

Chapter 6

The Human Body

Unit Summary

After students complete this chapter and the related course work, they will be able to describe and apply, in context, the body planes, topographic anatomy, and anatomic position. Students will be able to identify basic anatomic structures and related functions and describe each body system, discussing the roles of the structures within these systems and the interaction of body systems in maintaining the life support chain. Students will be able to discuss possible consequences of illness and injury of these structures and systems on proper functioning of the body.

National EMS Education Standard Competencies

Preparatory

Applies fundamental knowledge of the emergency medical services (EMS) system, safety/well-being of the emergency medical technician (EMT), medical/legal, and ethical issues to the provision of emergency care.

Anatomy and Physiology

Applies fundamental knowledge of the anatomy and function of all human systems to the practice of EMS.

Pathophysiology

Applies fundamental knowledge of the pathophysiology of respiration and perfusion to patient assessment and management.

Knowledge Objectives

1. Identify the body's topographic anatomy, including the anatomic position and the planes of the body. (pp 190–191)
2. Identify the anatomy and physiology of the skeletal system. (pp 191–197)
3. Describe the anatomy and physiology of the musculoskeletal system. (pp 197–198)
4. Discuss the anatomy and physiology of the respiratory system. (pp 198–207)
5. Discuss the anatomy and physiology of the circulatory system. (pp 207–220)
6. Discuss the anatomy and physiology of the nervous system. (pp 220–224)
7. Describe the anatomy and physiology of the integumentary system. (pp 224–226)
8. Explain the anatomy and physiology of the digestive system. (pp 226–230)

9. Describe the anatomy and the physiology of the lymphatic system. (p 230)
10. Discuss the anatomy and physiology of the endocrine system. (pp 230–232)
11. Describe the anatomy and physiology of the urinary system. (pp 232–233)
12. Discuss the anatomy and physiology of the genital system. (pp 233–234)
13. Describe the life support chain, aerobic metabolism, and anaerobic metabolism. (pp 235–236)
14. Define pathophysiology. (p 236)

Skills Objectives

There are no skills objectives in this chapter.

Readings and Preparation

Review all instructional materials including *Emergency Care and Transportation of the Sick and Injured, Twelfth Edition*, Chapter 6, and all related presentation support materials.

Support Materials

- Lecture PowerPoint presentation
- Case Study PowerPoint presentation
- Several copies of a human body diagram (anterior, posterior, and lateral if possible) for distribution in activities and assessments. Have several copies for each student, as they can serve as a template for many activities and assessments.
- Large (human body size) paper. Leftover newsprint paper works well if you have access to a newsprint facility, or consider taping several large pieces of paper together.

Enhancements

- Direct students to visit Navigate.
- **Content connections:** Inform students that a thorough understanding of anatomy and physiology will help them understand and apply concepts of pathophysiology in subsequent lessons. It is also the foundation for determining possible consequences of the mechanism of injury and nature of illness as they assess patients in the field.
- **Cultural considerations:** While teaching anatomy and physiology, keep in mind that students may assume that internally all people are the same. Other chapters point out the cultural differences that students need to consider to be most effective in assessment and care. While we think of culture as largely a learned set of behaviors, some cultures do have physical differences. Other groups of people, born with physical differences such as

dwarfism, Down syndrome, and hundreds of other conditions, often form subcultures not only for social support but also for networking and support for specific medical/physical differences and challenges.

Teaching Tips

- Images are integral to the retention of material. Prepare ahead of time and consider incorporating additional visual resources.
- Chapter 6, “The Human Body,” presents students with a lot of new information and details. Choosing a variety of approaches, including charts, interactive exercises, and group and self-assessments, will allow students to organize the new information and identify areas needing more review. Including multiple activities with visual components will reduce learning time and increase retention. See the group activities sections for suggestions. This chapter is particularly “visuals friendly”; with instructor guidance, students can engage in creative, fun learning.

Unit Activities

Writing assignments: Using the systems researched in the following Group Activities section, or selecting another system, structure, or organ, have each student or group of students write one or two paragraphs on one illness and one injury that could directly affect this organ/structure. What would they expect to see? Open up the presentations to class discussion if time allows.

Group activities:

- *Tracings:* Ask each group to use large paper or sidewalk chalk and the floor to trace the outlines of group members. Ask each group to sketch a specific system or segment of the body within each body outline.
- *The visible system:* Assign a body system to each group with instructions to create a presentation for the whole class on that system. Each group should be given the same guidelines and questions that must be answered within the presentation:
 - Each group must make a visual representation of their system. Suggestions include a life-size cardboard cutout of a student labeled with that system’s components. Another suggestion might include each group member making a cardboard or paper cutout of one of the organs or structures in their system and “wearing” it or taping it to their clothing in the appropriate place as their group presents their project to the class. Questions to consider include:
 - Which structures are within this system?
 - How does each structure work independently? How does each structure interact with the other parts of this system?

