AN INTRODUCTION TO HUMAN ANATOMY

Course Name: Anatomy and Physiology 1
Course Code: 0521122
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1.1 Anatomy and Physiology Defined

Anatomy:

(a-NAT-o¯-me¯; *ana-* up; *-tomy* process of cutting)

Is the science of body ***structures* and the relationships among them.**

Physiology:

(fiz-e¯-OL-o¯-je¯; *physio-* nature; *-logy* study of)

Is the science of body ***functions***—how the body parts work.**

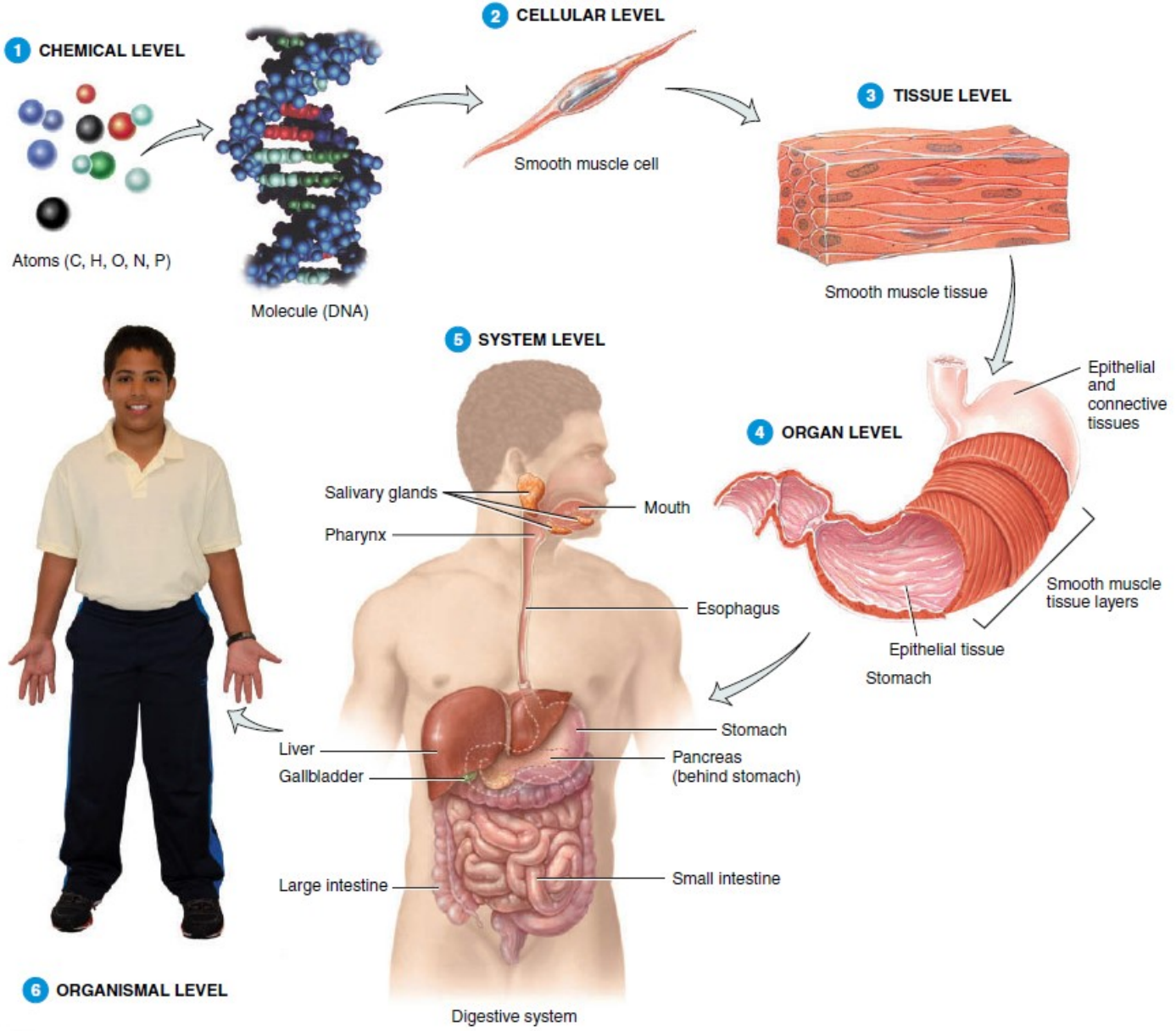
TABLE 1.1

Selected Branches of Anatomy and Physiology

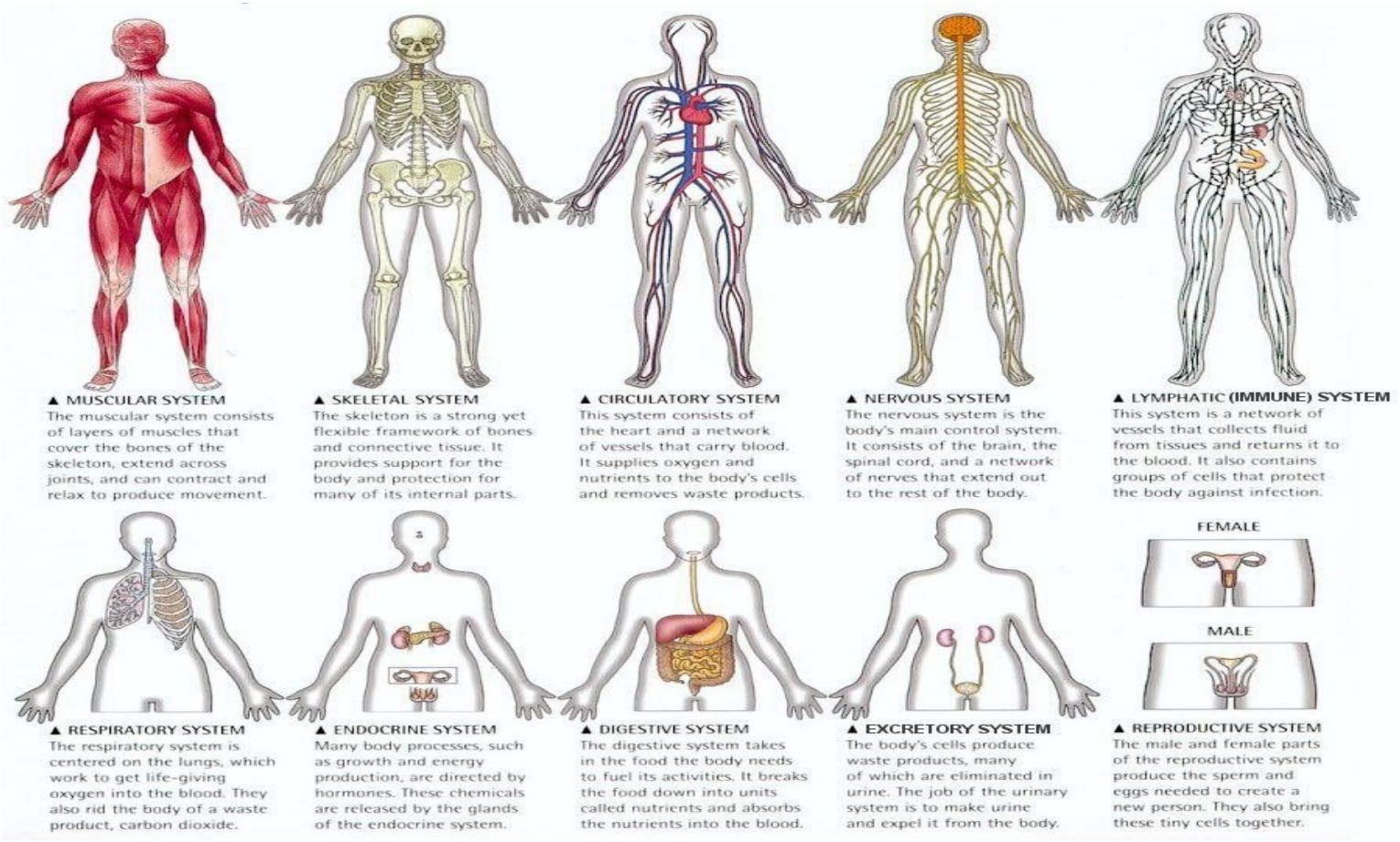
BRANCH OF ANATOMY	STUDY OF	BRANCH OF PHYSIOLOGY	STUDY OF
Embryology (em′-brē-OL-ō-jē; *embry-* = embryo; *-logy* = study of)	The first eight weeks of development after fertilization of a human egg.	**Neurophysiology** (NOOR-ō-fiz-ē-ol′-ō-jē; *neuro-* = nerve)	Functional properties of nerve cells.
Developmental biology	The complete development of an individual from fertilization to death.	**Endocrinology** (en′-dō-kri-NOL-ō-jē; *endo-* = within; *-crin* = secretion)	Hormones (chemical regulators in the blood) and how they control body functions.
Cell biology	Cellular structure and functions.	**Cardiovascular physiology** (kar-dē-ō-VAS-kū-lar; *cardi-* = heart; *vascular* = blood vessels)	Functions of the heart and blood vessels.
Histology (his-TOL-ō -jē; *hist-* = tissue)	Microscopic structure of tissues.	**Immunology** (im′-ū-NOL-ō-jē; *immun-* = not susceptible)	The body's defenses against disease-causing agents.
Gross anatomy	Structures that can be examined without a microscope.	**Respiratory physiology** (RES-pi-ra-tōr-ē; *respira-* = to breathe)	Functions of the air passageways and lungs.
Systemic anatomy	Structure of specific systems of the body such as the nervous or respiratory systems.	**Renal physiology** (RĒ-nal; *ren-* = kidney)	Functions of the kidneys.
Regional anatomy	Specific regions of the body such as the head or chest.	**Exercise physiology**	Changes in cell and organ functions due to muscular activity.
Surface anatomy	Surface markings of the body to understand internal anatomy through visualization and palpation (gentle touch).	**Pathophysiology** (Path-ō-fiz-ē-ol′-ō-jē)	Functional changes associated with disease and aging.
Imaging anatomy	Body structures that can be visualized with techniques such as x-rays, MRI, and CT scans.		
Pathological anatomy (path′-ō-LOJ-i-kal; *path-* = disease)	Structural changes (gross to microscopic) associated with disease.		

1.2 Levels of Structural Organization and Body Systems

The levels of structural organization are chemical, cellular, tissue, organ, system, and organismal.



