CHAPTER 1

An Introduction to Anatomy and Physiology
Chapter 1 Learning Outcomes

• 1-1
  • Describe the basic functions of living organisms.

• 1-2
  • Explain the relationship between anatomy and physiology, and describe various specialties of each discipline.

• 1-3
  • Identify the major levels of organization in living organisms.

• 1-4
  • Identify the 11 organ systems of the human body and contrast their major functions.
Chapter 1 Learning Outcomes

- 1-5
  - Explain the concept of homeostasis.

- 1-6
  - Describe how negative feedback and positive feedback are involved in homeostatic regulation.

- 1-7
  - Use anatomical terms to describe body sections, body regions, and relative positions.

- 1-8
  - Identify the major body cavities and their subdivisions.
Common Functions of All Living Things (1-1)

• Responsiveness

• Growth

• Reproduction

• Movement

• Metabolism
Responsiveness and Growth (1-1)

- **Responsiveness**
  - Also called irritability
  - An organism changes in response to its environment
  - Longer term change is called adaptation

- **Growth**
  - An increase in size, number of cells, complexity of cells, or all three
  - The process of developing a variety of cells is called differentiation
Reproduction and Movement (1-1)

- **Reproduction**
  - Creation of new generations of similar organisms

- **Movement**
  - Ability to transport things within the internal environment of the organism
  - Ability to transport the organism through the external environment
Metabolism (1-1)

- The sum total of all the chemical reactions in the organism
- Uses resources absorbed from the environment
- Uses respiration for cellular production of energy
- Organism excretes any waste products left over from the chemical reactions
1. How are vital functions such as responsiveness, growth, reproduction, and movement dependent on metabolism?
Anatomy (1-2)

• The word *anatomy* means "a cutting open"
• The structure of things or how things are built
• Specifics of:
  • Where things are
  • What they are made of
  • Physical relationships between parts
Gross Anatomy (1-2)

• Also called *macroscopic anatomy*

• Studies visible structures

• Includes:
  
  • **Surface anatomy**
    
    • Study of general form and superficial markings
  
  • **Regional anatomy**
    
    • Study of all the superficial and internal features of a specific region of the body
  
  • **Systemic anatomy**
    
    • Study of the structure of major *organ* systems
Microscopic Anatomy (1-2)

- Studies structures that cannot be seen without magnification

- Includes:
  - Cytology
    - Study of internal structure of individual cells
  - Histology
    - Study of tissues, groups of specialized cells and cell products that work together to perform specific functions
Physiology (1-2)

• The function of the anatomical structures

• Specifics of:
  • How structures, organs, and systems work separately and together
Physiology (1-2)

• **Human physiology** specialties include:
  • Cell physiology
    • Study of the functions of living cells
  • Special physiology
    • Study of the physiology of specific organs
  • Systemic physiology
    • Study of all aspects of the function of specific organ systems
  • **Pathological physiology** or pathology
    • Study of the effects of diseases on organ or system functions
2. Describe how anatomy and physiology are closely related.

3. Would a histologist more likely be considered a specialist in microscopic anatomy or gross anatomy? Why?
Levels of Organization (1-3)

- **Chemical level**
  - *Atoms* are the smallest stable units of matter
  - Atoms combine to form *molecules*
  - Molecular shape defines function

- **Cellular level**
  - Combination of molecules, atoms, and organelles to perform a specific function in a cell
Levels of Organization (1-3)

- **Tissue level**
  - A collection of cells working together to perform a specific function

- **Organ level**
  - Two or more tissues working together to perform specific functions
Levels of Organization (1-3)

- **Organ system level**
  - Two or more organs working together to perform specific functions

- **Organism level**
  - Multiple organ systems working together to maintain health
All the organ systems must work together for a person to remain alive and healthy.

The cardiovascular system includes the heart, blood, and blood vessels.

The heart is a complex organ composed of different tissues.

Cardiac muscle tissue makes up the bulk of the walls of the heart.

Interlocking heart muscle cells form cardiac muscle tissue.

Contractile protein fibers are structures within a heart muscle cell.

Molecules join to form complex contractile protein fibers.

