AP PSYCHOLOGY

Adapted from Aneeq Ahmad
Henderson State University

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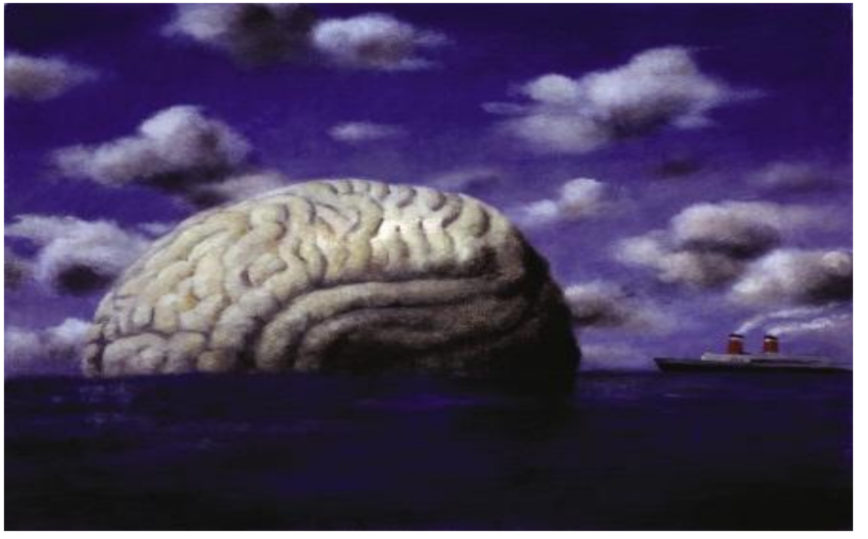

Neuroscience and Behavior

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Neuroscience and Behavior

Neural Communication

- Neurons
- How Neurons Communicate
- How Neurotransmitters Influence Us

The Nervous System

- The Peripheral Nervous System
- The Central Nervous System

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Neuroscience and Behavior

The Endocrine System

The Brain

- The Tools of Discovery
- Older Brain Structures
- The Cerebral Cortex
- Our Divided Brain
- Left Brain-Right Brain

History of Mind

Ancient Conceptions About Mind

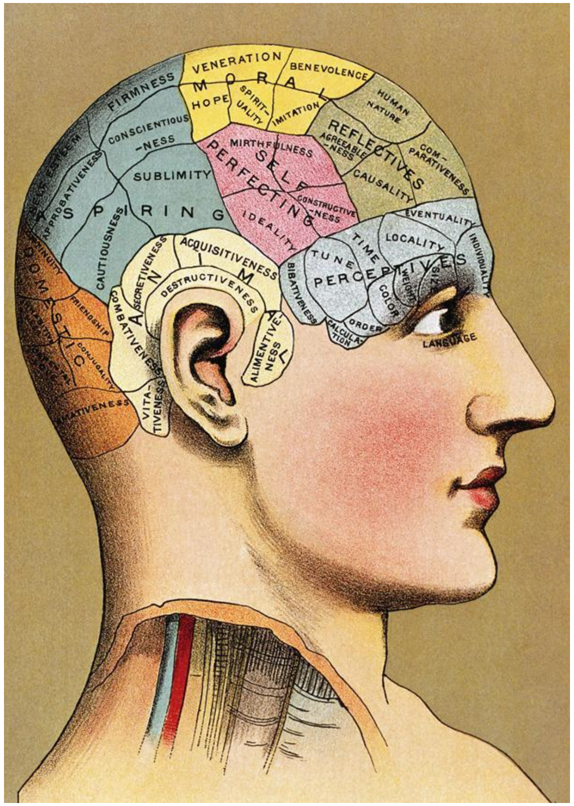
Plato correctly placed mind in the brain. However, his student Aristotle believed that mind was in the heart.

Today we believe mind and brain are faces of the same coin. Everything that is psychological is simultaneously biological.

History of Mind

Phrenology

In 1800, Franz Gall suggested that bumps of the skull represented mental abilities. His theory, though incorrect, nevertheless proposed that different mental abilities were modular.



Bettman/ Corbis

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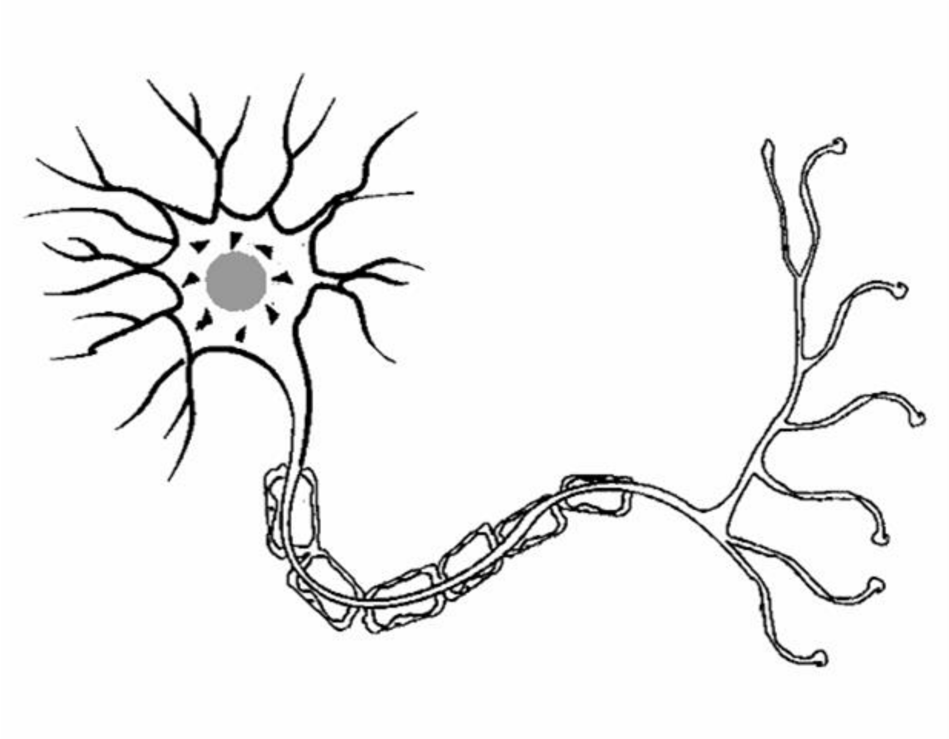
Neural Communication

The body's information system is built from billions of interconnected cells called ***neurons***.



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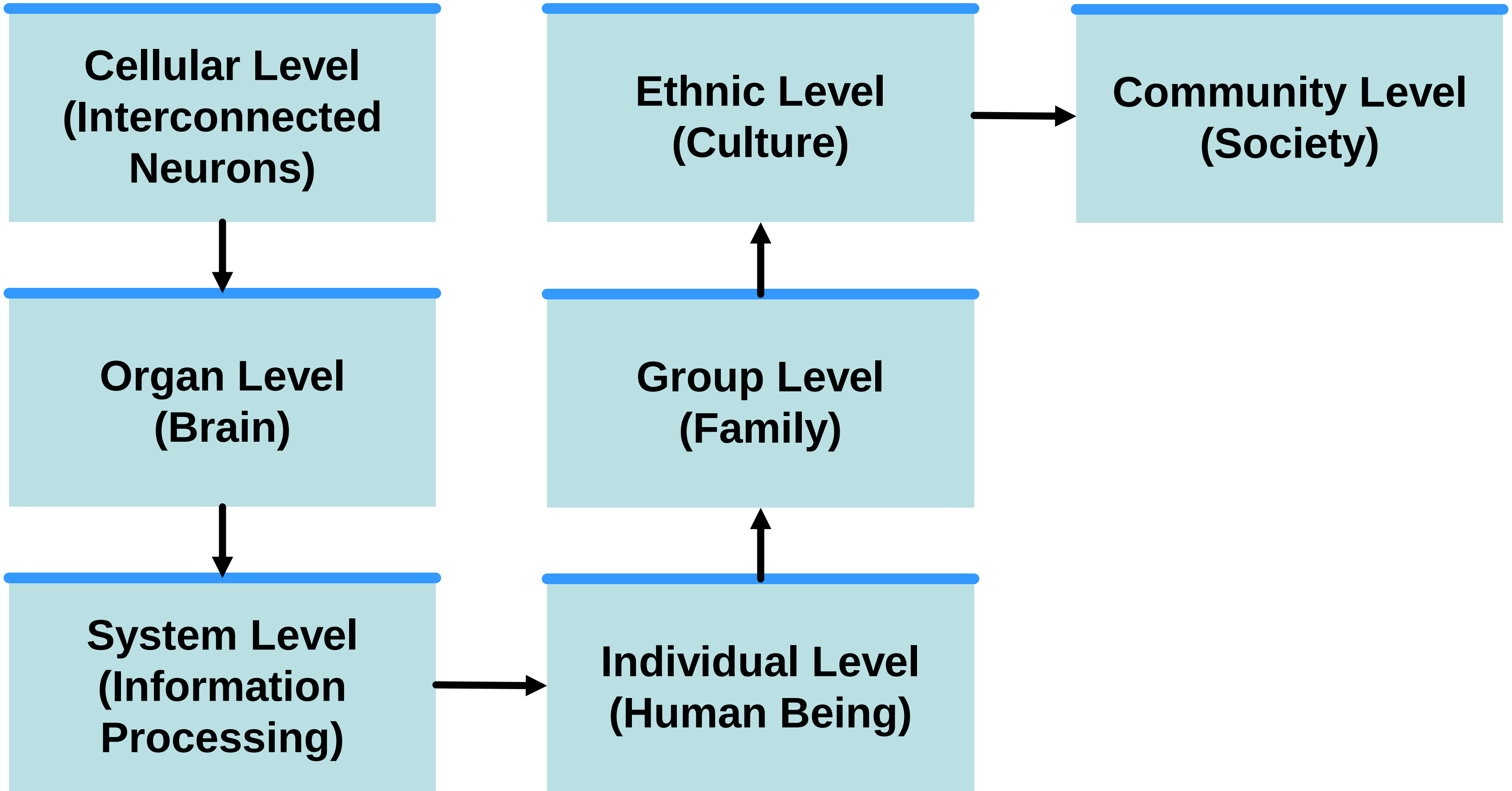
Neural Communication

We are a *biopsychosocial* system.



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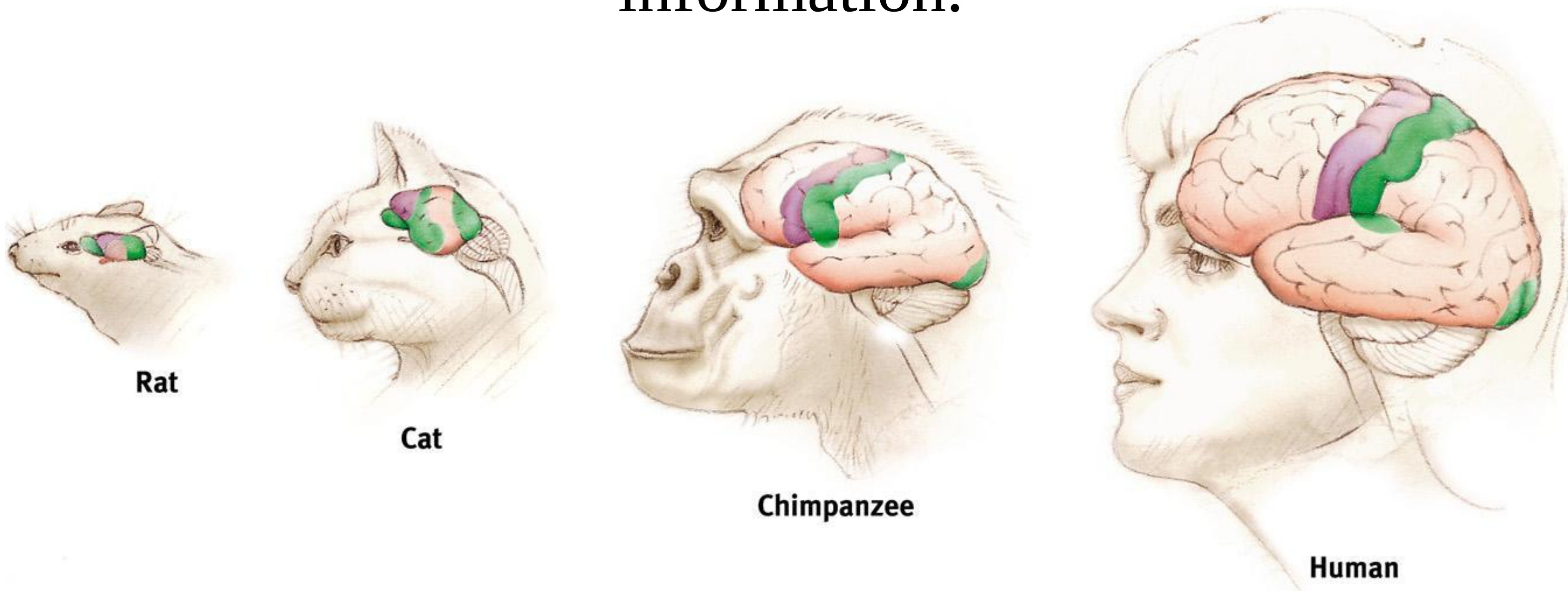
Neural Communication

Neurobiologists and other investigators understand that humans and animals operate similarly when processing information.



Note the similarities in the above brain regions, which are all engaged in information processing.

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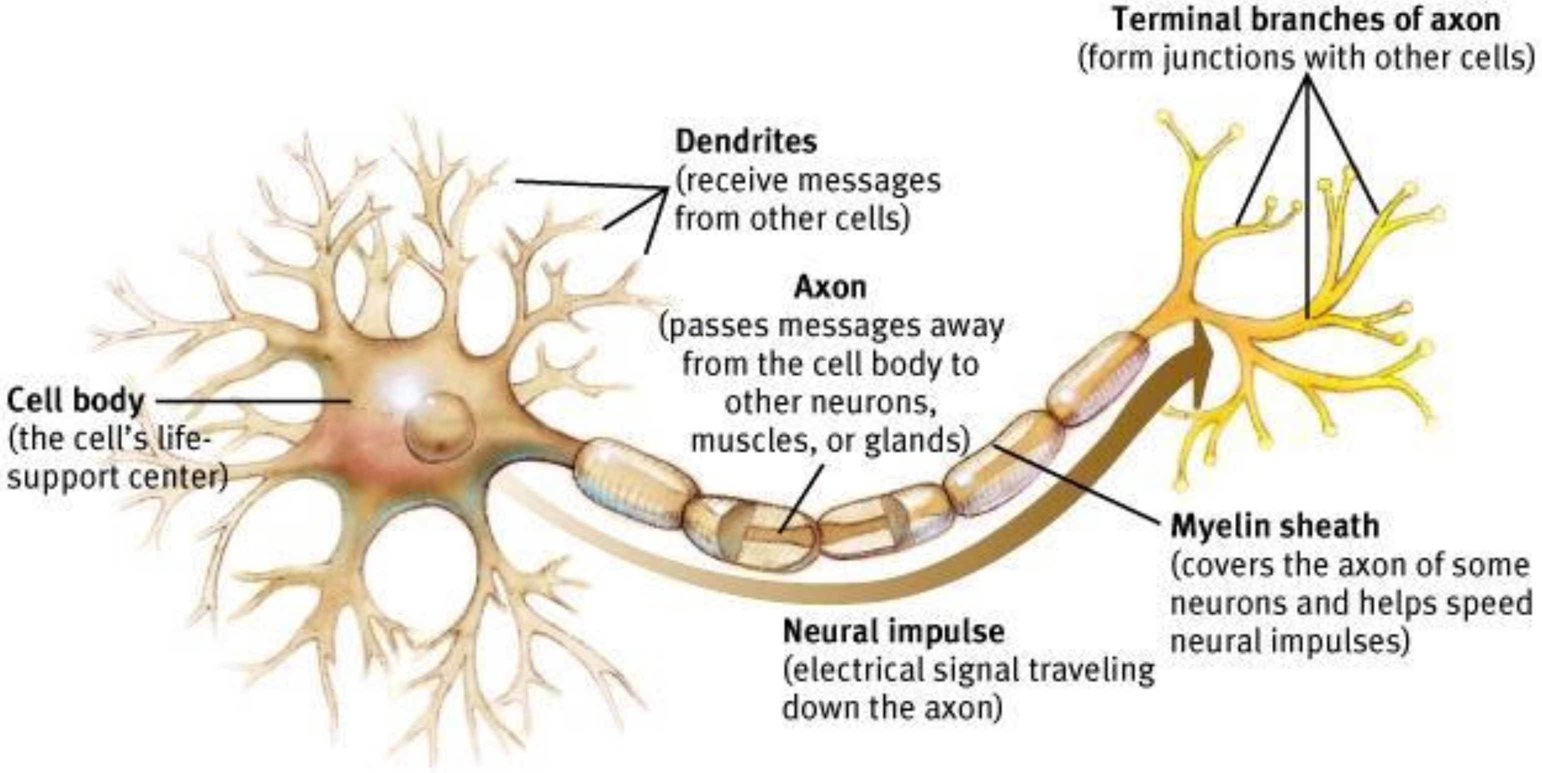
Neuron

A nerve cell, or a neuron, consists of many different parts.



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Parts of a Neuron

Cell Body: Life support center of the neuron.

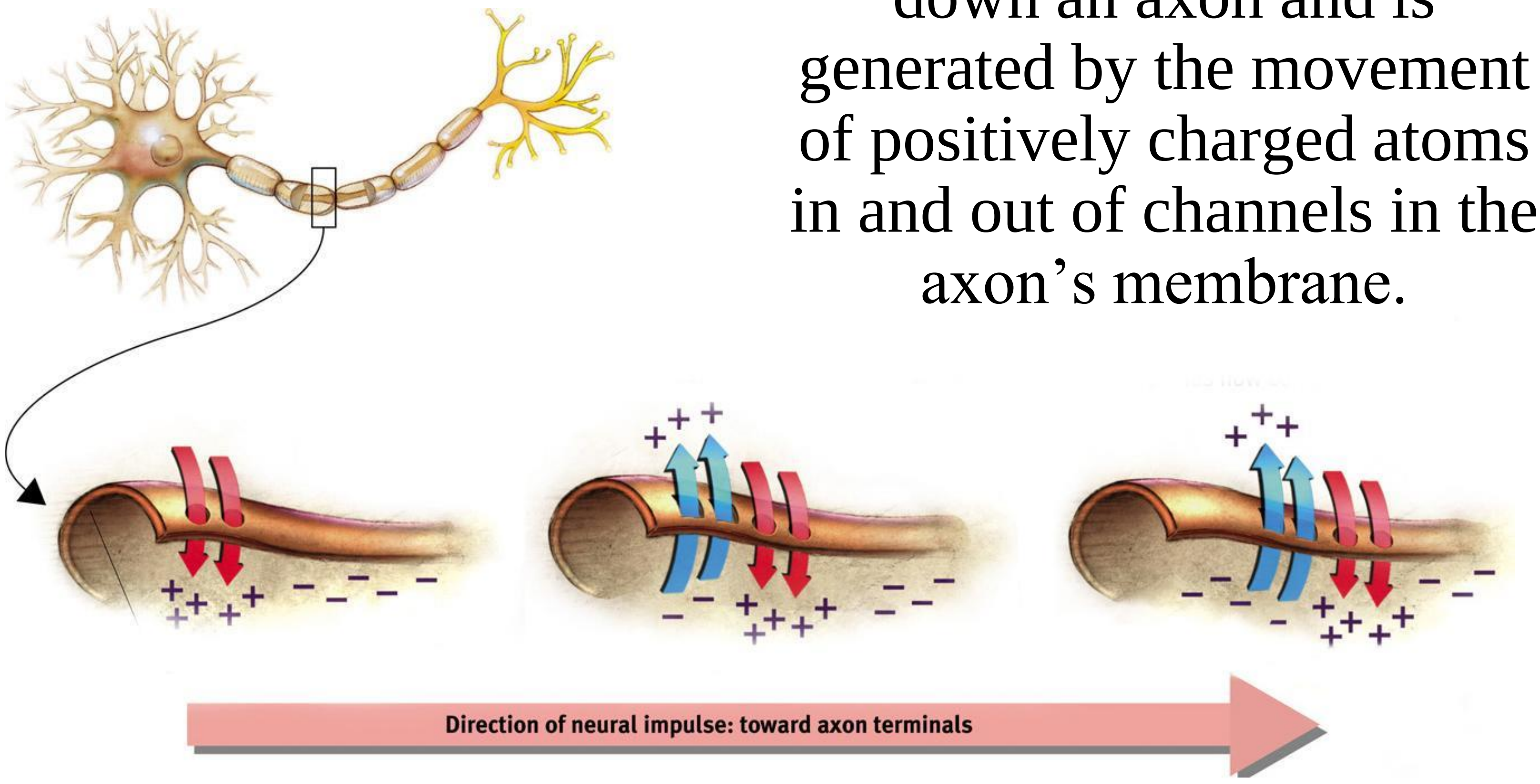
Dendrites: Branching extensions at the cell body. Receive messages from other neurons.

