

# WJEC (Wales) Biology A-level

## Unit 3.8 - The nervous system

### Flashcards

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State the components of a nervous response.



# State the components of a nervous response.

- Receptors
- Effectors
- Nervous system or hormones transfer information from receptors to effectors



Name the two main divisions of the nervous system.



Name the two main divisions of the nervous system.

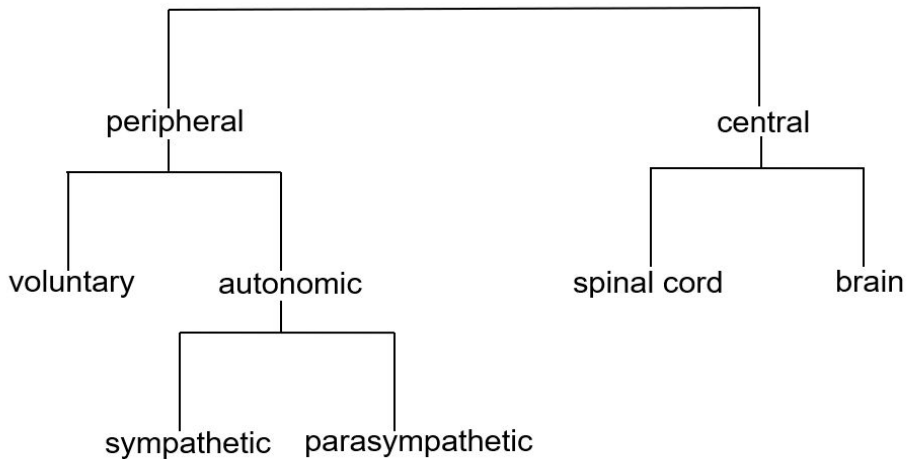
- Central nervous system (CNS)
- Peripheral nervous system (PNS)



Outline the gross structure of the mammalian nervous system.



# Outline the gross structure of the mammalian nervous system.



# What is the central nervous system (CNS)?





# What is the central nervous system (CNS)?

## Brain and spinal cord.



# What is the peripheral nervous system (PNS)?



# What is the peripheral nervous system (PNS)?

Pairs of nerves that originate from the CNS and carry nerve impulses into and out of the CNS.



Fill in the  
 missing labels  
 in this diagram  
 of a spinal  
 cord.

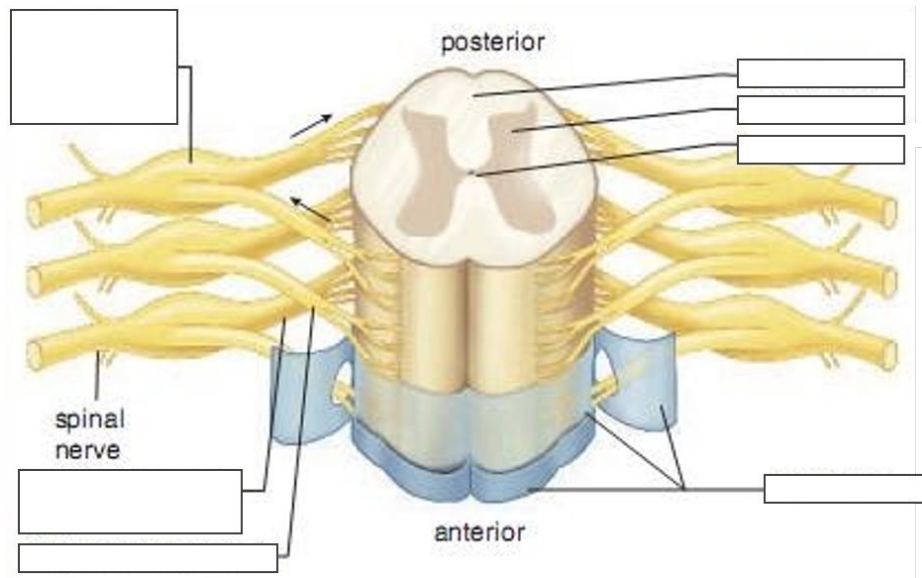


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Fill in the missing labels in this diagram of a spinal cord.

