Histology: A Study of Tissues

<table>
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<tr>
<th>Course</th>
<th>Anatomy &amp; Physiology</th>
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<td>Unit IV</td>
<td>Tissues</td>
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**Essential Question**

How do tissues differ from cells?

**TEKS**

130.203 (c)
1 A-F
2A-C
3A-C
4A-B

**Prior Student Learning**

Basic understanding of cellular biology and use of light microscope

**Estimated time**

3 – 5 hours

**Rationale**

A tissue is a group of similar cells and their intracellular substances that have a common embryonic origin and function together to perform a specialized activity. Tissues are classified into four principle categories based upon their structure and function.

**Objectives**

Upon completion of this lesson, the student will be able to:

- explain the hierarchy of body organization;
- name the four major tissue types and their subcategories;
- explain how the four major tissue types differ structurally and functionally;
- recognize the microscopic appearance of epithelial, connective, muscular, and nervous tissues;
- identify and describe the various body membranes;
- explain the significance of the fact that some tissue types (muscle and nerve) are largely amitotic after the growth stages are over;
- give examples of pathological conditions can lead to dead of cells, tissues, organs and systems; and
- describe the process of tissue repair (wound healing).

**Engage**

How can you explain why an injury to the skin takes much faster to repair as opposed to having an injury to the knee resulting with damage to the articular cartilage?

**Key Points**

I. Tissue Overview

   A. Hierarchy of organization
      1. Atoms -- tiny building blocks of all matter
      2. Molecules -- carbohydrates, proteins, lipids, nucleic acids
      3. Organelles -- miniature systems carrying out functions within the cell
      4. Cells -- fundamental unit of living organisms
      5. Tissues -- a collection of a group of similar cells that combine to perform similar specific functions

II. Classifications of Tissues

   A. Epithelial Tissues -- This is the lining, covering and glandular
tissue of the body.

B. Connective Tissues -- As the name implies, this tissue connects to the rest of the body and is the most abundant of all tissues.

C. Muscle Tissue -- Tissue highly specialized to contract or shorten to produce movement.

D. Nervous Tissue -- The tissues programmed control and direct the activities of all the functions of the body.

III. Epithelial Tissue

A. Special Characteristics:
   1. Epithelial tissues fit snugly to form continuous sheets bound by specialized junctions and desmosomes.
   2. The membranes always have one free end and the other attached to another organ or to the body’s exterior.
   3. Epithelial tissue is avascular or it contains no blood vessels.
   4. Epithelial tissues constantly regenerate themselves.

B. Classification of Epithelial Tissues -- Epithelium is carefully organized according to their cell shapes and arrangement.
   1. Shapes -- cell shapes will greatly influence the type of activity it is expected to perform, such as diffusion, secretion, storage, and absorption, to name a few.
      a. Squamous -- flattened cells to facilitate movement of minute or volatile substances in and out of the cell
      b. Cuboidal -- cube-like to assist in secretion or storage
      c. Columnar -- column-like to assist in absorption and secretion
   2. Arrangement
      a. Simple Epithelium -- tissue found in a single layer of cells
      b. Stratified Epithelium -- tissue found in several layers of cells

C. Subcategories of Tissues
   1. Simple Epithelia
      a. Simple Squamous Epithelium-- Arranged as a single layer of flattened cells to allow simple diffusion across cell membranes such as in the alveoli of the lungs, the walls of capillaries and the slick serous membranes of the ventral cavity.
      b. Stratified Squamous epithelium -- cells are arranged in several layers of flat cells in areas undergoing abrasion and constant wear and tear such as in the lining of the mouth or the vaginal canal.
      c. Simple Cuboidal Epithelium -- arranged in single cube-like cells such as those on the basement membrane that was previously mentioned. They are primarily found in glands such as pancreas and those that form saliva. It is also
found forming the walls of the kidney tubules and it covers the surface of the ovaries.

