Principles of Classification

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Thinking Exercise

- Think about an elephant. Develop a mental image of it. How would you describe it to someone who has never seen one? Take a moment to consider carefully . . .

Classification

- Placing objects, e.g., life, into some type of order.
- Taxon = a taxonomic group (plural = taxa).

How do Biologists Classify Organisms?

- Biologists also classify organisms into different categories mostly by judging degrees of apparent similarity and difference that they can see.
- The assumption is that the greater the degree of physical similarity, the closer the biological relationship.

Steps in Classifying Organisms

- On discovering an unknown organism, researchers begin their classification by looking for anatomical features that appear to have the same function as those found on other species.
- The next step is determining whether or not the similarities are due to an independent evolutionary development or to descent from a common ancestor.
- If the latter is the case, then the two species are probably closely related and should be classified into the same or near biological categories.

Homology

- Similarity resulting from common ancestry.
  - E.g., the forelimb bones of a bat, cat, beat the wing of a bird, and your arm have the same functional types of bones as did our shared reptilian ancestor.

Analogies (Analogous Structures)

- Analogies are anatomical features that have the same form or function in different species that have no known common ancestor
- For instance, the wings of a bird and a butterfly are analogous structures because they are superficially similar in shape and function
- Both of these very distinct species lines solved the problem of getting off of the ground in essentially the same way. However, their wings are quite different on the inside.
- Bird wings have an internal framework consisting of bones, while butterfly wings do not have any bones at all and are kept rigid mostly through fluid pressure
- Analogies may be due to homologies or homoplasies, but the common ancestor, if any, is unknown

BIO 102

PHYLUM PROTOZOA

Protozoa may be defined as "microscopic acellular animalcules existing singly or in colonies, without tissue and organs, having one or more nuclei". They belong to the kingdom Protista

Some of the characteristics of protozoans

1. There are about 50,000 known species of Phylum Protozoans
2. Protozoans exhibit mainly two forms of life; free-living (aquatic, freshwater, seawater) and parasitic (ectoparasites or endoparasites). They are also commensal in habitat.
3. They are small, usually microscopic, not visualize without a microscope.
4. They are the simplest and primitive of all animals.
5. They have a simple body organization. i.e. with a protoplasmic grade of organization.
6. The body is unicellular (without tissue and organs).
7. They have one or more nuclei which are monomorphic or dimorphic.
8. Body naked or bounded by a pellicle, but in some forms may be covered with shells and often provided with an internal skeleton.
9. They are solitary (existing alone/single) or colonial (individuals are alike and independent).
10. Body shape variables may be spherical, oval, elongated or flattened.
11. Body symmetry either none or bilateral or radial or spherical.
12. Body form usually constant, varied in some, while changing with environment or age in many.
13. Body protoplasm is differentiated into an outer ectoplasm and inner endoplasm.
14. The single-cell body performs all the essential and vital activities, which characterize the animal body; hence only subcellular physiological division of labor.
15. Locomotory organs are fingers like pseudopodia, whip-like flagella, hair-like cilia or none.
16. Nutrition may be holozoic (animal-like), holophytic (plant-like), saprozoic or parasitic.
17. Digestion occurs intracellularly which takes place inside the food vacuoles.
18. Respiration occurs by diffusion through the general body surface
19. Excretion occurs through the general body surface, but in some forms through a temporary opening in the ectoplasm or through a permanent pore called cytopyge.
20. Contractile vacuoles perform osmoregulation in freshwater forms and also help in removing excretory products.
21. Reproduction asexual (binary or multiple fission, budding, sporulation) or sexual (conjugation (hologamy), game formation (syngamy)).
22. The life cycle may be complicated with alternation of asexual and sexual phases (alternation of generation).
23. Encystment commonly occurs to resist unfavorable conditions of food, temperature, and moisture, and also helps in dispersal.
24. Protozoans exhibit mainly two forms of life; free-living (aquatic, freshwater, seawater) and parasitic (ectoparasites or endoparasites). They are also commensal in habitat. Examples: Euglena, Amoeba, Plasmodium, Paramecium, Podophyra, etc.

Classification of Protozoans

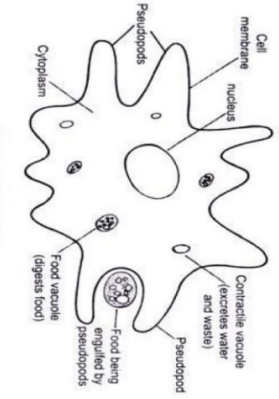
In the simplest form, protozoans can be grouped basically into four classes. They are classified basically on the type of locomotory organelles. The classes are listed below;

Different classes of protozoans

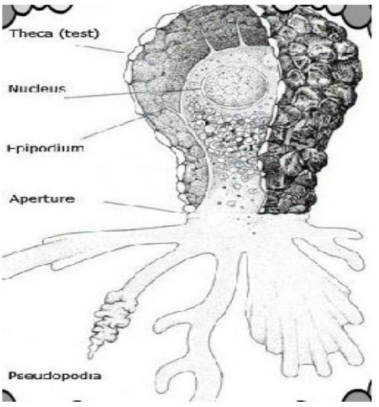
S/N	CLASS	LOCOMOTORY ORGANELLE	MODE OF LIFE	EXAMPLES
1.	Sarcodina	Pseudopodia	Free-living and Parasitic	*Amoebas, Entamoeba, Diffugia, Arcella*
2.	Mastigophorans	Flagella	Free living, commensals and Parasitic	*Euglena, Trypanosomes, Leishmania, Peranema, Ceratium, Volvox, Clymadomonax, Trichonympha, Opalina*
3	Ciliata	Cilia	Free living, commensals and Parasitic	*Paramecium, Balantidium, Vorticella, Stentor, Nyctotherus, Codonella*
4	Sporozoans	None	Parasitic	*Plasmodium, Toxoplasma, Babesia, Monocyst, Eimeria*

Characteristics of class Sarcodina

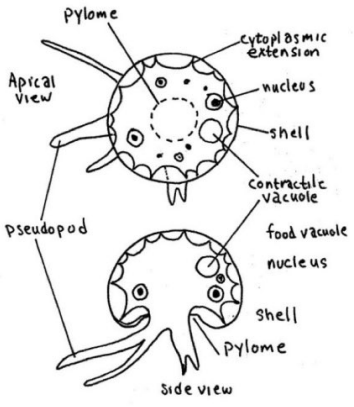
1. These organisms have streaming cytoplasm and use temporary cytoplasmic extensions called pseudopodia in locomotion (called amoeboid movement) and feeding.
2. Sarcodines include the genus Amoeba e.g *Amoeba proteus* and pathogenic species, e.g., dysentery-causing *Entamoeba histolytica*.
3. These protozoans' cells may be spherical or irregular in shape; the pellicle (or envelope) is usually thin and flexible.
4. Sometimes there is an external shell (see foraminiferan) or skeleton (see radiolarian).
5. The cytoplasm, composed of ectoplasm and endoplasm, may contain more than one nucleus. Food, which adheres to the body surface or is trapped by pseudopodia, is digested in food vacuoles.
6. Some sarcodines have flagella during certain stages of their development; in other groups flagellated and unflagellated generations alternate.
7. Sarcodines may be either solitary or colonial. Although some are parasitic on plants or animals, most sarcodines are free-living, feeding on bacteria, algae, other protozoans, or organic debris. The genera are distinguished by the structure of their pseudopodia.



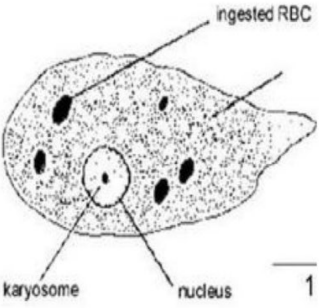
Amoeba proteus (Naked Amoeba)



Difflugia (Shelled or Testate Amoeba)



Arcella (Shelled or testate Amoeba)

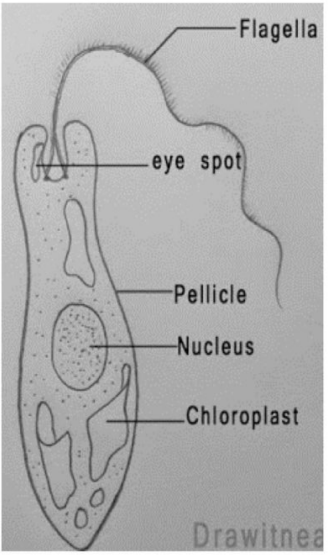


Entamoeba histolytica (Parasitic Amoeba)

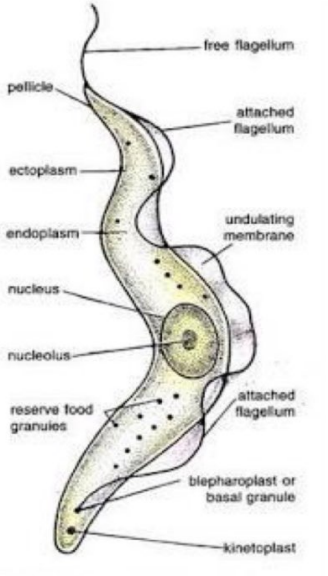
Characteristics of the class mastigiphora

1. They are group of flagellates with one to many flagella
2. Mastigophorans can be divided into 2; Phytomastigophora (Plant-like e.g. Euglena, Peranema, Clymadomonas) and Zoomastigophora (Animal-like e.g., Trypanosome, leishmania, Opalina)
3. They are unicellular with one nucleus
4. In zoomastigophorans, one of the flagellum is free (trailing flagellum) and the other flagellum is attached to the pellicle to form an undulating membrane
5. Body is covered with thin pellicle or test of cellulose, chitin or silica
6. Nutrition can be autotrophic (Euglena) or heterotrophic

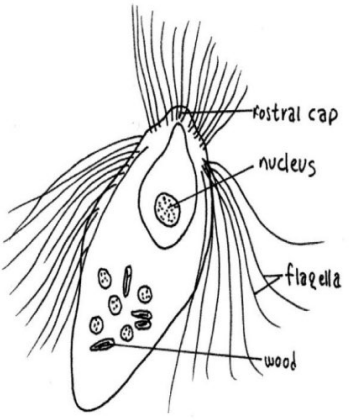
7. Asexual reproduction by longitudinal fission
8. Can be free-living or parasitic
9. Some of them are important pathogens of humans and other animals.
10. Parasitic members of the Mastigophora are the causative organisms of disease in humans and other animals. *Trypanosomes*, for example, are the cause of African sleeping sickness and Chagas' disease, and giardiasis is caused by the mastigophoran *Giardia lamblia*

