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 -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 -80 millivolts, the equilibrium potential for potassium ions is -70 millivolts, and the equilibrium potential for sodium ions is +60 millivolts.
    A. The addition of GABA to the physiological saline will lead to an increase in the amount of intracellular chloride and a decrease in the amount of intracellular potassium.
    B. The addition of glycine to the physiological saline will lead to no net change 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 events occur at the same time, or nearly at the same time, during the cardiac cycle of a healthy person?
    A. The QRS complex of the electrocardiogram and the closing of the left AV valve.
    B. The P wave of the electrocardiogram and increases in the membrane voltage of atrial muscle cells.
    C. The T wave of the electrocardiogram and decreases in the membrane voltage of ventricular muscle cells.
    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 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 receptors. 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 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.

4. 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.

5. 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.

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 are true for ventilation?
   A. The problems with ventilation induced by injection of curare occur because of the drug's direct action on muscarinic ACh Receptors (mAChRs) in the plasma membranes of the respiratory muscles (the diaphragm and the rib-cage muscles).
   B. 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).
   C. When the pressure within the alveoli is less 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.

8. 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 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 lung.
   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 serves as an actuating signal in a negative feedback system?
   A. Levels of erythropoietin (EPO) in the blood plasma.
   B. Levels of hydrogen ions in the blood plasma of the carotid artery.
   C. Action potentials in the axons of carotid artery peripheral hydrogen-ion chemoreceptor neurons.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

10. 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.

11. Which of the following processes occur in the lung?
   A. Binding of oxygen to hemoglobin in response to high partial pressures of oxygen in red blood cells in the lung.
   B. Removal of oxygen from hemoglobin in response to high levels of hydrogen ions in the cytosol of red blood cells in the lung.
   C. Net flux of oxygen from plasma into the cytosol of red blood cells in capillaries of 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. 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 function as an enzyme in the Gastrointestinal Tract by converting an inactive form of another enzyme to the active form of the other enzyme?
    A. Pepsinogen.
    B. Trypsinogen.
    C. Enterokinase.
    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 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 sodium 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 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 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 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.
    C. 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.
    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 cotransporter 1) is
    A. located in basolateral membranes of epithelial cells in the late proximal tubule of the kidney.
    B. located in basolateral membranes of epithelial cells of the small intestine.
    C. responsible for the net flux of glucose from intracellular spaces to interstitial 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. 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.

18. 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 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 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.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

19. 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 lower 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 higher 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.

20. Which of the following is an effect of the following drugs?
    A. Drug X is an antagonist of the Insulin Receptor. High levels of Drug X in the interstitial spaces surrounding fat cells will lead to high levels of exocytosis 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.

21. Which of the following is true?
    A. When blood plasma levels of glucagon are high and blood plasma levels of insulin are low, GLUT2 molecules are responsible for the net flux of glucose from the intracellular spaces of liver cells into the interstitial spaces surrounding liver cells.
    B. GLUT2 molecules are responsible for the net flux of glucose from the intracellular spaces of epithelial cells in the early proximal tubule into the interstitial spaces of the kidney medulla.
    C. GLUT4 molecules are responsible for the net flux of glucose from the intracellular spaces of beta-islet cells of the pancreas into the interstitial spaces surrounding 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.

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 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 lower than X's blood plasma levels of insulin at 8 PM on April 1.
    B. 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.
    C. 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.
    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 correct?
    A. An increase in cAMP levels in the cytosol of a liver cell leads to a decrease in the levels of glucagon in the cytosol of that liver cell.
    B. An increase in 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 that liver cell.
    C. An increase in glucagon binding to Glucagon Receptors in the plasma membrane of a liver cell leads to an increase in the exocytosis of GLUT2 molecules 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 is correct?
    A. An increase in insulin binding to Insulin Receptors in the plasma membrane of a liver cell leads to an increase in the levels of glycogen in the cytosol of the liver cell.
    B. An increase in insulin binding to Insulin 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.
    C. An increase in the amount of GLUT4 molecules in the plasma membrane of a skeletal muscle cell leads to an increase in the levels of insulin in the cytosol of the skeletal 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. 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 higher 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.