# FIRST SEMESTER B.Sc. ZOOLOGY PROGRAMME

ZOOLOGY CORE COURSE- I [Theory]

## ANIMAL DIVERSITY: NON-CHORDATA PART- I

Code: ZOL1B01T

[DIVERSITY, ADAPTATIONS AND FUNCTIONAL ANATOMY OF PROTOZOANS AND ACOELOMATE AND PSEUDOCOELOMATE NON-CHORDATES]

**[36 hours] [2 hours per week] [2 Credits]**

**COURSE OUTCOMES (COs)**

| COs | Course Outcome Statements |
|---|---|
| CO1 | Describe the principles of classification and nomenclature (5 hrs) |
| CO2 | Explain the five kingdom classification of living organisms (1 hr) |
| CO3 | Understand the concepts of classification of animals (4 hrs) |
| CO4 | Explain the classification with examples and characteristic features of kingdom Protista and describe the morphology and structural organization of *Paramecium* (6 hrs) |
| CO5 | Describe the characteristic features of subkingdom Mesozoa (1 hr) |
| CO6 | Explain the classification of phylum Porifera and elucidate the salient features of each class (3 hrs) |
| CO7 | Describe the characteristic features of phylum Cnidaria and Ctenophora, illustrate the classification of phylum Cnidaria down to classes and explain the structural organization of *Obelia* (8 hrs) |
| CO8 | Explain the salient features of phylum Platyhelminthes and illustrate its classification down to classes (3 hrs) |
| CO9 | Explain the characteristic features and classification of super-phylum Aschelminthes and phylum Nematoda (3 hrs) |
| CO10 | Elucidate the characters of Pseudocoelomate minor phyla Rotifera and Gastrotricha (2 hrs) |

**Question paper pattern for external examination**

*[Module 1-4: Short answer 5x2=10 marks, Paragraph 3x5=15 marks, Essay 1x10= 10 marks*
*Module 5-10: Short answer 7x2=14 marks, Paragraph 4x5=20 marks, Essay 1x10=10 marks]*

## Section A. CONCEPTS OF CLASSIFICATION OF ORGANISMS

### MODULE 1. Principles of classification and nomenclature (5 hrs)

Systematics: natural and classical. Nomenclature: Binomial and Trinomial nomenclature; International rules of Zoological nomenclature (brief account); Mention modern trends in systematics: Chemotaxonomy, Serotaxonomy, Cytotaxonomy, Evolutionary taxonomy, Numerical taxonomy (Phenetics), Cladistics (Phylogenetics), Molecular systematics, DNA barcoding.

***[Short answers/paragraphs/Essays]***

### MODULE 2. Five kingdom classification of living organisms (1 hr)

Mention Cavalier-smith's eight kingdom classification also.

***[Short answers/Paragraphs]***

### MODULE 3. Concepts of classification of animals (4 hrs)

Classification based on number of cells, tissue or organ system level of organization, development of germ layers, development of symmetry, development of coelom, segmentation, homology and analogy of organs and their origin, development of mouth and digestive tract (brief account).

***[Short answers/Paragraphs]***

## Section B. CLASSIFICATION OF KINGDOM PROTISTA

**MODULE 4. Kingdom: PROTISTA (6 hrs)**

Characteristic features and classification of Kingdom Protista down to phyla. [*Salient features of the major groups of protists given below with notes on the examples cited*]

| | |
|---|---|
| Phylum: Rhizopoda | e.g.*Entamoeba* |
| Phylum: Dinoflagellata | e.g.*Noctiluca* |
| Phylum:Parabasilia | e.g.*Trichonympha* |
| Phylum: Apicomplexa [=Sporozoa] | e.g. *Plasmodium* |
| Phylum: Ciliophora | e.g.*Vorticella.* |

Type ***Paramecium***: Morphology and structural organization [as revealed by compound microscopy]; locomotion, nutrition, excretion, osmoregulation and reproduction; conjugation in detail.

***[Short answers/Paragraphs/Essays]***

## Section C. KINGDOM: ANIMALIA

Salient features of the Major Phyla of animals and their diversity.

[*Habits, habitat,morphology, functional anatomy and life history of representative types (wherever specified) and classification of each phylum down to classes, except otherwise mentioned, and examples thereof: Study of animal diversity with typical examples from each class, with emphasis on ecological and adaptive features, economic importance and such other points of biological interest expected. Only very brief account of each example is to be studied.*]

**MODULE 5. Subkingdom: MESOZOA (1 hr)**

A brief account of Dicyemid (=Rhombozoans) mesozoans [e.g. *Dicyema*] and Orthonectid mesozoans [e.g. *Rhopalura*]

***[Short answers/Paragraphs]***

**MODULE 6. Subkingdom: PARAZOA (3 hrs)**

**Phylum: PORIFERA**

Classification down to classes and salient features of each class.

| | |
|---|---|
| Class Calcarea (=Calcispongiae) | e.g.*Leucosolenia* |
| Class Demospongiae | e.g.*Spongilla* |
| Class Hexactinellida (=Hyalospongiae) | e.g.*Euplectella* |

Give an account of canal system (Asconoid, Syconoid, Leuconoid and Rhagonoid); Mention amphiblastula, parenchymula and sponge gemmule.

***[Short answers/Paragraphs/Essays]***

**MODULE 7. Subkingdom: METAZOA (8 hrs)**

**Phylum CNIDARIA [=COELENTERATA] (7 hrs)**

Classification of the phylum down to classes and salient features of each class.

| | |
|---|---|
| Class Hydrozoa | e.g.*Halistemma, Physalia* |
| Class Scyphozoa | e.g.*Rhizostoma* |

Class Anthozoa e.g.*Adamsia, Zoanthus,* and *Madrepora*

Type ***Obelia***: Morphology and life cycle.
Polymorphism in cnidarians with special reference to siphonophores.

**Phylum CTENOPHORA [=ACNIDARIA] (1 hr)**

Unique features as exemplified by *Pleurobrachia*; mention cidippid larva.

***[Short answers/Paragraphs/Essays]***

**MODULE 8. ACOELOMATA (3 hrs)**

**Phylum PLATYHELMINTHES**

Classification down to classes and salient features of the following classes.

| | |
|---|---|
| ClassTurbellaria | e.g.*Bipalium* |
| Class Trematoda | e.g.*Fasciola* |
| Class Cestoda | e.g.*Taenia* |

Type ***Dugesia*** (Planaria):Structural organization, Digestive system, locomotion and reproduction.

***[Short answers/Paragraphs/Essays]***

**MODULE 9. PSEUDOCOELOMATA (3 hrs)**

**Super Phylum: ASCHELMINTHES**

Classification down to phyla; highlight the heterogeneous nature of animals of this group.

**Phylum: NEMATODA**

Characteristic features of *Ascaris*.
Examples: *Ancylostoma, Enterobius, Wuchereria*

***[Short answers/Paragraphs/Essays]***

**MODULE 10. PSEUDOCOELOMATE MINOR PHYLA (2 hrs)**

Salient features of the following pseudocoelomate minor phyla:

| | |
|---|---|
| Phylum **Gastrotricha** | e.g.*Chaetonotus* |
| Phylum **Rotifera** | e.g.*Brachionus* |

***[Short answers/Paragraphs]***

**Topics for assignments/seminars**

*(Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)*

1. Nutrition in protozoans.
2. Reproduction in protozoans.
3. Parasitic protozoans of man.
4. Helminth parasites of man.
5. Reef building corals and coral reefs.

**REFERENCES**


- Anderson, D. T. (2001). *Invertebrate Zoology*. 2nd edition. University of Michigan, Oxford University Press (Indian Edition. 2006).
- Barnes, R.D. (1982). *Invertebrate Zoology*, 5th Edition. Holt Saunders International Edition.

1ST SEM B.Sc. ZOOLOGY
CALICUT UNIVERSITY

# ANIMAL DIVERSITY NON- CHORDATA PART-1


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# MODULE 1

# PRINCIPLES OF CLASSIFICATION AND NOMENCLATURE

# PRINCIPLES OF CLASSIFICATION

## SYSTEMATICS

- The term "systematics" is derived from the latinized Greek word "systema"
- Father of modern systematic is *Carolus Linnaeus*
- Definition :
  1. Systematics is the scientific study of the kinds, diversity and interrelationships of organisms.
  2. It is the study of the diversity and natural relationships of organism.

## SIGNIFICANCE OF SYSTEMATICS

- Systematics presents a clear picture of **biodiversity** of our planet.
- Provides information about **phylogeny** of life, **organic evolution**, and the role of natural selection in evolution (phylogeny is the evolutionary history or relations of organisms).
- Reveals the **interrelationships among and between different kinds of organisms.**
- It accelerates the growth of other branches of biology.
- Brings to light the evolutionary implications of biodiversity.
- Provides a very convenient method for the understanding of extinct organisms (**species that is no longer alive**) and extant (**living species**)
- Provides a sound and simple universal system for the identification and classification of organisms.
- Provides a **universally acceptable system of biological nomenclature**.
- Serves as a basic tool for the preparation of an inventory of the flora and fauna.
- Plays a significant role in the study of economically important organisms and also in the **growth of applied biology.**

| Classical Systematics | New Systematics |
|---|---|
| Species are believed to be produced by special creation. | Species are believed to be produced by organic evolution. |
| Species are considered to be wholly separate and totally unrelated groups. | Species have genetic and evolutionary rela-tions. |
| Species are believed to have no common ancestry. | Related species share a distant common ancestry. |
| Species characters are believed to be immutable. | Species characters are mutable. |
| Includes artificial and natural classifications. | Includes phylogenetic classification. |
| Upholds the concepts of typological and morphological species. | Upholds the concepts of polytypic species and biospecies. . |
| Is based mostly on morphological considerations. | Is based mostly on cytological, genetical, molecular and physiological considerations |

| Artificial classification | Natural classification | Phylogenetic classsification |
|---|---|---|
| classification based on superficial resemblances in morphology, habitat, mode of life, adaptation etc. | Classification based on morphological, anatomical, physiological, embryological and behavioral similarities. Here, closely similar organism is placed in homogeneous groups. | classification based on genetic relation and evolutionary history or organism |

## NOMENCLATURE

- Nomenclature means to call by name (L. nomen = name; clatare = to call).
- Biological nomenclature is the scientific system of naming the taxonomic groups or taxa That are recognized in classification.
- It is the formal naming of taxa in a scheme of classification.
- It provides a universally acceptable name for each species. So, avoid the confusions caused by local name.

## BINOMIAL NOMENCLATURE

- Standard system of naming species by giving two part names(binomials).
- It consists of two epithets [words] - Generic epithet(name of genus) and Specefic epithet(name of species).
- It was first introduced by Linnaeus in 1751.
- How to write : - Genus comes first
  - Species follows next
  - Should be in Greek or Latin
  - Initial letter in Genus name should be capitalized and that of Species name should be in small letter.
- It should be italized or underlined.
- Specific name is often followed by the name of the author, who validly published the name.
- The author's name would be in an abbreviated form when it is very long.
- e.g., Annona squamosa Linn. (the abbreviations L. and Linn, represent Linnaeus.
- Eg: *Coffea arabica* (coffee*), Mangifera indica (*mango*), Canis familiaris (*domestic dog*), Felis domesticus (*domestic cat*)…etc*

## TRINOMIAL NOMENCLATURE

- It is only an extension of binomialism.
- It is the system of naming infra-specific taxa, such as sub-species, by giving three-word names (trinomials)
- proposed by Huxley and strickland.
- It Include Genus, Species, Sub species.
- First two names are still the GENUS and SPECIES but the third name is the sub species or variety.
- Used when organisms are divided into subspecies or varieties.
- Example: *Columba livia intermedia* (pigeon), *Homo sapiens neandertalensis*
- (Neandertal man), *Homo sapiens fossilis* (Cro-Magnon man - fossil man ) *Homo sapiens sapiens (*modern man).

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## INTERNATIONAL RULES OF ZOOLOGICAL NOMENCLATURE

- For naming **species**, the **Binomial system** has to be followed, and for naming **sub-species**, varieties , **the Trinomial system** has to be-followed.
- Scientific names should be **Greek or Latin**.
- It should be **printed in italics**, except when it forms a title or a sub-head. If handwritten or typed, it should be underlined.

- The first word of a binomial or trinomial must have a capital initial letter, and the second (and third) one must have a small initial letter.
- The first word of binomial should be singular noun,second word should be adjective of first one.
- **Uniqueness**: Every name must be unique,it means each taxon is known by a **specific** name.
- **Stability**: It should be free from frequent changes.
- **Universality**: A particular species or taxon known by same scientific name all over the world .It means scientific name must be universally acceptable.
- **principle of priority** : * it is the law of "**first come, first serve**" or "**let the prior name prevail"**
- In cases where two or more names have been given to the same taxon by different authors, the earliest name published after 1758 would be the valid one. All the later names may be discarded or may be considered as synonyms. This is called the principle of priority. The names published before 1758 are not considered in this regard.
- When a name is changed due to some reason, the name of original author must be given in parenthesis.
- The name of author,(full or abbreviated ) and the year of publication should follow in tha last word of scientic name…eg: *Entamoeba histolitica(*Shaudinn,1903).

## MODERN TRENDS IN SYSTEMATICS

### 1.CHEMOTAXONOMY

- Also known as biochemical systematic.
- It is the system of classification is based on characteristics of various chemical constituents of organisms like **amino acids, proteins, DNA sequences, alkaloids**, etc
- It involves detection of species based on different biochemical characteristics.

  For e.g.**: cuticular hydrocarbon of larvae of Anopheles gambiae**(malarial vector) have been useful in segregating different strain of this species.

### 2.SEROTAXONOMY

- It is based on analysis of blood serum.
- The classification of very similar plants by means of differences in the proteins they contain.
- Steps:

1. The protein extract of the plant origin ( i.e. the antigen) is extracted.
2. The antigen is injected into the blood stream of an experimental animal to form antibodies.
3. Then experimental animal produces specific antibody in response to the antigen.

4. The serum with antibodies is called antiserum. Antiserum is made to react in vitro with antigenic protein as well as proteins of other taxa, whose affinities are to be determined.
5. The amount of precipitation shows the degree of homology.

## 3. CYTOTAXONOMY

- Also known as chromosomal taxonomy.
- The classification of organisms based on cellular structure and function, especially on the **structure and number of chromosomes.**
- **Cytological aspect such as karyotype or chromosomal complement and** DNA content of cells are very valuable in taxonomy.
- These data are highly useful to segregating closely related species.

## 4. PHENETICS

- Also known as Numerical taxonomy, phonetic taxonomy, phenetic classification.
- Classifies organisms based entirely on observed phenotypic similarity and differences, (without considering whether similarities are due to evolutionary relation or common ancestry).
- It does not reflect evolutionary descent.
- **S**tructure, morphology and locomotory pattern are considered
- Tree like branching diagram that shows similarity or dissimilarity among organism or group is called **phenogram.**
- Low accuracy (while comparing with cladistics).
- Phenetics is employed mainly for classification of bacteria.

## 5. CLADISTICS

- Also known as Phylogenetic systematics, cladistictaxonomy, cladism
- Classifies organisms based on their phylogenetic(evolutionary) relationships and recency or antiquity of common descent, rather than on their observable similarity.
- This system is formulated by Willi Henning in 1966.
- A branching diagram showing the cladistic relationship between a number of species known as **cladogram.**
- According to it, organisms are placed into taxonomic groups, called **clades.**
- **Cladogenesis :** it is Cladogenesis is the dichotomous splitting of an ancestral lineage stock into two equal sister groups(clade)
- It does not consider the phenotypic differences between the descendants of a common ancestor.
- According to this,biological character are either **plesiomorphic** (primitive or ancestral) or **Apomorphic**(derived or specialized charecter).

- E.g.: long neck of giraff is apomorph and short neck of its ancestor is plesiomorph.
- Apomorphic character are of two type-
    1. Autoapomophs-**uniquely** derived character.
    2. Synapomorphs-**shared** derived character.

## 6. MOLECULAR SYSTEMATICS

- Classification based on molecular similarity between organism
- It utilizes molecular biology techniques.
- It utilizes data from nuclear DNA, chloroplast DNA, or mitochondrial DNA to elucidate phylogenetic relationship between plants.
- Application –

    1-to solve taxonomic problem

    2-To verify existing taxonomy

    3- To view existing taxonomy from molecular level.

## 7. DNA BARCODING

- Most advanced taxonomic approach.
- It is the convenient system for quick and accurate identification of species
- It was a shift from morphological dependence to dna based digital system.
- Here, **small genetic sequence** (stretch of DNA) from a standard part of genome is used.
- Standard region used to generate dna barcode is known as **marker.**
- This marker is present in mitochondrial gene in animal ( Cytochrome c oxidase 1 gene – COI).
- COI is highly effective in identifiying birds, butterflies, fish.
- 2 steps involved.-
    1. Build barcode library of identified species
    2. Sequence alignment (it involve matching of barcode sequence of unidentified sample with barcode library for its reference)
- After DNA processing and sequencing, dna barcode is making in the form of **chromatogram.**(Visual representation of dna sequence)
- Finally barcode is stored in database for further use.

**Application of dna barcoding**

(i) Identification and control of agricultural pests.

(in) Identification of disease vectors.

(in Protection of endangered species.

(iv) Monitoring of the quality of drinking water.

(v) Routine auta1hentication of natural health products.

(vi) Identification of plants using leaves when flowers or fruits are not available.

(vi) Identification of medicinal plants.

(vili) Identification of the diet of an animal, based on the analysis of its stomach contents or faeces.

(in) Forensic examination and identification of the victims from mutilated body parts, blood stains, semen stains, etc.

# MODULE -2

# FIVE KINGDOM CLASSIFICATION OF LIVING ORGANISM

# FIVE KINGDOM CLASSIFICATION OF LIVING ORGANISMS

- In 1969, R.H Whittaker proposed the five-kingdom classification
- The five kingdoms are Monera, Protista, Fungi, Plantae and Animalia.
- Whittaker's five-kingdom classification is based chiefly on four aspects, namely
    1. Cellular complexity
    2. Bodily complexity,
    3. Mode of nutrition
    4. Phylogenetic (ancestral) relations

- **KINGDOM MONERA**
    - Unicellular prokaryotes.
    - Eg : Eubacteria, Cyanobacteria.
    - They are autotropic or heterotropic
    - Autotrophic bacteria can be photosynthetic or chemosynthetic.
    - Heterotrophic bacteria can be parasitic or saprophytic.

- **KINGDOM PROTISTA**
    - Unicellular eukaryotes.
    - Protista consist of protophytes(plant like protist) and protozoa (animal like protist)
    - Protophytes are phototrophic eukaryote.
    - Protozoans are heterotrophic eukaryote.
    - Eg : Dianoflagellates, Amoeba etc..

