Unit 1: Introduction to Anatomy and Physiology Notes

Ms. Randall

Essential Questions:

- How is the body organized?
- What does the body do to maintain life?
- What terms are essential to understanding the anatomy of the human body?

Unit Objectives:

- Explain how structure complements function
- Name the levels of structural organization
- List the functions necessary for life
- List the survival needs of the body
- Define homeostasis and explain its significance
- Use correct anatomical terms to describe the body

Unit Vocabulary:

Anatomy
Physiology
Metabolism
Homeostasis
Receptor
Effector
Anatomical position
Section
Plane

Lesson 1: What is Anatomy?

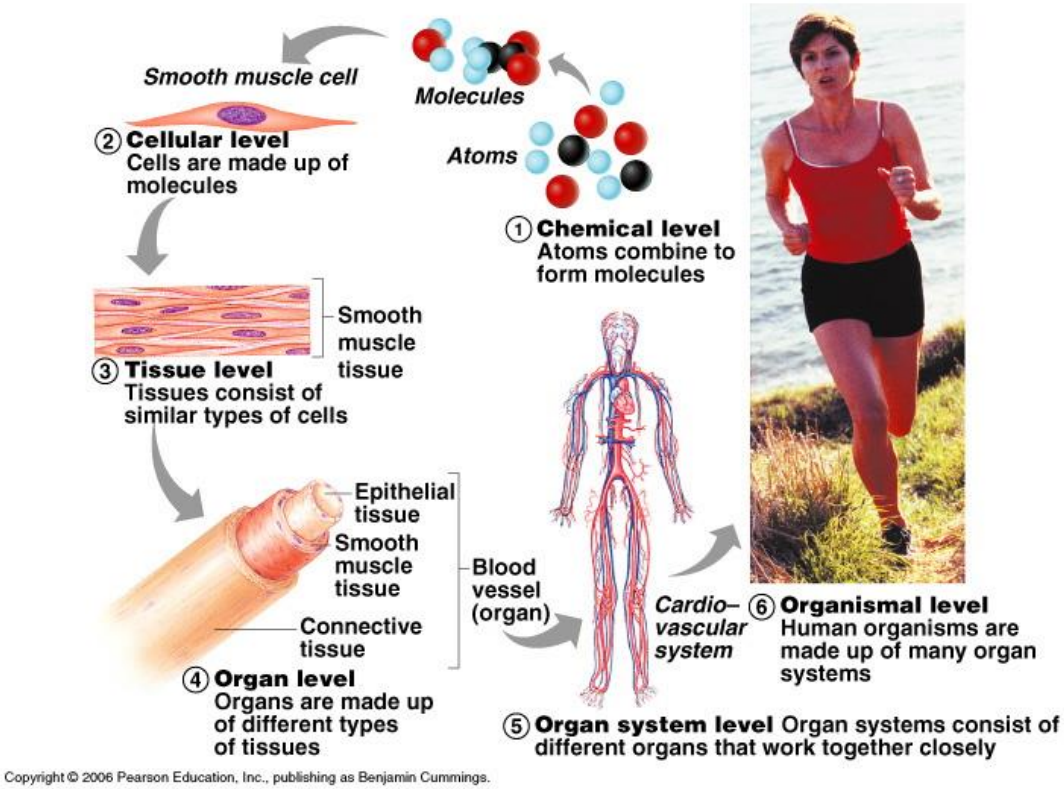
Objective:

- ***Explain how structure complements function***
- ***Name the levels of structural organization***

Anatomy is the study of the structure and relationship between body parts.

Physiology is the study of the function of body parts and the body as a whole. Some specializations within each of these sciences follow:

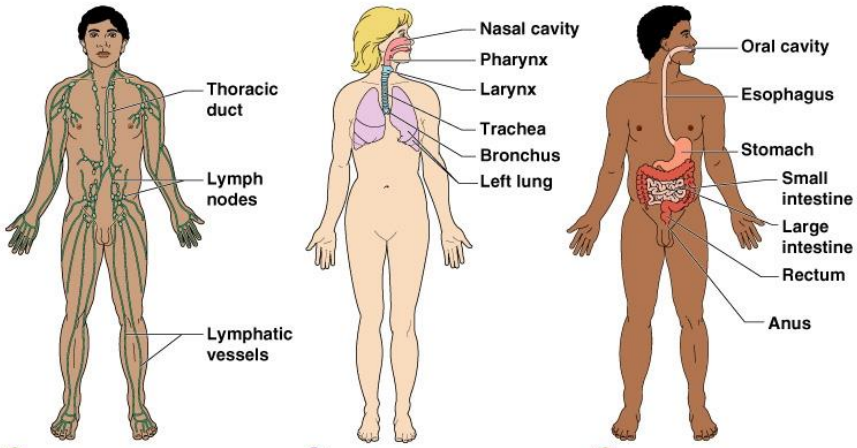
- *Gross (macroscopic) anatomy* is the study of body parts visible to the naked eye, such as the heart or bones.
- *Histology* is the study of tissues at the microscopic level.
- *Cytology* is the study of cells at the microscopic level.
- *Neurophysiology* is the study of how the nervous system functions.



