Biology 3B Laboratory
Histology

Objectives

- To be able to identify the four major types of vertebrate tissues (epithelial, connective, nervous and muscle).
- To understand how each type of tissue is organized and the distinguishing features of each type of tissue.
- To associate tissue structure with its function for each tissue type.

INTRODUCTION

Tissues are formed when cells with similar structure and embryonic origin are aggregated together, performing a particular function. In this laboratory you will examine the four major groups of tissues based upon their structure and function: **epithelial, connective, muscle** and **nervous tissues**. The study of tissues, especially the structure and arrangement, is called **histology**.

In Biology 3A, we examined organisms at the molecular and cellular levels of biological organization. Now, we will examine organisms from the tissue level of organization up. As you recall, tissues are grouped to form **organs** which work together as **systems**.

Atomic → Molecular → Cellular → Tissue → Organs → Organ systems → Organism

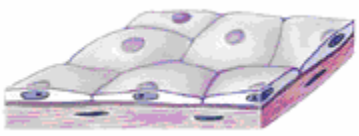
A. EPITHELIAL TISSUE

Epithelial tissue form sheet like layer of cells with very close cell to cell contact. They function in protection, absorption and excretion of materials for an organism. Epithelial tissue is classified based upon 1) the number of layers and 2) the shape of the cells on the free surface:

Simple epithelia are surface linings consisting of a single layer of cells. These are usually found at places where selective diffusion, absorption, or secretion occurs. Simple epithelia can range from **squamous** (flattened) to **cubiodal** to **columnar** in shape depending on their function. All epithelial cells secrete a non-living matrix called the **basement membrane**. This is essentially a dense layer of extracellular material that acts as a "glue" to hold cells together.

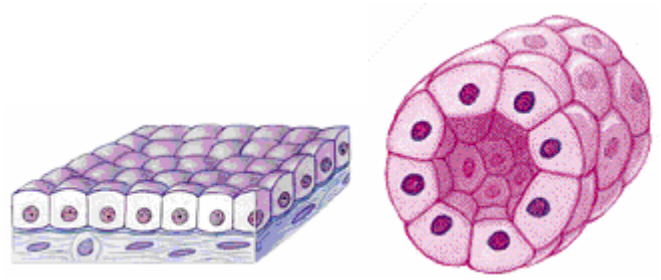
Simple squamous epithelium: a single layer of thin flattened cells, usually containing a flattened nucleus. They line the lumens of the entire blood vascular system (specifically called **endothelium** here), the renal corpuscles, and the lumenal surfaces of the pleural and peritoneal membranes. In these areas, they function in diffusion of materials. They also line the thoracic, abdominal and cardiac cavity (**mesothelium**).

- Observe dorsal view of the frog skin (may look hexagonal)
- Observe the cross section of a blood vessel and find the **endothelium** that lines the lumen of the blood vessel.



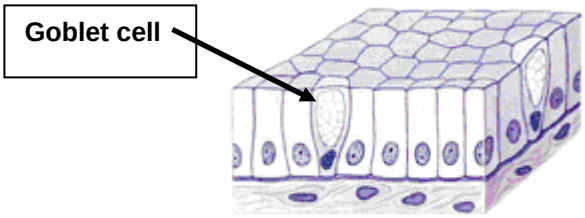
Simple cubiodal epithelium: a single layer of cube-shaped cells with a centrally located nucleus. This epithelial tissue can be found in exocrine glands (salivary and mucus), lining small ducts and tubules (kidney tubules). They function in secretion and some diffusion. Other areas found: ovaries and pancreatic duct

- You may be looking at the kidney tubules, thus look for circular tubes of simple cuboidal cells.

