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| **ZOOLOGY** | **PAPER No.: IX (NON-CHORDATES)** |
| | **MODULE No. 1 (NUTRITION IN PROTOZOA)** |

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## 1. Learning Outcomes:

In this module,

- You shall learn about the information regarding the concept of Nutrition in Protozoa.
- You shall learn about Various types of modes of feeding habitats in protozoa.
- You shall learn about habit and habitat, types of endoparasites, Fresh water, Protozoans.
- We can study in detail about the pathogens which spreads various disease which kills the hosts, which are never removed surgically.

## 2. INTRODUCTION:

Nutrition is a process by which the individuals obtain nourishment. It includes ingestion, digestion, absorption and egestion. Some protozons obtains their food from fresh water including algae diatoms small crustacians bacteria dead organic matter. Most of protozoans take liquid food from surrounding water or from body of its host. Some protozons feeds on the faecal matter of other invertebrates or vertebrates like Balantidium Dimastigamoeba,Clamydophrys .Specefic protozones takes food from the cell of hosts like RBC of vertebrates .Plasmodium,Leishmania,Ent amoeba .

Some important types of modes are as follows.

## 3. Types of Nutrition in Protozoa:

The nutrition of protozoa is manifested by following ways:

A. Holozoic or Zootrophic or Heterotrophic Nutrition

B. Holotrophic or Autotrophic or Phytotrophic Nutrition

C. Saprozoic or Saprophytic nutrition

D. Parasitic Nutrition

E. Myxotrophic Nutrition

F. Pinocytotic Nutrition

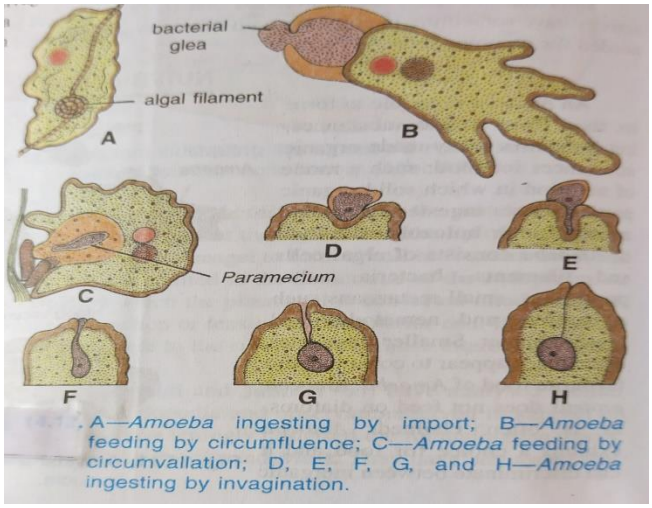
G. Coprozoic Nutrition

H. Parasitic Food Robber and Pathogen Nutrition

I. Nutrition in Ciliates (paramecium)

**(A) Holozoic or Zootrophic or Heterotrophic:**

In this method the food is animal or plant is smaller than the body of the protozoa are used as food sources (Fig.). Algal filaments or bacteria. The method is ultimately associated with ingestion, digestion, assimilation and egestion.



. A—*Amoeba* ingesting by import; B—*Amoeba* feeding by circumfluence; C—*Amoeba* feeding by circumvallation; D, E, F, G, and H—*Amoeba* ingesting by invagination.

**I. Ingestion:**

Most Sarcodina capture their food and take them inside the body through any part of the body. In Mastigophora and Ciliates food enters into the body through the cytostome. The lashing of flagella or cilia aids in bringing about the food particles to the cytostome. Foodgetting is no problem to parasitic forms when they are inside the body of the host.

In Sarcodina the following methods have been observed for the ingestion of food particles:

**(a) Import:**

The food is taken inside the body upon contact with little or no movement of body parts. It includes dead organic matter,passively food enters in the body of protozoa .

