ANIMAL KINGDOM

BASIS OF CLASSIFICATION

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1. Level of body organization :-

Protoplasmic level	→	In protozoans, unicellular body performs all biological activities
↓		
Cellular level	→	In sponges, cells are arranged as loose cell aggregates and division of labour occurs among cells (Tissues absent)
↓		
Tissue level	→	In coelenterates and ctenophores, cells performing the same function are arranged into tissues
↓		
Organ level	→	In platyhelminthes tissues are grouped together to form organs.
↓		
Organ system level	→	In higher animals, organs further organise to form organ systems e.g. Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata and Chordata

2. Symmetry :

(a) **Asymmetry :-** When any plane that passes through the centre does not divide the body of animals into two equal halves.

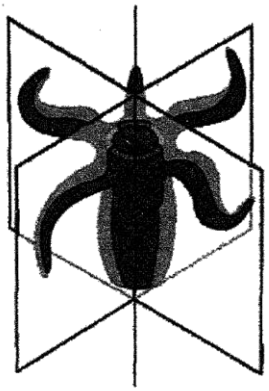
e.g : most of the sponges are asymmetrical.

(b) **Radial symmetry :-** When any plane passing through the central axis of the body divide the animal into two identical halves.

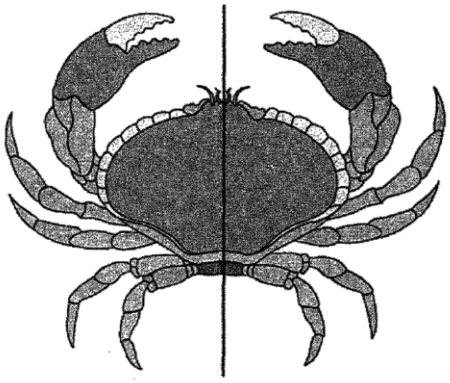
eg : Coelenterates, Ctenophores and Echinoderms (adult)

(c) **Bilateral symmetry :-** When the body can be divided into identical left & right halves in only one plane.

e.g : Platyhelminthes to Chordates.



Radial symmetry

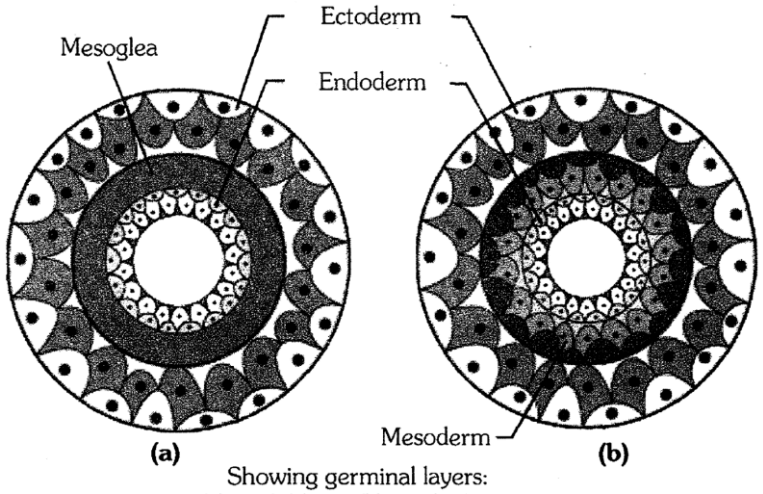


Bilateral symmetry

3. Germinal layers :-

(a) **Diploblastic :-** Animals in which the cells are arragned in two embryonic layers ectoderm and endoderm with an interveining undifferentiated mesoglea e.g. Coelenterates and Ctenophores.

(b) **Triploblastic :-** Those animals in which the developing embryo has a third germinal layer-Mesoderm in between the ectoderm and endoderm e.g. Platyhelminthes to Chordates.



Showing germinal layers:
(a) Diploblastic (b) Triploblastic

4. **Body Cavity or Coelom :-** Presence or absence of a cavity between the body wall and gut wall is very important in classification.

(a) **Acoelomates :-** Animals in which the body cavity is absent
e.g. Porifera. Coelenterata. Ctennophora, Platyhelminthes

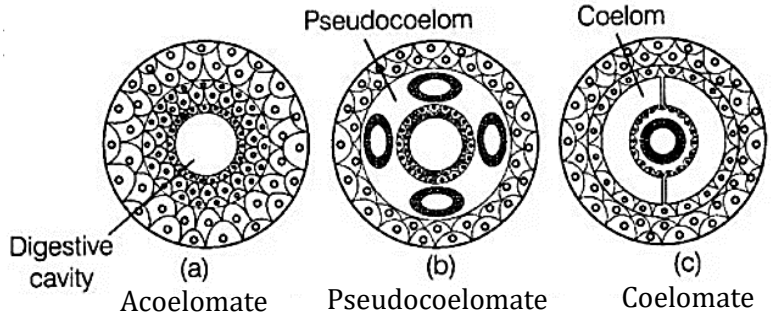
(b) **Pseudocoelomates :-** In same animals body cavity is not lined by mesoderm, instead, the mesoderm is present as scattered pouches in between the ectoderm and endoderm. Such a body cavity is called pseudocoelom.
e.g. Aschelminthes.

(c) **Coelomates :-** Animals possessing coelom i.e. the body cavity which is lined by mesoderm on all sides

- **On the basis of embryonic development, the coelom is of two types**

(i) **Schizocoel** - Coelom formed by splitting of a mesodermal mass
e.g. Annelida, Arthropoda, Mollusca.

(ii) **Enterocoel** - Coelom formed by fusion of gut pouches during embryonic stage
e.g. Echinodermata, Hemichordata and Chordata.



5. **Body plan :**

(a) **Cell-aggregate type :-** e.g. Sponges

(b) **Blind Sac type :-**Animals in which digestive system is incomplete, it has only single opening to the outside of the body that serves as both mouth and anus.
e.g. Coelenterates to Platyhelminthes

(c) **Tube-within-tube type :-** Found in those animals having complete digestive tract i.e. with separate openings mouth and anus.
e.g. Nemathelminthes to Chordates

6. **Segmentation :-**

(a) **Pseudometameric :-** e.g. Tapeworms

(b) **Metameric :-** In Annelids, Arthropods and Chordates.

In these animals, the body is externally and internally divided into segments with a serial repetition of atleast some organs, this is called metameric segmentation and the phenomenon is known as Metamerism.

7. **Notochord :-** It is a mesodermally derived rod-like structure formed on the dorsal side during embryonic development in some animals.

(a) Non-chordates :- Animals without notochord e.g. Porifera to Hemichordata

(b) Chordates : - Animals with notochord. eg. Chordata

8. **Circulatory system :-**

(a) Open type :- In which the blood is pumped out of heart and the cells & tissues are directly bathed in it.

e.g. Arthropods, Molluscs, Echinoderms, Hemichordates and some lower Chordates like tunicates

(b) Closed type :- In which the blood is circulated through a series of vessels of varying diameters i.e. arteries. veins and blood capillaries

e.g. Annelids, Cephalopod molluscs, Vertebrates etc.

9. **Embryonic development :-** On the basis of fate of blastopore, animals can be divided into two categories :