d. Simple Columnar Epithelium -- made up of a single layer of tall cells that fit closely together and are designed for the absorption and secretion of fluids found in nearly the entire digestive system.

e. Pseudostratified Columnar Epithelium -- falsely-stacked layers of column-shaped cells, usually embedded with specialized Goblet cells, that produce the protein mucin; the tissue is sometimes lined with hair-like structures called cilia used for trapping and removing particles, especially in the upper respiratory system or cilia found in the fallopian tubes to facilitate transfer of ovum.

f. Transitional Epithelium -- arranged in a waffle-like appearance giving way to stretching such as the bladder and retracting when empty.

2. Epithelial Membranes -- double-membrane with one side made of epithelial tissue and the other anchoring layer made primarily of connective tissue.

a. Cutaneous -- covers the entire body and is the main organ in the integumentary system used as a physical protective device; skin is the single largest visible organ.

b. Serous -- double-membrane that creates a lubricating fluid called serous fluid (serum-like) found lining the inner cavities of the body or surrounding organs such as the pleura of the lungs, the pericardium of the heart, and peritoneum of the abdominal cavity. The layers are:
   (i) Parietal -- pertaining to the layer on the outer wall area
   (ii) Visceral -- pertaining to the layer directly anchored to the organ itself

c. Mucous -- a specialized membrane that produces mucus, a specialized substance found in areas that are directly exposed to the outside environment used to trap and protect.

d. Synovial -- a tough, fibrous capsule producing a thick friction-reducing substance called synovium (meaning "with egg-like consistency") that is found between the joints.

IV. Connective Tissue

A. Special Characteristics
   1. Provides structure and binds structures together.
   2. Matrix composed mainly of collagen fibers.
   3. Vascular in nature.

B. Loose Connective Tissue -- It is slightly less densely-packed layers of Collagen that allows for tough structural stability yet
allowing movement. This explains why skin is able to stretch or move around without completely detaching or losing its shape.

1. Areolar Tissue -- literally meaning small spaces, this loose tissue is a filler material to hold internal structures together; found under cutaneous tissue.
2. Adipose Tissue -- made of oil-filled adipocytes or fat cells that are densely packed, located under cutaneous tissue, strategically surrounding or filling internal structures; it is designed for insulation, padding, and shock-absorption, and is used as a reserve fuel-source during emergency situations.
   a. Erythrocytes-- used to transport oxygen
   b. Leukocytes -- used to fight infections
   c. Thrombocytes -- used for blood clotting

C. Dense Connective Tissue -- Made of multiple layers of collagen fibers built like wire cables to create structural support in areas having a wider range-of-motion. This type of connective tissue indirectly receives blood flow and nourishment because of the mere anatomical arrangement of the dense fibers. The design does not allow very good vascular formation, sometimes leading to long recovery periods in these injured areas.
1. Cartilage -- made of compact chondrocytes with differing degrees of collagen; designed for structural support but allowing some elasticity and extensibility.
   a. Hyaline cartilage -- this cartilage has almost an equal amount of collagen and elastic fibers embedded within the chondrocytes giving support and allowing some resiliency; located in the articular cartilage at the ends of bones.
   b. Fibrocartilage -- cartilage cells and tough collagen fibers designed to bear weight and absorb shock such as in the intervertebral discs.
   c. Elastic Cartilage -- composed of elastic collagen fibers to allow more flexibility such as in the nose or ears.
2. Tendons -- Made of dense layers of collagen fibers in parallel direction; found in joint areas connecting bones to bones.
3. Ligaments -- Also made of dense layers of collagen and used as a structure to connect muscle to bones or muscles to muscles.
4. Bone -- Matrix is composed of calcified osteocytes in circular arrangements and is embedded with a rich vascular system; also the site for blood formation or hematopoiesis.

V. Muscle
   A. Special Characteristics
      1. Composed of contractile proteins called actin and myosin that
are designed for the sole purpose of movement.
2. The amount of mitochondria found within the muscle cells will be dictated by the type of movement it is intended for.

