* Important Criteria used for Zoological Classification up to Class in each Phylum

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INTRODUCTION

- If the taxonomists were satisfied merely with the describing and naming of species, he would be left with total chaos, considering the several million species of animals in existence. To convert this chaos into order, is the basic task of the classification.
- Good classification makes an enormous amount of diverse information readily and conveniently available to biologists, and indeed, to anyone dealing with the organism. It gives meaning by association.
- It should therefore be the objective of the taxonomists to produce a system which has high predictive value and will allow maximum information retrieval.
- Zoological classification is "the ordering of animals into the groups on the basis of their similarity and relationship".
- The meaning and the principles of biological classification as well as all the associated difficulties have been well discussed by different authors like- Michener (1957), Beckner (1959), Cain and Harrison (1960), Cain (1962), Gisin (1964) and Mayr (1965a, 1965b).
- A basic principle of taxonomic art is that its results should be useful. There are three basis subsidiary principle are:

  1. The basis of the classification should be the most biologically significant relationships among organisms and should bring as many of those as is practicable.

  2. Classification should be consistent with the relationship used as its basis.

  3. Classification should be as stable as it can be without contravening the two preceding principles.

- To maintain greatest usefulness, classification must be consistent not with knowledge of some fixed time in the past, but as nearly as may be with the constantly changing knowledge of body. It is therefore, desirable that classification should not remain static, but should change continually as pertinent knowledge expands.
- Classification is an absolutely essential means of conceptualization, communication and storage of information about animals. Despite the fact that a bewildering variety of species with different structures and forms exist out there, organisms share some common features among themselves. These similarities are the basis of classification. Classification is the systematic arrangement of things around us for easy identification and study. The basis of classification can vary according to the purpose of the classification. A biological classification generally pins out the morphological and evolutionary similarities as its basis.

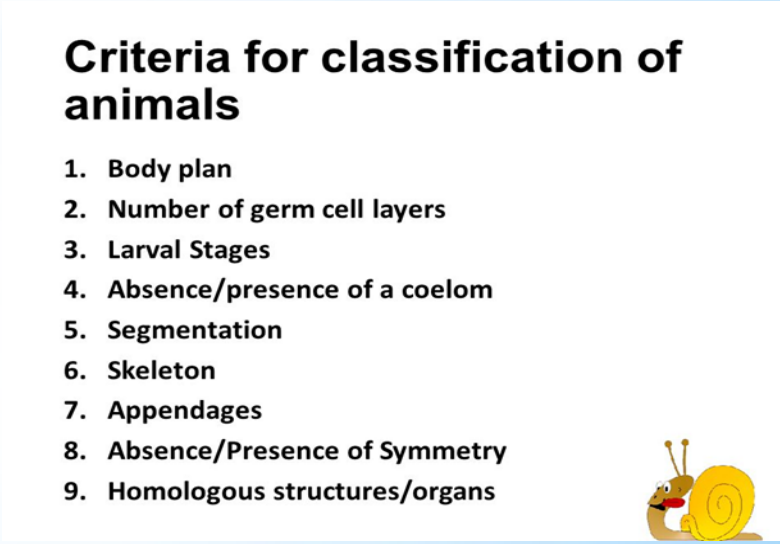
* Important Criteria used for Zoological Classification: At a Glance

- A consistent evolutionary classification is one whose implications drawn according to stated criteria of such classification., do not contradict the classifier's view as to the phylogeny of the group. The principle kinds of criteria, used to draw up an evolutionary classification and to study their implications are:

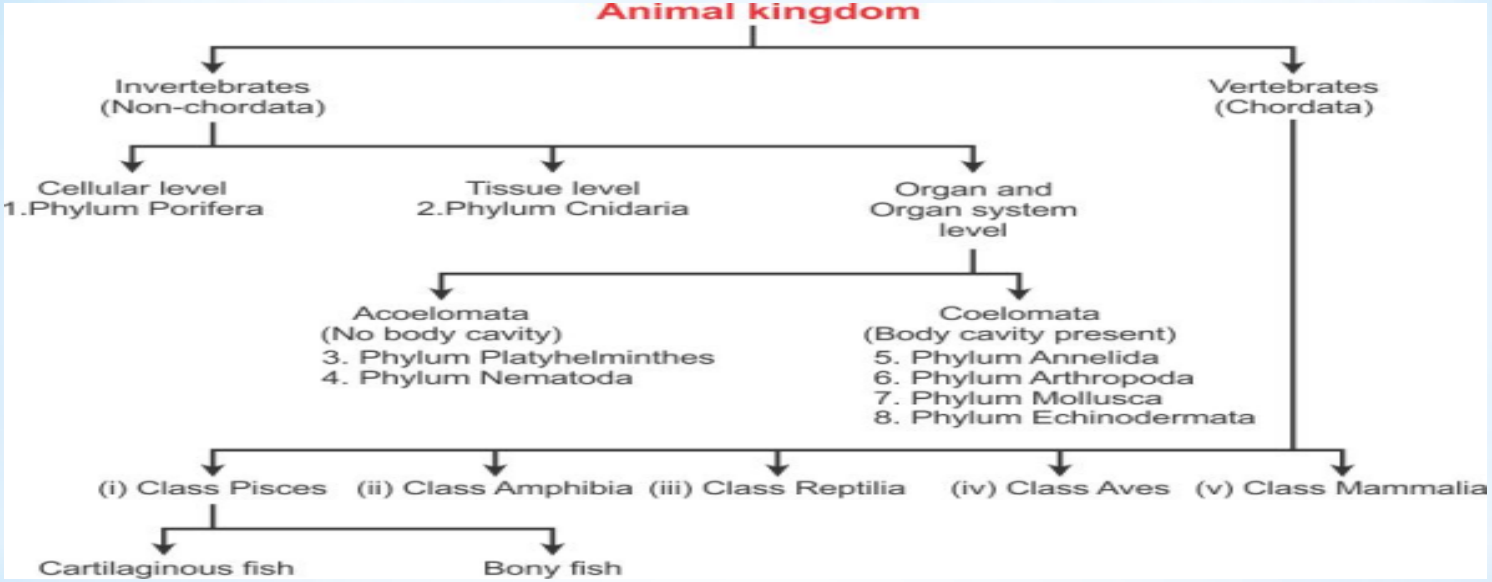
    1. Criteria related to objectivity, reality, arbitrariness, and the like.
    2. Criteria related to monophyly, polyphyly, clades and grades .
    3. Criteria related to the different kinds and degree of affinities involved in phylogeny.
    4. Criteria related to the relative antiquity of taxa.

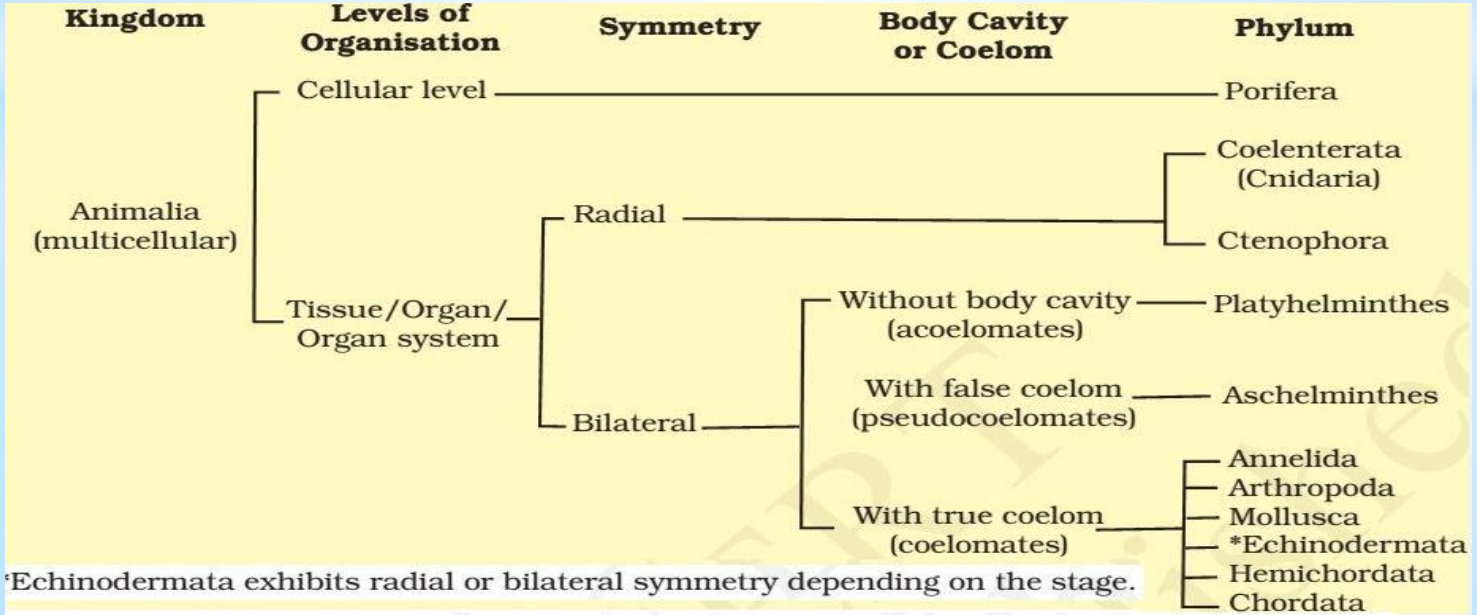
- Classification of Animal Kingdom up to class in each phyla, although consider different characters in case of different phyla, but in general, the following criteria are considered for classification of animal kingdom:

    1. Levels of Organisation,
    2. Diploblastic and Triploblastic Organisation
    3. Symmetry
    4. Coelom development,
    5. Segmentation of the body and
    6. Presence or absence of Notochord.



