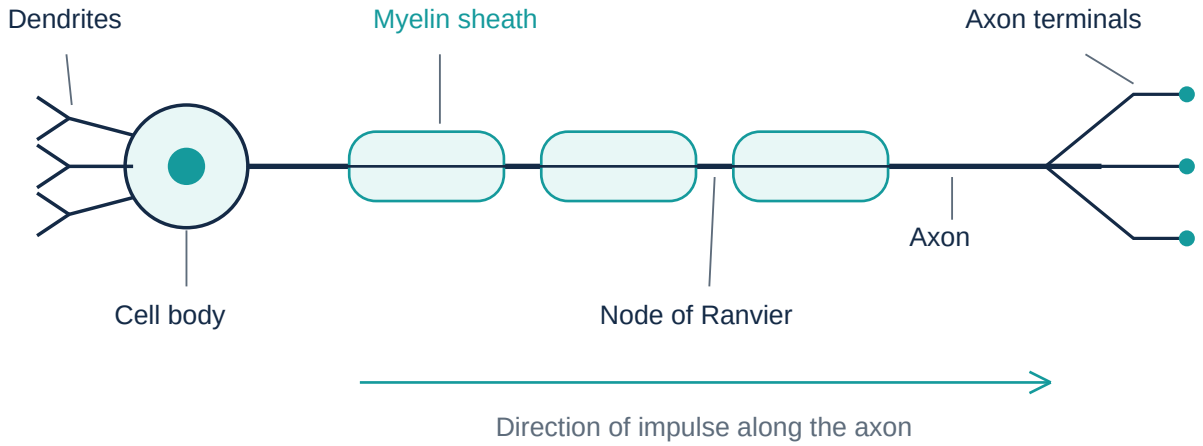
A cell specialised for signalling

Neurones transmit impulses between receptors, the central nervous system (CNS: brain and spinal cord), and effectors such as muscles and glands.

1. A MYELINATED MOTOR NEURONE



2. THREE ROLES IN A NERVOUS PATHWAY

Sensory	From receptors to the CNS; typically has a cell body on a side branch of a long process.
Relay / intermediate	Connects neurones within the CNS; often has a short axon and many branches.
Motor	From the CNS to an effector; usually has a cell body with branched dendrites and a long axon.

3. A RECEPTOR CONVERTS A STIMULUS

For example, a dissolved chemical stimulates a taste-bud receptor cell, changing its membrane potential. Depolarisation triggers transmitter release onto a sensory neurone. If the neurone reaches threshold, action potentials travel to the CNS. The receptor potential is graded; the resulting action potentials are all-or-nothing.

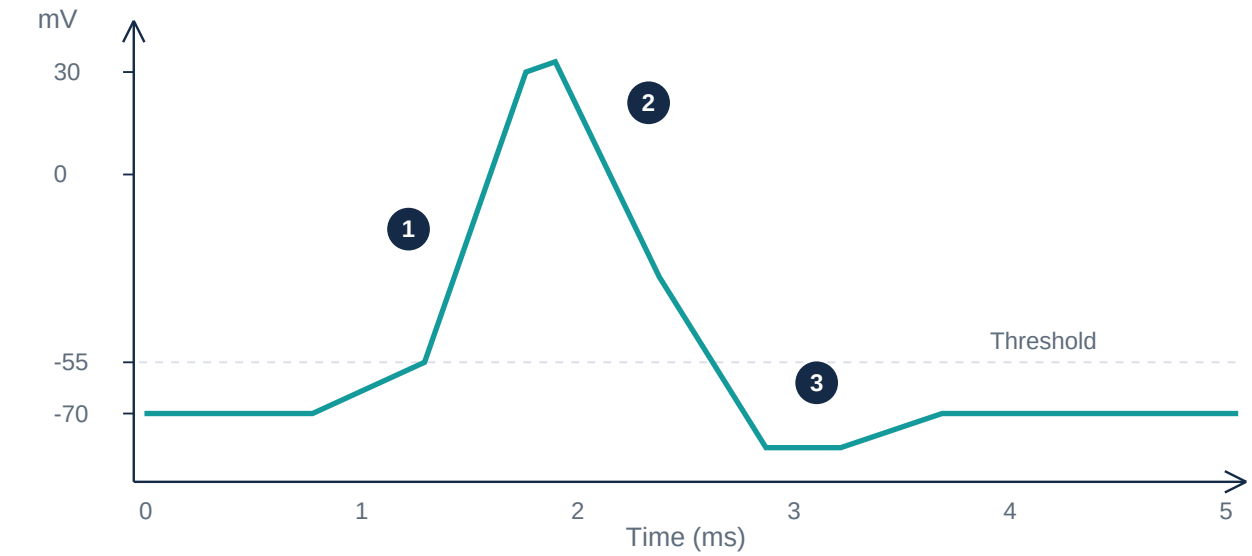
Neurone structures and myelin: OpenStax, Biology 2e 35.1.
Taste receptor transduction: OpenStax, Biology 2e 36.3.

