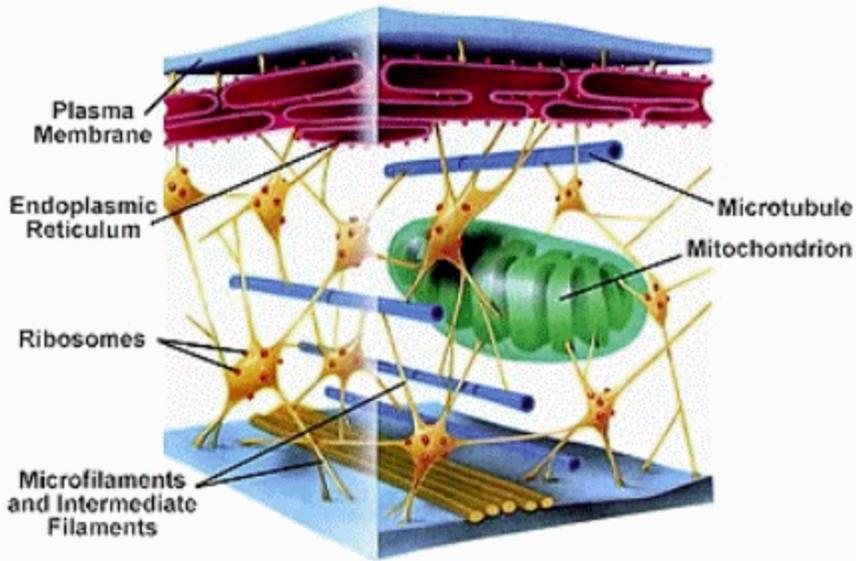
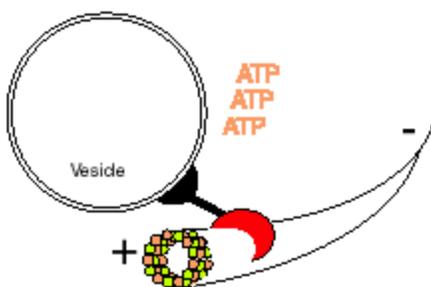
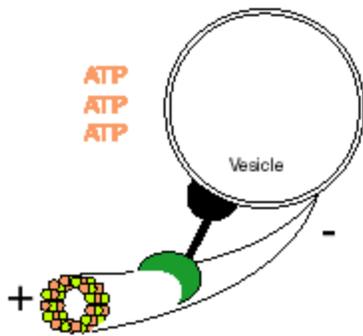


Cytoskeleton:



Introduction:

The cytoskeleton of a cell provides structure, strength, and motility. It provides a cellular scaffolding upon which the cellular organization is arranged. The figure shows a portion of a cell's cytoskeleton. Note that the cytoskeleton is very extensive. Also note that many ribosomes appear to be attached to the cytoskeleton. Polysome refers to two or more ribosomes. The ribosomes attached to the cytoskeleton are often referred to as "free" ribosomes to distinguish them from those ribosomes attached to the nuclear or ER membranes.



Network within the cytoplasm that:

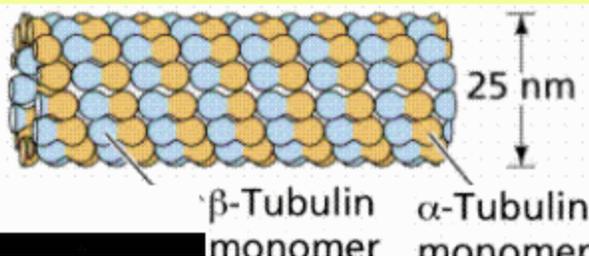
- Maintains cell shape
- Moves substances within the cell - cellular trafficking
- Anchors cellular structures - organelles, proteins, flagella, cilia

Various "motor" proteins are involved in moving cellular components

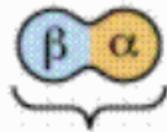
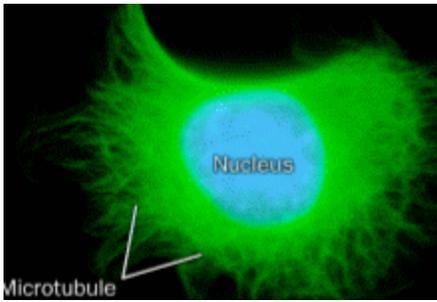
Three Types of Cytoskeleton Components:

1. **Microfilaments.** These are the thinnest cytoskeletal component and are composed of the globular protein **Actin**. Actin proteins associate in a head to tail fashion to form long chains called "microfilaments". When microfilaments associate they form a twisted double chain. When these chains associate in parallel they are referred to as **Stress fibers**.

