



Chapter 2

Neuroscience and Behavior

Neural Communication



- **Biological Psychology**
 - branch of psychology concerned with the links between biology and behavior
 - some biological psychologists call themselves *behavioral neuroscientists, neuropsychologists, behavior geneticists, physiological psychologist, or biopsychologists*
- **Neuron**
 - a nerve cell
 - the basic building block of the nervous system

Neural Communication



- **Dendrite**

- the bushy, branching extensions of a neuron that receive messages and conduct impulses toward the cell body

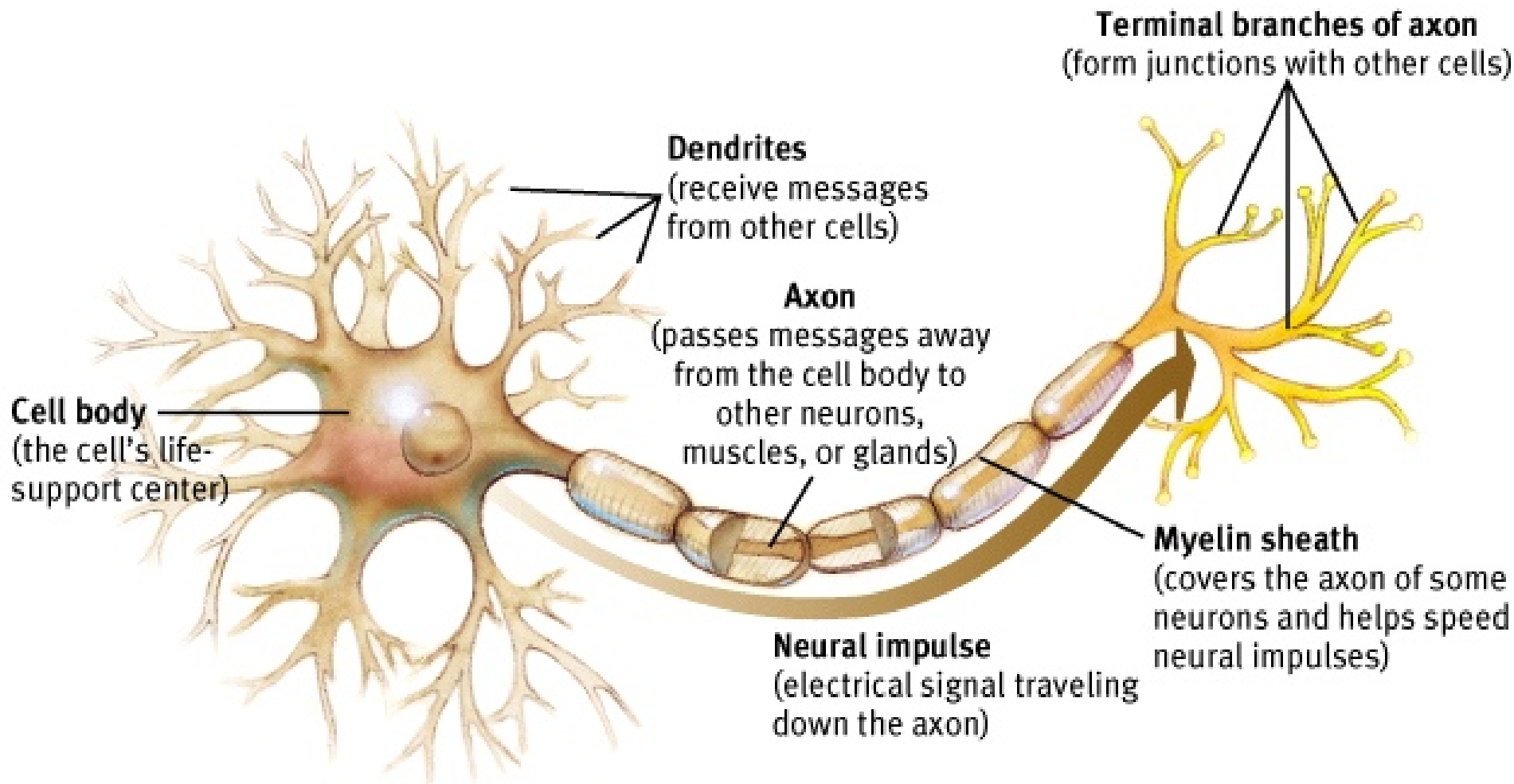
- **Axon**

- the extension of a neuron, ending in branching terminal fibers, through which messages are sent to other neurons or to muscles or glands

- **Myelin [MY-uh-lin] Sheath**

- a layer of fatty cells segmentally encasing the fibers of many neurons
- enables vastly greater transmission speed of neural impulses

