Cell Junctions

Most animal cells release materials into the extracellular space. The primary components of these materials are proteins, and the most abundant protein is collagen. Collagen fibers are interwoven with carbohydrate-containing protein molecules called proteoglycans. Collectively, these materials are called the **extracellular matrix.** . Not only does the extracellular matrix hold the cells together to form a tissue, but it also allows the cells within the tissue to communicate with each other.

Cells have protein receptors on the extracellular surfaces of their plasma membranes. When a molecule within the matrix binds to the receptor, it changes the molecular structure of the receptor. The receptor, in turn, changes the conformation of the microfilaments positioned just inside the plasma membrane. These conformational changes induce chemical signals inside the cell that reach the nucleus and turn "on" or "off" the transcription of specific sections of DNA, which affects the production of associated proteins, thus changing the activities within the cell.

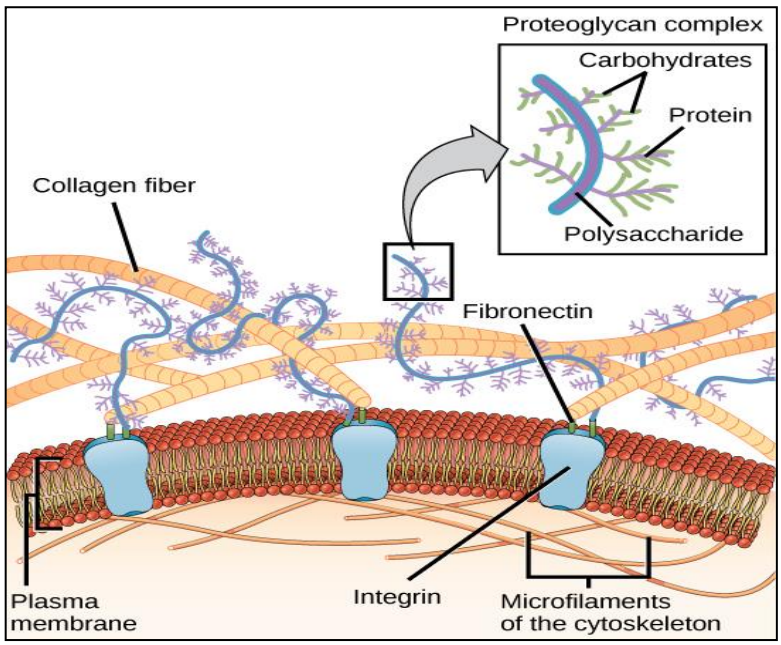


Fig: Extra cellular matrix

Intercellular Junctions: Cells can also communicate with each other via direct contact, referred to as intercellular junctions. There are some differences in the ways that plant and

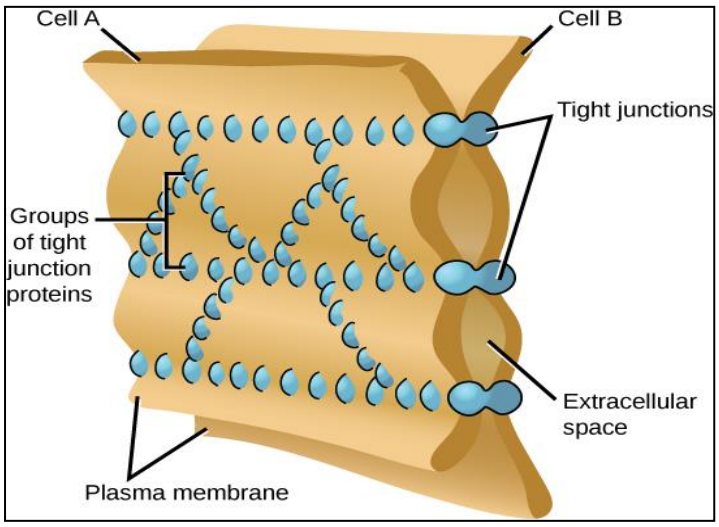
animal cells do this. Animal cell contacts include occluding junction (tight junctions), gap junctions, and adherens, whereas plasmodesmata are the junction between plant cells.

