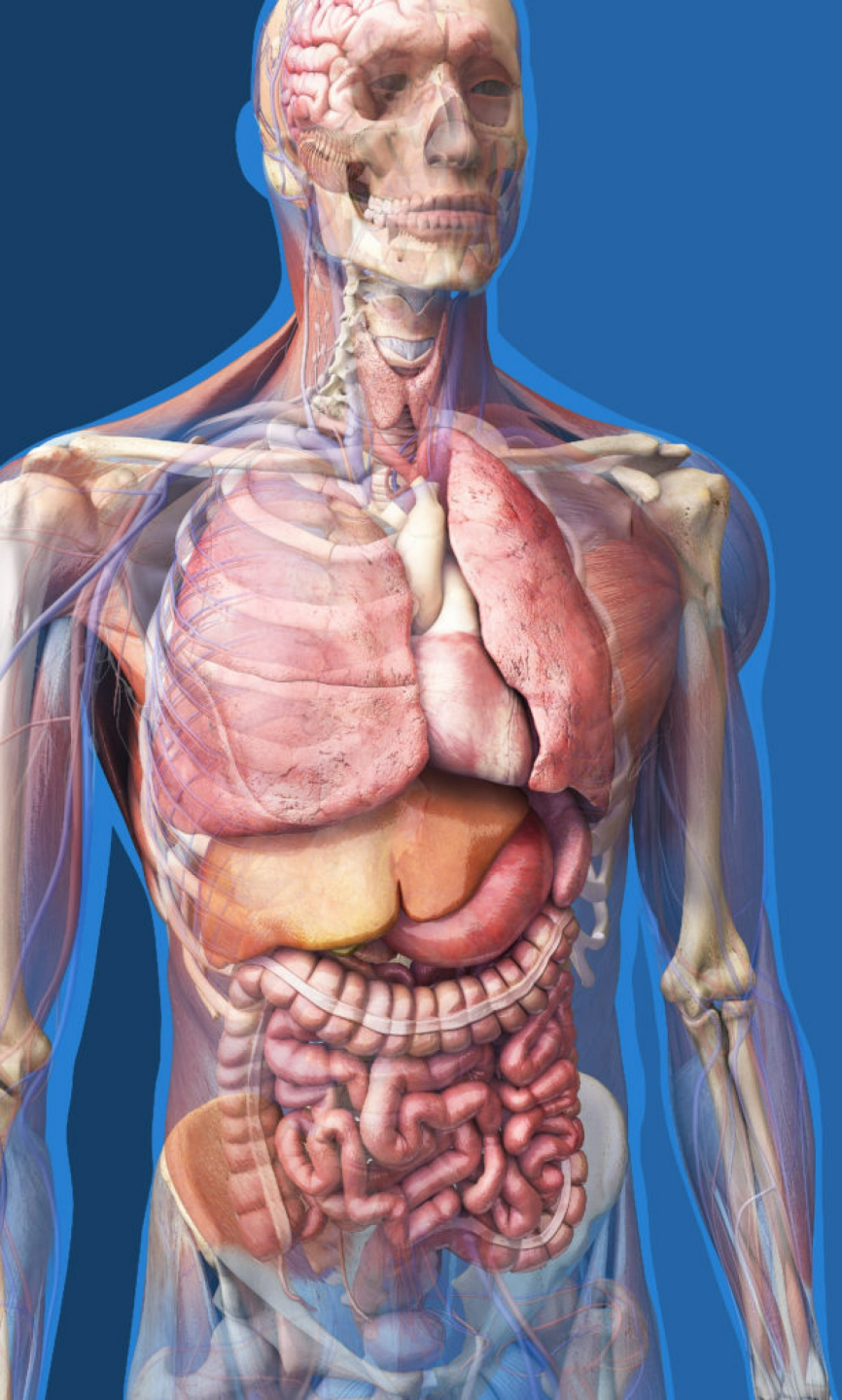




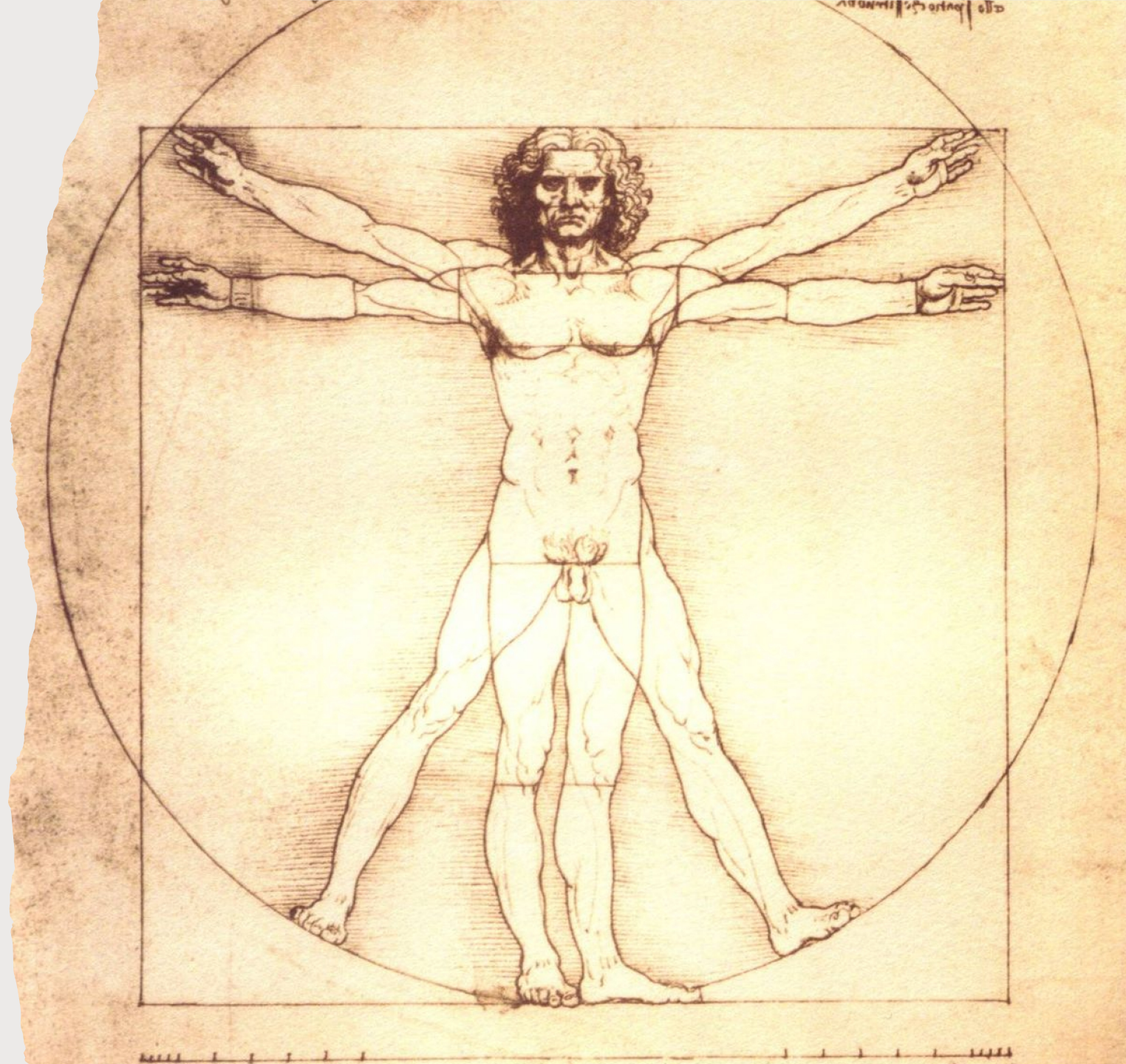
Chapter 1 | **FOUNDATIONS** **S** An Introduction to Anatomy

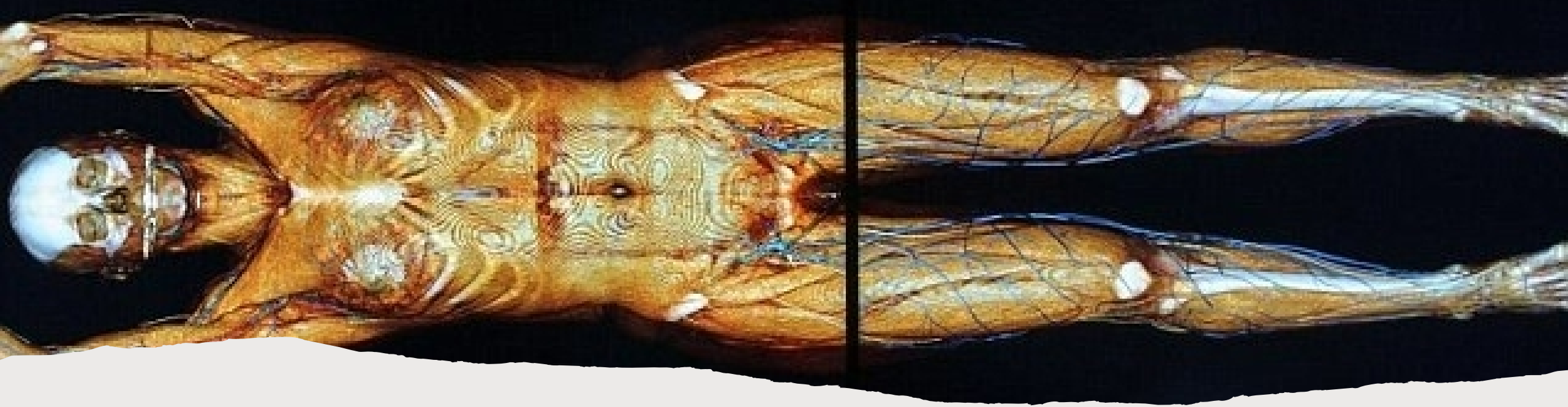
learning outcomes

- ▶ Define anatomy and physiology, and describe the subdisciplines of anatomy.
- ▶ Identify the levels of structural organization in the human body, and explain the interrelationships between each level.
- ▶ List the organ systems of the body, and briefly state their functions.
- ▶ Use metric units to quantify the dimensions of cells, tissues, and organs.
- ▶ Use the meaning of word roots to aid in understanding anatomical terminology.

What is Anatomy?

- **Anatomy** is the study of the structure of the human body. It is also called **morphology**.
- Anatomy is closely related to **physiology**, the study of body function, because structure supports function.





Subdisciplines of Anatomy - *Gross Anatomy*

- *Gross Anatomy* - the study of body structures that can be examined by the naked eye.
 - An important technique for studying gross anatomy is **dissection**.
 - **The** connective tissue is removed from between the body organs so that the organs can be seen more clearly. Then the organs are cut open for viewing.
 - The term *anatomy* is derived from Greek words meaning “to cut apart.”

Subdisciplines of Anatomy

- *Gross Anatomy*

- Studies of gross anatomy can be approached in several different ways.
 - In **regional anatomy**, all structures in a single body region, such as the abdomen or head, are examined as a group.
 - In **systemic anatomy**, by contrast, all the organs with related functions are studied together.
 - The systemic approach to anatomy is best for relating structure to function.
 - In **surface anatomy**, the shapes and markings (called *landmarks*) on the surface of the body that reveal the underlying organs are studied.





