



AN  
INTRODUCTION  
TO  
THE HUMAN  
BODY

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# Learning Objectives



- What is the difference between anatomy and physiology?
- What are the different levels of organization?
- What differentiates living things from non-living things?
- What is homeostasis?
- What are the components of a feedback mechanism?
- Explain anatomical body positions, directional terms used for location of a body organ in relation to other organs?



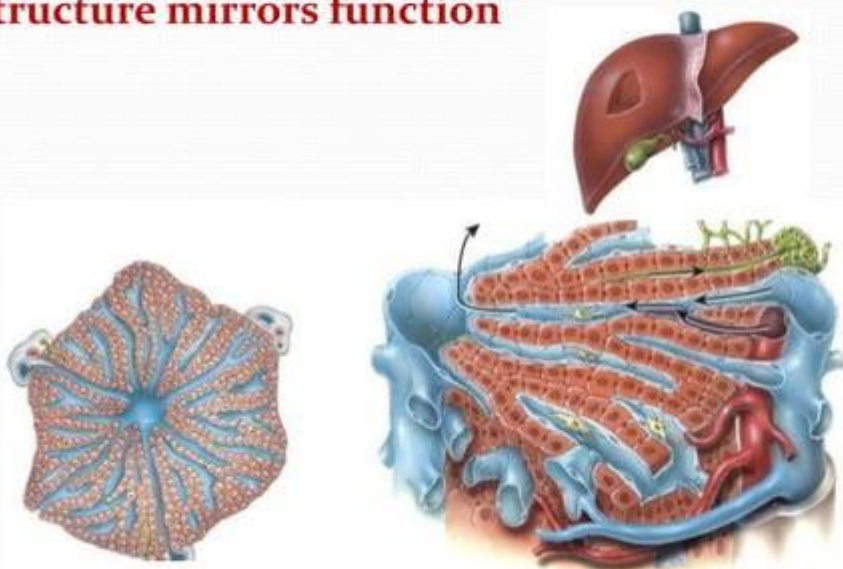
# Anatomy and Physiology



- ◆ Anatomy is the study of body structure.
  - science of structure
  
- ◆ Physiology is the science of body functions.
  - science of body functions



- **Structure mirrors function**



This *structure* is the liver, which has the *function* of filtering blood and producing bile. Can you see how the function is determined by the structure, and vice versa?

**TABLE 1.1****Selected Subspecialties of Anatomy and Physiology**

SUBSPECIALTIES OF ANATOMY	STUDY OF	SUBSPECIALTIES OF PHYSIOLOGY	STUDY OF
<b>Embryology</b> (em'-bré-OL-ô-jê; embry- = embryo; -logy = study of)	The first eight weeks of development after fertilization of a human egg.	<b>Neurophysiology</b> (NOOR-ô-fiz-ê-ol'-ô-jê; neuro- = nerve)	Functional properties of nerve cells.
<b>Developmental biology</b>	The complete development of an individual from fertilization to death.	<b>Endocrinology</b> (en'-dô-kri-NOL-ô-jê; endo- = within; -crin = secretion)	Hormones (chemical regulators in the blood) and how they control body functions.
<b>Cell biology</b>	Cellular structure and functions.	<b>Cardiovascular physiology</b> (kar-dê-ô-VAS-kû-lar; cardi- = heart; -vascular = blood vessels)	Functions of the heart and blood vessels.
<b>Histology</b> (hiss'-TOL-ô-jê; hist- = tissue)	Microscopic structure of tissues.	<b>Immunology</b> (im'-û-NOL-ô-jê; immun- = not susceptible)	The body's defenses against disease-causing agents.
<b>Gross anatomy</b>	Structures that can be examined without a microscope.	<b>Respiratory physiology</b> (RES-pir-a-to'-ré; respira- = to breathe)	Functions of the air passageways and lungs.
<b>Systemic anatomy</b>	Structure of specific systems of the body such as the nervous or respiratory systems.	<b>Renal physiology</b> (RE-nal; ren- = kidney)	Functions of the kidneys.
<b>Regional anatomy</b>	Specific regions of the body such as the head or chest.	<b>Exercise physiology</b>	Changes in cell and organ functions due to muscular activity.
<b>Surface anatomy</b>	Surface markings of the body to understand internal anatomy through visualization and palpation (gentle touch).	<b>Pathophysiology</b> (PATH-ô-fiz-ê-ol'-ô-jê)	Functional changes associated with disease and aging.
<b>Radiographic anatomy</b> (rà'-dê-ô-GRAF-ik; radio- = ray; -graphic = to write)	Body structures that can be visualized with x-rays.		
<b>Pathological anatomy</b> (path'-ô-LOJ-i-ka; path- = disease)	Structural changes (gross to microscopic) associated with disease.		

# Subdivisions of Anatomy

- **Surface Anatomy** is the study of form and markings of the body surface, often explored through visualization or palpation (without any “cutting”).
- **Gross Anatomy** is the study of anatomical structures visible to unaided eye. After making the appropriate surface marking in the prior picture, the gross dissection proceeds through “cutting.”

# Subdivisions of Anatomy

- **Gross Anatomy can be studied by two general approaches:**
  - **Systemic** approach (Systemic Anatomy):
  - **Regional** approach (Regional Anatomy)

# Subdivisions of Anatomy

- **Developmental anatomy**

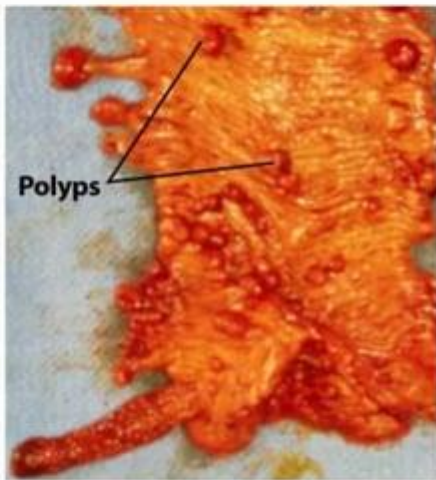
is the study of the fertilized egg developing into its adult form.( For e.g., Embryology)





# Subdivisions of Anatomy

- **Histology** is the study of **tissues**.
- **Cytology**, like histology, uses a microscope, but restricts the study to individual **cellular structures**.
- **Pathology** is the study of anatomical changes due to **disease**.



Courtesy of Randall W. Burt

# Clinical Connection

- An autopsy is a postmortem (after death) examination of the body and internal organs performed by a pathologist.

