1. Which of the following serves as a sensor, or as part of a sensor, that functions in a negative feedback system?
   A. Plasma-membrane Calcium Receptors located in cells in the kidney.
   B. Parathyroid Hormone (PTH) Receptors located in the plasma membranes of Parathyroid Gland cells.
   C. Insulin Receptors located in the plasma membranes of the beta-islet cells of the pancreas.
   D. All of the above.
   E. None of the above.

2. Which of the following serves as an actuating signal, or as part of an actuating signal, in a negative feedback system?
   A. Action potentials in the fibers of the diaphragm muscle.
   B. Blood plasma levels of oxytocin.
   C. Action potentials in sympathetic neurons that release acetylcholine (ACh) near the SA node of the heart.
   D. All of the above.
   E. None of the above.

3. Which of the following serves as an effector, or as part of an effector, that functions in a negative feedback system?
   A. Glycogen Receptors in the plasma membranes of liver cells.
   B. Insulin Receptors in the plasma membranes of liver cells.
   C. GLUT4 Transporters in the plasma membranes of beta-islet cells of the pancreas.
   D. All of the above.
   E. None of the above.

4. Which of the following serves as a controlled variable in a negative feedback system?
   A. Blood plasma levels of glucose.
   B. Blood plasma levels of glucagon.
   C. Blood plasma levels of glycogen.
   D. All of the above.
   E. None of the above.

5. An increase in blood plasma levels of parathyroid hormone
   A. occurs in response to an increase in the levels of calcium ions in blood plasma.
   B. leads to an increase in calcium ion excretion in the urine.
   C. leads to an increase in the amount of calcium stored in the bones.
   D. All of the above.
   E. None of the above.
6. Which of the following is true for a G-protein?
   A. After the ATP-ase of the alpha subunit of a G protein converts the ATP bound to the alpha subunit to ADP and inorganic phosphate (P$_i$), the alpha subunit of the G-protein recombines with the beta and gamma subunits of the G-protein.
   B. When an agonist binds to the binding site of a G-protein-coupled receptor (GPCR), this leads to GDP displacing a GTP bound to the alpha subunit of the G-protein.
   C. When GTP binds to an alpha subunit of the G-protein, this leads to the alpha subunit of the G-protein dissociating from the beta and gamma subunits of the G-protein.
   D. All of the above.
   E. None of the above.

7. At 1 AM, an impermeable membrane separates a 1 liter solution of 2M KCl in the left compartment from a 1 liter solution containing both 1M NaCl and 1M KCl in the right compartment. At 2 AM, the membrane became permeable to potassium ions. At 4 AM, the membrane once again became impermeable to potassium ions. At 6 AM, the membrane became permeable to chloride ions and, in addition, maintained potassium ion impermeability. At 8 AM, the membrane became permeable to potassium ions again and, in addition, maintained its permeability to chloride ions. The membrane stayed impermeable to sodium ions at all times.
   A. The amount of chloride ions in the right compartment at 9 AM will be equal to the amount of chloride ions in the right compartment at 7 AM.
   B. The amount of chloride ions in the right compartment at 7 AM will be less than the amount of chloride ions in the right compartment at 5 AM.
   C. The amount of potassium ions in the right compartment at 9 AM will be greater than the amount of potassium ions in the right compartment at 7 AM.
   D. All of the above.
   E. None of the above.

