Practical Handbook of Zoology

Animal Diversity - I & Animal Ecology

F. Y. B. Sc. (Sem.-I)

- Dr. Sachin A. Gurule
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Practical Handbook of Zoology

(Animal Diversity - I & Animal Ecology)

F.Y. B. Sc. (Sem. - I)

Course Code (ZO - 113)

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Preface

It is a matter of great pleasure for us to present this book to our esteemed readers. This book has been designed as standard text on 'Practical Handbook of Zoology' for F.Y. B. Sc. (Sem. - I).

This book comprehensively covers the entire syllabus of F. Y. B. Sc. (Zoology) Course of Savitribai Phule Pune University effective from 2019 onwards. It has been written to meet the requirements of students of F. Y. B. Sc. (Zoology). Some of the special features of the book are as follows:

1. *Full coverage of the revised syllabus of F. Y. B. Sc. (Zoology).*
2. *Chapter outline at the beginning of each chapter to give a bird's eye view of the topics covered in the chapter.*
3. *Point wise explanation of each topic in the chapter.*
4. *Topics are logically arranged in numbered paragraphs exactly according to the modified syllabus.*
5. *Proposed questions at the end of each chapter.*
6. *Extensive use of diagrams, tables and various forms to give visual view of key concepts and techniques.*
7. *Conversational, lucid and simple language.*

Every effort has been made to provide the readers with most up-to-date and authentic material on the subject.

We are very grateful to our publisher Mrs. and Mr. Rajesh Patne who have rendered all possible assistance in bringing out this book. We wish to acknowledge our deep gratitude to staff who have assisted and helped us in preparing this book. We will consider our efforts amply rewarded in case the book proves useful to the students and teachers of the subject.

Suggestions of readers are welcome and shall be acknowledged with gratitude.

With best wishes.

By Authors

Syllabus

Practical Handbook of Zoology (ZO - 113)

F.Y. B. Sc. (Sem. - I)

Practical No.	Topic
1	**Animal Diversity –I** **1.** Museum Study of phylum Protozoa: Euglena, Paramecium, Amoeba, Plasmodium sp. **2.** Museum study of Phylum Porifera: Sycon, Euplectella,Chalina, Spongilla. **3.** Museum study of phylum Cnidaria: Hydra, Physalia, Aurelia, Metridium. **4.** Museum Study of phylum Platyhelminthes: Planeria, Faciola hepatica, Taeniasolium **5.** Study of Paramecium: Culture, External morphology, Conjugation and Binary fission. **6.** Study of permanent slides: Spicules and Gemmules in Sponges, T.S. of Sycon, T.S. of Hydra, Taeniasolium: Scolex, Gravid proglottid. **7.** Identification of any three museum specimen with help of taxonomic identification key. **8.** Visit to Zoological survey of India/ Museum/National Park.
2	**Animal Ecology:** **1.** Estimation of Dissolved oxygen from given water sample. **2.** Estimation of Water Alkalinity from given water sample. **3.** Study of animal community structure by quadrate method (Field or Simulation). **4.** Determination of density, frequency and abundance of species by quadrat method. **5.** Study of microscopic fauna of freshwater ecosystem (from pond). **6.** Estimation of water holding capacity of given soil sample. **7.** Estimation of dissolved and free carbon dioxide from water sample. **8.** Study of Eutrophication in lake/river.

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Practical Handbook of Zoology (ZO - 113)
F.Y. B. Sc. (Sem. - I)

Section - I
(Animal Diversity-I)

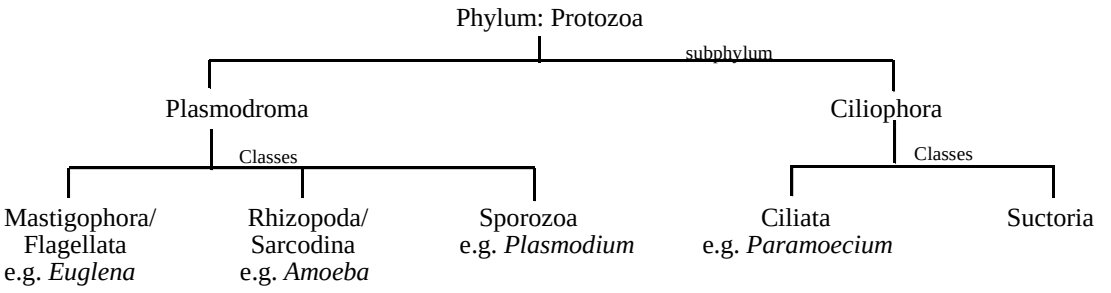
Practical No. 01

Aim: Museum Study of phylum Protozoa: *Euglena, Amoeba, Plasmodium* sp., *Paramecium*

Protozoa (Greek: protos = first, zoon = animal).

General Characters:

1. Protozoans are primitive, unicellular and microscopic organisms without tissues.
2. Body may contain one or more nuclei. They show variable shape some are spherical, oval, elongated or irregular.
3. They may be solitary or colonial in nature.
4. Body may be naked or bounded by the pellicle, but in some forms the body is covered with shell and often provided with skeleton.
5. Locomotion by pseudopodia or flagella or cilia. Locomotory organelles may be absent in some forms.
6. Nutrition may be holozoic (animal like), holophytic (plant like) or saprozoic or parasitic. Digestion is intracellular.
7. Respiration through general body surface by the process of diffusion.
8. Presence of contractile vacuoles for osmoregulation.
9. They reproduce asexually by binary fission, multiple fission or budding. Sexual reproduction by conjugation. Alternation of asexual and sexual phases is often seen.
10. Encystment commonly occurs to help in dispersal as well as to resist unfavorable conditions of food, temperature and moisture.



1. *Euglena*:

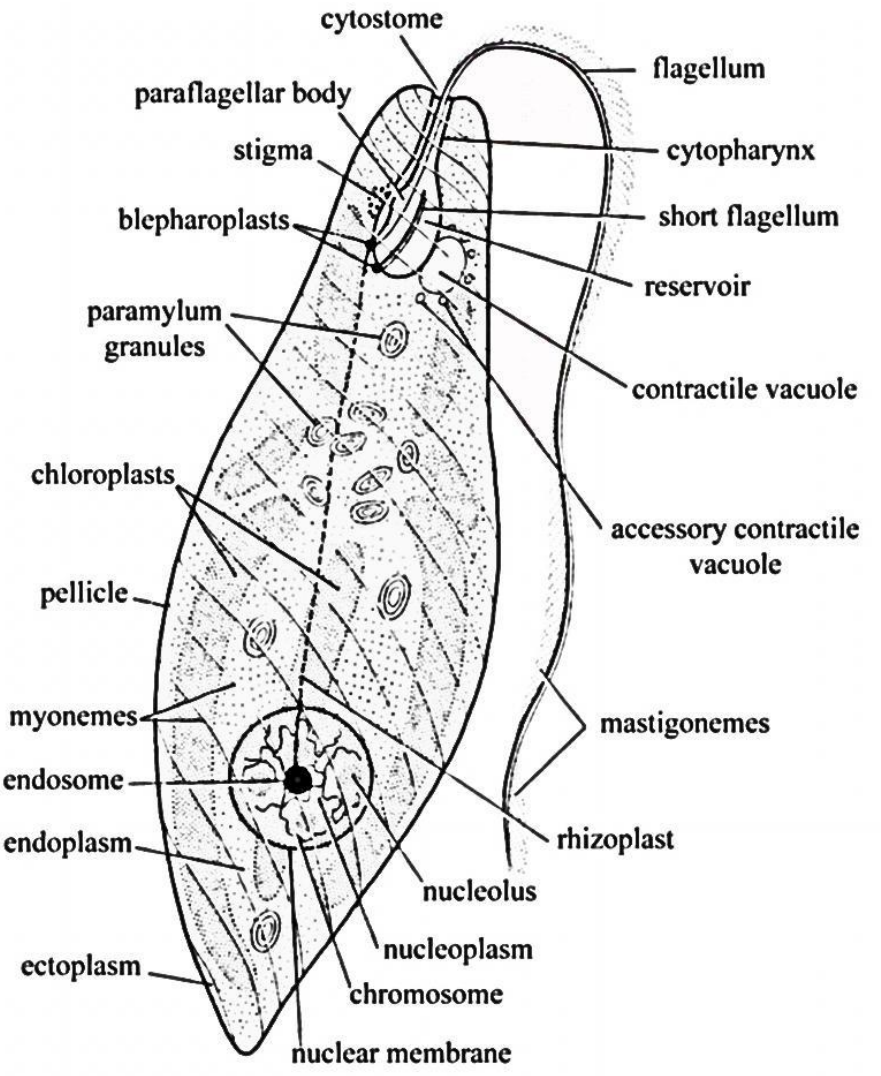


Figure 1.1: *Euglena*

Systematic Position:

Phylum: Protozoa	Unicellular, microscopic animals without tissue, organs.
Subphylum: Plasmodroma	Locomotion by flagella or pseudopodia, cilia are absent.
Class: Mastigophora	Flagella are the locomotory organs.
Order: Euglenida	Pellicle is soft, thick and firm. Cytostome

	andcytopharynx is present. Reserve food inthe form of paramylon and oils.Flagella either one or two in number.
Genus: *Euglena*	
Species: *viridis*	

Salient Features:

1. It has elongated, spindle shaped body with whip like flagellum; measures 60-100µm.
2. Body enclosed in thin, elastic, tough cuticle which lies beneath the plasma membrane.
3. Anterior end of body bears a small funnel like cytostome and tubular cytopharynx which leads into a large spherical reservoir.
4. Single large nucleus is present towards the posterior region of the body.
5. The cytoplasm is differentiated into ectoplasm and endoplasm.
6. Endoplasm contains several granules of paramylon, a polysaccharide similar to starch. This represents the reserve food material.
7. Numerous green chromatophores or chloroplasts are scattered in the cytoplasm.

2. *Ameoba*:

Phylum: Protozoa	Unicellular, microscopic animals without tissue and organ.
Subphylum: Plasmodroma	Locomotion by flagella or pseudopodia, cilia are absent.
Class: Rhizopoda	Pseudopodia are the locomotory organs.
Subclass: Lobosia	Pseudopodia lobose or filose; ecto- & endoplasm distinct.
Order: Ameobida	Body naked without pellicle. Pseudopodia arising at any point
Family: Amoebidae	Naked amoebae produces many pseudopodia
Genus: *Amoeba*	
Species: *proteus*	

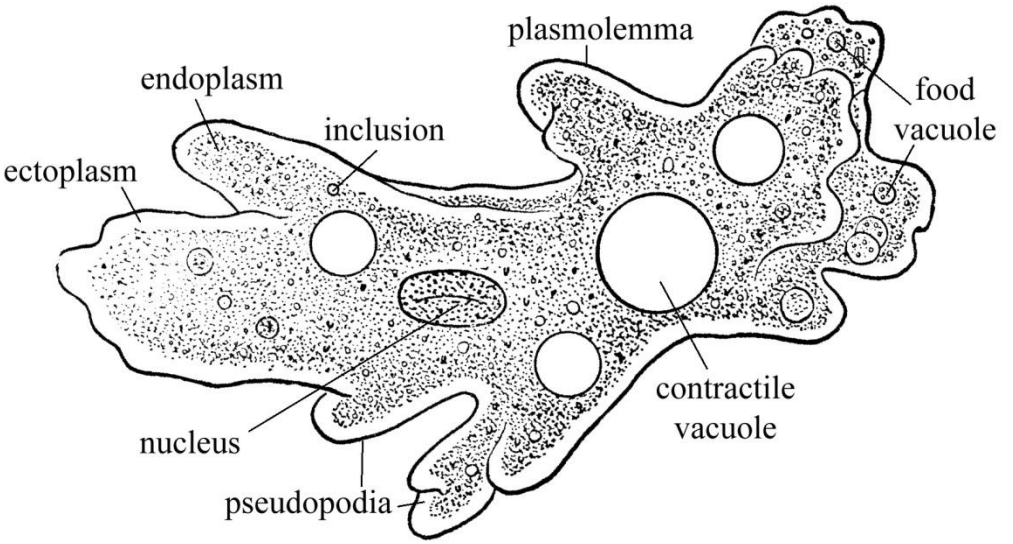


Figure 1.2: Amoeba

Salient Features:

1. *Ameobaproteus* is found on the bottom mud or on underside of aquatic vegetation in freshwater ponds, ditches, lakes, springs, pools and slow running streams.
2. It is irregularly shaped, colorless unicellular animalcule measuring about 250-600 µm
3. Body covered with thin, elastic semi-permeable layer of protoplasm i.eplasmalemma.
4. Cytoplasm divided as ectoplasm and endoplasm. Pseudopodia are locomotory organs.
5. Single nucleus, a large single contractile vacuole and number of food vacuoles.
6. Nutrition is holozoic. Reproduction by binary fission and multiple fission.

3. *Plasmodium*:

Systematic Position:

Phylum: Protozoa	Unicellular, microscopic animals without tissue.
Subphylum: Plasmodroma	Locomotion by flagella or pseudopodia, cilia are absent.
Class: Sporozoa	No locomotory organelles. Parasitic & forms spores.
Subclass: Telosporidia	Trophozoiteuninucleate; sporozoites elongate without capsules

Order: Haemosporidia	Trophozoite small, amoeboid & intracellular. Sporozoite naked
Family: Plasmodiidae	Parasitic alveolates responsible for malaria

Genus: *Plasmodium*

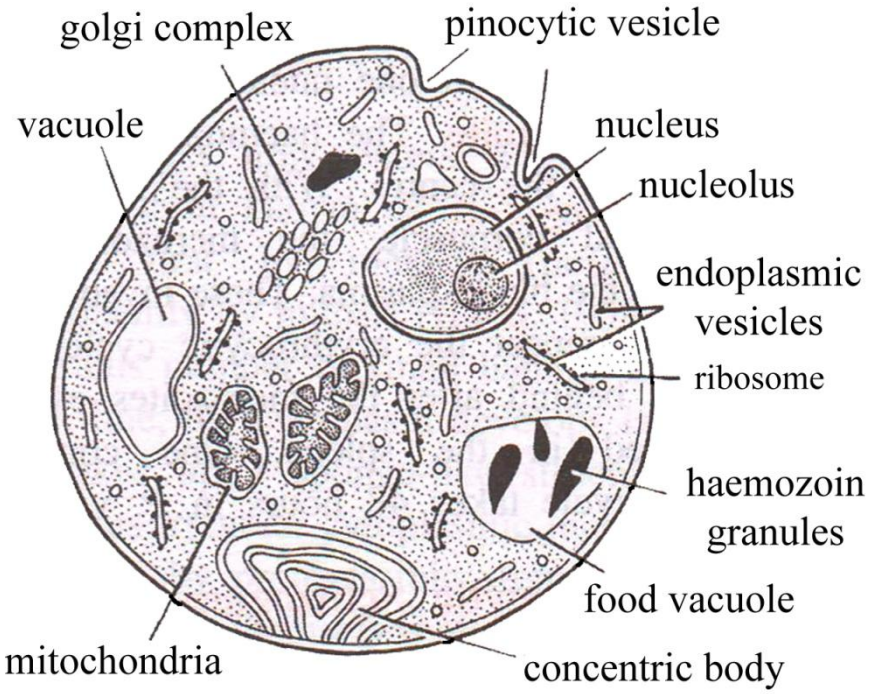


Figure 1.3: Trophozoite stage of *Plasmodium*

Salient Features:

1. It is an intracellular blood parasite of vertebrates. Adult stage is called as trophozoite.
2. Life cycle completed in two hosts partly in man as definitive host and partly in female *Anopheles* mosquito as intermediate host.
3. Infected female mosquitoes introduce sporozoite stage in blood of vertebrates which reaches in the liver and multiplies to form merozoite.
4. Trophozooite is an amoeboid uninucleate structure withgranular cytoplasm.
5. It contains double membrane plasma membrane.

4. *Paramoecium*:

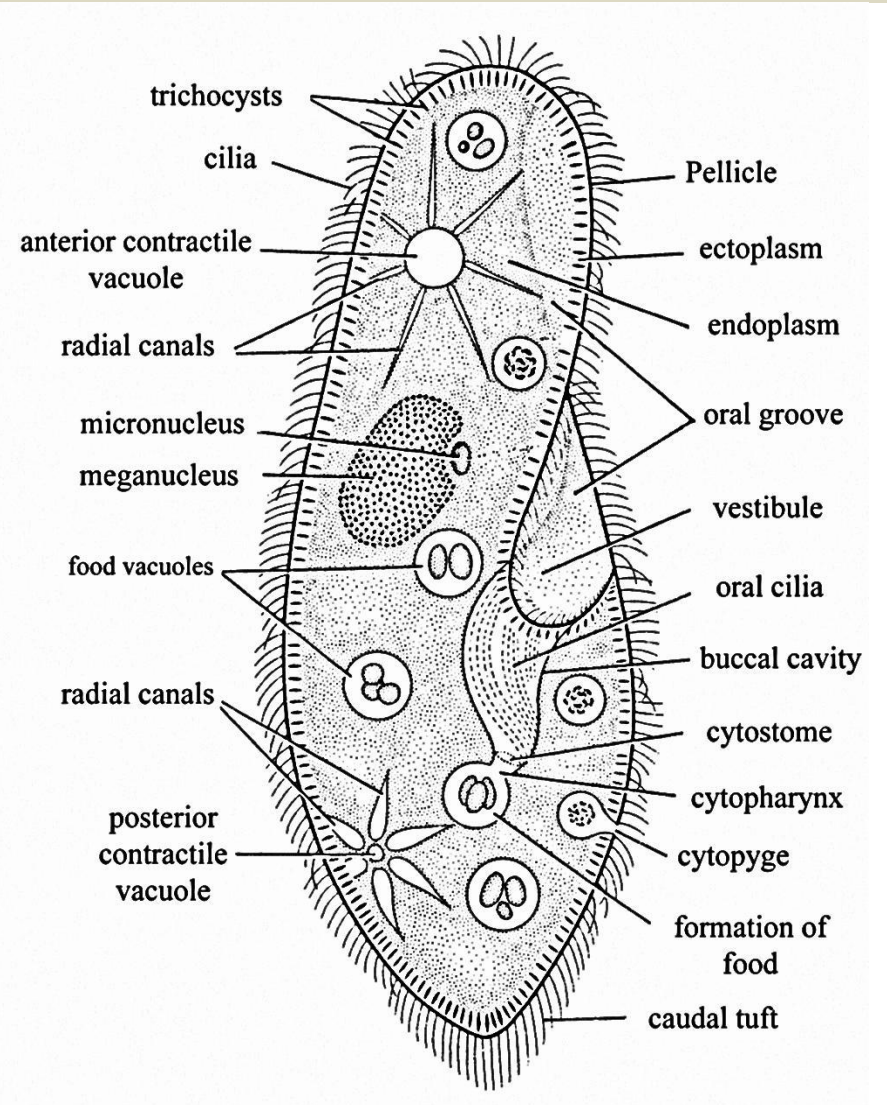


Figure 1.4: *Paramoecium*

Systematic Position:

Phylum: Protozoa	Unicellular, microscopic animals without tissue and organs.
Subphylum: Ciliophora	Cilia are the locomotory organ. Dimorphic nucleus.
Class: Ciliata	Numerous cilia persist throughout life. 1-2contractile vacuoles

Order: Holotricha	Cilia are uniform length and distributed evenly
Family: Parameciidae	Ciliates with anterior & posterior ends bounded by elastic pellicle.

