AQA Biology A-level

6.2 - Nervous coordination

Flashcards

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Describe the general structure of a motor neuron.

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Describe the general structure of a motor neuron.

Cell body: contains organelles & high proportion of RER.

Dendrons: branch into dendrites which carry impulses towards cell body.

Axon: long, unbranched fibre carries nerve impulses away from cell body.

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Describe the additional features of a myelinated motor neuron.

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Describe the additional features of a myelinated motor neuron.

- **Schwann cells:** wrap around axon many times.
- **Myelin sheath:** made from myelin-rich membranes of Schwann cells.
- **Nodes of Ranvier:** very short gaps between neighbouring Schwann cells where there is no myelin sheath.

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Name 3 processes Schwann cells are involved in.

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Name 3 processes Schwann cells are involved in.

- electrical insulation
- phagocytosis
- nerve regeneration

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How does an action potential pass along an unmyelinated neuron?

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How does an action potential pass along an unmyelinated neuron?

1. Stimulus leads to influx of Na+ ions. First section of membrane depolarises.
2. Local electrical currents cause sodium voltage-gated channels further along membrane to open. Meanwhile, the section behind begins to repolarise.
3. Sequential wave of depolarisation.

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Explain why myelinated axons conduct impulses faster than unmyelinated axons.

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Explain why myelinated axons conduct impulses faster than unmyelinated axons

Saltatory conduction: Impulse 'jumps' from one node of Ranvier to another. Depolarisation cannot occur where myelin sheath acts as electrical insulator.

So impulse does not travel along whole axon length.

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What is resting potential?

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What is resting potential?

Potential difference (voltage) across neuron membrane when not stimulated (-50 to -90 mV, usually about -70 mV in humans).

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How is resting potential established?

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How is resting potential established?

1. Membrane is more permeable to K^+ than Na^+.
2. Sodium-potassium pump actively transports $3Na^+$ out of cell & $2K^+$ into cell.

Establishes electrochemical gradient: cell contents more negative than extracellular environment.

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Name the stages in generating an action potential.

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Name the stages in generating an action potential.

1. Depolarisation
2. Repolarisation
3. Hyperpolarisation
4. Return to resting potential

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What happens during depolarisation?

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What happens during depolarisation?

1. Stimulus→facilitated diffusion of Na^+ ions into cell down electrochemical gradient.
2. p.d. across membrane becomes more positive.
3. If membrane reaches threshold potential (-50mV), voltage-gated Na^+ channels open.
4. Significant influx of Na^+ ions reverses p.d. to +40mV.

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What happens during repolarisation?

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What happens during repolarisation?

1. Voltage-gated Na^+ channels close and voltage-gated K^+ channels open.
2. Facilitated diffusion of K^+ ions out of cell down their electrochemical gradient.
3. p.d. across membrane becomes more negative.

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What happens during hyperpolarisation?

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What happens during hyperpolarisation?

1. ‘Overshoot’ when K^+ ions diffuse out = p.d. becomes more negative than resting potential.
2. Refractory period: no stimulus is large enough to raise membrane potential to threshold.
3. Voltage-gated K^+ channels close & sodium-potassium pump re-establishes resting potential.

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Explain the importance of the refractory period.

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Explain the importance of the refractory period.

No action potential can be generated in hyperpolarised sections of membrane:

- Ensures unidirectional impulse
- Ensures discrete impulses
- Limits frequency of impulse transmission

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What is the ‘all or nothing’ principle?

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What is the ‘all or nothing’ principle?

Any stimulus that causes the membrane to reach threshold potential will generate an action potential.

All action potentials have same magnitude.

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Name the factors that affect the speed of conductance.

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Name the factors that affect the speed of conductance.

- Myelin sheath
- Axon diameter
- Temperature

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How does axon diameter affect the speed of conductance?

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How does axon diameter affect the speed of conductance?

greater diameter = faster

- Less resistance to flow of ions (depolarisation & repolarisation).
- Less ‘leakage’ of ions (easier to maintain membrane potential).

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How does temperature affect speed of conductance?

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How does temperature affect speed of conductance?

Higher temperature = faster

- Faster rate of diffusion (depolarisation & repolarisation).
- Faster rate of respiration (enzyme-controlled) = more ATP for active transport to re-establish resting potential.

Temperature too high = membrane proteins denature.

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Suggest an appropriate statistical test to determine whether a factor has a significant effect on the speed of conductance.

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Suggest an appropriate statistical test to determine whether a factor has a significant effect on the speed of conductance.

Student's t-test (comparing means of continuous data)

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Suggest appropriate units for the maximum frequency of impulse conduction.

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Suggest appropriate units for the maximum frequency of impulse conduction.

