

STEIN IN-TERM EXAM -- BIOLOGY 3058 -- APRIL 19, 2012 -- PAGE 1 of 9

There are 25 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 25 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. Consider Neuron B in the frog central nervous system whose plasma membrane has a newly discovered ligand-gated ionotropic receptor, named the LGD receptor. The channel in the same molecular complex as the LGD receptor is termed the LGD receptor channel. The Nernst equilibrium potential for sodium in Neuron B is 0 mV, and the Nernst equilibrium potential for potassium in Neuron B is -100 mV. The threshold for an action potential in Neuron B is -60 mV and the resting potential for Neuron B is -75 mV. LGD is an agonist for the ligand-gated ionotropic receptor. When LGD binds to its binding site, there is an increase in conductance of the LGD receptor channel. Neuron A synapses onto Neuron B. Neuron A's transmitter is LGD.
 - A. Consider the situation that when the LGD receptor channel is open in Neuron B, it is permeable to both sodium and potassium. For this situation, when open, it is permeable to no other ions. For this situation, when open, its potassium conductance equals three times its sodium conductance. For this situation, in response to an action potential in Neuron A, then there will be a voltage decrease and an inhibitory postsynaptic potential in Neuron B.
 - B. Consider the situation that when the LGD receptor channel is open in Neuron B, it is permeable to both sodium and potassium. For this situation, when open, it is permeable to no other ions. For this situation, when open, its potassium conductance equals two times its sodium conductance. For this situation, in response to an action potential in Neuron A, then there will be a voltage increase and an excitatory postsynaptic potential in Neuron B.
 - C. Consider the situation that when the LGD receptor channel is open in Neuron B, it is permeable to sodium only. For this situation, when open, it is permeable to no other ions. For this situation, in response to an action potential in Neuron A, then there will be a voltage increase 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.

2. 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 the plasma membrane of Neuron A are AMPA Receptors. 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 have 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 an increase in Neuron C's action potential firing rate?
- A. At 2:01 AM, glycine is added to the bath.
 - B. At 2:01 AM, strychnine is added to the bath.
 - C. At 2:01 AM, CNQX 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.
3. Consider five culture dishes; each dish has one healthy neuron in it. Dish V has Neuron V 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: nAChRs (nicotinic Acetylcholine Receptors), NMDA Receptors, and Glycine Receptors. None of the neurons have metabotropic receptors. Each neuron has a chloride equilibrium potential of -70 millivolts. At 1:55 AM, a large amount of TTX is added to the physiological saline in all five 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 is added to the physiological saline of Dish V;
 - ACh is added to the physiological saline of Dish W;
 - glutamate and ACh are added to the physiological saline of Dish X;
 - glutamate, ACh, and glycine are added to the physiological saline of Dish Y;
 - glutamate, ACh, glycine, and strychnine are added to the physiological saline of Dish Z.
- A. At 2:01AM, the total sodium conductance in Neuron X is less than the total sodium conductance in Neuron Y. In addition, the total sodium conductance in Neuron W is less than the total sodium conductance in Neuron V.
 - B. At 2:01 AM, the total calcium conductance in Neuron Y will be less than the total calcium conductance in Neuron Z. In addition, the total calcium conductance in Neuron X will be less than the total calcium conductance in Neuron V.
 - C. For each neuron, MAXV is the maximum voltage that is reached by that neuron during the period from 2:00 AM to 2:02 AM. The MAXV in Neuron W is greater than the MAXV in Neuron V. In addition, the MAXV in Neuron Z is greater than the MAXV in Neuron Y.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