Axon: Long single extension of a neuron, covered with myelin [MY-uh-lin] sheath to insulate and speed up messages through neurons.

Terminal Branches of axon: Branched endings of an axon that transmit messages to other neurons.

Action Potential

A neural impulse. A brief electrical charge that travels down an axon and is generated by the movement of positively charged atoms in and out of channels in the axon's membrane.



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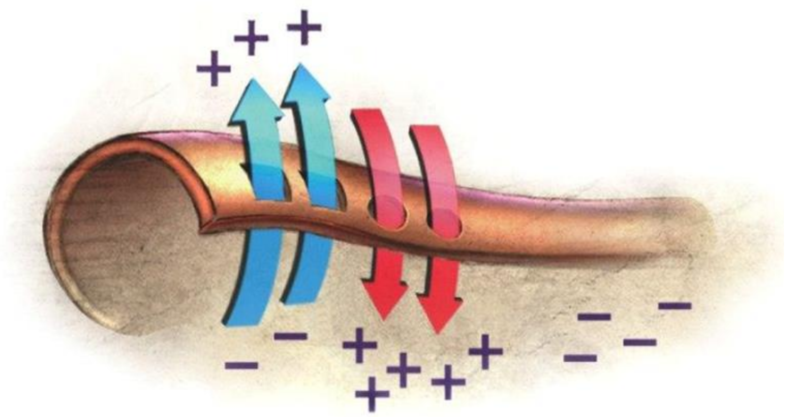
Depolarization & Hyperpolarization

Depolarization: Depolarization occurs when positive ions enter the neuron, making it more prone to firing an action potential. Hyperpolarization occurs when negative ions enter the neuron, making it less prone to firing an action potential.



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Threshold

Threshold: Each neuron receives depolarizing and hyperpolarizing currents from many neurons. When the depolarizing current (positive ions) minus the hyperpolarizing current (negative ions) exceed minimum intensity (threshold) the neuron fires an action potential.

Refractory Period & Pumps

Refractory Period: After a neuron fires an action potential it pauses for a short period to recharge itself to fire again.

Sodium-Potassium Pumps: Sodium-potassium pumps pump positive ions out from the inside of the neuron, making them ready for another action potential.

Action Potential Properties

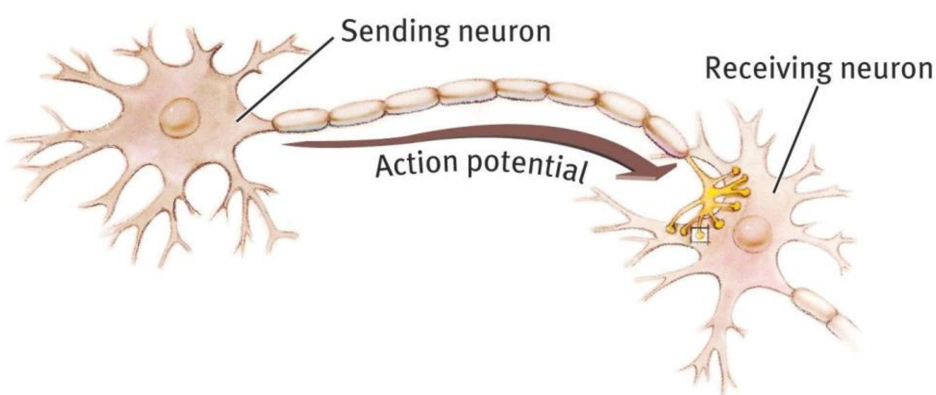
All-or-None Response: When the depolarizing current exceeds the threshold, a neuron will fire. If the depolarizing current fails to exceed the threshold, a neuron will *not* fire.

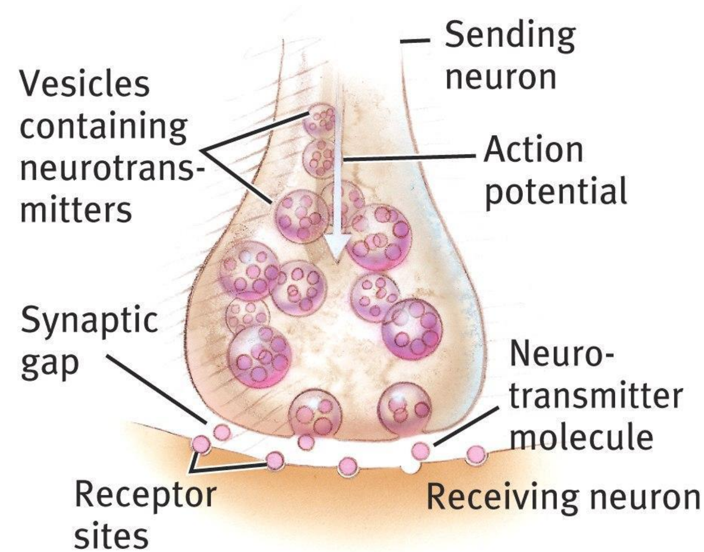
Intensity of an action potential remains the same throughout the length of the axon.

Synapse

Synapse [SIN-aps] a junction between the axon tip of the sending neuron and the dendrite or cell body of the receiving neuron. This tiny gap is called the *synaptic gap* or *cleft.*

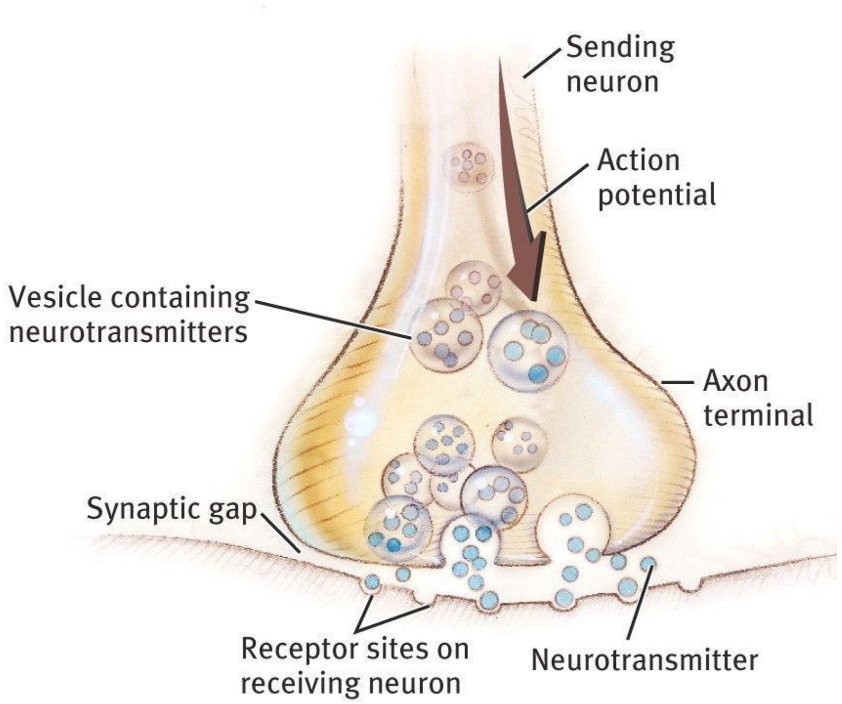
1. Electrical impulses (action potentials) travel from one neuron to another across a tiny junction known as a synapse.





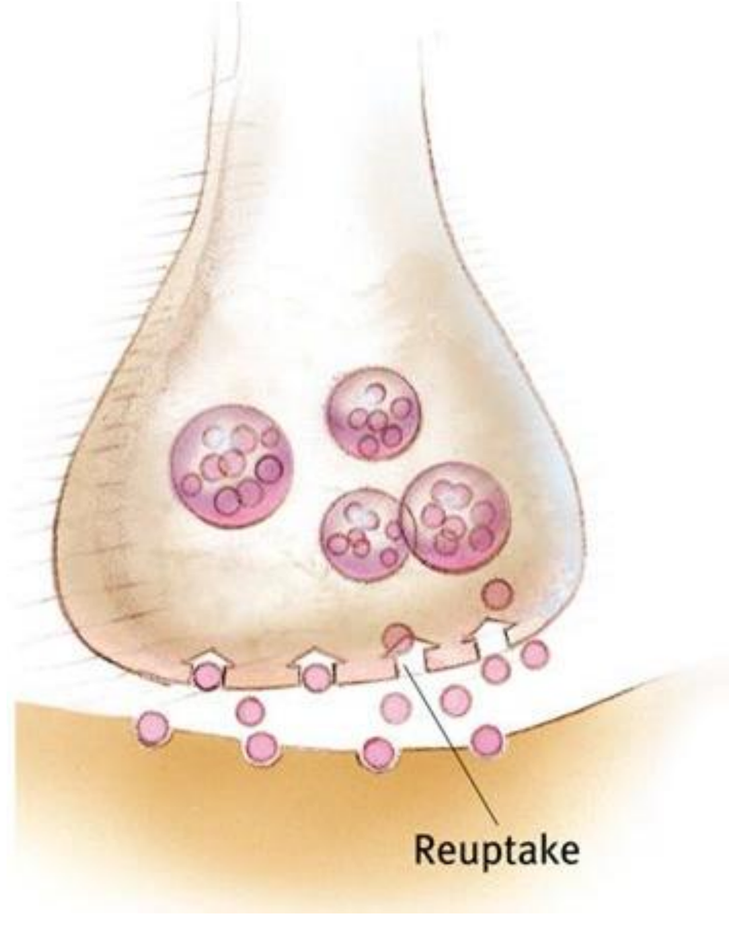
Neurotransmitters

Neurotransmitters (chemicals) released from the sending neuron travel across the synapse and bind to receptor sites on the receiving neuron, thereby influencing it to generate an action potential.



Reuptake

Neurotransmitters in the synapse are reabsorbed into the sending neurons through the process of reuptake. This process applies the brakes on neurotransmitter action.



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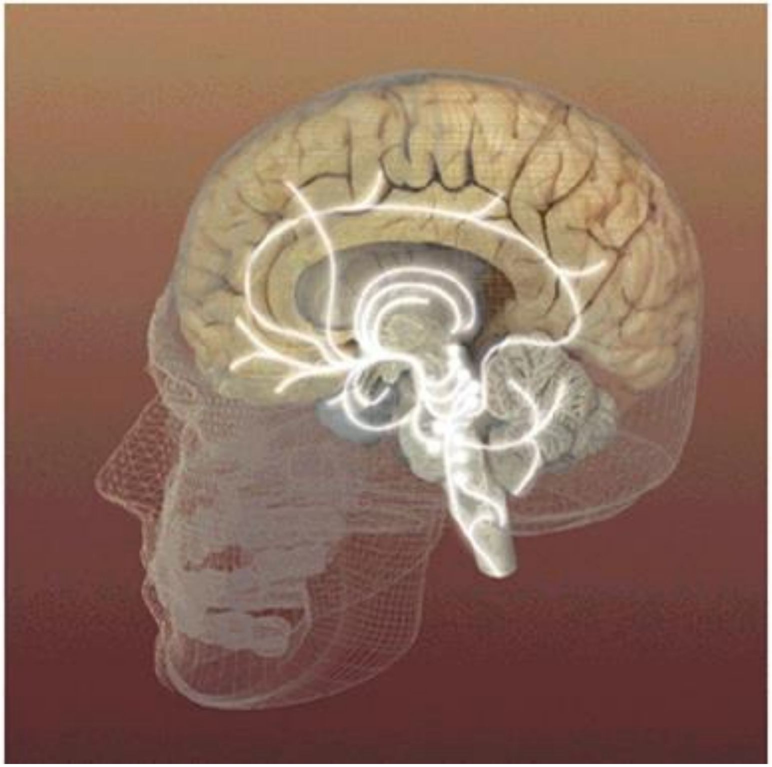
How Neurotransmitters Influence Us?

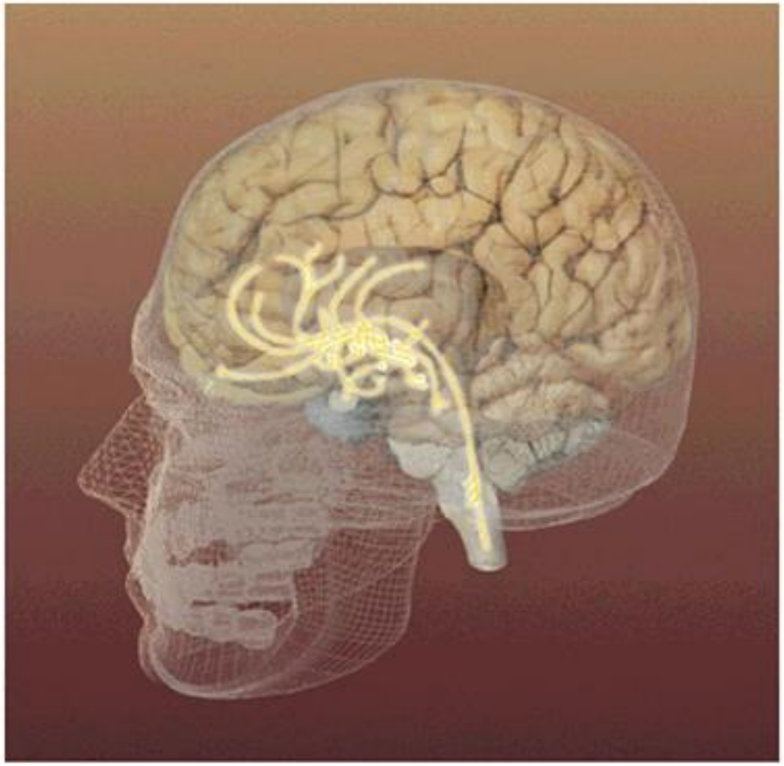
Serotonin pathways are involved with mood regulation.



From *Mapping the Mind*, Rita Carter, © 1989 University of California Press

Dopamine Pathways

Dopamine pathways are involved with diseases such as schizophrenia and Parkinson's disease.



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Neurotransmitters

SOME NEUROTRANSMITTERS AND THEIR FUNCTIONS

Neurotransmitter	Function	Examples of Malfunctions
Acetylcholine (ACh)	Enables muscle action, learning, and memory.	With Alzheimer's disease, ACh-producing neurons deteriorate.
Dopamine	Influences movement, learning, attention, and emotion.	Excess dopamine receptor activity linked to schizophrenia. Starved of dopamine, the brain produces the tremors and decreased mobility of Parkinson's disease.
Serotonin	Affects mood, hunger, sleep, and arousal.	Undersupply linked to depression; Prozac and some other antidepressant drugs raise serotonin levels.
Norepinephrine	Helps control alertness and arousal.	Undersupply can depress mood.
GABA (gamma-aminobutyric acid)	A major inhibitory neurotransmitter.	Undersupply linked to seizures, tremors, and insomnia.
Glutamate	A major excitatory neurotransmitter; involved in memory.	Oversupply can overstimulate brain, producing migraines or seizures (which is why some people avoid MSG, monosodium glutamate, in food).

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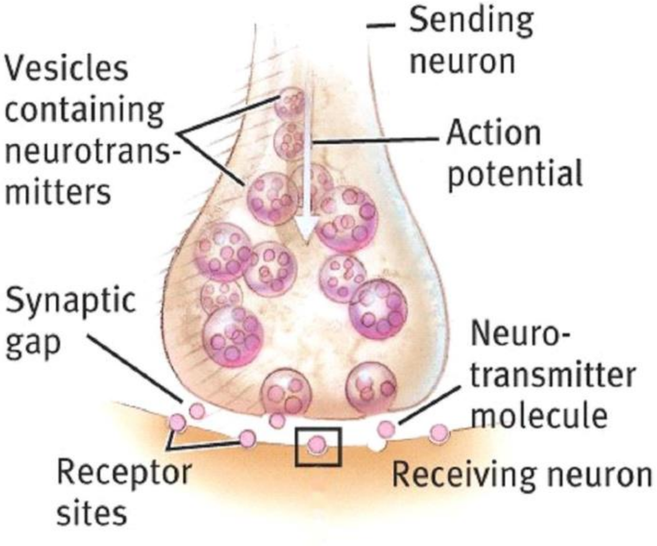
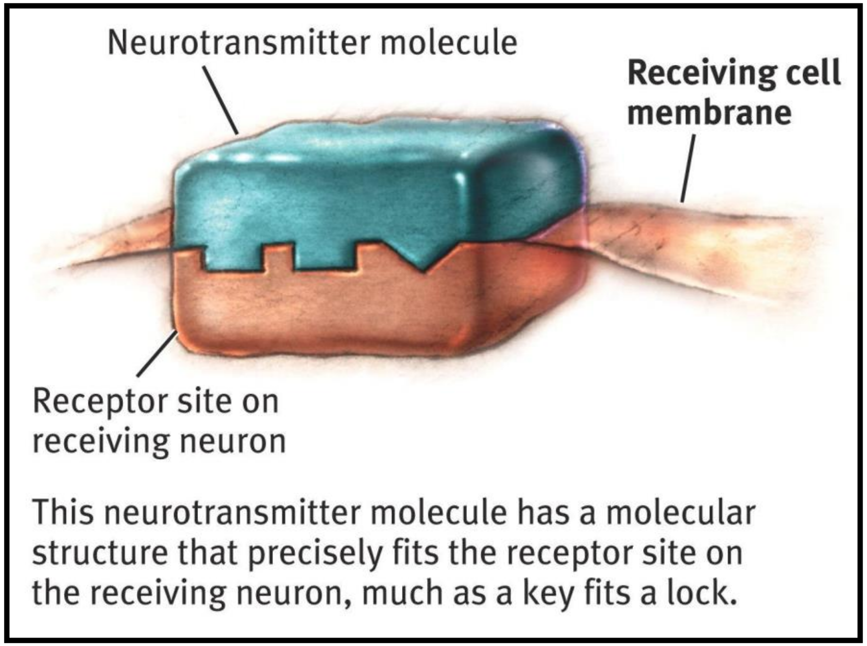
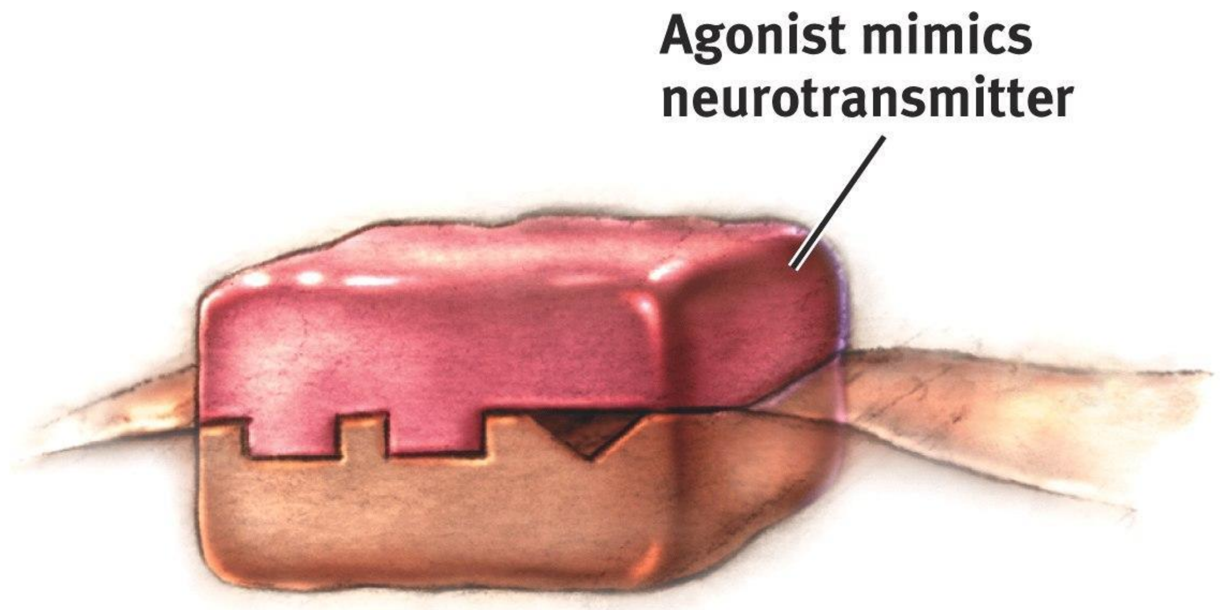
Lock & Key Mechanism

Neurotransmitters bind to the receptors of the receiving neuron in a key-lock mechanism.





