



# BIOLOGY

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# Phylum Porifera (Sponges)

## MAIN CHARACTERISTICS

Animals of this phylum show following important characters.

### NATURE

Most simple multicellular organisms. From evolutionary point of view they occupy a position between protozoa and true metazoa

### HABIT AND HABITAT

- Mostly marine but few in fresh water habitat.
- They are sessile, living attached to rocks, coral and other hard surfaces

### SHAPE AND STRUCTURE

- Their shape may be cylindrical, branching, globular, flat, bell shaped or cup shaped.
- Some are dull in colour and most are brightly coloured.
- The body is perforated by pores and canals.

### MICROSCOPIC STRUCTURE

Most of sponges contain following types of cell:

#### (A) PINACOCYTES

Forming the epidermis.

#### (B) POROCYTES

Form pores of the body wall

#### (C) CHOANOCYTES

These are flagellated cells, form the internal lining of the body. These cells are strikingly similar to the choano flagellates.

- Much of the body is composed of jelly like matrix containing a skeleton made of Protein, CaCO<sub>3</sub> or silica.
- Sponges are organized on cellular level, instead of a single cell carrying on all the life activities.
- Sponges show cellular differentiation but little or no coordination of cells to form tissues.
- They usually have an endoskeleton of separate spicules.
- They do not possess a head, an interior end, a mouth or gut cavity.
- They are sedentary organisms ranging in size from 1 to 200cm.

### DIGESTION

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## Phylum Cnidaria (Coelenterata)

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### MAIN CHARACTERS

#### *HABIT AND HABITAT*

They are aquatic animals, mostly marine and few fresh water forms. They are sedentary or free swimming and solitary or colonial

#### *STRUCTURE*

- The cnidaria are metazoa having the simplest type of body wall consisting of two layers. The outer epidermis and the inner gastrodermis which lines the body cavity.
- In between the two layers lies the mesogloea, non-cellular jelly secreted by them.
- Cnidarians, due to their two layers body wall are termed as diploblastic animals. All other metazoa possess a third layer called mesoderm in their body wall, laying in between the epidermis and gastrodermis (Endoderm) and are therefore called Triploblastic animals.
- They have radially symmetrical body plan organized as a hollow sac.
- The mouth is surrounded by a circle of tentacles bearing cnidoblasts stinging cells containing nematocysts.
- They have central digestive cavity connected to the outside by mouth.

#### *STRUCTURAL TYPES*

The Cnidarians are radially symmetrical and occur in two types of forms.

- (a) The polyp
- (b) The Medusa

#### (A) POLYP

The polyp like Cnidarian for example sea anemone has a cylindrical body with a mouth directed upwards and surrounded by tentacles. The basal surface of the body is attached to the substratum.

### (B) MEDUSA

The medusa like Cnidarians jelly fish are umbrella like in appearance. Their oral surface, bearing the mouth is directed downwards. Whereas the aboral surface is directed upward. The medusoid Cnidarians are usually free swimming.

### *PROCESS OF FEEDING AND DEFENCE*

- The Cnidarians feed mostly on animal diet.
- The food is digested in the gut and the waste products are expelled through the mouth.
- The Cnidarians so named, because they possess cnidoblasts bearing nematocysts which help in feeding and defence.

### **REPRODUCTION**

The Cnidarians reproduce by asexual as well as sexual methods. Polypoid Cnidarians possess a remarkable ability to regenerate.

### (A) REGENERATION

If the oral part of the body is lost. The remaining part regenerates the new mouth and the whole of tentacles.

### (B) ASEXUAL REPRODUCTION

A sexual reproduction takes place by Budding.

### (C) SEXUAL REPRODUCTION

- The sexual reproduction takes place through male or female gametes which are usually produced by different parents.
- The gametes develop in the interstitial cells and aggregate in gonads which are located either in the epidermis or in the gastodermis.
- The fertilized egg gives rise to “Planula Larva”

### **CLASSIFICATION OF CNIDARIA (COELENTERATA)**

The Phylum Cnidaria is divided into three classes:

1. Hydrozoa
2. Scyphozoa
3. Anthozoa

## 1. HYDROZOA

As the most primitive class of the Cnidarians, Hydrozoa is thought by some evolutionists to have given rise to both other classes. They show following characteristic features:

- They are mainly marine, but some are fresh water species
- Many species have both polyp and medusa

For e.g:

Hydra, Obelia and Physalia

## 2. SCYPHOZOA

- Most of animals of this class are commonly called “Jelly Fish”.
- They are semitransparent and are of various colours.
- Most are of marine habitat.

For e.g:

Aurelia and Cyanea (largest Jelly Fish)

## 3. ANTHOZOA

- These animals are mostly marine.
- Solitary or colonial Polyp forms are present.
- Medusa stage is absent.
- Gastrovascular cavity is divided into chambers, increase area for digestion.

For e.g:

Sea-anemones and Corals etc

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Phylum Platyhelminthes (Flat worms)

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## **MAIN CHARACTERS**

### *HABIT AND HABITAT*

Animals are mostly Parasitic in habitat and found in other higher animals. But some animals are also free living.

### *NATURE*

They are triploblastic in nature i.e. body is composed of three germinal layers, viz, ectoderm, mesoderm and endoderm

### *EXTERNAL FEATURES*

- Their bodies are compressed dorsoventrally and shows bilateral symmetry.
- Body shape generally worm like but vary from moderately elongated flattened to long flat ribbons and leaf like.
- The flat worms are small to moderate in size varying from microscopic to as long as up to 10-15 m.
- Majority of animals are white or colourless, some derive colour from ingested food.
- Anterior end of body is differentiated into head.
- Ventral surface bearing mouth and genital pores.
- Presence of great variety of adhesive parts e.g. suckers.
- Body is covered by cuticle or by ciliated epidermis.
- Hard part consist of cuticle, spines, thorns or hooks etc.