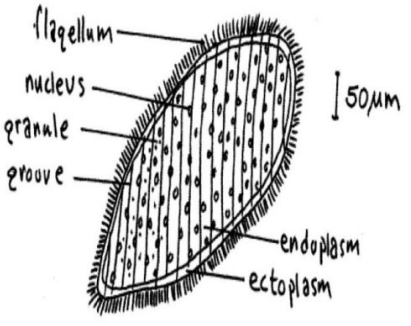


Euglena



Trypanosome



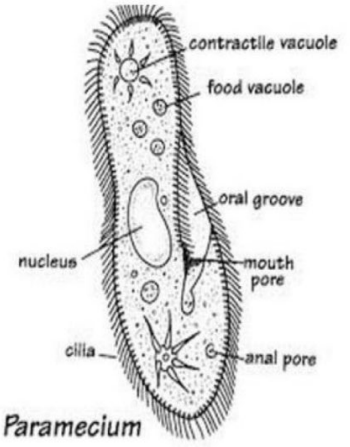


Trichonympha *Opalina*

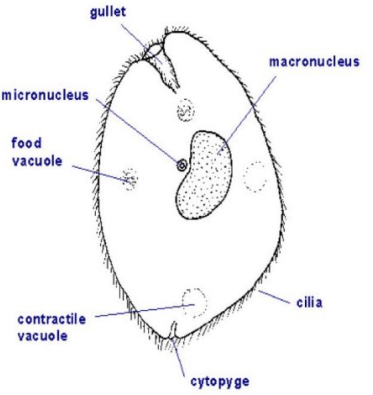
Characteristics of class Ciliata

1. They possess cilia for locomotion and for the generation of feeding currents in water
2. Relatively rigid pellicle and more or less fixed shape
3. Distinct cytostome (mouth) structure
4. Dimorphic nuclei, typically a larger macronucleus and one or more smaller micro nuclei
5. They possess trichocysts which are pellicular structures primarily used for protection. They are rod-like or oval organelles oriented perpendicular to the plasma membrane.
6. Some ciliates, such as Paramecium, have a ciliated oral groove along one side of the body
7. Cilia of the oral groove sweep small food particles toward the cytopharynx, where a food vacuole forms.
8. When the food vacuole reaches an upper size limit, it breaks free and circulates through the endoplasm.

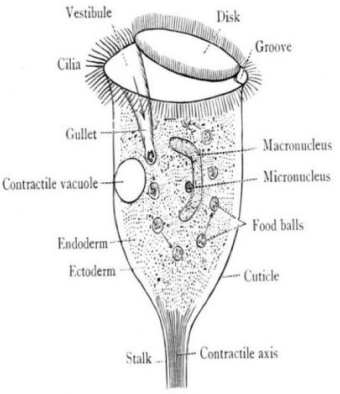
9. Some free-living ciliates prey upon other protists or small animals.
10. Suctorians are ciliates that live attached to their substrate. They possess tentacles whose secretions paralyze prey, often ciliates or amoebae.
11. Ciliates have two kinds of nuclei: A large, polyploidy macronucleus regulates daily metabolic activities. It is not involve in reproduction. One or more smaller micronuclei are the genetic reserve of the cell and it is involved in reproduction.
12. Asexual Reproduction: is by Transverse binary fission and budding, while that of sexual reproduction is through conjugation.



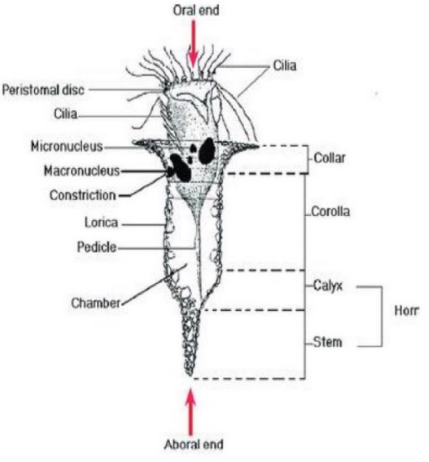
Paramecium



Balantidium coli



Vorticella



Tintinnid species

Characteristics of the sporozoans

Sporozoa is a large subphylum consisting of many unicellular, intracellular parasites. Currently, the group is suggested to contain over 65,000 species with varying morphological characteristics. Given that they are strictly parasitic, members of the subphylum are responsible for a variety of diseases in human beings e.g.

(i) Malaria caused *by Plasmodium falciparum, P. malariae, P ovale and P. vivax* ;
(ii) Babesiosis caused by *Babesia divergens, B.microti, and B. duncani*

(iii) Cyclosporiasis is caused by Cylospora species.

1. No locomotory organs.
2. Spore-formation is common.
3. It is comprised of protozoans that are characterized by having a special organelle called an apical complex.
4. Most of them are single-celled, parasitic, and spore-forming.
5. All sporozoa are obligate parasites, they form temporary non-motile spores which contain infective cells.
6. The majority of these organisms are also characterized by a complex life cycle that not only requires two hosts (vertebrate and invertebrate) but also alternates between sexual and asexual stages.
7. Unlike the adult/mature forms of some protozoa, sporozoans do not have flagella or cilia used for locomotion. For this reason, they depend on gliding, twisting, and bending to move.
8. Gliding also allows the parasites to penetrate host cells in order to maintain an intracellular lifestyle.
9. Being very simple organisms, members of the class Sporozoa lack organs required for feeding and digesting food material in their environment (within the cell of the host). For this reason, they heavily rely on osmosis to absorb nutrients (fluid nutrients).
10. While they are simple and do not have many of the organelles found in other eukaryotes, Sporozoa have been shown to have micropores
11. Schizonts of Plasmodium and other parasites are capable of phagotrophy (engulf food particles through phagocytic nutrition)
12. Four major groups are recognized on the basis of different spore morphology:

13. Generally, both sexual (Syngamy) and asexual reproduction (Schizogony) occurs in sporozoans:

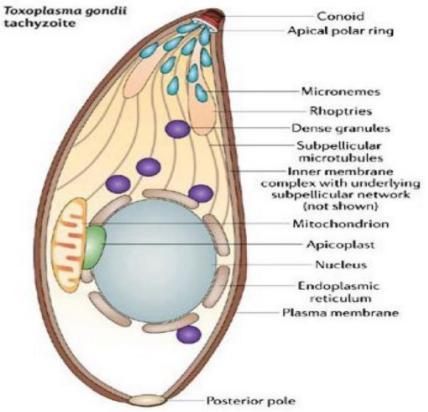
    Sporozoans have been grouped into 4 based on general spore morphology, these include:

    a. **Apicomplexan** parasites form distinctive oocysts containing infective sporozoites. Many species occur only in invertebrates whereas others may infect vertebrates causing severe diseases (such as malaria, tick fever, diarrhoea or abortion). They are characterized by the presence of *Apical complex*

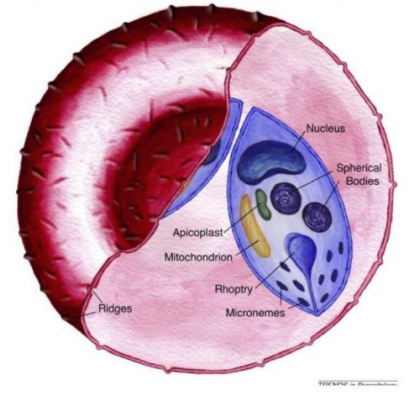
    b. **Microsporan** parasites form unicellular spores containing coiled polar tubes used to infect host cells. Most species infect invertebrates (especially insects) although some form cysts in vertebrates (mainly fish).

    c. **Haplosporidian** parasites form unicellular spores without polar filaments in the tissues of aquatic invertebrates. They cause significant morbidity and mortality in oysters throughout the world.

    d. **Paramyxean** parasites form unique spore-within-spore arrangements within the tissues of bivalves and polychaetes. They cause QX and Aber disease in oysters.



Toxoplasma gondii tachyzoite



Schematic diagram of Babesia in red blood cell

PHYLUM PORIFERA

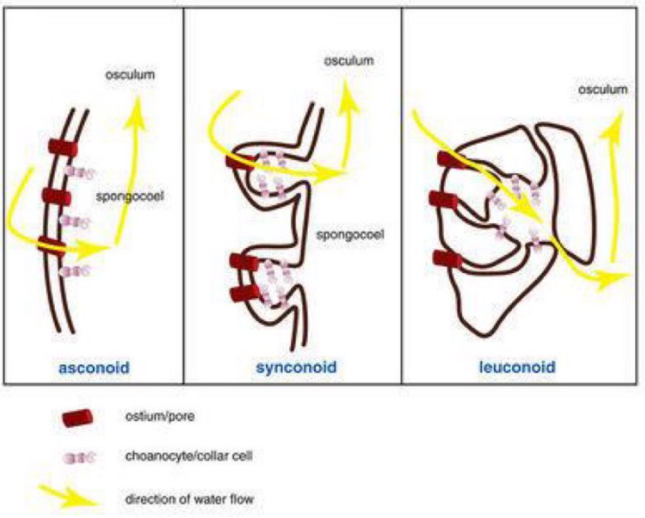
Phylum Porifera are the lowest multicellular animals belonging to the kingdom Animalia. The word "Porifera" mainly refers to the pore bearers or pore bearing species. Based on the embryological studies, sponges are proved as animals and are classified into a separate Phylum in the animals. This phylum includes about 5000 species. Poriferans are pore-bearing first multicellular animals. The pores are known as Ostia. The poriferans have a spongy appearance and are therefore called sponges. They are attached to the substratum and do not move. They have the ability to absorb and withhold fluids.They were initially regarded as plants due to the green colour and their symbiotic relationship with algae. Later, their life cycle and feeding system were discovered, and they were included in the animal kingdom.

Some characteristics of Phylum Porifera

1. The cells of Poriferans are loosely organized.
2. They are mostly found in marine water. Only a few are found in freshwater.
3. They are either radially symmetrical or asymmetrical.
4. Their body is usually cylindrical.
5. The scleroblast secretes spicules while spongin fibres are secreted by spongioblasts.
6. They are diploblsatic, i.e. the cells are arranged in two embryonic layers, external ectoderm and an internal endoderm
7. They have no organs in their body.
8. They depict cellular grade of organization.
9. The body comprises numerous pores known as Ostia and osculum
10. The central cavity is called spongocoel or atrium which opens to the outside through the osculum.
11. Water comes in trough the Ostia and goes out through the Osculum
12. They reproduce asexually by budding, and fragmentation.
13. The nutrition is holozoic. They filter the tiny, floating organic particles and planktons that they feed on, hence called filter-feeders.
14. They collect the food in specialized cells called choanocytes which are transported throughout the body by amoebocytes.
15. They have neurosensory cells but are devoid of any specific nervous system.
16. They have the power to regenerate the lost parts.
17. The development is indirect and the cleavage is holoblastic.
18. The exchange of respiratory gases and nitrogenous wastes occurs by the process of diffusion.

