CAIE Biology A-level

Topic 15: Control and Co-ordination

Flashcards

Compare the nervous system to the endocrine system.

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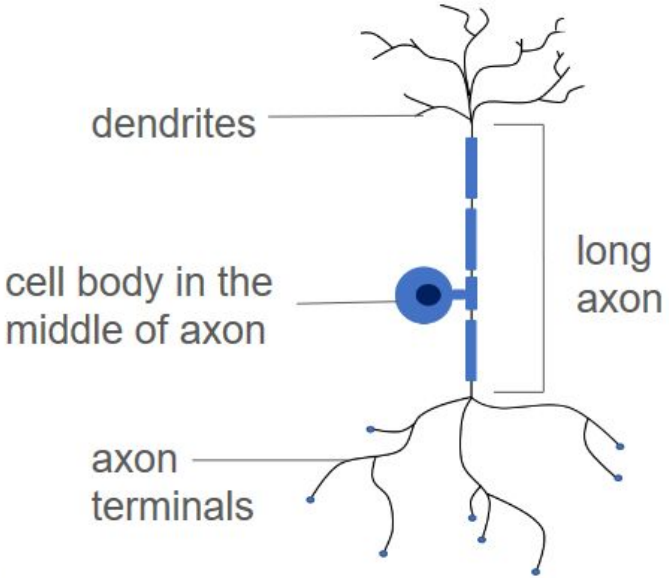
Nervous system	Endocrine system
The signal is a **nerve impulse**	The signal is a **hormone**
Transmission is through **neurones**	Transmission is via the **bloodstream**
The transmission is **fast**	The transmission is **slow**
The nerve impulse travels to a specific part of the body	The hormone encounters many tissues, but only acts on target cells with a specific receptor
The response is **rapid**, **localised** and usually lasts a **short time**	The response is **slower**, more **widespread** and can last much **longer**.

Describe the structure of a sensory neurone.

Describe the structure of a sensory neurone.

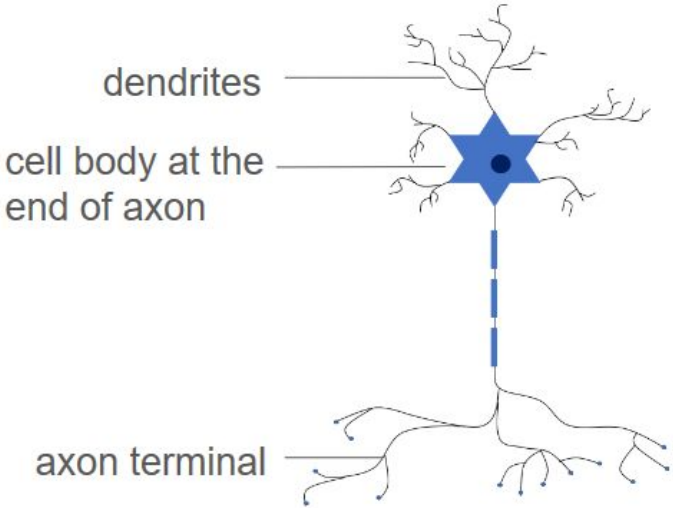
- Long axon, which carries impulses away from the cell body
- Long dendrites (carry information towards the cell body)
- Cell body in the middle of the axon



Describe the structure of a motor neurone.

Describe the structure of a motor neurone.

- Long axon
- Short dendrites
- Cell body usually found at one end of the axon



What are the functions of sensory and motor neurones?

What are the functions of sensory and motor neurones?

- **Sensory neurones** transmit impulses from sensory receptors to the central nervous system (CNS)
- **Motor neurones** transmit impulses from the CNS to the effectors (muscles and glands)

State the role of a sensory receptor.

State the role of a sensory receptor.

To detect stimuli (internal or external) and stimulate a sensory neurone to transmit a nerve impulse. A chemoreceptor in a taste bud is an example of a sensory receptor.

Outline the stages of the reflex arc.