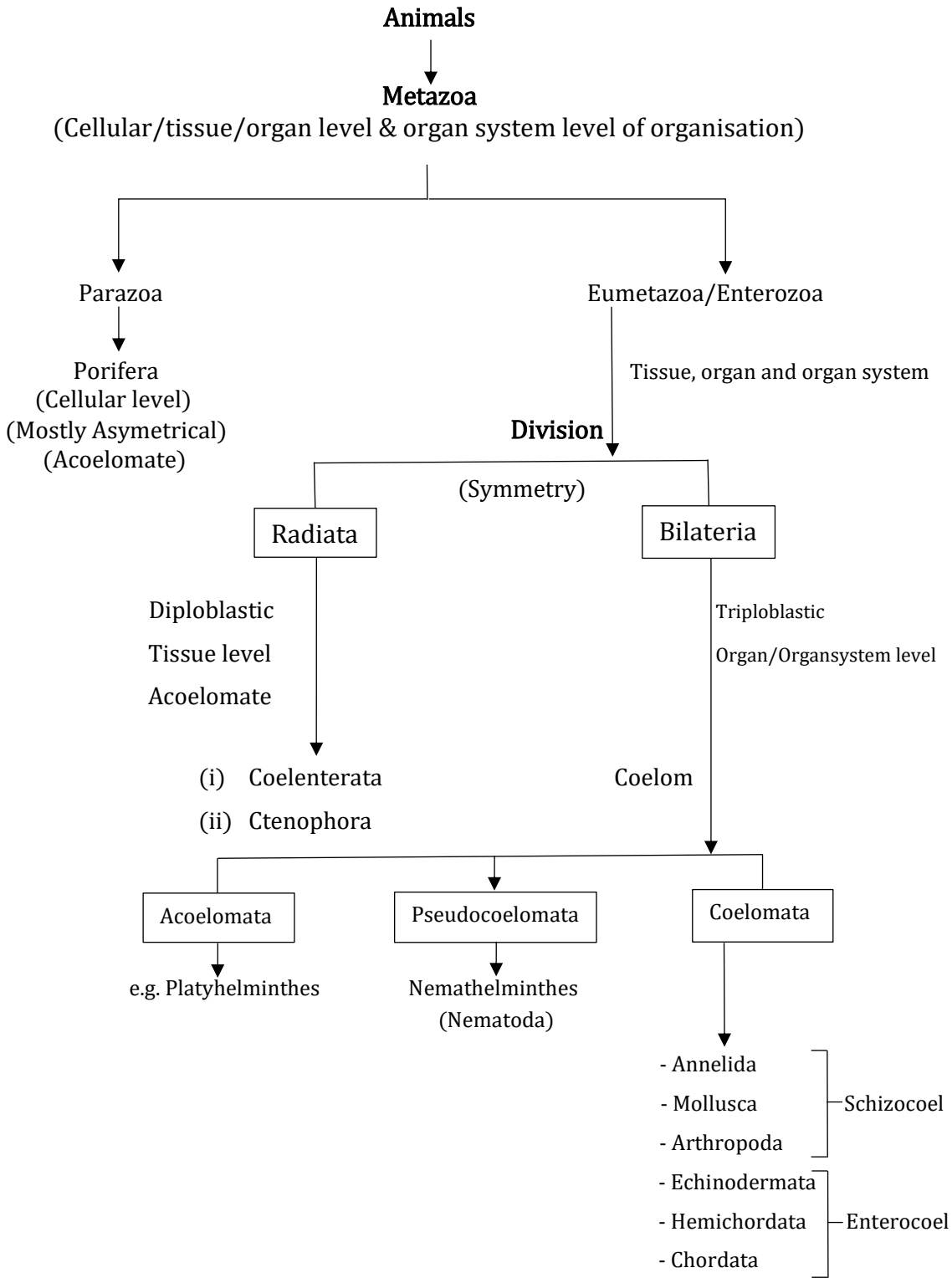
(a) Protostomiates :- Animals in which mouth is formed first (Blastopore ® Mouth)

e.g. Platyhelminthes to Mollusca

(b) Deuterostomiate : Animals in which anus is formed earlier than mouth (Blastopore ® Anus)

e.g. Echinoderms, Hemichordates and Chordates.

OUTLINE OF ANIMAL CLASSIFICATION



PHYLUM – PROTOZOA

1. It is **3rd largest phylum**. One celled body performed all the biological activities like multicellular animals. So they are termed as **"Acellular"** organism, proposed by **Dobell**.

2. **Protozoans were first studied by Leeuwenhoek. And the name Protozoa was coined by Goldfuss**. Study of protozons is known as **Protozoology**.

3. They are world wide, Cosmopolitan mostly **Microscopic** , **Aquatic, terrestrial , free living** (**Amoeba**) or **parasitic (Plasmodium)**. Solitary or colonial **(Proterospongia)**. Causes serious diseases or pathogenic.

4. Protozoans are small microscopic, **Eukaryotic Unicellular,** Colourless, Spherical, Oval, Bell shaped, Spindle shaped slipper like having irregular Symmetry

5. Body level of organisation of Protozons is **Protoplasmic level**. Their protoplasm is uninucleate or multinucleate animals are **naked** or some have body bounded by delicate membrane or a firm **pellicle/Test/shell/Lorica (Lose outer covring)**. In few groups of protozoa **$CaCO_3$** & **Silica shell's** exoskeleton is found. e.g. **Radiolarian group** & **Foraminiferan group**. Number of nuclei vary from one to many. Few show **nuclear dimorphism**. e.g. Paramoecium Body perfoms all necessary biological activity so in them **subcellular - Physiological division of Labour** is found.

6. Locomotion by means of Locomotory structures are

(i) Finger-like Pseudopodia e.g. Amoeba, Entamoeba
(ii) Whip-like Flagella e.g. Trypanosoma
(iii) Hairy Cilia e.g. Paramoecium
(iv) Absent in sporozoan parasites eg. Plasmodium

7. Nutrition in Protozoans is mainly holozoic (Amoeba) and Parasitic (Plasmodium). Digestion is intracellular takes place in food vacuole.

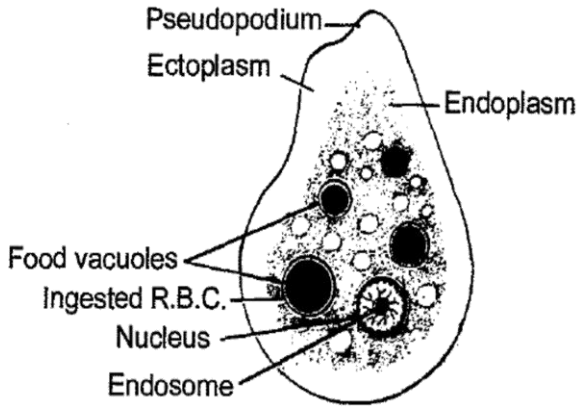
8. Respiration and Excretion take place by general body surface. Some excretion may occur through contractile vacuole. Nitrogenous waste is Ammonia. Some fresh water protozoans get rid of excess water through contractile vacuole by the process known as Osmoregulation.

9. Reproduction takes place by

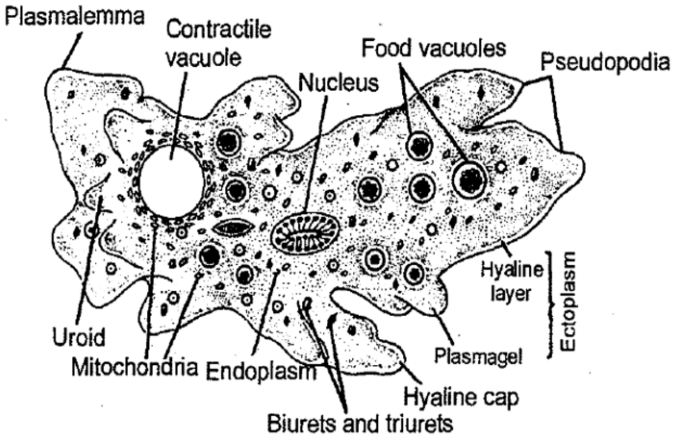
	Asexual		Sexual
(1)	Binary fission	(1)	Syngamy (Plasmodium)
	(a) Simple fission (Amoeba)		
	(b) Transverse fission (Paramoecium)		
	(c) Longitudinal fission (Trypanosoma)		
(2)	Multiple fission (Plasmodium)	(2)	Conjugation (Paramoecium)
(3)	Budding (Ephelota/ Sessile protozoan)		

10. They do not have natural death because in unicellular animals there is no differentiation of somatoplasm & germplasm, hence these are considered immortal.

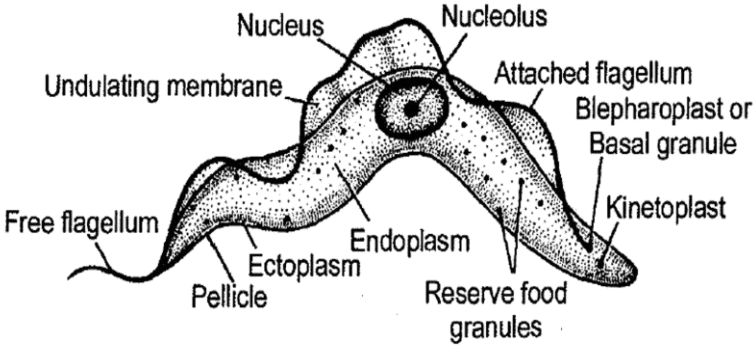
FEW COMMON PROTOZOANS



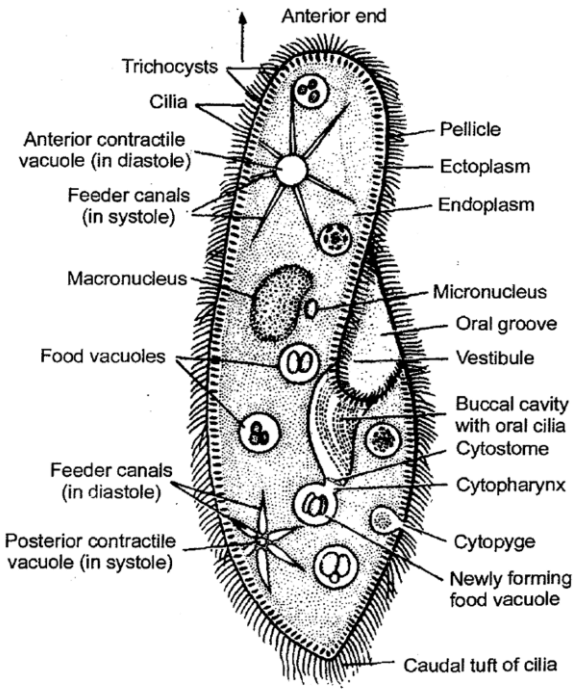
Trophozoite of *Entamoeba histolytica*



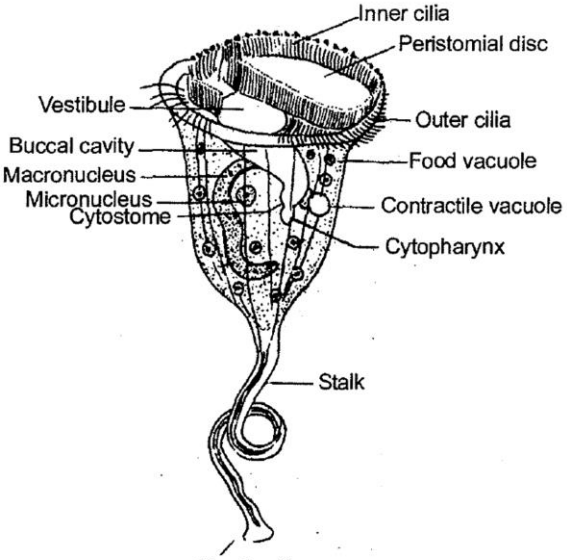
Structure of *Amoeba proteus*



Trypanosoma gambiense



Paramecium caudatum



Vorticella

PROTOZOA

4 Classes (on the basis of locomotory organs)

(1) Mastigophora or Flagellata

* Free living (aquatic) or parasitic
* Locomotion by 1 or 2 or many thread like flagella
* Body covered by pellicle
• Reproduction- Asexual by binary fission but sexual absent