The Eleven Systems of the Human Body



▲ MUSCULAR SYSTEM
The muscular system consists of layers of muscles that cover the bones of the skeleton, extend across joints, and can contract and relax to produce movement.

▲ SKELETAL SYSTEM
The skeleton is a strong yet flexible framework of bones and connective tissue. It provides support for the body and protection for many of its internal parts.

▲ CIRCULATORY SYSTEM
This system consists of the heart and a network of vessels that carry blood. It supplies oxygen and nutrients to the body's cells and removes waste products.

▲ NERVOUS SYSTEM
The nervous system is the body's main control system. It consists of the brain, the spinal cord, and a network of nerves that extend out to the rest of the body.

▲ LYMPHATIC (IMMUNE) SYSTEM
This system is a network of vessels that collects fluid from tissues and returns it to the blood. It also contains groups of cells that protect the body against infection.

▲ RESPIRATORY SYSTEM
The respiratory system is centered on the lungs, which work to get life-giving oxygen into the blood. They also rid the body of a waste product, carbon dioxide.

▲ ENDOCRINE SYSTEM
Many body processes, such as growth and energy production, are directed by hormones. These chemicals are released by the glands of the endocrine system.

▲ DIGESTIVE SYSTEM
The digestive system takes in the food the body needs to fuel its activities. It breaks the food down into units called nutrients and absorbs the nutrients into the blood.

▲ EXCRETORY SYSTEM
The body's cells produce waste products, many of which are eliminated in urine. The job of the urinary system is to make urine and expel it from the body.

FEMALE

MALE

▲ REPRODUCTIVE SYSTEM
The male and female parts of the reproductive system produce the sperm and eggs needed to create a new person. They also bring these tiny cells together.

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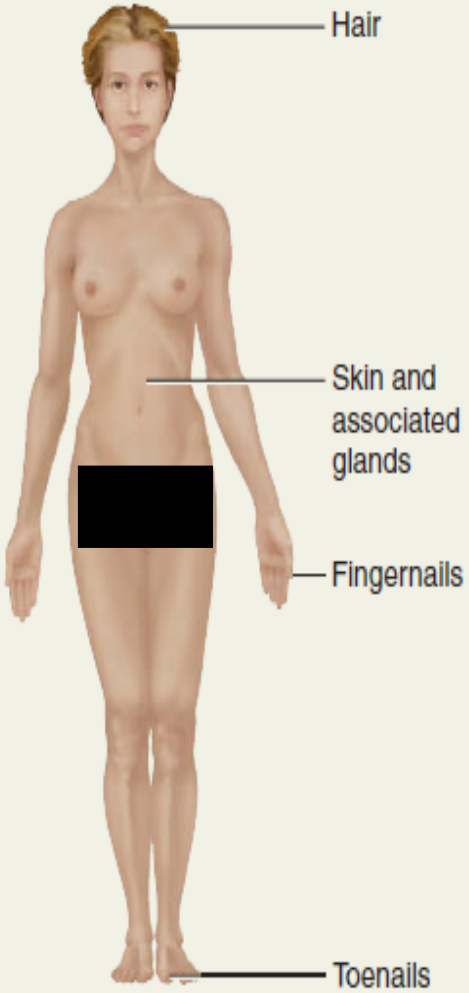
INTEGUMENTARY SYSTEM (CHAPTER 5)

Components: **Skin** and associated structures, such as **hair, fingernails** and **toenails, sweat glands**, and **oil glands**.

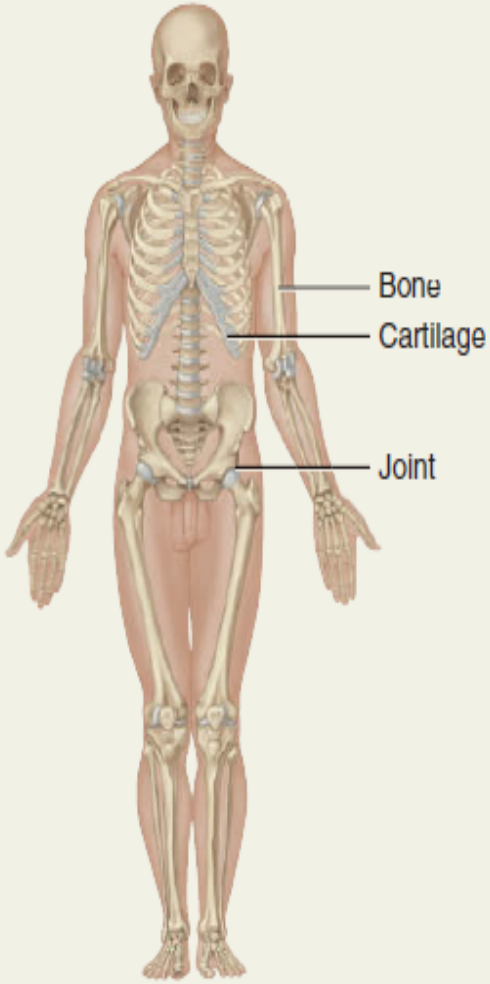
Functions: Protects body; helps regulate body temperature; eliminates some wastes; helps make vitamin D; detects sensations such as touch, pain, warmth, and cold; stores fat and provides insulation.



SKELETAL SYSTEM (CHAPTERS 6–9)

Components: **Bones** and **joints** of the body and their associated **cartilages.**

Functions: Supports and protects body; provides surface area for muscle attachments; aids body movements; houses cells that produce blood cells; stores minerals and lipids (fats).



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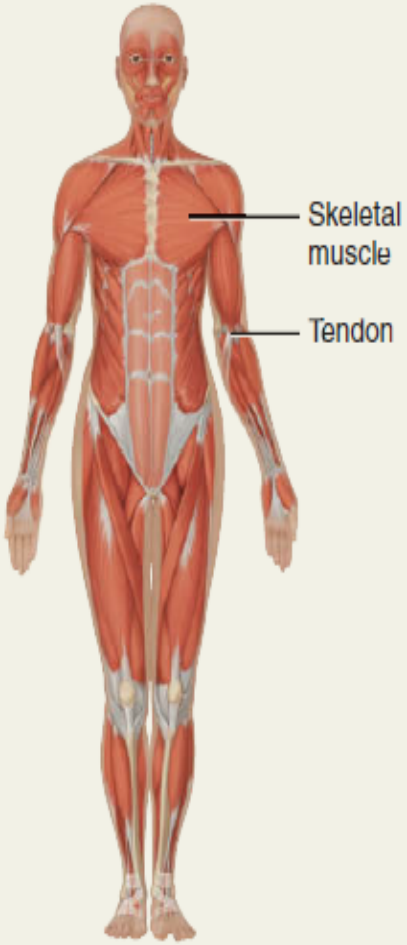
MUSCULAR SYSTEM (CHAPTERS 10, 11)

Components: Specifically, **skeletal muscle** tissue—muscle usually attached to bones (other muscle tissues include smooth and cardiac).

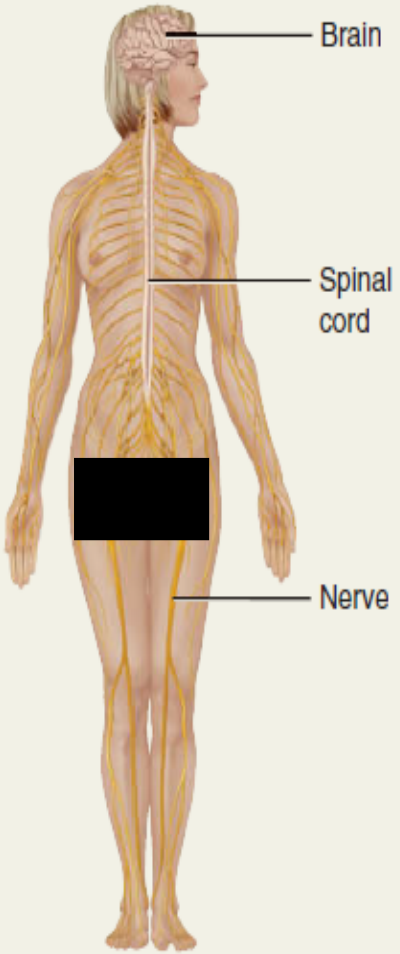
Functions: Participates in body movements, such as walking; maintains posture; produces heat.



NERVOUS SYSTEM (CHAPTERS 12–17)

Components: **Brain, spinal cord, nerves**, and special sense organs, such as **eyes** and **ears**.

Functions: Generates action potentials (nerve impulses) to regulate body activities; detects changes in body's internal and external environments, interprets changes, and responds by causing muscular contractions or glandular secretions.



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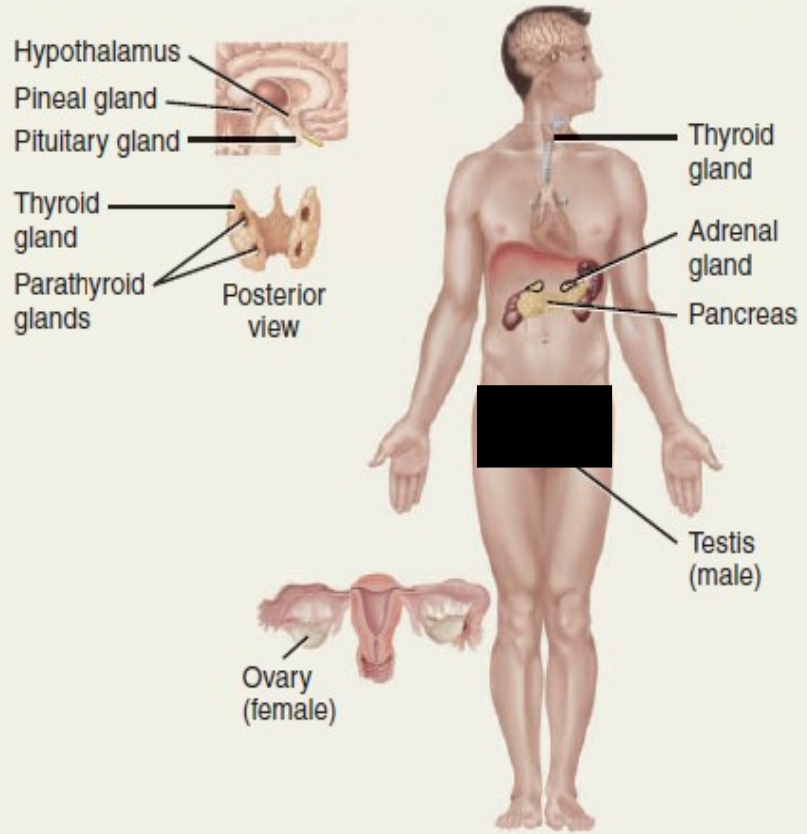
ENDOCRINE SYSTEM (CHAPTER 18)

Components: Hormone-producing glands (**pineal gland, hypothalamus, pituitary gland, thymus, thyroid gland, parathyroid glands, adrenal glands, pancreas, ovaries**, and **testes**) and hormone-producing cells in several other organs.