Body plan of Porifera

There are three different body plans found among sponges, and they are depicted in Figure below. The main difference between each body plan is the complexity of the canal system that pumps water through the animal.



1. Asconoid body plan:

The most basic body plan is called asconoid. In asconoid sponges the two major cell layers surround a fluid-filled cavity called the spongocoel, the large central cavity of sponges . Water is pumped directly through pores, called ostia, into the spongocoel and then out of the sponge through an opening called the osculum (plural oscula). The spongocoel is lined with specialized digestive cells called choanocytes that filter and take in food (e.g., *Leucosolenia*)

2. Syconoid body plan:

Synconoid is a more complex body plan. In synconoid sponges the ostia lead to a network of canals that are lined with choanocytes. Water is pumped into the ostia and through these canals before arriving at the spongocoel. There are no choanocytes lining the spongocoel of synconoid sponges so digestion takes place in the canals (e.g., *Scypha, Hyalonema, Euplectella, Sycon*).

3. Leuconoid body plan

The most complex sponge body plan is called leuconoid. In these sponges the canal system forms a more elaborate branched network, and the canals lead to digestive chambers instead of a spongocoel. In leuconoid sponges the choanocytes line the digestive chambers and not the canals. Once water has passed through the digestive chambers it is released into an exit canal that leads to the osculum. There is no real spongocoel in leuconoid sponges. One feature that is common to all three types of body plan is the presence of a holdfast at the base of each animal. The holdfast is what the sponge uses to anchor itself to a solid surface, such as a rock.

This prevents the sponge from being transported by water currents (e.g., *Cladorhizids, Spongia, Spongilla, Cliona*)

Classification of Phylum Porifera

Phylum Porifera is classified into three classes:

1. **Calcarea**

a. They are found in marine, shallow, and coastal water.
b. Their skeleton is composed of calcareous spicules made of calcium carbonate.
c. The body is cylindrical and exhibits radial symmetry.
d. The body organization is asconoid, syconoid, or leuconoid. Eg., Clathrina, Scypha

2. **Hexactinellids**

a. They are found in marine and the deep sea.
b. The skeleton is made up of six-rayed siliceous spicules.
c. The body is cylindrical in shape and exhibit radial symmetry.
d. The canal system is Sycon or Leucon. Eg., Euplectella, Hyalonema

3. **Desmospongiae**

a. They are found in marine or freshwater.
b. The body is asymmetrical and cylindrical in shape.
c. The canal system is a leuconoid type.
d. The skeleton comprises spongin fibres, siliceous spicules, which are monoaxon and triaxon. Eg: Spongia, Spongilla, etc.

Porifera Examples

Some of the common Porifera examples are:

1. **Sycon**

These are solitary or colonial marine sponges found in shallow waters attached to the rocks. The body is cylindrical in shape with numerous spores. The radial canal is made up of flagellated cells. Water enters the body through Ostia and reaches the radial canals by prosopyles. These species undergo both sexual and asexual mode of reproduction.

2. **Hylonema**

These are also known as glass rope sponges found in marine water. The body is round or oval with twisted root tufts. Small amphidiscs are present in the skeleton.

3. **Cliona**

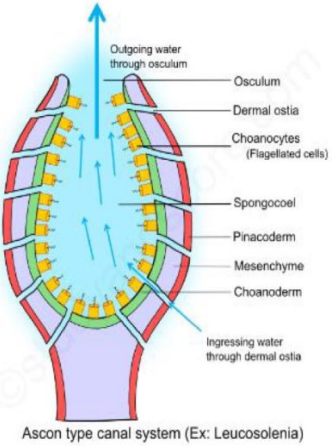
They are also known as Boring Sponges found in coral skeletons, mollusc shells, other calcareous objects. They are green, purple, or light yellow in colour. The canal system is the characteristic of the leuconoid type of sponges, and they reproduce asexually and sexually

4. Euplectella

These are also known as Venus flower basket and are found in deep waters. The body is cylindrical, long and curved fastened in the mud at the bottom of the sea. The canal system is simple synconoid type. The skeleton consists of siliceous spicules fused at the tips forming a three-dimensional network with parietal gaps.

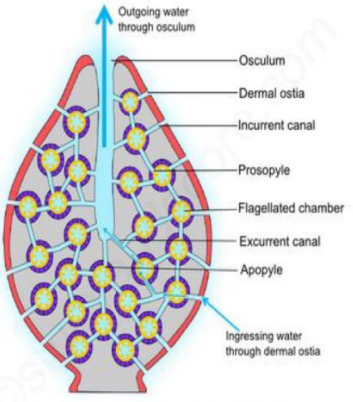
5. Spongilla

They are largely found in ponds, streams, lakes growing on submerged plants and sticks. The body wall consists of a thin dermis provided with pores called Ostia. They possess a rhagon type canal system. They reproduce sexually as well as asexually.

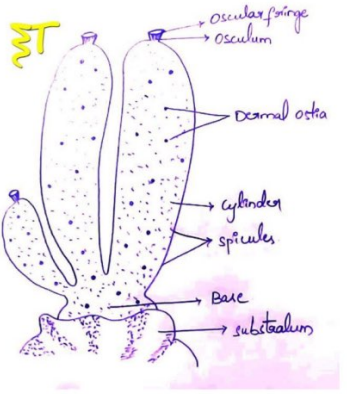


Ascon type canal system (Ex: Leucosolenia)

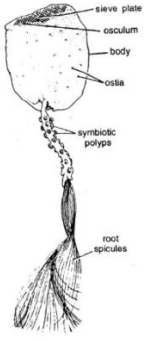
Sycon type canal system (Ex: Scypha)



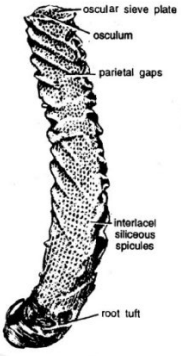
Leucon type canal system (Ex: Spongilla)



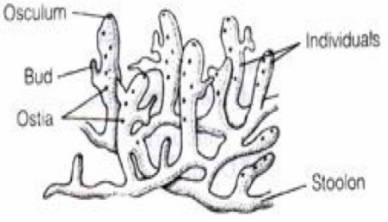
Spongilla



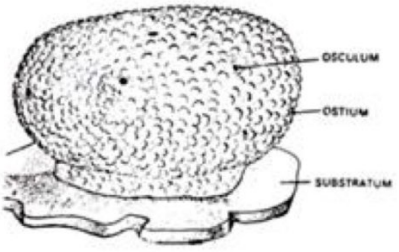
Hyalonema



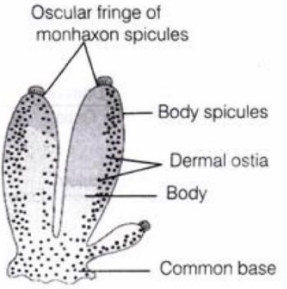
Euplectella



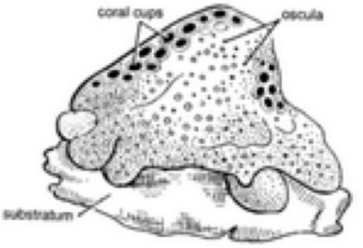
Leucosolenia



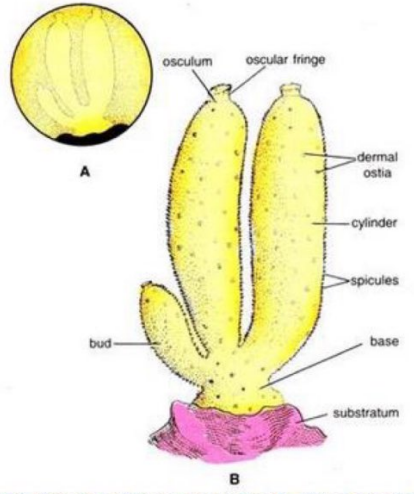
Euspongia



Sycon



Cliona



26.1. *Scypha.* A—Colony in natural size; B—Colony magnified.

BIO 102

Phylum Cnidaria: General characters and Classification

Introduction

Phylum Cnidaria or coelenterate includes diverse animals like jelly fish, sea anemones, corals and the more familiar Hydra. They are diploblastic eumetazoans with tissue grade of organization. The cnidarians are characterized by the presence of Cnidocytes, polyp and medusa forms.

General Characters of Phylum Cnidaria

1. These are mostly marine and a few like hydra live in fresh water
2. Many are colonial (Eg: Corals). Some are solitary (Eg: sea anemone)
3. They are diploblastic and show tissue grade of organization
4. The body is radially symmetric but sea anemones show biradial symmetry
5. Polyp and medusa re the two different forms of cnidarians. Polyp is hydroid form which is sessile with mouth-up orientation. Medusa is umbrella or bell shaped with mouth down orientation. It swims by constricting the bell.
6. The body wall is composed of an outer epithelium called as epidermis, an inner epithelium called gastrodermis, a gelatinous mesoglea between the outer and inner epidermis. Mesoglea consists of amoeboid cells derived from ectoderm. Mesoglea is thin in polyps. It is thick in medusa, in which it is important in buoyancy.
7. The body wall contains stinging cells called as cnidocytes. Hence the name cnidaria. Each cnidocyte cell contains a fluid filled membranous capsule called cnida. Cnidocytes help in defence and capture of prey.
8. The blind sac-like central cavity is called coelenterons or gastro vascular cavity. Hence the name Coelenterata. It opens out by mouth surrounded by tentacles. Mouth serves for ingestion as well as for egestion.
9. In medusa form the coelenterons is specialized into stomach, radial canals and ring canal. Coelenterons helps in digestion and circulation.

10. Digestion is first extracellular in the coelenterons and then intracellular in the nutritive muscular cells of gastrodermis.
11. Exchange of respiratory gases and elimination f the excretory wates occurs by diffusion through the body wall.
12. Neurons are interconnected to form a pair of nerve nets, one in epidermis and the other in the gastrodermis. The two nerve nets are joined by neurons that cross the mesoglea. Nerve impulse conduction is diffuse conduction. Nerve impulse can travel in any direction. Besides nerve nets, medusae have nerve rings and ganglia around the margin of the bell.
13. Sensory structures like statocysts occur in the medusoid form
14. Asexual reproduction takes place by budding, fission and fragmentation.
15. Cnidarians are generally unisexual but some are bisexual. Fertilization is external. Cleavage is holoblastic. Development is indirect and includes a free swimming ciliated larval stage called planula.
16. In species having polyp and medusa phases, the alternation of asexually reproducing polyp form and sexually reproducing medusa form is called as metagenesis.
17. Cnidarians have remarkable power of regeneration.

