OCR (A) Biology A-level

5.1.3 - Neuronal communication

Flashcards

What features are common to all sensory receptors?

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- Act as energy transducers which establish a generator potential.
- Respond to specific stimuli.

Describe the basic structure of a Pacinian corpuscle.

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Single nerve fibre surrounded by layers of connective tissue which are separated by viscous gel and contained by a capsule.

Stretch-mediated Na^+ channels on plasma membrane.

Capillary runs along base layer of tissue.

What stimulus does a Pacinian corpuscle respond to? How?

What stimulus does a Pacinian corpuscle respond to? How?

1. **Pressure** deforms membrane, causing **stretch-mediated Na^+ ion channels** to open.
2. If influx of Na^+ raises membrane to threshold potential, a **generator potential** is produced.
3. Action potential moves along sensory neuron.

Describe the features of all neurons.

Describe the features of all neurons.

Cell body: contains organelles & high proportion of RER.

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

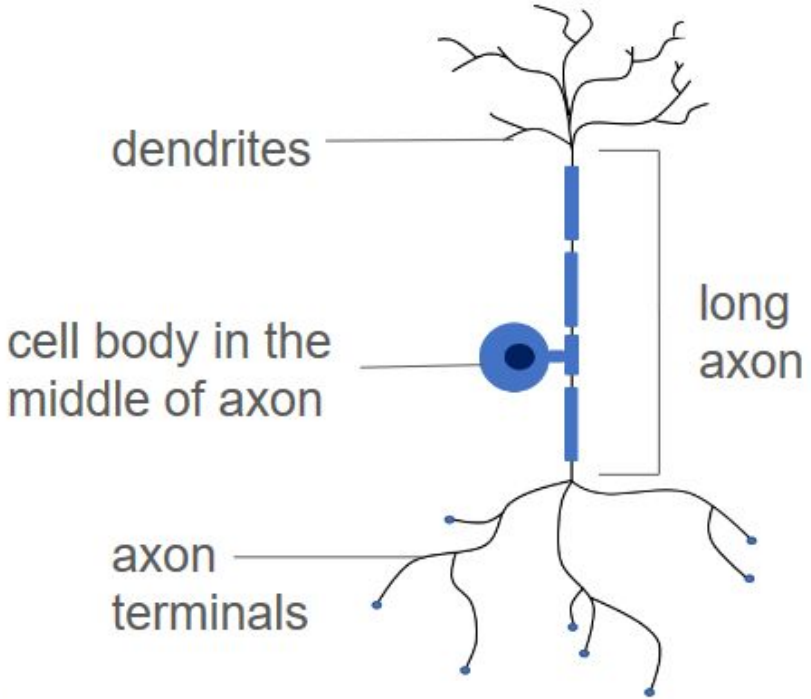
Axon: long, unbranched fibre carries nerve impulses away from cell body.

Describe the structure and function of a sensory neuron.

Describe the structure and function of a sensory neuron.

Usually unipolar.

Transmits impulses from receptors to CNS.



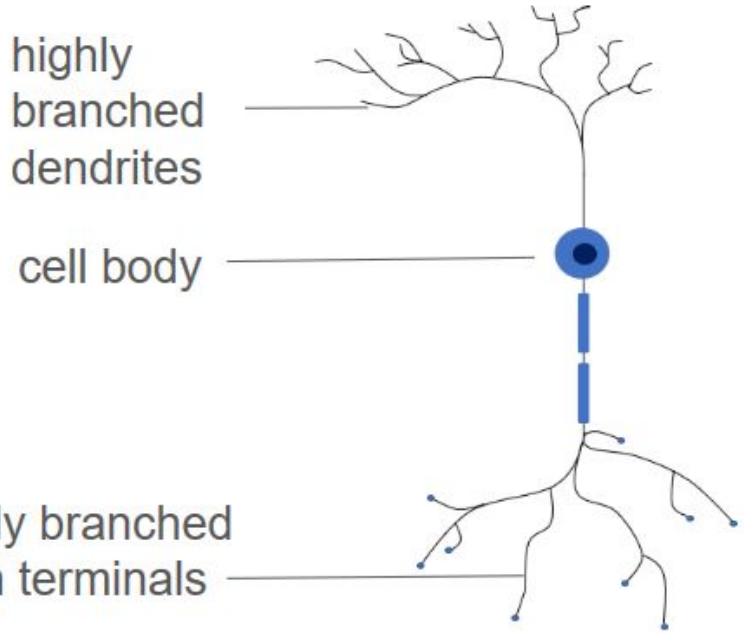
Describe the structure and function of a relay neuron.