Agonists



This agonist molecule excites.It is similar enough in structure to the neurotransmitter molecule that it mimics its effects on the receiving neuron. Morphine, for instance, mimics the action of endorphins by stimulating receptors in brain areas involved in mood and pain sensations.

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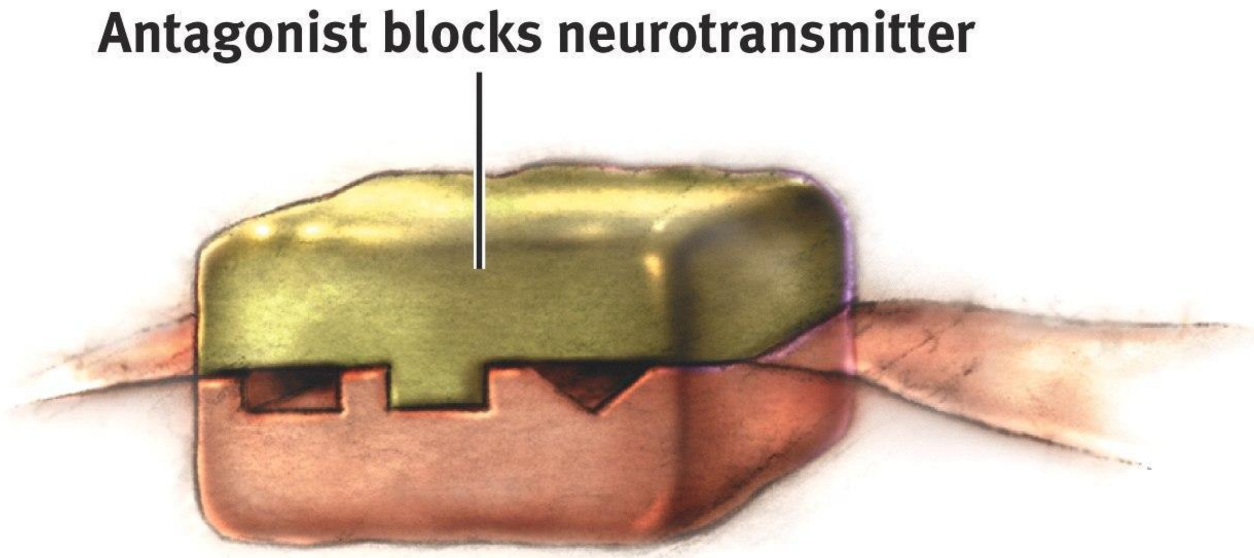
Antagonists



This antagonist molecule inhibits. It has a structure similar enough to the neurotransmitter to occupy its receptor site and block its action, but not similar enough to stimulate the receptor. Curare poisoning paralyzes its victims by blocking ACh receptors involved in muscle movement.

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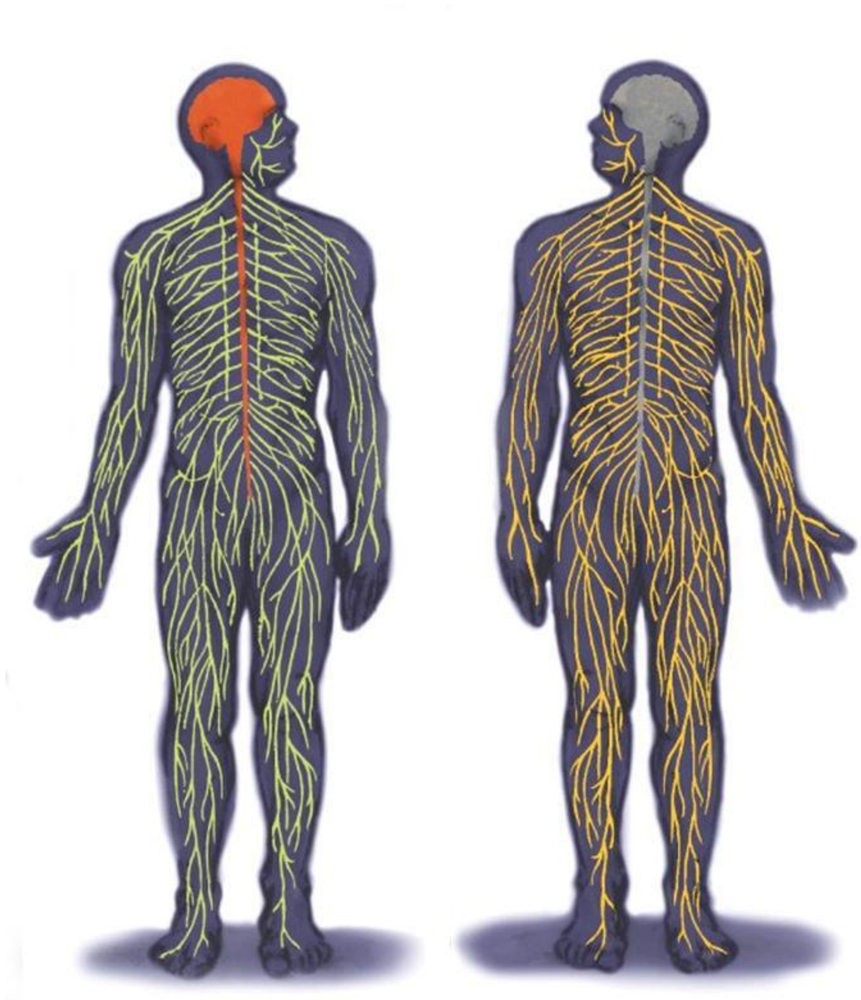
Nervous System

Central Nervous System (CNS)



Peripheral Nervous System (PNS)

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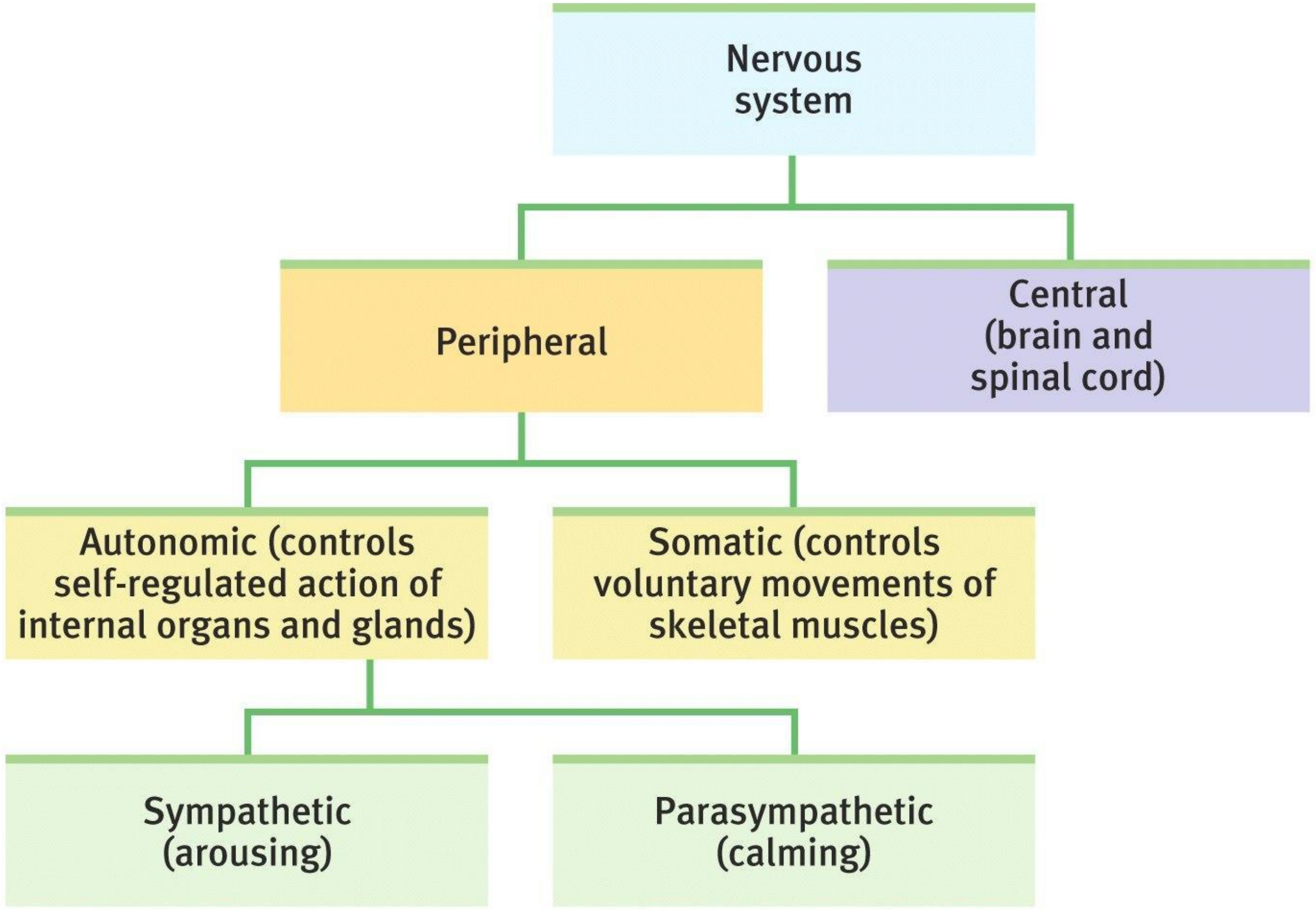
The Nervous System

Nervous System: Consists of all the nerve cells. It is the body's speedy, electrochemical communication system.

Central Nervous System (CNS): the brain and spinal cord.

Peripheral Nervous System (PNS): the sensory and motor neurons that connect the central nervous system (CNS) to the rest of the body.

The Nervous System



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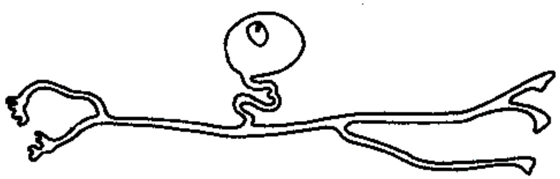
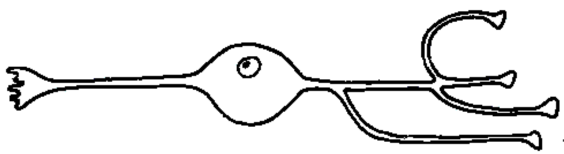
Kinds of Neurons

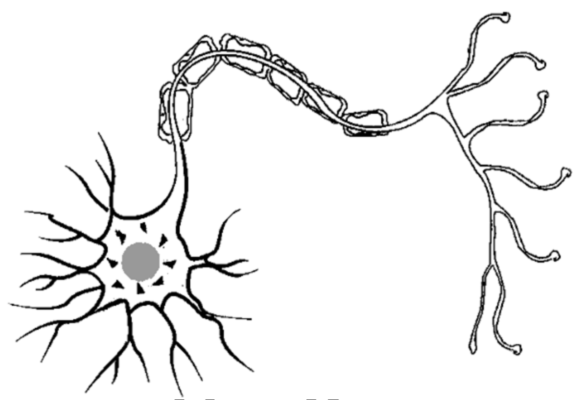
Sensory Neurons carry incoming information from the sense receptors to the CNS. Motor Neurons carry outgoing information from the CNS to muscles and glands. Interneurons connect the two neurons.



Interneuron Neuron
(Unipolar)



Sensory Neuron
(Bipolar)



Motor Neuron
(Multipolar)

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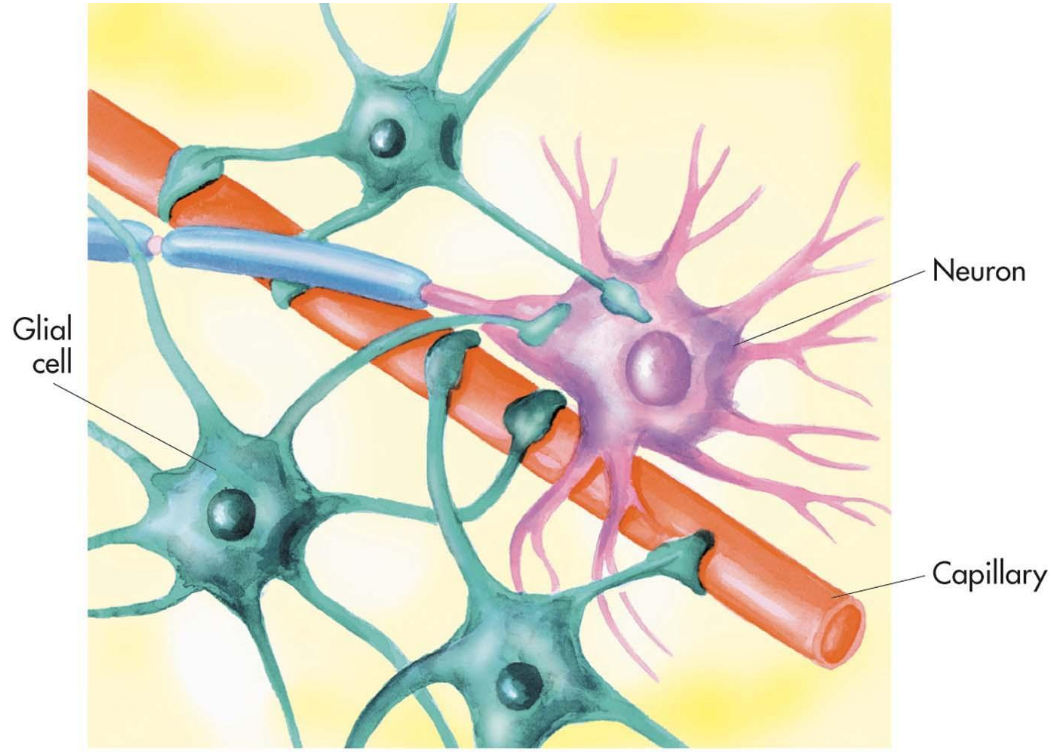
Kinds of Glial Cells

Astrocytes provide nutrition to neurons. Oligodendrocytes and Schwann cells insulate neurons as myelin.



Astrocytes

Peripheral Nervous System

Somatic Nervous System: The division of the peripheral nervous system that controls the body's skeletal muscles.

Autonomic Nervous System: Part of the PNS that controls the glands and other muscles.

The Nerves

Nerves consist of neural "cables" containing many axons. They are part of the peripheral nervous system and connect muscles, glands, and sense organs to the central nervous system.

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Autonomic Nervous System (ANS)

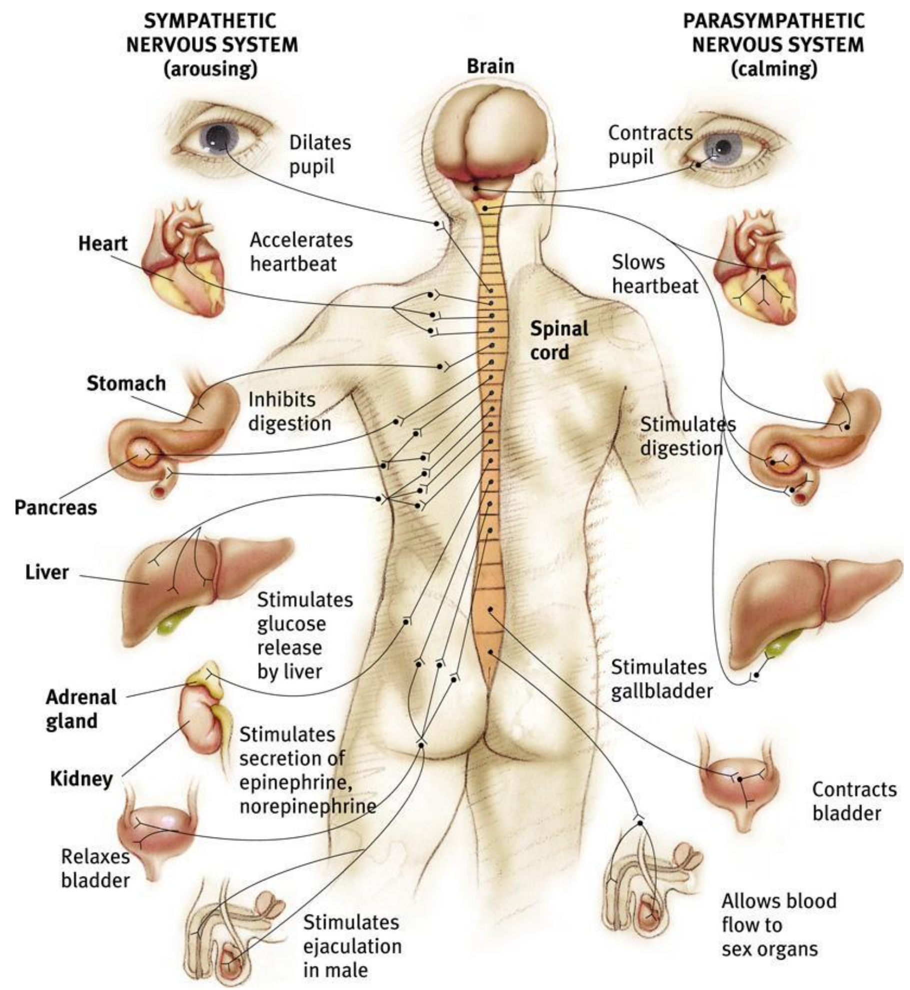
Sympathetic Nervous System: Division of the ANS that arouses the body, mobilizing its energy in stressful situations.

Parasympathetic Nervous System: Division of the ANS that calms the body, conserving its energy.

