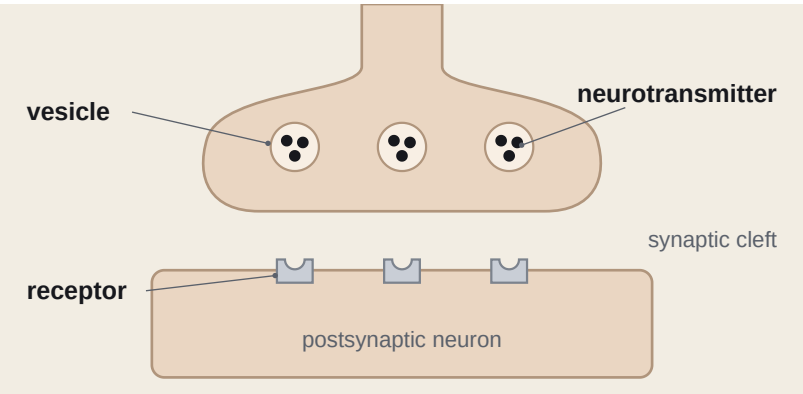
A4 · Crossing the synapse · Completed notes

Goals: Name the parts of a synapse. Describe the four steps that carry a message across a synapse. Say what acetylcholine, cholinesterase and norepinephrine are. Explain the difference between excitatory and inhibitory neurotransmitters. Explain summation. Predict what a drug or toxin does at a synapse.

These are the completed notes. The blanks are filled in and each question is worked.

Slide 1 of 6 · The synapse

In lesson A3, an action potential travelled to the end of an axon. The next cell is not joined to it. Today you see how the message gets across.



Key ideas

The place where a neuron meets the next cell is a **synapse**.

The gap between them is the **synaptic cleft**.

A chemical called a **neurotransmitter** carries the message across.

It is stored in **vesicles**. It fits **receptors** on the postsynaptic neuron.

Example

Name the neuron that releases the neurotransmitter, and the neuron that has the receptors.

1. The presynaptic neuron releases the neurotransmitter.
2. The postsynaptic neuron has the receptors.

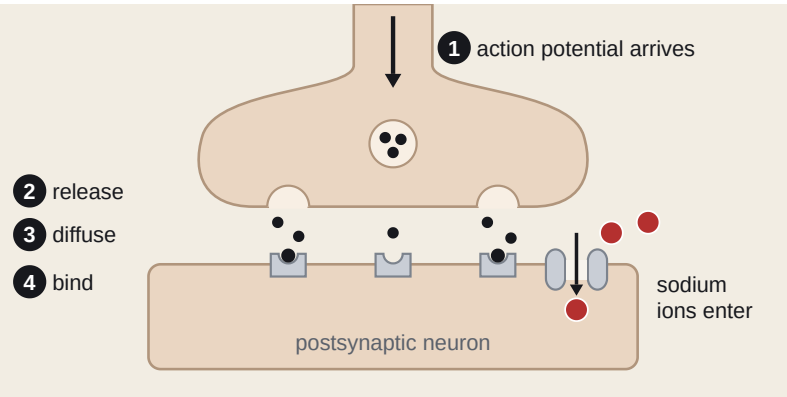
Try it

State where the neurotransmitter is stored before it is released.

1. It is stored in vesicles.
2. The vesicles are in the axon terminal of the presynaptic neuron.

Slide 2 of 6 · Crossing the synapse in four steps

On the last slide you named the parts of a synapse. Now you follow one message across it. The steps are numbered on the picture.



Key ideas

An action potential arrives at the **axon terminal**.

Vesicles **release** the neurotransmitter into the synaptic cleft.

It **diffuses** across and binds to receptors.

Sodium channels open in the postsynaptic membrane.

Example

List the four steps that carry a message across a synapse.

1. An action potential arrives at the axon terminal.
2. Vesicles release the neurotransmitter.
3. It diffuses across the synaptic cleft.
4. It binds to receptors, and sodium channels open.