* Basic Criteria for Classification of Animal Kingdom : At A Glance





Broad classification of Kingdom Animalia based on common fundamental features

Basic Criteria for Classification of Animal Kingdom : At A Glance

THE LIVING WORLD → PLANT KINGDOM

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ANIMAL KINGDOM
(No chlorophyll and cellulose cell-wall; locomotion and sensory reception developed)

- Subkingdom and Phylum (1) PROTOZOA (Unicellular)
- Subkingdom **Metazoa** (Multicellular)
  - Infrakingdom **Enterozoa** (tissue or organ grade; obvious mouth and digestive cavity present)
    - GRADE RADIATA (tissue grade; radial symmetry; common digestive and body cavities)
      - (3) Phylum CNIDARIA
    - GRADE BILATERIA (organ grade; bilateral symmetry; separate digestive cavity)
      - Section EUCOELOMATA (true coelom present)
        - **Schizocoelic**
          - (6) Phylum MOLLUSCA – soft, slimy unsegmented body.
          - (7) Phylum ANNELIDA – segmented worms with non-chitinous cuticle and unjointed appendages.
          - (8) Phylum ARTHROPODA – segmented body with chitinous cuticle and jointed appendages.
        - **Enterocoelic**
          - (9) Phylum ECHINODERMATA – unsegmented body; secondary pentamerous radial symmetry.
          - (10) Phylum CHORDATA – segmented, bilateral body with notochord, pharyngeal gill clefts and dorsal, hollow tubular central nervous system.
      - Section PSEUDOCOELOMATA (body cavity a pseudocoel)
        - (5) Phylum ASCHELMINTHES
      - Section ACOELOMATA (no body cavity)
        - (4) Phylum PLATYHELMINTHES
  - Infrakingdom **Parazoa** (cellular grade; no obvious mouth and digestive cavity)
    - (2) Phylum PORIFERA

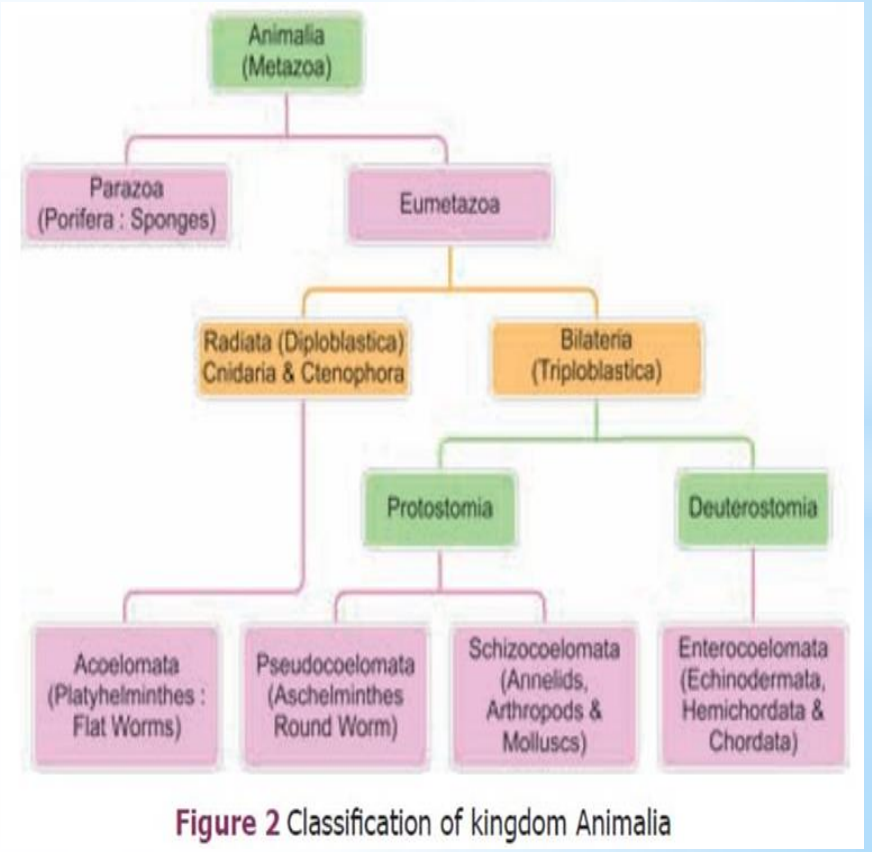


Figure 2 Classification of kingdom Animalia

* Important Criteria used for Zoological Classification: Levels of organisation

Levels of Organisation:

- Though all members of *Animalia* are multicellular, all of them do not exhibit the same pattern of **organisation of cells.**
- For example, in sponges, the cells are arranged as loose cell aggregates, *i.e.*, they exhibit cellular level of organisation. Some division of labour (activities) occur among the cells.
- In *Coelenterates*, the arrangement of cells is more complex. Here the cells performing the same function are arranged into tissues, hence is called **tissue level of organisation**.
- A still higher level of organisation, i.e., organ level [**organ level of organisation**] is exhibited by members of *Platyhelminthes* and other higher phyla where tissues are grouped together to form organs, each specialised for a particular function.
- In animals like *Annelids, Arthropods, Molluscs*, *Echinoderms* and *Chordates*, organs have associated to form functional systems, each system concerned with a specific physiological function. This pattern is called **organ system level of organisation.**
- Organ systems in different groups of animals exhibit various patterns of complexities.

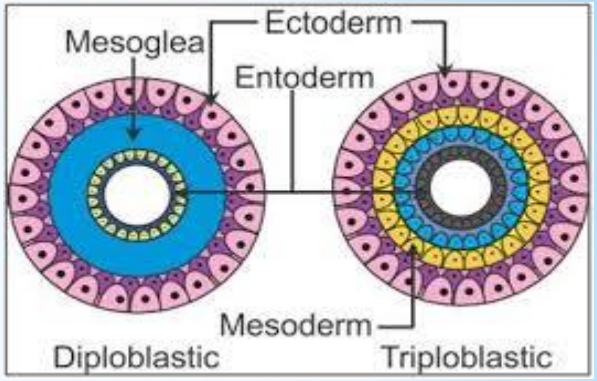
Example:

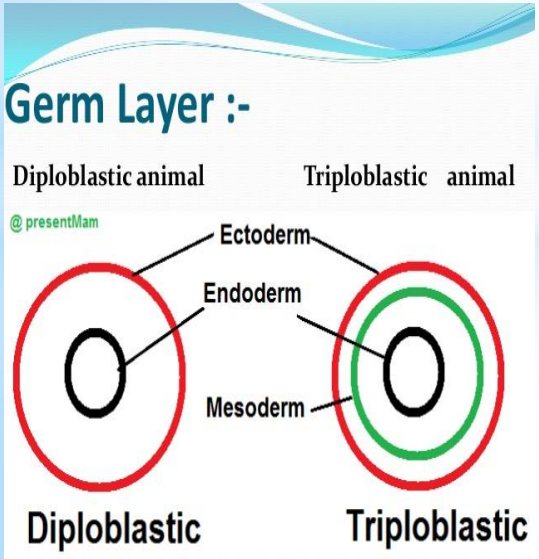
- The digestive system in *Platyhelminthes* (incomplete digestive system) has only a single opening to the outside of the body that serves as both mouth and anus, and is hence called incomplete. A complete digestive system has two openings, mouth and anus.
- Similarly, the circulatory system may be of two types: open type in which the blood is pumped out of the heart and the cells and tissues are directly bathed in it and closed type in which the blood is circulated through a series of vessels of varying diameters (arteries, veins and capillaries).

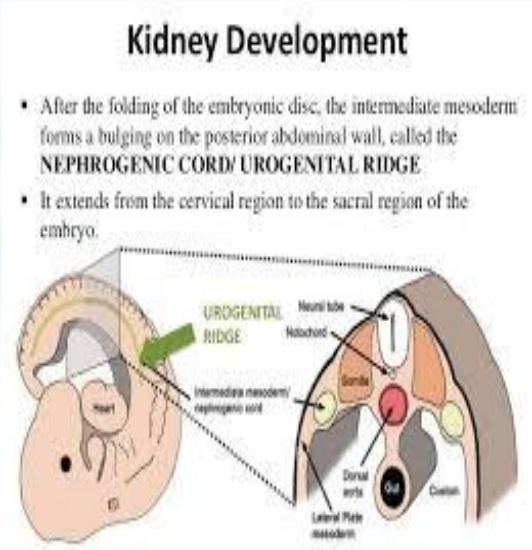
Important Criteria used for Zoological Classification: Levels of organisation (Contd..)