#### *INTERNAL FEATURES*

- Endo and Exo skeleton are completely absent, hence the body is generally soft.
- Acoelomate i.e. true coelom is absent.
- Body space between various organs is filled with MESENCHYME.
- Digestive system is poorly developed or absent.
- Respiratory and Circulatory systems are absent.
- Excretory system consists of Protonephridia or flame cells.
- Nervous system is primitive. The main nervous system consists of a pair of cerebral ganglia or brain and 1-3 pairs of longitudinal nerve cords, connected to each other by transverse commissures.

#### *REPRODUCTION*

- Platyhelmenthes are hermaphrodite i.e. male and female sex organs are present in same individual.
- In majority of forms eggs are devoid of Yolk but provided with special yolk cells.
- Cross fertilization as well as self fertilization is present.

- Life cycle may be simple or complicated involved one or more hosts.

### EXAMPLES

Planaria, Liver flukes, Schistosoma and Taenia Solium etc.

Phylum Aschelminthes (Nematoda/Round worm)

### **MAIN CHARACTERS**

#### *HABIT AND HABITAT*

- Nematoda have a very wide distribution and they seem to have mastered almost every habitat.
- Free living nematodes are found in the sea, fresh water or in the soil in all kinds of environment.
- There are also many Parasitic nematodes found in all groups of Plants and animals.
- The Saprophagous species live in decomposing plant and animal bodies and in rotting fruits.

#### *NATURE*

They have a bilaterally symmetrical, cylindrical body, glistening smooth surface. They are triploblastic.

#### *EXTERNAL FEATURES*

- They show no trace of segmentation.
- Most of the free living nematodes are less than a millimeter length.
- Some of the parasitic species attain a length of several meters e.g. Guinea worm (*Dracunculus medinensis*).
- They are usually long, round, tapered at both ends showing very little morphological diversity from species to species.
- The mouth of nematodes is modified for various modes of feeding such as cutting, tearing, piercing and sucking fluids from the host.
- Body is covered by cuticle, which moults only during the period of growth.

#### *INTERNAL FEATURES*

- The organs are packed in parenchyma when young, but later on it disappears in adult. So that organs lie in a fluid filled cavity. This cavity is termed as PSEUDOCOEL and it has not peritoneum.
- Muscles are only longitudinal.
- Excretory system has no flame cells.
- Alimentary canal is straight with ectodermal fore and hind gut and an endodermal mid gut.

### REPRODUCTION

- Sexes are generally separate.
- Gonades are tubular and continues with their ducts.
- Female organs are usually paired and open by vulva.
- Male organs are single and open into a cloaca.
- The life cycle of Parasitic species involves one, two or more hosts

### EXAMPLES

Ascaris (Round worms), Hookworms and Thread worms etc.

Phylum Annelida (Segmented worms)

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### MAIN CHARACTERS

#### *NATURE*

Annelida are triploblastic, symmetrical, coelomata and segmented metozoa.

#### *HABIT AND HABITAT*

Annelida are mostly aquatic, marine or fresh water, burrowing or living in tubes, some free living forms.

#### *EXTERNAL FEATURES*

- The most important feature of annelida is their metamerism (External segmentation).
- Segmentation is indicated externally by circular constrictions or grooves on the body wall.
- Outer covering of the body is cuticle secreted by the underlying epidermis.
- Appendages, when present are unjointed.

- Locomotory organs are segmentally arranged, paired setae or chaetae.

### *INTERNAL FEATURES*

- Body wall is contractile, consists of an outer epidermis, circular and longitudinal muscles.
- The gut, longitudinal blood vessels and the nerve cord extend throughout the body length, whereas other structures are repeated in each segment.
- Important character of annelida is the development of series of coelomic compartments in their body between the gut and the body wall.
- The Coelom is a cavity, which develop within the mesoderm and is lined by mesodermal cells.
- Segmented musculature plays an important part in locomotion of Annelids.

### *SYSTEMS OF BODY*

- Alimentary canal is tube like extending straight from mouth to anus.
- Respiration through general body surface, by gills in some forms.
- Blood vascular system is closed type.
- Blood is red due to haemoglobin.
- Excretory organs are Nephridia usually one pair in each segment.
- Nervous system consists of dorsal brain and longitudinal ventral nerve cord.
- Sexes may be united or separate.
- Development is direct when sexes are united and indirect when sexes are separate.

### EXAMPLES

Nereis, Earthworm and Leeches etc.

### CLASSIFICATION OF PHYLUM ANNELIDA

Phylum Annelida is divided into four classes:

1. Polychaeta
2. Oligochaeta

3. Hirudinea

4. Archiannelida

### **1. POLYCHAETA**

#### **LOCOMOTORY ORGANS**

The Polychaetes possess paired parapodia functioning as locomotory appendages, are present only in the class Polychaeta.

#### **PROSTOMIUM**

Usually there is a distinct head or Prostomium bearing sensory and feeding appendages.

#### **MODE OF LIFE**

The Polychaetes may be carnivorous, scavengers, or filter feeders.

#### **REPRODUCTION**

The sexes are separate and fertilization of eggs takes place outside body. Their free swimming larva is called Trochophore.

#### **RESPIRATION**

The respiration takes place through the body surface in many but in some gills may be present as respiratory organs.

#### **EXAMPLES**

Some well-known examples of marine polychaetes are Nereis, Arenicola and Sabella. Nereis lives beneath stones and in crevices of rocks.

### **2. CLASS OLIGOCHAETA**

#### **LOCOMOTORY ORGANS**

The Oligochaetes possess fewer numbers of Setae as compared to the Polychaetes. The setae help the earth worms in crawling.

#### **SENSE ORGANS**

The anterior end lacks eyes, or sensory appendages.

#### **CLITELLUM**

At sexual maturity, all of the oligochaetes develop in several segments, glandular epithelium, called clitellum.

**MODE OF LIFE**

- Oligochaetes live either in fresh water or on land.
- There is no free swimming larval stage in their development
- Majority of oligochaetes are scavengers, feeding on decomposing organic matter.
- Some fresh water species feed on algae.
- Burrowers like earth worm ingest a large quantity of soil, digest the organic matter and the living fauna.