Autonomic Nervous System (ANS)

Sympathetic NS
“Arouses”
(fight-or-flight)

Parasympathetic NS
“Calms”
(rest and digest)



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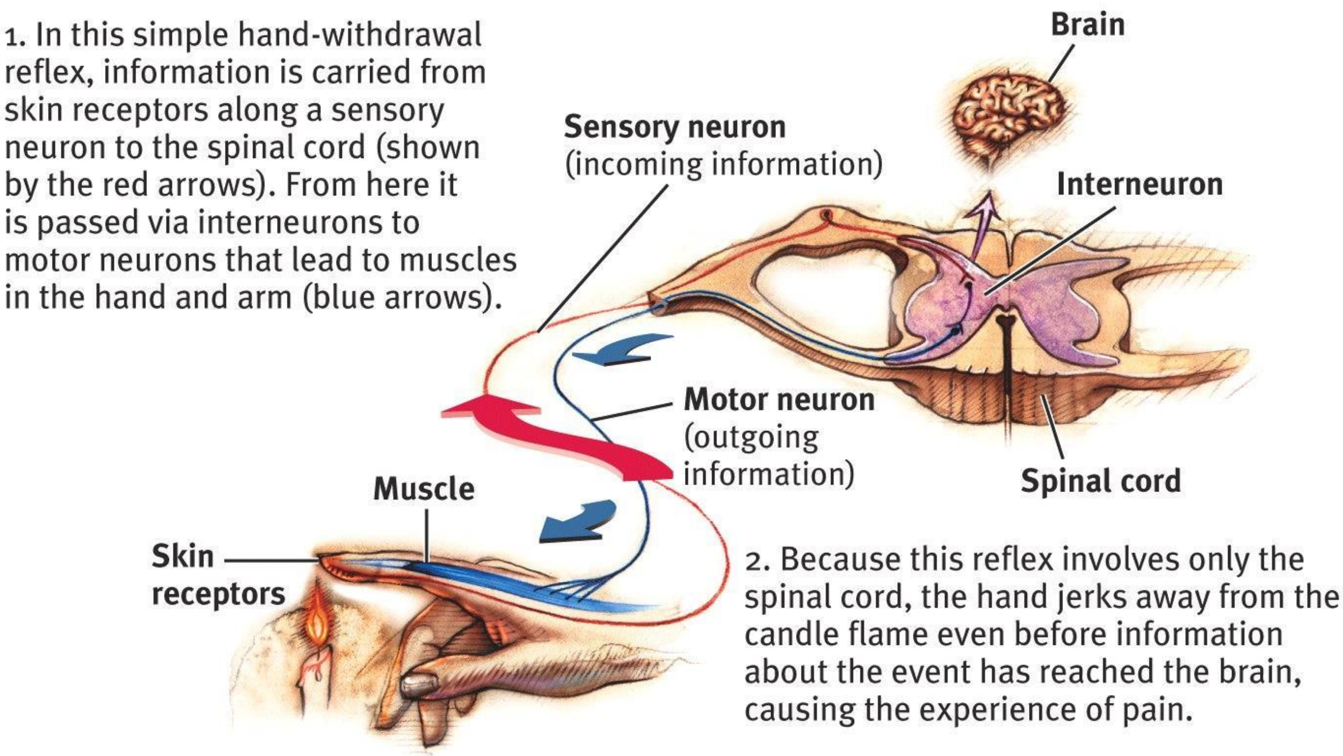
Central Nervous System

The Spinal Cord and Reflexes



Simple Reflex

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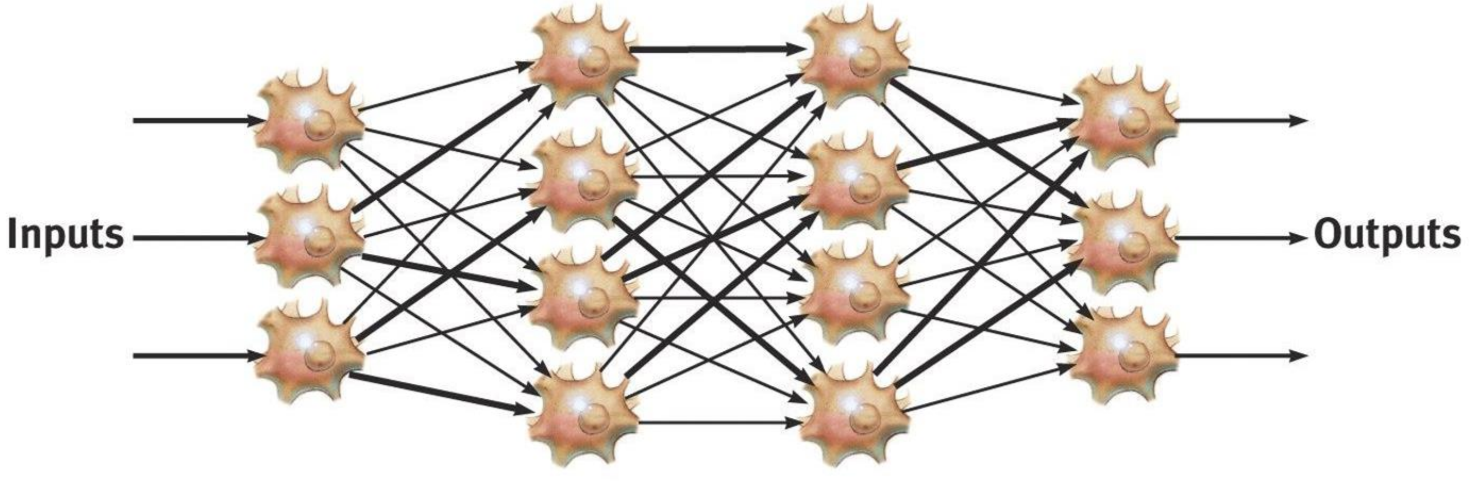
Central Nervous System

The Brain and Neural Networks

Interconnected neurons form networks in the brain. Theses networks are complex and modify with growth and experience.



Complex Neural Network

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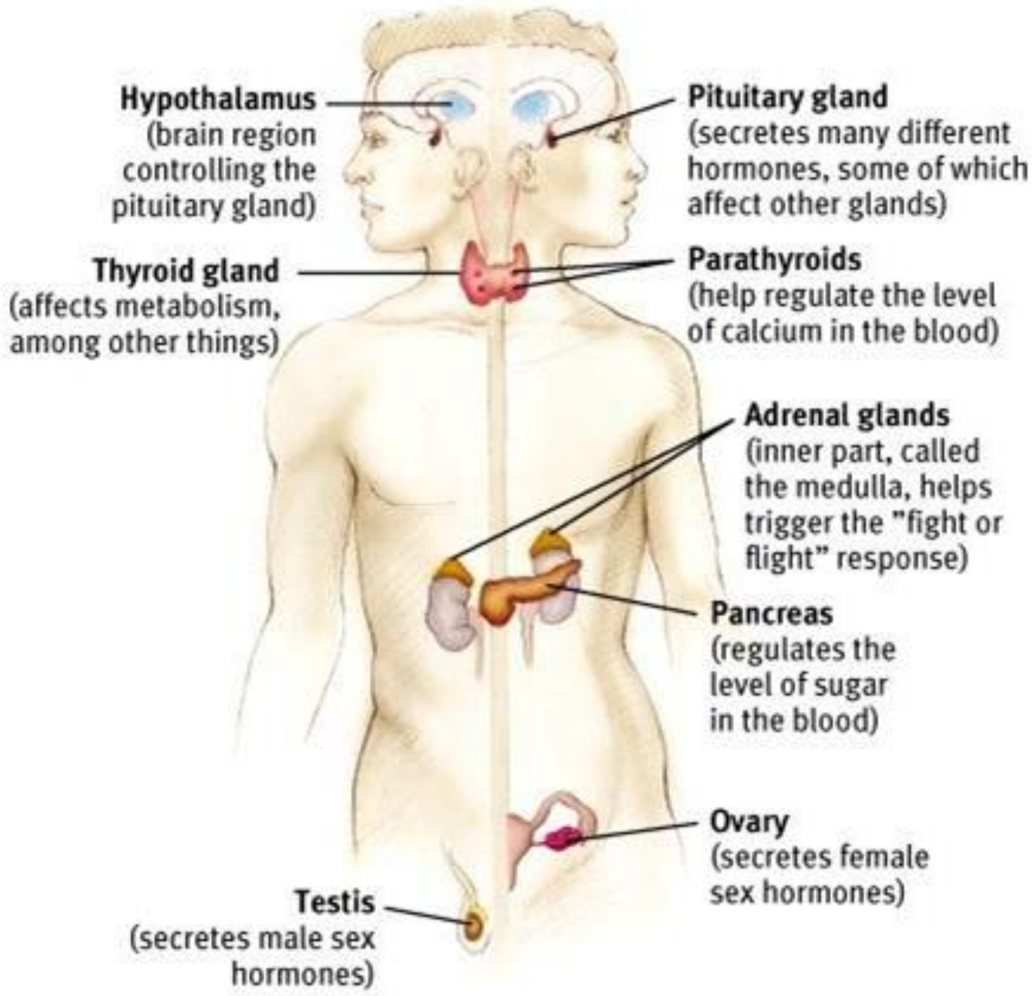
The Endocrine System



The Endocrine System is the body’s “slow” chemical communication system. Communication is carried out by hormones synthesized by a set of glands.

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Hormones

Hormones are chemicals synthesized by the endocrine glands that are secreted in the bloodstream. Hormones affect the brain and many other tissues of the body.

For example, epinephrine (adrenaline) increases heart rate, blood pressure, blood sugar and feelings of excitement during emergency situations.

Pituitary Gland

Is called the “master gland.” The anterior pituitary lobe releases hormones that regulate other glands. The posterior lobe regulates water and salt balance.

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Thyroid & Parathyroid Glands

Regulate metabolic and calcium rate.

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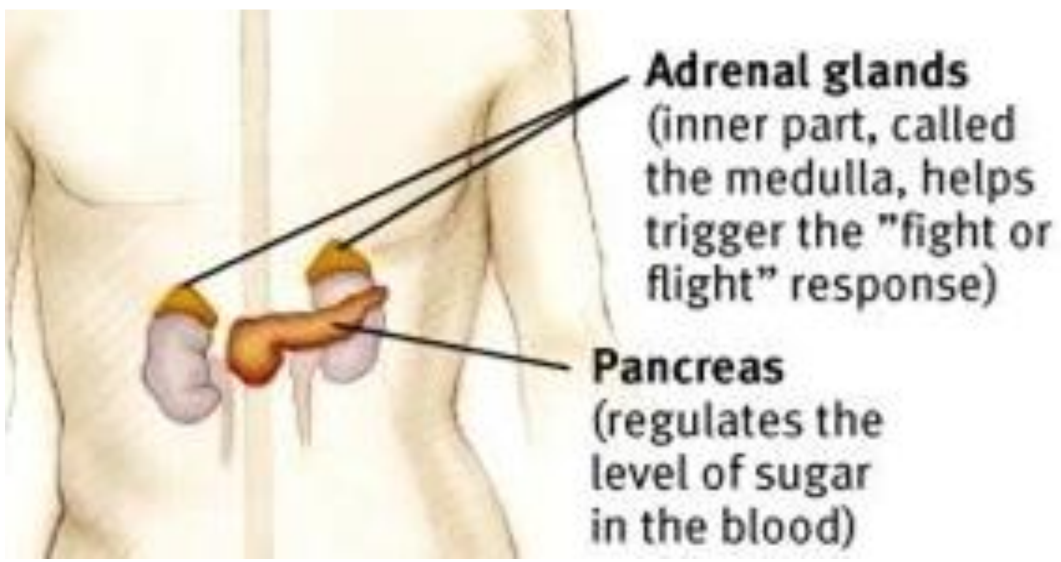
Adrenal Glands

Adrenal glands consist of the adrenal medulla and the cortex. The medulla secretes hormones (epinephrine and norepinephrine) during stressful and emotional situations, while the adrenal cortex regulates salt and carbohydrate metabolism.



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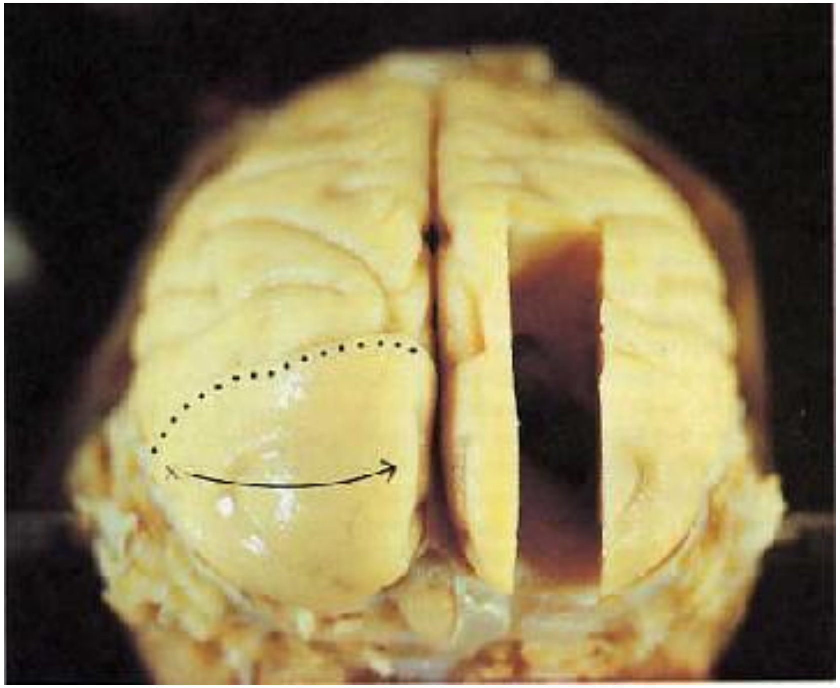
Gonads

Sex glands are located in different places in men and women. They regulate bodily development and maintain reproductive organs in adults.

The Brain

Techniques to Study the Brain

A brain lesion experimentally destroys brain tissue to study animal behaviors after such destruction.



Hubel (1990)

Clinical Observation

Clinical observations have shed light on a number of brain disorders. Alterations in brain morphology due to neurological and psychiatric diseases are now being catalogued.

Tom Landers/ Boston Globe

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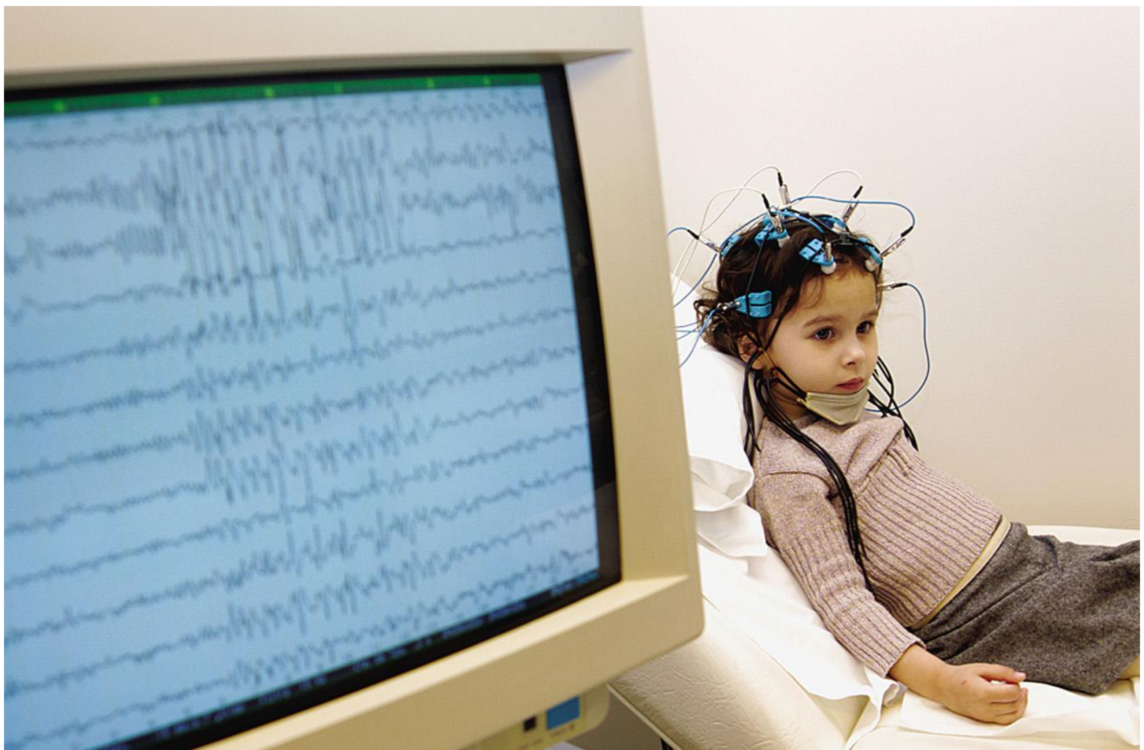
Electroencephalogram (EEG)

An amplified recording of the electrical waves sweeping across the brain's surface, measured by electrodes placed on the scalp.



AJ Photo/ Photo Researchers, Inc.

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PET Scan

PET (positron emission tomography) Scan is a visual display of brain activity that detects a radioactive form of glucose while the brain performs a given task.

Courtesy of National Brookhaven National Laboratories

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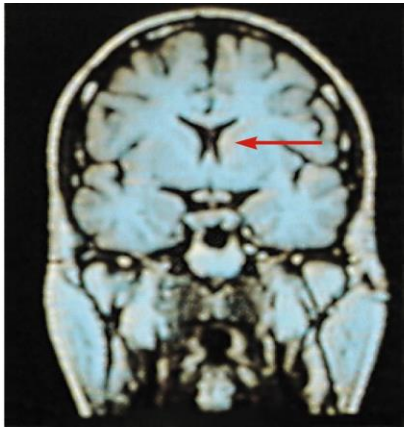
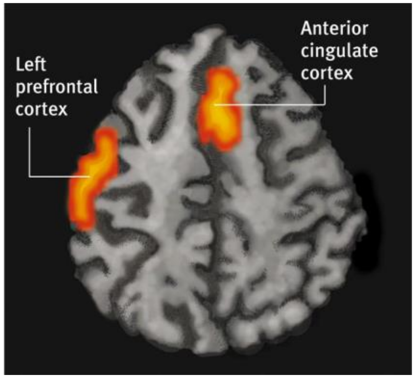
MRI Scan

MRI (magnetic resonance imaging) uses magnetic fields and radio waves to produce computer-generated images that distinguish among different types of brain tissue. Top images show ventricular enlargement in a schizophrenic patient. Bottom image shows brain regions when a participants lies.



Both photos from Daniel Weinberger, M.D., CBDB, NIMH

James Salzano/ Salzano Photo



Lucy Reading/ Lucy Illustrations

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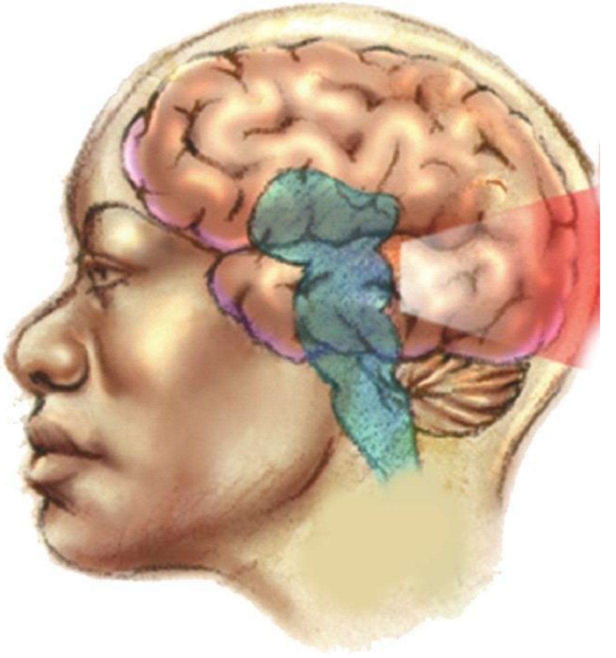
Older Brain Structures

The Brainstem is the oldest part of the brain, beginning where the spinal cord swells and enters the skull. It is responsible for automatic survival functions.



