

Classification of Tissues

Introduction:

As mentioned earlier, cells are the smallest units of life. In complex organisms, cells group together with one another based on similar structure and function to form **tissues**. Tissues provide the numerous functions of organs necessary to maintain biological life. This lab exercise seeks to introduce the various tissues found in the human body and to familiarize you with their composition and function. The study of tissues is called **histology**, and is important to the understanding of how the human body is able to function as a unit.

Classifications of Tissues:

The human body is composed of four basic types of tissues; **epithelium**, **connective**, **muscular**, and **nervous** tissues. These tissues vary in their composition and their function. A basic understanding of the role of each tissue makes understanding the specific functions easier.

1. Epithelium- lines and covers surfaces
2. Connective tissue- protect, support, and bind together
3. Muscular tissue- produces movement
4. Nervous tissue- receive stimuli and conduct impulses

Now that we have an understanding of the basic roles of the tissues, we turn our focus to a more thorough investigation of the form and function of the different types of tissues in the human body.

Epithelium:

Epithelium forms the coverings of surfaces of the body. As such, it serves many purposes, including protection, adsorption, excretion, secretion, filtration, and sensory reception. When considering the characteristics that make a tissue epithelium, it is important to think about the following:

- Polarity- Epithelium is arranged so there is one free surface (**apical surface**) and one attached surface (**basal surface**)
- Cellular nature- Cells in epithelium fit closely together side by side and sometimes atop each other to form sheets of cells. These sheets are held together by specialized junctions.
- Supported by connective tissue- Attachment to a layer of connective tissue at the **basal surface** forms a layer called the **basement membrane**, an adhesive layer formed by secretions from the epithelial cells and the connective tissue cells.
- **Avascular**- Epithelium typically lacks its own blood supply.
- Regeneration- Epithelium cells can regenerate if proper nourished.

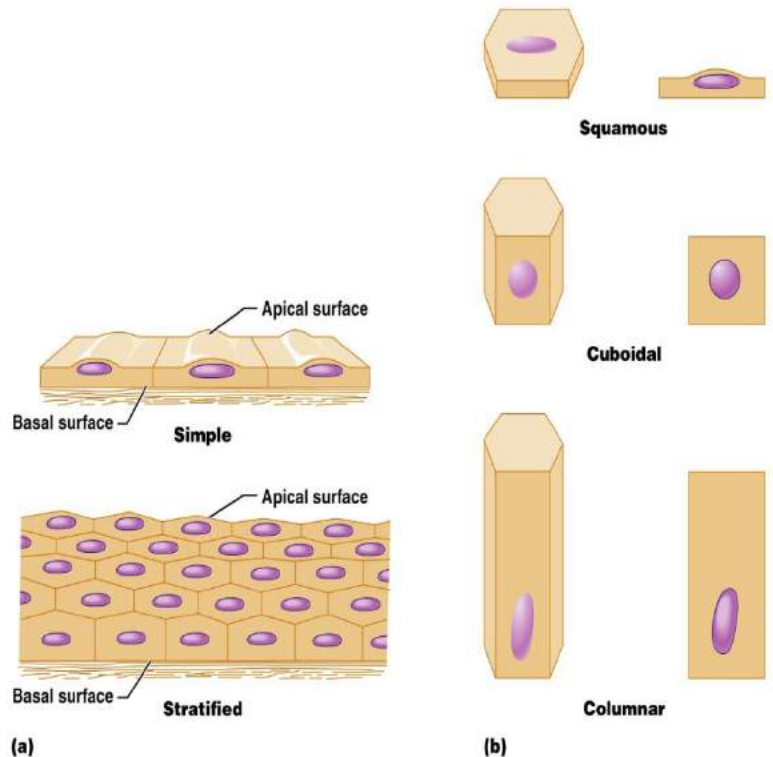
Classification of epithelium is based on the shape of the cells and the arrangement of the cells within the tissue. Typically, the arrangement of the cells is stated first, then the shape, and is followed by “epithelium” to complete the naming (Ex. Simple Squamous Epithelium).

Arrangements:

- **Simple**- Cells are found in a single layer attached to the basement membrane
- **Stratified**- Cells are found in 2 or more layers stacked atop each other
- **Pseudostratified**- a single layer of cells that appears to be multiple layers due to variance in height and location of the nuclei in the cells.
- **Transitional**- cells are rounded and can slide across one another to allow stretching

Shapes:

- **Squamous**- (Latin, *squama*- scale)- flat, thin, scale-like cells
- **Cuboidal**- cells that have a basic cube shape. Typically the cell's height and width are about equal.
- **Columnar**- tall, rectangular or column-shaped cells. Typically taller than they are wide.