Scope: Cambridge Biology 9700, section 15.1, outcomes 1-8, p. 39.

An action potential changes voltage

Membrane potential is the voltage inside relative to outside. Typical values below are illustrative; exact resting and threshold potentials vary among neurones.

1. READ ONE SPIKE AT ONE MEMBRANE LOCATION



Schematic time course, not experimental measurements.

2. RESTING POTENTIAL: ABOUT -70 mV

Na^+ concentration is higher outside; K^+ concentration is higher inside. The sodium-potassium pump uses ATP to move three Na^+ out for every two K^+ in. It maintains these gradients. At rest, greater permeability to K^+ through leak channels is a major reason the inside is negative.

3. MATCH THE NUMBERED PHASES TO ION MOVEMENT

1. Depolarisation: threshold opens voltage-gated Na^+ channels. Na^+ enters down its electrochemical gradient, opening further channels.

2. Repolarisation: Na^+ channels inactivate; delayed voltage-gated K^+ channels open. K^+ leaves, making the inside negative again.

3. Hyperpolarisation: K^+ channels close slowly, briefly making the potential more negative than rest. Leak currents restore the resting voltage.

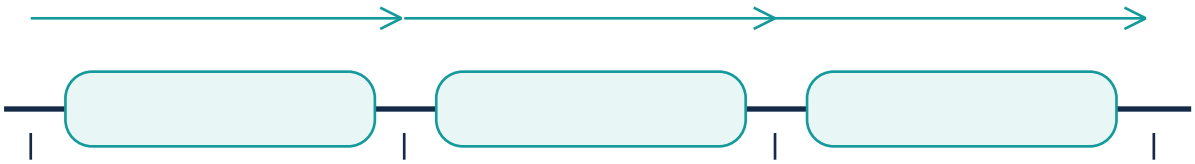
Membrane gradients and voltage-gated channels: OpenStax, Biology 2e 35.2.
Phases and refractory periods: OpenStax, Anatomy and Physiology 2e 12.4.

Scope: Cambridge Biology 9700, section 15.1, outcomes 1-8, p. 39.

Regenerate the impulse along the axon

Local currents from an active region depolarise the next excitable membrane region to threshold. A new action potential forms; the signal does not fade along a healthy axon.

1. MYELIN ENABLES SALTATORY CONDUCTION



Myelin insulates the axon. Voltage-gated channels are concentrated at the gaps (nodes of Ranvier), where spikes are regenerated. Local current spreads under the myelin: "jumping" describes the pattern, not ions leaping between nodes.

2. REFRACTORY PERIOD: RECOVERY TAKES TIME

During the absolute refractory period, inactivated Na^+ channels cannot reopen immediately. During the relative refractory period, a stronger stimulus may trigger a spike. Recovery of channels and membrane voltage limits maximum impulse frequency. The recently active region is refractory, favouring forward propagation during normal signalling.

3. STRONGER STIMULUS DOES NOT MEAN A TALLER SPIKE

For a given neurone, an action potential is all-or-nothing once threshold is reached. Stimulus strength is commonly encoded by impulse frequency and recruitment of additional neurones, not larger action potentials. The pump maintains ion gradients over time; it is not the direct cause of the rapid falling phase.

4. NERVOUS VERSUS ENDOCRINE COORDINATION

Nervous signalling uses impulses along neurones and transmitter release at junctions; effects are usually rapid and localised. Endocrine glands release hormones into blood; only cells with suitable receptors respond. Hormonal effects are often slower and longer-lasting. Insulin, glucagon and ADH are endocrine examples.

Propagation, myelin and coding: OpenStax, Biology 2e 35.2.
Coordination comparison: Cambridge Biology 9700, section 15.1.

Scope: Cambridge Biology 9700, section 15.1, outcomes 1-8, p. 39.