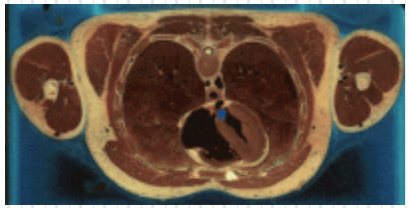


Introduction to Anatomy Physiology

Danil Hammoudi.MD

"Dispel from your mind the thought that an understanding of the human body in every aspect of its structure can be given in words; the more thoroughly you describe the more you will confuse... I advise you not to trouble with words unless you are speaking to blind men."
Leonardo da Vinci

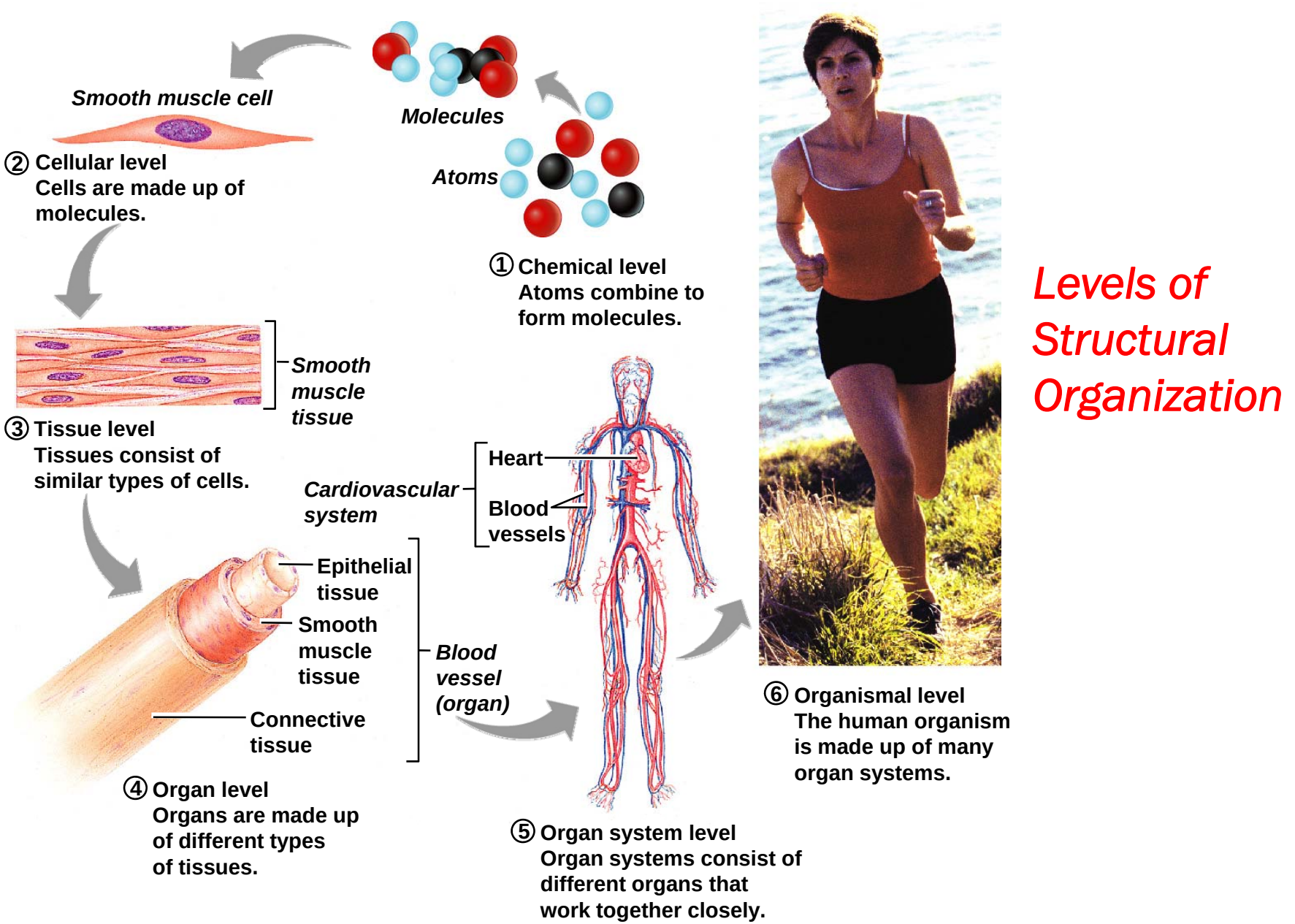

Smooth muscle cell
Molecules
Atoms
② Cellular level
Cells are made up of molecules.
① Chemical level
Atoms combine to form molecules.
Smooth muscle tissue
③ Tissue level
Tissues consist of similar types of cells.
Cardiovascular system
Heart
Blood vessels
Epithelial tissue
Smooth muscle tissue
Connective tissue
Blood vessel (organ)
④ Organ level
Organs are made up of different types of tissues.
⑤ Organ system level
Organ systems consist of different organs that work together closely.
⑥ Organismal level
The human organism is made up of many organ systems.
Levels of Structural Organization

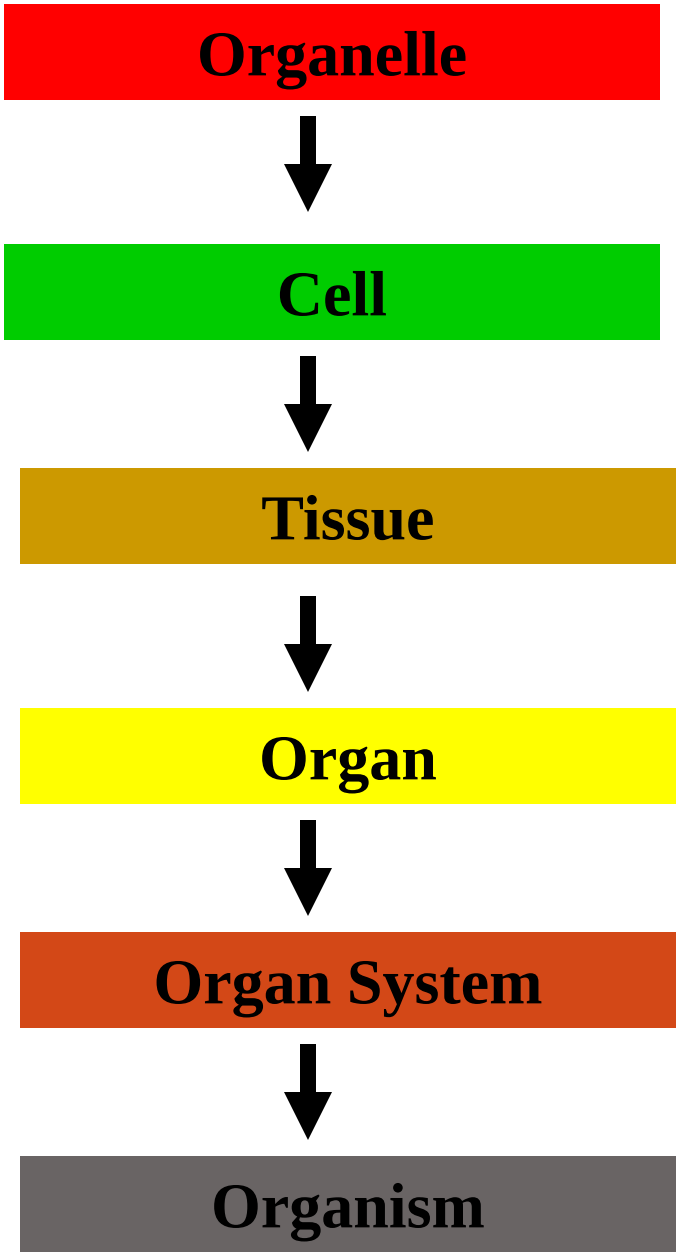
Figure 1.1

Levels of Structural Organization

- Chemical – atoms combined to form molecules
- Cellular – cells are made of molecules
- Tissue – consists of similar types of cells
- Organ – made up of different types of tissues
- Organ system – consists of different organs that work closely together
- Organismal – made up of the organ systems

Levels of Structure

- In order to understand how something is built and how something works, you must look at all of its components and analyze them both individually and together.
- In doing these collective and separate analyses, you must examine things at multiple structural levels, i.e., one must break them down from large to small – *this is called reductionism*
- An organism (such as a human being) may be broken down as illustrated on the left.



Overview of Anatomy and Physiology

- Anatomy – the study of the structure of body parts and their relationships to one another
  - Gross or macroscopic
  - Microscopic
  - Developmental
- Structure refers to
    - the shapes,
    - sizes,
    - and characteristics of the components of the human body.
- The word anatomy comes from 2 words:
  - *Ana* which means "up or apart"
  - *Tomos* which means "to cut"

Gross Anatomy

Study of stuff seen by the naked eye (*Gross Anatomy*).

- Regional – all structures in one part of the body (such as the abdomen or leg)
- Systemic – gross anatomy of the body studied by system
- Surface – study of internal structures as they relate to the overlying skin

Microscopic Anatomy

- Cytology – study of the cell
- Histology – study of tissues

Developmental Anatomy

- Traces structural changes throughout life
- Embryology – study of developmental changes of the body before birth

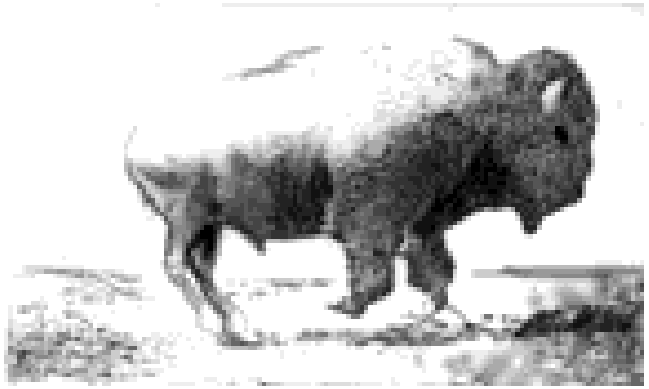
Specialized Branches of Anatomy

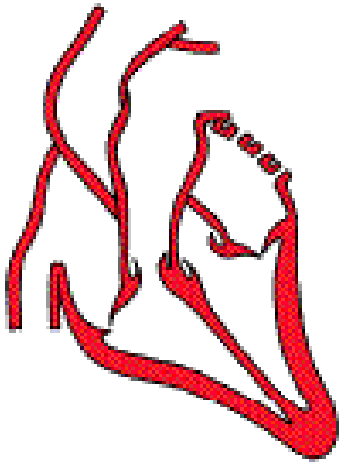
- Pathological anatomy – study of structural changes caused by disease
- Radiographic anatomy – study of internal structures visualized by specialized scanning procedures such as X-ray, MRI, and CT scans
- Molecular biology – study of anatomical structures at a subcellular level

Physiology

Physiology – the study of the function of the body's structural machinery

- Physiology is defined as the study of function – so human physiology attempts to explain how and why humans function.
- Physiology is where we figure out how stuff works.
  - How do muscles contract?
  - How do we run?
  - How does our heart beat?





Physiology

- Considers the operation of specific organ systems
  - Renal – kidney function
  - Neurophysiology – workings of the nervous system
  - Cardiovascular – operation of the heart and blood vessels
- Focuses on the functions of the body, often at the cellular or molecular level

Physiology

- Understanding physiology also requires a knowledge of physics, which explains
  - electrical currents
  - blood pressure
  - the way muscle uses bone for movement

Principle of Complementarity

- **Function always reflects structure**
- **What a structure can do depends on its specific form**

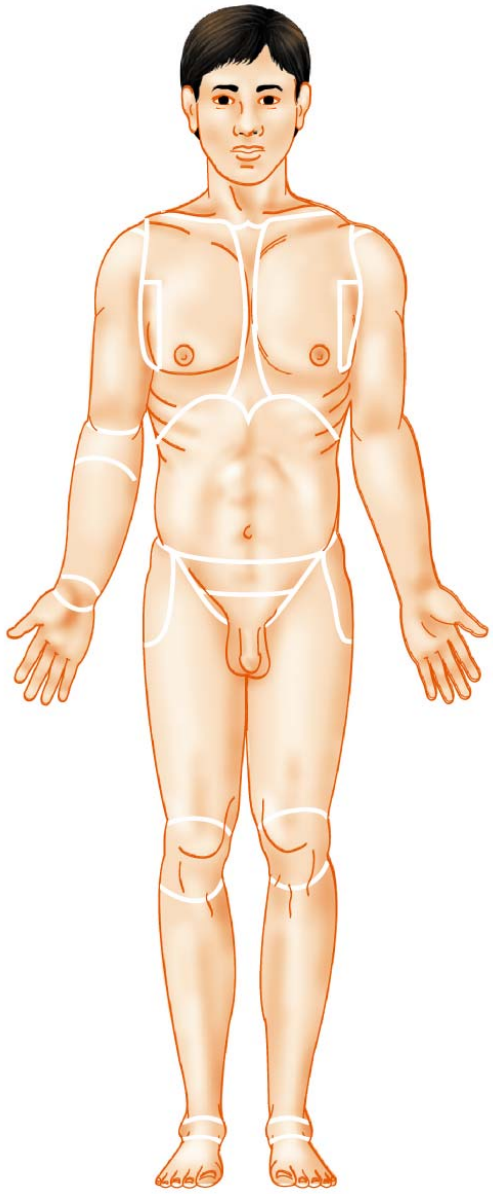
Can Anatomy & Physiology Be Separated?

- NOOOOOOO!!!!! Absolutely not!
- Structure and function are undeniably connected. We cannot divorce them.
- What do we mean by this?
  - Can you eat soup with a fork?
  - Find 2 everyday items and determine whether/how their structure (anatomy) relates to their function (physiology)

When you consider the structure of an organ, cell, or anything for that matter you must also consider its function!

