

The Human Body: An Orientation

Chapter 1

Definitions

- **Anatomy - The study of the structure of body parts and their relationships to one another.**
- **It is also called morphology, the science of form**
- **Physiology - The study of the function of living organisms.**

Definitions

- **Anatomy and physiology are often taught together because the disciplines are really inseparable**

Structure and Function

- **Structure and function are interrelated**
- **The function of a structure implies that function is dependent upon structure**
 - **Anatomy and physiology are truly inseparable sciences**
 - **In architecture “form follows function”**
 - **A description of anatomy is followed by an explanation of its function, the structural characteristics contributing to that physiologic function**

Topics of Anatomy

- **Gross Anatomy**
 - **The study of large body structures visible to the naked eye**

Topics of Anatomy

- **Regional Anatomy**
 - **The study of all structures (blood vessels, nerves, muscles) located in a particular region of the body**

Topics of Anatomy

- **Systemic Anatomy**
 - **The gross anatomy of the body studied system by system**

Topics of Anatomy

- **Surface Anatomy**
 - **The study of internal body structures as they relate to the overlying skin**

Topics of Anatomy

- **Microscopic Anatomy**
 - **The study of structures too small to be seen without the aid of a microscope**

Topics of Anatomy

- *Cellular Anatomy*
 - The study of cells of the body

Topics of Anatomy

- **Histology**
 - The study of the microscopic structure of tissues

Topics of Anatomy

- **Developmental Anatomy**
 - **The study of changes in an individual from conception to old age**

Topics of Anatomy

- **Embryology**

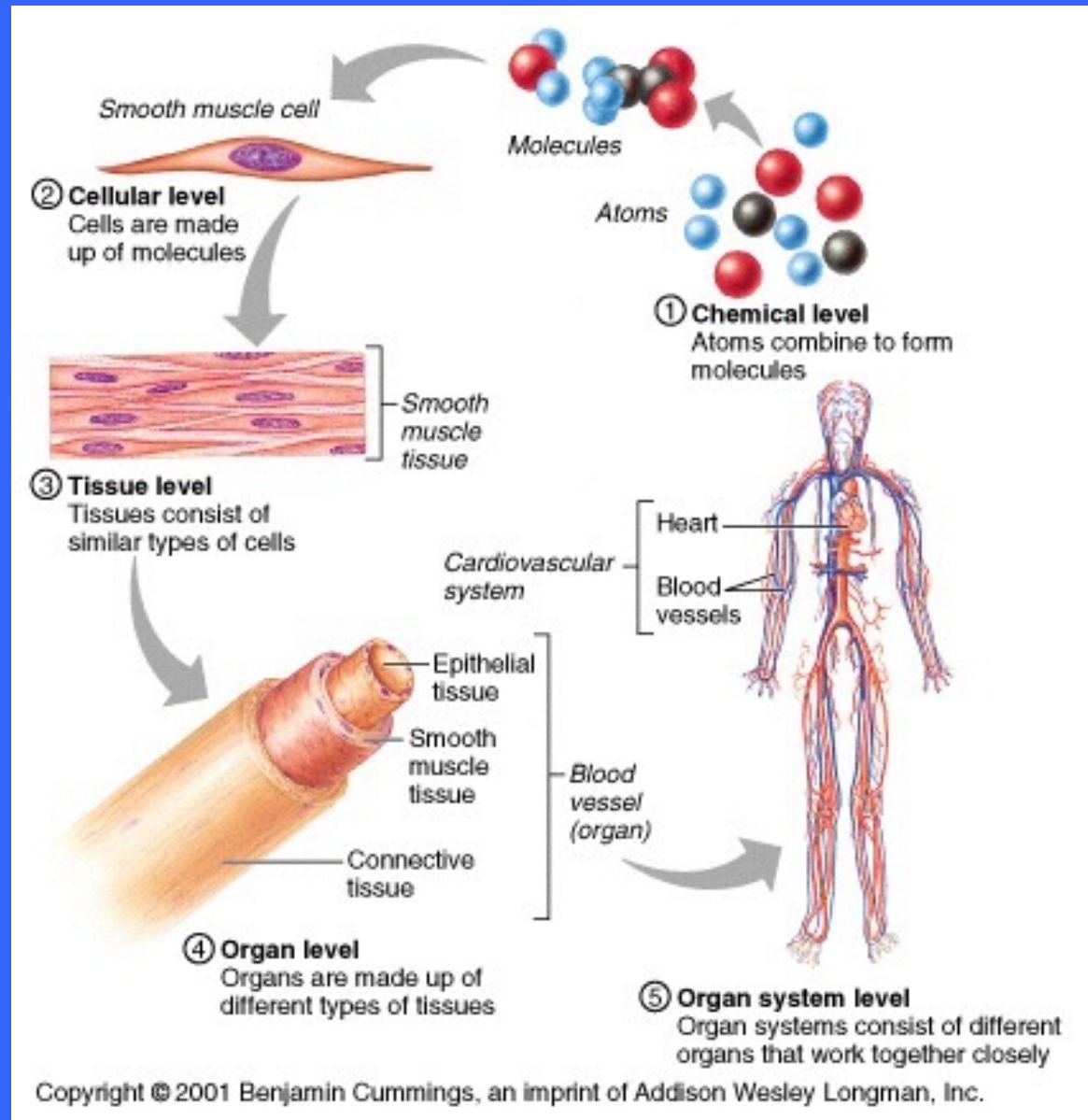
- The study of the developmental changes that occur before birth

Specialized Branches of Anatomy

- **Pathological anatomy**
 - The study structural changes in cells, tissues, and organs caused by disease
- **Radiographic anatomy**
 - The study of internal body structures by means of x-rays and imaging techniques
- **Functional morphology**
 - The study of functional properties of body structures and efficiency of design

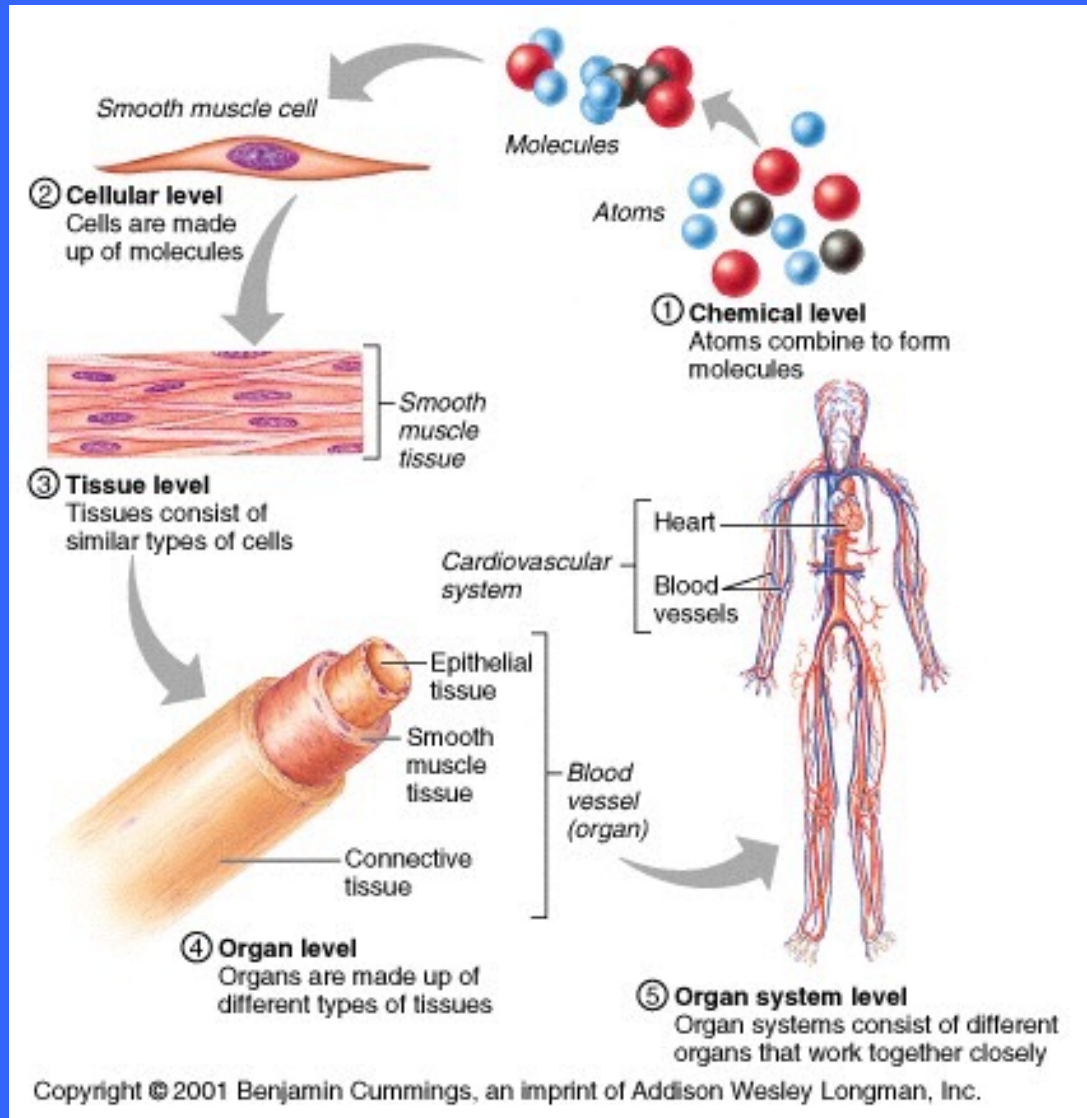
Structural Organization

- **Chemical Level**
 - At the chemical level atoms combine to form small molecules (CO_2 and H_2O) and larger macro molecules



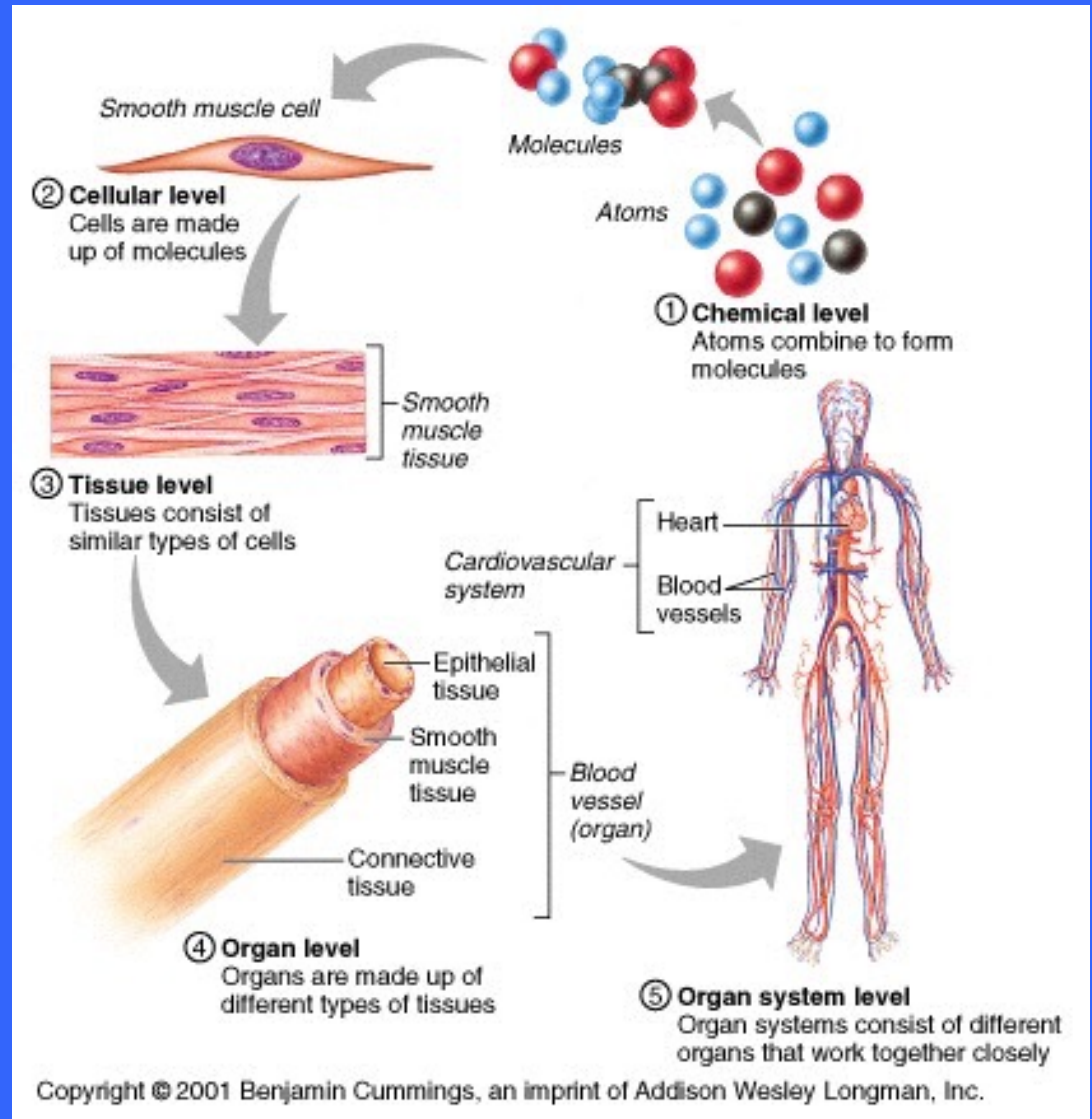
Structural Organization

- **Chemical level**
 - **Macromolecules of four classes are found in the body**
 - **These macro molecules include carbohydrates (sugars), lipids (fats), proteins and nucleic acids (DNA, RNA)**



Structural Organization

- **Cellular Level**
 - The smallest units of living tissue
 - Cells and their functional subunits called cellular organelles

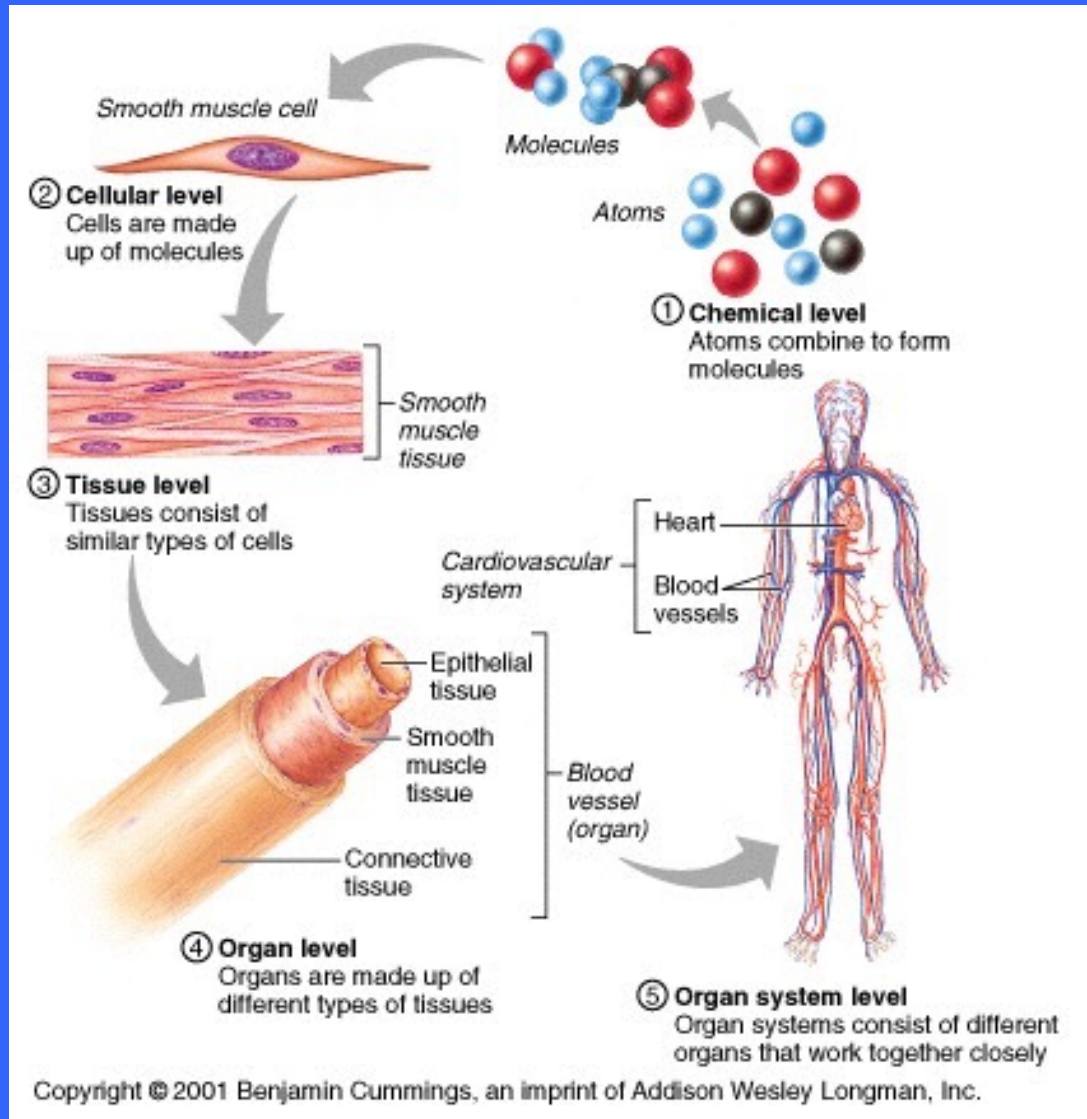


Structural Organization

■ Tissue Level

– Consists of groups of similar cells that have a characteristic function

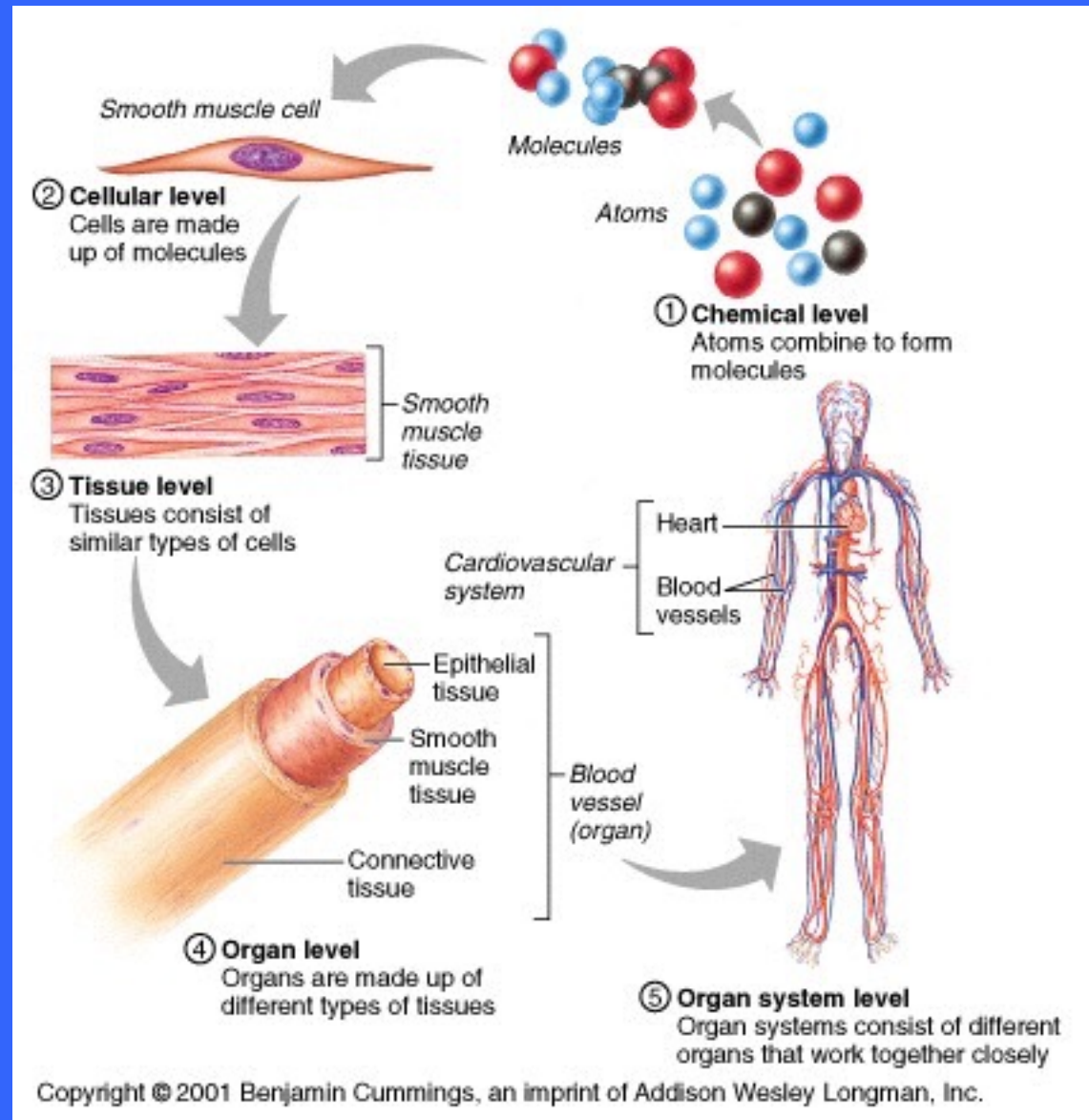
- epithelium
- muscle
- connective
- nervous



