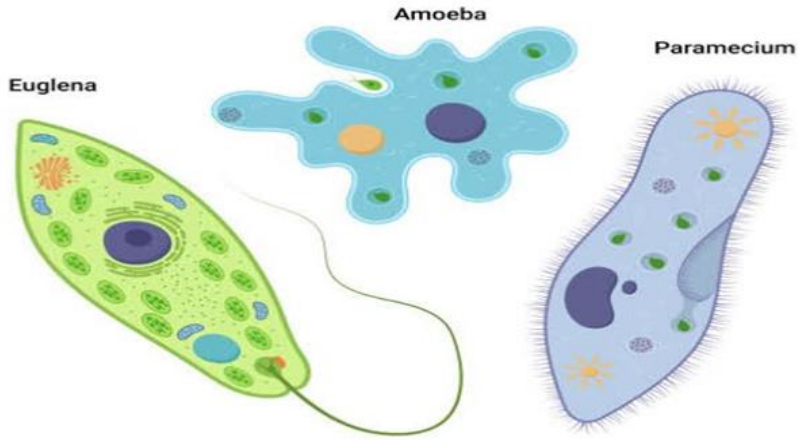
Invertebrates 1



FOR FIRST YEAR- 1st SEMESTER- BIOLOGY BRANCH

PREPARED BY Associate Proferror/ Zeinab Abd-EL-Khaleq

College Vision

The college seeks to help the university achieve its strategic goals by being one of the distinguished colleges and competing internally and externally in education, community service and scientific research by achieving a high level of performance and providing a distinguished graduate that meets the multiple needs of the local labor market and outer

College Mission

The Faculty of Education in Hurghada aims to excel through:

- Preparation of educators , specialized teachers and leaders in various pedagogical disciplines
- Developing the professional and scientific capabilities for educators to learn about recent educational trends.
- Conducting research and studies in the various educational disciplines in the college.
- Spreading modern educational thought and its contributions to solving the problems of the environment and society.
- Exchange of experiences and information with educational and cultural bodies and institutions.
- Intention aspects of students' personality and nurturing the gifted and creators.

Contents

INTRODUCTION

Classification of living organisms

Living organisms are similar in functional and structural unit (Cell) and properties of life (Feeding, growth, reproduction, respiration, movement, sensation, excretion). But they are different in many things (Ex. life way – shape –structure – nutrition – the way of reproduction). Due to the diversity of living organisms, the need of classification process emerged. The science which studies the classification of living organisms is called Taxonomy.

Animal Taxonomy

- There are 13 billion known species of organisms
- This is only 5% of all organisms that ever lived!!!
- New organisms are still being found and identified
- Classification is the arrangement of organisms into orderly groups based on their similarities
- Classification is also known as taxonomy
- Taxonomists are scientists that identify & name organisms.

History of Classification

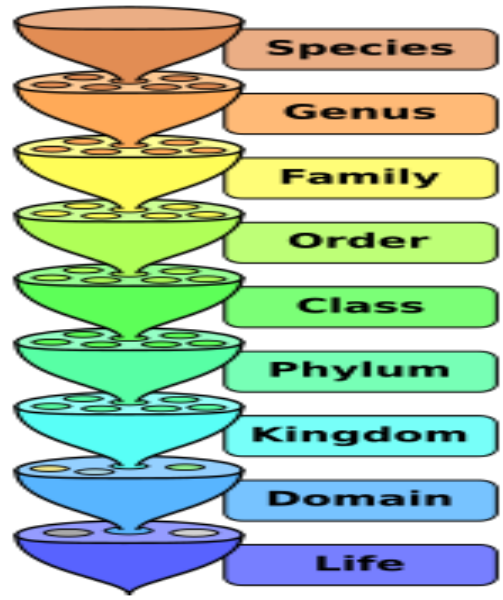
One of the first known classification systems was developed more than 2000 years ago. The Greek philosopher and naturalist Aristotle classified organisms into two large groups – plants and animals. Aristotle then classified animals into smaller groups based upon where the animals lived. Aristotle had three groups of animals: land animals, water animals and air animals.

- In the 17th century, an English botanist named John Ray identified and classified more than 18,000 plants. His work was used to form modern plant taxonomy. Ray also classified animals, and used the term species for each different kind of living thing.

- Ray defined a *species* as a group of organisms that looked alike and could reproduce among themselves.

- In the 18th century, a Swedish botanist, Carolus Linnaeus, developed a new way to classify organisms. Linnaeus is credited with being the founder of modern taxonomy. Linnaeus classified organisms according to their physical characteristics. In Linnaeus's system, organisms that looked alike were grouped together.

Linnaeus's System



Living things are classified into seven major groups; they are grouped in a hierarchy of 7 different taxonomic levels.

- 1- Kingdom: contains a number of phyla (Singular phylum)

  2- Phylum (Pl. Phyla): Represents a number of classes

- 3- Class: Contains a number of orders
- 4- Order: Contains a number of families
- 5- Family: Contains a number of genus
- 6- Genus: Contains a number of species
- 7- Species: It contains individuals capable of producing fertile individuals

- There are other groups between each two successive groups of the previously mentioned levels (Ex. sub-phylum, sub-order, sub-family, sub-genus)

Binomial System:

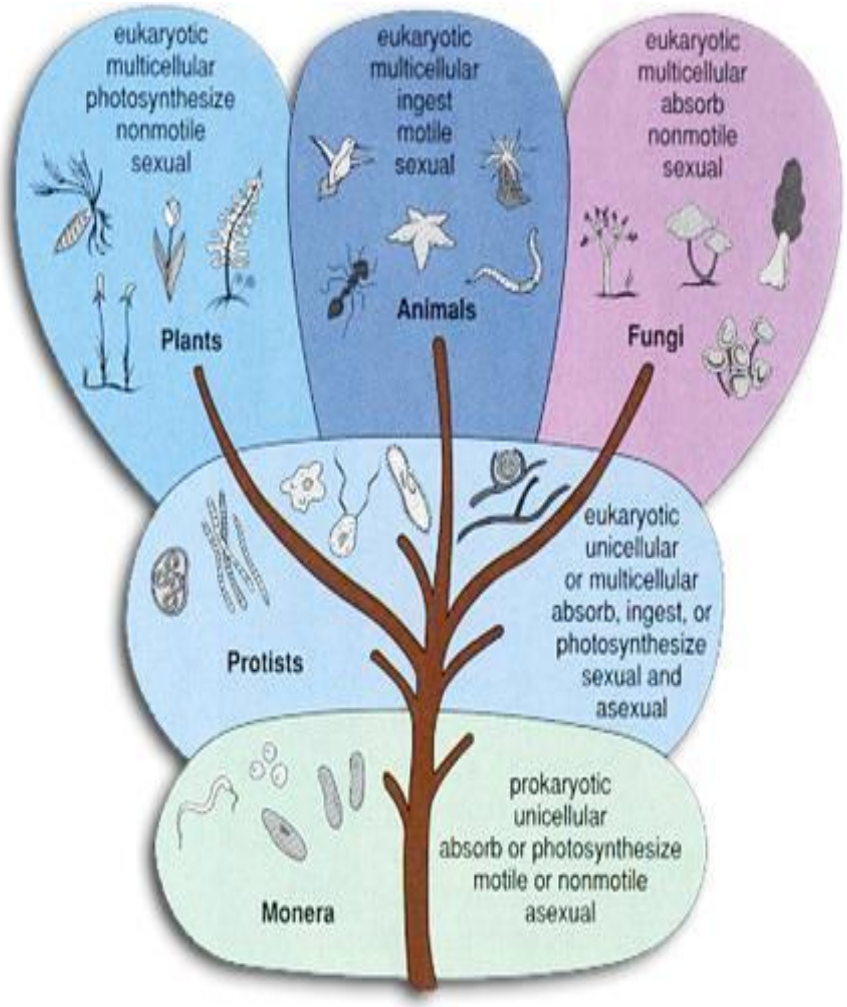
- Linnaeus developed a system for naming living things called the " Binomial System ", in this system, each kind of organism is identified by a two-part scientific name. Binomial is the system still used today.
- The first part is the name of the genus and the second part is the name of the species.

Naming Rules:

- 1- Name should be in two parts with Latin to be popularly known as the "**Latin name"**.
- 2- First name is Genus and second is species, the first letter in genus should be written with a capital letter.
- 3- Binomial should be printed in a (font) different from that used in the normal text when handwritten ***or*** underlined; for example, Homo sapiens. Each name should be underlined individually.

Modern Classification

- Scientist Robert H. Whittaker put a new classification system in 1969; this system was called Modern Classification. Whittaker classified living organisms into 5 kingdoms: Monera – Protista – Fungi – Plantae – Animalia



PROTISTA

Ernst Haeckel, a naturalist of German descent was the one who first introduced the idea of the Kingdom Protista, in 1866. Protista includes all eukaryotes that are not animals, plants, or fungi. Contains many different kinds of organisms. Most Protista are single-celled organisms. Some Protista, however, are multicellular organisms. Some of them are autotrophs. Others are heterotrophs. They possess cells with a defined nucleus and membrane- bound organelles. Protista can be found in various habitats like aquatic, moist terrestrial, and even as symbionts or parasites with other organisms.

Phylum: Protozoa

The protozoa (Gr., protos first or primitive; zoon animal) are microscopic, eukaryotic unicellular, solitary or colonial, commonly motile and phagocytic heterotrophic animalcules. The term protozoa was coined by Goldfuss (1818) and unicellular nature of protozoa was established by von Siebold (1845). There are about 50,000 species of protozoa (ie, 30,000 living and 20,000 extinct) which are found in all moist places such as sea, freshwater and soil Each protozoan functions as an independent unit and is able to perform effectively all the activities necessary for life.

GENERAL CHARACTERS

1. Protozoa are small, generally microscopic animalcules. Individual independent protozoa range in size from a micrometer (e.g. Micromonas) to a few millimeters in some dinoflagellates. amoebas and ciliates.

2. They are simplest and most primitive animals having cellular level of organisation

3. Unicellular or single-celled animals having no tissues or organs. Specialised parts of living material (ie, protoplasm) form membrane-bound organelles or organoids

4. The single cell performs all necessary functions. There is no physiological division of labour.

5. The body is bounded by the plasma membrane. The rigidity or flexibility of the body and its shape are largely dependent on the nature of the cytoskeleton (eg, pellicle;) and exoskeleton.

6. Animalcules may be free-living, commensal, mutualistic or parasitic (both ecto- parasitic and endoparasitic). The free-living protozoans are aquatic, inhabiting fresh and salt waters. These may be solitary or colonial; in colonial forms the individuals are alike and independent.

7. Body shape variable; it may be spherical, oval, elongated or flattened.

8. Cytoplasm is differentiated into an outer ectoplasm (or cell cortex) and inner endo- plasm.

9. Protozoans may have one or more nuclei which may be monomorphic or dimorphic. In case of dimorphic nuclei, two basic types are recognized: 1. vesicular, containing considerable nucleoplasm and 2. compact, containing little nucleoplasm.

10. Three major types of locomotor organelles namely flagella, pseudopodia and cilia occur among protozoa. The classification

of phylum Protozoa mainly depends on the type and distribution of these locomotory parts. Pseudopodia are semipermanent to transitory extensions of protoplasm of body surface and used by sarcodina. Flagella are permanent or semipermanent locomotory organelles of mastigophora Cilia are many and occur in ciliata. Some protozoans are sessile (attached or fixed) and do not move.

11. All types of nutrition occur in protozoa. Thus, nutrition may be holozoic (animal-like holophytic (plant-like, photoautotrophy), saprozoic (absorb soluble organic nutrients from their environment) or parasitic. 12. Holozoic protozoans have two general kinds of feeding hunting, which involves sucking and capturing prey; and trapping or suspension feeding, which is often used by sessile protozoans,

13. Digestion occurs intracellularly within a food vacuole by the help of enzymes of lysosomes, and food reaches the vacuole through a cell mouth (cytostome) or by engulfment by pseudopodia (endocytosis and phagocytosis)

14. Respiration, excretion and egestion of waste products occur through body surface Protozoans are mostly ammonotelic, ie, they excrete their nitrogenous wastes in the form of ammonia

15. Many protozoa osmoregulate to remove excess water (called water volume regulation) and to adjust the concentration and proportion of their internal ions (ionic regulation Osmoregulation is accomplished by contractile vacuoles. There is no evidence that the contractile vacuoles have any specific excretory function.

16. Cyclosis or cytoplasmic streaming distributes materials throughout the continuous protoplasmic mass of the organism. For example, in ciliates cyclosis occurs due to movements of food vacuoles along microtubules extending from the cytostome.

17. Protozoa are sensitive to many kinds of stimuli including touch, temperature changes, light, and many chemicals.

18. Reproduction is asexual or sexual, asexual reproduction by binary fission, multiple fission and budding or sporulation and sexual reproduction by gamete formation or conjugation of adults.

20. Resistant coverings are sometimes formed for brief parts of a life cycle. This is especially true of parasites, which usually pass from one host to another as cysts or spores, covered by a resistant membrane that protects them while out of the host. Many free-living protozoa also encyst to survive unfavourable environmental conditions and be dispersed by air or water currents in a protected stage.

21. In some protozoans, the life cycles are complicated and show alternation of generation, Le, life cycle includes asexual and sexual phases.

CLASSIFICATION

Phylum Protozoa

4 subphyla

1-Sarcomastigophora 2-Sporozoa 3- Cnidospora 4-Ciliophora

Subphylum Sarcomastigophora:

Locomotory organelles flagella or pseudopodia or both. nucleus single type expet in developmental stages of certain foraminifers. Spors formation absent. Sexually when present, essentially syngamy.

Superclass I. Mastigophora. Solitary or colonial; flagella one or more in trophozoites asexual reproduction by symmetrogenic binary fission; nutrition phototrophic orheterotrophic.

Class Phytomastigophorea. Mostly free living; flagella one or two; amoeboid forms common in some groups: chromatophores present, sexual reproduction takes place in some. Examples. Euglena, Cryptomonas, etc.

Class Zoomastigophorea. Mostly parasitic; flagella one to many; amoeboid forms with or without flagella in some groups; chromatophores absent; sexual reproduction is known in some. Example. Trypanosoma, Leishmania, etc.

Superclass II. Sarcodina. Mostly free living: body naked or with external and internal tests or skeletons; typical pseudopodia present; flagella, when present, restricted to developmental stages; asexual reproduction by fission: sexual reproduction, if present, with flagellate or, more rarely, amoeboid gametes.

Class Rhizopodea. Locomotion by psudopodia; nutrition phagotrophic. Subclass Lobosia. Pseudopodia lobose, rarely filiform or anastomosing. Examples. Amoeba, Entamoeba, etc.

Subphylum

CLASSIFICATION

Phylum: Protozoa

Subphylum: Sarcomastigophora

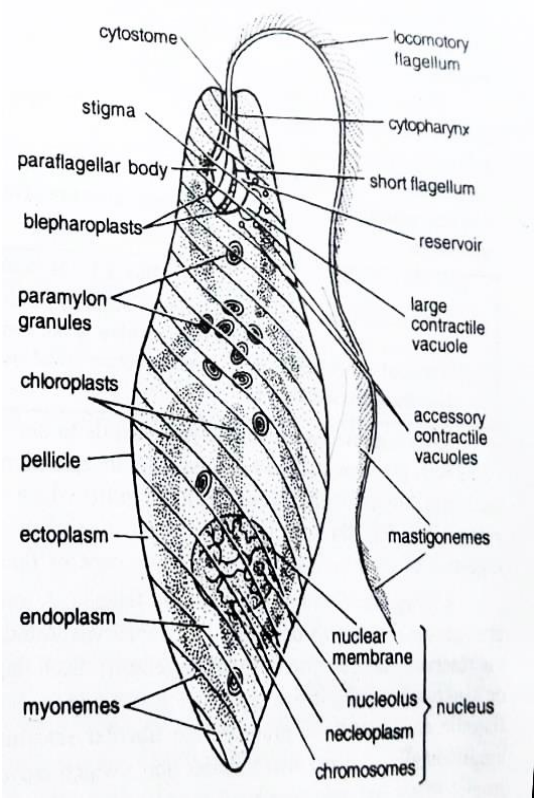
Superclass: Mastigophora

Class: Phytomastigophora

Order: Euglenida

Genus: *Euglena*

Species: *viridis*



Euglena viridis is a solitary, free-living (free-swimming) and freshwater protozoan. It is commonly found in ponds, ditches, pools, lakes, etc., especially in any other water that is rich in soluble organic matter (ie., stagnant waters containing decaying nitrogenous wastes such as dead bodies of plants and animals, and urine and faeces of animal). Under favourable environmental conditions it multiplies rapidly and forms green scum on the water surface *Euglena* needs sunlight for photo- synthesis, exhibits reactivity and rapidly multiplies by longitudinal binary fission.

1. **Shape and size**. *Euglena viridis* is green, slender, elongated and spindle- shaped in appearance. Its anterior end is bluntly rounded, the middle part is wider and posterior end is pointed. *Euglena viridis* is about 4-60 um in length and 14-20 µm in breadth at the thickest part of the body.
2. **Pellicle**. *Euglena* lacks a gell wall. The outer layer of the cell is the plasma membrane. immediately below which is the thin, flexible, strong, protei-naceous pellicle. Pellicle consists of a number of thickened longitudinal strips and microfibrils (microtubules) articulating with each other. body shape of Euglena. Pellicle protects the body (acts like exoskeleton), maintains its definite shape and helps in movements. Pellicle of Euglena flexible enough to is temporary changes in the body shape; these changes of body shape are called metaboly or euglenoid movement.
3. **Cytostome** and cytopharynx. A little to one side of the centre of the anterior blunt end of the body is a funnel-shaped depression or invagination, called cytostome (cell mouth). Cytostome leads into a short tubular cytopharynx or gullet which in turn opens into a spherical vesicle, called reservoir or flagellar sac. Quite curiously, the mouth or cytostome and gullet are not used for the ingestion of

food but as a canal for the escape of fluid from the reservoir.

