

## Chapter 5.3 & 5.4

### The Cell: Cytoskeleton

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## Cytoskeleton

- **Function**
  - ◆ structural support
    - maintains shape of cell
    - provides anchorage for organelles
  - ◆ motility
    - cell locomotion
    - cilia, flagella, etc.
  - ◆ regulation
    - organizes structures & activities of cell
  - ◆ signaling
    - important in cell to cell communication

## Cytoskeleton

- **Structure**
  - ◆ network of fibers extending throughout cytoplasm
  - ◆ 3 main protein fibers
    - microtubules
    - intermediate filaments
    - microfilaments

It's a matter of size...

## Evolutionary perspective

- Proteins that make up the fibers are very similar in all living things
  - ◆ from bacteria to humans
    - tubulin (all cells)
    - actin (eukaryote cells)
- Means that they are both ancient and essential for life

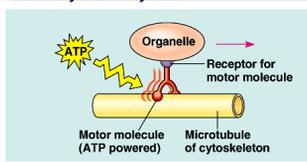
## Microtubules

- **Structure**
  - ◆ thickest fibers
  - ◆ hollow rods about 25nm in diameter
  - ◆ constructed of protein, tubulin
  - ◆ grow or shrink as more tubulin molecules are added or removed

## Microtubules

### Function

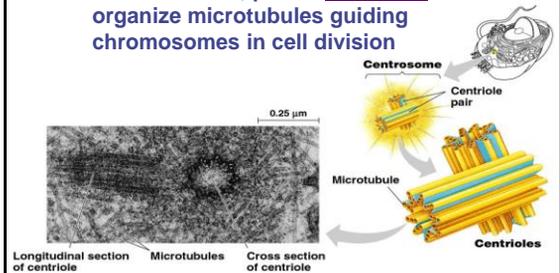
- ♦ structural support & cell movement
  - move chromosomes during cell division
    - ♦ **centrioles**
  - tracks that guide motor proteins carrying organelles to their destination
    - ♦ motor proteins: myosin & dynein
- ♦ motility
  - ♦ cilia
  - ♦ flagella



## Centrioles

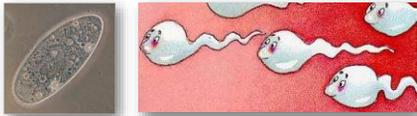
### Cell division

- ♦ in animal cells, pair of **centrioles** organize microtubules guiding chromosomes in cell division



## Cilia & flagella

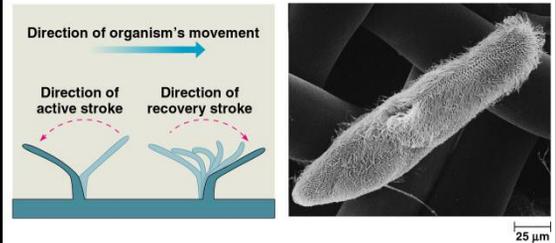
- Extensions of eukaryotic cytoskeleton
- **Cilia** = numerous & short (hair-like)
- **Flagella** = 1-2 per cell & longer (whip-like)
  - ♦ move unicellular & small multicellular organisms by propelling water past them
  - ♦ cilia sweep mucus & debris from lungs
  - ♦ flagellum of sperm cells



## Cilia

### Oar-like movement

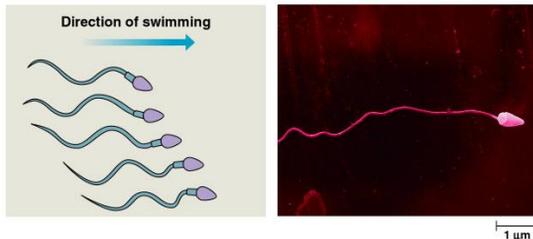
- ♦ alternating power & recovery strokes
- ♦ generate force perpendicular to cilia's axis



