biology 1010

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1.1 Classification of Major Biochemicals

1.Carbohydrates

1. Monosaccharides
   - Deoxyribose
   - glucose
   - fructose
2. Disaccharides
   - sucrose
   - lactose
3. Polysaccharides
   - glycogen
   - starch
   - cellulose

1. Lipids
   (a) Fatty acids

(b) Phospholipids

(c) Triglycerides

(d) Steroids

2. Proteins (Polymers made of *amino acid* monomers)

   - Gluten
   - Insulin
   - Elastin
   - Collagen
   - Hemoglobin

3. Nucleic Acids

   - DNA
   - RNA

1.1.1 Carbohydrates *macronutrient*

sugars, starches, and fibers found in fruits, grains, vegetables, and milk products. One of three main ways the body obtains energy or calories.

biological molecule consisting of carbon (C), hydrogen(H), and oxygen(O).

1. Monosaccharides

   - pop has monosaccharides
   - fructose is sweet
     - When there is no exercise, fructose → glycogen → fat.
   - Latin *mono-* one, smallest

   (a) Deoxyribose [2-deoxyribose] $C_5H_{10}O_4$
   - Modern *deoxy sugar* less oxygen; it is derived from the sugar ribose.

   (b) Glucose $C_6H_{12}O_6$ sugar with 6 carbon atoms classed as monosaccharides
   circulates in the blood of animals as blood sugar. In plants is made during photosynthesis from water and carbon dioxide, using energy from sunlight.

2. Disaccharides

   - Latin *di-* two

   (a) sucrose Sucrose is found in many food plants.

   (b) maltose Produced during the malting of barley.

3. Polysaccharides *polymeric carbohydrate* molecules composed of long chains of monosaccharides

   - Latin *poly-* many

(a) Glycogen
multibranched *polysaccharide* of *glucose*. Main storage form of *glucose* in the body.

(b) Starch polymeric carbohydrate with a large number of glucose joined by glycosidic bonds. Produced by most green plants as an energy store. Most common carbohydrate in human diets.

glycosidic bonds covalent bond that joins a carbohydrate (sugar) molecule to another group, which may or may not be another carbohydrate.

(c) Cellulose $C_6H_{10}O_5$ organic compund, a linear chain of several hundred to many thousands of $\beta(1\rightarrow4)$ linked D-glucose units. Important structural component of the primary cell wall of green plants, many forms of algae, and *oomycetes*.

D-glucose D-isomer of *glucose*, also known as *dextrose*, occurs widely in nature.

Oomycetes distinct phylogenetic lineage of fungus-like eukaryotic microorganisms.

1.1.2 Lipids

They are basically fats.

1. Fatty acids Carboxylic acid with a long aliphatic chain. This guy looks crazy, though.
   The chains range from 4 to 28 carbon atoms.
   - Unsaturated fatty acids
     - cis
     - trans

2. Phospholipids Major component of all cell membranes. They can form *lipid bilayers* because of their *amphiphilic* characteristic. (It has *hydrophilic* water loving and *lipophilic* fat loving properties.)
   hydrophilic phosphate head, *hydrophobic fatty acid* tails
   - *amphis* both *philia* love, friendship *hydro-* water

3. Triglycerides Ester derived from *glycerol* and three *fatty acids*. Having a high amount of *triglycerides* can be very bad for your heart. Triglycerides are *lipids* and are fatty.

   (a) glycerol Colorless, odorless, viscous liquid; sweet, non-toxic. This is the backbone found in all lipids know as triglycerides.
   Used in food industry as a sweetener and humectant and in pharmaceutical formulations.

   humectant keeps things moist.

4. Steroids Organic compound with four rings arranged in a specific configuration. Steroids serve two principal biological functions: certain steroids are important components of cell membranes which alter membrane fluidity, and many steroids are signaling molecules which activate steroid hormone receptors.

   (a) sex hormones Influence sex differences and support reproduction.
   - *androgens*, *estrogens*, and *progestagens*

(b) corticosteroids With natural product classes the *glucocorticoids* and the *mineralocorticoids*

glucocorticoids Regulates many aspects of metabolism and immune function.

mineralocorticoids Help maintain blood volume and control renal excretion of electrolytes.

1.1.3 Proteins

Large biomolecules, or macromolecules consisting of one or more long chains of *amino acid residues*. Just like *polysaccharides* and *nucleic acids*, *proteins* are essential parts of organisms and participate in virtually every process within cells.

They have an average lifespan of 1-2 days in mammalian cells.

1. Gluten Mixture of proteins found it wheat and related grains.
   - Latin *gluten* glue
2. Insulin Peptide hormone produced by beta cells. Affects the metabolism of carbohydrates.
3. Elastin Highly elastic protein in connective tissue. Elastin helps skin to return to its original position when it is poked or pinched.
4. Collagen Main structural protein in the extracellular space in the various connective tissues in animal bodies.
5. Hemoglobin (Hb 'or' Hgb) Iron-containing oxygen-transport metalloprotein. Hemoglobin in the blood carries oxygen from the respirator organs to the rest of the body.

   Also haemoglobin

   metalloprotein generic term for a protein that contains a *metal ion cofactor*.

1.1.4 Nucleic Acids

1. Deoxyribonucleic acid Molecule that carries the genetic instructions used in the growth, development, functioning, and reproduction of all know living organisms and many viruses.
2. Ribonucleic acid Polymeric molecule essential in various biological roles in coding, decoding, regulation, and expression of genes.

2 book

2.1 Ch. 1

2.1.1 Seven characteristics of life

- being made of cells

  Single-cell organisms have everything they need to be self-sufficient. In multicellular organisms, specialization increases until some cells do only certain things.

- responsiveness to the environment

  Living things will make changes in response to a stimulus in their environment. A behavior is a complex set of responses.

- growth and change

  Cell division – the orderly formation of new cells. cell enlargement – the increase in size of a cell. An organisms gets larger as the number of its cells increases.

- ability to reproduce

  Reproduction is not essential for survival of individual organisms, but must occur for species to survive.

- have the metabolism and breathe / have energy

  Living things take in energy and use it for maintenance and growth.

- maintain homeostasis

  There is an organization to all the parts of life that means they all depend on each other, and they must all be in equilibrium.

- passing traits onto offspring

  Adaptions are traits giving an organism an advantage in a certain environment.

1. Macromolecules

   Four major molecules essential for all known forms of life are

   - RNA
   - DNA
   - Proteins
   - Carbohydrates

2. Enzyme

   Macromolecule biological catalyst. *Enzymes* accelerate, or catalyze, chemical reactions. Lower *activation energy* to increase rate of a reaction.

   Usually *proteins*. A lot of the time used to break down more complex chemicals and compounds.

2.1.2 Scientific Method

- Ask a Question
- Construct a Hypothesis
- Test with experiment
- Analyze data and draw conclusions
- Communicate results

2.2 Ch. 2

Scale for acidity or basicity of an aqueous solution. Measure of the hydrogen ion density in the the solution.

- Carbon is the basis of organic molecules.
- Lipids are not soluble in water.

ATP *Adenosine triphosphate* A small molecule used in cells as a coenzyme.

The molecular unit of currency of intracellular energy transfer.

2.3 Ch. 3

Cholesterol An organic molecule; a sterol (or modified steroid), a lipid molecule and is biosynthesized by all animal cells. An essential structural component of all animal cell membranes that is required to maintain both membrane structural integrity and fluidity.

- Latin *chole-* bile *stereos* solid

Fluid mosaic The plasma membrane can be described as fluid combination of phospholipids, cholesterol, and proteins. Fluid on inside and outside of the membrane.

Diffusion Movement of molecules or atoms from a region of high concentration to a region of low concentration.

Osmosis Movement of solvent molecules **through a semi-permeable membrane** into a region of higher solute concentration.

2.3.1 Diffusion vs. Active Transport

Diffusion (Passive Transport)	Active Transport
quick	slow
down a gradient	up a gradient
no energy	need energy
no protein	need protein

Endocytosis Form of active transport in which a cell transports molecules by engulfing them in an energy-using process.

Exocytosis Form of active transport in which cell transports molecules out of the cell.

2.4 Ch. 5

The *skeletal system* is composed of bones, ligaments, and cartilage; it is an *organ system*. It supports and protects the other organ systems of the body and provides a structure that enables movement.

Bones are living cells surrounded by extracellular deposits of calcium minerals.

- Support
- Movement

- Protection
- Formation of blood cells
- Mineral and fat storage
  - like phosphorous, calcium

2.4.1 four types of bones

long arms, legs

short wrist, feet

flat ribs, skull

regular all the rest

2.4.2 Connective tissues

Bone Hard elements of the skeleton. Store minerals and produce the cellular components of blood.

Bones are hard because of nonliving extracellular crystals of calcium minerals; hard, rigid, appearance and feel. *Bones* are living cells, and undergo constant replacement, remodeling, and repair.

- support
- protection
- movement

Long bone It is longer than it is wide, consists of a cylindrical shaft ***diathesis***, and an enlarged knob called an ***epiphysis***.

Compact bone Forms the shaft and covers each end.

Osteocytes Mature bone cells that maintain the structure of bone. The *compact bone* is made up largely of extracellular deposits of calcium phosphate enclosing and surrounding living cells.

- Greek *osteo* bone *cyte* cell

Osteons [Haversian systems] Osteocytes arranged in rings in cylindrical structures.

Central canal [Haversian canal] *Ostecytes* nearest the center of an *osteon* receive nutrients from diffusion from blood vessels.

Spongy bone Inside each epiphysis. It is a latticwork of hard, relatively string *trabeculae* (Latin "little beams") composed of calcium minerals and living cells.

note Spongy bone doesn't need to rely on central canals for nutrients and waste removal. The slender *trabecular* structure of spongy bone gives each osteocyte access to nearby blood vessels in red bone marrow.

A *trabecular* structure is a latticework of interconnected beams.

Joint The point of contact between bones.

Ligaments Dense, fibrous connective tissue that attach bone to bone. They are a regular array of closely packed collaen fibers all oriented in the same direction, with just a few *fibroblasts* in between.

Ligaments are slow to heal because they have very few living cells and a poor blood supply.

Cartilage Specialized connective tissue consisting primarily of fibers of collagen and elastic in a gel-like fluid called *ground substance*.

Fibrocartilage Collagen fibers arranged in thick bundles.

Hyaline cartilage Smooth, glassy cartilage of thin collagen fibers.

Elastic cartilage Mostly elastin fibers, so it is highly flexible.

2.4.3 Bone development

At the earliest stages of fetal development, before organs develop, we have *chondroblasts*. After about two to three months of fetal development, *ossification* happens.

Chondroblasts Cartilage-forming cells that build a model of the future bone. These *chrondroblasts* are rudimentary models of future bones and are created out of *hyaline cartilage*.

Ossification Chondroblasts slowly die out and the cartilage models begin to dissolve and are replaced by bone.

Osteoblasts Young bone-forming cells that cause the hard extracellular matrix of bone to develop.

They secrete both *osteoids*, and *hydroxyapatite*. In mature *compact bone*, approximately one-third of the structure is *osteoid* and two-thirds is crystals of *hydroxyapatite*.

Eventually, the rate at which *osteoblasts* produce the *osteoid* matrix and stimulate the mineral deposits declines, and ***osteoblasts* become** mature ***osteocytes*** embedded in their individual *lacunae*.

Osteoid Mixture of proteins that forms a matrix that provides internal structure and strength to bone.

Hydroxyapatite Hard mineral salts of calcium phosphate

Osteclasts Bone-dissolving cells.

Cut through mature bone tissue, dissolving the *hydroxyapatite* and digesting the *osteoid* matrix in their path. The released calcium and phosphate ions enter the blood.

The areas from which bone has been removed attract new osteoblasts, which lay down new osteoid matrixes and stimulate the deposition of new hydroxyapatite crystals.

Growth plate [epiphyseal plate] A narrow stip of *cartilage* that remains in each *epiphysis*. This is where there is bone on one side, and cartilage on the other side.

Osteoporosis Common bone disease in which bones lose a great deal of bone mass (seemingly becoming "porous"). The honeycomb shape of bone becomes more porous for those with *osteoporosis*.

Hematoma Mass of clotted blood

Fibrocarttilage callus When a bone breaks, this forms between the broken ends and is later replaced with bone.

Parathyroid hormone [PTH] stimulates the *osteoclasts* to secrete more bone-dissolving enzymes.

Calcitonin stimulates *osteoblast* activity, causing calcium and phosphate to be removed from blood and deposited in bone.

2.4.4 Skeletal system

The *skull* and *vertebral column* protect the *brain* and *spinal cord*, the *rib cage* protects the organs of the chest cavity, and the *pelvic girdle* supports the body's weight and protects the pelvic organs. The upper limbs are capable of a wide range of motions (dexterous movement). The lower limbs are stronger but less dexterous than the upper limbs

Axial skeleton 80 bones, including the skull, vertebral column, ribs, and sternum.

Cranium [skull] Comprises over two dozen bones that protect the brain and form the structure of the face.

Cranial bones Flat bones in the skull that enclose and protect the brain.

Frontal bone Comprises the forehead and the upper ridges of the eye sockets.

Parietal bones [two] Upper left and right sides of the skull.

Temporal bones [two] Forms the lower left and right sides of the skull.

Sphenoid bone Forms the back of both eye sockets.

Ethmoid bone Contributes to the eye sockets and also helps support the nose.

Nasal bones [two] Small, narrow; underlie only the upper bridge of the nose; the rest of the fleshy protuberance called the nose is made up of cartilage and other connective tissue.

Lacrimal bones [small] At the inner eye socket, are pierced by a tiny opening through which the tear ducts drain tears from the eye sockets into the *nasal cavity.*

Mandible [lower jaw] Contains the sockets that house the lower row of teeth.

Occipital bone Curving underneath to form the back and base of the *skull.*

Foramen magnum [Latin "great opening"] Where the *vertebral column* connects to the *skull* and the *spinal cord* enters the *skull* to communicate with the brain.

Facial bones compose the front of the skull.

Maxilla On either side of the nose, forming part of the eye sockets and contain the sockets that anchor the upper row of teeth.

Palatine bones [two] Irregular bones, comprise the hard palate at the back part of the nasal cavity.

Zygomatic bones [cheekbone or malar bone] paired bone which articulates with the maxilla.

Sinuses Air spaces in the *cranial* and *facial bones* that make the skull lighter and give the human voice its characteristic tone and resonance.

Each sinus secretes *mucus*, a thick, sticky fluid that helps trap foreign particles in incoming air. They connect to the *nasal cavity* via small passageways through which the mucus normally drains.

Hyoid bone Does not make direct contact with other bones of the *axial skeleton*; it is attached to the *temporal bone* only by *ligaments*. Serves as a point of attachment for muscles of the *tongue*, the *larynx*, and the *pharynx*.

Vertebral column The body's main axis. It supports the head, protects the *spinal cord*, and serves as the site of attachment for the four limbs and various muscles. It has 5 anatomical regions.

Neighboring vertebrae are separated from each other by a flat, elastic, compressible ***intervertebral disk*** composed of a soft, gelatinous center and a tough outer layer of *fibrocartilage*.

Cervical vertebrae [7 vertebrae] Neck

Thoracic vertebrae [12 vertebrae] The chest or thorax

Lumbar vertebrae [5 vertebrae] Lower portion or "small" of the back which forms the lumbar curve of the spine

Sacral [5 vertebrae fused] In the *sacrum* or upper pelvic region

Coccygeal [4 vertebrae fused] The *coccyx* or tailbone. It is an example of a *vestigial structure*.

Ribs One end of each rib branches from the *thoracic* region of the *vertebral column*. The other ends of the upper seven pairs attach via *cartilage* to the *sternum*.

Humans have 12 pairs of ribs.

Sternum [breastbone] A flat blade-shaped bone composed of three separate bones that fuse during development.

Appendicular skeleton {Pectoral girdle, pelvic girdle, and limbs} Consists of those parts of the body that attach, or are appended to, the *axial skeleton*. Includes the arms, legs, and their attachments to the trunk, which are the *pectoral* and *pelvic girdles*.

Pectoral girdle Lends flexibility to the upper limbs.

Clavicle [collar bone] Extend across the top of the chest and attach to the *scapulas*. Most frequently broken bone.

Scapula [shoulder blade] The triangular bones in the upper back.

arm and hand Consists of 30 different bones.

The humerus is the first and meets at the scapula. The lower end of the *radius* an *ulna* meet the *carpal bones*. A group of eight small bones that make up the wrist. The five *metacarpal* bones form the palm of the hand, and they join with the 14 *phalanges*, which form the fingers and thumb.

Humerus [upper arm] The long bone of the upper arm, fits into a socket in the *scapula*.

Ulna Meets with the other end of the humerus as does the *radius*. Bone of the forearm. The elbow around here is nicknamed the "funny bone."

Radius bone of the forearm.

Carpal [wrist]

Repetitive motions can lead to health problems called *repetitive stress syndromes*. One well-known repetitive stress syndrome is *carpal tunnel syndrome*. Inflammation of the tendons causes them to press against the nerve supplying the hand, resulting in pain, tingling, or numbness in the wrist and hand.

Metacarpals [hand]

Phalanges [finger bones]

Pelvic girdle Supports the body, and consists of two *coxal* bones and the *sacrum* and *coccyx* of the *vertebral column*.

The primary function of the pelvic girdle is to support the weight of the upper body against the force of gravity. The lower limbs are larger and more firmly connected to the rest of the body than the pectoral girdle and upper limbs.

Coxal bone Attach to the *sacral* region of the *vertebral column* in back, then curve forward to meet in from at the *pubic symphysis*, which is right around the groin it looks like, where they are joined by cartilage.

Femur [thighbone] Longest and strongest bone in the body.

The rounded upper end of each *femur* fits securely into a socket in a *coxal bone*. The lower end of the femur intersects at the knee joint with the larger of the two bones of the lower leg, the *tibia*, which in turn makes contact with the thinner *fibula*.

Tibia [shinbone] Bigger lower leg bone in front.

Fibula [calf bone] Smaller of the two lower leg bones in the back.

At the ankle, the *tibia* and *fibula* join with the seven *tarsal bones* that make up the ankle and heel. Five long bones, the *metatarsals*, form the foot. The 14 bones of the toes, like those of the fingers, are called *phalanges*.

Patella [kneecap] A triangle-shaped bone that protects and stabilizes the knee joint.

Tarsals

Metatarsals

Phalanges

2.4.5 Joints form connections between bones

Structure and tissues that hold the skeleton together while still permitting us to move about freely: *joints*, *ligaments*, and *tendons*.

Joints are points of contact between bones. Fibrous joints are immovable in adults, cartilaginous joints permit some movement, and synovial joints are highly movable. Synovial joints are held together by ligaments and lubricated by synovial fluid.

Joints {articulations} The points of contact between bones.

Vary considerably from basically immovable to freely movable. Types of joints include *fibrous*, *cartilaginous*, and *synovial* joints.

Fibrous joints Immovable.

Fontanels At birth, the flat bones in a baby's skull are separated by relatively large spaces filled with fibrous connective tissue. These "soft spots" are *fontanels*.

The presence of joints also allows for brain growth and development after birth. During childhood these fibrous joints gradually harden. They are tiny, thin sutures by the time we are old.

Cartilaginous joints Bones are connected by *hyaline cartilage*, they are slightly movable and give some flexibility.

Examples include the cartilaginous joints that connect the *vertebrae* in the backbone, and those that attach the lower *ribs* to the *sternum*.

Synovial joints The most freely moving joints are these. Bones are separated by a thin fluid-filled cavity. The two bones are of a synovial joint are fastened together and stabilized by *ligaments*.

The interior is lined with a *synovial membrane* which secretes *synovial fluid* to lubricate and cushion the joint. The *articulating* surfaces of the two bones are covered with a tough but smooth layer of *hyaline cartilage*. Together the synovial membrane and the surrounding hyaline cartilage constitute the *joint capsule*.

To reduce friction there are small disks of *cartilage* on either side of the knee called *menisci*. The knee joint [hinge joint] also includes 13 small sacs of fluid, called *bursae*, for additional cushioning.