- Which other systems interact with this system? Describe at least one function that involves another system.

Medical terminology review: Distribute a body diagram drawn on an 8.5 × 11-inch piece of paper. Using a prepared list of terms (such as directional terms), have students write the number of the term on the corresponding area of the diagram. For example, one clue might read, “The patient has an injury to the distal end of the left radius. Place an *X* on this location of your body diagram.” Prepare statements such as this for each term. Students can discuss results with their groups, or this can be reviewed as a whole-class activity.

Pre-Lecture

You Are the Provider

“You Are the Provider” is a progressive case study that encourages critical thinking skills.

Instructor Directions

1. Direct students to read the “You Are the Provider” scenario found throughout Chapter 6.
2. You may wish to assign students to a partner or a group. Direct them to review the discussion questions at the end of the scenario and prepare a response to each question. Facilitate a class dialogue centered on the discussion questions and the Patient Care Report.
3. You may also use this as an individual activity and ask students to turn in their comments on a separate piece of paper.

Lecture

I. Introduction

A. A working knowledge of anatomy is important.

B. Terminology:

1. Anatomy: a field of study that focuses on the physical structure of the body and its systems
2. Physiology: examines the normal functions and activities of the body and its systems
3. Pathophysiology: the study of functional changes that accompany a particular disease or syndrome

II. Topographic Anatomy

A. Topographic anatomy applies to the body in the anatomic position, so that everyone is referring to the body in the same way.

1. Anatomic position: patient stands facing you, arms at side, palms forward

B. Planes of the body

1. Imaginary straight lines that divide the body
2. Three main areas depending on how the body is divided:
 - a. Coronal (frontal) plane: divides the body front and back
 - b. Sagittal (lateral) plane: divides the body left and right
 - c. Midsagittal (midline) plane: divides the body into equal left and right halves
 - d. Transverse (axial) plane: divides the body horizontally into top and bottom sections

III. From Cells to Systems

A. Cells are the foundation of the human body.

B. Cells that share a common function form tissue.

C. Groups of tissue that perform similar or interrelated jobs form organs.

D. Organs with similar functions work together to comprise body systems.

IV. The Skeletal System: Anatomy

A. The skeleton gives us our recognizable human form and protects vital internal organs.

B. Bones:

1. 206 bones compose the skeletal system.
 - a. Axial skeleton: forms the longitudinal axis of the body from the skull to the coccyx
 - i. Includes the skull, facial bones, thoracic cage, and vertebral column
 - b. Appendicular skeleton: comprises the upper and lower extremities and the points by which they connect to the axial skeleton
 - c. The pelvis includes portions from both the axial and appendicular skeletons.

C. Joints

1. Where two bones meet
2. Ligaments are fibrous tissues that connect bone to bone, helping to stabilize the joint.

3. Cartilage is a semirigid and flexible tissue that covers and cushions the ends of articulating bones.
4. Tendons attach bone to muscle.
5. Symphyses are joints where only slight movement is possible.
6. The bone ends of a joint are held together by a fibrous sac called the joint capsule.
7. Articular cartilage allows the ends of bones to glide easily.
8. The synovial membrane is the inner lining of the joint capsule.
 - a. Produces synovial fluid which allows the ends of bones to glide over each other
9. Types of joints:
 - a. Ball-and-socket joint: allows rotation and bending
 - i. The shoulder joint is an example.
 - b. Hinge joint: motion is restricted to flexion (bending) and extension (straightening)

D. The axial skeleton

1. Skull
 - a. Consists of 28 bones divided into three groups: the cranium, the facial bones, and three small bones in the ear
 - i. Cranium
 - (a) Protects the brain and consists of 4 bones:
 - (1) Occiput (posterior portion)
 - (2) Temporal bones (lateral portions)
 - (3) Parietal bone (located between the temporal bones and occiput)
 - (4) Frontal bone (forehead)
 - ii. Facial bones consist of 14 bones
 - (a) Upper, nonmovable jawbones (maxillae)
 - (b) Cheekbones (zygomas)
 - (c) Lower, movable portion of jaw (mandible)
 - (d) Orbits (eye sockets) include zygomas, maxillae, and frontal bones of cranium
 - (e) Very short bones that form the bridge of the nose
2. Spinal column
 - a. Composed of 33 vertebrae divided into 5 sections. The vertebrae in each section are numbered from top to bottom.
 - i. The cervical spine (neck) has 7 vertebrae.
 - ii. The thoracic spine (upper back) has one pair of ribs attached to each of the 12 vertebrae.
 - iii. The lumbar spine (lower back) has 5 vertebrae.
 - iv. The sacrum (back wall of pelvis) consists of 5 fused vertebrae that join the pelvis.

