

Unit 1: Biological Bases of Behavior

Unit 1 covers how genes, neurons, brain structures, sleep, and the senses produce behavior and mental processes. CED topics 1.1 through 1.6.

AP Psychology

Biological Bases

About 12 minutes to read

How to use this guide

Read it in order the first time because the topics build on each other. Genes influence how neurons are built, neurons make up the systems of the nervous system, those systems include the brain, the brain cycles through sleep, and the senses provide information to the whole system. Exam questions usually present a scenario and ask you to identify which part of that sequence is involved.

After the first read, use the trap boxes and the tables to review the distinctions that exam questions test most often. Finish with the practice questions, then complete the recall check on the last page out loud and note any items you cannot explain yet.

What this unit is worth. Every unit on the AP exam carries the same weight, 15 to 25 percent of the multiple-choice section, so Unit 1 counts exactly as much as the rest. The brain structures and neurotransmitters introduced here also appear in later units on memory, disorders, and motivation, so understanding them in this unit will help when those topics come up.

1.1 Heredity and Environment

The old question was nature versus nurture. The current answer is that the two cannot be separated in a living person. **Heredity** is the genetic material passed from parents. **Environment** is everything else, from nutrition before birth to the culture a person grows up in. A **genetic predisposition** means a person carries genes that raise or lower the chance of a trait showing up, rather than guaranteeing that the trait will appear.

Epigenetics describes how environmental experiences can turn gene expression up or down without changing the DNA sequence itself. Two people with the same gene can end up different because their environments switched that gene on at different levels.

How researchers study it

METHOD	LOGIC THAT EARNS THE POINT
Twin studies	Identical (monozygotic) twins share nearly all their genes. Fraternal (dizygotic) twins share about half. If identical twins resemble each other more on a trait, genes are implicated.
Family studies	Traits that cluster in families are candidates for genetic influence, but families share environments too, so this alone proves little.
Adoption studies	An adopted child shares genes with biological parents and environment with adoptive parents. Whichever the child resembles more points to the stronger influence for that trait.

The **evolutionary perspective** explains traits through **natural selection**. Characteristics that improved survival or reproduction in ancestral environments were passed on more often. The exam also includes **eugenics**, which was an attempt to improve the human population by controlling who reproduced. In this course it is presented as an example of scientific ideas being used to justify discrimination.

Trap. A finding that a trait is heritable does not mean environment cannot change it. Heritability describes variation in a population. It says nothing about how fixed a trait is in one person.

1.2 Overview of the Nervous System

The nervous system is organized into two main parts. The **central nervous system** is the brain and spinal cord. The **peripheral nervous system** is every nerve outside those two, carrying information in and commands out.

BRANCH	JOB
Somatic	Voluntary movement and sensory information. The branch you use to raise your hand.
Autonomic	Automatic processes. Heart rate, digestion, glands. Runs without conscious direction.
Sympathetic	Arouses. Speeds the heart, slows digestion, readies the body for action.
Parasympathetic	Calms. Slows the heart, restarts digestion, returns the body to baseline.

The endocrine system works alongside the nerves but slower. Glands release hormones into the bloodstream, and the effects take longer to start and longer to fade than a nerve signal.

1.3 The Neuron and Neural Firing

A **neuron** has three working parts. **Dendrites** receive messages. The **cell body** keeps the neuron alive and holds the nucleus. The **axon** carries the signal away, often wrapped in a fatty **myelin sheath** that speeds it up. **Glial cells** support neurons, supply nutrients, and help form myelin. Sensory neurons carry input in, motor neurons carry commands out, and interneurons handle the traffic between them, including the **reflex arc** that pulls a hand off a hot stove quickly.

Firing, step by step

1. At rest, the neuron holds a negative charge inside. This is the **resting potential**.
2. Incoming signals push the charge toward **threshold**, the minimum level needed to fire.
3. If threshold is reached, the neuron fires an **action potential**. Positive ions rush in and the charge flips. This wave is called **depolarization**.
4. Firing follows the **all-or-nothing principle**. The neuron fires fully or not at all. A stronger stimulus produces more frequent firing, never a bigger single impulse.
5. The neuron then enters a **refractory period**, a brief reset during which it cannot fire again.
6. At the terminal branches, the electrical signal becomes chemical. **Neurotransmitters** cross the synapse and bind to receptor sites on the next neuron.
7. Leftover neurotransmitters are taken back into the sending neuron. That cleanup is **reuptake**.

