

STEIN IN-TERM EXAM -- BIOLOGY 3058 -- APRIL 16, 2015 -- 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 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 a decrease in Neuron C's action potential firing rate?
 - A. At 2:01 AM, glycine is added to the bath.
 - B. At 2:01 AM, CNQX is added to the bath.
 - C. At 2:01 AM, TTX 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 is an agonist that binds to a receptor site that is part of a ligand-gated metabotropic receptor?
 - A. Muscarine.
 - B. GABA.
 - C. ACh (acetylcholine).
 - 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: AMPA 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 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; AMPA is added to the physiological saline of Dish W; NMDA is added to the physiological saline of Dish X; NMDA and glycine are added to the physiological saline of Dish Y; NMDA, glycine, and strychnine are added to the physiological saline of Dish Z.
- At 2:01 AM, the total calcium conductance in Neuron V is greater than the total calcium conductance in Neuron W. In addition, the total calcium conductance in Neuron Z is greater than the total calcium conductance in Neuron Y.
 - At 2:01 AM, the total sodium conductance in Neuron W is greater than the total sodium conductance in Neuron X. In addition, the total sodium conductance in Neuron Z is greater than the total sodium conductance in Neuron Y.
 - 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 X. In addition, the MAXV in Neuron Y is greater than the MAXV in Neuron X.
 - A and B.
 - A and C.
 - B and C.
 - A, B, and C.
 - None of the above.
4. Which of the following is true?
- The blood plasma levels of bicarbonate in the pulmonary artery are higher than the blood plasma levels of bicarbonate in the pulmonary vein.
 - 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.
 - 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.
 - A and B.
 - A and C.
 - B and C.
 - A, B, and C.
 - None of the above.

5. Which of the following processes in capillaries in the lungs assist in the removal of carbon dioxide from the body?
- A. Formation of carbonic acid from carbon dioxide and water by carbonic anhydrase in the blood plasma.
 - B. Net flux of carbon dioxide from red blood cells into blood plasma.
 - C. Net flux of bicarbonate from red blood cells into blood plasma.
 - 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 serves as an effector, or as part of an effector, in a negative feedback system?
- A. Dihydropyridine (DHP) Receptors in the transverse tubules of inspiratory rib cage muscles.
 - B. Ryanodine Receptors in the plasma membranes of expiratory rib cage muscles.
 - C. Insulin Receptors in the sarcoplasmic reticulum membranes of diaphragm muscles.
 - 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 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 the interstitial spaces near the body capillaries in the leg into blood plasma in 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.
8. Which of the following is true for ventilation?
- A. When the pressure within the alveoli is greater than atmospheric pressure, there will be expiration of air from the lungs into the atmosphere.
 - B. The problems with ventilation induced by injection of curare occur because of the drug's binding to Nicotinic Acetylcholine Receptors (nAChRs) in the plasma membranes 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 a decrease 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.

9. Which of the following will lead to an increase in the rate of ventilation?
- A. An increase in the binding of EPO (erythropoietin) to EPO Receptors located only in the plasma membranes of red blood cells.
 - B. A decrease in the partial pressure of oxygen in the blood plasma in the carotid artery in a person who is mountain climbing at high altitude.
 - C. An increase in levels of hydrogen ions in 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.
10. 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 central hydrogen-ion-sensitive chemoreceptors.
 - C. Action potentials in motor neurons that synapse upon 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.
11. Which of the following are involved in the long-term regulation of the oxygen-carrying capacity of the blood?
- A. Change in the total amount of hemoglobin in the blood.
 - B. Secretion of the hormone erythropoietin (EPO) from cells in the bone marrow.
 - C. Production of red blood cells by peritubular interstitial cells (PIC) of the renal cortex in response to EPO binding to EPO Receptors in the plasma membranes of the PIC of the renal cortex.
 - 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?
- A. Trypsinogen is produced in the pancreas and is secreted into the lumen of the stomach. It is converted into trypsin by enterokinase. Enterokinase is located in the membranes of cells in the walls of the stomach.
 - B. 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.
 - C. Pepsinogen is produced by cells in the walls of the small intestine and is secreted into the lumen of the small intestine. It is converted into pepsin by HCl in the lumen of the small intestine.
 - 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 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. 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.
14. 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. amount of water that is reabsorbed into the blood plasma from the lumen of the collecting duct.
 - B. net flux of water from the luminal spaces of the collecting duct to the interstitial spaces of the kidney medulla.
 - C. water permeability of the basolateral membranes of the collecting duct epithelial cells.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
15. Which of the following is true for Vasopressin2 Receptors (V2Rs) in medullary collecting duct epithelial cells?
- A. When antagonists bind to V2Rs in the plasma membrane of the cells, this leads to an increase in the intracellular amount of cAMP.
 - B. When agonists bind to V2Rs in the plasma membrane of the cells, this leads to an increase in the amount of ATP that is bound to alpha subunits of the G-proteins associated with the V2Rs.
 - C. When agonists bind to V2Rs in the plasma membrane of the cells, this leads to an increase in the amount of AQP2 in the luminal plasma membranes of the cells.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

16. SGLT1 (sodium-glucose co-transporter 1) is
- A. located in luminal membranes of epithelial cells in the late proximal tubule of the kidney.
 - B. located in luminal membranes of epithelial cells of the small intestine.
 - C. responsible for the net flux of glucose from luminal spaces to intracellular spaces in the late proximal tubule of the kidney.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
17. 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 (both SGLT1 and SGLT2) in the kidney for 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 higher 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.
18. 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 be 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.

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 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 luminal spaces to intracellular spaces via the sodium-glucose co-transporters located in the luminal membranes of the epithelial cells in the ascending limb of the Loop of Henle.
 - C. Net flux of sodium from intracellular spaces to interstitial spaces via the sodium-potassium-2chloride 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. 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 who produces no vasopressin.
 - B. A patient whose osmoreceptor neurons in the hypothalamus have a problem with exocytosis of neurotransmitter and do not release neurotransmitter into the synaptic cleft in response to action potentials.
 - 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 very 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.
21. 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 insulin.
 - B. Blood plasma levels of glucose.
 - 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.

22. Insulin binding to insulin receptors in the plasma membrane of a
- A. beta-islet cell of the pancreas will lead to an increase in the glucose permeability of the plasma membrane of the beta-islet cell.
 - B. skeletal muscle cell will lead to an increase in endocytosis of GLUT4 Transporters from the plasma membrane of the skeletal muscle cell into vesicular membranes.
 - C. liver cell will lead to an increase in amount of GLUT2 transporters in the plasma membrane of the liver 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, X's blood plasma levels of insulin will be higher than X's blood plasma levels of insulin at 8 PM on April 1.
 - B. At 8 PM on April 2, X's blood plasma levels of glucose will be higher than X's blood plasma levels of glucose at 8 PM on April 1.
 - C. At 8 PM on April 2, the glucose permeability of X's skeletal muscle cells will be lower than the glucose permeability of X's skeletal muscle cells 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 cells serve as both a sensor and a controller, or contain both a sensor and a controller, for a negative feedback system?
- A. Alpha islet cells of the pancreas.
 - B. Beta islet cells of the pancreas.
 - C. Peritubular interstitial cells (PIC) 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.
25. Glycogen
- A. binding to Glycogen Receptors in the plasma membrane 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 Glycogen 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.