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. 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 -55 mV and the resting potential for Neuron B is -80 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 its sodium conductance. For this situation, in response to an action potential in Neuron A, then there will be a voltage increase and an excitatory postsynaptic potential 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 there will be a voltage increase and an excitatory postsynaptic potential in Neuron B.
    C. 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 there will be a voltage decrease 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.

2. Which of the following is a neurotransmitter that binds to a receptor site that is part of a ligand-gated metabotropic receptor?
    A. Muscarine.
    B. GABA.
    C. ACh (acetylcholine).
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

3. 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 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 -90 millivolts, and the equilibrium potential for sodium ions is +60 millivolts.
    A. The addition of glycine and GABA to the physiological saline will lead to an increase in the amount of intracellular chloride and a decrease in the amount of intracellular potassium.
    B. The addition of glycine and glutamate to the physiological saline will lead to an increase in the amount of intracellular chloride and a decrease in the amount of intracellular sodium.
    C. The addition of glycine to the physiological saline will lead to an increase in the chloride conductance of the plasma membrane of the neuron.
    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 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. calcium conductance in the peripheral axon terminals of right knee extensor motor neurons.
    B. sodium conductance in the central axon terminals of IA muscle-spindle stretch receptor neurons whose peripheral terminals are in the right knee extensor muscle.
    C. potassium conductance in the membranes of the sarcoplasmic reticulum of the 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.

5. 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.

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 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 potassium ions in neuron A.
   B. If the value of R is less than E, 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 an increase in the amount of intracellular chloride ions in 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 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. Neuron A and Neuron B have a chloride equilibrium potential of -80 millivolts. Neuron C has a chloride equilibrium potential of -20 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 an increase in Neuron C's action potential firing rate?
   A. At 2:01 AM, glycine is added to the bath.
   B. At 2:01 AM, strychnine is added to the bath.
   C. At 2:01 AM, CNQX 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.

8. Consider five culture dishes; each dish has one healthly 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: AMPA 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;
glutamate and APV are added to the physiological saline of Dish W;
glutamate and CNQX are added to the physiological saline of Dish X;
glutamate and glycine are added to the physiological saline of Dish Y;
glutamate, glycine, and strychnine are added to the physiological saline of Dish Z.
   A. At 2:01AM, the total sodium conductance in Neuron X is less than the total sodium conductance in Neuron Y. In addition, the total sodium conductance in Neuron W is less than the total sodium conductance in Neuron V.
   B. At 2:01 AM, the total calcium conductance in Neuron Y will be less than the total calcium conductance in Neuron Z. In addition, the total calcium conductance in Neuron X will be less 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 X. 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.

9. Which of the following bind to a receptor site that is part of a ligand-gated ionotropic receptor?
   A. curare.
   B. muscarine.
   C. strychnine.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

10. 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 tetravalent anion named TRVA with a valence of -4. The threshold for an action potential in Neuron B is -65 millivolts and the resting potential for Neuron B is -80 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 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.
    B. 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 an increase in the membrane voltage of Neuron B, a decrease in the amount of intracellular TRVA in Neuron B, and an inhibitory postsynaptic potential in Neuron B.
    C. Consider the situation that the extracellular concentration of TRVA is 1,000,000 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, a decrease 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.

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 occur in response to an action potential in the plasma membrane of the muscle fiber?
    A. An increase in the amount of binding of Ryanodine to Ryanodine Receptors in the membranes of the sarcoplasmic reticulum.
    B. An increase in the amount of calcium ions bound to tropomyosin.
    C. An increase in the amount of Dihydropyridine (DHP) bound to DHP Receptors in the membranes of the transverse tubules.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

12. When the overlap between the thin and thick filaments of a sarcomere in a skeletal muscle is decreasing,
    A. the length of the A band minus the length of H zone is constant in the sarcomere.
    B. the total length of the I band plus the length of the A band minus the length of the H zone is constant in the sarcomere.
    C. the total length of the I 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.

