Biological Bases of Behavior

AP Psychology

Nature and Nurture

Psychology studies **behavior** (what a person does) and **mental processes** (what a person thinks and feels). Unit 1 asks where these come from in the body.

Heredity and environmental factors interact to shape behavior and mental processes. **Heredity** is what a person inherits from their parents. **Environment** is everything that happens around them. Neither one acts alone.

- **Nature and nurture** interact. For example, inherited tendencies and nutrition can both influence height.
- The **evolutionary perspective** asks how inherited tendencies may relate to survival and reproductive success. A plausible story about an advantage is not, by itself, proof of a particular behavior's origin.
- **Twin and adoption studies** compare patterns of similarity across relatedness and upbringing. Similarity between identical twins raised apart can support an inherited contribution, but it does not cleanly separate all inherited and environmental influences.

Worked interaction. In an illustrative case, assume a student inherits a tendency that helps distinguish musical sounds. Lessons, practice and access to an instrument help develop the ability. Performance improves after the school provides instruments. The inherited tendency is the stated heredity contribution; teaching, practice and access are environmental contributions. The opportunity helps develop the tendency. Improvement with access does not prove that all differences between students are environmental, or that inheritance fixes final performance. Do not infer inherited ability merely because someone performs well.

Evaluate a twin-study conclusion. Identical twins raised apart show similar scores on a behavioral trait. The similarity is consistent with an inherited contribution, not proof that the trait is entirely inherited. They share prenatal conditions and may encounter similar environments; placement into families is not a random experiment. Comparisons with other relatives and adoptive families add evidence about patterns, rather than assigning one person's behavior wholly to one cause.

Scope note: detailed genetics, DNA and chromosome mechanisms are outside this course framework. The relationship between heredity and environment is assessed.

The Nervous System

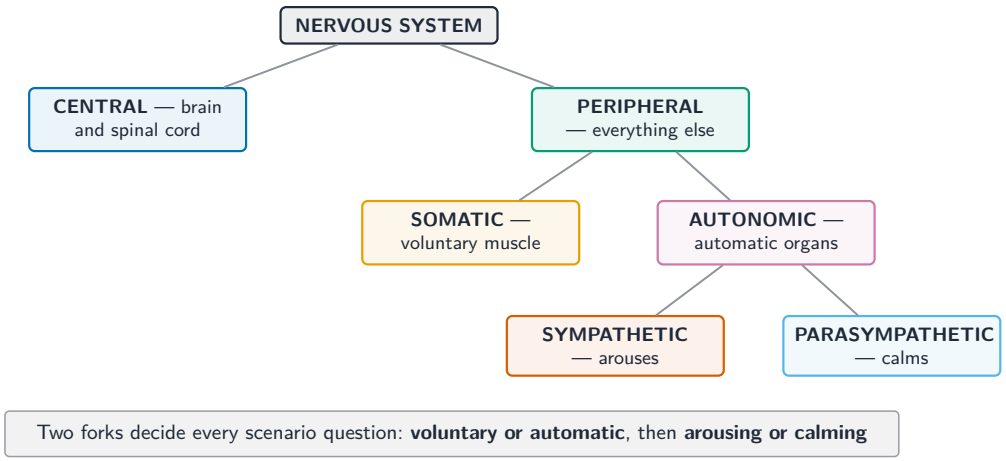
The **nervous system** carries information around the body. It has two main parts.

The **central nervous system (CNS)** is the brain and the **spinal cord**. It interacts with every process in the body.

