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 complete motor neuron is removed from a frog and placed in a large volume of modified extracellular 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 only ligand-gated Receptors in the neuron's plasma membrane are AMPA Receptors, $GABA_B$ Receptors, and glycine Receptors. The equilibrium potential for chloride ions is -70 millivolts, the equilibrium potential for potassium ions is -70 millivolts, and the equilibrium potential for sodium ions is +60 millivolts.
   A. The addition of GABA to the physiological saline will lead to an increase in the potassium conductance of the plasma membrane of the neuron.
   B. The addition of glycine and GABA to the physiological saline will lead to a decrease in the amount of intracellular chloride and a decrease in the amount of intracellular potassium.
   C. The addition of glycine and glutamate to the physiological saline will lead to an increase in the amount of intracellular chloride, an increase in the amount of intracellular sodium, and a decrease 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.

2. Which of the following ligands bind to a binding site that is part of a ligand-gated metabotropic receptor?
   A. curare.
   B. GABA.
   C. muscarine.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

3. Consider Neuron B in the frog central nervous system whose plasma membrane has a previously unknown channel that is selectively conductive to a newly discovered tetravalent anion named TRVA with a valence of -4. The threshold for an action potential in Neuron B is -50 millivolts and the resting potential for Neuron B is -65 millivolts. The TRVA 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 TRVA conductance of Neuron B. Neuron A synapses onto Neuron B. Neuron A's neurotransmitter is LGD.
    A. Consider the situation that the extracellular concentration of TRVA is 1,000 times greater than the intracellular concentration of TRVA. For this situation, in response to an action potential in Neuron A, there will be an increase in the membrane voltage of Neuron B, an increase in the amount of intracellular TRVA in Neuron B, and an excitatory postsynaptic potential in Neuron B.
    B. Consider the situation that the extracellular concentration of TRVA is 10,000 times greater than the intracellular concentration of TRVA. For this situation, in response to an action potential in Neuron A, there will be an increase in the membrane voltage of Neuron B, a decrease in the amount of intracellular TRVA in Neuron B, and an excitatory postsynaptic potential in Neuron B.
    C. Consider the situation that the extracellular concentration of TRVA is 100,000 times greater than the intracellular concentration of TRVA. For this situation, in response to an action potential in Neuron A, there will be a decrease in the membrane voltage of Neuron B, an increase in the amount of intracellular TRVA in Neuron B, and an inhibitory 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.

4. 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 R is equal to E, 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 chloride conductance of the plasma membrane of neuron A and no change in the amount of intracellular chloride ions in neuron A.
    B. If the value of R is equal to E, 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 no change in potassium conductance of the plasma membrane of neuron A and a decrease in the amount of intracellular potassium ions in neuron A.
    C. 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 a decrease in the amount of intracellular sodium ions in neuron A and an increase 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.

5. Consider Neuron B in the frog central nervous system whose plasma membrane has a newly discovered ligand-gated ionotropic receptor, named the LGD receptor. The channel in the same molecular complex as the LGD receptor is termed the LGD receptor channel and is a monovalent cation channel that, when open, is permeable to both sodium and potassium. The Nernst equilibrium potential for sodium in Neuron B is +100 mV, and the Nernst equilibrium potential for potassium in Neuron B is -100 mV. The threshold for an action potential in Neuron B is -50 mV and the resting potential for Neuron B is -60 mV. LGD is an agonist for the ligand-gated ionotropic receptor. When LGD binds to its binding site, there is an increase in conductance of both sodium and potassium in the LGD receptor channel. Neuron A synapses onto Neuron B. Neuron A's transmitter is LGD.
   A. Consider the situation that when the LGD receptor channel is open in Neuron B, its potassium conductance equals nine times its sodium conductance. For this situation, in response to an action potential in Neuron A, then the absolute value of the change in the amount of intracellular sodium in Neuron B is less than the absolute value of the change in the amount of intracellular potassium in Neuron B.
   B. Consider the situation that when the LGD receptor channel is open in Neuron B, its potassium conductance equals four times its sodium conductance. For this situation, in response to an action potential in Neuron A, then the absolute value of the change in the amount of intracellular sodium in Neuron B is equal to the absolute value of the change in the amount of intracellular potassium in Neuron B.
   C. Consider the situation that when the LGD receptor channel is open in Neuron B, its potassium conductance equals its sodium conductance. For this situation, in response to an action potential in Neuron A, then the absolute value of the change in the amount of intracellular sodium in Neuron B is equal to the absolute value of the change in the amount of intracellular potassium 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.