e.g. **1.** Proterospongia- Connecting link between protozoa and porifera.

2. Leishmania donovani - Dimorphic and digenetic parasite, causes Kala azar / Dum-dum fever/Leishmaniasis in humans,carrier-sandfly (Phlebotomus)

3. Trypanosoma gambiense. Polymorphic and Digenetic parasite, causes Sleeping sickness or African trypanosomiasis, Carrier-Tse tse fly (Glossina)

(4) Sarcodina / Rhizopoda

* Free living (aquatic) or parasitic
* Locomotion by different types of pseudopodia
* Body-naked or with shell
* Reproduction-Asexual by binary fission but sexual absent

e.g. 1. Amoeba - finger-like pseudopodia called lobopodia Cytoplasm differentiated into ecto- plasm and endoplasm

2. Pelomyxa - Chaos-chaos Largest and muttinucleated amoeba

3. Entamoeba histolytica - Dimorphic and monogenetic parasite, causes **"amoebic dysentry",** infection through contaminated food and water

(3) Ciliata

* Free living (aquatic) or parasitic
* Locomotion by numerous cilia
* Body covered by pellicle
* Binucleated, **meganucleus** for somatic functions and **micronucelus** for reproductive function.
* Reproduction - Asexual by binary fission and Sexualby conjugation

e.g. 1. Paramoecium - slipper animalcule Cytostome (cell-mouth) and cytopyge (cell-anus) are present Trichocyst for offence and defence

2. Vorticella - Bell animacule

(2) Sporozoa

* All are endop arasite and pathog enic
* Locomotory organelles absent
* Thick pellicle for protection
* Reproduction - Asexual by multiple fission and Sexual by syngamy

eg 1. Plasmodium Digenetic blood parasite(malari a) Carrier is female anopheles

2. Babesia - Digenetic and causes "Texas cattle fever I Red water fever/ Tick fever" in cattle Spread by ticks

4. Giardia intestinalis - (Grand old man of intestine) monogenetic that causes "Diarrhoea / Giardiasis and infection through contaminated food and water.

5. Trichomonas vaginalis Vaginal parasite of woman that causes "Leucorrhoea disease"

6. Trichonympha - Symbiont in intestine of termite and Cockroach

4. Entamoeba g ingivalis - Increases infection of **pyorrhoea** (Causative agent Trichomonas tinax)

5. Entamoeba coli w Found in colon as commensal

6. Actinophrys. Sun animalcule Pseudopodia supported with axial-fila-ments called **axopodia**

3. Balantidium coli - Found in colon of man

3. Monocystis : Monogenetic, found in seminal vesicle of earthworm.

4. Nosema : Causes pebrine disease in silkworm

PHYLUM – PORIFERA (SPONGES)

1. Members of this phylum are commonly known as" Sponges". Study of sponges is known as Parazoology.
2. All are aquatic and Sessile, mostly marine but few are found in fresh water also. They are solitary or colonial. Entire body with pores i.e. numerous small Ostia for entry and one large opening Osculum for exit of water.
3. Sponges have various body form and shapes with irregular shape mostly Asymmetrical. (Radial symmetry in Sycon and Leucosolenia)
4. Sponges are primitive multicellular acoelomate animals and have cellular level of organisation.

- Body wall consists of-

(i) Outer Pinacoderm - Consists of

(a) Pinacocytes (Flat cells)

(b) Porocytes (oval cells)

(ii) Inner Choanoderm

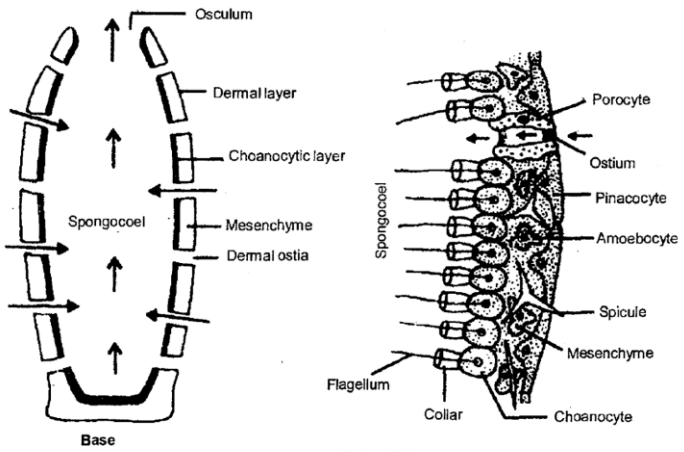
Consists of flagellated collar cells or choanocytes (Unique Characteristic of Porifera)

(iii) Between these two layers a gelatinous material Mesenchyme is present which contains certain Amoebocytes cells like -

Scleroblasts - For formation of skeleton elements

Archaeocytes - Totipotent cells (Formation of ova & spermatazoa)

5. Body wall encloses a large central cavity the spongocoel or paragastric cavity with small hollow canals.



BODY WALL OF A SPONGE (*LEUCOSOLENIA*)

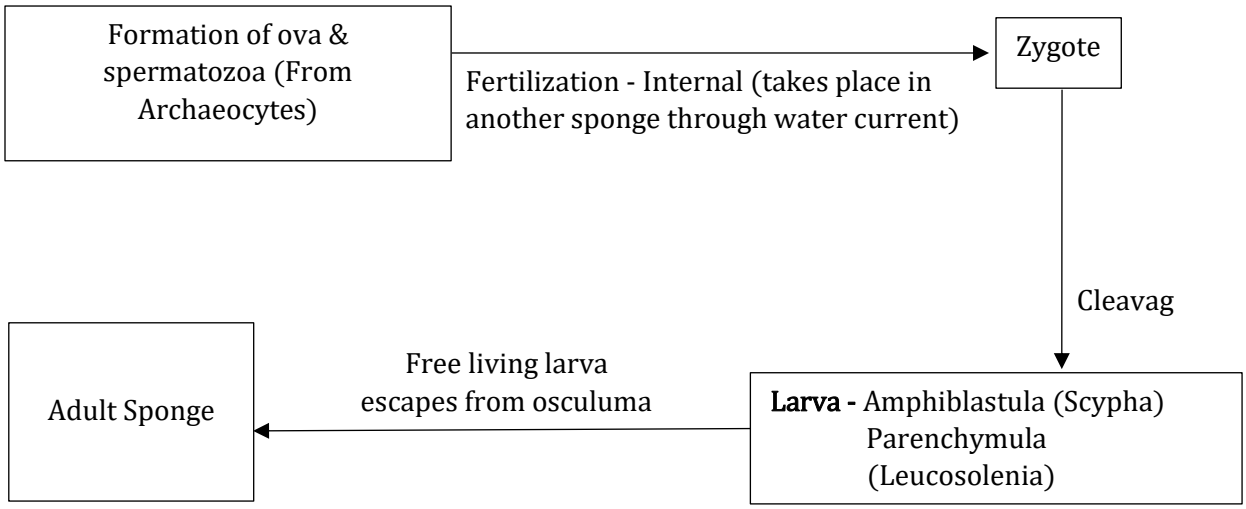
6. **Canal system or water transport system :-** It is unique feature of sponges, water enters through ostia in the body wall into spongocoel and goes out through osculum. This pathway of water transport is helpful in food gathering (Nutrition), respiratory exchange and removal of Wastes (excretion).
7. **Choanocytes** forms lining of Spongocoel and canals. Ceaseless beating of flagella helps in maintaining flow of water current.
8. **Nutrition is holozoic :-** Digestion is intracellular and occurs in food vacuoles of choanocytes.
9. Skeleton is internal, consist of tiny calcareous spicules or siliceous spicules or fine spongin fibre located in mesenchyme. Scleroblast secretes spicules and spongioblast secretes spongin fibres.
10. Respiration and Excretion takes place by diffusion of gases through body surface. Excretory matter is Ammonia.

