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. In a negative feedback system with a comparator as part of the controller,
   A. when the error signal is zero, the value of the set point equals the value of the controlled variable.
   B. the system is in steady state when the value of the controlled variable is near the set point for a reasonable length of time.
   C. the sensor measures the current value of the actuating signal.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

2. A decrease in the levels of parathyroid hormone in the blood plasma will lead to an increase in the calcium ion
   A. resorption from the bones into the blood plasma.
   B. excretion in the urine.
   C. absorption from the contents of the intestine into the blood plasma.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

3. Consider a properly functioning positive feedback system whose output variable is not equal to plateau at 1:00AM. At 1:00AM,
   A. a change in the value of the actuating signal will lead to a change in the output of the effector.
   B. the sensor measures the current value of the output variable.
   C. when the value of threshold is less than the value of the output variable, then the value of the output variable will increase to the value of the plateau.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

4. A new drug named ANTAG-CaSR has been developed that is an antagonist of calcium-binding sites of CaSRs (Calcium-Sensing Receptors) in the plasma membranes of parathyroid gland cells. Healthy Person P receives regular doses of ANTAG-CaSR as part of a clinical trial. When ANTAG-CaSR levels in the extracellular spaces surrounding parathyroid gland cells increase in Healthy Person P, then there is an increase in the amount of ANTAG-CaSR bound to binding sites on CaSRs in parathyroid gland cells. This increase in the amount of ANTAG-CaSR bound to binding sites on CaSRs in the parathyroid gland leads to
    A. a decrease in the amount of Parathyroid Hormone (PTH) bound to Parathryoid Hormone Receptors (PTHRs).
    B. an increase in the levels of Parathyroid Hormone in the blood plasma.
    C. a decrease in the amount of calcium excreted in the urine.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

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

6. Which of the following serves as an actuating signal, or as part of an actuating signal, in a system with negative feedback?
    A. Blood plasma levels of PTH (Parathyroid Hormone).
    B. Blood plasma levels of oxytocin (OXT).
    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.

7. An increase in blood plasma levels of 1,25-dihydroxyvitamin D {1,25-$(OH)_2$ vitamin D} will lead to an increase in the
    A. net flux of calcium from the blood plasma into the contents of the intestine.
    B. amount of 1,25-dihydroxyvitamin D that binds to the binding sites of Vitamin D Receptors (VDRs) in the nuclei of cells in the intestine.
    C. net flux of 1,25-dihydroxyvitamin D from the blood plasma into the intracellular spaces of cells of the intestine.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

8. Which of the following is true?
   A. CaSRs (Calcium-Sensing Receptors) are GPCRs (G-Protein Coupled Receptors) that are located in the nuclei of Parathyroid Gland cells.
   B. Calcium ions are antagonists of the binding site of CaSRs.
   C. CaSRs serve as sensors in a positive feedback control system that regulates the 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.

9. At 1 AM, an impermeable membrane separates a 1 liter solution of 1M NaCl in the left compartment from a 1 liter solution containing both 1M NaCl and 1M KCl in the right compartment. At 2 AM, the membrane became permeable to chloride ions. At 4 AM, the membrane once again became impermeable to chloride ions. At 6 AM, the membrane became permeable to sodium ions and, in addition, maintained chloride ion impermeability. At 8 AM, the membrane once again became impermeable to sodium ions. At 10 AM the membrane once again became permeable to chloride ions and, in addition, maintained sodium ion impermeability. The membrane maintained impermeability to potassium ions during the entire period.
   A. The amount of chloride ions in the left compartment at 11 AM will be greater than the amount of chloride ions in the left compartment at 5 AM.
   B. The amount of sodium ions in the left compartment at 7 AM will be less than the amount of sodium ions in the left compartment at 5 AM.
   C. The amount of chloride ions in the left compartment at 11 AM will be less than the amount of chloride 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.

10. Which of the following is true?
   A. During exocytosis in a skeletal muscle cell, an increase in the binding of insulin to insulin receptors in the plasma membrane leads to an increase in the insertion of tyrosine kinase molecules into the plasma membrane.
   B. During endocytosis in a kidney medullary collecting duct epithelial cell, there is an increase in the removal of AQP2 channels from luminal plasma membranes and an increase in the placement of AQP2 channels into vesicular membranes in response to a decrease in the amount of cAMP in the intracellular spaces of the cell.
   C. During exocytosis in a toe motor neuron, an increase in the intracellular amounts of calcium in the toe motor neuron axon terminals (near toe muscles) leads to an increase in the amount of ACh (acetylcholine) that moves from vesicles in these axon terminals into extracellular space.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

11. For movement of substances across the plasma membrane via AE1 (Anion Exchanger 1),
    A. ATP is directly required for the net flux of substances across AE1.
    B. the net flux of bicarbonate across the plasma membrane is in the same direction as the net flux of chloride across the plasma membrane.
    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.

