CHAPTER 4

Tissue: The Living Fabric: Part B
Warm Up 9/27/17

- Distinguish between **Connective** Tissue and **Epithelial** Tissue:
  - Explain what each tissue type is (ex. What makes an epithelial tissue an epithelial tissue? Connective?)
  - What are examples of each?
  - What are distinguishable characteristics of each?

Take out your 4B notes!
Connective Tissue

• Most abundant and widely distributed tissue type

• Four classes
  • Connective tissue proper
  • Cartilage
  • Bone tissue
  • Blood
<table>
<thead>
<tr>
<th>CONNECTIVE TISSUE AND EXAMPLE</th>
<th>SUBCLASSES</th>
<th>BONE TISSUE</th>
<th>SUBCLASSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connective Tissue Proper</td>
<td>1. Loose connective tissue</td>
<td></td>
<td>1. Compact bone</td>
</tr>
<tr>
<td></td>
<td>▪ Areolar</td>
<td></td>
<td>2. Spongy bone</td>
</tr>
<tr>
<td></td>
<td>▪ Adipose</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Reticular</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Dense connective tissue</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Regular</td>
<td>Compact bone</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Irregular</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Elastic</td>
<td>Blood</td>
<td>Blood cell formation and differentiation are quite complex.</td>
</tr>
<tr>
<td>Cartilage</td>
<td>1. Hyaline cartilage</td>
<td></td>
<td>Details are provided in Chapter 17.</td>
</tr>
<tr>
<td></td>
<td>2. Elastic cartilage</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Fibrocartilage</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Hyaline cartilage

Table 4.1
Comparison of Classes of Connective Tissues
Major Functions of Connective Tissue

- Binding and support
- Protection
- Insulation
- Transportation (blood)
Characteristics of Connective Tissue

• Connective tissues have:
  • Mesenchyme as their common tissue of origin
  • Varying degrees of vascularity
  • Cells separated by nonliving extracellular matrix (ground substance and fibers)
Structural Elements of Connective Tissue

• Ground substance
  • Medium through which solutes diffuse between blood capillaries and cells
• Components:
  • Interstitial fluid
  • Adhesion proteins ("glue")
  • Proteoglycans
    • Protein core + large polysaccharides (chondroitin sulfate and hyaluronic acid)
    • Trap water in varying amounts, affecting the viscosity of the ground substance
Structural Elements of Connective Tissue

- Three types of fibers
  - Collagen (white fibers)
    - Strongest and most abundant type
    - Provides high tensile strength
  - Elastic
    - Networks of long, thin, elastin fibers that allow for stretch
  - Reticular
    - Short, fine, highly branched collagenous fibers
Structural Elements of Connective Tissue

- Cells
  - Mitotically active and secretory cells = “blasts”
  - Mature cells = “cytes”
    - Fibroblasts in connective tissue proper
    - Chondroblasts and chondrocytes in cartilage
    - Osteoblasts and osteocytes in bone
    - Hematopoietic stem cells in bone marrow
    - Fat cells, white blood cells, mast cells, and macrophages
Figure 4.7

Cell types

- Macrophage
- Fibroblast
- Lymphocyte
- Fat cell
- Mast cell
- Neutrophil

Extracellular matrix

Ground substance

Fibers

- Collagen fiber
- Elastic fiber
- Reticular fiber

Capillary
Connective Tissue: Embryonic

• Mesenchyme—embryonic connective tissue
  • Gives rise to all other connective tissues
  • Gel-like ground substance with fibers and star-shaped mesenchymal cells
Overview of Connective Tissues

• For each of the following examples of connective tissue, note:
  • Description
  • Function
  • Location
Connective Tissue Proper

- **Types:**
  - Loose connective tissue
    - Areolar
    - Adipose
    - Reticular
  - Dense connective tissue
    - Dense regular
    - Dense irregular
    - Elastic
Connective tissue proper; loose - AREOLAR

(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 (300x).

Figure 4.8a
(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 in the hypodermis; around kidneys and eyeballs; within abdomen; in breasts.

**Photomicrograph:** Adipose tissue from the subcutaneous layer under the skin (350x).
(c) **Connective tissue proper: loose connective tissue, reticular**

**Description:** Network of reticular fibers in a typical loose ground substance; reticular cells lie on the network.

**Function:** Fibers form a soft internal skeleton (stroma) that supports other cell types including white blood cells, mast cells, and macrophages.

**Location:** Lymphoid organs (lymph nodes, bone marrow, and spleen).

**Photomicrograph:** Dark-staining network of reticular connective tissue fibers forming the internal skeleton of the spleen (350x).
(d) Connective tissue proper: dense connective tissue, dense regular

Description: Primarily parallel collagen fibers; a few elastic fibers; major cell type is the fibroblast.

