

STEIN FINAL EXAM -- BIOLOGY 3058 -- MAY 7, 2010 -- PAGE 1 of 16

There are 50 questions in this Biology 3058 exam.

All questions are "A, B, C, D, E, F, G, H" questions worth one point each.

There is a total of 50 points in this exam. Fill in your answers on the separate answer sheet.

The format for this exam is:

Fill in A if A is the only correct answer.

Fill in B if B is the only correct answer.

Fill in C if C is the only correct answer.

Fill in D if both A and B are correct (and C is NOT correct).

Fill in E if both A and C are correct (and B is NOT correct).

Fill in F if both B and C are correct (and A is NOT correct).

Fill in G if A and B and C are all correct.

Fill in H if none of the above is correct (A is NOT correct, B is NOT correct, and C is NOT correct).

ONLY MARK ONE LETTER PER QUESTION.

You may keep the question sheets.

Use a dark (black or blue) pencil or dark (black or blue) pen to fill in the answers.

DO NOT USE A RED PEN; DO NOT USE A RED PENCIL.

1. Which of the following serves as an actuating signal, or as part of an actuating signal, in a negative feedback system?
 - A. Blood plasma levels of Glucose.
 - B. Blood plasma levels of Glucagon.
 - C. Blood plasma levels of Glycogen.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

2. 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 beta-islet cells of the pancreas.
 - C. GLUT2 Transporters in the plasma membranes of skeletal muscle cells.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

3. 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 motor neurons that release acetylcholine (ACh) near diaphragm skeletal muscles.
 - B. Blood plasma levels of oxytocin.
 - C. Action potentials in parasympathetic neurons that release acetylcholine (ACh) near the SA node of the heart.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

4. 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 a decrease in the amount of calcium stored in the bones.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
5. Which of the following is true?
- A. During exocytosis in collecting duct epithelial cells, there is insertion of AQP2 channels from vesicular membranes into luminal membranes.
 - B. During exocytosis in toe motor neurons, there is release of Acetylcholine (ACh) from axonal terminals near toe skeletal muscles in response to a decrease in the amount of intracellular calcium in the axonal terminals of these neurons.
 - C. During endocytosis in fat cells, there is insertion of GLUT4 transporters from vesicular membranes into plasma membranes.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
6. At 1:02 AM, all the GLUT4 transporters of cell X are in the plasma membrane of cell X. Between 1:03 AM and 1:04 AM, there is endocytosis of all these GLUT4 transporters. No exocytosis of vesicles in cell X occurs between 1:00 AM and 1:06 AM.
- A. Between 1:03 AM and 1:04 AM, portions of the plasma membrane of cell X are removed.
 - B. The glucose permeability of the plasma membrane of cell X at 1:05 AM will be less than the glucose permeability of the plasma membrane of cell X at 1:02 AM.
 - C. Between 1:03 AM and 1:04 AM, GLUT4 transporters are released into extracellular space.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

7. 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 less than the amount of sodium ions in the right compartment at 7 AM.
 - B. 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 5 AM.
 - C. The amount of chloride ions in the left compartment at 11 AM will be less than the amount of chloride ions in the right compartment at 11 AM.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
8. Which of the following is true for a G-protein?
- A. When ATP 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.
 - B. When an agonist binds to the binding site of a G-protein-coupled receptor (GPCR), this leads to GTP displacing a GDP bound to the alpha subunit of the G-protein.
 - C. When an antagonist binds to the binding site of a G-protein-coupled receptor (GPCR), this leads to GTP displacing a GDP bound to the alpha subunit of the G-protein.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