**(b) Circumfluence:**

The food is surrounded on all sides by the cytoplasm and is engulfed.The prey is not active ,easily food ie taken in the endoplasm and food vacuole is immediately formed in which taken food is stored for digestion .

(c) **Circumvallation:**

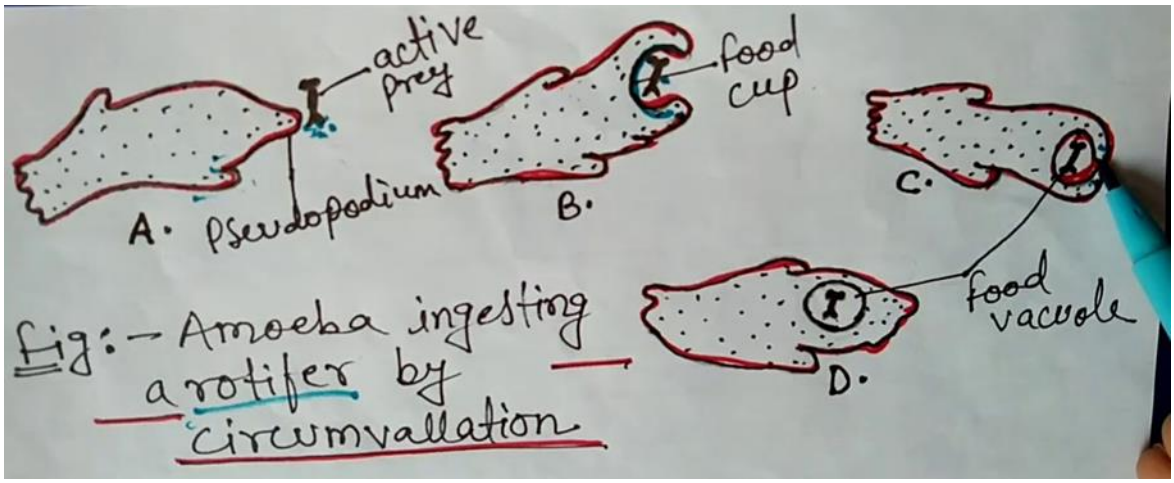


fig:- Amoeba ingesting a rotifer by circumvallation

The amoeba forms pseudopodia round the food particle and ingests it.The prey is always active The amoeba has to form the food cup with the help of pseudopodia and then the prey is caught and food vacule is formed .

**(d) Invagination:**

The ectoplasm of the amoeba, when comes in contact with the food particle, is invaginated or in pushed into the endoplasm as a tube. The cell membrane at the point of contact dissolves. Certain parasitic amoebae are capable of ingesting by invagination. In certain ciliates like Coleps and Didinium the cytostome remains closed ordinarily but it expands to an enormous size during feeding and the whole food is ingested in toto. In suctorians the tentacles are prehensile, and solid or liquid food matter is sucked in through the tubular tentacles.

