

STEIN IN-TERM EXAM -- BIOLOGY 3058 -- FEBRUARY 12, 2015 -- PAGE 1 of 8

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. Which of the following is true?
 - A. Calcium ions are antagonists of the binding site of CaSRs.
 - B. CaSRs serve as sensors in a positive feedback control system that regulates the blood plasma levels of Calcium.
 - C. CaSRs (Calcium-Sensing Receptors) 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.

2. 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 oxytocin.
 - B. Blood plasma levels of PTHR (Parathyroid Hormone 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.

3. Which of the following serves as an effector, or part of an effector, that functions in a negative 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.

4. In a properly functioning negative feedback system, the
- A. value of the controlled variable will always be very close to the threshold value 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 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.
5. 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 antagonist of the Parathyroid Hormone Receptor (PTHrP).
 - 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.
6. 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. when the value of the output variable is greater than the value of the threshold, then the value of the output variable increases to the value of the plateau.
 - C. the sensor measures the current value of the output variable.
 - 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. 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, this leads to
- A. an increase in the levels of calcium in the blood plasma.
 - B. an increase in the amount of calcium excreted in the urine.
 - C. an increase in the amount of 1,25-dihydroxyvitamin D binding to Vitamin D Receptors (VDRs) in the plasma membrane 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.
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 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 less 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.
10. At 1:02 AM, all the GLUT4 transporters of cell X are in the plasma membrane of cell X. Between 1:03 AM and 1:04 AM, there is endocytosis of all these GLUT4 transporters. No exocytosis of vesicles in cell X occurs between 1:00 AM and 1:06 AM.
- A. The glucose permeability of the plasma membrane of cell X at 1:05 AM will be less than the glucose permeability of the plasma membrane of cell X at 1:02 AM.
 - B. Between 1:03 AM and 1:04 AM, portions of the plasma membrane of cell X are removed.
 - C. Between 1:03 AM and 1:04 AM, GLUT4 transporters are released 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. Which of the following is an effect of the following drugs?
- A. Drug A is an antagonist 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 skeletal muscle 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 fat 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.
12. Diffusion of which of the following substances across the plasma membrane occurs via a spanning membrane protein channel?
- A. Steroid hormones.
 - 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.
13. 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 right compartment at 9 AM will be greater than the amount of chloride ions in the right compartment at 7 AM.
 - B. The amount of chloride ions in the right compartment at 7 AM will be greater than the amount of chloride ions in the right compartment at 5 AM.
 - C. The amount of potassium ions in the right compartment at 9 AM will be greater than the amount of potassium ions in the right 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.

14. For AE1 (also called Anion Exchanger 1 or the bicarbonate-chloride exchanger),
- A. ATP is directly required for the net flux of substances across the bicarbonate-chloride exchanger.
 - 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 a G-protein?
- A. After the ATP-ase 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.
 - 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 the
- A. nAChR (nicotinic acetylcholine receptor), the channel associated with the nAChR closes and ions flow across the plasma membrane via the closed channel.
 - B. V2R (vasopressin2 receptor), this activates only the beta subunits of G-proteins associated with the V2R.
 - C. insulin receptor, there is activation of a tyrosine kinase in the intracellular 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.
17. Which of the following is an antagonist that binds to the receptor site that is part of a ligand-gated ionotropic ion channel?
- A. Insulin.
 - B. Erythropoietin (EPO).
 - C. Acetylcholine (ACh).
 - 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 -60 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 force-gated ion channel X spanning proteins that are located in the plasma membrane of the cell body of neuron A. Channel X is the only force-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 force-gated ion channel X's channels are closed. At 1:05 AM, force is applied to the cell body of neuron A and all the ion channels of force-gated channel X are open. If the equilibrium potential for force-gated channel X is
- A. -58 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.
 - 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 an increase 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 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 right 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.

21. In a normal neuron at rest,
- A. the membrane voltage is greater than zero.
 - B. the membrane conductance to potassium ions is greater than the membrane conductance to sodium ions.
 - 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.
22. In the axon of a nerve cell,
- A. inactivation of the voltage-gated sodium channel occurs only when the potassium conductance of the cell is zero.
 - B. there is a net flux of potassium ions out of the cell immediately after the maximum membrane voltage of the action potential.
 - C. the potassium conductance of the voltage-gated potassium channels increases 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.
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 potassium increases.
 - B. sodium conductance of the voltage-gated sodium channels decreases 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. Which of the following is true for a primary motor cortex (M1) toe corticospinal interneuron N that produces action potentials during voluntary movements of the big toe of the right foot?
- A. A portion of the axon of interneuron N is located in a nerve in the right leg.
 - B. The axon terminals of interneuron N are located in the right half of the spinal cord.
 - C. The cell body of interneuron N is located in 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.
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 equal to 0 (zero) millivolts.
 - B. an increase in sodium conductance will lead to no change 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.