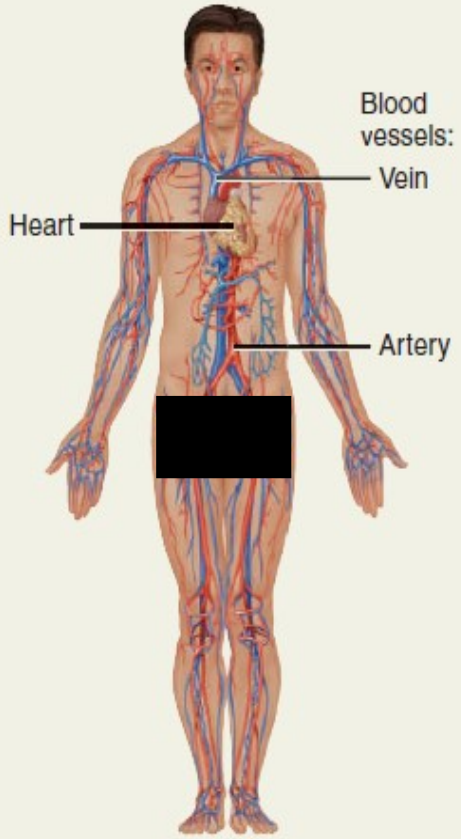
Functions: Regulates body activities by releasing hormones (chemical messengers transported in blood from endocrine gland or tissue to target organ).



CARDIOVASCULAR SYSTEM (CHAPTERS 19–21)

Components: **Blood, heart**, and **blood vessels**.

Functions: Heart pumps blood through blood vessels; blood carries oxygen and nutrients to cells and carbon dioxide and wastes away from cells and helps regulate acid–base balance, temperature, and water content of body fluids; blood components help defend against disease and repair damaged blood vessels.



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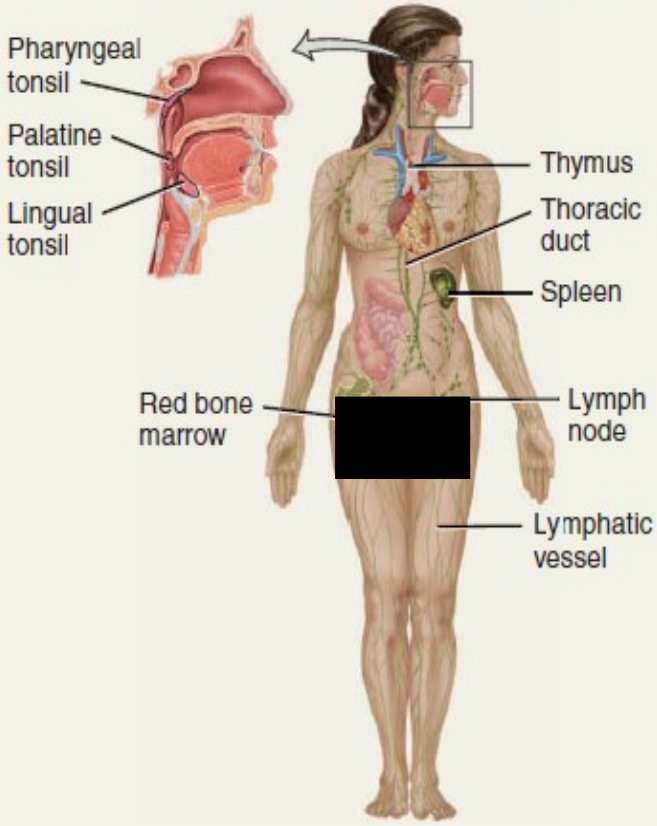
LYMPHATIC SYSTEM AND IMMUNITY (CHAPTER 22)

Components: **Lymphatic fluid** and **vessels; spleen, thymus, lymph nodes,** and **tonsils**; cells that carry out immune responses (**B cells, T cells**, and others).

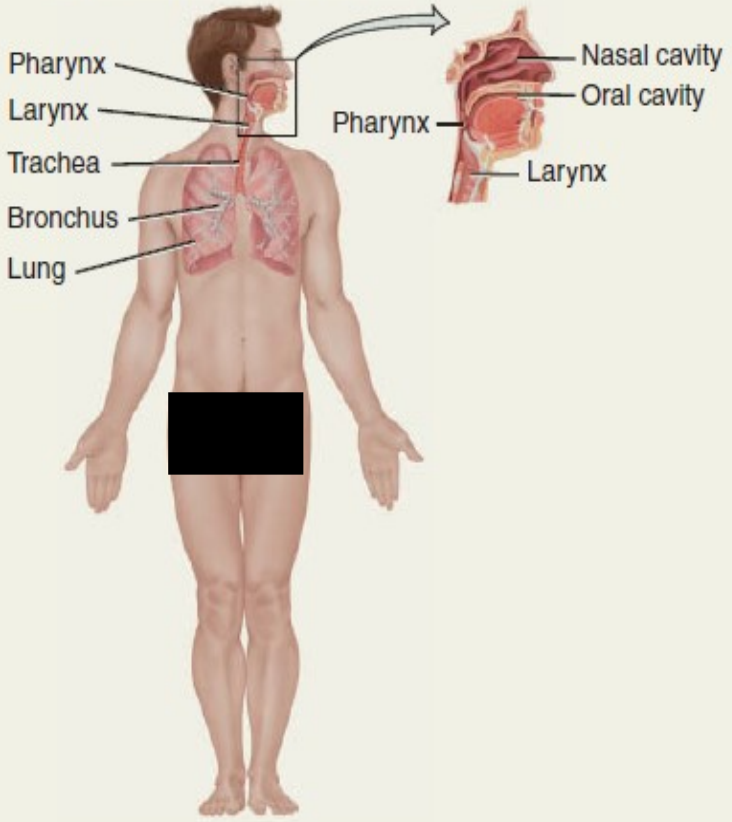
Functions: Returns proteins and fluid to blood; carries lipids from gastrointestinal tract to blood; contains sites of maturation and proliferation of B cells and T cells that protect against disease-causing microbes.



RESPIRATORY SYSTEM (CHAPTER 23)

Components: **Lungs** and air passageways such as the **pharynx** (throat), **larynx** (voice box), **trachea** (windpipe), and **bronchial tubes** leading into and out of lungs.

Functions: Transfers oxygen from inhaled air to blood and carbon dioxide from blood to exhaled air; helps regulate acid–base balance of body fluids; air flowing out of lungs through vocal cords produces sounds.



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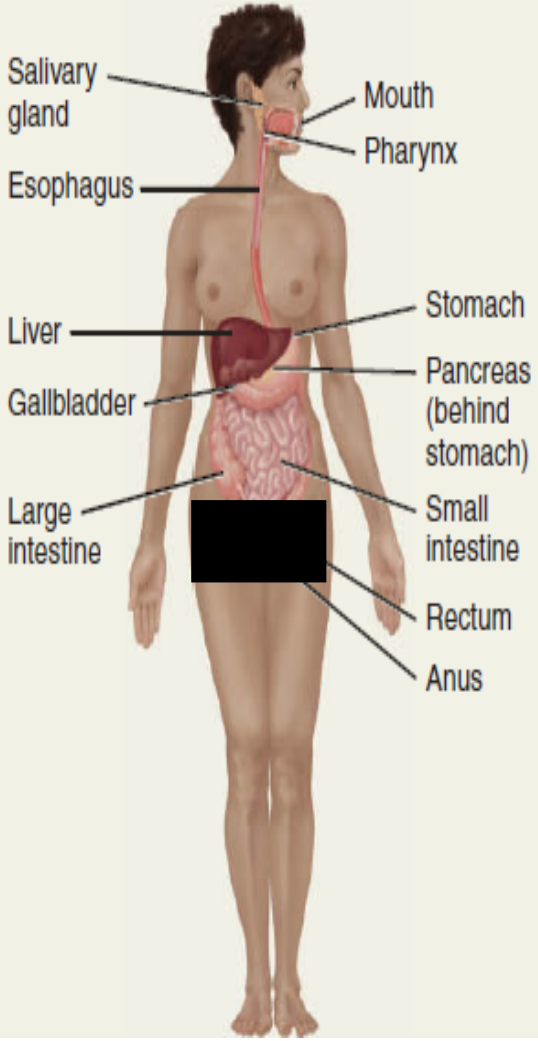
DIGESTIVE SYSTEM (CHAPTER 24)

Components: Organs of gastrointestinal tract, a long tube that includes the **mouth, pharynx** (throat), **esophagus** (food tube), **stomach, small** and **large intestines**, and **anus**; also includes accessory organs that assist in digestive processes, such as **salivary glands, liver, gallbladder**, and **pancreas**.

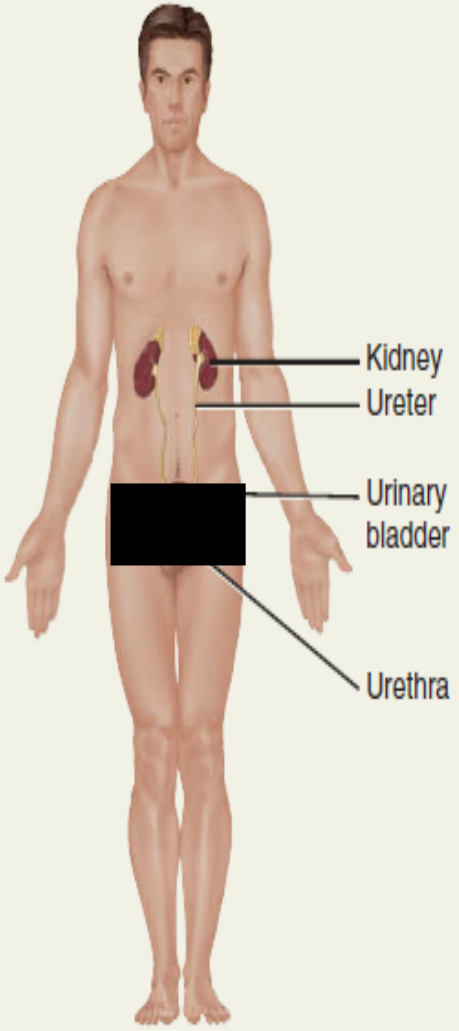
Functions: Achieves physical and chemical breakdown of food; absorbs nutrients; eliminates solid wastes.



