1. Cartilage is an example of which of the following types of tissue?
   a. connective
   b. reproductive
   c. nervous
   d. epithelial
   e. adipose

2. Platelets and fibrinogen function in
   a. the clotting response
   b. the immune response
   c. the hypersensitive reaction
   d. detoxifying the blood
   e. the lymphatic system

3. True or false. Goblet cells are found within the small intestine and secrete protective mucus.
   a. True
   b. False

4. Which type of muscle is responsible for moving food along the digestive tract?
   a. striated
   b. skeletal
   c. cardiac
   d. smooth
   e. voluntary

5. Tetanus refers to
   a. the partial sustained contraction of major supporting muscles.
   b. the all-or-none contraction of a single muscle filament.
   c. a stronger contraction resulting from the activation of multiple motor units.
   d. a smooth and sustained contraction, resulting from increased impulse frequency.
   e. a state of muscle fatigue caused by the depletion of ATP and the accumulation of lactate.

6. Bird lungs are more efficient than mammalian lungs because
   a. they have multiple air sacs that increase the surface area for diffusion
   b. they breath more air while they fly
   c. they have a one-way flow through their lungs, preventing mixing of deoxygenated and oxygenated air
   d. their hemoglobin binds more oxygen molecules than human hemoglobin
   e. their alveoli are thinner, allowing oxygen to diffuse faster
7. Three-chambered hearts generally consist of which of the following numbers of atria and ventricles?
   a. one atrium; one ventricle
   b. **two atria; one ventricle**
   c. three atria; no ventricles
   d. four atria; neg. one ventricle
   e. one atrium; two ventricles

8. Which of the following are the only vertebrates in which blood flows directly from respiratory organs to body tissues without first returning to the heart?
   a. amphibians
   b. birds
   c. **fishes**
   d. mammals
   e. reptiles

9. Through how many capillary beds must a human red blood cell travel if it takes the shortest possible route from the right ventricle to the right atrium?
   a. one
   b. **two**
   c. three
   d. four
   e. five

10. Damage to the sinoatrial node in humans
    a. is a major contributor to hypertension.
    b. would block conductance between the bundle branches and the Purkinje fibers.
    c. would have a negative effect on peripheral resistance.
    d. **would disrupt the rate and timing of cardiac muscle contractions.**
    e. would have an effect on blood pressure monitors in the aorta.

11. Countercurrent exchange in the fish gill helps to maximize
    a. endocytosis.
    b. blood pressure.
    c. **diffusion.**
    d. active transport.
    e. sugar transport.

12. Fick’s Law of Diffusion is an equation that describes diffusion rate. Which adaptation of an animal’s body increases A?
    a. Thin cell layer of the capillaries
    b. Molting of an exoskeleton
    c. Numerous teeth in the mouth of carnivores
    d. Bacteria in the cecum of herbivores
    e. **600 million alveoli in the human lung**
13. Which factors below can increase the risk of cardiovascular disease?
   a. Hypertension
   b. Atherosclerosis
   c. Blood clots
   **d. All of the above**
   e. None of the above

14. What is the role of calcium in muscle contractions?
   a. break the cross-bridges as a cofactor in the hydrolysis of ATP
   **b. bind to the troponin complex, which leads to the exposure of the myosin-binding sites**
   c. transmit the action potential across the neuromuscular junction
   d. spread the action potential through the T tubules
   e. fortify bones so they can withstand contraction

15. During the course of muscle contraction the potential energy stored in ATP is transferred to potential energy stored in
   a. the myosin head
   b. the myosin tail
   c. the thin filament
   d. actin
   e. the Z line

16. Which statement below is **not** an example of homeostasis in animals?
   a. Synthesis of digestive enzymes in an inactive form
   b. Countercurrent heat exchange in limbs of marine mammals
   c. The liver’s control over blood glucose levels
   d. Opening and closing of capillary beds
   **e. Vasodilatation and vasoconstriction**

17. In order for motion to occur, a muscle must
   a. connect to cartilage across two joints
   **b. cross one joint while connecting two bones**
   c. cross two joints before it attaches to one bone
   d. be large and flexible
   e. connect to a fast-twitch ligament