Classification of Phylum Cnidaria

Phylum Coelenterata/Cnidaria includes about 10,000 known species. It is classified into three classes namely Hydrozoa, Scyphozoa, Anthozoa and Cubozoa.

The following are the general characters of each of them

Class I: Hydrozoa (Gr. Hydros=water, zoon=animal)

- These are mostly marine animals but some may also live in fresh water.
- They are chiefly colonial. Some forms may also appear solitary.
- Medusa stage is absent in few animals. Sometimes both polyp and medusa stages are present in few animals of this class. Medusa is craspedote (presence of velum)
- Coelenteron of the polyps of this class is undivided
- Mesoglea is acellular

- Cnidocytes are restricted to the epidermis
- Gonads also occur in the epidermal region
- Their colonies are polymorphic with different types of zooids like gastrozooids (feeding type), dactylozooids (defensive type) and gonozooids (reproductive type).

Class II: Scyphozoa (Gr. skyphos=cup, zoon=animal)

- All the animals belonging to this class are marine in nature
- Medusa stage is predominant in this class. Medusa is acraspedote (No velum)
- Mouth is surrounded by four oral arms.
- Mesoglea is cellular and contains amoebocytes
- Cnidocytes occur in the epidermis and also in the gastrodermis region
- Gonads occur in the gastrodermal region.
- Polyps are solitary or may also exist in colonies. Polyp stage is syphistoma (body is divided by septa). This syphistoma produces juvenile medusa called as ephyrae by the process of strobilation. Finally this ephyra grows into the sexual adult medusa.
- This class includes Jelly fish

Class III: Anthozoa (Gr. anthos=flower, zoon=animal)

- All the animals of this class are marine
- They may be solitary or colonial
- All are sedentary polyploid forms. The medusa stage is absent
- Mouth is oval and is surrounded by a whorl of tentacles resembling a flower like structure. Hence the name of the class.
- The mouth leads into tubular pharynx called stomodaeum that in turn opens into coelenteron. Coelenteron is divided into radial compartments by vertical septa called as mesenteries.
- Cnidocytes occur in epidermal as well as gastrodermal region
- Gonads occur in the gastrodermis.

The phylum Cnidaria

Introduction

The name Cnidaria comes from the Greek word "cnidos," which means stinging nettle. Casually touching many cnidarians will make it clear how they got their name when their nematocysts eject barbed threads tipped with poison. The phylum Cnidaria is a diverse group of very simple-bodied animals includes corals, sea anemones, hydras, jellyfishes, and their relatives. About 9,000 living species are known. The Cnidaria are the simplest Metazoa, and do not even possess organs. All they have is a stomach and a mouth surrounded by tentacles.

Diversity of the Cnidarians

- Cnidarians are incredibly diverse in form, as evidenced by colonial siphonophores, massive medusae and corals, feathery hydroids, and box jellies with complex eyes.
- Yet, these diverse animals are all armed with stinging cells called nematocysts. Cnidarians are united based on the presumption that their nematocysts have been inherited from a single common ancestor.
- Many thousands of cnidarian species live in the world's oceans, from the tropics to the poles, from the surface to the bottom. Some even burrow. A smaller number of species are found in rivers and fresh water lakes.

Classification of Cnidarians

There are four main groups of cnidarians, Hydrozoa, Cubozoa, Scyphozoa and Anthozoa.

Class Hydrzoa

i. They are the most diverse group of cnidarian with siphonophores, hydroids, fire corals, and many medusae;
ii. They have two types of body the polyp and medusa forms in their life cycle.

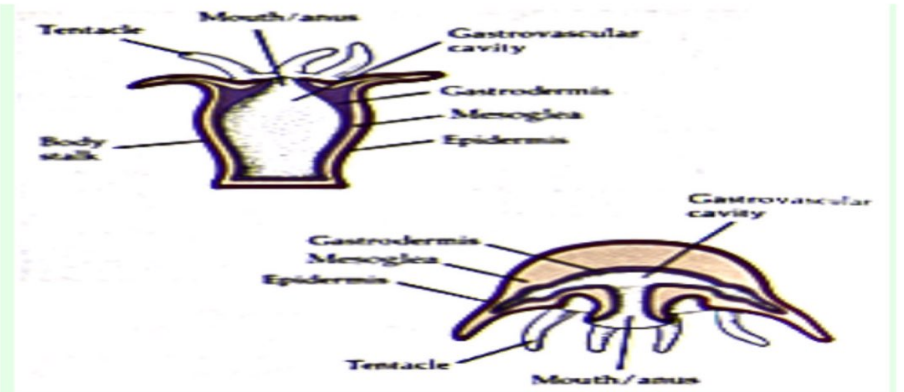


Fig 1: Two types of body the polyp and medusa

iii. The polyp is the predominant stage while the medusa is the simple stage.

iv. They reproduce by alternation of the asexual and sexual phases of their life cycles. e.g. *Hydra, Obelia, Physalia* (Portuguese man-of-war), *Bougainvillea* etc.

Class Scyphozoa

The Scyphozoa are considered the true jellyfish.

i. In this class, the polyp stage may either be reduced to a small larva or it may be absent; if present, it gives rise to medusae by transverse fission.

ii. They lack a gullet.

iii. Nematocysts are present in the ectoderm.

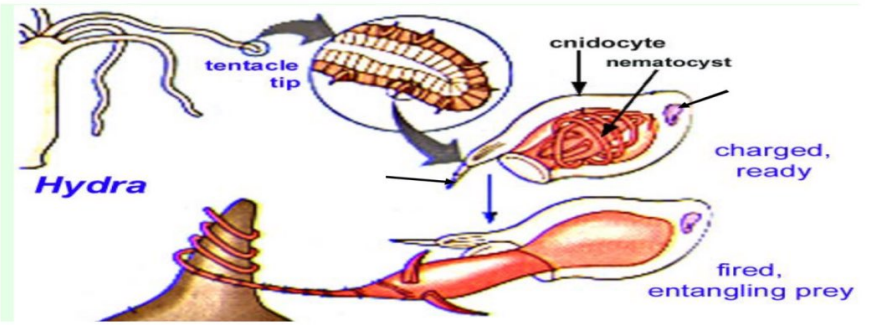


Fig 2: nematocysts

iv. They are exclusively marine.

e.g. *Aurelia* (jelly fish), *Pelagia* etc.

Class Anthozoa

i. They are exclusively marine cnidarians.

ii. They constitute the largest class.

iii. They occur only as polyps.

iv. Nematocysts are present in the endoderm.

E.g. Actinia (sea anemone), Astrangia (coral), and sea pens etc.

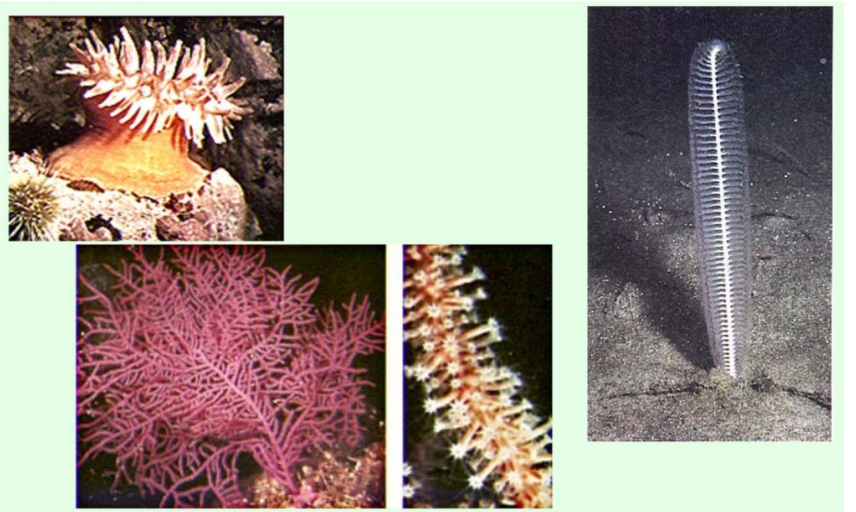


Fig 3: Anthozoa (Sea anemone, Sea fan, whip coral)

Class Cubozoa

i. They are referred to as the amazing box jellies with complex eyes.

ii. They produce potent toxins.

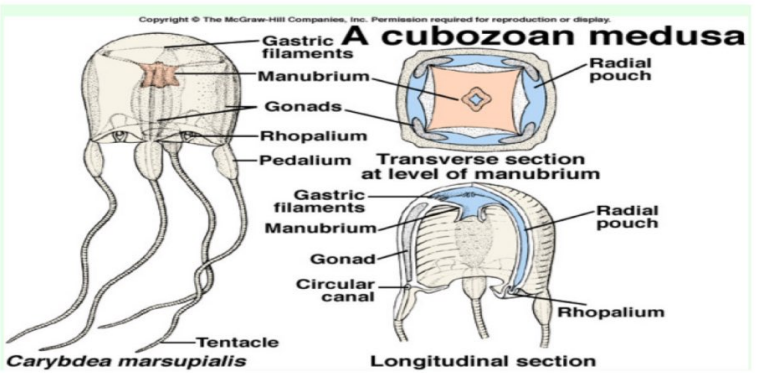


Fig 4: Cubozoan

This class includes jellies that have a box-shaped medusa, or a bell that is square in cross-section, and are colloquially known as "box jellyfish." These species may achieve sizes of 15 to 25 cm, but typically members of the Cubozoa are not as large as those of the Scyphozoa. However, cubozoans display overall morphological and anatomical characteristics that are similar to those of the scyphozoans. A prominent difference between the two classes is the arrangement of tentacles. The cubozoans contain muscular pads called pedalia at the corners of the square bell canopy, with one or more tentacles attached to each pedalium. In some cases, the digestive system may extend into the pedalia. Nematocysts may be arranged in a spiral configuration along the tentacles; this arrangement helps to effectively subdue and capture prey. Cubozoans include the most venomous of all the cnidarians (Figure 4).

These animals are unusual in having image-forming eyes, including a cornea, lens, and retina. Because these structures are made from a number of interactive tissues, they can be called true organs. Eyes are located in four clusters between each pair of pedalia. Each cluster consists of four simple eye spots plus two image-forming eyes oriented in different directions. How images formed by these very complex eyes are processed remains a mystery, since cubozoans have extensive nerve nets but no distinct brain. Nontheless, the presence of eyes helps the cubozoans to be active and effective hunters of small marine animals like worms, arthropods, and fish.

