McKinley/O'Loughlin/Bidle
***Anatomy and Physiology: An Integrative Approach*, 2/e**
Instructor Answer Key to In-chapter and End-of-chapter Questions

Chapter 1
Answers to "What Did You Learn?"

1. Comparative anatomy.

2. Anatomy is the study of structure and form. Physiology is the study of how the structures function.

3. Cardiovascular.

4. Anatomists focus on the form and structure of the small intestine. They examine the cells and tissues that form the small intestine, and describe the layers of the small intestinal wall. Physiologists focus on the function of the small intestine. They examine how the muscle of the smooth intestine propels food through the digestive tract and describe the process by which nutrients are broken down and absorbed. Both anatomists and physiologists know that form and function of the small intestine are interrelated.

5. The ability of organisms to respond to stimuli such as changes in either their external or internal environment provides them with a mechanism for maintaining a constant internal environment, even as the environment around them changes.

6. A higher level of organization does contain all of the levels beneath it. Each level of organization is a function of the arrangement of its subsequent subunits, which are in turn a function of the organization of their subunits. Therefore, each level organization is dependent on the organization of all of the levels below.

7. The urinary system is responsible for filtering and removing waste products from the blood.

8. A transverse plane, also called a horizontal or cross-sectional plane, would divide the mouth into superior and inferior sections.

9. Proximal.

10. The term *antebrachial* refers to the forearm, the portion of the upper limb between the elbow and wrist.

11. The lungs are located within the thoracic cavity. The serous membranes surrounding them consist of the parietal pleura lining the inside of the body wall and the visceral pleura lining the individual lungs.

12. Epigastric.

13. A homeostatic system consists of a receptor such as a sensory neuron in the skin or a stretch receptor within a muscle that detects either an internal or external stimulus, a control system that integrates the input from the receptor such as the brain or an endocrine gland, and an effector such as a muscle or a gland that causes changes in response to the stimulus.

14. The body may respond to a drop in temperature by decreasing the diameter of blood vessels carrying blood to the surface of the skin, thereby decreasing the amount of heat lost to external environment. Another response involves stimulation of skeletal muscles, causing "shivering" and thereby generating heat internally.

15. Negative feedback systems involve responses that are in opposition to the stimulus, thereby maintaining the environment near the set point or normal level. Conversely, positive feedback systems entail a series of responses, each increasing in intensity, until a climax event is reached, at which point the system will return to homeostasis.

16. Diabetes, an inability of the body to maintain blood sugar levels, may result in damage to anatomical structures throughout the body due to high levels of glucose.

Answers to "Do You Know the Basics?"

1. B
Feedback: *Surface anatomy* correlates superficial markings on the surface of the body and skin to deeper anatomical features.

2. C
Feedback: *Organs* are often composed of several tissue types working in concert to perform a common function.

3. A
Feedback: An organism's *metabolism* is the sum of all of its biochemical reactions.

4. C
Feedback: A midsagittal or median plane separates the body into equal *right and left halves* as compared to simply a sagittal section, which separates the body into unequal right and left portions. There can be numerous sagittal planes but only one possible midsagittal section along the midline of the body.

5. D
Feedback: The term *proximal* is used to describe the position of a structure on an appendage closest to the point of attachment to the trunk. Although in standard anatomical position a structure that is proximal is often also superior, proximal is the correct term for describing the position along an appendage. The term superior may be used to describe positions along the axis of the body, closer to the head.

6. A
Feedback: The *patellar* region is the anterior portion of the knee. The popliteal region is the posterior portion of the knee.

7. A
Feedback: The diaphragm comprises the barrier between the superior thoracic cavity and the inferior *abdominal cavity*. The pelvic cavity is located inferior to the superior edges of the pelvic bones.

8. D
Feedback: The pleural cavity surrounding the lungs consists of the parietal pleura lining the internal walls of the thoracic cavity and the *visceral pleura* lining the surface of the lungs.

9. B
Feedback: *Homeostasis* is an automated process for maintaining a constant internal environment.

10. D
Feedback: The *effector* increasing the stimulus is an example of positive feedback. In a negative feedback system, the response moves the system in opposition to the stimulus, back toward the set point.

