NAME: _____ DATE: _____

PARTNER: _____

CYTOLOGY & HISTOLOGY
THE STUDY OF CELLS AND TISSUES

For ease of study, multicellular animals are often examined at various levels of structural organization. Starting from the most basic units and proceeding to the most complex associations, this approach can be broken down as follows:

atoms → chemicals → cells → tissues → organs → organ systems → organism

In this laboratory exercise, we will explore aspects of the structures and relationships of the cells and tissues of eukaryotes with the primary emphasis being placed on vertebrate animals. The section on cytology (the study of cells) will consist of a review of cell structures and their primary functions as well as an exercise to observe the effects of cell membrane permeability on cell structure. The histology section (the study of tissues) will focus on the four main tissue groups of animals: epithelial tissue, connective tissue, muscle tissue and nervous tissue. Here, we will learn and observe the primary characteristics of these tissues and compare their similarities and differences with the other groups. For this exercise, it will be helpful to reference your text.

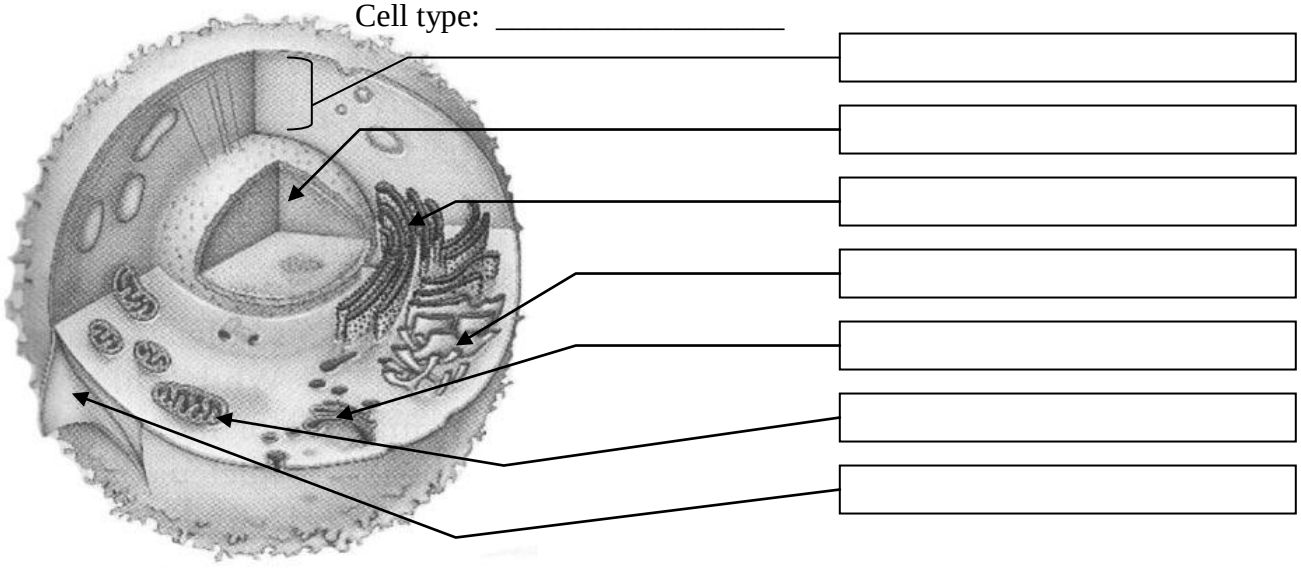
I. CELLS

A cell can be defined as the simplest complete functional unit of a living organism. For some organisms, such as many protistans, the cell may represent the entire organism. For others, such as the animals, the organism is composed of multiple cells. It is estimated that there are over a trillion cells in the human body! In multicellular organisms, these cells show tremendous diversity in shape and function, however, there are many characteristics that are common to all or most of these cells.