Neural Communication



Neural Communication



■ Action Potential

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

■ Threshold

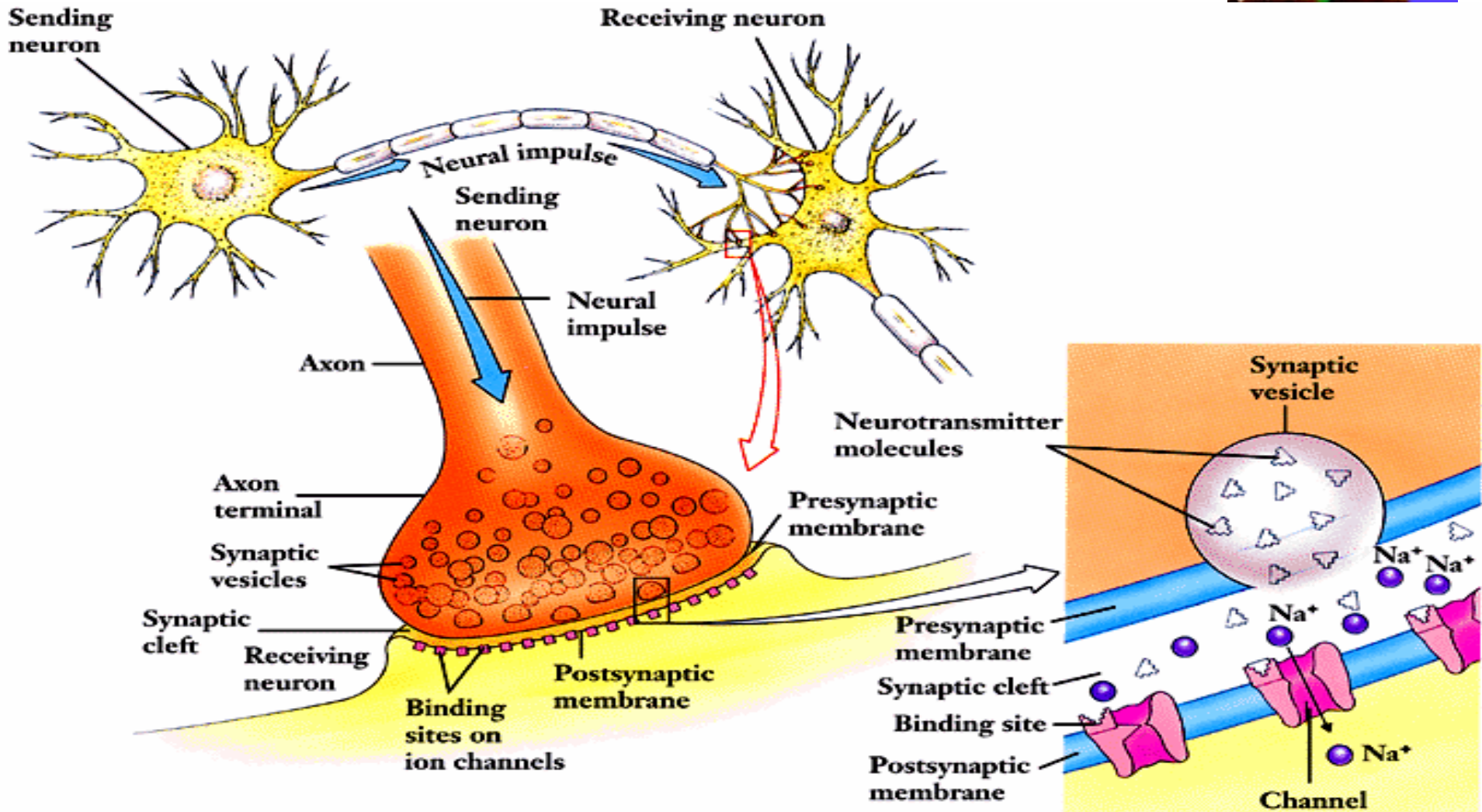
- the level of stimulation required to trigger a neural impulse

Neural Communication

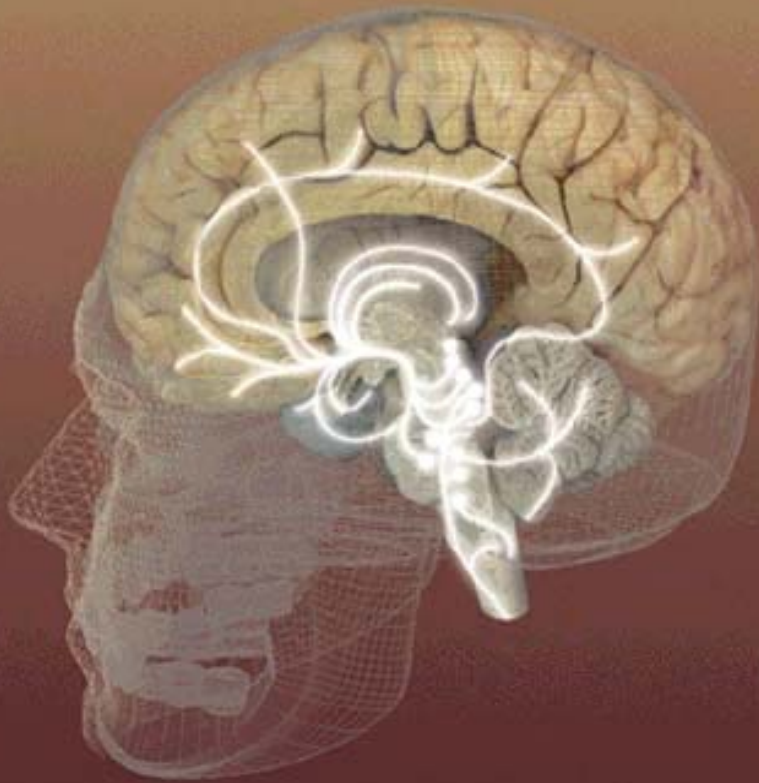
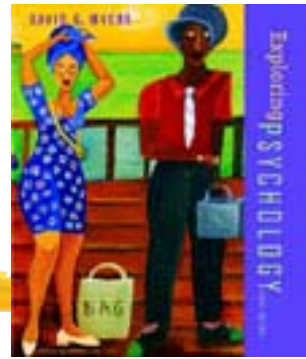


- Synapse [SIN-aps]
 - junction between the axon tip of the sending neuron and the dendrite or cell body of the receiving neuron
 - tiny gap at this junction is called the *synaptic gap* or *cleft*
- Neurotransmitters
 - chemical messengers that traverse the synaptic gaps between neurons
 - when released by the sending neuron, neurotransmitters travel across the synapse and bind to receptor sites on the receiving neuron, thereby influencing whether it will generate a neural impulse

