Structure of Flagella and Cilia:

They are fine hair like movable protoplasmic processes of the cells which are capable of producing a current in the fluid medium for locomotion and passage of substances.

Flagella are longer (100-200 μm) but fewer. Only 1-4 flagella occur per cell, e.g., many protists, motile algae, spermatozoa of animals, bryophytes and pteridophytes, choanocytes of sponges, gastro dermal cells of coelenterates, zoospores and gametes of thallophytes. Cilia are smaller (5-20 μm) but are numerous.

They occur in group ciliata of protista, flame cells of worms, larval bodies of many invertebrates, epithelium of respiratory tract, renal tubules, oviducal funnel, etc. Cilia present on the tracheal and bronchial epithelial cells are specialised to send back dust particles into the pharynx so that the lungs remain unharmed.

However, cigarette smoking reduces/stops ciliary activity so that air borne dust particles pass into the lungs of smokers causing irreparable harm. Both cilia and flagella are structurally similar and possess similar parts— basal body, rootlets, basal plate and shaft.

(i) Basal Body or Kinetosome:

It is also called basal granule or blepharoplasty. Basal body occurs embedded in the outer part of the cytoplasm below the plasma membrane.

It is like a micro cylinder which has a structure similar to a centriole with nine triplet fibrils present on the periphery without a central fibril, though a hub of protein is present here. Only sub-fibre A is complete (having 13 protofilaments) while sub-fibres B and C are incomplete as they share some of their protofilaments.

(ii) Rootlets:

They are striated fibrillar outgrowths which develop from the outer lower part of the basal body and are meant for providing support to the basal body. The rootlets are made of bundles of microfilaments.

(iii) Basal Plate:

It is an area of high density which lies above the basal body at the level of plasma membrane. In the region of basal plate, one sub-fibre of each peripheral fibril disappears. The central fibrils develop in this area.

(iv) Shaft:

It is the hair-like projecting part of flagellum or cilium. The length is 5- 20 µm in case of cilium and 100—200 µm in case of flagellum. The shaft is covered on the outside by a sheath which is the extension of plasma membrane. In whiplash flagellum, the sheath is smooth.

In tinsel flagellum, the sheath contains a number of thick hairy outgrowths called flimmers. Internally, it contains a semifluid matrix having an axoneme of 9 peripheral doublet fibrils and 2 central singlet fibrils (Fig. 8.46).

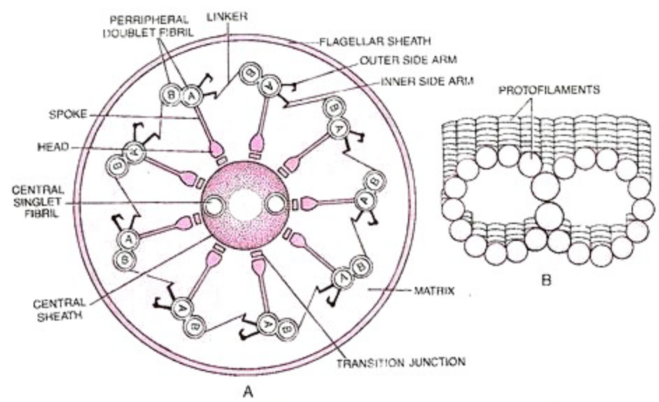

Fig. 8.46. A, ultrastructure of flagellum in cross-section. B, doublet fibril without arms.

This arrangement is called 9 + 2 or 11-stranded. However 9 + 1 (e.g., flatworm) and 9 + 0 (e.g., eel, Asian Horseshoe Crab) arrangements have also been observed. The two central singlet fibres are covered by a proteinaceous central sheath. They are connected by a double bridge. Each peripheral fibril consists of two microtubules or sub-fibres B and A.

The sub-fibre A is slightly narrower. It bears two bent arms, the outer one having a hook. They are about 15 nm long and made up of protein dynein with ATPase activity. Such activity is also present in central fibrils. Movement of flagella or cilia occurs due to sliding motion in which dynein arm establishes temporary connection with sub-tubule B of adjacent doublet fibre.

