Modification of Plasma Membrane

The plasma membrane has function in absorption of materials from the cell's environment or needs to move material that could found in the region. For this purpose, the membrane of some cells is folded out into small projections

There are many types of these projections

Cilia and flagella

Are membrane-covered extensions of the entire apical surface. They beat in waves, often moving a surface coat of mucus and trapped materials. They are motile cell projections with the typical 9 + 2 microtubular doublet arrangement called **axoneme** originating from basal bodies. Cilia and flagella have the same internal structure but the major difference is in their length.

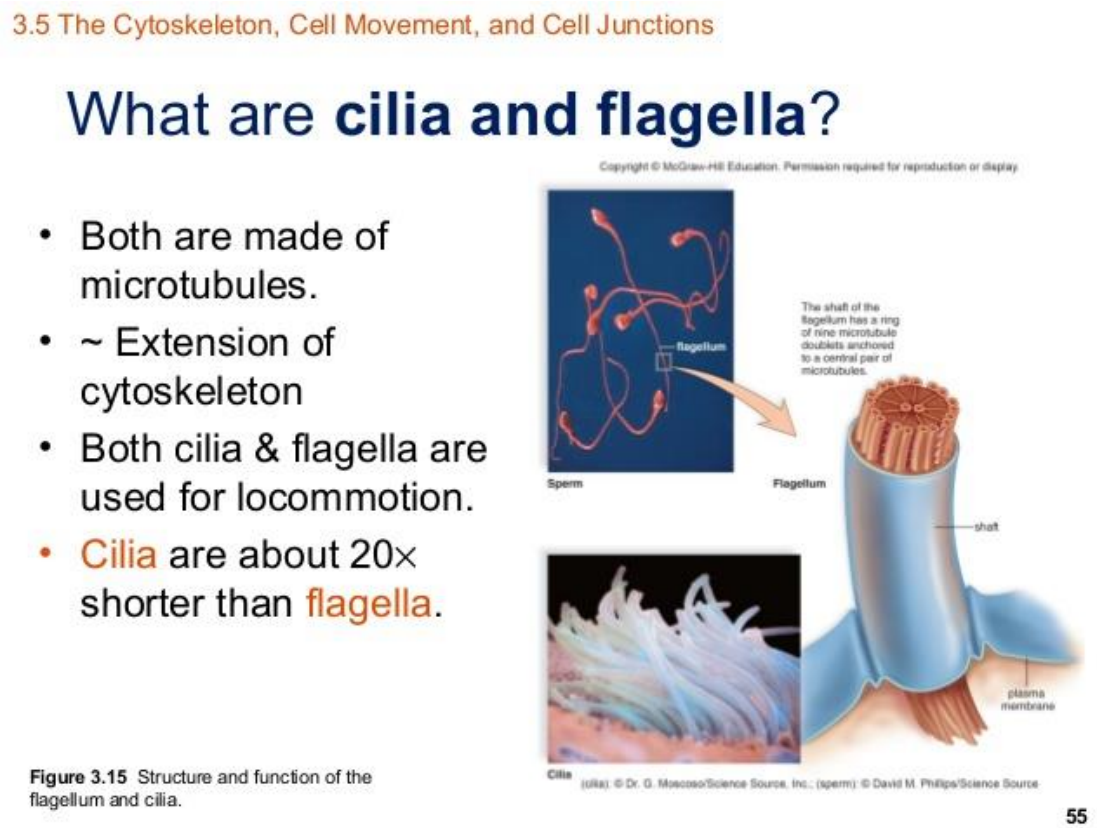


Figure 3.15 Structure and function of the flagellum and cilia.

Basal body

It is a cellular organelle associated with the formation of cilia and flagella and resembling the centriole in structure, also called basal granule .It is protein cylinder structure found beneath the plasma membrane, composed of microtubules that contain up to 13 protofilaments surrounding a hollow center. Its form during quiescence or the G1 phase of the cell cycle from a centriole and several additional protein structures.

From the basal body the **axoneme** is originate ,its consist of a circle of nine microtubules doublet ,each doublet have one complete tubule (A tubule) and one incomplete (B tubule) and the core doublets are both complete. Adjacent peripheral doublets are linked to each other by protein bridges called **nexins** and each doublet has a **radial spoke** projecting toward the center. Extending from the surface of microtubule A are inner and outer arms of axonemal dynein, which project toward the B microtubule of the next doublet and causes sliding of microtubules in the axonemes of cilia and flagella, so the dynein is responsible for the movement in cilia and flagella.

