

## Lab 4

### Connective Tissue, Muscle Tissue, and Nervous Tissue

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#### **Slide 1-3-5 Areolar Loose Connective Tissue (1) and (2) and (3):**

\*Some slides are presented after being “teased”, which means the fibers are separated to visualize them easier.

#### □ **Areolar Loose Connective Tissue**

— “*Areolar*” means “*a small open space*” which refers to the loose arrangement of fibers, cells and ground substance.

— Functions:

- is the space deep to all types of epithelium where interstitial fluid accumulates after it leaks from capillaries. Too much fluid here is called **Edema**.
- lymphatic capillaries would reabsorb this interstitial fluid and eventually return about 3 Liters per day to the Brachiocephalic Veins in your chest.
- WBCs (such as macrophages) phagocytize and activate the immune system if microbes gain access to this normally sterile tissue. Cancer cells and infections can metastasize and spread through this tissue.

— Common Locations:

- Lamina Propria (found deep to the epithelium of mucous membranes)
- surrounds all Capillaries
- under all epithelia types
- the thin surface covering of organs

#### □ **Collagen Fibers**

— thick, pink fibers with tensile properties like rope.

#### □ **Elastic Fibers**

— thin, purple fibers with tensile properties like rubber bands.

#### □ **Reticular Fibers**

— NOT easily visible on the slide. Have a branch pattern.

#### □ **Fibroblasts**

— dark purple nuclei easily seen. Cell makes all 3 fiber types.

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**Slide 1-3-6 Adipose Loose Connective Tissue (1) and (2):**

□ **Adipose Loose Connective Tissue**

— Very, very little matrix is visible, but technically it is the same as seen in areolar loose connective tissue, but the fibers are not easily visible.

□ **Adipocytes (or lipocytes)**

— Adipocyte cells (“fat cells”) are closely packed together.  
— nuclei of these cells are squished flat and pushed to the cell’s periphery by the large vacuole filled with **fat (lipids)** which are mostly **triglycerides** and **cholesterol esters**.

— Size: 50 µm to about 200 µm (*these bigger ones are visible without a microscope!*)

— Two Types:

- **White Adipose Loose Connective Tissue**

- this slide is of White Adipose Loose C.T.

- **Brown Adipose Loose Connective Tissue**

- no slide of this in the lab.

- darker color is due to the large amount of mitochondria (used to generate heat).

— Functions:

- **Food reserve**
- **Insulation**
- Support organs
- Protect organs

— Common Locations:

- **Hypodermis** (Superficial Fascia) of the Skin
- around many organs like the eye and kidney.
- Epiploic Appendages (on the Large Intestine)
- in the **Breasts**.

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**Slide 1-3-7 Reticular Loose Connective Tissue (1) and (2) and (3):**

□ **Reticular Loose Connective Tissue**

— “*Reticulum*” means “*branchy net or network*.”

— Reticular fibers are very, very thin and can be blue in with certain stains. My nickname for it is “*the blue sticker bush*”.

— sometimes it is called “Stroma” (meaning “bed or mattress”) because it forms the internal framework of solid organs for WBCs to move around on.

— Functions:

- forms the **Stroma** some solid organs.

— Common Locations:

- Stroma inside the **Lymph Nodes**
- **Bone Marrow**
- Stroma inside the **Spleen**

□ **Reticular Fibers**

— Reticular fibers are made by special fibroblasts called **reticular cells**. These reticular cells are very hard to see among all the other **WBCs** (mostly **lymphocytes**) present.

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## **Slide 1-4-1 Dense Regular Connective Tissue:**

### □ **Dense Regular Connective Tissue**

- large number of parallel bundles of **Collagen Fibers**.
- very few Elastic Fibers are present (not easily visible on slide)
- **Fibroblasts** with flattened purple nuclei are seen between the collagen fibers.
- DRCT has a very poor blood supply which is why it heals slowly and poorly.
- Tip: *sometimes this tissue is confused with Smooth Muscle*.
- divided into 2 forms:
  - “white fibrous connective tissue”
    - has very, very few elastic fibers in it.
    - this is the type seen in Slide 1-4-1.
    - Location: Tendons & Aponeuroses.
  - “yellow fibrous connective tissue”
    - has more elastic fibers in it making it yellow when seen in surgery or on a cadaver..
    - Location: Ligaments & Aponeuroses.
- comes in 2 arrangements:
  - cords (like a “rope”) — tendons & ligaments
  - sheath (like a “sheet”) — aponeuroses
- Functions:
  - attaches muscles to bone (tendon).
  - attaches bone to bone (ligament).
  - withstands tension forces along its length (1 direction).
- Common Locations:
  - **Tendons** (attach muscles to bone)
  - **Ligaments** (attach bone to bone)
  - **Aponeuroses** (join muscles to bone or muscle)

### □ **Type I Collagen Fibers**

- large number of parallel bundles of **Collagen Fibers**.
- 90% of the Collagen Fibers in your body are Type I collagen.