- v. The coccyx (tailbone) consists of 4 fused vertebrae.
 - b. Vertebrae are connected by ligaments and are protected by intervertebral disks.
3. Thorax
- a. The thoracic cavity contains the heart, lungs, esophagus, and great vessels.
 - b. Formed by 12 thoracic vertebrae and 12 pairs of ribs
 - c. Midline of chest is the sternum which is made up of the manubrium, body, and xiphoid process

E. Appendicular skeleton

1. Upper extremities
- a. Extend from the pectoral girdle to fingertips
 - i. The shoulder girdle is where the clavicle, scapula, and humerus come together.
 - b. Arm
 - i. Humerus is the supporting bone.
 - ii. Forearm consists of radius and ulna.
 - iii. Radius lies on the lateral, or thumb, side.
 - iv. Ulna is on the medial, or little finger, side.
 - v. Wrist and hand
 - (a) A modified ball-and-socket joint formed by the ends of the radius and ulna and carpal bones
 - (b) Five metacarpals extend from the carpal bones and make up the hand.
 - (c) Fingers are composed of phalanges.
2. Pelvis
- a. Pelvic girdle consists of two large hip bones (coxae), the sacrum, and the coccyx.
 - b. Each coxa is formed by fusion of the ilium, ischium, and pubis.
 - c. The pubic symphysis is cartilage that joins the left and right pubic bones and limits movement between the bones.
 - d. Articulates with the femur at the acetabulum
3. Lower extremities
- a. The femur is the longest and one of the strongest bones in the body.
 - i. The femoral head articulates with the acetabulum by a ball-and-socket joint.
 - ii. The greater and lesser trochanters serve as anchor points for the major muscles of the thigh.
 - iii. The knee is a hinge joint connecting the femur to the bones of the lower leg.
 - b. Lower leg
 - i. Tibia
 - ii. Fibula

4. Ankle and foot
 - a. The foot comprises the tarsals, metatarsals, and phalanges.
 - b. The distal ends of the tibia and fibula articulate with the talus to form the ankle.

IV. The Skeletal System: Physiology

A. Functions of the skeletal system

1. Gives the body its shape
2. Protects fragile organs
3. Allows for movement
4. Stores calcium
5. Helps create blood cells

V. The Musculoskeletal System: Anatomy

A. The musculoskeletal system provides:

1. Form
2. Upright posture
3. Movement
4. Protection for vital internal organs

B. Three types of muscle: skeletal, smooth, and cardiac

1. Skeletal muscle attaches to the bones of the skeleton and forms the major muscle mass of the body.
 - a. Known as voluntary muscle, because it is under direct voluntary control of the brain
2. Smooth muscle and cardiac muscle movement do not require conscious thought (involuntary).
 - a. Smooth muscle is found within blood vessels and intestines.
 - b. Cardiac muscle is found only within the heart.

C. Skeletal muscle

1. Often functions in antagonistic pairs (eg, biceps and triceps)

VI. The Musculoskeletal System: Physiology

A. Contraction and relaxation of the system make it possible to move and manipulate the environment.

1. A by-product of this movement is heat.
2. When you get cold, you shiver to produce heat.

B. Another function of muscles is to protect the structures under them.

VII. The Respiratory System: Anatomy

A. The respiratory system is responsible for breathing, or respiration, and the exchange of oxygen and carbon dioxide within the lungs.

B. Upper airway

1. Nose
2. Mouth (oral cavity)
3. Tongue
4. Jaw (mandible)
5. Larynx
 - a. Dividing line between the upper and lower airways
6. Pharynx
 - a. Nasopharynx
 - b. Oropharynx (throat)
 - c. Laryngopharynx
7. Trachea (windpipe)
 - a. Located at the bottom of the pharynx
8. Epiglottis
 - a. Thin, leaf-shaped flap that prevents food and liquid from entering the trachea

C. Lower airway

1. Thyroid cartilage (Adam's apple): forms the anterior part of the larynx
2. Cricoid cartilage: lies immediately below the thyroid cartilage
3. Cricothyroid membrane: lies between the thyroid and cricoid cartilage
4. Trachea: lies below the cricoid cartilage
 - a. The trachea ends at the carina.
 - b. It divides into the right and left main stem bronchi, which enter the lungs and branch into smaller airways.

D. Lungs

1. Each lung is divided into lobes.
2. Within the lobes are the bronchi and bronchioles, which end in alveoli.
 - a. Alveoli allow for gas exchange (oxygen and carbon dioxide).

