

A. Conceptual Questions

1. Explain how the nervous system acts as the body's electrical communication network.

The nervous system receives information from inside and outside the body, processes it in the brain and spinal cord, and sends electrical signals to muscles and glands. It functions like a central computer: **sensory neurons bring signals in**, the CNS interprets them, and **motor neurons send responses out** to create an action.

2. What is the functional difference between the CNS and the ANS?

- **CNS (Central Nervous System):** Includes the *brain and spinal cord*; responsible for processing information and making decisions.
- **ANS (Autonomic Nervous System):** Controls *involuntary* internal organs such as the heart, intestines, and glands. It regulates automatic functions like heart rate and digestion.

3. Describe the structure of a neuron and explain how its parts contribute to electrical signal transmission.

A neuron consists of:

- **Cell body** – receives information from other neurons.
- **Dendrites** – specialized branches that receive incoming signals.
- **Axon** – a long fiber that carries the electrical signal outward to muscles, glands, or other neurons. Each part helps transmit messages efficiently across the nervous system.

4. What is meant by the term polarization of a neuron?

Polarization refers to the electrical difference across the membrane of a resting neuron: the **inside is more negative than the outside** (typically -60 to -90 mV).

5. Why is the inside of a resting neuron more negative compared to the outside?

Because more negative ions are present inside the cell membrane than outside, creating an electrical potential difference across the membrane.

6. Define resting potential and action potential in your own words.

- **Resting potential:** The stable negative voltage across a neuron when it is not sending a signal.
- **Action potential:** A large, brief change in voltage that occurs when the neuron is stimulated; this is the electrical signal that travels along the axon.

7. Explain why neurons are described as being electrically excitable cells.

Neurons can rapidly change their membrane potential in response to stimulation. This ability to generate action potentials allows them to transmit electrical signals.

8. How does an axon differ from dendrites in both structure and function?

- **Dendrites:** Short, branching structures that *receive* incoming signals.
- **Axon:** A long fiber (sometimes up to 1 meter) that *sends* electrical signals away from the cell body.

9. Why is the myelin sheath essential for rapid nerve conduction?

Myelin acts as an electrical insulator, reducing membrane capacitance and preventing loss of signal. This allows the action potential to “jump” between nodes of Ranvier, greatly increasing conduction speed.

10. Describe how an action potential travels along an unmyelinated axon.

In an unmyelinated axon, the signal moves **continuously** along every point on the membrane. Each part of the membrane must depolarize in sequence, which makes conduction slower.

B. Application & Reasoning Questions

11. If resting potential becomes less negative (from -70 mV to -50 mV), what does this imply?

The neuron is **more excitable**. It is closer to the threshold needed to trigger an action potential and will fire more easily.

12. What would happen if the sodium-potassium pump stopped functioning?

Ion gradients would disappear.

- Resting potential would be lost.
- The neuron would no longer be able to generate action potentials.
- Signal transmission would eventually stop.

13. Explain how saltatory conduction allows faster transmission than continuous conduction.

In myelinated fibers, depolarization occurs only at nodes of Ranvier. The action potential “jumps” from node to node, skipping insulated segments. This dramatically increases speed because less membrane must depolarize.

14. Why does the action potential jump from node to node in a myelinated neuron?

Myelin prevents ion movement across the membrane, so only the exposed nodes can generate action potentials. The reduced capacitance in myelinated sections allows the signal to travel quickly to the next node.

15. Biological advantage of myelinated neurons conducting at 100 m/s vs. 1 m/s unmyelinated.

Faster conduction allows:

- Rapid reflexes
- Efficient coordination of muscle activity
- Faster sensory processing
- Improved survival (quick response to danger)

Organisms with myelinated nerves can move and react much faster.

16. If axon diameter increases, what happens to internal resistance and conduction speed? Why?

- **Internal resistance decreases** (a wider axon allows ions to flow more easily).
- **Conduction speed increases** because electrical current moves more efficiently along the axon.

17. How does membrane capacitance influence speed of signal propagation?

Higher capacitance means more charge must be stored before depolarization occurs, slowing signal propagation.

Lower capacitance (as in myelinated fibers) allows faster depolarization and quicker conduction.

18. Why can an action potential travel only away from the cell body and not backward?

After an action potential passes, the previous section of membrane enters a **refractory period**, during which it cannot fire again. This ensures one-way movement of the signal.

19. Explain how synapses ensure one-way transmission of impulses between neurons.

The synapse releases neurotransmitters only from the *presynaptic* terminal, and receptors exist only on the *postsynaptic* membrane. Because of this structure, the signal cannot reverse direction.

20. A disease damages myelin (e.g., multiple sclerosis). What happens to nerve transmission?

- Conduction becomes **slower** or **blocked**.
- Action potentials may fail to reach the next node.
- Motor coordination, sensation, and reflexes become impaired.
Loss of myelin increases capacitance and causes signal leakage, preventing proper saltatory conduction.