8. At 1 AM, an impermeable membrane separates a 1 liter solution of 1M NaCl in the left compartment from a 1 liter solution containing both 1M NaCl and 1M KCl in the right compartment. At 2 AM, the membrane became permeable to chloride ions. At 4 AM, the membrane once again became impermeable to chloride ions. At 6 AM, the membrane became permeable to sodium ions and, in addition, maintained chloride ion impermeability. At 8 AM, the membrane once again became impermeable to sodium ions. At 10 AM the membrane once again became permeable to chloride ions and, in addition, maintained sodium ion impermeability. The membrane maintained impermeability to potassium ions during the entire period.
   A. The amount of sodium ions in the left compartment at 7 AM will be greater than the amount of sodium ions in the right compartment at 7 AM.
   B. The amount of chloride ions in the left compartment at 3 AM will be greater than the amount of chloride ions in the left compartment at 1 AM.
   C. The amount of chloride ions in the left compartment at 11 AM will be greater than the amount of chloride ions in the left compartment at 9 AM.
   D. All of the above.
   E. None of the above.
9. Which of the following is true for exocytosis?
   A. During exocytosis in toe motor neurons, there will be release of Acetylcholine Receptors (AChRs) from axonal terminals near toe skeletal muscles in response to an increase in the amount of intracellular calcium in the axonal terminals of these neurons.
   B. During exocytosis in fat cells, there is insertion of GLUT2 transporters from vesicular membranes into plasma membranes.
   C. During exocytosis in collecting duct epithelial cells, there is insertion of AQP4 channels from vesicular membranes into luminal membranes.
   D. All of the above.
   E. None of the above.

10. Consider three culture dishes; each dish has one healthy neuron in it. Dish A has Neuron A in it; Dish B has Neuron B in it; and Dish C has Neuron C in it. At 1:00 AM: each neuron is bathed in normal physiological saline; all the neurons have the same properties; and each neuron is at rest with a resting potential of -70 millivolts. Each neuron has only two types of ionotropic ligand-gated receptors: AMPA Receptors and NMDA Receptors. None of the neurons have metabotropic receptors. Each neuron has a chloride equilibrium potential of -80 millivolts. At 1:55 AM, a large amount of TTX is added to the physiological saline in all three dishes. At 2:00 AM: glutamate is added to the physiological saline of Dish A; glutamate and APV are added to the physiological saline of Dish B; glutamate and CNQX are added to the physiological saline of Dish C.
   A. At 2:01 AM, the calcium conductance of Neuron C will be less than the calcium conductance of Neuron A.
   B. At 2:01 AM, the calcium conductance of Neuron B will be less than the calcium conductance of Neuron A.
   C. At 2:01 AM, the membrane voltage of Neuron C will be less than the membrane voltage of Neuron A.
   D. All of the above.
   E. None of the above.

11. Which of the following is an agonist that binds to a receptor site that is part of a ligand-gated metabotropic receptor?
   A. GABA.
   B. ACh.
   C. muscarine.
   D. All of the above.
   E. None of the above.

12. A complete motor neuron is removed from a frog and placed in a large volume of normal physiological saline. The neuron is healthy; it has a stable resting voltage of -70 millivolts. It is not producing any action potentials; its threshold for an action potential is -50 millivolts. The neuron's plasma membrane has GABA\(_{A}\), GABA\(_{B}\), and glycine receptors. The equilibrium potential for chloride ions is -70 millivolts and the equilibrium potential for potassium ions is -86 millivolts. The addition of GABA to the physiological saline will lead to
   A. a decrease in the amount of intracellular chloride.
   B. no change in chloride conductance.
   C. a decrease in potassium conductance.
   D. All of the above.
   E. None of the above.
13. Consider three culture dishes; each dish has one healthy neuron in it. Dish A has Neuron A in it; Dish B has Neuron B in it; and Dish C has Neuron C in it. At 1:00 AM: each neuron is bathed in normal physiological saline; all the neurons have the same properties; and each neuron is at rest with a resting potential of -70 millivolts. Each neuron has only two types of ionotropic ligand-gated receptors: AMPA Receptors and NMDA Receptors. None of the neurons have metabotropic receptors. Each neuron has a chloride equilibrium potential of -80 millivolts. At 1:55 AM, a large amount of TTX is added to the physiological saline in all three dishes. At 1:58 AM, the amount of intracellular calcium in each neuron is the same as that of each other neuron.