Structural Organization

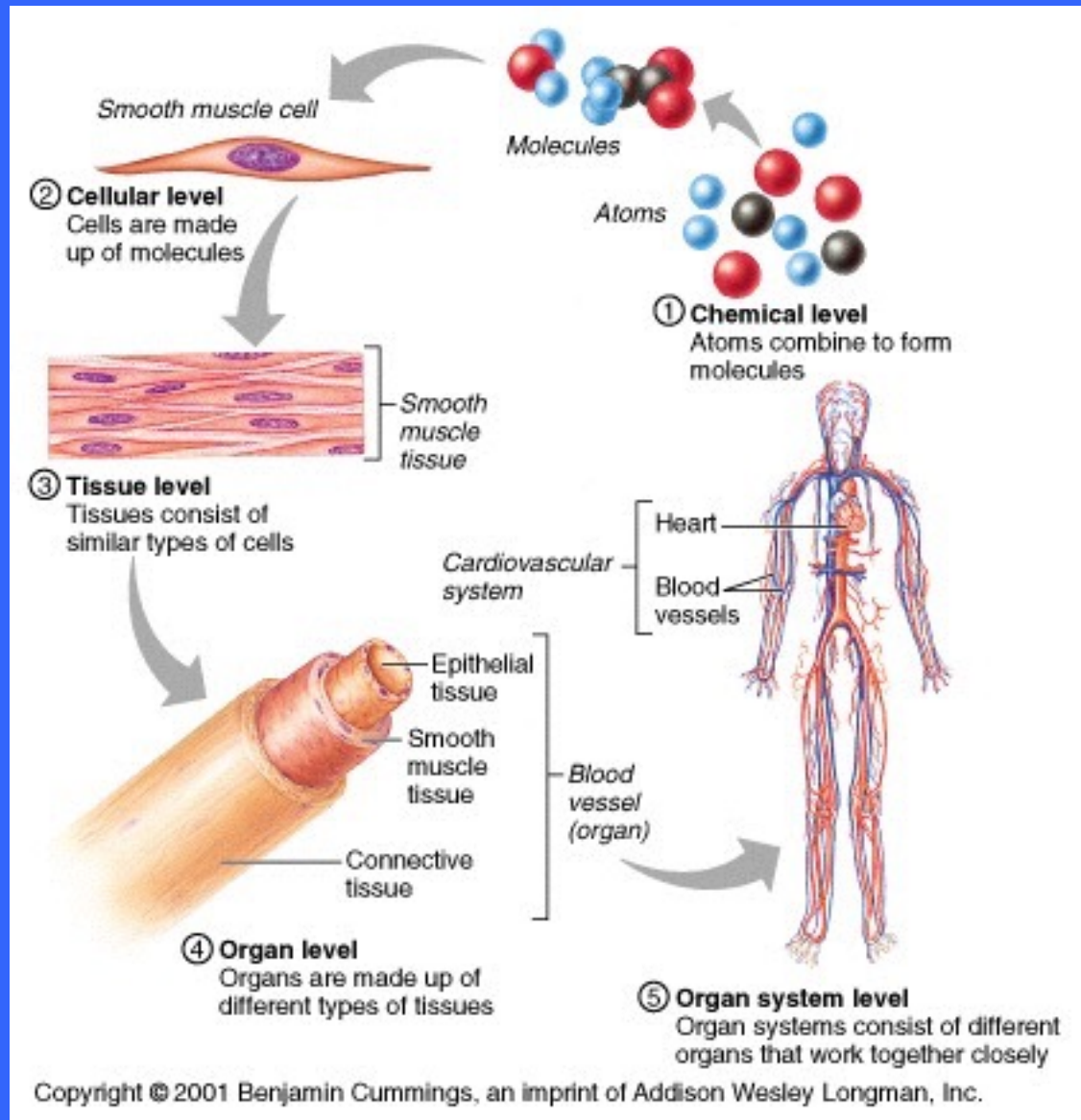
■ Organ Level

- A structure composed of at least two tissue types (with four the most common) that performs a specific physiological process or function



Structural Organization

- **Organ System Level**
 - Organs that cooperate with one another to perform a common function
 - Cardiovascular system is illustrated

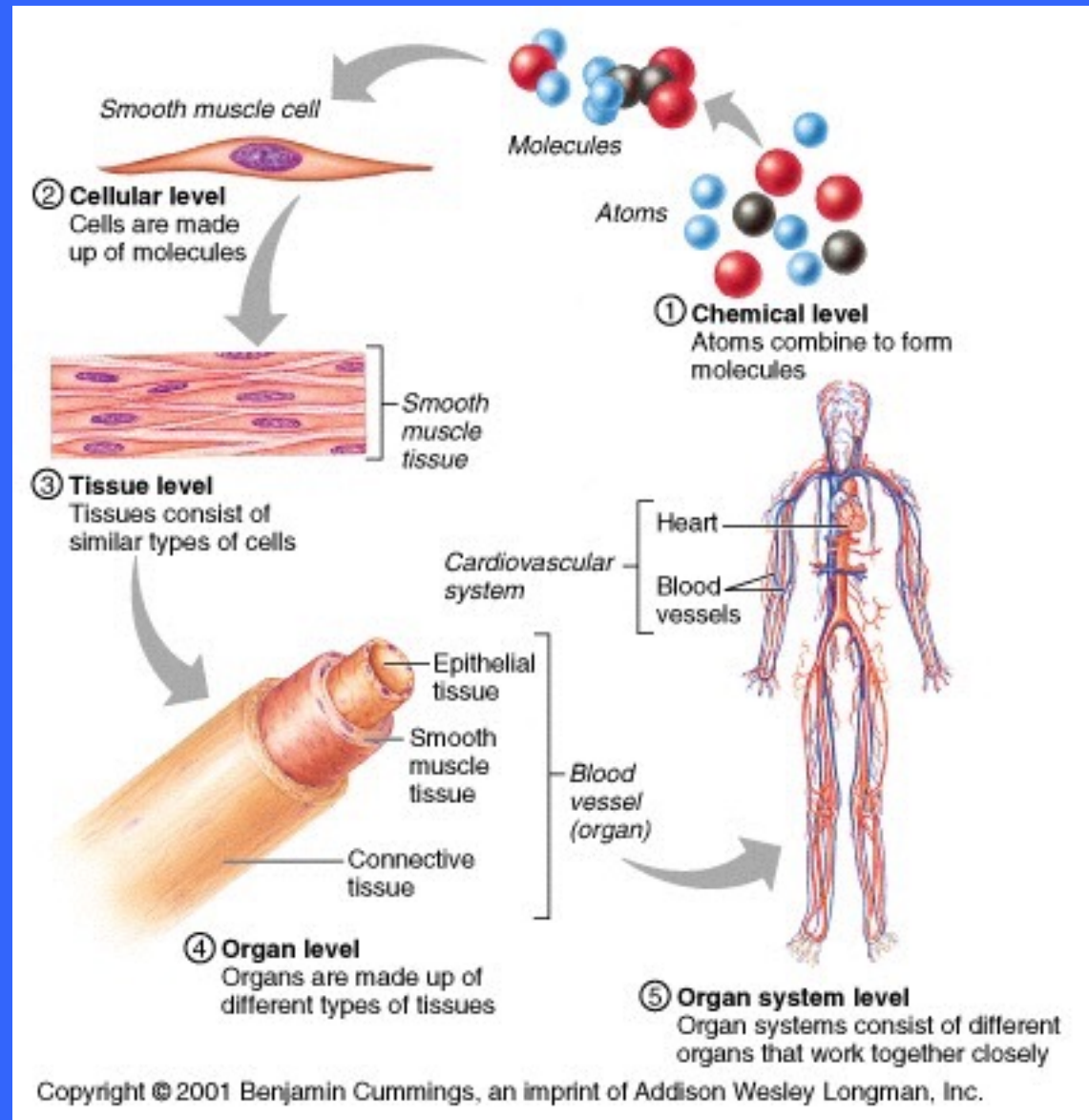


Structural Organization

- **The 11 human organ systems**
 - **Integumentary, skeletal, muscular, nervous, endocrine, cardiovascular*, lymphatic*, immune, respiratory, digestive, urinary, and reproductive**
 - **The cardiovascular and lymphatic are collectively known as the circulatory system because of their interrelated roles in circulating fluids**

Structural Organization

- **Organism Level**
 - The highest level of organization, the living organism
 - At this level life is sustained by the sustain efforts of the simpler levels



Homeostasis

- **Definition**
- **Control Mechanisms**
- **Negative feedback**
- **Positive feedback**
- **Homeostatic imbalances**

Homeostasis

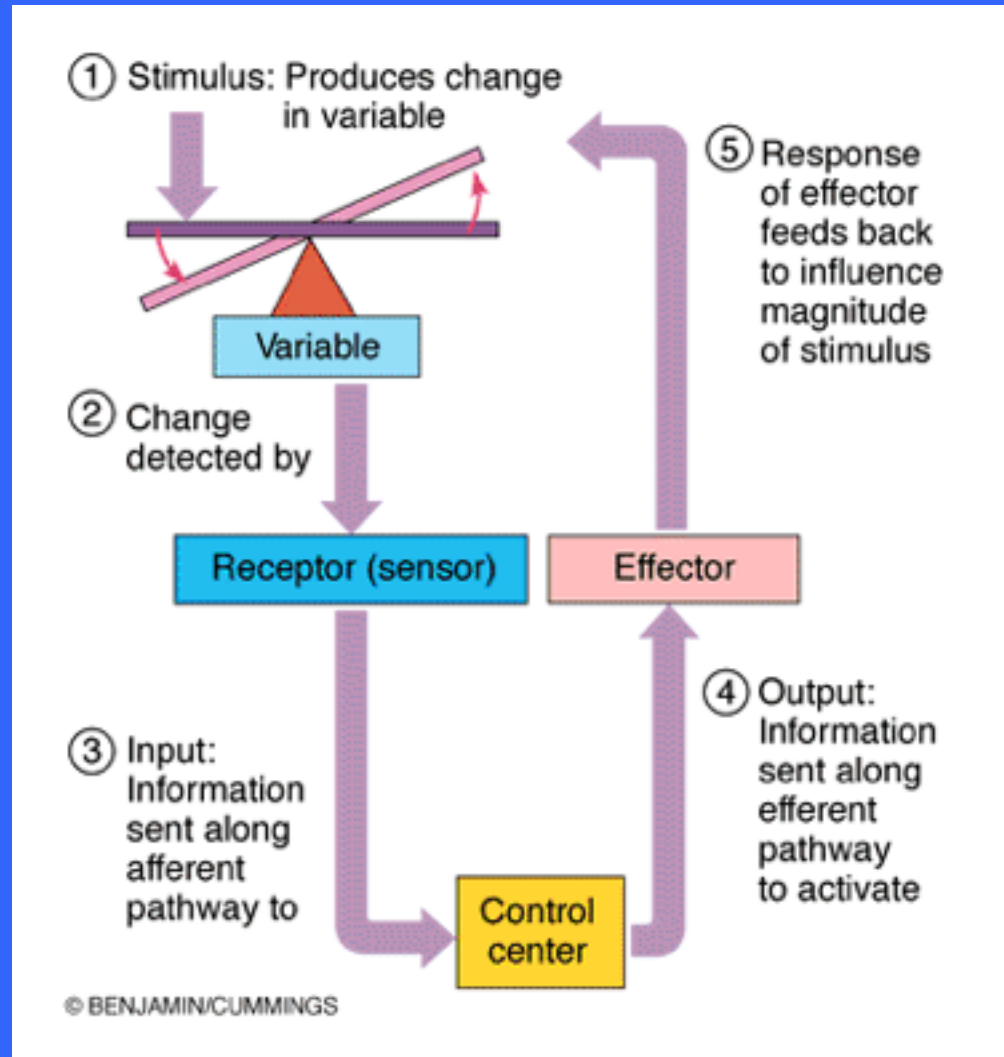
- **The ability of the body to maintain relatively stable internal conditions even though there is continuous change in the outside world**
 - **A state of dynamic equilibrium**
 - **The body functions within relatively narrow limits**
 - **All body systems contribute to its maintenance**

Control Mechanisms

- **Regardless of the factor or event (variable) being regulated, all homeostatic control mechanisms have at least three interdependent components**
 - **Receptor (stimuli of change is detected)**
 - **Control center (determines response)**
 - **Effector (bodily response to the stimulus)**

Control Mechanisms

■ Regulation of homeostasis is accomplished through the nervous and endocrine systems



Control Mechanisms

- **A chain of events . . .**
 - **Stimulus produces a change in a variable**
 - **Change is detected by a sensory receptor**
 - **Sensory input information is sent along an afferent pathway to control center**
 - **Control center determines the response**
 - **Output information sent along efferent pathway to activate response**
 - **Monitoring of feedback to determine if additional response is required**

Negative Feedback Mechanisms

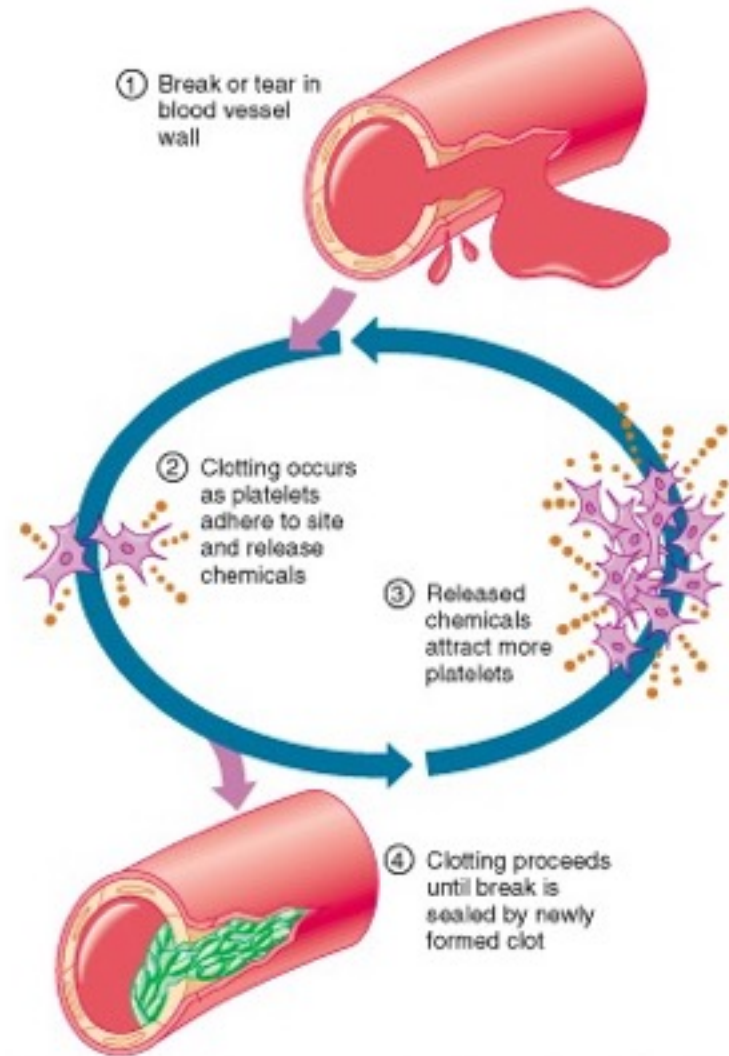
- **Most control mechanisms are negative feedback mechanisms**
- **A negative feedback mechanism decreases the intensity of the stimulus or eliminates it**
- **The negative feedback mechanism causes the system to change in the opposite direction from the stimulus**
 - **Example: home heating thermostat**

Positive Feedback Mechanisms

- **A positive feedback mechanism enhances or exaggerates the original stimulus so that activity is accelerated**
- **It is considered positive because it results in change occurring in the same direction as the original stimulus**
- **Positive feedback mechanisms usually control infrequent events such as blood clotting or childbirth**

Positive Feedback Mechanism

- Break or tear in blood vessel wall
- Clotting occurs as platelets adhere to site and release chemicals
- Released chemical attract more platelets
- Clotting proceeds until break is sealed by newly formed clot



Homeostatic Imbalances

- **Most diseases cause homeostatic imbalances (chills, fevers, elevated white blood counts etc)**
- **Aging reduces our ability to maintain homeostasis**
 - Heat stress

Scale: Length, Volume & Height

- **The metric system is used to describe the dimensions of cells, tissues and organs**
 - **Meters (6 feet is 1.83 meters)**
 - **Centimeters (2.54 centimeters in an inch)**
 - **Micrometer (millionth of a meter - μm)**
 - **Liter (slightly larger than a quart)**
 - **Milliliter (a thousandth of a liter)**
 - **Kilogram (about 2.2 pounds)**
 - **Gram (thousandth of a kilogram)**

Scale: Length, Volume & Height

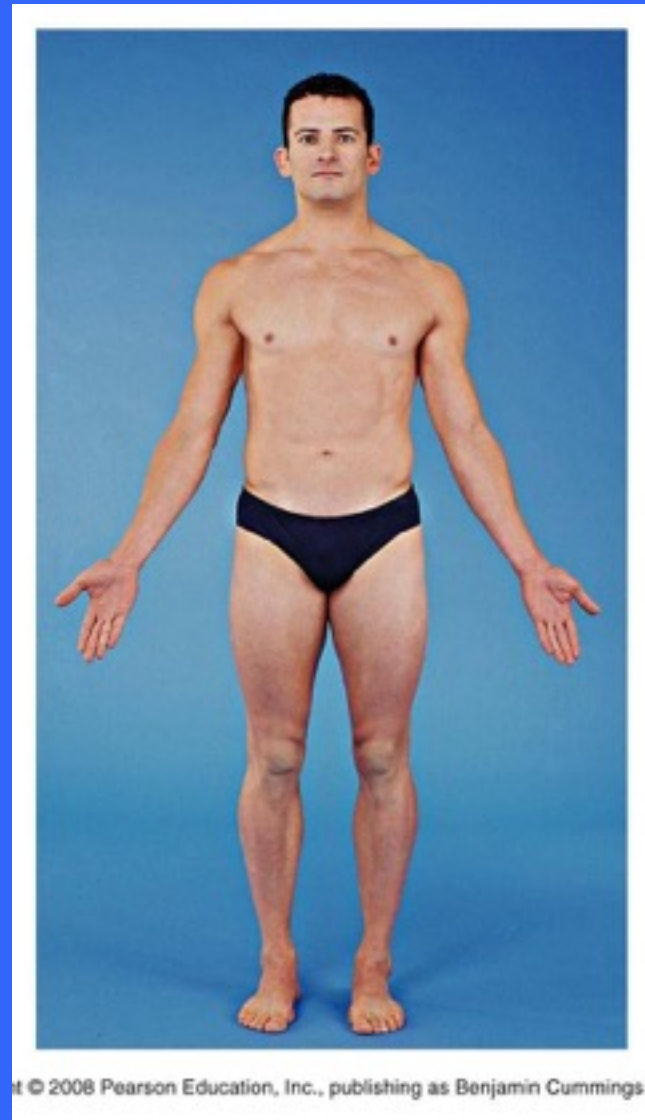
- **The metric system is used to describe the dimensions of cells, tissues and organs**
 - **Micrometers**
 - **Human cells average about 10 μm in diameter**
 - **Cells can range from 5 μm to 100 μm**
 - **Axons of nerve cells can be almost a meter in length**
 - **Human ovum (egg cell) is the largest human cell**

Gross Anatomy: Introduction

- **Anatomical position**
- **Directional terms**
- **Regional terms**
- **Body planes and sections**
- **Body cavities and membranes**
- **Abdominopelvic regions and quadrants**

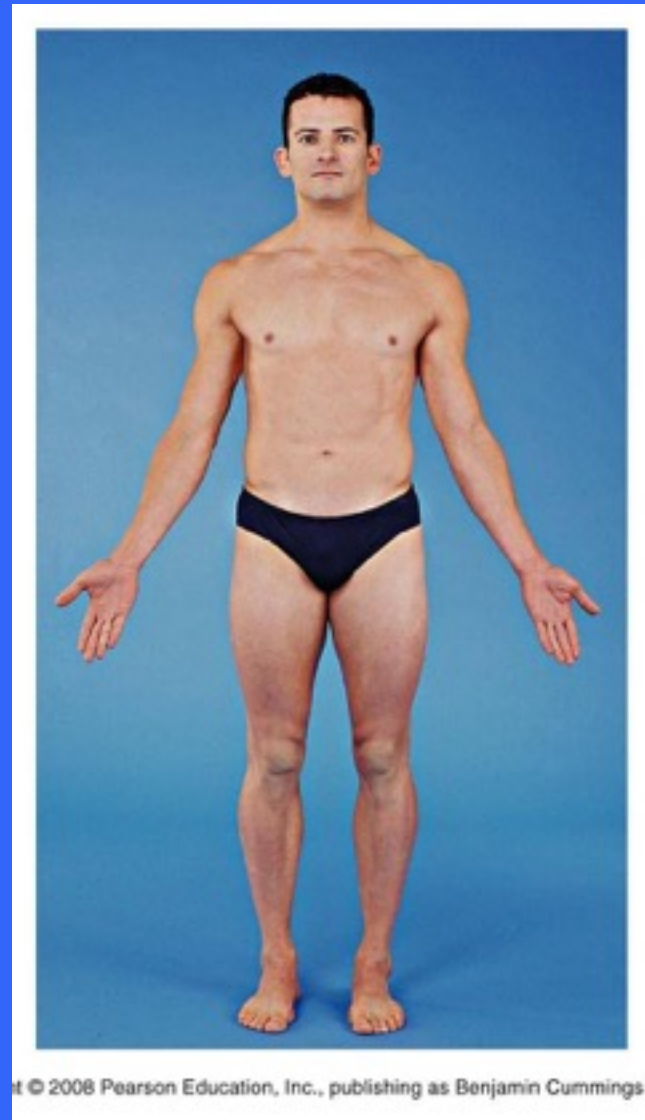
Anatomical Position

- **Anatomical position**
 - Body erect with feet together
 - Arms at side with palms forward
- **The anatomical position is the common visual reference point**

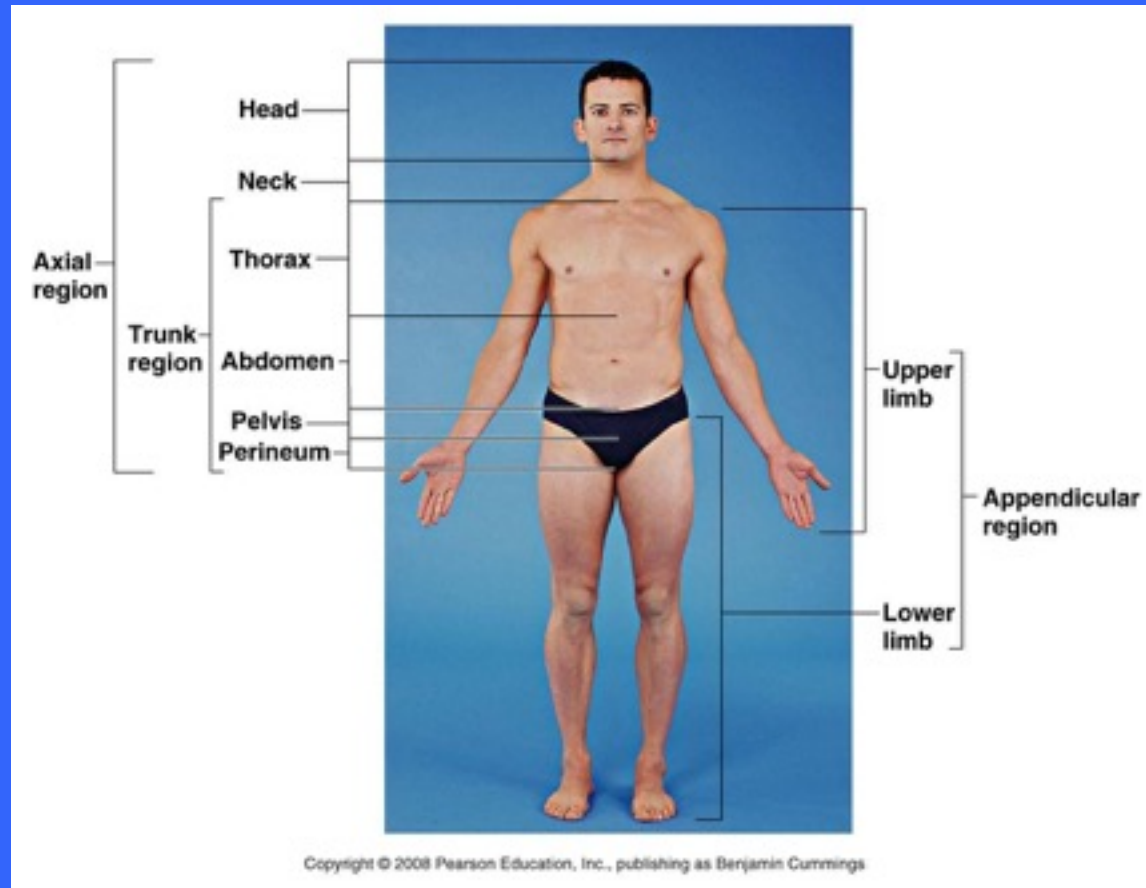


Anatomical Position

- **Directional terms used in anatomy reference deviations from the anatomical position (e.g. abduction of arm)**
- **Additionally, the terms right and left always refer to the person, cadaver, or skeleton being viewed and are not the viewers right and left.**



