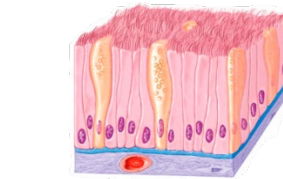


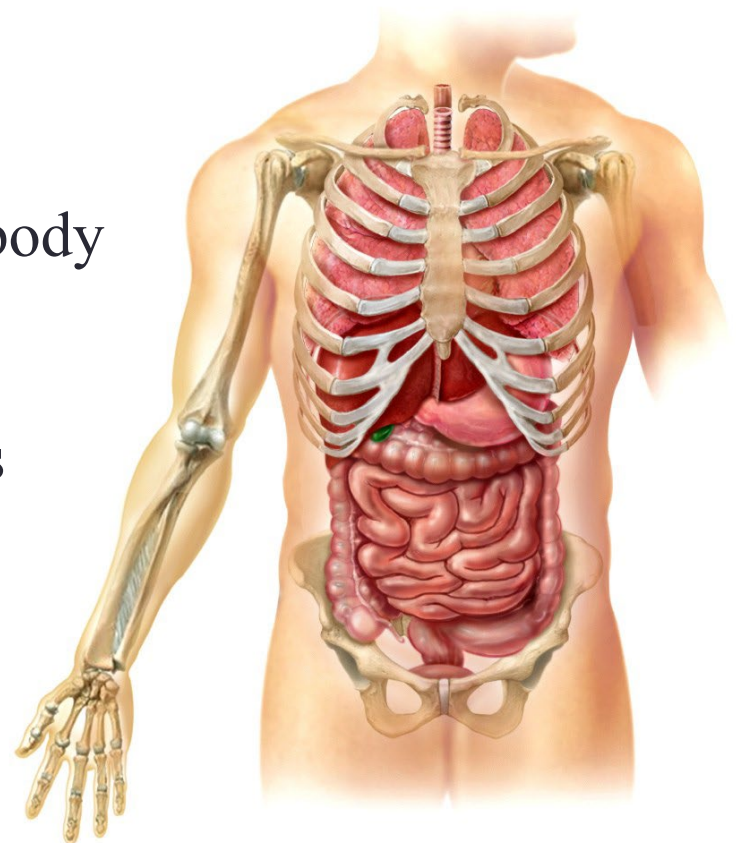
Chapter 1

An Introduction to the Human Body



Anatomy and Physiology

- ◆ Human Anatomy is the study of body structure.
 - Word is derived from the Greek and means “to cut” or “cutting backwards” (putting things together from slices).
- ◆ Human Physiology is the science of body functions.
 - Including the study of homeostasis (keeping the organs systems of the body in balance)



Anatomy and Physiology

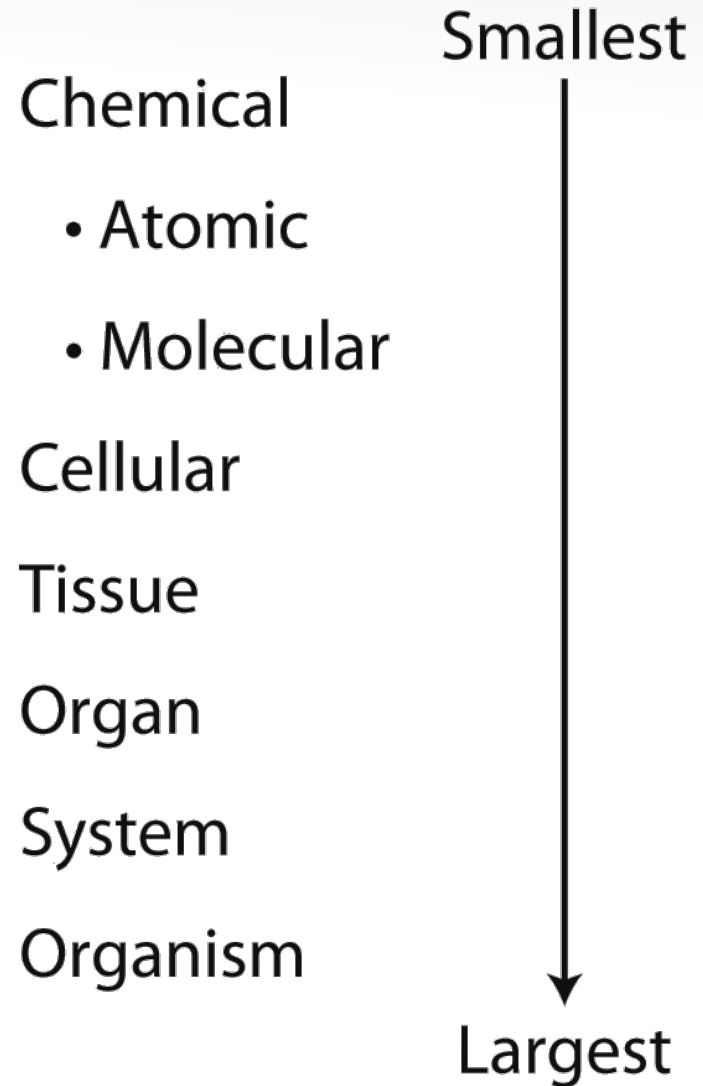
- ◆ **Structure and function** of the body are closely related:

Structure mirrors function

- Bones of the skull
are heavy and secure to
protect brain function.
- The thin air sacs of the
lungs permit movement
of gases from the lungs to the blood.

Levels of Organization

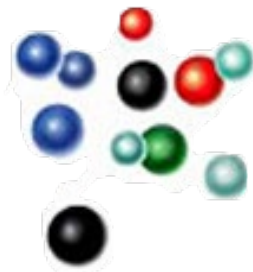
- ◆ In this course, we will study Anatomy and Physiology by starting with the most basic level of organization (atoms) and “working our way up”.



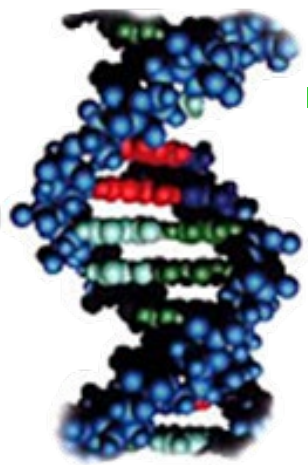
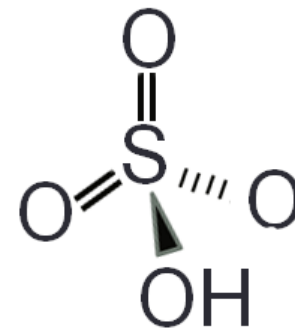
Levels of Organization

◆ The chemical level of organization is discussed in Chapter 2:

■ Atoms



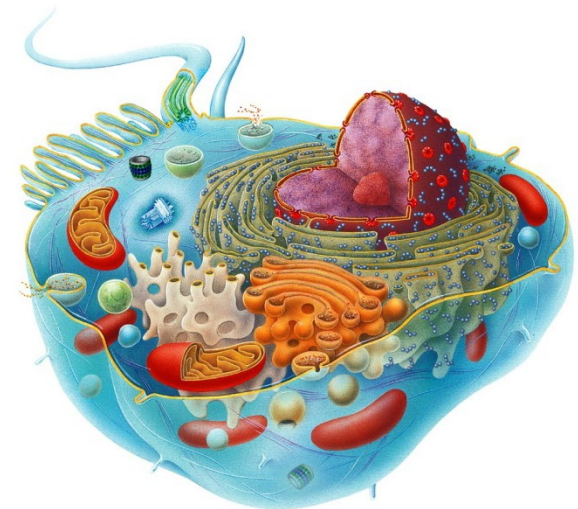
■ Inorganic Molecules (inorganic chemistry)



■ Organic Molecules (organic chemistry)

Levels of Organization

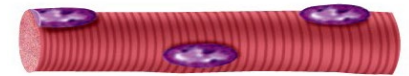
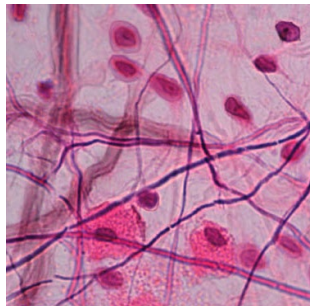
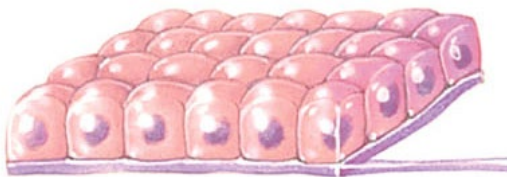
- ◆ The **Cell** is next in complexity, in fact many billions of times more complex than molecules.
 - **Cells are the basic structural and functional units of an organism .**



Levels of Organization

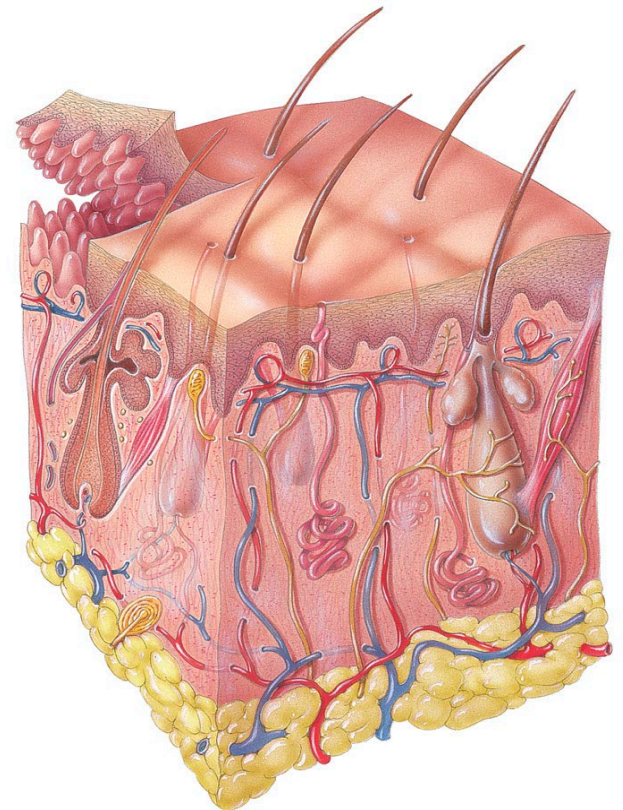
- ◆ **Tissues** are groups of cells that work together to perform a similar function.
- ◆ While there are many different types of cells, they all work to form 4 basic types of tissues:

- **Epithelium**
- **Muscle**
- **Connective Tissue**
- **Nerves**



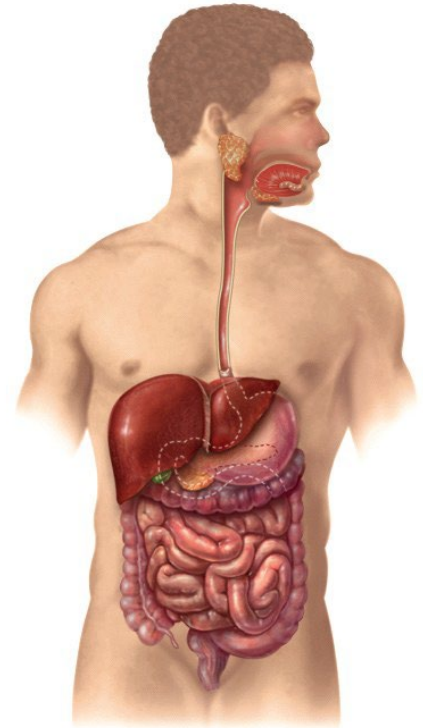
Levels of Organization

- ◆ **Organs** are structures composed of two or more different types of tissues (all but the simplest of organs have all 4 basic tissues represented.)
 - Organs have specific functions and recognizable shapes.



Levels of Organization

- ◆ An **organ system** consists of related organs with a common function. For instance, the Digestive system handles all aspects of taking in and breaking down food, absorbing nutrients, and eliminating wastes.
 - It includes all the organs of the mouth, esophagus, stomach, intestines, liver, gallbladder, and pancreas.
 - There are 11 organ systems in the body.



Levels of Organization

◆ An **organism** consists of a collection of organ systems.

■ Six important life processes:

- Metabolism
- Responsiveness
- Movement
- Growth
- Differentiation
- Reproduction



◆ In health, all parts of the body must be functioning together in a process called **homeostasis**.

Essential Life Processes

- ◆ **Metabolism** is the sum of all the **catabolic** (breaking down) and **anabolic** (building up) chemical processes that occur in the body.
- ◆ **Responsiveness** is the body's ability to detect and respond to changes which might represent an opportunity... or a threat!
 - Decrease in body temperature
 - Responding to sound
 - Nerve (electrical signals) and muscle cells (contracting)

Essential Life Processes

- ◆ **Movement** is any motion, including movement of tiny subcellular structures, or movement inside cells or organs.
 - Leg muscles move the body from one place to another.
- ◆ **Growth** involves an increase in body size due to an increase in existing cells, number of cells, or both.
 - In bone growth, materials between cells increase.

Essential Life Processes

- ◆ **Differentiation** is the development of a cell from an unspecialized to specialized state. Cells have specialized structures and functions that differ from precursor cells.
 - **Stem cells** give rise to cells that undergo differentiation.
- ◆ **Reproduction** is the formation of new cells (growth, repair, or replacement) or the production of a new individual.

Homeostasis

- ◆ A condition of **equilibrium** (balance) in the body's internal environment. It is a dynamic condition meant to keep body functions in the narrow range compatible with maintaining life.
- Blood glucose levels range between 70 and 110 mg of glucose/dL of blood.

Homeostasis

- ◆ **Body fluids** are defined as dilute, watery solutions containing dissolved chemicals inside or outside of the cell. Maintaining the volume and composition of body fluids is important.
 - Intracellular Fluid (**ICF**) is the fluid within cells
 - Extracellular Fluid (**ECF**) is the fluid outside cells
 - **Interstitial fluid** is ECF between cells and tissues

Homeostasis

◆ Some important body fluids:

- **Blood Plasma** is the ECF within blood vessels.
- **Lymph** is the ECF within lymphatic vessels.
- Cerebrospinal fluid (**CSF**) is the ECF in the brain and spinal cord.
- **Synovial fluid** is the ECF in joints.
- **Aqueous humor** is the ECF in eyes.

Homeostasis

- ◆ Cellular function depends on the regulation of the composition of the **interstitial fluid**.
 - Composition of interstitial fluid changes as substances move between plasma and the interstitial fluid.
 - Movement back and forth across capillary walls provides nutrients (glucose, oxygen, ions) to tissue cells and removes waste (carbon dioxide).

Homeostasis

- ◆ Control of homeostasis is constantly being challenged by:
 - **Physical insults** such as intense heat or lack of oxygen
 - **Changes in the internal environment** such as a drop in blood glucose due to lack of food
 - **Physiological stress** such as demands of work or school
- ◆ Disruptions are mild if balance is quickly restored.
- ◆ Intense disruptions are often prolonged and result in disease (poisoning or severe infections) or death.

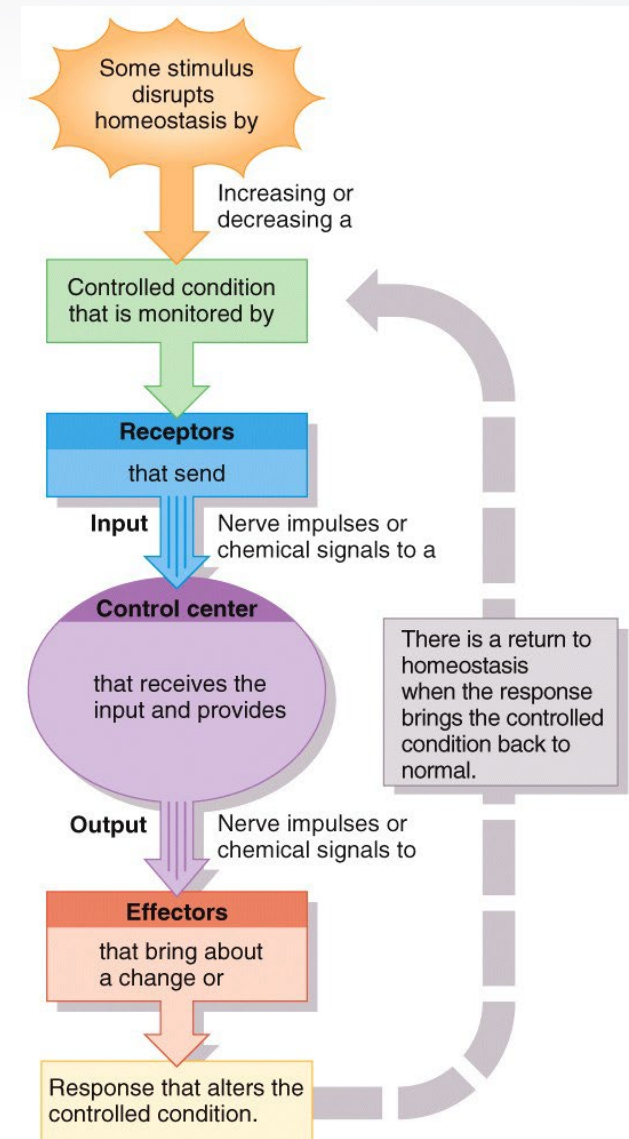
Feedback System

◆ Cycle of events:

- Body is monitored and re-monitored.
- Each monitored variable is termed a controlled condition.

