Edexcel (A) Biology A-level

8.4 + 8.14 + 8.15 - Synaptic Transmission

Flashcards

What is the function of synapses?

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- 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.

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.

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 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).

Explain the role of acetylcholine.

Explain the role of acetylcholine.

- Causes muscle contraction at motor end plate.
- Causes excitation at preganglionic neurons.
- Causes inhibition at parasympathetic postganglionic neurons (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.

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?

Via 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.

How might drugs increase synaptic transmission?

How might drugs increase synaptic transmission?

- Inhibit AChE
- Mimic shape of neurotransmitter

How might drugs decrease synaptic transmission?

How might drugs decrease synaptic transmission?

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

What is Parkinson's disease?

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Neurodegenerative disorder affecting movement & cognitive function.

Loss of dopaminergic neurons in cerebral cortex of brain. Characterised by formation of Lewy bodies (clumps of alpha synuclein protein).

Results in fewer threshold impulses to neurons in motor cortex.

How is L-Dopa used to treat Parkinson's disease?

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L-Dopa is a dopamine precursor that can cross the brain blood barrier. It is used to produce more dopamine in the brain to replace the neurotransmitter lost by death of neurons.

What is MDMA?

What is MDMA?

Chemical in ecstasy. Interacts with transmembrane proteins that transport serotonin, a neurotransmitter that regulates mood. Increases serotonin level in synaptic clefts in brain.

Describe the link between serotonin and depression.

Describe the link between serotonin and depression.

Correlation between low serotonin levels & depression. May be caused by low serotonin production, a problem with postsynaptic receptors or other linked variables.

Evidence shows that drugs which increase serotonin levels in synaptic cleft e.g. selective serotonin reuptake inhibitors (SSRIs) are effective treatments.