

The brain and hormonal control

Revision notes · Nervous and hormonal coordination, regions of the human brain, brain scanning (CT, MRI, fMRI, PET) and dopamine and serotonin imbalances.

For Pearson Edexcel International AS Biology XBI11 and International A Level Biology YBI11. **A Level only** is IA2 content (Units 4 to 6), not needed for the International AS.

The brain and hormonal control **Spec 8.13–8.16** **A Level only**

Nervous and hormonal coordination **Spec 8.13**

Coordination means that different parts of an animal work together in response to stimuli. It is brought about by the **nervous system** and by **hormones** released by the endocrine system. The two work together: the hypothalamus is part of the brain but controls the pituitary gland.

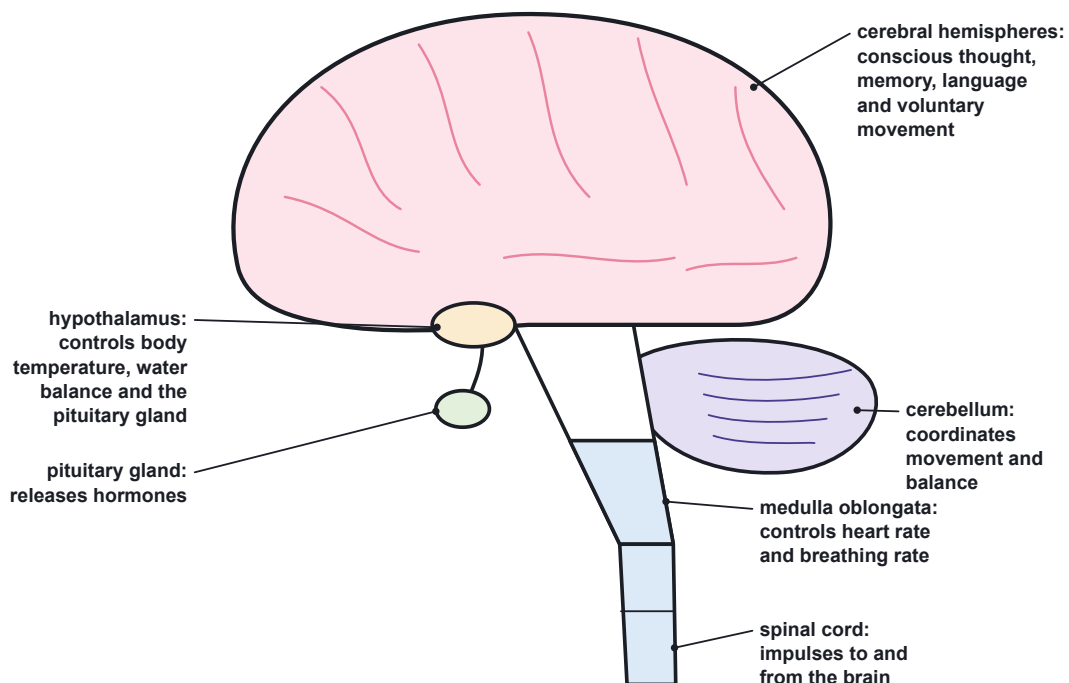
Nervous and hormonal control compared		
Feature	Nervous control	Hormonal control
Signal	Electrical impulses (action potentials) and neurotransmitters	Chemicals (hormones)
Transmitted by	Neurones	Blood (plasma)
Speed	Very fast (milliseconds)	Slower (seconds to hours)
Target	Specific effectors, usually one muscle or gland	Target cells with the complementary receptors, which may be widely spread
Duration	Short-lived, stops when the stimulus stops	Longer-lasting, because the hormone remains in the blood
Example	Withdrawal of a hand from a hot object	Adrenaline released from the adrenal glands

Many responses use both. In the ‘fight or flight’ response, nervous impulses from the hypothalamus stimulate the adrenal glands to release **adrenaline**. The nervous system gives a very fast response, and adrenaline then prolongs and widens it by raising heart rate, ventilation and blood glucose. The hypothalamus also detects changes in the blood and controls the **pituitary gland**, which secretes hormones that control other endocrine glands.

Exam tip: In compare questions use matching features: ‘nerves are fast, hormones are slower’ and ‘nervous effects are short-lived, hormonal effects longer-lasting’. Give a statement for both sides.

Regions of the human brain Spec 8.14

Regions of the brain you need to know		
Region	Location	Main functions
Cerebral hemispheres	Two large halves forming the upper and outer part of the brain, with a highly folded outer cortex	Sensory areas receive information from receptors; motor areas control voluntary movement; association areas are involved in conscious thought, learning, memory, language and decision-making
Hypothalamus	In the centre of the brain, below the thalamus	Monitors and regulates body temperature, water balance, hunger and thirst; makes hormones released by the posterior pituitary and controls the anterior pituitary; links the nervous and endocrine systems
Pituitary gland	Hangs from the base of the hypothalamus	Anterior lobe secretes hormones such as growth hormone and hormones controlling other glands; the posterior lobe releases ADH and oxytocin made in the hypothalamus
Cerebellum	At the back of the brain, below the cerebral hemispheres	Coordinates movement, balance and posture using information from the muscles, joints and ears; important for fine, skilled movement
Medulla oblongata	At the base of the brain, joining the spinal cord	Controls involuntary actions: heart rate, breathing (ventilation) rate and blood pressure; also swallowing and coughing reflexes

