

Chapter 5

Junctions Between Cells

In many **animal** tissues (e.g., connective tissue), each cell is separated from the next by an extracellular coating or matrix. However, in some tissues (e.g., epithelia), the plasma membranes of adjacent cells are pressed together. Four kinds of junctions occur in vertebrates:

1. **Tight junctions**
2. **Adherens junctions**
3. **Gap junctions**
4. **Desmosomes**

In many **plant** tissues, it turns out that the plasma membrane of each cell is continuous with that of the adjacent cells. The membranes contact each other through openings in the cell wall called

5. **Plasmodesmata.**

5.1. Tight Junctions

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

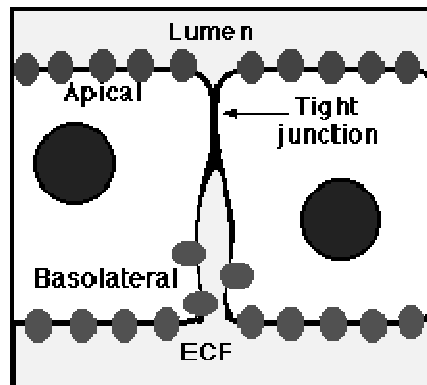


Fig.5.1. Tight Junction

Tight junctions perform two vital functions:

- They prevent the passage of molecules and ions through the space between cells. So materials must actually enter the cells (by diffusion or active transport) in order to pass through the tissue. This pathway provides control over what substances are allowed through.
- 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 and exocytosis at the basolateral surface can be preserved.

The epithelial cells of the human lung express a growth stimulant, called **heregulin**, on their **apical** surface and its receptors on the **basolateral** surface. (These receptors also respond to epidermal growth factor (**EGF**), and mutant versions have been implicated in cancer. As long as the sheet of cells is intact, there is no stimulation of its receptors by heregulin thanks to the seal provided by tight junctions. However, if the sheet of cells becomes broken, heregulin can reach its receptors. The result is an **autocrine** stimulation of mitosis leading to healing of the wound. Several disorders of the lung such as the chronic bronchitis of cigarette smokers, asthma and cystic fibrosis increase the permeability of the airway epithelium. The resulting opportunity for autocrine stimulation may account for the proliferation (piling up) of the epithelial cells characteristic of these disorders.

5.2. Adherens Junctions

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.

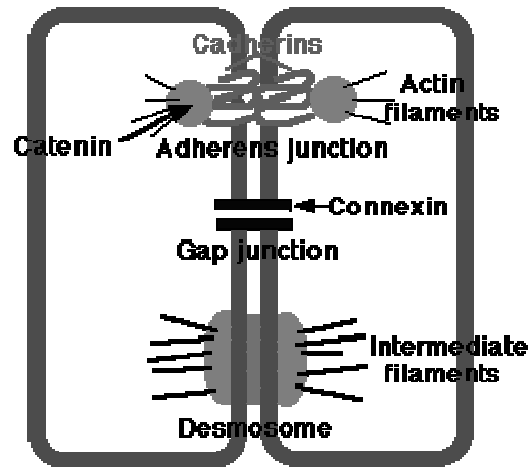


Fig.5.2. Adherens Junctions

Adherens junctions are built from **Cadherins** — transmembrane proteins whose extracellular segments bind to each other and whose intracellular segments bind to **catenins**. Catenins are connected to actin filaments. One of the **oncogenes** that is frequently found in **colon cancer** appears to be the mutated version of a protein that normally interacts with catenins. Loss of functioning adherens junctions may also lead to tumour **metastasis**.

5.3. Gap Junctions

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). They are constructed from 4 (sometimes 6) copies of one of a family of a transmembrane proteins called **connexins**. Because ions can flow through them, gap junctions permit changes in membrane potential to pass from cell to cell.

