

## Colour Key

- Key technical terms
- Key concepts + important points
- Highly \*examinable\* content
- Headings
- Subheadings

## Neurophysiology

**Neurophysiology** = the study of how the nervous system functions

→ It focuses on how signals are generated, transmitted, and processed within:

- The **central nervous system (CNS)** = Brain + spinal cord; functions as the body's control centre
- The **peripheral nervous system (PNS)** links the CNS to the rest of the body, and has **two main functions**
  - 1) Transmits sensory information from peripheral structures (eg arms, legs, hands) to the CNS
  - 2) Conducts motor commands from the CNS to the muscles to produce responses
- The **enteric nervous system (ENS)** = the huge network of neurons (~ 500 million) that manage **gastrointestinal functions**
  - The ENS is considered **semi-autonomous**: it is **capable** of operating independently of the brain and spinal cord, however, it **often communicates with the CNS to coordinate digestion**

**Neurons** = the primary working units of the nervous system. They're **excitable cells**, meaning they can **generate** and **propagate electrical signals** due to their membrane properties

→ The nervous system also includes **glial cells**, which provide structural and functional support to neurons

### Types of Glia

#### 1. Oligodendrocytes:

- Responsible for **myelinating CNS neurons** (ie, adding a fatty myelin sheath)
  - **Myelin** → speeds up signal transmission by 10x
- A single oligodendrocyte can myelinate multiple axons

#### 2. Schwann Cells:

- Responsible for **myelinating PNS neurons**
- Each Schwann cell myelinates **only one segment** of a **single axon**

#### 3. Microglia:

- Act as CNS's resident immune cells
- Responsible for **synaptic pruning**; breaking down synapses that are minimally active to optimise neural efficiency
- Tags damaged neurons with **complement proteins** so that they can be **repaired** or **phagocytosed** by other immune cells (eg phagocytes)
- Respond to neuronal damage by releasing **inflammatory cytokines** to notify other immune cells of damage
  - NOTE: **overactive microglia** are implicated in **neurodegenerative diseases** (eg Alzheimer's) and can contribute to **chronic inflammation**

#### 4. Astrocytes:

- Support neurons in a number of ways:

- **Clear GABA** and **glutamate** from the synapse, so they can be repackaged and re-used, or broken down
- Connect neurons to blood vessels

→ This is important because **neurons have virtually no capacity to store energy**, so they need to receive a continuous supply of energy in the form of **plasma glucose**

### 5. Ependymal Cells:

- Line the **ventricles** (fluid-filled structures in the brain)
- Help form the **BBB**, which regulates what substances are allowed to get into the CNS

### 6. Radial Glia:

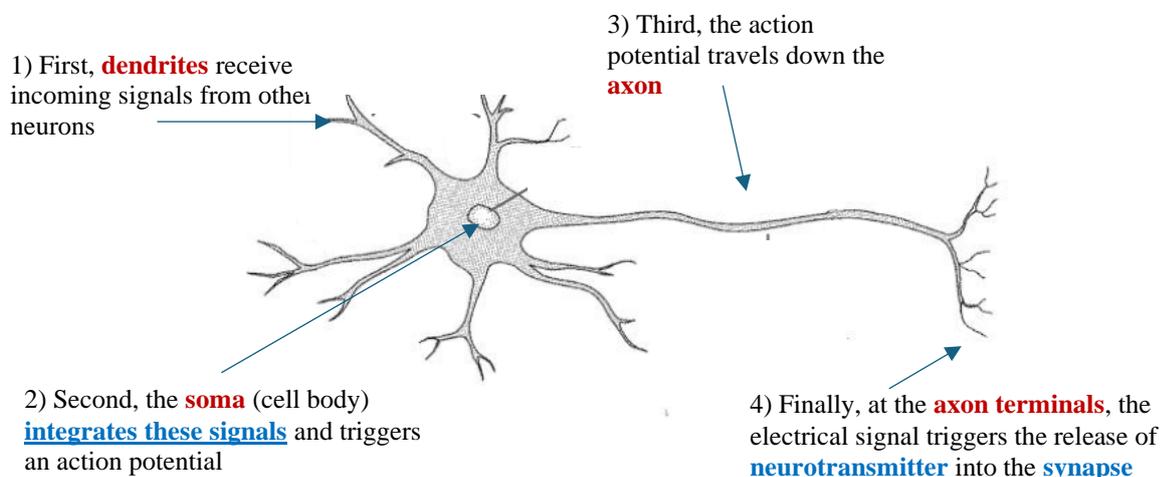
- Act as scaffolding during development → guide newly formed neurons to their proper positions in the brain