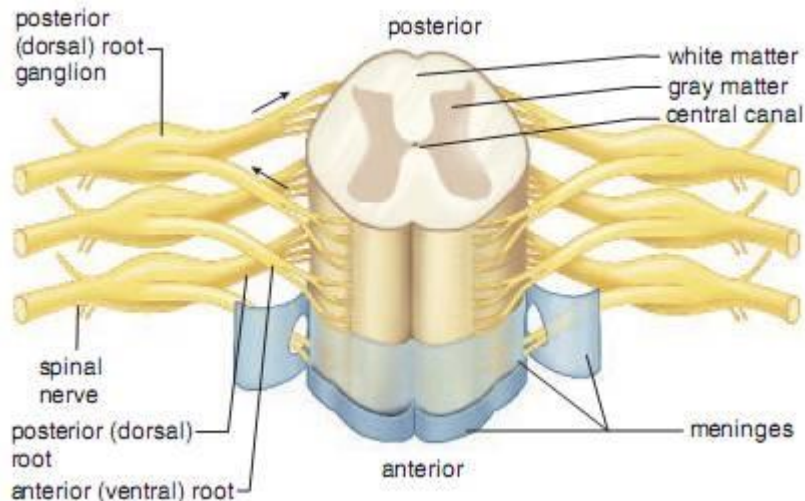


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# What is the dorsal root?



## What is the dorsal root?

- One of two roots that emerges from the spinal cord
- Travels to the dorsal root ganglion
- Sensory neurones enter the spinal cord via the dorsal root



# What is the ventral root?





## What is the ventral root?

- One of two roots that emerges from the spinal cord
- Motor neurones leave the spinal cord via the ventral root



# What is a reflex?



## What is a reflex?

A rapid, automatic response to a sensory stimulus by the body. It serves as a protective mechanism.



Outline a simple reflex arc.



Outline a simple reflex arc.

stimulus → receptor → sensory neurone →  
relay neurone (in CNS) → motor neurone →  
effector → response



# How does a reaction differ from a reflex?



## How does a reaction differ from a reflex?

- Reaction is voluntary and coordinated by the brain
- Reflex is non-voluntary and does not involve the brain



# What is a nerve net?





# What is a nerve net?

- Simplest form of nervous system found in Cnidarians
- Consists of interconnected nerve cells with short extensions allowing a response to a limited number of stimuli



State the three types of functional neurones.



State the three types of functional neurones.

- Sensory neurone
- Relay neurone
- Motor neurone



State the function of a sensory neurone.



State the function of a sensory neurone.

Carries nerve impulses from the receptors to the CNS via the dorsal root.



State the function of a motor neurone.



State the function of a motor neurone.

Carries nerve impulses from the CNS to the effectors via the ventral root.



Describe the structure of a motor neurone.



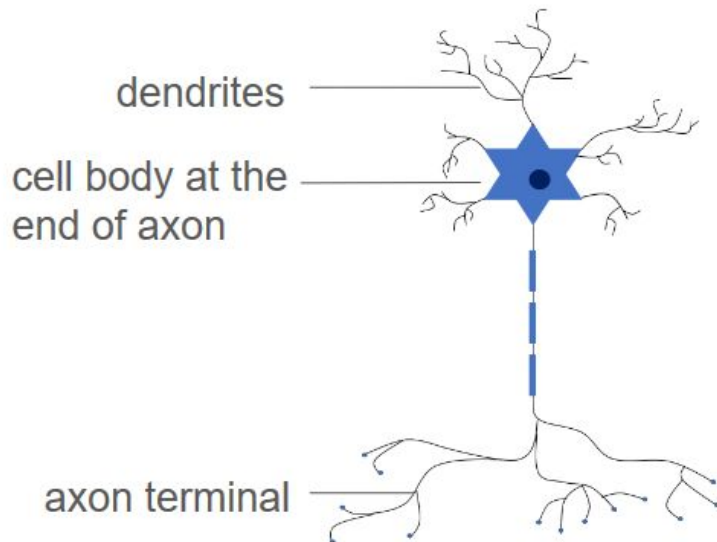


# Describe the structure of a motor neurone.

**Short dendrites** carry impulses from CNS to cell body

Cell body found at **one end** of neurone

**Long axon** carries impulses from cell body to effectors



State the function of a relay neurone.



State the function of a relay neurone.

- Located in the spinal cord
- Links the sensory neurone to the motor neurone



# What is the function of dendrites?



# What is the function of dendrites?

- Short, branched extensions of the cell body
- Receive nerve impulses from other neurones



Describe the cell body.



Describe the cell body.