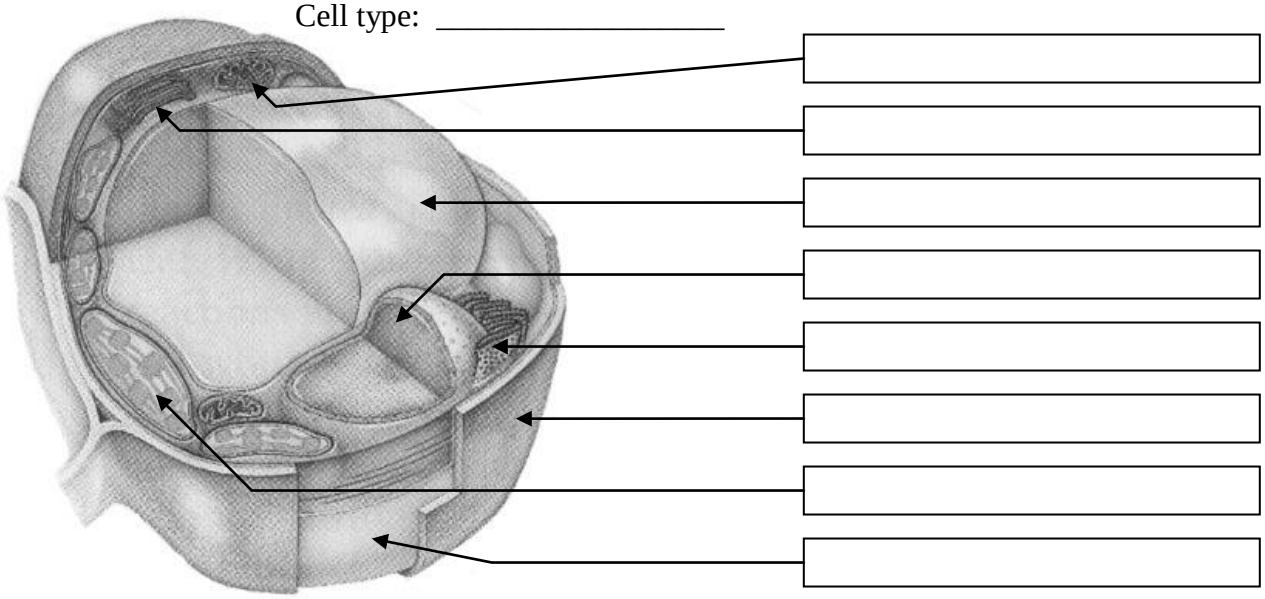
A. Comparison of Animal and Plant Cells

1. Using the terms below and your text for reference, name the structures indicated in the following diagrams.

Cell type: _____



Cell type: _____

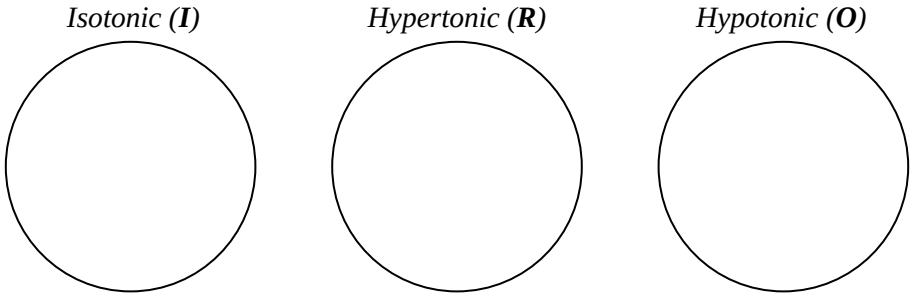


2. Next, identify the general functions of the organelles listed below.
   a. Cell wall = _____
   _____
   b. Central vacuole = _____
   _____
   c. Chloroplast = _____
   _____
   d. Cytoplasm = _____
   _____
   e. Golgi Apparatus = _____
   _____
   f. Mitochondria = _____
   _____
   g. Nucleus = _____
   _____
   h. Plasma membrane = _____
   _____
   i. Rough ER = _____
   _____
   j. Smooth ER = _____
   _____
3. Which of the structures identified are found in plant or animals cells but not both? Identify these structures and the type of cell to which they belong. _____
   _____
   _____

B. Osmosis and the Cell Membrane

The term osmosis describes the movement of water across a semipermeable membrane from areas of low solute concentration to areas of high solute concentration. In this exercise, we will examine how the tonicity of the solution surrounding the cell affects the movement of water across the cell membrane and how this affects overall cell structure. Refer to your text for additional information.

