Paramecium

6.1 CLASSIFICATION

Phylum	–	**Protozoa**
Subphylum	–	**Ciliophora**
Class	–	**Ciliata**
Subclass	–	**Holotrichia**
Genus	–	***Paramecium***
Species	–	***caudatum***

Paramecium is well-known ciliate protozoan. It demonstrates a very high degree of cell **differentiation**, exhibiting many complex organelles which have been designed to perform specific functions for the organism. Not only its structure show specialization, but its reproductive activity is also complex. There are about 10 species of *Paramecium*. Its common species are *P. caudatum* and *P. aurelia*.

6.2 HABIT AND HABITAT

Paramecium caudatum (Gr., *paramekes* = oblong; L. *caudata* = tail) is a free-living organism having cosmopolitan (world-wide) distribution. It lives in stagnant water of freshwater, ponds, pools, ditches, and slow flowing streams rich in decaying organic matter.

6.3 STRUCTURE (MORPHOLOGY)

Size and shape. *Paramecium caudatum* is a unicellular and microscopic protozoan. It measures 170 to 290 mm. It is visible to the naked eye. Its body has a constant elongated, slipper-like shape so the animal is commonly called **slipper animalcule**. The anterior end of animal's body is blunt and posterior end is thick and pointed. Body is **asymmetrical** exhibiting flat **ventral** or **oral surface** and convex **dorsal** or **aboral surface**. Cellular body of *Paramecium* has the following structure.

1. Pellicle. The whole body of *Paramecium* is covered by a thin, firm, flexible membrane the **pellicle**. It maintains a definite shape of the animal and also serves as a skeletal structure. The pellicle has a uniform appearance, being composed of a lattice of hexagonally shaped pits, which are centrally perforated by a single cilium. The margins of hexagonal depressions are slightly raised up as ridges. Trichocysts open in the ridges (Fig. 6.2).

Ultrastructure of pellicle. The electron microscopic study of pellicle (Fig. 6.3) by **Ehret and Powers** (1957) has revealed that the hexagonal depressions correspond to regular series of cavities the **alveoli**. All alveoli collectively form a continuous alveolar layer, which is delimited by an outer **alveolar membrane**. The outer alveolar layer is covered by **plasma membrane** which also surrounds the cilia. Thus, pellicle comprises of three membranes—1. Outer plasma membrane (outermost), 2. Outer alveolar membrane (middle membrane), and 3. Inner alveolar membrane (innermost).

2. Cilia. Entire body surface of *Paramecium* is covered with numerous (10,000 to 14,000) tiny (10–12 μm in length and 0.27 μm in diameter), hair-like projections of cytoplasm, called cilia.

