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 serves as an actuating signal, or as part of an actuating signal, in a negative feedback system?
   A. Action potentials in sympathetic neurons that release acetylcholine (ACh) near the smooth muscles that surround arterioles.
   B. Blood plasma levels of molecules that are parathryroid hormone (PTH) antagonists at binding sites on PTH Receptors.
   C. Action potentials in parasympathetic neurons that release norepinephrine (NE) near the SA node of the heart.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

2. A complete motor neuron is removed from a frog and placed in a large volume of normal physiological saline. The neuron is healthy; it has a stable resting voltage of -70 millivolts. It is not producing any action potentials; its threshold for an action potential is -50 millivolts. The neuron's plasma membrane has $GABA_A$, $GABA_B$, and glycine receptors. The equilibrium potential for chloride ions is -70 millivolts and the equilibrium potential for potassium ions is -90 millivolts.
   A. The addition of GABA to the physiological saline will lead to a decrease in the amount of intracellular chloride.
   B. The addition of glycine to the physiological saline will lead to no change in the amount of intracellular chloride.
   C. The addition of GABA to the physiological saline will lead to an increase in the amount of intracellular potassium.
   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 are true?
   A. Consider the channel associated with the $GABA_B$ receptor and the channel associated with the AMPA receptor. For both types of channel, there is a potassium conductance greater than zero when the channel is open.
   B. Consider the channel associated with the muscarinic ACh receptor and the channel associated with the nicotinic ACh receptor. For both types of channel, there is a potassium conductance greater than zero when the channel is open.
   C. ACh is an agonist both at the muscarinic ACh receptor and at the nicotinic ACh receptor.
   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 neurotransmitters?
   A. AMPA.
   B. Glycine.
   C. NMDA.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

5. Neuron A is a healthy neuron with all the usual ion channels. When at rest with a membrane voltage of R millivolts, neuron A produces no action potentials. The voltage threshold for an action potential in neuron A is T millivolts. T is greater than R; T is less than zero. In addition, neuron A's membrane includes the membrane-spanning molecule Z with an ion channel that opens when neurotransmitter Y binds to the Y receptor site on the extracellular surface of Z. The Nernst equilibrium potential for Z's ion channel is E millivolts. Neuron B synapses on neuron A; neuron B's neurotransmitter is neurotransmitter Y. Which of the following statements are true when neuron A is initially at rest and neuron B releases neurotransmitter Y?
   A. If the value of E is zero and if both sodium ions and potassium ions pass through open Z channels, then Y's binding to its receptor site on Z in neuron A produces an increase in the amount of intracellular potassium ions in neuron A.
   B. If the value of E is greater than R and if the value of E is less than T, and if chloride is the only ion that passes through open Z channels, then Y's binding to its receptor site on Z in neuron A produces a decrease in the amount of intracellular chloride ions in neuron A.
   C. If the value of E is equal to R, and if chloride is the only ion that passes through open Z channels, then Y's binding to its receptor site on Z in neuron A produces an increase in the chloride conductance of the plasma membrane 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.

6. Neuron A is a healthy neuron with all the usual ion channels. When at rest with a membrane voltage of R millivolts, neuron A produces no action potentials. The voltage threshold for an action potential in neuron A is T millivolts. T is greater than R; T is less than zero. In addition, neuron A's membrane includes the membrane-spanning molecule Z with an ion channel that opens when neurotransmitter Y binds to the Y receptor site on the extracellular surface of Z. The Nernst equilibrium potential for Z's ion channel is E millivolts. Neuron B synapses on neuron A; neuron B's neurotransmitter is neurotransmitter Y. Which of the following statements are true when neuron A is initially at rest and neuron B releases neurotransmitter Y?
   A. If the value of E is less than R and if chloride is the only ion that passes through open Z channels, then Y's binding to its receptor site on Z in neuron A produces an increase in the amount of intracellular chloride ions in neuron A.
   B. If the value of E is zero and if both sodium ions and potassium ions pass through open Z channels, then Y's binding to its receptor site on Z in neuron A produces no change in the membrane voltage of neuron A.
   C. If the value of E is less than R and if potassium is the only ion that passes through open Z channels, then Y's binding to its receptor site on Z in neuron A produces a decrease in the amount of intracellular potassium ions in neuron A.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