6. Which of the following occur in response to an increase in the length of the right knee extensor muscle in response to a quick tap applied to the right patellar tendon?
   A. An increase in the amount of calcium conductance in the membranes of the sarcoplasmic reticulum of motor neurons whose axon terminals synapse upon muscle fibers of the right knee extensor muscle.
   B. An increase in the amount of calcium conductance in the central axon terminals of IA muscle-spindle stretch receptor neurons whose peripheral terminals are in the right knee extensor muscle.
   C. An increase in the amount of glutamate released from the axon terminals of motor neurons that synapse upon muscle fibers of 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.

7. 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 glycine in its synaptic vesicles. Neuron B has GABA in its synaptic vesicles. The only ligand-gated receptors in Neuron A are AMPA Receptors. The only ligand-gated receptors in the plasma membrane of Neuron B are Glycine Receptors. The only ligand-gated receptors in the plasma membrane of Neuron C are $GABA_A$ 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 have 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, molecules of an antagonist to the AMPA Receptor are added to the bath.
   B. At 2:01 AM, molecules of an antagonist to the Glycine Receptor are added to the bath.
   C. At 2:01 AM, molecules of an antagonist to the $GABA_A$ Receptor are 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.

8. Which of the following are true?
   A. Consider the channel associated with the nicotinic ACh Receptor and the channel associated with the AMPA Receptor. For both types of channels, there is a potassium conductance greater than zero when the channel is open.
   B. ACh is an antagonist both at the muscarinic ACh Receptor and at the nicotinic ACh Receptor.
   C. Consider the channel associated with the $GABA_B$ Receptor and the channel associated with the Glycine Receptor. For both types of channels, there is a chloride conductance greater than zero when the channel is open.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

9. Person Z swallowed a large amount of substance X and, as a result, has convulsions (abnormal violent contractions of skeletal muscles). Swallowing which of the following substances could lead to convulsions?
   A. An agonist of the glycine receptor.
   B. An antagonist of the nicotinic ACh receptor.
   C. A blocker of the 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.

10. Consider five culture dishes; each dish has one healthy neuron in it. Dish V has Neuron V 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: nAChRs (nicotinic Acetylcholine Receptors), NMDA Receptors, and Glycine Receptors. None of the neurons have metabotropic receptors. Each neuron has a chloride equilibrium potential of -70 millivolts. At 1:55 AM, a large amount of TTX is added to the physiological saline in all five 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 V;
ACh is added to the physiological saline of Dish W;
glutamate and ACh are added to the physiological saline of Dish X;
glutamate, ACh, and glycine are added to the physiological saline of Dish Y;
glutamate, ACh, glycine, and strychnine are added to the physiological saline of Dish Z.
    A. At 2:01AM, the total sodium conductance in Neuron X is more than the total sodium conductance in Neuron Y. In addition, the total sodium conductance in Neuron W is more than the total sodium conductance in Neuron V.
    B. At 2:01 AM, the total chloride conductance in Neuron Y will be less than the total chloride conductance in Neuron Z. In addition, the total calcium conductance in Neuron X will be more than the total calcium conductance in Neuron V.
    C. For each neuron, MAXV is the maximum voltage that is reached by that neuron during the period from 2:00 AM to 2:02 AM. The MAXV in Neuron W is greater than the MAXV in Neuron V. In addition, the MAXV in Neuron Z is greater than the MAXV 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.

11. During chemical excitatory synaptic transmission via an ionotropic ligand-gated channel, there is always
    A. a delay of 100 milliseconds from the action potential in the presynaptic axon terminal until the change in ionic conductance of the postsynaptic membrane.
    B. diffusion of neurotransmitter into the intracellular space of the postsynaptic neuron for all types of neurotransmitter.
    C. a fusion of synaptic vesicle membrane with the plasma membrane of the postsynaptic neuron.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

12. 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 occur in response to an action potential in the plasma membrane of the muscle fiber?
    A. An increase in the amount of Dihydropyridine (DHP) bound to DHP Receptors in the membranes of the transverse tubules.
    B. An increase in the amount of calcium ions bound to troponin.
    C. An increase in the calcium conductance of the channel associated with the Ryanodine Receptor 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.