Directional and Regional Terms



- **Regional terms are the names of specific body areas. The areas labeled here pertain to the fundamental divisions of the body.**

Directional and Regional terms

- **There are two fundamental divisions of our body**
 - **Axial**
 - **Head,**
 - **Neck**
 - **Trunk**
 - **Appendicular**
 - **Shoulder / Arm**
 - **Pelvis / Leg**
- **Regional terms are used to designate specific areas within the major body divisions**
 - **Carpal / wrist**
 - **Oral / mouth**
 - **Femoral / thigh**
 - **Refer to Figure 1.4**

Cephalic

Frontal
Orbital
Nasal
Oral
Mental

Cervical**Thoracic**

Sternal
Axillary
Mammary

Abdominal

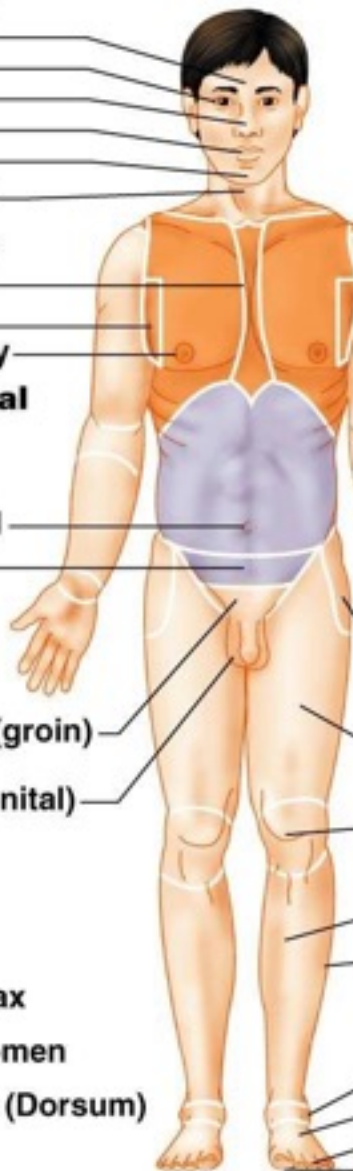
Umbilical

Pelvic

Inguinal (groin)

Pubic (genital)**Key:**

= Thorax
 = Abdomen
 = Back (Dorsum)

**(a) Anterior/Ventral****Upper limb**

Acromial
Brachial (arm)
Antecubital
Olecranal
Antebrachial (forearm)
Carpal (wrist)

Manus (hand)

Pollex
Metacarpal
Palmar
Digital

Lower limb

Coxal (hip)
Femoral (thigh)
Patellar
Popliteal
Crural (leg)
Sural (calf)
Fibular or peroneal

Pedal (foot)

Tarsal (ankle)
Calcaneal
Metatarsal
Digital
Plantar
Hallux

**(b) Posterior/Dorsal****Cephalic**

Otic
Occipital (back of head)

Cervical**Back (dorsal)**

Scapular
Vertebral
Lumbar
Sacral
Gluteal

Perineal (between anus and external genitalia)

Directional Terms

- **Superior** **Toward the head end or upper part of a structure or the body**
- **Inferior** **Away from the head end or toward the lower part of a structure or the body**

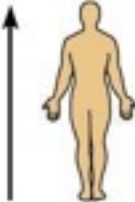
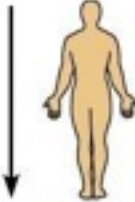
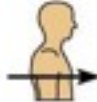
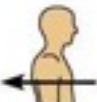
– Refer to table 1.1 on page 8

Directional Terms

- **Anterior** **Toward or at the front of the body (ventral)**
- **Posterior** **Toward the back of the body; behind (dorsal)**

TABLE

1.1 Orientation and Directional Terms

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

*Whereas the terms *ventral* and *anterior* are synonymous in humans, this is not the case in four-legged animals. *Ventral* specifically refers to the "belly" of a vertebrate animal and thus is the inferior surface of four-legged animals. Likewise,

although the dorsal and posterior surfaces are the same in humans, the term *dorsal* specifically refers to an animal's back. Thus, the dorsal surface of four-legged animals is their superior surface.

Directional Terms

- **Medial** **Toward or at the midline of the body**
- **Lateral** **Away from the midline of the body**
- **Intermediate** **Between a more medial and a more lateral structure**



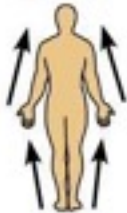

Directional Terms

- **Proximal** **Closer to the origin of the body part, or the point of attachment of a limb to the body trunk**
- **Distal** **Farther from the origin of a body part or the point of attachment of a limb to the body trunk**

TABLE

1.1

Orientation and Directional Terms





Term	Definition		Example
Medial	Toward or at the midline of the body; on the inner side of		The heart is medial to the arm.
Lateral	Away from the midline of the body; on the outer side of		The arms are lateral to the chest.
Proximal	Closer to the origin of the body part or the point of attachment of a limb to the body trunk		The elbow is proximal to the wrist.
Distal	Farther from the origin of a body part or the point of attachment of a limb to the body trunk		The knee is distal to the thigh.

Directional Terms

- **Superficial** **Toward or at the body surface**
- **Deep** **away from the body surface; more internal**

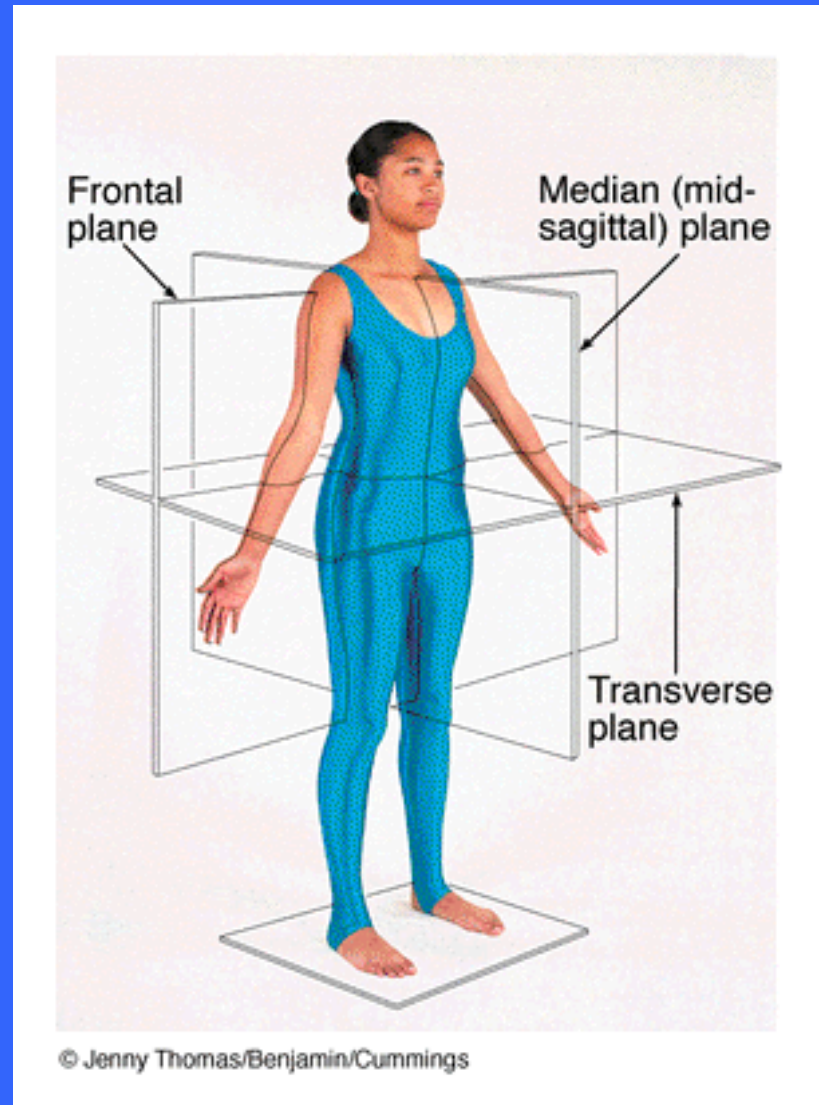
TABLE

1.1 Orientation and Directional Terms

Term	Definition		Example
Superficial (external)	Toward or at the body surface		The skin is superficial to the skeletal muscles.
Deep (internal)	Away from the body surface; more internal		The lungs are deep to the skin.
Ipsilateral	On the same side		The right hand and right foot are ipsilateral.
Contralateral	On opposite sides		The right hand and left foot are contralateral.

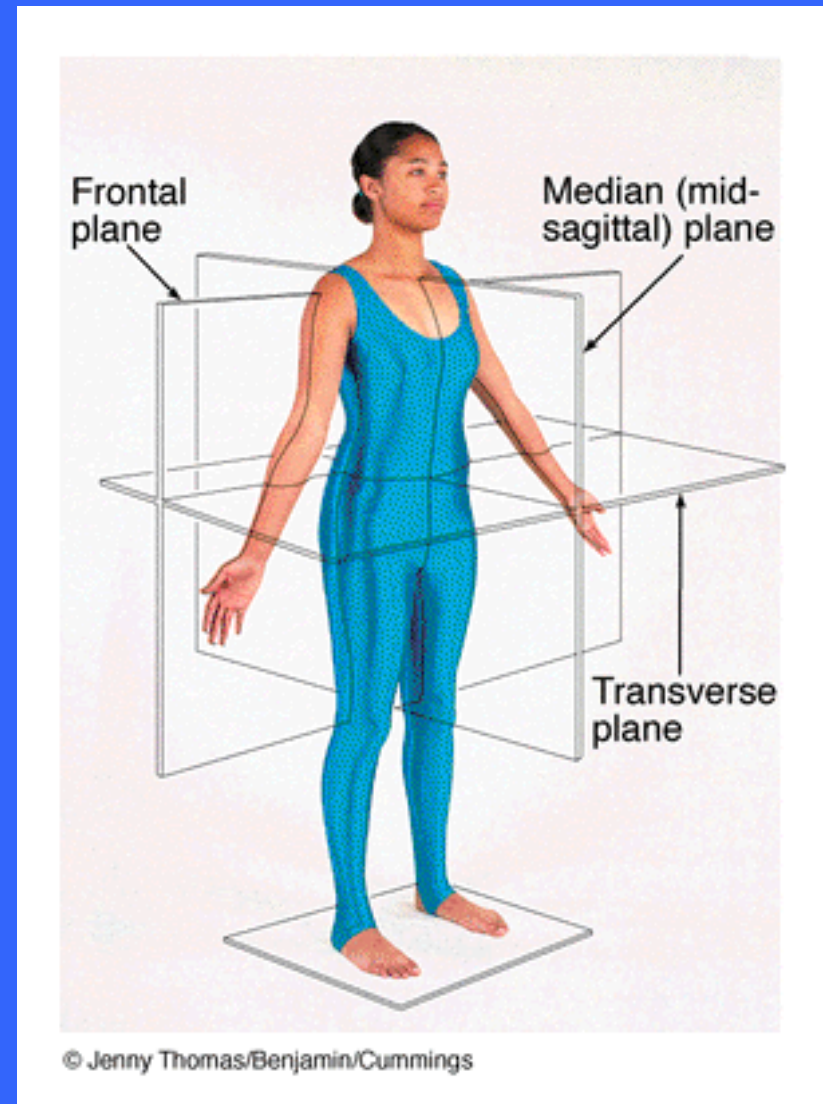
Body Planes and Sections

- The most frequently used body planes are sagittal, frontal and transverse which are at right angles to each other
- A section bears the name of the plane along which it is cut



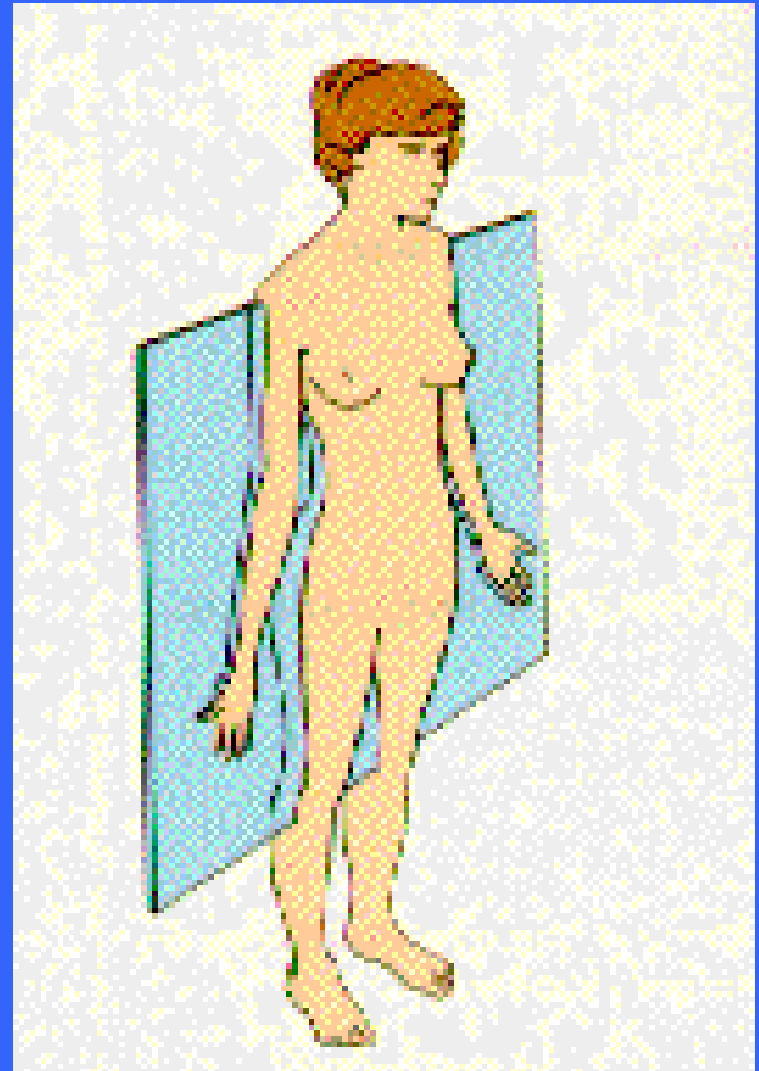
Body Planes and Sections

- In the study of anatomy, the body is often sectioned (cut) along a flat surface called a plane
- Planes section the body through portions of the anatomical position



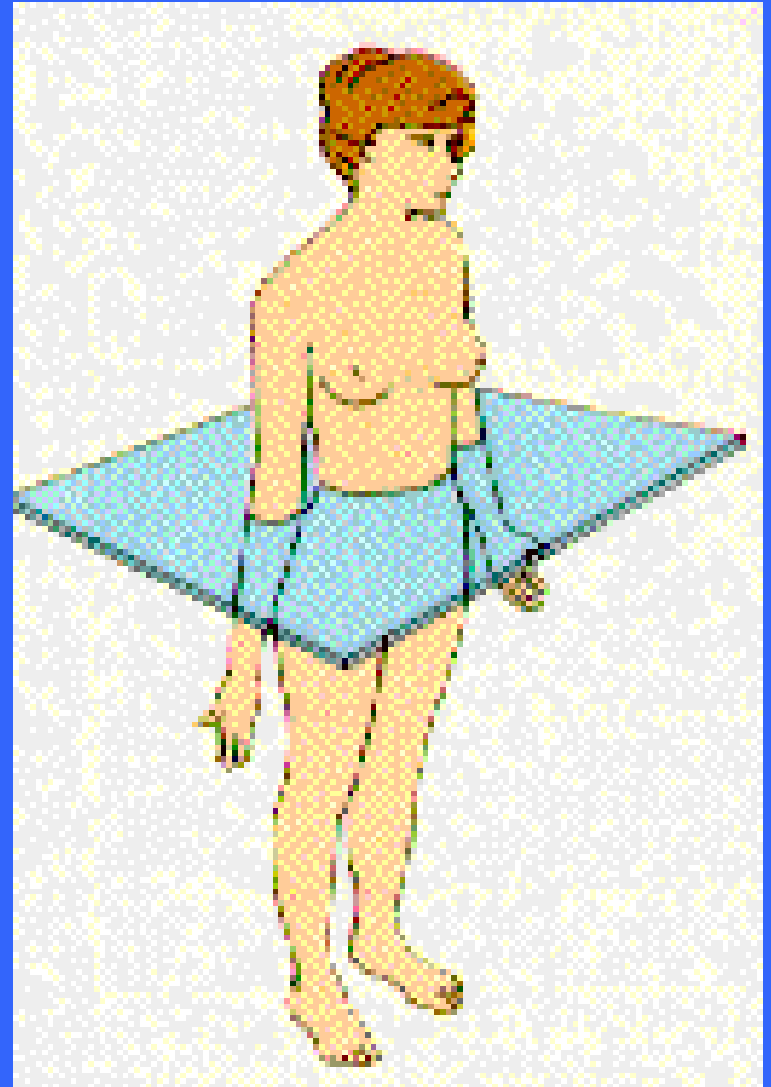
Body Planes

- The frontal plane divides the body into anterior and posterior sections
 - Also called a coronal when referencing the head



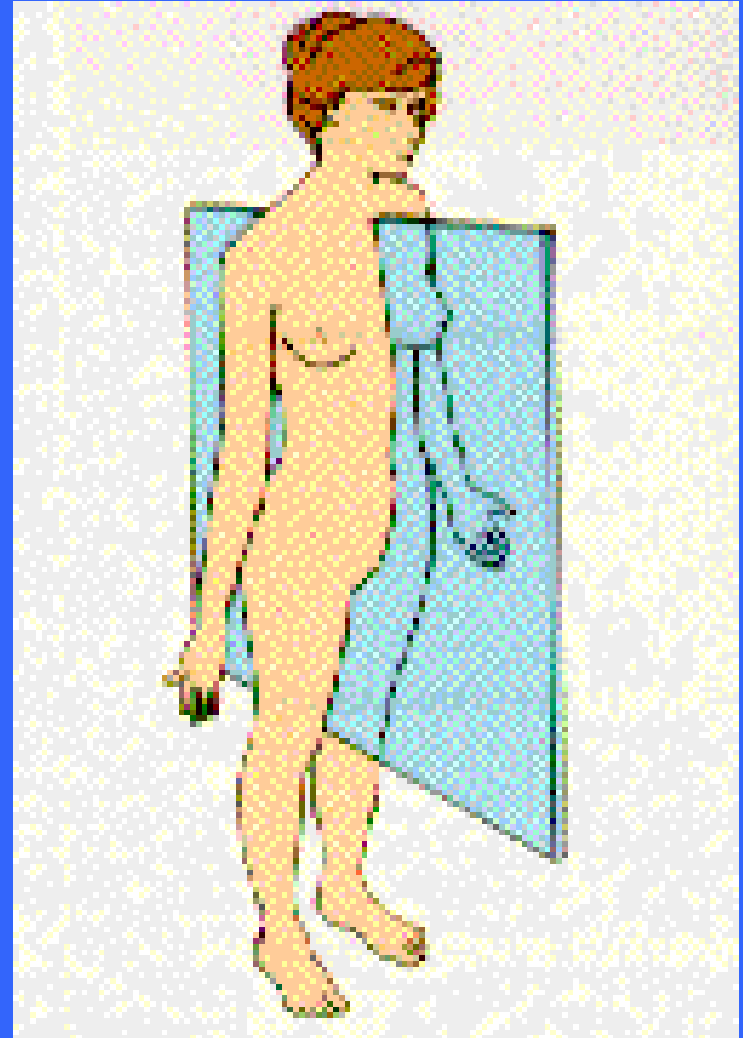
Body Planes

- A transverse plane runs horizontally and divides the body into superior and inferior sections
- Transverse sections are also called cross sections