7. Consider four culture dishes; each dish has one healthly neuron in it. Dish W has Neuron W in it; Dish X has Neuron X in it; Dish Y has Neuron Y in it; and Dish Z has Neuron Z in it. At 1:00 AM: each neuron is bathed in normal physiological saline; all the neurons have the same properties; and each neuron is at rest with a resting potential of -70 millivolts. Each neuron has only three types of ionotropic ligand-gated receptors:

   AMPA Receptors, NMDA Receptors, and $GABA_A$ Receptors. None of the neurons have metabotropic receptors. Each neuron has a chloride equilibrium potential of -80 millivolts. At 1:55 AM, a large amount of TTX is added to the physiological saline in all four dishes. Ignore any effects due to voltage-gated calcium channels with S4 helices. At 1:58 AM, the amount of intracellular calcium in each neuron is the same as that of each other neuron.
   At 2:00 AM:
   glutamate is added to the physiological saline of Dish W;
   glutamate and APV are added to the physiological saline of Dish X;
   glutamate and CNQX are added to the physiological saline of Dish Y;
   glutamate and GABA are added to the physiological saline of Dish Z.
   For each neuron, define MAXV as the maximum voltage that is reached by that neuron during the period from 2:00 AM to 2:02 AM.
   A. At 2:01AM, the total sodium conductance in Neuron Z is less than the total sodium conductance in Neuron W.
   B. MAXV of Neuron X is less than MAXV of Neuron Y.
   C. At 2:01 AM, the amount of intracellular calcium in Neuron W will be less than the amount of intracellular calcium in Neuron Y.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

8. Consider Neuron B in the frog central nervous system whose plasma membrane has a previously unknown channel that is selectly conductive to a newly discovered trivalent anion named TVA with a valence of -3. The threshold for an action potential in Neuron B is -55 millivolts and the resting potential for Neuron B is -70 millivolts. The TVA channel in Neuron B is part of an ionotropic receptor with an extracellular binding site for the newly discovered ligand LGD. When LGD binds to its binding site, there is an increase in the TVA conductance of Neuron B. Neuron A synapses onto Neuron B. Neuron A's neurotransmitter is LGD.
    A. The extracellular concentration of TVA is 10,000 times greater than the intracellular concentration of TVA. In response to an action potential in Neuron A, there will be an increase in the membrane voltage of Neuron B.
    B. The extracellular concentration of TVA is 1,000 times greater than the intracellular concentration of TVA. In response to an action potential in Neuron A, there will be a increase in the amount of intracellular TVA in Neuron B.
    C. The extracellular concentration of TVA is 100 times greater than the intracellular concentration of TVA. In response to an action potential in Neuron A, there will be an excitatory postsynaptic potential in Neuron B.
    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 occur in response to an increase in the length of the right knee extensors in response to a quick tap applied to the right patellar tendon? An increase in the amount of
    A. potassium conductance in the membranes of the sarcoplasmic reticulum of the muscle fibers of the right knee extensor muscle.
    B. potassium conductance in the peripheral axon terminals of right knee extensor motor neurons.
    C. open force-gated channels in the central axon terminals of IA muscle-spindle stretch receptor neurons whose peripheral terminals are in the right knee extensor muscle.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

10. Consider a system that contains three neurons in a culture dish bathed in normal physiological saline. All three neurons are healthy. Neuron A synapses onto Neuron B. Neuron B synapses onto Neuron C. Neuron A has GABA in its synaptic vesicles. Neuron B has glycine in its synaptic vesicles. The only ligand-gated receptors in Neuron A are AMPA channels. The only ligand-gated receptors in the plasma membrane of Neuron B are $GABA_A$ receptors. The only ligand-gated receptors in the plasma membrane of Neuron C are glycine receptors. All 3 neurons have no other ligand-gated receptors in their plasma membranes. All 3 neurons have a sodium equilibrium potential of +60 millivolts. All 3 neurons have a potassium equilibrium potential of -86 millivolts. All 3 neurons a chloride equilibrium potential of -80 millivolts. The threshold for an action potential in all 3 neurons is -55 millivolts. At 1:55 AM, glutamate is added to the physiological saline. At 2:00 AM, the action potential firing rate of each neuron is 100 Hz. Which of the following will lead to a decrease in Neuron C's action potential firing rate?
    A. At 2:01 AM, APV is added to the bath.
    B. At 2:01 AM, CNQX is added to the bath.
    C. At 2:01 AM, strychnine is added to the bath.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

