Biodiversity and Classification of Animal Kingdom - Part 1

Objectives

After going through this lesson, the learners will be able to understand the following:

- Grade of organization
- Classification of Animals
- Phylum Porifera
- Phylum Cnidaria

Content Outline

- Introduction
- Features of Animals as the Basis of Classification
  - Grade of Organisation
  - Body Plan
  - Symmetry
  - Diploblastic and Triploblastic animals
  - Segmentation
  - Body Cavity (coelom)
  - Heterotrophic Mode of Nutrition
  - Movement
  - Reproduction
  - Development
- Phylum Porifera
- Phylum Cnidaria
- Summary

Introduction

Our topic is “Classification of Animals”. As we know, there are approximately 8.7 million species of animals around us. Out of which, many million species of animals have been studied but still some are unknown and yet to be identified and described.

Of course, we can't study each and every individual animal, so we put them into similar groups i.e. we classify them.

8.7 million animals means so much diversity around us. Though there are differences in the form and structure of these animals, still there are some common characteristics which all of these animals have.

This module will deal with such basic, common features of animals and we will also have a detailed look at Phyla Cnidaria and Ctenophora.

Features of Animals as the Basis of Classification

A. Grade of organization

No two species of animals are the same. They differ from each other internally or externally, in size or shape but all of them have a level of organization which is either cellular, tissue, organ or organ system.

Acellular or unicellular level or Protoplasmic level: In this grade of organization, the organisms are at the level of protoplasm.

Example- It is seen in many Protozoa.

Cellular level: Here the organism has many cells aggregated together. The animals which possess this level of organization are called "Parazoa".

Example- Phylum Porifera (sponges)

Tissue level: Similar cells aggregate together which form tissues and they perform specific functions.

Example- Cnidarians, Ctenophores

Organ/Organ system level: The cells of the organism are arranged into tissues, which are further organized into organ and organ systems.

Example- Mollusca, Arthropoda, Annelida, Hemichordata, Chordata etc.

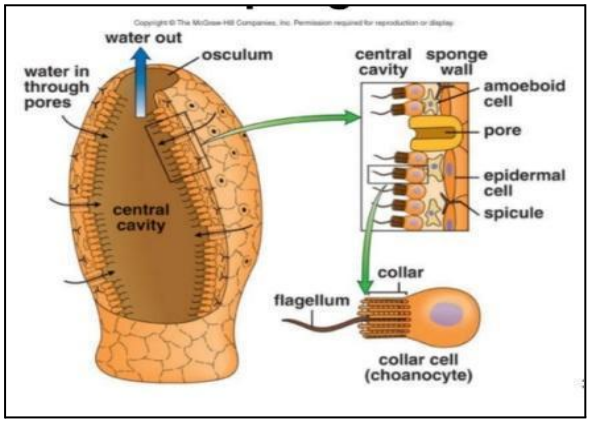
The animals having tissue, organ and organ system grade of organization are called "Eumetazoa".

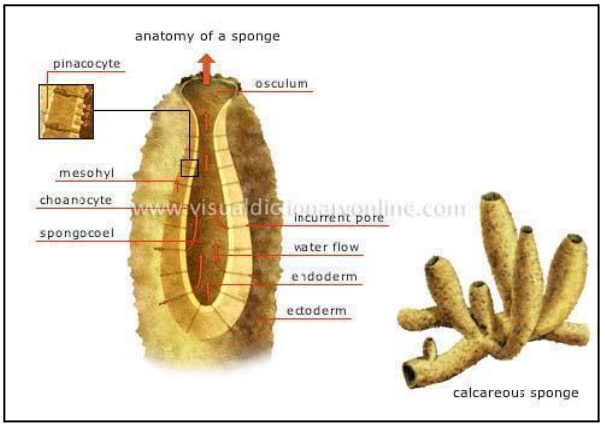
Organ systems in different groups of animals show various patterns of complexities like the digestive system in Platyhelminthes has only a single opening to the outside of the body that serves as both mouth and anus, and is hence called incomplete (Blind sac body plan). A complete digestive system has two openings, mouth and anus (Tube-with-in-tube body plan).