URINARY SYSTEM (CHAPTER 26)

Components: **Kidneys, ureters, urinary bladder**, and **urethra**.

Functions: Produces, stores, and eliminates urine; eliminates wastes and regulates volume and chemical composition of blood; helps maintain the acid–base balance of body fluids; maintains body's mineral balance; helps regulate production of red blood cells.



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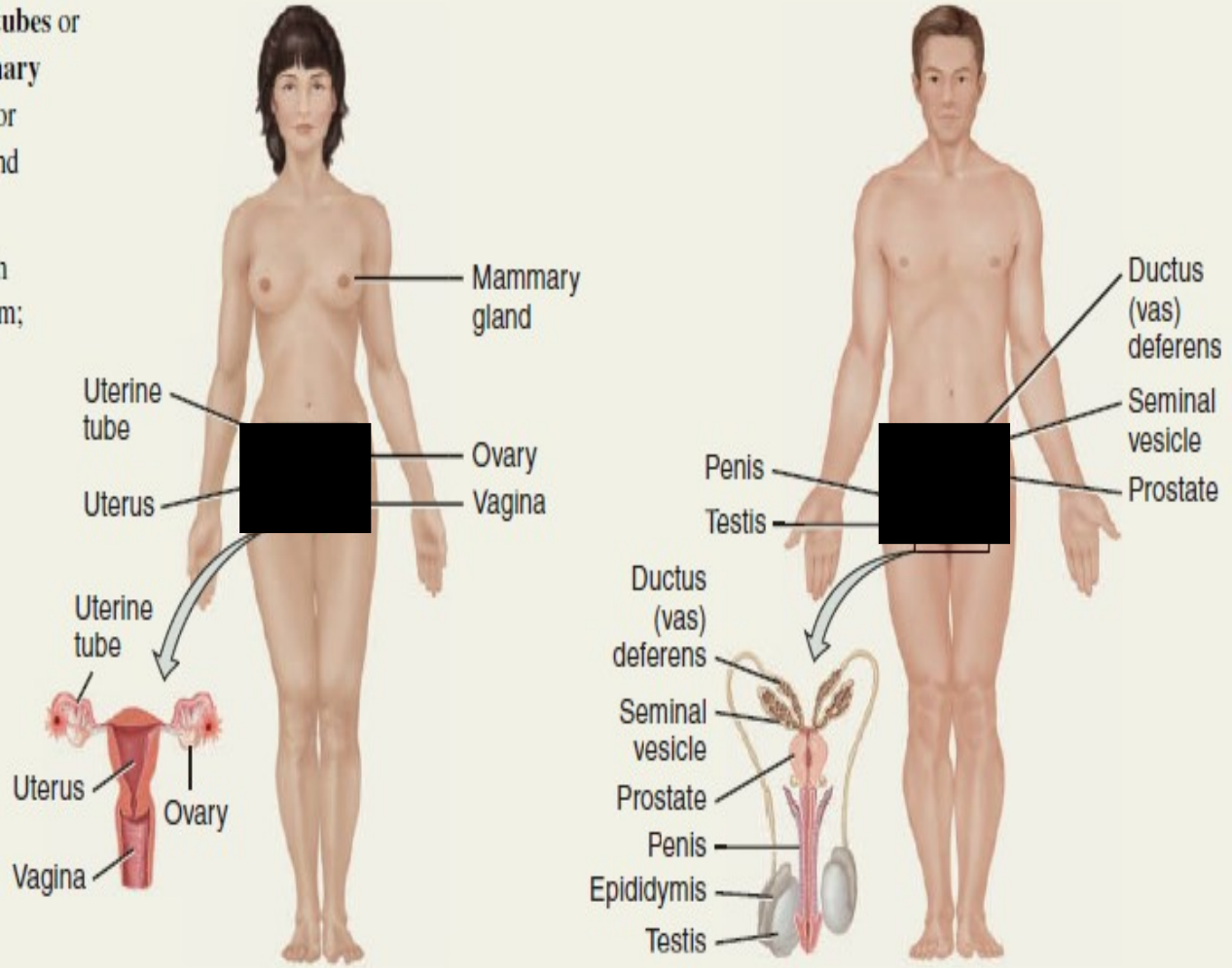
REPRODUCTIVE SYSTEMS (CHAPTER 28)

Components: **Gonads** (**testes** in males and **ovaries** in females) and associated organs (**uterine tubes** or *fallopian tubes*, **uterus, vagina**, and **mammary glands** in females and **epididymis, ductus** or **vas deferens, seminal vesicles, prostate**, and **penis** in males).

Functions: Gonads produce gametes (sperm or oocytes) that unite to form a new organism; gonads also release hormones that regulate reproduction and other body processes; associated organs transport and store gametes; mammary glands produce milk.



CLINICAL CONNECTION
Noninvasive Diagnostic Techniques

- Health-care professionals and students of anatomy and physiology commonly use several noninvasive diagnostic techniques to assess certain aspects of body structure and function.
- An understanding of anatomy is important for the effective application of most of these diagnostic techniques.
- A **noninvasive diagnostic technique** is one that does not involve insertion of an instrument or device through the skin or a body opening.

- In **inspection**, the examiner observes the body for any changes that deviate from normal.

  → For example, a physician may examine the mouth cavity for evidence of disease. Following inspection, one or more additional techniques may be employed.

- In **palpation** (pal-PA¯-shun; *palp-* gently touching) the examiner feels body surfaces with the hands.

  → An example is palpating the abdomen to detect enlarged or tender internal organs or abnormal masses.

CLINICAL CONNECTION
Noninvasive Diagnostic Techniques (continued)

- In **auscultation** (aws-kul-TA¯-shun; *auscult-* listening) the examiner listens to body sounds to evaluate the functioning of certain organs, often using a stethoscope to amplify the sounds.

  → An example is auscultation of the lungs during breathing to check for crackling sounds associated with abnormal fluid accumulation.

- In **percussion** (pur-KUSH-un; *percus-* beat through) the examiner taps on the body surface with the fingertips and listens to the resulting sound. Hollow cavities or spaces produce a different sound than solid organs.

  → For example, percussion may reveal the abnormal presence of fluid in the lungs or air in the intestines. It may also provide information about the size, consistency, and position of an underlying structure.

1.3 Characteristics of the Living Human Organism
→ Basic Life Processes:

Certain processes distinguish organisms, or living things, from non-living things.

1. **Metabolism** (me-TAB-o¯-lizm) is the sum of all chemical processes that occur in the body. → Anabolism (build-up) and catabolism (breakdown).
2. **Responsiveness** is the body's ability to detect and respond to changes.
3. **Movement** includes motion of the whole body, individual organs, single cells, and even tiny structures inside cells.
4. **Growth** is an increase in body size that results from an increase in the size of existing cells, an increase in the number of cells, or both.
5. **Differentiation** (dif-er-en-she¯-A¯-shun) is the development of a cell from an unspecialized to a specialized state. Such precursor cells, which can divide and give rise to cells that undergo differentiation, are known as **stem cells**.
6. **Reproduction** (re¯-pro¯-DUK-shun) refers either to (1) the formation of new cells for tissue growth, repair, or replacement, or (2) the production of a new individual.

1.4 Homeostasis

- **Homeostasis** (ho¯-me¯-o¯-STA¯-sis; *homeo-* sameness; *-stasis* standing still) is the condition of equilibrium (balance) in the body's internal environment due to the constant interaction of the body's many regulatory processes.

- Homeostasis is a dynamic condition. In response to changing conditions, the body's equilibrium can shift among points in a narrow range that is compatible with maintaining life.

- Homeostasis is maintained by regulatory processes.

Homeostasis and Body Fluids

- An important aspect of homeostasis is maintaining the volume and composition of **body fluids**, dilute, watery solutions containing dissolved chemicals that are found inside cells as well as surrounding them.

- The fluid within cells is **intracellular fluid** (*intra-* inside), abbreviated **ICF**.
- The fluid outside body cells is **extracellular fluid (ECF)** (*extra-* outside). The ECF that fills the narrow spaces between cells of tissues is known as **interstitial fluid** (in-ter-STISH-al; *inter-* between).
- **The proper functioning of body cells depends on precise regulation of the composition of the interstitial fluid surrounding them. Because of this, interstitial fluid is often called the body's *internal environment.***