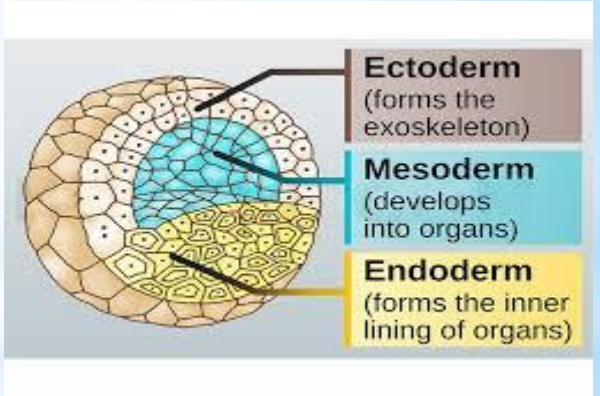
Diploblastic and Triploblastic Organisation:

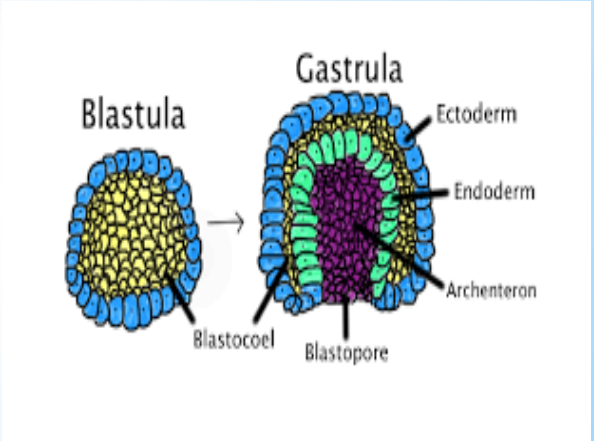
- Animals in which the cells are arranged in two embryonic layers, an external ectoderm and an internal endoderm, are called diploblastic animals, e.g., Coelenterates. An undifferentiated layer, mesoglea, is present in between the ectoderm and the endoderm.
- Those animals in which the developing embryo has a third germinal layer, mesoderm, in between the ectoderm and endoderm, are called triploblastic animals (platyhelminthes to chordates).











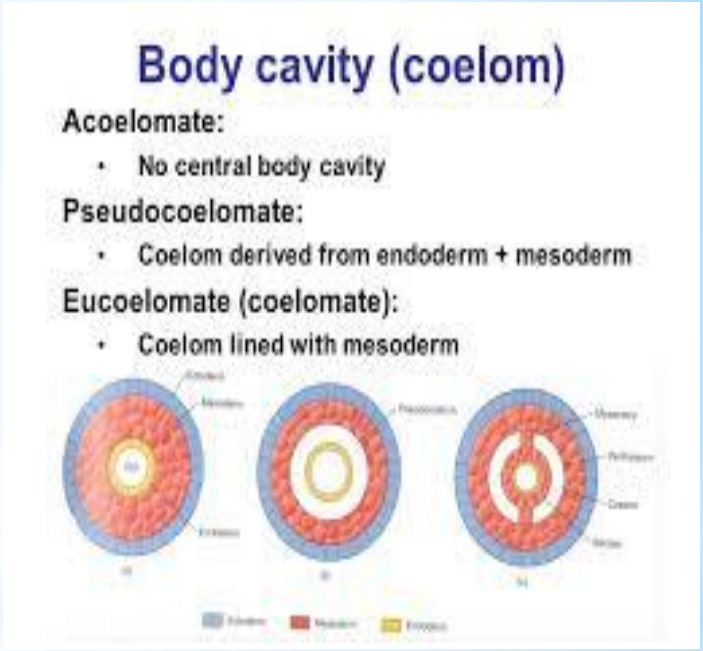
Important Criteria used for Zoological Classification: Coelom

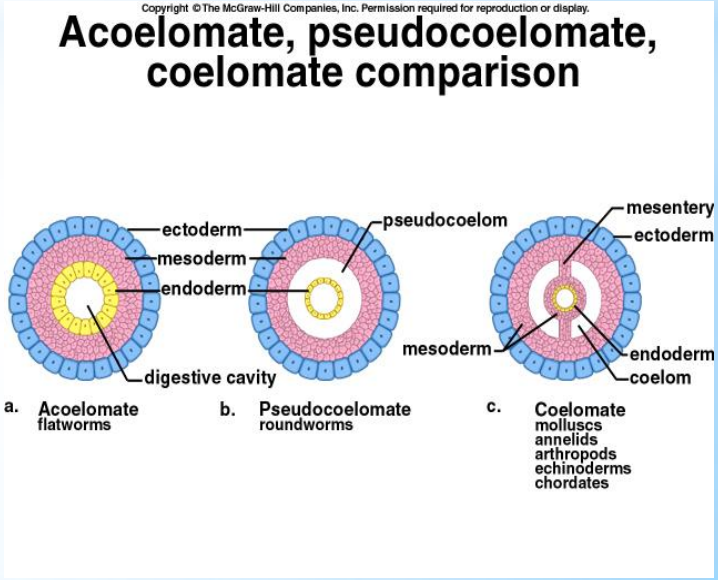
THE COELOM:

- **The coelom** is the main body cavity in most animals and is positioned inside the body to surround and contain the digestive tract and other organs. In some animals, it is lined with mesothelium. In other animals, such as molluscs, it remains undifferentiated. Coelom is the mesodermally lined cavity between the gut and the outer body wall.

- During the development of the embryo, coelom formation begins in the gastrulation stage. The developing digestive tube of an embryo forms as a blind pouch called the archenteron. In the past, and for practical purposes, coelom characteristics have been used to classify bilaterian animal phyla into informal groups.

- It is one of the significant criteria, being considered as the basis of classification of animal kingdom.





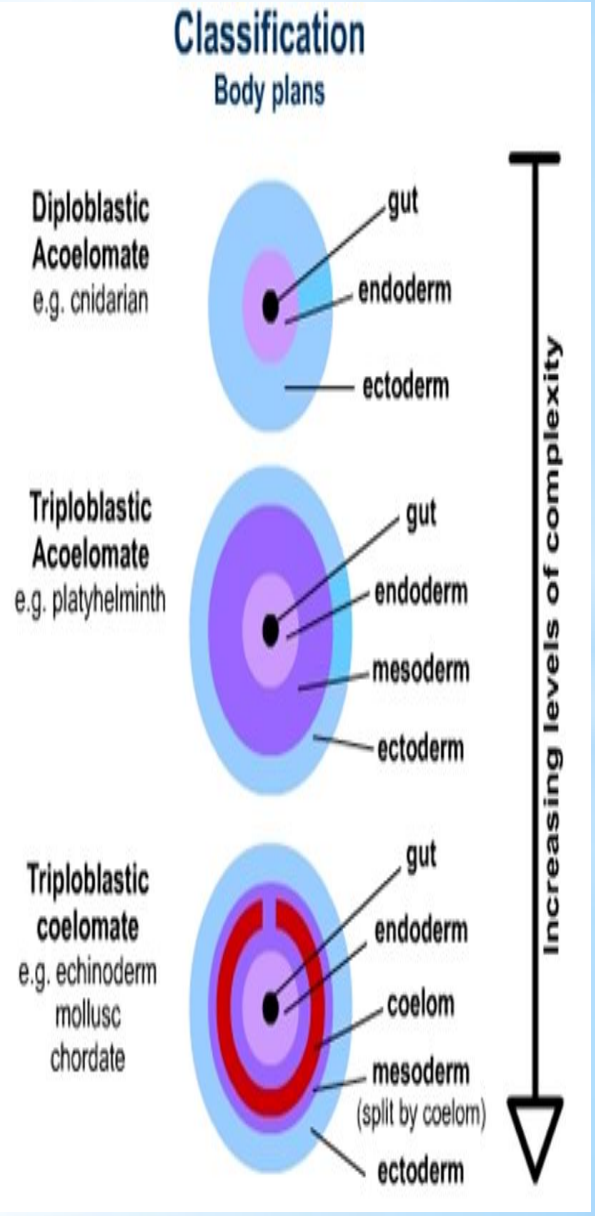
Important Criteria used for Zoological Classification: Coelom(Contd..)

ACOELOMATES:

- Acoelomates lack a fluid-filled body cavity between the body wall and digestive tract. This can cause some serious disadvantages. Fluid compression is negligible, while the tissue surrounding the organs of these animals will compress.
- Therefore, acoelomate organs are not protected from crushing forces applied to the animal's outer surface.
- Usually, the coelom can be used for diffusion of gases and metabolites etc. These creatures do not have this need, as the surface area to volume ratio is large enough to allow absorption of nutrients and gas exchange by diffusion alone, due to dorso-ventral flattening.