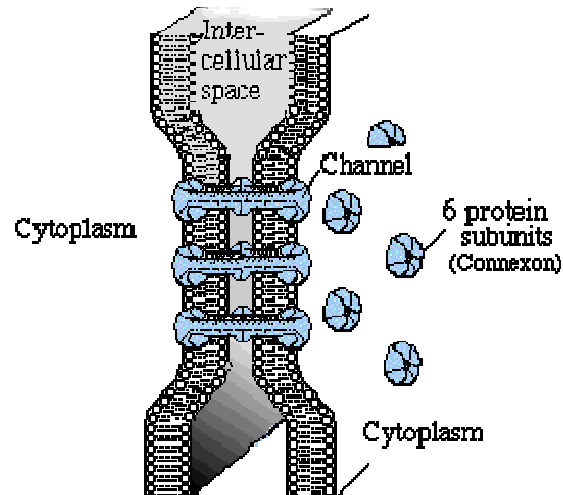


Fig.5.3. Gap Junctions

Examples:

- The **action potential** in heart (cardiac) muscle flows from cell to cell through the heart providing the rhythmic contraction of the heartbeat.
- At some **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.

Several inherited disorders of humans such as certain congenital heart defects and certain cases of congenital deafness have been found to be caused by mutant genes encoding **connexins**.

5.4. Desmosomes

Desmosomes are localized patches that hold two cells tightly together. They are common in epithelia (e.g., the skin). Desmosomes are attached to intermediate filaments of keratin in the cytoplasm. **Pemphigus** is an **autoimmune disease** in which the patient has developed antibodies against proteins (cadherins) in desmosomes. The loosening of the adhesion between adjacent epithelial cells causes blistering. **Carcinomas** are cancers of epithelia. However, the cells of carcinomas no longer have desmosomes. This may account for their ability to **metastasize**.

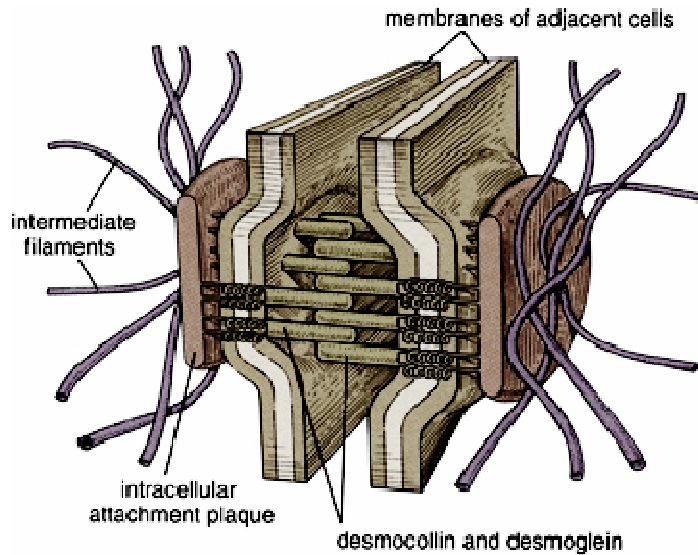


Fig.5.4. Desmosomes

5.5. Hemidesmosomes

These are similar to desmosomes but attach epithelial cells to the basal lamina ("basement membrane") instead of to each other. e.g. **Pemphigoid** is an autoimmune disease in which the patient develops antibodies against proteins (integrins) in hemidesmosomes. This, too, causes severe blistering of epithelia.

5.6. Plasmodesmata

Although each plant cell is encased in a boxlike cell wall, it turns out that communication between cells is just as easy, if not easier, than between animal cells. Fine strands of cytoplasm, called **plasmodesmata**, extend through pores in the cell wall connecting the cytoplasm of each cell with that of its neighbours.

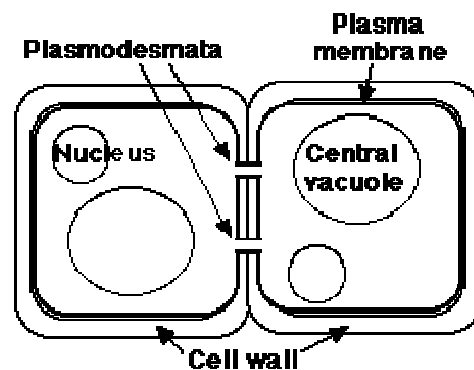


Fig.5.5. Plasmodesmata

Plasmodesmata provide an easy route for the movement of ions, small molecules like sugars and amino acids, and even macromolecules like RNA and proteins, between cells. The larger molecules pass through with the aid of **actin filaments**. Plasmodesmata are sheathed by a plasma membrane that is simply an extension of the plasma membrane of the adjoining cells. This raises the intriguing question of whether a plant tissue is really made up of separate cells or is, instead, a **syncytium**: a single, multinucleated cell distributed throughout hundreds of tiny compartments!