# Levels of Organization

Chemical  
• Atomic  
• Molecular

Cellular  
Tissue  
Organ  
System  
Organism

Smallest

Largest



# Levels of Organization

- The chemical level of organization
  - Atoms
  - Molecules
- The **Cell** is next in complexity, in fact many billions of times more complex than molecules.
  - **Cells (and this is important!) 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.

- **Epithelium**



- **Connective Tissue**



- **Muscle**



- **Nerves**

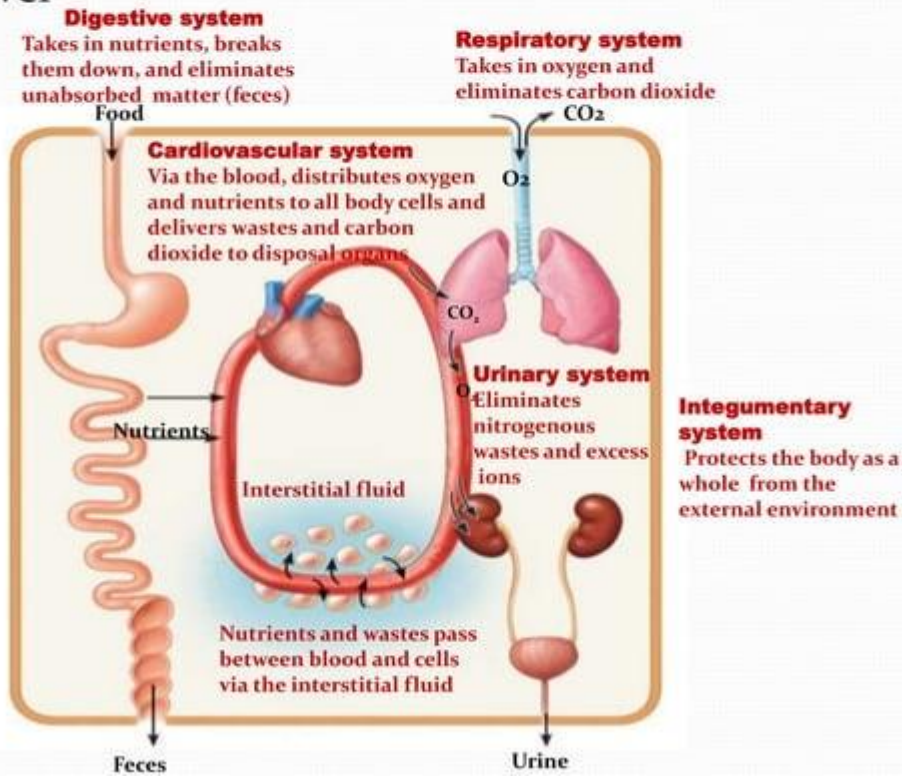


# Levels of Organization

- **Organs** are structures composed of two or more different types of tissues (all but the simplest of organs have all 4 basic tissues represented.)
- Organ systems work cooperatively to perform necessary life functions.

# Levels of Organization

## System Level



# 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**.





# Levels of Organization

1. Metabolism: All chemical reactions that occur in body cells
  - Catabolism and anabolism
2. Responsiveness: The ability to sense and respond to stimuli
  - Withdrawal reflex
3. Movement (contractility)
  - Of body parts (skeletal muscle)
  - Of substances (cardiac and smooth muscle)

# Levels of Organization

4. **Growth:** Increase in size of a body part or of organism
5. **Reproduction:**
  - Cellular division for growth or repair
  - Production of offspring
6. **Differentiation** is the development of a cell from an unspecialized to specialized state. Cells have specialized structures and functions that differ from precursor cells.

# Survival Needs

## 1. Nutrients

- Chemicals for energy and cell building
- Carbohydrates, fats, proteins, minerals, vitamins

## 2. Oxygen

- Essential for energy release (ATP production)