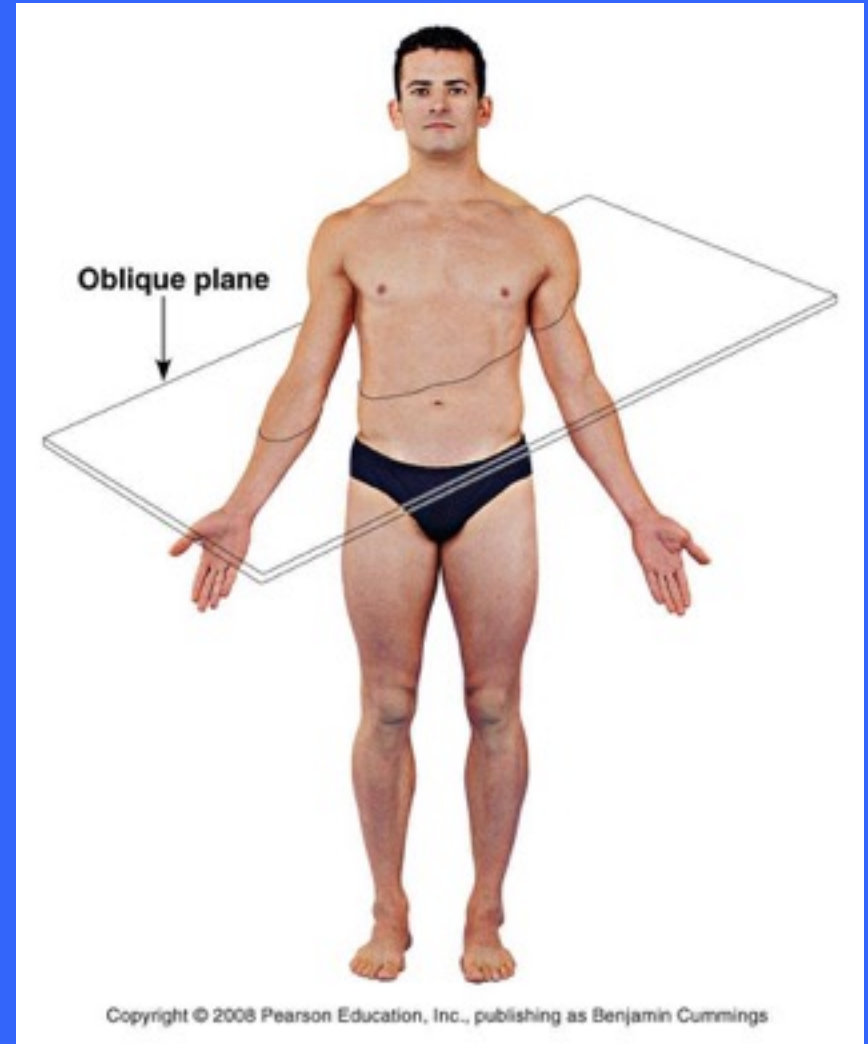
Body Planes

- The sagittal plane lies vertically and divides the body into right and left parts
- The sagittal plane lies exactly at midline and is also referred to as the median or midsagittal plane



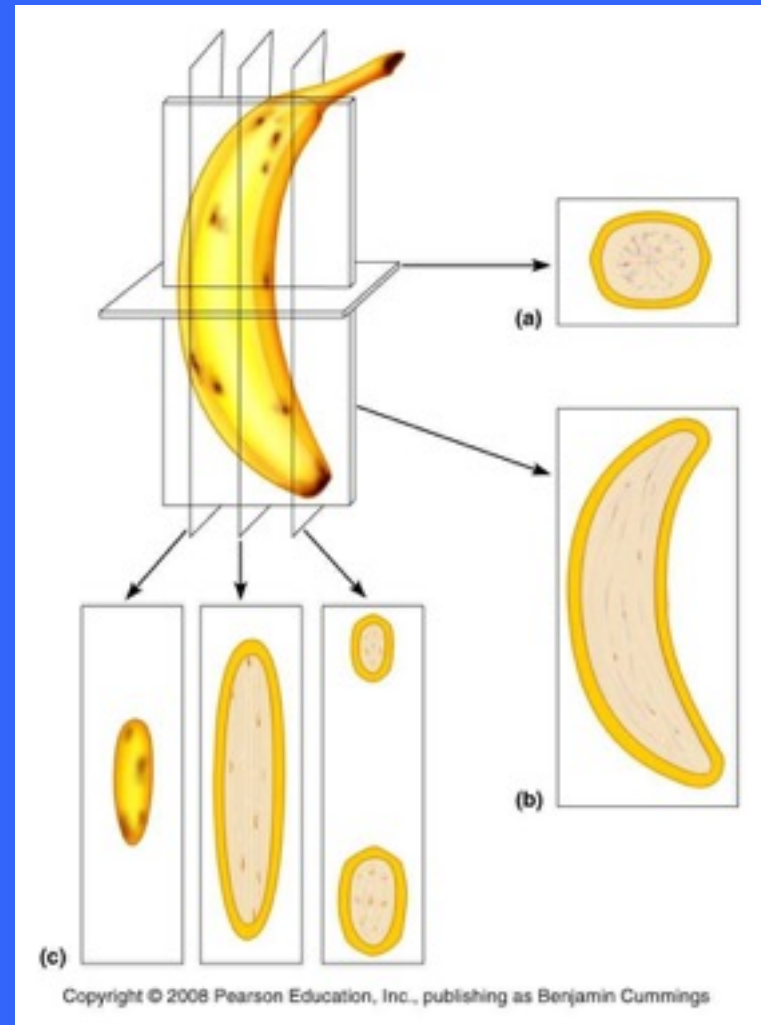
Body Planes

- Cuts made along any plane that lies diagonally between horizontal and vertical are called oblique sections
- Oblique sections are rarely used because normal planes of reference are not evident



Body Planes and Sections

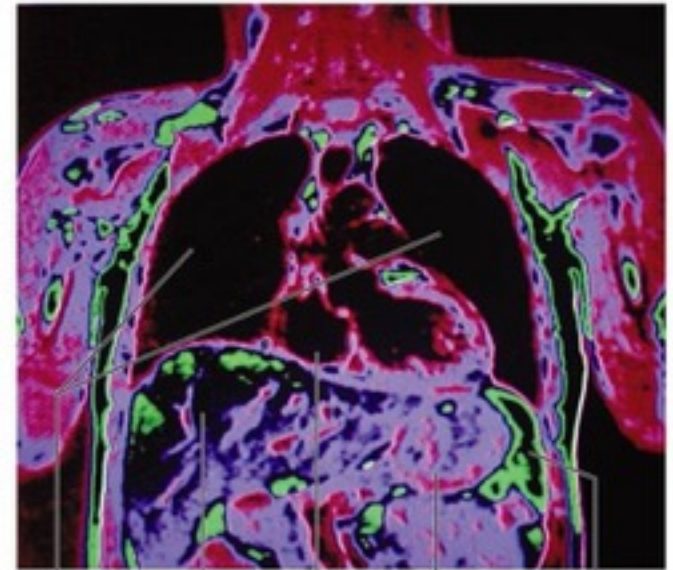
- Looking at the body or a familiar object can look odd when viewed in section
- However, looking at structures in section often can add insight into spatial relations and understanding of internal positioning



Body Planes and Sections

- In this frontal view a magnetic resonance imaging (MRI) system presents the internal structures of the torso
- Here you can readily see various organs with the torso

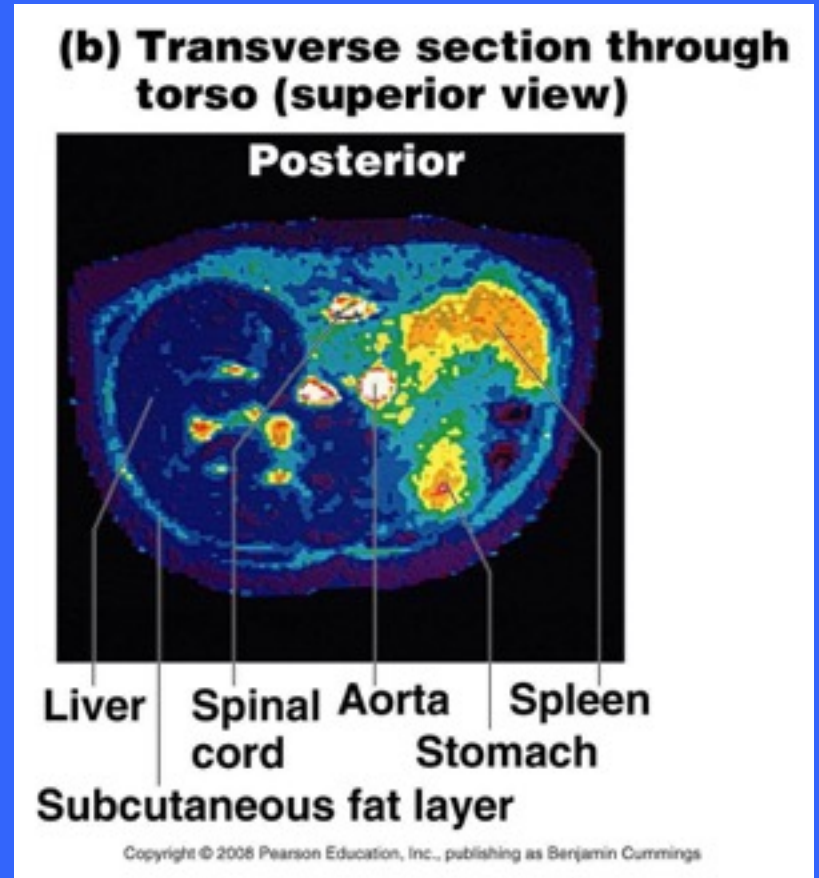
(a) Frontal section through torso



Left and right lung Liver Heart Spleen
Stomach

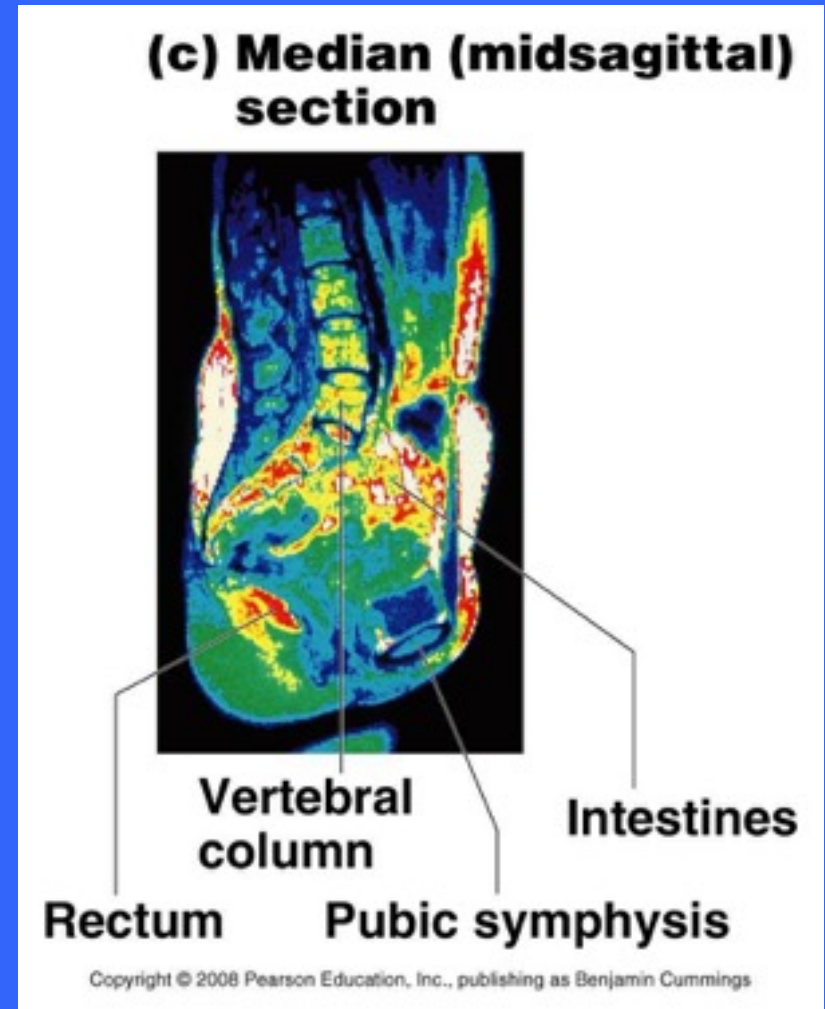
Body Planes and Sections

- In this transverse view a (MRI) system presents the internal structures of the torso
- This view is useful in illustrating how organs are distributed within the cavity from anterior/lateral or medial lateral perspective



Body Planes and Sections

- In this midsagittal view a (MRI) system presents the internal structures of the abdominopelvic cavity
- This view is useful in visualizing structures from a superior / inferior perspective



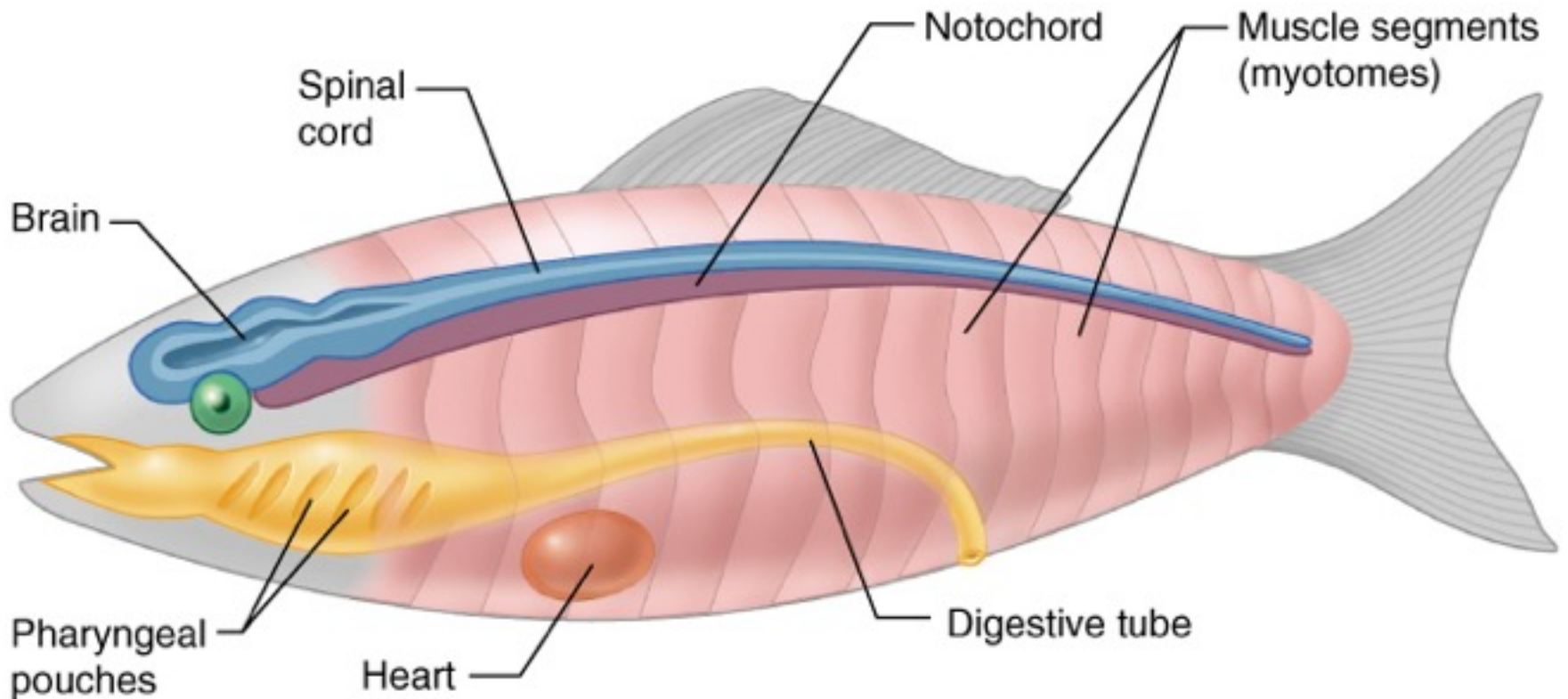
Anatomical Variability

- **There is a certain amount of anatomical variability that occurs in humans**
- **Extreme variations are not common since these variations are incompatible with survival**
- **However, you may note deviations that are not exactly consistent with the text**
- **Variation may occur in blood vessels, nerves or muscles (e.g. Psoas minor)**

Human Body Plan

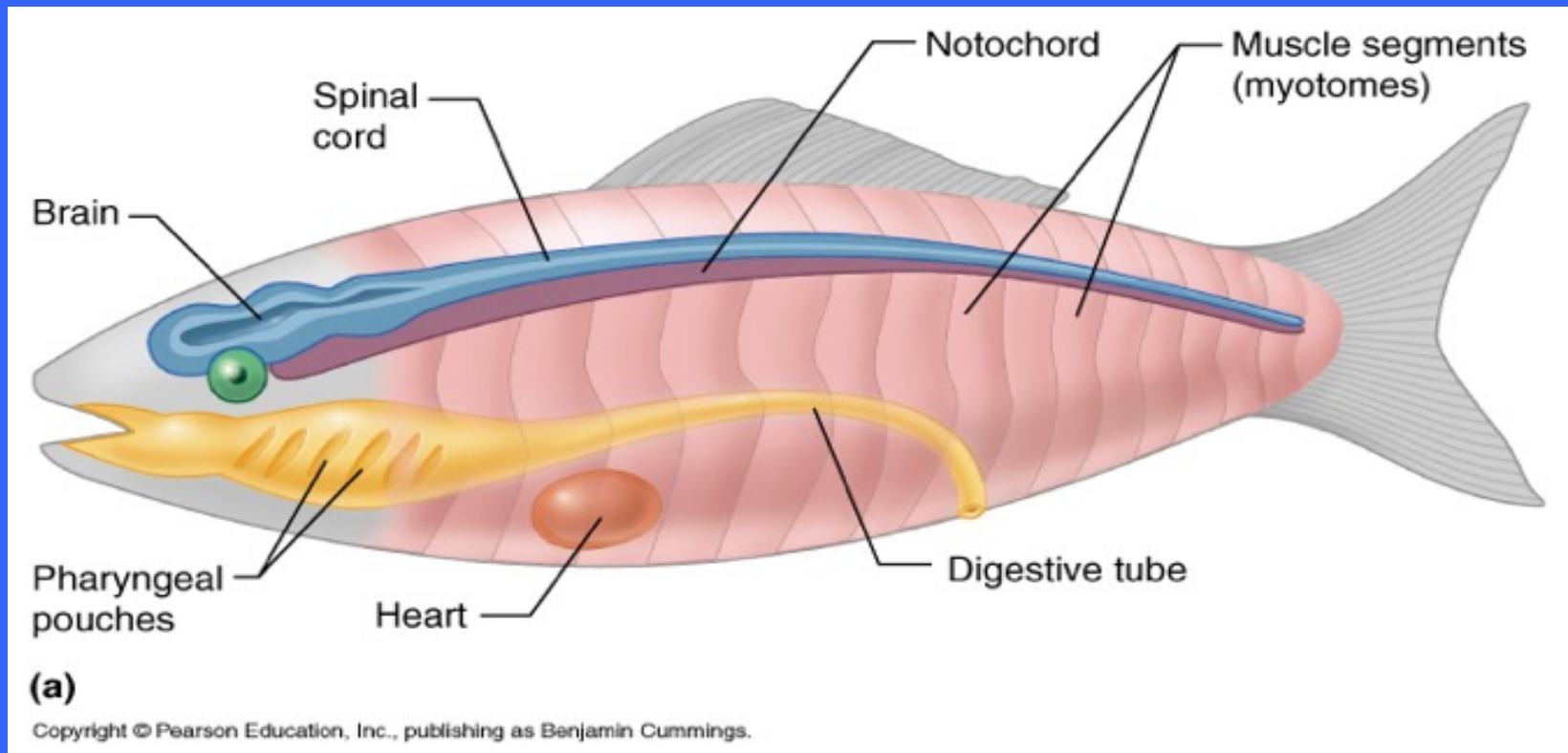
- **All vertebrates share the same basic features**
 - **Tube-within-a-tube body plan**
 - **Bilateral symmetry**
 - **Dorsal hollow nerve cord**
 - **Notochord and vertebrae**
 - **Segmentation**
 - **Pharyngeal pouches**

Human Body Plan



(a)

Tube-Within-A-Tube



- **Digestive organs form a tube that extends from the mouth to the anus**
- **The outer tube consists of the structures (axial skeleton and musculature) forming the outer body wall**

Bilateral Symmetry

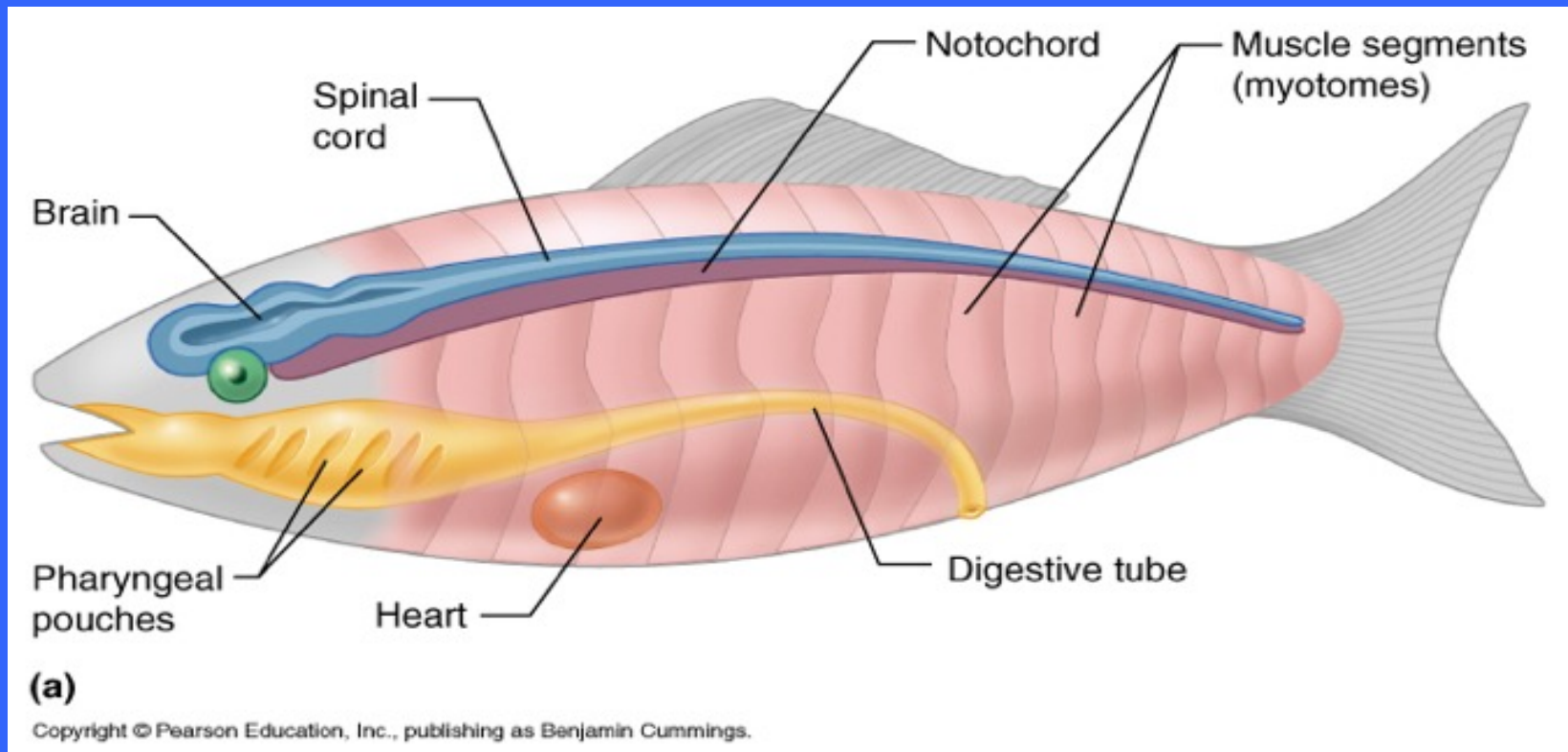
- Each body half is a mirror image of the other half with paired organs
- Structures in the midline plane are unpaired with symmetrical left and right sides