Subdisciplines of Anatomy

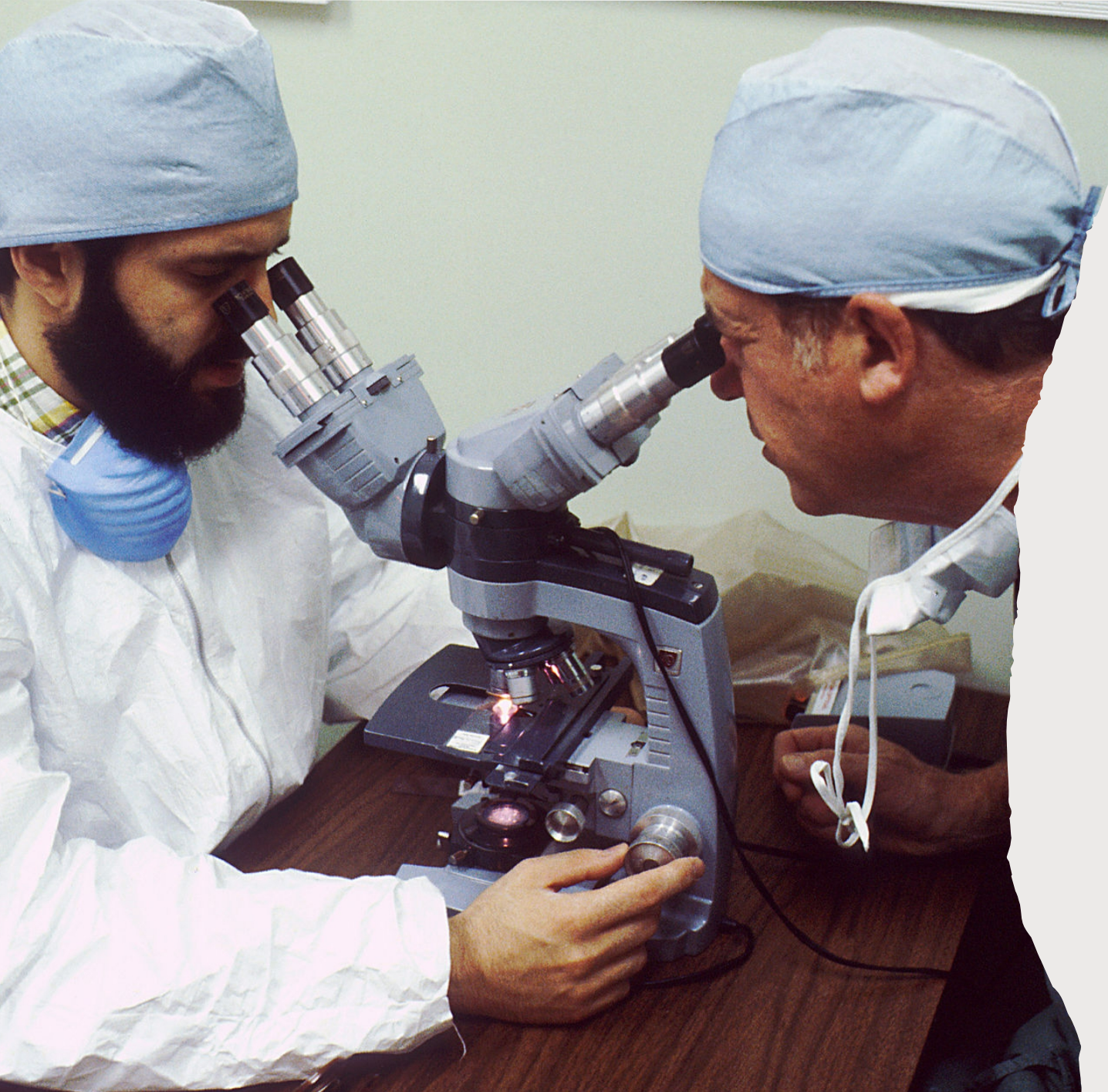
- *Microscopic Anatomy*

- **Microscopic anatomy**, or **histology** (“tissue study”), is the study of structures that are so small they can be seen only with a microscope.
 - These structures include cells and cell parts; groups of cells, called *tissues*; and the microscopic details of the organs of the body (stomach, spleen, and so on).

Subdisciplines of Anatomy - *Other Branches of Anatomy*

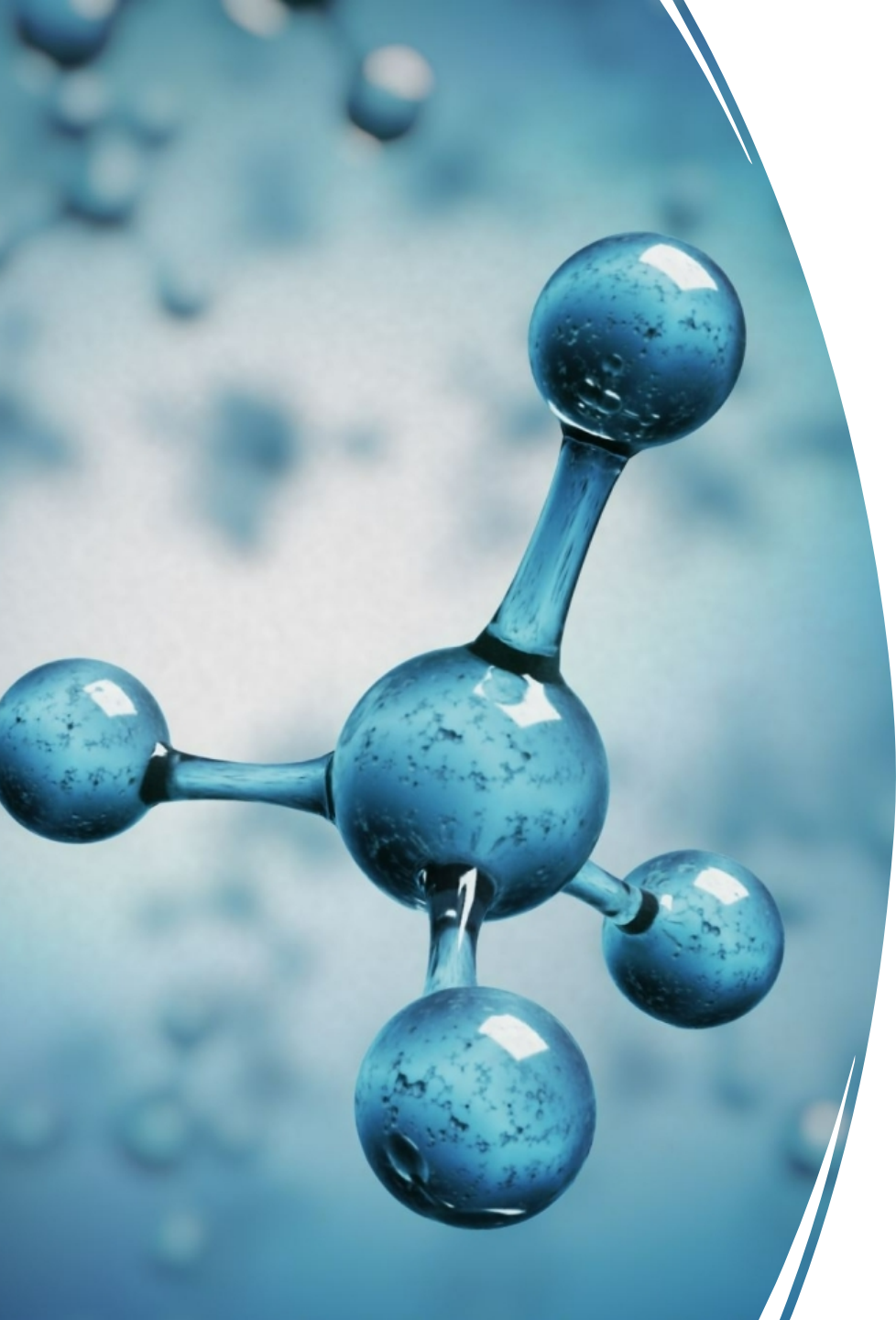
- Two branches of anatomy explore how body structures form, grow, and mature.
 - **Developmental anatomy** traces the structural changes that occur in the body throughout the life span and the effects of aging.
 - **Embryology** is the study of how body structures form and develop before birth.





Subdisciplines of Anatomy - *Other Branches of Anatomy*

- Some specialized branches of anatomy are used primarily for medical diagnosis and scientific research.
 - **Pathological** (pah-tho-loj i'-kal) **anatomy** deals with the structural changes in cells, tissues, and organs caused by disease. (**Pathology** is the study of disease.)
 - **Radiographic** (rade-ografic) **anatomy** is the study of internal body structures by means of X-ray studies and other imaging techniques.
 - **Functional morphology** explores the functional properties of body structures and assesses the efficiency of their design.



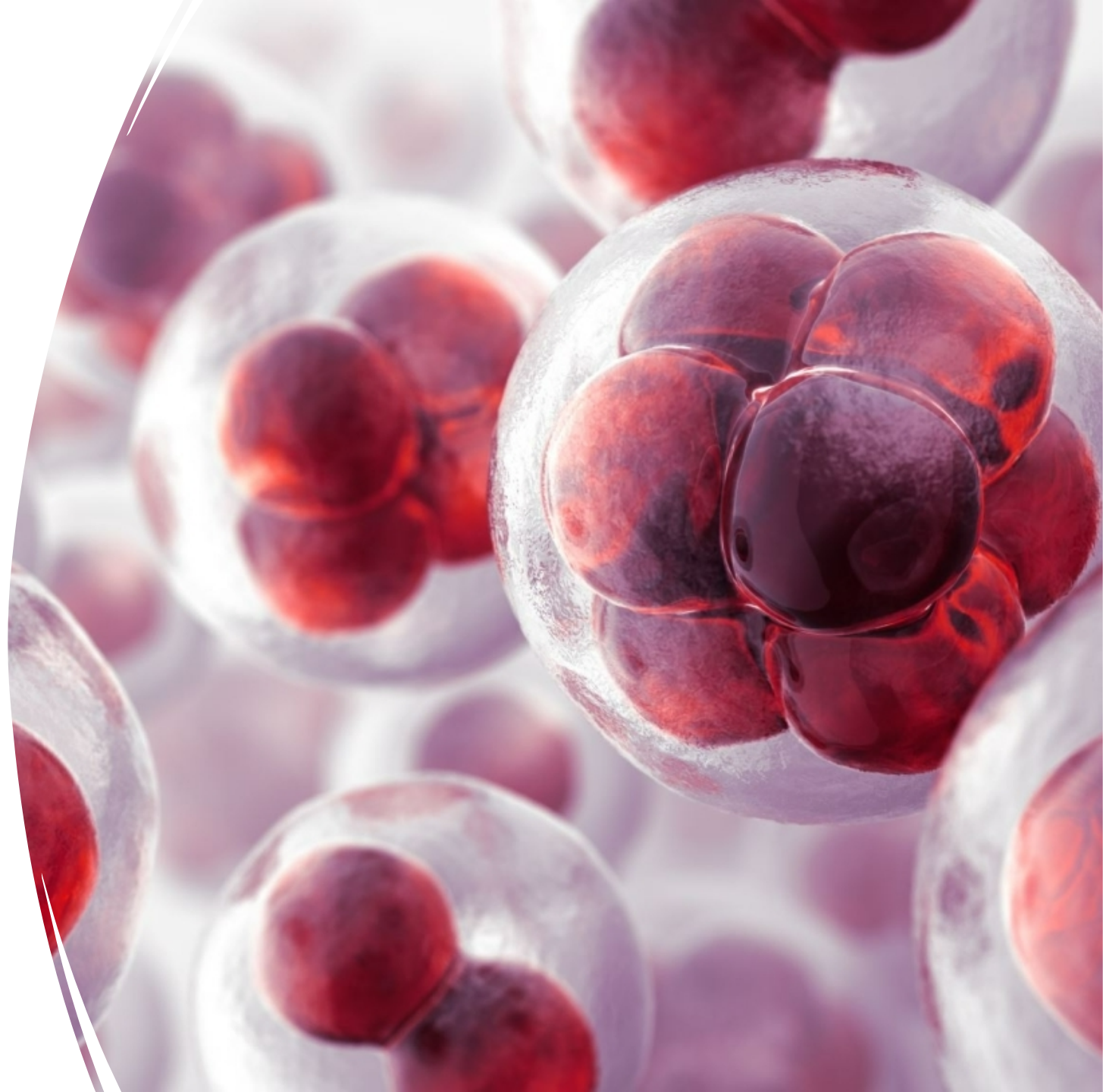
The Hierarchy of Structural Organization – The Chemical Level

The human body has many levels of structural complexity.