4**. Flagella**, *Euglena* contains two flagella. A long and thin and whip-like flagellum which emerges out of the cytostome through cytopharynx. Another much shorter flagellum which lies within the reservoir (called nonemergent flagellum). Each flagellum arises from a minute basal granule or kinetosome lying in the cytoplasm just inside the border (plasma membrane of reservoir). The flagella and their basal granules are fibrillar structures

3- **Cytoplasm** and organelles. The cytoplasm of Euglena is differentiated into a thin, clear and dense outer layer of ectoplasm and a more fluid and granular inner (central) layer of endoplasm Endoplasm contains a variety of cellular organelles such as stigma, chloroplasts (chromatophores). mitochondria, nucleus, contractile vacuole and also usual cellular organelles such as endoplasmic reticulum, Golgi apparatus, ribosomes, etc.

(i**) Nucleus**. A single, large, spherical, vesicular nucleus lies in the middle or toward posterior end of body. It contains only one chromosome (in the form of chromatin) and a few large endosomes or nucleoli. Nuclear membrane is not continuous with endoplasmic reticulum.

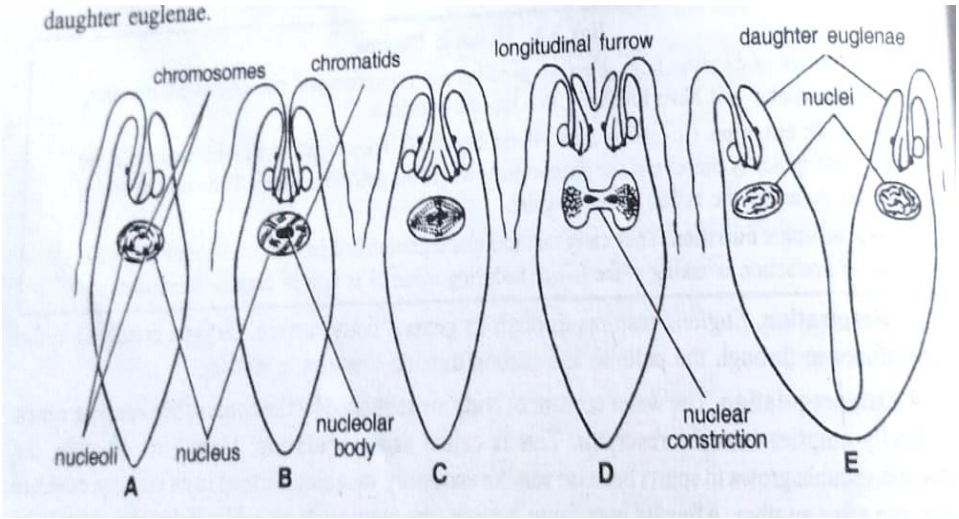
(ii) **Contractile vacuole**. A single large contractile vacuole lies near the reservoir on one side (opposite to stigma). It is surrounded by several minute accessory contractile vacuoles which fuse together to form the larger vacuole. The contractile vacuole discharges its watery contents into the reservoir, from there fluid escapes through cytopharynx and cytostome.

(iii) **Photoreceptor apparatus**. It includes stigma and paraflagellar body. Stigma or eyespot a small discoid red or

orange-red body which is located close to the inner end of the cytopharynx adjacent to reservoir.

REPRODUCTION

No sexual reproduction occurs in Euglena. Asexual reproduction of Euglena takes place by the following methods: 1. Longitudinal binary fission. Under favourable ecological conditions such as fo availability, optimum light, temperature and water, an active Euglena reproduces by longitudin binary fission (symmetrogenic). It is initiated by division of basal bodies. Karyokinesis (nuclear division) followed by cytokinesis (cytoplasmic division) which involves duplication of flagella, stigma contractile vacuole, chloroplasts,mitochondria, etc. During later stages reservoir, cytopharynx and cytostome are duplicated by a longitudinal furrow. During final step of cytokinesis, a longitudinal furrow appears at anterior end of body and proceeds backward, dividing the parent body into two daughters Euglena



Trypanosoma

African sleeping sickness is a Trypanosoma gambiense .fatal human disease that is caused by protozoan parasite.

Classification

Phylum: Protozoa

Subphylum: Sarcomastigophora

Superclass: Mastigophora (Flagellata)

Class : Zoomastigophora

Order: Kinetoplastida

Genus: Trypanosoma

T. gambiense is found in central Africa, West Africa (from Gambia to the Congo) and Uganda Commonly low marshy lands near the rivers and lakes have the greatest incidence of infection because the blood sucking insect vector, the tsetse fly (Glossina palpalis) inhabit these areas.

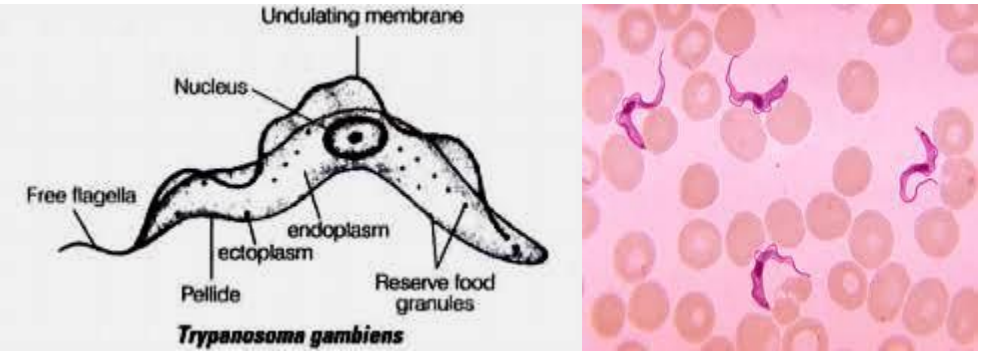
The genus *Trypansoma* is parasitic in the blood of most of the vertebrates such as fishes,amphibians, reptiles, birds and mammals. Many species of *Trypanosoma* are pathogenic causing human disease called trypanosomiasis. Only three species of it are pathogenic in human beings, viz., *T . gambiense , T. rhodesiense* and *T. cruzi T gambiense* and *T . rhodesiense* cause a fatal disease in human beings (hosts) called sleeping sickness in Africa, while *T. cre* causes chagas disease in children of South America. Their transmission from one vertebrate host to other takes place by invertebrate blood-sucking animals such as insects and leeches. These animals are called vectors. .

HABIT AND HABITAT

Trypanosoma gambiense lives as a digenetic endoparasite in the blood, lymph, lymph nodes, spleen or cerebrospinal fluid of human beings and in the intestine of blood-sucking insect, *Glossina palpalis*.

MORPHOLOGY

T. gambiense is a unicellular, microscopic, slender, elongated, colourless, leaf-like protozoan. Its body measures about 10 um to 40um in length and 1um to 5 uum in breadth. The anterior end of body is pointed and the posterior end is blunt.The body is covered by tough but elastic pellicle which is composed of numerous microtubules.



Pellicle is followed by cytoplasm which is differentiated into an outer clear layer called ectoplasm and an inner granular endoplasm. The endoplasm contains single nucleus, single mitochondrion, single Golgi apparatus, endoplasmic reticulum and ribosomes. It lacks contractile vacuole and food vacuoles, however, contains many scattered greenish refractile bodies, called volutin granules. These granules contain glycogen and

phosphates and represent reserve food material of Trypanosoma.

Nucleus is single, oval, vesicular and is located in the middle of its body. It contains a large endosome, karyosome or nucleolus. A small pocket-like depression on one side near the posterior end represents gullet and reservoir. Trypanosoma being mono flagellate contains single long flagellum which originates from a basal body which is located close to the gullet near posterior end of body.

REPRODUCTION

There is no sexual production in Trypanosoma. It reproduces by asexual reproduction, Le, longitudinal binary fission. It occurs in all forms found in both hosts (ie., human beings and tsetse fly). During binary fission, the basal body (blepharoplast) divides first, then subsequently the kinetoplast and nucleus and finally the cytoplasm. Usually one daughter individual retains the old flagellum and undulating membrane, and the other daughter develops a new one, which grows out before the complete separation of the daughters.

Amoeba Classification

Phylum: Protozoa

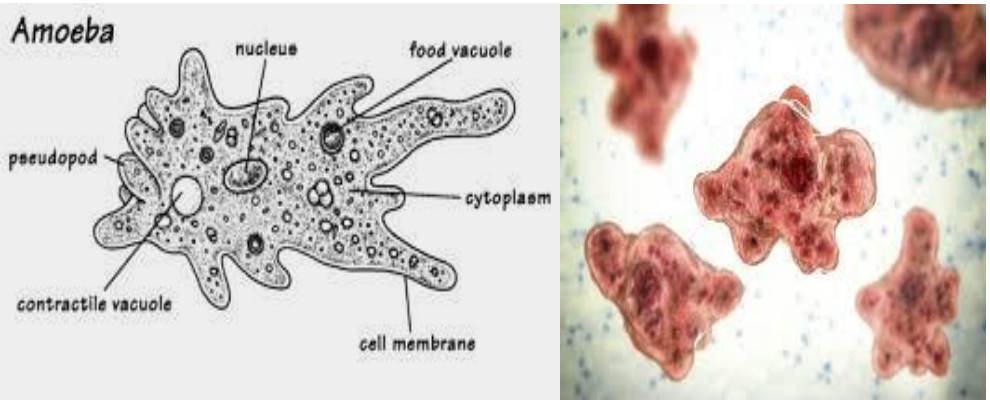
Subphylum: Sarcomastigophora

Superclass: Sarcodina

Class: Rhizopodea

Genus: *Amoeba* **Species: *proteus***

Amoeba proteus, is found on decaying bottom vegetation of freshwater streams and ponds. There are numerous parasitic amoebas. Of six species found in the human alimentary tract, ***Entamoeba histolytica*** causes amebic dysentery. Two related free-living genera of increasing biomedical importance are *Acanthamoeba* and *Naegleria*, strains of which have been recognized as disease-causing parasites in several vertebrates, including human. Amoebas are identified by their ability to form temporary cytoplasmic extensions called pseudopodia, or false feet, by means of which they move about. This type of movement, called amoeboid movement, is considered to be the most primitive form of animal locomotion.



Each amoeba contains a small mass of jellylike cytoplasm, which is differentiated into a thin outer plasma membrane, a layer of stiff, clear ectoplasm just within the plasma membrane, and a central granular endoplasm. The endoplasm contains food vacuoles, a granular nucleus, and a clear contractile vacuole. The amoeba has no mouth or anus; food is taken in and material excreted at any point on the cell surface. During feeding, extensions of cytoplasm flow around food particles, surrounding them and forming a vacuole into which enzymes are secreted to

digest the particles. Oxygen diffuses into the cell from the surrounding water, and metabolic wastes diffuse from the amoeba into the surrounding water. A contractile vacuole, which removes excess water from the amoeba, is absent in most marine and parasitic species. Reproduction is asexual (binary fission).

During adverse environmental periods many amoebas survive by encystment: the amoeba becomes circular, loses most of its water, and secretes a cyst membrane that serves as a protective covering. When the environment is again suitable, the envelope ruptures, and the amoeba emerges.

Pl ASMODIUM VIVAX

The malaria parasite, *Plasmodium vivax*, causing benign tertian or vivax malaria (fever recurs every third day) in man belong to order Coccidiida, subclass Coccidiompha, class Sporozoa phylum Protozoa. An lteration of generations associated with alternation of hosts is found in their life cycle.

Life history

The asexual cycle (schizogony) producing merozoites occurs in the red blood cell of man and the sexual cycle (sporogony) producing sporozoites occurs in the femal Anopheline mosquito. The gametogony (formation of gametocytes) star in the red blood cells of man and is completed with the formation of sporozoites in the mosquito. The sporozoites are infective to man. The incubation period is 10-17 day average 15 days.

Human cycle

Preerythrocytic Schizogony

Bite of an infected female Anopheles allows the entry of sporozoites in human blood. The sporozoites enter the reticuloendothelial cells of the liver. They star multiplying there for the first four days and merozoites are formed. A merozoite consists of a very small amount of cytoplasm and a fragment of chromatin. These merozoites may invade the liver cells to produce merozoites or attack red blood cells to start erythrocytic schizogony.

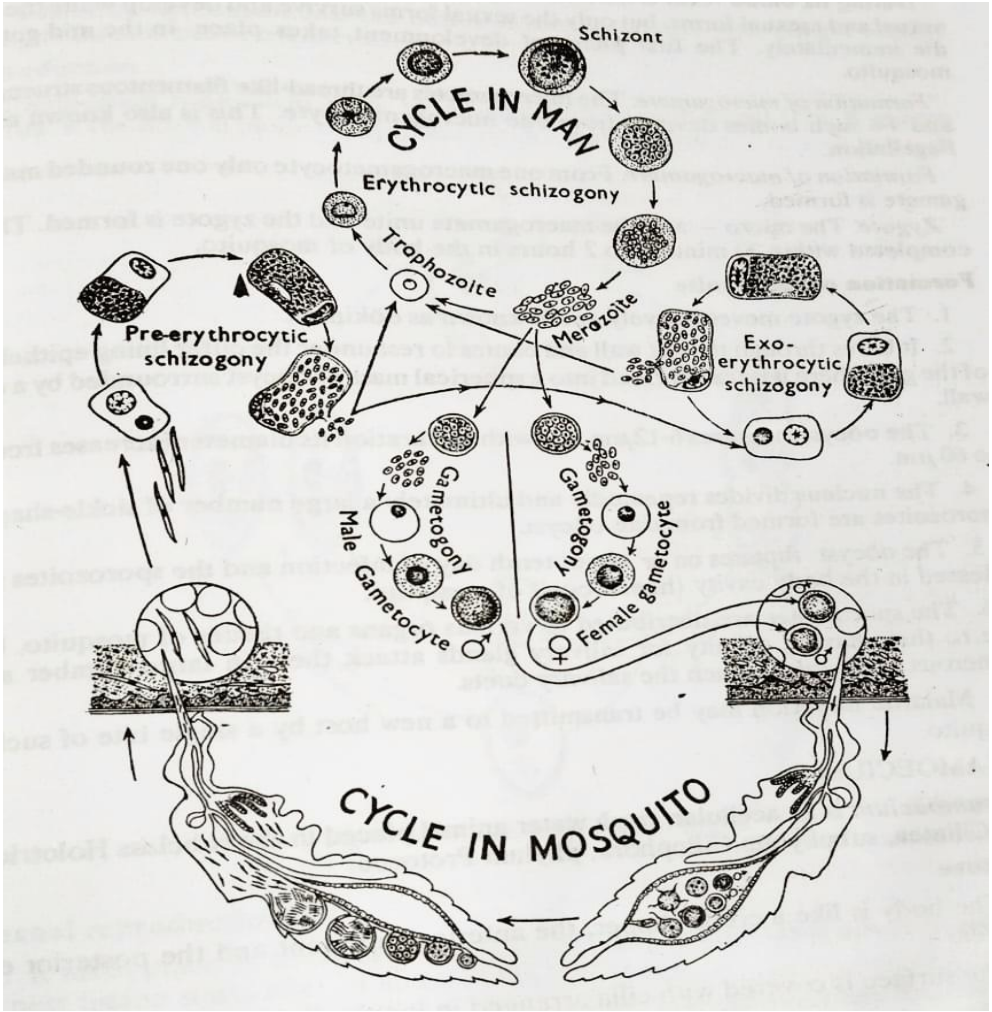
Erythrocytic Schizogony

On entering the red blood cells the merozoite reproduces by asexual method and passes through following stages: trophozoite, schizont and merozoite. The entire cycle of erythrocytic schizogony occupies a period of 2 days.

Trophozoite. It measures 2.5 to 3um and consists of a cytoplasmic ring thicker on one side, a chromatin dot (nucleus) and a vacuole. The trophozoite is active and constantly sends out pseudopodia.

Schizont. The trophozoite becomes full grown after about 36-40 hours. All amoeboid activities are lost; the parasite becomes round and measures 9-10 um. The vacuole disappears and the large nucleus lies at the periphery. In the next 6-8 hours, the nucleus divides and subsequently 12-14 daughter individuals or merozoites are formed.

The merozoites arrange themselves in the form of a 'rosette. The red blood cell cannot hold the parasites any longer, bursts and the merozoites are liberated. The release of merozoites is associated with the rise of temperature. Merozoite. It is oval in shape, measuring 0.5 Aum in breadth and contains a central chromatin. The merozoites attack new red blood cells and the cycle is repeated at every 48 hours.



Gametogony certain schizonts become modified for sexual reproduction and the resulting merozoites, instead of undergoing schizogony, are changed into sexual forms known as gametocytes. Merozoites of a schizont are either males (microgametocytes) or females (macrogametocytes).

EXOERYTHROCYTIC SCHIZOGONY

Evidences support the presence of excerythrocytic schizogony in Plasmodium vivax. In morphology, exoerythrocytic forms resemble preerythrocytic ones. The exoerythrocytic schizogony is independent of erythrocytic schizogony and lasts for period of about 3 years.

Mosquito cycle

During its blood meal from an infected person a female Anopheles ingests both sexual and asexual forms, but only the sexual forms survive and develop while the rea die immediately. The first phase of development takes place in the mid gut of mosquito.

Formation of microgamete. The microgametes are thread-like filamentous structures and 4-8 such bodies develop from one microgametocyte. This is also known as a exflagellation.

Formation of macrogamete. From one macrogametocyte only one rounded macro-gamete is formed.

Zygote. The micro- and the macrogamete unite and the zygote is formed. This is completed within 20 minutes to 2 hours in the body of mosquito.

Formation of sporozolte

1. The zygote moves actively and is known as ookinete. 2. It bores through the gut wall and comes to rest under the outer lining epithelium of the gut, where it is transformed into a spherical mass or oocyst surrounded by a cyn wall.

3-The oocyst measures 6-12um and with maturation its diameter increases from 6 to 60 um.

4-The nucleus divides repeatedly and ultimately a large number of sickle shaped sporozoites are formed from one oocyst.

5. The oocyst ruptures on or about tenth day of infection and the sporozoites are released in the body cavity (haemocoel) of mosquito.

6. The sporozoites are distributed to various organs and tissues of mosquito, but due to their having affinity for salivary glands attack them in large number and numerous sporozoites reach the salivary ducts.

7. Malarial infection may be transmitted to a new host by a single bite of such a mosquito.

PARAMOECIUM Sp.

Phylum: Protozoa

Subphylum: Ciliophora

Class: Ciliata

Subclass: Holotrichia

Genus: Paramecium Species: caudatum

Paramoecium is an acellular, fresh water animal placed in the subclass Holotricha ,class Ciliatea, subphylum Ciliophora, phylum Protozoa.

