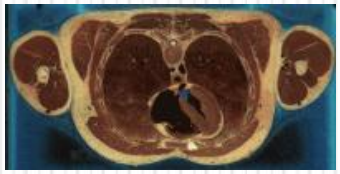
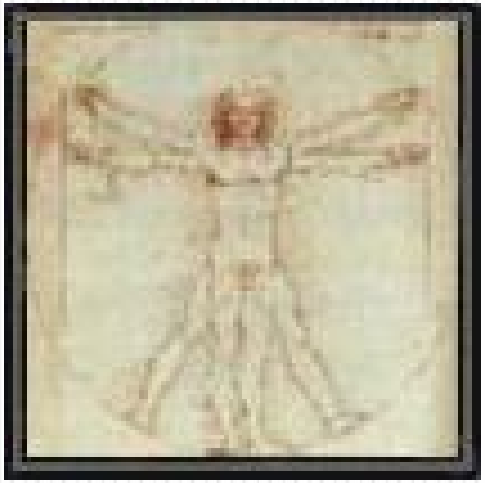
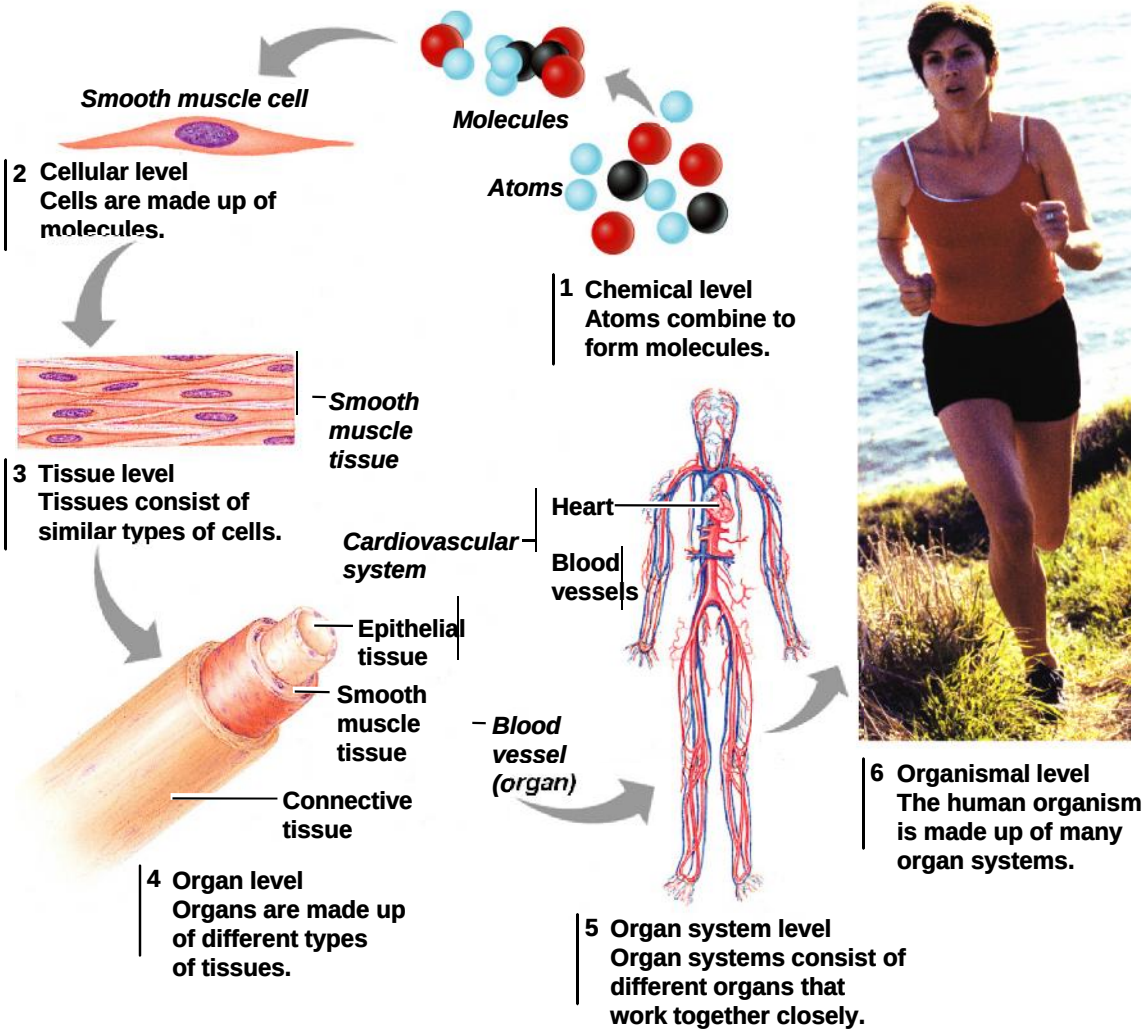


Introduction to Anatomy Physiology

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



Levels of Structural Organization

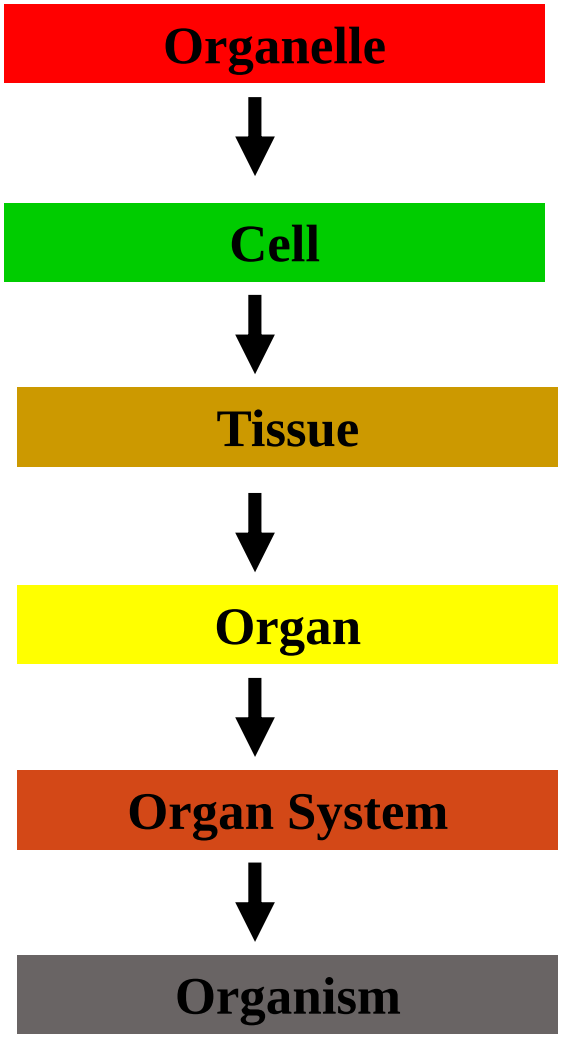
Figure 1.1

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

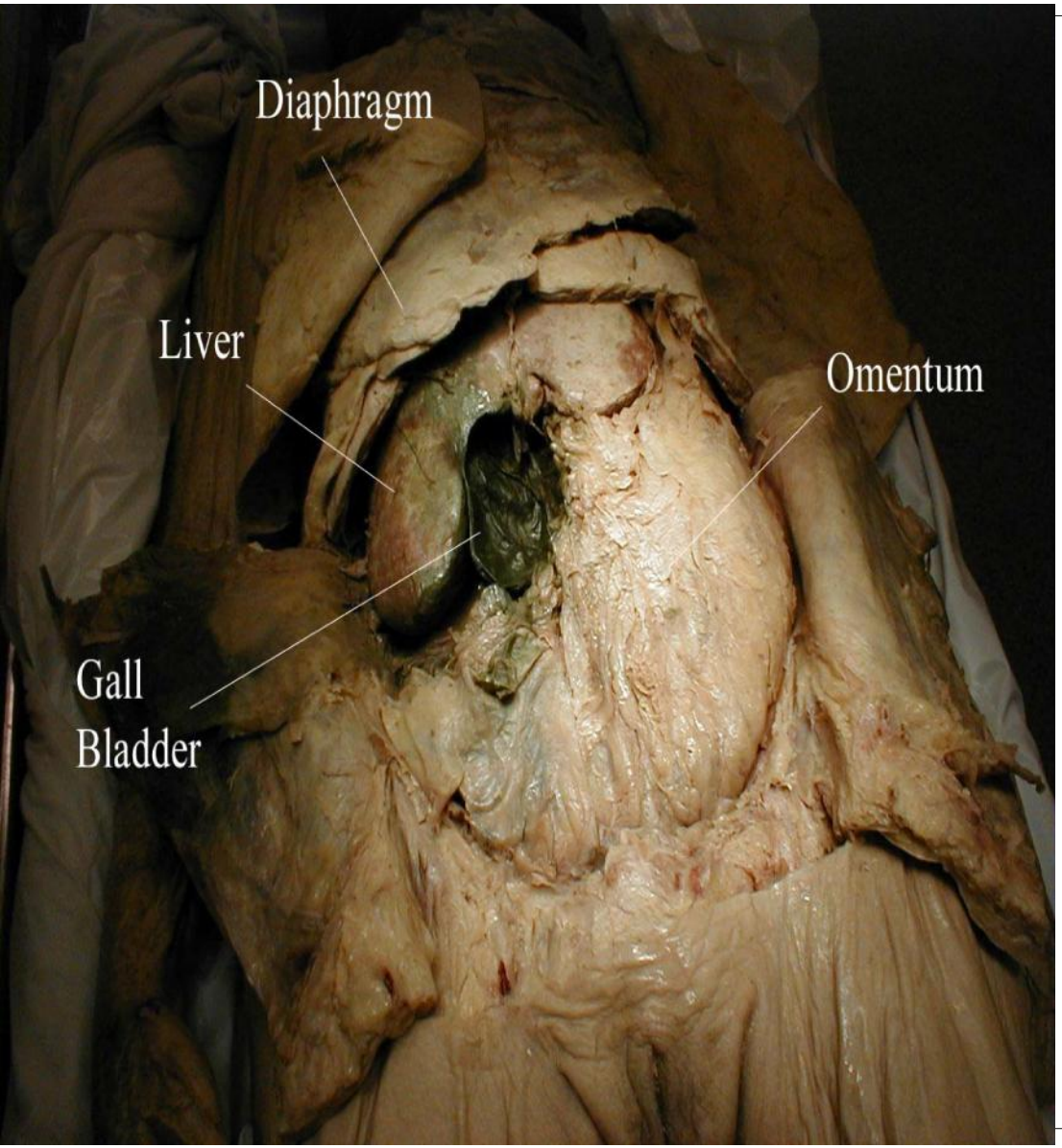
Levels of Structure

- 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"



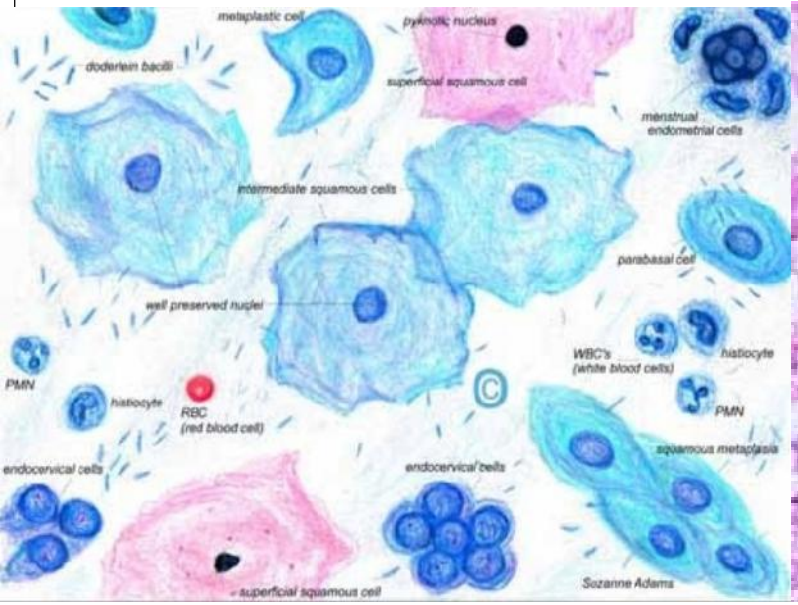
Gross Anatomy

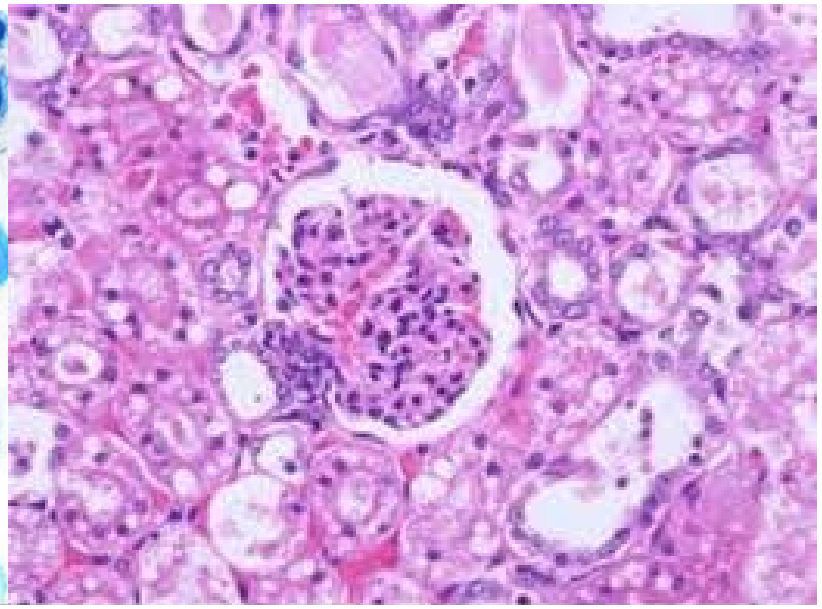
Study of stuff seen by the naked eye (*Gross Anatomy*).

- 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

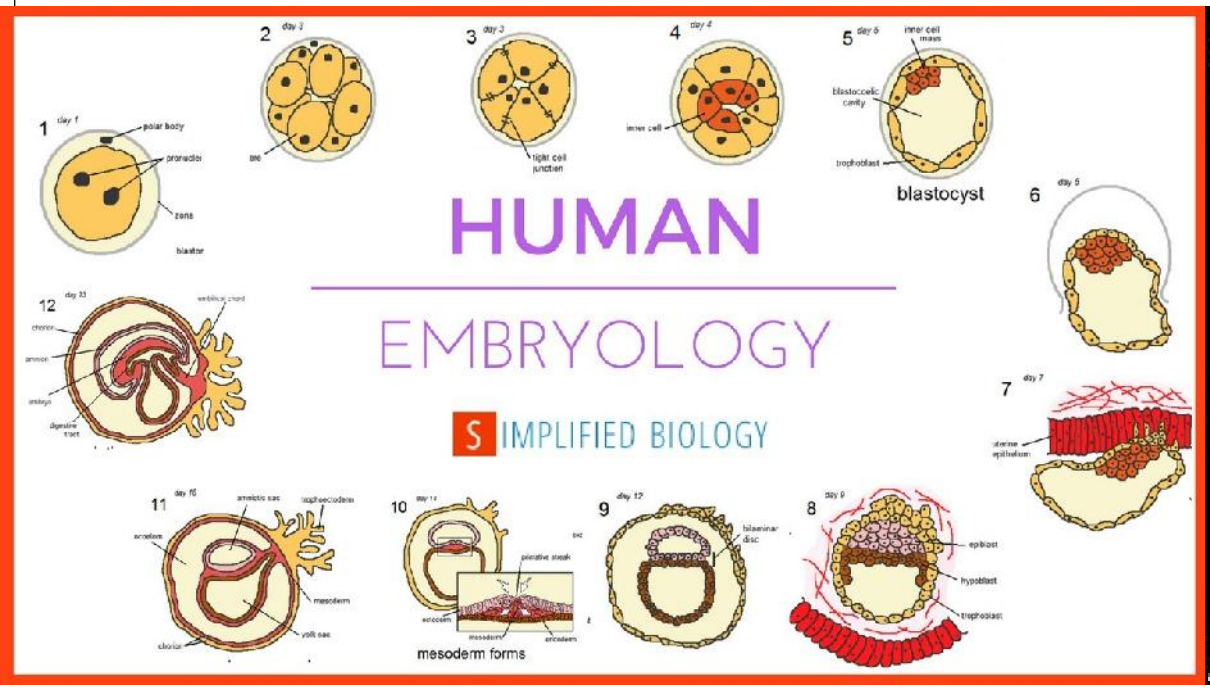
- Cytology – study of the cell
- Histology – study of tissues

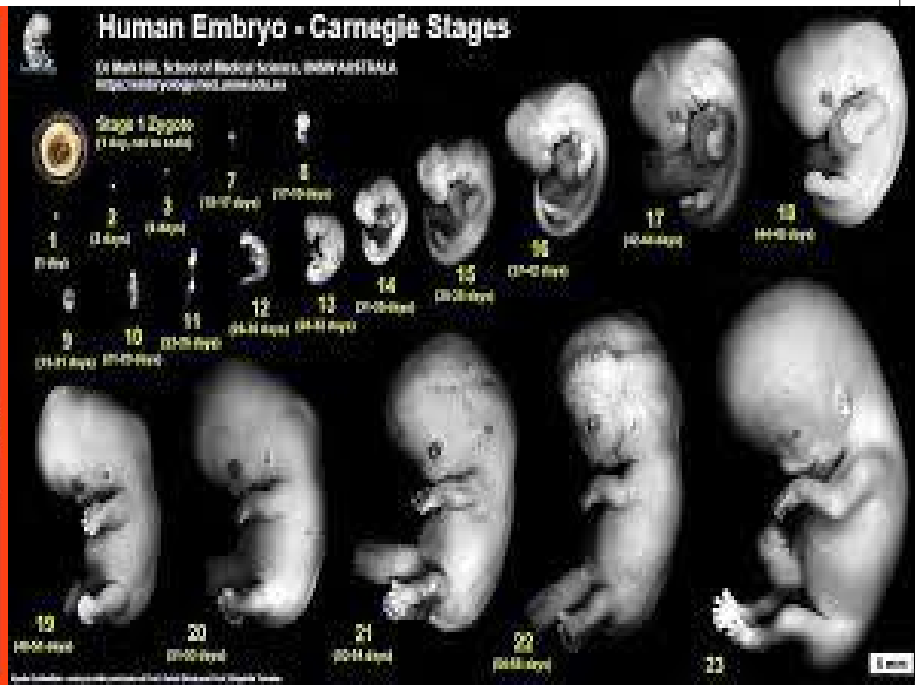




Developmental Anatomy

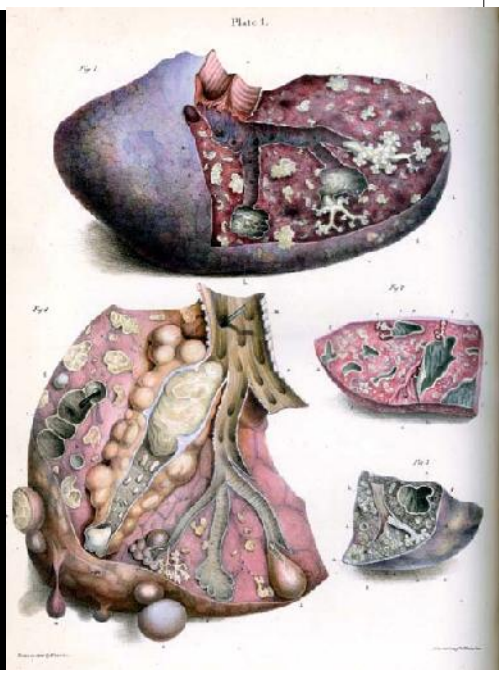
- Traces structural changes throughout life
- Embryology – study of developmental changes of the body before birth