The region of the neurone that contains the organelles, notably the nucleus and the rough endoplasmic reticulum.



# What is the function of the axon?





# What is the function of the axon?

A long fibre that conducts nerve impulses away from the cell body.



# What are axon terminals?



# What are axon terminals?

Branched endings of an axon that approach the muscle fibre.



# What is a synaptic end bulb?



# What is a synaptic end bulb?

The end of an axon that is bulbous shaped and contains synaptic vesicles filled with neurotransmitters.



Describe the additional features of a myelinated neurone.



# Describe the additional features of a myelinated neurone.

**Schwann cells:** wrap around axon; involved in electrical insulation, phagocytosis, nerve regeneration

**Myelin sheath:** made from myelin-rich membranes of Schwann cells

**Nodes of Ranvier:** small gaps between neighbouring Schwann cells where there is no myelin sheath

Electron micrograph of myelinated axon

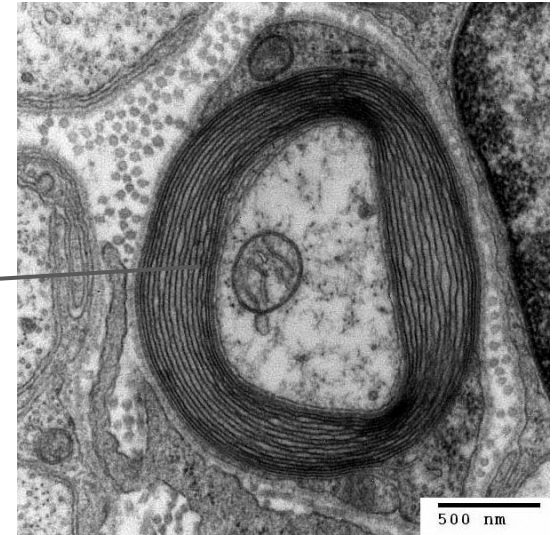


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Define action potential.





Define action potential.

The temporary change in electrical potential across the membrane of an axon in response to the transmission of a nerve impulse.



# What is resting potential?



# What is resting potential?

Potential difference (voltage) across a neurone membrane when not stimulated (-70 mV).



# How is resting potential established?



# How is resting potential established?

- Membrane more permeable to  $K^+$  than  $Na^+$
- Sodium-potassium pump actively transports **3Na<sup>+</sup> out** of cell and **2K<sup>+</sup> into** cell
- Organic phosphates and large protein anions remain in cytoplasm
- Establishes **electrochemical gradient**: cell contents more negative than extracellular environment



Name the stages of an action potential.



Name the stages of an action potential.

1. Depolarisation
2. Repolarisation
3. Hyperpolarisation
4. Return to resting potential



# What happens during depolarisation?





# What happens during depolarisation?

1. Stimulus causes a change in the voltage across an axon membrane, opening voltage-gated  $\text{Na}^+$  channels
2.  $\text{Na}^+$  diffuse into the axon
3. Potential difference across membrane becomes more positive, membrane **depolarises**



# What happens during repolarisation?



# What happens during repolarisation?

1. Membrane potential reaches **+40 mV**
2. Voltage-gated  $\text{Na}^+$  channels close and voltage-gated  $\text{K}^+$  channels open
3. Facilitated diffusion of  $\text{K}^+$  ions out of cell down their electrochemical gradient
4. Potential difference across membrane becomes more **negative**, membrane **repolarises**



# What happens during hyperpolarisation?



# What happens during hyperpolarisation?

1. 'Overshoot' when  $K^+$  ions diffuse out
2. Potential difference becomes more negative than resting potential
3. Membrane **hyperpolarises**, preventing another impulse occurring



# What is the refractory period?



# What is the refractory period?

Time period after an action potential during which further action potentials are prevented.



# Why is the refractory period important?





Why is the refractory period important?

Ensures that action potentials can only be propagated in one direction.



Describe the shape of an oscilloscope trace showing the passage of an action potential.