9. Consider four culture dishes; each dish has one healthy neuron in it. Dish W has Neuron W in it; Dish X has Neuron X in it; Dish Y has Neuron Y in it; and Dish Z has Neuron Z 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 three types of ionotropic ligand-gated receptors: nACh Receptors (nicotinic Acetylcholine Receptors), NMDA Receptors, and glycine Receptors. None of the neurons have metabotropic receptors. Each neuron has a chloride equilibrium potential of -20 millivolts. At 1:55 AM, a large amount of TTX is added to the physiological saline in all four dishes. Ignore any effects due to voltage-gated calcium channels with S4 helices. 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, acetylcholine, and curare are added to the physiological saline of Dish W; glutamate and acetylcholine are added to the physiological saline of Dish X; glutamate and glycine are added to the physiological saline of Dish Y; glutamate, glycine, and strychnine are added to the physiological saline of Dish Z.
- At 2:01AM, the total sodium conductance in Neuron Y is greater than the total sodium conductance in Neuron Z.
 - At 2:01 AM, the amount of intracellular calcium in Neuron Z will be greater than the amount of intracellular calcium in Neuron Y.
 - At 2:01AM, the total calcium conductance in Neuron X is less than the total calcium conductance in Neuron W.
 - A and B.
 - A and C.
 - B and C.
 - A, B, and C.
 - None of the above.
10. 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 glycine in its synaptic vesicles. Neuron B has GABA 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 glycine receptors. The only ligand-gated receptors in the plasma membrane of Neuron C are GABA_A 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. All 3 neurons a chloride equilibrium potential of -80 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?
- At 2:01 AM, GABA is added to the bath.
 - At 2:01 AM, CNQX is added to the bath.
 - At 2:01 AM, strychnine is added to the bath.
 - A and B.
 - A and C.
 - B and C.
 - A, B, and C.
 - None of the above.

11. 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 divalent cation named DIVCAT with a valence of +2. The threshold for an action potential in Neuron B is -55 millivolts and the resting potential for Neuron B is -70 millivolts. The DIVCAT 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 DIVCAT conductance of Neuron B. Neuron A synapses onto Neuron B. Neuron A's neurotransmitter is LGD.
- A. The intracellular concentration of DIVCAT is 1000 times greater than the extracellular concentration of DIVCAT. In response to an action potential in Neuron A, there will be: a decrease in the membrane voltage of Neuron B; a decrease in the amount of intracellular DIVCAT in Neuron B; and an inhibitory postsynaptic potential in Neuron B.
 - B. The intracellular concentration of DIVCAT is 100 times greater than the extracellular concentration of DIVCAT. In response to an action potential in Neuron A, there will be: an increase in the membrane voltage of Neuron B; an increase in the amount of intracellular DIVCAT in Neuron B; and an inhibitory postsynaptic potential in Neuron B.
 - C. The intracellular concentration of DIVCAT is 10 times greater than the extracellular concentration of DIVCAT. In response to an action potential in Neuron A, there will be: an increase in the membrane voltage of Neuron B; an increase in the amount of intracellular DIVCAT in Neuron B; and an excitatory postsynaptic potential in Neuron B.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. 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 only ligand-gated Receptors in the neuron's plasma membrane are AMPA Receptors, GABA_B Receptors, and glycine Receptors. The equilibrium potential for chloride ions is -70 millivolts, the equilibrium potential for potassium ions is -90 millivolts, and the equilibrium potential for sodium ions is +60 millivolts.
- A. The addition of glycine to the physiological saline will lead to no change in the amount of intracellular chloride.
 - B. The addition of glycine and GABA to the physiological saline will lead to a decrease in the amount of intracellular chloride.
 - C. The addition of glycine and glutamate to the physiological saline will lead to a decrease in the amount of intracellular chloride.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

