GENERAL HISTOLOGY

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PhD. Oral Pathology

INTRODUCTION

Cells:

The smallest living unit of organization in the body is the cell, because each cell is capable of performing any necessary functions without the aid of other cells (Figures 1 and 2, Table 1). Each cell has a cell membrane, cytoplasm, organelles, and inclusions. Thus, every cell is a world unto itself (like a small gated city) surrounded by a boundary, having "factories" and other "industries" that make it almost self-sufficient.

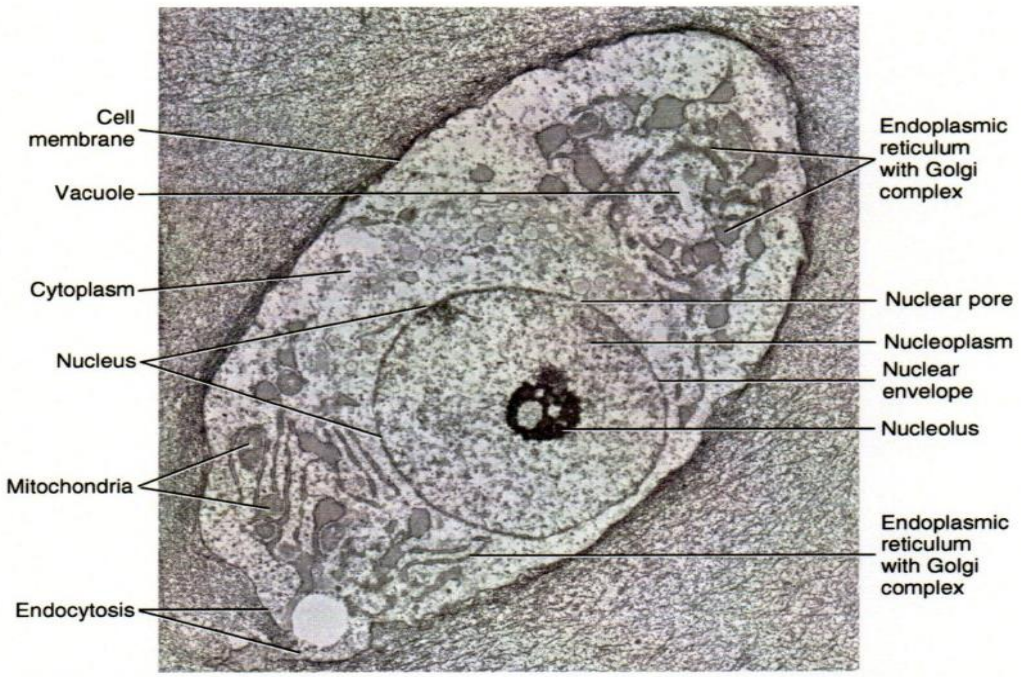

Figure 1. Electron micrograph of the cell and its most visible contents, such as its cell membrane and nucleus.

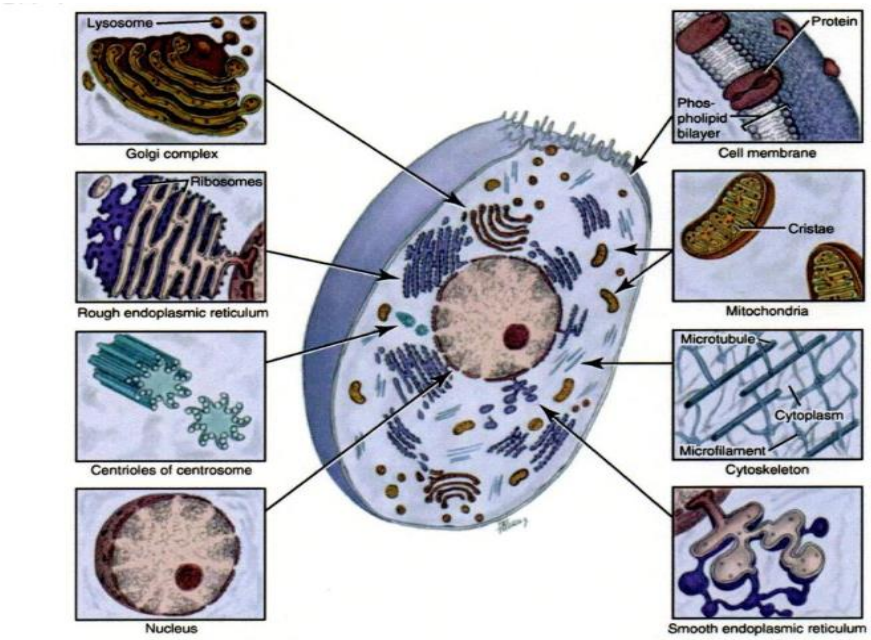

Figure 2. The cell with its organelles and cell membrane examined.