Atoms interact to form molecules.
4. Identify the major levels of organization of the human body from the simplest to the most complex.
The 11 Organ Systems of the Human Body (1-4)

1. Integumentary

2. Skeletal

3. Muscular

4. Nervous

5. Endocrine

6. Cardiovascular
The 11 Organ Systems of the Human Body (1-4)

7. Lymphatic

8. Respiratory

9. Digestive

10. Urinary

11. Reproductive
The Integumentary System

Protects against environmental hazards; helps control body temperature

- Hair
- Skin
- Nails
The Skeletal System

Provides support; protects tissues; stores minerals; forms blood cells

**AXIAL SKELETON**
- Skull
- Sternum
- Ribs
- Vertebrae
- Sacrum

**APPENDICULAR SKELETON**
- Supporting bones (scapula and clavicle)
- Upper limb bones
- Pelvis (supporting bones plus sacrum)
- Lower limb bones
The Muscular System

- Allows for locomotion;
- Provides support;
- Produces heat

Axial muscles

Appendicular muscles

Tendons
The Nervous System

Directs immediate responses to stimuli, usually by coordinating the activities of other organ systems.
The Endocrine System

Directs long-term changes in activities of other organ systems

- Pineal gland
- Parathyroid gland
- Pituitary gland
- Thyroid gland
- Thymus
- Pancreas
- Ovary in female
- Testis in male
- Adrenal gland
- Ovary in female
- Testis in male
The Cardiovascular System

Transports cells and dissolved materials, including nutrients, wastes, and gases
The Lymphatic System

Defends against infection and disease; returns tissue fluid to the bloodstream

- Thymus
- Lymph nodes
- Spleen
- Lymphatic vessel
The Respiratory System

Delivers air to sites where gas exchange can occur between the air and circulating blood; produces sound

- Nasal cavity
- Sinus
- Pharynx
- Larynx
- Trachea
- Bronchi
- Lung
- Diaphragm
The Digestive System

Processes food and absorbs nutrients

Salivary gland
Mouth and teeth

Pharynx

Liver
Gallbladder
Pancreas
Small intestine

Esophagus

Stomach

Large intestine

Anus
The Urinary System

Eliminates excess water, salts, and waste products

- Urinary bladder
- Urethra
- Kidney
- Ureter
The Male Reproductive System

- Prostate gland
- Seminal gland
- Ductus deferens
- Urethra
- Epididymis
- Testis
- Penis
- Scrotum

Produces sex cells and hormones
The Female Reproductive System

Produces sex cells and hormones; supports embryonic and fetal development from fertilization to birth

- Mammary gland
- Uterine tube
- Ovary
- Uterus
- Vagina
- External genitalia
Checkpoint (1-4)

5. Identify the organ systems of the body and list their major functions.

6. Which organ system includes the pituitary gland and directs long-term changes in the activities of other systems?
Homeostasis (1-5)

- The maintenance of a relatively stable internal environment
- The result of interdependence of organ systems functioning together
Homeostatic Regulation (1-5)

• The adjustments in physiological systems that preserve homeostasis

• A typical homeostatic loop contains:
  
  • A **receptor** that receives a *stimulus*
  
  • A **control center** that processes and integrates information from the receptor
  
  • An **effector** that responds to the control center to change the body's response
Figure 1-3 The Control of Room Temperature.

**RECEPTOR**
Thermometer

**STIMULUS:**
Room temperature rises

**HOMEOSTASIS**
Normal room temperature

**RESPONSE:**
Room temperature drops

**EFFECTOR**
Air conditioner turns on

**CONTROL CENTER**
(Thermostat)

Sends commands to

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7. Define homeostasis.

8. Why is homeostatic regulation important to an organism?
Negative Feedback (1-6)

• Corrects deviations from normal
• Most common form of feedback loop
• Variations from the norm that are increases are brought back down
• Variations from the norm that are decreases are brought back up
Negative Feedback: Thermoregulation (1-6)

• If body temperature drops too low:
  • The brain sends signals to skeletal muscles to start shivering
  • And to blood vessels in the skin to vasoconstrict
  • Bringing the temperature back up

• If body temperature is too high:
  • The brain sends a message to the skin to vasodilate and sweat
  • Bringing temperature back down
Positive Feedback (1-6)

- Reinforces or exaggerates deviations from normal
- Variations from the norm that are increases are further increased
- Fairly rare occurrence and must have an "off switch"
If blood vessels are damaged:

- Chemicals are released to attract platelets

Platelets release more chemicals

- Which start a cascade of reactions that lead to clot formation
  - Each step enhances the next step

Repair of the damaged vessels stops the first chemical secretion
Figure 1-4 Negative Feedback in Thermoregulation.

If body temperature climbs above 37.2°C (99°F), heat loss is increased through enhanced blood flow to the skin and increased sweating.