The peripheral doublet fibrils as well as central singlet fibrils are made up of tubulin. Each sub-fibre or central singlet fibril contains thirteen protofilaments. The peripheral doublet fibrils are interconnected by A-B linkers of protein nexin between B-sub-fibre of one and inner side arm of A-sub-fibre of adjacent fibril.

Each of their A sub-fibres sends a radial proteinaceous column to the centre. It is called spoke. The spokes are broader internally to form heads or knobs. Head is connected to central proteinaceous sheath through transition junction.

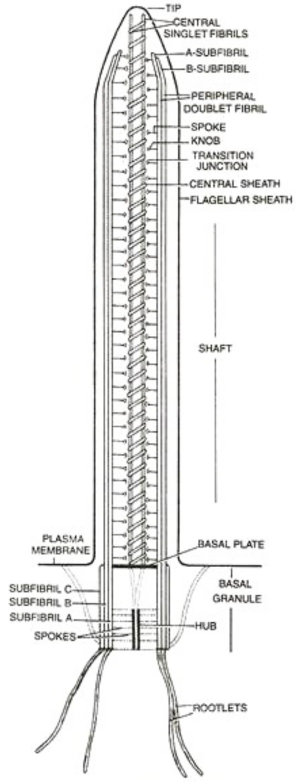

Fig. 8.47. L.S. of a flagellum (Diagrammatic).

The cilia and flagella move by sliding of the doublet fibrils against one another. Energy is provided by ATP.

Flagella perform independent undulatory movements while cilia show rowing type of sweeping motion either simultaneously (isochronic or synchronous) or one after the other (metachronic). In a flagellum, several symmetrical undulatory waves pass from base to the tip. This pushes the cell along. Undulations passing from tip to base pull the cell through water.

In tinsel flagellum having a number of flimmers, the undulatory wave moving down from base to tip also pulls the cell along instead of pushing it. There is always a power stroke and a recovery or return stroke (Fig. 8.48).

The power stroke is able to move the fluid with a jerk in the direction of the stroke. The cell moves in the opposite direction, if it is motile. The recovery or return stroke is slow and without much force. Therefore, it does not cause much disturbance in the fluid medium.

Rate of ciliary and flagellar movements is 10-40 strokes per second. Flagellate Monas stigmatica swims at the rate of 260 pm or 40 cell length/sec. It has the maximum speed per body length. Paramoecium caudatum has a speed of 1500 μm or 12 cell lengths/sec.

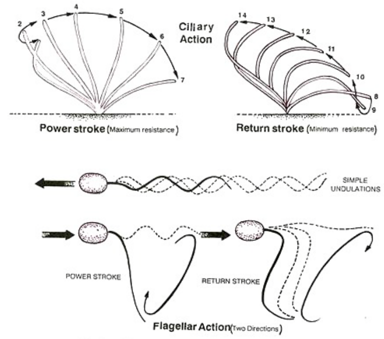

Fig. 8.48. The mode of movement in cilia and flagella.

Functions of Cilia and Flagella:

1. They help in locomotion in flagellate and ciliated organisms.

2. They create current for obtaining food from aquatic medium.

3. In some protists and animals, the organelles take part in capturing food.

4. The canal system of porifers operates with the help of flagella present in their collar cells or choanocytes.

5. In coelenterates, they circulate food in the gastro vascular cavity. In tunicates and lancelets, the cilia help in movement of food and its egestion.

6. In aquatic organisms cilia create currents in water for renewal of oxygen supply and quick diffusion of carbon dioxide.

7. In land animals the cilia of the respiratory tract help in eliminating dust particles in the incoming air.

8. Internal transport of several organs is performed by cilia, e.g., passage of eggs in oviduct, passage of excretory substances in the kidneys, etc.

9. Being protoplasmic structures they can function as sensory organs.

10. Their tips secrete sticky substance to help in conjugation and fusion of gametes.

11. In certain protistans, cilia fuse to form undulating membrane.

12. Cilia and flagella show sensitivity to changes in light, temperature and contact.

13. Ciliated larvae take part in dispersal of the species.