Example:

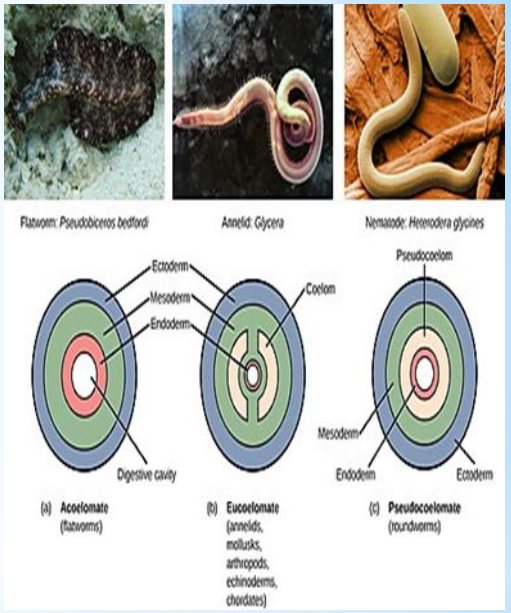
- Cnidarians (jellyfish and allies), and the ctenophores (comb jellies),
- Platyhelminthes
- Gastrotricha, traditionally viewed as blastocoelomates
- Entoprocta, traditionally viewed as blastocoelomates
- Gnathostomulida, traditionally viewed as blastocoelomates
- Cycliophora



* Important Criteria used for Zoological Classification: Coelom(Contd..)

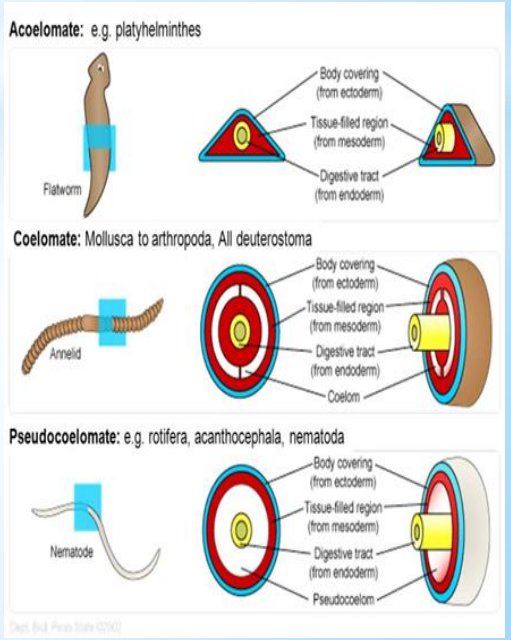
PSEUDOCOELOMATE:

- **Pseudocoelomate animals have a pseudocoelom** (literally "false cavity"), which is a fluid filled body cavity. Pseudocoelomate animals are also referred to as Blastocoelomate. A pseudocoelomate or blastocoelomate is any invertebrate animal with a three-layered body and a pseudocoel. The coelom was apparently lost or reduced as a result of mutations in certain types of genes that affected early development. Tissue derived from mesoderm partly lines the fluid filled body cavity of these animals. Thus, although organs are held in place loosely, they are not as well organized as in a coelomate Thus, pseudocoelomates evolved from coelomates. "Pseudocoelomate" is no longer considered a valid taxonomic group, since it is not monophyletic. However, it is still used as a descriptive term. All pseudocoelomates are protostomes; however, not all protostomes are pseudocoelomates.



Important characteristics:

- Most are microscopic parasites of almost every form of life (although some are free living), body usually covered by a secreted cuticle.
- Lack any kind of segmentation, a vascular blood system and a true skeleton, although hydrostatic pressure gives the body a supportive framework that acts as a skeleton.
- Diffusion and osmosis circulate nutrients and waste products throughout the body.
- They are often syncytial. They possibly represent pedomorphism. Larval stages are lost in some forms.



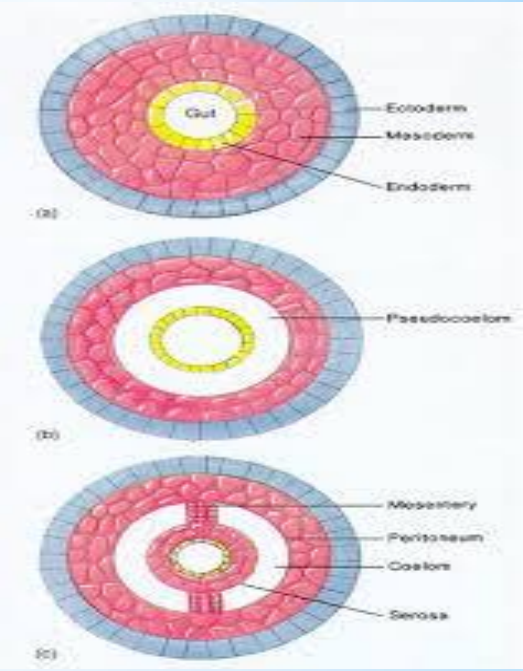
Examples: Rotifera, Kinorhyncha, Nematoda, Nematomorpha ,Acanthocephala, Loricifera,Ecdysozoans pseudocoelomates, Nematoda (roundworms), Nematomorpha (nematomorphs or horsehair worms), Loricifera, Priapulida, Kinorhyncha, Lophotrochozoans pseudocoelomates, Gastrotricha, Entoprocta, Rotifera (rotifers), Acanthocephala (spiny-headed worms).

* Important Criteria used for Zoological Classification: Coelom(Contd.,)

COELOMATE:

- **Coelomate animals or Coelomata** (also known as **eucoelomates** – "true coelom") have a body cavity called a coelom with a complete lining called peritoneum derived from mesoderm (one of the three primary tissue layers). The complete mesoderm lining allows organs to be attached to each other so that they can be suspended in a particular order while still being able to move freely within the cavity.

  Examples: According to Brusca and Brusca, the following bilaterian phyla possess a coelom: Nemertea, traditionally viewed as acoelomates, Priapulida, Annelida, Onychophora, Tardigrada, Arthropoda, Mollusca, Phoronida, Ectoprocta, Brachiopoda, Echinodermata, Chaetognatha, Hemichordata and Chordata.



- Based upon the mode of formation Coelomates may be divided into two: Protostomes and Deuterostome

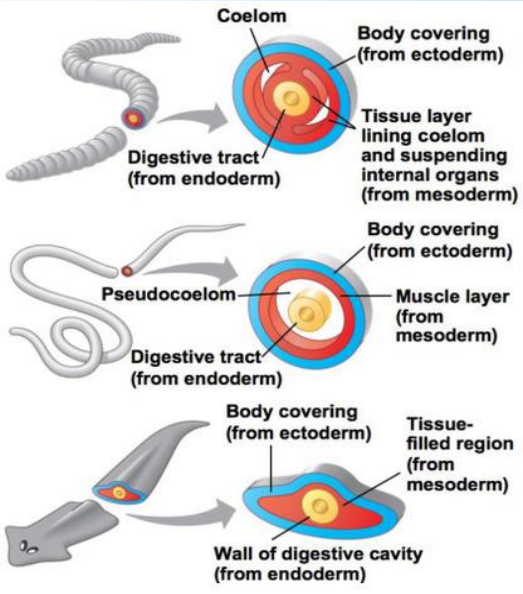
PROTOSTOME:

In Protostomes, the coelom forms by a process known as schizocoely. The archenteron initially forms, and the mesoderm splits into two layers: the first attaches to the body wall or ectoderm, forming the parietal layer and the second surrounds the endoderm or alimentary canal forming the visceral layer. The space between the parietal layer and the visceral layer is known as the coelom or body cavity.

DEUTEROSTOME:

In Deuterostomes, the coelom forms by enterocoely. The archenteron wall produces buds of mesoderm, and these mesodermal diverticula hollow to become the coelomic cavities. Deuterostomes are therefore, known as enterocoelomates.

Examples: Deuterostome coelomates belong to three major clades: chordates (vertebrates, tunicates, and lancelets), echinoderms (starfish, sea urchins, sea cucumbers), and hemichordates (acorn worms and graptolites).



* Important Criteria used for Zoological Classification: Symmetry

SYMMETRY:

- Symmetry in biology refers to the symmetry observed in organisms, including plants, animals, fungi, and bacteria. External symmetry can be easily seen by just looking at an organism.
- Internal features can also show symmetry, for example the tubes in the human body (responsible for transporting gases, nutrients, and waste products) which are cylindrical and have several planes of symmetry.
- While sponges and placozoans represent two groups of animals which don't show any symmetry (i.e. are asymmetrical), the body plans of most multicellular organisms exhibit, and are defined by, some form of symmetry. There are only a few types of symmetry which are possible in body plans. These are radial (cylindrical), bilateral, biradial and spherical symmetry.
- While the classification of viruses as an 'organism' remains controversial, viruses also contain icosahedral symmetry.