13. Which of the following is a neurotransmitter that binds to a receptor site that is part of a ligand-gated ionotropic receptor?
- A. AMPA.
 - B. CNQX.
 - C. NMDA.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
14. Which of the following is true for a primary motor cortex (M1) corticospinal interneuron that produces action potentials during movements of the big toe of the right foot?
- A. A portion of its axon is located in a nerve in the right leg.
 - B. Its dendrites are located in the left primary motor cortex (M1) which is in the left cerebral cortex.
 - C. Its axon terminals are located in the right side of the spinal cord.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
15. 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 potassium is the only ion that passes through open Z channels, then Y's binding to its receptor site on Z in neuron A produces a decrease in the membrane voltage of neuron A, an increase in the amount of intracellular potassium ions in neuron A, and an inhibitory postsynaptic potential in neuron A.
 - B. 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 the membrane voltage of neuron A, an increase in the amount of intracellular potassium ions in neuron A, and an excitatory postsynaptic potential in neuron A.
 - C. If the value of E is greater than R and less than T, 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 the membrane voltage of neuron A, a decrease in the amount of intracellular chloride ions in neuron A, and an inhibitory postsynaptic potential in neuron A.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

16. 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. potassium conductance in the peripheral axon terminals of right knee extensor motor neurons.
 - B. sodium conductance in the membranes of the sarcoplasmic reticulum of the muscle fibers of the right knee extensor muscle.
 - C. potassium conductance in the central axon terminals of IA muscle-spindle stretch receptor neurons whose peripheral terminals are in the right knee extensor muscle.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
17. 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 an increase 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 decrease in the Nernst equilibrium potential for potassium ion.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
18. A complete motor neuron is removed from a frog and placed in normal physiological saline at 1 AM. The neuron is healthy. At 2 AM, the physiological saline bathing the neuron is removed and replaced with a modified physiological saline. The composition of the modified physiological saline is as follows: its potassium concentration is the same as normal physiological saline; its sodium concentration is the same as the intracellular sodium concentration of the motor neuron; its total concentration of solutes (osmolarity) is the same as normal physiological saline. For this question, ignore any possible effects due to the sodium-potassium pump. At 2:05 AM, the resting membrane voltage of the neuron is -70 millivolts. At 2:06 AM,
- A. the value of the Nernst equilibrium potential for sodium ions for the neuron is greater than +20 millivolts.
 - B. an increase in sodium conductance will lead to an increase in the amount of intracellular sodium.
 - C. an increase in sodium conductance will lead to no change in the membrane voltage.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

19. Consider an axon of a neuron. At time= t_1 , its voltage is at threshold for an action potential; at time= t_2 , its voltage is at 0 millivolts prior to the peak of that action potential. In the time period between t_1 and t_2 of that single action potential,
- A. sodium conductance of the voltage-gated sodium channels increases as membrane voltage increases.
 - B. sodium conductance of the voltage-gated sodium channels changes with a slower time course than potassium conductance of the voltage-gated potassium channels.
 - C. the amount of intracellular sodium increases.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
20. During chemical synaptic transmission,
- A. neurotransmitter travels via diffusion in extracellular space.
 - B. there will always be release of neurotransmitter from the postsynaptic neuron.
 - C. neurotransmitter binds to receptors located on synaptic vesicles.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
21. An increase in the calcium conductance of all sarcoplasmic reticulum membranes of a skeletal muscle with no external forces on it leads to
- A. increased binding of calcium ions to tropomyosin.
 - B. a decrease in the amount of ATP molecules in the muscle.
 - C. an increase in the amount of calcium ions in the sarcoplasmic reticulum.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
22. When the overlap between the thin and thick filaments of a sarcomere in a skeletal muscle is decreasing,
- A. the total length of the I band is increasing in the sarcomere.
 - B. the length of H zone is increasing in the sarcomere.
 - C. the length of the A band minus the length of the H zone is increasing in the sarcomere.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. 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 GTP (that is bound to myosin) to GDP 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 troponin occurs when the myosin head is not attached to the troponin receptor site.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
24. 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 X to all the axons of the carotid artery baroreceptors at location L 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 X induces a previously unknown change in the excitability of the axon with the following property: for every one action potential produced between baroreceptor peripheral terminals and location L, there are two action potentials that continue down the axon between location L and baroreceptor central axonic terminals. Thus, chemical X causes a doubling of the rate of firing in the axons of carotid baroreceptors as action potentials pass location L.
- 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. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
25. Which of the following is true for the ATP-sensitive potassium channel?
- A. The channel is a spanning protein with a receptor site for ATP located on an intracellular region of the protein.
 - B. When blood plasma levels of glucose are very low, the potassium conductance of the ATP-sensitive potassium channels in the plasma membranes of beta-islet cells will be very high.
 - C. In smooth muscle cells surrounding an arteriole serving a region of the body that has just recently had very high levels of cellular activity, the potassium conductance of the ATP-sensitive potassium channels in the plasma membranes of these smooth muscle cells will be very high.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