Genus: *Paramoeciumcaudatum*

Salient Features:

1. Slipper shaped animalcule.
2. Body is elongated, blunt at the anterior end and slightly pointed at the posterior end.
3. Ventral surface bears oral groove.
4. Pellicle is present. Contains two nucleus i.e. mega- and micronucleus.
5. Body is covered by numerous, hair like cilia. They are uniform in length except at the posterior end.
6. The longer cilia present at the posterior end are referred to as the caudal tuft.
7. Asexual reproduction by binary fission and sexual reproduction by conjugation.

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Practical No. 02

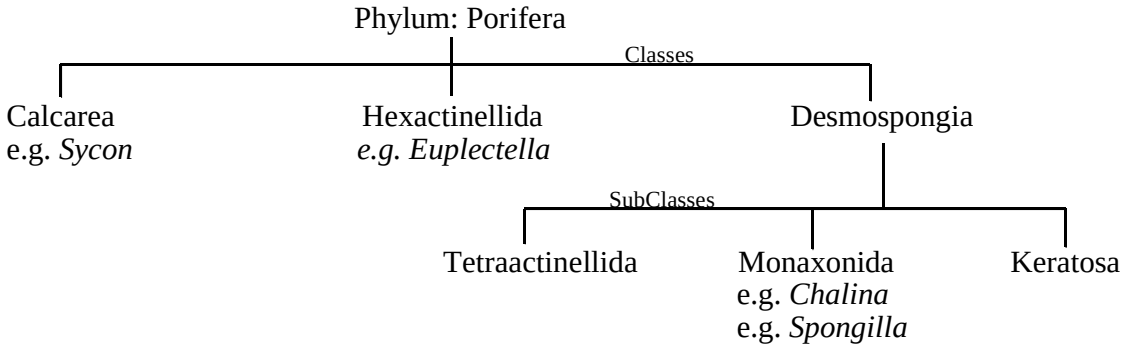
Aim: Museum study of Phylum Porifera: *Sycon, Euplectella,Chalina, Spongilla.*

Porifera (Latin, porus = pore; ferro = to bear) contains pore bearing primitive multicellular animals.

General characters:

1. It includes parazoans organism with loose aggregation of cells. They are primitive multicellular organisms.
2. Poriferan animals have cellular grade body organization and are without distinct tissues or organs.
3. Radial symmetry or no symmetry.
4. All are aquatic forms and mostly marine while few are fresh water e.gspongillidae.
5. They are sedentary, sessile or free living organisms.
6. Poriferan animals have variable body shapes viz. vase-shape, cylindrical,tubular and branched.
7. Body wall is made up of two layers outer **pinacoderm** and inner **choanoderm**.
8. Pinacoderm (dermal epithelium) consist of pinacocytes and is porus. There are large numbers of dermal openings or pores present known as **ostia** which serve for the flow of water.
9. Choanoderm (gastral epithelium) lines the body cavity called spongocoel and consist of flagellated collar cells called as choanocytes. The spongocoel opens outside the with large opening called **osculum** through which water exits from the body.
10. Skeleton made up of calcareous or siliceous spicules or of sponging fibers or may be absent in some forms.

11. Unique system of canal or space is present through which water flows within body of sponges. According to arrangement and complexity of internal channels canal system has been divided into three types viz. ascon, sycon and leucon type.
12. Digestion is intracellular. Respiratory and excretory system is absent. Nervous system is primitive. All forms are hermaphrodites, cross fertilization is prominent.
13. Poriferans reproduce both sexually and asexually. Asexual reproduction takes place by budding, fission or gemmule formation, whereas sexual reproduction occurs by gamete formation i.e.ova and sperms.
14. All the forms showgreat power of regeneration.
    e.g. *Sycon, Euplectella, Chalina, Spongilla, Euspongia*etc.



1. *Sycon* or *Scypha*(Urn Sponge):

Systematic Position:

Phylum: Porifera Pore bearing, multicellular organisms. Cellular grade body organization without forming tissue or organs.

Class: Calcarea Calcareous skeleton made up of one or three or four rayed calcareous spicules. Body shape cylindrical or vase like.

Order: Heteroceola Syconoid or leuconoid forms. Body is thick walled. Solitary or colonial animals.

Family: Sycettidae Tubular, flask shaped, ovoid and branching growth forms

Genus:*Sycon*(=*Scypha*)

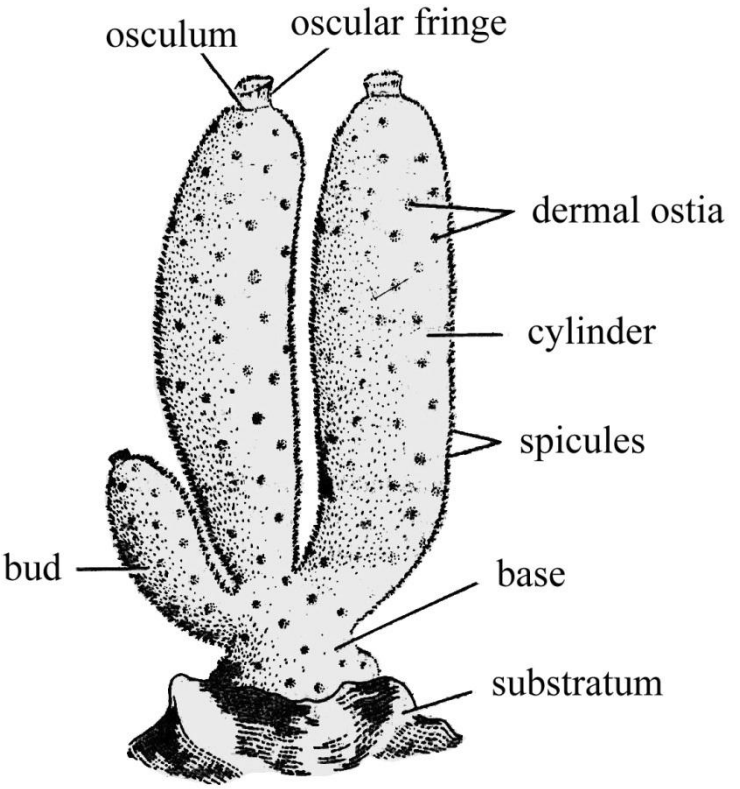


Figure 2.1: ***Sycon***

Salient Features:

1. It is a marine sponge and found attached to substratum in shallow water.
2. Body is slender, vase shaped cylindricalmeasuring about 20-30 mm in height and 5-6mm in diameter.
3. Sycon is radially symmetrical, solitary or may form colonies by budding.
4. Color may vary from grey to light brown.
5. Each cylinder buldges in the middle and opens to the exterior by osculum.
6. The body wall has numerous minute openings called dermal openings pores/ostia.
7. These ostia lead into the canal system. Canal system is synconoid type.
8. Skeleton bears calcareous monoaxon, triaxon or tertraxon spicules.
9. They reproduces both sexually (forming gamets) and asexually (budding).

2. Euplectella(Venus's flower basket):

Systematic Position:

Phylum: Porifera Pore bearing, multicellular organisms. Cellular grade body organization without forming tissue or organs.

Class: Hexactinellida Moderate sized glass sponges. Skeleton consist of triaxon, six-rayed siliceous spicules. Body shape vase or cup like.

Order: Hexasterophora Spicules are hexasters i.e. star like in shape. Flagellated chambers regularly and radially arranged. Usually attached to the substratum

Family: Euplectellidae Glass sponges.

Genus: *Euplectella*

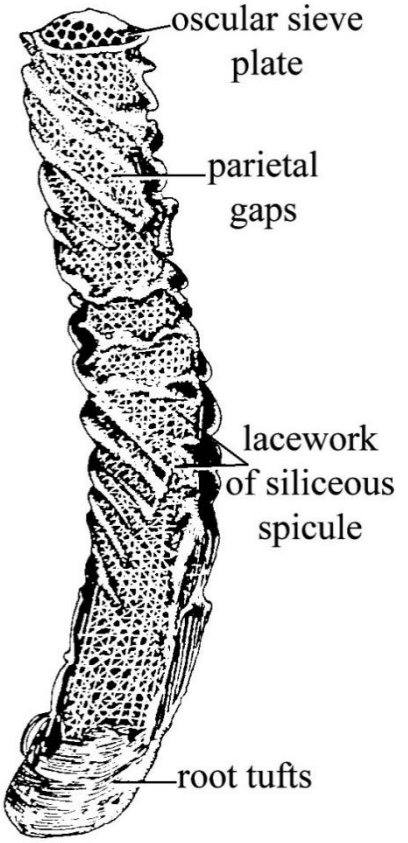


Figure 2.2: *Euplectella*

Salient Features:

1. Popularly known as venus's flower basket due to its beautiful shape and glossy appearance.
2. Body is long, curved, thin walled measuring 15-30cm in length and 2-5cm in diameter.
3. The skeleton consists of four and six rayed siliceous spicules interlaced and fused at their tips forming a three dimensional network with parietal gaps.
4. Upper end is closed by an oscular sieve plate. Canal system is syconoid type.
5. From the lower end of the body arises a tuft of root like long silicious threads which fasten the sponge to the mud of sea bottom.
6. Some species of genus *Euplectella* share commensal relationship with certain species of shrimps for life time.
7. Skeleton of sponge having superimposed shrimps inside is presented as a wedding gift to newly married couples in Japan which signifies association.

3. *Chalina* (Dead man's finger / Mermaid's gloves):

Systematic Position:

Phylum: Porifera	Pore bearing, multicellular organisms. Cellular grade body organization without forming tissue or organs.
Class: Demospongiae	(Gr. Demos- frame, spongos-sponge) Skeleton of siliceous spicules or sponginfibres. Spicules monaoxon or tetraaxon. Canal system is leuconoid type.
Subclass: Monaxonida	Skeleton hasmonaxon spicules with or without sponging. Spicules distinguished into megascleres and microscleres.
Order: Haplosclerina	Monaxon megascleres are diactinal; microscleres absent.Spoginfibres usually present. Large two rayed spicules.
Family: Chalinidae	Family of marine demosonges
Genus:*Chalina*	

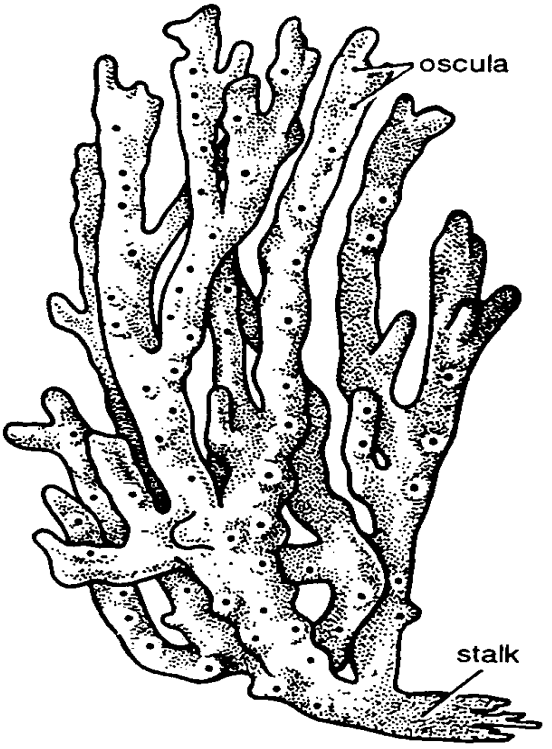


Figure 2.3: ***Chalina***

Salient Features:

1. It is popularly known as the mermaid's gloves or dead man's fingers because it appears like a hand having number of perforations (oscula).
2. Orange, yellowish brown or reddish in colour. It is deep water form.
3. Skeleton consists of the sponginfibres with siliceous spicules embedded in it.
4. Body surface is flattened consist of bunches of finger like branches perforated with numerous oscula.
5. Canal system is leuconoid type.
6. Asexual reproduction by regeneration and budding while sexual by producing free swimming larva.

4. *Spongilla*(Fresh water sponge):

Systematic Position:

Phylum: Porifera	Pore bearing, multicellular organisms. Cellular grade body organization without forming tissue or organs.
Class: Demospongiae	(Gr. Demos- frame, spongos-sponge) Skeleton of siliceous spicules or sponginfibres or both. Spicules monaoxon or tetraaxon, never triaxon. Canal system is leuconoid type.
Subclass: Monaxonida	Skeleton consist of monaxon spicules with or without sponging. Spicules distinguished into megascleres and microscleres.
Order: Haplosclerina	Monaxon megascleres are diactinal; microscleres absent. Spoginfibres usually present. Large two rayed spicules.
Family: Spongillidae	Family of fresh water sponges

Genus: *Spongilla*

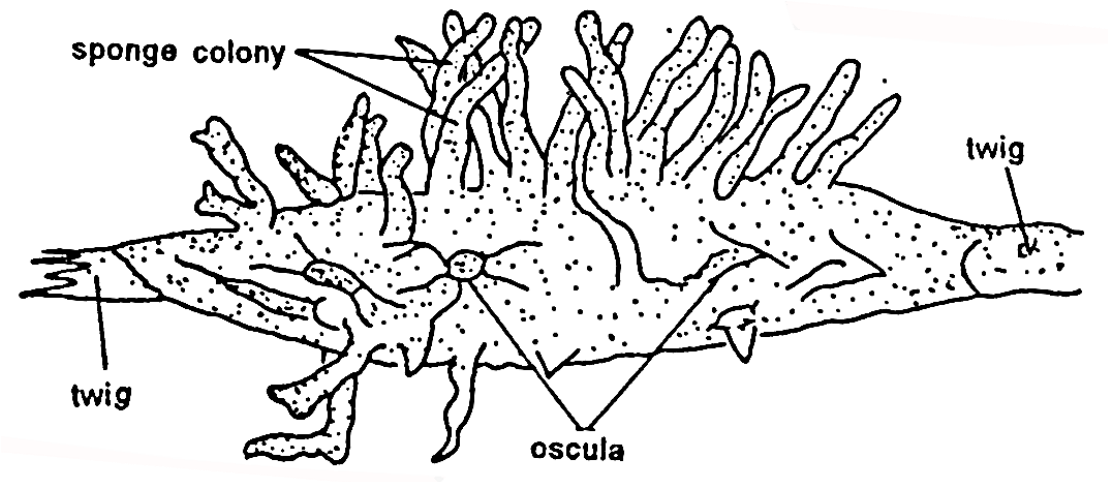


Figure 2.4: *Spongilla*

Salient Features:

1. It is fresh water colonialsponge.
2. It grows on the submerged plants and twigs in ponds and lakes.
3. It shows green color because of presence of symbiotic green algae.
4. The body wall consists of very thin dermal membrane provided with dermal pores or ostia and several oscula.
5. It has rhagon type of canal system.
6. Skeleton consist of siliceous spicules forming network of smooth or spiny large and small oxeas embedded in the sponging. Spicules are monoaxon type.
7. Asexual reproduction by formation of genmmules and sexual by free swimming larva.

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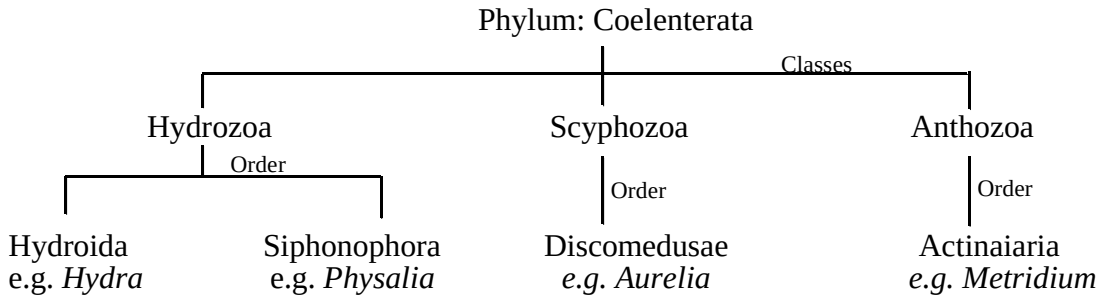
Practical No. 03

Aim: Museum study of phylum Coelenterata: Hydra, Physalia, Aurelia, Metridium

Coelenterata (Greek,koilos = hollow; enteron =intestine) includes primitive multicellular animals containing gastrovascular cavity.

General characters:

1. Coelenterates are metazoan (multicellular) animals with tissue grade of organization. They are aquatic, mostly marine and very few are fresh water forms.
2. They are sedentary or free swimming and solitary or colonial organisms.
3. Animals are radially or biradially symmetrical with a central gastrovascular cavity communicating with exterior by the mouth.
4. Exoskeleton is either chitinous or calcareous.
5. They are diploblastic with two cellular layer i.e. outer epidermis and inner gastrodermis and both are separated by gelatinous mass called mesogloea.
6. Individuals are either attached polyps or free swimming medusa and shows polymorphism.
7. Mouth of polyps and bell margin of medusae often encircled by short and slender tentacles.
8. Tentacles bear the stinging cells or cnidoblast cells called as nematocysts which serves for adhesion, food capturing, injecting poison, offense and defense.
9. Body cavity, respiratory, circulatory and excretory systems are absent.
10. Single internal cavity lined with gastrodermis called gastrovascular cavity or coelenteron.
11. Digestion is intracellular as well as extracellular (Contact digestion).
12. Nervous system primitive, consists of nerve net. Ocelli and statocysts are sensory organ.