Anatomical Position

- Body erect, feet slightly apart, palms facing forward, thumbs point away from body



(a)

Figure 1.7a

Directional Terms

- Superior and inferior – toward and away from the head, respectively
- Anterior and posterior – toward the front and back of the body
- Medial, lateral, and intermediate – toward the midline, away from the midline, and between a more medial and lateral structure

Directional Terms

- Proximal and distal – closer to and farther from the origin of the body part
- Superficial and deep – toward and away from the body surface

TABLE 1.1 Orientation and Directional Terms

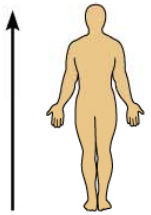
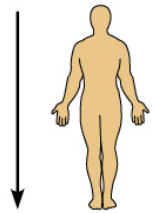
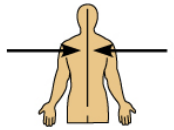
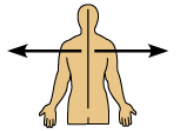
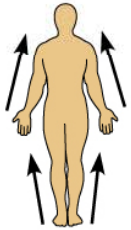
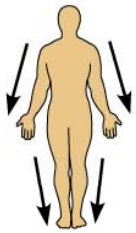
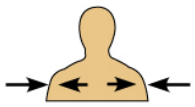
TERM	DEFINITION	EXAMPLE	
Superior (cranial)	Toward the head end or upper part of a structure or the body; above		The head is superior to the abdomen
Inferior (caudal)	Away from the head end or toward the lower part of a structure or the body; below		The navel is inferior to the chin
Ventral (anterior)*	Toward or at the front of the body; in front of		The breastbone is anterior to the spine
Dorsal (posterior)*	Toward or at the back of the body; behind		The heart is posterior to the breastbone
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
Intermediate	Between a more medial and a more lateral structure		The collarbone is intermediate between the breastbone and shoulder

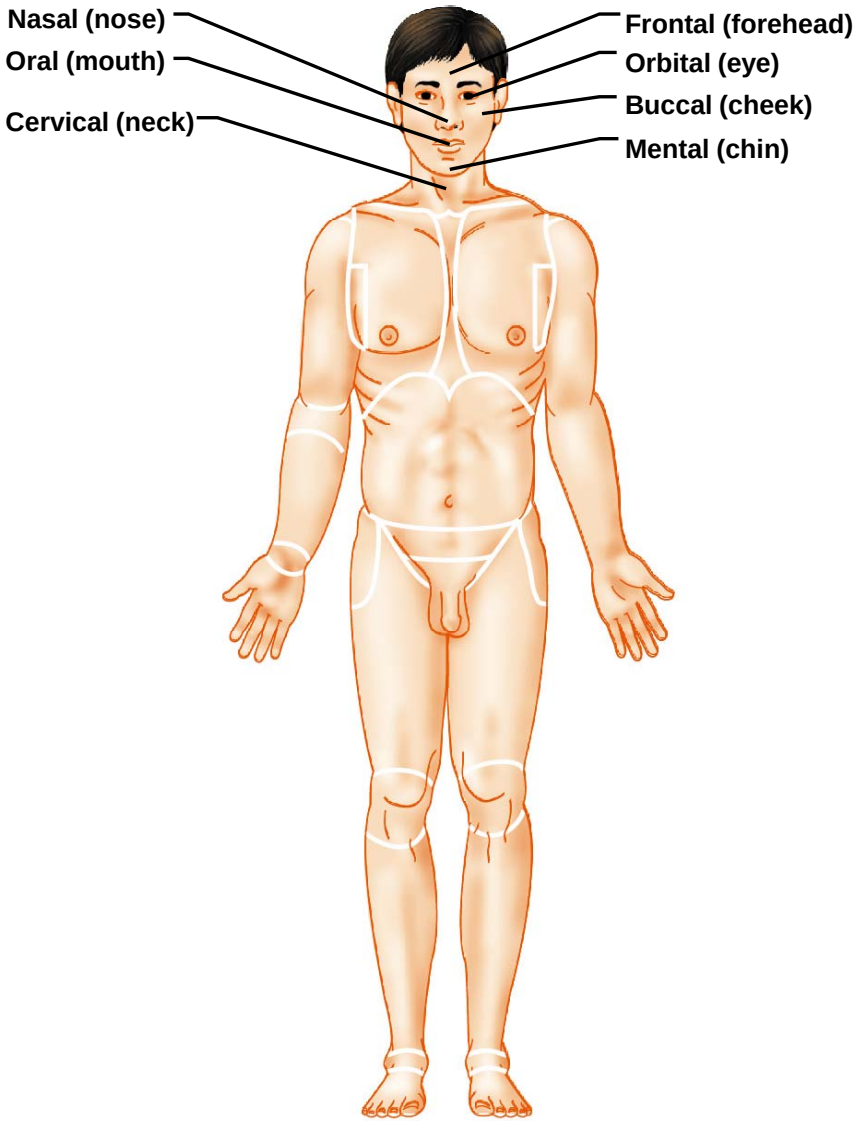
Table 1.1a

TABLE 1.1 Orientation and Directional Terms

TERM	DEFINITION	EXAMPLE	
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
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

*The terms *ventral* and *anterior* are synonymous in humans, but this is not the case in four-legged animals. Whereas *anterior* refers to the leading portion of the body (abdominal surface in humans, head in a cat), *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.

