Unit 1 Lecture 3

TISSUE LEVEL OF ORGANIZATION

TYPES OF TISSUES AND THEIR ORIGINS

A tissue is a group of similar cells that usually have the same embryological origin and are specialized for a particular function. In a tissue surrounding the cells is fluid called extracellular fluid. There are two types of extracellular fluid: interstitial fluid and plasma. Plasma is found in the blood stream and serves as a transport medium for the blood cells. In addition plasma carries nutrients, proteins, electrolytes, gases and wastes. Tissues are composed of cells connected together and to the extracellular matrix.

- Epithelial tissue is a specific type of tissue that covers body surfaces, lines hollow organs, body cavities, and ducts; forms glands.
- Connective tissue: protects and supports the body and its organs; binds organs together; stores energy reserves as fat; provides immunity.
- Muscle tissue: excitable cells responsible for movement and generation of force.
- Nervous tissue: excitable cells that initiate and transmit action potentials that help coordinate body activities.

CELL JUNCTIONS are points of contact between adjacent plasma membranes that hold cells together. One type is a tight junction that forms fluid tight seals between cells. These are common in epithelial cells that line the GI tract and the urinary bladder. Another type is anchoring junctions (desmosomes) that fasten cells to one another or to extracellular material. They are found in tissues subjected to friction and stretching (muscle tissue of the heart). Lastly are communicating or gap junctions which permit electrical or chemical signals to pass from cell to cell. These were once thought to only be found in heart muscle and smooth muscle of the GI tract, but recent research has found them to important in many types of cell-to-cell communication.

COMMUNICATION and SIGNAL PATHWAYS

Research in recent years has focused on communication and signaling system between the cells in the body. Our bodies employ four methods for cellular communication:

- gap junctions that allow direct cytoplasmic transfer of electrical and chemical signals between adjacent cells;
- contact dependent signals that occur when surface molecules on one cell bind to those on another cell;
- local communication by chemicals that diffuse through extracellular fluid; and
- long-distance communication through a combination of electrical and chemical signals.

The simplest form of communication is through gap junctions which are no more than protein channels. When open ions, small molecules, ATP, and electrical signals diffuse from one cell to the next. Paracrines and autocrines are secreted by cells to act on the cell that secreted it or on cells in its immediate vicinity. If the paracrine acts on the cell that secreted it, it is known as an autocrine. All cells in the body can release paracrines.

Long distance communication is controlled by the nervous and endocrine systems which can act by themselves or in concert together. The endocrine system communicates through hormones. The hormone travels to a cell that has receptors to the hormone. The nervous system uses a combination of electrical and chemical signals to communicate. A neurotransmitter is a chemical that acts rapidly over a short distance. A neurohormone is a chemical that is release into the bloodstream and travels a distance to the target cell. A target cell is a cell that contains the specific receptor to the chemical signal.

Signal Pathways

Signal pathways share these features:

- signal molecule binds to its receptor and is known as the **first messenger** because it bring the information to the cell.
- the binding process activates the receptor.
- the receptor activates one or more internal signal molecules **(second messengers)**.
- the last signal molecule initiates synthesis of a target protein or modifies a target protein to create a response.

Chemical signal molecules are either lipophilic (they like lipids) or they are lipophobic (they don't like lipids). Target receptors are located on the cell membrane, in the cytoplasm, or in the nucleus. If the signal is lipophilic it will diffuse across the membrane and bind to receptors in the cytoplasm or in the nucleus. When this happens a gene is usually turned on and a new protein is made. This is a slow process and usually involves hormones. Lipophobic signals cannot penetrate the cell membrane. However, their binding to receptors initiates pathways that are very rapid in response time. About half of all drugs use receptor proteins. Signal transduction pathways use membrane proteins and intracellular second messenger molecules to translate signal information into intracellular response. Some signal transduction pathways activate protein kinases; others activate amplifier enzymes that act as second messengers. The two most common second messenger pathways are cAMP (cyclic AMP) and cGMP (cyclic GMP). The most rapid signal pathways change ion flow through channels by binding and then opening a gate creating an electrical signal.

Some unique signal molecules are calcium which serves as an important intracellular signal and some gases such as NO and CO.

The response of a cell to a signal molecule is determined by the cell's receptor for the signal. Receptor proteins exhibit specificity, competition, and saturation. A receptor may have multiple ligands. Agonists are ligands that turn on receptors and thus mimic a signal molecule. Antagonists block the signal pathway. Transport activity can be maxed out because cells have a limited number of protein molecules as receptors. The cell can respond by inserting more receptors into the membrane by exocytosis. This is known as up-regulation. The cell can also down-regulate the number of receptors by removing them through endocytosis. Cells will up or down-regulate to keep its response at normal levels. In addition all cells have mechanisms in place to terminate the signal pathway. Many diseases are linked to problems with signal pathways.