**RESPIRATION**

Respiration takes place through their general body surface. Some aquatic species possess anal gills.

**ECONOMIC IMPORTANCE**

Earthworms increase the fertility of soil by physically over turning it. They ingest the soil, break it down and deposit it in the form of casts. The over turned soil is relatively in proportions of total nitrogen, organic carbon, calcium, magnesium and phosphorus.

**3. CLASS HIRUDINEA****BODY SEGMENTS**

Unlike polychaetes and oligochaetes, the number of body segment in leeches is fixed at 34.

**SUCKERS**

The anterior and posterior body segments are fused to form suckers.

**LOCOMOTION**

Leeches either swim or crawl.

**RESPIRATION**

Respiration generally takes place through the body surface. Leaf like gills may be present.

**PARASITIC NATURE**

Most leeches feed by sucking blood of aquatic invertebrates and vertebrates.

**4. ARCHIANNELIDA**

- It is a small group of marine worms.

- They are not segmented externally and don't have bristles.
- They live in the sea and show annelid characteristics to a minor extent.
- Their development is also characterized by Trochophore Larva.

#### *EXAMPLES*

Nerilla

Dinophilus

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## Phylum Arthropoda (Jointed Appendages Animals)

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#### **MAIN CHARACTERS**

- Arthropoda is the largest Phylum of the animal kingdom including 10, 00000 species of different types of animals.
- The word Arthropods is derived from Greek Arthos – Jointed and Podos – Foot.

#### *HABIT AND HABITAT*

Arthropodes have undergone an adaptive radiation for aerial, aquatic, terrestrial and parasitic environment. They are widely distributed in each and every place of the world.

#### *NATURE*

Arthropoda are “bilaterally symmetrical,” metamerically segmented metazoa.

#### *EXTERNAL FEATURES*

- Their body is covered by an exo-skeleton of “chitin” and protein.
- They possess paired jointed appendages.
- Their metamers are not alike but are specialized and their number is generally fixed.
- The head is well developed.

#### *INTERNAL FEATURES*

- Musculature is not continues but comprises separates striped muscles.

- The coelomic space in Arthropods is occupied by the blood vascular system and is thus called “Haemocoel.”
- Digestive tract is complete; mouth and anus lie at the opposite end of the body.
- Circulatory system is open with dorsal heart and arteries but without capillaries.
- Respiration through general body surface, by gills in aquatic forms, trachea or book lungs in terrestrial forms.
- Excretion by “Malpighian tubules” or Coelomoducts.
- Sexes are generally separate and sexual dimorphism is often exhibited by several forms.
- Fertilization is internal.
- Development is usually indirect through the larval stage.
- Nervous system of arthropods is quite similar to that of annelids and consists of dorsal anterior brain and a double ventral nerve cord.

### ***CLASSIFICATION OF ARTHROPODA***

Phylum Arthropoda is divided into following five classes:

#### **1. CLASS MEROSTOMATA**

- Almost all members of the class Merostomata are extinct. The only living merostomes, the king Crabs have survived.
- The animals are horse-shoe shaped.
- The long spike like tail that extends, posteriorly is used in locomotion. It is called “Telson.”
- They feed on mollusks, worms and other invertebrates that they find on the ocean floor.
- King Crabs a hors-shoe crabs have a tough “Carapace” jointed to a smaller abdomen.
- E.g:Limulus Polyphemus (King Crab).

#### **2. CLASS ARACHNIDA**

- This class includes spiders, scorpions, mites, ticks and many other terrestrial arthropods.

- The Arachnid body consists of a cephalothorax and abdomen.
- Cephalothorax is comprised of fused head and thorax.
- Arachnids have six pairs of jointed appendages.
- Most Arachnids are carnivorous and prey upon insects and other small arthropods.
- Respiration in arachnids takes place either by trachea or book lungs or by both.
- They are mainly terrestrial arthropods.
- They have no antenna.
- Cephalothorax is non-segmented.

E.g: Scorpions, Ticks & Mites, Spiders

### 3. CLASS CRUSTACEA

- They live both in marine and fresh waters.
- A few are terrestrial.
- Crustaceans are unique among arthropods in possessing two pairs of antenna.
- They always have one pair of mandibles and two pairs of maxillae around the mouth.
- Mandibles are usually adapted for biting and chewing. Maxillae are used for holding the food.
- Their body is divided into three distinct parts, i.e. the head, thorax and abdomen.
- Respiration usually takes place through gills associated with appendages.
- The sexes are usually separate and the reproduction is sexual.
- The thoracic and abdominal appendages may be variously modified for walking, swimming, feeding, respiration or as accessory reproductive structures.

E.g: Sacculina (Parasitic Crustacean), Astacus (Cray-fish), Prawns, Shrimps, Lobsters and Crabs etc.

### 4. CLASS MYRIAPODA

- All the animals are terrestrial.

- Their body is divided into a head and an elongated trunk with many segments.
- Each segment bears one or two pairs of legs.
- They are carnivorous /herbivorous.
- Eyes may present or absent.

E.g: Millipedes and Centipedes etc.

#### ***5. CLASS INSECTA (HEXAPODA)***

- Insecta is the largest class of the animal kingdom.

#### ***HABIT AND HABITAT***

- In their adaptive radiation, approximately a 8,50,000 species of insecta have occupied all types of terrestrial habitat.
- Some live in fresh water, however one small group is marine.

#### ***NATURE AND ADAPTATIONS***

- The great success of insects can be attributed partly to the development of flight in them.
- Flight has provided them the great capacity of dispersal, access to food sources, and favourable habitat and escape from enemies.
- Corresponding to their number of species, there exists a huge variation in their structural and biological adaptations.

#### ***EXTERNAL FEATURES***

- All insects have their body divided into three well-defined regions i.e. the head, thorax and abdomen.
- There is always a pair of antenna on the head.
- The thorax always consists of three segments:
  - (a) Prothorax
  - (b) Mesothorax
  - (c) Metathorax
- Each thoracic segment bears a pair of legs.
- Head consists of six fused segments and a pair of compound eyes and mouth parts.