- At the **chemical level**, *atoms* are tiny building blocks of matter such as carbon, hydrogen, oxygen, and nitrogen.
- Atoms combine to form small *molecules*, such as carbon dioxide (CO₂) and water (H₂O), and larger *macromolecules* (*macro* = big).
- Four classes of macromolecules are found in the body:
 - carbohydrates (sugars)
 - lipids (fats)
 - Proteins
 - nucleic acids (DNA, RNA).

The Hierarchy of Structural Organization - the **cellular level**

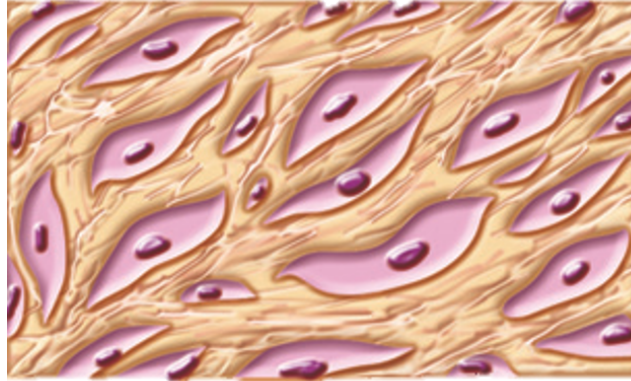
- The macromolecules are the building blocks of the structures at the **cellular level**:
 - The *cells* and their functional subunits, called *cellular organelles*.
 - Cells are the smallest living things in the body, and you have trillions of them.



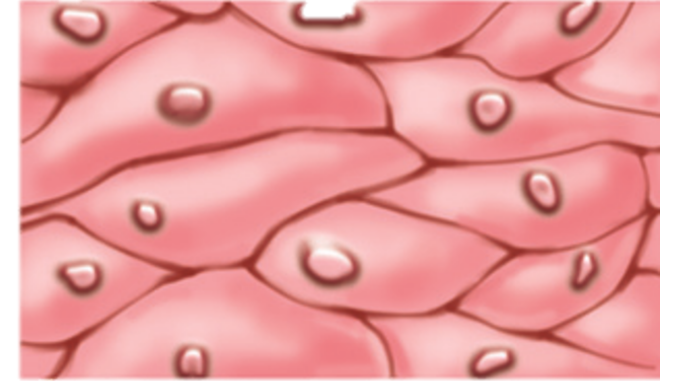
The Hierarchy of Structural Organization - the **tissue** level

- The next level is the **tissue level**.
- A tissue is a group of cells that work together to perform a common function.
- Only four tissue types make up all organs of the human body:
 - epithelial tissue (epithelium) – covers the body surface and lines its cavities
 - connective tissue - supports the body and protects its organs
 - muscle tissue - provides movement
 - nervous tissue - provides fast internal communication by transmitting electrical impulses

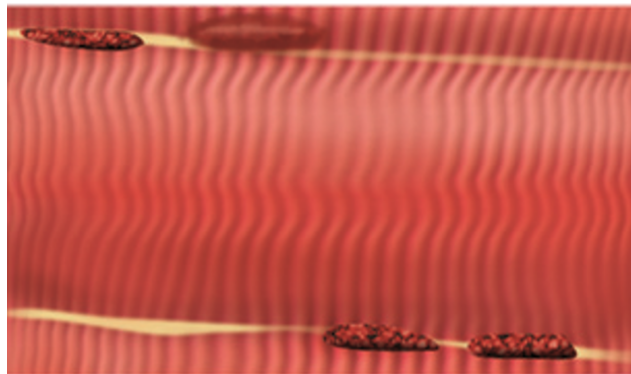
connective tissue



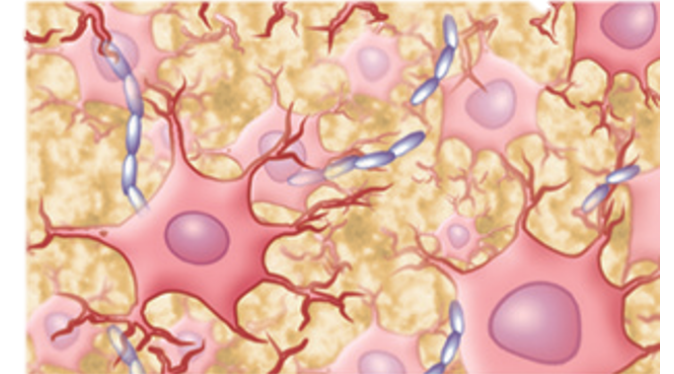
epithelial tissue (epithelium)



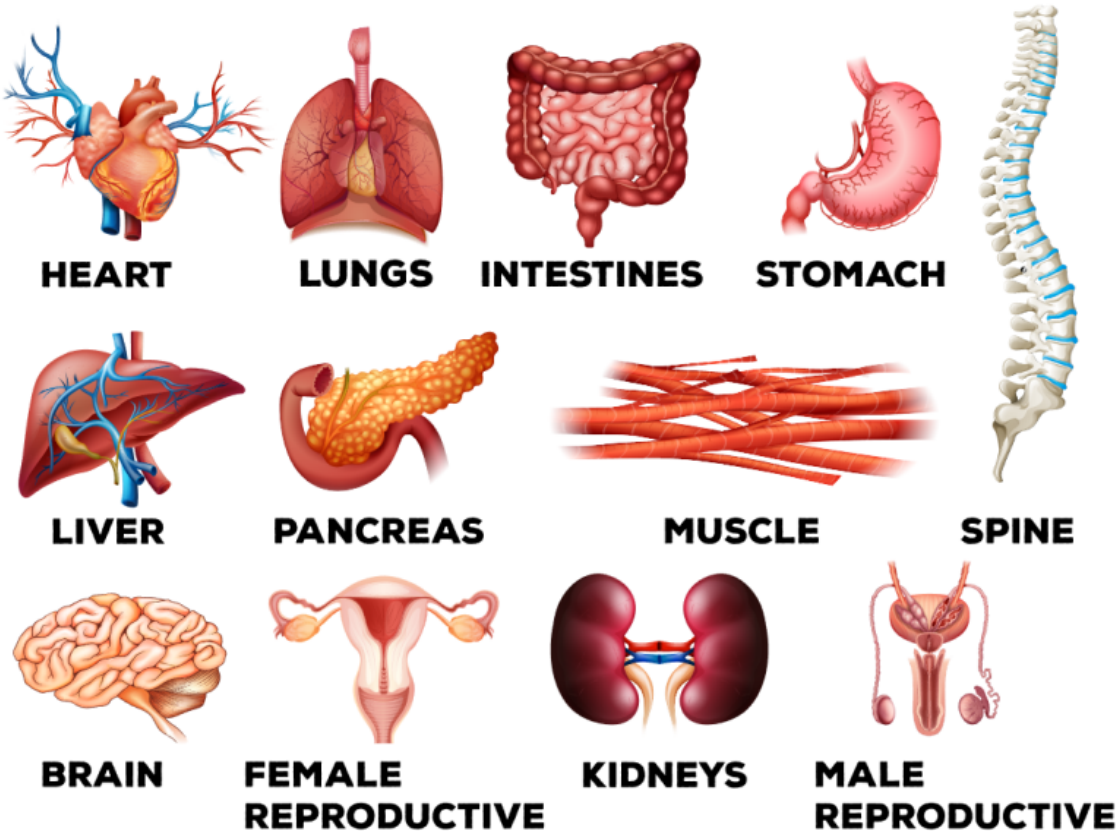
muscle tissue



nervous tissue



Human Organ Anatomy Set



The Hierarchy of Structural Organization - the **Organ** level

Extremely complex physiological processes occur at the **organ level**.

- An organ is a discrete structure made up of more than one tissue.
- Most organs contain all four tissues.
- The liver, brain, femur, and heart are good examples.
- You can think of each organ in the body as a functional center responsible for an activity that no other organ can perform.

The Hierarchy of Structural Organization - the Organ System level



- Organs that work closely together to accomplish a common purpose make up an **organ system**, the next level.
- For example, organs of the cardiovascular system—the heart and blood vessels—transport blood to all body tissues.
- Organs of the digestive system—the mouth, esophagus, stomach, intestine, and so forth—break down the food we eat so that we can absorb the nutrients into the blood.
- The body's organ systems are the *integumentary* (skin), *skeletal*, *muscular*, *nervous*, *endocrine*, *cardiovascular*, *lymphatic*, *immune*, *respiratory*, *digestive*, *urinary*, and *reproductive* systems.*



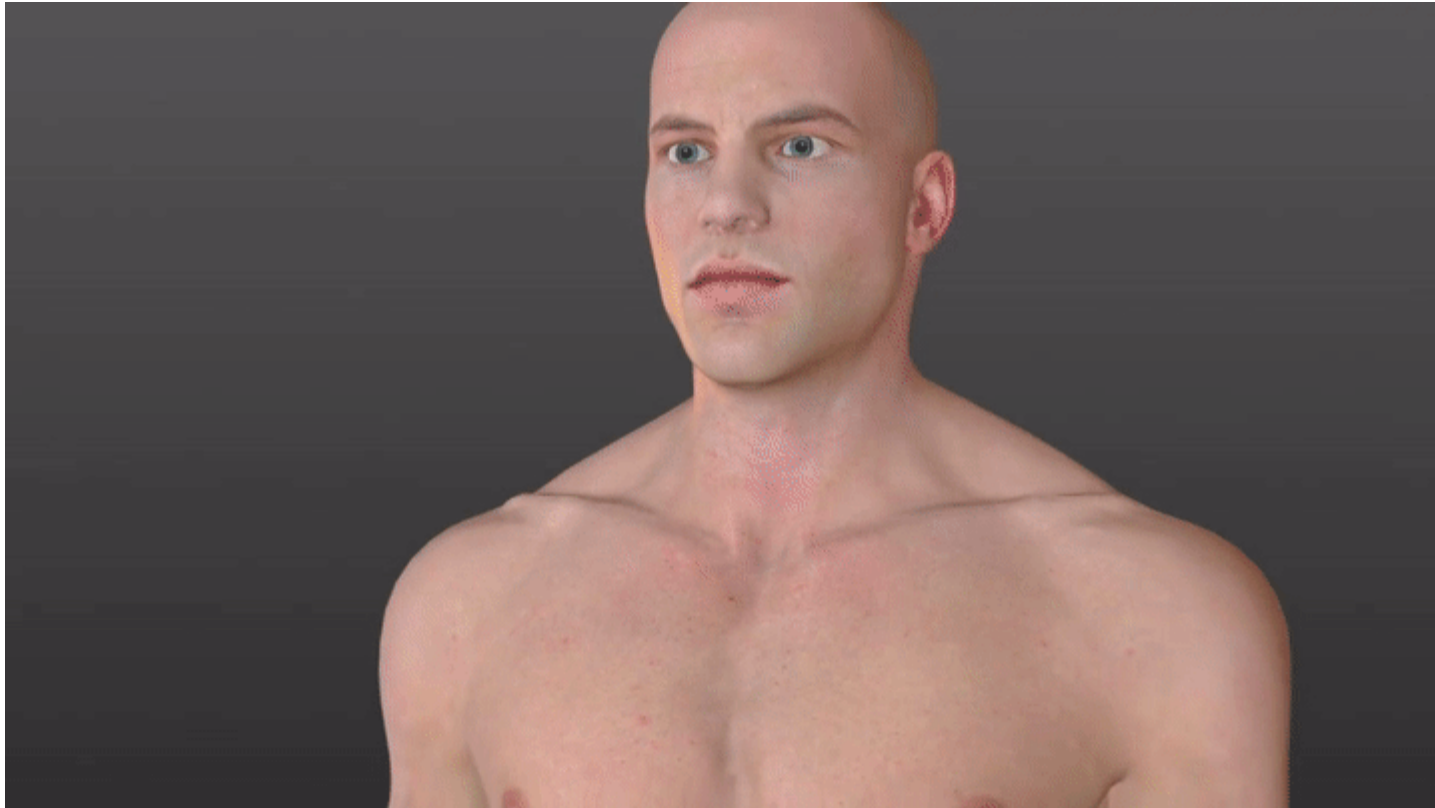
The Hierarchy of Structural Organization - the **Organism** level

- The highest level of organization is the **organismal level**; for example, the human organism is a whole living person.
- The organismal level is the result of all of the simpler levels working in unison to sustain life.

