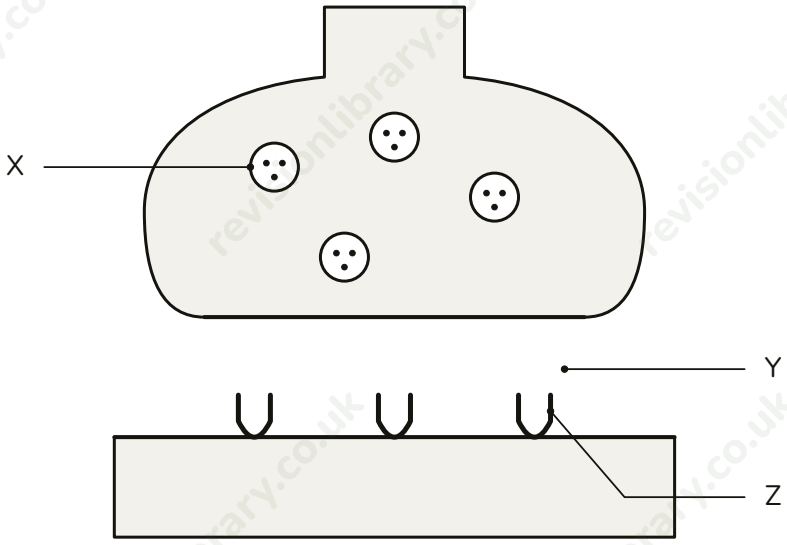
6.3 Neurons and Synaptic Transmission: 30-minute Pack

AQA 7182 · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions.



1 Label the synapse diagram: name X, Y and Z with single-term labels.

(Total for Question 1 is 3 marks)

2 Outline the concept of summation in the postsynaptic neuron, distinguishing between temporal and spatial summation, and explain briefly why summation is important for action potential generation.

(Total for Question 2 is 4 marks)

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3 Outline two structural differences between sensory (afferent) neurons and motor (efferent) neurons, and explain how each difference relates to their function in carrying information.

(Total for Question 3 is 4 marks)

4 Explain what is meant by an excitatory postsynaptic potential (EPSP) and an inhibitory postsynaptic potential (IPSP), and give one named neurotransmitter commonly associated with excitation and one commonly associated with inhibition in the brain.

(Total for Question 4 is 3 marks)

5 State two roles of the myelin sheath on an axon and explain briefly how each role affects the speed or reliability of neural transmission.

(Total for Question 5 is 4 marks)

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6 State one way in which dopamine and serotonin can differ in their typical roles in the brain, giving a named role for each neurotransmitter.

(Total for Question 6 is 3 marks)

7 Describe the process of synaptic transmission from the arrival of an electrical impulse at the presynaptic terminal to the generation of a postsynaptic potential, and explain how this process can lead to either excitation or inhibition of the postsynaptic neuron. In your answer be selective and organised.

(Total for Question 7 is 6 marks)

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Mark scheme · 6.3 Neurons and Synaptic Transmission: 30-minute Pack

Question 1

X labelled as synaptic vesicles cao	**B1**
Y labelled as synaptic cleft cao	**B1**
Z labelled as receptor sites or receptors cao	**B1**

Answer: X = synaptic vesicles. Y = synaptic cleft. Z = receptor sites (receptors).

Question 2

defines summation as the combining of multiple EPSPs and IPSPs at the axon hillock oe	**M1**
explains temporal summation as successive impulses from a single presynaptic neuron building up to reach threshold oe	**A1**
explains spatial summation as simultaneous inputs from several presynaptic neurons combining their effects oe	**M1**
explains why important: summation determines whether threshold is reached so an action potential will or will not be generated oe	**A1**

Answer: Summation is the combining of EPSPs and IPSPs at the axon hillock; temporal summation is rapid successive inputs from one presynaptic cell adding together, spatial summation is simultaneous inputs from many presynaptic cells adding together, and summation is crucial because it determines whether the threshold for an action potential is reached.