At 2:00 AM:
- glutamate is added to the physiological saline of Dish A;
- glutamate and APV are added to the physiological saline of Dish B;
- glutamate and CNQX are added to the physiological saline of Dish C.

For each neuron, define MAXV as the maximum voltage that is reached by that neuron during the period from 2:00 AM to 2:02 AM.

A. MAXV of Neuron B is less than MAXV of Neuron A.
B. MAXV of Neuron C is less than MAXV of Neuron B.
C. At 2:01 AM, the amount of intracellular calcium in Neuron B will be less than the amount of intracellular calcium in Neuron A.
D. All of the above.
E. None of the above.

14. Neuron A is a healthy neuron with all the usual ion channels. When at rest with a membrane voltage of $R$ millivolts, neuron A produces no action potentials. The voltage threshold for an action potential in neuron A is $T$ millivolts. $T$ is greater than $R$; $T$ is less than zero. In addition, neuron A's membrane includes the membrane-spanning molecule Z with an ion channel that opens when neurotransmitter Y binds to the Y receptor site on the extracellular surface of Z. The Nernst equilibrium potential for Z's ion channel is $E$ millivolts. Neuron B synapses on neuron A; neuron B's neurotransmitter is neurotransmitter Y. Which of the following statements are true when neuron A is initially at rest and neuron B releases neurotransmitter Y?

A. If the value of $E$ is less than $R$ and if chloride is the only ion that passes through open Z channels, then Y's binding to its receptor site on Z in neuron A produces an increase in membrane voltage in neuron A.
B. If the value of $E$ is less than $R$, and if chloride is the only ion that passes through open Z channels, then Y's binding to its receptor site on Z in neuron A produces an increase in the amount of intracellular chloride ions in neuron A.
C. If the value of $E$ is zero and if both sodium ions and potassium ions pass through open Z channels, then Y's binding to its receptor site on Z in neuron A produces an increase in the amount of intracellular potassium ions in neuron A.
D. All of the above.
E. None of the above.
15. Consider Neuron B in the frog central nervous system whose plasma membrane has a previously unknown channel that is selectively conductive to a newly discovered trivalent anion named TVA with a valence of -3. The threshold for an action potential in Neuron B is -55 millivolts and the resting potential for Neuron B is -70 millivolts. The TVA channel in Neuron B is part of an ionotropic receptor with an extracellular binding site for the newly discovered ligand LGD. When LGD binds to its binding site, there is an increase in the TVA conductance of Neuron B. Neuron Asynapses onto Neuron B. Neuron A's neurotransmitter is LGD.

A. The extracellular concentration of TVA is 10,000 times greater than the intracellular concentration of TVA. In response to an action potential in Neuron A, there will be a decrease in the membrane voltage of Neuron B.
B. The extracellular concentration of TVA is 1,000 times greater than the intracellular concentration of TVA. In response to an action potential in Neuron A, there will be a decrease in the amount of intracellular TVA in Neuron B.
C. The extracellular concentration of TVA is 100 times greater than the intracellular concentration of TVA. In response to an action potential in Neuron A, there will be an excitatory postsynaptic potential in Neuron B.
D. All of the above.
E. None of the above.

16. Consider a system that contains three neurons in a culture dish bathed in normal physiological saline. All three neurons are healthy. Neuron A synapses onto Neuron B. Neuron B synapses onto Neuron C. Neuron A has GABA in its synaptic vesicles. Neuron B has glycine in its synaptic vesicles. The only ligand-gated receptors in Neuron A are AMPA channels. The only ligand-gated receptors in the plasma membrane of Neuron B are GABA_A receptors. The only ligand-gated receptors in the plasma membrane of Neuron C are glycine receptors. All 3 neurons have no other ligand-gated receptors in their plasma membranes. All 3 neurons have a sodium equilibrium potential of +60 millivolts. All 3 neurons have a potassium equilibrium potential of -86 millivolts. Neurons A and B have a chloride equilibrium potential of -80 millivolts. Neuron C has a chloride equilibrium potential of -20 millivolts. The threshold for an action potential in all 3 neurons is -55 millivolts. At 1:55 AM, glutamate is added to the physiological saline. At 2:00 AM, the action potential firing rate of each neuron is 100 Hz. Which of the following will lead to a decrease in Neuron C's action potential firing rate?

