LOW PRICE EDITION

A TEXT BOOK OF
INVERTEBRATES

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SaraS
Publications

4. Rearing the enemies of mosquito and its larvae like larvivorous fishes (stickle backs, minnows and trouts), ducks, dragon flies, etc. This method is called ***biological control.***

5. Constructing mosquito proof houses.

6. Using mosquito nets.

7. Applying anti mosquito creams on the surface of the body.

Treatment

Malaria can be treated with the following drugs: ***Quinine, Daraprim, Chloroquine, Paludrine, Plasmoquine***, etc.

9. Paramecium

Phylum	:	*Protozoa*
Class	:	*Ciliophora*
Order	:	*Holotricha*

Paramecium is a ***unicellular*** or ***acellular*** or ***non-cellular animalcule.*** Hence it is included in the phylum Protozoa. It moves with the help of ***cilia.*** Hence it included in the class ***ciliata*** or ***ciliophora.***

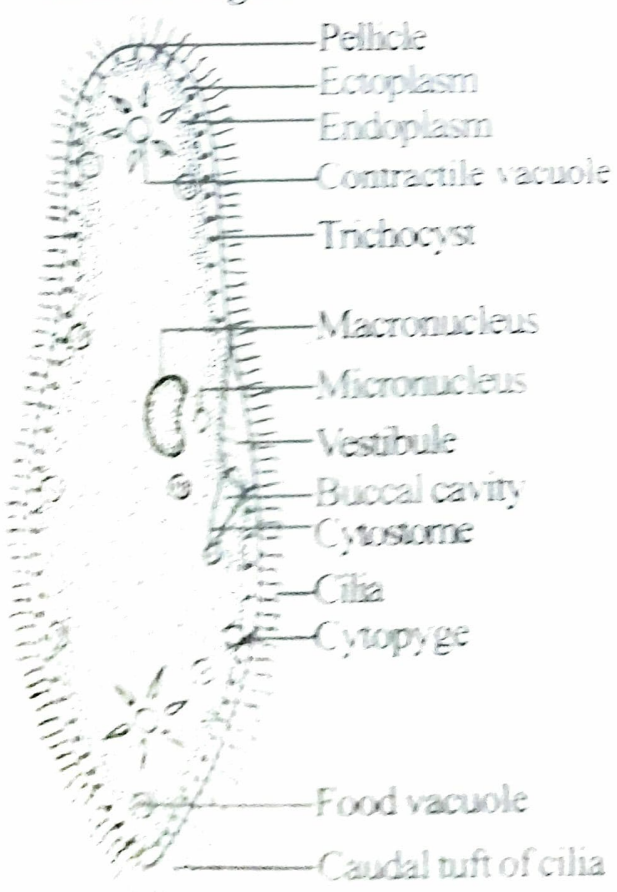


Fig. 3.14. Paramecium.

Paramecium lives in freshwater formations like ponds, pools, ditches, rivers, lakes and so on. It swims freely in the water. It is omnivorous in habit.

Paramecium looks like a slipper. Hence it is called ***slipper animalcule.*** It has a distinct anterior end, a posterior end, a dorsal side and a ventral side. The anterior end is blunt; the posterior end is pointed; the ***ventral*** side has an oral groove. *Paramecium* is smaller in size. It is minute and microscopic. It has a length of 0.17mm to 0.29mm..

Paramecium is covered by a thin, elastic membrane called ***pellicle.*** The pellicle bears hair-like structures called ***cilia.*** The body is filled with cytoplasm. The cytoplasm contains nucleus, contractile vacuole, food vacuoles, basal granules, trichocysts, etc.

Oral Apparatus

On the ventral side, there is a groove called ***oral groove.*** The oral groove leads into a funnel-like structure called ***vestibule.*** The vestibule leads into ***buccal cavity.*** The buccal cavity is followed by a small opening called ***cytostome.*** The cytostome opens into a short tubular structure called ***cytopharynx.*** The cytopharynx ends in the cytoplasm where new food vacuoles are formed. Just behind the cytopharynx there is a temporary opening called ***cytopyge*** or ***cell anus*** or ***anal spot.***

Cytoplasm

The body of the *Paramecium* is filled with a colloidal substance called ***cytoplasm.*** The cytoplasm is formed of two regions, namely ectoplasm and endoplasm. Ectoplasm is located just below the pellicle. It is a denser fluid. It contains ***basal granules*** and ***trichocysts.*** The central part of the cytoplasm is called ***endo-***

plasm. It is less dense. It contain a ***nucleus, contractile vacuoles*** and ***food vacuoles.***

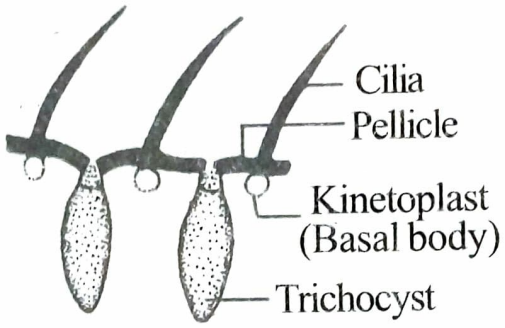


Fig.3.75: Paramecium: a portion showing cilia and trichocysts.

Cilia

Cilia are the locomotory structures situated on the body of *Paramecium*. They are arranged in longitudinal rows and are uniformly distributed on the body. This type of arrangement is called ***holotrichous.***

Each cilium arises from a spherical body called ***basal granule*** or ***kinetosome.*** The basal granule lies inside the ectoplasm. Each cilium is covered by a thin covering called ***cytoplasmic sheath.*** The substance of the cilium is called ***matrix.*** The matrix contains ***9 double longitudinal fibres.*** These fibres are arranged along the periphery of cilium. Hence these fibres are called ***peripheral fibres.*** In addition, in the centre of the cilium there are two longitudinal fibres. These are called ***central fibres.***

Trichocyst

Trichocysts are conical bag-like structures located in the ectoplasm of *Paramecium*. They are formed from basal granules. They lie perpendicular to the body surface in between the basal granules. The inner end has a ***cap.***

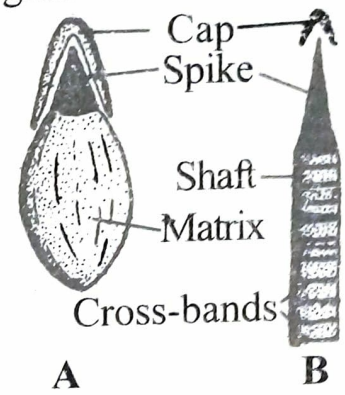


Fig.3.77: Trichocyst A. Resting B. Discharged

sule. The capsule is filled with a gelatinou***refractive fluid.*** The fluid contains a swellin substance. The refractive fluid and the swell ing substance together form the ***matrix.*** A the outer end of the trichocyst there is a spine like structure called ***spike.*** The spike is cov ered by a ***cap.***

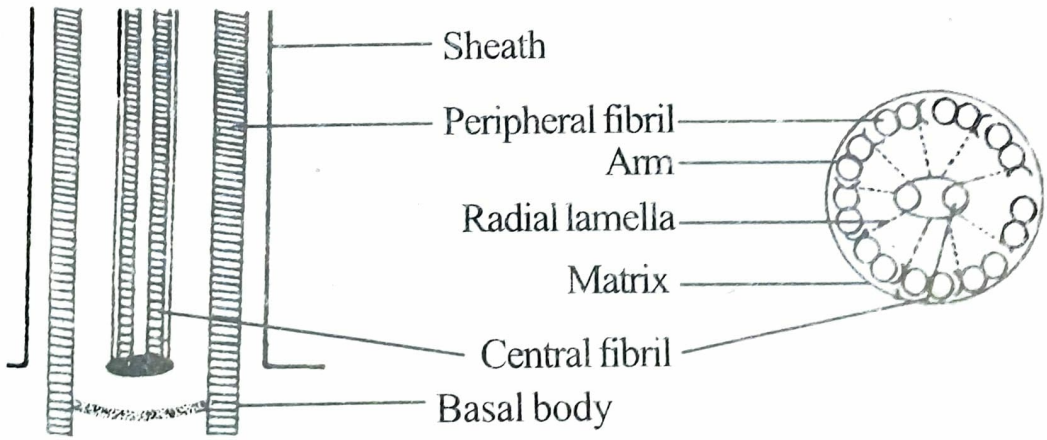


Fig.3.76: A - L.S. and B - T.S of Cilium.

When the *Paramecium* is disturbed, th trichocysts shoot out. The cap ruptures. Th discharged trichocyst is in the form of a stick elongated thread. It has a ***shaft.*** The shaft ha cross bands. One end is attached to capsule The free end has the ***spike.*** The main functio of the trichocyst is both ***offense*** and ***defence***

Nucleus

The endoplasm of *Paramecium* contains two nuclei. One nucleus is larger in size and the other is smaller in size. The larger nucleus is called ***macronucleus.*** It is bean-shaped or kidney-shaped. It controls all the vegetative functions of the body. The smaller nucleus is called ***micronucleus.*** It is located in the depression of the macronucleus. It is reproductive in function.

Contractile Vacuoles

Two contractile vacuoles are found in *Paramecium*. They are located one at each end of the body. They exhibit contraction (systole) and relaxation (diastole). Each contractile vacuole has a covering of thin, elastic and semi-permeable membrane. Each contractile vacuole opens to the outside on the dorsal side through a short ***discharge canal.***

Each contractile vacuole is surrounded by six to ten elongated canals called ***radial canals***. Each radial canal is formed of three regions, namely a proximal ***injector canal,*** opening into the contractile vacuole, a middle ***ampulla*** and a distal ***terminal part.*** The ***terminal part is*** connected with a network of minute tubules called ***nephridial canals*** ramifying the cytoplasm.

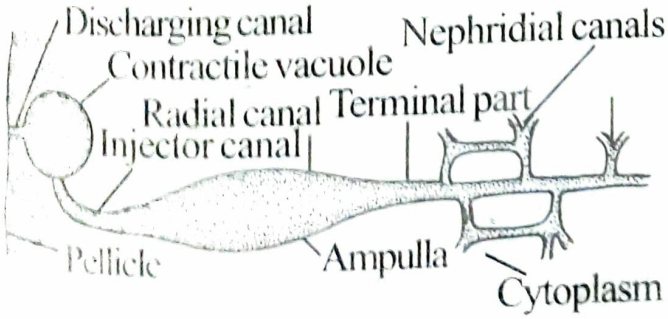


Fig. 3.78: Contractile vacuole of Paramecium.

Functions

The contractile vacuole has two functions, namely ***osmoregulation*** and ***excretion.***

Osmoregulation: Osmoregulation is a process where the body maintains a constant water content. *Paramecium* lives in freshwater. So the cytoplasm of the body is more concentrated than the freshwater. As a result freshwater continuously enters the body by ***endosmosis.*** This increases the water content of the body. This excess of water from the cytoplasm is collected by ***nephridial canals.*** They pour into the ampulla through the terminal part of the radial canal. When the ampulla is fully loaded, it discharges its contents into the contractile vacuole. When the contractile vacuole is fully loaded, it contracts***(systole).*** During systole, the water is expelled out through the discharge canal. Then the contractile vacuole relaxes***(diastole).*** During diastole, the contractile vacuole is gradually filled with water.

Excretion:The outgoing water also carries with it nitrogenous waste products.

Nutrition

Nutrition is a general term which includes ***oral apparatus, food, mode of feeding, digestion, absorption*** and ***egestion*** (defaecation). *Paramecium* swallows or engulfs the solid food materials. This mode of nutrition is called ***holozoic.***

Food

Paramecium feeds on bacteria, diatoms, algae, small protozoans and small pieces of animals and plants. As it feeds on animal and plant materials, *Paramecium* is called an ***omnivorous*** animal.

Oral Apparatus

Paramecium feeds with the help of oral apparatus. The oral apparatus is located on the ventral side. It is formed of ***oral groove, vestibule, buccal cavity, cytostome*** and ***cytopharynx.*** The cytopharynx opens into the endoplasm. The oral apparatus is well ciliated.

Behind the cytopharynx, a temporary opening is formed at the time of egestion. This opening is called ***cytopyge*** or ***cell anus*** or ***anal spot.***

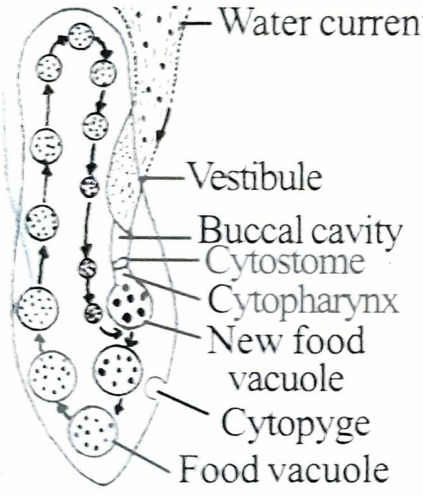


Fig.3.79: Paramecium: Nutrition.

