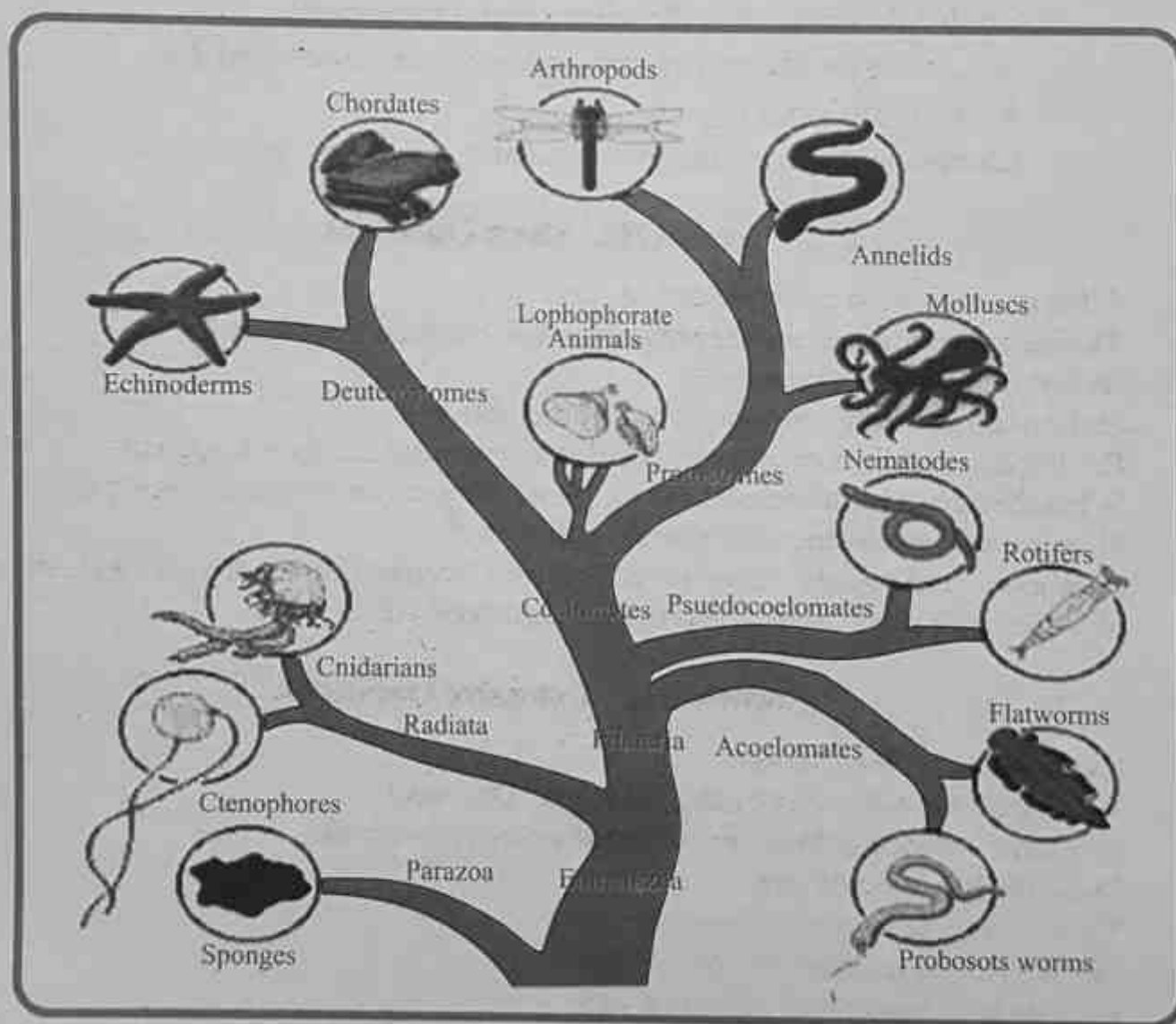


UNIT 9

DIVERSITY AMONG ANIMALS

Major Concepts

- 9.1 Characteristics of Animals.
- 9.2 Criteria for Animals Classification.
- 9.3 Invertebrates.
- 9.4 Vertebrates.(Chordates).



Students Learning Outcomes

On completion of this unit students will be able to:

- Describe the general characteristics of animals.
- Classify animals on the basis of presence or absence of tissues.
- Differentiate the diploblastic and triploblastic levels of organization.
- Describe the types of symmetry found in animals.
- Differentiate pseudocoelomates, acoelomates and coelomates.
- Classify coelomates into protostomes and deuterostomes.
- Describe the general characteristics, importance and examples of sponges, cnidarians, platyhelminthes, aschelminthes (nematodes), molluscs, annelids, arthropods and echinodermates.
- Describe the evolutionary adaptations in the concerned phyla for digestion, gas exchange, transport, excretion and coordination.
- Describe the characteristics of invertebrate chordates and vertebrates.
- List the diagnostic characteristics of jawless fishes, cartilaginous fishes and bony fishes.
- Describe the general characteristics of amphibians, reptiles, birds and mammals.
- Differentiate among monotremes, marsupials and placentals.
- Describe the evolutionary adaptations in concerned groups for gas exchange, transport and coordination.

Introduction

The kingdom Animalia includes all animals. The word animal is derived from Latin word **anima** which means breath or soul. Animals are multicellular ingestive heterotrophic organisms which are developed by fusion of haploid "n" non motile eggs and haploid "n" motile sperms. They were originated from animal-like protists. The branch of biology which deals with the study of animals is called Zoology.

9.1 Characteristics of Animals

All animals are eukaryotic multicellular heterotrophic organisms, found almost in all types of habitat (such as terrestrial, aquatic, aerial, arboreal etc). Most animals are **motile**, some are **sessile** but their larval stage is motile, few are parasite and size ranges from microscopic (worms) to very large in size (Blue whale) almost 150 tons. **Locomotion**, mostly by means of muscle fibers. Most animals contain two sets of chromosomes in their body cell. They **respire** both aerobically and anaerobically. The body of animals may be from soft to hard, diploblastic or triploblastic, either radially symmetrical or bilaterally symmetrical, few are asymmetrical. Their body is mostly covered with shell, chitin, bony plates, scales, furs, feathers etc. Bilateral symmetrical animals may be either **acoelomates** (Platyhelminthes) or **pseudocoelomates** (Nematodes) or **coelomates** (from Annelida to chordate). They possess only **ingestive heterotrophic** nutrition. Animals have either incomplete digestive system (single

opening) or complete **digestive system** i.e., tube like digestive system with mouth and anus at opposite ends. **Excretory system** is well developed in most animals while it is absent in poriferans and coelenterates. **Nervous system** in poriferans is absent while in coelenterates neuron net is present. It is well developed in most animals, sensory cells or sense organs are also present. **Respiratory system** is mostly present i.e., from arthropods to chordates, while lower non chordates respire only by diffusion from surrounding water.

Tit bits

Currently there are 66 thousand types of vertebrates, about 5% of total 1.3 million animal species.

Skeletal system is recorded in all animals, which is spicules or spongin fibers like in poriferans. In most invertebrates hydrostatic skeleton is present. While endoskeleton is recorded in few molluscs (cuttlefish), echinoderms and in all vertebrates. Exoskeleton is also present in many invertebrates (Arthropods, molluscs). It is also present in most chordates. The circulatory or **blood vascular system** is well developed from Annelida to Chordata, while in other invertebrates transportation occurs by diffusion.

All animals **reproduce** either asexually or sexually. Asexual by mitosis and sexual by meiosis and syngamy, embryo is present in all animals, they give birth to their young ones, or lay eggs.

Regeneration is present in poriferans, coelenterates, Platyhelminthes etc.

All animals lack cell wall, no plastids in their cells but **centrioles** are present.

9.2 Criteria for animal classification

Kingdom Animalia is divided into two subkingdoms i.e., parazoa and eumetazoa. (Table 9.1). The two subkingdoms are formed on the basis of presence or absence of cellular organization. The **parazoa** (para: beside; zoon; animal) are an ancestral sub kingdom of animals. They are simplest multicellular animals believed to be evolved from protozoans, their body is just collection of cells which are not differentiated into tissues or organs, there is some division of labour among cells but are not strongly associated to perform a specific collective function.

The only surviving parazoans are sponges belong to phylum **porifera**. Mostly asymmetrical animals, however, few are radially symmetrical.

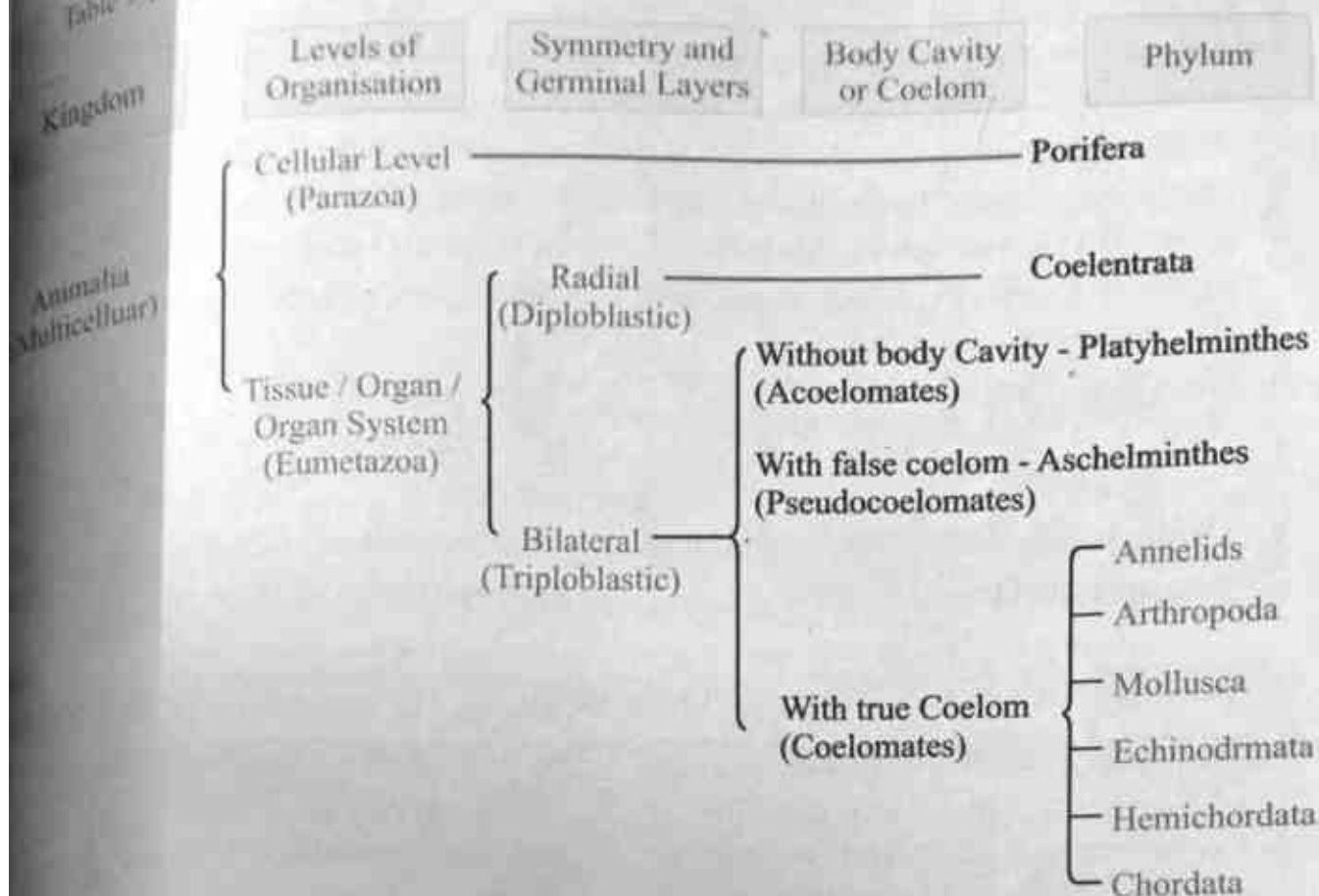
Sub kingdom eumetazoa includes animals, in which body cells are arranged into tissues, the tissues organized into organs and organs into **organ systems**. The cells or tissues of eumetazoans are arranged into layers, either diploblastic (two germinal layers) or triploblastics (Three germinal layers). Germinal layers are present during development of an embryo.

Do you know?

The geometrical view of an organism is called symmetry. The asymmetrical animals do not exhibit symmetry.

Table 9.1

Broad classification of Kingdom Animalia based on common fundamental features



Echinodermata exhibits radial or bilateral symmetry depending on the stage.

9.2.1 The sub kingdom eumetazoa can be classified on the basis of body symmetry into grade radiata and grade bilatera.

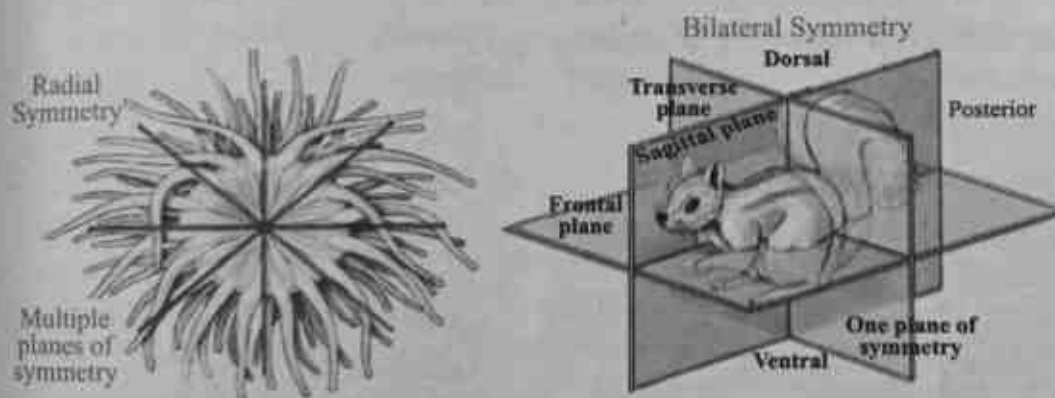


Fig. 9.1 Radial and bilateral symmetry

Table 9.2 Differences between Radiata and Bilateria

Grade Radiata	Grade Bilateria
1. This grade includes radially symmetrical animals e.g., coelenterates and adult of echinoderms.	1. This grade includes bilaterally symmetrical animals e.g., from phylum Platyhelminthes to Chordata.
2. The arrangement of body organ around a central axis and can be cut into two identical halves from any plane that pass through the central axis.	2. Their body can be cut into two identical halves from a single longitudinal plane running down the middle line.
3. No right and left side.	3. Right and left side, anterior and posterior ends, dorsal and ventral surface.
4. Mostly sessile animals thus considered an adaptation for a sessile life.	4. Mostly motile animals thus considered an adaptation to motility.

Table 9.3 Classification on the basis of arrangement of tissue layers. Either Diploblastic or Triploblastic

Diploblastic animals	Triploblastic animals
1. Two germ layers animals that is ectoderm and endoderm, in between these layers jelly like mesoglea is present which is mostly non cellular.	1. Three germ layers animals, the ectoderm, mesoderm and endoderm. These layers are visible only during embryonic development, later transformed into various organs.
2. Mostly devoid of specialized organs and organ systems.	2. Mostly specialized organs and organ systems are present.
3. They have no specialized nervous system rather have net work of neurons (nerve cells) with few ganglia. (aggregation of neurons).	3. They have specialized nervous system, having ganglia or brain.
4. Radially symmetrical animals.	4. Bilaterally symmetrical animals.
5. They have gastrovascular cavity with single opening, which act both as mouth and anus, example: phylum Coelenterata or Cnidarian.	5. They have well developed digestive system, which is tubular having anterior mouth and posterior anus or cloaca. Example: all phyla except coelenterata i.e. from Platyhelminthes to Chordata.

