Cell Junctions

Cell junctions

- Plasma membrane areas specialized to provide contact between cells
  - Dense clusters of cell adhesion molecules on the outside
  - linked to cytoskeleton on the inside
  - through adapter proteins
- Four classes of cell junctions

Cell junctions – types based on localization

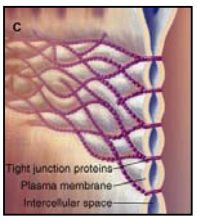
- Between cells
  - (1) tight junctions
  - (2) adherens junctions and desmosomes
  - (3) gap junctions
- Between cells and matrix
  - (4) hemidesmosomes

Cell junctions - types based on function

- Adhering junctions
  - (1) tight junctions
  - (2) adherens junctions and desmosomes
  - (4) hemidesmosomes
- Communicating junctions
  - (3) gap junctions

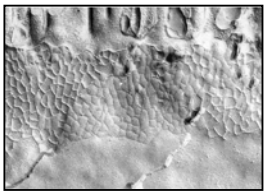
Tight junctions (zonula occludens)

- Belts of proteins that close extracellular space between cells
- Prevent passage of water and water-soluble substances
- Account for electrical resistance across epithelia



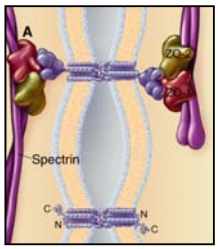
Tight junctions

- Isolate parts of plasma membrane (apical and basolateral)
- Completely encircle polarized cells
- Look like honey comb



Molecular structure of tight junctions

- Claudins (membrane proteins) zip two membranes together
- Stabilized by spectrin
- Connected to spectrin by adapter proteins ZO1 and ZO2



Regulation of tight junctions

- The “tightness” varies according to the barrier needs
- Leaky epithelia where there is need for some traffic

Regulation of tight junctions

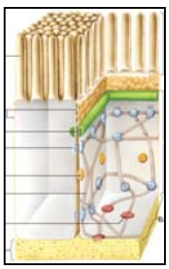
- Hormones
  - Vasopressin
- Cytokines
- Lack of ATP causes “leak”
- Extravasating leukocytes open tight junctions

Adhesive junctions

- Adherens junctions and desmosomes
- Hold cells tightly together
- Confer mechanical strength
- Common in tissue that are subject to severe stress such as skin and cardiac muscle

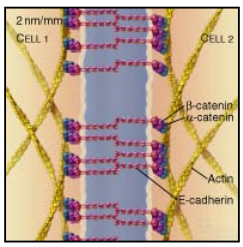
Molecular structure of adherens junctions

- Belt like junctions located just below tight junction
- Simple points of attachment, do not contain channels connecting the interiors of the two attached cells



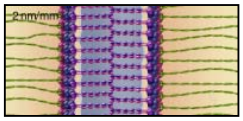
Adherens junctions

- Homophilic pairing of E-cadherins
- Adapter proteins (plakoglobin and α and β catenins) link cadherins to the belt of actin filaments



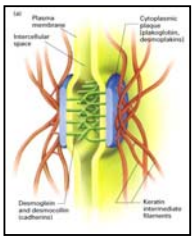
Desmosomes

- Button like welds joining opposing cell membranes
- Cadherins bind the membranes of adjacent cells in a way that gives strength and rigidity to the entire tissue



Molecular structure of desmosomes

- Two cadherins
  - Desmoglein
  - Desmocollin
- Adapter proteins
  - Plakoglobin and desmoplakin
- Linked to epidermal keratins



Gap junctions

- Junctions that provide direct connections (door) between cells
- Channels or pores through the membranes of two cells and across the intercellular space
- Form electrical synapses
  - Direct transmission of action potential without transmitter, receptors etc

Gap junctions

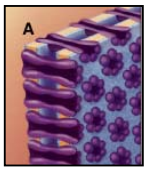
- Integrate the metabolism of the cells
- Metabolic coupling or metabolic cooperation – transfer of molecules that the neighboring cell can not synthesize (second messengers, precursors of DNA and RNA)

Cells that use gap junctions

- Skin epithelium
- Endocrine glands
- GI epithelium
- Smooth muscle
- Cardiac muscle
- Osteocytes
- Glial cells

Molecular structure of gap junction

- A ring of 6 membrane proteins called connexins - connexons
- Two connexons on neighboring membranes form a transmembrane channel that interconnects the cytoplasms of two cells
- Connexons are size filters

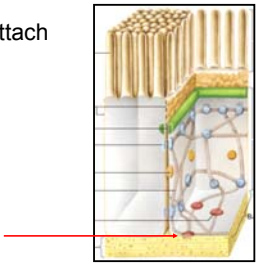


Regulation of gap junctions

- Flip between open and closed states as other channels do
- Cells may modulate the degree of coupling
  - Cytoplasmic levels of Ca^{2+} and pH
  - Phosphorylation
  - Oleamide – closes gap junctions and induces sleep

Hemidesmosomes

- Similar to desmosomes but totally different molecular structure
- Cell-matrix adhesions – attach cells to basal lamina



Molecular structure of hemidesmosomes

- Composed of integrins (outside) that bind to type XVII collagen and laminin-5
- Cytosolic side consist of a plague composed of adapter proteins (plectin) attaching integrins to keratin filaments