Microtubules



2. **Microtubules.** These are the

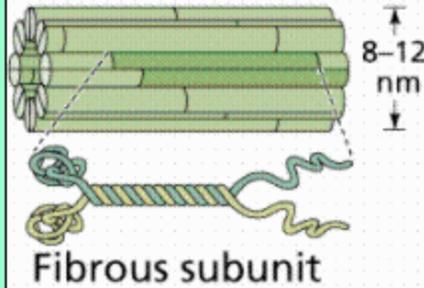


Tubulin dimer

thickest cytoskeletal component and are constructed of globular Tubulin proteins. Two tubulin proteins (alpha and beta tubulin) form a dimer. This tubulin dimer associates with other tubulin dimers which then arrange in a spiral to form a hollow tube - the microtubule. Microtubules radiate from center of cell in a "hub-spoke" fashion.

Intermediate fibers (IF)

intermediate in thickness compared to microtubules and microfilaments.

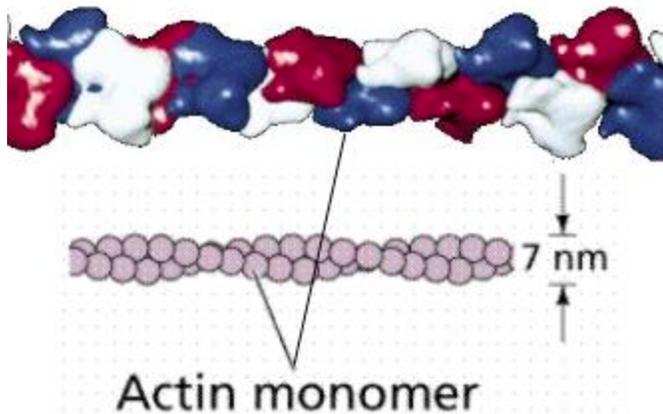


Fibrous subunit

- Intermediate fibers (IF).** IFs are intermediate in thickness as compared to microtubules and microfilaments. Keratin is an example of an IF. Thought to be a triple twisted chain which extends throughout cytoplasm.

Keratin is an example of an IF.

Microfilaments

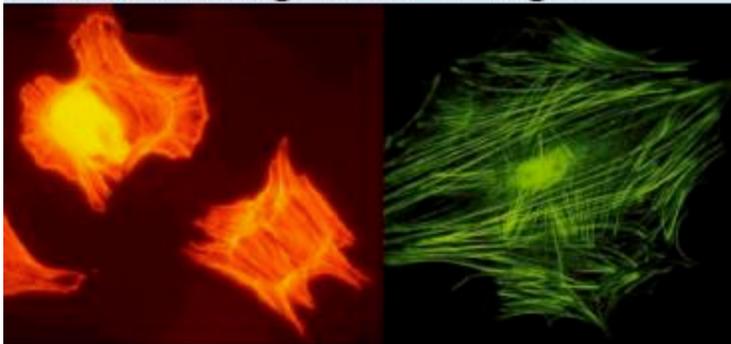


Actin monomer

Microfilament: Note that the filament is composed of many globular proteins - the protein actin. Each color indicates an identical polypeptide (the protein actin) - they are colored to allow you to easily see them.