Neural Communication



Neural Communication



Serotonin Pathways



Dopamine pathways

Neural Communication



SOME NEUROTRANSMITTERS AND THEIR FUNCTIONS

Neurotransmitter	Function	Examples of Malfunctions
Acetylcholine (ACh)	Enables muscle action, learning, and memory	Undersupply, as ACh-producing neurons deteriorate, marks Alzheimer's disease
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)

Neural Communication



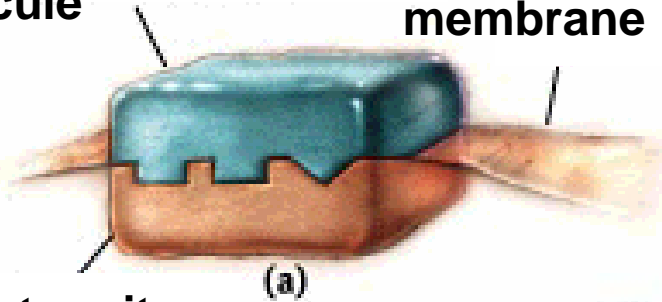
- Acetylcholine [ah-seat-el-KO-leen]
 - a neurotransmitter that, in addition to its role in learning and memory, triggers muscle contraction
- Endorphins [en-DOR-fins]
 - “morphine within”
 - natural, opiatelike neurotransmitters
 - linked to pain control and to pleasure

Neural Communication



Neurotransmitter molecule

Receiving cell membrane



(a)

Receptor site on receiving neuron

Agonist mimics neurotransmitter



(b)

Antagonist blocks neurotransmitter



(c)

The Nervous System



- Nervous System

- the body's speedy, electrochemical communication system
- consists of all the nerve cells of the peripheral and central nervous systems

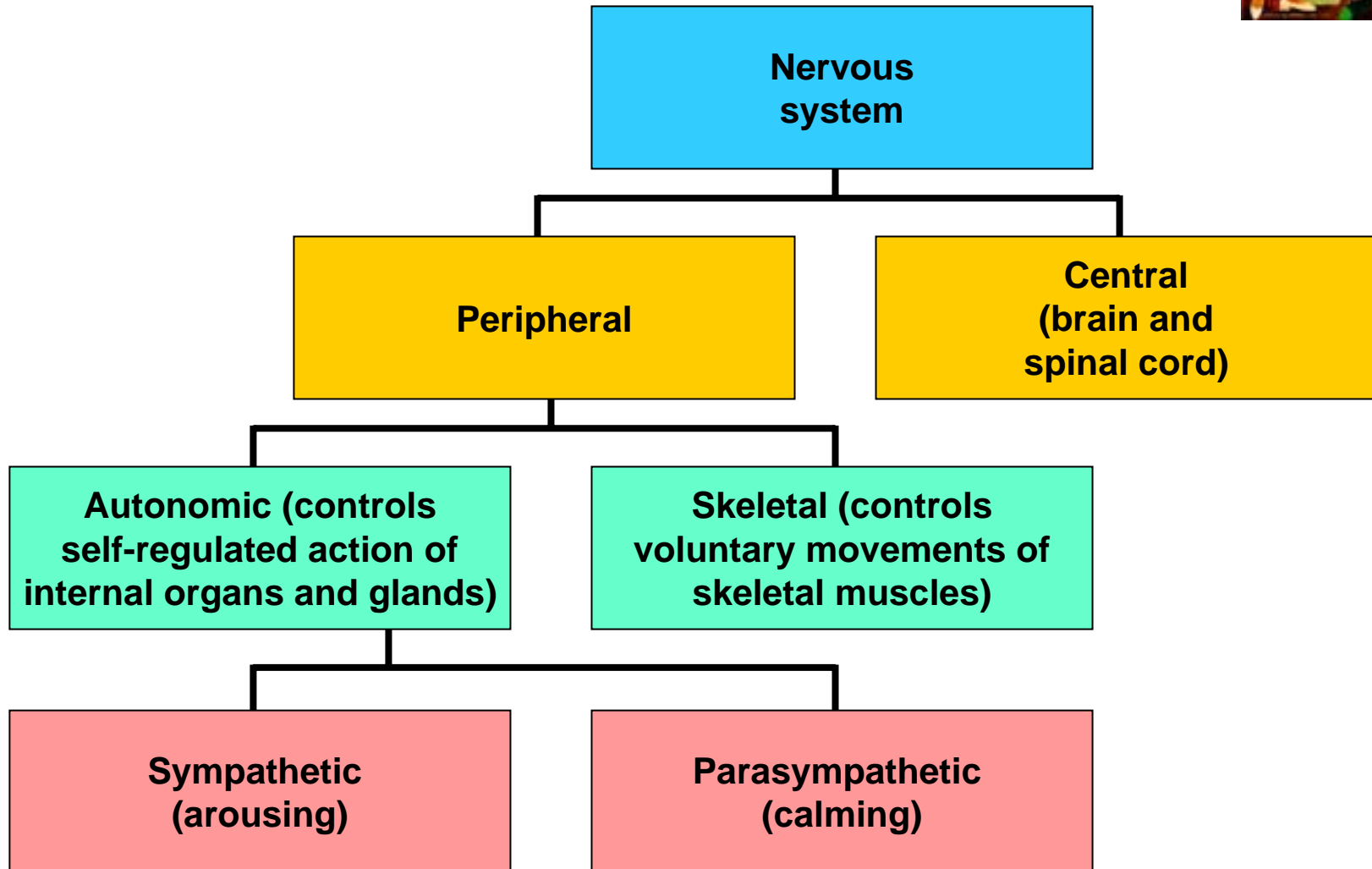
- Central Nervous System (CNS)

