

Neurones, reflexes and the nervous system

Revision notes · Sensory, relay and motor neurones, myelin and Schwann cells, the CNS and PNS, and the spinal reflex arc with grey and white matter.

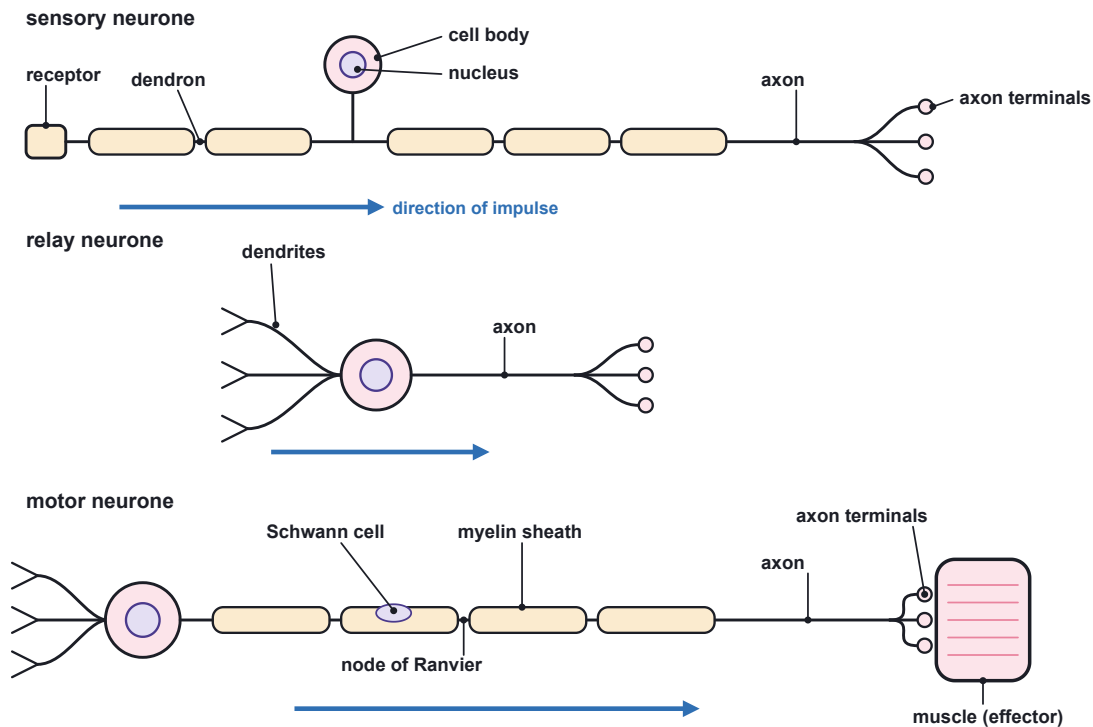
For Pearson Edexcel International AS Biology XBI11 and International A Level Biology YBI11. **A Level only** is IA2 content (Units 4 to 6), not needed for the International AS.

Neurones, reflexes and the nervous system Spec 8.1-8.3, 8.10 A Level only

Sensory, relay and motor neurones Spec 8.1

A **neurone** is a nerve cell specialised to conduct **nerve impulses** (action potentials) as rapid electrical signals. Each has a **cell body** containing the nucleus and organelles, extensions called **dendrites** or a **dendron** that carry impulses towards the cell body, and a long **axon** that carries impulses away from it. There are three types, which differ in structure because their jobs and positions in a pathway differ.

Sensory, relay and motor neurones compared			
Feature	Sensory neurone	Relay neurone	Motor neurone
Function	Carries impulses from a receptor to the central nervous system (CNS)	Carries impulses between sensory and motor neurones, entirely inside the CNS	Carries impulses from the CNS to an effector (a muscle or gland)
Position of cell body	Just outside the spinal cord, in a swelling of the dorsal root called the dorsal root ganglion; the cell body sits to one side of the long fibre	Inside the CNS, in the grey matter	Inside the CNS, in the grey matter; the cell body is at the start of the neurone
Dendrites and axon	One long dendron brings impulses from the receptor to the cell body; a shorter axon takes them into the CNS	Many short processes, with numerous dendrites and a short axon, giving many synapses	Many short dendrites on the cell body; one very long axon runs out to the effector
Myelin	Axon and dendron usually myelinated	Often unmyelinated or with a thin sheath because the distances are short	Axon usually myelinated, allowing fast conduction over a long distance



The **sensory, relay and motor neurones** of a reflex pathway; arrows show the direction of the impulse.

Schwann cells are glial cells that wrap their plasma membrane many times around an axon in the peripheral nervous system. The layers of membrane are rich in lipid, and together they form the **myelin sheath**. Myelin is an electrical insulator: ions cannot cross it. The sheath is interrupted by small gaps, about 1 mm apart, called **nodes of Ranvier**, where the axon membrane is exposed. Schwann cells also support the axon and help to repair it if it is damaged.

Exam tip: Describe the structure and the function for each neurone. A common mark is for the position of the cell body: sensory cell body in the dorsal root ganglion, relay and motor cell bodies in the grey matter of the CNS.

The nervous system and its effectors Spec 8.2, 8.10

The mammalian **nervous system** has two parts. The **central nervous system (CNS)** is the brain and spinal cord. The **peripheral nervous system (PNS)** is all the neurones outside the CNS: the cranial and spinal nerves that connect the CNS to receptors and effectors. The PNS contains sensory neurones, which bring information into the CNS, and motor neurones, which carry instructions out.