1. *Hydra*:

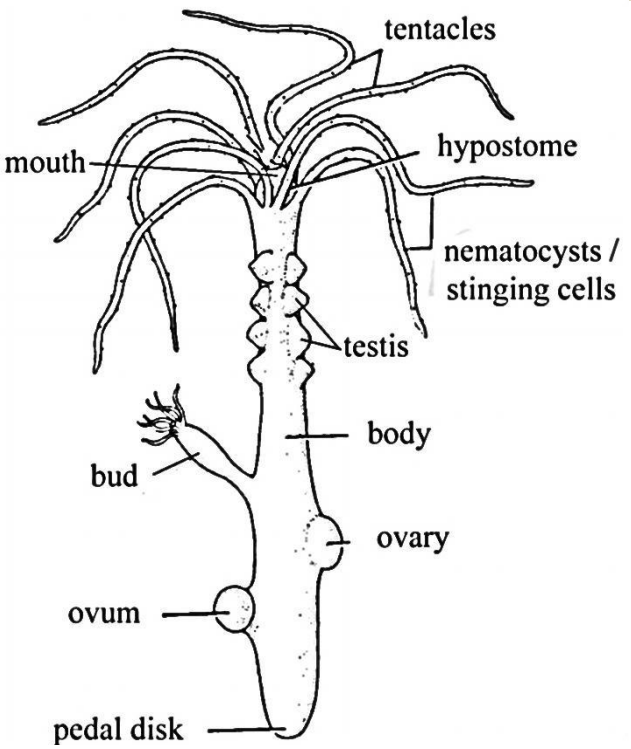


Figure 3.1: *Hydra*

Systematic Position:

Phylum: Coelenterata	Acoelomate, diploblastic multicellular organisms with tissue grade body organization.
Class: Hydrozoa	Aquatic solitary or colonial.Medusae with true velum
Order: Hydroida	Polyploid stage is predominant. Medusae short lived
Suborder: Anthomedusae	Hydrotheca and gonotheca absent. Statocysts absent.

Family: Hydridae Exclusively fresh water group represented by solitary hydroid.

Genus: *Hydra*

Salient Features:

1. It is fresh water sedentary organism attached to substratum.
2. *Hydra* is elongated, elastic cylindrical plant like organism measuring about 1-3 cm in length.
3. Basal or proximal end is attached to substratum with basal disc while free distal end or oral end bears the mouth situated on conical elevation called as hypostome.
4. Hypostome is encircled by 6 to 10 tentacles which are hallow, slender finger like projection provided with nematocysts.
5. Body wall encloses gastrovascular cavity which extends into the tentacles.
6. *Hydra* is hermaphrodite animal gonads appear as buds; Testis lie near oral end while ovaries near the base.
7. Asexual reproduction by budding and sexual by gametes formation.

***2. Physalia* (Portuguese man of war):**

Phylum:Coelenterata Acoelomate, diploblastic multicellular organisms with tissue grade body organization.

Class: Hydrozoa Aquatic solitary or colonial animals. Medusae with velum

Order: Siphonophora Pelagic colonial free swimming or floating forms and highly polymorphic. Polyps without oral tentacles. Medusae incomplete and rarely freed.

Suborder: Physophorida Upper end of colony bears a gas filled float or pneumatophore.

Family: Physaliidae Large oceanic siphonophores include Portuguese man-of-war.

Genus: *Physalia*

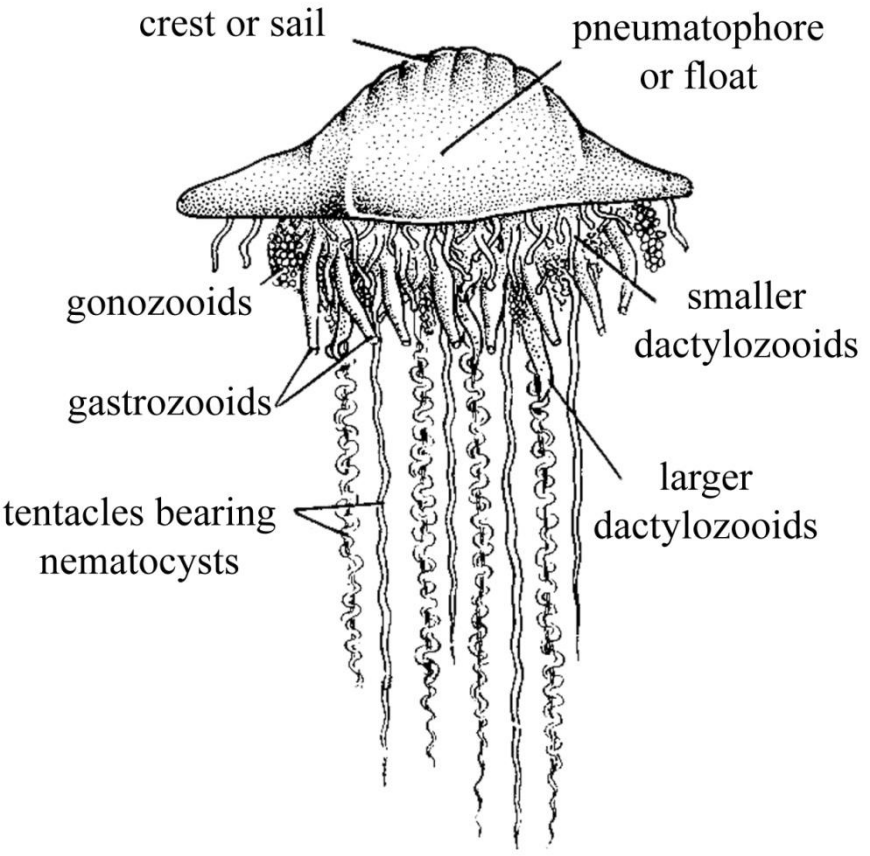


Figure 3.2: ***Physalia***

Salient Features:

1. *Physalia* forms huge free floating pelagic colony known as Portuguese man of war.
2. It has a characteristic huge bladder like brightly coloured float or pneumatophore. The upper surface of float is produced into crest or sail.
3. From underside of pneumatophore hangs dactylozoids with tentacles, gastrozooids without tentacles and branching blastostyles.
4. Tentacles have a great capacity for contraction and expansions.
5. Tentacles are large and bear stinging batteries or nematocysts to kill fishes and preys.
6. Colony exhibit polymorphism and the division of labor.

3. *Aurelia* (Jelly Fish / Umbrella):

Systematic Position:

Phylum: Coelenterata Multicellular organisms with tissue grade body organization.

Class: Scyphozoa Exclusively marine; Solitary forms. Medusa large umbrella shaped without true velum. Polyp stage reduced or absent. Gastrovascular cavity with gastric pouches and gastric filaments.

Order: Discomedusae/ Semaeostomeae Flat saucer or disc like umbrella. Eight tentaculocysts present. Square shaped mouth extending into 4 long oral arms. Gastric pouches and filaments are absent.

Family: Ulmaridae Simple or branched radial canal. With/without subgenital pits.

Genus: *Aurelia*

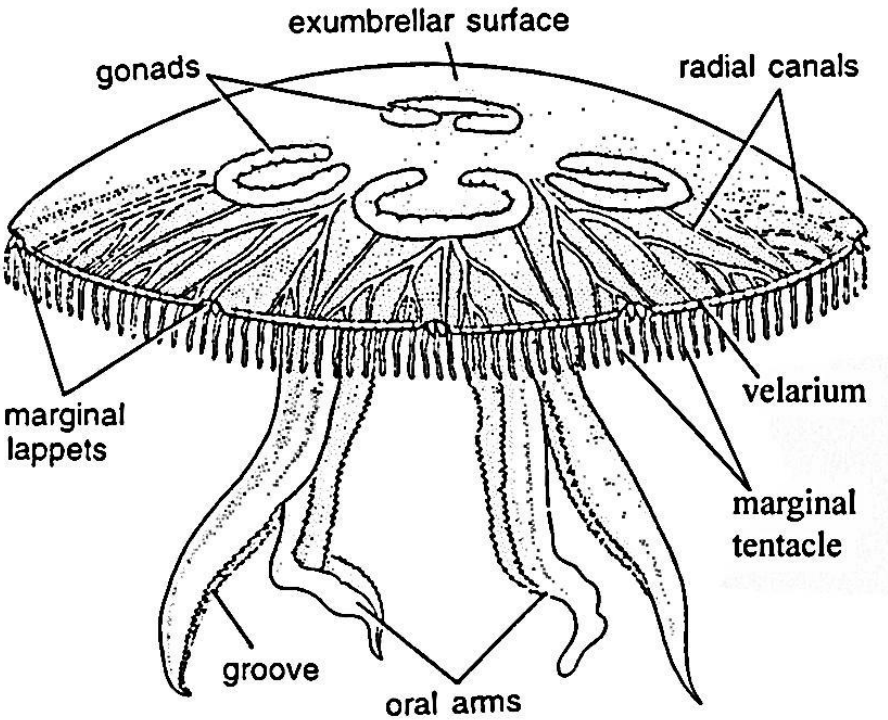


Figure 3.3: *Aurelia*

Salient Features:

1. They are easily recognized by their soft bell or umbrella shaped body with four red or purple horseshoe shaped gonads on its upper surface and four long narrow oral lobes hanging downwards from lower surface.
2. The medusa is bowl or saucer shaped having tetramerous radial symmetry.
3. Medusa or umbrella has a slightly convex upper surface known as exumbrellar surface and a lower concave the subumbrellar surface.
4. Manubrium is short and inconspicuous which hangs down from center of subumbrellar surface. At its free distal end a square mouth is present. From corner of the mouth, hang 4 oral arms.
5. Margin of the umbrella is divided into eight lobes by notches which contains tentaculocyst enclosed by a pair of marginal lappets.
6. Many short hallow tentacles are present on whole margin of umbrella and are called as marginal tentacles.
7. It is unisexual. The four gonads testes or ovaries lie on the floor of gastric pouch.

4. *Metridium* (Sea anemone):

Systematic Position:

Phylum: Coelenterata	Acoelomate, diploblastic multicellular organisms with tissue grade body organization.
Class: Anthozoa	Well known as flower animals. Exclusively marine solitary or colonial. All polupoid forms, medusae are absent. Gastrovascular cavity subdivided by 8 or more septa or mesenteries. Hexamerous symmetry.
Subclass: Hexacorallia	Tentacles usually unbranched, numerous but never eight. Gullet with two siphonoglyphs. Polyps usually monomorphic.

Order: Actiniaria Solitary sea anemone with large sized muscular body often with an aboral pedal disc. Skeleton is absent. Numerous tentacles.

Family: Metridiidae Known as sea anemones. Mesogloeal sphincter muscles present. Mesenteries not divided into macronemes and micronemes.

Genus: *Metridium*

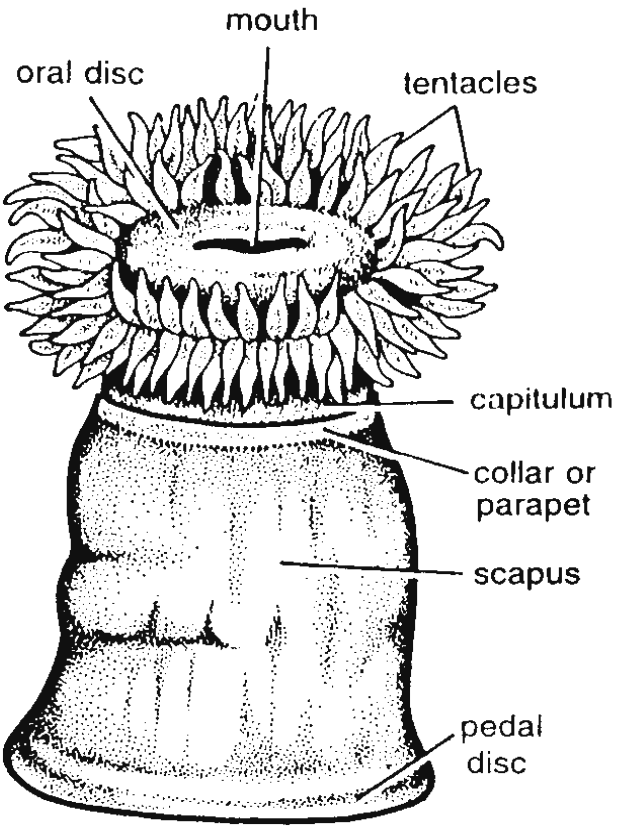


Figure 3.4: *Metridium*

Salient Features:

1. *Metridium*is solitary marine sea anemone found in shallow water, mostly attached to rocky substratum with pedal disc.

2. Body is short, cylindrical and radially symmetrical, divisible into three regions viz. pedal disc, column and oral disc.
3. Column is differentiated into two portion, distal thin walled short capitulum and proximal thick walled scapus by the groove and collar.
4. Oral disc is slightly convex and bears a slit like central mouth. Mouth is encircled by large number of hallow tentacle forming a sort of crown.
5. Mouth leads into short gullet which opens into gastrovascular cavity.
6. Sexes are separate. Gonads are borne on the mesentries.
7. Asexual reproduction by fragmentation and budding.

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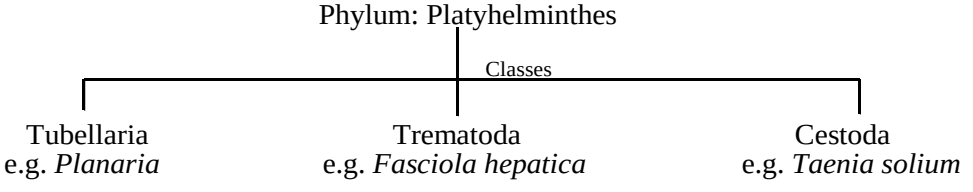
Practical No. 04

Aim: Museum Study of phylum Platyhelminthes: *Planeria, Faciola hepatica, Taeniasolium*

Platyhelminthes (Greek, platy = flat; helmins = worms)

General characters:

1. Acoelomate, triploblastic, bilaterally symmetrical organism with dorso-ventrally flattened body having tissue organ system grade of body organization.
2. They are aquatic or terrestrial and parasitic or free living animals.
3. Body covered with thick cuticle and has cellular or syncytial epidermis and with longitudinal muscle fibers in four bands.
4. Adhesive organ are hooks or suckers or they secrete a sticky fluid for attachment.
5. Digestive systemis absent in *Acoela* and tapeworms but incomplete without anus in other flatworms. Pharynx is muscular while intestine is non-muscular.
6. Circulatory and respiratory system are absent.
7. Excretory system consists of single or paired protonephredia with lateral canal and flame cells. In acoela, the protonephredia are absent.
8. Nervous system of primitive type.
9. Sense organs are poorly developed; Eye spots are present in free living forms.
10. Hermaphrodites, reproductive systems are well developed and complex. Internal fertilization may be cross or self.
11. In many fresh water tubellarians, asexual reproduction occurs by fission.



1. Planaria:

Systematic Position:

Phylum: Platyhelminthes	Tissue organ grade organization, acoelomate, dorso-ventrally flattened organisms. Parasitic or free-living
Class: Tubellaria	Usually free living, non-parasitic. Epidermis provided with rhabdites. Adhesive organs present. Mouth ventral.
Order: Tricladida	Pharynx plicate usually directed backwards, intestine with three branches with many diverticula.
Family: Planariidae	Family of fresh water planerians

Genus: *Planaria*(*Dugesia*)

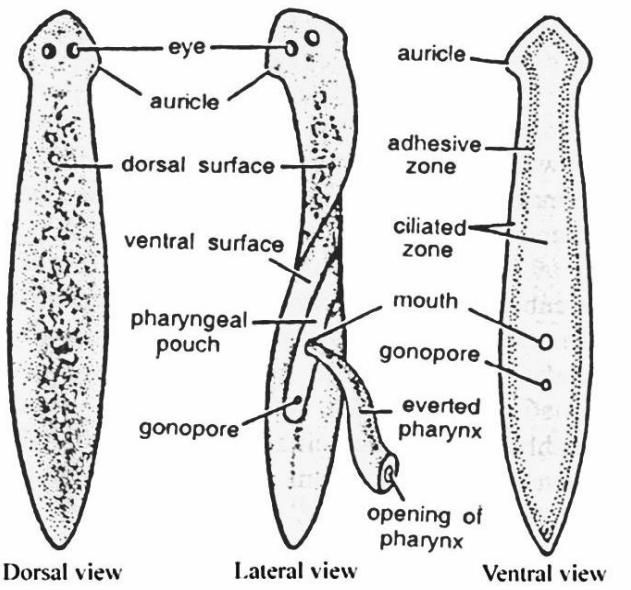


Figure 4.1 :*Planaria*

Salient Features:

1. Body is small, elongated leaf like, bilaterally symmetrical and dorso-ventrally flat.
2. Body colour is dull grey, brown to black and measures about 2 – 15 mm.
3. Body wall is slimy and transparent through which some internal organs are visible.
4. Head is triangular bears a pair of dark spots i.e. eyes; Head has small projection laterally known as auricle. Behind auricle body is constricted to form neck.

5. Digestive system consists of mouth, proboscis, pharynx, branched intestine, no anus.
6. Pharynx is plicate and directed backwards.
7. Genital pore situated a little posterior to the mouth.
8. Reproduction sexual and asexual. They exhibit great capacity of regeneration.

2.*Fasciola hepatica*(liver fluke):

Systematic Position:

Phylum: Platyhelminthes	Tissue organ grade organization, acoelomate, dorso-ventrally flattened organisms. Parasitic or free-living.
Class: Trematoda	Ecto- or endo-parasitic flatworms, called flukes. Leaf like body. Hooks and suckers are present. Rhabdites absent.
Order: Digenea	Endoparasites in vertebrates. 2 suckers devoid of hooks.
Family: Fasciolidae	Parasites with oral and ventral sucker i.e. acetabulum.
Genus: *Fasciola*	
species: *hepatica*	

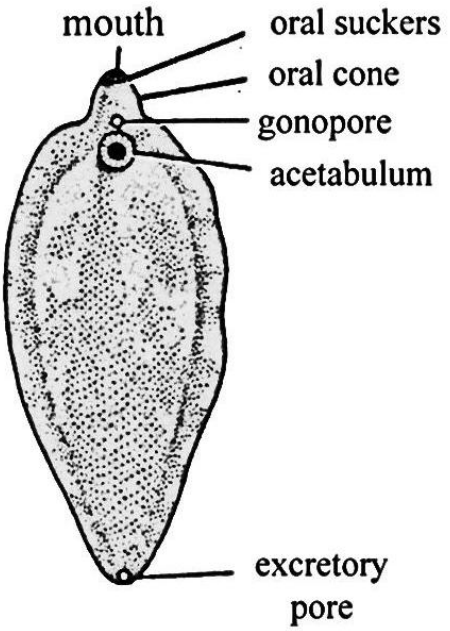


Figure 4.2: *Fasciola hepatica*

Salient Features:

1. It is an endo-parasite. Commonly known as sheep liver fluke. Causative agent of Liver rot disease. It is pinkish in color.
2. It occurs in many other mammals other than sheep, fresh water gastropod as *Limnea* being its intermediate host.
3. Body is leaf like, dorso-ventrally flattened and soft. Measures 1.8 to 3 cm in length. Body tapers at both the ends. Anterior end is broader while posterior end is pointed.
4. Oral cone on the anterior side of the body bears triangular mouth. Excretory and gonopores are also present.
5. Presence of two small suckers at both the ends. Hooks are absent.
6. Body is covered with tegument consisting of numerous spinnules.