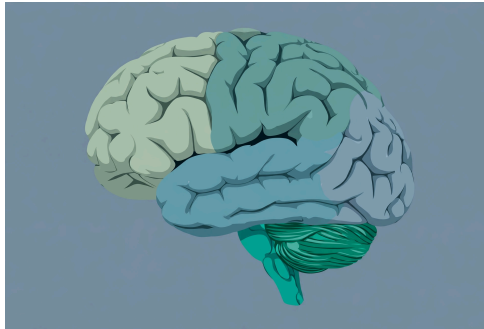
Trap. The signal travels electrically inside a neuron and chemically between neurons, and questions that blur that distinction are testing whether you keep the two steps separate.

Key neurotransmitters

TRANSMITTER	MAIN JOBS	WHEN IT GOES WRONG
Acetylcholine	Muscle action, learning, memory	Linked with the memory loss of Alzheimer disease
Dopamine	Movement, attention, reward and pleasure	Too little in movement disorders such as Parkinson disease. Excess activity associated with schizophrenia
Serotonin	Mood, hunger, sleep, arousal	Low activity associated with depression
Norepinephrine	Alertness and arousal	Undersupply can depress mood
GABA	Main inhibitory transmitter. Calms firing	Undersupply linked with seizures, tremors, insomnia
Glutamate	Main excitatory transmitter. Memory	Oversupply can overstimulate, linked with migraines and seizures
Endorphins	Pain control and pleasure	The body response that opioids imitate

An **agonist** increases a transmitter effect. An **antagonist** decreases it, usually by blocking receptors. In **multiple sclerosis** the myelin sheath deteriorates and signals slow. In **myasthenia gravis** acetylcholine receptors at muscles are attacked and movement weakens.

1.4 The Brain



The cerebrum from the side. The four lobes divide the cortex by job. Frontal in front, then parietal, temporal, and occipital at the back.

STRUCTURE	JOB TO ATTACH TO IT
Medulla	Heartbeat and breathing. Damage here is life threatening.
Reticular activating system	Arousal and alertness. Keeps the cortex awake and attentive.
Cerebellum	Balance, coordination, and fine motor control. Also stores procedural learning.
Thalamus	Sensory relay. Routes incoming senses to the right cortex area. Smell largely bypasses it.
Hypothalamus	Hunger, thirst, body temperature, and drives. Directs the pituitary gland.
Hippocampus	Forms new explicit memories. Damage blocks new long-term memories, not old ones.
Amygdala	Emotion, especially fear and aggression. Flags what is threatening.
Cerebral cortex	The outer layer where thinking happens. Divided into four lobes per hemisphere.
Corpus callosum	The band of fibers joining the two hemispheres so they can share information.

The four lobes, plus two language areas

Frontal lobes handle planning, judgment, personality, and voluntary movement in the motor cortex at their back edge. **Parietal lobes** receive touch and body position in the somatosensory cortex. **Temporal lobes** process hearing. **Occipital lobes** process vision. Two areas in these lobes appear often on the exam. **Broca area**, in the frontal lobe, produces speech. Damage leaves a person understanding language but struggling to speak. **Wernicke area**, in the temporal lobe, comprehends language. Damage leaves speech fluent but meaningless.

How researchers see the brain

METHOD	WHAT IT SHOWS, AND ITS LIMIT
EEG	Electrical activity over time. Excellent for sleep stages. Cannot pinpoint location well.
CT scan	X-ray images of structure. Shows damage, not activity.
PET scan	Activity, tracked through glucose use. Shows working areas, with radiation involved.
MRI	Detailed structure using magnetic fields. No activity information.
fMRI	Structure and activity together, through blood flow. The best all-purpose tool here.
Lesion and case studies	Damage reveals function. Powerful but uncontrolled, since no two injuries are identical.

Brain plasticity means the brain can reorganize after damage or practice, especially in younger people. Neighboring areas can take over lost functions. In **split-brain** patients, whose corpus callosum was cut to treat severe epilepsy, the hemispheres cannot share information. Research with these patients showed the left hemisphere usually handles language while the right leans toward spatial and facial processing. In an intact brain the two sides share information constantly, and simple left-brain or right-brain personality claims are not supported by this research.