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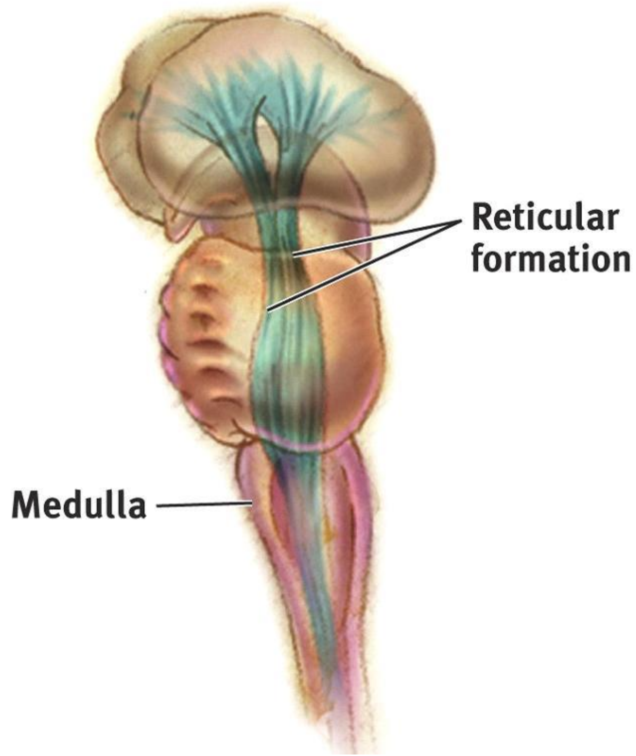
Brain Stem

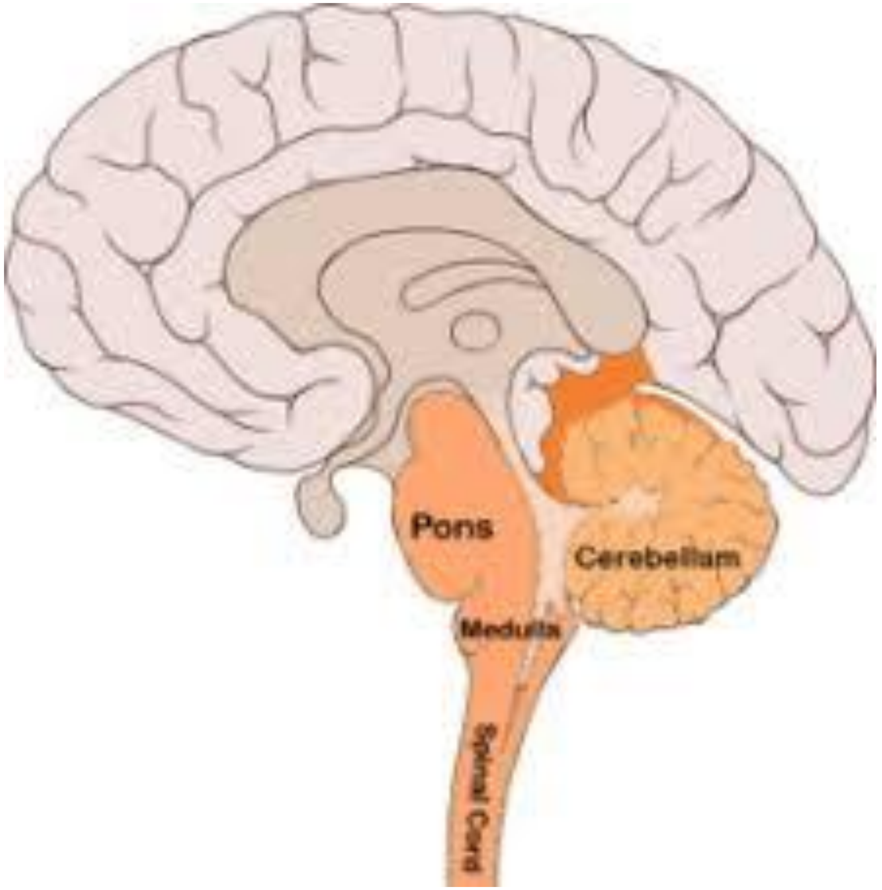
The Medulla [muh-DUL-uh] is the base of the brainstem that controls heartbeat and breathing.

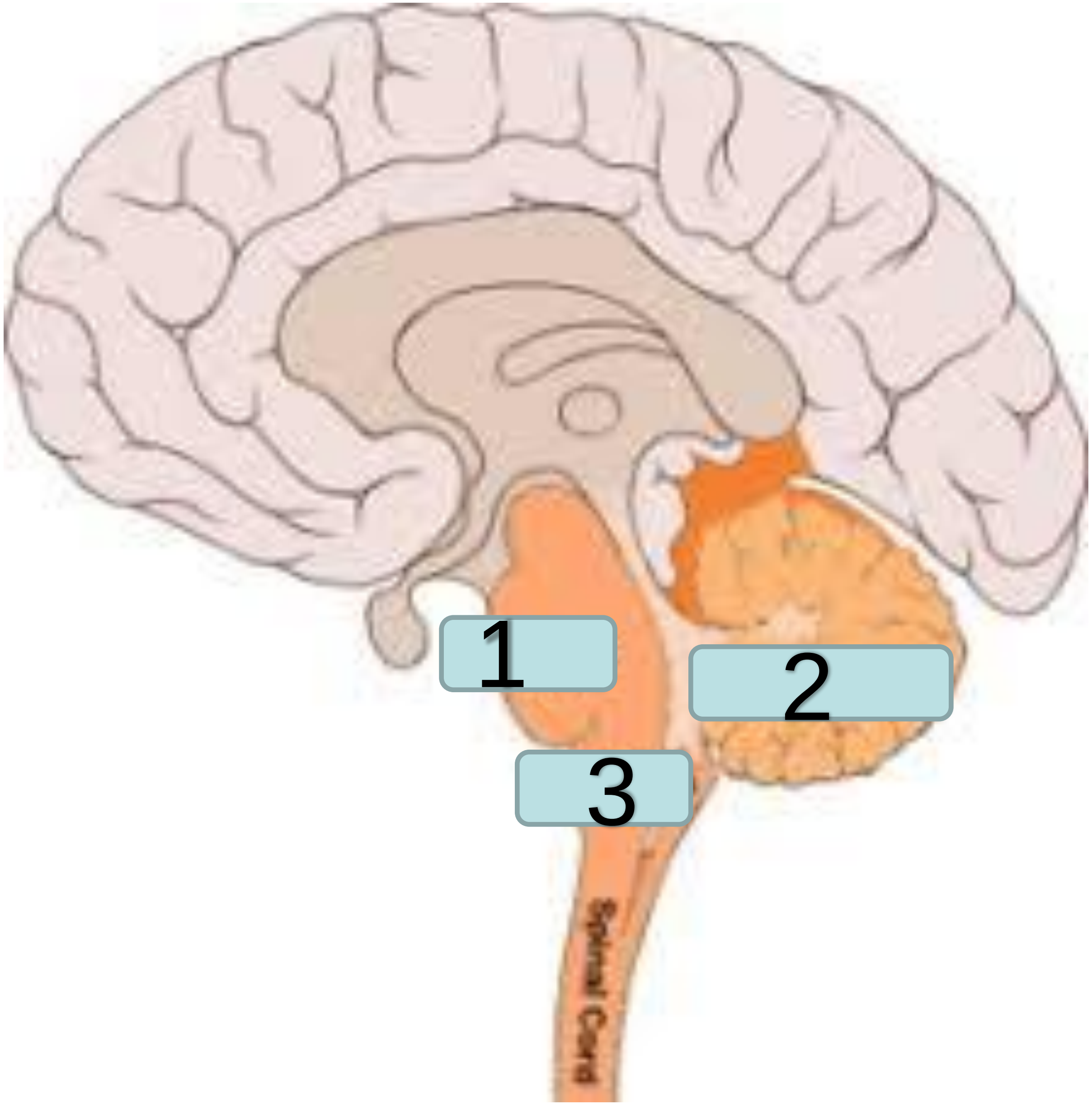
Reticular Formation is a nerve network in the brainstem that plays an important role in controlling arousal.



Pons

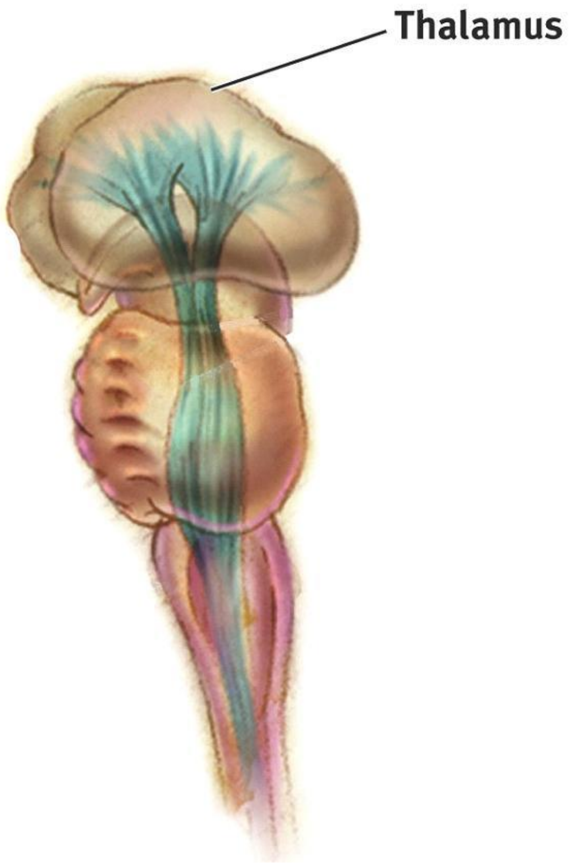
As part of the brain stem, the pons also impacts several automatic functions necessary for life. A section of the lower pons stimulates and controls the intensity of breathing, and a section of the upper pons decreases the depth and frequency of breaths. The pons has also been associated with the control of sleep cycles, as well as voluntary movements such as biting, chewing & swallowing.




1
2
3
Spinal Cord

Brain Stem

The Thalamus [THAL-uh-muss] is the brain's sensory switchboard, located on top of the brainstem. It directs messages to the sensory areas in the cortex and transmits replies to the cerebellum and medulla.



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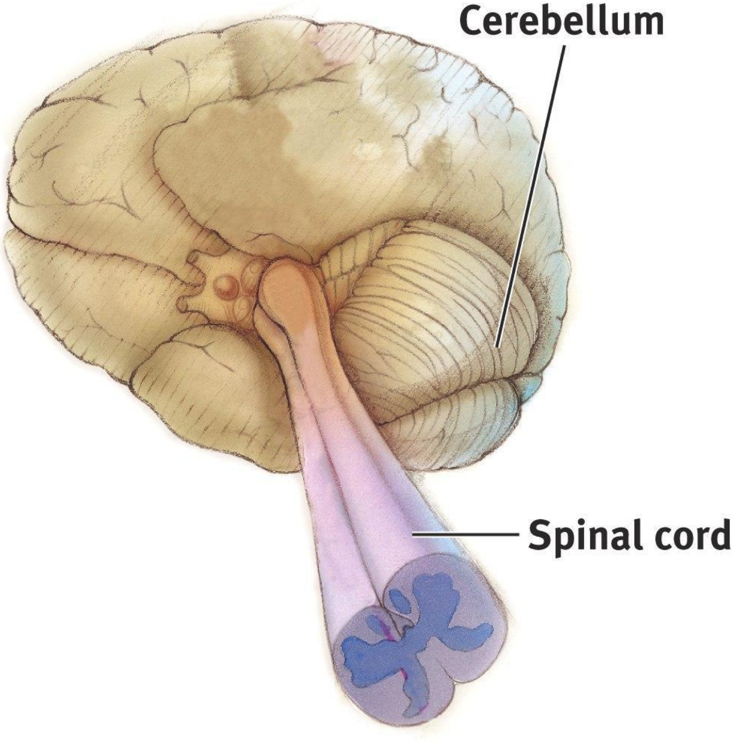
Cerebellum

The “little brain” attached to the rear of the brainstem. It helps coordinate voluntary movements and balance.



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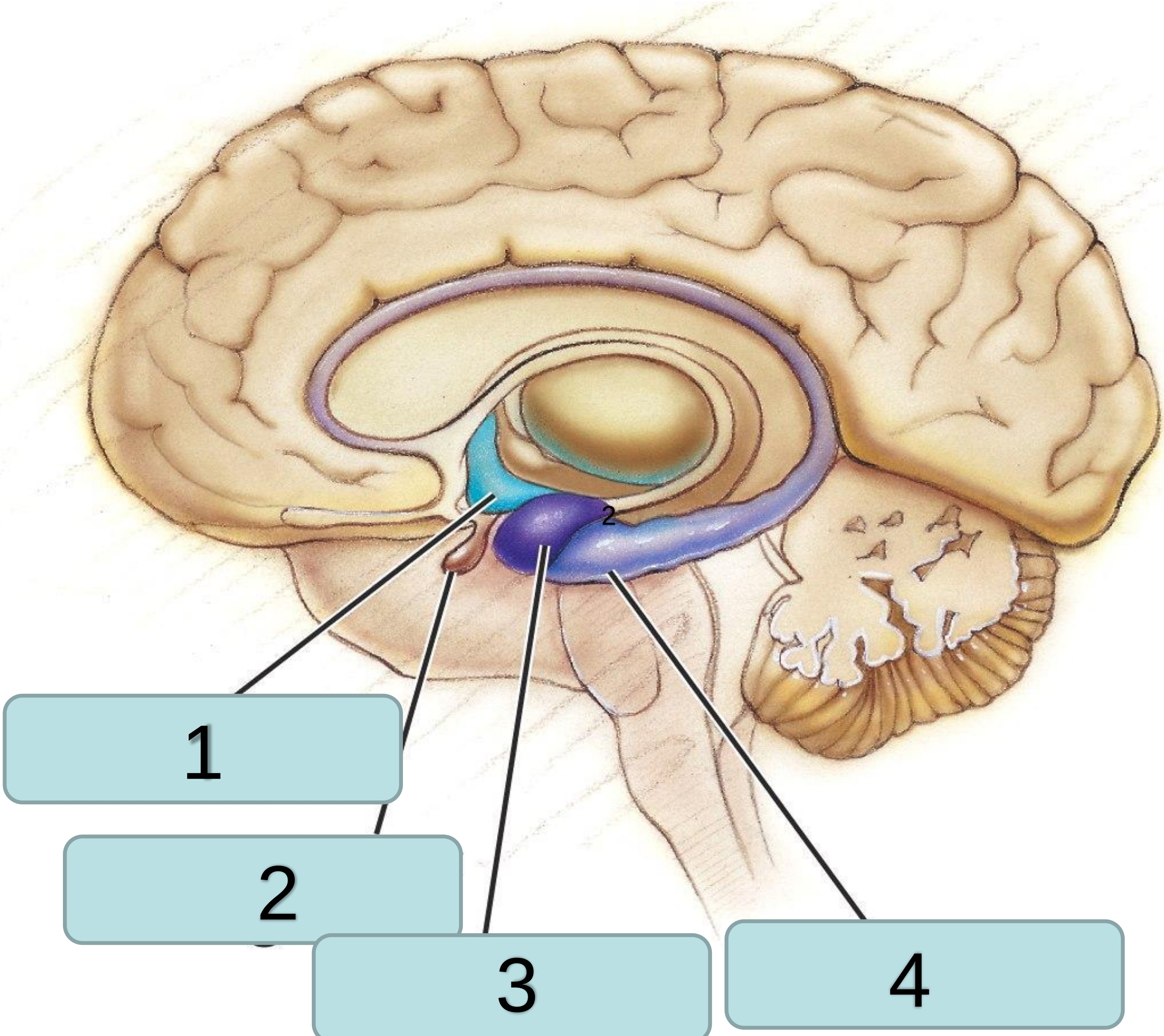
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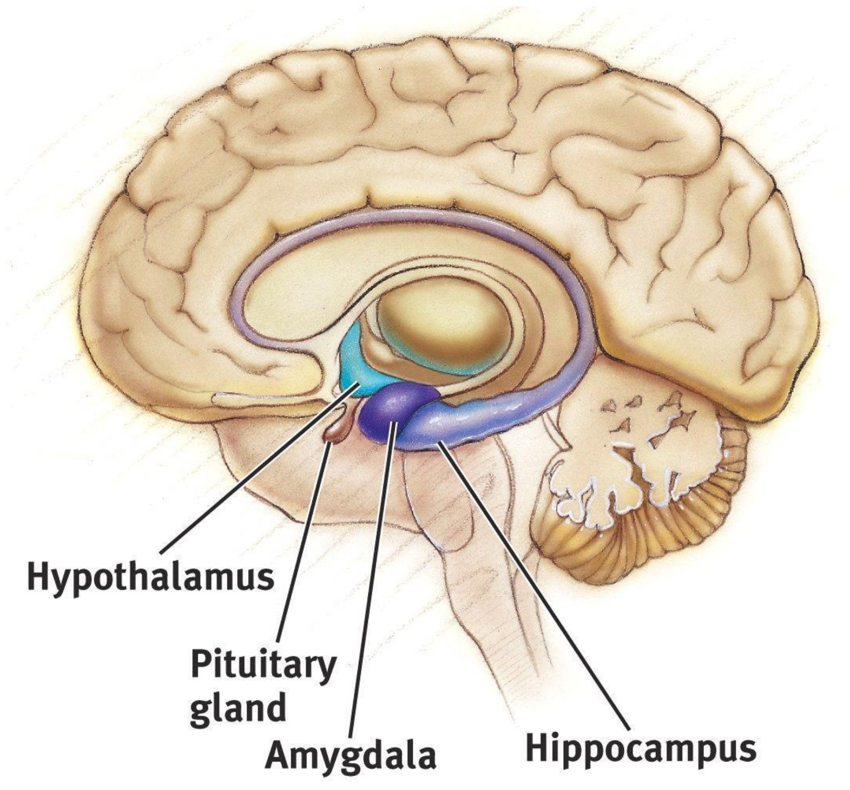
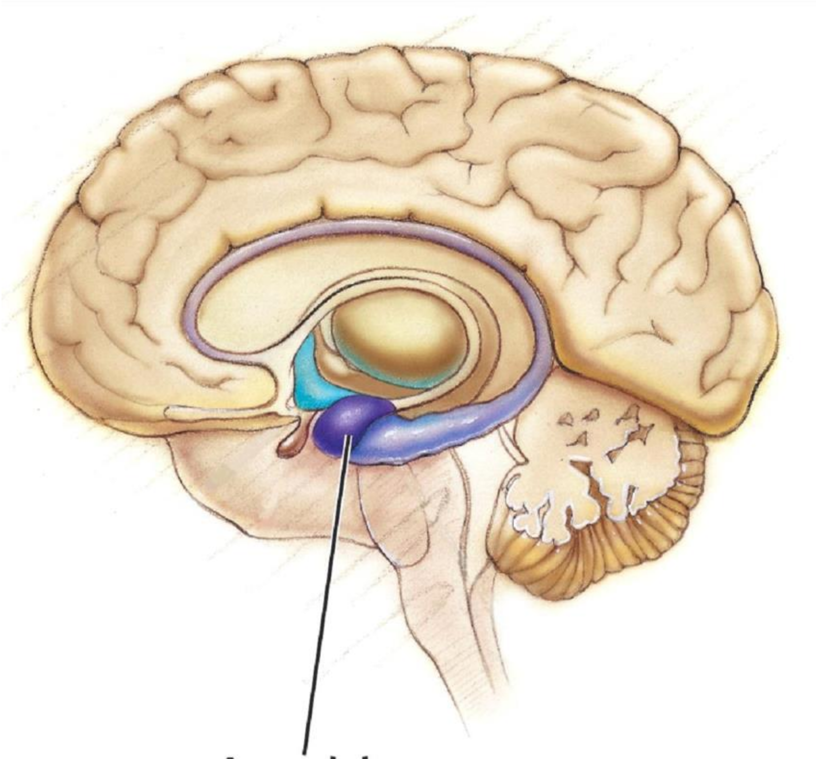
The Limbic System

The Limbic System is a doughnut-shaped system of neural structures at the border of the brainstem and cerebrum, associated with emotions such as fear, aggression and drives for food and sex. It includes the hippocampus, amygdala, and hypothalamus.



Amygdala

The Amygdala [ah-MIG-dah-la] consists of two almond-shaped neural clusters linked to the emotions of fear and anger.