A. At 2:01 AM, APV is added to the bath.
B. At 2:01 AM, CNQX is added to the bath.
C. At 2:01 AM, strychnine is added to the bath.
D. All of the above.
E. None of the above.
17. Which of the following occur in response to an increase in the length of the right knee extensors in response to a quick tap applied to the right patellar tendon? An increase in the amount of
A. calcium conductance in the central axon terminals of IA muscle-spindle stretch receptor neurons whose peripheral terminals are in the right knee extensor muscle.
B. sodium conductance in the sarcoplasmic reticulum of the muscle fibers of the right knee extensor muscle.
C. open force-gated channels in the peripheral axon terminals of right knee extensor motor neurons.
D. All of the above.
E. None of the above.

18. At 1 AM, a healthy squid giant axon is placed in a bath of normal squid physiological extracellular saline and is internally perfused with normal squid intracellular saline. Its resting potential at 1:55 AM is -70 millivolts. For this question, ignore any possible effects due to the sodium-potassium pump. At 2 AM, there is a change in the
A. intracellular perfusion fluid so that its concentration of potassium ion is increased. This will cause a decrease in the Nernst equilibrium potential for potassium ion.
B. intracellular perfusion fluid so that its concentration of potassium ion is increased. This will cause an increase in the resting membrane voltage.
C. extracellular saline so that its concentration of potassium ion is decreased. This will cause a increase in the Nernst equilibrium potential for potassium ion.
D. All of the above.
E. None of the above.

19. Person Z swallowed a large amount of substance X and, as a result, has convulsions (abnormal violent contractions of skeletal muscles). Swallowing which of the following substances could lead to convulsions?
A. An antagonist of the nicotinic ACh receptor.
B. An agonist of the glycine receptor.
C. A blocker of the voltage-gated sodium channel.
D. All of the above.
E. None of the above.

20. Which of the following are true?
A. Consider the channel associated with the GABA_B receptor and the channel associated with the AMPA receptor. For both types of channel, there is a sodium conductance greater than zero when the channel is open.
B. Consider the channel associated with the muscarinic ACh receptor and the channel associated with the nicotinic ACh receptor. For both types of channel, there is a potassium conductance greater than zero when the channel is open.
C. ACh is an antagonist both at the muscarinic ACh receptor and at the nicotinic ACh receptor.
D. All of the above.
E. None of the above.
21. At 1 AM, a healthy squid giant axon is placed in a bath of normal squid physiological extracellular saline and is internally perfused with normal squid intracellular saline. Its resting membrane voltage at 1:50 AM is -70 millivolts. At 1:55 AM, the axon is electrically stimulated so that it produces an action potential. At 2 AM, there is a change in the intracellular perfusion fluid so that the concentration of sodium ion is increased. At 2:05 AM, the axon is electrically stimulated so that it produces an action potential. For this question, ignore any possible effects due to the sodium-potassium pump. The

A. Nernst equilibrium potential for sodium ion at 2:10 AM is greater than the Nernst equilibrium potential for sodium ion at 1:50 AM.
B. resting membrane voltage at 2:10 AM is greater than the resting membrane voltage at 1:50 AM.
C. value of the peak of the action potential at 2:05 AM is less than the value of the peak of the action potential at 1:55 AM.
D. All of the above.
E. None of the above.

22. ATP is **directly** required in which of the following processes in muscle?

A. Net flux of potassium ions from intracellular space to interstitial space.
B. Net flux of calcium ions from the cytosol near troponin molecules into the sarcoplasmic reticulum.
C. Detachment of myosin heads from their binding sites on tropomyosin molecules.
D. All of the above.
E. None of the above.