Feeding Mechanism

Paramecium feeds when it is at rest. It moves to a place where there is plenty of food. The cilia of the oral apparatus beat vigorously. This causes a water current. The water current along with food particles passes through the oral groove and vestibule. The cilia of the vestibule direct the food particle into the cytopharynx through the cytostome. The food particles are collected at the tip of the cytopharynx in a membranous vesicle. When sufficient amount of food particles are collected, it is separated from the cytopharynx as a vesicle. This vesicle is called ***food vacuole.*** The food vacuole is a drop of water containing food particles. The food vacuole is formed every 1to 5 minutes.

Cyclosis

After separation from the cytopharynx, the food vacuole moves in the endoplasm in a definite direction. It moves backwards along the ventral side. After reaching the posterior end it moves forwards along the dorsal side. After reaching the anterior end, again it moves backwards along the ventral side. Finally it reaches the cytopyge. This cyclical movement of food vacuole is called ***cyclosis.*** Cyclosis is caused by the streaming movement of cytoplasm. During cyclosis, the food materials are killed, digested and absorbed. As digested food materials are absorbed into the cytoplasm during cyclosis the size of the food vacuole gradually decreases.

Digestion

In the beginning, hydrochloric acid is secreted into the food vacuole. Hence the food vacuole becomes ***acidic.*** In the acidic medium, the food materials are killed. Then digestive enzymes are secreted by the endoplasm and are poured into the food vacuole. As the food vacuole moves forward, the acid disappears and the medium of food vacuole changes into ***alkaline.*** In the alkaline medium, the food particles are digested.

Carbohydrate is digested into ***glucose;*** Proteins are digested into ***amino acid;*** Fats are digested into ***fatty*** acids and ***glycerol.***

Carbohydrate----------> Glucose

Proteins---------->Amino acids

Fats---------->Fatty acids + Glycerol

Absorption

The digested food materials are absorbed into the endoplasm. As absorption takes place, the food vacuole becomes smaller in size.

Egestion

When the food vacuole reaches the cytopyge it contains only undigested waste products. These waste products are eliminated through the cytopyge. This is called ***egestion*** or ***defaecation.***

Locomotion

Locomotion is the movement of animals from one place to another. *Paramecium* moves mainly with the help of cilia. Hence the locomotion in *Paramecium* is called ***ciliary***

locomotion. It can move forwards as well as backwards.

Mechanism of Locomotion

Paramecium moves by beating the cilia. The beating of each cilium can be compared to the oscillation of a pendulum. Each oscillation has a backward movement and a forward movement. The backward movement is called ***effective stroke.*** During effective stroke the cilium becomes slightly curved rigid and it strikes the water backwards like an oar. As a result of effective stroke, the animal is propelled forwards. The forward movement of cilium is called ***recovery stroke.*** During recovery stroke, the cilium becomes loose and is brought to its original place. It is now ready for the next effective stroke.

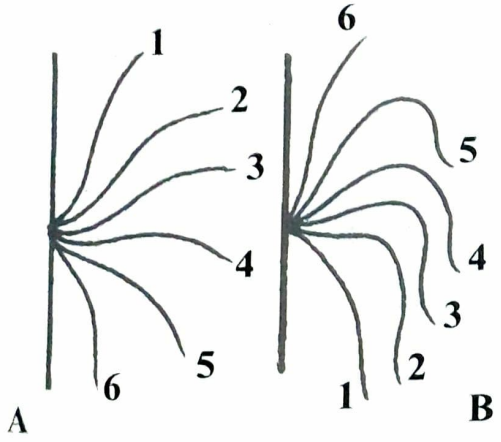


Fig.3.80: Ciliary movement: A. Effective stroke, B. Recovery stroke.

The cilia of the transverse row beat simultaneously. But the cilia of the longitudinal row beat one after another. This brings about a wave-like movement of cilia similar to the wave-like movement of paddy crop in a paddy field as wind flows. This wave like movement of cilia is called ***metachronal rhythm.***

Paramecium does not move in a straight line; but rotates spirally like a bullet. This is due to two reasons 1. The cilia of the oral apparatus beat vigorously, and 2. The cilia of the body do not beat straight but obliquely.

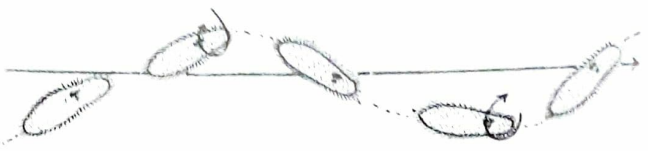


Fig.3.81: Spiral path and rotation of Paramecium.

Reproduction

Reproduction is a process by which offspring are produced by the parents. *Paramecium* exhibits asexual reproduction and sexual reproduction.

Asexual Reproduction

In asexual reproduction, offspring are produced without the involvement of gametes. The most common asexual reproduction exhibited by *Paramecium* is ***binary fission.***

Binary Fission

Binary fission is an asexual reproduction where a fully grown *Paramecium* is equally divided into two offsprings. Here the division occurs transversely; hence the binary fission is called ***transverse binary fission.***

It occurs during favourable seasons. During binary fission, the *Paramecium* stops feeding; oral apparatus disappears. The micronucleus elongates and becomes divided into two daughter micronuclei by mitosis. The macronucleus also elongates and becomes divided into two daughter macronuclei by amitosis. At the sametime a transverse constriction appears in the middle of the body. This constriction deepens gradually and finally the body is divided into two daughter *Paramecia.*

Each daughter *Paramecium* receives a contractile vacuole from the parent. The second contractile vacuole is developed newly. Each daughter also develops an oral apparatus.

The entire process of binary fission is completed within 30 minutes. A *Paramecium*

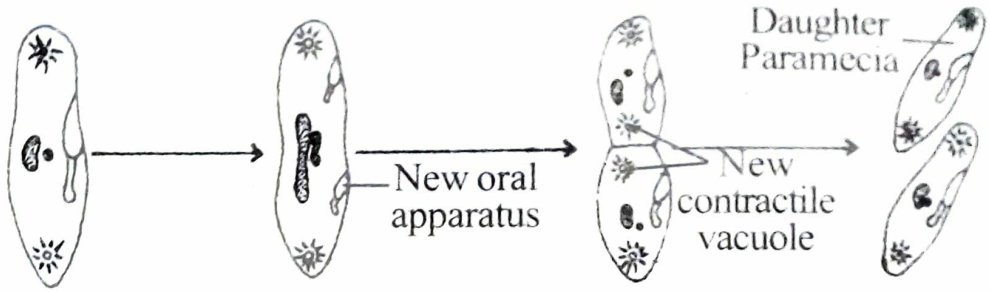


Fig.3.82: Paramecium - Binary fission.

undergoes binary fission once in every 26 hours.

Significance of binary fission: 1. It occurs during favourable season. 2. It produces a large number of offspring within a limited duration.

Sexual Reproduction

In sexual reproduction gametes are produced for the production of offspring. *Paramecium* exhibits about 5 types of sexual reproduction. They are

1. Conjugation
2. Autogamy
3. Endomixis
4. Hemixis and
5. Cytogamy.

1. Conjugation

Conjugation is the temporary union of two individuals for the exchange of nuclear materials.

In conjugation two *Paramecia* of different mating types come closer and contact with their ventral surfaces. These *Paramecia* are called ***conjugants.***

They stop feeding and their oral apparatus disappears. The pellicle and ectoplasm of the two individuals disappear at the point of contact. The conjugants are connected by a cytoplasmic bridge called ***conjugation canal.***

The macronucleus has no role in conjugation. It simply breaks into fragments and is absorbed into the cytoplasm.

The micronucleus divides by ***meiosis*** (reduction division). As a result four ***haploid*** daughter nuclei are produced in each conjugant.

Then three nuclei in each conjugant disappear.

The remaining nucleus unequally divides into two nuclei called ***pronuclei*** or gametic nuclei.

The large pronucleus is called ***stationary pronucleus*** or female pronucleus. The smaller pronucleus is called ***migratory pronucleus*** or male pronucleus.

The migratory nucleus of each conjugant passes through the conjugation canal into the other conjugant and fuses with the stationary nucleus.

The fused nucleus is called ***synkaryon*** or conjugation nucleus or ***zygotic nucleus.*** It is diploid.

After the formation of zygotic nucleus, the two conjugants separate.

The separated conjugant are called ***exconjugants.***

In each exconjugant, the zygotic nucleus divides thrice to produce 8 nuclei.

Of these, four nuclei enlarge to become ***macronuclei*** and the remaining form ***micronuclei.***

Then three micronuclei disappear.

The micronucleus divides into ***two*** with the binary fission of each exconjugant into ***two*** daughters. Now each daughter will be carrying one micronucleus and two macronuclei.

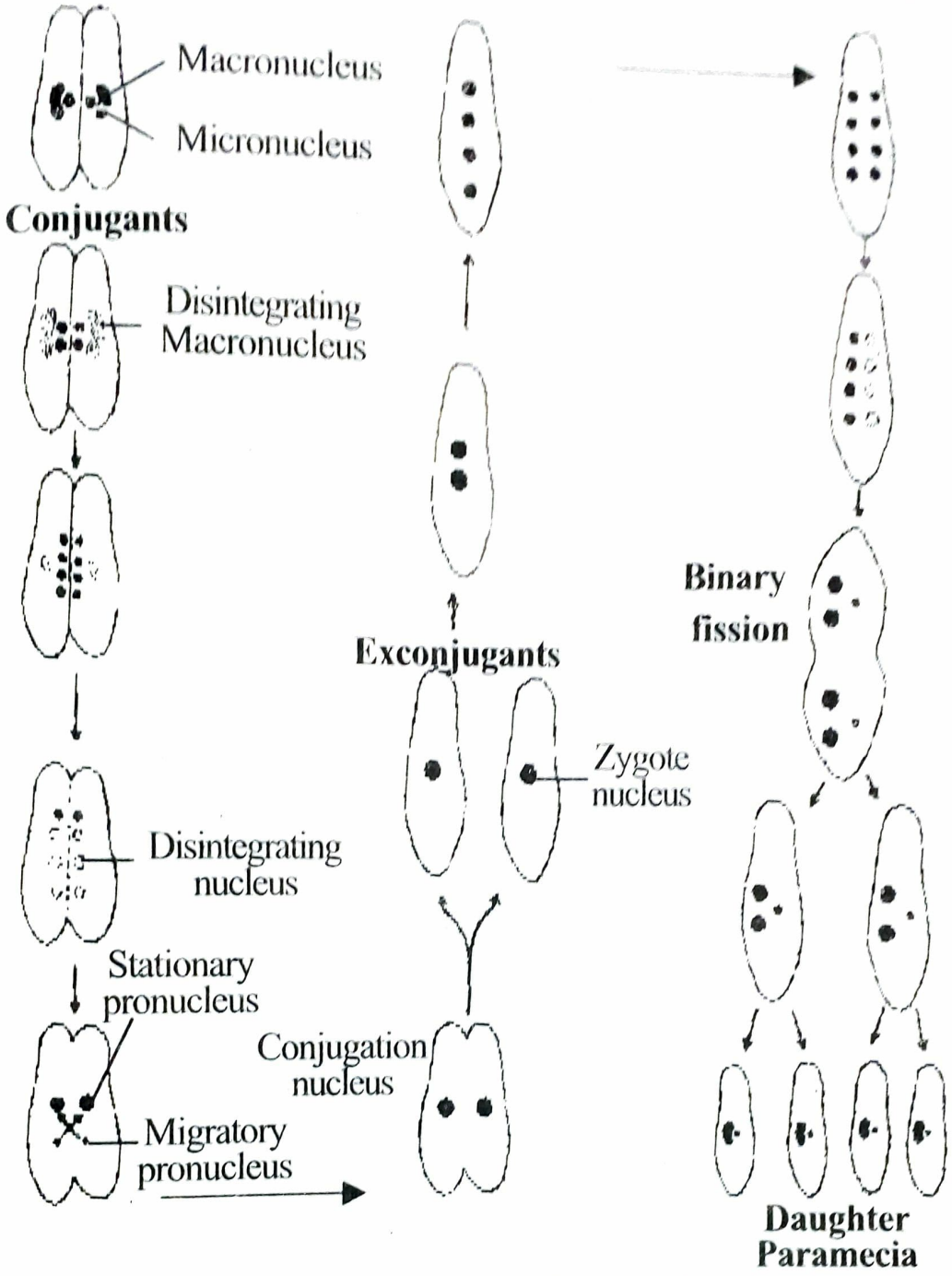


Fig.3.83: Paramecium: Conjugation.

Then the micronucleus again divides into two with the binary fission of the daughter *Paramecium*.

Thus each exconjugant produces 4 daughter *Paramecia*. As there are two exconjugants, in conjugation 8 daughter *Paramecia* are produced.

