Chapter 1: Functional Anatomy

Anatomical Position and Planes of Motion
Functions of the Cardiovascular System

- Transports oxygenated and deoxygenated blood
- Distributes nutrients to cells
- Removes metabolic wastes
- Regulates pH
- Transports hormones and enzymes
- Maintains fluid volume to prevent dehydration
- Maintains body temperature by absorbing and redistributing heat
The Heart: Tissue Layers

- Endocardium
- Myocardium
- Visceral pericardium (epicardium)
- Pericardial cavity
  - Serous layer
  - Fibrous connective tissue layer
- Parietal pericardium
The Heart: Cardiac Cycle, Chambers, and Valves
The Heart: Blood Supply

- Originates from left and right coronary arteries (LCA and RCA) at base of aorta immediately superior to semilunar aortic valve
The Heart: Blood Supply

- LCA branches into the LAD and circumflex
  - LAD supplies the interventricular septum and anterior myocardium
  - CxA supplies the laterodorsal walls of the LA and LV
The Heart: Conduction System

- Superior vena cava
- Sinoatrial node (pacemaker)
- Atrioventricular node
- Purkinje fibers
- Inferior vena cava
- Interventricular septum
- Aorta
- Pulmonary trunk
- Atrioventricular bundle
- Left and right bundle branches
Blood Vessels

• Arteries
  – Carry blood away from the heart
  – Large arteries (aorta, pulmonary) near the heart
  – Branch into smaller arteries, then arterioles, and then eventually capillaries where nutrient exchange occurs with tissues (muscle, liver)

• Veins
  – Carry blood toward the heart
  – From capillary beds, converge into small venules, then into small veins, and eventually larger veins
Anatomical Sites for Blood Pressure and Heart Rate Determination

- Pulse
  - Carotid: Anterior neck in groove between larynx and sternocleidomastoid muscles
  - Radial: Lateral aspect of forearm near distal head of radius
- Blood pressure typically taken at the brachial artery
Respiratory Anatomy

- Primary function: Gas exchange
  - CO₂ removal from the blood
  - O₂ addition to the blood
Respiratory Anatomy

- Trachea
- Bronchi
- Bronchioles
- Terminal bronchioles
- Respiratory bronchioles
- Alveolar ducts
- Alveolar sacs
Respiratory Anatomy

- Gas exchange occurs by passive diffusion across the respiratory membrane
  - Membrane wall is very thin, about 1/16 the diameter of a red blood cell
  - Large and thin membrane surface area leads to rapid gas diffusion into/out of the blood
• Blood supply to the lungs:
  – Pulmonary arteries carry deoxygenated systemic venous blood from the RV to the branches of bronchioles and alveolar capillaries for gas exchange
  – Bronchial arteries carry oxygenated blood from LV to supply the rest of the lung tissue
  – Deoxygenated blood from lung tissue returns to the LA via pulmonary veins, slightly diluting the oxygenated blood returning to the LA (≤5% of cardiac output)

• Ventilatory pump and mechanics of breathing
  – Respiration (air exchange)
    ✓ Inspiration (air in)
      ▪ Respiratory muscles contract \(\rightarrow\) ↑ thoracic dimension, inducing atmospheric pressure gradient (intralung pressure < extralung)
    ✓ Expiration (air out)
      ▪ Respiratory muscles relax \(\rightarrow\) ↓ thoracic dimension, inducing atmospheric pressure gradient (intralung pressure > extralung)
ACCESSORY:
- Sternocleidomastoid (elevates sternum)
- Scalenes
  - Anterior
  - Middle
  - Posterior (elevate and fix upper ribs)

PRINCIPLE:
- External intercostals (elevate ribs)
- Parasternal intercartilaginous muscles (elevate ribs)
- Diaphragm (domes descend, increasing longitudinal dimension of chest and elevating lower ribs)

ACTIVE BREATHING:
- Internal intercostals, except parasternal intercartilaginous part
- Abdominal muscles (depress lower ribs, compress abdominal contents, thus pushing up diaphragm)
- Rectus abdominis
- External oblique
- Internal oblique
- Transversus abdominis

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• Diaphragmatic respiration:
  – Diaphragm contracts and moves down, displacing abdominal contents and increasing thoracic area
  – Diaphragm relaxes and moves up, decreasing thoracic area
  – During active breathing (e.g., exercise), accessory muscles are recruited
    ✓ Intercostal and abdominal muscles

• Pleural spaces
  – Visceral pleura (inner layer that closely covers the lungs)
  – Parietal pleura (layer lining the inside of the chest wall and diaphragm)
  – Pleural space between them contains fluid and is airtight (negative pressure
First rib
Parietal pleura
Visceral pleura
Pulmonary ligament
Diaphragm
Musculoskeletal Anatomy

- **Skeletal system**
  - Primary functions: Support soft tissue, protect internal organs, provide nutrients and blood constituents, serve as rigid levers for movement
  - Axial skeleton: Skull, vertebral column, sternum, and ribs
  - Appendicular skeleton: All other bones of upper and lower limbs
- **Bone tissue structure**

  - Epiphyseal line (cartilage)
  - Medullary cavity
  - Compact bone
  - Spongy bone
  - C - Epiphysis
  - B - Metaphysis
  - A - Diaphysis

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• Joint classifications

- Fibrous: Bones are united by dense fibrous connective tissue (e.g., union between skull plates)
- Cartilaginous: Bones are united by cartilage (e.g., sternum and rib, intervertebral discs)
- Synovial: Fibrous articular capsule and an inner synovial membrane enclose a joint cavity filled with synovial fluid (e.g., elbow, knee, shoulder, hip)
- Synovial joint is most common
Joint movement and range of motion (ROM)

- Active ROM (AROM): Voluntary degree of movement at a joint
- Passive ROM (PROM): Degree of movement at a joint achieved by external means (e.g., examiner)
- Movements are many: See Tables 1-4, 1-5, and 1-6 in your text
• Muscular system
  - 3 types of muscle: skeletal, cardiac, and smooth
  - 4 characteristics of all muscle:
    1. Irritability—ability to respond to stimuli
    2. Contractility—ability to develop tension
    3. Extensibility—ability to stretch or increase in length
    4. Elasticity—ability to return to its original length

• Skeletal muscle structure
• Muscle contraction
  – Sliding filament theory
  – Twitch: Single, brief muscle contraction caused by a single action potential traveling down a motor neuron
  – Summation: Addition of individual twitch contractions to increase the intensity of the overall muscle force
  – Tetanus: Maximal amount of force the motor unit can develop


• Muscle fiber types

  – Type I (slow twitch): Relatively low force production, fatigue resistant, mostly “aerobic” metabolism
  – Type IIa (fast twitch): Relatively high force production, moderately fatigable, both “anaerobic” and “aerobic” metabolism
  – Type IIb (fast twitch): Relatively high force production, quickly fatigable, mostly “anaerobic” metabolism


Comparison of 3 different skeletal muscle fiber type classifications: histochemical staining for myosin adenosinetriphosphatase (mATPase), myosin heavy chain identification, and biochemical identification of metabolic enzymes. Note: in humans, MHCIIb are now more accurately referred to as MHCIIx/d. The question marks indicate the poor correlation between biochemical and myosin heavy chain or mATPase fiber type classification schemes.
• Muscle actions
  – Isometric: Muscle generates force without joint movement
  – Concentric: Muscle generates force and shortens
  – Eccentric: Muscle generates force and lengthens

• Muscle roles
  – Agonists: Create movement
  – Antagonists: Oppose the movement
  – Synergists: Prevent unwanted movement; help agonists perform more effectively