- **KINGDOM FUNGI**
    - Multicellular eukaryotes.
    - They are chlorophyll lacking.
    - So, Most of them are saprotrophic or heterotrophic.
    - Eg :Mashroom, Pencillium.

- **KINGDOM PLANTAE**
    - Multicellular eukaryotes
    - Chlorophyll-bearing ,phototrophic.
    - Chloroplast and cell wall bearing.
    - Most of them are autotrophic and some of them are heterotrophic as well.

- **KINGDOM ANIMALIA**
  - Multicellular eukaryotes.
  - They are heterotrophic.
  - They reproduce by sexual mode of reproduction.
  - Holozoic nutrition.

| Five kingdom classification - major features considered | | | | |
|---|---|---|---|---|
| Kingdoms | Main mode of nutrition | Major ecological role | Cellular status | Complexity of organism |
| Monera | Autotrophy | Producers & decomposers | Unicellular | Prokaryotes |
| Protista | Phototrophy & heterotrophy | Producers & consumers | Unicellular | Eurkaryotes |
| Plantae | Photosynthetic autotrophy | Producers | Multicellular | Eurkaryotes |
| Animalia | Holozoic heterotrophy | Consumers | Multicellular | Eurkaryotes |
| Fungi | Saprotrophic heterotrophy | Decomposers | Multicellular | Eurkaryotes |

**MERITS OF FIVE KINGDOM CLASSIFICATION**

- In the five-kingdom classification, plant and animal kingdoms are more homogeneous than in the two-kingdom classification.
- Five-kingdom classification reveals the course of evolution of early organisms into plants and animals.
- The inclusion of prokaryotes in an independent kingdom (Monera), separating them From higher plants, is fully justifiable.
- The inclusion of all unicellular organisms in the kingdom Protista could avoid the arbitrary inclusion of some of them (e.g., Euglena, Chlamydomonas, etc.) either in the plant kingdom or in the animal kingdom.

- The elevation of Fungi to the rank of an independent kingdom is fully justifiable,because they differ widely from plants with which they were formerly grouped in the plant kingdom.

**DEMERITS OF FIVE-KINGDOM CLASSIFICATION**

- The kingdoms Monera and Protista are not homogeneous groups, but are heterogenous with photosynthetic autotrophs and non-photosynthetic heterotrophs.

- The phylogenetic relations of some lower groups are not fully reflected: For example, green algae and some photosynthetic bacteria are quite similar . Still, they are placed in two different kingdoms.

- Eventhough yeast is a unicellular organism, they included in multicellular fungi.

- Viruses, viroids and prions have no place anywhere in any of the five kingdoms.

## EIGHT KINGDOM CLASSIFICATION

- Eight kingdom classification was proposed by cavalier smith in 1993
- 8 kingdoms are:
    1. Eubacteria
    2. Archaebacteria
    3. Archezoa
    4. Protozoa
    5. Chromista
    6. Fungi
    7. Plantae
    8. Animalia
- He split kingdom protista into 3. Such as Archezoa, Protozoa, Chromista.
- Eubacteeria eg: ecoli.
- Archaebacteria comprises thermophilic bacteria.
- Archezoa include Mitochondria lacking protist.
- Protozoa include animal like protist.they have mitochondria andthey are non photosynthetic protist.
- Chromista include mitochondriate and phototrophic protist.

# MODULE -3

# CONCEPTS OF CLASSIFICATION OF ANIMALS

# CONCEPTS OF CLASSIFICATION OF ANIMALS

## ➢ CLASSIFICATION BASED ON LEVEL OF ORGANISATION

### ➢ CELLULAR LEVEL OF ORGANISATION

- Here, body is composed of loose cells.
- Cells are not organized into tissue, or organ.
- There may be different kind of cell, which function without coordination.
- Muscle cell, nerve cells and nervous coordination are absent.
- Eg: sponges

### ➢ TISSUE LEVEL OF ORGANIZATION

- Here body is organized into tissue only.
- Organ and organ system are absent.
- Tissue is an organized group of similarly modified cell, specialized for a specific function.
- Epithelial cell, muscle cell, nervous cell, nerve coordination are present.
- Eg: in Cnideria and Ctenophora.

### ➢ ORGAN LEVEL OF ORGANIZATION

- The organ level of organization is when two or more tissues work together for a specific function.
- Muscle cell, Nervecell, nerve coordination are present.
- **Eg:** Members of Platyhelminthes

### ➢ ORGAN SYSTEM LEVEL OF ORGANIZATION

- The organ system level of organization is when two or more organs work together for a specific function.
- Eg: members of phylum Aschelminthes and above.

## ➢ CLASSIFICATION BASED ON DEVELOPMENT OF GERM LAYER

- Germ layers are the embryonic cell layers at the gastrula stage.
- Based on them, eumetazoans are grouped into diploblastica and triploblastica.
- In **Diploblastica**, there are two germ layers, namely outer **ectoderm** and inner **endoderm**. In between these two is a non-cellular, jelly-like substance, called mesogloea.
- Mesogloea may be thin (e.g., Hydra, Obelia) or tough and fibrous (e.g., jelly fishes and sea anemones).
- In **Triploblastica**, there are three germ layers, namely outer **ectoderm**, inner **endoderm**, and middle **mesoderm**.
- Diploblastica comprises the Cnidarians and Ctenophora, and Triploblastica comprises Platyhelminthes, Aschelminthes ,Annelida, Arthropoda
- In Triploblastica, ectoderm forms the epidermis of the body wall, fore-gut, hind-gut, nervous system and sense organs.
- Mesoderm gives rise to the dermis of the skin, connective tissue,muscle,genital organ.
- Endoderm form midgut, digestive glands, lungs, urinerybladder.

## ➢ CLASSIFICATION BASED ON SYMMETRY

- Symmetry is the condition in which body parts are arranged in relation to an axis or plane in such a way that the body gets definite form and shape.
- ASYMMETRY: Body has no pattern of symmetry. Eg: spongs, protist

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### (1) BILATERAL SYMMETRY

- It is the condition in which body parts are arranged in such a way that a section passing through the **median longitudinal axis** will give two similar halves.

- It occurs when animal body can be divided into two equal halves along a single plane.(median longitunal)

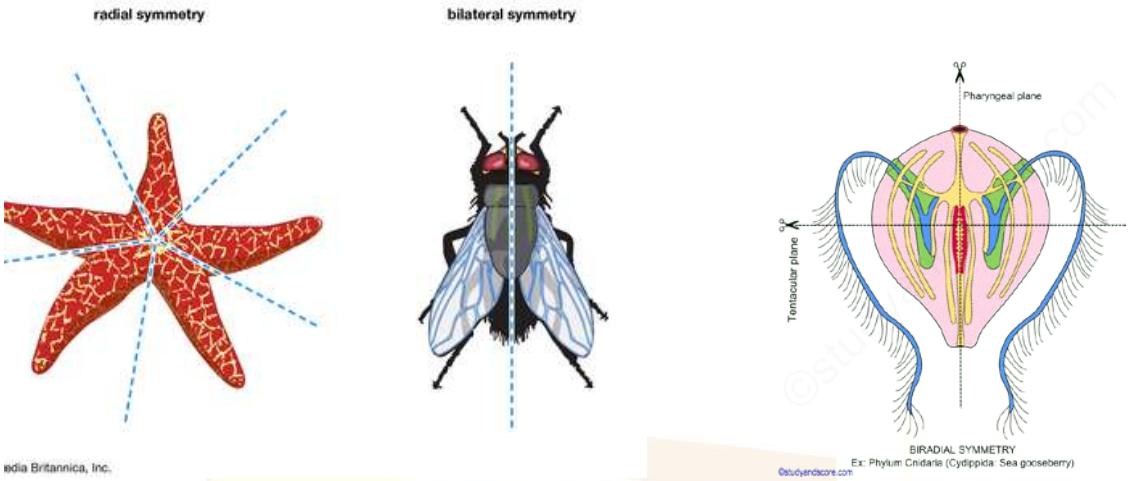
- Here, anterior posterior end, dorsal ventral surface, right and left halves exist.
- It is an adaptation for motility. Anterior region generally contain head and sense organ arranged for perceiving environmental stimuli.
- Eg: Chordates, echinodermata larvae,Annelida,Arthropoda,most mollusca.

**(2) <u>RADIAL SYMMETRY</u>**

- The condition in which body parts arranged around a **central cavity** in such a way that a section passing through a centre of body along **any axis** will give two similar halves.
- Radial symmetry can be divided equally in many planes.
- It is an adaptation for sessile life.animal canrecieve stimuli equally from all direction.
- Eg: adult echinodermata,cnideria.

**(3) <u>BIRADIAL SYMMETRY</u>**

- It is the condition intermediate between radial and and bilateral symmetry.
- Here,body is divisible into two similar halves along **two planes**
  (tendacular palne,pharyngeal plane) which are right angle to each other.
- Eg: combjelly




RADIAL SYMMETRY BILATERAL SYMMETRY BIRADIAL SYMMETRY

- CLASSIFICATION BASED ON METAMERISM
- Linear division of body into series of ideally corresponding compartment along anterior posterior axis.
- Such repeating compartments are called ***metameres.***
- Metamerically segmented animal are triploblastic.
- But all triploblastic animal are not metamerically segmented.
- Eg: Tapeworm, Annelids, Arthropods, and some molluscs.

- CLASSIFICATION BASED ON DEVELOPMENT OF MOUTH AND DIGESTIVE TRACT (PROTOSTOMIA AND DEUTEROSTOMIA)

- Protostomes are the animal in which mouth is first formed from blastopore, and anus is formed later as a second opening.
- It include annelids, arthropods, molluscs and some minor phyla.
- In protostomes, cleavage is spiral, and determinate.
- Deuterostomes are animal in which anus is formed first from blastopore, and mouth appear later as a second opening.
- In deuterstomes, cleavage is radial and indeterminate.
- It includes echinoderms, the hemichordates, and the chordates.

## ➢ CLASSIFICATION BASE ON DEVELOPMENT OF COELOM

- Coelom in greek language means a hollow cavity
- Space between alimentary canal and bodywall which is lined by mesodermal cell-coelom
- Coelom is the body cavity which is present in between alimentary canal and body wall and it is lined on all side by mesodermal cells.
- Based on the presence or absence of coelom, animal can be classified into 3.
- Acoelomata, Pseudocoelomata, Eucoelomata.

### 1. ACOELOMATE (Animal with no coelom)

- Absence of coelom
- Here body cavity is altogether absent.
- The space between body wall and alimentary canal is filled with a loose mesodermal tissue, called **parenchyma/mesenchyme.**
- Presence of mesenchyme restrict the movement of internal organs.
- In acoelomate, Alimentary canal is primitive and incomplete.
- eg: platyhelminthes

### 2. PSEUDOCOELOMATA (Animal with false coelom)

- Pseudocoelomates are bilaterally symmetrical and triploblastic animal in which body cavity is a fluid filled false coelom known as pseudocoel.
- This pseudocoel is not mesodermal in orgin and not lined by mesodermal epithelium.so,it is not a true coelom.
- Internal organs lie freely within pseudocoel.
- Eg : Aschelminthes .

### 3. EUCOELOMATA (Animal with true coelom)

- Here, true coelom is present
- Eucoelomates are bilaterally symmetrical, triploblastic animal with a coelomic body cavity.
- In some eucoelomates,perivisceral cavity is a blood filled space,called **haemocoel.**
- Eg: Annelida, Arthropoda, Mollusca, Echinodermata, Hemichordate, chordate.
- Eucoelomata can be classified into two based on nature of coelom formation.

1. Schizocoela
2. .Enterocoela

There are two mechanism of coelom formation in embryo.

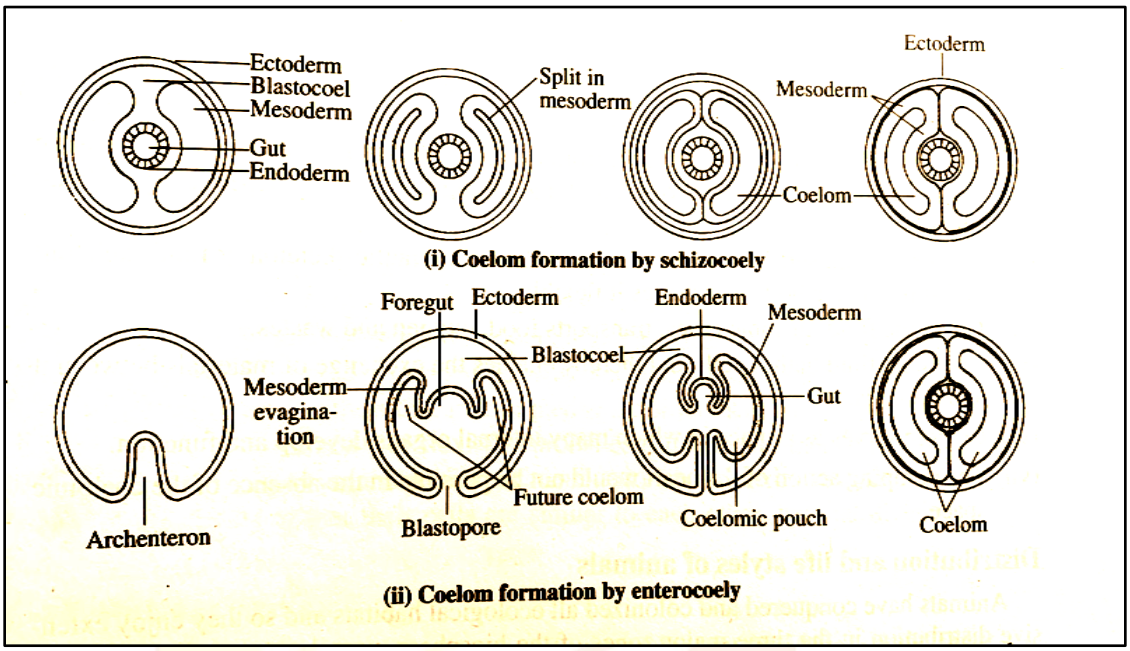
### 1. SCHIZOCOELY

- Schizen= to cleave; coely=holoow
- In schizocoelus coelom formation, two solid mesoderm are formed on either side of archenteron. They are called lateral plate mesoderm.
- Then a split appears in each band and enlarges to form a coelomic cavity.
- Finally the coelomic cavity get filled with coelomic fluid and lined by coleomic epithelium.
- This type of coelom formation occur in protostomes.
  (eg: annelid, arthropoda, mollusca, vertebrates)

### 2. ENTEROCOELY

- Enteron=gut; coely=cavity.
- Here, coelom is formed from archenteron.
- At first, archenteron undergoes evagination into blastocoels and produces lateral pouches.
- Then these pouches get pinched off from the archenteron and form independent coelomic compartments.
- Finally these compartment fuses together to form a spacious perivisceral cavity.

- This type of coelom formation occur in deuterostomes (eg: echinodermata, hemichordate, primitive chordates)
- COMPARISON BETWEEN COELOM FORMATION BY SCHIZOCOELY AND ENTEROCOEL




ADVANTAGES OF COELOM

- Coelom (and pseudocoelom) permits a clear separation between the muscles of the body wall and those of the gut wall.
- Coelom allows the passage of food along the digestive tube independently of body Movements.
- Coelomic fluid serves as a hydrostatic skeleton (hydraulic skeleton or fluid skeleton) and supports the body and makes it flexible.
- Coelomic fluid, in some cases, transports food, oxygen and wastes.
- Coelomic fluid bathes cells and thereby enables the exchange of materials between it and the cells.
- Coelom serves as a space in which many internal organs develop and function.
- The pumping action of the heart would not be possible in the absence of the coelomic space.

- HOMOLOGY AND ANALOGY

## Homologous organs

Homologous organs are those organs that have the same basic structural design and origin but have different functions.

- For example, the forelimbs of frogs, a lizard, a bird and a man can have a basic design of bones, but they perform different functions.