11. **Reproduction takes place by means of :-**

(a) **Asexual :-** By Budding or Fragmentation or by Spedal cell mass Gemmules containing Archaeocytes.

- Endogenous buds of asexual reproduction in sponge are known as Gemmules (In unfavourable condition).

(b) **Sexual :-** Sponges are Hermaphrodite, fertilization is internal and cross due to Protogynous condition and development is indirect having a larval stage which is morphologically distinct from adult.

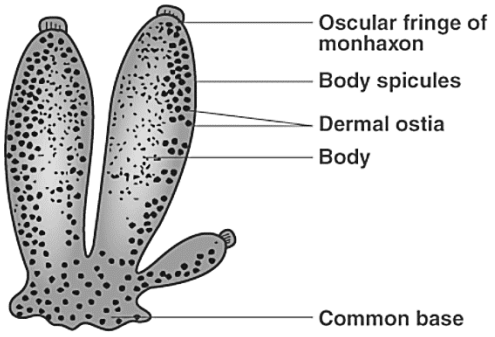


PORIFERA

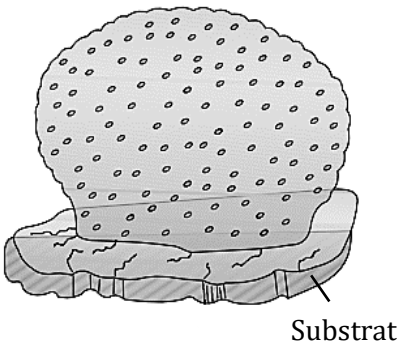
(3 classes – On the basis of Skeleton)

	Calcarea	Hexactinellida	Demospongia
Skeleton	Calcareous spicules	6-rayed siliceous spicules (Glass sponge)	1 or 4 rayed siliceous spicules or sponging fibre or both
Habitat	All marine and found in shallow water	All marine and found in deep sea water	Marine or fresh water sponges
e.g.	**1.** Leucosolenia- smallest sponge **2. Scypha (Sycon)** - Urn sponge	**1.** Euplectella - Venus flower basket, Bridal gift in japan, Shrimps (Spongicola) crustacean, shows commensalism with it **2.** Hyalonema - Glass rope sponge	**1. Euspongia** - Bath sponge **2. Spongilla** - Fresh water sponge **3. Cliona** - Boring sponge (harmful to Oyster)

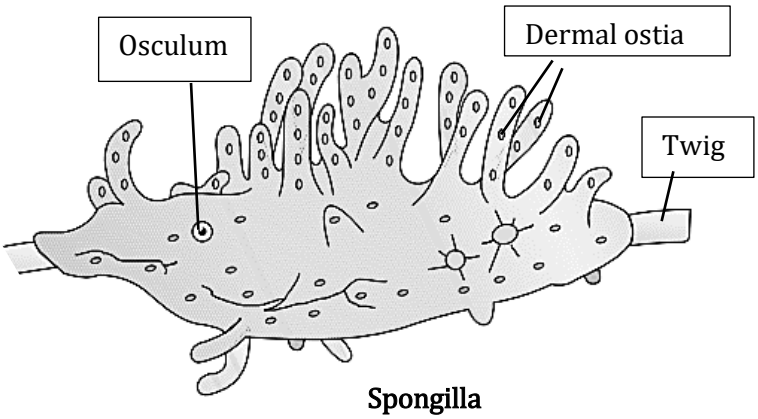
FEW COMMON SPONGES



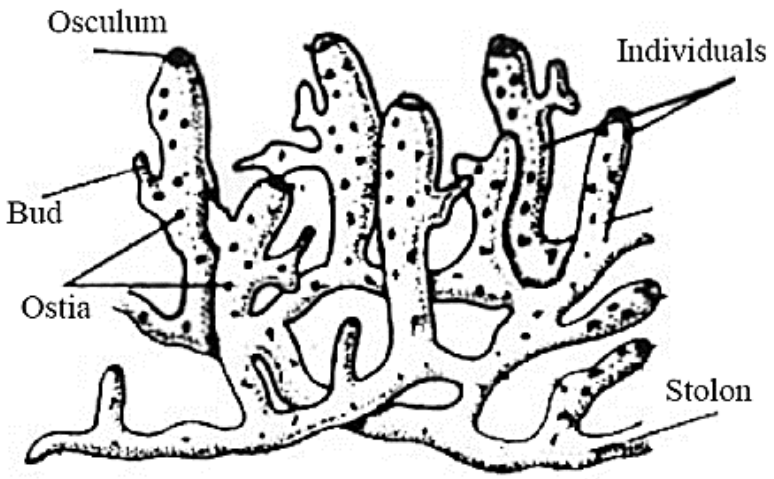
Sycon
Radially symmetrical



Euspongia
(Bath sponge)

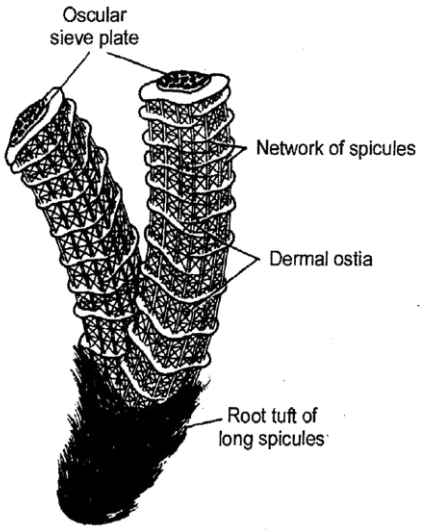


Spongilla
(Fresh water sponge)



A colony of leucosolenia

Radially symmetrical
Smallest sponge



Euplectella

Venus flower basket
Bridal gift in Japan

PHYLUM - COELENTERATA

- **Leuckart** named **Coelenterata**. **Hatschek** named **Cnidaria** on the basis of stinging cells.
- Mostly **marine**, **few fresh-water** (Hydra.) Carnivorous, some are fixed or free floating.
- Coelenterates have two types of **forms** (Dimorphic)
- Either or both zooids may occur in a species.
- If both are found in a species , two form alternate in life cycle. (Alternation of generation or Metagenesis)
- Polyps produce medusae as exully and medusae form the polyps sexually eg :- **Obelia**
- Group of different types of zooids in polyp or medusa shows polymorphism.
- Coelenterates are usually having **radial symmetry**, Some Anthozoans have **Biradial symmetry**.
- Coelenterates have **two Germs layers (1) Ectoderm (2) Endoderm** i.e. They are **Diploblastic** (mesogloea between two layers)
- Coelenterates have **Tissue level of organisation**.
- Cnidoblast or Chidocyte (contain stinging capsule as Nematocyst) present on the tentacles and body, which are used for anchorage, defence and for the capture of Prey.
- Body of coelenterates may be supported by horny or calcareous exoskeleton. eg. :- Corals
- Cavity of the **Coelenteron** is having single aperture. Mouth serve both purpose i.e. **Incomplete digestion tract (Blind sac)**.

  Digestion is **intercellular/extracellular** as well as **Intracellular** i.e. takes place in Coelenteron as well as in food vacuole.

  Coelenteron is also responsible for distribution of food besides partly digesting it. This dual role named coelenteron as **Gastrovascular** cavity.
- **Respiration** and **Excretion** takes place by diffusion of gases through **body surface**.

  Excretory matter is Ammonia.
- **Nervous system** consist of **non-polar** neurons & sensory cell.

  Cleavage is **Holoblastic**. Development includes larva (Indirect).

  Larva of **Obelia** - **Planula** (free living).

  Larva of **Aurelia** - **Ephyra.**

Classification : 3 classes

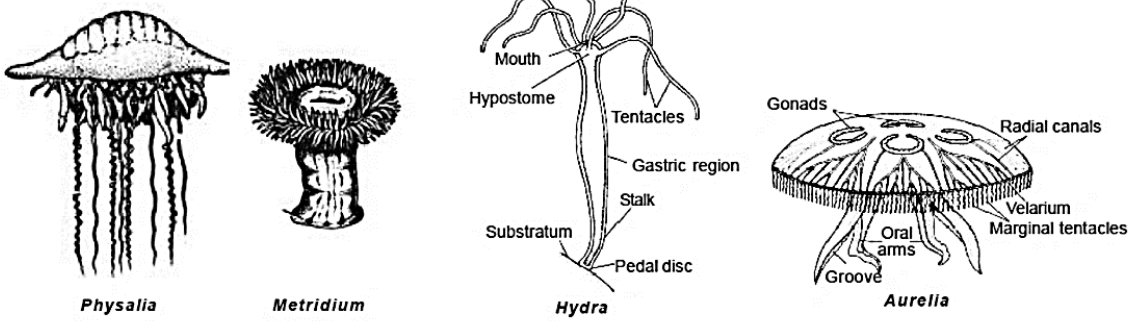
(On the basis of dominance of polyp and medusa)