Outline the stages of the reflex arc.

- Stimulus
- Receptor
- Sensory neurone
- Relay neurone
- Motor neurone
- Effector
- Response

Describe the roles of the neurones in the reflex arc.

Describe the roles of the neurones in the reflex arc.

- **Sensory neurone** sends the impulse (containing information about the stimulus) from the receptor to the relay neurone
- **Relay neurone** in the spinal cord transmits the impulse to a motor neurone, bypassing the brain so there is no conscious decision-making
- **Motor neurone** sends the impulse to the appropriate effector for a response

What is the function of the reflex arc?

What is the function of the reflex arc?

It is a fast, automatic response to stimuli that may cause harm, thereby protecting the body.

Define resting potential.

Define resting potential.

The potential difference across the membrane of a neurone when the cell is not being stimulated to conduct an action potential. It is usually around -70 mV in humans.

Explain how the resting membrane potential is established.

Explain how the resting membrane potential is established.

- Sodium-potassium pump actively transports 3 Na^+ ions out of the neurone for every 2 K^+ ions in
- The axon is more permeable to K^+ ions, so they can diffuse out of the axon through ion channels
- This results in the cytoplasm of the neurone being more negative than the exterior, creating an electrochemical gradient
- This results in a potential difference across the membrane

What is an action potential?

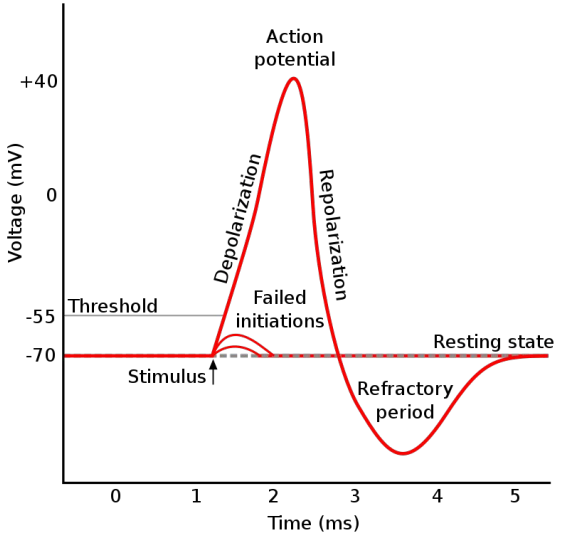
What is an action potential?

A rapid change in the potential difference across the neurone membrane, resulting in a propagating wave of depolarisation along the axon.

Name the 4 stages of an action potential.

Name the 4 stages of an action potential.

1. Depolarisation
2. Repolarisation
3. Hyperpolarisation
4. Re-establishment of the resting potential



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Describe how depolarisation occurs in an action potential.

Describe how depolarisation occurs in an action potential.

A stimulus causes voltage-gated sodium channels on the neurone membrane to open. This allows Na^+ ions to enter the axon and increases the potential difference slightly (less negative). If the change in potential difference is large enough to reach a threshold value, more Na^+ channels will open to allow a large influx of Na^+ ions. This depolarises the axon to +40 mV.

What prevents the potential difference of the axon increasing beyond +40 mV?

What prevents the potential difference of the axon increasing beyond +40 mV?

The voltage-gated Na^+ channels close to prevent any further influx of Na^+ ions.

Explain the process of repolarisation.

Explain the process of repolarisation.

At +40 mV, voltage-gated K^+ channels open. There is an efflux of K^+ ions (leaving the neurone) as the K^+ ions diffuse down their electrochemical gradient. This decreases the potential difference of the neurone (as there is less positive charge inside the axon).

Why does hyperpolarisation occur?