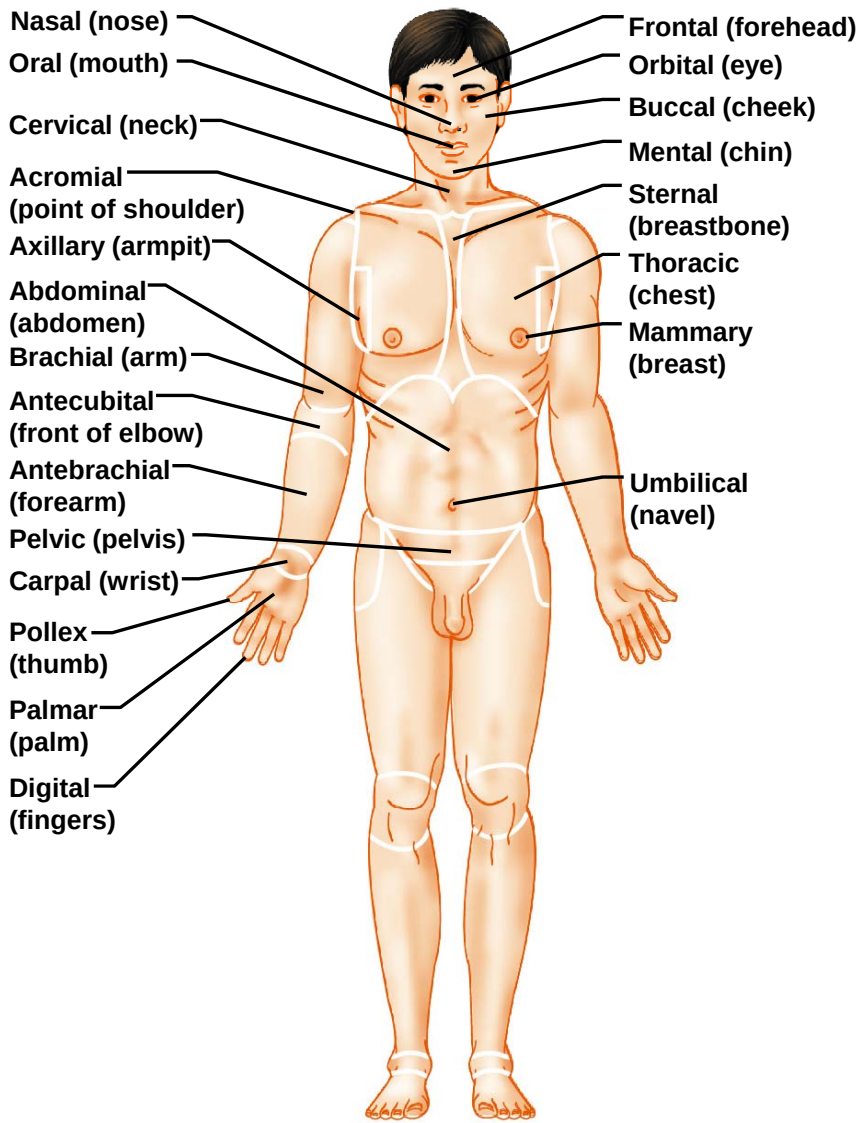
Regional Terms: Anterior View



(a) Anterior

Figure 1.7a

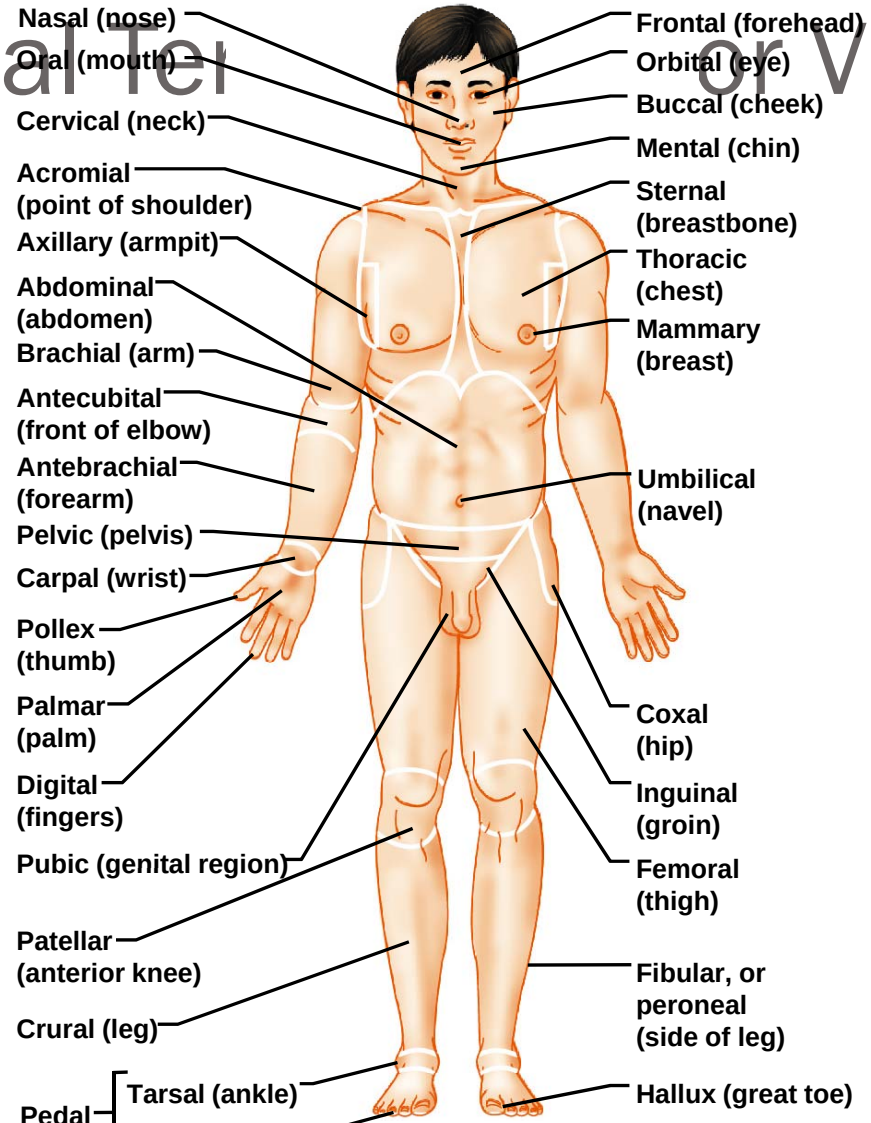
Regional Terms: Anterior View



(a) Anterior

Figure 1.7a

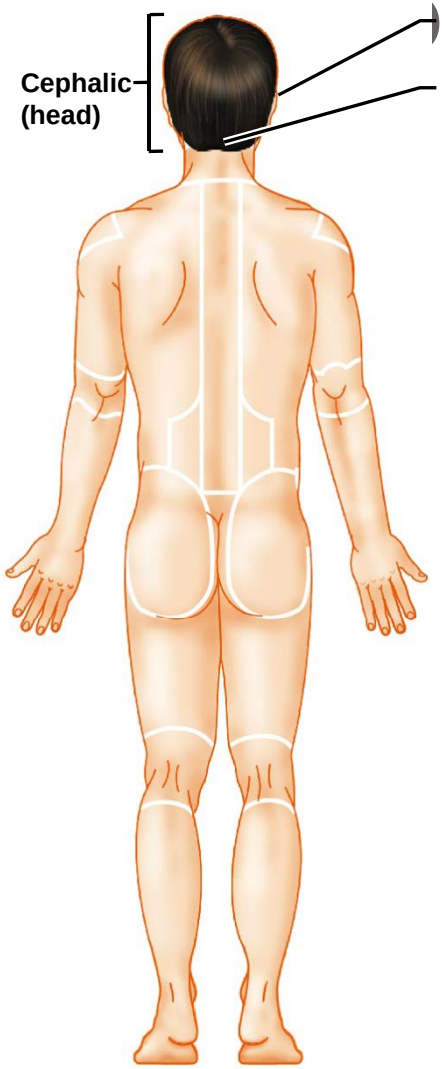
Regional Terms or View



(a) Anterior

Figure 1.7a

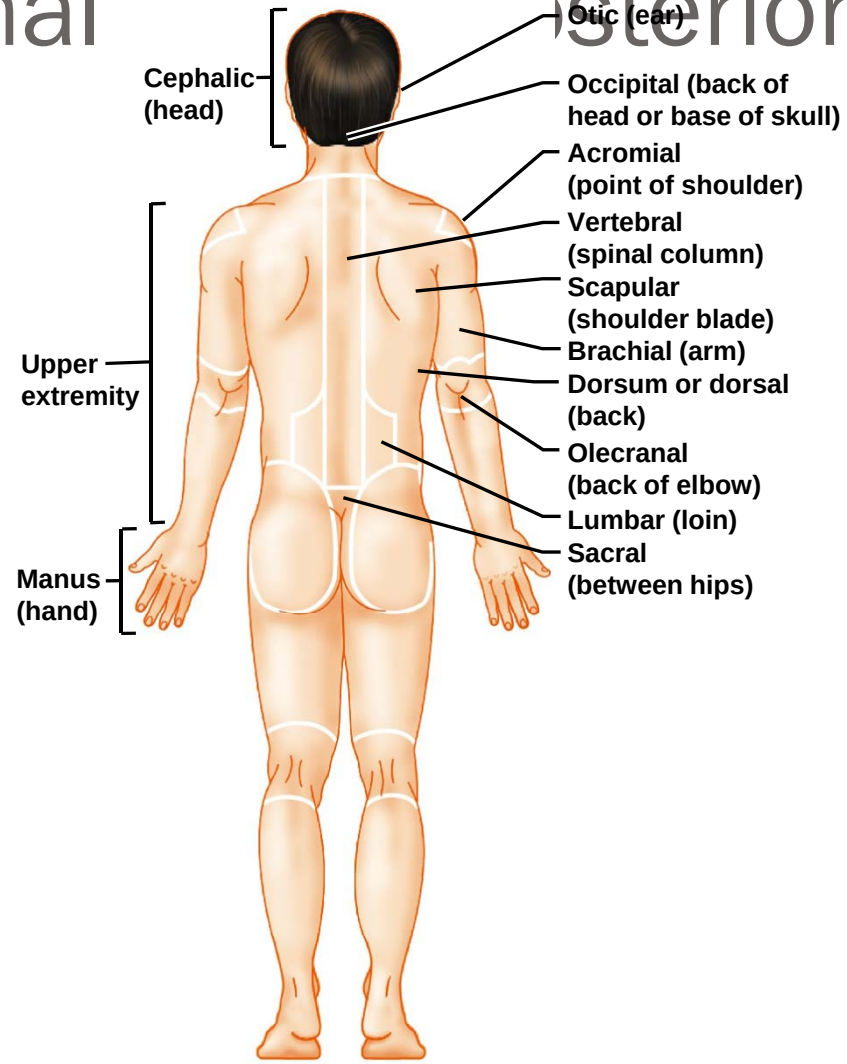
Regional Terms: Posterior View



(b) Posterior

Figure 1.7b

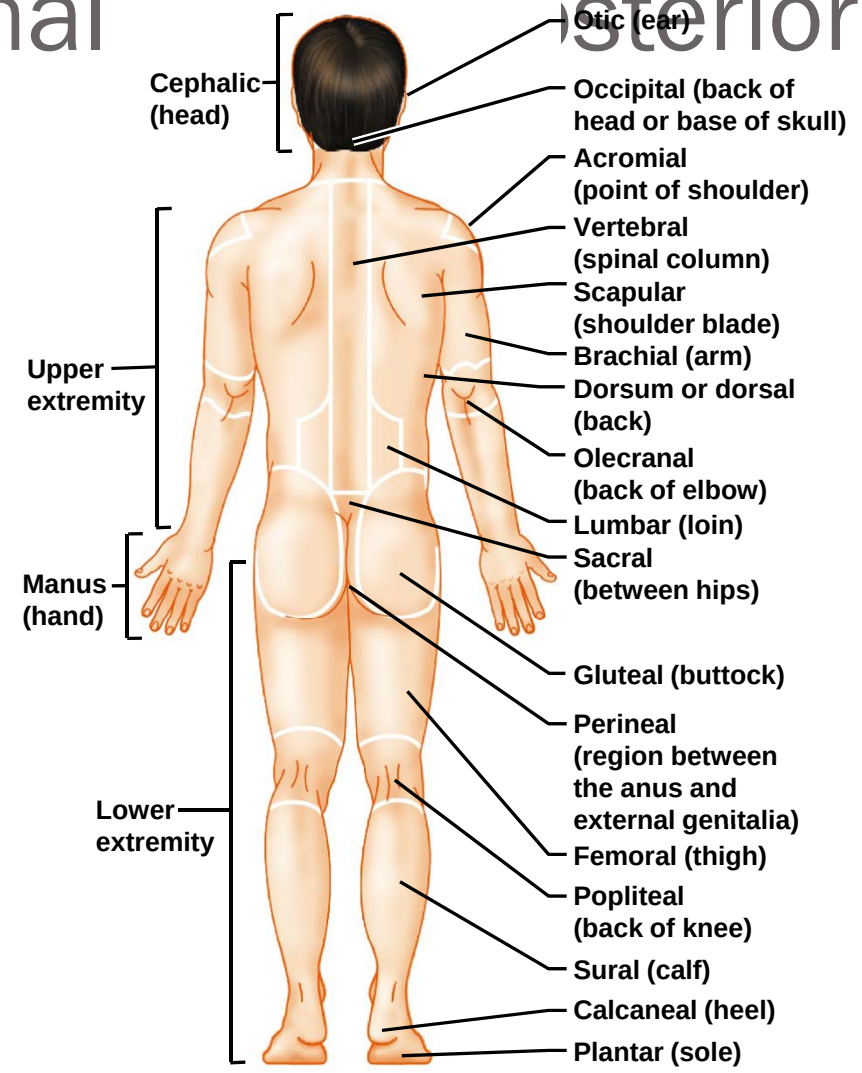
Regional Terms: Posterior View



(b) Posterior

Figure 1.7b

Regional Terms: Posterior View



(b) Posterior

Figure 1.7b

Body Planes

- Sagittal – divides the body into right and left parts
- Midsagittal or medial – sagittal plane that lies on the midline
- Frontal or coronal – divides the body into anterior and posterior parts
- Transverse or horizontal (cross section) – divides the body into superior and inferior parts
- Oblique section – cuts made diagonally

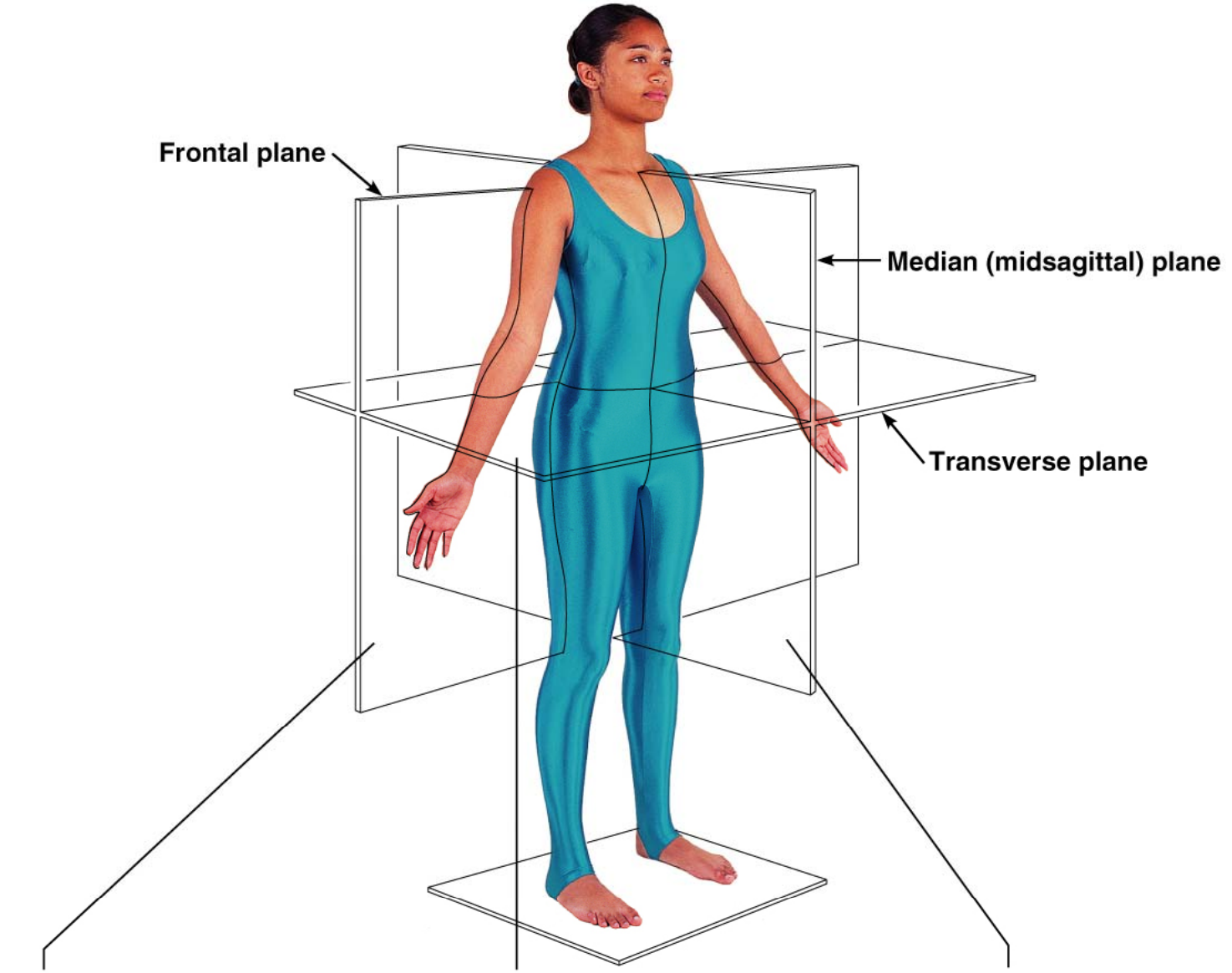

Frontal plane
Median (midsagittal) plane
Transverse plane
(a) Frontal section through torso
(b) Transverse section through torso (superior view)
(c) Median (midsagittal) section

Figure 1.8

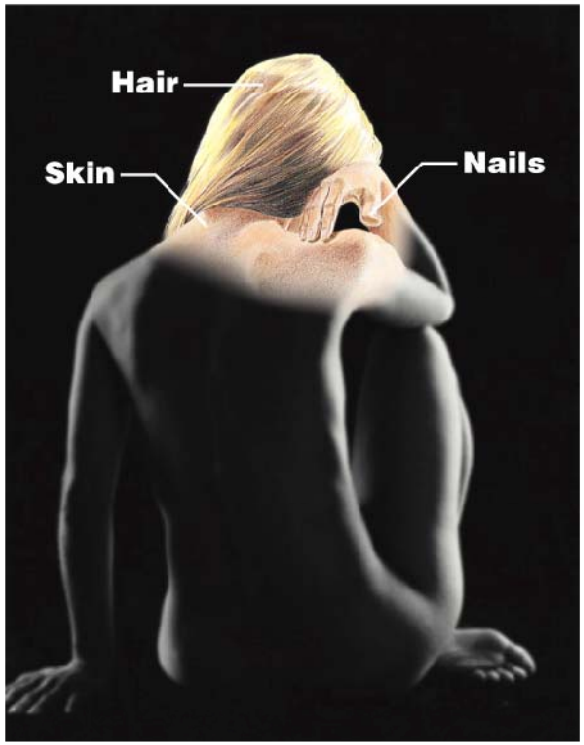
Anatomical Variability

- Humans vary slightly in both external and internal anatomy
- Over 90% of all anatomical structures match textbook descriptions, but:
  - Nerves or blood vessels may be somewhat out of place
  - Small muscles may be missing
- Extreme anatomical variations are seldom seen

Body System

Integumentary System

- Forms the external body covering
- Composed of the skin, sweat glands, oil glands, hair, and nails
- Protects deep tissues from injury and synthesizes vitamin D

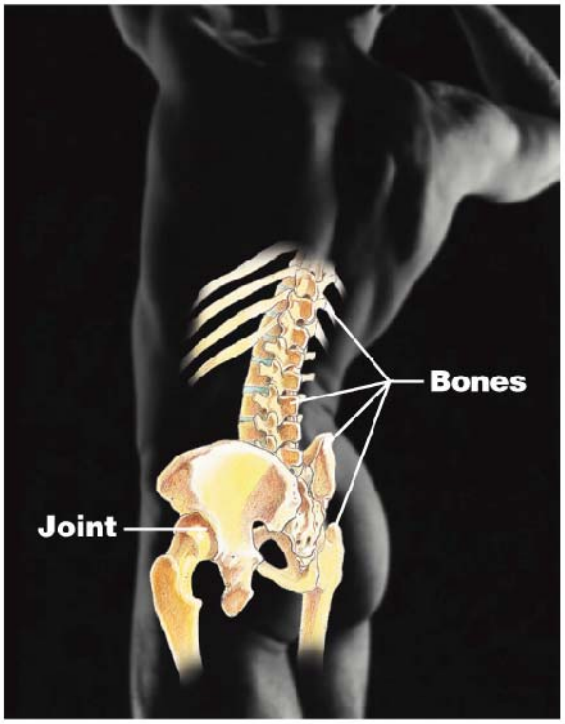


(a) Integumentary System

Figure 1.3a

Skeletal System

- Composed of bone, cartilage, and ligaments
- Protects and supports body organs
- Provides the framework for muscles
- Site of blood cell formation
- Stores minerals

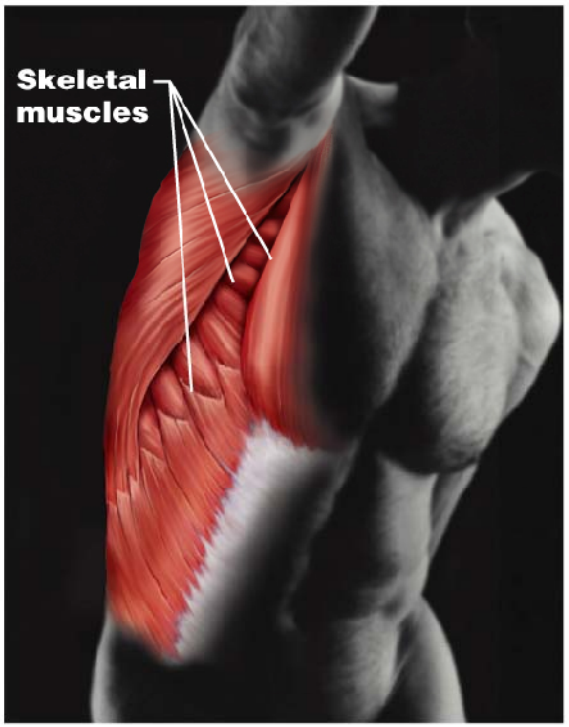


(b) Skeletal System

Figure 1.3b

Muscular System

- Composed of muscles and tendons
- Allows manipulation of the environment, locomotion, and facial expression
- Maintains posture
- Produces heat

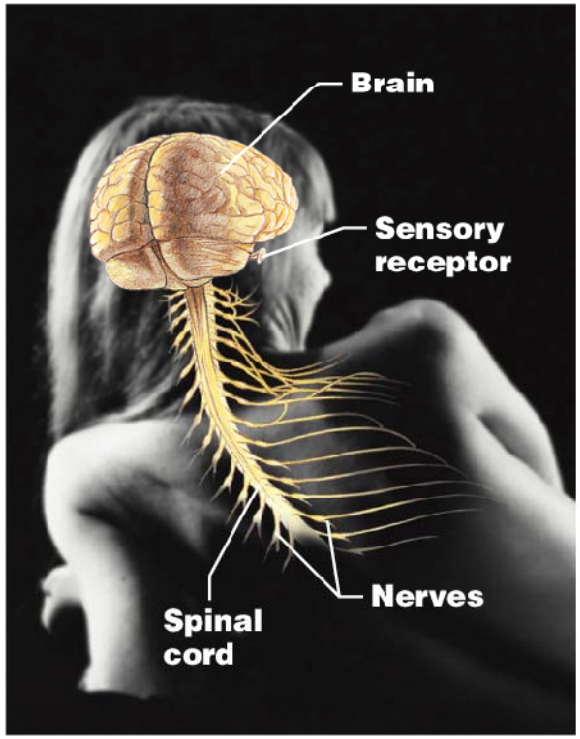


(c) Muscular System

Figure 1.3c

Nervous System

- Composed of the brain, spinal column, and nerves
- Is the fast-acting control system of the body
- Responds to stimuli by activating muscles and glands