Organizations of living systems

Living systems can be defined from various perspectives, from the broad (looking at the entire earth) to the minute (individual atoms). Each perspective provides information about how or why a living system functions:

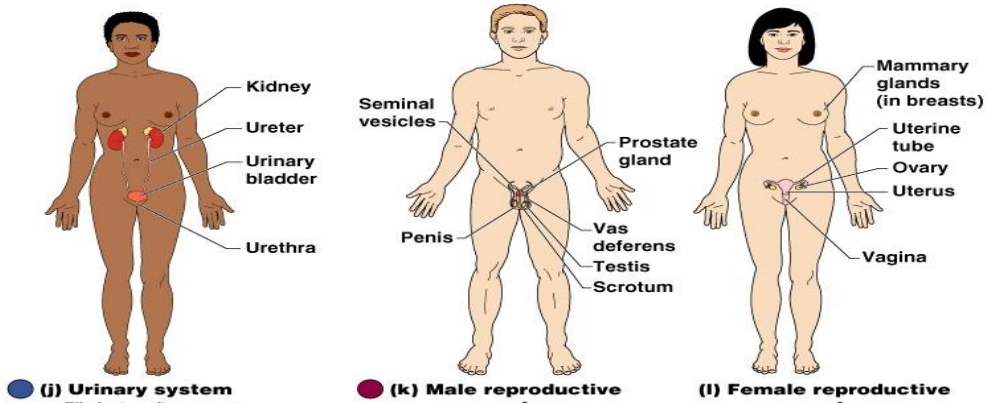
- At the chemical level, ***atoms***, *molecules* (combinations of atoms), and the chemical bonds between atoms provide the framework upon which all living activity is based.
- The ***cell*** is the smallest unit of life. **Organelles** within the cell are specialized bodies performing specific cellular functions. Cells themselves may be specialized. Thus, there are nerve cells, bone cells, and muscle cells.
- A ***tissue*** is a group of similar cells performing a common function. Muscle tissue, for example, consists of muscle cells.
- An ***organ*** is a group of different kinds of tissues working together to perform a particular activity. The heart is an organ composed of muscle, nervous, connective, and epithelial tissues.
- An ***organ system*** is two or more organs working together to accomplish a particular task. The digestive system, for example, involves the coordinated activities of many organs, including the mouth, stomach, small and large intestines, pancreas, and liver.
- An ***organism*** is a system possessing the characteristics of living things—the ability to obtain and process energy, the ability to respond to environmental changes, and the ability to reproduce.



(g) Lymphatic system
Picks up fluid leaked from blood vessels and returns it to blood; disposes of debris in the lymphatic stream; houses white blood cells involved in immunity.

(h) Respiratory system
Keeps blood constantly supplied with oxygen and removes carbon dioxide; the gaseous exchanges occur through the walls of the air sacs of the lungs.

(i) Digestive system
Breaks food down into absorbable units that enter the blood for distribution to body cells; indigestible foodstuffs are eliminated as feces.



(j) Urinary system
Eliminates nitrogenous wastes from the body; regulates water, electrolyte, and acid-base balance of the blood.

(k) Male reproductive system

(l) Female reproductive system

Overall function of the reproductive system is production of offspring. Testes produce sperm and male sex hormone; ducts and glands aid in delivery of viable sperm to the female reproductive tract. Ovaries produce eggs and female sex hormones; remaining structures serve as sites for fertilization and development of the fetus. Mammary glands of female breast produce milk to nourish the newborn.

Lesson 2: Homestasis

Objective:

- List the functions necessary for life
- List the survival needs of the body
- Define homeostasis and explain its significance

What Must We Do To Maintain Life?

Life Processes

All living organisms have certain characteristics that distinguish them from non-living forms. The basic processes of life include organization, metabolism, responsiveness, movements, and reproduction. In humans, who represent the most complex form of life, there are additional requirements such as growth, differentiation, respiration, digestion, and excretion. All of these processes are interrelated. No part of the body, from the smallest cell to a complete body system, works in isolation. All function together, in fine-tuned balance, for the well-being of the individual and to maintain life. Disease such as cancer and death represent a disruption of the balance in these processes.

The following are a brief description of the life process:

Organization

At all levels of the organizational scheme, there is a division of labor. Each component has its own job to perform in cooperation with others. Even a single cell, if it loses its integrity or organization, will die.

Metabolism

Metabolism is a broad term that includes all the chemical reactions that occur in the body. One phase of metabolism is catabolism in which complex substances are broken down into simpler building blocks and energy is released.

Responsiveness

Responsiveness or irritability is concerned with detecting changes in the internal or external environments and reacting to that change. It is the act of sensing a stimulus and responding to it.

Movement

There are many types of movement within the body. On the cellular level, molecules move from one place to another. Blood moves from one part of the body to another. The diaphragm moves with every breath. The ability of muscle fibers to shorten and thus to produce movement is called contractility.

Reproduction

For most people, reproduction refers to the formation of a new person, the birth of a baby. In this way, life is transmitted from one generation to the next through reproduction of the organism. In a broader sense, reproduction also refers to the formation of new cells for the replacement and repair of old cells as well as for growth. This is cellular reproduction. Both are essential to the survival of the human race.