Epithelial Tissue

Epithelial tissue is composed mostly of cells with little extracellular material and these cells are closely packed together and are arranged in continuous sheets in one or multiple layers. The apical surface is exposed to body cavity, lining of an internal organ or the exterior of the body and a basal surface which is attached to the basement membrane (two layers: basal and reticular lamina). Numerous cell junctions are present to secure cells to each other. Epithelial tissue is avascular (not supplied by blood vessels). It gets nutrients and removes wastes by diffusion. Epithelial tissue can be renewed easily and has a nerve supply.

The functional classification of epithelial tissue includes protection, filtration, lubrication, secretion, digestion, absorption, transportation, excretion, sensory reception, and reproduction. Arrangement of cells can be simple (one layer), stratified (cells stacked), or pseudostratified. The shapes can be squamous (flattened and scale like), cuboidal (cube shaped), columnar (tall and cylindrical), or transitional. Each type found has a different function. For example, simple squamous epithelium functions in filtration and diffusion. Simple cuboidal epithelium and non-ciliated simple columnar epithelium function in secretion and absorption. Ciliated columnar epithelium move fluids or particles along passageways by ciliary action. Stratified squamous and cuboidal epitheliums provide protection. Whereas stratified columnar epithelium provides both protection and secretion. Transitional epithelium permits distention. Pseudostratified columnar epithelium allows secretion and movement of mucous by ciliary action.

Glandular Epithelium

Exocrine glands secrete their products into ducts and are either unicellular or multicellular. Functional types include holocrine glands (oil gland of the skin), merocrine gland which discharge product by exocytosis, and apocrine glands (mammary glands).

The endocrine glands are ductless; secrete products (hormones) into extracellular fluid and into blood.

Connective Tissue

Connective tissue is the most abundant body tissue in the body. It consists of cells, ground substance and fibers which form a matrix. It does not occur on free surfaces. Except for cartilage and tendons, it has a nerve supply and usually has a good blood supply. Fixed cells are responsible for local maintenance, tissue repair, and energy storage. The mobile cells of connective tissue are responsible mainly for defense. The connective tissue matrix is comprised of ground substance and fibers. The fibers in the matrix provide the support and strength for tissues. Types of fibers include collagen fibers, elastic fibers, and reticular fibers.

Types of connective tissue cells found in the body include fibroblasts (which secrete the molecules that form the matrix), macrophages (which are derived from a monocyte and used to phagocytize other dead cells), plasma cells (which make and secrete antibodies), mast cells (which produce histamine), adipocytes (fat cells) and leukocytes (white blood cells).

Types of Mature Connective Tissue:

- loose connective tissue: fibers loosely woven
- areolar connective tissue: widely distributed in the body, combined with adipose tissue, it forms the subcutaneous layer
- adipose tissue, composed of adipocytes which store fats
- reticular connective tissue: helps to bind together the cells of smooth muscle
- dense connective tissue: contains more fibers and less cells than loose connective tissue
- dense regular connective tissue: provides strong attachment between various structures (tendons and ligaments)
- dense irregular connective tissue: provides strength (fasciae)
- elastic connective tissue: allows stretching off various organs (lungs)
- Cartilage: Hyaline cartilage is the most abundant type of cartilage in the body. In muscle tissue it is the gristle. It affords flexibility and support, reduces friction and absorbs shock. Fibrocartilage provides support and fusion. Elastic cartilage gives support, yet maintains shape (epiglottis).
- Bone tissue (osseous)
- Blood (vascular tissue)
- Muscle tissue: has the ability to contract and is excitable.
- Nervous tissue has two types of cells: neurons and glial cells

Membranes

Membranes are flat sheets of pliable tissue that cover or line a part of the body. They are comprised of an epithelial layer and an underlying connective tissue layer. Mucous membranes line a body cavity that opens directly to the outside such as found in the digestive and respiratory tracts. A serous membrane lines a cavity that does not open directly to the exterior of the body. The layer that attaches to the cavity wall is the parietal layer whereas the layer that attaches to the organs is the visceral layer. Finally, the cutaneous membrane is the organ we call skin.

Why is this chapter important?

A tissue is a group of similar cells that has a common embryonic origin and function together. We learned of the four types of tissue (epithelial, connective, muscular, and nervous). The cellular junctions were described in this chapter are important because they link the cells together. Epithelial coverings were described based on cell shape and arrangement. We looked at the different types of connective tissue and the types of cells which compose connective tissue. We observed that muscular and nervous tissue are excitable and are able to respond to certain stimuli.