

**HUMAN PHYSIOLOGY**  
**BIPN 100**  
**Winter 2024**  
**Midterm Exam #1**  
**Exam Version 1A**

**Honor Pledge:** *On my honor, I have neither received nor given any unauthorized assistance on this examination including- receiving unauthorized assistance, copying answers from others, looking at notes, or any conduct that constitutes cheating on an examination.*

Name (Print) \_\_\_\_\_

Sign here to make the honor pledge \_\_\_\_\_

<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"><b>Name</b></div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"><b>ID</b></div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"><b>Section</b></div> <div style="border: 1px solid black; padding: 5px;"><b>Date</b></div>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"><b>Version</b>   A   B   C   D   E</div> <div style="border: 1px solid black; padding: 5px; margin-bottom: 5px;"><b>Other</b></div> <div style="border: 1px solid black; padding: 5px;"><b>Marking Instructions</b> <small>Be sure to completely fill in the appropriate bubble.</small> <div style="display: flex; align-items: center; margin-top: 5px;"><div style="margin-right: 10px;"><b>Example</b></div><div style="display: flex; gap: 5px;"><div><input checked="" type="radio"/></div><div>B</div><div>C</div><div>D</div><div>E</div></div></div></div>
--	---

**Instructions:**

1. Write your name and SIS ID on your bubble sheet
2. Bubble in the exam version. This is exam version A
3. **Multiple Choice Questions:** choose the *best answer* to the questions, based on information we have covered in class to date. Mark your answer on the bubble sheet. 1 point each.
4. **Short Answer Questions: (SAQ)** write a concise answer based on the information we have covered in class to date. You may use bullet points and lists. You do not need to write in full sentences. Write directly on the exam.
5. Write your name on all **pages 1-4-** all those with short answer questions.

Name: \_\_\_\_\_ SIS #: \_\_\_\_\_

Consider a normal neuron with ion channels for the following ions (and only the following ions) listed below.

Ion	Equilibrium Potential	Ion Concentration
$\text{Na}^+$	$E_{\text{Na}^+} = +60 \text{ mV}$	Higher in ECF
$\text{K}^+$	$E_{\text{K}^+} = -90 \text{ mV}$	Higher in ICF
$\text{Ca}^{2+}$	$E_{\text{Ca}^{2+}} = +120 \text{ mV}$	Higher in ECF

**SAQ #1:** (1 point) The membrane potential for this neuron at rest is -70 mV. To which ion is the cell most permeable at rest?

*K+*

**SAQ #2:** (2 points) What equation should you use to predict membrane potential in this system? Explain why the parameters of the equation can predict membrane potential in this neuron.

*RMP should be predicted using GHK.*

*Must say that the membrane is permeable to multiple solutes*

**SAQ #3:** (2 points) Assuming some calcium permeability, describe  $I_{\text{Ca}^{2+}}$  (calcium current) when  $V_m = +30 \text{ mV}$  [circle one]

*Inward*

Outward

No net current

Unknown

Explain your answer to the question above. Mention both chemical and electrical forces.

*Calcium current is inward, because inward chemical forces > outward electrical forces at +30 mV*

**SAQ #4:** (2 points) Assuming some calcium permeability, describe  $I_{\text{Ca}^{2+}}$  when  $V_m = +120 \text{ mV}$  [circle one]

Inward

Outward

*No net current*

Unknown

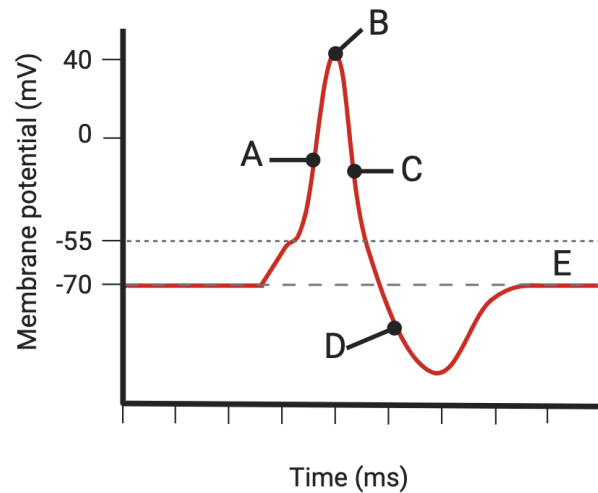
Explain your answer to the question above. Mention both chemical and electrical forces.