B. Types of Muscle
1. Skeletal muscle -- with proteins arranged in perfect linear formation giving the appearance of striations or stripes; it is also called voluntary muscle.
2. Cardiac muscle -- cells are arranged to connect with intercollated discs to be able to transport nerve impulses within the heart; this is considered an involuntary muscle.
3. Visceral muscle -- also called smooth muscle because the contractile proteins are not arranged in striations and they are designed for the propulsion or movement of internal structures; they are also involuntary muscles and are found in organs and vessels.

VI. Nervous tissue
A. Special Characteristics
1. Function is to communicate and control activities within the body.
2. Made of neurons or nerve cells:
   a. Dendrites -- part of the neuron that receive impulses
   b. Cell Body -- part of the neuron with nucleus where information is analyzed
   c. Axon -- part of the neuron that sends the message “away” to cause an action
   d. Nerves held together with glia -- a glue-like substance
3. Any damage to a neuron is irreversible and does not regenerate.

VII. Diseases Related to Tissues
A. Ketonuria -- Since diabetics cannot transport glucose into the cells due to lack of or ineffective insulin, the cells turn to alternate sources of fuel starting with stored fats and will finally resort to ingesting its own proteins. Fat and tissue breakdown will show in the urine as fruity-smelling ketones or show as high levels of cholesterol build-up in blood vessels.
B. Cystic Fibrosis -- Due to a transport failure, a build-up of mucus causes obstruction of vital and non-vital organs; complications result in pneumonia or malnutrition from inability to secrete enzymes or absorb nutrients because of abnormal thick mucus plugs.
C. Environmental Diseases -- Usually caused by allergens or pathogens found in the environment resulting in permanent tissue damage.
   1. Melanoma -- malignant form of cancer that results from
overexposure to UV rays; affects the bottom-most layer of the skin which contains the actively mitotic melanocytes and keratinocytes; causes irreversible cellular and tissue damage.

2. Lung Cancer -- destruction of cilia caused by smoke inhalation can cause lasting effects due to the inability to trap and remove particles from the air we breathe; lungs build up with tar and other toxins causing irreversible damage to tissue.

3. Cervical Cancer -- discovered to be acquired by exposure to the Human Papilloma Virus (virus which causes warts).

VIII. Organs -- Defined as a collection of related tissues performing a specific function.

A. Vital Organs -- Necessary for living
   1. Brain
   2. Heart
   3. Lungs

B. Non-Vital Organs -- Not necessary for living
   1. Kidneys- just need one healthy kidney to survive
   2. Appendix
   3. Spleen
   4. Gallbladder

Activity
I. Complete Histology: A Study of Tissues Key Term worksheet
II. Complete Histology: A Study of Tissues Review Sheet
III. Complete the Histology Laboratory Investigation

Assessment
Laboratory Investigation Rubric
Histology: A Study of Tissues Exam

Materials
Internet access to pictures of tissue slide samples
Histology: A Study of Tissues Exam -- KEY
microscope
prepared slides:
- epithelial tissues: skin, small intestine, kidney, trachea, urinary bladder
- connective tissues: loose connective, skin, tendon, adipose, bone, cartilage, blood
- muscular tissues: heart, small intestine, stomach, skeletal muscle
- nervous tissues: motor neuron, spinal cord

gloves
laboratory coat or apron
goggles
biohazard containers
surface disinfectant
paper towels

Accommodations for Learning Differences

For reinforcement the student will create a display board of all the tissue categories with picture cut-outs and a short description of where they are predominantly found.

For enrichment the student will interview a histotechnologist or pathologist. Research how tissues are processed and preserved to view and make a diagnosis. Include the names of special stains and dyes used to view the different types of tissues.

National Health Science Cluster Standards

National Health Science Cluster Standards
HLC01.01 Academic Foundations
Health care workers will know the academic subject matter required (in their area. They will use this knowledge as needed in their role.

