There are 50 physiology questions (Q2 to Q51) 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 50 points in this exam.
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 SELECT ONE LETTER PER PHYSIOLOGY QUESTION.

There are two honor questions, Q1 and Q52. In order to receive credit for this GRADED FINAL EXAM, you must truthfully answer TRUE for both questions. If you answer FALSE for either question or if you do not answer either question, your GRADED FINAL EXAM grade is 0 (zero).

Honor Question 1. I understand that this open-book, open-notes cumulative exam evaluates my knowledge of the material in Bio 3058. If I choose False, I know I will fail this exam. I therefore pledge to take it by myself, without assistance from any other person or the Internet.

A. TRUE.
B. FALSE.

2. Which of the following serves as an actuating signal, or as part of an actuating signal, in a negative feedback system?
   A. Levels of cAMP in the cytosol of epithelial cells in the medullary collecting duct of the kidney.
   B. Action potentials in sympathetic neurons that release acetylcholine (ACh) near the SA node of the heart.
   C. Action potentials in motor neurons that synapse on 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.

3. Which of the following serves as a controlled variable in a negative feedback system?
   A. Blood plasma levels of glucagon.
   B. Blood plasma levels of glucose.
   C. 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.

4. Which of the following serves as an effector, or part of an effector, that functions in a negative feedback system?
   A. Vitamin D Receptors (VDRs) located in the nucleus of cells in the intestine.
   B. Insulin Receptors in diaphragm muscle fibers.
   C. CaSRs (Calcium-Sensing Receptors) in the plasma membranes of cells in the Parathyroid Gland.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

5. An increase in the levels of parathyroid hormone in the blood plasma will lead to an increase in the calcium ion
   A. resorption from the bones into the blood plasma.
   B. excretion in the urine.
   C. absorption from the contents of the intestine 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.

6. A new drug named ANTAG-CaSR has been developed that is an antagonist at calcium-binding sites of CaSRs (Calcium-Sensing Receptors) in the plasma membranes of parathyroid gland cells. Healthy Person P receives regular doses of ANTAG-CaSR as part of a clinical trial. When ANTAG-CaSR levels in the extracellular spaces surrounding parathyroid gland cells increase in Healthy Person P, this leads to
   A. an increase in the levels of parathyroid hormone in the blood plasma.
   B. an increase in the levels of calcium in the blood plasma.
   C. an increase in the amount of 1,25-dihydroxyvitamin D binding to Vitamin D Receptors (VDRs) in the plasma membranes of cells in the intestine.
   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 is true for the sodium-potassium pump ATPase?
   A. There is a net flux of sodium from interstitial spaces into intracellular spaces via sodium-potassium pump ATPase spanning proteins located in the basolateral membranes of epithelial cells in the medullary collecting duct of the kidney.
   B. There is a net flux of sodium from cytosol near troponin molecules into the internal spaces of the sarcoplasmic reticulum via sodium-potassium pump ATPase spanning proteins located in the sarcoplasmic reticulum membranes of diaphragm muscles.
   C. There is a net flux of sodium from extracellular spaces into intracellular spaces via sodium-potassium pump ATPase spanning proteins located in the plasma membranes of toe motor neurons.
   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 GLUT2 molecules?
   A. GLUT2 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. When blood plasma levels of glucagon are low and blood plasma levels of insulin are high, GLUT2 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 molecules are responsible for the net flux of glucose from the intracellular spaces of epithelial cells in the early proximal tubule into 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.

9. Which of the following is an effect of the following drugs?
   A. Drug X is an agonist of the Vasopressin2 Receptor (V2R). High levels of Drug X in the interstitial spaces surrounding epithelial cells of the kidney medullary collecting ducts will lead to high levels of endocytosis of AQP2 molecules in these epithelial cells.
   B. Drug Y is an agonist of the Glucagon Receptor. High levels of Drug Y in the interstitial spaces surrounding liver cells will lead to a net flux of glucose from the cytosol of these liver cells to the interstitial spaces surrounding these liver cells.
   C. Drug Z is an antagonist of the Insulin Receptor. High levels of Drug Z in the interstitial spaces surrounding fat cells will lead to high levels of exocytosis of GLUT4 transporters 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.

