

STEIN IN-TERM EXAM -- BIOLOGY 3058 -- APRIL 18, 2013 -- 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 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_B 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 zero (0) 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.
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 sympathetic neurons that release ACh (acetylcholine) near SA node cells of the heart.
 - B. Action potentials in ventricular muscle cells of the heart.
 - C. Action potentials in carotid artery baroreceptor neurons.
 - 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 more than the total sodium conductance in Neuron Y. In addition, the total sodium conductance in Neuron W is more 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 more 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 less 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 is true for fluid exchange in capillaries?
- A. Osmotic pressure tends to push water from interstitial spaces external to the capillary into the blood plasma in the capillary.
 - B. In a normal steady state in a capillary, the magnitude of blood pressure greatly exceeds the magnitude of osmotic pressure.
 - C. Blood pressure tends to push water from the blood plasma in the capillary into the interstitial spaces external to the capillary.
 - 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 serves as an effector, or as part of an effector, in a negative feedback system?
- A. GLUT4 Transporters in skeletal muscles in the lung.
 - B. Insulin Receptors in the diaphragm muscle.
 - C. Voltage-gated calcium channels in the axon terminals of motor neurons that synapse upon inspiratory rib-cage muscles.
 - 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 is true?
- A. The blood plasma levels of bicarbonate in the pulmonary artery are higher than the blood plasma levels of bicarbonate in the pulmonary vein.
 - B. The partial pressure of oxygen in the blood plasma in the pulmonary artery is higher than the partial pressure of oxygen in the blood plasma in the pulmonary vein.
 - C. The percent Hemoglobin saturation (percent of oxygen-binding sites in Hemoglobin that have oxygen bound) in the red blood cells in the pulmonary artery is higher than the percent Hemoglobin saturation in the red blood cells in the pulmonary vein.
 - 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 is true?
- A. Erythropoietin (EPO) is secreted by bone marrow cells.
 - B. Erythropoietin Receptor (EPOR) levels in the blood plasma serve as an actuating signal in a long-term negative feedback loop that controls the amount of oxygen in the peritubular interstitial spaces of the kidney cortex.
 - C. Cells in the kidney cortex increase their production of red blood cells in response to increases in plasma levels of Erythropoietin (EPO).
 - 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 processes in capillaries in the lung 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 plasma into red blood cells.
 - C. Breakdown of carbonic acid into carbon dioxide and water 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.

9. Which of the following processes help bring oxygen to the body cells that are in a leg?
- A. A decrease in hydrogen ion concentration in red blood cells in the body capillaries in the leg.
 - B. Removal of oxygen from hemoglobin in response to high (that is, greater than 80 mmHg) partial pressures (concentration) of oxygen in red blood cells in the leg.
 - C. Net flux of oxygen from plasma in the body capillaries in the leg into the interstitial spaces near the body 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.
10. Which of the following is true for ventilation?
- A. When the pressure within the alveoli is less than atmospheric pressure, there will be inspiration of air into the lungs.
 - B. The problems with ventilation induced by injection of curare occur because of the drug's direct action on Dihydropyridine Receptors (DHPRs) in the transverse tubules of the respiratory muscles (the diaphragm and the rib-cage muscles).
 - C. An increase in the hydrogen ion concentration in the interstitial spaces of the brainstem leads to an increase in the duration of the respiratory cycle (duration of respiratory cycle equals duration of inspiration plus duration of expiration).
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
11. 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 greater than 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 equal to 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.

12. Consider a human who is at a high altitude climbing a mountain. Which of the following is true for that person at that altitude?
- A. A decrease in the oxygen concentration in the blood plasma in the carotid artery will lead to an increase in the firing frequency of the oxygen-sensitive carotid artery peripheral chemoreceptors.
 - B. An increase in the firing frequency of the oxygen-sensitive peripheral chemoreceptors whose central terminals are located in the brainstem will lead to a decrease in the rate of ventilation.
 - C. An increase in the hydrogen-ion concentration in the blood plasma in the carotid artery will lead to an increase in the firing frequency of the hydrogen-ion-sensitive carotid artery peripheral chemoreceptors.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
13. Healthy Person W is a 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 5 PM on May 2, W takes a dose of Z that completely blocks the net flux of glucose via all sodium-glucose cotransporters in the kidney for the next 12 hours. Drug Z has no direct effect on cells located outside of the kidney. 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, the amount of glucose in W's urine will be higher than the amount of glucose in W's urine at 8 PM on May 1.
 - B. At 8 PM on May 2, the net flux of glucose from intracellular spaces of proximal tubule epithelial cells in W's kidney to interstitial spaces surrounding these cells will be lower than the net flux of glucose from intracellular spaces of proximal tubule epithelial cells in W's kidney to interstitial spaces surrounding these cells at 8 PM on May 1.
 - C. At 8 PM on May 2, the osmolarity of the luminal fluid immediately before entering the descending Loop of Henle of W's kidney will be higher than the osmolarity of the luminal fluid immediately before entering the descending Loop of Henle of W's kidney 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.
14. Which of the following is true for the epithelial cells of the kidney proximal tubule?
- A. Sodium-glucose co-transporters (SGLT1 and SGLT2) in the basolateral membrane are 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 GLUT2 transporter in the luminal membrane is responsible for the net flux of glucose from luminal space to intracellular space.
 - 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 H takes a new drug named ANTICAMPCOLLDUCT that blocks the production of cyclic AMP (cAMP) in collecting duct epithelial cells in response to vasopressin binding to V2 receptors and results in a condition in which intracellular levels of cAMP in collecting duct epithelial cells are continuously very low. A single dose of the new drug creates this condition within one hour and this condition lasts for one week. Which of the following is true for Person H during the third day after taking the new drug?
- A. Water permeability of the luminal membranes of the collecting duct epithelial cells will higher than pre-drug levels.
 - B. The total amount of AQP2 channels stored in intracellular vesicles will be higher than pre-drug levels.
 - C. Person H will produce a greater volume of urine compared with the volume of urine produced by Person H 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.
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 an increase 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. 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 ions from luminal spaces to intracellular spaces via sodium-potassium-ATPase pumps located in the luminal membranes of the epithelial cells in the descending limb of the Loop of Henle.
 - B. 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.
 - C. 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.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