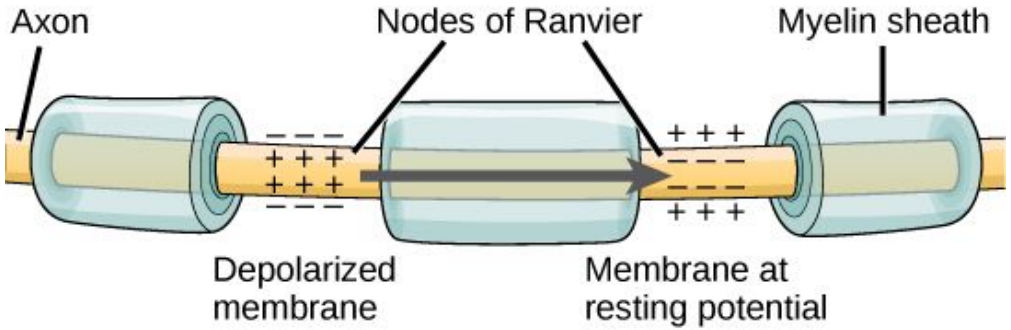
Why does hyperpolarisation occur?

As K^+ ions move out of the neurone, there is a temporary overshoot. This causes the potential difference of the neurone to become more negative than normal (below -70mV).

What is the myelin sheath?

What is the myelin sheath?

A lipid covering around the axon of a neurone. There are gaps in the myelin sheath called the **nodes of Ranvier**.



Name the cell that forms the myelin sheath.

Name the cell that forms the myelin sheath.

Schwann cells - the membranes of these cells surround the axon to form the myelin sheath.

How does the speed of an action potential differ in a myelinated neurone compared to an unmyelinated neurone?

How does the speed of an action potential differ in a myelinated neurone compared to an unmyelinated neurone?

Nerve impulses are conducted faster in myelinated neurones due to **saltatory conduction**.

What is saltatory conduction?

What is saltatory conduction?

The myelin sheath around the axon acts as an insulator, preventing depolarisation occuring at that point. Therefore, action potentials can only be initiated at the nodes of Ranvier. The impulse then ‘jumps’ to the next node, and can pass faster along the myelinated neurone than in unmyelinated neurone.

What is the refractory period?

What is the refractory period?

A time after an action potential when voltage-gated Na^+ channels are closed. Another action potential cannot be generated until the channels recover.

State why a refractory period is necessary.

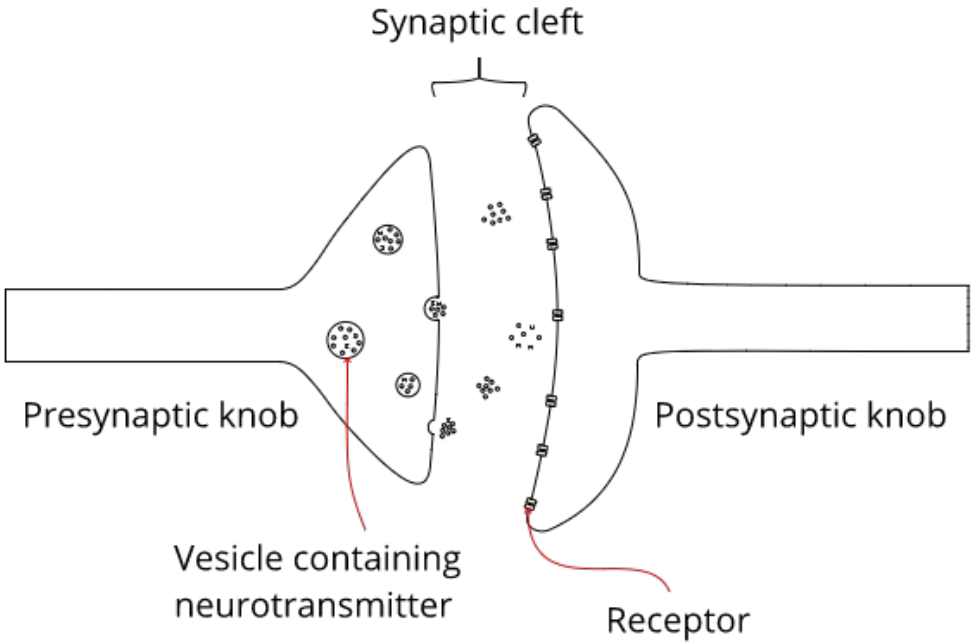
State why a refractory period is necessary.

