There are 25 questions in this Biology 3058 exam.
All questions are "A, B, C, D, E, F, G, H" questions worth one point each.
There is a total of 25 points in this exam. Fill in your answers on the separate answer sheet.
The format for this exam is:
Fill in A if A is the only correct answer.
Fill in B if B is the only correct answer.
Fill in C if C is the only correct answer.
Fill in D if both A and B are correct (and C is NOT correct).
Fill in E if both A and C are correct (and B is NOT correct).
Fill in F if both B and C are correct (and A is NOT correct).
Fill in G if A and B and C are all correct.
Fill in H if none of the above is correct (A is NOT correct, B is NOT correct, and C is NOT correct).

ONLY MARK ONE LETTER PER QUESTION.

You may keep the question sheets.

Use a dark (black or blue) pencil or dark (black or blue) pen to fill in the answers.

DO NOT USE A RED PEN; DO NOT USE A RED PENCIL.

1. When the value of the controlled variable in a properly functioning negative feedback system is much greater than the value of the set point, then
   A. the effector will decrease the value of the controlled variable.
   B. the system is in steady state.
   C. the error signal will equal zero.
   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, or as part of an actuating signal, in a negative feedback system?
   A. Blood plasma levels of Parathyroid Hormone Receptors (PTHRs).
   B. Blood plasma levels of Oxytocin.
   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.

3. At 2:00 AM, the blood plasma levels of calcium are equal to the set point value of the blood plasma levels of calcium. At 2:05AM, there is a decrease in the blood plasma levels of calcium. This will lead to
   A. an increase in the calcium ion excretion in the urine.
   B. a decrease in the calcium ion absorption from the contents of the intestine into the blood plasma.
   C. an increase in the blood plasma levels of 1,25-dihydroxyvitamin D.
   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 substances serve as ligands that bind to G-Protein Coupled Receptors (GPCRs)?
   A. Calcium.
   B. Insulin.
   C. Oxytocin.
   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 AGON-CaSR has been developed that is an agonist at calcium-binding sites of CaSRs (Calcium-Sensing Receptors) in plasma membranes of parathyroid gland cells. Healthy Person P receives regular doses of AGON-CaSR as part of a clinical trial. When AGON-CaSR levels in the extracellular spaces surrounding parathyroid gland cells increase in Healthy Person P, this leads to
   A. an increase in the levels of calcium in the blood plasma.
   B. an increase in the levels of parathyroid hormone (PTH) in the blood plasma.
   C. an increase in the plasma levels of 1,25-dihydroxyvitamin D.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

6. In a properly functioning negative feedback system, the
   A. value of the controlled variable is near the value of the set point for a reasonable length of time when the system is in steady state.
   B. sensor measures the current value of the actuating signal.
   C. the current value of the actuating signal is always near the value of the threshold when the system is in steady state.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

7. Which of the following is true for Parathyroid Hormone Receptors (PTHRs)?
   A. Parathyroid Hormone Receptors (PTHRs) are located only in the plasma membranes in parathyroid gland cells.
   B. Parathyroid Hormone Receptors (PTHRs) serve as a sensor, or as part of a sensor, in a negative feedback system.
   C. Levels of Parathyroid Hormone Receptors (PTHRs) in the blood plasma serve as an actuating signal in a negative feedback system.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

8. Which of the following are a part of an effector in the negative feedback loop controlling plasma levels of calcium?
   A. Vitamin D Receptors (VDRs) in the plasma membranes of cells in the intestine.
   B. Parathyroid Hormone Receptors (PTHRs) in the nucleus of bone cells.
   C. Parathyroid Hormone Receptors (PTHRs) in the plasma membranes of cells in the kidney.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