1. Obtain 3 microscope slides and label them **I** for isotonic, **R** for hypertonic and **O** for hypotonic.
2. Add 1 very small drop of blood to the center of each slide.
3. Add the following reagents to the drop of blood on the slides:
   a. To slide **I**, mix in 1 drop of physiological saline (0.9% NaCl).
   b. To slide **R**, mix in 1 drop of "concentrated saline" (3% NaCl).
   c. To slide **O**, mix in 1 drop of "dilute saline" (0.3% NaCl).
4. Carefully add a coverslip to each slide and observe under the microscope. Start at low power (4x objective) and work your way up to the 40x objective lens. It may take a few minutes to observe some of the results.
   a. Draw the appearance of a single representative red blood cell observed under the different conditions.



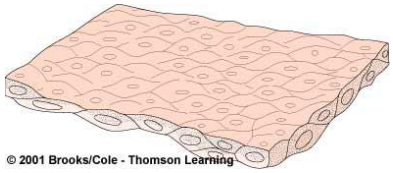
   b. Describe the osmotic events that should occur in each case and how this would affect the shape of the cells (do they shrink, swell, or remain the same?).
   - When the surroundings are isotonic to the cell:
     Water flow - _____
     _____
     Cell shape - _____
   - When the surroundings are hypertonic to the cell:
     Water flow - _____
     _____
     Cell shape - _____
   - When the surroundings are hypotonic to the cell:
     Water flow - _____
     _____
     Cell shape - _____

II. MAMMALIAN TISSUES

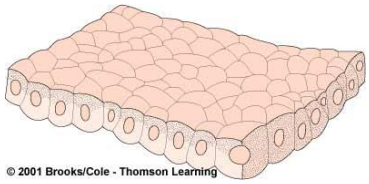
The cells of multicellular organisms "specialize" (or differentiate) to perform specific functions for the organism. Groups of these cells that have similar characteristics and which perform common or similar functions are what are known as tissues. In vertebrate animals, there are four primary tissue groups: epithelial tissue, muscle tissue, connective tissue and nervous tissue. In this exercise, we will examine some representatives of these groups to learn some of their key structures, learn how to distinguish them from other tissues and learn how they function for the organism.

A. Epithelial Tissue

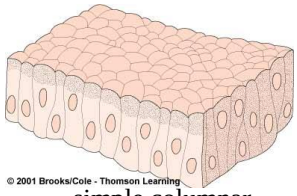
Epithelial tissues cover the surfaces and line the cavities of the body. These tissues are typically described in terms of their thickness and the general shape of the outermost layer of cells. Simple epithelia are composed of a single layer of cells while stratified epithelia contain two or more cell layers. In terms of their appearance, squamous epithelia are composed of flattened cells, cuboidal epithelia are roughly cube shaped and columnar epithelia are column shaped.



simple squamous

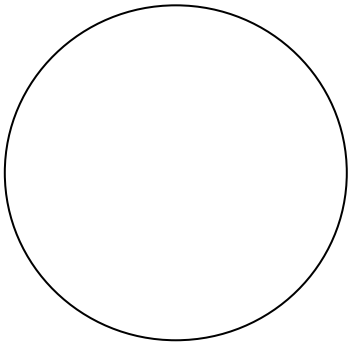


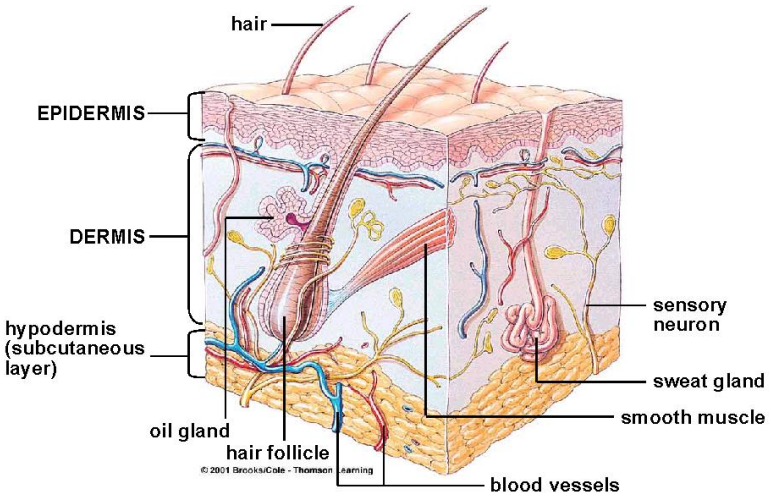
simple cuboidal



simple columnar

1. Examine a slide of human **skin** (10x-40x). Make a simple sketch of the epidermis and identify the layer of dead cells providing a protective function to the skin.





a. What type of epithelium is the epidermis? _____

b. How does its construction (shape, number of layers) contribute to its primary function?