11. Anatomy is the study of structure and form, whereas physiology is the study of how the structures function. It is important to understand the anatomy of a structure in order to understand how it performs its function. Conversely, understanding the function of an anatomical feature helps to put into perspective the significance of its arrangement.

12. The simplest level of organization within an organism is found at the chemical level and is composed of atoms and molecules. At the cellular level of organization, molecules are organized into cells and subcellular components, forming the basic units of life. Groupings of similar cells performing similar functions are referred to as tissues, and groups of tissues may be found working in concert, forming organs at the organ level of organization. Related groups of organs working together in order to coordinate activities within the organism are called organ systems.

13. A hierarchical organization, metabolism, growth and development, responsiveness, regulation, and reproduction are characteristics common to all living organisms. All living things are arranged in a hierarchical manner with increasing levels of complexity from molecules to cells. They are capable of metabolism, growth and development, and responsiveness to stimuli. They are also able to regulate their internal environment in order to maintain homeostasis, ultimately surviving long enough to reproduce.

14. The human body consists of eleven organ systems. They are the integumentary, skeletal, muscular, nervous, endocrine, cardiovascular, lymphatic, respiratory, urinary, digestive, and reproductive systems.

15. A body in anatomical position is standing upright with the feet flat on the floor. The upper limbs are at the side of the body with palms facing anteriorly. The head is level and the eyes are looking forward. The anatomic position is the point of common reference used by anatomists and physiologists for accuracy and clarity. It provides an initial point of reference, from which all anatomic parts are described.

16. The forearm is the antebrachial region, the wrist is the carpal region, the chest is the thoracic region, the armpit is the axillary region, the thigh is the femoral region, and the entire foot is the pes.

17. The cranial cavity and vertebral canal are located within the posterior aspect of the body. The cranial cavity houses the brain and the vertebral canal contains the spinal cord.

18. The serous membranes are found lining the compartments of the ventral cavity of the body. They consist of a parietal layer lining the inside of the body wall and a visceral layer covering internal organs. In between the two membranes is a potential space, the serous cavity, which contains serous fluid.

19. A homeostatic system consists of a receptor that detects an internal or external stimulus, a control system that integrates the input from the receptor, and an effector such as a muscle or a gland that causes changes in response to the stimulus.

20. Negative feedback systems involve responses that are in opposition to the stimulus, thereby maintaining the environment near the set point or normal level. Conversely, positive feedback systems entail a series of responses, each increasing in intensity until a climax event is reached, at which point the system will return to homeostasis.

Answers to "Can You Apply What You've Learned?"

1. B
Feedback: The pain is coming from a region below the umbilicus, hence it is in the lower portion of the abdomen and it is located on the right side. It is therefore in the *right lower quadrant*.

2. D
Feedback: The *right iliac region* is located just medial to the pelvic bones.

3. B
Feedback: X-rays are not absorbed by soft tissue such as the appendix. They are usually used to visualize dense structures.

4. B
Feedback: Sweat glands release sweat at the surface of the skin.

5. B
Feedback: Serotonin is a neurotransmitter responsible for regulating both pathways associated with depression in the brain and gastric motility in the stomach. Drugs such as SSRIs are used to treat depression in individuals with low levels of serotonin in the brain by inhibiting its reuptake by neurons. Because the SSRI drugs cannot specifically target the brain, they also have an effect within the digestive system, causing nausea and diarrhea.

Answers to "Can You Synthesize What You've Learned?"

1. Lynn has broken the bones within her forearm, the radius and ulna. She has an abrasion on her chin as well as bruising on her buttocks and thigh.

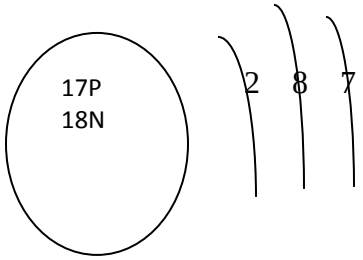
2. The epinephrine counteracted the effect of the bee sting, acting in opposition to the stimulus; it was therefore an example of negative feedback.

3. X-rays and CT scans are optimal for visualizing dense tissues such as tumors. An MRI or ultrasound would be better suited for examining soft tissues.

