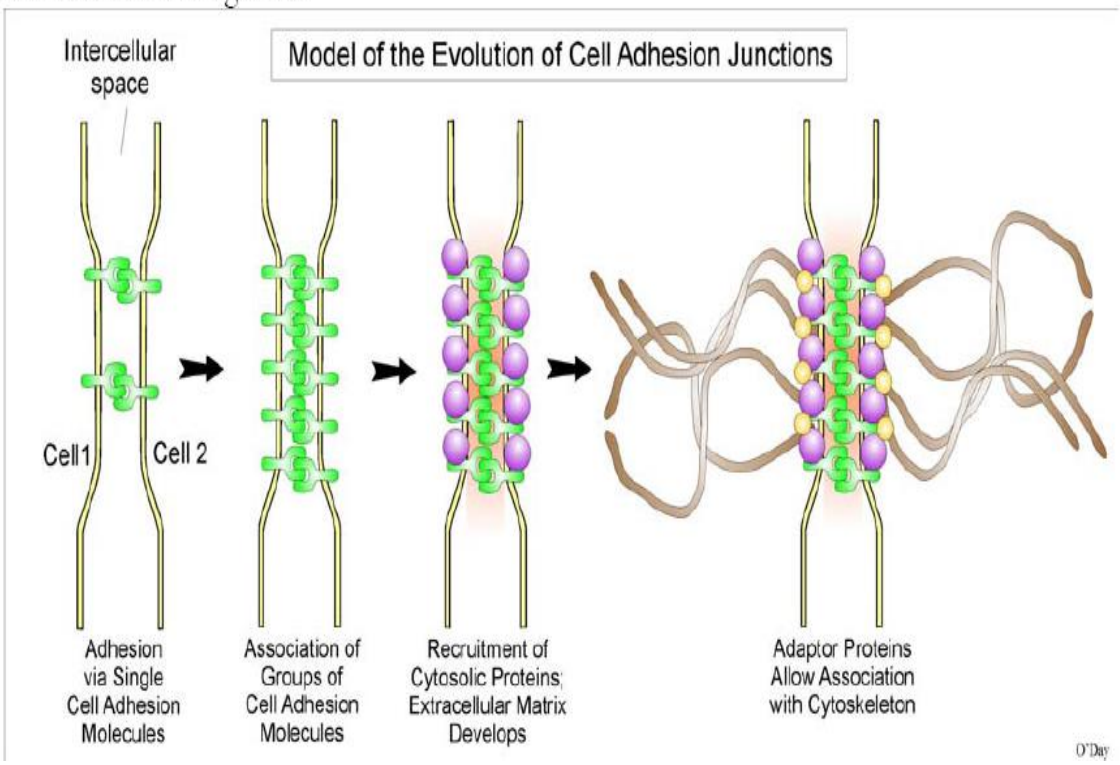
CELL BIOLOGY

Dr. Treefa F. Ismail **4th stage**

Lecture 5: Cell Connections & Junctions 1/11/2021

Introduction

The evolution of higher organisms required that single cells first formed multicellular associations. Once this was accomplished individual cells or groups of cells could then specialize for specific functions. Ultimately the evolution of tissues and organs was possible. But likely it all began with the first cell adhesion molecules that allowed two cells to stick together.



INTERCELLULAR JUNCTIONS

***C**ell junctions are plasma membrane specializations, mediate between neighboring cells and between cells and the basal lamina.

*Cell junctions consist of multiprotein complexes that provide contact between cells.

*Cell junctions are particularly abundant in epithelia, they build up the paracellular barrier of epithelia and control the paracellular transport. They also form barriers that inhibit the movement of water and solutes.

*Cell adhesion between two identical molecules called **homotypic cell adhesion,** while binding between two different cell adhesion molecules is called **heterotypic cell adhesion**.

*On the molecular level, intercellular junctions typically consist of three components which differ depending on the type of junction:

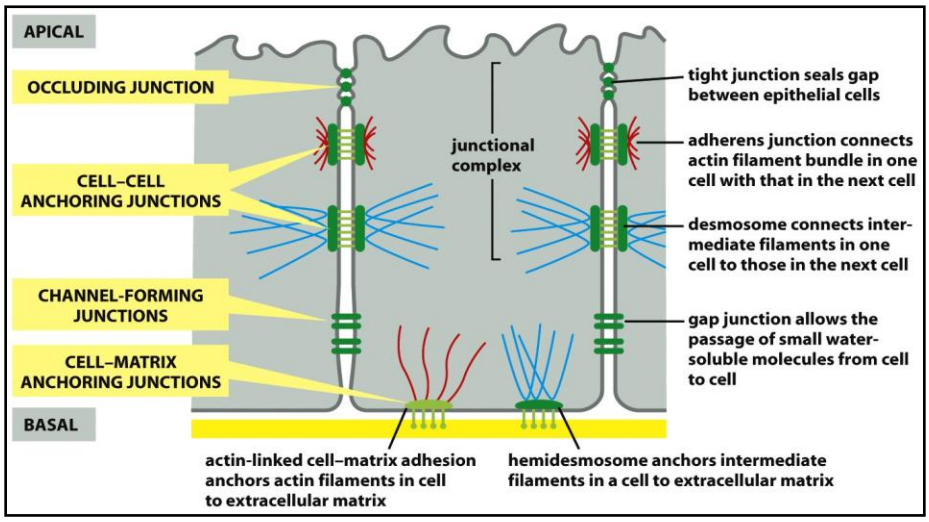
Transmembrane adhesiveprotein

Cytoplasmic adapter protein

Cytoskeletal filaments

In vertebrates, there are three major types of cell junction:

- Tight junctions (occluding junctions)
- Adherens junctions, desmosomes and hemidesmosomes (anchoring junctions)
- Gap junctions (communicating junction)



Tight junctions (Occluding junctions)

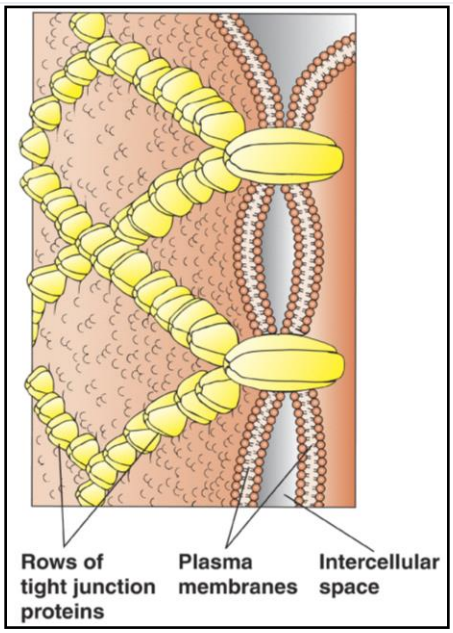
Found primarily in the epithelial lining of an animal's digestive tract, stitch two cells together so tightly, that the intercellular space at the site of the junction is eliminate. This junction not only **keeps the cells together** but also performs a very important secondary function of **blocking the movement of bacteria and small molecules** from the lumen (interior) of the gut into the intercellular space. In other words, tight junctions make the gut leak-proof. Nutrients obtained from the food we eat must pass through the gut's epithelial lining, where they are screened before being allowed to enter general circulation. Without the tight junctions, unwanted chemicals, possibly of a toxic nature, would be absorbed.

In addition, the millions of bacteria that inhabit an animal's intestinal tract would quickly spread throughout the body, leading to a fatal infection.

Endothelial cells in most regions of the brain and spinal cord are joined by **tight junctions**. The blood-brain barrier separates the blood from the interstitial fluid.

Function of Tight Junction

- Strength and stability (Mechanical connection)
- Selective permeable for ions.
- Fencing function
- Maintance of cell polarity
- Blood-brain barrier



Adherens junctions, Desmosomes (Anchoring Junction)

Desmosomes are a type of anchoring junction in animal tissues that connect adjacent cells. Anchoring junctions are button-like spots found all around cells that bind adjacent cells together.

They are found in high numbers in tissues that are subject to a lot of mechanical forces. For example, many are found in the epidermis, which is the outer layer of skin, and the myocardium, which is muscle tissue in the heart. They are also found in between squamous epithelial cells, which form the lining of body parts like the, blood vessels, air sacs of the lungs, and esophagus.

The main parts of Desmosome are:

* A **protein plaque**, analogous to a rivet head, is located beneath the membranes of adjacent cells.