Significance of Conjugation: 1. Conjugation maintains the vigour. 2. In conjugation, the old macronucleus is replaced by a new macronucleus. 3. In conjugation, the nuclear materials of two different mating types are exchanged. Hence conjugation brings about the recombination of genetic materials and the origin of ***genetic variations.***

2. Autogamy (Automixis)

It is the nuclear reorganization occurring in a single individual. It occurs in *Paramecium aurelia* which is characterized by the presence of one macronucleus and two micronuclei. The macronucleus breaks into fragments and is absorbed into the cytoplasm. The micronuclei divide by reduction division. As a result 8 haploid nuclei are produced; 7 of these nuclei disappear and the remaining one divides into two gametic nuclei. At this time, the *Paramecium*

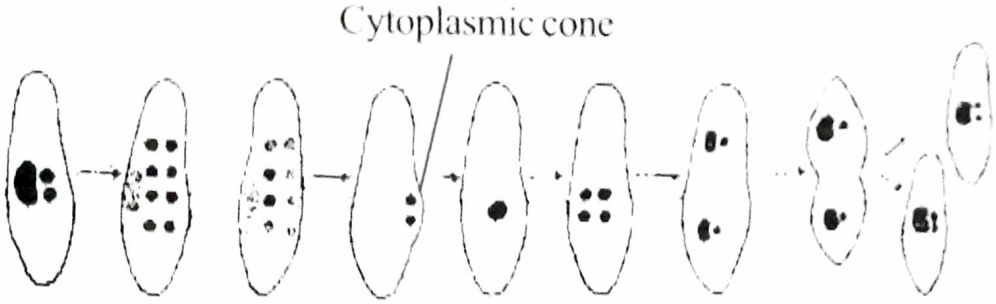


Fig.3.84: Paramecium: Autogamy.

develops a cytoplasmic cone on the ventral side. The two gametic nuclei enter the cytoplasmic cone and fuse together to form a diploid ***zygotic nucleus*** or ***synkaryon.*** The synkaryon divides two times to produce 4 nuclei. Two of these nuclei increase in volume and become macronuclei and the remaining two form the micronuclei. At this time micronuclei divide into two followed by the binary fission of the parent, producing two daughter *Paramecia*, each receiving one macronucleus and two micronuclei. Thus in autogamy two daughter *Paramecia* are produced.

3. Endomixis

It is another type of sexual reproduction occurring in P. aurelia. In endomixis, reorganization of nuclear material occurs in a single individual. The macronucleus divides into fragments and is absorbed into the cytoplasm. The micronuclei divide twice to produce eight daughter nuclei; six nuclei degenerate; *Paramecium* undergoes binary fission; each daughter receives one nucleus. Then the micronucleus divides twice, in each daughter producing four nuclei. Two nuclei enlarge to become macronuclei and the remaining two become the micronuclei. Then the micronuclei divide with the binary fission of the individual into two daughter *Paramecia*. Each daughter *Paramecium* receives one macronucleus and two micronuclei. Thus endomixis produces four daughter individuals from a single *Paramecium*.

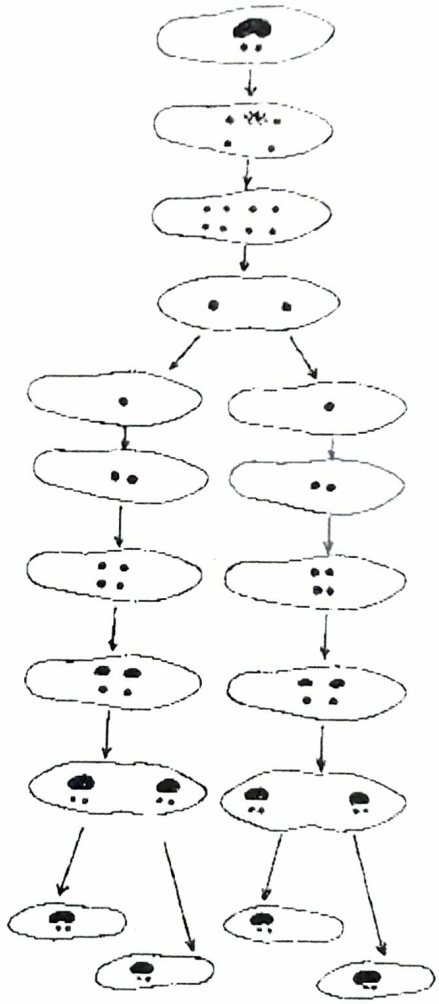


Fig.3.85: Endomixis.

Fig.3.86: Hemixis.

4. Hemixis

Hemixis is a kind of reproduction where the macronucleus alone undergoes reorganization. The micronucleus remains inert. The macronucleus divides into many fragments. Certain fragments are absorbed into the cytoplasm. The remaining fragments become the macronuclei. This is followed by the binary fission.

5. Cytogamy

It is a kind of sexual reproduction where two individuals temporarily fuse and then separate without any nuclear exchange. It occurs in *Paramecium caudatum*. In cytogamy, two *Paramecia* come together by their ventral surfaces. But the pellicle does not break. The micronucleus divides thrice to form eight micronuclei. Six micronuclei disintegrate. The remaining two nuclei fuse together to form a ***synkaryon.*** The two *Paramecia* now separates.

2. Ascon Sponge (Leucosolenia)

Phylum : *Porifera*

Class : *Calcarea*

Order : *Homocoela*

Leucosolenia is a simple type of sponge called ***asconoid sponge.*** As its body is perforated by numerous pores, it is included in the phylum ***Porifera.*** Porifera includes the most primitive multicellular organisms.

It is a marine colonial sponge. It is found attached to rocks. It is found in sea-shore areas.

Leucosolenia is a branched ***colony.*** The colony consists of ***horizontal tubes*** and ***vertical tubes.***

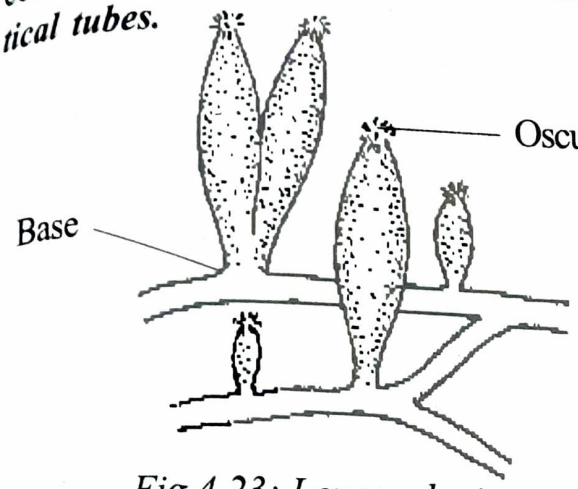


Fig.4.23: Leucosolenia.

The horizontal tubes are branched and they bear ***adhesive discs*** by which the colony is attached to the substratum.

The vertical tubes are unbranched and they form the individuals of the colony.

Each individual is ***vase-shaped.*** It is 2.5 cm in height. The surface of the body contains numerous minute openings called ***ostia.*** The ostia open into a large cavity called ***spongocoel*** located inside the body. The spongocoel opens to the outside by a large opening called ***osculum*** situated at the free end of the body.

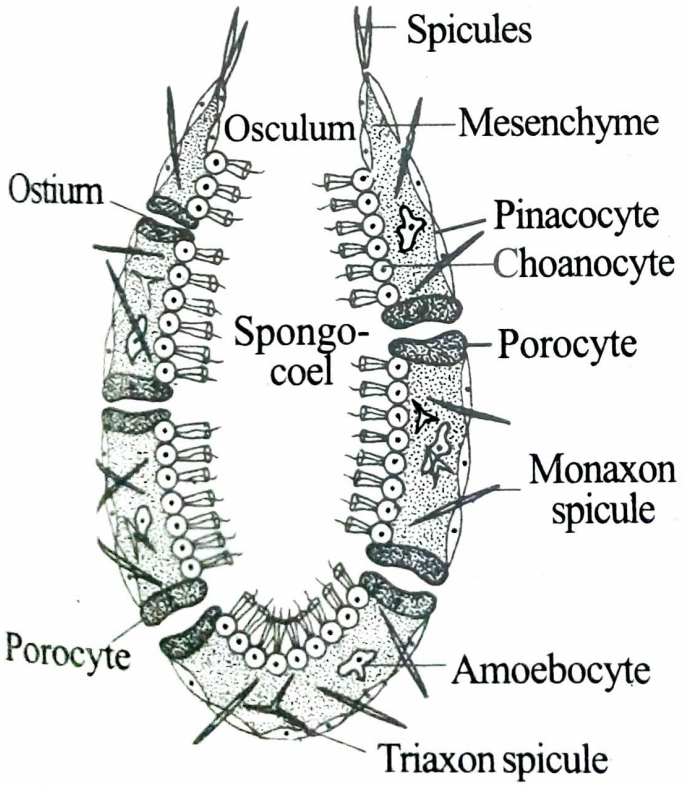


Fig.4.24: L.S. of Leucosolenia.

Body Wall

The body wall is ***diploblastic.*** It is formed of an outer ***ectoderm*** and an inner ***choanoderm***. There is a gelatinous substance lying in between them, called ***mesenchyme.***

1. Ectoderm

It is the outer layer. It is formed of a layer of flat, polygonal cells called ***pinacocytes***. Certain ***pinacocytes*** are tubular in shape. They are called ***porocytes.*** Each porocyte contains a minute canal inside called ***ostium.*** The ostia open into the spongocoel.

2. Choanoderm

It is the inner layer. It is formed of a layer of flagellated cells called ***choanocytes***. A choanocyte has a ***cell body*** and a ***collar.*** The cell body contains a ***nucleus***. The collar is funnel-shaped and it surrounds a ***flagellum*** which arises from a ***basal granule.*** Choanocytes have two functions, namely ***feeding*** and ***creating water current.***

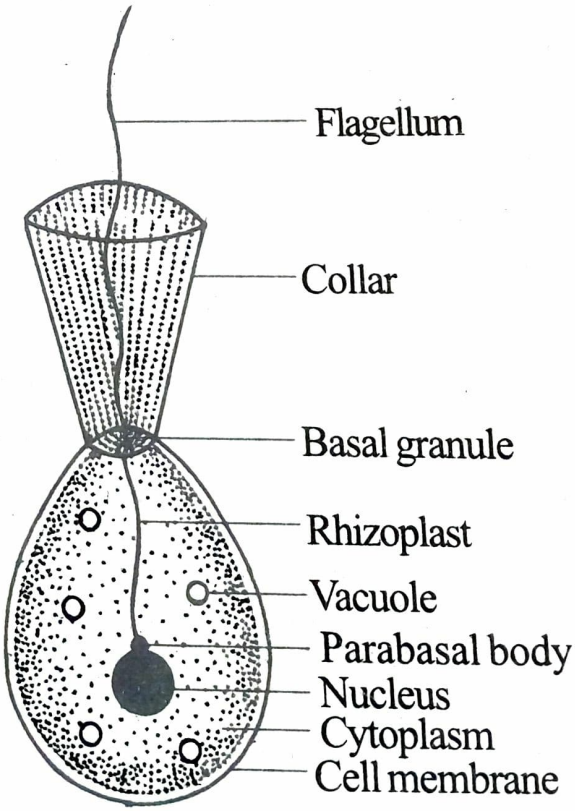


Fig.4.25: A choanocyte.

3. Mesenchyme

It is a gelatinous mass lying between ectoderm and choanoderm. It contains amoebocytes

and spicules. The large-sized amoebocytes are called ***archaeocytes***. They are ***totipotent*** and they can develop into any type of cells.

Spicules

Spicules are calcareous endoskeleton of sponges. They are embedded in the body wall. They are produced by a special type of archaeocytes called ***scleroblasts.*** *Leucosolenia* has three types of spicules, namely ***monaxon, triaxon*** and ***tetraxon*** spicules.

1. Monaxon spicules: These are needle-like with pointed ends.

2. Triaxon spicules: These spicules have three rays.

3. Tetraxon spicules: These spicules have four rays.

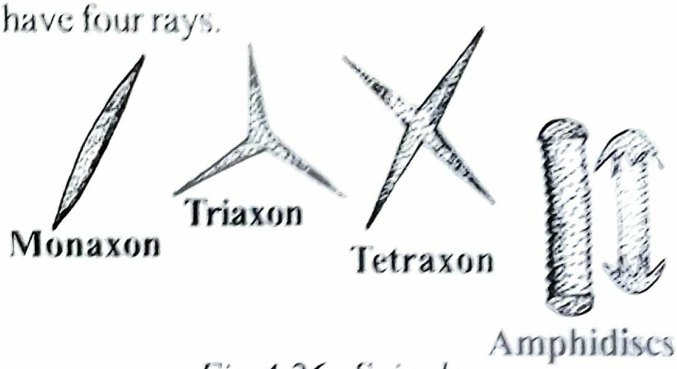


Fig.4.26: Spicules.