26. At 1:00 AM, person X's blood pressure is equal to the blood pressure set point. At 1:01 AM, there is an increase in the firing rate of carotid artery baroreceptors,
- A. this will lead to a decrease in the amount of ACh (acetylcholine) released near the SA node of the heart.
 - B. this will lead to an increase in the heart rate.
 - C. this will lead to an increase in the diameter of the arterioles.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
27. 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 -80 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 an increase in the SA node cell's action potential firing rate?
- A. At 1:01 AM, glutamate is added to the bath.
 - B. At 1:01 AM, glycine is added to the bath.
 - C. At 1:01 AM, muscarine is added to the bath.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
28. Which of the following is true for SA node cardiac muscle cells?
- A. An increase in the binding of norepinephrine to alpha-adrenergic receptors in SA node cells will lead to an increase in intracellular levels of cAMP in these cells.
 - B. An increase in intracellular levels of cAMP in SA node cells will lead to an increase in the amount of time between two successive action potentials in SA node cells.
 - C. An increase in the binding of acetylcholine to nicotinic ACh receptors in SA node cells will lead to a decrease in heart rate.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

29. Which of the following is true for channels in the plasma membrane of a SA node cell in the heart?
- A. The equilibrium potential of its voltage-gated calcium channels is greater than the value of the threshold voltage for the action potential.
 - B. The equilibrium potential of its F channels is less than the value of the threshold voltage for the action potential.
 - C. The equilibrium potential of its voltage-gated potassium channels is less than the equilibrium potential of its F channels.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
30. Which of the following processes in capillaries in the leg assist in the removal of carbon dioxide from the body?
- A. Net flux of carbon dioxide from red blood cells into plasma.
 - B. Net flux of bicarbonate from red blood cells into plasma.
 - C. Formation of carbonic acid by carbonic anhydrase in red blood cells.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
31. Two compartments of equal volume of physiological saline are separated by a membrane permeable only to oxygen. At 1:00 AM equal amounts of oxygen are dissolved into both left and right compartments. At 3:00 AM healthy red blood cells are prepared so that they contain no oxygen. At 3:05 AM these cells are placed into the right compartment. For this question, ignore effects of cellular respiration in the red blood cells.
- A. At 4:00 AM, the amount of extracellular oxygen in the right compartment will be less than the total amount of oxygen in the right compartment at 2:00 AM.
 - B. At 4:00 AM, the total amount of oxygen in the left compartment will be equal to the amount of extracellular oxygen in the right compartment at 4:00 AM.
 - C. At 4:00 AM, the total amount of oxygen (extracellular, intracellular bound, and intracellular unbound oxygen) in the right compartment will be greater than the total amount of oxygen in the left compartment at 4:00 AM.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
32. Which of the following serves as a controlled variable in a negative feedback system?
- A. Blood plasma levels of erythropoietin (EPO).
 - B. Blood plasma levels of hydrogen ions in the carotid artery.
 - C. Levels of hydrogen ions in the interstitial spaces of the brainstem.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

