

Paramecium

Systematic position

- α. Phylum - Protozoa
- β. Phylum - Ciliophora
- Class - Ciliata
- β. Class/Order - Holotricha
- Order - Peritricha
- Genus - Paramecium
- Sp. - caudatum

② Habit and Habitat - Small one celled (= unicellular) living organism found in fresh and stagnant water of ponds, pools, ditches, streams, swamps, lakes etc, rich in decaying organic matter.

③ Structure - Oval, slipper shaped, cigar shaped or spindle shaped unicellular, microscopic organism of different sizes.
(Largest sp - P. caudatum : It measures between 0.2-0.3 mm long.)
The body of P. caudatum is elongated, blunt. Blunt at the ant. end and pointed at the posterior end.

Because of its slipper like shape, the paramecium is sometimes called the 'slipper animalcule'.

Its body is asymmetrical with flat oral or ventral surface and convex aboral or dorsal surface.

Following structures can be seen, associated with the body of the Paramecium.

- ① Pellicle - (= Cell wall) - living, clear, thin, firm elastic outer covering (= Cuticular membrane) that gives a definite shape to the body. Pellicle consists of thin membranes.
 - a) the outer - Surface membrane
 - b) alveoli - beneath outer membrane
 - c) the outer and inner membrane of the alveoli (= Middle or Inner membrane)
- ② Cilia - The entire body surface is covered by a uniform covering of hair like projections called Cilia (nearly 10-12 μ in length)
- ③ Protoplasm - Within pellicle, the ~~cytoplasm~~^{protoplasm} of body is clearly differentiated into two regions:

① Ectoplasm - narrow, peripheral, clear and dense zone

② Endoplasm - large, central, granular and semi fluid zone

Following structures can be seen in the protoplasm

(a) Trichocyst - Peculiar rod-like / spindle shaped or oval organelle lies embedded in the cytoplasm alternating with body sides and perpendicular to the body surface.

Each trichocyst consists of an elongated shaft and a barbed spine covered with a cap.

When irritated by external stimuli, the trichocyst are discharged (mechanically, chemically + electrically + irritation) as long sticky thread which is believed to be the organ of defence.

(b) Oral groove - broad, shallow or groove on the ventral surface. It extends obliquely backwards into a conical funnel shaped depression called vestibule.

Oral grooves mainly collect and direct food into the cell.

- (c) Cytostome - a small opening at the posterior part of oral groove.
- (d) Cytopharynx - a narrow tube which starts from cytostome and enters into endoplasm. It forms a food vacuole at its proximal end.
- (e) Nucleus (= heterokaryotic) - It possesses two types of nuclei.
 - (1) Macronucleus (= large nucleus) - kidney shaped and with many nuclei and much more chromatin material (DNA). It controls metabolic activities of the cell.
 - (2) Micronucleus (= small) - lodged in a depression on the surface of the macronucleus. It is spherical with nuclear membrane and with diploid no. of chromosomes. It controls the reproductive activities of the organism.