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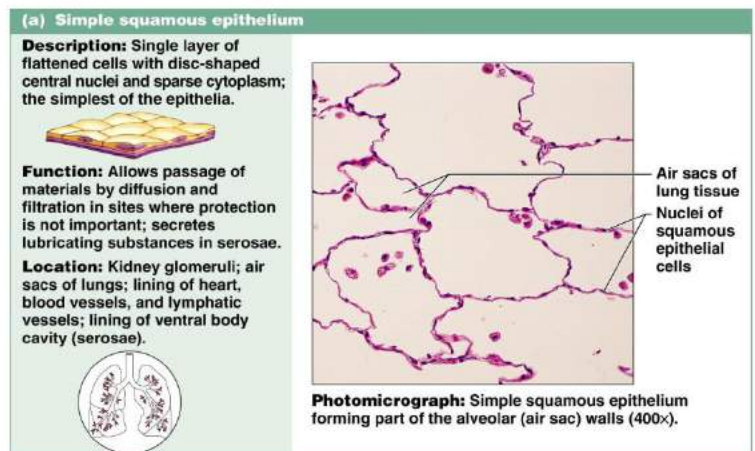
Special Features of Epithelium:

- **Cilia**- (singular= cilium, Latin= eyelash)- hair-like appendages attached to the apical surface of cells that act as sensory structures or to produce movement.
- **Goblet cells**- specialized cells that produce mucus to lubricate and protect the surface of an organ
- **Villi**- (singular= villus, Latin= shaggy hair)- finger-like projections that arise from the epithelial layer in some organs. They help to increase surface area allowing for faster and more efficient adsorption.
- **Microvilli**- smaller projections that arise from the cell's surface that also increase surface area. Due to the bushy appearance that they sometimes produce, they are sometimes referred to as the **brush border** of an organ.

Observing Epithelial Tissue:

Simple Squamous Epithelium:

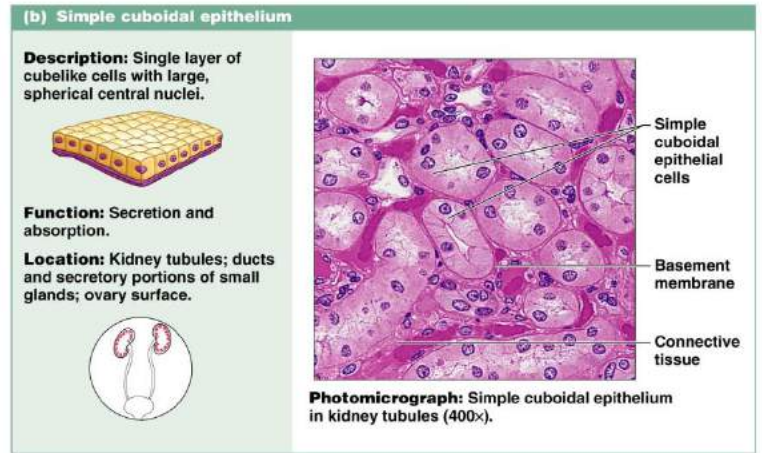
1. Obtain a slide of the lung.
2. Using proper technique, mount the slide on the stage and locate the tissue.
3. The lungs contain small air sacs called **alveoli** and these structures are composed of a single layer of flattened cells called simple squamous epithelium.
4. Notice that one surface is facing an open space to the inside of the air sac. This open space is referred to as the **lumen** (used to refer to any space or opening inside an organ or structure) and the cell surface facing it is the **apical surface**.
5. For additional images, click [HERE](#).



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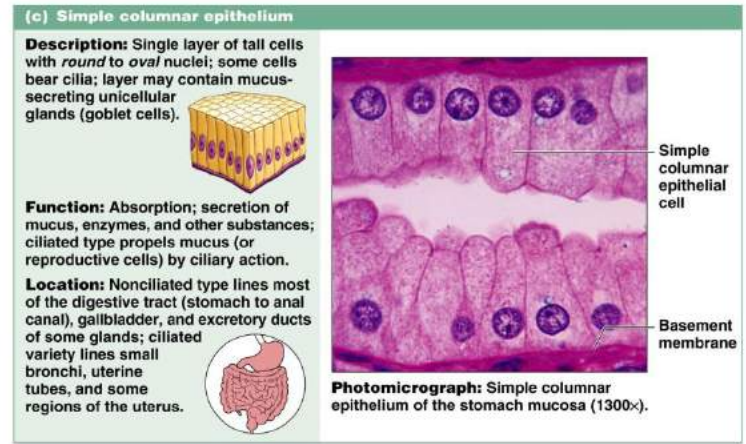
Simple Cuboidal Epithelium:

1. Obtain a slide of the kidney.
2. Using proper technique, mount the slide on the stage and locate the tissue.
3. The kidney tubules are composed of simple cuboidal epithelium and will appear as thick-walled circular structures scattered throughout the slide.
4. Again, notice the **lumen** in the center of each tubule and take note of the single layer of square cells surrounding it.
5. For additional images, click [HERE](#).