## Flagella

### undulatory movement

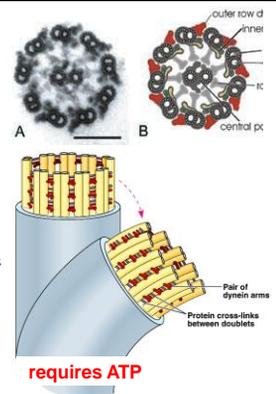
- ♦ force generated parallel to flagellum's axis

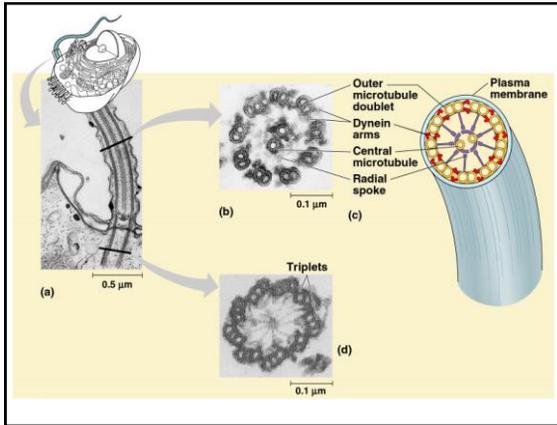


## Cilia & Flagella

### Structure

- ♦ remember **9+2!**
- ♦ 9 pairs of microtubules around 2 single microtubules in center
- ♦ bending of cilia & flagella is driven by motor protein
  - **dynein**





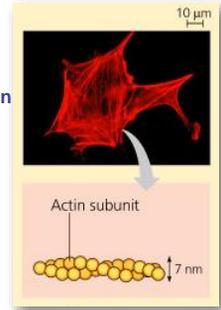
### Microfilaments (actin filaments)

#### Structure

- ◆ thinnest class of fibers
- ◆ solid rods of protein, **actin**
- ◆ twisted double chain of actin subunits
- ◆ about 7nm in diameter

#### Function

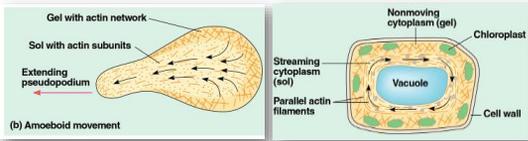
- ◆ 3-D network inside cell membrane
- ◆ in muscle cells, **actin** filaments interact with **myosin** filaments to create muscle contraction



### Microfilaments (actin filaments)

#### Dynamic process

- ◆ actin filaments constantly form & dissolve making the cytoplasm liquid or stiff during movement
  - movement of *Amoeba*
  - **cytoplasmic streaming** in plant cells
    - ◆ speeds distribution of materials



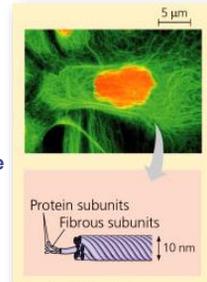
### Intermediate filaments

#### Structure

- ◆ specialized for bearing tension
- ◆ built from **keratin** proteins
  - same protein as hair
- ◆ intermediate in size 8-12nm

#### Function

- ◆ hold "things" in place inside cell
- ◆ more permanent fixtures of cytoskeleton
- ◆ reinforce cell shape & fix organelle location
  - nucleus is held in place by a network of intermediate filaments



### Summary

#### Microtubules

- ◆ thickest
- ◆ cell structure & cell motility
- ◆ tubulin

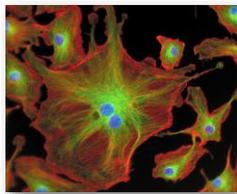
- **actin**
- **microtubule**
- **nuclei**

#### Microfilaments

- ◆ thinnest
- ◆ internal movements within cell
- ◆ actin, myosin

#### Intermediate filaments

- ◆ intermediate
- ◆ more permanent fixtures
- ◆ keratin



**A cell is a living unit greater than the sum of its parts!**