1. <u>Occluding junctions (Tight Junctions)</u> : Occluding/Tight junctions are virtually (but also partly selectively) impermeable seals that encircle cells and bind them together into leakproof sheets. In other words, the plasma membranes of adjacent cells essentially fuse together tightly in order to limit the leakage of various substances between the two cells.

Epithelia are sheets of cells that provide the interface between masses of cells and a cavity or space (a lumen).s

- The portion of the cell exposed to the lumen is called its **apical** surface.
- The rest of the cell (i.e., its sides and base) make up the **basolateral** surface.

Tight junctions seal adjacent epithelial cells in a narrow band just beneath their apical surface. They consist of a network of **claudins** and other proteins.



<u>Fig: Occluding/Tight Junction</u>

Tight junctions perform two vital functions:

- They limit the passage of molecules and ions through the space between cells. So most materials must actually enter the cells (by diffusion or active transport) in order to pass through the tissue. This pathway provides tighter control over what substances are allowed through.

For example: In the skin, they keep us somewhat watertight and help keep allergens out of our body. In the digestive system, they help prevent the leakage of digestive enzymes into our bloodstream

- They block the movement of integral membrane proteins between the apical and basolateral surfaces of the cell. Thus the special functions of each surface, for example

  - ✓ receptor-mediated endocytosis at the apical surface
  - ✓ exocytosis at the basolateral surfacecan be preserved.

- Tight junctions also serve as a structural support mechanism that helps keep the epithelium together.

2. Gap Junctions: Gap junctions are also called **communicating junctions**, macula communicans, or nexuses. These are connections that allow for the direct passage of molecules between two cells. Gap junctions consist of a number of transmembrane channels called pores that are found in a closely packed arrangement. The number of gap junctions shared between two cells can vary as well.

Gap junctions are intercellular channels some 1.5–2 nm in diameter. These permit the free passage between the cells of ions and small molecules (up to a molecular weight of about 1000 daltons).

Because ions can flow through them, gap junctions permit changes in membrane potential to pass from cell to cell.

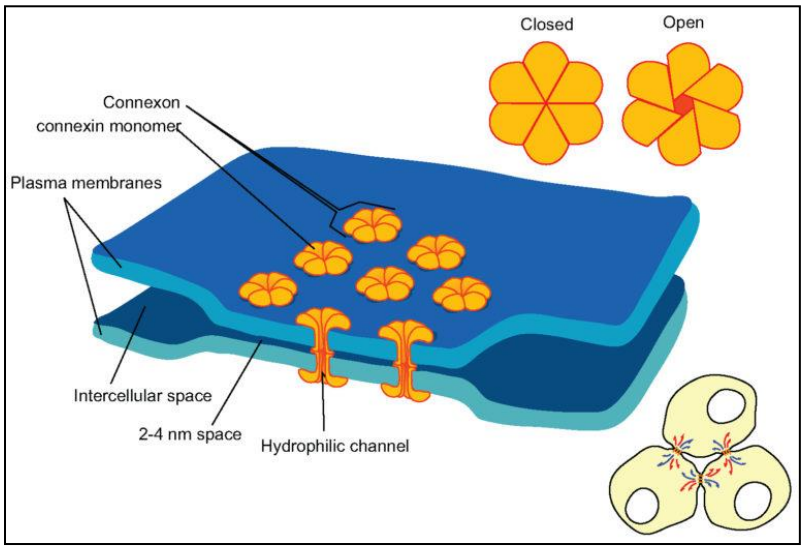
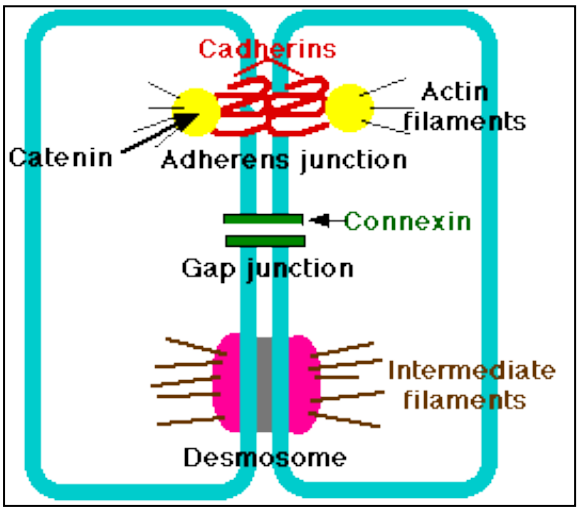


