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Chapter 13

Short Notes on: *Paramecium*

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***Classification of Paramecium* -**
Phylum Protozoa
Sub-Phylum Ciliophora
Class Ciliates
Order Hymenostomatida
Genus Paramecium
Species Caudatum

General Characteristics -
Paramecium is a unicellular organism with a shape resembling the sole of a shoe. It ranges from 50 to 300um in size which varies from species to species. It is mostly found in a freshwater environment. It is a single-celled eukaryote belonging to kingdom Protista and is a well-known genus of ciliate protozoa. As well, it belongs to the phylum Ciliophora. Its whole body is covered with small hair-like filaments called the cilia which helps in locomotion. There is also a deep oral groove containing not so clear oral cilia. The main function of this cilia is to help both in locomotion as well as dragging the food to its oral cavity.

Structure and Function -
1. Shape and Size
P. cadatum is a microscopic, unicellular protozoan. Its size ranges from 170 to 290um or up to 300 to 350um. Surprisingly, paramecium is visible to the naked eye and has an elongated slipper like shape, that's the reason it's also referred to as a slipper animalcule. The posterior end of the body is pointed, thick and cone-like while the anterior part is broad and blunt. The widest part of the body is below the middle. The body of a paramecium is asymmetrical. It has a well-defined ventral or oral surface and has a convex aboral or dorsal body surface.
2. Pellicle -
Its whole body is covered with a flexible, thin and firm membrane called pellicles. These pellicles are elastic in nature which supports the cell membrane. It is made up of a gelatinous substance.
3. Cilia -
Cilia refers to the multiple, small hair-like projections that cover the whole body. It is arranged in longitudinal rows with a uniform length throughout the body of the animal. This condition is called holotrichous. There are also a few longer cilia present at the posterior end of the body forming a caudal tuft of cilia, thus named caudatum.The structure of cilia is the same as flagella, a sheath made of protoplast or plasma membrane with longitudinal nine fibrils in the form of a ring. The outer fibrils are much thicker than the inner ones with each cilium arising from a basal granule. Cilia have a diameter of 0.2um and helps in its locomotion.
4. Cytostome -
- **Oral groove :** There is a large oblique shallow depression on the ventrio-lateral side of the body called peristome or an oral grove. This oral groove gives an asymmetrical appearance to the animal. It further extends into a depression called a vestibule through a short conical funnel. This vestibule further extends into the cytostome through an oval-shaped opening, through a long opening called a cytopharynx and then

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the esophagus leads to the food vacuole.

- **Cytopyge :** Lying on the ventral surface, just behind the cytostome is the cytopyge also called a cytoproct. All the undigested food gets eliminated through the cytopyge.
- **Cytoplasm :** Cytoplasm is a jelly-like substance further differentiated into the ectoplasm. The ectoplasm is a narrow peripheral layer. It is a dense and clear layer with an inner mass of endoplasm or semifluid plasmasol that is granular in shape.
- **Ectoplasm :** Ectoplasm forms a thin, dense and clear outer layer containing cilia, trichocysts, and fibrillar structures. This ectoplasm is further bound to pellicle externally through a covering.
- **Endoplasm :** Endoplasm is one of the most detailed parts of the cytoplasm. It contains several different granules. It contains different inclusions and structures like vacuoles, mitochondria, nuclei, food vacuole, contractile vacuole etc.
- **Trichocysts :** Embedded in the cytoplasm are small spindle-like bodies called trichocysts. Trichocysts are filled with a dense refractive fluid containing swelled substances. There is a conical head on the spike at the outer end. Trichocysts are perpendicular to the ectoplasm.

5. Nucleus -

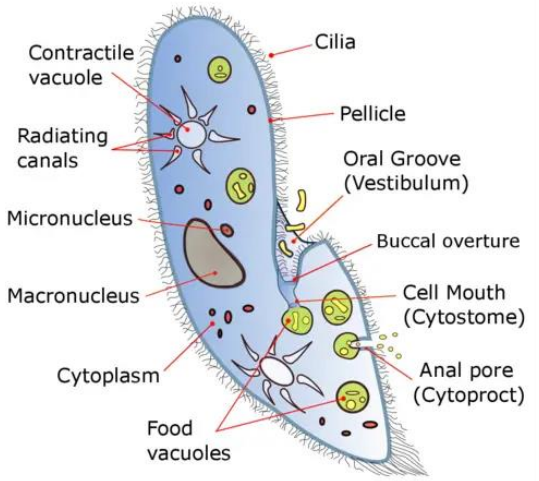
The nucleus further consists of a macronucleus and a micronucleus.

- **Macro Nucleus :** Macronucleus is kidney like or ellipsoidal in shape. It's densely packed within the DNA (**chromatin granules**). The macronucleus controls all the vegetative functions of paramecium hence called the vegetative nucleus.
- **Micro Nucleus :** The micronucleus is found close to the macronucleus. It is a small and compact structure, spherical in shape. The fine chromatin threads and granules are uniformly distributed throughout the cell and control reproduction of the cell. The number in a cell varies from species to species. There is no nucleolus present in caudatum.