4. 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 synapse upon skeletal muscles in the lung.
 - B. Action potentials in parasympathetic neurons that synapse upon skeletal muscles surrounding the arterioles.
 - C. Action potentials in carotid artery baroreceptors.
 - 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 processes in capillaries in the lung assist in the removal of carbon dioxide from the body?
- A. Net flux of carbon dioxide from plasma into red blood cells.
 - B. Net flux of bicarbonate from plasma into red blood cells.
 - 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.
6. Which of the following are true for ventilation?
- A. The problems with ventilation induced by injection of curare occur because of the drug's direct action on muscarinic ACh Receptors (mAChRs) in the plasma membranes of the respiratory muscles (the diaphragm and the rib-cage muscles).
 - B. An increase in the hydrogen ion concentration in the interstitial spaces of the brain stem leads to an increase in the duration of the respiratory cycle (duration of respiratory cycle equals duration of inspiration plus duration of expiration).
 - C. When the pressure within the alveoli is less than atmospheric pressure, there will be inspiration of air into the lungs.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
7. Which of the following processes occur in the lung?
- A. Binding of oxygen to hemoglobin in response to high partial pressures of oxygen in red blood cells in the lung.
 - B. Removal of oxygen from hemoglobin in response to high levels of hydrogen ions in red blood cells in the lung.
 - C. Net flux of oxygen from plasma into red blood cells in capillaries of the lung.
 - 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 serves as an effector, or as part of an effector, in a negative feedback system?
- A. GLUT4 Transporters in rib cage inspiratory muscles.
 - B. Insulin Receptors in the diaphragm muscle.
 - C. Central Hydrogen-Ion-Sensitive Chemoreceptors in the brain stem.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
9. Which of the following processes in capillaries of the leg assist in the removal of carbon dioxide from the body?
- A. Breakdown of carbonic acid by carbonic anhydrase in red blood cells.
 - B. Net flux of carbon dioxide from plasma into red blood cells.
 - C. Net flux of bicarbonate from red blood cells into plasma.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
10. 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 total amount of oxygen (extracellular, intracellular bound, and intracellular unbound oxygen) in the right compartment will be equal to the total amount of oxygen in the left compartment at 4:00 AM.
 - B. 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.
 - C. At 4:00 AM, the total amount of oxygen in the left compartment will be less than the amount of extracellular oxygen in the right 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.
11. 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 leaving the lungs have a greater amount of hydrogen ions bound to hemoglobin than red blood cells in blood entering the lungs.
 - C. Red blood cells in blood entering the lungs have a lower percentage of hemoglobin oxygen-binding sites occupied with oxygen than red blood cells in the 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.

12. Which of the following is true for ventilation?
- A. Motor neurons that excite the diaphragm muscle utilize ACh (acetylcholine) as their neurotransmitter.
 - B. Central chemoreceptors that sense the levels of hydrogen ions in interstitial spaces are located in the brain stem.
 - C. Peripheral chemoreceptors that sense the levels of hydrogen ions in interstitial spaces are located 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.
13. Erythropoietin (EPO)
- A. acts by increasing the production of red blood cells by cells in the kidney.
 - B. binds to EPO Receptors that are only located in the plasma membranes of the peritubular interstitial cells of the kidney cortex.
 - C. levels in the blood plasma serve as an effector in a long-term negative feedback loop that controls the levels of oxygen in the peritubular interstitial spaces of the kidney cortex.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
14. Healthy Person H takes a new drug named CAMPCOLLDUCTUP that results in continuous very high values of cyclic AMP (cAMP) in medullary collecting duct epithelial cells in the kidney. 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 higher than pre-drug levels.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

15. Healthy Person P takes a drug that produces a strong effect on the epithelial cells of the kidney collecting duct within one hour and lasts for one week after taking the drug. There is no direct effect of the drug on other cells in the body. One day after taking the drug, which of the following drugs will produce a condition with the symptoms of diabetes insipidus in Healthy Person P?
- A. Drug X that blocks exocytosis of AQP2 for one week.
 - B. Drug Y that produces a condition in which the levels of intracellular cyclic AMP (cAMP) are very low for one week.
 - C. Drug Z that is an antagonist at V2 receptors that remains bound to V2 receptors for one week.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
16. Consider the case of a rare mutant in which the concentration of solutes in the kidney medulla interstitial spaces is equal to the concentration of solutes in the liquid in the lumen of the medullary collecting duct in the kidney. The defective molecules associated with this rare mutation are **NOT** located in the epithelial cells of the kidney medullary collecting duct; the defective molecules are located in other cells of the kidney. In this rare mutant, an increase in the amount of vasopressin that binds to V2 Receptors in the kidney will lead to **NO CHANGE** in the
- A. water permeability of the luminal membranes of the collecting duct epithelial cells.
 - B. amount of water that is reabsorbed into the blood plasma from the lumen of the collecting duct.
 - C. net flux of water from the luminal spaces of the collecting duct to the interstitial spaces of the kidney medulla.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
17. 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 produce large volumes of urine.
 - B. X will have a high water permeability in the luminal membranes of X's medullary collecting duct epithelial cells.
 - C. X will need to drink large amounts of water to survive.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