Cubozoans have separate sexes and fertilization occurs inside the female. Planula larvae may develop inside the female or be released, depending on species. Each planula develops into a polyp. These polyps may bud to form more polyps to create a colony; each polyp then transforms into a single medusa.

Phylum Platyhelminthes

Introduction

The platyhelminthes (flatworms) are bilaterally symmetrical and triploblastic i.e. composed of three fundamental cell layers. They have no body cavity other than the gut (and the smallest free-living forms may even lack that!) and lack an anus; the same pharyngeal opening both takes in food and expels waste.

General Characteristics of the Platyhelminthes

i. These are flatworms because they are dorso-ventrally flattened.
ii. Cephalization and bilateral symmetry.
iii. Triploblastic organization.

iv. Organ-system level of organization.

v. They are acoelomates i.e. the mesoderm is solid with no space between the ectoderm and the gut.

vi. They possess a central nervous system.

vii. They lack blood vascular (circulatory) and respiratory systems.

viii. Respiration and excretion are mainly by diffusion through the body surface.

ix. They possess a unique excretory and osmoregulatory system of branched protonephridial tubes that end in flame cells.

x. The gut (when present) has only one opening, the mouth; no anus.

xi. They are hermaphrodites.

The Turbellaria

Introduction

The Turbellarians are a large class of ribbon-shaped flatworms found primarily on the bottoms of oceans. While most are drably colored, some marine species are vivid and brilliantly patterned. The Monogeneans are parasitic flatworm that spends its entire life cycle on the outside of the same fish.

Classification of Turbellaria

Turbellarians make up the class Turbellaria in the flatworm phylum, Platyhelminthes.

The planarian belongs to the genus *Dugesia.*

General Characteristics of the Monogenea (Fig. 2.6)

i. They are mostly ectoparasites of fish, turtles and amphibians.

ii. A few are endoparasitic.

iii. They have simple life-cycles and have only one host.

iv. Possess hooked attachment structures.

v. The large posterior attachment structure is called the haptor.

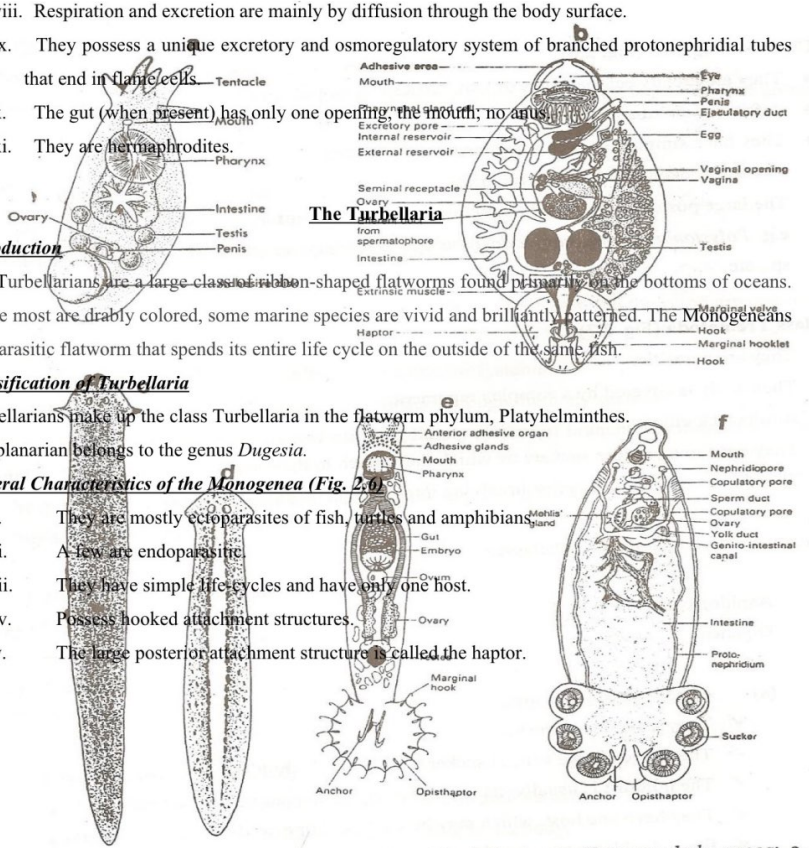


Fig. 2.6. Phylum **Platyhelminthes**: Class **Turbellaria**: **a,** *Temnocephala caeca*; **c, d,** Tw species of *Dugesia*; Class **Monogenea**: **b,** *Entobdella soleae*; **e,** *Gyrodactylus* (opisthaptor haptor); **f,** *Polystoma* (opisthaptor = haptor).

e.g. *Polystoma sp., Macrogyrodactylus sp., Dactylogyrus sp., Gyrodactylus sp., Diplozoon sp.* etc.

The Trematoda

Introduction

The Trematoda is a class within the phylum Platyhelminthes that contains two groups of parasitic worms, commonly referred to as flukes.

Classification of the Trematodes

The class Trematoda contains two subclasses, one of which, the Digenea is a large and successful group with much economic importance to mankind. The second subclass is the Aspidogastrea which are a small group of absolutely no economic importance to mankind at all (Fig. 2.7).

The Digenea

i. They are endoparasitic in all groups of vertebrates.
ii. Suckers are usually two; oral and ventral suckers.
iii. They have two or more hosts in their life-cycles.

e.g. *Fasciola hepatica, Fasciola gigantica, Fasciolopsis buski, Schistosoma mansoni, Clonorchis sinensis, Transversotrema,* etc.

The Aspidogastrea

The Aspidogastrea are an interesting group of about 80 species of parasitic Platyhelminths. They are are all aquatic and as far as we know they all have indirect life cycles, meaning they have more than one host species. Most species use some sort of mollusc or arthropod as the intermediate host and a vertebrate such as a fish or a turtle as the primary host. Some species however reach maturity in the invertebrate host, and it must be remembered that there are a number of species in this group that we know very little about.

Aspidogastreans have more simple life cycles than their Digenean relatives as they lack the intermediate forms that make Digeneans so prodigious in terms of numbers of young resulting from one egg, for the Aspidogastreans one egg means one larvae and then one adult. They are mostly small animals ranging in size from 1 mm to several cm. They also tend lack much in the way of 'host specificity' meaning they can be infective to a wide range of hosts. They have a large posterior sucker which is used to attach to the host.

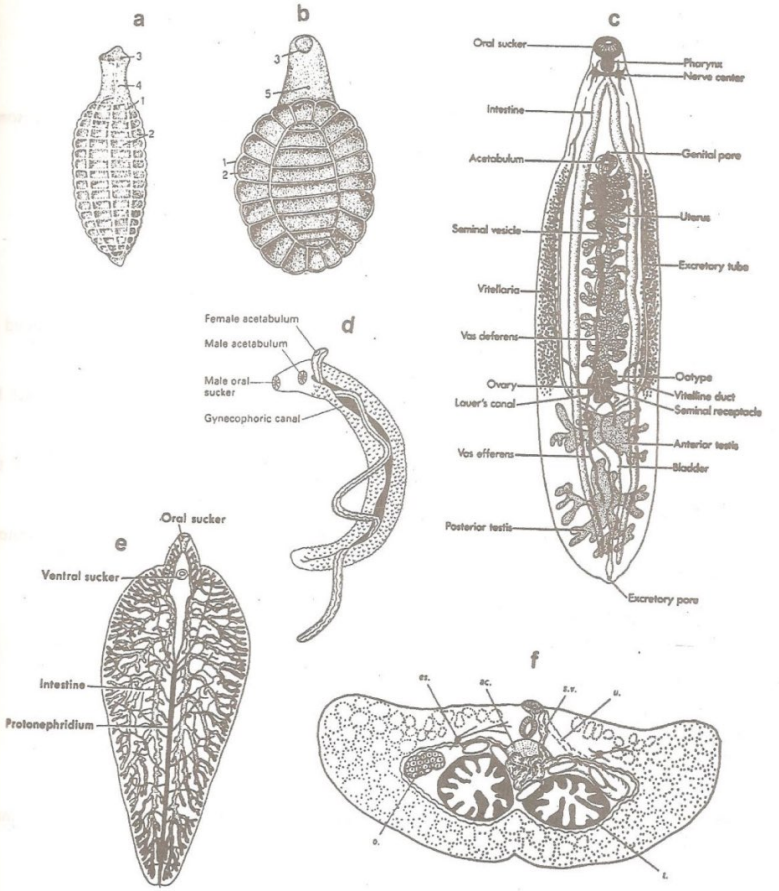


Fig. 2.7. Phylum **Platyhelminthes:** Class **Trematoda**: Subclass **Aspidogastrea**: **a,** *Aspidogaster*; **b,** *Cotylaspis* (1, sucker; 2, alveolus; 3, mouth; 4, pharynx; 5, genital pore). Subclass **Digenea**: **c,** *Clonorchis sinensis* (Chinese liver fluke); **d,** *Schistosoma mansoni*; **e,** *Fasciola hepatica*; **f,** *Transversotrema* (ac, acetabulum/ventral sucker; o, ovary; e.s., eyespot; s.v., seminal vesicle; t, testis; u, uterus).

Eggs are laid and pass out of the host animal with its faeces. In some species, such as *Amphilina foliacea*, the eggs do not hatch until they are eaten by the intermediate host.

Class Cestoidea (Cestoda)

Introduction

Cestodes or tapeworms are the most specialised of the Platyhelminthes parasites. All cestodes have at least one, and sometimes more than one, secondary or intermediate host as well as their primary host.

Physical Characteristics of Cestodes

i. Commonly called tapeworms.

ii. They are endoparasitic and their adults live in the gut of vertebrates.

iii. Body is typically elongated, tape-like and segmented; each segment is called a proglottis/proglottid (Fig. 2.8).

