

Chemical signalling **HL only**

**What is a receptor?**

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**Ligand**

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**What is quorum sensing?**

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**How does *Vibrio fischeri* use quorum sensing?**

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**Name the four functional categories of signalling chemicals in animals.**

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**Three chemical groups of hormones, with an example of each.**

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**Chemical groups of neurotransmitters**

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**Contrast the spread of hormones and neurotransmitters.**

The signalling chemical that binds to the binding site of a receptor.

A protein with a binding site for a specific signalling chemical.

Its signalling chemical builds up at high density, binds receptors, and promotes transcription of genes for bioluminescence.

Cell signalling by bacteria in which they detect their own population density and respond only when it is high.

Amines (epinephrine), proteins (insulin), steroids (oestradiol).

Hormones, neurotransmitters, cytokines and calcium ions.

Hormones are transported in the blood (distant effects); neurotransmitters diffuse across a synaptic gap (localized effects).

Amino acids (glutamate), peptides (endorphins), amines (dopamine) and the gas nitric oxide.

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**Distribution of amino acids in a transmembrane receptor**

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**Which ligands bind intracellular receptors?**

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**Signal transduction pathway**

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**What happens when acetylcholine binds its receptor?**

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**How does a G protein-coupled receptor convey a signal into a cell?**

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**Epinephrine pathway in order**

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**Why do 'adrenaline' and 'epinephrine' both exist?**

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**What does the tyrosine kinase activity of the insulin receptor do?**

Hydrophobic ligands such as steroid hormones, which pass through the plasma membrane into the cell.

Hydrophobic amino acids in the region within the membrane; hydrophilic amino acids in the parts facing water on either side.

An ion channel in the receptor opens, positive ions ( $\text{Na}^+$ ) diffuse in and the membrane potential changes.

The sequence of responses within a cell set off by binding of a signalling chemical to a receptor.

Receptor  $\rightarrow$  G protein  $\rightarrow$  adenylyl cyclase  $\rightarrow$  cAMP (second messenger)  $\rightarrow$  protein kinase A  $\rightarrow$  cascade, e.g. glycogen breakdown.

Ligand binding changes the receptor's shape, activating a G protein (GDP swapped for GTP) that activates or inhibits a target protein.

Phosphorylates tyrosine inside the cell, starting reactions that move vesicles of glucose transporters to the plasma membrane.

Both names refer to production by the adrenal gland above the kidney, from Latin and Greek roots; both persist in use.

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**Why does insulin increase glucose uptake?**

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**How do steroid hormones affect gene expression?**

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**Target cells of oestradiol (IB example)**

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**Effect of progesterone on the endometrium**

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**Negative vs positive feedback**

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**Example of negative feedback in signalling**

Neural signalling

**Neuron**

Neural signalling

**Axon vs dendrites**

They bind and activate an intracellular receptor, which binds specific DNA sequences and promotes transcription.

More glucose transporters are inserted into the plasma membrane, so glucose enters faster by facilitated diffusion.

Maintains the thickened endometrium and its blood supply, ready for implantation.

Cells in the hypothalamus that secrete GnRH. Sustained high oestradiol late in the follicular phase increases GnRH secretion; lower levels inhibit it.

Insulin lowers blood glucose, and lower glucose reduces insulin secretion.

Negative: the response reduces the stimulus (stabilizes). Positive: the response increases the stimulus (amplifies).

Axon: one long single fibre. Dendrites: multiple shorter fibres. Both project from the cell body.

A cell within the nervous system that carries electrical impulses.

Neural signalling

## Sodium-potassium pump

Neural signalling

## Three reasons the resting potential is negative

Neural signalling

## Nerve impulse

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## Why is a nerve impulse electrical?

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## Threshold potential

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## Ion movements in depolarization and repolarization

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## Local currents

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## Axes of an oscilloscope trace of an action potential

More positive ions pumped out than in;  $K^+$  leaks out faster than  $Na^+$  leaks in; negatively charged proteins stay inside.

Uses ATP to pump 3  $Na^+$  out and 2  $K^+$  in, establishing and maintaining concentration gradients.

It involves movement of positively charged ions ( $Na^+$  and  $K^+$ ) across the membrane.

An action potential propagated along a nerve fibre.

Depolarization:  $Na^+$  channels open,  $Na^+$  in.  
Repolarization:  $K^+$  channels open,  $K^+$  out.

About  $-55$  mV: the membrane potential that must be reached for voltage-gated sodium channels to open.

Membrane potential (mV) on the y-axis  
against time (ms) on the x-axis.

Diffusion of  $Na^+$  along the inside and outside of the axon that brings the next region to threshold.

Neural signalling

**Two factors that increase impulse speed**

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**Coefficient of determination ( $R^2$ )**

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**Saltatory conduction**

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**Synapse**

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**Role of calcium ions at a synapse**

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**Excitatory postsynaptic potential**

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**Where is acetylcholine used as a neurotransmitter?**

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**How do neonicotinoids affect insect synapses?**

r squared: the proportion of variation in the dependent variable explained by variation in the independent variable.

Larger axon diameter and myelination.

A junction between neurons or between a neuron and an effector cell.

Propagation of an action potential from node to node of Ranvier in myelinated fibres, giving faster impulses.

Depolarization of the postsynaptic membrane when a neurotransmitter such as acetylcholine binds receptors and positive ions enter.

Enter the presynaptic neuron on depolarization and act as a signal for vesicles to release neurotransmitter by exocytosis.

Bind to acetylcholine receptors and are not broken down, blocking synaptic transmission.

At many types of synapse, including neuromuscular junctions, where it triggers contraction of muscle fibres.

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**Inhibitory postsynaptic potential**

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**Summation**

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**How do free nerve endings detect pain?**

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**Consciousness as an emergent property**

Adding the effects of excitatory and inhibitory inputs; an action potential occurs only if threshold is reached (all-or-nothing).

Hyperpolarization of the postsynaptic membrane by an inhibitory neurotransmitter, making an action potential less likely.

A property that emerges from the interaction of individual neurons in the brain, not present in any single neuron.

Channels for positive ions open in response to heat, acid or capsaicin; ions enter, threshold is reached, impulses go to the brain.