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



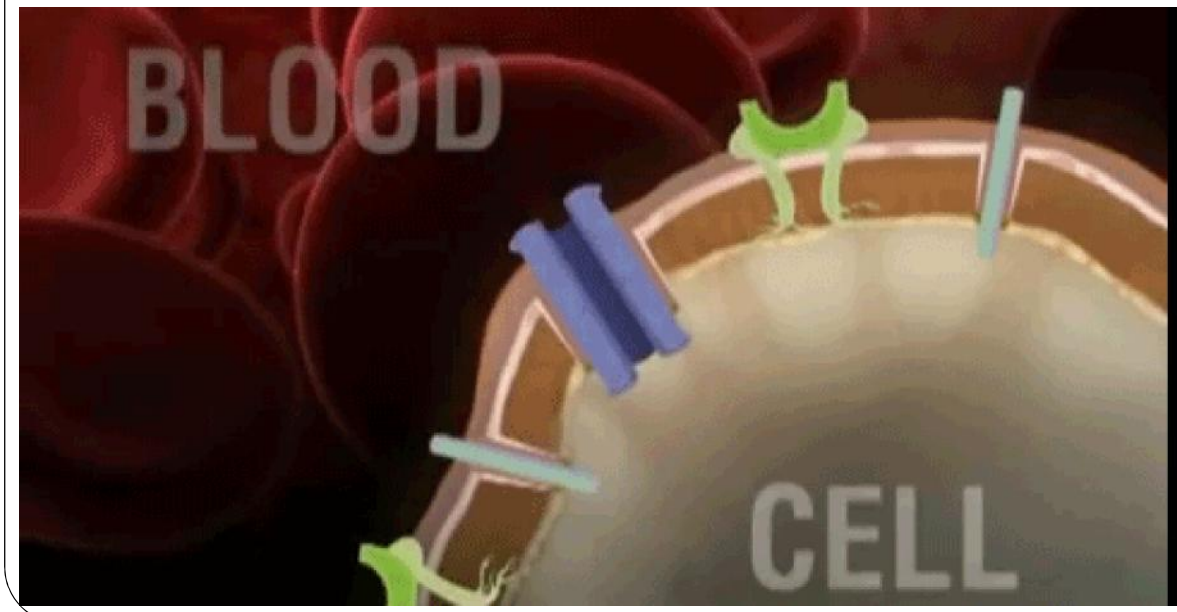
Physiology

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?
- 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**

Principle of Complementarity of Structure and Function

- The form of each body structure allows that structure to carry out its specific task
  - Function follows form, and form follows function
    - Function always reflects structure
    - What a structure can do depends on its specific form

COMPLEMENTARITY OF STRUCTURE AND FUNCTION

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

hard mineral deposits → bone → support body

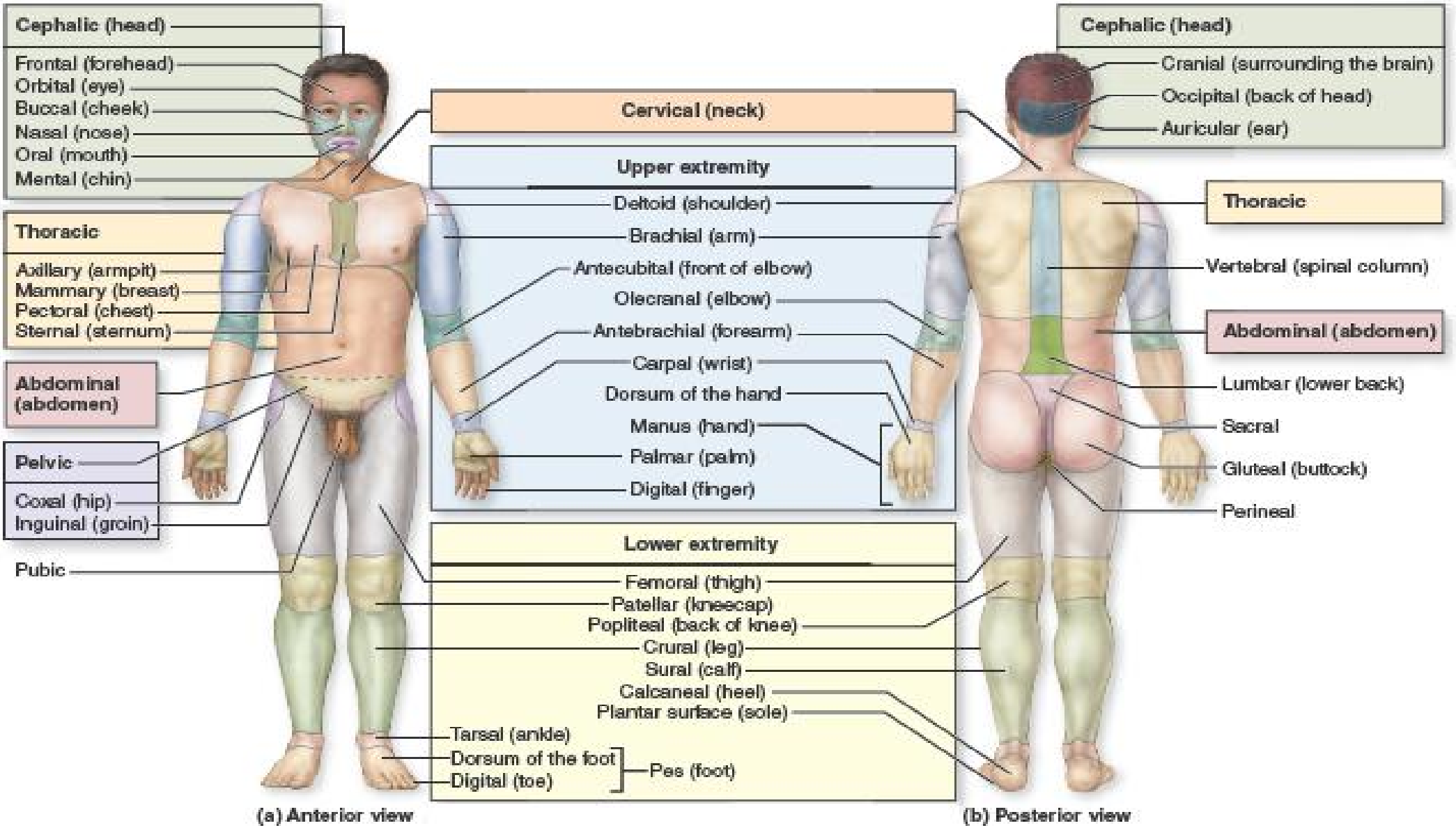
valves in the heart → prevent blood backflow → one direction blood flow

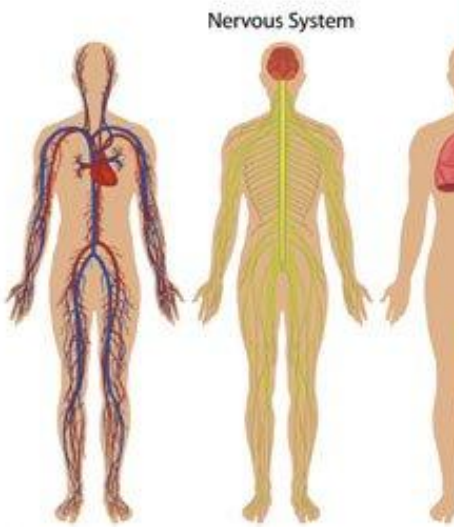
Think about more examples in your body…..

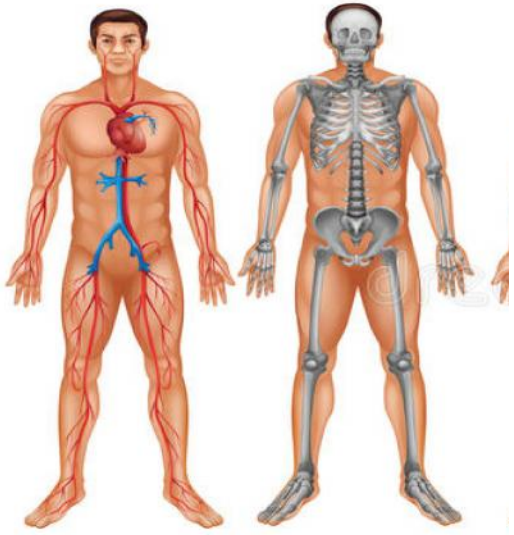
Can Anatomy & Physiology Be Separated?

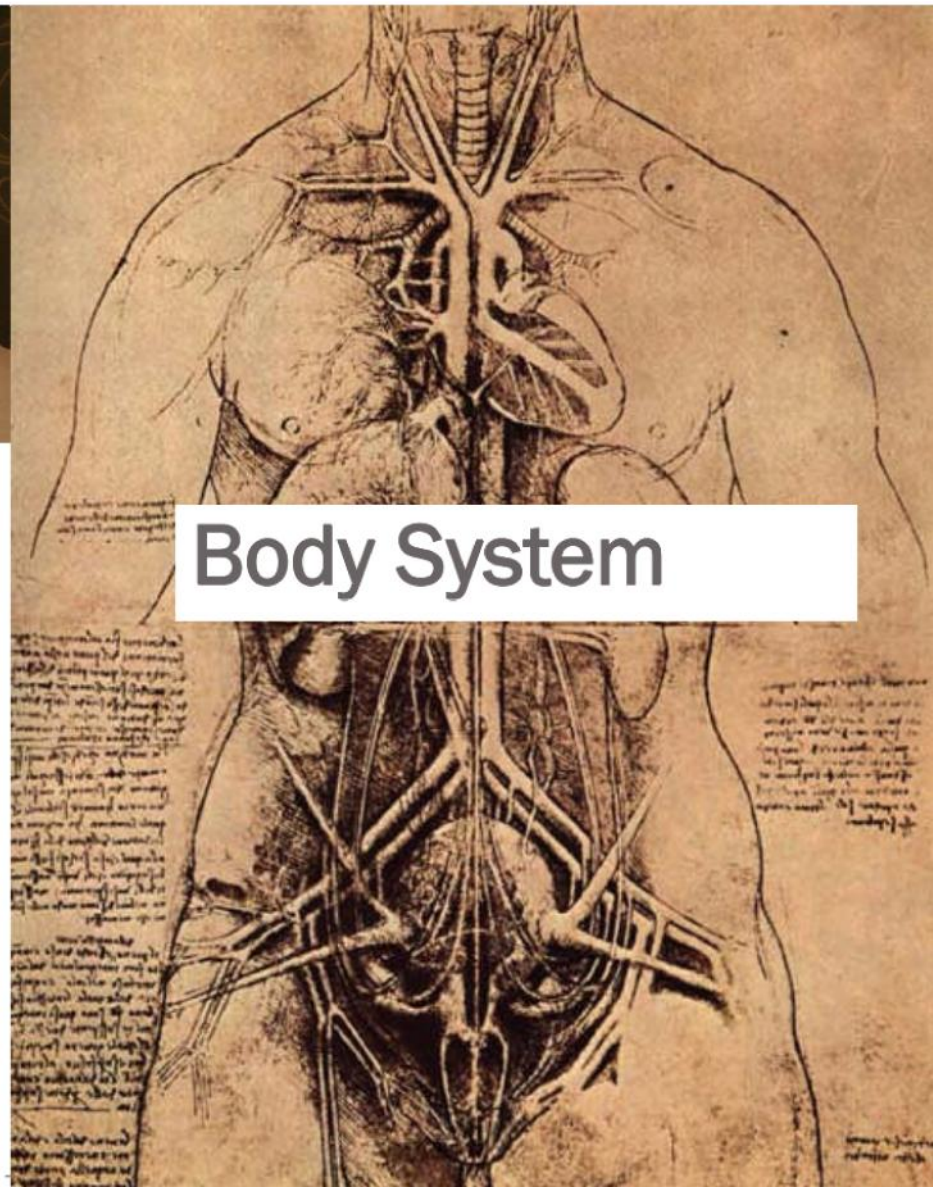
- NOOOOOOO!!!!! Absolutely not!
- Structure and function are undeniably connected. We cannot divorce them.
- What do we mean by this?
  - Can you eat soup with a fork?
  - Find 2 everyday items and determine whether/how their structure (anatomy) relates to their function (physiology)

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


Cephalic (head)
Frontal (forehead)
Orbital (eye)
Buccal (cheek)
Nasal (nose)
Oral (mouth)
Mental (chin)
Thoracic
Axillary (armpit)
Mammary (breast)
Pectoral (chest)
Sternal (sternum)
Abdominal (abdomen)
Pelvic
Coxal (hip)
Inguinal (groin)
Pubic
Cervical (neck)
Upper extremity
Deltoid (shoulder)
Brachial (arm)
Antecubital (front of elbow)
Olecranal (elbow)
Antebrachial (forearm)
Carpal (wrist)
Dorsum of the hand
Manus (hand)
Palmar (palm)
Digital (finger)
Lower extremity
Femoral (thigh)
Patellar (kneecap)
Popliteal (back of knee)
Crural (leg)
Sural (calf)
Calcaneal (heel)
Plantar surface (sole)
Tarsal (ankle)
Dorsum of the foot
Digital (toe)
Pes (foot)
(a) Anterior view
Cephalic (head)
Cranial (surrounding the brain)
Occipital (back of head)
Auricular (ear)
Thoracic
Vertebral (spinal column)
Abdominal (abdomen)
Lumbar (lower back)
Sacral
Gluteal (buttock)
Perineal
(b) Posterior view