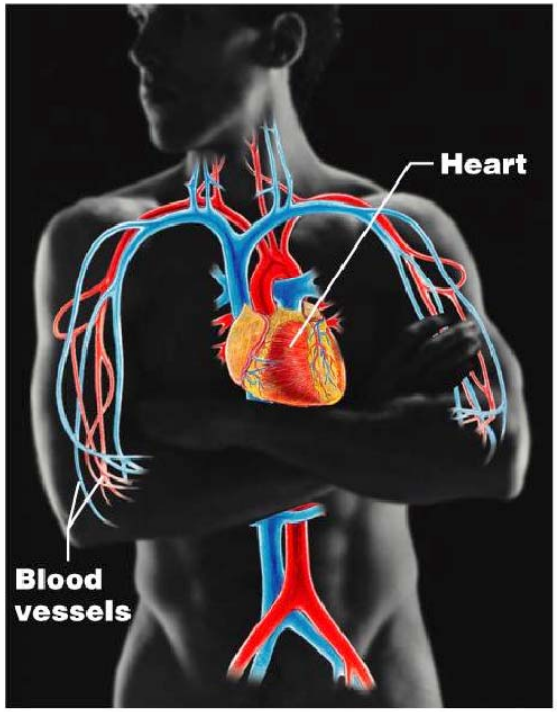


(d) Nervous System

Figure 1.3d

Cardiovascular System

- Composed of the heart and blood vessels
- The heart pumps blood
- The blood vessels transport blood throughout the body

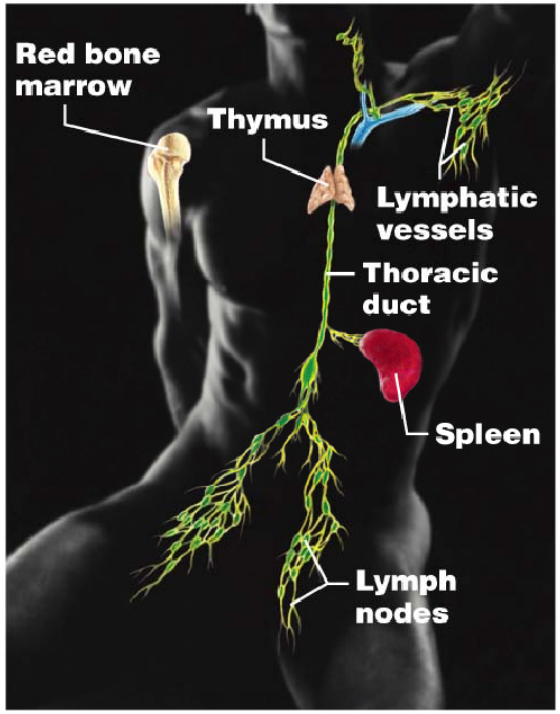


(f) Cardiovascular System

Figure 1.3f

Lymphatic System

- Composed of red bone marrow, thymus, spleen, lymph nodes, and lymphatic vessels
- Picks up fluid leaked from blood vessels and returns it to blood
- Disposes of debris in the lymphatic stream
- Houses white blood cells involved with immunity

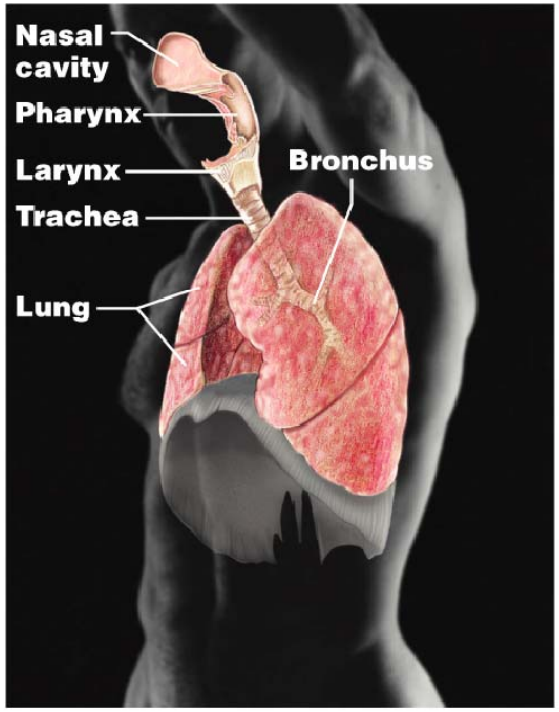


(g) Lymphatic System/Immunity

Figure 1.3g

Respiratory System

- Composed of the nasal cavity, pharynx, trachea, bronchi, and lungs
- Keeps blood supplied with oxygen and removes carbon dioxide

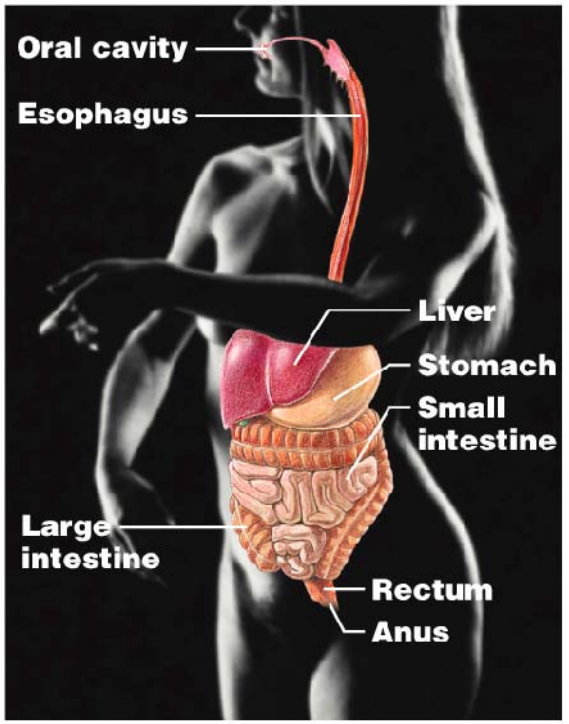


(h) Respiratory System

Figure 1.3h

Digestive System

- Composed of the oral cavity, esophagus, stomach, small intestine, large intestine, rectum, anus, and liver
- Breaks down food into absorbable units that enter the blood
- Eliminates indigestible foodstuffs as feces

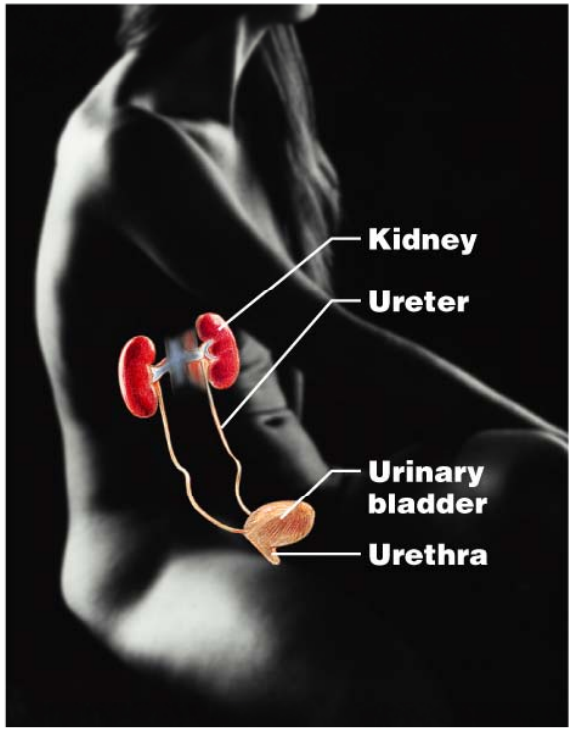


(i) Digestive System

Figure 1.3i

Urinary System

- Composed of kidneys, ureters, urinary bladder, and urethra
- Eliminates nitrogenous wastes from the body
- Regulates water, electrolyte, and pH balance of the blood

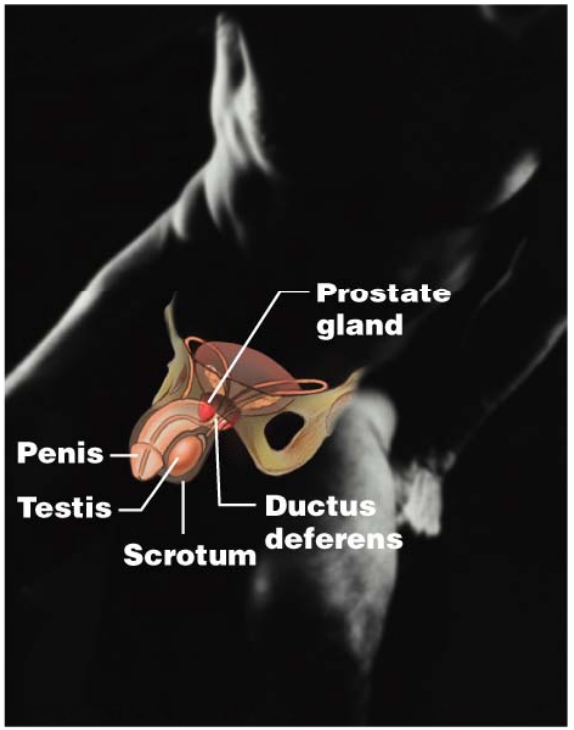


(j) Urinary System

Figure 1.3j

Male Reproductive System

- Composed of prostate gland, penis, testes, scrotum, and ductus deferens
- Main function is the production of offspring
- Testes produce sperm and male sex hormones
- Ducts and glands deliver sperm to the female reproductive tract

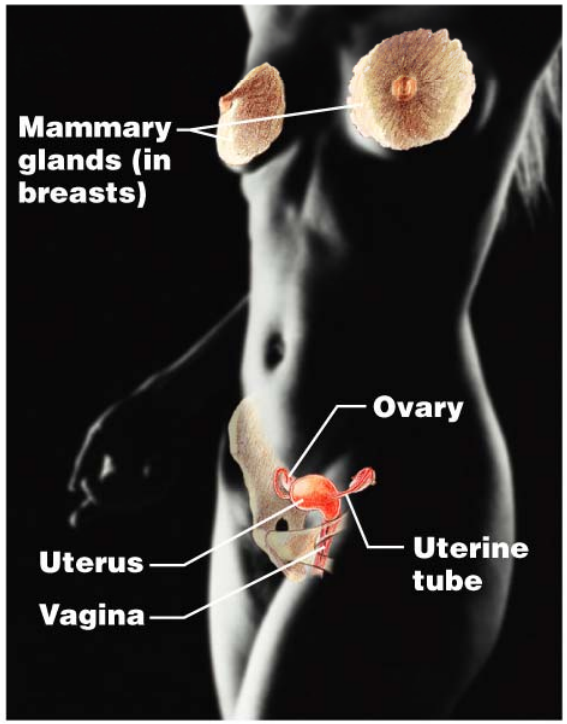


(k) Male Reproductive System

Figure 1.3k

Female Reproductive System

- Composed of mammary glands, ovaries, uterine tubes, uterus, and vagina
- Main function is the production of offspring
- Ovaries produce eggs and female sex hormones
- Remaining structures serve as sites for fertilization and development of the fetus
- Mammary glands produce milk to nourish the newborn



(l) Female Reproductive System

Figure 1.3l

Organ Systems Interrelationships

- The integumentary system protects the body from the external environment
- Digestive and respiratory systems, in contact with the external environment, take in nutrients and oxygen

Organ Systems Inte

- Nutrients and oxygen are distributed by the blood
- Metabolic wastes are eliminated by the urinary and respiratory systems