Synovial fluid

Synovial membrane

Joint capsule

Hinge joint Like the knee or elbow, gets its name because it allows movement in one plane like the hinges on a door.

Ball and socket joint Permits an even wider range of movement that the *hinge joint*. Thanks to its design, a synovial joint can withstand tremendous friction without wearing out. It gets its strength from *ligaments*, *tendons*, and *muscles*.

Ligaments and tendons Connective tissues that stabilize many joints.

Ligaments and tendons contain collagen arranged in parallel fibers, making ligaments and tendons as strong and as flexible as a twisted nylon rope. You can test how good these things are by loosening up your legs and moving your *patella* around. When you put tension in the ligaments and tendons again though it doesn't move.

2.4.6 Diseases and disorders of the skeletal system

2.5 Ch. 6

2.5.1 Muscles produce movement or generate tension

40% of body weight in males in muscle, 32% in females.

Skeletal muscles Most interact with the skeleton and cause bones to move (or to prevent them from moving) relative to each other.

- Shivering, threading a needle, lifting heaving weights, standing completely still, etc. are all tasks accomplish be skeletal muscles.
- We have more that 600 skeletal muscles, often organized into pairs or groups. Hundreds of muscles, each controlled by nerves and acting either individually or in groups, produce all possible human motions. Muscle groups that work together to create the same movement are called *synergistic muscles*. Muscles that oppose each other are called *antagonistic muscles*.

Smooth muscle [involuntary] Contracts/relaxes without your conscious though.

Cardiac muscle [involuntary muscle] Makes up the heart.

Skeletal muscle [voluntary] Muscle tissue that is typically attached to the skeletal muscle for movement.

Tendons Connects muscles to bones.

Ligaments Connects bones to bones.

Synergistic muscles Muscles that work together to create the same movement.

Antagonistic muscles Muscles that oppose each other.

Origin End of muscle that attaches to relatively stationary bone.

Insertion End of muscle attached to another bone across a joint; the "movable" end of the muscle.

1. Muscles Muscles either produce or resist movement. Their fundamental activity is *contraction*. A muscle is composed of many muscle cells arranged in parallel, each containing numerous *myofibrils*. The contractile unit in a myofibril is called a *sarcomere*. A sarcomere contains think filaments of a *protein* called *myosin* and thin filaments of a protein called *actin*.

   (a) Internal

   Myofibrils The nuclei of singular muscle cells need to be located just under the cell membrane because nearly the entire interior of the cell is packed with these long cylindrical structures arranged in parallel, called *myofibrils*.
   Myofibrils are packed with contractile *proteins* called *actin* and *myosin*.

   Sarcomere A segment of a *myofibril* from one Z-line to the next is called a *sarcomere*. A *sarcomere* consists of two kinds of *protein filaments*. Thick filaments composed of a protein called *myosin* are interspersed at regular intervals within filaments of a different protein called *actin*.

   Actin

   Myosin

   (b) Specific muscles

   Buccinator Thin quadrilateral muscle, occupying the interval between the maxilla and the mandible at the side of the face.

   Orbicularis oris A complex of muscles in the lips that encircles the mouth.

   Zygomaticus major

   Frontalis

   Orbicularis oculi

   Masseter

   Sternocleidomastoid

   Pectoralis major Draws arm forward and toward the body

   Deltoid Raises arm

   Latissimus dorsi Rotates and draws arm backward and toward body

   Trapezius Lifts shoulder blade, braces shoulder, draws head back.

   Serratus anterior Helps raise arm, contributes to pushes, draws shoulder blade forward

   External intercostals

   Rectus abdominis Compress abdomen, bends backbone, compresses chest cavity

   External oblique Lateral rotation of trunk, compresses abdomen.

Transversus abdominis

Biceps brachii Straightens forearm at elbow

Triceps brachii Lifts shoulder blade, braces shoulder, draws head back. Rotates and draws arm backward and toward body.

Gluteus maximus Butt muscles; extends thigh, rotates thigh laterally.

Hamstrintgs helps your knee bend; draws thigh backward, bends knee

Biceps femoris [not important]

Semimembranosus [not important]

Semitendinosus [not important]

Adductor Longus Flexes thigh, rotates thigh laterally, draws thigh toward body. Inner thigh muscle.

Gastrocnemius Bends lower leg at knee, bends foot away from knee. Calf muscles

Quadriceps femorus Flexes thigh at hips, extends leg at knee. Front of upper leg area.

Rectus femoris

Vastus lateralis

Vastus medialis

Vastus intermedius

Sartorius Rotates thigh outward.

Tibialis anterior Front of lower leg. Shin splints area

Achilles tendon Connects gastrocnemius muscle to heel.

(c) Always contract, never push

- The can only Pull, never PUSH
- Muscles contract in response to electrical or chemical stimuli.

2. another word to eat

mastication another word for eating.

A lab T.A. said this would be on the test!

3. Movements

Flexion Decreases angle of the joint between two structures.

Extension Increases angle of the joint between two structures.

Abduction Moves bone away from the midline of the body.

Adduction Moves bone toward the midline of body ("add" to the body's midline).

Rotation Bone spins around its own axis.

Circumduction Bone describes a cone in three-dimensional space.

Supination Rotation of the forearm so palm faces anteriourly (imagine holding a bowl of soup).

Pronation Rotation of the forearm so palm faces posteriorly.

2.5.2 Individual muscle cells contract and relax

During a muscle contraction each sarcomere shortens just a little. Subtle though this action seems, it is also powerful. The contraction of an entire skeletal muscle depends on the simultaneous shortening of the tiny sarcomeres in its cells.

- A skeletal muscle cell must be activated by a nerve. It does not contract on its own.
- Nerve activation increases the concentration of calcium (Ca) in the vicinity of the contractile proteins.
- The presence of calcium permits contraction. The absence of calcium prevents contraction.
- When a muscle cell is no longer stimulated by a nerve, contraction ends.

1. Nerves activate skeletal muscles

   Motor neurons Skeletal muscle cells are stimulated to contract by these nerve cells.

   The motor neuron secretes *acetylcholine* (ACh) a *neurotransmitter*. The nerve cell has only either an excitatory or inhibitory effect.

   Neuromuscular junction The junction between a motor neuron and a skeletal muscle cell.

   Acetylcholine is released when there are electrical impulses traveling in a motor neuron. Acetylcholine binds to receptor sites on the muscle cell membrane, causing muscle cell membrane to generate an electrical impulse traveling in all directions. *T tubules* or *transverse tubules* transmit these random electrical impulses to all parts of the cell as quickly as possible.

2. Activation releases calcium

   Sarcoplasmic reticulum A series of membrane-bound chambers in close contact to transverse tubules. It is forced to fit into the small amount of space in the cell not occupied by myofibrils. The primary function of the sarcoplasmic reticulum is to store ionic calcium (Ca^{2+})

   Latin *sarco-* flesh or muscle

3. Calcium initiates the sliding filament mechanism Contraction is inhibited unless calcium is present. Closely associated to the *actin* and *myosin* are two other *protein* molecules called *troponin* and *tropomyosin*, together *troponin-tropomyosin protein complex*.

   Sliding filament mechanism Muscles contract when sarcomeres shorten, and sarcomeres shorten when the thick and thin filaments slide past each other.

2.6 Ch. 9

The Immune System and Mechanisms of Defense

Pathogen Living organisms (bacteria) which cause disease.

Note that not *all* bacteria are pathogens. Indeed, some are highly beneficial.

2.6.1 Self vs. non-self

B cell Each B cell produces unique B cell receptors which react only to specific antigens. (Also applicable to T cells.) Created in bone marrow with a random.

2.6.2 Pathogens cause disease

2.6.3 The lymphatic system defends the body

2.6.4 Keeping pathogens out: The first line of defense

Various mechanisms create an inhospitable environment for pathogenic microorganisms. Skin is a dry outer barrier. Tears, saliva, earwax, and mucus trap pathogens or wash them away. Acidic conditions kill them or inhibit their growth; urination, defecation, and vomiting forcibly expel them; and resident bacteria compete with pathogens for food.

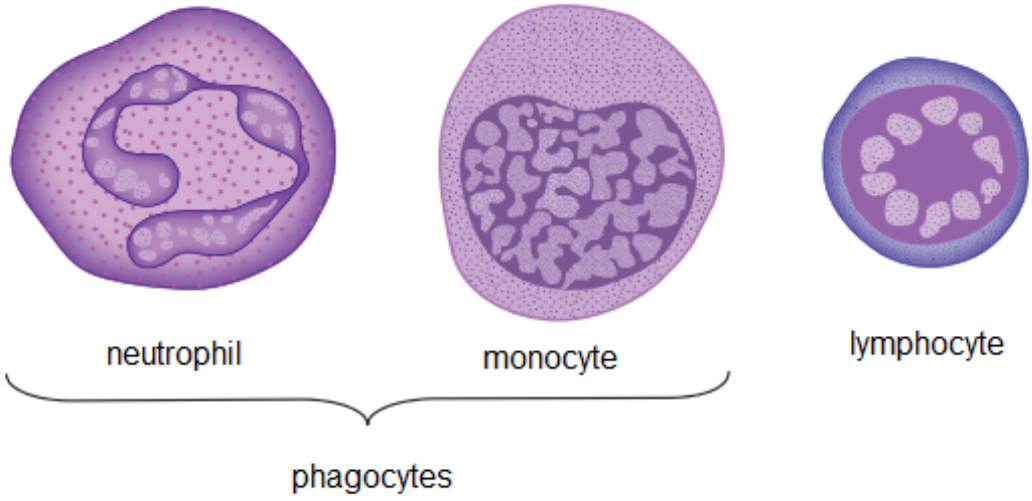
Most successful *pathogens* enter the body at places where we do not have *skin*. Enter through the mucous membranes that line the *digestive*, *urinary*, *respiratory*, and *reproductive* tracts; taking advantage of moist surfaces in direct contact with living cells.

- Skin
    1. **structure** has *keratin* which is good
    2. **constant replacement** sheds away pathogens on skin
    3. **acidic pH** Low pH makes skin a hostile environment for many microorganisms.
    4. production of **antibiotic** by sweat glands
- **tears**, **saliva**, and **earwax** contain *lysozyme*. Saliva lubricates, and prevents cracking.
- **Mucus** Thick, gel-like material secreted by cells at various surfaces of the body. Microorganisms coming in contact with mucus becomes mired and cannot gain access to the cells beneath.
- **Digestive** and **vaginal acids**. Undiluted, acids are strong enough to kill nearly all pathogens.
- **Vomiting**, **urination**, and **defecation**
- **Resident bacteria** Help control the population of deadly pathogens by competing with them successfully for food.

Keratin Forms a dry, tough, somewhat elastic barrier to the entry of microorganisms.

Lysozyme An enzyme that kills many bacteria.

2.6.5 Nonspecific defenses: The second line of defense



Nonspecific defense mechanisms involve a general attack against all foreign and damaged cells. *Neutrophils* and *macrophages* engulf and digest bacteria and damaged cells, and *eosinophils* bombard larger organisms (too large to be engulfed) with digestive enzymes. The inflammatory response attracts *phagocytes* and promotes tissue healing. *Interferons* interfere with viral reproduction, and a modest *fever* enhances our ability to fight infections.

If *pathogens* manage to breach our physical and chemical barriers and start to kill or damage cells, there is a problem. The body must actively seek out the *pathogens* and get rid of them, then clean up the injured area and repair the damage. *Phagocytes* are *white blood cells* that destroy foreign cells through the process of *phagocytosis*. A *phagocyte* first captures a bacterium with its cytoplasmic extensions, then draws the bacterium in, eventually engulfing it (*endocytosis*) and enclosing it in a membrane-bound vesicle. Powerful enzyme in the *lysosomes* dissolve the bacterial membranes and then the WBC jettisons the bacterial wastes (*exocytosis*).

Monocyte (WBC) Largest type of leukocyte; can differentiate into macrophages.

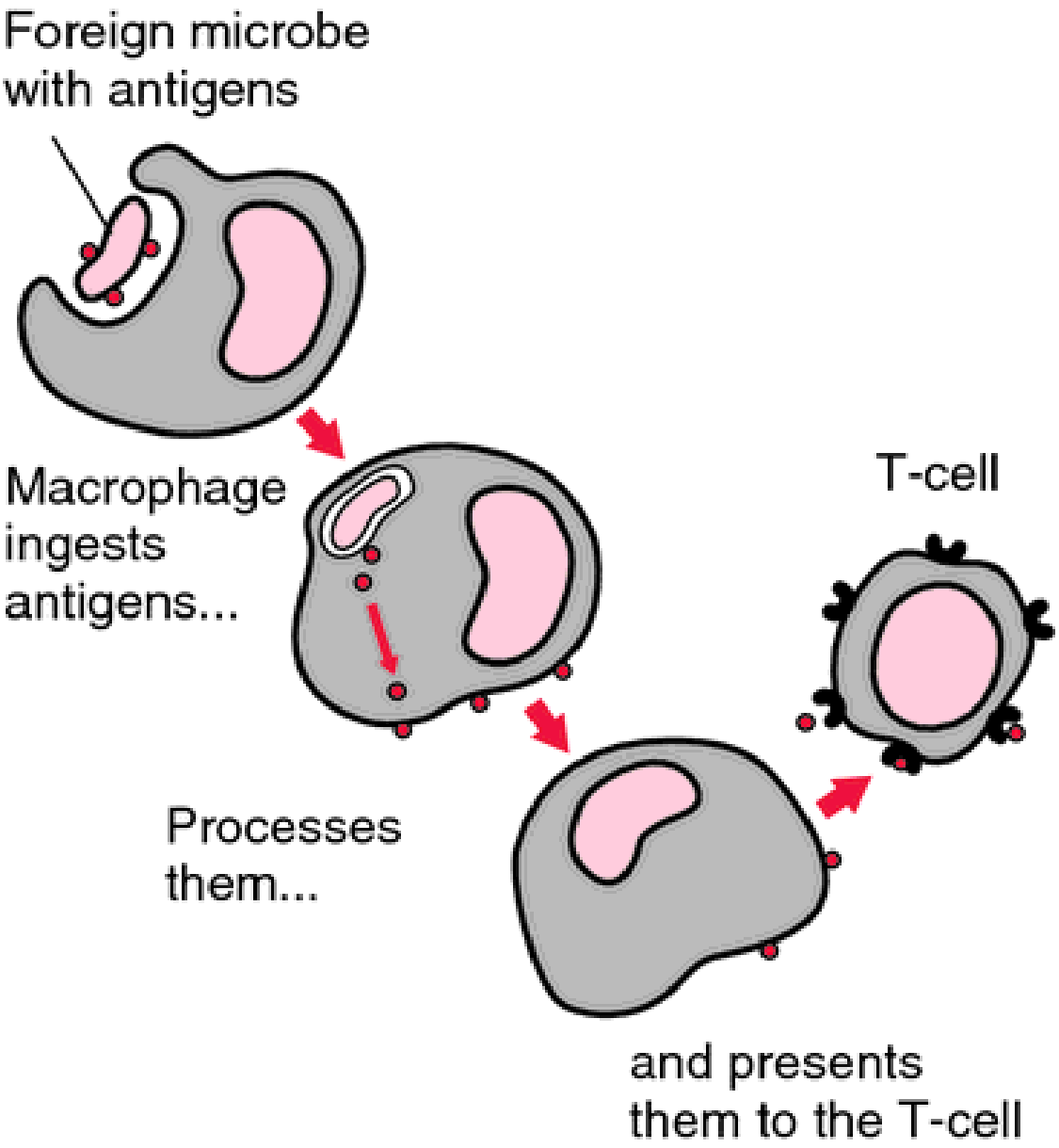
Phagocyte Cells which protect the body by ingesting (phagocytosing) harmful foreign particles.

Phagocytosis Process in which white blood cells destroy foreign cells in the body by engulfing it inside a membrane and digesting it with enzymes.

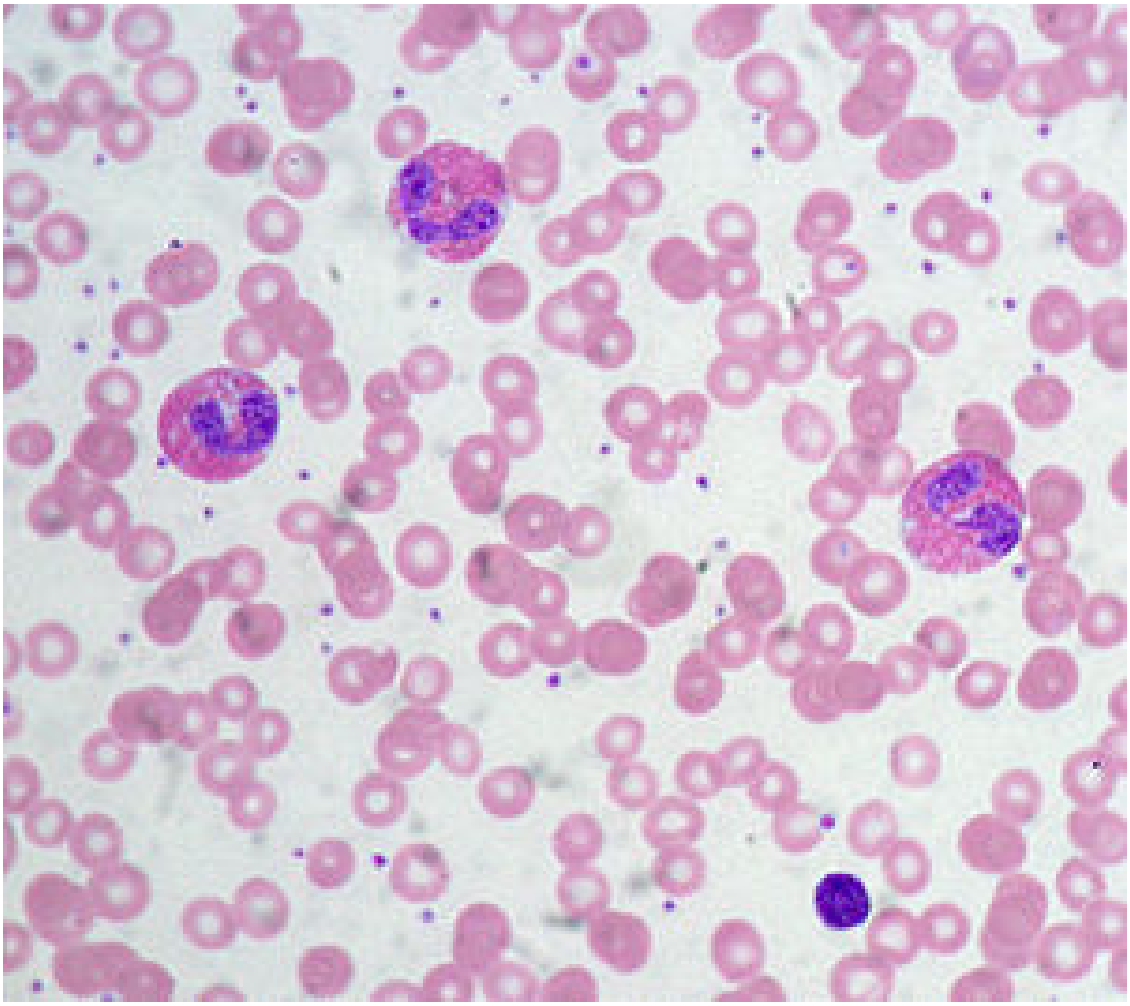
Lyososome Membrane-bound organelle found in animal cells. Spherical vesicles containing enzymes which break down virtually all kinds of biomolecules.

Neutrophils First white blood cells to respond to infection. Most abundant type of white blood cell.

Macrophages White blood cells leaving the vascular system and entering into tissue fluids. They then engulf and digest large numbers of foreign cells, especially viruses and bacterial parasites. Technically no longer blood cells, as they're no longer in the blood.



Eosinophils WBC which take on invaders too big for *phagocytosis*. They cluster around large parasites such as flukes and pinworms and bombard them with digestive enzymes. Also digest certain foreign *protein*.