Chapter 2
Answers to "What Did You Learn?"

1.The mass of an atom is determined by the combined number of protons and neutrons within its nucleus. The charge of an atom is determined by the number of positively charged protons and negatively charged electrons.

2.The nucleus of a chlorine atom consists of 17 protons and 18 neutrons. The electrons are arranged into three separate shells; the first shell closest to the nucleus contains two electrons, the second shell contains eight electrons, and the third outer shell contains seven electrons for a total of 17 electrons.



3. Isotopes are atoms of the same element. They only differ in their number of neutrons, thus they differ in their atomic mass. A radioisotope is unstable because of extra neutrons. Stability can ultimately be reached through the loss of nuclear components in the form of high-energy radiation (e.g., alpha particles, beta particles). Thus, the radioisotope will decay as radiation is released.

4. The octet rule is the tendency for atoms to lose, gain or share electrons to obtain a complete outer shell and thus become chemically stable.

5. Common cations (positively charged ions) of the human body include: sodium ions (Na^+), potassium ions (K^+), calcium ions (Ca^{2+}), magnesium ions (Mg^{2+}), and hydrogen ions (H^+). Common anions (negatively charged ions) include: chloride ions (Cl^-), bicarbonate ions (HCO_3^-), and phosphate ions (PO_4^{3-}).

6. Sodium (atomic number 11), potassium (atomic number 19), calcium (atomic number 20), magnesium (atomic number 12), hydrogen (atomic number 1), and chlorine (atomic number 17) should be highlighted.

7. In order to satisfy the octet rule, atoms may either lose or gain electrons to become chemically stable (have a complete outer shell of electrons). However, a charge is developed because the number of positively charged protons is no longer equal to the number of negatively charged electrons. For example, atoms with only one electron in their outer shell may give up the electron, resulting in a positive cation, now with a full outer shell. Conversely, atoms with seven electrons in their outer shell may accept an electron from another atom, becoming a negative anion, but now with a full outer shell.

8. Ionic bonds are formed due to an attraction between ions with different charges. Therefore, an ionic bond cannot be formed between two cations; nor can it be formed between two anions.

9. The structural formula exhibits the type and number of atoms in a molecule, and their arrangement within the molecule. In comparison, the molecular formula provides information only for the type and number of atoms in a molecule (but not how the atoms are arranged within the molecule).

10. Isomers are molecules composed of the same type and number of elements, but are arranged differently (i.e., they have the same molecular formula, but a different structural formula).

11. A covalent bond is formed when atoms share electrons in their outer orbitals in order to satisfy the octet rule.

12. Nitrogen is more electronegative that hydrogen, thus it is designated with a partial negative charge, whereas hydrogen is less electronegative than nitrogen and is designated with a partial positive charge.

13. A covalent bond between atoms of the same element (with both atoms equally electronegative) will result in electrons being shared equally between the two atoms. Thus, the resulting bond is a nonpolar bond. A covalent bond formed between two different atoms (with one atom more electronegative than the other) will result in electrons being shared unequally between the two atoms. Thus, the resulting bond is a polar bond. The more electronegative atom will have a slightly negative charge and the less electronegative atom will have a slightly positive charge. Note: Because carbon and hydrogen atoms are nearly equal in terms of electronegativity, atoms of these two different elements essentially share electrons equally and form a nonpolar covalent bond between them.

14. Both molecular oxygen (O_2) and carbon dioxide (CO_2) are nonpolar molecules. (This is significant for understanding how these respiratory gases are transported in the blood, a topic that is covered in chapter 23.)

15. A hydrogen bond is a weak attraction between a partially positive hydrogen atom within a polar molecule and a partially negative atom within a polar molecule (usually oxygen, but sometimes nitrogen).

16. Hydrogen bonds are the intermolecular bonds that are significant in determining the properties of water.

17. Surfactant is required to decrease surface tension (the cohesive attraction between water molecules) in the alveoli of the lungs. Body temperature is regulated through sweating because of water's high heat of vaporization. Sweating is less effective on a humid day because of the increased water in the environment that impedes additional water evaporating from the skin.