HLC1O.01 Technical Skills
Health Care Workers will apply technical skills required for all career specialties. They will demonstrate skills and knowledge as appropriate.

TEKS
130.206 (c)(1)(A) demonstrate safe practices during laboratory and field investigations;
130.206 (c)(2)(A) know the definition of science and understand that it has limitations, as specified in subsection (b)(2) of this section;
130.206 (c)(2)(B) know that hypotheses are tentative and testable statements that must be capable of being supported, or not supported, by observational evidence. Hypotheses of durable explanatory power which have been tested over a wide variety of conditions are incorporated into theories;
130.206 (c)(2)(C) know scientific theories are based on natural and physical phenomena and are capable of being tested by multiple independent researchers. Unlike hypotheses, scientific theories are well-established and highly-reliable explanations, but they may be subject to change as new areas of science and new technologies are developed;
130.206 (c)(2)(D) distinguish between scientific hypotheses and scientific theories;
130.206 (c)(2)(E) plan and implement descriptive, comparative, and experimental investigations, including asking questions, formulating testable hypotheses, and selecting equipment and technology;
130.206 (c)(2)(F) collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as
calculators, spreadsheet software, data-collecting probes, computers, standard laboratory glassware, microscopes, various prepared slides, stereoscopes, metric rulers, electronic balances, hand lenses, Celsius thermometers, hot plates, lab notebooks or journals, timing devices, Petri dishes, lab incubators, dissection equipment, meter sticks, and models, diagrams, or samples of biological specimens or structures;
130.206 (c)(3)(A) in all fields of science, analyze, evaluate, and critique scientific explanations by using empirical evidence, logical reasoning, and experimental and observational testing, including examining all sides of scientific evidence of those scientific explanations, so as to encourage critical thinking by the student;
130.206 (c)(4)(C) analyze the effects of energy deficiencies in mal-absorption disorders such as diabetes, hypothyroidism, and Crohn's

Texas College and Career Readiness Standards

*English Language Arts*

II. B. Understand new vocabulary and concepts and use them accurately in reading writing and speaking.
III. B. Develop effective speaking styles for both group and one-on-one situations.
IV. A. Apply listening skills as an individual and as a member of a group in a variety of settings.
IV. B. 2. Listen actively and effectively in one-on-one communication situations.