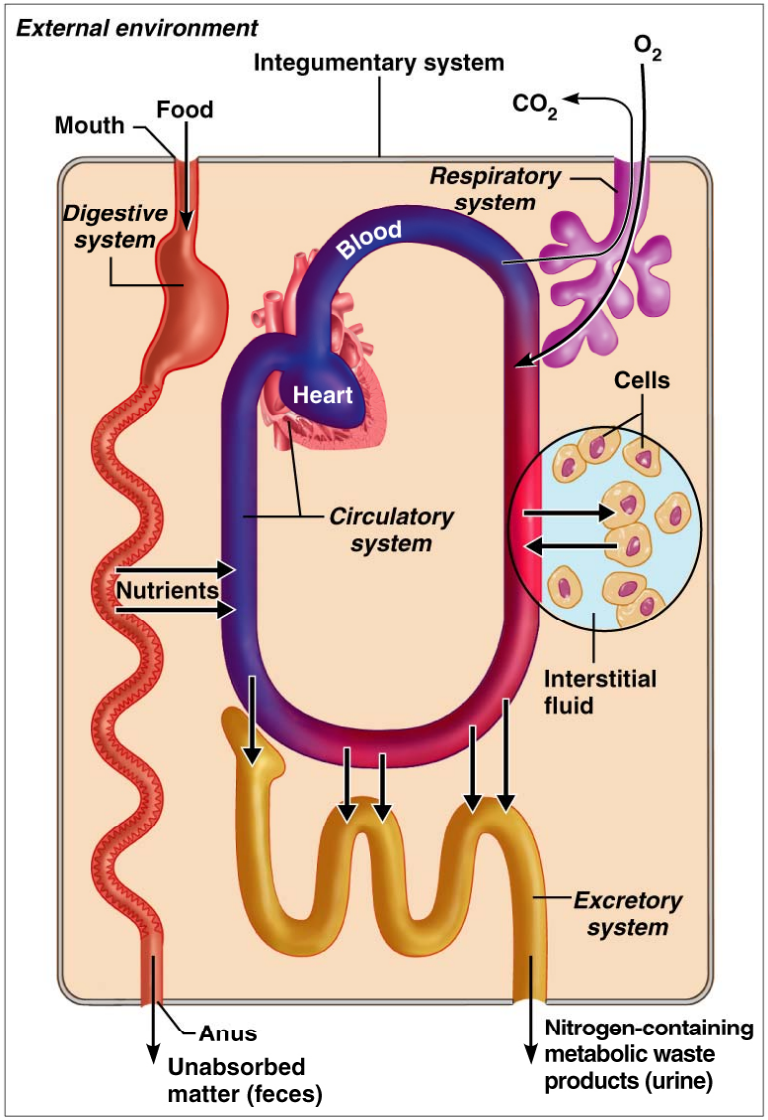


Figure 1.2

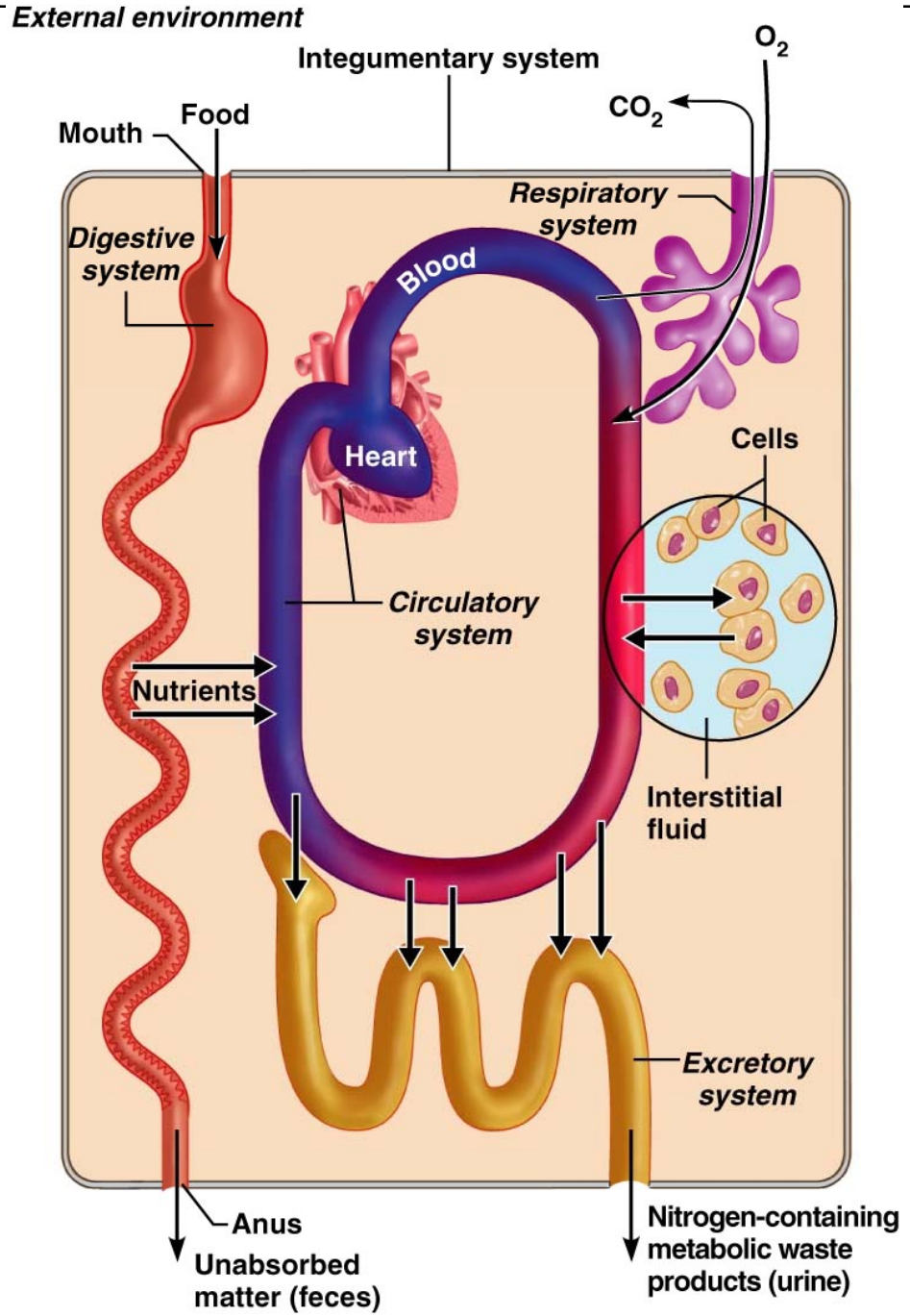

External environment
Integumentary system
O_2
CO_2
Mouth
Food
Respiratory system
Digestive system
Blood
Heart
Cells
Circulatory system
Nutrients
Interstitial fluid
Excretory system
Anus
Unabsorbed matter (feces)
Nitrogen-containing metabolic waste products (urine)

Figure 1.2

Necessary Life Functions

- Maintaining boundaries – the internal environment remains distinct from the external environment
  - Cellular level – accomplished by plasma membranes
  - Organismal level – accomplished by the skin
- Movement – locomotion, propulsion (peristalsis), and contractility

Necessary Life Functions

- **Responsiveness** – ability to sense changes in the environment and respond to them
- **Digestion** – breakdown of ingested foodstuffs
- **Metabolism** – all the chemical reactions that occur in the body
- **Excretion** – removal of wastes from the body

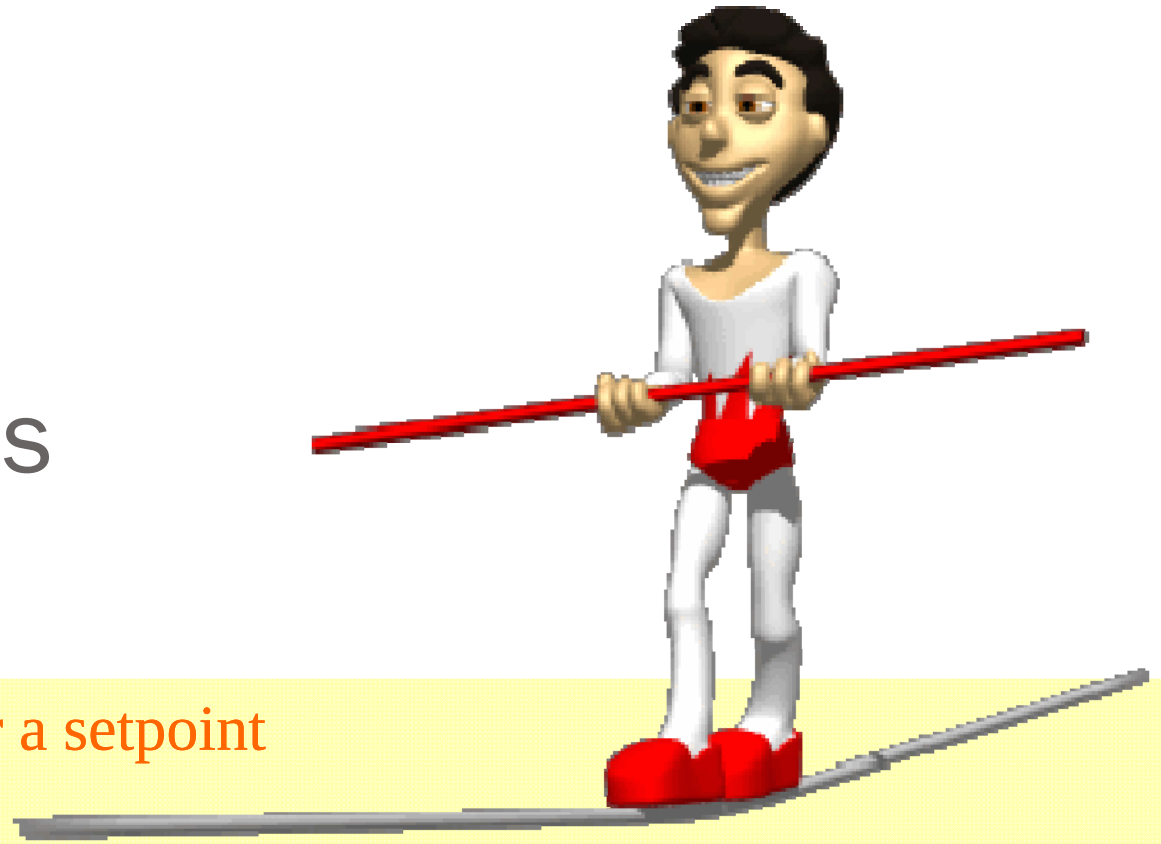
Necessary Life Functions

- Reproduction – cellular and organismal levels
  - Cellular – an original cell divides and produces two identical daughter cells
  - Organismal – sperm and egg unite to make a whole new person
- Growth – increase in size of a body part or of the organism

Survival Needs

- Nutrients – needed for energy and cell building
- Oxygen – necessary for metabolic reactions
- Water – provides the necessary environment for chemical reactions
- Normal body temperature – necessary for chemical reactions to occur at life-sustaining rates
- Atmospheric pressure – required for proper breathing and gas exchange in the lungs

Homeostasis

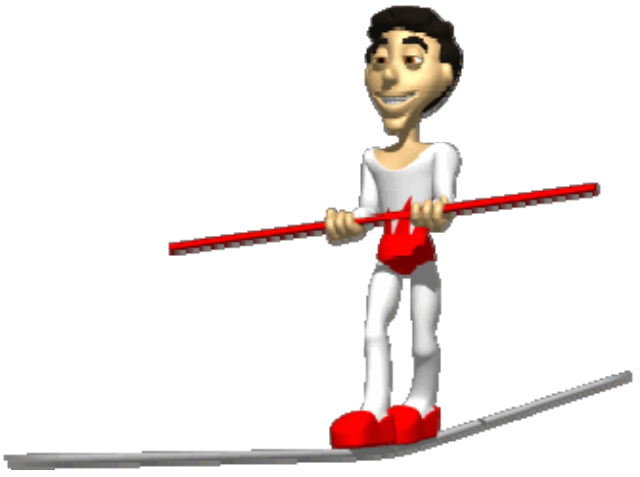


Relative constancy near a setpoint

- Dynamic
  - Energy-consuming
- Negative feedback loops
- Stability of variable is vital to survival
- Interdependence of variables (pyramid)

Homeostasis

- Homeostasis – ability to maintain a relatively stable internal environment in an ever-changing outside world
- The internal environment of the body is in a dynamic state of equilibrium
- Chemical, thermal, and neural factors interact to maintain homeostasis



Homeostatic Control Mechanisms

- Variables produce a change in the body
- The three interdependent components of control mechanisms:
  - Receptor – monitors the environments and responds to changes (stimuli)
  - Control center – determines the set point at which the variable is maintained
  - Effector – provides the means to respond to stimuli

Homeostatic Control Mechanisms

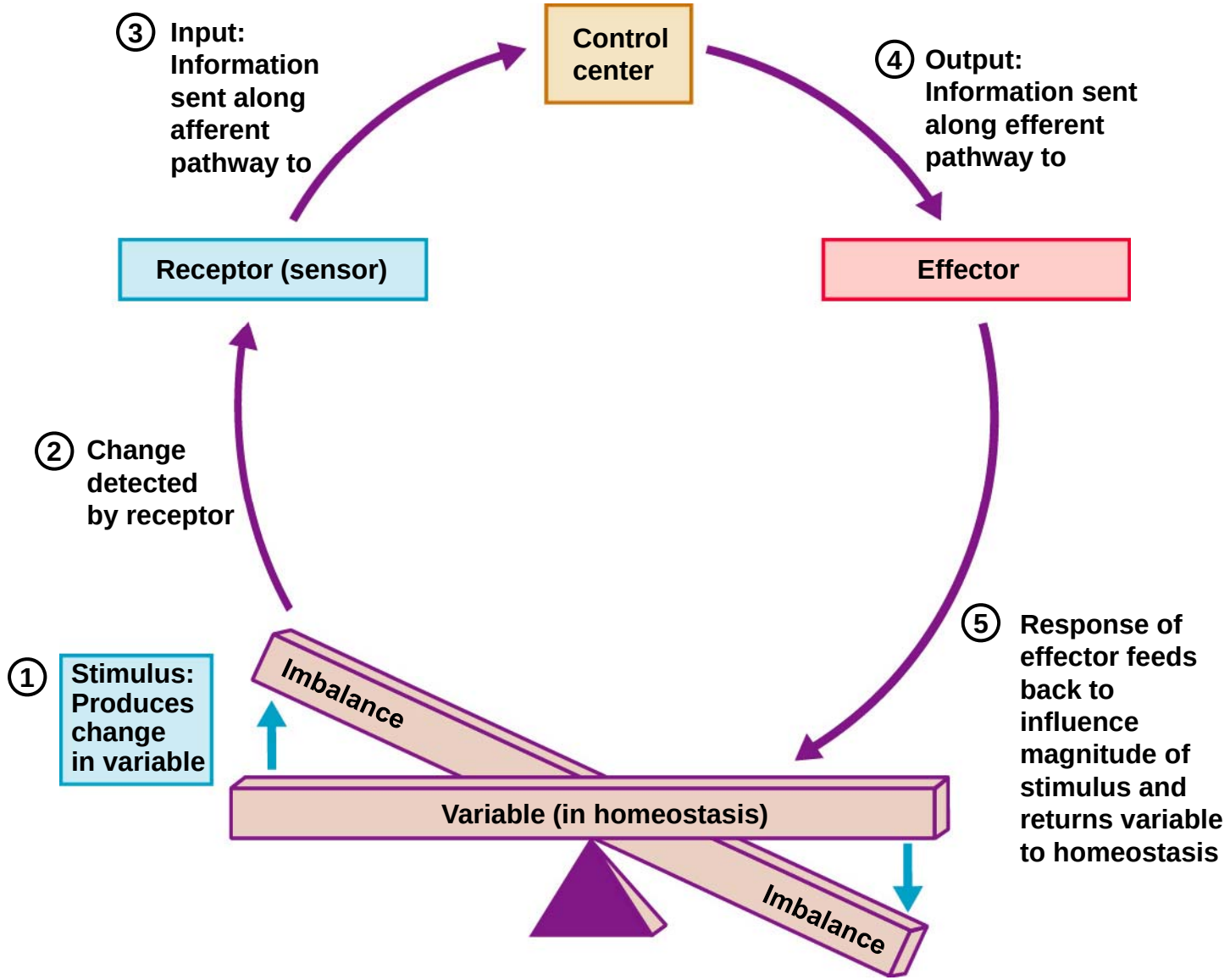


Figure 1.4

Negative Feedback

- In negative feedback systems, the output shuts off the original stimulus
- Example: Regulation of room temperature