Growth

Growth refers to an increase in size either through an increase in the number of cells or through an increase in the size of each individual cell. In order for growth to occur, anabolic processes must occur at a faster rate than catabolic processes.

Differentiation

Differentiation is a developmental process by which unspecialized cells change into specialized cells with distinctive structural and functional characteristics. Through differentiation, cells develop into tissues and organs.

Respiration

Respiration refers to all the processes involved in the exchange of oxygen and carbon dioxide between the cells and the external environment. It includes ventilation, the diffusion of oxygen and carbon dioxide, and the transport of the gases in the blood. Cellular respiration deals with the cell's utilization of oxygen and release of carbon dioxide in its metabolism.

Digestion

Digestion is the process of breaking down complex ingested foods into simple molecules that can be absorbed into the blood and utilized by the body.

Excretion

Excretion is the process that removes the waste products of digestion and metabolism from the body. It gets rid of by-products that the body is unable to use, many of which are toxic and incompatible with life.

The ten life processes described above are not enough to ensure the survival of the individual. In addition to these processes, life depends on certain physical factors from the environment. These include water, oxygen, nutrients, heat, and pressure.

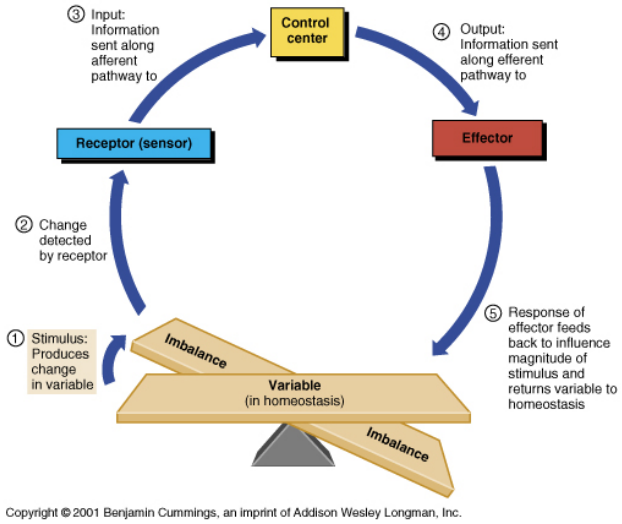
When we refer to all of the life functions of an organism, we are referring to its **METABOLISM**--the total of all the life functions required to sustain life (to stay alive)

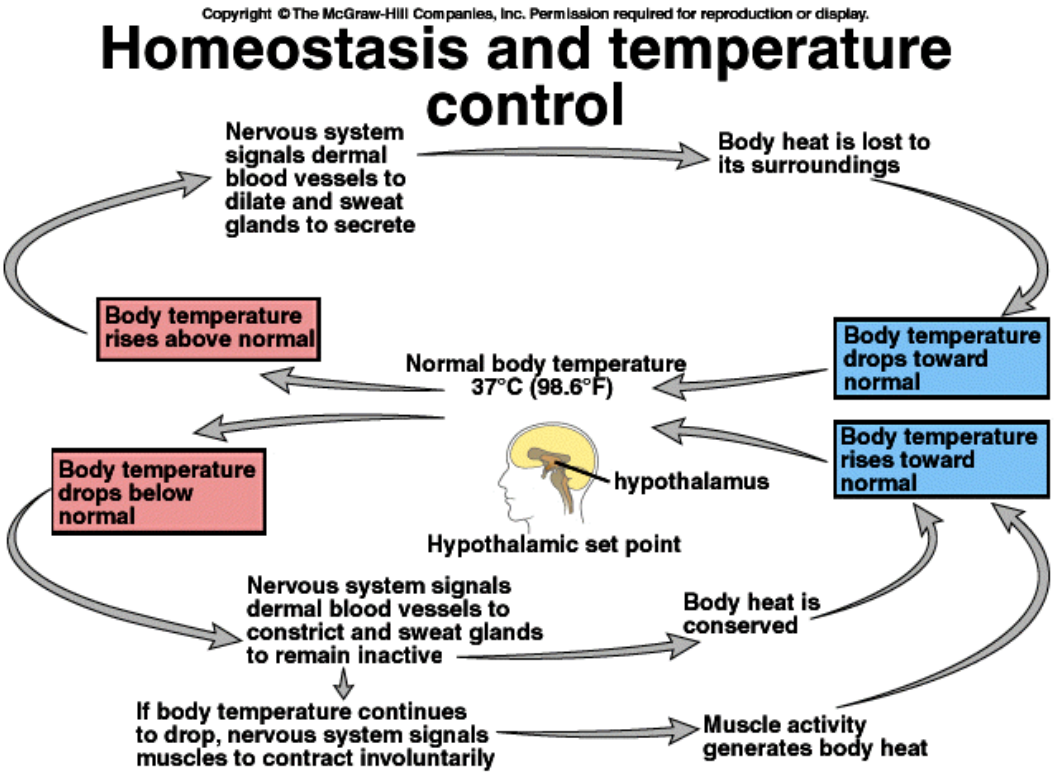
An organism's external (outside) environment is always changing. By keeping the control and regulation of its metabolic activities, an organism can maintain a stable internal (inside) environment. This is called **HOMEOSTASIS**.