6. Vacuole -

Contractile vacuole:

There are two contractile vacuoles present close to the dorsal side, one on each end of the body. They are filled with fluids and are present at fixed positions between the endoplasm and ectoplasm. They disappear periodically and hence are called temporary organs. Each contractile vacuole is connected to at least five to twelve radical canals. These radical canals consist of a long ampulla, a terminal part and an injector canal which is short in size and opens directly into the contractile vacuole. These canals pour all the liquid collected from the whole body of paramecium into the contractile vacuole which makes the vacuole increase in size. This liquid is discharged to the outside through a permanent pore. The contraction of both the contractile vacuoles is irregular. The posterior contractile vacuole is close to the cytopharynx and hence contract more quickly because of more water passing through. Some of the main functions of contractile vacuoles include osmoregulation, excretion, and respiration.



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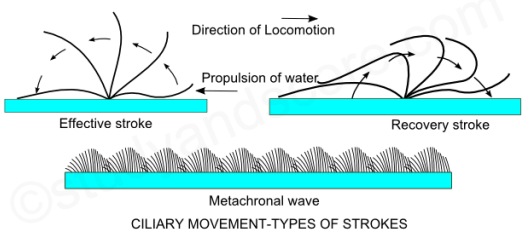
Food vacuole:
Food vacuole is non-contractile and is roughly spherical in shape. In the endoplasm, the size of food vacuole varies and digest food particles, enzymes alongside a small amount of fluid and bacteria. These food vacuoles are associated with the digestive granules that aid in food digestion.

Locomotion in Paramiecium:
Paramecium has a streamlined body which helps it to swim in the water which less friction. The rapid swimming is facilitated by the beating of fine and hair -like cellular organelles called cilia. Cilia cover the entire body surface of this protozoan.

Ciliary movement -
In Paramecium locomotion mainly occurs by movement of cilia. It can move forward and backward. While moving forward, cilia strongly move from anterior to posterior. Similarly, for backward movement cilia strongly move from posterior to anterior. All the cilia do not move at a time. Cilia of transverse row move at the same time. It is called synchronous rhythm, whereas cilia of longitudinal row move one after another. It is called Metachronous rhythm.The back and forth movements of the cilia are also called as effective and recovery strokes respectively. Cilium moves just like a pendulum or a paddle. The cilium moves the water parallel to the surface of its attachment like that of paddle stroke movement. The movement of water is perpendicular to the longitudinal axis of cilium.



CILIARY MOVEMENT-TYPES OF STROKES

Effective stroke -
During effective stroke, the cilium bends and beats against water thus bringing the body forward and sending the water backwards.

Recovery stroke -
During recovery stroke, the cilium comes back to original position by its backward movement without any resistance.

Cilia shows two types of coordinated rhythms

Synchronous rhythm, where in the cilia beast simultaneously in a transverse row.

Metachronous rhythm, where in cilia beat one after another in a longitudinal row. The metachronal waves pass from anterior to posterior end.

The beating of the cilia can be reversed to move backwards when a Paramecium encounters any undesirable object in its path. The ciliary movement is coordinated by infraciliary system though neuromotor center called as motorium present near the cytopharynx in the ciliates like Paramecium. The infraciliary system together with motorium form neuromotor system which helps in coordination of the beating of the cilia. Ciliary movement is the fastest locomotion in protozoans.

Nutrition in Paramecium :
Paramecium is a tiny unicellular organism found in water. It follows

1. **Ingestion:** Paramecium engulfs food by the use of cilia. Cilia is a hair like structure present on surface on body of paramecium. Food is ingested by cilia through oral groove into gullet. The food is ingested with a little surrounding water to form a food vacuole.
2. **Digestion:** In Paramecium, food is digested in food vacuole by the digestive enzymes released by cytoplasm. Digestion in Paramecium is termed as **"intracellular digestion"**
   Each food vacuole consists of food particles and it undergoes circulation in definite path along with cyclosis. Digestion takes place with the help of certain enzymes secreted by protoplasm into the vacuoles. The

contents of vacuole first become acidic and then become alkaline. The major digestion of food occurs during the alkaline phase. In digestion proteins are converted into aminoacids, carbohydrates into soluble sugar and glycogen. Products of digestion are diffused into the surrounding cytoplasm and either stored or used for vital activity and growth. Finally the undigested food materials is eliminated from the body through anal spot or cytoproct on ventral surface.

3. **Absorption:** The digested food present in the food vacuole of Paramecium is absorbed directly into the cytoplasm by diffusion. After absorption of food, the food vacuole shrinks.
4. **Assimilation:** The absorbed food nutrients is stored and utilized later for synthesis of energy.
5. **Egestion:** The undigested food is expelled out through anal pore.
6. **Feeding Mechanism:** Paramecium feeds holozoically with the help of **cilium**. Food includes bacteria, unicellular plants **(algae, diatoms, yeasts, etc.)** and small bits of animal and vegetables. Paramecium swims to place where it can get its food. It does not move while feeding. Food is ingested by cytosome lying at the bottom of buccal cavity. At first cilia of oral groove move very fast that drives current of water with food particles toward vestibule. Ciliary tracts of vestibule direct the food particles into buccal cavity. Larger food materials are rejected whereas smaller food materials are selected and ingested through cytosome into **cytopharynx**. The food now gradually collects at the bottom of **cytopharynx** into a **membranous** vesicle which is later released off as food vacuole.