# Describe the shape of an oscilloscope trace showing the passage of an action potential.

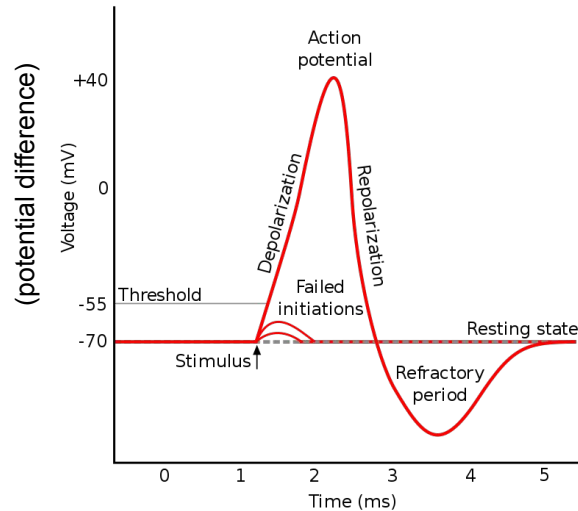


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Describe the 'all or nothing' law.



Describe the 'all or nothing' law.

Principle that states that all stimuli above a certain threshold value will generate the same size of action potential, regardless of the strength of the stimulus.



State the factors affecting the speed of conduction of a nervous impulse.



State the factors affecting the speed of conduction of a nervous impulse.

- Temperature
- Axon diameter
- Myelin sheath



Explain why myelinated axons conduct impulses faster than unmyelinated axons.





Explain why myelinated axons conduct impulses faster than unmyelinated axons.

**Saltatory propagation:** Impulse ‘jumps’ from one node of Ranvier to another (depolarisation cannot occur where myelin sheath acts as electrical insulator). Therefore, impulse does not travel along whole axon length.



How does temperature affect the speed of conduction of nervous impulses?



How does temperature affect the speed of conduction of nervous impulses?

The higher the temperature, the faster the speed of conduction.



How does axon diameter affect the speed of conduction of nervous impulses?



How does axon diameter affect the speed of conduction of nervous impulses?

The larger the diameter, the faster the speed of conduction.



# What is a synapse?



# What is a synapse?

The junction between two nerve cells or a nerve cell and an effector.