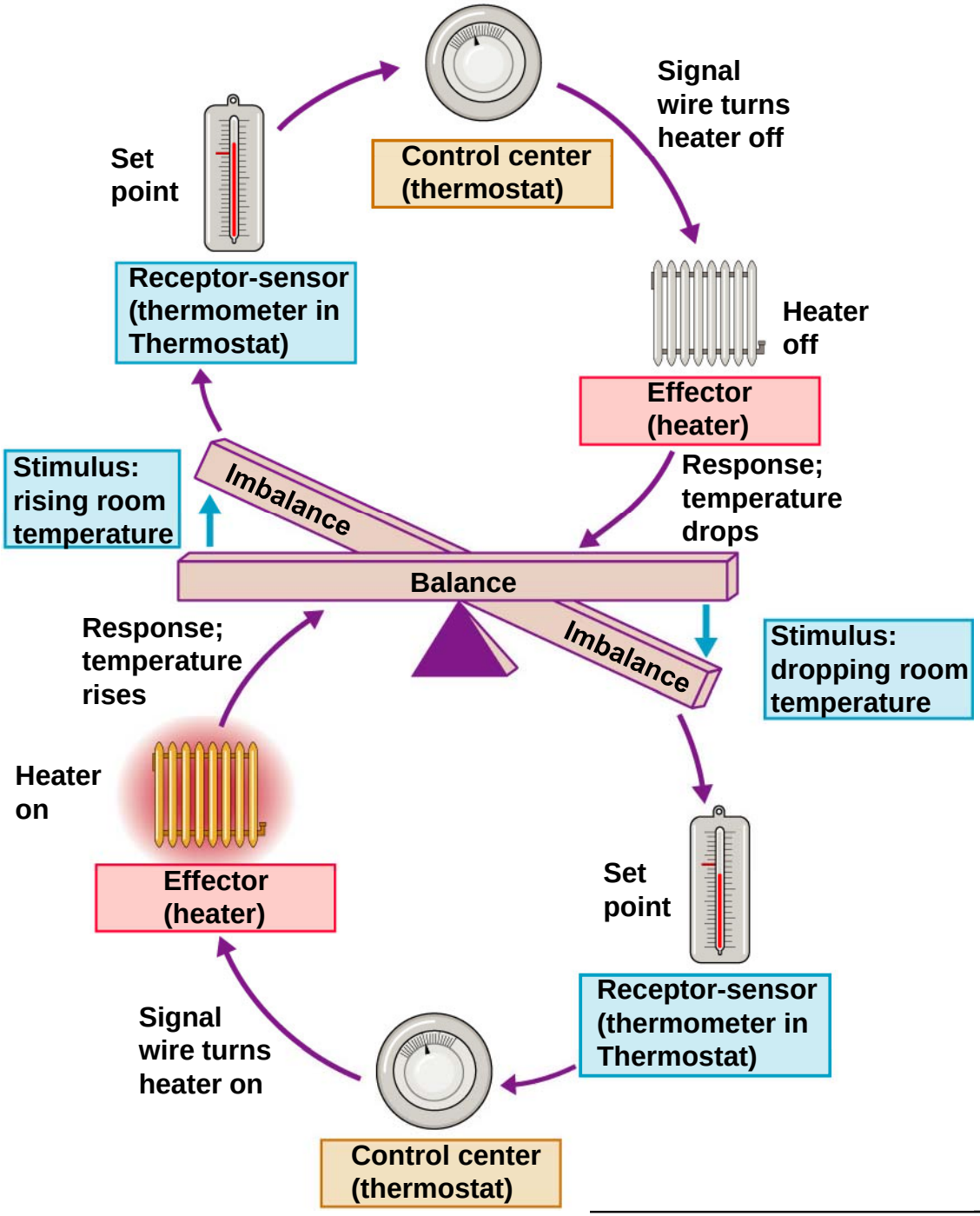
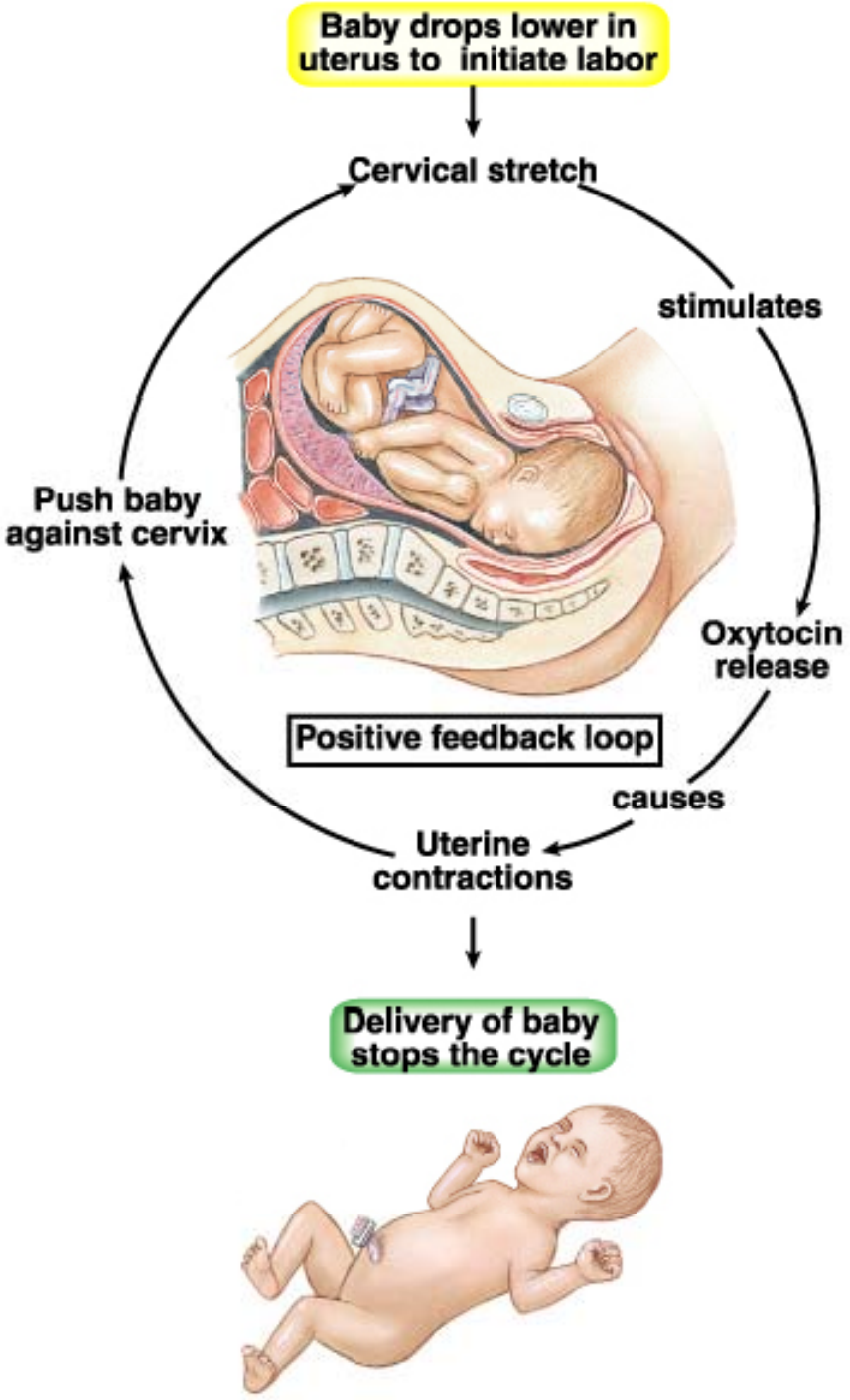

Control center (thermostat)
Signal wire turns heater off
Set point
Receptor-sensor (thermometer in Thermostat)
Heater off
Effector (heater)
Stimulus: rising room temperature
Imbalance
Response; temperature drops
Balance
Response; temperature rises
Imbalance
Stimulus: dropping room temperature
Heater on
Effector (heater)
Set point
Receptor-sensor (thermometer in Thermostat)
Signal wire turns heater on
Control center (thermostat)

Figure 1.5

Positive Feedback in Childbirth



Positive Feedback

- In positive feedback systems, the output enhances or exaggerates the original stimulus
- Example: Regulation of blood clotting

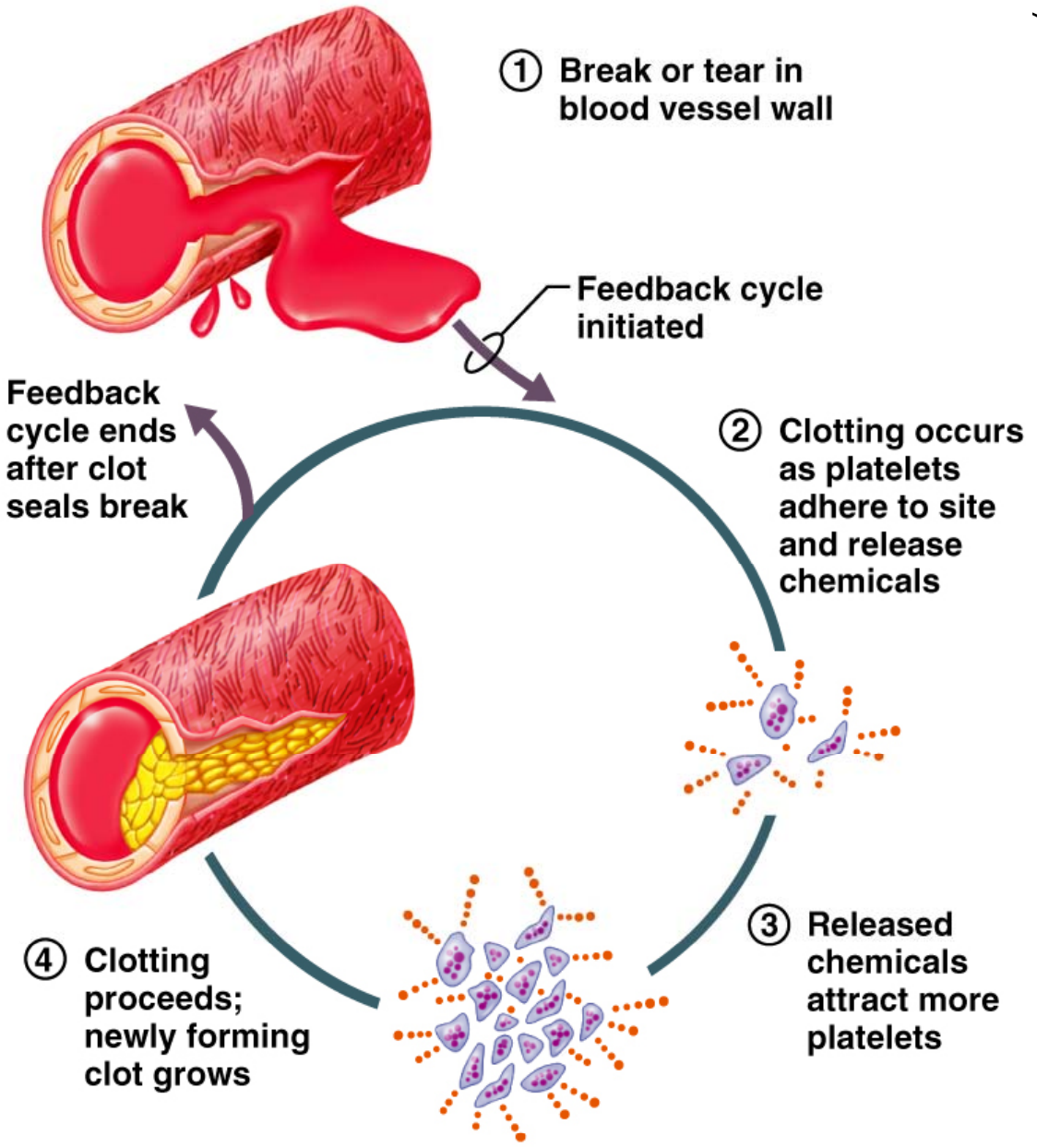


Figure 1.6

Homeostatic Imbalance

- Disturbance of homeostasis or the body's normal equilibrium
- Overwhelming the usual negative feedback mechanisms allows destructive positive feedback mechanisms to take over

Dangerous Positive Feedback

Rise in body temperature

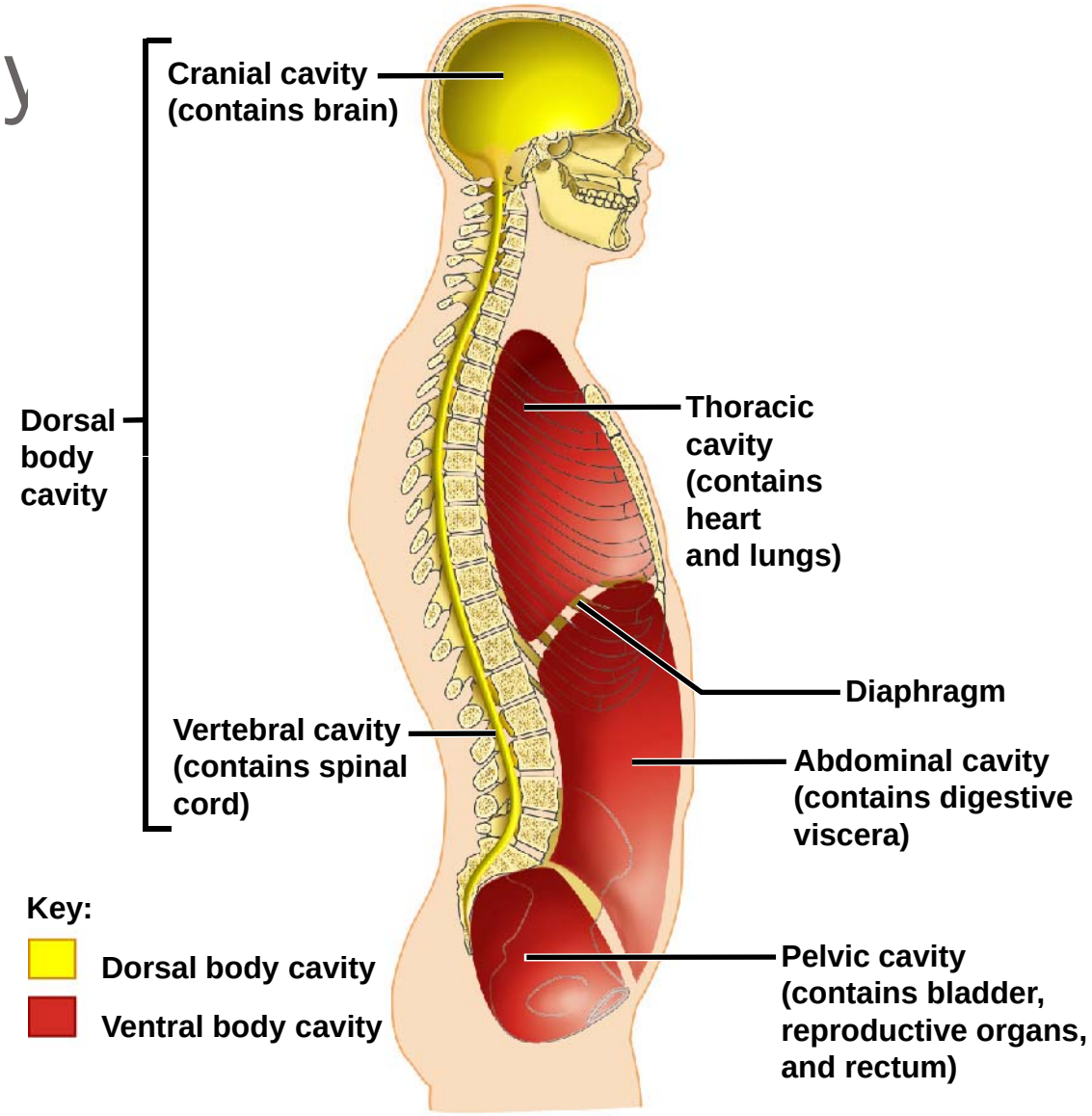
Increase in body metabolism

Increase in body heat production

Body Cavities

- Dorsal cavity protects the nervous system, and is divided into two subdivisions
  - Cranial cavity – within the skull; encases the brain
  - Vertebral cavity – runs within the vertebral column; encases the spinal cord
- Ventral cavity houses the internal organs (viscera), and is divided into two subdivisions
  - Thoracic
  - Abdominopelvic