- Abdomen comprises 7-11 segments and devoid of appendages.

### *MOUTH PARTS*

The feeding appendages consists of three pairs:

- (a) Mandibles
- (b) First Pair of Maxilla
- (c) Second Pair of Maxilla

- The second pair of maxillae have fused together to form the "LABIUM," or lower lip
- The upper lip is formed by the projections head and is called the "LABRUM."

*Types:-* The mouth appendages have been greatly modified to form five basic types of pattern:

- (i) Biting
- (ii) Chewing
- (iii) Piercing
- (iv) Sucking
- (v) Siphoning or Sponging

### *INTERNAL FEATURES*

- Heart is elongated, tubular and divided into chambers situated in the abdomen.
- Excretion takes place through "Malpighian tubules."
- Liver is absent but salivary glands are usually present.
- Respiration is by "TRACHEA". External gills may be present as accessory respiratory organs in some aquatic insects.

### *REPRODUCTION*

Reproduction is sexual in most insects. However it takes place parthenogenetically i.e. eggs developing without being fertilized by sperms in a number of insects e.g: Aphids and Termites etc.

### *METAMORPHOSIS*

- The development of insects after hatching from egg into adult stage involves considerable growth and in some cases drastic morphological changes.

- The entire post-hatching development is termed as "Metamorphosis."

#### (A) INCOMPLETE METAMORPHOSIS

- In some insects the immature form that hatch from the egg are essentially similar in shape to their adults, but are smaller in size, lack wings and reproductive organs
- They attain adult characters after some growth period. This type of metamorphosis is called "Incomplete Metamorphosis."
- Three stages are Egg → Nymph → Adult.

For example Cockroach, Grasshopper, Bugs etc.

#### (B) COMPLETE METAMORPHOSIS

- In this type the animal shows following stages during its complete development: Egg → Larva → Pupa → Adult.

For example Mosquito, Butter fly, House fly etc.

### *ECONOMIC IMPORTANCE OF INSECTS*

Insects are of very great importance to man.

#### BENEFICIAL INSECTS

1. Apis, the honey bees produce honey and also give wax.
2. Insects bring about the cross-pollination.
3. Bombyx and Eupterote are silk-moths and produce silk.
4. The larvae of Lucilla and Pharmia are used in wound healing of bones.
5. Some insects feed upon and destroy harmful insects.
6. Some insects are Scavengers

#### HARMFUL INSECTS

1. Many types of mosquitoes, flies, fleas, lice and bugs transmit diseases to man and animals.
2. Human food is spoiled by cockroaches, ants and flies.
3. Tinea and Teniola are cloth-moths and destroy cloths.
4. Tenebrio is mealworm. They eat meal, flour and grains.
5. Lepisma destroy the books.
6. Termites destroy books and wood.
7. Many insects injurious to crops e.g. Tree hoppers, Leaf hoppers, Aphids, White flies and bugs.

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## Phylum Echinodermata

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### GENERAL CHARACTERS

#### *HABIT AND HABITAT*

The Echinoderms are exclusively marine including the largest invertebrate “Giant Squids.”

#### *EXTERNAL FEATURES*

- Symmetry usually radial, nearly always pentamerous.
- Body shape is rounded to cylindrical or star like.
- Surface of the body is rough.
- Body wall consists of an outer epidermis, a middle dermis and inner lining of peritoneum.

#### *INTERNAL FEATURES*

- Endoskeleton consists of closely fitted plates forming shell usually called “THECA,” may be composed of separate small “OSSICLES.”
- Coelom is spacious, lined by peritoneum and occupied mainly by digestive and reproductive systems.
- Presence of “Water Vascular System” is most characteristic feature.
- Alimentary tract is usually coiled.
- Circulatory or Haemal or blood lacunar system is typically present.
- Excretory system is wanting.
- Nervous system is primitive, consists of ganglionated nerve cord.
- Sense organs are poorly developed.
- Sexes are usually separate.
- Reproduction is usually sexual, fertilization is external.

#### *WATER CANAL SYSTEM*

Water canal system is unique in possessing an internal closed system of canals containing a watery fluid.

#### *REGENERATION*

Regeneration of lost part is common

### ***IMPORTANCE OF WATER CANAL SYSTEM***

These canals are provided with tubular protrusions called "Tube Feet," which serve a number of functions like locomotion, anchoring to hard surfaces, grabbing the prey, diverting food particles towards mouth and in some cases also respiration. The watery fluid is drawn from the surrounding water through a perforated disc called the "Madreporite."

### **EXAMPLE**

Star Fish, Brittle stars, Sea urchins, Sea-cucumbers, Sea-Dollar, Sea-lilies and Feather stars.

### **LARVA**

Bipinnaria larva

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Phylum Hemichordata

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### **GENERAL CHARACTERS**

- It is a small group of animals, which include about 90 species.
- They are soft-bodied animals, which usually live in shallow "U" shaped burrows in the sandy or muddy sea bottom.

### ***EXTERNAL FEATURES***

- They are cylindrical or vase shaped animals, bilaterally symmetrical and lack any segmentation.
- They may be solitary or colonial and usually range between a few millimeter and 250 cm in length.
- Sexes are separate in hemichordates.

### ***INTERNAL FEATURES***

- Circulatory system is open and coelom is divided into three chambers.
- A dorsal and a ventral nerve cord are present.

### **LARVA**

Tornaria larva

### **EXAMPLE**

Balanoglossus, Acron worm etc.

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## Phylum Chordata

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### GENERAL CHARACTERS

The chordate animals at some time in their life history exhibit the following diagnostic characters:

#### 1. NOTOCHORD

- It is an elastic, solid, skeletal rod lying below the nerve cord and above the alimentary canal.
- It serves as a primitive internal skeleton and acts as a rigid axis.
- It may persist throughout life or it may be replaced partially or completely by a backbone or vertebral column.