## 3. Water

- Most abundant chemical in the body
- Site of chemical reactions

## 4. Normal body temperature

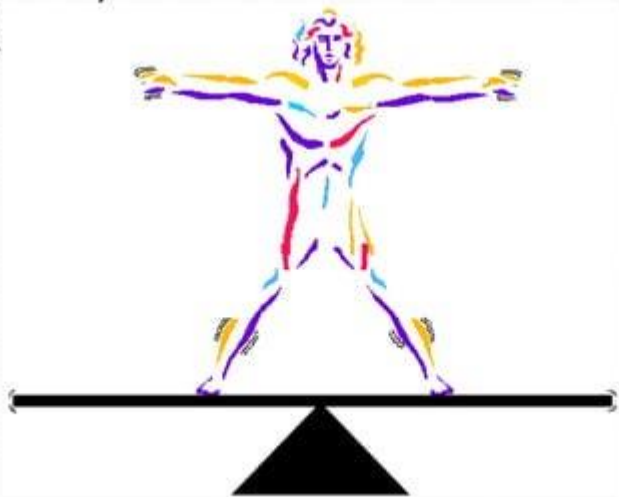
- Affects rate of chemical reactions

## 5. Appropriate atmospheric pressure

- For adequate breathing and gas exchange in the lungs

# 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 m



# 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).

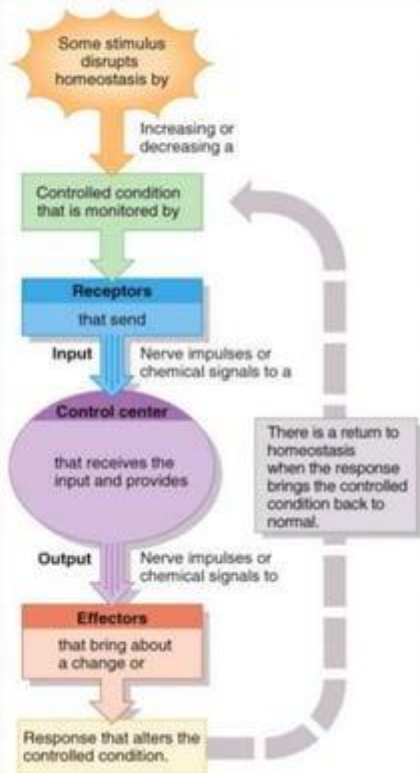
# Homeostasis

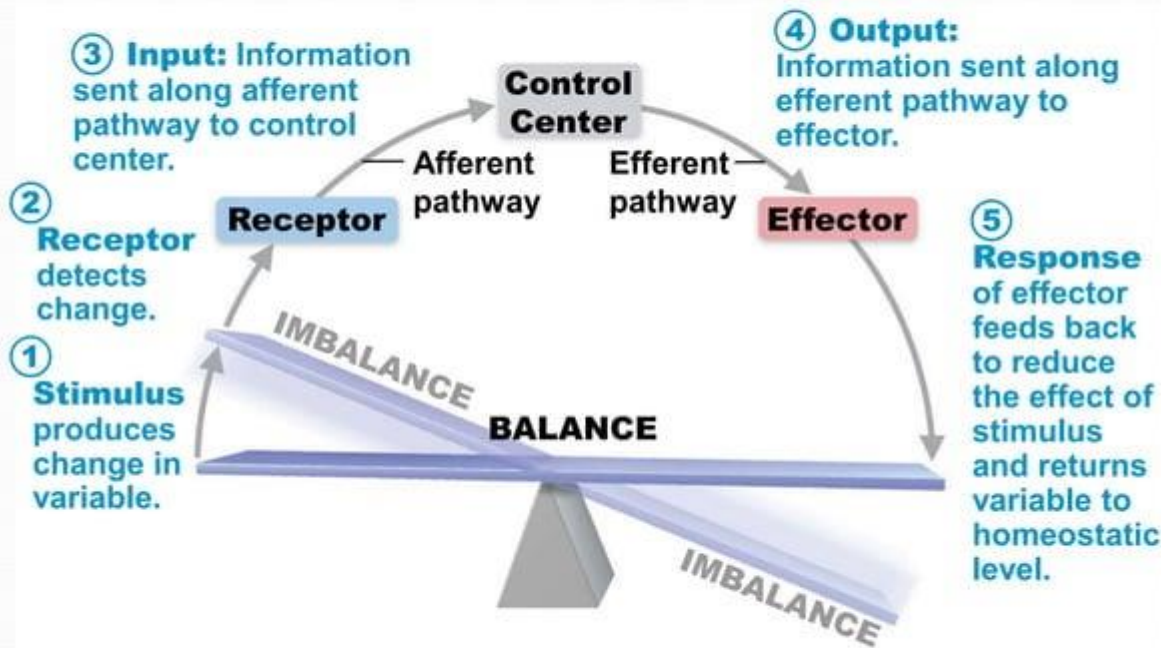
- Control of homeostasis is constantly being challenged by:
  - **Physical insults** such as intense heat or lack of oxygen
  - **Changes in the internal environment** such as a drop in blood glucose due to lack of food
  - **Physiological stress** such as demands of work or school



# 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**



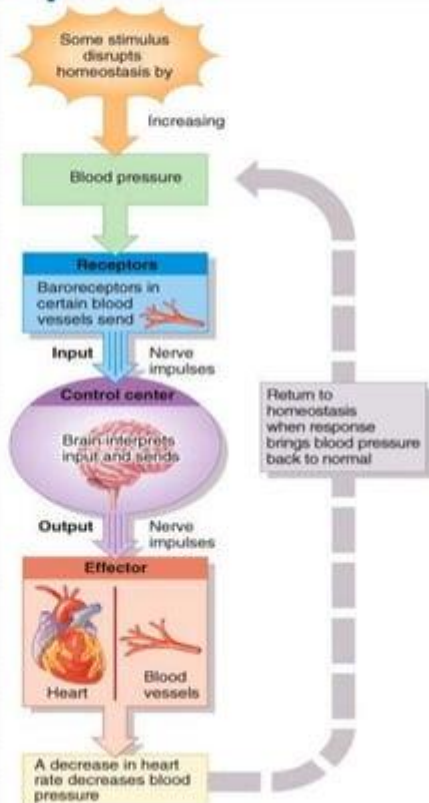


# Feedback System

- **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

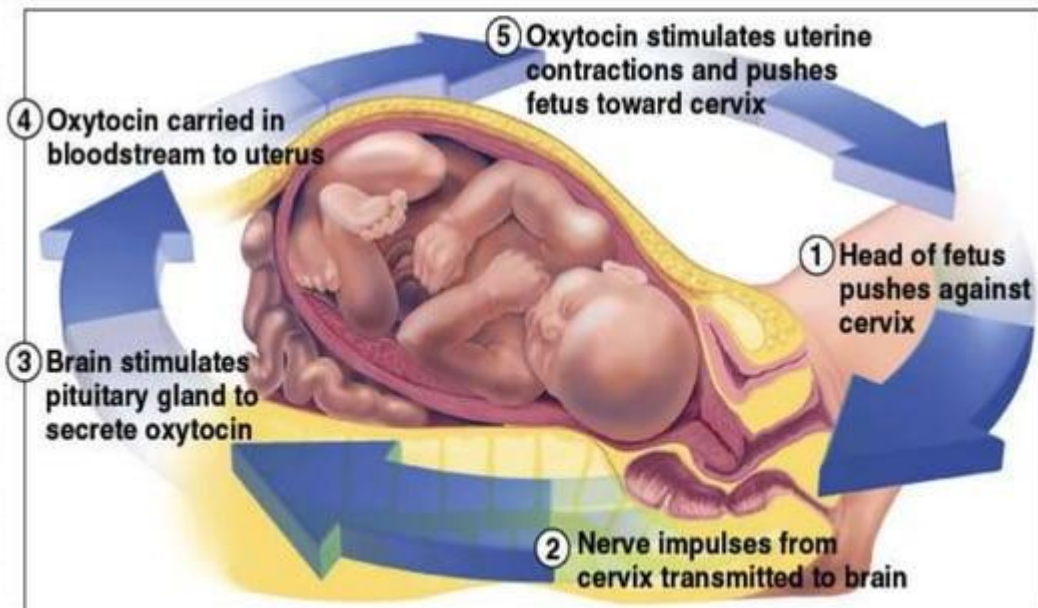
# Feedback System

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



# Feedback System

- Childbirth is an example of a positive feedback system:

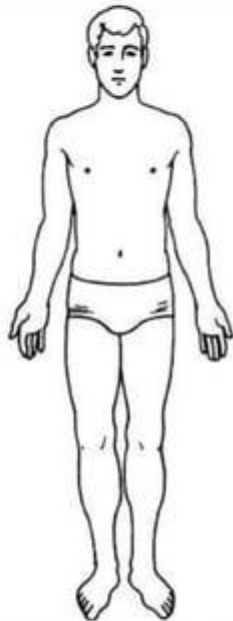




# Anatomical Terminology

- **Anatomical Position**

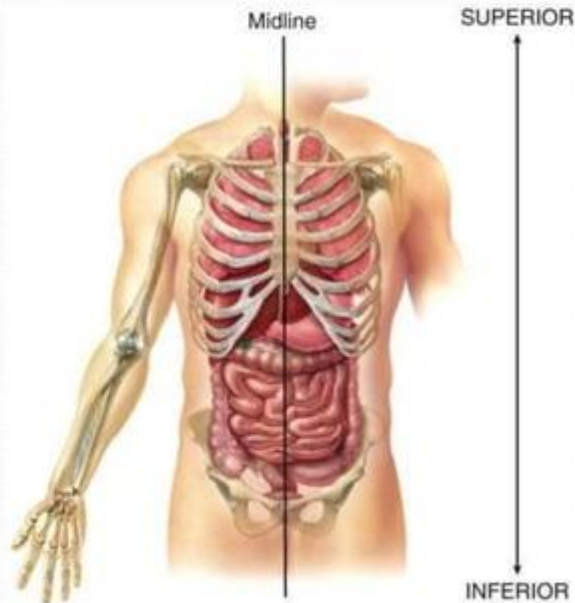
- In the anatomical position, the subject stands erect facing the observer with the head level, the eyes facing forward, feet flat on the floor directed forward, and the arms at their sides, palms forward.
- All anatomical descriptions are in reference to this position.



