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. Hydrogen-ion-sensitive central chemoreceptors whose peripheral axon terminals are located in the walls of the carotid artery.
   B. Carotid artery baroreceptors whose central axon terminals are located in the walls of the carotid artery.
   C. Glucagon Receptors located in the plasma membranes of alpha 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.

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 calcium.
   C. Osmolarity of the luminal fluid in the medullary collecting duct 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.

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 diaphragm muscle fibers.
   B. Blood plasma levels of glycogen.
   C. Action potentials in sympathetic neurons that release acetylcholine (ACh) near the SA node 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.

4. Which of the following serves as an effector, or as part of an effector, in a negative feedback system?
   A. Dihydropyridine (DHP) Receptors in rib cage muscles.
   B. Glycogen Receptors in the plasma membranes of liver cells.
   C. Ryanodine Receptors in the sarcoplasmic reticulum membranes of diaphragm muscles.
   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, this leads to
   A. a decrease in the levels of calcium in the blood plasma.
   B. a decrease in the levels of parathyroid hormone (PTH) in the blood plasma.
   C. an increase in the amount of PTH binding to PTH Receptors in bone.
   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 equal to 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. Which of the following is true?
   A. During exocytosis in fat cells, there is insertion of GLUT4 molecules from vesicular membranes into plasma membranes.
   B. During exocytosis in medullary collecting duct epithelial cells, there is insertion of AQP2 channels from luminal membranes into vesicular membranes.
   C. During exocytosis in toe motor neurons, there is release of Acetylcholine (ACh) from axonal terminals near toe skeletal muscles in response to a decrease in the amount of cytosolic calcium in the axonal terminals of these 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 the sodium-potassium pump ATPase?
   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 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 intracellular spaces into extracellular 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.

9. 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 luminal spaces of the kidney cortex into the intracellular spaces of epithelial cells in the early proximal tubule.
   C. 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.
   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. After the ATP-ase of the alpha subunit of a G-protein converts the ATP bound to the alpha subunit to ADP and inorganic phosphate (P_i), the inorganic phosphate (P_i) is released from the alpha subunit. The alpha subunit of the G-protein with ADP bound to it then associates with the beta and gamma subunits of the G-protein.
    B. 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.
    C. When an agonist binds to the binding site of a G-protein-coupled receptor (GPCR), this leads to GDP displacing a GTP bound to the alpha subunit 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 is true for Vasopressin2 Receptors (V2Rs) in medullary collecting duct epithelial cells?
    A. When antagonists bind to V2Rs in the plasma membrane of the cells, this leads to an increase in the intracellular amount of cAMP.
    B. When agonists bind to V2Rs in the plasma membrane of the cells, this leads to an increase in the amount of AQP2 in the luminal plasma membranes of the cells.
    C. When agonists bind to V2Rs in the plasma membrane of the cells, this leads to an increase in the amount of GTP that is bound to alpha subunits of the G-proteins associated with the V2Rs.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

12. 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 +50 mV, and the Nernst equilibrium potential for potassium in Neuron B is -100 mV. The threshold for an action potential in Neuron B is -45 mV and the resting potential for Neuron B is -50 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 two 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 its 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 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.

13. 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 pump. At 2:05 AM, the resting membrane voltage of the neuron is -70 millivolts. At 2:06 AM,

A. the value of the Nernst equilibrium potential for sodium ions for the neuron is less than -10 millivolts.
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.

14. Which of the following occur in response to an increase in the length of the right knee extensors in response to a quick tap applied to the right patellar tendon?

A. An increase in the amount of sodium ions in the cytosol of the peripheral axon terminals of IA muscle-spindle stretch receptor neurons whose peripheral axon terminals are in the right knee extensor muscle.
B. An increase in the amount of calcium ions in the sarcoplasmic reticulum of right knee extensor muscles.
C. An increase in the amount of sodium ions in the cytosol of the cell bodies of right knee extensor motor neurons.
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 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 0 (zero) 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, molecules of an antagonist to the AMPA Receptor are added to the bath.
   B. At 2:01 AM, molecules of an antagonist to the Glycine Receptor are added to the bath.
   C. At 2:01 AM, molecules of an antagonist to the $GABA_B$ Receptor are 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 are true?
   A. Curare is an antagonist both at the muscarinic ACh Receptor and at the nicotinic ACh Receptor.
   B. Consider the channel associated with the $GABA_A$ Receptor and the channel associated with the Glycine Receptor. For both types of channel, there is a chloride conductance greater than zero when the channel is open.
   C. Consider the channel associated with the AMPA Receptor and the channel associated with the nicotinic ACh receptor. For both types of channel, there is a potassium conductance greater than zero when the channel is open.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

17. 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 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 no change in the amount of intracellular sodium ions in neuron A.
   B. If the value of E is equal to R, 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 no change in the amount of intracellular chloride ions in neuron A.
   C. If the value of E is equal to R, 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 no change in the chloride conductance of the plasma membrane of neuron A.
   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 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. Consider the situation that the extracellular concentration of DVA is 1,000 times greater than the intracellular concentration of DVA. For this situation, 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. Consider the situation that the extracellular concentration of DVA is 100 times greater than the intracellular concentration of DVA. For this situation, 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. Consider the situation that the extracellular concentration of DVA is 10 times greater than the intracellular concentration of DVA. For this situation, 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.