## Classifying Different Neuron Types

Neurons can be grouped based on several characteristics:

- Morphology:** the **shape, structure** and **physical characteristics** of a neuron
  - For example, **pyramidal neurons** have a triangular cell body and long axons, which help them send signals across different layers of the brain
- Location:** where they reside
  - For example, **sensory neurons** reside in the **sensory cortex**
- Function:** what the neurons do
  - For example, neurons can be **excitatory, inhibitory, motor-specific**, etc
- Neurotransmitter:** the substances they respond to and release, which can be identified through
  - **Immunohistochemistry** = A technique that involves using **antibodies** to tag neurotransmitters so that we can identify their **distribution** and **location**
  - **In situ hybridisation** = Involves identifying DNA and RNA sequences involved in **neurotransmitter production**

## Information Flow in Neurons



**Practice Questions**

**1. A difference between Schwann cells and oligodendrocytes is that...**

- A) Schwann cells myelinate multiple axons, while oligodendrocytes myelinate only a single axon
- B) Schwann cells are found exclusively in the CNS, whereas oligodendrocytes are found in the PNS
- C) Schwann cells provide immune defense in the CNS, whereas oligodendrocytes produce CSF
- D) Schwann cells are limited to one segment of a single axon, while oligodendrocytes can myelinate several axons

**2. Why are Nodes of Ranvier functionally important?**

- A) They regenerate action potentials through clusters of voltage-gated Na<sup>+</sup> and K<sup>+</sup> channels
- B) They insulate axons, preventing ion leakage during signal transmission
- C) They produce myelin to accelerate action potential conduction
- D) They facilitate unidirectional axo-somatic signal flow in neurons

**3. Which of the following glial cell types is incorrectly matched with its function?**

- A) Astrocytes: Form the blood-brain barrier and clear synaptic neurotransmitters
- B) Ependymal Cells: Line ventricles and contribute to the blood-brain barrier
- C) Microglia: Generate cerebrospinal fluid and provide neural stem cells
- D) Oligodendrocytes: Myelinate multiple axons in the CNS

**4. Which of the following characteristics is unique to cholinergic neurons compared to other types of neurons?**

- A) Ability to release acetylcholine as a neurotransmitter
- B) Presence of axo-somatic synapses to enable rapid communication
- C) Exclusive use of in situ hybridisation for identification
- D) Excitation of motor neurons in both CNS and PNS

**5. Which of the following statements about radial glia is true?**

- A) Radial glia line the brain's ventricles and produce CSF
- B) Radial glia guide newly formed neurons to their target locations during development
- C) Radial glia myelinate axons during early stages of neurodevelopment
- D) Radial glia connect blood vessels to neurons to regulate extracellular ions

**6. What distinguishes astrocytes from satellite cells?**

- A) Astrocytes are found exclusively in the PNS, whereas satellite cells reside in the CNS
- B) Astrocytes form the blood-brain barrier, while satellite cells do not
- C) Satellite cells regulate ion concentrations, while astrocytes primarily provide structural support
- D) Satellite cells clear neurotransmitters in synaptic clefts, while astrocytes produce CSF

**7. What mechanism allows astrocytes to prevent hyperexcitability in neurons?**

- A) Astrocytes buffer excess Cl<sup>-</sup> released during neuronal firing, preventing inhibitory feedback
- B) Astrocytes release gliotransmitters that directly hyperpolarise neuronal membranes
- C) Astrocytes buffer excess K<sup>+</sup> using connexons and spatial buffering mechanisms
- D) Astrocytes increase intracellular Ca<sup>2+</sup> to deactivate voltage-gated Na<sup>+</sup> channels