The body's organ systems and their major functions.

Integumentary System

- Forms the external body covering and protects deeper tissues from injury.
- Synthesizes vitamin D and houses cutaneous receptors (pain, pressure, etc.) and sweat and oil glands.



The body's organ systems and their major functions.

Skeletal System

- Protects and supports body organs and provides a framework the muscles use to cause movement.
- Blood cells are formed within bones.
- Bones store minerals.

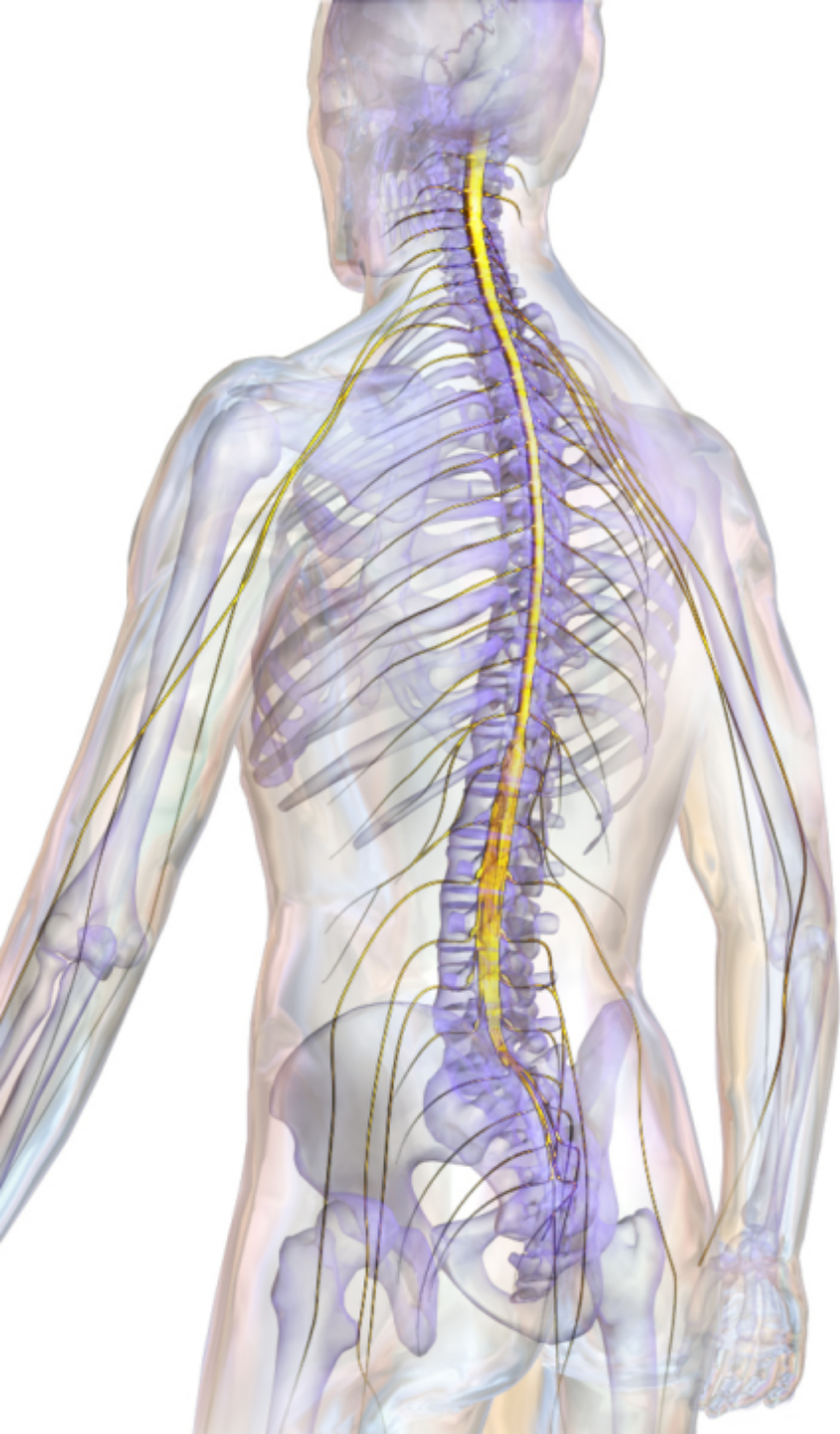


The body's organ systems and their major functions.

Muscular System

- Allows manipulation of the environment, locomotion, and facial expression.
- Maintains posture and produces heat.





The body's organ systems and their major functions.

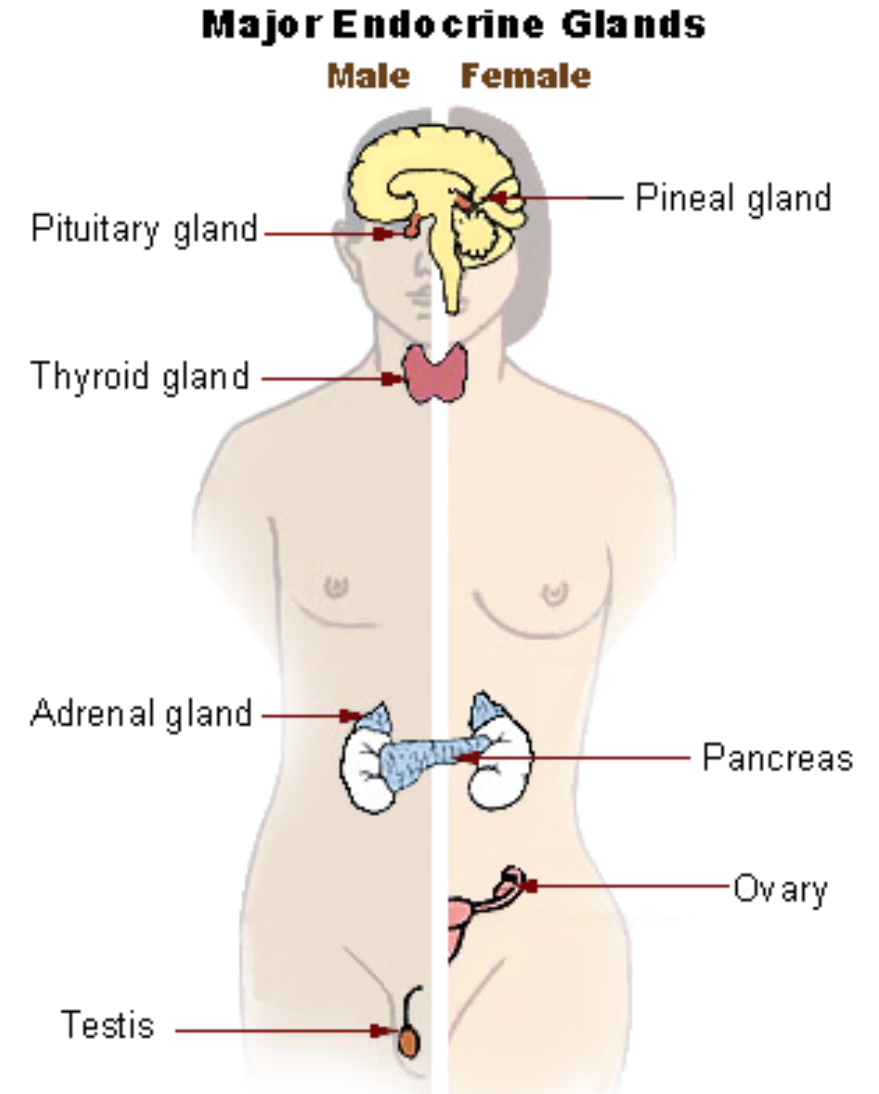
Nervous System

- As the fast-acting control system of the body, it responds to internal and external changes by activating appropriate muscles and glands.

The body's organ systems and their major functions.

Endocrine System

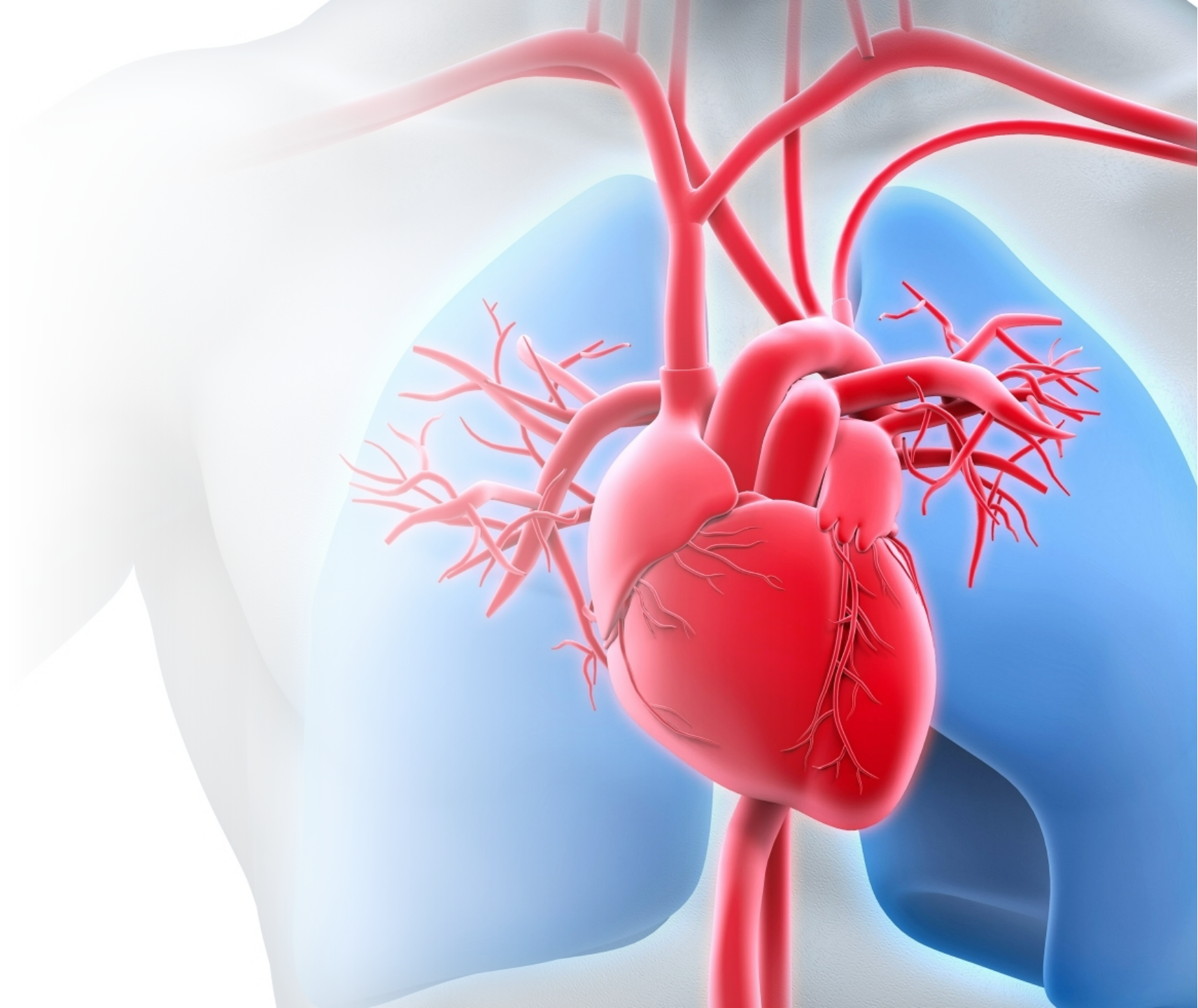
- Glands secrete hormones that regulate processes such as growth, reproduction, and nutrient use (metabolism) by body cells.