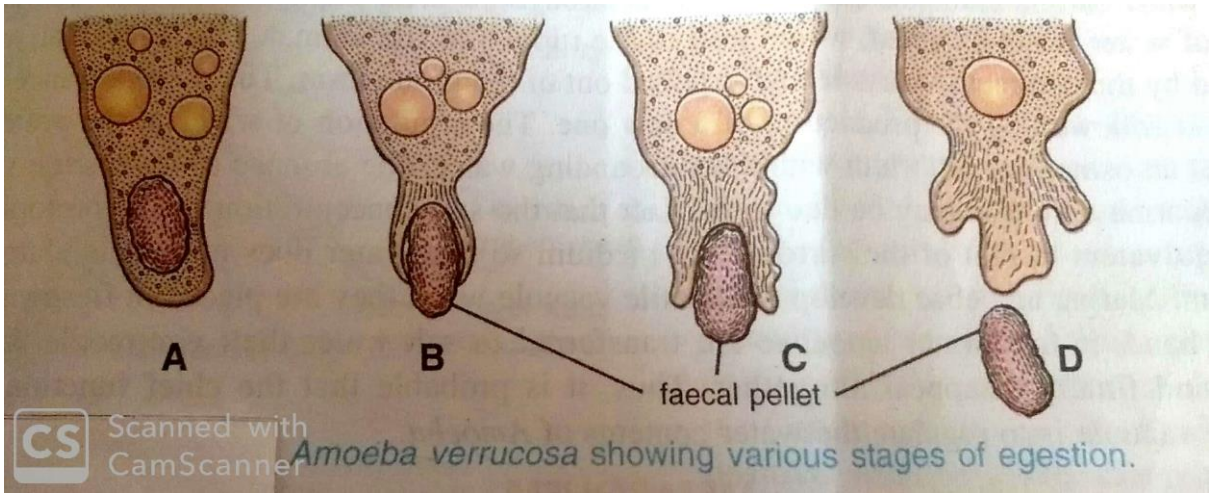
**II. Digestion:**

The ingested food particles surrounded by a film of fluid remain in the endoplasm in 'food vacuoles. The food vacuoles always remain in motion in the endoplasm and show 'cyclosis'.This is well seen in Paramoecium. The vacuole contains food particles in killed, paralysed or alive conditions. However, all activities on the part of the prey stop a few minutes after its entry into the food vacuole. Digestion is done within the food vacuoles.

**III. Absorption:**

Digested food gets diffused into endoplasm, where it is assimilated into protoplasm. Excess food may be stored as glycogen, lipids, chromatoid bodies, etc.

**IV. Egestion:**



Scanned with CamScanner
*Amoeba verrucosa* showing various stages of egestion.

Non-digested residue is thrown out of the body through the plasma membrane or through cytopyge or temporary cell-anus.

**(B) Holotrophic or Autotrophic or Phytotrophic:**

This type of nutrition is equivalent to the photosynthesis of plants. The process involves the photolytic decomposition of H2O ultimately liberating O2 and reduction of CO2 to form carbohydrates. Holophytic nutrition is predominant in Phytomastigina and few chlorophyllbearing ciliates.In Euglena this type of nutrition is seen . In the presence of O2 and sunlight Euglena can produce its own food because its body contains chlotoplast (photosynthesis) but during unfevarable conditions it feeds heterotrophically.

**(C) Saprozoic or Saprophytic:**

In this process the nourishing substances enter into the body by diffusion through body surface and no organelle are involved. The nourishing substances are simpler compounds formed by the activities of bacteria on dead or decomposed bodies of animals or plants. Many free-living protozoans, especially the flagellates, nourish themselves by this process.

**(D) Parasitic:**

Many protozoa live inside the body of other living organism and nourish themselves from the food of the host. In some cases, the digested or decomposed substances of the hosts enter into the body of the parasites by diffusion as in Monocystis , Plasmodium . However, many parasitic protozons shows such types modes.

**It shows again two types**

I. **Food robbers**: parasites feeds upon the undigested or digested food of their host.
II. **Pathogenic:** the protozoan parasite causes harms to their host.

**(E) mixotrophic:**

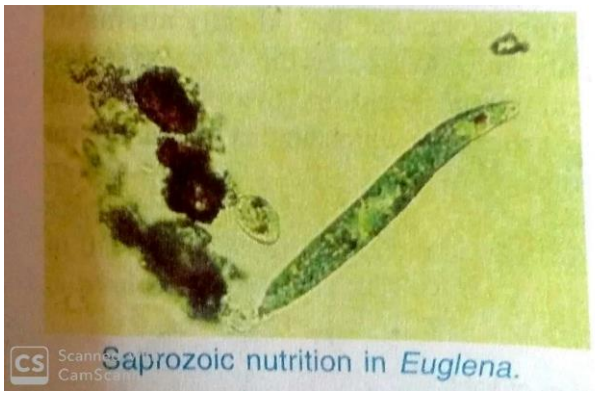
Mixotrophic organisms can combine two functionally different modes of nutrition to acquire carbon: (i) by using photosynthesis for inorganic carbon fixation; and (ii) by taking up organic sources. Because of these different metabolic pathways, their biochemical composition, for example, the amount and composition of consumer-relevant compounds such as polyunsaturated fatty acids, varies, and thus, we tested the hypothesis that the mode of nutrition of an osmo-mixotrophic flagellate determines the food quality for their consumers: three rotifer species.

