsal tubular nerve cord, and postanal tail Presence of an endostyle or thyroid gland
- Complete digestive tract.
- Ventral, contractile blood vessel (heart)
- The four characteristics listed in number 2 are unique to chordates and are discussed further in the paragraphs that follow (figure 17.6).
- The phylum is named after the notochord
- It consists of a connective-tissue sheath that encloses cells
- This arrangement gives the notochord some turgidity, which prevents compression along the anteroposterior axis.
- At the same time, the notochord is flexible enough to allow lateral bending
- In most adult vertebrates, cartilage or bone partly or entirely replaces the notochord.

Q.5 Subphylum Urochordata and its characteristics?

Urochordates have a sparse fossil record. A Precambrian fossil known as *Yarnemia* has been referred to the Urochordata, but this assignment is doubtful. Complete body fossils of tunicates are rare, but tunicates in some families generate microscopic *spicules* that may be preserved as microfossils. Such spicules have occasionally been described from Jurassic and later rocks. Few paleontologists are familiar with them; tunicate spicules may be mistaken for sponge spicules.

Urochordates: General Characteristics

- Tail chordate
- Most primitive of the chordates
- They are found in the marine environment.
- They are sessile and filter-feeders.
- They are also known as tunicates because their body is surrounded by a leathery sheath composed of **tunicin** (cellulose).
- **Retrogressive metamorphosis** : The notochord appears in the larval stage in the tail of the larva and disappears in the adult.
- Triploblastic
- U shaped gut
- Coelom absent
- Hermophroditic
- Respiration occurs through gills.
- They have an Incomplete closed circulatory system.
- Haemocyanin as blood pigment
- The excretory organs are absent.
- They reproduce asexually by budding.
- Eg., tunicates or sea squirts.

Q.6 Introduction about Tunicates and their body organization?

Ascidians: tunicates

- The ascidians comprise the largest class of tunicates.
- They are sessile as adults and are either solitary or colonial.
- The appendicularians and thaliaceans are planktonic as adults. In some localities, tunicates occur in large enough numbers to be considered a dominant life-form.

- Sessile urochordates attach their saclike bodies to rocks, pilings, ship hulls, and other solid substrates.

- The unattached end of urochordates contains two **siphons** that permit seawater to circulate through the body.

- One siphon is the oral siphon, which is the inlet for water circulating through the body and is usually directly opposite the attached end of the ascidian.

- It also serves as the mouth opening. The second siphon, the atrial siphon, is the opening for excurrent water.

- Tunicates derive their name from a thick extracellular body covering, called a **tunic ,** that is made up of cellulose-like, complex sugars. Another interesting feature of tunicates is their circulatory system. Instead of blood vessels, the heart pumps blood through a number of small pockets called **sinuses.** In addition, the heart periodically changes the direction that it pumps blood.

Tunicates: Digestion and Respiration

Tunicates mainly eat phytoplankton, zooplankton, detritus and other small organisms in the water, these organisms are filtered through the tunicate. They have cilia in the pharynx and they also produce mucus. Their food gets stuck in the mucus and with the help of beating cilia the mucus moves toward the digestive system. There are also predatory tunicates, which eat small creatures that get pulled through their siphon and get stuck on their mucous.

Tunicates: Digestion

- The most obvious internal structures of the urochordates are a very large pharynx and a cavity, called the atrium, that surrounds the pharynx laterally and dorsally.

- The pharynx of tunicates originates at the oral siphon and is continuous with the remainder of the digestive tract.

- The oral margin of the pharynx has tentacles that prevent large objects from entering the pharynx.

- Numerous pharyngeal slits called stigmas perforate the pharynx. Cilia associated with the stigmas cause water to circulate into the pharynx, through the stigmas, and into the surrounding atrium. Water leaves the tunicate through the atrial siphon.

- The digestive tract of adult tunicates continues from the pharynx and ends at the anus near the atrial siphon.

- During feeding, cells of a ventral, ciliated groove, called the **endostyle**, form a mucous sheath.
- Cilia move the mucous sheet dorsally across the pharynx.
- Food particles, brought into the oral siphon with incurrent water, are trapped in the mucous sheet and passed dorsally.
- Food is incorporated into a **string of mucus** that ciliary action moves into the next region of the gut tract.
- Digestive enzymes are secreted in the **stomach**, and most absorption occurs across the walls of the intestine.
- **Excurrent water** carries digestive wastes from the anus out of the atrial siphon.
- In addition to its role in feeding, the pharynx also functions in **gas exchange**.
- Gases are exchanged as water circulates through the tunicate.

