Overview of Anatomy and Physiology

- Anatomy – the study of the structure of body parts and their relationships to one another
  - Gross or macroscopic
  - Microscopic
  - Developmental
- Physiology – the study of the function of the body’s structural machinery
Gross Anatomy

- Regional – all structures in one part of the body (such as the abdomen or leg)
- Systemic – gross anatomy of the body studied by system
- Surface – study of internal structures as they relate to the overlying skin
Microscopic Anatomy

- Cytology – study of the cell
- Histology – study of tissues
Developmental Anatomy

- Traces structural changes throughout life
- Embryology – study of developmental changes of the body before birth
Specialized Branches of Anatomy

- Pathological anatomy – study of structural changes caused by disease
- Radiographic anatomy – study of internal structures visualized by specialized scanning procedures such as X-ray, MRI, and CT scans
- Molecular biology – study of anatomical structures at a subcellular level
Physiology

- Considers the operation of specific organ systems
  - Renal – kidney function
  - Neurophysiology – workings of the nervous system
  - Cardiovascular – operation of the heart and blood vessels
- Focuses on the functions of the body, often at the cellular or molecular level
Understanding physiology also requires a knowledge of physics, which explains:

- electrical currents
- blood pressure
- the way muscle uses bone for movement
Principle of Complementarity

- Function always reflects structure
- What a structure can do depends on its specific form
Levels of Structural Organization

- Chemical – atoms combined to form molecules
- Cellular – cells are made of molecules
- Tissue – consists of similar types of cells
- Organ – made up of different types of tissues
- Organ system – consists of different organs that work closely together
- Organismal – made up of the organ systems
Levels of Structural Organization

**Figure 1.1**

1. Chemical level
   - Atoms combine to form molecules.

2. Cellular level
   - Cells are made up of molecules.

3. Tissue level
   - Tissues consist of similar types of cells.

4. Organ level
   - Organs are made up of different types of tissues.

5. Organ system level
   - Organ systems consist of different organs that work together closely.

6. Organismal level
   - The human organism is made up of many organ systems.
Integumentary System

- Forms the external body covering
- Composed of the skin, sweat glands, oil glands, hair, and nails
- Protects deep tissues from injury and synthesizes vitamin D
Skeletal System

- Composed of bone, cartilage, and ligaments
- Protects and supports body organs
- Provides the framework for muscles
- Site of blood cell formation
- Stores minerals
Muscular System

- Composed of muscles and tendons
- Allows manipulation of the environment, locomotion, and facial expression
- Maintains posture
- Produces heat

Figure 1.3c
Nervous System

- Composed of the brain, spinal column, and nerves
- Is the fast-acting control system of the body
- Responds to stimuli by activating muscles and glands
Cardiovascular System

- Composed of the heart and blood vessels
- The heart pumps blood
- The blood vessels transport blood throughout the body

Figure 1.3f
Lymphatic System

- Composed of red bone marrow, thymus, spleen, lymph nodes, and lymphatic vessels
- Picks up fluid leaked from blood vessels and returns it to blood
- Disposes of debris in the lymphatic stream
- Houses white blood cells involved with immunity

Figure 1.3g
Respiratory System

- Composed of the nasal cavity, pharynx, trachea, bronchi, and lungs
- Keeps blood supplied with oxygen and removes carbon dioxide

Figure 1.3h
Digestive System

- Composed of the oral cavity, esophagus, stomach, small intestine, large intestine, rectum, anus, and liver
- Breaks down food into absorbable units that enter the blood
- Eliminates indigestible foodstuffs as feces
Urinary System

- Composed of kidneys, ureters, urinary bladder, and urethra
- Eliminates nitrogenous wastes from the body
- Regulates water, electrolyte, and pH balance of the blood
Male Reproductive System

- Composed of prostate gland, penis, testes, scrotum, and ductus deferens
- Main function is the production of offspring
- Testes produce sperm and male sex hormones
- Ducts and glands deliver sperm to the female reproductive tract
Female Reproductive System

- Composed of mammary glands, ovaries, uterine tubes, uterus, and vagina
- Main function is the production of offspring
- Ovaries produce eggs and female sex hormones
- Remaining structures serve as sites for fertilization and development of the fetus
- Mammary glands produce milk to nourish the newborn
Organ Systems Interrelationships

- The integumentary system protects the body from the external environment
- Digestive and respiratory systems, in contact with the external environment, take in nutrients and oxygen
Organ Systems Interrelationships

- Nutrients and oxygen are distributed by the blood
- Metabolic wastes are eliminated by the urinary and respiratory systems
Necessary Life Functions

- Maintaining boundaries – the internal environment remains distinct from the external environment
  - Cellular level – accomplished by plasma membranes
  - Organismal level – accomplished by the skin
- Movement – locomotion, propulsion (peristalsis), and contractility
Necessary Life Functions