11. A healthy skeletal muscle fiber is isolated and has no external forces on it. It has normal intracellular levels of ATP and is bathed in physiological saline. Which of the following will lead to an increase in the overlap between thin and thick filaments in the muscle fiber?
    A. binding of curare to the nicotinic acetylcholine (nACh) receptor on the surface of the muscle.
    B. an increase in the pumping rate of calcium ATPase pumps in the membranes of the sarcoplasmic reticulum.
    C. an increase in the amount of calcium ions bound to tropomyosin.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

12. Healthy Person X is walking on level ground. Which of the following is true for the knee extensor muscle of X's right leg during the step cycle?
    A. The right knee extensor muscle has a lengthening contraction near the end of the right leg's swing phase just prior to start of the right leg's stance phase.
    B. Just after the right foot touches the ground at the start of stance phase, the sum of the lengths of all the overlap regions between the thick and thin filaments (= the region of the A band not in the H zone) will decrease in the right knee extensor muscle.
    C. Just after the right foot touches the ground at the start of the stance phase, the sum of the lengths of all the H zones will increase in the right knee extensor muscle.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

13. ATP is **directly** required in which of the following processes in muscle?
    A. Net flux of potassium ions from intracellular space to extracellular space.
    B. Detachment of myosin heads from their binding sites on troponin molecules.
    C. Net flux of calcium ions from the cytosol into the sarcoplasmic reticulum.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

14. When the overlap between the thin and thick filaments of a sarcomere in a skeletal muscle is decreasing, the
    A. total length of the I band minus the length of the H zone remains the same.
    B. the length of H zone is increasing in the sarcomere.
    C. the length of the A band minus the length of the H zone is increasing in the sarcomere.
    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 in a skeletal muscle?
    A. Movement of the cross-bridge occurs only when the myosin head is detached from the actin molecule.
    B. The binding of ATP to troponin causes detachment of the myosin head from the actin molecule.
    C. The head of a myosin molecule is activated (energized) during the hydrolysis of GTP (which is bound to the myosin head) to GDP and $P_i$.
    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 the following receptors in skeletal muscle?
    A. The nAChR (nicotinic Acetylcholine Receptor) is a spanning membrane protein located in the plasma membrane.
    B. The DHP (dihydropyridine) Receptor is a voltage-sensitive spanning membrane protein located in the membranes of the transverse tubules.
    C. The Ryanodine Receptor is a spanning membrane protein that is located in the membranes of the sarcoplasmic reticulum.
    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 are true for the SA node cardiac muscle cells?
    A. An increase in the binding of norepinephrine to beta-adrenergic receptors in the plasma membranes of SA node cells will lead to an increase in heart rate.
    B. An increase in the potassium conductance of potassium channels associated with nicotinic ACh receptors in the plasma membranes of SA node cells will lead to a decrease in heart rate.
    C. An increase in the binding of acetylcholine to muscarinic ACh receptors in the plasma membranes of SA node cells will lead to an increase in heart rate.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

18. Consider a system that contains a healthy SA node cell in a culture dish bathed in normal physiological saline. The SA node cell contains all of the usual molecules.

    You use a technique to measure $G_{F\text{-}channel}$ (F-channel conductance) when the membrane of the SA node cell is held at a constant voltage of -75 millivolts starting at 1:55 AM. The technique allows you to keep the SA node cell at that voltage for 10 minutes. You also have the ability to control directly the intracellular amounts of cAMP. You can also add substances to the extracellular saline bathing the SA node cell. At 2:00 AM, you measure $G_{F\text{-}channel}$.
    A. At 2:01 AM, norepinephrine is added to the physiological saline.

       This will lead to a decrease in $G_{F\text{-}channel}$ compared with its 2:00 AM value.
    B. At 2:01 AM, there is a decrease in the intracellular amount of cAMP.

       This will lead to a decrease in $G_{F\text{-}channel}$ compared with its 2:00 AM value.
    C. At 2:01 AM, ACh (acetylcholine) is added to the physiological saline.