18. Nonelectrolyte molecules such as glucose dissolve but do not dissociate in water. Electrolytes such as sodium chloride (NaCl) both dissolve and disassociate into constituent ions in water, forming a solution capable of conducting electricity.

19. In an aqueous environment, amphipathic molecules such as phospholipids will orient themselves so that their hydrophobic domains face each other while the hydrophilic portions are exposed to water. This is the basis for the arrangement of phospholipids within a bilayer and a micelle.

20. Each water molecule can disassociate into one positively charged hydrogen ion and one negatively charged hydroxyl ion. It is considered neutral since it has an equal distribution of positive and negative charges.

21. An acid dissociates in water and releases hydrogen ions.

22. pH is a measure of the relative amounts of H^+ in a solution. The relationship between $[H^+]$ and pH is inverse. As $[H^+]$ increases, pH decreases, whereas as $[H^+]$ decreases, pH increases.

23. A buffer helps prevent pH changes if either excess acid or base is added. It acts either to accept H^+ from excess acid or donate H^+ to neutralize excess base. (Buffers act as H^+ sponges, absorbing H^+ if acid is added and releasing H^+ if base is added.)

24. Blood would be characterized as a suspension because blood cells settle to the bottom of a tube when left standing.

25. Blood is also considered a colloid because it contains a mixture of proteins within the liquid portion of the blood, and it is a solution because it contains salts, glucose and other dissolved nonprotein substances in the plasma.

26. The concentration of a solution may be expressed as (1) mass of solute per volume of solution [mass/volume], (2) grams of solute per 100 milliliters (mL) of solution [mass/volume percent], (3) moles of solute per liter of solution [molarity], and (4) moles of solute per kilogram of solvent [molality].

27. Biological molecules typically contain carbon (C), hydrogen (H), and oxygen (O) and in some cases may also contain nitrogen (N), phosphorus (P), and sulfur (S). Hydrogen is the element that both (a) forms a common ion and (b) is a common element in biomolecules.

28. Carboxylic acids and phosphates are capable of acting as acids.

29. A polymer is composed of repeating monomer subunits. Proteins are composed of amino acid monomers, carbohydrates contain sugar monomers, and nucleic acids have nucleotide monomers.

30. Lipids are fatty, water-insoluble, hydrophobic molecules and do not typically dissolve in water.

31. Phospholipids are amphipathic molecules that form chemical barriers of cell membranes. They contain both a hydrophilic head group (that dissolves in water) and a pair of hydrophobic fatty acid tails (that do not dissolve in water), making them ideally suited for forming cellular membranes.

32. Glycogen is composed of repeating glucose monomers or subunits and is stored by animals within the liver and skeletal muscle cells.

33. Fructose, galactose, and glucose are monosaccharides. Sucrose, maltose, and lactose are disaccharides. Glycogen and starch are polysaccharides.

34. Nucleic acids store and transfer genetic information within cells. They ultimately determine the types of proteins synthesized within cells.

35. RNA molecules contain a ribose sugar in their nucleotides rather than the deoxyribose sugar that is within the nucleotides of DNA. The nucleotides of both RNA and DNA may contain the nitrogenous bases of adenine, guanine, and cytosine. The base uracil is present within nucleotides of RNA. In comparison, the base thymine is present in the nucleotides composing DNA. RNA is a single strand, whereas DNA is a double strand (double helix).

36. Amino acids are the monomers of a protein and they are covalently linked by peptide bonds.

37. A dipeptide consists of 2 amino acids, an oligopeptide contains 3 to 20 amino acids, a polypeptide contains 21 to 199 amino acids, and a protein consists of 200 or more amino acids. The term *protein* is generally used to refer to oligopeptide, polypeptide and protein.

38. The R group of leucine is a nonpolar hydrocarbon, making it a nonpolar amino acid.

39. The tertiary structure refers to the three-dimensional shape exhibited by *one* completed polypeptide chain. The quaternary structure refers to the three-dimensional shape of *two or more* polypeptide chains that form the functional protein.