# Anatomical Terminology

- **Directional Terms**

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





# Anatomical Terminology

- **Directional Terms**
  - **Anterior (Ventral)**
  - **Posterior (Dorsal)**



Anterior view

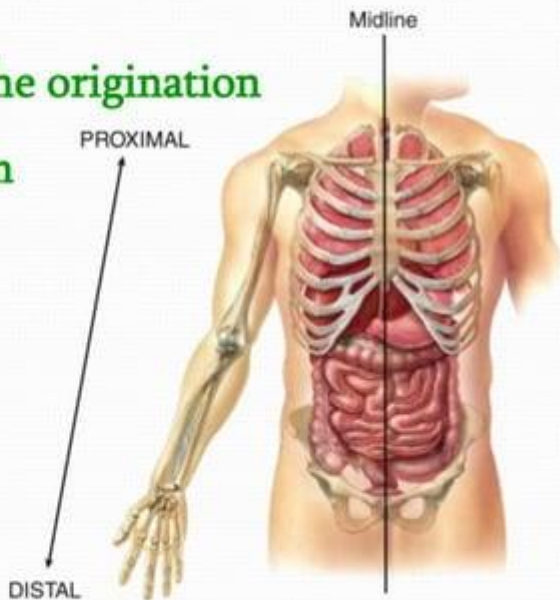


Posterior view

# Anatomical Terminology

## • Directional Terms

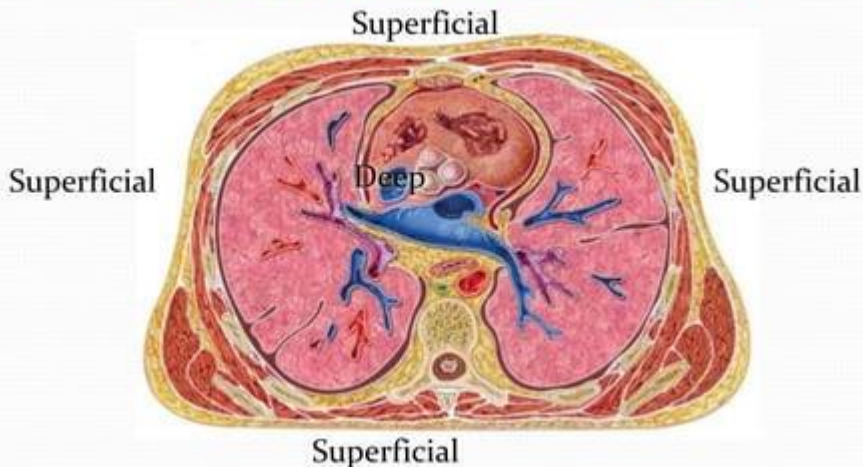
- Proximal      ▪ Nearest to the origination
- Distal        ▪ Farther from origination



# Anatomical Terminology

- **Directional Terms**

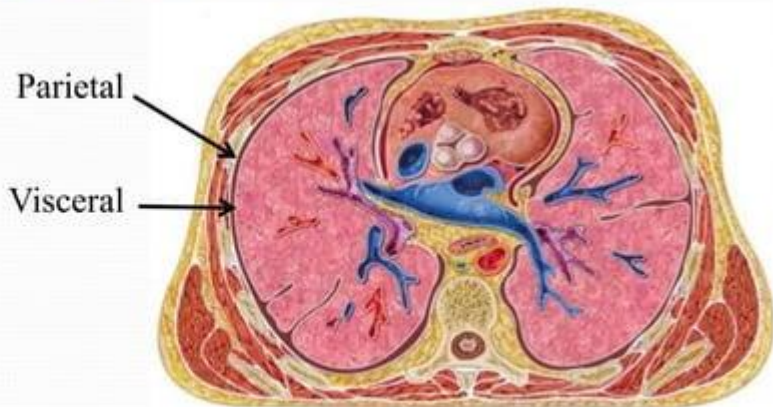
- **Superficial**   ▪ **Towards the surface**
- **Deep**       ▪ **Towards the core of the body**



# Anatomical Terminology

- **Descriptive Terms**

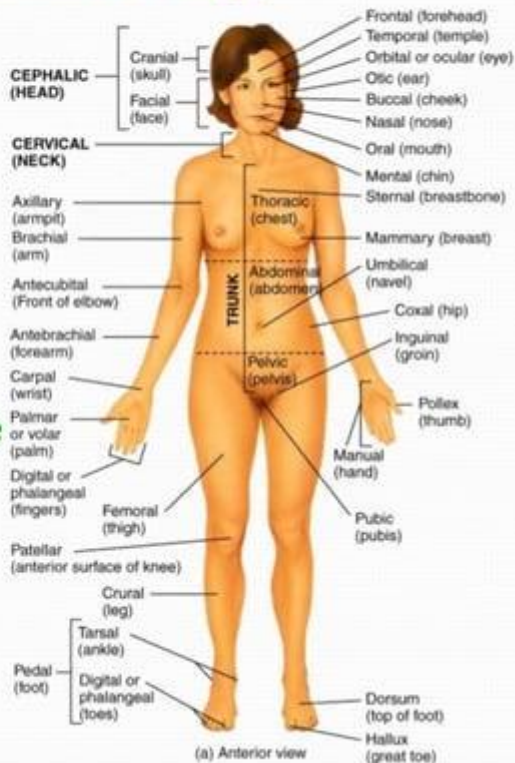
- **Visceral**      ■ **Pertaining to a covering over an organ**
- **Parietal**      ■ **Pertaining to a covering against a cavity wall**