E. Mechanics of breathing

1. Pleura
 - a. Visceral pleura covers the lungs.
 - b. Parietal pleura lines the chest wall.
 - c. A thin layer of fluid between them facilitates movement of the lungs.
 - d. The pleural space is a potential space between the two pleura.
2. Muscles of breathing
 - a. The diaphragm is the primary muscle of breathing.
 - i. Contains voluntary and involuntary muscle
 - b. Cervical muscles
 - c. Intercostal muscles
 - d. Abdominal muscles
 - e. Pectoral muscles
3. Inhalation
 - a. Diaphragm and intercostal muscles contract enlarging the thoracic cage.
 - b. Pressure within the thoracic cavity decreases and the lungs fill (negative-pressure ventilation).
 - c. Active part of the respiratory cycle
4. Exhalation
 - a. Diaphragm and intercostal muscles relax.
 - b. Thoracic cavity returns to its normal shape and volume.
 - c. Passive portion of the respiratory cycle

VIII. The Respiratory System: Physiology

- A. The respiratory system's function is to provide the body with oxygen and eliminate carbon dioxide.**
- B. Ventilation and respiration are two separate, yet interdependent functions of the respiratory system.**
 1. Ventilation: the movement of air between the lungs and the environment
 2. Respiration: the exchange of oxygen and carbon dioxide in the alveoli and in tissues of the body
- C. Respiration**
 1. Oxygen and carbon dioxide move across the membrane between the capillaries and alveoli via diffusion.
 - a. Diffusion is a passive process in which molecules move from an area with a higher concentration of molecule to an area of lower concentration.

D. The chemical control of breathing

1. The brainstem controls breathing by monitoring levels of carbon dioxide in the blood and spinal fluid.
2. Breathing is automatically controlled if the level of carbon dioxide or oxygen in the arterial blood is too high or too low.
3. Breathing occurs as the result of a buildup of carbon dioxide in the cerebrospinal fluid which causes the pH to decrease.
 - a. The medulla oblongata stimulates the phrenic nerve causing the diaphragm to contract.
 - b. The primary reason for breathing is to lower carbon dioxide levels not to increase oxygen levels.
4. Hypoxic drive “backup” system to control respiration.
 - a. The stimulus to breathe comes from low oxygen levels.

E. The nervous system control of breathing

1. Medulla oblongata
 - a. Responsible for initiating the ventilation cycle
 - b. Primarily stimulated by high carbon dioxide levels
 - c. Helps control the rhythm of breathing, initiate inspiration, set the base pattern for respiration, and send the signal to the diaphragm via the phrenic nerve
2. Pons
 - a. Has two areas which help augment respirations during emotional or physical stress
 - b. Helps change the depth of inspiration, expiration, or both

F. Ventilation

1. Tidal volume
 - a. Amount of air that is moved into or out of the lung in a single breath
 - b. Generally 500 mL in an adult
2. Inspiratory reserve volume is the deepest breath you can take after a normal breath.
3. Expiratory reserve volume is the maximum amount of air you can forcibly breathe out after a normal breath.
4. Residual volume is the gas remaining in the lungs after exhalation.
5. Dead space is the portion of the respiratory system that has no alveoli and little to no gas exchange.
6. Minute ventilation
 - a. Used to assess the adequacy of ventilation

- b. Amount of air that moves in and out of the lungs in one minute
- c. Minute volume = respiratory rate \times tidal volume

G. Characteristics of normal breathing

1. Normal rate and depth
2. Regular rhythm or pattern of inhalation and exhalation
3. Clear, audible breath sounds on both sides of the chest
4. Regular rise and fall movement on both sides of the chest
5. Movement of the abdomen

H. Inadequate breathing in adults

1. Labored breathing
 - a. Significant effort requiring the use of accessory muscles
2. Breathing slower than 12 breaths/min or more than 20 breaths/min
3. Additional signs
 - a. Muscle retractions above the clavicles, between the ribs, and below the rib cage
 - b. Pale or cyanotic skin
 - c. Cool, damp skin
 - d. Tripod position

IX. The Circulatory System: Anatomy

A. The circulatory system (cardiovascular system) is a complex arrangement of connected tubes.

1. Arteries, arterioles, capillaries, venules, and veins

B. Two circuits

1. The systemic circulation carries oxygen-rich blood from the left ventricle through the body and back to the right atrium.
2. The pulmonary circulation carries oxygen-poor blood from the right ventricle through the lungs and back to the left atrium.