9.2.2 Classification of animals according to coelom (Body cavity).

Coelom is a fluid filled cavity between outer body wall and the alimentary canal which is lined by mesodermal membranes.

The grade Bilateria is divided into three groups on the basis of kind of coelom.

1. Acoelomate
2. Psuedocoelomate
3. Coelomate

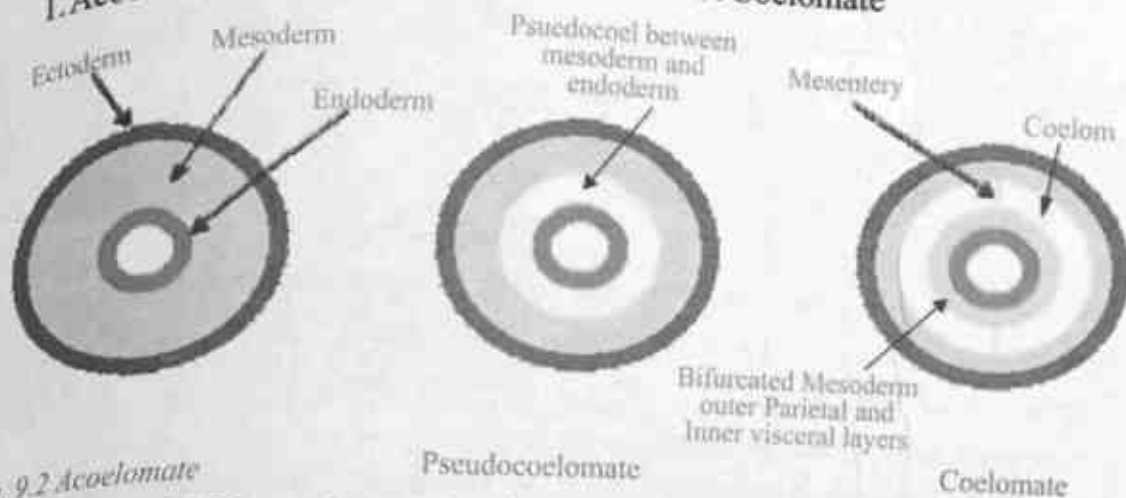


Fig. 9.2 Acoelomate

Table 9.4 Differences between Acoelomates, Psuedocoelomates and Coelomates

Acoelomates	Psuedocoelomates	Coelomates
1. No body cavity or coelom and recorded only in Platyhelminthes.	1. Possess false coelom thus called psuedocoelom and recorded only in nematodes (Aschelminthes).	1. Possess true body cavity or coelom and recorded from annelids to chordates.
2. No body cavity between digestive tract and outer body Wall, mesoderm form a loose, cellular tissue called parenchyma or mesenchyma.	2. Coelom is present between mesoderm and endoderm thus not covered by coelomic epithelium and is the remnant of blastocoel.	2. The mesoderm splits into outer parietal layer and inner visceral layer and filled with coelomic fluid.

9.2.3 Coelomates

Coelomates can be classified into two groups on the basis of early development.

1. Protostomes
2. Deuterostomes

The differences between Protostomes and deuterostomes are explained in table 9.5.

Tit bits

Cleavage is the division of zygote in which number of cells increase but size of cell hardly increase, cleavage is either radial or spiral.

Do you know?

The blastopore is the first opening of the embryo while archenteron is the primitive gut.

Critical Thinking

Bilateral symmetry is more successful body plane than radial symmetry. Can you guess why?

Table 9.5 Differences between Protostomes and Deuterostomes

Protostomes	Deuterostomes
1. Cleavage of zygote is spiral and determinate.	1. Cleavage of zygote is radial and indeterminate.
2. Blastopore or its anterior margin becomes mouth and anus is formed later on during development.	2. Blastopore become anus and mouth is formed afterwards during development.
3. Schizocoelous (that is coelom is formed by mesodermal splitting).	3. Enterocoelous (coelom is formed by out pouching of endoderm (archenteron)).
4. The lips of blastopore produces mesoderm. Examples: Nematoda, Annelids, Molluscs and Arthropods.	4. The wall of archenteron produces mesoderm. Examples: Echinodermata, Hemichordata and chordata

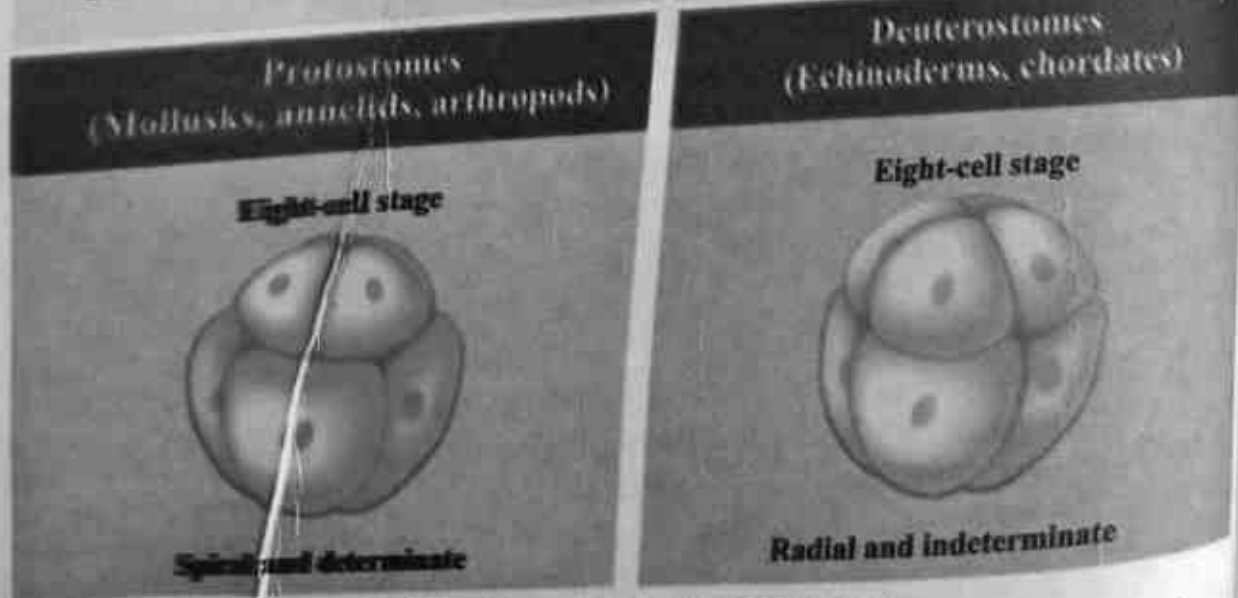


Fig. 9.3 Comparison between Protostomes and Deuterostomes

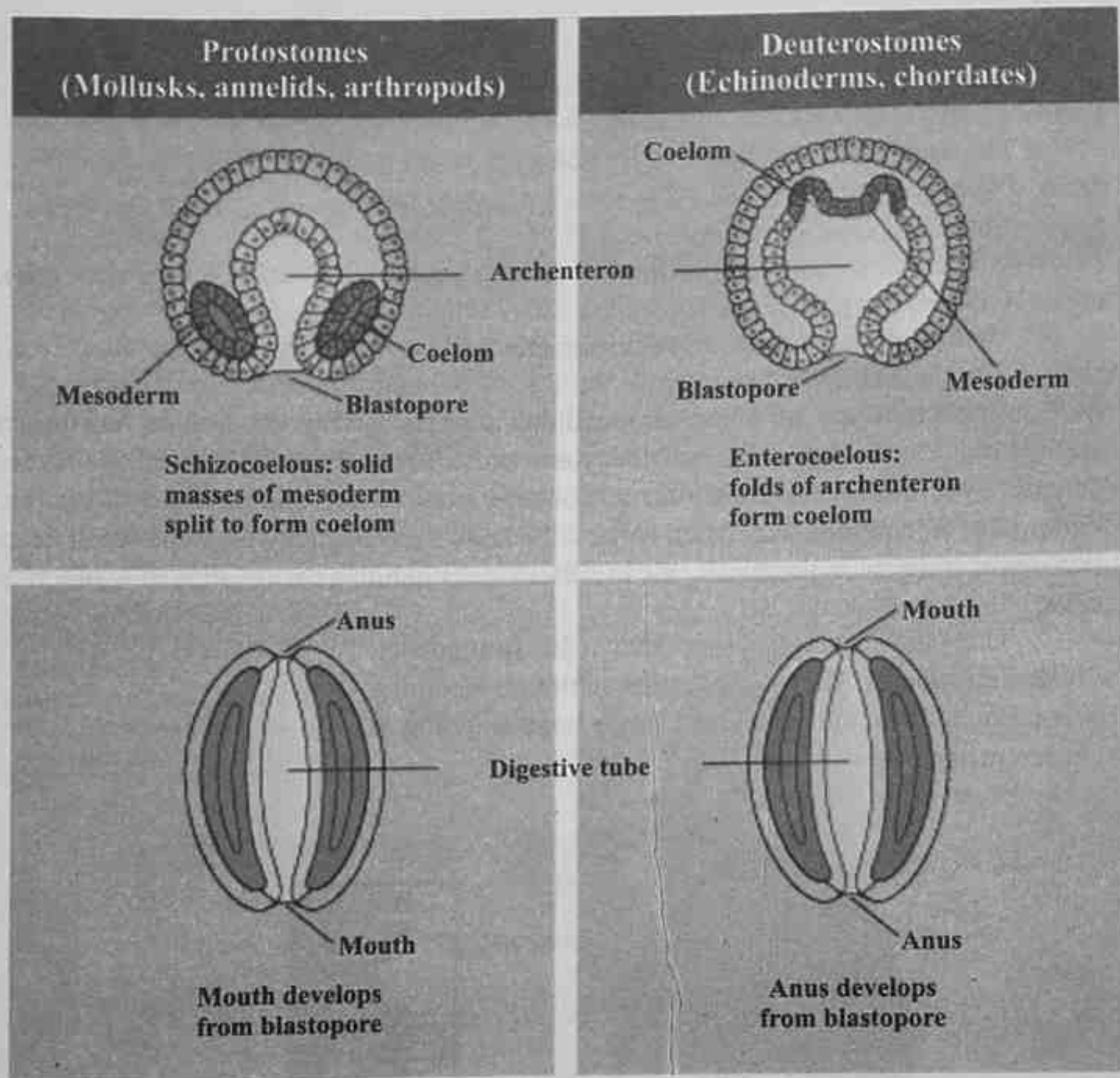


Fig. 9.3: Comparison between Protostomes and Deuterostomes

9.3 Invertebrates

Most biologists have divided the animals into two groups on the basis of presence or absence of vertebral column (back bone).

The group invertebrates lack vertebral column while group vertebrate possess vertebral column. Invertebrates account for 95% of known animal species, invertebrates are divided into eight major phyla, which are Porifera, Coelenterata, Platyhelminthes, nematodes, annelids, Mollusca, Arthropoda and Echinodermata.

9.3.1 Phylum Porifera

(Greek: Poros means channels, Latin: Ferre means bear)

The name Porifera was given by Robert E. Grant in 1836. Phylum Porifera is also known as sponges and possess following characteristics.

Habitat: Their larval stage is motile while adult is sessile (attached to submerged rock), about 10,000 species have been recorded.

Their **size** range from a few millimeter wide to more than a meter long (e.g., *scolymastra joubini* from Antarctica).

Body: Poriferans are simplest multicellular animals having no tissues and organ organization. Asymmetrical or radially symmetrical. The body wall is formed of an outer dermal layer known as **pinacoderm**, contains pinacocytes and an inner layer, the **choanoderm**, contains flagellated collar cells known as choanocytes. In between these two derms is a gelatinous matrix, the mesenchyma containing many kinds of wandering cells.

They have single body cavity, the **spongocoel**, divided into canals. The body contains numerous incoming or incurrent pores, the **ostia** and a single large outgoing or excurrent pore, the **osculum**.

Tit bits

The mesenchyma of sponges contain amoeboid cell, store food give color while scleroblasts are spicules and spongin fibers forming cell.

Activity

Draw the evolutionary tree diagram of coelomates. You may take help from the figure on title page of this chapter.

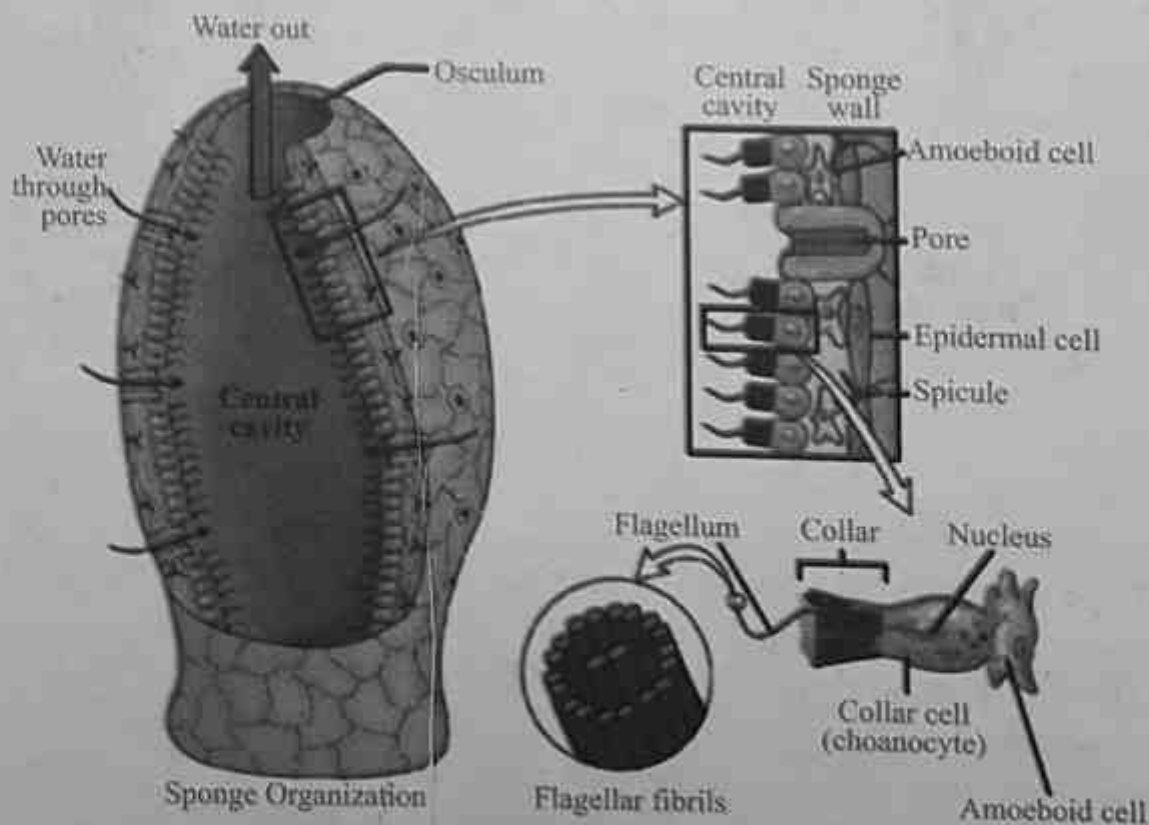


Fig. 9.4 Anatomy of sponges

Nutrition: Sponges are heterotrophic depend on food coming to their body with water current through ostia and moved in by flagella of choanocytes, where intracellular digestion takes place, the digested foods are transported by mesenchymal cells. The waste material either diffuse out of the sponges directly through the body wall or through osculum.

Nervous system is absent, but neuron and neurosensory cells help to coordinate water flow. The **skeleton** is formed of needle like structures the **spicules** (either **calcareous** or **silicious**) while some sponges, like **bath sponge** possess **sponging fibers**, osculum and ostia also contain spicules. The sponges possess both asexual and sexual reproduction. **Asexual**, either by external budding or internal budding (**gemmule** formation), **regeneration** is also common. Sponges are mostly **hermaphrodite** (Bisexual) and **protandrous** (male gametes develop before the female). **Fertilization** is internal, occur in mesenchyma. The sponges have probably evolved from flagellated protists known as **choanoflagellates**. Examples: sycon (marine sponge), *Leucosolenia* (erect tube shaped), *Euplectella* (glassy frame work), *Spongilla* (fresh water sponge).

