Chapter 5.3 & 5.4
The Cell: Cytoskeleton

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

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

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

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

- **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!