23. Which of the following is true in a skeletal muscle?

A. The myosin head is activated (energized) by the conversion of ATP (that is bound to myosin) to ADP and P\(_i\) (that are bound to myosin).
B. Detachment of the myosin head from its actin binding site always occurs during rigor mortis.
C. The binding of ATP to myosin occurs only when the myosin head is not attached to the actin molecule.
D. All of the above.
E. None of the above.

24. Healthy Person X is walking on level ground. Which of the following is true for the knee extensor muscle of X's right leg during the step cycle?

A. The right knee extensor muscle has a lengthening contraction near the end of the right leg's swing phase just prior to start of the right leg's stance phase.
B. Just after the right foot touches the ground at the start of stance phase, the length of the overlap region between the thick and thin filaments (= the region of the A band not in the H zone) will increase in every sarcomere of the right knee extensor muscle.
C. Just after the right foot touches the ground at the start of the stance phase, the length of the H zone will decrease in every sarcomere of the right knee extensor muscle.
D. All of the above.
E. None of the above.
25. Consider a system that contains two neurons and one cardiac SA node cell in a culture dish bathed in normal physiological saline. All three cells are healthy. Neuron A synapses onto Neuron B. Neuron B synapses onto the SA node cell. Neuron A has glycine in its synaptic vesicles. Neuron B has acetylcholine (ACh) in its synaptic vesicles. The only ligand-gated channels in the plasma membrane of Neuron A are AMPA receptors. The only ligand-gated channels in the plasma membrane of Neuron B are glycine receptors. Both neurons have no metabotropic receptors in their plasma membranes. Neuron A, Neuron B, and SA node cell each have a chloride equilibrium potential of -20 millivolts and a potassium equilibrium potential of -86 millivolts. The threshold for an action potential in all 3 cells is -55 millivolts. The SA node cell has its usual set of molecules. At 1:00 AM, Neuron A's action potential firing rate is 100 Hz, Neuron B's action potential firing rate is 100 Hz, and the SA node cell's action potential firing rate is 1.00 Hz. Which of the following will lead to a decrease in the SA node cell's action potential firing rate?
   A. At 1:01 AM, strychnine is added to the bath.
   B. At 1:01 AM, norepinephrine is added to the bath.
   C. At 1:01 AM, AMPA is added to the bath.
   D. All of the above.
   E. None of the above.

26. Starting at 1:00 AM, you record the firing frequency of the axons of carotid artery baroreceptors as well as the blood pressure in the carotid artery. At 2:00 AM, you directly apply chemical W to all the axons of the carotid artery baroreceptors at location M in a peripheral nerve at a place that is midway between the baroreceptor peripheral terminals and the baroreceptor central axonic terminals. You discover that chemical W induces a previously unknown change in the excitability of the axon with the following property: for every two action potentials produced between baroreceptor peripheral terminals and location M, there is one action potential that continues down the axon between location M and baroreceptor central axonic terminals. Thus, chemical W causes a reduction of the rate of firing in the axons of carotid baroreceptors as action potentials pass location M.
   A. At 2:10 AM, blood pressure will be higher than at 1:50 AM.
   B. At 2:10 AM, the parasympathetic output to the heart will be higher than at 1:50 AM.
   C. At 2:10 AM, arteriolar diameter will be larger than at 1:50 AM.
   D. All of the above.
   E. None of the above.
27. Consider a system that contains a healthy SA node cell in a culture dish bathed in normal physiological saline. The SA node cell contains all of the usual molecules. You use a technique to measure $G_{F-channel}$ (F-channel conductance) when the membrane of the SA node cell is held at a constant voltage of -75 millivolts starting at 1:55 AM. The technique allows you to keep the SA node cell at that voltage for 10 minutes. You also have the ability to control directly the intracellular amounts of cAMP. You can also add substances to the extracellular saline bathing the SA node cell. At 2:00 AM, you measure $G_{F-channel}$.

