There are 50 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 50 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. Which of the following serves as a sensor, or as part of a sensor, that functions in a negative feedback system?
   A. Peripheral thermoreceptor neurons whose peripheral axon terminals are located in the skin.
   B. Peripheral axon terminals of carotid artery baroreceptors.
   C. Peripheral hydrogen-ion sensitive chemoreceptors whose central axon terminals are located in the walls 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.

2. Which of the following serves as a controlled variable in a negative feedback system?
   A. Blood plasma levels of glucose.
   B. Blood plasma levels of glucagon receptors.
   C. Blood plasma levels of insulin.
   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 an actuating signal, or as part of an actuating signal, in a negative feedback system?
   A. Action potentials in SA node cells.
   B. Action potentials in parasympathetic neurons that release acetylcholine (ACh) near the SA node of the heart.
   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.

4. Which of the following serves as an effector, or as part of an effector, in a negative feedback system?
   A. GLUT4 Transporters in the plasma membranes of liver cells.
   B. Insulin Receptors in diaphragm muscle fibers.
   C. Action potentials in diaphragm muscle fibers.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

5. 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, then there is an increase in the amount of ANTAG-CaSR bound to binding sites on CaSRs in parathyroid gland cells. This increase in the amount of ANTAG-CaSR bound to binding sites on CaSRs in the parathyroid gland leads to
   A. an increase in the levels of parathyroid hormone in the blood plasma.
   B. an increase in the amount of calcium excreted in the urine.
   C. an increase in the amount of 1,25-dihydroxyvitamin D binding to sites on the extracellular surfaces of Vitamin D Receptors (VDRs) located only 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.

6. At 1 AM, an impermeable membrane separates a 1 liter solution of 2M KCl 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 potassium ions. At 4 AM, the membrane once again became impermeable to potassium ions. At 6 AM, the membrane became permeable to chloride ions and, in addition, maintained potassium ion impermeability. At 8 AM, the membrane became permeable to potassium ions again and, in addition, maintained its permeability to chloride ions. The membrane stayed impermeable to sodium ions at all times.
   A. The amount of chloride ions in the right compartment at 9 AM will be greater than the amount of chloride ions in the right compartment at 7 AM.
   B. The amount of chloride ions in the right compartment at 7 AM will be greater than the amount of chloride ions in the right compartment at 5 AM.
   C. The amount of potassium ions in the right compartment at 9 AM will be greater than the amount of potassium ions in the right compartment at 7 AM.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

7. A new drug called NVM (No Vesicle Movement) has been developed just in time for the exam. When NVM is added to the extracellular fluid surrounding a cell in a dish, the NVM prevents all movements of all vesicles in that cell for 24 hours. All other movements of substances are normal. Each cell is healthy. The extracellular fluid surrounding each cell is normal physiological saline. Dish E contains cell E, a medullary collecting duct epithelial cell. Dish F contains cell F, a fat cell. Dish L contains cell L, a liver cell containing intracellular amounts of glycogen. At 1:30AM, NVM is added to the extracellular fluid of each dish. At 1:45AM, glucose is added to the extracellular fluid in each dish so that, for each cell, the extracellular concentration of glucose equals the intracellular concentration of glucose. Ignore all effects of enzymes that degrade cAMP.
    A. Consider the situation that at 2:00AM, vasopressin is added to the extracellular fluid of Dish E. The amount of cAMP in the cytosol of cell E at 2:30AM will be greater than the amount of cAMP in the cytosol of cell E at 1:55AM.
    B. Consider the situation that at 2:00AM, insulin is added to the extracellular fluid of Dish F. The glucose permeability of the plasma membrane of cell F at 2:30AM will be greater than the glucose permeability of the plasma membrane of cell F at 1:55AM.
    C. Consider the situation that at 2:00AM, glucagon is added to the extracellular fluid of Dish L. The amount of glucose in the extracellular fluid of Dish L at 2:30AM will be greater than the amount of glucose in the extracellular fluid of Dish L at 1:55AM.
    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?
    A. During exocytosis in kidney collecting duct epithelial cells, there is an increase in the removal of AQP2 channels from luminal membranes and an increase in the placement of AQP2 channels into vesicular membranes in response to an increase in the amount of cAMP in the cytosol of the cell.
    B. During exocytosis in a fat cell, there is an increase in the insertion of GLUT2 molecules into the plasma membrane in response to an increase in the binding of insulin to insulin receptors in the plasma membrane.
    C. During exocytosis in a carotid artery baroreceptor neuron, an increase in the cytosolic amounts of calcium in central axon terminals of the carotid artery baroreceptor neuron leads to an increase in the release of glutamate from the central axon terminals.
    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 true?
   A. There is a net flux of sodium from intracellular spaces into luminal spaces via sodium-potassium pump ATPase spanning proteins located in the luminal membranes of epithelial cells in the medullary collecting duct of the kidney.
   B. There is a net flux of calcium from the internal spaces of the sarcoplasmic reticulum into the cytosol near troponin molecules via calcium 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.

