

UNIT – II: General characters and classification of Invertebrate phyla

PHYLUM 1: PROTOZOA

DEFINATION:

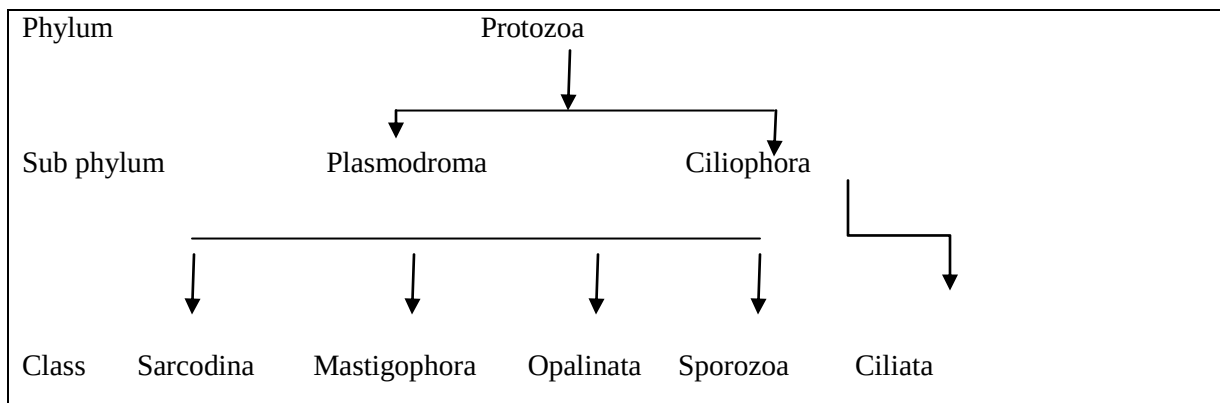
Protozoa may be defined as microscope, unicellular, eukaryotic animalcules and perform all physiological function similar to animals.

- It is included under protista by R, H Whittaker.
- Protozoans were first observed by Antony Von Leeuwen Hock in 1671 and called as animalcules. About 40000 thousand species are known
- The name protozoa was coined by GOLDFUSS (1817)
- They are called as non cellular or acellular by DOBEL.
- VON SIEBOLD called as unicellular organisms.

GENERAL CHARACTERISTICS:

1. The protozoans live as solitary or colonial form. They may be free living, sedentary parasitic or symbiotic forms.
2. The protozoans are minute microscopic, eukaryotic organisms.
3. They have a cellular or protoplasmic grade of organization.
4. They are cosmopolitan in distribution. They are found in marine water, freshwater, moist places and as parasites.
5. They are solitary, colonial, free living or parasitic and some are symbiotic.
6. The body is covered by plasma membrane, pellicle or shell. Some are necked.
7. They exhibit various shapes and symmetries.
8. They contain one, two or more nuclei in their protoplasm.
9. They have locomotor organelles such as pseudopodia, cilia, flagella or may be absent.
10. Nutrition is holozoic, holophytic, saprophytic or mixotrophic.
11. Digestion in Intra cellular.
12. Respiration and Excretion through body surface by diffusion.
13. Fresh water protozoans contain contractile vacuoles for osmoregulation. They involve in excretion.
14. Encystment occurs during unfavorable conditions. It helps in dispersal.
15. The protoplasm is not distinguishable into somatoplasm and germplasm.
16. Reproduction is by sexual and asexual methods. Asexual reproduction includes budding, binary fission (binary, transverse or oblique), and multiple fission. The sexual reproduction includes autogamy, gametogony or conjugation.

CLASSIFICATION:



CLASS: SARCODINA/ Rhizopoda

Includes more than 8000 species

- They are found fresh water, marine water, Sea water, and in moist place
- They are free living or parasites
- Their body is naked, in some animals the body is covered by test or shell. Pellicle is absent.
- Pseudopodia are present in all these animals for locomotion and food capture, flagella are present only in some stage of life they are not permanent
- Contractile vacuole are present in some
- Cytostome is absent in these animals
- They contain single nucleus. Some are multinucleated.
- Nutrition is holozoic
- Asexual reproduction is by binary fission, multiple fission, sporulation and budding.
- Sexual reproduction by syngamy .

Ex. *Amoeba*, *Entamoeba*, *Arcella*, *Elphidium* or *polystomella* , *Actinophrys*, *Globigerina* etc.

CLASS: MASTIGOPHORA OR FLAGELLATA

- About 2000 species are present
- It includes primitive protozoans covered by pellicle.
- They are freshwater, marine or parasitic.
- Solitary or colonial.
- Free living or parasites with definite shape.
- Contractile vacuole are present in some

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- They possess one or more flagella.
- Nutrition is autotrophic or heterotrophic, saprozoic or mixotrophic.
- Some flagellates have chlorophyll and synthesize their food by photosynthesis.
- Contain single nucleus.
- Reproduce by both sexually (syngamy) and asexually (binary or multiple fission).
- It is divided into 2 classes.

1. Phytomastigophora . Ex. *Euglena*, *Volvox*, *Noctiluca*, *Ceratium* etc.

2. Zoomastigophora. Ex. *Trypanosoma*, *Leishmania*, *Giardina*, *Trichomonos* etc..

CLASS : OPALINATA:

- They live in the host body as parasites or commensalisms
- They are found in the cold blood vertebrates
- Body is covered by uniform cilia like structures
- There is no cytostome
- Saprozoic mode of nutrition occurs
- Contractile vacuoles are absent.
- Asexual reproduction is binary fission.
- Undergo encystation during breeding season
Ex. *Opalina*

CLASS: SPOROZOA:

- They are parasites on vertebrates, insects, molluscs
- The body is covered by thick cuticle
- Locomotory organelles, cytostome vacuoles are absent.
- Nutrition is saprozoic or holozoic.
- Asexual reproduction is multiple fission sexual reproduction by spore formation and syngamy, where the infective stages of life cycle are sporozoites.
- Life cycle shows alternation of generation.

Ex. *Monocystis*, *Plasmodium*, *Sarcocystis*, etc.