10. At 1 AM, an impermeable membrane separates a 1 liter solution of 1M NaCl in the left compartment from a 1 liter solution containing both 1M NaCl and 1M KCl in the right compartment. At 2 AM, the membrane became permeable to chloride ions. At 4 AM, the membrane once again became impermeable to chloride ions. At 6 AM, the membrane became permeable to sodium ions and, in addition, maintained chloride ion impermeability. At 8 AM, the membrane once again became impermeable to sodium ions. At 10 AM the membrane once again became permeable to chloride ions and, in addition, maintained sodium ion impermeability. The membrane maintained impermeability to potassium ions during the entire period.
   A. The amount of chloride ions in the left compartment at 11 AM will be less than the amount of chloride ions in the left compartment at 5 AM.
   B. The amount of chloride ions in the right compartment at 3 AM will be less than the amount of chloride ions in the right compartment at 1 AM.
   C. The amount of sodium ions in the left compartment at 7 AM will be greater than the amount of sodium ions in the left compartment at 5 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 is true for Vasopressin2 Receptors (V2Rs) in medullary collecting duct epithelial cells of the kidney?
    A. When agonists bind to V2Rs in the plasma membrane of these cells, this leads to an increase in the amount of ATP that is bound to alpha subunits of the G-proteins associated with these V2Rs.
    B. When antagonists bind to V2Rs in the plasma membrane of these cells, this leads to an increase in the intracellular amount of cAMP in these cells.
    C. When agonists bind to V2Rs in the plasma membrane of these cells, this leads to an increase in the amount of AQP4 in the luminal plasma membranes of these cells.
    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 for these messengers binding to their receptors?
    A. An increase in the amount of vasopressin that binds to V2 Receptors (Vasopressin 2 Receptors) in the basolateral membrane of an epithelial cell in the medullary collecting duct of the kidney leads to an increase in the amount of unbound GDP in the cytosol of the epithelial cell.
    B. An increase in the amount of ACh that binds to mAChRs (muscarinic Acetylcholine Receptors) in a SA node cell of the heart leads to a decrease in the amount of cAMP in cytosol of the SA node cell.
    C. An increase in the amount of glucagon that binds to Glucagon Receptors in a liver cell leads to an increase in the amount of cAMP 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.

13. Which of the following is a ligand that binds to a receptor site that is part of a ligand-gated ionotropic receptor?
    A. Strychnine.
    B. TTX (tetrodotoxin).
    C. Muscarine.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

14. Neuron A is a healthy neuron with all the usual ion channels. When at rest with a membrane voltage of R millivolts, neuron A produces no action potentials. The voltage threshold for an action potential in neuron A is T millivolts. T is greater than R; T is less than zero. In addition, neuron A's membrane includes the membrane-spanning molecule Z with an ion channel that opens when neurotransmitter Y binds to the Y receptor site on the extracellular surface of Z. The Nernst equilibrium potential for Z's ion channel is E millivolts. Neuron B synapses on neuron A; neuron B's neurotransmitter is neurotransmitter Y. Neuron A is initially at rest. Which of the following statements are true when neuron B produces an action potential and releases neurotransmitter Y?
    A. If the value of E is greater than R, and if the value of T is greater than E, and if chloride is the only ion that passes through open Z channels, then Y's binding to its receptor site on Z in neuron A produces an inhibitory postsynaptic potential in neuron A, an increase in chloride conductance of the plasma membrane of neuron A, and an increase in the amount of intracellular chloride ions in neuron A.
    B. If the value of R is equal to E, and if chloride is the only ion that passes through open Z channels, then Y's binding to its receptor site on Z in neuron A produces an inhibitory postsynaptic potential in neuron A, no change in chloride conductance of the plasma membrane of neuron A, and no change in the amount of intracellular chloride ions in neuron A.
    C. If the value of E is zero and if both sodium ions and potassium ions pass through open Z channels, then Y's binding to its receptor site on Z in neuron A produces an excitatory postsynaptic potential in neuron A, an increase in the amount of intracellular sodium ions in neuron A, and a decrease in the amount of intracellular potassium ions in neuron A.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

15. 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 the plasma membrane of 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.