*Calcium current is 0, because chemical forces = electrical forces at  $E_{\text{Ca}^{2+}}$*

**You inject a stimulating current into the neuron, and record the following voltage-time**

**Name:** \_\_\_\_\_ **SIS #:** \_\_\_\_\_

**graph.**



**SAQ #5:** (7 points total)

**5.1** Describe voltage-gated Na<sup>+</sup> channels at Point A. Mention all relevant gates.

*Activation gate is open*                  or        *Activated*  
*Inactivation gate is open*                  *Not inactivated*

**5.2 Describe voltage-gated K<sup>+</sup> channels at Point C. Mention all relevant gates.**

*Activation gate is open*                      *or*                      *Activated*

**5.3** Describe voltage-gated Na<sup>+</sup> channels at Point C. Mention all relevant gates.

*Activation gate is open*                      or                      *Activated*  
*Inactivation gate is closed*                      *Inactivated*

**5.4** Describe the direction of K<sup>+</sup> flow at Point D. Mention all relevant ion channels.

*K<sup>+</sup> efflux via VG K<sup>+</sup> channels*  
*K<sup>+</sup> efflux via leak K<sup>+</sup> channels*

**SAQ #6:** (3 points) You apply a drug that completely prevents voltage-gated K<sup>+</sup> channels from opening. Then, you inject a -55 mV stimulus depolarization. **Draw a second line on the graph above**, depicting a hypothesized voltage-time graph.

(1) Higher peak (2) Lower slope of repolarization (3) No hyperpolarization. Can have steeper depolarization]

**SAQ #7:** (1 point) You repeatedly and continuously inject 10 depolarizing stimuli that each raise

the membrane potential to -55 mV. You record 5 rapid action potentials, and then the neuron stops firing. Characterize the way the neuron responds to enduring stimuli.

*Phasic or fast-adapting*

**SAQ #8:** (2 points) List two different ways that the nervous system codes high intensity stimuli, relative to low intensity stimuli.

*Higher amplitude graded potential or receptor potential or PSP*

*Frequency coding: More frequent action potentials*

*Higher quantal release*

*Population coding: More & higher-threshold neurons recruited*

- 
1. Clearance is defined as the
    - A. Volume of load in the body
    - B. Rate of metabolic production
    - C. Speed of an action potential moving down the axon
    - D. **Rate at which substance is removed from the blood**
  2. What is current?
    - A. **Ion movement**
    - B. Difference in electrical charge across a membrane
    - C. Membrane permeability
    - D. Attraction between receptor and ligand
  3. Compared to axons with smaller diameter, giant squid axons have:
    - A. **Lower internal resistance**
    - B. Slower speed of conduction
    - C. Higher membrane resistance
    - D. A and B
  4. Which of the following increases as a result of ion channels closing?
    - A. Current flow
    - B. Membrane conductance
    - C. **Membrane resistance**
    - D. A and B
  5. Which of the following describes a graded potential, but NOT an action potential?
    - A. Produced by ion movement across the membrane
    - B. **Amplitude is proportional to the size of a stimulus**
    - C. Triggered by a stimulus
    - D. Does not diminish in amplitude
  6. Threshold potential is the membrane potential:
    - A. in a neuron at rest
    - B. **required to open voltage-gated ion channels**
    - C. required to trigger exocytosis
    - D. required for a graded potential
  7. Which of the following describes a mechanism with positive feedback?

- A. Voltage-gated K<sup>+</sup> channels repolarize the membrane
  - B. Autocrine signals suppress release of more neurotransmitter
  - C. An action potential triggers another action potential in adjacent axon segments
  - D. A and B
8. The brain accounts for 20% of the body's energy consumption, despite making up just 2% of its weight. Which of the following processes use cellular energy?
- A. Exocytosis
  - B. Maintenance of the resting membrane potential
  - C. Diffusion across leak channels
  - D. A and B
9. Dendritic spikes increase surface area, most likely providing more space for:
- A. Exocytosis
  - B. Ligand-gated ion channels
  - C. Voltage-gated ion channels
  - D. Nuclei
10. Which of the following describes the falling phase of the action potential.
- A. Depolarization
  - B. Hyperpolarization
  - C. Repolarization
  - D. Unpolarization
11. Which of the following describes the membrane in a typical neuron at rest?
- A. More K<sup>+</sup> leak channels
  - B. More Na<sup>+</sup> leak channels
  - C. More voltage-gated K<sup>+</sup> ions open
  - D. More voltage-gated Na<sup>+</sup> channels open
12. Which of the following is the function of the relative refractory period?
- A. Prevents action potentials from overlapping
  - B. Prevents action potentials from traveling toward the soma
  - C. Limits frequency of action potentials
  - D. A and B
13. Action potential never occurs during \_\_\_\_\_ refractory period, because \_\_\_\_\_ are closed.
- A. absolute; voltage-gated Na<sup>+</sup> channel inactivation gates
  - B. absolute; voltage-gated Na<sup>+</sup> channel activation gates
  - C. relative; voltage-gated Na<sup>+</sup> channel inactivation gates
  - D. relative; voltage-gated K<sup>+</sup> channel activation gates
14. Which of the following effects does the myelin sheath have on myelinated axons?
- A. Decrease internal resistance
  - B. Increase conductance across the membrane
  - C. Increase membrane resistance
  - D. Increase speed of continuous conduction
15. Which of the following is the most direct result of increased intracellular calcium levels?
- A. Action potential in the synaptic terminal
  - B. Vesicles fuse with the plasma membrane
  - C. Synaptic vesicles travel across the synaptic cleft
  - D. Neurotransmitters are packaged into vesicles