Class: Ciliata :

- It includes about 5000 Species.
- They are solitary or colonial
- Ciliates are highly developed protozoans
- They all possess cilia on their body surface all over the body or in some parts of the body.
- They are found in fresh water or in sea water. Majority of them are free living some are sedentary or parasites.
- Nutrition is holozoic Two types of nuclei are present.
- The large macro nuclei are present regulates the vegetative activities; the micronucleus regulates the reproductive activities
- Contractile vacuoles are present in some.
- The body is covered by pellicle.
- Mouth and gullet are present
- Asexual reproduction takes by transverse binary fission or budding.
- Sexual reproduction by conjugation (temporary union two ciliates of different clones for exchange of nuclear material) and autogamy.

Ex. *Paramoesium*, *Vorticella*, *Baletidium*, *Stenter* etc.

PHYLUM -2 : PORIFERA

- The study of poriferans is known as parazoology.
- Their living nature was first observed by John Ellis. He discovered that water passes through the body of sponge.
- Robert E Grant (1836) established their animal nature and called them as porifera.
- Huxley and Sollas (1884) stated that sponges may be allotted separate sub kingdom parazoa.

GENERAL CHARACTERS:

1. They are about 10,000 sp in this phylum.
2. These are primitive multicellular animals with cellular grade of organization commonly known as sponges
3. They are aquatic; mostly marine and very few are fresh water.
4. They are sessile, solitary or colonial forms.
5. They exhibit various colors, shapes and variable in size.
6. They may be asymmetrical or radially symmetrical.
7. The body wall consists of two layers. Outer pinacodermis, and inner choanodermis between these two there is a mesoglea contain many amoeboid cells. Pinacodermis is made up of pinacocytes and choanodermis is made up of choanocytes or collar cells or flagellated cells.
8. The body of sponges is perforated by numerous pores called Ostia for the entry of water and osculum to leave the water from body.
9. They contain a cavity called spongocoel or paragastric cavity.
10. Water circulates in the body through canals which are together known as canal system.
11. The canal system helps in Digestion, respiration, circulation excretion and reproduction.
12. Mesoglea contain amoebocytes they are differentiated into trophocytes (nutritive) chromocytes (give color) scleroblasts (produce spicules) spongeoblasts (produce spongin fibres) Archaeocytes – (Totipotent)

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thesocytes (store reserve food) myocytes (regulate diameter of ostia) Gland cells (secrete adhesive substance).

13. Nutrition is holozoic, digestion is intracellular
14. Respiration is through diffusion.
15. Skeletal system is made up of calcarious spicules or sillcious spicules or spongeon fibres or both.
16. Excretory product is ammonia (aminotellic)
17. Nervous system is not developed so cells are independent.
18. No sense organs.
19. Reproduction is both asexual and sexual. Asexual reproduction is by budding or by producing internal buds called gemmules.
20. Sponges are hermaphrodites. Ova are developed from archaeocytes ,Ova are produced earlier than sperms. (protogynous)
21. Fertilization is always cross, and internal. Cleavage is holoblastic .
22. Development includes larval form known as parenchymula or Amphiblastula or stereogastrula.
23. They have the power of regeneration.

CLASSIFICATION:

Phylum: According to Storer and Usinger (1971) porifera is classified into 3 classes on the basis of spicules. They are Calcaria, Hexactinellida and Demospongia.

CLASS – 1 Calcaria or Calciospongiae:

1. They are calcareous sponges.
2. They are purely marine, live in shallow water.
3. They small in size, grown up to 10 to 15 cm height.
4. They are colonial or solitary forms with radial symmetry.
5. Skeleton is made up of calcareous spicules which are made of CaCO_3 . They are monaxon, triradlate or tetra radiated.
6. Canal system is simple ascon, syconoid or leuconoid type.
7. Reproduction takes place is asexually by budding.
8. Larva is amphiblastula.

Eg: *Leucosolenia*, *Sycon*, *Grantia*, *Leucella*, *Clathrina*

CLASS – 2.

1. They are known as glass sponges.
2. They are marine present in deep water.
3. They give appearance of glass wool – due to projecting tufts of glassy spicules.
4. They are vas or cup shaped, attached to substratum directly or with the help of stalk made up of tuft of spicules.
5. They are radially symmetrical, colonial or solitary forms.
6. The skeleton is made up of silicious spicules which are six rayed (Hexactine)
7. The canal system is syconoid or leuconoid type.
8. Asexual reproduction by budding takes place.
9. Sexual reproduction also takes place. Larva is stereogastrula.

Eg: 1. *Euplectella* (venus flower basket) 2. *Hyalonema* (glass rope sponge). 3. *Pheronema* (Oldmen's beard)

CLASS – 3 DEMOSPONGIA

1. It includes small to large sized sponges.
2. Mostly marine live in shallow to deep sea a water but some members of family spongillidae are fresh water.
3. Solitary or colonial, exhibit various shapes like flat, round, elongated, lobed, irregularly branched end also various colors.
4. They are found attached to substratum (sessile)
5. Skeleton is made up of monaxon or tetraxon (8 rayed) spicules of sillicic acid or spongeon fibres or both.
6. Some have no skeleton (*Oscarella*).
7. Canal system is leuconoid, Eutyptylous or Aphodal type.
8. Asexual reproduction by budding some develop internal buds known as Gemmules.
9. They also reproduce sexually.
10. Larva is stereogastrula.

Eg: *Cliona* (Boring sponge) *chalina* (mermoid glove or dead man's finger sponge), *Oscarella* – (No skeleton), *Proterion* – (Neptune's cup) *Helchondria* (bread sponge or crumb sponge), *Spongilla* (F.W.sponge) *Euspongia* – (bath sponge) *Hippospongia* – (Horse sponge) *Phylbeporgia* (Leaf sponge), *Chondrilla* (chicken liver sponge).

