Classification of Tissues

Time Allotment: 2 hours.


Eroschenko’s Interactive Histology (DE: CD-ROM)
Practice Anatomy Lab™ 3.0 (PAL) (PE: DVD, Website)

Laboratory Materials

Ordering information is based on a lab size of 24 students, working in groups of 4. A list of supply house addresses appears in Appendix A.

- 24 compound microscopes, lens paper, lens cleaning solution, immersion oil
- 24 slides of simple squamous, simple cuboidal, simple columnar, stratified squamous (non-keratinized), stratified cuboidal, stratified columnar, pseudostratified ciliated columnar, and transitional epithelium
- 24 slides of mesenchyme; adipose, areolar, reticular, and dense connective tissue, regular (tendon) and irregular (dermis); hyaline cartilage, elastic cartilage, fibrocartilage; bone (cross section); and blood smear
- 24 slides of skeletal, cardiac, and smooth muscle (longitudinal sections)
- 24 slides of nervous tissue (spinal cord smear)
- 6 envelopes containing color images of epithelial tissues
- 6 envelopes containing color images of connective tissues, nervous tissue, and muscle tissues
- 6 envelopes containing a color image of a section of the trachea

Advance Preparation

1. Set out prepared slides of simple squamous, simple cuboidal, simple columnar, stratified squamous (non-keratinized), stratified cuboidal, stratified columnar, pseudostratified ciliated columnar, and transitional epithelium.
2. Set out prepared slides of mesenchyme; adipose tissue, areolar connective tissue, reticular connective tissue, dense connective tissue regular (tendon), and irregular (dermis) varieties; hyaline cartilage, elastic cartilage, and fibrocartilage; bone (cross section); and blood smear.
3. Set out prepared slides of skeletal, cardiac, and smooth muscle (longitudinal sections).
4. Set out prepared slides of spinal cord smear.
5. Set out lens paper and lens cleaning solution. Have compound microscopes available.
6. For Group Challenge 1, obtain 6 medium brown envelopes. Using old histology atlases or lab manuals, cut out several color images of each of the epithelial tissues. Place various examples of the tissues in each of the 6 envelopes. You need not include all of the tissues in each envelope. Distribute 1 envelope to each group after they have studied the epithelial tissues.
7. For Group Challenge 2, obtain 6 medium brown envelopes. Using old histology atlases or lab manuals, cut out several color images of each of the connective tissues, nervous tissue, and each of the muscle tissues. Place various examples of the tissues in each of the 6 envelopes. You need not include all of the tissues in each envelope. Distribute 1 envelope to each group after they have studied the connective tissues, nervous tissue, and the muscle tissues. For the second part of this Group Challenge, obtain 6 more medium brown
envelopes. Using old histology atlases or lab manuals, cut out a color image of a section of the trachea. As you proceed away from the luminal side of the tissue, you should see ciliated pseudostratified columnar epithelium, areolar connective tissue of the lamina propria, epithelial tissue of the submucosal glands, and hyaline cartilage. Give this envelope to each group at the end of the study of tissues.

Comments and Pitfalls

1. Slides of the lung are suggested for simple squamous epithelium, and slides of the kidney are suggested for simple cuboidal epithelium. An analogy using a quarter or pavement stone will help students visualize the 3-dimensional shape of a squamous cell.
2. The dense fibrous regular connective tissue slide is sometimes labeled white fibrous tissue.
3. Students may have trouble locating the appropriate tissue on slides with multiple tissue types. Encourage them to consult lab manual Figures 6.3–6.7, available histology texts, and each other for help.
4. A television camera with a microscope adapter and monitor is very useful in this lab. By watching the monitor, students can observe the instructor locating the correct area of tissue on the slide (see item 3 in Comments and Pitfalls). It also makes it easier to answer student questions and share particularly good slides with the class.
5. Use the final envelope containing a section of the tracheal wall to help students understand how tissues are organized to form an organ. Encourage them as they look at this complicated image; tell them to start at the luminal surface and look at each tissue carefully.

Answers to Pre-Lab Quiz (p. 67)

1. d, tissues 6. c, neurons
2. 4 7. true
3. true 8. neurons
4. c, squamous 9. 3
5. c, mesenchyme 10. c, smooth

Answer to Group Challenge 1 (pp. 74–75)

<table>
<thead>
<tr>
<th>Magnified Appearance</th>
<th>Tissue Type</th>
<th>Locations in the Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Apical surface has dome-shaped cells (flattened cells may also be mixed in).</td>
<td>Transitional epithelium</td>
<td>Urinary bladder, ureters, and part of the urethra</td>
</tr>
<tr>
<td>• Multiple layers of cells are present.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Cells are mostly columnar.</td>
<td>Pseudostratified (ciliated) columnar epithelium</td>
<td>Trachea and most of the upper respiratory tract</td>
</tr>
<tr>
<td>• Not all cells reach the apical surface.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Nuclei are located at different levels.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Cilia are located at the apical surface.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Apical surface has flattened cells with very little cytoplasm.</td>
<td>Simple squamous epithelium</td>
<td>Alveoli (air sacs of the lungs), blood vessels, lymphatic vessels, lining of the heart, lining of the ventral body cavity</td>
</tr>
<tr>
<td>• Cells are not layered.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Apical surface has square cells with a round nucleus.</td>
<td>Simple cuboidal epithelium</td>
<td>Kidney tubules, ducts of small glands, surface of the ovary</td>
</tr>
<tr>
<td>• Cells are not layered.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Answers to Activity Questions

