Modification of plasma membrane:

Each cell has an apical domain (Free surface) and basolateral domain (lateral surfaces and a basal surface attached to the basal lamina).

1-**The apical Domain:** is the region of the cell that is exposed to the lumen or external environment, it is specialized to carry out functions that occur at these interfaces, including secretion, absorption, and movement of luminal contents. 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.

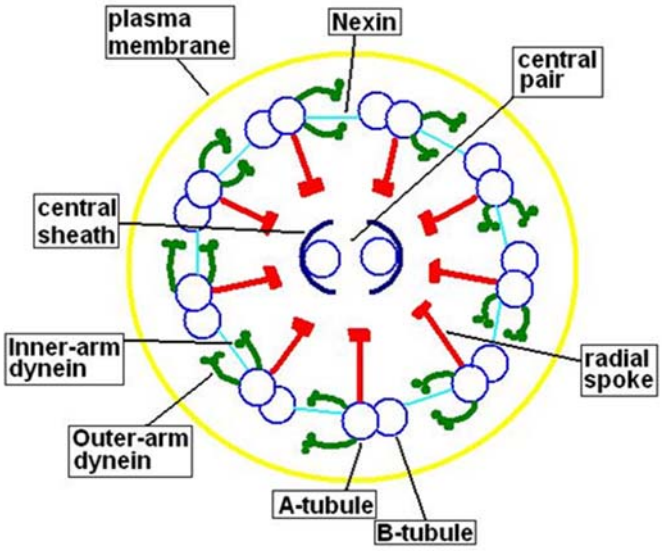
Basal body

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.

From the basal body the axoneme is originate, it consists of a circle of nine microtubules doublet, each doublet has 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.



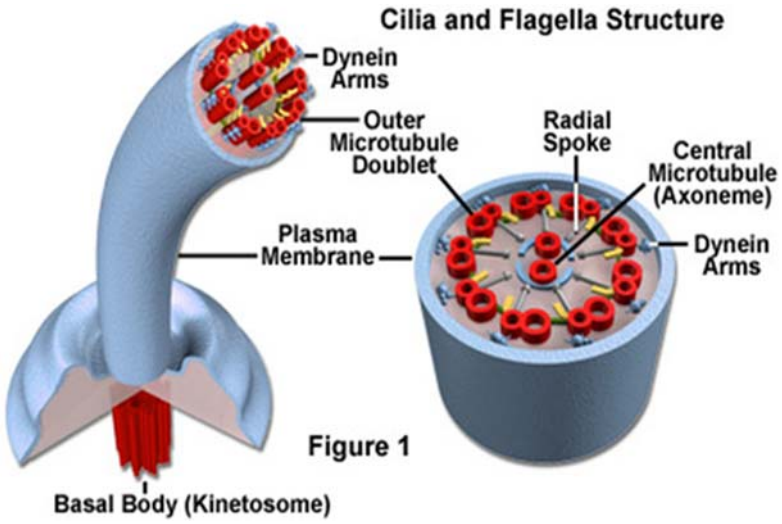


Figure 1

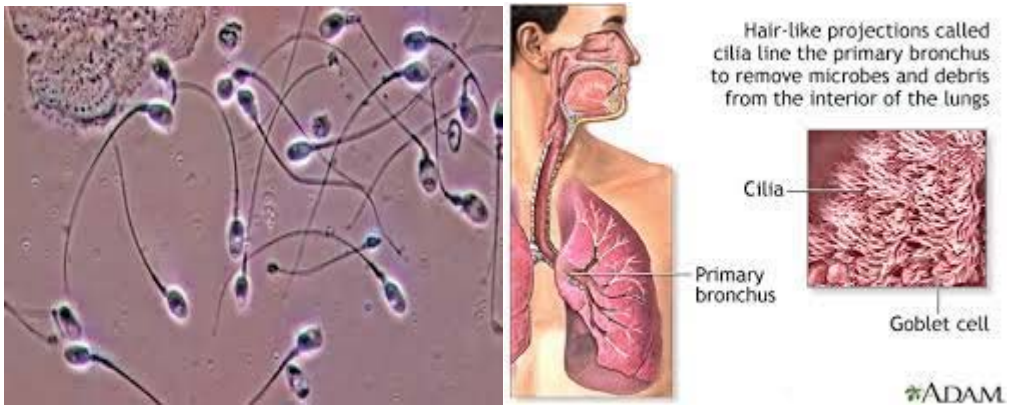
Cilia can be grouped into two categories:

First, there are motile cilia; found together on cells, always moving in a single direction and coordinate their movements to be most effective making up for their small size

An epithelial cell in the trachea may have 250 cilia

The second type of cilia is non-motile cilia (primary cilia), which do not have central microtubules, they have a 9+0 structure and responsible for sensing the surrounding environment.

Cilia and flagella but the major difference is in their length, flagella have the same structure to cilia concerned with movement, but are much longer here is usually only one flagellum per cell, e.g. Sperm.



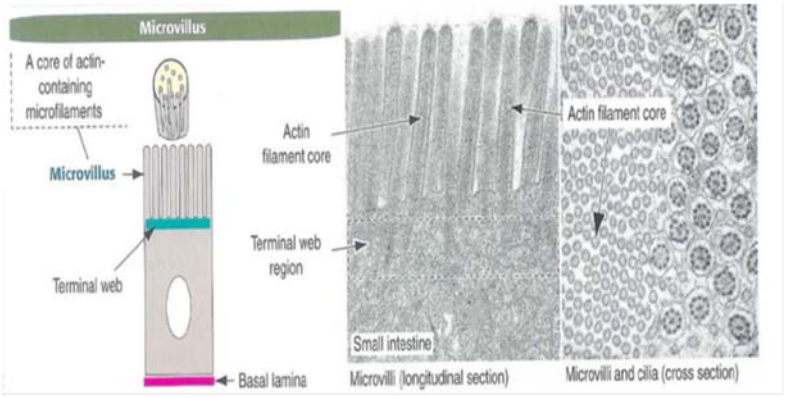
Microvilli

Are plasma membrane-covered extensions of the cell surface, Non-motile, finger-like cytoplasmic projections, each with a core of cross-linked microfilaments.

At the cytoplasmic end, bundles of actin extend into the terminal web (a network of filaments that helps to anchor the actin).

These structures are coated with glycocalyx that may contain enzymes (disaccharides', peptidases), and greatly increase the absorptive surface at the apex of the cell.

Example: apical surfaces of absorptive cells in the intestine (striated border) and the apical surfaces of renal tubules (brush border).

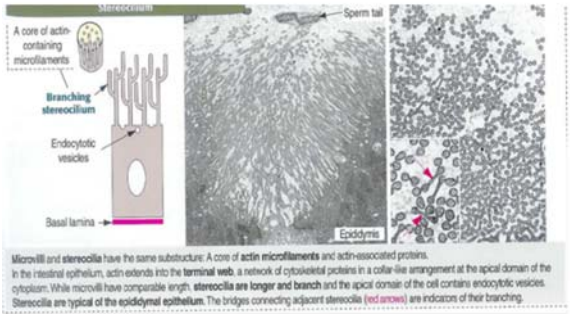


Stereocilia

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.