*Science*

1.E.1. Use several modes of expression to describe or characterize natural patterns and phenomena. These modes of expression include narrative, numerical, graphical, pictorial, symbolic, and kinesthetic.
1.E.2. Use essential vocabulary of the discipline being studied.
3.A.1. Use correct applications of writing practices in scientific communication.
## Histology: A Study of Tissues Terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<td>Atherosclerosis</td>
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<td>Collagen</td>
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<td>Cuboidal</td>
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<td>Cutaneous membranes</td>
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<td>Epithelial tissue</td>
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<td>Glia</td>
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<td>Homeostasis</td>
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<td>Ketones</td>
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<td>Ketonuria</td>
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<td>Neurons</td>
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<td>Parietal</td>
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<td>Pseudostratified</td>
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<td>Serous membranes</td>
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<td>Skeletal muscle</td>
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<td>Squamous</td>
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<td>Stratified</td>
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<td>Striated muscle</td>
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<td>Synovial membrane</td>
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<td>Synovium</td>
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<td>Transitional</td>
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<td>Visceral</td>
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<td>Term</td>
<td>Definition</td>
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<tr>
<td>Atherosclerosis</td>
<td>An abnormal condition resulting in hardening of the arteries due to fatty deposits</td>
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<tr>
<td>Collagen</td>
<td>A protein fiber that becomes the matrix or filler material for most connective tissue</td>
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<tr>
<td>Cuboidal</td>
<td>A cell shape resembling a cube</td>
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<tr>
<td>Cutaneous membranes</td>
<td>A layer of tissue primarily found on the outer surface of the skin</td>
</tr>
<tr>
<td>Epithelial tissue</td>
<td>A type of tissue found in outer coverings or inner lining used for protection</td>
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<tr>
<td>Genitourinary</td>
<td>Pertaining to the urinary and reproductive organs</td>
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<tr>
<td>Glia</td>
<td>A glue-like structure that holds nerve cells together</td>
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<tr>
<td>Homeostasis</td>
<td>The process of maintaining balance</td>
</tr>
<tr>
<td>Ketones</td>
<td>A by-product of protein breakdown</td>
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<tr>
<td>Ketonuria</td>
<td>Having ketones in the urine; indicating tissue break-down</td>
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<tr>
<td>Meninges</td>
<td>The membranes that cover the brain and spinal cord</td>
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<tr>
<td>Melanoma</td>
<td>A cancerous tumor affecting the pigmenting cells of the skin called melanocytes</td>
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<tr>
<td>Neurons</td>
<td>The functional unit of the nervous system; a nerve cell</td>
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<tr>
<td>Parietal</td>
<td>Pertaining to part of the membrane toward the “outside wall;” not attached to an actual organ.</td>
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<tr>
<td>Pseudostratified</td>
<td>Cells arranged in a “falsey-stacked” formation; sometimes found with goblet cells to produce mucus or with cilia to trap and move particles</td>
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<td>Serous membranes</td>
<td>Specialized epithelial tissue that produces a “serum-like” substance used to reduce friction between internal structures such as the pleura, pericardium or peritoneum</td>
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<td>Skeletal muscle</td>
<td>One main type of tissue used for the function of movement</td>
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<td>Squamous</td>
<td>Flat-like in appearance</td>
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<tr>
<td>Stratified</td>
<td>Giving the appearance of being stacked</td>
</tr>
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<td>Striated muscle</td>
<td>Voluntary muscle with its contractile proteins arranged in such a way as to give the appearance of stripes in the muscle tissue</td>
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<tr>
<td>Synovial membrane</td>
<td>A specialized epithelial tissue that is located around joint cavities and produces a friction-reducing substance called synovium</td>
</tr>
<tr>
<td>Synovium</td>
<td>A friction-reducing substance found in joint spaces, that literally means with “egg-like” consistency</td>
</tr>
<tr>
<td>Transitional</td>
<td>A type of tissue arranged in a crisscross or waffle formation and found in structures that need to stretch when filled; will retract when emptied</td>
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<tr>
<td>Visceral</td>
<td>Pertaining to organs</td>
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Histology Laboratory Investigation

NAME: __________________________ DATE: _______ COURSE: __________

Purpose
In this laboratory investigation, the student will observe tissue samples and differentiate between epithelium, connective (or supportive), muscular, and nervous.

Background Information

Materials
- microscope
- prepared slides:
  - epithelial tissues: skin, small intestine, kidney, trachea, urinary bladder
  - connective tissues: loose connective, skin, tendon, adipose, bone, cartilage, blood
  - muscular tissues: heart, small intestine, stomach, skeletal muscle
  - nervous tissues: motor neuron, spinal cord
- gloves
- laboratory coat or apron
- goggles
- biohazard containers
- surface disinfectant
- paper towels

Procedure
1. Wash hands and put on gloves and goggles.
2. Assemble equipment and materials.
3. Prepare work area.
4. View the tissue slides.
5. Record data.
6. Clean work area with surface disinfectant. Remove goggles and gloves and wash hands.
Data
Observe, sketch and label an example of each tissue type.

Epithelium

Connective

Muscular
Conclusions:
1. What are the defining characteristics of each of the four major tissue types?

2. Explain why blood is considered a connective tissue.

3. Explain why injuries to dense connective tissue such as to tendons or ligaments take a long time to heal. How does this differ from nervous tissue?