## Analogous organs

Analogous organs are those organs which have different basic structural design and origin but have similar functions

- For example, the wings of birds and insects.

| **Homologous Structure** | **Analogous Structure** |
|---|---|
| Similar anatomy | Dissimilar anatomy |
| Dissimilar functions | Similar Functions |
| Inherited from a common ancestor | Not inherited from ancestors |
| Develops in related species | Develops in unrelated species |
| A result of divergent evolution<br>Share similar developmental pattern. | A result of convergent evolution<br>Developmental pattern are dissimilar to each other. |

| | |
|---|---|
| ➢ Developed as a result of the adaptation to a different environment | ➢ Developed as a result of the adaptation to a similar environment |
| ➢ An arm of a human, the leg of a dog or a flipper of a whale is all homologous structures. (Bones in front flipper of whale are homologous to bones in human arm.) | ➢ wings in birds, bats and insects are all analogous structures. |

# MODULE - 4

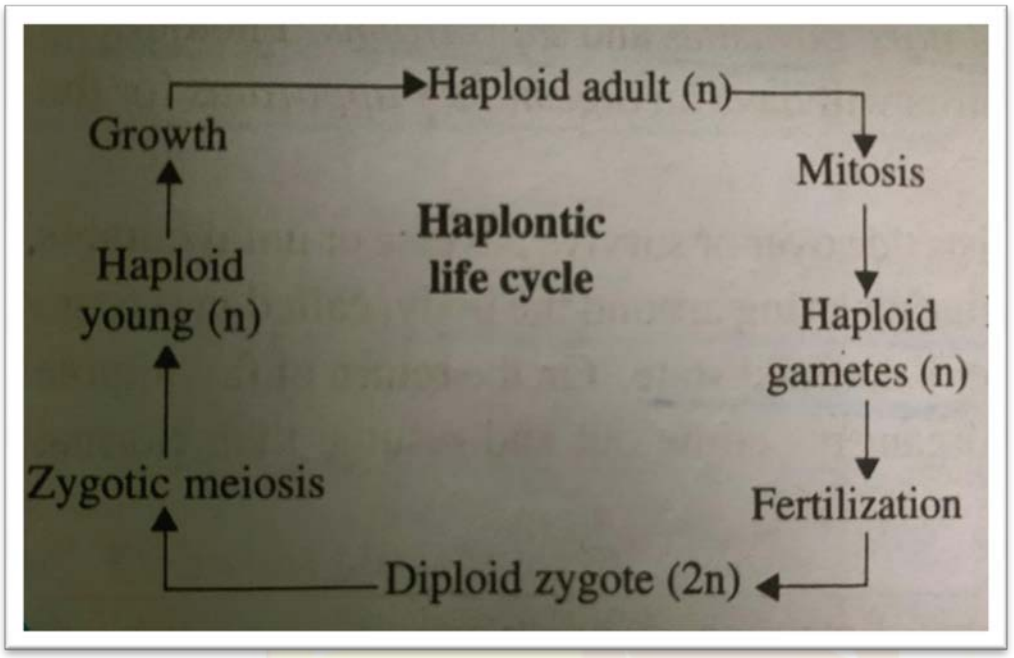
# KINDGOM PROTISTA

# KINGDOM PROTISTA

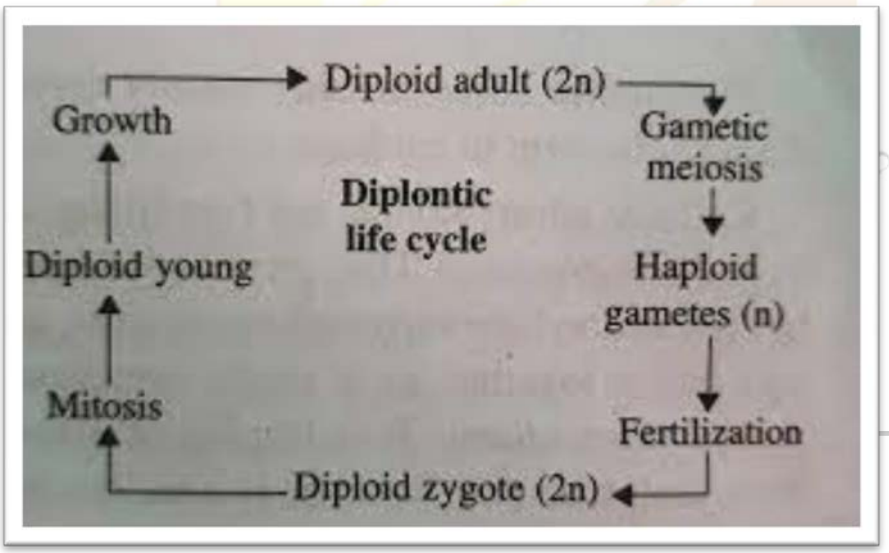
## SALIENT FEATURES OF PROTISTS

- Mostly aquatic, Unicellular
- Colonial or Coenobial eukaryotes.
- Colonial body without tissues and organs.
- Locomotor structures include pseudopodia, flagella and cilia.
  **Pseudopodia** (e.g:Amoeba), **flagella** (e.g: Euglena), or **cilia** (e.g:Paramecium).
- Nutrition is Autotrophic or Heterotrophic.
- Chlorophyll-bearing forms are photosynthetic autotrophs (phototrophs). Heterotrophs include predators, parasites and saprotrophs.
- Predators will have an ingestatory apparatus for the intake of food.
- Cyst formation (**encystment**): Some protists tide over or survive adverse or unfavorable Conditions by the formation of a protective covering around the body, called cyst (e.g.,Amoeba). Within the cyst, they remain in a dormant state.
- On the return of favourable conditions, the cyst dissolves and the organisms come out and resume their normal activities. This is called **excystment.**
- Protists reproduce asexually and sexually. Asexual reproduction involves only one parent and no sex cells, where as sexual reproduction involves two parents and sex cells
- Asexual reproduction is of three kinds,
  1. Fission
  2. Plasmotomy
  3. Budding.
- **Fission** is the mitotic division of the parent body into daughter organisms. Fission is two type.
  1. Binary fission : 2 daughter individuals are formed from a parent (e.g., Paramecium)
  2. Multiple fission: more than two daughter individuals are formed (e,g., Plasmodium).
- **Plasmotomy** is a modified type of fission, found among multinucleate protists
- (e.g: Opalina). Here, division of the body is not accompanied by nuclear division.
- **Budding** is the formation of a daughter individual from a prominence of the parent Body, called bud.
- In sexual reproduction, two sex cells fuse together and form a single cell. The fusing cells are called gametes, their fusion is called syngamy and the single cell formed is called zygote.
- The individuals formed by sexual reproduction are called **offspring** and Those formed by asexual reproduction are called **clones.**
- Life cycle involves haplontic life cycle and diplontic life cycle

- **HAPLONTIC LIFE CYCLE**




- **DIPLONTIC LIFE CYCLE**



## 1. PHYLUM RHIZOPODA (SARCODINA)

- They are Animal-like Protists. (protozoans)
- Rhizopoda is a group of pseudopodia-bearing amoeboid protists.
- Body is symmetrical or asymmetrical, without definite anterior and posterior ends and dorsal and ventral surfaces.
- Cytoplasm is marked out into ectoplasm and endoplasm.
- Locomotor structures are **pseudopodia.**
- Contractile vacuoles are present in freshwater forms for osmoregulation.
- Nutrition is typically **holozoic**. But, some are saprobes.
- Asexual reproduction is by binary fission.
- Encystment occurs in some cases for protection from unfavourable conditions.
- Examples: Amoeba, Entamoeba, Difflugia.

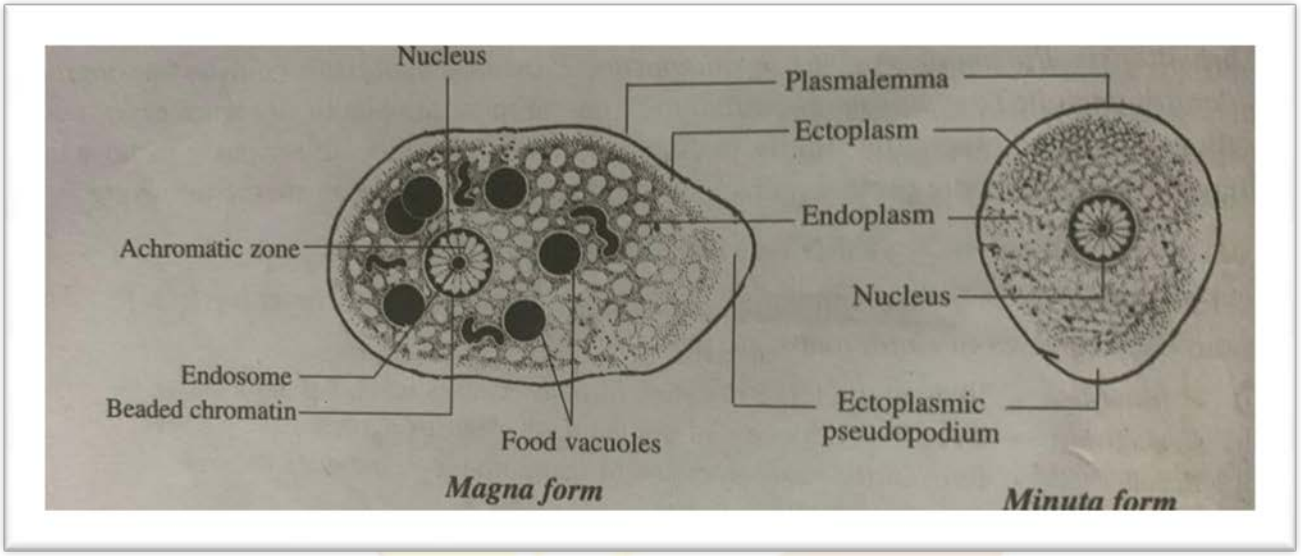
## ENTAMOEBA HISTOLYTICA

- Entamoeba is a gastro intestinal parasite in man and some other vertebrates. The
- It lives in the large intestine of man - causes intestinal amoebiasis.
- It is popularly known as the "**dysentery amoeba",**
- It is the causative agent of human **intestinal amebiasis.**
- It is an endoparasite in the lumen and sub-mucous layer of the large intestine of man. Sometimes, it penetrate the blood vessels,

**Morphology**

- E. histolyrica occurs in three morphologically distinct forms,
    1. Trophozoite
    2. Pre-Cystic form
    3. Cystic Form.
- Trophozoite is the fully mature feeding and growing vegetative form.
- It exists in two interchangeable forms,
    1. **magna** form
    2. **minuta** form.
- Magna form is the large and harmful form that inhabits the ulcers of the intestinal wall.
- It is haematophagous (feeds on human blood cells.
- Minuta form is the small and harmless form.living in the intestinal lumen.
- Pre-cystic form is a transitory stage between the trophozoite and the cystic form. It is much smaller in Size, and rounded or ovoid in shape.

- Cystic form is the encysted stage, living in the intestinal lumen. It is almost spherical in form.
- In Trophozoite body is covered all around by the plasmalemma or plasma membrane.
- The cytoplasm differentiated into two regions,
    - Outer ectoplasm
    - Inner endoplasm.
- Endoplasm contains a single nucleus, several food vacuoles and numerous granules.
- Food vacuoles are absent in the pre-cystic and cystistic form.
- Nucleus is spherical.
- Trophozoite has only a single ectoplasmic pseudopodium for locomotion. It is flat, blunt and lobular and Hence called **lobopodium.**

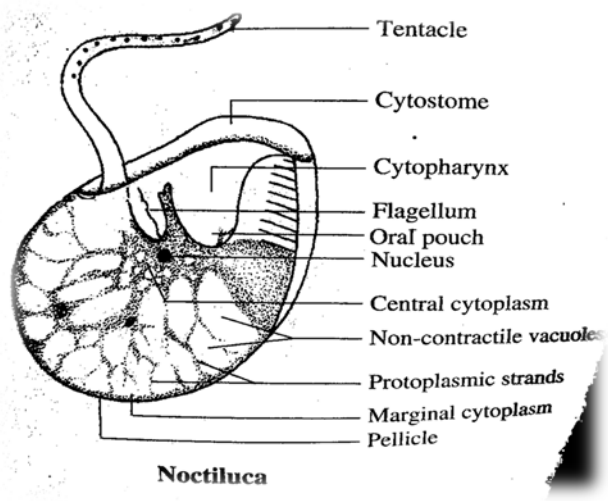



## 2. PHYLUM DINOFLAGELLATA

- Large group of biflagellate
- Body id enclosed within a shell called lorica/theca.
- ***Redtide*** effect : dense population of some marine dinoflagellate often cause phenomenon redtide,which make sea surface red.red tide can be disasterous to marine life,because dense population compete for oxygen and produce toxic substance.some time it cause air pollution resulting in respiratory complaints in people living nearby.
- Some species of dinoflagellate exhibit ***bioluminescence.***They emit light which make sea surface glowing in darkness. Light is produced by oxidation of protein luciferin by the enzyme luciferase.
- Eg; Noctiluca, Gymnodium, Gonyaulax

### NOCTILUCA

- Also known as Sea sparkle
- Large sized, pelagic, noon thecate & luminescent marine dinoflagellate.
- Transparent



Noctiluca

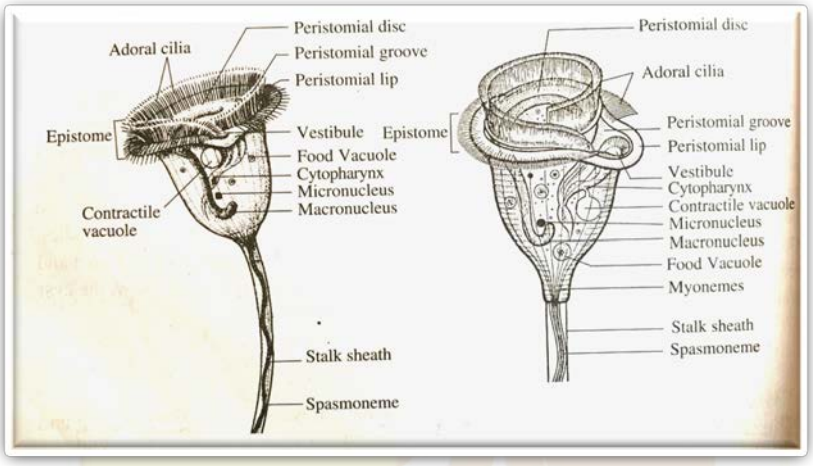
- Body Covered by pellicle
- Polar mass – contents within the pellicle
- Cytoplasm is highly vacuolated, consist of central mass (endoplasm) & a marginal layer (ectoplasm).
- Protoplasmic strands – connects central mass & marginal layer of cytoplasm
- Protoplasmic strand contain light emitting granules, called photogenic granule.
- These granule contain lucifein (protein) and luciferase (enzyme).
- Non contractile vacuoles – filled with gelatinous material – located in between the strands, provides buoyancy.
- Tentacle – used for locomotion & food capture – leading from cytostome.
- Nutrition is holozoic
- Reproduction by binary fission & hologamy
- Exhibit bioluminescence & red tide.

## 3. PHYLUM CILIOPHORA

- Diverse & large group
- Commonly called ciliates.
- Symmetrical or nearly symmetrical body
- Definite shape, anterior & posterior ends
- Body s covered by pellicle – consists of outer cell membrane & inner alveolar layer of flattened membraneous sacs.
- Cilia present – locomotor, food-collecting & ingestatory organelles
- Infra ciliary apparatus – complex fibrillar structure below pellicle consist of kinetosome & kinetodesmata.
- Cytoplasm – outer ectoplasm & inner endoplasm
- Trichocysts – saccular extrusomes in the cortex for adhesion, anchorage & defence
- Presence of ingestatory or food collecting apparatus

- Heterokaryotic & dimorphic nuclei – one small micronucleus – controls reproduction
  one or more large macronuclei – controls metabolism
- Nutrition – holozoic & saprotrophic
- Asexual reproduction – binary fission
- Eg:-Paramecium, Vorticella.

## VORTICELLA




- Bell animalcule.
- Stalked, solitary, sessile & fresh water form.
- Contractile stalk – attached to substratum.
- Body covered by pellicle, marked by parallel striations.
- Enlarged oral region – peristomial region – epistome.
- Peristomial disc – outwardly bulging polar disc of epistome.
- Peristomial lip/border – projecting rim of peristomial disc.
- Peristomial groove – between disc & lip.
- Vestibule – depression in the peristomial groove.
- Adoral zone – definite area in epistome where cilia present.
- Nutrition – holozoic.

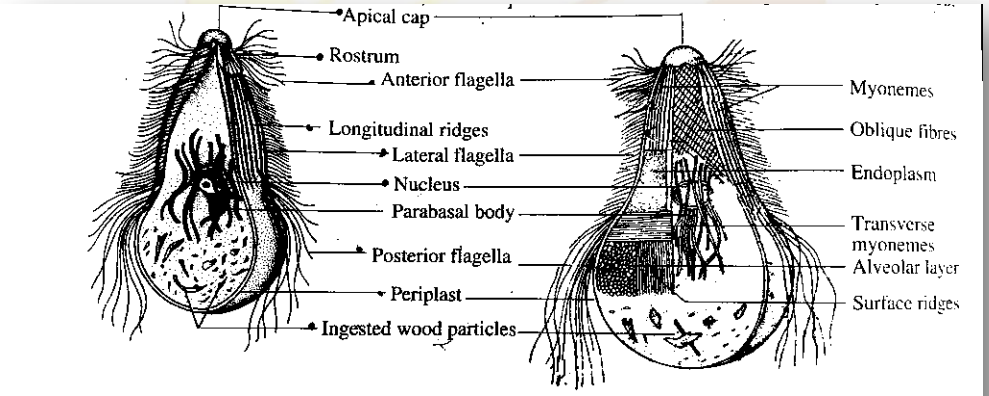
## 4. PHYLUM PARABASALIA

- A group of anaerobic, flagellate protists, with a parabasal apparatus
- Presence of flagella, arranged in one or more clusters near the anterior end of the body
- Presence of at least one parabasal apparatus.
- Presence of an axial, rod-like, microtubular supporting structure, called **axostyle**.
- It runs through the longitudinal axis of the body.
- Mitochondria are secondarily lost, but there are small hydrogenosomes.
- Absence of ingestatory apparatus.

- Presence of one or more nuclei.
- Most of them are endosymbionts in the gut of termites, cockroaches, etc
- Examples : Trichomonas, Trichonympha, Mixotricha

## TRICHONYMPHA

- It is a symbiotic parabasalid protist, in the intestine of Termites.
- Body is oval or pear-shaped.
- Body covered by pellicle.
- The surface of the pellicle bears longitudinal ridges, and grooves and numerous flagella.
- 3 sets of flagella, anterior middle and posterior.
- Body differentiated into anterior, middle and posterior regions.
- Anterior region has tapering end, called rostrum.
- Middle region bears most of the flagella.
- Posterior region is rounded and non-flagellated.
- The cytoplasm differentiated into ectoplasm and endoplasm.
- Ectoplasm contains an alveolar layer, oblique fibres and transverse myonemes.
- Endoplasm contains a centrally located nucleus, Several parabasal bodies and longitudinal myonemes.



**Trychonympha companula - Sectional view**

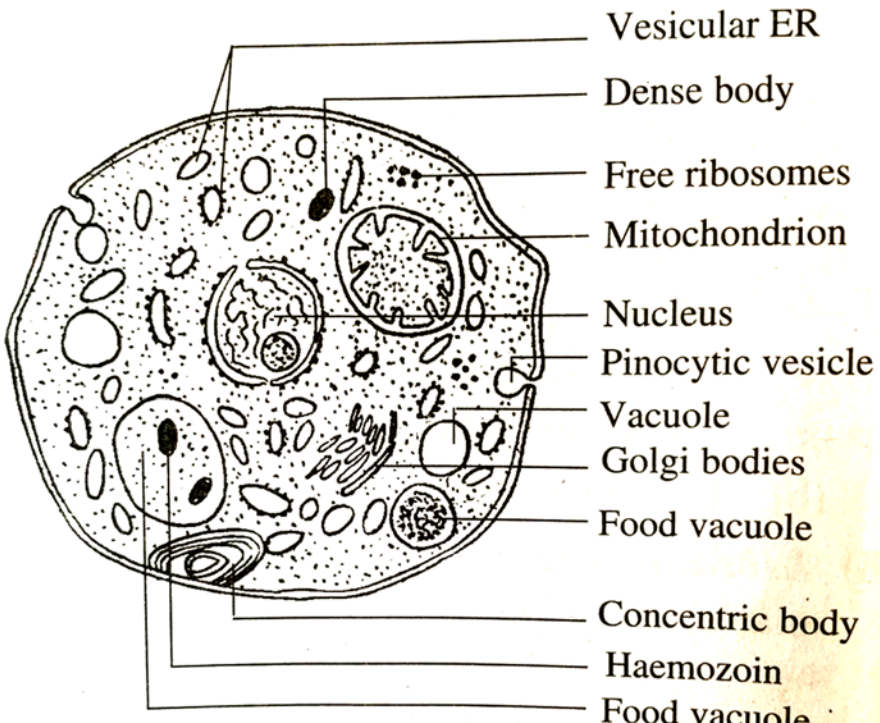
- ***Mutualism In Trichonympha***
- Relation between Trichonympha and termites is example for obligatory mutualism.
- They cannot live in separation from each other.
- Termites get their food digested with the help of Trichonympha.
- In ruturm, Trichonympha gets shelter, food, protection and all biological requirements.
- Termites have no enzymes to digest cellulose.
- So, cellulose digestion in termites occurs by the enzymes provided by Trichonympha.