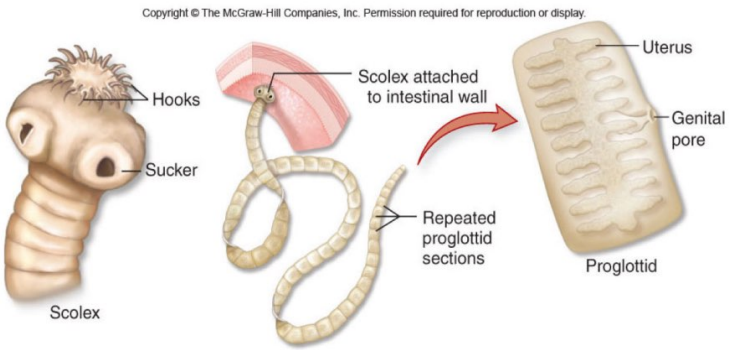


Fig: 2.8 Tape worm body part

iv. They have a head region known as the scolex, which mostly bears hooks and suckers for attachment to the host.

v. The anterior proglottides close to the scolex are young without complement of the reproductive system.

vi. The middle proglottides are mature and have full complement of the reproductive system, while the posterior segments are gravid and contain ripe eggs.

vii.

iv. The middle proglottides are mature and have full complement of the reproductive system, while the posterior segments are gravid and contain ripe eggs.

v. Each proglottis contains a complete set of male and female reproductive organs.

vi. They have no mouth and no digestive system.

vii. They absorb digested food from the intestine of their host through the body surface.

viii. Their bodies are covered by a thick cuticle.

ix. No cilia in adults.

x. Life-cycle is complex and involves intermediate hosts.

E.g. *Taenia solium, Taenia saginata, Echinococcus granulosus, Hymenolepis nana, Diphyllobothrium latum,* etc.

xi. The body of most tapeworms is flat and much longer than it is wide, so that it looks like a tape or ribbon. The length varies from 0.02 inch (0.6 millimeter) to 98 feet (30 meters), the longest worms being found in sperm whales.

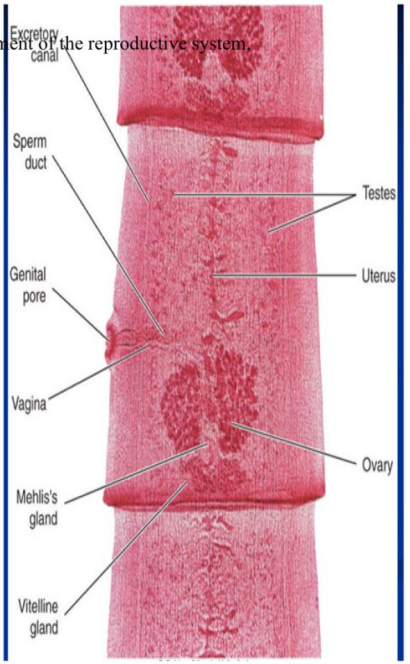


Fig 2.9 proglottides are mature and have full complement of the reproductive system

xii. The body of tapeworms has three regions: scolex, neck, and strobila. The scolex is the head. It has spines, hooks, suckers, tentacles, glands releasing sticky secretions, or a combination of these structures that the worm uses to attach itself to the inner wall of the intestine of the final host, also called the primary host.

xiii. Suckers are the most common attachment tool. Suckers are usually cup shaped and have powerful muscular walls. The neck is the region of the body just behind the scolex. It is usually short.

xiv. The strobila is behind the neck. It consists of a row of segments called proglottids. The strobila is made up of anywhere from a few to more than one thousand proglottids but usually contains several dozen.

xv. Each proglottid starts development at the neck, and proglottids form one by one throughout the life of the tapeworm in the final host. Just behind the neck, the proglottids are short and

narrow. When a new proglottid forms at the neck, already formed proglottids are pushed toward the rear, grow, and eventually contain the reproductive organs.

xvi. Behind the new proglottids, each strobila contains the following types of proglottids, from front to back: premature proglottids, with the beginnings of reproductive organs; mature proglottids, which contain functioning male and female reproductive organs; postmature proglottids, which contain developing eggs; and gravid proglottids, which contain ripe eggs.

xvii. Gravid proglottids at the end of the worm break off and pass into the environment with the host's feces. A few species of tapeworms have no proglottids.

BIO 102
Introductory Biology

Phylum Nematoda

Phylum Nematoda

- nema = Thread
- eidos = form
- Common name: round worms
- >20,000 extant species
- Mostly widespread and abundant of all metazoans

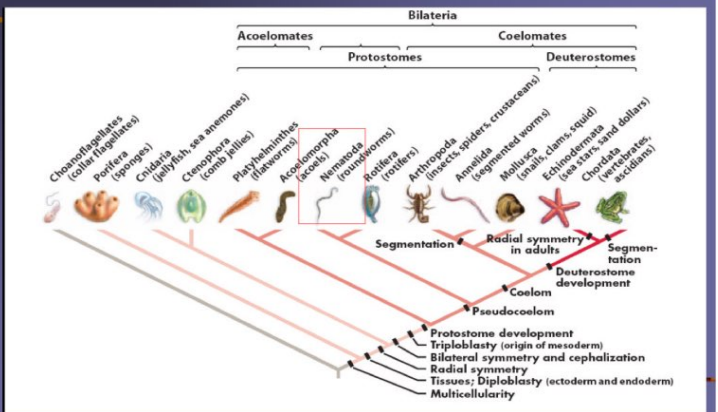
Helminthology: Study of animal parasitic nematodes

Nematology: Study of (plant parasitic nematode)

Phylum Nematoda: Diversity

- Free-living forms found in nearly every environment i.e they are cosmopolitan
  - Free-living marine & freshwater
  - Between grains of beach sand
  - Key soil dwellers (nutrient processing)
  - Polar ice fields
- Key plant & animal parasites.

Phylogeny: Based on body plan & development



PHYLUM NEMATODA: CLASSIFICATION

- KINGDOM Animalia
- Classified based on the presence or absence of a caudal sense organ- PHASMID
  - 1. Class Adenophorea (Aphasmidea- those without phasmids)
  - 2. Class Secernentea (Phasmidea- those with phasmids).

There are 17 Orders in the Phylum Nematoda. Important orders are

- Order Ascaroidea - *Ascaris*
- Order Strongyloidea – *Ancyclostoma*
- Order Filarioidea - *Wuchereria*
- Order Trichuroidea - *Trichuris*

HABIT AND HABITAT

- Cosmopolitan in distribution
- Freshwater, marine and soil dwellers
- Majority are free living, some are parasite in plants and animal
- Mode of Nutrition is Holozoic
- Most free living <2.5 mm in length. Some parasites > 50 cm in length.

EXTERNAL FEATURES

- **Body covered by a tough, smooth and elastic cuticle.**

Anteriorly,

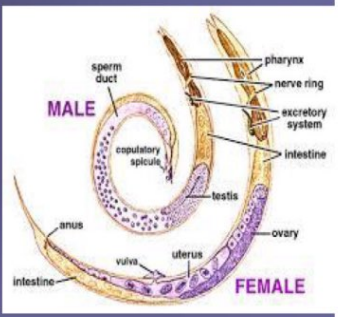
- **Possession of six lips (Labia) fused up in some.**
- **Presence of olfactory chemoreceptors called Amphids**

Posteriorly,

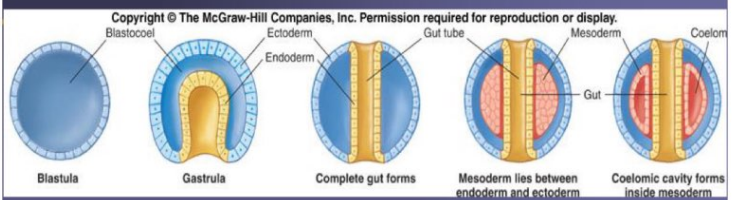
- **Presence of anus with thick lips**
- **Male has cloaca from which two equal chitinous spicules (penial setae) projects.**

External Features cont'd

- Presence of papillae in male connected with copulation.
- Presence of short post-anal tail. Straight in female, curled in male
- Male smaller and thinner than females
- Presence of genital aperture (vulva or gonopore) in female on the ventral side.
- Presence of excretory pore at mid ventral location.



BODY CAVITY or PSEUDOCOEL

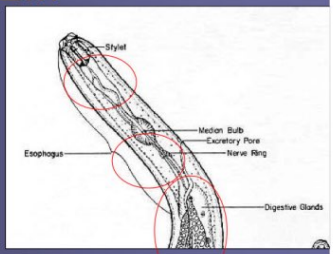


Nematodes are pseudocoelomate i.e there is a space (cavity) between the endoderm and mesoderm.

DIGESTIVE SYSTEM

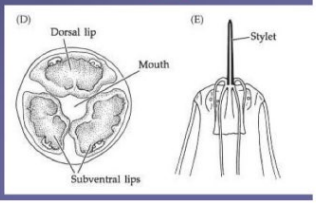
Consist of :

- Mouth (lips, teeth , stylet and jaw)
- Short Muscular pharynx
- Oesophagus



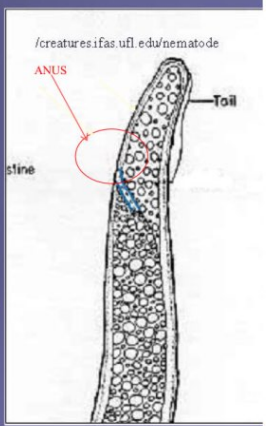
Oesophagus forms

- 1. Foregut; long intestine
- 2. Midgut
- 3. Hindgut: Short rectum



Digestive system cont"d

- Buccal Cavity varies depending on prey
  - Bacteria - no teeth or stylet
  - Plant root - stylet
  - Carnivore - small teeth and sometimes stylet
  - Intestine - large hook-like teeth



Hindgut

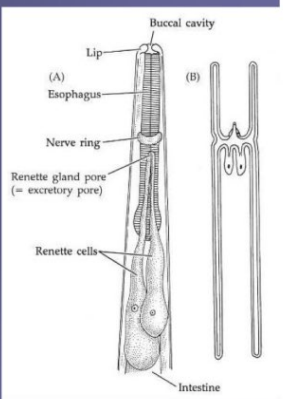
- Hindgut opens to a cloaca in male, but in females open to an anus.
- Contraction causes feacal materials to be discharged.

FOOD AND FEEDING

- Foods comprising blood, tissue, bacteria, plants are partly or fully digested food of host.
- Food sucked in by suctorial action of pharynx
- Digestion is extracellular in intestinal lumen
- Digestion facilitated by proteases, amylases and lipases secreted by glands of the pharynx
- Digested nutrients absorbed by microvilli on intestinal wall and distributed in pseudocoelomic fluid.
- Excess food stored as reserve glycogen in intestinal wall and muscles

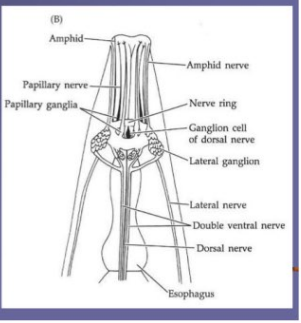
EXCRETION

- Excretory system consists of one or two large RENETTE glands cells lying in the pseudocoel near the pharynx and intestine.
- A duct arise from each RENETTE gland cell and open by an excretory pore
- Excretion also via the digestive system
- Excretory system regulates Water-salt balance, Ionic balance
- Body wall helps to excrete Ammonia



Nervous system

- Nervous system is well developed, complicated and hypodermic (situated in the body wall)
- It is organized into:
  - Nerve ring
    - Plus associated ganglia
    - Sensory nerve input
  - Four major nerve cords:
  - 1 dorsal,
  - 1 ventral,
  - 2 lateral



RESPIRATORY SYSTEM

- RESPIRATORY ORGAN IS ABSENT.
- However Parasites carry on ANAEROBIC respiration.
- They break down glycogen into CO_2 and Fatty acids which are excreted through the cuticle.