18. Which statement is **true** about countercurrent oxygen exchange in fish gills?
   a. Diffusion of oxygen from the water to the blood can only occur for a short distance because the surface area for diffusion becomes small
   b. The deoxygenated blood and the oxygenated water flow in the same direction
   **c. Diffusion of oxygen is maximized because ∆P is maintained over a longer distance**
   d. Oxygen can diffuse directly into gills because they do not have capillaries
   e. Fish do not require oxygen therefore they do not use countercurrent exchange
19. If a molecule of CO₂ released into the blood in your left toe travels out of your nose, it must pass through all of the following structures except the
   a. right atrium.
   b. pulmonary vein.
   c. alveolus.
   d. trachea.
   e. right ventricle.

20. Structures 2 and 4 are which 2 structures respectively?
   a. alveoli and bronchiole
   b. systemic vessels and alveoli
   c. alveoli and capillaries
   d. bronchus and pulmonary vessels
   e. alveoli and pulmonary vessels

21. Within which structure(s) would oxygen be present?
   a. 2 only
   b. 3 & 4 only
   c. 1 & 4 only
   d. 2, 3, & 4 only
   e. 1, 2, 3, & 4
The above diagram is of two skeletal muscle sarcomeres. Different regions of the sarcomeres are labeled 1 – 4. Answer the following 3 questions using this diagram.

22. Which region(s) anchors the actin filaments?
   a. 1
   b. 2, 4
   c. 4
   d. 1, 2
   e. 1, 2, 4

23. Which protein is not present in region 3?
   a. actin
   b. myosin
   c. tropomyosin
   d. troponin
   e. fibrin

24. When a muscle is fully contracted, which region(s) disappear?
   a. 1
   b. 2, 4
   c. 2, 3, 4
   d. 2, 3
   e. 1, 2
Refer to the diagram above of a portion of the vertebrate digestive tract to answer the following questions.

25. Structure 1 functions in
   a. Storage of bile only
   b. Absorption of bile only
   c. Production of bicarbonate
   d. Absorption of HCl
   e. Production and secretion of bile

26. Pepsinogen is produced and activated in structure
   a. 1 & 5
   b. 2 & 3
   c. 2 only
   d. 3 only
   e. 5 only

27. Trypsinogen in produced in structure ___ but it is activated in structure ___.
   a. 1, 2
   b. 2, 5
   c. 3, 5
   d. 5, 3
   e. 3, 2

28. Structure 5 will empty its contents directly into the
   a. Anus
   b. Stomach
   c. Small intestine
   d. Large intestine
   e. Liver
Refer to the diagram above of a mammalian heart to answer the following questions.

29. Structure 1 is called the
   a. Pulmonary artery
   b. Pulmonary vein
   c. Anterior vena cava
   d. Posterior vena cava
   e. Aorta

30. Structure 2 delivers blood to the
   a. Systemic circuit
   b. Right ventricle
   c. Left ventricle
   d. **Pulmonary circuit**
   e. Brain

31. Which feature of the heart prevents the backflow of blood from structure 4 to structure 5?
   a. Cardiac sphincter
   b. **Atrioventricular valve**
   c. Semilunar valve
   d. The “do not enter” sign
   e. Atrioventricular node
32. Starting and ending with structure 1, list the order in which blood travels through the other structures. 
   a. 1, 2, 4, 5, 6, 3, 1  
   b. 1, 3, 6, 5, 4, 2, 1  
   c. 1, 6, 5, 4, 3, 2, 1  
   d. 1, 6, 5, 4, 2, 3, 1  
   e. 1, 3, 2, 4, 5, 6, 1

33. The Bundle branches and Purkinje fibers are found within the walls of which structure(s)?
   a. 1 & 2  
   b. 4 only  
   c. 5 only  
   d. 1, 2, & 6  
   e. 3 & 4