## 5. PHYLUM APICOMPLEXA

- Sporeforming obligatory endoparasitic prtists.
- Presence of a unique organelle, called apical complex.
- Body is covered by a semi-rigid pellicle.
- It consists of the outer plasma membrane and two alveolar membranes.
- Absence of locomotor structures in the adult.
- Presence of an apical organelle, called apical complex for adhesion or penetration. (The phylum gets its name from this feature).
- This complex organelle (apical complex) consists of a cone-like structure.
- one or two polar rings of microtubules.
- several flask-like glandular structures called rhoptries
- Tubular micronemes.
- This organelle secretes enzymes which dissolve the host cell for adhesion or penetration.
- (Cytoplasm -ectoplasma and endoplasm.
- Multinucleate.
- Nutrition is parasitic.
- Life cycle is complex, involving more than one host.
- Examples : **Plasmodium** (human malarial parasite), Gregarina (parasite in grass hoppers)

## Plasmodium

- Malarial parasite.
- Mature feeding and growing intracellular parasite in man –***TROPHOZOITE***
- Two host
    - Female Anopheles mosquito – primary host – extracellular endoparasite in the gut cavity, salivary apparatus & haemocoel – undergo sexual phase.
    - Man – secondary host – intracellular endoparasite in side RBC & parenchymatous liver cells – Undergo asexual phase.
- Trophozoite – mature feeding & growing intracellular parasite in man.
- Amoeboid & uninucleate.
- Enveloped by plasma lemma
- Cytoplasm is granular & vacuolated.
- Haemozoin – food vacuole contains dark residual pigment formed during the digestion of haemoglobin by parasite.




**Plasmodium - Trophozoite**

# CPA COLLEGE OF GLOBAL STUDIES, PUTHANATHANI

## DEPARTMENT OF ZOOLOGY

### ANIMAL DIVERSITY : NON CHORDATA PART – 1

**1ST SEMESTER**

**SECTION C. KINGDOM : ANIMALIA**

**MODULE 5**

**SUB KINGDOM : MESOZOA**

Mesozoa is a small group of minute, worm like endoparasites, inhabiting marine invertebrates.



## *Salient features*

- Small vermiform body – formed of only less than 100 cells.
- Body has 2 divisions, anterior – ***calotte*** & posterior – ***trunk***
- Body is diploblastic, outer – ***somatoderm*** & inner – ***axoderm***.
- Simple internal organization, without body cavity, nerve cells, muscle cells, skeletal elements, tissues & organs.
- Complex reproduction & life cycle with alternation of asexual & sexual generations.

## *Classification*

- Classified into two phyla – ***orthonectida & rhombozoa.***



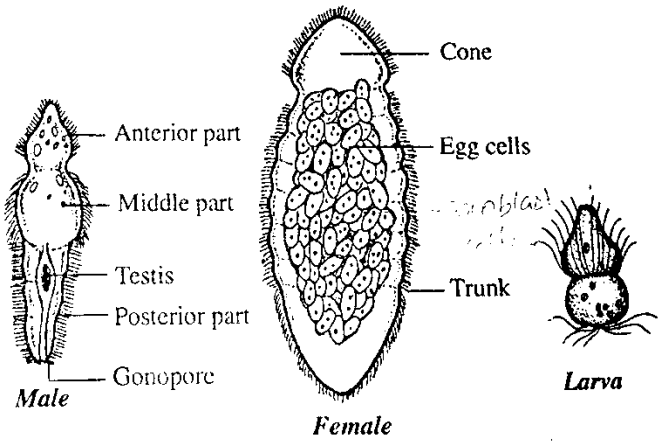
## Orthonectida

- Endoparasitic mesozoans
- Inhabiting turbellarians, gastropods, ascidians,..
- Adults are unisexual
- Axial cell is absent in adult sexual phase
- Exhibit sexual dimorphism – females are larger than males.
- Fertilization & development is internal
- Zygote develops to two layered ciliated larva.
- Eg:- Rhopalura

Prepared by Jasla Mol KK
Assistant Professor, Department of Zoology

## *Rhopalura*

- Endoparasites in annelids, molluscs, echinoderms, tunicates,..
- Body is minute with ciliary covering
- Body is enveloped by thin cuticle
- Below the cuticle is somatoderm – formed of single layered ciliated somatic or jacket cells.
- Below somatoderm – extracellular matrix & a contractile sheath – formed of ***myocytes*** or contractile cells – encloses developing sperm or ova.
- Myocytes contains protein ***paramyosin***
- Gonochoric
- Female body – bipartite – trunk filled with egg mass
- Male body – tripartite – somatoderm of anterior contains refractive granules, middle region contains testis, posterior region bears gonopore



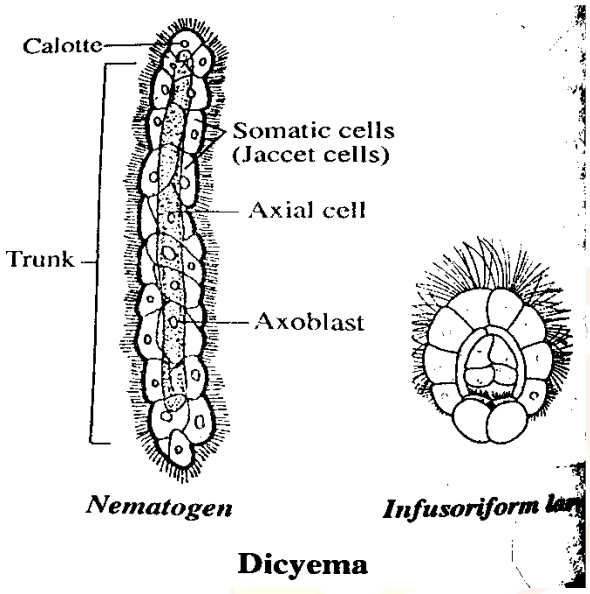

**Rhopalura**

## Rhombozoa

- Also called dicyemida
- Living in excretory organs of cephalopod molluscs
- Larger than orthonectids
- Hermaphrodites
- Self – fertilization is rule
- Larva escapes from adult along with urine
- Eg:- Dicyema

## *Dicyema*

- Endoparasites living in the ***excretory organs*** of octopuses, cuttle fishes,..
- Free living stage is an ineffective ciliated larva
- First adult stage – ***Nematogen***
- ***Calotte*** – adhesive part specialized for the attachment to the nephridial lining of the host




**Dicyema**

- Outer – somatoderm , inner – axoderm
- ***Somatoderm*** – single layered – formed of ciliated somatic or jacket cells
- ***Axoderm*** – consist of single axial or tube cell – contains reproductive stem cells called ***axoblasts***
- Axoblasts can undergo asexual & sexual reproduction
- ***Stem nematogens*** – axoblasts undergoing asexual reproduction
- ***Daughter nematogens*** – stem nematogens develop parthanogenetically
- Clonal multiplication continues till the population becomes very dense
- At this point, sexual reproduction occurs.
- ***Rhombogens*** – axoblasts develops to different individual in sexual reproduction
- ***Infusorigens –*** self fertilizing hermaphroditic individual
- ***Infusoriform larvae*** – ciliated & bilaterally symmetrical larva.

B.SC. ZOOLOGY CORE COURSE

ANIMAL DIVERSITY : NON CHORDATA PART – 1

1ST SEMESTER

## SECTION C. KINGDOM : ANIMALIA

## MODULE 6

## SUB KINGDOM : PARAZOA

## PHYLUM PORIFERA

- Commonly called ***sponges or pore bearers***
- Sessile, aquatic – mostly are marine
- ***Cellular grade of organization*** – body is formed of loose aggregation of cells, without tissues & organs
- ***Porous body*** – openings called ostia or incurrent pores
- ***Internal canal system*** – circulation of water & the transport of food & oxygen
- Presence of ***spongocoel or paragastric cavity*** – central cavity opens outside by ostia, passage known as osculum
- Presence of ***choanocytes*** – flagellated & collar cells in the lining of spongocoel & canal system
- Body is supported by ***spicules & spongin fibres –*** supports the gelatinous matrix in the body wall
  ***Spongin*** – silk like & elastic substance
  ***Spicules*** – small bristles formed of silica or calcium carbonate
- Very ***high power for regeneration***
- Reproduction – sexual & asexual



## Classification

- Phylum porifera is divided into three classes **– *Calcispongiae, Demospongiae & Hyalospongiae***
- Based on chemical composition & the structure of the supporting skeleton

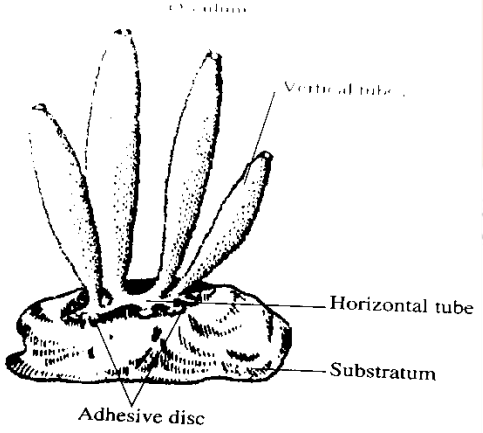
## *Calcispongiae*

- Also called ***calcarea***
- Commonly called ***calcareous sponges***
- Primitive of all sponges
- Members are small sized, simple & solitary or colonial

- Cylindrical or vase like body
- Spicules are formed of ***calcium carbonate***
  Monaxonic (single layered) or tetraxonic (four layered)
- Osculum is fringed with bristles
- Choanoytes are large
- Eg:- ***Leucosolenia***

## *Leucosolenia*

- Simplest form of sponges
- Small, delicate, sedentary, branching, colonial marine sponge
- Colony may be simple or complex
- Colony consists of a few simple vase like vertical tubes arising from horizontal tubes attached to the substratum with adhesive discs.
- Each tube encloses a central cavity – spongocoel – open out by osculum
- Tube bears numerous ostia
- Complex colonies have a complex network of branching horizontal tubes
- Outermost tubes fuse together forming a false surface or pseudoderm and leaving a few large openings or pseudopores.




**Leucosolenia**

- The body wall is thin and consists of outer epidermis and inner endodermis, known respectively as *pinacoderm and choanoderm*.
- The two cellular layers are separated by a jelly like non cellular layer of *mesenchyme or mesogloea.*
- The cells of the pinacoderm are called *pinacocytes* and those of the choanoderm are called *choanocytes or collar cells*.
- A choanocyte is a flagellated oval cell whose flagellum is surrounded basally by a contractile and transparent protoplasmic collar
- The beating of the flagella of choanocytes maintains a water current in the body.

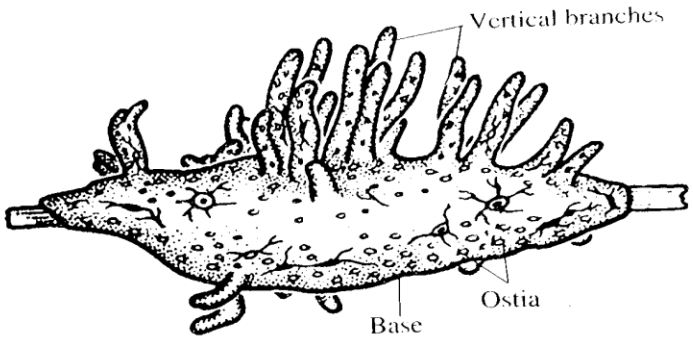
- Choanocytes secrete mesenchyme which holds the calcareous spicules or sclerites in place.
- The spicules are scereted by scleroblast cells and they remain embedded in the mesenchyme.
- Leucosolenia has no locomotor powers, and it is devoid of sensory cells and nerve cells.
- Feeding is by means of canal system, which is of the asconoid type
- There is no specialized organs for respiration and excretion and these processes take place by diffusion
- Reproduction is by sexual and asexual methods.
- Asexual reproduction is by budding
- Hermaphrodite
- Internal cross fertilization is the rule
- Has great powers for regeneration

## ***Demospongiae***

- Largest group of sponges
- Family ***Spongillidae*** – fresh water form
- Compact, massive & brightly coloured body
- Spicules & fibres are formed of ***spongin or silica***
  Monaxonic or tetraxonic
  Differentiated into large megascleres & small microscleres
  In some forms these are absent
- Spongocoel is absent
- Contractile vacuoles are present in fresh water species
- Eg:- ***Spongilla***

## *Spongilla*

- Sedentary, branching and colonial freshwater sponge
- Permanently attached to submerged sticks and plants in ponds, lakes and streams
- Due to the presence of the green algae *Zoochlorellae* in its tissues.
- Spongilla is generally green in colour.
- Spongilla colony has a flat and branching base for attachment.
- Arising from it are numerous vertical branches, with terminal oscula.
- The surface of the vertical tubes bears numerous ostia, which open to the spongocoel.




- The canal system is of the ***rhagon*** type.
- Skeleton consists of a network of siliceous spicules, embedded in spongin.
- Spongin is valuable in medical and dermatological treatments.
- Spongilla mostly feeds on algae.
- Reproduction is both asexual and sexual.
- Asexual reproduction is by gemmules.
- Sexual reproduction involves an unusual free swimming larva, which is characteristic of spongilla.

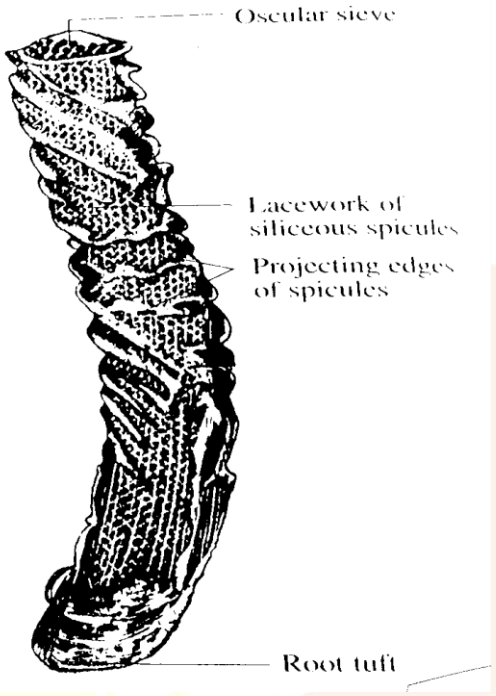
## *Hyalospongiae*

- Also called ***hexactinellida***
- Commonly called ***glass sponges***
- Mostly deep sea forms – living in dark & cold places
- Solitary forms
- Cylindrical or funnel shaped body
- Outer layer & inner flagellated layer of the body wall are syncytial
- Contractile elements are absent in the body wall
- Spicules – ***glass like silicious***
  Hexaxonic (six layered) – hence the name hexactinellida
- Simple canal system
- Eg:- ***Euplectella***

## *Euplectella*

- Euplectella is otherwise called ***glass sponge or Venus flower basket***
- It is a solitary marine sponge
- The body of Euplectella is cylindrical, thin-walled and curved.
- An oscular sieve, formed of fused spicules, closes the upper end.
- The lower end has anchoring siliceous root spicules.

- The body encloses a spongocoel.
- There is no epidermis of pinacocytes.
- Encircling the cylinder are projecting ledges of spicules.
- Skeleton is made of siliceous tetraxon and hexaxon spicules bound together by siliceous cement.



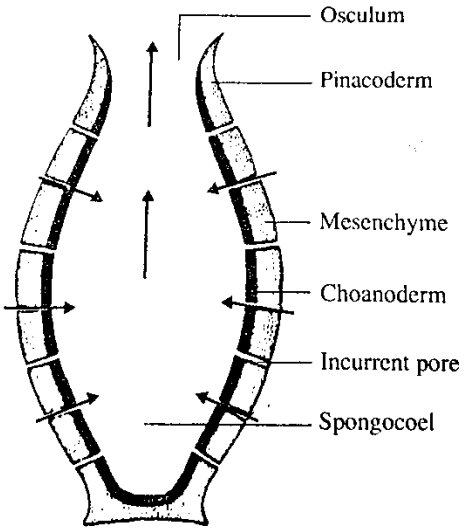

- Canal system of Eupectella is of the sycon type.
- The large spongocoel of Euplectella often harbours crustacean commensals, such as *Spongicola venusta*.