# Anatomical Terminology

## • Regional Names

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



# 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)



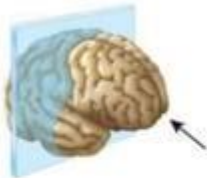
- **Frontal** (coronal)



# Body Planes



A midsagittal section of the human brain



A frontal (or coronal) brain section

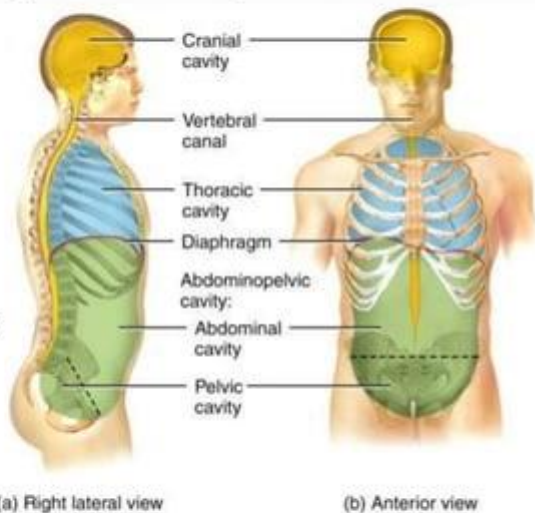


A transverse (or horizontal) brain section

# Body Cavities

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

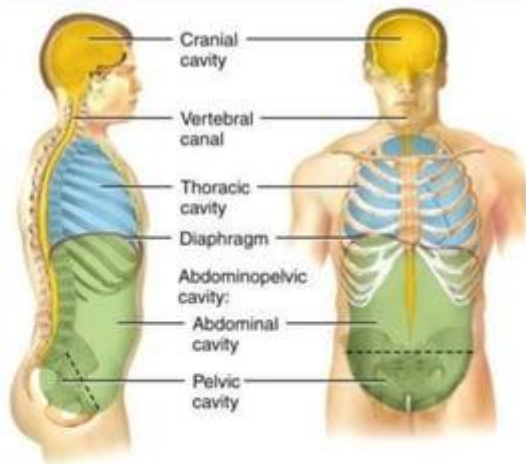
- The brain and spinal cord develop in a **dorsal cavity**.
- The remaining body organs are found in the **ventral body cavity**.





# 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
- **Meninges**
  - Layers of protective tissue that line the cranial cavity and vertebral canal