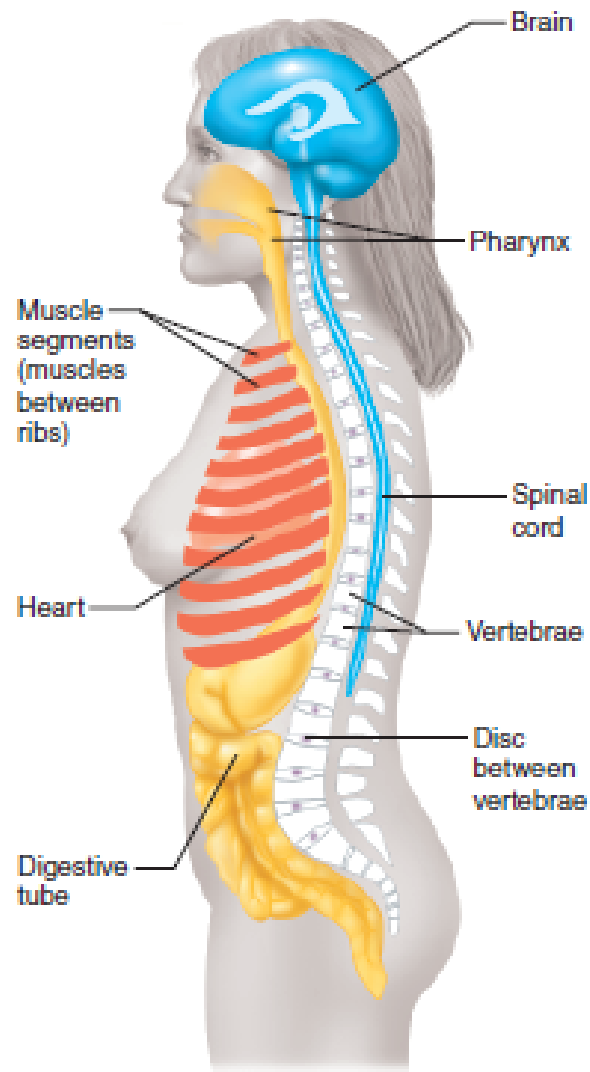


The body's organ systems and their major functions.

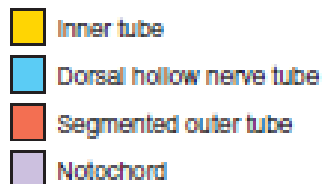
Cardiovascular System

- Blood vessels transport blood, which carries oxygen, carbon dioxide, nutrients, wastes, etc.
- The heart pumps blood.





(c) Adult human



The Human Body Plan

- Humans belong to the group of animals called *vertebrates*. All vertebrates share the following basic features:
- **1. Tube-within-a-tube body plan.** The inner tube extends from the mouth to the anus and includes the respiratory and digestive organs (yellow structures in Figure 1.5).
- The outer tube consists of the axial skeleton and associated axial muscles that make up the outer body wall, and nervous structures.

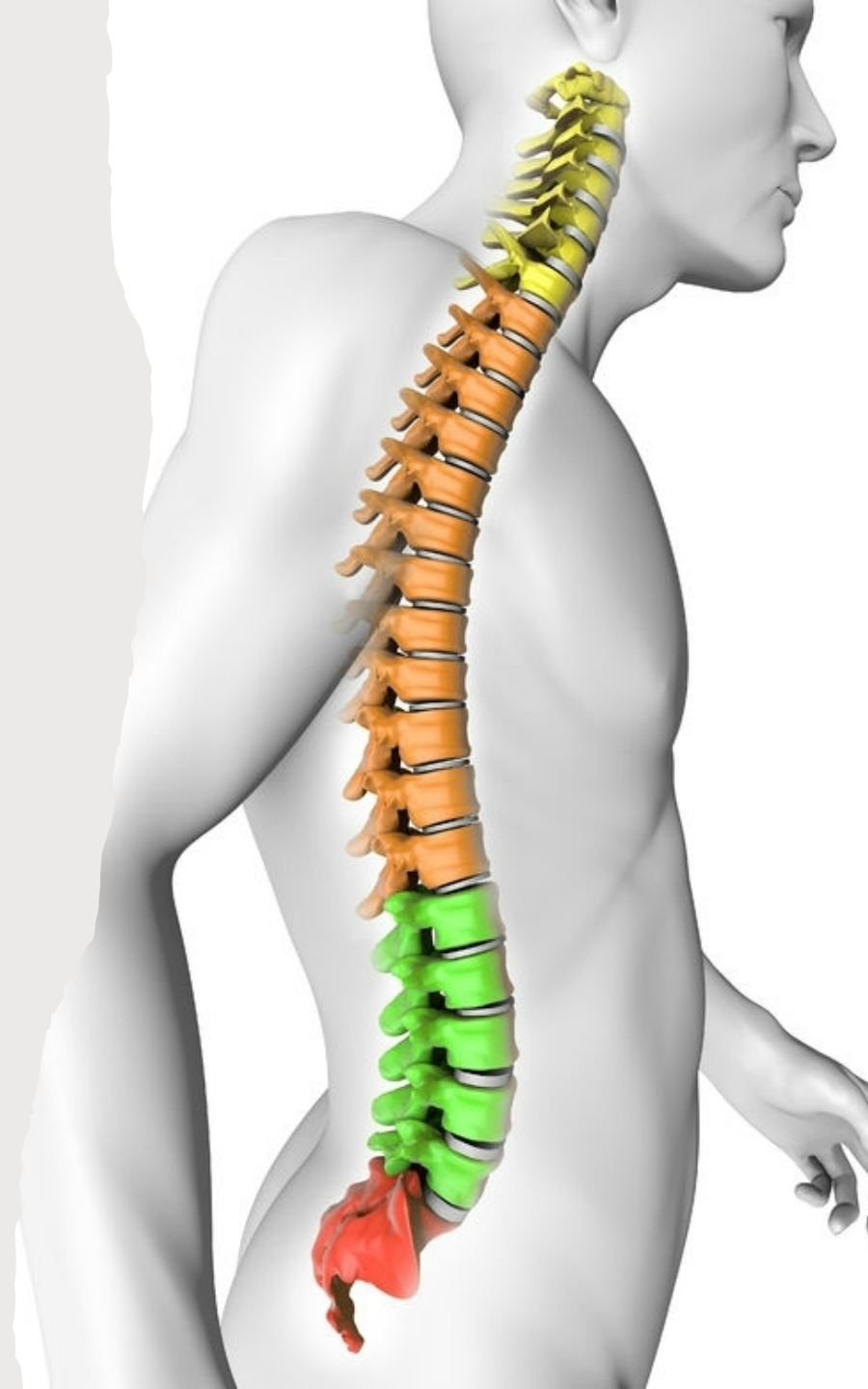


The Human Body Plan

- **2. Bilateral symmetry.** The left half of the body is essentially a mirror image of the right half.
- **3. Dorsal hollow nerve cord.** All vertebrate embryos have a hollow nerve cord running along their back in the median plane. This cord develops into the brain and spinal cord.
- **4. Notochord and vertebrae.** In humans, a complete notochord forms in the embryo, and is quickly replaced by the vertebrae.