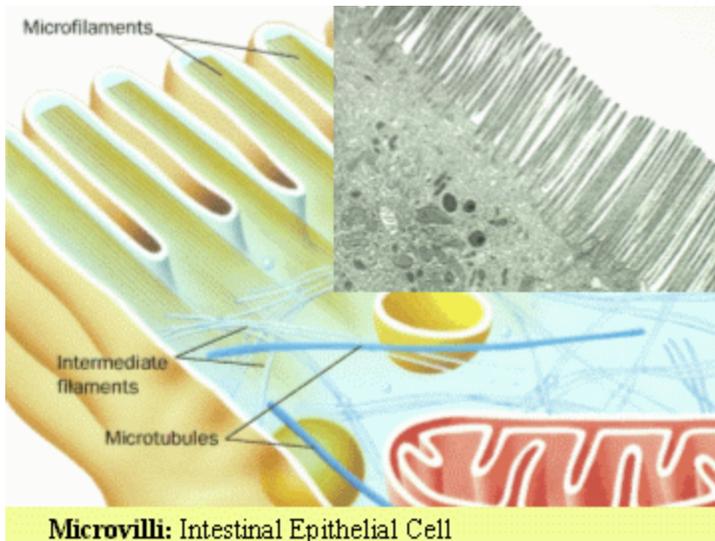
Microfilaments - Stress Fibers

Actin marked with orange fluorescence on the left and green on the right.



Stress Fibers - these stress fibers lie immediately underneath the cell membrane. The stress fibers are composed of two twisted microfilaments (composed of the protein actin). The actin is marked with an orange fluorescence on the left and a green fluorescence on the right.

Microvilli



Intestinal Epithelial Cell Demonstrating Microvilli

Cells maximize their surface to volume ratios

The plasma membrane may be folded into finger-like projections called Microvilli - these increase the surface area of a cell to allow greater interaction with the environment; therefore greater absorptive capability. The microvilli finger-like protrusions of the cell membrane are possible due to the underlying cytoskeletal arrangement of actin (microfilaments).

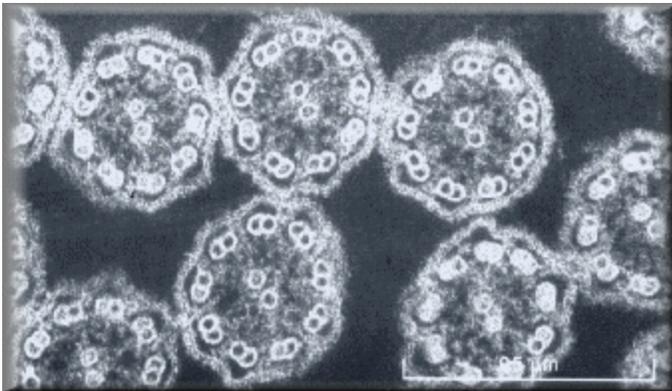
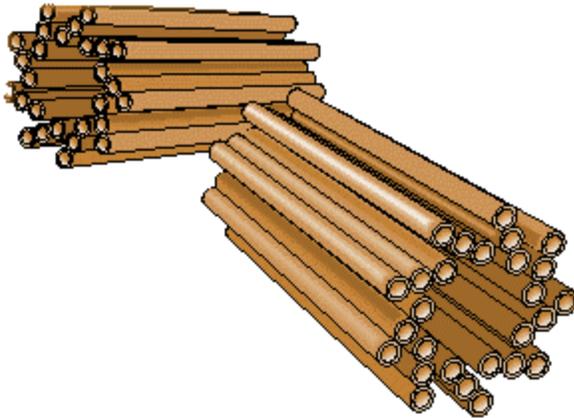
An example of specialized cells containing microvilli are the small intestinal epithelial cells.

Flagella and Cilia

These structures provide movement to a cell (motility).

Eukaryotic flagella (and cilia) are composed of microtubules, prokaryotic flagella are not composed of microtubules. The difference in the construction of the eukaryotic and prokaryotic flagella explains the difference in their generation of motion:

- eukaryotic flagella generate motion to a cell by acting like a whip.
- prokaryotic flagella generate motion by acting like a propeller.