## Canal system in sponges

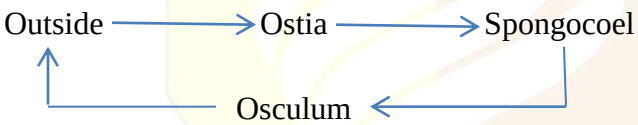
- Unique feature
- System of pores, canals & cavities
- Lined by flagellated collar cells – ***choanocytes***
- Helps in nutrition, respiration, excretion & reproduction
- Four types – ***asconoid, syconoid, leuconoid & rhagonoid***

## *Asconoid*



**Asconoid type**

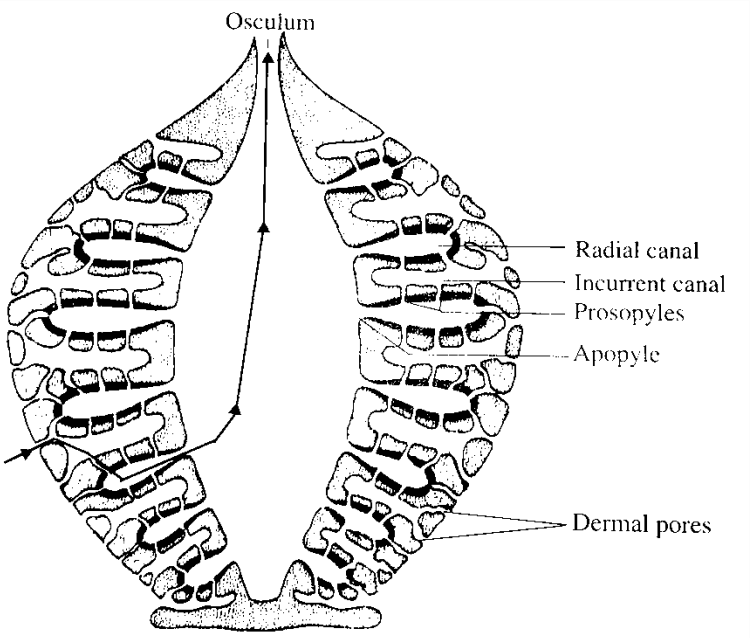
- Simplest type
- Important features
    1. Simple wall
    2. Continuous lining of choanocytes interrupted only by ostia
- Body wall – thin –encloses spongocoel
- Spongocoel opens out by osculum
- Body wall – three layers
    1. Outer epithelium – pinacoderm – single layer of flat cells
    2. Inner epithelium – choanoderm – choanocytes
    3. Middle mesenchyme – gelatinous matrix – spicules & amoebocytes
- Incurrent pores or ostia – microscopic pores on body wall – intracellular
- Porocytes – pores run through specialized cells
- Course of water current




- Eg:- Leucosolenia

## *Syconoid*

- Modified form of asconoid type
- Radial canals – wall is pushed out into finger like projections at regular intervals
  Flagellated canals – radial canals are lined with choanocytes & are called flagellated canals
  Primitive forms – projections are free
  Advanced forms – walls are fused
- Incurrent canals – walls of radial canals fuse together to form a tubular spaces
- Dermal ostia or dermal pores – opening of incurrent canal to outside
- Internal ostia or apopyles – radial canals opens to spongocoel
- Prosopyles – incurrent canal opens to radial canal




**Syconoid type**

- Course of water current

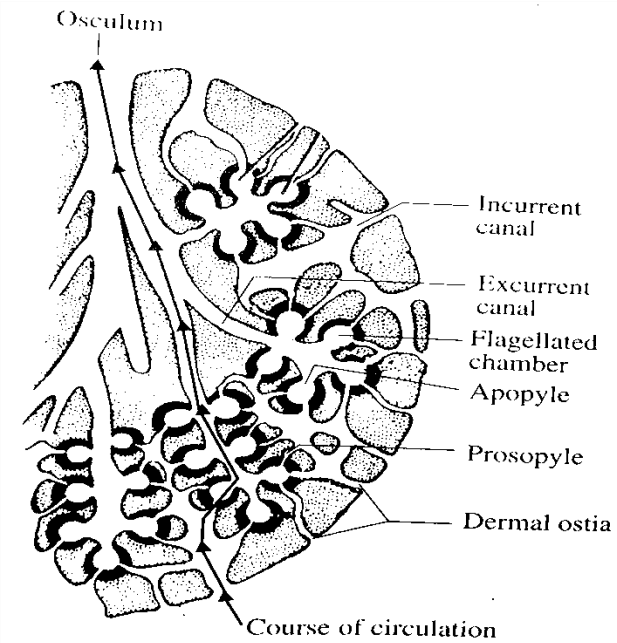
Outside → Dermal pores → Incurrent canals → Prosopyles ↓

Osculum ← Spongocoel ← Apopyles ← Radial canals

- Eg:- Sycon

## *Leuconoid*

- Advanced & complex than asconoid & syconoid.
- Modification of syconoid.
- Increased outfolding of choanoderm & further thickening of body wall.
- Radial canals in syconoid evaginates to form clusters of small rounded or oval ***flagellated chambers.***
- Choanocytes are limited to flagellated chambers.
- Mesenchyme fill the space in between chambers.
- Spongocoel is invisible.




**Leuconoid type**

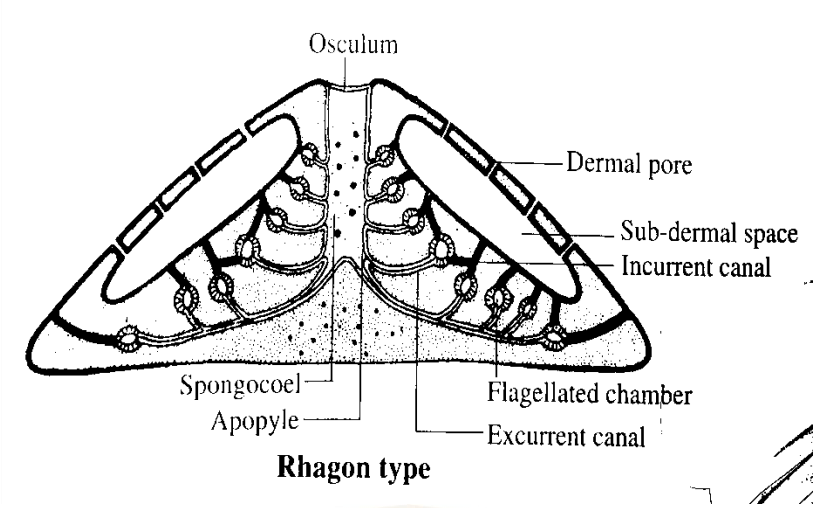
- Course of water current

Outside → Ostia → Incurrent canals → Prosopyles → Flagellated chambers → Apopyles → Excurrent canals → Large channels → Osculum → Outside

- Eg:- Spongilla

## *Rhagonoid*

- Arises by the direct re arrangement of the inner cell mass.
- Conical in shape
- Broad base
- Basal wall is devoid of flagellated chambers – hypophare.
- Upper wall – spongophare, bears a row of small, oval flagellated chambers.
- Choanocytes are limited to flagellated chambers.
- Between chambers & epidermis is a thick mass of mesenchyme – traversed by incurrent canals & sub – dermal spaces.




**Rhagon type**

- Course of water current

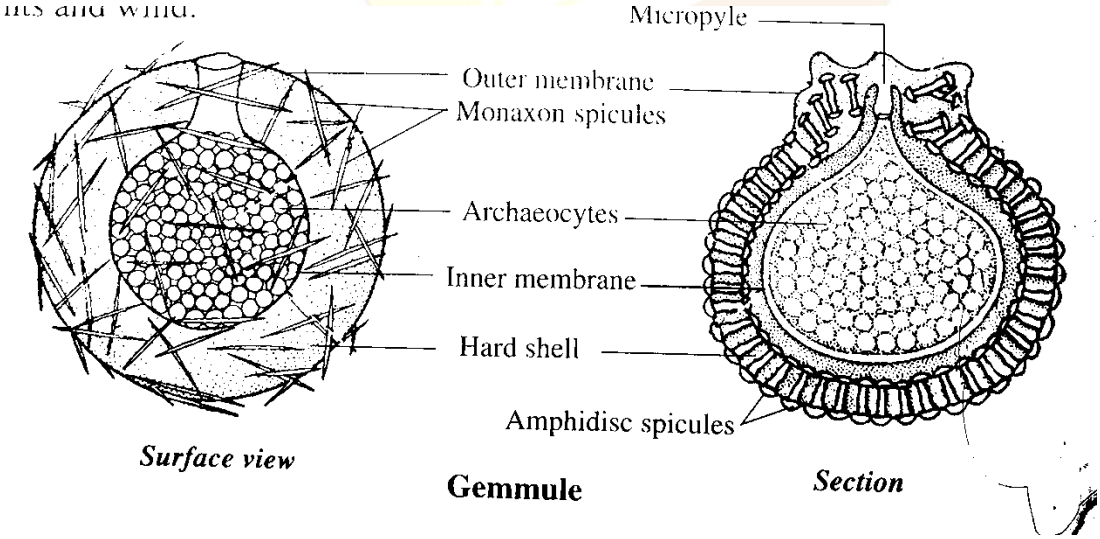
Outside → Ostia → Sub dermal spaces → Incurrent canals → Prosopyles

↓

Flagellated chambers → Excurrent canals → Apopyles → Spongocoel → Osculum

- Eg:- Spongilla larva

## Sponge gemmule




*Surface view* **Gemmule** *Section*

- Asexual endogenous buds of sponges
- Come into activity on the death of parent sponge.
- Occurs in fresh water sponges & also in some marine forms.
- Highly resistant bodies.

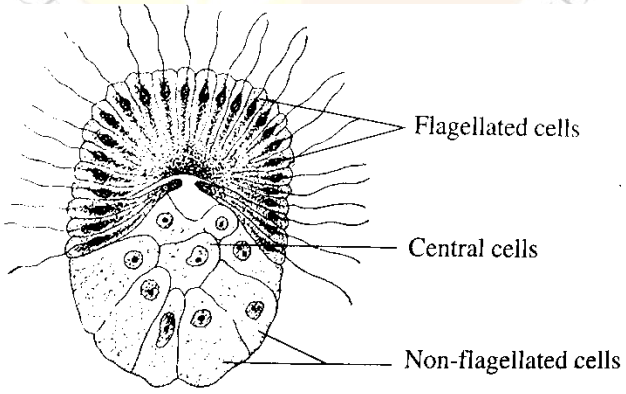
- Enable sponges to tide over adverse climatic conditions.
- It is a food laden packet of multinucleate mesenchymal archaeocytes, contained within a membraneous bag & enclosed by a shell.
- ***Trophocytes*** – special nurse cells contains reserve proteins.
- Shell is secreted by amoebocytes & strengthened by spicules by ***amphidiscs***.
- ***Micropyle*** – small opening, represents future escape opening.
- Gemmules may be carried far & wide by water currents & wind.
- They form large numbers in autumn.
- Germinate or hatch out during spring.
- During hatching, multinucleate archaeocytes undergo division & form uninucleate small cells – ***histioblasts***.
- ***Foraminal tube or neck*** – outpushing of membraneous coat through micropyle.
- Some histioblasts differentiate to scleroblasts & secrete spicules, rest remain embryonic.

**Sexual reproduction**

- Sponges are hermaphrodites.
- Cross fertilization is the rule.
- Some are oviparous & some are larviparous.

## Amphiblastula

- Hollow ball – composed of two type of cells – anterior flagellated & posterior granular.
- Found in calcareous sponges & demospongiae.



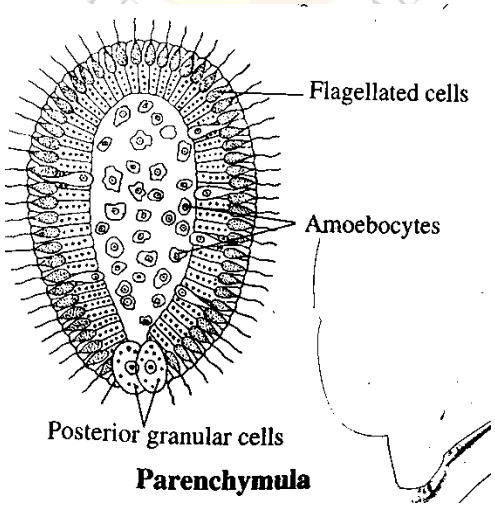

**Amphiblastula**

- At 16 celled stage – embryo forms flat disc shape.
- Cells are arranged in two tiers of eight each.
- Eight cells next to maternal layer – future epidermis.

- Inner layer – future choanoderm.
- *Choanocytes divide rapidly & aquire flagella on inner side.*
- *Epidermal cells becomes granular & form large cells.*
- *Break appears in the centre* – ***Stomoblastula.***
- *Stomoblastula undergoes inversion through opening.*
- *Flagellated cells brought to outside & a hollow ball of cells is formed with anterior flagellated & posterior granular –* ***Amphiblastula****.*
- Amphiblastula is enclosed within a trophic membrane – supplies nutrients.
- It escapes from the parent body.
- Embolic gastrulation – flagellated anterior part invaginates & non flagellated cells spread over them.
- Larva fixes to a substratum & further development occurs.

## Parenchymula

- Free swimming flagellated larva.
- Found in calcareous sponges & demospongiae.
- It is a solid mass of cells – outer flagellated , inner amoeboid & posterior granular cells (non flagellated polar cells).
- Formation occur in different ways :-
  1. ***Stereoblastula*** – outer cells flagellated (single layer) & encloses the other cells.
  2. ***Coeloblastula*** – single layer of flagellated cells around a central cavity (blastocoel). Some of the flagellated cells lose their flagella & migrate to central cavity & become amoeboid. Flagellated gastrula is formed – ***stereogastrula***.
- Parenchymula detaches from parent & attaches to a substratum & metamorphoses to a sponge.



**Parenchymula**

B.SC. ZOOLOGY CORE COURSE

ANIMAL DIVERSITY : NON CHORDATA PART – 1

1ST SEMESTER

## SECTION C. KINGDOM : ANIMALIA

## MODULE 7

## SUB KINGDOM : METAZOA

## PHYLUM CNIDARIA

- Radial or biradial symmetry
- Tissue grade organization
- Diploblastic body
- ***Tentacles***: Cnidarians have characteristic finger-like or thread-like structures, called tentacles. Tentacels are helpful in defence, locomotion and food collection. They are armed with batteries of offensive and defensive cells, called ***cnidocytes***.
- Presence of cnidoblasts and cnidae : The presence of cnidoblasts (cnidocytes, nematoblasts, nematocytes, or stinging cells) is a unique feature of cnidarians. Each cnidoblast contains a poison-filled membranous capsule - ***cnida*** (nematocyst or spirocyst).
- Presence of coelenteron
- Primitve nervous system formed of a nerve net.
- Presence of polypoid & medusoid individuals.
- Polymorphism & division of labour.
- Asexual reproduction by budding.
- Sexual reproduction involves ***planula larva***.
- Metagenesis or alternation of generations.



### *Classification*

Classified into four – hydrozoa, scyphozoa, anthozoa & cubozoa.

### Class Hydrozoa

1. Tetramerous or polymerous radial symmetry.
2. Ideal diploblastic condition, with typically non-cellular mesoglea.
3. Presence of an outer perisarcal covering, secreted by the epidermis.
4. Simple gastro-vascular cavity.
5. Presence of polypoid and medusoid individuals.
6. Medusae are typically craspedote (provided with velum).
7. Occurrence of metagenesis

Prepared by Jasla Mol KK
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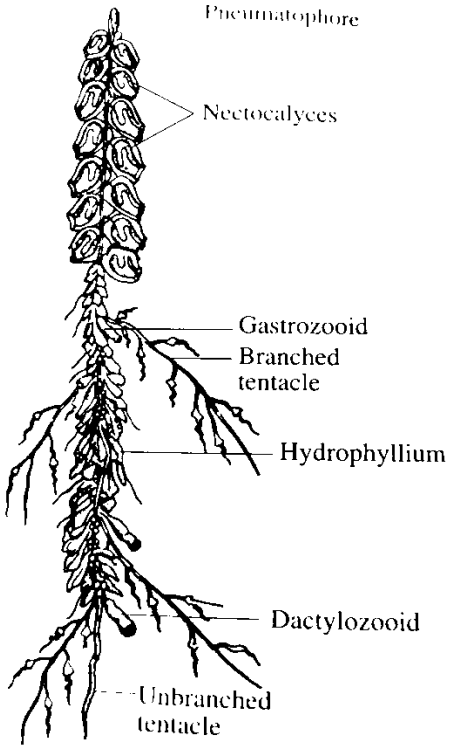
## *Halistemma*

- Marine
- Polymorphic
- Pelagic hydrozoan colony
- Division of labour among the zooids.
- The colony consists of a small gas-filled apical float or bladder called ***pneumatophore***.
- Hanging down from it is a long and slender floating stem.
- The stem bears a series of bilaterally arranged polymorphic zooids.
- Below the pneumatophore there are numerous closely set swimming zooids, called ***nectocalyces*** or swimming bells (singular- nectocalyx) - They are concerned with the locomotion of the colony.
- Below the nectocalyces are several clusters of zooids, called ***cormidia***.

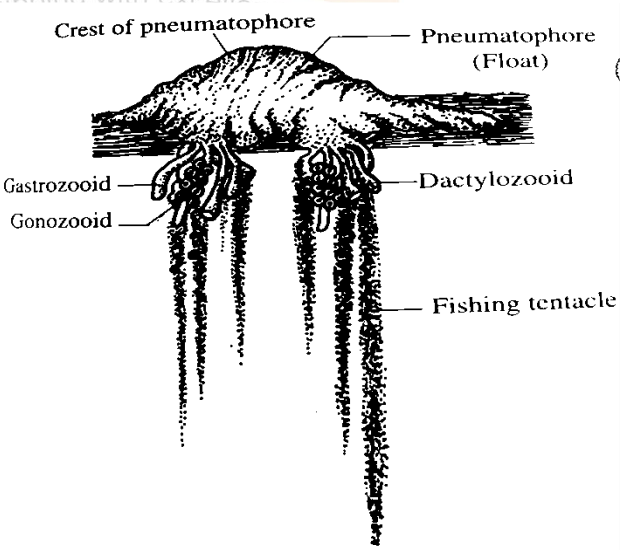



- Each cormidium consists of four kinds of zooids, namely ***gastrozooids, dactylozooids, gonozooids and hydrophyllium or bract.***
- ***Gastrozooids*** are tubular ***nutritive zooids***, with mouth, manubrium and a long and branched oral tentacle. The tentacle is armed with batteries of nematocysts.
- ***Dactylozooids*** are tubular ***defensive zooids***, without mouth, manubrium and oral tentacle but with an unbranched and sensory basal tentacle.
- ***Gonozooids or sporosacs*** are the ***reproductive zooids***, with bunches of gonophores but without mouth, manubrium and tentacle.

- ***Hydrophyllium or bract*** is the shield-like ***protective zooid*** which covers and protects the cormidium.
- *Halistemma* exhibits metagenesis or a regular alternation between asexual and sexual generations in its life cycle.
- Gonozooids reproduce sexually. This involves a ***planula larva.***
- After a short period of free-swimming life, planula elongates. Then, its upper end invaginates and becomes the pneumatophore. The lower end becomes a polyp. This initial polyp elongates, undergoes repeated budding and thus forms a colony.

## *Physalia*

- ***Portugese – man – of war or blue bottle***.
- Marine
- Polymorphic, colonial

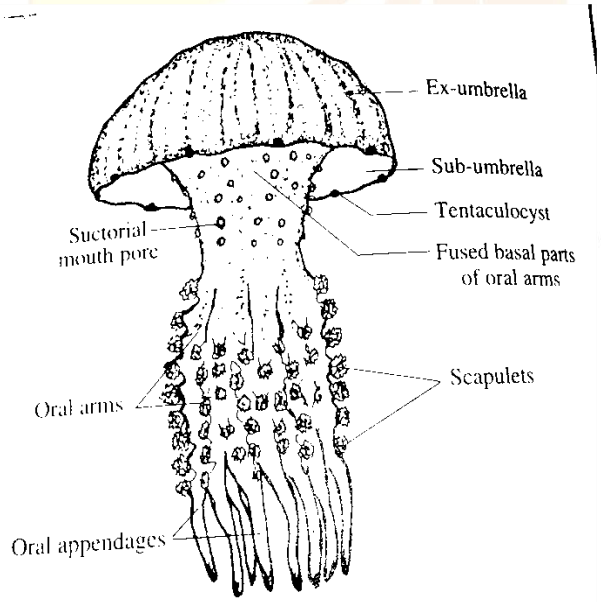



- Division of labour among zooids.
- Colony floats with the help of pneumatophore.
- Cormidia arranged in the ventral side of the pneumatophore.
- Three kinds ef polypoid zooids - gastrozooids or trophozooids, gonozooids and dactylozooids.
- Gastrozooids are nutritive
- Gonozooids reproductive
- Dactylozooids defensive in function.
- Gonozooids are borne on a branching blastostyle, called gonodendron.
- The numerous nematocytes, fired from the tentacles of physalia, may cause painful irritations and festering wounds on the victim.
- Physalia is ***brilliantly coloured and spectacular***.
- Its zooids are usually tinted blue, giving the colony an attractive appearance.