Structure

1. The body is like a crude slipper, the anterior end blunt and the posterior end narrower.

2. The surface is covered with cilia arranged in longitudinal spiral rows.

3. A large depression, known as peristome is present on the ventral surface. The peristome narrows down to form the gullet which ends in the soft endoplasmic mass.

4. The cytoplasm is divisible into an outer firmer cortex and an inner granular medulla.

5. The nuclei are two in number, one is larger and called the macronucleus and the other is smaller, the microuncleus, 6. The micronucleus lies close to the macronucleus.

7. Contractile vacuoles are two and placed at the opposite poles. To each of them is connected a number of radiating feeder canals. In some species of Paramoecium (P. putrinum and P. trichium) the radiating canals are absent.

8. Food vacuoles are many and move along a definite path.

9. Under certain conditions, the cortex is seen to project into minute radially arranged threads called trichocysts.

Reproduction

Paramoecium reproduces both by asexual and sexual (Fimeans. Asexual is the normal mode of reproduction in *Paramoecium*.

Asexual reproduction

1. It takes place by transverse binary fission. One fission takes about 2 hours and the next fission starts after 24 hours of the first fission.

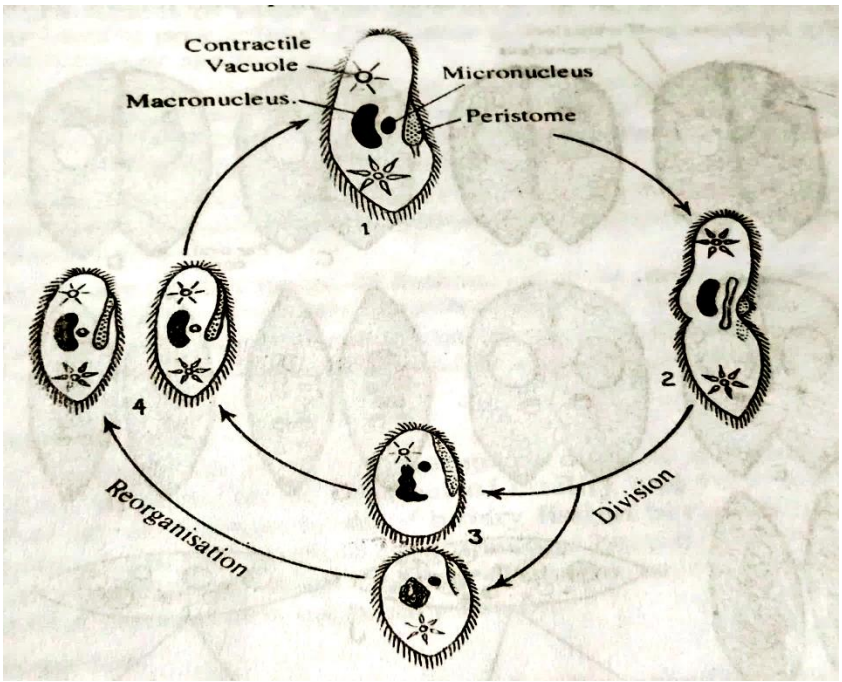
2. Both the micro- and macronuclei elongate and constrictions appear in the middle.

3. A small, new gullet is formed from the posterior end of the old gullet and it moves backward.

4. A constriction appears at the middle of the cytoplasmic mass.
5. A new contractile vacuole appears on each side of the constriction.

6. The constrictions of both the cytoplasm and nuclei grow deeper. The micronucleus divides into two by mitosis, and the macronucleus by vegetative division.

7. Finally, the cytoplasm is divided into two equal halves and each half receives one micro- and one macronucleus, two contractile vaculoes and one gullet.



8. The undulating membrane appears in the newly formed gullet and two identical daughter individuals are formed.

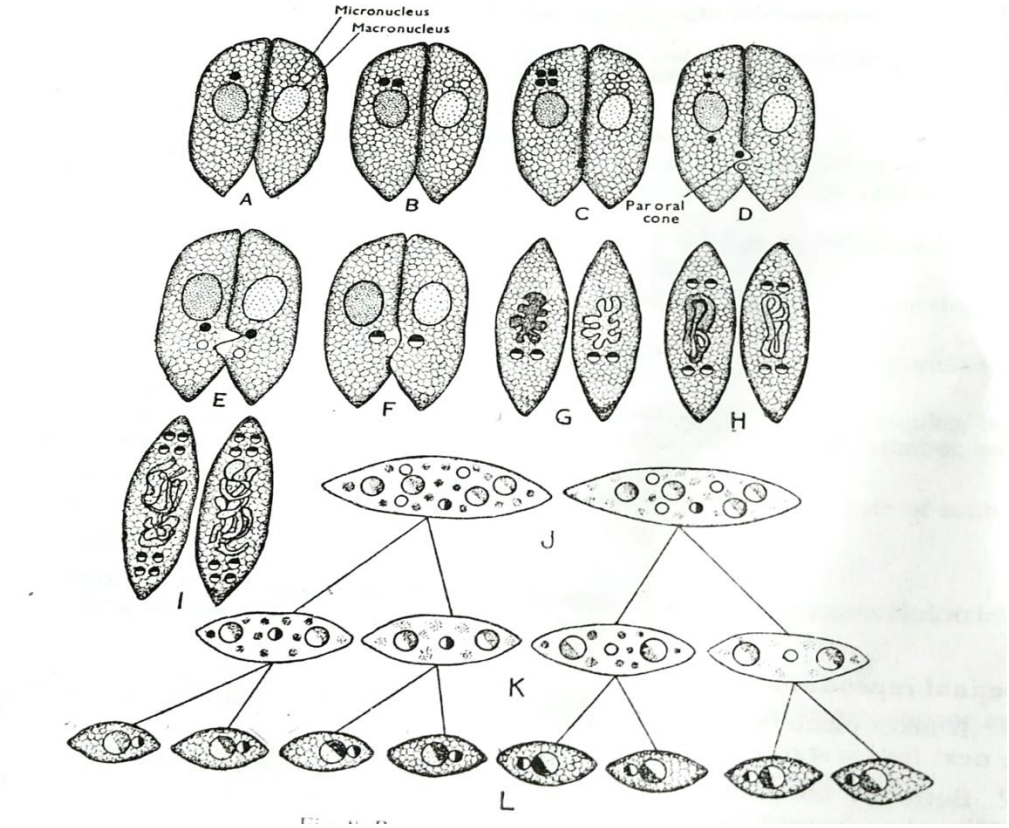
Sexual reproduction

Sexual reproduction takes place by conjugation.

A. **Conjugation** It is a temporary union between two individuals in which the uniting gametes are similar, i.e. they cannot be differentiated into male and female gametes.

Conjugation is a peculiar type of sexual behaviour which is limited to the subphylum Ciliophora. In this process, two individuals come and attach themselves along their oral sides,

and exchange their gamete nuclei after which they separate and a new nuclear apparatus arises from the products of the fusion-nucleus, or syncaryon in each exconjugant, while the old macronucleus degenerates. Following are the main events in the process of conjugation.



1. Two individuals known as conjugants approach each other and become applied along their oral sides.

2. The macronucleus remains unchanged but the micronucleus of each conjugant undergoes two divisions producing four haploid nuclei.

3. Three out of four disappear and the fourth one divides to produce two pronuclei .The pronuclei usually take a position near the oral region, where a cone-shaped protrusion, the paroral cone extends from each towards the other.

4. One of the pronuclei is known as the active pronucleus and the other as the passive or stationary pronucleus.

5. The active pronucleus of each individual migrates through the paroral cones and fuses with the passive pronucleus of the other and the fusion nucleus is known as fusion or zygote nucleus or syncaryon.

6. The conjugants begin to separate, the macronuclei gradually become transformed into a skein, which breaks up and is ultimately lost. Each zygote nucleus divides thrice to form 8 nuclei. Four of these begin to grow and are known as macronuclear anlagen. since each of them will develop into a macronucleus.

7. As growth of the anlagen proceeds, three of the other four nuclei grow slightly. then begin to degenerate and ultimately disappear, while the eighth nucleus becomes the functional micronucleus,

8. At this stage binary fission starts. In fission, only the micronucleus divides and the macronuclear anlagen are simply distributed in the four descendants. Each daughter individual gets one macro- and one micronucleus. During these changes the fragments of the old macronucleus are gradually absorbed, while the anlagen attain their full size.

Effect of conjugation

The essence of conjugation is the exchange of nuclear materials between two individuals; its effect appears to be renewal of vitality and rejuvination. The old macronucleus, after several generations of binary fission becomes tired and invalid, and the replacement of the old nucleus by a new one becomes imperative. The new macronucleus is produced from micronuclear elements, so that, the individuals can reproduce for several generations by binary fission.

KINGDOM: ANIMALIA

Characteristics of animals:

1- They are multicellular eukaryotes

2- They have the ability to move and transport

3- They have the ability to quickly respond to outer environmental stimuli

4- Most of the reproduce sexually

Kingdom Animalia was divided into 9 phyla according to their structure complexity. Some of these phyla have vertebral column and called Vertebrates, while those which do not have vertebral columns are invertebrates.

Phylum - Porifera (Sponges)

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 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 their 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.

1. Sponges are plant-like, fixed, aquatic metazoan.

2. All of them are marine except the single family spongillidae, living in fresh water.

3. A continuous single cavity is present within the body. In most cases, the cavity is thrown into folds to form a complex canal system.

4. The skeleton or supporting framework consists of fine flexible fibers made of spongin, or spongin fibers and siliceous spicules, or siliceous spicules alone; or spicules of calcium carbonate.

5. Cells are of two types' ectoderm and endoderm.

6. Reproduction takes place asexually by the development of gemmules and sexually by sperms and ova. 7. The larva is ciliated and free swimming.

Due to the presence of a uniformity of structures within the group, the phylum not subdivided and it consists of a single class Porifera.

The **class Porifera** is classified as follows

1. Subclass Calcarea

(a) Sponges with a skeleton consisting solely of calcareous spicules.

(b) The collared cells or choanocytes are comparatively larger in size.

Examples. Clathrina, Scypha, etc.

2. Subclass Hexactinellida

(a) Sponges with purely siliceous spicules composed of six rays

(b) Canal system is represented by unbranched or branched flagellate chambers with small choanocytes. (c) Mesogloea is absent. The soft parts are connected by a meshwork of trabeculae formed by branching cells of the dermal layer.

Examples. Euplectella, Hyalonema, Epizoanthus, etc.

3. Subclass Demospongia

(a) Sponges either without skeleton, or having a skeleton made of spongin fibers alone, or of a combination of spongin fibres and siliceous spicules.

(b) Spicules when present are never six-rayed.

(c) The canal system is complicated and is rhagon type. The flagellate chambers are lined by small choanocytes. Examples. *Cliona*, *Fuspongia*, *Oscarella*, etc.

SCYPHA Sp.

External features

Sycon, recently named Scypha, is the simplest form of sponges, marine in habitat. It remains attached to sea shore rocks just below the tide line. The colour of a l specimen is a combination

of shades of grey and light brown. The body The Scypha is either a simple solitary cylinder or a number of cylindrical branches connected together to form a colony. Solitary or colonial, it is anchored rock by a structure called stolon at the base. The cylinder is vase-shaped, swollen at the middle and narrows down at both the ends, being a little narrower at the tree distal end. Due to protrusion of numerous monaxon spicules from the surface appears bristly.

The osculum

The osculum or the exhalant pore is a wide opening, present at the free end of the cylinder. It establishes direct communication between the paragastric cavity or the spongocoel and the exterior. The osculum is surrounded by numerous straight, monaxon, calcareous spicu- les arranged in a circlet, imparting the appear- ance of a delicate fringe to it.

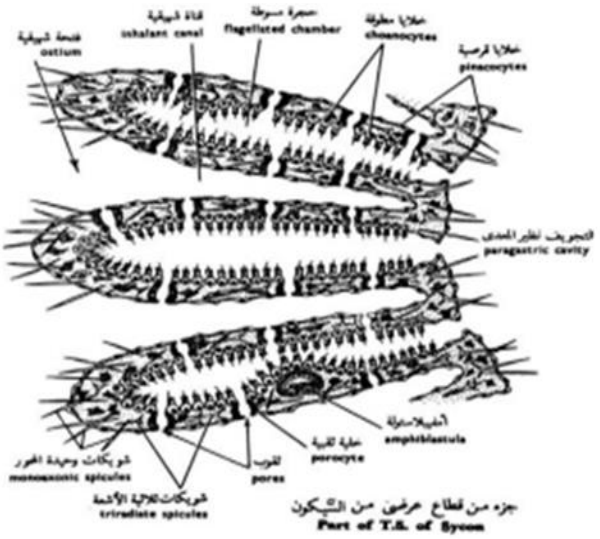
Dermal pores

The body surface bears numerous regularly arranged, polygonal elevations separated by depressed lines or furrows. Numerous micro- spic apertures are present in the furrows. These are ostia or inhalant pores or dermal pores leading to the incurrent canals.

The canal system

It is evident form the term 'porifera', the surface of the body bears a large number of pores, minute in size and inhalant in function. These pores open into a system of channels, which after penetrating almost all the portions of the body, open to the exterior by an opening, known as osculum at the tip of the

branch. All the canals are collectively called canal system. The canal system establishes a continuous passage for the inflow and outflow of water within the body of a sponge.



The following structures are found in association with the canal system of Scypha.

1. **Spongocoel.** At the free end of the body a fairly large aperture known as osculum is present. Osculum leads internally into a canal, the spongocoel, which runs along the middle of the body and receives a large number of excurrent canals of the branch. The paragastric cavities or spongocoels of different branches in a colonial form are in communication with one another through a broad chamber at the base. The cavity is lined by flattened cells of ectodermal origin.

2. **Incurrent canal**. The surface of each branch of Scypha is provided with alternate elevations and depressions. At each depression a group of minute pores known as inhalant pores or ostia are present. Ostia lead internally into the incurrent canal.

The canal is dilated towards the outer end and narrower and blind at the inner end. It is lined by flattened cells of ectodermal origin.

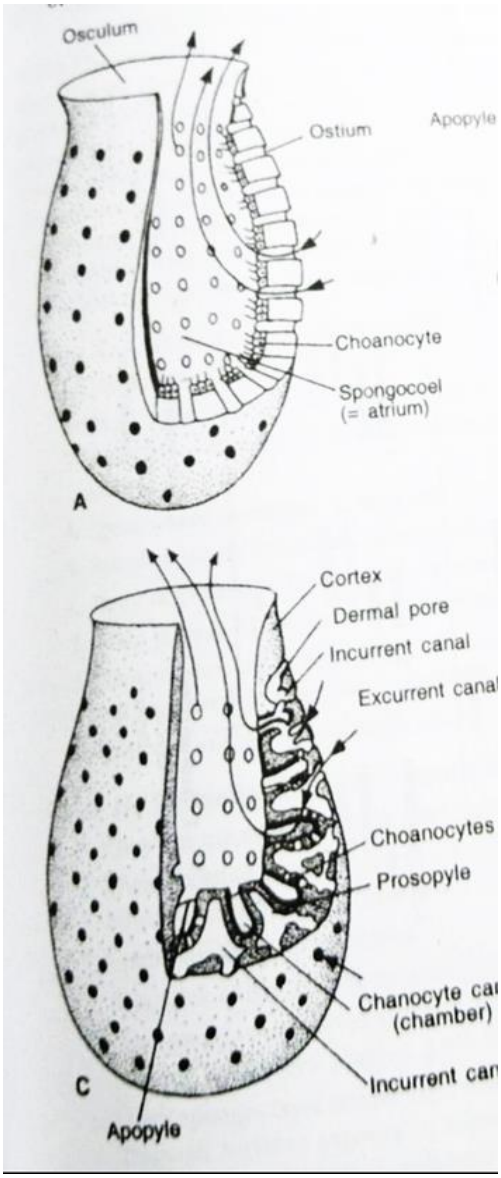
3. **Radial canal**. Lying alternate and parallel to the incurrent canals are the radial canals. The radial canals are situated opposite to the points of elevations on the surface. Each canal is narrower and blind towards the outer end but broad and open at the inner end. It is lined by flagellated choanocyte cells of endodermal origin.

The radial canals are connected with the incurrent canals by narrow passages known as prosopyles. 4. Excurrent canal. These are short but wide canals. Each canal is situated along the same long axis of the radial canal. It is lined by flattened cells of ectodermal origin.

The excurrent canal is connected at the outer end with the radial canal by an aperture, the apopyle and at the inner end with the paragastric cavity by a large aperture, the gastric or internal ositum.

Course of water current. Due to the rapid backward movement of the flagella of the cells lining the radial canals constant water current is maintained in the canal system. The rate of flow of water can, of course, be regulated by increasing or decreasing the diameter of the different apertures in the canal system. Water from outside enters the incurrent canals through ostia and from there to the radial canals through the prosopyles. It passes from radial canals to excurrent canals through the

apopyles and from there to the spongocoel through gastric ostia and thence to the exterior through the osculum.



Role of the canal system.

The canal system serves various functions

1. It serves the purpose of nutrition. The foods such as diatoms, protozoans, etc., pass through the water current and reach the radial canals where they are picked up and digested by the flagellate cells.

2. Oxygen for respiration is carried by the streaming current of water.

3. It functions for excretion. Current of water, passing out of the osculum also remove the carbonic acid and other nitrogenous waste matters.

4. The outward current takes away the reproductive units from the body of the sponge.

5. The complicated canal system also increases the surface area of the animal which is directly exposed to water.

Histological elements

The different microscopic elements constituting the body wall of Scypha are known as histological elements. The elements may be divided into three following groups: cell elements, skeletal elements and mesenchymal substance.

Cell elements

The cells of the sponges are fairly differentiated, but excepting choanocytes, others seem to be only modified forms of undifferentiated amoeboid cells corresponding to the primitive connective tissue cell of higher animals. Following different types of cells are found in the body wall of *Scypha* .

(a) Ectodermal cells. These are flattened scale-like cells with inconspicuous nuclei and there edges are closely cemented together to form an epithelium. The cells of the dermal layer covering the outer surface of the sponge are known as pinacocytes. Each pinacocyte has a thickened central bulging containing a nucleus. Some pinacocytes (endopinacocytes) also line the incurrent canals and spongocoel. They are highly contractile and those lining the incurrent canals are called skeletogenous cells.

