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 error signal is near zero 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. 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 plasma membranes of cells in the intestine.
   B. net flux of calcium from the contents of the intestine into the blood plasma.
   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.

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 an increase in the blood plasma levels of calcium. This will lead to
   A. a decrease in the blood plasma levels of 1,25-dihydroxyvitamin D.
   B. a decrease in the calcium ion absorption from the contents of the intestine into the blood plasma.
   C. a decrease in the calcium ion excretion 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.

4. 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 PTHRs (Parathryroid Hormone Receptors).
   B. Blood plasma levels of CaSRs (Calcium-Sensing Receptors).
   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 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) located only in the nucleus of bone cells.
   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.

6. Which of the following serves as an effector, or part of an effector, that functions in a positive feedback system?
   A. CaSRs (Calcium-Sensing Receptors) in the plasma membranes of cells in the Parathyroid Gland.
   B. Vitamin D Receptors (VDRs) located in the nucleus of cells in the intestine.
   C. Oxytocin Receptors (OXTRs) located in the plasma membranes of cells in the walls of the uterus of a pregnant female.
   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 (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.

8. Which of the following drugs taken by healthy human H will convert a closed-loop negative-feedback system in H into an open-loop system?
   A. H takes Drug A. Drug A prevents exocytosis of all vesicles containing Parathyroid Hormone (PTH).
   B. H takes Drug B. Drug B is an antagonist of the Parathyroid Hormone Receptor (PTHR) and is bound to all PTHRs in the body.
   C. H takes Drug C. Drug C is an antagonist of the Calcium-Sensing Receptor (CaSR) and is bound to all CaSRs in the body.
   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 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 greater than the amount of chloride ions in the left compartment at 7 AM.
   B. The amount of chloride ions in the left compartment at 7 AM will be greater than the amount of chloride ions in the left compartment at 5 AM.
   C. The amount of potassium ions in the left compartment at 9 AM will be greater 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.

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 GLUT4 molecules into the plasma membrane.
   B. During exocytosis in a kidney collecting duct epithelial cell, there is an increase in the removal of AQP2 channels from luminal membranes and an increase in the placement of AQP2 channels into vesicular membranes in response to an increase in the amount of cAMP in the cytosol of the cell.
   C. During exocytosis in a toe motor neuron, a decrease in the intracellular amounts of calcium in the toe motor neuron axon terminals (near toe muscles) leads to an increase in the release of ACh (acetylcholine) from 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. 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. Glucose.
    C. Water.
    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 collecting duct epithelial cells of the kidney?
    A. When agonists bind to V2Rs in the plasma membrane of these cells, this leads to an increase in the amount of GTP that is bound to alpha subunits of the G-proteins associated with these V2Rs.
    B. When antagonists bind to V2Rs in the plasma membrane of these cells, this leads to an increase in the intracellular amount of cAMP in these cells.
    C. 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 these cells.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

13. 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 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 cotransporter 2 (SGLT2).
    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 Anion Exchanger 1 (AE1),
    A. the net flux of sodium across the plasma membrane is in the same direction as the net flux of potassium across the plasma membrane.
    B. the net flux of bicarbonate across the plasma membrane is in the opposite 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.

15. Which of the following is true for the secondary active cotransport of sodium and glucose?
    A. The net flux of glucose is from a region of low glucose concentration to a region of high glucose concentration.
    B. The spanning protein responsible for the secondary active cotransport is an ATPase, that is, it directly breaks down ATP.
    C. The net flux of sodium ions is from a region of low sodium ion concentration to a region of high 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.

16. Which of the following is true for a G-protein?
    A. 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.
    B. 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 beta 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 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.

17. Which of the following serve as a ligand that binds to a binding site on the extracellular surface of a G-Protein Coupled Receptor (GPCR)?
    A. Oxytocin.
    B. Insulin.
    C. Calcium.
    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), the channel associated with the nAChR opens and 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 located only 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.

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. 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.

20. 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 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.

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 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 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 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.

22. Which of the following is true for a toe motor neuron that excites a toe muscle that moves the big toe in the left foot?
    A. All of the axon terminals of the toe motor neuron are located in the left 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 of the axon of the toe motor neuron is located in the right primary motor cortex (M1) of the right cerebral cortex.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

23. In a normal neuron at rest,
    A. the membrane voltage is less than zero.
    B. the membrane conductance to potassium ions is greater than the membrane conductance to sodium ions.
    C. the membrane voltage is less than the threshold value for 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.

24. 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 peak of the action potential at 3:05 AM is greater than the voltage of the resting potential at 3:04 AM.
    B. The voltage of the resting potential at 3:04 AM is less than the voltage of the resting potential at 2:04 AM.
    C. The voltage of the peak of the action potential at 3:05 AM is less than the voltage of the peak of the action potential at 2:05 AM.
    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 1:00 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 +20 millivolts.
    B. an increase in membrane voltage will lead to no change 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.