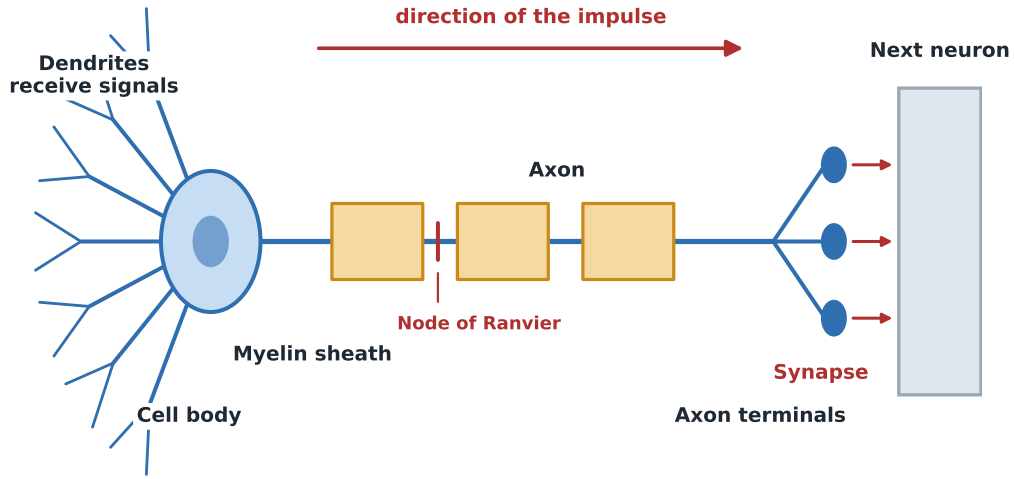
The **peripheral nervous system (PNS)** relays messages between the CNS and the rest of the body. It divides again:

- The **somatic nervous system** controls **voluntary** movement, such as raising your hand.
- The **autonomic nervous system** controls **involuntary** processes, such as heartbeat and digestion. It has two branches that work against each other: the **sympathetic nervous system** prepares the body for action (the "fight or flight" response), and the **parasympathetic nervous system** calms the body down afterwards.

Worked pathway choice. A student deliberately raises a hand, experiences a faster heartbeat before a presentation, and later notices a slowing heart rate during recovery. The deliberate skeletal movement involves the somatic division carrying motor commands. Heartbeat is an autonomic process: the sympathetic branch supports arousal and the parasympathetic branch supports recovery. These are PNS pathways interacting with the CNS. Classify the specific response, not the whole event as only voluntary or automatic. A racing heart alone does not establish one particular emotion.



Neurons and How They Fire



A neuron receives at the dendrites, fires along the axon, and passes the message across the synapse

Two kinds of cell do the work. **Neurons** transmit information. **Glial cells** provide structure, insulation, communication, and waste transport. Together they are the building blocks of all behavior and mental processes.

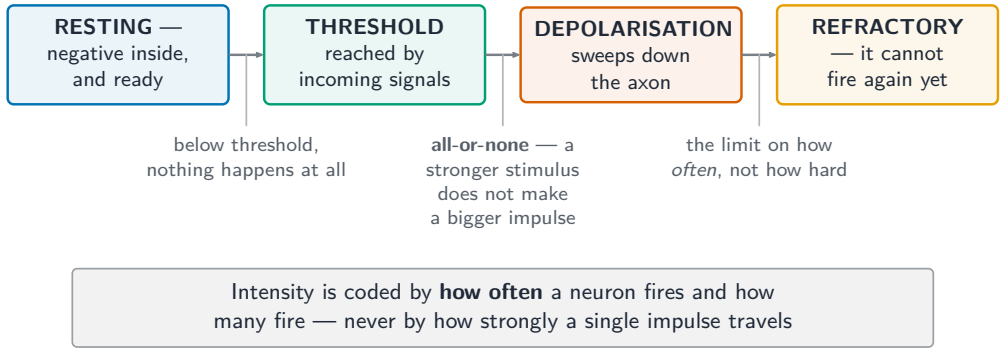
A neuron has **dendrites** that receive signals, a **cell body**, and an **axon** that carries the signal away. Many axons are wrapped in a **myelin sheath**, which speeds the signal up.

Neural transmission follows a set order:

- At rest the neuron holds a **resting potential**, ready but not firing.
- If incoming signals pass the **threshold**, the neuron **depolarizes** and fires.
- Firing follows the **all-or-none principle**: the neuron fires at full strength or not at all. A stronger stimulus makes it fire more often, not harder.
- Straight after firing there is a **refractory period** when the neuron cannot fire again.
- At the **synapse**, the gap between neurons, chemicals cross to the next cell. Leftover chemicals are taken back in a process called **reuptake**.