# What is the function of synapses?



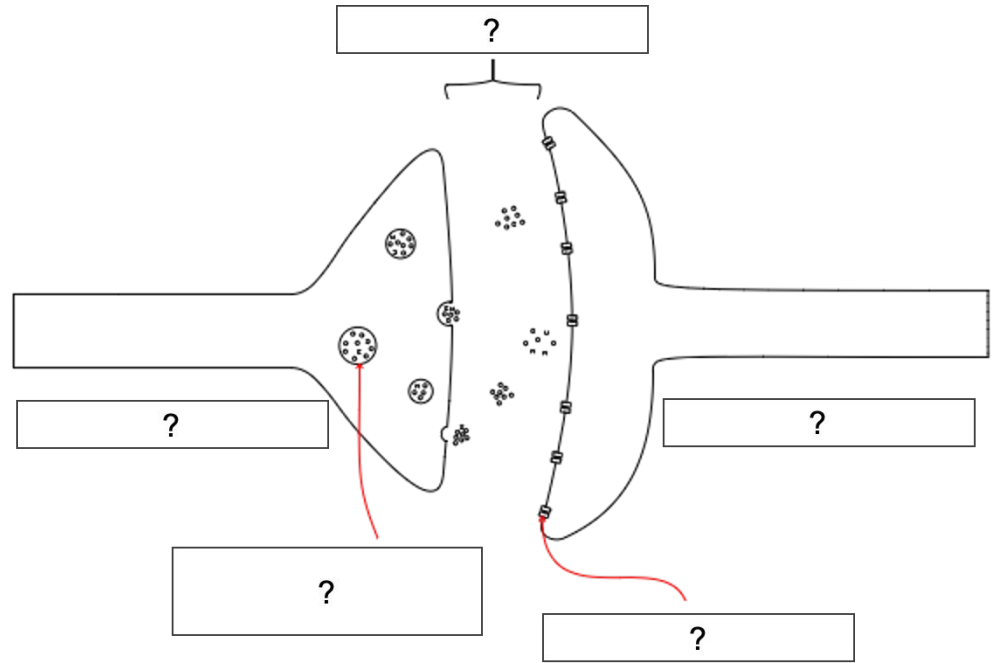


# What is the function of synapses?

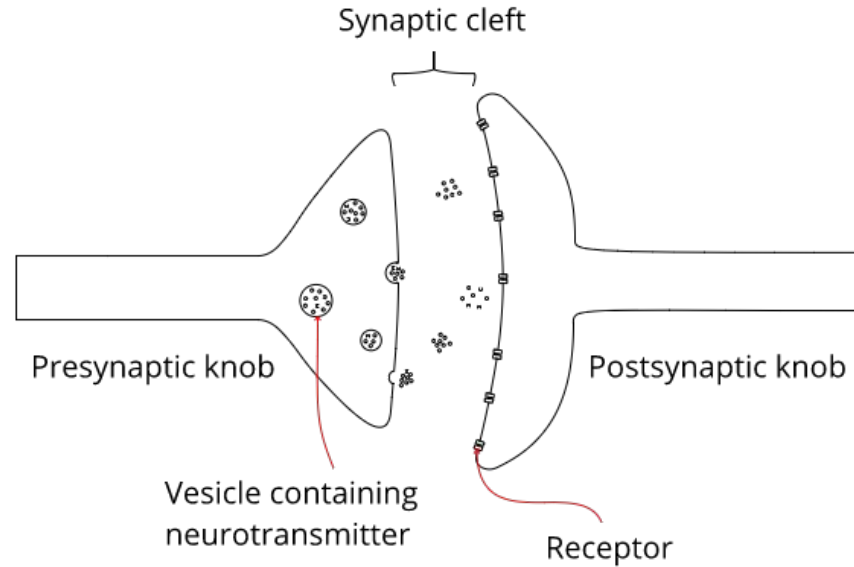
- Electrical impulse cannot cross junction
- Neurotransmitters send impulses between neurones or from neurones to effectors
- Summation of sub-threshold impulses
- New impulses can be initiated in several different neurones for multiple simultaneous responses



Fill in the  
missing  
labels in this  
diagram of a  
synapse



Fill in the missing labels in this diagram of a synapse.



Describe the structure of a synapse.



# Describe the structure of a synapse.

- **Presynaptic neurone** ends in **synaptic knob**
- Synaptic knob contains a high concentration of mitochondria, endoplasmic reticulum and vesicles of neurotransmitter
- **Synaptic cleft**, 20-30 nm gap
- **Postsynaptic neurone** has complementary receptors to neurotransmitter (ligand-gated  $\text{Na}^+$  channels)



# What is the synaptic cleft?



# What is the synaptic cleft?

A small gap between neurones across which a nerve impulse is transmitted via neurotransmitters.



Describe synaptic transmission in the presynaptic neurone.





# Describe synaptic transmission in the presynaptic neurone.

1. Wave of depolarisation travels down presynaptic neurone, causing voltage-gated  $\text{Ca}^{2+}$  channels to open
2.  $\text{Ca}^{2+}$  cause vesicles of **acetylcholine** to move towards and fuse with presynaptic membrane
3. Exocytosis of neurotransmitter (e.g. acetylcholine) into synaptic cleft



# How do neurotransmitters cross the synaptic cleft?



# How do neurotransmitters cross the synaptic cleft?

## Via simple diffusion



Describe synaptic transmission in the postsynaptic neurone.



## Describe synaptic transmission in the postsynaptic neurone.

1. Acetylcholine diffuses across synaptic cleft and binds to specific receptors on postsynaptic membrane
2. Ligand-gated  $\text{Na}^+$  channels open
3. If influx of  $\text{Na}^+$  ions raises membrane to threshold potential, action potential is generated



How is the merging of impulses prevented during synaptic transmission?



## How is the merging of impulses prevented during synaptic transmission?

- Active transport of  $\text{Ca}^{2+}$  out of synaptic knob
- Role of **cholinesterase**
- Reabsorption of neurotransmitters



Describe the role of cholinesterase in synaptic transmission.





Describe the role of cholinesterase in synaptic transmission.

- Hydrolyses **acetylcholine** in the postsynaptic neurone
- Products diffuse back across the cleft



What is the effect of organophosphates on the transmission of impulses?



# What is the effect of organophosphates on the transmission of impulses?

- Act as **cholinesterase inhibitors**, preventing the hydrolysis of **acetylcholine** in the postsynaptic neurone
- Results in continuous stimulation of the neurone



Where are organophosphates  
commonly found?



Where are organophosphates commonly found?

Component of insecticides.



How do psychoactive drugs (e.g. amphetamine) affect the transmission of impulses?



How do psychoactive drugs (e.g. amphetamine) affect the transmission of impulses?

- **Excitatory** drugs
- Stimulate the release of neurotransmitters such as **noradrenaline**