#### 2. DORSAL HOLLOW NERVOUS SYSTEM

- There is a dorsal, hollow, fluid filled nerve cord.
- It is formed by enfolding of a mid-dorsal strip of ectoderm and it generally sinks below the surface.
- It lies above the notochord and outside the coelom.
- It persists throughout life in most chordates, but in a few it degenerates before maturity.

#### 3. GILL CLEFTS

- These are paired openings leading from the Pharynx to the exterior.
- Such gill clefts appear during the development of every chordate, but in many aquatic forms they are lined with vascular lemae, which forms gills for respiration.
- In terrestrial chordates, which never breath by gills, gill clefts are present during early development but later on, they disappear.

#### 4. PHARYNGEAL POUCHES

- All the chordates have paired pharyngeal pouches at some stage of their life cycle.
- These extend from laterally from the anterior part of the digestive tract towards the body wall.

### OTHER FEATURES

- Chordates are triploblastic.

- They are bilaterally symmetrical.
- True coelom is found.
- They are found in almost all the habitats of the World.

### ***CLASSIFICATION OF PHYLUM CHORDATA***

The Phylum Chordata is divided into two groups which are:

1. Acraniata (Protochordata)
2. Craniata (Vertebrata)

#### **1. GROUP ACRANIATA (PROTOCHORDATA)**

- They are first or simple Chordates.
- Brain box (Cranium) is absent and hence brain is not prominent.
- Notochord does not transform into vertebral column.

This group is further divided into two sub-phyla, which are as follows:

- a) Sub-Phylum Urochordata (Notochord in tail)
- b) Sub-Phylum Cephalochordata (Notochord head to tail)

#### **A) SUB-PHYLUM UROCHORDATA (NOTOCHORD IN TAIL)**

- They are also known as “Tunicates” because their body is enclosed in a sac called “Tunic.”
- All members are marine and sessile.
- Body possesses two openings, an incurrent or buccal siphon and an excurrent or Atrial siphon, through these openings exchange of gases and food or waste material take place.
- As a result of “Retrogressive metamorphosis” the larva loses its tail and most of chordate characters and converts into an adult.

E.g: Ascidia, Herdmania etc.

#### **B) SUB-PHYLUM CEPHALOCHORDATA (NOTOCHORD FROM HEAD TO TAIL)**

- This is a small group of marine animals, body with pointed ends.
- Usually live buried in sand, in shallow water with anterior end protruded out.

- They show all typical chordate characters (hollow dorsal nerve chord, pharyngeal gill slits and notochord).
- Only two genera are present around the world.

E.g: Branchiostoma (Amphioxus) etc

## 2. GROUP CRANIATA (VERTEBRATA)

- In these chordates brain is protected inside a skeletal brain box called "CRANIUM."
- Also known as "Vertebrates" because notochord is replaced by a vertebral column.
- This group is sub-divided into two sub-phyla, which are as follows:

a) Sub-Phylum Agnatha (Mouth without Jaws)

b) Sub-Phylum Gnathostomata (Mouth with Jaws)

### A) SUB-PHYLUM AGNATHA (MOUTH WITHOUT JAWS)

- This is a small group of marine vertebrates also known as "Cyclostomes."
- Superficially they resemble the fish but lack the jaw so they are often known as "Jawless Fishes."
- They have rounded suctorial mouth with many rings of teeth.
- Paired fins and scales on body.
- Usually parasitic in nature.

E.g: Hag Fish, Lamprey etc.

### B) SUB-PHYLUM GNATHOSTOMATA (MOUTH WITH JAWS)

- It is a large group of vertebrates with both upper and lower jaw.
- Teeth may be present or absent.

Gnathostomata are divided into two super classes, which are as follows:

i) Pisces (Fishes)

ii) Tetrapoda

#### I) SUPER CLASS PISCES (FISHES)

- This is the largest group of chordates, which includes half of the chordate (25,000 species).

- Study of fishes is called “Ichthyology.”
- Body is streamlined with paired fins and covered over by dermal scales.

Super class Pisces is divided into two classes, which are:

i-a) Chondrichthyes (Cartilage Fishes)

i-b) Osteiochthyes (Bony Fishes)

#### *I-A) CLASS CHONDRICHTHYES (CARTILAGE FISHES)*

- Alternate name is “Class Elasmobranchii.”
- Usually includes marine fishes with endoskeleton of cartilage (soft bone).
- Skin contains sharp tiny enamel coated denticles called “Placoid Scales,” which form exoskeleton.
- Mouth is ventral in position and tail fin is “Heterocercal.”
- Five exposed gill slits, which are not covered over by a gill cover.
- Common examples are Skates, Sharks, Rays and Scoliodon (Dog Fish)- a small Shark etc.

#### *I-B) CLASS OSTEIOCHTHYES (BONY FISHES)*

- Alternate name is “Teleostom,” actually the largest class of chordates.
- Includes marine and fresh water fishes.
- Mouth is present at anterior tip.
- Endoskeleton in these fishes is made up of hard bone while exoskeleton is made up of thin bony plates, which are known as “Cycloid” or “Ctenoid scales.”
- Gills are covered over on each side by a gill cover called “Operculum.”
- An air bladder is present which acts as a hydrostatic organ.
- Tail fin is usually “Homocercal or Diphycercal.”
- Common e.g are Eel, Sea-Horse, Flying Fish, Globe Fish etc

#### LUNG FISHES

- Zoogeographically important fishes, belonging to group “Dipnoi, included in Class Osteiochthyes.

- Only three living genera.
- They respire by gills and by lungs during drought period (Lungs-Modified air bladder).
- Limited distribution in South America, Africa and Australia.