- Responsiveness – ability to sense changes in the environment and respond to them
- Digestion – breakdown of ingested foodstuffs
- Metabolism – all the chemical reactions that occur in the body
- Excretion – removal of wastes from the body
Necessary Life Functions

- Reproduction – cellular and organismal levels
  - Cellular – an original cell divides and produces two identical daughter cells
  - Organismal – sperm and egg unite to make a whole new person
- Growth – increase in size of a body part or of the organism
Survival Needs

- Nutrients – needed for energy and cell building
- Oxygen – necessary for metabolic reactions
- Water – provides the necessary environment for chemical reactions
- Normal body temperature – necessary for chemical reactions to occur at life-sustaining rates
- Atmospheric pressure – required for proper breathing and gas exchange in the lungs
Homeostasis

- Homeostasis – ability to maintain a relatively stable internal environment in an ever-changing outside world
- The internal environment of the body is in a dynamic state of equilibrium
- Chemical, thermal, and neural factors interact to maintain homeostasis
Homeostatic Control Mechanisms

- Variables produce a change in the body
- The three interdependent components of control mechanisms:
  - Receptor – monitors the environments and responds to changes (stimuli)
  - Control center – determines the set point at which the variable is maintained
  - Effector – provides the means to respond to stimuli
Homeostatic Control Mechanisms

1. Input: Information sent along afferent pathway to Receptor (sensor).
2. Change detected by receptor.
4. Output: Information sent along efferent pathway to Effector.
5. Response of effector feeds back to influence magnitude of stimulus and returns variable to homeostasis.
Negative Feedback

- In negative feedback systems, the output shuts off the original stimulus
- Example: Regulation of room temperature
Positive Feedback

- In positive feedback systems, the output enhances or exaggerates the original stimulus

- Example: Regulation of blood clotting
Homeostatic Imbalance

- Disturbance of homeostasis or the body’s normal equilibrium
- Overwhelming the usual negative feedback mechanisms allows destructive positive feedback mechanisms to take over
Anatomical Position

- Body erect, feet slightly apart, palms facing forward, thumbs point away from body
### Directional Terms

<table>
<thead>
<tr>
<th>TERM</th>
<th>DEFINITION</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior (cranial)</td>
<td>Toward the head end or upper part of a structure or the body; above</td>
<td>The head is superior to the abdomen</td>
</tr>
<tr>
<td>Inferior (caudal)</td>
<td>Away from the head end or toward the lower part of a structure or the body; below</td>
<td>The navel is inferior to the chin</td>
</tr>
<tr>
<td>Ventral (anterior)*</td>
<td>Toward or at the front of the body; in front of</td>
<td>The breastbone is anterior to the spine</td>
</tr>
<tr>
<td>Dorsal (posterior)*</td>
<td>Toward or at the back of the body; behind</td>
<td>The heart is posterior to the breastbone</td>
</tr>
<tr>
<td>Medial</td>
<td>Toward or at the midline of the body; on the inner side of</td>
<td>The heart is medial to the arm</td>
</tr>
<tr>
<td>Lateral</td>
<td>Away from the midline of the body; on the outer side of</td>
<td>The arms are lateral to the chest</td>
</tr>
<tr>
<td>Intermediate</td>
<td>Between a more medial and a more lateral structure</td>
<td>The collarbone is intermediate between the breastbone and shoulder</td>
</tr>
</tbody>
</table>

*Table 1.1a*
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<tr>
<th>TERM</th>
<th>DEFINITION</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proximal</td>
<td>Closer to the origin of the body part or the point of attachment of a limb to the body trunk</td>
<td>The elbow is proximal to the wrist</td>
</tr>
<tr>
<td>Distal</td>
<td>Farther from the origin of a body part or the point of attachment of a limb to the body trunk</td>
<td>The knee is distal to the thigh</td>
</tr>
<tr>
<td>Superficial (external)</td>
<td>Toward or at the body surface</td>
<td>The skin is superficial to the skeletal muscles</td>
</tr>
<tr>
<td>Deep (internal)</td>
<td>Away from the body surface; more internal</td>
<td>The lungs are deep to the skin</td>
</tr>
</tbody>
</table>

*The terms ventral and anterior are synonymous in humans, but this is not the case in four-legged animals. Whereas anterior refers to the leading portion of the body (abdominal surface in humans, head in a cat), ventral specifically refers to the “belly” of a vertebrate animal and thus is the inferior surface of four-legged animals. Likewise, although the dorsal and posterior surfaces are the same in humans, the term dorsal specifically refers to an animal’s back. Thus, the dorsal surface of four-legged animals is their superior surface.*
Regional Terms: Anterior View

Nasal (nose)
Oral (mouth)
Cervical (neck)
Acromial (point of shoulder)
Axillary (armpit)
Abdominal (abdomen)
Brachial (arm)
Antecubital (front of elbow)
Antebrachial (forearm)
Pelvic (pelvis)
Carpal (wrist)
Pollex (thumb)
Palmar (palm)
Digital (fingers)
Pubic (genital region)
Patellar (anterior knee)
Crural (leg)
Pedal (foot)
Tarsal (ankle)
Digital (toes)
Frontal (forehead)
Orbital (eye)
Buccal (cheek)
Mental (chin)
Sternal (breastbone)
Thoracic (chest)
Mammary (breast)
Umbilical (navel)
Coxal (hip)
Inguinal (groin)
Femoral (thigh)
Fibular, or peroneal (side of leg)
Hallux (great toe)