PHYLUM 3 : COELENTERATA (Gr. Koilos- cavity; enteron- Intestine) (CNIDARIA

- Cuvier, Linnaeus and Lamarck included Sponges, Coelenterate and Echinodermata into a single phylum called Radiata.
- The animal nature was established by Pessonel and Trembly .
- In 1847 Leuckart constituted phylum coelenterate. But he included sponges and ctenophores.
- In 1888 Hatschek divided coelenterate into Cnidaria , spongiaria and ctenophore.
- Barnes coined the word Cnidaria
- The study of coelenterate or cnidaria is called Cnidology
- Phylum Cnidaria includes about 9000 species.
- This phylum includes animals like hydras. Jelly fishes, sea anemones and corals.

General characters

1. These are universal in distribution. They are all aquatic and mostly marine but hydras are fresh water living.
2. They are multicellular animals with tissue grade organization

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3. sedentary or free living and solitary or colonial.
 4. They have radial (or) biradial symmetry.
 5. They are diploblastic. The body wall consists of outer layer ectoderm and inner layer endoderm (gastroderm). Between these two layers is non cellular gelatinous mesoglea is present.
 6. Cephalization and segmentation is absent.
 7. Some have exo or endoskeleton. Exoskeleton is made up of CaCO_3 i.e. in coral cnidarians
 8. Mesoderm is absent. Hence coelome is absent. The body cavity is called gastro vascular cavity or coelenteron.
 9. Mouth is present near the anterior end. It opens into the gastro vascular cavity, but anus is absent. Mouth is surrounded by tentacles. Tentacles serve for food capture.
 10. Coelenteron is not similar to coelom, this cavity take part in gaseous exchange, digestion, excretion and reproduction.
 11. There is a special type of cells known as cnidoblasts; they secrete nematocysts which act as stinging cells and help in offence and defense.
 12. There are two types of structures known as polypoid and medusoid forms.
 13. Polypoid forms are sessile asexual cylindrical and medusoid forms are sexual free living cup or umbrella shaped.
 14. Some exhibit the phenomenon of polymorphism. I.e. it the condition in which different functions are assigned to different individuals (zooids) it helps in division of labour.
 15. Movement in these animals due to contraction and relaxation of smooth muscles in the body wall.
 16. Digestion is intra cellular and extracellular. Intra cellular digestion takes place in musclonutritive cells. Extra cellular digestion takes place in gastro vascular cavity.
 17. Excretion and respiration takes by diffusion through body wall.
 18. Nervous system consist of nerve network in the ectoderm or endoderm
 19. Sense organs like eye spots statocysts, tentaculocysts are present.
 20. Sexes are separate or united.
 21. Reproduction takes place by asexual or sexual methods
 22. Asexual reproduction occurs by budding and sexual reproduction by formation of gametes.
 23. Alternation of generation occurs in some forms, where sexual form (medusa) alternates with asexual form (polyp) in the life history.
 24. Fertilization is external or internal.
 25. Development includes larval form called plannula.
 26. Regeneration is also common in many coelenterates.
- The phylum coelenterata is divided in to 3 classes.

CLASSIFICATION

According to Hyman phylum coelenterate is divided into 3 Classes.

Class 1: Hydrozoa. (Water animals)

1. They are fresh water or marine solitary or colonial.
 2. Symmetry is tetramerous or polymerous , radial symmetry .
 3. Diploblastic, consisting of ectoderm and endoderm.
 4. Mesoglea is non cellular gelatinous
 5. Nematocysts are ectodermal.
 6. In some hydrozoans epidermis secretes a horny cuticle called perisarc . In some animals coenosarcs secrete calcareous skeleton and forms a hard stone like structure called coral.
 7. Polyp and medusa forms are well developed.
 8. Pelagic forms exhibit remarkable degree of **polymorphism** having zooids of various form performing diverse functions.
 9. There are no sense organs in these animals
 10. Gastrovascular cavity is simple, without stomodeum and communicates directly to the exterior by a single aperture called mouth.
 11. They exhibit alternation of generation sexual forms in one generation alternate with the sexual forms.
 12. Reproduction by sexual and asexual methods.
 13. Fertilization is external or internal.
 14. Gonads are ectodermal in origin
 15. Development includes plannula larva.
- Ex. *Hydra*, *Obelia*, *Physalia*, *Mellipora*, *Velella*, *Porpita*, *Tubularia*, *Bougainvillia*, *Hydractina* ,*complanularia* *Plumularia*, *holistemma* etc.

CLASS 2 : SCYPHOZOA

1. It includes jelly fishes
2. They are all marine pelagic forms.
3. Some scyphozoans are attached to coral reefs or mud banks
4. They are semi transparent glassy in appearance but often have brilliant colours they are radially symmetrical , umbrella like animals with upper umbrella surface and lower sub umbrella surface
5. Medusoid forms large and umbrella like, polypoid generations are absent, if present it is represented by small polyp called Schyphistoma .
6. Gastrovascular cavity without stomodium with gastric filaments and it forms pouches.
7. Mesoglea is cellular gelatinous matrix contain amoeboid cells.
8. Gonads are endodermal in origin and sex cells are discharged into the stomach.
9. Reproduction is by both sexual and asexual.
10. Fertilization is external

11. Life history includes larva called Ephyra.

12. No coral forms.

Ex. Aurelia, Lucernaria, Charybdea, Cyanaea, Rhyzostoma

Class 3: Anthozoa- (skypos-cup: zoa-animal)

1. They are exclusively marine, solitary or colonial

2. They are exclusively polypoid and attached to substratum. Medusoid stage is absent.

3. The body is cylindrical with biradial symmetry.

4. Skeleton is external or internal.

5. Mouth leads in to a tubular stomodaeum.

6. The stomodaeum is divided into compartments.

7. Nematocysts are present on ectoderm and endoderm.

8. Gonads are endodermal. Sex cells are discharged into the body cavity; fertilization is external.

9. Development includes planula larva.

10. Includes coral forms which secrete thick exoskeleton made up of CaCO_3

Example: *Metridium* (Sea anemone), *Zooanthus*, *Meandrina*, *Fungia*, *Madrepora*, *Gorgonium*, *Adamsia*, *Tubipora*, *Renella*, *Astraea*, *Actinia*, *Heliopora*, *Alcyonium* etc.

PHYLUM 4 – PLATYHELMINTHES (FLAT WORMS)

➤ In 1758 Linnaeus included all worms in phylum vermes.