◆ Three basic components:

- **Receptor**
- **Control center**
- **Effector**



Feedback System

◆ **Negative Feedback systems:**

- Reverses a change in a controlled condition
 - Regulation of blood pressure

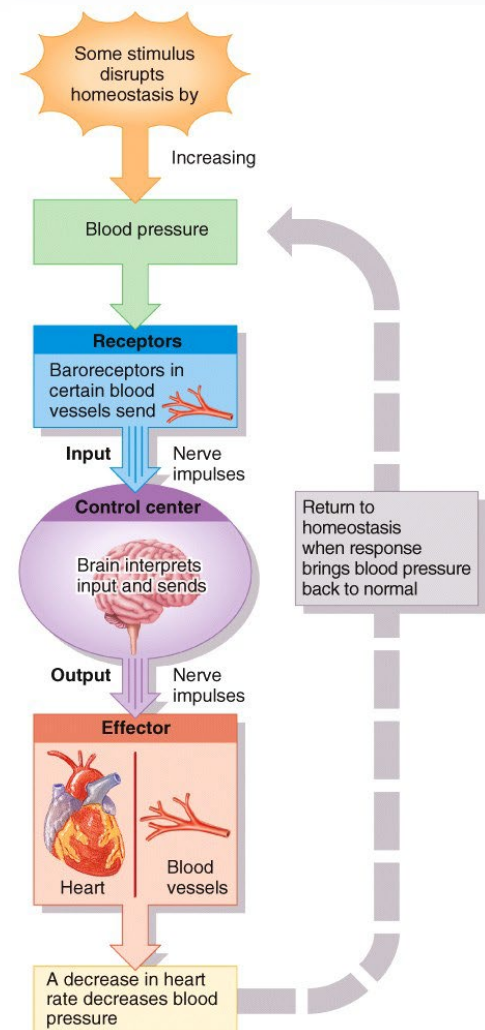
◆ **Positive Feedback systems:**

- Strengthens or reinforces a change in one of the body's controlled conditions
 - Normal child birth

Feedback System

◆ Blood Pressure regulation is a **negative feedback system**.

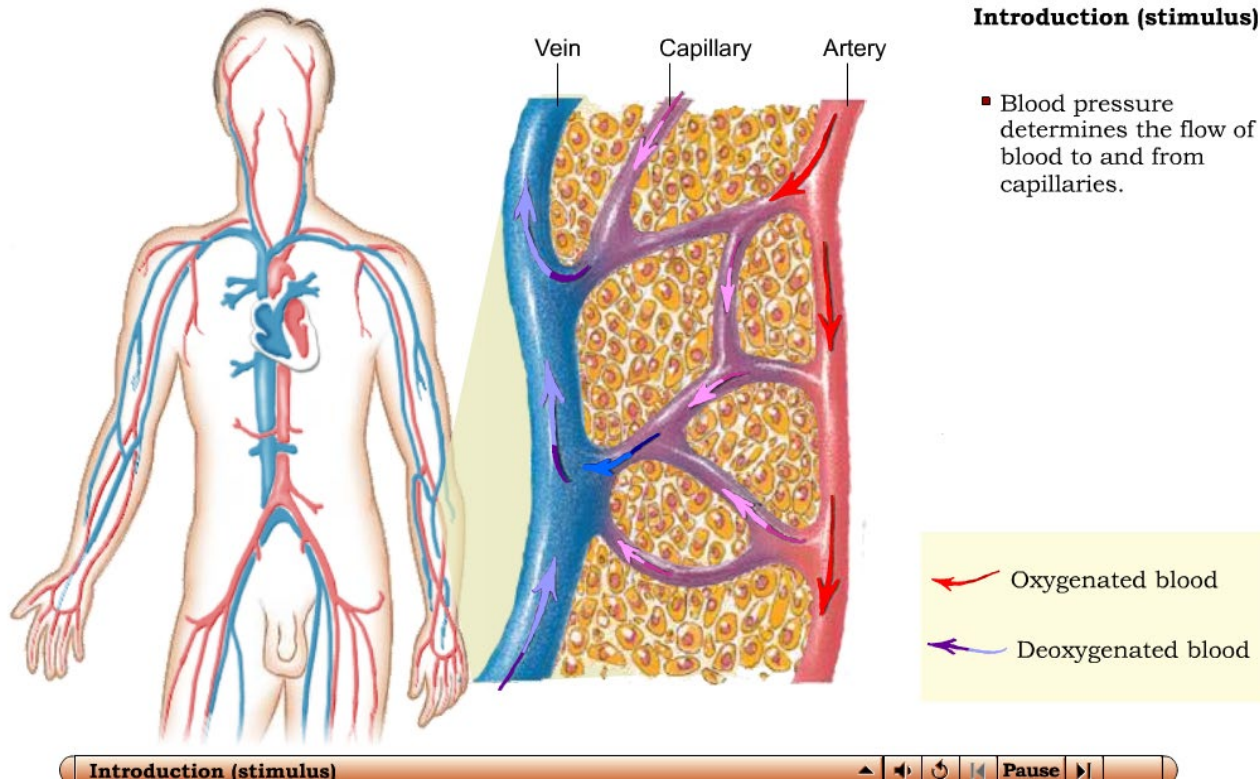
- External or internal stimulus increases BP.
- Baroreceptors (pressure sensitive receptors) detect higher BP and send a nerve impulse to the brain (interpretation).
- Responses sent via nerve impulses to the heart and blood vessels cause the BP to drop (homeostasis is restored.)



Blood Pressure Regulation

Interactions Animation

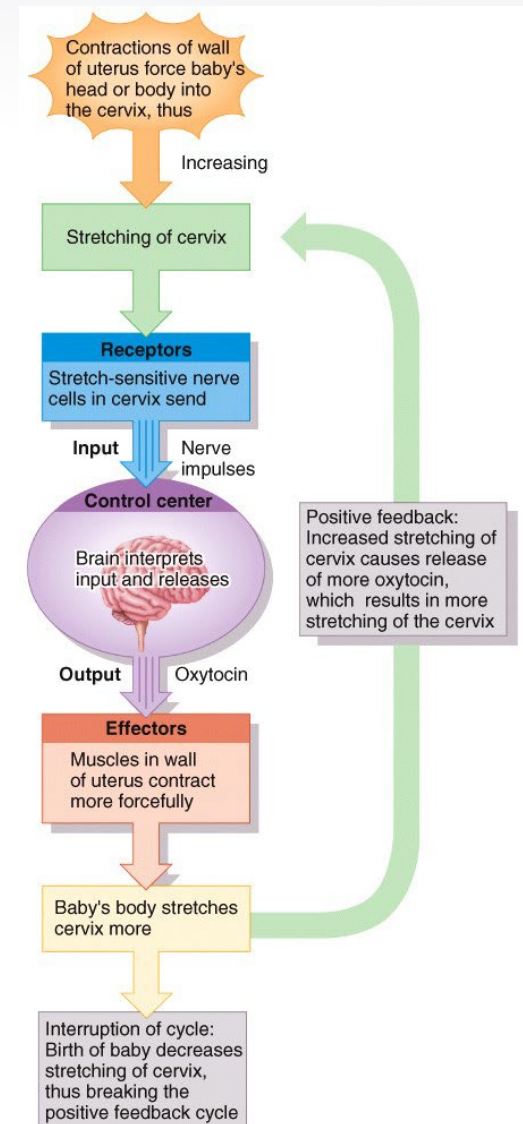
◆ Negative Feedback Control of Blood Pressure



You must be connected to the internet to run this animation.

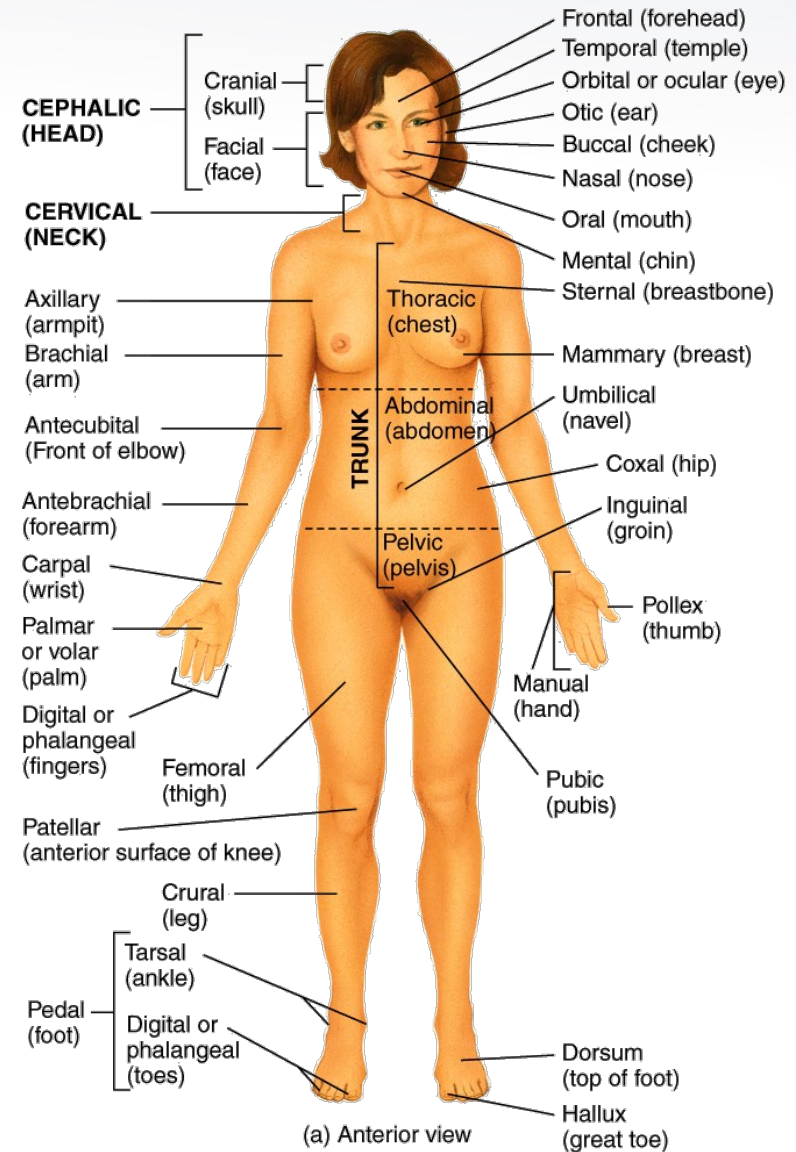
Feedback System

- ◆ Childbirth is an example of a positive feedback system:
 - Uterine contractions cause vagina to open.
 - Stretch-sensitive receptors in cervix send impulses to brain.
 - Oxytocin is released into the blood.
 - Contractions enhanced and baby pushes farther down the uterus.
 - Cycle continues to the birth of the baby (no stretching).



Anatomical Terminology

- ◆ Anatomists use a common language referring to body structures and their functions.
- One key concept is the definition of the standard anatomical position.
- Other special vocabulary is used in relating one body part to another.



Anatomical Terminology

◆ Anatomical Position

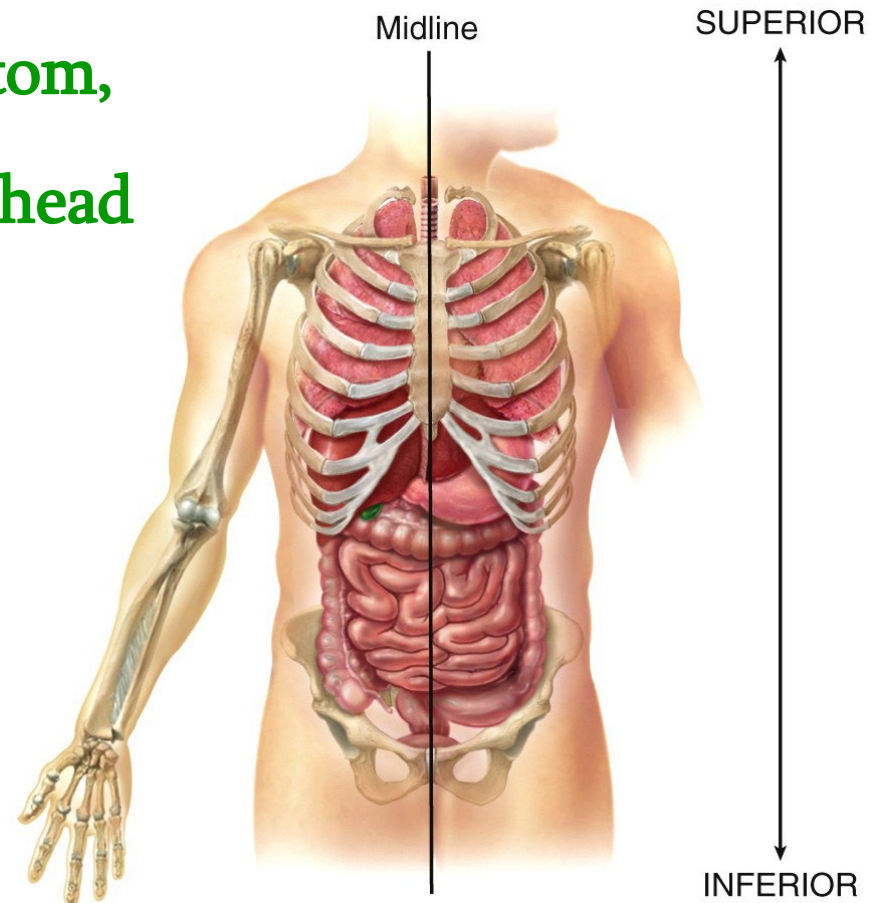
- In the anatomical position, the subject stands erect facing the observer with the head level, the eyes facing forward, feet flat on the floor directed forward, and the arms at their sides, palms forward.
- All anatomical descriptions are in reference to this position.



Anatomical Terminology

◆ Directional Terms

- **Superior** ■ **Above, top, toward head**
- **Inferior** ■ **Below, bottom, away from head**



Anatomical Terminology

◆ Directional Terms

- **Anterior (Ventral)**

Toward the front

- **Posterior (Dorsal)**

Toward the back



Anterior view

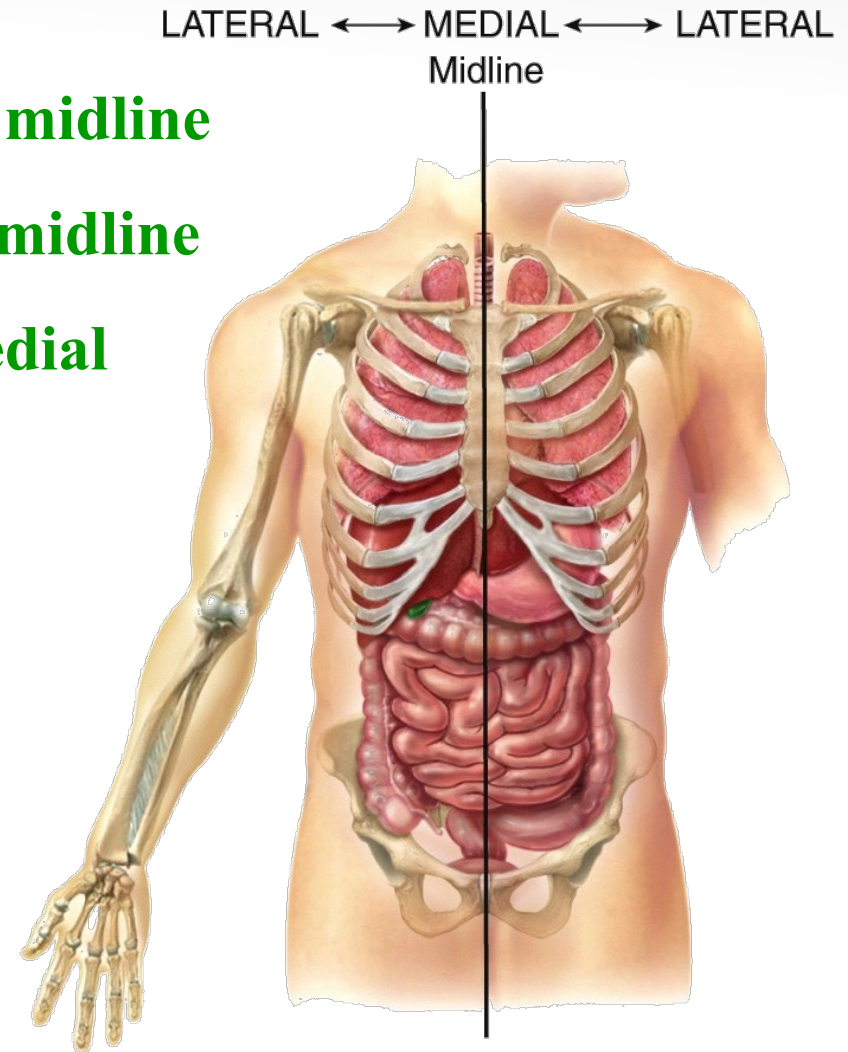


Posterior view

Anatomical Terminology

◆ Directional Terms

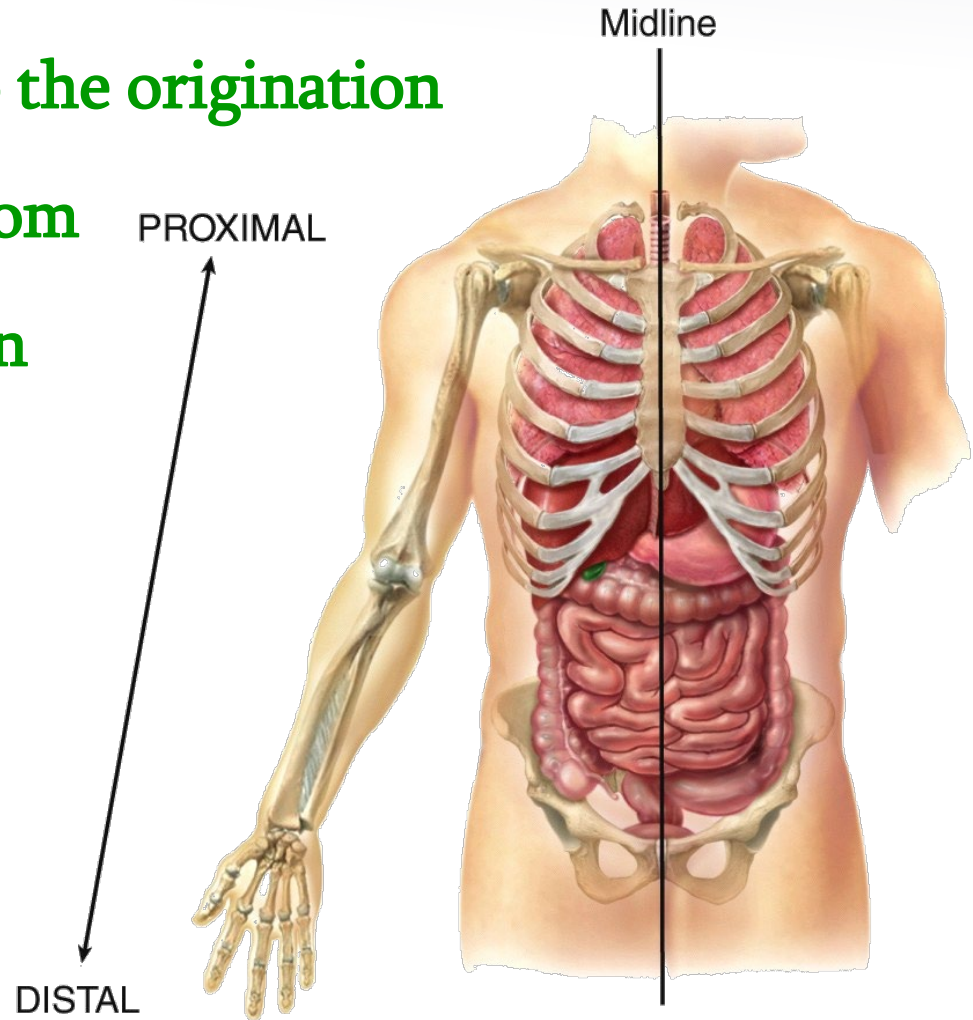
- **Medial** ■ **Toward the midline**
- **Lateral** ■ **Away from midline**
- **Intermediate** ■ **Between medial
and lateral**