If body temperature falls below 36.7°C (98°F), heat loss is decreased through reduced blood flow to the skin and sweating, and heat is produced by shivering.
If body temperature climbs above 37.2°C (99°F), heat loss is increased through enhanced blood flow to the skin and increased sweating.
If body temperature falls below 36.7°C (98°F), heat loss is decreased through reduced blood flow to the skin and sweating, and heat is produced by shivering.
Damage to cells in the blood vessel wall releases chemicals that begin the process of blood clotting. The chemicals start chain reactions in which cells, cell fragments, and dissolved proteins in the blood begin to form a clot. As clotting continues, each step releases chemicals that further accelerate the process. This escalating process is a positive feedback loop that ends with the formation of a blood clot, which patches the vessel wall and stops the bleeding.
Damage to cells in the blood vessel wall releases chemicals that begin the process of blood clotting.

Figure 1-5 Positive Feedback. (1 of 4)
The chemicals start chain reactions in which cells, cell fragments, and dissolved proteins in the blood begin to form a clot.
As clotting continues, each step releases chemicals that further accelerate the process.

Figure 1-5 Positive Feedback. (3 of 4)
This escalating process is a positive feedback loop that ends with the formation of a blood clot, which patches the vessel wall and stops the bleeding.
9. Explain the function of negative feedback systems.

10. Why is positive feedback helpful in blood clotting but unsuitable for the regulation of body temperature?

11. What happens to the body when homeostasis breaks down?
Anatomical Terminology (1-7)

• Medical terminology

• Describes body regions, anatomical positions and directions, and body sections
  • Surface anatomy
  • Sectional anatomy
Anatomical Landmarks (1-7)

• **Anatomical position**
  
  • Hands at the sides with the palms facing forward and feet together
    
    • **Supine** (face up)
    
    • **Prone** (face down)
Figure 1-6a  Anatomical Landmarks.
Figure 1-6b Anatomical Landmarks.

- **Cephalon** or head (cephalic)
- **Cervicis** or neck (cervical)
- **Shoulder** (acromial)
- **Dorsum** or back (dorsal)
- **Olecranon** or back of elbow (olecranal)
- **Lumbus** or loin (lumbar)
- **Gluteus** or buttock (gluteal)
- **Popliteus** or back of knee (popliteal)
- **Calcaneus** or heel of foot (calcaneal)
- **Planta** or sole of foot (plantar)

*Posterior view in the anatomical position*
Anatomical Regions (1-7)

- Major regions of the body
- Two methods to map the surface of the abdomen and pelvis
  1. Abdominopelvic quadrants
  2. Abdominopelvic regions
Abdominopelvic quadrants. The four abdominopelvic quadrants are formed by two perpendicular lines that intersect at the navel (umbilicus). The terms for these quadrants, or their abbreviations, are most often used in clinical discussions.
Abdominopelvic regions. The nine abdominopelvic regions provide more precise regional descriptions.
Anatomical relationships. The relationship between the abdominopelvic quadrants and regions and the locations of the internal organs are shown here.
Anatomical Directions (1-7)

- Provide an orientation of structures relative to anatomical position
- *Left* and *right* always refer to the left and right sides of the subject, not the observer
Figure 1-8  Directional References.

(a) A lateral view. Posterior or dorsal vs. Anterior or ventral. Cranial vs. Caudal.