10. Which of the following is true for a G-protein?
   A. When an antagonist binds to the binding site of a G-protein-coupled receptor (GPCR), this leads to GTP displacing a GDP bound to the alpha subunit of the G-protein.
   B. When an agonist binds to the binding site of a G-protein-coupled receptor (GPCR), this leads to GTP displacing a GDP bound to the beta subunit of the G-protein.
   C. After the GTP-ase of the alpha subunit of a G-protein converts the GTP bound to the alpha subunit to GDP and inorganic phosphate (P_i), the inorganic phosphate (P_i) is released from the alpha subunit. The alpha subunit of the G-protein with GDP bound to it then disassociates 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.

11. Which of the following serve as a ligand that binds to a binding site on the extracellular surface of a G-Protein Coupled Receptor (GPCR)?
   A. Muscarine.
   B. FSH (Follicle Stimulating Hormone).
   C. GABA.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

12. A complete motor neuron is removed from a frog and placed in normal physiological saline at 1 AM. The neuron is healthy. At 2 AM, the physiological saline bathing the neuron is removed and replaced with a modified physiological saline. The composition of the modified physiological saline is as follows: its potassium concentration is the same as normal physiological saline; its sodium concentration is the same as the intracellular sodium concentration of the motor neuron; its total concentration of solutes (osmolarity) is the same as normal physiological saline. The modified physiological saline also contains molecules that block the flux of ions via the sodium-potassium primary active transport ATPase pump. At 2:01 AM, the resting membrane voltage of the neuron is -70 millivolts. At 2:02 AM,
    A. glutamate is added to the modified physiological saline. This will lead to an increase in the membrane voltage, an increase in the amount of intracellular sodium, and a decrease in the amount of intracellular potassium.
    B. an increase in membrane voltage will lead to an increase in sodium conductance.
    C. an increase in sodium conductance will lead to no change in the amount of intracellular sodium.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

13. 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 channels. 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 a chloride equilibrium potential of -10 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, GABA 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.

14. 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 -60 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 potassium conductance equals its sodium conductance. For this situation, in response to an action potential in Neuron A, there is an excitatory postsynaptic potential in Neuron B. In addition for this situation in response to an action potential in Neuron A, the absolute value of the change in the amount of intracellular sodium in Neuron B is greater 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 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.
    C. Consider the situation that when the LGD 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.

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

16. 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. Which of the following statements are true when neuron A is initially at rest and neuron B releases neurotransmitter Y?
    A. If the value of R 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 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 potassium 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 increase in potassium conductance of the plasma membrane of neuron A and a decrease in the amount of intracellular potassium 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 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.

17. 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 anion named DVA with a valence of -2. The threshold for an action potential in Neuron B is -50 millivolts and the resting potential for Neuron B is -70 millivolts. The DVA channel in Neuron B is part of an ionotropic receptor with an extracellular binding site for the newly discovered ligand LGD. When LGD binds to its binding site, there is an increase in the DVA conductance of Neuron B. Neuron A synapses onto Neuron B. Neuron A's neurotransmitter is LGD.
    A. The extracellular concentration of DVA is 1000 times greater than the intracellular concentration of DVA. 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 DVA in Neuron B; and an inhibitory postsynaptic potential in Neuron B.
    B. The extracellular concentration of DVA is 100 times greater than the intracellular concentration of DVA. In response to an action potential in Neuron A, there will be: an increase in the membrane voltage of Neuron B; a decrease in the amount of intracellular DVA in Neuron B; and an inhibitory postsynaptic potential in Neuron B.
    C. The extracellular concentration of DVA is 10 times greater than the intracellular concentration of DVA. 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 DVA 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.