HOMEOSTASIS

The process by which an organism's metabolic activities are in a state of balance is known as ***homeostasis.***

Examples: body temp, blood sugar levels



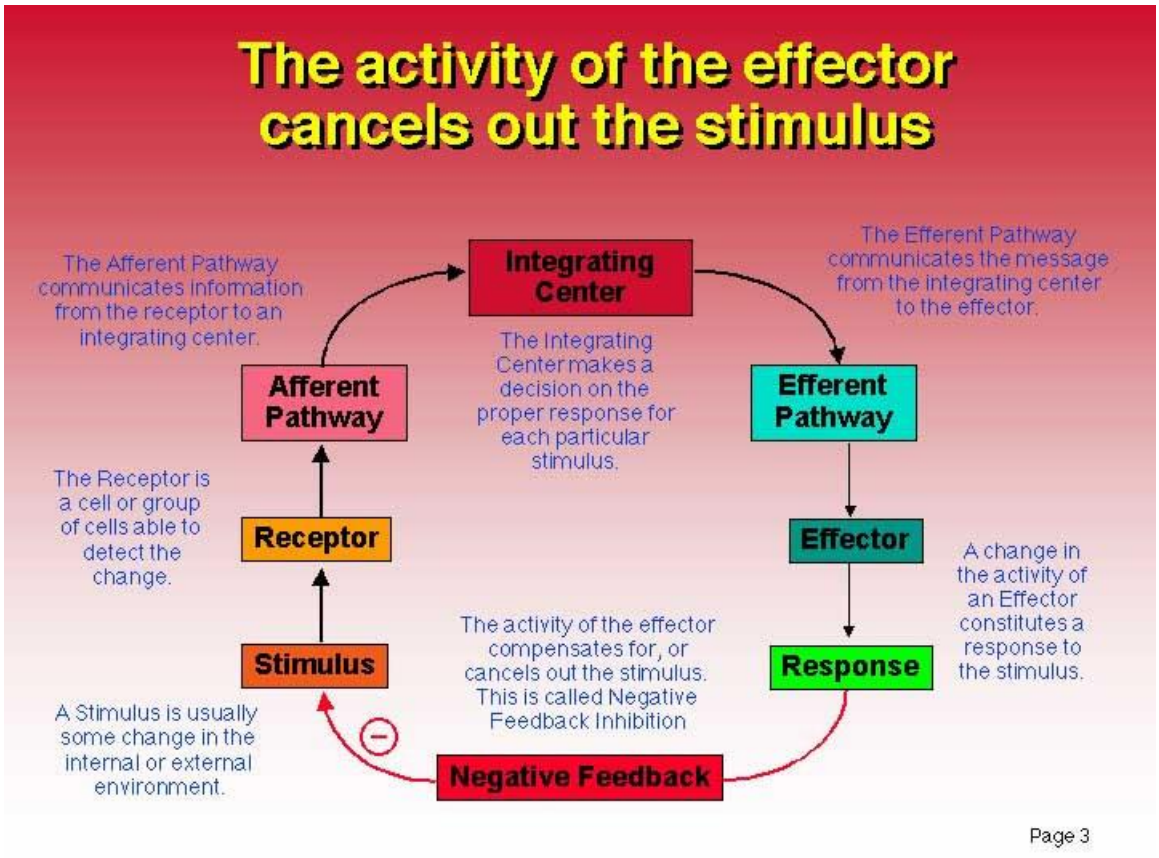


Maintaining Homeostasis

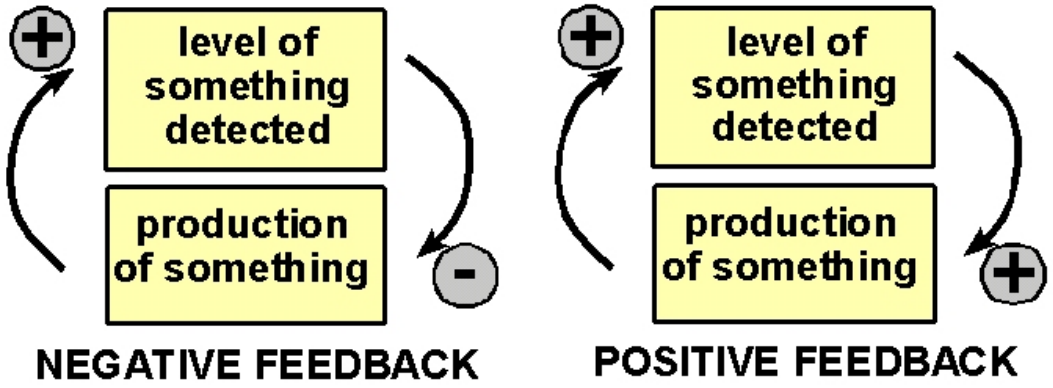
A characteristic of all living systems is **homeostasis**, or the maintenance of stable, internal conditions within specific limits. In many cases, stable conditions are maintained by negative feedback.