The movement of these structures which required ATP for energy happened because of the interactions of a set of microtubules inside these structures.

Basal bodies perform several functions important to cilia and flagella activities.

1- Orients and positions the cilium or flagellum, which is critical to the correct movement of fluids within the axoneme.

2- Regulate the entry of proteins into the axoneme.

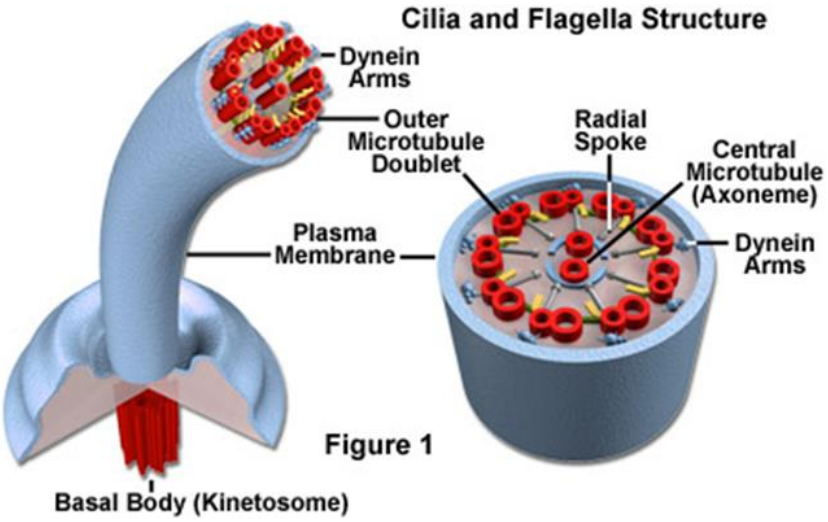
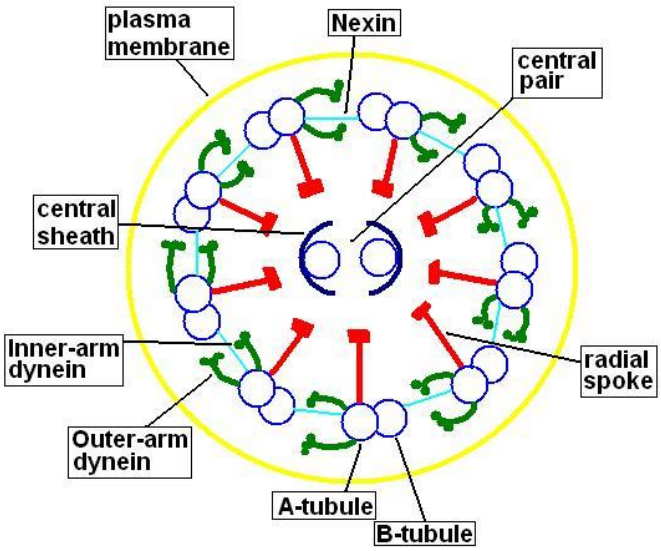


Figure 1



Any basal body malfunctions can lead to various diseases.

Cilia can be grouped into two categories.

First, there are **motile cilia**, which are always moving in a single direction. They help the cell move around in the cellular fluids and help move fluids past the cell. Motile cilia are found together on cells and

coordinate their movements to be most effective, making up for their small size.

The second types of cilia are non-motile cilia, and these are responsible for sensing the surrounding environment. They are also called **primary cilia** which do not have central microtubules. They have a **9+0 structure.**

Flagella are structurally similar to cilia concerned with movement, but are much longer .There is usually only one flagellum per cell, eg. Sperm.

Defects in the cilia and flagella are associated with some medical problems. For example, Kartagener's syndrome which is caused by problems with the dynein arms that extends between the microtubules present in the axoneme (absence of dynein).

Microvilli

Are plasma membrane-covered extensions of the cell surface.