Similarly, the circulatory system may be of two types:

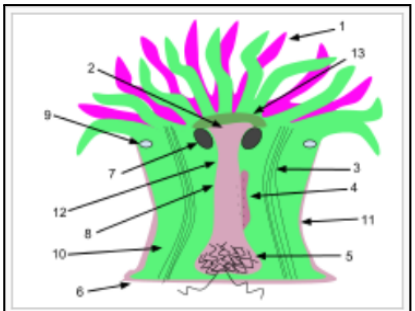
a. open type in which the blood is pumped out of the heart and the cells and tissues are directly bathed in it and,
b. closed type in which the blood is circulated through a series of vessels of varying diameters (arteries, veins and capillaries).

B. Body Plan: Animals have three types of body plans:



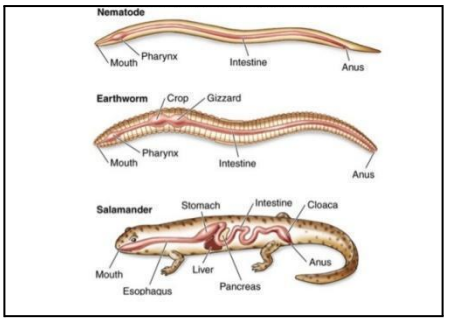


Cell Aggregate Plan: In this, the body is just a mass of cells and there is no coordination between them and the differentiation is very less. Eg:- sponges.



Sea Anemone Anatomy.
1. Tentacles 2. Mouth 3. Retracting muscles 4. Gonads 5. Acontial filaments 6. Pedal disk 7. Ostium 8. Coelenteron 9. Sphincter muscle 10. Mesentery 11. Column 12. Pharynx

Blind Sac Plan: These multicellular animals have organ-system organization but there is incomplete alimentary canal in which single opening acts as both mouth (for ingestion) and anus (for egestion). Eg- Flatworms (*Fasciola hepatica* -liver fluke), coelenterates (*Hydra*) .



Tube-within-a-tube plan: In this, multicellular animal has organ-system organization and is with complete alimentary canal having two separate openings i.e. mouth for ingestion at anterior end and anus or cloacal aperture for egestion at posterior end. It is again of two types:

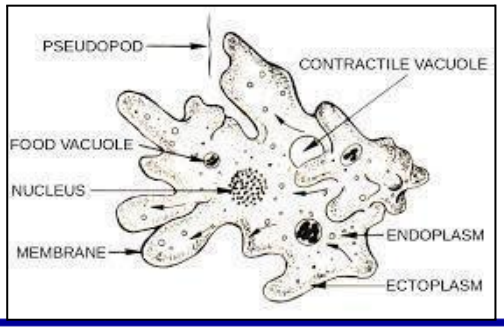
- **Protostomous**: In this, the mouth is formed earlier than anus during the development of the embryo. Eg- in roundworms, annelids, molluscs, arthropods.
- **Deuterostomes**: In this, anus is formed earlier than the mouth during the development of the embryo. Eg- in echinoderms and chordates.

C. Symmetry

Symmetry is the repetition of body parts or shapes within the body of an organism in an orderly fashion.

Asymmetric: Parazoans (like Porifera) do not have definite symmetry.

Asymmetry in amoeba



The “Eumetazoans” are divided into two categories:

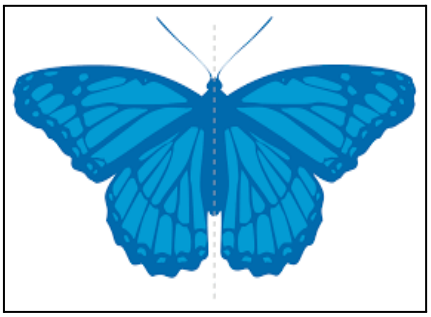
Radial Symmetry: When the body of the organism can be divided into equal halves by any plane, then it is said to possess radial symmetry.

Radial symmetry in starfish and jellyfish:

Example- It is observed in Phylum Cnidaria and Ctenophora.

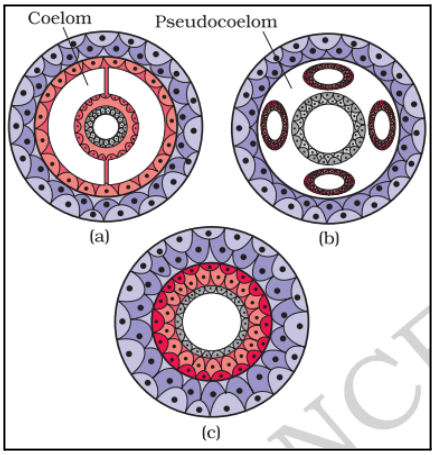
Bilateral Symmetry: When the body of the organism can be divided into equal halves by only a single plane, then it is said to possess bilateral symmetry.

