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Essentials of PHYSIOLOGY *for* Paramedical Students



K Sembulingam
Prema Sembulingam

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2
CHAPTER

Cell Junctions

CHAPTER OUTLINE

- DEFINITION AND CLASSIFICATION
- OCCLUDING JUNCTIONS
  - TIGHT JUNCTION
- COMMUNICATING JUNCTIONS
  - GAP JUNCTION
  - CHEMICAL SYNAPSE
- ANCHORING JUNCTIONS
  - ADHERENS JUNCTIONS
  - FOCAL ADHESIONS
  - DESMOSOME
  - HEMIDESMOSOME

DEFINITION AND CLASSIFICATION

Cell junction is defined as the connection between neighboring cells or the contact between the cell and extracellular matrix. It is also called **membrane junction**.

Connection between two cells is called **intercellular junctions**. Tight junction, gap junction, adherence junction and desmosome are intercellular junctions. Contact between the cell and extracellular matrix are focal adherence and hemidesmosome. Cells junctions are mostly formed by cell junction proteins.

Cell junctions are classified into three types:

I. Occluding junction.
II. Communicating junction.
III. Anchoring junction.

OCCLUDING JUNCTIONS

Cell junctions which prevent the movement of ions and molecules from one cell to another cell are called the occluding junctions. Tight junctions belong to this category.

TIGHT JUNCTION

Tight junction is formed by the tight fusion of the cell membranes from the adjacent cells. The area of the fusion is very tight and forms a ridge. This type of junction is present in the apical margins of epithelial cells in intestinal mucosa, wall of renal tubule, capillary wall and choroid plexus **(Fig. 2.1)**.

Proteins involved in tight junction are occludin, claudin, JAMs, cingulin, symplekin and ZO–1, 2, 3.

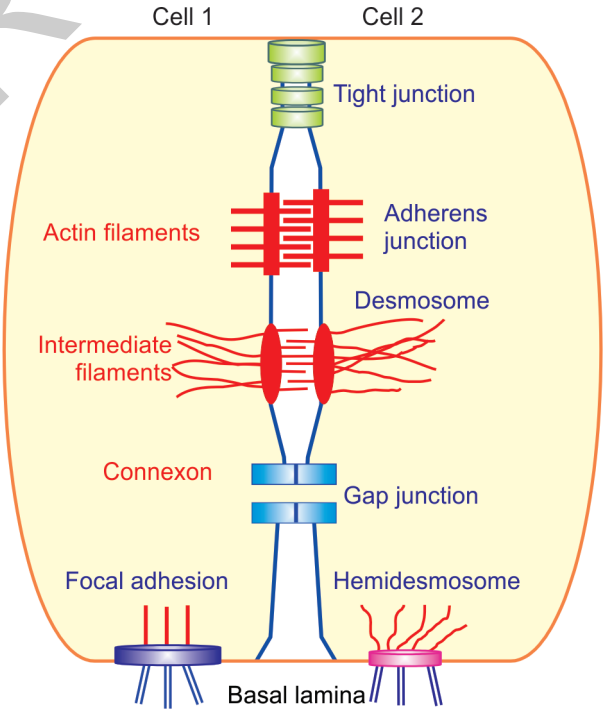


FIGURE 2.1: Different types of cell junctions.

Functions of Tight Junction

1. The tight junction holds the neighboring cells of the tissues firmly and thus provide strength and stability to the tissues **(Table 2.1)**

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TABLE 2.1: Cell junctions.

Junction types	Proteins involved	Functions	Examples
Tight junction	1. Occludin 2. Claudin 3. JAMs 4. Cingulin 5. Symplekin 6. ZO–1, 2, 3	1. Strength and stability to tissues 2. Selective permeability 3. Fencing function 4. Maintenance of cell polarity 5. Formation of blood-brain barrier	1. Epithelial lining of intestinal mucosa and renal tubule 2. Endothelium in capillary wall and choroid plexus
Gap junction	1. Connexins	1. Allows passage of small molecules, ions and chemical messengers 2. Propagation of action potential	1. Epithelial lining 2. In syncytium of heart 3. Epithelium of intestine
Adherens junction	1. Cadherins	1. Cell to cell attachment	1. Epithelial lining 2. In intercalated disks of cardiac muscle 3. Epidermis
Focal adhesions	1. Integrins	Cell attachment to: 1. Basal lamina 2. Extracellular matrix	1. Epithelial lining
Desmosome	1. Cadherins	1. Cell to cell attachment	1. Epithelial lining 2. Skin
Hemidesmosome	1. Integrins	Cell attachment to: 1. Basal lamina 2. Extracellular matrix	1. Epithelial lining