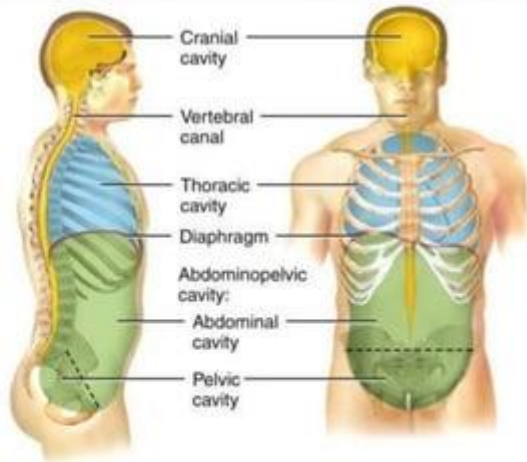


(a) Right lateral view

(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

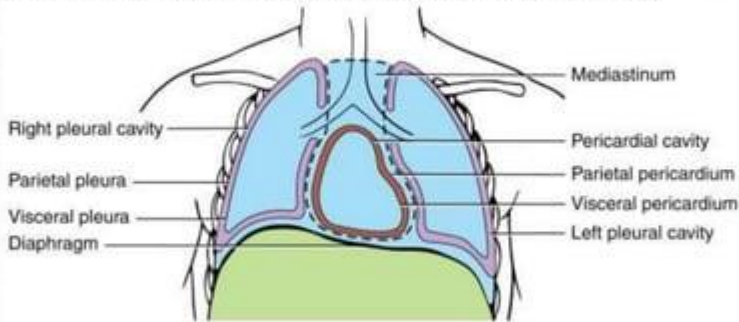


(a) Right lateral view

(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



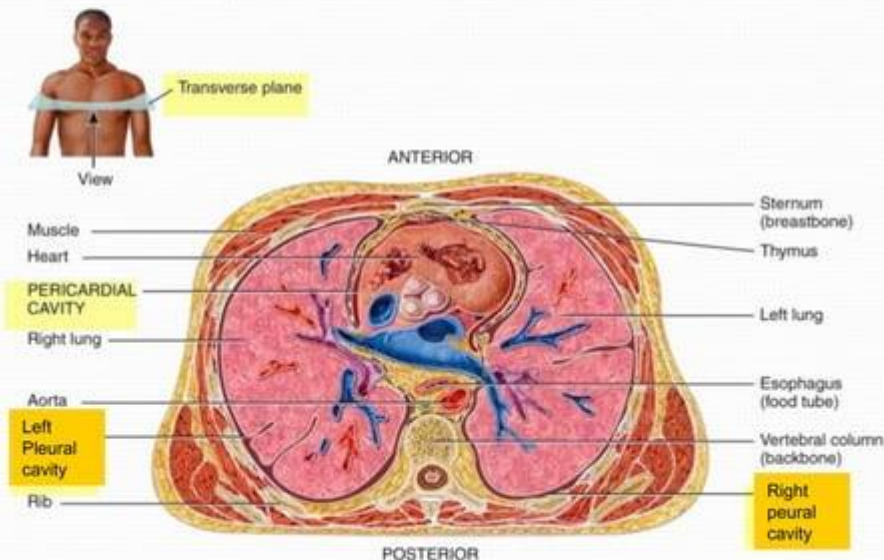
(a) Anterior view of thoracic cavity

# 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).

# Body Cavities

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



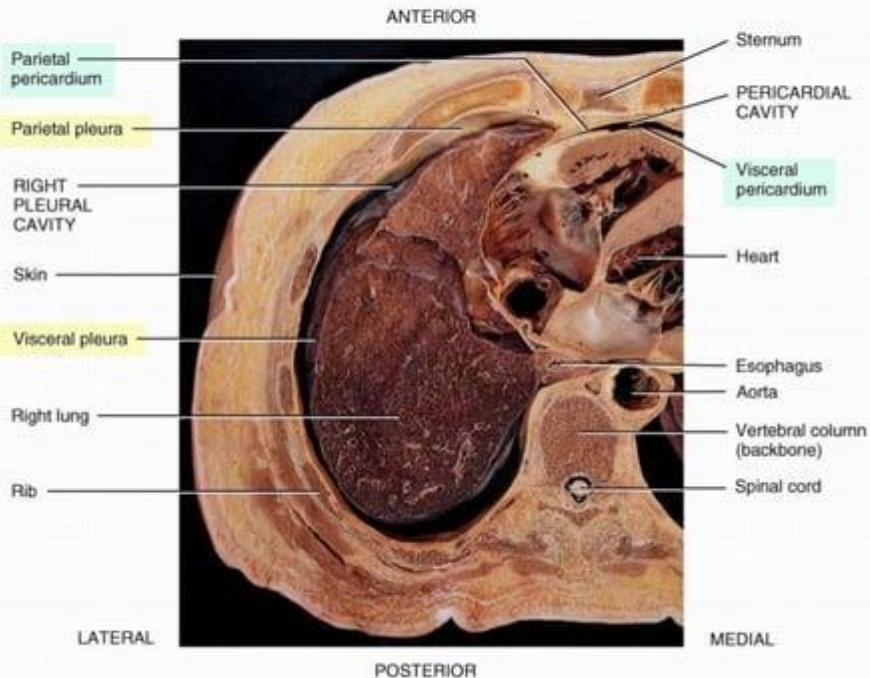
(b) Inferior view of transverse section of thoracic cavity

# 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.

# Body Cavities

- **Membranes of the body cavities**



(c) Inferior view of transverse section of thoracic cavity

# Body Cavities

- **Other body cavities**

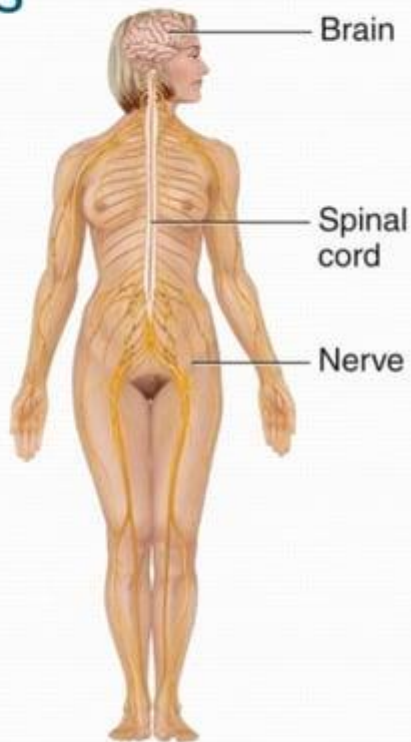
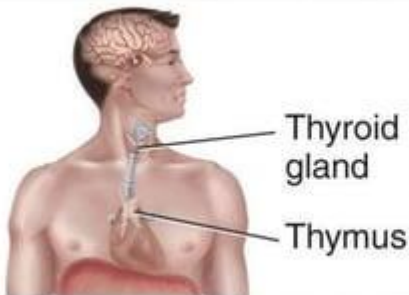
- Oral (mouth) cavity contains the tongue and teeth.
- Nasal cavity is part of the upper airways (Chapter 23).
- Orbital cavities contain the eyeballs and various nerves and blood vessels.
- Middle ear cavities contain the small bones of the middle ear.
- Synovial cavities are found in freely moveable joints like the large joints of the shoulder and hip.





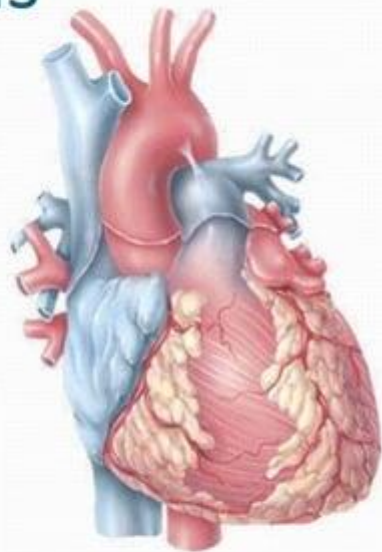
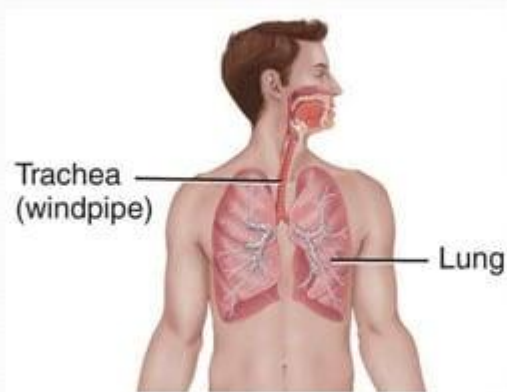
# Major Body Organs

- Brain
- Spinal Cord
- Thyroid Gland
- Thymus



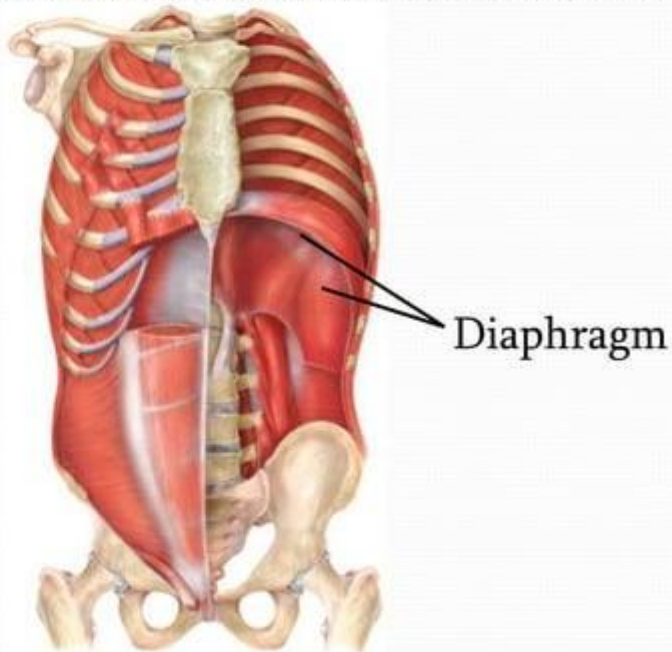
# Major Body Organs

- Lungs
- Trachea
- Superior vena cava
- Inferior vena cava
- Aorta
- Heart



# Major Body Organs

- The diaphragm is a powerful skeletal muscle that divides the thorax (thoracic cavity) from the abdomen (abdominal cavity).