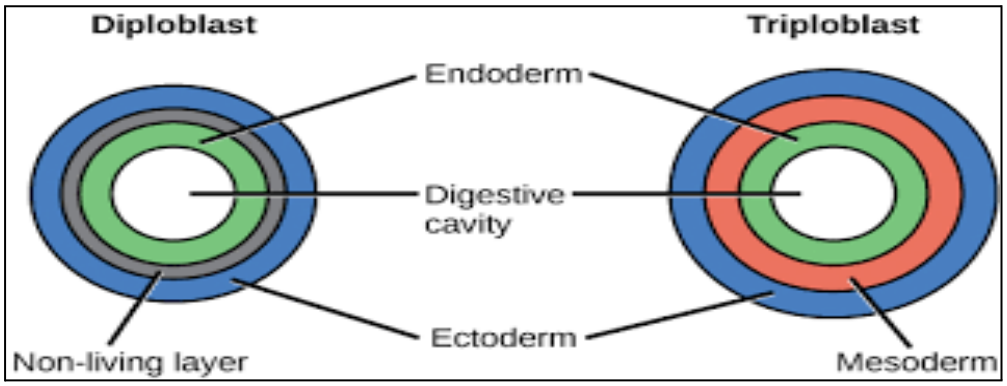
Example- Phyla Platyhelminthes, Nematodes, Annelids, Arthropoda, Mollusca, Echinodermata, Hemichordata and Chordata.



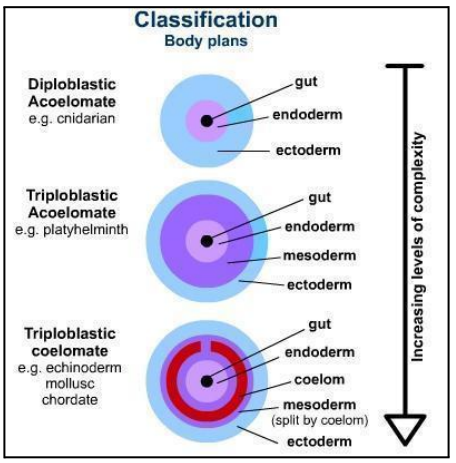
D. Diploblastic and Triploblastic Animals

Diploblastic animals have two fundamental germ layers i.e. an outer ectoderm and an inner endoderm, for example in phylum Cnidaria and Ctenophora whereas triploblastic animals possess three germ layers. They have an additional layer of mesoderm present between ectoderm and endoderm, for example in Phyla Platyhelminthes, Nematodes, Arthropodes, Chordates, Mollusca, Annelida.





E. Segmentation



Segmentation means the division of animal body into a series of repetitive segments.

In some bilateral organisms, like in phylum Annelida, the body shows many segments. Such type of segmentation is called metameric segmentation and the phenomenon is called "metamerism".

F. Coelom or Body Cavity

The space between the body wall and body cavity or the alimentary canal is lined by mesoderm and is known as coelom. Many visceral organs lie here.

Acoelomate: are the animals which do not have coelom. For example- Phyla Porifera, Cnidaria, Ctenophora.

Pseudocoelomate: are the animals which have the coelom or body cavity. For example- Phylum Nematoda.

Coelomate or Eucoelomate: are the animals which have true coelom. For example- Phyla Annelids, Arthropoda, Mollusca, Echinodermata, Hemichordata and Chordata.

G. Heterotrophic mode of nutrition

Heterotrophic nutrition is nutrition obtained by digesting organic compounds. Animals, fungi, and protists are unable to synthesize organic compounds to use as food. They are known as heterotrophs.

Heterotrophic organisms have to acquire and take in all the organic substances they need to survive. Almost all heterotrophs have to convert solid food into soluble compounds capable of being absorbed (digestion). When the soluble products of digestion of the organism where complex materials (assimilation) are broken down for the release of energy (respiration). All heterotrophs depend on autotrophs for their nutrition. Heterotrophic are of following types:

Parasites: are the organisms which obtain food from other living organisms (the host), with the host receiving no benefit from the parasite. When a parasite is present inside the body of the host, it is known as an endoparasite. Generally endoparasites attack and live in the intestine of an organism whereas parasites such as mites and leeches attach themselves to the outside of the host's body. They are known as ectoparasites. They suck and feed on the blood of the host. Eg: mosquito.

