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 179–180)

2. Identify the anatomy and physiology of the skeletal system. (pp 180–181)

3. Describe the anatomy and physiology of the musculoskeletal system. (pp 186–187)

4. Discuss the anatomy and physiology of the respiratory system. (pp 187–196)

5. Discuss the anatomy and physiology of the circulatory system. (pp 196–208)

6. Discuss the anatomy and physiology of the nervous system. (pp 208–212)

7. Describe the anatomy and physiology of the integumentary system. (pp 212–214)

8. Explain the anatomy and physiology of the digestive system. (pp 214–218)

9. Describe the anatomy and the physiology of the lymphatic system. (p 218)

10. Discuss the anatomy and physiology of the endocrine system. (pp 218–220)

11. Describe the anatomy and physiology of the urinary system. (pp 220–221)

12. Discuss the anatomy and physiology of the genital system. (pp 221–223)

13. Describe the life support chain, aerobic metabolism, and anaerobic metabolism. (pp 223–224)

14. Define pathophysiology. (p 224)

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***, **Eleventh 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 2.

• **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 Student Presentation and 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. Knowledge of anatomy helps to communicate correct information:

1. To other medical professionals

2. To others who may not understand medical terms

II. Topographic Anatomy

A. Superficial landmarks serve as guides to the structures that lie beneath them.

B. 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

C. Planes of the body

1. Imaginary straight lines that divide the body

2. Three main areas depending on how the body is divided:

a. Frontal (coronal) plane: divides the body front and back

b. Transverse (axial) plane: divides the body top and bottom

c. Sagittal (lateral) plane: divides the body left and right

III. The Skeletal System: Anatomy

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

B. Components of the skeleton:

1. 206 bones (constitute the structure of skeletal system)

2. Ligaments (connect bones to each other)

3. Tendons (connect muscles to bones)

4. Cartilage (smooth connective tissue covering the ends of bones at mobile joints)

D. The skeletal system is divided into two portions: the axial skeleton and the appendicular skeleton.

1. Axial skeleton: foundation to which the arms and legs are attached

a. Skull

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

b. Spinal column

i. Central supporting structure of the body

ii. Composed of 33 vertebrae

iii. The spine is divided into 5 sections (top to bottom), and the vertebrae in each section are numbered from top to bottom.

(a) The cervical spine (neck) has 7 vertebrae.

(b) The thoracic spine (upper back) has one pair of ribs attached to each of the 12 vertebrae.

(c) The lumbar spine (lower back) has 5 vertebrae.

(d) The sacrum (back wall of pelvis) consists of 5 fused vertebrae that join the pelvis.

(e) The coccyx (tailbone) consists of 4 fused vertebrae.

c. Thorax

i. The thoracic cavity contains the heart, lungs, esophagus, and great vessels.

ii. Formed by 12 thoracic vertebrae and 12 pairs of ribs

iii. Midline of chest is the sternum

2. Appendicular skeleton: arms, legs, their connection points, and pelvis

a. Joints

i. Occur wherever bones come in contact

ii. Consist of the ends of the bones and the surrounding connecting and supporting tissues

iii. Two types of joints

(a) Ball-and-socket joint (eg, shoulder)

(1) Allows rotation and bending

(b) Hinge joint

(2) Motion is restricted to flexion (bending and extension)

b. Upper extremities

i. Extend from shoulder girdle to fingertips

ii. Composed of arms, forearms, hands, and fingers

(a) The shoulder girdle is where three bones come together:

(1) Clavicle (collarbone)

(2) Scapula (shoulder blade)

(3) Humerus (supporting bone of the arm)

(b) Arm

(1) Humerus is the supporting bone

(2) Forearm consists of radius and ulna

(3) Radius lies on the lateral, or thumb, side

(4) Ulna is on the medial, or little, finger

(c) Wrist and hand

(1) A modified ball-and-socket joint formed by the ends of the radius and ulna and carpal bones

(3) Five metacarpals extend from the carpal bones and make up the hand

(4) Fingers are composed of phalanges

c. Pelvis

i. Closed bony ring consisting of three bones: the sacrum and two pelvic bones

ii. Each pelvic bone is formed by fusion of the ilium, ischium, and pubis.

d. Lower extremities

i. Femur (thighbone)

(a) Longest and one of the strongest bones in the body

(b) The femoral head is where the femur connects into the acetabulum (the pelvic girdle) by a ball-and-socket joint.

ii. Knee

1. Connects the upper leg to the lower leg
2. Hinge joint

(c) Kneecap (patella)

iii. Lower leg

(a) Tibia: shinbone

(b) Fibula

iv. Ankle

(a) Hinge joint

(b) Allows flexion and extension of the foot

v. Foot

(a) Contains 7 tarsal bones

(b) 5 metatarsal bones form the substance of the foot

(c) 5 toes formed by 14 phalanges

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. Also called voluntary muscle, because it is under direct voluntary control of the brain

b. Movement of the body results from skeletal muscle contraction or relaxation.