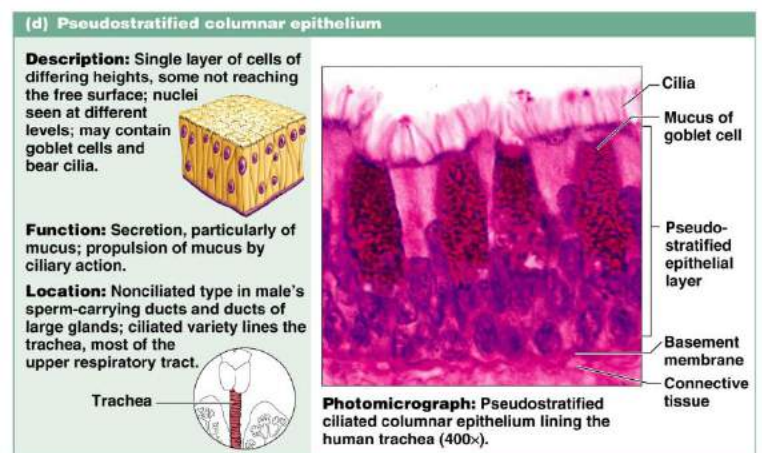
Simple Columnar Epithelium:

1. Obtain a slide of the intestine.
2. Using proper technique, mount the slide on the stage and locate the tissue.
3. Notice that the lining of the intestine is marked with finger-like projections hanging into the lumen. These structures are called **villi** and they act to increase the surface area of the intestine to encourage absorption.
4. The tissue lining the inside of the organ is simple columnar epithelium. Notice the large rectangular cells. You might also notice clear looking cells which are **goblet cells**. These cells produce mucus to lubricate and protect the lining of the intestine.
5. For additional images, click [HERE](#).



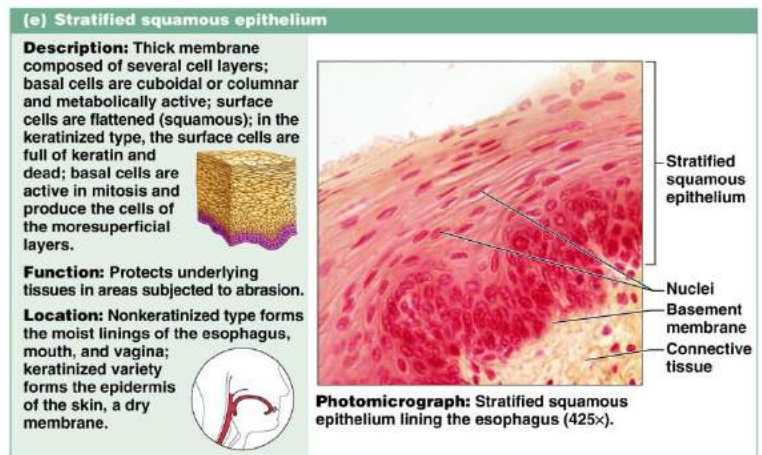
Pseudostratified Columnar Epithelium:

1. Obtain a slide of the trachea.
2. Using proper technique, mount the slide on the stage and locate the tissue.
3. The tissue lining the trachea is marked by the presence of goblet cells and is covered with tiny hair-like structures called **cilia**. The cilia act to trap debris and to distribute the mucus secreted by the goblet cells across the surface of the tissue.
4. Notice that the cells are irregularly shaped and that the nuclei of the cells are found in differing spots within the cells. This is what gives the tissue its false layered appearance. If you examine the tissue closely, you will see that a single cell stretches from the **apical surface** to the **basement membrane**.
5. For additional images, click [HERE](#).