➤ In 1851 Karl Vot divided vermes into Rotatoria, platelmia and Nematelmia.

➤ In 1859 Gegenbaur used the words platyhelminthes for platelmia and Nematelminthes for Nematelmia.

➤ Platy means flat and helminthes means worms. Hence flat worms are included under this phylum.

➤ Flat worms are leaf or ribbon shaped dorsoventrally compressed.

General characters:

1. About 13,000 species are present in this phylum.

2. Free living planarians live in water and moist soil; majority are ecto or endoparasites.

3. Stoll (1947) estimated about 2200 million people infected by parasites. 200 million people are infected with flat worm and the rest by round worms.

4. These are first bilaterally symmetrical animals.

5. These are first triploblastic animals. They are first to develop mesoderm.

6. The body exhibits tissue – organ system grade of organization.

7. There is no body cavity. Hence these are Acoelomates. The space present between body wall and various organs is filled with loose mesenchyme tissue.

8. There is no segmentation. The cestoda exhibit pseudometamerism only.

9. There is no cephalization. The head is only an organ of attachment.

10. The body wall is soft and the hard parts are tegument and spines present as setae.

11. The body is covered by ciliated epidermis (planaria) or tegument (flukes and tape worms)

12. The digestive system contains branched intestine. But in tapeworms the digestive system is completely absent.

13. Anus is absent hence, the digestive system is incomplete.

14. Respiration takes place by diffusion through body wall.

15. Endoskeleton and blood vascular system are absent.

16. The excretory organs are flame cells. This system is called protonephridial system. Flame cell is a modified mesenchymal cell.

17. Flame cells develop from mesoderm. Their primary function is osmoregulation. They secondarily perform excretion.

18. The nervous system is ladder like. The free-living ones have photoreceptors and ciliated pits as sense organs.

19. Free-living planarians have sense organs like photoreceptors and ciliated pits.

20. Majority members are hermaphrodites (Schistosoma – Unisexual)

21. In female reproductive system germarium and vitellarium are separate.

22. The part of female reproductive system producing ova is called germarium (ovary) and the part of female reproductive system producing yolk cells is called vitellarium (vitelline gland)

23. In platyhelminthes ectolecithal eggs are produced. It is because of separate germarium and vitellarium.

24. In male reproductive system the copulatory organ called cirrus is present. It is useful in copulation.

25. Fertilization is internal.

26. Development may be direct or indirect. In indirect development one or many larval stages are present.

27. The endoparasites have one or many hosts in the life history.

CLASSIFICATION OF PLATYHELMINTHES

Phylum platyhelminthes is divided into three classes. They are Turbellaria, Trematoda and Cestoda.

I CLASS : TURBELLARIA:-

1. It includes about 1500 species.

2. The members of this class are popularly called planarians.

3. All members are free-living. They live in fresh water, marine waters and damp soils.

4. The body is covered by ciliated epidermis.

5. Some epidermal cells contain Rhabdites.

6. Mouth is ventral. The pharynx protrudes through mouth and hangs outside.

7. No segmentation.

8. The life history is simple. Direct development occurs.

9. Some planarians possess Muller's larva (or) Gotte's larva.

10. The regeneration is common. It exhibits polarity in regeneration.

Ex: 1. *Dugesia* (planaria) 2. *Convoluta* (it is are marine, only turbellarian with multicellular gland) 3. *Microstomum* (nematocysts is in epidermis. 4. *Thysanozoon* – The body surface contain a number of papilla (or) Tubercles each containing an intestinal branch 5. *Bipalium* (Land Planaria).

II. CLASS :TREMATODA:

1. It is the biggest class in platyhelminthes including 6000 species.
2. Members of this class are called flukes.
3. They live as ecto (or) endo parasites.
4. The body is covered by tegument. It is a living layer and cytoplasm layer.
5. Tegument contains small spines. Cilia and Rhabdites are absent.
6. Body is unsegmented, thin and flat leaf like.
7. Generally two suckers are present. They are organs of attachment.
8. Mouth is present in anterior oral sucker. The digestive system bifurcate and each branch highly branched ending with intestinal caecae.
9. The life cycle is complicated with one two or more hosts.
10. Indirect development includes more than one larval stage.

Ex: 1. *Fasciola hepatica* (sheep liver fluke). 2. *Schistosoma haematobium* (human blood fluke) 3. *Gyrodactylus* 4. *Aspidogaster* 5. *Diplozoon*. 6. *Paragonim*.

III.CLASS :CESTODA:

1. This class includes about 5500 species.
2. The members of this class are called tapeworms.
3. They are generally endoparasites and intestinal parasites.
4. The body is covered by tegument. It does not contain cilia or rhabdites. But contain microvilli.
5. The microvilli on tegument increase the surface area of absorption.
6. The body is ribbon like and divided into segments called proglottids.
7. The organ of attachment is scolex with hooks and suckers.
8. Digestive system is completely absent. Senses organs are also absent.
9. Every proglottid contains a set of male and female reproductive organs.

Ex: 1. *Taenia solium* (pork tape worm) *Taenia saginata* (beef tape worm) *Echinococcus granulosus* (dog tape worm or hydatid worm) *Dibothriocephalus latus*(fish tape worm) etc.

PHYLUM 5: ASCHELMITHES OR NEMATHELMINTHES (class :NEMATODA)

The phylum **Aschelminthes** includes Nematodes (nema = thread) the roundworms or thread worms, They are the “pseudocoelomate” protostomes showing triploblastic nature and bilateral symmetry.