Hydrozoa	Scyphozoa	Anthozoa
- Polyp & medusa often show metagenesis e.g. 1. Hydra – Frest water polyp (medusa absent) 2. Obleia – Sea fur 3. Physalia – Portuguese man-of-war. (Neurotoxic, gas gland present)	- Medusa form is more common, polyp may be reduced or absent e.g. 1. Aurelia – jelly fish, Moon jelly.	- Only polyp form dominant, medusa may be reduced or absent. - This class has two types of animals (A) Sea Anemones (Skeleton absent) e.g. 1. Adamsia 2. Metridium - Sea anemones show commensalism with Hermit crab (B) Corals ($CaCO_3$ Skeleton) 3. Pennatula - Sea) pen 4. Gorgonia - Sea fan 5.Meandrina-Brain coral 6. Tubipora- Organ pipe coral 7. Alcyonium -Dead man's finger (Soft coral) 8. Corallium - Red coral (Moonga)

UNIQUE FEATURES

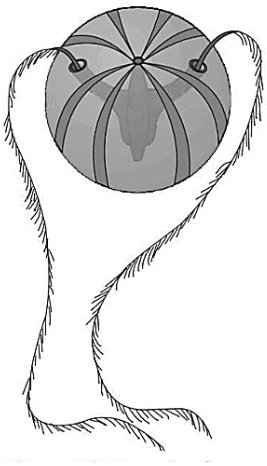
- Tissue level of organisaton of the body.
- Special stinging cells, the cnidoblats, for defence and offence.
- Incomplete digestive tract bounded by body wall.
- A simple nervous system in the form of a network of nerve cells and fibres.
- Simple gonands without gonoducts.

FEW CNIDARIANS



PHYLUM-CTENOPHORA

1. Ctenophores are known for their beauty and delicate nature. In sunlight their comb-plates give the effect of a rainbow. They are commonly known as "Sea-gooseberries" or "Comb-jellies" or "Sea-walnuts".



2. Nematoblasts are absent, so they are also called “acnidarians”.
3. They are exclusively marine.
4. Bioluminescence (fhe property of a living organism to emit light) is well marked.
5. Body is soft transparent jelly like. They are radially symmetrial.

   Diploblastic organism with tissue grade body organisation.
6. Locomotion takes place by the presence of 8 ciliary comb plates on the body surface.
7. Digestion is both extracellular and intracelluar.
8. Skeletal, Excretory and Respiratory systems are absent.
9. They are carnivorous. A pair of long solid tentacles are present. In place of nematoblasts, special type of cells are present on tentacles, called Lasso cells (Colloblasts) which help in catching the prey.
10. Sexes are not separate. Reproduction takes place only by sexual means. Fertilization is external.
11. Development is of indirect type. Life cycle involves a free living Cydippid larval stage.

    e.g.

    1. Pleurobrachia
    2. Ctenoplana
    3. Beroe- Swimming eye of Cat.
    4. Cestum- Venus's girdle

PHYLUM-PLATYHELEMINTHES

1. They have dorsoventrally flattened body hence are called flat worms.
2. These are mostly endoparasites found in animals including human being but some are Free living (aquatic).
3. Study of worms causing parasitic infestation in human is called Helminthology.
4. Body is Bilaterally symmetrical and body organisation is of organ /organ system grade.
5. Body is Triploblastic i.e. body is formed from three germinal layers i.e. Ectoderm, Endoderm & Mesoderm.
6. Locomotary organs are absent in these animals but adhesive organs like suckers, hooks etc are present in parasitic form.
7. Epidermis is sometimes ciliated. On the body wall of parasitic animals a thick cuticle is present i.e. Tegument.

Thick cuticle protects the parasite from the digestive enzymes of the host.

Muscles in the body-wall are mesodermal. Below the epidermis, longitudinal, circular and oblique muscles are present.

8. These are acoelomate. In between various organs a solid, loose mesodermal tissue called Mesenchyma or Parenchyma is present.
9. Digestive system is incomplete (Blind sac body plan) and without anus but in Tapeworm digestive system is completely absent. They absorb nutrients from the host directly through their body surface.
10. Skeleton, respiratory and circulatory systems are absent.
11. They respire through body surface. Anaerobic respiration is found in internal parasites like Taenia.
12. Excretion occurs through specialised cells called flame cells or Solenocytes (Protonephridia). They also help in osmoregulation.
13. Nervous system is ladder like, consist of a nerve ring and longitudinal nerve cords.
14. They are Bisexual. Reproductive system is complex and well developed. Fertilization is internal. Development indirect through many larva stages.
15. Some members like Planaria possess high regeneration capacity.

DIVIDED INTO THREE CLASSES

Turbellaira	Trematoda	Cestoda
- Fresh water/ Marine water - Mostly free living, called Eddy worms 1. Dugesia or Planaria	- Mostly Endoparasite - Body is flat and leaf like so called flukes 1. Fasciola – Sheep liver flukes 2. Schistosoma – the blood flukes 3. paragonimus – Lung fluke worm in lungs of man and pig 4. Opisthorchis – Human liver fluke or Chinese liver fluke	- Endoparasite, mostly intestinal parasite - Body is ribbon-like and segmented so called tape worms 1. Taenia solium – Pork tapeworm 2. Taenia saginata – Beef tapeworm 3. Echinococcus – Dog tapeworm 4. Hymenolepis – Smallest tapeworm in man's intestine – 200 proglottids (monogentic)

Shows special multiplication in larva stage namely **Miracidium**, **Sporocyst**, **Redia** and **Cercaria** and **Metacercaria.**

Infective stage for Primary host (Sheep) - Metacercaria.

Infective stage for Secondary host (Snail) - Miracidium. (Free swiming)

Schistosoma - (Blood fluke) Found in veins of human bladder and intestine. Unisexual , Large male carries female in a groove gynaecophoric canal on ventral side. Life history shows sexual dimorphism

Life history involve two hosts (Digenetic)

(1) Primary host - **Man**

(2) Secondary host - **Garden-snail** (**Planorbis, Lymnea, Bulinus**)

Shows special multiplication in larva stage namely Miracidium, Sporocyst and Cercaria.

Infected stage of **Primary host** (Man) - Cercaria.

Infected stage of **Secondary host** (Snail) - Miracidium. (Free swiming)

Larva enters human body by boring in skin while bathing in ponds .

It damages the liver & causes intestinal disorder - Schistosomiasis or Bilharzia

Taenia solium :- (Pork tapeworm) Flate, white ribbon - like, Size - 4m x 6mm

Three region:

(1) head or scolex with hooks & suckers

(2) Neck-for forming new proglottides

(3) long strobila 850 proglottides.

T. Solium is human gut parasite. Attached to intestinal wall by hooks & suckers. Saprozoic nutrition, anaerobic respiration.

Hermaphrodite Self fertislization (Between two different Proglottids of the same species). Man gets infection from undercooked pork containing encysted larvae cysticerci.

Life history involve two hosts (Digenetic)

(1) Primary host - **Man**

(2) Secondary host – **Pig**

Shows special multiplication in larva stage namely **Onchosphere**, **Hexacanth**, **Bladder worm** and **Cysticercus**

Infective stage of **Primary host Man - Cysticercus.**

Infective stage of **Secondary host Pig - Onchosphere**

It causes the disease **Cysticercosis**

There are three types of Proglottids:

(1)
Immature proglottids
- with developing sex organs

(2)
Mature proglottids
- Fully formed sex organs
-Each has set of testis and ovary.

(3)
Gravid proglottids
-Uterus packed with capsule (Fertilised eggs)

↓

Detached from strobila (Known as **Apolysis**) & pass out in host faeces as a capsules (egg+yolk in a

↓

-Development of embryo
-Pig swallowing egg with **Onchosphere** larva - It is infective stage for Pig

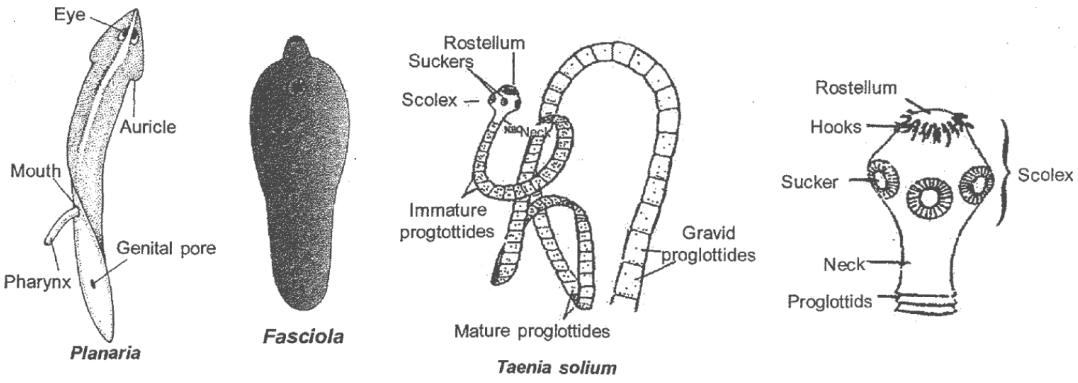
←

Development of **Hexacanth** into **bladder worm.**
-It develops into **Cysticercus** larva
Remain alive in the pig muscles for 5-6 years (Infective stage for Man)

←

Man gets infection from undercooked pork. (Measly pork - having cysticerci)

FEW COMMON FLATWORMS



AENIA SAGINATA (BEEF TAPEWORM)-

Digenetic - Primary host - Man

Secondary - Cow sometime Sheep

The Beef tapeworm, infects the beef eating population. Scolex without rostellum & hooks.