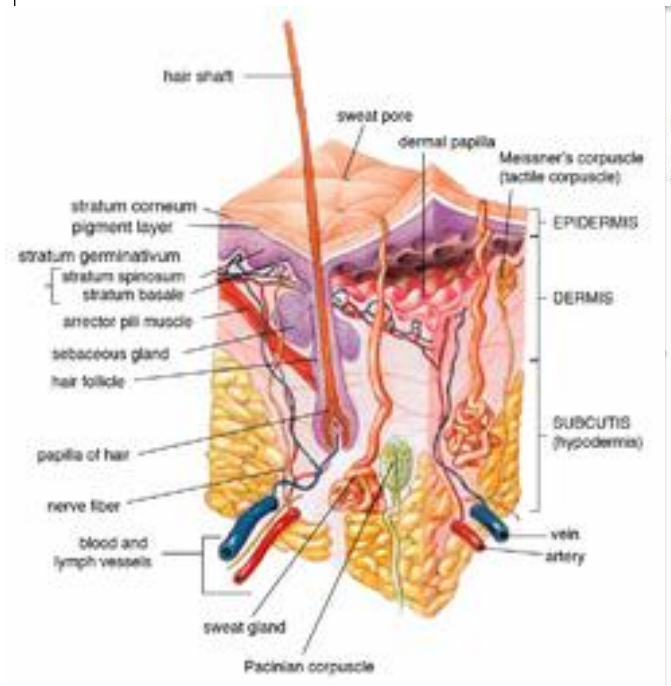


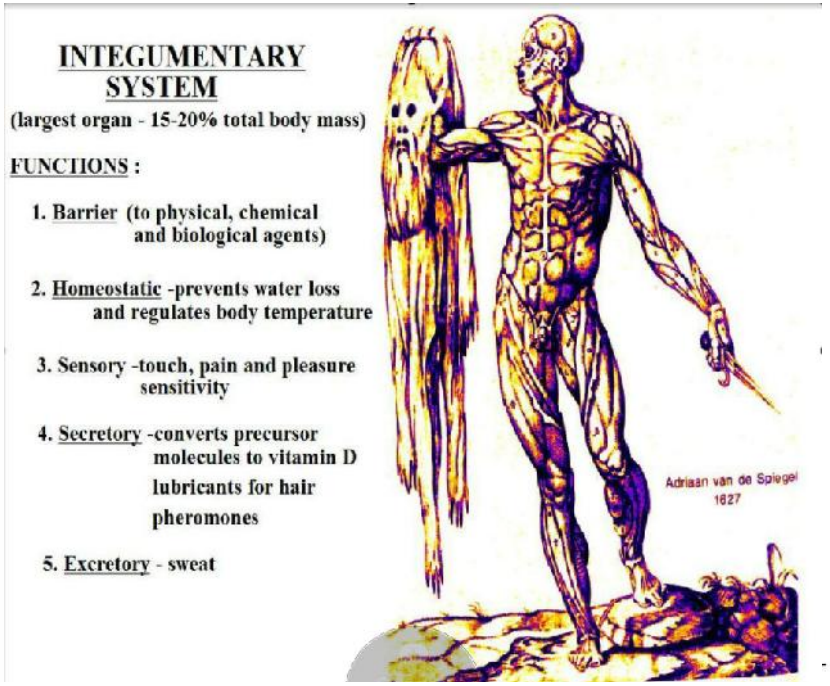


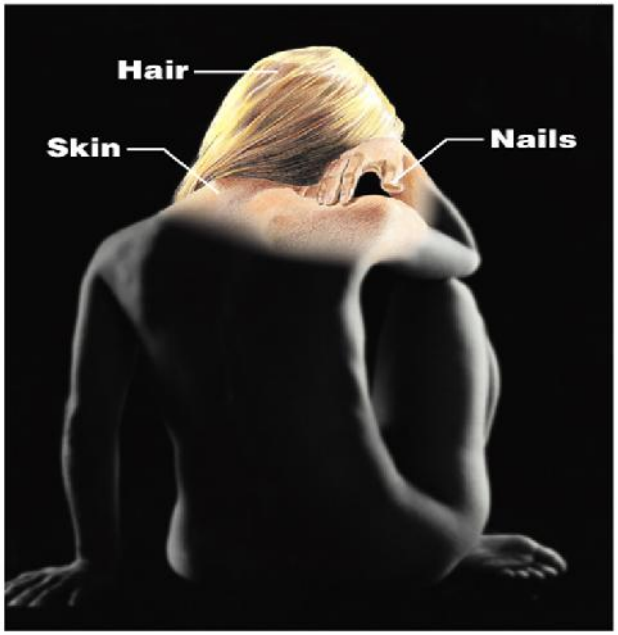
Body System

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



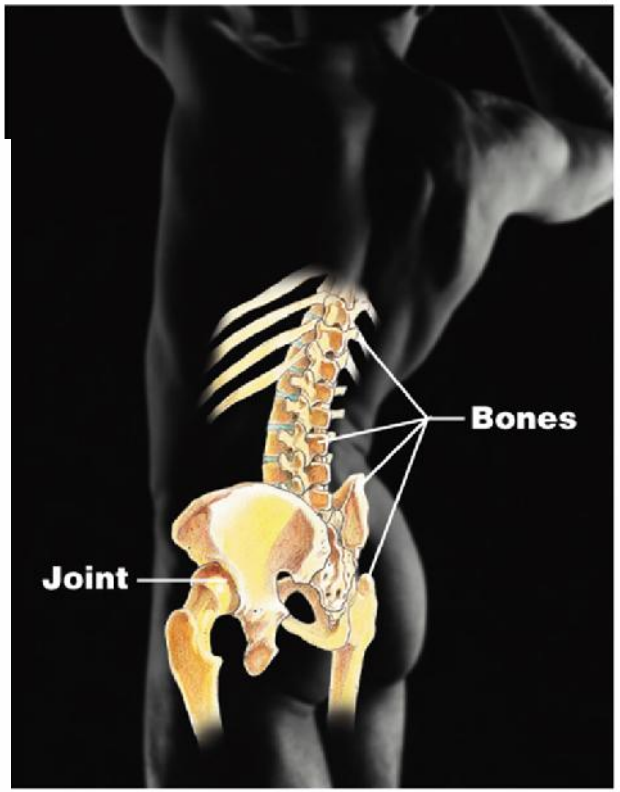




(a) Integumentary System

Skeletal System

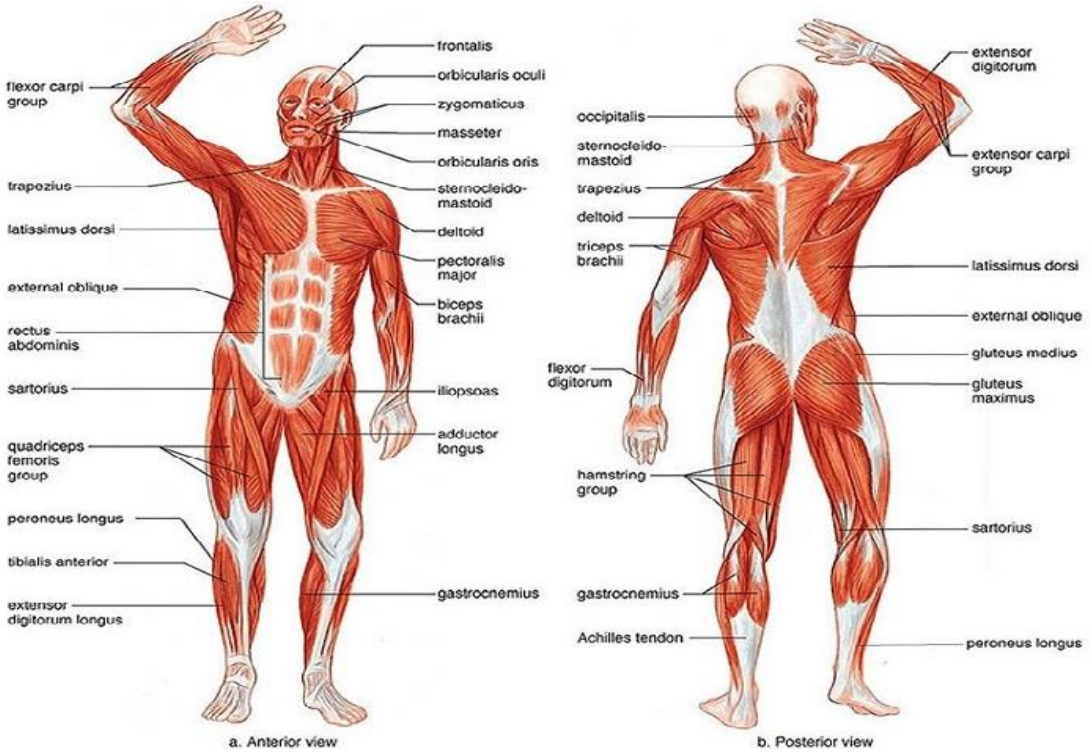
- Composed of bone, cartilage, and ligaments
- Protects and supports body organs
- Provides the framework for muscles
- Site of blood cell formation
- Stores minerals

