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 peripheral chemoreceptors whose peripheral axon terminals are located in the brain stem.
   B. Carotid artery baroreceptors whose peripheral axon terminals are located in the walls of the carotid artery.
   C. CaSR (Calcium-Sensing Receptors) located 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.

2. Which of the following serves as an actuating signal in a negative feedback system?
   A. Action potentials in diaphragm muscle fibers.
   B. Blood plasma levels of Glucagon Receptors.
   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.

3. Which of the following serves as an effector, or as part of an effector, in a negative feedback system?
   A. Binding sites for calcium ions on troponin molecules in rib cage inspiratory muscles.
   B. GLUT2 transporters in beta-islet cells of the pancreas.
   C. GLUT2 transporters in the basolateral membranes of epithelial cells 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.

4. Which of the following serves as a controlled variable in a negative feedback system?
   A. Blood plasma levels of vasopressin.
   B. Blood plasma levels of PTH (parathryroid hormone).
   C. Blood plasma levels of calcium.
   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 interstitial spaces surrounding parathyroid gland cells increase in Healthy Person P, this leads to
   A. a decrease in the levels of parathyroid hormone (PTH) in the blood plasma.
   B. an increase in the amount of PTH binding to PTH Receptors in bone.
   C. a decrease in the levels of calcium in 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. 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 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 intracellular spaces of liver cells into the interstitial spaces surrounding 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.

7. Which of the following is an effect of the following drugs?
   A. Drug A is an agonist of the Vasopressin2 Receptor (V2R). High levels of Drug A in the interstitial spaces surrounding cells of the kidney medullary collecting ducts will lead to high levels of exocytosis of AQP4 molecules in these cells.
   B. Drug B is an agonist of the Insulin Receptor. High levels of Drug B in the interstitial spaces surrounding fat cells will lead to high levels of exocytosis of GLUT2 transporters in these cells.
   C. Drug C is an agonist of the Glucagon Receptor. High levels of Drug C in the interstitial spaces surrounding liver 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.

8. 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 less than the amount of potassium ions in the left compartment at 9 AM.
   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 for the sodium-glucose cotransporter?
   A. The net flux of sodium ions is from a region of high sodium ion concentration to a region of low sodium ion concentration.
   B. The net flux of glucose is from a region of high glucose concentration to a region of low glucose concentration.
   C. There are sodium-glucose cotransporters in the luminal membranes of epithelial cells in the 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.

10. Which of the following are ligands that bind to the nicotinic Acetylcholine Receptor (nAChR)?
    A. Curare.
    B. Nicotine.
    C. Muscarine.
    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 a G-protein?
    A. 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 alpha subunit of the G-protein recombines 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 GDP 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.

12. 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 -55 millivolts and the resting potential for Neuron B is -70 millivolts. The DIVCAT 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 DIVCAT conductance of Neuron B. Neuron A synapses onto Neuron B. Neuron A's neurotransmitter is LGD.
    A. Consider the situation in which 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 in which 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: an increase 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.
    C. Consider the situation in which 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; a decrease 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.

13. Which of the following are true?
    A. Tetraethylammonium (TEA) blocks the potassium conductance of the channel associated with the nAChR (nicotinic Acetylcholine Receptor).
    B. Tetrodotoxin (TTX) blocks the sodium conductance of the voltage-gated sodium channel.
    C. Consider the situation of an NMDA receptor in the membrane of a neuron. The membrane potential of the neuron is at -70 mV. When NMDA and CNQX are added to the interstitial spaces surrounding the neuron, magnesium ions in channel associated with the NMDA Receptor block calcium conductance in the channel associated with the NMDA Receptor.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

14. 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 only ligand-gated Receptors in the neuron's plasma membrane are AMPA 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 glycine and 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 and glutamate to the physiological saline will lead to an increase in the amount of intracellular chloride and an increase in the amount of intracellular sodium.
    C. The addition of GABA to the physiological saline will lead to an increase in the chloride conductance of the plasma membrane of the neuron.
    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 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? An increase in the amount of
    A. glutamate released from central axon terminals of IA muscle-spindle stretch receptor neurons whose peripheral axon terminals are in the left knee extensor muscle.
    B. acetylcholine bound to nAChRs (nicotinic Acetylcholine Receptors) in the membranes of the sarcoplasmic reticulum in the muscle fibers of the right knee extensor muscle.
    C. potassium conductance in the plasma membranes of dendrites of right knee extensor motor neurons located in the right side of the spinal cord.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

16. 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 -55 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, a decrease 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.

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 R is less than E, if the value of E is less than T, 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 the chloride conductance of the plasma membrane of 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 an increase 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 no change in the amount of intracellular sodium 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.