Function: Attaches muscles to bones or to muscles; attaches bones to bones; withstands great tensile stress when pulling force is applied in one direction.

Location: Tendons, most ligaments, aponeuroses.

Photomicrograph: Dense regular connective tissue from a tendon (500x).
**DENSE IRREGULAR**

(e) Connective tissue proper: dense connective tissue, dense irregular

**Description:** Primarily irregularly arranged collagen fibers; some elastic fibers; major cell type is the fibroblast.

**Function:** Able to withstand tension exerted in many directions; provides structural strength.

**Location:** Fibrous capsules of organs and of joints; dermis of the skin; submucosa of digestive tract.

**Photomicrograph:** Dense irregular connective tissue from the dermis of the skin (400x).
**Connective tissue proper; dense - ELASTIC**

---

**Description:** Dense regular connective tissue containing a high proportion of elastic fibers.

**Function:** Allows recoil of tissue following stretching; maintains pulsatile flow of blood through arteries; aids passive recoil of lungs following inspiration.

**Location:** Walls of large arteries; within certain ligaments associated with the vertebral column; within the walls of the bronchial tubes.

---

**Photomicrograph:** Elastic connective tissue in the wall of the aorta (250x).
Connective Tissue: Cartilage

• Three types of cartilage:
  • Hyaline cartilage
  • Elastic cartilage
  • Fibrocartilage
(g) Cartilage: hyaline

**Description:** Amorphous but firm matrix; collagen fibers form an imperceptible network; chondroblasts produce the matrix and when mature (chondrocytes) lie in lacunae.

**Function:** Supports and reinforces; has resilient cushioning properties; resists compressive stress.

**Location:** Forms most of the embryonic skeleton; covers the ends of long bones in joint cavities; forms costal cartilages of the ribs; cartilages of the nose, trachea, and larynx.

**Photomicrograph:** Hyaline cartilage from the trachea (750x).
Cartilage - ELASTIC

(h) Cartilage: elastic

Description: Similar to hyaline cartilage, but more elastic fibers in matrix.

Function: Maintains the shape of a structure while allowing great flexibility.

Location: Supports the external ear (pinna); epiglottis.

Photomicrograph: Elastic cartilage from the human ear pinna; forms the flexible skeleton of the ear (800x).
(i) Cartilage: fibrocartilage

**Description:** Matrix similar to but less firm than that in hyaline cartilage; thick collagen fibers predominate.

**Function:** Tensile strength with the ability to absorb compressive shock.

**Location:** Intervertebral discs; pubic symphysis; discs of knee joint.

**Photomicrograph:** Fibrocartilage of an intervertebral disc (125x). Special staining produced the blue color seen.
**Others - Bone**

(j) **Others: bone (osseous tissue)**

**Description:** Hard, calcified matrix containing many collagen fibers; osteocytes lie in lacunae. Very well vascularized.

**Function:** Bone supports and protects (by enclosing); provides levers for the muscles to act on; stores calcium and other minerals and fat; marrow inside bones is the site for blood cell formation (hematopoiesis).

**Location:** Bones

**Photomicrograph:** Cross-sectional view of bone (125x).
(k) Others: blood

**Description:** Red and white blood cells in a fluid matrix (plasma).

**Function:** Transport of respiratory gases, nutrients, wastes, and other substances.

**Location:** Contained within blood vessels.

**Photomicrograph:** Smear of human blood (1860x); two white blood cells (neutrophil in upper left and lymphocyte in lower right) are seen surrounded by red blood cells.
Quick Review!!
Tissue Lab Part 2 Connective Tissue Day!

(Slides 6-11) (Questions 9-15) **SKIP #13**

→ Share pics of your slides on social media!

*If you need to makeup and Epithelial slides from last lab... now’s the time!

**PRACTICE focusing the microscope!!!**
When you’re finished…

→ Return all slides, microscopes, and class copies

→ You should be finished with questions 1-15 as of today (for pacing)

→ You should have labeled and colored pictures of slides 1-11 as of today!

After you’ve done this - you may start tissue note cards

Set 2

Running Packet Checklist

1. Body Map
2. Tissue Introduction
3. Unit 2 Guide
4. 4A Notes
5. Microscope Intro Lab
6. Nose Stem Cell Article and Questions
7. Modeling Epithelial Tissues Activity/?s
8. Tissue Notecards
9. Cancer Article Exchange
10. Tissue Lab (Parts 1-4)
What are the 4 major types of connective tissue? List any subdivisions of these categories...

