Tissues (Script)

Slide 2

Tissues are a collection of specialized cells that function together. They are formed by **cells** and **matrix**.

The **matrix** is the non-living, extracellular material that surrounds the cells. It is composed of **protein fibers** and a clear, gel-like **ground substance**.

There are 4 categories of tissues: **epithelial, connective, muscle**, and **nervous**.

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Epithelial tissue usually lines surfaces. It is **avascular** (no blood supply) and has tightly packed cells with very little to no space (matrix) between the cells. The cells are also **highly mitotic**, meaning that they reproduce rapidly. Epithelial tissue also has a **basement membrane** at its deepest point. The basement membrane is a layer of large, complex molecules (such as collagen adhesive molecules and proteins) between epithelial tissue and the underlying tissue. It helps to anchor the epithelial tissue. Epithelial tissues also have an apical surface, which is the most superficial surface of the tissue opposite of the basement membrane.

Epithelial tissues can have various functions:

1. Protection, such as the outer layer of the skin.
2. Secretion, such as the digestive enzymes secreted from the inner lining of the small intestine.
3. Excretion, such as the cells that line the kidney tubules excreting waste products into what is ultimately going to be urine.
4. Absorption, such as the cells lining the small intestine.
5. Filtration, such as the cells that line the blood vessels in the kidney that allow material to be filtered out of the blood.
6. Sensation, such as cells in the lining of the skin that are sensitive to stimulation.

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Epithelial tissues are classified based on two characteristics: **cell shape** and **number of layers of cells** between its basement membrane and its apical surface. Cell shapes include **squamous** (flat), **cuboidal** (plump or boxy), and **columnar** (tall and narrow). Layers are either **simple** (one layer) or **stratified** (two or more layers). The columnar-shaped cells can also have a unique layering called **pseudostratified**, in which each cell rests upon the basement membrane (simple), but some cells 'lean over' others to create the impression that there are 2 or more layers (stratified).

Transitional epithelial tissue is a separate classification that can vary in its cell shape, depending on whether the tissue is being compressed (squamous appearance) or not (cuboidal appearance).

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The top row shows simple vs. stratified. The top left is an example of simple, where every cell touches the basement membrane. If you notice in the middle picture, not all of the cells reach the apical surface, but every one touches the basement membrane. This is an example of pseudostratified epithelial tissue. It looks like the cells are stacked, but technically, every cell touches the basement membrane. The top right shows stratified. Only one layer touches the basement membrane and all other cells are stacked in layers on top of that bottom, or basal, layer. The second row shows the various shapes: squamous on the left, cuboidal in the middle, and columnar on the right.

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Connective tissue consists mostly of non-living **matrix** (protein fibers and ground substance) with widely spaced cells. This greatly contrasts to epithelial that has little fibers and ground substance and cells tightly packed together.

It also differs from epithelial tissue in that it is **vascular** (has a blood supply).

Connective tissue has many functions, but mainly it does what the name implies, connect. Connective tissue is used in the:

1. Binding of organs, or enclosing of the organs
2. Support of the body, keeping us upright
3. Physical protection of vital organs, as in how the skull protects the brain
4. Immune protection, for example, the White Blood cells that look for infectious microorganisms
5. Movement, our bones are levers for the muscles to act on
6. Energy storage, in the form of lipids
7. Heat production and temperature regulation
8. Transportation of nutrients and gases via the blood

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There are five major classifications of connective tissue: **fibrous, adipose, cartilage, bone**, and **blood**.

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There are a number of different cell types found in **fibrous** connective tissue:

1. **Fibroblasts** produce the fibers and ground substance.
2. **Mast cells** are found along blood vessels and secrete hormones that regulate blood flow and clotting.
3. **Macrophages** are specialized white blood cells that ingest and help get rid of particles and infectious microorganisms.
4. **Leukocytes** are white blood cells that play various protective roles.

5. **Plasma cells** are specialized white blood cells that help with immunity.

6. **Adipocytes** are fat-storing cells.

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The **matrix**, or the non-living material around the cells, has **fibers** and **ground substance**.

Fibers are found in three forms.

1. **Collagenous** are made of the protein collagen. Collagen is one of the most abundant proteins in the body. It is tough and flexible and resists stretching.

2. **Reticular** have thin collagen fibers. They often form a sponge-like lattice.

3. **Elastic** are made of the protein elastin. They are capable of stretching but also recoiling back to their original state once released.

Ground Substance is usually featureless and has a gelatinous, rubbery consistency. It helps absorb compressive forces and protects the cells.

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One type of fibrous connective tissue is called **areolar** tissue. Areolar has a loose arrangement of collagenous and elastic fibers, scattered cells of various types, lots of ground substance and blood vessels. It is found underlying nearly all epithelial tissue and surrounds blood vessels and nerves. It functions to loosely bind epithelial tissue to its surface and provides blood and nutrients for epithelial tissue.

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Reticular also has a loose arrangement of fibers, mainly reticular fibers. In addition, there are numerous lymphocytes and other blood cells. It is found in the lymph nodes, spleen, and bone marrow and functions as a supportive sponge-like network for the lymphatic system. The arrangement of fibers allows for filtering of lymphatic fluid.