_____

_____

_____

Muscle Tissue

Although the three types of muscle tissue (skeletal, cardiac, smooth) are all involved in creating some type of body movement, they are distinctly different in structure.

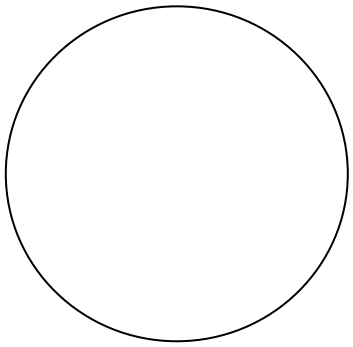
2. Examine the slides of muscle tissue and fill in the following table (use your text for reference) comparing these muscle types.

	Skeletal Muscle	**Cardiac Muscle**	**Smooth Muscle**
Location			
General Shape			
Control (voluntary / involuntary)			
Striations (yes/no)			
Function			

B. Nervous Tissue

This tissue makes up the primary control and communication system of the body: the brain, spinal cord and peripheral nerves.

1. Examine a slide of nerve tissue (**spinal cord**). Locate a neuron (10x-40x) and draw a simple sketch in the space below.



   a. Label the following structures in your diagram: cell body, cell processes, nucleus, nucleolus (if visible).
   b. What is the functional difference between an axon and a dendrite? Can you tell the difference between the two simply by viewing them under the microscope?

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C. Connective Tissue

Although this group of tissues is the most structurally diverse in terms of the appearance of its members, they all share two common attributes: 1) a cellular component (the characteristic cell type of the tissue), and 2) an extracellular matrix (the cellular secretions that form the characteristic features of the tissue). The latter contains both an amorphous material which is important in determining the fluidity of the tissue (the ground substance) and a fibrous component that can add strength, flexibility and support (collagen, elastin and reticular fibers).

1. Loose Connective Tissue
   a. Examine the slide of ***areolar*** connective tissue (10x-40x) and make a simple sketch in the space provided.

   b. Where might one find this tissue in the body and how does its location relate to its function as a "connective" tissue? _____

   _____

   _____

   c. Label a collagen fiber in your diagram. What is its role in this tissue? _____

   _____

2. Dense Connective Tissue

   There are two types of dense connective tissue based on the arrangement of collagen fibers within the matrix. Dense irregular connective tissue has collagen bundles arranged in more irregular arrays so as to provide strength along multiple planes of tension. This type of tissue makes up the majority of the dermis (lower layer) of the skin. In dense regular connective tissue, the collagen bundles are more parallel to provide maximum strength along a common plane. Ligaments (attach bone-bone) and tendons (attach muscle-bone) are composed of this tissue type.

   a. How are the collagen fibers arranged in tendons and ligaments and how is this significant in terms of the functions of these structures?

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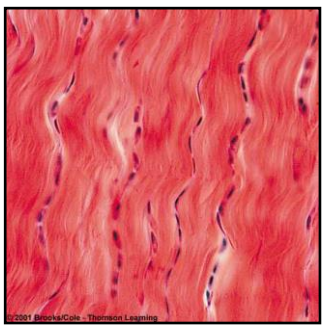
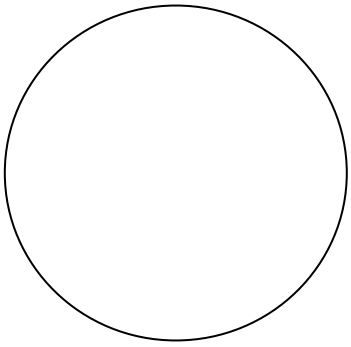


3. Cartilage

   Of the three types of cartilage found in within the body (hyaline, elastic, fibrocartilage), hyaline cartilage is by far the most abundant. It can be found at the articulations (joints) between bones where it covers and protects the harder more brittle bone surfaces at those junctions.

   a. Examine the slide of the ***trachea*** (10x-40x) to observe a representative of hyaline cartilage and make a simple sketch of this tissue.



   b. In your diagram, label a lacuna; the space within the cartilaginous matrix where the cells (chondrocytes) can be found. It is interesting to note that these cells have actually become trapped within the matrix that they have secreted. This tissue is also non-vascularized, meaning that is does not contain blood vessels to carry nutrients to the chondrocytes trapped within the lacunae. Since this is so, how do you suppose they obtain the nutrients they need for survival?