12. Which of the following is an agonist that binds to a receptor site that is part of a ligand-gated ionotropic ion channel?
    A. Erythropoietin (EPO).
    B. Acetylcholine (ACh).
    C. Insulin.
    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 Insulin Receptors in skeletal muscle cells?
    A. When there is an increase in the amount of agonists that are bound to Insulin Receptors in the plasma membrane of these cells, this leads to an increase in the amount of cAMP that is bound to alpha subunits of G-proteins associated with these Insulin Receptors.
    B. When there is an increase in the amount of agonists that are bound to Insulin Receptors in the plasma membrane of these cells, this leads to a decrease in the amount of GLUT4 that is stored in vesicular membranes in these cells.
    C. When there is an increase in the amount of agonists that are bound to Insulin Receptors in the plasma membrane of these cells, this leads to an increase in the amount of GTP that is bound to alpha subunits of G-proteins associated with these Insulin Receptors.
    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 is true for the secondary active cotransport of sodium and glucose?
    A. The spanning protein responsible for the secondary active cotransport is an ATPase, that is, it directly breaks down ATP.
    B. The net flux of sodium ions is from a region of low sodium ion concentration to a region of high sodium ion concentration.
    C. The net flux of glucose is from a region of low glucose concentration to a region of high glucose concentration.
    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 substances serve as ligands that bind to G-Protein Coupled Receptors (GPCRs)?
    A. Cyclic AMP (cAMP).
    B. 1,25-dihydroxyvitamin D {1,25-$(OH)_2$ vitamin D}.
    C. Insulin.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

16. At 1:02 AM, cell X has GLUT4 molecules included in the vesicular membranes of all its intracellular vesicles. Between 1:03 AM and 1:04 AM, there is exocytosis of all these vesicles of cell X. No endocytosis in cell X occurs between 1:00 AM and 1:06 AM.
    A. The amount of GLUT4 molecules in the plasma membrane of cell X at 1:05 AM will be greater than amount of GLUT4 molecules in the plasma membrane of cell X at 1:02 AM.
    B. The glucose permeability of the plasma membrane of cell X at 1:05 AM will be greater than the glucose permeability of the plasma membrane of cell X at 1:02 AM.
    C. The amount of plasma membrane of cell X at 1:05 AM will be less than the amount of plasma membrane of cell X at 1:02 AM.
    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) in a skeletal muscle cell, the channel associated with the nAChR opens and there is flux of monovalent cations through the open channel.
    B. V2R (vasopressin2 receptor), a tyrosine kinase located in the intracellular portion of the V2R is activated.
    C. insulin receptor, G-proteins associated with the insulin receptor are activated.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

18. Which of the following is true for a G-protein?
    A. When an agonist binds to the binding site of a G-protein coupled receptor (GPCR), this leads to GTP displacing a GDP bound to the alpha subunit of the G-protein.
    B. After the ATP-ase activity of the alpha subunit of a G-protein converts the ATP bound to the alpha subunit to ADP and inorganic phosphate (P_i), the alpha subunit of the G-protein recombines with the beta and gamma subunits of the G-protein.
    C. When GTP binds to an alpha subunit of the G-protein, this leads to the alpha subunit of the G-protein dissociating from the beta and gamma subunits of the G-protein.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

19. Consider an axon of a neuron. At time=t_1, its voltage is at threshold for an action potential; at time=t_2, its voltage is at 0 millivolts prior to the peak of that action potential. In the time period between t_1 and t_2 of that single action potential,
    A. the sodium conductance of the voltage-gated sodium channels increases as membrane voltage increases.
    B. the amount of intracellular sodium increases.
    C. the potassium conductance of the voltage-gated potassium channels changes with a faster time course than the sodium conductance of the voltage-gated sodium channels.
    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 corticospinal interneuron that excites toe motor neurons that, in turn, excite a toe muscle that moves the big toe in the right foot?
    A. All of the axon terminals of the toe corticospinal interneuron are located in the left half of the spinal cord.
    B. The cell body of the toe corticospinal interneuron is located in the right half of the spinal cord.
    C. The dendrites of the toe corticospinal interneuron are located in the left motor cortex (M1) of the left cerebral cortex.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

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

22. At 1:00AM, Neuron A is at rest with membrane potential equal to -70 millivolts; it is producing no action potentials. The threshold for an action potential in neuron A is -60 millivolts. There is a large amount of mechanically-gated ion channel X spanning proteins located in the plasma membrane of the cell body of neuron A. Channel X is the only mechanically-gated ion channel in neuron A. At 1:00 AM, there are no external forces on the cell body of neuron A and all the ion channels of mechanically-gated ion channel X are closed. At 1:05 AM, force is applied to the cell body of neuron A and all the ion channels of mechanically-gated ion channel X are open. If the equilibrium potential of open channels of mechanically-gated ion channel X is
    A. -65 millivolts, then at 1:05AM there will be a decrease in membrane voltage when force is applied to the cell body of neuron A.
    B. -70 millivolts, then at 1:05AM there will be no change in membrane voltage when force is applied to the cell body of neuron A.
    C. -75 millivolts, then at 1:05AM there will be an increase in membrane voltage when force is applied 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.

23. A complete motor neuron is removed from a frog and placed in normal physiological saline at 1:00 AM. The neuron is healthy. At 2:00 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 pump. At 2:20 AM, the resting membrane voltage of the neuron is -66 millivolts. At 2:22 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 an increase 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.

24. In a normal neuron at rest,
    A. the membrane voltage is less than the threshold value of an action potential.
    B. the membrane conductance to potassium ions is less than the membrane conductance to sodium ions.
    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.

25. The value of the Nernst equilibrium potential for sodium at 20^{o}C will be
    A. greater than zero millivolts if extracellular sodium ion concentration is less than intracellular sodium ion concentration.
    B. greater than +50 millivolts if extracellular sodium concentration is ten times that of intracellular sodium ion concentration.
    C. zero millivolts if extracellular sodium ion concentration is equal to intracellular sodium ion concentration.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.