C. Heart

1. An involuntary muscle made of specialized cardiac muscle (myocardium)
2. Works as two paired pumps
3. Each side is divided into:
 - a. Left side is muscular and a high-pressure pump.
 - b. Right side is thinner and a low-pressure pump.
 - c. Atrium (upper chamber)

- d. Ventricle (lower chamber)
- 4. Circulation
 - a. The heart receives its blood from the aorta via coronary arteries.
 - b. The right side of the heart receives deoxygenated blood from the veins of the body.
 - c. Oxygenated blood returns from the lungs through the pulmonary veins into the left side of the heart and is pumped into the aorta and then to the arteries of the body.
 - d. Valves guide the path of blood through the heart.
- 5. Normal heartbeat
 - a. Normal pulse rate for an adult: 60–100 beats/min
 - b. Stroke volume (SV): the amount of blood moved by one beat
 - c. Cardiac output (CO): the amount of blood moved in 1 minute
 - i. $CO = HR \times SV$
- 6. Electrical conduction system
 - a. A network of specialized tissue that is capable of initiating and conducting electrical current runs throughout the heart
 - b. Electrical impulses begin high in the atria at the sinoatrial (SA) node, travel to the atrioventricular (AV) node and bundle of His, and then move through the Purkinje fibers to the ventricles.
 - c. This movement produces a smooth flow of electricity, producing a coordinated pumping action.
 - d. If injured, the heart will not beat properly.

D. Arteries

- 1. Carry blood from the heart to all body tissues
- 2. Aorta
 - a. Main artery leaving the left side of the heart and carrying freshly oxygenated blood to the body
 - b. Has many branches that supply the vital organs
- 3. The pulmonary artery originates at the right ventricle and carries oxygen-poor blood to the lungs.
- 4. Arteries branch first into smaller arteries and then into arterioles.
 - a. Arterioles branch into increasingly smaller vessels until they connect to the capillaries.
- 5. Pulse is created by the forceful pumping of blood out of the left ventricle and into the major arteries.
 - a. Palpated most easily at the neck, wrist, or groin

E. Capillaries

1. Tiny blood vessels that connect arterioles to venules
2. Oxygen and nutrients pass from blood cells and plasma in the capillaries to individual tissue cells through the very thin walls of the capillaries.
3. Capillaries allow blood to move through them one cell at a time.

F. Veins

1. Return oxygen-depleted blood to the heart
2. Have thinner walls than arteries and are generally larger in diameter
3. Major veins
 - a. The superior vena cava carries blood returning from the head, neck, shoulders, and upper extremities.
 - b. The inferior vena cava carries blood from the abdomen, pelvis, and lower extremities.
4. Systemic vascular resistance (SVR)
 - a. The resistance to blood flow within all blood vessels except the pulmonary vessels.

G. Spleen

1. Solid organ located under the rib cage in the left upper part of the abdomen
2. Filters worn-out blood cells, foreign substances, and bacteria from the blood
3. Highly vascular and particularly susceptible to injury from blunt trauma

H. Blood composition

1. Plasma (the liquid portion of blood) contains:
 - a. Water (primary component)
 - b. Proteins (primary component)
 - c. Oxygen, carbon dioxide, nitrogen
 - d. Nutrients
 - e. Cellular wastes
2. Red blood cells (erythrocytes)
 - a. Contain hemoglobin, which carries oxygen
3. White blood cells (leukocytes)
 - a. Play a role in the body's immune defense to fight infection
4. Platelets
 - a. Essential in the initial formation of a blood clot

X. The Circulatory System: Physiology

- A. Blood pressure: pressure that blood exerts against the walls of arteries**
- B. Systole: When the left ventricle of heart contracts, it pumps blood from the ventricle into the aorta.**
- C. Diastole: When the muscle of the ventricle relaxes, the ventricle fills with blood.**
- D. Forceful ejection of blood from the left ventricle into the aorta is transmitted through the arteries as a pulsatile pressure wave.**
 - 1. Can be measured with a blood pressure cuff (sphygmomanometer)
 - 2. Systolic blood pressure: high point of wave as heart is contracting
 - 3. Diastolic blood pressure: low point of wave as heart is in relaxation phase
- E. Normal circulation in adults**
 - 1. Automatically adjusted and controlled
 - 2. Perfusion: the circulation of blood in an organ or tissue in adequate amounts to meet the current needs of the cells
 - 3. Hypoperfusion: inadequate blood supply to organs, tissues, and cells
 - a. Also called shock
- F. Inadequate circulation in adults**
 - 1. The system can adjust to compensate for a small blood loss.
 - a. Vessels constrict.
 - b. The heart pumps more rapidly.
 - 2. With a large loss, adjustment fails, and the patient goes into shock.
 - 3. Mean arterial pressure can help detect shock.
 - a. The average arterial pressure during systole and diastole
 - b. $MAP = CO \times SVR$
- G. Functions of blood**
 - 1. Fighting infection
 - 2. Transporting oxygen
 - 3. Transporting carbon dioxide
 - 4. Controlling pH
 - 5. Transporting wastes and nutrients
 - 6. Clotting (coagulation)
- H. Nervous system control of the cardiovascular system**
 - 1. Sympathetic nervous system