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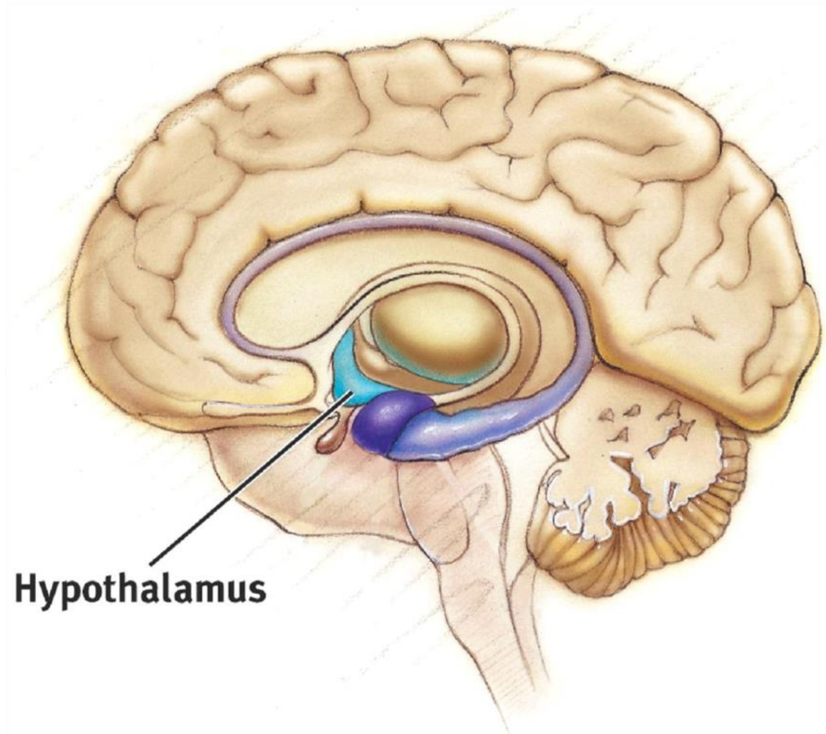
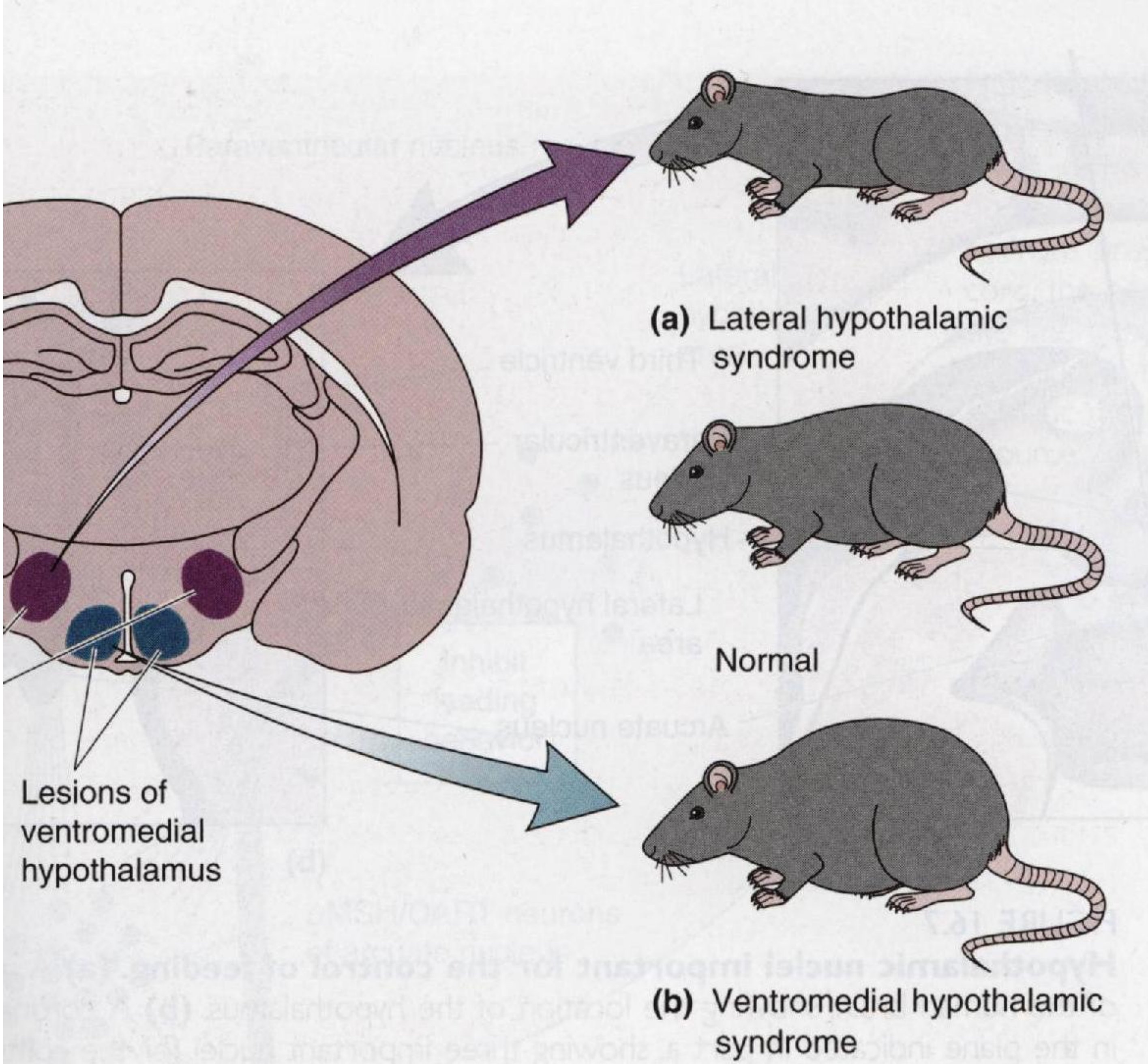
Hypothalamus

The Hypothalamus lies below (*hypo*) the thalamus. It directs several maintenance activities like eating, drinking, body temperature, and control of emotions. It helps govern the endocrine system via the pituitary gland.

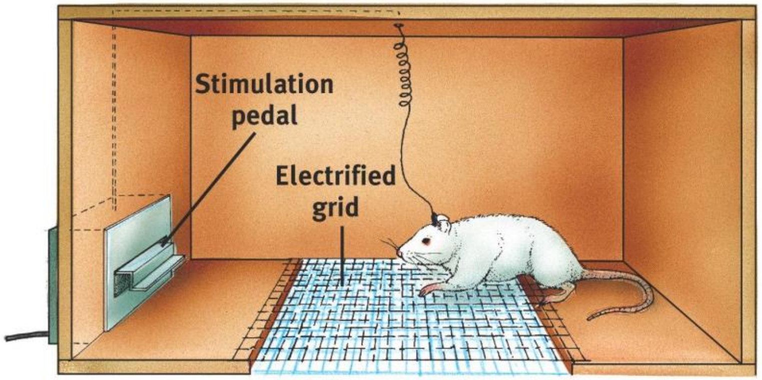



(a) Lateral hypothalamic syndrome
Normal
Lesions of ventromedial hypothalamus
(b) Ventromedial hypothalamic syndrome


290
640

Reward Center

Rats cross an electrified grid for self-stimulation when electrodes are placed in the reward (hypothalamus) center (top picture). When the limbic system is manipulated, a rat will navigate fields or climb up a tree (bottom picture).



Sanjiv Talwar, SUNY Downstate

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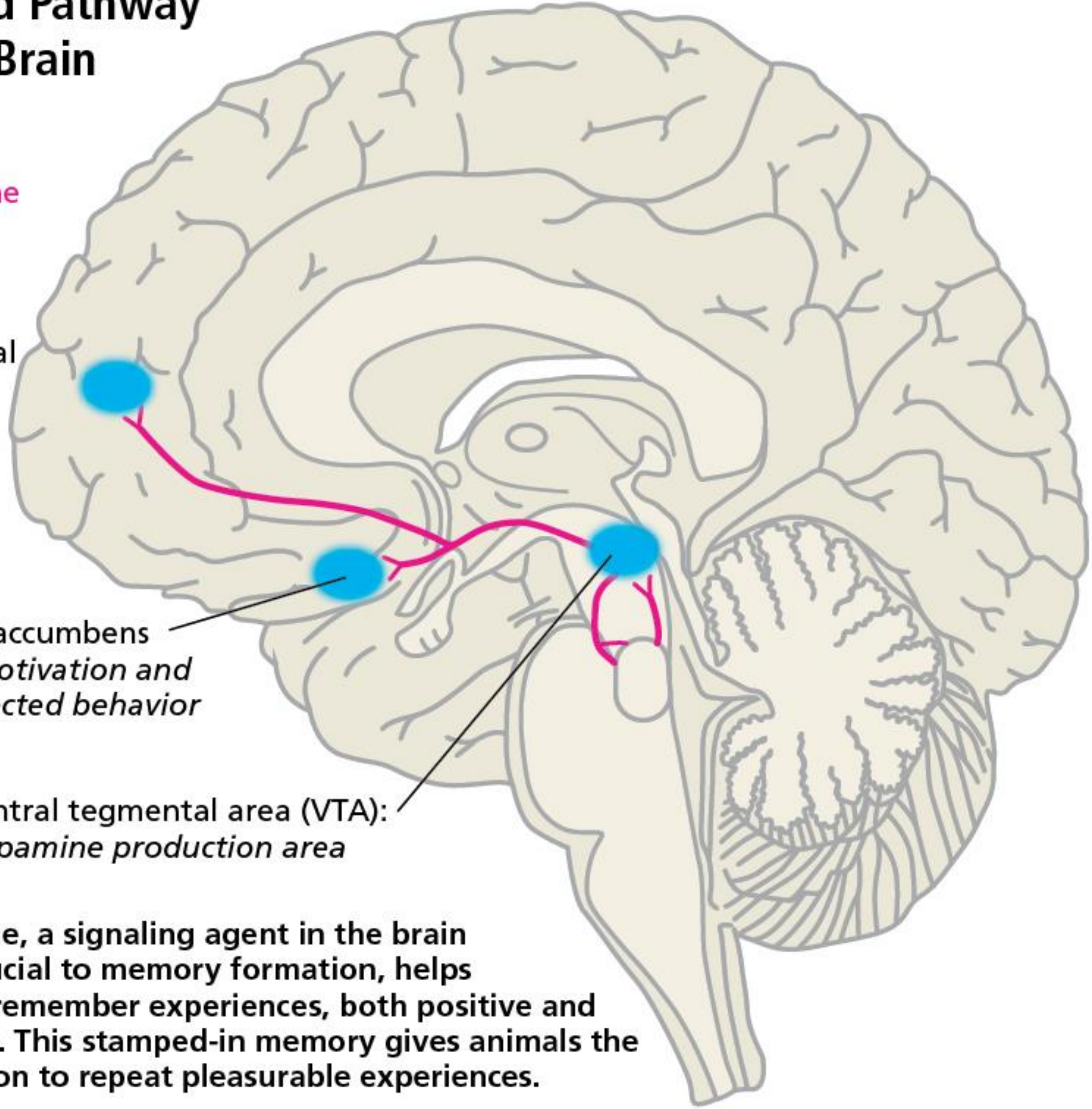
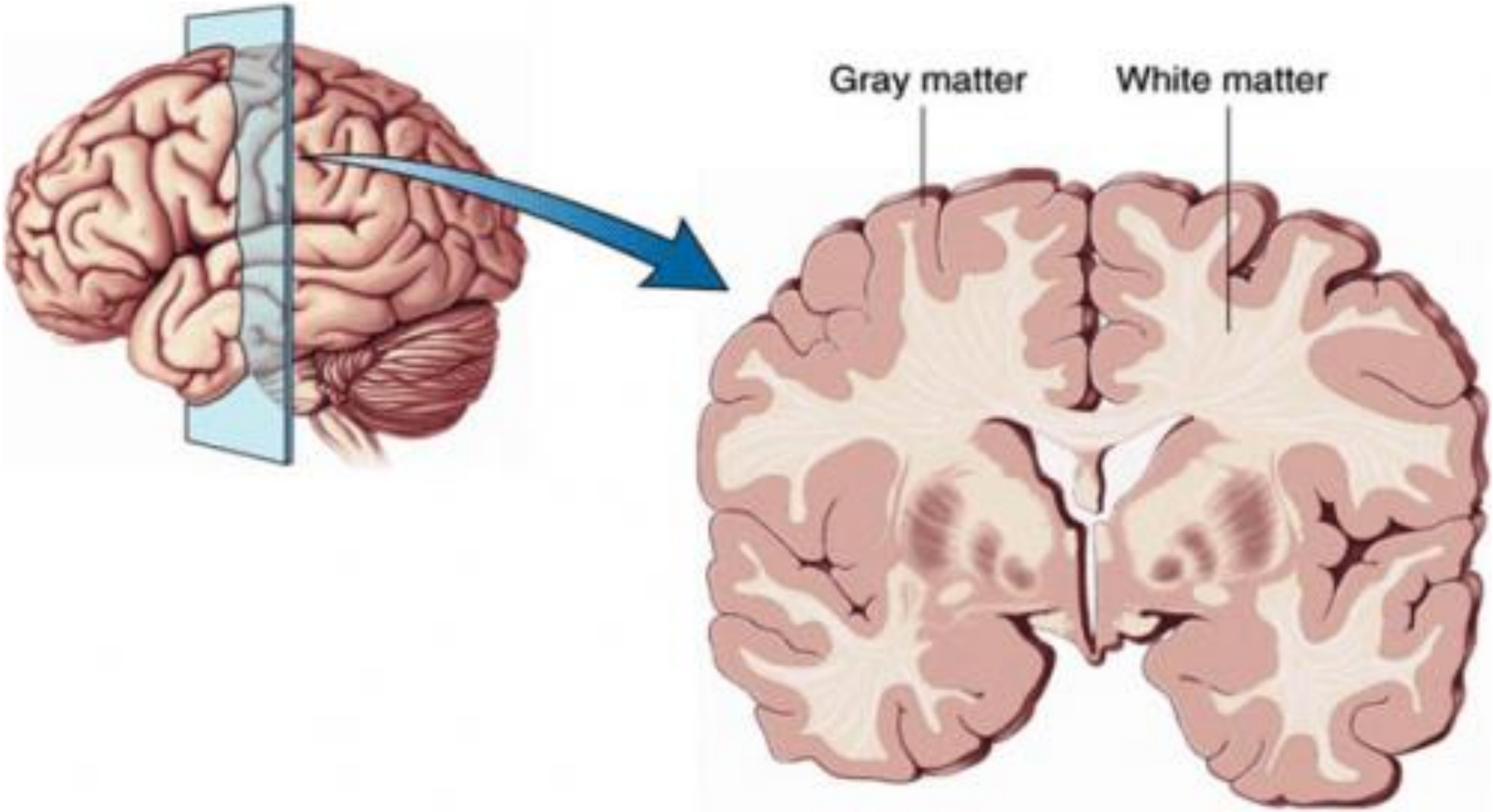
Reward Pathway in the Brain

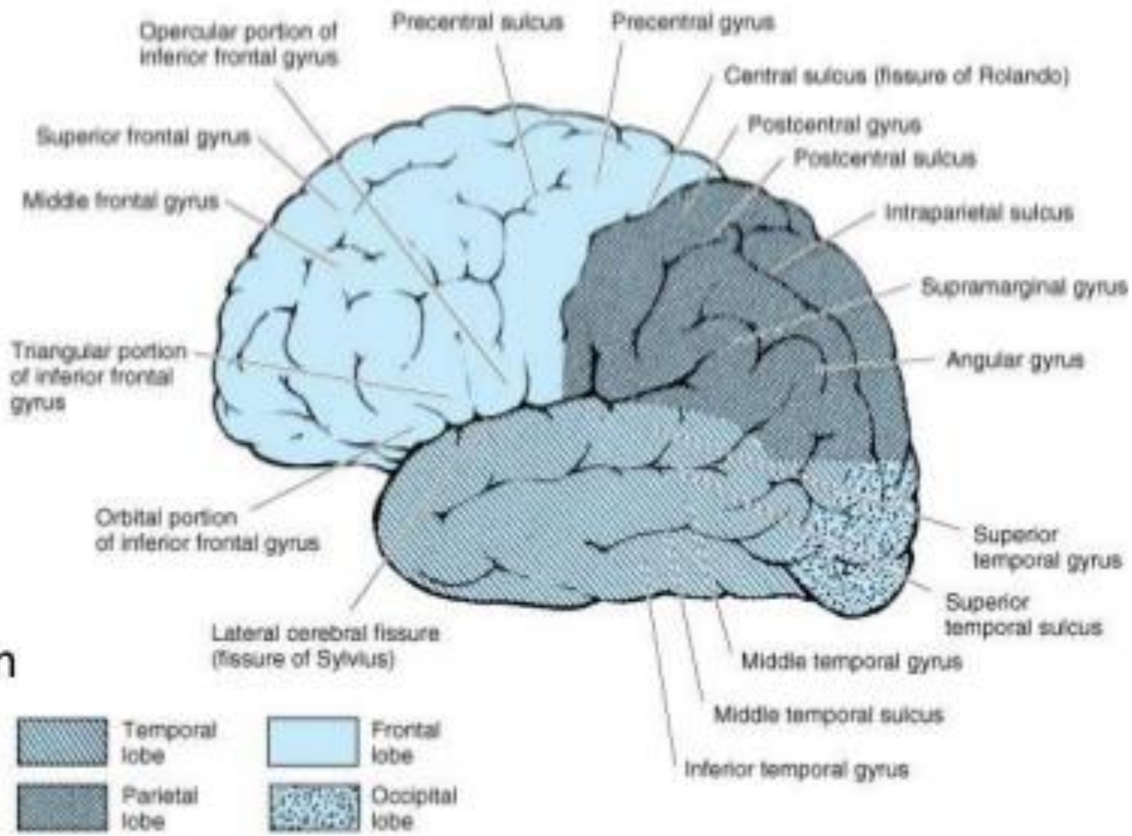


Dopamine, a signaling agent in the brain that's crucial to memory formation, helps animals remember experiences, both positive and negative. This stamped-in memory gives animals the motivation to repeat pleasurable experiences.


Gray matter
White matter

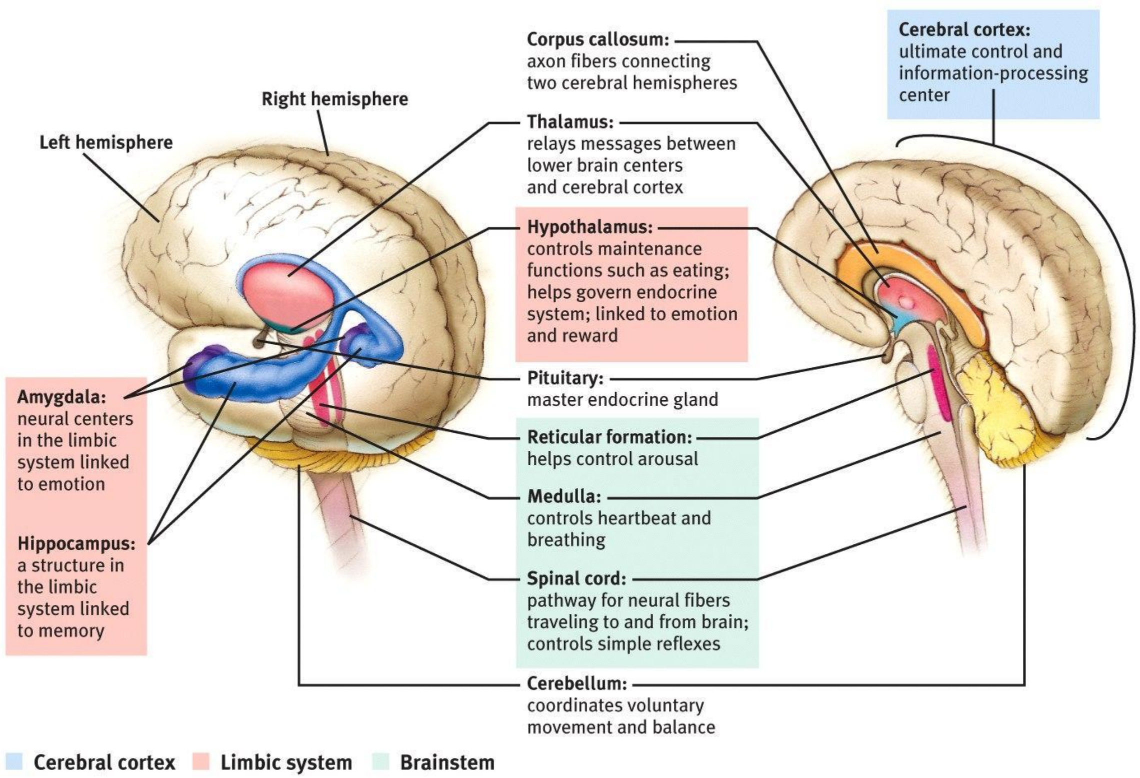
Main Sulci & Fissures

- The surfaces of the cerebral hemispheres contain many fissures and sulci that separate the frontal, parietal, occipital, and temporal lobes from each other and the insula.
- The **central sulcus** (the **fissure of Rolando**) arises about the middle of the hemisphere, and separates the frontal lobe from the parietal lobe.
- The **parieto-occipital fissure** separates the parietal lobe from the occipital lobe.
- The **lateral cerebral fissure (Sylvian fissure)** separates the temporal lobe from the frontal and parietal lobes.



The Cerebral Cortex

The intricate fabric of interconnected neural cells that covers the cerebral hemispheres. It is the body's ultimate control and information processing center.