Symmetry as one of the criteria for study of evolution in animals:

- Symmetry is often selected for in the evolution of animals.
- Traditionally it has been suggested that bilateral animals evolved from a radial ancestor.
- Cnidarians, a phylum containing animals with radial symmetry, are the most closely related group to the bilaterians. Cnidarians are one of two groups of early animals considered to have defined structure, the second being the ctenophores.
- Ctenophores show biradial symmetry leading to the suggestion that they represent an intermediate step in the evolution of bilateral symmetry from radial symmetry. In such animals the part that moves forward (and usually contains the mouth) is termed anterior.
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* Important Criteria used for Zoological Classification: Radial Symmetry

RADIAL SYMMETRY:

- Rotational symmetry, also known as radial symmetry in biology, is the property a shape has when it looks the same after some rotation by a partial turn. An object's degree of rotational symmetry is the number of distinct orientations in which it looks exactly the same for each rotation.
- Organisms with radial symmetry show a repeating pattern around a central axis such that they can be separated into several identical pieces when cut through the central point, much like pieces of a pie. Typically, this involves repeating a body part 4, 5, 6 or 8 times around the axis – referred to as tetramerism, pentamerism, hexamerism and octomerism, respectively. Such organisms exhibits no left or right sides but do have a top and a bottom surface, or a front and a back.
- George Cuvier classified animals with radial symmetry in the taxon Radiata (Zoophytes,which is now generally accepted to be an assemblage of different animal phyla that do not share a single common ancestor (a polyphyletic group).
- Most radially symmetric animals are symmetrical about an axis extending from the centre of the oral surface, which contains the mouth, to the centre of the opposite (aboral) end. Animals in the phyla Cnidaria and Echinodermata generally show radial symmetry, although many sea anemones and some corals within the Cnidaria have bilateral symmetry defined by a single structure, the siphonoglyph.
- Radial symmetry is especially suitable for sessile animals such as the sea anemone, floating animals such as jellyfish, and slow moving organisms such as starfish. Whereas, bilateral symmetry favours locomotion by generating a streamlined body.

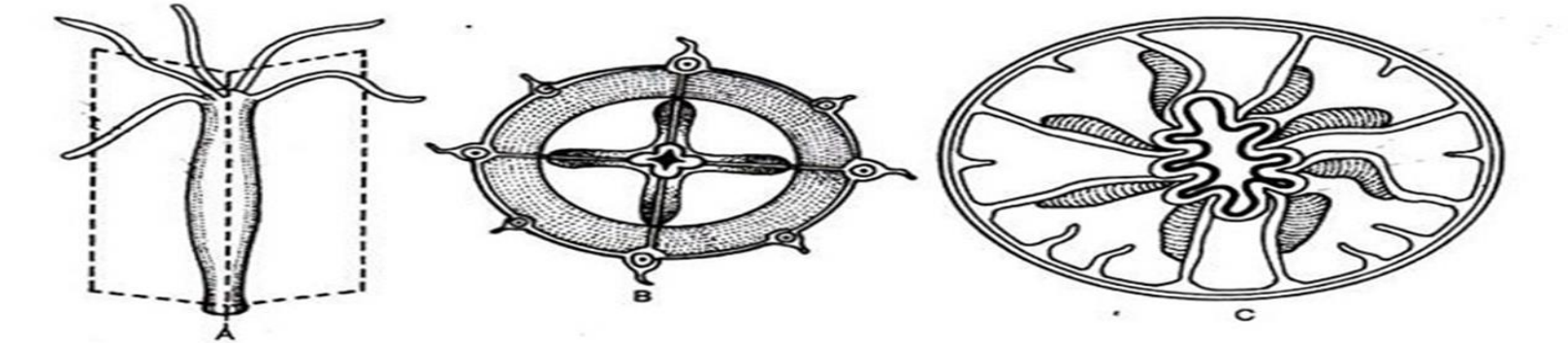


Fig. 9.3: Diagrams showing the different forms of radial symmetry. A. Radial symmetry (Hydra). B. Tetramerous radial symmetry (Jelly fish). C. Octomerous radial symmetry (a octocorallian polyp).

* Important Criteria used for Zoological Classification: Icosahedral and Spherical Symmetry

Icosahedral symmetry:

- **Icosahedral symmetry** occurs in an organism which contains 60 subunits generated by 20 faces, each an equilateral triangle, and 12 corners. Within the icosahedron there is 2-fold, 3-fold and 5-fold symmetry. Many viruses, including canine parvovirus, show this form of symmetry due to the presence of an icosahedral viral shell. Such symmetry has evolved because it allows the viral particle to be built up of repetitive subunits consisting of a limited number of structural proteins (encoded by viral genes), thereby saving space in the viral genome.

Spherical symmetry:

- **Spherical symmetry** is characterised by the ability to draw an endless, or great but finite, number of symmetry axes through the body. This means that spherical symmetry occurs in an organism if it is able to be cut into two identical halves through any cut that runs through the organism's centre. True spherical symmetry is not found in animal body plans. Organisms which show approximate spherical symmetry include the freshwater green alga Volvox.
- Bacteria are often referred to as having a 'spherical' shape. Bacteria are categorized based on their shapes into three classes: cocci (spherical-shaped), bacillus (rod-shaped) and spirochetes (spiral-shaped) cells. In reality, this is a severe over-simplification as bacterial cells can be curved, bent, flattened, oblong spheroids and many more shapes. Due to the huge number of bacteria considered to be cocci (coccus if a single cell), it is unlikely that all of these show true spherical symmetry. It is important to distinguish between the generalized use of the word 'spherical' to describe organisms at ease, and the true meaning of spherical symmetry. The same situation is seen in the description of viruses – 'spherical' viruses do not necessarily show spherical symmetry, usually they are icosahedral.

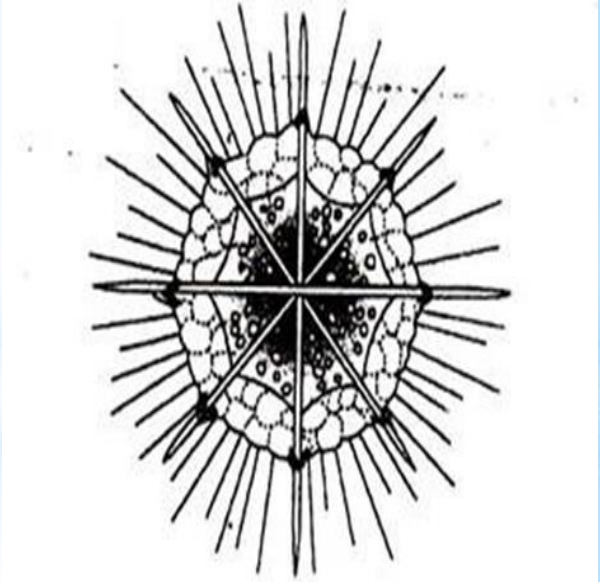


Fig. 9.2: Diagram of a radiolarian showing the spherical symmetry.

* Important Criteria used for Zoological Classification: Bilateral Symmetry

Bilateral symmetry:

- Organisms with bilateral symmetry contain a single plane of symmetry, the sagittal plane, which divides the organism into two roughly mirror image left and right halves – approximate reflectional symmetry.
- Animals with bilateral symmetry are classified into a large group called the bilateria which contains 99% of all animals (comprising over 32 phyla and 1 million described species). All bilaterians have some asymmetrical features, for example the human heart and liver are positioned asymmetrically despite the body having external bilateral symmetry.
- The bilateral symmetry of bilaterians is a complex trait which develops due to the expression of many genes. The bilateria have two axes of polarity. The first is an anterior-posterior (AP) axis which can be visualised as an imaginary axis running from the head or mouth to the tail or other end of an organism. The second is the dorsal-ventral (DV) axis which runs perpendicular to the AP axis. During development the AP axis is always specified before the DV axis.
- Bilateral symmetry is associated with the term cephalization—meaning the specialization of the anterior end of the body to form the head where the nervous tissues, sense organs and feeding organs are concentrated. The opposite end is posterior; the back or upper surface is termed dorsal, and the under surface (usually toward the ground) is termed ventral (1.venter, belly). Structures on or toward the central longitudinal axis and those toward the sides are termed as medial and lateral respectively.

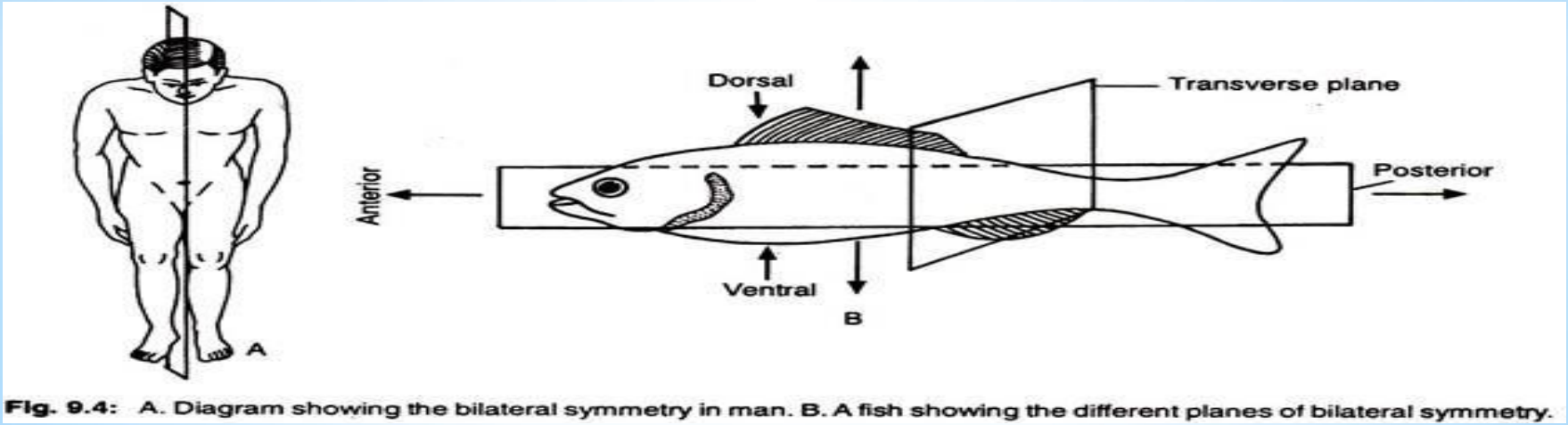


Fig. 9.4: A. Diagram showing the bilateral symmetry in man. B. A fish showing the different planes of bilateral symmetry.