2. Smooth muscle is found within blood vessels and intestines.

3. Cardiac muscle is found only within the heart.

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 consists of structures of the body that contribute to the process of breathing (respiration).

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

9. Esophagus

a. Immediately posterior to the trachea

b. Food and liquids enter the pharynx and then pass into the esophagus, which carries them to the stomach.

**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 small grape-like sacs called alveoli.

a. Alveoli allow for gas exchange (oxygen and carbon dioxide).

E. Muscles involved in breathing

1. Diaphragm

a. Primary muscle of breathing

b. Divides the thorax from the abdomen

2. Intercostal muscles

a. During inhalation, the diaphragm and intercostal muscles contract, moving the ribs up and out, enlarging the chest cavity, decreasing the pressure in the lungs, and moving air in.

b. During exhalation, the diaphragm and intercostal muscles relax, decreasing the chest cavity, increasing the pressure in the lungs, and moving air out.

3. Neck (cervical muscles)

4. Abdominal muscles

5. Pectoral muscles

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. Respiration

a. Respiration: the exchange of oxygen and carbon dioxide in the alveoli and in tissues of the body

b. Diffusion: the passive process in which oxygen molecules move from an area with a higher concentration of oxygen molecules to an area of lower concentration.

c. The brain stem automatically controls breathing if the level of carbon dioxide or oxygen in arterial blood is too high or too low.

i. The medulla initiates the ventilation cycle when stimulated by high carbon dioxide levels.

2. Ventilation

a. Ventilation: simple movement of air into and out of the lungs

b. Tidal volume: the amount of air that is moved into or out of the lungs during a single breath

c. Residual volume: the gas that remains in the lungs to keep the lungs open

d. Minute volume: the amount of air that moves in and out of the lungs in 1 minute minus the dead space

e. Respiratory rate × tidal volume = minute volume

C. Normal breathing

1. Normal rate and depth (tidal volume)

2. Regular rhythm or pattern of inhalation and exhalation

3. Clear, audible breath sounds on both sides of chest

4. Regular rise and fall movement on both sides of the chest

5. Movement of the abdomen

D. Inadequate breathing patterns

1. Labored breathing

2. Muscle retractions above the clavicles, between the ribs, and below the rib cage

3. Pale or cyanotic (blue) skin

4. Cool, damp (clammy) skin

5. Patient in the tripod position (leaning forward on arms stretched forward)

6. Agonal gasps

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. Made of specialized cardiac muscle (myocardium)

2. Works as two paired pumps

3. Each side is divided into:

a. Atrium (upper chamber)

b. Ventricle (lower chamber)

4. Circulation

a. The heart receives its blood from the aorta.

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.

5. Normal heart rate (HR)

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 × 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. 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.

F. Veins

1. Return oxygen-depleted blood to the heart

2. 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.

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 is 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. Blood enters organs and tissues through the arteries and leaves through the veins

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.

G. Functions of blood

1. Perfusion

2. Transporting oxygen

3. Transporting carbon dioxide

4. Transporting wastes and nutrients

5. Clotting (coagulation)

XI. The Nervous System: Anatomy and Physiology

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

B. Divided into two main portions

1. Central nervous system (CNS): the brain and spinal cord

a. The brain is the controlling organ of the body.

i. Cerebrum

(a) Largest part of the brain

(b) Four lobes, each responsible for a specific function such as hearing, balance, and speech

ii. Cerebellum

(a) Coordinates body movements

iii. Brain stem

(a) Controls body functions necessary for life, including cardiac and respiratory functions and regulation of consciousness

b. The spinal cord is an extension of the brain.

i. Transmits messages between the brain and the body

ii. Cerebrospinal fluid (CSF) cushions the brain and spinal cord.

2. Peripheral nervous system

a. Links the CNS to the various organs of the body

b. 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) Controls involuntary actions necessary for basic body functions such as digestion, dilation, and constriction of blood vessels

c. Two types of nerves within peripheral nervous system

i. Sensory nerves carry information from the body to the CNS.