- the brain and spinal cord

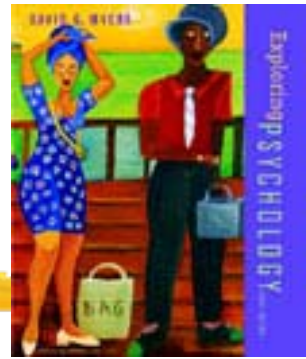
- Peripheral Nervous System (PNS)

- the sensory and motor neurons that connect the central nervous system (CNS) to the rest of the body

The Nervous System



The Nervous System



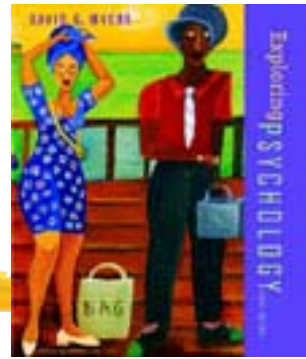
■ Nerves

- neural “cables” containing many axons
- part of the peripheral nervous system
- connect the central nervous system with muscles, glands, and sense organs

■ Sensory Neurons

- neurons that carry incoming information from the sense receptors to the central nervous system

The Nervous System



- **Interneurons**

- CNS neurons that internally communicate and intervene between the sensory inputs and motor outputs

- **Motor Neurons**

- carry outgoing information from the CNS to muscles and glands

- **Somatic Nervous System**

- the division of the peripheral nervous system that controls the body's skeletal muscles

The Nervous System



- **Autonomic Nervous System**

- the part of the peripheral nervous system that controls the glands and the muscles of the internal organs (such as the heart)

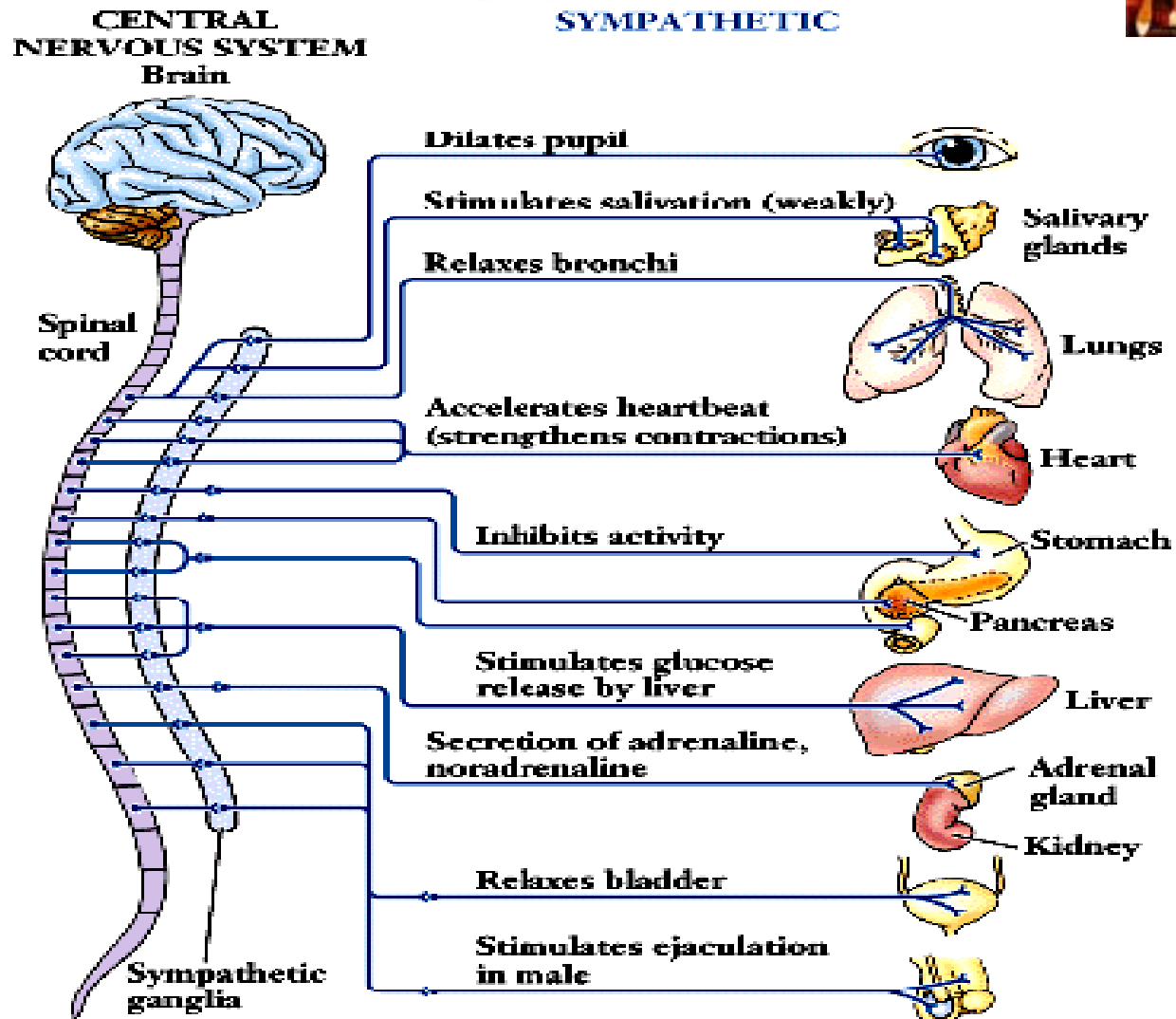
- **Sympathetic Nervous System**

- division of the autonomic nervous system that arouses the body, mobilizing its energy in stressful situations