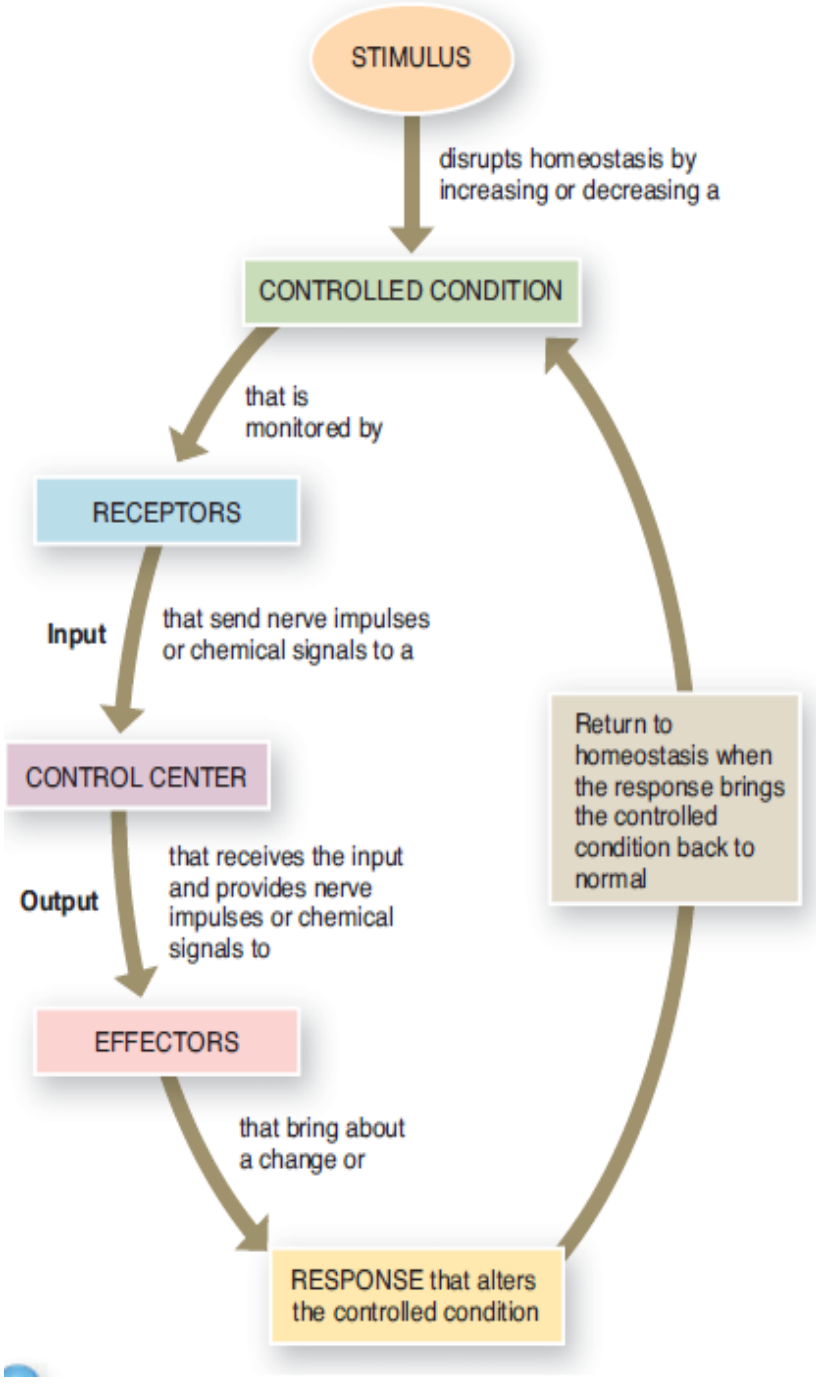
Control of Homeostasis
Feedback Systems

A **feedback system** or *feedback loop* is a cycle of events in which the status of a body condition is monitored, evaluated, changed, remonitored, reevaluated, and so on.

Each monitored variable, such as body temperature, blood pressure, or blood glucose level, is termed **a *controlled condition***.

Any disruption that changes a controlled condition is called a ***stimulus***.

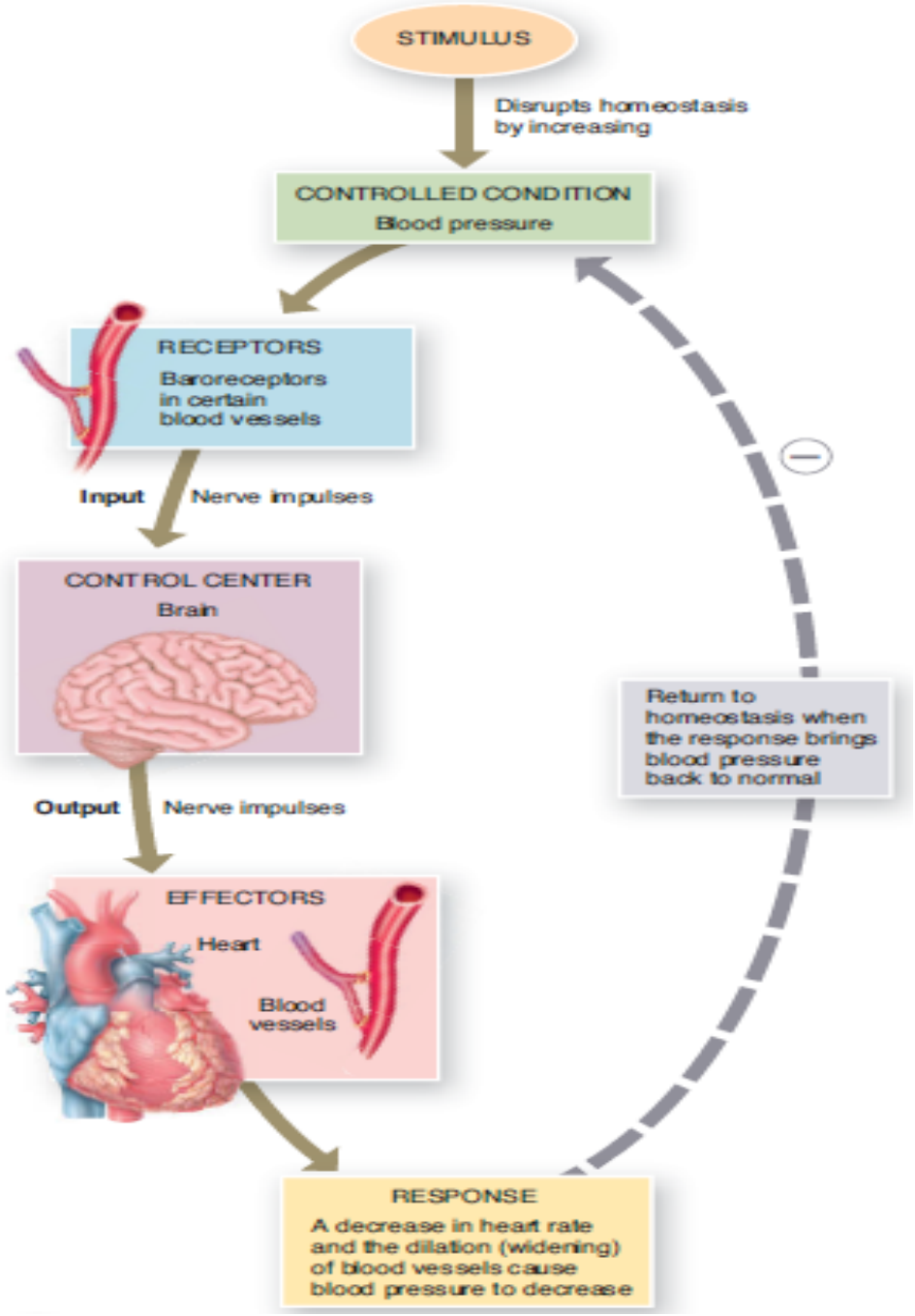
A feedback system includes three basic components: **a receptor, a control center, and an effector**



Control of Homeostasis

- **NEGATIVE FEEDBACK:** If the response reverses the stimulus, a system is operating by negative feedback

Homeostatic regulation of blood pressure by a negative feedback system.
→ The broken return arrow with a negative sign surrounded by a circle symbolizes negative feedback.

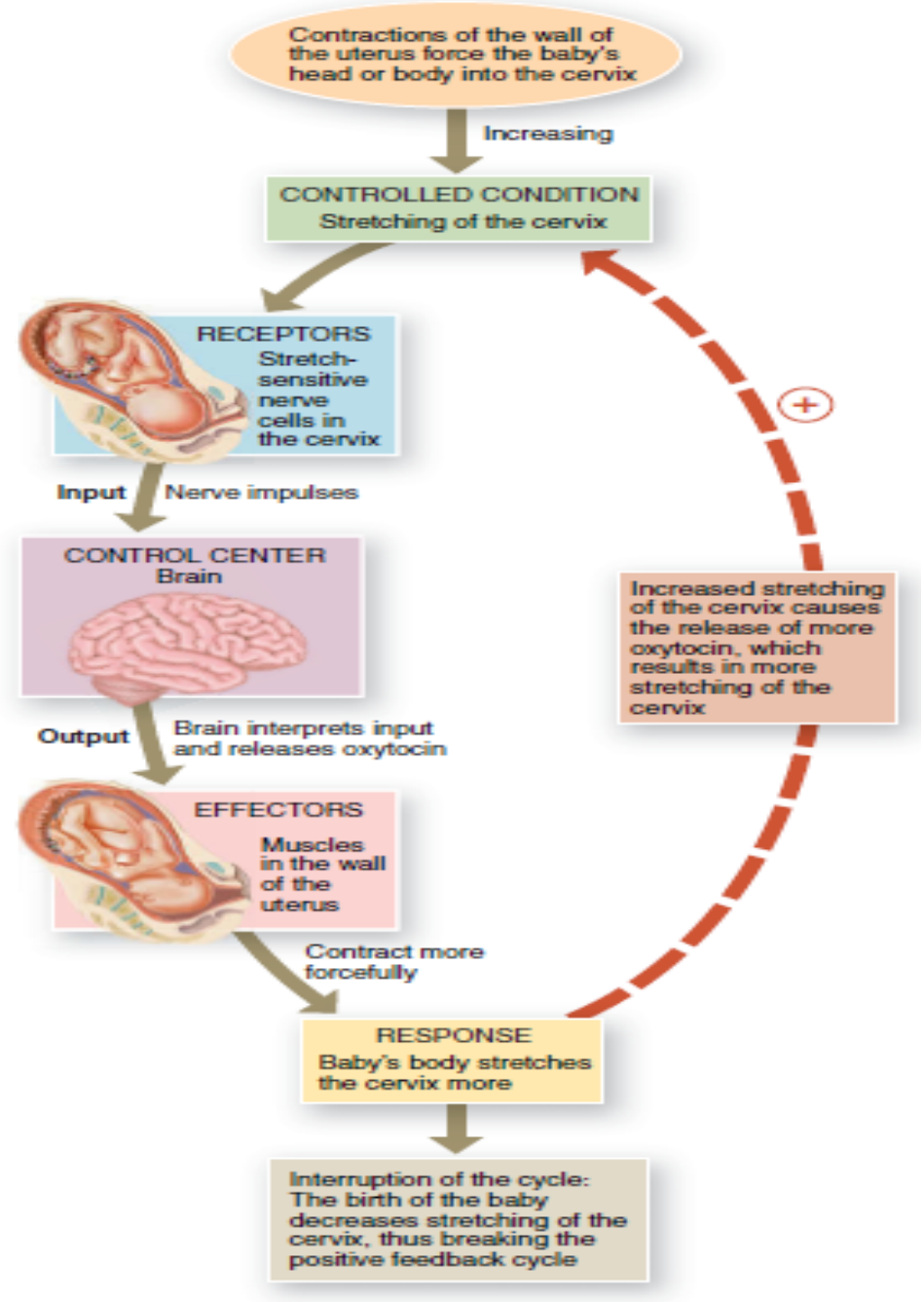


Control of Homeostasis (continued)

- **POSITIVE FEEDBACK:** If the response enhances or intensifies the stimulus, a system is operating by positive feedback

  Positive feedback control of labor contractions during birth of a baby.