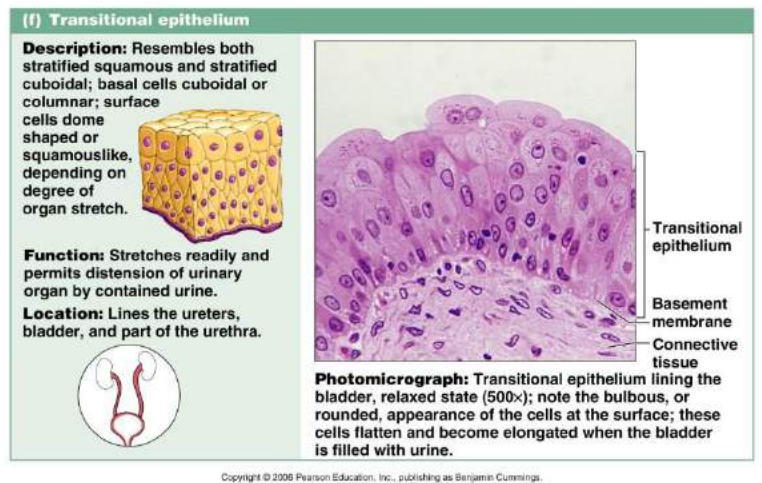
Stratified Squamous Epithelium:

1. Obtain a slide of the skin.
2. Using proper technique, mount the slide on the stage and locate the tissue.
3. The outer layer of the skin, the epidermis, is composed of multiple layers of flattened cells. As the cells are pushed higher, they flatten more and eventually die, composing the outer dead layers of the **epidermis**.
4. The cells die due to the loss of nutrients, whose source is located in the connective tissue underneath.
5. For additional images, click [HERE](#).



Transitional Epithelium:

1. Obtain a slide of the bladder.
2. Using proper technique, mount the slide on the stage and locate the tissue.
3. The inner lining of the bladder is composed of rounded cells that resemble a mix of cuboidal and columnar shaped cells. This is transitional epithelium. This tissue can stretch and distend when necessary without causing gaps or perforations in the lining.
4. For additional images, click [HERE](#).



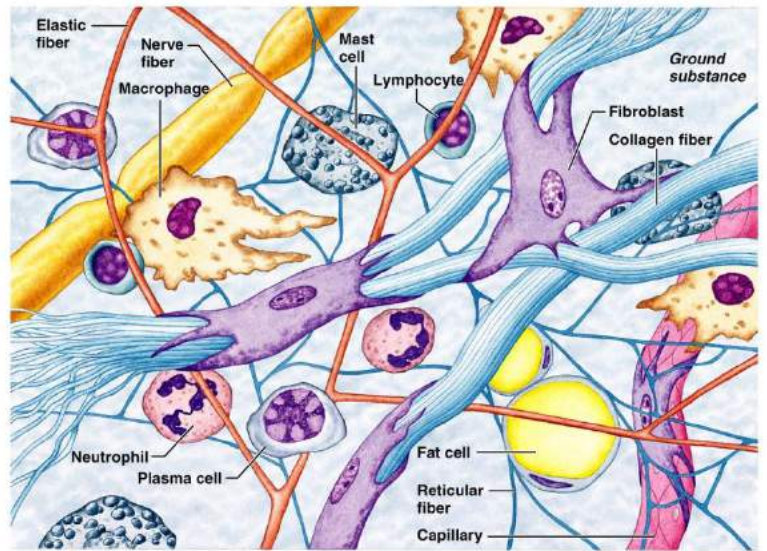
Connective Tissue:

Connective tissue is the most abundant and widely distributed tissue type found in the human body. The role of connective tissue is to protect, support, and bind together parts of the body. While other functions are attributed to connective tissues, these are the main ones and the ones we should focus on in our study. When considering the characteristics that make a tissue a connective tissue, we should consider the following:

- Connective tissues tend to be very **vascular** (have a rich blood supply). Some exceptions, such as tendons, ligaments, and cartilages, are less vascularized, but overall, connective tissues possess a great blood supply than the epithelial tissue previously discussed.
- Connective tissues are made up of many types of specialized cells.
- Connective tissues contain a large amount of non-living material referred to as the **matrix** (composed of **ground substance** and **fibers**). Typically, this material is manufactured and secreted by the cells of the specific connective tissues.

There are four types of connective tissues found in the human body:

1. Connective tissue proper
 - a. Loose Connective Tissue
 - i. **Areolar**
 - ii. **Adipose**
 - iii. **Reticular**
 - b. Dense Connective Tissue
 - i. **Dense regular**
 - ii. **Dense irregular**
 - iii. **Elastic**
2. Cartilage
 - a. **Hyaline**
 - b. **Elastic**
 - c. **Fibrocartilage**
3. **Bone (osseous tissue)**
4. **Blood**



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Observing Connective Tissues:

Areolar Tissue:

1. Obtain a slide of areolar tissue and proper mount it on the slide.
2. Notice as you examine the tissue that it is composed of a jumble of fibers and cells. Areolar tissue is a loose connective tissue type and has a very diffuse arrangement.
3. The cells (dark spots within the tissue) are called **fibroblasts** (fibro= fiber, blast= to make or create). These are the cells responsible for secreting the fibers present. The larger fibers (typically pink) are called **collagen fibers**. The small black fibers are **elastic fibers**. Collectively, the fibers and the rest of the substance surrounding the cells would be referred to as the **matrix**.
4. For additional images, click [HERE](#).