Euglena belongs to the phylum Euglenozoa. These are unicellular organisms which can produce their own food via photosynthesis and also can consume food because they are heterotrophic organisms too.

The Euglenas appear typically green because of the presence of chloroplast but some of the species become red in colour due to carotenoids in large amounts. The colourful euglenas are in large numbers congregating on brackish ponds; it looks like green or red blooms inside water. When they feed as a heterotroph Euglena takes nutrients by the help of osmotrophic and can live in absence of light on a diet of organic matter.

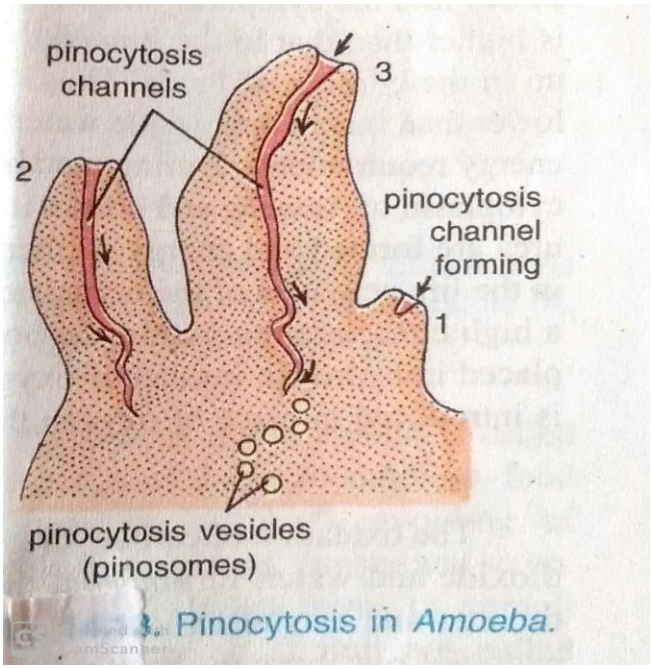
Whenever there is sunlight, it starts feeding by photo trophy which makes the food using chloroplast containing the pigments of chlorophyll a and chlorophyll b to produce sugar by photosynthesis. Euglena are majority found in the water as it forms a green or red film over top of it as they are good indicators of water pollution.

In the Euglena cell wall is absent and a proteinaceous layer is found called pellicle. The pellicle consists of overlapping and interlocking strips packed in a spiral shape. These pellicular strips give flexibility to the cell. Sliding of these strips with each other leads to the movement of the cell. Because of the strips the cell contracts and manipulates shape. They have structures such as flagella, eyespot, contractile vacuole and chloroplast. Light sources are used to photosynthesize which are seen with the eyespot.




Flagellates like Euglena can nourish themselves in more than one method. On the demand of the external condition (in the absence of light) they can change their mode of nutrition from holophytic to saprophytic type.

**(F) Pinocytosis:**

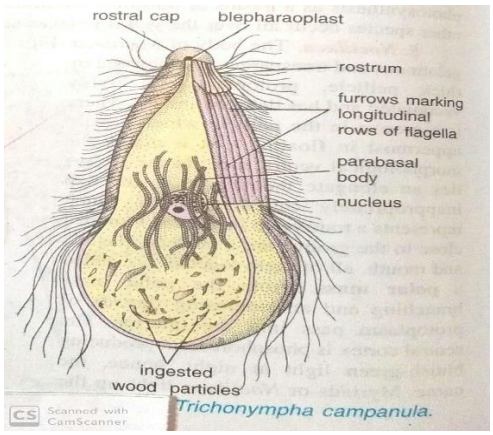


Pinocytosis in *Amoeba*.

