Chapter 1 Muscular System
Connective tissue comprises a diverse group of specialized cells and tissues. Connective tissues function in:

- Support
- Transport
- Storage
- Immune defense

Two major groupings of connective tissues are recognized:

- Connective tissue proper: includes loose and dense connective tissue (arranged in either an irregular or regular conformation)
- Specialized connective tissue: includes cartilage, bone, adipose tissue (fat), hemopoietic tissue, blood and lymph

Connective tissue proper includes a variety of different cell types and fibers enmeshed in a ground substance that comprises an extracellular matrix. Loose connective tissue is found largely under epithelia lining both the body’s surface and its internal organ systems. It often is the first line of defense against infection. Dense connective tissue has many fibers but few cells and includes tendons, ligaments, the submucosa and reticular layers that offer support.

The fibrous elements in connective tissue include:

- **Collagen fibers**: numerous in connective tissues and offer flexibility and strength
- **Elastic fibers**: interwoven fibers that offer flexibility and retain their shape if stretched
- **Reticular fibers**: are thinner collagen fibers that provide strength but are the least common of the fibrous elements

The most common cellular elements in connective tissue include:

1. **Plasma cells**: secrete immunoglobulins and are derived from B lymphocytes
2. **Macrophages**: phagocytic cells (engulf pathogens and cell debris) derived from monocytes in the blood
3. **Lymphocytes**: the principal cells of the immune system
4. **Mast cells**: respond early to immune challenges and secrete powerful vasoactive and chemotactic substances
5. **Adipocytes**: store and release triglycerides as needed by the body (fat cells), produce hormones and growth factors
6. **Myofibroblasts**: fibroblasts that are capable of contraction and function similar to fibroblasts and smooth muscle cells
7. **Fibroblasts**: abundant cells that synthesize all the fibrous elements and elaborate the matrix
8. **Eosinophils**: respond to allergens and parasitic infections, and are phagocytes
9. **Neutrophils**: respond to injury and immune challenges, and are capable of phagocytosis

**COLOR** each of the following major cell types found in connective tissue proper, using a different color for each cell type:

- 1. Plasma cell (note its eccentrically placed nucleus)
- 2. Macrophage (note its large size and irregular shape)
- 3. Lymphocyte (note its small size, with the nucleus taking up most of the cell volume)
- 4. Mast cell (note its cytoplasm is filled with small granules)
- 5. Adipocyte (note its large size and small eccentrically placed nucleus)
- 6. Myofibroblast (note its elongated and branched structure and thin nucleus)
- 7. Eosinophil (note its cytoplasmic granules and eccentric, bi-lobed nucleus)
- 8. Fibroblast (note its thin or sometimes stellate shape and thin, small, central nucleus)
- 9. Neutrophil (note its multi-lobed nucleus)
Connective Tissues

1. Collagen fibers
2. Reticular fibers
3. Blood vessel
4. Elastic fibers
5. Ground substance
6. Collagen fibers
7. Connective tissue proper
8. Adipose
9. Tendon
10. Cartilage

Advance Sample Chapter -- NOT FINAL PRODUCT
The human skeleton is divided into two descriptive regions:

- **Axial skeleton**: the bones of the skull, vertebral column (spine), ribs and sternum (they form the “axis” or central line of the body)
- **Appendicular skeleton**: the bones of the limbs, including the pectoral (shoulder) and pelvic girdles (they comprise the upper and lower limbs that attach to the axial skeleton)

**Tonsils**

The tonsils include collections of lymphatic tissue in the oral cavity (palatine tonsils, visible when you open your mouth and say "ahh"), lingual tonsils on the base of the tongue, pharyngeal tonsils (when enlarged and inflamed they are called "adenoids") in the roof of the nasopharynx, and tubal tonsils around the opening of the auditory (eustachian) tube. Together, these lymphatic aggregations form "Waldeyer’s lymphatic ring." They play an important immune role by protecting the nasal and oral passages from invading pathogens, especially during childhood. Some of these tissues atrophy with advancing age and become less important.

Each kidney is supplied by a large renal artery, which then divides into the following branches:

- **Segmental arteries**: one artery for each of about 5 segments
- **Interlobar arteries**: several arise from each segmental artery and course between the renal pyramids, ascending to the cortex and arching over the base of each pyramid
- **Arcuate arteries**: the arching terminal portions of the interlobar arteries at the base of each renal pyramid
- **Interlobular arteries**: arise from the arcuate arteries and ascend into the renal cortex (90% of the blood flow to the kidney perfuses the renal cortex)
- **Afferent arterioles**: arise from the interlobular arteries and pass (one each) to the nephron’s glomerulus to form the glomerular capillary tuft
- **Efferent arterioles**: glomerular capillaries of the juxtamedullary nephrons reuniting to form efferent arterioles that descend into the medulla and form the vasa recta, countercurrent exchange pathway.

