Cellular interaction

- Cell–cell interaction refers to the direct interactions between cell surfaces that play important role in the development and function of multicellular organisms.
- These interactions allow cells to communicate with each other in response to changes in their microenvironment, also to send and receive signals is essential for the survival of the cell.
- Interactions between cells can be stable such as those made through cell junctions which can involve in the communication and organization of cells within a particular tissue.
- Or transient (temporary) such as those between cells of the immune system or the interactions involved in tissue inflammation. These types of intercellular interactions are distinguished from other types such as those between cells and the extracellular matrix.
- The loss of communication between cells can result in uncontrollable cell growth and cancer.

Stable interactions

Stable cell-cell interactions are required for cell adhesion within a tissue and controlling the shape and function of cells. These stable interactions involve cell junctions which are multiprotein complexes that provide contact between neighboring cells. Cell junctions allow for the preservation and proper functioning of epithelial cell sheets. These junctions are also important in the organization of tissues where cells of one type can only adhere to cells of the same tissue rather than to a different tissue. Cell junction in stable interaction is divided to:

- **Tight junctions**

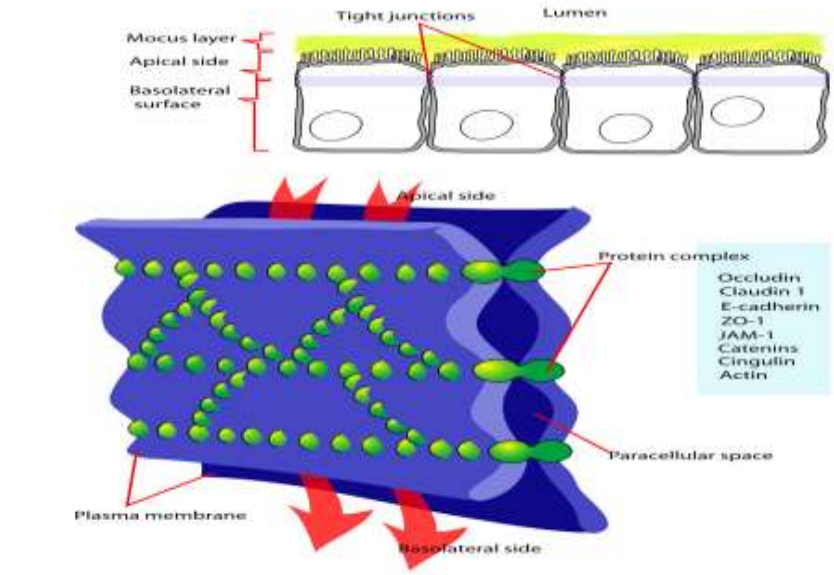
Tight junctions, also known as occluding junctions or zonulae occludentes, are the closely associated areas of **two cells whose membranes join together forming a virtually impermeable barrier to fluid.** It is a type of junctional complex present only in vertebrates. Tight junctions are composed of **a branching network of sealing strands**, each strand acting independently from the others. Therefore, the efficiency of the junction in preventing ion passage increases exponentially with the number of strands. Each strand is formed from a row of trans membrane proteins embedded in both plasma membranes.

The main functions of tight junction:

- They hold cells together.
- Barrier function, which can be further subdivided into protective barriers and functional barriers serving purposes such as material transport and maintenance of osmotic balance.

- Tight Junctions help to maintain the polarity of cells by preventing the lateral diffusion of integral membrane proteins between the apical and lateral/basal surfaces, this makes sure that the proper endocytosis and exocytosis processes occur in both sides.
- Tight Junctions prevent the passage of molecules and ions through the space between plasma membranes of adjacent cells.

Tight junction found in epithelial of lung, intestine, stomach and bladder.