### □ **Fibroblasts**

- dark, purple, flat nuclei easily seen in between the collagen fibers.

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### Slide 1-4-2 Dense Irregular Connective Tissue:

□ **Dense Irregular Connective Tissue**

- large number of irregularly arranged **Collagen Fibers**.
- very few Elastic Fibers are present (not easily visible on slide)
- **Fibroblasts** with flattened purple nuclei are seen between the collagen fibers.
- DICT has a better blood supply than DRCT which is why it has a good chance to heal (regenerate) with minimal scarring.
- Functions:
  - withstands tension forces in *many* directions.
  - provides structural strength (like the fibers in duct tape)
- Common Locations:
  - **Fibrous Capsule** of some organs (kidney, Lymph node, spleen, etc...)
  - **Fibrous Capsule** of Synovial Joints.
  - **Reticular Layer of the Dermis**
    - this is the place for *tattoo ink*.
    - this is the place for *stretch marks (striae)*.
    - this is the place *stitches & staples* grip.
  - submucosa of the digestive tract

□ **Type I Collagen Fibers**

- large number of irregularly arranged **Collagen Fibers**.
- 90% of the Collagen Fibers in your body are Type I collagen.

□ **Fibroblasts**

- dark, purple, flat nuclei easily seen in between the collagen fibers.

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### Slide 1-4-3 Dense Elastic Connective Tissue:

□ **Dense Elastic Connective Tissue**

- Dense Regular Connective Tissue + a lot of Elastic Fibers !!!
- Functions:
  - allows for the *stretch & recoil* of tissues just like a rubber band or bungie cord.
  - this tissue in the wall of elastic and muscular arteries is what allows you to have a pulse (with a systolic and diastolic pressure).
  - allows for the lungs to have passive recoil to make expiration easier.
- Common Locations:
  - muscular walls of elastic arteries (e.g., aorta).
  - in some ligaments of the vertebral column
  - in the walls of the bronchial tubes
- dark, purple, flat nuclei NOT easily seen in this tissue.
- produced by fibroblasts and smooth muscle cells.
- appear as thin dark purple strings in this slide.
- *can stretch up to 1.5 times their length before recoiling.*

□ **Fibroblasts**

□ **Elastic Fibers**

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**Slide 1-4-5 Hyaline Cartilage:**

□ **Hyaline Cartilage**

- “*hyaline*” is a word derived from Greek that means “*glass-like, transparent, or crystal-like*”. *Hyaline Cartilage in a cadaver or in surgery looks “frosted white/blue” to “pearly-grey” in color.*
- *in synovial joints, hyaline cartilage has a kinetic coefficient of friction of 0.003, which is lower than that of ice (0.02 to 0.09)! The surface of healthy Hyaline Cartilage is very, very slippery!*

— Functions:

- supports & reinforces surrounding tissues
- has **resilient cushioning properties** (like a sponge filled with gel).
- **resists compressive stress.**
- **can absorb fluid (like a sponge).**

— Common Locations:

- most of the **embryonic skeleton**
- synovial joint surfaces
- costal cartilages (how the ribs connect to the sternum).
- **nose cartilage**
- **tracheal ring cartilages**
- **laryngeal cartilages**
- **parts of the growth plate (epiphyseal plate)**

□ **Chondrocytes in Lacunae**

- “lacuna” (plural: lacunae) is Latin for “gap”. It is a space, “cavity” or “depression” with a chondrocyte in it.
- lacunae are “*randomly*” spaced throughout the matrix.
- matrix has very fine collagen fibers (mostly **Type II collagen fibers**).

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**Slide 1-5-1 Elastic Cartilage (1) and (2):**

□ **Elastic Cartilage**

- has a mixture of **Type II Collagen fibers & Elastic Fibers** in the matrix.
- Elastic fibers appear dark purple with the Van Gieson stain, some slides are just H&E stained so the fibers look dark pink.
- Elastic Cartilage looks yellow (due to the elastic fibers) on a cadaver or in surgery.
- Functions:
  - allows a structure to flex and recoil many times per day and still maintain its original shape.
- Common Locations:
  - **external ear** (pinna)
  - **epiglottis**
  - **eustachian tube** (or pharyngotympanic tube, or auditory tube).
  - Corniculate cartilage and Cuneiform cartilages of the larynx (which anchor the vocal chords and have a role in voice quality in pitch).