33. Which of the following is true?
- A. Blood plasma entering the lungs has a greater amount of bicarbonate ions than blood plasma leaving the lungs.
 - B. Red blood cells in blood entering the lungs have a higher percentage of hemoglobin oxygen-binding sites occupied with oxygen than red blood cells in the blood leaving the lungs.
 - C. Red blood cells in blood entering the lungs have a greater amount of hydrogen ions bound to hemoglobin than red blood cells in blood leaving the lungs.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
34. Which of the following processes help bring oxygen to the body cells that are in a leg?
- A. Net flux of oxygen from blood plasma into the red blood cells in capillaries near body cells in a leg.
 - B. A decrease in hydrogen ion concentration in red blood cells in the body capillaries in a leg.
 - C. Removal of oxygen from hemoglobin in response to an increase in the amount of HbRH (Hemoglobin Releasing Hormone) in the intracellular spaces of red blood cells in capillaries in the leg.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
35. Which of the following is true for the epithelial cells of the kidney proximal tubule?
- A. The sodium-glucose co-transporter in the basolateral membrane is responsible for the net flux of glucose from intracellular space to interstitial space.
 - B. The sodium-potassium pump in the basolateral membrane is responsible for the net flux of sodium from intracellular space to interstitial space.
 - C. The GLUT4 transporter in the basolateral membrane is responsible for the net flux of glucose from intracellular space to interstitial space.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
36. Healthy Person H takes a new drug named ANTICAMPCOLLDUCT that blocks the production of cyclic AMP (cAMP) in medullary collecting duct epithelial cells in response to vasopressin binding to V2 receptors. 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. Water permeability of the luminal membranes of the medullary collecting duct epithelial cells will lower than pre-drug levels.
 - B. The total amount of AQP2 channels stored in intracellular vesicles in medullary collecting duct epithelial cells will be higher than pre-drug levels.
 - C. H will produce a higher volume of urine compared with the volume of urine produced prior to taking the drug.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

37. A new drug named ANTI-V2R has been developed that is a V2 receptor antagonist. When ANTI-V2R binds to a V2 receptor, there is no binding of vasopressin to that V2 receptor and there is no activation of G proteins. ANTI-V2R will help relieve some of the problems for which of the following patients?
- A. A patient with neurogenic diabetes insipidus who produces no vasopressin.
 - B. A patient with nephrogenic diabetes insipidus caused by a mutation in the AQP2-channel gene.
 - C. A patient whose blood plasma vasopressin levels are always very high due to a tumor whose cells are vasopressin-containing neurosecretory cells that continuously secrete high levels of vasopressin into the blood plasma.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
38. Patient X is no longer able to produce vasopressin. All parts of X's kidney are normal. X is continuously given high doses of vasopressin directly into X's blood plasma. While X is on these high doses,
- A. X will need to drink large amounts of water to survive.
 - B. X will produce large volumes of urine.
 - C. X will have a low water permeability in the luminal membranes of X's medullary collecting ducts.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
39. Luminal plasma membranes of epithelial cells in which of the following regions of the nephron have high water permeability in a human with blood plasma levels of vasopressin that are very low?
- A. Descending limb of the Loop of Henle.
 - B. Ascending limb of the Loop of Henle.
 - C. Medullary Collecting Ducts.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
40. Which of the following is true for the G.I. (Gastro-Intestinal) system?
- A. Skeletal muscles directly control the movement of substances at the entrance of the G.I. system.
 - B. Skeletal muscles control the movement of substances in the small intestine.
 - C. The external anal sphincter is a skeletal muscle that helps control the timing of removal of solid waste products from the G.I. system.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

41. Which of the following is true?
- A. Binding of GH to GH Receptors located in the plasma membranes of cells in the anterior pituitary leads to the secretion of GHRH Receptors from cells in the anterior pituitary.
 - B. GHRH Receptors travel in the specialized capillaries located between the hypothalamus and the anterior pituitary.
 - C. Binding of GHRH to GHRH Receptors located in the plasma membranes of cells in the hypothalamus leads to the secretion of GH (Growth Hormone) from cells in the hypothalamus.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
42. 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 higher 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 lower than the glucose permeability of W's skeletal muscle cells at 8 PM on May 1.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
43. Glucagon
- A. production in the liver increases in response to an increase in blood plasma levels of glycogen.
 - B. is secreted by alpha-islet cells of the pancreas.
 - C. binding to Glucagon Receptors in the plasma membranes of liver cells leads to an increase in the exocytosis of GLUT2 Transporters from intracellular vesicles into the plasma membranes of liver cells.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

