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Action Potentials, Neurons & Neurotransmission

Study Guide — Action Potentials

High-school/pre-med level questions on neuron structure, resting potential, action potentials, synapses, neurotransmitters, and myelination.

32 items — Study Guide with Answers

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1 **Which structure typically carries action potentials AWAY from the cell body of a neuron?**

A Dendrite

B **Axon** ✓

C Nucleus

D Ribosome

E Myelin sheath

▶ **Explanation:** Dendrites usually receive signals; the axon conducts action potentials away from the cell body towards synaptic terminals.

2 **The small gaps between segments of myelin along a myelinated axon are called:**

A Synaptic clefts

B **Nodes of Ranvier** ✓

C Dendritic spines

D Axon hillocks

E Boutons

▶ **Explanation:** Nodes of Ranvier are gaps in the myelin sheath where voltage-gated ion channels are concentrated and action potentials are regenerated.

3 **At rest, the membrane potential of a typical neuron is approximately:**

A +70 mV (inside positive)

B **-70 mV (inside negative)** ✓

C 0 mV (no difference)

D +30 mV (inside positive)

E -120 mV (inside very negative)

▶ **Explanation:** The resting membrane potential is typically around −70 mV, with the inside of the neuron negative relative to the outside.

4 Which statement correctly compares ion concentrations INSIDE and OUTSIDE a typical resting neuron?

A Na^+ is higher inside; K^+ is higher outside

B **Na^+ is higher outside; K^+ is higher inside** ✓

C Both Na^+ and K^+ are higher outside

D Both Na^+ and K^+ are higher inside

E There is no difference in ion concentrations

▶ **Explanation:** At rest, extracellular fluid has high Na^+ and low K^+; the cytoplasm has high K^+ and low Na^+.

5 The Na^+/K^+ pump (sodium–potassium ATPase) in neurons moves ions in which directions per ATP hydrolysed?

A 3 Na^+ in, 2 K^+ out

B **3 Na^+ out, 2 K^+ in** ✓

C 2 Na^+ out, 3 K^+ in

D Na^+ and K^+ both out

E Na^+ and K^+ both in

▶ **Explanation:** The pump actively exports 3 Na^+ and imports 2 K^+ per ATP, helping maintain ion gradients and a negative resting potential.

6 **During the rising phase (depolarisation) of a typical action potential, which main event occurs?**

A Voltage-gated K^+ channels open and K^+ rushes out

B **Voltage-gated Na^+ channels open and Na^+ rushes in** ✓

C Na^+/K^+ pumps shut down completely

D Cl^- channels open and Cl^- rushes in

E Myelin sheaths are destroyed

▶ **Explanation:** Depolarisation is caused mainly by Na^+ influx through voltage-gated Na^+ channels.

7 **Which best describes REPOLARISATION during an action potential?**

A Opening of Na^+ channels and closing of K^+ channels

B **Opening of voltage-gated K^+ channels, allowing K^+ to leave the cell** ✓

C Massive entry of Ca^{2+} into the cell body

D Sudden shutting of all ion channels

E Inactivation of all Na^+/K^+ pumps

▶ **Explanation:** Repolarisation follows depolarisation and is mainly due to K^+ efflux through voltage-gated K^+ channels.

8 **The 'all-or-nothing' principle of the action potential means that:**

A The neuron can only fire once in its lifetime

B **If threshold is reached, an action potential of fixed amplitude occurs; if not, there is no action potential** ✓

C Stronger stimuli produce larger amplitude action potentials

D Neurons never have graded potentials

E Action potentials can be half-size when threshold is barely reached

▶ **Explanation:** Above threshold, action potentials have stereotyped size; stimulus strength is encoded mainly by frequency, not amplitude.

9 **The threshold potential at which a neuron usually fires an action potential is typically around:**

A 0 mV

B -90 mV

C **-55 mV** ✓

D +30 mV

E -10 mV

▶ **Explanation:** Many neurons fire when the membrane potential depolarises from about −70 mV to around −55 mV.

10 **The refractory period of a neuron is important because it:**

A Prevents any further action potentials ever from occurring

B **Allows action potentials to travel in only one direction along the axon** ✓

C Increases the amplitude of action potentials

D Is when neurotransmitter is synthesised

E Stops the Na^+/K^+ pump permanently

▶ **Explanation:** During the refractory period, recently opened Na^+ channels are inactivated, making it harder or impossible to fire again, ensuring one-way propagation.