16. Which of the following occur after an increase in the length of the right knee extensor muscle that happens after a quick tap is applied to the right patellar tendon?
    A. An increase in the total amount of intracellular calcium in the central axon terminals of IA muscle-spindle stretch receptor neurons whose peripheral axon terminals are located in the right knee extensor muscle.
    B. An increase in the total amount of intracellular sodium in the peripheral axon terminals of IA muscle-spindle stretch receptor neurons whose peripheral axon terminals are located in the right knee extensor muscle.
    C. An increase in the total amount of calcium conductance of the membranes of the sarcoplasmic reticulum of the right knee extensor muscle.
    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 is a neurotransmitter that binds to a receptor site that is part of a metabotropic receptor?
    A. AMPA.
    B. NMDA.
    C. GABA.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

18. Consider Neuron B in the frog central nervous system whose plasma membrane has a previously unknown channel that is selectively conductive to a newly discovered divalent cation named DIVCAT with a valence of +2. The threshold for an action potential in Neuron B is -40 millivolts and the resting potential for Neuron B is -50 millivolts. The DIVCAT channel in Neuron B is part of an ionotropic receptor with an extracellular binding site for the newly discovered ligand LGDZ. When LGDZ binds to its binding site, there is an increase in the DIVCAT conductance of Neuron B. Neuron A synapses onto Neuron B. Neuron A's neurotransmitter is LGDZ. In this experiment, the temperature of the frog central nervous system is 20° C.
    A. Consider the situation that the intracellular concentration of DIVCAT is 1000 times greater than the extracellular concentration of DIVCAT. In response to an action potential in Neuron A, there will be: a decrease in the membrane voltage of Neuron B; an increase in the amount of intracellular DIVCAT in Neuron B; and an inhibitory postsynaptic potential in Neuron B.
    B. Consider the situation that the intracellular concentration of DIVCAT is 100 times greater than the extracellular concentration of DIVCAT. In response to an action potential in Neuron A, there will be: a decrease in the membrane voltage of Neuron B; a decrease in the amount of intracellular DIVCAT in Neuron B; and an inhibitory postsynaptic potential in Neuron B.
    C. Consider the situation that the intracellular concentration of DIVCAT is 10 times greater than the extracellular concentration of DIVCAT. In response to an action potential in Neuron A, there will be: an increase in the membrane voltage of Neuron B; an increase in the amount of intracellular DIVCAT in Neuron B; and an excitatory postsynaptic potential 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.

19. Consider an axon of a neuron. At time=t_1, its voltage is at threshold for an action potential; at time=t_2, its voltage is at 0 millivolts prior to the peak of that action potential. In the time period between t_1 and t_2 of that single action potential,
    A. the sodium conductance of the voltage-gated sodium channels changes with a faster time course than the potassium conductance of the voltage-gated potassium channels.
    B. sodium conductance of the voltage-gated sodium channels increases as membrane voltage increases.
    C. the amount of intracellular sodium increases.
    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 a G-protein?
    A. When an agonist binds to the binding site of a G-protein coupled receptor (GPCR), this leads to ATP displacing a ADP bound to the alpha subunit of the G-protein.
    B. After the GTP-ase activity of the alpha subunit of a G-protein converts the GTP bound to the alpha subunit to GDP and inorganic phosphate (P_i), the alpha subunit of the G-protein recombines with the beta and gamma subunits of the G-protein.
    C. When GTP binds to an alpha subunit of the G-protein, this leads to the alpha subunit of the G-protein dissociating from the beta and gamma subunits of the G-protein.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

21. 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 and a decrease in the amount of intracellular potassium.
    B. The addition of glycine to the physiological saline will lead to an increase in the chloride conductance of the plasma membrane of the motor neuron.
    C. The addition of glycine and glutamate to the physiological saline will lead to an increase in the amount of intracellular chloride, 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.

22. Consider Neuron B in the frog central nervous system whose plasma membrane has a newly discovered ligand-gated ionotropic receptor, named the LGDY Receptor. The channel in the same molecular complex as the LGDY Receptor is termed the LGDY 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 mV, and the Nernst equilibrium potential for potassium in Neuron B is -100 mV. The threshold for an action potential in Neuron B is -40 mV and the resting potential for Neuron B is -50 mV. LGDY is an agonist for the LGDY ligand-gated ionotropic Receptor. When LGDY binds to its binding site, there is an increase in conductance of both sodium and potassium in the LGDY Receptor channel. Neuron A synapses onto Neuron B. Neuron A's neurotransmitter is LGDY.
    A. Consider the situation that when the LGDY 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 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 equal to the absolute value of the change in the amount of intracellular potassium in Neuron B.
    B. Consider the situation that when the LGDY 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 to the absolute value of the change in the amount of intracellular potassium in Neuron B.
    C. Consider the situation that when the LGDY 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.