In addition to phagocytosis, pinocytosis or cell drinking has been reported in Amoeba and certain flagellates and ciliates. This involves ingestion of liquid food by invagination through surface of body. Pinocytosis channels are formed at some parts of body surface to enclose the fluid food from surrounding medium. Lower ends of channels are pinched off as food vacuoles which circulate into the endoplasm. Pinocytosis is induced only by certain active substances in the medium surrounding the cell, such as some proteins and many salts.

**G. Copozoic nutrition:**

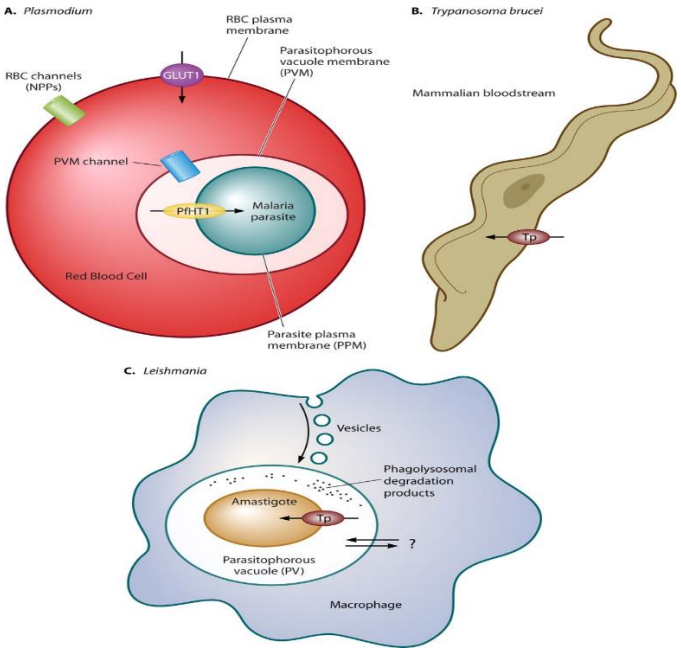
Certain free-living protozoans are in habit of feeding upon the the faecal matters of other organisms like clamydophrys and Dimastigamoeba.



*Trichonympha campanula*.