44. Which of the following is true?
- A. GLUT2 transporter molecules are responsible for the net flux of glucose from the interstitial spaces surrounding beta-islet cells of the pancreas into the intracellular spaces of beta-islet cells of the pancreas.
 - B. GLUT2 transporter molecules are responsible for the net flux of glucose from the interstitial spaces of the kidney cortex into the intracellular spaces of proximal tubule epithelial cells.
 - C. When blood plasma levels of glucagon are high and blood plasma levels of insulin are low, GLUT2 transporter molecules are responsible for the net flux of glucose from the interstitial spaces surrounding liver cells into the intracellular spaces of liver cells.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
45. Person X is a healthy human who has volunteered to take experimental drug Y. Person X has a normal dinner at 6 PM on April 1 and then does not eat for 12 hours. At 2 AM on April 2, X takes a dose of Y that closes all the ATP-sensitive potassium channels in X's beta-islet cells of the pancreas. The full action of drug Y occurs within 10 minutes and lasts for 6 hours. For this question, ignore any effects due to alpha-islet cells of the pancreas.
- A. At 3 AM on April 2, X's intracellular amounts of calcium ions in X's beta-islet cells of the pancreas will be lower than X's intracellular amounts of calcium ions in X's beta-islet cells of the pancreas at 1 AM on April 2.
 - B. At 3 AM on April 2, the plasma-membrane glucose permeability of X's skeletal muscle cells will be higher than the plasma-membrane glucose permeability of X's skeletal muscle cells at 1 AM on April 2.
 - C. At 3 AM on April 2, X's blood plasma levels of insulin will be lower than X's blood plasma levels of insulin at 1 AM on April 2.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
46. In an adult male, which of the following is true?
- A. When LH binds to LH Receptors in the plasma membranes of Leydig cells, this stimulates the Leydig cell to secrete FSH.
 - B. Testosterone Receptors are located in intracellular spaces of Sertoli cells.
 - C. When FSH binds to FSH Receptors in the plasma membranes of Sertoli cells, this stimulates the Sertoli cells to secrete LH.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

47. A healthy young adult human female who is not pregnant receives a chemical implant that is programmed to alternate between two conditions. The first condition lasts one week; during the first condition, the implant releases no chemicals. The second condition lasts three weeks; during the second condition, the implant releases high levels of estrogen and progesterone into the blood plasma. Every 4 weeks, this female will
- A. have high levels of LH.
 - B. ovulate.
 - C. menstruate.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
48. Healthy human female X is 25 years old and not pregnant. During the postovulatory phase of X's menstrual cycle,
- A. there are low blood plasma levels of LH and FSH.
 - B. there are high blood plasma levels of hCG (human Chorionic Gonadotropin).
 - C. the corpus luteum releases high levels of LH and FSH into the blood plasma.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
49. Right-handed adult patient X with a complete transection of the corpus callosum is presented with a simple written question in his left 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.
- A. Patient X will be able to respond correctly to the sentence with a verbal reply.
 - B. The presentation of the simple written question will lead to a change in the firing rates of some neurons in the right visual cortex of Patient X.
 - C. Patient X will be able to use a pencil in his right hand to spell out the correct answer on a piece of paper.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
50. A question is flashed on a screen in the right visual world of right-handed person Z. Person Z is a healthy individual with a 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. 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.
 - B. The stimulus will excite neurons in the right half of Z's left retina.
 - C. The stimulus will excite neurons in Z's right visual cortex.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.