

STEIN IN-TERM EXAM -- BIOLOGY 3058 -- FEBRUARY 16, 2017 -- PAGE 1 of 9

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. 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 parathyroid leads to
 - A. a decrease in the levels of parathyroid hormone in the blood plasma.
 - B. a decrease in the amount of calcium excreted in the urine.
 - C. a decrease in the amount of 1,25-dihydroxyvitamin D binding to Vitamin D Receptors (VDRs) in the nucleus of cells in the intestine.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.

2. Patient X has blood plasma levels of Parathyroid Hormone (PTH) that are always very high due to a tumor consisting of Parathyroid Gland cells that continuously secrete high levels of PTH into the blood plasma. Which of the following drugs will help relieve some of the problems for Patient X?
 - A. Drug A that is an agonist of the Parathyroid Hormone Receptor (PTHr).
 - B. Drug B that is an antagonist of the calcium-binding site of the Calcium-Sensing Receptor (CaSR).
 - C. Drug C is a lipid-soluble molecule that is an agonist of the Vitamin D Receptor (VDR).
 - 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 actuating signal, or as part of an actuating signal, in a negative feedback system?
- A. Blood plasma levels of Parathyroid Hormone Receptors (PTHrRs).
 - 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.
4. Which of the following are a part of an effector in the negative feedback loop controlling plasma levels of calcium?
- A. Parathyroid Hormone Receptors (PTHrRs) in the nucleus of bone cells.
 - B. Parathyroid Hormone Receptors (PTHrRs) in the plasma membranes of cells in the kidney.
 - C. Vitamin D Receptors (VDRs) in the nucleus of cells in the intestine.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
5. 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 error signal.
 - C. the system is in steady state when the value of the error signal is near zero 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.
6. 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 contents of the intestine into the blood plasma.
 - 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.

7. Which of the following is true?
- A. CaSRs (Calcium-Sensing Receptors) are GPCRs (G-Protein Coupled Receptors) that are located in the plasma membranes of Parathyroid Gland cells.
 - B. Calcium ions are agonists 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.
8. In a properly functioning negative feedback system, the
- A. sensor measures the current value of the controlled variable.
 - B. value of the controlled variable will always be very close to the value of the error signal when the system is in steady state.
 - C. the current value of the actuating signal will always be very close to the value of the set point 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.
9. 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 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.
10. Diffusion of which of the following substances across the plasma membrane can occur via a spanning membrane protein channel?
- A. Water.
 - B. 1,25-dihydroxyvitamin D.
 - 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.

11. Which of the following is true?
- A. During endocytosis in a toe motor neuron, an increase in the amount of intracellular calcium in axon terminals of the neuron leads to an increase in the release of ACh (acetylcholine) from the axon terminals.
 - B. During endocytosis in kidney collecting duct epithelial cells, 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 fat cell, there is an increase in the insertion of GLUT4 molecules into the plasma membrane in response to an increase in the binding of insulin 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.
12. At 1 AM, an impermeable membrane separates a 1 liter solution of 1M NaCl and 1M KCl in the left compartment from a 1 liter solution containing both 1M NaCl and 2M 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 right compartment at 7 AM will be greater than the amount of sodium ions in the right 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 more than 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.
13. For AE1 (Anion Exchanger 1),
- A. the net flux of bicarbonate across the plasma membrane is in the opposite direction as the net flux of chloride across the plasma membrane.
 - B. ATP is directly required for the net flux of substances across AE1.
 - 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.

14. Which of the following is true for Vasopressin₂ Receptors (V₂Rs) in collecting duct epithelial cells of the kidney?
- A. When antagonists 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 agonists 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.
15. 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 plasma membrane of cell X at 1:05 AM will be greater than the amount of plasma membrane of cell X at 1:02 AM.
 - B. 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.
 - C. 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.
 - 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. After the GTP-ase activity 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 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.
 - C. When ATP 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.

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 serve as a ligand that binds to a binding site on the extracellular surface of a G-Protein Coupled Receptor (GPCR)?
- A. Cyclic AMP (cAMP).
 - B. 1,25 dihydroxyvitamin 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.
19. At 1:00AM, Neuron A is at rest with membrane potential equal to -80 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. -90 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. -80 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. -70 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.

20. An experimenter has removed a complete neuron from a frog and placed it in a large volume of physiological saline. The neuron is healthy. The experimenter has developed new techniques to study resting potentials in the neuron. During each experiment, the experimenter has complete control in the neuron: (1) over all Nernst equilibrium potentials; (2) over all amounts of Leak Channels in the plasma membrane; (3) over all the total conductances of each ion; and (4) over the Na-K pump. The Na-K pump is disabled for the duration each experiment. The neuron's plasma membrane includes a population of Leak-K⁺ channels and a population of Leak-Na⁺ channels. All of the Leak-Na⁺ channels are NALCN channels whose channel equilibrium potential is zero (0) mV. For this question: ignore possible contributions of calcium; ignore possible contributions of chloride; ignore possible contributions of voltage-gated channels. The neuron is at rest and is not producing action potentials. The experimenter measures the resting potential of the neuron when membrane voltage is at steady state.
- A. Consider the following during Experiment A for Neuron A. In Neuron A, the Nernst equilibrium potential for sodium equals +60 mV and the Nernst equilibrium potential for potassium equals -90 mV. Neuron A's plasma membrane conductances are set so that total potassium conductance equals total sodium conductance. Under these conditions in Experiment A, Neuron A's resting potential will be -15 mV.
 - B. Consider the following during Experiment B for Neuron B. In Neuron B, the Nernst equilibrium potential for sodium equals zero (0) mV and the Nernst equilibrium potential for potassium equals -100 mV. Neuron B's plasma membrane conductances are set so that total potassium conductance equals ten times the total sodium conductance. Under these conditions in Experiment B, Neuron B's resting potential will be -100 mV.
 - C. Consider the following during Experiment C for Neuron C. The Nernst equilibrium potential for sodium equals zero (0) mV and the Nernst equilibrium potential for potassium in Neuron C equals -100 mV. The plasma membrane conductances are set so that total potassium conductance equals four times the total sodium conductance. Under these conditions in Experiment C, Neuron C's resting potential will be -80 mV.
 - D. A and B.
 - E. A and C.
 - F. B and C.
 - G. A, B, and C.
 - H. None of the above.
21. 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. sodium conductance of the voltage-gated sodium channels increases as membrane voltage increases.
 - B. the amount of intracellular sodium increases.
 - C. the magnitude (= absolute value) of the net flux of sodium ions across the plasma membrane is greater than the magnitude (= absolute value) of the net flux of potassium ions across 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.

22. 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 decreased. At 3:00 AM, there will be an increase 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.
23. 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. The dendrites of the toe motor neuron are located in the right half of the spinal cord.
 - B. Some of the axon of the toe motor neuron is located in the left motor cortex (M1) of the left cerebral cortex.
 - C. Axon terminals of the toe motor neuron 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.

24. In a normal neuron at rest,
- A. the membrane voltage is greater than zero.
 - B. the membrane conductance to potassium ion is less than the membrane conductance to sodium ion.
 - C. the membrane voltage is greater 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.
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 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.