3. *Taeniasolium*(Tape worm):

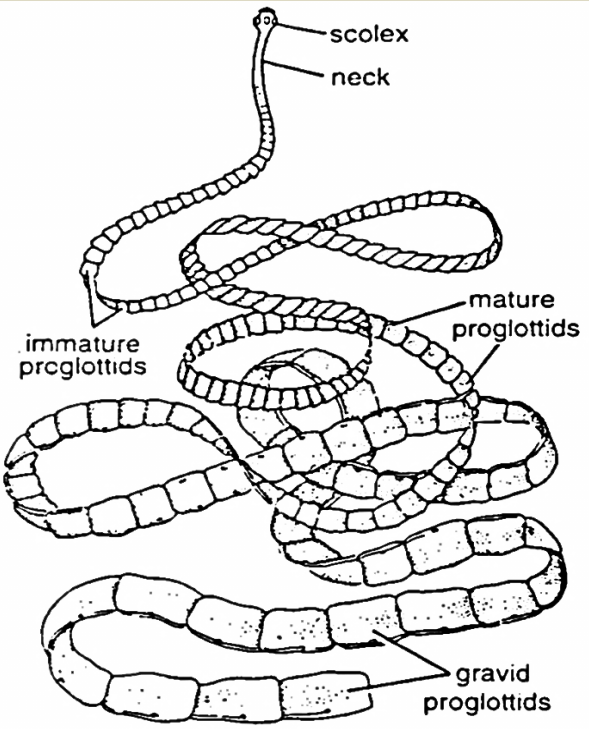


Figure 4.3: *Taeniasolium*

Systematic Position:

Phylum: Platyhelminthes	Aoelomate, dorso-ventrally flat. Parasitic or free-living forms.
Class: Cestoda	Endoparasite. Body is segmented, flat and ribbon like.
Order: Taenioidea (Cyclophyllidea)	Scolex with four large suckers and hooks. Ovary is lobed. Yolk gland single and compact.
Family: Taeniidae	Parasites of mammals commonly known as tapeworms.
Genus: *Taenia*	
species: *solium*	

Salient Features:

1. It is an endoparasite in small intestine of humans with pig as the intermediate host.
2. Body is elongated, narrows anteriorly and broadens towards the posterior side.
3. Numerous segments called proglottids are present.
4. Body is divided as anterior scolex, short neck and segmented strobila.
5. Scolex consists of four suckers and numerous hooks.
6. Neck is narrow. It is the region from which the strobila are budded off and pushed backwards adding to the segments of strobila.
7. Strobila forms the main bulk of the body consisting of 800-1000 proglottids. Proglottids in strobila are of three types: Immature towards the neck region, Mature middle part where both male and female reproductive organs grow and third one is the ripe or gravid.

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Practical No. 05

Aim: Study of *Paramoecium*: Culture, External morphology, Binary fission and Conjugation

Culturing of *Paramoecium*:

Paramoecium is microscopic, unicellular freshwater organism, easily grown in wide mouth jar at laboratory condition. If water rich with decaying organic vegetation containing bacteria are provided to parameciathey grows rapidly and multiply at faster rate. Parameciacan be cultured by simply collecting the pond water with some decaying organic matter containing *Paramoecium*. Scientific method of culture is known as Hay culture.

Requirements: Wheat grains, Hay stems, *Paramoecium* from pond water, Beaker, Burner, Distilled water etc.

Procedure for Hay culture method:

1. Boil 10 gm of wheat grains and 10–20pieces of hay stems in 500 ml distilled water for about 10-15 minutes so as to soften.
2. Allow it to cool at room temperature. This is the culturing medium for Paramecia.
3. Using suitable bottle or beaker collect the water from ponds or ditches as paramecia are abundantly found in such water bodies.
4. Inoculate the paramecia into the prepared culture by adding water sample collected from the pond or ditch.
5. Keep the culture in a dark and cool place for about a week. Within few days existing paramecia will multiple and increase in number.
6. Take a drop of water from this culture medium on the slide and observe the paramecia under microscope.

External Morphology of *Paramoecium*:

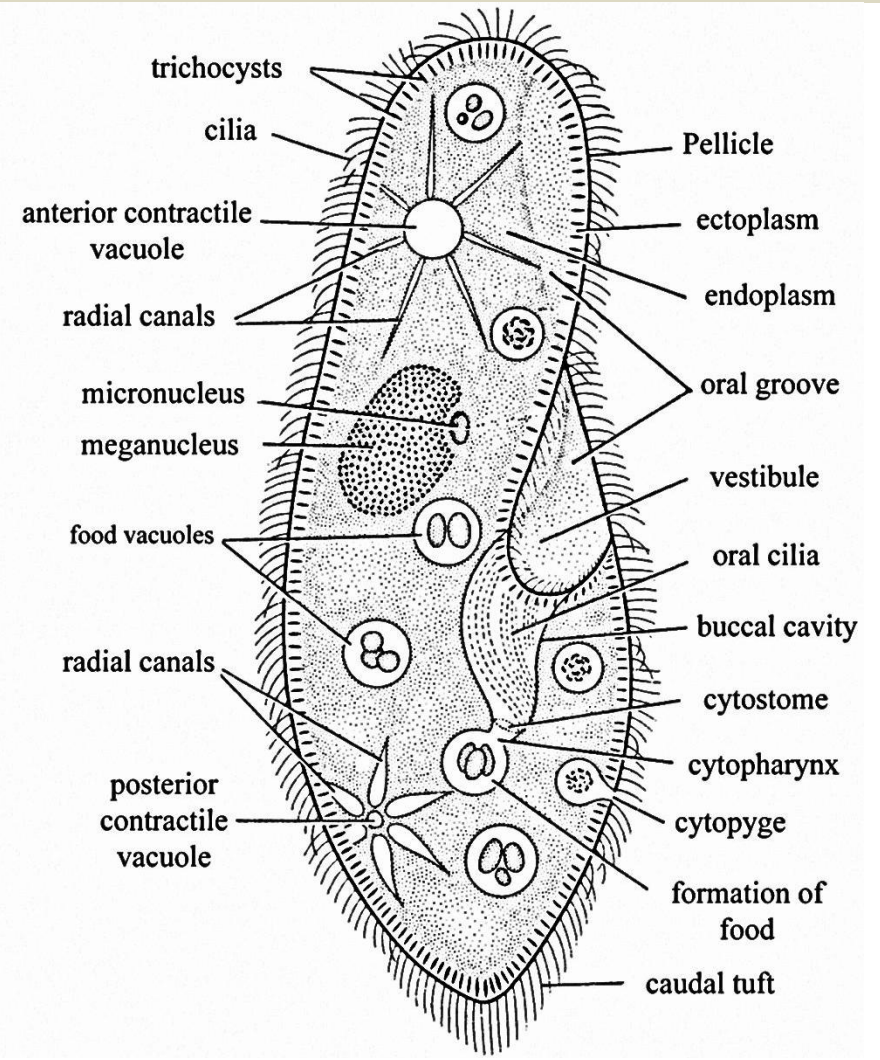

Figure 5.1: *Paramoecium*

Systematic Position:

Phylum: Protozoa	Unicellular, microscopic animals without tissue and organs.
Subphylum: Ciliophora	Cilia are the locomotory organ. Dimorphic nucleus.
Class: Ciliata	Numerous cilia persist throughout life. 1-2contractile vacuoles

Order: Holotricha	Cilia are uniform length and distributed evenly
Family: Parameciidae	Ciliates with anterior & posterior ends bounded by elastic pellicle.
Genus: *Paramoecium*	
species: *caudatum*	

Salient features:

1. It is a unicellular, slipper shaped animalcule. Size ranges from 80µ to 330 µ.
2. The body is blunt and round at the anterior end whereas the posterior end is roughly pointed.
3. Body is well distinguished as oral or ventral surface and aboral or dorsal surface.
4. Body covered by small hairlike cilia for locomotion. Cilia are uniform in length and evenly distributed, except at the posterior region where they are longer and form a tuft like structure called as caudal tuft. This is the characteristic feature of *P.caudatum.*
5. Body is enclosed in a flexible, thin and firm membrane called pellicle.
6. Small spindle-like bodies called trichocysts are present.
7. Cytoplasm differentiated into the dense ectoplasm and granular endoplasm.
8. Binucleate. Macronucleus is bean shaped or ellipsoidal in shape. It controls all the vegetative functions hence called the vegetative nucleus. Small, spherical micronucleus controls reproduction of the cell, hence called as reproductive nucleus.
9. Presence of two large contractile vacuoles which are osmo regulatory and excretory in function. Food vacuoles are also present.
10. Sexual reproduction occurs by conjugation, whereas asexual by binary fission.

Binary fission:

1. It is the asexual reproduction in *Paramecium,* occurring during favorable conditions.
2. In Binary fission single full- grown *Paramecium* divides into two daughter paramecia in transverse plane, at right angles to the longitudinal axis of the body.

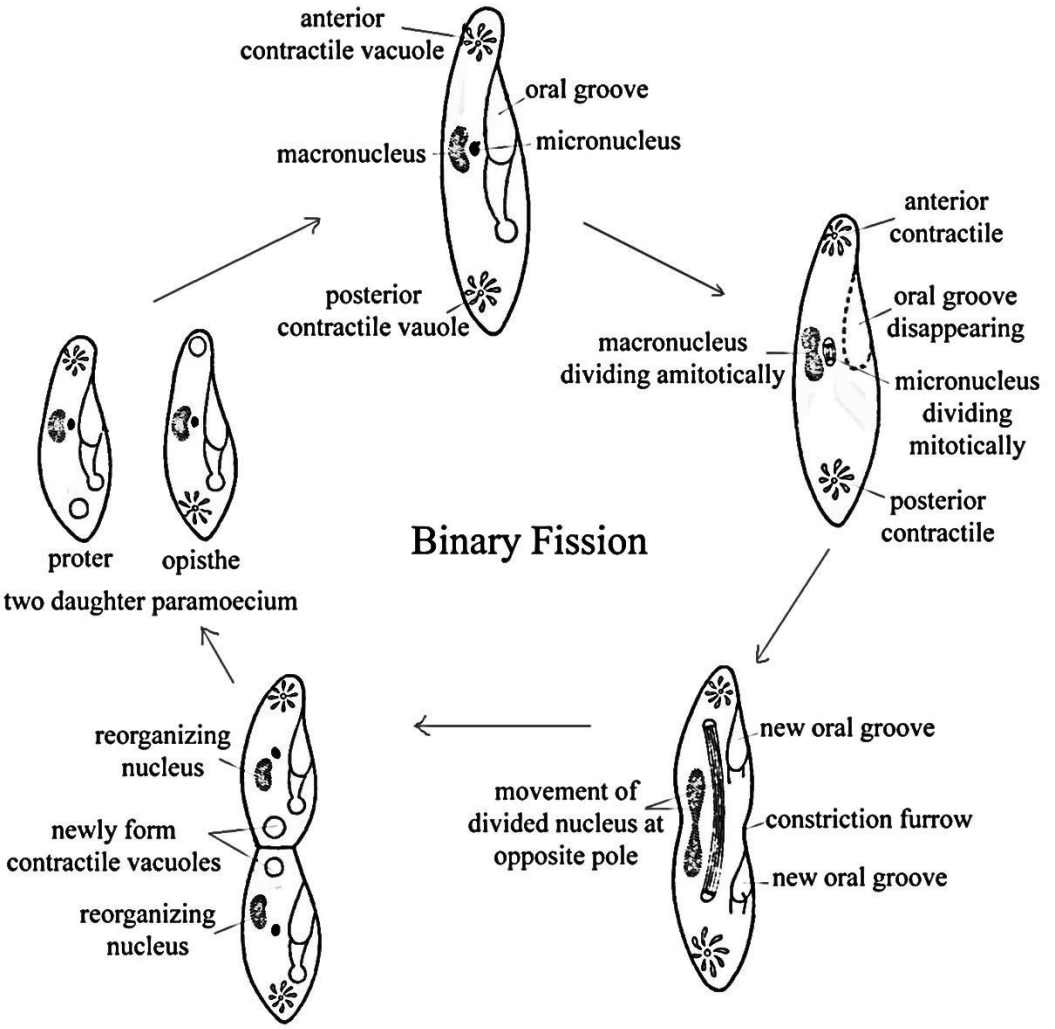

Figure 5.2 : Binary Fission in *Paramoecium*

3. Before the initiation of binary fission *Paramecium* stops feeding and its oral grooves disappears. Macronucleus divides by amitosis whereas micronucleus by mitosis.
4. Two nuclei start migrating towards the opposite ends.
5. Nuclear division is followed by cytoplasmic division.
6. Constriction starts to develop at the middle region of the body which eventually divides the cytoplasm equally.

7. This gives rise to two daughter paramecia of equal size, one on the anterior side is called as proter and that on the posterior side is opisthe.
8. Oral groove and cytopharynx are newly formed in both the daughters.
9. One contractile vacuole from parent *Paramoecium* goes to each of the daughter cells i.e. anterior contractile vacuole receive by proter while posterior contractile vacuole goes into opisthe.
10. Entire process of binary fission is completed within 2 hours and may occur one to four times a day.

Conjugation in *Paramoecium*:

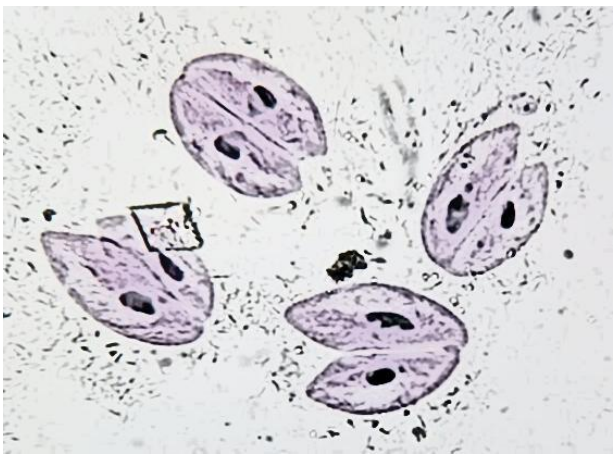

Figure 5.4: Micrograph of conjugants during Conjugation process

Process of Conjugation:

1. Conjugation is the sexual reproduction in *Paramoecium*. It is necessary for survival and rejuvenation of the species.
2. It generally occurs after continuous multiplication by binary fission or under unfavorable conditions.
3. This process includes temporary union of two paramecia of different mating types. Both the paramecia get attached to one another by their ventral or oral surface.

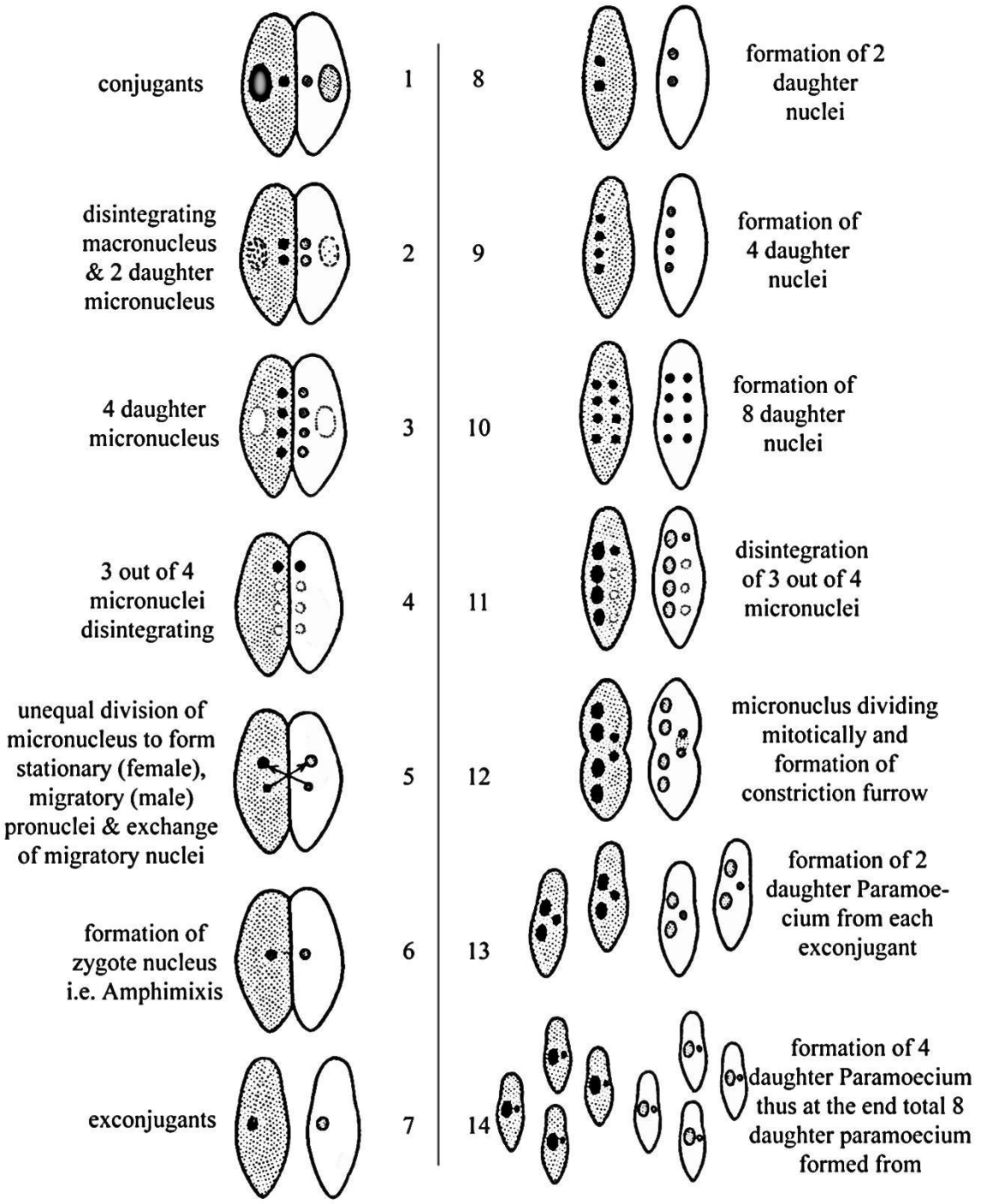

Figure 5.3: Conjugation in *Paramoecium*

4. Post attachment there is degeneration of cilia, trichocyst and feeding apparatus.
5. Also, a cytoplasmic bridge is formed by the degeneration of pellicle and ectoplasm. These united paramecia are called as conjugants.
6. Macronucleus also gets fragmented and absorbed into the cytoplasm as is not having any role in conjugation process.
7. Micronucleus undergoes two divisions to form total four nuclei.
8. Three out of four again degenerates while remaining nucleus divides into two unequal pronuclei, smaller migratory is known as male pronuclei, whereas larger stationary is female pronuclei.
9. The migratory pronucleus of one conjugant passes through the protoplasmic bridge into another conjugant and fuses with its stationary female pronuclei.
10. This fusion results in the formation of a single diploid zygote nucleus, called as synkaryon. This processes of complete fusion of two nuclei from two different individuals to form a zygote nucleus is called as amphimixis.
11. The attached conjugants sperate and are now called as exconjugants.
12. Zygote nucleus and the conjugants will now undergo several divisions to form four daughter cells from each exconjugant.