- The broken return arrow with a positive sign surrounded by a circle symbolizes positive feedback.



Homeostatic Imbalances

✓Lifelong good health is not something that happens effortlessly. The many factors in this balance called health include the following:

- The environment and your own behavior.
- Your genetic makeup.
- The air you breathe, the food you eat, and even the thoughts you think.

✓The way you live your life can either support or interfere with your body's ability to maintain homeostasis and recover from the inevitable stresses life throws your way.

✓Many diseases are the result of years of poor health behavior that interferes with the body's natural drive to maintain homeostasis.

Homeostatic Imbalances (continued)

- A **disorder** is any abnormality of structure or function.
- **Disease** is a more specific term for an illness characterized by a recognizable set of signs and symptoms.

→A *local disease* affects one part or a limited region of the body (for example, a sinus infection);

→A *systemic disease* affects either the entire body or several parts of it (for example, influenza).

Diseases alter body structures and functions in characteristic ways.

A person with a disease may experience **symptoms**, *subjective* changes in body functions that are not apparent to an observer. Examples of symptoms are headache, nausea, and anxiety.

Objective changes that a clinician can observe and measure are called **signs**. Signs of disease can be either anatomical, such as swelling or a rash, or physiological, such as fever, high blood pressure, or paralysis.

1.5 Basic Anatomical Terminology

- **Body Positions**
- **Regional Names**
- **Directional Terms**
- **Planes and Sections**
- **Body Cavities**

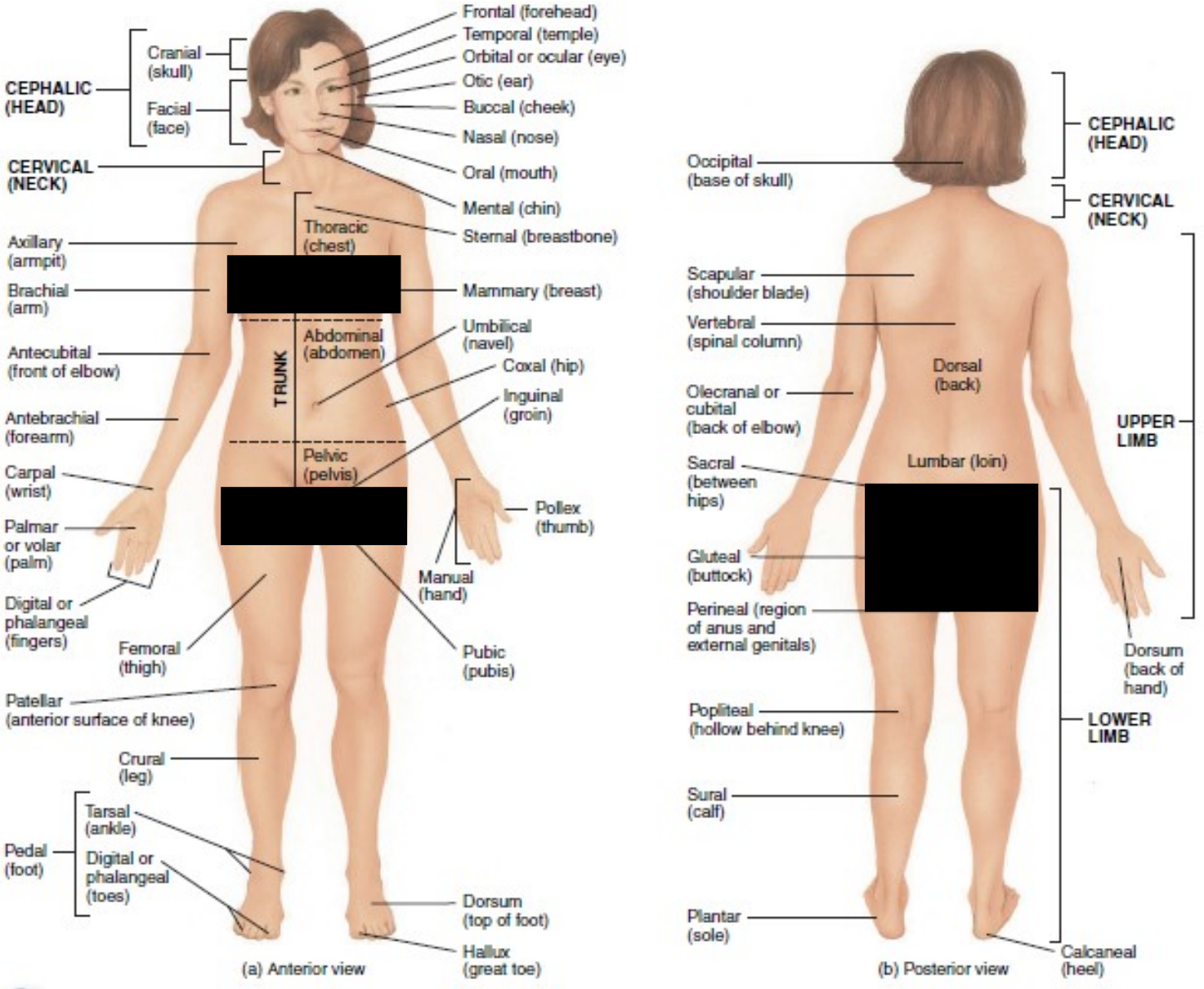
Body Positions

- Descriptions of any region or part of the human body assume that it is in a standard position of reference called the **anatomical position** (an-a-TOM-i-kal).
- In the anatomical position, the subject stands erect facing the observer, with the head level and the eyes facing directly forward. The lower limbs are parallel and the feet are flat on the floor and directed forward, and the upper limbs are at the sides with the palms turned forward.
- **Two terms describe a reclining body:**

➢ If the body is lying facedown, it is in the **prone** position.

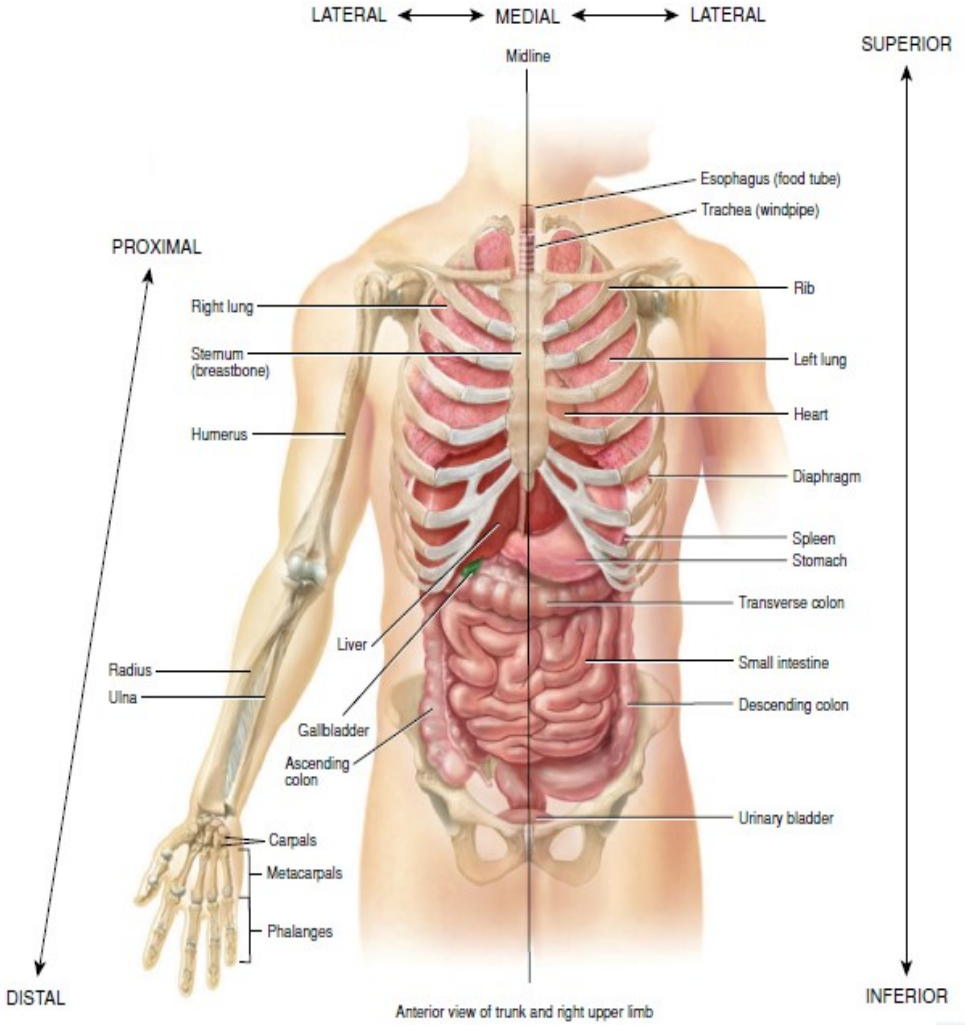
➢ If the body is lying faceup, it is in the **supine** position.

Regional Names: Names given to specific regions of the body for references



Directional Terms

Directional terms precisely locate various parts of the body relative to one another.