Anatomical Terminology

● Directional Terms

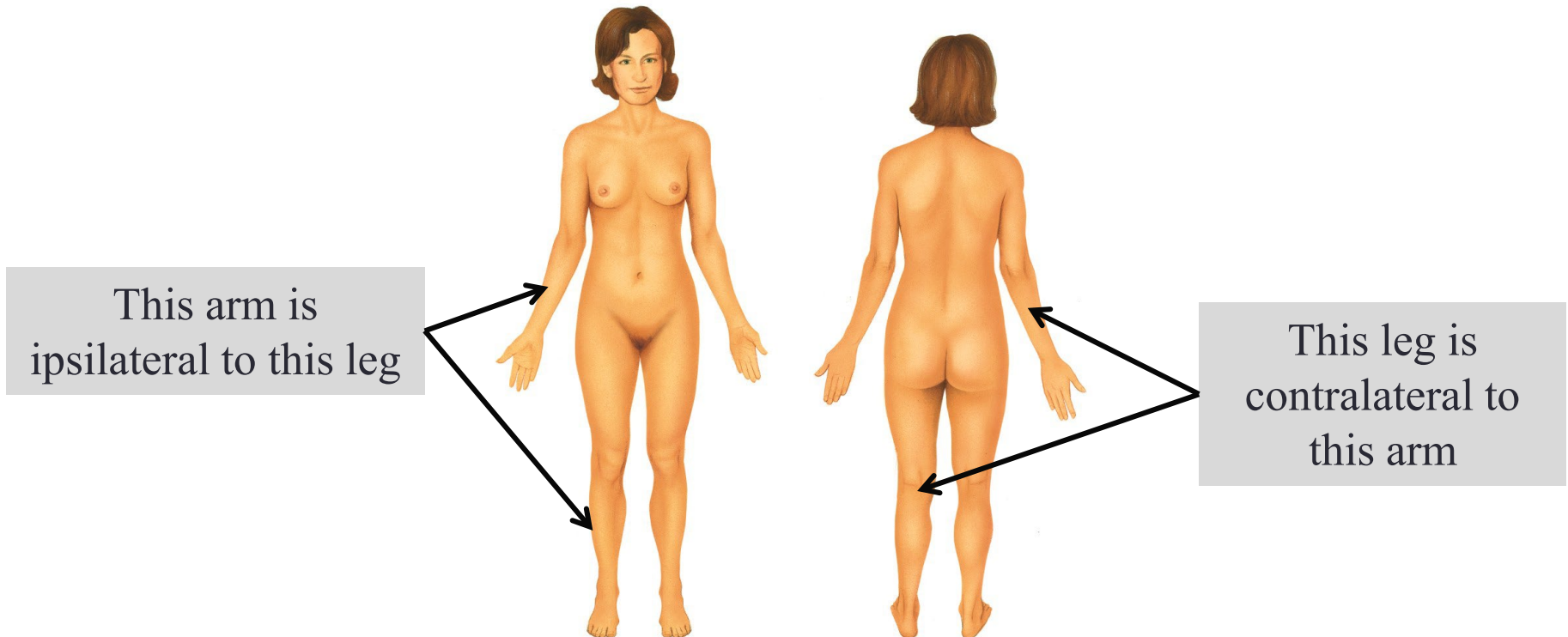
- Proximal ■ Nearest to the origination
- Distal ■ Farther from origination



Anatomical Terminology

◆ Directional Terms

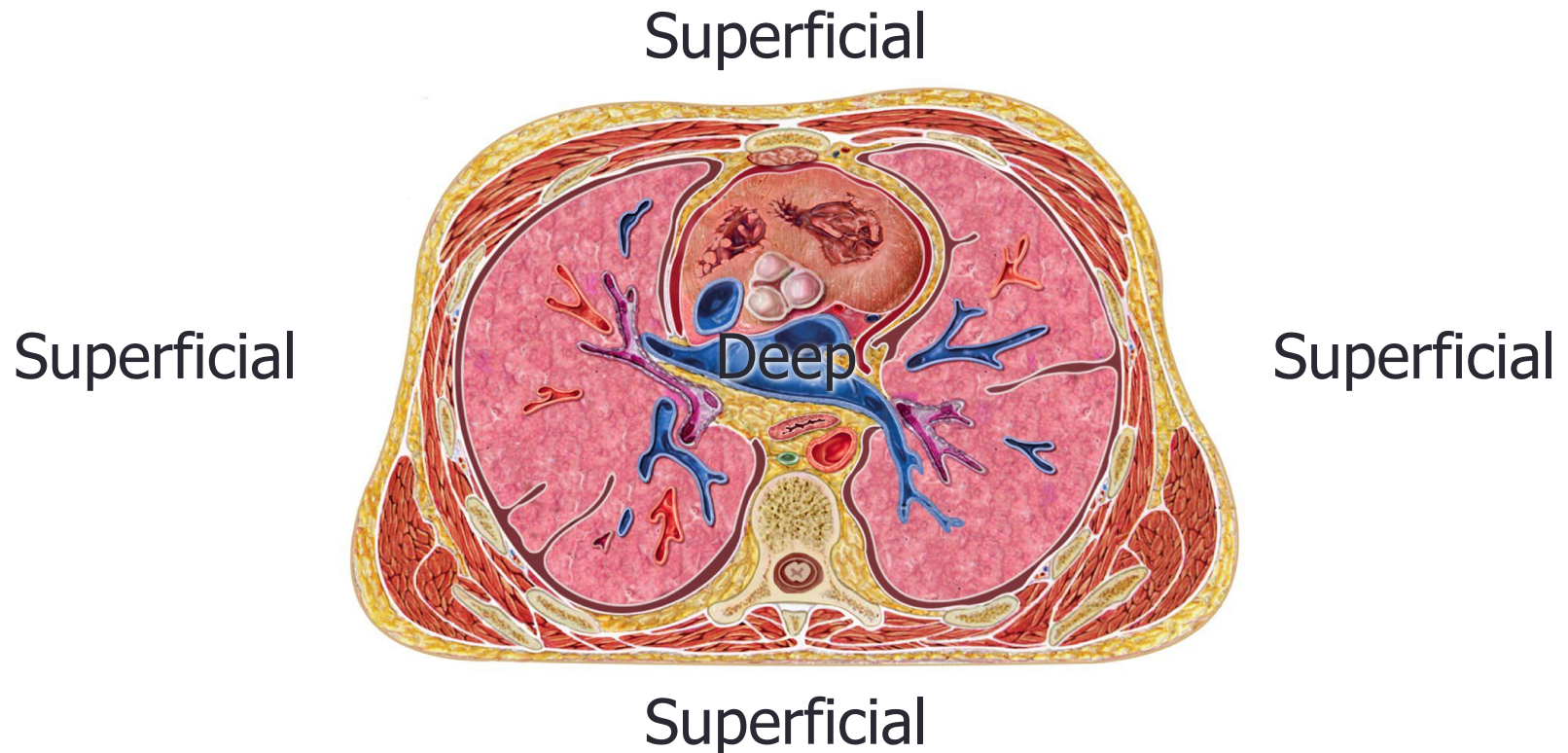
- Ipsilateral
- Contralateral
- Same side of the body
- Opposite side of the body



Anatomical Terminology

◆ Directional Terms

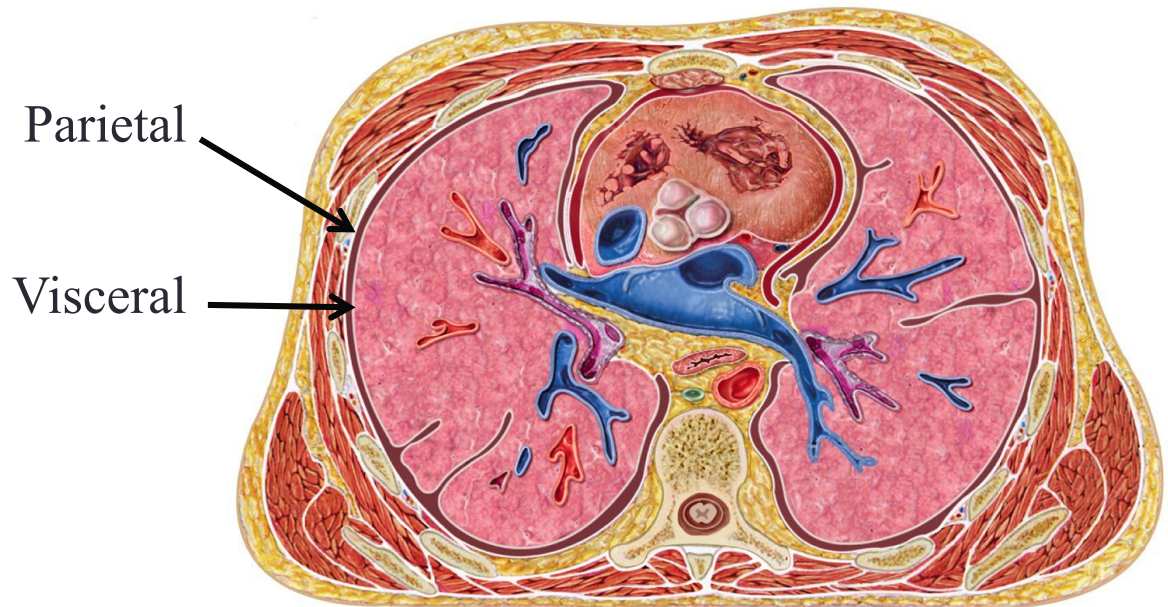
- **Superficial** ■ **Towards the surface**
- **Deep** ■ **Towards the core of the body**



Anatomical Terminology

◆ Descriptive Terms

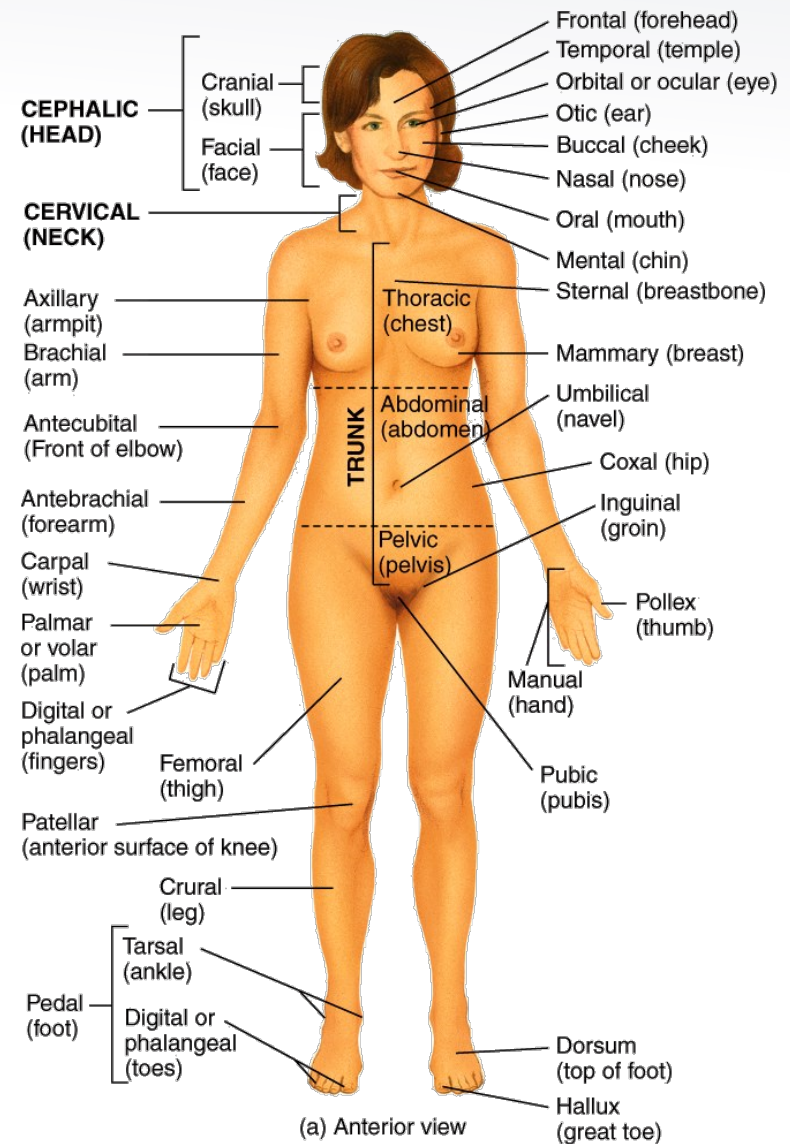
- **Visceral** ■ **Pertaining to a covering over an organ**
- **Parietal** ■ **Pertaining to a covering against a cavity wall**



Anatomical Terminology

◆ Regional Names

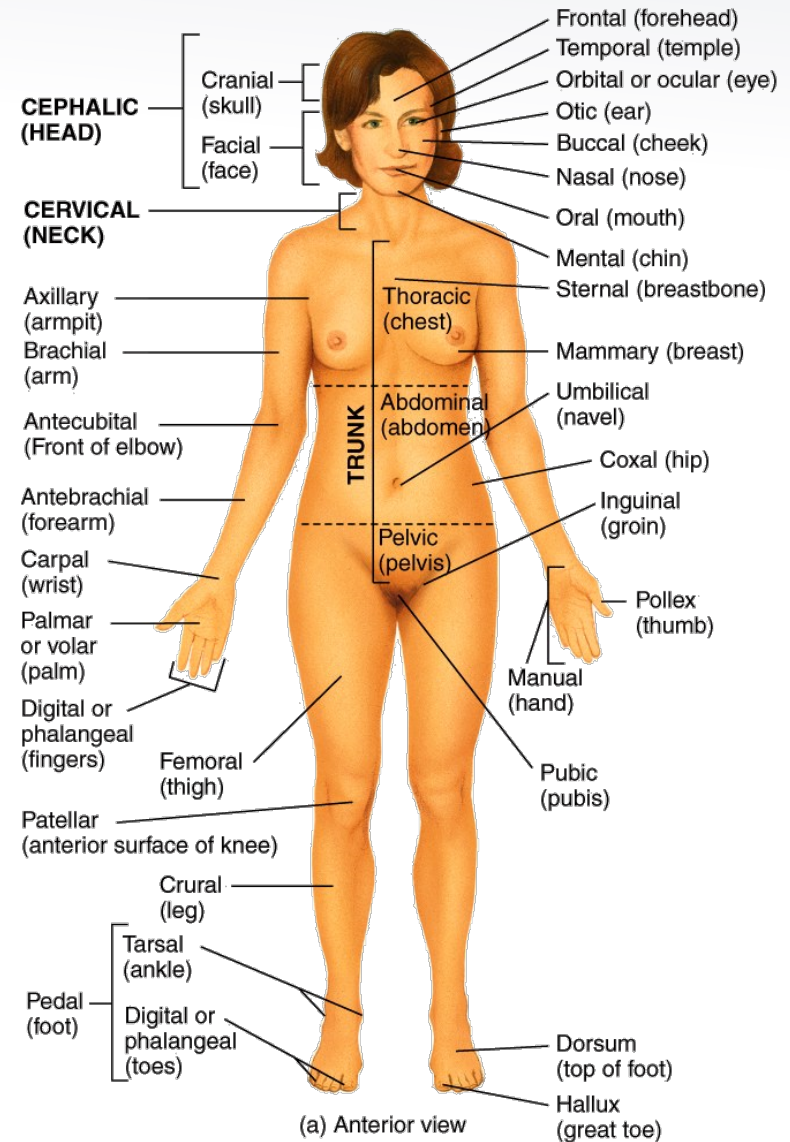
- | | |
|------------|-----------------|
| ■ Cranial | ■ Skull |
| ■ Cervical | ■ Neck |
| ■ Cubital | ■ Elbow |
| ■ Carpal | ■ Wrist |
| ■ Patellar | ■ Front of knee |
| ■ Orbital | ■ Eye |
| ■ Thoracic | ■ Chest |
| ■ Inguinal | ■ Groin |