18. Which of the following is true for the epithelial cells of the kidney proximal tubule?
- A. The GLUT2 transporter in the basolateral membrane is responsible for the net flux of glucose from intracellular space to interstitial space.
 - B. The sodium-glucose co-transporter in the luminal membrane is responsible for the net flux of sodium from intracellular space to interstitial space.
 - C. The sodium-potassium pump in the basolateral membrane is responsible for the net flux of potassium 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.
19. Which of the following processes assist in the maintenance of high levels of dissolved solutes in the interstitial spaces of the kidney medulla?
- A. Net flux of sodium from luminal spaces to intracellular spaces via the sodium-potassium-2chloride co-transporters located in the luminal membranes of the epithelial cells in the ascending limb of the Loop of Henle.
 - B. Net flux of sodium ions from intracellular spaces to interstitial spaces via sodium-potassium-ATPase pumps located in the basolateral membranes of the epithelial cells in the ascending limb of the Loop of Henle.
 - C. Net flux of sodium ions from intracellular spaces to interstitial spaces via the sodium-glucose co-transporters located in the basolateral membranes of the epithelial cells in the ascending limb of the Loop of Henle.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
20. Which of the following is true?
- A. Pepsinogen is produced in the pancreas and is converted into its active form by the enzyme enterokinase; the enzyme enterokinase is located in the membranes of cells in the walls of the stomach.
 - B. Trypsinogen is produced in the pancreas and is converted into its active form by HCl in the lumen of the stomach.
 - C. Pancreatic amylase is produced in the pancreas and secreted into the small intestine; in the small intestine, it breaks down long chains of carbohydrates into double sugars.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

21. Which of the following functions of the Gastrointestinal tract occur in the mouth?
- A. Movement of carbohydrates in the Gastrointestinal tract.
 - B. Digestion of proteins in the Gastrointestinal tract.
 - C. Secretion of enzymes that digest fats into the Gastrointestinal tract.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
22. 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 for 6 hours. For this question, ignore any effects due to alpha-islet cells of the pancreas.
- A. At 3 AM, X's blood plasma levels of glucose will be higher than X's blood plasma levels of glucose at 1 AM.
 - B. At 3 AM, the glucose permeability of X's skeletal muscle cells will be higher than the glucose permeability of X's skeletal muscle cells at 1 AM.
 - C. At 3 AM, X's blood plasma levels of insulin will be higher than X's blood plasma levels of insulin at 1 AM.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
23. 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 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 higher 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.

24. Insulin binding to insulin receptors in the plasma membrane of a
- A. liver cell will lead to an increase in amount of GLUT2 transporters in the plasma membrane of 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 to vesicular membranes.
 - 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 exocytosis?
- A. In medullary collecting duct epithelial cells of the kidney, there will be exocytosis of AQP2 channels from intracellular vesicles into luminal membranes in response to high levels of vasopressin binding to V2 receptors in basolateral membranes.
 - B. In skeletal muscle cells, there will be exocytosis of GLUT4 transporters from intracellular vesicles into plasma membranes in response to high levels of insulin binding to insulin receptors in plasma membranes.
 - C. In IA muscle-spindle stretch receptor neurons, there will be exocytosis and release of glutamate from central axon terminals of these neurons in the spinal cord in response to an increase in intracellular calcium levels in these central axon terminals.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.