Canal System

The body of sponges contains a system of canals and pores called ***canal system.*** The canal system of *Leucosolenia* is simple and it consists of ***ostia, spongocoel*** and ***osculum.*** *The surface of the body contains numerous openings* called ***ostia.*** *They open into a wide opening* called ***spongocoel.*** *The spongocoel opens to the outside through a large opening* called ***osculum***. The water flows into the spongocoel through the ostia and goes out through the osculum. This water current is used for ***respiration, feeding, excretion*** and ***reproduction.***

Nutrition

A water current flows into the ***spongocoel*** through the ***ostia*** and it goes out through the ***osculum.***

The water current has three function namely ***nutrition, excretion*** and ***respiration.***

The water current brings the organisms which are its prey. They are captured by ***choanocytes*** and ***amoebocytes.*** Digestion is ***intracellular.***

Reproduction

Reproduction occurs in ***asexual*** and ***sexual*** methods.

Asexual Reproduction

It takes place by ***budding.*** A bud develops from the base of the individual as an outgrowth. It grows in length and develops an ***osculum*** at the free end.

Sexual Reproduction

Leucosolenia is ***hermaphrodite.*** Gonads are not formed. Gametes are produced by the ***archaeocytes*** of mesogloea. Sperms and ova are released into the water.

Development

Development is ***indirect*** as there are larval stages. Fertilization is ***external*** and the fertilized egg is called ***zygote.*** The zygote undergoes segmentation called ***cleavage.*** Cleavage is ***holoblastic*** and ***equal***. Cleavage produces a hollow sphere of cells called *coeloblastula.*

Coeloblastula: It is formed of a single layer of ***columnar flagellated cells.*** These cells enclose a cavity called ***blastocoel.*** At the posterior pole of the blastula, there is a mass of rounded non-flagellated cells called ***archaeocytes***. They develop into the archaeocytes of adults.

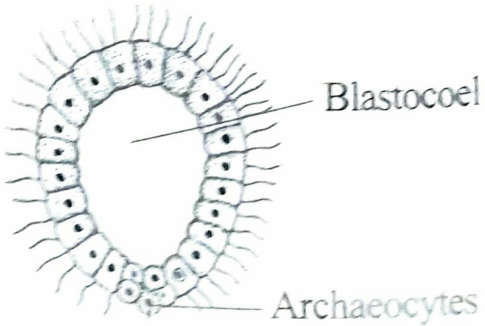


Fig.4.27: Leucosolenia; Coeloblastula.

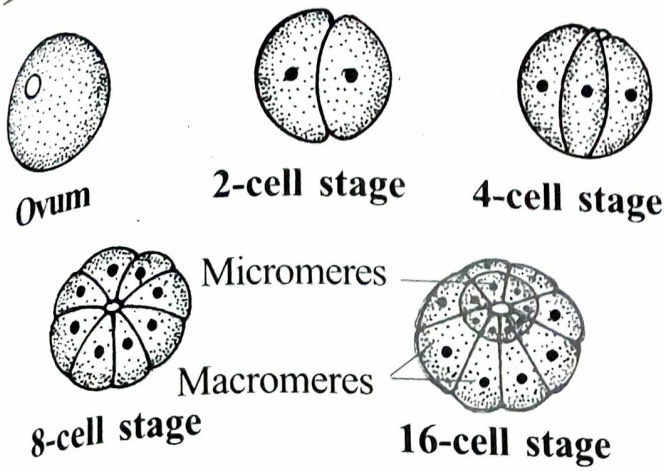


Fig.4.28: Leucosolenia: Cleavage.

Parenchymula larva: The parenchymula larva develops from the coeloblastula. The archaeocytes enter the blastocoel and ***fill the cavity.***

Parenchymula is a free swimming larva. It is oval in shape. It is solid in nature. It is formed of a single layer of columnar ***flagellated cells.*** The centre of the larva is filled with a mass of rounded cells called ***amoebocytes*** (archaeocytes).

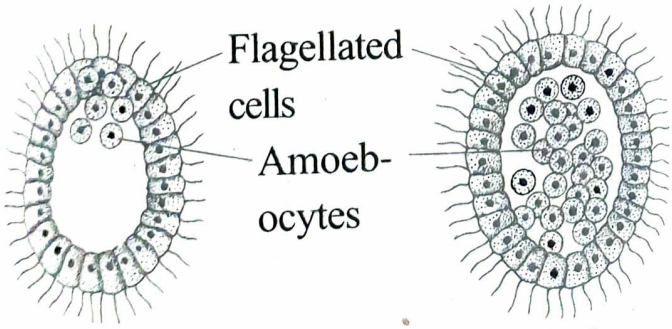


Fig.4.29: Leucosolenia: Parenchymula larva.

Metamorphosis: After a brief free swimming life, the larva is attached to the substratum by its anterior end. It is converted into a flat plate. Most of the amoebocytes move to the outer surface and form the ***ectoderm*** and ***mesogloea.*** The flagellated cells of the larva thus become internal. They form the ***choanoderm***. A ***spongocoel*** appears. It opens to the outside by osculum. Certain non-flagellated cells are converted into ***porocyte*** and they develop ***ostia***. Spicules are secreted and an adult ascon sponge is produced.

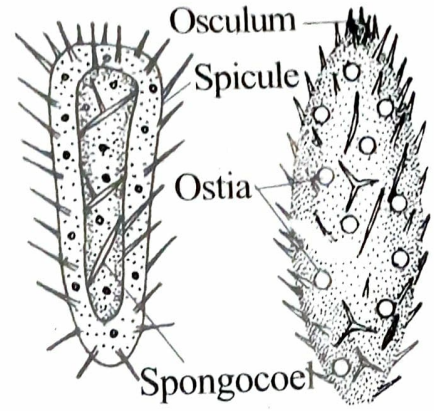


Fig.4.30: Leucosolenia: A. Young; B. Adult.

3. Sycon Sponge (Scypha)

Phylum : *Porifera*
Class : *Calcarea*
Order : *Heterocoela*

Scypha is a complex type of sponge called ***Sycon sponge.*** As its body is perforated by many minute pores, it is included in the phylum ***Porifera.***

It is a ***marine colonial*** or ***solitary sponge*** found attached to rocks. It lives in shallow waters where the waves are gentle.

Scypha has an ***urn-shaped*** body. It grows to 2.5 cm in height.

One end is attached to the substratum and the other end bears a large opening called ***osculum.*** The osculum is surrounded by a row of spicules forming a ***collar***.

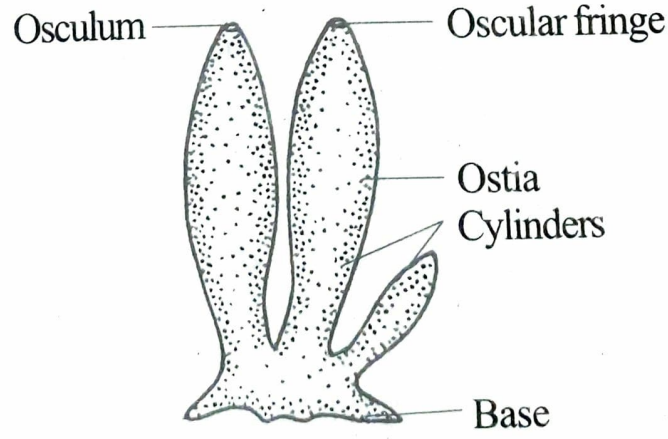


Fig.4.31: Scypha.

Many minute openings are located on the surface of the body. These are called ***ostia.***

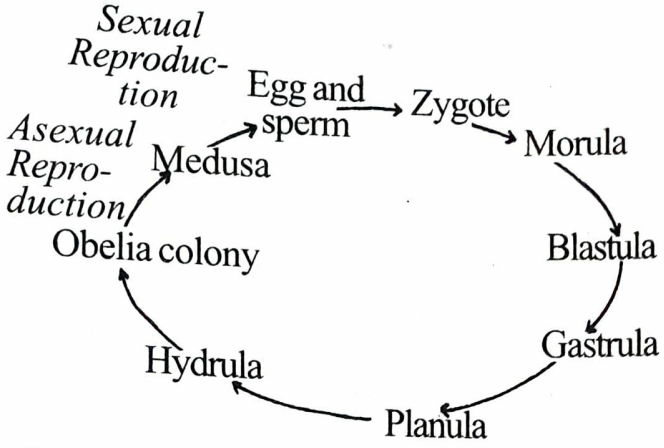


Fig.5.63: Life cycle of Obelia colony.

3. Aurelia

Phylum	:	*Coelenterata*
Class	:	*Scyphozoa*
Order	:	*Semaeostomeae*

Aurelia is commonly called ***jelly fish***. It is included in the class ***Scyphozoa*** of phylum ***Coelenterata.***

Aurelia aurita is a common ***jelly fish***. It is a ***marine animal.*** It floats on the surface of water. It is ***cosmopolitan*** in distribution.

In the centre of the subumbrellar surface there is a short handle-like structure called ***manubrium.***

The free end of the manubrium has a ***mouth*** which is square-shaped.

Each corner of the mouth is produced into a long process called ***oral arm.*** So there are four oral arms arising from the manubrium. Each oral arm has a ***groove*** from the apex to the base leading into the mouth.

Aurelia is ***radially symmetrical.*** The lines represented by the four oral arms are called ***per-radii.*** Between the two per-radii lies the ***inter-radius***. Between each per-radius and inter-radius lies the ***adradius.***

The margin of the umbrella has eight ***notches.*** Each notch is bordered by a pair of leaf-like structures called ***marginal lappets.***

Each notch is provided with a sensory organ called ***tentaculocyst*** or ***statocyst.***

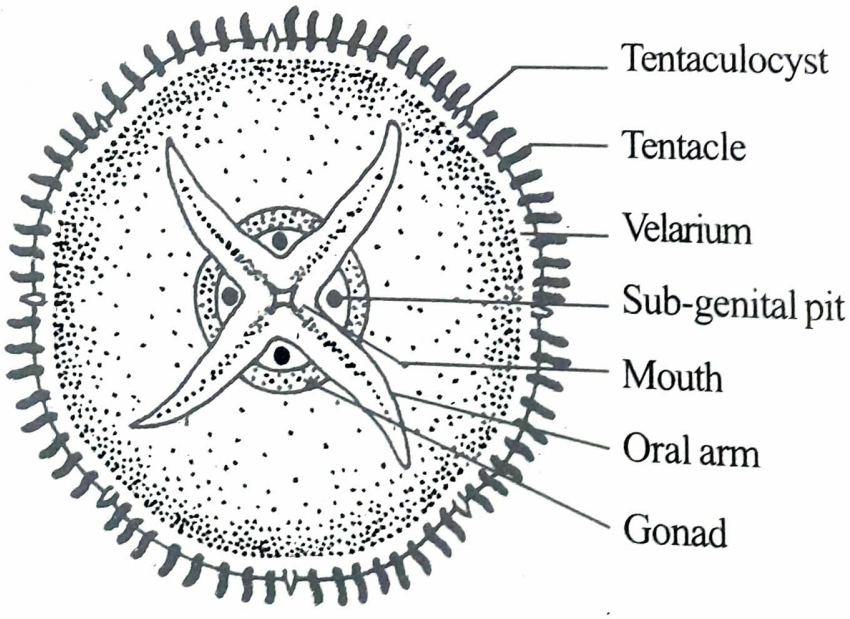


Fig.5.64: Aurelia aurita.

It is a ***medusoid form.*** It is ***umbrella-shaped.*** It has two surfaces, namely a lower concave ***subumbrellar surface*** or ***oral surface*** and an upper convex ***exumbrellar surface*** or ***aboral surface.*** It grows to a diameter of 4 inches.

The margin of the umbrella, containing the lappets and tentacles, forms a thin flexible flap called ***velarium*** or ***pseudovelum.***

In each inter-radius, between the arms near the mouth, there is a depression called ***subgenital pit.*** Its function is not known.

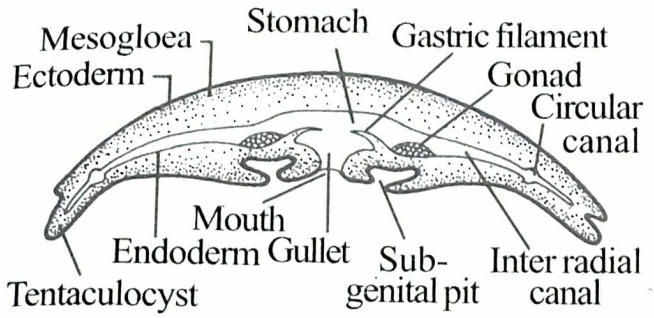


Fig.5.65: Aurelia; Vertical section.

Above each subgenital pit inside the umbrella there is a ***horse-shoe***-shaped structure called ***gonad.***

Body Wall

The body wall is ***diploblastic.*** It is formed of an outer ***ectoderm*** and an inner ***endoderm.*** Between the ectoderm and the endoderm, there lies a gelatinous mass called ***mesogloea.*** The mesogloea is very thick and it forms the main bulk of the body. It contains ***elastic fibres*** and ***amoeboid cells.***

Gastrovascular System

It is a system of canals used for both ***nutrition*** and ***circulation.***

It starts from the mouth situated at the apex of the ***manubrium.*** The mouth leads into a ***gullet*** situated inside the manubrium.

The gullet leads into a rectangular ***stomach.*** The stomach is produced into four pouches called ***gastric pouches.*** The floor of the gastric pouches contains a row of ***gastric filaments*** containing nematocysts.