E.g: *Protopterus* (African Lung Fish)

## *II) SUPER CLASS TETRAPODA*

It includes following classes:

- a) Class Amphibia
- b) Class Reptilia
- c) Class Aves
- d) Class Mammalia

### A) CLASS AMPHIBIA

- This class includes the animals that came out of the water and established a successful life on land.
- They took advantages of the improved possibilities by remaining close to water, by keeping a soft and moist skin, by developing lungs and by evolving a bony skeleton with a strong vertebral column and four legs.
- They cope with seasonal changes by burrowing during extreme cold and save water by sealing themselves in a mucous envelop on dry land.
- The bony endoskeleton is the main body support.
- The notochord is absorbed during development
- Breathing is mostly by means of skin and also lung, and also by lining of buccal cavity.
- In larva the breathing is mostly by means of external or internal gills.
- The circulatory system shows a three chambered heart, with two atria and one ventricle.
- The amphibians are “Cold Blooded” (Poikilothermic) that is having internal temperature that very with the environment.
- Eggs and sperms are laid in water and fertilization is external.

E.g: Frog and Toads, Salamanders, Newts, Mud puppies etc.

### **B) CLASS REPTILIA**

#### **GENERAL CHARCTERS**

The earliest reptiles evolved from the amphibians.

#### **HABIT AND HABITAT**

Reptiles are generally well adapted to life on land, in semi-dry, completely dry and even desert habitat.

#### **NATURE**

- All reptiles lay their eggs on land.
- They are cold-blooded animals and are less active during low temperature.

#### **STRUCTURAL FEATURES**

- They possess dry skin covered with epidermal scales.
- In some lizards and crocodiles, small bony plates develop below the epidermal scales.
- The skeleton is built on the same plane as that of amphibians, but is much stronger to support their body weight.
- Respiration takes place exclusively through lungs.
- Heart is three chambered, two auricles and one incompletely divided ventricle. (In Crocodiles, the ventricle is completely divided into two chambers.)
- The excretion takes place through kidneys. The reptiles secrete much of their waste products in form of non-toxic "Uric-Acid."

#### **REPRODUCTION**

- In most reptiles fertilization is internal.
- Eggs are provided with a shell and are laid on land.
- The early development of embryo takes place on the large quantities of yolk and albumin present in the egg.
- Due to the presence of a protective membrane called "AMNIOTIC" in the egg, reptiles are included in the "Amniota Group" of Vertebrates.

### ***EXAMPLE***

Alligators, Crocodile, Snake, Turtle and Gecko etc.

### **C) CLASS AVES (BIRDS)**

#### **EVOLUTION**

- Aves have evolved from reptiles.
- As they acquired the capability of true flight they were able to exploit the aerial environment and became the largest class of terrestrial vertebrates.

#### **CHARACTERS OF CLASS AVES**

#### **HABIT AND HABITAT**

The birds live from pole to pole in all type of ecological zones. They all breed on land.

#### **FLIGHT AND ADAPTATION**

- Feathers differentiate birds from all other vertebrates.
- Feathers originated as extraordinary development of Reptilian scales.
- Instead of growing all over the body and spreading evenly, the feathers grow in definite tracts.
- The feathers play an important role in the thermoregulation of birds. They trap air, which is a bad conductor of heat and so prevent loss of body heat.
- To fly efficiently the birds have reduced their body weight in a variety of ways.
- Many bones become hollow, thin and light.
- Synsacrum and pygostyle are formed by the fusion of vertebrae and give strength to skeleton.
- Birds possess strong muscles to control the use of wing in flight.

#### **ADAPTATION FOR COMMUNICATION**

- They possess large eyes with well-developed sight.
- The birds communicate with members of their species with sound signals for which the sense of hearing is well developed.

#### **STRUCTURAL FEATURES**

- The great mobility of neck is helpful in feeding, nest building, preening and defence.
- There are developed a number of types of bills according to their feeding habits.
- The digestive system of birds is compact and can accommodate large quantity of food.
- The food is stored for a short period in the crop.
- “Gizzard” possess thick muscular wall with horny lining, small stones swallowed by birds are passed on the gizzard for grinding the food.
- The “Syrinx” or sound-producing organ is found in no other vertebrate except the birds. It is located at the junction between the trachea and the paired bronchi.
- The lungs of birds are small, solid, spongy and slightly distensible. They are in contact with a number of air sacs.

### MIGRATION IN BIRDS

A large number of species of birds exhibit a deep-rooted phenomenon of migration, during which they travel long distances from their summer breeding homes towards areas of warm climate.

### SUB-CLASSES OF AVES

There are two main sub-classes of aves, which are:

- i) Sub-Class Ratitae (Flightless Birds)
- ii) Sub-Class Carinatae (Free-Flying Birds)

#### I) SUB CLASS RATITAE (FLIGHTLESS BIRDS)

- This sub-class includes modern big sized flight less birds.
- They comparatively have heavy weight and their wings are either vestigial or rudimentary.
- They have a flat sternum without keel.
- Their flight muscles are poorly developed.
- The distribution of these birds is restricted to few areas of the World.

E.g: Ostrich, Rhea, Emu, Cassowary, Kiwi and Penguin.

#### II) SUB-CLASS CARINATAE (FREE FLYING BIRDS)

- In this sub-class modern flying birds are included.
- They are usually small, light weight birds with highly developed wings and feathers with interlocking system.
- They possess sternum with a crest like keel to accommodate the highly developed pectoral flight muscles.
- The flying birds are distributed all around the World.

E.g: Sparrow, Pigeons, Myna, Bulbul, Hoopoes, Crow, Doves, Parrots, Fowls, Cuckoo and Ducks etc.

#### D) CLASS MAMMALIA

##### GENERAL CHARACTERS

Early mammals are originated from reptiles. The distinctive characteristic of mammals are at the highest grade of development in animal kingdom.

##### HABIT AND HABITAT

Mostly terrestrial, a few aquatic.

##### NATURE

- They are warm-blooded animals.
- They can maintain a fairly high body temperature and so can successfully survive in colder areas of the world.

##### TEMPERATURE REGULATION

- Heat is generated by high metabolic rate of their body and is lost by increasing blood circulation in the skin and evaporation of sweat.
- The mammalian body temperature is maintained at  $35^{\circ}\text{C}$ - $40^{\circ}\text{C}$ .