Anatomical Terminology

◆ Regional Names

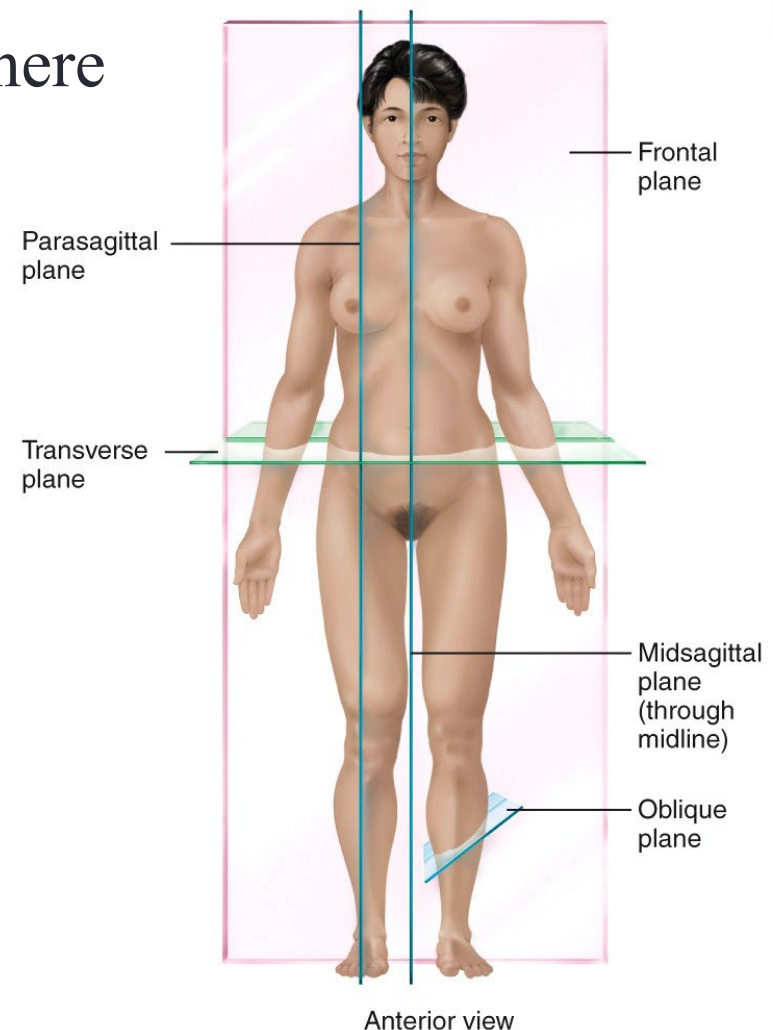
- Metacarpal • Hand/palm
- Plantar • Sole of foot
- Buccal • Cheek
- Axillary • Armpit
- Femoral • Thigh
- Gluteal • Buttock
- Tarsal • Ankle
- Digital • Toes
- or Phalangeal or Fingers



Body Planes

◆ Body Planes are imaginary flat surfaces that separate the body or body part into portions. There are three major planes at right angles to one another:

- **Sagittal** (midline)
- **Transverse** (horizontal)
- **Frontal** (coronal)

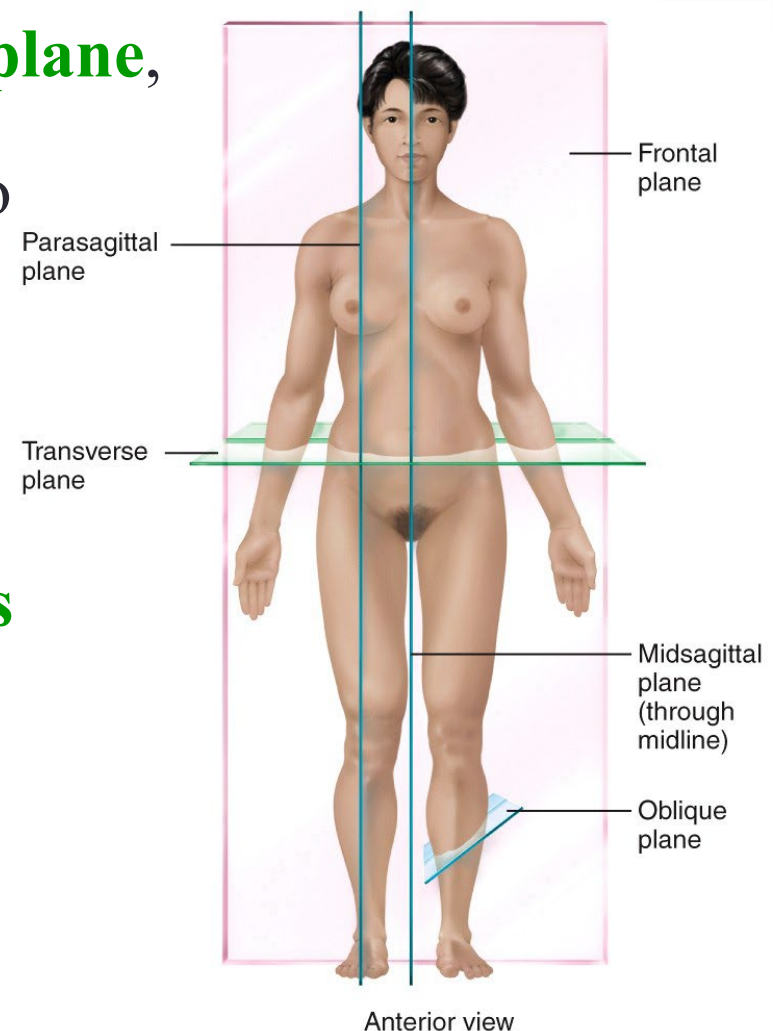


Body Planes

◆ **Sagittal planes** divide the body into right and left sides.

■ There is only one **midsagittal plane**, and it divides the body into two equal, mirror-image halves.

■ There are an infinite number of possible **parasagittal planes** to the right and left of the midsagittal that divide the body into unequal parts.



Body Planes

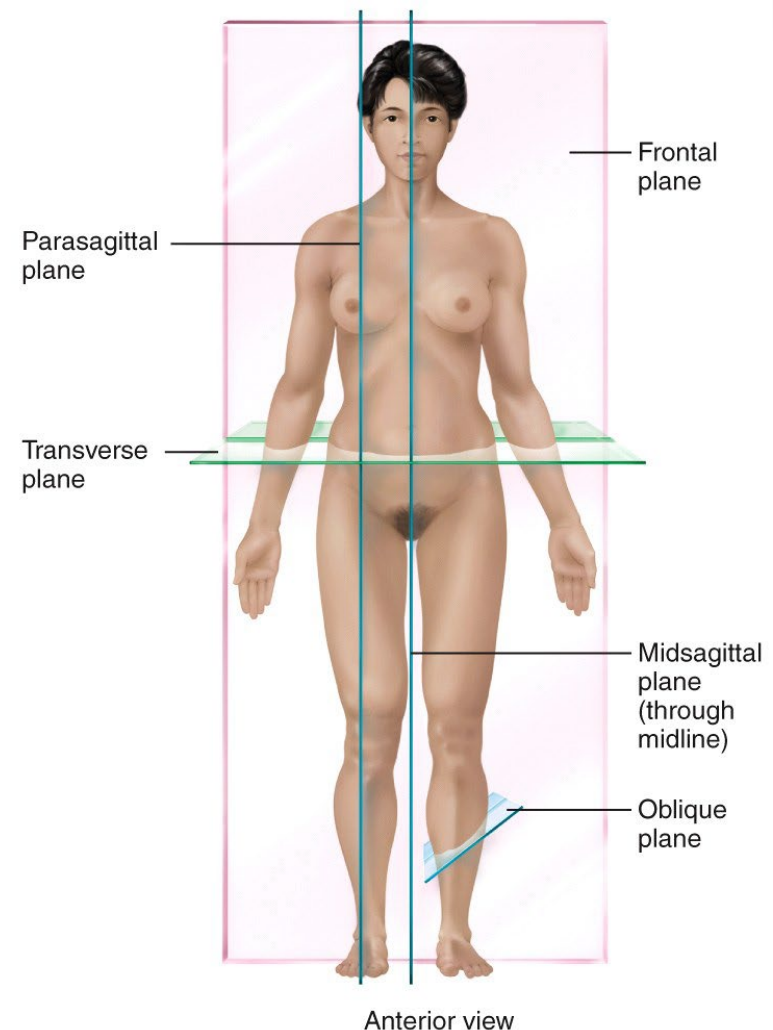
◆ **Frontal or coronal planes** divide the body (or an organ)

into anterior (front) and posterior (back) portions.

◆ **Transverse planes** (also called

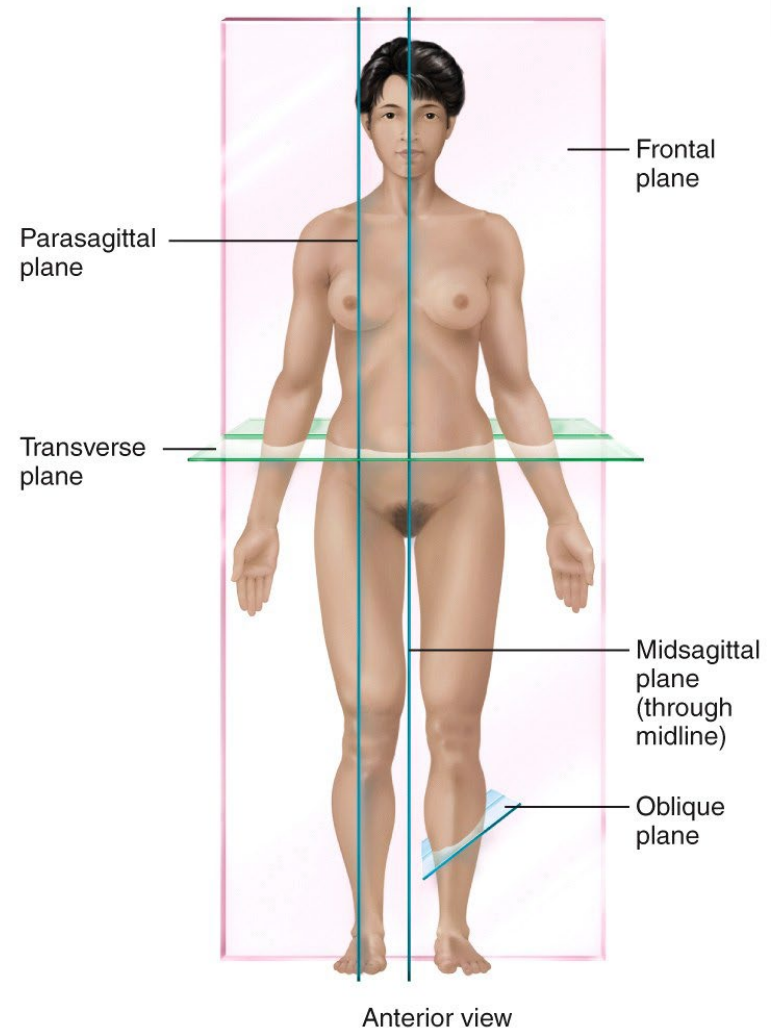
cross-sectional or horizontal planes) divide the body into

superior (upper) and inferior (lower) portions.

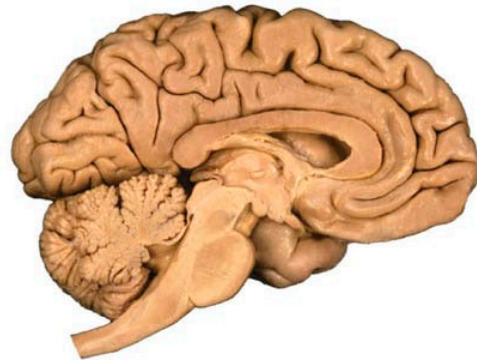
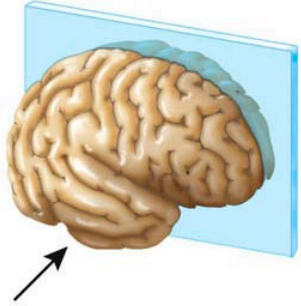


Body Planes

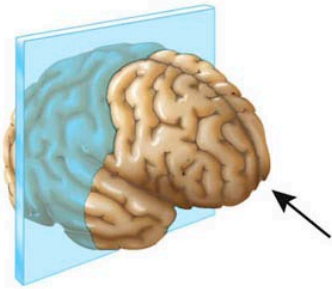
- ◆ In addition to the right angle sagittal, coronal and transverse planes, the body can also be divided into an infinite number of **oblique planes** that pass through the body or organ at an angle.
- ◆ Sections are cuts of the body made along a plane.



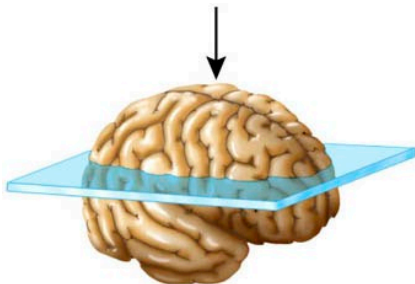
Body Planes



A midsagittal section of the human brain



A frontal (or coronal) brain section

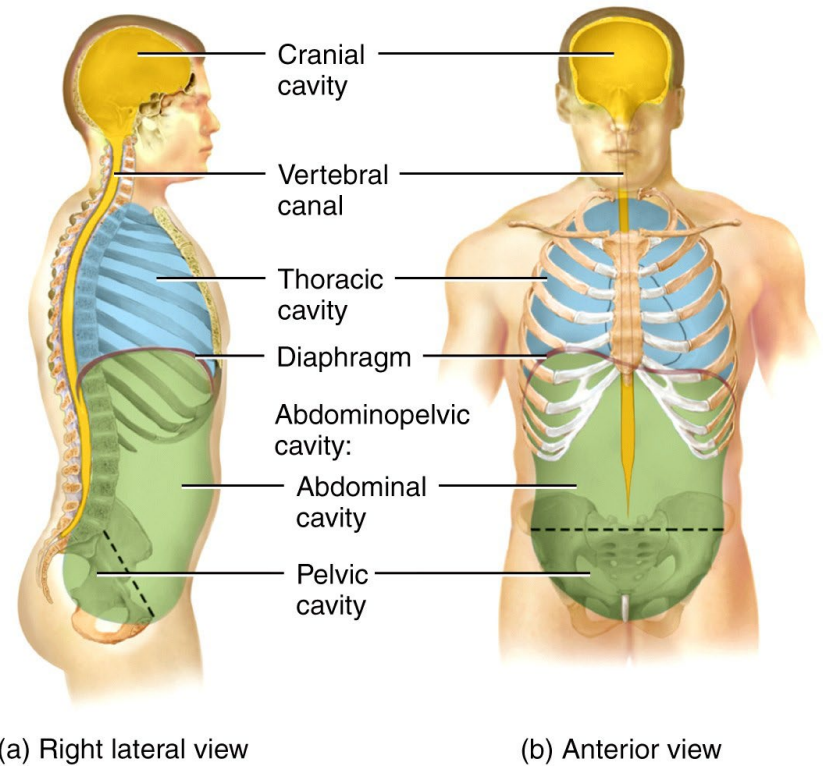


A transverse (or horizontal) brain section

Body Cavities

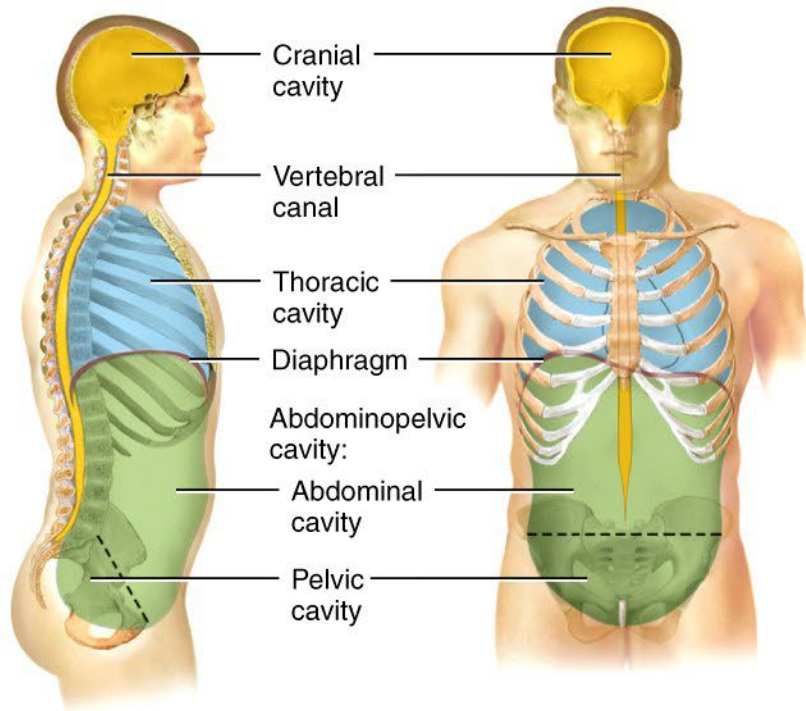
◆ Embryologically, the human organs develop within two major body cavities:

- The brain and spinal cord develop in a **dorsal cavity**.
- The remaining body organs are found in the **ventral body cavity**.



◆ Both dorsal and ventral cavities have **subdivisions**.

Body Cavities



(a) Right lateral view

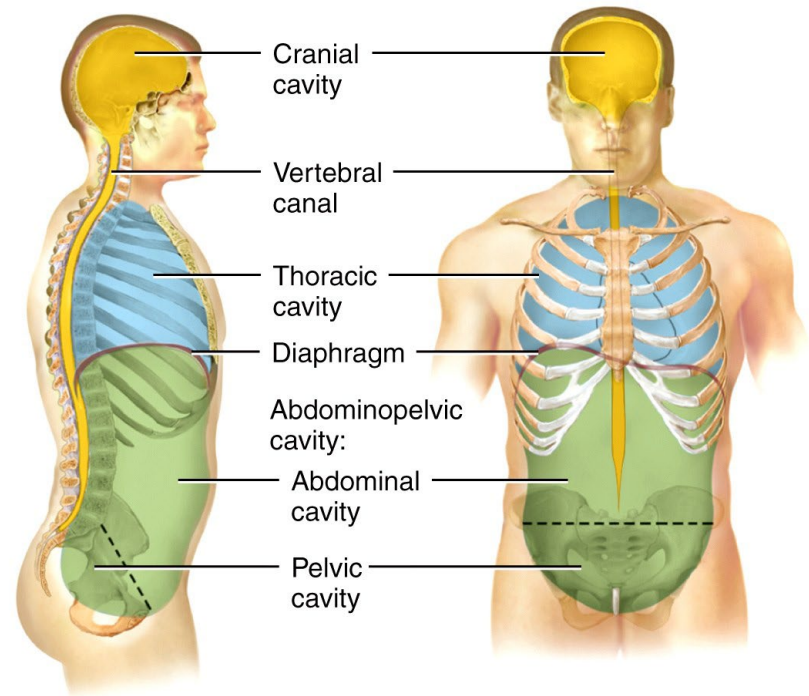
(b) Anterior view

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.
<i>Pleural cavity</i>	Each surrounds a lung; the serous membrane of each pleural cavity is the pleura.
<i>Pericardial cavity</i>	Surrounds the heart; the serous membrane of the pericardial cavity is the pericardium.
<i>Mediastinum</i>	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.
<i>Abdominal cavity</i>	Contains stomach, spleen, liver, gallbladder, small intestine, and most of large intestine; the serous membrane of the abdominal cavity is the peritoneum.
<i>Pelvic cavity</i>	Contains urinary bladder, portions of large intestine, and internal organs of reproduction.