From the gastric pouches arise narrow canals called ***radial canals***. The radial canals are named ***per-radial canals, interradial canals*** and ***adradial canals.*** The per-radial canals are unbranched and all the other canals are branched.

All the radial canals open into a ***circular canal*** situated at the margin of the umbrella. The gastrovascular system is lined with cilia.

Course of Circulation: The cilia of the gastrovascular system creates a water current. The water flows in the following routes.

Mouth ⟶ gullet ⟶ stomach ⟶ gastric pouches ⟶ adradial canals ⟶ circular canals ⟶ per-radial and inter-radial canals ⟶ gullet ⟶ oral grooves.

This circulation of water has three main functions, namely ***nutrition, respiration*** and ***excretion.***

Nutrition

Aurelia is a ***carnivore.*** It feeds on planktonic organisms and small marine invertebrates.

Planktonic organisms are brought in by the water current. Oral arms capture larger prey. The prey are paralyzed by the nematocysts of oral arms and gastric filaments.

There are two types of digestion. They are ***extracellular digestion*** and ***intracellular digestion.*** Extracellular digestion occurs inside the ***stomach*** and ***gastric pouches.***

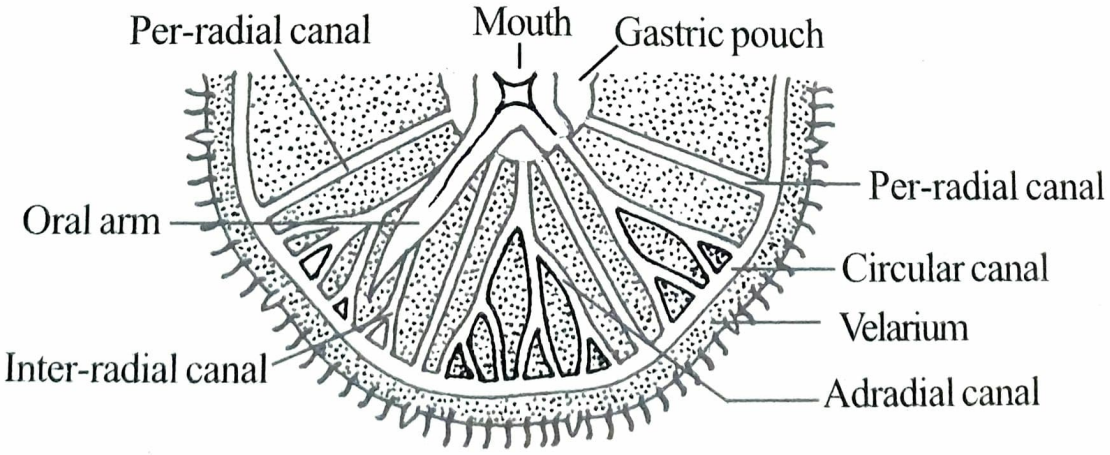


Fig.5.66: Gastrovascular system.

Intracellular digestion occurs inside the ***endoderm cells.*** The undigested food is passed out through the outgoing water.

Nematocysts

Nematocysts are the ***stinging cells***. They occur all over the umbrella, tentacles, oral arms, gastric filaments, etc. *Aurelia* has three main types of nematocysts. They are as follows:

1. Atrichous isorhizas: This type of nematocyst has the following salient features: a. The capsule is long b. The thread-tube is open at the tip and c. The butt and spines are absent.

2. Holotrichous isorhizas: It has the following salient features: a. The capsule is oval b. The thread-tube opens at the tip and c. The butt and the thread tube are armed with spines.

3.Heterotrichous microbasic eurytheles: It has the following salient features: a. The capsule is small b. The thread-tube is armed with spines and it opens at the tip c. A short butt with spines is present and d. The butt has a swelling.

Nervous System

The nervous system is formed of two ***nerve nets*** and eight ***rhopalial ganglia.*** One nerve net is located below the ectoderm and it is called ***sub-epidermal nerve net.*** The second nerve net lies beneath the endoderm and it is called ***sub-endodermal nerve net.*** The rhopalial ganglia are situated near the notches.

Sensory Organs

Aurelia has eight sensory organs called ***rhopalia.*** They are situated in notches. Each rhopalium is surrounded by a pair of marginal ***lappets.*** Each rhopalium is formed of three structures, namely ***tentaculocyst, ocelli*** and ***olfactory pits.***

Tentaculocyst

It is a ***balancing organ***. Each tentaculocyst is a modified tentacle. It has a club-shaped structure located in the notch between the lappets. It is called ***statocyst.*** The outer side of the statocyst is covered by a process of umbrella called ***hood.***

The statocyst has a cavity which is formed by the extension of the circular canal. This cavity is lined with endoderm. The distal part of the tentaculocyst has a mass of closely packed endoderm cells called ***statolith cells.*** Each cell contains a calcareous particle called ***statolith.*** The tentaculocysts control the ***equilibrium*** of the animal.

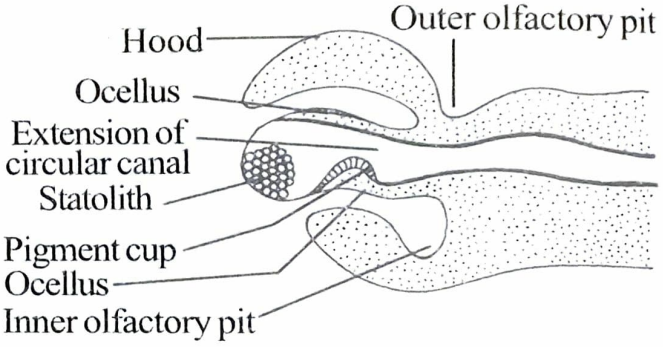


Fig.5.67: A tentaculocyst.

Ocelli

Ocelli are ***photoreceptors.*** Each tentaculocyst has two ***ocelli.*** They are ***pigment spot*** and ***pigment cup.*** The pigment spot is formed of a thickened and pigmented patch of epidermal cells located on the outer side of tentaculocyst. The pigment cup is a pigmented endodermal cup located on the inner side of the tentaculocyst.

Olfactory Pits

Olfactory pits are the ***chemoreceptors.*** There are two olfactory pits situated at the base of each tentaculocyst. Each olfactory pit is in the form of a depression formed by the thickening of ectoderm. One olfactory pit is situated at the base of the hood. It is called ***outer***

olfactory pit. The other pit is located beneath the base of the tentaculocyst. It is called ***inner olfactory pit.***

Reproductive System

The sexes are separate. But there is no sexual dimorphism.

The gonads are four in numbers. They are located inter-radially on the floor of the gastric pouches. They are ***horse-shoe-shaped.*** They are ***endodermal*** in origin. The gametes are released into the stomach. From the stomach they are passed out through the mouth.

Life History

The eggs are fertilized in the gastric pouches. Hence fertilization is ***internal.*** Development takes place inside the oral arms or stomach or gastric pouches. Development is ***indirect.***

Blastula: The fertilized egg is called ***zygote.*** It divides repeatedly. The division is called ***cleavage.*** Cleavage leads to the formation of a hollow ball of cells. This hollow ball is called ***blastula.*** The cavity of the blastula is called ***blastocoel.***

Gastrula: Soon the blastula invaginates to produce a double-walled cup-like structure called ***gastrula.*** The two layers of the gastrula are the ***ectoderm*** and the ***endoderm.*** The cavity of the gastrula is called ***archenteron.*** It opens to the outside by an opening called ***blastopore.*** The gastrula elongates and develops into a ***planula larva.***

Planula: The gastrula develops into a larva called ***planula larva.*** It is a ***free swimming larva.*** It is ***cylindrical*** in shape. It is covered by ***cilia.*** It has a ***coelenteron*** and two layers of cells, namely ***ectoderm*** and ***endoderm.*** After a short free swimming life, the planula loses its cilia and becomes attached to the substratum to develop into the next larva called ***scyphistoma.***

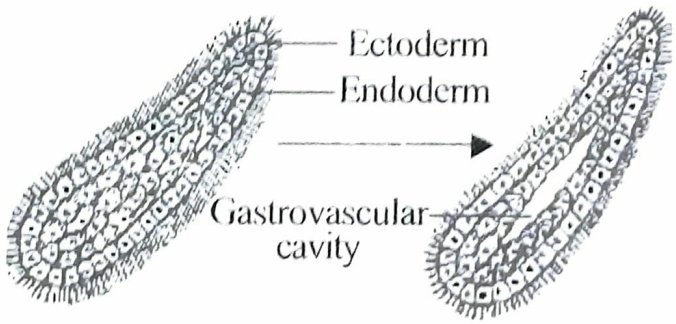


Fig.5.69: Planula larva.

Scyphistoma: It develops from the planula larva. It is trumpet-shaped and it looks like a *Hydra*; hence it is also called ***hydra tuba.*** It is a ***sedentary*** larva found attached to rocks with the help of a ***basal disc.*** The free end bears a short ***manubrium.*** The manubrium

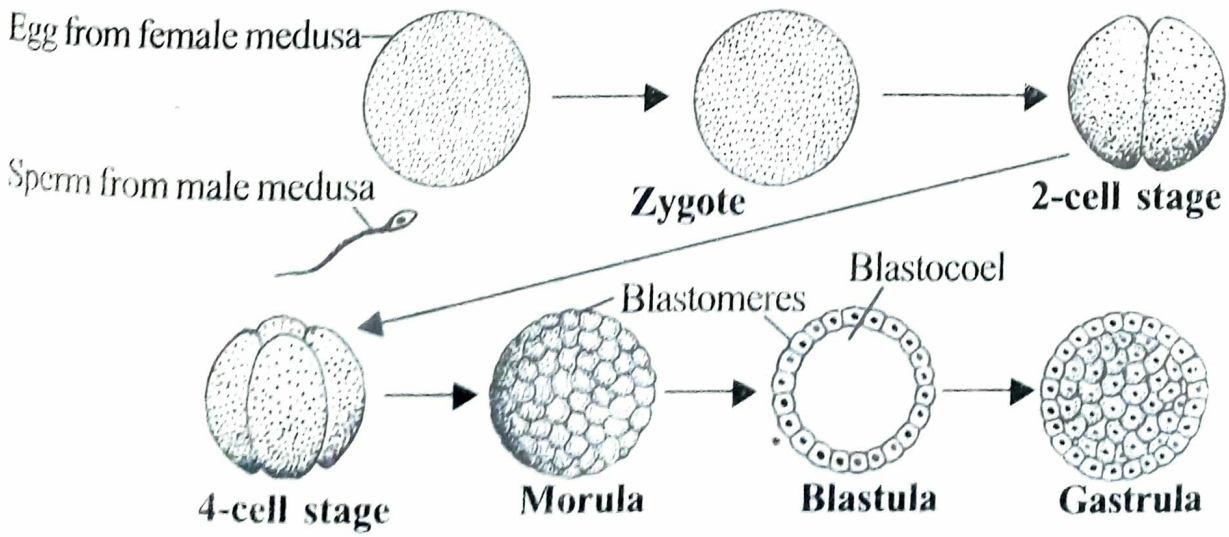


Fig.5.68: Cleavage, Blastula and Gastrula.

bears a square-shaped ***mouth.*** The mouth is surrounded by ***tentacles.***

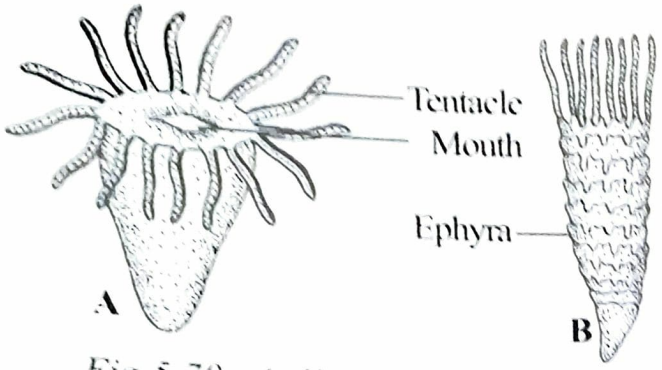


Fig.5.70: A. Young Scyphistoma; B. Scyphistoma.

Strobilation: The scyphistoma undergoes a process of ***transverse fission*** called ***strobilation.*** The resulting individuals are called ***ephyra larvae.*** They are arranged one above the other. The scyphistoma with many ephyra larvae is called ***strobila.*** About twelve ephyra larvae are seen in one strobila. When fully matured, the ephyra larva gets separated and becomes a free swimming larva.

Ephyra larva: It develops from scyphistoma by strobilation. It is a free swimming larva.