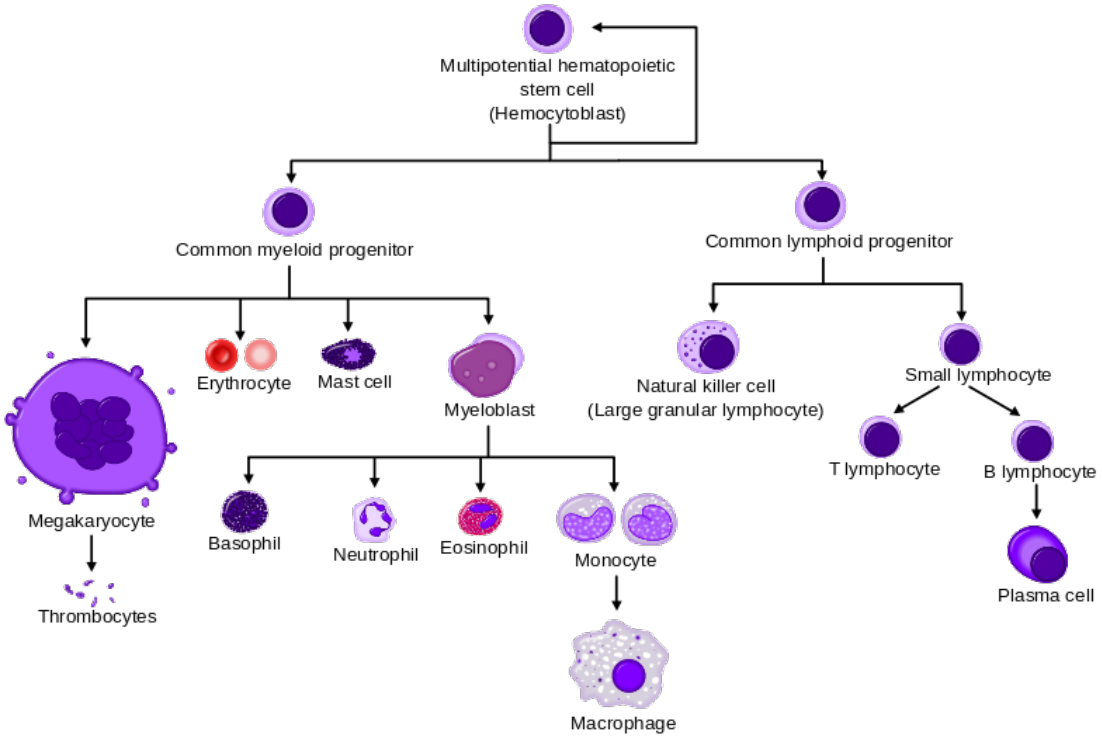
Inflammation Four outward signs: redness, warmth, swelling, and pain. Starts when tissue is injured. Triggers vasodilation which increases capillary permeability for phagocytes to squeeze through.

Interferons Cells infected by viruses which secrete a group of proteins called *interferons* which diffuse to nearby healthy cells, bind to their cell membranes, and stimulate the healthy cells to produce proteins that interfere with the synthesis of *viral proteins*, making it harder for the viruses to infect the protected cells.

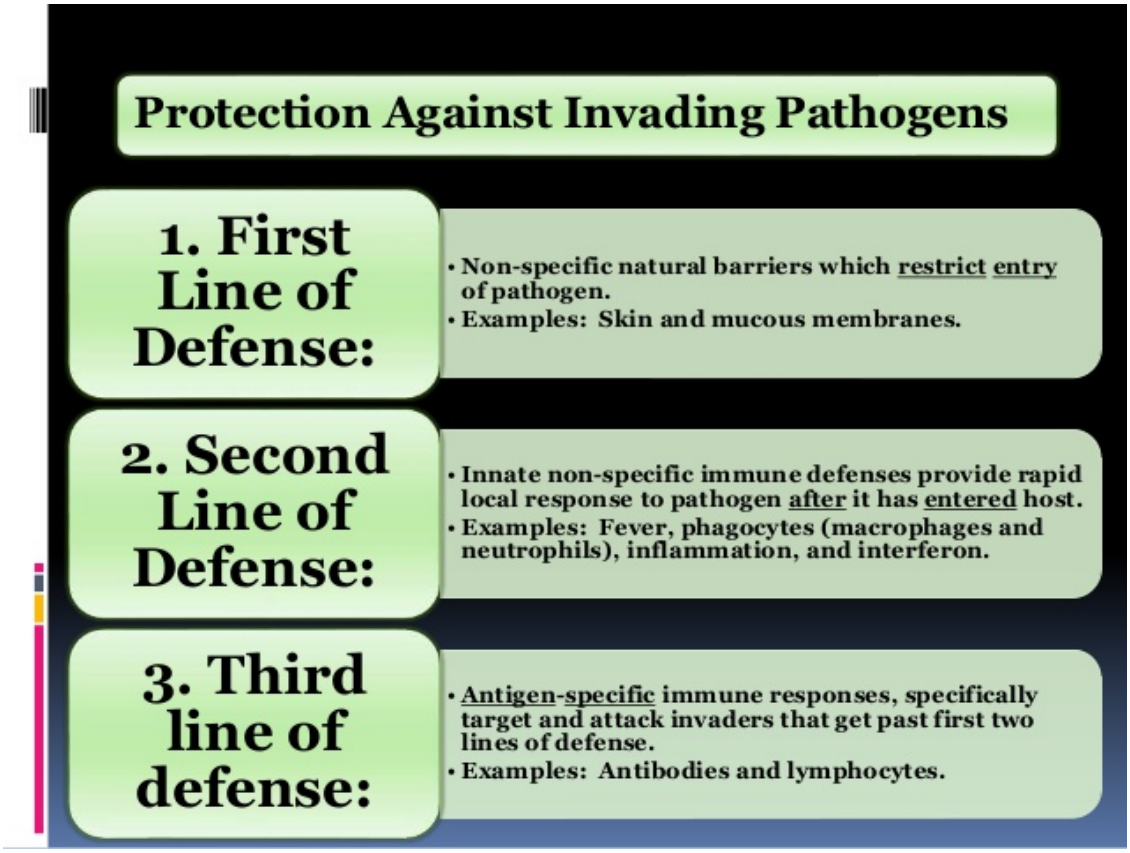
Complement system (?) Comprises at least 20 plasma proteins that circulate in the blood and complement, or assist, other defense mechanisms.

Fevers

2.6.6 Specific defense mechanisms: The third line of defense



An *antigen* is any substance that provokes an *immune response*. When activated by first exposure to a specific *antigen*, *lymphocytes* called *B cells* quickly produce *antibodies* against the *antigen*. They also produce a few long-lived *memory cells* that remain inactive until the next exposure to the same *antigen*. Other *lymphocytes* called *T cells* mature in the *thymus gland*. Helper *T cells* stimulate other immune cells, cytotoxic *T cells* attack abnormal and foreign cells, and memory *T cells* store information until the next exposure to the same *antigen*.



First exposure to a specific antigen generates a *primary immune response*. *Subsequent exposure* to the same antigen elicits a *secondary immune response* that is faster, longer lasting, and more effective than the primary immune response.

At first exposure to a particular antigen, the immune system generates a *primary immune response*. This involves recognition of the antigen, and production and proliferation of *B* and *T cells*.

Antigen A substance or part of a substance (living or non-living) that the *immune system* recognizes as foreign. It activates the *immune system* and reacts with immune cells or their products, such as *antibodies*.

They are like keys for the lock, or antigen-binding site.

Antibody A *protein molecule* released by a *B cell* or plasma cell that binds to a specific *antigen*.

Natural killer (NK) cells WBC (*lymphocytes*) which target destroy tumor cells and cells infected by viruses. NK cells are able to recognize certain changes that take place in the plasma membranes of tumor cells and virus-infected cells. "Natural killer" is more like "non-specific killer." Not phagocytes, instead they release chemicals that break down their targets' cell membranes.

Immunity B and T cells create a population of memory cells. This is the *secondary immune response* that is faster, longer lasting, and more effective than the first.

2.6.7 Immune memory creates immunity

2.6.8 Medical assistance in the war against pathogens

Active immunization Induction of immunity after exposure to a an *antigen*. Can occur naturally or can be artificial.

Vaccine Biological preparation that provides active acquired immunity to particular disease. An *artificial active immunization*.

2.6.9 Tissue Rejection: A medical challenge

2.6.10 Inappropriate immune system activity causes problems

2.6.11 Immune deficiency: The special case of AIDS

2.7 Ch. 10

The Respiratory System: Exchange of Gases

2.8 Ch. 13

The Endocrine System

The *endocrine system* triggers sexual maturation, sexual desire, uterine contractions during childhood, and milk letdown. It is involved in response to stress, digestion, cellular metabolism, and overall organ growth and development. Also is wholly or partly responsible for the maintenance of homeostasis of many of the most important variables in the body, including salt and water balance, blood pressure, the production of red blood cells, and blood calcium concentration.

2.8.1 The endocrine system produces hormones

Hormones are bloodborne units of information, just as *nerve impulses* are units of information carried in *nerves*. The hormones help to maintain *homeostasis* by regulating various body functions through *feedback loops*. *Hormones* secreted by glands of the *endocrine system* act only on *target cells* with appropriate receptors. *Hormones* reach their targets via the *circulatory system*, making *endocrine system* control slower than *nervous system* control. The two systems frequently interact.

Endocrine has certain characteristics setting it apart from the nervous system as a communications system

1. *Hormones* of the *endocrine system* reach nearly every living cell. A distinct advantage over the nervous system. Hormones conveniently circulate in the *blood* which is everywhere (except CNS).

2. Each *hormone* acts only on certain cells. Each hormone acts only on a certain group of cells, called its *target cells*.

3. Endocrine control tends to be slower than nervous system. A consequence of using the cardiovascular system as the message delivery system. Endocrine is better with longer-term controls, such as regulation of blood pressure, production of red blood cells, and onset of puberty.

4. The *endocrine* and *nervous systems* can (and often do) interact with each other. The timing of growth and sexual maturation, for example, involves a complex sequence of changes in both neural and endocrine signals, and the release of some hormones depends on input from *sensory neurons*.

Hormones Circulating chemical messenger molecules secreted by the *endocrine system*'s collection of *specialized cells*, *tissues*, and *glands*.

Endocrine glands Where the *hormones* are secreted. Ductless organs that secrete their products into interstitial fluid, lymph, and blood.

- *endocrine* means "secreted internally"

Target Cells The specific cell in the body with the appropriate receptor for the targeting hormone. As an analogy consider a car needing a specific set of car keys; when the key is put into the ignition it causes the car to start up.

2.8.2 Hormones are classified as steroid or non-steroid

Hormones participate in *negative feedback loops*. As messenger molecules, some *hormones* participate in internal *homeostatic* control mechanisms and control vital physiological processes (they maintain *homeostasis*). *Steroid hormones* enter the *target cell*, activate specific genes, and cause the production of new *proteins*. *Non-steroid hormones* bind to a *cell membrane receptor* that either opens or closes ion channels or activates a *second messenger* within the cell.

note: Most of the *hormones* discussed in this chapter are non-steroid. The only *steroid hormones* are those produced by the cortex of the *adrenal gland* (cortisol and aldosterone) and the sex hormones produced by the *testes* (testosterone) and *ovaries* (estrogen and progesterone).

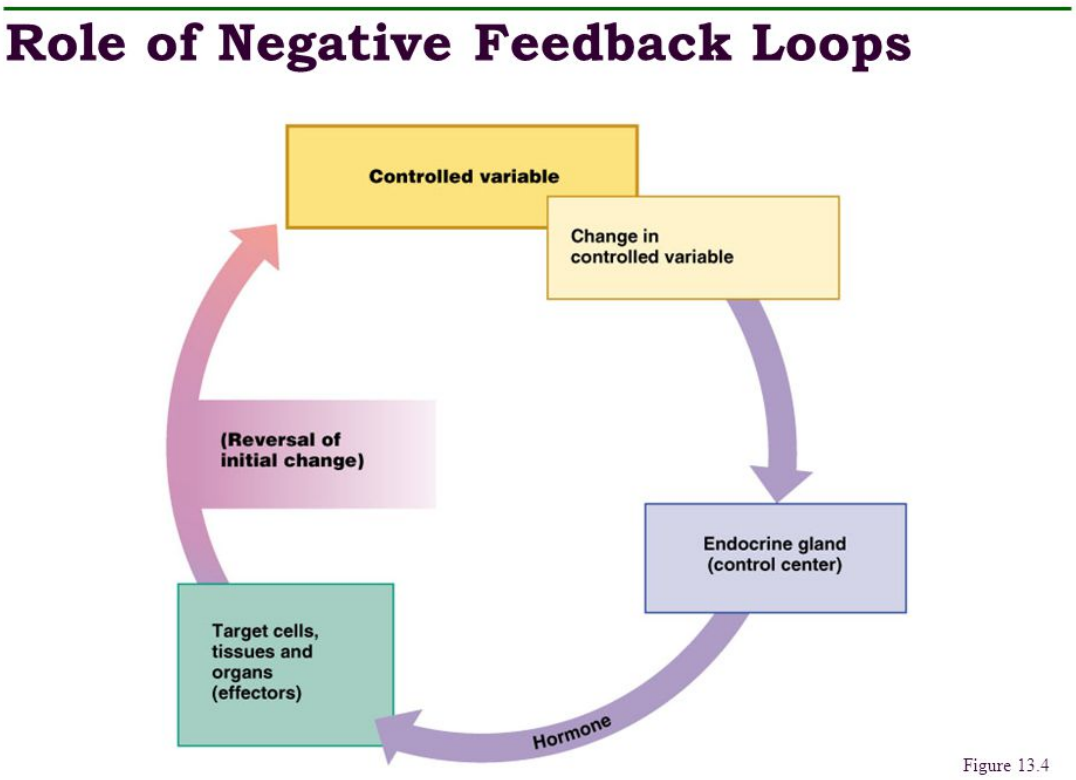


Figure 13.4

A negative feedback loop involving a hormone. In response to a change in the controlled variable, the endocrine gland releases a hormone that acts on target cells to return the controlled variable to its normal state. Any change in the controlled variable sets in motion a response that reverses that change.

Steroid hormones Structurally related to *cholesterol* (a *lipid*), and therefore they are lipid-soluble. Diffuses into the *target cells*. Hormone-receptor complex attaches to *DNA*, activating specific genes, then causing the formation of *messenger RNA*.

Nonsteroid hormones Structurally related to *proteins*; therefore, *lipid* insoluble and cannot cross the *cell membrane*. Bind to receptors on outer surface of *target cell membranes*. Some cause ion channels in the *cell membrane* to open or close, similar to the action of a *neurotransmitter*.

Second messenger Commonly, hormone-receptor binding converts an inactive molecule within the cell into an active molecule. The activated molecule generated with the cell is this *second messenger*.

A common second messenger is cyclic AMP, produced from ATP. Which then activates an enzyme already present within the cell, which activates another, which in turn activates another, and so on.

ATP → Cyclic AMP (*second messenger*) → Enzyme 1 activated → Enzyme 2 activated → Enzyme 3 activated → Final product alters cell activity

2.8.3 The hypothalamus and the pituitary gland

- 13.3 goes into a lot of hormones we do not need to know at this time like Pituitary Hormones

- focus on FSH and LH in conjunction with testosterone and negative feedback

Each anterior *pituitary hormone* is produced and secrete by a separate cell type, and each hormone is regulated by a separate mechanism. *FSH* and *LH* stimulate the reproductive organs. They are called *gonadotropins* because they stimulate the growth, development, and function of the reproductive organs in both males and females. In females, *FSH* induces egg development, *LH* promotes ovulation (egg release), and both hormones stimulate the secretion of the ovarian hormone *estrogen*. In addition, *LH* stimulates the secretion of the ovarian hormone *progesterone* after ovulation. In males, *FSH* induces sperm development and *LH* stimulates the production of the hormone *testosterone* by the testes.

FSH {pituitary gland} → SPERM/EGGS
LH {pituitary gland} → TESTOSTERONE/(OVULATION/PROGESTERONE)

Hypothalamus Small region of the brain that serves as a homeostatic control center.

Pituitary gland (master gland) {hypophysis} *Endocrine gland* the size of a pea and weighing 0.5 grams; protrusion off the bottom of the *hypothalamus* at the base of the *brain*. *Hormones* secreted from the pituitary gland help control: growth, blood pressure, certain functions of the sex organs, thyroid glands, and metabolism, as well as some aspects of pregnancy, childbirth, nursing, water/salt concentration at the kidneys, temperature regulation and pain relief.

Follicle-stimulating hormone (FSH) {gonadotropin, glycoprotein polypeptide} Synthesized and secreted by the anterior *pituitary gland*. Regulates the development, growth, pubertal maturation, and reproductive processes of the body.

Luteinizing hormone (LH) {lutropin/lutrophin} Synthesized and secreted by the anterior *pituitary gland*. In females triggers ovulation. In males (where LH had also been called interstitial cell-stimulating hormone) it stimulates Leydig cell production of *testosterone*.

2.8.4 The pancreas secretes glucagon, insulin, and somatostatin

[focus on insulin]

Endocrine cells of the *pancreas* are located in small clusters scattered throughout the pancreas called the *islets of Langerhans*. Insulin lowers glucose levels by facilitating *glucose* uptake and storage.

1. Alpha cells secrete *glucagon*.
2. Beta cells secrete *insulin*, which lowers blood sugar. After a meal, *blood glucose* levels rise as *sugars* are absorbed from the digestive tract. The high glucose concentration stimulates the *beta cells* to secrete *insulin* into the blood, where it does the opposite of glucagon. *Insulin* promotes the uptake of *glucose* by cells of the *liver*, *muscle*, and *fat tissue*. It also promotes the conversion of *glucose* into *glycogen* in the liver, both *glycogen* and *proteins* in muscle, and fats in *adipose tissue*.
3. Delta cells secrete somatostatin.

Pancreas Both an *endocrine gland* (secreting hormone into the blood) and an *exocrine gland* (secreting *enzymes*, *fluids*, and *ions* into the *digestive tract* to aid in digestion).