In **negative feedback**, a sensing mechanism (a **receptor**) detects a change in conditions beyond specific limits. A control center, or **integrator** (often the brain), evaluates the change and activates a second mechanism (an **effector**) to correct the condition; for example, cells that either remove or add glucose to the blood in an effort to maintain homeostasis are effectors. Conditions are constantly monitored by receptors and evaluated by the control center. When the control center determines that conditions have returned to normal, corrective action is discontinued. Thus, in negative feedback, the variant condition is canceled, or negated, so that conditions are returned to normal.

The regulation of glucose concentration in the blood illustrates how homeostasis is maintained by negative feedback. After a meal, the absorption of glucose (a sugar) from the digestive tract increases the amount of glucose in the blood. In response, specialized cells in the pancreas (alpha cells) secrete the hormone insulin, which circulates through the blood and stimulates liver and muscle cells to absorb the glucose. Once blood glucose levels return to normal, insulin secretion stops. Later, perhaps after heavy exercise, blood glucose levels may drop because muscle cells absorb glucose from the blood and use it as a source of energy for muscle contraction. In response to falling blood glucose levels, another group of specialized pancreatic cells (beta cells) secretes a second hormone, glucagon. Glucagon stimulates the liver to release its stored glucose into the blood. When blood glucose levels return to normal, glucagon secretion stops.



Compare this with **positive feedback,** in which an action intensifies a condition so that it is driven farther beyond normal limits. Such positive feedback is uncommon but does occur during blood clotting, childbirth (labor contractions), lactation (where milk production increases in response to an increase in nursing), and sexual orgasm.



Lesson 3: The Language of Anatomy

Objective:

- Use correct anatomical terms to describe the body

Anatomic terminology

In order to accurately identify areas of the body, clearly defined anatomical terms are used. These terms refer to the body in the anatomical position—standing erect, facing forward, arms down at the side, with the palms turned forward. In this position, the following apply:

- Directional terms are used to describe the relative position of one body part to another. These terms are listed in Table 1.

- Body planes and sections are used to describe how the body or an organ is divided into two parts:
  - *Sagittal planes* divide a body or organ vertically into right and left parts. If the right and left parts are equal, the plane is a midsagittal plane; if they're unequal, the plane is a parasagittal plane.
  - A *frontal (coronal) plane* divides the body or organ vertically into front (anterior) and rear (posterior) parts.
  - A *transverse (horizontal) plane* divides the body or organ horizontally into top (superior) and bottom (inferior) parts. This is also known as a cross-section.
  - An *oblique plane* divides in a diagonal fashion between horizontal and vertical.

- Regional terms identify specific areas of the body. In some cases, a descriptive word is used to identify the location. For example, the axial region refers to the main axis of the body—the head, neck, and trunk. The appendicular region refers to the appendages—the arms and legs. Other regional terms use a body part to identify a particular region of the body. For example, the nasal region refers to the nose.

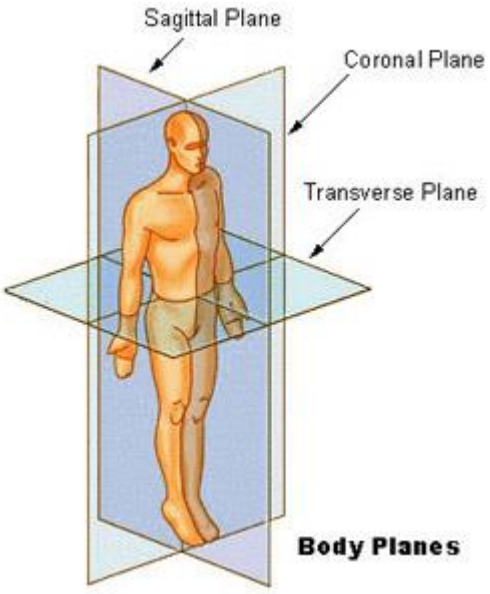
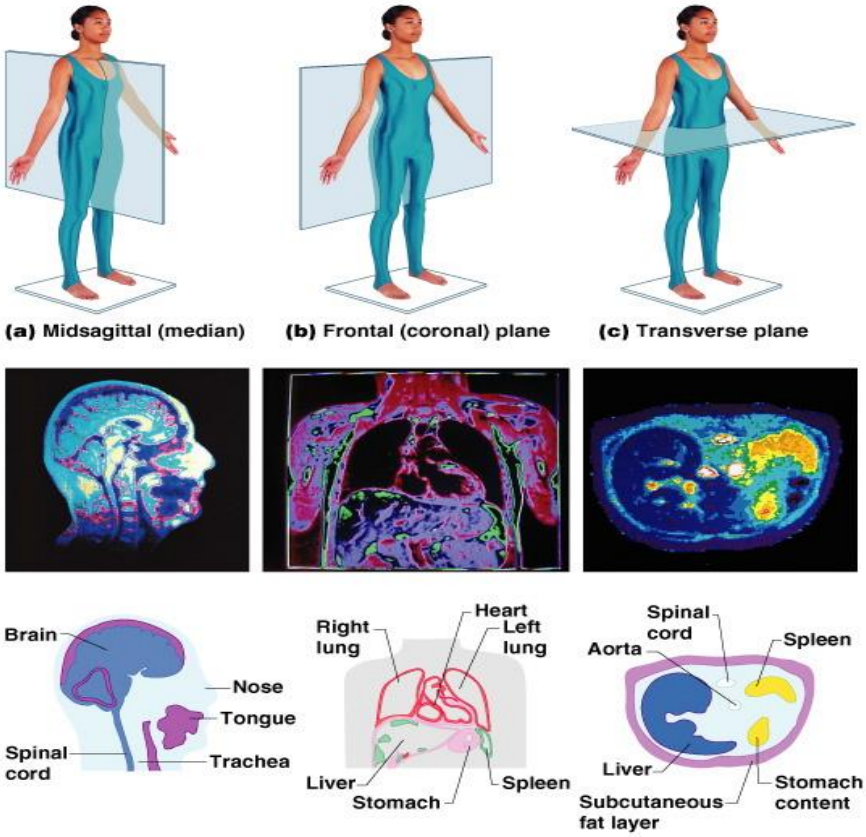
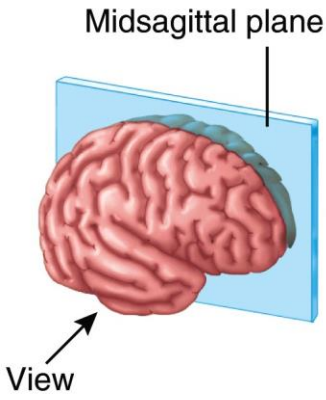
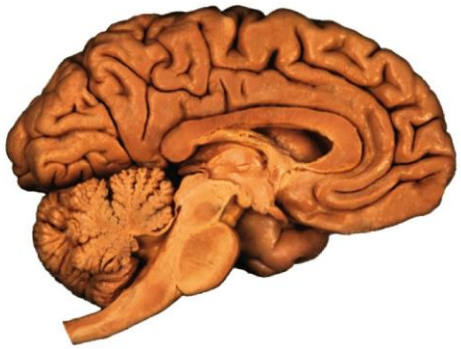