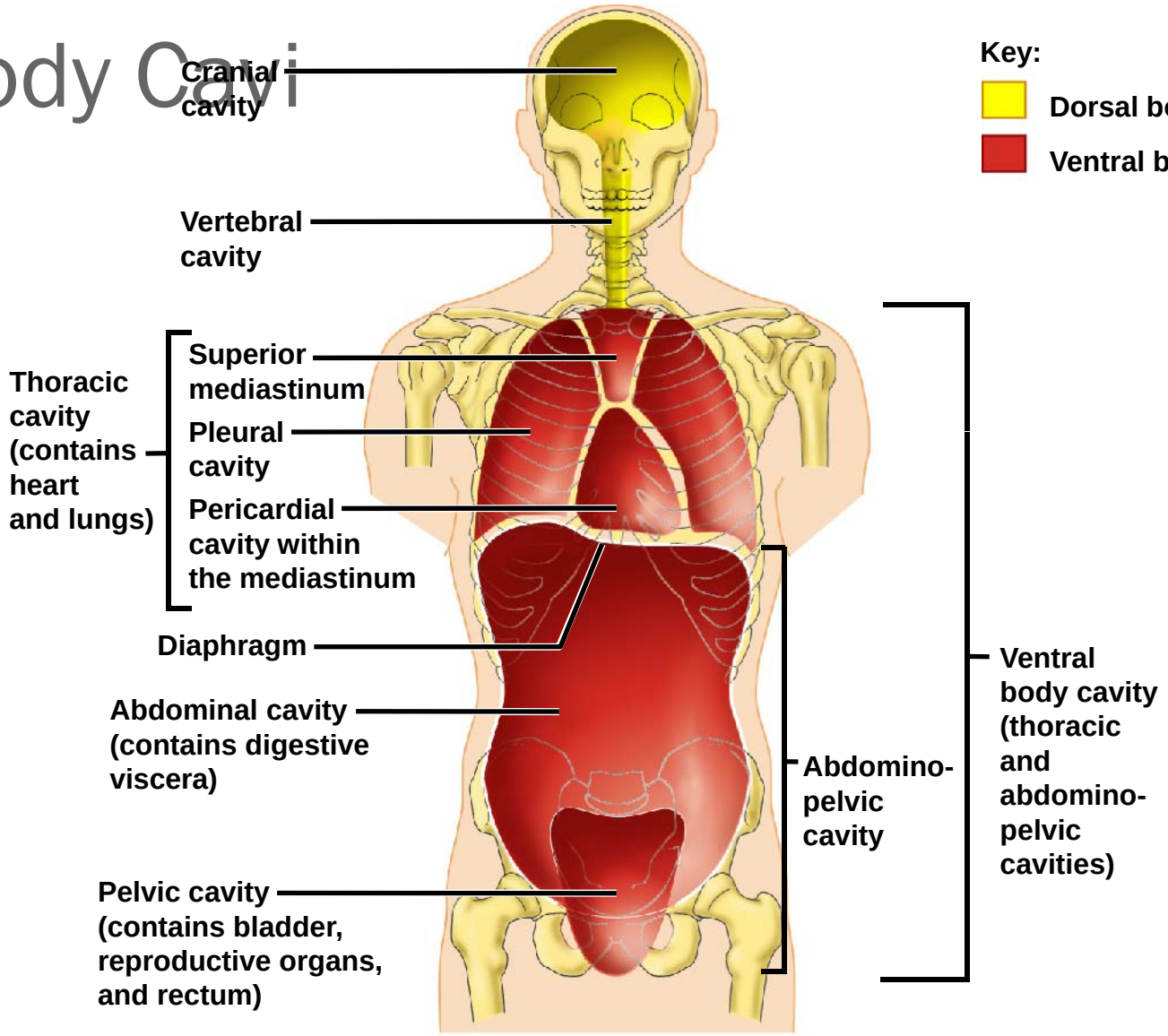
Body



(a) Lateral view

Figure 1.9a

Body Cavi



(b) Anterior view

Figure 1.9b

Body Cavities

- Thoracic cavity is subdivided into two pleural cavities, the mediastinum, and the pericardial cavity
  - Pleural cavities – each houses a lung
  - Mediastinum – contains the pericardial cavity; surrounds the remaining thoracic organs
  - Pericardial cavity – encloses the heart

Body Cavities

- The abdominopelvic cavity is separated from the superior thoracic cavity by the dome-shaped diaphragm
- It is composed of two subdivisions
  - Abdominal cavity – contains the stomach, intestines, spleen, liver, and other organs
  - Pelvic cavity – lies within the pelvis and contains the bladder, reproductive organs, and rectum

Ventral Body Cavity Membranes

- Parietal serosa lines internal body walls
- Visceral serosa covers the internal organs
- Serous fluid separates the serosae

Serous Membrane Relationship

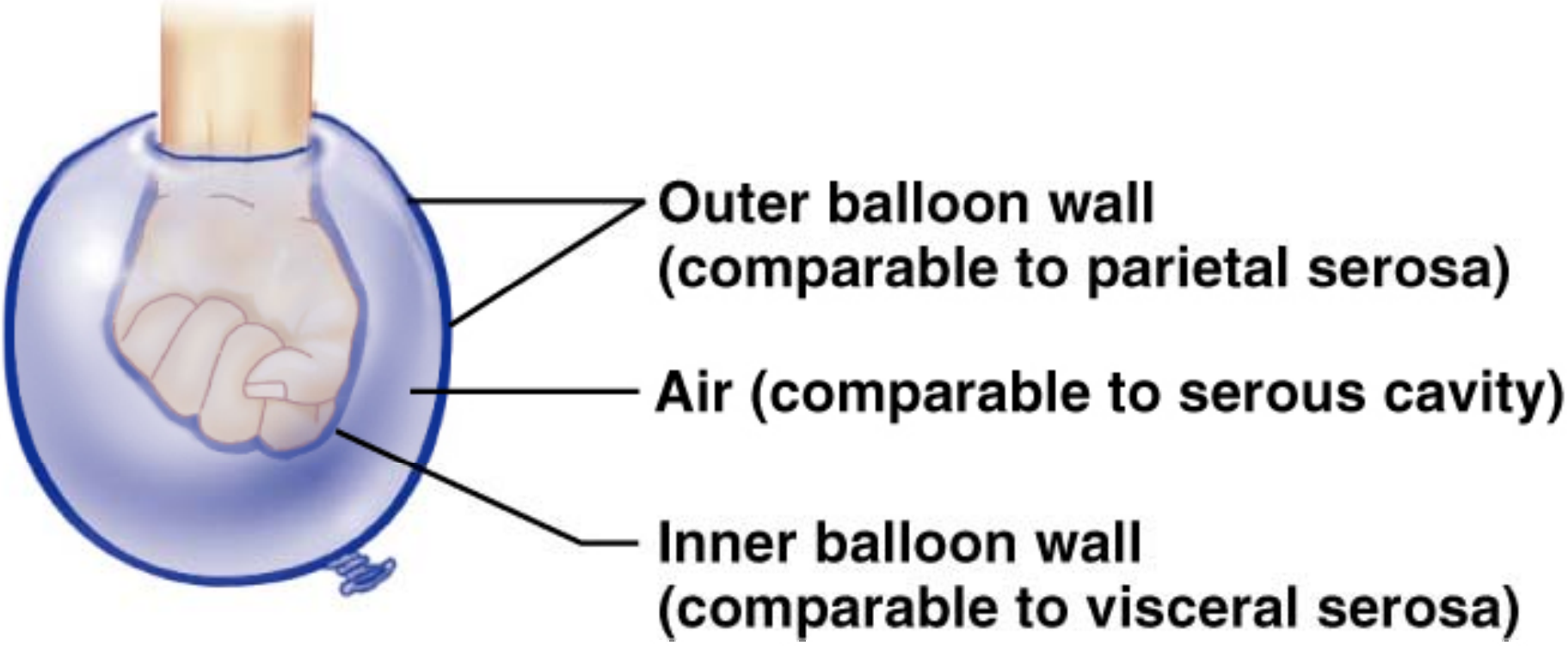


Figure 1.10a

Heart Serosae

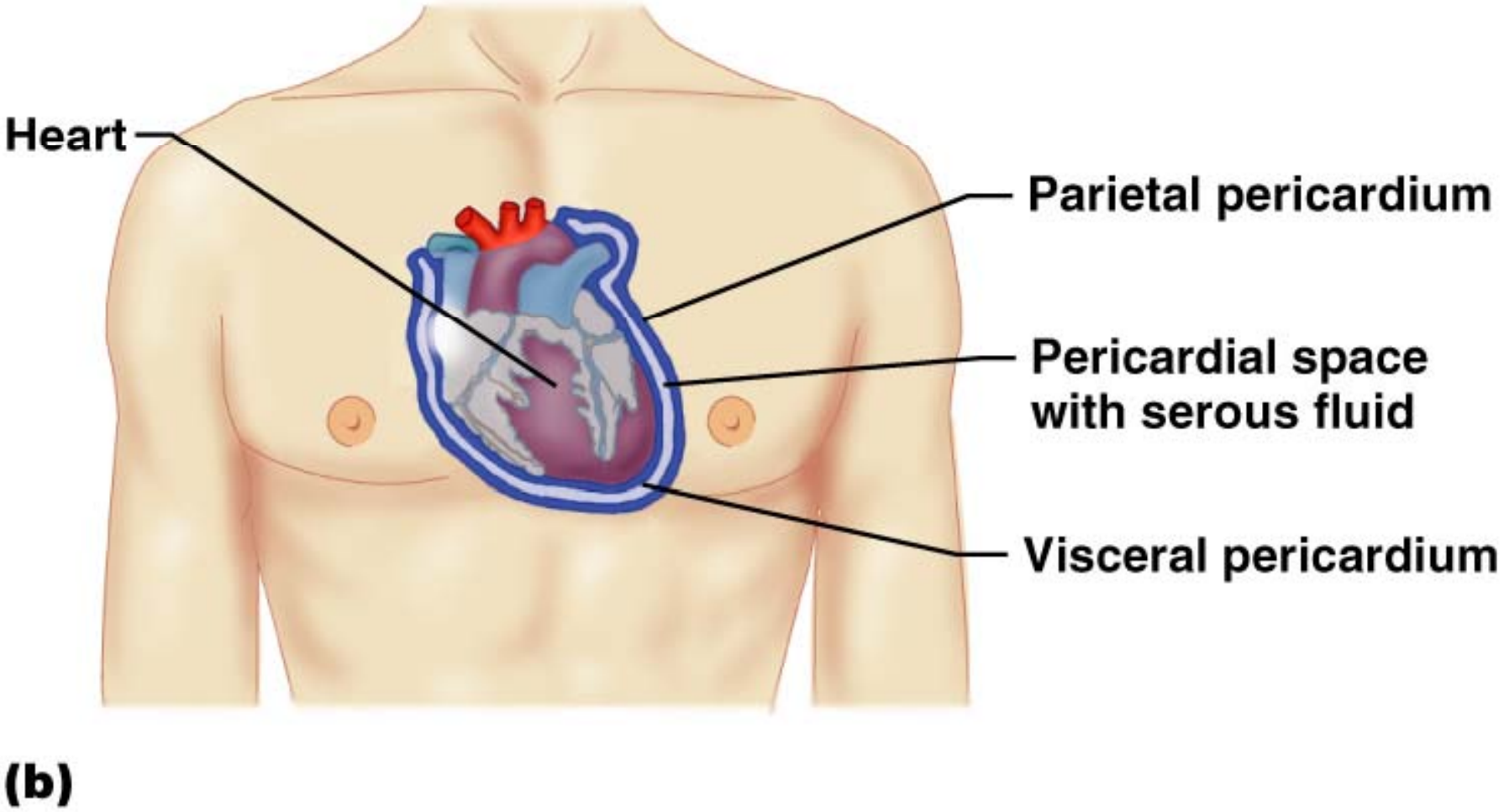


Figure 1.10b

Other Body Cavities

- Oral and digestive – mouth and cavities of the digestive organs
- Nasal –located within and posterior to the nose
- Orbital – house the eyes
- Middle ear – contains bones (ossicles) that transmit sound vibrations
- Synovial – joint cavities