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. 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

a. Sweat is secreted to the skin surface from the sweat glands.

3. Transmit information from the environment to the brain

XIV. The Digestive System: Anatomy

A. Digestion: the processing of food that nourishes the individual cells of the body

1. The 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.

i. Right upper (RUQ): contains the liver, gallbladder, and a portion of the colon

ii. Left upper (LUQ): contains the stomach, spleen, and a portion of the colon

iii. Right lower (RLQ): contains two portions of the large intestine (cecum and ascending colon)

iv. Left lower (LLQ): contains the descending and sigmoid portions of the colon

c. The small intestine, pancreas, large intestine, and urinary bladder lie in more than one quadrant.

2. Mouth

a. Consists of lips, cheeks, gums, teeth, and tongue

b. Salivary glands

3. Oropharynx

a. Tubular structure that extends from the back of the mouth to the esophagus and trachea

4. 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.

5. Stomach

a. Hollow organ in LUQ

b. Receives food, stores it, and provides for its movement into the bowel

6. 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.

7. 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

8. 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

9. 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.

10. 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)

11. Rectum

a. Large, hollow organ at the lowermost end of the colon adapted to hold quantities of feces until it is expelled

b. At its terminal end is the anus.

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.

3. 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.

4. 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 tightly controlled communication 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 to store energy.

2. Aerobic metabolism uses oxygen.

3. Cells switch to anaerobic metabolism when oxygen is limited.

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. Hypercarbia: elevated level of carbon dioxide in the body

2. Factors that impair ventilation:

a. Blocked airway

b. Impairment of the muscles of breathing

c. Physiologic obstruction of the airway (eg, asthma attack)

d. Numerous other factors

3. Factors that impair respiration:

a. Change in the atmosphere

b. High altitudes

c. Impaired movement of the gas across the cell membrane

**C. 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.

**D. 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.

**E. 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.

**F. Impairment of cellular metabolism results in the inability to properly use oxygen and glucose at the cellular level.**

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

This section contains various student-centered end-of-chapter activities designed as enhancements to the instructor’s presentation. As time permits, these activities may be presented in class. They are also designed to be used as homework activities.

## Assessment in Action

This activity is designed to assist the student in gaining a further understanding of issues surrounding the provision of prehospital care. The activity incorporates both critical thinking and application of basic EMT knowledge.

### Instructor Directions

**1.** Direct students to read the “Assessment in Action” scenario located in the Prep Kit at the end of Chapter 6.

**2.** Direct students to read and individually answer the quiz questions at the end of the scenario. Allow approximately 10 minutes for this part of the activity. Facilitate a class review and discussion of the answers, allowing students to correct responses as may be needed. Use the quiz question answers noted below to assist in building this review. Allow approximately 10 minutes for this part of the activity.

**3.** You may wish to ask students to complete the activity on their own and turn in their answers on a separate piece of paper.

### Answers to Assessment in Action Questions

1. **Answer:** A Coronal

2. **Answer:** B Carotid

3. **Answer:** C Femur

4. **Answer:** D Calcium

5. **Answer:** A Zygoma

6. **Answer:** C Radius

7. **Answer:** A Hinge

8. **Answer:** Respiratory compromise is the inability of the body to move gas effectively. It occurs when either ventilation or respiration is impaired. The heart and brain cells cannot survive without a constant supply of oxygen, and will die in minutes.

Decreased oxygen levels force cells to move from aerobic metabolism to anaerobic metabolism. Cellular functions become impaired. Lactic acid is created as a by-product of anaerobic metabolism. Once too much lactic acid is created, the pH of the blood will drop, and cells will die.

9. **Answer:** The brain stem is the control center that regulates a person’s level of consciousness and vital signs. The brain stem is composed of three smaller components: the midbrain, medulla, and pons. The midbrain is responsible for a person’s level of consciousness, whereas the pons and the medulla regulate and maintain the blood pressure, heart rate, and respiratory rate.

10. **Answer:** The autonomic nervous system is divided into two halves−the parasympathetic nervous system that dominates during periods of rest and relaxation, and the sympathetic nervous system that takes over in times of stress. When the body recognizes that irregularities are occurring, the sympathetic nervous system kicks into action and increases the vital signs to help the body adapt and attempt to reestablish normal function. The brain stem also helps to control the heart rate.

## Assignments

A. Review all materials from this lesson and be prepared for a lesson quiz to be administered (date to be determined by the instructor).

B. Read Chapter 7, “Life Span Development,” for the next class session.