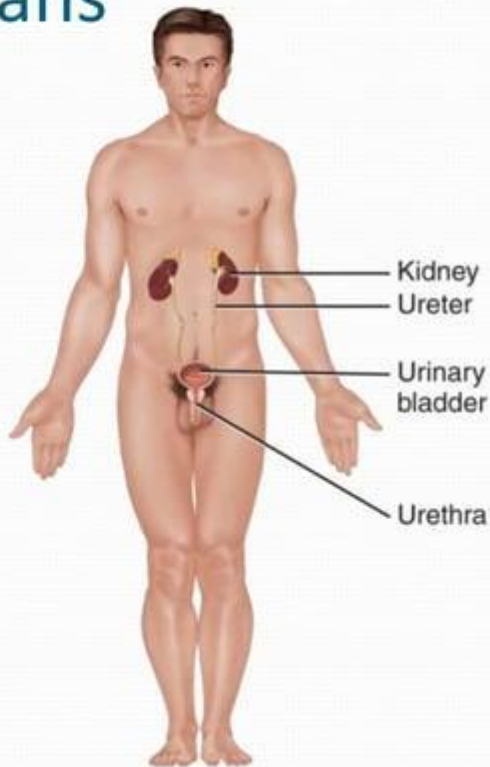
# Major Body Organs

- Trachea
- Esophagus
- Stomach
- Liver
- Small Intestine
- Large Intestine



# Major Body Organs

- Kidneys
- Urinary bladder

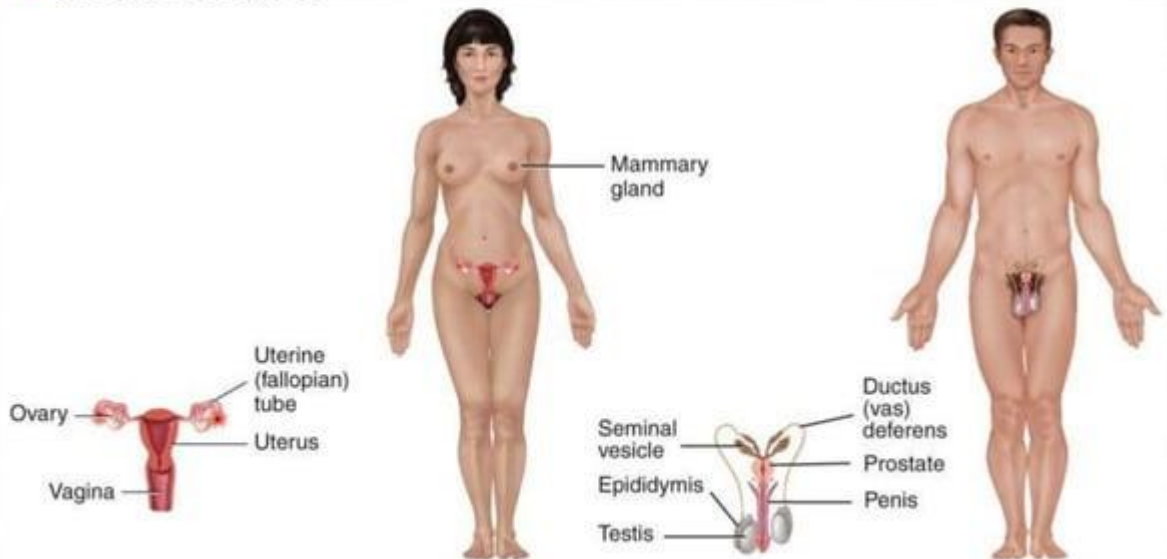


# Major Body Organs

- Ovaries
- Uterine tubes

◆ Uterus

◆ Testes



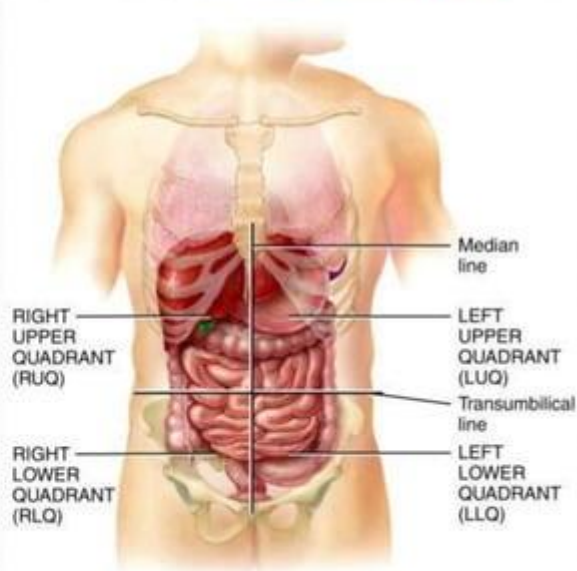
# Abdominopelvic Quadrants & Regions

- ◆ 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 ( )