* See **Figure 1.10** for details of the thoracic cavity.

Body Cavities

- ◆ **Cranial cavity** is formed by the cranial bones.
 - Protects the brain
- ◆ **Vertebral canal** is formed by bones of vertebral column.
 - Contains the spinal cord



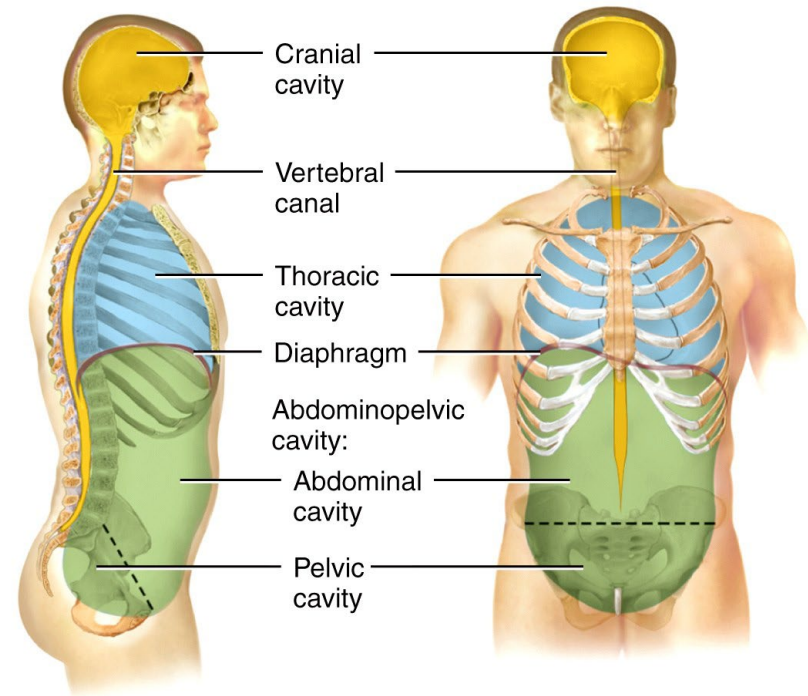
(a) Right lateral view

(b) Anterior view

Body Cavities

◆ **Thoracic cavity** is formed by the sternum, ribs, and the thoracic portion of the bony vertebral column.

- Also called chest cavity
- Stabilized by the internal and external muscles of the chest

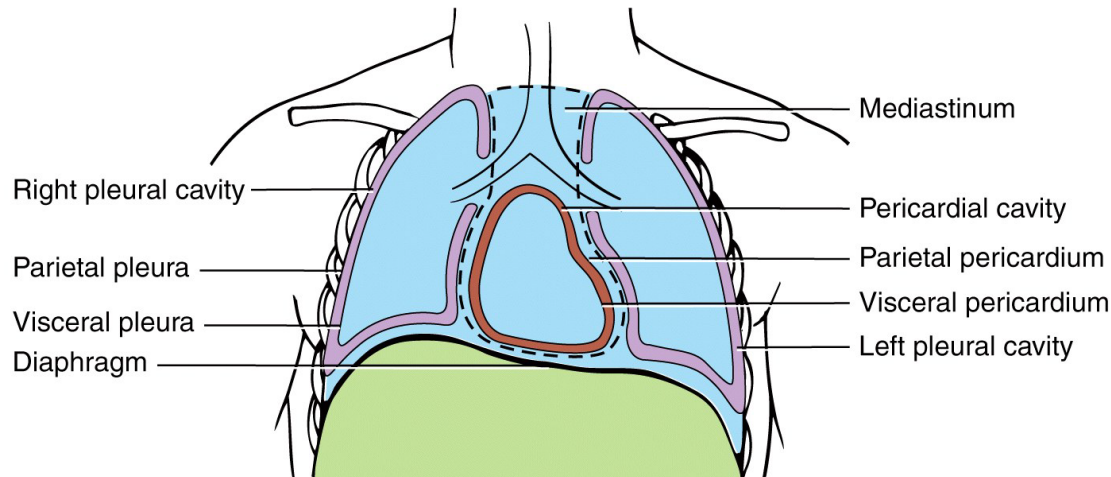


(a) Right lateral view

(b) Anterior view

Body Cavities

- ◆ Other cavities are contained within the thoracic cavity:
 - **Mediastinal cavity**
 - Located in the central part of the thoracic cavity
 - Left and Right **Pleural cavities**
 - Two fluid-filled spaces that surround each lung

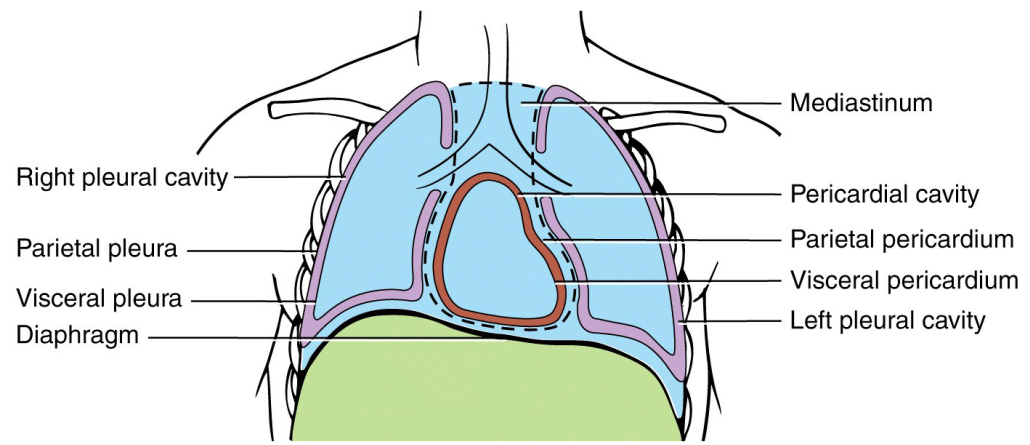


(a) Anterior view of thoracic cavity

Body Cavities

◆ **Pericardial cavity** is itself located within the middle part of the mediastinal cavity in the thoracic cavity (like a set of Russian nesting dolls of decreasing size—one placed inside the other).

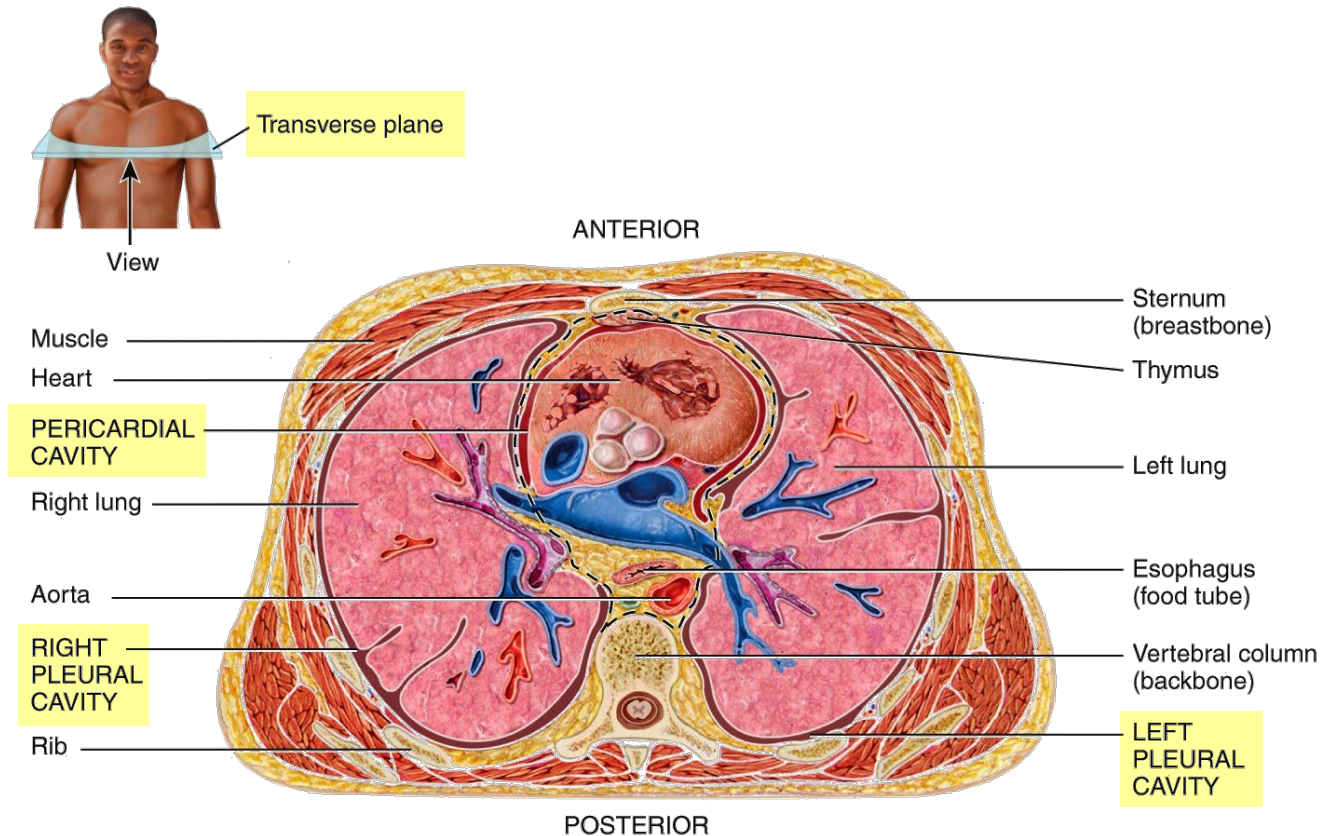
- Fluid-filled space that surrounds the heart



(a) Anterior view of thoracic cavity

Body Cavities

- ◆ The **pericardial cavity** is shown here nestled in the middle **mediastinum**:

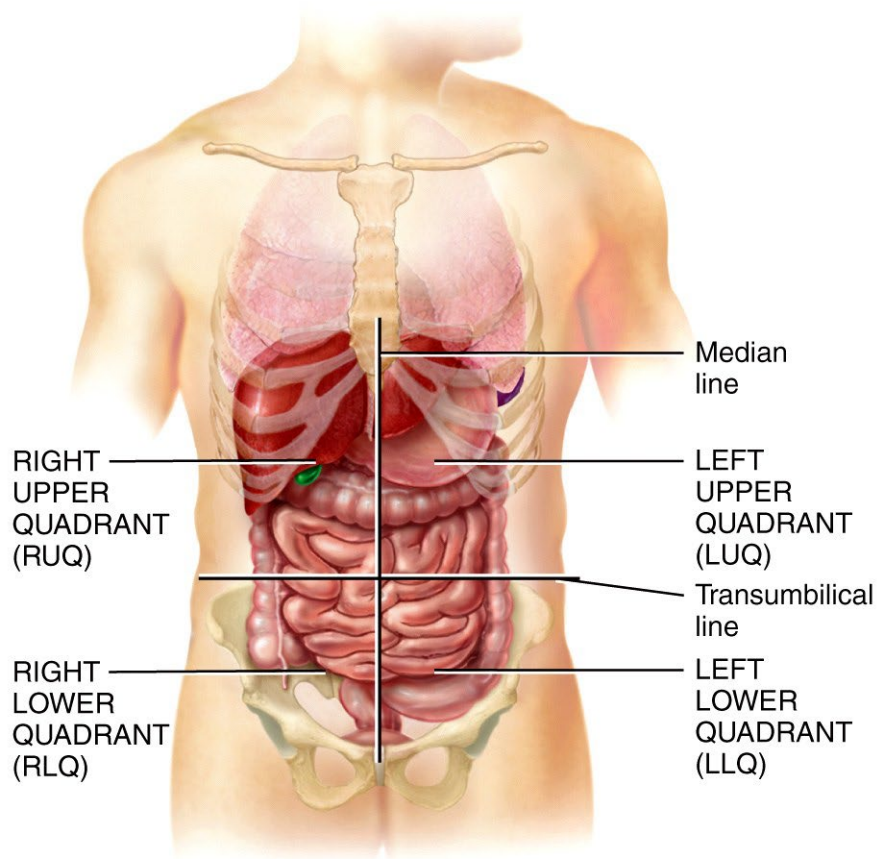


(b) Inferior view of transverse section of thoracic cavity

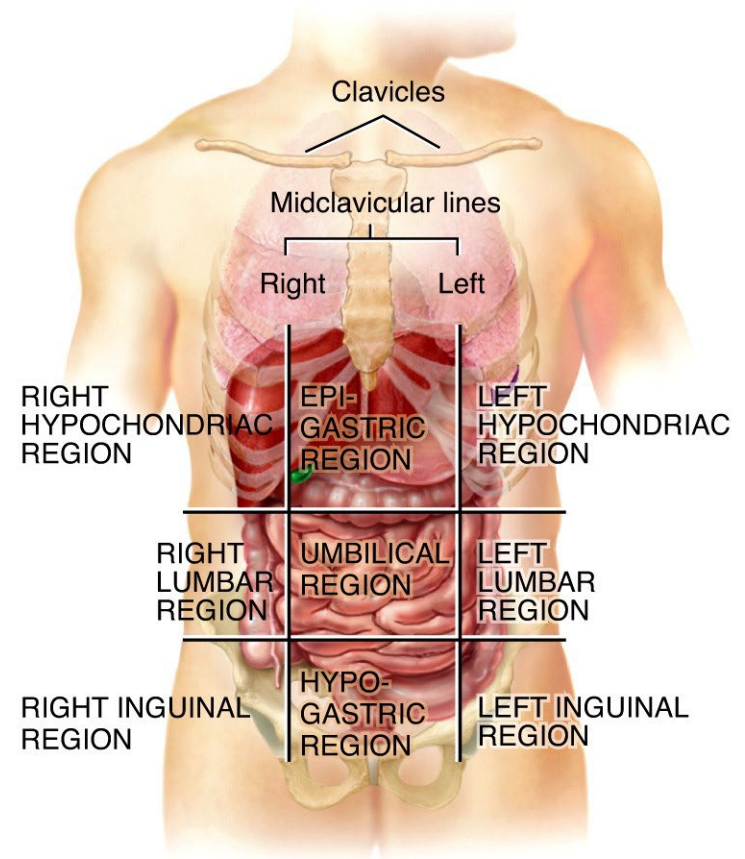
Body Cavities

- ◆ **Abdominopelvic Cavity** extends from the diaphragm to the groin and is encircled by the abdominal wall and bones and muscles of the pelvis.
 - Divided into two portions:
 - **Abdominal cavity** contains the stomach, spleen, liver, gallbladder, small and large intestines.
 - **Pelvic cavity** contains the urinary bladder, internal organs of reproductive system, and portions of the large intestine.

Abdominopelvic Quadrants & Regions



(c) Anterior view showing location of abdominopelvic quadrants



(b) Anterior view showing location of abdominopelvic regions

Body Cavities

◆ Other body cavities

- Oral (mouth) cavity contains the tongue and teeth.
- Nasal cavity is part of the upper airways
- Orbital cavities contain the eyeballs and various nerves and blood vessels.
- Middle ear cavities contain the small bones of the middle ear.
- Synovial cavities are found in freely moveable joints like the large joints of the shoulder and hip.