A. At 2:01 AM, norepinephrine is added to the physiological saline. This will lead to a decrease in $G_{F-channel}$ compared with its 2:00 AM value.

B. At 2:01 AM, there is a decrease in the intracellular amount of cAMP. This will lead to a decrease in $G_{F-channel}$ compared with its 2:00 AM value.

C. At 2:01 AM, ACh (acetylcholine) is added to the physiological saline. This will lead to an increase in $G_{F-channel}$ compared with its 2:00 AM value.

D. All of the above.

E. None of the above.

28. Patient A has a disease that causes continuous maximal contractions of all the smooth muscles that control the diameter of patient A's arterioles. Which of the following will help restore patient A's blood pressure toward normal levels?

A. Lower values of activity in sympathetic neurons that synapse on SA node cells of the heart compared with pre-disease levels of activity in these sympathetic neurons.

B. Higher values of activity in parasympathetic neurons that synapse on the smooth muscles that control the diameter of patient A's arterioles compared with pre-disease levels of activity in these parasympathetic neurons.

C. Lower values of activity in parasympathetic neurons that synapse on SA node cells of the heart compared with pre-disease levels of activity in these parasympathetic neurons.

D. All of the above.

E. None of the above.

29. A decrease in parasympathetic discharge to the heart leads to

A. an increase in the conductance of F-channels in SA node cells.

B. an increase in the conductance of potassium channels associated with muscarinic ACh receptors in SA node cells.

C. an increase in the amount of ACh (acetylcholine) released near SA node cells of the heart.

D. All of the above.

E. None of the above.
30. Two compartments of equal volumes of normal physiological saline containing NO bicarbonate ions are separated by a membrane permeable only to carbon dioxide. At 1 AM, equal amounts of carbon dioxide are dissolved into both left and right compartments. At 3 AM, healthy red blood cells are prepared so that they contain NO carbon dioxide and high amounts of oxygen. At 3:05 AM, these cells are placed into the right compartment. For this question, ignore cellular respiration in these red blood cells: assume that no carbon dioxide is produced by cellular respiration in these red blood cells.

A. At 4 AM, the amount of extracellular carbon dioxide in the right compartment will be equal to the total amount of carbon dioxide in the right compartment at 2 AM.
B. At 4 AM, the amount of extracellular bicarbonate in the right compartment will be higher than the amount of extracellular bicarbonate in the right compartment at 2 AM.
C. At 4 AM, the total amount of carbon dioxide (extracellular, intracellular unbound, and intracellular bound to Hemoglobin) in the right compartment will be equal to the total amount of carbon dioxide in the left compartment at 4 AM.
D. All of the above.
E. None of the above.

31. Which of the following serves as an actuating signal, or part of an actuating signal, in a negative feedback system?

A. Action potentials in motor neurons that release ACh (acetylcholine) and synapse upon diaphragm muscle fibers.
B. Blood plasma levels of erythropoietin.
C. Action potentials in parasympathetic neurons that release ACh (acetylcholine) near SA node cells of the heart.
D. All of the above.
E. None of the above.

32. In a red blood cell, which of the following will lead to a decrease in the percentage of hemoglobin that has oxygen bound to it?

A. A decrease in the amount of HbRH (Hemoglobin Releasing Hormone) that is bound to HbRH Receptors in the plasma membrane of the red blood cell.
B. An increase in the concentration of dissolved oxygen in the red blood cell.
C. An increase in the concentration of hydrogen ions in the red blood cell.
D. All of the above.
E. None of the above.