## Class Scyphozoa

- A group of ***large-sized medusoid coelenterates.***
- Popularly known as ***jelly-fishes***.
- Members are exclusively marine, pelagic and solitary.
- Polypoid phase is absent or reduced.
- Medusoid phase is prominent.
- Medusae are acraspedote.
- ***Tentaculocysts or rhopalia*** are the characteristic marginal sensory receptors.
- Gastro-vascular cavity has no stomodaeum.
- Mesogloea is usually cellular, containing wandering amoeboid cells.
- Medusoid adults are dioecious, each with four gonads.
- Gonads and sex cells are endodermal.
- Sex cells are discharged to the gastro-vascular cavity, and not directly to the outside.

### *Rhizostoma*




- Popularly called ***jelly fish***
- Large sized
- Free swimming
- Body is gelatinous & umbrella shaped
- Marginal tentacles are absent.
- Mouth is absent in adult.
- It gets closed due to the overgrowth of oral arms.

- The gastro-vascular cavity opens out by thousands of small sectorial pores, called ***mouth pores***.
- This is called ***polystomatous***.
- Oral arms are four in number.
- Each arm terminally divides into two oral appendages.
- Oral arms are provided with root-like tentacles and fringed outgrowths, called ***scapulets***.
- Scapulets are provided with mouth pores, mucus cells and cnidoblasts for food collection.
- Digestion occurs outside, with the help of the secretions from mouth pores.

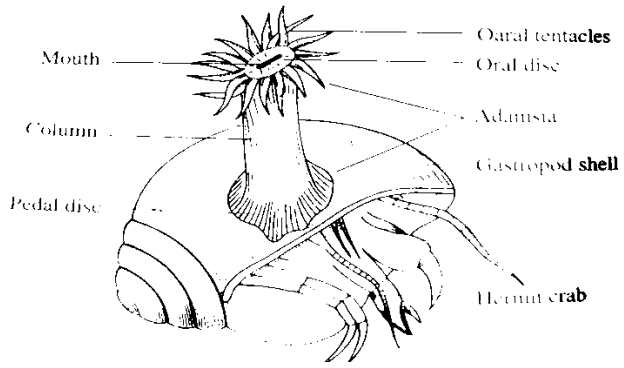
## Class Anthozoa

- The ***largest coelenterate class*** of solitary or colonial marine forms.
- Only ***polypoid forms*** are present; medusoid stage is completely suppressed.
- Cylindrical body with hexamerous, octomerous, or polymerous biradial or radio bilateral symmetry.
- Oral end is expanded radially, forming an oral disc.
- Loosely cellular (mesenchymatous) mesogloea with wandering amoeboid cells and branching muscle fibres.
- A horny exoskeleton, secreted by the epidermis, is present in most forms.
- Gastro-vascular cavity has prominent stomodaeum.
- At one or both the ends, stomodaeum has a ciliated groove, known as ***siphonoglyph***.
- Most individuals are unisexual. Gonads are endodermal. Sex cells are discharged the coelenteron, and not directly to the outside.



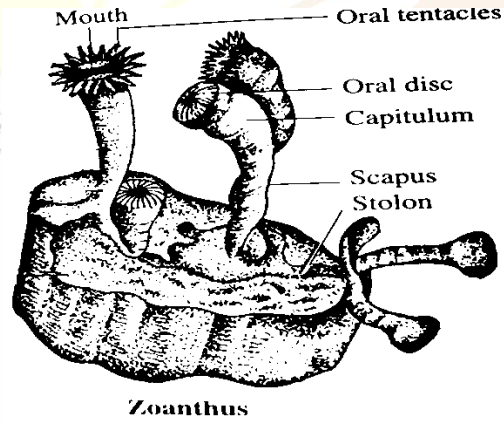
### *Adamsia*

- *Adamsia* is a marine, solitary and sedentary ***sea-anemone.***
- It remains attached to rocks, or to the ***shells of gastropods occupied by hermit crab***.
- The body of *Adamsia* has three divisions, namely ***pedal disc, column and the oral disc***.
- Pedal disc is the flat, saucer shaped and sucker - like basal portion.
- It has two prominent lobes or discs for attachment.
- Column is the long, cylindrical and highly contractile middle portion.
- It bears a band of cinclidal tubercles at its base.
- Cinclides (singular - cinclids) are perforations for the extrusion of acontia (thread like processes of mesenteric filaments, armed with nematocytes).
- Oral disc is the flat terminal part, which bears the central mouth and a crown of marginal tentacles.
- Mouth leads to the coelenteron, which is partitioned by six pairs of mesenteries.




- ***Ecological association*** :- Adamsia and hermit crab furnish an excellent example of facultative mutualism.
- Crab usually occupies an empty gastropod shell and provides adamsia free transportation and some food particles.
- In return, Adamsia provides the crab camouflage and protection from enemies.
- It covers and protects the crab and scares away enemies by firing stinging cells.
- Hermit crab dislodges the anemone from rock with the help of its appendages and fixes it on the back of the shell.

## *Zoanthus*

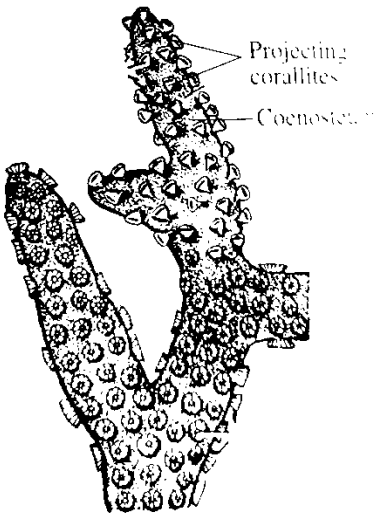


Zoanthus

- *Zoanthus* is a marine, colonial anthozoan.
- All the zooids of a colony are joined together by a branching, fleshy stolon, give out from the initial polyp.
- *Zoanthus* colony is epizoic.
- Its body has two portions, namely oral disc and column.
- Oral disc bears the mouth and a marginal circlet of unbranched & brightly coloured oral tentacles.

- Tentacles are arranged in two alternating cycles on the margin of the disc, namely exocoelic cycle and endocoelic cycle.
- Mouth is oval.
- It leads to a laterally flattened gullet, which has only a single ventral siphonoglyph (longitudinal groove).
- Column is the cylindrical. It is divisible into two portions, namely the basal ***scapus*** and the terminal ***capitulum.***
- Sexes are separate in *Zoanthus.*
- Sexual reproduction involves a pelagic larva, known as *Semper's larva* or *Zoanthina larva.*

## Madrepora






- ***Staghorn coral***
- Branching and reef-building colonial coral.
- The branching colony consists of numerous small, crowded polyps, housed in cylindrical cups, called ***corallites***.
- They are conspicuously elevated or projecting and distinctly separate from each other.
- The entire skeleton of the whole colony is called ***corallum***.
- The porous portion of the corallum in between the corallites is called ***coenosteum***.
- Each corallite has a dense outer wall, called ***theca***.
- It encloses a central cavity.
- Extending from the thecal wall to the centre of the thecal cavity are numerous vertical partitions, called ***selerosepta***.

## Type Obelia: Morphology and life cycle

- Obelia is marine, polypoid and dimorphic colonial coelenterate.
- Living in large number in the shallow coastal waters.
- It is a branching sessile form.
- Characterized by polymorphism, division of labour and metagenesis.
- Obelia colony consists of numerous organically continuous individuals, known as ***zooids.***
- All the zooids of a colony are formed by the repeated budding of a hydra-like parental or primary polyp, called ***hydrula***.
- The zooids - hydranths or gastrozooids and gonangia or gonozooids.
- Hydranths are nutritive, and gonangia reproductive in function - division of labour.
- Gonangia reproduce asexually and forms free-swimming sexual zooids - ***medusae***.
- Obelia colony has a branching base for attachment - ***hydrorhiza or stolon***.
- From it arise numerous vertical stems, called ***hydrocauli***.
- Hydrocauli bears numerous branches & ends in zooids.
- Obelia reproduces asexually and sexually.
- The polypoid colony reproduces asexually by budding.
- Medusa reproduce sexually by syngamy.
- Mature medusae undergo sexual reproduction.
- Sperms from male medusae and ova from female medusae are discharged to the surrounding sea water.
- Fertilization takes place in the open water.
- But occasionally, sperms may reach the female medusa through incoming water currents. In such cases, fertilization may take place inside female medusae.
- The zygote undergoes holoblastic and equal cleavage. The resulting blastomeres initially form a solid ball, called ***morula***.
- Morula undergoes blastulation. Forms coeloblastula.
- Blastulation is followed by gastrulation & forms stereogastrula.
- It develops to free swimming larva – ***planula***.
- Metagenesis – regular & cyclic alternation between asexual & sexual generations.

## Polymorphism in cnidarians with special reference to siphonophores

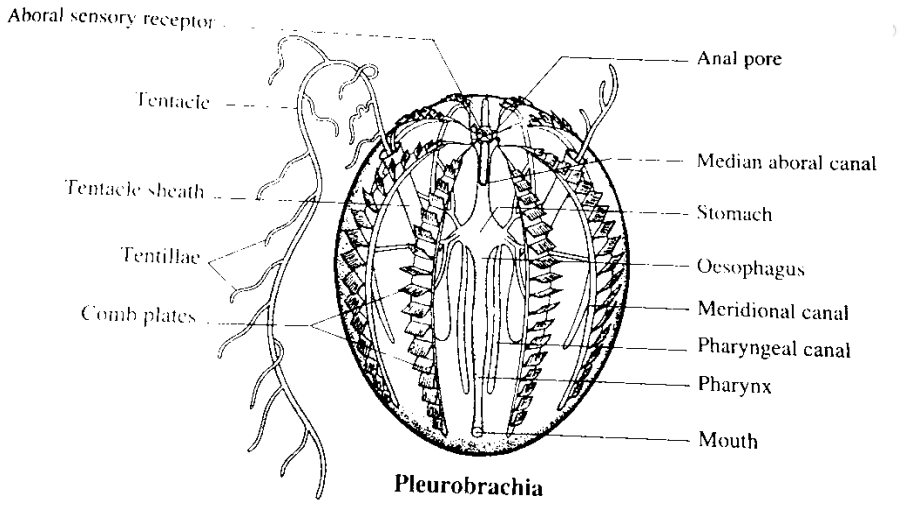
- There are three kinets of polypoid zooids and four kinds of medusoid zooids in a siphonophoran colony.
- The polypoid zooids includes gastrozooids, dactylozooids and gonozooids or blastostyles.
- The medusoid zooids include floating or hydrostatic pneumatophores or floats, locomotor nectocalyces, protective phyllozooids, reproductive gonophores.
- Gonophores are dioecious.

- A colony may contain male and female gonophores.
- The zooids of a colony may be arranged in bundles, called ***cormidia***.
- A siphonophore colony originates as an inverted axial polyp.
- The elongated and tubular axial stem of this polyp is called ***siphonosome or column***.
- Its pedal (aboral) end in almost all cases is invaginated to form a gas-filled float, called ***pneumatophore***.
- The opposite oral end of the axial polyp bears a mouth, and sometimes tentacles also.
- The zooids of the colony arise as lateral buds of the siphonosome.
- As the colony grows, new cormidia may be added to it in regular succession towards the pedal end. So, the youngest cormidium located near the pneumatophore, and the oldest one near the mouth.

## PHYLUM CTENOPHORA

- Ctenophora or Acnidaria
- Small group of exclusively marine, radially or biradially symmetrical, delicate, transparent and solitary pelagic animals.
- They are popularly known as ***comb jelljes or comb-bearers***.

## Pleurobrachia



Pleurobrachia

- Popularly known as the ***combjelly, sea walnut" or "sea gooseberry***".
- planktonic ctenophore
- inhabiting the surface water of seas.
- Pear shaped
- Biradially symmetrical

- Transparent and gelatinous
- Broad upper or aboral pole & a narrow lower oral pole.
- Centre of oral pole is mouth.
- Centre of aboral pole are two anal pores and a characteristic aboral sensory receptor.
- Running between the two poles of the body are eight equally spaced meridional rows of ciliary bands, known as ***comb-ribs, comb-rows, or costae***.
- Each band consists of a series of paddle-like transverse ciliary plates, known variously as ***ctenes, combs, comb-plates, paddle plates, or swimming plates***.
- Each plate, in turn, is a transverse ridge formed by the fusion of long cilia. The cilia are fused basally but free distally, just like the teeth of a comb.
- Comb-plates are locomotor structures and the constant beating of their cilia brings about the swimming movement of the animal.
- Near the aboral pole, there are two deep pouches – ***tentacle sheaths.***
- Emerging from each sheath is a long, muscular and extensile tentacle.
- Tentacles are equipped with specialized adhesive epidermal cells; called ***collocytes***.
- Tentacles play an active role in food capture and ingestion.

## *Cydippid larva*

- Sexual reproduction of ctenophora involves the development of planktonic juvenile larva.
- Juvenile attains precocious sexual maturity & reproduces successfully.
- There are two sexually mature stages in the same animal – juvenile & adult.
- This phenomenon is called ***dissogeny or dissogony***.

B.SC. ZOOLOGY CORE COURSE

ANIMAL DIVERSITY : NON CHORDATA PART – 1

1ST SEMESTER

## SECTION C. KINGDOM : ANIMALIA

## MODULE 8

## ACOELOMATA

### PHYLUM PLATYHELMINTHES

- Commonly called ***flatworms***.
- Soft, flat, bilaterally symmetrical and unsegmented body
- Triploblastic body
- Presence of adhesive organs: Flatworms have spines, hooks, bothria and bothridia for attachment.
- Parenchyma fills the interior
- Branching alimentary canal without anus
- Protonephridia with flame cells for excretion
- Ladder-like nervous system
- Complex reproductive system
- Internal fertilization
- Absence of locomotor, circulatory and respiratory organs.



### *Classification*

Classified into three classes, namely turbellaria, trematoda & cestoda.

### Class Turbellaria

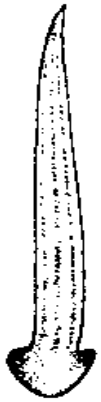
- Free -living flatworms
- Most of them are large and visible to the naked eye.
- Unsegmented body, without cuticular covering.
- Single-layered and ciliated epidermis and rod-shaped sub-epidermal bodies, called rhabdites or rhabdoids.
- Adhesive structures include glandular and glandulo-muscular cells.
- Conplex musculature, consisting of girdle-like outer circular and inner longitudinal muscles.
- Blindly ending digestive tract.
- Excretory and osmoregulatory organs are protonephridia with flame cells.

Prepared by Jasla Mol KK
Assistant Professor, Department of Zoology

- Simple nervous system with an unspecialized brain and two or more longitudinal nerve cords.
- Sense organs include photoreceptors, tangoreceptors, chemoreceptors and mechanoreceptors.
- Reproduction is asexual as well as sexual.
- High regenerative powers.
- Sexual individuals are mostly hermaphrodites.
- Development, in general, is direct. But, in some polyclads it is indirect with uniformly ciliated, planktotrophic (plankton-feeding) larvae, such as four-armed ***Goette's larvae*** and eight-armed ***Muller's larvae***.
- Eg:- *Bipalium*

## *Bipallium*

- Free-living, brilliantly coloured and nocturnal.
- Body is long, slender, soft, and flat, with detinite anterior and posterior ends, and dorsal and ventral surfaces.
- The dorsal surface of the body is variously coloured and striped, and the ventral surface bears a creeping sole.
- A distinct head is absent.



- Anterior end is broad, flat, almost triangular, and spatulate or axe-shaped.
- Along its border is a row of ocelli or eye spots.
- Mouth is ventral and intestine is tripartite
- Reproduction is asexual as well as sexual.
- Asexual multiplication is by architomic fragmentation in which the body divides into fragments and each fragment regenerates the lost parts and becomes a full fledged individual.
- Has great powers for restorative and reparative regeneration by which the animal can reconstruct the lost parts and repair damages.

## Class Trematoda

- Parasitic flatworms, commonly called ***flukes***.
- Flat, leaf-like and unsegmented adult body, without ciliary covering.
- Body is covered by a non-cellular living layer, called ***tegument***, which is a dense mass of cytoplasm.
- Adhesive organs include oral and ventral suckers and, in some cases, hooks also.
- Epidermis does not exist as a discrete cellular layer in the adult.
- Blindly ending alimentary canal, with bifid and branched intestine.
- Excretory and osmoregulatory organs are protonephridia with flame cells.
- Reproduction is exclusively sexual.
- Most members are hermaphrodites.
- Highly organized reproductive system with a common genital atrium and a common gonopore.
- Male system consists of two or more testes and their ducts and an eversible penis.
- Female system consists of an ovary, numerous vetelline glands and several shell glands.
- Life cycle is simple or complex.
- Complex life cycle involves several larval stages and one or more intermediate hosts.
- Eg:- *Fasciola*

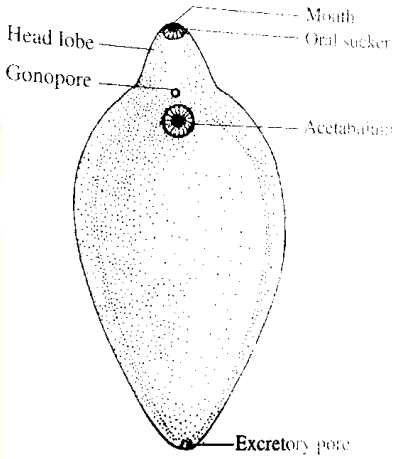
## *Fasciola hepatica*

- Popularly known as the ***sheep liver fluke.***
- It causes the serious disease ***fasciolasis or "liver rot'.***
- Adult liver fluke has a soft, dorso-ventrally flattened and conical body.
- At its broad anterior end is a conical projection, called ***oral cone*** (apical cone or head lobe).
- Mouth is situated at the tip of this cone, encircled by an ***oral sucker*** (or anterior sucker).
- Ventrally, a litte behind the oral cone, is the posterior or ventral sucker - called the ***acetabulum*** - serves as an adhesive organ for attachment to the host.
- Just in front of the acetabulum, is the common gonopore.
- At the extreme posterior tip of the body is the excretory opening.
- During breeding season, a temporary opening may be formed on the mid-dorsal surface - the external opening of a short duct, called ***Laurer's canal***, that leads out from the oviduct.
- Fasciolasis is characterized by the enlargement, inflammation & damages to the liver & bile duct.