16. The drug Naloxone has a higher binding affinity than heroin at opioid receptors. Which of the following accurately describes the binding of Naloxone and heroin, if at equal concentrations in the synapse?
- A. [Heroin-Receptor complex] > [Naloxone-Receptor complex]
  - B. [Unbound Naloxone] > [Unbound Heroin]
  - C. [Unbound heroin] > [Unbound Naloxone]
  - D. A and B
17. Dopamine reuptake inhibitors act by blocking reuptake of dopamine, therefore directly:
- A. Reducing dopamine in the synapse
  - B. Slowing termination of dopamine
  - C. Reducing release of dopamine into the synapse
  - D. Reducing dopamine diffusion into the postsynaptic cell
18. Which of the following describes inhibitory postsynaptic potentials (IPSPs)?
- A. Can be caused by K<sup>+</sup> efflux
  - B. Depolarization
  - C. Increase the likelihood of an action potential
  - D. Can be caused by Na<sup>+</sup> influx
19. After neurotransmitter release, vesicles can be returned the intracellular fluid via:
- A. Exocytosis
  - B. Endocytosis
  - C. Diffusion
  - D. Reuptake
20. Action potentials travel down unmyelinated axons via:
- A. Fast axon transport
  - B. Saltatory conduction
  - C. Slow axon transport
  - D. Continuous conduction
21. Which of the following describes fast exocytosis, but NOT the kiss-and-run pathway?
- A. Results in neurotransmitter release
  - B. Vesicles fully fuse with the plasma membrane
  - C. Triggered by increases in intracellular [Ca<sup>2+</sup>]
  - D. Involves the expansion of a fusion pore
22. Which of the following describes BOTH small molecule neurotransmitters and large polypeptide neurotransmitters?
- A. Stored in synaptic vesicles
  - B. Active neurotransmitter is synthesized in the axon terminal
  - C. Neurotransmitter precursors are transported from the soma in vesicles
  - D. A and B
23. Neurotransmitters binding at which of the following triggers rapid ion flow?
- A. Ionotropic receptors
  - B. Metabotropic receptors
  - C. Voltage-gated ion channels
  - D. G-protein coupled receptors

24. You are studying a circuit of three neurons: Neuron A, Neuron B, and Neuron C. Which of the following describes divergence?
- A. Neuron A and Neuron B synapse on Neuron C
  - B. Neuron A synapses on both Neuron B and Neuron C**
  - C. Neuron A synapses on Neuron B. Neuron B synapses on Neuron C.
  - D. A and B
25. Complete the following sentence describing a structure-function relationship. The Nodes of Ranvier are axonal regions with high concentrations of \_\_\_\_\_, which allows them to \_\_\_\_\_.
- A. voltage-gated Na<sup>+</sup> channels ; regenerate action potentials**
  - B. synaptic vesicles ; release neurotransmitters
  - C. myelin ; conduct an action potential
  - D. ligand-gated ion channels ; respond to chemical messengers
26. A GABAergic (GABA-releasing) presynaptic neuron fires frequent action potentials, and triggers rapid postsynaptic responses. Which of the following is most likely occurring in the postsynaptic neuron?
- A. Spatial summation of excitatory postsynaptic potentials
  - B. Spatial summation of inhibitory postsynaptic potentials
  - C. Temporal summation of excitatory postsynaptic potentials
  - D. Temporal summation of inhibitory postsynaptic potentials**
27. Which of the following does NOT function to protect the brain?
- A. Meninges
  - B. Vertebral column**
  - C. Skull
  - D. Blood brain barrier
28. Which of the following functions to direct sensory information to the cerebral cortex?
- A. Hippocampus
  - B. Hypothalamus
  - C. Amygdala
  - D. Thalamus**
29. Damage to the cerebellum will most likely result in:
- A. Impaired long-term memory formation
  - B. Reduced fear
  - C. Difficulty producing coordinated movement**
  - D. Suppressed spinal reflexes
30. Which of the following describes the spinal cord, but NOT the brain?
- A. Outer layers are composed of gray matter
  - B. Outer layers are made up of myelinated axons**
  - C. Part of the central nervous system
  - D. Has hollow chambers called ventricles
31. Which of the following is true about nervous system nuclei AND ganglia?
- A. Bundles of cell bodies**
  - B. Found in the central nervous system
  - C. Bundles of axons
  - D. Found in the peripheral nervous system