9. Impermeable membrane number one separates one liter of a 2M NaCl solution in the left compartment from one liter of a 2M KCl solution in the middle compartment. Impermeable membrane number two separates the 2M KCl solution in the middle compartment from one liter of a 3M KCl solution in the right compartment. At 2 AM membrane number two becomes permeable only to potassium ions. At 4 AM membrane number one becomes permeable only to chloride ions and membrane number two maintains its permeability only to potassium ions.
   A. The amount of potassium ions in the right compartment at 5 AM is less than the amount of potassium ions in the right compartment at 3 AM.
   B. The amount of chloride ions in the middle compartment at 3 AM is greater than the amount of chloride ions in the middle compartment at 1 AM.
   C. The amount of chloride ions in the middle compartment at 5 AM is greater than the amount of chloride ions in the middle compartment at 3 AM.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

10. A normal healthy cell is bathed in a normal extracellular saline. The plasma membrane of the cell contains voltage-gated sodium channels, sodium-glucose co-transporters, and sodium-potassium ATPase pumps. Via which of these spanning proteins is the net flux of sodium ions always from a region of low concentration of sodium to a region of high concentration of sodium? The movement of sodium ions via
   A. an open voltage-gated sodium channel.
   B. the sodium-potassium ATPase primary active transport pump.
   C. the sodium-glucose secondary active cotransporter.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

11. At 1 AM, an impermeable membrane separates a 1 liter solution of 1M NaCl in the left compartment from a 1 liter solution containing both 1M NaCl and 1M KCl in the right compartment. At 2 AM, the membrane became permeable to chloride ions. At 4 AM, the membrane once again became impermeable to chloride ions. At 6 AM, the membrane became permeable to sodium ions and, in addition, maintained chloride ion impermeability. At 8 AM, the membrane once again became impermeable to sodium ions. At 10 AM the membrane once again became permeable to chloride ions and, in addition, maintained sodium ion impermeability. The membrane maintained impermeability to potassium ions during the entire period.
    A. The amount of sodium ions in the left compartment at 7 AM will be greater than the amount of sodium ions in the left compartment at 5 AM.
    B. The amount of chloride ions in the right compartment at 11 AM will be less than the amount of chloride ions in the right compartment at 9 AM.
    C. The amount of sodium ions in the left compartment at 11 AM will be equal to the amount of sodium ions in the right compartment at 11 AM.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

12. Which of the following is true for Vasopressin2 Receptors (V2Rs) in kidney collecting duct epithelial cells?
    A. When antagonists bind to V2Rs in the plasma membrane of these cells, this leads to an increase in the intracellular amount of cAMP.
    B. When agonists bind to V2Rs in the plasma membrane of these 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 these cells, this leads to an increase in the amount of GDP 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.

13. Which of the following is true for exocytosis?
    A. During exocytosis in fat cells, there is insertion of GLUT4 molecules into plasma membranes in response to binding of insulin to insulin receptors in plasma membranes.
    B. During exocytosis in toe motor neurons, there is release of ACh (acetylcholine) from axon terminals in response to a decrease in the amount of intracellular calcium in these axon terminals.
    C. During exocytosis in kidney collecting duct epithelial cells, there is insertion of AQP2 channels into luminal membranes in response to binding of cAMP to Vasopressin2 Receptors (V2Rs) 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.

14. For the bicarbonate-chloride exchanger (also called Anion Exchanger 1 or AE1),
    A. the net flux of bicarbonate across the plasma membrane is in the same direction as the net flux of chloride across the plasma membrane.
    B. ATP is directly required for the net flux of substances across the bicarbonate-chloride exchanger.
    C. the net flux of bicarbonate across the plasma membrane is from a region with a high concentration of bicarbonate to a region with a low concentration of bicarbonate.
    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 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.