11 **Which statement about MYELINATION is TRUE?**

A Myelin increases the amplitude of each action potential

B Myelin prevents action potentials from occurring at all

C **Myelin increases the speed of conduction along the axon** ✓

D Myelin is mainly found on dendrites

E Myelin changes the direction of action potentials

▶ **Explanation:** Myelin acts as an electrical insulator, allowing saltatory conduction and greatly increasing conduction velocity.

12 **Saltatory conduction refers to:**

A Action potentials that are continuously regenerated along every nanometer of the axon

B **Action potentials that appear to 'jump' from node of Ranvier to node of Ranvier along a myelinated axon** ✓

C Action potentials that move equally in both directions

D The failure of action potentials in myelinated axons

E The opening of chemical synapses

▶ **Explanation:** In myelinated axons, depolarisation spreads rapidly under the myelin and is regenerated only at nodes, giving the 'jumping' pattern.

13 Which of the following would generally INCREASE the speed of action potential conduction along an axon?

A Decreasing axon diameter and removing myelin

B **Increasing axon diameter and adding myelin** ✓

C Increasing membrane resistance by blocking all ion channels

D Reducing the number of nodes of Ranvier to zero

E Making the resting potential more positive without myelin

▶ **Explanation:** Large diameter reduces internal resistance, and myelin reduces leak and supports saltatory conduction—both speed up transmission.

14 Multiple sclerosis (MS) is an example of a disease where myelin in the central nervous system is damaged. Which effect would you expect?

A Faster conduction of nerve impulses

B **Slowed or blocked conduction along affected axons** ✓

C Larger action potential amplitude

D No change in neuronal function

E Increased neurotransmitter synthesis

▶ **Explanation:** Loss of myelin disrupts saltatory conduction, slowing or blocking action potentials and causing neurological symptoms.

15 **At a chemical synapse, which ion's entry into the presynaptic terminal directly triggers vesicle fusion and neurotransmitter release?**

A Na^{+}

B K^{+}

C **Ca^{2+}** ✓

D Cl^{-}

E Mg^{2+}

▶ **Explanation:** Depolarisation at the terminal opens voltage-gated Ca^{2+} channels; Ca^{2+} influx triggers synaptic vesicle fusion.

16 **The small gap between a presynaptic neuron and a postsynaptic cell at a chemical synapse is the:**

A Axon hillock

B Node of Ranvier

C **Synaptic cleft** ✓

D Myelin gap

E Voltage gap

▶ **Explanation:** The synaptic cleft is the extracellular space into which neurotransmitters are released.

17 **Which neurotransmitter is released at the neuromuscular junction in vertebrates and stimulates skeletal muscle contraction?**

A GABA

B Glutamate

C **Acetylcholine (ACh)** ✓

D Dopamine

E Serotonin

▶ **Explanation:** Motor neurons release ACh onto muscle fibre receptors, causing depolarisation and contraction.

18 **Which is the main inhibitory neurotransmitter in the BRAIN of most vertebrates?**

A Glutamate

B Acetylcholine

C **GABA** ✓

D Dopamine

E Noradrenaline

▶ **Explanation:** GABA (gamma-aminobutyric acid) is the principal inhibitory neurotransmitter in the CNS.

19 **Which is the main excitatory neurotransmitter in the BRAIN?**

A **Glutamate** ✓

B GABA

C Glycine

D Dopamine

E Serotonin

▶ **Explanation:** Glutamate is the major excitatory neurotransmitter in the CNS.

20 **Dopamine, serotonin and noradrenaline are examples of:**

A Peptide hormones only

B Steroid hormones

C **Monoamine neurotransmitters** ✓

D Gaseous neurotransmitters

E Purine nucleotides

▶ **Explanation:** These are small-molecule monoamine neurotransmitters involved in mood, reward, attention and more.

21 **An excitatory postsynaptic potential (EPSP) typically:**

A Hyperpolarises the postsynaptic membrane, making action potentials less likely

B **Depolarises the postsynaptic membrane, bringing it closer to threshold** ✓

C Has no effect on membrane potential

D Blocks voltage-gated Na^+ channels

E Occurs only in motor neurons

▶ **Explanation:** EPSPs make the inside less negative (depolarised), increasing the chance of crossing threshold.

22 **An inhibitory postsynaptic potential (IPSP) usually results from:**

A Opening channels that allow Na^+ influx

B **Opening channels that allow K^+ efflux or Cl^- influx, hyperpolarising the cell** ✓

C Closing all ion channels

D Activation of voltage-gated Ca^{2+} channels at the terminal

E Random changes unrelated to neurotransmitters

▶ **Explanation:** IPSPs make the inside more negative (hyperpolarised), moving the membrane potential further from threshold.