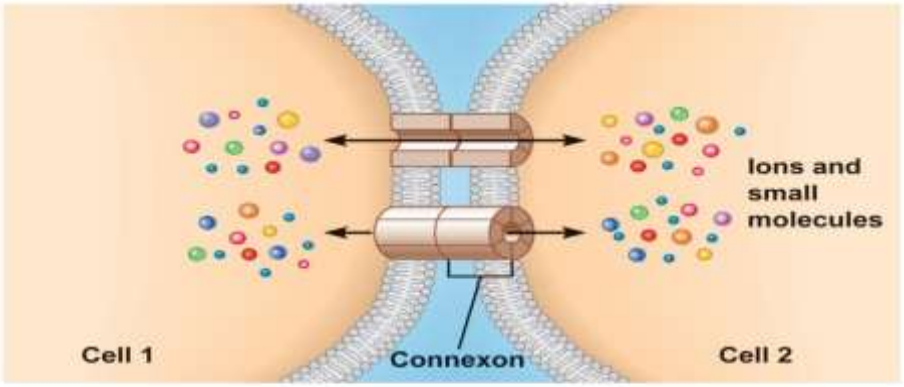
Gap junction

Is a specialized cell junction that **directly connects the cytoplasm of two cells**. A gap junction channel is composed of two connexin protein, also known as hemichannels that line up across the intercellular space.

The main functions of gap junction:

- Gap junctions allow the exchange of ions, second messengers, and small metabolites between adjacent cells.
- The primary regulators of gap junction permeability are pH and cytosolic Ca2+ concentration as.
- Regulated the extracellular signals including neurotransmitters like dopamine.

Gap junctions are found in many places throughout the body. This includes epithelia, which are the coverings of body surfaces, as well as nerves, cardiac (heart) muscle, and smooth muscle , skeletal muscle and mobile cell types such as sperm or erythrocytes.