Body Cavities

◆ Membranes of the body cavities

- The thoracic and abdominal body cavities are lined by thin, slippery, double-layered membranes called serous membranes.
- These membranes adhere to the outer surface of the organs or “viscera”, and then double-back on themselves to line the body cavity wall.
 - **Visceral layer** covers the organs within the cavities
 - **Parietal layer** lines the cavity walls

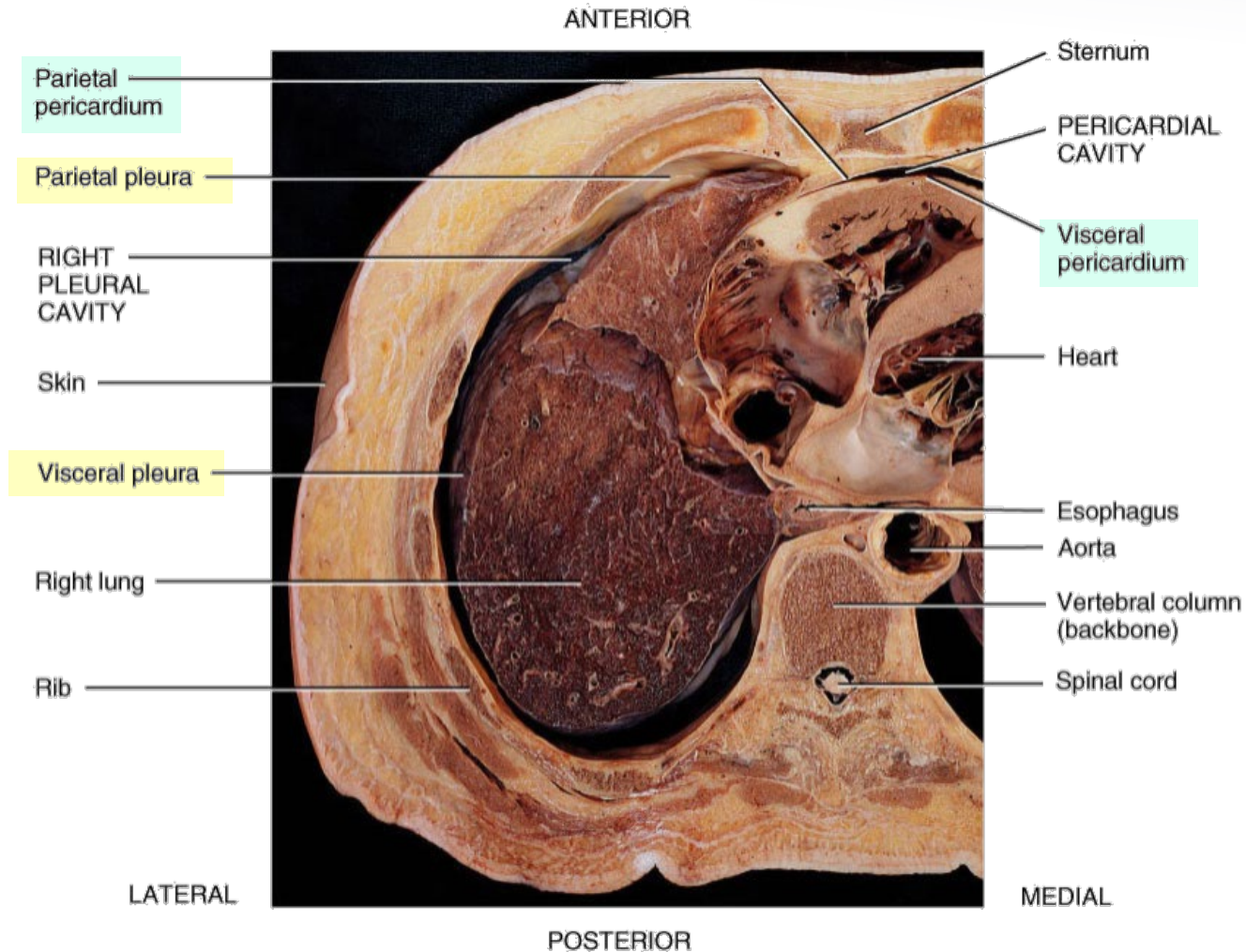
Body Cavities

◆ Membranes of the body cavities

- The right and left **pleural membranes** are the serous membranes that covers the lungs (visceral pleura) and the walls of the pleural cavity (parietal pleura).
- The **pericardial membrane** is the serous membrane that covers the heart (visceral pericardium) and the pericardial cavity walls (parietal pericardium).
- The **peritoneal membrane** is the serous membrane that covers the abdominal organs (visceral peritoneum) and the abdominal cavity walls (parietal peritoneum).

Body Cavities

◆ Membranes of the body cavities



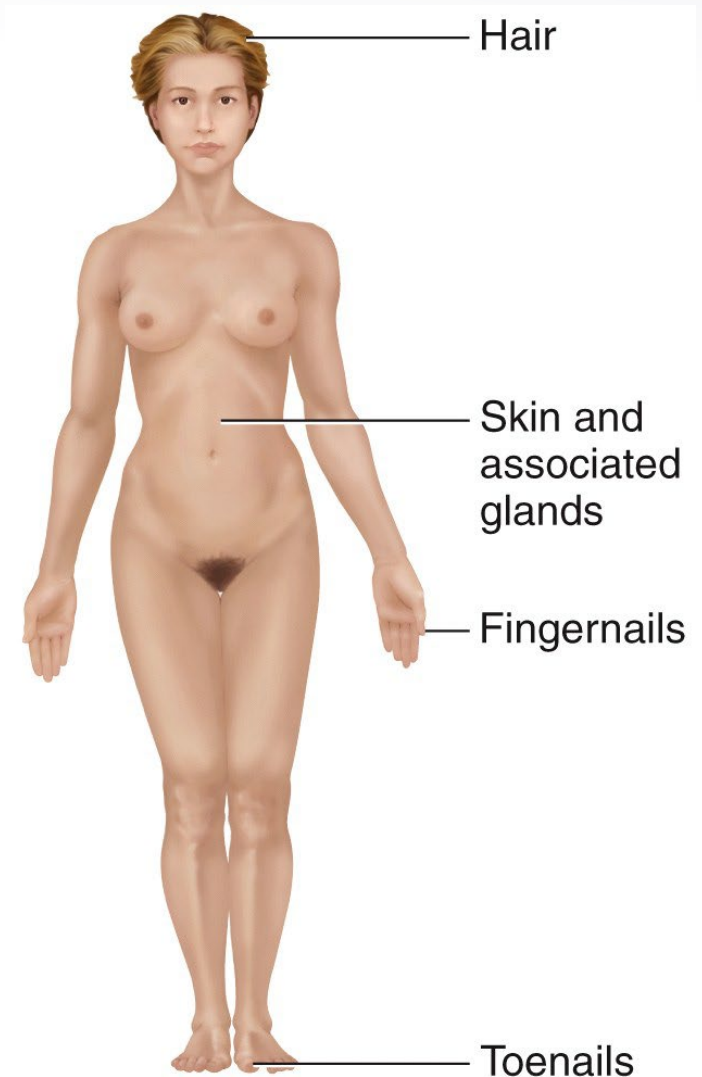
(c) Inferior view of transverse section of thoracic cavity

Organ Systems of the Body

◆ Integumentary System (Chapter 5)

consists of the skin and related structures (hair, nails, and glands).

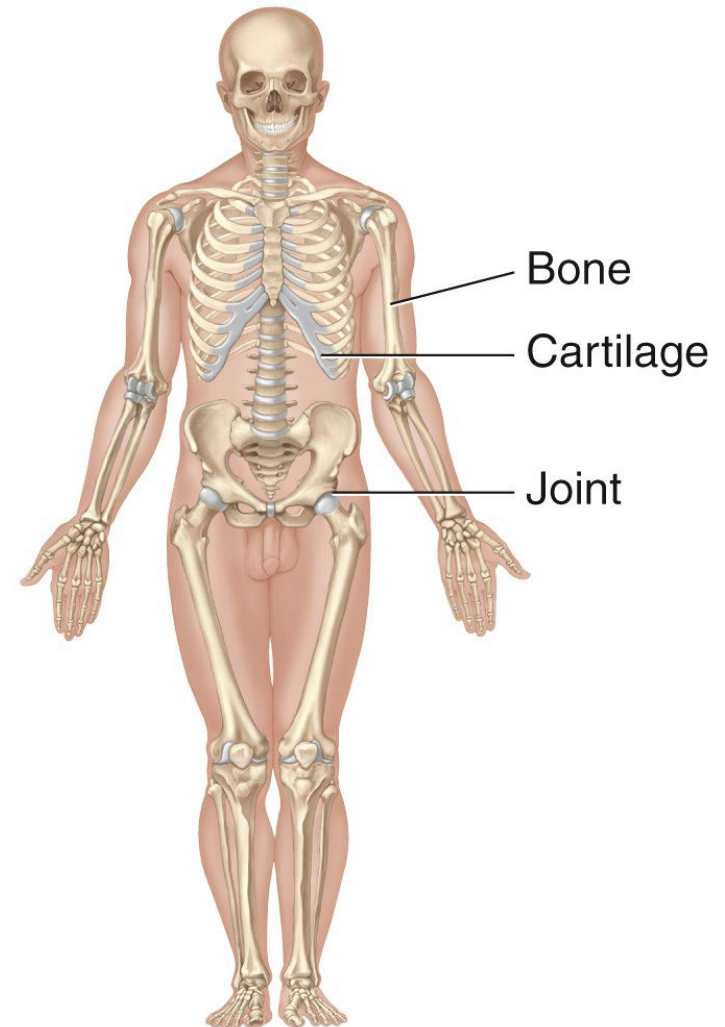
- Protects body, regulates temperature, and eliminates wastes through sweat and other secretions



Organ Systems of the Body

◆ **Skeletal System (Chapters 6-9)** consists of the bones and joints.

- Provides protection and support
- Houses cells that will become red blood cells, white blood cells, and platelets
- Stores minerals

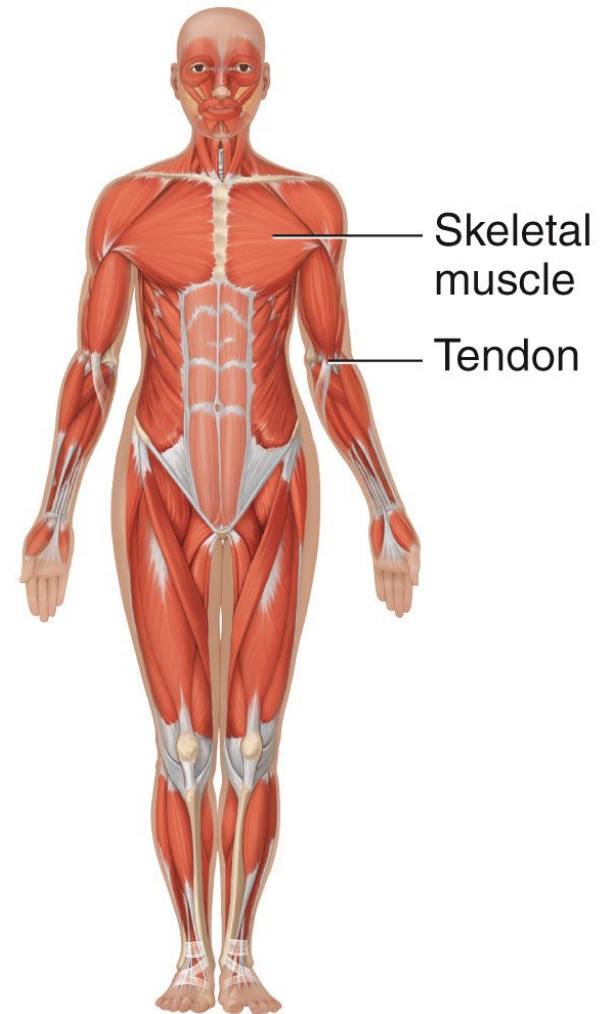


Organ Systems of the Body

◆ **Muscular System (Chapters 10-11)** consists of the

named skeletal muscles, as well as smooth muscle and cardiac muscle.

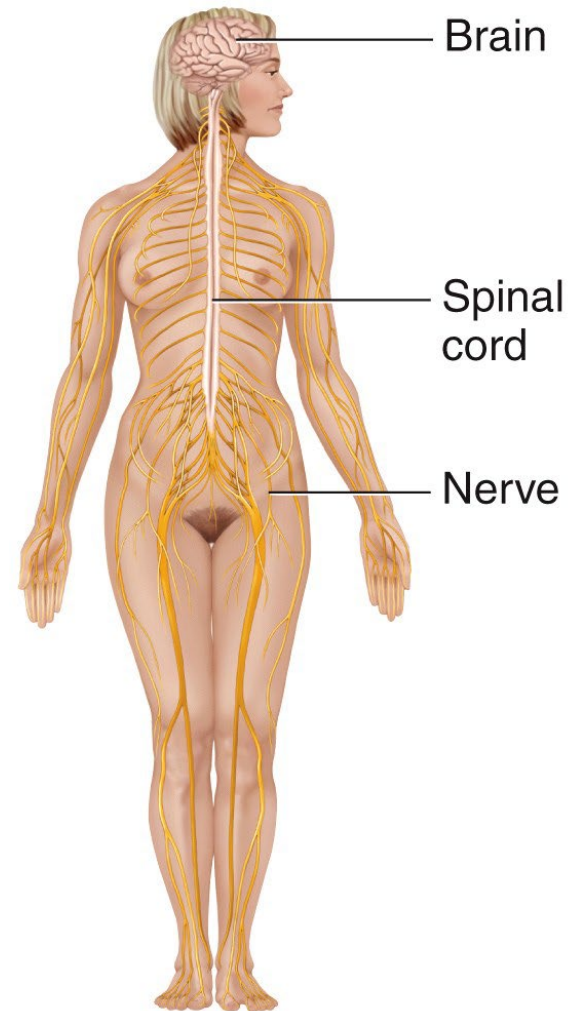
- Participates with the skeletal system to facilitate movement and maintain posture
- Generates the heat necessary for warm-blooded organisms to maintain a constant body temp.



Organ Systems of the Body

◆ **Nervous System (Chapters 12-17)** consists of the brain, spinal cord, nerves, and sensory organs).

- Senses and responds to body conditions through nerve impulses



Organ Systems of the Body

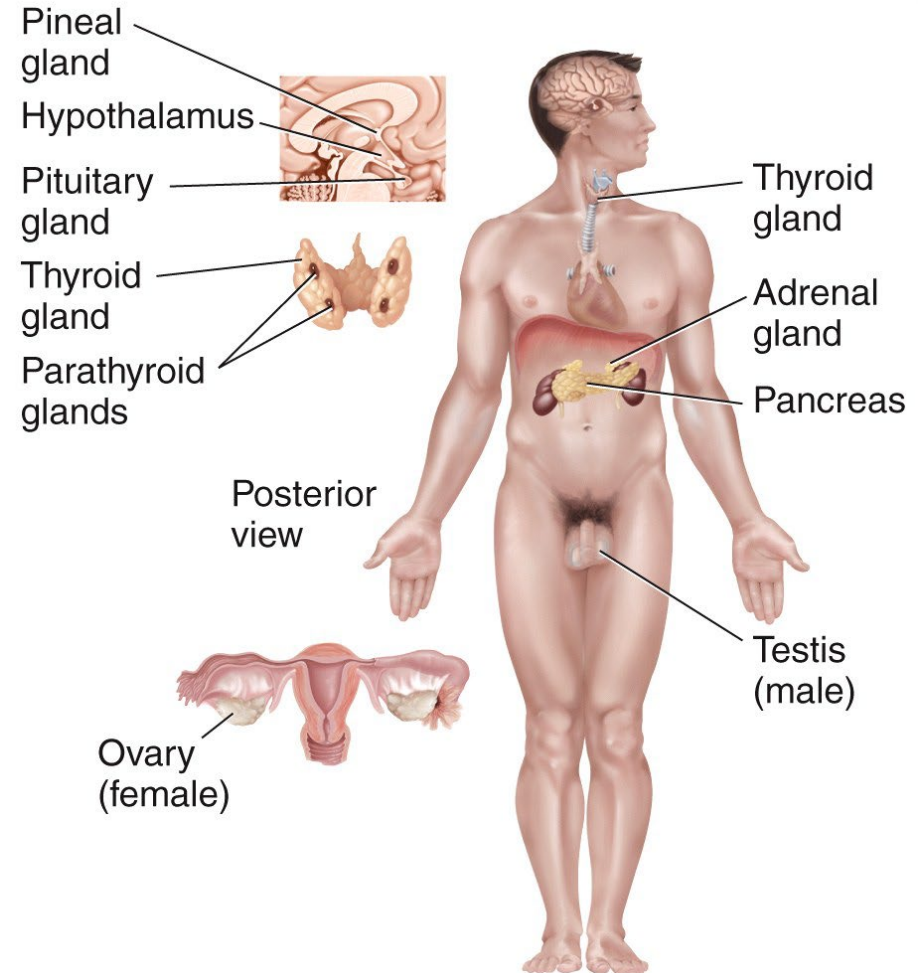
◆ Endocrine System (Chapter 18) consists of hormone-

producing cells and glands

scattered throughout the

body.

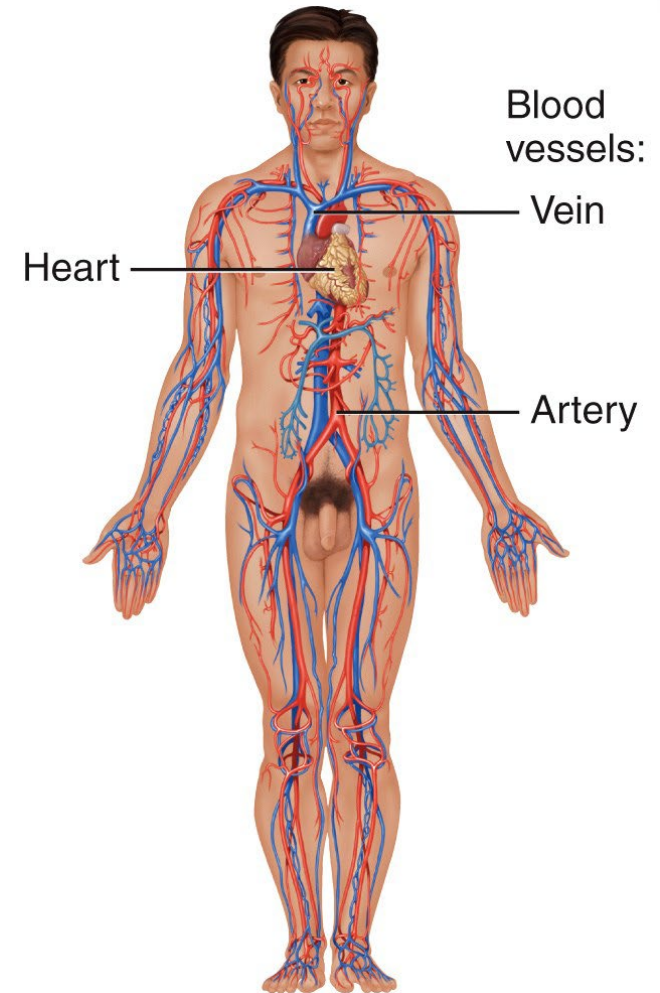
- Regulates the body through chemical mechanisms (by releasing hormones into the blood)



Organ Systems of the Body

◆ **Cardiovascular (Chapters 19-21)** consists of the heart, blood, and blood vessels.