LOCOMOTION

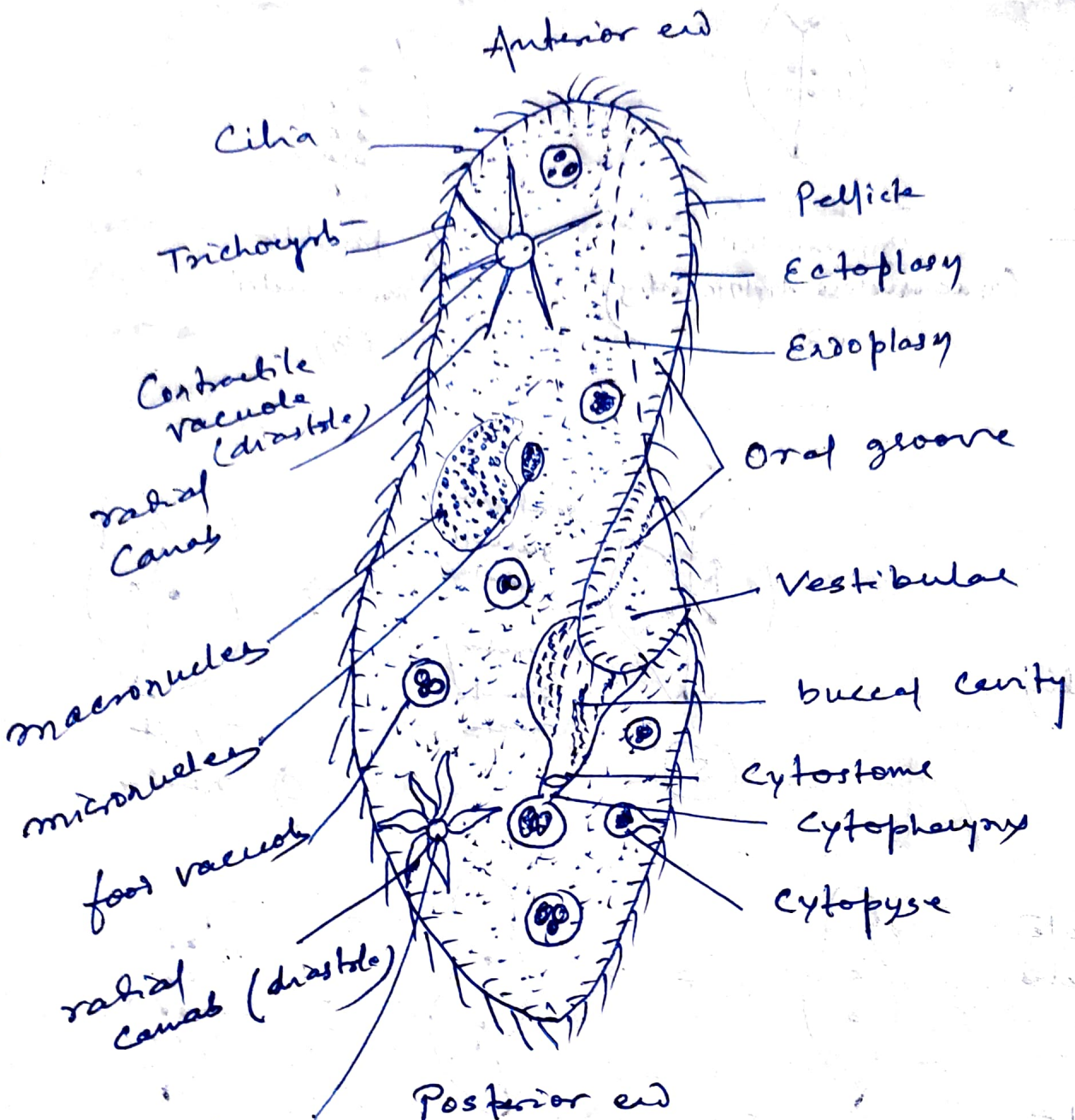
The locomotion of P. caudatum is performed with the help of cilia (= hair like cellular organelles).