19. At 1 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 AM, the researcher replaces both the intracellular and the extracellular salines.

   A. In the 2 AM intracellular perfusion saline, the concentration of potassium ion is increased; in the 2 AM extracellular saline, the concentration of potassium ion is not changed. This will cause a decrease in the Nernst equilibrium potential for potassium ion.
   B. In the 2 AM intracellular perfusion saline, the concentration of potassium ion is increased; in the 2 AM extracellular saline, the concentration of potassium ion is not changed. This will cause an increase in the resting membrane voltage.
   C. In the 2 AM extracellular saline, the concentration of potassium ion is decreased; in the 2 AM intracellular perfusion saline, the concentration of potassium ion is not changed. This will cause an increase in the Nernst equilibrium potential for potassium ion.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

20. A complete motor neuron is removed from a frog and placed in a large volume of normal physiological 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 neuron's plasma membrane has $GABA_A$, $GABA_B$, and glycine receptors. The equilibrium potential for chloride ions is -70 millivolts and the equilibrium potential for potassium ions is -90 millivolts.

   A. The addition of GABA to the physiological saline will lead to a decrease in the amount of intracellular chloride.
   B. The addition of glycine to the physiological saline will lead to an increase in the amount of intracellular chloride.
   C. The addition of GABA to the physiological saline will lead to 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.

21. Which of the following is true for primary motor cortex (M1) corticospinal interneuron A that produces action potentials during movements of the big toe of the right foot in right-handed Patient X who has a complete transection of the corpus callosum.

   A. In Patient X, the cell body of interneuron A is located in between the central sulcus of the right cerebral cortex and the right eye.
   B. The axon terminals of interneuron A are located on the right side of Patient X's spinal cord.
   C. Interneuron A will increase its action potential firing rate after Patient X reads the statement "Wiggle the big toe of your right foot" presented in Patient X's left visual field.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

22. For a sarcomere of a skeletal muscle, use the following definitions:
A is the length of the A Band; H is the length of the H Zone;
I is the total length of the I Bands in the sarcomere.
When the length of the sarcomere decreases during a shortening of the entire muscle,
  A. The value of A plus the value of I (= A + I) increases.
  B. The value of A minus the value of H (= A - H) decreases.
  C. The value of A remains constant.
  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. During rigor mortis, myosin heads that are already attached to actin molecules remain attached to the actin molecules due to no GTP or very low levels of GTP in the cytosol of the muscle.
  B. The binding of calcium to troponin causes movement of tropomyosin so that the tropomyosin no longer blocks binding sites on actin for energized myosin heads.
  C. The head of a myosin molecule is activated (energized) during the hydrolysis of ATP (which is bound to the myosin head) to ADP and P_i.
  D. A and B.
  E. A and C.
  F. B and C.
  G. A, B, and C.
  H. None of the above.

24. ATP is **<u>DIRECTLY</u>** required in which of the following processes in muscle?
  A. Net flux of sodium ions from intracellular space to extracellular space.
  B. Net flux of calcium ions from the cytosol into the sarcoplasmic reticulum.
  C. Detachment of myosin heads from their binding sites on troponin molecules.
  D. A and B.
  E. A and C.
  F. B and C.
  G. A, B, and C.
  H. None of the above.

25. Consider a single cycle in a healthy heart. Define the start of the cycle as the peak of the action potential in a SA node cell, which occurs at t_1, and the end of the cycle as the peak of the following action potential in that same SA node cell, which occurs at t_2. During the interval between t_1 and t_2, there are 2 heart sounds. The first heart sound is *lub*; the second heart sound is *dub*. Which of the following is true during the time interval between t_1 and the start of the *lub* sound in that single cycle?
  A. There is a decrease in the volume of blood in the left ventricle.
  B. In the electrocardiogram, there is an occurrence of the T wave.
  C. There is an occurrence of the opening of an aortic valve, that is, it goes from a closed position to an open position.
  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 the cells in the right bundle branch will be the same as the firing rate of the cells in the left bundle branch.
    B. The firing rate of SA node cells will be the same as the firing rate of atrial muscle cells.
    C. The firing rate of atrial muscle cells will the same as 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 is true for SA node cardiac muscle cells?
    A. An increase in intracellular levels of cAMP in SA node cells will lead to a decrease in the amount of time between two successive action potentials in SA node cells.
    B. An increase in the binding of norepinephrine to beta-adrenergic receptors in SA node cells will lead to a decrease in intracellular levels of cAMP in these cells.
    C. An increase in the binding of acetylcholine to muscarinic ACh receptors in SA node cells will lead to an increase in heart rate.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