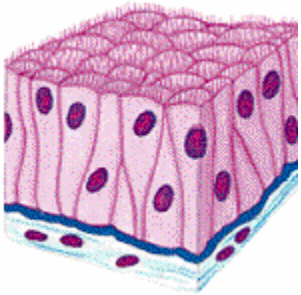


Simple columnar epithelium: the height of these cells are great than the width and the depth. All the cells touch the basement membrane and the nuclei are usually aligned in the center or towards the bottom of the cells. Some cells are ciliated. These cells are specialized in secretion and some absorption. **Goblet cells** are often associated with columnar cells and secrete mucus. *Are any of these cells ciliated?*

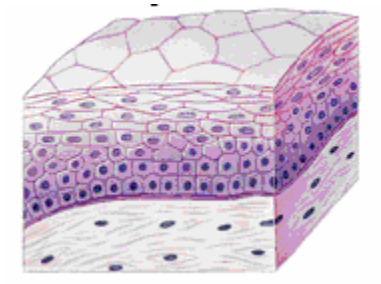
Locations:	<u>nonciliated</u>	<u>ciliated</u>
	lines stomach & intestines	uterine tubes
	some salivary glands	fallopian tubes
	gall bladder	upper respiratory tract



Psuedostratified columnar epithelium: all cells begin at a common basement membrane but some cells do not reach the free surface. The nuclei in largest dimension of cytoplasm; therefore, appear in two rows, thus the appearance of stratification. Some may be ciliated. Typical locations include: eustachian tubes, upper respiratory tract, epididymis, vas deferens. They are typically found in areas of high abuse forming linings.



Stratified squamous epithelium: composed of cells with many layers, cells flattened at free surface but typically cuboidal or columnar at basement layer. They function in protection and coverings, in areas with lots of abuse. Locations include: skin and lining wet surfaces: mouth, esophagus, and vagina.



B. CONNECTIVE TISSUE

There are two types of connective tissue: loose, the most wide spread connective tissue, and dense connective tissue. Connective tissue is composed of cells and extracellular fibers imbedded in a **ground substance (matrix)**. The ground substance or matrix can be jelly-like, liquid or solid non-living cement of glue secreted by the cells. There are three types of fibers that are typically found in the various types of connective tissue. **Elastic fibers** are composed of **elastin** (protein) with a stretchy and flexible characteristic. These fibers form thin wavy lines that can be stained purple, red or brown in color. **Collagen fibers** are composed of collagen protein and found only in animals. These fibers are characteristically thick and resist stretching. When stained, they appear as thick wavy lines that are either pink or red. **Reticular fibers** are inelastic and branching forming a network. These fibers are difficult to see without specialized staining.

Cells that are found in connective tissues are named according to their function. Cells called "**blasts**" are responsible for production a particular substance, "**clasts**" are responsible for reabsorbing substances, and "**cytes**" are resting or mature cells that are not producing or reabsorbing substances. For example, fibroblasts produce fibers. Fibrocytes are mature fiber cells and fibroclasts are responsible for reabsorbing (breaking down) fibers.

Loose Connective Tissue:

Areolar connective tissue: this is the least specialized connective tissue in the adult organism. This is essentially the "packing material" of the body. It is often found anchoring blood vessels, nerves and body organs.

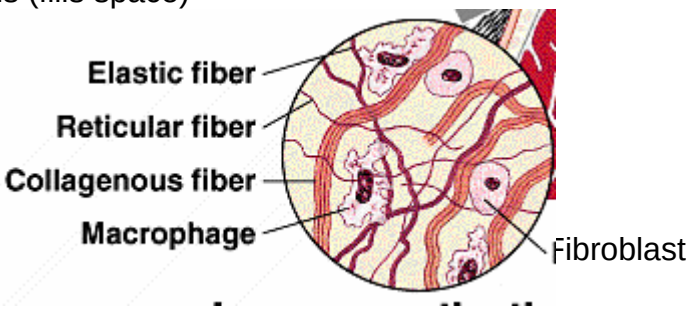
cells: fibroblasts/macrophages/mast cell/adipose cells/plasma cells

fibers: elastic fibers = composed of protein elastin (stretch & rebound)

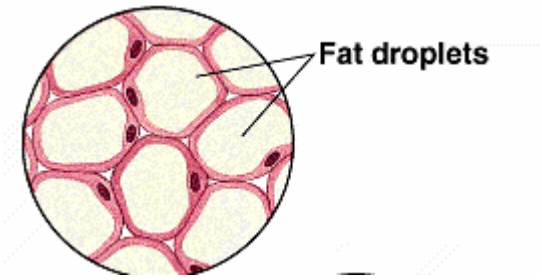
collagenous fibers = composed of protein collagen