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A third type of fibrous connective tissue is **dense regular**. It is characterized by few cells, but numerous collagen and elastic fibers. Fibers occupy more space than cells or ground matrix, so the fibers really stand out. Dense regular has an organized, wavy pattern. This is how it gets its name, the fibers are densely packed together, but in an organized, parallel manner. This particular arrangement resists stress in one direction. It is found in ligaments and tendons.

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A fourth type of fibrous connective tissue is **dense irregular**. Dense irregular also has few cells and a lot of collagen fibers, but the fibers are not organized, they are all over the place. This arrangement of fibers resists stress in multiple directions. Dense irregular is found in the dermis of the skin.

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Adipose tissue is a second major type of connective tissue. It consists primarily of closely-packed **adipocytes** (fat cells). The cells store triglycerides, which provide energy, thermal insulation, and protective cushioning. Adipose tissue can be found at the base of the skin, in the tissues of the breasts, and around some internal organs.

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Cartilage has a stiff, rubbery matrix, which gives cartilage its structural characteristics. Within this matrix are **chondrocytes** (cartilage cells). Cartilage is the only connective tissue that is avascular. There are three forms: hyaline, elastic, and fibrocartilage

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Hyaline cartilage has a glassy-like appearance, due to its fine collagen fibers. It is used at the end of bones to reduce friction, as part of the trachea and larynx of the respiratory system, and is used to make up most of the fetal skeleton.

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Elastic cartilage has some elasticity to it due to having both elastin and collagen fibers. It is used for the external ear and the epiglottis in the throat.

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Fibrocartilage has coarse collagen fibers that provide more toughness than the other fibers. It is used in areas that need more long-term durability due to stress, such as the discs between the vertebrae, the menisci pads within the knee joints, and the pubis symphysis found where the hip bones join.

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Bone tissue is the fourth major type of connective tissue. It contains **osteocytes** (bone cells) surrounded by a matrix that is both strong (due to minerals) and flexible (due to collagen fibers). Bone tissue provides support for softer tissues, leverage for muscles to generate movement, protection of some internal organs, and storage of minerals such as calcium and magnesium needed by other areas of the body. This tissue makes up the bones (organs) of the skeleton.

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Blood is the fifth major classification of connective tissue. It has a liquid matrix that surrounds cells and cell-like structures known collectively as **formed elements**. These include red blood cells, white blood cells, and platelets. Because it has a liquid matrix, blood can be circulated to help transport substances such as nutrients and wastes around the body. It also contains material that aids in protection from infection, such as antibodies. Blood is found in the chambers of the heart and in the hollow lumens of the blood vessels.

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Nervous tissue is used to transmit electrical signals within the body for communication. **Neurons** are the highly-excitable cells that transmit these signals, and **neuroglia** are the cells that support the

neurons in some way. Nervous tissue can be found in the brain, spinal cord, and nerves. We will discuss nervous tissue in more detail at a later time.

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Muscle tissue is used to cause movement. **Myocytes** (muscle cells) are elongated and highly-excitable. They can contract (shorten) when excited, leading to movements of the body and/or movement of substances within the body. There are three types of muscle tissue: **skeletal, cardiac**, and **smooth**. Muscle tissue is found within the skeletal muscles (skeletal), the heart (cardiac), and the walls of various internal organs (smooth). We will discuss muscle tissue in greater detail at a later date.

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Glands are cells or organs that secrete substances for use elsewhere in the body (secretion) or for elimination of a waste product (excretion).

Exocrine glands use tube-like structures called ducts to secrete or excrete their products to a nearby surface. Sweat glands and salivary glands are examples. **Endocrine glands** secrete their products into the bloodstream for transport to another cell. These products are called hormones.

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A **membrane** is a flat sheet or layer made up of several tissues working closely together. There are a few different types.

The first type is a **mucous membrane**. Mucous membranes line passages that open to exterior of the body. For example, the digestive, respiratory, reproductive, and urinary tracts.

There are 3 layers: epithelium (the type of epithelial tissue varies based on the organ and system), areolar, and this membrane actually has a layer of smooth muscle to help move things along. This membrane functions in absorption, secretion, and protection. Goblet cells are often found in this membrane for the production of mucus.

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The **serous membrane** is simple squamous epithelial over a thin layer of areolar tissue. It produces serous fluid which is a watery fluid that lubricates. It is found on organs and lines/surrounds cavities. The fluid produced by the serous membrane helps reduce friction as organs can rub against each other when they move. This membrane lines cavities that are not exposed to external environments. It is found in the lining of 3 primary body cavities, as well as the pleural and pericardial cavities which are smaller cavities inside the thoracic cavity. The membrane has two layers, the parietal layer and the visceral layer. The parietal layer contacts the wall of the cavity, and the visceral layer contacts the organ.

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SYNOVIAL MEMBRANE

This membrane is made only of connective tissue and is associated with joints. It secretes synovial fluid which helps to protect and lubricate joints. We'll see this one again when we discuss joints.

ENDOTHELIUM

The endothelium lines the vessels of the circulatory system. It is made of simple squamous epithelial tissue resting on a thin layer of areolar connective tissue. Because it is so thin it allows for exchange of nutrients and gases from the blood to the surrounding tissues. Again, we'll talk about this one later on in the semester when we discuss the cardiovascular system.

CUTANEOUS MEMBRANE

This is commonly know as skin and we will actually be discussing this in the next module.