Hz

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How can an organism detect the strength of a stimulus?

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How can an organism detect the strength of a stimulus?

Larger stimulus raises membrane to threshold potential more quickly after hyperpolarisation = greater frequency of impulses.

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What is the function of synapses?

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What is the function of synapses?

- Electrical impulse cannot travel over junction between neurons.
- Neurotransmitters send impulses between neurons/ from neurons to effectors.
- New impulses can be initiated in several different neurons for multiple simultaneous responses.

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Describe the structure of a synapse.

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Describe the structure of a synapse.

Presynaptic neuron ends in **synaptic knob:** contains lots of mitochondria, endoplasmic reticulum & vesicles of neurotransmitter.

synaptic cleft: 20-30 nm gap between neurons.

Postsynaptic neuron: has complementary receptors to neurotransmitter (**ligand-gated Na^+ channels**).

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Outline what happens in the presynaptic neuron when an action potential is transmitted from one neuron to another.

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Outline what happens in the presynaptic neuron when an action potential is transmitted from one neuron to another.

1. Wave of depolarisation travels down presynaptic neuron, causing voltage-gated Ca^{2+} channels to open.
2. Vesicles move towards & fuse with presynaptic membrane.
3. Exocytosis of neurotransmitter into synaptic cleft.

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How do neurotransmitters cross the synaptic cleft?

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How do neurotransmitters cross the synaptic cleft?

Via simple diffusion

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Outline what happens in the postsynaptic neuron when an action potential is transmitted from one neuron to another.

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Outline what happens in the postsynaptic neuron when an action potential is transmitted from one neuron to another.

1. Neurotransmitter binds to specific receptor on postsynaptic membrane.
2. Ligand-gated Na^+ channels open .
3. If influx of Na^+ ions raises membrane to threshold potential, action potential is generated.

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Explain why synaptic transmission is unidirectional.

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Explain why synaptic transmission is unidirectional.

Only presynaptic neuron contains vesicles of neurotransmitter & only postsynaptic membrane has complementary receptors.

So impulse always travels presynaptic → postsynaptic.

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Define summation and name the 2 types.

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Define summation and name the 2 types.

Neurotransmitter from several sub-threshold impulses accumulates to generate action potential:

- temporal summation
- spatial summation

NB no summation at neuromuscular junctions.

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What is the difference between temporal and spatial summation?

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What is the difference between temporal and spatial summation?

Temporal: **one** presynaptic neuron releases neurotransmitter several times in quick succession.

Spatial: **multiple** presynaptic neurons release neurotransmitter.

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What are cholinergic synapses?

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What are cholinergic synapses?

Use acetylcholine as primary neurotransmitter.

Excitatory or inhibitory. Located at:

- Motor end plate (muscle contraction).
- Preganglionic neurons (excitation).
- Parasympathetic postganglionic neurons (inhibition e.g. of heart or breathing rate).

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What happens to acetylcholine from the synaptic cleft?

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What happens to acetylcholine from the synaptic cleft?

1. Hydrolysis into acetyl and choline by acetylcholinesterase (AChE).
2. Acetyl & choline diffuse back into presynaptic membrane.
3. ATP is used to reform acetylcholine for storage in vesicles.

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Explain the importance of AChE.

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Explain the importance of AChE.

- Prevents overstimulation of skeletal muscle cells.
- Enables acetyl and choline to be recycled.

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What happens in an inhibitory synapse?

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What happens in an inhibitory synapse?

1. Neurotransmitter binds to and opens Cl^- channels on postsynaptic membrane & triggers K^+ channels to open.
2. Cl^- moves in & K^+ moves out via facilitated diffusion.
3. p.d. becomes more negative: hyperpolarisation.

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Describe the structure of a neuromuscular junction.

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Describe the structure of a neuromuscular junction.

Synaptic cleft between a presynaptic neuron and a skeletal muscle cell.

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Contrast a cholinergic synapse and a neuromuscular junction.

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Contrast a cholinergic synapse and a neuromuscular junction.

Difference	Cholinergic	Neuromuscular
Postsynaptic cell	Another neuron	Skeletal muscle cell
AChE location	Synaptic cleft	Postsynaptic membrane
Action potential	New action potential produced	End of neural pathway
Response	Excitatory or inhibitory	Always excitatory
Neurons involved	Motor, sensory or relay	Only motor

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How might drugs increase synaptic transmission?

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How might drugs increase synaptic transmission?

- Inhibit AChE
- Mimic shape of neurotransmitter

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How might drugs decrease synaptic transmission?

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How might drugs decrease synaptic transmission?

- Inhibit release of neurotransmitter.
- Decrease permeability of postsynaptic membrane to ions.
- Hyperpolarise postsynaptic membrane.

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