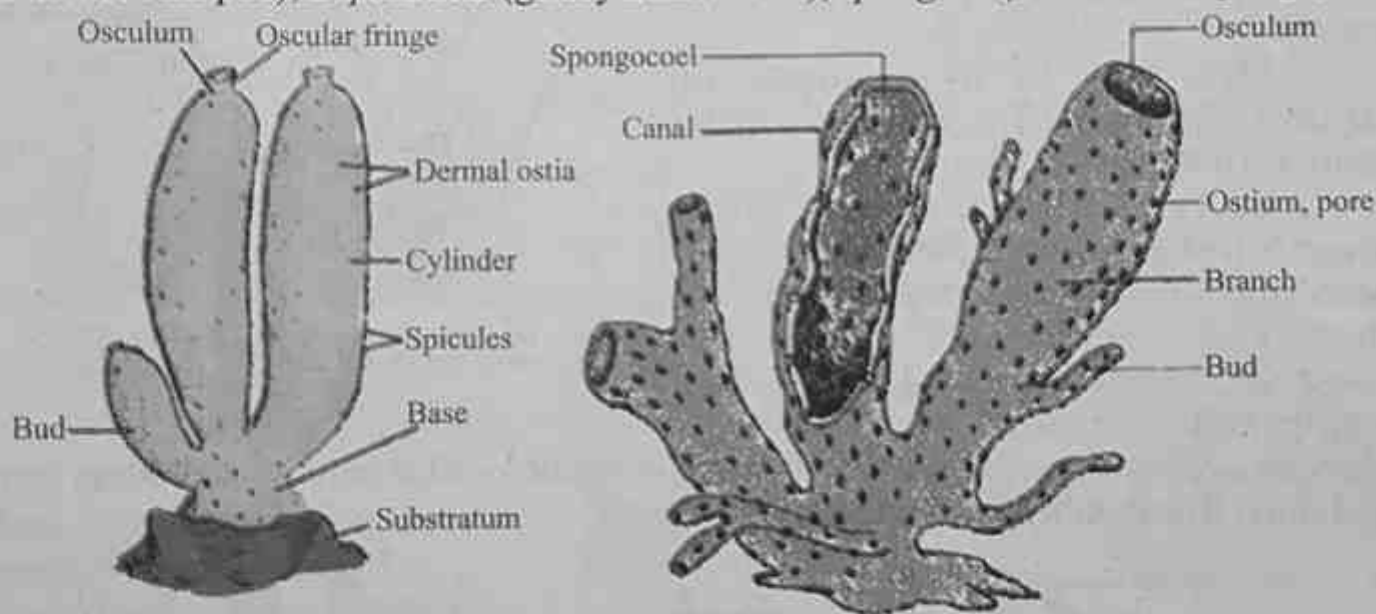


Fig.9.5 Scypha and Leucosolenia

Evolutionary adaptation in Porifera:

Sponges having intracellular digestion, which is facilitated by flagellated collar cells. The respiration occurs by diffusion, because almost each body cell is in contact with water.

Transportation of substances (food, excretory products) either by diffusion or by water current through canal systems. "Water enters through ostia into spongocoel and goes out of body through the osculum." They have weak coordination, only some neurosensory cells and neurons coordinate water flow.

Tit bits

The food of sponges is 20% Zooplankton and phytoplankton, 80% detritus. **Detritus** is dead and decaying organic matter.

Importance of sponges:

The **bath sponges** are used for washing and bathing by human. Sponges can greatly **absorb water** thus are used in surgical operation for absorbing fluid and blood. In large buildings, sponges are used for sound absorption, to **prevent echo**. They are also used as **decorative** purpose and used in shoe or **vehicle polishing**.

9.3.2 Phylum Cnidaria (Gk. Kindle, nettle, + L. aria connected with)

The name Cnidaria is given to this phylum due to the presence of specialized stinging cells called cnidocytes all over the body which give rise to nematocysts. The **nematocyst** is a capsule with paralyzing venom which acts as offensive and defensive organ. Phylum Cnidaria exhibit following characteristics.

Habit and Habitat: Cnidarian are either sessile e.g., hydra or free living motile e.g., jellyfish). Many are colonial (e.g., *Obelia*). Most of them are carnivores. All cnidarians are aquatic (both marine and fresh water).

Size: may be from microscopic (*Hydra*) to very large (e.g., *Brachioceranthus*, up to two meter in length.)

Body: Cnidarian are radially symmetrical, most are diploblastic i.e., have outer ectoderm and inner endoderm between these two layers, there is gelatinous cementing substance, called mesoglea. A single hollow internal cavity known as **enteron** or gastrovascular cavity with a single opening called mouth (act both as mouth and anus). The mouth is surrounded by **tentacles**.

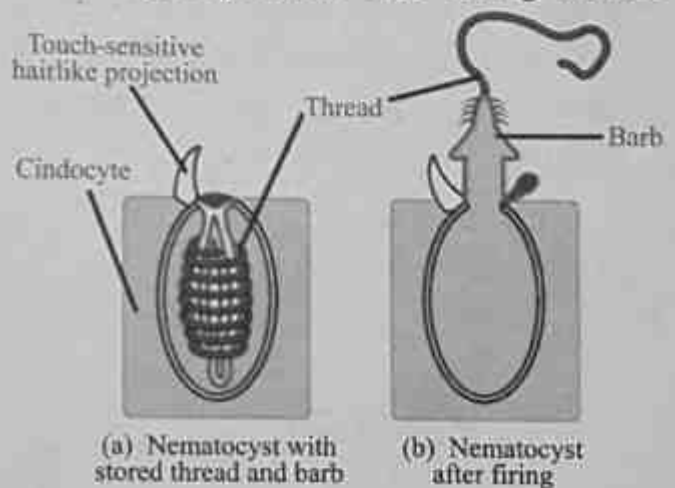


Fig.9.6 Structure of Cnidocyte

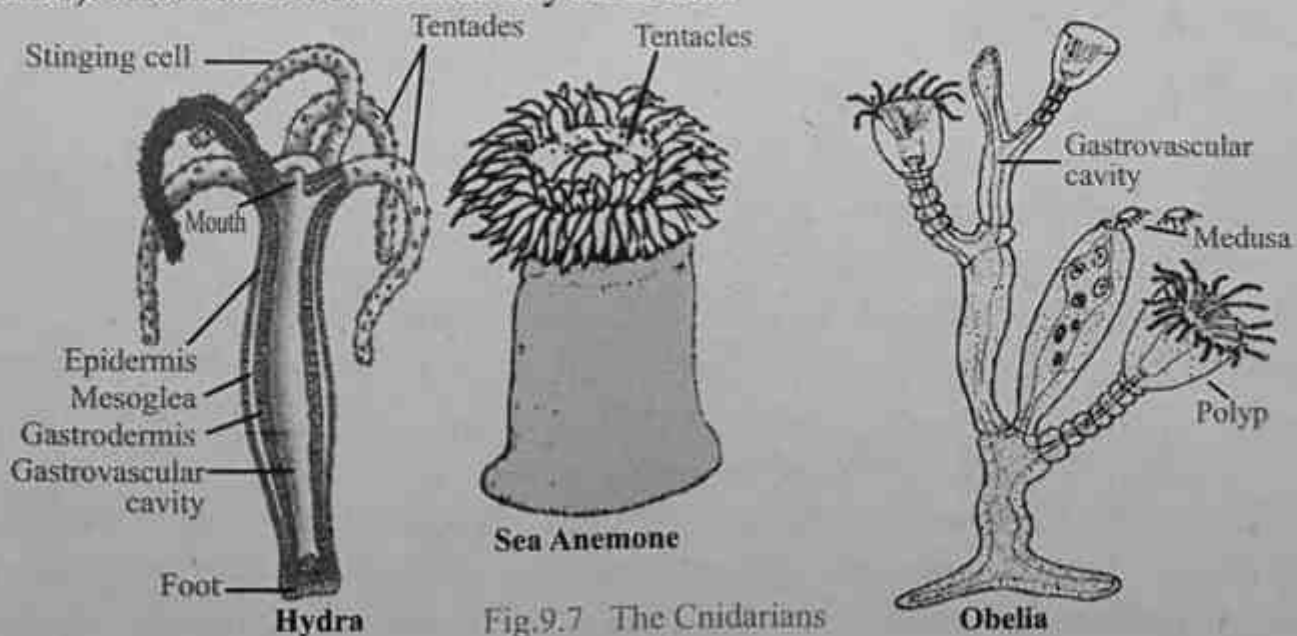


Fig.9.7 The Cnidarians

Nervous system consists of irregularly placed network of neurons with few ganglia. Some colonial cnidarians exhibit **Polymorphism**.

They can reproduce both asexually and sexually. Asexual by means of budding and regeneration (such as in hydra), in sexual reproduction gametes are formed.

Evolutionary Adaptation in Cnidarians:

In cnidarian colonial forms exhibit **polymorphism** and **alternation of generation**, both polyp and medusa are diploid and diploblastic. Some colonies (like corals) grow to a great size, living in their own secreted skeleton, made of Calcium carbonate (lime) which they get from sea water by ectodermal cells. These skeletons form **coral reef** (under water ridge or rock) and even an island. Mostly found in Florida, West Indies, Austria, east coast of Africa. In cnidarian most systems are still not appeared such as transport, excretory, respiratory, thus only diffusion help in respiration and excretion. Although a sac like gastrovascular cavity is present.

Importance of Cnidarians:

Cnidarians are both beneficial and harmful such as coral reefs protect the shores from **erosion** by tidal waves. Many jewellery items are made by corals. Used as decoration in aquarium and rock garden. Some Cnidarians **sting human** (Jelly fish and sea anemone).

In Pakistan, they are common at sea shores of Mekran and Karachi. Many people are affected by poisonous cnidarians while they swim.

9.3.3 Phylum Platyhelminthes (Gk. Platy: flat, helminth: worm)

Platyhelminthes are also called flat worms or **acoelomate** worms. The characteristics of phylum Platyhelminthes are:

Habit and Habitat: Platyhelminthes are either free living (e.g., planaria) or parasitic (e.g., tapeworm). These worms are recorded both in fresh water and marine, while parasitic worms are also found in the liver and gut of humans beings.

Body: Flat worms are triploblastic, bilaterally symmetrical and soft bodied animals. Their body is dorsoventrally flattened and acoelomate. Free living forms possess

Do you know?

Class anthozoa of cnidarians is triploblastic.

Tit bits

*Polymorphism is a condition, in which a species has two or more very different structural forms there is division of labour among different group of cells, which are formed in units known as zooids, mainly they are of two types: **polyps** or **hydrozooids**; cylindrical feeding zooids, mouth is upwards and **Medusa** are **umbrella shaped** reproductive zooid. Their mouth is downward.*

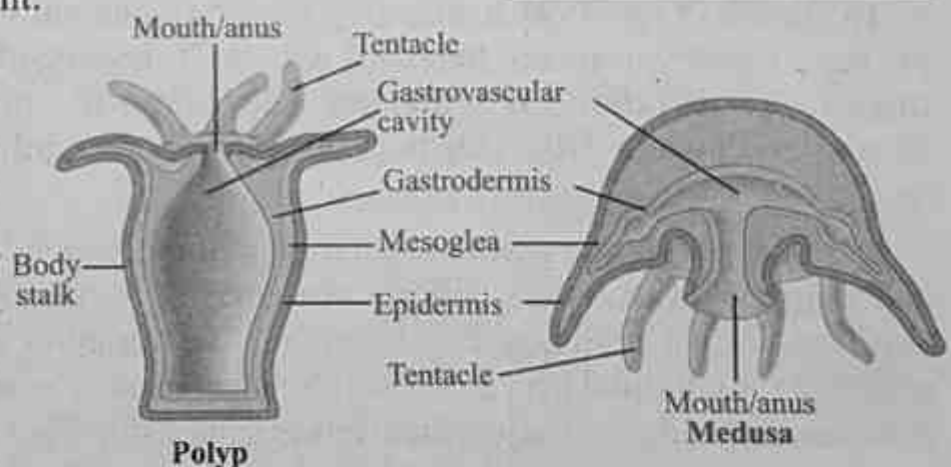


Fig.9.8 Polyp and Medusa

incomplete digestive system i.e., with a single opening known as mouth while less developed or absent in parasitic forms. **Excretory system** is well developed protonephridial system containing flame cells. **Nervous system** consists of network of nerves, with two longitudinal nerves and anterior cerebral ganglion. Locomotion occurs by means of underside cilia.

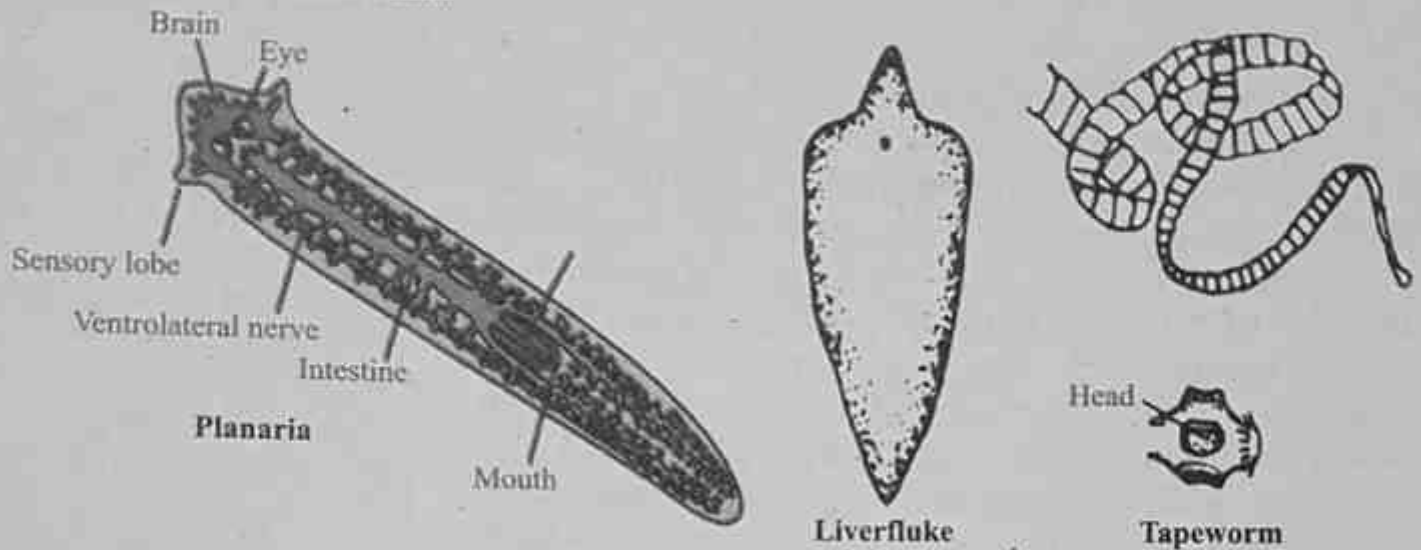


Fig.9.9 Platyhelminthes

Reproductive system: Asexual by fission (regeneration) sexual reproduction is also present. These worms are **bisexual** with well developed gonads, ducts and accessory organs, **fertilization is internal**, development may be direct or indirect. Examples: Planaria (*Dugesia*), liver fluke (*Fasciola*) and Tapeworm (*Taenia*).

Evolutionary Adaptation in Platyhelminthes:

There is simple gastrovascular type of incomplete digestive system. Respiratory and transport systems are still not appeared, it occurs by diffusion. Excretory organs appeared, called protonephridial system. The initiation of centralized nervous system with two longitudinal nerves and cerebral ganglion. The parasitic form developed many parasitic adaptations to adjust themselves in parasitic life.