Damage to this process can cause disorders such as **multiple sclerosis** or **myasthenia gravis**.

In the spinal cord, the **reflex arc** shows the system working as a unit. **Sensory neurons** carry information in, **interneurons** connect inside the cord, and **motor neurons** carry the command out - a withdrawal can be initiated through spinal circuits before conscious awareness, while signals also travel toward the brain.



Neurotransmitters, Hormones, and Drugs

Neurotransmitters are the chemicals that cross the synapse. Each has its own job, and the effect can depend on where in the nervous system it acts. A message is either **excitatory** (making firing more likely) or **inhibitory** (making firing less likely).

Only these are examinable: **dopamine** (reward and movement), **serotonin** (mood and sleep), **norepinephrine** (alertness), **glutamate** (the main excitatory transmitter), **GABA** γ- (the main inhibitory transmitter), **endorphins** (pain relief), **substance P** P (pain signalling), and **acetylcholine** (muscle movement and memory).

Hormones travel through the blood and can influence the brain as well as other organs. Their route differs from communication across a synapse; blood-borne does not mean unable to affect behavior. Again only five are examinable: **adrenaline**, **leptin** (reduces hunger), **ghrelin** (increases hunger), **melatonin** (sleep), and **oxytocin** (bonding).

Psychoactive drugs can change behavior by acting on neurotransmission. Three mechanisms taught in the course are:

- An **agonist** activates or supports a transmitter's effect. In an introductory excitatory-signal example, this encourages firing.
- An **antagonist** blocks a transmitter's action. With that excitatory signal, blocking it reduces its contribution to firing.
- A **reuptake inhibitor** blocks reabsorption, leaving more transmitter in the synapse.

Worked synapse comparison. Assume a transmitter normally activates a receiving receptor and makes firing more likely. Hypothetical substance X activates the same

receptor: it acts as an agonist in this case. Y occupies that receptor without activating it and prevents the transmitter acting: it is an antagonist. Z stops reabsorption into the sending cell: it is a reuptake inhibitor, leaving more transmitter available in the gap without directly copying it at the receiving receptor. State the affected step before predicting its consequence.

The example explicitly uses an excitatory signal. Supporting an inhibitory signal can strengthen inhibition; blocking it can remove inhibition. An agonist is not a universal synonym for stimulation of the whole nervous system. Receptor, transmitter and location matter, and the three taught mechanisms are examples rather than all possible drug mechanisms.

Drug categories: **stimulants** (caffeine, cocaine) increase neural activity; **depressants** (alcohol) decrease it; **hallucinogens** (marijuana) distort perception; **opioids** (heroin) relieve pain. Repeated use can lead to **tolerance**, where more is needed for the same effect, and to **addiction**, with **withdrawal** symptoms when use stops.

The Brain

The brain is studied from the bottom up, because the lower structures handle the most basic jobs.

- The **brain stem**, including the **medulla**, controls breathing and heart rate.
- The **reticular activating system** controls alertness and arousal.
- The **cerebellum** controls coordination, balance, and some **procedural learning**.
- The **limbic system** sits inside the cerebral cortex and includes the **thalamus** (a relay station for the senses), the **hypothalamus** (hunger, thirst, temperature), the **pituitary gland**, the **hippocampus** (forming new memories), and the **amygdala** (fear and emotion).

The **cerebral cortex** is divided into two **hemispheres** and four lobes: the **occipital lobes** process vision at the rear; the **temporal lobes** process hearing and language at the sides; the **parietal lobes** hold the **somatosensory cortex** for touch; and the **frontal lobes** handle higher-order thinking and **executive function**.

Language sits mainly in the left hemisphere: **Broca's area** for speech production and **Wernicke's area** for comprehension.