2.8.5 The adrenal glands comprise the cortex and medulla

[skip]

2.8.6 Thyroid and parathyroid glands

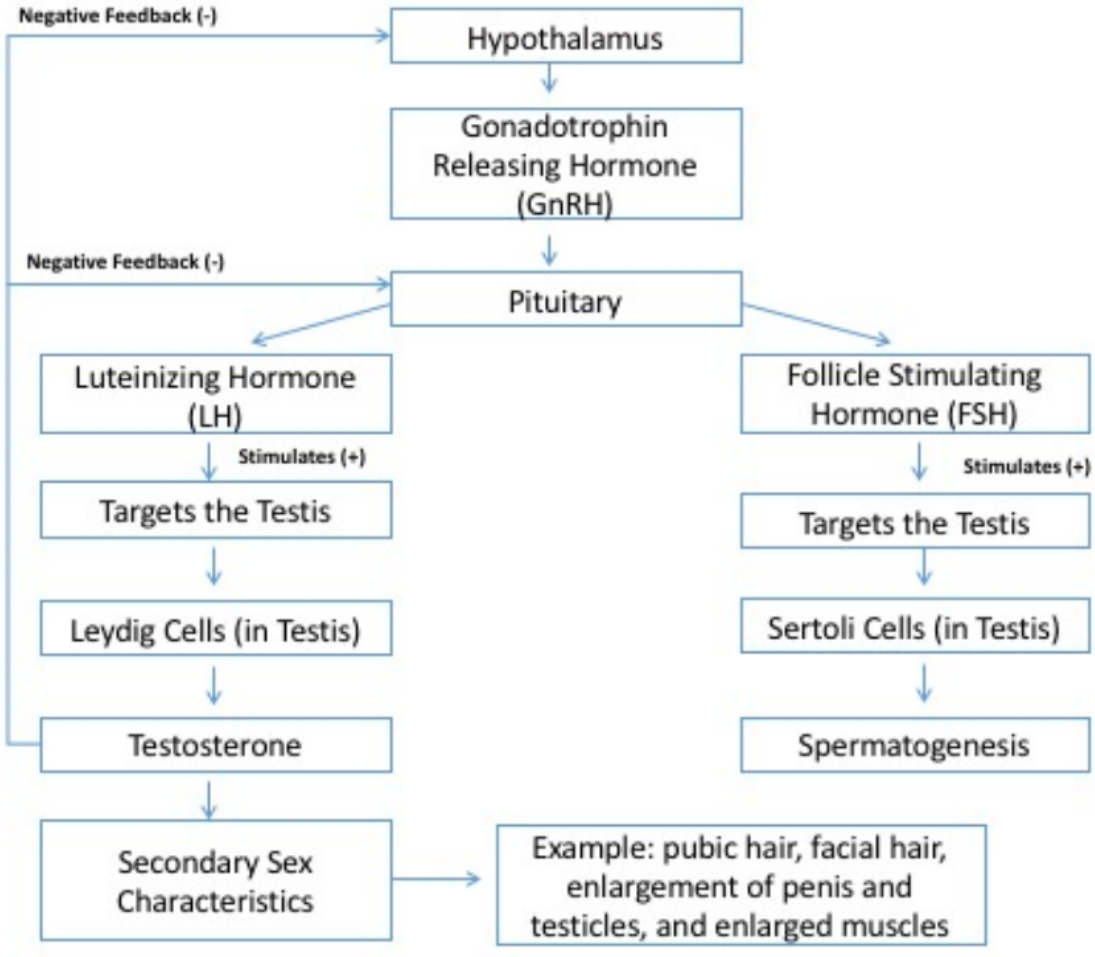
[skip]

2.8.7 Testes and ovaries produce sex hormones

- focus on testes and ovaries

The human *gonads* are the *testes* of males and *ovaries* of females. Responsible for the production of *sperm* and *eggs*; both organs are also *endocrine glands* in that they produce the steroid *sex hormones*.

During puberty: In males, the *anterior pituitary gland* begins to release *luteinizing hormone* (LH) which stimulates the testes to resume *testosterone* production. In females, the *anterior pituitary* starts to release *luteinizing hormone* (LH) and *follicle-stimulating hormone* (FSH). These hormones stimulate the ovaries to begin secreting *estrogen* and *progesterone*.



Testes Located in the *scrotum*, produce *androgens*, the male *sex hormones*.

Ovaries Located in the abdomen, produces the female sex hormones know collectively as *estrogens* (*17b-estradiol*, *estrone*, and *estriol*), and also *progesterone*.

2.8.8 Other glands and organs also secrete hormones

[skip]

2.8.9 Other chemical messengers

[skip]

2.8.10 Disorders of the endocrine system

[skip]

2.9 Reproductive

- Epididymis
- Vas deferens

Seminal Vesicles Secrete fructose to provide energy source.

Prostate Secretes alkaline fluid to neutralize vaginal acid for sperm passage.

Bulbourethral Secrete mucus into urethra to wash away acidic urine and provide lubrication.

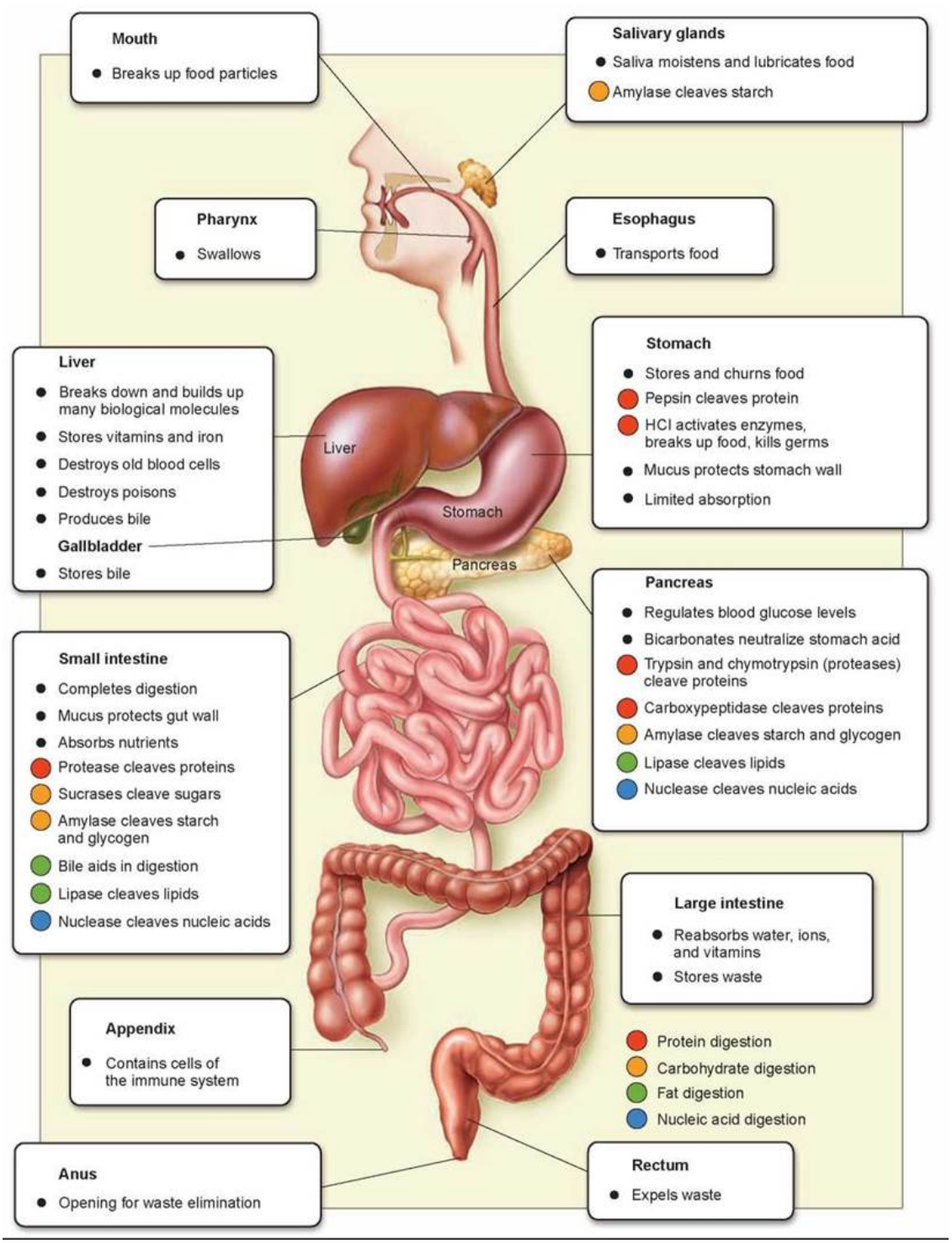
Penis Houses the urethra, the common route for both urine and sperm; male sex organs.

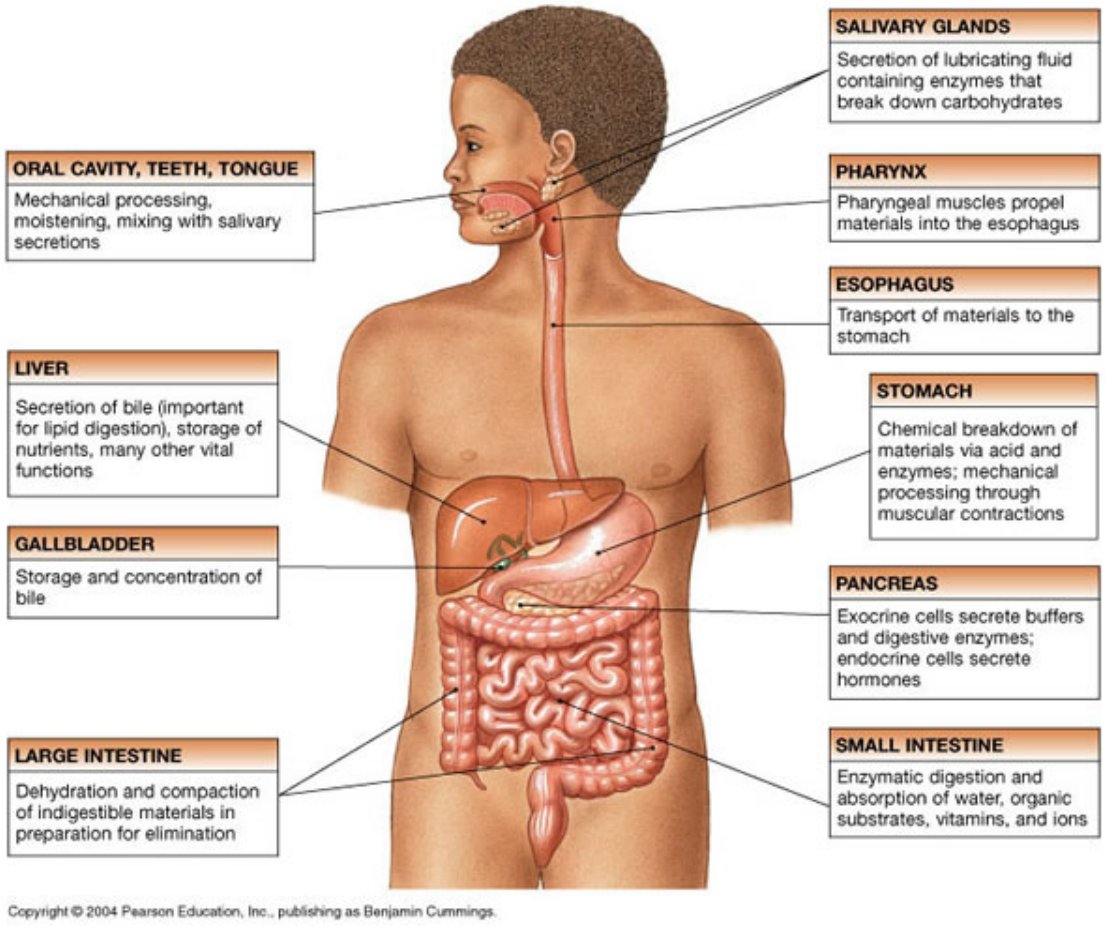
2.10 Ch. 14

- 14.1–14.7; particularly 14.1 and table 14.1
- Read 14.8
- How are macromolecules broken down, absorbed, and used?

The digestive system and its accessory organs digest and absorb nearly everything we eat and drink, regardless of how much we eat or drink. The stomach stores ingested food and water until it can be delivered to the *small intestine*; also secreting a strong acid *hydrochloric acid* (*HCL*) that breaks down proteins and most bacteria. Leftover non-absorbed waste products and bacteria are stored until they are eliminated as feces. Nutrients and water are absorbed in the small intestine (and lesserly to the large intestine). *Enzymes* from the *pancreas* and the *small intestine* break down *carbohydrates* and *fats* to be absorbed. To maintain a constant body weight, energy intake must equal energy expenditure.

In many ways the *digestive system* is a highly efficient disassembly line, taking in food and processing it, breaking it into small pieces and digesting the fragments with *enzymes* and *strong chemicals*.


Mouth
Breaks up food particles
Salivary glands
Saliva moistens and lubricates food
Amylase cleaves starch
Pharynx
Swallows
Esophagus
Transports food
Liver
Breaks down and builds up many biological molecules
Stores vitamins and iron
Destroys old blood cells
Destroys poisons
Produces bile
Gallbladder
Stores bile
Liver
Stomach
Pancreas
Stomach
Stores and churns food
Pepsin cleaves protein
HCl activates enzymes, breaks up food, kills germs
Mucus protects stomach wall
Limited absorption
Pancreas
Regulates blood glucose levels
Bicarbonates neutralize stomach acid
Trypsin and chymotrypsin (proteases) cleave proteins
Carboxypeptidase cleaves proteins
Amylase cleaves starch and glycogen
Lipase cleaves lipids
Nuclease cleaves nucleic acids
Small intestine
Completes digestion
Mucus protects gut wall
Absorbs nutrients
Protease cleaves proteins
Sucrases cleave sugars
Amylase cleaves starch and glycogen
Bile aids in digestion
Lipase cleaves lipids
Nuclease cleaves nucleic acids
Large intestine
Reabsorbs water, ions, and vitamins
Stores waste
Appendix
Contains cells of the immune system
Protein digestion
Carbohydrate digestion
Fat digestion
Nucleic acid digestion
Anus
Opening for waste elimination
Rectum
Expels waste



nutrients Substances in food that are required for growth, reproduction, and the maintenance of health.

Salivary amylase Breaks down carbohydrates (generally polysaccharides which are a monosaccharide and dissacharide units linked by glycosidic bonds.)

2.10.1 The digestive system brings nutrients into the body

The digestive system consist of organs and accessory organs that share the function of bringing nutrients into the body. The wall of the GI tract consists of four tissue layers: the *mucosa*, the *submucosa*, the *muscularis*, and the *serosa*. The five basic processes of digestion are:

1. mechanical processing and movement (mechanical digestion)
2. secretion
3. digestion (chemical digestion)
4. absorption
5. elimination

Accessory Organs

- Don't directly contact food
- Liver, Gallbladder, Pancreas, Salivary Glands

From the *esophagus* to the *anus*, the walls of the *GI tract* share common structural features consisting of four different layers. Some of the organs of the GI tract are separated from each other by thick rings of circular smooth muscle called *sphincters*, which close off passageways between *organs*.

The digestive system All the organs that share the common function of getting nutrients into the body. Including a series of hollow organs extending from the *mouth* to the *anus*: the *mouth*, *pharynx*, *esophagus*, *stomach*, *small intestine*, *large intestine*, *rectum*, and *anus*.

Gastrointestinal tract (*GI tract*) The organs of the *digestive system* creating a hollow tube through the body. The area through which food and liquids travel—the space within the tube—is called the *lumen*.

Mucosa (mucosal layer) Innermost tissue layer

Submucosa Next to the *mucosa* is a layer of connective tissue containing *blood vessels*, *lymph vessels*, and *nerves*, called the *submucosa*.

Muscularis Third layer of GI tract tissue responsible for motility or movement. Two r three sub-layers of *smooth muscle*.

Serosa Outermost layer of the GI tract wall is a thin connective tissue sheath that surrounds and protects the other three layers.

Five basic processes which accomplish digestive system function:

1. *Mechanical processing and movement.* Chewing breaks food into smaller pieces, and two types of movement (motility) mix the contents of the *lumen* and propel it forward.
2. *Secretion.* Fluid, digestive *enzymes*, acid, alkali, bile, and mucus are all secreted into the GI tract at various places. In addition, several hormones that regulate digestion are secreted into the bloodstream.
3. *Digestion.* The contents of the *lumen* are broken down both mechanically and chemically into smaller and smaller particles, culminating in *nutrient molecules*.
4. *Absorption. Nutrient molecules* pass across the *mucosal layer* of the *GI tract* and into the *blood* or *lymph*.
5. *Elimination.* Undigested material is eliminated from the body via the *anus*.

The smooth muscle of the GI tract produces two kinds of motility, called *peristalsis* and *segmentation*. *Peristaltic waves* of contraction ripple through the organs of the *GI tract*, mixing the contents of the *stomach* and pushing the contents of the *esophagus* and *intestines* forward. Peristalsis is mostly prevalent in the esophagus, where it transports food rapidly to the stomach.

Peristalsis Propels food forward. The lump of food (*bolus*) is pushed down the *esophagus* because of *smooth muscle* contracting before the *bolus* and relaxing after the *bolus* around the portion of *GI tract* near the *bolus*.

Segmentation Mixes food. Short sections of *smooth muscle* contract and relax in seemingly random fashion. The result is a back-and-forth mixing of the contents of the *lumen*.

1. Other

   Small intestine Digests *proteins*, *fats*, and *carbohydrates*. Absorbs most of the *water* and *nutrients*. Secretes digestive *hormones* and *enzymes*.

   Sigmoid colon Stores feces.

   Rectum Passageway for feces.

   Anus Expels undigested material.

2.10.2 The mouth processes food for swallowing

The four kinds of teeth (*molars*, *premolars*, *canines*, and *incisors*) mechanically digest chunks of food. *Salivary glands* secrete *saliva*, which moistens food, begins the chemical digestion of *carbohydrates*, maintains the *pH* of the *mouth*, and protects the teeth against *bacteria*.

The mouth is the entrance to the *GI tract*. *Digestion* begins in the *mouth* with the process of chewing, which breaks food into smaller and smaller chunks. The *mouth* functions as an effective food processor. Chewing would be inefficient without the muscular tongue, which positions food over the teeth and mashes it against the roof of the mouth.

Mouth Teeth chew food. *Tongue* positions and tastes foods.

1. **Molars (12)** flat surfaces well adapted to grinding and crushing
2. **Premolars (8)**
3. **Canines (4)** tear food
4. **Incisors (8)** sharp-edged cut food

Salivary glands (three pairs) Produce a watery fluid called *saliva*. Saliva moistens food, making it easier to chew and swallow.

2.10.3 The pharynx and esophagus deliver food to the stomach

Swallowing begins with voluntary movements of the *tongue*; the presence of food initiates an involuntary swallowing reflex. *Peristalsis* and gravity transfer food through the *esophagus* to the *stomach*.

Voluntary movements of the *tongue* and *jaws* push a *bolus* of food into the *pharynx*, stimulating receptors that initiate the "swallowing reflex," an involuntary act that cannot be stopped once it is started. This closes off the passageways for air by closing off the passageway into the *nasal cavity* and bending the *epiglottis* down to close the airway to the *trachea*, temporarily halting breathing.

Pharynx (throat) Tongue pushes food down this to swallow.

Esophagus Just beyond the *pharynx* is the *esophagus*, a muscular tube consisting of both *skeletal* and *smooth muscle* that connects the *pharynx* to the *stomach*.

2.10.4 The stomach stores food, digests protein, and regulates delivery

The *stomach* stores food, digests it, and regulates its delivery to the *small intestine*. *Gastric juice* dissolves *connective tissue*, large *proteins*, and peptides in food. The presence of food stretches the *stomach* and increases *peristalsis*. *Peristaltic contractions* mix the *chyme* and push it gradually into the *small intestine*.

The stomach is a muscular, expandable sac that performs the following three important functions

1. **Food storage**. The *stomach* stores food until it can be digested and absorbed. The *stomach* shrinks when empty, and then expands to 1–3 liters of capacity when eating.

2. **Digestion**. The *stomach* digests *proteins*, using strong *acid*, and protein-digesting *enzymes*. The strong *acid* also kills most bacteria. Muscle contractions mix the secretions (*acids*, *enzymes*) with food, assisting in mechanically breaking apart food particles, and push the mixture into the *small intestine*.

3. **Regulation of delivery**. The *stomach* regulates the rate at which food is delivered to the *small intestine*.

Gastric Juice breaks down the proteins. Some of the cells lining the glands in the lining of the stomach secrete either *hydrochloric acid* (*HCL*) or *mucus*, but most secrete *pepsinogen*. Typically, the *stomach* produces 1–2 liters of *gastric juice* per day, most of it immediately after meals, making the *stomach pH* approximately 2.

Some of the cells lining the *stomach* and *gastric glands* continuously produce a protective barrier of *mucus*, preventing the *stomach* from digesting itself.

Stomach Muscular, expandable sac.

Pepsinogen *Pepsin's* proenzyme released by the chief cells in the stomach wall which activates in the presence of *hydrochloric acid* of the *gastric juice*.

Pepsin Becomes a protein-digesting *enzyme* from *pepsinogen* which is secreted by the cells lining the *gastric glands* after being exposed to *acid* in the *stomach*.

Chyme Watery mixture of partially digested food and gastric juice delivered to the *small intestine*. The *pyloric sphincter* between the *stomach* and the *small intestine* regulates the rate of transport of *chyme* into the *small intestine*.

Cardiac sphincter Prevents acid reflux into *esophagus*

Pyloric shpincter Regulates passage of chyme to *small intestine*.

Peptic ulcer Open, (sometimes) bleeding sore which occasionally occur in the *esophagus* and upper part of the *small intestine* as well.