Longer than T. solium

Echinococcus - (Dog tapeworm or Hydatid worm)

Digenetic - Primary host - Dog

Secondary - Pig

With two or three proglottids.

It causes the disease Hydatid

UNIQUE FEATURES

- Bilateral symmetry.
- Organ level of organization.
- Head with sense organs at the front end,
- Three germ layers,
- Muscle layers both in the body wall and gut
- Brain ring and nerve cords,
- Organised excretory system, and
- Gonoducts and copulatory organs

PHYLUM- NEMATHELMINTHES (ASCHELMINTHES)

1. Phylum includes round wonns which appear circular in cross section.
2. Nematods are found everywhere, they may be free living (aquatic and terrestrial) or parasite in plants and animals.
3. They have long, cylindrical body with tapering ends and without segmentation.
4. Symmetry - Bilateral. Germ layer - Triploblastic, Level of organisation - Organ-system level and having tube within tube body plan.
5. Anterior end does not show distinct head (Cephallsation absent).
6. Body wall consists of

(i) Cuticle -Non living, thick and resistant to digestive enzymes of host.

(ii) Epidennis - Syncytial i.e. a continuous layer of cytoplasm having scattered nuclei.

(iii) Muscle layer- Only Longitudinal muscle fibres present

7. They are Pseudocoelomate animals, body cavity is there between body wall and digestive tract which is not lined by mesodermal epithelium i.e. Pseudocoel (developed from embryonic blastocoel)
8. Skeleton is absent but fluid pressure in the pseudocoelom maintains body shape. It is called Hydroskeleton.
9. Digestive tract is complete and differentiated into mouth, pharynx, intestine and anus. Pharynx is muscular and well developed. It is used to suck the liquid food. Intestine is non muscular.
10. Respiration is through body surface by diffusion.
11. Excretory system is H-shaped and consists of excretory canals (Protonephridia) which removes body wastes from body cavity through excretory pores. They develop from an embryonic "Renette cell".
    Excretory matter is ammonia.
12. Nervous system comprises of a nerve ring (Brain) and longitudinal nerve cords. Sense organs like Papillae (tangoreceptors), Amphids (chemoreceptor) are present on lips while Phasmids (chemoreceptor) are found on tail.
13. Reproduction system is developed and sexes are separate (Dioecious). Fertilization· is internal and development may be direct or indirect.
14. Sexual dimorphism is present.
    In Ascaris male is smaller than female and curved from its caudal end. Male has Pineal setae for copulation. Genital tract joins with digestive tract to form cloaca. Female is larger than male and straight at both ends. Genital and digestive tract open independently (Cloaca absent).

Eg.

(1) **Ascaris** - Round worm (in small intestine), larva- Rhabditiform/Rhabditoid

(2) **Ancylostoma** - Hookworm (in small instestine)

(3) **Wuchereria** - Filarial worm (Viviparous)

- Digenetic parasite that causes Filariasis/Elephantiasis disease.
- Carrier host is female Culex mosquito.
- Adult mainly infects lymph vessels and lymph nodes in humans.

(4) **Dracunculus** - Guinea worm (madina worm) or Fiery serpent (Digenetic- Cyclops as intermediate host)

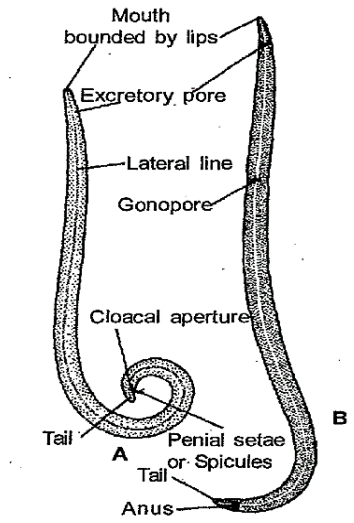
(5) **Enterobius** - Pin worm or seat worm (in large intestine)

(6) **Trichuris** - Whipworm (in intestine)

(7) **Rhabditis** - Free living nematode

(8) **Trichinella** - Infection in intestine and striated muscles (viviparous)

SOME ROUNDWORMS THAT PRARASITIZE MAN



***Ascaris* : (A) Male, (B) Female**

Nematoda has been classified into two classes on the basis of specilised sense organ, Caudal receptor & Excretory system.

1. PHASMIDAIA :

e.g.

Ascaris - Intestinal round worm (in small intestine) larva - **Rhabditiform/Rhabditoid**

Enterobius - Pin worm or seat worm (in large intestine)

Ancylostoma - Hookworm (in small instestine)

Wuchereria - Filarial worm (in Lymph vessels/gland) by female culex mosquito.Viviparous (Digenetic) (Causes elephantiasis)

Loa - loa - Eye worm. (African eye worm)

Trichuris - Whip worm (in intestine)

Rhabditis - Free living

Trichinella - (First in intestine then in stripped muscle)

Dracunculus - Guinea worm (madina worm) or Fiery serpent (Digenetic - Cyclops as intermediate) (Oldest discovered Nematode)

2. APHASMIDA

eg. Desmoscolex

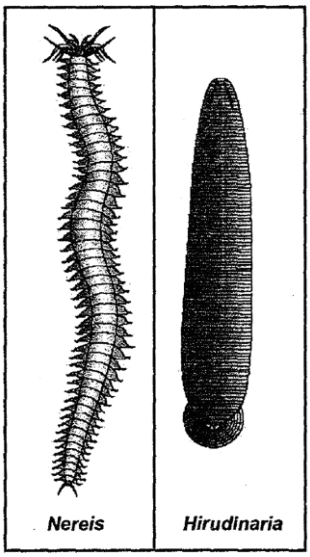
UNIQUE FEATURES

- Syncytial epidermis.
- Body wall musculature of longitudinal fibres only.
- Pseudocoel, a body cavity without a lining of mesodermal coelomic epithelium.
- Complete digestive tract,
- Fluid-filled body cavity,
- Separate sexes.

PHYLUM-ANNELIDA

1. Free living found in moist soil ITerristriall, fresh water or marine but few are parasite.
2. Body is soft elongated, cylindrical and divided into segments or metameres by ring like grooves called Annuli.
3. They are bilaterally symmetrical. triploblastic and have organ system level of organisation with tube within tube body plan.

- They are metamerically segmented and coelomate animals.
- Anterior end has a distinct head with sense organs in few annelids. (eg : Nereis)



4. They have Chitinous Setae and lateral muscular appendages called Parapodia for locomotion.
5. Body wall consist of

(i) Cuticle - Moist and elastic

(ii) Epidermis - Uving layer that secretes dead cuticle outside

(iii) Muscle layer- Contains circular and longitudinal muscles which help in Locomotion

6. Body cavity is true coelom lined by mesodermal coelomic epithelium. (Schizocoel/First Eucoelomate).

   It is filled with coelomic fluid that serves as a hydrostatic skeleton.
7. Digestive tract is complete, straight and extends through entire body. Digestive glands are developed for the first time in Annelida.
8. Respiration is through moist skin (Cutaneous respiration), Some have gills (branchial respiration).
9. Circulatory system is closed type and pulsatile heart present.

- The blood is red with haemoglobin like pigment which remains dissolved in plasma (Erythrocruorin). It has amoeboid corpuscles only. (RBCs absent)

10. Excretory organ is Nephridia (sing. nephridium). They also help in osmoregulation. Excretory matter (1) Ammonia in aquatic form (2) Urea in land form
11. Nervous system consists of a nerve ring (Brain) and a solid. double and ventral nerve cord with ganglia.
12. Reproduction is sexual, Nereisis dioecious but earthworms and leeches are monoecious.

- Development is direct or indirect with free swimming ciliated trochophore larva.

UNIQUE FEATURES

To suck impure blood by Leech is called **Phlebotomy**

Metameric segmentation

Nephridia for excretion and osmoregulation.

Closed circulatory system with respiratory pigment dissolved in the plasma.

Setae in the body wall in most forms.

Head, appendages and respiratory organs in some cases,

Ciruclar and longitudinal muscles in both body wall and gut wall.