- inelastic = high tensile strength
- can flex but NOT stretch to any great degree

location: subcutaneous layer of skin, supports blood vessels, nerves and epithelia around body organs (fills space)

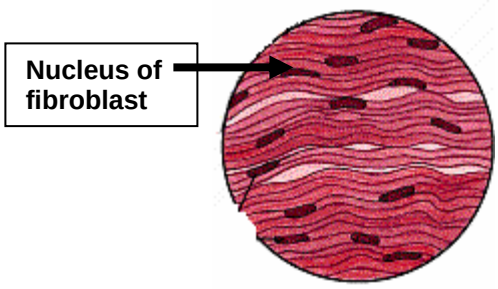


Adipose tissue: the cells are the dominant feature with gigantic vacuoles for lipid storage. fibroblasts are present. Elastic & collagenous fibers are present but may not be visible in slides. These fibers are laid down randomly in all directions. Adipose tissue can be found nearly everywhere but especially around the kidneys, heart, eyes, greater omentum, subcutaneous connective tissue.

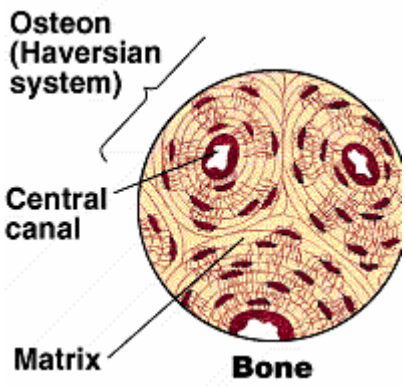


Dense Connective Tissue:

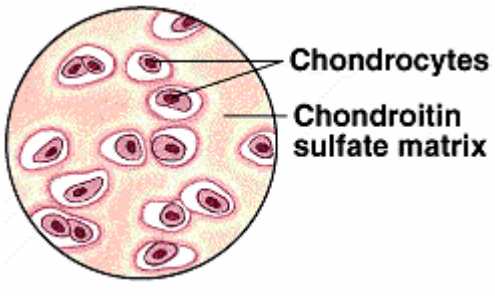
White (dense) fibrous connective tissue: collagenous fibers are the dominant type of fiber that's arranged in wavy, parallel lines. Typical locations include tendons, aponeuroses, cornea, most ligaments and periosteum. The cell that you'll see in this tissue is most-likely **fibroblasts**.



Bone: bone is composed of collagen and mineralized calcium and phosphate salts. Compact bone is composed of numerous **Haversian systems**. Within each Haverian system there is a **Haversian (osteon) canal** that has an arteriole, venule, and nerve supply. **Osteoblasts**, the bone forming cells that wall themselves in within the **lacunae**. At that point they stop producing bone and are called **osteocytes**. The cells in lacunae are interconnected by tiny branching channels called **canaliculi**. These channels allow for the passage of nourishments to the cells from the blood supply. Nourishment can also be passed from one osteon canal to another osteon canal via **Volkmann's canal**. The osteoblasts/osteocytes are arranged in concentric layers called **lamellae** (this is similar to the growth rings of a tree). The function of bone is for mechanical support, locomotion, protection and mineral salt reservoir.



Hyaline cartilage: the most common type of cartilage (gristle). This cartilage contains both elastic and collagenous fibers - neither is visible in light microscope prep. Within the lacunae are the **chondroblasts** which produce the ground substance, cartilage. In the outer portion of the cartilage are the **chondrocytes**. Locations include: articular surface of bones, end of nose, fetal skeleton, trachea, costal cartilage



Elastic cartilage: within the matrix, there are numerous elastic fibers (resilience & flexibility). The lacunae are more densely clustered containing chondrocytes
locations: external ear, auditory tube, epiglottis

Vascular Tissue: Blood and lymph are derived from loose connective tissue with various cells called **corpuscles** (or formed elements) which are suspended in a fluid matrix called **plasma** (ground substance). Vascular tissue transports nutritive substances, oxygen and hormones to tissues and carries away waste products.

Erythrocytes, red corpuscles or red blood cells (RBCs): humans typically have approximately 4.5 - 5.0 x 10^6 RBCs/mm^3. Mammalian RBCs are biconcave in shape because there is no nucleus present. Avian and amphibian RBCs are nucleated. All contain hemoglobin for oxygen and carbon dioxide transport.