- It ensures action potentials only propagate in one direction along the neurone
- It means impulses are discrete and separate from each other
- It limits how many action potentials can be produced in a given time

What is a synapse?

What is a synapse?

The junction between two neurones.



Describe the structure of a synapse.

Describe the structure of a synapse.

- The ends of the neurones are separated by a **synaptic cleft**
- The end of the presynaptic neurone is called a **synaptic knob**, which contains lots of mitochondria and endoplasmic reticulum
- Neurotransmitters in the synaptic knob are stored in vesicles
- The postsynaptic neurone has receptors for the neurotransmitters on its surface

Describe the process of synaptic transmission at a cholinergic synapse.

Explain the process of synaptic transmission at a cholinergic synapse.

- The action potential arrives at the synaptic knob, causing Ca^{2+} channels to open
- Ca^{2+} enters the presynaptic neurone and causes vesicles to fuse with the presynaptic membrane, releasing acetylcholine into the synaptic cleft
- Acetylcholine diffuses across the cleft and binds to receptors on ligand-gated Na^{+} channels on the postsynaptic membrane
- Na^{+} ions enter the postsynaptic neurone and cause depolarisation. If the threshold is reached, an action potential occurs in the postsynaptic neurone

What happens to the acetylcholine in the synaptic cleft?

What happens to the acetylcholine in the synaptic cleft?

The acetylcholine is hydrolysed by acetylcholinesterases in the synaptic cleft. The products are choline and acetyl, which diffuse back into the presynaptic neurone.

State the roles of the synapse.

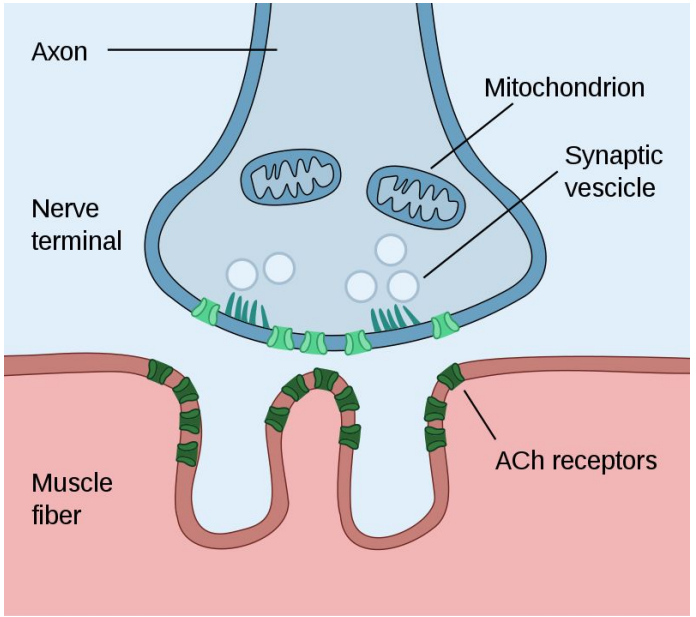
State the roles of the synapse.

- Ensures that nerve impulses can only travel in one direction - presynaptic to postsynaptic
- Allows connections between many neurones in one place - many presynaptic neurones may contact a postsynaptic neurone

What is a neuromuscular junction?

What is a neuromuscular junction?

The junction between a motor neurone and a motor end plate on a skeletal muscle fibre.



What are transverse tubules (T-tubules)?