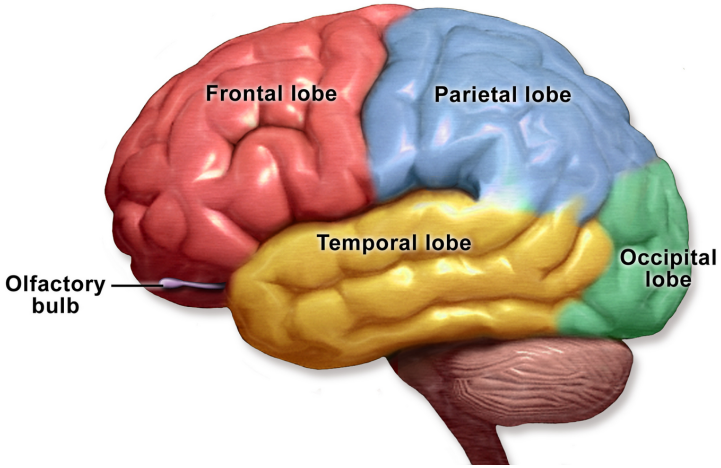
Split-brain research, done on patients whose **corpus callosum** was cut to treat severe epilepsy, shows the two hemispheres can work independently. Researchers present information to one **visual field** at a time, because each field is processed by the opposite hemisphere.

Brain plasticity is the brain's ability to rewire itself and form new connections, which supports recovery after damage. Research methods include **EEG** and **fMRI** scans, case studies, and **lesioning**.

Worked method choice. To identify rapid electrical patterns distinguishing sleep stages, choose EEG: scalp electrodes record electrical patterns with fine timing, although locating a precise source is more limited. To compare where blood-oxygen signals change during a memory task and a comparison task, choose fMRI: it commonly tracks regional blood-oxygen changes associated with activity. It gives useful spatial detail but measures an indirect, slower-changing signal rather than each neuron's firing. Both methods can track changes over time; that phrase alone does not distinguish them. A regional change during a task does not, by itself, establish that the region is necessary for the task or reveal exact thoughts. Match the research aim to the signal and state a limitation.

REGION	WHAT IT DOES	DAMAGE LOOKS LIKE
brainstem and medulla	breathing, heart rate, arousal	life-threatening — these are not optional
cerebellum	balance, and smooth learned movement	clumsy, uncoordinated movement
hippocampus	forming new long-term memories	old memories intact, no new ones
amygdala	fear, and emotional salience	blunted fear, poor threat learning
frontal lobe	planning, judgement, inhibition	impulsivity and personality change

Scenario questions arrive as the **third** column. Learn the table in that direction and the retrieval matches the question



Consciousness and Sleep

Consciousness is awareness of internal and external events, and it varies in level.

The sleep/wake cycle is a **circadian rhythm** of about 24 hours. **Jet lag** and shift work disrupt it.

Sleep stages are identified by **EEG** patterns. **NREM sleep** covers stages 1 to 3; **hypnagogic sensations** occur as you fall asleep. **REM sleep** is called **paradoxical sleep** because the brain looks awake while the body is most relaxed, and most dreaming happens here.

Two examinable theories explain dreams: **activation-synthesis theory** - (the brain interprets random activity) and **consolidation theory** (dreams reflect memory processing). Sleep itself is explained by **memory consolidation** and **restoration** theories.

Note: the psychoanalytic theory of dreams is outside the exam's scope.

Sleep disorders disrupt waking behavior and health: **insomnia** , **narcolepsy** , **sleep apnea** , **somnambulism** (sleepwalking), and **REM sleep behavior disorder** .

Sensation

Sensation is detecting information from the environment and **transducing** it into neural signals the brain can use. Detection needs a certain **absolute threshold** .

- The **just-noticeable difference** is the smallest change a person can detect.
- **Sensory adaptation** is reduced sensitivity to an unchanging stimulus - you stop noticing a smell.
- **Sensory interaction** means the senses work together. **Synesthesia** is when one sense triggers another.

Vision. Light is focused onto the **retina** by the **lens** changing shape, a process called **visual accommodation** ; when this fails the result is **nearsightedness** or **farsightedness** . **Rods** lie in the periphery and detect shape and movement in low light. **Cones** sit in the **fovea** and detect colour and detail. Colour vision needs two theories: **trichromatic theory** (blue, green and red cones) and **opponent-process theory** , which explains **afterimages** . Damage to the occipital lobes can cause **prosopagnosia** , or face blindness.