(a) Connective tissue proper: loose connective tissue, areolar

Description: Gel-like matrix with all three fiber types; cells: fibroblasts, macrophages, mast cells, and some white blood cells.

Function: Wraps and cushions organs; its macrophages phagocytize bacteria; plays important role in inflammation; holds and conveys tissue fluid.

Location: Widely distributed under epithelia of body, e.g., forms lamina propria of mucous membranes; packages organs; surrounds capillaries.

Photomicrograph: Areolar connective tissue, a soft packaging tissue of the body (400x).

Labels in diagram: Epithelium, Lamina propria.

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Adipose Tissue:

1. Obtain a slide of adipose tissue (or use a kidney or trachea slide).
2. Use proper technique to mount the slide and locate the tissue.
3. Adipose tissue appears as large, irregular, bubble-like cells lumped together.
4. The cells that you are observing are suspended in a matrix similar to the previous slide. The cells themselves are filled with fat, which is used as stored energy, insulation, and protection.
5. For additional images, click [HERE](#).

(b) Connective tissue proper: loose connective tissue, adipose

Description: Matrix as in areolar, but very sparse; closely packed adipocytes, or fat cells, have nucleus pushed to the side by large fat droplet.

Function: Provides reserve food fuel; insulates against heat loss; supports and protects organs.

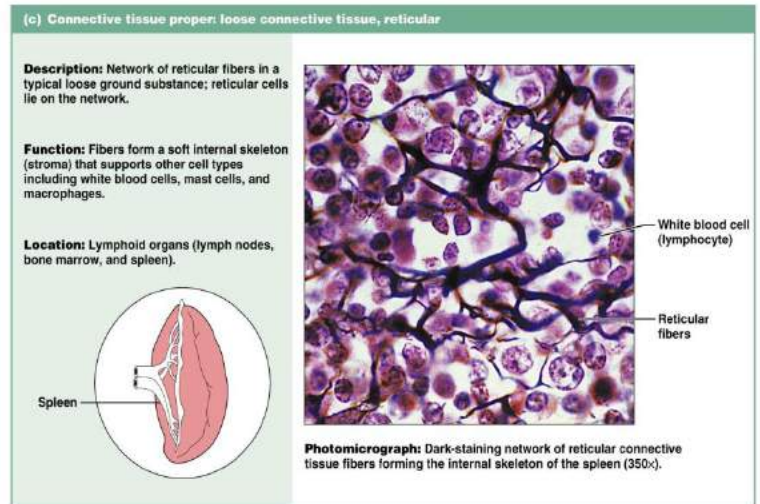
Location: Under skin; around kidneys and eyeballs; within abdomen; in breasts.

Photomicrograph: Adipose tissue from the subcutaneous layer under the skin (450x).

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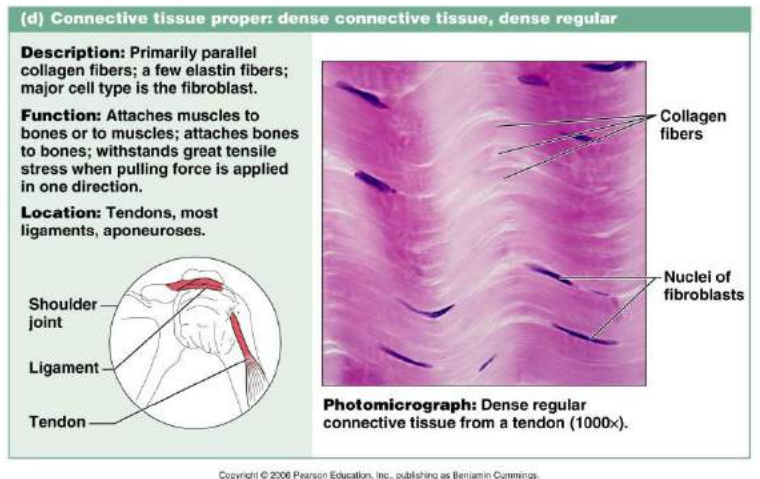
Reticular Tissue:

1. Obtain a slide of reticular tissue. Use proper technique to place the slide on the stage and locate the tissue.
2. Notice the evident cells (**reticular cells**) and the large, dark fibers (**reticular fibers**).
3. These fibers form a soft internal skeleton that support the cells of certain organs, such as the spleen, lymph nodes, and bone marrow.
4. For additional images, click [HERE](#).



