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 -90 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 amount of intracellular potassium.
   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 ionotropic 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 divalent cation named DIVCAT with a valence of +2. The threshold for an action potential in Neuron B is -55 millivolts and the resting potential for Neuron B is -70 millivolts. The DIVCAT 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 DIVCAT conductance of Neuron B. Neuron A synapses onto Neuron B. Neuron A's neurotransmitter is LGD.
    A. The intracellular concentration of DIVCAT is 1000 times greater than the extracellular concentration of DIVCAT. 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 DIVCAT in Neuron B; and an inhibitory postsynaptic potential in Neuron B.
    B. The intracellular concentration of DIVCAT is 100 times greater than the extracellular concentration of DIVCAT. 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 DIVCAT in Neuron B; and an inhibitory postsynaptic potential in Neuron B.
    C. The intracellular concentration of DIVCAT is 10 times greater than the extracellular concentration of DIVCAT. 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 DIVCAT in Neuron B; and 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.

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 greater than 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 an increase in potassium conductance of the plasma membrane of neuron A and no change 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 0 (zero) mV, and the Nernst equilibrium potential for potassium in Neuron B is -100 mV. The threshold for an action potential in Neuron B is -45 mV and the resting potential for Neuron B is -50 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 sodium conductance equals nine times its potassium conductance. For this situation, in response to an action potential in Neuron A, there is an increase in the membrane voltage of Neuron B. In addition for this situation in response to an action potential in Neuron A, the absolute value of the change in the amount of intracellular sodium in Neuron B is greater 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, there is no change in the membrane voltage of Neuron B. In addition for this situation in response to an action potential in Neuron A, 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, there is an increase in the membrane voltage of Neuron B. In addition for this situation in response to an action potential in Neuron A, the absolute value of the change in the amount of intracellular sodium in Neuron B is greater than 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 glutamate released from the axon terminals of motor neurons that synapse upon muscle fibers of the right knee extensor muscle.
    B. An increase in the amount of chloride conductance in the membranes of the sarcoplasmic reticulum in the muscle fibers of the right knee extensor muscle.
    C. An increase in the amount of sodium conductance 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.

7. 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: 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 2:01 AM, the total calcium conductance in Neuron V is greater than the total calcium conductance in Neuron W. In addition, the total calcium conductance in Neuron Z is greater than the total calcium conductance in Neuron Y.
   B. At 2:01 AM, the total sodium conductance in Neuron W is greater than the total sodium conductance in Neuron X. In addition, the total sodium conductance in Neuron V is greater than the total sodium conductance in Neuron Y.
   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 Y is less than the MAXV in Neuron Z.
   D. A and B.
   E. A and C.
   F. B and C.
   G. A, B, and C.
   H. None of the above.

8. 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 channels. 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 a chloride equilibrium potential of -70 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, 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.

9. Which of the following is an antagonist 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.

10. Which of the following are neurotransmitters?
   A. AMPA.
   B. GABA.
   C. NMDA.
   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
   A. a delay of 100 milliseconds from the action potential in the presynaptic axonic 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. A conformational change in Dihydropyridine (DHP) Receptors in the membranes of the transverse tubules.
   B. An increase in the amount of calcium ions bound to tropomyosin.
   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. In the sarcomere of a skeletal muscle, there are
    A. actin molecules in the I band.
    B. both tropomyosin and myosin molecules in the region of the A band that is not in the H zone.
    C. myosin molecules 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.

14. Which of the following is true for a skeletal muscle?
    A. During a lengthening contraction, the length of the H zone will decrease.
    B. During a shortening contraction, there is a decrease in the amount of calcium ions in the sarcoplasmic reticulum.
    C. During a lengthening contraction, there is a decrease in the length of the overlap region between the thick and thin filaments (= the region of the A band 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.

15. Which of the following is true in a skeletal muscle?
    A. Binding of calcium ion to its receptor site on the actin molecule blocks the attachment of the head of the tropomyosin molecule to its binding site on the actin molecule.
    B. The binding of ATP to tropomyosin causes detachment of the tropomyosin head from the actin molecule.
    C. The head of a myosin molecule is activated (energized) during the hydrolysis of ATP (which is bound to the myosin head) to ADP 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. An increase in the calcium conductance of all sarcoplasmic reticulum membranes of a skeletal muscle with no external forces on it leads to
    A. an increase in the amount of calcium ions in the sarcoplasmic reticulum.
    B. an increase in the amount of calcium ions that are bound to troponin.
    C. a decrease in the amount of ATP molecules in the muscle.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

17. The AV 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 SA 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.

18. Which of the following will lead to an increase in total peripheral resistance?
    A. An increase of firing rate in all the sympathetic neurons that innervate smooth muscles that surround arterioles.
    B. An increase in the diameter of every arteriole.
    C. A decrease 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.

19. 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 entire time interval between the end of the *lub* sound and the beginning of the *dub* sound in that single cycle?
    A. There is an increase in the volume of blood in the left ventricle.
    B. The value of the membrane voltage of a ventricular muscle cell is less than the value of the voltage threshold for an action potential in that cell.
    C. The right AV valve is open, that is, it is not 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.

20. 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 increases in membrane voltage of atrial muscle cells.
    B. The T wave of the EKG and membrane voltage greater than zero millivolts in atrial 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.

21. 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 norepinephrine near smooth muscles that surround arterioles.
    B. Action potentials in carotid artery baroreceptor neurons.
    C. Action potentials in Bundle of His 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, norepinephrine (NE) 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. 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 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.

24. 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 -20 millivolts, a potassium equilibrium potential of -86 millivolts, and a sodium equilibrium potential of +60 millivolts. The SA node cell has a calcium equilibrium potential of +70 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 1:55AM, glutamate is added to the physiological saline. At 2:00 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 2:01 AM, CNQX is added to the physiological saline.
    B. At 2:01 AM, strychnine is added to the physiological saline.
    C. At 2:01 AM, muscarine is added to the physiological saline.
    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 serves as an effector, or as part of an effector, that functions in a negative feedback system?
    A. F-channels in the cells of the AV valves of the heart.
    B. Alpha-adrenergic Receptors in smooth muscles surrounding the arterioles.
    C. Nicotinic Acetylcholine Receptors (nAChR) 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.