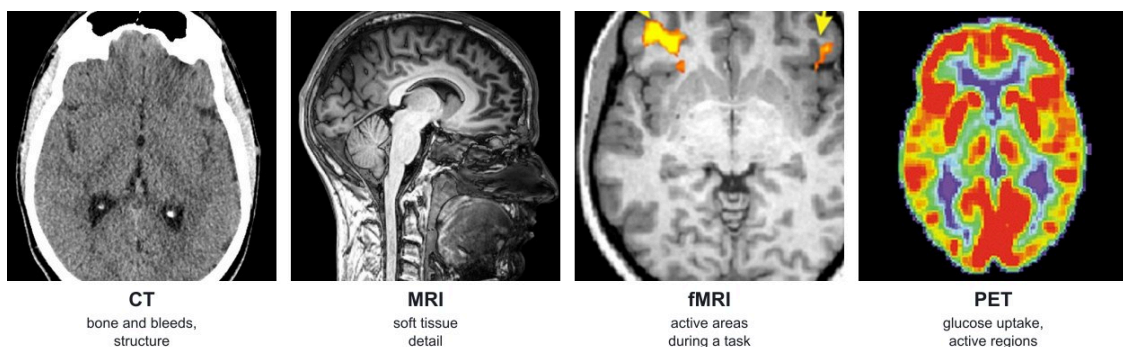


The main regions of the **brain** and what each does.

Common mistake: Do not say that the cerebellum 'starts' movement. The motor areas of the cerebral hemispheres start voluntary movements; the cerebellum coordinates them to make them smooth and balanced.

Imaging the brain: CT, MRI, fMRI and PET Spec 8.15

Brain imaging techniques			
Technique	How it works	What it shows and uses	Advantages and limitations
CT (computed tomography)	An X-ray source rotates around the head. Detectors measure how much is absorbed by tissues; a computer builds cross-sectional slices.	Brain structure: bone, tumours, bleeding in stroke or head injury	Quick and widely available. Uses ionising radiation; poorer soft-tissue contrast than MRI; shows structure, not activity.
MRI (magnetic resonance imaging)	A strong magnetic field aligns hydrogen nuclei in water. A pulse of radio waves knocks them out of line; they emit signals as they return, which differ between tissues.	Detailed images of soft tissue: tumours, damage to brain tissue, multiple sclerosis, structural abnormalities	No ionising radiation and high resolution. Slow, noisy, expensive; cannot be used with some metal implants or pacemakers.
fMRI (functional MRI)	MRI that detects changes in blood oxygen. Active neurones use more oxygen, so blood flow to them increases, which changes the signal.	Which parts of the brain are active during a task, such as speaking or moving a hand	Shows function as well as structure and uses no radiation. Indirect measure of activity; expensive; the person must keep still.
PET (positron emission tomography)	A radioactive tracer, such as a glucose analogue labelled with a positron emitter, is injected. Active cells take up more of it. Detectors record the gamma rays produced.	Metabolic activity, such as areas that are abnormally active or inactive in epilepsy, dementia or tumours	Shows chemical activity. Uses radioactivity; costly; the tracer has a short half-life, so it must be made close to the scanner.



CT and MRI show structure; fMRI and PET show activity.

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Exam tip: Choose the scan by what the question asks: structure (CT or MRI) or function (fMRI or PET). Then give a reason and a limitation, because 'evaluate' questions need both.

Brain chemicals and ill health Spec 8.16

Imbalances of brain chemicals		
	Parkinson's disease	Depression
Chemical	Dopamine	Serotonin
Imbalance	Neurones that make dopamine, in a region of the brain controlling movement, die, so dopamine is deficient	Low serotonin activity at synapses is associated with low mood
Symptoms	Tremor, muscle rigidity, slow movement, poor balance	Persistent low mood, loss of interest, changes in sleep and appetite
Treatment	L-DOPA, which is converted to dopamine in the brain; drugs that act like dopamine (agonists) or reduce its breakdown	Drugs that block the reuptake of serotonin (selective serotonin reuptake inhibitors, SSRIs), so serotonin stays in the synaptic cleft for longer

Understanding how synapses work makes it possible to **design new drugs** that act at a particular target: a receptor, an enzyme that breaks down a transmitter or the protein that takes a transmitter back up. A drug must reach the brain, so it needs to cross the blood-brain barrier, and it must be tested for effectiveness and side effects in clinical trials before it can be used.

Common mistake: The cause of depression is complex and an imbalance of serotonin is only one factor linked to it. Say 'associated with' or 'contributes to', not 'is caused by'.

Quick check

1. Which region of the brain coordinates movement and balance?
2. Which region of the brain controls heart rate and breathing rate?
3. What does fMRI show that MRI alone does not?
4. Which neurotransmitter is lacking in Parkinson's disease?

Quick check answers

The brain and hormonal control

1. The cerebellum.
2. The medulla oblongata.
3. Which areas of the brain are active, by detecting changes in blood oxygen.
4. Dopamine.