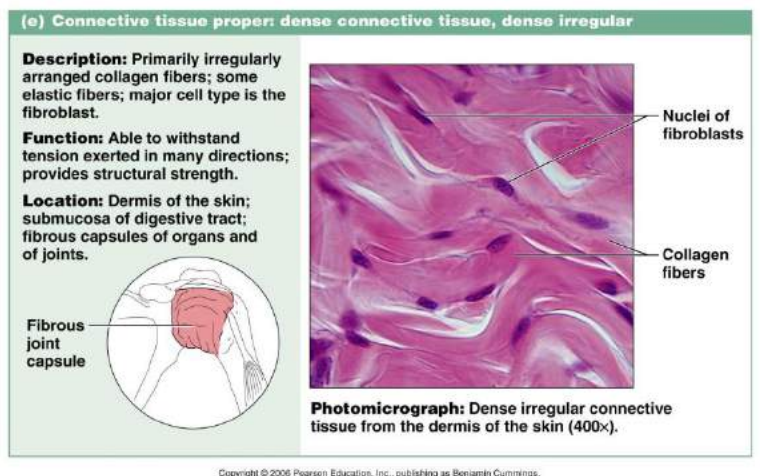
Dense Regular Connective Tissue:

1. Obtain a slide of a tendon. Use proper technique to mount the slide and to locate the tissue.
2. Notice the orderly fibers running throughout the tissue. These fibers are collagen fibers.
3. Embedded within the fibers are the fiber-producing cells called **fibroblasts**.
4. This tissue forms tendons and ligaments needed to connect muscles to bones and bones to other bones.
5. For additional images, click [HERE](#).



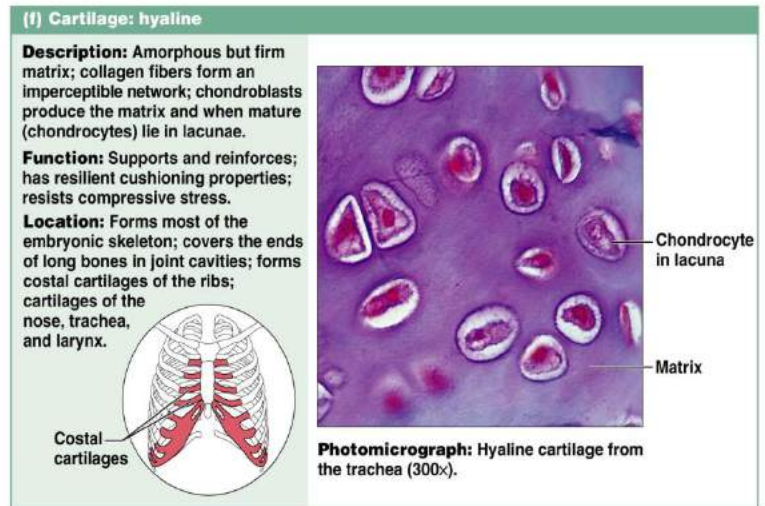
Dense Irregular Connective Tissue:

1. Obtain a slide of skin. Use proper technique to mount the slide and to locate the tissue.
2. The middle layer of the skin is called the **dermis**, and it is composed of dense irregular connective tissue. The composition of the tissue is the same as that of dense regular tissue, but the components are not arranged as orderly as in that tissue.
3. For additional images, click [HERE](#).



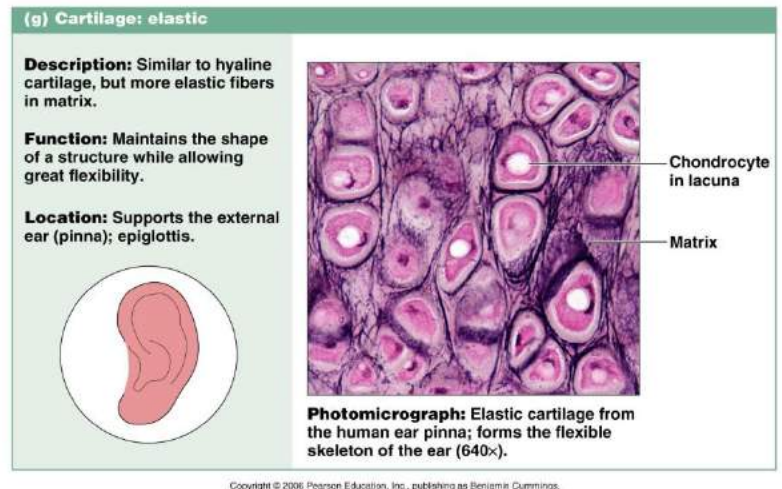
Hyaline Cartilage:

1. Obtain a trachea slide or a slide labeled hyaline cartilage. Use proper technique to mount the slide and locate the tissue.
2. Earlier, we observed the lining of the trachea. Below that layer of tissue, we will find rings of hyaline cartilage embedded within the organ to provide structure and support.
3. The hyaline cartilage will have a smooth, **amorphous** (no form) **matrix** with cells suspended within it. The matrix is compact fibers of collagen and the cells producing the matrix are called **chondrocytes**. They are contained within tiny chambers called **lacunae** (“little lakes”).
4. For additional images, click [HERE](#).



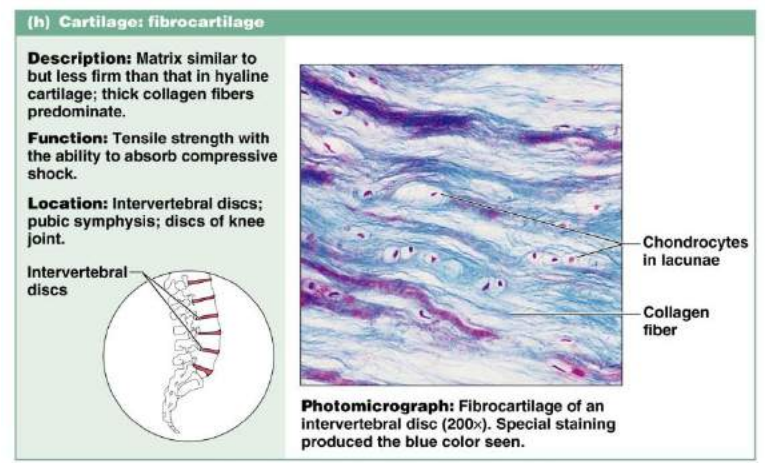
Elastic Cartilage:

1. Obtain a slide of elastic cartilage. Use proper technique to mount the slide and locate the tissue.
2. Notice the large chondrocytes located in the lacunae.
3. Also notice the presence of elastic fibers within the matrix of the tissue. While the tissue is similar in composition to hyaline cartilage, the addition of more elastic fibers allows it to stretch and maintain its shape. This type of tissue is found forming most of the structure of the external ear.
4. For additional images, click [HERE](#).



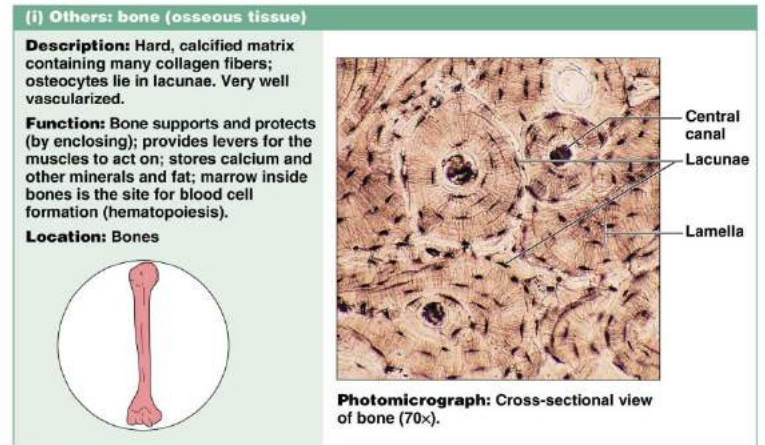
Fibrocartilage:

1. Obtain a slide of fibrocartilage. Use proper technique to mount the slide and locate the tissue
2. Fibrocartilage is found forming the intervertebral discs in the spinal column, the **pubic symphysis**, and in the discs of the knee. While its composition is similar to that of hyaline cartilage, it is not as firm and possesses more noticeable **collagen fibers**.
3. The cells present are still referred to as **chondrocytes** and are found in **lacunae** in this tissue as well.
4. For additional images, click [HERE](#).