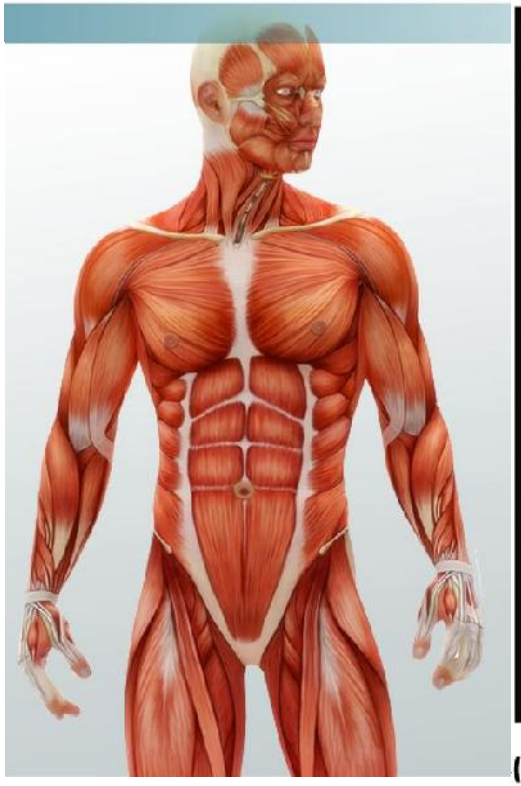


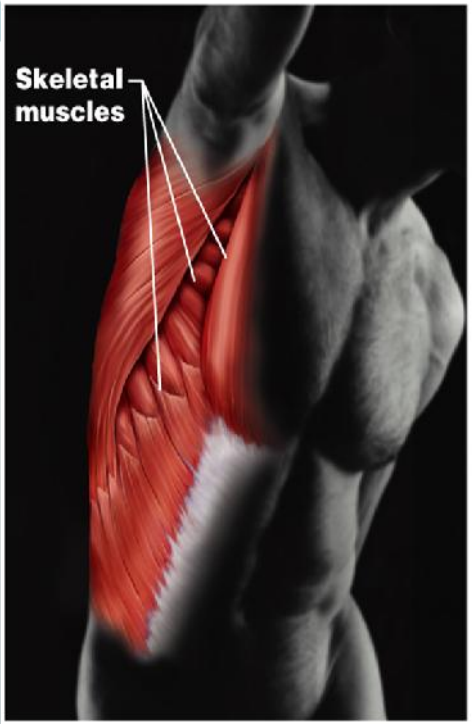
(b) Skeletal System

Muscular System

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



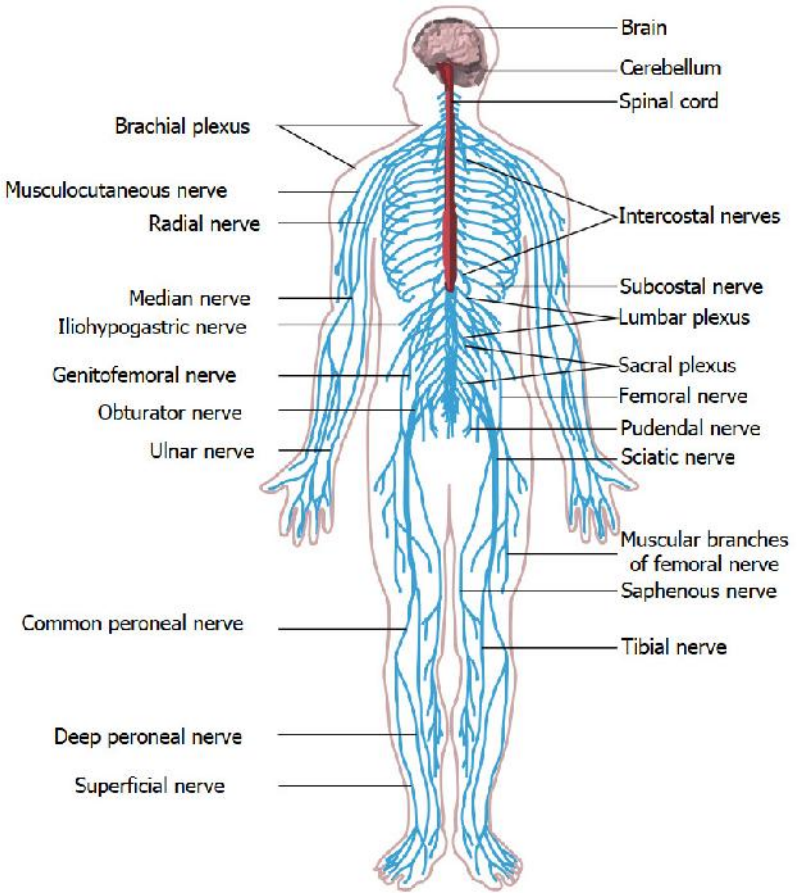


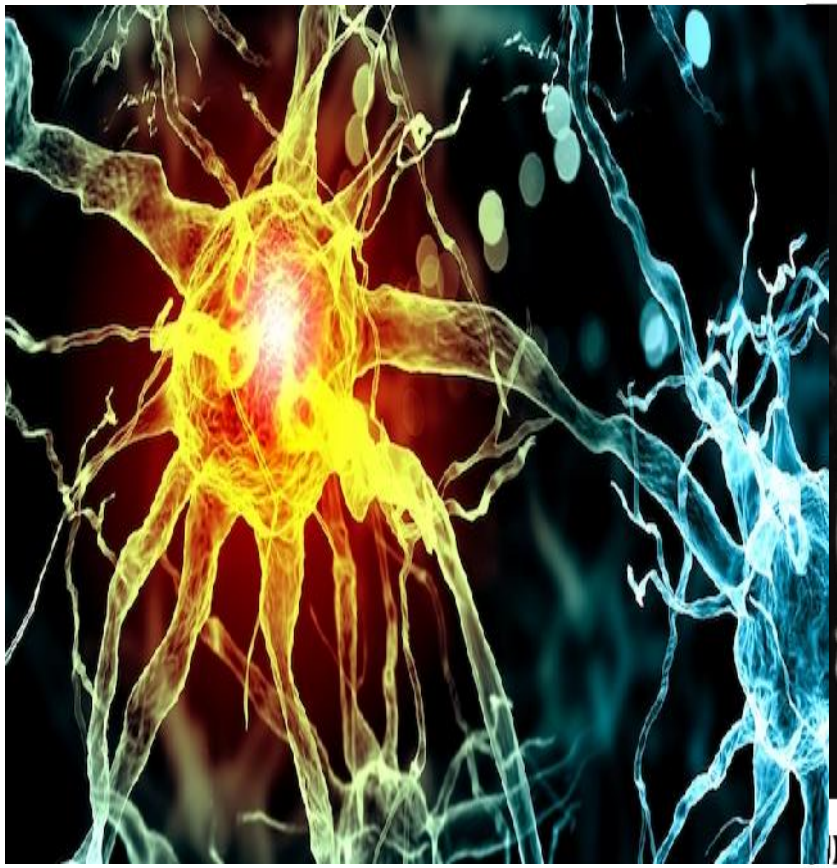


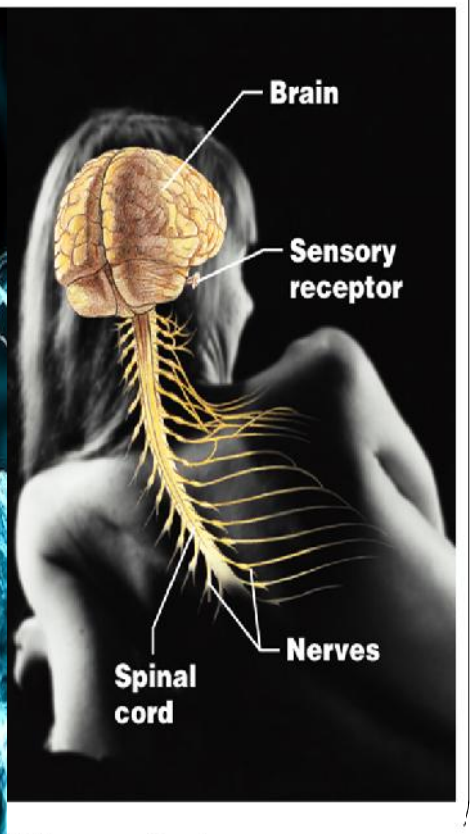
(c) Muscular System

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



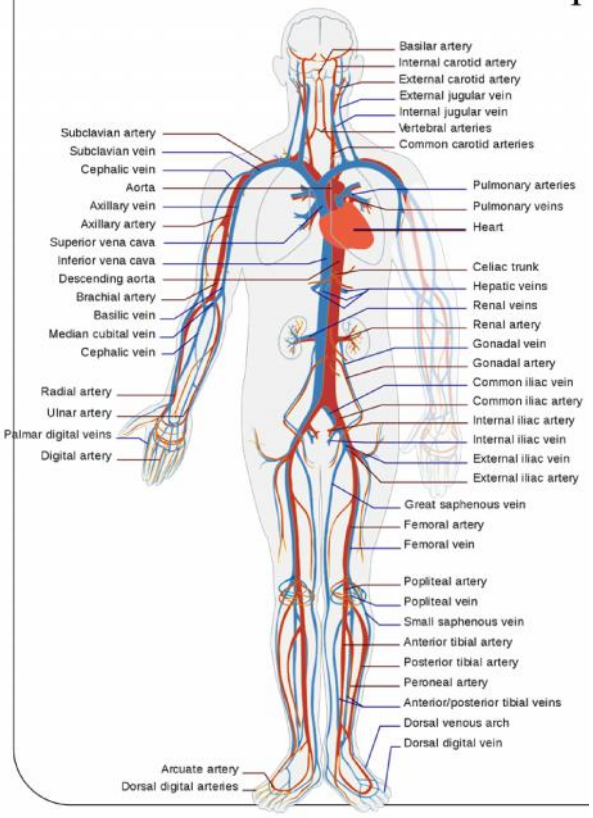


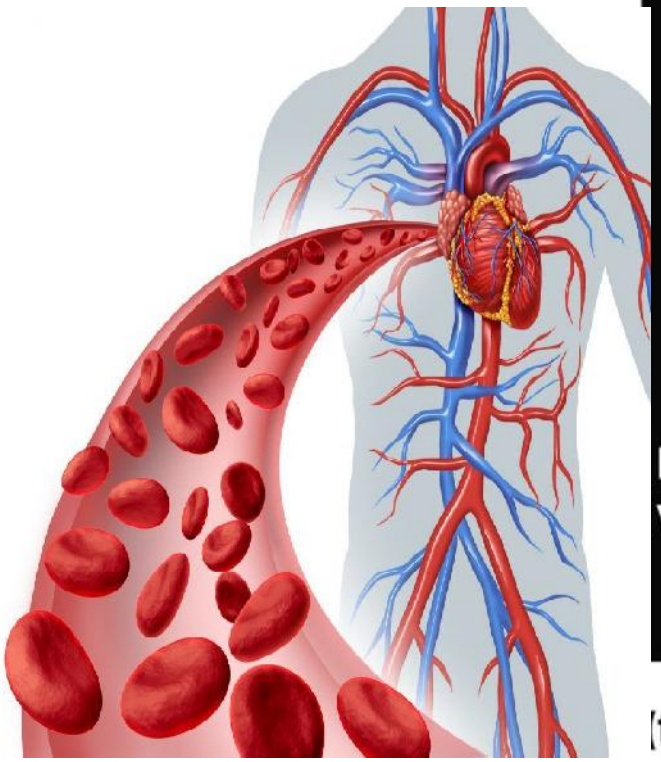


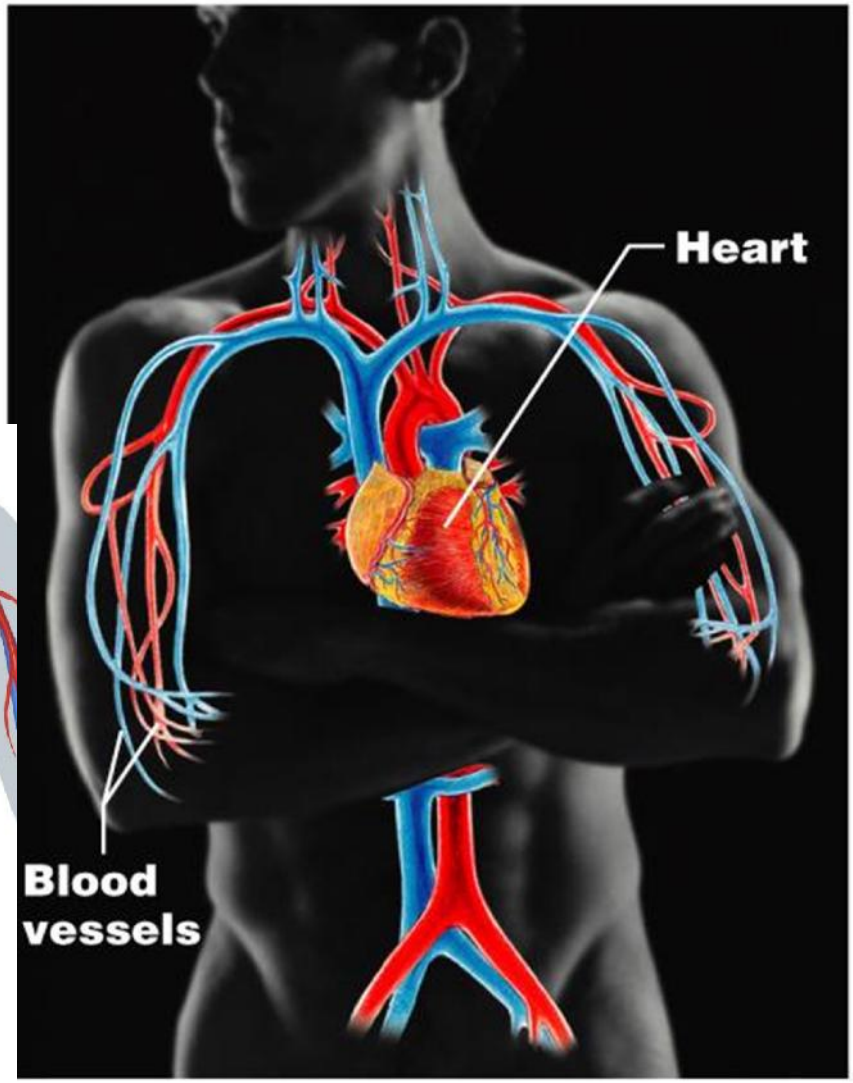
) Nervous System

Cardiovascular System

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



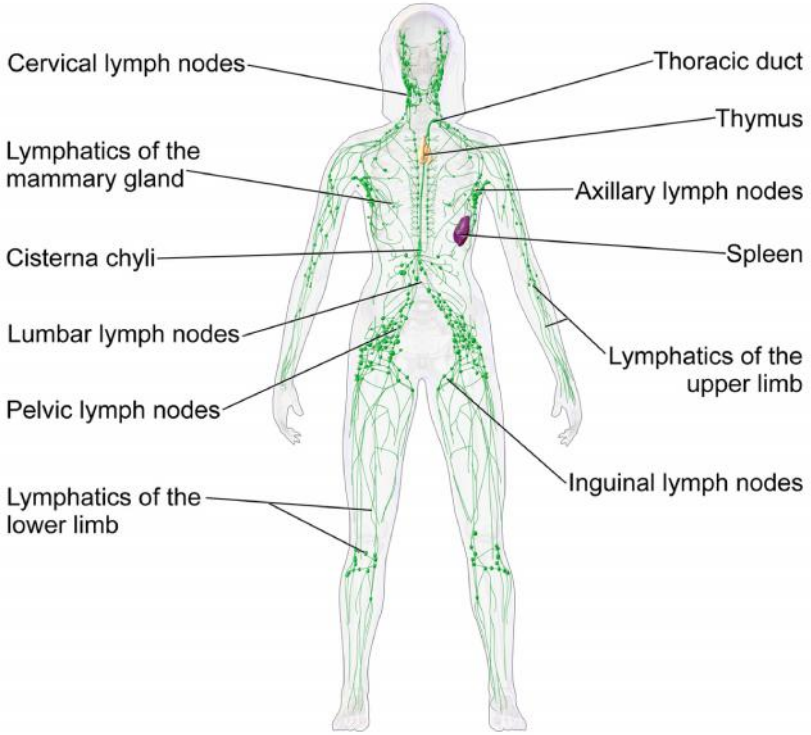


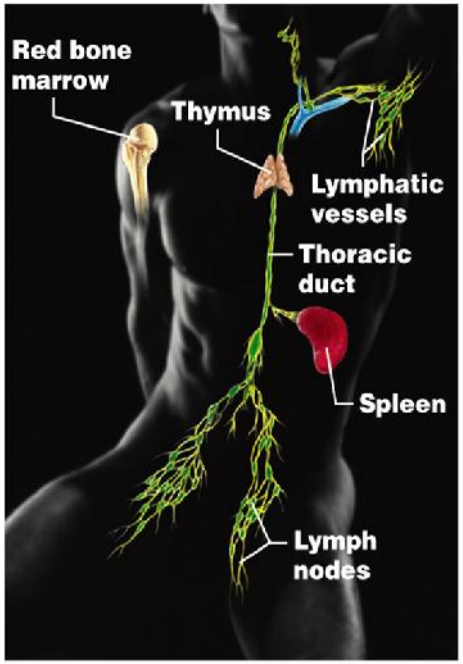


(f) Cardiovascular System

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

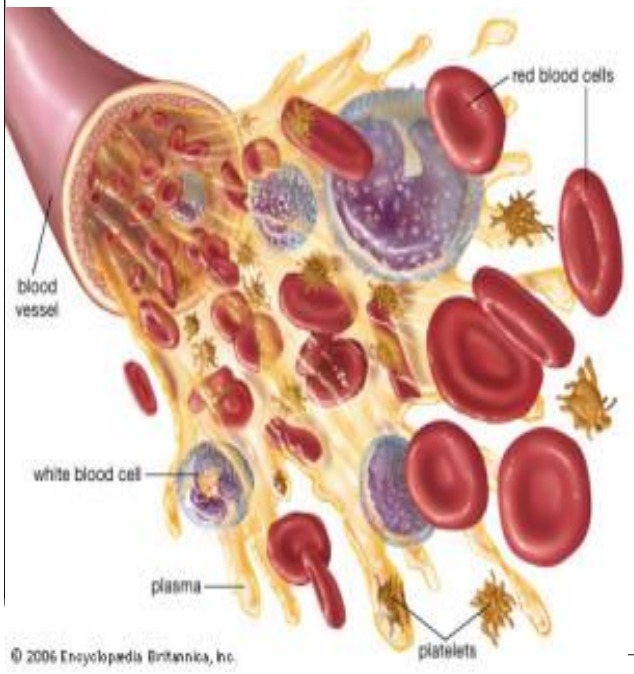


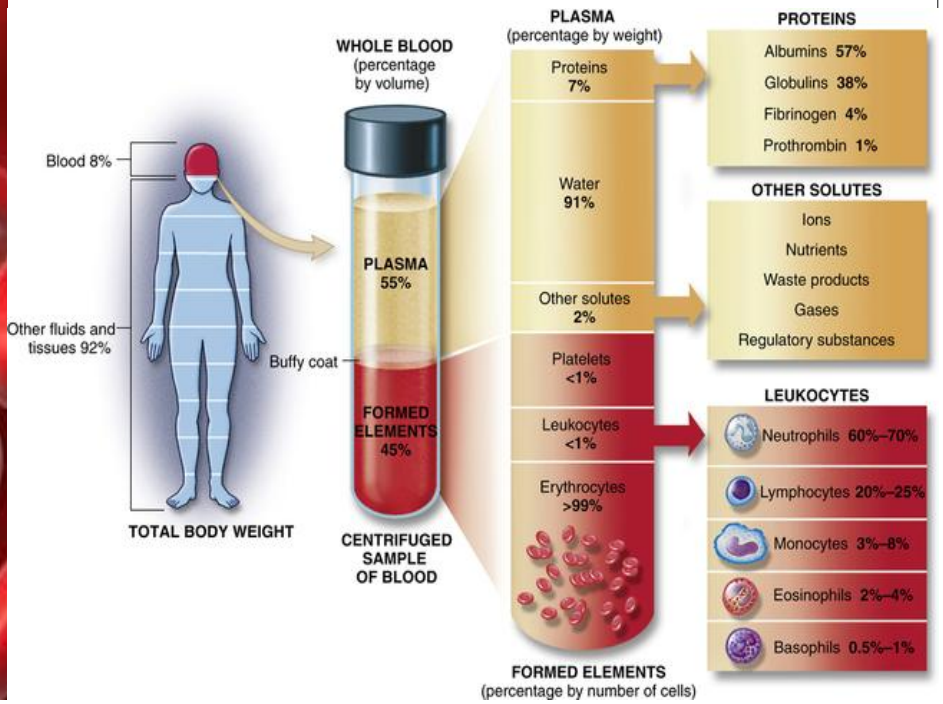


(g) Lymphatic System/Immunity

Hematological system /hematopoietic system

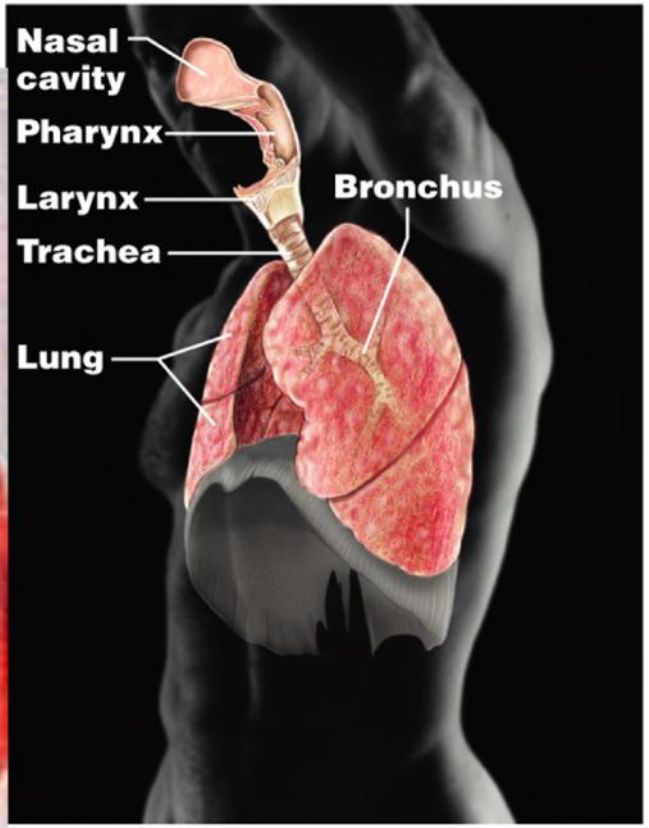
- include the blood, blood vessels, and blood-forming organs (bone marrow, spleen, liver, lymph nodes, and thymus gland).
- The hematologic system also pays an important role in hormone transport, the inflammatory and immune responses, temperature regulation, fluid-electrolyte balance, and acid-base balance.





Respiratory System

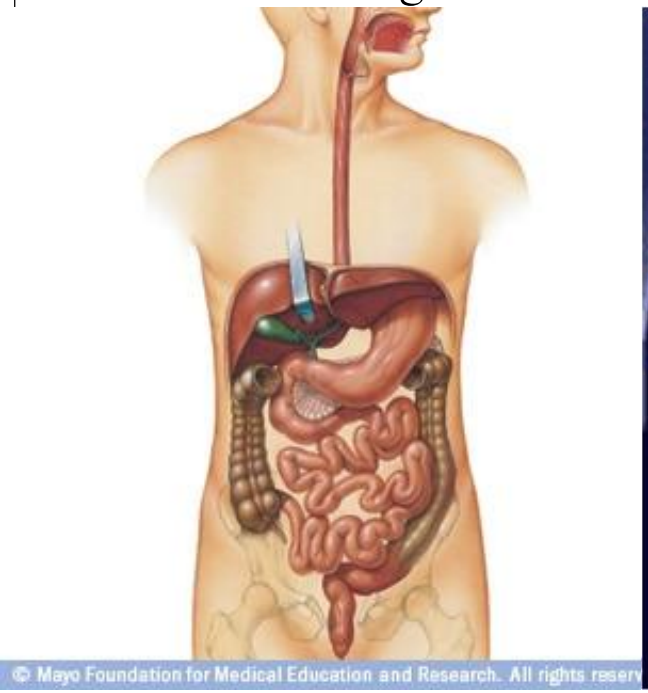
- Composed of the nasal cavity, pharynx, trachea, bronchi, and lungs
- Keeps blood supplied with oxygen and removes carbon dioxide