18. 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 amount of calcium binding to calcium-binding sites on tropomyosin molecules in muscle fibers of the right knee extensor muscle.
    B. An increase in the amount of glutamate released from the central axon terminals of IA muscle-spindle stretch receptor neurons that synapse directly upon the dendrites of right knee extensor motor neurons.
    C. An increase in the amount of calcium conductance in the plasma membranes of the central axon terminals of IA muscle-spindle stretch receptor neurons whose peripheral terminals are in 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.

19. Person Z swallowed a large amount of substance X and, as a result, has convulsions (abnormal violent contractions of skeletal muscles). Swallowing which of the following substances could lead to convulsions?
    A. An antagonist of the nicotinic ACh receptor.
    B. An antagonist of the glycine receptor.
    C. A blocker of the voltage-gated sodium channel.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

20. At 1:00 AM, a researcher places a healthy squid giant axon in a bath of normal squid physiological extracellular saline and internally perfuses the axon with normal squid intracellular saline. Its resting potential at 1:55 AM is -70 millivolts. For this question, ignore any possible effects due to the sodium-potassium pump. At 2:00 AM, the researcher replaces both the intracellular and the extracellular salines. All intracellular and extracellular salines used in these experiments have the same total osmolarity.
    A. In the 2:00 AM intracellular perfusion saline, the concentration of potassium ion is increased and the concentration of sodium ion is not changed; in the 2:00 AM extracellular saline, the concentration of potassium ion is not changed and the concentration of sodium ion is not changed. At 3:00 AM, there will be a decrease in the Nernst equilibrium potential for potassium ion compared to its value at 1:55 AM.
    B. In the 2:00 AM intracellular perfusion saline, the concentration of potassium ion is decreased and the concentration of sodium ion is not changed; in the 2:00 AM extracellular saline, the concentration of potassium ion is not changed and the concentration of sodium ion is not changed. At 3:00 AM, there will be an increase in the resting membrane voltage compared to its value at 1:55 AM.
    C. In the 2:00 AM intracellular perfusion saline, the concentration of potassium ion is not changed and the concentration of sodium ion is not changed; in the 2:00 AM extracellular saline, the concentration of potassium ion is not changed and the concentration of sodium ion is increased. At 3:00 AM, there will be an increase in the resting membrane voltage compared to its value at 1:55 AM.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

21. 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. sodium conductance of the voltage-gated sodium channels increases as membrane voltage increases.
    B. the amount of intracellular sodium increases.
    C. sodium conductance of the voltage-gated sodium channels changes with a faster time course than potassium conductance of the voltage-gated potassium channels.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

22. Which of the following is true 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 an actin molecule for an activated (energized) myosin head.
    B. The head of an actin molecule is activated (energized) during the hydrolysis of ATP (which is bound to the actin head) to ADP 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.

23. In the sarcomere of a skeletal muscle, there are
    A. myosin molecules in the I band.
    B. actin molecules in the H zone.
    C. troponin and tropomyosin molecules in the region of the A band that is not 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.

24. A healthy skeletal muscle fiber is isolated and has no external forces on it. It has normal intracellular levels of ATP and is bathed in physiological saline. Which of the following occur in response to an action potential in the plasma membrane of the muscle fiber?
    A. A conformational change in Dihydropyridine (DHP) Receptors in the membranes of the transverse tubules.
    B. An increase in the amount of calcium ions in the sarcoplasmic reticulum.
    C. An increase in the calcium conductance of the channel associated with the Ryanodine Receptor in the membranes of the sarcoplasmic reticulum.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