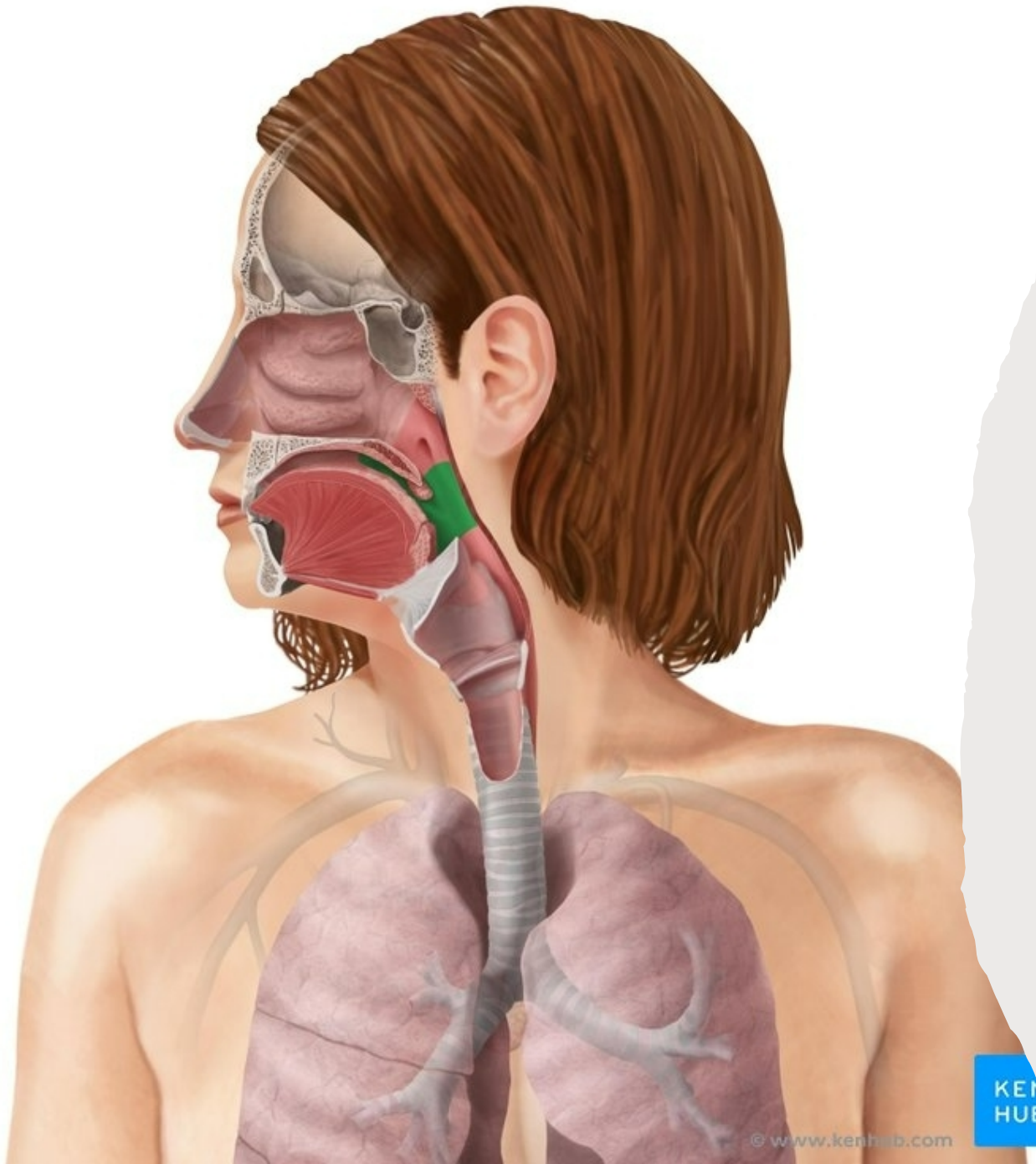
The Human Body Plan

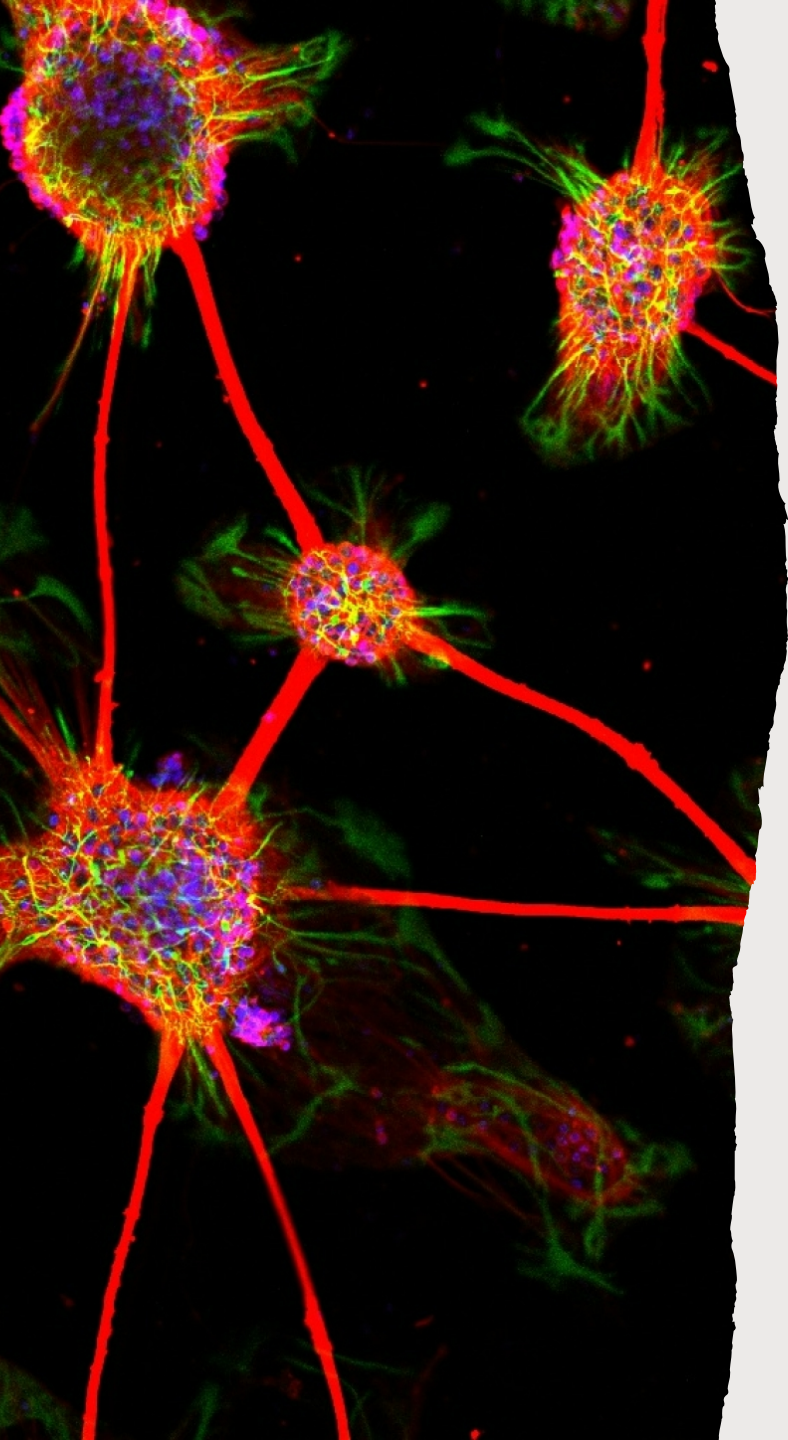
- **5. Segmentation.** Segments are repeating units of similar structure that run from the head along the full length of the trunk.
- In humans, the ribs and the muscles between the ribs are evidence of segmentation, as are the many nerves branching off the spinal cord. The bony vertebral column, with its repeating vertebrae, is also segmented.



The Human Body Plan

- **6. Pharyngeal pouches.** Humans have a **pharynx** (faringks), which is the throat region of the digestive and respiratory tube, which develops during the embryonic stage from outpocketings called *pharyngeal* (far-rinje-al) *pouches*.





MICROSCOPIC ANATOMY: AN INTRODUCTION

- **Microscopy** is the examination of small structures with a microscope.
- Two main types of microscopes are now used to investigate the fine structure of organs, tissues, and cells:
 - the **light microscope (LM)**
 - One of the most commonly used histological stains is a combination of two dyes, hematoxylin and eosin (H&E stain). Hematoxylin is a basic stain that binds to the acidic structures of the cell (the nucleus, ribosomes, rough ER) and colors them a dark blue to purple hue. Eosin, an acidic stain, binds to basic cytoplasmic structures and extracellular components, coloring them red to pink.
 - the **transmission electron microscope (TEM or just EM)**
 - For transmission electron microscopy, tissue sections are stained with heavy-metal salts. These metals deflect electrons in the beam to different extents, thus providing contrast in the image.

Most anatomical terms are based on ancient Greek or Latin words.

- This terminology, which came into use when Latin was the official language of science, provides a standard nomenclature that scientists can use worldwide, no matter what language they speak.

LANGUAGE



Regional and Directional Terms - **anatomical position**

- To accurately describe the various body parts and their locations, you need to use a common visual reference point.
- This reference point is the **anatomical position**.
 - In this position, a person stands erect with feet flat on the ground, toes pointing forward, and eyes facing forward.
 - The palms face anteriorly with the thumbs pointed away from the body.
 - Additionally, the terms *right* and *left* always refer to those sides belonging to the person or cadaver being viewed—not to the right and left sides of the viewer.



FIGURE 1.2 Anatomical position.

Regional and Directional Terms - Regional terms

- **Regional terms** are the names of specific body areas.
 - The fundamental divisions of the body are the *axial* and *appendicular* (apen-diku-lar) *regions*.
 - The **axial region**, so named because it makes up the main axis of the body, consists of the *head*, *neck*, and *trunk*.
 - The trunk, in turn, is divided into the *thorax* (chest), *abdomen*, and *pelvis*; the trunk also includes the region around the anus and external genitals, called the *perineum* (per i ~-neum; "around the anus").
 - The **appendicular region** of the body consists of the limbs, which are also called *appendages* or *extremities*.

Appendicular Skeleton



Axial Skeleton



Regional and Directional Terms - directional terms

- Standard directional terms are used by medical personnel and anatomists to explain precisely where one body structure lies in relation to another.
- Most often used are the paired terms
 - **superior/inferior**,
 - **anterior (ventral)/posterior (dorsal)**,
 - **medial/lateral**, and **superficial/deep**

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 <i>The head is superior to the abdomen.</i>
Inferior (caudal)	Away from the head end or toward the lower part of a structure or the body; below <i>The intestines are inferior to the liver.</i>
Medial	Toward or at the midline of the body; on the inner side of <i>The heart is medial to the lungs.</i>
Lateral	Away from the midline of the body; on the outer side of <i>The thumb is lateral to the pinky.</i>
Proximal	Closer to the origin of the body part or the point of attachment of a limb to the body trunk <i>The elbow is proximal to the wrist.</i>

Distal	Farther from the origin of a body part or the point of attachment of a limb to the body trunk <i>The knee is distal to the thigh.</i>
Ipsilateral	On the same side <i>The right hand and right foot are ipsilateral.</i>
Contralateral	On opposite sides <i>The right hand and left foot are contralateral.</i>
Anterior (ventral)*	Toward or at the front of the body; in front of <i>The sternum is anterior to the heart.</i>
Posterior (dorsal)*	Toward or at the back of the body; behind <i>The vertebra is posterior to the heart.</i>
Superficial (external)	Toward or at the body surface <i>The skin is superficial to the skeletal muscles.</i>
Deep (internal)	Away from the body surface; more internal <i>The lungs are deep to the skin.</i>

Body Planes and Sections

- A **sagittal plane** (sag i-tal; “arrow”) extends vertically And divides the body into left and right parts.
 - The specific sagittal plane that lies exactly in the midline is the **median plane**, or **midsagittal plane**.
 - All other sagittal planes, offset from the midline, are **parasagittal** (*para* = near).
- A **frontal (coronal) plane** also extends vertically and divides the body into anterior and posterior parts.
- A **transverse (horizontal) plane** runs horizontally from right to left, dividing the body into superior and inferior parts.
 - A transverse section is also called a **cross section**.
- Cuts made along any plane that lies diagonally between the horizontal and the vertical are called **oblique sections**.
 - oblique sections are difficult to interpret because the orientation of the view is not obvious. For this reason, oblique sections are seldom used.