    Thus, at the end of the process there will formation of eight daughter paramecia.

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Practical No. 06

Aim: Study of permanent slides: Spicules and Gemmules in Sponges, T.S. of *Sycon*, T.S. of *Hydra, Taeniasolium*: Scolex, Gravid proglottid.

Spicules and Gemmules in sponges:

Sponges possess a skeleton composed of spicules or sponginfibres or the combination of both. This skeleton provides structure and support to the sponge.

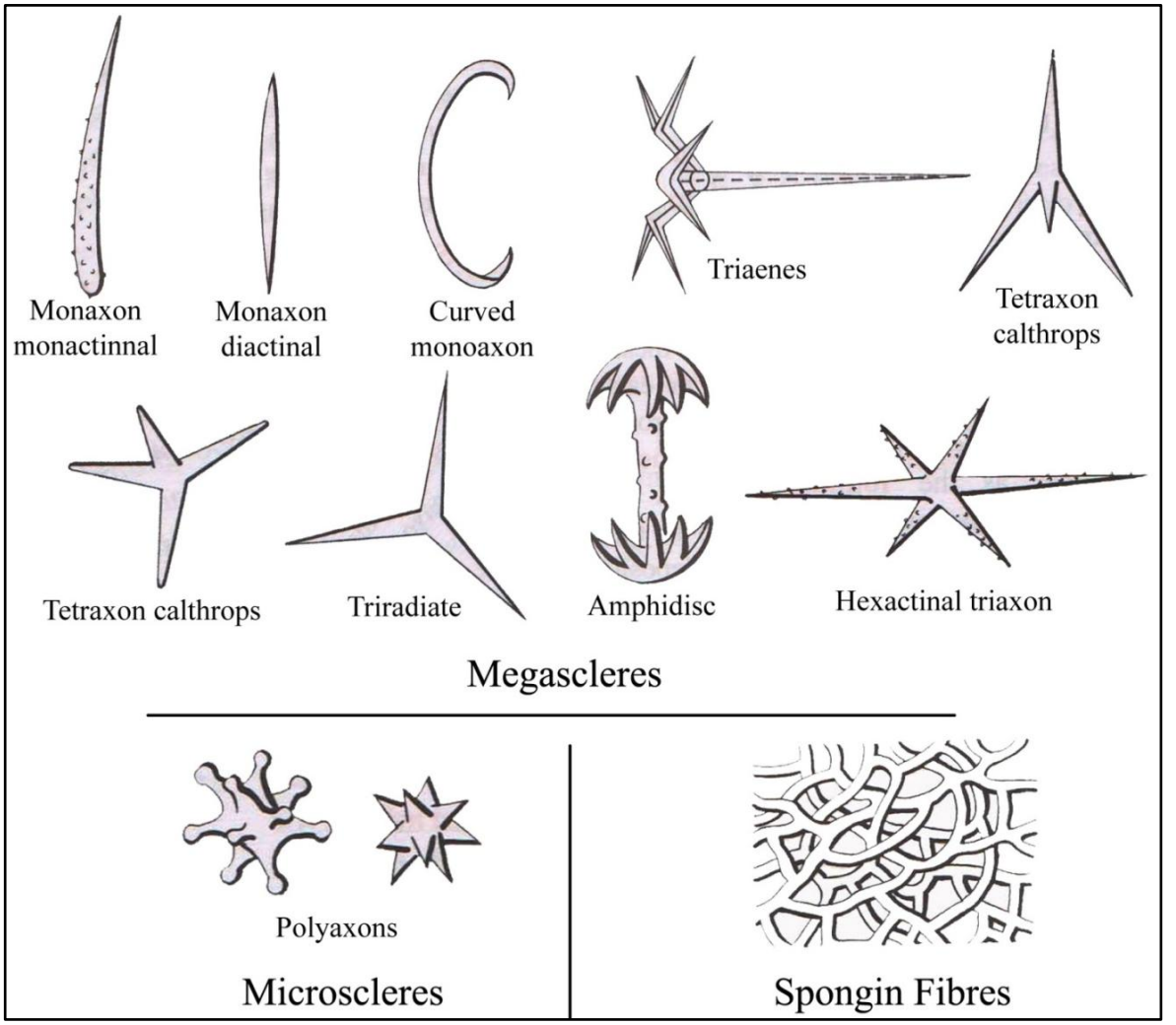

Figure 6.1: Spicules and Sponginfibres in Porifera

A) Spicules:

The spicules are crystalline bodies made up of simple spines or of spines radiating from a point. They are either calcareous or siliceous in nature. The calcium carbonate or hydrated silica deposition takes place around an axis of organic material. Spicules are basically classified as larger **megascleres** and smaller **microscleres.** Being larger in size the megascleres form the main supporting framework of the sponge body. Microscleres are the small flesh spicules present in the mesenchyme.

1. **Monoaxon**: Growth of the spicule is along a single axis. Monoaxon spicules may be straight or curved. Monoaxon spicules are further classified as:
   a) **MonoaxonMonactinal**: In this spicule growth takes place in one direction of the single axis.
   b) **Monaxon Diactinal:** In this spicule growth takes place on both sides of the single axis.
2. **Tetraxons:** They are also called as tetractines and quadriradiates. Tetraxonspicules consists of the four rays projecting in different directions from the common point. Tetraxons can be further classified as:
   a) **Triaenes:** They have one out of the four rays larger than the other three. It has an appearance of the crown.
   b) **Calthrops:**All the four rays are similar in length.
   c) **Triradiate:** One of the four rays is lost and only three remain.
   d) **Amphidisc:** the elongated ray bears a disc at both ends.
3. **Triaxons:** The triaxon or hexactinal spicules are characterized by three axes crossing at right angles, thus producing six rays.Triaxons are characteristic of glass sponges.
4. **Polyaxons:** There are many equal rays radiating from the central pointhence called as polyaxons. They may be grouped to give star like appearance. Polyaxons are common among the microscleres.

5. **Sponging fiber**: Spongin fibers are fine threads consisting of a soft granular axial core or medulla, surrounded externally by concentric layers of spongin. Spongin is an organic, horny, elastic substance resembling silk /collagen in chemical composition. Sponging is made up of scleroprotein associated with sulphur. Sponging fibers are secreted by specialized mesogleal cells, called spongioblasts. Spongin occurs in various forms in Demospongia.

B) Gemmules:

Formation of the gemmules is one of the methods of reproduction in many of the sponges. It occurs in all the fresh water sponges and also in some marine forms. Gemmules are the internal buds formed by the sponge for the purpose of asexual reproduction. These internal buds eventually detach and develop into a new individual. A gemmule is small tough round structure. It consists of the food laden archeocytes, and is covered by resistant chitinous capsule. Capsule is made up of two membranes. At one end of the capsule, a small outlet is present called as micropyle.

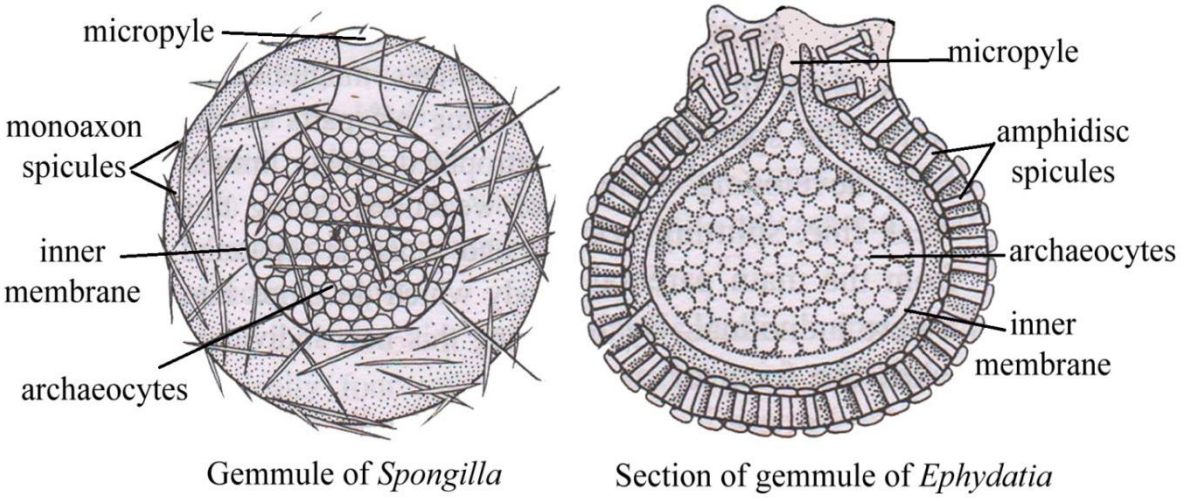

Figure 6.2: Gemmules in Porifera

Gemmule may have additional strengthening structures as siliceous amphidisc spicules or monoaxon spicules. Gemmules are capable of tolerating excessive cold or draught condition along with desiccation. Under the unfavorable conditions the sponge may die and degenerate but the gemmules survive and remain dormant until the favorable condition. Degeneration of the adult body results into setting free of the gemmules from body. During the favorable conditions the histoblasts(living content inside the gemmule) are set free. They produce sperm and ova thus giving rise to the new sponge.

Transverse Section (T.S.) of *Sycon*:

A transverse section of *Sycon* reveals that there are two cellular layers viz. pinacoderm and choanoderm, in between these two layers lies the mesenchyme. Pinacoderm controls the interrelations between the mesenchyme and external medium, while choanoderm controls nutrition.

Pinacoderm: It is formed by the pinacocytes and is differentiated as exopinacoderm and endopinacoderm. Exopinacoderm forms covering of entire body surface except dermal ostia and osculumwhile endopinacoderm forms epithelial lining of incurrent canal and spongocoel. Pinacoderm has characteristic pinacocyteswhich are the large, flattened and polygonal cells with central nucleus, and are closely cemented to one another.

Sponge body is capable of increasing and decreasing the size of the body due to the highly contractile nature of pinacocytes. Some of the pinacocyte cells at the incurrent canal are modified to form the tubular, thin walled porocytes. Nucleus of the porocytes is present at the periphery. The pinacocytes surrounding the osculum and ostia are elongated and highly contractile and acts like muscle cells.

Choanoderm: It constitutes the gastral epithelium. It is formed of the oval or rounded collar cells known as choanocytes (choano- funnel, kytos- cell). These cells are arranged in the form of loose layer above mesenchyme. Each cell comprises of one or two contractile vacuoles, reserve food, kinetosome and a long whip like flagellum.

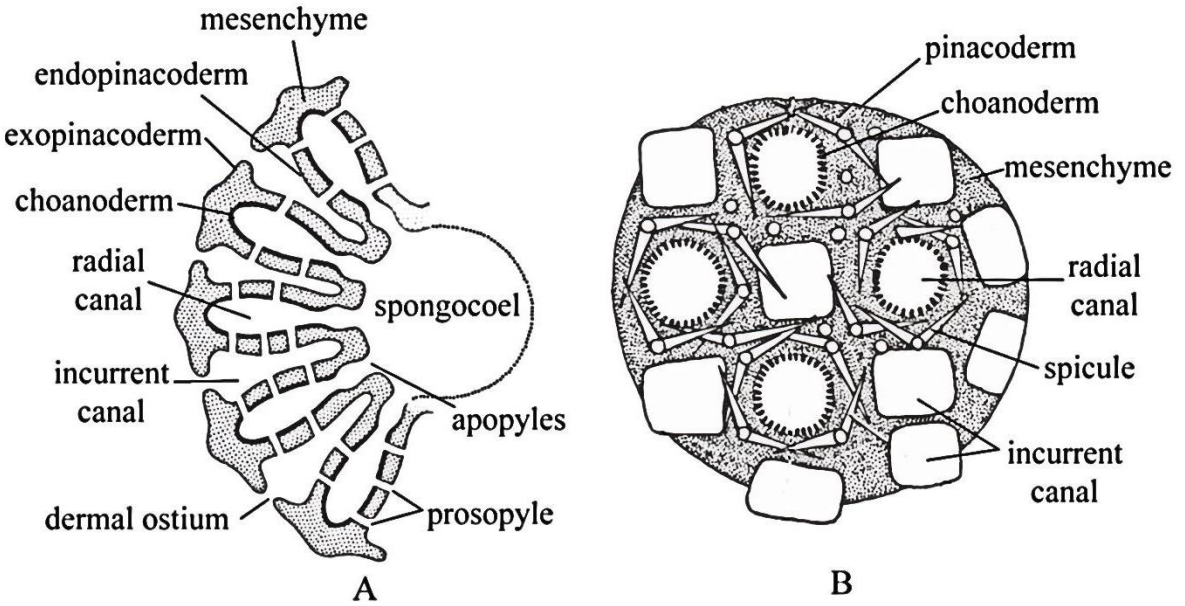

Figure 6.3: A) T.S. of Sycon Diagrammatic representation B) Tangential section of portion of body wall showing arrangement of incurrent and radial canals

Mesenchyme: It is the gelatinous matrix interconnecting the pinacoderm and choanoderm. It is supposed to be secreted by the pinacoderm. There are variety of amoebocytes found in the mesenchyme as archaeocytes, collenocytes, chromocytes, thesocytes, Myocytes, scleroblasts, gland cells, germ cells (ova and sperm). Embedded in the mesenchyme are the monoaxon and triaxon type of spicules.

Transverse section (T.S.) of *Hydra*:

In a transverse section body of hydra shows a central cavity coelenteron referred to as gastrovascular cavity surrounded by the body wall. There are two distinct layers viz. **epidermis** (ectodermal in origin) and **gastrodermis** (endodermal in origin). In between epidermis and gastrodermis there is non-cellular, thin and transparent **mesoglea**.

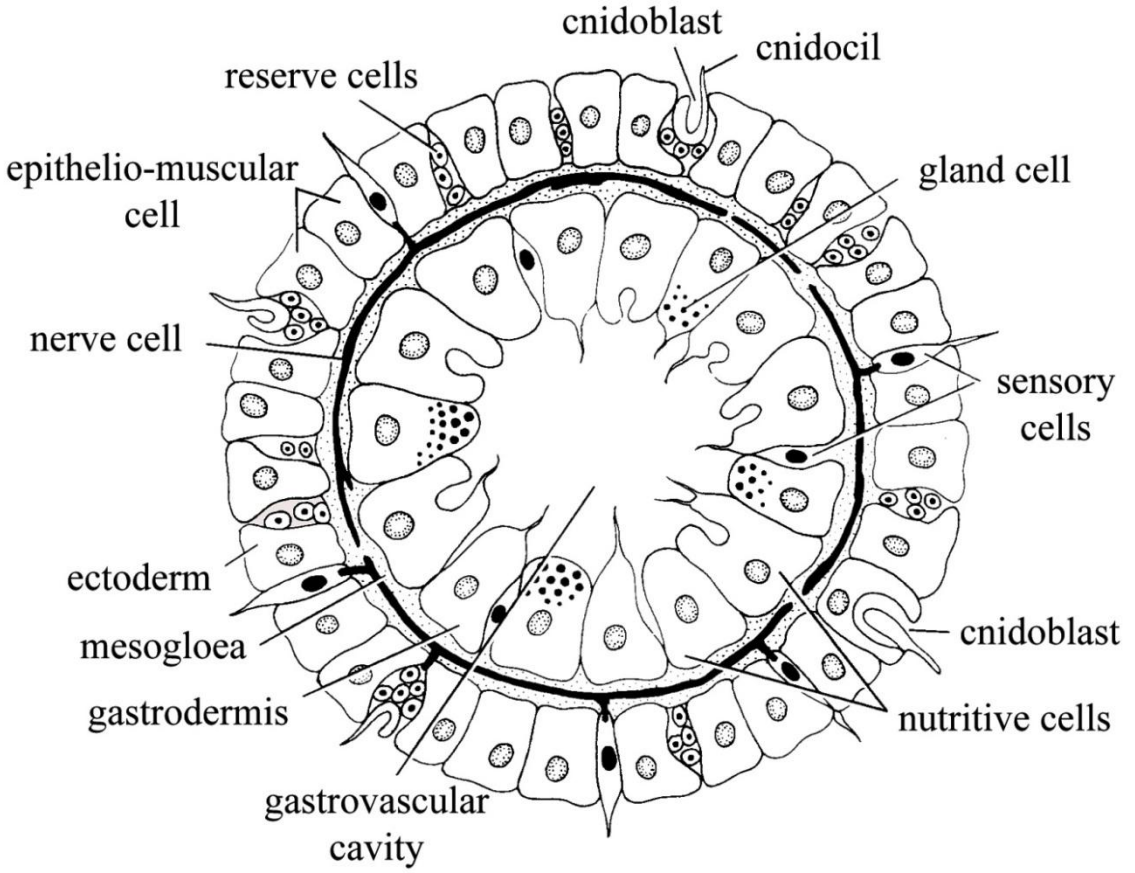

Figure 6.4: T.S. of Hydra

1. **Epidermis:** This is the outer cellular layer, contains roughly cuboidal cells, covered by thin cuticular coating. There are various types of cells present in this layer. They are as follows:
   a. **Epithelio- muscle cells**: They are more or less conical or pear shaped cells. They are useful for both epithelial covering and also for muscular contraction. Each of the epithelio- muscular cell has two parts **outer epithelial** extending up to the body surface and the **inner muscular** part. The cell membrane at the outer free surface has microvilli. Mucous bodies are present below this membrane.

b. Gland cells: These are the tall cells chiefly found on the pedal disc and also around the mouth region. They serve for secretion of the mucous like sticky material which is useful for attachment, protection and also for entanglement of the prey.

c. Interstitial cells: Spaces between the narrow basal ends of epithelia; the muscle cells are occupied by the small rounded undifferentiated cells measuring about 5µm. These cells are called as interstitial cells. They play an important role in regeneration, growth, budding and sexual reproduction.

d. Cnidoblasts: The interstitial cells get modified and forms a specialized structure called as cnidoblasts. These are somewhat oval in shape with basal nucleus and a sac like stinging cells or nematocyst.

e. Sensory cells: They are scattered throughout the epidermis among the epithelio-muscle cells. They are tall, narrow, columnar and threadlike cells. They possess the delicate hair like process. Their inner ends are connected to the nerve cell by a fine nodulated process. They are responsible for receiving and transmission of impulse. Sensitivity to touch, temperature and chemical stimuli are its characteristics.

f. Nerve cells: Nerve cells occur at the base of the epithlio- muscle cells just above their muscle processes forming a nerve net.

g. Germ cells: Interstitial cells in certain areas divide and proliferate and forms germ cells which later on differentiates into testis and ovaries.