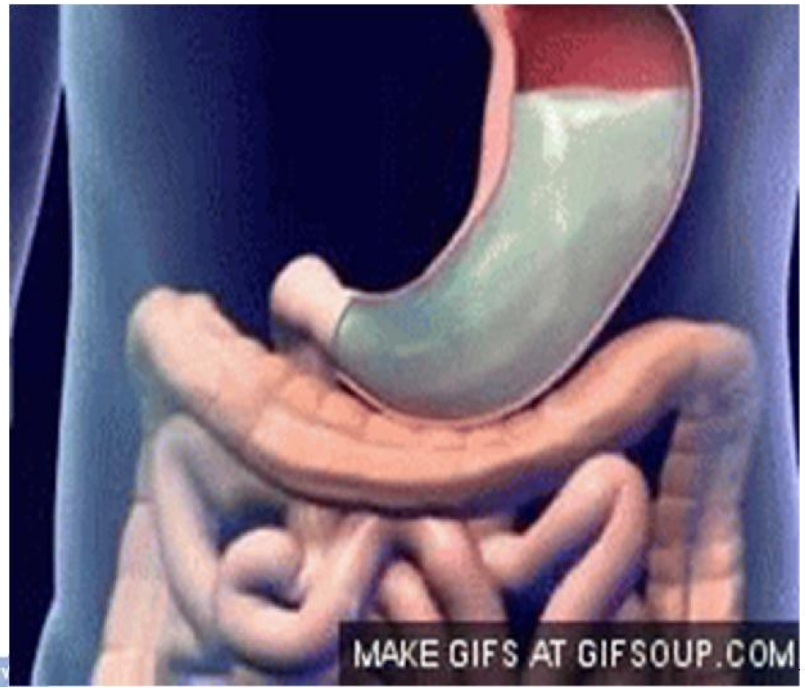


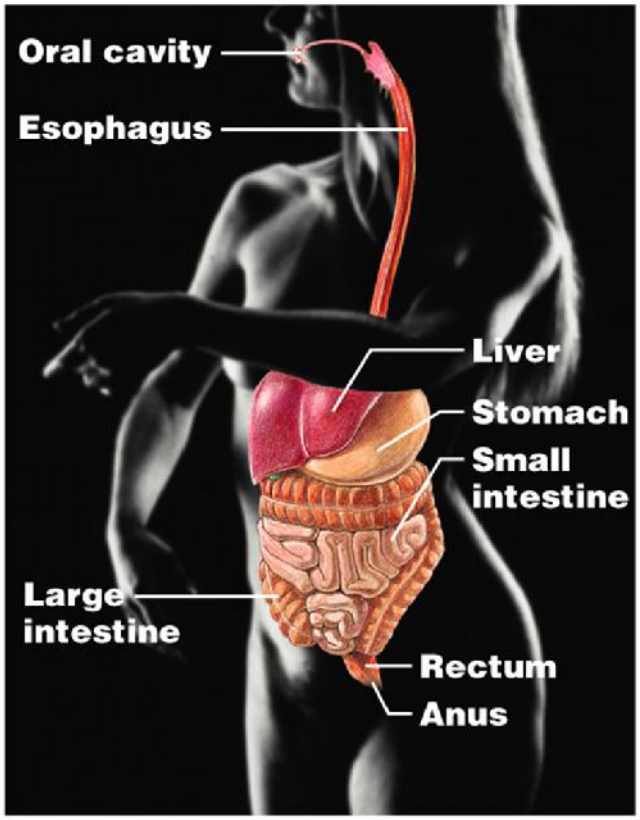
(h) Respiratory System

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



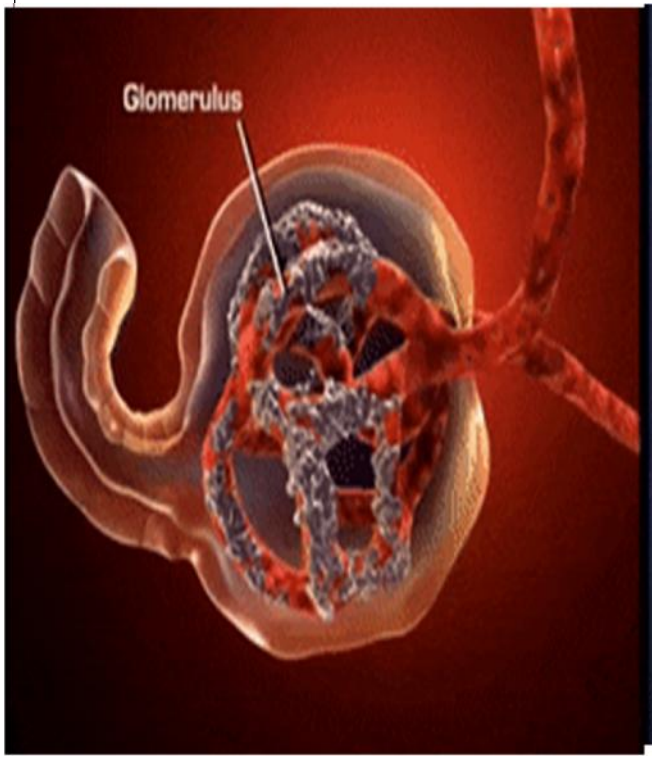


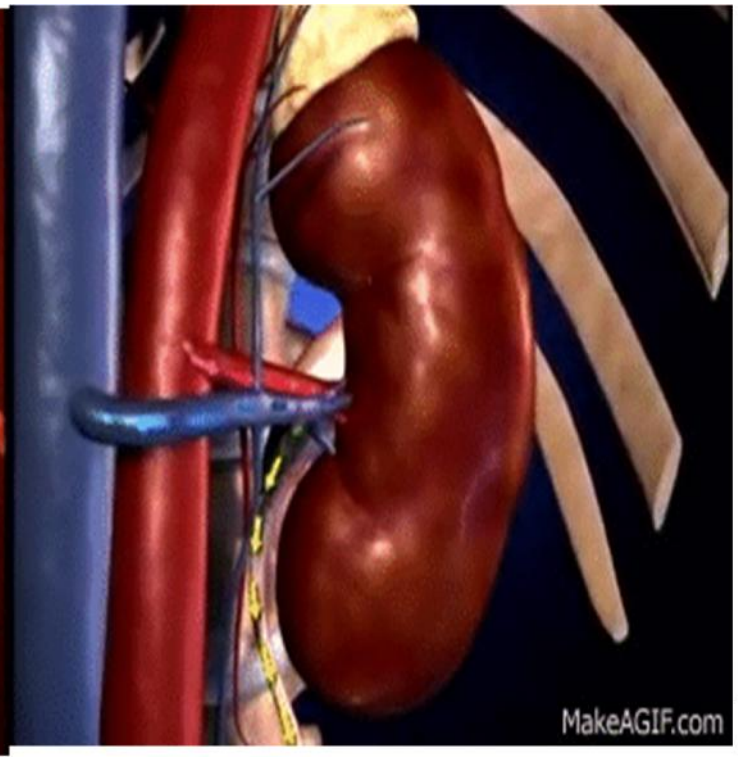


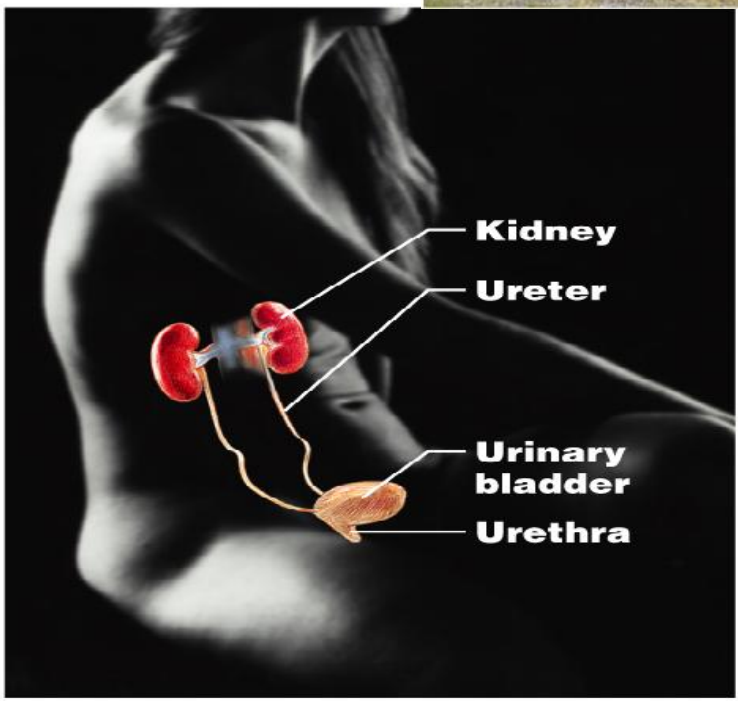
(i) Digestive System

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



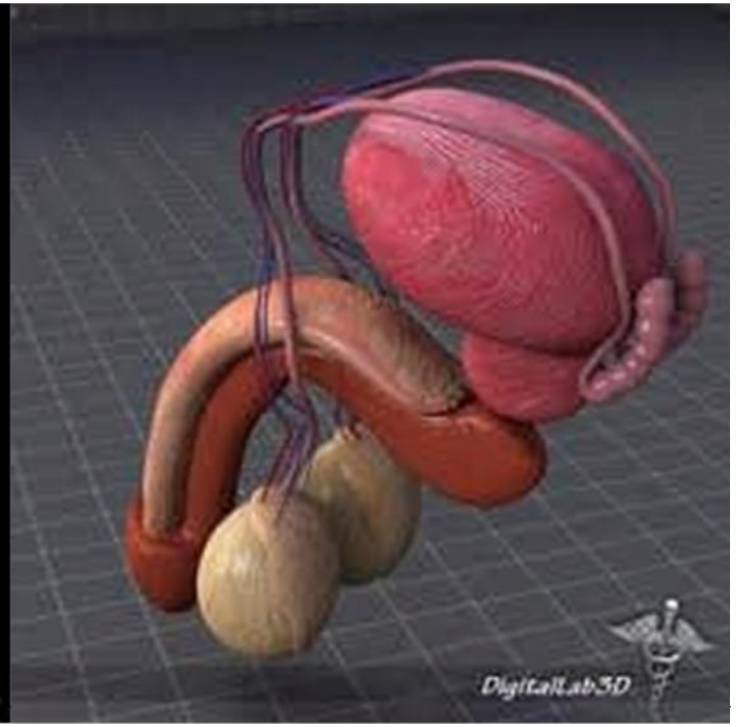


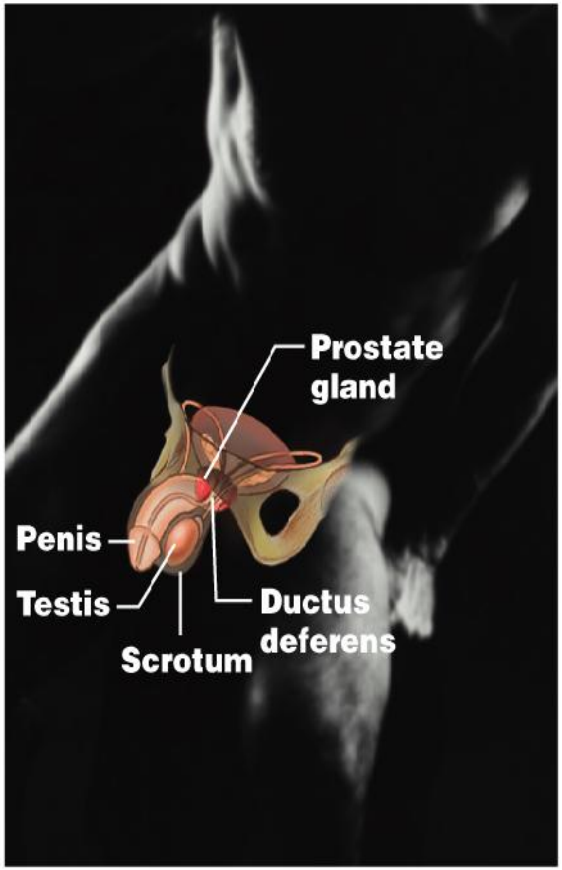


(j) Urinary System

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

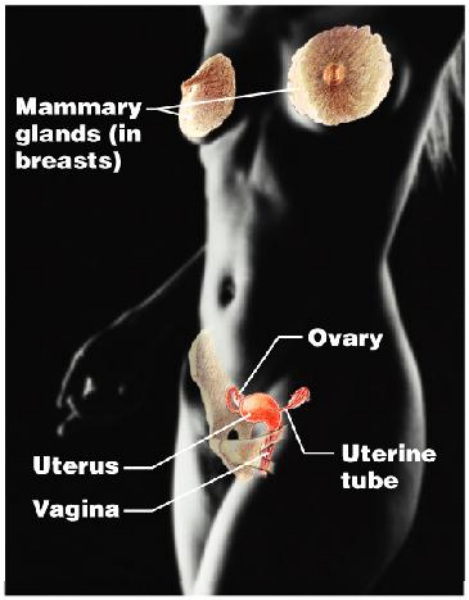




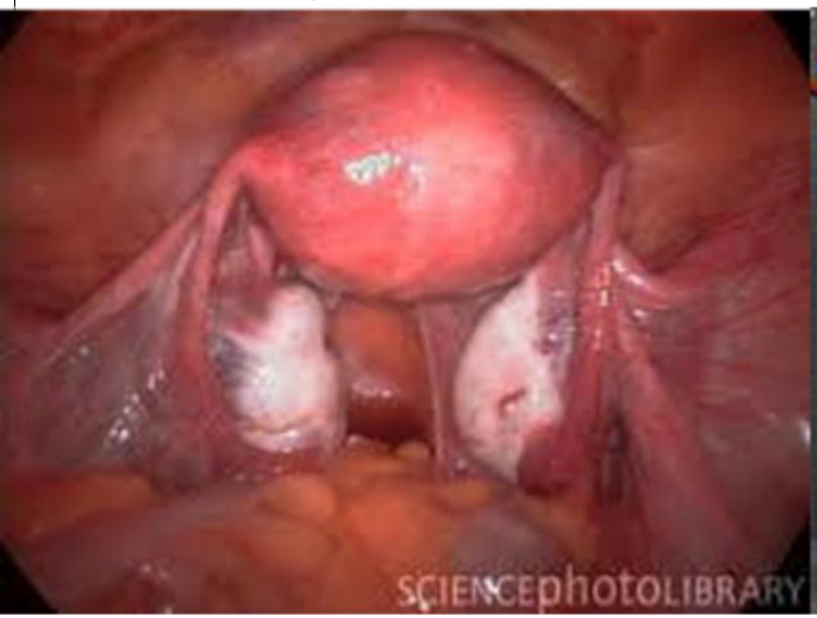
(k) Male Reproductive System

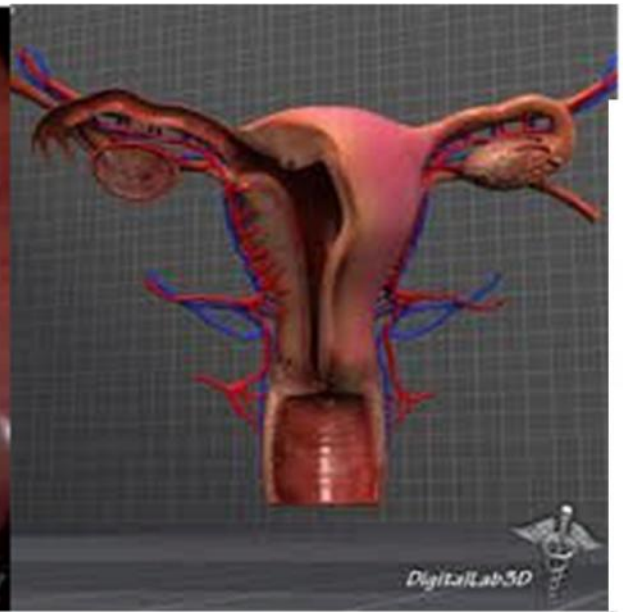
Female Reproductive System

- 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



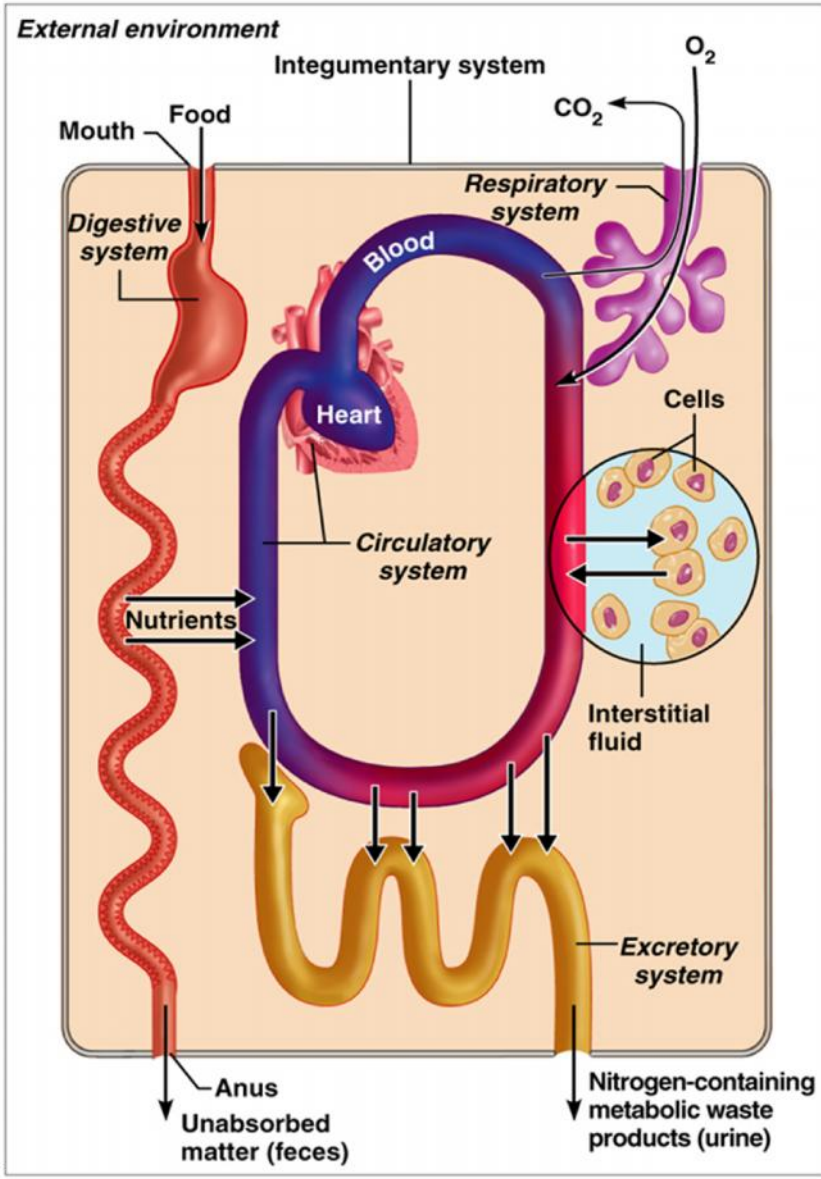
(I) Female Reproductive System





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



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

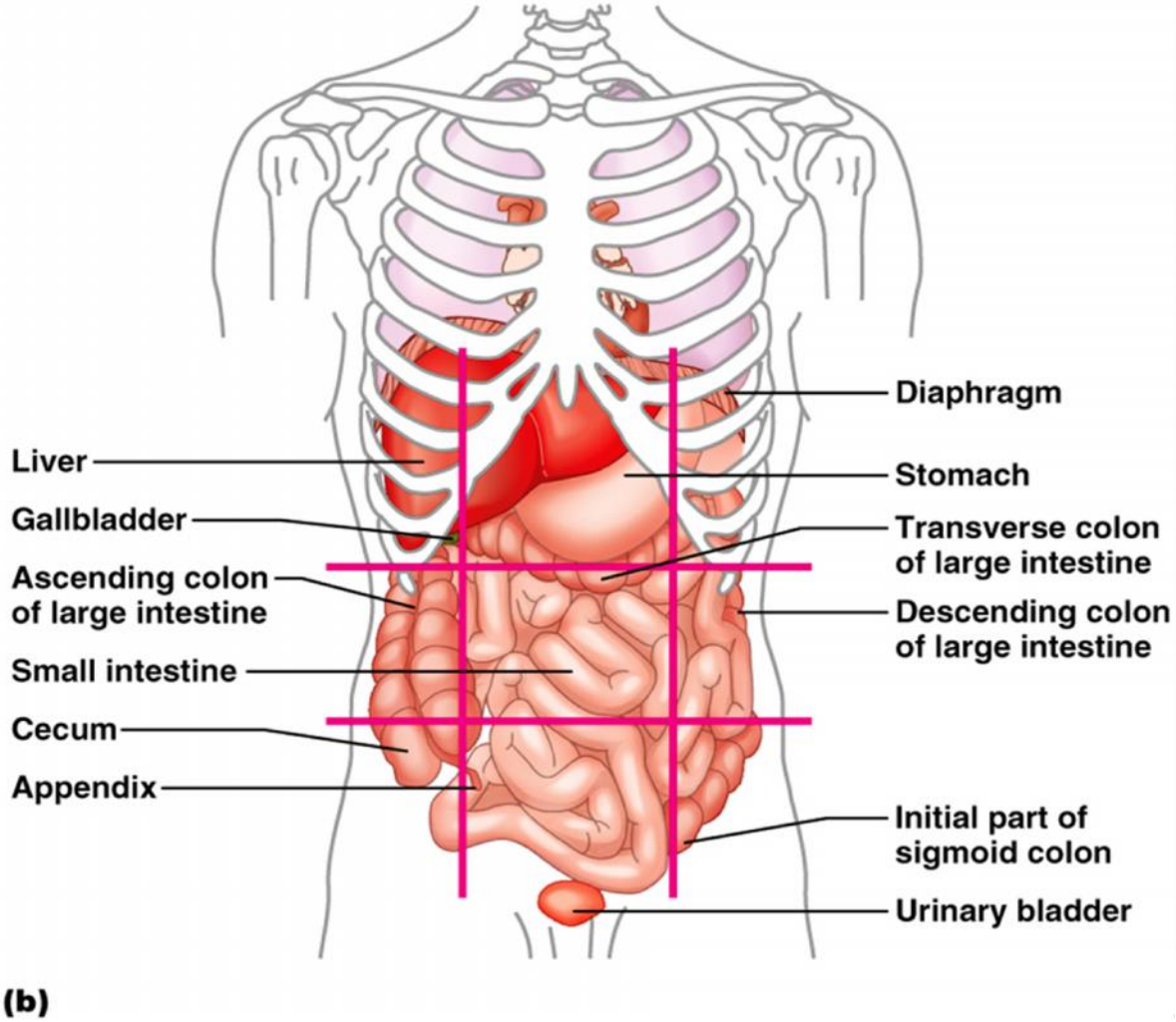
- **Responsiveness** – ability to sense changes in the environment and respond to them
- **Digestion** – breakdown of ingested foodstuffs
- **Metabolism** – all the chemical reactions that occur in the body
- **Excretion** – removal of wastes from the body

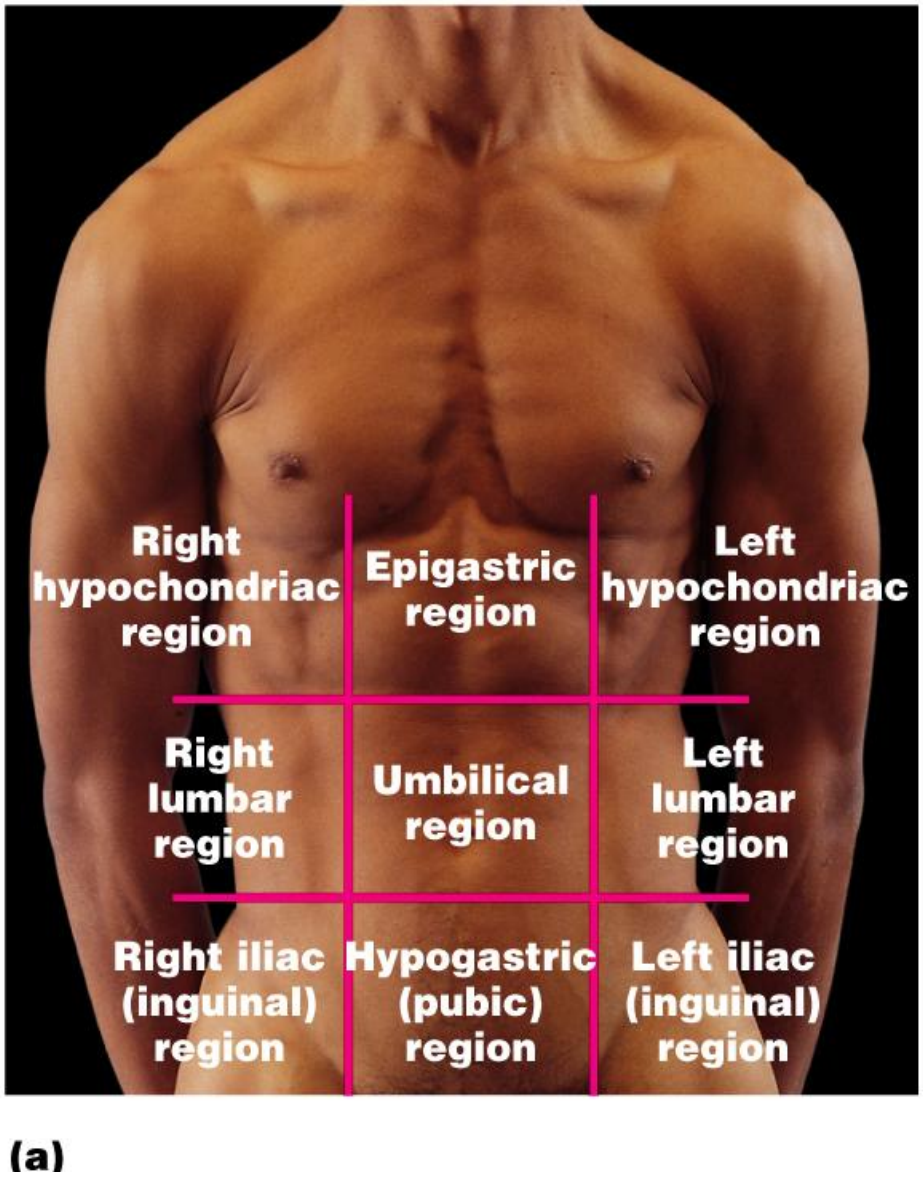
- Reproduction – cellular and organismal levels
  - Cellular – an original cell divides and produces two identical daughter cells
  - Organismal – sperm and egg unite to make a whole new person
- Growth – increase in size of a body part or of the organism