(a) Median (midsagittal) plane



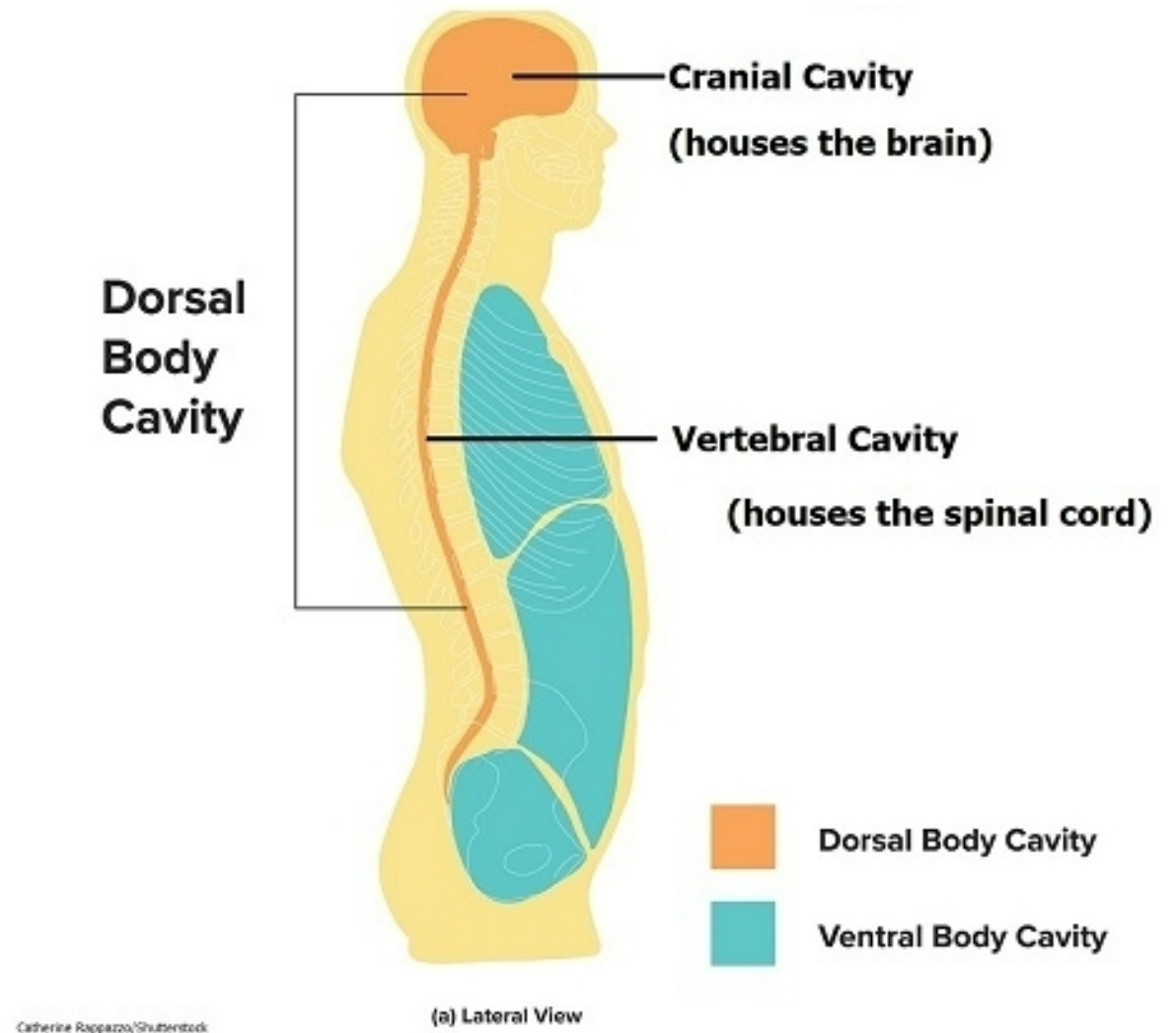
(b) Frontal (coronal) plane



(c) Transverse plane

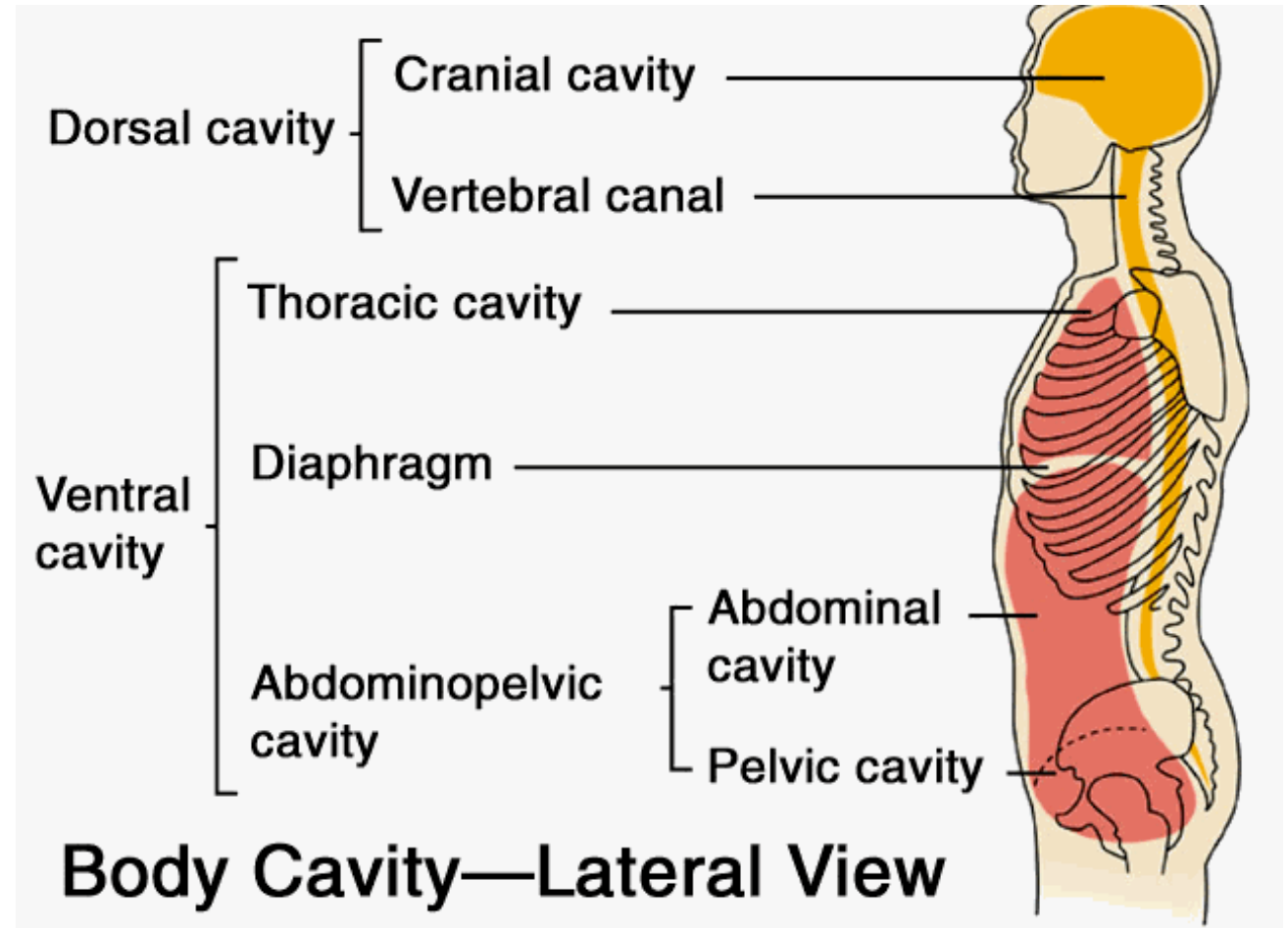
Body Cavities and Membranes

- *Dorsal Body Cavity*
- The **dorsal body cavity** is subdivided into a **cranial cavity**, which lies in the skull and encases the brain, and a **vertebral cavity**, which runs through the vertebral column to enclose the spinal cord.



Body Cavities and Membranes

- *Ventral Body Cavity*
- The more anterior and larger of the closed body cavities is the **ventral body cavity**. The organs it contains,
- such as the lungs, heart, intestines, and kidneys, are called **visceral organs** or **viscera** (viser-ah).
- The ventral body cavity has two main divisions:
 - (1) a superior **thoracic cavity**, surrounded by the ribs and the muscles of the chest wall; and
 - (2) an inferior **abdominopelvic** (ab-dom i'-no-pelvic) **cavity** surrounded by the abdominal walls and pelvic girdle.
- The thoracic and abdominal cavities are separated from each other by the diaphragm, a dome-shaped muscle used in breathing.



Body Cavities and Membranes

- The *thoracic cavity* has three parts:
- (a) two lateral parts, each containing a lung surrounded by a **pleural cavity**
- (b) a central band of organs called the **mediastinum** which contains the heart surrounded by a **pericardial cavity**

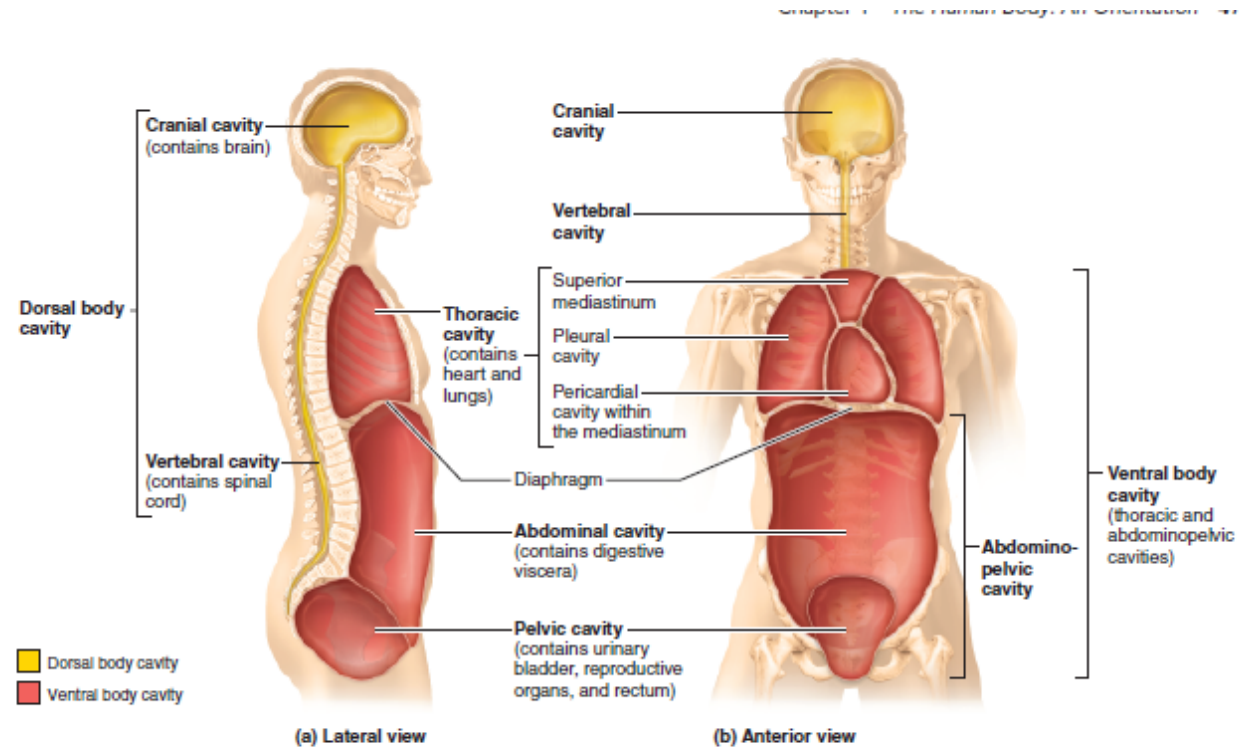


Figure 1.6 Dorsal and ventral body cavities and their subdivisions.

Body Cavities and Membranes

- The *abdominopelvic cavity* is divided into two parts.
 - The superior part, called the **abdominal cavity**, contains the liver, stomach, kidneys, and other organs.
 - The inferior part, or **pelvic cavity**, contains the bladder, some reproductive organs, and the rectum.
- These two parts are continuous with each other, not separated by any muscular or membranous partition.
- Many organs in the abdominopelvic cavity are surrounded by a **peritoneal** (per i'-to-neal) **cavity**.