23 **Which statement about GRADED potentials vs ACTION potentials is TRUE?**

A Graded potentials are all-or-nothing, action potentials are graded

B **Graded potentials decrease with distance; action potentials are regenerated and maintain size** ✓

C Only graded potentials use ion channels

D Action potentials cannot travel along axons

E Graded potentials occur only in muscles

▶ **Explanation:** Graded potentials vary in size and decay with distance; action potentials are propagated without losing amplitude.

24 **Where are action potentials usually initiated in a multipolar neuron?**

A Dendritic tips

B Axon terminals

C **Axon hillock / initial segment** ✓

D Nucleus

E Myelin sheath

▶ **Explanation:** The axon hillock/initial segment has a high density of voltage-gated Na^+ channels and serves as the usual trigger zone.

25 **Which of the following is NOT part of a typical neuron?**

A Cell body (soma)

B Dendrites

C Axon

D Synaptic terminals

E **Sarcomeres** ✓

▶ **Explanation:** Sarcomeres are contractile units of muscle fibres, not neuronal structures.

26 **Which best describes the role of SCHWANN cells?**

A **Form myelin around axons in the peripheral nervous system** ✓

B Form myelin around axons in the central nervous system

C Produce cerebrospinal fluid

D Act as sensory receptors in the skin

E Generate action potentials in skeletal muscle

▶ **Explanation:** Schwann cells myelinate peripheral axons; oligodendrocytes myelinate CNS axons.

27 **Which glial cell type forms myelin in the central nervous system?**

A Schwann cells

B **Oligodendrocytes** ✓

C Astrocytes

D Microglia

E Ependymal cells

▶ **Explanation:** Oligodendrocytes extend processes that myelinate multiple CNS axons.

28 **In an UNMYELINATED axon, action potentials propagate because:**

A Only one Na^+ channel is present at the terminal

B **The depolarisation at one patch of membrane brings adjacent patches to threshold** ✓

C Ions move only inside the cell and not across the membrane

D The axon contains many sarcomeres

E The Na^+/K^+ pump carries the action potential forward

▶ **Explanation:** Local currents spread along the membrane, depolarising neighbouring regions and triggering new action potentials.

29 **Which of the following is TRUE regarding the effect of myelination on the ENERGY USE of neurons?**

A Myelination greatly increases the amount of Na^+ and K^+ crossing the membrane, increasing

ATP use

B **Myelination reduces ion leakage and therefore can reduce ATP required by the Na^+/K^+ pump** ✓

C Myelination stops the Na^+/K^+ pump from working

D Myelination has no effect on energy use

E Myelination stores ATP for later use

▶ **Explanation:** Because less membrane is exposed, fewer ions cross during an action potential, so pumps need to do less work restoring gradients.

30 **Which statement correctly describes the DIRECTION of action potential propagation in a normal neuron?**

A **From dendrites to cell body to axon terminal** ✓

B From axon terminal to cell body to dendrites

C Randomly in both directions at the same time

D Only within the cell body

E Only from the terminal back to the cell body

▶ **Explanation:** Signals are usually received at dendrites/cell body, trigger at the axon hillock, and propagate along the axon towards terminals.

31 **Which statement about the SYNAPTIC delay at a CHEMICAL synapse is TRUE?**

A Chemical synapses are faster than action potential conduction along the axon

B **Chemical synapses are slightly slower than electrical conduction due to steps of vesicle release and diffusion** ✓

C Chemical synapses have zero delay

D Synaptic delay is caused only by Na^+/K^+ pumps

E Synaptic delay is unique to myelinated axons

▶ **Explanation:** At chemical synapses, transmitter release, diffusion and receptor activation take time, producing a small synaptic delay.

32 Which of the following is a CORRECT pairing of neurotransmitter with a function or association?

A Serotonin – mainly neuromuscular junction contraction

B **Dopamine – reward pathways and motor control** ✓

C Acetylcholine – main inhibitory neurotransmitter in the brain

D Glutamate – main inhibitory neurotransmitter in the spinal cord

E GABA – main excitatory neurotransmitter in the cortex

▶ **Explanation:** Dopamine is important in reward and movement; ACh is excitatory at neuromuscular junction; glutamate is excitatory; GABA is inhibitory.