Fig: Gap junction

A gap junction channel is composed of two connexons, also known as hemichannels that line up across the intercellular space. Most gap junction hemichannels are composed of a complex of six connexin proteins, each characterized by four transmembrane domains. Six connexin sub-units assemble to create one connexon, or hemichannel.

- For Example: The action potential in heart (cardiac) muscle flows from cell to cell through the heart providing the rhythmic contraction of the heartbeat.
- At some so-called electrical synapses in the brain, gap junctions permit the arrival of an action potential at the synaptic terminals to be transmitted across to the postsynaptic cell without the delay needed for release of a neurotransmitter.
- As the time of birth approaches, gap junctions between the smooth muscle cells of the uterus enable coordinated, powerful contractions to begin.

3. <u>Anchoring junctions (Adherens Junctions)</u>: Anchoring/Adherens junctions are also referred to as zonula adherens, intermediate junction, or as belt desmosomes. Zonula means small zone or belt-like, and adherens refers to adhesion (sticking together). As a result, the zonula adherens often runs like a belt around the entire cell in a continuous fashion, and it acts as an adhesion belt.



<u>Fig; Adherens Junction</u>

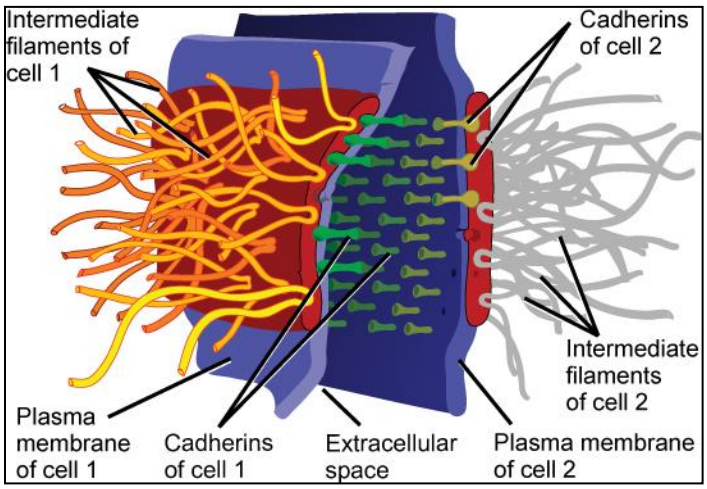
Adherens junctions provide strong mechanical attachments between adjacent cells.

- They hold **cardiac muscle** cells tightly together as the heart expands and contracts.
- They hold **epithelial cells** together.
- They seem to be responsible for contact inhibition.
- Some adherens junctions are present in narrow bands connecting adjacent cells.
- Others are present in discrete patches holding the cells together.

Adherens junctions are built from:

- **Cadherins**: **Cadherins**, specialized adhesion proteins, are found on the membranes of both cells and interact in the space between them, holding the membranes together. Inside the cell, the cadherins attach to a structure called the cytoplasmic plaque, which connects to the intermediate filaments and helps anchor the junction.

- **catenins** : Catenins are connected to actin filaments



The extracellular portions of the cadherin molecules of adjacent cells are bonded together by calcium ions (or another protein in some cases). This means that the functional as well as morphological integrity of the adherens junctions are calcium dependent. If we remove calcium from the equation, this type of cell junction would disintegrate as a result.