18. Consider five culture dishes; each dish has one healthy neuron in it. Dish V has Neuron V in it; Dish W has Neuron W in it; Dish X has Neuron X in it; Dish Y has Neuron Y in it; and Dish Z has Neuron Z in it. At 1:00 AM: each neuron is bathed in normal physiological saline; all the neurons have the same properties; and each neuron is at rest with a resting potential of -70 millivolts. Each neuron has only three types of ionotropic ligand-gated receptors: AMPA Receptors, NMDA Receptors, and Glycine Receptors. None of the neurons have metabotropic receptors. Each neuron has a chloride equilibrium potential of +20 millivolts. At 1:55 AM, a large amount of TTX is added to the physiological saline in all five dishes. Ignore any effects due to voltage-gated calcium channels with S4 helices. At 1:58 AM, the amount of intracellular calcium in each neuron is the same as that of each other neuron.
At 2:00 AM:
glutamate is added to the physiological saline of Dish V;
glutamate and APV are added to the physiological saline of Dish W;
glutamate and CNQX are added to the physiological saline of Dish X;
glutamate, CNQX, and glycine is added to the physiological saline of Dish Y;
glutamate, CNQX, glycine, and strychnine are added to the physiological saline of Dish Z.
    A. At 2:01 AM, the total calcium conductance in Neuron Y will be less than the total calcium conductance in Neuron Z. In addition, the total calcium conductance in Neuron X will be greater than the total calcium conductance in Neuron V.
    B. At 2:01AM, the total sodium conductance in Neuron X is less than the total sodium conductance in Neuron Y. In addition, the total sodium conductance in Neuron W is less than the total sodium conductance in Neuron V.
    C. For each neuron, MAXV is the maximum voltage that is reached by that neuron during the period from 2:00 AM to 2:02 AM. The MAXV in Neuron W is greater than the MAXV in Neuron X. In addition, the MAXV in Neuron Z is greater than the MAXV in Neuron Y.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

19. At 1 AM, a healthy squid giant axon is placed in a bath of normal squid physiological extracellular saline and is internally perfused with normal squid intracellular saline. Its resting membrane voltage at 1:50 AM is -70 millivolts. At 1:55 AM, the axon is electrically stimulated so that it produces an action potential. At 2 AM, there is a change in the intracellular perfusion fluid so that the concentration of sodium ion is decreased. At 2:05 AM, the axon is electrically stimulated so that it produces an action potential. For this question, ignore any possible effects due to the sodium-potassium pump.
    A. The resting membrane voltage at 2:10 AM is less than the resting membrane voltage at 1:50 AM.
    B. The Nernst equilibrium potential for sodium ion at 2:10 AM is greater than the Nernst equilibrium potential for sodium ion at 1:50 AM.
    C. The value of the peak of the action potential at 2:05 AM is greater than the value of the peak of the action potential 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.

20. Consider a system that contains two neurons and one cardiac SA node cell in a culture dish bathed in normal physiological saline. All three cells are healthy. Neuron A synapses onto Neuron B. Neuron B synapses onto the SA node cell. Neuron A has glycine in its synaptic vesicles. Neuron B has acetylcholine (ACh) in its synaptic vesicles. The only ligand-gated channels in the plasma membrane of Neuron A are AMPA receptors. The only ligand-gated channels in the plasma membrane of Neuron B are glycine receptors. Both neurons have no metabotropic receptors in their plasma membranes. Neuron A, Neuron B, and SA node cell each have a chloride equilibrium potential of -80 millivolts, a potassium equilibrium potential of -86 millivolts, and a sodium equilibrium potential of +60 millivolts. The SA node cell has a calcium equilibrium potential of +70 millivolts. The threshold for an action potential in all 3 cells is -55 millivolts. The SA node cell has its usual set of molecules. At 1:55AM, glutamate is added to the physiological saline. At 2:00 AM, Neuron A's action potential firing rate is 100 Hz, Neuron B's action potential firing rate is 100 Hz, and the SA node cell's action potential firing rate is 1.00 Hz. Which of the following will lead to a decrease in the SA node cell's action potential firing rate?
    A. At 2:01 AM, CNQX is added to the physiological saline.
    B. At 2:01 AM, strychnine is added to the physiological saline.
    C. At 2:01 AM, acetylcholine (ACh) is added to the physiological saline.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

