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 LGD1 receptor. The channel in the same molecular complex as the LGD1 receptor is termed the LGD1 receptor channel and is a monovalent cation channel that, when open, is permeable to both sodium and potassium. The Nernst equilibrium potential for sodium in Neuron B is +20 mV, and the Nernst equilibrium potential for potassium in Neuron B is -80 mV. The threshold for an action potential in Neuron B is -45 mV and the resting potential for Neuron B is -65 mV. LGD1 is an agonist for the ligand-gated ionotropic receptor. When LGD1 binds to its binding site, there is an increase in conductance of both sodium and potassium in the LGD1 receptor channel. Neuron A synapses onto Neuron B. Neuron A's transmitter is LGD1.
   A. Consider the situation that when the LGD1 receptor channel is open in Neuron B, its potassium conductance equals its sodium conductance. For this situation, in response to an action potential in Neuron A, there is an excitatory postsynaptic potential in Neuron B. In addition for this situation in response to an action potential in Neuron A, the absolute value of the change in the amount of intracellular sodium in Neuron B is equal to the absolute value of the change in the amount of intracellular potassium in Neuron B.
   B. Consider the situation that when the LGD1 receptor channel is open in Neuron B, its potassium conductance equals four times its sodium conductance. For this situation, in response to an action potential in Neuron A, there is an inhibitory postsynaptic potential in Neuron B. In addition for this situation in response to an action potential in Neuron A, the absolute value of the change in the amount of intracellular sodium in Neuron B is greater than the absolute value of the change in the amount of intracellular potassium in Neuron B.
   C. Consider the situation that when the LGD1 receptor channel is open in Neuron B, its potassium conductance equals nine times its sodium conductance. For this situation, in response to an action potential in Neuron A, there is an inhibitory postsynaptic potential in Neuron B. In addition for this situation in response to an action potential in Neuron A, the absolute value of the change in the amount of intracellular sodium in Neuron B is less than the absolute value of the change in the amount of intracellular potassium 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. A complete motor neuron is removed from a frog and placed in a large volume of modified extracellular 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, $GABA_A$ 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 GABA to the physiological saline will lead to a decrease in the amount of intracellular chloride.
   B. The addition of glycine and glutamate to the physiological saline will lead an increase in the amount of intracellular chloride.
   C. The addition of glycine to the physiological saline will lead to no change 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.

3. Consider a single cycle in a healthy heart. Define the start of the cycle as the beginning of the action potential in a SA node cell, which occurs at t_1, and the end of the cycle as the beginning of the following action potential in that same SA node cell, which occurs at t_2. The beginning of the SA node cell action potential is the time when the voltage of the SA node cell crosses the threshold for an action potential, that is, the time when SA node cell voltage goes from below threshold to above threshold. During the interval between t_1 and t_2, there are 2 heart sounds. The first heart sound is *lub*; the second heart sound is *dub*. Which of the following is true?
   A. In that single cycle, the volume of blood in the left ventricle at the end of the *lub* sound is greater than the volume of blood in the left ventricle at the start of the *dub* sound.
   B. In that single cycle during the time interval between t_1 and the time immediately prior to the start of the QRS wave in the electrocardiogram, the pressure in the left atrium is less than the pressure in the left ventricle and the left AV valve is in the open position.
   C. In that single cycle during the time interval between the end of the *dub* sound and t_2, there is a decrease in the volume of blood in the left ventricle.
   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 processes in capillaries in the lung assist in the removal of carbon dioxide from the body?
    A. Formation of carbonic acid from carbon dioxide and water by carbonic anhydrase in red blood cells.
    B. Net flux of bicarbonate from red blood cells into blood plasma.
    C. Net flux of carbon dioxide from blood plasma into 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.

5. Which of the following are involved in the long-term regulation of the oxygen-carrying capacity of the blood?
    A. Secretion of the hormone erythropoietin (EPO) from bone marrow cells in response to low partial pressure levels of oxygen in the interstitial spaces surrounding these bone marrow cells.
    B. Changes in the total amount of hemoglobin in the blood.
    C. Changes in the amount of red blood cells produced by peritubular interstitial cells (PIC) of the renal cortex in response to EPO binding to EPO Receptors in the plasma membranes of these peritubular interstitial cells (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.

6. Which of the following is true?
    A. 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.
    B. The percent Hemoglobin saturation (percent of oxygen-binding sites in Hemoglobin that have oxygen bound to them) 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.
    C. The blood plasma levels of bicarbonate in the pulmonary artery are higher than the blood plasma levels of bicarbonate 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 processes help bring oxygen to the body cells that are in a leg?
    A. An increase in hydrogen ion concentration in the cytosol of red blood cells in the body capillaries in the leg.
    B. Removal of oxygen from hemoglobin in response to a low partial pressure (concentration) of oxygen in the body capillaries in the leg.
    C. Net flux of oxygen from red blood cells into blood plasma in the 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 are true for ventilation?
   A. The problems with ventilation induced by injection of curare occur because of the drug's direct action on nicotinic ACh Receptors (nAChRs) in the plasma membranes of skeletal muscles in the lung.
   B. 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).
   C. When the pressure within the alveoli is greater 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.

9. Which of the following processes in capillaries in the leg assist in the removal of carbon dioxide from the body?
   A. Formation of carbonic acid from carbon dioxide and water by carbonic anhydrase in red blood cells.
   B. Net flux of bicarbonate from red blood cells into blood plasma.
   C. Net flux of carbon dioxide from blood plasma into 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.