* Important Criteria used for Zoological Classification: Biradial Symmetry & Segmentation

Biradial symmetry:

- **Biradial symmetry** is found in organisms which show morphological features (internal or external) of both bilateral and radial symmetry. Unlike radially symmetrical organisms which can be divided equally along many planes, biradial organisms can only be cut equally along two planes. This could represent an intermediate stage in the evolution of bilateral symmetry from a radially symmetric ancestor.
- The animal group with the most obvious biradial symmetry is the ctenophores. In ctenophores the two planes of symmetry are
- (1) the plane of the tentacles and
- (2) the plane of the pharynx.
- In addition to this group, evidence for biradial symmetry has even been found in the 'perfectly radial' freshwater polyp Hydra (a cnidarian). Biradial symmetry, especially when considering both internal and external features, is more common than originally accounted for.

Segmentation:

- In some animals, the body is externally and internally divided into segments with a serial repetition of at least some organs and the phenomenon is called as metamerism.
- In the annelids, arthropods, and chordates there is a linear repetition of body parts known as segmentation (metamerism); each repeated unit is a somite (metamere). In earth-worms the successive somites are essentially alike, but they are unlike in different body regions of a crayfish or insect.
- Metamerism is conspicuous both externally and internally in annelids, is mostly external with arthropods, and mainly internal in man and other chordates (vertebrae, body muscles, some blood vessels, and nerves).

Important Criteria used for Zoological Classification: Appendages, Skeleton, Sex and Embryonic Development

Appendages:

- Protruding parts that serve in locomotion, feeding, and other ways are termed appendages; examples are the tentacle of sea anemones, minute setae of earthworms, antennae and legs of arthropods, and the fins, legs, and wings of vertebrates.

Skeleton:

- Most land dwellers and many aquatic animals have a skeleton for support or protection; it may be internal (frog, man, etc.) or external (coral, crab, insect) and may be of either inorganic or material.

Sex:

- An animal containing both female and male sex organs in one individual is termed monoecious (also hermaphroditic); members of most higher phyla are dicoecious, each individual being either male or female.

Embryonic development:

- Cleavage of the egg is complete or holoblastic in many invertebrates, amphioxus, amphibians, and mammals. In eggs with much yolk, cleavage is incomplete or meroblastic, confined to a limited part as in squids, insects, many fishes, reptiles, and birds.

* Important Criteria used for Zoological Classification: Larvae and Notochord

Larvae:

- The young stages known as larvae often provide important information on relationships not evident in adult animals. Many have features obviously adapted to particular environments such as cilia for swimming. Their basic structure, however, is usually characteristic for each phylum or class. Barnacles and tunicates, for example, were first properly classified by study of their larvae.
- Many aquatic invertebrates in the protostome line have a common type of larva- minute, transparent, and free-swimming. Often it is top shaped, and encircled by two lines of cilia that beat so as to suggest a rotating wheel, hence the name trochophore (Gr. Trochos, wheel + phoros, bear). The upper end has a plate with a tuft of cilia and a sense organ. With various modifications this is the early larva of many marine flatworms, nemerteans, mollusks, and some annelids.

- **Notochord:**

- **Notochord** is a mesodermally [the middle layer of cells or tissues of an embryo, or the parts derived from this (e.g. cartilage, muscles, and bone)] derived rod-like structure formed on the dorsal side [posterior] during embryonic development in some animals. Notochord is also one of the basic criteria used for classification of animals.
- Animals with notochord are called chordates and those animals which do not form this structure are called non-chordates, e.g., Porifera to Echinoderms.

The Classification of Animal Kingdom Up to Phyla

Animal Kingdom: Basis of Classification:

- The animal kingdom is the largest kingdom among the five kingdoms consisting of all animals. Animals are multicellular eukaryotes; don't possess cell wall or chlorophyll like plants, and share the same mode of nutrition, that is, the heterotrophic mode. Besides these similarities, they are also related to their cell arrangement, body symmetry, the level of organization, coelom, presence/absence of notochord, etc. Based on these features, the animal kingdom has been classified into 11 different phyla.

The Animal Kingdom is classified into:

- Phylum - Protozoa
- Phylum – Porifera
- Phylum – Coelenterata (Cnidaria)
- Phylum – Ctenophora
- Phylum – Platyhelminthes
- Phylum – Aschelminthes (Nemotoda) Annelida
- Phylum – Arthropoda
- Phylum – Mollusca
- Phylum – Echinodermata
- Phylum – Hemichordata
- Phylum – Chordata

The Classification of Animal Kingdom Up to Phyla: Porifera

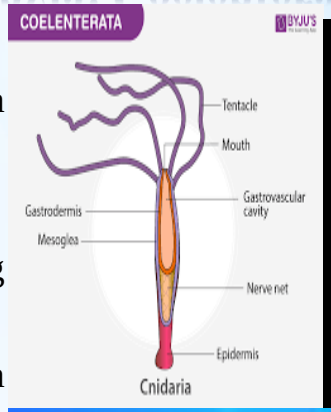
Phylum – Porifera

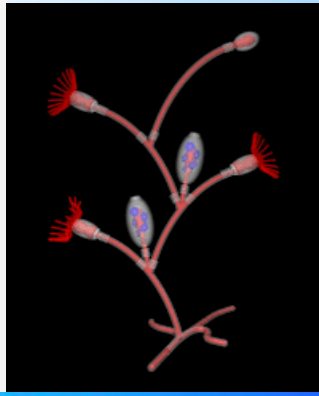
- Phylum – Porifera includes organisms with holes.
- They are primitive multicellular animals and have cellular level of organisation.
- They are non-motile animals attached to some solid support.
- The body design involves very minimal differentiation and division into tissues.
- They are commonly called sponges.
- They are generally marine and mostly asymmetrical animals.
- Sponges have a water transport or canal system.
- Water enters through minute pores (ostia) in the body wall into a central cavity, spongocoel, from where it goes out through the osculum.
- This pathway of water transport is helpful in food gathering, respiratory exchange and removal of waste.
- The body is supported by a skeleton made up of spicules or spongin fibres.
- Sexes are not separate (hermaphrodite), i.e., eggs and sperms are produced by the same individual.
- Sponges reproduce asexually by fragmentation and sexually by formation of gametes.
- Fertilisation is internal and development is indirect having a larval stage which is morphologically distinct from the adult.
- Porifera - Sycon - Euspongia - Spongilla
- **Examples:** A. Sycon (Scypha), B. Spongilla (Fresh water sponge) and C. Euspongia (Bath sponge).

The Classification of Animal Kingdom Up to Phyla: Coelenterata

Phylum – Coelenterata (Cnidaria)

- The name cnidaria is derived from the cnidoblasts or cnidocytes (which contain the stinging capsules or nematocytes) present on the tentacles and the body.
- Cnidoblasts are used for anchorage, defense and for the capture of prey.
- Coelenterata (Cnidaria) are aquatic, mostly marine sessile or free-swimming radially symmetrical
- They exhibit tissue level of organization [have more body design differentiation than sponges].
- They have a central gastro-vascular cavity with a single opening.
- They are diploblastic.
- Some of these species live in colonies (corals).
- Some have a solitary [living alone] like–span (hydra).
- Some of the cnidarians, e.g., corals have a skeleton composed of calcium carbonate. Cnidarians exhibit two basic body forms called polyp and medusa. The former is a sessile and cylindrical form like Hydra, Adamsia (Sea anemone), etc. whereas, the latter is umbrella-shaped and free-swimming like Aurelia or jelly fish.
- 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).
- Jellyfish and sea anemones are common examples.
- Digestion is extracellular and intracellular.
- **Examples:** Aurelia (jelly fish), Physalia (Portuguese man-of-war), Adamsia (Sea anemone), Pennatula (Sea-pen), Gorgonia (Sea-fan) and Meandrina (Brain coral).