GENERAL CHARACTERS:

1. They are triploblastic, bilaterally symmetrical, pseudocoelomate animals with long, cylindrical unsegmented body.
 2. Some are microscopic, some are large grow a meter long.
 3. They live in soil and water as free – living organisms and some of them are “parasites” (in plants and animals).
 4. Body is covered by a transparent tough, collagenous protective cuticle (collagenous cuticle is unique to the nematodes). Cuticle often bears spines, bristles.
 5. They have no cilia.
 6. The epidermis is syncytial (formed by the fusion of many cells).
 7. Body wall contains longitudinal muscles only and circular muscles are absent.
 8. Body cavity (perivisceral space) is a pseudocoel – a remnant of the embryonic blastocoel; since the body cavity is not entirely enclosed by mesoderm it is not considered a true coelom; it is a pseudocoelom; it is a fluid filled cavity which provides a “hydrostatic skeleton” to the organism.
 9. Alimentary canal is a simple, straight tube without musculature except pharynx, with a “mouth” at the anterior end and “anus” at the posterior end.
 10. Wall of the digestive tract consists of a single layer of endodermal cells and muscle layer is absent. As mesodermal musculature does not occur in its wall, absorption of digested foods into the pseudocoelomic fluid becomes easy; absence of circulatory system is compensated by this feature.
 11. Respiratory and Blood vascular systems are absent and the “pseudocoelomic fluid” transports the nutrients throughout the body.
 12. Excretory system consists of canals (arranged in the form of ‘H’) or gland like structures (renette gland); flame cells are absent.
 13. Nervous system consists of a circum-enteric nerve ring with ganglia and nerves extending anteriorly and posteriorly.
 14. Sense organs like amphids (chemo receptors of the anterior region of the body) and phasmids (glandular-sensory structures) in the posterior region of the body occur. Papillae, bristles and eye spots also occur in some.
 15. Sexes are separate and they exhibit sexual dimorphism. Males are generally smaller and they usually have a curved posterior end. They possess a cloaca and one or two copulatory spicules or penial spicules. Females are longer and the genital pore is separate from the anus. Fertilization internal, development is indirect
 16. The eggs are microscopic with chitinous shell.
 17. A majority of them are oviparous (e.g. *Ascaris*) but a few are Ovo-viviparous (e.g. *Wuchereria*). Fertilization is “internal” and eggs are laid in large numbers. Growth involves four molts of the cuticle.
- Ex. *Ascaris* , *Ancylostoma*, *Dracunculus*, *Enteriobius*, *Loa loa*, *Trichuris*, *Wucheraria*, *Trichenella* etc.

Other classes of this phylum are Rotifera, Gastrotricha, kinorhyncha, Nematomorpha, Priapulida

PHYLUM6: ANNELIDA

Definition

- Annelidans are Triplablastic ,metamerically segmented coelomate worms, body clothed (covered) externally by means of a flexible proteinaceous cuticle.

General characters:

1. Bilaterally symmetrical triploblastic, coelomate & metamerically segmented animals.
2. Body is elongated and vermiform & divided into a number of segments or metameres.
3. Definite head is lacking the posterior and anterior ends are well marked.
4. Metamerism or segmentation is true and in origin i.e., external segmentation exactly corresponds with the internal segmentation. The body cavity is also divided into number of segments further the segments are separated by one another by means of inter segmental septa.
5. A thin cuticle is secreted by the underlying epidermis divided of chitin.
6. Locomotion by means of setae or parapodium paired appendages is present never jointed.
7. Respiration is usually performed by the general body surface which is kept moist by the secretion of the mucus secreting glands. The skin is richly vascularised (provided with blood vessels) by means of diffusion.
8. Digestive system is complete and extends throughout the length of the body; digestion is extracellular taking place within the stomach.
9. Circulatory system is closed type heart is dorsal in position; blood is red in colour due to presence of hemoglobin.
10. Nervous system comprises of a pair of cerebral ganglion and a pair of circum oesophageal connectives & a double ventral nerve cord.
11. The organs of excretion are in the form of paired nephridia arranged metamerically.
12. Sexes may be separate (or) may be united development may be direct (or) indirect.
13. Indirect development is been accompanied by characteristic larva called "TROCHOPHORE" larva.
14. The majority annelids are free living & few are tube dwellers and seldom parasitic forms.
15. Regarding the habitat they may be marine terrestrial or fresh water forms.

This phylum divided into following classes.

1. Polychaeta. 2. Oligochaeta. 3. Hirudineria. 4. Archeanneleida

Class 1: Polychaeta

1. All are marine & carnivorous. A few are fresh water.
2. Body usually elongated, cylindrical & distinctly segmented into numerous similar metamers.
3. Presence of distinct head having sense organs such as eyes, tentacles, clitellum and mouth.
4. Usually each body segment bears a pair flattened lateral outgrowth of the body wall called "parapodia" which are Locomotory & respiratory in function.
5. Clitellum is absent
6. Sexes usually separate, gonads simple. Metamerically repeated and developed only during breeding season.
7. Fertilization is external development is direct with a free swimming trochophore larva.
8. Many reproduce asexual by serial or lateral budding.

Ex: Neris, Hetero Neris, Chaetopterous, Aphrodite, Polydora, Syllis, Unice (Pacific Palolo Worm.)

Class2: Oligochaeta:

1. Mostly terrestrial but some fresh water and a very few living buried intertidal sand of the sea shore.
2. Indistinct head, without appendages prostomium is usually small.
3. Parapodium is absent. But a few are like a rod like seta embedded in pits in the body wall of each segments. A clitellum is usually present.
4. Hermaphrodites, gonads present throughout the year they occur in body segments with the testis lying in form of the ovaries – A copulation and fertilization occur as a rule.
5. Remarkable great power of regeneration.

Ex: Earth worm.

Class3: Hirudineria.

1. Body is made up of fixed no. of segment.
2. Some of the anterior most segments & posterior most segments are fused together so as to form anterior sucker and posterior sucker which acts as organs of attachment as they lead ectoparasitic mode of life.
3. Each segment is further divided 4-5 segments what are called as Annuli (secondary segmentation).
4. Annular receptors are present.
5. Salivary glands which are so called digestive glands generally secrete salivary juice which helps in digesting the carbohydrate part of the food. In this context the salivary glands are so misnamed as they do not aid in the process of digestion on the other hand the salivary juice contain a chemical substance called HIRUDINE. An anti coagulant substance which the of blood while feeding and facilitates the continuous flows of blood while sucking from host body.

Ex: Hirudanaria granulose.

4.. Archaeanneleida

1. A small group of marine worms with ciliated skin which constitute the locomotory structure.
2. External segmentation is lost, internal segmentation is present.
3. Sexes are separate development is indirect accompanied by a characteristic trochophore larva.
4. However members of this class are regarded as a primitive & have evolved earlier.