18. A new drug named AGON-V2R has been developed that is a V2 Receptor agonist. When AGON-V2R binds to a V2 Receptor, there is activation of G proteins that are normally activated by binding of vasopressin to that V2 Receptor. AGON-V2R will help relieve some of the problems for which of the following patients?
- A. 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 very high levels of vasopressin into the blood plasma.
 - B. A patient with neurogenic diabetes insipidus who produces no vasopressin.
 - C. A patient with nephrogenic diabetes insipidus caused by a mutation in the AQP2-channel gene.
 - 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 is true?
- A. Trypsinogen is produced in the pancreas and is secreted into the lumen of the small intestine. It is converted into trypsin by enterokinase. Enterokinase is located in the membranes of cells in the walls of the small intestine.
 - B. Pepsinogen is produced by cells in the walls of the stomach and is secreted into the lumen of the stomach. It is converted into pepsin by HCl in the lumen of the stomach.
 - C. Pancreatic amylase is produced in the pancreas and secreted into the stomach. In the stomach, 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.
20. Which of the following is true for the G.I. (Gastro-Intestinal) system?
- A. Smooth muscles directly control the movement of substances at the entrance of the G.I. system.
 - B. Smooth 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.

21. Glucagon
- A. binding to Glucagon Receptors in the plasma membranes of a liver cell leads to an increase in the exocytosis of GLUT2 Transporters from intracellular vesicles into the plasma membrane of the liver cell.
 - B. levels in a liver cell decrease in response to an increase in cAMP levels in the cytosol of the liver cell.
 - C. binding to Glucagon Receptors in the plasma membrane of an alpha-islet cell of the pancreas leads to an increase in the levels of cAMP in the cytosol of the alpha-islet cell.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
22. Which of the following is true?
- A. Glucagon binding to Glucagon Receptors in the plasma membrane of a liver cell leads to an increase in the levels of cAMP in the cytosol of the liver cell.
 - B. Acetylcholine (ACh) binding to muscarinic Acetylcholine Receptors (mAChRs) in the plasma membrane of a SA node cell leads to a decrease in the levels of cAMP in the cytosol of the SA node cell.
 - C. Vasopressin binding to V2 Receptors (V2Rs) in the luminal membrane of a medullary collecting duct epithelial cell leads to an increase in the levels of cAMP in the cytosol of the medullary collecting duct epithelial cell.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
23. 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 5 PM on April 2, X takes a dose of Y that opens all the ATP-sensitive potassium channels in X's beta-islet cells of the pancreas for 12 hours. Person X has a normal dinner at 6 PM on April 2 and then does not eat for 12 hours. For this question, ignore any effects due to alpha-islet cells of the pancreas.
- A. At 8 PM on April 2, the glucose permeability of the plasma membranes of X's skeletal muscle cells will be lower than the glucose permeability of the plasma membranes of X's skeletal muscle cells at 8 PM on April 1.
 - B. At 8 PM on April 2, X's blood plasma levels of glucose will be lower than X's blood plasma levels of glucose at 8 PM on April 1.
 - C. At 8 PM on April 2, X's blood plasma levels of insulin will be lower than X's blood plasma levels of insulin at 8 PM on April 1.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

24. Which of the following is true?
- A. Insulin binding to Insulin Receptors in the plasma membrane of a liver cell leads to a decrease in intracellular levels of Glycogen in the liver cell.
 - B. Insulin binding to Insulin Receptors in the plasma membrane of a fat cell leads to an increase in the amount of GLUT2 Transporters in the plasma membrane of the fat cell.
 - C. Insulin binding to Insulin Receptors in the plasma membrane of a diaphragm muscle cell leads to an increase in the exocytosis of GLUT4 transporters into the sarcoplasmic reticulum membranes of the diaphragm muscle.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
25. Person Y is a healthy human who has volunteered to take experimental drug Z. Person Y has a normal dinner at 6 PM on May 1 and then does not eat for 12 hours. At 6 AM on May 2, Y 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 Y 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, Y's blood plasma levels of glucose will be much higher than Y'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 Y's beta-islet cells will be higher than potassium conductance of the ATP-sensitive potassium channels in Y's beta-islet cells at 8 PM on May 1.
 - C. At 8 PM on May 2, the glucose permeability of Y's skeletal muscle cells will be much higher than the glucose permeability of Y'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.