□ **Chondrocytes in Lacunae**

- “lacuna” (plural: lacunae) is Latin for “gap”. It is a space, “cavity” or “depression” with a chondrocyte in it.
- lacunae are “*randomly*” spaced throughout the matrix.
- has a mixture of **Type II Collagen Fibers & Elastic Fibers** in the matrix.

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**Slide 1-5-2 Fibrocartilage (or Fibrous Cartilage):**

□ **Fibrocartilage (or Fibrous Cartilage)**

- Matrix has lots of thicker Type I Collagen Fiber mixed with few Type II Collagen fibers seen in the other two types of cartilage. This makes it less flexible but much tougher.
- lacunae arranged in “*short stacks*” in the direction of the compressive forces. More matrix is seen... less cells.
- fibrocartilage tissue LACKS a perichondrium.
- Functions:
  - High Tensile Strength
  - **Absorbs Compressive Shock.**
- Common Locations:
  - **Pubic Symphysis**
  - Anulus Fibrosus in the **Intervertebral discs.**
  - Medial and Lateral **Menisci** of the knee.
  - Triangular Fibrocartilage Complex of the medial wrist.
  - articular disc in the temporomandibular joint.
  - acromioclavicular joint
  - sternoclavicular joint
  - Acetabular Labrum
  - Glenoid Labrum

□ **Chondrocytes in Lacunae**

- “lacuna” (plural: lacunae) is Latin for “gap”. It is a space, “cavity” or “depression” with a chondrocyte in it.
- lacunae arranged in “*short stacks*” in the direction of the compressive forces.

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### **Slide 1-5-3 Osseous Tissue\*:**

\*This slide is specifically from a “*cross-section*” of **compact bone**. Some slides may include also include a longitudinal section next to the cross-section. Just study the cross-section of the compact bone for this lab. We will look at other slides of osseous tissue in a future lab.

NOTE: These slides tend to have much thicker coverslips and histologic slices underneath them. For that reason, please do NOT use 1000X (the 100X oil immersion objective lens) as it almost always hits the coverslip and can crack it.

#### □ **Osseous Tissue (Bone Tissue)**

— The Greek word for bone is “*osteon*”.

— 2 forms:

- **Compact Bone** (or Cortical Bone)

- **Osteon** (or **Haversian System**) is the structure providing the ability of the bone to support your body weight, and other mechanical forces exerted on them.

- **Central Canal (Haversian Canal)**

- **Perforating Canal (Volkmann’s Canal)**

- **Spongy Bone** (or Cancellous Bone, Trabecular Bone)

— Functions:

- support
- protection
- provides levers for the muscles to act on
- stores about 99% of all the Calcium ions in your body.
- stores fat in the marrow cavity of adults.
- is the main site for forming RBCs, WBCs, and PLTs.

— Common Locations:

- any of the 206+ **bones** in the body.

#### □ **Osteocytes in Lacunae**

— “lacuna” (plural: lacunae) is Latin for “gap”. It is a space, “cavity” or “depression” with an osteocyte in it.

— lacunae are “*arranged between the lamellae*” of compact bone and very small with many **canaliculi** extending outward. The lacunae look like “*flat black stars*” arranged in a ring-like pattern.

— matrix has **Type I cartilage fibers**. The collagen fibers have two arrangements:

- woven bone (fibrous bone) – haphazard arrangement. It is mechanically weak.
  - lamellar bone – regular, parallel arrangement into sheets (called lamellae). It is mechanically strong.
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### **Slide 1-5-4 Blood:**

\*This slide is specifically covered in great detail in BIOL 221 Anatomy & Physiology 2, so only a brief discussion of it is here. This is a slide of whole blood treated with Wright's Stain to differentiate the different white blood cells.

#### **Blood**

- a “liquid connective tissue”.
- has “formed elements” and “plasma” (a fluid matrix).
- Functions:
  - transport of oxygen and carbon dioxide gases.
  - transport of nutrients
  - transport of waste products
  - transport of hormones
  - etc...
- Common Locations:
  - within the blood vessels of the cardiovascular system
  - chambers of the heart

#### **Erythrocytes (Red Blood Cells)**

- about 42% of the volume of whole blood in adult females.
- about 47% of the volume of whole blood in adult males.
- has the hemoglobin molecule for carrying oxygen gas.