28. At 1:00 AM, healthy person X's blood pressure is equal to the blood pressure set point. At 1:01 AM, there is an increase 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 a decrease in the heart rate.
    C. this will lead to an increase in the diameter of the arterioles.
    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 active hyperemia, a local control mechanism within the circulatory system?
    A. There will be an increase in force developed by smooth muscles surrounding arterioles that lead into a local region in which there has been an increase in the rates of activity of body cells in that region.
    B. There will be more blood flow into a local region in response to an increase in the rates of activity of body cells in that region.
    C. There will be a decrease in the potassium conductance of ATP-sensitive potassium channels in smooth muscle cells in response to a decrease in the levels of intracellular ATP in those cells.
    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. Net flux of carbon dioxide from red blood cells into plasma.
    B. Net flux of bicarbonate from red blood cells into plasma.
    C. Breakdown of carbonic acid into carbon dioxide and water by carbonic anhydrase in the plasma.
    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 are true for ventilation?
    A. An increase in the hydrogen ion concentration in the interstitial spaces of the brain stem leads to an increase in the duration of the respiratory cycle (duration of respiratory cycle equals duration of inspiration plus duration of expiration).
    B. When the pressure within the alveoli is less than atmospheric pressure, there will be inspiration of air into the lungs.
    C. The problems with ventilation induced by injection of curare occur because of the drug's direct action on nicotinic ACh Receptors (nAChRs) in the plasma membranes of the respiratory muscles (the diaphragm and the rib-cage muscles).
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

32. Which of the following is true for red blood cells?
    A. Carbonic anhydrase is the intracellular enzyme **DIRECTLY** responsible for the breakdown of carbonic acid into bicarbonate and hydrogen ions.
    B. ATP is **DIRECTLY** required for the net flux of bicarbonate across the plasma membrane via the Anion Exchanger 1 (AE1) in the plasma membrane of the red blood cells.
    C. An increase in the plasma concentration of erythropoietin (EPO) leads to an increase in the rate of production of red blood cells by the 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.

33. Which of the following is true?
    A. The partial pressure of oxygen in the blood plasma in the right ventricle is lower than the partial pressure of oxygen in the blood plasma in the left ventricle.
    B. The blood plasma levels of bicarbonate in the right ventricle are lower than the blood plasma levels of bicarbonate in the left ventricle.
    C. The percent Hemoglobin saturation (percent of oxygen-binding sites in Hemoglobin that have oxygen bound) in the red blood cells in the right ventricle is lower than the percent Hemoglobin saturation in the red blood cells in the left ventricle.
    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 effector, or as part of an effector, in a negative feedback system?
    A. Bone marrow cells.
    B. Hydrogen-ion-sensitive peripheral chemoreceptors whose peripheral axon terminals are located in the walls of the carotid artery.
    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.

35. 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.

36. SGLT1 (sodium-glucose co-transporter 1) is
    A. located in luminal membranes of epithelial cells in the late proximal tubule of the kidney.
    B. located in luminal membranes of epithelial cells of the small intestine.
    C. responsible for the net flux of glucose from 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.

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 exocytosis of AQP2 and blocks endocytosis 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 levels of intracellular cyclic AMP (cAMP) are very low for one week in the epithelial cells of the kidney medullary collecting duct.
    C. Drug Z that is an antagonist at V2 receptors that remains bound to V2 receptors in 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.

38. 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 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 net flux of glucose from intracellular spaces of proximal tubule epithelial cells in W's kidney to interstitial spaces surrounding these cells will be much lower than the net flux of glucose from intracellular spaces of proximal tubule epithelial cells in W's kidney to interstitial spaces surrounding these cells at 8 PM on May 1.
C. At 8 PM on May 2, the osmolarity of the luminal fluid in the medullary collecting duct of W's kidney will be much higher than the osmolarity of the luminal fluid in the medullary collecting duct of W's kidney at 8 PM on May 1.
D. A and B.
E. A and C.
F. B and C.
G. A, B, and C.
H. None of the above.