##### APPARENT FEATURE

- All mammals possess hair on skin.
- Sweat glands and sebaceous glands are present on skin.
- Mammary glands secrete milk in females.
- External ears (Pinna) are present.
- Teeth are heterodont i.e. not uniform. The different types of teeth are: Incisors, Canine, Premolars, Molars.

##### SKELETAL SYSTEM

- Skull with two occipital condyles is present.
- Lower jaw is composed of single bone on each side.
- Vertebrae are “Gastrocentrous,” composed of three pieces i.e. the centrum and two epiphyses.
- Digits of fore and hind limbs are usually five.
- Cervical (Neck) vertebrae are seven.

### INTERNAL FEATURES

- A thick muscular septum “Diaphragm” is present between abdomen and thoracic cavity.
- Heart is four-chambered.
- R.B.Cs are non-nucleated.
- Brain with four optic lobes.
- Kidney is metanephrous.
- The stomach is simple sac but rarely complicated.

### REPRODUCTION

- Mammals give birth to young ones (Viviparous), which are nourished by parents. Except Prototherians that lay eggs.
- Fertilization is internal.
- Development of eggs occurs in the uterus of female, where the developing embryo develops relationship with mother (Placenta).
- After the birth of the child, the mother nourishes her young ones.

### CLASSIFICATION OF CLASS MAMMALIA

Mammals are divided into three sub-class:

#### 1. SUB-CLASS PROTOTHERIA

Includes the egg laying mammals. For example Duck billed, Echidna (Spiny anteater).

#### 2. SUB-CLASS METATHERIA

Includes the pouched mammals, also known as “Marsupial mammals.” For example Kangaroo, Koala Bear and Opossums etc.

### 3. SUB-CLASS EUTHERIA

Includes the placental mammals. For example Monkey, Cow, Elephant, Cat, Dog, Bat, Whale and Human being etc.

#### Summary of Kingdom Anamalia

##### (1) PHYLUM PORIFERA

- Porous body
- CaCO<sub>3</sub> Silica Skeleton
- Asymmetrical
- Amphiblastula larva
- Diffuse cellular organization
- Spongocoel body cavity

##### (2) PHYLUM CNIDARIA

- Radially symmetrical
- Body cavity "Coelentron"
- Pnedoblast – Defensive cells
- Diploblast (Ecto + Endoderm)
- Middle non-cellular layer "Mesoglea"
- Larva – Planula Larva
- Morphologically

a- Medusa = Umbrella like

b- Polyp = Rod shaped

##### (3) PHYLUM PLATYHELMINTHES

- Flatworms
- Totally Parasite
- Flat or Ribbon shaped
- Excretory organs – Proto nephridia (Flame cells)
- Aeoelomate (Absence of body cavity)
- It is the first phylum containing triplo blastic animals
- Usually Hermaphrodites
- Planaria is the only free living member
- High fertility rate
- Bilaterally Symmetrical

##### (4) PHYLUM ASCHELMINTHES (NEMATODA – ROUND WORMS)

- Totally parasitic including 50 human parasite
- Bilaterally symmetrical with cylindrical body
- Two openings (Mouth & Anus)
- Psudocoelomates
- Common diseases – Ascariasis, filariasis (elephantiasis), hook worm infection.

#### (5) *PHYLUM ANNELIDA (SEGMENTED WORMS)*

- Metamers (External segmentation)
- Septae (Internal segmentation)
- Setae (Locomotory organs) or cheata
- Digestive, excretory, nervous, reproductive system well developed.
- Respiration through diffusion
- Blood is red with a closed type of circulatory system (with many pulsatile hearts)

#### CLASS POLYCHEATA

- Setae with Parapodia
- Separate sexes
- *Sabella* (Peacock worm), *Nereis* (Clam worm)

#### CLASS OLIGOCHЕАТА

- Setae without Parapodia
- *Pheretima* (Earth worm)

#### CLASS HIRUNDINIA (LEACHES)

- Free living, Ecto or Endo parasite
- Contains a Enzyme hirudin which prevents blood clotting

#### (6) *PHYLUM MOLLUSCA (SOFT BODIED ANIMAL)*

- Second largest phylum
- Largest invertebrate – Gram squids
- External hard covering calcium carbonate shell
- A grinding structure radula is present in the buccal cavity
- Thin membranous covering of the body – mantle
- Respiration through gills
- Locomotory organ a muscular foot

- Larva – Trocophore larva

### CLASS GASTROPODA

- A phenomenon torsion is present in which the animal body rotates at the angle of 180°

Example: Pila

### CLASS BIVALVIA

- Second largest class of mollusca
- Shell consist of two parts and attached with each other by hinge joint
- Common examples: Unio, mytilus and pearl oysters

### CLASS CEPHALOPODA

- All members are marine
- Locomotory organ foot transformed into suckers which bears tentacles and arms
- Example: Sepia (cuttle fish), loligo (squids), octopus (devil fish)
- Shell is absent in octopus

## (7) PHYLUM ARTHROPODA (JOINTED LEGS)

- Largest phylum
- One million species
- Metamerically segmented animals
- Blood filled cavity haemocoel is present
- Blood without haemoglobin (white)
- Respiration: Gills, Trachea or Book lungs
- Excretory organs malpighian tubules
- Nervous system well developed
- Compound eyes with sharp vision
- Metamorphosis = developmental changes which transforms a larva into its developed adult form
- Incomplete metamorphosis = egg → nymph → adult e.g. cockroach
- Complete metamorphosis = ® egg ® larva ® pupa ® adult e.g. Butterfly, common, housefly and mosquito
- Moulting (ecdysis)

- Changing over of old exoskeleton and formation of a new one
- Apiculture => Farming of honey bees
- Sericulture => Farming of silk worms

#### CLASS MEROSTOMATA

- Limulus (king crab)

#### CLASS ARCHINIDA (SPIDER LIKE)

- Group of Spiders & Scorpions
- Respiration through book lungs
- Four pair of walking legs