10. 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 axon 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.

11. Which of the following serves as an effector, or as part of an effector, in a negative feedback system?
    A. Action potentials in the diaphragm muscle.
    B. GLUT4 molecules in rib-cage inspiratory muscles.
    C. Insulin Receptors in 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.

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 triglycerides into monoglycerides and fatty acids.
    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. The external anal sphincter is a smooth muscle that helps control the timing of removal of solid waste products from the G.I. system.
    B. Smooth muscles control the movement of substances in the small intestine.
    C. Skeletal muscles directly control the movement of substances at the entrance of 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. Which of the following is true for the epithelial cells of the early proximal tubule of the kidney?
    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-potassium ATPase pump in the basolateral membrane is responsible for the net flux of sodium from interstitial space to intracellular space.
    C. The SGLT2 cotransporter 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 P takes a drug that produces a condition with a strong effect on the epithelial cells of the kidney medullary 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 stimulates endocytosis of AQP2 and blocks exocytosis of AQP2 for one week in the epithelial cells of the kidney medullary collecting duct.
    B. Drug Y that is an antagonist at V2 receptors that remains bound to V2 receptors in the basolateral membranes of the epithelial cells of the kidney medullary collecting duct for one week.
    C. Drug Z that produces a condition in which the amounts of cytosolic cAMP in the epithelial cells of the kidney medullary collecting duct are very high 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. 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 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 net flux of glucose from intracellular spaces of early 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 early proximal tubule epithelial cells in W's kidney to interstitial spaces surrounding these cells at 8 PM on May 1.
    B. 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.
    C. At 8 PM on May 2, the amount of glucose in the cytosol of early proximal tubule epithelial cells in W's kidney will be higher than the amount of glucose in the cytosol of early proximal tubule epithelial cells 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.

17. From March 1 to March 31, Healthy Person W ate a normal diet with normal amounts of food and water. From April 1 to April 30, Healthy Person W was on a diet that consisted of normal amounts of food and very small amounts of water.
    A. April 15 values of W's water permeability across the luminal membranes of the medullary collecting duct epithelial cells were higher than March 15 values of W's water permeability across the luminal membranes of the medullary collecting duct epithelial cells.
    B. April 15 values of the concentration of dissolved solutes in W's urine were lower than March 15 values of the concentration of dissolved solutes in W's urine.
    C. April 15 values of W's blood plasma levels of vasopressin were higher than March 15 values of W's blood plasma levels of vasopressin.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

18. 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. The epithelial cells of the kidney medullary collecting duct are all normal. In this rare mutant, an increase in the amount of vasopressin that binds to V2 Receptors in the kidney will lead to
    A. an increase in the amount of water that is reabsorbed into the blood plasma from the lumen of the medullary collecting duct.
    B. an increase in the water permeability of the luminal membranes of the medullary collecting duct epithelial cells.
    C. no change in the net flux of water from the luminal spaces of the medullary 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.

19. 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. Person H will produce a greater volume of urine compared with the volume of urine produced by Person H prior to taking the drug.
    B. Water permeability of the luminal membranes of the collecting duct epithelial cells will be higher than pre-drug levels.
    C. The total amount of AQP2 channels stored in intracellular vesicles will be lower 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.

20. Which of the following is true for the plasma membranes of epithelial cells in the Loop of Henle of the kidney?
    A. Sodium-potassium-ATPase pump molecules are located in the basolateral membranes of epithelial cells in the ascending limb of the Loop of Henle.
    B. AQP1 (Aquaporin 1) molecules are located in the basolateral membranes of epithelial cells in the descending limb of the Loop of Henle.
    C. NKCC2 (sodium-potassium-2chloride co-transporter) molecules are located in the basolateral membranes of 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.

21. 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 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 1 AM.
    B. At 3 AM on April 2, the glucose permeability of X's liver cells will be higher than the glucose permeability of X's liver cells at 1 AM.
    C. At 3 AM on April 2, 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.

22. Which of the following is true?
    A. GLUT2 transporter molecules are responsible for the net flux of glucose from the interstitial spaces of the kidney cortex into the intracellular spaces of early proximal tubule epithelial cells.
    B. 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 intracellular spaces of liver cells into the interstitial spaces surrounding liver cells.
    C. 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.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

23. Glycogen
    A. levels in the cytosol of a liver cell decrease in response to an increase in cAMP levels in the cytosol of the liver cell.
    B. 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.
    C. binding to Glycogen 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.
    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 serves as an actuating signal, or as a part of an actuating signal, in a negative feedback system?
    A. The amount of GLUT2 Transporters in the blood plasma.
    B. The amount of Insulin Receptors in the blood plasma.
    C. Action potentials in the axons of motor neurons whose axon terminals synapse on diaphragm muscle fibers.
    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 an effect of the following drugs?
    A. Drug X is an agonist of the Insulin Receptor. High levels of Drug X in the interstitial spaces surrounding fat cells will lead to high levels of endocytosis of GLUT4 molecules in these cells.
    B. Drug Y is an antagonist of the Vasopressin2 Receptor (V2R). High levels of Drug Y in the interstitial spaces surrounding cells of the kidney medullary collecting ducts will lead to high levels of exocytosis of AQP2 molecules in these cells.
    C. Drug Z is an agonist of the Insulin Receptor. High levels of Drug Z in the interstitial spaces surrounding liver cells will lead to high levels of exocytosis of GLUT4 molecules in these cells.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.