Tunicates: Circulation:

- The tunicate heart lies at the **base of the pharynx**.
- One vessel from the heart runs anteriorly under the endostyle, and another runs posteriorly to the digestive organs and gonads.
- Blood flow through the heart is **not unidirectional**.
- Peristaltic contractions of the heart may propel blood in one direction for a few beats; then the direction is reversed.
- The significance of this reversal is not understood.
- Tunicate **blood plasma is colorless** and contains various kinds of amoeboid cells.

Tunicates: Excretion:

- Ammonia diffuses into water that passes through the pharynx and is excreted.
- In addition, **amoeboid cells** of the circulatory system accumulate uric acid and sequester it in the intestinal loop.

- **Pyloric glands** on the outside of the intestine are also thought to have excretory functions.

Tunicates: Reproduction:

- Urochordates are monoecious.
- Gonads are located near the loop of the intestine
- Genital ducts open near the atrial siphon.
- Gametes may be shed through the atrial siphon for external fertilization or eggs may be retained in the atrium for fertilization and early development.
- Although self-fertilization occurs in some species, cross-fertilization is the rule.

Tunicates: Development:

- Development results in the formation of a tadpole like larva with all four chordate characteristics.
- Metamorphosis begins after a brief free-swimming larval existence, during which the larva does not feed.
- The larva settles to a firm substrate and attaches by adhesive papillae located below the mouth.
- During metamorphosis, the outer epidermis shrinks and pulls the notochord and other tail structures internally for reorganization into adult tissues.
- The internal structures rotate 180°, positioning the oral siphon opposite the adhesive papillae and bending the digestive tract into a U shape.

Q.7 Explain Subphylum Cephalochordata?

Cephalochordata: General Characteristics

- Members of the subphylum Cephalochordata are called lancelets.

- The cephalochordates consist of two genera, Branchiostoma (amphioxus) and Asymmetron, and about 45 species.
- They are distributed throughout the world's oceans in shallow waters that have clean sand substrates.
- Cephalochordates are small (up to 5 cm long), tadpole like animals.
- They are elongate, laterally flattened, and nearly transparent.
- In spite of their streamlined shape, cephalochordates are relatively weak swimmers
- They spend most of their time in a filter feeding position partly to mostly buried with their anterior end sticking out of the sand
- The notochord of cephalochordates extends from the tail to the head, giving them their name.
- Unlike the notochord of other chordates, most of the cells are muscle cells, making the notochord somewhat contractile.
- Both of these characteristics are probably adaptations to burrowing.
- Contraction of the muscle cells increases the **rigidity of the notochord** by compressing the fluids within, giving additional support when pushing into sandy substrates.
- Relaxation of these muscle cells increases **flexibility for swimming**.
- Muscle cells on either side of the notochord cause **undulations** that propel the cephalochordate through the water.
- **Longitudinal, ventrolateral folds** of the body wall help stabilize cephalochordates during swimming
- **Median dorsal fin and a caudal fin** also aid in swimming**.**

Cephalochordates: Feeding

Cephalochordates are filter feeders.

During feeding, they are partially or mostly buried in sandy substrates with their mouths pointed upward.

Cilia on the lateral surfaces of gill bars sweep water into the mouth.

Water passes from the pharynx, through pharyngeal slits to the atrium, and out of the body through the atriopore.

Food is initially sorted at the cirri.

Larger materials catch on cilia of the cirri.

As these larger particles accumulate, contractions of the cirri throw them off.

Smaller, edible particles are pulled into the mouth with water and are collected by cilia on the gill bars and in mucus secreted by the endostyle**.**

Cephalochordates: Digestion

As in tunicates, the endostyle is a ciliated groove that extends longitudinally along the midventral aspect of the pharynx.

Cilia move food and mucus dorsally, forming a food cord to the gut.

A ring of cilia rotates the food cord, dislodging food.

Digestion is both extracellular and intracellular.

A diverticulum off the gut, called the midgut cecum, extends anteriorly.

Cephalochordates: Circulation

Cephalochordates do not possess a true heart.

Contractile waves in the walls of major vessels propel blood.

Blood contains amoeboid cells and bathes tissues in open spaces.

Cephalochordates: Excretion

Excretory tubules are modified coelomic cells closely associated with blood vessels.

This arrangement suggests active transport of materials between the blood and excretory tubules.

The coelom of cephalochordates is reduced, compared to that of most other chordates.

It is restricted to canals near the gill bars, the endostyle, and the gonads.