(b) Endodermal cells. These are columnar cells, each with a large nucleus, one or more vacuoles and bears flagellum at the inner end, the base of which is surrounded by a delicate, transparent collar-like upgrowth. Such cells are known as choanocytes and are restricted to the radial canals."

(c) Myocytes. These are fusiform contractile cells around the ostia, prosopyles and apopyles affecting the closure of the apertures, and are usually arranged in a circular fashion to form a sphincter.

Mesenchyme substance

The mesenchyme consists of a gelatinous, transparent matrix generally known as mesogloea, supposed to be protein in nature. It affords rigidity to the animal. The mesogloea contains to some extent, free wandering cells or amoebocytes. Following types of amoebocytes are found in Scypha.

(a) Amoeboid wandering cells. These are amoeba-like and canand can move from place to place. They are concerned with the nutrition of the animal.

(b) Collencytes. These are with slender branching pseudopods and connect the different elements of the body. If bipolar, collencytes are termed desmacytes or fibre cells.

(c) Chromocytes. These are with lobose pseudopods and contain pigments. The colouration of the sponge is dependent on this pigment.

(d) Thesocytes. These are also with lobose pseudopods and store reserve food materials.

(e) Scleroblasts. These cells secrete the skeletal elements or spicules. They are of two types.

(i) Calcoblasts. Amoebocytes secreting culcareous spicules.

(ii) Silicoblas.s. Amoebocytes secreting siliceous spicules.

(f) Reproductive cells. These are modified amoebocytes and possibly also modified choanocytes.

The mesenchyme is responsible, after all, for one of the most important characters in sponges, that is, secreting the skeletal elements.

Skeletal elements

These are hard structures connected together and arranged in such a way as to support and protect the soft parts of the body. These structures are pointed and made of calcium carbonate and known as spicules. Spicules develop from the scleroblasts and one scleroblast is required to form each arm of a spicule. The spicules may be needle-like or club-shaped and range from one to many axes or monaxon to polyaxon, of which triaxon one is the most abundant type. There are spicules where the body is round and the growth is concentric. These are known as spheres while the crepis on being deposited with layers of silica in an irregular fashion is termed Desma. The club-shaped spicules projecting on the outer surface beyond the ectoderm are known as oxeote spicules. Spicules are responsible for the framework of Scypha. Although the primary function of the calcareous skeleton is to support, it also serves to buffer the mesenchyme against any drop in pH that could cause hardening of the ground substance.

Reproduction and development

Reproduction in sponges takes place both by asexual and sexual means.

A. Asexual reproduction

It is affected by internal buds or gemmules. Some of the amoebocytes come to lie in the mesogleal layer around the lining cells of the radial canals, and after repeated division a mass of cells or the gemmule is formed. The process is known as gemmation. A gemmule cannot escape to the outside until the branch in which it grows is separated from the main body of the sponge and lost. For this reason, gemmules are formed in older Branches. By the time of its liberation the gemmule is transformed into an amphiblastula, the subsequent development of which is like that of the samein sexual reproduction.

B. Sexual reproduction

Sponges are monoecious, i.e. ova and sperms develop in the same individua Sexual reproduction is effected by the formation of the archaeocytes (specialized amoebocytes). Sex organs are absent. The mesenchyme around the gastral layer of the flagellated chamber is the seat of the sex cells.

Spermatozoon is with a round head and a long tail. Spermatozoa from anothe sponge are carried to the radial canal with water current. The ovum is large and round and remains attached to the maternal tissue. Fertilization takes place within the body. The fertilized egg of Scypha divides vertically and eight conical cells are formed. The cells then undergo horizontal cleavage, with the result that eight long cells and eight small cells are formed enclosing a blastocoel. The long cells are destined to form the future epidermis while the small cells form the future

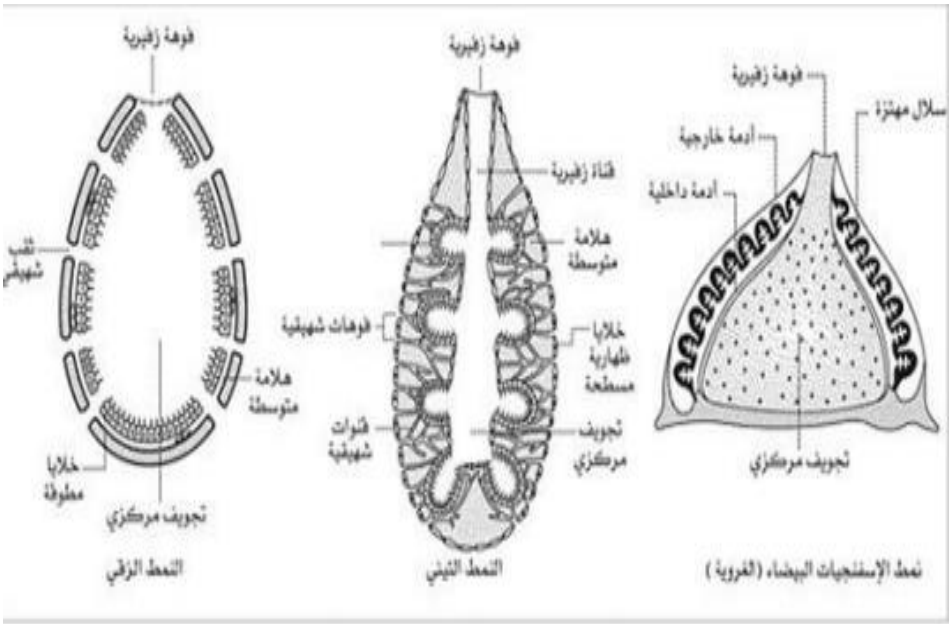
choanocytes. The eight small cells increase in size, elongate, and each acquires a flagellum on its inner side. The large cells do not divide, instead, assume a round form and become granular. The mouth opening appears at their middle which absorbs the neighbouring cells. This stage of the blastula is known as stomoblastula. The blastula undergoes inversion and the flagellated cells are brought outside.

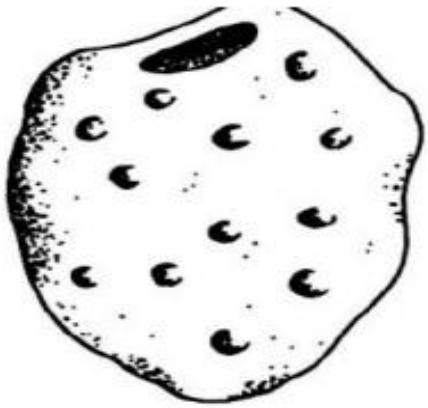
The embryo at this stage is known as amphiblastula. This is a typical calcareous larva. It escapes from the parent and has two types of cells; the small narrow flagellated cells and the large round granular cells. After a brief period of free existence which may last for a few to several hours the larva undergoes gastrulation, in which the flagellated half is invaginated into or overgrown by the large granular cells. and it attaches itself to some solid object by the blastoporal end and is gradually transformed into a narrow cylinder and then to a small sponge. The flagellated cells become the collared cells, while the granular cells become numerous and form the dermal epithelium. The mesenchyme cells are formed from both the layers. Gradually, the cylinder (larva) increases in thickness. With the growth of the intermediate layer the radial layer and other canals gradually appear.

Commercial Sponge

Sponges are mostly beneficial to man. Skeleton of some sponges are used to manufacture commercial sponge, which is of great economic importance. The spongin skeleton is treated with hydrochloric acid and the spicules are dissolved. The residue left after the acid treatment is further subjected to chemical

treatment, and the skeleton becomes marketable as the 'bath sponge'. Sponges are extensively used in bath rooms, laboratories and in surgical operations.





Phylum: Cnidaria (Coelenterata)

These are typically invertebrate animals, which show a very simple level tissue organization. They are aquatic animals and are mostly found in marine environments, attached to the rocks at the bottom of the ocean. A few species are also found in freshwater habitats. Cnidarians can be found solitarily or in colonies. You can find them sedentary or free swimming.

Cnidarians can be called as the simplest animal group that has true tissues and have the characteristic coelenteron or the gastro vascular cavity.

Characteristic Features of Phylum Cnidaria:

•They are multicellular organisms, exhibiting tissue grade of the organization.

•They are diploblastic, with two layers of cells, an outer layer called the ectoderm and the inner layer called the endoderm. There is a non-cellular layer that is the mesoglea in between the ectoderm and the endoderm.

•They show radial symmetry.

•They have a single opening in the body through which food is taken in and also waste is expelled out.

•The opening in the body is surrounded by tentacles.

•Digestion takes place in the body cavity which is the coelenteron.

•They can live in marine or freshwater habitats.

•They can be solitary or live in colonies. Each individual is a zooid.

•These organisms show two morphological forms – Polyps and Medusa.

•Polyps contain exoskeleton and endoskeleton.

•The skeletons are composed of calcium carbonate.

•Most if the coelenterates are carnivorous in nature with a few exceptions such as the s corals. They get their food from other animals that live symbiotically within them.

•Digestion is both intracellular and extracellular.

•Tentacles have special structures known as the nematocysts which help in capturing and paralyzing prey. Coelenterates simply wave their tentacles and when a prey comes in contact, the nematocysts inject the toxin that paralyses or kills the prey. Nematocysts are the most distinguishing feature of this phylum.

•Coelenterates do not have sensory organs.

•Respiration and excretion occur through simple diffusion.

•The circulatory system is absent.

•Asexual reproduction is seen in polyps, through budding and sexual reproduction is seen in medusa form, through gametic

Classification of the phylum Cnidaria

1. Cnidarians are radially symmetrical metazoa in which the primary long axis of the gastrula becomes the long axis of the adult.

2. A single cavity having the combined function of coelom and enteron (coelenteron) is present, which is communicated to the exterior by a single aperture, the mouth.

3. Body wall consists of two layers, ectoderm and endoderm, separated by a gelatinous non cellular layer of mesogloea.

4. Cnidoblasts in various forms are present.

5. Adults radially symmetrical.

The phylum has been divided into three classes

Class Hydrozoa

1. The individuals are colonial in most cases, some are polymorphic.

2. The medusa develops from the sessile polyp colony by budding and is always free swimming.

3. Vertical partition is never found in the enteron.

4. Tentacles are usually solid.

5. A horny external skeleton present. 6. Medusa with a velum and a nerve ring.

7. Medusa buds are unisexual.

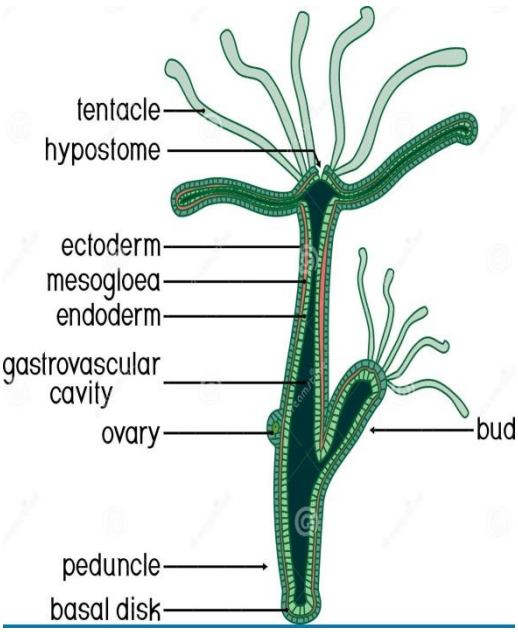
8. Gonads commonly of ectodermal origin.

9. An alternation of generations is present in most cases. 2,700 species, solitary or colonial, chiefly marine.

Examples. Hydra, Obelia, Polylcolpa Stylaster. Physalia, etc.

Hydra sp.

External features belongs to the class Hydrozoa, phylum Cnidaria. *Hydra*



1. The body is more or less cylindrical and one end remains attached to a submerged object, wood or stone.

2. The attached end is known as the proximal end, the point of attachment is the pedal disc.

3. The distal or the opposite end is provided with 6 or 8 tentacles radiating in all directions and arranged in a circle.

4. Hypostome is a small, elevated cone surrounded by the tentacles.

5. The mouth is round and situated at the centre of the hypostome.

6. The mouth communicates the coelenteron or the gastrovascular cavity to the exterior.

7. The whole surface of the body, except the pedal disc is provided with a large number of stinging cells or cnidoblasts. (i) The cnidoblasts are crowded in the hypostome and the tentacles.

8. One or more buds, the tubular outgrowths, similar to the structure of the body are often present, as lateral outgrowths of the body.

9. Small, conical outgrowths, male or female gonads, also called as testis or ovary are present on the body.

10. Indian Hydra is unisexual.

Body wall

Hydra is the simplest fresh water metazoa. The wall of the body, tentacles and buds are made up of two layers of cells, the outer ectoderm and the inner endoderm separated by a thin layer of noncellular gelatinous mesogloea. The ectodermal layer is protective, receptive and reproductive and the endodermal layer is mainly nutritive.

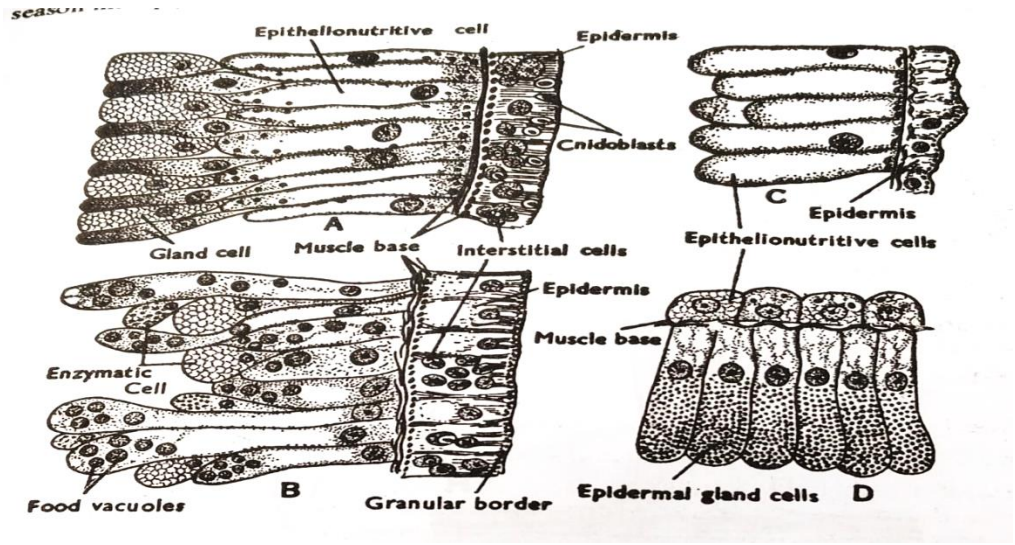
Cells confined to ectoderm

1**. Epitheliomuscular cells**. These are large elongated cells with oval nucleus.

The free ends are smooth with rounded corners and being placed side by side forma continuous surface. Two basal strands, opposite each other are present in each cell. A myoneme extends through them at the base of the cell. By the contraction of these processes the animal is shortened and can bend in various directions. The

cells of the pedal disc can send pseudopodia by which hydra can move.

2. **Cnidoblasts**. The cell is oval in shape and provided with a capsule, the nematocyst, filled up with a poisonous fluid, hypnotoxin, protein in nature. The neck of the capsule is drawn into a narrow hollow thread, which remains coiled within it. A delicate cytoplasmic process, the cnidocil projects from the surface. When the cnidocil is touched, the whole cell undergoes a sudden contraction and the thread is shot out with a great force. The thread pierces the body of the victim and one or two drops of the poisonous fluid is injected into the prey which paralyses it. Cnidoblast once used becomes nonfunctional and is cast off.



The **nematocysts** may be roughly of the following types:

(a) Volvent, (b) Glutinant, (c) Penetrant.

The ectoderm of the tentacles and the oral region always contains an abundance of cnidoblasts. The ectoderm of the stem also has a fair number of them.

3. **Reproductive cells**. Hydra is dioecious or monoecious. Undifferentiated male and female germ cells are present in the ectodermal layer which in the breeding season multiplies to form the gonads, testis or ovary.

Cells confined to endoderm

1. **Epithelionutritive** or Nutritive muscular cells. These are large cells with one or more vacuoles and a prominent nucleus. Two flagella are present at the free tip of some of them. The basal end is provided with two contractile extensions containing a myoneme. The extensions take a circular course next to mesogloea. The Hydra elongates when these processes contract. These cells carry out nutritive function.

2. **Mucous cells**. These are modified gland cells situated in the oral gastrodermis and possess flagella. Their secretion helps in the lubrication of food for easy swallowing

3. **Albumen cells**. These are elongated cells with narrow bases and may or may not possess flagella. They supply albumen to the developing ovum.

4. **Storage cells**. These are modified gland cells. Cells common to ectoderm and endoderm

1. **Gland cells**. These are abundant in tentacles, oral region and pedal disc. Ln Hydra, the pedal disc is thickly populated (beset) with glandulomuscular cells, and they have muscular basal extensions. In the gastrodermis, they secrete digestive ferments.

2. **Sensory cells**. These are elongated cells found in the tentacular and the oral region. Their bases are continuous into one or more fine fibrils passing into the general nerve plexuses.

3. **Nerve cells**. These are commonly known as ganglion cells, which conduct functional impulses.

4. **Interstitial cells**. These are situated between the narrow bases of the epithelial cells and are considered as persistent undifferentiated embryonic cells. They are capable of secreting nematocysts, transforming into sex cells as well as other types of cells. They are also supposed to take part in building and repairing processes.

Obelia sp.

Obelia is a marine, sedentary, colonial coelenterate under the class Hydrozoa and phylum Cnidaria.

Structure

1. It is a branched, fixed colony . Some of the horizontal branches anchoring. The colony on some support are known as Hydrorhiza while other branches are vertical.

2. Each branch consists of a granular coenosare made of two cell layers enclosing the coelenteron and surrounded by a thin transparent horny perisare.