39. Consider the case of a rare mutant in which the concentration of solutes in the kidney medulla interstitial spaces is equal to the concentration of solutes in the liquid in the lumen of the medullary collecting duct in the kidney. The defective molecules associated with this rare mutation are <u>**NOT**</u> located in the epithelial cells of the kidney medullary collecting duct; the defective molecules are located in other cells of the kidney. In this rare mutant, an increase in the amount of vasopressin that binds to V2 Receptors in the kidney will lead to <u>**NO CHANGE**</u> in the

A. net flux of water from the luminal spaces of the collecting duct to the interstitial spaces of the kidney medulla.
B. water permeability of the luminal membranes of the collecting duct epithelial cells.
C. amount of water that is reabsorbed into the blood plasma from the lumen of the collecting duct.
D. A and B.
E. A and C.
F. B and C.
G. A, B, and C.
H. None of the above.

40. Which of the following is true for the luminal membranes of epithelial cells in the descending 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 descending limb of the Loop of Henle.
B. NKCC2 (sodium-potassium-2chloride co-transporter) molecules are located in the luminal membranes of epithelial cells in the descending limb of the Loop of Henle.
C. AQP1 (Aquaporin 1) molecules are located in the luminal membranes of epithelial cells in the descending 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. 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 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.
    B. 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.
    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.

42. Healthy Person P takes a new drug that is a member of a drug family that results in a condition in which there are constant very high levels of cytosolic cyclic AMP (cAMP) in one and only one cell type in the body. A single dose of each member of the new drug family works within one hour to produce this condition and the condition lasts for one week. Which of the following is true for P two days after taking a specific member of the new drug family?
    A. Consider the situation that P takes Drug A that results in a condition in which the levels of cytosolic cAMP in the epithelial cells of the medullary collecting duct of the kidney are constant at a very high level. Two days after taking Drug A, the net flux of water from luminal spaces to intracellular spaces across the luminal membranes of these cells in P will be more than pre-drug levels of the net flux of water from luminal spaces to intracellular spaces across the luminal membranes of these cells in P.
    B. Consider the situation that P takes Drug B that results in a condition in which the levels of cytosolic cAMP in the SA node cells of the heart are constant at a very high level. Two days after taking Drug B, the firing rate of action potentials in P's atrial muscle cells will always be higher than the firing rate of action potentials in P's ventricular muscle cells.
    C. Consider the situation that P takes Drug C that results in a condition in which the levels of cytosolic cAMP in the cells of the liver are constant at a very high level. For this situation, ignore any effects due to insulin binding to insulin receptors in the liver. Two days after taking Drug C, the amount of glucagon in P's liver cells will be lower than pre-drug levels of the amount of glucagon in P's liver cells.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

43. 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 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, 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 insulin will be higher than X's blood plasma levels of insulin 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.

44. Which of the following is correct?
    A. 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.
    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 glycogen in the cytosol of the liver cell.
    C. An increase in insulin binding to Insulin Receptors in the plasma membrane of a liver cell leads to an increase in the exocytosis of GLUT4 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.

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

46. Which of the following is true?
    A. Binding of GHRH (Growth Hormone Releasing Hormone) to GHRHR (Growth Hormone Releasing Hormone Receptors) located in the plasma membranes of cells in the posterior pituitary leads to the secretion of GH (Growth Hormone) from the posterior pituitary into the blood plasma.
    B. The blood plasma levels of VRH (Vasopressin Releasing Hormone) serve as an actuating signal in a negative feedback system.
    C. ORH (Oxytocin Releasing Hormone) travels in specialized capillaries located in the pituitary stalk between the hypothalamus and the anterior pituitary.
    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. shivering may occur when the actual body temperature is lower than the set point for body temperature during the fever.
    B. 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.
    C. the control system for body temperature functions as a closed-loop positive-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. Healthy young adult human female F has very high blood plasma levels of hCG (human Chorionic Gonadotropin). During the time that F's blood plasma hCG levels are very high,
    - A. she will menstruate once a month.
    - B. she will secrete high levels of LH and FSH from cells in the anterior pituitary.
    - C. she will ovulate 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 in a young adult human female who is not pregnant?
    - A. High blood plasma progesterone levels and thick endometrial walls of the uterus.
    - B. High blood plasma FSH levels and follicle development.
    - C. High blood plasma LH levels and ovulation.
    - D. A and B.
    - E. A and C.
    - F. B and C.
    - G. A, B, and C.
    - H. None of the above.

50. A complex question is flashed on a screen in the left 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 right eye so that Z sees the question only in Z's left eye.
    - A. The stimulus will lead to a response that includes excitation of neurons in the left half of Z's left retina.
    - B. The stimulus will lead to a response that includes excitation of neurons in Z's right V1 (primary visual cortex).
    - C. Z will be able to use a pencil in his right hand to write 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.