Parts of the mammalian nervous system		
Part	Made up of	Role
Central nervous system (CNS)	Brain and spinal cord	Receives and processes information, then sends out impulses; the coordinator
Peripheral nervous system (PNS)	Sensory and motor neurones in nerves outside the brain and spinal cord	Links receptors to the CNS and the CNS to effectors

Nervous systems allow an organism to respond to a **stimulus**, a change in the internal or external environment. The response follows a fixed sequence:

1. A **receptor** detects the stimulus and converts its energy into electrical energy, producing a nerve impulse.
2. A **sensory neurone** carries the impulse to the CNS.

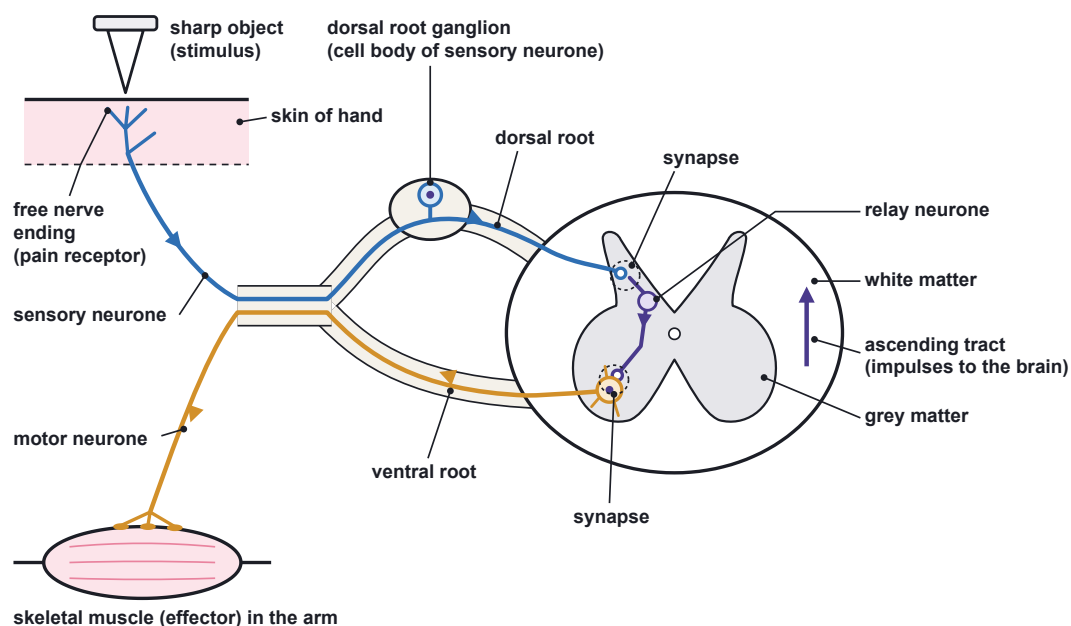
3. The CNS acts as the **coordinator**: relay neurones pass the impulse on and, in the brain, the information is processed.
4. A **motor neurone** carries impulses from the CNS to an **effector**.
5. The effector responds: a muscle contracts or a gland secretes.

Common mistake: The effector is the muscle or gland, not the motor neurone. The spinal cord is part of the CNS, but the nerves leaving it belong to the PNS.

The spinal reflex arc Spec 8.3

A **reflex** is a rapid, automatic response to a stimulus that does not involve conscious thought. The pathway is a **reflex arc**. In a **spinal reflex arc** the neurones pass through the spinal cord, so the response does not wait for the brain. This makes it fast, which is protective: for example, the withdrawal of a hand from a hot object.

In cross-section the spinal cord has an inner, butterfly-shaped region of **grey matter** surrounded by **white matter**. Grey matter contains the cell bodies of relay and motor neurones and many synapses. White matter looks pale because it consists of the myelinated axons of neurones, which run up and down the cord carrying impulses to and from the brain. A fluid-filled central canal runs through the middle.



A **reflex arc** through the spinal cord: receptor, sensory neurone, relay neurone, motor neurone, effector.

Adapted from an IB-style diagram drawn for this site.

1. A receptor (for example a pain receptor in the skin) detects a stimulus and generates an impulse.
2. The impulse passes along a sensory neurone, whose cell body lies in the dorsal root ganglion, into the spinal cord by the dorsal root.
3. In the grey matter the sensory neurone synapses with a relay neurone.
4. The relay neurone synapses with a motor neurone.
5. The motor neurone carries the impulse out by the ventral root to an effector (a muscle), which contracts to withdraw the limb.

At the same time, relay neurones pass impulses up the white matter to the brain, so you become aware of the stimulus after the response has begun. The brain can also send impulses down the cord to override some reflexes.

Exam tip: Link structure to function in a reflex: few synapses and a short pathway mean a faster response, and the response is automatic so it protects the body before pain is felt.

Quick check

1. Where is the cell body of a sensory neurone found?
2. What is myelin made from?
3. Name the two parts of the mammalian nervous system.
4. What does the white matter of the spinal cord contain?

Quick check answers

Neurones, reflexes and the nervous system

1. In the dorsal root ganglion, just outside the spinal cord.
2. Many layers of the plasma membrane of Schwann cells, which are rich in lipid.
3. The central nervous system (brain and spinal cord) and the peripheral nervous system.
4. Myelinated axons carrying impulses up and down the cord.