Medical Biology

Lec 5
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Cytoskeleton

It is a **dynamic** structure that:

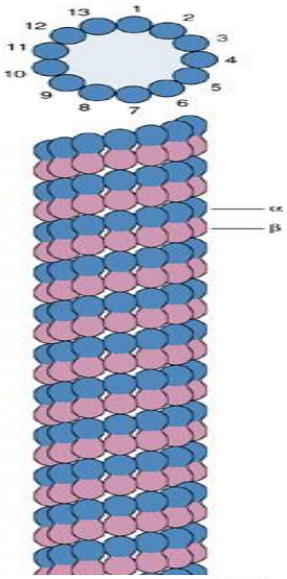
1. maintain cell shape.
2. has been known to protect the cell.
3. enables cellular motion.
4. play an important role in the movement of organelles and intracytoplasmic vesicles.
5. play role in cellular division.

Components of cytoskeleton:

1. **Microtubules.**
2. **Microfilaments.**
3. **Intermediate filaments.**

4. **microtubules:**

Microtubules are found in all eukaryotic cells as a hollow cylinder's structure. The subunit of microtubule is a heterodimer composed of α and β tubulin molecules related amino acid composition. Tubulin are organized into a spiral. A total of 13 units are present in one complete turn of the spiral. Microtubules provide the basis for several complex cytoplasmic components, including centrioles, basal bodies, cilia, and flagella.



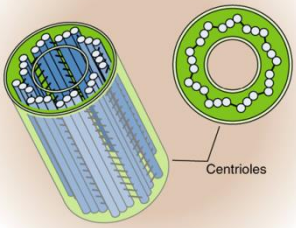
They play key role in:

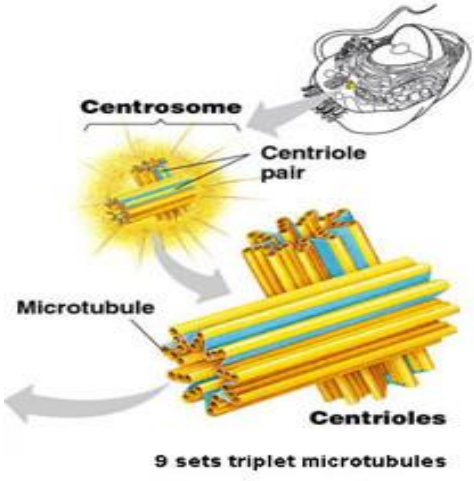
a. Intracellular transport (they transport organelles like mitochondria or vesicles).
b. The axoneme of cilia and flagella.
c. The mitotic spindle.
d. Synthesis of cell wall in plants.
e. They maintain the shape of the cell because they are rigid.

❖ **Centrosome:**

The centrosomes of most animal cells contain pair of centrioles, oriented perpendicular to each other, the centrioles are cylindrical structure consisting of nine bundles of microtubules (three per bundle), similar to the basal bodies of cilia and flagella.

They are **not** found in plant cells, many unicellular eukaryotes, and some animal cells.





The centrioles play important role in cell division, one of the pair moves around to the opposite side of the nucleus from the other centriole, fiber spread out from each centriole towards the center of the cell and in some way act to move the chromosomes in cell division (mitosis and meiosis).

❖ **Cilia and flagella:**

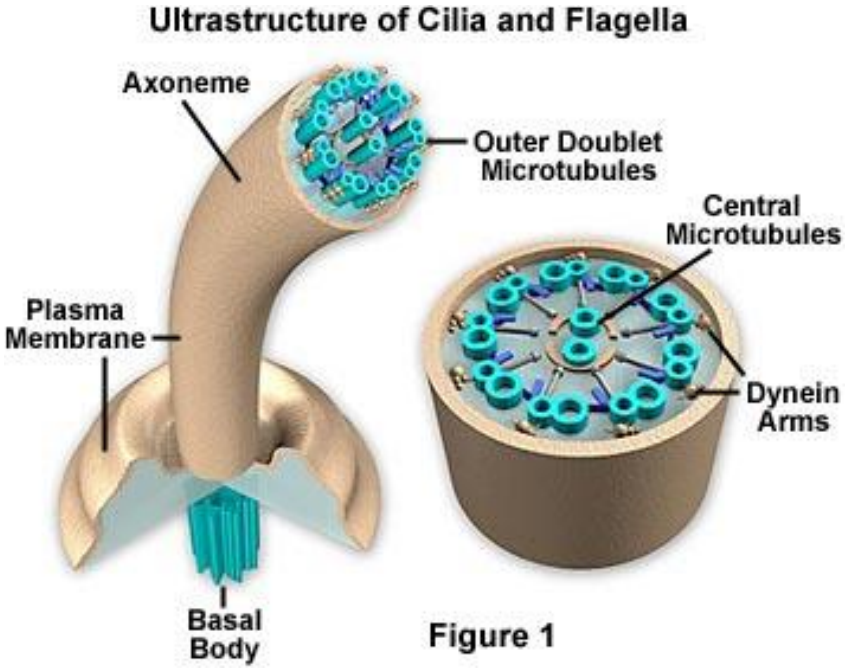


Figure 1

Cilia and flagella are motile projections of the plasma membrane that is responsible for movement of a variety of eukaryotic cells. Eukaryotic cilia and flagella are very similar structures. Cilia functions:

1. to move a cell or
2. to help transport fluid or materials past them.
3. The respiratory tract in humans is lined with cilia that keep inhaled dust and harmful micro-organisms from entering the lungs.