Question 3

identifies a genuine structural difference, e.g. sensory neurons often have receptor endings and a long peripheral axon or a cell body in a dorsal root ganglion, whereas motor neurons have a cell body in the CNS and multiple dendrites oe	**M1**
explains how this relates to function: sensory neuron structure transmits sensory information from receptors towards the CNS, while motor neuron structure sends signals from the CNS to effectors such as muscle oe	**A1**
second structural difference: sensory neurons can be unipolar/has peripheral process, motor neurons are multipolar with many dendrites oe	**M1**
explains functional consequence of the second point, e.g. many dendrites allow motor neurons to integrate multiple inputs before triggering muscle contraction oe	**A1**

Answer: E.g. sensory neurons often have receptor endings and a peripheral process that carries signals into the CNS, whereas motor neurons have their cell body in the CNS and many dendrites with a long axon out to muscle; this suits sensory neurons for transmitting receptor information in and motor neurons for sending commands out.

Question 4

defines EPSP as a small depolarisation of the postsynaptic membrane that makes the neuron more likely to fire an action potential oe	**M1**
defines IPSP as a small hyperpolarisation that makes the postsynaptic neuron less likely to fire oe	**M1**
gives one named neurotransmitter associated with excitation (e.g. acetylcholine or glutamate) and one associated with inhibition (e.g. GABA or serotonin in some pathways) cao	**A1**

Answer: EPSP: a small depolarisation making firing more likely; IPSP: a small hyperpolarisation making firing less likely. Example neurotransmitters: acetylcholine or glutamate for excitation; GABA for inhibition.

Question 5

states one role: electrical insulation of the axon oe	**M1**
explains that insulation prevents ion leakage and maintains the strength of the action potential, improving reliability of transmission oe	**A1**
states second role: enabling saltatory conduction so impulses jump between nodes of Ranvier oe	**M1**
explains that saltatory conduction increases conduction velocity, so signals travel faster along myelinated axons oe	**A1**

Answer: Roles: electrical insulation, which reduces ion leakage and helps maintain signal integrity; and enabling saltatory conduction, where impulses jump between nodes of Ranvier to increase conduction speed.

Question 6

states a role for dopamine, e.g. involved in reward, motivation and motor control oe	**M1**
states a role for serotonin, e.g. involved in mood regulation, appetite and sleep oe	**M1**
makes the contrast explicit, e.g. dopamine often linked to reward/motor function while serotonin is often linked to mood regulation oe	**A1**

Answer: Dopamine: commonly associated with reward, motivation and motor control. Serotonin: commonly associated with mood regulation, appetite and sleep; dopamine is more linked to reward and motor function while serotonin is more linked to mood.

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Question 7

Level 3 Detailed, accurate and well organised description of synaptic transmission. Key steps are clearly explained in sequence, including arrival of the action potential, Ca2+ entry, vesicle fusion and neurotransmitter release, diffusion across the cleft, receptor binding and ion channel actions. Explanation includes how receptor action produces EPSPs or IPSPs and a clear account of how excitation or inhibition results. Specialist terms used correctly.	**5-6**
Level 2 Clear description of the main steps of synaptic transmission with some detail. Most key processes are described, for example vesicle release and receptor binding, but explanation of how excitation or inhibition arises may be incomplete or less well developed. Organisation is adequate and terminology mostly correct.	**3-4**
Level 1 Limited description, missing several key steps or showing some inaccuracies. May mention neurotransmitter release or receptor binding but lacks clear sequence or explanation of excitation versus inhibition. Little organisation and limited technical vocabulary.	**1-2**
Level 0 No relevant content.	**0**

Indicative content:

- Action potential arrives at presynaptic terminal and depolarises the membrane.
- Voltage-gated calcium channels open, Ca2+ ions enter the presynaptic terminal.
- Ca2+ influx triggers synaptic vesicles to move to and fuse with the presynaptic membrane, releasing neurotransmitter by exocytosis into the synaptic cleft.
- Neurotransmitter molecules diffuse across the synaptic cleft to the postsynaptic membrane.
- Neurotransmitter binds to specific receptor proteins on the postsynaptic membrane, causing ion channels to open or close.
- If receptor activation opens Na+ channels this produces an EPSP (depolarisation); if it opens K+ channels or Cl- channels this produces an IPSP (hyperpolarisation).
- Summation of EPSPs and IPSPs at the axon hillock determines whether the postsynaptic neuron reaches threshold and fires an action potential.
- Named neurotransmitters may be included: e.g. acetylcholine acting at neuromuscular junctions or central cholinergic synapses as excitatory, dopamine involved in modulatory/excitatory pathways, serotonin often modulates mood and can have inhibitory effects in some circuits, and GABA as a major inhibitory transmitter.
- Mention of reuptake or enzymatic breakdown may be included as part of clearing neurotransmitter from the cleft and terminating the signal.

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