Importance of Platyhelminthes:

The parasitic flat worms cause many serious diseases. In human, such as liver fluke infect liver, tape worm to human intestine, and the blood fluke to cattle etc.

9.3.4 Phylum Aschelminthes (Greek: Askos means Sac, Helminths means worms) Nematodes or The round worms

Habit: Mostly parasitic, some are free living.

Habitat: Muscular and intestinal parasites of human and other animals, some are free living (in soil, roots of plants).

Body: Triploblastic and bilaterally symmetrical. Segmentation absent, body cylindrical and pointed at both ends. The body cavity is pseudocoel, which is remnant of blastocoel (not formed by mesoderm).

Digestive system:

It is complete, consists of a single tube with a mouth at the anterior end and anus at the posterior end.

Muscular layer: It is not continuous: divided into four longitudinal quadrants, (two dorsolateral and two ventrolateral). **nervous system** consist of nerve ring from which nerve cord and fibers extend in various directions.

Senses: Sensory papillae are present in front part of the body, especially on lips.

Sexes are mostly separated. Dioecious some are monoecious, fertilization is internal.

Circulatory and respiratory systems are absent.

Size: varies from microscopic to large such as *Ascaris*, more than one feet in length. Examples: among parasites are *Ascaris*, pinworm and guinea worm, *Gaenorhabditis* (free living) etc.

Evolutionary adaptation in Aschelminthes:

These worms have adopted themselves in almost all types of habitat. This is the first phylum in which complete digestive system appeared, begin from mouth and end at anus. The circulatory and respiratory organs are still not appeared, however, excretory system consists of canals and protonephridia. Nervous system is also better developed than Platyhelminthes, possesses pharyngeal ring and many nerves.

Importance of Nematodes:

- Aschelminthes (nematodes) are cause of many serious parasitic diseases, such as:
1. *Ascaris lumbricoides* is a human intestinal parasite which causes anemia, abdominal pain, fever, it also migrates to the lungs and causes cough and other complications.
 2. *Rhabditis*: many species of this genus live in soil, organic matter, water and feces of many animals.
 3. *Enterobius vermicularis* (pinworm): It is found all over the world especially in Europe, America live in caecum, appendix and colon of man, causes itching of anus, inflammation of colon and appendix, resulting insomnia and loss of

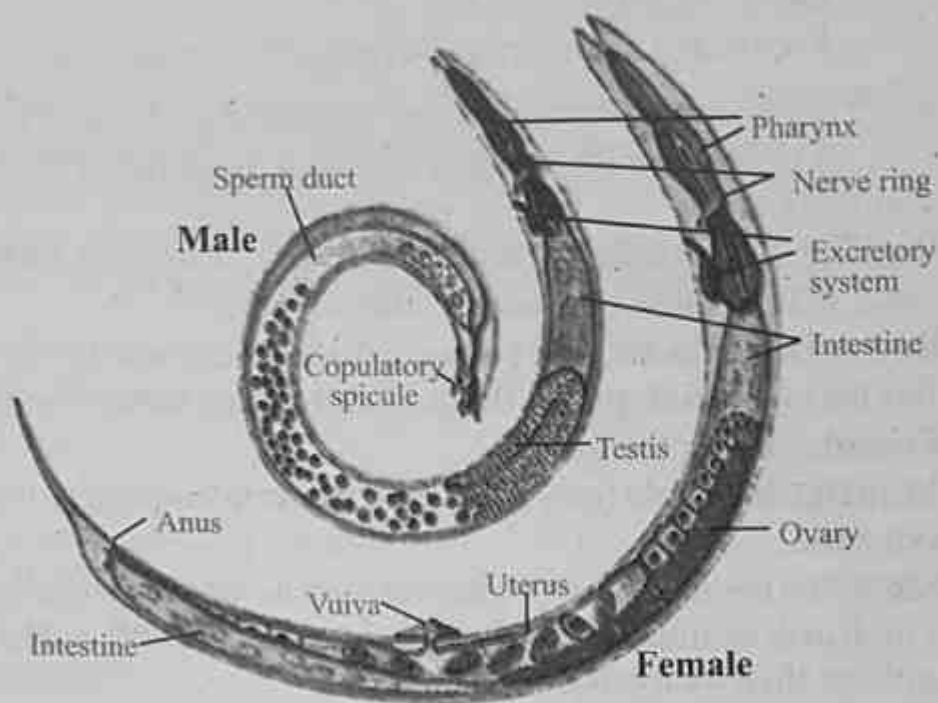


Fig.9.10 Ascaris

Activity

What are endangered species? Make a list of endangered animal species of Pakistan by searching internet and other reliable sources.

- appetite.
- Hook worms: (*Acyclostoma duodenale*) it is also parasite of human intestine and cause bleeding.
 - Free round worm: in soil, causes disease to potato, onion, cotton, apple etc.

9.3.5 Phylum Mollusca (Soft Bodied Animals) (L. Mollis, soft).

The term mollusk was introduced by Kontson in 1650 (about 50,000 species are recorded).

Habitat and habits: mostly free living, some are attached (sessile) found in fresh water, marine, moist soil and mountain rocks.

Body: Triploblastic, soft bodied animals. They are mostly haemocoelomate, coelom is divided into blood spaces. Body contains head, visceral region and muscular foot.

Found: all over the world.

Mantle: the whole body is covered in an envelope of glandular epithelial tissues known as mantle.

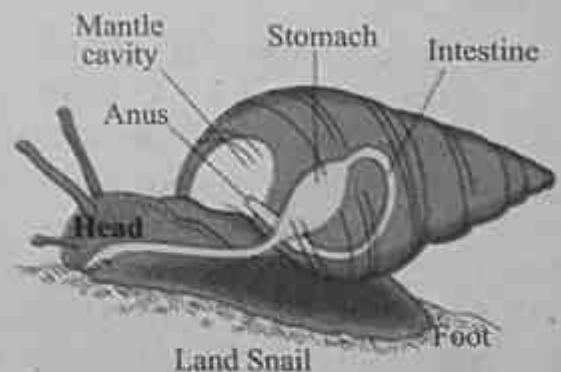
Shell: the mantle in many cases secretes a calcareous shell, which may be internal (cuttle fish) or external (snail), some without shell (octopus).

Systems: most systems are well developed (such as digestive, circulatory, respiratory, nervous and reproductive systems). **Respire** through gills or mantle. **Blood circulatory system** is of an open type (except, class cephalopods).

Radula: Tongue like structure provided with horny teeth. **Nephridia** are their excretory organs (may be one, two or six). **Nervous system** consists of a collection of ganglia in the head region forming a ganglionic mass, which is connected with the ganglia of foot and visceral mass. Mostly **Unisexual** few are bisexual. **Indirect development** (trochophore larva). **First invertebrate** in which both endo and exoskeletons were originated.

Do you know?

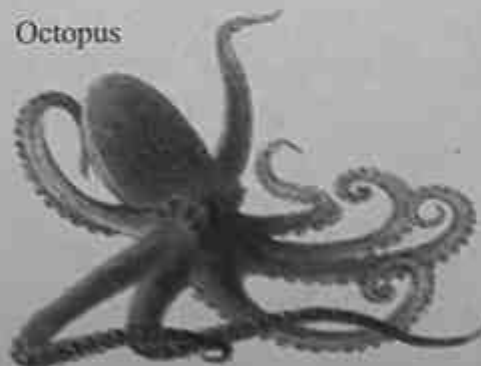
Squid is largest invertebrate
15 meters long, including
tentacles.



Mussel (*Unio*)



Octopus



Chiton



Fig.9.11 Molluscs

Evolutionary Adaptations in Molluscs:

Molluscs have complete digestive system, in the mouth cavity of many molluscs has rasping tongue (Radula) having many horny teeth, help in scraping flesh of animals and wood of ship. (e.g., *Toredo*)

Respiration occurs through gills, in many snails the mantle cavity is converted by a lung. Most molluscs possess open blood circulatory system, consist of heart and blood spaces (sinuses). Excretion takes place through metanephridia, which open into the pericardial cavity, nervous system consists of three pairs of interconnected ganglia in the head, foot and viscera. The brain of octopus is large and complex enclosed in a shell and has got great ability to learn.

Economic importance of Molluscs:

They are both useful and harmful.

Useful Molluscs:

1. Some oysters make precious pearls e.g., pearl oyster.
2. Used in button industry (such as shell of fresh water mussel).
3. Used in road building (oyster shells are mixed with tar).
4. Used for the making ornaments.
5. Source of food in many countries (such as oyster, mussel, clam).
6. Oysters are used as for decoration.

Harmful Molluscs:

1. They cause injuries while working in garden e.g., slugs.
2. They destroy woods of ships e.g. *Toredo* a ship worm.
3. They destroy plants by cutting up their roots and stems.

9.3.6 Phylum Annelida (Segmented Worms)

(Latin, annulus; a little ring, Greek: eidos means form).

Habit and habitat: Free living, found on soil (earthworm) fresh water and marine (*Nereis*), some are ectoparasites (leech).

Body: Triploblastic, **metamerically segmented** (**Metamerism:** body is divided into segments both internally and externally by a transverse partition called septa (**septum** is a membrane) between segments. **Possess true coelom**, divided into compartments by septa contain coelomic fluid also acts as **hydrostatic skeleton** (i.e., become hard by fluid pressure).

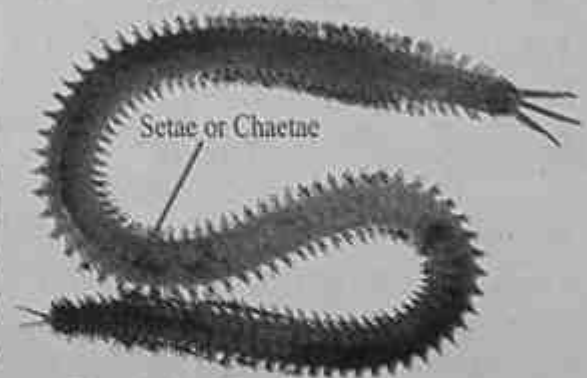


Fig.9.12 Nereis

Digestive system: It is simple in free living annelids while less developed in parasitic forms, consist of straight alimentary canal with mouth and anus at opposite ends.

Circulatory system: It consists of closed blood circulatory system.

(Note: first animal group, in which Closed Blood vascular system originated).

Excretory system segmentally arranged nephridia are their excretory organs.

Nervous system: Central nervous system is present having a dorsal pair of cerebral ganglia (a ventral double ganglionated nerve cord from which nerves arise).

Respiration is through skin.

Locomotion: The body wall is muscular in which there is an outer circular and inner longitudinal muscles. Muscles with hydrostatic skeleton help in locomotion. Chitinous **chaetae** or **setae** are locomotory organs in earth worm (embedded in sacs) while in *Nereis* **parapodia** are present. Leech is without locomotory organs.

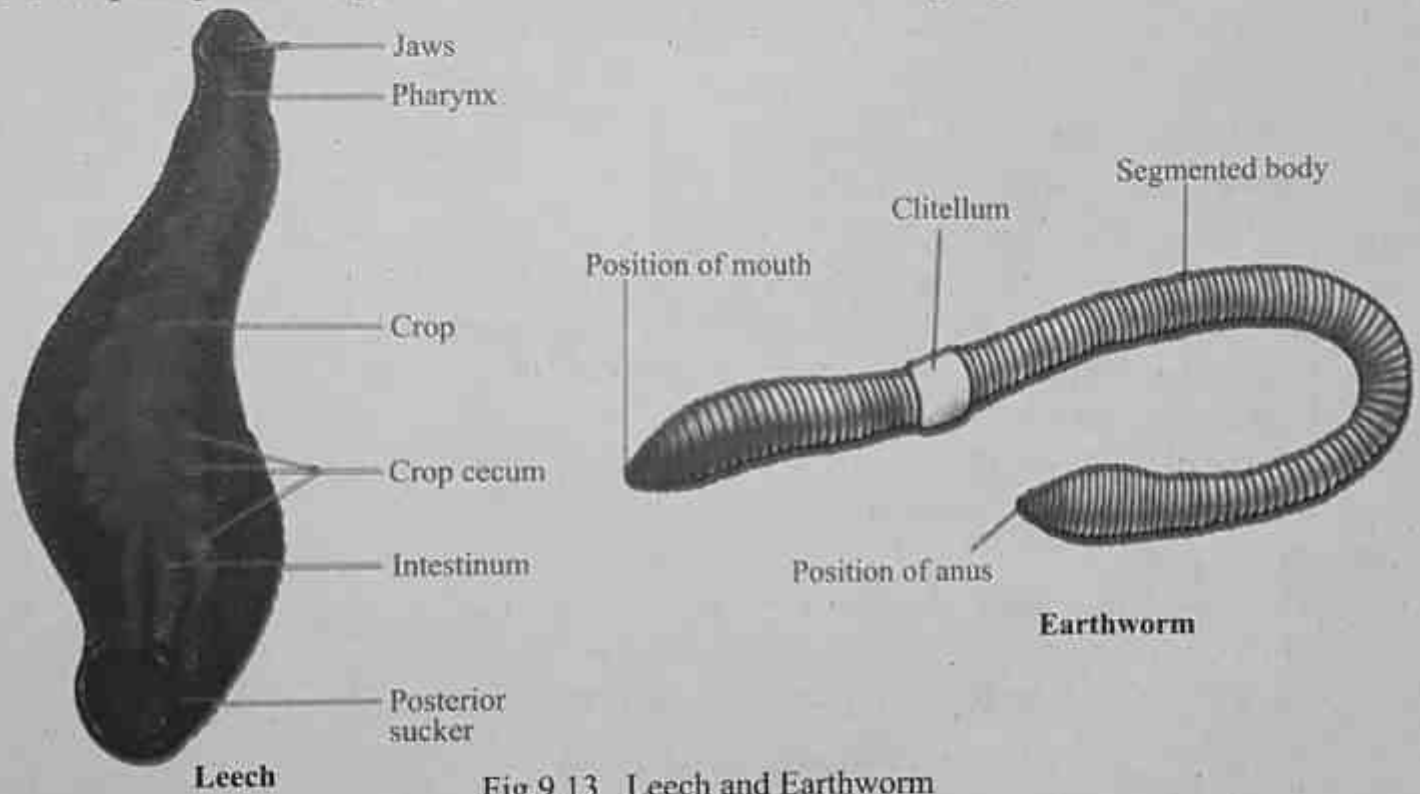


Fig.9.13 Leech and Earthworm

Reproduction: Most animals are bisexual or monoecious (e.g., leeches, earthworm), some are unisexual or dioecious (nereis).

Development: Either direct or indirect through trochophore larva.

Regeneration is present.

Evolutionary adaptation in Annelida:

There is great evolutionary adaptation in terms of feeding, that is from the sucking pharynx of the class oligochaeta and the chitinous jaws of carnivorous in class polychaeta to specialized tentacles and **cirri** of the ciliary feeders. The organs of locomotion are chitinous chetae or setae (in earth worm) and parapodia (in *Nereis*), in circulatory system formation of specialized blood vessels is another evolutionary adaptation.

Economic importance of Annelida:

Earthworms burrow itself in the soil thus permits great penetration of air into soil and improve **drainage capacity** of the soil and make the soil soft. It eases the penetration of roots. The earth worms are also known as the **nature's plough**. Many worms are used as food by fishes.

Table 9.6 Comparing Flatworms, Roundworms and Annelids

Characteristic	Flatworms	Roundworms	Annelids
Shape	Flattened	Cylindrical with tapering ends	Less cylindrical
Segmentation	No	No	Yes
Body cavity	Acoelomate	Pseudocoelomate	Coelomate
Digestion and excretion	Gastrovascular cavity with one opening only; flame cells remove metabolic wastes	Tube-within-a-tube digestive tract; opening at each end; metabolic wastes excreted through body wall	Tube-within-a-tube digestive tract; opening at each end; nephridia remove metabolic wastes
Respiration	Through skin; no respiratory organs	Through skin; no respiratory organs	Through skin; aquatic annelids breathe through gills

9.3.7 Phylum Arthropoda

(Gk. Arthron; jointed, pous; foot). Joint footed animals.