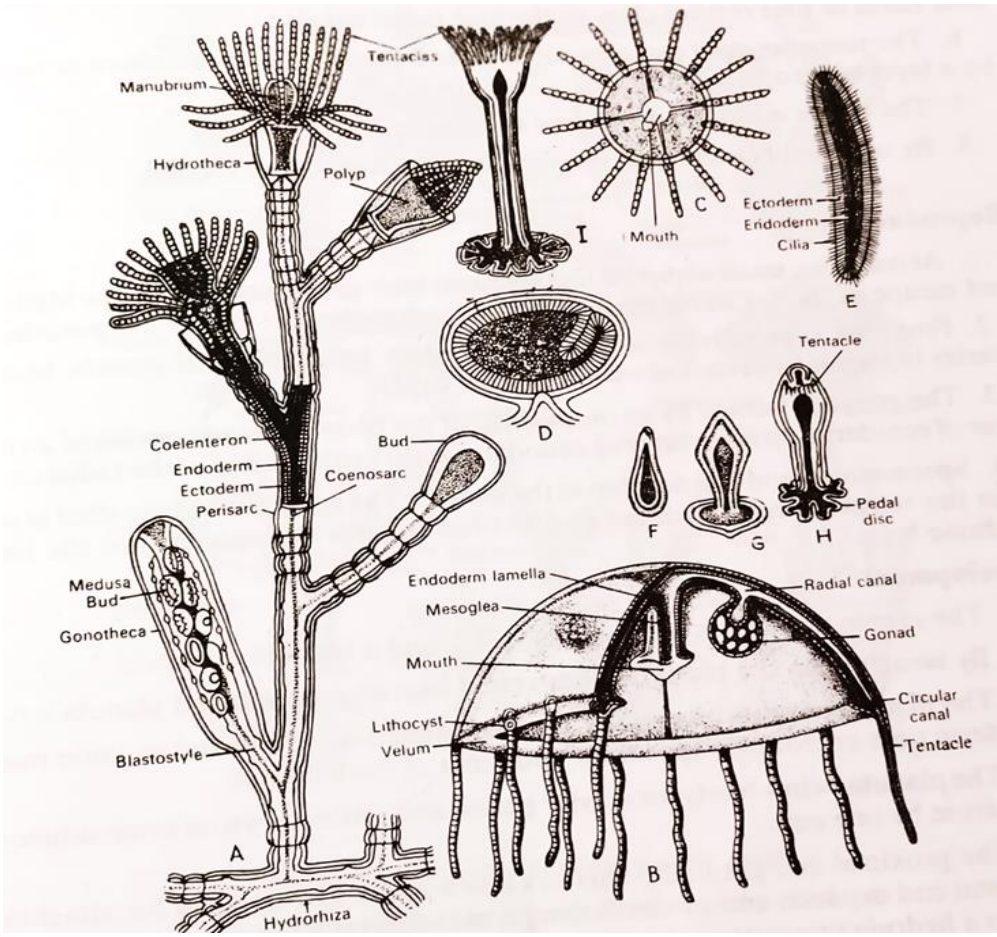
3. The vertical branches towards the base are further branched and all the branches end in zooids.

4. Zooids are of three types:

(a) Polyps or vegetative zooids. Barrel-shaped and responsible for the nutrition of the colony.

(b) Blastostyles. Club-shaped zooids, bearing the medusae buds.
(c) Medusae buds. Umbrella-like reproductive zooids bearing gonads.

5. Medusae buds are unisexual and free living at maturity. One medusa bears either four testes or four ovaries close to the four radial canals.



6. The tentacles in all cases are solid; there is a solid core of endoderm surrounded by a layer of ectoderm cells.

7. The larvae are ciliated and free swimming.

8. By repeated branching of the simple polyp, a colony is formed.

Reproduction

1. At maturity, small umbrella-like medusae buds get detached from the blastostyle and escape in the sea water through an aperture at the free end of the gonotheca.

2. From the subumbrellar surface of a medusa hang four oval gonads, testes or ovaries in immediate relation with the radial canals.

3. The gonad is formed by an out pushing of the body wall and consists of an outer layer of ectoderm, an inner layer of endoderm and a prolongation of the radial canal.

4. Spermatozoa and ova develop in the gonads. The spermatozoa are shed in water from the testes of male medusae and fertilize the ova still attached to the female medusae buds.

Development

1. The zygote undergoes complete cleavage and a blastula is formed.

2. By invagination the blastula is converted into an oval ciliated planula larva.

3. The planula consists of an outer layer of ciliated ectoderm and an inner mass of endoderm cells enclosing a space, the rudiment of coelenteron.

4. The planula swims freely for a brief period and settles down on some submerged substratum by one end.

5. The proximal end gradually narrows down and a disc appears for attachment. The distal end expands and by developing a manubrium and a circlet of tentacles it turns to a hydrula or simple polyp.

6. The hydrula sends out lateral buds and by a repetition of this process it is converted into a complex *obelia* colony.

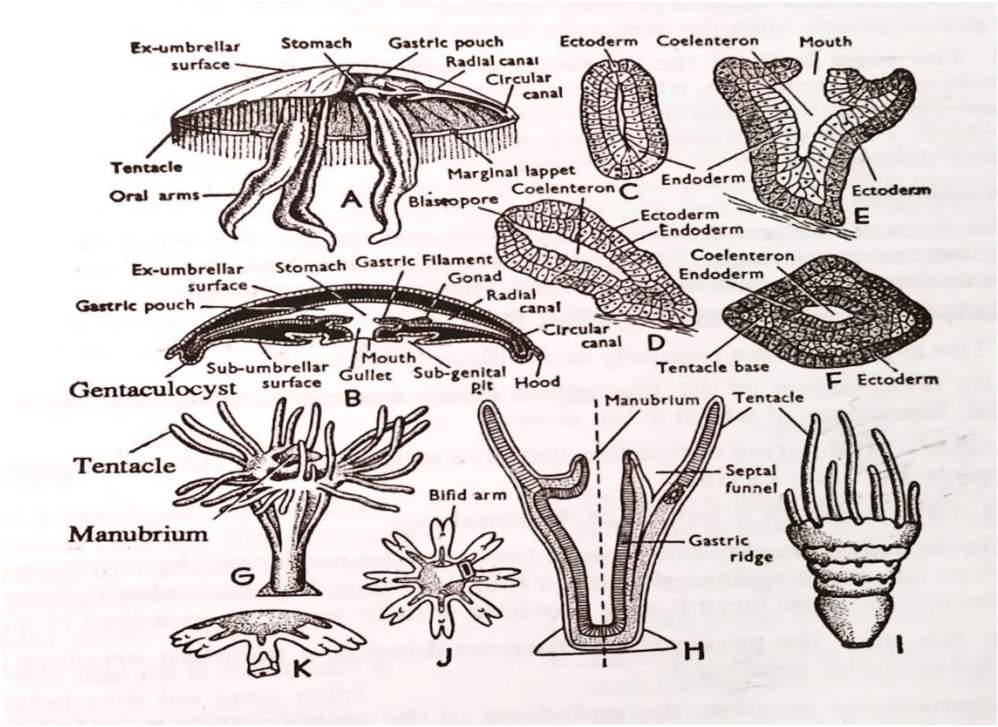
Alternation of generations

A distinct alternation of generations or metagenesis is present in the life history of *Obelia*. The *Obelia* colony is sexless, bears no gonads and it is developed by asexual process, i.e. by repeated budding of the hydrula. But the medusae buds, some of the zooids of the colony, develop gonads and from their fertilized egg new *Obelia* colony arises. The asexual generation is dependent on and is alternated by the sexual generation.

Obelia is a permanently fixed colony but the planula larvae, it produces; are free swimming. The larva can swim from place to place with the help of cilia and being aided by water current it can travel a long distance. Thus, a nonlocomotory species becomes locomotory and an overcrowding of individuals within a limited area is avoided and thereby the species is successfully continued.

Aurelia sp.

Aurelia is a marine, free swimming jelly fish placed in the class Scyphozoa, phylum Cnidaria.



Structure

1. The animal consists of a gelatinuous disc with a slightly convex exumbrella and bears a four cornered mouth on a short manubrium guarded by four oral arms at the center of the subumbrella.

2. The margin bears a large number of tentacles and is smooth except eight notches, each with a pair of marginal lappets. Along the edge, the umbrellar portion is very thin and flexible which together with its marginal notches and tentacles form the velarium.

3. The mouth leads into a spacious central stomach, which gives out four pouches known as gastric pouch. Each pouch moves a little distance and then gives off numerous fine canals, which run

outward and ultimately unite to form a circular canal lodged within the edge of the umbrella.

4. Gonads are four in number, and are visible through the transparent umbrella as coloured horseshoe-shaped patches. They are frill-like structures lying on the floor of the gastric pouch, with the concavity facing inwards.

5. The main bulk of the umbrella is mesogloeal in structure but it contains numerous amoeboid cells, which come from the ectoderm. It has also some branching fibres. The outer (ex-) and the inner (sub) surfaces of the umbrella are covered with ectoderm. The stomach and the canal system are lined with endodermal cells and are ciliated throughout.

Reproduction

The sexes are lodged in distinct individuals and the four horseshoe-shaped gonads are either testes or ovaries. The spermatozoa or ova are shed in the stomach and these come to the exterior with water current. Fertilization is external. Development and Life history

1. The zygote divides regularly and a blastula is formed.

2. By invagination of the blastula an oval, two-layered ciliated planula larva is formed, blastopore of which is not closed.

3. After a brief period of free life, the larva settles down by the end opposite to the blastopore and loses its cilia.

4. A definite mouth is formed at the distal end.

5. On the opposite side of the mouth two tentacles are formed by out pushing. Soon two others appear at right angles to the first pair: then four and subsequently 8 more tentacles appear. The larva is now provided with 16 tentacles arranged in a circlet.

6. By this time, the proximal end narrows down to a stalk-like structure and the distal end becomes expanded.

7. Interradial in position, the endoderm of the gastric cavity is folded into four longitudinal ridges, the gastric ridges or taenioles.

8. The mouth assumes a square shape and its sides are elevated to form a short manubrium.

9. The ectoderm of the region between the mouth and the circlet of tentacles becomes invaginated in four interradii to form four septal funnels or infundibula which sink in the four gastric ridges.
10. This stage of a scyphozoan polyp is known as scyphistoma larva, and it is about 1.25 cm in length.

11. Several transverse constrictions appear on the larva and as the constrictions grow deeper, the larva appears like a pile of discs one placed above the other

12. The edge of each disc is provided with eight bifid arms bearing deep notches. As the constriction proceeds, the stomach becomes closed on the lower surface of each disc, while on the upper surface it remains open and its outer edges are transformed into a manubrium.

13. Finally, the disc-like bodies separate from one another, turn upside down and are known as ephyra. Each ephyra carries with it a part of the stomach with the gastric ridges.

14. The mouth becomes elevated on the manubrium, tentaculocysts appear at the notches of the bifid arms, gastric filaments appear on the gastric ridges, soon followed by others and the stomach extends in the arms.

15. The swimming ephyra grows rapidly, notches are filled up and the umbrella becomes rounded; four oral arms and marginal tentacles appear and it is transformed into an adult Aurelia,

Alternation of generations

In a sense, an alternation of generations is present in the life history of *Aurelia.* The sexual generation is represented by the adult *Aurelia*, which is produced by asexual means from the scyphistoma larva and the scyphistoma is produced sexually from the adult *Aurelia*. But unlike the budding of the hydrozoan polyp, the polyp undergoes several constrictions to produce a few adult individuals and it is not considered as a case of asexual generation. The life history of Aurelia may better be described as a metamorphosis complicated by multiplication in the larval stage than a true alternation of generations. It has also been seen that under certain conditions, direct development from egg to scyphistoma, and that to the adult Aurelia occurs without the intervention of the so called asexual reproduction.

Tealia sp.

Sea anemones are members of the class Anthozoa under the phylum Cnidaria. This class as a whole has undergone high grade of specialization in an entirely different direction. All the members of the class remain as polyps, incapable of producing a free swimming medusoid generation. Sea anemones are brilliantly

coloured flower- like animals found attached to rocks at low water mark. Some are inserted in the sand.

Body form and mesentery

1. Column-like body, broader than high.

2. At the anterior end lies the oral disc.

3. In the middle of the oral disc lies the mouth.

4. From the edges of the oral disc are given off a number of short conical tentacles arranged in five rings.

5. Outermost whorl carries the maximum number of tentacles, which is 48. The subsequent whorls bear successively lesser number of tentacles.

6. The posterior region of the body is flattened to form a basal disc for the purpose of attachment.

7. The oral disc invaginates to form a gullet or food tube, suspended into the general cavity.

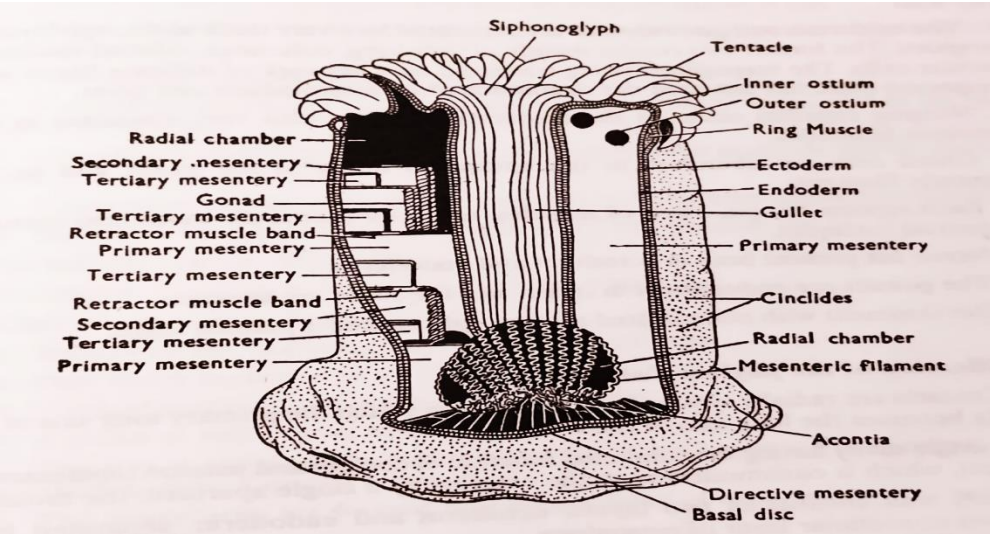
8. The gullet has on its either side a pair of smooth, heavily ciliated furrow, placed one at each end of the long diameter, through which the water passes to the enteron,the siphonoglyph.

9. The general cavity is subdivided into radial compartments by 6 distinct septa, each of which extends from the wall to the gullet. The septa are complete and known as primary mesenteries.

10. In between the primary mesenteries, two types of incomplete partition walls are found to be inserted; some are larger than the other. The larger incomplete partition wall is known as secondary

mesentery and the smaller as the tertiary mesentery. Thus the gastrovascular cavity is subdivided into a number of vertical chambers by projecting partitions.

11. Each septum has a pair of ostia beneath the oral disc, for direct communication of the intermesenteric compartments.



12. The thick free inner margin of the septum convolutes to form mesenterie filament, and continues posteriorly as thread-like acontium. Acontin protrudes either through the mouth or through cinclides (openings in the body wall) for subduing prey.

Body wall

1. The epidermis and gastrodermis are separated by a very thick and tough layer of mesogloea. The former two consist mainly of very long, columnar, ciliated epithelio-muscular cells. The mesogloea, being traversed by a network of delicate fibres with interspersed cells, has assumed the characters of an intermediate cell layer.

2. Stinging capsules occur in the epidermis, and are also very abundant in the mesenteric filaments

3. Gland cells are abundant in the epidermal lining of the gullet and in the mesenteric filaments

4. Each septum has got 3 sets of muscles, retractor (vertical), transverse (across) and parietal (oblique).

5. Nerve net present both in ectoderm and endoderm.

6. The gonads are endodermal in origin and the sexes are separate.

7. Development with complicated metamorphosis and a planula stage.

Phylum Platyhelminthes

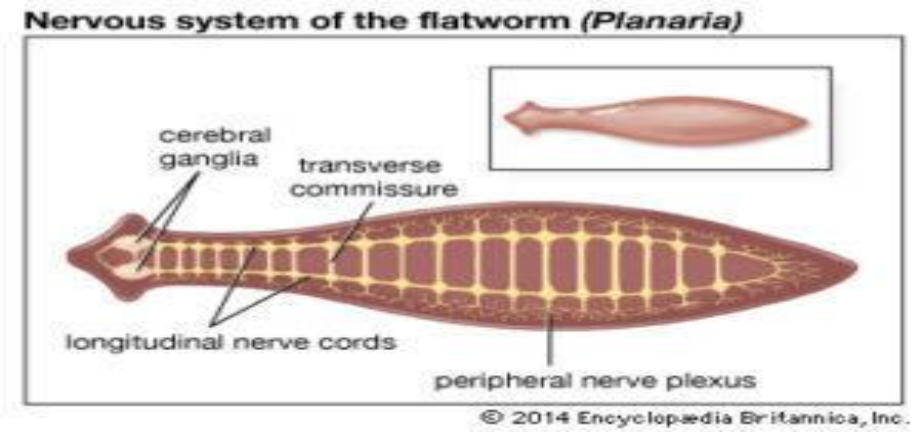
Platyhelminthes very commonly known as flatworms or tapeworms, these animals are soft-bodied invertebrate animals. There are around 20,000 species of these animals. A few of these live as parasites on humans and other animals. It is because of this parasitic nature that they do cause some amount of trouble for the host animal. A few species belonging to this phylum can be a major cause of certain diseases. Schistosomiasis, or bilharzia or bilharziasis, is a disease caused by these parasitic flatworms belonging to the family Schistosomatidae.

The most distinguishing feature of these invertebrates is their flat body. As the body does not have any cavity, they are flat. The body is also not segmented and they do not have specialized systems.

Around eighty percent of the flatworms are parasitic in nature, while a few free-form flatworms are also present. The free-living species are scavengers or predators. The parasitic species feed on the tissues of the host organism in which they live.

The animals in this phylum have a diverse range in size. Some are microscopic, while a few go up to two feet long. They are also hermaphrodites, which mean that both the sexes are present in the same organism.