2. Gastrodermis: It is the inner cell layer of the body wall, it lines the gastrovascular cavity. It is formed by the large columnar cells. It is nutritive in function. It comprises of the following cell types:

a. Endothelio-muscle/ Nutritive cells: They are similar to the epithelio- muscle cells except for their basal contractile processes are single and at right angles to the long axis of the body. They bear a long flagella usually two in number by

which the liquid food in the body is kept in motion It also contains the pseudopodia to engulf the food particles.

b. **Endothelio-gland cells:** They are smaller than nutritive muscle cells and occur interspersed between them. They are of two type, enzymatic gland cells and mucous glands.

Gastrodermis also has its own network consisting of **interstitial cells**, **sensory cells**, **nerve cells**. Nematocytes are absent in gastrodermis.

Scolex in *Taeniasolium*:

Body of *Taeniasolium* is divided into three parts, anterior head or scolex, short unsegmented neck and segmented strobila.Scolex is the organ of attachment. It is a quadrangular, knob like structure measuring about 0.6 -1mm wide.

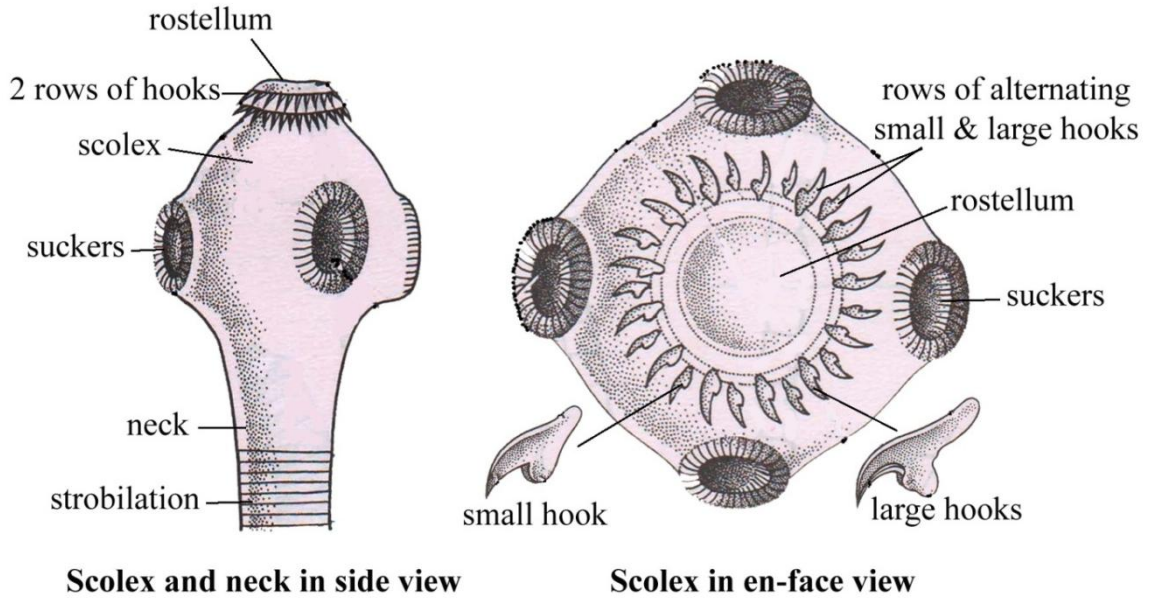

Figure 6.5: Scolex in *Taeniasolium*

At the apex it bears bulbous rounded mobile cone known asrostellum, it is surrounded by two rows of 22 to 32 curvedchitinous hooks. Hooks at the anterior circle

are larger (0.14 – 0.18mm) and that of the posterior circle are smaller (0.11 – 0.14mm). Each hook has a base for attachment, a blunt projection or handle and a blade. Scolex bears highly suctorial muscular suctorial organs, the acetabulum or suckers. These suckers are present at each angle of quadrangle. Suckers are devoid of hooks. With the help of two rows of hooks and suckers the scolex remains firmly attached to the intestinal mucosa.

Gravid proglottid in *Taeniasolium*:

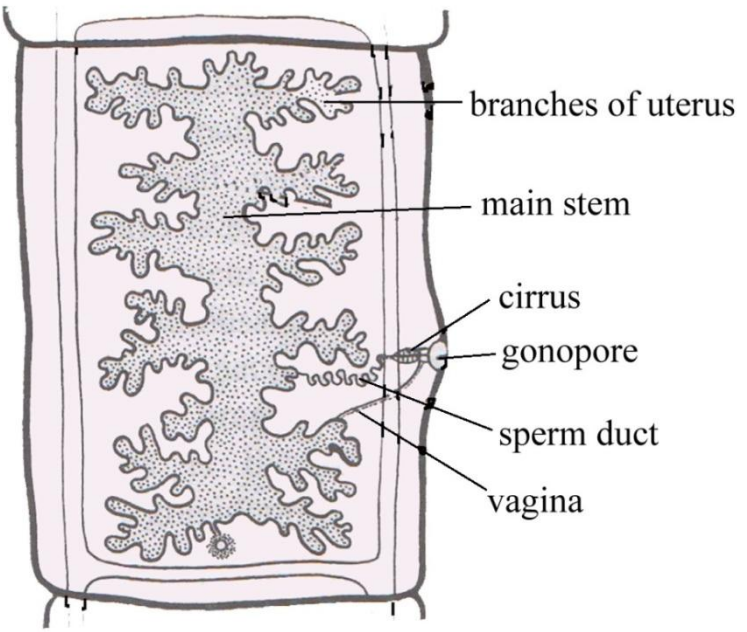

Figure 6.6: Gravid Proglottids in *Taeniasolium*

Strobila of *T. solium* has three types of proglottids**immature, mature and gravid.** The 200 just below the neck are considered as immature, there is no sexual maturity. The other 400-450 are considered as the mature as they have matured male and female reproductive organs, thus making the organism hermaphrodite. At the last there are 150-350 proglottids are the gravid or ripenproglottids.

Gravid proglottidsare largest and oldest of the other kind of proglottids. It extends up to the last segment of the body. In gravid proglottids the male and female reproductive organs degenerate, only uterus persists, it is full of fertilized eggs. Small group of gravid proglottids get detached from the main strobila and pass out through the faeces. The process of shading of the gravid proglottids is termed as apolysis. Apolysis brings about two main function, maintains the size of the body and secondly transfers the eggs to the new host.

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Practical No. 07

Aim: Identification of museum specimen with help of taxonomic identification key

Dichotomus Taxonomic Keys upto classes for Phylum Porifera and Coelenterata:

1a Body mass or colony has the appearance of an amorphous mass. May be hard, spongy or gelatinous. May be a thin or thick crust or may be erect. Often have holes, which may be either single, paired, or scattered and may be on the tips of elevations on the mass ……... **2**

1b Body mass or colony variable, but does not have the appearance of an amorphous mass ……..... **3**

2 Mass is soft or hard and may contain calcium or glass spicules. Larger holes, if present, do not occur in pairs ……..…..… **Phylum Porifera : Sponges 20**

3a Body is gelatinous and the species is pelagic ……...…….. **4**

3b The body is not gelatinous or the species is not pelagic ……...……. **9**

4a Radially symmetrical. Have one or more swimming bells that contract for propulsion, or swim by beating rows of comblike cilia ……. **5**

4b Not radially symmetrical ……..…….. **8**

5a Swim by beating rows of comblike cilia……..**Phylum Ctenophora**

5b Swim by contracting one or more gelatinous bells, but not by beating rows of comblike cilia. Contain stinging cnidocytes…… **6**

6a Solitary medusae which are often large, often colored (red, yellow, orange, and pink). The margin of the bell is often bordered into lappets. No velum. Manubrium is drawn out into 4 or 8 frilly oral arms. The gut may be in form of four pouches lined with colorful gonads, or may have gastrovascular canals. ……**Phylum Coelenterata Class Scyphozoa, Order Semaestomae**

6b Solitary medusae or a colony of swimming bells. Not often more than 6 cm in diameter. Usually not colored. The margin of the bell is not bordered into lappets but often has a velum. Mouth is in the form of a tubelike manubrium but is not drawn out into frilly oral arms, though its margins may be lobed or frilly. Gut is a small central cavity with radiating canals and a ring canal near the margin of the umbrella. A swollen tentacular bulb occurs at the junction of each radial canal with the ring canal. Colonial forms consist of a string of swimming bells, tentacles, and perhaps a gas-filled float …….. **Class Hydrozoa 7**

7a Solitary medusa …..…….……..……..**Hydrozoan medusae**

7b Colonial……. **Class Hydrozoa, Order Siphonophora**

8a Swim by beating comblike rows of cilia …...……**Phylum Ctenophora**

9a Radially symmetrical, a jellyfish which is attached to the substrate by a stalk from its exumbrella ……...**Phylum Coelenterata, Class- Scyphozoa, Order- Stauromedusae**

9b Not a jellyfish ……..... **10**

10a A modified poly which floats on the ocean surface. Has a chitinous sail. Normally oceanic but may be blown ashore during storms……..**Phylum- Colenterata, Class- Hydrozoa**

10b Not a modified, floating polyp with a sail …… **11**

11a Growth form is a cuplike polyp, either solitary or as a colony. Polyps may be large or nearly microscopic …… **12**

11b Growth form is not as a polyp nor a colony of polyps ….**Chordata, Urochordata**

12a Small polyps, a few solitary but mostly colonial due to budding. Colonies may be arborescent (bushlike) or pinnate (featherlike). Not usually brightly colored. Different polyps in the colony are often polymorphic. Polyps are usually at least partially surrounded by a proteinaceous coat called a perisarc… **Class Hydrozoa, Polyps of Order Hydroida**

12b Polyps large and solitary, or if small, not in an arborescent or pinnate colony surrounded by a protein perisarc ……..…. **13**

13a Polyps have eight pinnate tentacles with featherlike side branches ……..…..
……**Class Anthozoa, Subclass Alcyonaria (Octocorallia)**

13b Tentacles not eight in number, and not pinnate …… **14**

14a Polyps larger than 1 mm in diameter, with no calcified skeleton ……. **15**

14b Polyps with a calcified skeleton, and may be 1 mm or less in diameter ……...**17**

15a Solitary polyps, not connected by a stolon …….…….. **16**

15b Colonial polyps, connected by a stolon …….. **Order Zoabthidae, Zoanthids**

16a Tentacles taper to a point, no knoblike tips …..**Order Actiniaria: Sea Anemones**

16b Tentacles end with knoblike tips ……**Order Corallimorpharia: *Corynactis***

17a Solitary polyps, diameter greater than 2 mm, with mesenteries and tentacles in multiples of six ……..…….. **Order Scleractinia: True corals**

17b Polyps colonial, polyp diameter may be less than 2 mm. Mesoglea is acellular. Usually purple, calcified colonies of many polyps …… **Class Hydrozoa, Order Stylasterina: Hydrocorals**

18a Spicules calcareous (can be dissolved by hydrochloric acid) and belonging to 3 or 4 main types i.e. tetraxon, triaxonoxeas. These sponges have no spongin……...……..……. **Class Calcarea**

18b Spicules are silicious are not dissolved by hydrochloric acid(spicules are absent in the Demospongiae) ……...……..…..…**19**

19a Basic spicule 6-rayed, but often modified by reduction or loss of certain rays; the dominant large spicules are either fused together to form, a lattice or cover the species as a feltlike mat; typically white or yellow, unless covered by silt, and larger than 10 cm; strictly subtidal, at depths of more than 15 cm ……...……..… **Class Hexactinellida**

19b Spicules not basically 6-rayed; spicules not fused to form a lattice, although in some cases they are held firmly together by fibers of spongin; some species white or dull tan, but others colorful; includes most of the intertidal and subtidal species. …….…..…… **Class Demospongiae**

Further museum specimens belongs to different classes of phylum Porifera and Coelenterata can be identified by following the systematic classification and characters mentioned as in previous practicals.

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Practical No. 08

Aim: Visit to Zoological survey of India/ Museum/National Park

Field visits to places of zoological interest promote a deep affinity towards the subject amongst the student. Observation of concepts taught theoretically in class reinforces the urge for gaining further knowledge. Moreover, zoology is a subject that can be better understood on field experience than within the confined walls of the classroom. The following aspects must be kept in mind while observing fauna in the field visits.

1. Students in small groups along with the in-charge teacher should visit nearby Zoos/ National park / Sanctuaries / Museum / Museum of Zoological Survey of India.
2. Keen observation of different animals / specimens in the museum should be done.
3. Enlist all the observations carefully in a sequence.
4. Describe all the salient features of listed organisms with their systematic position.
5. Take the pictures of organisms with due permission from the authority.
6. Write report and submit it to practical in-charge and head of department.
7. Study tour / field visit report must include details of the visit, including date and time, and also the description of all zoological specimens or facilities observed. Attachment of photographs along with report will further upgrade the report.

Note: If the visit is to a applied related field request the facility in-charge to provide useful information like certificate courses held, reading resources and contacts of the experts for guidance on career opportunities.

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Section - II
(Animal Ecology)

Practical No. 01

Aim: Estimation of dissolved Oxygen from given water sample by Winkler's method.

Principle :

The winkler method is based on two oxidation-reduction reaction is widely used and is the standard means of determining dissolved oxygen. This method is based on the fact that sodium hydroxide (NaOH) reacts with manganoussulphate ($MnSO_4$) to give a white precipitate of manganous hydroxide. In the presence of oxygen, in a highly alkaline solution, the whitemanganous hydroxide ($Mn(OH)_2$) is oxidised to brown colouredmanganousoxyhydrate ($MnO(OH)_2$). This occurs in direct proportion to the amount of oxygen present, may be judged from the intensity of the brown colouration of the precipitate. In strongly acidic media, manganic ions are freed and they react with the free iodine ions of potassium iodied (KI) to from free iodine. The amount of free iodine is equivalent to the amount of oxygen present in the sample. The amount of iodine can be determined by titration with sodium thiosulphate ($Na_2S_2O_4$).

Reactions :

$MnSO_4 + 2\ NaOH \longrightarrow Mn(OH)_2 + Na_2SO_4$ (White ppt.)

$2MnSO_4 + O_2 \longrightarrow 2MnO(OH)_2$ (Brown ppt)

$MnO(OH)_2 + 2H_2SO_4 \longrightarrow Mn(SO_4)_2 + 3H_2O$

$Mn(SO_4)_2 + 2\ KI \longrightarrow MnSO_4 + K_2SO_4 + I_2$ (Yellow Sol.^{n})

$2Na_2S_2O_3 + I_2 \longrightarrow Na_2S_2O_4 + 2\ NaI$ (Colourless Sol.^{n})

Requirements : Glass stoppered bottle; Beakers; Conical flask; Measuring cylinders; Burette; Pipette; Reagent bottle; Water sample; Winkler's A & B solution; H_2SO_4; Starch indicator; Burette stand etc.

Prepartion of Reagents :

1. **Magnous Sulphate Solution (Winkler A) :**Dissolve 48 gm of $MnSO_4$. $4H_2O$ or 40 gm $MnSO_4$. $2H_2O$ or 36.4 gm $MnSO_4$. H_2O in 10 ml of boiled distilled water and make quantity upto 100 ml.
2. **Alkaline Sodium / Potassium Iodide (Winkler B) :** Dissolve 50 gm of NaOH or 70 gm KOH and 13.5 gm of NaI or 15 gm of KI in the 100 ml of the boiled distilled water.
3. **Sodium Thiosulphate (N/80 or 0.0125 N) :**

   For 0.1N Sodium Thiosulphate Stock solution: Dissolve 24.82 gm of $Na_2S_2O_3$, $5H_2O$ in the boiled water and make up the volume upto 1 litre. Add 0.4 gm of NaOH as a stabilizer. This is 0.1 N stock solution stores in dark bottle & in a cool place. The solution should be freshly made every 4 weeks.

   Take 125 ml from stock solution and dilute it up to 1000 ml to prepare 0.0125N solution. Keep in the brown glass stoppered bottle.
4. **1 % Starch Solution:** Dissolve 1 gm of starch powder in 100 ml of hot distilled water and add a few drops of formaldehyde solution. Solution is perfectly clear.

Procedure for Dissolve Oxygen Measurement :

1. For control take 250 ml or 300 ml of pond water in closed stoppered bottle.
2. Add 1ml each of Winkler's A and Winkler's B solution one by one. At first white ppt will be observed followed by brown ppt respectively after addition of reagents.
3. Add concentrated H_2SO_4drop by dropto this content till theppt is dissolved. Clear yellowish brown solution will be observed indicating liberation of iodine.
4. Take 100 ml of this yellowish brown solution from stoppered bottle into 200 ml capacity conical flask and add 3-4 drops of starch indicator, after addition of indicator bluish green colour develops in solution.
5. Titrate this solution against 0.0125 N Sodium thiosulphate till solution becomes colourless. (End point is bluish green to colourless).

6. Note down the reading of the consumed volume of the thiosulphate from burrete.
7. Repeat this procedure for 2 or 3 times and obtain mean burette reading.