40. Denaturing a protein changes its conformation and affects its activity. Exposure of a protein to higher than normal concentration of hydrogen ions (a decrease in pH) results in the positively charged H^+ binding with negatively charged structures that were participating in electrostatic interactions that were holding the protein in its final shape. The loss of these electrostatic interactions between the amino acids that compose the protein results in its unfolding (or denaturation).

Answers to "Do You Know the Basics?"

1. C
Feedback: *Isotopes* are atoms of the same element that have the same number of protons and electrons, but differ in the number of neutrons.

2. A
Feedback: *Lipids* are hydrophobic molecules and are not soluble (do not dissolve) in water.

3. C
Feedback: Water has a high *specific heat*, allowing it to absorb and release energy without changing temperature. In addition, the high *heat of vaporization* for water allows it to dissipate a large amount of energy during evaporative cooling of the skin.

4. D
Feedback: A pH less than 7.0 is acidic and a pH greater than 7.0 is basic.

5. D
Feedback: The formed elements of blood act as a suspension. Dissolved proteins in the plasma act as a colloid. The numerous dissolved solutes also make blood a solution.

6. A
Feedback: *Triglycerides* are not considered polymers because they are not composed of repeating monomer subunits.

7. C
Feedback: Glucose is stored in animal tissues as *glycogen*.

8. B
Feedback: Although phosphates which contain phosphorus are common ions in the body, phosphorus itself is not a common ion.

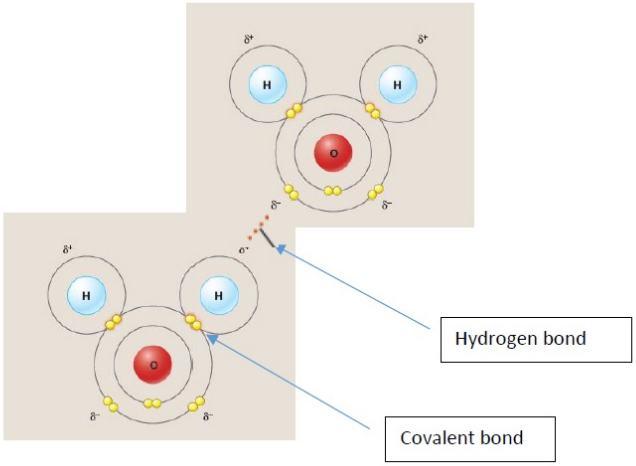
9. B
Feedback: A *hydrogen bond* is an intermolecular attraction between a slightly positive hydrogen atom within a polar molecule and a slightly negative atom (e.g., oxygen, nitrogen) in a polar molecule.

10. B
Feedback: *Denaturing* a protein changes its conformation. Excessive denaturation can permanently affect protein structure and possibly its function as well.

11. Common cations of the human body include sodium ions (Na^+), potassium ions (K^+), calcium ions (Ca^{2+}), magnesium ions (Mg^{2+}), and hydrogen ions (H^+). Common anions include chloride ions (Cl^-), bicarbonate ions (HCO^{3-}), and phosphate ions (PO_4^{3-}).

12. Polar bonds have varying degrees of unequal electron sharing between two different atoms, except for C-H, an oxygen atom bonded to a hydrogen atom. Oxygen, the more electronegative of the atoms, will have a stronger pull on the electrons and will thus have a slightly more negative charge around it, while the hydrogen atom will be relatively more positive (or less negative). A polar molecule is a molecule that contains a prevalence of polar bonds between the atoms that compose it. For example, water is a polar molecule composed of two polar covalent bonds between the oxygen atom and each hydrogen atom.

13.



14. Polar molecules (e.g., glucose) will dissolve in water because hydrogen bonds are formed between the water and the polar molecules. The polar molecule does not dissociate, remaining intact as in this example of a glucose molecule. In comparison, ionic compounds both dissolve and dissociate. Ionic compounds such as sodium chloride (NaCl) will disassociate in water because the polar water molecules will disrupt the electrostatic interactions between sodium and chloride ions, thereby separating them.

15. An acid contributes hydrogen ions to a solution, making it more acidic (having a lower pH). A base binds hydrogen ions from a solution, making it more basic (having a higher pH). pH is the measure of hydrogen ions in a solution. A buffer is capable of either absorbing or releasing hydrogen ions, thereby helping to prevent pH changes when acids or bases are added.