- Observe both mammalian, amphibian and bird red blood cells. Make a size and shape comparison.

Leukocytes, white corpuscles or white blood cells (WBCs): WBCs are responsible for the defense. Some release chemicals while others are phagocytic. Classification of WBCs are based on granules in the cytoplasm that stain.

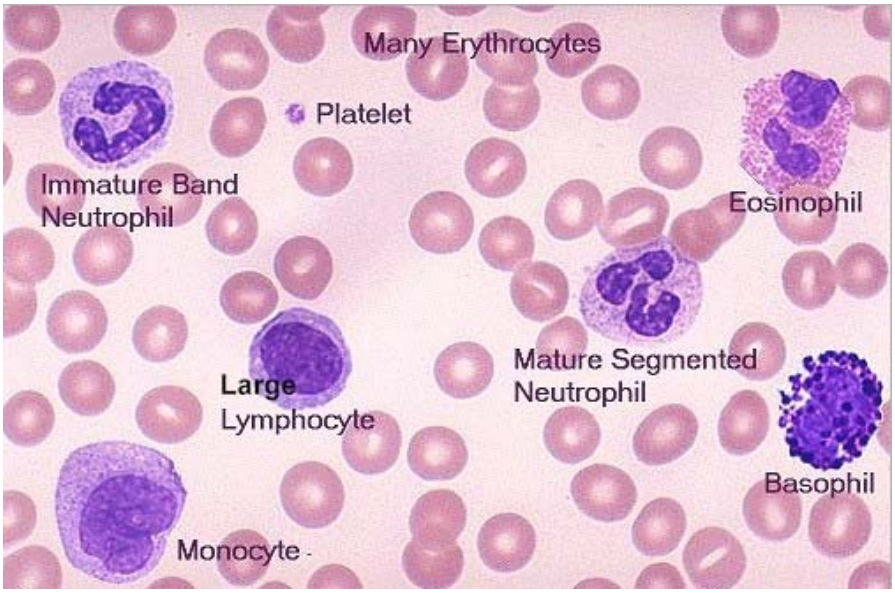
Agranulocytes: without granules in the cytoplasm

- **Lymphocytes**: comprise 20-25% of the WBCs. They are small with a large dark blue nucleus with thin crescent shaped rim of light blue cytoplasm. These are involved in the specific immune response (T lymphocytes). B lymphocytes are responsible for making antibodies against foreign antigens.

- **Monocytes**: comprise 3-8% of the WBCs. They have a large, kidney or U-shaped nucleus. These are considerably larger than lymphocytes. They are phagocytic on foreign bodies in loose connective tissue. They're called **macrophages** when they are actively phagocytizing foreign bodies.

Granulocytes: have granules that stain in the cytoplasm

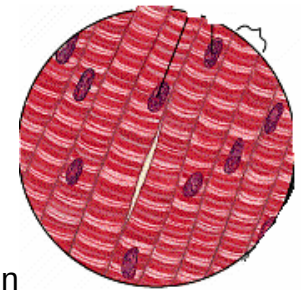
- **Neutrophils**: are the most numerous of the WBCs (65-75%). They have a nucleus with 3-5 interconnected lobes (typically 3 lobed). The granules stain light pink-purple. They are phagocytic in connective tissue.
- **Eosinophils**: comprises 2-5% of WBCs. They have bilobed nucleus that's often difficult to see. The granules stain red-orange or what ever color the red blood cells are. The function of eosinophils is still relatively unknown. However, there is an increase in their numbers with parasitic infections and allergic reactions. Some may even secrete histamine.
- **Basophils**: comprises less than 1% of WBCs. They have an S-shaped nucleus that's often obscured by the large, very dark purple granules. No cytoplasm can be seen. If you do see blue cytoplasm, the cell is most-likely a lymphocyte. Basophils are involved in the non-specific inflammatory response. They release histamine which causes redness and swelling as a result of increased fluid movement into the area.