23. Which of the following is true in a skeletal muscle?
    A. The binding of calcium to troponin leads to a movement of the tropomyosin molecule so that the tropomyosin molecule no longer blocks a binding site on a myosin molecule for an activated (energized) actin head.
    B. The head of a myosin molecule is activated (energized) during the hydrolysis of GTP (which is bound to the myosin head) to GDP and P_i.
    C. The binding of GTP to the head of the myosin molecule causes detachment of the head of the myosin molecule from its receptor site on the actin molecule.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

24. An increase in the calcium conductance of all sarcoplasmic reticulum membranes of a skeletal muscle with no external forces on it leads to
    A. a decrease in the amount of calcium ions in the sarcoplasmic reticulum.
    B. a decrease in the amount of ATP molecules in the muscle.
    C. a decrease in the amount of calcium ions that are bound to troponin.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

25. In the sarcomere of a skeletal muscle, there are
    A. actin molecules in the I band.
    B. troponin molecules in the region of the A band that is not in the H zone.
    C. myosin molecules in the H zone.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

26. The AV node of a mammalian heart is destroyed. All other parts of the heart are normal and healthy.
    A. The firing rate of SA node cells will be greater than the firing rate of atrial muscle cells.
    B. The firing rate of atrial muscle cells will be greater than the firing rate of ventricular muscle cells.
    C. The firing rate of cells in the Bundle of His will be greater than the firing rate 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.

27. 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 opening of the left AV valve, that is, the left AV valve goes from a closed state to an open state.
    B. The T wave of the electrocardiogram and the opening of the aortic valve, that is, the aortic valve goes from a closed state to an open state.
    C. The P wave of the electrocardiogram and the closing of the left AV valve, that is, the left AV valve goes from an open state to a closed state.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

28. 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 the end of the *lub* sound in that single cycle and t_2.
    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 less than the pressure in the left ventricle and the left AV valve is in the closed position.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

29. Which of the following is true for SA node cells?
    A. An increase in intracellular levels of cAMP in SA node cells will lead to an increase in the amount of time between two successive action potentials in each of these cells.
    B. An increase in the binding of norepinephrine to beta-adrenergic receptors in SA node cells will lead to an increase in intracellular levels of cAMP in each of these cells.
    C. An increase in the binding of acetylcholine to nicotinic ACh Receptors in SA node cells will lead to a decrease in intracellular levels of cAMP in each of these cells.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

30. At 1:00 AM, healthy person X's blood pressure is equal to the blood pressure set point. At 1:01 AM, there is a decrease in the firing rate of carotid artery baroreceptors,
    A. this will lead to a decrease in the amount of ACh (acetylcholine) released near the SA node of the heart.
    B. this will lead to an increase in the diameter of the arterioles.
    C. this will lead to an increase in the heart rate.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

31. Which of the following will lead to an increase of total peripheral resistance?
    A. A decrease in the firing frequency of all the carotid artery baroreceptors.
    B. A decrease in the diameter of every arteriole.
    C. A decrease in the firing rate in all the sympathetic neurons that innervate smooth muscles that surround arterioles.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

32. 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 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.

33. 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. Production of red blood cells by bone marrow cells in response to hemoglobin binding to Hemoglobin Receptors in the plasma membranes of the bone marrow cells.
    C. Secretion of the hormone erythropoietin (EPO) from 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.

34. 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 blood plasma into red blood cells 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.

35. 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 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 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.

36. Which of the following is true for red blood cells?
    A. Carbonic anhydrase is a spanning protein in the plasma membrane of red blood cells that is directly responsible for the net flux of bicarbonate across the plasma membrane.
    B. Anion Exchanger 1 (AE1) is an enzyme in the cytosol of red blood cells responsible for formation of carbonic acid from hydrogen ions and bicarbonate.
    C. Hemoglobin is a spanning protein in the plasma membrane of red blood cells with binding sites for oxygen on the extracellular portion of the protein.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

37. Which of the following is true for the molecules in the G.I. (Gastro-Intestinal) system?
    A. Pancreatic amylase is produced in the pancreas and is secreted into the lumen of the small intestine. In the lumen of the small intestine, it breaks down carbohydrates into double sugars.
    B. 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.
    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 breaks down proteins into small chains of amino acids.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

38. Which of the following is true for the muscles in the G.I. (Gastro-Intestinal) system?
    A. The external anal sphincter is a skeletal muscle that helps control the timing of removal of solid waste products from the G.I. system.
    B. Skeletal 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.

