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 a sensor, or as part of a sensor, that functions in a negative feedback system?
   A. CaSRs (Calcium-Sensing Receptors) located in the plasma membranes of Parathyroid Gland cells.
   B. muscarinic Acetylcholine Receptors (mAChRs) located in the plasma membranes of SA node cells.
   C. Force-gated (mechanically-gated) channels in the plasma membranes of mechanoreceptor (force-sensitive) neurons whose central terminals are located in the walls of the carotid artery.
   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 an agonist that binds to a receptor site that is part of a ligand-gated metabotropic receptor?
   A. GABA.
   B. nicotine.
   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. 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.

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 is 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 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.
    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 no change in the amount of intracellular sodium 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 previously unknown channel that is selectively 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 a decrease 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 an 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 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.

6. 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 to the physiological saline will lead to no change in the chloride conductance of the plasma membrane.
    B. The addition of glycine and GABA to the physiological saline will lead to a increase in the amount of intracellular chloride.
    C. The addition of glycine and glutamate to the physiological saline will lead to an increase in the amount of intracellular chloride.
    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 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 $GABA_B$ 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 -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, GABA is added to the bath.
    B. At 2:01 AM, CNQX is added to the bath.
    C. At 2:01 AM, glycine 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. Which of the following is an antagonist that binds to a receptor site that is part of a ligand-gated ionotropic receptor?
    A. AMPA.
    B. CNQX.
    C. NMDA.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

9. 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: nACh Receptors (nicotinic Acetylcholine Receptors), NMDA Receptors, and $GABA_A$ Receptors. None of the neurons have metabotropic receptors. Each neuron has a chloride equilibrium potential of -20 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:
ACh (acetylcholine) is added to the physiological saline of Dish W;
glutamate is added to the physiological saline of Dish X;
GABA and glutamate are added to the physiological saline of Dish Y;
ACh, 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 Y is greater than the total sodium conductance in Neuron X.
   B. At 2:01 AM, the amount of intracellular calcium in Neuron X will be less than the amount of intracellular calcium in Neuron Z.
   C. MAXV of Neuron W is less than MAXV of Neuron X.
   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 an increase in Neuron C's action potential firing rate?
   A. At 2:01 AM, GABA 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. 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. open force-gated channels in the peripheral terminals of IA muscle-spindle stretch receptor neurons whose peripheral terminals are in the right knee extensor muscle.
    B. glutamate released from the axon terminals of knee extensor motor neurons whose axon terminals are located near the right knee extensor muscle.
    C. sodium conductance in the dendrites of knee extensor motor neurons whose cell bodies are located in the left half of the spinal cord.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

12. Which of the following is true?
    A. Consider the channel associated with the nicotinic ACh receptor and the channel associated with the AMPA receptor. For both types of channel, there is a sodium conductance greater than zero when the channel is open.
    B. Consider the channel associated with the $GABA_B$ 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.

13. Which of the following is true for the following spanning membrane proteins?
    A. The mAChR (muscarinic Acetylcholine Receptor) is a spanning membrane protein located in the membranes of the sarcoplasmic reticulum.
    B. The Ryanodine Receptor is a voltage-sensitive spanning membrane protein located in the membranes of the transverse tubules.
    C. The Calcium Pump ATPase 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.

14. In the sarcomere of a skeletal muscle, there are
    A. myosin 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. both tropomyosin and troponin 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.

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 actin 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. 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 is decreasing in the sarcomere.
    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 decreasing 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.

17. An increase in the calcium conductance of all sarcoplasmic reticulum membranes of a skeletal muscle with no external forces on it leads to
    A. increased binding of calcium ions to tropomyosin.
    B. an increase in the amount of ATP molecules in the muscle.
    C. an increase in the amount of calcium ions in 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.

18. 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 NE (norepinephrine) 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.

19. 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 an increase in $G_{F\text{-}channel}$ compared with its 2:00 AM value.
B. At 2:01 AM, ACh (acetylcholine) is added to the physiological saline.
   This will lead to an increase in $G_{F\text{-}channel}$ compared with its 2:00 AM value.
C. 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.
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 active hyperemia, a local control mechanism within the circulatory system?

A. There will be a decrease 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 less 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 a 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.

21. 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 decrease.
B. Arteriole diameter will decrease.
C. Parasympathetic discharge to 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.

22. Patient A has a disease that has destroyed half of the alpha-adrenergic receptors on each of 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 cardiac output compared with pre-disease values of cardiac output.
    B. Lower 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.
    C. Higher values of activity in the parasympathetic neurons that synapse on the smooth muscles that control the diameter of patient A's arterioles compared with pre-disease values of activity in these neurons.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

23. A decrease in parasympathetic discharge to the heart leads to
    A. an increase in the conductance of F-channels in SA node cells.
    B. a decrease in the conductance of potassium channels associated with muscarinic ACh receptors in SA node cells.
    C. an increase 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.

24. Which of the following is true for the valves in a mammalian heart?
    A. The valve at the entrance to the left ventricle closes at the same time as the valve at the exit of the left ventricle closes.
    B. They control the flow of blood from the left atrium directly to the right atrium.
    C. The sounds generated by their movement can be heard by an external observer.
    D. A and B.
    E. A and C.
    F. B and C.
    G. A, B, and C.
    H. None of the above.

25. The AV node of a mammalian heart is destroyed.
    A. A depolarization in a cell in the left atrium will cause a depolarization of a cell in the left ventricle.
    B. The contraction of the left ventricle will occur at a different time than the contraction of the right ventricle.
    C. The rate of ventricular contractions will be higher than 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.