(The name was given by Ernst Von Siebold 1845).

Habit and Habitat:- May be free living or parasitic, found almost in all habitats.

Number: The biggest phylum comprised about 75% of the animal kingdom.

Body: (i) Segmented body (which are attached with one another by thin, flexible cuticle).

(ii) Possess several pairs of jointed limbs (appendages),

(iii) Body is usually divided into head, thorax and abdomen.

(iv) Body is covered with chitinous cuticle.

Coelom: Reduced haemocoel (connected with open blood vascular system).

Digestive system: Well developed with mouth and anus or cloaca.

Nervous system: Consists of paired ganglia

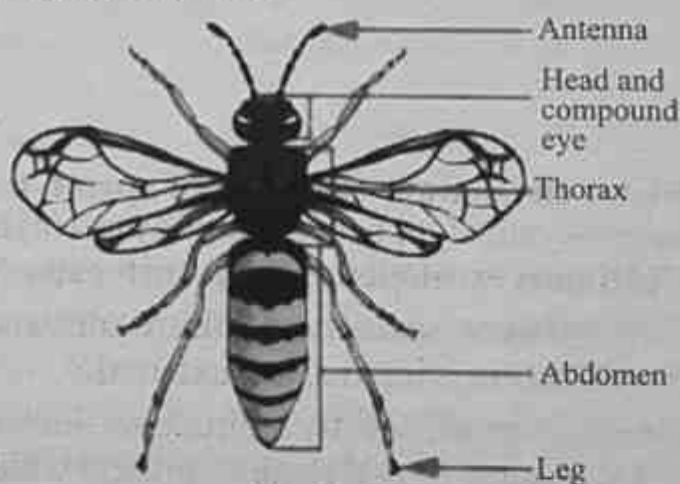


Fig.9.14 Wasp



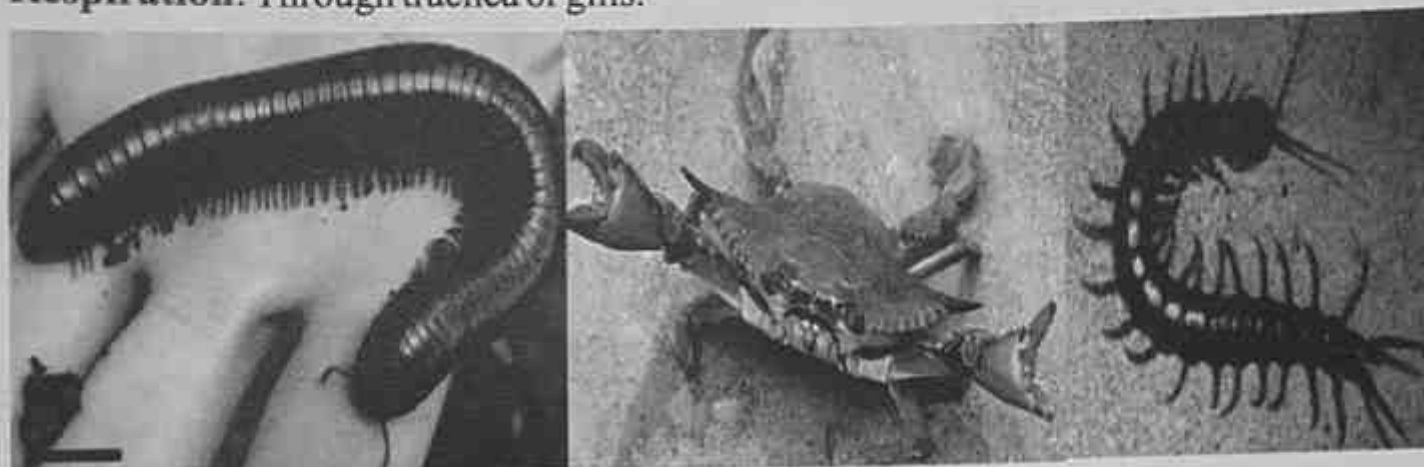
Fig.9.15 Scorpion

which is simple brain and a central ganglionated nerve cord.

Sensory receptors especially eyes are present and also cuticular hairs. The mechanoreceptors e.g antenna.

Excretory system: Uric acid and guanine is their nitrogenous waste, removed through unique excretory organs called **Malpighian tubules** or **green glands**.

Respiration: Through trachea or gills.



Millipede

Crab

Centipede

Fig 9.16

Activity

Insects are most diverse and successful group of animals. Find out the secrets of their success through internet or any other source available to you and make a list of their adaptive characters.

Blood circulatory system is of open type, blood is colorless without haemoglobin but haemocyanin (copper containing protein) is present.

Chitinous exoskeleton is present for attachment of muscles.

Reproduces: sexually and all are unisexual.

Fertilization is internal and external.

Development; Mostly indirect, accompanied by metamorphosis, which is of two types:
a) Incomplete (larval stage) is present which is similar to adult and known as nymph e.g., cockroach, b) Complete metamorphosis through egg, larva, pupa and adult e.g., butterfly.

Ecdysis or moulting: The periodic shedding of exoskeleton occurs during metamorphosis.

Why Arthropods are successful among Animals?

They possess jointed feet, segmented body, which provides them great mobility. Chitinous exoskeleton protects the body, and makes it light. Internal fertilization and development within egg case (cocoon). Appendages perform various functions such as quick movement, defense and offense and help them to live in variety of habitat.

Origin of Arthropods: It seems that both annelids and arthropods have some common

ancestors because both groups possess segmented body, presence of cuticle, appendages but arthropods evolved several new advanced characters which made them most successful phylum in the animal kingdom.

Evolutionary Adaptation in Arthropods:

- There is great variation in the respiratory system of arthropods. e.g, marine arthropods respire through gills (prawn), terrestrial form have tracheae (cockroaches), book lungs (spiders) their blood circulation system is open type, i.e., no capillaries but possess dorsal contractile heart, arteries and blood sinuses which are formed by reduced haemocoel.
- Well developed complete digestive system with mouth and anus (cloaca). Mouth parts have modified forms of appendages which are adapted for different methods of feeding.
- Excretory organs are paired with excretory glands known as coxal, antennae or maxillary glands. In many forms Malpighian tubules act as excretory organs.
- Central nervous system has dorsal brain connected by ring around the oesophagus with double ganglionated ventral nerve cord. Compound eyes and some other receptors (ocelli) are also recorded.

9.3.8 Economic importance of Arthropods

They are both useful as well as harmful to mankind.

Crustaceans: Provide food directly and indirectly to human (such as prawn, crab, lobster etc. Some are harmful because act as intermediate host for human parasite (larvae of nematodes) is carried by Cyclops.

Beneficial insects: Help in **pollination** (such as ants, butterfly, bees).

Used as food in some parts of world (such as grasshopper, cricket).

Scavengers; Eat dead and decaying plants and animals.

Commercial substances such as honey, bee's wax, silk and shellac are produced by the honey bees, silkworms, and lac insects respectively.

Destroy useless weeds by feeding upon them.

Eat other harmful insects such as dragon fly feed on mosquitoes.

Scientific use: Several insects are being used for scientific studies, such as cockroach, fruit fly, grasshopper etc.

Harmful insects:

Destroy stored foods, grains.(ants and weevils).

Carrier of many parasitic diseases (mosquito; malaria), (Tse tse fly; sleeping sickness).

Damage crops, fruit trees and timber tree: For example grass hopper, bugs, locusts, beetles, caterpillars, weevils, aphids etc.

Damage books (silver fish), house hold articles (such as white ants destroy furniture).

They irritate human in various ways, such as bees sting, causes many eye diseases. There are certain blood sucking insects e.g., Louse.

Arachnida: Poisonous arachnids like scorpion, certain spiders sting human. Ticks and

mites are parasitic disease carriers. Mites destroy crops.
Beneficial arachnids like scorpion and spiders feed on injurious insects.

9.3.9 Phylum Echinodermata (Spiny skinned animals)

(Greek: Echinus means spine, derma means skin)

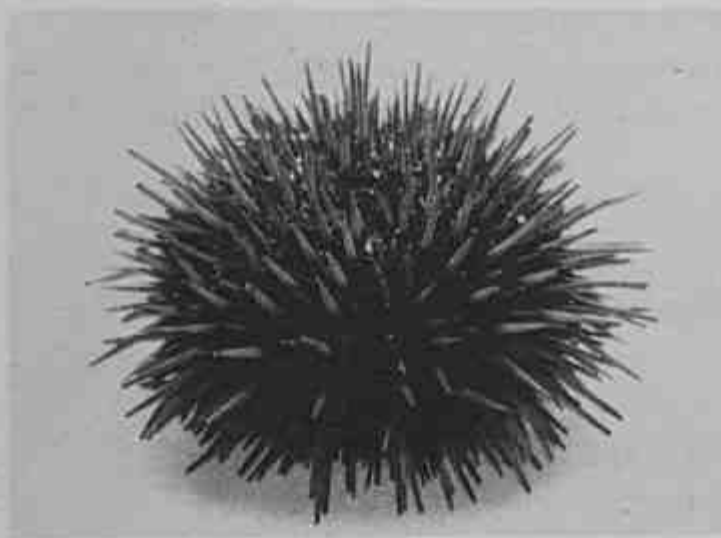
Habit: Mostly free living, some are attached to substratum.

Phylum name was given by Leuckert in 1847.

Habitat: Exclusively marine.

Numbers: More than 5,000 known species are so far recorded.

Body: a) Triploblastic, b) Coelomate. c) Adult is radially symmetrical, d) A delicate epidermis covers the body, under which there is a firm mesodermal calcareous exoskeleton. e) The mouth is on lower surface (oral) and anus is on upper surface (aboral). f) From a central disc arms are radiated.



Sea urchin



Sea cucumber

Fig.9.17(a) Sea Urchin and Sea Cucumber

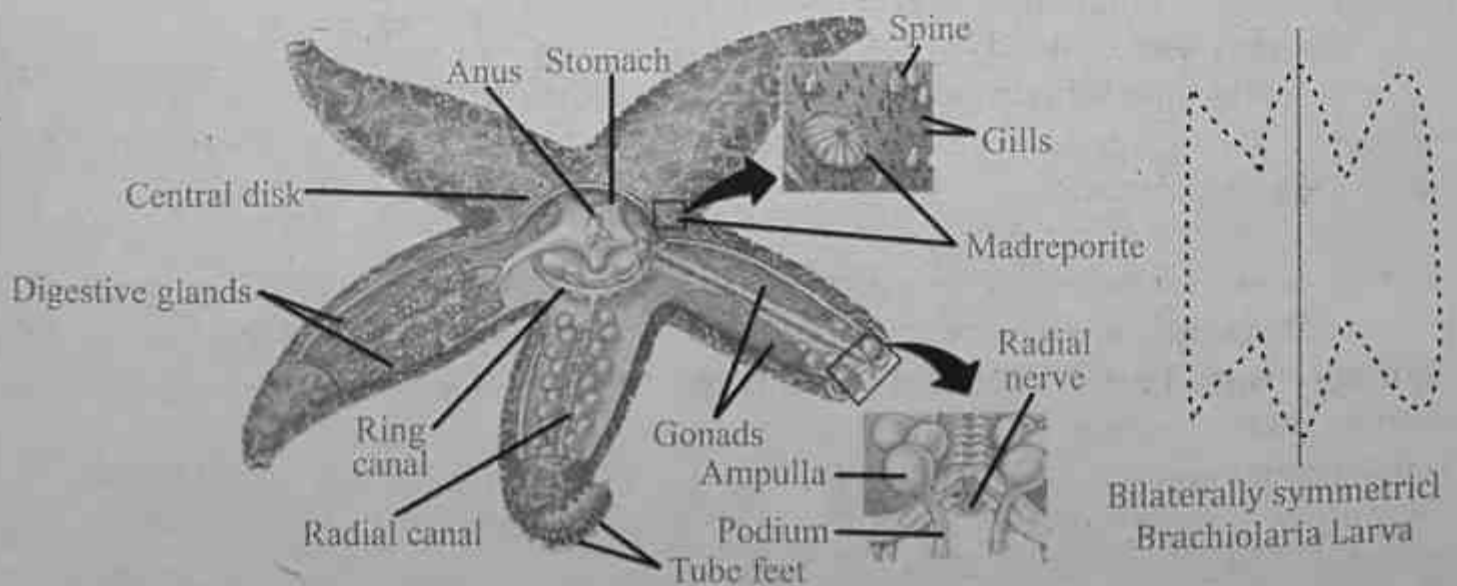


Fig.9.17(b) Sea Star

Shape: Biscuit shape, (such as cake urchin), star shaped with short arms (star fish), globular (sea urchin), star shaped with long arms (brittle star) or elongated (sea cucumber).

Water vascular systems: It is a system of complex tubes and spaces surrounding the mouth and passing into the arms and tube feet. In echinoderms water circulates through these coelomic channels, which enter through a sieve like plate called **madreporite** (present in the aboral body surface).

Locomotion occurs through tube feet.

Digestive and reproductive systems are well developed.

No specialized organs for respiration or excretion.

Poorly developed nervous system, consist of only a pharyngeal nerve ring.

Circulatory system is also less developed.

Fertilization is external and these are unisexual.

Development is indirect (complex and bilaterally symmetrical larva named as Bipinnaria and Brachiolaria).

Regeneration is common.

Examples: star fish, sea cucumber, sea Lilly, brittle star and sea urchin.

Evolutionary Adaptations in Echinoderms:

Echinoderm are first and only invertebrates which are deuterostomes, therefore, these are placed at the top of invertebrates, near to chordates.

Their body structure is simple, exclusively marine, (either **benthic or pelagic**). Digestive System usually complete, axial or coiled anus, absent in group ophiuroids. Nervous system become reduced due to marine nature, no brain, only nerve ring and radial nerve cord is present. Breath by dermal gills, tube feet and respiratory tree. No excretory organs.

Economic importance of echinoderms:

Many are used as food, starfish act as scavenger and thus clean sea water. Many echinoderms are used as fertilizer, because their dried skeleton contain large amount of calcium and nitrogenous compounds. Many echinoderms are poisonous such as sea urchin, sting human and other animals. They also damage oyster beds.

9.4 (a) Phylum Hemichordata (affinities)

Hemichordates closely resemble with both echinoderms and chordates because only these three groups are deuterostomes. So far only 70 species of them are recorded.

Hemichordates were earlier placed in chordates as a group, but now they are placed in a separate phylum. Although these animals have some chordate like characters such as deuterostome, pharyngeal gill slits, a dorsal nerve cord (some time may be hollow). However lack a complete chordate like notochord, Blood vascular system is non

chordate like i.e., dorsal heart, epidermal nervous system like non-chordates characters. Thus given an independent phylum of its own and named hemichordata, and placed at the top of invertebrate phyla.

9.4 (b) General characteristics of Hemichordates (Tongue worms)

- Their body is soft and unsegmented and mostly worm like in shape.
 - Body can be distinguished into proboscis, collar and trunk.
 - Epidermis contains mucus secreting cells.
 - Bilaterally symmetrical and triploblastic.
 - Coelom consists of three portions.
 - Gills are their respiratory organs.
 - Blood is colorless and without cells.
 - A dorsal heart having invertebrate like blood vessel.
 - Well developed excretory system (glomerulus is present).
 - Epidermal nervous system.
 - These are either unisexual or bisexual.
- Fertilization is external, indirect development.