34. Which of the following is the correct sequence that occurs during the excitation and contraction of a muscle cell?
1) Tropomyosin shifts and unblocks the cross-bridge binding sites.  
2) Calcium is released and binds to the troponin complex.  
3) The myosin head of the thick filament forms a cross-bridge with the thin filament.  
4) The thin filaments are ratcheted across the thick filaments by the heads of the myosin molecules using energy from ATP.  
5) The motor neuron stimulates the muscle cell, which depolarizes the muscle cell membrane. 
   a. 1, 2, 3, 4, 5  
   b. 2, 1, 5, 3, 4  
   c. 2, 3, 4, 1, 5  
   d. 5, 2, 1, 3, 4  
   e. 5, 3, 2, 1, 4

35. Which of the following could be associated with peristalsis?
   a. hydrostatic skeletons surrounded by an exoskeleton  
   b. hydrostatic skeletons and movement in earthworms  
   c. smooth muscle and contractions along the human digestive tract causing movement of the contents within  
   d. A and C only  
   e. B and C only

36. True or false. Oxygen and carbon dioxide enter and exit the body only by diffusion.
   a. True  
   b. False
37. Which of the following characteristics of blood best explains its classification as connective tissue?
   a. **Its cells are widely dispersed and surrounded by a fluid matrix**
   b. It contains more than one type of cell
   c. It transports oxygen and carbon dioxide
   d. Its cells can move from place to place
   e. It is found within all the organs of the body

38. True or false. Fick’s Law of Diffusion describes how a body can maximize the diffusion rate by adjusting the temperature of the blood.
   a. True
   b. False

39. Ingested proteins stimulate the stomach to produce the hormone gastrin, which then acts upon the stomach. What does gastrin cause the stomach to do?
   a. **Produce HCl and pepsinogen**
   b. Produce mucus
   c. Stop producing HCl
   d. Move the contents of the stomach to the small intestine
   e. Vomit

40. True or false. Specialized regions within a bird’s gut include the crop, which is used to moisten the food, and the gizzard, which is used to break apart the food.
   c. True
   d. False

41. Which statement below is **false** about the compartmentalization of the digestive system?
   a. Digestive enzymes are produced in an inactive form
   b. Digestion and absorption mostly occur in the highly convoluted small intestine
   c. **Bile is synthesized in the gall bladder but stored in the liver for later use**
   d. Acid produced in the stomach is neutralized in the small intestine by bicarbonate
   e. Water absorption and waste compaction occur in the large intestine

42. Bones contain
   a. osteocytes
   b. blood vessels
   c. compact tissue
   d. spongy tissue
   e. **all of the above**

43. True or false. Synergistic muscles work together to perform the same action or motion.
   a. True
   b. False
44. What is the main difference between glycolytic and oxidative muscle fibers?
   a. The amount of stored glycogen
   b. The quantity of myosin protein
   c. The amount of creatine phosphate
   d. **The way ATP is synthesized**
   e. One is found in a rock climber, the other in a couch potato

45. While rock climbing, forearm muscles frequently become “pumped”, a state in which the muscle cannot relax and remains contracted. What causes this to happen?
   a. Being afraid of heights
   b. Not having enough mitochondria in the muscle fibers
   c. **Not having available ATP to break the cross-bridge between myosin and actin**
   d. Not having available calcium to open the myosin binding sites
   e. Having too much blood in the muscle, causing it to swell

46. Bile is composed of all of the following except
   a. dead bacteria
   b. **digestive enzymes**
   c. dead red blood cells
   d. bile salts
   e. cholesterol

47. Once digested, amino acids, nucleotides, and carbohydrates enter the blood and travel via the hepatic portal vein to the
   a. liver
   b. stomach
   c. heart
   d. lungs
   e. small intestine

48. Which is **not** an accessory gland of the digestive system?
   a. liver
   b. pancreas
   c. salivary gland
   d. **duodenum**
   e. gall bladder

49. Which is **not** a characteristic of a gastrovascular cavity?
   a. It performs intracellular digestion
   b. It has only one opening that functions in acquisition and elimination of materials
   c. It is found in Cnidarians
   d. **Vertebrates contain a small one that functions in cellulose digestion**
   e. It functions in circulation
50. True or false. When a heart chamber is in systole it is relaxed, not contracted.
   a. True
   b. False

51. Which statement below best describes why the atrioventricular node delays the action potential for 0.1 seconds?
   a. The aorta needs the extra time to relax
   b. To ensure complete emptying of the ventricles
   c. **To ensure complete emptying of the atria**
   d. To allow the lungs to expand fully
   e. To prevent contamination of oxygenated blood