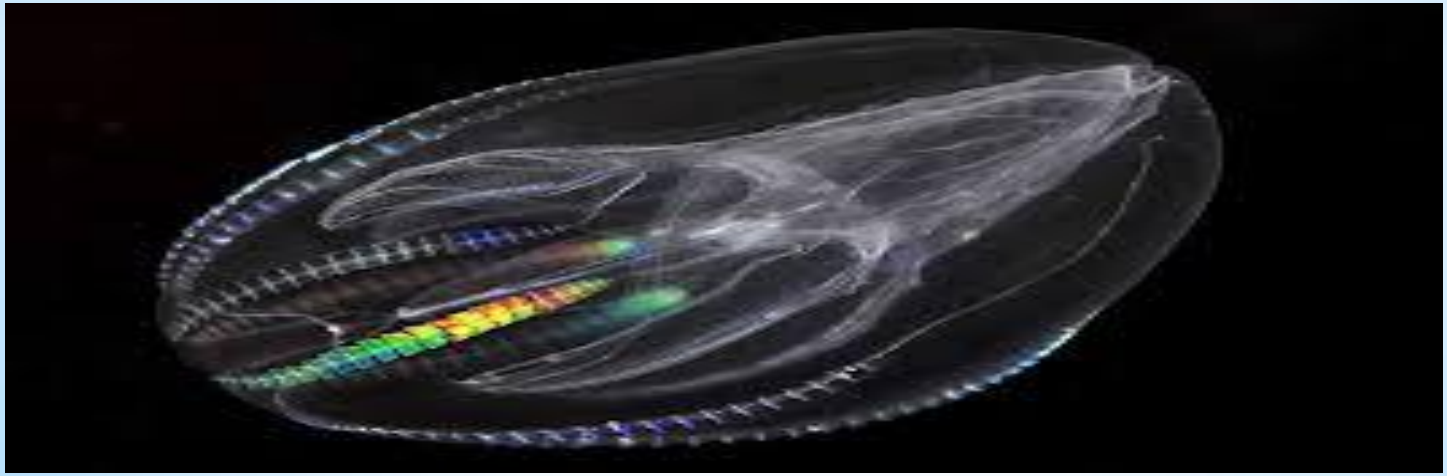
The Classification of Animal Kingdom Up to Phyla: Ctenophora

Phylum – Ctenophora

- Ctenophora are commonly known as sea walnuts or comb jellies.
- They exclusively marine, radially symmetrical, diploblastic
- They exhibit tissue level of organisation.
- The body bears eight external rows of ciliated comb plates, which help in locomotion.
- Digestion is both extracellular and intracellular.
- Bioluminescence (the property of a living organism to emit light) is well-marked in ctenophores.
- Sexes are not separate and reproduction takes place only by sexual means.
- Fertilisation is external [fertilization occurs outside the body] with indirect development [zygote → larvae → animal].

Examples:

Pleurobrachia and Ctenoplana. Comb jelly.



The Classification of Animal Kingdom Up to Phyla: Platyhelminthes

Phylum – Platyhelminthes

- Platyhelminthes are more complexly designed than the earlier groups.
- They are bilaterally symmetrical.
- They are triploblastic. This allows outside and inside body linings as well as some organs to be made. There is thus some degree of tissue formation [organ level of organisation].
- The body is flattened dorsi-ventrally, meaning from top to bottom, which is why these animals are called flatworms.
- They may be free living or parasitic. Hooks and suckers are present in the parasitic forms.
- Some examples are free living animals like planarians, or parasitic animals like
- Parasites are mostly endo-parasites found in animals including human beings. Some of them absorb nutrients from the host directly through their body surface.
- Acoelomate: There is no true internal body cavity or coelom, in which well developed organs can be accommodated.
- Specialised cells called flame cells help in osmoregulation and excretion.
- Sexes are not separate.
- Fertilisation is internal and development is indirect.
- Some members like Planaria possess high regeneration capacity.
- **Examples**- Tape worm - liver fluke

The Classification of Animal Kingdom Up to Phyla: *Aschelminthes*

Phylum – Aschelminthes (Nemotoda)

- Body in aschelminthes (Nemotoda) is cylindrical [bilaterally symmetrical] rather than flattened.
- They exhibit organ-system level of body organization [there are tissues, but no real organs].
- They are triploblastic. A sort of body cavity or a pseudo-coelom, is present.
- They are free living, aquatic, terrestrial or parasitic in plants and animals.
- These are very familiar as parasitic worms causing diseases, such as the worms causing elephantiasis (filarial worms) or the worms in the intestines (roundworm or pinworms).
- The body is circular in cross-section, hence, the name roundworms.
- Alimentary canal is complete.
- An excretory tube removes body wastes from the body cavity through the excretory pore.
- Sexes are separate (dioecious), i.e., males and females are distinct.
- Often females are longer than males.
- Fertilisation is internal and development may be direct (the young ones resemble the adult) or indirect.

Examples: Ascaris, Wuchereria

The Classification of Animal Kingdom Up to Phyla: Annelida

Phylum – Annelida

- Annelida are aquatic [marine and fresh water] or terrestrial; free-living, and sometimes parasitic.
- Their body surface is distinctly marked out into segments or metameres [metamerically segmented] and, hence, the phylum name Annelida (Latin, annulus: little ring).
- They exhibit organ-system level of body organization.
- They are coelomate [true body cavity]. This allows true organs to be packaged in the body structure.
- They are bilateral symmetric and triploblastic.
- They possess longitudinal and circular muscles which help in locomotion.
- Aquatic annelids like Nereis possess lateral appendages, parapodia, which help in swimming.
- A closed circulatory system is present.
- Nephridia (sing. nephridium) help in osmoregulation and excretion.
- Neural system consists of paired ganglia (sing. ganglion) connected by lateral nerves to a double ventral nerve cord.
- Nereis, an aquatic form, is dioecious [Sexes are separate], but earthworms and leeches are monoecious [having both the male and female reproductive organs in the same individual].
- Reproduction is sexual.

Examples: Pheretima, Hirudinea, Nereis

The Classification of Animal Kingdom Up to Phyla: Arthropoda

Phylum – Arthropoda

- Insects, arachnids and crustaceans are members of the largest category of creatures on the planet: arthropods.
- Arthropods have hard, external shells called “exoskeletons,” segmented bodies and jointed legs.
- Some familiar **examples** are- prawns, butterflies, houseflies, spiders, scorpions and crabs and some
- They exhibit organ-system level of organisation.
- They are bilaterally symmetrical, triploblastic, segmented and coelomate The coelomic cavity is blood-filled.
- The body of arthropods is covered by chitinous The body consists of head, thorax and abdomen.
- There is an open circulatory system, and so the blood does not flow in well defined blood vessels.
- Respiratory organs are gills, book gills, book lungs or tracheal system.
- Sensory organs like antennae, eyes (compound and simple), statocysts or balance organs are present.
- Excretion takes place through malpighian tubules.
- They are mostly dioecious.
- Fertilisation is usually internal.
- They are mostly oviparous.
- Development may be direct or indirect.

The Classification of Animal Kingdom Up to Phyla: Arthropoda (Contd..) and Mollusca

Arachnids

- Spiders, harvestmen, mites, ticks and other arachnids are members of the class Arachnida.

Crustaceans

- Crustaceans make up a large group of arthropods that includes animals such as crabs, lobsters, crayfish and shrimp. They breathe with gills and have two pairs of antennae.

Insects

- In general, insects have three-part bodies, six jointed legs, compound eyes and two antennae.
- Bees, wasps, beetles, mosquitoes, flies, grasshoppers, ants, butterflies and moths, and dragonflies and damselflies are common types of insects.

Phylum – Mollusca

- Mollusca are the second largest animal phylum. They are terrestrial or aquatic.
- They exhibit organ-system level of organization.
- They are bilaterally symmetrical, triploblastic, coelomate animals. There is little segmentation.
- They have an open circulatory system and kidney-like organs for excretion. The anterior head region has sensory tentacles. The mouth contains a file-like rasping organ for feeding, called radula.
- They are usually dioecious and oviparous with indirect development.
- Body is covered by a calcareous shell and is unsegmented with a distinct head, muscular foot and visceral hump. A soft and spongy layer of skin forms a mantle over the visceral hump.
- **Examples**: octopus, snails and mussels.

The Classification of Animal Kingdom Up to Phyla: Echinodermata

Phylum – Echinodermata

- These animals have an endoskeleton of calcareous ossicles [calcium carbonate structures] and, hence, the name Echinodermata (spiny skinned organisms).
- They are exclusively free-living marine animals with organ-system level of organisation.
- They are triploblastic with a coelomic cavity [coelomate animals]. The adult echinoderms are radially symmetrical but larvae are bilaterally symmetrical.
- Water-driven tube system [water vascular system] are used for locomotion, capture and transport of food and respiration.
- They are triploblastic and coelomate animals.
- Digestive system is complete. An excretory system is absent.
- Sexes are separate. Reproduction is sexual. Fertilisation is usually external.
- Development is indirect with free-swimming larva.

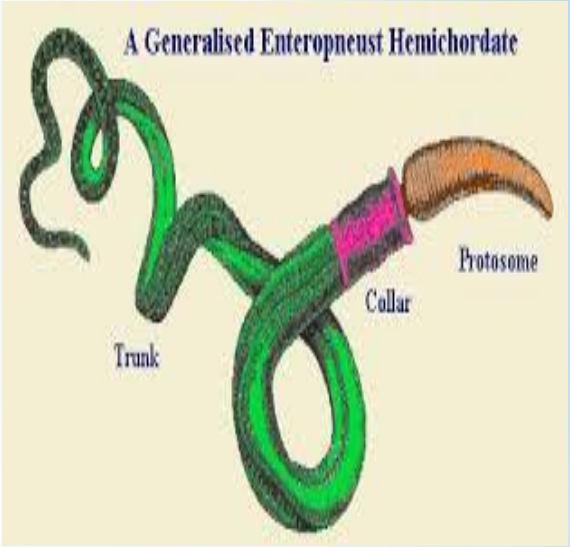
Examples: Star fish, Sea urchin, Sea lily, Sea cucumber, Brittle star.