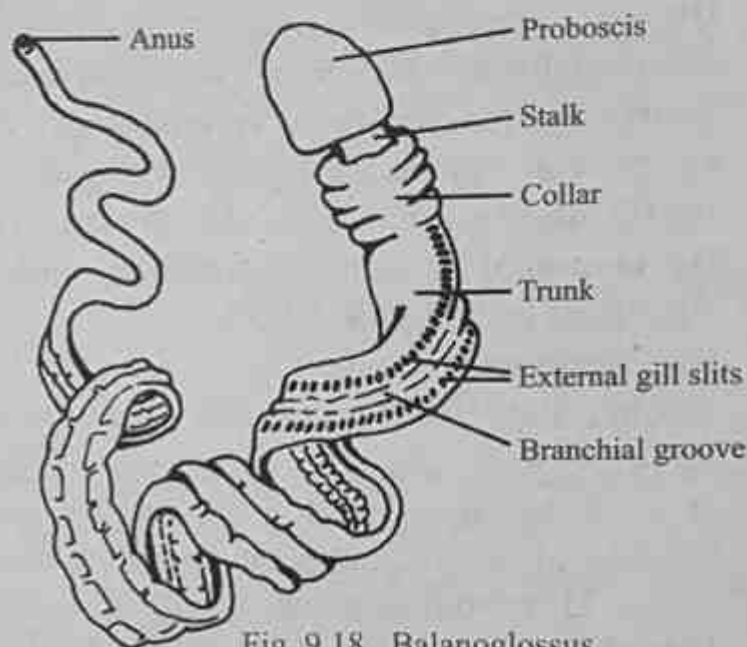


Fig. 9.18 Balanoglossus

Habits: Marine, either solitary or colonial, free living or fixed.

Nutrition: Feed on micro living things. Examples: Balanoglossus, Saccoglossus.

Phylum Chordata: The most successful, well known and widely distributed animals are chordates. Chordates exhibit great diversity of form, habitat and habit.

This phylum is divided mainly into two groups, invertebrate chordates (acrania) and vertebrate chordates (Craniata).

9.4.1 Fundamental or Basic Characteristics of Chordates

All chordates possess three basic or fundamental characteristics, during some stages or in whole life that is notochord, dorsal hollow nervous system, gill slits and as a fourth character and some times tail is also present.

Notochord is unjointed solid skeleton, placed above the alimentary canal and below the dorsal body wall and central nervous system appeared in the embryo of all chordates. In invertebrate chordates, it is present as such throughout life but in the vertebrates replaced into vertebral column, which is segmented. Serves as axial endoskeleton and give support to the body.

Dorsal hollow nervous system:

The central nervous system in chordates is dorsally placed, located above the notochord. It is hollow and fluid filled and non ganglionated nerve cord.

Pharyngeal Gill slits and gill pouches are paired sets of openings in the pharyngeal region, in aquatic

chordates it persists and functions as respiratory organ but in terrestrial vertebrates it is replaced into Eustachian or auditory tube, Parathyroid, tonsils and thymus.

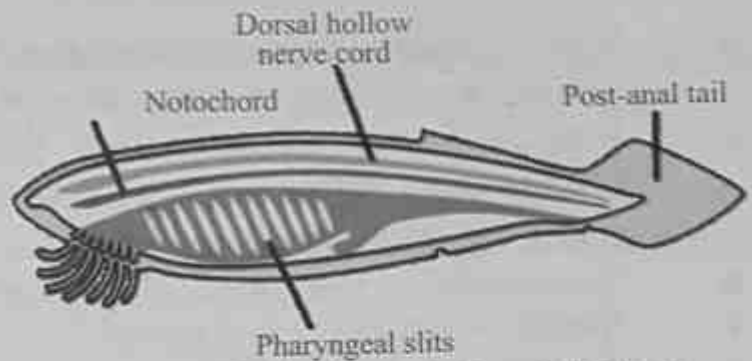
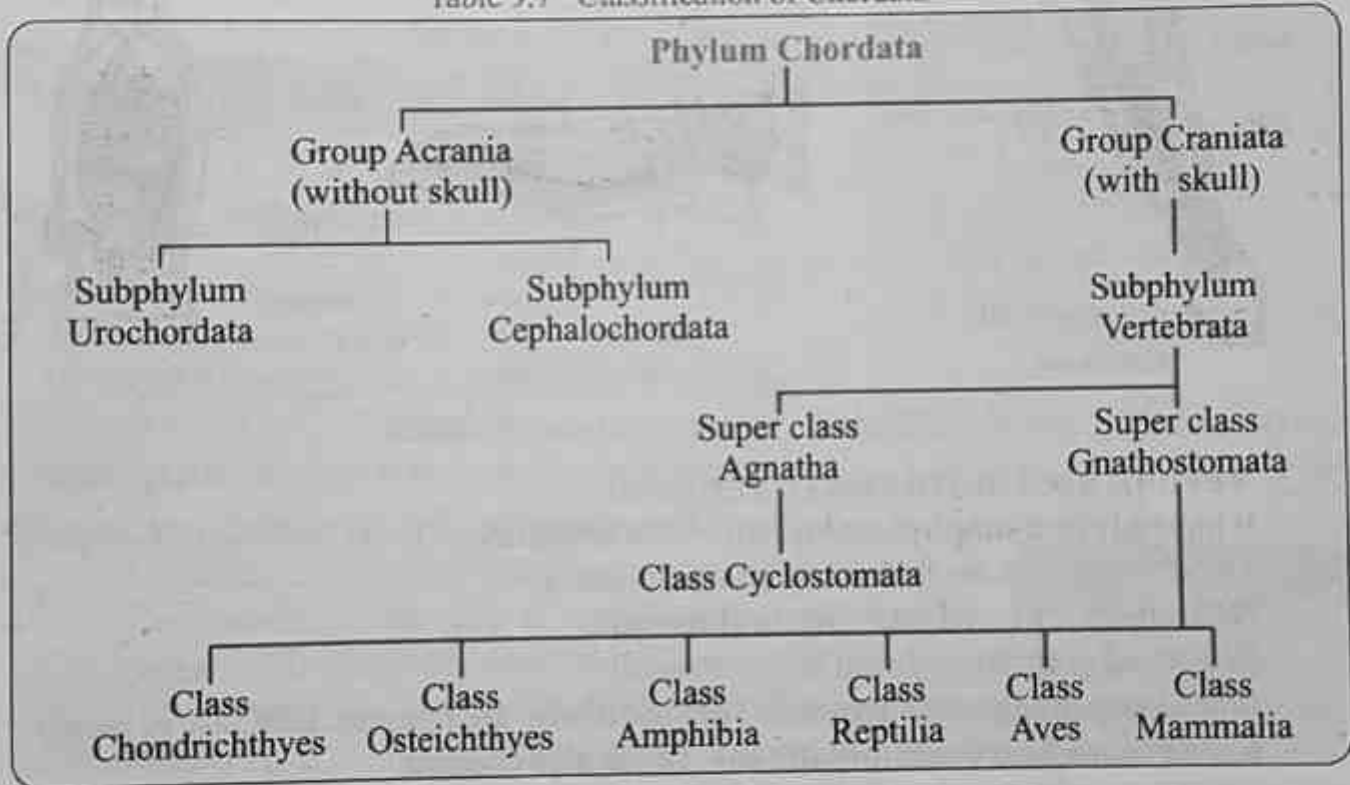


Fig. 9.19 Basic characteristics of chordates

Table 9.7 Classification of Chordata



9.4.2 Invertebrate Chordates (Acrania)

The term Acrania means "without skull"

This division includes animals with following characteristics:

- These are without brain and cranium (brain box).
- Jaws, RBC and paired appendages are absent.
- Notochord never changed into vertebral column.
- This group consists of two subphyla.

Subphylum Urochordata (Uro; tail):

- In this sub phylum notochord is present only in tail region of larva while disappears in adult.

- Nerve cord also disappears in adult, only dorsal ganglion is present.
- The larvae are free swimming while adult are non motile.
- Body is covered with tunic (test). therefore also called **tunicata** e.g., ascidia, herdmania, molgula.

Subphylum Cephalochordata (Cephalo; head):

- Notochord runs mid dorsally throughout the body.
- Notochord and nerve cord persist throughout life.
- Example Amphioxus (Branchiostoma).

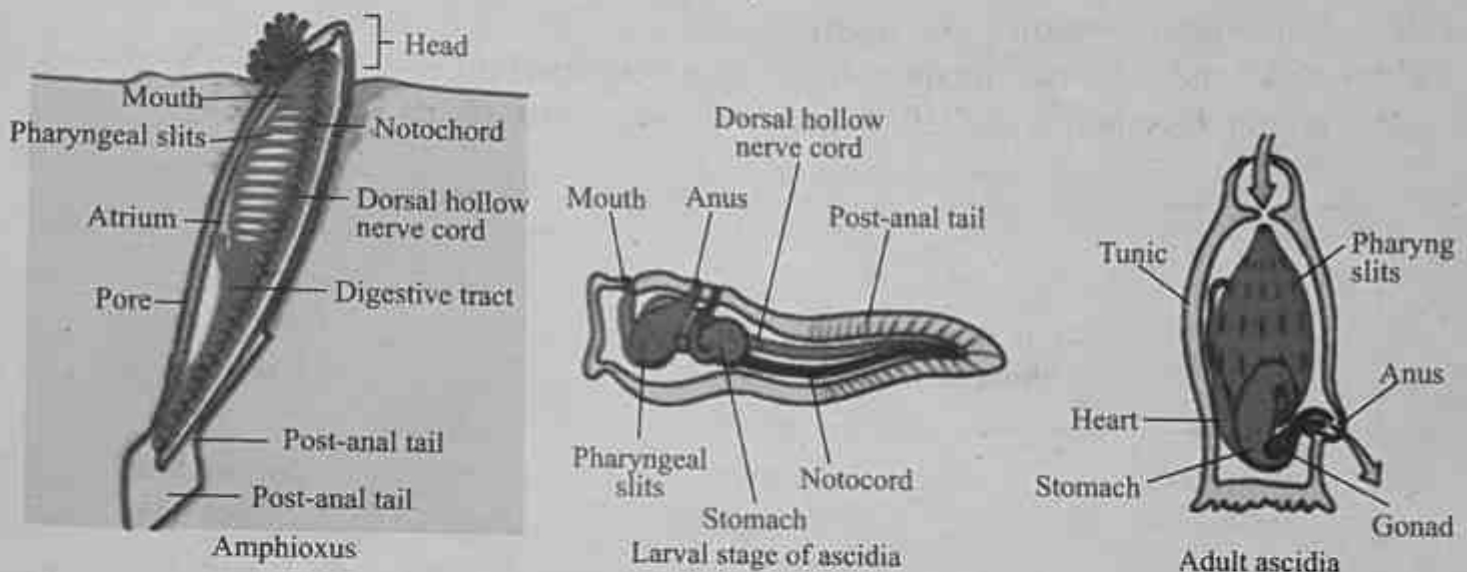


Fig. 9.20 Some Invertebrate Chordates

9.4.3 Vertebrate Chordates (Craniata)

It has only one subphylum known as **vertebrates**.

Vertebrates possess following characteristics:-

- Notochord replaced into vertebral column.
- Brain and cranium or brain box is present.
- Paired appendages are present. Teeth and jaws are present. RBC are present.
- Kidneys are their excretory organs. Tail is also present.
- Either aquatic or terrestrial. Many are aerial and arboreal.

The vertebrate chordates are divided into two super classes, **Agnatha** and **Gnathostomata**.

The **Agnatha** are without true jaws and no paired appendages while **Gnathostomata** with true jaws and paired appendages.

Agnatha: It has only one living class **Cyclostomata**.

9.4.4 Class Cyclostomata

(Cyclo; circular, stoma; mouth, because their mouth is circular).

These fishes are without true jaws and the most primitive group of living vertebrate. Their body is eel shaped and scales are absent. The skin is smooth and soft.

Cartilaginous skeleton and suctorial mouth. No paired appendages. Two chambered venous heart and many aortic arches. Digestive system without stomach. These animals contains 6-14 pairs of gills for respiration. Either unisexual (such as lamprey) or bisexual (such as hag fish). Cyclostomes have single testis or single ovary and without ducts. Fertilization is external, both direct and indirect development is present. In Lamprey prolonged larval period. Example; Myxini and Lamprey.

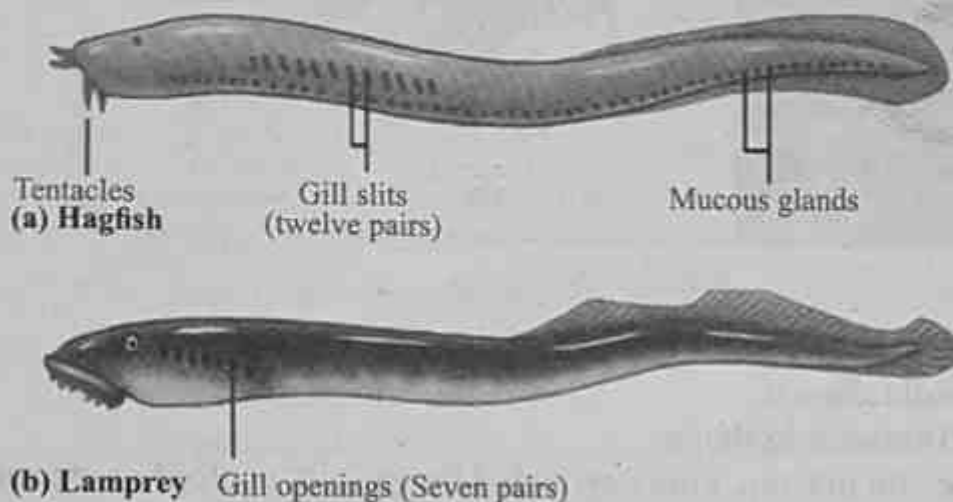


Fig. 9.21 Hagfish and Lamprey

Activity

All vertebrates are chordates but all chordates are not vertebrates. Why? Echinoderms have been placed closet to chordates, write their affinities with chordates.

9.4.5 Gnathostomata

This super class is divided into six classes, (Chondrichthyes, Osteichthyes, Amphibia, Reptilia, Aves, Mammalia). The gnathostomata have true jaws and paired appendages.

Class Chondrichthyes (Cartilaginous fishes):

- These have spindle shaped body.
- The mouth is ventral and semi circular and nasal sacs do not open to the oral cavity.
- Tough skin is covered with sand paper like placoid scales.
- Respire through 5-7 pairs of gills, without operculum (lid).
- Endoskeleton is completely cartilaginous.
- Swim bladder is absent. They have cloaca.
- Stomach is J-shaped.
- Venous or branchial or single circuit heart; consists of a single auricle and single ventricle. 5-7 pairs of aortic arches.
- Sexes are separate and possess paired gonads. Fertilization is internal, oviparous or ovoviviparous.
- The largest of all fishes are included in this group (30-50 feet long).
- Examples: skate, rays, sting ray, electric ray, dog fish (sharks) etc.

Tit bits

Two classes of fishes that is Chondrichthyes and Osteichthyes, some time together placed in a division known as Pisces.