Trap. The amygdala and hippocampus are often confused with each other. The amygdala is involved in emotion, especially fear, while the hippocampus is involved in forming new memories. This pair is worth drilling on its own until the two stop blending together. It is in the Biological Bases deck in Rycal as flashcards that return to that distinction over several reviews.

1.5 Sleep



Sleep moves through a repeating cycle of stages, with a full pass taking about 90 minutes and repeating through the night.

Your **circadian rhythm** is the roughly 24-hour internal clock that times sleepiness and alertness. Light is its main setting signal. The suprachiasmatic nucleus in the hypothalamus tracks light and directs the pineal gland to release melatonin as darkness falls.

The stages

STAGE	WHAT HAPPENS
NREM-1	Light sleep at the boundary. People report floating sensations and sudden muscle jerks.
NREM-2	Real sleep begins. The brain produces bursts called sleep spindles. Most of the night is spent here.
NREM-3	Deep slow-wave sleep. Hard to wake. Growth hormone is released and the body repairs itself. Sleepwalking starts here, not in dreams.
REM	Rapid eye movement sleep. Vivid dreaming, an active brain, and a paralyzed body. Memory consolidation is a major job of this stage.

The course presents several working explanations for sleep rather than one settled answer. Sleep protects, keeping animals inactive when they are vulnerable. It restores the body and clears waste from the brain. It helps turn experiences from the day into memories. Dreaming may also support creative problem solving, since people often wake with a connection they could not find the night before.

Sleep disorders

DISORDER	WHAT GOES WRONG
Insomnia	Persistent trouble falling or staying asleep.
Narcolepsy	Sudden, uncontrollable attacks of sleep that can drop a person straight into REM.
Sleep apnea	Breathing repeatedly stops during the night, fragmenting sleep. Often undiagnosed.
Somnambulism	Sleepwalking during NREM-3. Most common in children and usually outgrown.
REM sleep behavior disorder	The normal paralysis of REM fails, so the person physically acts out dreams.

Trap. Sleepwalking happens in deep NREM-3 sleep, not during dreaming. If a scenario has someone walking around, the answer is the deep stage, even though the story feels like a dream.

1.6 Sensation

Sensation is the process of detecting energy from the world, such as light, sound waves, pressure, and chemicals, and converting it into neural signals. That conversion is **transduction**. Interpreting those signals is perception, which is covered in a later unit, so this section focuses on detection and transduction.

CONCEPT	WORKING DEFINITION AND EXAMPLE
Absolute threshold	The weakest stimulus a person detects 50 percent of the time. A candle flame seen at roughly 30 miles on a clear dark night is the classic image.
Difference threshold (JND)	The smallest change between two stimuli that a person can detect.
Weber law	The JND is a constant proportion, not a constant amount. Add one pound to a 10-pound load and you notice. Add it to 100 pounds and you do not.
Sensory adaptation	Sensitivity drops under constant stimulation. You stop feeling your watch. This is the senses prioritizing change over sameness.
Sensory interaction	Senses influence each other. Flavor collapses when smell is blocked by a cold.
Synesthesia	One sense triggers another automatically, such as hearing a note and seeing a color.

Subliminal stimuli fall below the absolute threshold. They can register weakly and briefly, which is called priming, but the course position is that they do not produce the powerful hidden persuasion of popular imagination. If a question claims an under-threshold message made someone buy something, be skeptical of that option.

Confusions That Cost Points

Most missed questions in this unit come from a short list of pairs that look alike under time pressure. Review each pair carefully so you can tell them apart when you see them in a question.