- Create a mind map or chart to represent the different classifications of connective tissue.
- At first, try not to use your notes – remember what you can! Then feel free to use your 4B notes.
Connective Tissue Proper -

**Loose:** Areolar, Adipose, Reticular

**Dense:** Dense Regular, Dense Irregular, Elastic

**Cartilage** -
Hyaline, Elastic, Fibrocartilage

**Bone** - Osseous Tissue

**Blood**
Four Corners…

**Front Left**  
I feel AWESOME about this!  
*I should be teaching this class 😊*

**Front Right**  
I need some help,  
*but I’m starting to get it…*

**Back Left**  
I feel okay with this… need to study a little more!

**Back Right**  
I don’t understand this AT ALL (yet;))
Nervous Tissue

• Nervous system (more detail with the Nervous System, Chapter 11)
**Nervous tissue**

**Description:** Neurons are branching cells; cell processes that may be quite long extend from the nucleus-containing cell body; also contributing to nervous tissue are nonirritable supporting cells (not illustrated).

**Function:** Transmit electrical signals from sensory receptors and to effectors (muscles and glands) which control their activity.

**Location:** Brain, spinal cord, and nerves.

**Photomicrograph:** Neurons (350x)
Muscle Tissue

• Skeletal muscle (more detail with the Muscular System, Chapter 10)
**Description:** Long, cylindrical, multinucleate cells; obvious striations.

**Function:** Voluntary movement; locomotion; manipulation of the environment; facial expression; voluntary control.

**Location:** In skeletal muscles attached to bones or occasionally to skin.

**Photomicrograph:** Skeletal muscle (approx. 460x).
Notice the obvious banding pattern and the fact that these large cells are multinucleate.
Muscle Tissue

• Cardiac muscle (more detail with the Cardiovascular System, Chapters 18 and 19)
**Description:** Branching, striated, generally uninucleate cells that interdigitate at specialized junctions (intercalated discs).

**Function:** As it contracts, it propels blood into the circulation; involuntary

**Location:** The walls of the heart.

**Photomicrograph:** Cardiac muscle (500X); notice the striations, branching of cells, and the intercalated discs.
Muscle Tissue

- Smooth muscle
(c) Smooth muscle

**Description:** Spindle-shaped cells with central nuclei; no striations; cells arranged closely to form sheets.

**Function:** Propels substances or objects (foodstuffs, urine, a baby) along internal passageways; involuntary control.

**Location:** Mostly in the walls of hollow organs.

**Photomicrograph:** Sheet of smooth muscle (200x).
Epithelial Membranes

• Cutaneous membrane (skin) (More detail with the Integumentary System, Chapter 5)
(a) Cutaneous membrane (the skin) covers the body surface.
Epithelial Membranes

• Mucous membranes
  • Mucosae
  • Line body cavities open to the exterior (e.g., digestive and respiratory tracts)
(b) Mucous membranes line body cavities open to the exterior.
Epithelial Membranes

• Serous Membranes
  • Serosae—membranes (mesothelium + areolar tissue) in a closed ventral body cavity
  • Parietal serosae line internal body walls
  • Visceral serosae cover internal organs
(c) Serous membranes line body cavities closed to the exterior.
Steps in Tissue Repair

• Inflammation
  • Release of inflammatory chemicals
  • Dilation of blood vessels
  • Increase in vessel permeability
  • Clotting occurs
Inflammation sets the stage:
- Severed blood vessels bleed and inflammatory chemicals are released.
- Local blood vessels become more permeable, allowing white blood cells, fluid, clotting proteins and other plasma proteins to seep into the injured area.
- Clotting occurs; surface dries and forms a scab.
Steps in Tissue Repair

- Organization and restored blood supply
  - The blood clot is replaced with granulation tissue
  - Epithelium begins to regenerate
  - Fibroblasts produce collagen fibers to bridge the gap
  - Debris is phagocytized
Organization restores the blood supply:
- The clot is replaced by granulation tissue, which restores the vascular supply.
- Fibroblasts produce collagen fibers that bridge the gap.
- Macrophages phagocytize cell debris.
- Surface epithelial cells multiply and migrate over the granulation tissue.
Steps in Tissue Repair

• Regeneration and fibrosis
  • The scab detaches
  • Fibrous tissue matures; epithelium thickens and begins to resemble adjacent tissue
  • Results in a fully regenerated epithelium with underlying scar tissue
Regeneration and fibrosis effect permanent repair:
- The fibrosed area matures and contracts; the epithelium thickens.
- A fully regenerated epithelium with an underlying area of scar tissue results.
Developmental Aspects

- Primary germ layers: ectoderm, mesoderm, and endoderm
  - Formed early in embryonic development
  - Specialize to form the four primary tissues
    - Nerve tissue arises from ectoderm
    - Muscle and connective tissues arise from mesoderm
    - Epithelial tissues arise from all three germ layers
16-day-old embryo (dorsal surface view)

- Ectoderm
- Mesoderm
- Endoderm

Muscle and connective tissue (mostly from mesoderm)

Nervous tissue (from ectoderm)

Epithelium