2. It provides the barrier or **gate function** by which the interchange of ions, water and macromolecules between the cells is regulated.
3. It acts like a fence by preventing the lateral movement of integral membrane proteins and lipids from cell membrane.
4. By the **fencing function**, the tight junctions maintain the cell polarity by keeping the proteins in the apical region of the cell membrane.
5. Tight junctions in the brain capillaries form the **blood-brain barrier** (BBB) which prevents the entrance of many harmful substances from the blood into the brain tissues.

COMMUNICATING JUNCTIONS

Cell junctions, which permit the movement of ions and molecules from one cell to another cell, are called communicating junctions.

Communication junctions are of two types:

1. Gap junction.
2. Chemical synapse.

GAP JUNCTION OR NEXUS

Gap junction is also called **nexus**. It is present in heart, basal part of epithelial cells of intestinal mucosa, etc.

Structure of Gap Junction

Membranes of the two adjacent cells lie very close to each other and the **intercellular space** becomes a narrow channel. Cytoplasm of both the cells is interconnected and molecules move from one cell to another cell through these channels without having contact with extracellular fluid (ECF). The channel is surrounded by 6 subunits of proteins which are called **connexins** or **connexons**.

Functions of Gap Junction

1. Diameter of the channel in the gap junction is about 1.5 to 3 nm. So, the substances having molecular weight less than 1,000 such as glucose can pass through this junction easily.
2. It helps in the exchange of chemical messengers between the cells.
3. It helps in rapid propagation of action potential from one cell to another cell.

CHEMICAL SYNAPSE

Chemical synapse is the junction between a nerve fiber and a muscle fiber or between two nerve fibers, through which the signals are transmitted by the release of chemical transmitter. Refer Chapter 79 for details.

ANCHORING JUNCTIONS

Anchoring junctions are the junctions, which provide firm structural attachment between two cells or between a cell and the extracellular matrix. Anchoring junctions are divided into four types.

1. ADHERENS JUNCTIONS: CELL TO CELL JUNCTION

Adherens junction is a **cell to cell junction** that is the junction found between the cells. The connection occurs through the actin filaments. Adherens junctions are present

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in the intercalated disk of cardiac muscles (Chapter 56) and epidermis of the skin. Proteins involved in this junction are cadherins.

2. FOCAL ADHESIONS: CELL TO MATRIX JUNCTION

Focal adhesion is a **cell to matrix junction** that is junction between the cell and the extracellular matrix. The connection occurs through the actin filaments. This type of junction is seen in epithelia of various organs. Proteins involved in this junction are integrins.

3. DESMOSOME: CELL TO CELL JUNCTION

Desmosome is also **cell to cell junction**, but here the membranes of the cells are thickened and connected by intermediate filaments. So, desmosome functions like tight junction. This type of junction is found in areas subjected for stretching such as the skin. Proteins involved in this junction are cadherins.

4. HEMIDESMOSOME: CELL TO MATRIX JUNCTION

Hemidesmosome is also **cell to matrix junction** and the connection is through intermediate filaments. It is like half desmosome because here, the membrane of only one cell thickens. So, this is known as hemidesmosome or half desmosome. Mostly, the hemidesmosome connects the cells with their basal lamina. Proteins involved in this junction are integrins **(Table 2.1)**.

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K Sembulingam PhD is a renowned person in the field of Physiology. He has a long and vast experience of teaching Physiology to undergraduate and postgraduate medical students in various institutions in India and abroad. He had served MR Medical College, Kalaburagi, Karnataka, India; Sri Ramachandra Medical College and Research Institute, Chennai, Tamil Nadu, India; School of Health Sciences, Universiti Sains Malaysia, Kelantan, Malaysia; Sri Lakshmi Narayana Institute of Medical Sciences, Puducherry, India; Sri Manakula Vinayagar Medical College and Hospital, Puducherry, India; Shri Sathya Sai Medical College and Research Institute, Nellikuppam, Tamil Nadu, India; and Madha Medical College and Research Institute, Chennai, Tamil Nadu, India.

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