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

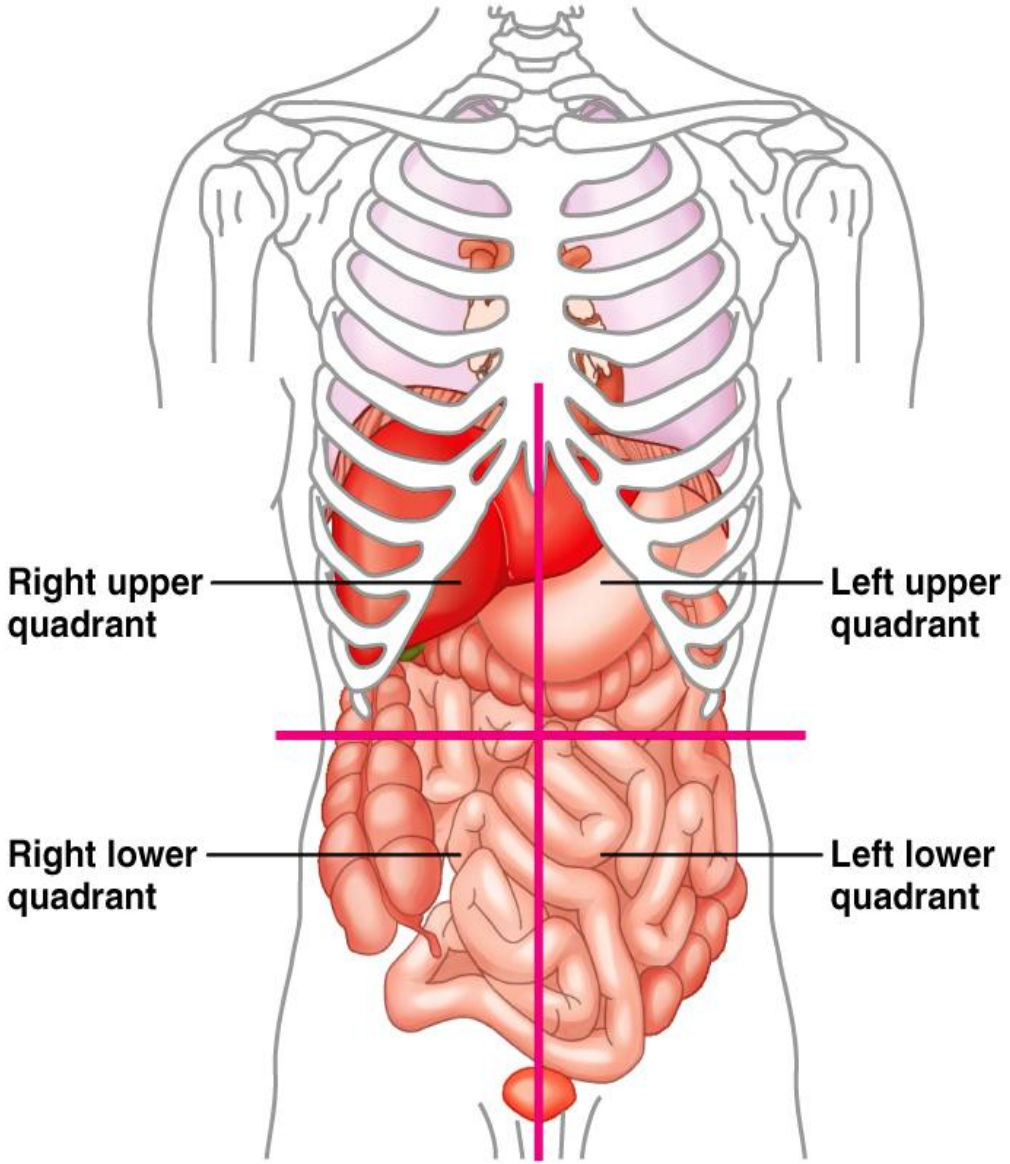
Abdominopelvic Regions





Abdominopelvic Quadrants

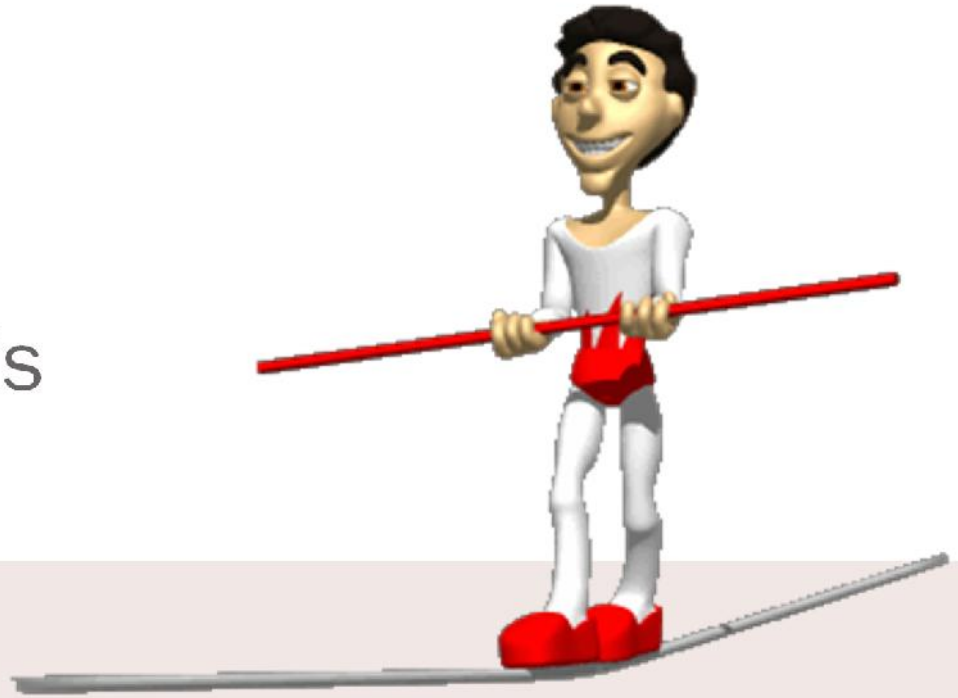
- Right upper
- Left upper
- Right lower
- Left lower



Abdominal quadrants

Right upper quadrant	Left upper quadrant
Liver right lobe Gallbladder, stomach, pylorus, doudenum, Pancreas head, R suprarenal gland, R kidney, R colic flexure, Ascending colon superior part, Transvrse colon R half.	Liver left lobe Spleen, stomach, jejunum, prox ileum, pancreas body and tail, left kidney, L suprarenal, left colic flexure, Transverse colon left part, descending colon superior part.
Right lower quadrant	**Left lower quadrant**
Cecum, Appendix, Ileum, Asc. Colon, R ovary, R uterine tube, R ureter, R spermatic cord, Uterus, Urinary bladder (full)	Sigmoid colon, Desc. Colon, L ovary, L uterine tube, L ureter, L spermatic cord, Uterus enlarge, Urinary bladder (full).

Homeostasis

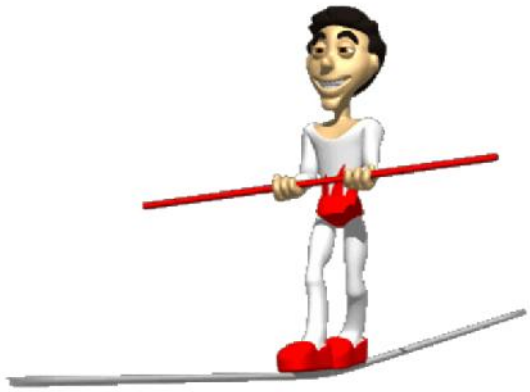


Relative constancy near a setpoint

- 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

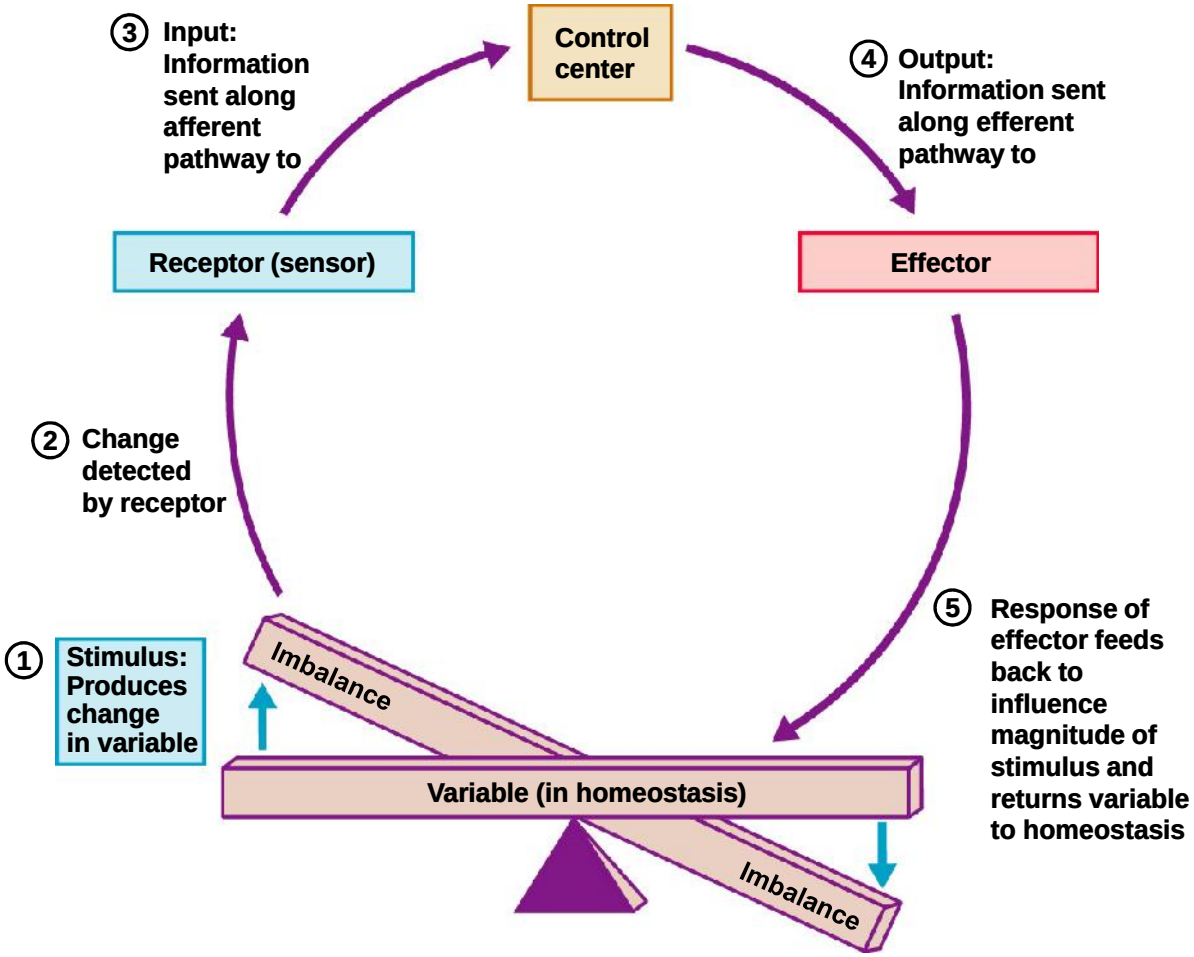


Figure 1.4

Negative Feedback

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

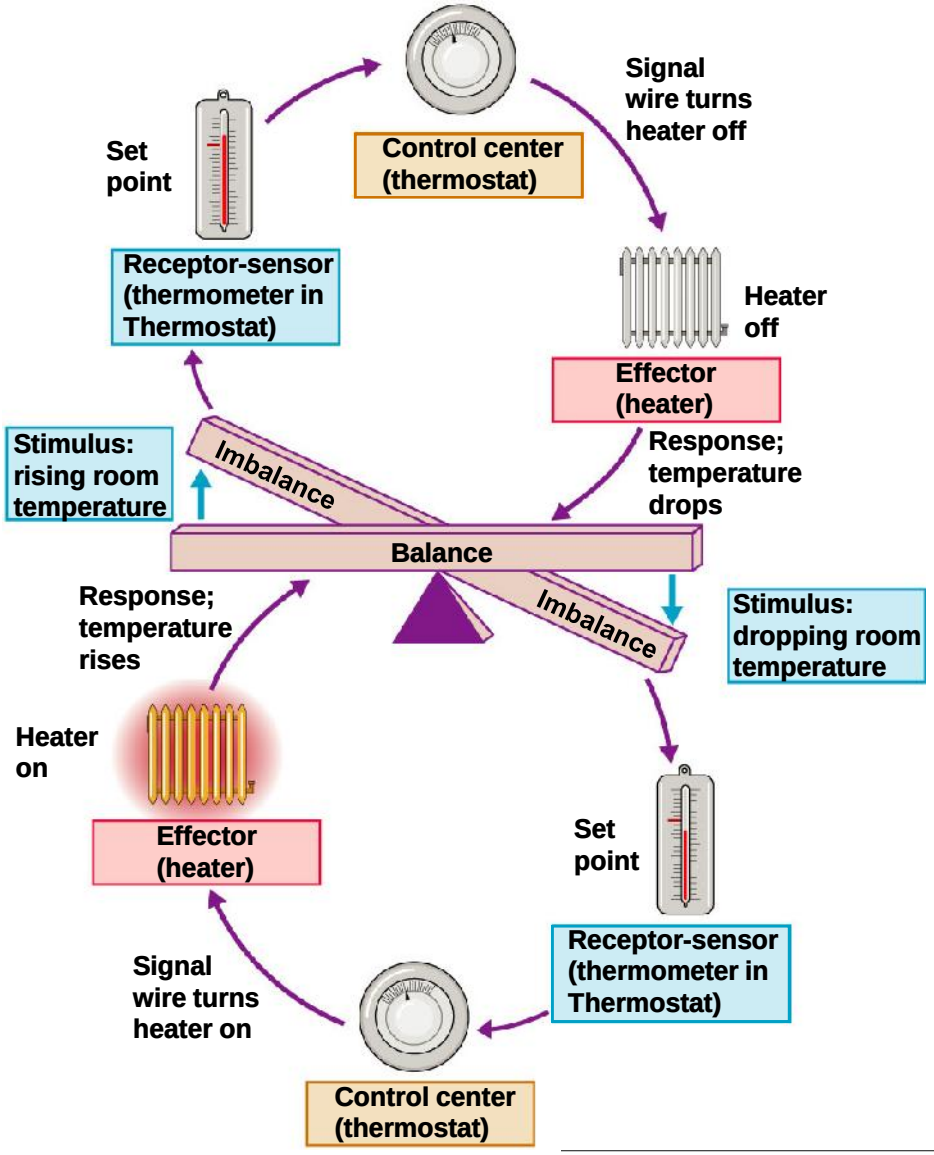
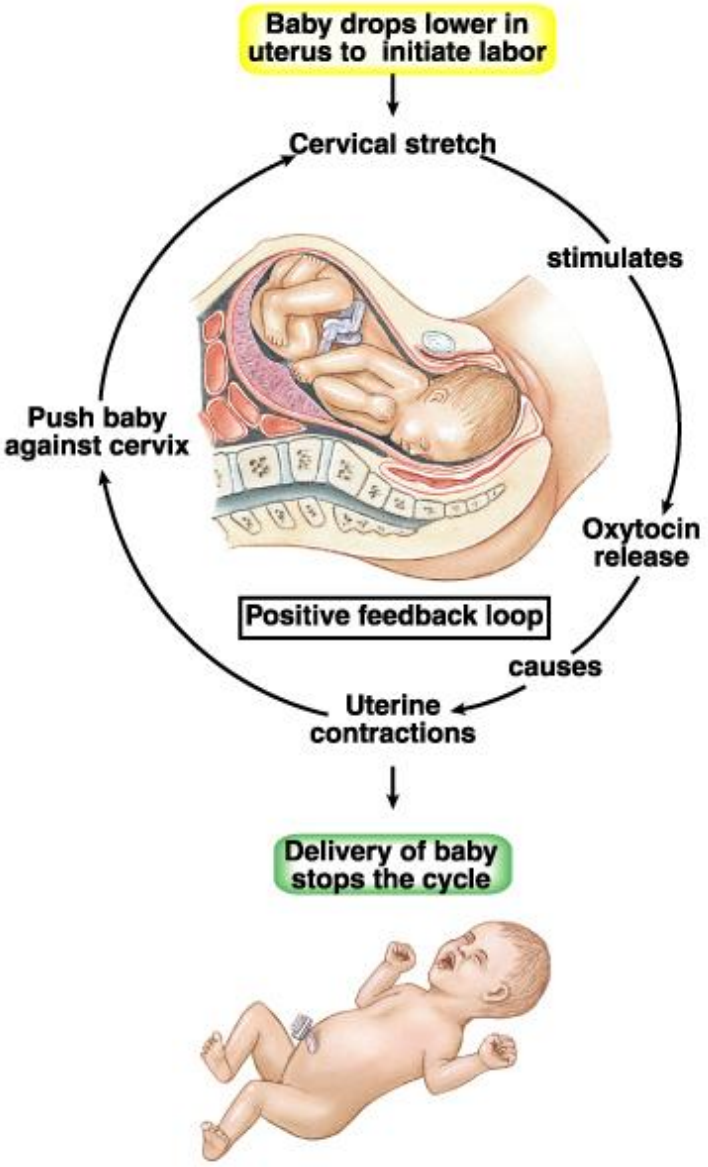

Control center (thermostat)
Signal wire turns heater off
Heater off
Effector (heater)
Response; temperature drops
Stimulus: dropping room temperature
Set point
Receptor-sensor (thermometer in Thermostat)
Signal wire turns heater on
Control center (thermostat)
Heater on
Effector (heater)
Response; temperature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