**Preventive measures**

- The most effective method of controlling fasciolasis is the destruction of pond snails, which harbour the larvae of Fasciola.

- Pond snails can be destroyed in three principal ways:
  (a) by poisoning their habitats (ponds, marshes, ditches, ..) with copper sulphate solution
  (b) by making use of ducks which feed on them
  (c) by exposing them to hot sun and drought by draining out water from their habitats.
- Man can escape from the infection of liver fluke by eating only properly washed and cooked vegetables and also by excluding snails from the diet.
- Killing of adult flukes in the sheep by the administration of antihelminth drugs
- Prolonged storage of sheep's faeces or their treatment with quick lime or copper sulphate to destroy the eggs.




**Treatment**

- Administration of carbontetrachloride and tetrachloroethane to sheep is recommended to control infection.
- Injection of emitine hydrochloride or the synthetic drug hydroemitine is recommended to control the infection in man.

**Parasitic adaptations of liver fluke**

- Parasitic adaptations are of two main categories, namely ***degenerations and neoformations.***
- ***Degenerations*** involve the reduction or loss of existing structures.
- ***Neoformations*** involve the formation of new structures or the modification of existing ones.
- Degenerative adaptations include the absence or loss of locomotor, respiratory and circulatory organs, the absence of specialized sense organs, etc.
- Modifications and neoformations include the development of a resistant and protective tegument, the appearance of adhesive organs, high power of anaerobic respiration, hermaphroditism, complex reproductive systems, enormous fecundity, polyembryony, etc.

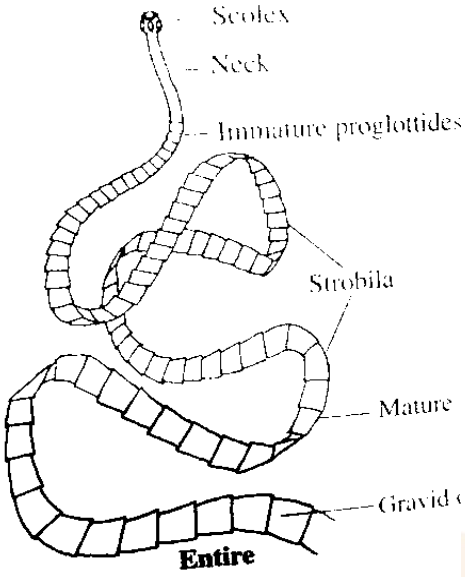
## Class Cestoda

- Endoparasitic flatworms, commonly called the ***tapeworms***.
- Intestinal parasites in vertebrates.
- Adult body is flat, segmented and ribbon-like or tape-like.
- Composed of a few to many segments, called ***proglottides***.
- Body is divisible into three regions, namely ***scolex, neck, and strobila***.
- ***Scolex*** is the unsegmented "head" region, specialized for attachment.
- ***Strobila*** is the segmented body.
- ***Neck*** is the narrow region in between scolex and strobila.
- Adhesive organs include ***hooks, suckers, bothria & bothridia***.
- Body is covered by a non-cellular protoplasmic layer, called ***tegument***, which is very important in protection, absorption, gas exchange and excretion.
- Absence of a discrete epidermal layer in the adult.
- Absence of locomotor, digestive, circulatory, respiratory and sensory organs as an adaptation to an endoparasitic mode of life.
- Excretory organs are ***protonephridia with flame cells***.
- Reproduction is sexual.
- Hermaphrodites.
- In segmented forms, each mature segment may contain a complete set of male and female organs.
- Life cycle is complex with a hooked embryo, a definitive vertebrate host and one or more intermediate invertebrate hosts.
- Eg:- *Taenia*



## *Taenia solium*

- Pork tape worm
- Endoparasitic cestode in the small intestine of man.
- Thin, flat & tape like
- Exhibits pseudosegmentation
- Body has three regions : scolex, neck & strobili.
- ***Scolex*** – small, pin head like anterior part
- Four suckers & a rostellum – terminal retractile cone – armed with chitinous hooks
- ***Neck*** – short unsegmented region – budding zone
- ***Strobila*** – long, ribbon like, segmented posterior part
- Segments called proglottids – immature, mature & ripe
- Infection causes, adult – taeniasis, cysticerci – cysticercosis
- Caused by eating improperly cooked measly pork




**Pathogenic effects**

- Intestinal irritation and intestinal blockage, leading to indigestion, constipation, diarrhoea, abdominal discomfort, gastric disturbances, anaemia, etc
- Neurological problems due to the absorption of the toxic wastes of the worms.
- Puncture of the intestinal wall by the hooks, causing peritonitis.

**Preventive measures**

- Steam-cooking or deep-freezing of pig's meat to kill cysticerci.
- Scientific inspection of pig's meat in slaughter houses to ascertain that it is free from cysticerci.
- Avoidance of improperly cooked pork.
- Sanitary control of sewage disposal and effective treatment of infected individuals.

**Treatment**

- Administration of anti-helminthic drugs

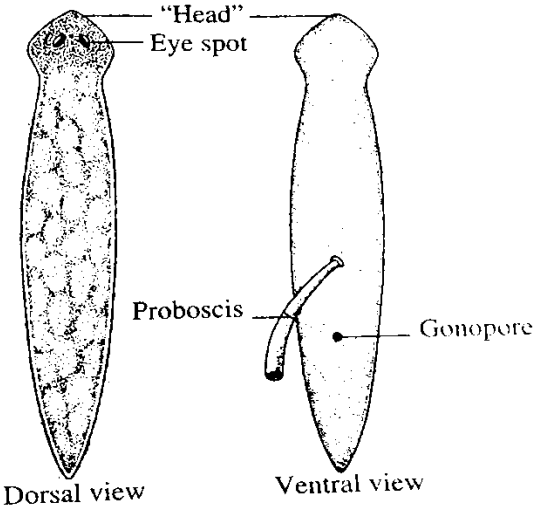
**Parasitic adaptations**

- Loss of locomotor, digestive, circulatory and respiratory organs.
- Presence of rostellum, hooks and suckers for adhesion and anchorage.
- Presence of a resistant and freely permeable covering, called tegument, for protection from host's enzymes and also for the absorption of nutrients.
- Great powers for anaerobic respiration
- Absence of brain and receptor organs.
- Hermaphroditism
- Enormous reproductive power.

## *Dugesia ( Planaria)*

## *Structural organization*

- Free -living fresh-water flatworm.
- Avoids light and during day time.
- At night, it moves about in search of food,
- The body of *Dugesia* is 15-25 mm long, thin, bilaterally symmetrical, dorso-ventrally flattened, leaf-like and more or less transparent.



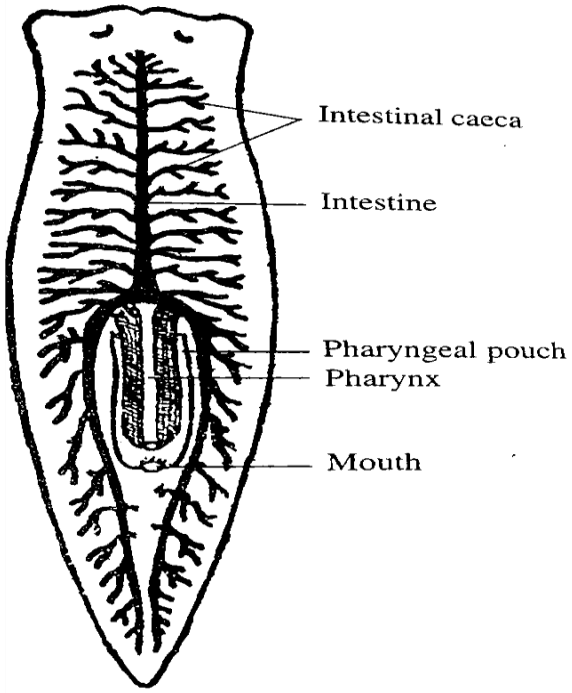

**Dugasia**

- Its dorsal surface is arched, and the ventral surface is flat.
- The anterior end of the body is broad, blunt and triangular.
- Posterior end is tapering.
- Mid-dorsally, head bears a pair of black eye spots.
- Laterally, head bears a pair of lobular processes, called auricles or auricular lobes.
- Mouth has an unusual position; it is located mid-ventrally, behind the middle of the body.
- Through the mouth opening pharynx can be protruded out as a long tube known as ***proboscis***.
- Behind the mouth is the median gonopore.
- Excretory openings are very minute and are dorsally located.
- The whole body surface is uniformly covered with cilia.

## *Digestive system*

- Incomplete type.
- Digestive tract is a blind sac that opens out only by mouth; anus is altogether absent.
- The digestive tract comprises the mouth, pharynx and a tripartite intestine.
- Mouth is a mid-ventral opening, located a little behind the middle of the body.

- It leads to a cylindrical, thick-walled and muscular pharynx.
- Pharynx is enclosed within a muscular sheath, called ***pharyngeal pouch***.
- Pharynx can be protruded out through the mouth as a long tube, known as proboscis.
- Proboscis serves to grasp and ingest the food.
- Pharynx leads to the intestine, which has three main branches or limbs, one antero - median and the others postero-lateral.
- Each main or primary branch gives out numerous secondary branches, called ***intestinal caeca or intestinal diverticula***.




**Dugasia - Digestive system**

- The ultimate branches of the intestine end blindly in the parenchyma.
- The branching intestine provides an increased area for the digestion, absorption and distribution of the food.
- Intestine is thin-walled - permits the simple diffusion of soluble substances across its wall.
- The intestinal lumen has an endodermal lining, called ***gastrodemis***.
- Pharyngeal lumen is lined by ectoderm, and also in that the nuclei of some of the ectodermal cells remain sunken deep into the parenchyma.

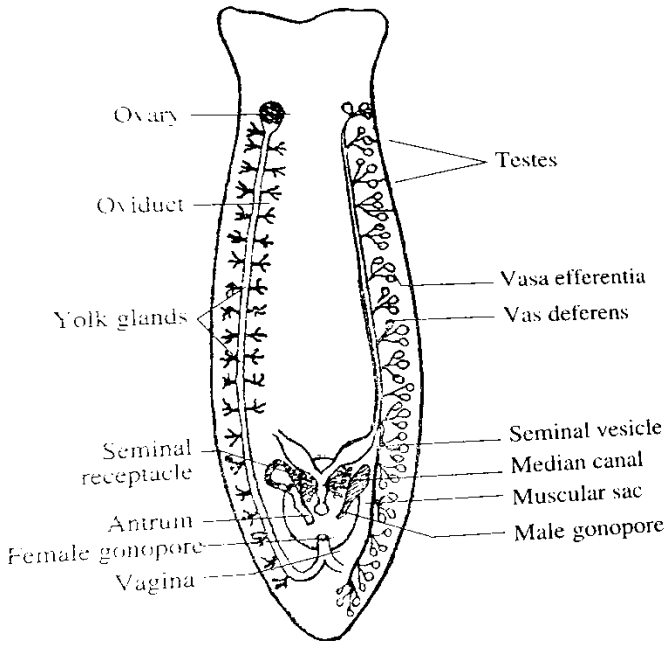
## *Locomotion*

- Moves about by two principal methods - namely gliding and crawling.
- Unable to swm in water.

- Gliding is effected solely by ciliary action.
- In gliding, the head region is kept slightly raised.
- Crawling is effected by rapid muscular contraction.
- Muscular contraction pass from before backwards driving the animal forwards.
- During this, the sub-epidermal circular muscles contract first to extend the body.
- Then the anterior end of the body is fixed to the substratum with the help of the secretions of the epidermal adhesive glands.
- Soon, the longitudinal muscles contract with the result that the animal get pulled forward.
- Then, the anterior end is released and the whole series of events repeated.

## *Reproduction*

- Sexually & asexually
- Asexual reproduction by architomy.
- Hermaphrodite
- Common gonopore




**Dugasia - Genital organs**

- Male genital system consists of numerous minute testes on the right and left sides of the body.
- Each testis is a spherical body formed of germinal epithelium from which biflagellate, long and filamentar spermatozoa are formed.
- Leading from each testis is a small spermductule or vas efferens.
- On each side, the vasa efferentia join a long longitudinal duct, known as vas deferens.

- Posteriorly, it dilates to a seminal vesicle or spermiducal vesicle.
- In this vesicle, mature sperms are stored for some time.
- The right and left vesicles then join together and form a ***median canal*** – surrounds numerous unicellular prostate glands.
- These glands impart vigour and vitality to the sperms.
- The median canal pass through a muscular copulatory organ, known as ***cirrus or penis***.
- Terminally it opens to a chamber, called antrum or genital atrium, by the male gonopore.
- Cirrus is used for the transfer of sperms to the partner during copulation.
- Female genital system consists of two spherical ovaries near the anterior end.
- Formed of germinal epithelium from which ova proliferate.
- Leading backward from ovary is a long oviduct.
- It receives numerous vitelline ducts from vitelline glands and then continues as the ovo-vitelline duct.
- Secretions of the vitelline glands form a protective covering around fertilized ova and supply the necessary nutients tor the developing embryo.
- Terminally, the right and left oviducts join together and form a common duct, known as ***vagina***.
- It opens to the genital atrium by the female gonopore.
- Opening to the genital atrium there are two saccular female structures - seminal receptacle and muscular sac.
- Seminal receptacle serves to receive the cirrus and sperms of the partner during copulation.
- Cross copulation and cross-fertilization is the rule.
- After insemination, sperms become active.
- They migrate from the seminal vesicle to the ovo-vitelline ducts.
- Almost simultaneously ripe ova are discharged from the ovaries to the oviducts.
- Fertilization takes place in the ovo-vitelline ducts.
- Fertilized ova gradually pass down to the genital atrium and finally escape to the outside through the common gonopore.
- During this descent, they get coated with yolk cells and enclosed in egg capsules or cocoons.
- In about three weeks, the embryo in each zygote develops to an immature adult.

B.SC. ZOOLOGY CORE COURSE

ANIMAL DIVERSITY : NON CHORDATA PART – 1

1ST SEMESTER

## SECTION C. KINGDOM : ANIMALIA

## MODULE 9

### SUPER PHYLUM ASCHELMINTHES

- Aschelminthes is an assemblage of several divergent groups of animals.
- Aschelminthes is truly a heterogeneous group of evolutionarily unrelated organisms.
- Pseudocoelomate
- Mostly vermiform
- Bilaterally symmetrical
- Un segmented or superficially segmented body clothed within cuticle
- Digestive tube is complete, straight or sometimes curved, terminating in an anus
- The cuticular covering may be tough and resistant, often marked by rings, or modified into spines, scales, plates and bristles.
- Respiratory and circulatory systems are absent.
- Typical protonephridia are present in all Aschelminthes other than Nematoda and Nematomorpha.
- Sexes are almost always separate.
- Super-phylum Aschelminthes comprises nine phyla, namely Nematoda, Nematomorpha, Rotifera, Gastrotricha, Kinorhyncha (Echinodera), Priapulida, Entoprocta, Acanthocephala and Loricifera

## Phylum Nematoda

- Bilaterally symmetrical, un segmented and vermiform body
- Cuticular covering - It is removed and renewed (moulted) four or five times in life.
- Syncytial epidermis in the adult
- Pseudcoelomic body cavity
- Body muscles are all longitudinal
- Straight and complete alimentary canal
- Absence of locomotor cilia and respiratory and circulatory systems
- Exceretory tubules and renette cells for excretion

Prepared by Jasla Mol KK
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- Simple nervous system without brain
- Gonochorism and sexual dimorphism
- Eg:- *Ascaris, Ancylostoma*..

## *Classification of Nematoda*

### *Class Adenophorea (Aphasmidia)*

- Presence of amphids and absence of phasmids
- ***Amphids are paired saccular or tubular chemoreceptor and mechanoreceptor sensory pits on the oral lips.***
- ***Phasmids are porous caudal papillae which are chemosensory, glandular, or excretory function.***
- Uninucleate epidermal cells.
- Excretory glands are present, but excretory tubules and canals are absent
- Testes are usually paired.
- Free-living members are microphages or detritivores.
- Adenopnorea comprises free living as well as parasitic forms.
- Eg:- *Trichinella*

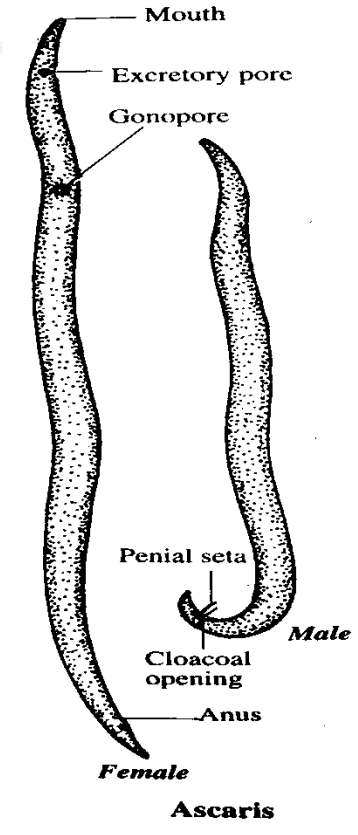
### *Class Secernentea (Phasmidia)*

- Terrestrial nematodes
- Presence of both amphids and phasmids.
- Epidermal cells are uninucleate or multinucleate.
- Excretory canals and excretory glands are present.
- Single testis and paired ovaries
- Secernentea comprises both free-living and parasitic forms.
- Eg:- *Ascaris*

## *Ascaris Lumbricoides*

- Human round worm
- Endoparasite in the small intestine of man & apes
- Causes the disease *ascariasis* or worm trouble.
- The body of Ascaris is soft, cylindrical and pointed at both ends.
- The body is reddish or pinkish in colour due to the presence of haemoglobin (absorbed from host).
- The body surface has numerous ring-like markings, which give the parasite a segmented appearance.

- On the body surface there are four longitudinal lines, one dorsal, one ventral and the other two lateral
- Anterior tip of the body is the mouth - guarded by three lips - called labial palps.
- Borne on these are minute sensory papillae - labial papillae.
- A little behind the mouth ventrally is the excretory pore
- Median ventral gonopore is present in female, absent in male
- Just in front of the posterior tip, is the anus in female, and the cloacal aperture in male.
- Protruding out of the cloacal opening is a pair of copulatory spicules, known as penial setae.