       This will lead to a decrease in $G_{F\text{-}channel}$ compared with its 2:00 AM value.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

19. Patient A has a disease that causes continuous maximal contractions of all the smooth muscles that control the diameter of patient A's arterioles. Which of the following will help restore patient A's blood pressure toward normal levels?
    A. Lower values of activity in sympathetic neurons that synapse on SA node cells of the heart compared with pre-disease levels of activity in these sympathetic neurons.
    B. Higher values of activity in parasympathetic neurons that synapse on the smooth muscles that control the diameter of patient A's arterioles compared with pre-disease levels of activity in these parasympathetic neurons.
    C. Higher values of activity in parasympathetic neurons that synapse on SA node cells of the heart compared with pre-disease levels of activity in these parasympathetic neurons.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

20. At 1:00 AM a frog heart is removed from the body and placed in normal physiological saline. At 3:00 AM, the SA node is destroyed.
    A. The cardiac output at 4:00 AM will be lower than the cardiac output at 2:00 AM.
    B. The number of atrial contractions per minute at 4:00 AM will be lower than the number of atrial contractions per minute at 2:00 AM.
    C. The number of atrial contractions per minute at 4:00 AM will be equal to the number of ventricular contractions per minute at 4:00 AM.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

21. Starting at 1:00 AM, you record the firing frequency of the axons of carotid artery baroreceptors as well as the blood pressure in the carotid artery. At 2:00 AM, you directly apply chemical X to all the axons of the carotid artery baroreceptors at location L in a peripheral nerve at a place that is midway between the baroreceptor peripheral terminals and the baroreceptor central axonic terminals. You discover that chemical X induces a previously unknown change in the excitability of the axon with the following property: for every one action potential produced between baroreceptor peripheral terminals and location L, there are two action potentials that continue down the axon between location L and baroreceptor central axonic terminals. Thus, chemical X causes a doubling of the rate of firing in the axons of carotid baroreceptors as action potentials pass location L.
    A. At 2:10 AM, blood pressure will be lower than at 1:50 AM.
    B. At 2:10 AM, the parasympathetic output to the heart will be higher than at 1:50 AM.
    C. At 2:10 AM, arteriolar diameter will be smaller than at 1:50 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 active hyperemia, a local control mechanism within the circulatory system?
    A. There will be more blood flow into a local region in response to high rates of activity of body cells in that region.
    B. There will be a decrease in the potassium conductance of GTP-sensitive potassium channels in smooth muscle cells in response to a increase in the levels of intracellular GTP in those cells.
    C. There will be a decrease in force developed by smooth muscles surrounding arterioles that lead into a local region in which there has been high rates of activity of body cells in that region.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

23. Consider a system that contains two neurons and one cardiac SA node cell in a culture dish bathed in normal physiological saline. All three cells are healthy. Neuron A synapses onto Neuron B. Neuron B synapses onto the SA node cell. Neuron A has glycine in its synaptic vesicles. Neuron B has acetylcholine (ACh) in its synaptic vesicles. The only ligand-gated channels in the plasma membrane of Neuron A are AMPA receptors. The only ligand-gated channels in the plasma membrane of Neuron B are glycine receptors. Both neurons have no metabotropic receptors in their plasma membranes. Neuron A, Neuron B, and SA node cell each have a chloride equilibrium potential of -80 millivolts and a potassium equilibrium potential of -86 millivolts. The threshold for an action potential in all 3 cells is -55 millivolts. The SA node cell has its usual set of molecules. At 1:00 AM, Neuron A's action potential firing rate is 100 Hz, Neuron B's action potential firing rate is 100 Hz, and the SA node cell's action potential firing rate is 1.00 Hz. Which of the following will lead to a decrease in the SA node cell's action potential firing rate?
    A. At 1:01 AM, glutamate is added to the bath.
    B. At 1:01 AM, strychnine is added to the bath.
    C. At 1:01 AM, muscarine is added to the bath.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

24. At 1:00 AM, person X's blood pressure is equal to the blood pressure set point. At 1:01 AM, there is a decrease in the firing rate of carotid artery baroreceptors,
    A. this will lead to a decrease in the amount of ACh (acetylcholine) released near the SA node of the heart.
    B. this will lead to a decrease in the heart rate.
    C. this will lead to a decrease in the diameter of the arterioles.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

25. A decrease in parasympathetic discharge to the heart leads to
    A. an increase in the conductance of F-channels in SA node cells.
    B. an increase in the conductance of potassium channels associated with muscarinic ACh receptors in SA node cells.
    C. a decrease in the amount of ACh (acetylcholine) released near SA node cells of the heart.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.