Hearing. Sound is air movement; wavelength gives **pitch** and amplitude gives **loudness** . Pitch perception is explained by **place theory** , **volley theory** , and **frequency theory** . **Sound localization** tells us where a sound comes from. Hearing loss may be **conduction deafness** or **sensorineural deafness** .

The chemical senses. Olfaction is the only sense not relayed first through the thalamus. **Gustation** covers sweet, sour, salty, bitter, **umami** , and

oleogustus . The two interact: without smell, taste is muted.

Touch, pain, and body position. Skin receptors transduce touch; "hot" comes from warm and cold receptors firing together. Pain is processed in body and brain, and **gate control theory** explains why attention changes how much it hurts; **phantom limb** sensations show the brain's role. The **vestibular sense** controls balance through the **semicircular canals** , and **kinesthesis** is the sense of body movement.

Worked evidence-based generalization (2025 AP Psychology Set 1 Article Analysis). The study recruited 127 students at one large university for course credit. They were aged 18–39, with a mean age of 21.21; 69% were women and 31% men. Consider how far the findings can be extended to adults aged 65 and over.

One supported response is: the findings may not extend to adults aged 65 and over because all participants were university students aged 18–39. The study provides no direct participant evidence about that older population. This is a limit on the evidence, not proof that older adults would behave differently. A sample's size alone does not show that it represents every population. Random assignment to misinformation conditions helps compare the experimental groups; it does not turn a university sample into a representative sample of all adults.

The official Part E criterion requires a generalization claim supported by specific, relevant participant evidence. Name the population, select a participant feature and explain the link. An unexplained label such as "biased" or a statement about sample size is insufficient. This is an authored model response grounded in the source and scoring criterion, not a quotation of a scored student answer.

Exam tips

- Learn only the listed **neurotransmitters** and **hormones**; the exam will not ask about others, and the endocrine glands are out of scope apart from the pituitary.
- Keep **sensation** separate from perception: sensation is detecting and transducing, perception is interpreting (Unit 2).
- The **all-or-none principle** means intensity is coded by how *often* a neuron fires, never by how strongly.
- Match structure to job before you write: hippocampus forms memories, amygdala handles fear, cerebellum coordinates movement.
- **Sympathetic** arouses, **parasympathetic** calms. If a question describes a racing heart, name the sympathetic branch.
- Say what a scan can and cannot show. **EEG** records rapid electrical patterns; **fMRI** commonly tracks regional blood-oxygen changes associated with activity.

Vocabulary card meanings

mental processes: Activities of the mind such as perceiving, remembering, and deciding. Nature and nurture: The joint influence of inherited traits and of experience. Twin and adoption studies: Research that compares relatives reared together or apart to separate heredity from environment. peripheral nervous system (PNS): The nerves outside the brain and spinal cord. somatic nervous system: The division that carries commands to skeletal muscles and also brings sensory signals in from the body. voluntary: Done under conscious command, as with moving an arm. autonomic nervous system: The division that runs organs without a person deciding each action. involuntary: Happening without a conscious decision, as with heartbeat. sympathetic nervous system: The division that prepares the body for urgent action. parasympathetic nervous system: The division that calms the body and restores energy. Neurons: Nerve cells that carry signals through the nervous system. dendrites: Branching fibres that receive signals into a nerve cell. resting potential: The voltage difference across a nerve-cell membrane while the cell is not firing. depolarizes: Makes the inside of the membrane less negative, which lets a nerve impulse start. all-or-none principle: A nerve cell either fires a full impulse or does not fire at all. refractory period: A short interval after one firing when another firing is impossible, or possible only with a stronger stimulus. multiple sclerosis: A disease in which the insulating sheath around nerve fibres is damaged. myasthenia gravis: A disease in which signals fail to make muscles contract with normal strength. Sensory neurons: Nerve cells that carry information in from the sense organs. interneurons: Nerve cells that connect other nerve cells, especially in the spinal cord and brain. motor neurons: Nerve cells that carry commands out to muscles and glands. excitatory: Making the next nerve cell more likely to fire. inhibitory: Making the next nerve cell less likely to fire. dopamine: A chemical messenger linked with reward, movement, and attention. serotonin: A chemical messenger linked with mood, sleep, and appetite. norepinephrine: A chemical messenger that raises alertness and helps the stress response. glutamate: The main chemical messenger that excites nerve cells in the brain. GABA: The main chemical messenger that quiets nerve signals in the brain. endorphins: Natural chemicals that reduce pain and can produce a feeling of well-being. substance P: A chemical messenger involved in sending pain signals. leptin: A hormone from fat tissue that signals fullness to the brain. ghrelin: A hormone from the stomach that signals hunger. melatonin: A hormone that helps set the daily sleep-wake rhythm. oxytocin: A hormone linked with bonding, birth, and trust. agonist: A drug that mimics a messenger and turns its receptor on. antagonist: A drug that blocks a receptor so the usual messenger cannot act. reuptake inhibitor: A drug that keeps a messenger in the gap between nerve cells for longer. stimulants: Drugs that speed up neural activity and bodily arousal. depressants: Drugs that slow neural activity and bodily arousal. hallucinogens: Drugs that distort perception and can produce sensations with no outside source. opioids: Drugs, related to opium, that relieve pain and can be highly addictive. occipital lobes: The rear parts of the brain that first process vision. temporal lobes: The side parts of the brain involved in hearing and in some memory. parietal lobes: The upper side parts of the brain that process touch and spatial layout. somatosensory cortex: The strip of brain that maps touch from different body parts. frontal lobes: The front parts of the brain used for planning, speech, and self-control. executive function: Mental skills for