16. When an agonist binds to the receptor site of a ligand-gated ion channel,
    A. it activates a tyrosine kinase.
    B. the molecular complex formed by the agonist and the channel immediately enters the cell nucleus.
    C. the ion channel opens. This leads to a net flux of ligand molecules from extracellular space into intracellular space via the open ion channel.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

17. When an agonist binds to the receptor site of the
    A. nAChR (nicotinic acetylcholine receptor), the channel associated with the nAChR opens and no ions flow across the plasma membrane via the open channel.
    B. V2R (vasopressin2 receptor), this activates an alpha subunit of a G-protein associated with the V2R.
    C. insulin receptor, there is activation of a tyrosine kinase in the extracellular portion of the insulin receptor.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

18. At 1:00AM, Neuron A is at rest with membrane potential equal to -65 millivolts; it is producing no action potentials. The threshold for an action potential in neuron A is -55 millivolts. There is a large amount of mechanically-gated channel X spanning proteins that are located in the plasma membrane of the cell body of neuron A. Channel X is the only mechanically-gated channel in neuron A. At 1:00 AM, there are no external forces on the cell body of neuron A and all the mechanically-gated channel X's channels are closed. At 1:05 AM, force is applied to the cell body of neuron A and all the mechanically-gated channel X's channels are open. If the equilibrium potential for mechanically-gated channel X is
    A. -58 millivolts, then at 1:05AM there will be an increase in membrane voltage and an action potential following the application of force to the cell body of neuron A.
    B. -70 millivolts, then at 1:05AM there will be a decrease in membrane voltage following the application of force to the cell body of neuron A.
    C. -60 millivolts, then at 1:05AM there will be an increase in membrane voltage following the application of force to the cell body 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.

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 decreased; in the 2 AM extracellular saline, the concentration of potassium ion is not changed. This will cause an increase in the Nernst equilibrium potential for potassium ion.
    B. In the 2 AM intracellular perfusion saline, the concentration of potassium ion is decreased; 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 increased; in the 2 AM intracellular perfusion saline, the concentration of potassium ion is not changed. This will cause a decrease 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. Which of the following is true for a toe motor neuron that excites a toe muscle that moves the big toe in the right foot?
    A. All of the axon terminals of the toe motor neuron are located in the right half of the spinal cord.
    B. The cell body of the toe motor neuron is located in the right half of the spinal cord.
    C. Some of the axon of the toe motor neuron is located in a peripheral nerve in the left leg.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

21. In a normal neuron at rest,
    A. the membrane conductance to potassium ions is less than the membrane conductance to sodium ions.
    B. the membrane voltage is less than the threshold value for the action potential.
    C. the membrane voltage is less than zero.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

22. At 2 AM a healthy nerve cell is resting in a bath of normal physiological saline. At 2:05 AM the cell is depolarized just over threshold so that an action potential occurs. At 3 AM the nerve cell is placed in a new saline solution that contains a sodium ion concentration that is one half the concentration of normal physiological saline. Potassium ion concentration is not changed. At 3:05 AM the cell is depolarized just over threshold so that an action potential is produced. For this question, ignore any possible effects due to the sodium-potassium pump.
    A. The voltage of the action potential peak at 3:05 AM is less than the voltage of the resting potential at 3:04 AM.
    B. The voltage of the peak of the action potential at 3:05 AM is greater than the voltage of the peak of the action potential at 2:05 AM.
    C. The voltage of the resting potential at 3:04 AM is greater than the voltage of the resting potential at 2:04 AM.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

23. Consider an axon of a neuron. At time=t_1, its voltage is at threshold for an action potential; at time=t_2, its voltage is at 0 millivolts prior to the peak of that action potential. In the time period between t_1 and t_2 of that single action potential,
    A. the amount of intracellular sodium increases.
    B. sodium conductance of the voltage-gated sodium channels increases as membrane voltage 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.

24. For the voltage-gated sodium channel in a neuron, there will be a very large net flux of sodium via the channel when
    A. TTX (tetrodotoxin) binds to the voltage-gated sodium channel.
    B. the voltage-gated sodium channel is inactivated due to the block of the intracellular entrance of the channel by the "ball-and-chain" inactivation gate.
    C. the voltage-gated sodium channel is closed.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

25. 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 sodium conductance will lead to an increase in the amount of intracellular sodium.
    C. an increase in membrane voltage will lead to an increase in sodium conductance.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.