13. Which of the following is true in a skeletal muscle?
    A. During rigor mortis, myosin heads that are already attached to actin molecules remain attached to the actin molecules due to the high levels of ATP in the cytosol of the muscle.
    B. The binding of ATP to troponin causes movement of tropomyosin so that the tropomyosin no longer blocks binding sites on actin for energized myosin heads.
    C. The head of a myosin molecule is activated (energized) during the hydrolysis of ADP (which is bound to the myosin head) to cyclic AMP 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.

14. ATP is **directly** needed in which of the following processes in muscle?
    A. net flux of potassium ions from extracellular spaces into intracellular spaces.
    B. net flux of calcium ions from the sarcoplasmic reticulum into the cytosol.
    C. movement of tropomyosin molecules to expose binding sites on actin molecules.
    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? The net flux of calcium ions
    A. from intracellular space to extracellular space via open voltage-gated calcium channels in a SA node cell.
    B. from the cytosol to the inside of the sarcoplasmic reticulum via open Ryanodine receptors in sarcoplasmic reticulum membranes of a skeletal muscle fiber.
    C. from intracellular space to extracellular 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. In the sarcomere of a skeletal muscle, there are
    A. troponin molecules in the H zone.
    B. tropomyosin molecules in the I band.
    C. both actin and myosin molecules in the region of the A band that is not in the H zone.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

17. A decrease in parasympathetic discharge to the heart leads to
    A. a decrease in the conductance of F channels associated with muscarinic ACh receptors in SA node cells.
    B. an increase in the conductance of potassium channels associated with muscarinic ACh receptors in SA node cells.
    C. an increase in the amount of cyclic AMP (cAMP) in the 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.

18. Which of the following are true for the SA node cardiac muscle cells?
    A. An increase in the binding of norepinephrine to alpha-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 muscarinic 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 nicotinic ACh receptors in the plasma membranes of SA node cells will lead to a decrease 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.

19. Which of the following events occur at the same time, or nearly at the same time, of the cardiac cycle of a healthy person?
    A. The T wave of the EKG and closing of the AV valves.
    B. The P wave of the EKG and decreases in membrane voltage of atrial muscle cells.
    C. The QRS complex of the EKG and increases in membrane voltage of Purkinje fibers.
    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 will lead to a decrease of total peripheral resistance?
    A. An increase in the diameter of every arteriole.
    B. An increase of firing rate in all the sympathetic neurons that innervate smooth muscles that surrounding arterioles.
    C. An increase in the firing frequency of all the carotid artery baroreceptors.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

21. Which of the following serves as an actuating signal, or as part of an actuating signal, that functions in a negative feedback system?
    A. Action potentials in parasympathetic neurons that release acetylcholine (ACh) from their axon terminals near the SA node cells of the heart.
    B. Action potentials in carotid artery baroreceptor neurons that release glutamate from their axon terminals in the central nervous system.
    C. Action potentials in Purkinje fibers that release norepinephrine (NE) near ventricular muscle 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.

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

23. The AV node of a mammalian heart is destroyed.
    A. The firing rate of action potentials in SA node cells will equal the firing rate of action potentials in atrial muscle cells.
    B. Each contraction of the left ventricle will occur at the same time, or nearly at the same time, as each contraction of the right ventricle.
    C. The firing rate of action potentials in Purkinje fibers will equal the firing rate of action potentials in ventricular muscle cells.
    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, 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 an increase 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 an increase 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. Which of the following is true for active hyperemia, a local control mechanism within the circulatory system?
    A. There will be an increase in force developed by smooth muscles surrounding arterioles that lead into a local region in which there has been an increase in the rates of activity of body cells in that region.
    B. There will be more blood flow into a local region in response to an increase in the rates of activity of body cells in that region.
    C. There will be an increase in the potassium conductance of ATP-sensitive potassium channels in smooth muscle cells in response to an increase in the levels of intracellular ATP in those cells.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.