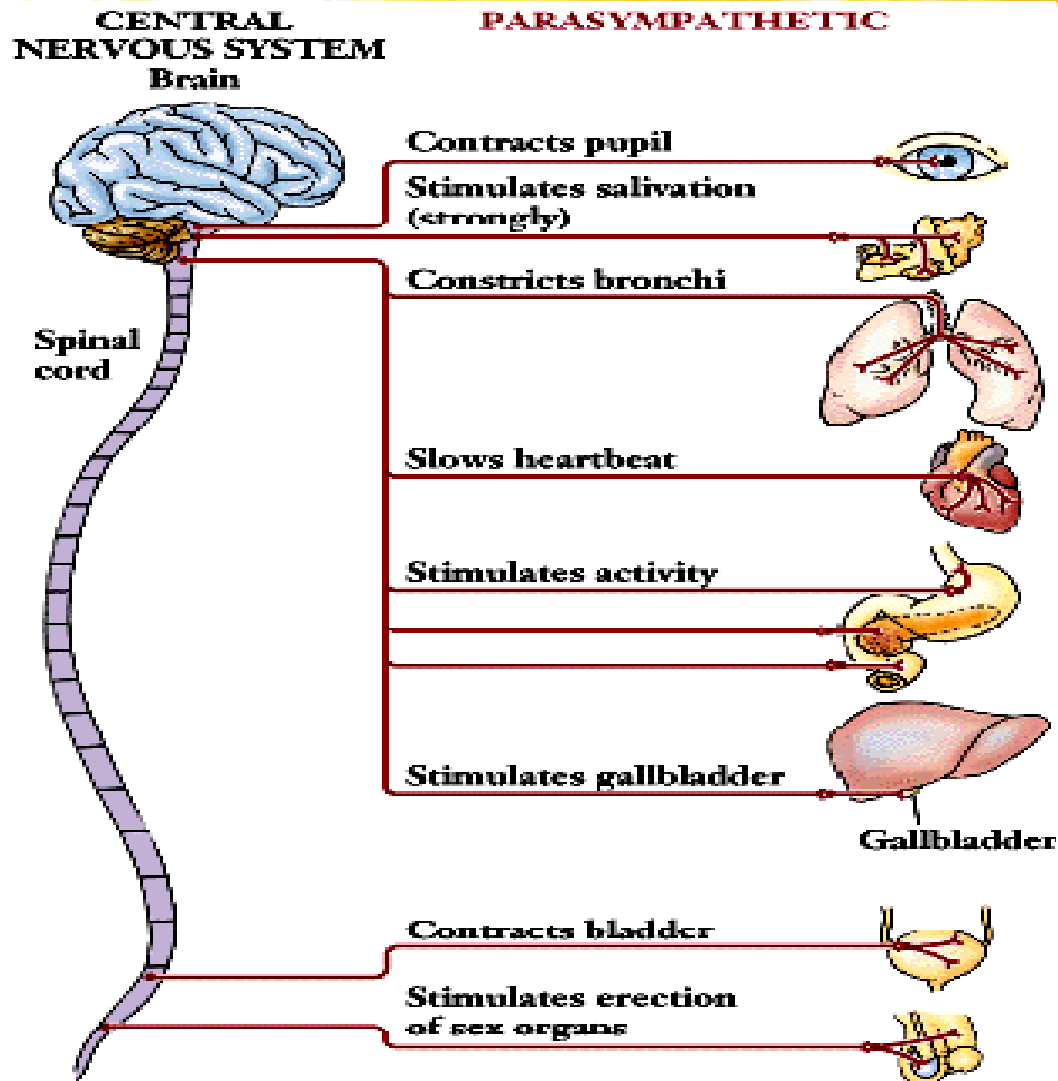
- **Parasympathetic Nervous System**

- division of the autonomic nervous system that calms the body, conserving its energy