Observations table :

Burette : Sodium thiosulphate of solution N/80

Indicator : Strach

End point : Blue to colourless

Observation table :

Sample (in conical flask)in ml	Burette reading in ml			Mean Burette Reading
	1st Reading	2nd Reading	3rd Reading	
Water sample 100 ml				

Calculations :

1 ml of N/80 $Na_2S_2O_3$. 5 H2O = 0.1 mg of Oxygen

1 ml of N/80 $Na_2S_2O_3$. 5 H2O = 0.0001 gm of Oxygen

1 ml of N/80 $Na_2S_2O_3$. 5 H_2O at NTP = $\frac{0.0001 \times 22400}{32}$ ml of Oxygen

Then, volume of dissolved oxygen in water sample = $\frac{v \times 0.0001 \times 22400 \times 1000}{32 \times \mu}$

$= \frac{v \times 70}{\mu}$ ml of Oxygen /litre at NTP

Where,

v = volume of$Na_2S_2O_3$ used for titration

µ = volume of sample water taken

NTP = Normal Temperature Pressure

Result :

The amount ofdissolved oxygen present in given water sample is ……ml of oxygen/liter at NTP.

Practical No. 02

Aim : Estimation of Water Alkalinity from given water sample.

Total alkalinity is the measure of the capacity of the water to neutralize strong acids. The alkalinity in the water is generally imparted by the salts of carbonates, bicarbonates, phosphates, nitrates, borates, silicates etc. together with hydroxyl ions in Free State. Howevere, most of the waters are rich in carbonates and bicarbonates with little concentration of other alkalinity imparting ions.

Principle :

Pure water is neutral in nature with pH 7. Due to the presence of dissolvedminerals in rain water, the pH increases and becomes alkaline. Alkalinity in water isdue to the presence of hydroxide (OH^-), carbonate (CO_3^{2-}) and bicarbonate (HCO^{3-})ions. Total alkalinity, carbonates and bicarbonates can be estimated by titrating the sample with a strong acid (HCl or H_2SO_4), first to pH 8.3 using phenolphthalein as an indicator and then further to pH between 4.2 and 5.4 with methyl orange or mixed indicator. In first case, the value is called as phenolphthalein alkalinity (PA) and in second case, it is total alkalinity (TA).

Hydroxide ions are completely neutralized to water using phenolphthalein indicator (single step neutralization)

$$OH^- + H^+ \longrightarrow H_2O$$

Carbonate ions are neutralized to bicarbonate ions using phenolphthalein indicator in the first step. In the second step, these bicarbonate ions are completely neutralized to water and carbon dioxide using methyl orange indicator (double step neutralization).

$$CO_3^{2-} + H^+ \longrightarrow HCO_3^-$$

$$HCO_3^- + H^+ \longrightarrow H_2O + CO_2$$

Bicarbonate ions are completely neutralized to water and carbon dioxide usingmethyl orange indicator (single step neutralization).

$$HCO_3^- + H^+ \longrightarrow H_2O + CO_2$$

Values of carbonates, bicarbonates and hydroxyl ions can be computed from the values of phenolphthalein and total alkalinites.

Requirements : Conical flask; Measuring cylinders; Burette; Burette stand, Pipette; Beaker, Hydrochloric acid, Methyl orange indicator, Phenolphthlein indicator, Sodium carbonate (Na_2CO_3), Ethanol, Sodium hydroxide (NaOH), Distilled water etc.

Preparation of Reagents :

1. **Hydrochloric acid 0.1N :** Dilute 12N concentrated HCl of specific gravity 1.18 to 12 times to prepare 1N HCl stock solution i.e. 8.34 ml of concentrated HCl dissolved in 100 ml of distilled water. Dilute the 1N stock solution further to make 0.1N HCl as per requirement. (suppose if there is requirement of 1000 ml 0.1N HCl take 100 ml of 1N HCl from stock solution and dissolve it in 900 ml distilled water). Standardize it against sodium carbonate solution.
2. **Methyl orange indicator 0.05%:** Dissolve 0.5 gm of methyl orange powder in 100ml of distilled water.
3. **Phenolphthalein indicator :** Dissolve 0.5 gm of phenolphthalein in 50 ml of 95% ethanol and add 50 ml of distilled water. Add 0.05N CO_2 free NaOH solution dropwise, until the solution turns faintly pink coloured.
4. **Sodium carbonate 0.1N :** Dissolve 5.300 gm of Na_2CO_3 dry powder in 1000 ml of distilled water.

Procedure :

1. Take 100 ml of water sample in the conical flask and add 2-3 drops of phenolphthalein indicator

2. If the solution remains colourless, phenolphthalein alkalinity (PA) is zero and total alkalinity can be determined by following step 4 directly.
3. If the colour changes to pink after addition of phenolphthalein, titrate it with 0.1N HCl until the colourdisapperars at end point. This is the phenolphthalein alkalinity (PA) of test water sample.
4. Add 2-3 drops of methyl orange indicator to the same sample solution and continue the titration with 0.1N HCl further, until the yellow colour changes to pink at end point. This is the total alkalinity (TA) of test water sample.

Observations table :

Burette	:	0.1N HCl
Conical flask	:	100 ml of test water sample
Indicatior 1	:	Phenolphthalein (2-3 drops)
Indicator 2	:	Methyl orange (2-3 drops)
End point for PA	:	Pink to colourless
End point for TA	:	Yellow to Pink

Test	Sample in ml	Burette reading (0.1N HCl) in ml			Mean Burette Reading
		1st Reading	2nd reading	3rd reading	
Phenolphthaein alkalinity (PA)	100 ml				A = ……
Total Alkalinity (TA)	Same sample carry forward				B =…….

Calculations :

Phenolphthalein alkalinity (PA) as $CaCO_3$ mg/lit = $\frac{\text{(A x Normality) of HCl x 1000 x 50}}{\text{ml of sample}}$

Total alkalinity (TA) as $CaCO_3$ mg/lit = $\frac{\text{(B x Normality) of HCl x 1000 x 50}}{\text{ml of sample}}$

Where, A = ml of HCl used with only phenolphthalein

B = ml of total HCl used with phenolphthalein and methyl orange

Using the data of phenolphthalein alkalitnity (PA) and total alkalinity (TA) the concentration of caronates, bicarbonates and hydroxyl ions can be determined from following table.

Result of Titration	**OH alkalinity as $CaCO_3$**	**CO_3 alkalinity as $CaCO_3$**	**HCO_3 alkalinity as $CaCO_3$**
P = 0	0	0	T
P < ½ T	0	2P	T – 2P
P = ½ T	0	2P	0
P > ½ T	2P – T	2 (T- P)	0
P = T	T	0	0

Where, P = Phenolphthalein alkalinity; T = Total alkalinity

Result :

1. Phenolpthalein alkalinity of given water sample is …… as $CaCO_3$mg/lit.
2. Total alkalinity of given water sample is …… as $CaCO_3$ mg/lit.
3. Concentration of Hydroxyl ions (OH^-) in given water sample is …… mg/lit.
4. Concentration of Carbonate ions (CO^-_3) in given water sample is ……... mg/lit.
5. Concentration of Bicarbonate ions (HCO^-_3) in given water sample is ……. mg/lit.

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Practical No. 03

Aim: Study of animal community structure by quadrate method (Field or Simulation).

A group of several animal or plant species which live together with mutual tolerance and shows beneficial interaction within themselves in a definite area is called as *community*. The community is the part of an ecological system where transformation, accumulation and flow of energy involved. Functioning of this system is intimately related with the components of the community. The components vary in quality as well as in quantity and impart a structure to the community.

The structure of a community can be studied by taking into consideration a number of characters which are usually grouped into two viz. analytic and synthetic characters. Certain analytical characters as frequency, density, abundance and dominance can be expressed quantitatively while others such as sociability, vitality, periodicity and stratification find only qualitative expressions. Synthetic characters include presence, constancy and fidelity of components and may be computed from analytic characters of several stands of a community.

The analytic characters of a community are determined by means of three main sampling units viz. area, line and point, as employed in quadrat, transect and point method respectively.

Quadrats:

These have been used extensively in determining the distribution of plant communities but can also be used for slow moving invertebrates such as those which occur in leaf litter or in intertidal habitats.

Quadrats are sampling units of a known area. Sampling is necessary as it is not often possible to count all the individual animals or plants within the given population.

This would not only be extremely laborious and time consuming, but would almost certainly involve disturbance and damage to the habitat and population we wish to study. Thus by sampling we aim to select small area representing the total population. These sample units must be distinct, must not overlap and together they make up the total population. The number of individuals of a species in each sampling unit is then counted or estimated and from this information we can calculate frequency and distribution of that species in the population as a whole.

Structure of quadrats: Usually the quadrats have rectangular frame (figure 1A) with a variety of dimensions as per area needed to study. If the frame is not available then we can make quadrat of known dimensions by using 4 pegs and string strong thread. The pegs are inserted in the ground at four corners with equal distance from each other (figure 1B). The distance dimension may be decided by oneself.

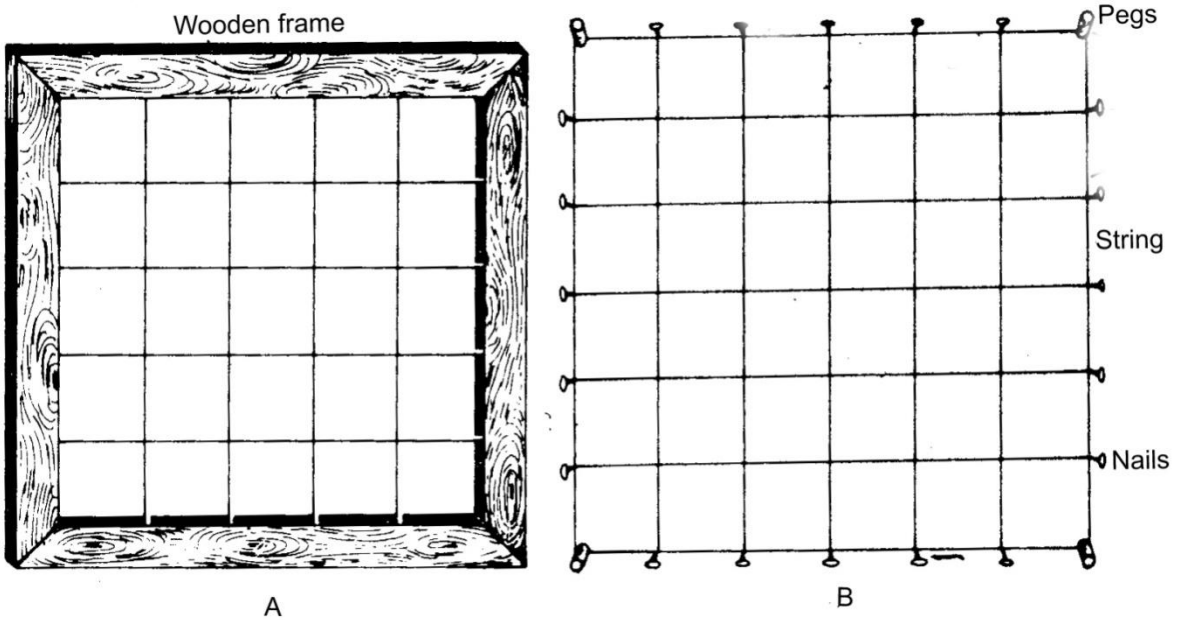

Figure 1: A) Quadrat wooden frame with wires fixed at definite intervals
B) Quadrat made using pegs at 4 corners and strings are fixed at equal distance using nails.

When we use quadrat, it is assumed that its contents will represent the whole sampling area. Commonly used dimensions are 1 m^2 and 0.25 m^2 frames of quadrats. These are easily constructed out of wood and with cross wires or strings subdividing them at 10 cm intervals for the ease of counting.

Size of the quadrat depends on dispersion and size of individuals in the population. If the dispersion of a population within the sampling area is truly random, then all the quadrat sizes would be equally efficient in the estimation of that population. However spatial dispersal of a population is seldom random or regular. An aggregated distribution is more likely with individuals found in path. This is because several environmental factors will be unevenly distributed within a sampling area.

Generally small size quadrat has been found to be more efficient than a large one when population is aggregated due to following reasons:

1. More small samples can be taken for the same amount of labour.
2. More number of small quadrats covers a wider range of habitat than a few large ones and the sample will be more representative.
3. Statistical errors will be reduced as a sample of many small units will have more degree of freedom than a sample of a few large units.

Although a small quadrat may be theoretically best, there are practical considerations which set a lower limit on the size. Thus when sampling in a woodland a small quadrat may under-sample the dominant species of trees and large sized animals. In addition, the smaller the quadrat greater the sampling errors at its edges; are the plants and animals on the edges of the quadrat to be included or not?

Thus, for determining the optimum quadrat size for a particular type of vegetation, a series of quadrats of increasing size are laid out. The cumulative number of species counted after each successive increase in quadrat size is then recorded. For example as follows:

Quadrat size in m^2	Total number of species recorded
0.025	10
1	14
4	19
8	22
16	23

Eventually a point is reached where further large increase in quadrat size results in only a few extra species. Since the common species will have already been included, the extra time and efforts required in recording very large quadrat is unproductive. The optimum quadrat size is reached when a 1% increase in quadrat size produces no more than a 0.5% increase in number of species present in it.

Procedure:

1. Throw a quadrant of lay of definite measurement; draw a quadrant in a specific area of grass land, forest or garden or any place where community is to be studied.
2. Divide the selected quadrant by small squares using rope for better measurement of community present in the area.
3. Observe carefully each type of animals & plants present or occurring in squares of the quadrant.
4. Note down the common or scientific name of all the animals and plants in observation table.
5. Count & note down the total number of individuals observed in the quadrant for each of the animal and plant in observation table.

Observation and result table:

Sr. No.	Name of species recorded	No. of individual in each Quadrant									Total no. of individual species
		1	2	3	4	5	6	7	8	9	
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											
11.											
12.											
13.											
14.											
15.											

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Practical No. 04

Aim: Determination of density, frequency and abundance of species by quadrat method.

Quadrat or transect is one of the sampling method which involves counting the organisms of a single or multiple species in plots or transects of appropriate size and number to get an estimate of the density of the organisms in the area sampled. This method is applicable to a wide variety of terrestrial and aquatic species in environment ranging from forests to the bottom of the sea.

Requirement: Quadrant of definite size, large nail or sticks, rope and meter scale.

Procedure:

1. Throw a quadrant of lay of definite measurement; draw a quadrant in a specific area of grass land, forest or garden or any place where community is to be studied.
2. Divide the selected quadrant by small squares using rope for better measurement of community present in the area.
3. Observe carefully each type of animals & plants present or occurring in squares of the quadrant.
4. Note down the common or scientific name of all the animals and plants in observation table.
5. Count and note down the total number of individuals observed in the quadrant for each of the animal and plant listed in observation table.
6. Repeat the procedure by throwing or laying down the quadrant randomly in the area for at list 10 times.
7. Analyze the data collected in the field sample to calculate frequency, density and abundance of different species recorded in the quadrant.

Calculations:

A] Frequency %:

Frequency is the no. of sampling units in which particular species assured.

$$\text{Frequency \%} = \frac{\text{Total no. of quadrant in which species assumed or occurs}}{\text{Total no. of quadrant studied}} \times 100$$

$$= \frac{\text{Column E}}{\text{Column F}} \times 100$$

B] Density:

Density of a particular species is the number of its individuals occurring per unit area.

$$\text{Density} = \frac{\text{Total no. of individual species}}{\text{Total no. of quadrant studied}}$$

$$= \frac{\text{Column D}}{\text{Column F}}$$

The density value obtained from above formula for each species to be expressed as individual per unit area e.g. calculated value for species according to above formula is the value in 10000 cm^2 i.e. if area of quadrant used 100 x 100 cm. If in 10000 cm^2 area there is only 1 individual. Hence, in 1 cm^2 area there would be 1 / 10000Individual present and in 500 x 500 cm^2it can be calculated as follows

$$= \frac{250000}{10000} \times 1 = 25$$

Thus, the density of species is to be expressed 25 cm^2 instead of 1abundance.

C] Abundance:

$$\text{Abundance} = \frac{\text{Total no. of individual species}}{\text{Total no. of quadrant in which species occurs}} = \frac{\text{Column D}}{\text{Column E}}$$

Observationand result table:

Sr. No.	Name of species recorded	No. of individual in each Quadrant									Total no. of individual species	No. of quadrant in which sp. occurs	Total no. of quadrant studied	Frequency %	Density per unit area	Abundance
A	**B**	**C**									**D**	**E**	**F**	**G**	**H**	**I**
		1	2	3	4	5	6	7	8	9						
1.																
2.																
3.																
4.																
5.																
6.																
7.																
8.																
9.																
10.																
11.																
12.																
13.																
14.																
15.																

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Practical No. 05

Aim : Study of microscopic fauna of freshwater ecosystem (from pond).

Every fresh water body has its own characteristic biotic community that contains both macroscopic and microscopic organisms. Microscopic organisms are phytoplankton (microscopic plants) and zooplanktons (microscopic animals) occur in huge densities. Among these, zooplanktons are the free floating microscopic heterogeneous group of aquatic microorganisms commonly found in fresh water bodies. Zooplanktons includes wide array of taxonomic groups like Protozoa, Copepoda, Cladocera and Rotifera.

Zooplanktons are of prime importance for nutrition and growth of fishes and other animals in any fresh water bodies. Zooplanktons forms important link in transformation of energy in aquatic food web because of their drifting nature, large densities, high diversity and capacity to bear stress. Zooplanktons are major biotic community of water bodies hence shows drastic changes in response to change in physio-chemical properties of water. Thus their association, abundance, richness and diversity can be used as tool for assessment of water pollution. Zooplanktons are helpful for determining conditions and health of an aquatic ecosystem.