Stomach contractions mix food and push it forward. While empty, the *stomach's* muscle contractions keep it small. When eating, the muscle contractions cease and *stomach* relaxes, signaling *peristalsis* to increase. *Chyme* with a high acid or fat content stimulates the release of *hormones* that slow *stomach peristalsis*.

2.10.5 The small intestine digests food and absorbs nutrients and water

The *small intestine* has two major functions: 1) digesting *proteins*, *carbohydrates*, and *lipids*, and 2) absorbing approximately 90% of the *nutrients* and *water* we consume. Projections called *villi* in the *mucosa* increase the *small intestine's* surface area for absorption.

The process of digestion continues in the *small intestine*. It has two major functions:

1. *Digestion.* The *stomach* partially digests *proteins* to smaller *peptides*, under the influence of strong *acids* and *pepsin*. *Protein* digestion continues in the *small intestine*, but also digests *carbohydrates* and *lipids*. Digestion of *protein*, *carbohydrates*, and *lipids* in the *small intestine* involves neutralizing the highly acidic *gastric juice* and adding additional digestive *enzymes* from the *intestine* and *pancreas*.

2. *Absorption.* Eventually, the *proteins*, *carbon*, and *lipids* in food are broken down to single *amino acids*, *monosaccharides*, *fatty acids*, and *glycerol*, which are small enough to be transported (i.e. NOT DIFFUSED) across mucosal cells into the blood. Nearly 90% of the *nutrients* able to be absorbed and *water* is absorbed in the *small intestine*.

The *small intestine* consists of three different regions. The *duodenum*, the *jejunum*, the *ileum*.

Duodenum About 10 inches long. Most of the *digestion* takes place here. The *products of digestion* are absorbed primarily in the other two segments, the *jejunum* and the *ileum*, which together are about 10 feet long.

Peptide Basically just small *proteins*.

Villus (plural: **villi**) The mucosa contains large folds covered with microscopic projections called *villi*, which each *epithelial cell* of the *villi* has dozens of even smaller, *cytoplasmic projections* called *microvilli*. The folds increase the surface area for absorption.

2.10.6 Accessory organs aid digestion and absorption

The *pancreas* secretes *digestive enzymes* and *sodium bicarbonate*. The *sodium bicarbonate* neutralizes *stomach acid*, making the *digestive enzymes* more effective. The *liver* produces *bile*, which is stored in the *gallbladder* until after a meal. The *liver* also produces *plasma proteins*; inactivates *toxic chemicals*; destroys old *red blood cells*; stores *vitamins*, *iron*, and certain products of *metabolism*; and performs other functions important for *homeostasis*.

The *digestive system* has four *accessory organs*: *salivary glands*, *pancreas*, *gallbladder*, and *liver*.

The pancreas secretes enzymes and $NaHCO_3$. The exocrine products of the pancreas are:

1. *Sodium bicarbonate.* Except for *pepsin*, most *digestion enzymes* work best at a fairly neutral *pH*. *sodium bicarbonate* from the *pancreas* neutralizes the *stomach acid* in the *small intestine* so that further digestion can proceed.

2. *Digestive enzymes*

   proteases Enzymes that digest proteins.

   pancreatic amylase Continues the digestion of carbohydrates only partially accomlished by salivary amylase.

   lipase *Lipid-digesting enzyme.* The *small intestine* does not have lipase, so the this *pancreas* product is important.

The *liver* serves a number of functions that maintain *homeostasis*:

- Storing fat-soluble vitamins (A, D, E, and K) and iron.
- Storing glucose as glycogen after a meal, and converting glycogen to glucose between meals.
- Manufacturing plasma proteins, such as *albumin* and *fibrinogen*, from *amino acids*.
- Synthesizing and storing some lipids.
- Inactivating many chemicals, including *alcohol*, *hormones*, *drugs*, and *poisons*.
- Converting *ammonia* (NH_3), a toxic waste product of metabolism, into less toxic *urea*.
- Destroying worn-out red blood cells

Liver injury can be particularly dangerous. Overexposure to *toxic chemicals*, *medications*, or *alcohol* can damage the *liver* because it takes up these substances to "detoxify" them, killing some *liver cells* in the process. Long-term exposure can destroy enough *cells* to permanently impair *liver* function, a condition known as *cirrhosis*.

Pancreas Elongated organ which lies just behind the stomach. Secretes digestive *enzymes* (*proteases*, *amylase*, *lipase*) into *small intestine*; most of the enzymes involved in digestion come from the pancreas (the small intestine contributes only a limited amount of protein- and carbohydrate-digesting enzymes). Secretes *sodium bicarbonate* into *small intestine* to neutralize *stomach acid*. Delivers *enzymes* and *sodium bicarbonte* to the *duodenum* via *ducts*. The most important hormones it secretes into the blood are *insulin* and *glucagon*.

The *pancreas* is also an *exocrine gland* that produces and secretes several products directly into *ducts* leading to the *digestive tract*.

Sodium Bicarbonate (Baking Soda) Natural substance in the body within the bloodstream that regulates *pH* as a counterbalance to acid build up. Also a first line of defense for a vast range of sickness like cancer, flu, diabetes, kidney disease, and the common cold.

Liver Upper-right *abdominal cavity*. Produces *bile* (*water* and *electrolytes*, *cholesterol*, *bile salts*, *lecithin*, and *pigments*). Performs various functions associated with processing and storing *nutrients*.

Bile Watery mixture containing *electrolytes*, *cholesterol*, *bile salts* derived from *cholesterol*, a *phospholipid* called *lecithin*, and *pigments* (primarily *bilirubin*) derived from the breakdown of *hemoglobin*.

Hepatic portal system Generally, a *portal system* carries *blood* from one *capillary bed* to another. Here, the hepatic portal system carries nutrient-rich blood directly from the digestive organs to the liver via the hepatic portal vein.

Gallbladder *Bile* produced by the *liver* flows through *ducts* to the *gallbladder*. Stores and concentrates *bile*. Delivers bile to the *duodenum* via the common *bile duct*. Concentrates *bile* by removing most of the *water*, then stores the *concentrated bile* until it is needed.

2.10.7 The large intestine absorbs nutrients and eliminates wastes

Large intestine

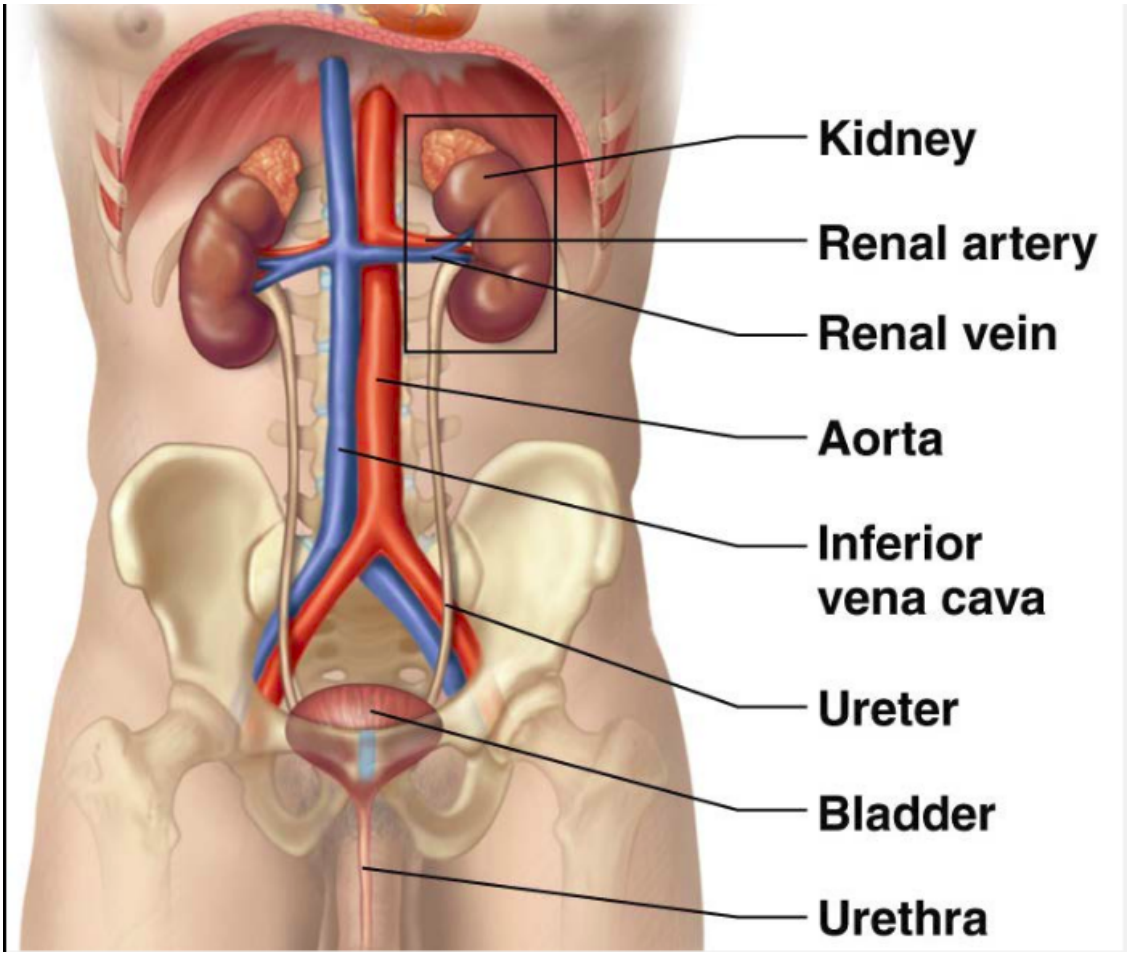
Appendix

Colon

2.10.8 How nutrients are absorbed

2.11 Ch. 15

- Sections 15.1 to 15.4, 15.8 (page 356–364, 371–373 in 7th ed.)
- Figure 15.1 and figure 15.6
- **Note**: You do NOT need to memorize blood vessels supplying the kidneys—focus on the nephrons and where/how filtration, reabsorption and secretion take place.
- Overarching goal: Explain the role of the urinary system (∗especially kidneys*_) in maintaining homeostasis.



2.11.1 The urinary system contributes to homeostasis

Organ systems involved in removing wastes and maintaining homeostasis of *water* and *solutes*. The *kidneys* of the *urinary system* are the organs primarily responsible for the mainenance of homeostasis of water and solutes and for the excretion of most waste products.

Table 15.1

Water gain (ml/day)		Water loss (ml/day)	
Drinking fluids	1,000	Urine	1,500
Water in food	1,200	Evaporative loss (lungs)	500
Metabolic Production	300	Evaporative loss (skin)	350
		Feces	150
Total	2,500	Total	2,500

The *urinary system* maintains a constant internal environment by regulating *water balance* and body levels of *nitrogenous wastes*, *ions*, and other substances. It filters metabolic wastes from the *blood* and *excretes* them in *urine*. The major *nitrogenous waste* product is *urea*.

- The digestive system + nutrients + water → food residues
- Lungs + O_2 → carbon dioxide gas
- Skin + heat → water + salt
- liver + numerous inactivate-able substances → (sometimes) bile in feces

The kidneys regulate water levels. The kidneys have a tremendous capacity to adjust water excretion as necessary, from a minimum of about 1/2 liter per day to nearly 1 liter per hour.

The kidneys regulate nitrogenous wastes and other solutes. The primary solutes excreted by the *kidneys* are *nitrogenous wastes*, excess ions, and trace amounts of other substances. The normal metabolism of proteins leaves us with excess *nitrogenous wastes*, which must be *excreted* by the *kidneys*.

- It regulates *urinary excretion* of these *ions*:

  NA^+ and CL^- determine the volume of the extracellular fluids, including blood.

  K^+ Maintains electrical charges

  CA^{2+} Important in nerve and muscle activity

  H^+ Maintains acid–base balance.

  Creatinine Produced during metabolism of creatine phosphate which gives urine its yellow color

Excretion Process that removes wastes and excess materials from the body.

Urinary system Consists of the two *kidneys*, the *ureters*, the *bladder*, and the *urethra*.

Kidney Two *kidneys* produce urine. carefully regulate how much water and salt (*ions*) are *excreted* in order to maintain homeostasis of fluid volume and blood pressure. Retain within the body all three classes of *nutrients* (*carbohydrates*, *lipids*, and *proteins*)

Bowman's capsule Cup underneath the glomerulus which catches the filtrate(is this the right word?).

Bowman's space Space inside Bowman's capsule.

Endothelial cells (Renestrated, or has a lot of holes/pores)

Basement membrane membrane underneath the endothelial cells.

Tubular cells (epithelial cell) Action point at the end of Bowman's capsule.

Urine Waste water and waste solutes (various ions, drugs, vitamins, toxic chemicals, virtually every small waste molecule produced anywhere in the body).

Urea ($H_2N–CO–NH_2$). Created with water from ammonia molecules (which are toxic to cells) and carbon dioxide.

Ammonia (NH_4^+)

Diuretics (called water pills) Any substance which promotes an increased production of urine. Treat a variety of conditions, such as high *blood pressure*, *glaucoma*, and *edema*. Help rid the body of salt (sodium) and water. *Kidneys* release more sodium into *urine*.

Persistent proteinuria Urine has proteins in it which are not supposed to be in urine. This might happen in somebody with *kidney disease*—as it is the job of the kidney not to put proteins in the urine.

2.11.2 Organs of the urinary system

Organs of the *urinary system* include the *kidneys*, *ureters*, *bladder*, and *urethra*. The *kidneys* are the principal urinary organs, although they have several homeostatic functions as well. The *ureters* transport *urine* to the *bladder*, where it is stored until carried by the *urethra* to the body's eternal opening.

Organ	Function
Kidneys	Excrete metabolic wastes, especially urea Maintain water and salt homeostasis Help regulate acid–base balance Help regulate blood pressure (produce renin, an enzyme) Control RBC production (produce erythropoietin, a hormone) Activate vitamin D
Ureters	Transport urine to bladder
Urinary bladder	Stores urine until excretion
Urethra	Transports urine to outside the body

Kidneys: the principal urinary organs

The *kidneys* are located on either side of the vertebral column, near the posterior body wall. A *renal artery* and a *renal vein* connect each kidney to the aorta and inferior vena cava, respectively.

Ureters transport urine to the bladder

Urinary bladder stores urine

Consists of three layers of *smooth muscle* lined on the inside by *epithelial cells*. Typically holds about 600–1,000 ml of *urine*.

Medulla

Cortex

Renal pelvis

Ureter Muscular tube that transports urine to the bladder. About 10–15 seconds a peristaltic wave of smooth muscle contraction occurs pushing urine from the 10-inch length of the *ureters* to the *bladder*.

Urethra During urination, *urine* passes through *this*, a single, muscular tube extending from the *bladder* to the body's external opening.

2.11.3 Nephrons produce urine

- Yeah, so I really doubt that most of the big words in the this section are actually going to be useful. Basically, there are nephrons in the kidney that pull blood into the kidney where the nephron then takes out a tiny piece of garbage and inserts it into the collecting duct with some water, calling it urine.

A nephron is the function unit of a kidney. A nephron tubule consists of a glomerular capsule, where fluid is filtered, and four reguions in which the filtrate is modified before it becomes urine: proximal tubule, loop of Henle, distal tubule, and collecting duct. Blood flows to the glomerulus via the renal artery and afferent arteriols. Peritubuluar capillaries carry the blood to the proximal and distal tubules, and vasa recta supply the loops of Henle and collecting ducts.

Each kidney contains approximately a million small functional units called *nephrons*. An individual *nephron* consists of a thin, hollow tube of *epithelial cells*, called a *tubule*, plus the *blood vessels* that supply the *tubule*.

Nephron

Glomerular capsule

Glomerulus

Proximal tubule

Loop of Henle

2.11.4 Formation of urine: Filtration, reabsorption, and secretion

- In the first part, proteins are separated from the solutes and water; solutes and water placed into tubule. Most of what is extracted is then reabsorbed—nearly all the filtered water and sodium and all the major nutrients. In the third part, the waste products are placed into the tubule to be secreted as urine.

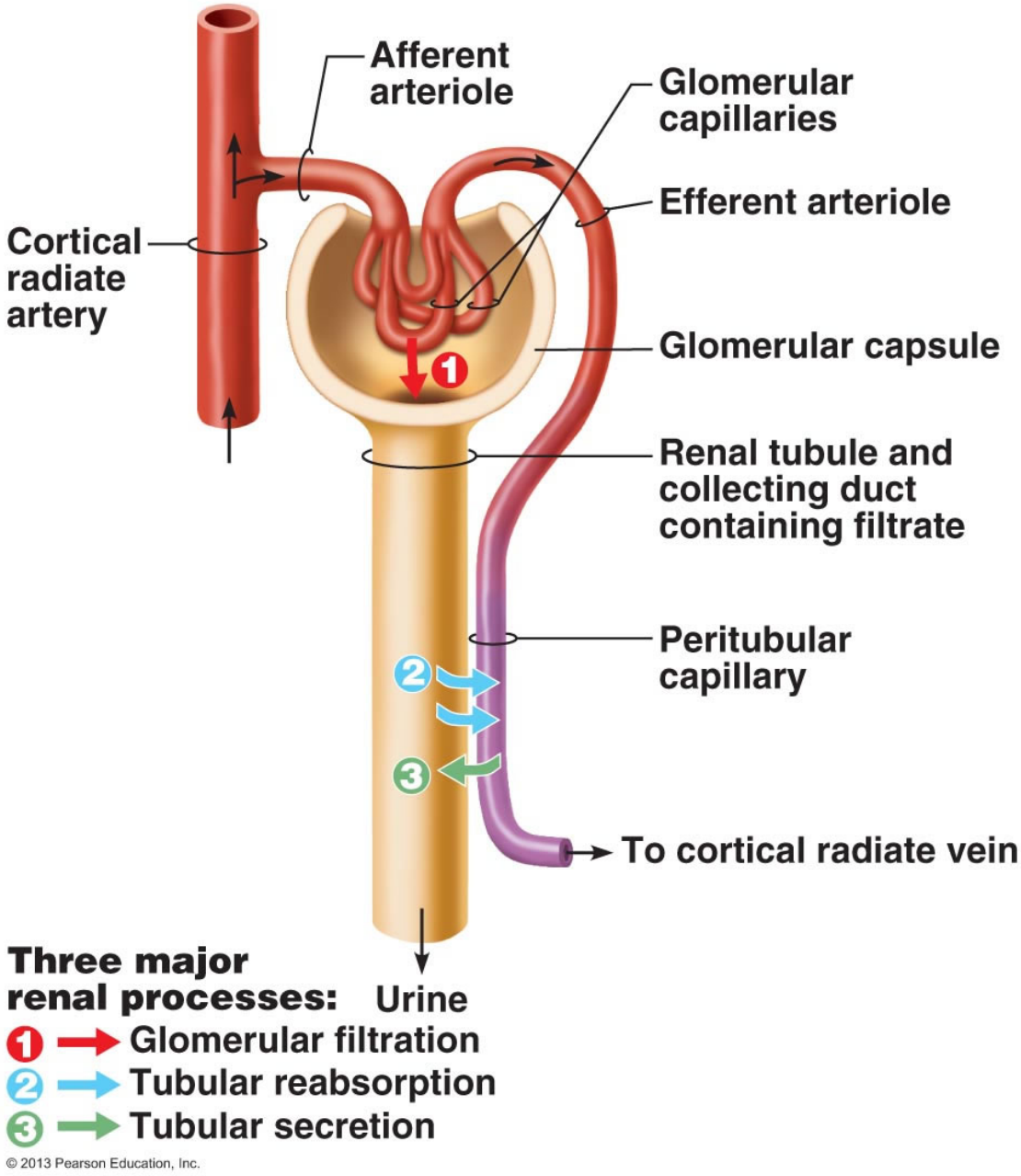


Figure 15.6 The three processes that contribute to the formation of urine.