25. Which of the following is true?
    A. Cyclic AMP (cAMP) in the interstitial fluid surrounding SA node cells binds to a cAMP binding site on the F-channel that is located only on the extracellular surface of the F-channel.
    B. When the membrane voltage of a SA node cell is -80 mV, then the conductance of the F-channels in that cell is zero.
    C. The S4 gene is the gene whose sequence is responsible for the F-channel.
    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 cells in the Bundle of His will be greater than the firing rate of ventricular muscle cells.
    B. The firing rate of SA node cells will be greater than the firing rate of atrial muscle cells.
    C. The firing rate of atrial muscle cells 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. 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 an increase in the amount of ACh (acetylcholine) released near the SA node of the heart.
    B. this will lead to an increase in the heart rate.
    C. this will lead to an increase in the firing rate of sympathetic neurons whose axon terminals are near SA node cells of the heart.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

28. Which of the following is true?
    A. 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 these cells.
    B. An increase in intracellular levels of cAMP in SA node cells will lead to an increase in heart rate.
    C. An increase in heart rate will lead to an increase in the firing rate 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.

29. 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 start of the *lub* sound in that single cycle.
    B. In that single cycle, the volume of blood in the left ventricle at the end of the *lub* sound is more than the volume of blood in the left ventricle at the start of the *dub* sound.
    C. In that single cycle, the volume of blood in the left ventricle at t_1 is less than the volume of blood in the left ventricle at the start of the *lub* sound.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

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

31. Which of the following processes in the lung help bring oxygen into the body?
    A. Net flux of oxygen from alveolar spaces into the blood plasma in capillaries in the lung.
    B. Binding of oxygen to hemoglobin in red blood cells in capillaries in the lung in response to a high partial pressure (concentration) of oxygen in these red blood cells in capillaries in the lung.
    C. Net flux of oxygen from the cytosol of red blood cells in capillaries in the lung into the blood plasma in 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.

32. Which of the following are involved in the long-term regulation of the oxygen-carrying capacity of the blood?
    A. Changes in the total amount of hemoglobin in the blood.
    B. 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.
    C. Changes in the amount of red blood cells produced by peritubular interstitial cells (PIC) of the renal cortex in response to EPO binding to EPO Receptors in the plasma membranes of these peritubular interstitial cells (PIC) of the renal cortex.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

33. 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 Nicotinic Acetylcholine Receptors (nAChRs) 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.

34. 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 motor neurons that synapse upon skeletal muscles in the lung.
    B. Action potentials in central hydrogen-ion-sensitive chemoreceptors.
    C. Action potentials in motor neurons that synapse upon 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.

35. In epithelial cells of the small intestine, which of the following are involved in processes that (either directly or indirectly) 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 intracellular spaces to interstitial spaces via sodium-potassium ATPase pumps.
    B. Net flux of glucose across the basolateral membranes of the epithelial cells from intracellular spaces to interstititial spaces via GLUT2 transporters.
    C. Net flux of glucose across luminal membranes of the epithelial cells from luminal spaces to intracellular spaces via SGLT1 cotransporters (sodium-glucose cotransporters 1).
    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 function in the Gastrointestinal Tract by converting an inactive form of an enzyme to its active form?
    A. Pepsinogen.
    B. Enterokinase (also called Enteropeptidase).
    C. Trypsinogen.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

37. Healthy Person P takes a drug that produces a condition with a strong effect on the epithelial cells of the kidney medullary collecting duct within one hour and lasts for one week after taking the drug. There is no direct effect of the drug on other cells in the body. One day after taking the drug, which of the following drugs will produce a condition with the symptoms of diabetes insipidus in Healthy Person P?
    A. Drug X that stimulates endocytosis of AQP2 and blocks exocytosis of AQP2 for one week in the epithelial cells of the kidney medullary collecting duct.
    B. Drug Y that is an antagonist at V2 receptors that remains bound to V2 receptors in the basolateral membranes of the epithelial cells of the kidney medullary collecting duct for one week.
    C. Drug Z that produces a condition in which the amounts of cytosolic cAMP in the epithelial cells of the kidney medullary collecting duct are very low 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.

38. 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 higher 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.

