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

2. 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. amount of 1,25-dihydroxyvitamin D that binds to the binding sites of Vitamin D Receptors (VDRs) in the nucleus of cells in the intestine.
   B. net flux of calcium from the blood plasma into the contents of the intestine.
   C. net flux of 1,25-dihydroxyvitamin D from the intracellular spaces of cells 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. Which of the following is true for Parathyroid Hormone (PTH)?
   A. Parathyroid Hormone (PTH) is a spanning protein that is only located in the plasma membranes in parathyroid gland cells.
   B. Parathyroid Hormone (PTH) serves as a sensor, or as part of a sensor, in a negative feedback system.
   C. Levels of Parathyroid Hormone (PTH) in the blood plasma serve as an actuating signal in a 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.

4. Which of the following is true?
    A. Calcium ions are agonists of the binding site of CaSRs (Calcium-Sensing Receptors).
    B. CaSRs serve as sensors in a positive feedback control system that regulates the blood plasma levels of Calcium.
    C. CaSRs are GPCRs (G-Protein Coupled Receptors) that are spanning proteins located in the plasma membranes of Parathyroid Gland cells.
    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 actuating signal, or as part of an actuating signal, in a system with feedback? (either positive feedback or negative feedback)
    A. Blood plasma levels of PTHRs (Parathryroid Hormone Receptors).
    B. Blood plasma levels of calcium.
    C. Blood plasma levels of oxytocin.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

6. An increase in the levels of parathyroid hormone in the blood plasma will lead to an increase in the calcium ion
    A. release from the bones.
    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.

7. A new drug named ANTAG-CaSR has been developed that is an antagonist at calcium-binding sites of CaSRs (Calcium-Sensing Receptors) in the plasma membranes of parathyroid gland cells. Healthy Person P receives regular doses of ANTAG-CaSR as part of a clinical trial. When ANTAG-CaSR levels in the extracellular spaces surrounding parathyroid gland cells increase in Healthy Person P, then there is an increase in the amount of ANTAG-CaSR bound to binding sites on CaSRs in parathyroid gland cells. This increase in the amount of ANTAG-CaSR bound to binding sites on CaSRs in the parathyroid gland leads to
    A. an increase in the 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. an increase 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.

8. 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 actuating signal.
   C. when the value of threshold is greater than the value of the output variable, then the value of the output variable always increases 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.

9. Diffusion of which of the following substances across the plasma membrane can occur via a spanning membrane protein channel?
   A. 1,25-dihydroxyvitamin D.
   B. Water.
   C. Calcium ions.
   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 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 an increase in the amount of GLUT4 that is stored in vesicular membranes in the 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.

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 sodium ions. At 4 AM, the membrane became permeable to chloride ions and maintained its sodium ion permeability. The membrane maintained impermeability to potassium ions during the entire period.
    A. The amount of sodium ions in the left compartment at 1 AM will be equal to the amount of sodium ions in the left compartment at 3 AM.
    B. The amount of sodium ions in the left compartment at 5 AM will be greater than the amount of sodium ions in the left compartment at 3 AM.
    C. The amount of chloride ions in the left compartment at 5 AM will be greater than the amount of chloride ions in the left 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.

12. A normal healthy cell is bathed in a normal extracellular saline. The plasma membrane of the cell contains voltage-gated sodium channels, the sodium-glucose cotransporter 2 (SGLT2), and sodium-potassium ATPase pumps. Via which of these spanning proteins is the net flux of sodium ions from a region of high concentration of sodium to a region of low concentration of sodium? The movement of sodium ions via
    A. the sodium-potassium ATPase primary active transport pump.
    B. the sodium-glucose cotransporter 2 (SGLT2).
    C. an open voltage-gated sodium channel.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

13. Which of the following is an active transport process?
    A. Net flux of glucose across the plasma membrane via GLUT4 molecules.
    B. Net flux of glucose across the plasma membrane via sodium-glucose cotransporters (SGLTs).
    C. Net flux of sodium across the plasma membrane via 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.

14. 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 extracellular spaces surrounding cells of the kidney collecting ducts will lead to high levels of exocytosis of AQP2 molecules in these cells.
    B. Drug B is an agonist of the Insulin Receptor. High levels of Drug B in the extracellular spaces surrounding fat cells will lead to high levels of exocytosis of GLUT4 molecules in these cells.
    C. Drug C is an agonist of the Insulin Receptor. High levels of Drug C in the extracellular spaces surrounding skeletal muscle cells will lead to high levels of endocytosis of GLUT4 molecules 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.

15. 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 left compartment at 9 AM will be less than the amount of chloride ions in the left compartment at 7 AM.
    B. The amount of potassium ions in the left compartment at 9 AM will be greater than the amount of potassium ions in the right compartment at 9 AM.
    C. The amount of potassium ions in the left compartment at 9 AM will be less than the amount of potassium ions in the left 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.

16. Which of the following substances serve as antagonists that bind to G-Protein Coupled Receptors (GPCRs)?
    A. PTH (Parathryroid Hormone).
    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.

17. 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 ATP displacing a ADP bound to the alpha subunit 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. After the GTP-ase of the alpha subunit of a G-protein converts the GTP bound to the alpha subunit to GDP and inorganic phosphate (P_i), the inorganic phosphate (P_i) is released from the alpha subunit. The alpha subunit of the G-protein with GDP bound to it then associates with 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.

18. 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 sodium ions and potassium ions through the open channel.
    B. PTHR (Parathyroid Hormone Receptor), the G-protein associated with the PTHR is activated.
    C. V2R (vasopressin2 receptor), a tyrosine kinase located in the intracellular portion of the V2R is activated.
    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 amount of intracellular sodium decreases.
    B. the sodium conductance of the voltage-gated sodium channels changes with a faster time course than the potassium conductance of the voltage-gated potassium channels.
    C. sodium conductance of the voltage-gated sodium channels decreases as membrane voltage increases.
    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 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 greater than +20 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.

21. 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 left half of the spinal cord.
    C. Some portions of the axon of the toe motor neuron are located in the left primary 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.

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

24. In a normal neuron at rest,
    A. the membrane voltage is always greater than the threshold value of an action potential.
    B. the membrane voltage is greater than zero.
    C. the membrane conductance to potassium ions is greater than the membrane conductance to sodium ions.
    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. zero millivolts if extracellular sodium ion concentration is equal to intracellular sodium ion concentration.
    B. -58 millivolts if extracellular sodium concentration is ten times that of intracellular sodium ion concentration.
    C. less than zero millivolts if extracellular sodium ion concentration is less than 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.