39. Healthy Person H takes a new drug named UPCAMPCOLLDUCT that stimulates the production of cyclic AMP (cAMP) in medullary collecting duct epithelial cells of the kidney and results in a condition in which intracellular levels of cAMP in the medullary collecting duct epithelial cells are continuously very high. 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 higher volume of urine compared with the volume of urine produced by Person H prior to taking the drug.
    B. The total amount of AQP2 channels stored in intracellular vesicles of the medullary collecting duct epithelial cells will be lower than pre-drug levels.
    C. Water permeability of the luminal membranes of the medullary collecting duct epithelial cells will be higher 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.

40. 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 Drug 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 glucose will be higher than X's blood plasma levels of glucose at 8 PM on April 1.
    B. 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.
    C. At 8 PM 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 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.

41. 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 SGLT2 cotransporter 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.

42. 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 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.
    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.

43. Which of the following is true for the plasma 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. AQP1 (Aquaporin 1) molecules are located in the basolateral 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 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.

44. Glucagon
    A. levels in the cytosol of a liver cell increase in response to an increase in cAMP levels in the cytosol of the liver cell.
    B. binding to Glucagon 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 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.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

45. Which of the following is true for Insulin Receptors?
    A. Insulin binding to Insulin Receptors in the plasma membrane of a diaphragm muscle cell leads to an increase in the exocytosis of GLUT4 Transporters into the sarcoplasmic reticulum membranes of the diaphragm muscle.
    B. Insulin binding to Insulin Receptors in the plasma membrane of a liver cell leads to an increase in the amount of glycogen that is converted to glucose in the liver cell.
    C. Insulin binding to Insulin Receptors in the plasma membrane of a fat cell leads to an increase in the amount of AQP2 channels in the plasma membrane of the fat cell.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

46. Which of the following is true for RH (Releasing Hormone) Receptors?
    A. VRH Receptors (Vasopressin Releasing Hormone Receptors) are located in the plasma membranes of cells in the posterior pituitary.
    B. GnRH Receptors (Gonadotropin Releasing Hormone Receptors) are located in the plasma membranes of cells in the anterior pituitary.
    C. Binding of GHRH (Growth Hormone Releasing Hormone) to GHRHR (Growth Hormone Releasing Hormone Receptors) located in the plasma membranes of cells in the anterior pituitary leads to the secretion of GH (Growth Hormone) from the anterior pituitary 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.

47. During a fever in a human,
    A. there is a decrease in the value of the set point for body temperature when compared with the value of the set point for body temperature when that person was healthy prior to the fever.
    B. shivering can occur when the actual body temperature is higher than the set point for body temperature during the fever.
    C. the control system for body temperature functions as a closed-loop negative feedback system.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

48. Which of the following is true for GLUT molecules?
    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. GLUT1 molecules are responsible for the net flux of glucose from the intracellular spaces of epithelial cells in the late proximal tubule into the interstitial spaces of the kidney cortex.
    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.

49. Which of the following is true for insulin binding to Insulin Receptors?
    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 insulin binding to Insulin Receptors in the plasma membrane of a skeletal muscle cell leads to a decrease in the amount of GLUT4 Transporters that are stored in vesicles 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.

50. 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. Bone marrow cells.
    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.

51. Which of the following serves as a sensor, or as part of a sensor, that functions in a negative feedback system?
    A. Osmoreceptor neurons whose peripheral axon terminals are located in the walls of the carotid artery.
    B. Calcium-Sensing Receptors (CaSRs) located in the plasma membranes of Parathyroid Gland cells.
    C. Mechanically-gated channels located in the plasma membranes of peripheral axon terminals of carotid artery baroreceptor neurons.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

Honor Question 52. I did NOT receive assistance on this exam from any other person or from the Internet.
    A. TRUE.
    B. FALSE.

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ANSWER KEY:

2. C
3. B
4. D
5. E
6. D
7. H
8. A
9. B
10. F
11. H
12. G
13. A
14. C
15. F
16. G
17. C
18. F
19. G
20. F
21. G
22. E
23. H
24. D
25. G
26. B
27. H
28. A
29. B
30. E
31. D
32. C
33. E
34. G
35. E
36. H
37. E
38. E
39. F
40. A
41. G
42. A
43. H
44. H
45. H
46. F
47. C
48. D
49. E
50. F
51. F

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