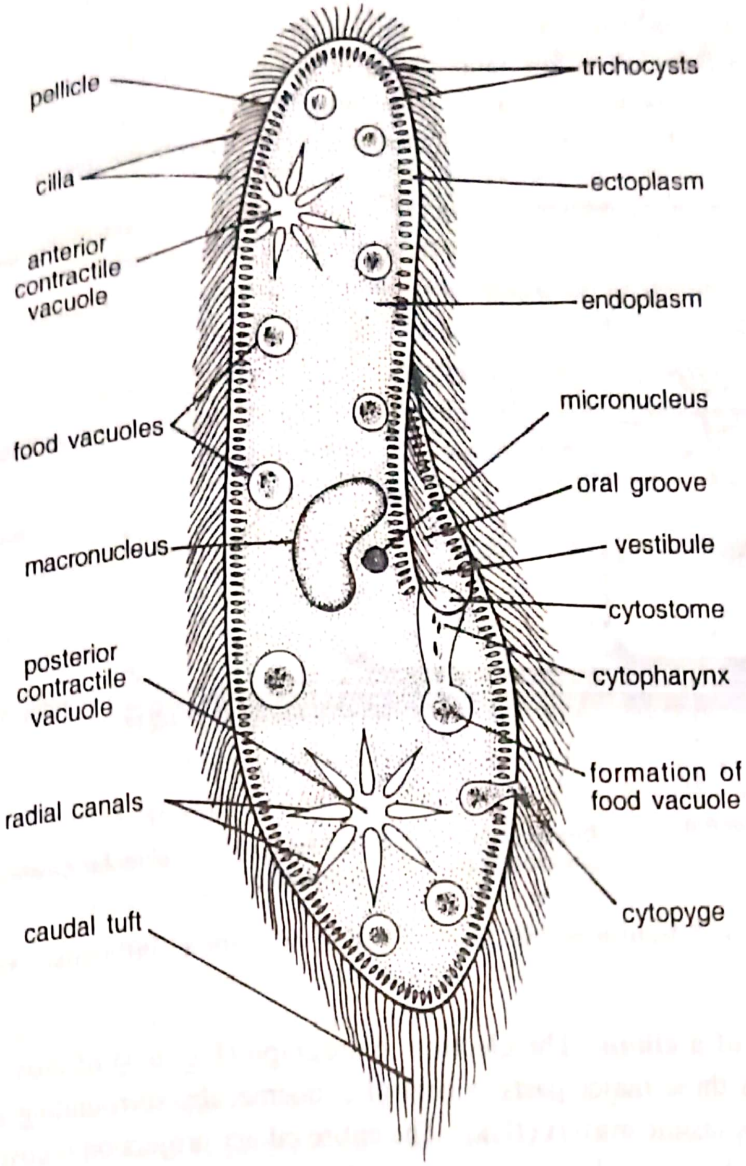

Fig 6.1. *Paramecium caudatum*. Structure.

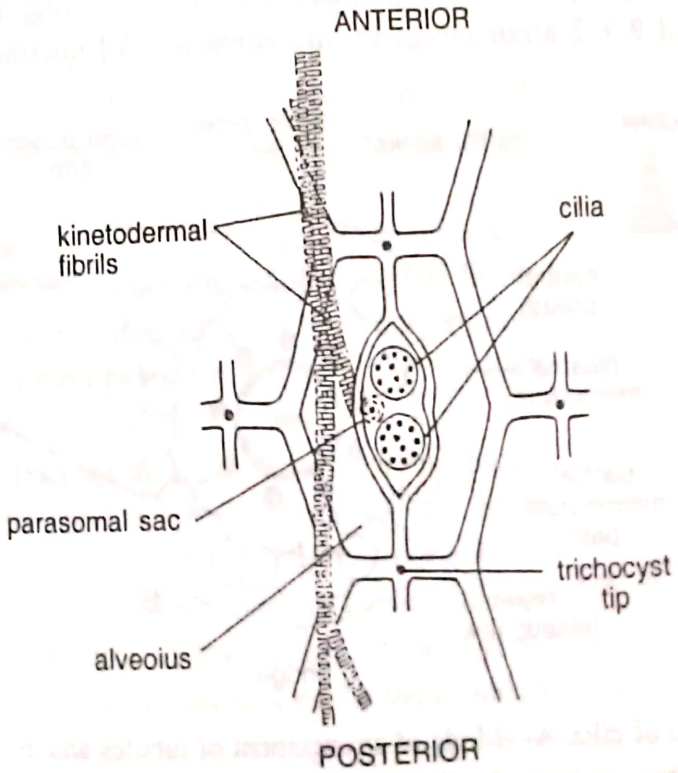

Fig. 6.2. *Paramecium aurelia*. Hexagonal area or ciliary field.

They are arranged in longitudinal rows, which are almost parallel on the dorsal surface and slightly oblique on the ventral surface. The length of cilia is unifrom throughout the body (a condition called **holotrichous**), but there are a few longer cilia at the posterior end of body. These form **caudal tuft** of cilia (hence the name **caudatum**). According to **Green** *et al*., 1990, certain caudal cilia are **tactile cilia**, they are stiff and non-locomotory ones and are used in the detection of external stimuli.