The Nervous System



The Nervous System

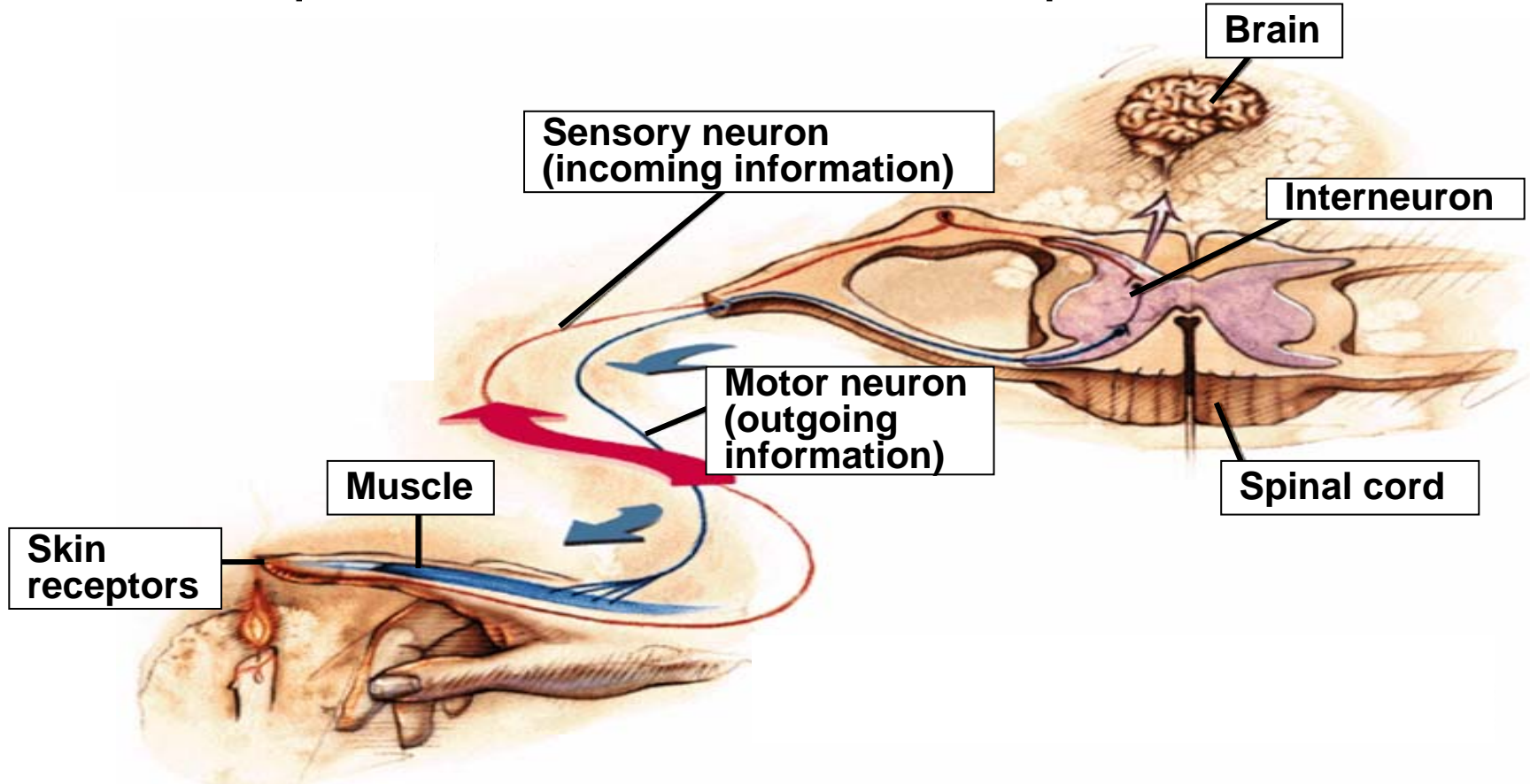


The Nervous System



■ Reflex

- a simple, automatic, inborn response to a sensory



The Brain



- **Brainstem**

- the oldest part and central core of the brain, beginning where the spinal cord swells as it enters the skull
- responsible for automatic survival functions

- **Medulla [muh-DUL-uh]**

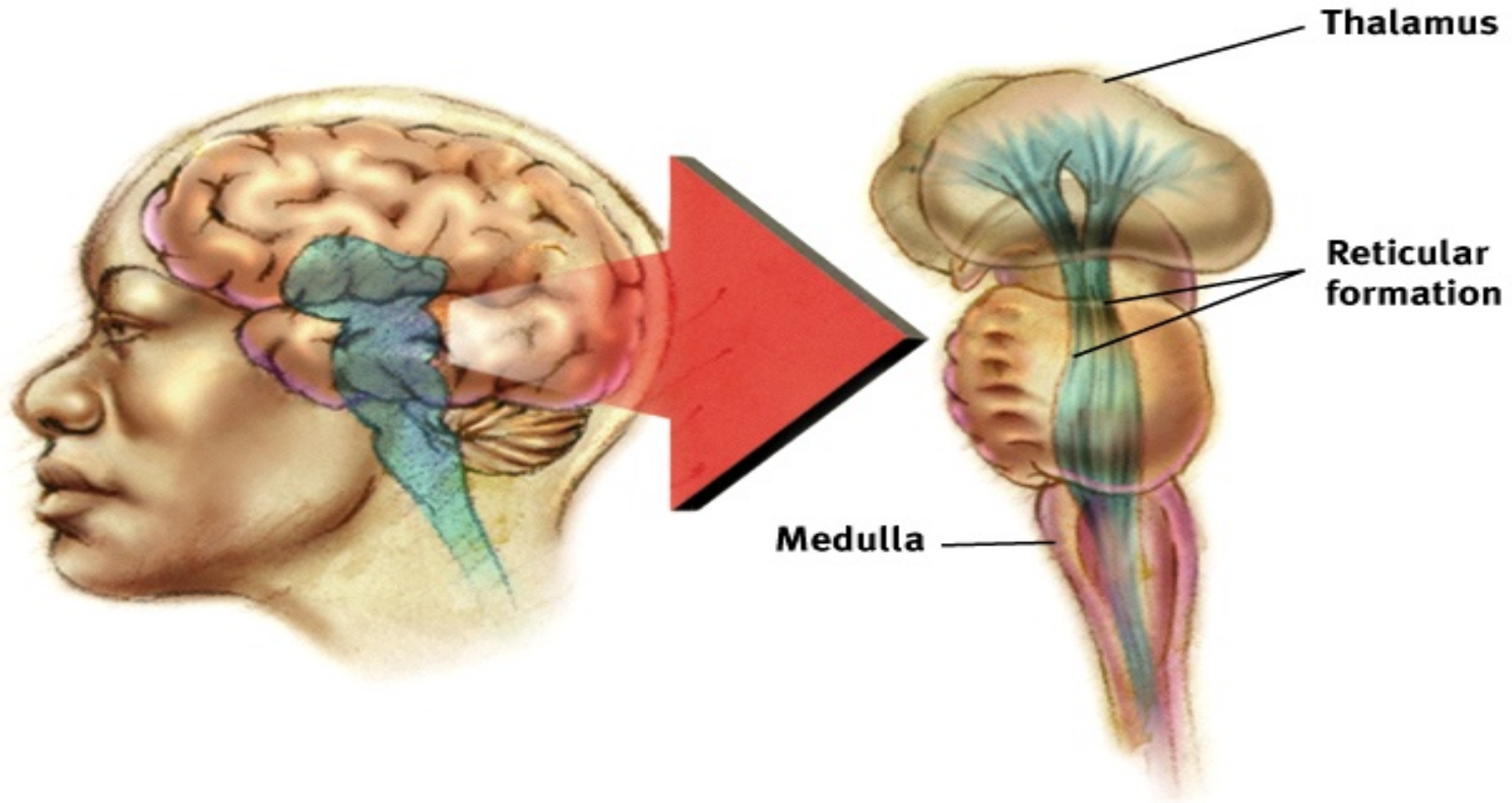
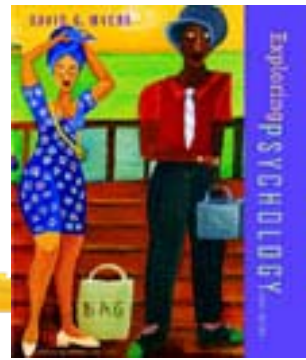
- base of the brainstem
- controls heartbeat and breathing

