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GRADE 10 / SCIENCE

Chapter 6

Control and Coordination



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Control and Coordination

Neurons and reflex arcs

A withdrawal reflex can begin through a spinal circuit before you consciously perceive the painful stimulus. The brain also receives information.



Follow a withdrawal reflex

Pain receptor → sensory neuron → relay neuron in spinal cord → motor neuron → arm muscle.

Receiving a signal

Nerve endings in the skin can respond to potentially damaging heat. A sensory neuron carries a signal towards the spinal cord.

Moving the limb

In the withdrawal pathway, relay neurons connect sensory input to motor neurons. Motor neurons activate muscles that pull the limb away.

WORKED EXAMPLE

Why can your hand begin to withdraw before you have decided to move it?

The spinal circuit can send a motor response without waiting for a conscious decision. Signals also ascend towards the brain, where pain is perceived.

SELF-CHECK

Which part carries the outgoing command: the sensory neuron or the motor neuron?

The motor neuron carries the command to muscle. The sensory neuron carries information from the receptor towards the central nervous system.

Brain and voluntary action

Reaching for a cup, pulling away from heat and keeping your balance involve different control pathways.



Reaching · voluntary | Withdrawal · reflex | Balance · coordination

Pain receptor → sensory neuron → spinal relay → motor neuron → muscle

Cerebrum

Processes sensory information and helps plan and initiate voluntary movement, such as reaching for a cup.

Cerebellum

Coordinates the timing and precision of muscle movements and helps maintain posture and balance.

Medulla

Helps regulate involuntary functions such as breathing and cardiovascular activity.

Withdrawal reflex

Painful heat triggers a rapid spinal response. Signals also reach the brain, where the stimulus becomes consciously perceived.

WORKED EXAMPLE

Which part is the reflex when someone reaches for a hot plate, touches it and jerks back?

Jerking the hand away is the withdrawal reflex. Reaching towards the plate was a voluntary action.

SELF-CHECK

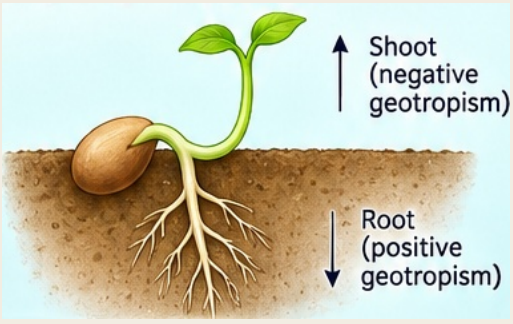
A cyclist decides to turn, then stays upright through the bend. Which centres contribute?

The cerebrum helps plan the turn. The cerebellum helps coordinate movements and balance.

Control and Coordination

How plants respond

Plants can respond by growing in a particular direction or by making a rapid movement that does not depend on growth.



Root growth follows gravity



Leaflets fold after touch

A shoot bends

Under one-sided light, unequal elongation can bend a young shoot towards the light. In the usual school model, cells on the shaded side elongate more.

A leaf folds

Touch-me-not leaflets fold when cells at their joints change water pressure. The direction of folding follows the structure of the leaf.

WORKED EXAMPLE

A shoot keeps bending towards a side window. A touch-me-not leaf folds quickly and later reopens. How do the mechanisms differ?

The shoot changes shape through unequal growth. The touch-me-not movement uses a reversible change in cell turgor.

SELF-CHECK

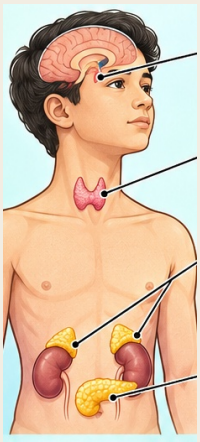
A tendril coils round a support after touching it. Which kind of response is this?

Thigmotropism. Directional growth depends on which part touches the support. Rapid leaflet folding is a different response to touch.

Control and Coordination

Hormones as messengers

A hormone travels in the blood. The response depends on the receptors in the target tissue and the signal it receives.



Which gland sent the signal?

Pituitary → growth hormone → growth of bones and other tissues. Thyroid → thyroxine → regulation of metabolism. Adrenal medulla → adrenaline → rapid response to a challenge.

Blood glucose rises

After a meal, pancreatic beta cells release insulin. It promotes glucose uptake in tissues such as skeletal muscle and helps the body store glucose as glycogen.

Blood glucose falls

Pancreatic alpha cells release glucagon. It signals the liver to release glucose into the blood. Both responses oppose the original change.

WORKED EXAMPLE

During a sudden fright, your heart beats faster. Which hormone can contribute?

Adrenaline from the adrenal medulla can rapidly increase heart rate and help make energy available to muscles.

SELF-CHECK

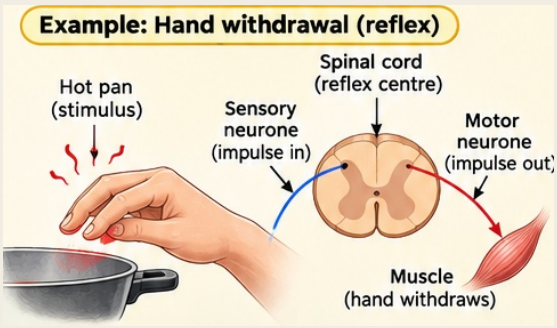
Why can iodine deficiency affect the thyroid?

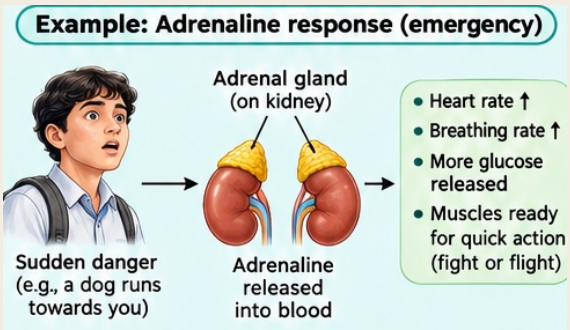
Iodine is needed to make thyroid hormones, including thyroxine. Inadequate iodine can impair hormone production and may lead to enlargement of the gland.

Control and Coordination

Nervous vs hormonal control

Nerve pathways and hormones both carry information. They reach their targets by different routes and can act together.





Nervous control

An electrical impulse travels along a neuron. At a typical chemical synapse, a neurotransmitter passes the message to the next cell. Connections help specify the target.

Hormonal control

Endocrine cells release hormones into the bloodstream. Only cells with suitable receptors respond. Some hormonal effects are rapid, while others develop over longer periods.

WORKED EXAMPLE

Your hand pulls away from a hot object. Moments later your heart is racing. Which routes can explain these responses?

A spinal reflex can activate the muscles that withdraw the arm. Autonomic nerves and circulating adrenaline can both contribute to a faster heartbeat.

SELF-CHECK

Why does a hormone circulating throughout the body affect only certain cells?

Only target cells with the appropriate receptor can recognise and respond to that hormone.

ONE LAST CHALLENGE

Did your hand beat your brain?

You touch a hot pan and pull back before you consciously register the pain. How?



THE REVEAL

A spinal reflex.

A sensory signal reaches the spinal cord and activates motor neurons. Your muscles pull the hand away while signals also travel to the brain.

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