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 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 0 (zero) mV, and the Nernst equilibrium potential for potassium in Neuron B is -100 mV. The threshold for an action potential in Neuron B is -50 mV and the resting potential for Neuron B is -80 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 both sodium and potassium in 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, its sodium conductance equals nine times its potassium conductance. For this situation, in response to an action potential in Neuron A, there is an increase in the membrane voltage of 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.
    B. Consider the situation that when the LGD 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 no change in the membrane voltage of 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.
    C. Consider the situation that when the LGD 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 increase in the membrane voltage of 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.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

2. 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;
glutamate and APV are added to the physiological saline of Dish W;
glutamate and CNQX are added to the physiological saline of Dish X;
glutamate, CNQX, and glycine are added to the physiological saline of Dish Y;
glutamate, CNQX, glycine, and strychnine are added to the physiological saline of Dish Z.
   A. At 2:01 AM, the total calcium conductance in Neuron Y is greater than the total calcium conductance in Neuron Z. In addition, the total calcium conductance in Neuron X is less than the total calcium conductance in Neuron V.
   B. At 2:01 AM, 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.
   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 X. 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.

3. Consider a single cycle in a healthy heart. Define the start of the cycle as the peak of the action potential in a SA node cell, which occurs at t_1, and the end of the cycle as the peak of the following action potential in that same SA node cell, which occurs at t_2. 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 during the time interval between the end of the *dub* sound and t_2 in that single cycle?
   A. There is an increase in the volume of blood in the left ventricle.
   B. In the electrocardiogram, there is an occurrence of the QRS voltage deflection.
   C. There is an occurrence of the peak of the action potential in a Bundle of His cell.
   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 inspiratory rib-cage motor neurons that release glutamate near rib-cage muscles.
    B. Action potentials in the diaphragm muscle.
    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.

5. 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 lower 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.

6. 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 the blood plasma.
    B. Net flux of carbon dioxide from red blood cells into plasma.
    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.

7. Which of the following are true for ventilation?
    A. An increase in the hydrogen ion concentration in the interstitial spaces of the brain stem leads to a decrease in the duration of the respiratory cycle (duration of respiratory cycle equals duration of inspiration plus duration of expiration).
    B. When the pressure within the alveoli is greater than atmospheric pressure, there will be inspiration of air into the lungs.
    C. The problems with ventilation induced by injection of curare occur because of the drug's direct action on nicotinic ACh Receptors (nAChRs) in the membranes of the sarcoplasmic reticulum in the respiratory muscles (the diaphragm and the 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.

8. Which of the following serves as an effector, or as part of an effector, in a negative feedback system?
   A. Action potentials in diaphragm motor neurons.
   B. GLUT4 Transporters 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.

9. 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.
   B. Net flux of oxygen from red blood cells into blood plasma in the capillaries in the lung.
   C. Removal of oxygen from hemoglobin in response to a low partial pressure (concentration) of oxygen 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.

10. Which of the following is true for red blood cells?
   A. Carbonic anhydrase is the intracellular enzyme needed for the binding of carbon dioxide to hemoglobin.
   B. Oxygen binds directly to the Anion Exchanger 1 (AE1) in the plasma membrane of the red blood cells.
   C. Hemoglobin is a spanning membrane protein in the plasma membrane of red blood cells with binding sites for oxygen on the extracellular portion of the hemoglobin protein.
   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 a controlled variable in a negative feedback system?
    A. Levels of hydrogen ions in the blood plasma of the carotid artery.
    B. Levels of hydrogen ions in the interstitial spaces of the brainstem.
    C. Levels of erythropoietin (EPO) in the blood plasma of the carotid artery.
    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 converted into its active form in the stomach by the enzyme enterokinase; the enzyme 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 shorter chains of fatty acids.
    C. Pepsinogen is produced in the small intestine and is converted into its active form 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 are true for the Gastrointestinal system?
    A. Contractions of smooth muscles in the walls of the stomach assist in the movement of chyme.
    B. When absorption takes place in the small intestine, small molecules eventually pass from the lumen of the small intestine into the blood plasma of nearby capillaries.
    C. During digestion of carbohydrates, simple sugars are chemically linked to form long chains of sugars called glycogen.
    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 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 lower than pre-drug levels.
    B. The total amount of AQP2 channels stored in intracellular vesicles will be lower 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.

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 produces a condition in which the levels of intracellular cyclic AMP (cAMP) are very high for one week.
    B. Drug Y that is an antagonist at V2 receptors that remains bound to V2 receptors for one week.
    C. Drug Z that stimulates endocytosis of AQP2 and blocks exocytosis of AQP2 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 an increase in the
    A. net flux of water from the luminal spaces of the collecting duct to the interstitial spaces of the kidney medulla.
    B. water permeability of the luminal membranes of the collecting duct epithelial cells.
    C. amount of water that is reabsorbed into the blood plasma from the lumen of the collecting duct.
    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 small 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 early portion 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 SGLT2 co-transporter in the luminal membrane is responsible for the net flux of sodium from luminal space to intracellular space.
    C. The sodium-potassium pump in the basolateral membrane is responsible for the net flux of sodium 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. You are presented with patient X who has a genetic disease. You discover a mutation in all aquaporin2 (AQP2) channels manufactured in the epithelial cells of the collecting duct so that there is no increase in water permeability when the mutated channels are inserted into the plasma membrane in response to vasopressin binding to the V2 receptor. Patient X will
    A. produce urine with a very low concentration of dissolved solutes.
    B. benefit from injections of vasopressin into the blood plasma.
    C. produce large volumes of urine.
    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 luminal membranes of epithelial cells in the ascending limb of the Loop of Henle of the kidney?
    A. Sodium-potassium-ATPase pump molecules are located in the luminal membranes of epithelial cells in the ascending limb of the Loop of Henle.
    B. SGLT2 sodium-glucose co-transporter molecules are located in the luminal membranes of epithelial cells in the ascending limb of the Loop of Henle.
    C. NKCC2 sodium-potassium-2chloride co-transporter molecules are located in the luminal 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. Glycogen
    A. levels in 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.

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 lower 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 lower 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. 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 exocytosis of GLUT4 Transporters from vesicular membranes to the plasma membrane of the skeletal muscle cell.
    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.

25. 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 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.
    C. levels in 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.