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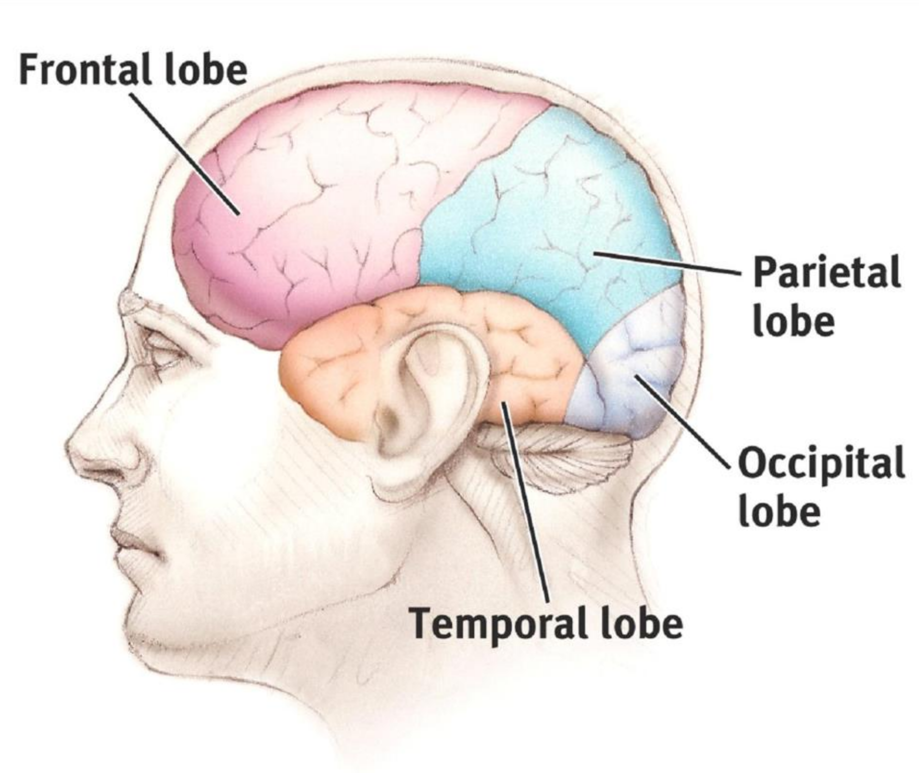
Structure of the Cortex

Each brain hemisphere is divided into four lobes that are separated by prominent fissures. These lobes are the frontal lobe (forehead), parietal lobe (top to rear head), occipital lobe (back head) and temporal lobe (side of head).



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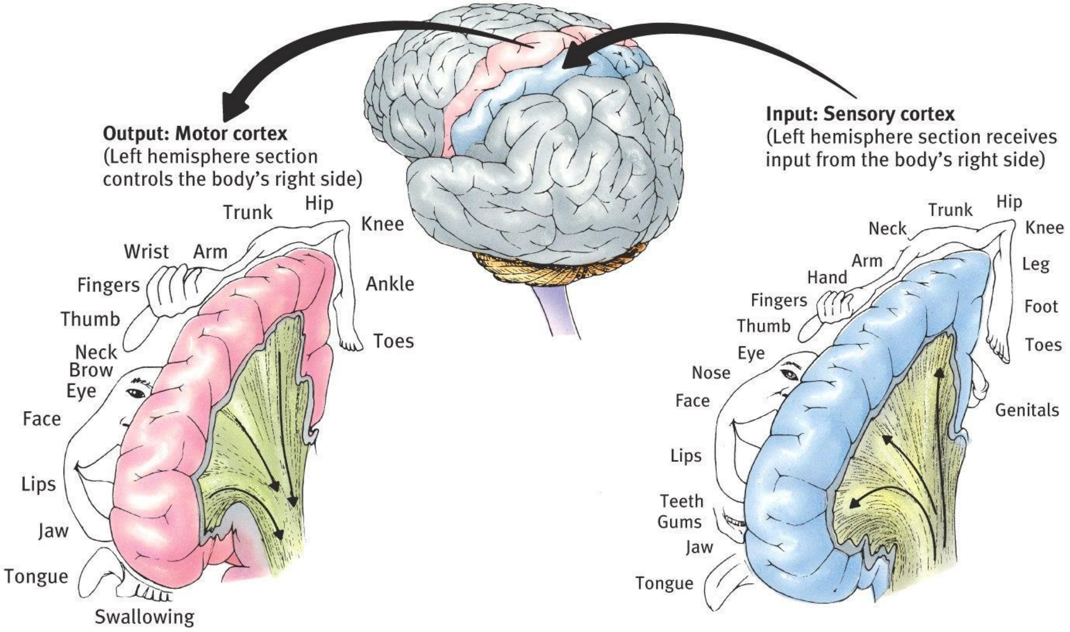
Functions of the Cortex

The Motor Cortex is the area at the rear of the frontal lobes that control voluntary movements. The Sensory Cortex (parietal cortex) receives information from skin surface and sense organs.



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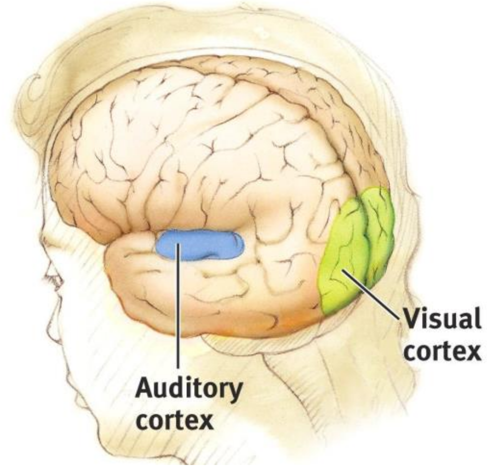
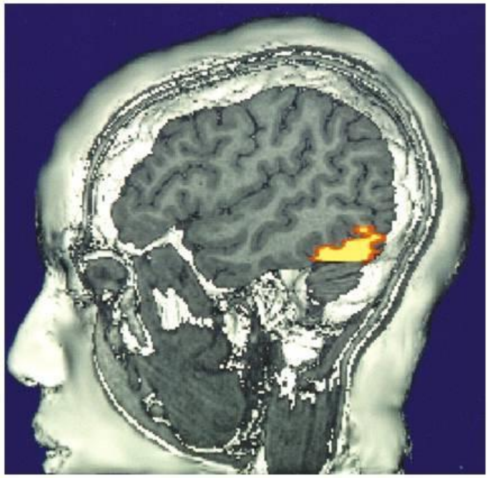
Visual Function

The functional MRI scan shows the visual cortex is active as the subject looks at faces.

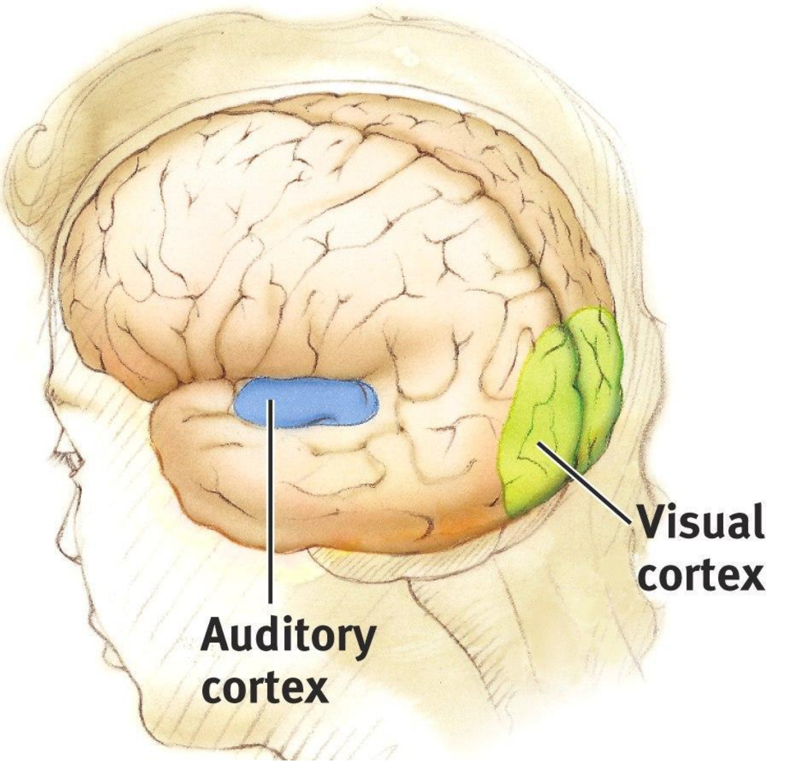




Courtesy of V.P. Clark, K. Keill, J. Ma. Maisog, S. Courtney, L.G. Ungerleider, and J.V. Haxby, National Institute of Mental Health

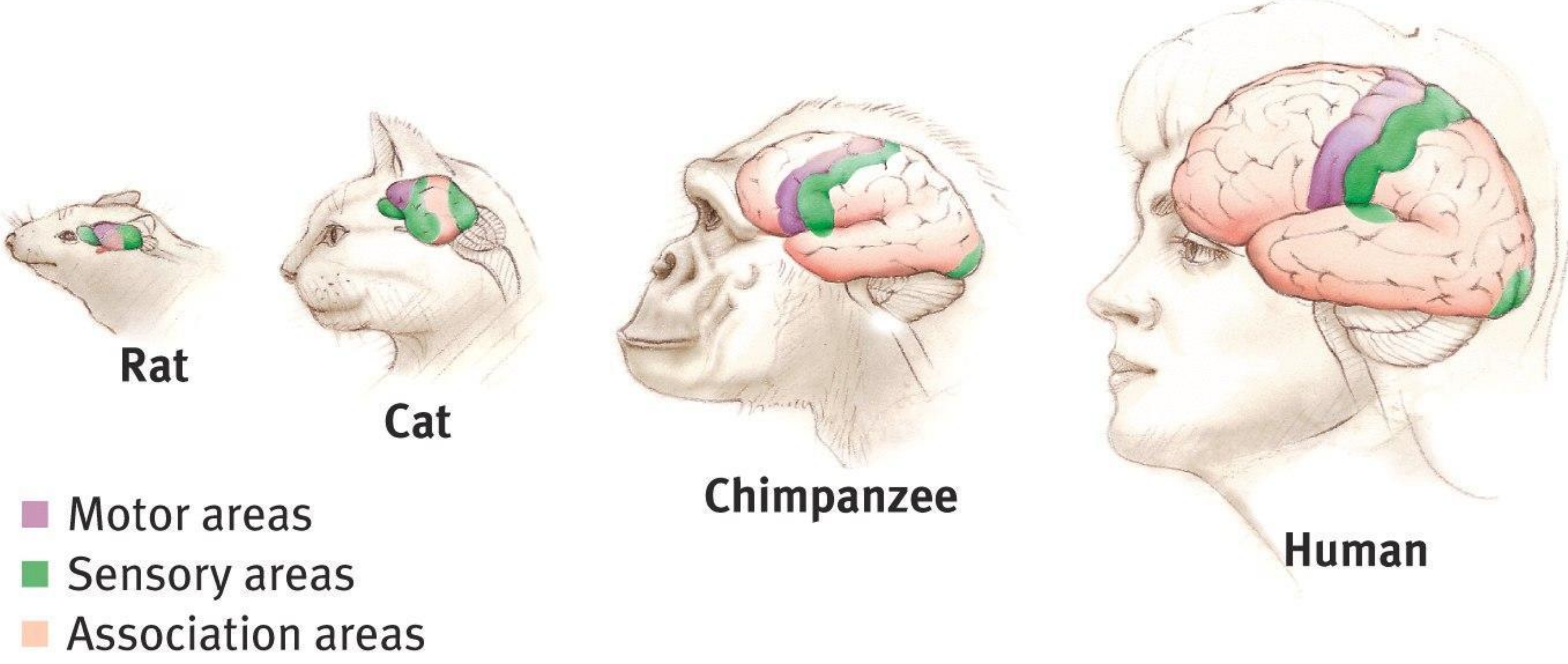
Auditory Function

The functional MRI scan shows the auditory cortex is active in patients who hallucinate.



Association Areas

More intelligent animals have increased "uncommitted" or association areas of the cortex.



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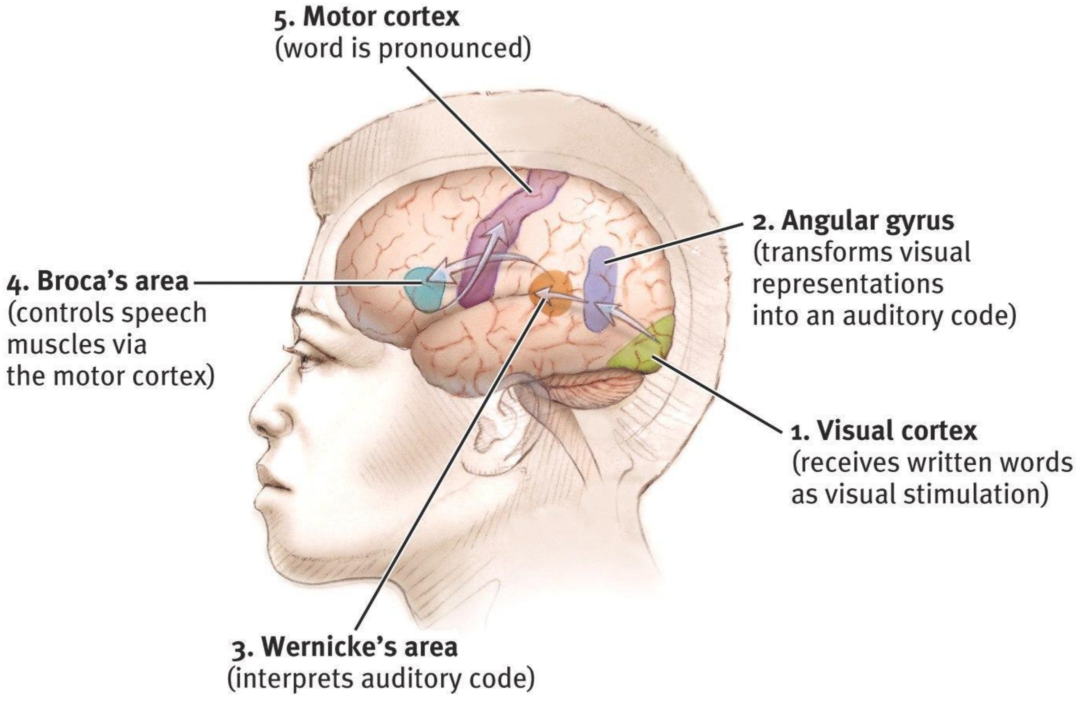
Language

Aphasia is an impairment of language, usually caused by left hemisphere damage either to Broca's area (impaired speaking) or to Wernicke's area (impaired understanding).



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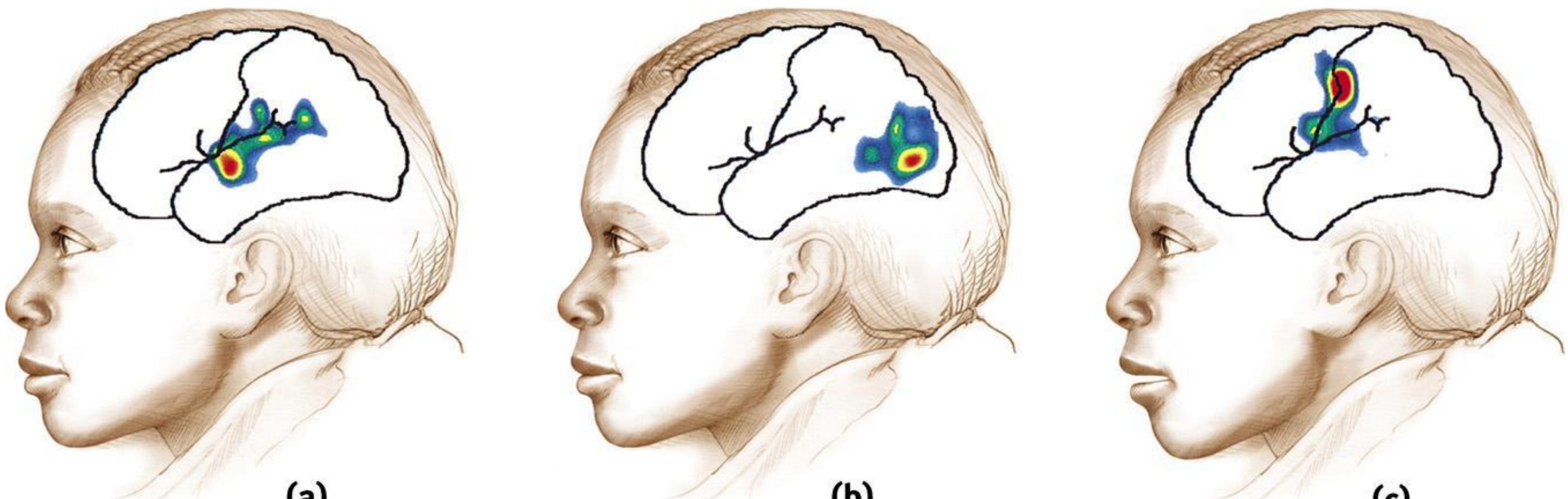
Specialization & Integration

Brain activity when hearing, seeing, and speaking words



(a) Hearing words (auditory cortex and Wernicke's area)

(b) Seeing words (visual cortex and angular gyrus)

(c) Speaking words (Broca's, area and the motor cortex)

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The Brain's Plasticity

The brain is sculpted by our genes but also by our experiences.

Plasticity refers to the brain's ability to modify itself after some type of injury or illness.