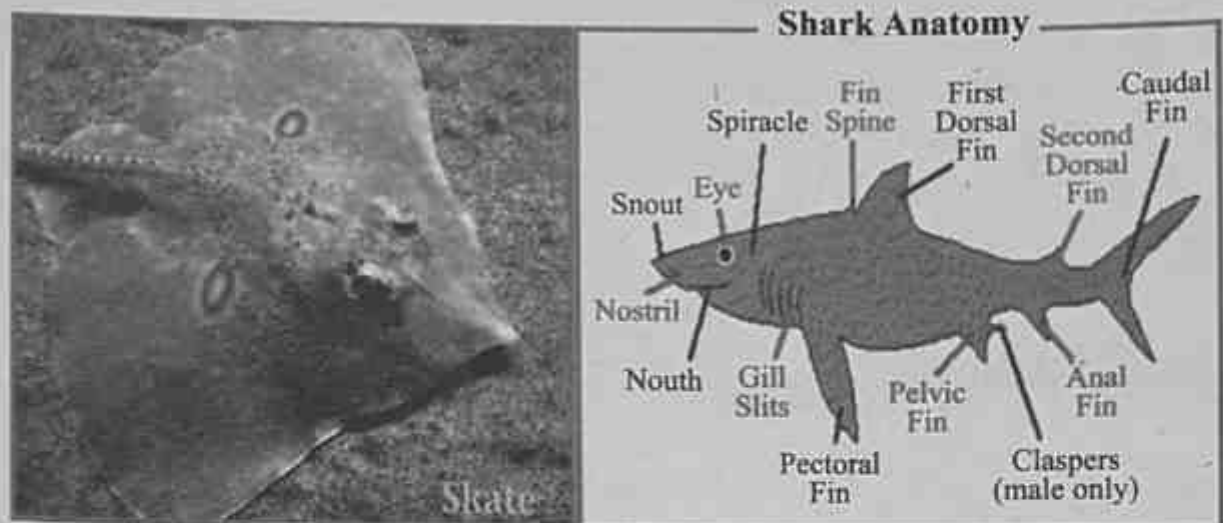


Fig. 9.22 Skate and Shark

9.4.5 Class Osteichthyes (Bony fishes).

- Their body is also spindle shaped.
- Mouth is terminal and variable in shape.
- The dermal scales are non placoid, either provided by ganoid, cycloid or ctenoid scales.
- Respire through, four pairs of gills which are supported by bony arches and covered with lid called operculum.
- Mostly possess bony endoskeleton.
- Swim bladder usually present which help in buoyancy.
- They have anus.
- Stomach is variable in shape.
- Venous heart consists of two chambers (an auricle and a ventricle).
- They have 4 pairs of aortic arches.
- Sexes are separate and paired gonads.
- Mostly external fertilization, few exhibit internal.
- Mostly oviparous however some are ovoviviparous.
- Brain has ten pairs of cranial nerves. Examples:- trout, cod, carp, catfish etc.

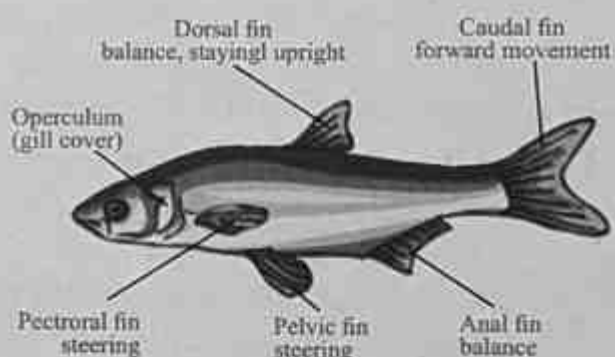


Fig. 9.23 Rohu

Economic Importance of Chondrichthyes:

Beneficial (1) Source of food (especially sharks and rays).

- (2) Many commercial products are prepared by them (such as oil of shark liver is the source of vitamin A and D).
- (3) The skin leather of shark is being used for making bags and shoes.
- (4) Great medicinal value of pituitary gland of shark.

Harmful effect: Sharks feed on most of sea food which are used by human like prawn, crab, lobster and palatable fishes.

Economic Importance of Osteichthyes:

Beneficial effects:

1. Both fresh water and marine bony fishes are important source of our food such as cod, herring and salmon are examples of marine and trout, carp, catfish and mullet are fresh water fishes.
2. Commercial products such as fish oil, fish meat and liquid glue are made by bony fish.
3. Cod liver oil is the source of vitamin A and D.

Adaptation of Aquatic Life in Fishes (Pisces):

1. Their body becomes streamlined, which offer little resistance to water during swimming.
2. Presence of swim bladder in bony fishes help in buoyancy.
3. Fins: paired and unpaired fins help them in swimming and maintain their balance.
4. Gills for respiration.
5. Developed central nervous system and sensory organs.

Adaptation of Animals for Terrestrial (Land) Mode of Life:

Following adaptations are made by animals for terrestrial mode of life,

1. The skin is developed for protection against dry conditions.
2. Shelled eggs prevent the embryo from drying.
3. Large quantity of yolk as stored food in eggs.
4. Development of lungs for terrestrial respiration.
5. Modification of jointed appendages for running, walking, climbing and flying.
6. Well developed senses and specialized central nervous system.

9.4.6 Class Amphibia (Gk. Amphi; both, bios; life)

First land vertebrates (i.e., transition from aquatic to land habitat).

Origin: probably originated from Dipnoi which are lobe fin lung fishes.

Skin: smooth, moist, scale less and with many mucus glands, (also poisonous glands in some amphibians, chromatophores are also present).

Body form:- divided into head, trunk, tail or without tail.

Appendages: usually two pairs of legs but some are leg less (caecilians).

Respiration: In larvae it occurs through gills while in adult mostly through lungs and skin or few with gills e.g. in Siren.

Blood vascular system:- five chambered heart (right and left auricle, a single ventricle, sinus venosus and truncus arteriosus).

Sexes are separate with paired sex organs. Fertilization usually external (in some internal).

Mostly oviparous and exhibit Indirect development through metamorphosis.

They are **Anamniotes** (The embryo lacks protective membrane), **Poikilothermic** (cold blooded) that is why they hibernate in winter. Examples: frogs and toads tailless, salamanders are tailed amphibians. Caecilian are limbless.

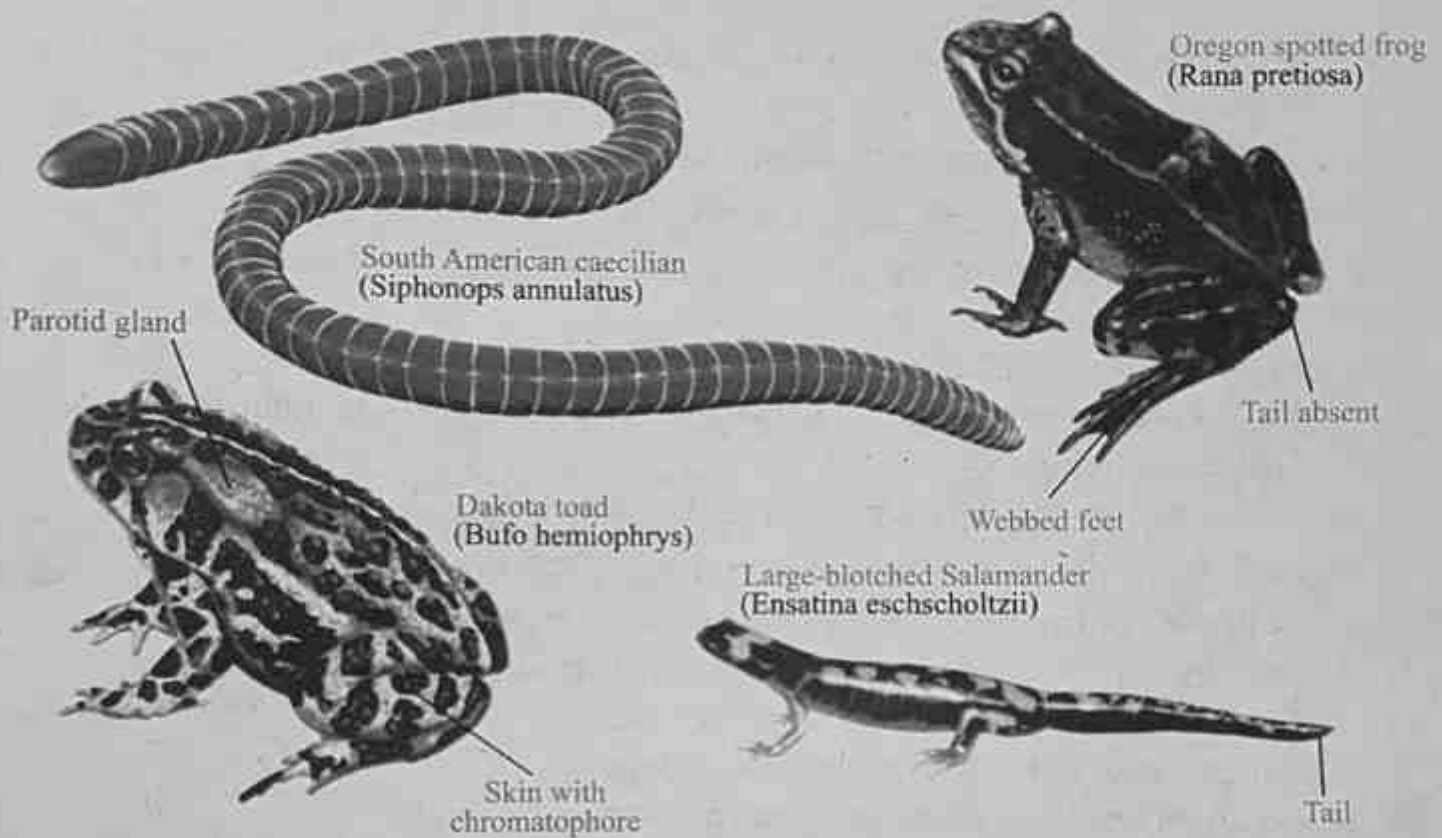


Fig. 9.24 Amphibians

9.5.7 Class Reptilia (Latin. Repere; to crawl)

Skin: Dry non-gladular scaly skin (snakes and lizards) or bony plates (tortoise and crocodile).

Appendages: either tetrapod and pentadactyl or some reptiles are limbless. They have four chambered heart (right and left auricle, a partly divided ventricle & a sinus venosus) except crocodile which have completely divided right and left ventricles and right & left atria.

All are cold blooded thus hibernate in winter.

Unisexual and fertilization is internal.

Mostly oviparous and amniotic eggs. Lays large yolky shelled eggs.

Skull with one occipital condyle.

They respire through lungs thus predominantly terrestrial and **first successful terrestrial group**.

Examples: cobra, wall lizard, turtle, crocodile.

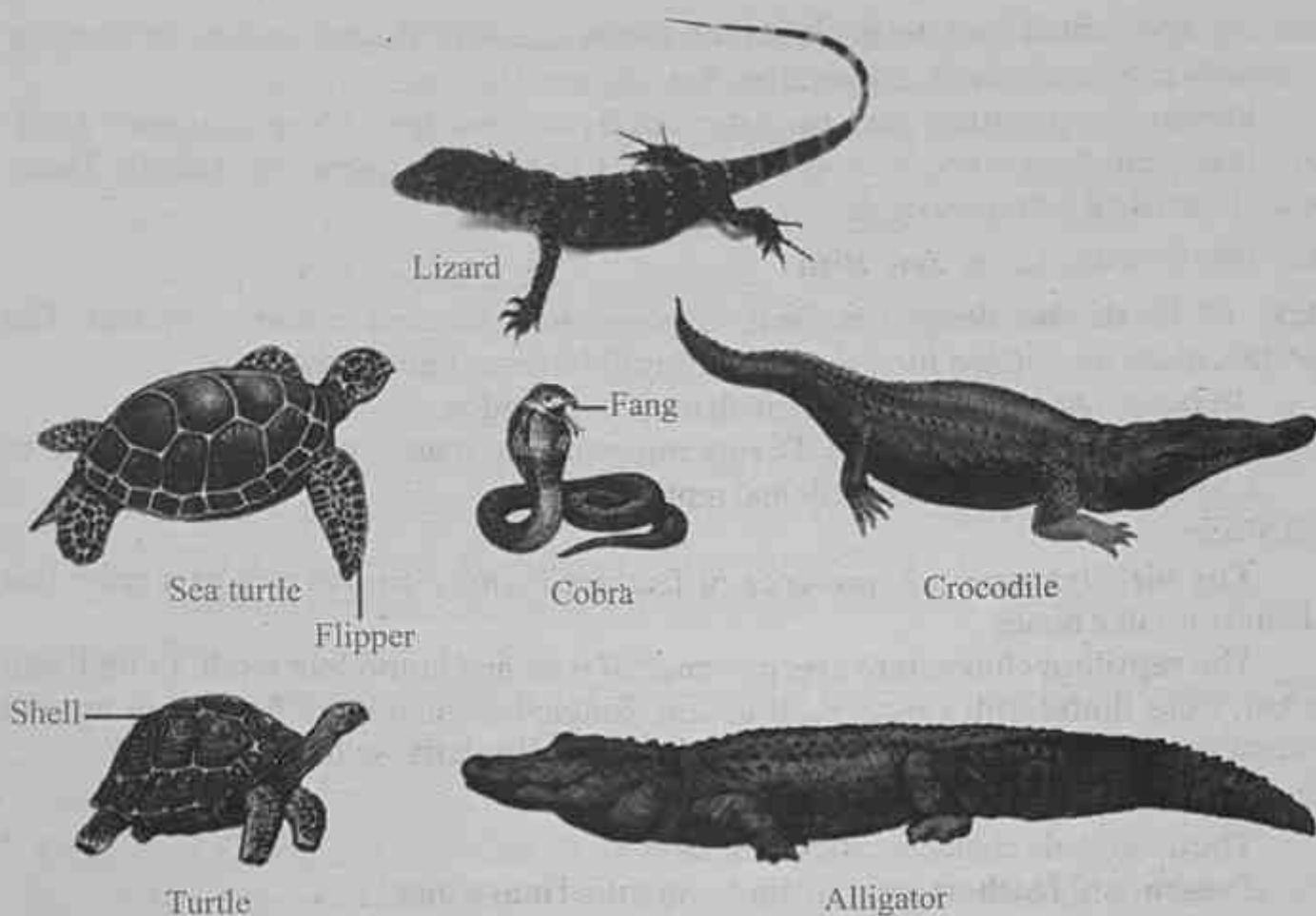


Fig.9.25 Reptilians

History of Reptiles:

The reptiles were flourished dominantly throughout Mesozoic period (i.e., about 225 millions to 65 million years ago) in geological time scale, during these periods they were represented by some giant species commonly known as dinosaurs. Today they are extinct (now only fossils record found). Most reptiles became extinct during tertiary period (about 50 million years ago) due to adverse climatic conditions.

Reptiles, in present

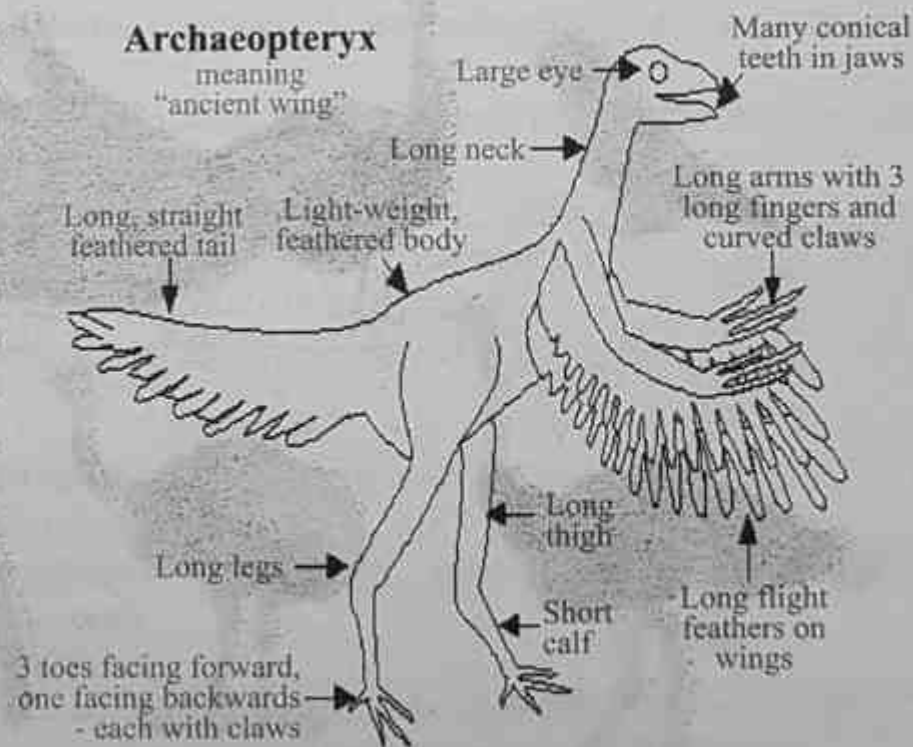


Fig.9.26 Archaeopteryx

times are represented by four evolutionary lines i.e., Lizards and snakes, sphenodon (found only in New Zealand), Crocodiles, Tortoises and turtles.