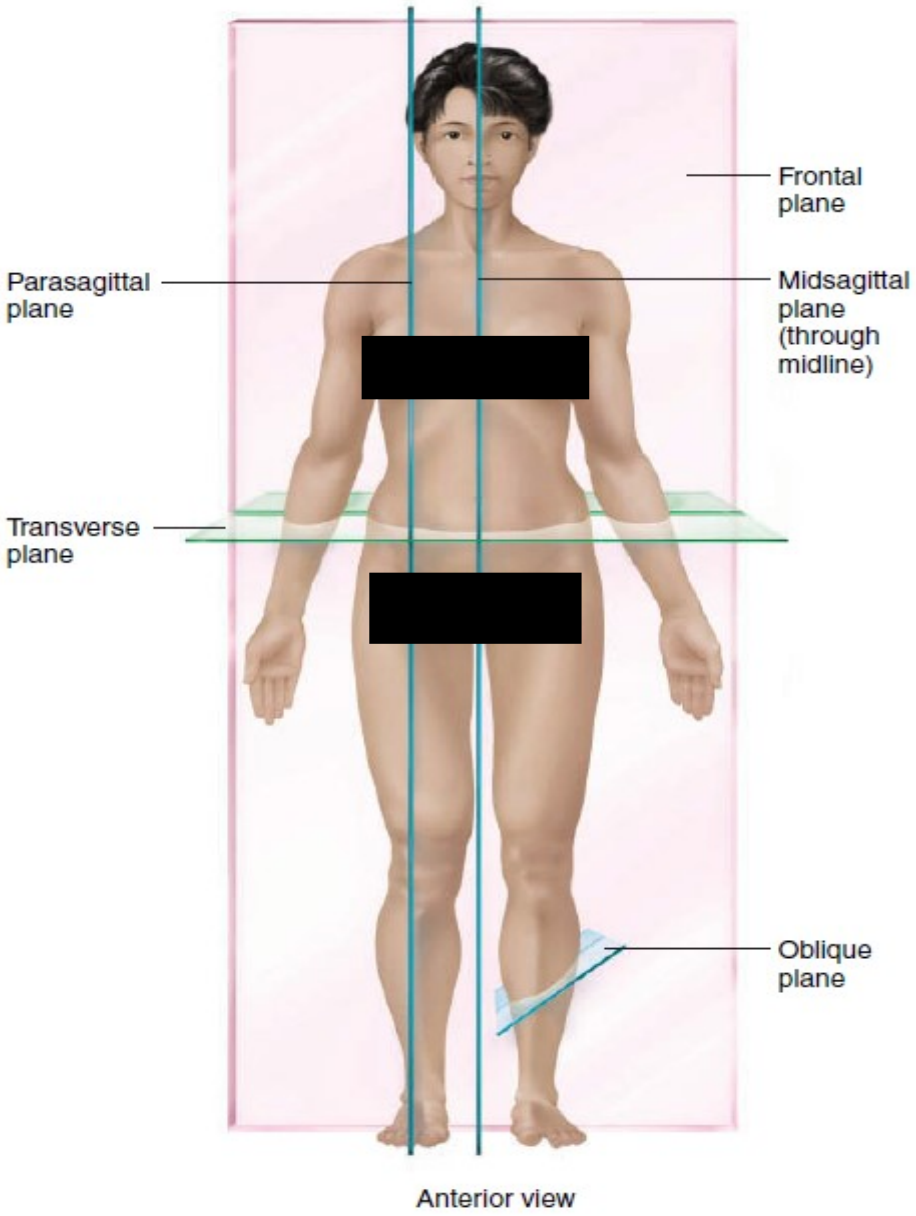
Directional Terms

→Note that the terms anterior and ventral mean the same thing in humans.
→However, in four-legged animals ventral refers to the belly side and is therefore inferior.
→ Similarly, the terms posterior and dorsal mean the same thing in humans, but in four-legged animals dorsal refers to the back side and is therefore superior.

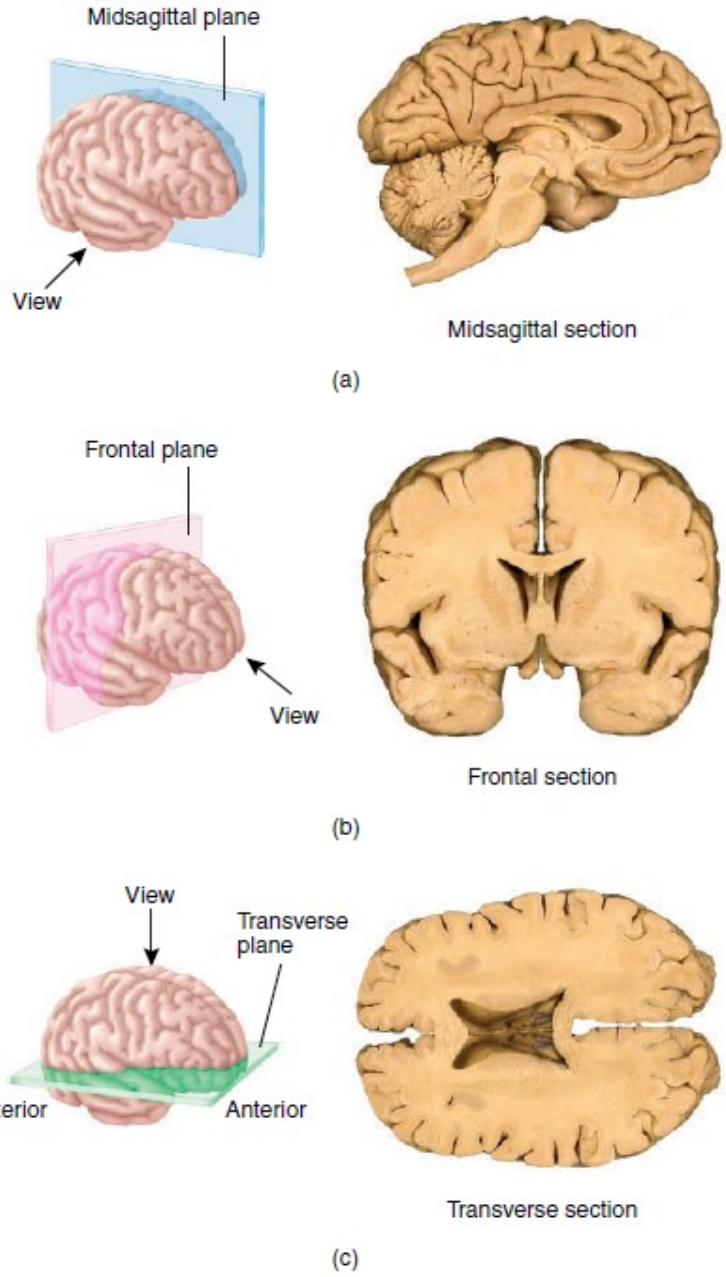
DIRECTIONAL TERM	DEFINITION	EXAMPLE OF USE
Superior (soo′-PĒR-ē-or) (cephalic or cranial)	Toward the head, or the upper part of a structure.	The heart is superior to the liver.
Inferior (in-FĒ-rē-or) (caudal)	Away from the head, or the lower part of a structure.	The stomach is inferior to the lungs.
Anterior (an-TĒR-ē-or) (ventral)*	Nearer to or at the front of the body.	The sternum (breastbone) is anterior to the heart.
Posterior (pos-TĒR-ē-or) (dorsal)	Nearer to or at the back of the body.	The esophagus (food tube) is posterior to the trachea (windpipe).
Medial (MĒ-dē-al)	Nearer to the midline (an imaginary vertical line that divides the body into equal right and left sides).	The ulna is medial to the radius.
Lateral (LAT-er-al)	Farther from the midline.	The lungs are lateral to the heart.
Intermediate (in′-ter-MĒ-dē-at)	Between two structures.	The transverse colon is intermediate to the ascending and descending colons.
Ipsilateral (ip-si-LAT-er-al)	On the same side of the body as another structure.	The gallbladder and ascending colon are ipsilateral.
Contralateral (KON-tra-lat-er-al)	On the opposite side of the body from another structure.	The ascending and descending colons are contralateral.
Proximal (PROK-si-mal)	Nearer to the attachment of a limb to the trunk; nearer to the origination of a structure.	The humerus (arm bone) is proximal to the radius.
Distal (DIS-tal)	Farther from the attachment of a limb to the trunk; farther from the origination of a structure.	The phalanges (finger bones) are distal to the carpals (wrist bones).
Superficial (soo′-per-FISH-al) (external)	Toward or on the surface of the body.	The ribs are superficial to the lungs.
Deep (Internal)	Away from the surface of the body.	The ribs are deep to the skin of the chest and back.

Planes and Sections

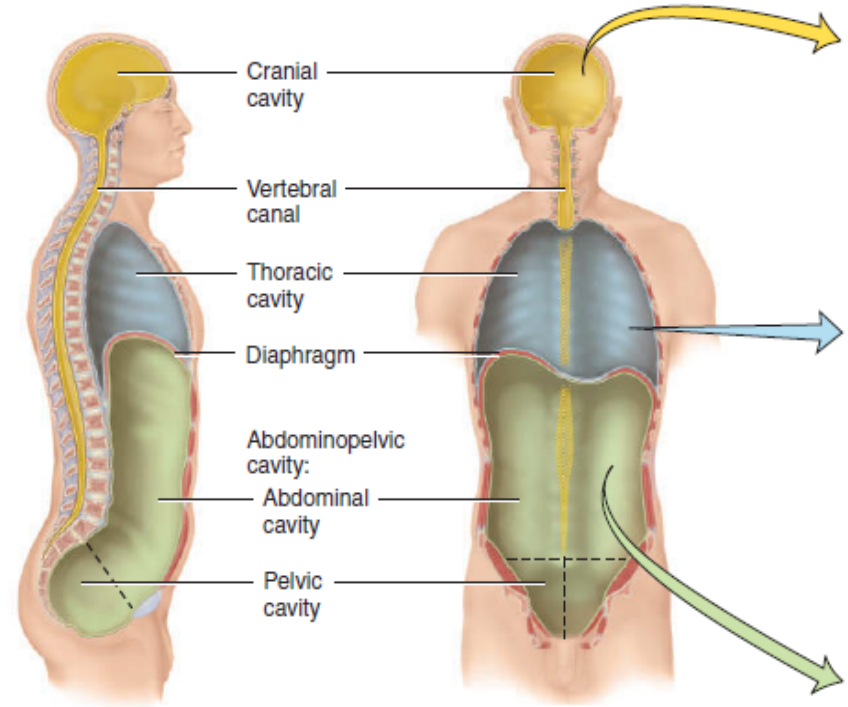
Parts of the body relative to **planes**, imaginary flat surfaces that pass through the body parts.