#### CLASS CRUSTACEA

- Class of prawns, shrimps, lobsters, crabs
- Two pairs of antennae, one pair of mandible and two pair of maxilla
- Exoskeleton a large plate of carapace
- Sacculina is the only parasitic member

#### CLASS MYRIAPODA

- Class of millipedes and centipedes
- Body is divided into similar multiple segments

#### CLASS INSECTA OR HEXAPODA

- Largest class (eight lakhs & 50,000 members)
- Study of insects is called entomology
- Three pairs of walking legs
- Pterygota (insects with wings)
- Apterygota (insects without wings)
- Social insects: Ants, termites, honey bees

#### (8) PHYLUM ECHINODERMATA (ANIMAL WITH SPINY SKIN)

- Marine animals
- Radially symmetrical
- Pentamerous body
- Water vascular system is present
- Locomotory organs are tube feet = External openings of the water vascular system

- Exoskeleton is made up of calcarious plates in the form of spines
- Power of regeneration is very great
- Phylum echinodermata, hemichordata & chordate posses common ancestor
- Bipinnaria larva is present
- Common e.g. Sea Star (Star fish, Brittle star, Sea dollar, Sea urchins, Sea cucumbers.

#### (9) PHYLUM HEMICHORDATA (ANIMAL WITH HALF NOTOCHORD)

- Notochord in future = Vertebral column + Skull
- Dorsal nerve cord = Brain and Spinal cord
- Pharyngeal gill slits  $\leftrightarrow$  Aquatic animals = gills
- $\rightarrow$  Terrestrial = Internal neck structures
- Only 90 species are present
- Larva is tornaria larva
- Open circulatory system

#### (10) PHYLUM CHORDATA

##### GROUP ACRANIATA

Brain without any covering or skull

##### SUB-PHYLUM UROCHORDATA

- Also known as tunicates
- Body is enclosed in a sac tunic
- Only embryonical stages show chordate characters

##### SUB-PHYLUM CEPHALO CHORDATA

Embryonic as well as adult both forms show typical chordate characters

##### GROUP CRANIATA OR VERTEBRATA

Brain and spinal cord is enclosed in a hard covering skull & vertebral column respectively

##### SUB-PHYLUM AGNATHA (ANIMALS WITHOUT JAWS)

- Also known as cyclostomes or jawless fishes
- Totally parasitic
- Teeth are present in the form of rings
- Common e.g. Hag fishes, lamprey

### SUB-PHYLUM GNATHOSTOMATA (ANIMAL WITH JAWS)

- Teeth may be present or absent
- Amphibians and bird lack teeth
- Fishes, reptiles, mammals do have teeth

#### **1. SUPER – CLASS PICSES (FISHES)**

Study of fish is known as echthylogy

#### SUB – CLASS CHONDRICHTHYES (CARTILAGENOUS FISHES)

- Endo skeleton is cartilaginous (soft boned)
- Exoskeleton – Placoid scales
- Fins are heterocircle (different size and shaped)
- Gills without any covering
- Common example (Sharks, Squids, torpedo, electric ray)
- Scolidoen (dog fish) – Small Shark

#### SUB – CLASS OSSEOCHYTHES (BONY FISHES)

- Exoskeleton cycloid or ctenoid scales
- Operculum is present (covering of gills)
- Fins are homocircle (Same size and shape)
- Lung fishes are included in order dipnoi.

#### **2. SUPER CLASS TETRAPODA**

##### 1. CLASS AMPHIBIA

- Exoskeleton is absent
- Respiration by lungs, gills or skin
- Fertilization is external
- Cold blooded
- Having the characteristics of hibernation & aestivation
- Common e.g. Toads, frogs, salamanders etc.

##### 2. CLASS REPTILIA

- Included in group amniota due to the presence of amnion in eggs
- Fertilization is internal
- Exoskeleton is made up of thick horny scales
- Important members are snakes, turtles, lizards, crocodiles and alligators

- Venom → Snake poison
- Fangs → sharped and curved teeth of snake

### 3. CLASS AVES (BIRDS)

- Study of birds is called ornithology
- They posses hollow bones (Pneumatic bones)
- Sound producing organ “Syrinx” is present instead of larynx.
- Teeth totally absent.

#### SUB CLASS RETITA (FLIGHT LESS BIRDS)

E.g. Penguin, Kiwi, Ostrich.

Ostrich → Largest Bird.

#### SUB CLASS CARNIATAE (FLYING BIRDS)

- Wings with interlocking system.
- Common e.g. Peacock, Seagulls, Kites, Falcon etc.
- Archeopetryx → Intermediate specie between reptiles and birds.

### 4. CLASS MAMMALIA

- Presence of mammary glands and hairs.
- A muscular organ diaphragm, which separates thoracic cavity from abdominal cavity.
- Teeth are present with different size and shape (heterodont).
  - a- Incisors → for biting and cutting purpose
  - b- Canives → Tearing purpose
  - c- Pre-Molars -> For grinding and holding purpose
  - d- Molars -> For grinding and holding purpose

#### SUB CLASS PROTOTHERIA (EGG LAYING MAMMALS)

- Also called monotremous.
- Two genera with 3 species
- Oviparous.
- Common urogenital opening Cloaca is present.
- External ear is absent.
- It is a connecting link between reptiles and true mammals. e.g. spiny anteater, duck billed platypus.

#### SUB CLASS METATHERIA (POUCHED MAMMALS)

- Marsupials
- Give birth to live young ones.
- Special pouch like bag is present in the ventral side of female.
- This pouch is known as marsupial.
- Common e.g. Kangaroo, Kuala bear, Opossums.

#### SUB CLASS EUTHERIA (PLACENTAL ANIMALS)

- 95% of mammals are included in this group.
- Viviparous.
- Placenta → connecting link between mother and fetus.
- Common e.g. Camel, donkey, elephant, bat, whale, dolphin.
- Markhor is the national animal of Pakistan also known as Wild goat.