PAIR	HOW TO SEPARATE THEM
Sympathetic vs parasympathetic	Sympathetic speeds you up for action. Parasympathetic calms you back down. One spends energy, the other restores it.
Amygdala vs hippocampus	Amygdala is emotion and fear. Hippocampus is forming new memories. Alarm versus archive.
Broca vs Wernicke	Broca produces speech, frontal lobe. Wernicke comprehends speech, temporal lobe. Broken Broca means halting speech with meaning intact.
Agonist vs antagonist	Agonists increase a neurotransmitter effect. Antagonists block it. Think agree versus against.
Absolute vs difference threshold	Absolute is detecting something at all. Difference is detecting a change between two things.
NREM-3 vs REM	Deep sleep and sleepwalking live in NREM-3. Dreaming and body paralysis live in REM.
Sensation vs perception	Sensation detects and transduces. Perception organizes and interprets. Bottom-up raw input comes before top-down meaning.
MRI vs fMRI	MRI shows structure. The f in fMRI is function, activity over time.

Practice Questions

Original questions written for this guide in the style of the AP exam. Answers and explanations are on the next page, so complete the questions before checking them.

- 1.** Identical twins raised apart are found to be more similar in intelligence scores than fraternal twins raised together. This finding most directly supports which conclusion?
 - A. Environment has no influence on intelligence
 - B. Genetic similarity contributes to similarity in intelligence
 - C. Adoption eliminates the effects of heredity
 - D. Intelligence is determined entirely before birth

- 2.** After eating a large meal, your heart rate slows and digestion picks up. Which branch of the nervous system is most active?
 - A. Sympathetic
 - B. Somatic
 - C. Parasympathetic
 - D. Central

- 3.** A medication eases depression by preventing serotonin from being taken back into the sending neuron, leaving more of it in the synapse. In this process, the medication acts as
 - A. an antagonist for serotonin
 - B. an agonist that increases serotonin activity
 - C. a myelin sheath on the axon
 - D. a form of reuptake itself

- 4.** A stroke patient speaks in fluent, well-formed sentences that make no sense, and cannot understand what others say to her. Damage most likely occurred in
 - A. Broca area
 - B. the occipital lobe
 - C. Wernicke area
 - D. the cerebellum

- 5.** A 7-year-old is found walking around the house at night with her eyes open. She has no memory of it in the morning and is very difficult to wake during the episode. She is most likely experiencing
- A. REM sleep behavior disorder
 - B. narcolepsy
 - C. somnambulism during NREM-3 sleep
 - D. a vivid dream in REM sleep
- 6.** A weightlifter notices when a coach adds 2 pounds to a 40-pound bar but cannot tell when 2 pounds are added to a 200-pound bar. This best illustrates
- A. sensory adaptation
 - B. Weber law
 - C. the absolute threshold
 - D. signal detection
- 7.** During a fire alarm, students feel their hearts pound and their mouths go dry as they exit the building. Ten minutes later, outside and safe, their bodies settle. The settling phase is driven by
- A. the parasympathetic nervous system
 - B. the somatic nervous system
 - C. the spinal cord alone
 - D. increased sympathetic activity
- 8.** A researcher wants to watch which brain areas become active while participants solve puzzles, without using radiation. The best choice is
- A. CT scan
 - B. EEG alone
 - C. fMRI
 - D. a lesion study

Answer Key

- 1. B.** Identical twins share nearly all genes, so their extra similarity points to genetic contribution. A and D overclaim. Heritability never means environment has zero effect. C invents a claim adoption research does not make.
- 2. C.** The parasympathetic branch runs digestion and slows the heart after arousal. A does the opposite, B handles voluntary movement, and D is the brain and spinal cord, not a digestive control.
- 3. B.** Blocking reuptake leaves more serotonin active, so the drug increases its effect. That is an agonist action. A would block receptors, C confuses insulation with chemistry, and D names the process being blocked, not the blocker.
- 4. C.** Fluent nonsense speech plus poor comprehension is Wernicke area damage in the temporal lobe. A produces halting speech with comprehension intact, B handles vision, and D governs coordination.
- 5. C.** Sleepwalking occurs in deep NREM-3 sleep, which fits the hard waking and no memory. A involves acting out dreams because REM paralysis failed, B is sudden daytime sleep, and D is the trap. Walking around is not REM, because the body is paralyzed in REM.
- 6. B.** Weber law says the detectable change is a proportion of the original weight, not a fixed amount. A is fading sensitivity to a constant stimulus, C is detecting a stimulus at all, and D is too broad to name this pattern.
- 7. A.** The parasympathetic branch restores the body to baseline after sympathetic arousal. D reverses the direction, B handles voluntary movement, and C ignores that autonomic control involves the brain as well.
- 8. C.** fMRI tracks activity through blood flow without radiation. A shows structure only, B records timing of electrical activity but cannot localize areas well, and D waits for damage rather than observing a working brain.