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

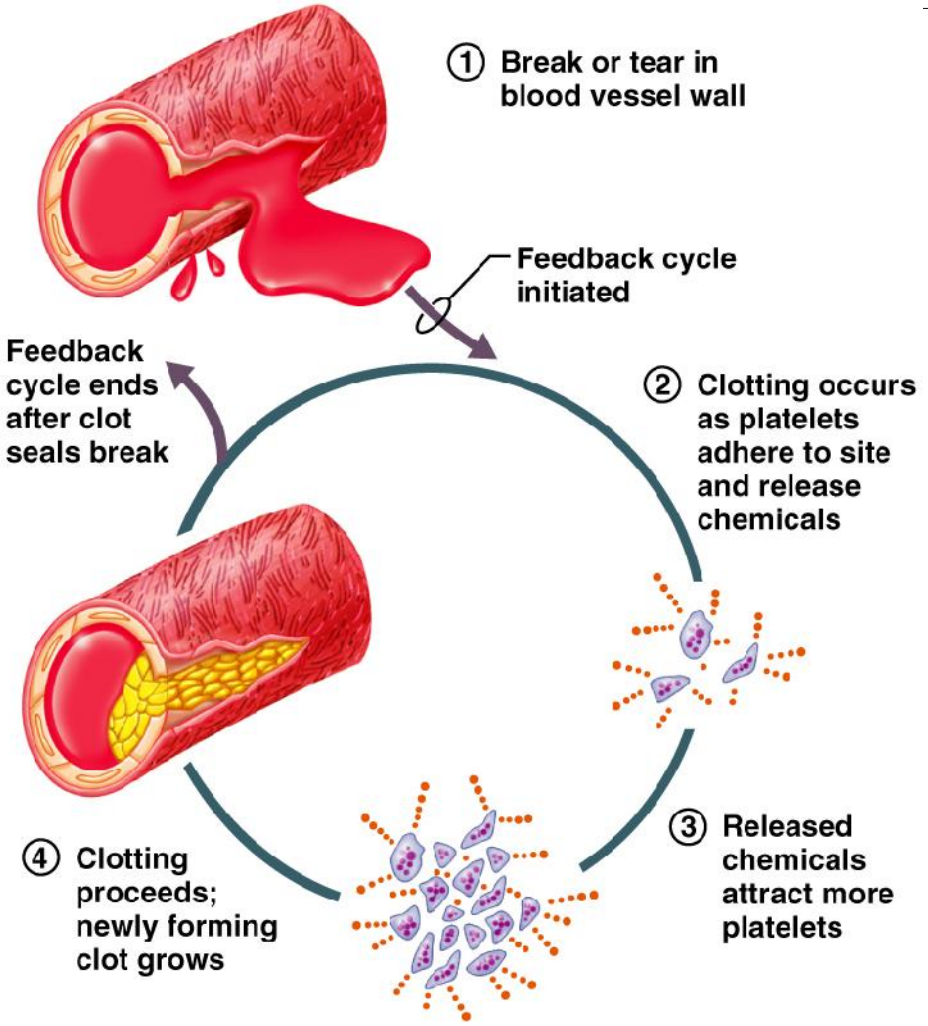
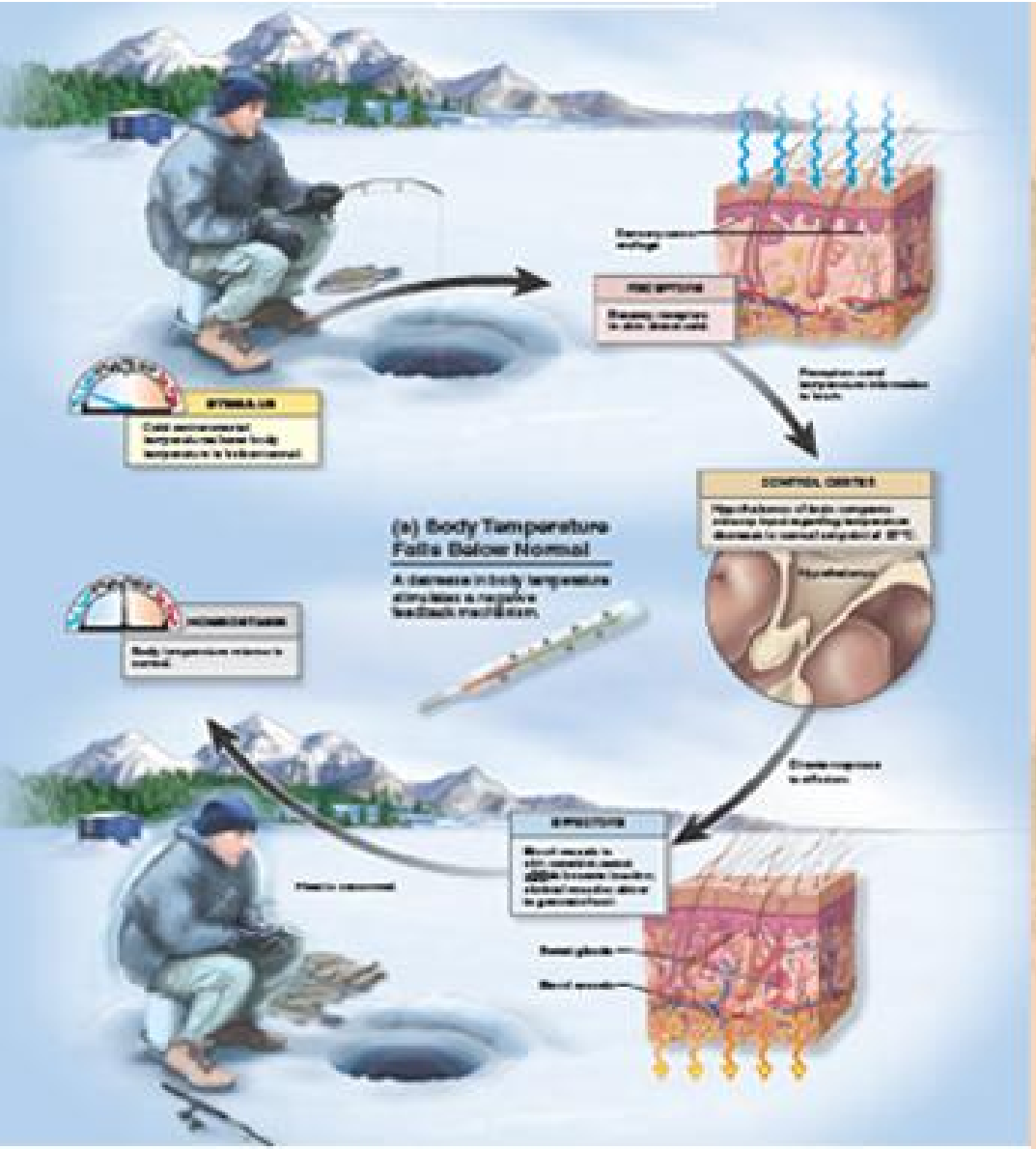
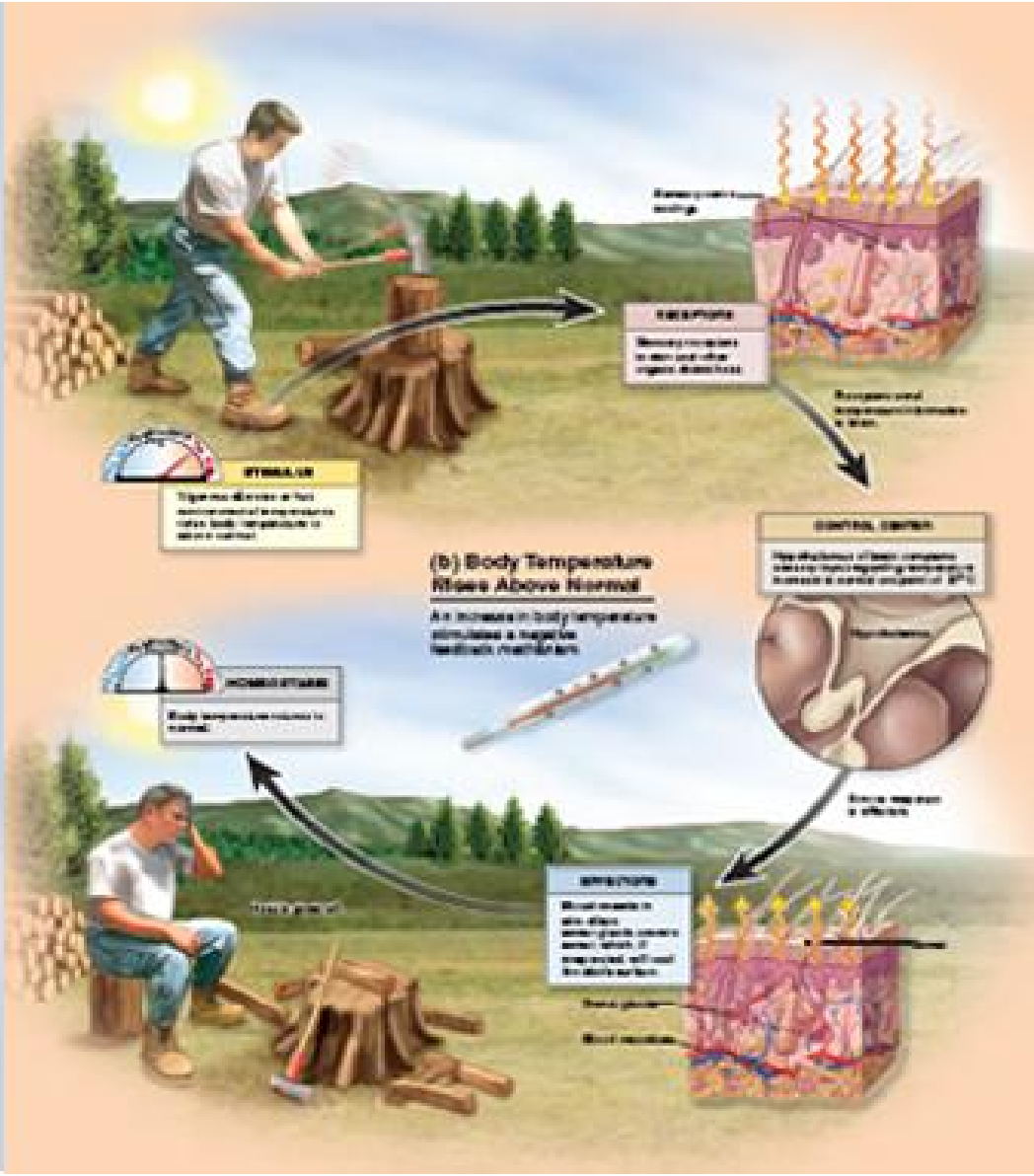


Figure 1.6

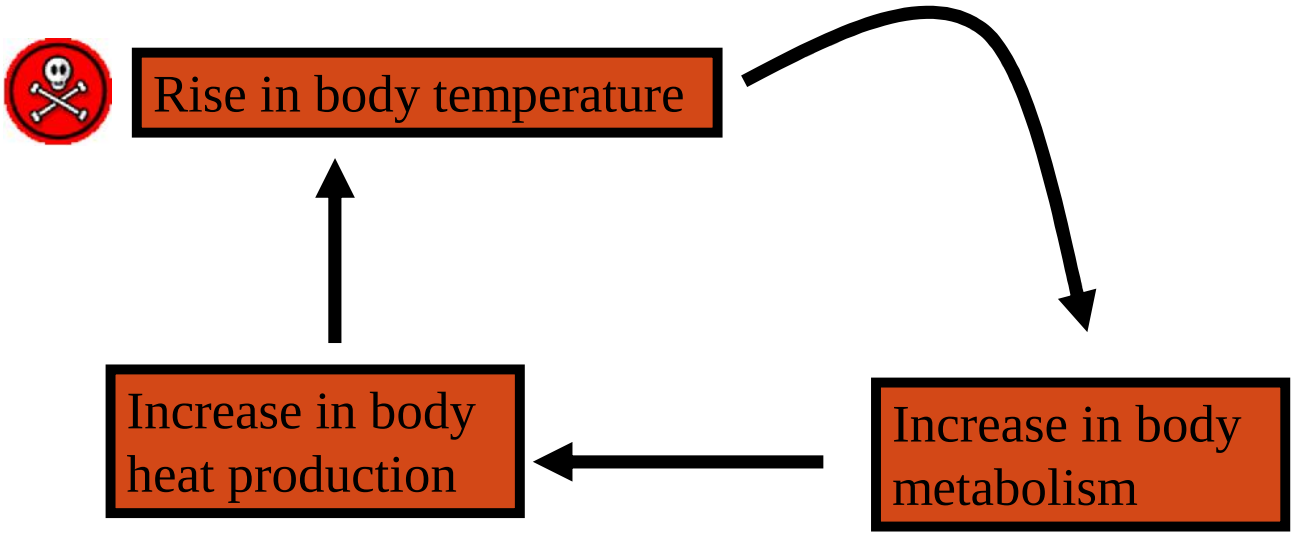
Homeostatic Imbalance

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


(a) Body Temperature Falls Below Normal


(b) Body Temperature Rises Above Normal

Dangerous Positive Feedback



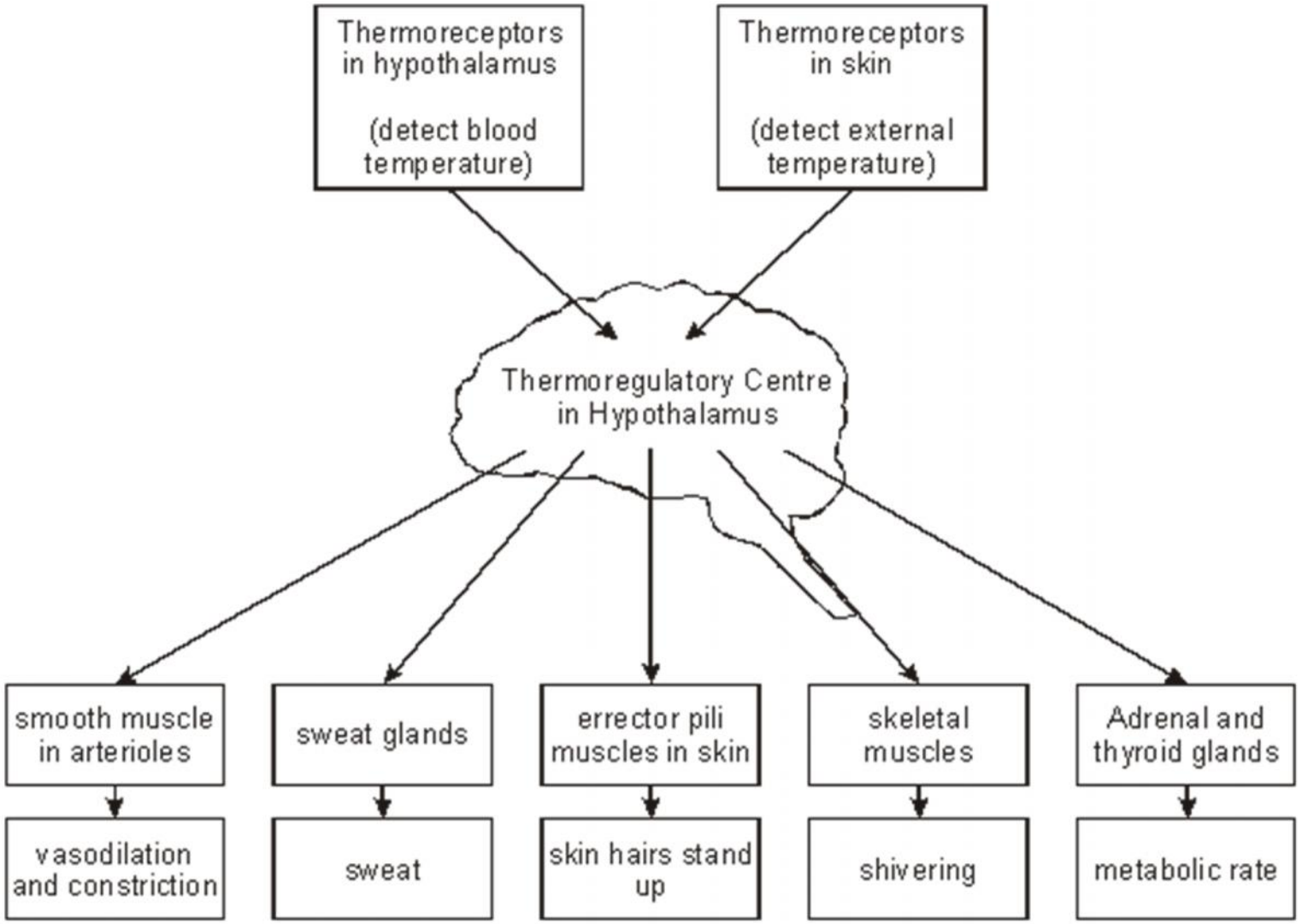

Thermoreceptors in hypothalamus (detect blood temperature)
Thermoreceptors in skin (detect external temperature)
Thermoregulatory Centre in Hypothalamus
smooth muscle in arterioles
sweat glands
errector pili muscles in skin
skeletal muscles
Adrenal and thyroid glands
vasodilation and constriction
sweat
skin hairs stand up
shivering
metabolic rate

Figure 1.5 Regulation of body temperature by a negative feedback mechanism.

