Midterm 1

Provide a concise answer to each of the following questions. Your answers should fit in the spaces provided. Diagrams are welcome but must be accompanied by written explanations.

1. Claude Bernard developed the important physiological concept of the “internal environment.” What exactly is the internal environment? (4 points)

2. Imagine that a physiological variable, blood [Na⁺] for example, is being actively regulated by an animal. If [Na⁺] starts to drop, how might the animal try to change Na⁺ influx in response? How about efflux? (4 points)

3. Your blood pressure (BP) tends to stay relatively constant despite changes in blood flow to different tissues as their oxygen demands change. One mechanism to help maintain BP involves vasoconstriction and vasodilation of blood vessels (which influences BP by changing the resistance to flow in your circulatory system). The medulla oblongata controls the diameter of vessels through sympathetic neurons, and receives information on current BP from baroreceptors (located in a number of arteries) via afferent neurons.

Based on this information, what role does each of the following play in the negative feedback loop helping to control BP? (Some components may have more than one possible answer.) (5 points)

Blood vessels:

Medulla:

Baroreceptors:

Sympathetic neurons:

Afferent neurons:
4. Briefly describe three ways in which humans can respond to a drop in body temperature below their current setpoint. (6 points)

5. Consider the following scenario. Region $A$ contains one liter of a 1.0M solution of a non-ionic solute $X$, while $B$ contains one liter of a 2.0M solution of a non-ionic solute $Y$. If a membrane permeable to $X$ but not to $Y$ or water separates the two, what should the equilibrium state be?

How would the initial rate of diffusion have changed if the initial concentration of $X$ had been 2.0M?

Consider a different scenario. Region $A$ contains a 1.0M solution of a non-ionic solute $X$, while $B$ contains a 1.0M solution of a non-ionic solute $Y$. The membrane is permeable to $X$ and water but not to $Y$. What is the expected pattern of movement of solutes and water? (You do not need to describe the equilibrium state.) (6 points total for these questions)
6. For each of the following mechanisms that move substances across a cell membrane, provide a brief definition and an example. (6 points)

Facilitated diffusion:

Permeation:

Secondary active transport:

7. List and briefly describe the effects of the different components of the efferent division of the peripheral nervous system. (5 points)

8. Match each glial cell type to its function: (4 points)

<table>
<thead>
<tr>
<th>Type</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microglia</td>
<td>Support neurons and help control neurotransmitter levels</td>
</tr>
<tr>
<td>Schwann cell</td>
<td>Create myelinated regions on axons</td>
</tr>
<tr>
<td>Astrocyte</td>
<td>Provide a barrier layer between CNS and other regions</td>
</tr>
<tr>
<td>Ependymal cell</td>
<td>Scavenge debris and attack pathogens</td>
</tr>
</tbody>
</table>
9. Explain why resting cell membranes normally show a negative potential, rather than a zero or positive value. (4 points)

10. On the graph below, draw the pattern of voltage change seen during a typical action potential. Then, either on the graph or in writing, indicate when voltage-gated Na$^+$ channels and VG K$^+$ channels are open and when they are closed. (6 points)
11. Describe the process of action potential propagation in a myelinated axon. (6 points)

12. Describe the general process by which neurotransmitter is released from an axon terminal, starting with the arrival of an action potential at the terminal. End your description with the arrival of the neurotransmitter at the receptors. You do not need to describe what happens to the receptors or neurotransmitter beyond this point. (6 points)
13. What is the difference between ionotropic and metabotropic receptors in terms of the timecourse and potential magnitude of effects on the postsynaptic membrane potential? (4 points)

14. Consider a postsynaptic neuron, Z, with two associated presynaptic neurons, A and B. If A releases a neurotransmitter than depolarizes Z, then an action potential arriving at A’s axon terminal will cause a(n) ____________________________ in the postsynaptic membrane. If action potentials arrive at A’s terminal in rapid succession, we may see ________________ summation in Z.

If action potentials arrive at the terminals of A and B at about the same time, we may see ________________ summation. If this summation results in a smaller depolarization of Z than we saw when A acted alone, we can guess that the effect of B on the postsynaptic membrane is to _____________________ membrane potential. (4 points)

15. Match each sensory receptor type to the correct description: (4 points)

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Photoreceptors</td>
<td>Associated with gustation</td>
</tr>
<tr>
<td>Mechanoreceptors</td>
<td>Detect tissue damage</td>
</tr>
<tr>
<td>Chemoreceptors</td>
<td>Synapse with bipolar cells</td>
</tr>
<tr>
<td>Nociceptors</td>
<td>Associated with audition</td>
</tr>
</tbody>
</table>
16. Briefly explain the difference between a phasic receptor and a tonic receptor. (4 points)

17. What is the purpose of lateral inhibition in sensory systems? (You do not need to describe how it works, just what it’s good for.) (4 points)

18. Describe how the otolith organs (or maculae) allow us to detect changes in acceleration. Include in your description a brief explanation of how hair cells work. (6 points)
19. How do human ears detect differences in the volume (amplitude) and pitch (frequency) of sounds? You do not need to provide a complete explanation of how the cochlea works, just how these components of sound are detected. (6 points)

20. Explain how rod photoreceptors transduce light into a change in membrane potential. (6 points)