- Carries blood and nutrients to specific locations
- Regulates body temperature, and water balance



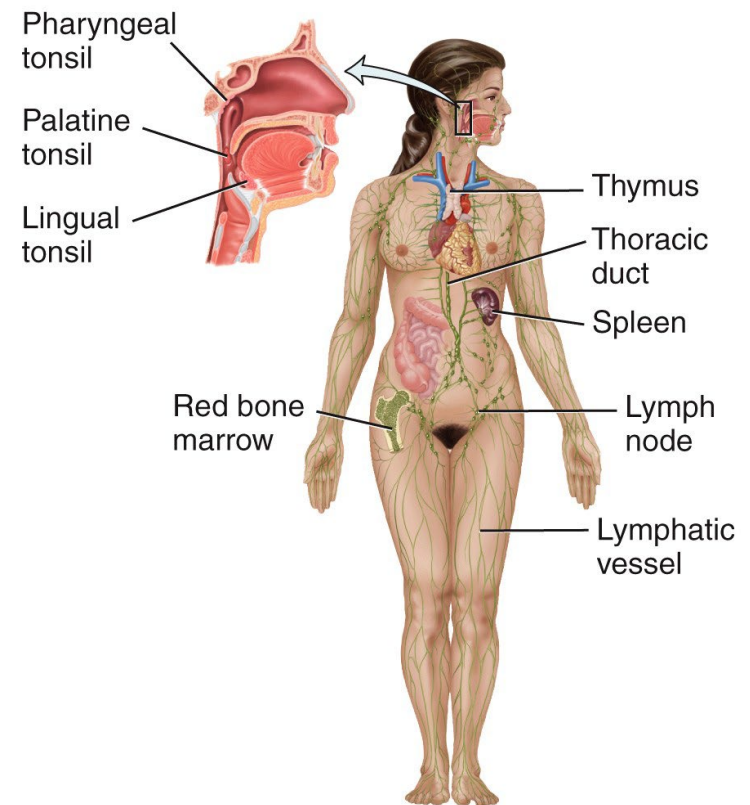
Organ Systems of the Body

◆ **Lymphatic System and Immunity (Chapter 22)** consists of

the lymphatic fluid, lymph nodes, and lymphocytes – and the

other associated organs of the immune system like the tonsils, spleen and thymus gland.

- Filters blood and protects against disease



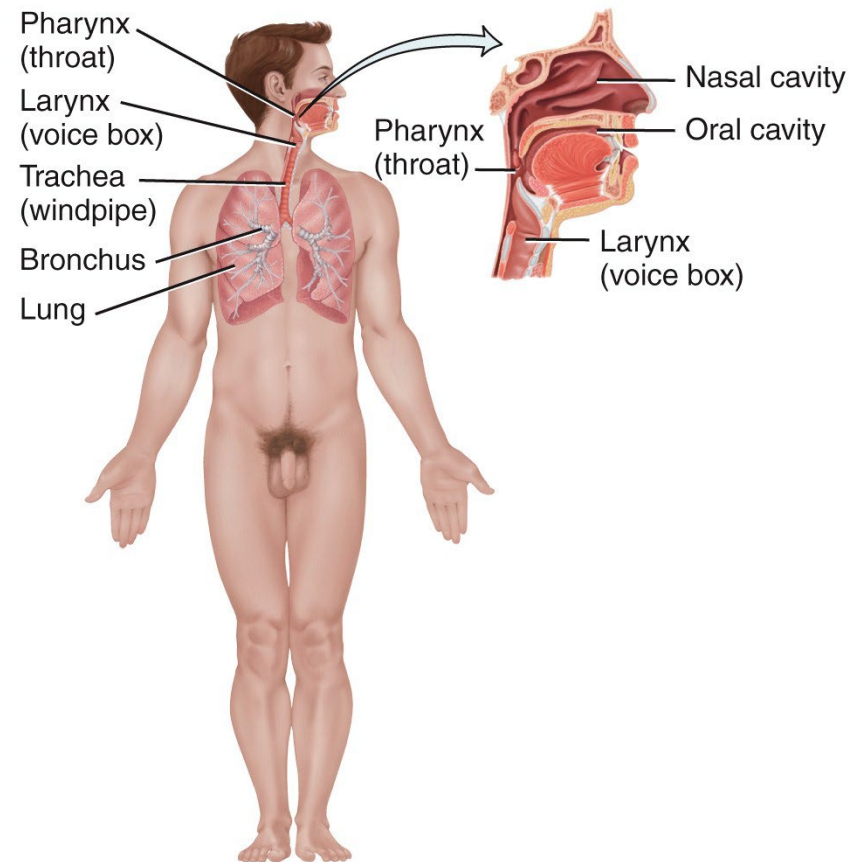
Organ Systems of the Body

◆ **Respiratory System (Chapter 23)** consists of the upper

airways, the trachea and major

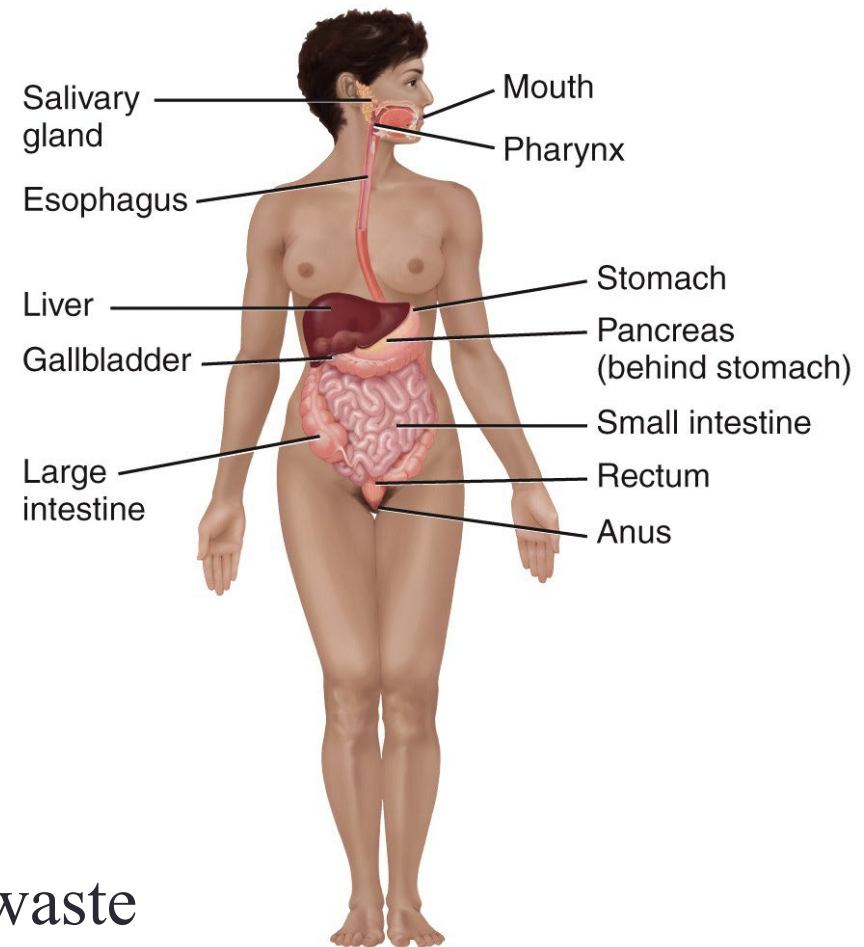
bronchi, and the lungs.

- Extracts O_2 and eliminates CO_2
- In conjunction with the kidneys, regulates acid/base balance



Organ Systems of the Body

- ◆ **Digestive System (Chapter 24)** consists of the esophagus, stomach and intestines, and the accessory digestive glands like the salivary glands, liver, and gallbladder.
- Accomplishes the physical and chemical breakdown of food and elimination of waste

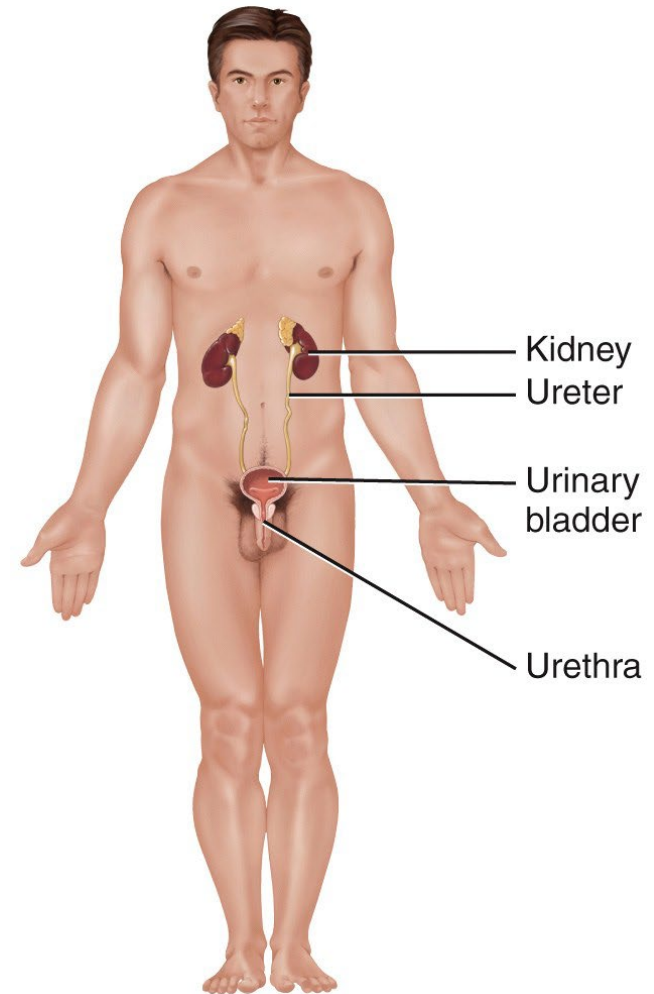


Organ Systems of the Body

◆ **Urinary System (Chapter 26)** consists of the kidneys,

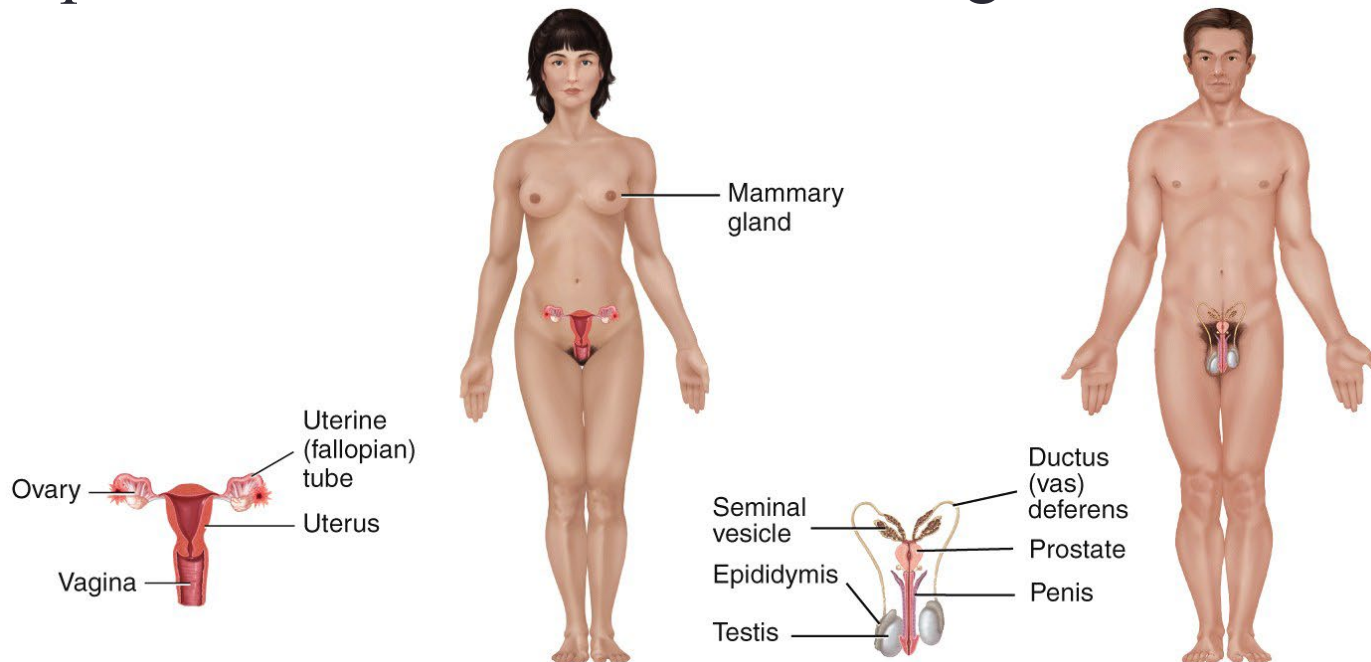
ureters , bladder, and urethra.

- Involved in the collection and excretion of waste products in urine, and the regulation of fluid, electrolyte, & acid/base balance

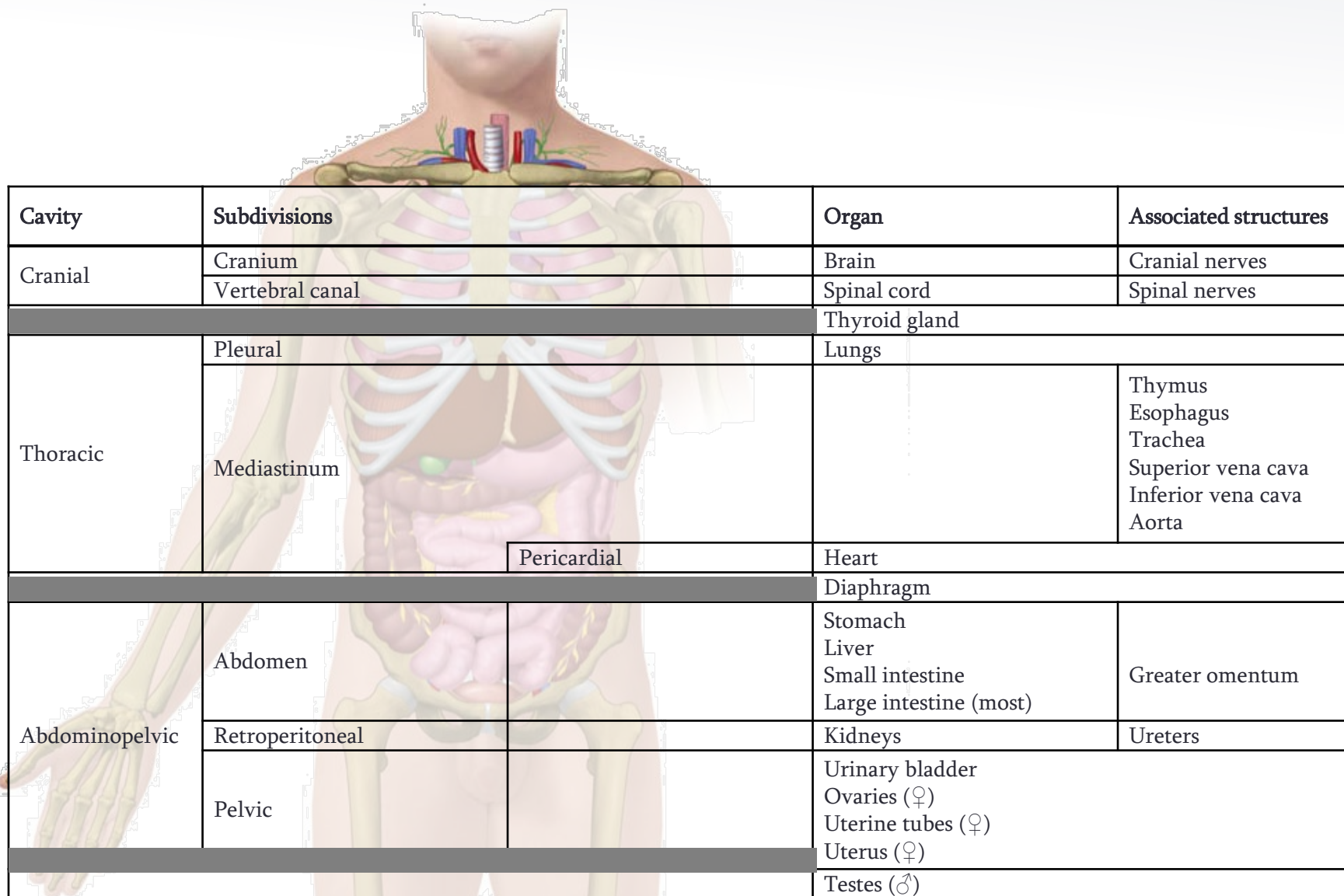


Organ Systems of the Body

- ◆ **Reproductive System (Chapter 28)** consists of the ovaries, uterus and vagina in the female, and the testes and penis in the male (along with associated organs and glands in both sexes).
- Reproduction of an individual or organism



Major Body Organs



The illustration shows a human torso from the neck to the upper thighs. The skeletal structure is visible, including the skull, ribs, spine, and pelvis. Major organs are highlighted in various colors: the brain is pink, the spinal cord is yellow, the lungs are green, the heart is red, the stomach is pink, the liver is green, the small intestine is yellow, the large intestine is pink, the kidneys are red, the urinary bladder is pink, the ovaries are pink, the uterine tubes are pink, the uterus is pink, and the testes are pink. The table below provides a detailed breakdown of these organs and their associated structures, organized by cavity and subdivisions.