Saprobiontic or saprotrophic: Organisms which feed on dead organic remains of other organisms. Eg: decomposers.

Holozoic nutrition: the word holozoic is made from two words- "holo" means whole and "zoikos" means animals. Hence, holozoic means the animals which eat their food whole. This food is taken into the digestive system and broken down into small pieces for easy absorption. This consists of 5 stages: ingestion, digestion, absorption, assimilation and egestion. Eg: human.

H. Active Movement

Almost all the animals have a unique feature of performing a more rapid and complex way of movement than the members of other kingdoms. This movement is due to the flexibility of the cells of animals. Some animals can run or walk on land (like dog, leopard, man), some can fly in air (like bird, bat, butterfly) and some can swim in water (like fish, whale, squid).

I. Reproduction

Another special feature of the animal kingdom is reproduction. Most of the animals can reproduce sexually and some reproduce asexually. Most animals exhibit sexual dimorphism i.e. male and female animal can be distinguished externally.

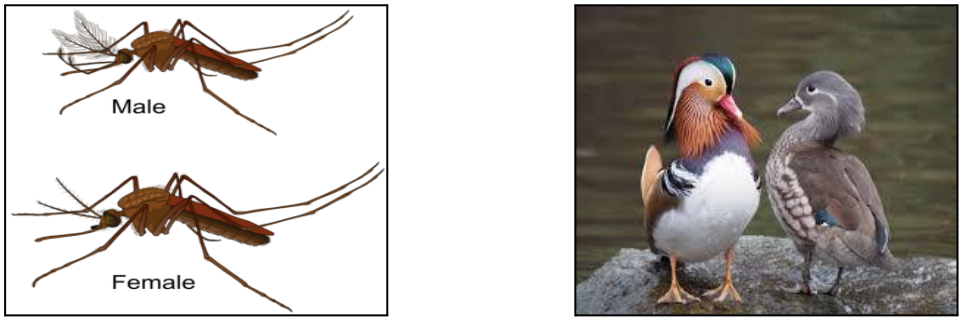


Fig.: Sexual dimorphism in mosquito and in Mandarin ducks
male (left) and female (right)

Fertilization takes place when male and female gametes are fused. It could be external or internal depending upon the complexity of animals.

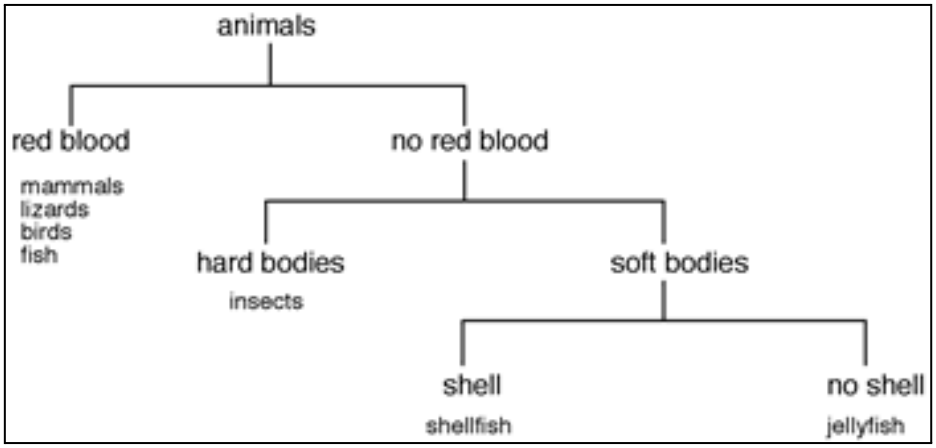
J. Development

Development means the changes that take place in an organism from its inception till its maturity. The zygote is formed after the fusion of male and female gametes. Then, this zygote undergoes a series of developmental changes to produce a complete organism.

Classification of Animals

Different scientists gave different theories for classifying animals.

Aristotle divided animals into two major groups i.e. Anaima (having animals without red blood as in sponges, mollusca) and Enaima (having animals with red blood as in vertebrates).



R.H. Whittaker gave 5 kingdom classification and put all the animals into 5 categories or kingdoms which are monera, protista, fungi, plantae and animalia.