**H. Parasitic Food Robber and Pathogen Nutrition:**

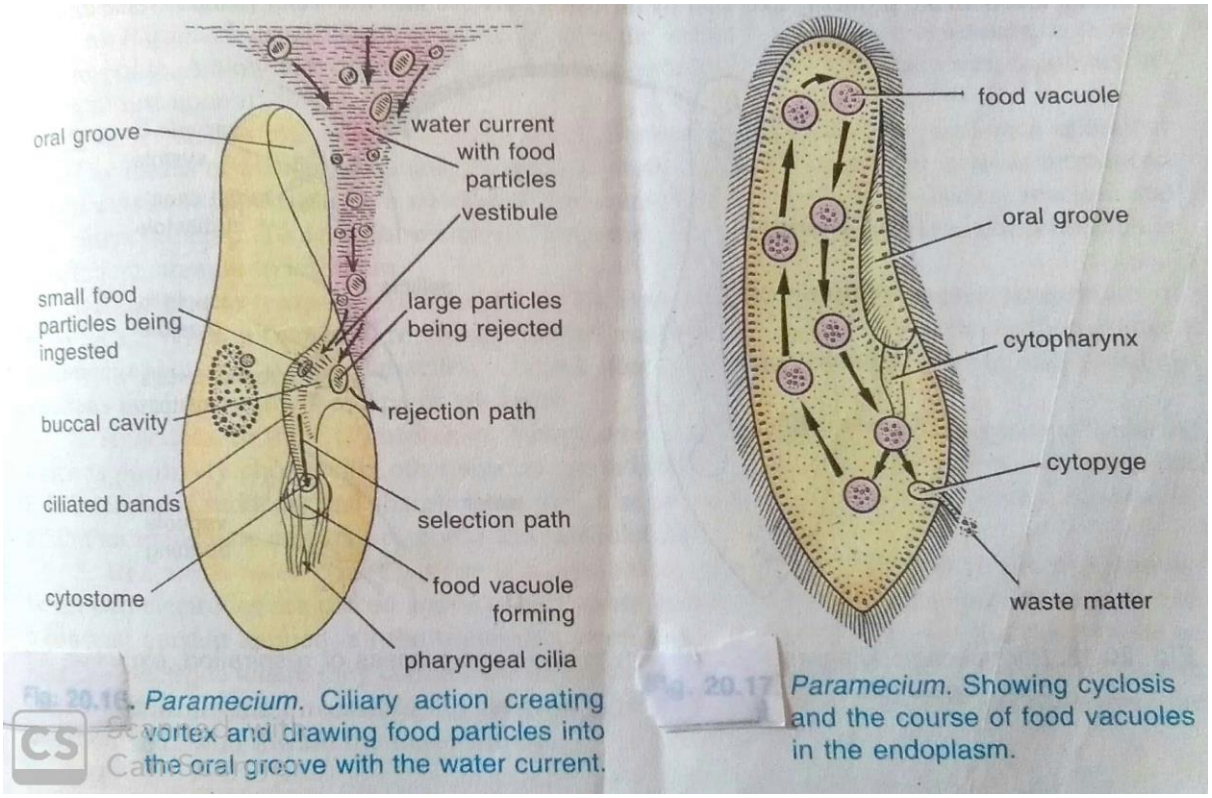
Parasitic protozoa are responsible for a host of devastating diseases worldwide, including malaria, African trypanosomiasis, Chagas' disease, leishmaniases, toxoplasmosis, and many others. While all organisms must acquire nutrients from their environment, the parasitic mode of life has a number of consequences regarding nutrient uptake. First, the parasite must compete with its insect and vertebrate hosts for acquisition of many essential compounds and thus must evolve efficient uptake mechanisms. Second, the typical parasitic life cycle entails at least two hosts, one of which is often an invertebrate vector and the other a vertebrate host.




Thus, the microbe cycles between multiple physiologically distinct milieus that may present pronounced differences in available nutrients, pH, temperature, ionic composition, etc. The parasite must express nutrient uptake systems that accommodate these profound alterations in environment and may employ regulatory mechanisms to alter the level of uptake according to nutrient availability and/or life cycle stage. The capacity of a parasite to import critical nutrients is central to its ability to be transmitted, to infect a host, and to cause disease and hence is an important component of pathogenesis.

**I. Nutrition Ciliates:**

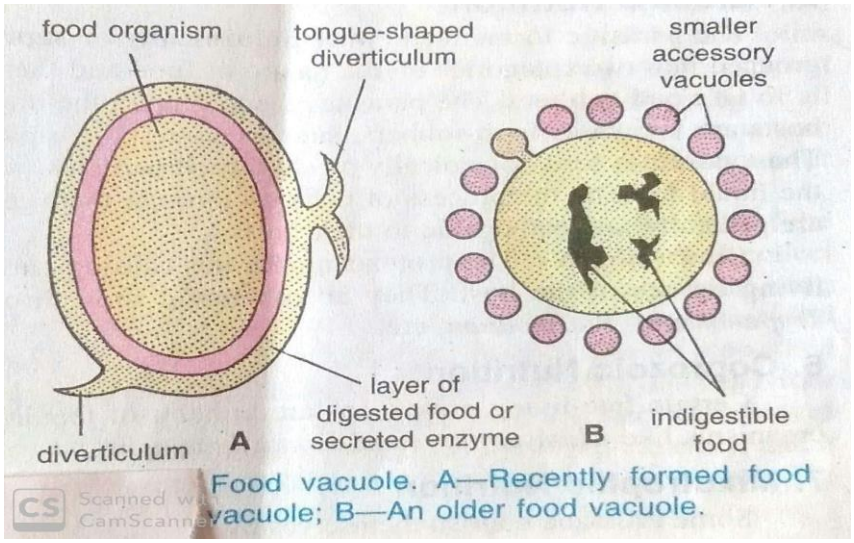
Most ciliates are heterotrophic and feed on smaller organisms such as bacteria and algae. With a few exceptions, ciliates have a "mouth." Food particles are swept into the funnel-shaped oral groove and toward the cell mouth by rows of cilia. The food particles are then engulfed by phagocytosis, forming a food vacuole. Lysosomes then fuse with the food vacuole. The digestive enzymes in the lysosomes break down the food. The food particles are then small enough to diffuse through the membrane of the food vacuole and into the cytoplasm. Anything left in the food vacuole by the time it reaches the anal pore is discharged by exocytosis. Some ciliates do not have an oral groove and feed instead by absorption, while others are predatory and feed on other ciliates.