Figure 1.7a
Regional Terms: Posterior View

- Brachial (arm)
- Otic (ear)
- Occipital (back of head or base of skull)
- Acromial (point of shoulder)
- Vertebral (spinal column)
- Scapular (shoulder blade)
- Brachial (arm)
- Dorsum or dorsal (back)
- Olecranal (back of elbow)
- Lumbar (loin)
- Sacral (between hips)
- Gluteal (buttock)
- Perineal (region between the anus and external genitalia)
- Femoral (thigh)
- Popliteal (back of knee)
- Sural (calf)
- Calcaneal (heel)
- Plantar (sole)

Manus (hand) - Upper extremity

(b) Posterior
Body Cavities

- Dorsal cavity protects the nervous system, and is divided into two subdivisions
  - Cranial cavity – within the skull; encases the brain
  - Vertebral cavity – runs within the vertebral column; encases the spinal cord
- Ventral cavity houses the internal organs (viscera), and is divided into two subdivisions
  - Thoracic
  - Abdominopelvic
Body Cavities

Figure 1.9a

Cranial cavity (contains brain)

Dorsal body cavity

Vertebral cavity (contains spinal cord)

Thoracic cavity (contains heart and lungs)

Diaphragm

Abdominal cavity (contains digestive viscera)

Pelvic cavity (contains bladder, reproductive organs, and rectum)

Key:
- Yellow: Dorsal body cavity
- Red: Ventral body cavity

(a) Lateral view
Body Cavities

- Thoracic cavity is subdivided into two pleural cavities, the mediastinum, and the pericardial cavity
  - Pleural cavities – each houses a lung
  - Mediastinum – contains the pericardial cavity; surrounds the remaining thoracic organs
  - Pericardial cavity – encloses the heart
Body Cavities

- The abdominopelvic cavity is separated from the superior thoracic cavity by the dome-shaped diaphragm

- It is composed of two subdivisions

  - Abdominal cavity – contains the stomach, intestines, spleen, liver, and other organs

  - Pelvic cavity – lies within the pelvis and contains the bladder, reproductive organs, and rectum
Body Cavities

(b) Anterior view

Key:
- Dorsal body cavity
- Ventral body cavity

Thoracic cavity (contains heart and lungs)
- Superior mediastinum
- Pleural cavity
- Pericardial cavity within the mediastinum

Abdominal cavity (contains digestive viscera)

Diaphragm

Pelvic cavity (contains bladder, reproductive organs, and rectum)

Abdomino-pelvic cavity

Ventral body cavity (thoracic and abdomino-pelvic cavities)
Other Body Cavities

- Oral and digestive – mouth and cavities of the digestive organs
- Nasal – located within and posterior to the nose
- Orbital – house the eyes
- Middle ear – contains bones (ossicles) that transmit sound vibrations
- Synovial – joint cavities
Other Body Cavities

Figure 1.13

- Orbital cavity (orbit)
- Nasal cavity
- Oral cavity (mouth)
- Middle ear cavity
- Synovial cavity in a joint between neck vertebrae
- Fibrous capsule around joint
Abdominopelvic Regions

(a)
Organs of the Abdominopelvic Regions

Figure 1.11b

- Liver
- Gallbladder
- Ascending colon of large intestine
- Small intestine
- Cecum
- Appendix
- Diaphragm
- Stomach
- Transverse colon of large intestine
- Descending colon of large intestine
- Initial part of sigmoid colon
- Urinary bladder
Abdominopelvic Quadrants

- Right upper
- Left upper
- Right lower
- Left lower
Ventral Body Cavity Membranes

- Parietal serosa lines internal body walls
- Visceral serosa covers the internal organs
- Serous fluid separates the serosae
Serous Membrane Relationship

Figure 1.10a

Outer balloon wall (comparable to parietal serosa)

Air (comparable to serous cavity)

Inner balloon wall (comparable to visceral serosa)
Heart Serosae

(b)

Figure 1.10b
Body Planes

- Sagittal – divides the body into right and left parts
- Midsagittal or medial – sagittal plane that lies on the midline
- Frontal or coronal – divides the body into anterior and posterior parts
- Transverse or horizontal (cross section) – divides the body into superior and inferior parts
- Oblique section – cuts made diagonally
Body Planes

Figure 1.8
Anatomical Variability

- Humans vary slightly in both external and internal anatomy
- Over 90% of all anatomical structures match textbook descriptions, but:
  - Nerves or blood vessels may be somewhat out of place
  - Small muscles may be missing
- Extreme anatomical variations are seldom seen