Practicing Planes and Sections



Body Cavities: spaces within the body that help protect, separate, and support internal organs

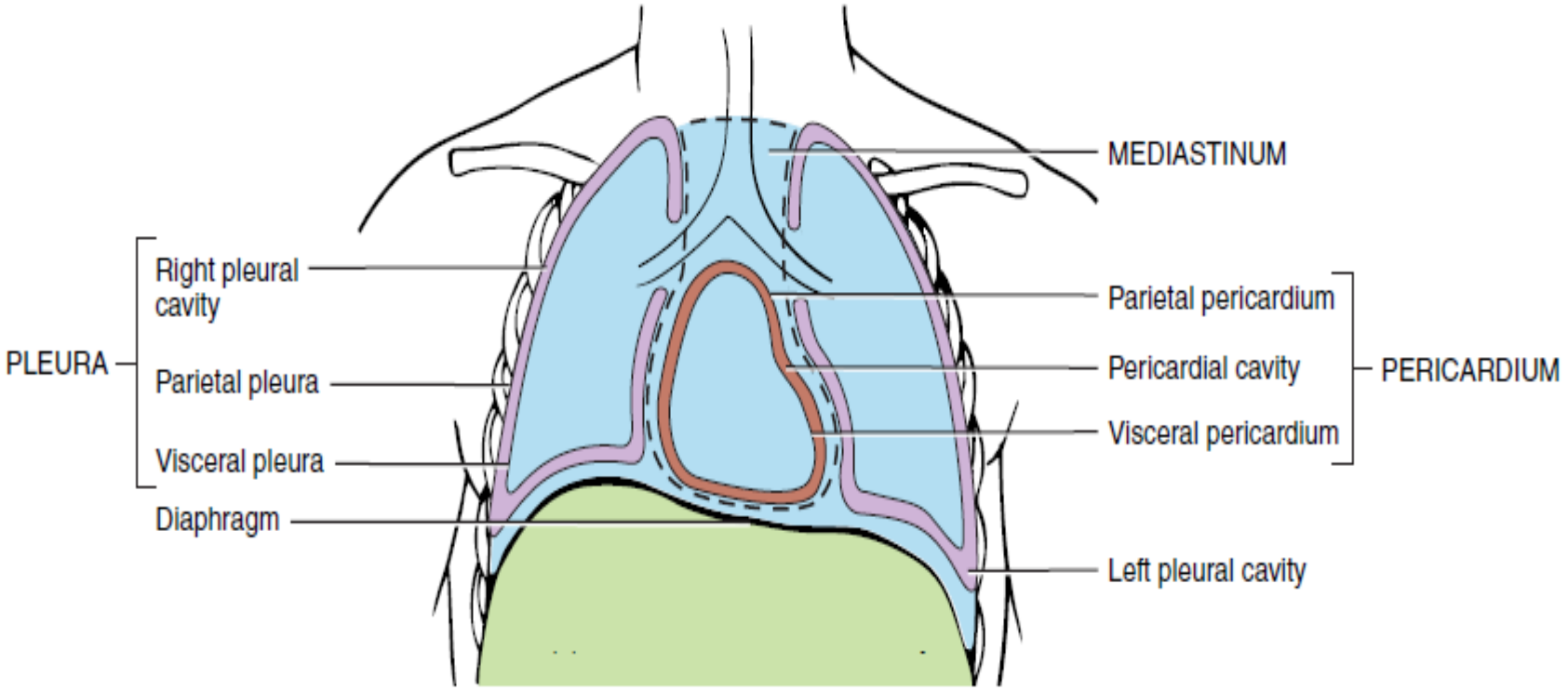


(a) Right lateral view (b) Anterior view

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 the mediastinum.
Pleural cavity	A potential space between the layers of the pleura that surrounds a lung.
Pericardial cavity	A potential space between the layers of the pericardium that surrounds the heart.
Mediastinum	Central portion of thoracic cavity between the lungs; extends from sternum to vertebral column and from first rib 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, gallbladder, 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.

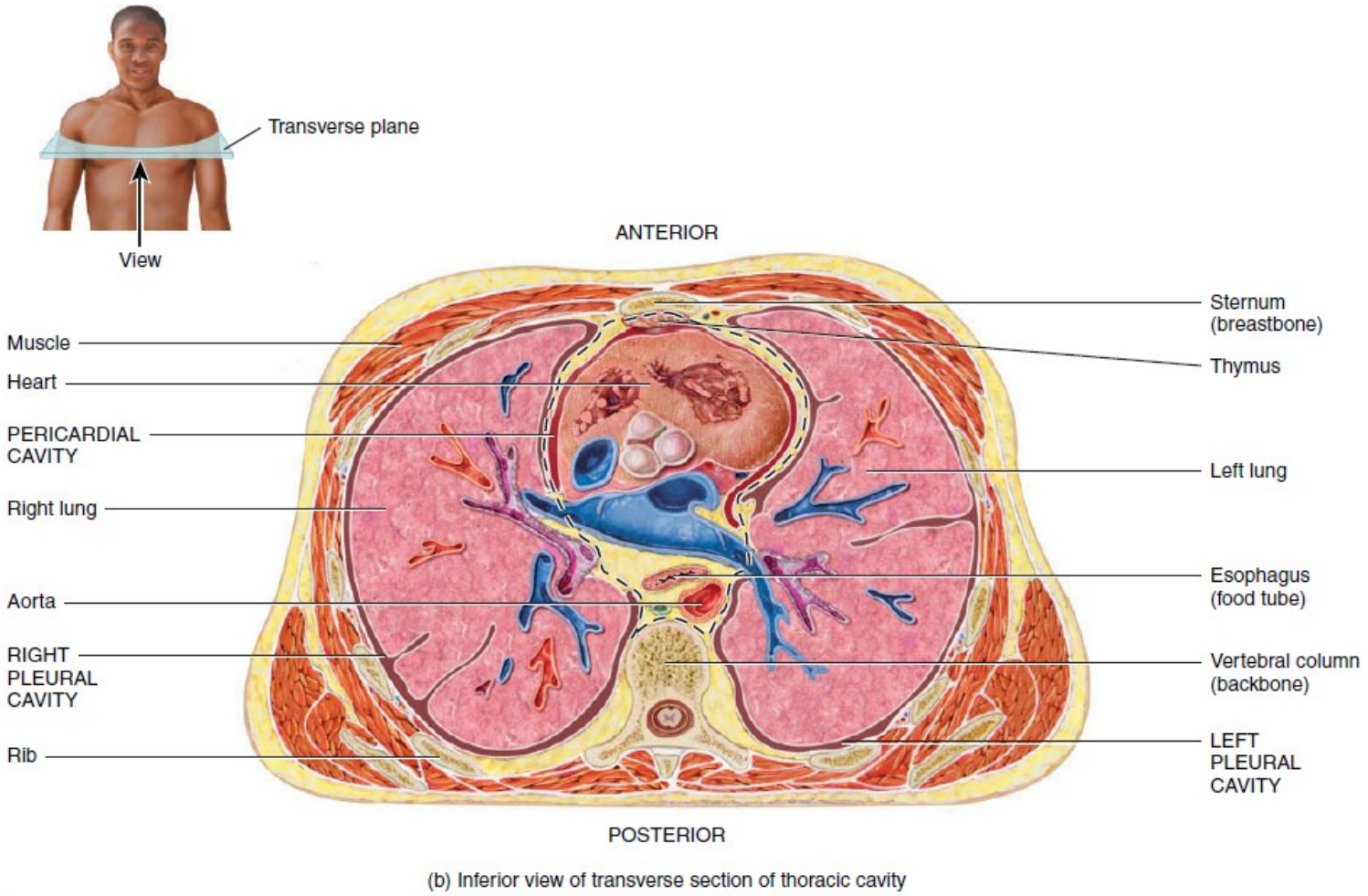
* See Figure 1.10 for details of the thoracic cavity.

The thoracic cavity. The black dashed lines indicate the borders of the mediastinum. Note: When transverse sections are viewed inferiorly (from below), the anterior aspect of the body appears on top and the left side of the body appears on the right side of the illustration.
→ The thoracic cavity contains three smaller cavities and the mediastinum.



(a) Anterior view of thoracic cavity

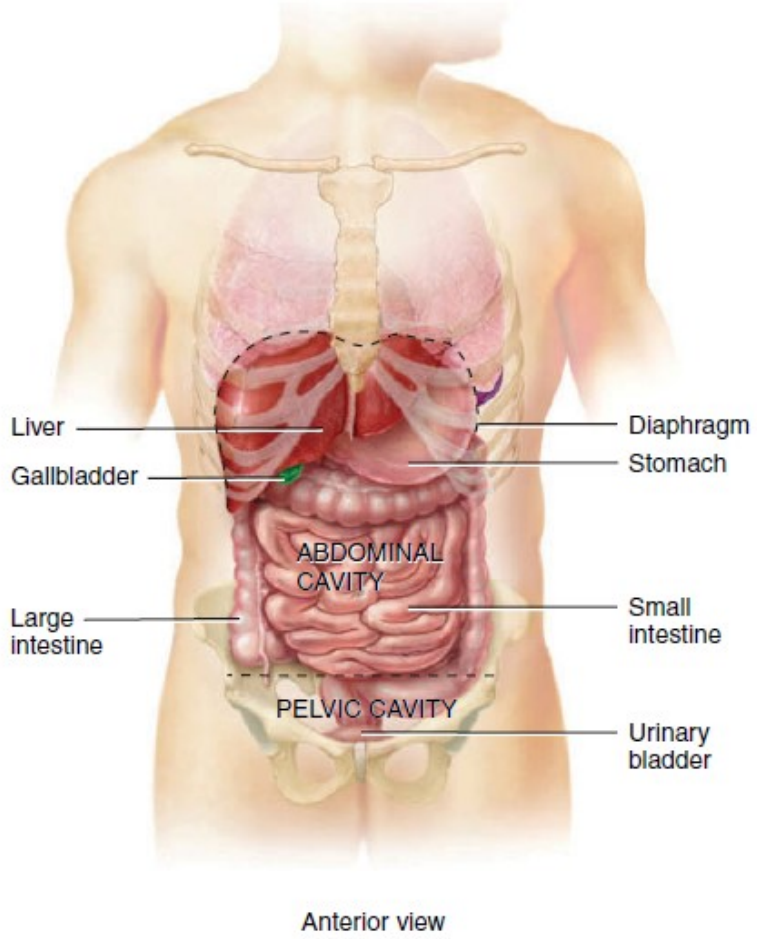
The thoracic cavity



(b) Inferior view of transverse section of thoracic cavity

The abdominopelvic cavity. The black dashed lower line shows the approximate boundary between the abdominal and pelvic cavities.

→ The abdominopelvic cavity extends from the diaphragm to the groin.



Abdominopelvic Regions and Quadrants:

The nine-region designation is used for anatomical studies; the quadrant designation is used to locate the site of pain, tumors, or some other abnormality.