planning, switching tasks, and holding back impulses. Broca's area: A region, usually on the left, needed to produce fluent speech. Wernicke's area: A region, usually on the left, needed to understand speech. visual field: The whole area a person can see at one moment without moving the eyes. lesioning: Destroying or damaging a small brain area in order to study its job. NREM sleep: Stages of sleep in which the eyes do not move rapidly, during which dreams can still occur. hypnagogic sensations: Brief vivid feelings, such as falling, as a person is drifting into sleep. paradoxical sleep: A sleep stage in which the brain is active but most muscles are paralysed. activation-synthesis theory: The idea that dreams are the brain's attempt to make a story from random activity. memory consolidation: The stabilising of a new memory so that it lasts. restoration: The idea that sleep repairs the body and replenishes energy. insomnia: Ongoing difficulty falling asleep or staying asleep. narcolepsy: A disorder of sudden, uncontrollable sleep attacks. sleep apnea: A disorder in which breathing repeatedly stops during sleep. somnambulism: Walking about while still asleep. REM sleep behavior disorder: A condition in which the usual muscle paralysis of dreaming sleep fails. transducing: Converting one form of energy, such as light, into nerve signals. absolute threshold: The smallest stimulus detected about half the time. Sensory adaptation: Reduced sensitivity after constant, unchanging stimulation. Synesthesia: A condition in which one sense triggers an experience in another, such as seeing sound. lens: The clear structure in the eye that bends incoming light. nearsightedness: Seeing nearby objects more clearly than distant ones. farsightedness: Seeing distant objects more clearly than nearby ones. fovea: The small central pit of the retina where vision is sharpest. afterimages: Sensations that linger after the original stimulus has gone. prosopagnosia: An inability to recognise familiar faces. place theory: The idea that pitch depends on which part of the inner ear is stimulated. volley theory: The idea that groups of auditory nerve cells fire in rotation to code pitch. frequency theory: The idea that pitch depends on how fast auditory nerve cells fire. Sound localization: Judging where a sound comes from, using differences between the two ears. conduction deafness: Hearing loss from a problem in the outer or middle ear's mechanical path. sensorineural deafness: Hearing loss from damage to the inner ear or the auditory nerve. Gustation: The sense of taste. umami: The savoury taste associated with glutamate in foods. oleogustus: A proposed taste quality for fatty acids. gate control theory: The idea that signals from the spinal cord can open or close the path for pain. phantom limb: The feeling that a missing limb is still present, sometimes with pain. semicircular canals: Fluid-filled loops in the inner ear that sense rotation of the head.