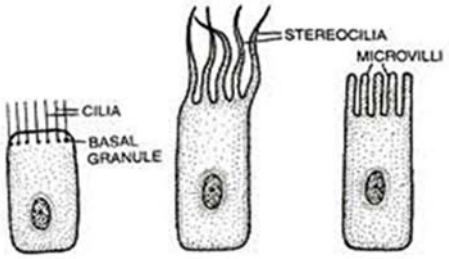


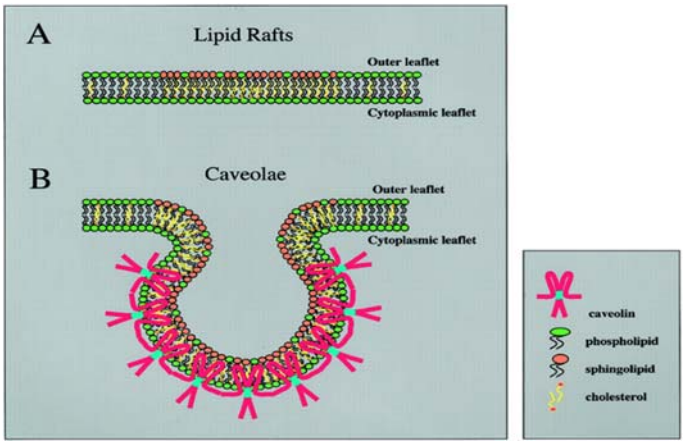
Fig. 7.2. Epithelial cells showing projections in the form of cilia, stereocilia and microvilli.

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.



2-The basolateral domain modifications (proved by cell junctions)

In basolateral domain, between adjacent cells there are structures called cell junctions connect and help to communicate the cells with each other.

There are three major types of junctions

1- Occluding junctions (zonula occludens, tight junctions)

Occluding junctions are symmetrical structures on opposite sides of two adjacent cells separating the apical domain from the basolateral domain, made up of transmembrane protein called **claudin** which forms linear fibrils. Its form a belt-like seal around the apical surfaces of two adjacent cells, so the junctions are very tight and prevent movement of lipids and proteins between adjacent cells.

2-Anchoring junctions:

Composed of three types of junction's belt- desmosome, spot-desmosome and hemi desmosome.

Anchoring junctions connect the cytoskeleton of a cell to the cytoskeleton of its neighbors or to the extracellular matrix and found bellow the tight junctions.

Belt desmosome and spot desmosome are symmetrical structures that anchor adjacent cells at the apical domains which provide strength and rigidity to the cell layer.

Hemidesmosomes are not symmetrical structures that anchor the basal domain of the cell to the basal lamina.

Anchoring junctions are widely distributed in animal tissues and most abundant tissues are subjected to several mechanical stresses, such as heart, muscle and epidermis.

3-Gap (communicating) junctions

Button-like structures made up of integral membrane protein called **connexins**, six connexins sub units assemble in the plasma membrane to form a hollow cylinder called **connexons**.

Connexons from adjacent cells when aligned together form direct channels of communication between the cytoplasm of two cells.

Connexons usually form patches and facilitate the movement of molecules such as ca+2 and AMP between cells.

Gap junctions have a little strength but serve as intercellular channels for flow materials and allow the passage of small signaling molecules between adjacent cells to coordinate the response, and most cells in animal tissues are in communication with their neighbors via gap junctions, which present in most mammalian tissues.

Functions of gap junctions

1-permit the rapid exchange between cells of molecules with small diameter (1.5 nm).

2-responsible for the heart coordinated beat because some molecules move radially through gap junctions, allowing cells in many tissues to act in coordinated manner rather than as independent units.

Figure 1–12

Anchoring junctions

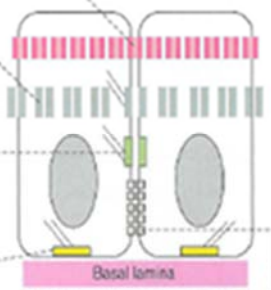
Occluding junctions
They define cell polarity and control the passage of substances between adjacent cells. Occluding junctions have a **beltlike** distribution like a ribbon internally bracing the cells.

Zonula adherens or belt desmosome
This anchorage junction has a **beltlike** distribution and is associated with **actin** filaments.

Macula adherens or spot desmosome
This anchorage junction has a **spotlike** distribution and is associated with **intermediate filaments**.

Hemidesmosome
Hemidesmosomes link the basal domain of an epithelial cell to the basal lamina. **Intermediate filaments** are associated with a **plaque**.

Note that occluding and gap junctions **are not** associated with cytoskeletal components.



Gap or communicating junctions
They connect functionally two adjacent cells. A gap junction is formed by **connexons**, channel-like structures that enable the passage of small molecules (< 1.2 kDa) between cells.