52. The epithelium best adapted for a body surface subjected to abrasion, such as skin, is
   a. simple squamous
   b. simple cuboidal
   c. simple chitin
   d. stratified tubular
   e. **stratified squamous**

53. True or false. Blood pressure readings are measuring the systolic and diastolic pressure within your veins.
   a. True
   b. False

54. True or false. When a person inhales, their diaphragm and external intercostal muscles relax, allowing air to flow into their lungs.
   a. True
   b. False

55. Carbon dioxide is transported from tissue back to the lungs by three different mechanisms. The most common and most important mechanism is the conversion of carbon dioxide into carbonic acid. How does this conversion increase the diffusion rate of carbon dioxide?
   a. **The AP for carbon dioxide is greatly increased**
   b. The diffusion distance is decreased for carbon dioxide
   c. The surface area in which carbon dioxide can diffuse is increased
   d. Carbonic acid can directly transport carbon dioxide
   e. Carbon dioxide does not need to diffuse, it is actively transported

56. Which statement below is **true** about a ruminant digestive system?
   a. The stomach contains two chambers for digestion and two chambers for absorption
   b. The cud is regurgitated because saliva contains enzymes that help digest cellulose
   c. The stomach contains regions called a crop and a gizzard that aid in digestion
   d. **The four-chambered stomach contains microorganisms that digest cellulose**
e. A large cecum is found at the end of the stomach, before the small intestine

57. In order for a muscle to get larger, the muscle must
   a. add more muscle cells
   b. change the speed of ATP hydrolysis
   c. add more capillaries
   d. go on a diet
   e. add more myosin and actin filaments

58. All three tissue layers of a plant (dermal, ground, and vascular) are found in which organ(s)?
   a. Leaves only
   b. Stems and leaves only
   c. Roots, stems and leaves
   d. Roots and stems only
   e. Roots only

59. Which statement below is false about plant growth?
   a. Primary growth occurs from apical meristems
   b. Secondary growth occurs from lateral meristems
   c. Lateral shoots and lateral roots are considered primary growth
   d. Growth in girth is considered primary growth
   e. They are all false

60. True or false. Water will always move from a region with less negative water potential to a region with more negative water potential.
   a. True
   b. False

61. Which statement below is false about water transport in the xylem?
   a. Transpiration from the leaves causes negative pressure (tension) in the xylem
   b. Within a plant there is a water potential gradient that drives water transport
   c. Water that is transported throughout the plant is acquired from the soil via the roots
   d. Water is cohesive, allowing it to be pulled up the plant
   e. Water transport is driven by the loading of sugars into the xylem

62. Opening the stomata allows plants to
   a. release carbon dioxide
   b. acquire oxygen
   c. absorb water
   d. acquire carbon dioxide
   e. excrete metabolic waste
63. True or false. Cation exchange in the soil allows plants to exchange extra cations for anions.
   a. True
   b. False

64. Plant hormones
   a. work antagonistically and synergistically
   b. are required in large amounts
   c. are acquired from the soil
   d. prevent the plant from responding to the environment
   e. are used to attract other plants for mating

65. The plant enzyme phytochrome is
   a. activated by blue light and inactivated by far-red light
   b. activated by far-red light and inactivated by green light
   c. activated by green light and inactivated by far-red light
   d. activated by far-red light and inactivated by red light
   e. activated by red light and inactivated by far-red light

66. Four of the five answers listed below are true for carbohydrates. Select the incorrect answer.
   a. Carbohydrates are not important "energy storage" molecules.
   b. Important examples of carbohydrates are starch, cellulose, and glycogen.
   c. Polysaccharides are large carbohydrate polymers made up of individual monomer (sugar) units.
   d. The chemical bond that joins two sugar monomers together is called a glycosidic linkage.
   e. Chitin is a carbohydrate that serves a structural role.