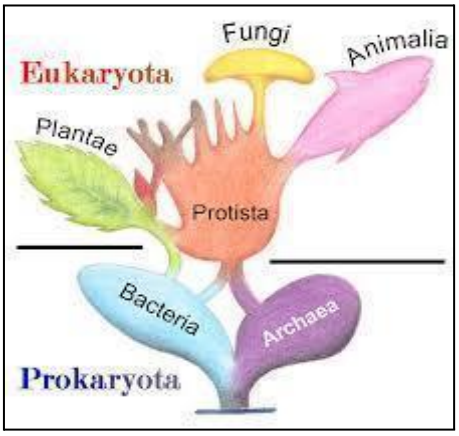


Fig.: Outline Of Classification Of Animal Kingdom (NCERT)

(This diagram shows the broad classification of Kingdom Animalia on the basis of their common fundamental features)

The animal kingdom includes about 35 phyla of which 11 are considered as major phyla which we are going to discuss in these modules. Almost 99% of animals are invertebrates i.e. animals without backbone and the remaining 1% are vertebrates i.e. animals with backbone. Apart from this, the members of the animal kingdom are divided broadly into two major groups- chordates and non-chordates on the basis of presence or absence of notochord in some of the stages of their life.

Now, let us study each major phylum in detail:

Phylum Porifera

Etymology: From the Latin *porus* for pore and *Ferre* to bear, hence an animal with pores.

The members of this phylum are commonly called sponges.

Habitat: Sponges are aquatic animals. They are mostly marine, only a few live in freshwater. Some are solitary or colonial whereas others are sessile. They have characteristic flagellated choanocytes. The coelenterates have tentacles and bear cnidoblasts.

Level of Organization: They are primitive multicellular and have cellular level of organization.

Symmetry: Mostly asymmetric, but some primitive sponges like Asconoid and Syconoid (explained later) are radially symmetrical.

Germ Layer: They are diploblastic animals i.e. have only two germ layers.

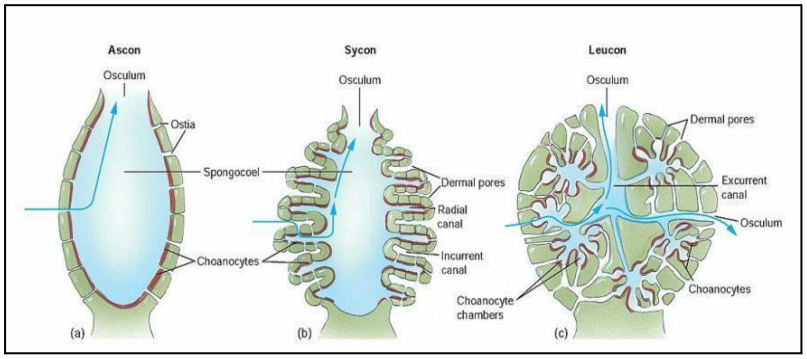
Body Form: The body of sponges is porous i.e. they possess minute pores on their body. The pores are of two types- inhalant pores are called ostia and exhalant pores are called oscula.

Body Plan: Sponges have three kinds of cell types:

1. Pinacoderm is like a dermal layer. It is the outermost cellular layer of sponges and contains flat pinacocytes and oval porocytes.
2. Chaonoderm is just like the gastral layer. This is the inner layer which has specialized flagellated cells called choanocytes or collar cells.
3. Mesohyl layer is equivalent to mesenchyme. It is present in between pinacoderm and choanoderm. It has sponging fibres and spicules. There are amoebocytes which are modified into archaeocytes, trophocytes, collencytes, gland cells, thesocytes, scleroblasts, myocytes, germ cells, chromocytes and phagocytes.

