Chapter 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
  - 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

Any Questions??