Characteristic features of Phylum Platyhelminthes



- Their body is dorsoventrally flattened.
- They exhibit bilateral symmetry.
- Also, they are triploblastic, with three germ layers.
- They do not have a body cavity and are acoelomate.
- Body is soft and unsegmented.
- They are mostly parasitic with a few free-living

- They exhibit an organ system grade of organization.
- The digestive system is incomplete or absent. There is a single opening which leads to a well-developed gastro-vascular cavity. The anus is absent. There is no true stomach structure. In a few species, the digestive system is completely absent.
- Respiratory and circulatory systems are absent. Respiration generally occurs through diffusion through the general body surface.
- The excretory system has protonephridia with the flame
- There is primitive nervous system present.
- These animals are hermaphrodites.
- Sexual reproduction happens through gametic fusion.
- Asexual reproduction also happens in a few species through regeneration and fission.
- Fertilization is internal.
- The life cycle of these organisms can be complex, especially if they are parasitic, as this may involve one or more host animals.

Classification of Phylum Platyhelminthes

The different classes under this phylum are:

- Class: Turbellaria (*Planeria*)
- Class: Trematoda (*Fasciola hepatica* - *Scistosoma haematobium*)
- Class: Cestoda (*Taenia solium*)

***Fasiola sp*. (Liver fluke)**

Fasciola, a common endoparasite in the larger bile ducts of sheep, goat or cattle, is placed in the class Trematoda, phylum Platyhelminthes. *It's another* host is an amphibian land snail, Lymnaea truncatula.

Structure

1. Body soft, flattened, leaf-like with a triangular head lobe. It is brown to pale-grey in colour and measures 2.15-3 cm x 1.2-1.5 cm. The body is covered with a cuticle, the greater portion of which bears minute spines.

2. The mouth is anterior and terminal, surrounded by the oral sucker.

3. The posterior sucker is ventral and behind the mouth.

4. The genital aperture is placed in between the two suckers.

5. The excretory pore is median and posterior terminal.

Reproductive organs

1. The animal is hermaphrodite and bears organs of both the sexes.

2. The male organs consist of a paired, much branched testes, a pair of vasa deferentia, a common vesicula seminalis, and an ejaculatory duct opening in the male aperture in the cirrus.

3. The female organs consist of a single branched ovary, an oviduct, a uterus, an ootype, vitelline glands and their ducts and shell glands. The uterus opens in the cirrus.

4. A small cavity, the genital atrium bearing the external aperture of male and female duct is formed when the cirrus is withdrawn.

Fertilization and development

1. The eggs are large ovoidal structures with brown colour due to the presence of bile pigment. On the average, they measure 40-80 um (microns). The eggs are fertilized in the uterus and self or cross fertilization may occur.

2. The zygote receives yolk and a chitinoid covering in the ootype, remains in the uterus for a short period and is discharged. Passing down the bile duct, the zygote reaches the intestine of the host and passes to the exterior with the faeces.

3. Active development starts and after 2-3 weeks the miracidium larva hatches out of the egg.

Life History

Miracidium larva

(a) The body is conical with a triangular head lobe and is covered with vibratile cilia.

(b) A pair of crossed eye spots are present anteriorly

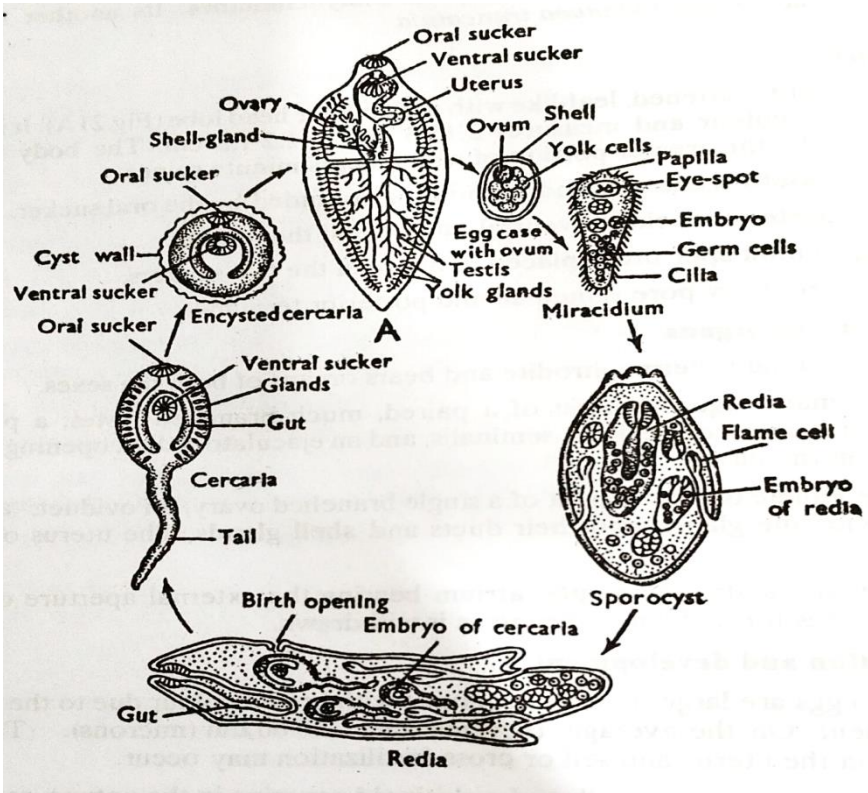
(c) An imperfectly developed intestine and a pair of flame cells opening to the exterior are present.

(d) The rest of the interior is filled up with a mass of germ cells.

4. The miracidium swims actively in water or moves on damp herbage and can survive only if it reaches an amphibian snail, the other host, approximately within 8 hours.

5. The embryo bores into the snail and comes to the pulmonary sac or other organs.

6. The ciliated ectoderm is lost; it grows to an elongated sac and forms the sporocyst.



Sporocyst

(a) Its wall is formed by a single layer of cells. (b) The flame cells and remnants of eye spots are present.

(c) The internal cavity contains germ cells.

7. The germ cells of the sporocyst behave like parthenogenetic ova. Each cell divides to produce blastula, gastrula and finally a form of larva, the redia

8. Five to eight rediae are usually formed in each sporocyst.

Redia

(a) The body is cylindrical, with a circular ridge near the anterior end, and a pair of short processes near the posterior end.

(b) The mouth leads into pharynx and a sac-like intestine is present.

(c) A system of excretory vessel is present.

(d) Germ cells are present in the internal cavity.

(e) A birth opening is situated anteriorly near the circular edge.

9. From the germ cells in the redia, 14-20 cercariae develop in each redia.Cercariae are produced if the season is summer but redia gives rise to a fresh generation of 8-12 rediae if the season is winter.

10. The cercaria escapes through the birth opening of the redia.

Cercaria

(a) The body is oval with a long tail.

(b) The anterior and posterior suckers, the mouth, pharynx and a bifid intestine are present.

(c) The gonads, glands, etc., begin to appear.

11. The cercaria forces its way out of the snail, loses its tail, becomes encysted and remains attached to blades of grass or other herbage.

12. The encysted cercaria known as metacercaria, is taken by the host with the grass and the young fluke on escape, may reach the liver through bile ducts or hepatic portal vein, and grows rapidly to reach the adult stage. The eggs come out with the faeces about 3 to 4 months (incubation period) after infection.

Effect of parasitis

On host. The attack of liver fluke causes 'liver-rot', which is disastrous to the host and death, has been recorded in most cases of liver-rot. Jaundice and adenomata have also been reported.On parasite. Due to parasitic life, considerable degeneration of the vegetative organs has taken place in Fasciola.

The reproductive organs are more developed. On the other hand a single fluke may produce about 50,000 eggs. Twice in its life cycle, the young embryos are exposed to the environment and the cycle which is already full of risks becomes more risky. To compensate the huge loss during its perilious journey from host to host further multiplication by asexual means has appeared, in addition to the already accentuated rate of multiplication.

Taenia solium (Tape worm)

Taenia solium, an endoparasite living in the intestine of man is placed under the class Cesloidea, phylum Platyhelminthes. Its definite host is man** and the intermediate or larval host is the pig. It is cosmopolitan in distribution.

Structure

1. Body ribbon-like. 2-3 meters long and consists of about 800-900 segments known as proglottides .

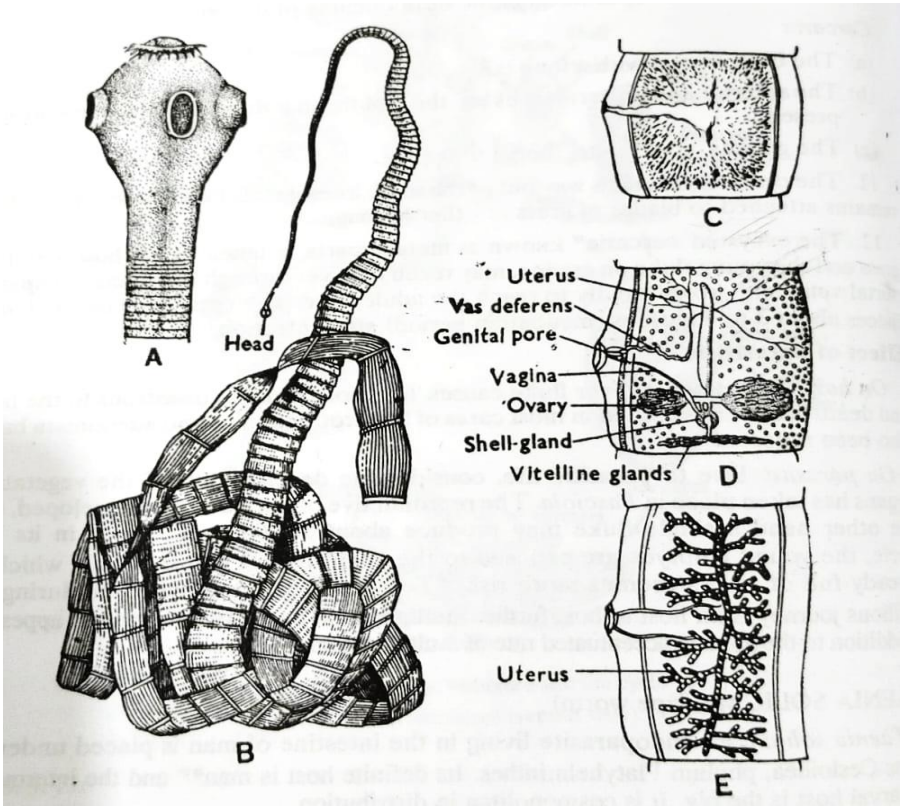
2. The pear-shaped head bears 28 curved chitinoid hooks arranged in two row and four adhesive suckers.

3. Just behind the head there is a small unsegmented region which may be called the neck.

4. Each proglottis is a complete hermaphrodite sexual unit.

Reproductive organs

1. The reproductive organs first appear at about 200th segment: the male part of the reproductive system appears first, becomes mature at about 400th segment and the posterior segments are filled up with greatly increased uterus, heavily loaded with developing embryos.



2. The male organs consist of a much lobed testis witn efferent ducts, vas deferens and cirrus, opening in the genital atrium by the male genital aperture.

3. The female organs consist of a paired ovary with their ducts, uterus, yolk glands with ducts, shell glands with ducts, oötype, receptaculum seminis and the vagina opening in the genital atrium through the female genital aperture. 4. With the development of the uterus, the other reproductive organs are degenerated and the gravid uterus looks like a longitudinal stem with 5-10 lateral branches.

Fertilization and development

1. Eggs are fertilized in the oviduct and self or cross fertilization may take place.

2. The zygote becomes surrounded by yolk and a chitinoid egg shell, and passes to the uterus. 3. The ripe proglottides loaded with developing embryos get detached in chains of 5 or 6, and pass to the exterior with the faeces of the host.

4. The proglottides are eaten up by pig: muscles of the segments get digested and six-hooked or hexacanth embryos are liberated.

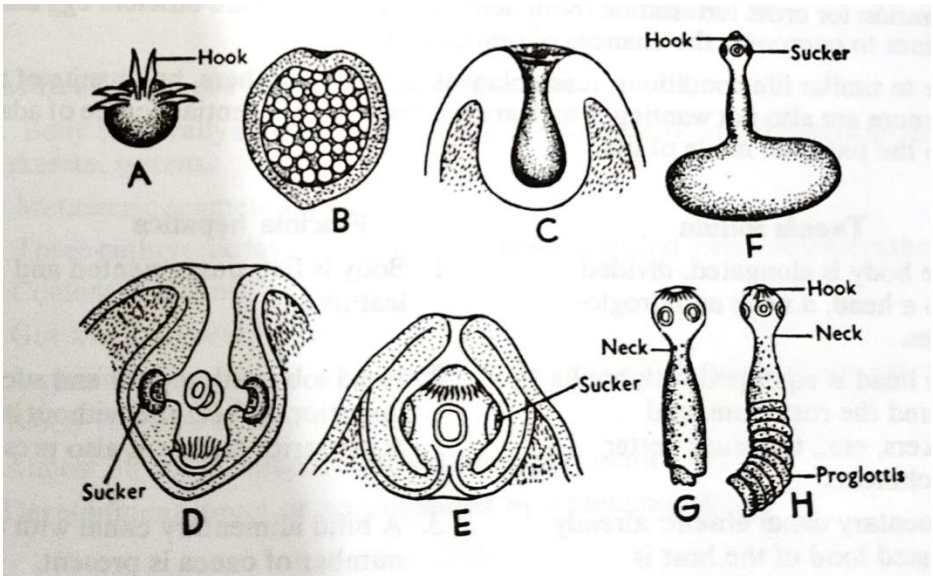
Life history

Hexacanth embryo or onchosphere

(a) The body is rounded and enclosed in two membranes.

(b) Six curved chitinoid hooks are present at one end.

5. The embryos bore the wall of the gut of the host with the hooks and reach the voluntary muscles where the hooks are lost. The embryo then enters the general circulation, usually through the portal vein and reaches the following organs in succession liver right side of the heart-lungs left side of the heart the systemic circulation. The embryo is filtered out and finally enters the muscular tissue.



6. Here the embryo increases greatly in size, having a large cavity filled up with watery fluid and assumes a bladder-like structure. 7. A hollow invagination or ingrowth takes place at one point of the bladder and on the inner surface of this invagination develop 28 hooks and 4 suckers, characteristic of the head of adult Taenia.

8. The hollow ingrowth becomes everted and the suckers and hooks come close to the surface.

9. The embryo now looks like a bladder with a head and neck of Taenia lying within it. This is known as bladder worm or cysticercus stage. It is rich in salt and albuminous material and when the pig's flesh is infected with the cysticercus cellulose, it is known as measly pork.

10. If a portion of measly pork is eaten by man, the bladder is dissolved in the gastric juice. The gastric juice causes the albuminous material to swell up and forces the fluid into the cavity, therby the head comes out through the pore. The scolex attaches itself to the wall of the intestine by hooks and suckers and develops the series of proglottides to reach the adult stage.

11. The worm gains sexual maturity by 2-3 months' time, and survive for 25 years or more.

The influence of parasitic mode of life on the structures of *Taenia solium* and *Fasciola hepatica*. The liver fluke and the tape worm both are included in the same phylum Platyhelmin thes, but they belong to different classes Trematoda and Cestoidea respectively. Both are endoparasites with an intermediate host to spend an apprenticeship in a third kind before they are ready for their life of smooth and ease in their final hosts. Both are highly adapted to the parasitic mode of life with remarkable simplification of some

organs and complication of certain others; both have to a large extent substituted self-fertilization for cross fertilization (both hermaphrodite); both are efficient egg making machines to overcome the chances of destruction.

Phylum Nematoda

Phylum Nematoda are un-segmented vermiform animals with anterior lateral chemosensory organs or amphids and with a persistent blastocoel or pseudocoelom; dorsal and ventral nerve cords in epidermis and excretory system of renette cells or tubules.

General Characteristic Features of Phylum Nematoda:

1. Body of Phylum Nematoda is un-segmented, bilaterally symmetrical, elongated and tapering at both ends.

2. Triploblastic animals with perivisceral cavity are more extensive than that of Platyhelminthes.

3. The body of is generally covered with thick, flexible multi-layered collagenous cuticle and often bears cuticular setae (hairs), spines or annulations.

4. Cuticle molted periodically.

5. Epidermis or hypodermis syncytial; i.e., the nuclei are not separated from each other by cell membranes.

6. Only longitudinal body-wall muscles; no circular body-wall muscles.

7. The Body cavity of is pseudocoel filled with parenchyma in most cases.

8. Alimentary canal provided with distinct mouth and anus (complete digestive tract). Muscular pharynx and the inner surface of the gut usually not lined by cilia. Extracellular digestion.

9. Mouth of is surrounded by six lips.

10. Blood vascular system and respiratory system are absent in of Phylum Nematoda.

11. Haemoglobin sometimes present in the pseudocoelomic fluid.

12. Excretory system without nephridia and flame cells. In the class Adenophorea glandular renette cells with a duct or in the class Secernentea excretory canal system without flame cells act as excre¬tory system.

13. Dorsal and ventral nerve cords in the epidermis.

14. Chemosensory organs are small cuticular projections called amphids which are situated on the lips, derived from cilia and opening to the exterior through a small pore, and lined with modified non-motile cilia called sensillae.

