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. 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 -90 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 GABA to the physiological saline will lead to no change in the amount of intracellular potassium.
   B. The addition of glycine to the physiological saline will lead to an increase in the amount of intracellular chloride.
   C. The addition of glutamate to the physiological saline will lead to an increase in the amount of intracellular sodium and a decrease in the amount of intracellular potassium.
   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 a ligand that binds to a receptor site that is part of a ligand-gated metabotropic receptor?
   A. ACh (acetylcholine).
   B. Muscarine.
   C. GABA.
   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 the electrocardiogram, the peak value of the T wave occurs during the time interval between t_1 and the end of the *lub* sound in that single cycle.
   B. In that single cycle, the volume of blood in the left ventricle at t_1 is greater than the volume of blood in the left ventricle at the start of the *lub* sound.
   C. 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 greater than the pressure in the left ventricle and the left AV valve is in the open position.
   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 effector, or as part of an effector, in a negative feedback system?
   A. GLUT2 spanning proteins in plasma membranes of rib-cage inspiratory muscles.
   B. Insulin Receptors in the diaphragm muscle.
   C. Action potentials 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.

5. 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 lower 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 lower 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.

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

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

8. 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 high partial pressure (concentration) of oxygen in the body capillaries in the leg.
   C. Net flux of oxygen from blood plasma into red blood cells 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.

9. 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 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.
   C. Changes in the total amount of hemoglobin in the blood.
   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 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 Muscarinic Acetylcholine Receptors (mAChRs) in the plasma membranes of 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. Which of the following is an actuating signal in a negative feedback system?
    A. Levels of vasopressin in the blood plasma.
    B. Levels of erythropoietin (EPO) in the blood plasma.
    C. Action potentials in motor neurons that synapse upon skeletal muscles in the lung.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

12. In epithelial cells of the small intestine, which of the following are involved in processes that contribute to the absorption of glucose from the lumen of the small intestine into the blood plasma?
    A. Net flux of sodium across the basolateral membranes of the epithelial cells from interstitial spaces to intracellular spaces via sodium-potassium ATPase pumps.
    B. Net flux of glucose across the luminal membranes of the epithelial cells from intracellular spaces to luminal spaces via SGLT1 transporters (sodium-glucose transporters 1).
    C. Net flux of glucose across basolateral membranes of the epithelial cells from interstitial spaces to intracellular spaces via GLUT2 transporters.
    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?
    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. In the lumen of the small intestine, trypsin breaks down carbohydrates into double sugars.
    B. Pancreatic amylase is produced in the pancreas and is secreted into the lumen of the small intestine. In the small intestine, it breaks proteins down into small chains of amino acids.
    C. 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. In the stomach, it converts triglycerides into monoglycerides and fatty acids.
    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 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 is an antagonist at V2 receptors and remains bound to V2 receptors in the basolateral membranes of the epithelial cells of the kidney medullary collecting duct for one week.
    B. Drug Y 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.
    C. Drug Z that stimulates exocytosis of AQP2 and blocks endocytosis of AQP2 for one week in the epithelial cells of the kidney medullary collecting duct.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

15. 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 large amounts of water.
    A. April 15 values of W's blood plasma levels of vasopressin were lower than March 15 values of W's blood plasma levels of vasopressin.
    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 water permeability across the luminal membranes of the medullary collecting duct epithelial cells were lower than March 15 values of W's water permeability across the luminal membranes of the medullary 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.

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. 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 water permeability of the luminal membranes of the medullary collecting duct epithelial cells.
    B. an increase in the amount of water that is reabsorbed into the blood plasma from the lumen of the medullary collecting duct.
    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.

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 the sodium-glucose co-transporters (SGLT1 and SGLT2) 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 from luminal spaces to intracellular spaces via the sodium-potassium-2chloride co-transporters (NKCC2) 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. 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.

19. 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 lower 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 lower 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 lower 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.

20. Healthy Person P takes a new drug that is a member of a drug family that results in a condition in which there are constant very high levels of cytosolic cyclic AMP (cAMP) in one and only one cell type in the body. A single dose of each member of the new drug family works within one hour to produce this condition and the condition lasts for one week. Which of the following is true for P two days after taking a specific member of the new drug family? Compare the situation two days after taking the drug with the situation prior to taking the drug.
    A. Consider the situation that P takes Drug X that results in a condition in which the levels of cytosolic cAMP in the cells of the liver are constant at a very high level. For this situation, ignore any effects related to insulin binding to insulin receptors in the liver. The amount of glycogen in P's liver cells two days after taking Drug X will be higher than the amount of glycogen in P's liver cells prior to taking Drug X.
    B. Consider the situation that P takes Drug Y that results in a condition in which the levels of cytosolic cAMP in the SA node cells of the heart are constant at a very high level. The firing rate of action potentials in P's SA node cells two days after taking Drug Y will be higher than the firing rate of action potentials in P's SA node cells prior to taking Drug Y.
    C. Consider the situation that P takes Drug Z that results in a condition in which the levels of cytosolic cAMP in the epithelial cells of the medullary collecting duct of the kidney are constant at a very high level. The amount of net flux of water from luminal spaces to intracellular spaces across the luminal membranes of these cells in P two days after taking Drug Z will be lower than the amount of net flux of water from luminal spaces to intracellular spaces across the luminal membranes of these cells in P prior to taking Drug Z.
    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, X's blood plasma levels of insulin will be higher than X's blood plasma levels of insulin at 1 AM.
    B. At 3 AM on April 2, 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 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.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

22. In a healthy person, 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 early 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.

23. 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 agonist 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.

24. Glucagon
    A. 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. binding to Glucagon Receptors in the plasma membrane of a liver cell leads to an increase in glucose permeability of the plasma membrane of the liver cell.
    C. levels in the cytosol of a liver cell decrease in response to an increase in cAMP levels in the cytosol 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.

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. For this question, ignore any effects due to alpha-islet cells of the pancreas.
    A. At 8 PM on May 2, the glucose permeability of Y's skeletal muscle cells will be much lower than the glucose permeability of Y's skeletal muscle cells at 8 PM on May 1.
    B. 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.
    C. 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.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.