The Classification of Animal Kingdom Up to Phyla: Hemichordata

Phylum – Hemichordata

- Hemichordata was earlier considered as a sub-phylum under phylum Chordata. But now it is placed as a separate phylum under non-chordata.
- This phylum consists of a small group of worm-like marine animals with organ-system level of organisation.
- They are cylindrical [bilaterally symmetrical], triploblastic, coelomate animals.
- The body is Circulatory system is of open type.
- Respiration takes place through gills.
- Excretory organ is present.
- Sexes are separate. Fertilisation is external. Development is indirect.

Examples: Balanoglossus(A) and Sarccoglossus (B).



The Classification of Animal Kingdom Up to Phyla: Chordata

Phylum – Chordata

- Animals belonging to phylum Chordata are fundamentally characterised by the presence of a notochord, a dorsal hollow nerve cord and paired pharyngeal gill slits.
- They are bilaterally symmetrical, triploblastic, coelomate with organ-system level of organisation.
- They possess a post anal tail and a closed circulatory system.
- Phylum Chordata is divided into three subphyla: Urochordata or Tunicata, Cephalochordata and Vertebrata.
- Subphyla Urochordata and Cephalochordata are often referred to as protochordates and are exclusively marine.
- In Urochordata, notochord is present only in larval tail, while in Cephalochordata, it extends from head to tail region and is persistent throughout their life.

Examples:

Urochordata – Ascidia, Salpa, Doliolum;

Cephalochordata – Amphioxus or Lancelet.

Chordata- All chordates possess the following features:

- having a notochord
- having a dorsal nerve cord
- All are triploblastic
- having paired gill pouches
- All are coelomate.

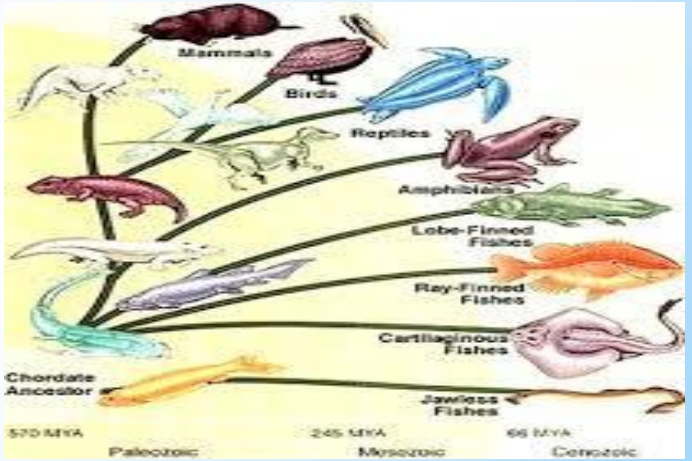
The Classification of Animal Kingdom Up to Phyla: Chordata (Contd..)

Vertebrata

- These animals have a true vertebral column and internal skeleton, allowing a completely different distribution of muscle attachment points to be used for movement.
- The members of subphylum Vertebrata possess notochord during the embryonic period.
- The notochord is replaced by a cartilaginous or bony vertebral column in the adult.
- Thus all vertebrates are chordates but all chordates are not vertebrates.
- Besides the basic chordate characters, vertebrates have a ventral muscular heart with two, three or four chambers, kidneys for excretion and osmoregulation and paired appendages which may be fins or limbs.
- Vertebrates are bilaterally symmetrical, triploblastic, coelomic and segmented, with complex differentiation of body tissues and organs.

Comparison of Chordates and Non-chordates

S.No.	Chordates	Non-chordates
1.	Notochord present.	Notochord absent.
2.	Central nervous system is, dorsal, hollow and single.	Central nervous system is, ventral, solid and double.
3.	Pharynx perforated by gill-slits.	Gill slits are absent.
4.	Heart is ventral.	Heart is dorsal (if present).
5.	A post-anal part (tail) is present.	Post-anal tail is absent.



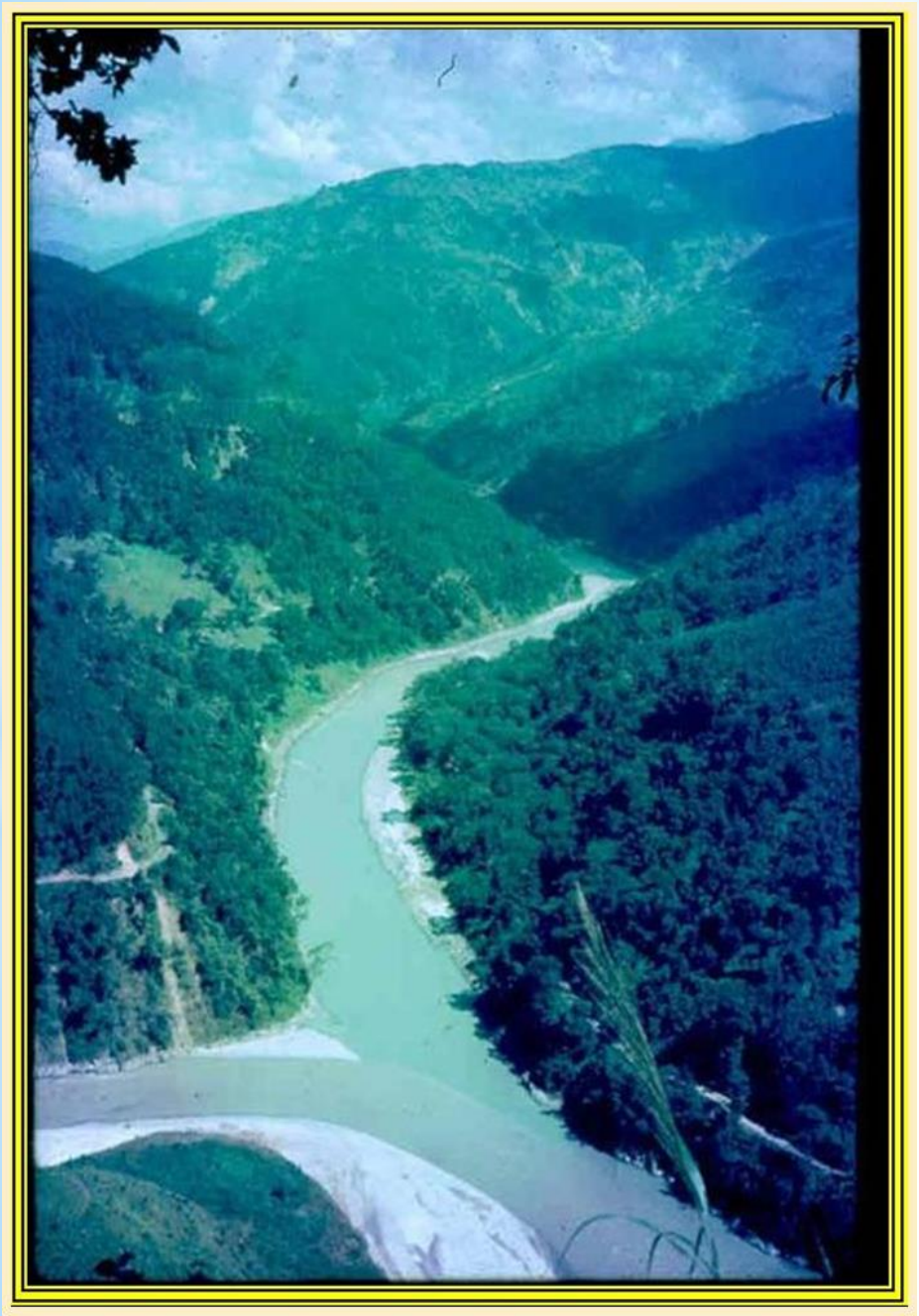
CONCLUSION

- Classification is an absolutely essential means of conceptualization, communication and storage of information about animals. Despite the fact that a bewildering variety of species with different structures and forms exist out there, organisms share some common features among themselves. These similarities are the basis of classification. Classification is the systematic arrangement of things around us for easy identification and study. The basis of classification can vary according to the purpose of the classification. A biological classification generally pins out the morphological and evolutionary similarities as its basis.
- The principle kinds of criteria, used to draw up an evolutionary classification and to study their implications are:

    1. Criteria related to objectivity, reality, arbitrariness, and the like.
    2. Criteria related to monophyly, polyphyly, clades and grades .
    3. Criteria related to the different kinds and degree of affinities involved in phylogeny.
    4. Criteria related to the relative antiquity of taxa.

- Classification of Animal Kingdom up to class in each phyla, although consider different characters in case of different phyla, but in general, the following criteria are considered for classification of animal kingdom:

    1. Levels of Organisation,
    2. Number of germ cell layers
    3. Diploblastic and Triploblastic Organisation
    4. Absence/ presence of symmetry
    4. Coelom development,
    5. Segmentation of the body and Appendages
    6. Presence or absence of Notochord/skeleton.
    7. Homologous structures and organs
    8. Larval stages, embryonic development and sex.



THANK YOU