The skeletal system is composed of a living, dynamic, rigid connective tissue that forms the bones and cartilages of the human skeleton. While we say the skeleton has 214 bones, this number may actually vary somewhat. Cartilage is attached to some bones, especially where flexibility is important and covers some of the articular (joint) surfaces of bones. About 99% of the body’s calcium is stored in bones and many bones possess a central cavity that contains bone marrow, collection of hemopoietic (blood-forming) cells. Most individual bones can be classified into one of 5 shapes:

- Long bones
- Short bones
- Flat bones
- Irregular bones
- Sesamoid bones
Advance Sample Chapter -- NOT FINAL PRODUCT
Three muscles (external abdominal oblique, internal abdominal oblique, and transverses abdominis) wrap around the abdominal wall and are direct continuations of the three muscle layers found in the thoracic wall, where they lie between the ribs and comprise the intercostal muscles.

The functions of these anterior abdominal muscles include:
- Compressing the abdominal wall and increase intra-abdominal pressure, especially when lifting, and during urination, defecation, and childbirth.
- Assisting the diaphragm during forced expiration (this occurs unexpectedly when a blow is administered to the anterior abdominal wall and the “wind is knocked out of you”).
- Helping flex and rotate the trunk
- Tensing the abdominal wall

**COLOR** these three labeled muscles using a different color for each. Work from the superficial to the deeper layer and note the direction of the muscle fibers as your color:
- 1. External abdominal oblique
- 2. Internal abdominal oblique
- 3. Transversus abdominis

<table>
<thead>
<tr>
<th>MUSCLE</th>
<th>PROXIMAL ATTACHMENT (ORIGIN)</th>
<th>DISTAL ATTACHMENT (INSERTION)</th>
<th>INNERVATION</th>
<th>MAIN ACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>External oblique</td>
<td>External surfaces of 5th to 12th ribs</td>
<td>Linea alba, pubic tubercle, and anterior half of iliac crest</td>
<td>Inferior six thoracic nerves and subcostal nerve</td>
<td>Compresses and supports abdominal viscera; flexes and rotates trunk</td>
</tr>
<tr>
<td>Internal oblique</td>
<td>Thoracolumbar fascia, anterior two thirds of iliac crest, and lateral half of inguinal ligament</td>
<td>Inferior borders of 10th to 12th ribs, linea alba, and pubis via conjoint tendon</td>
<td>Ventral rami of inferior six thoracic and first lumbar nerves</td>
<td>Compresses and supports abdominal viscera; flexes and rotates trunk</td>
</tr>
<tr>
<td>Transversus abdominis</td>
<td>Internal surfaces of 7-12 costal cartilages, thoracolumbar fascia, iliac crest, and lateral third of inguinal ligament</td>
<td>Linea alba with aponeurosis of internal oblique, pubic crest, and pecten pubis via conjoint tendon</td>
<td>Ventral rami of inferior six thoracic and first lumbar nerves</td>
<td>Compresses and supports abdominal viscera</td>
</tr>
<tr>
<td>Rectus abdominis</td>
<td>Pubic symphysis and pubic crest</td>
<td>Xiphoid process and costal cartilages 5-7</td>
<td>Ventral rami of inferior six thoracic nerves</td>
<td>Flexes trunk and compresses abdominal viscera</td>
</tr>
</tbody>
</table>

Two midline muscles (Rectus abdominis and Pyramidalis) lie within the rectus sheath, a tendinous sheath composed of the aponeurotic layers of the three abdominal muscles colored (1-3). The layers (lamina) that compose the sheath are deficient below the arcuate line (in the lower quarter) of the rectus sheath where only the transversalis fascia lies in contact with the rectus abdominis.

**COLOR** the midline muscles of the anterior abdominal wall, using a different color from those used previously:
- 4. Rectus abdominis (note the three tendinous intersections—the infamous “six-pack” abs)
- 5. Pyramidalis

**COLOR** the three muscle layers, as done initially (1-3) and then using different color for each, color the aponeurosis extending from the muscle to form the layers of the rectus sheath (labeled 1A-3A to denote their relationship to the muscles):
- 1A. Aponeuroses of external oblique muscle
- 2A. Aponeuroses of internal oblique muscle
- 3A. Aponeuroses of transversus abdominis muscle

Clinical Note:
Hernias, abnormal outpouchings of underlying structures due to a weakness of the wall, can occur on the anterior abdominal wall. The most common types include:
- Umbilical hernias – usually seen up to age 3 years or after the age of 40
- Linea alba hernias – often occur in the epigastric region along the midline linea alba
- Incisional hernias – occur at sites of previous abdominal surgical scars
- Inguinal hernias – related to the inguinal canal in the inguinal region (where abdomen and thigh meet)

*Stimulation of the center causes the responses listed.*
Anterior Abdominal Wall Muscles

1. Intercostal muscles
2. Inguinal ligament
3. Conjoint tendon
4. Rectus Sheath Cross-Section
   - Linea alba
   - Transversalis fascia
   - Skin

- Above acuate line
- Below acuate line