1. **Glomerular filtration** The movement of a *protein*-free solution of fluid and solutes from the *glomerulus* into the space within the *glomerular capsule*. Water, ions, glucose, amino acids, bicarbonate, and waste products (urea, creatinine) are filtered from the *glomerular capillaries* into the space within the *glomerular capsule*.

2. **Tubular reabsorption** The return of most of the fluid and solutes back into the *peritubular capillaries* or *vasa recta*. Water, amino acids, glucose, most ions (including bicarbonate), and some urea are reabsorbed back into the *peritubular capillaries*, primarily in the *proximal tubule* but also in other *nephron* segments.

3. **Tubular secretion** The addition of certain solutes from the *peritubular capillaries* or *vasa recta* into the tubule. Some drugs, waste products, and ions (primarily hydrogen, ammonium, and potassium) are *actively secreted* from the *peritubular capillaries* primarily into the *distal tubule* but also in other *nephron* segments.

- *Efferent* arterial is much narrower than the *afferent* arterial, and the *efferent* arterial has pretty high pressure. The kidneys thus do not need to use any energy in the *filtration* process because diffusion is so easy.

The rate of filtration is regulated in two ways:

- Under resting conditions, pressure-sensitive cells in the *arterioles* and flow-sensitive cells in the *tubule* walls can release chemicals to adjust the diameter of the *afferent arterioles*. These feedback mechanisms maintain a relatively constant rate of *glomerular filtration*, allowing the kidneys to carry out their regulatory functions.
- During times of stress (such as after an injury or while running a marathon), blood flow to the *kidneys* falls substantially as blood is redistributed to more critical organs. The *sympathetic* division of the *autonomic nervous system* constricts *afferent* and *efferent arterioles*, reducing blood flow and the rates of *glomerular filtration* and urine formation. The *kidneys* are unharmed because they do not need a high blood flow to survive, and the body can cut back on urine production temporarily without ill effects.

2.11.5 Disorders of the urinary system

2.12 Ch. 16

Oxytocin [hormone, neuropeptide, medication] Normally produced in the hypothalamus and released by the posterior pituitary. Plays a role in social bonding, sexual reproduction in both sexes, and during and after childbirth.

2.12.1 The male reproductive system delivers sperm

The male reproductive system comprises the *testes*, the *penis*, and associated ducts and glands. *Semen* consists of *sperm* and three glandular secretions that provide energy and the proper pH environment for the *sperm* and also lubrication for sexual intercourse. Millions of *sperm* form every day throughout a man's life; a typical ejaculate contains up to 300 million *sperm*. *Testosterone* stimulates the growth and function of the male reproductive system, and encourages aggressive and sexual behavior. Blood level of *testosterone* are regulated by a *negative feedback loop* involving *GnRH* from the *hypothalamus* and *LH* and *FSH* from the *anterior pituitary*.

Sperm

Egg

Testes

Scrotum

Each testis is only about 2 inches long, but it contains over 100 yards of tightly packed *seminiferous tubules*. Seminiferous tubules join to become the *epididymis*.

Seminiferous tubules Site of sperm production.

Epididymis Tube that connects a *testicle* to a *vas deferens*.

Ductus (vas) deferens

Ejaculatory duct

Penis

Erection

Semen

The entire process of sperm formation and maturation takes about 9–10 weeks.

Seminal vesicles Produce seminal fluid, a watery mixture containing fructose and prostaglandins that represents about 60% of the volume of semen.

Prostate gland

Bulbourethral glands

Gametes Cells having only 23 chromosomes. Female gametes are called *oocytes*.

Sertoli cells Large cells which nourish spermatogonia which are to begin sperm.

Testosterone

Gonadotropin-releasing hormone (GnRH)

Luteinizing hormone (LH)

Inhibin Highly active sertoli cells secrete a hormone called inhibin that directly inhibits the secretion of FSH.

2.12.2 The female reproductive system produces eggs and supports pregnancy

The *ovaries* secrete *estrogen* and *progesterone*, store immature *oocytes*, and (usually) release one *oocyte* at a time at intervals of about 28 days. The *oocyte* travels through the *oviduct* to the *uterus*, where implantation occurs if the egg has been fertilized. The *vagina* is the female organ of sexual intercourse and the birth canal; around its opening are the structures of the *vulva*. *Mammary glands* are accessory organs that produce and store milk.

Oviduct The tube through which an *ovum* or egg passes from an *ovary*. In female mammals this passageway is know as the *uterine tube* or *Fallopian tube*.

Ovaries

Estrogen

Progesterone

Oviduct

Uterus

Endometrium

Cervix

Vagina

Labia majora Two prominent longitudinal cutaneous folds that extend downward.

Labia minora (inner labia) Folds of skin in the very middle of *vulva* between thicker *labia majora*.

Clitoris

Mammary glands Accessory organs that produce and store milk.

Lactation

2.12.3 Menstrual cycle consists of ovarian and uterine cycles

During the *ovarian cycle*, a primary *oocyte* within a developing *follicle* divides once to form a secondary *oocyte*. The *follicle* ruptures, releases the *oocyte*, and forms the *corpus luteum* that secretes *progesterone* and *estrogen*. Rising levels of *estrogen* cause the *endometrium* to proliferate. If pregnancy does not occur, hormone levels fall and the *endometrial layer* disintegrates and is shed, a process known as *menstruation*. *Ovulation* is triggered by a surge of *LH*, which in turn is caused by the *positive feedback* effect of a high concentration of *estrogen* from the maturing *follicle*. During the second half of the *menstrual cycle*, sustained high levels of *estrogen* and *progesterone* from the *corpus luteum* inhibit further *ovulation*.

Menstrual cycle

Ovarian cycle

Follicle

Ovulation

Corpus luteum

Menstruation

2.12.4 Human sexual response, intercourse, and fertilization

Women and men experience the same four phases of sexual responsiveness. Sexual arousal in the male results in penile erection that leads to orgasm and ejaculation. Females experience sexual arousal and pleasurable orgasms marked by rhythmic muscular contractions. During ejaculation, the male deposits several hundred million sperm in the vagina. Fertilization of the egg by a single sperm occurs within five days, if it occurs at all.

Orgasm

Ejaculation

2.12.5 Birth control methods: Controlling fertility

Surgical sterilization should be considered a permanent method of birth control. Hormonal methods—pills, injections, patches, and rings—are also relatively effective but can have side effects. Physical barriers (diaphragms, cervical caps, and condoms) and chemical spermicides are moderately effective; a few afford some protection against diseases. IUDs are fairly effective against pregnancy but do not protect against diseases. Withdrawal and periodic abstinence are not effective forms of birth control in the long term. Abortion is an elective but controversial procedure that terminates a pregnancy.

2.12.6 Infertility: Inability to conceive

Male infertility is an insufficiency or lack of sperm. Causes of female infertility are variable and include failure to ovulate, damage to oviducts, pelvic inflammatory disease, secretions that impair sperm function, uterine tumors, endometriosis, age-related changes, and miscarriages. The choice of options to improve fertility depends on the cause of the infertility. Options include artificial insemination, in vitro fertilization, gamete intrafallopian transfer, zygote intrafallopian transfer, fertility-enhancing drugs, and surrogate motherhood.

2.12.7 Sexually transmitted diseases

Major bacterial STDs include gonorrhea, syphilis, and chlamydia. The most dangerous viral STD is HIV. Hepatitis BUT can be prevented by a vaccine. Genital herpes is irritating but not particularly deadly. HPV can cause warts and is a risk factor for cervical cancer—it, to, can be prevented by a vaccine. Yeast, normally present in the vagina, can multiply and cause a yeast infection. Pubic lice are tiny arthropods that are transmitted during intimate contact or by contact with clothes or bedding. You can reduce your risk of contracting an STD with a little effort. Choose your partner wisely, use a barrier method of birth control, and , if you suspect you have a disease, get tested promptly.

2.13 Ch. 8

Cardiovascular system Provides the power to move the blood, and the vascular system represents the network of branching conduit vessels through which the blood flows.

- Greek *kardia*, hear Latin *vasculum* small vessel

2.13.1 Blood vessels transport blood

A branching system of thick-walled *arteries* distributes blood to every area of the body. *Arterioles* regulate blood flow to local regions, and precapillary sphincters/ regulate flow into individual *capillaries*. Capillaries/ consisting of a single layer of cells exchange materials with the *interstitial fluid*. The *lymphatic system* removes excess fluid. The thin-walled *veins* return blood to the heart and serve as a volume reservoir for blood.

A branching network of blood vessels transports blood to all parts of the body. The network is so extensive that if our blood vessels were laid end to end, they would stretch 60,000 miles!

There are three major types of blood vessels: *arteries*, *capillaries*, and *veins*. Thick-walled arteries transport blood to body tissues under high pressure. As blood leaves the heart it is pumped into the large, muscular arteries.

Arteries Transport blood away from the heart. Larger arteries have a thick muscle layer because they need to withstand high pressure from the heart.

The vessel is a sandwich of three distinct layers surrounding the *lumen*, or hollow interior of the vessel:

1. *endothelium*.
2. Largest layer of smooth muscle with interwoven elastic connective tissue.
3. Outermost layer of large and medium-sized arteries have a tough supportive layer of connective tissue, primarily collagen.

Aneurysm [ballooning of the artery wall] The *endothelium* becomes damaged, blood seeps through the injured area and the two outer layer, splitting them apart.

Endothelium *Squamous epithelial cells* in a thin, flattened layer. A continuation of the lining of the heart.

Capillary *Epithelial cells* of capillary *endothelium*.

2.13.2 Arterioles and precapillary sphincters regulate blood flow

Eventually blood reaches the smallest arteries, or *arterioles*.

Precapillary sphincter Smooth muscle that serves as gates for controlling blood flow into individual capillaries.

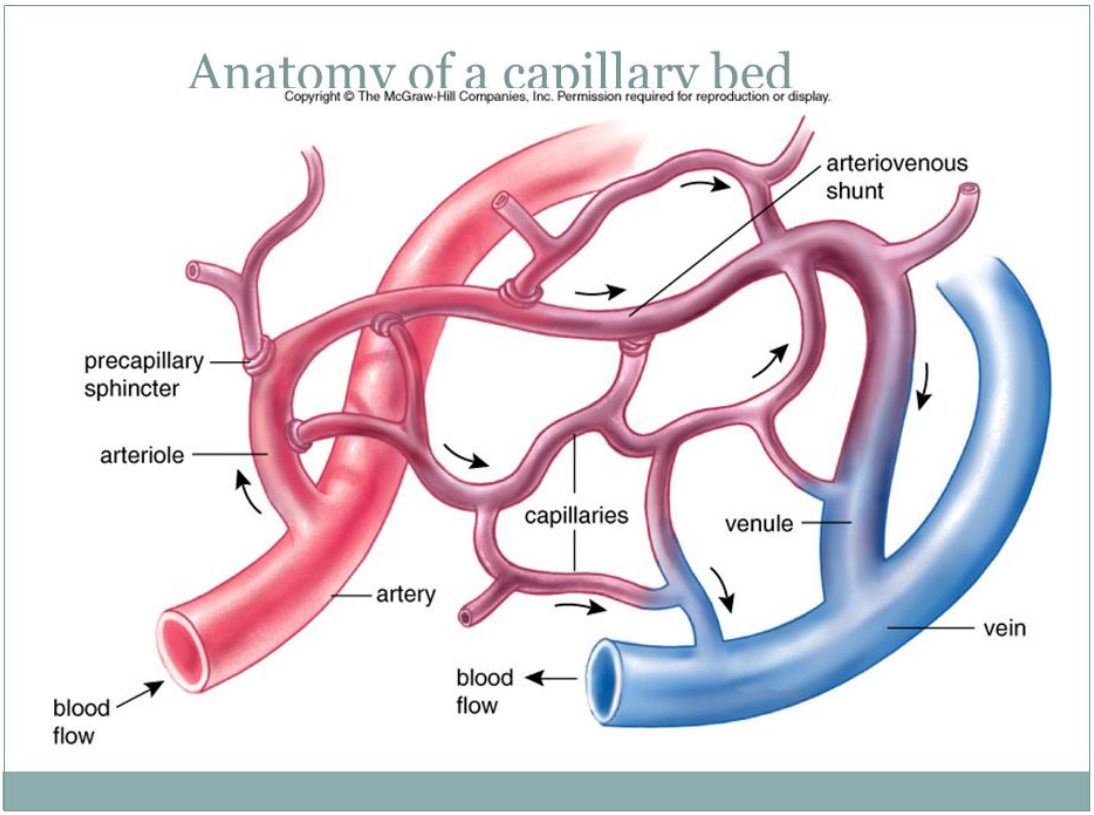
Vasoconstriction *Arterioles* and *precapillary sphincters* reduce diameter → reduces blood flow.

Vasodilation *Arterioles* and *precapillary sphincters* increase diameter → increase blood flow.

Arterioles Little *arteries*. Simpler in structure than arteries because they don't need to support as much pressure as arteries do. The diameter is control by *smooth muscle* control, the *precapillary sphincters*.

2.13.3 Capillaries: Where blood exchanges substances with tissues

Porous walls allow blood to exchange *oxygen*, *carbon dioxide*, *nutrients*, and waste/ products with *tissue cells*.



Capillaries Thin-walled vessels about as think as the *red blood cells* that travel through them. Biological strainers that permit selective exchange of substances with the *interstitial fluid*.

Capillary beds Found in all areas of the body. Capillary walls consist of a single layer of *squamous epithelial cells*.

2.13.4 Lymphatic system helps maintain blood volume

The *lymphatic system* is somewhat similar to the venous system of blood vessels, except that the fluid it contains *lymph* does not contain *plasma proteins* or *red blood cells*.

Lymphatic system Collection system of larger vessels where excess plasma fluid is absorbed by blind-ended capillaries.

2.13.5 Veins return blood to the heart

Blood flows back to the heart through *venules* (small veins) and *veins*. Has three layers similar to *arteries*, but much thinner. Veins have a larger *lumen*, however.

Pressure goes down as it moves through the cardiovascular system, so veins require only a small fraction of the pressure in arteries. Veins accommodate large volumes of blood at low pressures.

Most veins contain valves consisting of small folds of the inner layer that protrude into the lumen; permitting only one-way flow.

Veins Carries blood to the heart.

Blood pools into your legs and feet when standing upright. People who spend a lot of time on their feet may develop *varicose veins*.

Vericose veins Permanently swollen veins that look twisted and bumpy from pooled blood.

2.13.6 The heart pumps blood through the vessels

The heart wall consists of three layers: the *epicardium*, the *myocardium*, and the *endocardium*. The heart contains four chambers and four one-way valves. The *right atrium* and *right ventricle* pump blood to the *lungs*; the *left atrium* and *left ventricle* pump blood to the rest of the *body*. Each *cardiac cycle* is a repetitive sequence of contraction (*systole*) and relaxation (*diastole*).

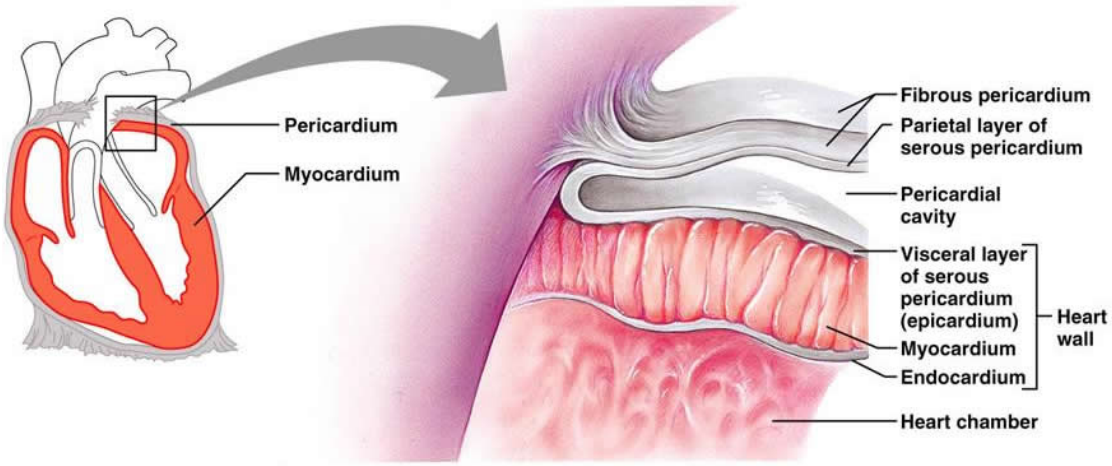
The *heart* is located in the *thoracic cavity* between the *lungs* and behind the sternum/, or breastbone. It consists mostly of *cardiac muscles*.

Cardiac muscle Doesn't connect to bone. Pumps ceaselessly in a squeezing motion to propel blood through the *blood vessels*.

Pericardium Tough, fibrous sac. Protects the *heart*, anchors it to surrounding structures, and prevents it from overfilling with blood.

Pericardial cavity Contains a film of lubricating fluid that reduces friction and allows the *heart* and the *pericardium* to glide smoothly against each other when the heart contracts.

There are three layers in the walls of the heart.



Epicardium Outermost layer consisting of a thin layer of *epithelial* and *connective tissue*.

Myocardium Middle layer consisting mainly of *cardiac muscle* that forms the bulk of the heart. The layer that contracts every time the heart beats.

Endocardium Innermost, thin *endothelial* layer resting on a layer of *connective tissue*. Continuous with the *endothelium* that lines the blood vessels.

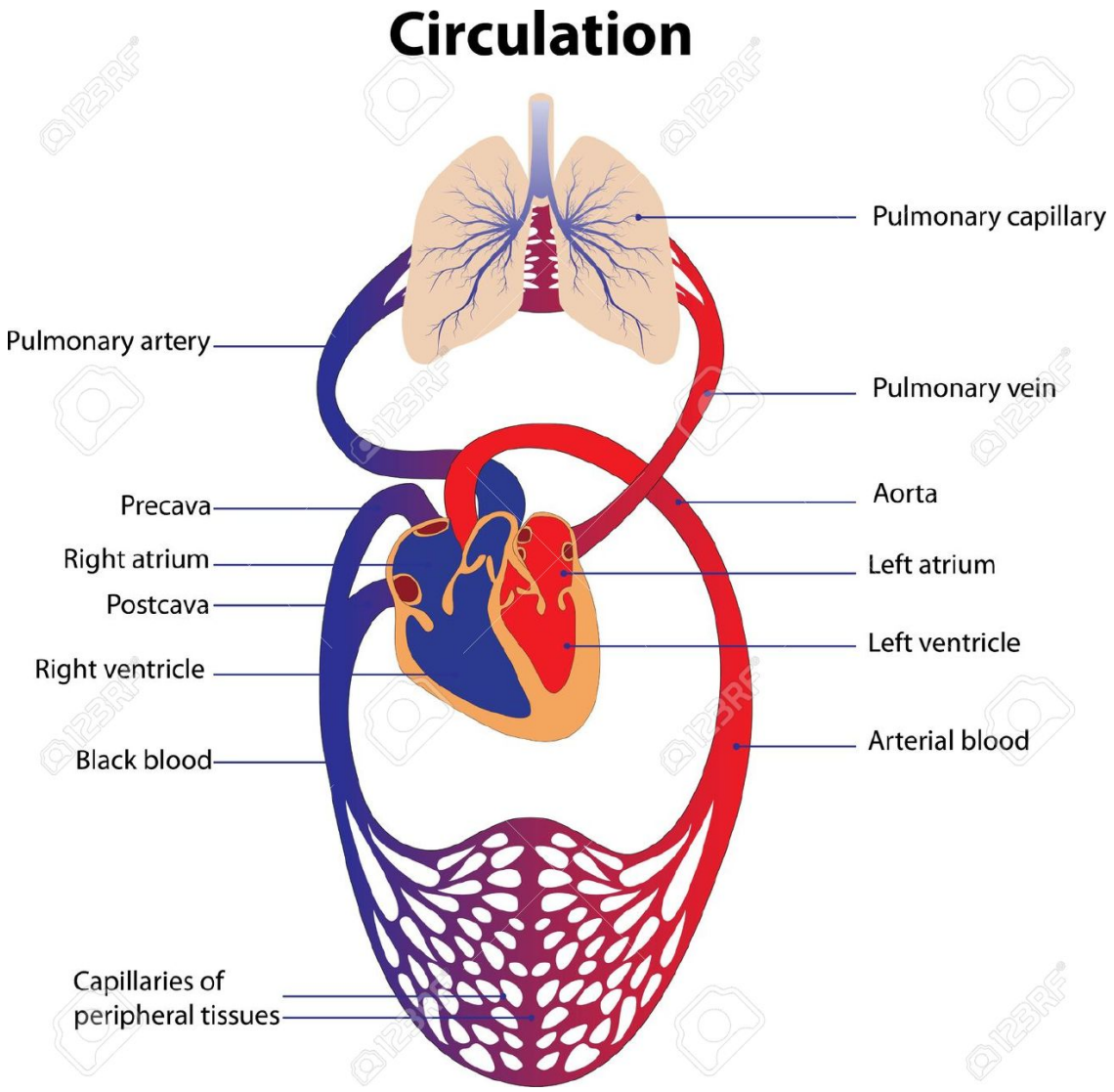
Problems*

Pericarditis Inflammation of the *pericardium*.