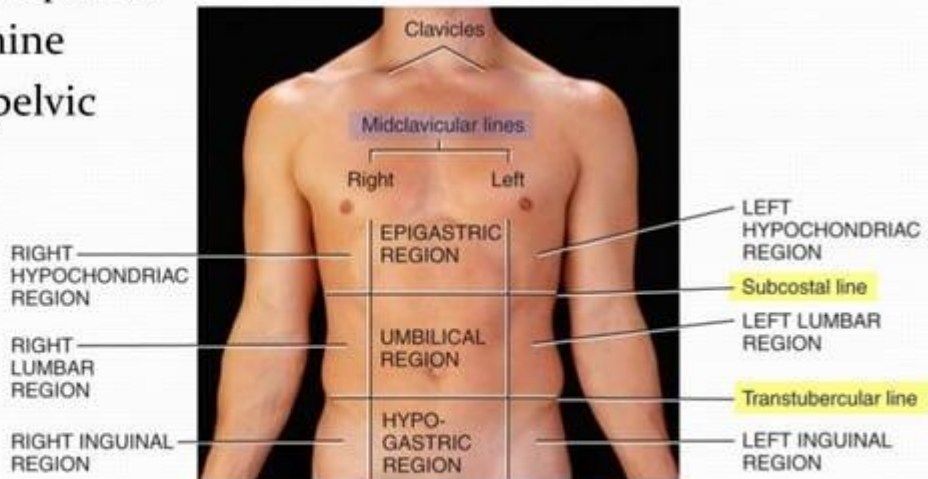


(c) Anterior view showing location of abdominopelvic quadrants



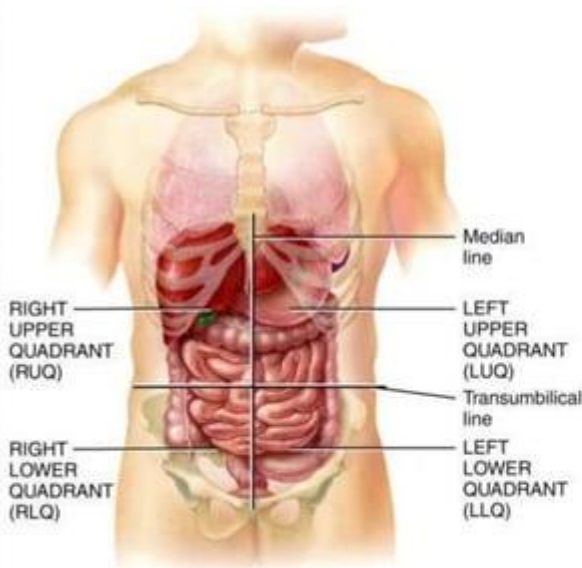
# Abdominopelvic Quadrants & Regions

- ◆ 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

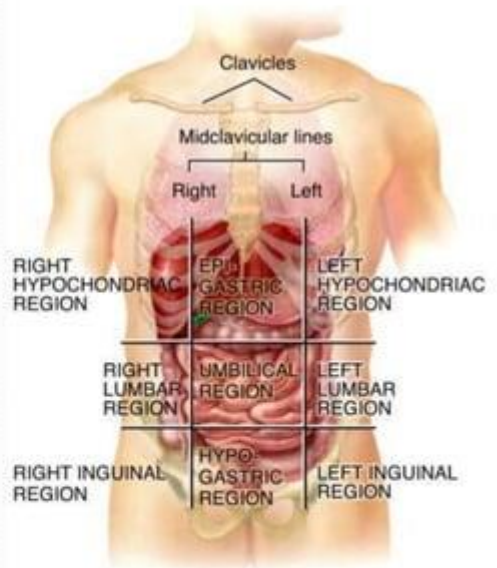


(a) Anterior view showing abdominopelvic regions

# Abdominopelvic Quadrants & Regions



(c) Anterior view showing location of abdominopelvic quadrants



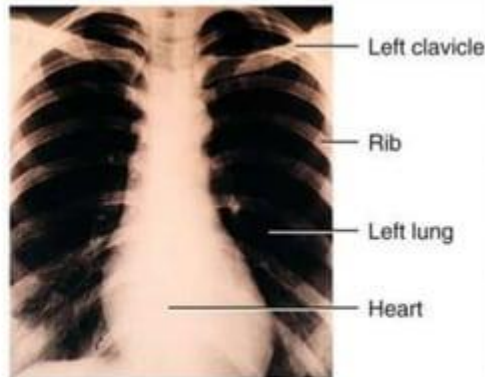
(b) Anterior view showing location of abdominopelvic regions

# 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 (breast)
      - Mammography (breast)
      - Bone densitometry (bone density)



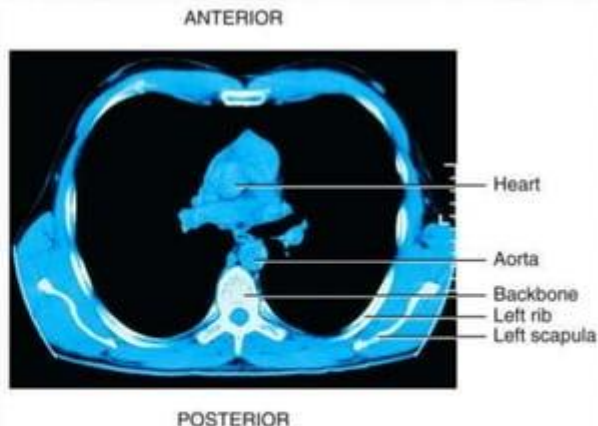
Radiograph of the thorax in anterior view

# 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

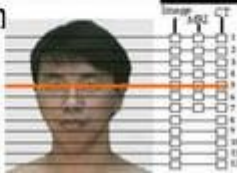
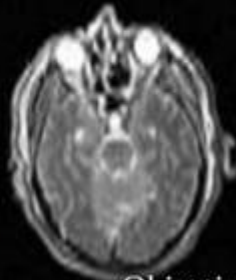
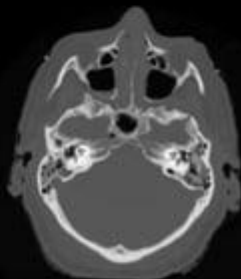
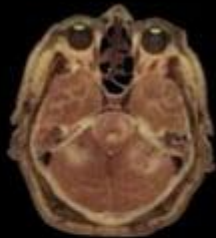
- Computed Tomography or **CT-Scans** are done using a computer to organize x-rays to form a 3D image. It is used to visualize soft tissue in more detail than conventional radiography.
  - Tissue intensities show varying degrees of gray.
  - Whole-body CT scans expose the body to a high dose of x-rays.



Computed tomography scan of the thorax in inferior view

# Medical Imaging

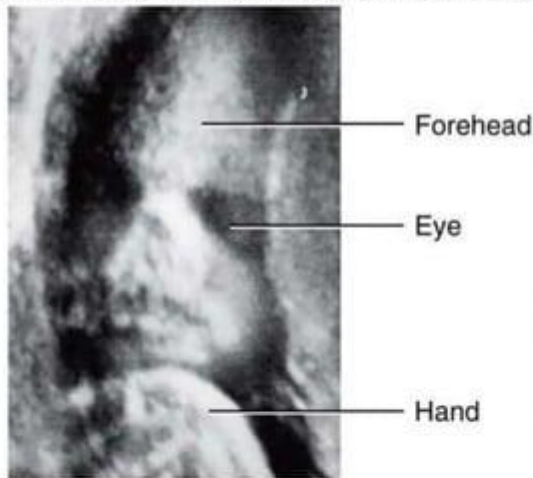
- Here are 3 cross sectional images of a head from the *Visible Human Project*. They are done using the three modalities discussed above.
- From top to bottom:
  - Photograph of frozen, sawed head
  - CT scan of the same level/plane
  - MRI scan of the same level/plane





# Medical Imaging

- Ultrasound Scanning (sonography) is done using high frequency sound waves. It is noninvasive and painless.

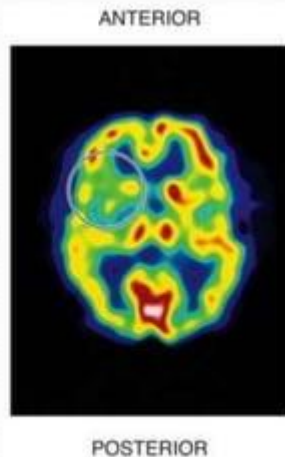


Sonogram of a fetus (Courtesy of Andrew Joseph Tortora and Damaris Soler)



# 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)



Positron emission tomography scan of a transverse section of the brain (circled area at upper left indicates where a stroke has occurred)

# 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.