- a. The heart and blood vessels have alpha-adrenergic receptors and beta-adrenergic receptors.
 - i. Adrenergic means related to the adrenal gland where epinephrine and norepinephrine are made.
 - b. Alpha-adrenergic receptors are found in blood vessels.
 - i. When stimulated, blood vessels contract.
 - c. Beta-adrenergic receptors are found in the heart and lungs.
 - i. When beta-1 receptors are stimulated, the heart rate and force of contraction increase.
 - ii. When beta-2 receptors are stimulated, the bronchi in the lungs dilate.
2. Parasympathetic nervous system
 - a. Causes the heart rate to slow and beat more weakly
 3. The sympathetic and parasympathetic nervous system balance each other.
 4. Baroreceptors sense pressure in the blood vessels.
 - a. Found in the aorta and carotid bodies
 - b. Cause stimulation of the sympathetic nervous system and parasympathetic nervous system to adjust blood pressure

XI. The Nervous System: Anatomy and Physiology

A. The nervous system is perhaps the most complex organ system in the body.

1. Divided into two main portions
 - a. Central nervous system (brain and spinal cord)
 - b. Peripheral nervous system (the nerves outside of the brain and spinal cord)
 - i. Somatic nervous system regulates voluntary activities.
 - ii. Autonomic nervous system controls functions that occur automatically.

B. Central nervous system

1. Brain
 - a. Cerebrum
 - i. Largest part of the brain
 - ii. Surface is made up of neurons
 - iii. Responsible for higher brain function
 - iv. Can be divided into to halves or hemispheres
 - (a) Each hemisphere has four lobes
 - (1) Frontal lobe: personality, judgment, planning, problem solving, concentration, and self-awareness
 - (2) Parietal lobe: spatial recognition
 - (3) Occipital lobe: vision
 - (4) Temporal lobe: taste, hearing, and ability to understand words

- b. Cerebellum
 - i. Controls balance, muscle coordination, and posture
 - c. Brainstem
 - i. Controls body functions necessary for life, including cardiac and respiratory functions and regulation of consciousness
 - ii. Comprises the midbrain, the pons, and the medulla oblongata
 - iii. Reticular activating system: regulates consciousness
 - d. Cerebrospinal fluid (CSF)
 - i. Filters out impurities and toxins
 - ii. Cushions the brain and spinal cord
 - e. Circulation in the head
 - i. Oxygenated blood is supplied via the carotid arteries.
 - ii. Deoxygenated blood is drained from the head via the internal and external jugular veins.
2. Spinal cord
- a. An extension of the brainstem
 - b. Leaves the skull via the foramen magnum
 - c. Encased with the vertebral column
 - d. Ends at the level of the second lumbar vertebra
 - e. Primary function is to transmit messages between the brain and spinal cord.
3. Peripheral nervous system
- a. Divided into two parts:
 - i. Somatic nervous system (voluntary)
 - (a) Transmits signals from the brain to voluntary muscles
 - (b) Allows for activities such as walking, talking, and writing
 - ii. Autonomic nervous system (involuntary)
 - (a) Sympathetic nervous system
 - (b) Parasympathetic nervous system
 - b. Two types of nerves within peripheral nervous system
 - i. Sensory nerves carry information from the body to the CNS.
 - (a) Found in the eyes, ears, skin, muscles, joints, lungs, and other organs
 - ii. Motor nerves carry information from the CNS to the muscles.

XII. The Integumentary System (Skin): Anatomy

A. Two layers of skin

- 1. Epidermis (superficial)
 - a. Forms a protective watertight barrier
 - b. Composed of several layers of cells

- i. Germinal layer: produces new cells
 - ii. Stratum corneal layer: surface layer of dead cells
 - iii. Skin cells are constantly being replaced.
2. Dermis (deeper)
 - a. Contains special structures of the skin
 - i. Sweat glands
 - ii. Sebaceous glands
 - iii. Hair follicles
 - iv. Blood vessels
 - v. Mucous membranes

B. Below the skin lies subcutaneous tissue, a layer of fat that serves as an insulator and as an energy reservoir.

XIII. The Integumentary System (Skin): Physiology

A. The skin is the largest single organ in the body.

B. Three major functions:

1. Protect the body in the environment.
2. Regulate body temperature.
3. Transmit information from the environment to the brain.