15. Sexes of are separate (gonochoristic).

16. Tubular gonads are present.

17. Amoeboid sperm cells.

18. Fertilization is internal.

19. Determinate cleavage (mosaic).

20. Generally complex life history.

21. They are free-living or phytoparasitic or zooparasitic.

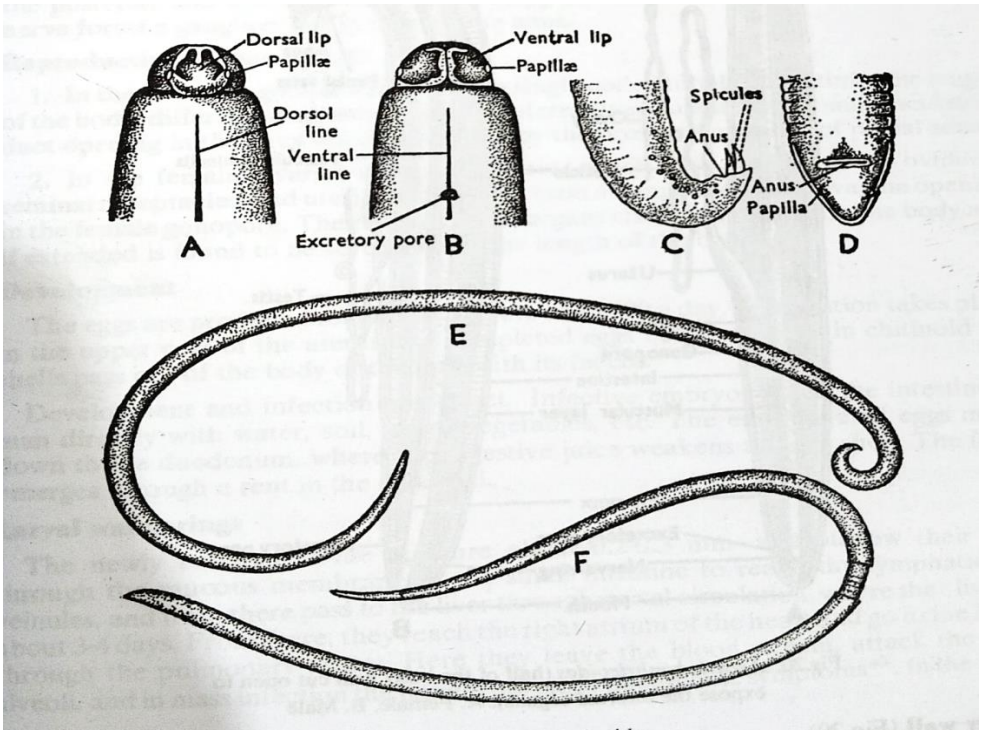
Ascaris sp.

Ascaris is a parasitic nematode which lives in the intestine of man. It is the largest of the common intestinal nematode parasite in man. The female is about 25-40 cm long and 6-8 mm in diameter. The male is considerably smaller, about 15-25 cm long with a maximum diameter of 3-4 mm.

External characters

1. The animal is narrow, elongated and light-yellowish brown in colour. Four white longitudinal streaks, one dorsal, one ventral and two laterals are present.

2. The mouth is anterior and terminal, markedly constricted off, and is bounded by three lips; one median and dorsal and two ventrolateral.



A. anterior end (dorsal view). B. anterior end (ventral view). C. posterior end of male (side view).D. posterior end of female (ventral view). E. male, F. female

3. Excretory pore is ventral and near the anterior end.

4. In male, the tail end is curved ventrally in the form of a hook with a conical tip.The anus opens at this tip and serves as a common aperture for rectum and genital duct. Two copulatory setae protrude from the aperture.

5. In female, the posterior extremity is conical and straight. The anus is situated slightly anterior to the posterior extremity on the ventral surface, guarded by one pair of postanal papillae.

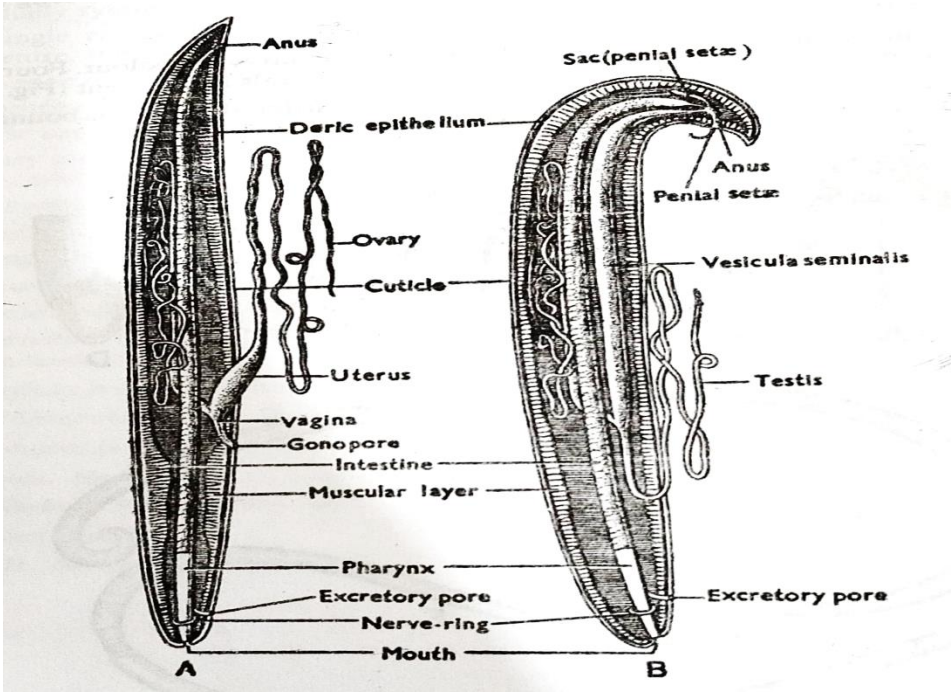
6. At about one-third of the entire length from the anterior end, the body is narrower in female and this region is known as vulvar waist. The vulva is situated on the ventral surface of the vulvar waist.

Body wall

1. The body is covered with a thick elastic transparent cuticle, which is divisible into several layers with numerous vertical channels. The transverse wrinklings of the cuticle give the characteristic segmental appearance of the body.

2. The epidermis is thickened along four longitudinal lines and consists of a proto- plasmic matrix, the syncitial ectoderm.

3. A single layer of longitudinal muscular fibres lines the coelom.



Digestive organ

It is a narrow straight tube divisible into three regions; the club-shaped fore gut or oesophagus is about 10-15 mm long and lined with cuticle; the voluminous mid gut is of endodermal origin and the hind gut or rectum is lined by cuticle.

Excretory organ

It consits of two lateral longitudinal canals which meet together ventrally and open in the excretory pore. Four or six big tuft-shaped cells with ramifying processes are in close contact with the canal. They absorb solid wastes and hand over the same to the canals in a dissolve state.

Nervous system

A nerve ring is present around the pharynx from which run six nerves forwards and six backwards. Of the six backwards, two; one dorsal and another ventral run up to the posterior end and they are connected by transverse nerve bands. The ventral nerve forms a ganglion just in front of the anus.

Reproductive organs

1. In the male, the genitalia consists of a single,coiled tubule, eight times the length of the body, differentiating into testis, vas deferens, vesicula seminalis and ejaculatory duct opening in the anus which is marked by the presence of a pair of penial setae.

2. In the female, ovaries are paired tubes, which pass gradually into oviducts, seminal receptacles and uteri, which join to form an unpaired conical vagina opening in the female gonopore. The female genital organs also remain coiled in the body and if extended is found to be several times the length of the body.

Development

The eggs are produced roughly at the rate of 20,000 a day. Fertilization takes place in the upper part of the uterus and completed eggs being enclosed in chitinoid egg shells pass out of the body of the host with its faeces. Development and infection are direct. Infective embryos reach the intestine of man directly

with water, soil, green vegetables, etc. The embryonated eggs move down to the duodenum, where the digestive juice weakens the egg shell. The larva emerges through a rent in the egg shell.

Larval wanderings

The newly hatched larvae measure about 0.2-0.3 mm and burrow their way through the mucous membrane of the small intestine to reach the lymphatics or veinules, and from there pass to the liver through portal circulation, where the live for about 3-4 days. From there, they reach the right atrium of the heart and go to the lungs through the pulmonary artery. Here they leave the blood stream, attack the lung alveoli, and in mass infection the patient develops pneumonic symptoms. In the lungs they moult twice. The larvae now crawl up the glottis and finally reach the intestine again. The cycle covers, on the average, a period of 10-15 days and the size of the larva increases from 0.2 mm to 2 mm. Fourth moulting occurs in the upper intestine in between 25th-29th day and the young continues to grow to attain the normal size Sexual maturity is attained in about 6-10 weeks .

Parastic adaptation

Because of certain peculiarities in structure such as the reduction of some organs and specialisation of others, Ascaris has been adopted to lead a normal life. A few of them are noted below.

1. The body is long, cylindrical in shape with both the ends pointed.

2. The body wall is covered with cuticle, formed of albuminous proteins and is resistant to the digestive enzymes of the host. Physiological studies show that the worm produces enzyme inhibitors that protect it from the host's digestive enzyme.

3. Locomotory organs are absent as protection from enemies and food supply are ensured by host.

4. Cilia are completely absent.

5. The alimentary canal is simple and poorly developed as the parasite feeds on the contents of the intestine of host which are in semi digested condition.

6. Respiration is almost entirely anaerobic. There is a large accumulation of fatty acids within the parasite, and this settles the first step needed for anaerobic glycolysis of glycogen, richly present in the tissue of the parasite. The energy thus produced is adequate for the worm to carry on its vital processes. It possesses some cytochrome thus it can respire aerobically also. For this is sometimes correctly referred to as 'facultative anaerobe' and not an obligate anaerobe.

7. Sense organs are poorly developed, being present only on lips in the form of papillae.

8. It is normally hypo osmotic to intestinal fluid.

9. The reproductive system is highly developed. Numerous eggs are produced and are covered with thick warty chitinous shell which protects them from the digestive enzyme of the host, prolonged dryness and cold for several days.

Phylum Annelida

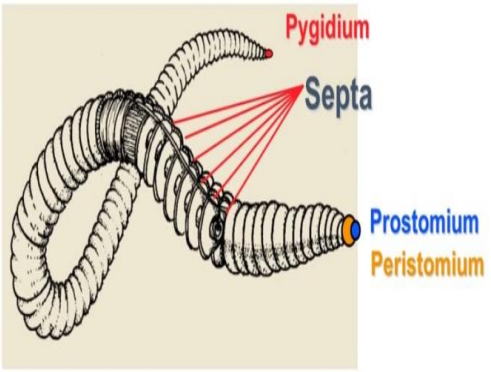
Annelids are also known as ringworms or segmented worms. Having over 17,000 species, they exist in various environments including marine waters, fresh waters and also in moist terrestrial areas. The size of the annelids can range from a few millimeters to an amazing three meters in length. The Australian earthworm measures around 3 meters. Furthermore some species from this phylum exhibit some unique shapes and brilliant colours. Annelids exhibit bilateral symmetry, coelomate and triploblastic. The body is segmented which is the most distinguishing feature of annelids.

Characteristics of Phylum Annelida

1. Elongated, segmented worms and the segments are often expressed externally by ring-like constrictions.

2. The head usually consists of a preoral prostomium and a postoral peristomium bearing sense organs in many cases.

3. The alimentary canal is straight and divisible into distinct regions.



4. The mouth and anus terminal and opposite.

5. Setae embedded in the skin are found in many cases. 6. The body cavity is a true coelom enclosed between the layers of mesoderm.

7. The nervous system consists of two dorsal cerebral ganglia connected with a ganglionated double-ventral nerve cord by two circumoesophageal connectives.

8. A closed blood vascular system is present.

9. The excretory organs are paired tubes, arranged metamerically and are known as nephridia or segmental organs. 10. Development may be direct or indirect with a trochophore larva.

The phylum has been divided into three classes

A. Class Polychaeta

1. Şetae develop in skin-sacs and elevated on the parapodia.

2. Segments are usually numerous, well-marked and similar throughout.

Class 1. Polychaeta

Class Polychaeta (Gr., poly-many; chaete- bristles) includes more than 8000 species having great diversity .

2. Exclusively marine; mostly carnivorous (predaceous or scavengers), some are herbivorous or deposit feeders.

3. Polychaetes may be errant (free-moving) or sedentary.

4. Polychaetes have varied habitats: surface-dwelling (crawling), gallery-dwelling, burrowing and tubicolous.

5. The majority is less than 10 cm long; some are as small as 1 mm and others as large as 70 cm.

6. Colour of the body may be red, pink or green.

7. Body is elongated and segmented. Each segment carries a pair of lateral, fleshy, paddle- like appendages or feet called parapodia. Parapodia bear many large setae or chaetae (in bundles).

8. Head is well developed (ie., cephalization well marked). It contains eyes, tentacles, cirriand palps.

9. Clitellum absent.

10. Cirri or branchiae (gills) or both may be present for respiration. Some part of parapodia is also used as a gas exchange surface.

11. Internal transport occurs through blood-vascular system or coelomic fluid or both. Gas transport uses three types of iron-containing respiratory pigments: haemoglobin (red in colour and most common), chlorocruorin (green in colour and occurs in Serpula, etc.) and haemerythrin [a nonhaem (lacking porphyrin) red protein pigment of Magelona]

12. Main sensory organs include eyes, nuchal organs or ciliated pits (chemoreceptors) and statocysts (e.g.. Arenicola).

13. Sexes are separate. Gonads are localized but extending throughout whole body.

14. Fertilization external, free-swimming larval stage is trochophore larva. No cocoon is formed.

15. Power of regeneration is well developed. For example, Chaetopterus can be regenerated from a single segment but this power is restricted in anterior most 14 segments.

16. Asexual reproduction occurs by lateral budding

Neanthes (previous name *Nereis*)

Belongs to Class polychaeta, phylum Annelida. It is commonly known as sandworm because it is found buried in sand, and also clam worm as it lives with clams. It is cosmopolitan in distribution. Neanthes lives in shallow seas, in rock crevices or hidden under the stones or sea weeds some live in tubular burrows of loose tubes made up of mucous in sand or mud at tide level. It is a carnivore, feeding on dead fishes, molluses etc. It is active during night and remains passive in day time.

"External features

1. The body is long, narrow, dorsoventrally flattened, bilaterally symmetrical with a tapering posterior and a broader anterior end.

2. The size varies from 300 to 400 mm in length and 2 to 6 mm in width.

3. Colour usually greenish-blue with tinges of red or yellowish brown.

4. A distinct head is present at the anterior end of the body. The rest of the body or the trunk is divided by ring-like narrow grooves into a series of segments, the metameres or somites, arranged in a linear series.

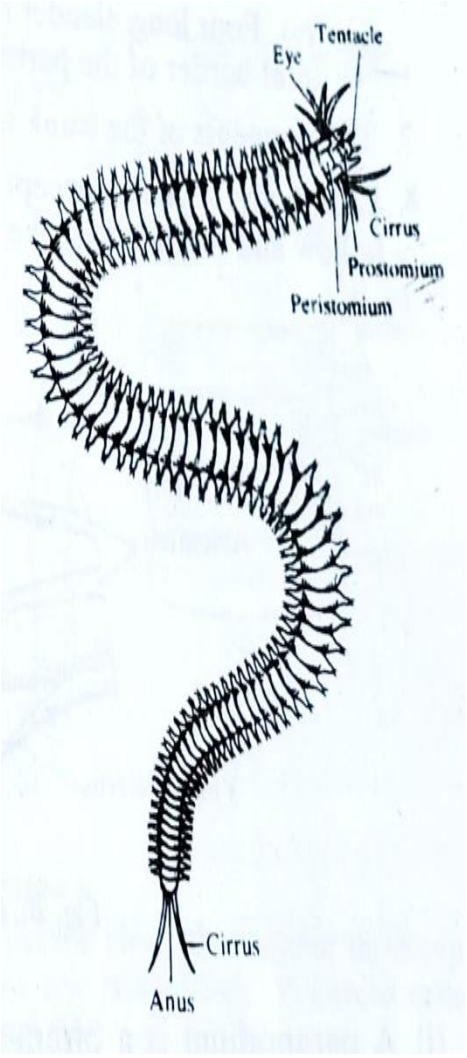
5. The number of metameres varies from 80 to 200.

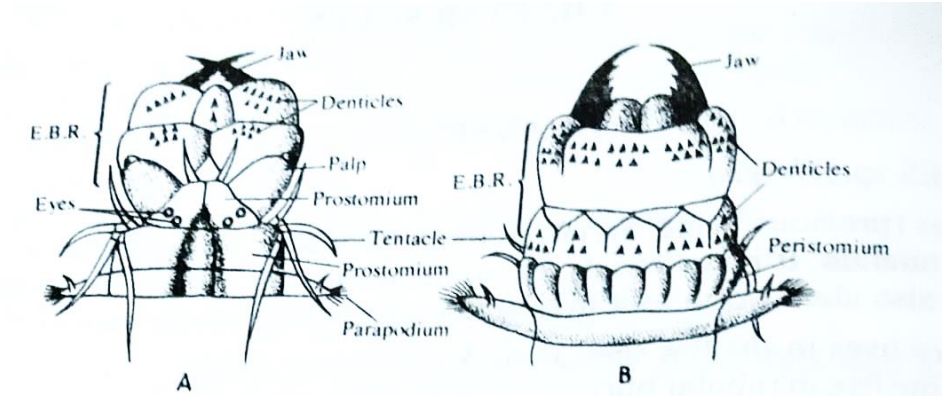
6. The head is differentiated into an anterior prostomium and a posterior peristomium

(a) The prostomium is a narrow, nearly tri- angular fleshy outgrowth situated mid- dorsally in front of the mouth.

(b) It is a large ring-like structure with a transverse ventral mouth and is formed by the fusion of first two body segments. It forms the lateral and ventral margins of the mouth.

(c) The head bears several sense organs. The important sense organs are - pro-stomial eyes, prostomial tentacles, prostomial palps, nuchal organs and peri- stomial cirri.





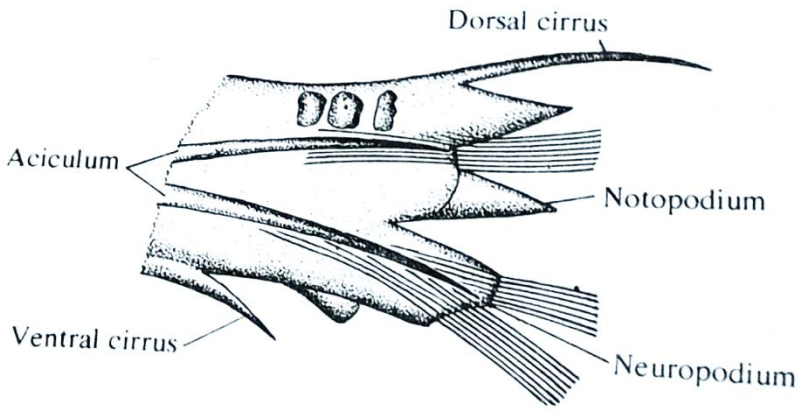
(i) Prostomial eyes are four and dorsal in position. They are round, black and sensitive to light.

(ii) The tentacles are a pair of short, cylindrical tactile organs projecting from the anterior border of the prostomium.

(iii) The palps are paired, long and jointed and tactile in function, located on the ventral side of the prostomium.

(iv) The nuchal organs are ciliated pits of doubtful function, one on each side of the prostomium. (v) Four long, slender cirri, tactile in function are present on the anterola teral border of the peristomium.