*Paramecium*. Ciliary action creating vortex and drawing food particles into the oral groove with the water current.

*Paramecium*. Showing cyclosis and the course of food vacuoles in the endoplasm.

Ciliates constantly take in water from their environment by osmosis. They need to expel this extra water, otherwise they would burst. Most ciliates also have one or more large contractile vacuoles, which collect water and expel it from the cell to maintain osmotic pressure. The contractile vacuoles have a distinctive star-shape, as shown in Figure above, with each "point" of the star being a water collecting tube.



Food vacuole. A—Recently formed food vacuole; B—An older food vacuole.

The digested food from the food vacuole is diffused out into the endoplasm and finally assimilated in the body to manufacture the protoplasm. The excess of food is stored in form of glycogen paramylon, Para glycogen bodies in the endoplasm.

**Summary:**

Ciliophora, called ciliates due to their numerous cilia, tend to be large protozoa, with a few species reaching 2 mm in length. They are some of the most complex protists in terms of structure, more complex than a single cell of a multicellular organism. Paramecia, which are ciliates, obtain food by moving food particles into their oral groove with their beating cilia. They reproduce by binary fission. They exchange genetic information by conjugation, giving each other a copy of a micronucleus.

Video:
https://drive.google.com/file/d/1YprJmp6NoUqAYiocMOq5kGgoToWuFk8Y/view?usp=sharing

Assignment:
https://docs.google.com/forms/d/e/1FAIpQLSeAd1LDQfnPTvx3RdK44g1OYOdx8Ne8AhCTzkOr14oSexvf7w/viewform?usp=sf_link

Know more:

Suggested readings, web links:


1) Jordan E.L., & Verms P.S. (2000) Invertebrate Zoology, S. Chand Publishing, New Dehli 110055.
2) https://www.biologydiscussion.com/invertebrate-zoology/protozoa/protozoa-nutrition-respiration-and-excretion/32547
3) https://ask.learncbse.in/t/explain-the-nutrition-process-in-an-amoeba/24912
4) https://www.bestfunquiz.com/q/ultimate-trivia-quiz-on-phylum-protozoa-subphylum-sarcodina
5) https://journals.asm.org/doi/10.1128/EC.00287-10
6) https://www.google.com/search?q=Nutrition+Ciliates:&tbm=isch&source=iu&ictx=1&fir=_WH4488NRnaN-M%252CHphMr9BVP1-8PM%252C_&vet=1&usg=AI4_-kSZu2vPlimq_7eyGT9tBF1jCqjbkA&sa=X&ved=2ahUKEwjc5Ym7_6_yAhWGxDgGHcP4A_oQ_h16BAgjEAE#imgrc=_WH4488NRnaN-M
7) https://besjournals.onlinelibrary.wiley.com/doi/full/10.1111/j.1365-2435.2007.01333.x
8) Text book of Invertebrates Dhami Dhami
9) Invertebrates by R.L.Kotpal
10) Text book of Non chordates by S.N.Prasad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