It progresses by the following two methods: -

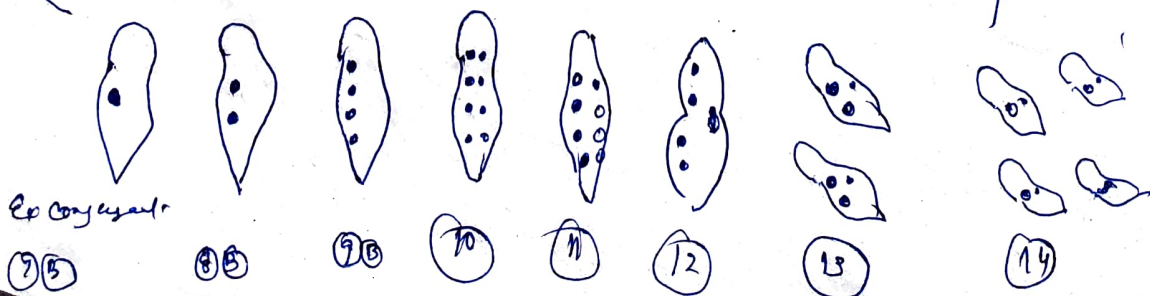
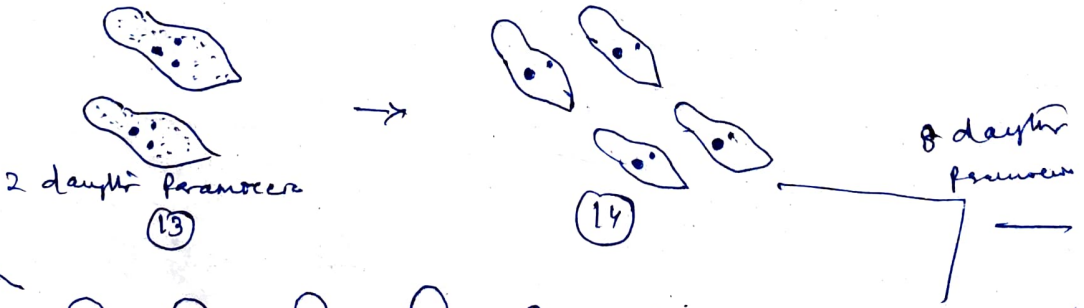
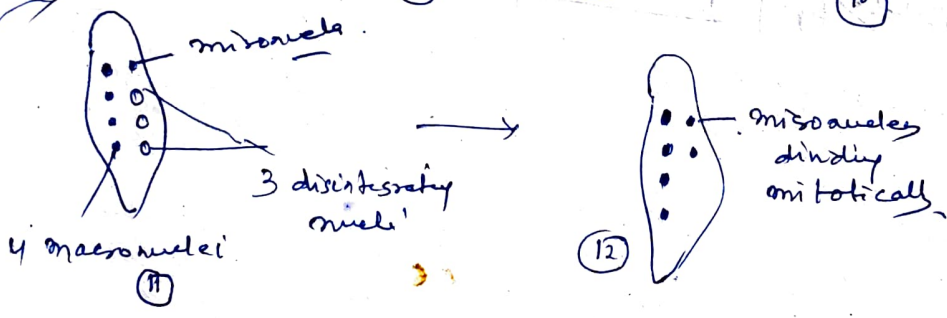
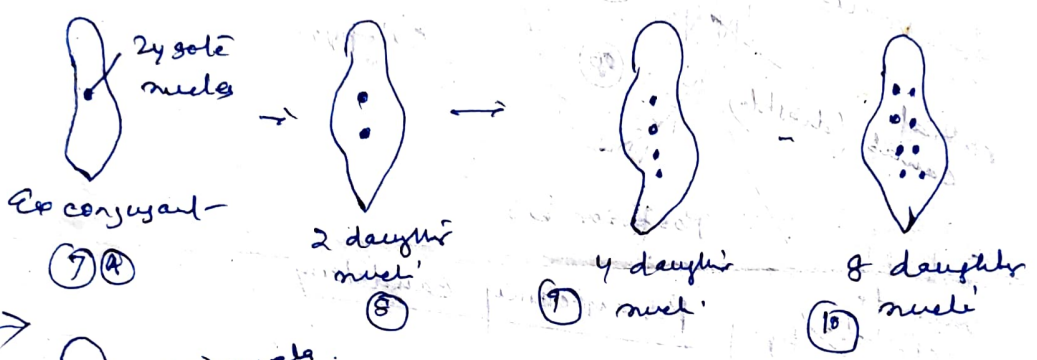
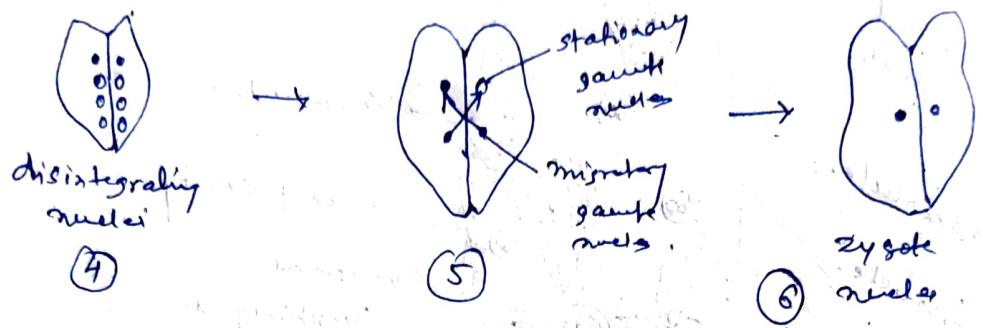
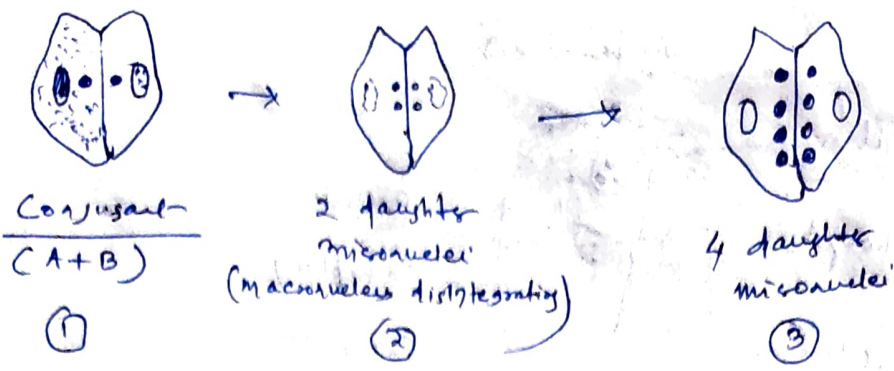
- (1) Ciliary movement - Cilia are the main locomotory organelle of paramecium. There are fine, hair like protoplasmic processes all over the body; inclined backward and their beating drives the body forward. The movement of cilia is controlled by the neuromotor system. Each oscillation of cilia consists of two strokes: -
 - (a) The effective stroke - When cilia become rigid and slightly curved to strike the water like an oar (=oar).
 - (b) Recovery stroke - when cilia remain flexed to offer least resistance to the current.
- (2) Creeping - when paramecium passes through a passage narrower than its body by the contraction and twisting of its body and again assume the normal life.