4. Describe the tissue types that are affected when you cut your finger with a knife and it bleeds. Which tissues are involved as the wound heals?
## Laboratory Investigation Rubric

**NAME:** __________________________ **DATE:** _______ **COURSE:** ____________

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<td>Problem is appropriately identified</td>
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<td>Problem is precise, clear, and relevant</td>
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<td>Association between the problem and the predicted results is direct and relevant</td>
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<td>All variables are clearly operationalized</td>
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<td>All significant data is measured.</td>
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<td>Data is recorded effectively and efficiently</td>
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<td>Data table is well designed to the task requirements</td>
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<td>All graph forms are appropriate.</td>
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<td>All data accurately plotted</td>
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<td>Graph visually compelling; highlights conclusions of the study</td>
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<td>Conclusion relates directly to hypothesis</td>
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<td>Conclusion relates the study to general interest</td>
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Histology: A Study of Tissues Review

1. What are the four types of epithelial tissues and can you describe their function?
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________

2. Between mucus and mucous, which is the adjective and which is the noun? Explain your answer.

3. In diabetic patients, what molecule is missing in the transport system? Explain why tissue damage is so common in diabetics.

4. Identify the type of membrane that produces a serum-like lubricating fluid that lines body cavities or surrounds organs and give 3 examples.
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________
   ___________________________________________________________________

5. What type of tissue is blood classified as?

6. List the proper order for the hierarchy of organization starting with molecules.
   A. Molecules
   B. ___________________________
   C. ___________________________
   D. ___________________________
   E. ___________________________
   F. ___________________________

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7. This type of membrane

8. Define the word synovium and where do you find it?

9. What is the function of cilia and where do you find it?

10. Explain why cuboidal cells would not work as well as squamous cells in the alveoli of the lungs.

11. Explain why injuries to dense connective tissue, such as to tendons or ligaments, take a long time to heal. How does this differ from nervous tissue?

12. What is the scientific name for nerve cells?

13. What two systems are responsible for controlling the activities of other structures of the body?
   a. _________________________________
   b. _________________________________

14. What is the filler material that makes up the matrix in majority of the connective tissue?

15. Why is there close correlation with skin cells and cancer cells?
Histology: A Study of Tissues Exam

MATCHING: Circle the best answer

1. Which membrane produces serum-like, friction-reducing fluid that lines internal cavities and covers organs?

2. Identify the most appropriate cell type for the function of diffusion of gasses.
   a. Stratified squamous   b. Simple columnar   c. Simple cuboidal   d. Simple squamous

3. This type of tissue is designed with tough fibrous collagen layers made to join tough structures together.

4. The side of the serous membrane that directly attaches to an organ is the

5. Meaning “with egg consistency,” this viscous fluid creates a friction-reducing surface.

6. Designed best for absorption, this type of tissue has cells arranged into convoluted finger-like projections that line the gastrointestinal system.

7. Simple squamous epithelium is best designed for ______________ of gases such as in the alveoli of the lungs.

8. Cutaneous tissue and cancer cells are similar in that they are both constantly:

9. This type of membrane is used for lubrication, for trapping and protection, and is found in many areas such as the digestive system and respiratory system.
10. Pseudostratified ciliated epithelium is found in the:
   a. Fallopian tubes
   b. Upper respiratory system
   c. Both a and b
   d. None of the above

Matching:

11. _____ Muscular   a. Used for lining and protection
12. _____ Connective   b. Used for movement and transport
13. _____ Epithelial   c. Designed for communication and support
14. _____ Nervous   d. Designed for structural support

Short Answer:

15. What are the three types of muscle tissue and explain why some muscle types have more mitochondria than others?

16. Can you explain why many diabetics’ blood cholesterol levels increase after chronic ketosis? Where does the cholesterol come from, even if the patient is following a prudent diet?
Histology: A Study of Tissues Exam- Key

1. C
2. D
3. D
4. C
5. B
6. C
7. C
8. B
9. D
10. C
11. B
12. D
13. A
14. C

15 & 16: Answers will vary