The Brain

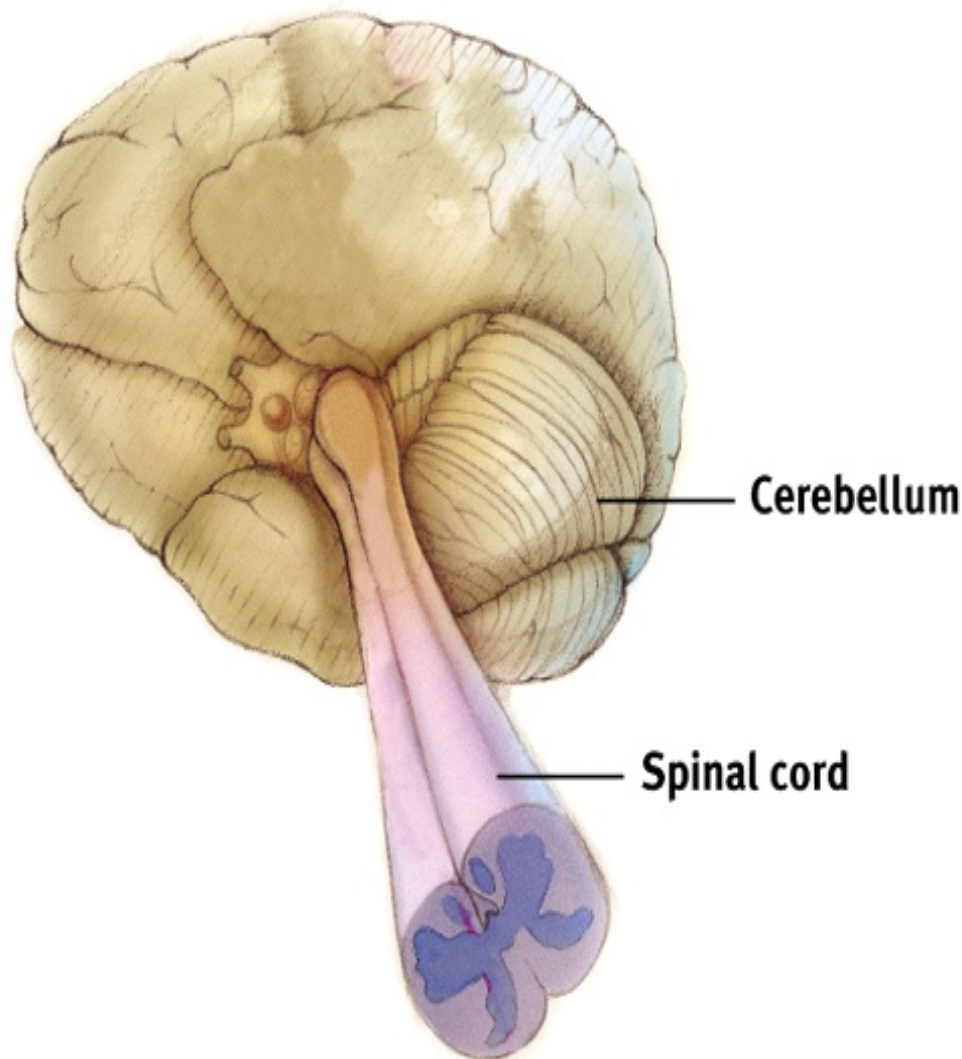


- Reticular Formation
 - a nerve network in the brainstem that plays an important role in controlling arousal
- Thalamus [THAL-uh-muss]
 - the brain's sensory switchboard, located on top of the brainstem
 - it directs messages to the sensory receiving areas in the cortex and transmits replies to the cerebellum and medulla

The Brain

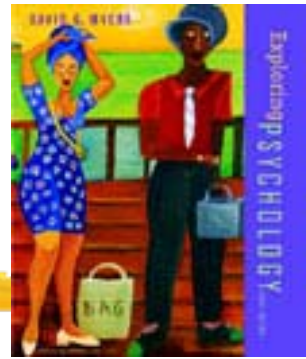


The Brain



- Cerebellum [seh-uh-BELL-um]
 - the “little brain” attached to the rear of the brainstem
 - it helps coordinate voluntary movement and balance

The Brain



- Lesion
 - tissue destruction
 - a brain lesion is a naturally or experimentally caused destruction of brain tissue

Electroencephalogram (EEG)



- an amplified recording of the waves of electrical activity that sweep across the brain's surface
- these waves are measured by electrodes placed on the scalp