XIV. The Digestive System: Anatomy

A. Digestive system is also called the gastrointestinal system.

B. Components of the digestive system

1. Abdomen
 - a. Contains major organs of digestion and excretion
 - b. Quadrants are the easiest way to identify areas.
2. Organs and vascular structures
 - a. Right upper (RUQ): contains the liver, gallbladder, and a portion of the colon
 - b. Left upper (LUQ): contains the stomach, spleen, and a portion of the colon
 - c. Right lower (RLQ): contains two portions of the large intestine (cecum and ascending colon)
 - d. Left lower (LLQ): contains the descending and sigmoid portions of the colon
 - e. The small intestine, pancreas, large intestine, and urinary bladder lie in more than one quadrant.
 - f. The kidneys and pancreas lie behind the abdominal cavity (retroperitoneal).
3. Mouth

- a. Consists of the lips, cheeks, gums, teeth, and tongue
 - b. Hard and soft palate
 - c. Salivary glands
 - i. Two sets of salivary glands
 - ii. Saliva is approximately 98% water and 2% mucus, salts, and organic compounds.
4. Oropharynx
- a. Tubular structure that extends from the back of the mouth to the esophagus and trachea
5. Esophagus
- a. Collapsible tube about 10 inches long that extends from the end of the pharynx to the stomach
 - b. Muscles in the wall of the esophagus propel food to the stomach.
6. Stomach
- a. Hollow organ in LUQ
 - b. Receives food, stores it, and provides for its movement into the bowel
7. Pancreas
- a. Flat, solid organ that lies below and behind the liver and stomach
 - b. Contains two portions: exocrine and endocrine
 - i. The exocrine portion secretes pancreatic juice containing enzymes that aid in digestion of fat, starch, and protein.
 - ii. The endocrine portion (islets of Langerhans) produces insulin and glucagon.
8. Liver
- a. Large, solid organ immediately beneath the diaphragm in the RUQ, extending into the LUQ
 - b. Functions of the liver:
 - i. Filtering harmful substances
 - ii. Forming the factors needed for blood clotting and normal plasma production
 - iii. Storing sugar or starch for immediate use by the body for energy
 - iv. Producing bile to assist with the digestion of fat
 - c. Bile ducts
 - i. Connects the liver to the small intestine
 - ii. Carries bile from the gallbladder where bile is stored, to the duodenum
9. Small intestine
- a. Major hollow organ of the abdomen
 - b. Produces enzymes and mucus to aid in digestion
 - c. Composed of the duodenum, jejunum, and ileum
10. Large intestine

- a. Major hollow organ consisting of the cecum, colon, and rectum
- b. The major function of the colon is to absorb the final 5–10% of digested food and water from the intestine to form solid stool.

11. Appendix

- a. A 3- to 4-inch-long tube that opens into the cecum (first part of large intestine) in the RLQ of the abdomen
- b. May easily become obstructed, inflamed, or infected (appendicitis)

12. Rectum

- a. Large, hollow organ at the lowermost end of the colon adapted to hold quantities of feces until it is expelled
- b. The anus is located at the end.
- c. Sphincters control the release of liquids, gases, and solids from the digestive tract.

XV. The Digestive System: Physiology

A. Digestion is a complicated chemical process.

1. Enzymes are added to food by the salivary glands, stomach, liver, pancreas, and small intestine.
2. They convert food into basic sugars, fatty acids, and amino acids.
 - a. These basic products of digestion are carried across the wall of the intestine to the liver and processed further and stored or transported to the heart.
 - b. Circulated via blood throughout the body

XVI. The Lymphatic System: Anatomy and Physiology

A. Composed of the spleen, lymph nodes, lymph, lymph vessels, thymus gland, and other components

B. Supports the circulatory system and immune system

C. Lymph is a thin, straw-colored fluid that carries oxygen, nutrients, and hormones to the cells and waste products of metabolism away from the cells to be excreted.

1. Lymph vessels form a network throughout the body that serves as an auxiliary to the circulatory system.
2. Lymph nodes are tiny, oval-shaped structures that filter lymph.
3. They help rid the body of toxins and other harmful materials.

XVII. The Endocrine System: Anatomy and Physiology

- A. The endocrine system is a complex message and control system that integrates many body functions.**
- B. Endocrine glands release hormones directly into the bloodstream.**
 - 1. Each endocrine gland produces one or more hormones.
 - 2. Each hormone has a specific effect on some organ, tissue, or process.
- C. The brain controls the release of hormones.**
 - 1. This system uses primary and secondary feedback loops to keep the body in balance.
- D. Excesses or deficiencies in hormones can cause disease processes, such as diabetes.**

XVIII. The Urinary System: Anatomy and Physiology

- A. The urinary system controls the discharge of certain waste materials filtered from the blood by the kidneys.**
- B. Functions of the urinary system:**
 - 1. Control fluid balance in the body.
 - 2. Filter and eliminate wastes.
 - 3. Control pH balance.
- C. The kidneys are two solid organs that lie in the retroperitoneal space.**
 - 1. Rid the blood of toxic waste products and control the balance of water and salt.
 - 2. A ureter passes from each kidney and drains into the urinary bladder.
- D. The urinary bladder is located immediately behind the pubic symphysis in the pelvic cavity and empties to the outside of the body through the urethra.**