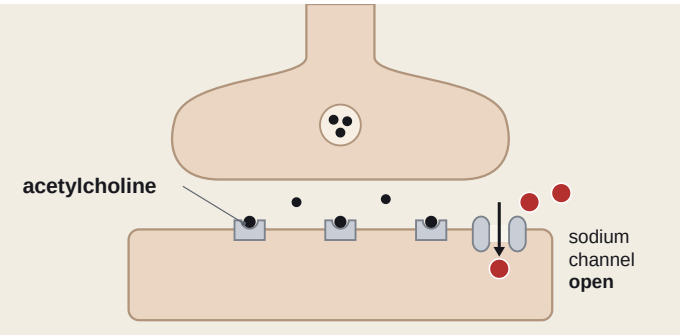
Try it

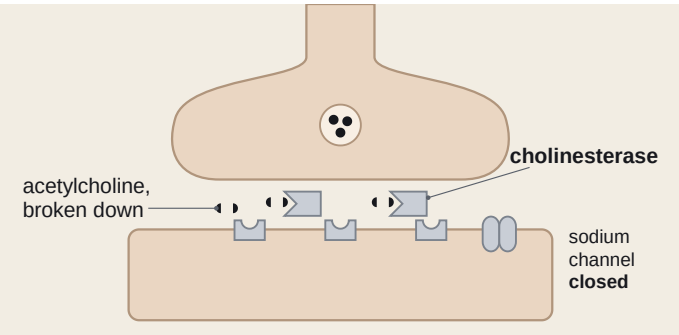
Explain why a message slows down at a synapse.

1. The neurotransmitter crosses by diffusion.
2. Diffusion is slow.

Slide 3 of 6 · Acetylcholine and cholinesterase

On the last slide, a neurotransmitter bound to receptors and sodium channels opened. Here is one neurotransmitter by name, and how it is cleared away.





Key ideas

Acetylcholine is a neurotransmitter. It opens sodium channels.

While it stays on the receptors, the sodium channels stay **open**.

The enzyme **cholinesterase** breaks down acetylcholine.

Then the postsynaptic cell can **recover**.

Example

State the job of cholinesterase.

1. It is an enzyme.
2. It breaks down acetylcholine, so the sodium channels close.

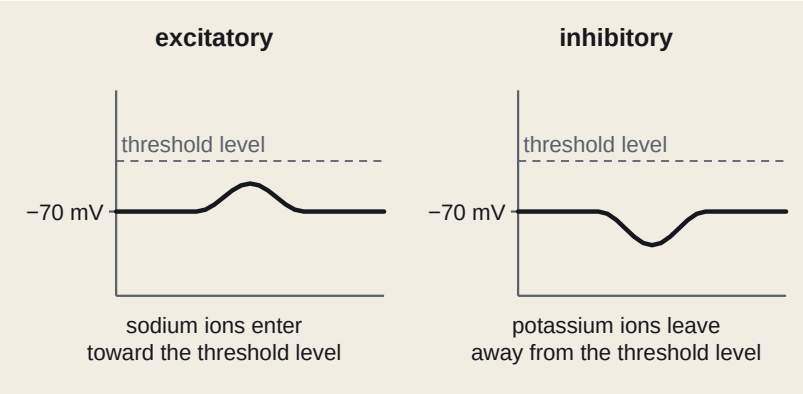
Try it

Predict what happens to a muscle if acetylcholine is not broken down.

1. Acetylcholine stays on the receptors.
2. The sodium channels stay open.
3. The muscle stays contracted.

Slide 4 of 6 · Excitatory and inhibitory neurotransmitters

On the last slide, acetylcholine opened sodium channels and excited the next cell. Some neurotransmitters do the opposite.



Key ideas

An **excitatory** neurotransmitter lets sodium ions in. The neuron moves toward the threshold level.

An **inhibitory** neurotransmitter lets potassium ions out. The neuron moves away from it.

Acetylcholine is excitatory at **skeletal muscles**.