GOLDEN KEY POINTS

During course of evolution metameric segmentation, true coelom, closed circulatory system and pumping heart appeared first in annelids.

e.g

1. **Nereis** – Sandwarm/ Ringworm

(a) Cephalisation is present.
(b) Parapodia helps in locomotion.
(c) Unisexual
(d) Larva is trochophore

2. **Pheretima** – Earthworm

(a) Cephalisation absent
(b) Setae for locomotion
(c) Bisexual or hermaphrodite

3. **Hirudinaria** - Fresh water leech (Blood sucking leech)

(a) Cephalisation and setae absent
(b) Parapodia and setae absent

(c) Bisexual

(d) Hirudin (anticoagulant) present

4. **Aphrodite** - Sea mouse

PHYLUM - ARTHROPODA

- Arthropoda is **the biggest phylum.** (Two-third of named species on earth) are Arthropods.
- Arthopods are found in water, land, sea, in plant and animal. They are Colonial, gregarious, shows parental care.
- Sometime **Parthenogenesis** Phenomenon also found i.e. Development of an unfertilized egg into an offspring.
- Fossil arthropoda are called **Trilobites**.
- Body is **Bilateral** , **Triploblastic** with **organ system level** of organisation
- Head is distinct [High digree of cephalization], Consists of well developed sense organ such as simple eyes, compound eyes, antennae, statocyst or balance organ.

  Compound eye consists of many similar units **ommatidia** each having lense and capable of forming image (mosaic).
- Arthropoda have various shapes with externally segmented body. Body is mostly divided into three region Head, thorax & abdomen

  Some or all segments bear **jointed appendages**. Hence name arthro - joints, poda - foot.
- The body of Arthropods is covered by Chitinous exoskeleton.
- Muscle are arranged in bundles. Muscle are striped/straited - Voluntary (first time devepoled in Arthropods)
- Due to presence of joints muscle are separate in them.

  Body cavity around viscera contain blood and is called the **haemocoel**.

  Digestive Tract is complete

- **Mouth parts** adapated for -

(1) Biting and chewing type - Grasshopper, Cockroach, Termites, Caterpillars.

(2) Piercing- Sucking type - Mosquitose, Bugs, Fleas.

(3) Chewing- Lapping type – Bee

(4) Sponging type - Housefly, fruitfly.

(5) Siphoning type - Butterflies, moths

- **Respiration** is through **body surface** or special structure such as **gills** (e.g. Prawn), **Trachea** (e.g Insects), **Book-lungs** (e.g. Scorpion), **Book-gills** (e.g. King crabs) . Trachea carry oxygen direct to the cells.

- **Circulatory system** is **Open** i.e. blood flows in hoemocoel instead of blood vessels.

  Blood - With white corpuscle, colourless - **Haemolymph**. (e.g. Insect)

- Copper containing pigment **haemocyanin** (e.g. Prawn)

  Heart - A dorsal, tubular pulsatile, one to many chambered tubular structure.

Excretory organs are -

(1) Antennary or **green glands** or **maxillary gland** (e.g. Crustaceans) opening directly to the exterior.

(2) Coxal gland (e.g. Arachnids)

(3) Malpighian tubules (e.g. Insects) opening into the gut.

Excretory matter is **Ammonia** in aquatic animal and **Uric acid** in land animal

- **Nervous system** comprises of a circumenteric **ring** and a **double**, **solid midventral nerve cord** bearing a **pair of ganglia** per segment or less (Ganglia). With sensory organ like eyes, compound eyes statocyst etc.

  Insects communicate by **Pheromones** by releasing chemical into the environment. Also acts on a sex attraction.

Sexes are separate . **Fertilization internal** but few aquatic has **external**. Gonads have ducts. Larva stage-undergoes degree of **Metamorphosis**. Sexual dimorphism may be present. Mostly **oviparous**, **few viviparous.**

- Animals of **Arthropoda** are most **successful invaders of terrestrial** enviornment in

  invertebrates due to presence of (1) **Cuticle** (2) **Appendages** (3) **Wings**

  Examples :-

  Economically important insect - **Apis** (Honey bee), **Bombyx** (Silk worm), **Laccifer** (Lac insect)

  Vectors - **Anophelese, Culex Aedes** (mosquitoes)

  Gregarious pest - **Locusta** (Locust)

  Living Fissil - **Limulus** (King crab)

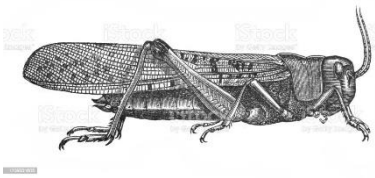
  Others - Butterfly, Scorpion, Prawn, Spider, **Cyclops**, Centripede, Millipede, **Peripatus** etc.

UNIQUE FEATURES

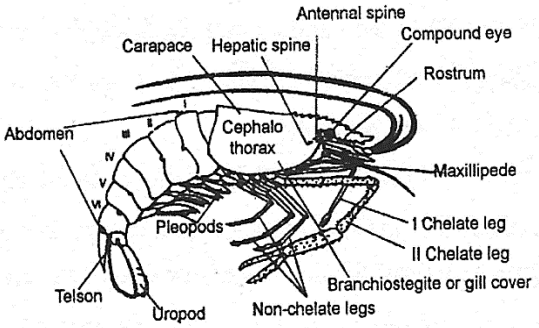
- Jointed appendages modified for a variety of functions.
- Tough, jointed exoskeleton of chitinous plates.
- Tracheae for respiration in majority of cases.
- Compound eyes.
- Malpighian tubules for excretion.
- Power of flight in most insects.
- Striped muscles arranged in bundles for moving particular parts,

WITNESS FEW ARTHROPODS

FEW ARTHROPODS

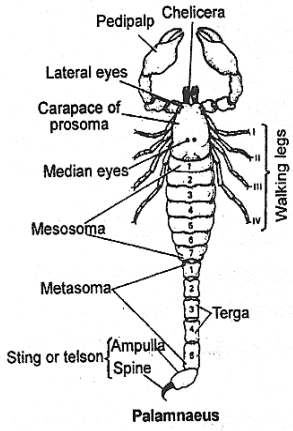


Locust



Palaemon

Butterfly



Palamnaeus

PHYLUM - MOLLUSCA

- It is **second largest** Phylum. \
- Mollusca (Soft bodied) are **marine**. some are also found in **fresh water** or on **land.**

  Johnston coined the name **Mollusca.**
- Study of this phylum is known as **Malacology** & study of shells of molluscan is known as

  Conchology.
- Body is unsegmented with variety of shapes. **Neopilina** is exceptionally segmented.
- Molluscns are usually **bilateral**. Few are secondarily **asymmetrical** (snail) due to twisting

  (Torsion) during growth. These are **triploblastic** with **Organ system** level.
- Body is covered with calcareous shell with distict.

(1) **Head** with sense organ like Eyes, Tentacles. (Head is absent in Pelecypoda & Scaphopoda).

(2) Dorsal **visceral mass/** hump containing organ system.

(3) **Ventral muscular foot** for locomotion.

Thin fleshy fold or soft and spongy layer of skin form mantle or pallium.

The space between hump and mantle is called mantle cavity.

The mantle usually secretes an external limy **shell**. Shell is made up of **Calcium carbonate and Concheolin protein**.

Shell may also be internal (Cuttle fish), reduced and even absent **(Octopus)**

- **Coelom** is greatly **reduced**. It is represented by cavities in the **pericardium**, **kidneys** and **gonads**. Space among the viscera contain blood and form **haemocoel.**
- **Digestive tract** is complete. Buccal cavity contain a file-like rasping organ the **Radula**, with transverse row of teeth. Anus opens into the mantle cavity. Digestive glands are known as **hepatopancreas**.
- **Respiration** is usually by feather like **gills** i.e. **Ctenidia** are in the mantle cavity which also assists in excretion but respiration may takes place by **body surface** also. **Dentalium** respire by **Mantle**. **Pila** respire by **pulmonary sac** on land and by **gills** in water..
- **Circulatory system** is **open**. It includes dorsal pulsatile heart and a few arteries that open into sinuses.

  Cephalopoda has **closed** type of circulatory system

  Blood has a copper containing, blue respiratory pigment **Haemocyanin**. Blood is colourless with amoebocytes.
- **Excretory system** includes 1 or 2 pairs of sac like **kidneys**, which open into the mantle cavity.

  Kidney of molluscans are **Metanephridia** known as **Kaber's organs** or **Organ of Bojanus** . Excretory matter is **ammonia** or **uric acid.**
- **Nervous system** comprises three paired **ganglia**

  (1) **Cerebral** (above the mouth) (2) **Pedal** (in the foot) (3) **Visceral** (in visceral mass)

  These are inter connected by

  (1) **Commissure** (Joins similar ganglia)

  (2) **Connectives** (Joins dissimilar ganglia)

  Senses organ includes

  (1) **Eye** - Present over a stalk called **ommatophore** (Gastropoda).

  (2) **Statocyst/Lithocyst** - For equilibrium in foot

(3) **Osphradia** - Chemoreceptor/Olfactory as well as for testing chemical & physical nature of water.

exes usually **separate** or Dioecious. (Snail has ovotestis). They are mostly oviparous. Fertilization may be **external** or **internal**.