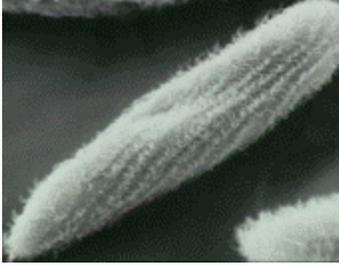


A cilium (pl; cilia) is a fine, cytoplasmic structure projecting from the cell surface. Cilia are quite numerous on the cellular surface as opposed to flagella which are present in limited number of one or two.

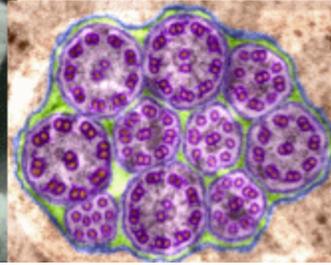
Cilium structure is similar to the flagellum, consisting of an outer membrane surrounding a matrix containing 2 central microtubules around which is a ring of 9 more microtubules (a 9 + 2 structure).

Cilia are connected in such a way that their motility is coordinated. Cilia beat constantly in one direction, either moving liquid (and

**Ciliated cell -
Paramecium**



**xs of Cilia from
epithelial cell**



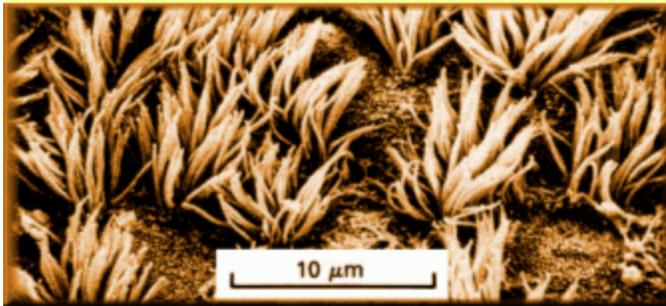
suspended particles) over the surface of the cell or moving the cells in relation to the liquid, for example, locomotion in the protozoa (paramecium, etc.).

Basal bodies are cytoskeletal elements which attach (anchor) the cilia and flagella to the cell. Cilia are connected in such a way that their motility is coordinated

Typical locations of the cilia are:

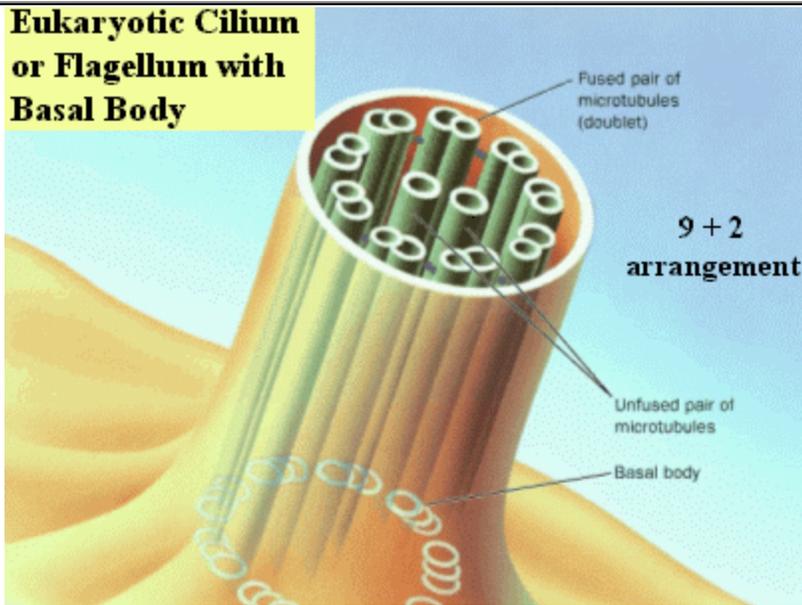
- Surface of various microorganisms - eg; paramecium
- Lung tissue

**Cilia from the trachea of a hamster -
motile structures composed of
microtubules.**



Cilia from the trachea of a hamster - motile structures composed of microtubules.

**Eukaryotic Cilium
or Flagellum with
Basal Body**



Cilium/Flagellum with Basal Body
Flagella and cilia - The main difference between the two is that cilia are shorter and more numerous. Basal bodies form the base of the cilium or flagellum.