MUSCLE TISSUE

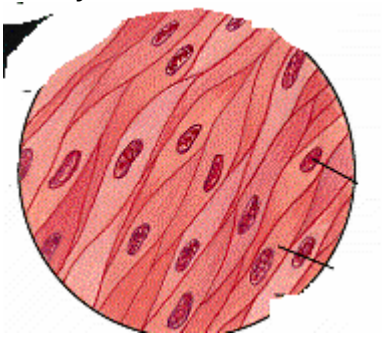
Skeletal/striated muscle: You will observe two different sections of skeletal muscle, longitudinal and cross. In the longitudinal section, the fibers are large, long and straight. You should notice the long cells with striations and multiple peripheral nuclei. These are among the largest cells in vertebrate body (1 fiber ~ 1 "cell"). Skeletal muscle cells that are thin in are capable of rapid activity (i.e. extrinsic eye muscles) whereas cells that are thicker, such as those found associated with the appendicular skeleton contract more slowly but with greater force. These are also known as "voluntary" muscles of the body because we have conscience control over them.

In cross section, each "circle" represents one fiber and gives the massive end view of myofibrils. Note peripheral nuclei that may be present.

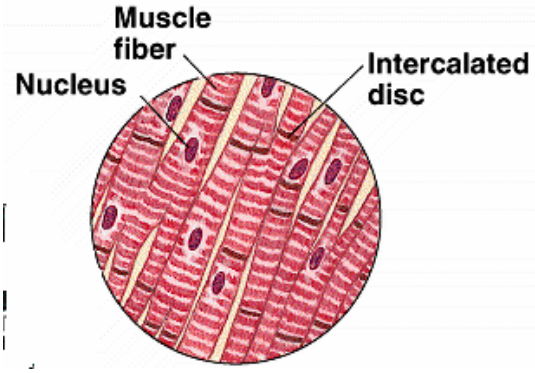


Longitudinal section

Smooth/nonstriated muscle: Smooth muscles have more of a spindle shaped cell with no striations. They are also mononucleated. These muscles are involuntary since we do not have conscience control over these. They are found in organs of the body and vessels.



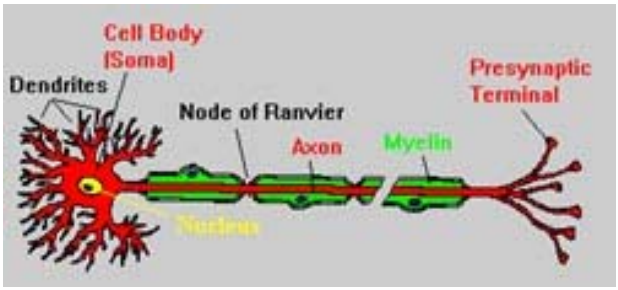
Cardiac muscle: Cardiac muscle is also striated; however, the cells are branched and contain a single central nucleus. Between the cells are the **intercalated disks** with gap junctions. Found in the heart.



NERVOUS TISSUE

Nervous tissue is composed of neurons. The basic anatomy of neuron consists of a **cell body** or **soma** that contains the nucleus. There may be numerous extensions called **dendrites** around the soma which function in receiving electrical impulses from various stimuli and transmitting this information to the soma. The longer **axon** then carries the impulses away from the soma to a particular organ to elicit an affect. The axon may or may not be **myelinated**. Myelinated axons are enclosed by concentric rings of lipid layer that insulates the axon. The myelin sheath is produced by **Schwann cells**. Between each myelin sheath are small gaps in which the axon is actually exposed portion called **nodes of Ranvier**. As the nerve impulse is forced to "jump" (salutatory conduction) from node to node down the axon, the rate of conduction is increased. At the end of the axon, there are numerous **axon termini** which innervate various structures. At the end of each axon terminus is the foot or **terminal bouton**. The small gap between the terminal

bouton and the innervated structure is called the **synapse**. This is where the release of neurotransmitters takes place.



Giant multipolar neuron: In a smear from spinal cord, you will observe numerous neurons that typically stain bluish-purple. You should be able to see the **soma, nucleus, nucleolus and dendrites**.

Myelinated axon: Schwann cells create the myelin sheaths that are composed of lipids. Find the **nodes of Ranvier**.

Histology Links: There's substitute for looking at the actual slides!!!

http://cats.med.uvm.edu/cats_teachingmod/histology/lectures_online/histo_topics_index.html

http://www.saddleback.edu/faculty/charrison/chart.html