Cavity	Subdivisions	Organ	Associated structures
Cranial	Cranium	Brain	Cranial nerves
	Vertebral canal	Spinal cord	Spinal nerves
		Thyroid gland	
Thoracic	Pleural	Lungs	
	Mediastinum		Thymus Esophagus Trachea Superior vena cava Inferior vena cava Aorta
		Pericardial	Heart
		Diaphragm	
Abdominopelvic	Abdomen	Stomach Liver Small intestine Large intestine (most)	Greater omentum
		Retroperitoneal	Kidneys
	Pelvic	Urinary bladder Ovaries (♀) Uterine tubes (♀) Uterus (♀)	
		Testes (♂)	

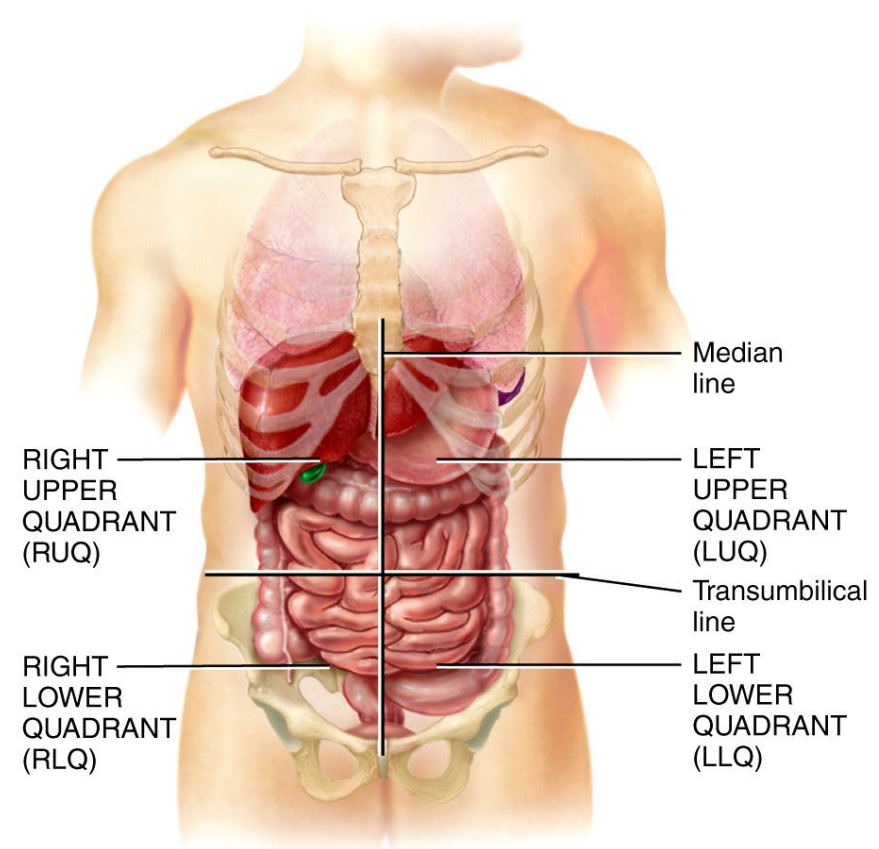
Abdominopelvic Quadrants & Regions

- ◆ Identification of quadrants and regions in the abdominopelvic cavity helps clinicians describe the location of the many abdominal and pelvic organs.
- ◆ There are **4 abdominopelvic quadrants** and **9 regions**.
 - The dividing lines between these are centered on the umbilicus (“belly button”).

Abdominopelvic Quadrants & Regions

◆ Vertical and horizontal lines pass through the **umbilicus**

- Right upper quadrant (RUQ)
 - liver
- Left upper quadrant (LUQ)
 - spleen and left kidney
- Right lower quadrant (RLQ)
 - appendix
- Left lower quadrants (LLQ)
 - left ovary (♀)

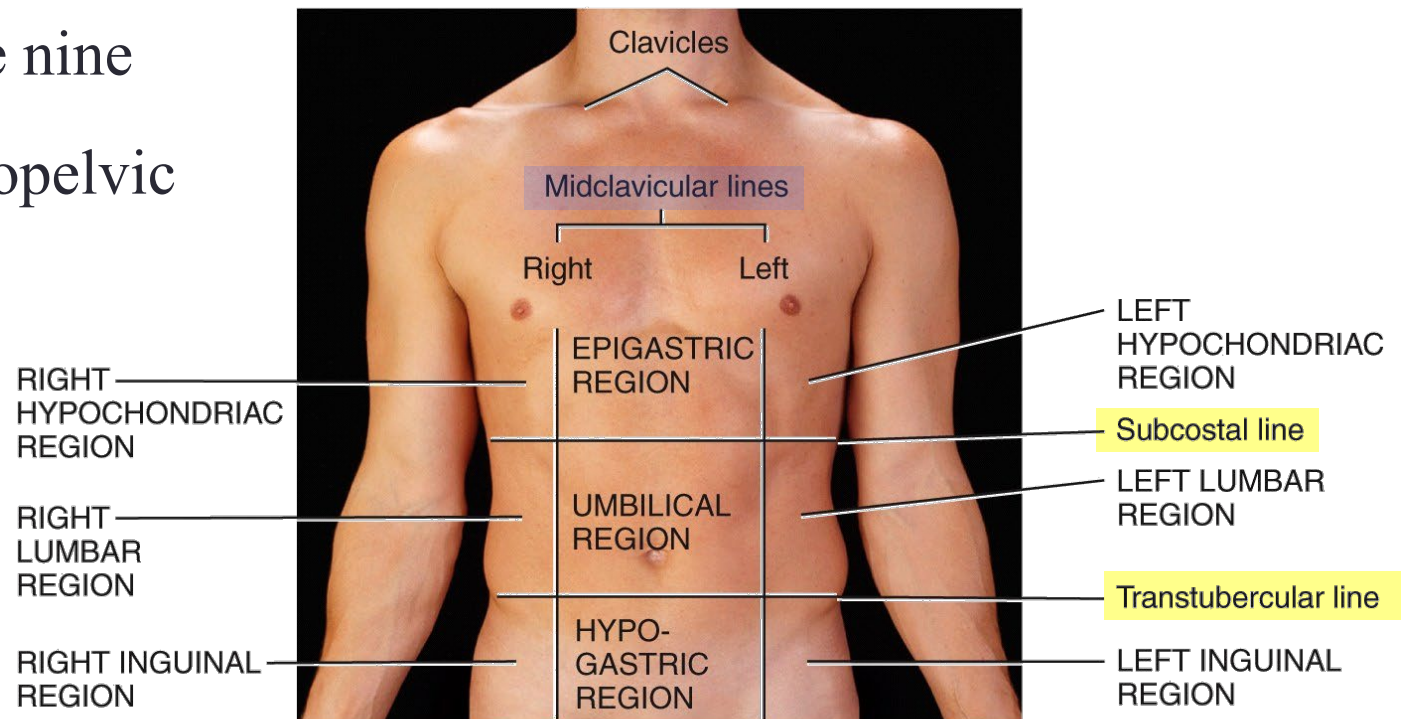


(c) Anterior view showing location of abdominopelvic quadrants

Abdominopelvic Quadrants & Regions

- ◆ Dividing the abdomen and pelvis into regions is done using a **Tic-Tac-Toe grid**. It is a little more complex than using quadrants, but is also more specific

- There are nine abdominopelvic regions



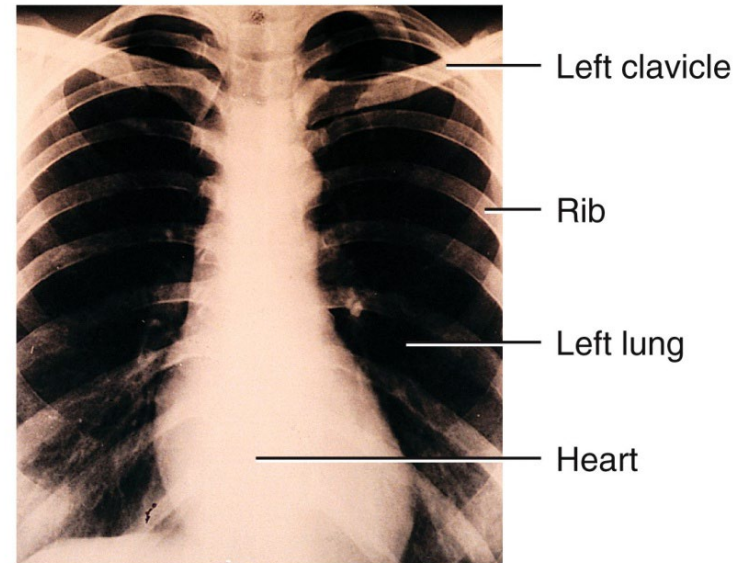
(a) Anterior view showing abdominopelvic regions

Medical Imaging

- ◆ Techniques and procedures used to create images of the human body
 - Allow visualization of structures inside the body
 - Diagnosis of anatomical and physiological disorders
 - Conventional radiography (X-rays) have been in use since the late 1940's

Medical Imaging

- ◆ **Radiography** is done using X-rays to produce an image of interior structures. They are inexpensive and quick.
 - Hollow structures appear black or gray
 - Do not pass easily through dense structure (bone)
- ◆ At low dose, useful for soft tissue
 - Mammography (breast)
 - Bone densitometry (bone density)



Radiograph of the thorax in anterior view

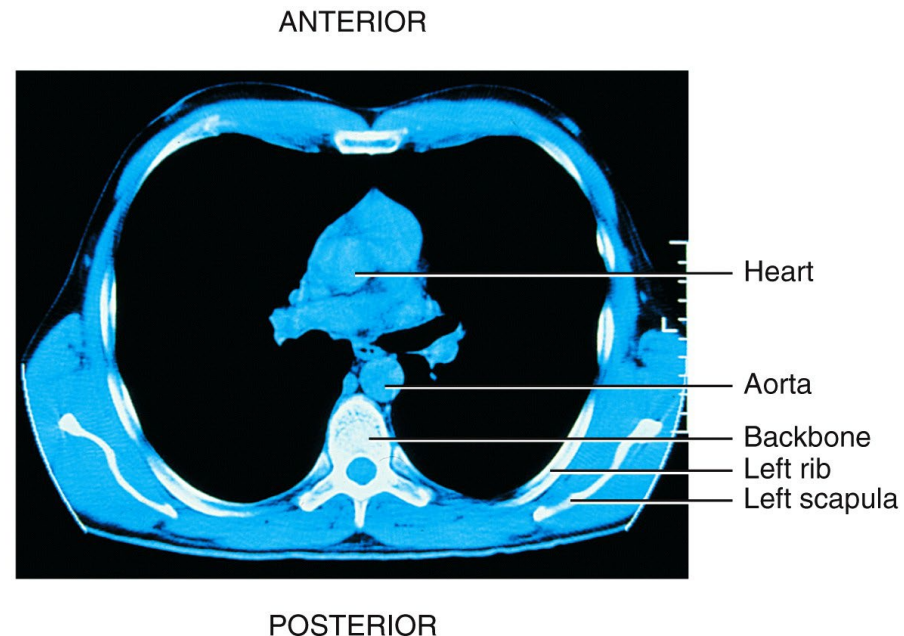
Medical Imaging

- ◆ Magnetic Resonance Imaging (**MRI**) is done using an extremely powerful magnetic field. It is a safe procedure but cannot be used on patients containing metal.
 - Protons in body fluid align with field
 - Used for differentiating normal and abnormal tissues (tumors, brain abnormalities, blood flow)
 - 2D and 3D color images can be viewed on a video monitor.

Medical Imaging

◆ Computed Tomography or **CT-Scans** are done using a computer to organize x-rays to form a 3D image. It is used to visualize soft tissue in more detail than conventional radiography.

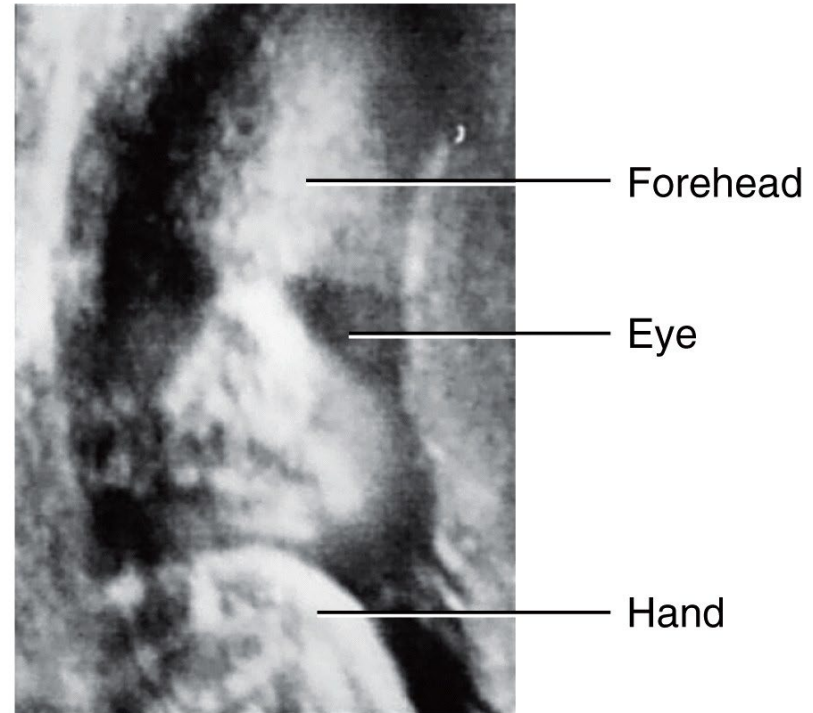
- Tissue intensities show varying degrees of gray.
- Whole-body CT scans expose the body to a high dose of x-rays.



Computed tomography scan of the thorax in inferior view

Medical Imaging

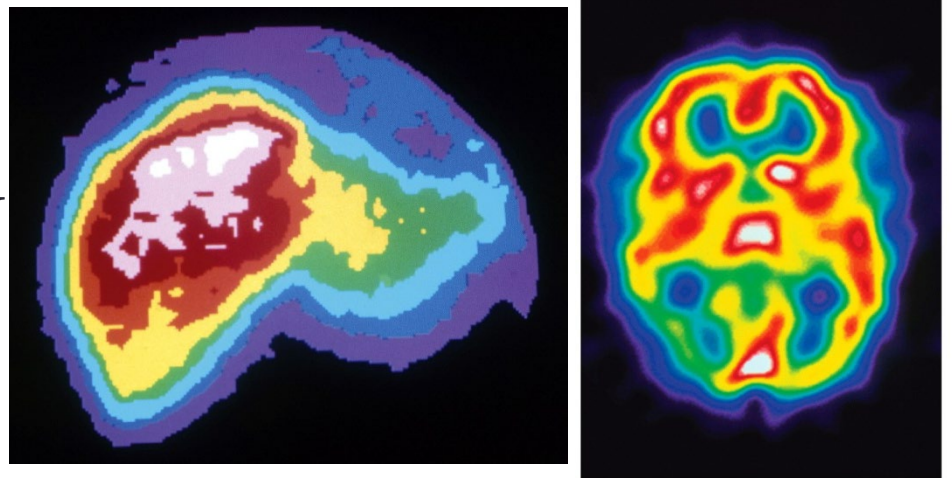
- ◆ Ultrasound Scanning (sonography) is done using high frequency sound waves. It is noninvasive and painless.
 - Because of its safety profile, it is commonly used to monitor the progress of fetal development during pregnancy.



Sonogram of a fetus (Courtesy of Andrew Joseph Tortora and Damaris Soler)

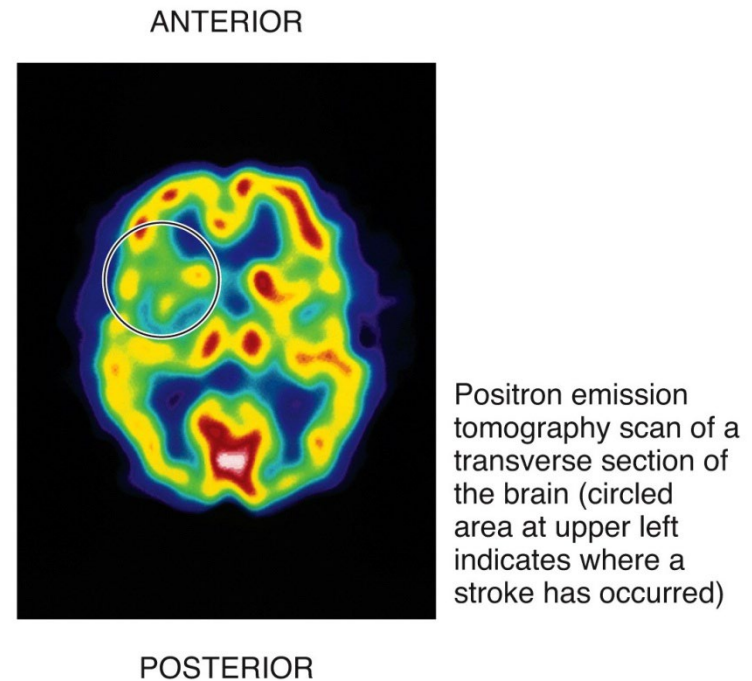
Medical Imaging

- ◆ **Radionuclide Scanning** is done by giving a radioactive substance (radionuclide) intravenously.
 - Gamma rays emitted by tissues that take up the radionuclide are detected by a camera and displayed on a video monitor. The color intensity represents the amount of uptake.
- ◆ Single-photo-emission computerized tomography (**SPECT**) is a specialized form of this technique.



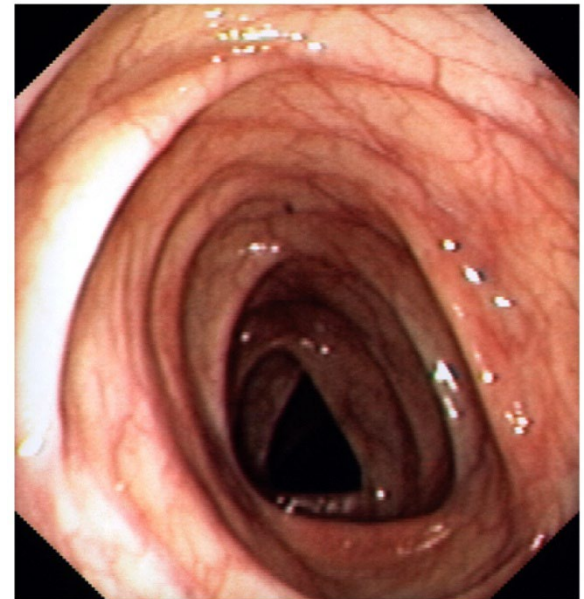
Medical Imaging

- ◆ Positron Emission Tomography (PET scan) is done by injecting a substance emitting positively charged particles into the body. The collision between positrons and negatively charged electron in body tissues produce gamma rays used to form a computer assisted image.
 - Used to study physiology of body structures (metabolism)



Medical Imaging

- ◆ Endoscopy is done using a lighted instrument with a lens projecting an image onto a monitor.
 - Colonoscopy is a study of the interior of the colon.
 - Laparoscopy is a study of the organs in the abdominopelvic cavity.
 - Arthroscopy is a study of the interior of a joint (knee).



Clinical Connection

- ◆ **Noninvasive Diagnostic Techniques** are used to inspect different aspects of the body:
 - Is often done to assess structure and function and to search for the presence of disease.
 - **Palpation** is gently touching body surfaces with hands.
 - **Auscultation** is listening to body sounds (stethoscope).
 - **Percussion** is tapping on the body surface with fingertips and listening to echoes.