Activity 2: Examining Connective Tissue Under the Microscope (p. 82)
All connective tissues consist of cells located within a matrix. Blood is no exception, but its cells float freely in a liquid matrix. The matrix ground substance is the straw-colored fluid called plasma. Its proteins are soluble, rather than fibrous, and include albumin, globulins, and fibrinogen.

Answer to Group Challenge 2 (p. 83)

<table>
<thead>
<tr>
<th>Magnified Appearance</th>
<th>Tissue Type</th>
<th>Locations in the Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Large, round cells are densely packed. &lt;br&gt;• Nucleus is pushed to one side.</td>
<td>Adipose tissue</td>
<td>Under the skin, around kidneys and eyeballs, within the abdomen, in breasts</td>
</tr>
<tr>
<td>• Lacunae (small cavities within the tissue) are present. &lt;br&gt;• Lacunae are not arranged in a concentric circle. &lt;br&gt;• No visible fibers are in the matrix.</td>
<td>Hyaline cartilage</td>
<td>Embryonic skeleton, the ends of long bones, costal cartilage (ribs), nose, trachea, larynx</td>
</tr>
<tr>
<td>• Fibers and cells are loosely packed with visible space between fibers. &lt;br&gt;• Fibers overlap but do not form a network.</td>
<td>Areolar connective tissue</td>
<td>Key type of connective tissue located beneath epithelia</td>
</tr>
<tr>
<td>• Extracellular fibers run parallel to each other. &lt;br&gt;• Nuclei of fibroblasts are visible.</td>
<td>Dense regular connective tissue</td>
<td>Tendons and ligaments</td>
</tr>
<tr>
<td>• Lacunae are sparsely distributed. &lt;br&gt;• Lacunae are not arranged in a concentric circle. &lt;br&gt;• Fibers are visible and fairly organized.</td>
<td>Fibrocartilage</td>
<td>Intervertebral discs, pubic symphysis, discs of the knee joint</td>
</tr>
<tr>
<td>• Tapered cells with darkly stained nucleus centrally located are seen. &lt;br&gt;• No striations are present. &lt;br&gt;• Cells are layered to form a sheet.</td>
<td>Smooth muscle</td>
<td>The walls of hollow organs</td>
</tr>
</tbody>
</table>
Tissue Structure and Function—General Review

1. Define tissue. A group of cells similar to one another in structure that perform a common or related function.

2. Use the key choices to identify the major tissue types described below.

   Key: a. connective tissue   b. epithelium   c. muscle   d. nervous tissue

   b; epithelium  1. lines body cavities and covers the body’s external surface
   c; muscle  2. pumps blood, flushes urine out of the body, allows one to swing a bat
   d; nervous c; muscle  3. transmits electrical signals
   a; connective  4. anchors, packages, and supports body organs
   b; epithelium  5. cells may absorb, secrete, and filter
   d; nervous  6. most involved in regulating and controlling body functions
   c; muscle  7. major function is to contract
   b; epithelium  8. synthesizes hormones
   a; connective  9. the most durable tissue type
   a; connective  10. abundant nonliving extracellular matrix
   a; connective  11. most widespread tissue in the body
   d; nervous  12. forms nerves and the brain

Epithelial Tissue

3. Describe five general characteristics of epithelial tissue. The cells fit closely together, forming sheetlike membranes. Little intercellular material between the cells. Avascular. Membrane has a free edge. Generally has a high regenerative capacity.

4. On what basis are epithelial tissues classified? Number of layers and cell shape.
5. List five major functions of epithelium in the body, and give examples of each.

Function 1: **protection**  
Example: **skin**

Function 2: **absorption**  
Example: **cells lining digestive tract**

Function 3: **filtration and secretion**  
Example: **kidney tubule cells**

Function 4: **secretion**  
Example: **glandular cells or kidney cells**

Function 5: **sensory reception**  
Example: **free endings of sensory neurons**

6. How does the function of stratified epithelia differ from the function of simple epithelia? **Stratified epithelia have more layers for protection. Simple epithelia allow materials to move across them and are less protective.**

7. Where is ciliated epithelium found? **Lining of the trachea and upper respiratory tract and of the female reproductive tracts (uterine tubes)**

What role does it play? **In the respiratory tract, it acts to sweep mucus superiorly away from the lungs. In the reproductive tracts, it acts to propel ova along the tract.**