Describe the structure and function of a relay neuron.

Usually bipolar.

Transmits impulses

between neurons.

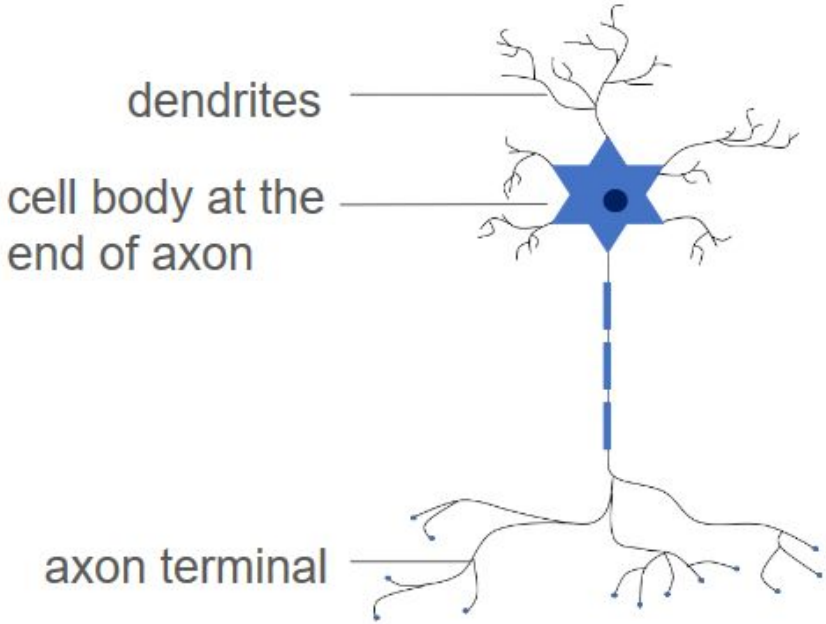


Describe the structure and function of a motor neuron.

Describe the structure and function of a motor neuron.

Usually multipolar.

Transmits impulses from relay neurons in the CNS to effectors.



Describe the additional features of a myelinated neuron.

Describe the additional features of a myelinated 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.

Name 3 processes Schwann cells are involved in.

Name 3 processes Schwann cells are involved in.

- electrical insulation
- phagocytosis
- nerve regeneration

Explain why myelinated axons conduct impulses faster than unmyelinated axons.

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.

Where are myelinated and non-myelinated neurons found in the body?

Where are myelinated and non-myelinated neurons found in the body?

Myelinated: most neurons in central & peripheral nervous systems e.g. those involved in spinal reflex.

Non-myelinated: group C nerve fibres involved in transmitting secondary pain.

What is resting potential?

What is resting potential?

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

How is resting potential established?

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.

Name the stages in generating an action potential.

Name the stages in generating an action potential.

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

What happens during depolarisation?

What happens during depolarisation?

1. Stimulus → facilitated diffusion of Na^+ 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. (positive feedback mechanism).
4. Significant influx of Na^+ ions reverses p.d. to +40mV.

What happens during repolarisation?

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.

What happens during hyperpolarisation?

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.

Explain the importance of the refractory period.

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; larger stimuli have higher frequency.

Why is the frequency of impulse transmission significant?

Why is the frequency of impulse transmission significant?

Enables organism to distinguish size of stimulus although all action potentials have same magnitude.

Larger stimuli result in higher frequency of transmission since they overcome hyperpolarisation more quickly.

What is the function of synapses?

What is the function of synapses?

- Electrical impulse cannot cross junction.
- Neurotransmitters send impulses between neurons/ from neurons to effectors for excitatory or inhibitory response.
- Summation of sub-threshold impulses.
- New impulses can be initiated in several different neurons for multiple simultaneous responses.

Describe the structure of a synapse.

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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**).

What happens in the presynaptic neuron when an action potential is transmitted between neurons?

What happens in the presynaptic neuron when an action potential is transmitted between neurons?

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.

How do neurotransmitters cross the synaptic cleft?

How do neurotransmitters cross the synaptic cleft?

simple diffusion

What happens in the postsynaptic neuron when an action potential is transmitted between neurons?

What happens in the postsynaptic neuron when an action potential is transmitted between neurons?

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.

What happens in an inhibitory synapse?

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 so no action potential is generated.

Define summation and name the 2 types.

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

- temporal summation
- spatial summation

NB no summation at neuromuscular junctions.

What is the difference between temporal and spatial summation?

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.

What are cholinergic synapses?

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)

What happens to acetylcholine from the synaptic cleft?

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.