21. When the overlap between the thin and thick filaments of a sarcomere in a skeletal muscle is increasing,
    A. the length of the A band minus the length of H zone is increasing in the sarcomere.
    B. the total length of the I band plus the length of the A band minus the length of the H zone is increasing in the sarcomere.
    C. the total length of the I band plus the length of the H zone is decreasing in the sarcomere.
    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 for exocytosis in a skeletal muscle?
    A. During exocytosis in a skeletal muscle, there will be release of acetylcholine (ACh) from the sarcoplasmic reticulum into the cytosol.
    B. During exocytosis in a skeletal muscle, there will be release of calcium ions from intracellular vesicles in the sarcoplasmic reticulum in response to high levels of Ryanodine binding to Ryanodine Receptors in the transverse tubules.
    C. During exocytosis in a skeletal muscle, there will be insertion of GLUT4 transporters into the plasma membrane in response to Insulin binding to Insulin Receptors in the plasma membrane.
    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 ATP to tropomyosin causes detachment of the tropomyosin head from the actin molecule.
    B. 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.
    C. Binding of calcium ion to its receptor site on the actin molecule blocks the attachment of the head of the tropomyosin molecule to its binding 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. 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. An increase in the calcium conductance of the channel associated with the Ryanodine Receptor in the membranes of the sarcoplasmic reticulum.
    B. An increase in the amount of calcium ions bound to troponin.
    C. A conformational change in Dihydropyridine Receptors (DHPRs) in membranes of the transverse tubules.
    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 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 EKG and closing of the AV valves.
    B. The P wave of the EKG and increases in membrane voltage of atrial muscle cells.
    C. The T wave of the EKG and increases in membrane voltage of ventricular muscle cells.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

26. Consider a time when the membrane voltage of a SA node cell in the heart is at its minimum value (near -80 mv).
    A. At this time, the membrane voltage will be less than the threshold voltage for the action potential.
    B. At this time, all the voltage-gated calcium channels will be open.
    C. At this time, F-channel conductance will be high when compared to F-channel conductance at the peak of the action potential.
    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?
    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.

28. The axons of all the baroreceptors in the body were destroyed at 2 AM. All else is normal. Which of the following statements is true for the system at 2:10 AM when compared to their values at 1:50 AM?
    A. Parasympathetic discharge to the heart will increase.
    B. Blood pressure will decrease.
    C. Arteriole diameter will decrease.
    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 serves as an actuating signal in a negative feedback system?
    A. Action potentials in parasympathetic neurons that release ACh (acetylcholine) near SA node cells of the heart.
    B. Action potentials in ventricular muscle cells of the heart.
    C. Action potentials in 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.

30. Which of the following is true?
    A. The partial pressure of oxygen in the blood plasma in the pulmonary artery is higher than the partial pressure of oxygen in the blood plasma in the pulmonary vein.
    B. The blood plasma levels of bicarbonate in the pulmonary artery are higher than the blood plasma levels of bicarbonate in the pulmonary vein.
    C. The percent Hemoglobin saturation (percent of oxygen-binding sites in Hemoglobin that have oxygen bound) in the red blood cells in the pulmonary artery is lower than the percent Hemoglobin saturation in the red blood cells in the pulmonary vein.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

31. Which of the following processes help bring oxygen to the body cells that are in a leg?
    A. Net flux of oxygen from blood plasma into the red blood cells in capillaries near body cells in a leg.
    B. An increase in hydrogen ion concentration in the cytosol of red blood cells in capillaries near body cells in a leg.
    C. Removal of oxygen from hemoglobin in response to an increase in the amount of HbRH (Hemoglobin Releasing Hormone) that binds to HbRHRs (Hemoglobin Releasing Hormone Receptors) in the plasma membranes of red blood cells in capillaries near body cells in a leg.
    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 will lead to an increase in the rate of ventilation?
    A. An increase in the partial pressure of oxygen in the blood plasma in the carotid artery in a person who is mountain climbing at high altitude.
    B. An increase in the binding of EPO (erythropoietin) to EPO Receptors located only in the plasma membranes of the diaphragm muscle.
    C. An increase in levels of hydrogen ions in interstitial spaces of the brain stem.
    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 processes in capillaries in the lung assist in the removal of carbon dioxide from the body?
    A. Formation of carbonic acid by carbonic anhydrase in red blood cells.
    B. Net flux of carbon dioxide from blood plasma into red blood cells.
    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.

34. During ventilation,
    A. acetylcholine (ACh) is released into synaptic clefts near rib cage muscles.
    B. skeletal muscles in the lung contract.
    C. inspiration occurs when the pressure in the alveoli is greater than the atmospheric pressure.
    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 cells serve as both a sensor and a controller, or contain both a sensor and a controller, for a negative feedback system?
    A. Alpha islet cells of the pancreas.
    B. Beta islet cells of the pancreas.
    C. Bone marrow cells.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

36. Healthy Person H takes a new drug named ANTICAMPCOLLDUCT that blocks the production of cyclic AMP (cAMP) in collecting duct epithelial cells in response to vasopressin binding to V2 receptors and results in a condition in which intracellular levels of cAMP in collecting duct epithelial cells are continuously very low. A single dose of the new drug creates this condition within one hour and this condition lasts for one week. Which of the following is true for Person H during the third day after taking the new drug?
    A. Water permeability of the luminal membranes of the collecting duct epithelial cells will lower than pre-drug levels.
    B. The total amount of AQP2 channels stored in intracellular vesicles will be higher than pre-drug levels.
    C. Person H will produce a greater volume of urine compared with the volume of urine produced by Person H prior to taking the drug.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

37. 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 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 higher 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 lower 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.