39. Which of the following is true for the epithelial cells of the late proximal tubule of the kidney?
    A. The GLUT1 transporter in the basolateral membrane is responsible for the net flux of glucose from interstitial space to intracellular space.
    B. The sodium-potassium ATPase pump in the basolateral membrane is responsible for the net flux of sodium from intracellular space to interstitial space.
    C. The SGLT1 cotransporter in the luminal membrane is responsible for the net flux of glucose from intracellular space to luminal space.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

40. 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 sodium-potassium-ATPase pumps located in the luminal membranes of the epithelial cells in the descending limb of the Loop of Henle.
    B. Net flux of sodium ions from luminal spaces to intracellular spaces via the SGLT2 cotransporters located in the luminal 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.

41. Which of the following serves as an actuating signal, or part of an actuating signal, in a negative feedback system?
    A. Blood plasma levels of oxytocin.
    B. Blood plasma levels of vasopressin.
    C. Cytosolic levels of cAMP in 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.

42. During a fever in a human,
    A. there is an increase 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. the control system for body temperature functions as a closed-loop positive-feedback system.
    C. shivering can occur when the actual body temperature is lower than the set point for body temperature during the fever.
    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 correct?
    A. An increase in insulin binding to Insulin Receptors in the plasma membrane of a liver cell leads to a decrease 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.

44. Person X is a healthy human who has volunteered to take experimental drug Y. Person X has a normal dinner at 6 PM on April 1 and then does not eat for 12 hours. At 2 AM on April 2, X takes a dose of Y that closes all the ATP-sensitive potassium channels in X's beta-islet cells of the pancreas for 6 hours. For this question, ignore any effects due to alpha-islet cells of the pancreas.
    A. At 3 AM on April 2, the glucose permeability of X's skeletal muscle cells will be higher than the glucose permeability of X's skeletal muscle cells at 1 AM.
    B. At 3 AM on April 2, the glucose permeability of X's liver cells will be higher than the glucose permeability of X's liver cells at 1 AM.
    C. At 3 AM on April 2, X's blood plasma levels of insulin will be lower 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.

45. Which of the following is true?
    A. GLUT2 transporter molecules are responsible for the net flux of glucose from the interstitial spaces of the kidney cortex into the intracellular spaces of early proximal tubule epithelial cells.
    B. When blood plasma levels of glucagon are high and blood plasma levels of insulin are low, GLUT2 transporter molecules are responsible for the net flux of glucose from the interstitial spaces surrounding liver cells into the intracellular spaces of liver cells.
    C. GLUT2 transporter molecules are responsible for the net flux of glucose from the interstitial spaces surrounding beta-islet cells of the pancreas into the intracellular spaces of beta-islet cells of the pancreas.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

46. Glycogen
    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 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.

47. Which of the following is true?
    A. GnRH Receptors (Gonadotropin Releasing Hormone Receptors) are located in the plasma membranes of cells in the anterior pituitary.
    B. ORH (Oxytocin Releasing Hormone) travels in specialized capillaries located in the pituitary stalk between the hypothalamus and 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.

48. Healthy young adult human female F has high blood plasma levels of hCG (human Chorionic Gonadotropin). During the time that F's blood plasma hCG levels are high,
    A. she will ovulate once a month.
    B. she will secrete high levels of estrogen and progesterone from cells in the anterior pituitary into the blood plasma.
    C. she will menstruate once a month.
    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 pairs of events occur at, or nearly at, the same time during the menstrual cycle?
    A. High LH secretion and menstruation.
    B. High progesterone secretion and ovulation.
    C. High progesterone secretion and follicle development.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

50. A simple question is flashed on a screen in the right visual field of right-handed Person Z. Person Z is a healthy individual with a normal nervous system. Person Z has a patch over Z's left eye so that Z sees the question only in Z's right eye.
    A. The stimulus will excite neurons only in the right half of Z's right retina.
    B. The stimulus will excite neurons in Z's left V1 (left primary visual cortex).
    C. Z will be able to use a pencil in his right hand to spell out the correct answer on a piece of paper even when all action potentials in all axons of Z's corpus collosum are completely blocked by Drug XCC. All other neurons and axons in Person Z are not directly affected by Drug XCC.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.