Table 1

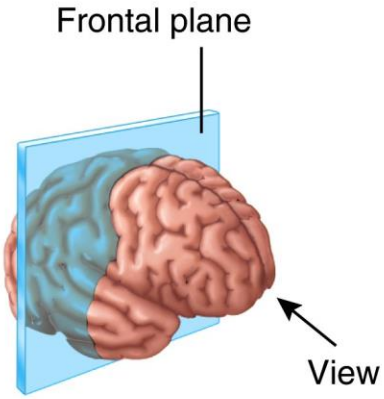


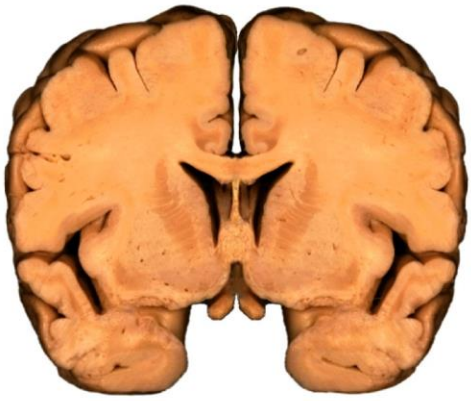




Midsagittal section

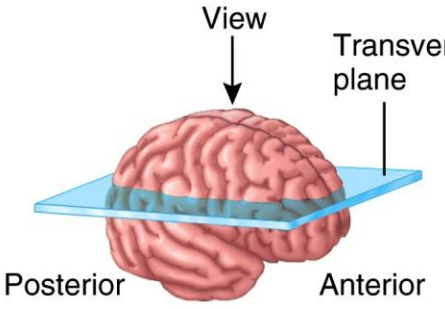
Dissection Shawn Miller; Photograph Mark Nielsen





Frontal section

Dissection Shawn Miller; Photograph Mark Nielsen



Transverse section

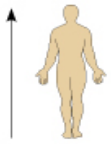
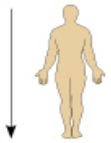
Dissection Shawn Miller; Photograph Mark Nielsen

Directional Terms

Directional terms describe the positions of structures relative to other structures or locations in the body.

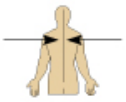
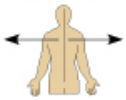
Term of Position or Direction	Definition
anterior	front of the body; ventral
anteroposterior	passing from the anterior (front) of the body to the posterior (rear)
caudal	toward the tailbone
cephalic	toward the head
distal	away from the point of origin
dorsal	back of the body; posterior
external	outer part of the body
inferior	body part located below another part or closer to the feet
internal	deep within the body
lateral	toward the side of the body
medial	toward the midline of the body
posterior	toward the back of the body
posteroanterior	passing from the posterior (rear) of the body to the anterior (front)
prone	lying face down with the palms facing downward
proximal	closer to the point of origin
superior	body part located above another part or closer to the head
supine	lying on the back with the palms facing upward
ventral	front of the body; anterior

TABLE 1.1 Orientation and Directional Terms

Term	*Definition*	*Example*	
Superior (cranial)	Toward the head end or upper part of a structure or the body; above		The head is superior to the abdomen
Inferior (caudal)	Away from the head end or toward the lower part of a structure or the body; below		The navel is inferior to the chin
Anterior (ventral)*	Toward or at the front of the body; in front of		The breastbone is anterior to the spine

*Whereas the terms *ventral* and *anterior* are synonymous in humans, this is not the case in four-legged animals. *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.