XIX. The Genital System: Anatomy and Physiology

- A. The genital system controls the reproductive processes by which life is created.**
- B. The male reproductive system consists of the testicles, epididymis, vasa deferentia, prostate gland, seminal vesicles, and penis.**
 - 1. Lies outside the pelvic cavity (except for the prostate gland and seminal vesicles)
- C. The female reproductive system consists of the ovaries, fallopian tubes, uterus, cervix, and vagina.**
 - 1. Contained entirely within the pelvic cavity (except the clitoris and labia)

XX. Life Support Chain

- A. Cells are the foundation of the human body.**

1. All cells in the body require oxygen, nutrients, and removal of waste.
2. The respiratory and circulatory systems are the carriers of these supplies and wastes.
3. If interference occurs, cells become damaged and die.

B. Cells use oxygen to take available nutrients and turn them into chemical energy through metabolism.

1. Adenosine triphosphate (ATP) is used in energy metabolism and storage.
2. Aerobic metabolism uses oxygen.
3. Cells switch to anaerobic metabolism when oxygen is limited.
 - a. Lactic acid can build up inside the cells.
 - b. As lactic acid and other wastes accumulate around the cell, the area become toxic and cells can die.
4. Movement of oxygen, waste, and nutrients occurs by diffusion.

XXI. Pathophysiology

A. Pathophysiology is the study of functional changes that occur when the body reacts to disease.

B. Respiratory compromise is the inability to move gas effectively.

1. Can lead to:
 - a. Hypoxia: decreased level of oxygen in the body
 - b. Hypercapnia: elevated level of carbon dioxide in the body
2. Factors that impair ventilation:
 - a. Blocked airway
 - b. Impairment of the muscles of breathing
 - i. Neuromuscular disease
 - ii. Trauma
 - c. Physiologic obstruction of the airway (eg, asthma attack)
 - d. Drug overdose, trauma to the chest wall, allergic reaction
3. Factors that impair respiration:
 - a. Change in the atmosphere
 - b. High altitudes
 - c. Impaired movement of the gas across the cell membrane

C. Ventilation/Perfusion Mismatch

1. The V/Q ratio describes how much gas is being moved effectively through the lungs and how much blood is flowing around the alveoli.

2. A mismatch occurs when one of those two variables is abnormal.
 - a. Pulmonary embolism preventing blood flow
 - b. Edema inside of the alveoli
 - c. When either the “V” or the “Q: is impacted, respiratory compromise can occur.

D. Effects of respiratory compromise on the body

1. Oxygen levels throughout the body fall and carbon dioxide levels rise.
2. The brain detects an increase in carbon dioxide levels.
3. The body increases its respiratory rate in an attempt to return the carbon dioxide levels to normal.
4. If increased respiratory does not occur or is not effective in returning the carbon dioxide levels to normal, the blood will become more acidic.
5. Blood oxygen levels will begin to fall, which will cause the brain to issue further commands to breathe.
6. Decreased oxygen levels will force cells to move from aerobic to anaerobic metabolism.

E. Shock

1. A condition in which organs and tissue receive an inadequate flow of blood and oxygen
2. Impaired oxygen delivery causes cellular hypoxia, which leads to anaerobic metabolism, lactic acid production, and organ dysfunction.
3. Shock is categorized into several types depending on the cause.

F. The effects of shock on the body are similar to those of respiratory compromise.

1. The level of oxygen supplied to the tissues falls.
2. Cells engage in anaerobic metabolism, resulting in lactic acid production.
3. Severe metabolic acidosis ensues, leading to increased levels of carbon dioxide within the blood.
4. Baroreceptors detect decreased blood pressure and initiate the release of epinephrine and norepinephrine.
5. The heart rate increases, the heart beats more forcefully, and blood vessels constrict.
6. Interstitial fluid moves into the capillaries.

G. Alteration of cellular metabolism

1. When there is inadequate oxygen, cells will create energy through anaerobic metabolism.
 - a. Can result in metabolic acidosis

- b. Requires more energy than when using glucose for fuel
- c. Decreases the blood's ability to effectively carry oxygen to the cells
- d. Decreases the functioning of oxygen within the cell
- e. Brain cells cannot use alternative fuels.
 - i. If their supply of glucose decreases dramatically, brain cells will quickly become damaged or die.
- f. Cellular injury, up to a point, may be repairable if normal tissue perfusion is restored.

Post-Lecture

Assessment in Action

A. Assessment in Action is available in the Navigate course.