7. The segments of the trunk are almost similar in structure except the last one. 8. Each body segment except the anal bears on either lateral side a flat, fleshy, hollow and vertical flap-like outgrowth, the parapodium.



(i) A parapodium is a biramous appendage consisting of an upper or dorsal blade, the notopodium and a lower or ventral blade, the neuropodium. Each blade is further subdivided into two lobes, an upper and a lower.

(ii) The dorsal margin of the notopodium is produced into a short, cylindrical tactile appendage, the dorsal cirrus. A similar structure, ventral cirrus is present on the ventral margin of the neuropodium.

(iii) Both the noto and neuropodium have a bundle of bristle-like setae or chaetae, lodged in setigerous or chaetigerous sac formed by the invagination of the epidermis. The setae are moved by strands of muscle fibres present in the parapodium.

(iv) A stout, straight, thick and dark coloured chitinous rod called aciculum deeply embedded in the parapodium is present in the middle of each bundle of setae. The two acicula constitute the endoskeleton of the parapodium and serve to support and for attachment of the setal muscles.

9. The parapodia of the mid-body segments are largest and decrease in size towards both the anterior and posterior ends.

10. On the ventral side of the body, laterally and close to the base of each parapodium a minute opening, the excretory pore or nephridiopore is present.

11. The last segment is elongated; devoid of parapodia and bears a pair of long ventrally placed anal cirri and the anus. The segment is called as tail or analsegment or pygidium.

Class 2. Oligochaeta

1. Class Oligochaeta (Gr., oligo-few, chaete-bristles) includes about 3100 species. Oligochaetes approximate the polychaetes in size. Mostly freshwater or terrestrial (i.e, damp earth) forms

Pheretima sp. (Earthworm)

The earthworm (Pheretima) is a member of the order oligochaeta, class chaetopoda and phylum Annelida. It lives in self-made burrows in the upper layers of moist soil.

External features

1. The body of the earthworm is long, narrow, and almost cylindrical and slightly narrows down at both the ends. The anterior end is pointed, while the posterior end is more or less blunt.

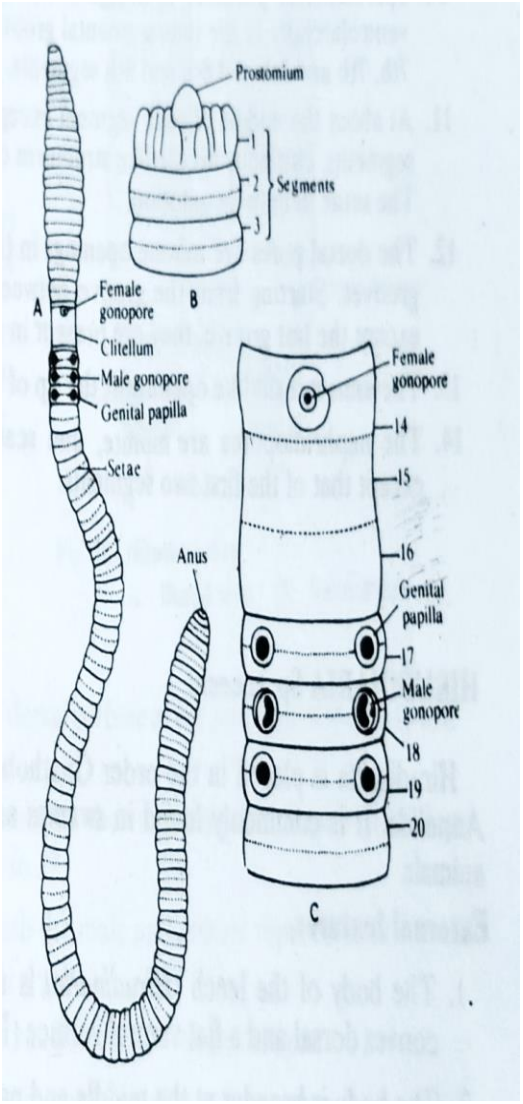
2. A full grown worm is about 150 mm long and 3 to 5 mm in diameter in the broadest portion of the body.

3. The dorsal surface is brown in colour while the ventral surface is dull grey. A dark median line runs along the dorsal surface throughout the length of the body.

4-The surface bears a series of narrow ring-like grooves, and the body is divided into about 100 to 200 small segments or metameres.

5. The external segmentation corresponds to internal segmentation and the body is separated internally into a number of compartments.

6. The mouth is a slightly ventral, crescent-shaped opening at the anterior end.



A small, fleshy lobe, the prostomium is situated on the dorsal surface of the first or the buccal segment and overhangs the mouth. 8. At a distance of about 20 mm posterior to the anterior end, a prominent band known as clitellum is present. 9. The clitellum includes three segments 14 to 16, and divides the body into three distinct regions; the anterior or the preclitellar, the middle clitellar and the posterior postelitellar regions.

(i) A median round aperture, the female genital pore is present on the ventral surface of the 14th segment.

(ii) A pair of crescentic apertures on raised papillae, the male genital pores are present on the ventral surface of the 18th segment (27C).

(ii) In front and behind the male pores, on the 17th and 19th segments, a pair of papillae, the genital papillae are present in each segment. The ventral surface of the 17th to 19th segments is called the genital area.

10. Spermathecal pores or openings of the spermathecae are four pairs, placed ventrolaterally in the intersegmental grooves between the 5th and 6th, 6th and 7th, 7th and 8th and 8th and 9th segments.

11. At about the middle of each segment except the first, the last, and the clitellar segments, chitinous needle-like structures called setae are arranged in a circle. The setae help in locomotion.

12. The dorsal pores are minute openings in the middorsal line of intersegmental grooves. Starting from the groove between the 12th and 13th segments and except the last groove, they are present in all the intersegmental grooves.

13. The anus is a slit-like opening at the tip of the last segment.

14. The nephridiopores are minute, and scattered irregularly all over the skin except that of the first two segments.

Class 3. Hirudinea

1. Class Hirudinea (L., hirudo a leech) includes about 500 species of leeches

2. Most are freshwater; some are marine or terrestrial. Some are ectoparasites.

3. Body is elongated and dorso-ventrally flattened.

4. Body consists of definite number of segments which may be further divided externally into 2 to 4 annuli. Head is indistinct.

5. Setae (except one genus), parapodia and cephalic appendages are absent.

6. Body is provided with a small suctorial anterior sucker and a large posterior sucker used for adhesion or locomotion. Both suckers are situated ventrally.

7. Clitellum present.

8. Coelom is greatly reduced. It is represented by a specialized circulatory system, called haemocoelomic system. True blood vessels are also present.

9. Coelom is filled up with characteristic botryoidal tissue. 10 The septa are absent. Metamerism is shown by nephridia and nervous system (ie, by gangila of the ventral nerve cord).

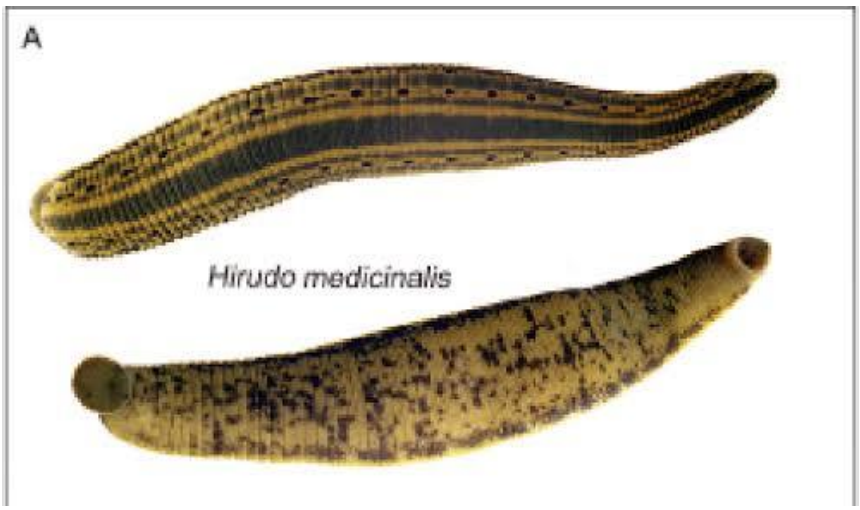
11. Hermaphrodite; fertilization is internal (cross fertilization due to copulation).

12. Development is direct (ie, no larval stage); eggs are laid in cocoons.

13. Vertebrates form the principal hosts of ectoparasitic, or blood-sucking leeches. Digestion of blood, which is slow, depends on exopeptidases (enzymes) produced by the leech and a symbiotic bacterial flora

Hiurdo medicinals

The general morphology of medicinal leeches follows that of most other leeches. Fully mature adults can be up to 20 centimeters in length, and are green, brown, or greenish-brown with a darker tone on the dorsal side and a lighter ventral side. The dorsal side also has a thin red stripe. These organisms have two suckers, one at each end, called the anterior and posterior suckers. The posterior is used mainly for leverage, whereas the anterior sucker, consisting of the jaw and teeth, is where the feeding takes place. Medicinal leeches have three jaws (tripartite) that resemble saws, on which are approximately 100 sharp edges used to incise the host. The incision leaves a mark that is an inverted Y inside of a circle. After piercing the skin, they suck out blood while injecting anticoagulants (hirudin).



Large adults can consume up to ten times their body weight in a single meal, with 5–15 mL being the average volume taken. These leeches can live for up to a year between feedings.

Medicinal leeches are hermaphrodites that reproduce by sexual mating, laying eggs in clutches of up to 50 near (but not under) water, and in shaded, humid places. A study done in Poland found that medicinal leeches sometimes breed inside the nests of large aquatic birds, noting that conservation efforts directed at bird habitats may also indirectly help preserve dwindling leech populations

Beneficial secretions

Medicinal leeches have been found to secrete saliva containing about 60 different proteins.These achieve a wide variety of goals useful to the leech as it feeds, helping to keep the blood in liquid form and increasing blood flow in the affected area. Several of these secreted proteins serve as anticoagulants (such as hirudin), platelet aggregation inhibitors (most notably apyrase, collagenase, and calin), vasodilators, and proteinase inhibitors.It is also thought that the saliva contains an anesthetic,as leech bites are generally not painful.

Phylum Arthropoda

The phylum Arthropoda contains a wide diversity of animals with hard exoskeletons and jointed appendages.

Arthropods are considered the most successful animals on Earth.

The phylum includes more species and more individuals than all other groups of animals combined. Over 85 percent of all known animal species are arthropods. They live in the widest range of habitats and eat the greatest varieties of food.

This phylum includes arachnids (e.g. spiders, mites and scorpions), crustaceans (e.g. crayfish, prawns and barnacles), insects (e.g. bugs, beetles and dragonflies) and myriapods (e.g. millipedes and centipedes).

Characteristic features of Phylum Arthropoda

1- The body is triploblastic, segmented, and bilaterally symmetrical.

2- They exhibit organ system level of organization.

3- The body is divided into head, thorax, and abdomen.

4-Their body has jointed appendages which help in locomotion.

5- The coelomic cavity is filled with blood.

6-They have an open circulatory system.

7- The head bears a pair of compound eyes.

8- The exoskeleton is made of chitin.

9- The terrestrial Arthropods excrete through Malpighian tubules while the aquatic ones excrete through green glands or coaxal glands.

10- They are unisexual and fertilization is either external or internal.

11- They have a well-developed digestive system.

12- They respire through the general body surface or trachea.

13- They contain sensory organs like hairs, antennae, simple and compound eyes, auditory organs, and statocysts.

Classification of Phylum Arthropoda

6 Subphyla Crustacea, Myriapoda, Hexapoda, Chelicerata, Onychophora and Trilobitomorpha.

Crustacea

- They are aquatic, terrestrial, or parasitic.
- The head is fused with the thorax region known as the cephalothorax.
- Respiration occurs through gills or general body surface.
- The body is covered by a single large carapace.
- They possess two pairs of antennae and five pairs of appendages.
- They excrete through green glands or antennal glands.
- They have a pair of compound eyes and gonopores.
- Development is indirect. Larval stage is present.

  Eg., Daphnia, Palaemon

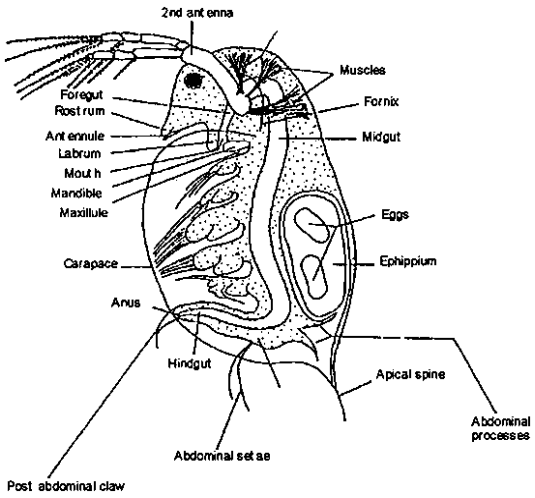
- The subphylum Crustacea is divided into six classes-

(Branchiopoda , Remipedia , Chephlocarida, Maxillopoda,

Ostracoda and Malacostraca)

Daphnia is a genus of small planktonic crustaceans, and are one of the several small aquatic crustaceans commonly called water fleas because their saltatory swimming style resembles the movements of fleas.The body of a *Daphnia* species is usually 1–5 mm (0.039–0.197 in) long, and is divided into segments, although this division is not visible. The head is fused, and is generally bent down towards the body with a visible notch separating the two. In most species, the rest of the body is covered by a carapace, with a ventral gap in which the five or six pairs of legs

lie. The most prominent features are the compound eyes, the second antennae, and a pair of abdominal setae. In many species, the carapace is translucent or nearly so, so they make excellent subjects for the microscope, as one can observe the beating heart.



Even under relatively low-power microscopy, the feeding mechanism can be observed, with immature young moving in the brood pouch; moreover, the eye being moved by the ciliary muscles can be seen, as well as blood cells being pumped around the circulatory system by the simple heart. The heart is at the top of the back, just behind the head, and the average heart rate is about 180 bpm under normal conditions. *Daphnia* sp., like many animals, are prone to alcohol intoxication, and make excellent subjects for studying the effects of the depressant on the nervous system due to the translucent exoskeleton and the visibly altered heart rate. They are tolerant of being observed live under a coverslip and appear to suffer no harm when returned to open water. This experiment can also be performed using nicotine, or adrenaline, each producing an increase in the heart rate.

Due to its intermediate size, Daphnia spp. use both diffusion and circulatory methods, producing hemoglobin in low-oxygen environments.

Myriapoda

- These are mostly terrestrial.
- The body is elongated with numerous segments.
- The head is provided with antennae, two pairs of jaws, and a pair of simple eyes.
- They contain numerous legs.
- The upper lip of the mouth contains epistome and labrum, and the lower lip contains a pair of maxillae.
- A pair of mandibles is present inside the mouth.
- They respire by trachea and excretion occurs by Malpighian tubules.

  Eg., Julus, Scolopendra

- The subphylum Myriapoda is divided into the following classes: Chilopoda ,Diplopoda, Pauropoda ,Symphyla
  The genus ***Scolopendra*** contains many species of centipedes found across the world's tropics and warmer temperate areas. The species vary considerably in coloration and size. *Scolopendra* are mostly very large centipedes. The largest species found in tropical climates can exceed 30 cm (12 in) and are the largest

living centipedes in the world. All *Scolopendra* species can deliver a painful bite, injecting venom through their forcipules, which are not fangs or other mouthparts; rather, these are modified legs on the first body segment.

Scolopendra species are active predators, feeding primarily on insects and other invertebrates. Larger specimens have been observed preying on frogs, tarantulas, lizards, birds, snakes, rodents, and even bats.

Hexapoda

- They are mostly terrestrial.
- The body is differentiated into head, thorax, and abdomen.
- Head bears a pre-segmental acron.
- The thorax is divided into three segments.
- The abdomen has 7-11 segments.
- They have three pair of appendages.
- It has a pair of compound eyes
- They respire through gills and trachea.
- Malpighian tubules are the excretory organ.
- Development is indirect, and the larval stage is present.

Eg., Tabernus, Mosquitoes, Ants.

- The subphylum Hexapoda is divided into two classes:

  Insecta and Entognatha

As true flies, mosquitoes have one pair of wings, with distinct scales on the surface. Their wings are long and narrow, as are

their long, thin legs. They have slender and dainty bodies of length typically 3–6 mm, with dark grey to black coloring. Some species harbor specific morphological patterns. When at rest they tend to hold their first pair of legs outward.

Chelicerata

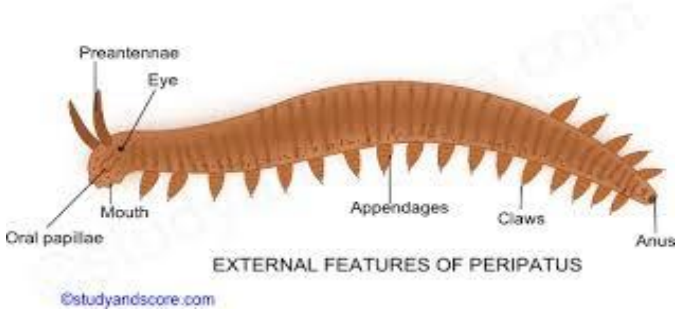
- They are mostly found on land.
- The body is differentiated into cephalothorax and abdomen.
- Antennae are absent.
- The abdomen is divided into 13 segments.
- It has four pairs of interior appendages.
- They respire through trachea or gills.
- The Malpighian tubules help in excretion.

Eg., Aramea, Limulus , *Buthus*(scorpion)

- The subphylum Chelicerata is divided into the following classes: Arachnida , Merostomata ,Pycnogonida

Onychophora

- These are small-sized, terrestrial arthropods.
- The body is divided into segments.
- Excretion occurs through nephridia.
- They respire through



the trachea.

Eg., Paripatus

Trilobitomorpha

- These are primitive arthropods and are extinct.
- They were found in abundance during the Paleozoic era.
- The body was divided into three lobes- one median and two lateral lobes.
- Head bore a pair of compound eyes and a pair of antennae.
- There was no structural differentiation of the body parts.
- The body was divided into head, thorax and pygidium.
- Appendages are biramous.
- The subphylum had only one class- Trilobita

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