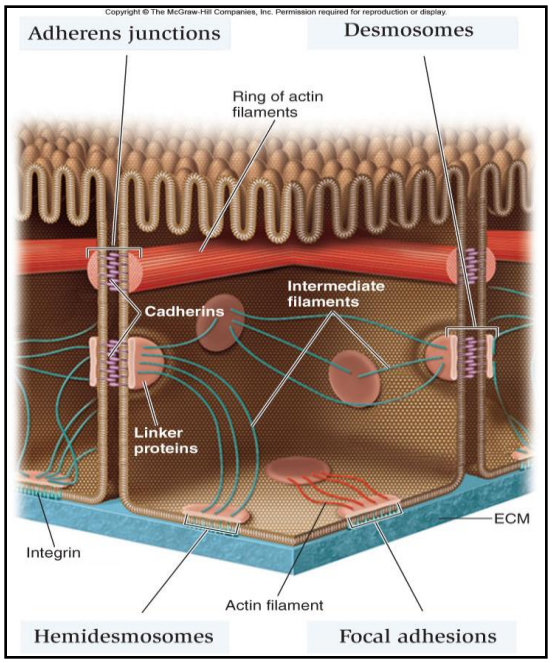
* Another protein, called **cadherin**, projects from the plaques into the intercellular space where they form chemical bonds with each other, thus holding the two cells together.

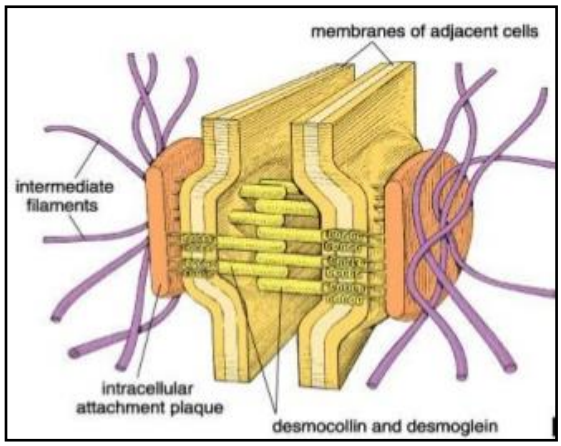
*Intermediate filaments which is:

-keratin filaments in most epithelial cells

-desmin filaments in heart and muscle cells.

This junction is more relaxed than a tight junction, and molecules are free to diffuse throughout the intercellular space.

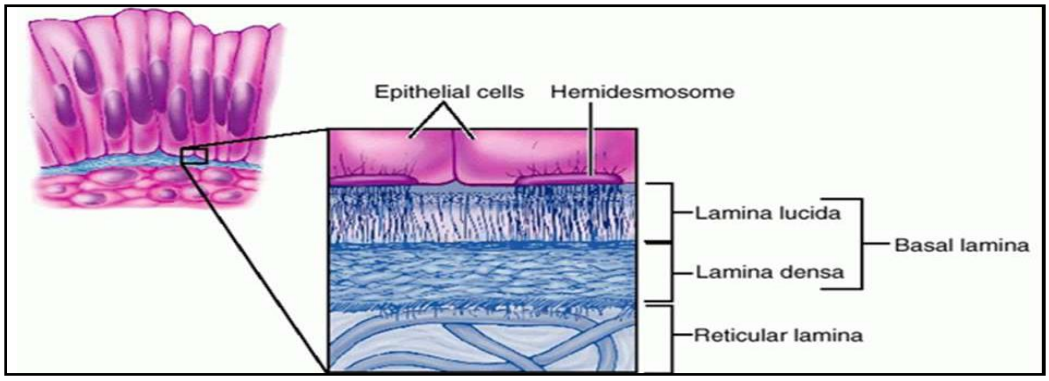




Hemidesmosomes

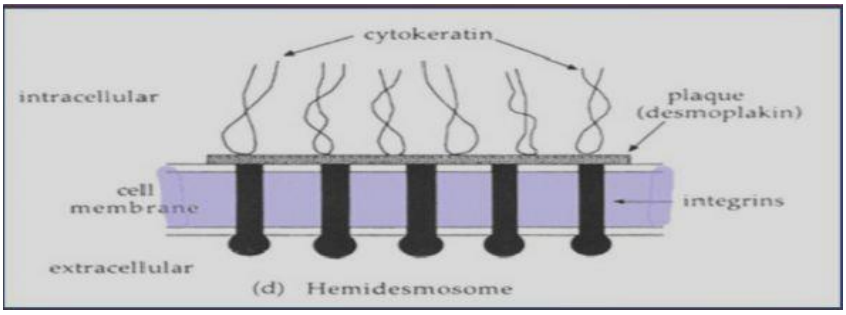
look like half-desmosomes that attach cells to the underlying basal lamina. Hemidesmosomes have a dense plaque on the cytoplasmic surface that anchors of intermediate filaments.