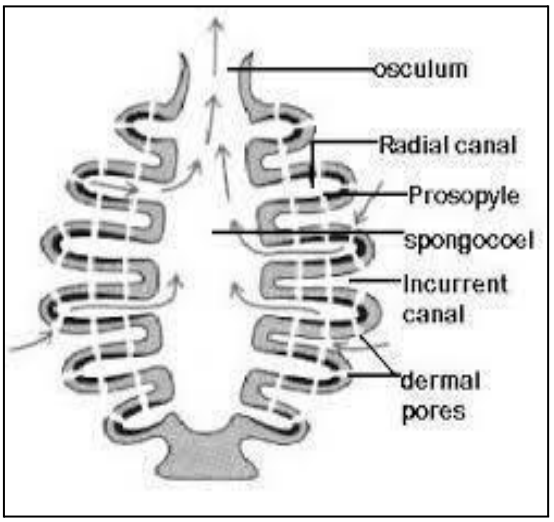
Canal System: Sponges have a canal system for transportation of water. There are three types of canal systems in sponges:

1. **Asconoid:** These sponges are the simplest and least common sponge body form. These sponges have multiple *ostia*, this is where water enters the sponge, and only has one osculum, where water exits the sponge. The openings lead to the sponge's central chamber called a spongocoel that is lined with choanocytes. They are vase-like in shape. It is found in *Leucosolenia*
2. **Syconoid:** Sponges are more complex than ascon sponges but are simpler than leucon sponges. These sponges have multiple dermal pores, where water enters the sponge, and only have one osculum. The openings lead to radial canals that are lined with choanocytes and after they lead to the spongocoel. They have folded walls that have incurrent canals. It is found in *Sycon.*
3. **Leuconoid:** They are the most complex of the sponge body forms and also most common. These sponges have multiple dermal pores and can have more than one osculum. The openings lead to canals that lead to chambers that are lined with choanocytes and then to the excurrent canal. They have branched canal systems that lead to chambers. It is found in *Spongilla.*



Function of choanocytes:

- gathering food
- exchanging gases
- reproduction
- removing waste like carbon dioxide and excretory matter.



Choanocytes make up the principle 'pump' and' filter' of the system, driving water through the sponge, trapping and phagocytizing suspended bacteria and other particulate food, which is then digested and nutrients distributed among the cells of the mesohyl that facilitate the functions of feeding, respiration and reproduction. The flow of water inside a sponge is unidirectional: the water is drawn in through tiny pores (ostia) in the pinacoderm and exits through one or more larger openings (osculae). The aquiferous system of a sponge is usually supported by a combination of two types of skeletal elements: mineral spicules (either calcareous or siliceous) and special protein fibers (spongin), although either one or both of these elements can be absent.

Digestion: The process of digestion in sponges is intracellular. i.e. it occurs inside the food vacuole.

Circulation: The distribution of food is done by amoebocytes of the mesohyl layer.

Respiration and Excretion: They occur through diffusion of water.

Skeleton: There are two main components of a sponge skeleton, a protein called spongin which forms a tough fibrous network throughout the sponge and normally works in

conjunction with the spicules. Spicules are non-living aggregates of a chemical nature, secreted and made from either silica or calcium carbonate as calcite or aragonite. These spicules are important in the classification of sponges.

Reproduction: Sexes are not separate. They are hermaphrodite i.e. both the egg and sperm are produced by the same organism. They can reproduce both asexually by fragmentation or gemmules and sexually by formation of gametes.

Fertilization is internal. The new born or the larva is morphologically different from the adults.

What makes them unique?

Presence of canal system, ostia and oscula.

Spicules and spongin fibres in the skeleton.

All sponges are filter feeders on small to extremely small particles and most are sedentary or immobile as adults, i.e they spend their adult lives fixed to a substrate.

Examples: *Sycon* (Scypha), *Spongilla* (Freshwater sponge) and *Euspongia* (Bath sponge).

Let's have a quick review:

Characteristics of Porifers-

1. No definite symmetry.
2. Body is multicellular, with few tissues, no organs.
3. Cells and tissues surround a water filled space but there is no true body cavity.
4. All are sessile, (live attached to something as an adult).
5. Reproduce sexually or asexually.
6. Has no nervous system.
7. Often have a skeleton of spicules.
8. Lives in aquatic environments, mostly marine.
9. All are filter feeders.
10. Body with pores and canals in walls.

Phylum Cnidaria

The phylum Cnidaria consists of around 9000 species of animals. They are commonly known as comb jellies. Their most significant feature is the 'combs' is "groups of cilia" which they use for swimming.

Habitat: Most of the species are marine, few like Hydra are fresh water. Some of them are sessile and others are free-swimming.

Level of Organization: Cnidarians are the first multicellular animals.

Symmetry: They show radial symmetry.

Germ Layer: They are diploblastic animals.