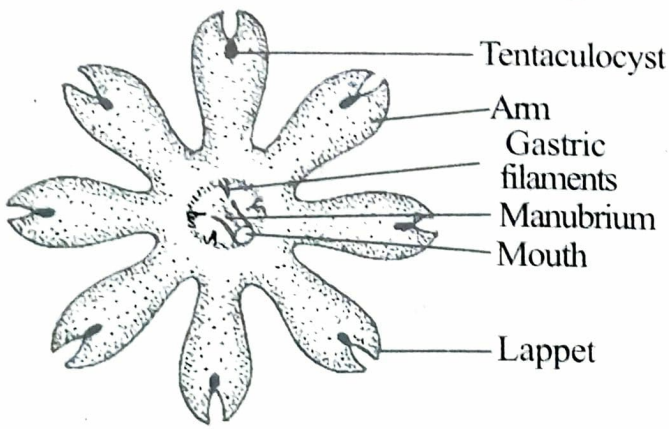


Fig.5.71: Ephyra larva.

It is a medusoid form. It has a ***tetramerous symmetry.*** It is umbrella-shaped. It has eight bilobed ***arms.*** The tip of each arm has a notch with two ***marginal lappets.*** The notch contains a ***tentaculocyst.*** The centre of the subumbrellar side has a short ***manubrium*** and a ***mouth.*** The ***gastrovascular system*** with gastric filaments is present. The larva swims actively and feeds on minute organisms.

Metamorphosis: The ephyra larva grows in size. The space between the arms is filled up. Mesogloea increases in thickness. Four oral arms appear. The margin develops tentacles. Now the ephyra becomes an *Aurelia.*

Alternation of Generations

In the life history of *Aurelia*, ***sexual reproduction alternates*** with ***asexual reproduction.*** This is called ***alternation of generations.*** *Aurelia* reproduces by sexual reproduction. It represents the sexual generation.

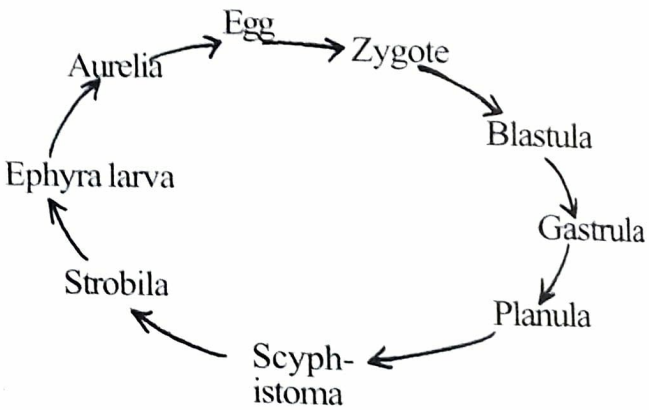


Fig.5.72: Life cycle of Aurelia.

The fertilized egg develops into ***scyphistoma.*** The scyphistoma produces ephyra larva by ***asexual reproduction***. Hence scyphistoma represents the asexual generation. Hence there is alternation of sexual and asexual generations in the life history of *Aurelia.*

4. Sea Anemone (Metridium)

Phylum	:	*Coelenterata*
Class	:	*Anthozoa*
Subclass	:	*Hexacorallia*
Order	:	*Actiniaria*

Sea anemone is a brightly coloured, polyp-like marine coelenterate included in the class ***Anthozoa.***

3. Trypanosoma

Phylum : *Protozoa*

Class : *Mastigophora*

Order : *Protomonadina*

Trypanosoma is an ***unicellular*** or ***acellular*** organism. Hence it is included in the phylum ***Protozoa.*** It has flagellum for locomotion. Hence it is included in the class ***Flagellata*** or ***Mastigophora.***

It is an ***endoparasite*** living in the ***blood*** of man. Hence it is called a ***haemoflagellate***. This parasite lives in Africa only. It causes a disease called ***gambia fever*** or ***sleeping sickness***.

It is a ***digenic*** parasite living in two hosts, namely ***man*** and ***tse-tse fly.***

It is ***microscopic.*** The body is elongated antero-posteriorly and flattened like a leaf. The anterior end is ***pointed*** and the posterior end is ***blunt.*** The anterior end has a free ***flagellum.***

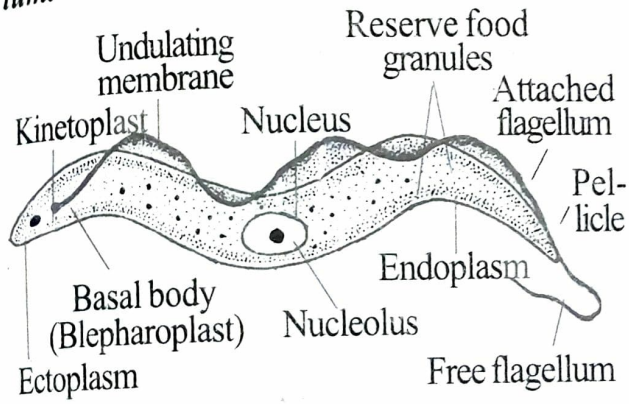


Fig.3.49: Trypanosoma.

The body is covered by a thin and elastic membrane called ***pellicle***. The pellicle is supported by longitudinal thread-like structures called ***microtubules***.

The body is filled with ***cytoplasm.*** It has two regions, namely the ***ectoplasm*** and the ***endoplasm.*** The cytoplasm contains ***blepharoplast, kinetoplast*** and ***nucleus.***

Near the posterior end, a spherical body is situated. It is called ***basal body*** or ***blepharoplast.***

A whip-like structure called ***flagellum*** arises from the basal body. It runs forwards and protrudes from the anterior end.

The flagellum is attached to the pellicle throughout its length, but the anterior end of the flagellum is free. When the flagellum beats, the pellicle is drawn out into a membrane called ***undulating membrane.***

The flagellum and the undulating membrane are used for swimming in the blood.

A disc-like structure is situated behind the basal body. It is called ***kinetoplast.*** It is formed of mitochondria and DNA.

The ***nucleus*** is located in the centre of the body. It is covered by a nuclear membrane. It is filled with ***nucleoplasm.*** The nucleoplasm contains chromosomes and a spherical ***nucleolus*** or ***endosome.***

The ***nutrition*** is ***parasitic.*** It obtains its food from the blood plasma by osmosis.

Trypanosoma multiplies by ***longitudinal binary fission.*** During this process, the blepharoplast becomes divided into two. Then the kinetoplast becomes divided into two. This is followed by the division of the nucleus into two daughter nuclei by mitosis. Then the cytoplasm becomes divided longitudinally. The cytoplasmic division starts from the ***anterior end.***

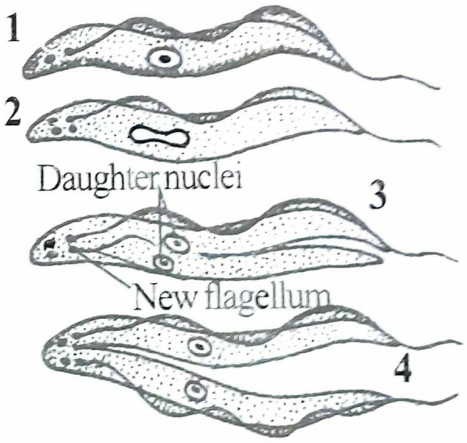


Fig.3.50: Trypanosoma: Binary fission.

This results in the formation of two daughter Trypanosomes. One daughter receives the original flagellum and the other daughter develops a new flagellum from the blepharoplast.

Life History

Trypanosoma is a ***protozoan*** parasite. It is an ***endoparasite*** of man. It lives in the blood of man. Hence it is a ***haemoparasite*** or ***haemoflagellate.***

Trypanosoma completes its life history in two hosts. Hence it is a ***digenic parasite***. The two hosts are ***man*** and a ***mosquito*** called ***tse-tse fly.*** Man is the ***primary host*** or the ***definitive host*** and the mosquito is the ***secondary host*** or ***vector***.

Life Cycle in Man

When a tse-tse fly bites a man, *Trypanosoma* is introduced into the blood of man. *Trypanosoma* feeds on the blood and becomes a long ***slender*** form.

It multiplies by longitudinal ***binary fission.*** Then it stops feeding and is transformed into an ***intermediate form***. In the intermediate form, the flagellum gets shortened.

Then it becomes shortened further and transformed into a ***short*** and ***stumpy form***. It has no flagellum. It does not feed and does not multiply. It is the infective stage. Further development takes place only inside the gut of tse-tse fly.

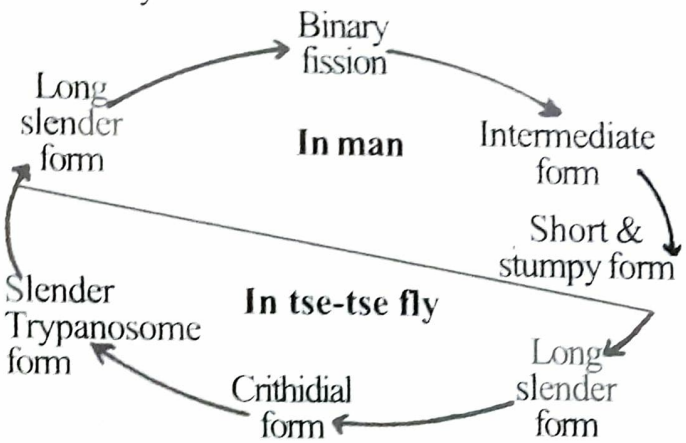


Fig.3.51: Life cycle of Trypanosoma.

Life cycle in Tse-tse fly

When a tse-tse fly bites a man, the ***short*** and ***stumpy*** form enters the gut of the tse-tse fly along with the blood. In the gut it becomes elongated and forms a ***long slender form***.

It multiplies by longitudinal binary fission. Then it enters the salivary gland and is transformed into ***crithidial form***. The crithidial form is short. The kinetoplast is located in front of the nucleus.

The crithidial form it multiplies by longitudinal binary fission and is transformed into a ***slender trypanosome form.*** It is the infective stage. For further development it has to be introduced into the blood of man.

Infection

The parasite is introduced into the blood of man when the tse-tse fly bites him. While feeding, the fly punctures the skin; then it introduces some saliva which prevents the clotting of blood. Along with saliva the parasite also enters the blood. In human blood, it feeds and grows into a long slender form.

Gambia Fever

Gambia fever is caused by *Trypanosoma* and is transmitted by ***tse-tse fly.*** It is also called ***sleeping sickness.*** It is characterized by the following symptoms:

1. Recurrent fever
2. Severe head-ache
3. Weakness
4. Loss of weight.
5. Anaemia
6. The patient falls asleep
7. Ultimate result is death if not treated.

Prevention

The infection of gambia fever can be prevented by the following methods:

1. Destruction of tse-tse fly.
2. Spraying DDT in the areas of tse-tse fly.
3. By taking an injection of one gram of ***suranin*** every two or three months.

Treatment

Gambia fever can be treated with the following drugs: 1. ***Bayer 205*** (Antrypol, Germanin or Suranin) 2. ***Pentamidine*** or ***Lomidine,*** etc.

3. Sporulation

In sporulation, spores are produced. It occurs during unfavourable season. It does not involve encystment. Sporulation occurs in the following methods:

1. Nuclear membrane ruptures.

2. The nucleus breaks into several ***chromatin blocks.***

3. Each chromatin block develops a nuclear membrane around it and it forms the daughter nucleus.

4. Each daughter nucleus gets surrounded by some cytoplasm and it forms the ***amoebula.***

5. Each amoebula develops a spore-case around it and it forms the ***spore.***

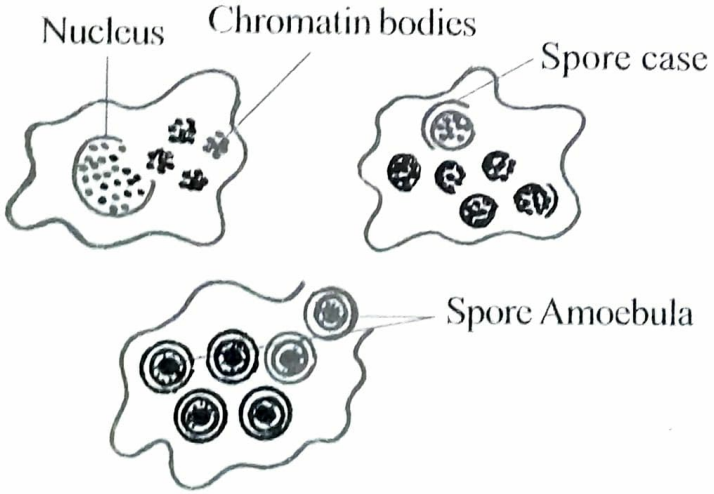


Fig. 3.64: Amoeba; Encystment and multiple fission.

6. About 200 spores are formed. They remain inside the parent.

7. When the parent disintegrates, the spores are released.

8. During favourable season, the spore-case ruptures and the amoebula develops into the *Amoeba.*

5. Entamoeba histolytica

Phylum : *Protozoa*
Class : *Rhizopoda*
Order : *Gymnamoeba.*

Entamoeba is an ***unicellular*** or ***acellular*** organism. Hence it is included in the phylum ***Protozoa***. It has ***pseudopodium*** for locomotion. Hence it is included in the class ***Rhizopoda.***

It lives inside the large ***intestine*** of man. So it is an ***endoparasite.*** It causes a disease called ***amoebiasis*** or ***amoebic dysentery.*** *Entamoeba* is cosmopolitan in distribution.