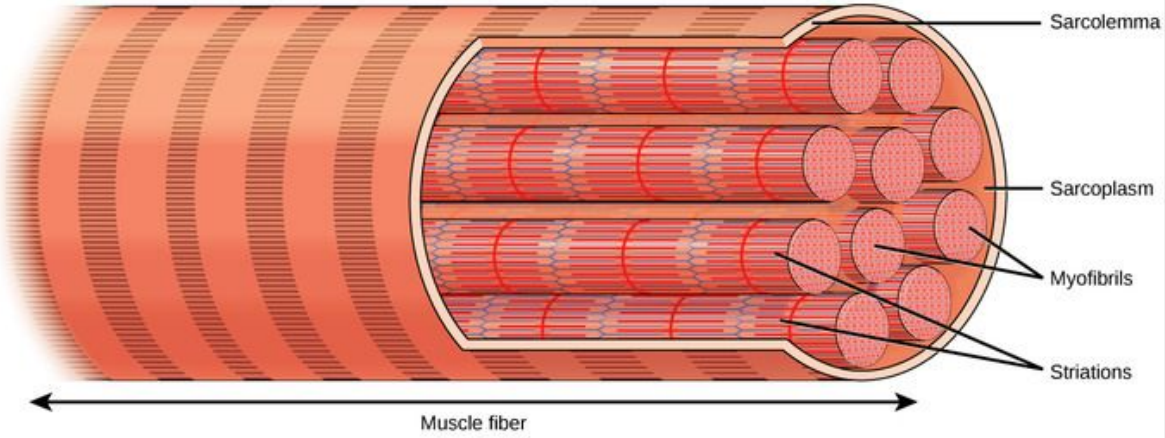
What are transverse tubules (T-tubules)?

- A system of infoldings of the cell surface membrane of the muscle fibre
- The tubules extend throughout the cell and are in contact with sarcoplasmic reticulum of the muscle fibre

Define sarcoplasm.

Define sarcoplasm.

The cytoplasm of the muscle fibre.



Name the contractile unit of muscle.

Name the contractile unit of muscle.

The sarcomere.

Describe how an action potential initiates muscle contraction.

Describe how an action potential initiates muscle contraction.

An action potential travels into the T-tubules and contacts the sarcoplasmic reticulum. This opens Ca^{2+} channels, causing the entry of Ca^{2+} into the sarcoplasm. Ca^{2+} acts on the sarcomere to induce contraction.

Outline the ultrastructure of striated muscle.

Outline the ultrastructure of striated muscle.

Thick myosin filaments and thin actin filaments.

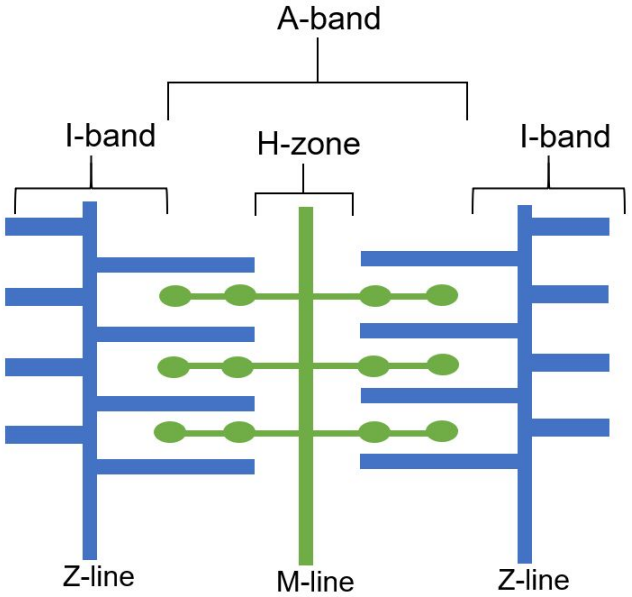
A-band = region of overlap between actin and myosin

H-zone = myosin only

M-line = middle of sarcomere

I-band = actin only

Z-line = boundary between sarcomeres



Describe how Ca^{2+} ions allow contraction to occur.

Describe how Ca^{2+} ions allow contraction to occur.

The Ca^{2+} ions enter the sarcoplasm and bind to troponin. This pulls on tropomyosin, changing its shape to expose the binding sites on the actin filament.