Body Form: Cnidarians exhibit two basic body forms called polyp and medusa. The former is a sessile and cylindrical form like Hydra, *Adamsia*, etc. whereas, the latter is umbrella-shaped and free-swimming like *Aurelia* or jellyfish. Those cnidarians which exist in both forms exhibit alternation of generation (Metagenesis), i.e., polyps produce medusae asexually and medusae form the polyps sexually (e.g., *Obelia*).

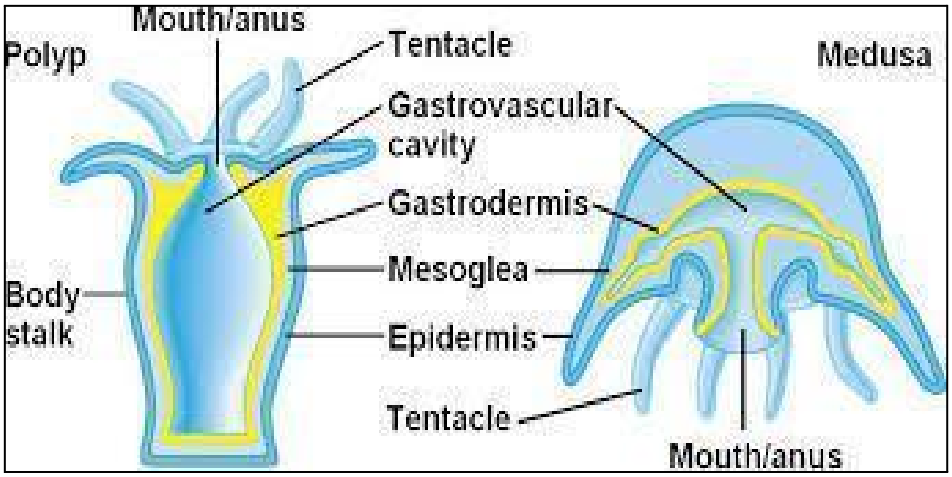
This alternation of generation should not be confused with those of plants where one phase is haploid and the other is diploid whereas here, in Cnidarians, both the phases are diploid.

Some cnidarians like *Obelia* are trimorphic i.e. having three kinds of zooids - polyps, blastostyles and medusae.

The occurrence of more than one type of individuals performing different functions in the colony of the same organism is called polymorphism.

Difference between polyp and medusa:

Polyp	Medusa
Poly is cylindrical in shape.	Medusa is an umbrella-like in shape.
They are fixed.	They are free swimming.
They do not have gonads.	They have gonads.
They do not have sense organs.	They have sense organs.
They feed the colony and protect them.	They help in sexual reproduction and dispersal of seeds.
They represent asexual generation.	They belong to sexual generation.



Digestion: In Cnidarians, digestion is both extracellular and intracellular. They have a central gastro-vascular cavity with a single opening, mouth on hypostome which also acts as anus. Thus, the digestive tract is incomplete.

The enteron having a single opening is called coelenteron, thus giving this name to this phylum.

Body Plan: The body wall has two layers- outer epidermis and inner gastrodermis. The name cnidaria is derived from the cnidoblasts or cnidocytes (which contain the stinging capsules or

nematocysts) present on the tentacles and the body. Cnidoblasts are used for anchorage, defence and for the capture of prey.

Skeleton: Some of the cnidarians, e.g. corals have a skeleton composed of calcium carbonate.

Reproduction: They reproduce both asexually by budding and sexually. They also have the power of regeneration.

What makes them unique?

Cnidoblast cells which help in defense.

They are the first (or most primitive) animals having tissue level of organization.

Examples: *Physalia* (Portuguese man-of-war), *Aurelia* (Jellyfish), *Adamsia* (Sea anemone), *Pennatula* (Sea-pen), *Gorgonia* (Sea-fan) and *Meandrina* (Brain coral).

<u>Let's have a quick review:</u>

Characteristics of Coelenterates-

1. Radial symmetry.
2. Body is multicellular, tissue level organization, and diploblastic.
3. Exhibit polymorphism.
4. All are sessile, (live attached to something as an adult).

5. Reproduce sexually or asexually.
6. Has a primitive form of nervous system.
7. Digestive system is incomplete.
8. Lives in aquatic environments, mostly marine.
9. Special cnidoblast cells are present.

Summary

By now, you all must be aware of the general characteristics of animals. We also discussed the features of animals belonging to Phylum Porifera and Cnidaria.