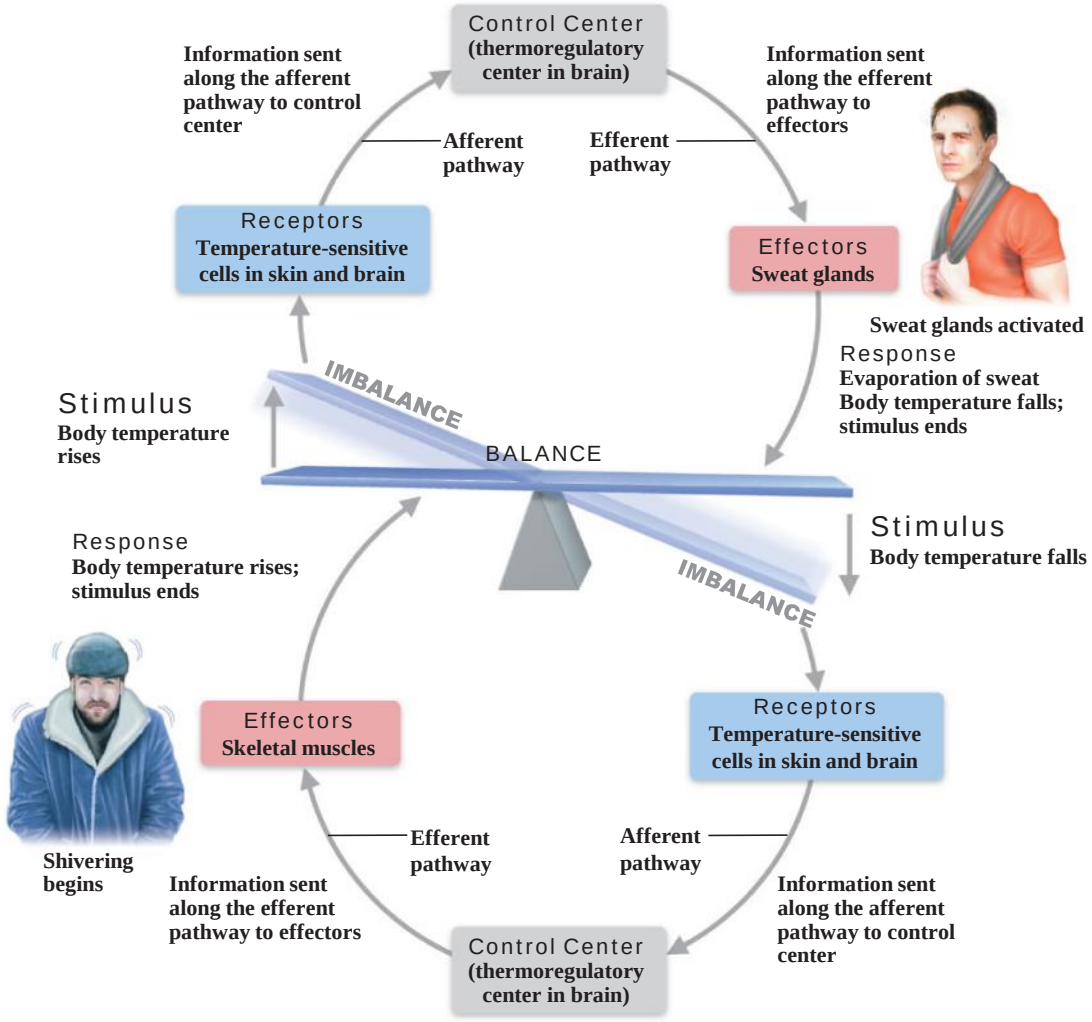
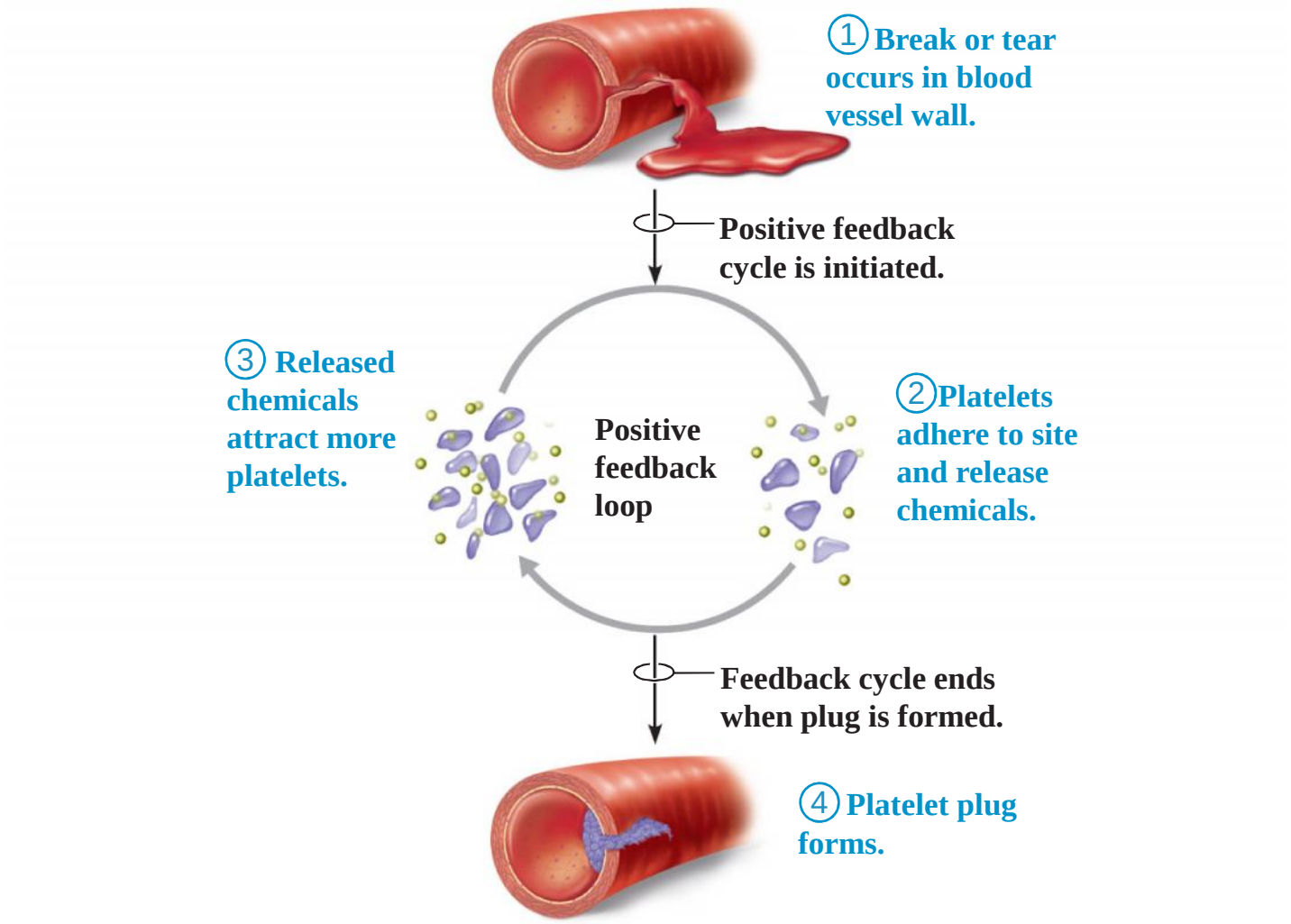
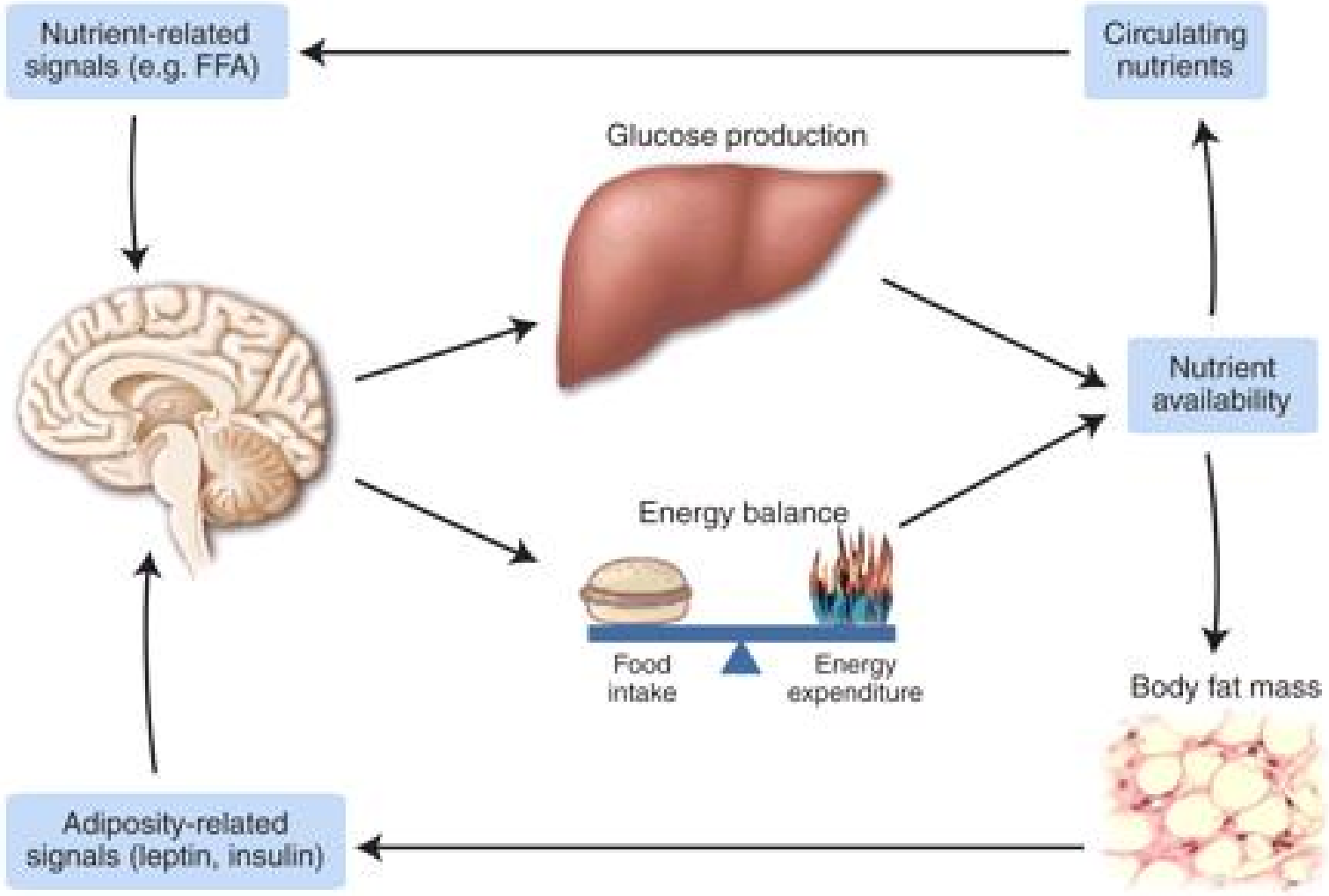
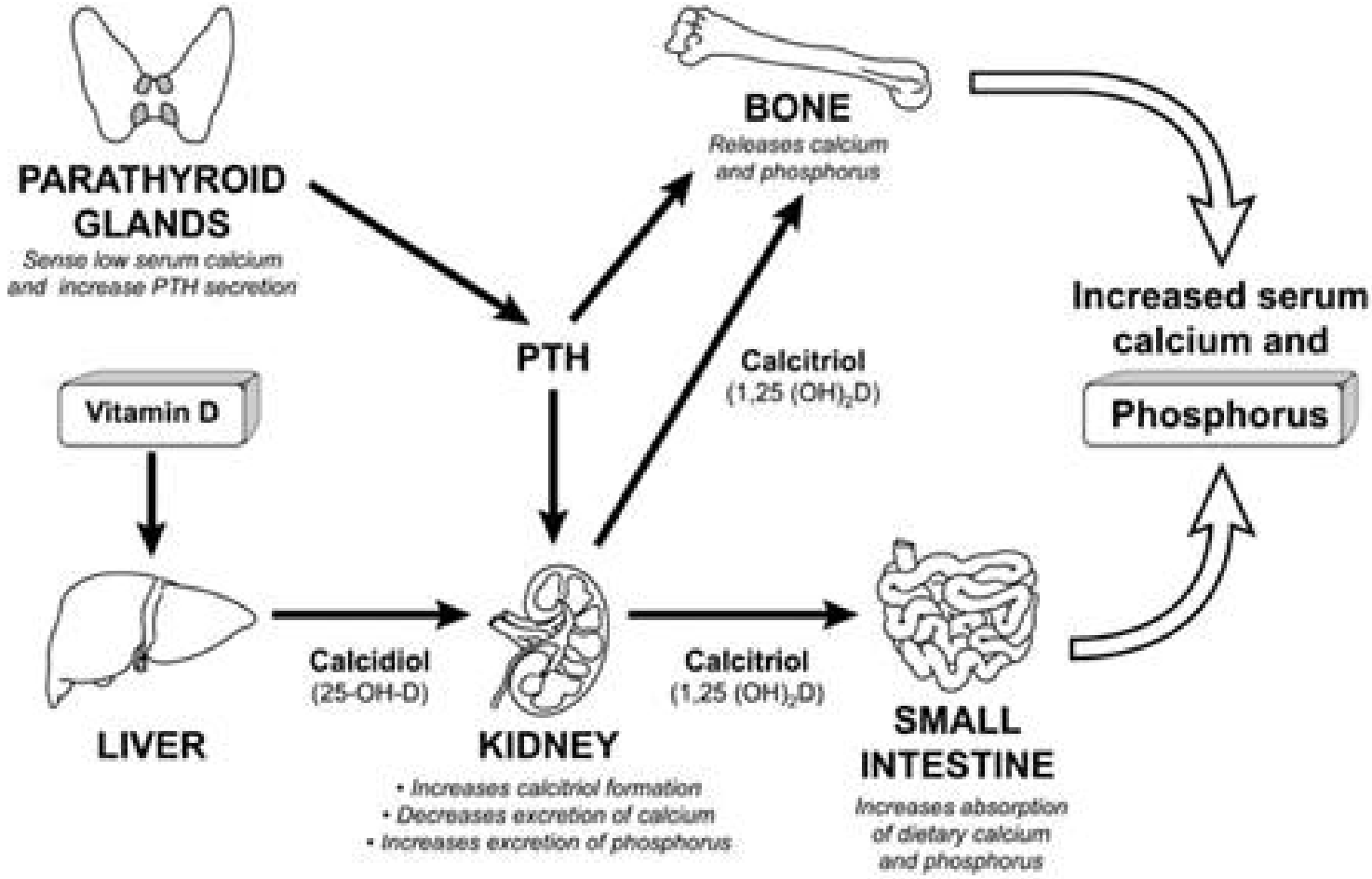


Figure 1.6 Summary of the positive feedback mechanism regulating formation of a platelet plug.

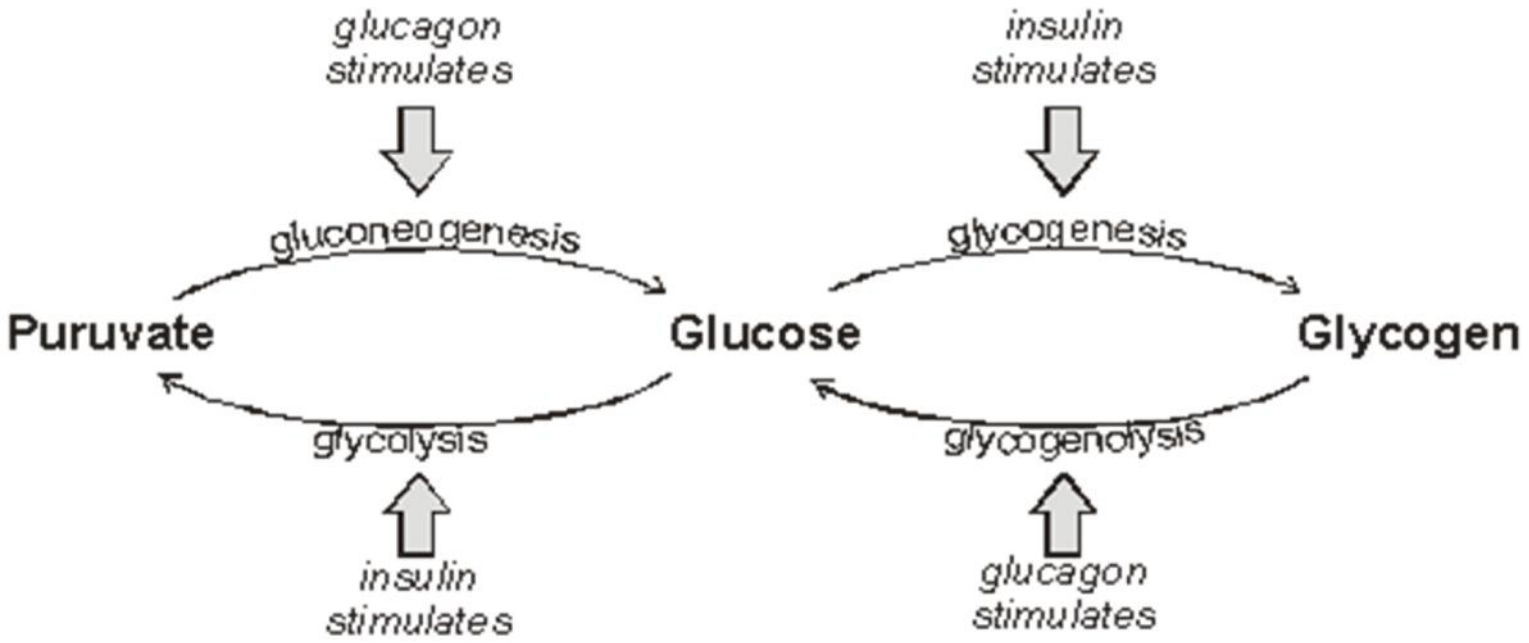



Nutrient-related signals (e.g. FFA)
Circulating nutrients
Glucose production
Nutrient availability
Energy balance
Food intake
Energy expenditure
Body fat mass
Adiposity-related signals (leptin, insulin)


PARATHYROID GLANDS
Sense low serum calcium and increase PTH secretion
BONE
Releases calcium and phosphorus
Increased serum calcium and Phosphorus
PTH
Calcitriol (1,25 (OH)2D)
Vitamin D
Calcidiol (25-OH-D)
Calcitriol (1,25 (OH)2D)
LIVER
KIDNEY
• Increases calcitriol formation
• Decreases excretion of calcium
• Increases excretion of phosphorus
SMALL INTESTINE
Increases absorption of dietary calcium and phosphorus

Effector	Response to low temperature	Response to high temperature
Smooth muscles in peripheral arterioles in the skin.	• Muscles contract causing vasoconstriction. • Less heat is carried from the core to the surface of the body, maintaining core temperature. • Extremities can turn blue and feel cold and can even be damaged (frostbite). •	• Muscles relax causing vasodilation. • More heat is carried from the core to the surface, where it is lost by convection and radiation. • Skin turns red.
Sweat glands	• No sweat produced.	• Glands secrete sweat onto surface of skin, where it evaporates. • This is an endothermic process and water has a high latent heat of evaporation, so it takes heat from the body.
Erector pili muscles in skin (attached to skin hairs)	• Muscles contract, raising skin hairs and trapping an insulating layer of still, warm air next to the skin. • Not very effective in humans, just causing "goosebumps".	• Muscles relax, lowering the skin hairs and allowing air to circulate over the skin, encouraging convection and evaporation.
Skeletal muscles	• Muscles contract and relax repeatedly, generating heat by friction and from metabolic reactions.	• No shivering.
Adrenal and thyroid glands	• Glands secrete adrenaline and thyroxine respectively, which increase the metabolic rate in different tissues, especially the liver, so generating heat.	• Glands stop releasing adrenaline and thyroxine.
Behaviour	• Curling up, huddling, finding shelter, putting on more clothes. •	• Stretching out, finding shade, swimming, removing clothes.

Another feedback



Excretion means the removal of waste products from cells.
There are five important excretory organs in humans:

- **Skin** excretes sweat, containing water, ions and urea
- **Lungs** excrete carbon dioxide and water
- **Liver** excretes bile, containing bile pigments, cholesterol and mineral ions
- **Gut** excretes mucosa cells, water and bile in faeces. (The bulk of faeces comprises plant fibre and bacterial cells, which have never been absorbed into the body, so are not excreted but egested.)
- **Kidneys** excrete urine, containing urea, mineral ions, water and other “foreign” chemicals from the blood.