13. Which of the following is true in a skeletal muscle?
    A. The binding of calcium to troponin causes movement of tropomyosin so that the tropomyosin no longer blocks binding sites on myosin for energized actin heads.
    B. 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.
    C. During rigor mortis, myosin heads that are already attached to actin molecules remain attached to the actin molecules due to no ATP or very low levels of ATP in the cytosol of the muscle.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

14. For a sarcomere of a skeletal muscle, define the following terms: A is the length of the A Band; H is the length of the H Zone; I is the total length of the I Bands in the sarcomere. When the length of the sarcomere decreases during a shortening of the entire muscle,
    A. The value of A remains constant.
    B. The value of A plus the value of I (= A + I) decreases.
    C. The value of A minus the value of H (= A - H) decreases.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

15. For which of the following processes is the net flux of calcium ions from a region of high concentration of calcium to a region of low concentration of calcium?
    A. The net flux of calcium ions from extracellular space to intracellular space via open voltage-gated calcium channels in a SA node cell.
    B. The net flux of calcium ions from the inside of the sarcoplasmic reticulum to the cytosol via channels associated with open Ryanodine Receptors in sarcoplasmic reticulum membranes of a skeletal muscle fiber.
    C. The net flux of calcium ions from extracellular space to intracellular space via open NMDA Receptor channels with magnesium ion block removed due to a 20 mV voltage increase following the opening of AMPA Receptor channels in the dendrites of toe motor neurons.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

16. 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. At 2:00 AM, primary active transport of calcium ions across the sarcoplasmic reticulum is blocked and it remains blocked until 2:30 AM. At 2:01 AM, the muscle fiber is stimulated to produce action potentials at high frequency for 10 minutes. At 2:11 AM, stimulation is stopped.
    A. At 2:12 AM, there will be a high net flux of calcium ions from the cytosol into the sarcoplasmic reticulum.
    B. At 2:12 AM, there will be binding of the heads of myosin molecules to receptor sites on actin molecules.
    C. The total length of the muscle fiber at 2:12 AM will be greater than the total length of the muscle fiber at 2:00AM.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

17. Consider a single cycle in a healthy heart. Define the start of the cycle as the peak of the action potential in a SA node cell, which occurs at t_1, and the end of the cycle as the peak of the following action potential in that same SA node cell, which occurs at t_2. During the interval between t_1 and t_2, there are 2 heart sounds. The first heart sound is *lub*; the second heart sound is *dub*. Which of the following is true during the time interval between the end of the *lub* sound and the beginning of the *dub* sound in that single cycle?
    A. There is a decrease in the volume of blood in the left ventricle.
    B. The value of the membrane voltage of a ventricular muscle cell is greater than the value of the voltage threshold for an action potential in that cell.
    C. The right AV valve is not open, that is, it is in the closed state.
    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 events occur at the same time, or nearly at the same time, during the cardiac cycle of a healthy person?
    A. The P wave of the EKG and decreases in membrane voltage of atrial muscle cells.
    B. The T wave of the EKG and increases in membrane voltage of ventricular muscle cells.
    C. The QRS complex of the EKG and opening of the AV valves.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

19. 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 parasympathetic neurons that release ACh (acetylcholine) near SA node cells of the heart.
    B. Action potentials in carotid artery baroreceptor neurons.
    C. Action potentials in 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.

20. Which of the following is true for SA node cells in a healthy heart?
    A. An increase in intracellular levels of cAMP in SA node cells will lead to an increase in the amount of time between two successive action potentials in SA node cells.
    B. An increase in the binding of acetylcholine to muscarinic ACh receptors in SA node cells will lead to a increase in heart rate.
    C. An increase in the binding of norepinephrine to beta-adrenergic receptors in SA node cells will lead to an increase in intracellular levels of cAMP 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.

21. The SA node of a mammalian heart is destroyed. All other parts of the heart are normal and healthy.
    A. The firing rate of the cells in the right bundle branch will be the same as the firing rate of the cells in the left bundle branch.
    B. The firing rate of AV node cells will be higher than the firing rate of cells in the Bundle of His.
    C. The rate of ventricular contractions will be equal to the rate of atrial contractions.
    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, healthy person X's blood pressure is equal to the blood pressure set point. At 1:01 AM, there is an increase 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 an increase 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.

23. 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 permanent and 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, arteriolar diameter will be smaller than at 1:50 AM.
    B. At 2:10 AM, blood pressure will be lower than at 1:50 AM.
    C. At 2:10 AM, the firing rate of sympathetic neurons that innervate the heart will be lower 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.

24. Which of the following will lead to an increase in total peripheral resistance?
    A. A decrease of firing rate in all the sympathetic neurons that innervate smooth muscles that surround arterioles.
    B. A decrease in the firing frequency of all the carotid artery baroreceptors.
    C. An increase in the diameter of every arteriole.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

25. The axons of all the baroreceptors in the body were destroyed at 2 AM. All else is normal. Which of the following statements is true for the system at 2:10 AM when compared to their values at 1:50 AM?
    A. Blood pressure will increase.
    B. Arteriolar diameter will decrease.
    C. The firing rate of parasympathetic neurons innervating the SA node of the heart will decrease.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.