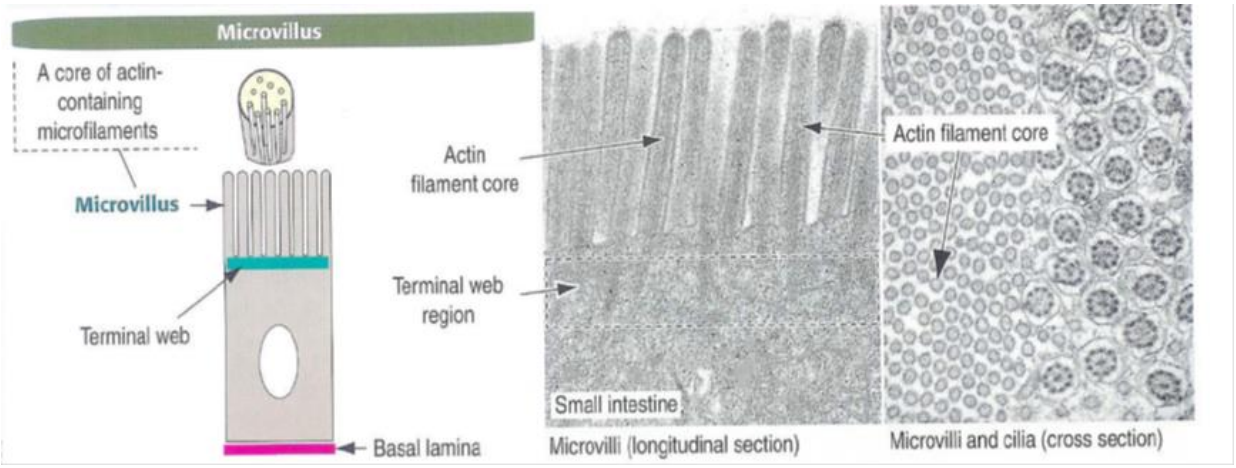
Non-motile, finger-like cytoplasmic projections about 0.1 μm diameter and 2 μm in length.

Each microvillus has a core of cross-linked of actin filaments and there are very little or no cellular organelles in these structures.

The microvilli greatly increase the absorptive surface at the apex of the cell.

Also these structures are packed with enzymes such as disaccharides', peptidases and glycosidases that help in breakdown complex nutrient into simpler compound to be easier for absorbed, so the microvilli increase the absorptive surface of the cell the number of digestive enzymes in this area.

Example: apical surfaces of absorptive cells in the intestine and renal tubules.



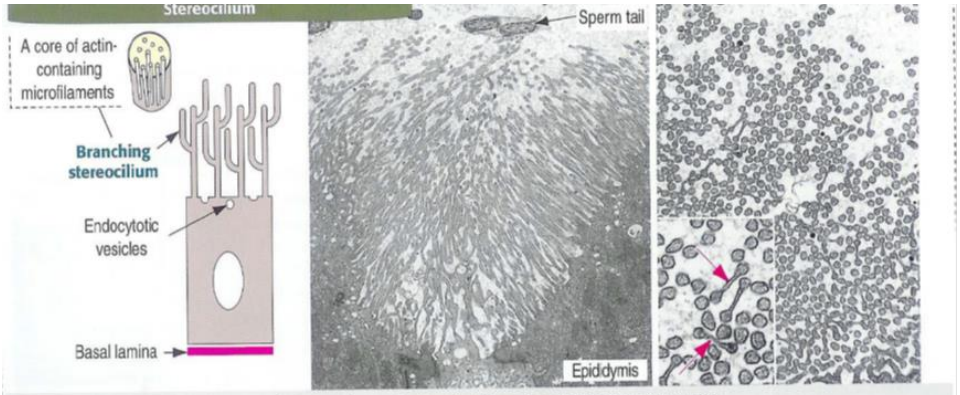
Stereocilia ---Are not true cilia but long and branching finger-like projections from the apical surface (very long microvilli).

They are found in the male reproductive tract (epididymis. ducts deferens), where they have an absorptive function, and in the internal

ear, where they have a sensory function.

Stereocilia also increase the surface area of the cell and facilitate the movements of molecules into and out of the cell

Even though this structure has “cilia” in its name, the microtubular axoneme is absent and thus is nonmotile.



Microvilli and **stereocilia** have the same substructure: A core of **actin microfilaments** and actin-associated proteins. In the intestinal epithelium, actin extends into the **terminal web**, a network of cytoskeletal proteins in a collar-like arrangement at the apical domain of the cytoplasm. While microvilli have comparable length, **stereocilia are longer and branch** and the apical domain of the cell contains endocytotic vesicles. **Stereocilia are typical of the epididymal epithelium.** The bridges connecting adjacent stereocilia (red arrows) are indicators of their branching.