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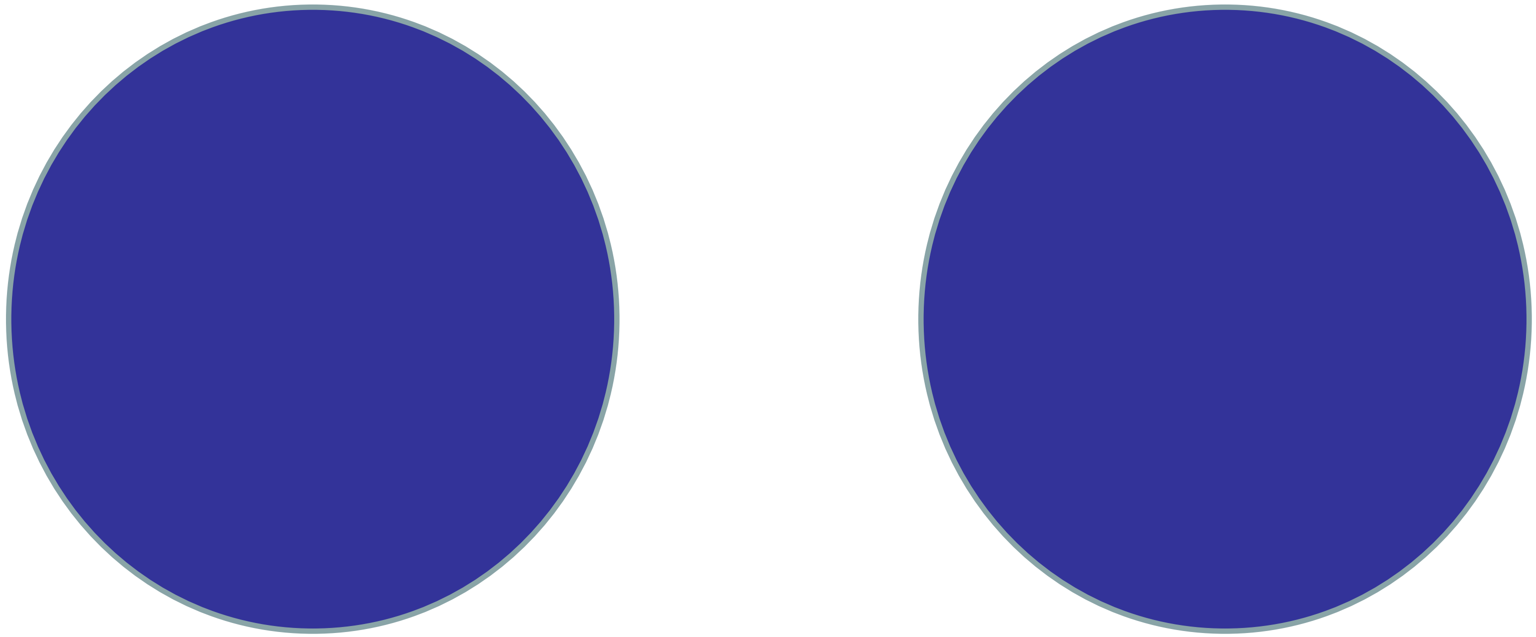


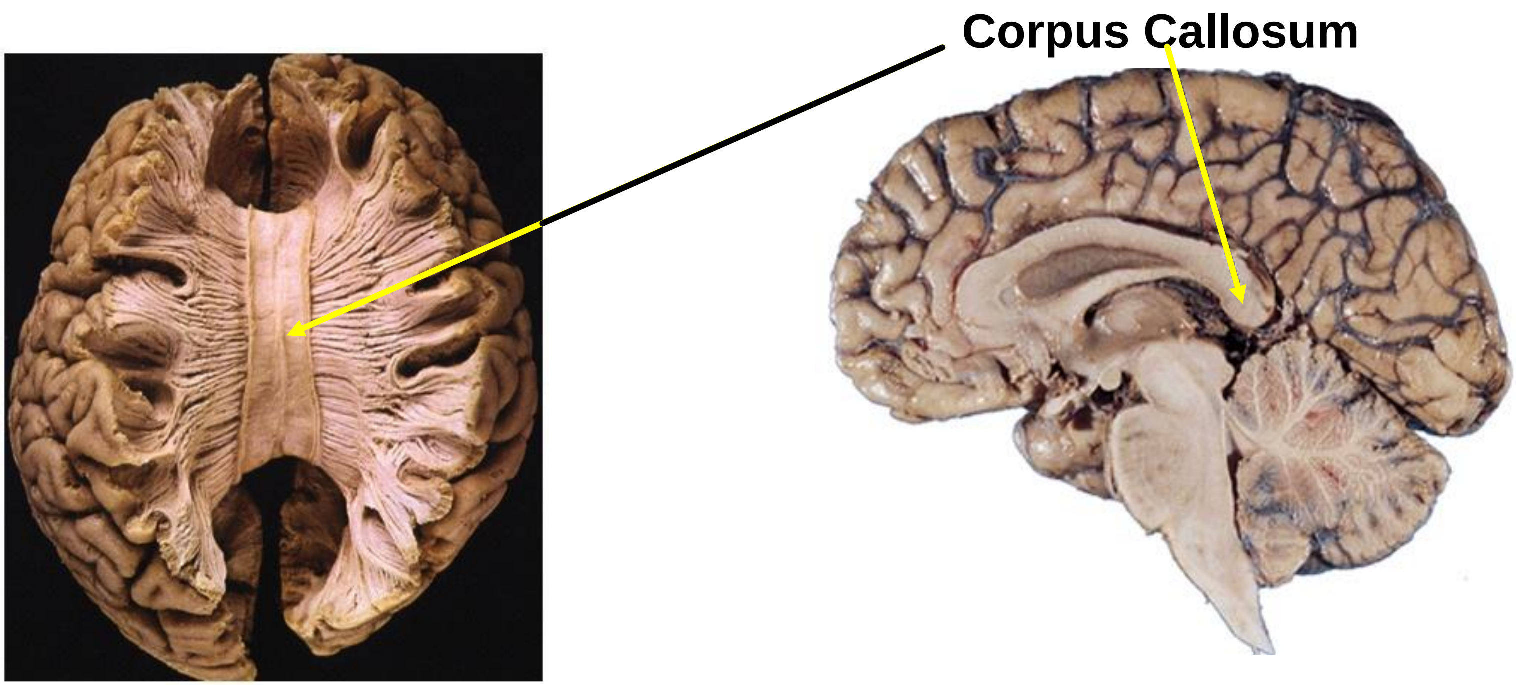
Our Divided Brain

Our brain is divided into two hemispheres.

The left hemisphere processes reading, writing, speaking, mathematics, and comprehension skills. In the 1960s, it was termed as the dominant brain.

Splitting the Brain

A procedure in which the two hemispheres of the brain are isolated by cutting the connecting fibers (mainly those of the corpus callosum) between them.



Courtesy of Terence Williams, University of Iowa

Martin M. Rother

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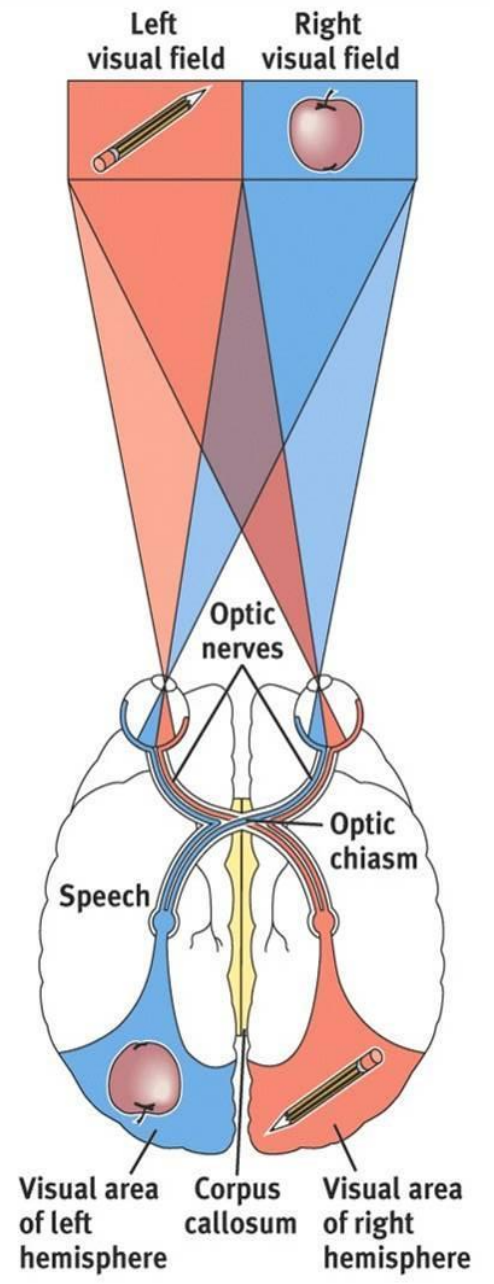
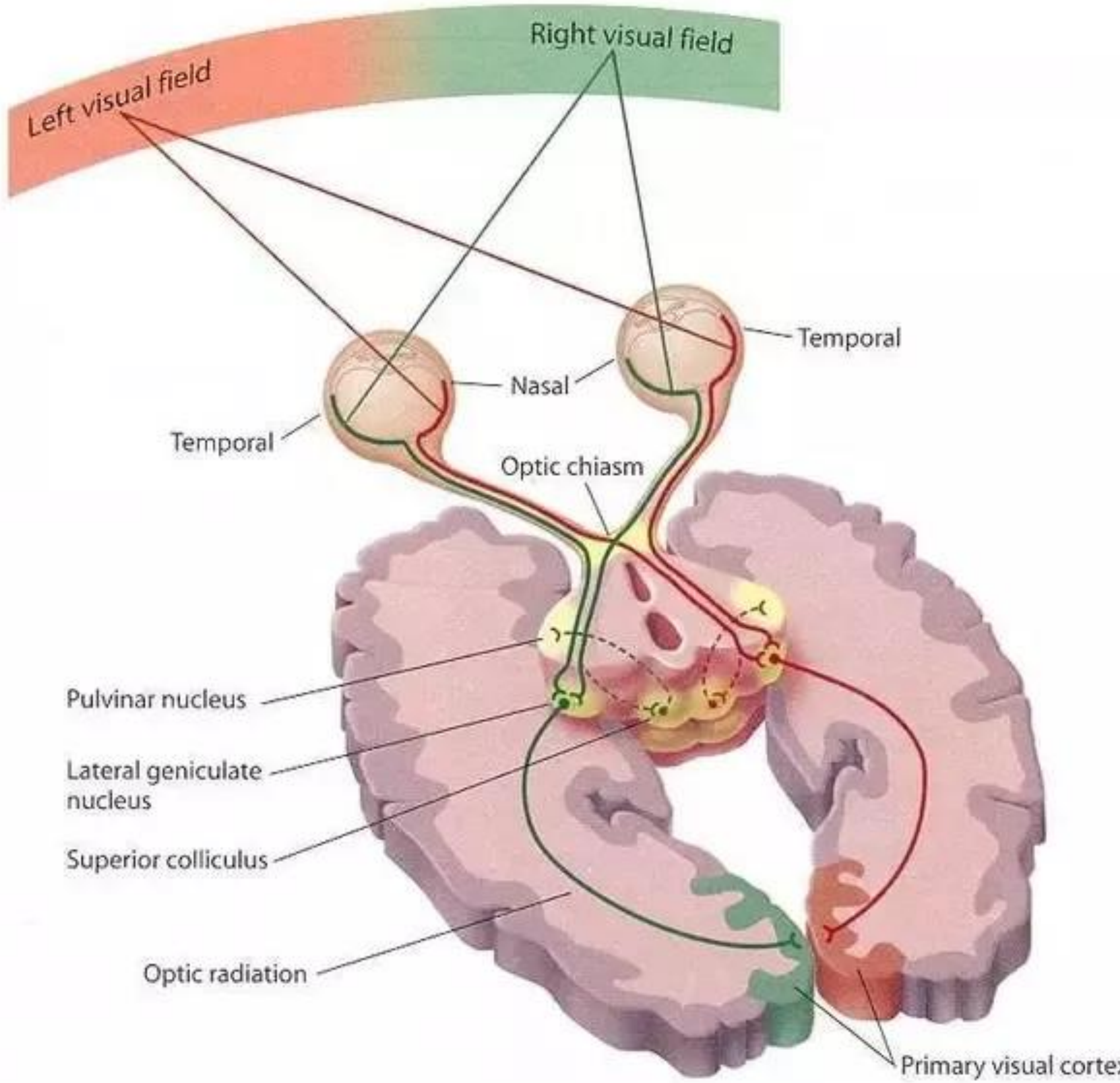
Split Brain Patients

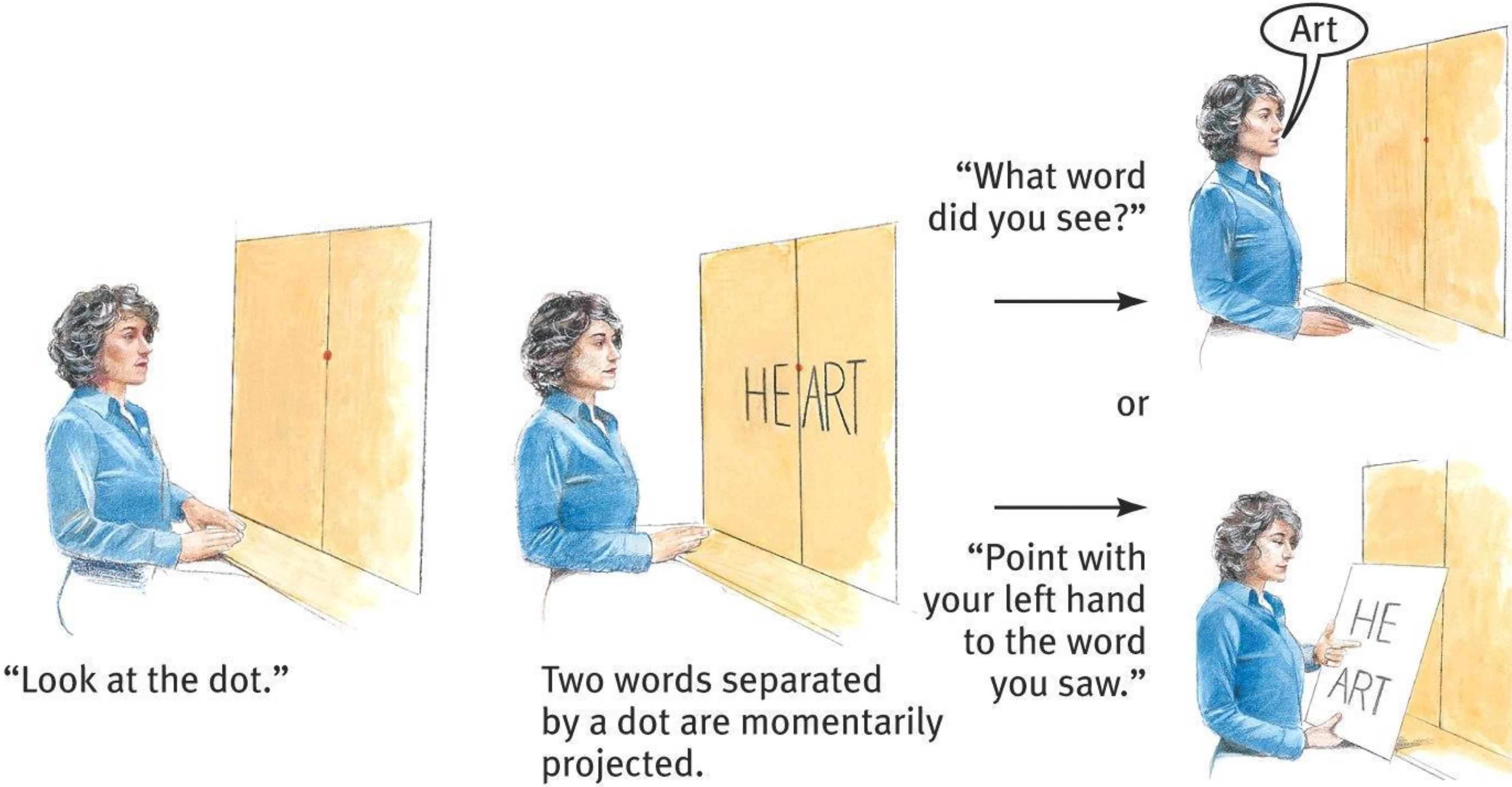
With the corpus callosum severed, objects (apple) presented in the right visual field can be named. Objects (pencil) in the left visual field cannot.





Left visual field
Right visual field
Temporal
Nasal
Temporal
Optic chiasm
Pulvinar nucleus
Lateral geniculate nucleus
Superior colliculus
Optic radiation
Primary visual cortex

Divided Consciousness



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Try This!

Try drawing one shape with your left hand and one with your right hand, simultaneously.

BBC

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Non-Split Brains

People with intact brains also show left-right hemispheric differences in mental abilities.

A number of brain scan studies show normal individuals engage their right brain when completing a perceptual task and their left brain when carrying out a linguistic task.

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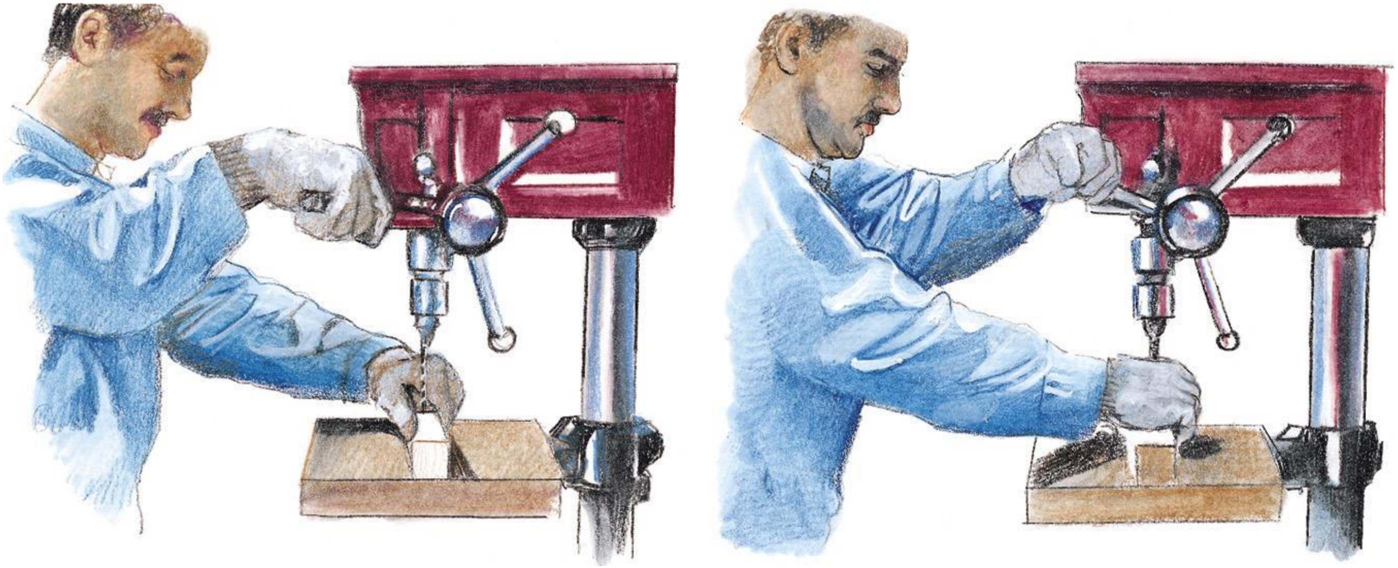
Brain Organization & Handedness

Is handedness inherited? Yes. Archival and historic studies, as well as modern medical studies, show that the right hand is preferred. This suggests genes and/or prenatal factors influence handedness.

Is it Alright to be Left Handed?

Being left handed is difficult in a right-handed world.



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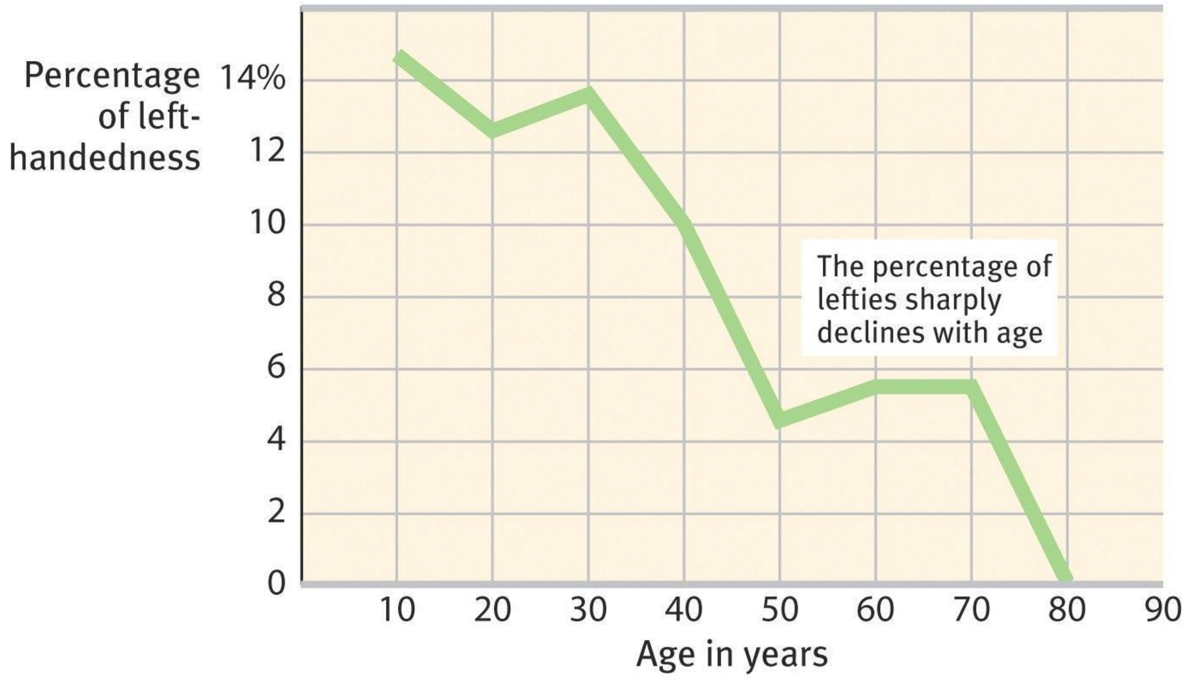
Is it Alright to be Left Handed?

The percentage of left-handed individuals decreases sharply in samples of older people (Coren, 1993).



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