(a) Direct communication through gap junctions

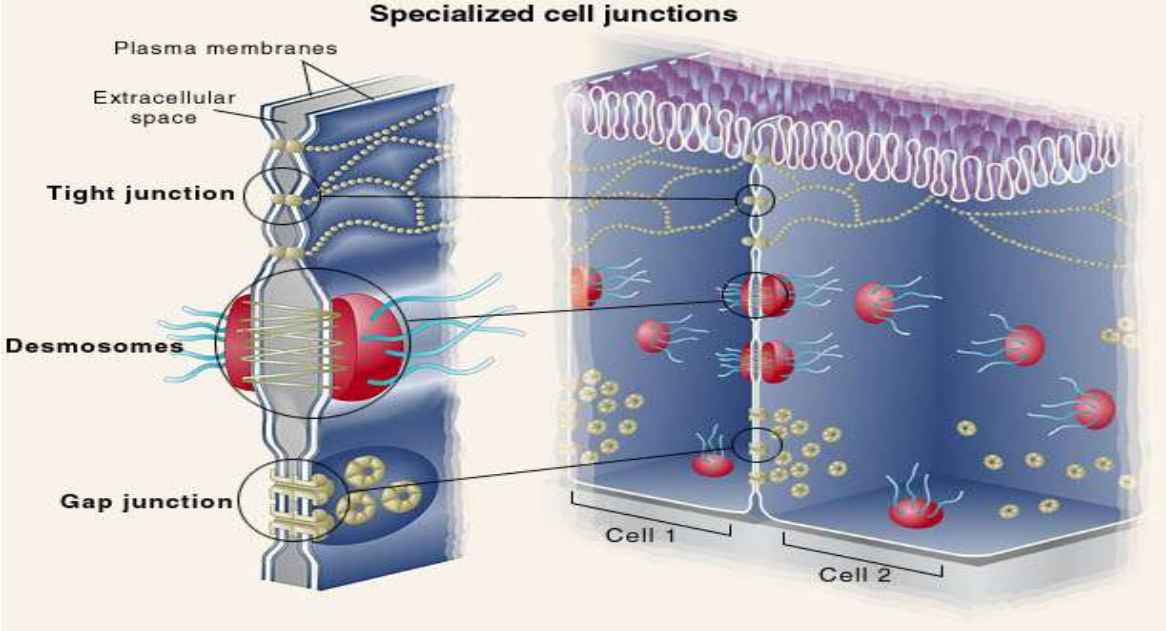
Desmosomes

A desmosome also known as a macula adhaerens, is a cell structure specialized for cell-to-cell adhesion. They are **localized spot-like adhesions randomly arranged on the lateral sides of plasma membranes**. Desmosomes are molecular complexes of cell adhesion proteins and linking proteins that attach the cell surface adhesion proteins to intracellular keratin cytoskeletal filaments.

The main functions of desmosomes:

- Desmosomes form links between cells
- Provide a connection between intermediate filaments of the cell cytoskeletons of adjacent cells. This structure gives strength to tissues.

Desmosomes are found in simple, stratified squamous epithelium and muscle tissue where they bind muscle cells to one another.



Transient interaction:

Transient interaction is occurring by the following:

- In immune system, when the movement of leukocyte into tissues by (extravasation) for fight infections, these cell-cell interactions are mediated mainly by a group of Cell Adhesion Molecules (CAM).
- T helper cells, central to the immune system, interact with other leukocytes by releasing signals known as cytokines which activate and stimulate the proliferation of B cells and T cells.
- T helper cells also directly interact with macrophages, cells that engulf foreign matter and display antigens on its surface.
- In coagulation, when the platelets are interacting and stick to the exposed connective tissue through specific cell-surface receptors, then, it activation and aggregation to fibrin formation and blood clotting.

Pathological implications

- In normal cells and when loss of cell-cell interaction, because the growth is controlled by contact inhibition, contact inhibition is lost and results in uncontrolled growth or proliferation, tumor formation, and metastasis.
- Cell–cell interactions are highly specific and are tightly regulated. Genetic defects and dysregulation of these interactions can cause many different disease that leads to leukocyte migration into healthy tissues and cause conditions such as acute respiratory distress syndrome , some types of arthritis and the autoimmune disease.
- Bacterial cells can bind to many host cell surface structures such as glycolipids and glycoproteins which serve as attachment receptors. Once attached, the bacteria begin to interact with the host to disrupt its normal functioning and disrupt or rearrange its cytoskeleton.

Extracellular

- **Extracellular matrix (ECM):** Is a macromolecular network composed of collagens, proteoglycan, glycos, aminoglycans, elastin, fibronectin, laminins and several other glycoproteins.
- Matrix components bind each other as well as cell adhesion receptors forming a complex network into which cells reside in all tissues and organs.
- Cell surface receptors transduce signals into cells form ECM, which regulate diverse cellular functions, such as survival, growth, migration, and differentiation, and are vital for maintaining normal homeostasis, as well as regrowth and healing of tissues (injury repair and tissue engineering).
- Deregulation of ECM composition and structure is associated with the development and progression of several pathologic conditions

Extracellular fluid (ECF):

- body fluid that is not contained in cells. It is found in blood, in lymph, in body cavities lined with serous membrane, in the cavities and channels of the brain and spinal cord, and in muscular and other body tissues.
- It differs from intracellular fluid (fluid within the cells) in that it generally has a high concentration of sodium and low concentration of potassium, while intracellular fluid is high in potassium and low in sodium.
- The extracellular fluid provides the medium for the exchange of substances between the ECF and the cells, and this can take place through dissolving, mixing and transporting in the fluid medium.
- Substances in the ECF include dissolved gases, nutrients, and electrolytes, all needed to maintain life.
- The ECF also contains materials secreted from cells in soluble form, but which quickly coalesces into fibers (e.g. collagen, reticular, and elastic fibres) or precipitates out into a solid or semisolid form (e.g. proteoglycans which form the bulk of cartilage, and the components of bone).