Ex: Polygordius.

PHYUM 7: ARTHROPODA

1. The term Arthropoda is coined by Von Siebold.
2. It includes more than 80 % of the animals of animal kingdom
3. They are most successful invertebrate animals. Exhibit great degree of adaptive radiation they are aquatic terrestrial and aerial.
4. They are free living solitary or colonial and some are parasitic.
5. They are triploblastic bilaterally symmetrical with segmented body. Organ level of organization
6. The body is covered by non living chitinous cuticle. it undergo periodical moulting called ecdysis
7. Body is divisible into head thorax and abdomen
8. In some head thorax fused to form cephalothorax
9. They have segmentally arranged jointed appendages which are variously modified for different functions
10. The true coelom is confined to only reproductive organs, excretory organs, much replaced by hemocoel .
11. Only striped mussels are found in bundles, capable of rapid contraction. Digestive system is complete, mouth and anus lies at opposite ends of the body,
12. Respiration through body surface gills trachea or book lungs.
13. circulatory system is open type with heart arteries without capillaries
14. Excretory system includes Malpighian tubules green or coxal glands. Nervous system consists of a nerve ring with dorsal brain attached to ventral nerve cord.
15. Sensory organs comprises of eyes, chemo, tactile receptors, statocysts.
16. Sexes separate , sexual dimorphism is present
17. Fertilization is internal or external
18. They are oviparous or viviparous
19. Development is direct or indirect with one or many larval forms.
20. Some exhibit parthenogenesis and parental care

Storer divided phylum Arthropoda in to 3 subphyla

They are 1. Trilobitomorpha 2. Chelicerata 3 Mandibulata .

Sub phylum: Trilobitomorpha

1. It includes only fossil trilobite animals which are marine and extinct.
2. The body divided into three lobes by two longitudinal grooves
3. Each segment bears one pair of biramus jointed appendages
4. They were bottom dwellers lived paeleozoic era (cambrian to Permian)

Ex. *Triarthrus*, *Dalmanites*

Sub phylum: Chelecerata

1. Body is divisible into cephalothorax and abdomen
2. First pair of appendages are chelicerae which assist in feeding
3. 2nd pair is called pedipalps
4. Antennae and mandibles Jaws are absent.
5. Mostly terrestrial some are aquatic it includes two classes 1.Merostomata (Xiphiura) 2. Arachnida

Class1.Merostomata (Xiphiura):

They are marine

Body is divided in to prosoma and ophisthosoma

Prosoma bears 5-6 pairs of jointed appendages gills or bronchi are respiratory organs

Abdomen ends with telson

It is divided in to Xiphosura and Eurypterida

Xiphosura :

- Prosoma covered by broad carapace
- Six pairs of appendages are present

Ex. *Limulus* (king crab.)

Eurypterida:

- Prosoma or cephalothorax is covered by small carapace.

Ex. *Eurypterus*

Class: Arachnida :

1. Mostly terrestrial, few are aquatic some are parasitic some are poisonous
2. Body is divided into prosoma , ophisthosoma
3. Prosoma bears simple eyes and six pairs of appendages first pair is chelicerae second pair is pedipalps
4. Remaining four pairs are walking legs
5. Respiration by trachea or book gills
6. Excretory organs are coxal glands or malpighian tubules sexes are separate oviparous or viviparous
7. Development is direct.

Ex.

Invertebrate -classification

1. *Palamnaeus* (scorpion)
2. *Argiope* (Spider)
3. *Aranea* (spider)
4. *Sacoptes* (mite)
5. *Idodex* (tick)
6. *Chiroptes* (mite)

Sub phylum : Mandibulata

1. Terrestrial or aquatic
2. Body is divisible in to head, thorax and abdomen.
3. Head consist of antennae, compound eyes, mandibles and or pair of maxillae.
4. Thorax abdomen bears jointed appendages in some abdomen bears appendages
5. Respiration by gills or tracheae.
6. Excretion by malpighian tubules or green glands sexes are usually separate with sexual dimorphism development usually involves larval forms

It is divided in to 4 classes crustacea, diplopoda , chilopoda, insecta

Class 1:Crustacea

1. Aquatic marine fresh water or marine, few are living in moist places
2. Free living or Parasites head and thorax is fused to form cephalothorax.covered by carapace
3. Head bears compound eyes, five pairs of appendages,
4. Appendages are biramus , modified for different functions
5. Respiration by gills and generally body surface
6. Coelom is reduced excretory organs antennary or green glands sexes are separate
7. Development includes larval forms

Eg.

- | | | | |
|-------------------|---------------------|---------------------|----------------------|
| 1. <i>Daphnia</i> | 5. <i>Balanus</i> | 9. <i>Squilla</i> | 13. <i>Hippa</i> , |
| 2. <i>Cyclops</i> | 6. <i>Sacculina</i> | 10. <i>Palaeman</i> | 14. <i>Eupagarus</i> |
| 3. <i>Cypris</i> | 7. <i>Mysis</i> | 11. <i>Peneus</i> | |
| 4. <i>Lepas</i> | 8. <i>Gammarus</i> | 12. <i>Astacus</i> | |

Class: Diplopoda

1. It includes millipedes
2. They are terrestrial body is cylindrical and elongated body is divisible in to head , thorax and and abdomen
3. Head consist of five segments, thorax consist of four segments and abdomen has 20- 100 segments
4. Head poses one pair of antennae one pair of mandibles one pair of maxillae
5. Thoracic segment bears one pair of legs on each segment
6. Tracheae is respiratory organs
7. Malpighian tubules are excretory organs
8. Non poisonous herbivorous
9. Oviparous direct development

Ex. *Julus*.

Class: Chilopoda

1. It includes centipedes
2. Body is flattened and elongated
3. Body is divisible in to head and trunk
4. Head bears a pair of antennae, a pair of mandibles and a pair of maxillae
5. Each segment of the trunk segment bears a pair of clawed legs
6. First pair of legs is modified in to poisonous claws.
7. Tracheae is respiratory organs
8. Malpighian tubules are excretory organs
9. They are carnivorous sexes are separate development is direct

Ex. *Scutegera*, *Scolopendra*.