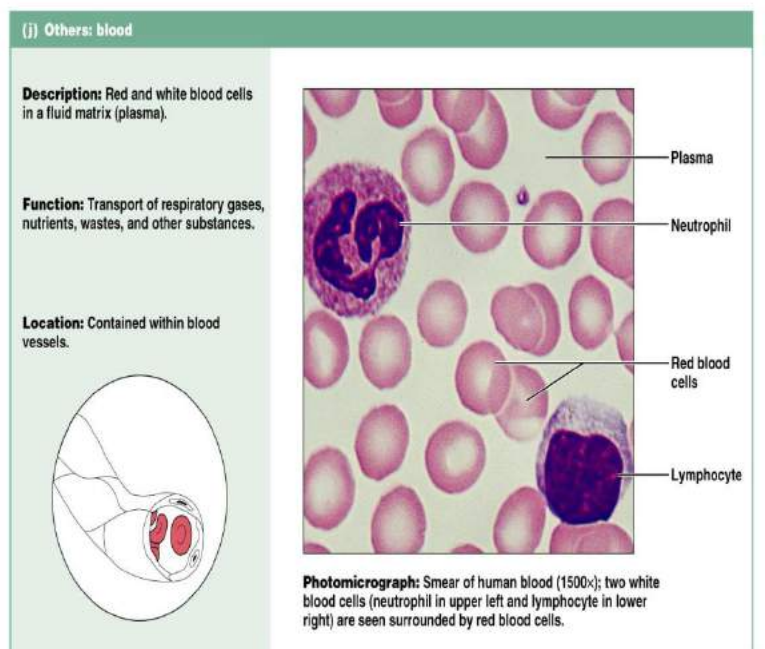
Bone (Osseous) Tissue:

1. Obtain a slide of ground bone. Use proper technique to mount the slide and locate the tissue.
2. Bone is arranged in concentric ring structures called **osteons**. In the center of each ring is a structure called a **Haversian canal**. This canal carries blood vessels through the bone to nourish the cells embedded within the tissue.
3. Around the **Haversian canal**, rings of bone tissue from called **lamellae**. Within these rings are the chambers called **lacunae** that would contain the cells. The cells themselves are called **osteocytes** (osteo= bone, cyte= cell).
4. Radiating out from the **lacunae** are tiny channels that allow interaction of the cells with the blood supply. These tiny channels are called **canaliculi**.
5. For additional images, click [HERE](#).



Blood:

1. Obtain a blood smear slide. Use proper technique to mount and locate the tissue.
2. Students typically do not consider blood to be a tissue due to its liquid state. However, it meets all the criteria set forward to be designated a connective tissue.
3. Notice that there are two types of cells easily recognizable; red blood cells (erythrocytes) and white blood cells (leukocytes). Also seen among the cells are tiny fragments of cells called platelets.
4. The liquid portion of blood is the matrix. This part is typically called plasma and is made up of water, salts, gases, and proteins (nonliving materials). You will learn more about blood as a tissue, including the functions of the components in AP2. For now, we want to be able to recognize the major components.



The Integument:

The body is protected externally by one of its largest organs, the skin or integument. While protection is the main function of the skin, it performs many other functions, such as providing insulation, helping with temperature regulation, and provides tactileity (sense of touch). It even functions in the production of vitamin D needed for proper body function.

Skin Composition:

The skin is formed by three distinctive layers; the epidermis (outer layer), the dermis (middle layer), and hypodermis {subcutaneous layer} (innermost layer).

[Bracketed numbers next to structures correspond to the numbers on the following image]

- Epidermis- composed of keratinized stratified squamous epithelium
 - Arranged into five layers called strata (singular = stratum)
 - Stratum corneum- outermost layer of flattened, dead cells [1]
 - Stratum lucidum- thin, translucent layer found only in thick areas of the skin. [2]
 - Stratum granulosum- names for the abundance of granules present. Upper boundary of this layer is where cells begin to die [3]
 - Stratum spinosum- layer where cells divide rapidly. Usually one of the thicker layers of the epidermis. [4]
 - Stratum basale- the lowest layer of the skin. Attached to the dermis where it forms a basement membrane. Cells are constantly dividing to produce new cells. [5]
- Dermis- composed of dense irregular connective tissue [6]
 - Dermal papillae- projections or ridges that arise from the dermis that serve as attachment points for the epidermis
- Hypodermis- composed of adipose tissue [7]

Skin also has unique structures that perform various functions:

- Gland Structures
 - Eccrine gland (sudoriferous gland)- produces sweat (mixture of water, salts, and urea) that acts to cool the body. [22]
 - Sebaceous gland- produce sebum (oil) to help keep the skin soft and pliable. [10]
- Nervous Structures
 - Free nerve endings- associated with pain sensation; located in near dermal papillae [29]
 - Meissner's corpuscle- touch receptors- associated with tactileity; located in near dermal papillae [28]
 - Pacinian corpuscle- pressure receptors; located deep within dermis at the boundary of the dermis and hypodermis.[31, 32, 33]
- Muscle Structures
 - Arrector pili- muscle that pulls up hair follicle leading to goose flesh or "goose bumps" [20]
- Appendages
 - Hair shaft [8]
 - Hair follicle [12]

Skin



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