Nutrition (= Holozoic type)

The food consists of bacteria, algae, diatoms, yeast and other small protozoans and is ingested through cytostome. For this purpose, a current of water produced by the constant beating of cilia of oral groove by which food particles are swept -



Contractile vacuole (cytostole) Ap: 1 Paramecium caudatum



der on forming the food vacuole, which are swept by the
"ring movement" of endoplasm into the body and are carried
a definite course. The rotatory movement is known as Cyclosis.
The food is digested inside the food vacuole (which is first
acid and alkaline later on)

a digested food is assimilated by the endoplasm during cyclosis.
Excess faecal matter is discharged outside through a definite
spot or cytopogge

Food vacuole - Numerous, non-contractile, round storage pocket for
food

Contractile vacuole - Two large contractile vacuole, one on either
end of the body. Each contractile vacuole is
surrounded by 6-10 elongated radiating canals (= feeding canals)
each feeding canal is differentiated into -

Injector canal - Opens into vacuole
ampulla - that collapse when empty
Terminal part - Extends into cytoplasm
each canal has two parts

Terminal part - store excretory material
Proximal part - send excretory material to central vacuole

Cytopogge - (anal aperture) - lies on the ventral side of the body
- a little behind the cytostome or mouth

Respiration - through general body surface

Excretion - The waste products such as urea, uric acid and other
nitrogenous compound, produced as a result of catabolic
activities of the body also diffuse out through the general
body surface.

Osmoregulation - The amount of water in the body is controlled by two
contractile vacuoles (on on either side of the body) which
contract (= systole) and expand (= diastole) at regular intervals assisted by
the myofibrils.

Irritability or Sensitivity - Exhibit great sensitivity to the various stimuli
and its movement are more definite.