33. Which of the following processes in capillaries in the lung assist in the removal of carbon dioxide from the body?

A. Formation of carbonic acid by carbonic anhydrase in red blood cells.
B. Breakdown of carbonic acid in red blood cells into hydrogen ions and bicarbonate.
C. Net flux of bicarbonate from blood plasma into red blood cells.
D. All of the above.
E. None of the above.
34. Which of the following are true for ventilation?
   A. An increase in the hydrogen ion concentration in the interstitial spaces of the brain stem leads to a decrease in the duration of the respiratory cycle (duration of respiratory cycle equals duration of inspiration plus duration of expiration).
   B. A decrease in the pressure within the chest cavity results in the inspiration of air into the lungs.
   C. The problems with ventilation induced by injection of curare occur because of the drug's direct action on the nAChRs (nicotinic Acetylcholine Receptors) in the plasma membranes of the diaphragm skeletal muscle and the rib-cage skeletal muscles.
   D. All of the above.
   E. None of the above.

35. Healthy Person H takes a new drug named CAMPCOLLDUCTUP that results in continuous very high values of cyclic AMP (cAMP) in collecting duct epithelial cells. A single dose of the new drug works within one hour and lasts for one week. Which of the following is true for H one day after taking the new drug?
   A. The total amount of AQP2 channels stored in H's intracellular vesicles of collecting duct epithelial cells will be lower than pre-drug levels.
   B. H's urine will be very similar to the urine of a patient with nephrogenic diabetes insipidus.
   C. Water permeability of H's luminal membranes of collecting duct epithelial cells will be lower than pre-drug levels.
   D. All of the above.
   E. None of the above.

36. Which of the following is true for the epithelial cells of the kidney proximal tubule?
   A. GLUT4 transporters in the basolateral membrane are responsible for the net flux of glucose from intracellular space to interstitial space.
   B. Sodium-glucose co-transporters in the luminal membrane are responsible for the net flux of glucose from luminal space (in the lumen of the proximal tubule) to intracellular space.
   C. AQP2 channels in the basolateral membrane are responsible for the net flux of water from intracellular space to interstitial space.
   D. All of the above.
   E. None of the above.

37. Which of the following is true?
   A. A patient with neurogenic diabetes insipidus will benefit from injections of vasopressin into the blood plasma.
   B. A patient with no functional AQP2 channels in collecting duct epithelial cells will receive no benefit from injections of vasopressin into the blood plasma.
   C. If a patient with neurogenic diabetes insipidus is not treated, the patient will produce large volumes of dilute urine.
   D. All of the above.
   E. None of the above.
38. For a healthy person who is on a diet that consists of very small amounts of water, which of the following is true?
   A. This person will have very low intracellular levels of cAMP in their collecting duct epithelial cells.
   B. This person will produce a small amount of concentrated urine with high amounts of dissolved solutes.
   C. This person will have very low water permeability across the luminal membranes of the collecting duct epithelial cells.
   D. All of the above.
   E. None of the above.

39. Which of the following are **directly** responsible for the chemical breakdown of food molecules?
   A. Trypsinogen.
   B. Fibrin.
   C. Pepsin.
   D. All of the above.
   E. None of the above.

40. Which of the following is an inactive form of an enzyme that is converted into an active form within the gastro-intestinal tract?
   A. Pepsinogen.
   B. Progesterone.
   C. Enterokinase.
   D. All of the above.
   E. None of the above.

41. Which of the following substances are released from cells whose cell bodies are in the hypothalamus?
   A. Oxytocin.
   B. Vasopressin.
   C. GnRH.
   D. All of the above.
   E. None of the above.