The fully grown and mature *Entamoeba* is called ***trophozoite.*** It looks like an *Amoeba.* The body is covered by ***plasmalemma***. The plasmalemma encloses the cytoplasm.

The cytoplasm has an outer ***ectoplasm*** and an inner ***endoplasm***.

The endoplasm contains a ***nucleus*** and ***food vacuoles.***

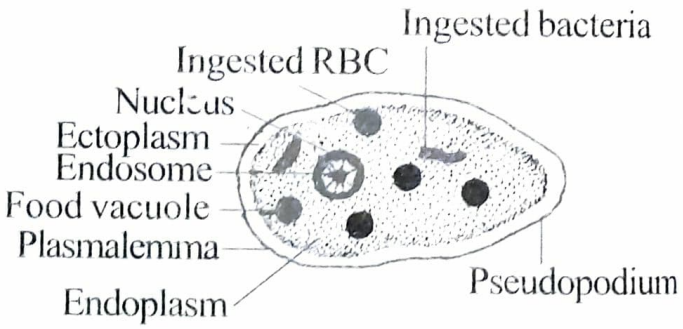


Fig. 3.65: Entamoeba.

The ***food vacuole*** contains ingested RBC, WBC, epithelial cells and so on.

There is ***no contractile vacuole.***

The nucleus is spherical in shape. It is surrounded by a nuclear membrane. In the centre of nucleus a spherical body is situated. It is called ***endosome*** or ***karyosome.*** It is surrounded by ***chromatin bodies.***

Entamoeba has a single ***pseudopodium.*** It is called ***monopodium***. It is formed at the anterior end.

Nutrition is ***holozoic.*** It feeds on bacteria, RBC, WBC and intestinal cells.

Life Cycle

Entamoeba is a ***protozoan*** parasite. It lives in the ***intestine*** of man. It is an ***endoparasite.*** It causes ***amoebiasis.***

Entamoeba completes its life cycle in only one host.

Hence it is a ***monogenic*** parasite.

Binary fission

The mature *Entamoeba* is called ***trophozoites.*** The trophozoite undergoes asexual reproduction by ***binary fission.*** During binary fission, the nucleus divides into two daughter nuclei by mitosis. This is followed by the division of the cytoplasm into two pieces resulting in the formation of two daughter *Entamoebae.*

Most of the daughter amoebae feed and grow into ***trophozoites***. Others undergo a process called ***encystment.***

Encystment

The *Entamoeba* loses its pseudopodium and becomes spherical. It secretes a thin tough and flexible membrane around itself. It is called ***cyst wall.*** *Entamoeba* with a cyst wall is called ***cyst.*** The process of formation of cyst is called ***encystment.***

The early cyst contains a single ***nucleus,*** a few rod-like ***chromatoid bodies*** and one or two ***glycogen granules.*** The glycogen granules and chromatoid bodies ***disappear*** as the age of the cyst increases.

In the beginning, the cyst contains only one nucleus. Hence the cyst is called ***uninucleate cyst.***

Soon the single nucleus divides into two by mitosis. At this stage the cyst contains two nuclei, hence the cyst is called a ***binucleate cyst.***

Then the two nuclei again divide by mitosis to produce four nuclei. Now the cyst contains four nuclei and hence it is called a ***tetranucleate cyst.***

Further development takes place inside the intestine of another man. The whole process of encystment occurs within a few hours.

Infection

The tetranucleate cyst is transmitted from one person to another through the following

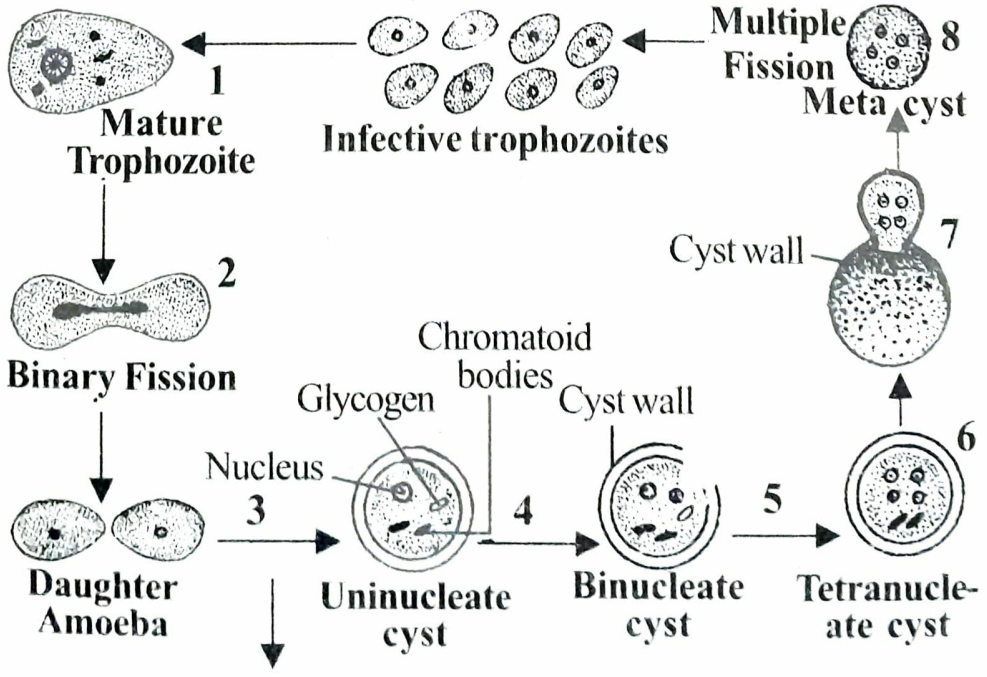


Fig.3.66: Entamoeba; Life cycle.

agents: 1. Contaminated food and 2. Contaminated water.

Excystment

The tetranucleate cyst enters the intestine of another man through contaminated food or water. Here the cyst wall ruptures and the tetranucleate *Amoeba* comes out. The *Amoeba* then undergoes a special kind of ***multiple fission*** resulting in eight daughter *Amoeba*. The *Amoebae* enter the large intestine and grow into trophozoites.

Amoebiasis

The disease caused by *Entamoeba* in man is called ***amoebiasis*** or ***amoebic dysentery.*** Amoebiasis is characterized by the following symptoms:

1. *Entamoeba* feeds on the mucous epithelium. This causes ***ulcer*** in the intestine.
2. In the ulcer, blood vessels are damaged and hence blood oozes into the intestine.
3. The stool contains mucous and blood.
4. The stool becomes loose.
5. The patient defaecates frequently.
6. There is severe pain in the intestine.

Prevention

Infection by *Entamoeba* can be easily prevented by the following methods:

1. Before every meal, the hands should be properly washed and cleaned.
2. Finger nails should be closely cut.
3. Vegetables and other food stuffs should be properly cooked.
4. Drinking water should be well boiled.
5. Food stuffs and water should be protected from houseflies and other insects.

Treatment

Amoebiasis is a ***curable disease***. It can be treated with the following drugs:

1. Emetine
2. Dehydroemetine
3. Chloroquine
4. Diodoquine
5. Terramycin
6. Aureomycin and
7. Erythromycin.

Other Species of Entamoeba in Man

There are many species of *Entamoeba*. A few are given below:

1. Entamoeba coli: It lives in the colon (intestine) of man.

2. E. gingivalis: It lives in the mouth between the teeth and gum.

6. Elphidium (Polystomella)

Phylum : *Protozoa*
Class : *Rhizopoda*
Order : *Foraminifera*

The most common shelled protozoans are belonging to the order ***Foraminifera*** of the class ***Rhizopoda.*** Their shells are perforated by numerous minute pores or ***foramina***; so they are called ***Foraminiferans*** which means ***'pore-bearers'.***

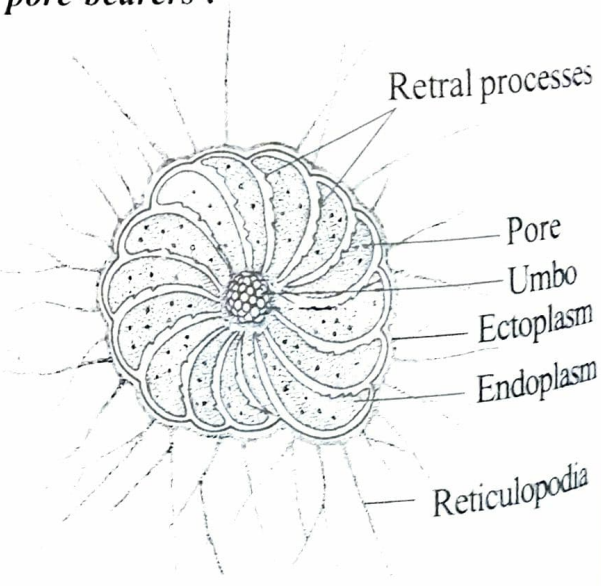


Fig.3.67: Elphidium

8. Plasmodium

Phylum : *Protozoa*
Class : *Sporozoa*
Order : *Haemosporidia*

Plasmodium is an unicellular organism. Hence it is included in the phylum ***Protozoa***. It is a parasite reproducing by the formation of ***spores***. Hence it is included in the class ***Sporozoa.***

It is an ***endoparasite*** living in the ***blood*** of man. It causes ***malaria*** in man. It is ***cosmopolitan*** in distribution.

Plasmodium completes its life cycle in two hosts, namely man and the female *Anopheles* mosquito. Hence it is a ***digenic parasite***. Man is the ***intermediate host**** and the mosquito is the ***primary host*****.

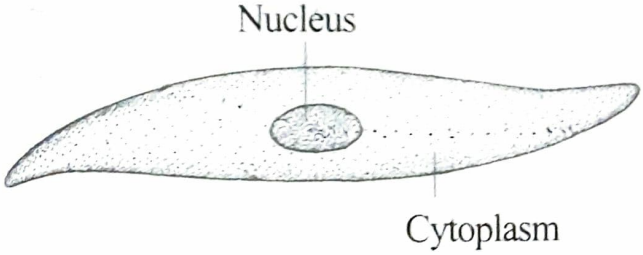


Fig.3.70: Plasmodium.

Life cycle in Man (Cycle of Golgi)

The life cycle of *Plasmodium* in man is called the ***cycle of Golgi.*** It occurs in three stages. They are

1. *Pre-erythrocytic cycle*
2. *Exo-erythrocytic cycle*
3. *Endoerythrocytic cycle.*

1. Pre-erythrocytic Cycle

This cycle occurs in the ***liver***. When a mosquito bites a man, it introduces the ***parasite*** into the blood of man.

The parasite introduced is called ***sporozoite.*** It is spindle-shaped and is covered with ***pellicle***. It contains a large nucleus in the centre.

The sporozoite enters the ***liver cells,*** it feeds and grows and becomes spherical in shape. The parasite in this stage is called ***cryptoschizont***.

The cryptoschizont undergoes a special kind of ***asexual reproduction*** called ***schizogony.*** It divides and produces about 1000 daughter cells called ***cryptomerozoites.***

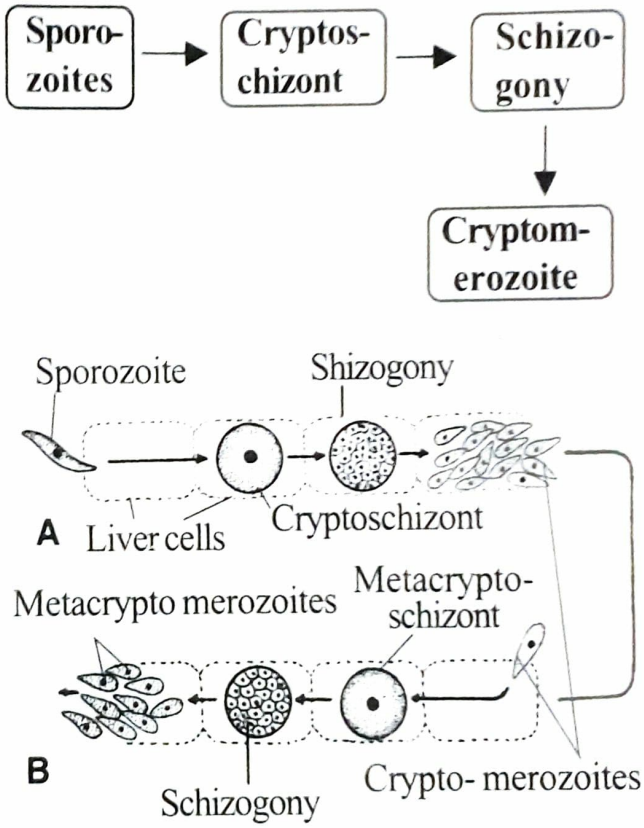


Fig.3.71: Plasmodium-Life history: A. Pre-erythrocytic cycle B. Exo-erythrocytic cycle.

Cryptomerozoites are released into the liver by the rupture of liver cells.