Norepinephrine can be excitatory or inhibitory.

Example

An inhibitory neurotransmitter binds to a neuron. State which ion moves and which way.

1. Potassium channels open.
2. Potassium ions leave the neuron.
3. The inside becomes more negative.

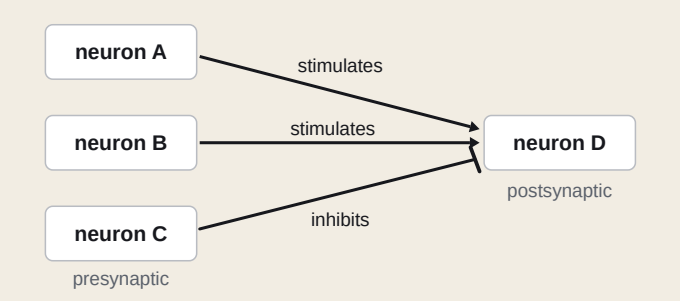
Try it

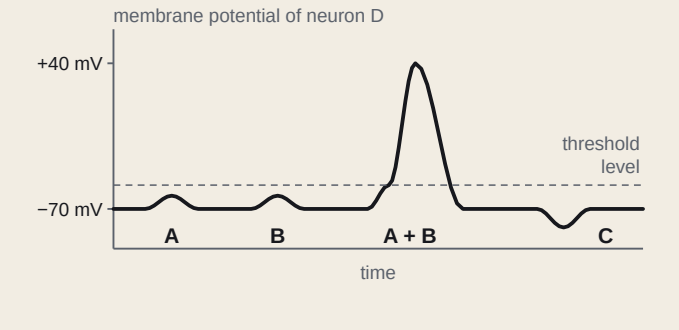
An excitatory neurotransmitter binds to a neuron. State which ion moves and which way.

1. Sodium channels open.
2. Sodium ions enter the neuron.
3. The neuron moves toward the threshold level.

Slide 5 of 6 · Summation

On the last slide, one neurotransmitter acted on one neuron. A real neuron has synapses with many neurons at once.





Key ideas

One neuron may not move the next neuron to the **threshold level**.

Two neurons **together** may reach it.

Adding the effects of two or more neurons is **summation**.

Example

Neuron A alone cannot make neuron D fire. Neuron B alone cannot. Together they can. Name this effect.

1. Each one moves D part of the way to the threshold level.
2. Together the effects add up.
3. This is summation.

Try it

Neurons A and B are excitatory and C is inhibitory. All three fire. Is D more or less likely to fire than with A and B alone? Explain.

1. C moves D away from the threshold level.
2. So D is less likely to fire.

Slide 6 of 6 · Method: what a drug or toxin does at a synapse

Many drugs and toxins act at synapses. A toxin is a poison made by a living thing. These four steps predict the effect of any of them.

1. **Find** what the drug or toxin changes at the synapse.
2. **Decide** if more or less neurotransmitter reaches the receptors.
3. **Check** if the neurotransmitter is excitatory or inhibitory.
4. **State** what the postsynaptic cell does.



Check: more of an excitatory neurotransmitter means more firing.

Used again in: the page for this lesson

Key ideas

Step 1: find what the drug or toxin **changes** at the synapse.

Step 2: decide if **more or less** neurotransmitter reaches the receptors.

Step 3: check if the neurotransmitter is **excitatory** or inhibitory.

Step 4: state what the **postsynaptic cell** does.

Example

Use the four steps. An insecticide stops cholinesterase from working at a muscle.

1. It changes the breakdown: acetylcholine is not broken down.
2. More acetylcholine stays on the receptors.
3. Acetylcholine is excitatory at a muscle.
4. The muscle contracts and cannot relax.

Try it

Use the four steps. A toxin stops vesicles from releasing acetylcholine at a muscle.

1. It changes the release: no acetylcholine is released.
2. Less neurotransmitter reaches the receptors.
3. Acetylcholine is excitatory at a muscle.
4. The muscle cannot contract.