Reproduction

- Sexual reproduction
  - Sexes are separate i.e dioecious
  - internal fertilization
    - Male has cuticular spicules
    - Males have curled end and are shorter
  - sperm lack flagella (amoeboid)
  - Oviparous or ovoviviparous
  - High incidence of parthenogenesis
    - In some, mating occurs but sperm nucleus not used.
  - Some are hermaphrodites

ECONOMIC IMPORTANCE

- Nematodes are of economic importance as they are causative agents of diseases in plants and animals….
- Plant parasitic nematode such as root-knot nematode (*Genus Meloidogyne*) infect about 2000 plants worldwide and they cause approximately 5% of global crop loss.

ECONOMIC IMPORTANCE

- Animal Parasitic nematodes causes diseases in human and animals. Over 5000 species are known to infect animal and human. Many of Tropical Diseases are of nematode origin. These include
  - Onchocerciasis, Lymphatic filariasis, Loa loa, Strongyloides, ascariasis, hookworm, trichuriasis, enterobiosus,
  - In animal, there is Ascarida, Heterakis,in Chicken, Haemonchus and Oesophagostomum in Cattle/Sheep

Ascaris Lumbricoides (Common name: roundworm)

- Phylum Nematoda
- Class: Secernentea
- Order: Ascaroidea
- Family: **Ascaridae**
- Genus: Ascaris
- Species : lumbricoides

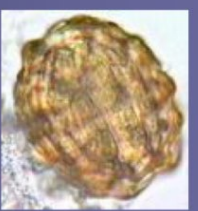
Parasitic life cycle, medical importance

Ascaris lumbricoides (Life cycle)

- Adult worms live in the lumen of the small intestine of human. Over 2 billion people are infected worldwide. Thus it is the commonest human helminth infection.
- A female may produce approximately 200,000 eggs per day, which are passed with the feces
- After infective eggs are swallowed, the larvae hatch, invade the intestinal mucosa, and are carried to the lungs.
- The larvae penetrate the alveolar walls, ascend the bronchial tree to the throat, and are swallowed.
- Upon reaching the small intestine, they develop into adult worms.

Forms and Shapes of *A. lumbricoides*

Massive Ascaris infection in child. A large bolus of roundworms expelled following anthelminthic treatment.



BIO 102
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PHYLUM ANNELIDA

Unlike the nematodes and the earlier animal groups, animals from annelids onwards

- Have developed **fluid-filled coelom**
  - Coelomic fluid separate the body wall from the alimentary tract.
  - The majority of the mesoderm which lines the coelom develops into muscle
  - Muscle of the body wall aids locomotion of the whole animal while that of the gut causes peristalsis of food.
  - Transport of materials between the gut wall and the body wall is achieved by a well-developed blood vascular system

Characteristics features of the Annelids

- They are triploblastic
- They are coelomate
  - The coelom of the of the annelid provides a form of hydrostatic skeleton against which its muscles could act during locomotion and burrowing
- They are bilaterally symmetrical
- They are metamerically segmented
- They have central nervous system of paired supra-oesophageal ganglia connected to ventral nerve cord by commissures

- The annelid body typically has a two-part head, composed of a **prostomium** and a **peristomium** followed by a segmented body
- They have solid nerve cord, usually double with segmented nerves
- Excretory organs are segmental, ectodermal in origin, ciliated and called **nephridia**
- They have definite cuticle secreted by ectoderm
- They have chaetae of chitin arranged segmentally (except in leeches)
- Larva are typically a trochophore
- Respiratory gas exchange through skin, **gills, or parapodia**
- **Closed circulatory system with muscular blood vessels** and aortic arches (hearts) for pumping blood

The phylum is divided into three classes:

- Class Polychaeta
- Class Oligochaeta
- Class Hirudinea

Class Polychaeta

- The largest class of annelids is the Polychaeta with more than 10,000 species,
- Most of them are marine dwellers.
- Although most polychaetes are 5 to 10 cm long, some are less than 1 mm, and others may be as long as 3 m.
- Many polychaetes live under rocks, in coral crevices, or in abandoned shells. A number of species burrow into mud or sand and build their own tubes on submerged objects or in bottom sediment.

- They play a significant part in marine food chains because they are eaten by fish, crustaceans, hydroids, and many other predators.
- Polychaetes differ from other annelids in having a **well differentiated head** with specialized sense organs; paired appendages, called **parapodia**, on most segments; and no clitellum
- They have many setae, usually arranged in bundles on the parapodia.

- Polychaetes are often divided into two morphological groups based on their activity

1. **Sedentary polychaetes**:
   - Sedentary polychaetes spend much or all of their time in tubes or permanent burrows.
   - Many of them, especially those that live in tubes, have elaborate devices for feeding and respiration
2. **Errant polychaetes (free moving)**:
   - These include free-swimming pelagic forms, active burrowers, crawlers, and tubeworms that only leave their tubes for feeding or breeding.
   - Example include clam worms in the genus *Nereis* which are predatory and equipped with jaws or teeth to capture prey

Other characteristics

- Sedentary polychaetes feed on suspended particles, or they may be deposit feeders, consuming particles on or in the sediment.
- Errant polychaetes are typically predators and scavengers.
- Polychaetes usually have separate sexes.
- Fertilization is external, and the early larva is called a **trochophore**
- Examples include *Nereis, Aphrodita, Glycera, Arenicola, Chaetopterus, Amphitrite, Riftia.*

Class Oligochaeta

- They include the familiar earthworms and many species that live in freshwater.
- Most are terrestrial or freshwater forms, but some are parasitic, and a few live in marine or brackish water.
- Setae are less numerous in oligochaetes than in polychaetes
- There are no parapodia
- Most oligochaetes are scavengers.
- Earthworms feed mainly on decaying organic matter, bits of leaves and vegetation, refuse, and animal matter.

- Osmoregulation occurs as a function of the body surface and the nephridia, as well as the gut and dorsal pores.
- Salts as well as water passes across the integument; salts apparently being actively transported.
- Earthworms are monoecious (hermaphroditic); both male and female organs are found in the same animal

- Examples include *Lumbricus, Stylaria, Aeolosoma, Tubifex*

Class Hirudinea*: Leeches*

- Leeches occur predominantly in freshwater habitats, but a few are marine, and some have even adapted to terrestrial life in warm, moist places.
- They are more abundant in tropical countries than in temperate zones.
- Body with fixed number of segments (normally 34; 15 or 27 in some groups)
- There are no parapodia
- Many leeches live as carnivores on small invertebrates; some are temporary parasites; and some are permanent parasites, never leaving their host.

- They have lost the setae used by oligochaetes in locomotion and have developed **suckers** for attachment while sucking blood
- Aquatic leeches swim with an undulatory movement.
- Leeches are popularly considered parasitic, active predators or scavengers
- Most leeches are fluid feeders. Many prefer to feed on tissue fluids and blood pumped from open wounds.

- Some freshwater leeches are true bloodsuckers, preying on cattle, horses, humans, and other mammals.
- An example of the true bloodsuckers include the medicinal leech, *Hirudo medicinalis*
- Gas exchange occurs only through the skin except in some fish leeches, which have gills.
- Leeches are hermaphroditic but cross-fertilize during copulation.
- Examples include *Hirudo, Placobdella, Macrobdella*

PHYLUM MOLLUSCA

The Phylum contains a variety of animals such as snails, squid, octopus, clams, whelks and periwinkle.

They are important economically as food, vector, pest (defoliator), jewellry, etc.

CHARACTEISTICS

1) They are triploblastic
2) Bilaterally symmetrical and non-metamerically segmented coelomates
3) The head bears 2 pairs of tentacles and 2 eyes
4) The foot is ventral, muscular and flat , used for creeping

CLASSIFICATION OF MOLLUSCS

1) Class Monoplacophora e.g Neopilina
2) Class polyplacophora e.g chitons
3) Class Bivalvia e.g clams
4) Class Gastropoda e.g snails
5) Class Scaphopoda e.g. Elephant tusk shell
6) Class Cephalopoda e.g Squids,octopuses

CLASS GASTROPODA (gut as foot)

Gastropods constitute the largest class of molluscs. The class includes snails, limpets, whelks etc. Gastropods possess distinct and well developed head bearing tentacles and eyes. Also, Radula and jaw are well developed. The shell is is in one piece (Univalve). The mantle covers only the visceral mass, while the foot and head are exposed.

One main characteristic of gastropods is TORSION. This is the anti-clockwise rotation of the visceral massthrough 180^{o} in relation to the head and foot. As a result of torsion, the mantle cavitybecome anterior, dorsal and opens in front.

BIOLOGY OF GIANT AFRICAN LAND SNAIL (*Archachatina marginata)*

The giant African land snail (*A. marginata*) occur commonly in the high forest and fringing forest of derived savannah regions of Africa. Land snails are active during the rains, but remains inactive under a rock and decomposing trees during dry season. The state of inactivity is called AESTIVATION, when the shell aperture is closed up with EPIPHRAGM, a thin whitish membrane formed by calcified slime.

The locomotory organ is the foot which is slightly triangular in shape. The lubrication of the substrate which is necessary for the gliding movements of snails is provided by mucus produced by the **pedal gland.**

Land snails have lost the gills as in other pulmonates. The mantle cavity is converted to lungs which is responsible for respiration.

Archachatina marginata feeds mainly at night and feeds include vegetables, pawpaw fruits and leaves. The mouth leads to a buccal mass while Radulalies at the floor of the buccal mass. The oesophagus dilates into a thin walled Crop on the side of which are the branched salivary glands.

The heart of Archachatina has one auricle and one ventricle. It has an open circulatory system where the fluid is called HAEMOLYMPH, a bluish, copper containing respiratory pigment- HAEMOCYANIN.

Archachatina is hermaphrodite , but practices mating/copulation because it is **protandrous**.

Land snail

Anatomy of land snail.