Other Body Cavities

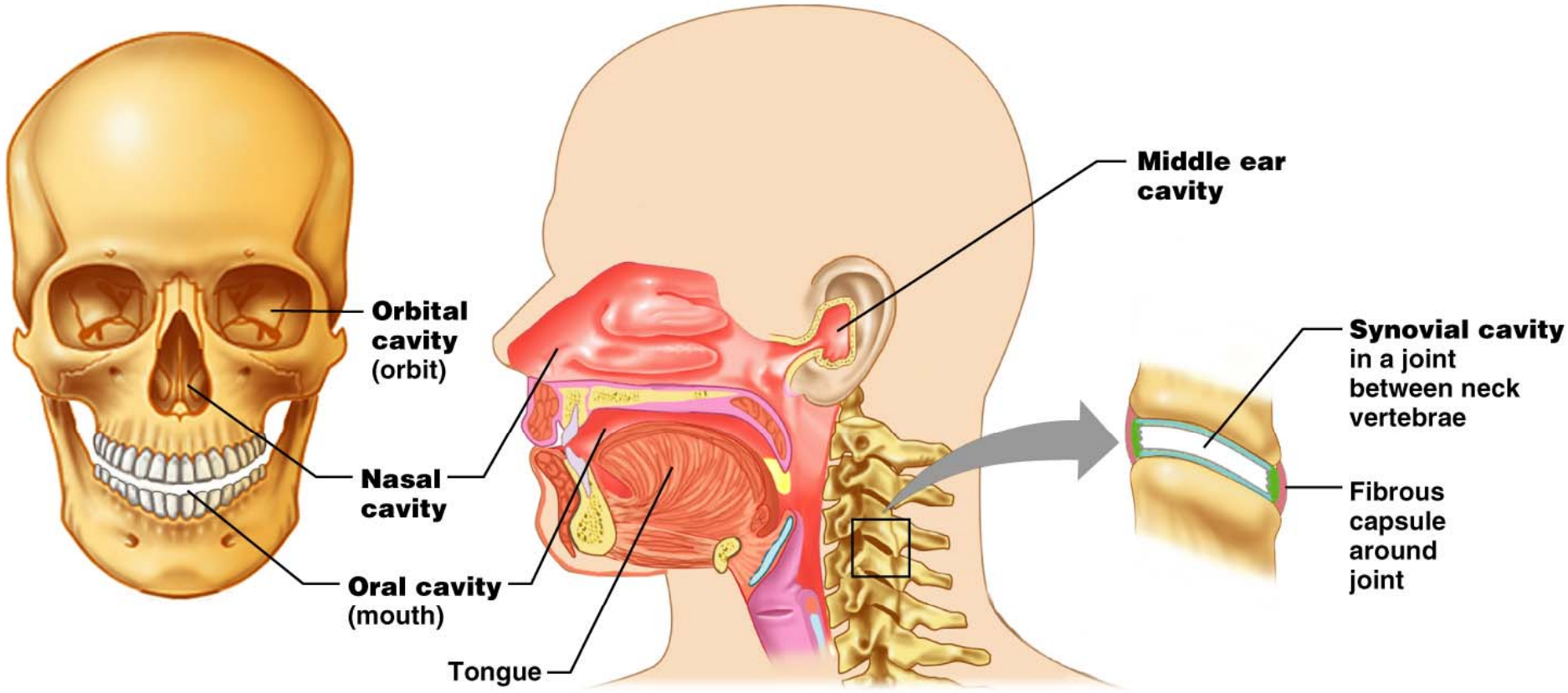


Figure 1.13

Abdor

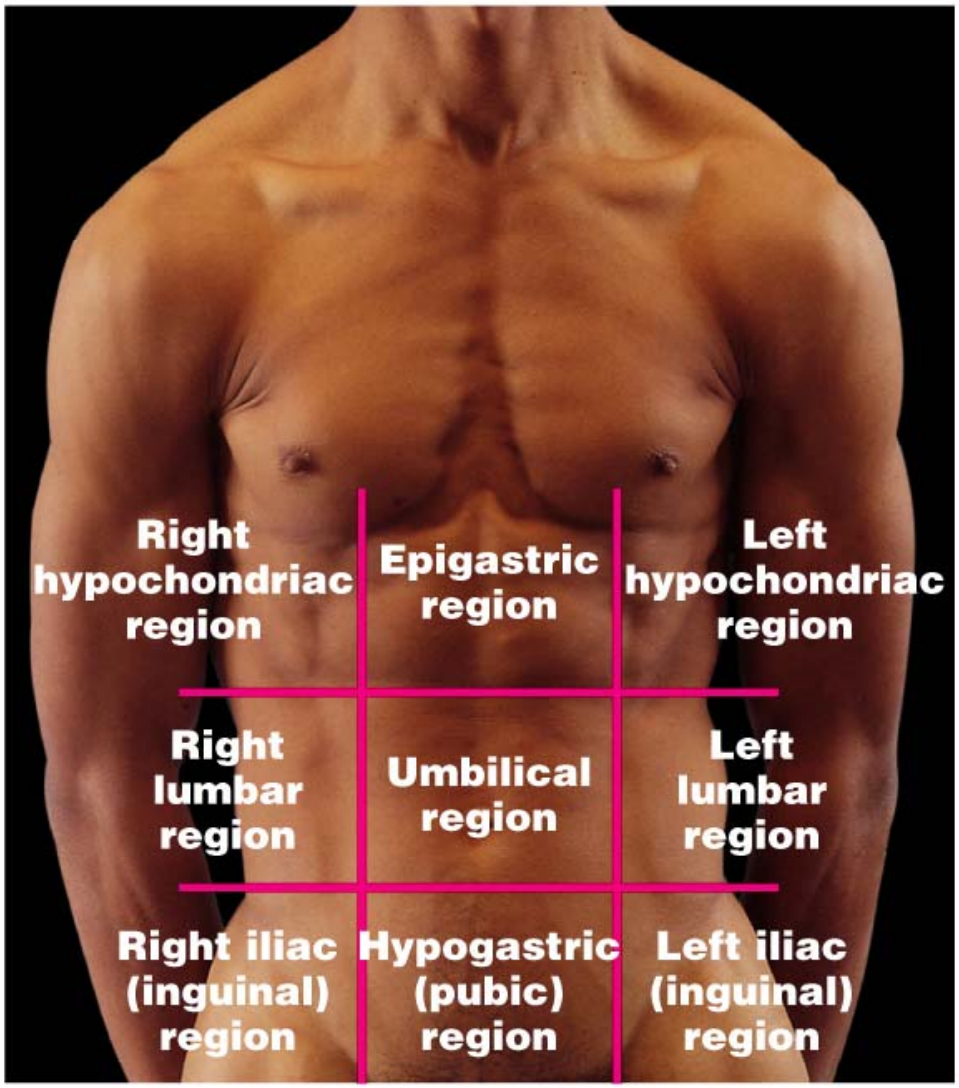


Figure 1.11a

Or ons

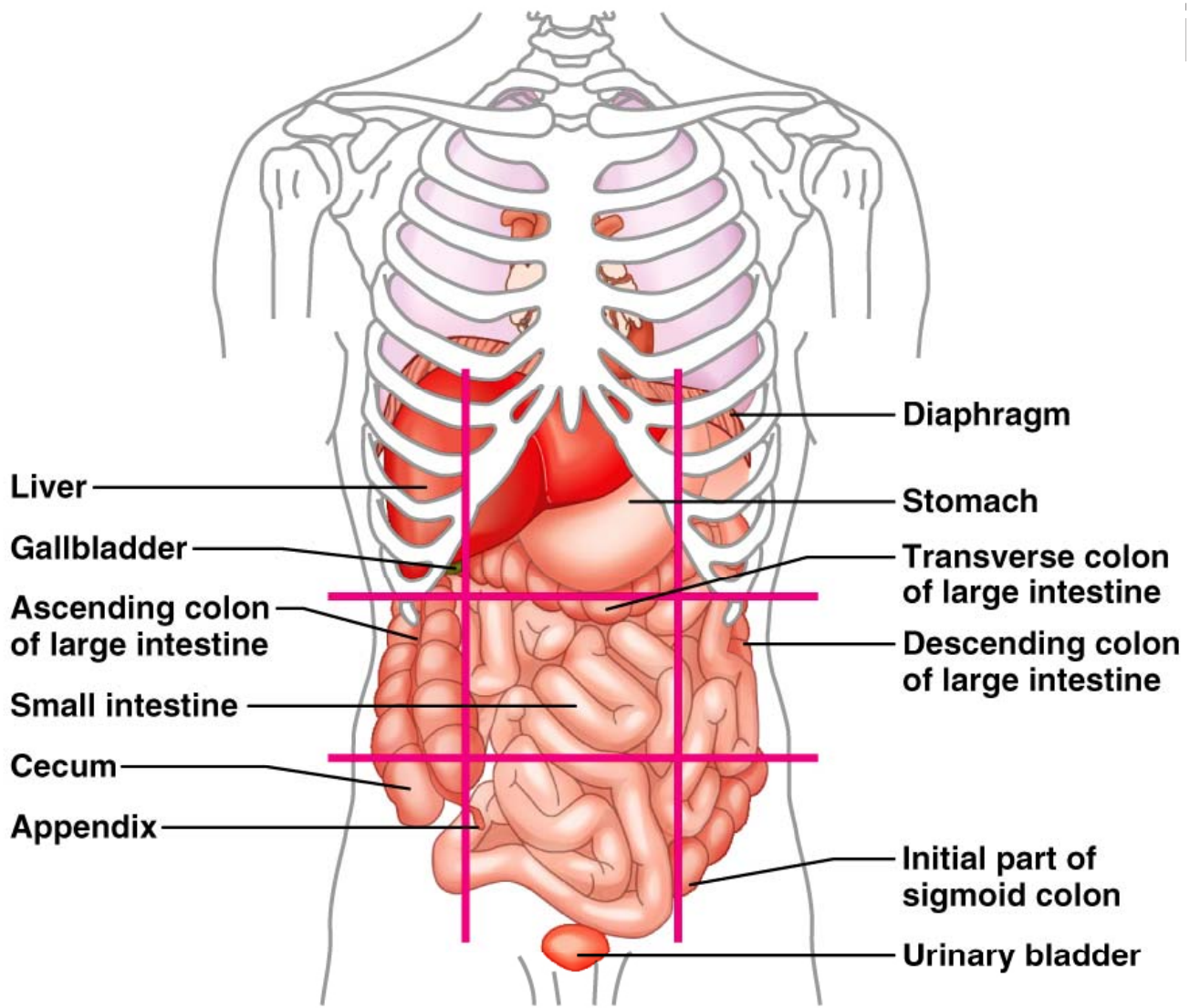


Figure 1.11b

Abdominop

- Right upper
- Left upper
- Right lower
- Left lower

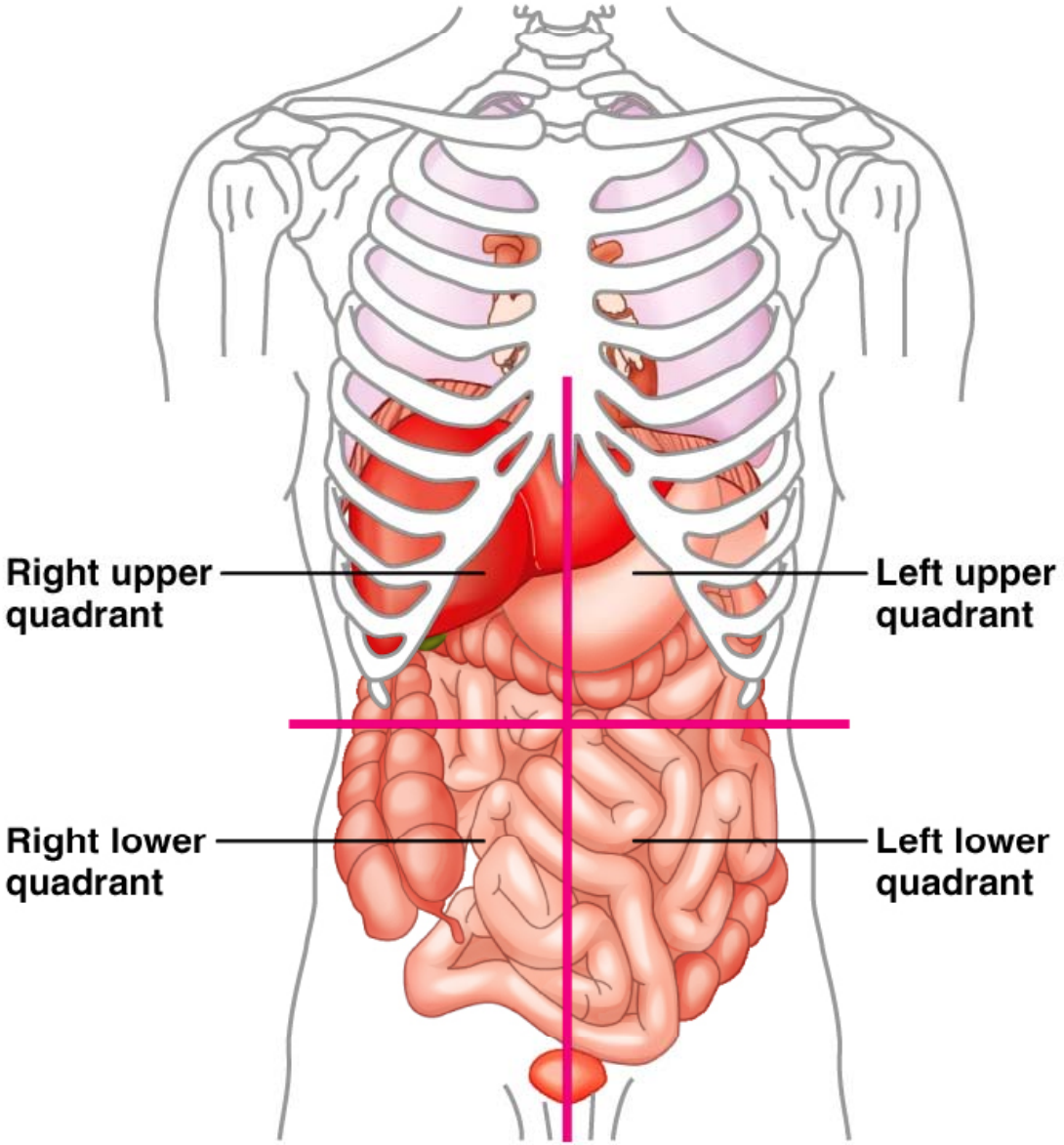


Figure 1.12