Cephalochordates: Reproduction and Development

Cephalochordates are dioecious.

Gonads bulge into the atrium from the lateral body wall.

Gametes are shed into the atrium and leave the body through the atriopore.

External fertilization leads to a bilaterally symmetrical larva.

Larvae are free-swimming

But they eventually settle to the substrate before metamorphosing into adults.

Phylogenetic Relationships between hemichordates and chordates;

Phylogenetic Relationships:

Animals in the phyla Hemichordata and Chordata share deuterostome characteristics with echinoderms.

Most zoologists, therefore, believe that ancestral representatives of these phyla were derived from a common, as yet undiscovered, triploblastic ancestor.

The chordates are characterized by a dorsal tubular nerve cord, a notochord, pharyngeal slits or pouches, and a postanal tail.

The only characteristics they share with the hemichordates are pharyngeal slits and, in some species, a dorsal tubular nerve cord.

Therefore, most zoologists agree that the evolutionary ties between the chordates and hemichordates are closer than those between echinoderms and either phylum.

Chordates and hemichordates, however, probably diverged from widely separated points along the deuterostome lineage. The diverse body forms and lifestyles present in these phyla support this generalization.

Q.8 The evolutionary relationships between the hemichordates and chordates are difficult to document with certainty.

- The dorsal tubular nerve cord and pharyngeal slits of hemichordates are evidence of evolutionary ties between these phyla.
- Synapomorphies that distinguish chordates from hemichordates include tadpole larvae, a notochord, a postanal tail, and an endostyle.
- The earliest echinoderms were probably sessile filter feeders.
- The lifestyle of adult urochordates suggests a similar ancestry (perhaps from a common ancestor with echinoderms) for chordates.

- The evolution of motile chordates from attached ancestors may have involved the development of a tadpole like larva.

- Increased larval mobility is often adaptive for species with sedentary adults because it promotes dispersal.

Q.9 Explain Phylogenetic Relationship of Fishes?

- Fishes are members of the chordate subphylum Vertebrata; thus,

- They have **vertebrae** that surround their spinal cord and provide the primary axial support.

- They also have a **skull** that protects the brain.

- Zoologists do not know what animals were the first vertebrates?

- Molecular evidence gathered by comparing gene similarities of cephalochordates and vertebrates suggests that the vertebrate lineage may go back about **750 million years**.

- This date has not been confirmed by fossil evidence.

- Recent cladistic analysis of vertebrate evolution indicates that a group of fishes called **hagfishes are the most primitive vertebrates** known (living or extinct).

- Making a connection between this lineage and other vertebrates depends on the analysis of two key vertebrate characteristics, **the brain and bone**.

- Chinese researchers have recently unearthed the oldest alleged vertebrate fossils, a small, **lancelet-shaped animal** that has characteristics that suggest an active, predatory lifestyle.

- A brain is present that would have processed sensory information from the pair of eyes that are seen in fossils.

- **Muscle blocks** along the body wall suggest an active swimming existence. This evidence means that these **530 million-year-old animals located prey by sight** and then pursued it through prehistoric seas.

- The **origin of bone** in vertebrates is equally intriguing.

- A group of ancient eel-like animals, **the conodonts**, are known from fossils that date back about **510 million years**.

- They have been assigned to a variety of phyla, but recent evidence is bringing a growing number of zoologists to accept them as full fledged vertebrates.

- The importance of freshwater in the evolution of fishes is evidenced by the fact that over **41% of all fish species are found in freshwater**.

- Even though freshwater habitats represent only a small percentage **(0.0093% by volume)** of the earth's water resources.

Q.10 Other phylogenetic considerations

- Most cladistic and anatomical evidence indicates that the lungfish lineage gave rise to no other vertebrate taxa.

- Two important series of evolutionary events occurred during the evolution of the **Osteichthyes**.

- One of these was an evolutionary explosion that began about 150 million years ago and resulted in the vast diversity of **teleosts** living today.

- The second series of events involves the evolution of **terrestrialism**.

- The presence of functional lungs in modern lungfishes has led to the suggestion that the lungfish lineage may have been ancestral to modern terrestrial vertebrates.

- Another group of Scarcopterygii, the osteolepiforms, are now believed to be ancestors of terrestrial vertebrates.

- These fish probably occupied relatively shallow-water habitats that would have allowed them to avoid falling prey to larger predatory fishes.

- Young osteolepiforms may have inhabited very shallow water.

- In the warm, shallow-water environments, depleted oxygen would have favored the evolution of sarcopterygian lungs.