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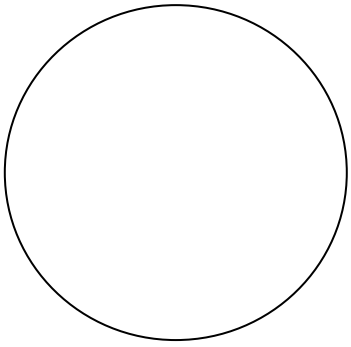
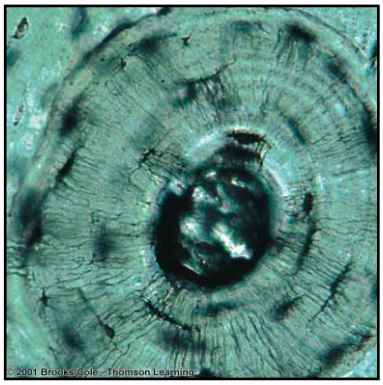
_____

4. Bone

   Bone tissue is by far the most dense of the connective tissues. This is a must for this tissue to perform its primary functions: supplying the body framework, providing the attachment sites and levers for muscles and protecting vital body organs. The matrix of this tissue is composed of alternating layers of collagen fibers with a calcified ground substance to add hardness.

   a. Examine a slide of ***ground bone*** (10x-40x) and make a simple sketch of this tissue. Label an osteocyte (mature bone cell).





b. In bone, the extracellular matrix has become calcified and is hardened to the point that diffusion is prevented. That being the case, how is it that the osteocytes, the cells of bone tissue, are able to receive nutrients and release wastes?

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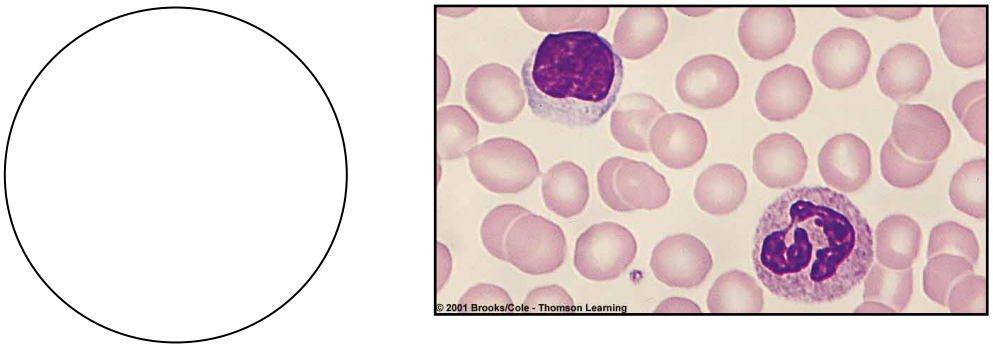
5. Blood

Although in appearance it may be the most unlike the other types of connective tissue, it still has the same embryological origins and has both a cellular fraction (erythrocytes, leukocytes, platelets) and a matrix portion (plasma).

a. Examine a slide of ***blood*** (40x) and make a simple sketch of this tissue.



b. From your drawing, label an erythrocyte (red blood cell) and a leukocyte (white blood cell). What are the primary functions of these two cell groups?

_____

_____

_____

c. You may observe that all of the erythrocytes look pretty much the same. Why do you think that many of the leukocytes differ in appearance? _____

_____

_____

_____

d. You should also notice that there are more red blood cells than white blood cells. Red blood cells make up ~45% of the total blood volume (~5 million cells/ml) while white blood cells make up <1% of the total blood volume (~5,000-10,000 cells cells/ml). How might this be significant in terms of the functions of these cells in relation to which needs of the body they serve? _____

_____

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_____