

Control & Coordination

A-Level Biology ■ Topic 15

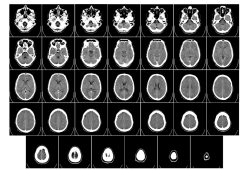
A-Level Biology



Control & Coordination

What we will cover

- 1 Two control systems
- 2 Neurones & the reflex arc
- 3 The nerve impulse
- 4 The synapse
- 5 Muscle contraction
- 6 Plant coordination



the brain coordinates it all

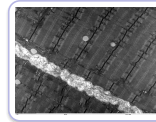
1 Systems and neurones

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└ Systems and neurones

Two control systems

nervous 神经系统
electrical **impulses** 冲动
– fast, short-lived

endocrine 内分泌系统
chemical **hormones** 激素
in blood – slow, longer



Muscle striations TEM

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└ Systems and neurones

Neurones

sensory

receptor → CNS

relay

inside the CNS

motor

CNS → effector

A motor neurone: cell body in the CNS, long axon to the muscle, many dendrites in.

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The reflex arc

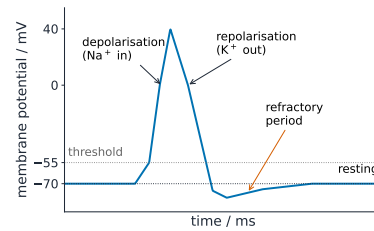
Receptor → sensory neurone → relay neurone (spinal cord) → motor neurone → effector.

The brain is not needed, so the response is **fast** and stereotyped.

2 Impulses and synapses

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Impulses and synapses

The nerve impulse



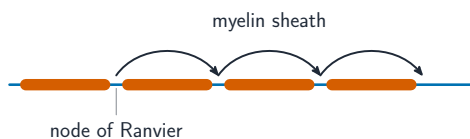
- **resting potential** 静息电位 – inside negative
- **action potential** 动作电位 – Na^+ in (**depolarisation** 去极化), then K^+ out (**repolarisation** 复极化)
- **refractory period** 不应期 – limits the frequency

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Impulses and synapses

Faster impulses and the synapse

Myelin 髓鞘 makes the impulse jump node to node (**saltatory conduction** 跳跃式传导) – much faster.

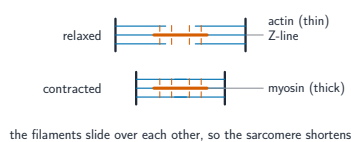
At a **synapse** 突触, Ca^{2+} triggers **acetylcholine** 乙酰胆碱 release; it crosses the gap and starts a new impulse.



3 Muscle and plants

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Muscle and plants

Muscle contraction

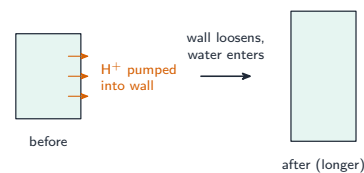


The **sliding filament model** 肌丝滑动模型:

- Ca^{2+} uncovers binding sites on **actin** 肌动蛋白
- **myosin** 肌球蛋白 heads pull it in (using ATP)
- the **sarcomere** 肌节 shortens

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Muscle and plants

Plant coordination



Auxin 生长素 causes "acid growth": it pumps H^+ into the wall, loosening it so the cell stretches longer.
Gibberellin 赤霉素 switches on amylase for **germination** 萌发; the Venus fly trap uses fast electrical signals.

4 Recap

Control & Coordination
↳ Recap

Worked example – across the synapse

Explain how an impulse crosses a cholinergic synapse.

- The action potential depolarises the presynaptic membrane, opening voltage-gated Ca^{2+} channels.
- Ca^{2+} enters; vesicles fuse and release acetylcholine by exocytosis.
- ACh diffuses across and binds receptors, opening Na^+ channels $\Rightarrow$ postsynaptic depolarisation.
- Acetylcholinesterase breaks ACh down, so the synapse resets $\Rightarrow$ one-way, brief.

Vesicles are only on one side and receptors only on the other – that is what makes transmission unidirectional.

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↳ Recap

Topic 15 – key takeaways

1 Two systems

nervous fast electrical; endocrine slow chemical

2 Impulse

Na^+ in depolarises; K^+ out repolarises

3 Synapse

acetylcholine crosses to start a new impulse

4 Muscle

sliding filaments shorten the sarcomere

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↳ Recap

Check yourself

- 1 Which ion rushes in during depolarisation?
- 2 What is myelin's jumping conduction called?
- 3 Which neurotransmitter acts at a cholinergic synapse?
- 4 Which filament slides in muscle contraction?



Answers 1. sodium (Na^+) 2. saltatory conduction 3. acetylcholine 4. actin (thin filament)