Table 1. Body Components

Body Components	Features
Cell	Smallest living unit of organization: epithelial cell, neuron, myofiber, chondrocyte, osteocyte, fibroblast, erythrocyte, macrophage, sperm
Tissue	Collection of similarly specialized cells: epithelium, nervous tissue, muscle, cartilage, bone, connective tissue, blood
Organ	Independent body part formed from tissue: skin, brain, heart, liver
System	Organs functioning together: central nervous system, respiratory system, immune system, cardiovascular system

Cells also interact with one another similar to how a city interacts with other cities. Cells with similar characteristics of form and function are grouped together to form a tissue, analogous to how states are then formed from cities having a common goal (see Table 1).

Thus, a tissue is a collection of similarly specialized cells, which are most often surrounded by extracellular materials. Various tissue types are then bonded together to form an organ, a somewhat independent body part that performs a specific function or functions, similar to countries formed from like-minded states. Organs can further function together globally as a system.

Cells in a tissue undergo cell division to reproduce and replace the dead tissue cells. As a result of the division process, two daughter cells that are identical to each other and to the original parent cell are formed. This process consists of different phases, in regard to the different components of the cell.

However, cells also interact with the extracellular environment in many ways. Cells can perform exocytosis, which is an active transport of material from a vesicle within the cell out into the extracellular environment. Exocytosis occurs when there is fusion of a vesicle membrane with the cell membrane and subsequent expulsion of the contained material.

The uptake of materials from the extracellular environment into the cell is endocytosis. Endocytosis can take place as an invagination of the cell membrane. Endocytosis can also take the form of phagocytosis, which is the engulfing and then digesting of solid waste and foreign material by the cell through enzymatic breakdown of the material.

Cell Anatomy

The cell membrane (or plasma membrane) surrounds the cell (see Figures 1 and 2). Despite its fragile microscopic structure, it is a tough and resourceful "gatekeeper" for the cell's interior. The cell membrane is associated with many of the mechanisms of intercellular junctions and other functions of the cell.

The cytoplasm includes the semifluid part contained within the cell membrane boundary, as well as the skeletal system of support or cytoskeleton. The cytoplasm contains not only a number of structures but also cavities or vacuoles.

Organelles

The organelles are metabolically active specialized structures within the cell (see Figures 1 and 2). The organelles allow each cell to function according to its genetic code. Organelles also subdivide the cell into compartments. The major organelles of the cell include the nucleus, mitochondria, ribosomes, endoplasmic reticulum, Golgi complex, lysosomes, and the cytoskeleton.

Inclusions

The cell also contains inclusions, which are metabolically inert substances that are also considered transient over time in the cell (see Figure 2). These include masses of organic chemicals and often are recognizable microscopically. These inclusions are released from storage by the cell and used as demand dictates. Lipids and glycogen can be decomposed for energy from inclusions in the cell. Melanin is stored as inclusions in certain cells of the skin and oral mucosa and is responsible for the pigmentation of these tissue types. Inclusions also include residual bodies, which are spent lysosomes and their digested material.

Cell Division

Cell division or mitosis is a complex process involving many of the organelles of the cell. Mitosis functions during tissue growth or regeneration, and its activity is dependent on the length of the individual cell's lifespan.

Extracellular Materials

The cells in each tissue type are surrounded by extracellular materials, which include both tissue fluid and intercellular substance. Tissue fluid (or interstitial fluid) provides a medium or matrix for dissolving, mixing, and transporting substances and for carrying out chemical reactions. Similar to blood plasma in its content of ions and diffusible substances, tissue fluid contains a small amount of plasma proteins.

Tissue fluid enters the tissue to surround the cells by diffusing through the capillary walls as a filtrate from the plasma of the blood. Tissue fluid then drains back into the blood as lymph through osmosis, via the lymphatics. The amount of tissue fluid varies from tissue to tissue, with smaller variations occurring over time within any one tissue.

An excess amount can accumulate when an injured tissue undergoes an inflammatory response, leading to edema with its tissue enlargement. ***Intercellular substance*** (or ground substance) is shapeless, colorless, and transparent material in which the cells of a tissue are imbedded; it also fills the spaces between the cells in a tissue.

The intercellular substance serves as a barrier to the penetration of foreign materials into the tissue as well as a medium for the exchange of gases and metabolic substances.

The surrounding cells produce the intercellular substance, and one of its most common elements is hyaluronic acid.

Intercellular Junctions

Certain cells in varying tissue are joined by the mechanism of intercellular junctions. These are mechanical attachments formed between cells, and also between cells and adjacent noncellular surfaces. With the formation of these intercellular junctions, the cell membranes of different cells come close together but do not completely attach. Higher-power magnification is needed to visualize these attachments, which appear as dense bodies. All intercellular junctions involve some sort of intricate attachment device. The attachment device includes an attachment plaque that is located within the cell as well as adjacent tonofilaments.

An intercellular junction between cells is formed by a desmosome, such as that present in the superficial layers of the skin or oral mucosa (Figure 3).