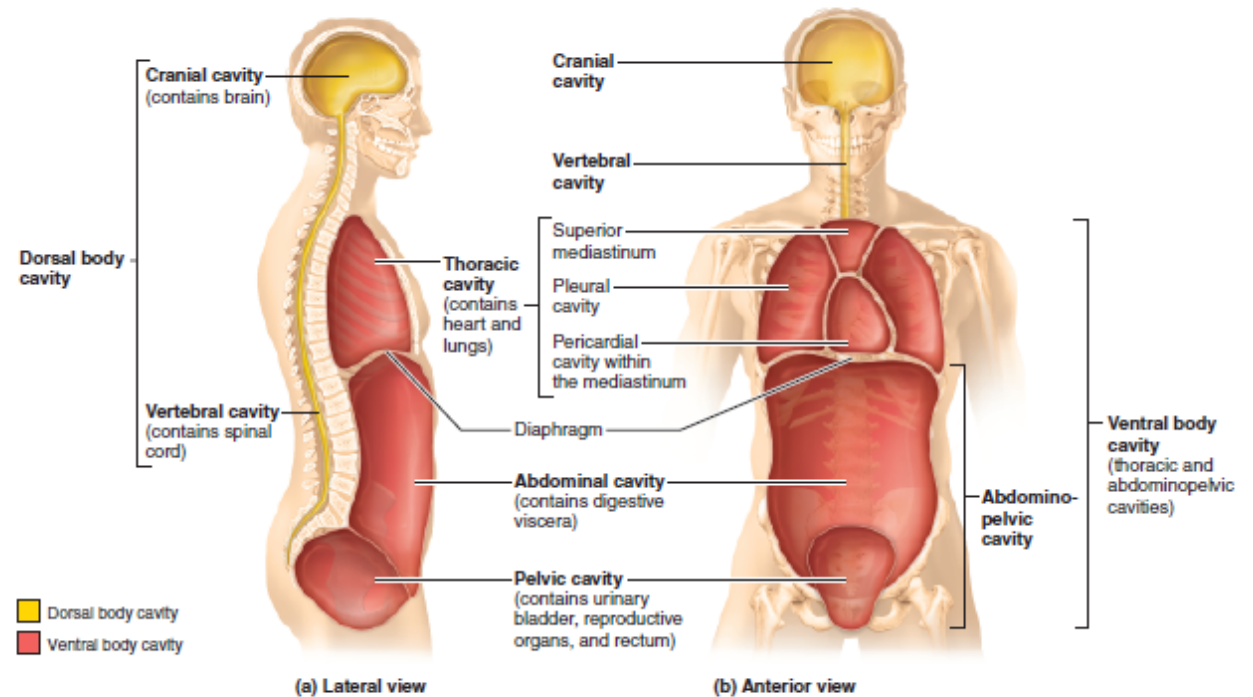
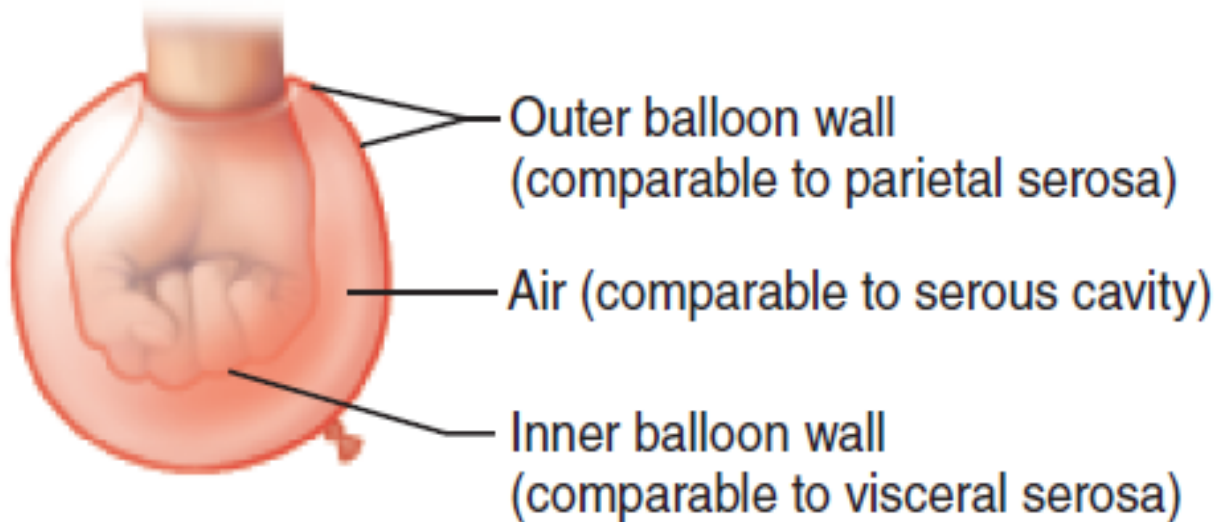


Figure 1.6 Dorsal and ventral body cavities and their subdivisions.

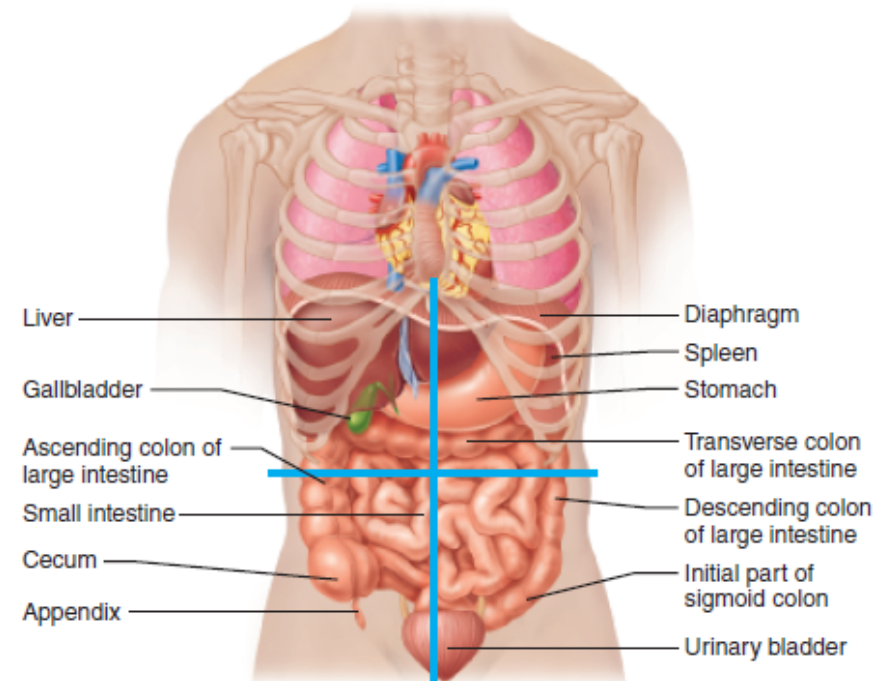
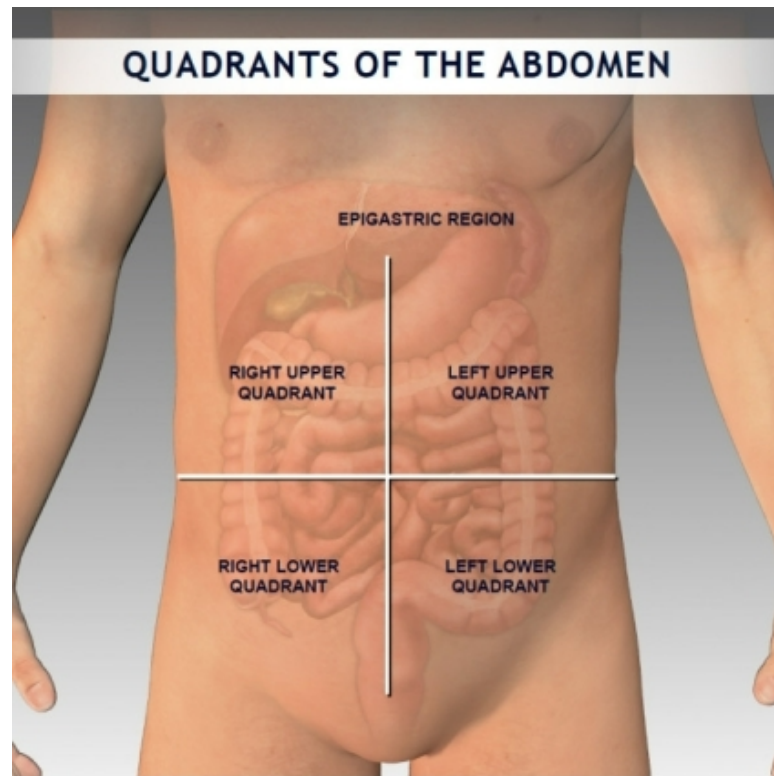
Serous Cavities



- Serous cavities are lined by a **serous membrane**, or **serosa**.
- The part of a serosa that forms the outer wall of the cavity is called the **parietal** (pah-rie~tal; “wall”) **serosa**.
- The parietal serosa is continuous with the inner, **visceral serosa**, which covers the visceral organs.
 - You can visualize the relationship of the serous membranes by pushing your fist into a limp balloon-
 - The part of the balloon that clings to your fist represents the visceral serosa on the organ’s (your fist’s) outer surface.
 - The outer wall of the balloon represents the parietal serosa.
 - The balloon’s thin airspace represents the serous cavity itself.

Abdominal Quadrants

- the abdomen is divided into four **quadrants** (“quarters”) by drawing one vertical and one horizontal plane through the navel.



(b) Anterior view of the four quadrants showing the superficial organs

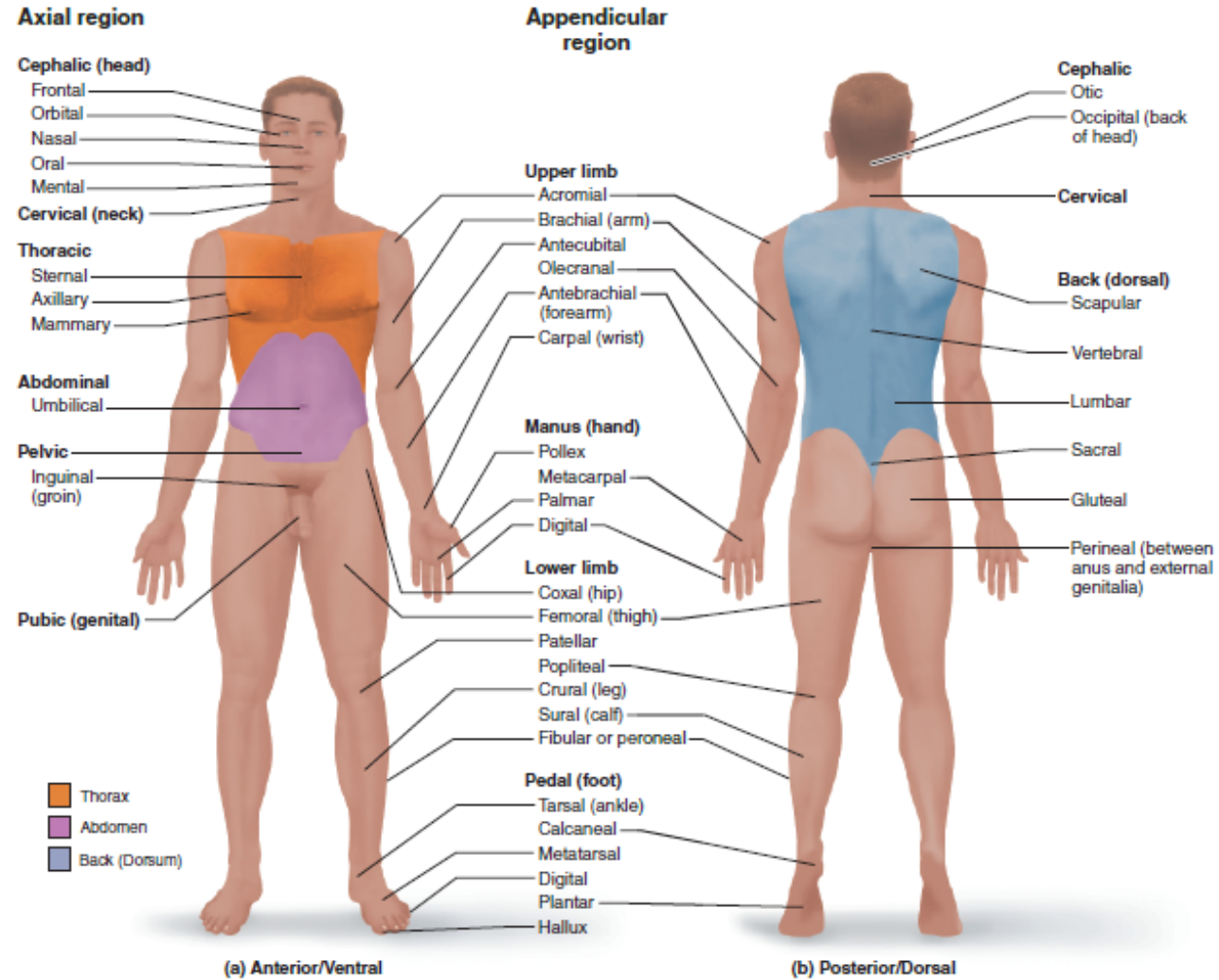


Figure 1.3 Anatomical position and regional terms.