TABLE 1.1 Orientation and Directional Terms

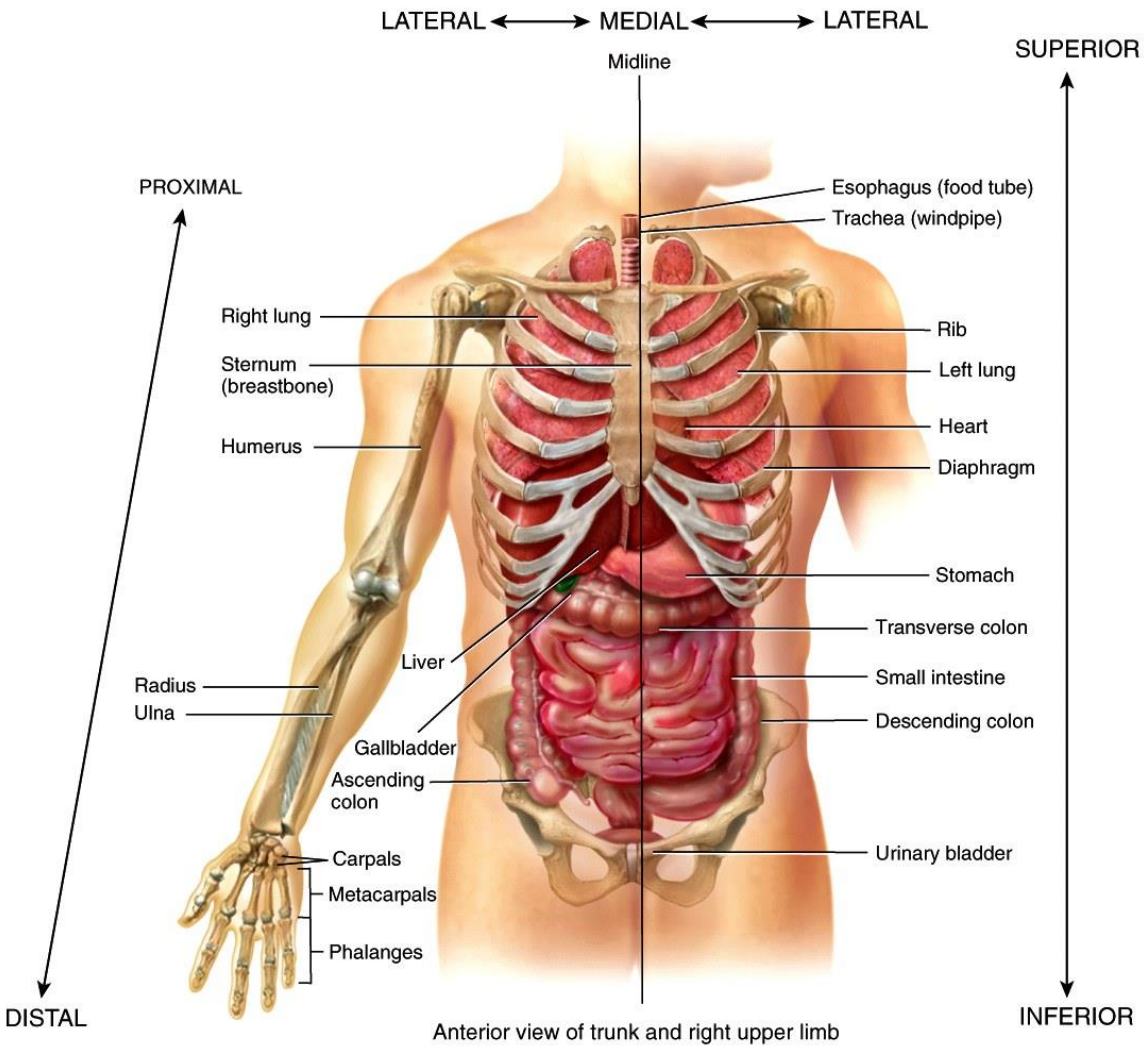
Term	*Definition*	*Example*	
Posterior (dorsal)*	Toward or at the back of the body; behind		The heart is posterior to the breastbone
Medial	Toward or at the midline of the body; on the inner side of		The heart is medial to the arm
Lateral	Away from the midline of the body; on the outer side of		The arms are lateral to the chest
Intermediate	Between a more medial and a more lateral structure		The collarbone is intermediate between the breastbone and shoulder

*Whereas the terms *ventral* and *anterior* are synonymous in humans, this is not the case in four-legged animals. *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.