All epithelia are separated from the underlying connective tissue by a layer of extracellular matrix organized as a thin sheet immediately adjacent to the epithelial cells. The basal lamina, along with hemidesmosomes, attaches the epithelium to the underlying connective tissue, functions as a filter to control the passage of molecules between the epithelium and connective tissue, and acts as a barrier to cell migration.



Hemidesmosom structure:

- Transmembrane glycoprotein –**integrin**
- Attachment proteins – **adhesion plaque**
- Cytoskeletal element - **intermediate filaments**
- Extracellular-matrix protein - **laminin**.



Channel forming junctions (Gap Junctions)

- Cells need to be anchored to each other. In many cases, they also need to exchange fluids.
- Gap junctions, consisting primarily of hollow protein tubes, provide both an anchor and a fluid conduit in higher organisms. The sharing of cytoplasm is especially important in cardiac muscle, where the contraction of each myocyte is coordinated by the movement of ions through gap junctions.

Function of gap junction

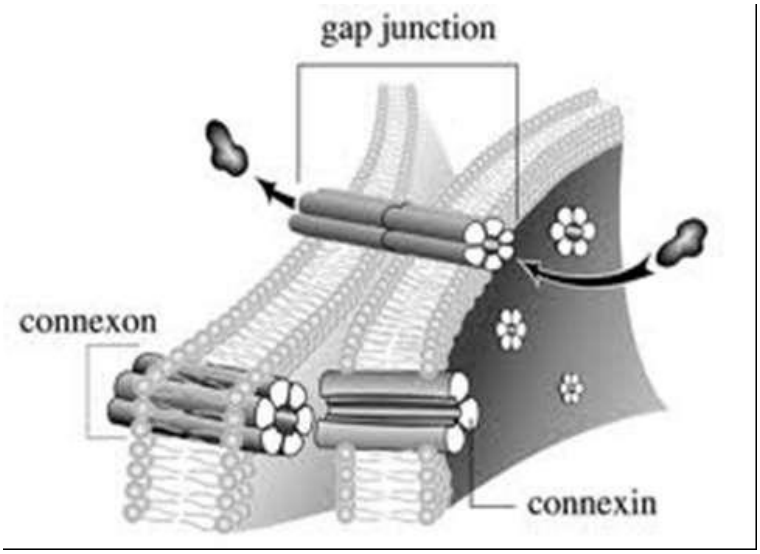
- Channel passage the substance have molecular weight less than 1000 D.
- Exchange of chemical messenger between cells
- Rapid propagation of action potential from one cell to another cell.

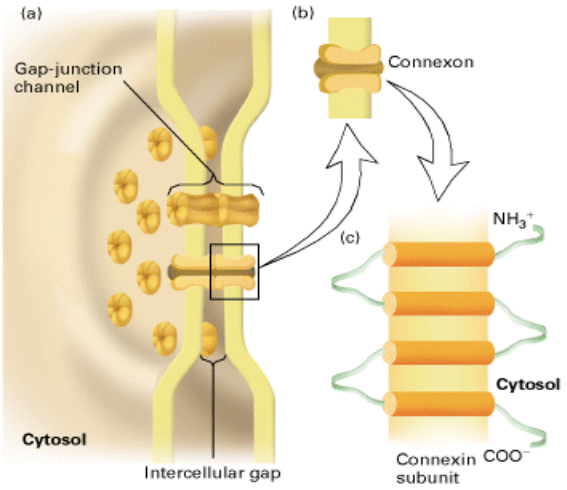
Gap junctions were first discovered in myocardium and nerve because of their properties of electrical transmission between adjacent cells (Furshpan and Potter 1957).

Gap Junction(MACULA COMUNICANS) Found in:

- Epithelial tissue
- Intercalated disk
- Smooth muscle tissue
- Electrical synapse
- Glial cells
- Osteocytes

- The gap junction channels consist of two halves, called connexons or hemichannels.
  - Each consists of six protein subunits called connexins.
  - Over 20 different connexin genes are found in humans.
  - These combine to form a variety of connexon types.





Signal relaying junctions

*Chemical synapses are specialized junctions through which neurons signal to each other and to non-neuronal cells such as those in muscles or glands.

*Chemical synapses allow neurons to form circuits within the central nervous system. The key feature is the presence of synaptic vesicles at presynaptic terminals. These vesicles are filled with 1 or more neurotransmitters. It is these chemical agents that act as messengers between the communicating neurons that gives it a name as chemical synapse.