(a) Anterior

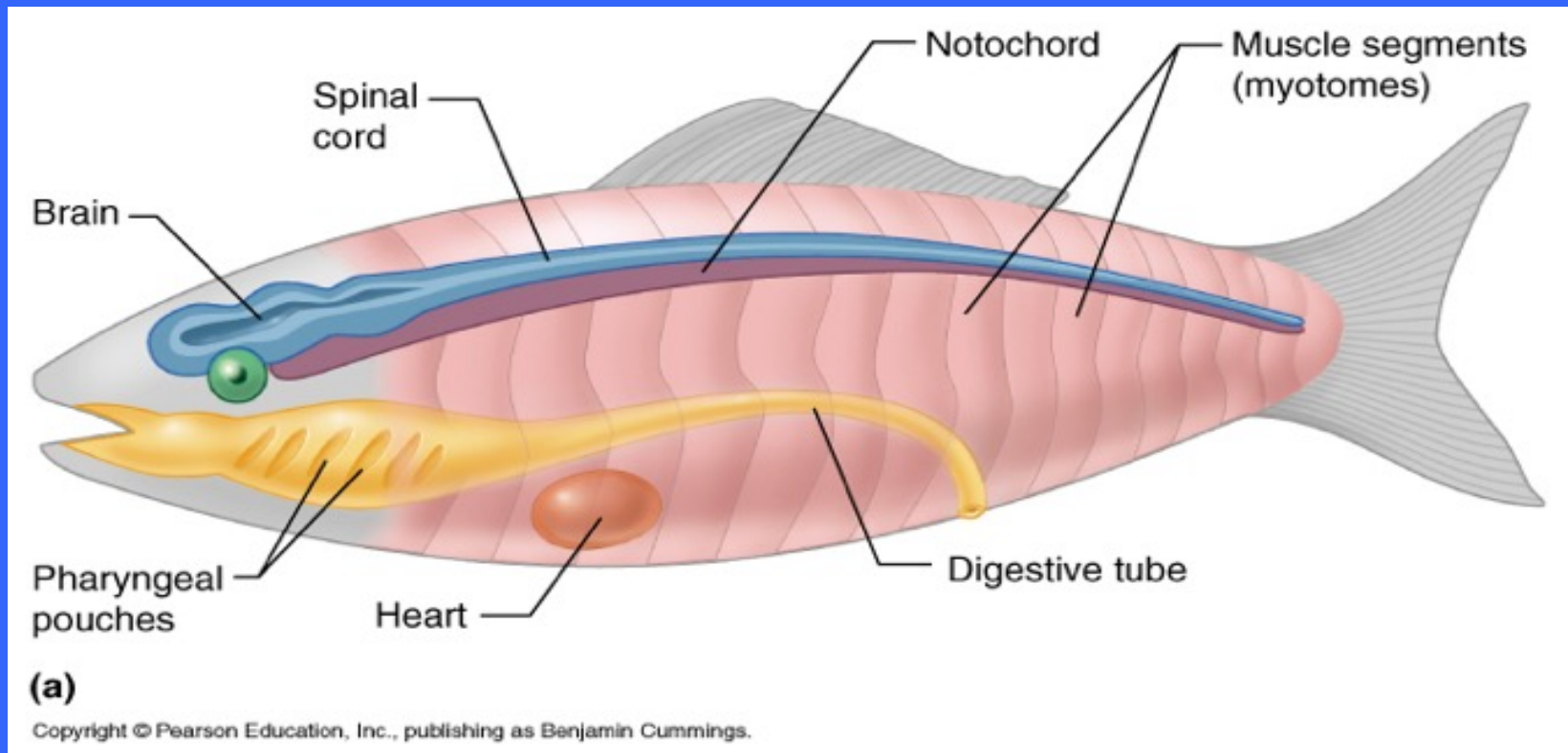
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Dorsal Hollow Nerve Cord



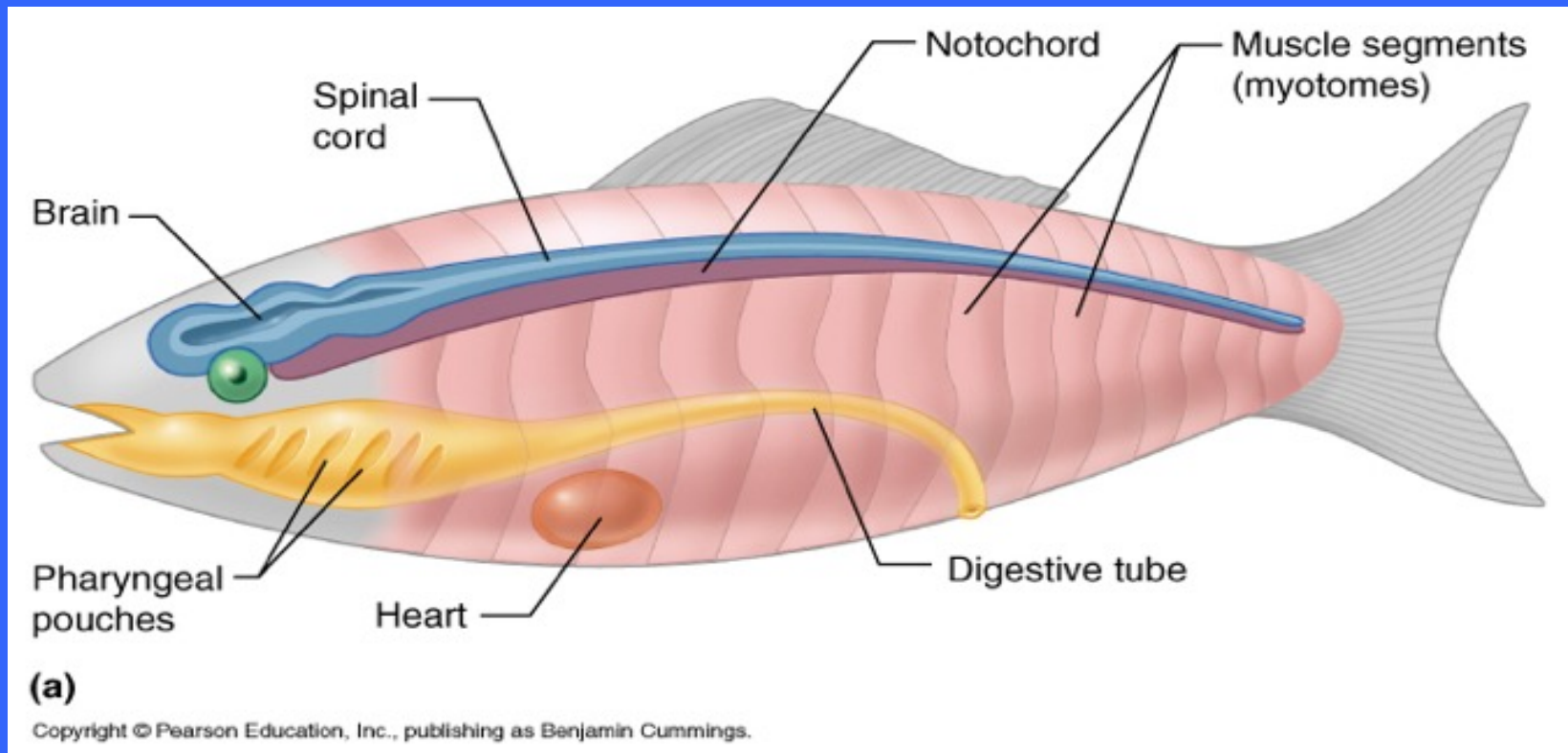
- All vertebrate embryos have a hollow cord running along their back in the median plane
- The cord develops into the brain and spinal cord

Notochord and Vertebrae



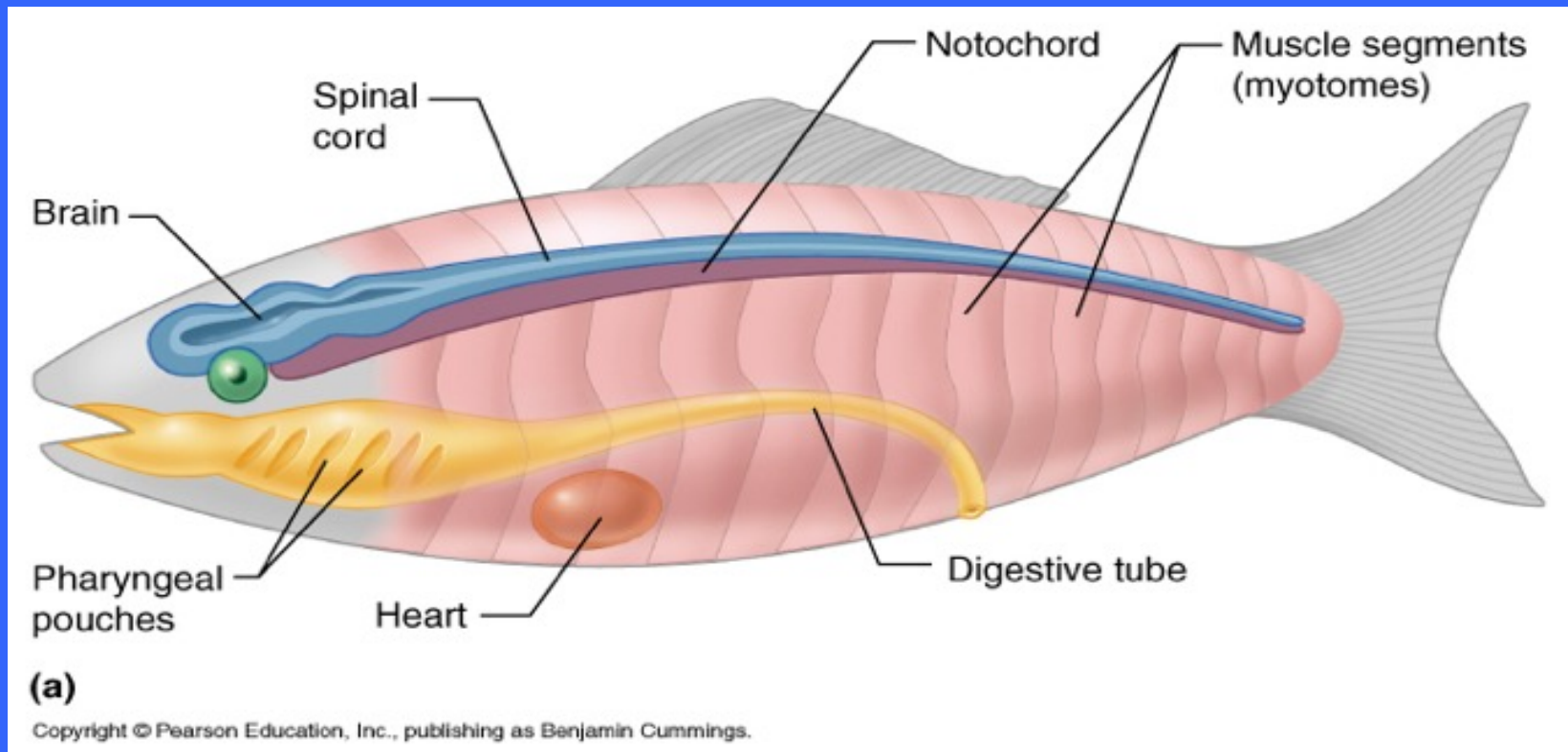
- **The notochord is a stiffening rod in the back just deep to the spinal cord**
- **The notochord in the embryo is replaced by vertebrae**

Segmentation



- Segments are repeating units of similar structure that run from the head along the length of the trunk
- Example: area between the ribs / spinal nerves

Pharyngeal Pouches

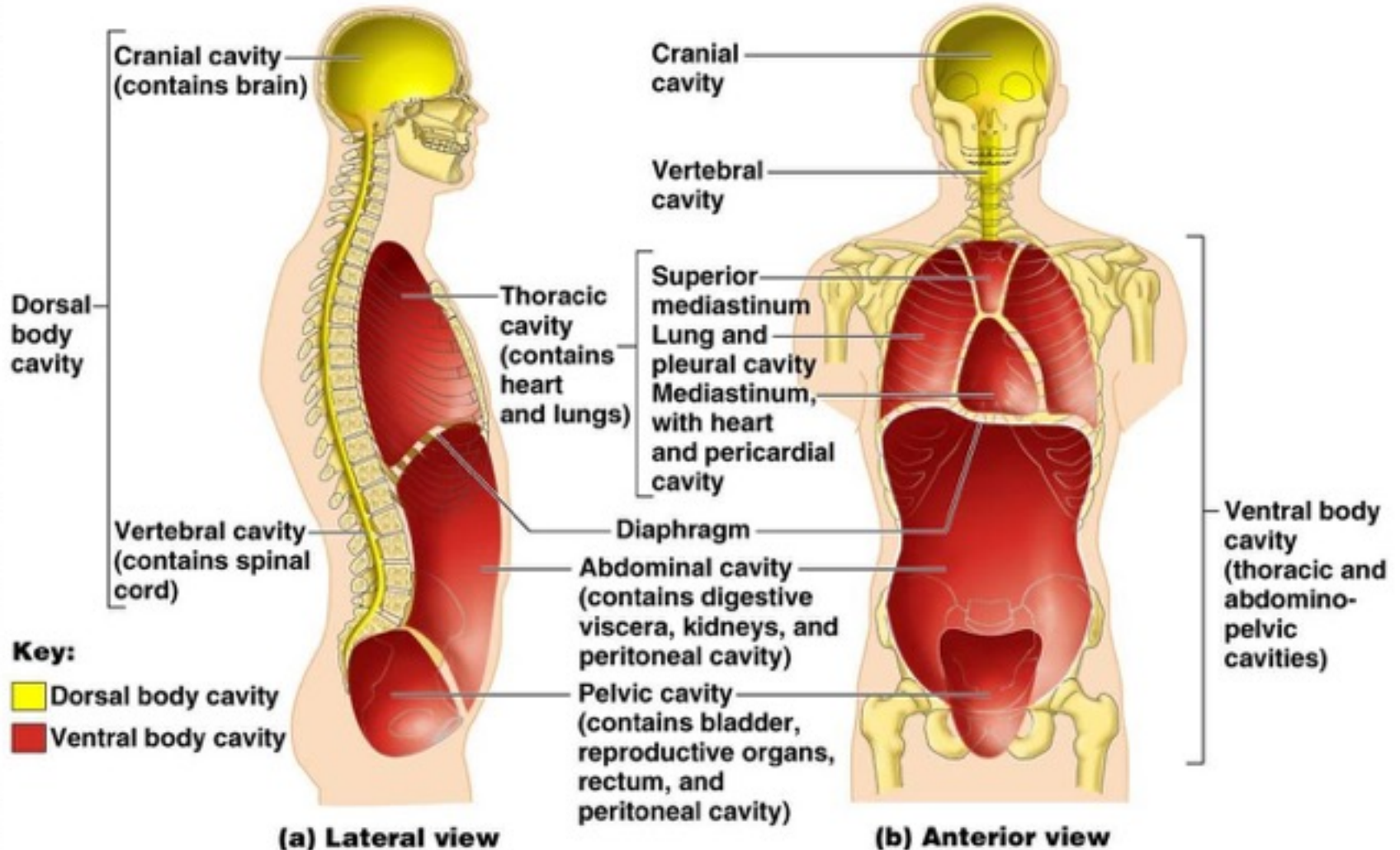


- In humans the pharynx is part of the digestive tube
- In the embryonic stage, our pharynx has a set of pouches that correspond to the clefts of fish gills

Pharyngeal Pouches

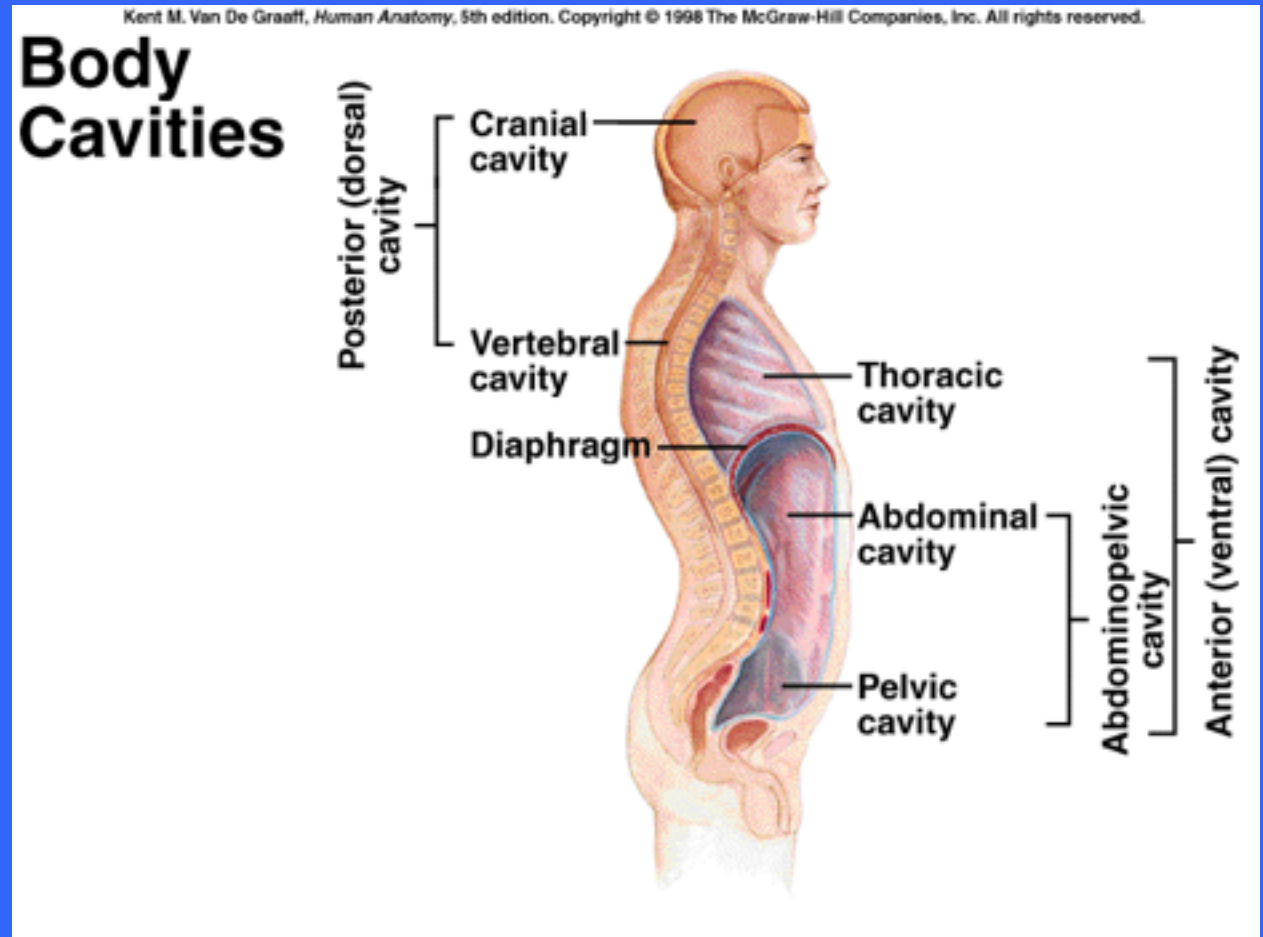
- **Pharyngeal pouches give rise to some structures in our head and neck**
- **Example: The middle ear cavity which runs from the eardrum to the pharynx**

Body Cavities



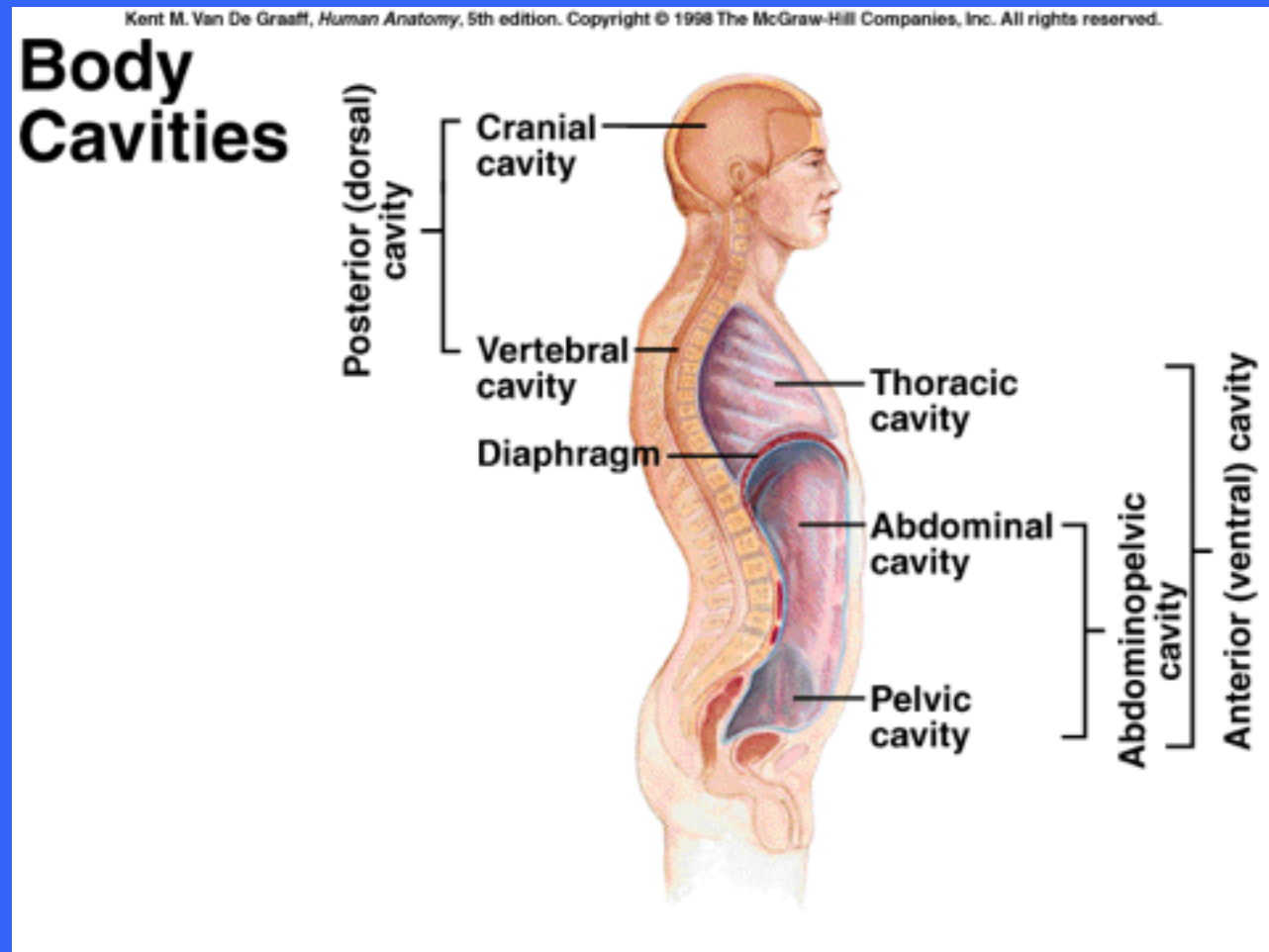
Body cavities

- **Dorsal body cavity is divided into a cranial cavity which encases the brain, and the vertebral cavity which encases the spinal cord**