Describe the sliding filament model of muscle contraction.

Describe the sliding filament model of filament contraction.

- The actin binding sites are exposed, which allows the myosin heads to attach, forming a **cross-bridge**
- There are ADP molecules on the myosin heads. These are released when the myosin head pulls on the actin filament
- An ATP molecule attaches to the myosin head and the myosin head detaches from actin
- The ATP molecule is hydrolysed, which provides energy to **re-cock** the myosin head to its original position
- The myosin head can now repeat the cycle

What is needed to activate the ATPase enzyme for muscle contraction?

What is needed to activate the ATPase enzyme for muscle contraction?

Ca^{2+} ions

Name the sources of ATP in the muscle.

Name the sources of ATP in the muscle.

- Aerobic respiration in the mitochondria
- Anaerobic respiration
- Phosphocreatine (which provides a phosphate to combine with ADP)

Where are the hormones FSH and LH secreted from?

Where are the hormones FSH and LH secreted from?

Follicle-stimulating hormone (FSH) and luteinising hormone (LH) are secreted by the **anterior pituitary gland**.

Name the hormones produced in the ovaries.

Name the hormones produced in the ovaries.

Oestrogen and progesterone.

Explain the roles of hormones in the menstrual cycle.

Explain the roles of hormones in the menstrual cycle.

- **FSH** stimulates the egg to mature in the ovary, and causes the release of oestrogen from the ovary
- **Oestrogen** inhibits the release of FSH (negative feedback), stimulates the production of LH, and causes the repair and growth of the endometrium
- **LH** triggers the egg to be released from the ovary
- **Progesterone** maintains the endometrium, ready for fertilisation. If there is no fertilisation and implantation, the uterus lining is shed

Outline how contraceptive pills containing oestrogen and/or progesterone work.

Outline how contraceptive pills containing oestrogen or progesterone work.

- Oestrogen and progesterone prevent the production of FSH and LH, which are required for maturation of the egg and ovulation (release)
- Progesterone by itself makes the mucus of the cervix more viscous, preventing the sperm reaching the egg to fertilise it

Explain how the Venus flytrap catches its prey.

Explain how the Venus flytrap catches its prey.

The sensory hairs on the lobe are deflected by insects. This opens Ca^{2+} channels at the base of the hair, creating a receptor potential.

If two hairs are stimulated, or one hair is stimulated twice in a short time, an action potential is generated. The action potential spreads across the lobes and causes them to close.

Further stimulation of the hairs causes the edges of the lobes to seal, and digestive enzymes are released.

State the function of auxin.

State the function of auxin.

It coordinates and controls the growth of the plant.

Explain how auxin works.

Explain how auxin works.

- Auxin stimulates proton pumps within cells to pump H^+ ions from the cytoplasm to the cell wall
- The decrease in pH in the cell wall activates **expansin proteins**, which loosens the cell wall and allows the cell to elongate
- This activates K^+ ion channels and K^+ ions move from the cell wall to the cytoplasm. The water potential of the cytoplasm is lowered so water moves in by osmosis

State the two processes gibberellin is involved in.

State the two processes gibberellin is involved in.

Seed germination and stem elongation.

Describe the role of gibberellin in germination.

Describe the role of gibberellin in germination.

- The seed absorbs water causing the release of gibberellins in the embryo
- Gibberellin stimulates the aleurone cells to synthesise amylase
- Amylase can then hydrolyse starch into maltose and glucose for respiration to produce ATP

Explain the effects of the dominant allele *Le* and the recessive allele *le* on gibberellin synthesis.

Explain the effects of the dominant allele *Le* and the recessive allele *le* on gibberellin synthesis.

- The dominant allele (*Le*) of the gene codes for a f**unctional enzyme** in the pathway which synthesises gibberellin. This leads to stem elongation and tall plants.
- The recessive allele (*le*) of this gene codes for a **non-functional enzyme** in this pathway, so gibberellin is not produced. This results in a short plant.