2.13.7 The heart has four chambers and four valves

Blood returning to the *heart* from the body's tissues enters the heart at the *right atrium*. From the right atrium, the blood passes through a valve into the *right ventricle*. The right ventricle is more muscular than the right atrium because it pumps blood at considerable pressure through a second valve and into the *artery* leading to the *lungs*.

Blood returning from the *lungs* to the *heart* enters the *left atrium*, then passes through a third valve into the *left ventricle*. The very muscular left ventricle pumps blood through a fourth valve into the body's largest *artery*, the *aorta*.



Atria [two atria, each an atrium] Each goes to the corresponding ventricle. Body attaches to the right atrium. Lungs attach to the left atrium.

Ventricles [two ventricles] Left ventricle goes to the body. Right ventricle goes to the lungs.

Septum Muscular partition separating the right and left sides of the heart.

Atrioventricular (AV) valves Between the corresponding *atrium* and *ventricle* is an *atrioventricular valve* which prevents the backwards flow of *blood* in the *heart*.

Semilunar valves [two, pulmonary and aortic] Prevent backflow into the ventricles from the main arteries leaving the heart when the heart relaxes.

2.13.8 The pulmonary circuit provides for gas exchange and the systemic circuit serves the rest of the body

Pulmonary circuit The circuit where blood travels to and from the lungs.

Systemic circuit The circuit where blood travels to and from the body.

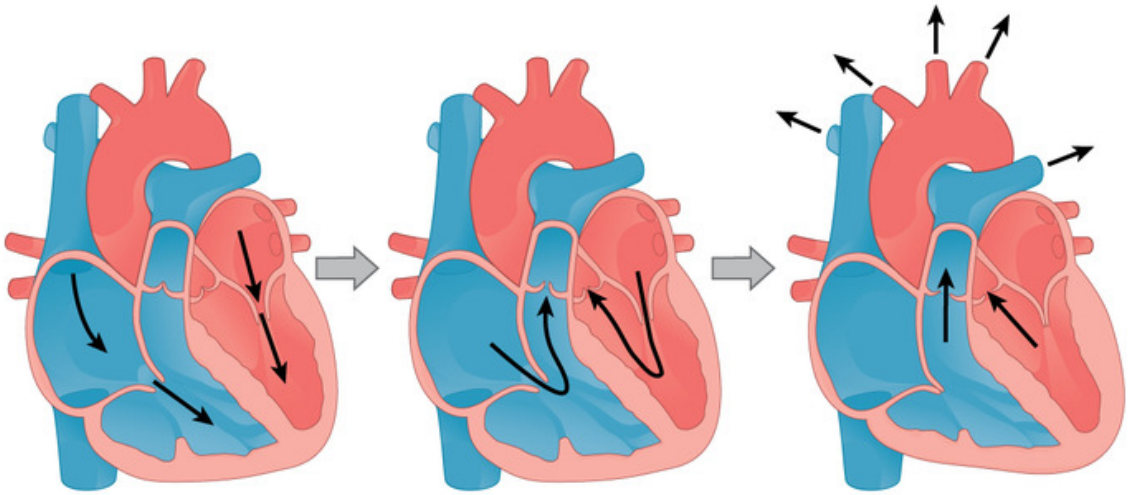
Coronary arteries Supply the *heart muscle* with *blood*. They branch from the *aorta* just above the *aortic semi-lunar valve* and encircle the *heart's* surface.

- Latin *corona* encircling like a crown

Cardiac veins Collect the *blood* from the *capillaries* in the *heart muscle* and channel it back to the *right atrium*.

2.13.9 The cardiac cycle: The heart contracts and relaxes

A complete *cardiac cycle* involves contraction of the two *atria*, which forces *blood* into the *ventricles*, followed by contraction of the two *ventricles*, which pumps blood into the *pulmonary artery* and the *aorta*, followed by a relaxation of the entire *heart*.



(a) Cardiac diastole: all chambers are relaxed, and blood flows into the heart.

(b) Atrial systole, ventricular diastole: atria contract, pushing blood into the ventricles.

(c) Atrial diastole, ventricular systole: after the atria relax, the ventricles contract, pushing blood out of the heart.

Systole The period of contraction.

Diastole The period of relaxation.

Cardiac cycle The entire sequence of contraction and relaxation.

1. *Atrial systole.* Contraction starts, the heart is already nearly filled with *blood* that entered the *ventricles* and *atria* passively during the previous *diastole*. During *atrial systole*, both *atria* contract, raising blood pressure in the *atria*, then filling the two *ventricles* to capacity.

2. *Ventricular systole*. Contraction that began in the *atria* spreads to the *ventricles*, then both *ventricles* contract simultaneously. *Pulmonary* and *Aortic semilunar valves* open and *blood* is ejected into the *pulmonary trunk* and the *aorta*.
3. *Diastole*. Both *atria* and both *ventricles* are relaxed. Pressure within falls, the *pulmonary* and *aortic semilunar valves* close, preventing backflow, then the *AV valves* open and blood begins to flow passively into the *heart*.

2.13.10 Cardiac conduction system coordinates contraction

The coordinated sequence of the cardiac cycle is due to the *cardiac conduction system* a group of specialized *cardiac muscle cells* that initiate and distribute electrical *impulses* throughout the *heart*.

Sinoatrial (SA) node A small mass of *cardiac muscle cells* located near the junction of the *right atrium* and *superior cardiac muscle cells* elsewhere in the *heart*.

Atrioventricular (AV) node Mass of muscle cells between the *atria* and *ventricles* that receives signals.

Atrioventricular (AV) bundle From the *AV node*, the electrical signal sweeps to this bundle or group of conducting fibers in the *septum* between the two *ventricles*.

2.13.11 Blood exerts pressure against vessel walls

Blood pressure is the force that blood exerts on the wall of a *blood vessel*. It is measured as two numbers corresponding to *systolic* and *diastolic pressures*. *Hypertension* (high blood pressure) is a serious risk factor for *cardiovascular disease* and other health problems.

Blood pressure category	**systolic** (mm Hg)		**Diastolic** (mm Hg)
Normal	Less than 120	and	Less than 80
Prehypertension	120–139	or	80–89
Hypertension, Stage 1	140–159	or	90–99
Hypertension, Stage 2	160 or higher	or	100 or higher

Blood pressure Force that *blood* exerts on the wall of a *blood vessel* as a result of the pumping action of the *heart*.

Sphygmomanometer A tool for measuring *blood pressure*.

Systolic pressure The highest pressure of the cycle reached during *ventricular systole* when the *ventricles* contract to eject *blood* from the *heart*.

Diastolic pressure The lower pressure occurring during *ventricular diastole* when the *ventricles* relax.

Hypertension *Blood pressure* higher than normal. Significant risk factor for *cardiovascular disease*, because the greater pressure means more strain on *cardiovascular system*.

It is called the "$_{\text{silent}}$ killer_" because usually it has no symptoms.

Hypotension When blood pressure is too low. Generally only a problem only if *blood pressure* falls enough to reduce *blood* flow to the *brain*, causing dizziness and fainting.

2.13.12 Cardiovascular disorders: A major hearth issue

Cardiovascular disorders are the number one killer in the United States. Most disorders are caused either by conditions that result in failure of the *heart* as a pump or by conditions in which damage to *blood vessels* restricts flow or ruptures vessels.

Heart attack (*myocardial infarction*) Sudden death of an area of *heart tissue* due to oxygen starvation.

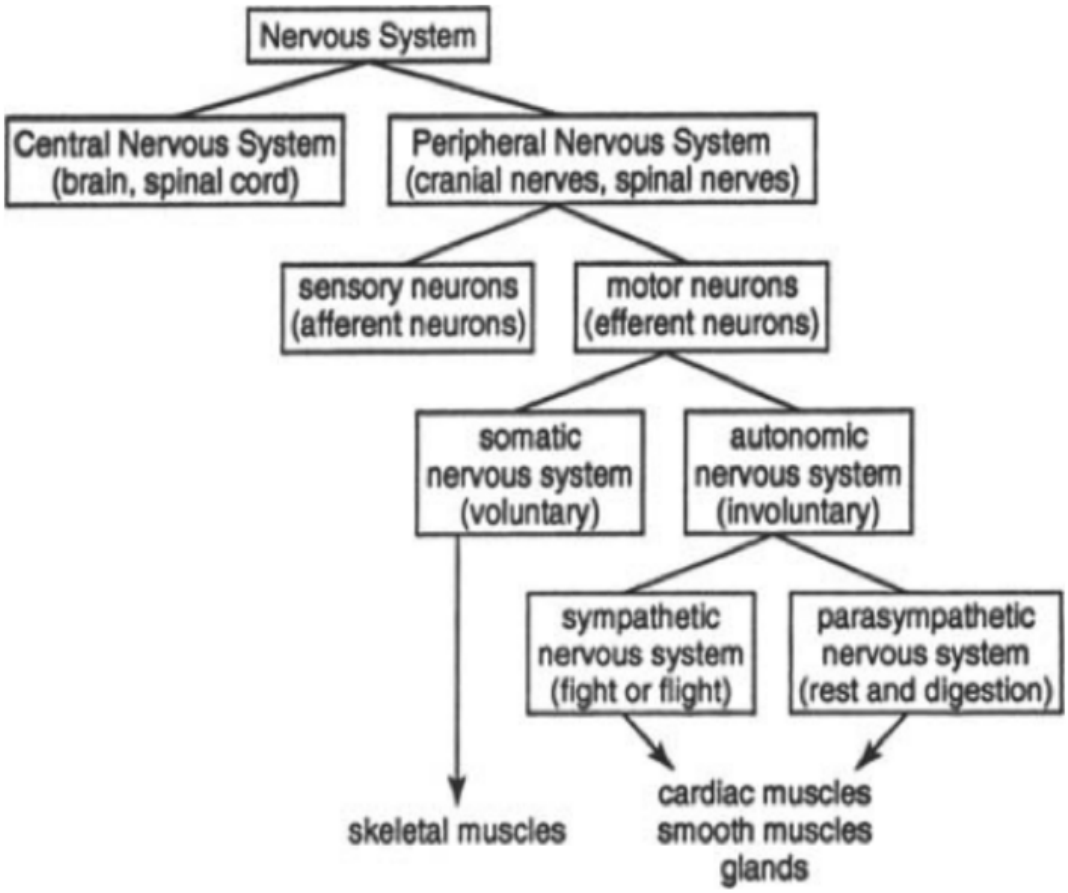
Congestive heart failure High *capillary blood pressure* causes more fluid that usual to filter out of the *capillaries* and into the *interstitial space*, causing fluid congestion.

2.14 Ch. 11

2.14.1 The Nervous System

The nervous system has two major subdivisions: the *central nervous system* (CNS), consisting of the *brain* and *spinal cord*, and the *peripheral nervous system* (PNS), which includes all parts of the nervous system that lie outside the CNS. The motor division of the PNS has a *somatic division*, which controls *skeletal muscles*, and an *autonomic division*, which controls *smooth muscles*, *cardiac muscles*, and *glands*.

The nervous system is the body's main control system. Controls physical movements, maintains homeostasis of many internal variables, and even initiates our higher thought processes and emotions.



Central nervous system {CNS} Consists *exclusively* of the *brain* and *spinal cord*; all other nervous tissue is considered to be part of the peripheral nervous system

Brain An organ of soft nervous tissue contained in the skull.

Spinal cord Bundle of *nervous tissue* and *support cells* that extends from the *medulla oblongata* in the brain stem to the lumbar region of the vertebral column.

Peripheral nervous system {PNS} All nervous tissue considered not to be part of the brain or spinal cord.

Sensory nerves {afferent nerves} Nerves that collect information from your surrounds or from parts of your body and transmit it *toward* the CNS for processing.

- Signals from external environment
- Signals from skin, tendons, and muscles
- Signals from internal organs

Motor nerves {efferent nerves} Nerves that transmit commands *away* from the CNS to muscles, organs, glands, and vessels in response to information collected from the sensory nerves.

Also *motor neuron*, a nerve cell whose cell body is located in the spinal cord and whose fiber (*axon*) projects outside the *spinal cord* to directly or indirectly control effector organs. They are *efferent nerve fibers*.

Somatic nervous system Controls voluntary and involuntary skeletal muscle movement.

Autonomic nervous system Made up of involuntary pathways that control *smooth muscle*, *cardiac muscle*, and *glands*. Further divides into two systems...

Sympathetic [flight or flight] Excitatory pathway that helps your body in times of stress by elevating blood pressure, heart rate, respiratory rate, and the volume of blood flow to muscles.

Parasympathetic [rest and digest] System most active in tames of relaxation, and it stimulates gland secretions and digestive processes while dampening sympathetic effects.

Neuroglia Specialized connective tissue cells of the nervous system. They do not generate or transmit impulses. Some secrete a special substance called *myelin*. Neuroglial cells support and protect *neurons*. Neuroglial cells called *Schwann cells* (in the PNS) and *oligodendrocytes* (in the CNS) form *myelin sheaths* that protect *axons* and speed transmission of impulses.

In the PNS, many *neuron axons* are enclosed and protected by *neuroglial cells* called *Schwann cells*. In the CNS, they are oligodendrocytes.

Greek // neuron, glue

Schwann cells Neuroglia that secrete *myelin* in the *peripheral nervous system*. Schwann cells wrap themselves around a short segment of an axon many times as a sort of insulating blanket, creating a shiny white protective layer around the axon called a *myelin sheath*.

Principal *glia* of the peripheral nervous system

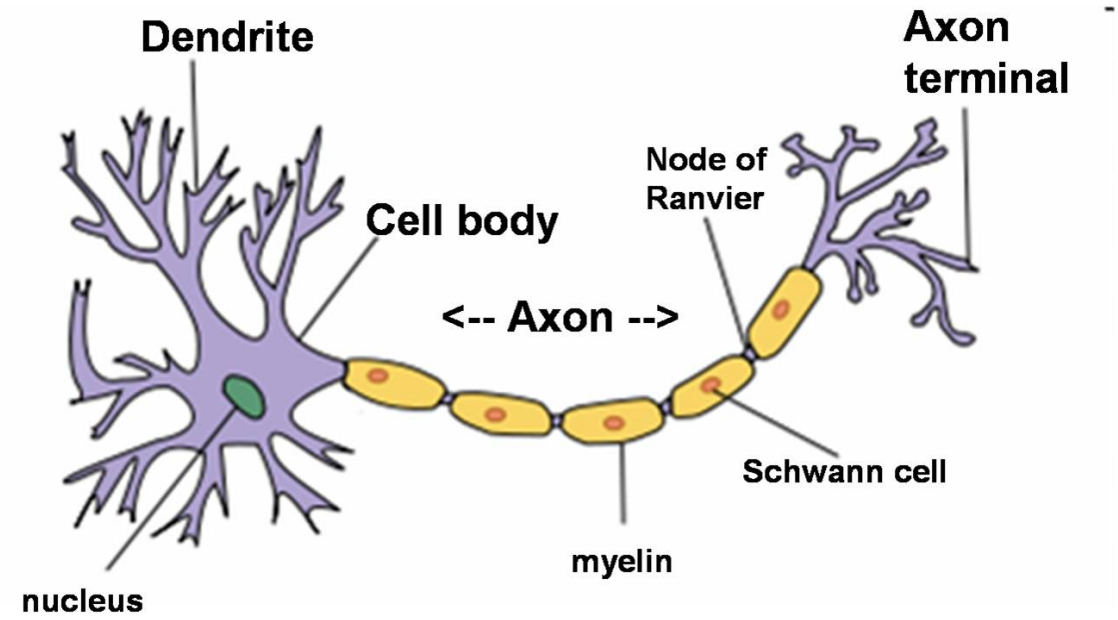
Oligodendrcytes Neuroglia that secrete myelin in the *central nervous system*. Unlike the sheath formed by Schwann cells, the sheath formed by oligodendrocytes degenerates once the axon it protects is destroyed, so the neurons of the central nervous system do not regenerate after injury–this is why spinal cord injuries and CNS disorders result in a permanent change or loss of function.

- Do Oligodendrocytes send nerve signals? **NO**, no *neuroglia* send signals.

Astrocytes neuroglial cells that form barriers around the neurons, shielding them from direct contact with substances carried in the blood. Form the basis of the blood-brain barrier.

Myelin sheath Surrounds the *axon* of some nerve cells forming an electrically insulating layer around the neuron. White in color.

Three important functions: **1)** It saves the *neuron* energy, **2)** speeds up the transmission of impulses by preventing nearly all leakage of charged ions across the axon membrane causing action potentials to jump between nodes of Ranvier causing the *saltatory conduction*, and **3)** it helps damaged or severed axons of the peripheral nervous system regenerate.



Nerve

Neurons Cell present in the nervous system highly specialized for communication.

Carry electrical impulses in nervous tissue. Myelinated neurons can transmit electrical impulses more quickly than unmyelinated neurons.

Also *interneurons* within the CNS transmit impulses between components of the CNS. *Interneurons* input from sensory neurons, integrate this information, and influence the function of other neurons.

Axon long, slender projection of a nerve cell, or *neuron*, that typically conducts electrical impulses away from the neuron's cell body. Contains a small amount of *cytoplasm*. Each axon terminal ends in a small, rounded tip called an *axon bulb*.

Dendrite Branched projections of a *neuron* that act to propagate the electrochemical stimulation received from other neural cells to the cell body, or *soma*.

- Greek *déndron* tree

Soma Bulbous end of a *neuron* containing the *cell nucleus*. The survival of some sensory neurons depends on *axon terminals* making contact with sources of survival factors that prevent apoptosis.

- Greek *somas* body

Apoptosis process of programmed cell death that occurs in multicellular organisms. Between 50 and 70 billion cells die each day due to apoptosis in the average human adult.

- Ancient Greek *apoptosis* a falling off

Node of Ranvier [myelin sheath gaps] Periodic gaps in the insulating *myelin sheath* of myelinated axons where the axonal membrane is exposed to the extracellular space.

2.14.2 Neurons initiate action potentials

There are millions of these *Sodium* and *Potassium* gates. Neurons generate and transmit electrical impulses from one part of the body to another. Sensory neurons transmit impulses to the CNS. Interneurons transmit impulses between components of the CNS. Motor neurons transmit impulses away from the CNS to muscles and glands.

Action potential is greater in larger-diameter axons and in axons covered by an *insulating sheath*. A neuron's *resting potential* of about -70 millivolts is maintained by the constant action of the sodium-potassium pump. Impulses arriving from other neurons can cause small, local changes in the neuron's membrane potential called *graded potentials*. The sum of all graded potentials may initiate a self-propagating, all-or-none action potential in a neuron. An action potential involves *three events*: depolarization, repolarization, and reestablishment.

Depolarization *Sodium* moves into the axon. When threshold is exceed, voltage-sensitive Na^+ channels in the axon's membrane open briefly and Na^+ ions diffuse rapidly *into* the cytoplasm of the axon.