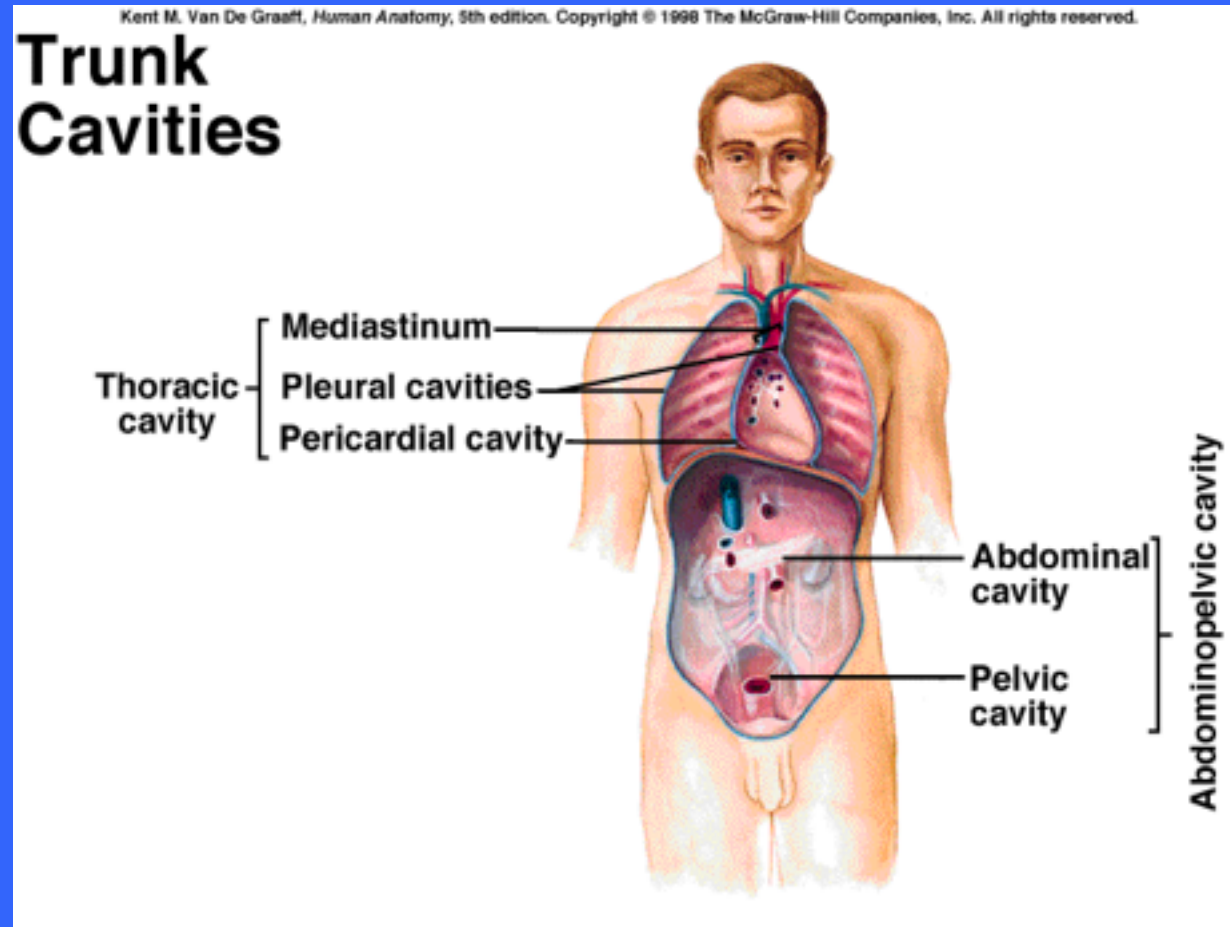
Body cavities

- The ventral body cavity houses the visceral organs
- The ventral body cavity is divided into the thoracic, abdominal, and pelvic cavities



Thoracic Cavity

- The thoracic cavity is surrounded by the ribs and muscles of the chest
- It is further divided into
 - pleural cavities
 - mediastinum
 - pericardial



Abdominopelvic Cavity

- **Abdominopelvic cavity lies below the diaphragm**

- **It is further divided into . .**

- **Abdominal cavity**

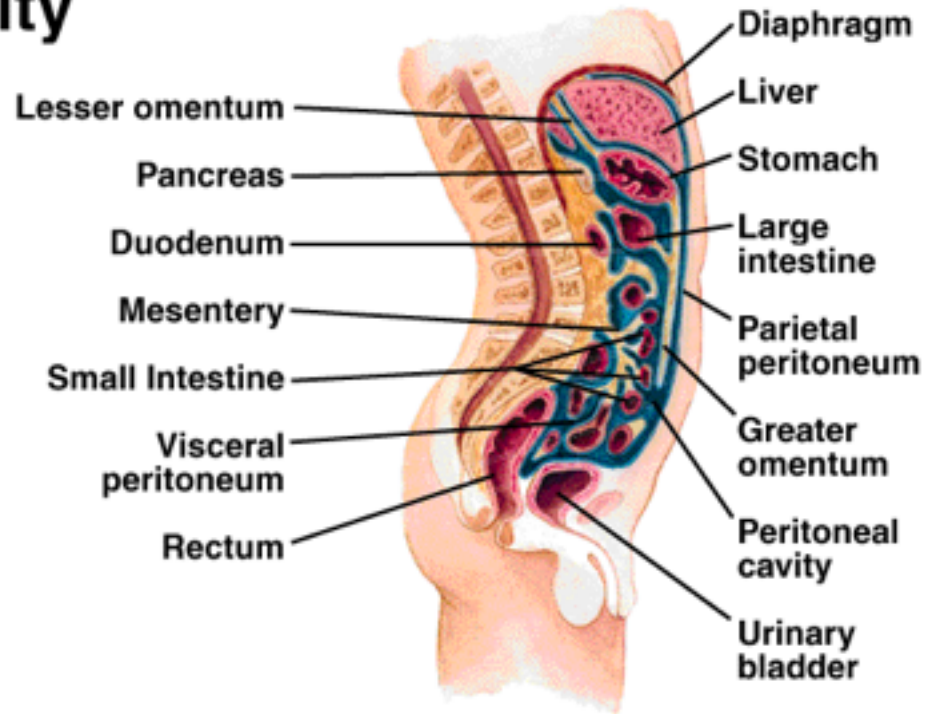
- **Stomach, intestines, spleen, liver**

- **Pelvic cavity**

- **Bladder, rectum, and some reproductive organs**

Kent M. Van De Graaff, *Human Anatomy*, 5th edition. Copyright © 1998 The McGraw-Hill Companies, Inc. All rights reserved.

Abdominopelvic Cavity

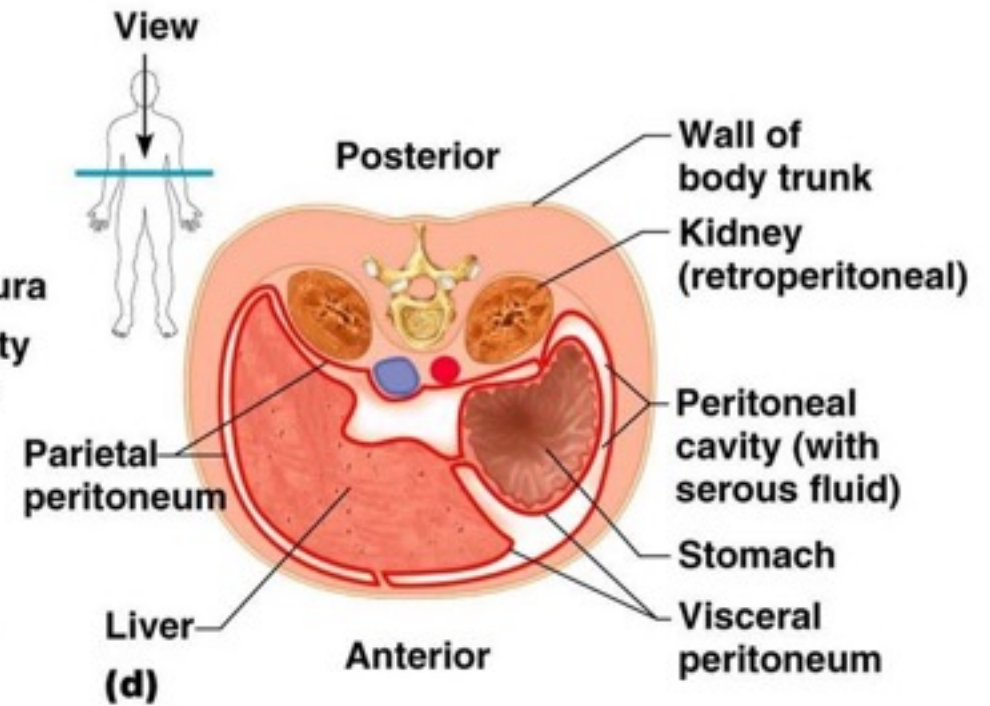
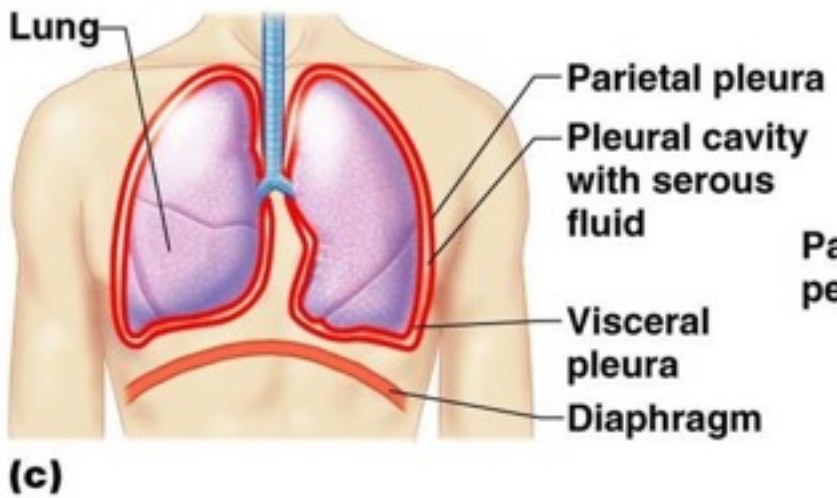
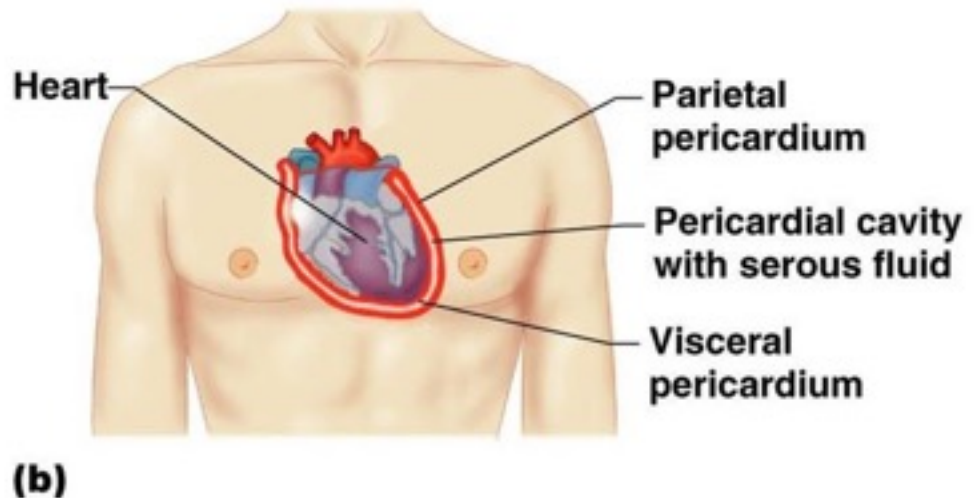
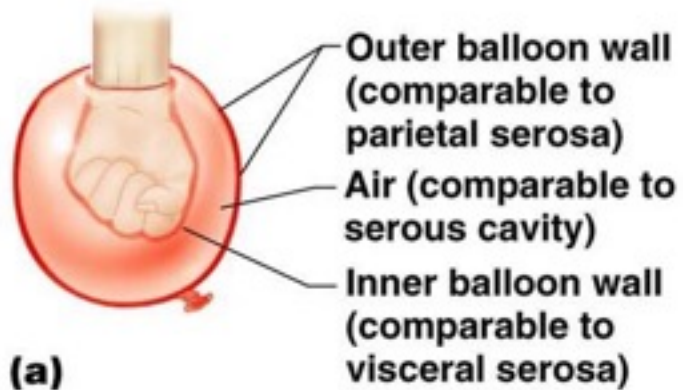


Serous Cavities

- **A serous membrane (serosa) is a thin double layered membrane that covers the ventral body cavity and outer surface of the organs**
 - **Parietal serosa is the layer of the membrane that lines the walls of the cavity**
 - **Visceral serosa is the layer that covers the organs in the cavity**
 - **Serous fluid is a lubrication found between the two serosa membranes**

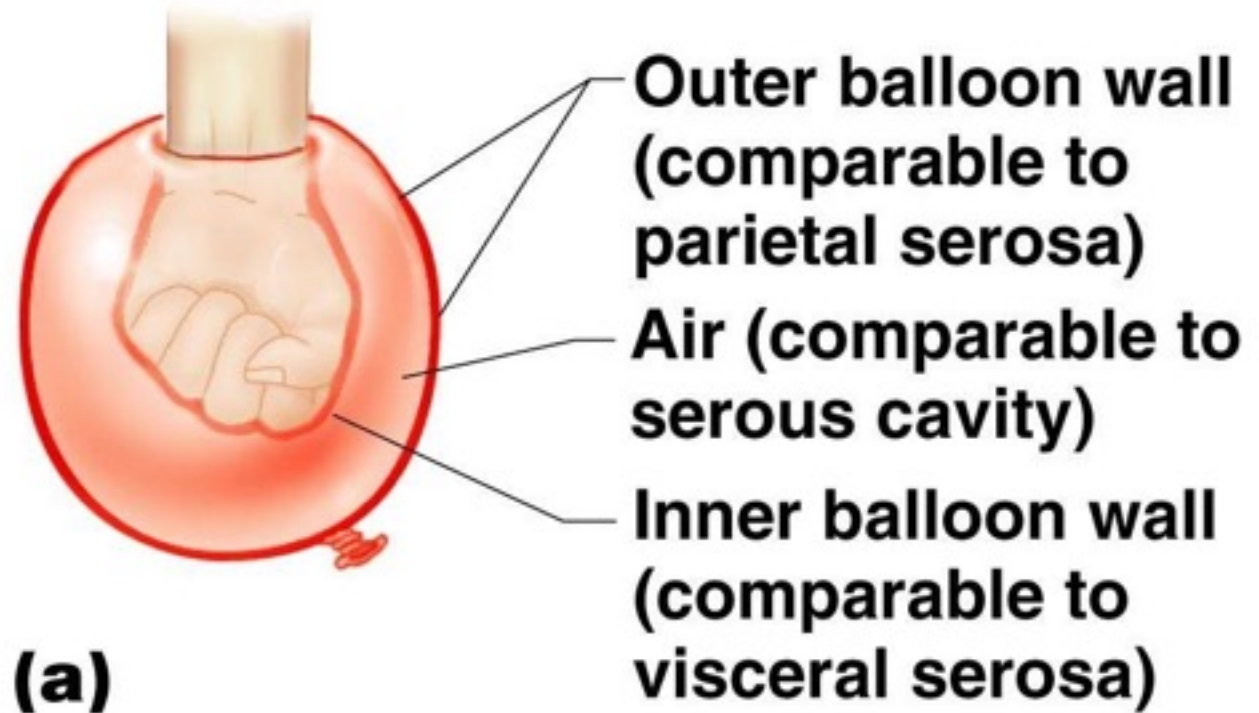
Membranes in the Ventral Cavity

- **Specific serous membranes are named for the cavity in which they are found**
 - **Parietal and visceral pericardium surrounds the heart**
 - **Parietal and visceral pleura surrounds the lungs**
 - **Parietal and visceral peritoneum covers the abdominal cavity**



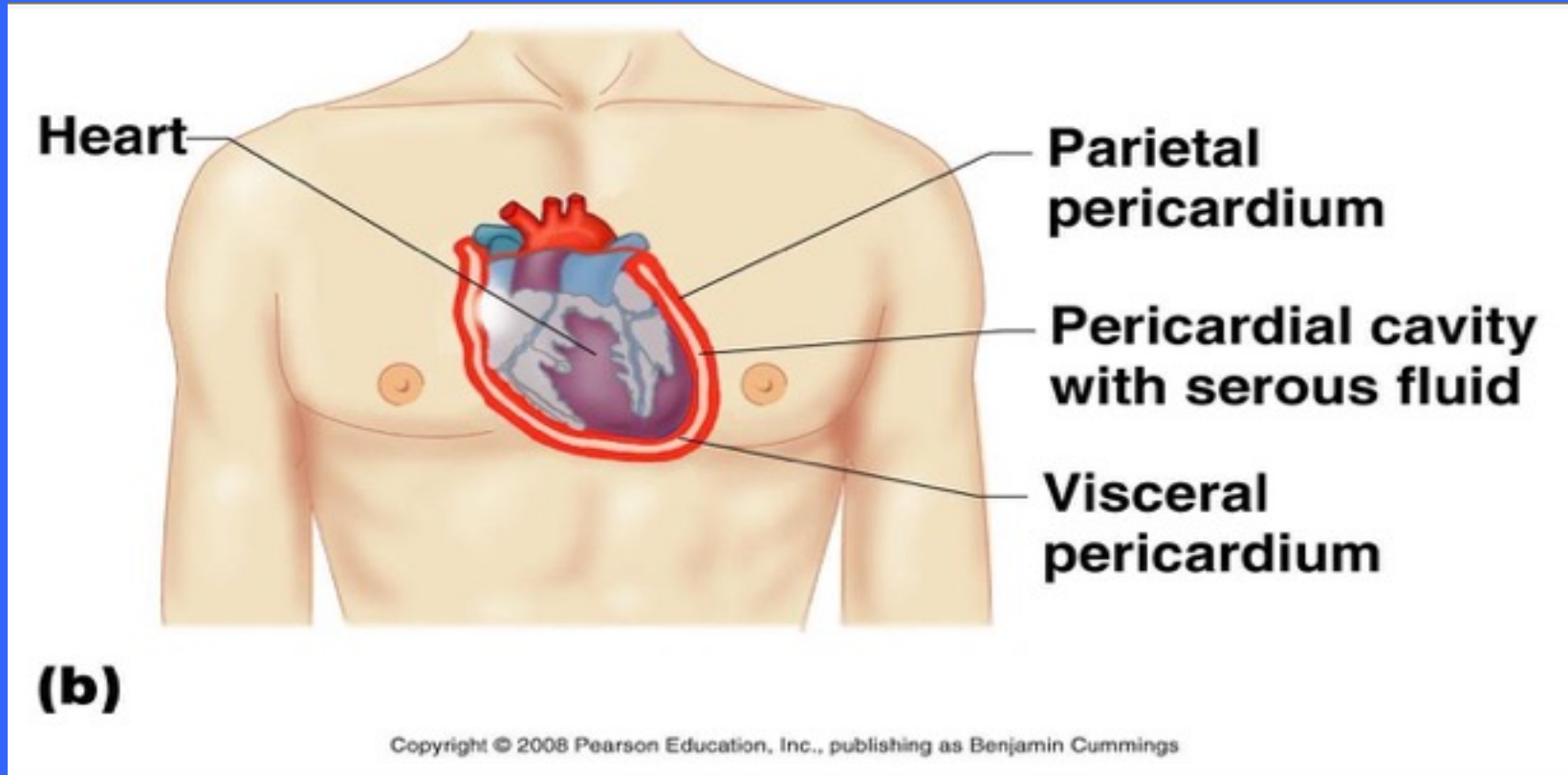
Serous Membrane Relationship

- A serous membrane needs to be viewed as a double layer membrane separated by fluid



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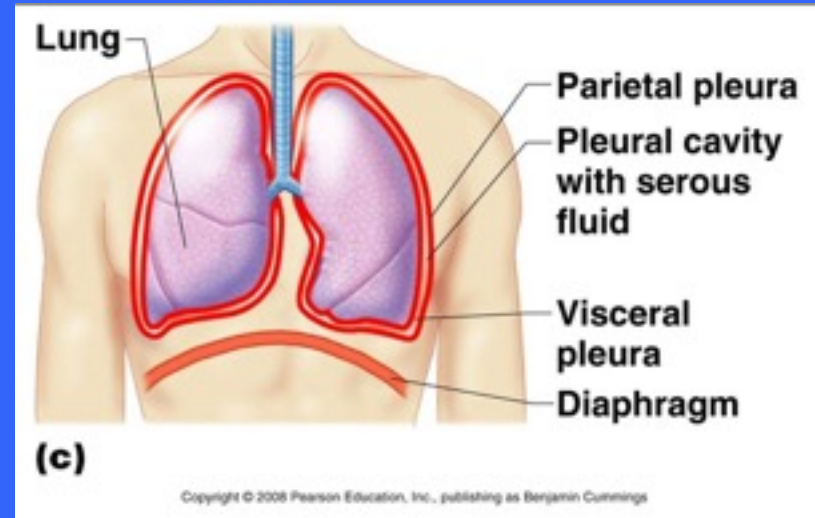
Pericardial Cavity



- The parietal pericardium is the outer lining
- The visceral pericardium clings to the heart