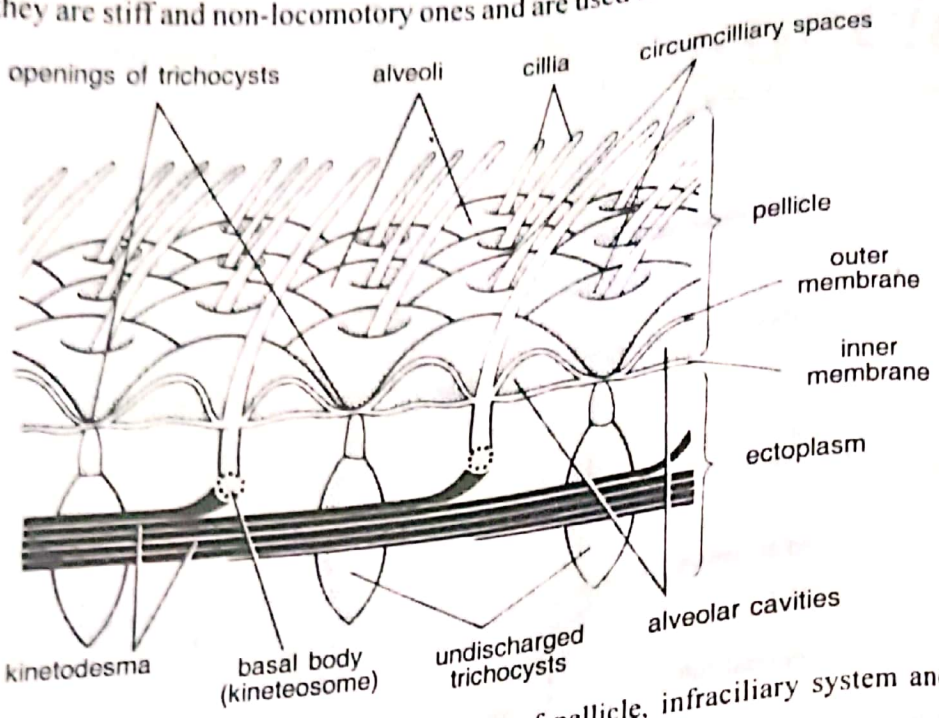

Fig. 6.3. *Paramecium*. Electron microscopic structure of pellicle, infraciliary system and associated structure.

Ultrastructure of a cilium. The electron micrograph (Fig. 6.4) of cross section of a cilium (or flagellum) exhibits three major parts: a central axoneme, the surrounding **plasma membrane** and the interposed cytoplasmic **matrix** (fluid). The entire ciliary projection is covered by a membrane that is continuous with the outer plasma membrane of pellicle. The core or shaft of the cilium, called the **axoneme**, contains an array of microtubules that run longitudinally through the entire organelle. Axoneme consists of nine peripheral doublet microtubules surrounding a central pair of single microtubules (*i.e.*, typical 9 + 2 arrangement of microtubules). All microtubules of the axoneme

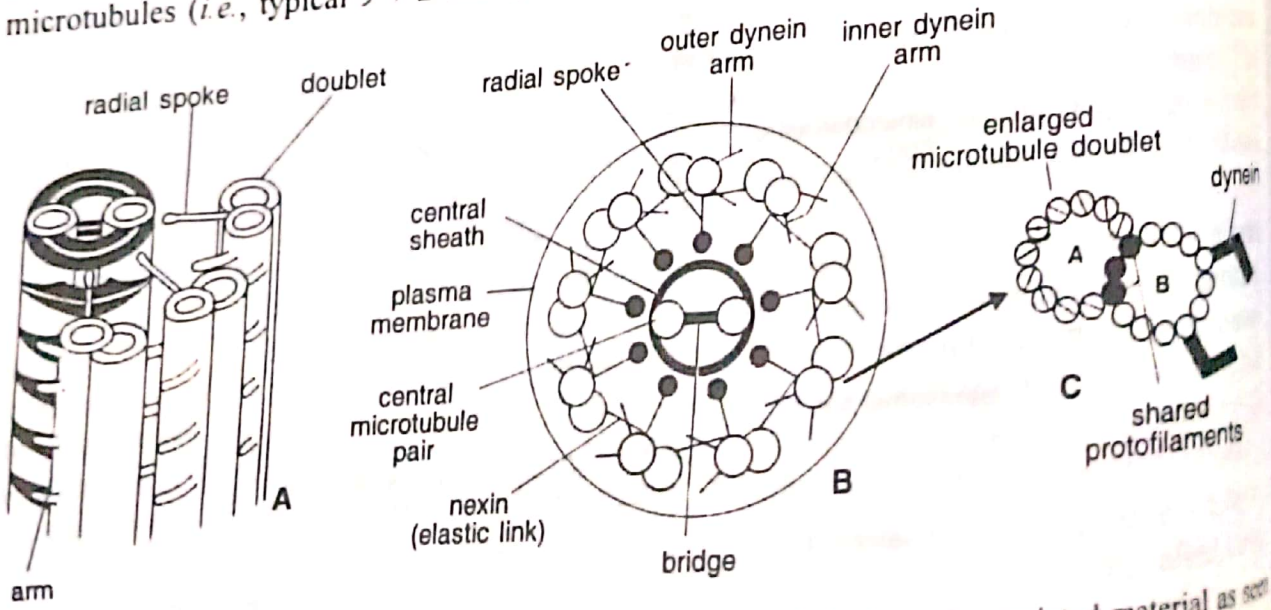

Fig. 6.4. Internal organization of cilia. A—Mode of arrangement of tubules and associated material as seen from outside. B—Cross section of cilia. C—An enlarged microtubule doublet.

have the same polarity: their plus ends are the tip of the projection and their **minus ends** at the base. Each peripheral doublet consists of one complete microtubule, the **A tubule**, and one incomplete microtubule, the **B tubule**, which contains 10 or 11 subunits (protofilaments of a and b tubulin proteins) rather than usual 13.