Arrows indicate important directional terms used in this text; definitions and descriptions are given in Table 1-1.
<table>
<thead>
<tr>
<th>Term</th>
<th>Region or Reference</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anterior</td>
<td>The front; before</td>
<td>The navel is on the anterior (ventral) surface of the trunk.</td>
</tr>
<tr>
<td>Ventral</td>
<td>The belly side (equivalent to anterior when referring to the human body)</td>
<td>The shoulder blade is located posterior (dorsal) to the rib cage.</td>
</tr>
<tr>
<td>Posterior</td>
<td>The back; behind</td>
<td></td>
</tr>
<tr>
<td>Dorsal</td>
<td>The back (equivalent to posterior when referring to the human body)</td>
<td></td>
</tr>
<tr>
<td>Cranial or Cephalic</td>
<td>The head</td>
<td>The cranial, or cephalic, border of the pelvis is superior to the thigh.</td>
</tr>
<tr>
<td>Superior</td>
<td>Above; at a higher level (in the human body, toward the head)</td>
<td>The nose is superior to the chin.</td>
</tr>
<tr>
<td>Caudal</td>
<td>The tail (coccyx in humans)</td>
<td>The hips are caudal to the waist.</td>
</tr>
<tr>
<td>Inferior</td>
<td>Below; at a lower level</td>
<td>The knees are inferior to the hips</td>
</tr>
<tr>
<td>Medial</td>
<td>Toward the body’s longitudinal axis</td>
<td>The medial surfaces of the thighs may be in contact; moving medially from the arm across the chest surface brings you to the sternum.</td>
</tr>
<tr>
<td>Lateral</td>
<td>Away from the body’s longitudinal axis</td>
<td>The thigh articulates with the lateral surface of the pelvis; moving laterally from the nose brings you to the eyes.</td>
</tr>
<tr>
<td>Proximal</td>
<td>Toward an attached base</td>
<td>The thigh is proximal to the foot; moving proximally from the wrist brings you to the elbow.</td>
</tr>
<tr>
<td>Distal</td>
<td>Away from an attached base</td>
<td>The fingers are distal to the wrist; moving distally from the elbow brings you to the wrist.</td>
</tr>
<tr>
<td>Superficial</td>
<td>At, near, or relatively close to the body surface</td>
<td>The scalp is superficial to the skull.</td>
</tr>
<tr>
<td>Deep</td>
<td>Farther from the body surface</td>
<td>The bone of the thigh is deep to the surrounding skeletal muscles.</td>
</tr>
</tbody>
</table>
Sectional Anatomy (1-7)

- A "slice" through the body in three primary sectional planes

  1. Transverse plane
     - Divides body into **superior** and **inferior** portions

  2. Frontal plane
     - Divides body into **anterior** and **posterior** portions

  3. Sagittal plane
     - Divides body into **left** and **right** portions
Figure 1-10 Planes of Section.

- Frontal plane
- Sagittal plane
- Transverse plane
<table>
<thead>
<tr>
<th>Plane</th>
<th>Orientation of Plane</th>
<th>Directional Reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transverse or horizontal</td>
<td>Perpendicular to Long Axis</td>
<td>Transversely or horizontally</td>
<td>A transverse, or horizontal, section separates superior and inferior portions of the body.</td>
</tr>
<tr>
<td>Sagittal</td>
<td>Parallel to Long Axis</td>
<td>Sagittally</td>
<td>A sagittal section separates right and left portions. You examine a sagittal section, but you section sagittally.</td>
</tr>
<tr>
<td>Midsagittal</td>
<td></td>
<td></td>
<td>In a midsagittal section, the plane passes through the midline, dividing the body in half and separating right and left sides.</td>
</tr>
<tr>
<td>Frontal or coronal</td>
<td>Frontally or coronally</td>
<td></td>
<td>A frontal, or coronal, section separates anterior and posterior portions of the body; coronal usually refers to sections passing through the skull.</td>
</tr>
</tbody>
</table>
12. What is the purpose of anatomical terms?

13. Describe an anterior view and a posterior view in the anatomical position.

14. What type of section would separate the two eyes?
Body Cavities (1-8)

- Protect internal organs
- Allow organs to change shape
Ventral Body Cavity (1-8)

- Contains **viscera**
  - Organs of the respiratory, cardiovascular, digestive, urinary, and reproductive systems
- Cavities are lined (*parietal* layer) and organs are enclosed (*visceral* layer) by serous membranes
- Two major divisions
  1. Thoracic cavity
  2. Abdominopelvic cavity
Thoracic Cavity (1-8)

- Three internal chambers
  - One pericardial cavity and two pleural cavities
- Each cavity is defined by a serous membrane
Pericardial Cavity of the Thoracic Cavity (1-8)

- Contains the heart, and is found in the mediastinum
- Defined by serous membrane, pericardium
- Visceral pericardium is the layer covering the heart
- Parietal pericardium is the outer layer
- In between two layers is serous fluid to reduce friction
Pleural Cavities of the Thoracic Cavity (1-8)

- Each lung is found within its own pleural cavity
- Serous membrane is the **pleura**
- *Visceral pleura* is the layer covering the lung
- *Parietal pleura* defines the edge of the mediastinum and lines the inner surface of the chest wall
Abdominopelvic Cavity (1-8)

- Subdivided into superior *abdominal cavity* and inferior *pelvic cavity*
- Contains the *peritoneal cavity*, lined with *peritoneum*
  - *Visceral peritoneum* covers internal organs
  - *Parietal peritoneum* lines inner surface of body wall
15. Describe two essential functions of body cavities.

16. Identify the subdivisions of the ventral body cavity.

17. If a surgeon makes an incision just inferior to the diaphragm, what body cavity will be opened?