#### **Leukocytes (White Blood Cells)**

- Neutrophils
- Eosinophils
- Basophils
- Lymphocyte
- Monocyte

- the “white blood cells” come in 5 basic cell types:
- multi-lobed nucleus, with tiny purple granules in cytoplasm.
- 2-lobed nucleus, with large red-orange granules in cytoplasm.
- U or S-shaped nucleus, with large blue granules in cytoplasm.
- no granules, smallest WBC with a very large nucleus.
- no granules, largest WBC with a U or S-shaped nucleus.

#### **Platelets (Thrombocyte)**

- very tiny, purple cell fragments with a role in clotting blood.

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**Slide 1-5-5 Skeletal Muscle (1) and (2):**

□ **Skeletal Muscle**

- **myocyte** cells are as long as the muscle they come from.
  - longitudinal section
    - can see the striations best.
    - nuclei look flat and at the periphery of cells.
  - cross-section
    - can see the fascicles (bundles of cells).
- multinucleate cells (dozens to potentially hundreds of nuclei).
- visually “striated” (best seen on longitudinal sections).
- about 2% of the cell’s interior is full of mitochondria.
- Functions:
  - **voluntary (conscious) control of movement.**
- Common Locations:
  - any of the 640+ **Skeletal Muscles** of the body

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**Slide 1-6-1 Cardiac Muscle (1) and (2) and (3):**

□ **Cardiac Muscle**

- **cardiomyocytes** (or **myocardiocytes**, or **cardiac myocytes**) are short, visually “striated” cells that with branches.
  - longitudinal section
    - can see the striations best.
    - **Intercalated Disc** are visually dark striations seen binding neighboring cells together.
    - large, oval nucleus near middle of cell.
  - cross-section
    - can see the fascicles (bundles of cells).
- usually just one nucleus, but may have as many as 4 nuclei.
- about 25% of the cell’s interior is full of mitochondria.
- Functions:
  - pumps the blood in the 4 chambers of the heart.
  - **involuntary (unconscious) control.**
- Common Locations:
  - **myocardium** of the walls of the heart.

and

**Slide 1-6-2 Cardiac Muscle (teased):**

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**Slide 1-6-3 Smooth Muscle\*:**

\*Digestive Tract Muscular Wall.

□ **Smooth Muscle**

and

**Slide 2-8-5 Gallbladder\*\*:**

\*\*Good example of Smooth Muscle.

- “*spindle-shaped*” or “*fusiform-shaped*” cells which are the widest in the middle where the single nucleus is, with both ends tapered to a point.
- Slide 1-6-3 has longitudinal and cross-sections of a thick wall of smooth muscle. Slide 2-8-5 shows an example of a thin wall of smooth muscle.
- Functions:
  - longitudinal arrangements of smooth muscle in the gastrointestinal system can propel the contents by **peristalsis**.
  - circular arrangements of smooth muscle in the gastrointestinal system can compress the contents with **segmentation**, and thicker bundles of circularly arranged smooth muscle form **sphincters**.
  - **involuntary (unconscious) control**.
- Common Locations:
  - walls of the distal 1/3 of the esophagus.
  - **walls of the stomach**, and gall bladder.
  - walls of the small intestine, large intestine, and rectum.
  - walls of vessels (arteries, arterioles, venules, & veins).
  - **walls of the urinary bladder**, and ureters.
  - **walls of the uterus** & fallopian tubes.

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**Slide 1-6-4 Nervous Tissue\*:**

\*Demo slide is from a Spinal Cord. Other slides may be from the Brain or Cerebellum might also have the same label #.

□ **Nervous Tissue**

- composed of two basic groups of cells:
  - **Neurons**
    - Very large cell body with many processes.
      - numerous very short dendrites.
      - one axon (can be very long & branch)
  - **Neuroglial Cells**
    - Central Nervous System neuroglial cells:
      - Astrocytes
      - Microglial cells
      - Ependymal cells
      - Oligodendrocytes
    - Peripheral Nervous System neuroglial cells:
      - Satellite cells
      - Schwann cells
- Functions:
  - Neurons transmit electrical signals.
  - Neuroglial Cells support the neurons in their activity.
- Common Locations:
  - Central Nervous System: **Brain & Spinal Cord**
  - Peripheral Nervous System: Cranial & Spinal Nerves