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 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.

39. Luminal plasma membranes of epithelial cells in which of the following regions of the nephron have high water permeability in a human with blood plasma levels of vasopressin that are high?
    A. Ascending limb of the Loop of Henle.
    B. Descending limb of the Loop of Henle.
    C. Medullary Collecting Ducts.
    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?
    A. Trypsinogen is produced in the pancreas and is converted into its active form in the small intestine by the enzyme enterokinase; the enzyme enterokinase is located in the membranes of cells in the walls of the small intestine.
    B. Pancreatic amylase is produced in the pancreas and secreted into the small intestine; in the small intestine, it breaks down long chains of carbohydrates into shorter chains of fatty acids.
    C. Pepsinogen is produced in the stomach and is converted into its active form by HCl in the lumen of the stomach.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

41. 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 intracellular spaces to interstitial spaces across the basolateral membranes of these cells in P will be greater than pre-drug levels of the net flux of water from intracellular spaces to interstitial spaces across the basolateral 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 ventricular muscle cells will be greater than pre-drug levels of 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 glycogen in P's liver cells will be greater than pre-drug levels of the amount of glycogen 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.

42. Which of the following is true?
    A. Binding of GH (Growth Hormone) to GH Receptors (Growth Hormone Receptors) located in the plasma membranes of cells in the anterior pituitary leads to the secretion of GHRH (Growth Hormone Releasing Hormone) from the anterior pituitary into the blood plasma.
    B. GHRH Receptors (Growth Hormone Releasing Hormone Receptors) are located only in the plasma membranes of axon terminals in the posterior pituitary.
    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.

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, the glucose permeability of the plasma membranes of X's skeletal muscle cells will be lower than the glucose permeability of the plasma membranes of X's skeletal muscle cells at 8 PM on April 1.
    B. At 8 PM on April 2, X's blood plasma levels of glucose will be lower than X's blood plasma levels of glucose at 8 PM on April 1.
    C. At 8 PM on April 2, X's blood plasma levels of insulin will be lower than X's blood plasma levels of insulin at 8 PM on April 1.
    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 true?
    A. Insulin binding to Insulin Receptors in the plasma membranes of liver cells leads to an increase in intracellular levels of Glucagon in the liver cells.
    B. Glycogen binding to Glycogen Receptors in the plasma membranes of liver cells leads to an increase in intracellular levels of cAMP in the liver cells.
    C. Insulin binding to Insulin Receptors in the plasma membranes of diaphragm muscle cells leads to an increase in the exocytosis of GLUT4 transporters into the plasma membranes of the diaphragm muscles.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

45. Glucagon
    A. levels in a liver cell decrease in response to an increase in cAMP levels in the cytosol of the liver cell.
    B. binding to 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.

46. A healthy young adult human female who is not pregnant receives a chemical implant that is programmed to alternate between two conditions. The first condition lasts one week; during the first condition, the implant releases no chemicals. The second condition lasts three weeks; during the second condition, the implant releases high levels of estrogen and progesterone into the blood plasma. Every 4 weeks, this female will
    A. ovulate.
    B. menstruate.
    C. have high levels of LH.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

47. 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 is pregnant.
    B. she will ovulate once a month.
    C. she will secrete high levels of FSH and LH from the corpus luteum.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

48. A human male with normal levels of LH in his blood plasma (and interstitial spaces of his testes) and with **NO** FSH in his blood plasma (and interstitial spaces of his testes) will
    A. have normal sperm production.
    B. will have normal levels of cAMP in his Sertoli cells.
    C. have normal levels of testosterone.
    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 primary motor cortex (M1) corticospinal interneuron A that produces action potentials during movements of the big toe of the left foot in right-handed Patient X who has a complete transection of the corpus callosum.
    A. In Patient X, the central sulcus of the right cerebral cortex is located in between the cell body of interneuron A and the right eye.
    B. The axon terminals of interneuron A are only 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 left foot" presented in Patient X's right visual field.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

50. A 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 excite neurons in the right half of Z's left retina.
    B. The stimulus will excite neurons in Z's right V1 (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.