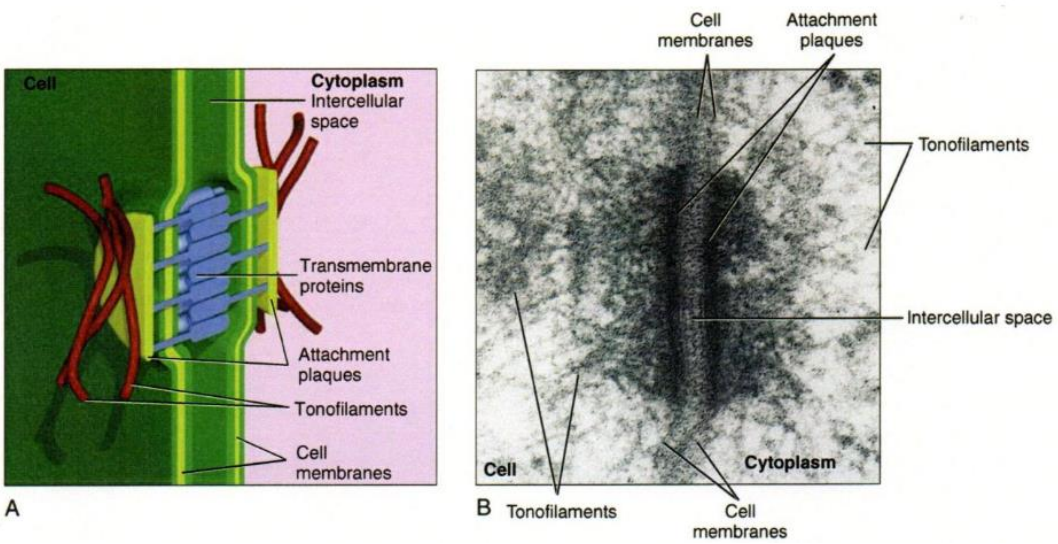

Figure 3. Intercellular junction between cells via a desmosome. A, Diagram. B, Electron micrograph. The cell adhesion between cell membranes is mediated by transmembrane proteins.

The desmosomal junctions are also released during tissue turnover and then become reattached in new locations as the cells migrate, such as during repair after an injury to the skin or oral mucosa (see Figure 3 in Lecture 3).

Another type of intercellular junction is formed by a hemidesmosome, which involves an attachment of a cell to an adjacent noncellular surface (Figure 4). This type of attachment is used for attaching the epithelium to connective tissue, such as with the basement membrane in the skin and oral mucosa (see Figure 4 in Lecture 3).

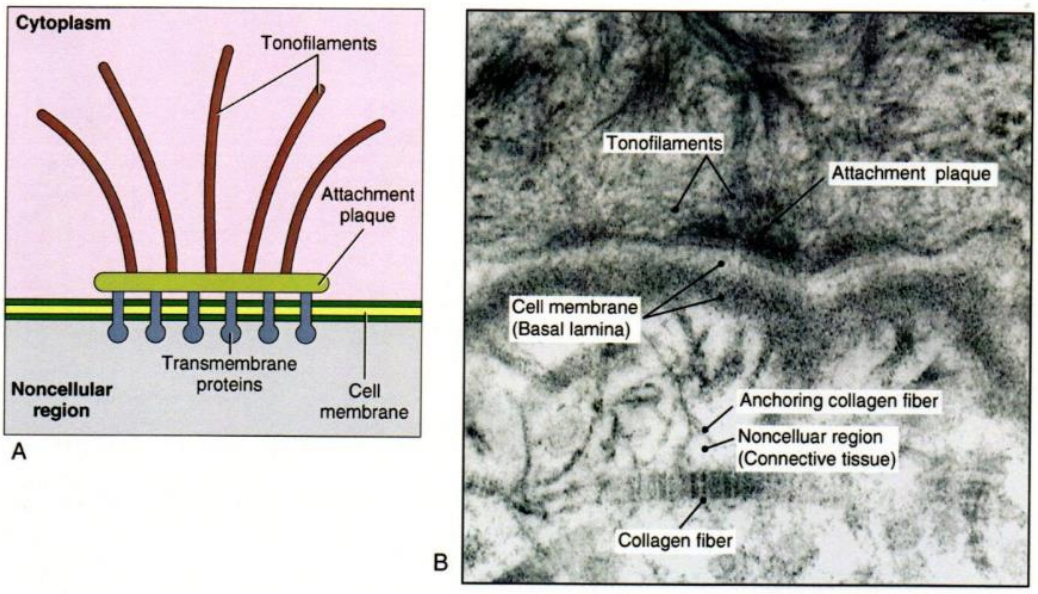

Figure 4. Intercellular junction between a cell with its cytoplasm and noncellular surface via a hemidesmosome. A, Diagram. B, Electron micrograph. The attachment of cells is to an adjacent noncellular surface is by the adhesion of the noncellular surface mediated by transmembrane protein.

The attachment device of a hemidesmosome represents half of a desmosome because it involves a smaller attachment plaque and has tonofilaments from only the cellular side. Thus, it appears as a thinner disc because the noncellular surface cannot produce the other half of the attachment mechanism. Hemidesmosomes are also involved as a mechanism allowing gingival tissue to be secured to the tooth surface by the epithelial attachment, which is similar to the attachment between the nails and adjoining nail beds.