16. The concentration of a solution may be expressed as either the ratio of the mass of solute compared to the volume of the solution (mass/volume), as the percent of mass of solute in 100 milliliters of solution (mass/volume %), as the number of moles of solute per liter of solution (molarity), or the number of moles of solute per kilogram of solvent (molality).

17. Proteins are composed of amino acids (repeating units); carbohydrates are composed of simple sugars (repeating units); nucleic acids are composed of nucleotides (repeating units); but lipids are **not** composed of repeating units. There are four primary types of lipids: triglycerides (composed of glycerol and fatty acids); phospholipids (composed of glycerol, two fatty acids, a phosphate, and various organic groups); steroids (cholesterol, steroid hormones, and bile salts—composed predominantly of hydrocarbons that differ in the side chains extending from the rings); and eicosanoids (prostaglandins, thromboxanes, and leukotrienes—composed of modified 20-carbon fatty acids synthesized from arachidonic acid).

18. Nucleotides (composed of a sugar, phosphate, and a nitrogenous) that compose DNA and RNA contain nitrogen that forms a nitrogenous waste called uric acid. Amino acids contain an amine functional group, $—NH_2$, that is converted to a nitrogenous waste called urea. Both uric acid and urea must be effectively eliminated by the kidney for an individual to remain healthy.

19. In an aqueous environment, amphipathic molecules such as phospholipids will orient themselves so that their hydrophobic domains face each other while the hydrophilic domains are exposed to water. This is the basis behind the arrangement of phospholipids within a phospholipid bilayer of the plasma membrane of a cell.

20. A protein's function is dependent upon the retention of its normal 3-dimensional shape. Denaturation is a change in the conformation of a protein that changes/affects its activity. Exposure of a protein to either an increase in temperature or a pH outside of its normal environment can denature the protein by disrupting electrostatic interactions such as ionic bonds within the molecule.

An increase in temperature can weaken the intramolecular attractions between the amino acids in the primary structure of the protein strand, causing the protein to unfold or denature such that it can no longer function normally.

Changes in H^+ concentration that are associated with changes in pH interfere with the electrostatic interactions within the protein that hold it in its 3-dimensional shape. Exposure of a protein to higher than normal concentration of hydrogen ions (a decrease in pH) results in the positively charged H^+ binding with negatively charged structures that were participating in electrostatic interactions that were holding the protein in its final shape. Exposure of a protein to lower than normal concentration of hydrogen ions (an increase in pH) results in the positively charged H^+ that were participating in electrostatic interactions and holding the protein in its final shape being removed. The loss of these electrostatic interactions between the amino acids that compose the protein results in its unfolding (or denaturation).

Answers to "Can You Apply What You've Learned?"

1. C
Feedback: Surface tension is high within the air sacs in the lungs of premature infants that are not producing sufficient surfactant. Surfactant is a detergent-like substance that prevents hydrostatic interactions between water molecules, thereby preventing the lungs from collapsing and the alveolar walls from sticking together. Premature babies often lack the ability to produce surfactant and are at risk for respiratory problems.

2. B
Feedback: Electrolytes such as sodium ions, potassium ions, and chloride ions are capable of conducting electricity. Nonelectrolytic molecules such as *glucose* are not able to conduct electricity.

3. B
Feedback: Isotopes are atoms of the same element that differ in their number of neutrons. In a *radioisotope* the extra neutrons will decay and be released as radiation, which may be measured or visualized during a diagnostic test.

4. D
Feedback: Calcium (Ca^{2+}) ions are an important structural component of bone tissue.

5. C
Feedback: *Proteins* consist of covalently bonded amino acids held together by peptide bonds. If insulin is administered orally, the peptide bonds are broken by enzymes of the digestive system (to form individual amino acids).

Answers to "Can You Synthesize What You've Learned?"

1. High-energy radiation can cause mutations within DNA.

2. The number of hydrogen ions in the blood increases, resulting in a lower pH (a condition called acidosis). The increasing number of hydrogen ions may interfere with the hydrostatic interactions holding proteins together, thus denaturing the proteins.

3. The drug would regulate the levels of the monosaccharide glucose within the blood.