Ascaris

- Exhibits distinct sexual dimorphism
- 1. Femaile is long and stout, where as male is short and thin.
  2. The posterior end of female is straight, but that of male is curved and hook-like
  3 A separate gonopore is present in female, but absent in male.
  4. Anus is present in female, but in its place is the cloacal opening in male.
  5. Male has a pair of penial setae, which are absent in female.

*Pathogenicity*

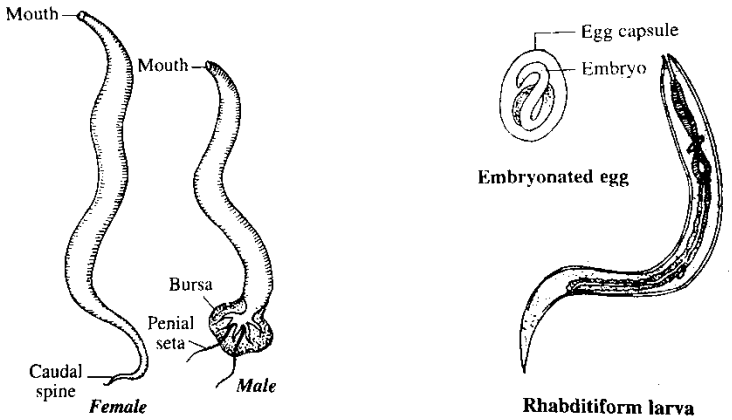
- Heavy infection may cause the disease ascariasis
- It may block the intestine, bile duct and pancreatic duct - interfere with normal digestion and cause abdominal discomfort, colic and intestinal pain, diarrhoea, vomiting and anorexia.
- It produces some toxins, which irritate and injure intestinal mucosa -This causes peritonitis and destroys the protein-digesting enzyme trypsin.
- Rhabditiform larvae in the lungs may cause extensive rupture of blood capillaries, pulmonary haemorrhage and fatal

*Parasitic adaptations*

- Absence of locomotor, circulatory and respiratory organs
- Presence of anti-enzymes and a resistant cuticular covering
- Simple alimentary canal and the absence of digestive glands
- Muscular and suctorial pharynx for sucking in fluid food
- Great powers for anaerobic respiration.
- Microaerophilic habit
- Absence of brain and specialized sense organs
- Enormous fecundity and the production of large numbers of sex cells to compensate their wastage and loss.
- Hard and protective egg shell for the protection of the embryo from adverse environmental conditions.

## *Ancylostoma*

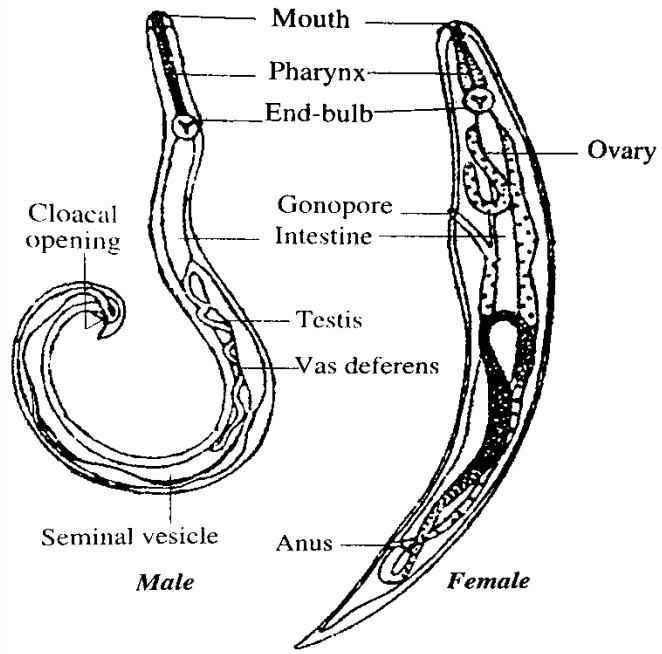
- Popularly known as the human hookworm
- Endoparasitic nematode inhabiting the small intestine of man.
- Causes *ancylostomiasis* or "*hookworm disease*".
- Adult hook worm has a slender and cylindrical body, covered by cuticle
- Curved body, with a hook-like anterior end
- Buccal capsule is armed with four hook-like teeth and two knob-like dental plates or cutting plates.




- Ancylostoma is dioecious.
- Male is shorter and stouter than female
- At the posterior end male has a cloacal opening, where as female has an anal opening
- Posterior end of the female is pointed with a caudal spine, while that of male is broad without caudal spine
- Male has a trilobed cuticular expansion around the cloacal opening, known as copulatory bursa or caudal bursa, to grip the female during mating.
- Protruding from the cloaca is a pair of long and slender copulatory spicules or penial setae in male.
- The percutaneous penetration of the larvae may cause severe itching and the formation of vesicular rashe - "ground itch' or "water sore (*Ancylostoma dermatitis*). haemorthage,
- Adult hookworms in the intestine may feed on blood and body fluids and cause ancylostomiasis or hook-worm disease - characterized by chronic intestinal bleeding, abnormal fall in the haemoglobin content, severe and progressive iron deficiency anaemia, intestinal lesion and ulceration, vomiting, diarrhoea, etc,
- Treatment of ancylostomiasis involves the administration of antihelminthic drugs

## *Enterobius*

- Popularly known as the pinworm, seatworm, or threadworm
- Endoparasitic nematode living in the caecum, vermiform appendix and ascending colon of man.
- Adult worms are small-sized, white-coloured, fusiform, and thread-like, with pointed ends.
- Their body is covered by a finely striated cuticle.
- Mouth is surrounded by three wing like cuticular expansions, called 'cervical alae'.
- A true buccal cavity is absent.
- Pharynx has a bulb-like terminal dilation, called end-bulb.




**Enterobius vermicularis**

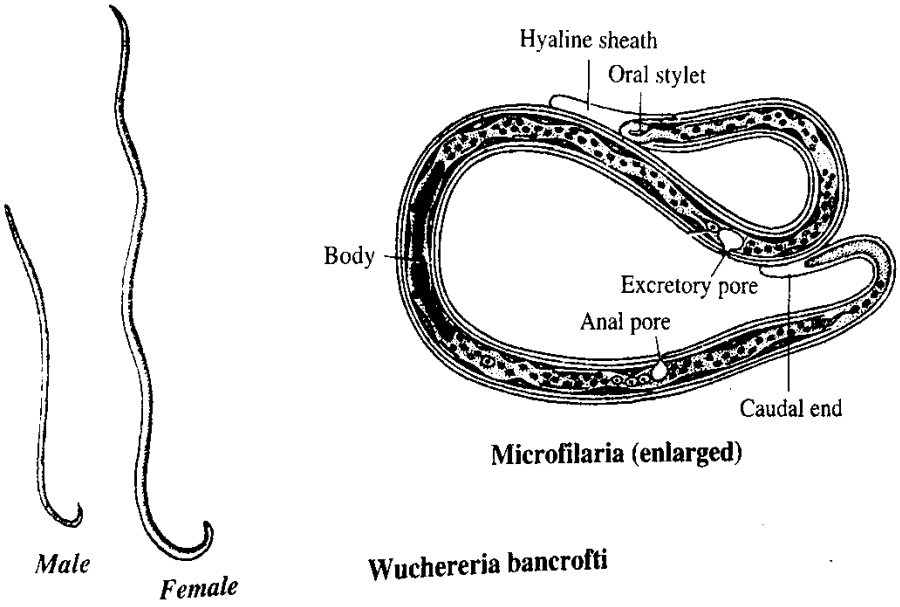
- Male and female exhibit some degree of sexual dimorphism.
- Male is much smaller than female.
- Posterior end of the male is tightly curved, but that of the female is straight, sharply pointed and tail-like.
- Posteriorly, male bears a cloacal opening and a copulatory spicule, which are absent in female
- Female has a pre terminal anus
- Gonopore just behind the middle of the body
- Anus & gonopore are absent in male
- Male worm dies soon after mating, female live for 30-100 days

*Pathogenicity*

- Pinworm infection causes enterobiasis or oxyuriasis.
- Symptoms - perianal irritation and itching, gastrointestinal discomfort, restlessness, insomnia, anorexia, eczematous skin around the anus, salpingitis (inflammation of oviduct),
- In children, nocturnal enuresis and daytime tiredness may also be observed.
- The attachment of adult worms to intestinal mucosa may cause inflammatory lesions - leading to haemorrhage and ulceration.

## *Wuchereria*

- Filarial worm
- Causes lymphatic filariasis in man.
- Endoparasitic nematode, inhabiting the lymphatic system of man.
- Adult worms are long, slender, creamy white and translucent.
- Their body is covered by a smooth & transversely striated cuticle.




- Male and female exhibit some degree of sexual dimorphism.
- Male is much shorter than female.
- The posterior end of the male is curved downward and provided with 12-15 pairs of sessile papillae and two unequal spicules.
- The posterior end of the female is straight and without papillae and spicules.
- Posteriorly, male has a cloacal opening, where as female has anal opening.
- A separate gonopore is present in female, but absent in male.
- Usually, the male and female remain tightly coiled around each other.
- Filarial infection or filariasis is of two types, asymptomatic and symptomatic. In asymptomatic, detectable clinical manifestations are absent
- In symptomatic,there are detectable clinical signs and symptoms.
- Symptomatic filariasis is of three kinds, acute, chronic and occult. Acute filariasis manifested by episodic (irregular) or sporadic (occasional) lymphadenitis and lymphangitis (1nflammation of lymph glands and lymph vessels respectively), associated with fever.
- Chronic filariasis develops usually 10-15 years after the onset of the first acute attack.

- Occult filariasis is the filarial infection in which microfilariae are very seldom found in peripheral blood, although they may be seen in tissues.
- Elephantiasis is the late complication of filariasis

*Prophylaxis*

- Chemotherapy of infected persons
- Isolation of infected persons from mosquitoes
- Destruction of mosquitoes using insecticides

B.SC. ZOOLOGY CORE COURSE

ANIMAL DIVERSITY : NON CHORDATA PART – 1

1ST SEMESTER

## SECTION C. KINGDOM : ANIMALIA

## MODULE 9

## PSEUDO COELOMATE MINOR PHYLA

# Phylum Gastrotricha

- Bilaterally symmetrical and un segmented body with flat ventral side and arched dorsal side.
- Body is divisible into head, neck, trunk and tail.
- Forked tail with a pair of adhesive tubes, which contain cement glands.
- Body wall is formed of cuticle epidermis and circular and longitudinal muscles.
- The cuticular covering on the dorsal side is modified into scale, spines and bristles
- Spacious body cavity is absent
- Digestive tract is a straight tube
- Circulatory and respiratory systems are absent.
- Excretory system consists of a pair of internally flagellated protonephridial tubules.
- Nervous system consists of a bilobed cerebral ganglion or brain
- Reproduction is sexual as well as asexual.
- Locomotion is by ciliary gliding.
- Locomotor cilia are restricted to the flat ventral side of the body (the name gastrotrich denotes this ventral ciliation).
- Gastrotrichs mainly feed on bacteria, protists and fungi.

## *Chaetonotus*

- Chaetonotus is a freshwater gastrotrich
- living in fine sediments or detritus
- Its body is short and unsegmented, and covered with loçomotor cilia.
- The animal is capable of reversing its ciliary beat in order to withdraw from an unpleasant stimulus.
- The body is elongated dorsally arched and ventrally flattened.

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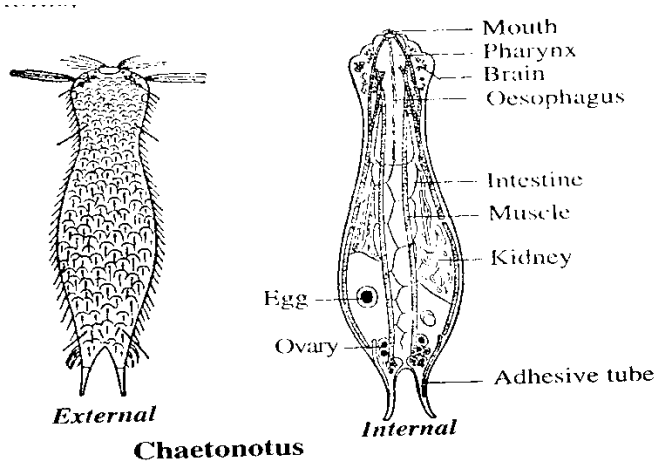


**Chaetonotus**

- It has distinct head, trunk, and forked tail with two or more caudal organs for adhesion.
- Body wall is formed of cuticle, syncytial epidermis, and circular and longitudinal muscles.
- Cuticle is elaborated into scales, bristles and spines.
- Chaetonotus moves about by ciliary gliding.
- It feeds on dead organic particles, and also on live protists and bacteria,
- Food is sucked into the mouth by the powerful pumping pharynx.
- Males are unknown and so reproduction is by parthenogenesis
- Parthenogenetic females deposit eggs on aquatic weeds or in the exuviae (parts sloughed out or cast off) of crustaceans.

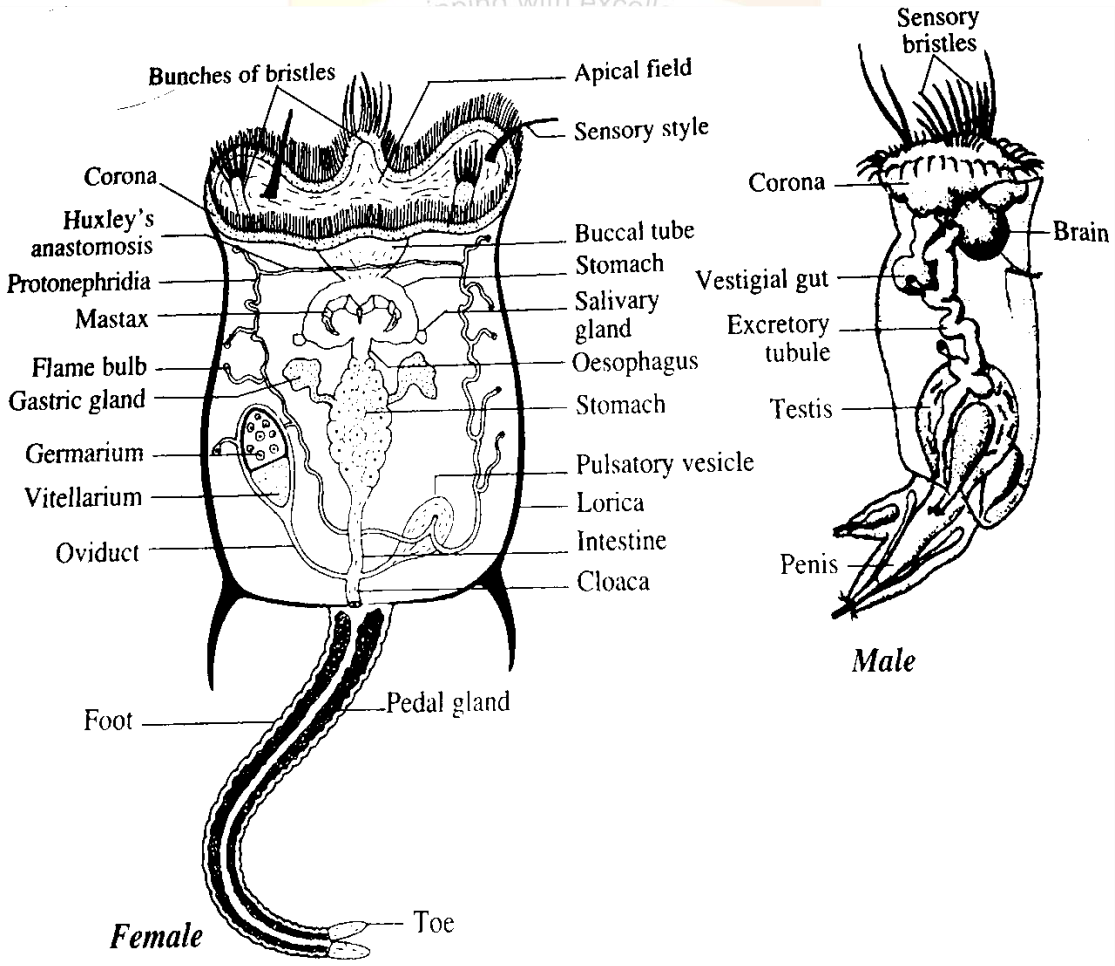
## Phylum Rotifera

- Popularly known as "***wheel animalcules***"
- Minute and microscopic body, imperfectly differentiated into head, trunk and tail or foot.
- Head region is broad with a non-ciliated central disc, called ***apical field***.
- Apical field is encircled by a ciliary zone, known as ***corona***
- Body is covered by a cuticle, formed of a glycoprotein, without chitin or collagen.
- The cuticular covering sometimes becomes a hard and thick encasement, called ***lorica***.
- Rotifers with lorica are called loricates, and those without lorica are called illoricates.
- Epidermis is mostly syncytial, except in the region of corona.
- Pharynx is modified into a muscular mill, called ***mastax.***
- It is provided with a masticatory apparatus or '***dental mill'***, composed of hard and jaw like cuticular structures called ***trophi or internal jaws***.
- Mastax and trophi are characteristic of rotifers.
- Excretion is ammonotelic.
- Excretory organs are protonephridia with flame bulbs.

- Nervous system consists of a bilobed brain and several radiating nerves.
- Sexes are separate.

## *Brachionus*

- Brachionus is a common freshwater rotifer, inhabiting ponds, ditches
- It exhibits sexual dimorphism.
- Male is much smaller than female, short-lived, and aberrant or degenerate in organization,
- Without mouth, digestive tract and anus, but with disproportionately enlarged testis and penis.




**Brachionus**

- Internal organs are well developed in female
- The body of a female Brachionus is almost cone-shaped.

- It is differentiated into head, trunk and foot or tail.
- Head is broad and truncated, trunk is large and cylindrical, and foot is long and slender.
- Head has a non-ciliated terminal disc, called apical field.
- It is encircled by a ciliary zone, called corona or wheel organ - it is involved in locomotion and food collection.
- Corona is usually subdivided into several retractile lobes, called trochal discs.
- In some rotifers, corona is surrounded by double ciliated ring, called velum.
- It consists of outer and inner ciliary bands, known respectively as cingulum and trochus.
- Trunk is the largest part of the body - contains the important visceral organs.
- Trunk is enclosed by a thick and hard cuticular encasement, called lorica – often sculptured ornamented, or spiny
- Foot or tail is long, slender and terminally tapering.
- Anus is located mid-dorsally at or near the junction between trunk and foot
- Foot contains the pedal glands or cement glands whose ducts open at the tip of toes - the adhesive secretions of these glands serve for temporary attachment during feeding.