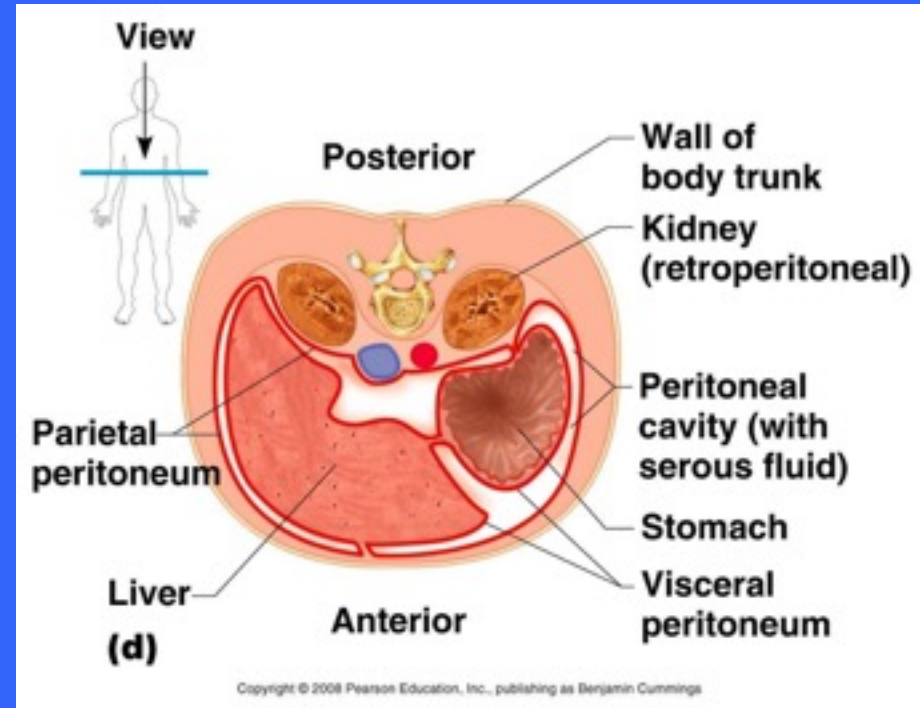
Serous Cavities

- Serous cavities are open cavities but rather slit-like in appearance and dimension
- The cavities contain a small volume of a serous fluid secreted by the membranes
- The serous fluid allows the visceral organs to slide with little friction during routine function



Peritoneal Cavity

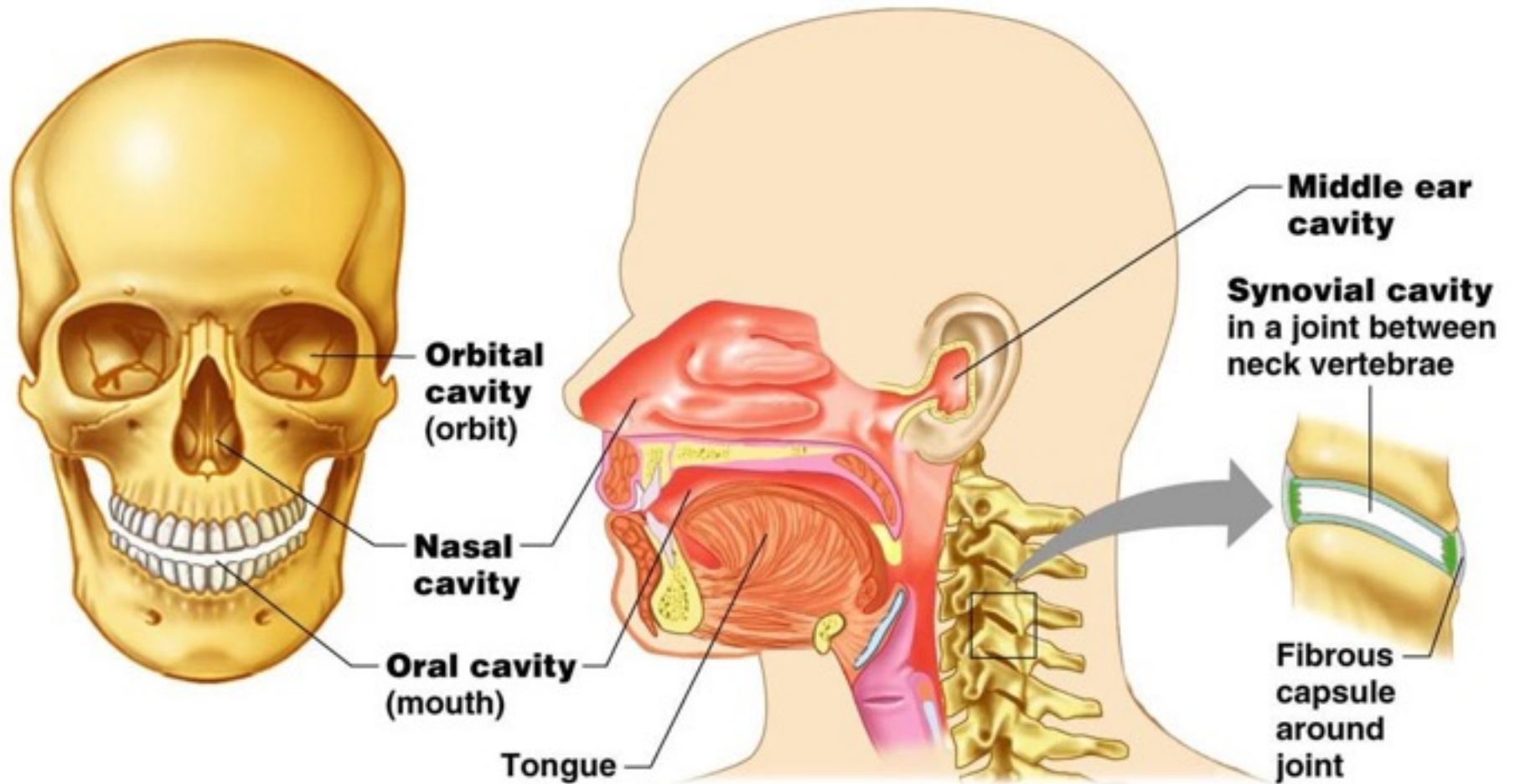
- The peritoneal cavity encloses most of the visceral organs of the abdominopelvic cavity
- However, some organs are retro-peritoneal, that is behind the peritoneum (e.g. kidneys)



Other Cavities

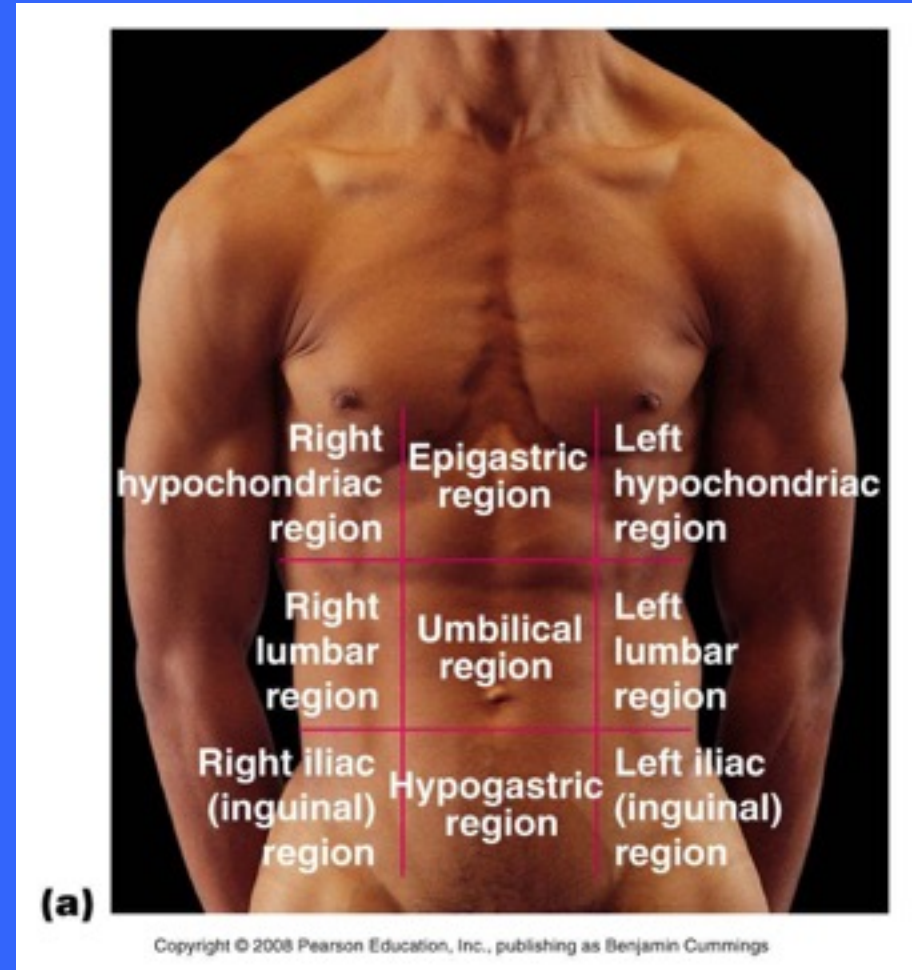
- **In addition to the large, closed body cavities there are several types of smaller body cavities**
 - **Oral cavities**
 - **Nasal cavities**
 - **Orbital cavities**
 - **Middle ear cavities**
 - **Synovial cavities**

Other Cavities



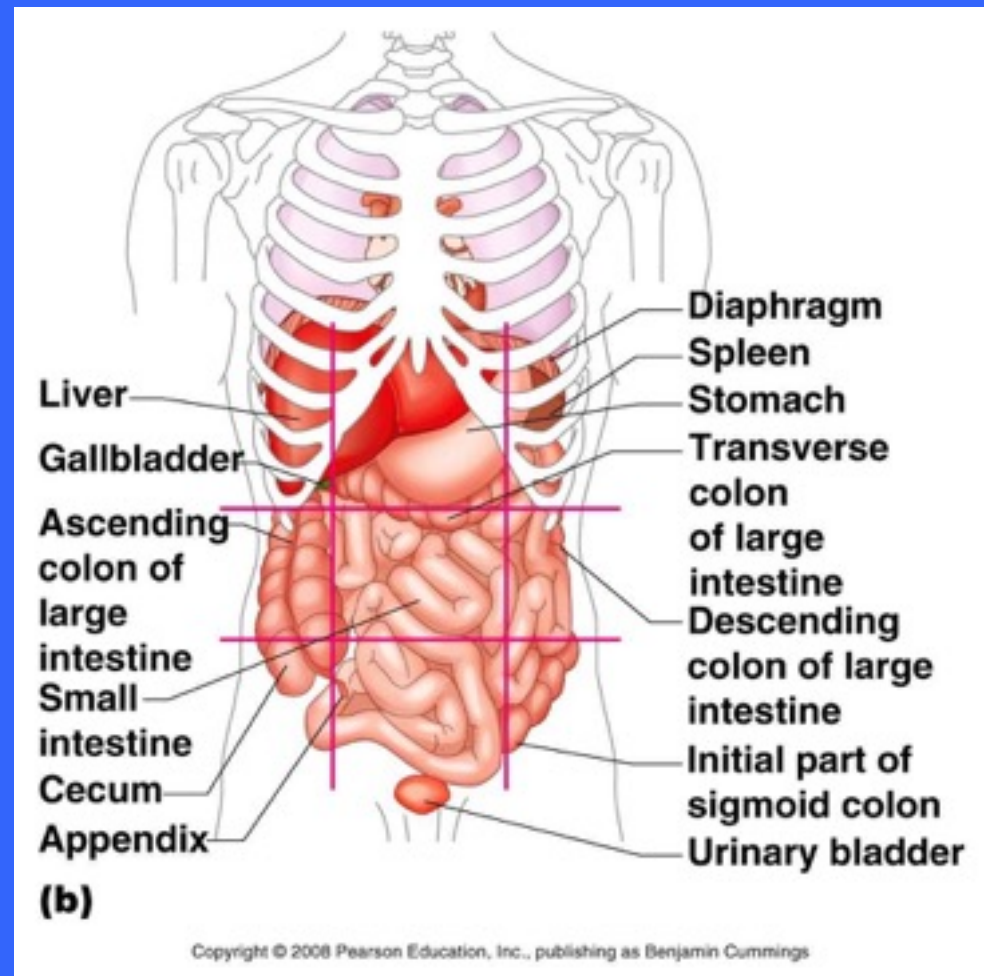
Abdominal Regions & Quadrants

- Anatomists often divide the body cavity into smaller regions for study
- Two transverse and two parasagittal planes divide the abdomen into nine regions



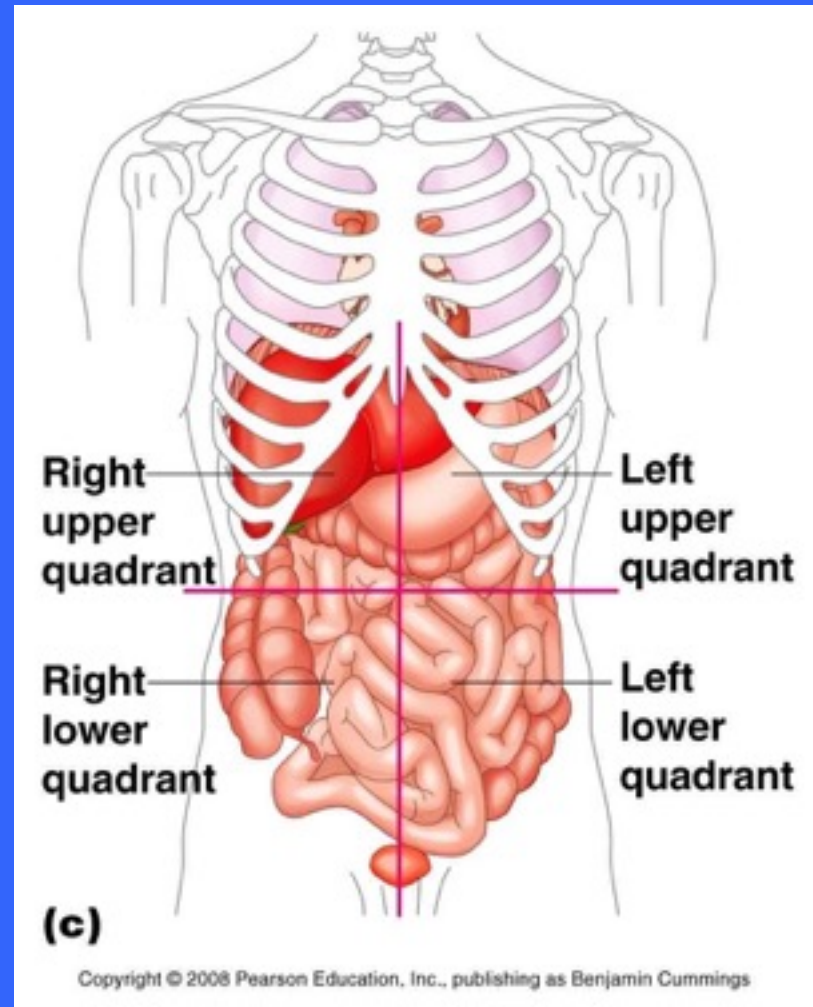
Abdominal Regions & Quadrants

- Your text will reference structures found within these regions



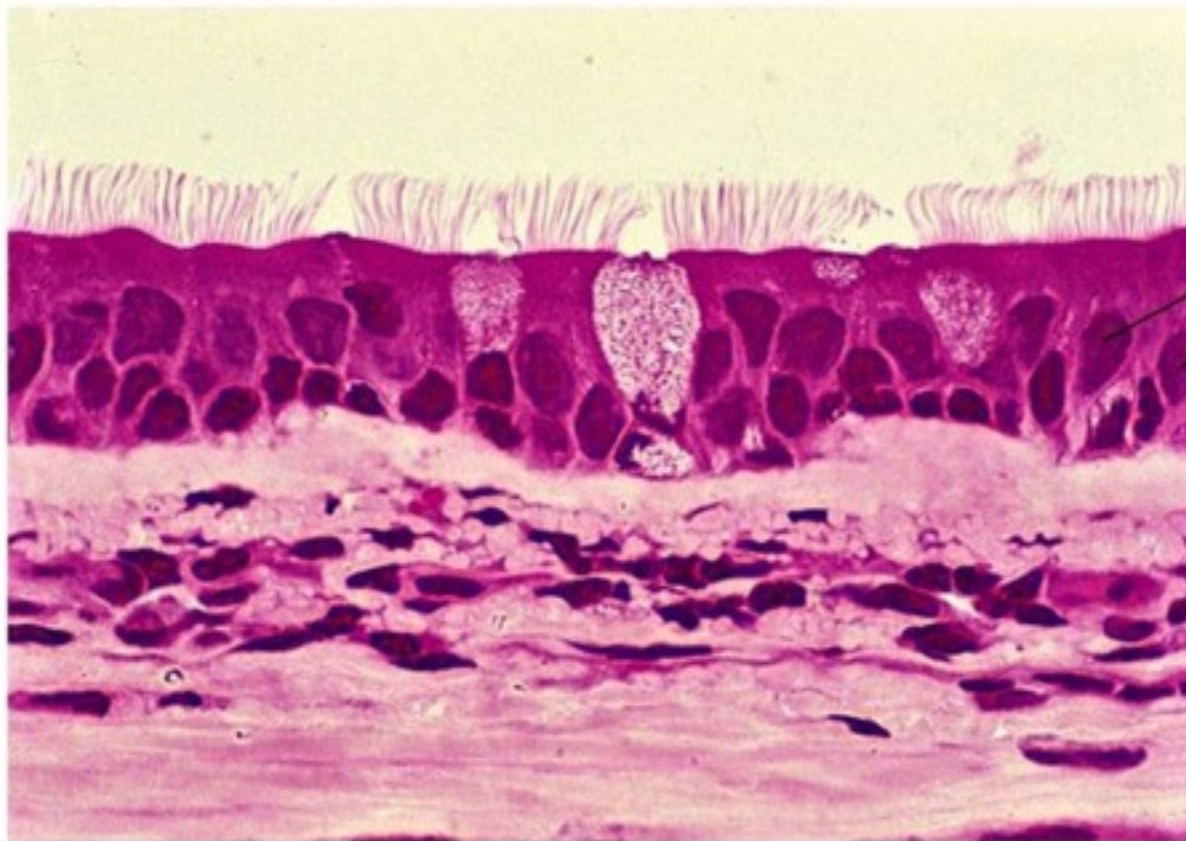
Abdominal Regions & Quadrants

- A more generalized scheme for locating abdominal structures is based on quadrants



Advanced Imaging Systems

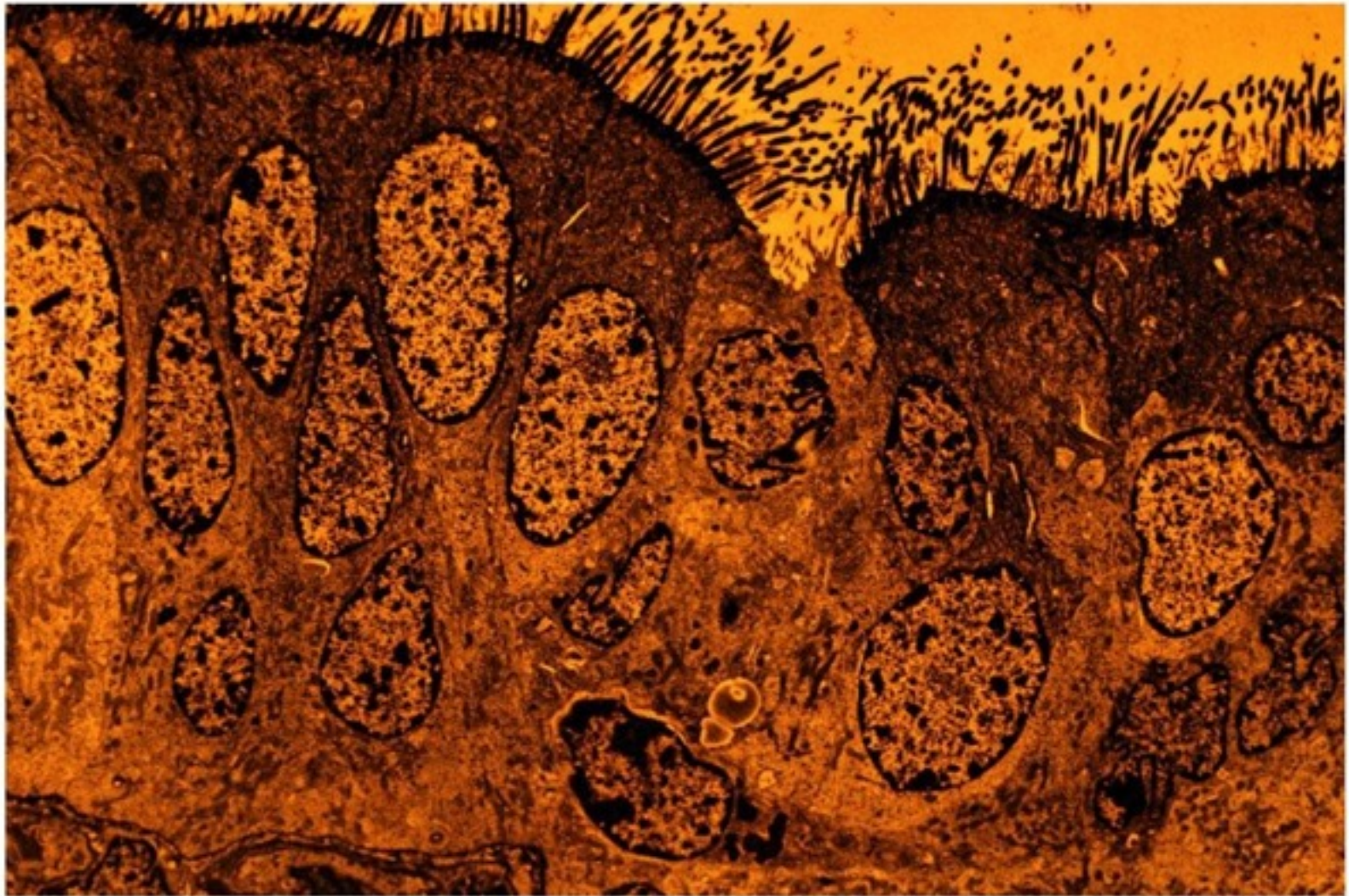
- **Medical personnel now employ a variety of advanced imaging systems that allow for study of internal structures without disrupting tissue**
- **These systems are frequently utilized in clinical applications to examine for evidence of disease**