42. Insulin binding to insulin receptors in the plasma membrane of a
   A. liver cell will lead to an increase in the intracellular amounts of cAMP in the liver cell.
   B. beta-islet cell of the pancreas will lead to an increase in the glucose permeability of the plasma membrane of the beta-islet cell.
   C. skeletal muscle cell will lead to an increase in endocytosis of GLUT4 Transporters from the plasma membrane of the skeletal muscle cell.
   D. All of the above.
   E. None of the above.
43. Person W is a healthy human who has volunteered to take experimental drug Z. Person W has a normal dinner at 6 PM on May 1 and then does not eat for 12 hours. At 6 AM on May 2, W takes a dose of Z that completely blocks the net flux of glucose via all GLUT2 transporters in the beta-islet cells of the pancreas for 24 hours. Drug Z has no effect on any other cells. Person W has a normal dinner at 6 PM on May 2 and then does not eat for 12 hours.
   A. At 8 PM on May 2, W's blood plasma levels of glucose will be much lower than W's blood plasma levels of glucose at 8 PM on May 1.
   B. At 8 PM on May 2, the potassium conductance of the ATP-sensitive potassium channels in W's beta-islet cells will be higher than potassium conductance of the ATP-sensitive potassium channels in W's beta-islet cells at 8 PM on May 1.
   C. At 8 PM on May 2, the glucose permeability of W's skeletal muscle cells will be much higher than the glucose permeability of W's skeletal muscle cells at 8 PM on May 1.
   D. All of the above.
   E. None of the above.

44. During a fever in a human,
   A. the control system for body temperature becomes an open loop system.
   B. there is a decrease in the value of the set point.
   C. shivering occurs when the actual body temperature is greater than the set point.
   D. All of the above.
   E. None of the above.

45. Healthy human female X is 25 years old and not pregnant. During the postovulatory phase of X's menstrual cycle,
   A. there are high plasma levels of LH and FSH.
   B. there are high plasma levels of hCG (human Chorionic Gonadotropin).
   C. the corpus luteum releases high levels of FSH into the plasma.
   D. All of the above.
   E. None of the above.

46. In an adult male, which of the following is true?
   A. The plasma membranes of Leydig cells contain GnRH receptors.
   B. The plasma membranes of Sertoli cells contain LH receptors.
   C. Testosterone receptors are located in intracellular spaces of Sertoli cells.
   D. All of the above.
   E. None of the above.
47. Patient X is a right-handed adult who had a normal nervous system until the age of 30. At the age of 31, X had a stroke that produced severe damage to Broca's area. After the stroke,
   A. X's speech was slow and labored and X had difficulty producing sentences with complex grammar.
   B. X lost the ability to comprehend spoken language.
   C. X had paralysis of muscles controlling speech.
   D. All of the above.
   E. None of the above.

48. Right-handed adult patient X with a complete transection of the corpus callosum is presented with a simple written question in his right visual world. A barrier is positioned so that patient X can see his right hand only in his right visual world and his left hand only in his left visual world. Patient X will be
   A. unable to respond correctly to the sentence with a verbal reply.
   B. able to use his left hand to move scrabble tiles (pieces of wood with letters on them) so that he spells out the correct answer with his left hand.
   C. able to use a pencil in his right hand to spell out the correct answer on a piece of paper.
   D. All of the above.
   E. None of the above.

49. A question is flashed on a screen in the left visual world of right-handed person Z. Person Z is a healthy individual with an normal nervous system. Person Z has a patch over Z's right eye so that Z sees the question only in Z's left eye.
   A. The stimulus will excite neurons in the right half of Z's left retina.
   B. The stimulus will excite neurons in Z's left visual cortex.
   C. Z will understand the meaning of the question and generate a correct oral answer even when all action potentials in all axons of Z's corpus callosum are completely blocked by Drug XCC. All other axons in Person Z are not affected by Drug XCC.
   D. All of the above.
   E. None of the above.

50. Which of the following is true for a motor cortex corticospinal interneuron A that produces action potentials during movements of the big toe of the left foot in right-handed Patient X who has a complete transection of the corpus callosum.
   A. In Patient X, the central sulcus of the right cerebral cortex is located in between the cell body of interneuron A and the right eye.
   B. The axon terminals of interneuron A are located on the left side of Patient X's spinal cord.
   C. Interneuron A will increase its action potential firing rate after Patient X reads the statement "Wiggle the big toe of your left foot" presented in Patient X's right visual field.
   D. All of the above.
   E. None of the above.