Class: Insecta

It is biggest class in kingdom Animalia

Invertebrate -classification

1. Terrestrial or aquatic
2. Free living or parasitic
3. Solitary or colonial
4. Body is divisible into head, thorax and abdomen
5. Head consists of six fused segments
6. Head bears compound eyes, antennae mouth parts of different types
7. Thorax consists of three segments bears three pairs of legs and two pairs of wings in some one pair of wings are present or absent
8. Abdomen is made up of 8-11 segments and devoid of appendages.
9. Salivary glands are present.
10. Tracheal respiration takes place
11. Excretion by Malpighian tubules
12. Sexes are separate
13. Development is direct or indirect
Ex. *Lepisma* (silver fish), Cockroaches (*Periplaneta americana*, *Blattella*), *Phyllium*, locusts, grass hopper, mantis, flies (stone, house, fruit, sand, Drogon) , *Gryllus* , termites, ants, lice, *Belostoma*, aphids, scale insects , butter flies , moths , beetles , weevils , mosquitoes , fleas , wasps. Etc.

PHYLUM 8: MOLLUSCA

Definition:

Molluscs are coelomated bilaterally symmetrical triploblastic unsegmented soft bodied usually with a broad ventral foot, generally covered by calcareous shell and pharynx with characteristic rasping. Organ. Radula and mantle taking up the function of respiration.

1. General characters:
2. Molluscs are mainly aquatic in habitat and majority of them are sluggish.
3. Bilaterally symmetrical animals and it is reduced to asymmetrical condition within the members of the gastropods. On account of morphological phenomenon called torsion (torsion can be defined as twisting of the visceral hump arm through violent degrees through anti clockwise where as head and foot remains fixed)
4. Molluscs are soft unsegmented animals.
5. The soft body partly wholly covered by a calcareous shell which may be uni wall or bi wall or may be made up of many pieces secreted by the underlying mantle epithelium.
6. The body proper is covered by a fold of a skin called mantle and the space b/n the internal body organs and the mantle constitutes the cavity.
7. The organs of the respiration in case of terrestrial forms is mantle: it is richly vascularised however in aquatic forms the gills or tentidium does the function of respiration the shell may be external or internal or may be absent.
8. Ventral body wall is modified into highly muscular foot which is variously employed depending upon the habit and habitat.
9. Digestive system is complete and is associated with digestive glands such as hepatopancreas. Digestion is both intra cellular and extra cellular.
10. Vascular system is of open type heart is dorsal in position with one or two atriates and a median vertical, blood is colourless due to the absence of hemoglobin and instead of hemoglobin hemocyanin is present which when oxidized gives bluish white tinge (colour).
11. Well developed nerve system with commissure and connectives. Central nerve system consisting of 3 parts or ganglia namely cerebral, plural & visceral, pedal nerves are separate may be united, development may be direct or indirect & in case of indirect development, larval forms such as trochophore, veliger and glochidium the members of the phylum are highly adaptive and found in almost all possible niches except aerial.

Invertebrate -classification

Detail classification of the phylum mollusca the phylum is divided into following classes and the classification is mainly done depending upon the nature of foot, mantle nerve system, respiratory organs and no of auricles the heart has.

Class 1 : Aplacophora

- Vermiform
- Shell reduced to calcareous spicules forms devoid of head and mantle.
- Alimentary canal is straight pharynx with radula. Ex: chaetoderma.

Class2 : Monoplacophora:

- Bilaterally symmetrical body which is elliptical in shaped.
- Monoplacophorans alone exhibit or display internal metamerism on account of repeated arrangement of teridium.
- Shell is single piece and domb shaped.
- Foot is mid ventrally situated.
- Majority of the members are extinct. Ex: Neopila.

Class 3 : Polyplacophora

- Flattened eleptical marin forms
- Shell made up of & distinct overlapping values, (pieus).
- Distinct head but divide of eyes and tentacles.
- Respiration by means of gills. Ex: Chiton (sea mouse).

Class 4: Gastropoda:

- Body is originally bilaterally symmetrical and this is altered to asymmetrical condition as they have undergone morphological change known torsion.
- Torsion can be defined as “ a twist in the visceral hump through 180 anticlockwise where as head and foot remains in a fisued position. By this tarst mouth and anus are brought approximately to the same level.
- Presence of uniwall shell which is after spirally coiled and encloses the visceral mass.
- Presence of a large ventral foat which is in the form of creeping sole.
- A members of the gastropods are highly adapture and are found to be marine, freshwater and terristerial.
- Presence of distinct head with are or two pairs of tentacles and eyes. Ex: patella (Marine), Aripthanta (garden snail)

Class5: Scaphopoda:

- Bilaterally symmetrical, Burrawing, mairne forms.
- Shell tubular and tusk like and opens at both the ends.
- Foot is reduced which is trilobe in condition and aids in burrowing.
- Absence of tenedium and hence mantle take the function of respiration.
- No distinct head and eyes. Ex: Dentalium (task shell)

Class 6: Pelecypoda (lamellibranchita or bivalves)

- Bilaterally symmetrical body which is compressed laterally.
- Mantle epithelium secrets bivalve shell the two shell valves join dorsally and pre ventrally and forms the gab are month of the shell through which the animal comes out of the shell.
- Members which are included under this class are very sluggish as such they are filter feeder or micro feeders.
- Absence of head, eyes & tentacles.
- Pharynx is devoid of radula.
- Since they are filter feeders.
- Presence of a pair of highly developed ctenedium which is in the form of basket shaped, hence, it is also called as lamellibranchiata

Invertebrate -classification

- Sexes are separate development may be direct or indirect with or without larval stages (villiger) in case of marine and glochidium in case of fresh water.
- As per as their habitat is concerned they are marine, fresh water and terrestrial.

Ex: Unio, oyster, Mytilus.