Repolarization *Potassium* moves out of the axon. After a short delay, Na^+ channels close automatically. But the reversal of the membrane polarity triggers the opening of K^+ channels that allows K^+ ions to diffuse rapidly *out* of the cell.

Reestablishment K^+ channels are slow to close, so there is a brief overshoot of membrane voltage during which the interior of the *axon* is slightly hyperpolarized. Shortly after the K^+ channels close, the resting potential is reestablished.

2.14.3 Information is transferred from a neuron to its target

At the axon terminal of a neuron, the action potential and its information must be converted to another form for transmittal to its target (muscles cell, gland cell, or another neuron). It reaches a junction called a *synapse*, where a chemical is released called a *neurotransmitter* because it transmits a signal from a neuron to its target.

synapse A junction where information is converted from one form to another.

presynaptic membrane The cell membrane of the neuron that is sending the information.

postsynaptic membrane The membrane of the cell that is about to receive the information.

synaptic cleft Fluid-filled gap that separates the pre- and post- synaptic membranes.

neurotransmitter

2.14.4 regions of the brain

Parietal lobe Interprets sensory information from skin.

Occipital lobe Processes visual information.

Frontal lobe Initiates motor activity. Responsible for speech. Conscious thought.

Temporal lobe Interprets auditory information. Comprehends language. Perceptual judgment.

Prefrontal cortex (PFC) The *cerebral cortex* which covers the front part of the *frontal lobe*. Implicated in planning complex cognitive behavior, personality expression, decision making, and moderating social behavior.

2.14.5 parts of the brain

Pituitary gland Referred to as the 'master gland', but is about the size of a pea. Protrusion off the bottom of the *hypothalamus* It controls several of the other *hormone glands* (e.g. *adrenals*, *thyroid*). It sits in a bony hollow called the *pituitary fossa* (it was called *sella turcica* elsewhere as well).

amygdala A part of the *limbic system* in the *temporal lobe*. When the amygdala senses threat, it becomes over-activated, blocking new sensory information from accessing the memory and association circuits.

THIS MEANS THAT IF A STUDENT IS STRESSED OUT, THEY ACTUALLY CAN NOT LEARN. THE AMYGDALA IS BLOCKING information from going to higher cognitive centers of the brain, like the *prefrontal cortex* where information is processed, associated, and stored for later retrieval and executive functioning

1. **Forebrain** Determines most complex behavior, including emotions and conscious though. Important to the forebrain is *hypothalamus* and *thalamus*, *limbic system*, and *cerebrum*.

   The hypothalamus and thalamus maintain homeostasis and process information. The hypothalamus is a small region at the base of the forebrain that coordinates some automatic functions of the *pituitary gland*.

   Cerebrum Coordinates language. Controls decision making. Produces conscious thought.

   Corpus callosum Bridges the two cerebral hemispheres.

   Thalamus Receives, processes, and transfers information.

   Hypothalamus Part of the *limbic system*. Works mostly with the *autonomic nervous system*.

2. Midbrain Most function of the midbrain relate to vision and hearing. Visual and auditory sensory inputs pass through the midbrain before being relayed to higher brain centers.

Midbrain Relays visual and auditory inputs. Coordinates movement.

3. **Hindbrain** The evolutionarily oldest, more primitive hindbrain controls must automatic activities.

   Medulla oblongata Controls automatic functions of internal organs.

   Pons Connects cerebellum, spinal cord with higher brain centers. Aids medulla in regulating respiration.

   Cerebellum Controls basic and skilled movements.

2.14.6 misc vocabulary

saltatory conduction Leaping pattern of conduction along myelinated neurons.

- Latin *saltare* dance

Neuroplasticity Plasticity is the capacity of the brain to change with learning. There are three circumstances where neuroplasticity occurs in the brain:

1. At the beginning of life: when the immature brain organizes itself.
2. In case of brain injury: to compensate for lost functions or maximize remaining functions.
3. Through adulthood: whenever something new is learned and memorized.

2.14.7 Common neurotransmitters

NTS stands for Neurotransmitter Senses. Chemical messengers, are endogenous chemicals that enable neurotransmission.

Neurotransmitters do not use a transport system.

Neurohormone Just a hormone.

Acetylcholine Excitatory on skeletal muscles; excitatory or inhibitory at other sites, depending on receptors. Neurotransmitter used at the *neuromuscular junction*—it is the chemical that *motor neurons* of the nervous system release in order to activate muscles.

- *Neuromuscular junctions*, *autonomic nervous systems*, *brain*
- binds muscle cell(s)—causes depolarization.

Norepinephrine [noradrenaline] Excitatory or inhibitory, depending on receptors, plays a role in emotions. Synthesized and released by *central nervous system* and also by the *sympathetic nervous system*. Norepinephrine is produced in closely packed *brain cell neurons*. Exert powerful effect on the brain. Sympathetic ganglia, located in the *spinal cord* or in the *abdomen*, uses norepinephrine; norepinephrine also is released directly into the bloodstream by the *adrenal glands*. Mobilizes the brain and body for action.

- Latin *noradrenaline* at or alongside the kidneys
- Areas of brain and spinal cord, autonomic nervous system

Serotonin Usually inhibitory; involved in moods, sleep cycle, appetite

- Areas of brain, spinal

Dopamine Excitatory or inhibitory, depending on receptors; plays a role in emotions

- Areas of brain, parts of peripheral nervous systems

Glutamate Usually excitatory; major excitatory neurotransmitter in brain. By a wide margin, *glutamate* is abundant neurotransmitter in the vertebrate nervous system. well over 90% of the synaptic connections in the human brain happen with *glutamate*.

- Areas of brain, spinal cord

Endorphins Natural opiates that inhibit pain; usually inhibitory

- Many areas in brain, spinal cord

Gamma-aminobutyric acid Usually inhibitory; principal inhibitory neurotransmitter in brain

- Areas of brain, spinal cord

Somatostatin Usually inhibitory; inhibits pancreatic release of growth hormone

- Areas of brain, pancreas

3 other

3.1 Medical Professions

Cardiology Medical science dealing with the heart and heart diseases.

- Latinized Greek *cardia, kardia* "heart"

Dermatology Study of the skin and its diseases.

- Latin *derm* "skin"

Endocrinology Study of the hormones, hormone-secreting glands, and their diseases.

- Latin *endo* "within"

Epidemiology Study of the factors determining the distribution and frequency of the occurrence of health-related conditions within a defined human population.

- Latin *epi* "upon, among" *demos* "people"

Gastroenterology Study of the stomach and intestines and their diseases.

- Latin *gastro* "stomach" *entero* "intestines"

Geriatrics Branch of medicine dealing with older individuals and their medical problems.

- Latin *geros* "old"

Gynecology Study of the female reproductive system and its diseases.

- Latin *gyno* "pertaining to women"

Hematology Study of the blood and blood diseases.

- Latin *hem* "blood"; also *hemo* and *hemato*

Histology Study of the structure and function of tissues, also called microscopic anatomy.

- Latin *hist* "tissue"

Immunology Study of the body's resistance to disease.

- Latin *im-* "negation"

Neonatology Study of newborns.

- Latin *neo* "new"

Neurology Study of the nervous system and its disorders.

- Latin *neuro* "nerve"

Obstetrics Branch of medicine dealing with pregnancy and childbirth.

- Latin *obstare* "to stand by"

Oncology Study of cancers

- Latin *onco* "cancer"

Ophthalmology Study of the eye and eye diseases

- Latin *onco* "cancer"

Orthopedics Branch of medicine dealing with the muscular and skeletal systems and their problems.

- Greek *orthos* "correct"

Otolaryngology Study of the ear, nose, and throat (larynx), and their diseases.

- Latin *ot* "ear" *lary* "larynx"

Pathology Study of structural and functional changes that disease produces.

- Greek *pathos* "suffering, disease"

Pharmacology Study of drugs and their uses in the treatment of disease.

- Latin *pharm* "drug"

Psychiatry Branch of medicine dealing with the mind and its disorders.

- Greek *psyc* "the mind"

Radiology Study of X-rays and radioactive substances and their uses in the diagnosis and treatment of diseases.

- Latin *radio* "wireless transmission"

Toxicology Study of poisonous substances and their effects upon body parts.

- Latin *toxi* "poison"

Urology Branch of medicine dealing with the urinary system, apart from the kidneys (nephrology), and male reproductive system, and their diseases.

- Latin *uro* "urine"

3.2 lab

3.2.1 vocabulary (lab 2)

concentration gradient relative difference in concentration

crenation [process] shriveling of the cell or the movement of water out of the cell

diffusion [process] a *solutes* move from an area of higher to an area of lower concentration

equilibrium concentration of salt on both sides of the membrane is the same

hypertonic solution has greater *solute* concentration than another solution

hypotonic solution has lesser *solute* concentration than another solution

isotonic solution have equal number of total molecules suspended

lyse [process] rupturing of the cell or the movement of water into the cell

osmosis [process] *solvent* molecules travel down their concentration gradient

solution contains two parts, the *solvent* and the *solute*

solvent dissolving agent of a solution

solute the molecules suspended in the solvent

3.2.2 lab vocabulary (lab 3)

genome complete copy of information

protease an enzyme that breaks down proteins and peptides

lysis the disintegration of a cell by rupture of the cell wall or membrane

gene specific stretch of DNA transcribed into messenger RNA *mRNA*

DNA Deoxyribonucleic acid

RNA Ribonucleic acid

mRNA messenger Ribonucleic acid

Cellular organisms use mRNA to convey genetic information (using G, U,A, and C to denote the nitrogenous bases guanine, uracil, adenine, and cytosine)

tRNA transfer RNA

Deliver amino acids to the ribosome, where ribosomal RNA (rRNA) then links amino acids together to form protein pairs.

cardiomyocyte Shorten and lengthen their size to proper form during the beating of the heart.

Make up the *atria* where blood enters the heart.

(phase one) systole Rest phase, considered polarized.

(phase two) diastole

genotype Genetic constitution of an individual organism.

A listing of *alleles*.

dominant (vs. recessive) Always expressed when present in individual's genome. *Recessive alleles* get masked by *dominant alleles*.

transcription [process] make a complementary strand of mRNA from genomic *DNA*.

phenotype Results of the interaction of its genotype with the environment. Observable.

homozygous Both individual's *alleles* for a specific trait are the **same**.

heterozygous Both individual's *alleles* for a specific trait are **different**.

codominance *Alleles* don't encode A or B. Both alleles are expressed equally. Observable in individuals with the blood type AB.

incomplete dominance Can occur with *heterozygous phenotypes*.

This is the red flower and a white flower make a pink flower type of thing.

translation [process] *ribosomes* build proteins out of their sub-unit pieces called *amino acids*.

allele (vs. gene) Alternative versions of a *gene*. One has two potentially different copies of each gene.

antibody (vs. antigen) *Protein* displayed on the surface of the cell. RBCs created from DNA that encodes the type A allele which each display the type A antigen, or protein on the outside of the cell membrane. Type B cells display type B surface protein.

***case* OO** This person has inherited no genes for surface antigens and thus has no surface antigens displayed on the surface of their RBCs.

Transcription

Carbohydrate *polysaccharides* long chains of sugars. Provide the body with a source of fuel and energy

Lipid Long hydrocarbon chains with a large amount of energy, energy storage molecules. Energy storage mechanic of the body.

Glycolipids Contains oligosaccharides with 1-15 saccharide residues.

Phospholipids Contain positively charged head linked to the negatively charged phosphate groups.

Serols head contain a steroid ring.

Protein Many different functions like, structural support, help in body movement, defense against germs and infections.

Monosaccharides simple sugars composed of 3-7 carbon atoms. Monosaccharides and disaccharides are sweet, crystalline and water soluble substances.

glycosidic bonds

free aldehye *reducing sugars* reducing agents

free ketone *reducing sugars* reducing agents

Nucleic Acid Large biomolecules essential for all know forms of life. They function in encoding, transmitting, and expressing genetic information.

Sugar Sweet, short-chain *carbohydrates*, many of which are used in food.

3.2.3 vocabulary (lab 4)

theory Refers to a broad theme of concepts that unify a single topic.

natural selection Organisms that are better adapted for their environment will reproduce more successfully.

evolution Better adapted organisms create a higher distributions of allele frequencies in a population over time.

fitness An individual's ability to reproduce.

1. data

   replicate Snapshot of data that shouldn't be changed, but rather adapted into more readable format for other things

3.3 important

3.3.1 cells

Eukaryote Have membrane-bound organelles, especially the nucleus, which contains the genetic material and is enclosed by the *nuclear envelope*.

Prokaryote A single-celled organism that lacks a membrane-bound nucleus, mitochondria, or any other membrane-bound organelle.

All the intracellular water-soluble components (proteins, DNA, and metabolites) are located together in the cytoplasm enclose by the cell membrane.

cytoplasm Material or protoplasm within a living cell, excluding the cell nucleus.

Nucleus Contain most of the cell's genetic material, organized as multiple long linear DNA molecules in complex with a large variety of proteins like *histones* and *chromosomes*.

- Latin *nucleus* kernel, seed

Nucleolus Largest structure in the nucleus of eukaryotic cells, primarily serving as the site of ribosome synthesis and assembly.

Ribosomes Complex molecular machine, serving as the site of biological protein synthesis (translation). Link amino acids together in the order specified by mRNA molecules.

Endoplasmic reticulum Organelle in eukaryotic cells. Forms interconnected network of flattened, membrane-enclosed sacs or tube-like structures known as *cisternae*.

Folds protein molecules in sacs called *cisternae*. Transport synthesized proteins in *vesicles* to the *Golgi apparatus*.

Golgi apparatus Organelle part of the cellular endomembrane system. Packages proteins into membrane-bound vesicles inside the cell before being sent to destination.

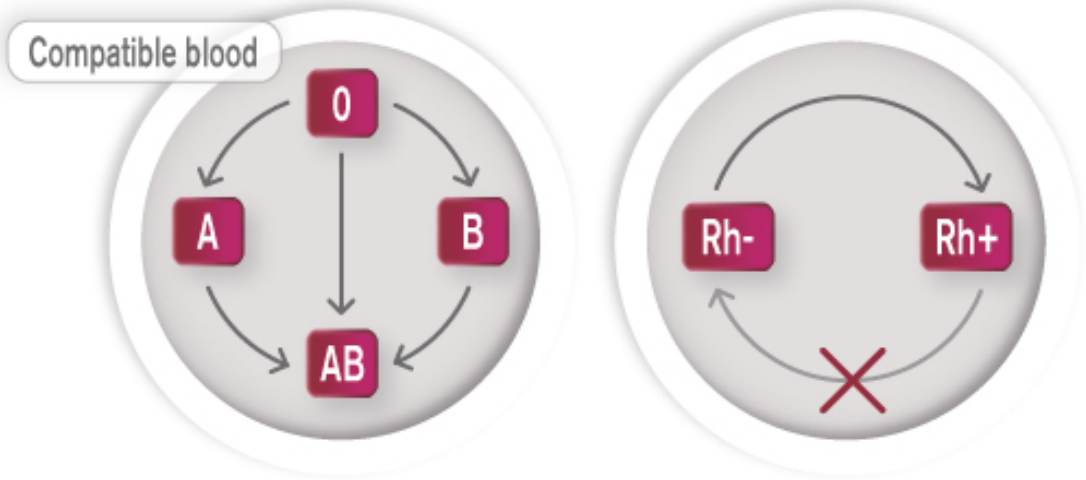
Various vesicles Small structure within a cell; a fluid enclosed by a *lipid bilayer*. Used to carry things (?)

Mitochondria The powerhouse of the cell. Generate most of the cell's adenosine triphosphate (ATP).

Cytoskeleton Complex network of interlinking filaments and tubules that extend throughout the cytoplasm. The function of this depends highly on the cell in question.

Cilia and flagella Projections from the cell. Move the cell itself or move substances over or around the cell.

3.3.2 Blood typing



agglutination mixtures have clumping

- Blood agglutinating means the bloods mixed are not compatible with the kind of antibody.
- No agglutination in tube with A antibodies means patient's RBC do not have A antigens.
- Agglutination in tube with B antibodies means patient's RBC have B antigens.
- No agglutination in the Rh tube means the patient's RBC do not have Rh antigens, so the blood is Rh-.

ABO blood system **O** receives O

A receives A and O

B receives B and O

AB receives AB, A, B, and O

Rh blood system **Rh+** receives Rh+

Rh- receives Rh-

O Rh- *universal donor*

3.3.3 Anatomy and Levels of Organization

1. Explanation of levels

   (a) Atom
   Smallest unit of an element of matter.

   (b) Molecule
   More than one atom in a stable association.

   (c) Cell
   Smallest Unit of Life.

   (d) Tissue
   An association of *cells* with the same general structure and function.

      i. Epithelium :: animal tissue that lines the cavities and surfaces of blood vessels and organs throughout the body.
         - Latin *epi-* "on" *thele* "nipple"

   (e) Organs & Organ Systems
   An ossociation of several tissue types that carry out a specific function. Two more organs work together to carry out a general function in an *organ system*.

   (f) Organism
   An individual living being composed of several organs or organ systems.

   (g) Population
   A group of individuals of the same species living in the same area.

   (h) Community
   Several populations of different species who inhabit the same area and interact with each other.

   (i) Ecosystem
   All of the organisms in a given area plus all of the nonliving matter and energy.

   (j) Biosphere
   All ecosystems combined. The portion of Earth occupied by living organisms, plus those organisms.

2. Organs & Organ Systems

   An association of several tissue types that carry out a specific function. Two more organs work together to carry out a general function in an *organ system*.

   integumentary skin, hair, nails

   integument natural covering, as a skin, shell, or rind

- Latin *integumentum* a covering; from *integere* to cover

skeletal bones, as well as ligaments, and cartilages

- modern Latin *sceleton* bones, bony framework of a the body; greek *skeleton soma* dried-up body, mummy, skeleton from *skeletos* dried-up or *skellein* dry up, make dry, parch; PIE root *skele-* to parch, wither

muscular muscles

- French *muscle* muscle; Latin *musculus* a muscle, literally little mouse, diminutive of *mus* mouse

nervous brain, spinal cords, nerves, sense organs

- Latin *nervosus* sinewy, vigourous *nervus* sinew, nerve

endocrine endocrine glands and hormones, pituitary gland

collection of glands of an organism that secrete hormones to the circulatory system

- Latinized Greek *endo*; Greek *krinein* to separate, distinguish

digestive mouth, tongue, teeth, salivary glands, pharynx, esophagus, stomach, liver, gall-bladder, pancreas, small intestine, and large intestine

- Old French *digestif*; Latin *digestivus* pertaining to digestion Latin *digerere* digest

cardiovascular heart, arteries, veins, capillaries, and blood

- modern Latin *vascularis* of or pertaining to vessels or tubes; Latin *vasculum* a smell vessel; *vas* [diminutive] vessel; Latinized Greek *cardia, kardia* heart

lymphatic lymphatic vessels, lymph fluid, lymph nodes, thymus gland, and spleen are all part of the circulatory system; vital part of immune system; carrying clear fluid called *lymph* directly towards the heart.

- Latin *lymphaticus* from *lympha* water (or mad, frenzied)

respiratory nasal cavity, pharynx, larynx, trachea, bronchi, and lungs

- modern Latin *respiratorius* French *respiratoire* Latin *respirationem* breathing, respiration

urinary kidneys, ureters, urinary bladder, and urethra

- modern Latin *urinarius*; Latin *urina* urine

reproductive (male) scrotum, testes, prostate gland, penis, and urethra

- French *reproduire*; Old French, Latin *re-* again, back, anew, against; Latin *producere* lead or bring forth, draw out

reproductive (female) ovaries, uterine tubes, uterus, vagina, and clitoris

- French *reproduire*; Old French, Latin *re-* again, back, anew, against; Latin *producere* lead or bring forth, draw out

3. Issues and controversies

The slide makes a point that each of these has a corresponding level of problem which needs to be dealt with as well. For example, on a community we need to consider problems about animal life that we impact, or on a cellular level we need to deal with cloning adult animals, plants, and humans from a single cell.