TABLE 1.1 Orientation and Directional Terms

Term	*Definition*	*Example*	
Proximal	Closer to the origin of the body part or the point of attachment of a limb to the body trunk		The elbow is proximal to the wrist
Distal	Farther from the origin of a body part or the point of attachment of a limb to the body trunk		The knee is distal to the thigh
Superficial (external)	Toward or at the body surface		The skin is superficial to the skeletal muscles
Deep (internal)	Away from the body surface; more internal		The lungs are deep to the skin

*Whereas the terms *ventral* and *anterior* are synonymous in humans, this is not the case in four-legged animals. *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.

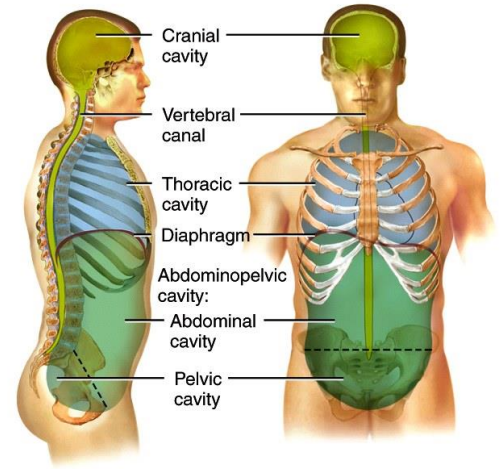


Body Cavities

Body cavities are enclosed areas that house organs. These cavities are organized into two groups:

- The *posterior/dorsal* body cavity includes the cranial cavity (which contains the brain) and the vertebral cavity (which contains the spinal cord).

- The *anterior/ventral* body cavity includes the thoracic cavity (which contains the lungs, each in its own pleural cavity, and the heart, in the pericardial cavity) and the abdominopelvic cavity (which contains the digestive organs in the abdominal cavity and the bladder and reproductive organs in the pelvic cavity.



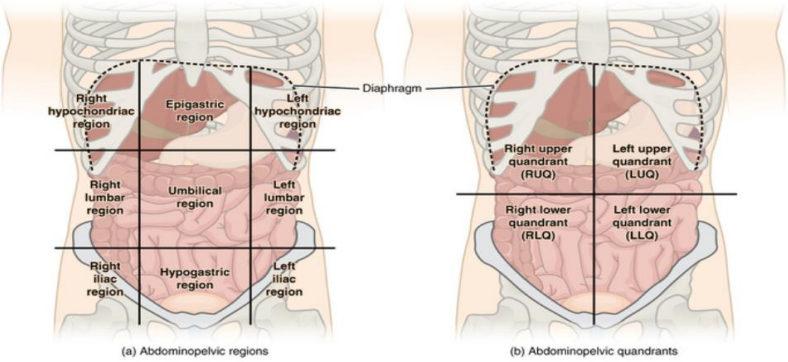
(a) Right lateral view (b) Anterior view

CAVITY	COMMENTS
Cranial cavity	Formed by cranial bones and contains brain.
Vertebral canal	Formed by vertebral column and contains spinal cord and the beginnings of spinal nerves.
Thoracic cavity*	Chest cavity; contains pleural and pericardial cavities and mediastinum.
Pleural cavity	Each surrounds a lung; the serous membrane of each pleural cavity is the pleura.
Pericardial cavity	Surrounds the heart; the serous membrane of the pericardial cavity is the pericardium.
Mediastinum	Central portion of thoracic cavity between the lungs; extends from sternum to vertebral column and from neck to diaphragm; contains heart, thymus, esophagus, trachea, and several large blood vessels.
Abdominopelvic cavity	Subdivided into abdominal and pelvic cavities.
Abdominal cavity	Contains stomach, spleen, liver, gallblader, small intestine, and most of large intestine; the serous membrane of the abdominal cavity is the peritoneum.
Pelvic cavity	Contains urinary bladder, portions of large intestine, and internal organs of reproduction.

* See Figure 1.9 for details of the thoracic cavity.

The abdominopelvic cavity can be subdivided into four quadrants and nine regions. The quadrants are labeled by location: the right upper, right lower, left upper, and left lower quadrants. The nine regions are smaller than the four abdominopelvic quadrants and include the right hypochondriac, right lumbar, right iliac, epigastric, umbilical, hypogastric (or pubic), left hypochondriac, left lumbar, and left iliac divisions. The perineum is sometimes considered to be the tenth division. The purpose of the abdominal divisions is to describe regional anatomy in the abdomen, and to help clinicians determine which organ and tissues are involved in a disease based on which regions experience pain.

- **Left upper quadrant**: The left upper quadrant is the location of the left portion of the liver, the larger portion of the stomach, the pancreas, left kidney, spleen, portions of the transverse and descending colon, and parts of the small intestine.
- **Right upper quadrant**: The right upper quadrant contains the right portion of the liver, gallbladder, right kidney, a small portion of the stomach, portions of the ascending and transverse colon, and parts of the small intestine.
- **Left lower quadrant**: The left lower quadrant houses the majority of the small intestine, some of the large intestine, the left female reproductive organs, and the left ureter.
- **Nine divisions**: An alternate system for dividing the abdominopelvic cavity into regions.
- **Right lower quadrant**: In the right lower quadrant sits the cecum, appendix, part of the small intestines, the right female reproductive organs, and the right ureter.



(a) Abdominopelvic regions (b) Abdominopelvic quadrants