When you check your answers, note which distinction each miss came from. Make a flashcard for that distinction and drill it spaced out over the next few days instead of rereading the whole section. If you missed one of these questions, the same distinction is worth practicing again in Rycal, where the Biological Bases deck has flashcards for it and more practice questions use the same kinds of traps.

One-Page Recall Check

Say each answer out loud before you look back, and mark the ones you cannot finish. Anything you cannot say out loud yet belongs in your flashcard deck. In Rycal, add those items to the Biological Bases deck and let spaced review bring them back over the next few days.

- Explain genetic predisposition without using the word determined.
- Describe how an adoption study separates genes from environment.
- Name the two divisions of the peripheral nervous system and give one job of each.
- Explain why sympathetic and parasympathetic are opponents, using heart rate and digestion.
- Walk through neural firing from resting potential to reuptake, in order, without notes.
- Explain the all-or-nothing principle to someone who thinks a stronger stimulus makes a stronger impulse.
- Match each neurotransmitter to one malfunction. Dopamine, serotonin, GABA, glutamate, acetylcholine.
- Give the difference between an agonist and an antagonist using a real drug example from the unit.
- Match medulla, cerebellum, thalamus, hypothalamus, hippocampus, and amygdala to their jobs.
- State the job of each lobe, then place Broca and Wernicke areas in the right lobes.
- Choose between EEG, PET, MRI, and fMRI for a question about sleep stages, and defend the choice.
- Describe what happens in NREM-1, NREM-2, NREM-3, and REM, one sentence each.
- Explain why sleepwalking points to NREM-3 and dreaming points to REM.
- Define absolute threshold, difference threshold, and Weber law, then invent one example for each.
- Explain sensory adaptation using something you stopped noticing today.

Where to go next. Turn every missed item above into flashcards and drill them spaced out over several days rather than in one sitting. In Rycal, open the Biological Bases deck under AP Psychology. The deck covers the terms in this guide, and its practice questions target the same traps named here. If you have a test date, add it in the Test Planner. You can also start your next review with a Brain Dump, then check what you missed against this guide.

Key terms for this unit

Heredity, genetic predisposition, epigenetics, natural selection, eugenics, twin studies, adoption studies, central nervous system, peripheral nervous system, somatic, autonomic, sympathetic, parasympathetic, endocrine system, neuron, dendrites, axon, myelin sheath, glial cells, sensory neurons, motor neurons, interneurons, reflex arc, action potential, resting potential, threshold, depolarization, all-or-nothing principle, refractory period, neurotransmitter, synapse, reuptake, agonist, antagonist, medulla, reticular activating system, cerebellum, thalamus, hypothalamus, hippocampus, amygdala, cerebral cortex, corpus callosum, Broca area, Wernicke area, plasticity, circadian rhythm, melatonin, NREM, REM, insomnia, narcolepsy, sleep apnea, somnambulism, absolute threshold, difference threshold, Weber law, transduction, sensory adaptation, sensory interaction, synesthesia, Accommodation (vision), Activation-synthesis theory, Addiction, Adrenaline, Afterimages, All-or-none principle, Aphasia, Association areas, Autonomic nervous system, Basic tastes, Blind spot, Blindsight, Brain's reward center, Brain stem, Broca's area, Circadian rhythm (sleep/wake cycle), Color vision deficiency, Conduction deafness, Cones, Consciousness, Consolidation theory (dreams), Contralateral hemispheric organization, Depressants, Dichromatism, Environmental factors, Excitatory messages, Farsightedness, Fovea, Frequency theory, Ganglion cells, Gate control theory, Ghrelin, Gustation, Hallucinogens, Hypnagogic sensations, Inhibitory messages, Jet lag, Just-noticeable difference, Kinesthesia, Leptin, Lesioning, Limbic system, Loudness, Memory consolidation theory (sleep), Monochromatism, Nearsightedness, Neural transmission (action potential), NREM sleep, Olfaction, Opponent-process theory, Oxytocin, Phantom limb sensation, Pheromones, Pitch, Place theory, Prefrontal