Plasmodesmata: Plant cells, surrounded as they are by cell walls, don't contact one another through wide stretches of plasma membrane the way animal cells can. However, they do have specialized junctions called **plasmodesmata** (singular, **plasmodesma**), places where a hole is punched in the cell wall to allow direct cytoplasmic exchange between two cells.

Plasmodesmata are lined with plasma membrane that is continuous with the membranes of the two cells. Each plasmodesma has a thread of cytoplasm extending through it, containing an even thinner thread of endoplasmic reticulum.

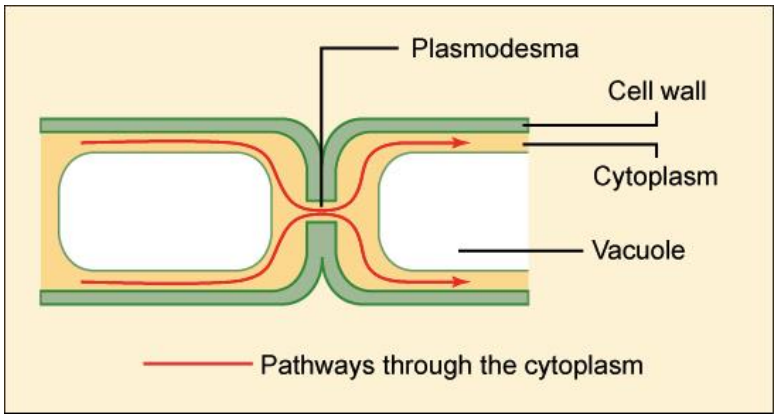


Fig: Plasmodesmata

Molecules below a certain size (the size exclusion limit) move freely through the plasmodesmal channel by passive diffusion. The size exclusion limit varies among plants, and even among cell types within a plant.

In summary: Animal cells communicate via their extracellular matrices and are connected to each other via tight junctions, adherens, desmosomes, and gap junctions. When protein receptors on the surface of the plasma membrane of an animal cell bind to a substance in the extracellular matrix, a chain of reactions begins that changes activities taking place within the cell. Plasmodesmata are channels between adjacent plant cells while gap junctions are channels between adjacent animal cells. However their structures are quite different. A tight junction is a watertight seal between two adjacent cells, while a desmosome acts like a spot weld.