Cilia are usually shorter and occur together in much greater numbers than flagella.

The fundamental structure of both cilia and flagella is the axoneme which is composed of microtubules and their associated proteins. Both are membrane- bounded cylinders enclosing a matrix area, the microtubules are arranged in characteristic 9+2 pattern in which a central pair of microtubules is surrounded by nine outer microtubule doublets, a plasma membrane surrounds the entire axoneme complex, which is attached to the cell at a structure termed the basal body. Cilia and flagella move when the microtubule doublets slide past one another.

❖ **Basal body:**

The intracellular end of the microtubules of cilia and flagella are fixed in a basal body which is similar in structure to a centriole and contains nine triplets of microtubules.

Clinical notes:

Several mutations have been described in the proteins of the cilia and flagella. They are responsible for the **immotile cilia syndrome**, the symptoms of which are immotile spermatozoa, male infertility, and chronic respiratory infections caused by the lack of the cleansing action of cilia in the respiratory tract.

2. microfilaments:

Microfilaments are solid rods made of a protein known as actin.

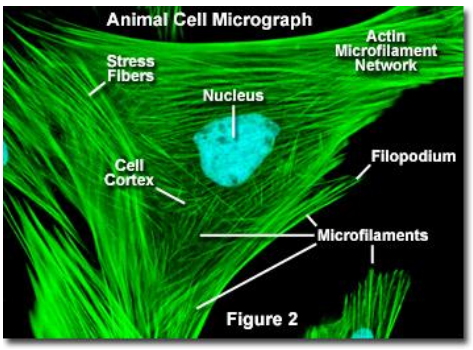


Figure 2

Functions of microfilaments:

a. They function in the maintenance of cell shape by bearing tension.
b. In skeletal muscle they are present as filament protein called actin associated with the filament called myosin which are responsible for contractile activity in muscle cells.
c. In most cells, microfilament form a thin sheath just beneath the plasma membrane called **the cell cortex**. These filaments appear to be associated with membrane activities such as endocytosis, exocytosis, and cell migratory activity.

3. intermediate filaments:

Present in almost all eukaryotic cells, the diameter ranges between 10- 12 nm. They are of different types:

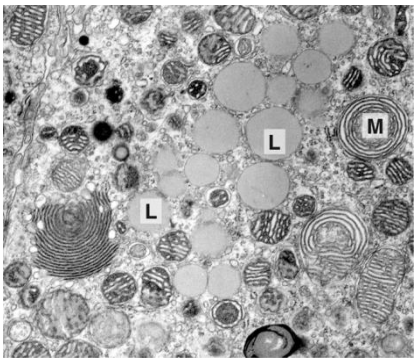
1) **Keratin:** are found in most epithelia, they provide defense against loss of water and heat and supply physical protection.
2) **Vimetin:** found in mesenchymal cells (mesenchyme is an embryonic tissue).

3) **Desmin (skeletin):** found in smooth muscle and the z-disks of skeletal and cardiac muscle.
4) **Glial filament:** found in astrocytes.
5) **Neurofilaments:** found in neuron.

Medical Application

The presence of a specific type of intermediate filament in tumors can reveal which cell originate the tumor, information important for diagnosis and treatment of cancer. Identification of intermediate filament proteins by means of immunocytochemical methods is a routine procedure.

Non- living inclusion bodies:

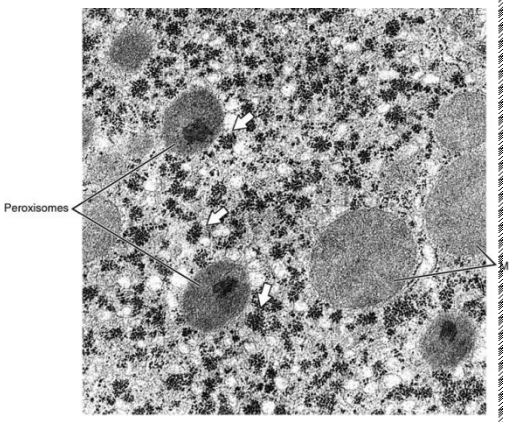


They are temporary components of the cytoplasm composed of one of the following metabolites:

Lipids: fat droplets, they are present mainly in adipose tissue, adrenal cortex, and liver cells. They serve as a source of energy.

Glycogen: present in liver and skeletal muscle cells, they can be break down into glucose and used by the cell.

Proteins: they are present either as granule e.g. in glandular cells or as crystals e.g. in adrenal cells.



Pigments: these are deposits of colored substances. e.g.:

a. **Melanin:** dark- brown pigment present in the skin, hair, retina, and some parts of the central nervous system (CNS).
b. **Lipofuscin:** yellow- brown pigments represent undigested substances of secondary lysosomes, they are present in long-lived cells and usually increase with age.
c. **Hemosiderin:** gold- yellow in color, they are the end product of Hb degradation of old red blood cells. They are present in the liver, spleen, and bone marrow.
d. **Crystals:** are structures of crystalline forms of certain proteins. They are not commonly found in cells, except for steroid cells, and interstitial cells of testes, and occasionally in macrophages.