32. Which of the following most accurately sequences the flow of information from a sensory receptor to the brain? [*> represents an arrow, where Step 1 > Step 2 > etc*]
- A. Afferent neuron > Dorsal root > Ascending tracts
  - B. Afferent neuron > Ventral root > Ascending tracts
  - C. Efferent neuron > Dorsal root > Ascending tracts
  - D. Efferent neuron > Ventral root > Descending tracts
33. Guillain-Barre Syndrome is a demyelinating disease that affects the peripheral nervous system. Which of the following regions are most likely to be directly impaired?
- A. Ventral horn of the spinal cord
  - B. Cerebral cortex
  - C. Ascending tracts of the spinal cord
  - D. Spinal cord nerves
34. Tight junctions \_\_\_\_\_ between adjacent cells.
- A. allow ions to flow
  - B. prevent solutes from diffusing
  - C. are gaps
  - D. speed conduction
35. Sensory transduction converts \_\_\_\_\_ to \_\_\_\_\_.
- A. stimulus energy ; change in membrane potential
  - B. sensation ; perception
  - C. stimulus energy ; perception
  - D. sensory receptors ; interneurons
36. Which of the following best describes an event in sweet-sensitive taste receptor cells when exposed to sugar?
- A. Phospholipids are converted into Phospholipase C
  - B. DAG binds to G-protein coupled receptors
  - C. Gustducin activates Phospholipase C
  - D. Protein Kinase C opens K<sup>+</sup> channels
37. Which of the following is the most immediate effect of IP<sub>3</sub> in sweet-sensitive taste receptor cells?
- A. Neurotransmitter exocytosis
  - B. Calcium release from the endoplasmic reticulum
  - C. Conformational change of the G-protein coupled receptor
  - D. Activation of Protein Kinase C
38. Which of the following describes BOTH complex and simple sensory receptors?
- A. Afferent neurons
  - B. Have free nerve endings
  - C. Nerve endings are covered in connective tissue
  - D. Nonneural receptors
39. Researchers studying a signal transduction pathway in olfactory receptors created a modified sensory neuron that does not express G-proteins. Which of the following is a direct consequence that researchers will most likely observe?
- A. No olfactory stimuli
  - B. No conformational change at G-protein coupled receptors (GPCRs)
  - C. Increased receptor potentials
  - D. No second messenger activation



Name: \_\_\_\_\_ SIS #: \_\_\_\_\_

40. Which of the following provides information about stimulus modality?
- A. Receptive field
  - B. Action potential amplitude
  - C. Labeled-line coding
  - D. Duration of action potential spiking
41. The tongue can discriminate between two points 1.2 mm apart on the tongue, but not on the shoulder. Which of the following explains difference in two-point discrimination?
- A. The tongue has more primary receptive fields
  - B. The tongue has less convergence of sensory neurons
  - C. The tongue is represented by fewer neurons in the cerebral cortex
  - D. A and B
42. Which of the following does NOT generate a receptor potential?
- A. Na<sup>+</sup> diffusing into salt taste receptor cells
  - B. Glutamate binding at an interneuron
  - C. Opening of TRP channels in thermoreceptors
  - D. Light activating G-proteins in the eye
- 

**Prof M falls down the stairs in MOS 114 and bumps her head. Match Prof M's symptoms with possible sites of damage:**

- |                                      |                   |
|--------------------------------------|-------------------|
| 43. Motor deficits                   | A. Frontal lobe   |
| 44. Blindness/Loss of vision         | B. Occipital lobe |
| 45. Numbness/loss of somatosensation | C. Temporal lobe  |
| 46. Deafness                         | D. Parietal lobe  |
- 

**Match the components of the taste circuitry pathway with the type of neuron. Answers may be used more than once, or not at all.**

- |                           |                    |
|---------------------------|--------------------|
| 47. Taste receptor cell   | A. Interneuron     |
| 48. Gustatory neuron      | B. Nonneural cell  |
| 49. Gustatory cortex cell | C. Afferent neuron |
|                           | D. Efferent neuron |
- 

50. Is your name and SIS # written on pages 1, 2, 3, and 4?
- A. Yes
  - B. Yes
  - C. Yes
  - D. No... ok yes now it is