The central tubules are enclosed by projections that form **central sheath**, which is connected to A tubules of the peripheral doublets by a set of nine **radial spokes**. The doublets are connected to one another by an **interdoublet bridge** composed of an elastic protein, called **nexin**. Extending from each A tubule are two **dynein arms**—an **outer arm** and an **inner arm**, that are oriented in the same direction in all peripheral doublets, *i.e.*, clockwise when the axoneme is viewed from base to tip. Since dynein protein is capable of hydrolyzing ATP, it acts as an ATPase enzyme.

3. Cytoplasm. Beneath the pellicle lies the cytoplasm. The cytoplasm is differentiated into an outer narrow peripheral layer of clear and dense **plasmagel**, called **ectoplasm** and an inner large central mass of granular and semifluid **plasmasol** or **endoplasm**.

A. Ectoplasm of *Paramecium* contains the following organelles:

(*a*) Infraciliary system. It consists of basal bodies **(kinetosomes)** of cilia and **kinetodesmata**, all located just beneath the alveoli of pellicle in the ectoplasm (Fig. 6.3).

(*i*) Basal body or kinetosome. The base of each cilium is connected with a tubular **basal body** or **kinetosome**, the structure from which cilium is formed. Structure of the basal body is comparable to the centriole. Like a cilium, a basal body contains nine peripheral fibres, but each consists of three microtubules rather than two. The A tubule is complete, while the B and C tubules are both incomplete. There is no central microtubules in the basal body or centriole. The A and B tubules of basal body elongate to form the doublets of the cilium (or flagellum, Fig. 6.4).

(*ii*) Kinetodesmata (kinetodesma). A single fine fibril, called **kinetodesmos** or **kinetodesmal fibril**, arises from each kinetosome and extends forwards and obliquely to its right (6.3). It joins other fibrils from adjacent kinetosomes to form a longitudinal bundle of striated fibrils, called a **kinetodesma**. The individual fibrils do not run anteriorly farther than the five kinetosomes. Thus, the number of fibrils in each kinetodesma remains five. The kinetosomes and fibrils of a particular row are collectively known as a **kinety**. All the kinety systems together form **infraciliary system** which coordinate beating of cilia and also plays an important role in the morphogenesis of *Paramecium* and other ciliates.

Motorium. There is also a dense bilobed mass or network of fibrils situated in the endoplasm near the cytostome. This is called **neuromotorium (Lund, 1933)** or **motorium**. It has branches which interconnect with the fibrils of the ectoplasm and the whole fibrillar system is believed to act as controlling centre for feeding movement of oral cilia.

M fibres. At the boundary between ectoplasm and endoplasm are large bundles of **microfilaments** called **M fibres** or **myonemes**. These are contractile in their activity and promote a change of shape in *Paramecium* to enable it to squeeze through narrow spaces.

(*b*) Trichocysts. Trichocysts are minute (4 mm in length) flask-shaped or fusiform sac-like organelles embedded in the ectoplasm. Trichocysts alternate with basal bodies and are perpendicular to surface of body. They open to outside through the permanent pores existing in the ridges of hexagonal depressions of pellicle. Trichocysts are formed by basal bodies.

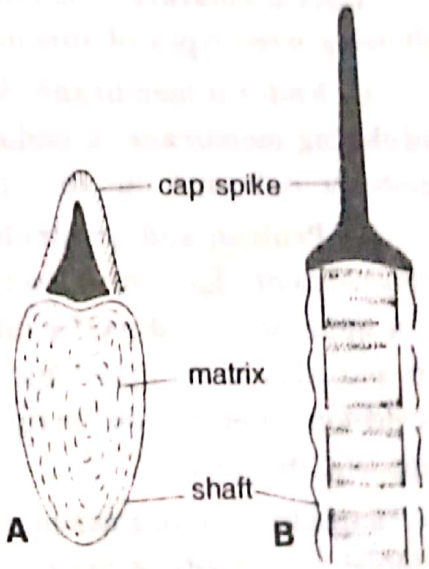

Fig. 6.5. *Paramecium*. A—An undischarged trichocyst. B—Apical portion of a discharged trichocyst.