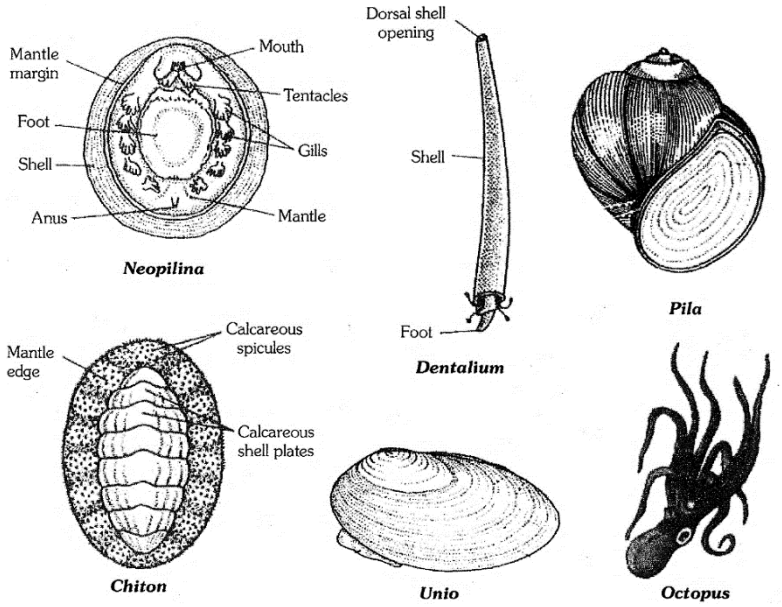
Cleavage is **spiral**, **determinate**, **unequal** and **holoblastic.**

Development is - **Mostly indirect**. **Trochophore** is very common larva of Mollusca phylum. Larva - **Glochidium** (Fresh water mussel) and **Veliger**, **(Pila)**

EXTRA POINTS :

- Precious pearl of the size of tennis- ball is made by a giant mollusc- Tridecna
- "Nacre layer" is called "Mother of Pearl" : This layer is made up of $CaCO_3$ and choncheolin protein.
- Molluscs are classified on the basis of shell and foot into six classes.

FEW MOLLUSCS



E.g.

1. Neopilina- Living fossil (Connecting link between Annelida and Mollusca)

2. Chaetopleura(Chiton) - "Coat of maU shell'' or Sea-mica
3. Dentalium -Tusk- shell (Respire by mantle)
4. Pila - Apple-snail
5. Aplysia - Sea hare
6. Doris-Sea lemon
7. Turbinella- Shankh
8. Planorbis -Land snail
9. Lymnea - Land snail

Shell is spirally coiled so animals becomes asymmetrical

10. Pinctada- Pearl oysters
11. Unio- fresh water mussel
12. Teredo- Ship worm
13. Octopus - Devil fish (8 arms) - Shell is absent
14. Sepia-Cuttle fish (10 arms) - Shell is internal
15. Loligo-Squid (Radula absent)

Belongs to class cephalopoda in which closed blood vascular system is present

UNIQUE FEATURES

- Three body regions : head, visceral mass and foot.
- A glandular fold, the mantle, over the body.
- Mantle cavity with anal, excretory and genital apertures in it.
- Calcareous shell around the body in most cases.
- A rasping organ, the radula, in the buccal cavity.
- Much better sense organs, such as eyes, statocysts, osphradia, etc.

Precious pearl of the size of tennis - ball is made by a mollusc - **Tridekna**

"Nacre layer" is called **"Mother of Pearl"**:This layer is made up of $CaCO_3$ and choncheolin protein.

Father of pearl industry - **Kokichi Mikimoto**

Molluscs are classified on the basis of shell, Foot, Nervous system and Gills into seven classes.

PHYLUM-ECHINODEMATA

1. All are Marine. Generally live at bottom and slow moving.
- Body shape is star like, cylindrical, melon-like or disc-like.
2. The adult Echinoderms are radially symmetrical but larvae are bilaterally symmetrical.
3. They are triploblastic and coelomate animals with organ- system level of organisation. Echinoderms have true Coelom
- They do not have distinct head.
4. Skin of echinoderms contains calcareous spines, pedicellariae and endoskeleton consists of calcareous plate (dermal ossicle).
- Minute pincer like structure pedicellariae comes out through skin. They keep body surface clear of debris.
5. The most distinctive feature of echinoderms is presence of water filled ambulacral or water vascular system with tube feet to help in locomotion. capture and transport of food. excretion and respiration. A perforated plate madreporite permits entry of water into ambulacral system, Structures like- Tube feet, radial canals, tiedmann body and stone canal are also found in water vascular system.
6. Digestive tract is complete with mouth on lower side (ventral) and anus on the upper side (dorsal).
7. Respiration takes place by body surface or gills called dermal branchiae or papulae in most of Echinoderms like Starfish.
8. Circulatory system is reduced and open type. No heart or pumping vessel.
9. There is no excretory system. Nitrogenous waste ammonia diffuses out through body surface.
10. Nervous system is simple and less developed includes a Nerve ring and radial nerves with simple sense organ. They don't have head and brain.
11. Reproduction is sexual, sexes are separate (unisexual).
12. Fertilization is usually external and development is indirect with free swimming larva.

Larva

Star fish	**®**	**Bipinnaria ,**	**Brittle star**	**®**	**Ophiopluteus**
Sea urchin	**®**	**Echinopluteus ,**	**Sea cucumber**	**®**	**Auricularia**
Feather star	**®**	**Doliolaria,**			

- Few echinoderms (star fish) have great power of **regeneration**. They brack off their arms for defence purpose. This phenomenon is known as **Autotomy**.
- Echinoderms in angry or frightened state vomits out viscera (internal organ). This phenomenon is known as **Evisceration**.

UNIQUE FEATURES

- Bilateral symmetry in the larva and radial symmetry in the adult.
- Mesodermal endoskeleton of calcarous plates, usually with spines.
- Modification of a part of the coelom into a water vascular system for aid in locomotion.
- Characteristic tube feet for locomotion.
- Peculiar pedicellariae for cleaning the body surface.
- Echinoderms have some chordate like characters like enterocoelic coelom, mesodermal skeleton and deuterostomic embryonic development.
- Few echinoderms (star fish) have great power of regeneration. They break off their arms for defence purpose. This phenomenon is known as Autotomy.
- Sea cucumbers in angry or frightened state vomits out viscera (internal organ). This phenomenon is known as Evisceration.

e.g.

1. **Asterias** – star fish

STAR FISH

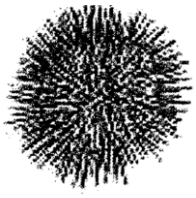
2. **Ophiura** -Brittle star

3. **Ophiothrix** - Brittle star

BRITTLE STAR

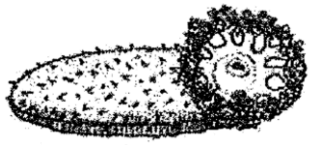
4. **Echinus** - sea urchin (arms are absent)

   Mouth- with Aristotle's lantern i.e. Masticating apparatus with 5 teeth.



SEA URCHIN

5. **Cucumaria** (Sea rucurnber)
6. Holothuria (Sea cucumber) (Arms are absent)



SEA CUCUMBER

7. **Antedon** – (Sea lily)

SEA LILY

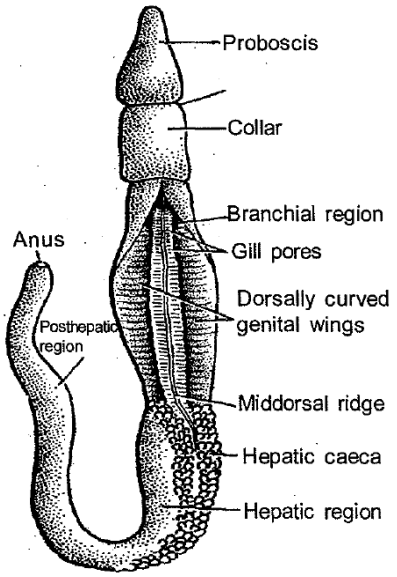
PHYLUM-HEMICHORDATA

Hemichordata is a connecting link between Non- chordata & Chordata.

1. Hemichordata was earlier considered as a sub-phylum of chordata. But now it is placed as a separate phylum under non-chordata.
2. This phylum consists of a small group of worm like marine animals with organ system level of organisation.
3. They are bilaterally symmetrical. triploblastic and coelomate animals.
4. The body is cylindrical, unsegmented and divided into three parts : anterior proboscis, middle collar and a posterior long trunk.

- Body cavity is enterocoelus, which is divided into Protocoel, Mesocoel and Metacoel.

5. Mostly ciliary feeders, digestive tract is complete.
6. A notochord like structure is found in their buccal cavity, that is called "Buccal diverticulum" or "Stomochord" (outgrowth of buccal cavity) but true notochord is absent.
7. Respiration takes place through gills.



Balanoglossus :
External features in dorsal view

8. Circulatory system is open type. Blood is colourless with amoeboid corpuscles. Respiratory pigment vanadium is present in some cases. Heart is situated dorsally.
9. Excretion occurs through a single glomerulus or proboscis gland.
10. Central nervous system is just like non chordates.
11. Reproduction is sexual and Mostly animals are unisexual

- Fertilization is external.
- Development is indirect with tornaria larva which is similar to bipinnaria larva of echinodermata in their developmental stages.

eg.

1. **Balanoglossus :**-Tongue worm or Acorn worm
2. **Saccoglossus**