Present day's reptiles have been derived from dinosaurs of Jurassic period (196-136 million years before) and cretaceous period (136-65 million years ago (mya)). Today reptiles flourished in tropical zones.

Class Aves (Birds) Latin: avis; Bird

Origin of Birds:-No doubt that birds evolved from ancient running reptiles. The important discovery of two Jurassic (144-208 million years ago) birds:

1. *Archaeopteryx*, preserved in British museum London.
2. *Archaeornis*, preserved in Berlin museum Germany, provided evidence of connecting link between birds and reptiles.

Affinities:

The bird features are, presence of feathered wings; similarities to a crow like skull and bird like bones .

The reptilian characters are: presence of jaws and homodont teeth. Long lizard like tail. Fore limbs with claws. Keel absent. Single occipital condyle. Bones are not pneumatic. Except feathers fossils birds showed great similarity with dinosaurs.

9.4.8 Characteristics of Aves

The diagnostic characteristics of birds are:

Presence of feathers and fore limbs modified into wings.

Beak is present and teeth are absent.

Sternum is with keel.

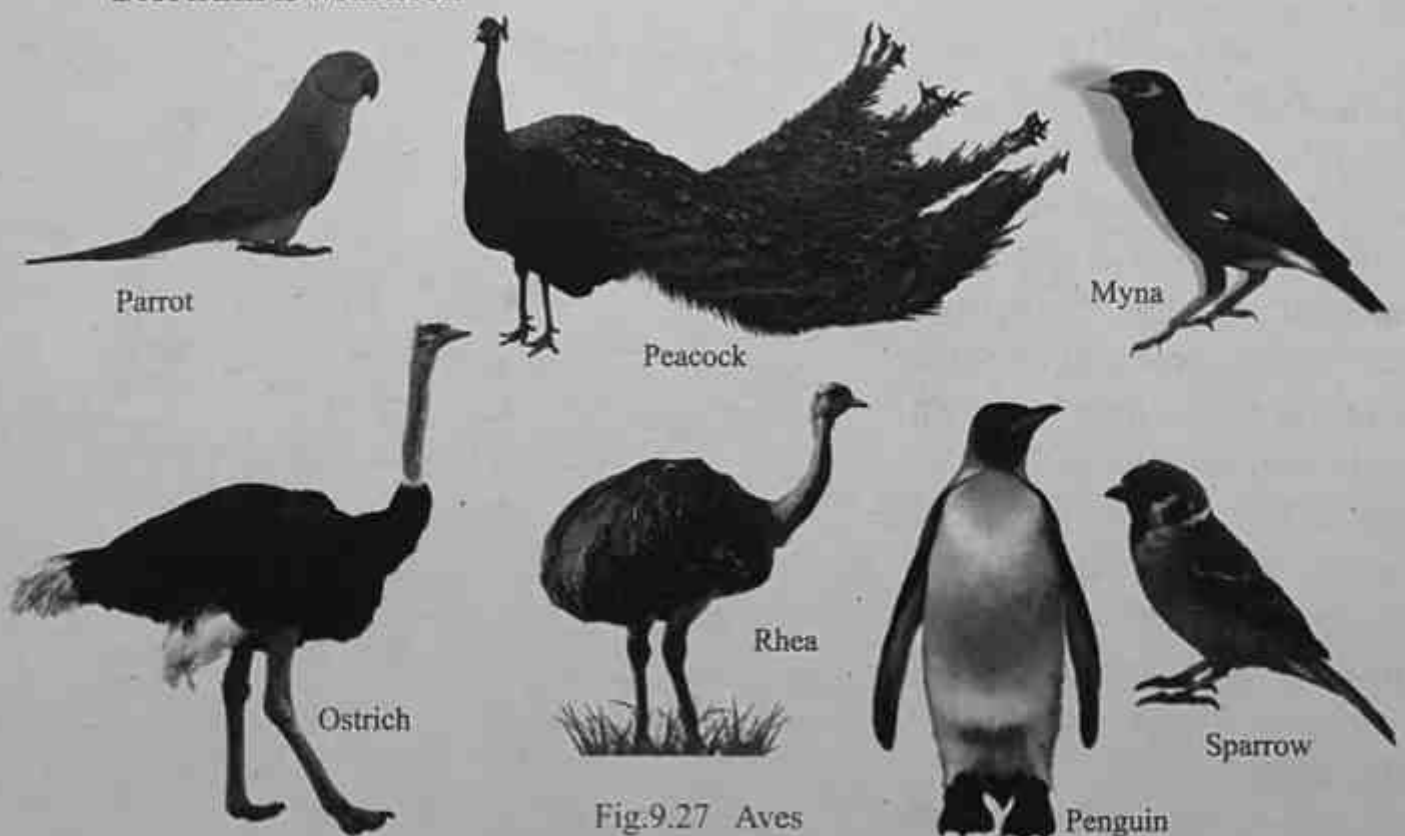


Fig.9.27 Aves

They have Single occipital condyle. Warm blooded (**homeothermic**).

Stream lined body is divided into a head, neck, trunk and a tail.

Bipedal locomotion and hind limbs are also modified for **perching**.

Hind limbs contain scales and claws and endoskeleton light and hollow.

Four chambered heart (two auricles and two ventricles) is present.

Only right aorta (aortic arch) is present.

Lungs are their respiratory organs, which are supplemented with **air sacs** and exhibit double respiration..

Syrinx is voice box in birds.

Kidneys are their excretory organs. Urinary bladder is absent to reduce weight.

Nitrogenous waste is uric acid which is removed as crystals through faeces.

Gizzard is grinding organ in their digestive system.

Unisexual and fertilization is internal. Birds lay large yolky eggs (Oviparous. Left ovary is functional.

Some birds have secondarily lost power of flight and are called running birds, such as kiwi, ostrich, emu, etc. Examples of flying birds: parrot, crow, pigeon, sparrow, kite etc, Example of aquatic bird is penguin.

Origin of Class Mammalia: (The Hairy Animals):

- There is no doubt that mammal forms the highest group in animal kingdom. They attained the most complete structural, physiological and developmental adaptations to terrestrial life and some secondarily also form aquatic life.
- Two most remarkable features of mammals are mammary gland in females and presence of hairs.
- Mammals have been evolved from cotylosaurian reptiles (evidence from fossil record).
- Fossil record exhibits that ancestral mammals and reptiles lived together during Jurassic period and have been called mammal like reptiles (in size mice like and were arboreal, One of these was genus varanops found as fossil in Texas in USA).
- Mammals became dominant in coenozoic period (66.4 millions years ago till now).

9.5.9 General Characteristics of Mammals

The name was given by Linnaeus in 1785.

The diagnostic characteristics of mammals are presence of **mammary glands** (by which females nurse their young ones).

Body is mostly covered with **hairs** or **fur**.

The CNS is highly developed. Lungs possess numerous alveoli and bronchioles.

Diaphragm is present (muscular partition between chest and abdomen).

External ears (pinnae) are mostly present.

Sweat and sebaceous (oil) gland are also present.

Their bodies are of different shapes and mostly divided into head, neck, trunk and tail. **Warm blooded** animals. They have two pairs of pentadactyle limb modified for different habitats.

These have two occipital condyles in the skull and a large cranium.

Two sets of teeth during their life span (milk teeth and permanent teeth) dentition is heterodont. Heart with two atria and two ventricles and only **left aorta** is present.

Non nucleated Red blood cells except camels.

Testes mostly extra abdominal and urinogenital opening and anus is separated. Fertilization is internal and they are mostly viviparous (Birth of living young ones).

Classification of mammals:

The class mammalia is divided into three sub classes: Prototheria, Metatheria and Eutheria.

Sub Class Prototheria: (Egg Laying Mammals): Order Monotremes

They are connecting link between reptiles and mammals because they exhibit the characteristics of both groups.

Mammalian characters are: the presence of mammary glands, hair, diaphragm, left aorta.

Reptilian characters are: presence of cloaca, lay eggs, some reptilian skeleton, found only in Australia.

- Examples:
1. **Echidna (spiny ant eater).**
 2. **Duck billed platypus** are adaptive for aquatic life, the bill is modified like the beak of duck and webbed feet.

Class Metatheria: (Pouched Mammal; Marsupial).

Females possess an abdominal pouch (marsupium) in which they rear their immature young ones.

Mammary glands and nipples are present inside pouch.

They are generally burrowing and herbivorous.

Found in Australia and America. Examples: Opossum, Kangaroo, Tasmanian wolf.

Sub Class Eutheria: (Placental Mammals):

It is the largest group of mammals in which development of young one takes place inside the body of mother. The young are nourished through placenta thus true viviparous. Anus and urinogenital openings are completely separated. Possess almost all mammalian Characteristics i.e., diaphragm, external ears, hair and mammary glands.

In some forms hair modified into spines like porcupine and hedge hog while in pangolin into scales. Examples: Goat, dog, horse, elephant, seal, whale, dolphin, man, monkey etc.



Elephant



Kangaroo



Echidna



Bat



Whale



Lion



Chimpanzee



Deer



Panda



Polar bear



Zebra

Fig.9.28 Mammals

Do you know?



Shrews have so little body fat that they cannot go more than a couple of hours without food. Missing a meal is a sure way to a quick death. A good night's sleep could be fatal.



Do you know?



A female Pacific Grey Whale gestates and delivers a 2000 pound baby, migrates over 10,000 miles, and produces 6 tons of breast milk without eating a bite of food using just her blubber for fuel.



SUMMARY

- Radially-symmetrical animals are diploblastic, developing two germ layers: an inner layer (endoderm) and an outer layer (ectoderm). Diploblasts have a mesoglea between the endoderm and ectoderm. Bilaterally-symmetrical animals are called triploblastic, developing three tissue layers: an inner layer (endoderm), an outer layer (ectoderm), and a middle layer (mesoderm).
- True animals can be largely divided into three groups based on the type of symmetry of their body plan: radially symmetrical, bilaterally symmetrical, and asymmetrical.
- Triploblasts can be differentiated into three categories: those that do not develop an internal body cavity called a coelom (acoelomates), those with a true coelom (coelomates), and those with "false" coelom (pseudocoelomates).
- Bilaterally symmetrical, tribloblastic coelomates can be further divided into two groups based on differences in their early embryonic development. These two groups are separated based on which opening of the digestive cavity develops first: mouth (protostomes) or anus (deuterostomes).
- Poriferans are characterized by the presence of minute pores called ostia on their body.
- Cnidarians contain specialized cells known as cnidocytes "stinging cells", which contain organelles called nematocysts (stingers).
- Phylum Platyhelminthes is composed of the flatworms: acoelomate organisms that include many free-living and parasitic forms.
- The name "mollusk" is derived from the Latin molluscus ("soft"), indicating that the mollusks are soft bodied animals. The group includes the snails, bivalves, chitons, squid, octopus.
- The clitellum is the reproductive structure of an annelid. It creates mucus that aids in sperm transfer and gives rise to a cocoon within which fertilization occurs.
- The name "arthropoda" means "jointed legs" (in the Greek, "arthros" means "joint" and "podos" means "leg").
- Among the hexapods, the insects are the largest class in terms of species diversity as well as Biomass in Terrestrial habitats.
- Echinodermata are so named owing to their spiny skin (from the Greek "echinos" meaning "spiny" and "dermos" meaning "skin").
- Echinoderms possess a unique ambulacral or water vascular system, consisting of a central ring canal and radial canals that extend along each arm.

EXERCISE

Section I: Objective Questions

Multiple Choice Questions

A. Choose the best correct answer.

1. Vertebrates and tunicates share
 - (a) Jaws adapted for feeding
 - (b) A high degree of cephalisation
 - (c) A notochord and a dorsal, hollow nerve cord
 - (d) The formation of structures from the neural crest
2. The water vascular system of echinoderms
 - (a) Functions as a circulatory system
 - (b) Functions in locomotion, feeding, and gas exchange
 - (c) Is bilateral in organization,
 - (d) Involves suspension feeding
3. Acoelomates are characterized by
 - (a) The absence of brain
 - (b) The absence of mesoderm
 - (c) A solid body without a cavity surrounding internal organs
 - (d) A coelom that is not completely lined with mesoderm
4. Gastrovascular cavity is present in
 - (a) Porifera
 - (b) Annelida
 - (c) Nematoda
 - (d) Coelenterata
5. All monotreme species are found in
 - (a) Australia
 - (b) Asia
 - (c) Europe
 - (d) Africa
6. Gemmules are helpful in
 - (a) Digestion
 - (b) Sexual reproduction
 - (c) Secretion of spicules
 - (d) Survival in drought
7. Nematocysts are the organs of:
 - (a) Sensation
 - (b) Reproduction
 - (c) Defence and offence
 - (d) Respiration
8. Liver fluke belongs to
 - (a) Arthropoda
 - (b) Platyhelminthes
 - (c) Annelida
 - (d) Nematoda

9. Ascaris normally inhabits the lumen of:

(a) Stomach	(b) Small intestine
(c) Appendix	(d) Large intestine
10. Echidna belongs to subphylum

(a) Prototheria	(b) Metatheria
(c) Eutheria	(d) Cyclostomata

B. Fill in the blanks.

1. Cnidarians are included in grade _____.
2. In protostomes the cleavage is _____.
3. Jaws less fishes belong to class _____.
4. The gastrovascular cavity in cnidarians also known as _____.
5. Cephalochordata and _____ belong to group invertebrate chordates.
6. _____ is the only phylum which is acoelomate.
7. _____ is the only phylum which is psuedocoelomate.
8. A tongue like structure with horny teeth found in Mollusca is called _____.
9. Malpighian tubules are excretory organ in _____.
10. Bipinnaria and brachiolaria larvae are present in the animal of phylum _____.
11. Swim bladder is recorded in class of fishes named _____.
12. _____ locomote either with chaetae or setae and few with parapodia.
13. The presence of different zooids in the same organism is called _____.
14. The group of vertebrate which need water for their reproduction are called _____.
15. The round worms which are psuedocoelomates placed in phylum _____.

Section II: Short Questions.

1. How useful is the study of the nature of body cavity and coelom in the classification of animals?
2. Distinguish between incomplete and complete digestive system.
3. What is the difference between direct and indirect development?
4. What are the peculiar features that you find in parasitic platyhelminthes?
5. What are the reasons that you can think of for the arthropods to constitute the largest group of the animal kingdom?

6. "All vertebrates are chordates but all chordates are not vertebrates". Justify the statement.
7. Write note on the importance of presence of swim bladder, gills and fins in Pisces.
8. What are the modifications that are observed in birds that help them fly?
9. Write note on marsupium.
10. What do you know about egg laying mammals.
11. Write any three diagnostic characters of mammals.
12. How radially symmetrical animals differ from bilateral symmetrical animals.
13. Define coelom, how psuedocoel differ from true coelom.
14. Write three differences between protostomes and deuterostomes.

Section III: Extensive Questions

1. What are pinacocytes and choanocytes? Explain general characteristics of sponges.
2. Differentiate between diploblastic and triploblastic.
3. Define the term acoelomate, describe characteristics of any acoelomate worms which you have studied.
4. Explain general characteristics of coelomate segmented worms.
5. Write note on spiny skinned invertebrates.
6. Differentiate between Chondrichthyes and Osteichthyes.
7. What is poikilotherms? write general characteristics of birds.
8. Explain general characteristics of hairy animals.