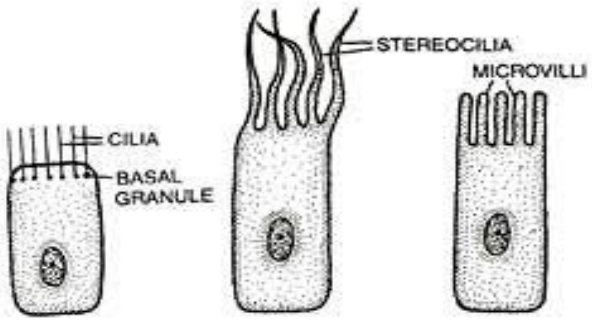
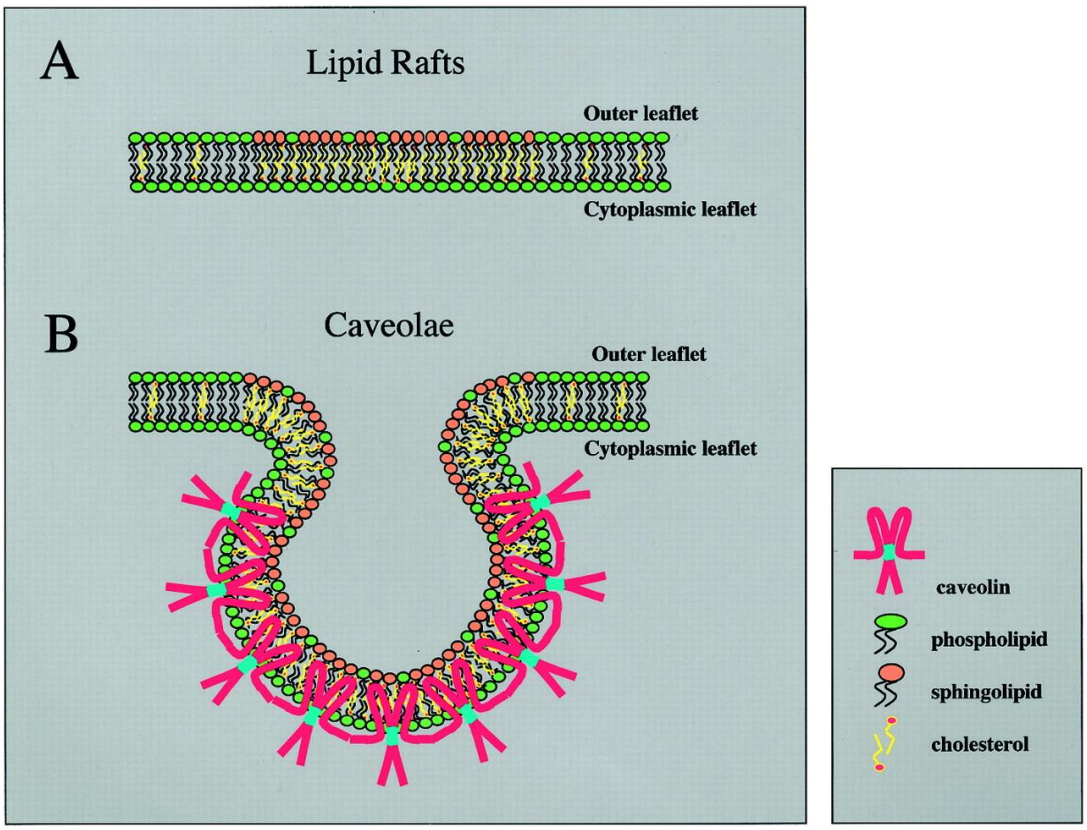


Fig. 7.2. Epithelial cells showing projections in the form of cilia, stereocilia and microvilli.

Caveolae: are small invaginations of plasma membrane in many cell types such as embryonic cells, endothelial cells and adipocytes cells.

Caveolae have flask shape, small in size about 50-100 nm, rich in proteins and lipids like cholesterol and sphingolipids.



These structures play an important role in signal transduction by associate with some signaling molecules , endocytosis because caveolae are one source of many sources of clathrin as well as play very important role in protection of cells from mechanical stress in many types of tissue like endothelial cells and skeletal muscle.