Class7: Cephalopoda:

- Bilaterally symmetrical forms with well formed head and complex eyes.
- Anterior part of the foot forms behaves as tentacles and arms around the head and the remaining part of the foot forms a muscular funnel or septa.
- The mouth has horny jaws or radula.
- Shell may be internal external or may be absent.
- Development is direct.
- Exclusively marine forms.
- Shell may be external, internal or may be absent.
- Development of ink gland to camp only defensive mechanism for the animal.
- Ex: Loligo and nautilus, septa.

PHYLUM 9 : ECHINODERMATA (Gr. Echino= hedgehog +derma= skin+ ata= characterize.)

1. Name is coined by Jacob Klein
2. Echinodermates can be defined as triploblastic deuterostomous enterocoelomate invertebrates with organ – system grade of organization.
3. They are exclusively marine, widely distributed animals (Intertidal zones – great depths in all seas)
4. The adults echinoderms exhibit radial symmetry, often pentamerous. But their larval forms are bilaterally symmetrical.
5. The body is unsegmented with globular, star, spherical or elongated shape without a distinct head.
6. Body surface is marked by symmetrically radiating areas. Ambulacra and five alternating interradial.
7. Endoskeleton consists of closely arranged mesodermal calcareous ossicles which may bear the Caco₃ test in some animals, with spines covered by epidermis.
8. Coelome is of enterocoelomous type, It is spacious almost internal cavity.
9. Presence of water vascular system of coelomic origin is a most important characteristic feature. It consists of (tubes filled with water) tube feet, podia and a madreporite (some if is absent).
10. Alimentary canal is coiled & straight.
11. Vascular system and haemal system enclosed in perivisceral canals.
12. Respiratory organs include dermal branchiae, tube feet, cloacal respiratory tree, genital bursae and peristomial gills.
13. Nervous system is primitive, without brain consisting of network concentrated into the radial ganglionated nerve cords.
14. Sense organs are poorly developed, it includes tactile organs, chemoreceptors, Photoreceptors and statocysts.
15. There are no excretory organs. Excretory system is wanting.
16. They are dioecious with few exceptions, gonads are large and single or multiple.
17. Reproduction is usually sexual, few reproduce asexually or by regeneration.
18. Fertilization is external, development through free swimming larvae.
19. They have capacity of regeneration of lost parts.
20. Development is indeterminate including larvae which undergoes metamorphosis into adults.

CLASSIFICATION:

Phylum echinodermata is divided into five classes as, Asterozoa, Ophiurozoa, Echinozoa, Holothurozoa and Crinozoa.

CLASS – I : ASTEROZOA

Characters:

1. It includes star shaped organisms. Body is flattened and pentagonal.

Invertebrate -classification

2. They are commonly called as star fishes or sea stars. The body is pentamerous with central disc consisting 5 to 50 long or short rays or arms radiating symmetrically from central disc.
3. Body is flattened, divisible into oral and aboral surfaces.
4. The oral surface bears mouth, tube feet, ambulacral grooves with suckers.
5. The aboral end bears anus and medipore. Ambulacra are restricted to oral surface extending from the peristome to the tips of the arms and form prominent grooves with podia.
6. All are free living, predaceous and scavengerous.
7. Endoskeleton is flexible, made up of separate ossicles.
8. Respiration is by papulae.
9. Sexes are separate, Development includes bipinnaria or brachiolaria larva. Examples: Asterias, Pentaceros, Luidia, Astropecten, etc.

CLASS – II: OPHIUROIDEA

Characters:

1. Ophiuroidea are exclusively found in marine water.
2. They are commonly called as brittle stars.
3. Body is star like with snake tail like arms with a central disc. Oral and aboral surfaces are distinct.
4. Stomach is sac like.
5. Oral end bears medipore.
6. Anus is absent. Ambulacral grooves are absent.
7. Body is covered by ossicles.
8. There are no excretory organs.
9. Nervous system is simple.
10. These are dioecious, gonads are pentamerous.
11. Development is direct or indirect through larval stages includes pleuteus larva. Examples: Ophiothrix, Ophioderma, Astoporpa.

CLASS – III : ECHINOIDEA

Characters:

1. They are commonly called as sea urchins or sea dollars.
2. Body is discoid, oval or semicircular, heart shaped without arms.
3. Skeleton system consisting a movable spines and there are three jawed pedicellaria.
4. It bears a chewing apparatus called aristotle's lantern with teeth.
5. Ambulacral grooves are covered by ossicles. Tube feet is provided with suckers.
6. Mouth is on the oral surface surrounded by membranous peristome. Anus is located at the aboral pole surrounded by peripore.
7. They are dioecious. Gonads are pentamerous.
8. Fertilization is external development is indirect. Includes free swimming echinopluteus larva. Examples: Sea urchin, Bothrioidaris, Diodema etc.

CLASS – IV : HOLOTHUROIDEA

Characters:

1. They are commonly called as sea cucumbers.
2. The body is bilaterally symmetrical elongated on oral and aboral axis having mouth at one end and anus at other end.
3. Body wall is coarse, leathery, bag like, appears like a cucumber.
4. There are no arms and spines.
5. Mouth is anterior surrounded by tentacles, attached to water vascular system.
6. Ambulacral grooves are reduced and tube feet bear suckers.
7. The respiratory organs are respiratory tree.
8. Alimentary canal is long and coiled and cloaca is with respiratory trees.
9. Development is indirect. Examples: Cucumeria, Holothuria, Thyone Mesothuria, Synapta, etc.

CLASS – V : CRINOIDEA

Invertebrate -classification

Characters:

1. It consists of both extinct and living forms.
2. They are commonly called as sea lilies or feather stars.
3. Living members are without stalk and free moving but extinct forms attached by stalk.
4. Body is pentamerous consists of an aboral cup, the calyx and the oral cover or roof, the tegument and strongly pentamerous in structure.
5. Oral surface is directed upwards, mouth and anus on oral surface.
6. Arms are movable, branched consisting five or ten pinnules or without pinnules.
7. Ambulacral grooves are open and extended along arms and pinnules to their tips.
8. Madreporite, spines and pedicellariae are present.
9. Sexes are separate; development is indirect through doliolaria larva. Examples: Antedon (sea lily) Neometra (feather star) Metacrinus.