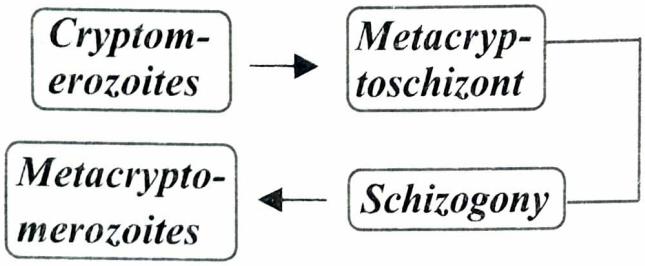
2. Exo-erythrocytic Cycle

This cycle occurs in the ***liver.*** The cryptomerozoites enter fresh liver cells. Here they grow and increase in size and become spherical in shape. The parasite in this stage is called ***metacryptoschizont.***

***Primary host:** The host in which the parasite completes the sexual reproduction is called the primary host.*

***Intermediate host*:** *The host in which the parasite completes the asexual reproduction is called the intermediate host.*

The metacryptoschizont undergoes ***schizogony*** resulting in thousands of daughter individuals called ***metacrypto-merozoites.*** The metacryptomerozoites are released by the rupture of liver cells.



The pre-erythrocytic cycle and the exo-erythrocytic cycle are completed within 8 days. After this period the metacryptomerozoites, enter the blood. Until this time there will not be any symptom of malaria.

3. Erythrocytic Cycle or Endoerythrocytic Cycle

This cycle occurs within the ***RBC.***

The metacryptomerozoite penetrates the RBC. Inside the RBC the parasite becomes rounded. This stage of the parasite is called ***trophozoite.***

It grows and increases in size.

It becomes ring-like and is called ***signet ring.*** It has a ***vacuole inside.***

After sometime the vacuole disappears and the parasite develops many ***pseudopodia.*** At this time the parasite is in the ***amoeboid stage.***

It feeds on the contents of the RBC. The parasite secretes digestive enzymes which break the haemoglobin of RBC into ***haem*** and ***globin.*** Globin is digested and used as food by the parasite. The haem is converted into a toxic pigment called ***haemozoin*** which remains scattered in the cytoplasm of the parasite.

When feeding stops, the pseudopodia disappear and the parasite becomes rounded. This stage of the parasite is called ***schizont.*** The schizont contains a single nucleus and haemozoin pigments in the cytoplasm. Then the schizont undergoes ***schizogony.***

In schizogony, the nucleus and cytoplasm divide into 12 to 24 daughter parasites called ***merozoites.***

The merozoites are arranged more or less like the petals in a rose flower. Hence this stage is called ***rosette.***

The merozoites are released into the blood by the rupture of RBC.

The erythrocytic cycle takes 48 hours (two days) for completion.

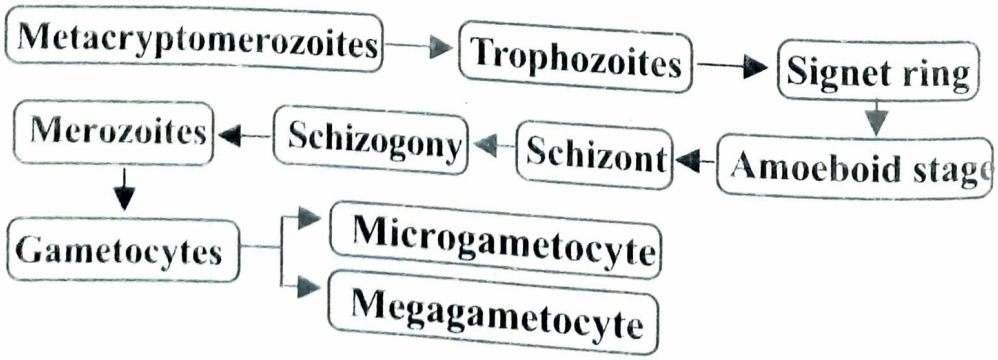
The merozoites again attack fresh RBC and the cycle is repeated several times until almost all the RBCs are attacked.

After several generations, the merozoites entering the RBC, increase in size and become rounded. They are now called ***gametocytes.***

Some gametocytes are smaller in size and their nuclei are larger in size. These gametocytes are called male or ***microgametocytes.***

Others are larger in size but with smaller nuclei. These gametocytes are called female or ***megagametocytes.***

For further development the gametocytes must be taken into the body of the female Anopheles mosquito.



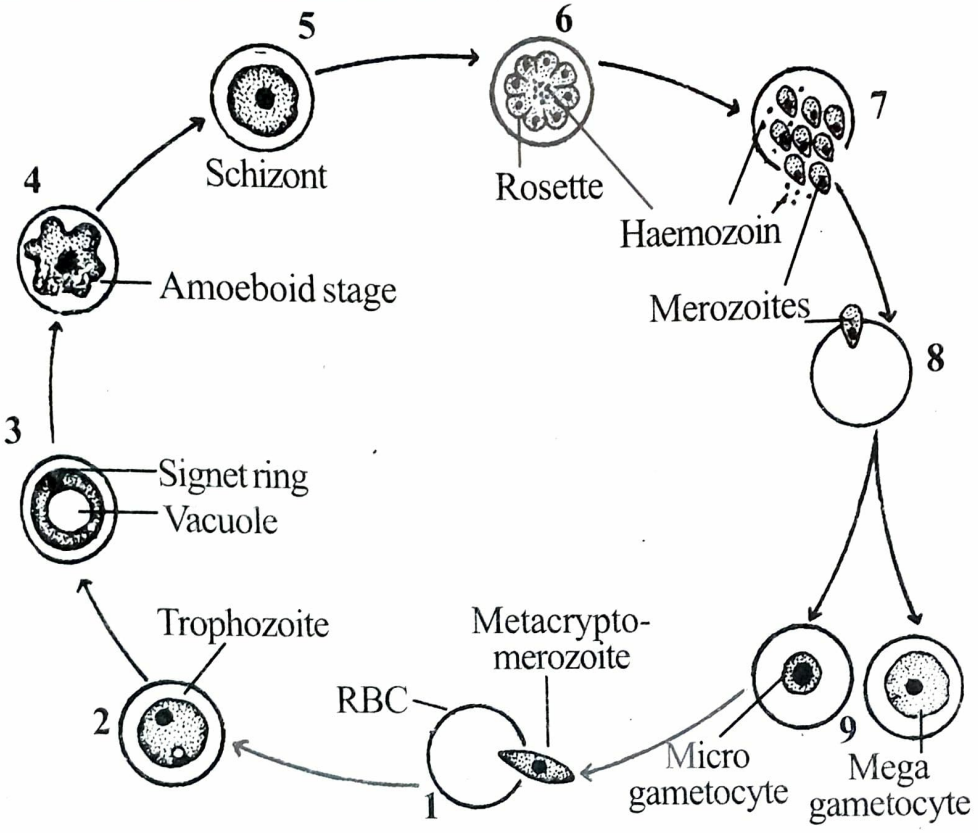


Fig.3.72: Plasmodium-Life history; Endoerythrocytic cycle.

Life cycle in Mosquito (Cycle of Ross)

The life cycle of *Plasmodium* in mosquito was first studied by ***Sir Ronald Ross.*** Hence this cycle is called the ***cycle of Ross.***

Plasmodium undergoes ***sexual reproduction*** in *Anopheles*. Hence *Anopheles* is the ***primary host.*** As it transmits the parasite from one man to another, it is called a ***vector.***

When a female *Anopheles* mosquito sucks the blood of man, the gametocytes enter the gut. The RBCs are digested and the gametocytes are released.

The megagametocyte is reorganized and becomes a ***female gamete*** or ***megagamete.***

In microgametocyte, the nucleus divides into 6 to 8 daughter nuclei. The daughter nuclei are arranged in the periphery of the gametocyte. The cytoplasm grows out into 6 to 8 long thin flagella-like structures. Each nucleus moves into a flagellum-like structure. Each flagellum-like structure is now called a ***microgamete***.

The microgametes break off from the microgametocyte by violent movements. The formation of microgametes from microgametocyte is called ***exflagellation.***

The microgametes exhibit gliding movement inside the lumen of the gut. The megagametocyte gives out a small cytoplasmic projection. It is called ***fertilization cone.***

When a microgamete comes into contact with the megagamete, it penetrates through the fertilization cone. Now the two gametes fuse together. This is called ***fertilization*** or ***syngamy***. The resulting structure is called ***zygote*** or ***synkaryon.***

The zygote is spherical in shape. It is a diploid cell. It is non-motile. Soon it becomes elongated and spindle-shaped; it exhibits gliding movement. At this stage the parasite is called an ***ookinete.***

The parasite penetrates the wall of the gut and comes to lie beneath the outer layer of the

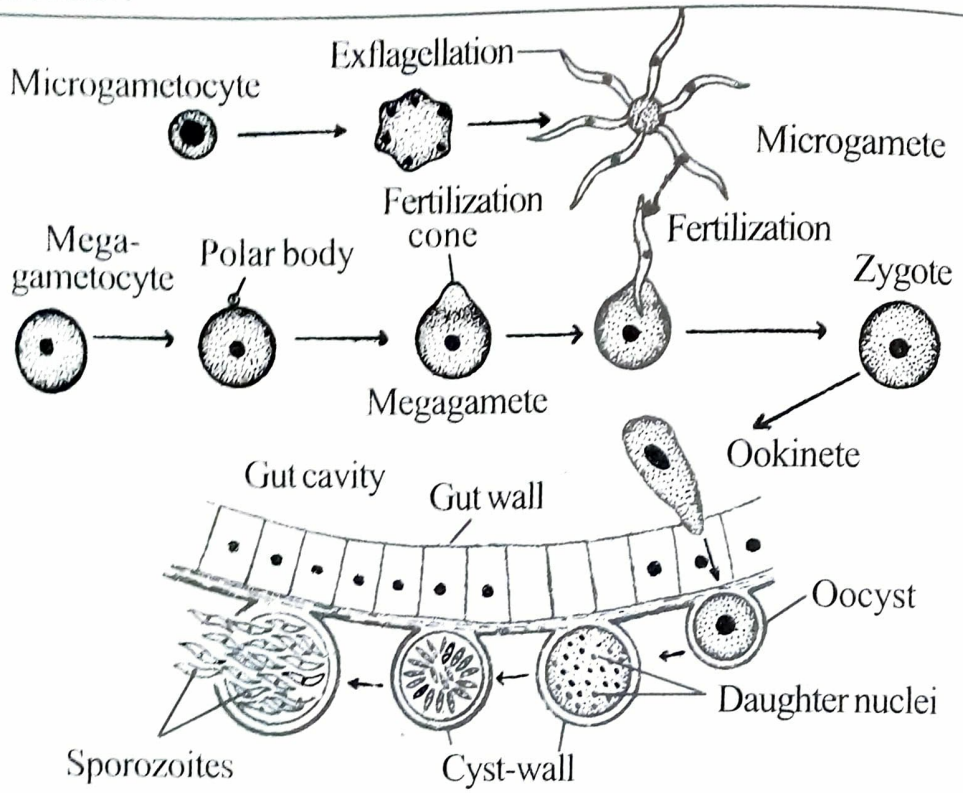


Fig.3.73: Plasmodium: Life history(Cycle of Ross).

gut wall. Here it becomes spherical and secretes a ***cyst wall*** around it. Now the parasite is called ***oocyst.***

It grows by absorbing nutritive materials from the mosquito through the cyst wall. As a result it increases in size. The fully grown oocysts are seen as projections on the surface of the gut.

The oocyst now undergoes a special kind of sexual reproduction called ***sporogony.*** During sporogony the nucleus and cytoplasm divide into about 1000 parasites called ***sporozoites.***

Each sporozoite is spindle-shaped. They are released into the body cavity of the mosquito by the rupture of the oocyst and the outer layer of the gut wall. They then enter the salivary gland.

For further development, the sporozoites must be introduced into the blood of man.

When a mosquito bites a man, it introduces a small amount of saliva to prevent the coagulation of blood. Along with the saliva the sporozoites are also introduced into the blood of man and the cycle is repeated.

Malaria

It is a kind of fever caused by *Plasmodium* and transmitted by the female *Anopheles* mosquito. Malaria shows the following symptoms:

1. Loss of appetite
2. Nausea
3. Constipation
4. Headache
5. Muscular pain and ache in joints
6. Shaking chillness
7. Sweating
8. Rise in body temperature as high as 106^0F at an interval of 48 hours and
9. Anaemia.

Control and Prevention of Malaria

Malaria can be controlled and prevented by the following methods:

1. Destruction of mosquito and its larva.
2. Spraying DDT in and around the houses.
3. Sterilization of mosquito..

4. Rearing the enemies of mosquito and its larvae like larvivorous fishes (stickle backs, minnows and trouts), ducks, dragon flies, etc. This method is called ***biological control.***

5. Constructing mosquito proof houses.

6. Using mosquito nets.

7. Applying anti mosquito creams on the surface of the body.

Treatment

Malaria can be treated with the following drugs: ***Quinine, Daraprim, Chloroquine, Paludrine, Plasmoquine***, etc.