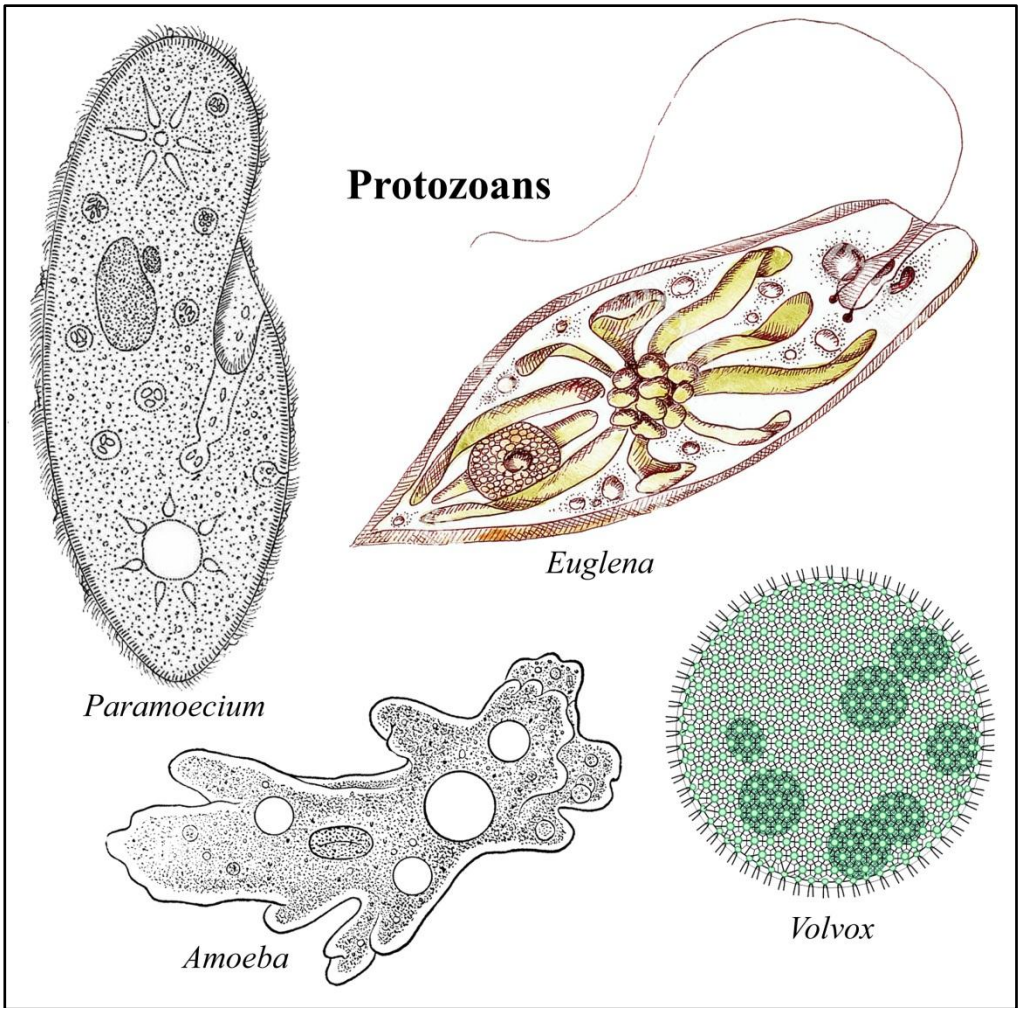
Requirements: Clean slides, coverslips, dropper, cotton threads, pond water sample, compound microscope etc.

Procedure :

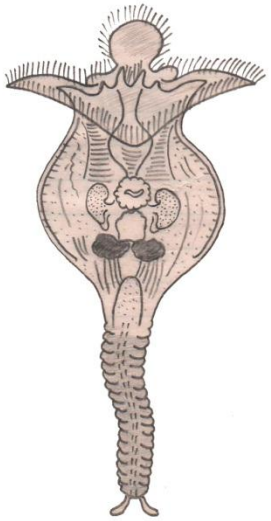
1. Take a clean glass slide and keep it on the flat surface.
2. Spread few fine threads of cotton on to the slide.
3. With the help of dropper take few drops of ponds water sample on spreaded cotton threads and put the coverslip using needle.
4. Focus the compound microscope at 10x magnification and reduce the light source.

5. Place the prepared slide under microscope and examine the microscopic organisms present in the slide and record your results.
6. Draw a diagram of identified zooplanktons and identify them using reference books.

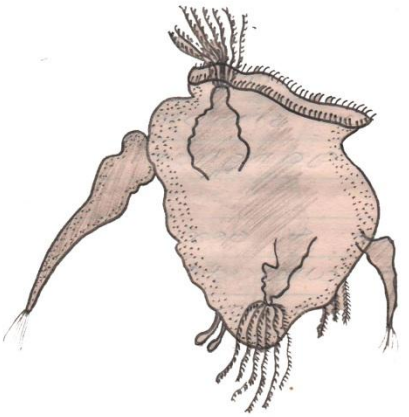
Some of the common zooplanktons found in fresh water bodies are as follows:



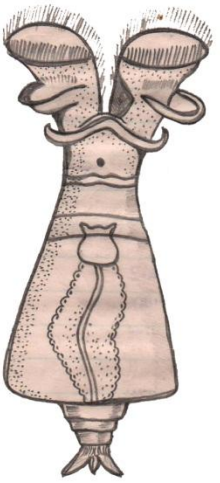
Rotifers



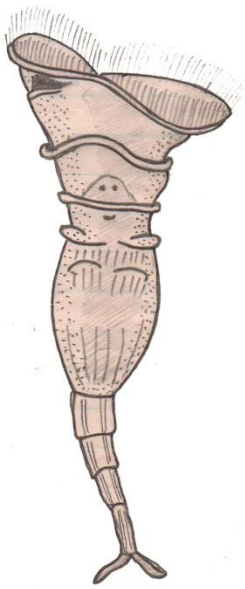
Brachionus rubens



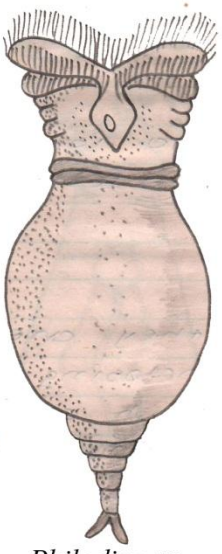
Hexarthra sp.



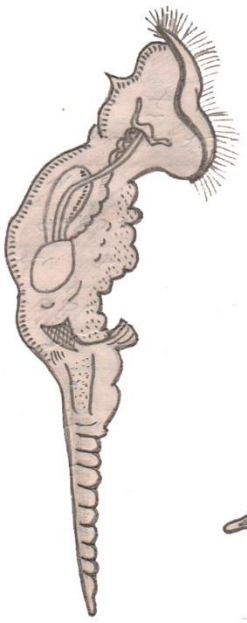
Philodina citrina



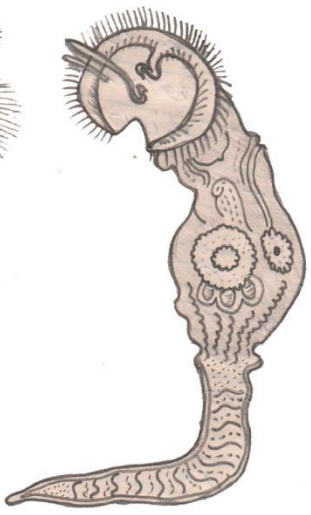
Rotaria vulgaris



Philodina sp.

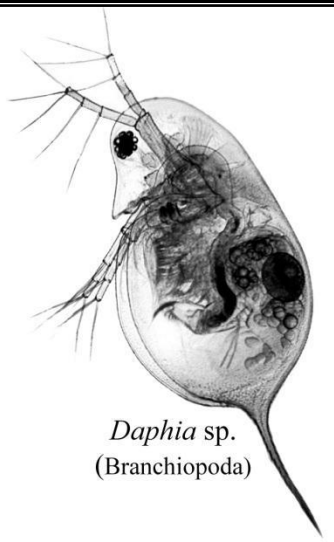


Lacinularia socialis

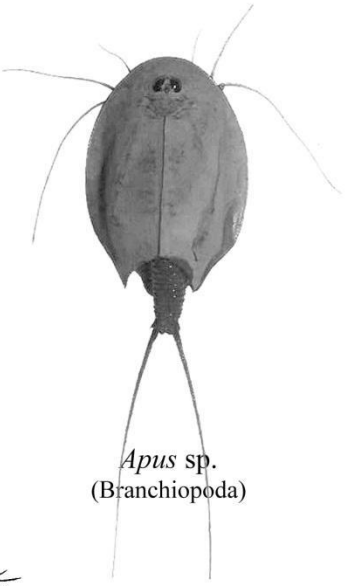


Conochilus volvox

Microscopic Crustaceans

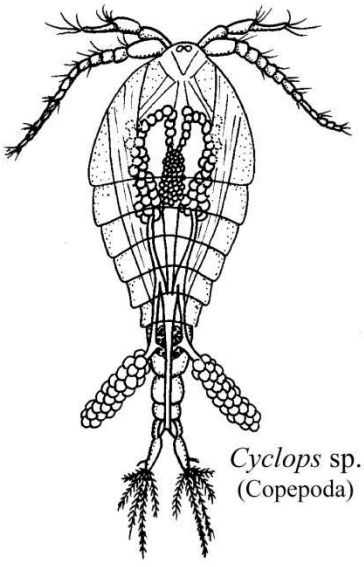


Daphia sp.
(Branchiopoda)



Apus sp.
(Branchiopoda)

Branchipus sp.
(Branchiopoda)



Cyclops sp.
(Copepoda)

Cypris sp.
(Ostracoda)

Practical No. 06

Aim : Estimation of Water Holding Capacity (WHC) of given soil sample.

Water holding capacity (WHC) of soil usually refers to the maximum amount of water which can held by the saturated soil. It is generally measured as the amount of water taken up by unit weight of dry soil when immersed in water under standardised conditions.

The field capacity of a soil is defined as the amount of water held in soil after the excess of gravitational water has drained away under free drainage and minimum evaporation.

Requirements : Hot air oven, Keen box (Circular soil boxes 5.6 cm diameter, 1.6 cm height and bottom perforated with holes of 0.75 mm diameter), Whatman filter paper (No. 42), Petridish, weighing balance, sissor, soil samples, water etc.

Procedure :

1. Place a filter paper in the keen box of an appropriate dimension so as to cover the whole perforated bottom of the keen box.
2. Take the weight of the keen box along with filter paper (W_1) using digital weighing balance.
3. Now, transfer the crushed soil sample in an oven at 105^0C. The dried soil sample is placed inside the perforated bottom of the circular soil box.
4. Take weight of keen box along with filter paper and dried soil sample (W_2) using digital weighing balance.
5. Place the keen box containing dried soil sample in a petridish of 10 cm diameter containing water and keep overnight, so that water enters the soil in keen box from perforation and saturates the soil with water.

6. On the next day remove the soil keen box from water, wipe and again record the final weight (W_3) of saturated soil along with keen box and filter paper.
7. From W_1, W_2, W_3 readings calculated the water holding capacity of soil sample.

Calculations :

W_1 = Weight of keen box + filter paper

W_2 = Weight of keen box + filter paper + soil

W_3 = Weight of the water absorbed + keen box + filter paper

Weight of the soil = $W_2 - W_1$

$$\text{Water Holding Capacity (WHC) \%} = \frac{\text{Wt.of water absorbed by soil } (W_3) - \text{Wt. of box, filter paper, soil } (W_2)}{\text{Weight of Soil sample } (W_2 - W_1)} \times 100$$

$$\text{WHC (\%)} = \frac{(W_3 - W_2)}{(W_2 - W_1)} \times 100$$

Result :

Water Holding Capacity (WHC) of given soil sample is ……%.

Environmental significance:

Knowledge about the quantity of water is hold by the soil is very important for plant growth. Soils that can hold a lot of water supports more plant growth and are less succeptible to leaching losses of nutrients and pesticides. All of the water hold by soil is not available for plant growth. The water holding capacity test determine the amount of water the can hold by the soil at field capacity.

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Practical No. 07

Aim: Estimation of free carbon dioxide from water sample.

Principle:

The free carbon dioxide (CO_2) mg/lit in water sample can be determined by titrimetric method using phenolphthalein indicator. The water sample containing carbon dioxide when titrate with a strong alkali like NaOH forms sodium bicarbonate $NaHCO_3$ at about 8.3 pH. Completion of the above reaction can be traced using phenolphthalein indicator as it produces pink colour. The water sample should be gently swirled during titration but care should be taken before and after titration to keep aeration at a minimum.

$$H_2O + NaOH + CO_2 \xrightarrow{\text{Phenolphthalein 2-3 drops}} NaHCO_3 \text{ (Pink Colour)}$$

Requirement: Conical flask, Burette, burette stand, beakers, Pipette, indicator bottle, measuring cylinder, Sodium hydroxide, distilled water,phenolphthalein indicator, test water samples.

Preparation of Reagents:

1. **Sodium Hydroxide (NaOH) 0.05N:** Dissolve 40 gm of NaOH in CO_2 free 100 ml boiled distilled water and make final volume 1000 ml by adding distilled water. This is 1N stock solution of NaOH. For preparing 0.05N NaOH working solution dilute 50 ml of 1N NaOH from stock solution using distilled water to make final volume of 1L. Standardize it with H_2SO_4, HCl or Oxalic acid.
2. **Phenolphthalein indicator:** Dissolve 0.5 gm of phenolphthalein in 50 ml of 95% ethanol and add 50 ml of distilled water.

Procedure:

1. Measure 100 ml of test water sample using measuring cylinder and take it in the conical flask.

2. Add 2-3 drops of phenolphthalein indicator in the water sample in the conical flask.
3. If the colour of water sample turns pink the free carbon dioxide (CO_2) is absent.
4. If the water sample remains colourless then titrate this water sample in conical flask against 0.05N NaOH until the pink colour appears.
5. End point is from colourless to faint pink.

Observation table:

Burette : Sodium Hydroxide 0.05N

Indicator : Phenolphthalein indicator

End point : Colourless to faint Pink

WaterSample in ml	Burette reading (0.05N NaOH) in ml			Mean Burette Reading
	1st Reading	2nd reading	3rd reading	
100 ml				…… ml

Calculation:

1 mole of CO_2 = 1 mole of NaOH

44 gm of CO_2 = 40 gm of NaOH

1000 cc (N) NaOH = 40gm of solid NaOH

1000 cc (N) NaOH = 44 gm of CO_2

$$\text{Free carbon dioxide } CO_2 \text{ mg/lit} = \frac{(\text{Mean burette reading} \times \text{Normality}) \text{ of NaOH} \times 1000 \times 44}{\text{ml of sample taken for titration}}$$

$$= \frac{\ldots\ldots\ldots\ldots \times 0.05 \times 1000 \times 44}{100}$$

Result:

Free carbon dioxide CO_2present in given water sample is …… mg/lit.

Practical No. 08

Aim : Study the Eutrophication in Lake/ River.

Most elements needed for plant growth are available in excess in a well-established lake; a few are present in quantities close to that required for plant growth and when present in insufficient quantities will be limiting factors. They maintain a balance in the lake. Increase in the amount of these limiting factors results in the process of eutrophication.

Eutrophs = rich / corpulent originally mean leading to promote nutrition. Eutrophication is the process in which a water body becomes excessively rich with nutrients as phosphates and nitratesresulting into an explosive growth of the aquatic plants.

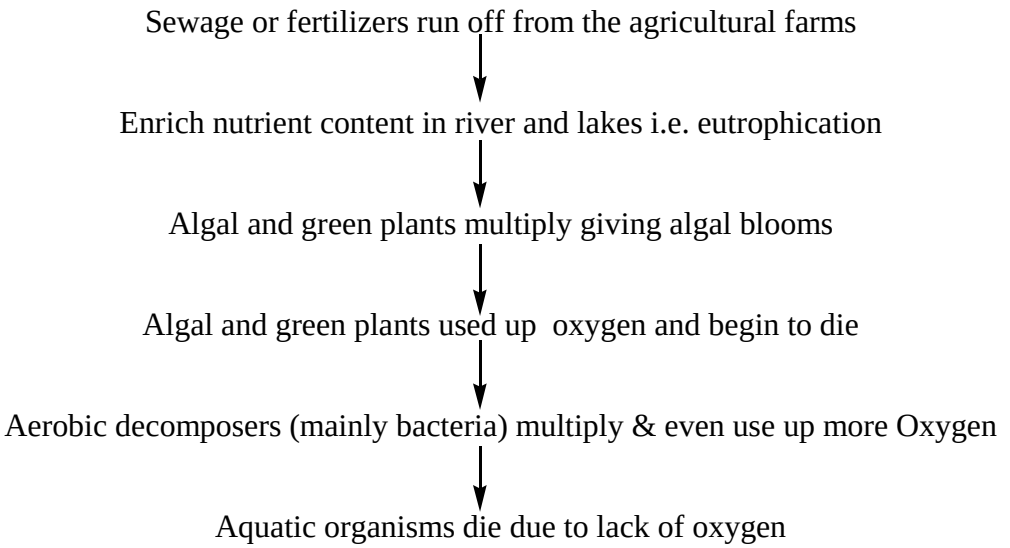
Natural Eutrophication: It is very slow process taking often a period of over hundreds of years. There is gradual increase in the nutrients due sedimentation of rocks or organic matter. This will eventually lead to increase in number of aquatic plants. As the lake biomass increases the organic deposits fill the bottom and it becomes shallower, rich and warmer.Progressively increased plants take more space so that lakes are filled up.The lake begins to decrease in size and volume eventually becomes a marsh.

Artificial Eutrophication: Artificial eutrophication is due to the anthropological (human) activities; which is dramatically fast process than natural one.Domestic waste, agricultural residue, pH nutrient, land drainage and industrial nutrients from organic waste add supplementary nutrients in the water bodies which stimulates luxuriant growth of algae in that water. Also, the algal flora, Blue green algae begins to predominate, this forms algal bloom. The algal blooms compete with other aquatic plants for

photosynthesis. The water becomes turbid and greenish. Decay of plants increases the consumption of oxygen resulting in depletion of oxygen. These algal blooms also release some toxic chemicals which kills fishes and other aquatic animals and thus water begins to sink.

The water bodies become poorly oxygenated with higher carbon dioxide (CO_2) level, which further kills fishes and other aquatic animals; such a water body is said to be **Eutrophic.** It smell's offensively as BOD rises level and its aesthetic value goes down. Eutrophication is the limiting factor in supply of clean drinking water, fishing and navigation.

Flow chart showing the sequence of events which may result into Eutrophication



Control measures:

1. Sewage and domestic waste water should be treated before its discharge in water bodies like lake or rivers.
2. Destruction of algal food web by stimulating aerobic decomposers.

3. Prevent the recycle of nutrients into water through harvesting and removing algal blooms.
4. Use of physical and chemical methods for removal of dissolved nutrients from water.

Conclusion:

Enrichment of water bodies by input of organic material, surface runoff containing nutrients & phosphates, directly control the growth of algae and other aquatic plants.

A lake with high productivity is called as eutrophic lake. Several hundreds or thousands of years may require when oligotrophic lakes become eutrophic naturally. Following are some differences between oligotrophic and eutrophic lakes.

Sr. No.	Oligotrophic Lake	Eutrophic lake
1	All nutrients are recycled completely.	Recycling of nutrients is unable to maintain.
2	All biological material is get decomposed by decomposers.	There isimbalance between production and decomposition.
3	It has indigenous nutrients.	It has Nutrients from outside.

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