Cells

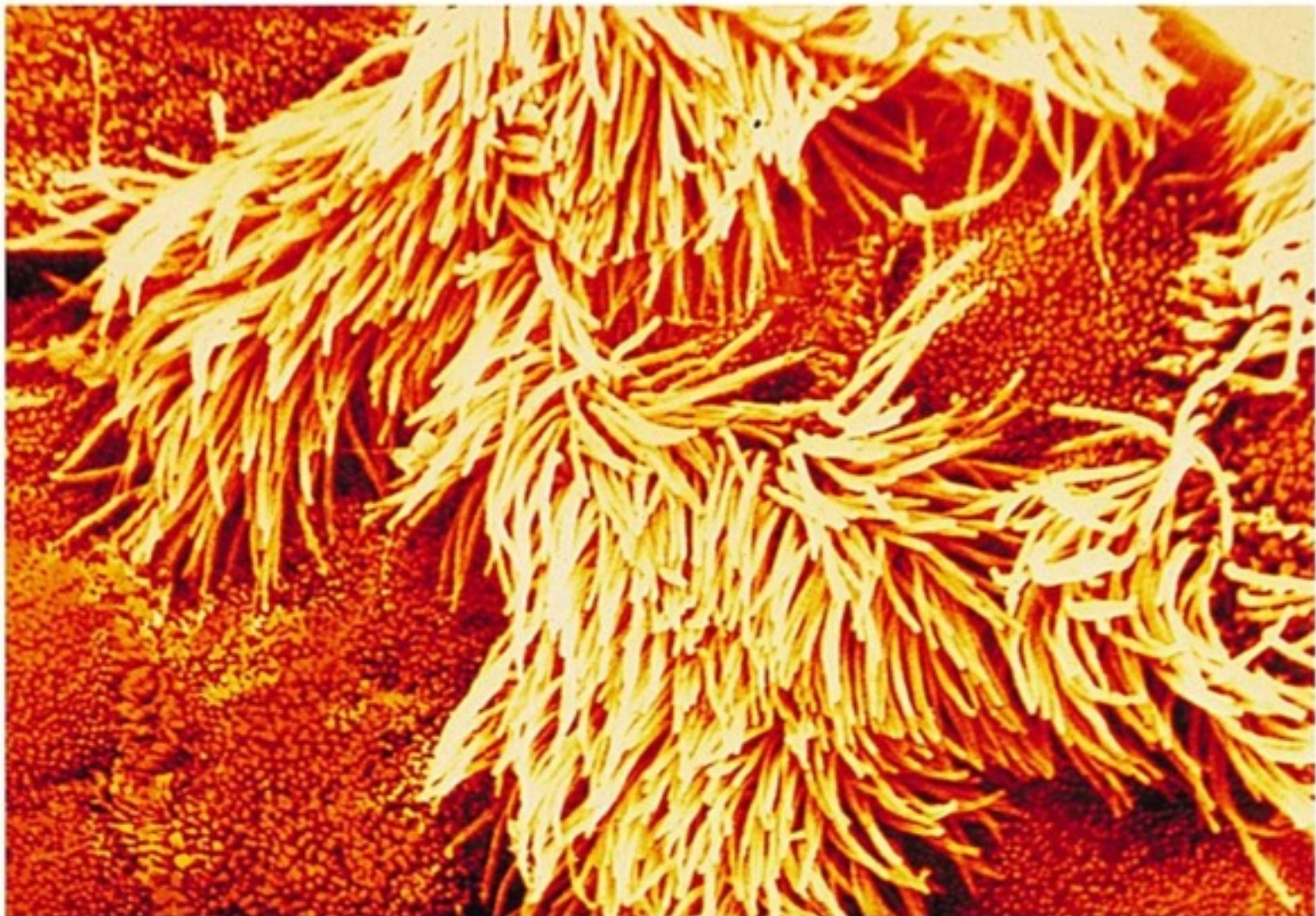
(a) Light micrograph

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(b) Transmission electron micrograph

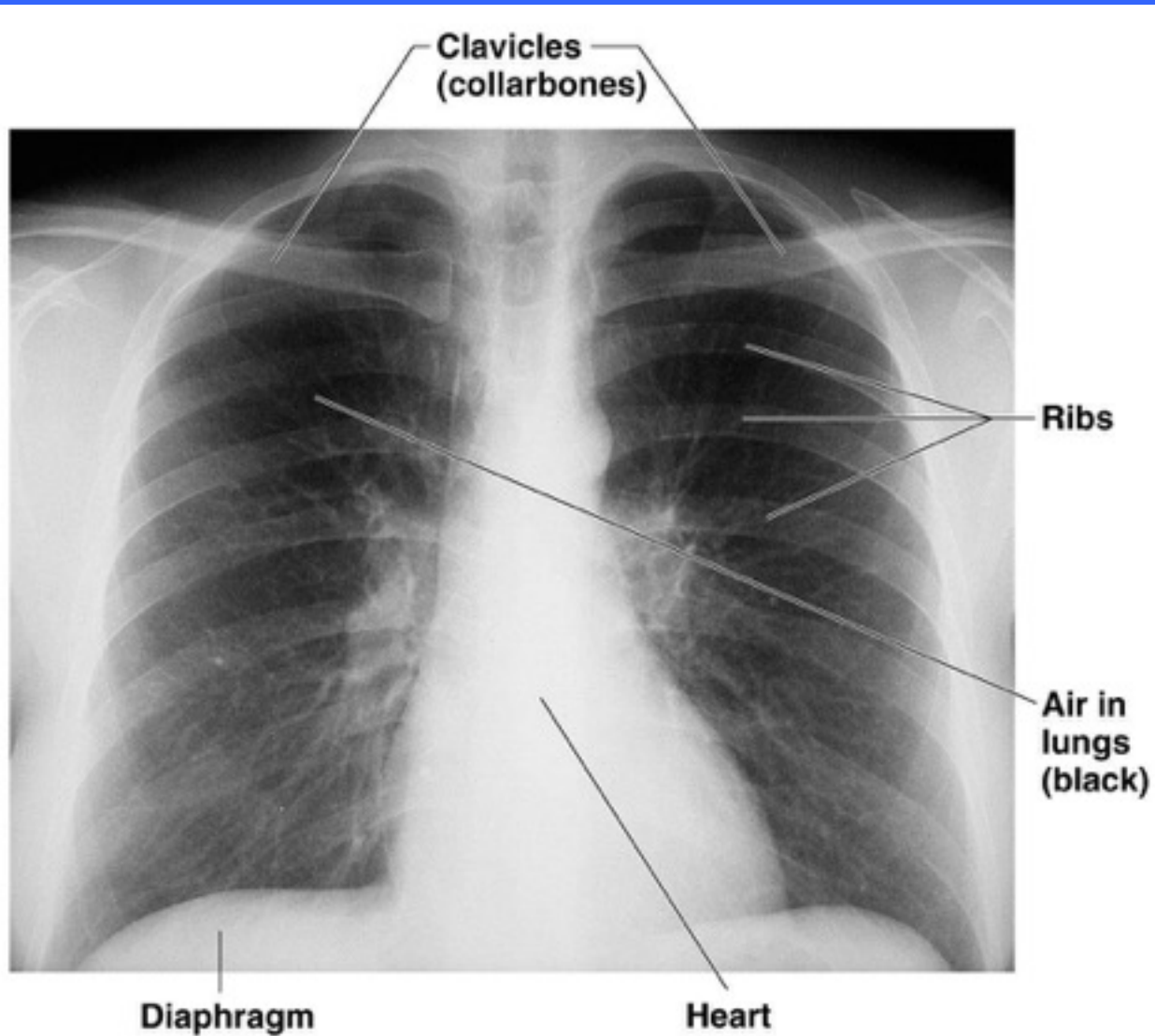
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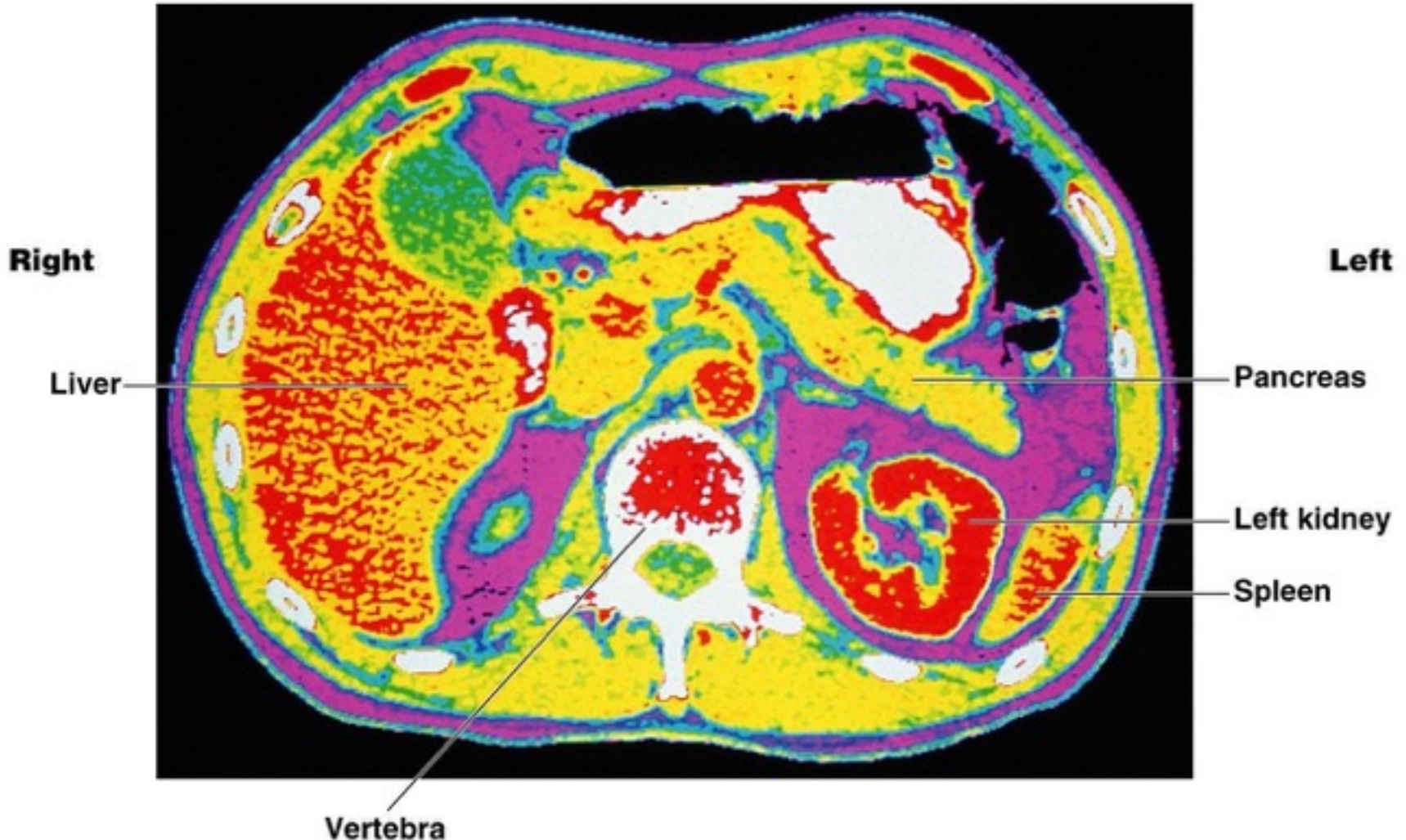
(c) Scanning electron micrograph

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X-ray



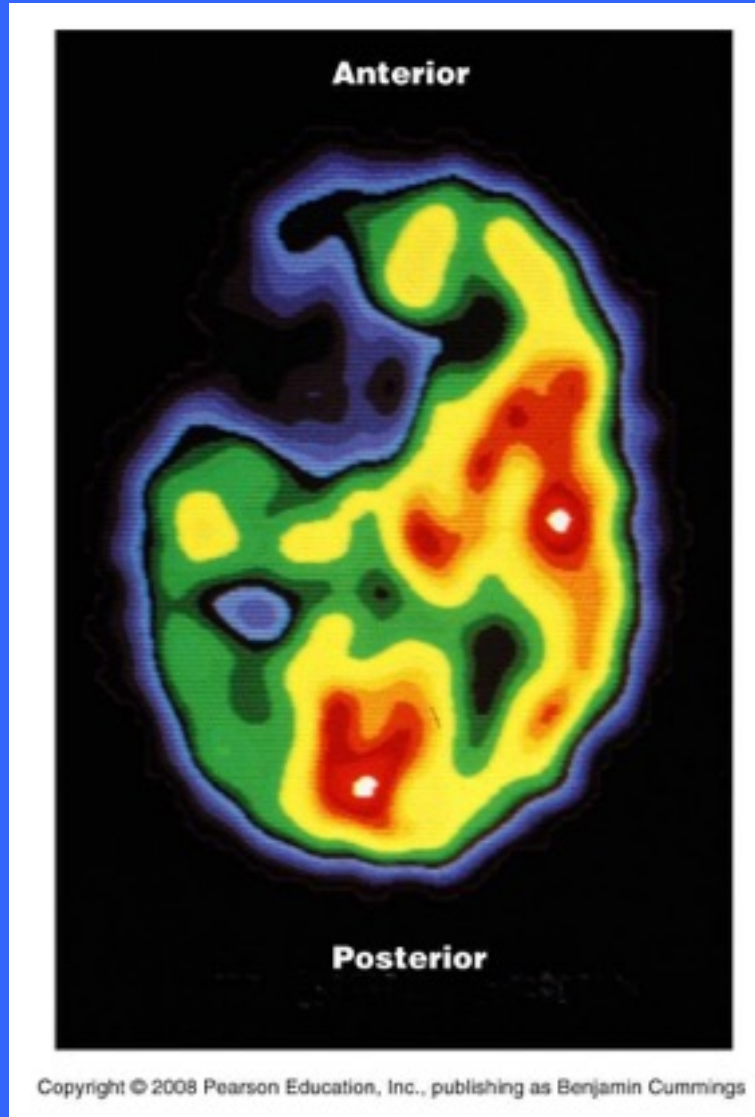
Computerized Tomography



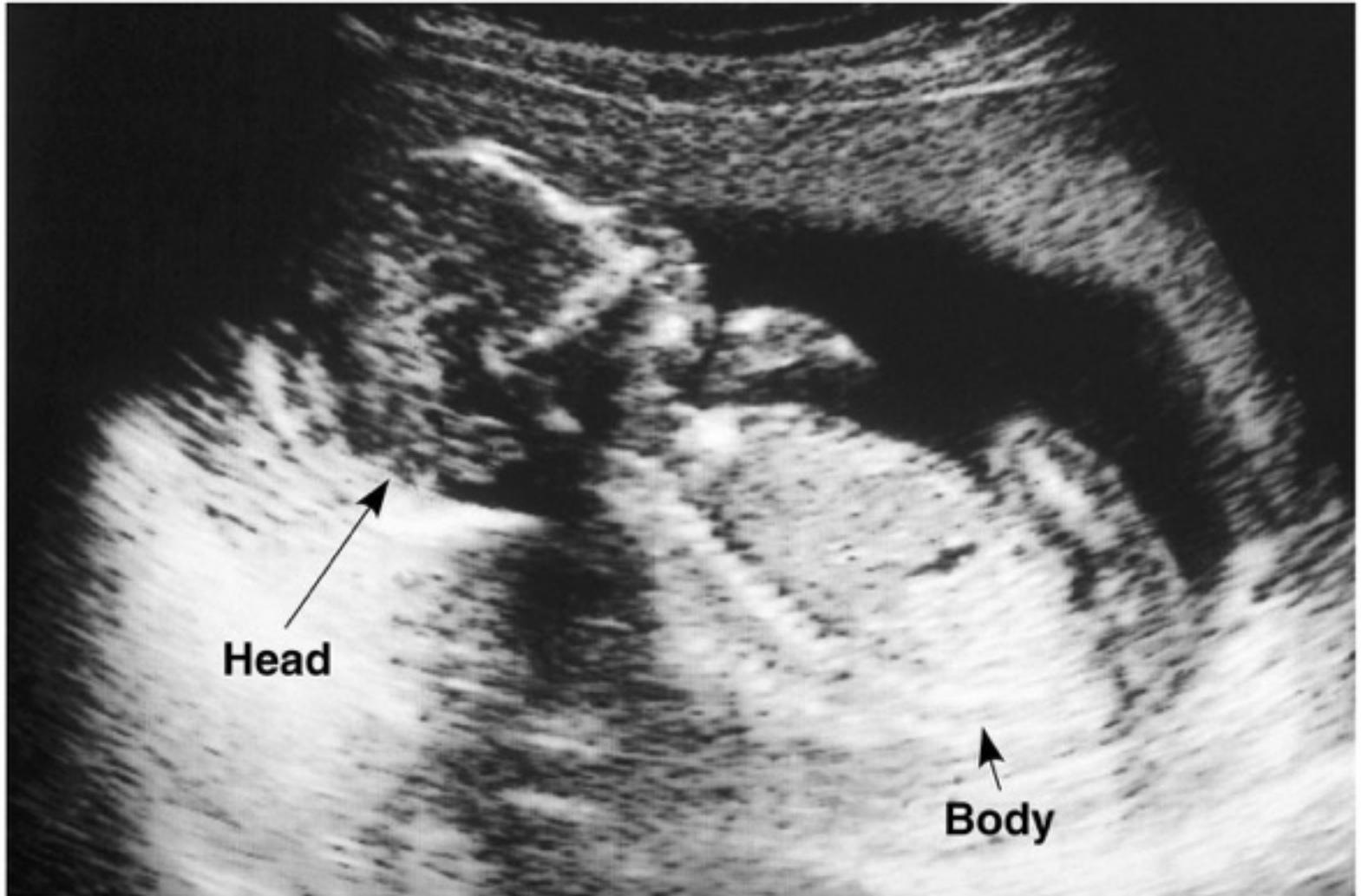
Digital Subtraction Angiography



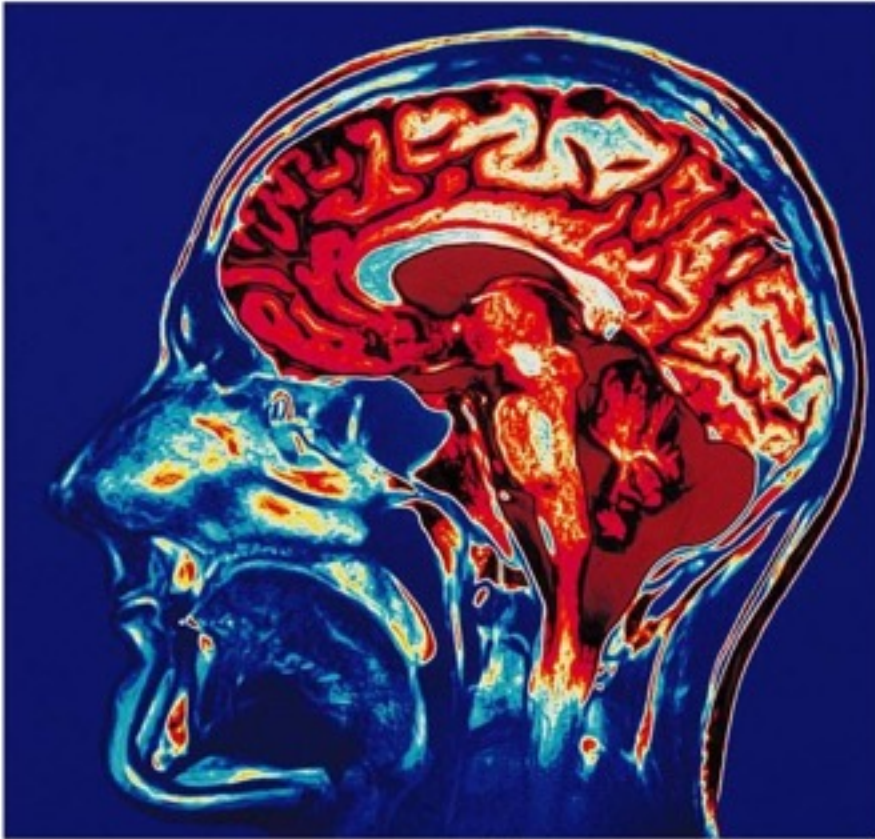
Positron Emission Tomography



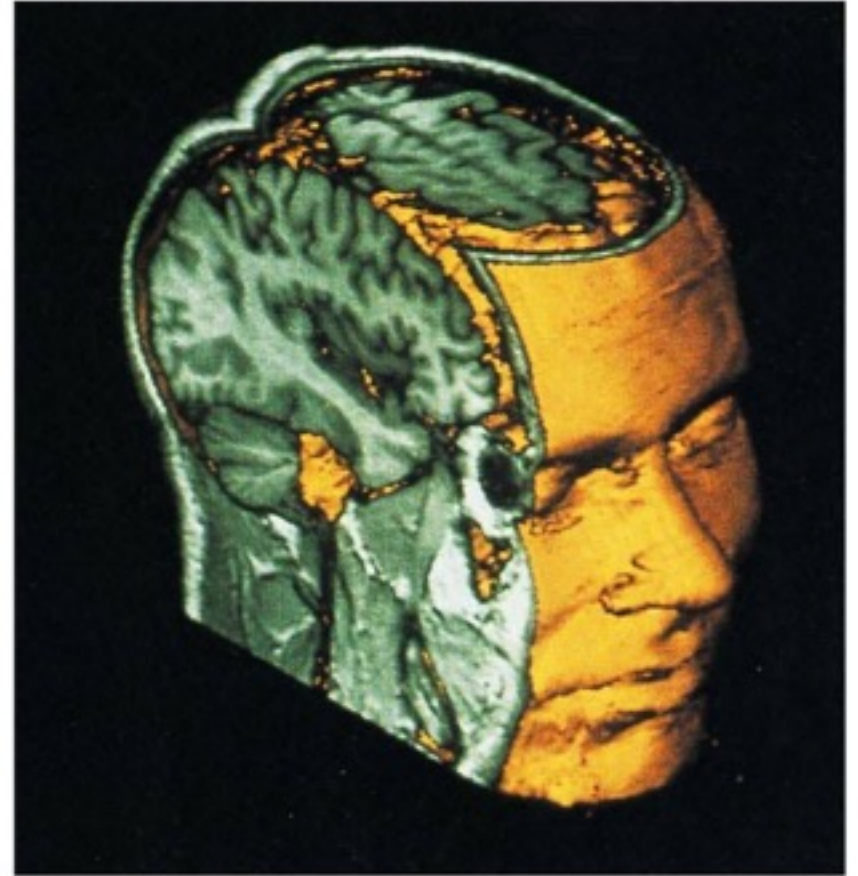
Sonography



MRI



(a)



(b)