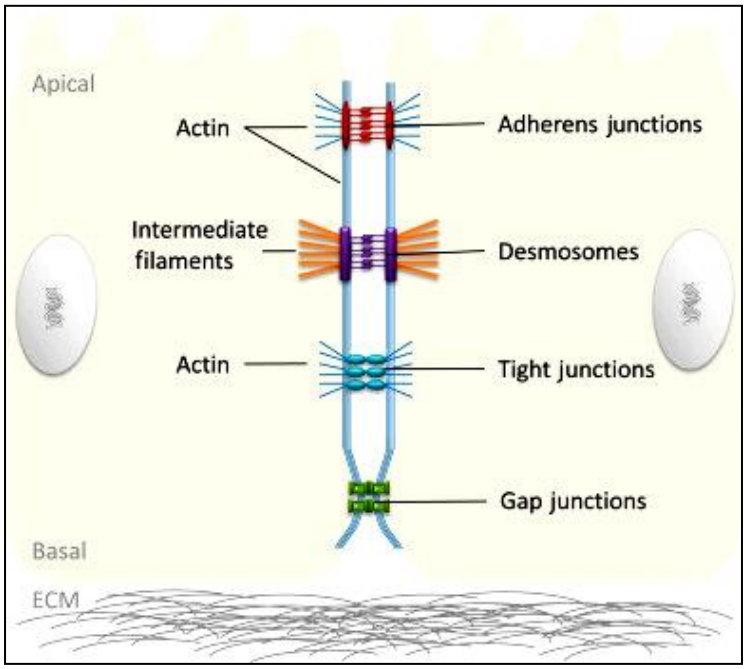


Fig: Cell junctions of animal cells

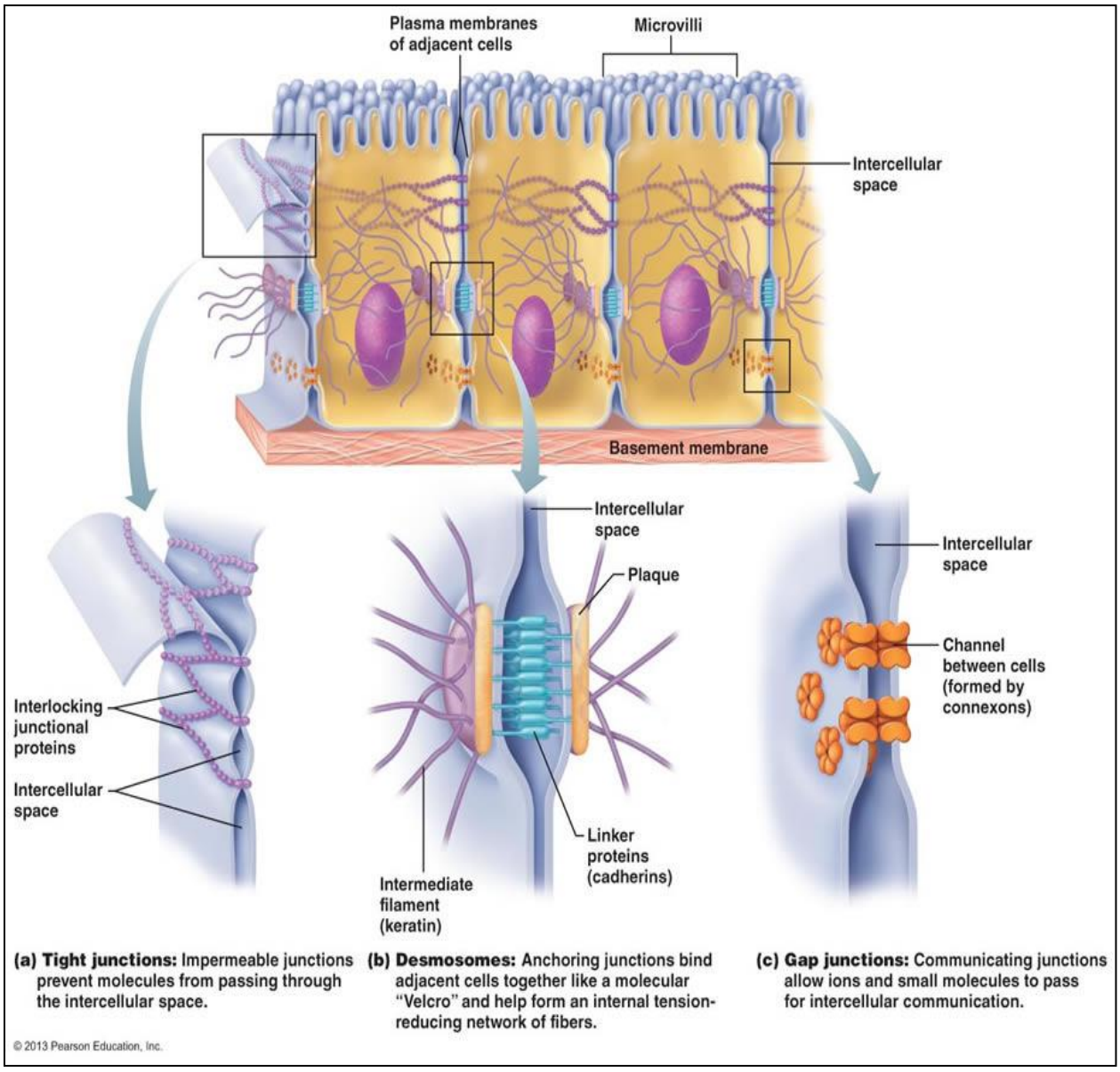


Fig: Different type of animalcell junctions

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