PHYLUM ECHINODERMATA (Spiny skin)

This phylum contains sea cucumbers, star fishes, sea urchins,brittle stars and feather stars. Echinoderms are exclusively marine and are abundant as fosils. They are vital phylum because they are the closest relative of the chordates.

CHARACTERISTICS

1) The skin contains calcareous spines and ossicles in the dermis
2) They lack head and the is differentiated into a central disc which radiate 5- arms
3) Echinoderms are not metamerically segmented
4) Possess a water vascular system
5) Locomotion is by unique tube feet
6) They lack excretory organs
7) They have poor blood system
8) Sexes are separated

CLASSIFICATION OF ECHINODERMATA

1) Class Asteroidea
2) Class Ophiuroidea
3) Class Echinoidea
4) Class Holothuroidea
5) Clascs Crinoidea

THE BIOLOGY OF STAR FISH (ASTROPECTEN)

Star- fishes occur at the sea edge, in snady beaches. Astropecten usually burrows in sand but other star fishes have suckers on their tube feet that can be used to cling to rock surfaces.

The body is divided into a central disc and 5 radiating arms. The surface bearing the mouth is called Oral surface while the upper surface is called the Aboral. Star fishes feed on bivalves by using the arms to remove the flesh from the shells.

Asexual reproduction occurs in star fishes through regeneration. Sexual reproduction occurs when star fishes release gamates into the water where fertilization takes place. The zygote develops into BIPINNARIA larva which later become a BRACHLOLARIA.

Star fish (Asteroidea)

External anatomy of star-fish

PHYLUM ARTHROPODA (Jointed Appendages)

The phylum Arthropoda is the largest in the animal kingdom. It contains about 80% of all the animal species. The phylum includes a variety of animals such as crayfishes, crabs, spiders, ticks, millipedes, centipedes and insects.

Arthropods are regarded as the most successful group of animals because:

1) They have the largest number of species and individuals
2) They are widespread in terms of habitat and geographical distribution
3) They exploit greatest variety of food sources
4) They are always defend themselves against enemies

CHARACTERISTICS OF ARTHROPODS

1) Arthropods are triploblastic, bilateral symmetrical and metamerically segmented coelomates
2) The epidermis secretes chitinous exoskeleton or cuticle
3) Growth occurs after moulting, that is, shedding of cuticle
4) The vascular system is open
5) The excretory organs are the malpighian tubules
6) Compound eyes are present

CLASSIFICATION OF THE PHYLUM ARTHROPODA

1) Sub-phylum Onychophora
2) Sub-phylum Chelicerata
   i) Class Merostomata
   ii) Class Arachnids
   iii) Class Pycnogonida
3) Sub-phylum Crustacea
4) Sub-phylum Uniramia
   i) Class Insect
   ii) Class Chilopoda
   iii) Class Diplopoda
   iv) Class Symphyla
   v) Class Pauropoda

a) Subphylum Onychophora are terrestrial caterpillar-like animals. They are regarded as the

missing link between annelids and Arthropods because they possess a combination of Arthropod and annelid characters. They occur in tropical, subtropical and forest, underneath logs of wood, leaves and beneath the bark of rotten logs. They are nocturnal and usually avoid light. An example is *Peripatus.*

b) The Subphylum chelicerata contains the spider, scorpions, ticks . The body is divided into 2 regions : a prosoma and opisthosoma. Respiration is by gill books, trachea or lung-books. The sexes are separate and fertilization is internal . The subphylum chelicerata consists of two main classes: (i) Class Merostomata e.g king crab (ii) Class Arachnida e.g Scorpions, spiders, ticks.

i) CLASS MEROSTOMATA

This class contains primarily aquatic chelicerates, the extinct giant water scorpions and the horse shoe crab- *limulus* . The body consists of the prosoma, opisthosoma and a long spinelike telson.

The horse shoe crabs are active at night. They feed on soft molluscs and bottom algae.

ii) CLASS ARACHNIDA

This class is large and comprising scorpions, spiders, mites and ticks. The dominant orders are i) scorpionida (ii) pseudoscorpionida (iii) opiliones (iv) araneae (spiders) (v) acarina (mites and ticks).

a) Order Scorpionida (Scorpions)

Scorpions occur in warm tropical regions. They hide under stones or in shallow burrows during the day and are active at night. The body of scorpion shows clear demarcation into Prosoma and Opisthosoma. The distinctly segmented opithosoma is differentiated into a mesosoma and metasoma. The metasoma ends in a telson which is modified into a sting.

Scorpions feed on insects and spiders caught with pedipalps, torn and chewed by the chelicerae. The sting helps to paralyse larger animals.

b) Order Araneae (Spiders)

Spiders are arachnids in which the prosoma is clearly demarcated from opithosoma by a waist or pedicel. A telson is missing. The chelicera has two jointed and claw-like fang containing the duct of poison gland situated in the prosoma. Spiders respire by trachea or lung books. Spiders are predaceous, they feed mostly on insects. Poison from the chelicerae help to kill captured preys. There are three pairs of special abdominal glands producing a protein material which solidify into silk thread when in contact with air. The spider web has tensile strength and elasticity. The silk produced by web glands is used for locomotion, making nests, lining burrows, capturing preys and wrapping sperms.

A spider

A small venous spider

c) Order Acarina (Mites and Ticks)

They are known as pest destroying crops, stored food and other natural products. The body is rounded, no apparent division into prosoma and opisthosoma. There are no external signs of body segmentation. A telson is absent. The legs are modified for swimming in water mites. Excretion is by malphighian tubules and respiration is by trachea.

Ticks are blood sucking ectoparasites. The chelicerae have serrated cutting tips which cut into host's flesh. Ticks are often carriers of diseases of domestic animals.

A Wood lice

(iv) CLASS CRUSTACEA (HARD SHELL)

Crustaceans are primarily aquatic arthropods examples are barnacles, crayfishes, crabs, water fleas, wood lice. Crustaceans have two pairs of antenna. The body crustaceans divides into : the head, thorax and abdomen. Respiration is by gills. Sexes are separate. Nitrogenous waste is excreted mainly as ammonia though the gills. The green glands are osmoregulatory in function.

There are 6 sub classes under class crustacean, namely: Subclass Branchiopoda, Ostracoda, copepod, Branchiura, Cirripedia and Malacostraca.

The subclass malacostraca contains crayfishes, crabs, shrimps, lobsters,prawns. The subclass includes three orders: Isopoda, amphipoda and decapoda.

Order Decapoda

This order contains shrimps, prawns, crayfishes lobsters, and crabs. Decapods have five pairs of legs for walking (10 legs).

A Crab

Shrimp

(v) CLASS MYRIAPODA (many- footed)

Myriapods include Diplopoda (millipedes), Chilopoda (centipedes), Symphyla, Pauropoda. Myriapods are primarily terrestrial athropods. The body consists of the head and a long trunkwhich is not divided into thorax and abdomen. Myriapods lack waxy epicuticle and thus susceptible to desiccation. They are active at night.

A Centipede.

A Millipede

(vi) CLASS INSECTA (Hexapods)

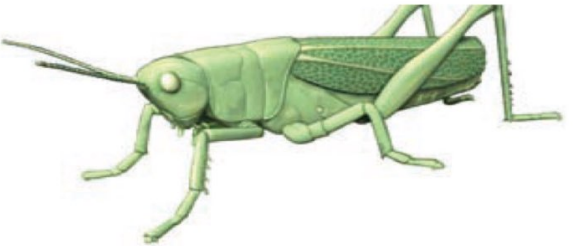
Insects are the most successful group of animals. Insects live in every type of environment- marine, land and fresh water. Insects are very successful because of the following: i) ability to fly (ii) small size (iii) resistant eggs (iv) resistance to desiccation (exoskeleton) (v) very adaptable.

The body is divided into three parts: head, thorax and abdomen. They respire by means of trachea and use malphigian tubules for excretion.

Insects are divided into two broad groups:

i) Apteryogota – wingless forms

ii) Pterygota – winged form. The pterygots are classified into 25 orders.



Grasshopper

Mating Grashopper

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PHYLUM CHORDATA

- Animals most familiar to most people belong to phylum Chordata.
- Humans are members and share the characteristic from which the phylum derives its name — **the notochord**
- All members of the phylum possess the notochord, either restricted to early development or present throughout life

Characteristics of Phylum Chordata

- Bilateral symmetry; segmented body; three germ layers; well developed coelom
- **Notochord (a skeletal rod) present at some stage in the life** cycle
- **Single, dorsal, tubular nerve cord; anterior end of cord** usually enlarged to form brain
- **Pharyngeal pouches present at some stage in the life cycle;** in aquatic chordates these develop into pharyngeal slits
- **Endostyle in floor of pharynx or a thyroid gland derived** from the endostyle

Characteristics of Phylum Chordata

- **Post-anal tail projecting beyond the anus at some stage but** may or may not persist
- Complete digestive system
- **Segmentation, if present, restricted to outer body wall,** head, and tail and not extending into coelom
- **Ventral heart, with dorsal and ventral blood** vessels; closed blood system
- A cartilaginous or bony **endoskeleton present in** most members (vertebrates)

Classification of Phylum Chordata

Subphylum Urochordata

- Class Ascidiacea
- Class Appendicularia
- Class Sorberacea
- Class Thaliacea

Subphylum Cephalochordata

- They have body laterally compressed and transparent
- They are fishlike
- Example is Amphioxus (*Branchiostoma*)

Classification of Phylum Chordata

Subphylum Vertebrata

- **Class Cephalaspidomorphi** e.g. Lampreys
- **Class Myxini** e.g. Hagfishes
- **Class Chondricthyes**
  - Fishlike with cartilaginous skeleton and no swim bladder.
  - E.g. Skates, rays and sharks
- **Class Osteichthyes**
  - Bony skeleton with swim bladder and operculum present.
  - E.g. Bony fishes

Classification of Phylum Chordata

- **Class Amphibia**
  - Skin with mucoid secretions,
  - moist skins,
  - possess lungs and or gills.
  - Examples include the frogs, toads and salamanders
- **Class Reptilia**
  - Dry skin with epidermal scales,
  - amniotic eggs,
  - terrestrial embryonic development.
  - Examples include snakes, lizards and alligators

Classification of Phylum Chordata

- **Class Aves**
  - Scales modified into feathers for flight,
  - efficiently regulate body temperature (endothermic),
  - amniotic eggs.
  - Examples are Birds
- **Class Mammalia**
  - Bodies covered with hair,
  - endothermic,
  - young ones are nursed from mammary glands,
  - amniotic eggs.
  - Examples include all mammals