67. Macromolecules (polymers) are constantly being made and broken down in both plant and animal cells. Select the statement that best describes the relationship between condensation synthesis (dehydration reactions) and hydrolysis.
   a. Condensation synthesis takes place in animals and hydrolysis takes place in plants.
   b. Hydrolysis creates monomers and condensation synthesis breaks them apart.
   c. Hydrolysis is very important to organisms, but condensation synthesis is less important.
   d. Hydrolysis takes place during the night and condensation synthesis takes place during the day.
   e. Condensation synthesis connects monomers to form polymers and polymers are disassembled (broken down) to monomers by hydrolysis.
68. Four of the five sets of structure-function relationships listed below are true. Select the incorrect answer.

a. **smooth endoplasmic reticulum (ER)—synthesis of secretory proteins (such as glycoproteins)**
b. plasma membrane—selective barrier of the cell
c. peroxisomes—makes and gets rid of hydrogen peroxide produced during chemical reactions
d. chloroplast—converts carbon dioxide and water in the presence of light to sugars, water, and oxygen
e. ribosomes—sites of protein synthesis in the cell

69. Four of the five answers listed below are **true** for “compartmental organization” of a eukaryotic cell. Select the incorrect answer.

a. Membranes serve an important function; they are fundamental to this organization.
b. These compartments provide different local environments that facilitate specific metabolic (cellular) functions.
c. These compartments allow eukaryotic cells to perform incompatible processes simultaneously inside the same cell.
d. Although this compartmental organization exists in eukaryotic cells, cells can “communicate” through the dynamic nature of the endomembrane system.
e. **For cellular processes, eukaryotic cells do not require compartmental organization.**

70. If you placed an animal cell (for example, a red blood cell) in an isotonic solution, what would you expect to be the **most likely** outcome?

a. Water will leave the cell faster than it will enter and the cell would shrivel.
b. **Water will enter and leave the cell at the same rate and the cell would be normal.**
c. Water will enter the cell faster than it will leave and the cell would burst (lyse)
d. Water will enter and leave the cell at the same rate and the cell would be flaccid.
e. Water will enter the cell faster than it will leave and the cell would be turgid (normal).
71. Which statement(s) below **best** describes passive transport?

- a. Osmosis is a special case of passive transport.
- b. It occurs when molecules move from a region of lower concentration to one of higher concentration.
- c. It is the diffusion of substances across a biological membrane; ATP is not required.
- d. Answers A, B, and C are all correct.
- e. **Answers A and C are correct, but answer B is incorrect.**

72. Which of the following statements is **true** for exergonic reactions?

- a. The **products have less energy than the reactants; \( \Delta G \) is negative.**
- b. The products have more energy than the reactants: \( \Delta G \) is positive.
- c. These are spontaneous reactions. An input of energy is necessary to drive the reaction.
- d. These reactions are not spontaneous. Energy is necessary to drive the reaction.
- e. None of the above statements are correct.

73. Four of the five statements listed below are true for enzymes. Select the **incorrect** answer.

- a. Enzymes are biological catalysts that increase the rate of chemical reactions and are very specific for a particular substrate.
- b. Enzymes are not used up or permanently altered in the chemical reactions; they are reusable.
- c. Most enzymes are proteins.
- d. **Enzymes do not change the activation energy required for a chemical reaction to occur.**
- e. A substrate is a molecule that binds to the active site of an enzyme.

74. Four of the five statements below are true for the Chemiosmotic Mechanism. Select the **incorrect** answer.

- a. Takes place in both photosynthesis (photophosphorylation) and cellular respiration (oxidative phosphorylation).
- b. A special enzyme called ATP synthase is used.
- c. A membrane is required; differences in proton (H\(^+\)) concentrations are established.
- d. **Important in the Krebs cycle.**
- e. Takes place in both plants and animals.
75. Four of the five answers listed below are true for photosynthesis. Select the **incorrect** answer.

a. The Calvin cycle takes place in the stroma of the chloroplast.

b. **The ATP made during the light reactions is made by substrate-level phosphorylation.**

c. The light reactions take place in the thylakoid membranes of the chloroplast.

d. The primary function of the Calvin cycle is the incorporation of carbon dioxide into sugars and other organic molecules.

e. The primary function of the light reactions is the generation of energy in the form of ATP and NADPH; oxygen is released during the light reactions.