8. Transitional epithelium is actually stratified squamous epithelium with special characteristics.

How does it differ structurally from other stratified squamous epithelia? **When stretched, its top layers are squamous, but when not stretched, its top layers are pillow shaped.**

How does the structural difference support its function? **The surface cells have the ability to slide over one another, increasing the internal volume of the organ (e.g., bladder) as it fills and maintaining an intact lining whether stretched or contracted.**

9. How do the endocrine and exocrine glands differ in structure and function? **Endocrine glands are ductless glands. They produce hormones, which are liberated into the extracellular fluid to enter the blood. Exocrine glands maintain their ducts and manufacture secretions of various types (perspiration, oil, digestive enzymes, etc.), which are ducted to the body (or membrane) surface.**

10. Respond to the following with the key choices. Some tissues are used more than once.

Key:  
a. simple squamous  
b. simple cuboidal  
c. simple columnar  
d. pseudostratified ciliated columnar  
e. stratified squamous  
f. transitional

**Answers:**
e; stratified squamous  
c; simple columnar  
a; simple squamous  
b; simple cuboidal  
1. lining of the esophagus  
2. lining of the stomach  
3. alveolar sacs of lungs  
4. tubules of the kidney
Connective Tissue

11. What are three general characteristics of connective tissues? Common origin of connective tissue from mesenchyme, varied degrees of vascularity, and a large amount of extracellular matrix that varies with tissue type.

12. What functions are performed by connective tissue? Protection, support, and the binding together of other body tissues. Transportation of substances within the body is another function.

13. How are the functions of connective tissue reflected in its structure? There is a wide variety in the structures of connective tissue. This is reflected in the wide variety of functions they perform. Also, the large amount of nonliving matrix seen provides the strength needed to protect the body and carry out the normal functions of the body.

14. Using the key, choose the best response to identify the connective tissues described below. Some tissues are used more than once.

Key: a. adipose connective tissue b. areolar connective tissue c. dense fibrous connective tissue d. elastic cartilage e. elastic connective tissue f. fibrocartilage g. hematopoietic tissue h. hyaline cartilage i. osseous tissue

1. attaches bones to bones and muscles to bones
2. insulates against heat loss
3. the dermis of the skin
4. makes up the intervertebral discs
5. forms the hip bone
6. composes basement membranes; a soft packaging tissue with a jellylike matrix
7. forms the larynx, the costal cartilages of the ribs, and the embryonic skeleton
8. provides a flexible framework for the external ear
9. firm, structurally amorphous matrix heavily invaded with fibers; appears glassy and smooth
10. matrix hard owing to calcium salts; provides levers for muscles to act on
11. acts as storage depot for fat
12. walls of large arteries

15. Why do adipose cells remind people of a ring with a single jewel? They contain a large fat-filled vacuole occupying most of the cell volume. The nucleus is pushed to the periphery, giving the cell a “signet ring” appearance.
Nervous Tissue

16. What two physiological characteristics are highly developed in neurons (nerve cells)? __Irritability and conductivity__

17. In what ways are neurons similar to other cells? __They contain a nucleus and the usual organelles.__

How are they different? __Their cytoplasm is drawn out into long processes.__

18. Describe how the unique structure of a neuron relates to its function in the body.

_**Neurons conduct impulses over relatively long distances in the body. This is facilitated by their long cytoplasmic extensions.**_

Muscle Tissue

19. The three types of muscle tissue exhibit similarities as well as differences. Check the appropriate space in the chart to indicate which muscle types exhibit each characteristic.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Skeletal</th>
<th>Cardiac</th>
<th>Smooth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voluntarily controlled</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Involuntarily controlled</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Striated</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Has a single nucleus in each cell</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Has several nuclei per cell</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Found attached to bones</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Allows you to direct your eyeballs</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Found in the walls of the stomach, uterus, and arteries</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Contains spindle-shaped cells</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Contains branching cylindrical cells</td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Contains long, nonbranching cylindrical cells</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Has intercalated discs</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Concerned with locomotion of the body as a whole</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Changes the internal volume of an organ as it contracts</td>
<td></td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Tissue of the heart</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
For Review

20. Label the tissue types illustrated here and on the next pages, and identify all structures provided with leaders.

(a) Simple columnar epithelial

(b) Pseudostratified ciliated columnar epithelial

(c) Stratified squamous epithelial

(d) Transitional epithelial

(e) Areolar connective tissue

(f) Dense fibrous connective tissue, or dense regular connective tissue
Nuclei of fat cells
Vacuole containing fat droplet

Canaliculi
Lacuna
Matrix

Matrix
Chondrocyte
Lacunae

Smooth muscle tissue
Nuclei

Nuclei

Skeletal muscle fiber (cell)

Intercalated discs
Nucleus of cardiac muscle cell

(g) Bone (osseous tissue)
(h) Hyaline cartilage
(i) Adipose tissue
(j) Smooth muscle tissue
(k) Skeletal muscle tissue
(l) Cardiac muscle tissue