Reproduction

Paramecium reproduce both sexually & asexually

① Asexual reproduction (by means of binary fission)

(Occurs during favourable conditions of water, food & temperature)

During reproduction

① Animal stops feeding & micronucleus divide into two by antero

② and move apart towards the opposite end

the macronucleus elongates and gets constricted into two aunitotically.

③ a transverse constriction appears & finally dividing the body into two
equal halves.

- (5) Contractile vacuole in each half also divides.
- (6) Two now separate and start their free existence.
- (7) Entire process takes $\frac{1}{2}$ to 2 hours.

Sexual reproduction

- Conjugation:
- (1) Two individuals or pre-conjugants, from two different mating types (but same species) fuse together. Ventrally always in oral region.
 - (2) They stop feeding and their buccal structures start to disappear. The pellicle and ectoplasm degenerate at the point of contact and a protoplasmic bridge is formed between the two individuals (= Conjugants).
 - (3) Nuclear changes in both conjugants occur. The vegetative macronucleus breaks and is absorbed in the endoplasm.
 - (4) The micronucleus of each conjugant first grows in size as it divides by meiosis. Of the resulting 4 haploid nuclei, 3 degenerate or become pycnotic and the remaining one produces 2 unequal pronuclei or gamete nuclei by mitotic division. The smaller one is the active migratory gamete nucleus and the bigger one is the passive stationary gamete nucleus.

Autogamy - N.F. Diller (1936) described a process of nuclear reorganization in *P. aurelia*, which takes place within a single individual. It is called autogamy or self-conjugation.

During autogamy in *P. aurelia* the 2 diploid micronuclei divide by meiosis to form eight haploid daughter nuclei.

Cytogamy - In 1940, R. Wichterman reported a sexual process in *P. caudatum* without exchange of nuclear material.

In this process two small paramecia temporarily fuse by their oral surface.

Endomitosis

The vegetative macronucleus degenerates and disappears while the micronuclei divide three mitotically, produce 8 daughter nuclei of which 6 degenerate.

Paramecium also divides at this stage. Each daughter receiving one micronucleus. It divides twice forming 4 nuclei; 2 of which become macronuclei at 2 micronuclei, in each individual.

The micronuclei again divide with the binary fission into two, each getting one macronucleus at 2 micronuclei.

Thus 4 daughters are produced from a single parent.

Significance - By reproducing asexually, for serving searching, the paramecium loses its vigour and enters into a period of depressed physiological efficiency.

To avoid this ageing paramecium resorts to conjugation to rejuvenate and revive its lost vigour for sexual reproduction.

Union - (frequently referred as sexual reproduction)

simply

gation is temporary pairing of two individuals of the same species for the exchange of nuclear material.

occurs after repeated binary fission and is essential for rejuvenation and continuity of race.

In conjugation

- 1) two individuals or pre-conjugants come in contact - virtually as with by their oral grooves.
- 2) Stop feeding and their buccal structures disengage.
- 3) Pellicle at Ectoplasm (in the region of union) disintegrates at post-pharynx. Continuity is established between the two - called conjugants
- 4) macronucleus disintegrates into fragments and is absorbed in the cytoplasm.
- 5) micronucleus undergoes two premeiotic divisions of which first is reduction resulting 4 daughter micronuclei (with haploid no. of chromosomes)
- 6) four daughter nuclei disengage in each conjugant.
- 7) remaining micronucleus divides unequally producing a small active migratory male pronucleus at a large and passive stationary pronucleus potentially female.
- 8) Male pronucleus of the two conjugants are exchanged so that the male pronucleus of one pass into the other and fuse with the female pronucleus forming the zygote nucleus.
- 9) Conjugants now separate and are called Ex-conjugants
- 10) The zygote nucleus in each conjugant divides thrice and eight nuclei are formed. Four of them enlarge and form macronuclei, while the remaining four are known as micronuclei.
- 11) Three of the four micronuclei disintegrate.
- 12) The single micronucleus in each conjugant divides twice and each division is accompanied over the division of the body and a result four daughter paramecia are formed from each ex-conjugant, each with one macronucleus and one micronucleus.

Significance.

Several types of nuclear re-organization ~~are~~ several as endomitosis, autogamy have also been reported.