The Brain

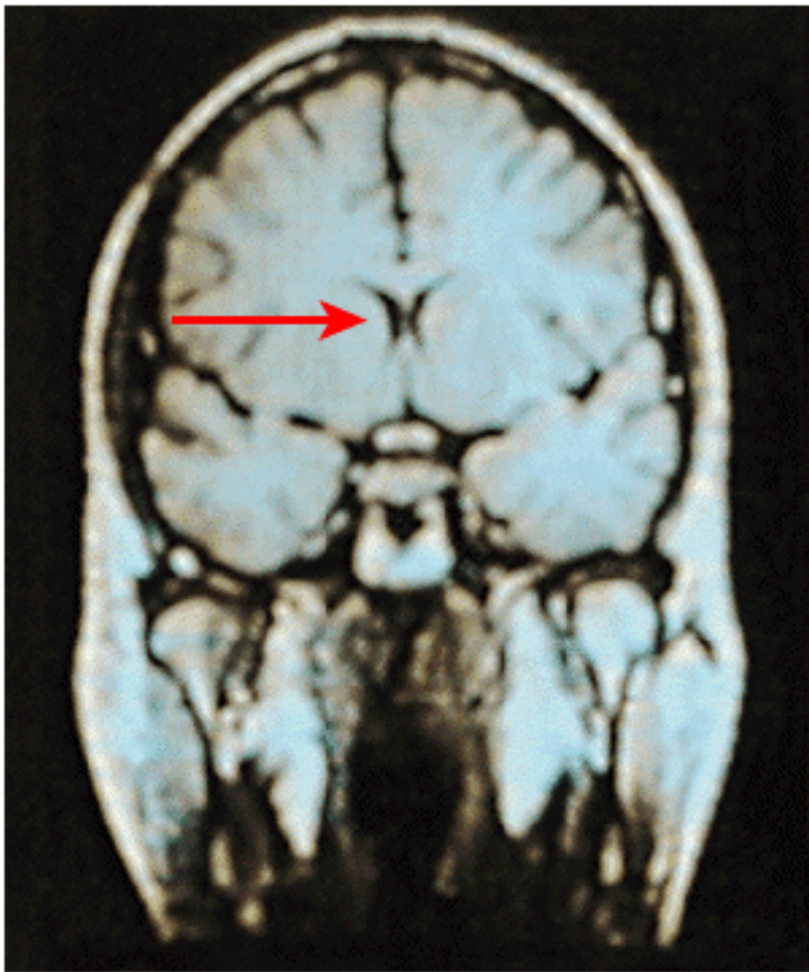


- **Computed Tomography (CT) Scan**
 - a series of x-ray photographs taken from different angles and combined by computer into a composite representation of a slice through the body. Also called *CAT scan*
- **Positron Emission Tomography (PET) Scan**
 - a visual display of brain activity that detects where a radioactive form of glucose goes while the brain performs a given task
- **Magnetic Resonance Imaging (MRI)**
 - a technique that uses magnetic fields and radio waves to produce computer-generated images that distinguish among different types of soft tissue; allows us to see structures within the brain

PET Scan



MRI Scan



The Brain



- **Limbic System**

- a doughnut-shaped system of neural structures at the border of the brainstem and cerebral hemispheres
- associated with emotions such as fear and aggression and drives such as those for food and sex
- includes the hippocampus, amygdala, and hypothalamus.

- **Amygdala [ah-MIG-dah-la]**

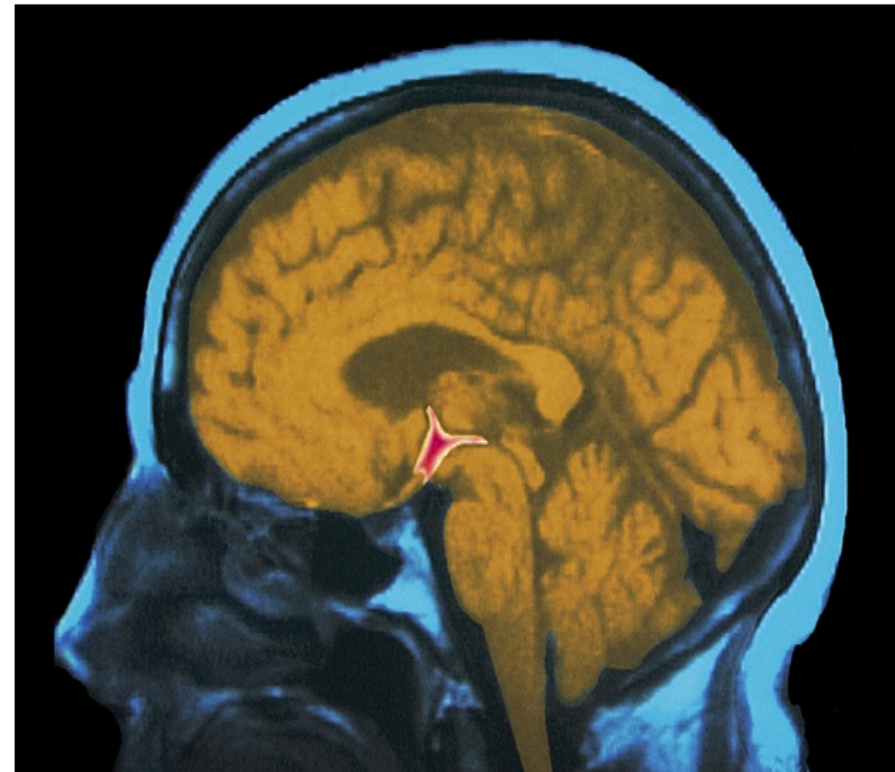
- two almond-shaped neural clusters that are components of the limbic system and are linked to emotion

The Brain

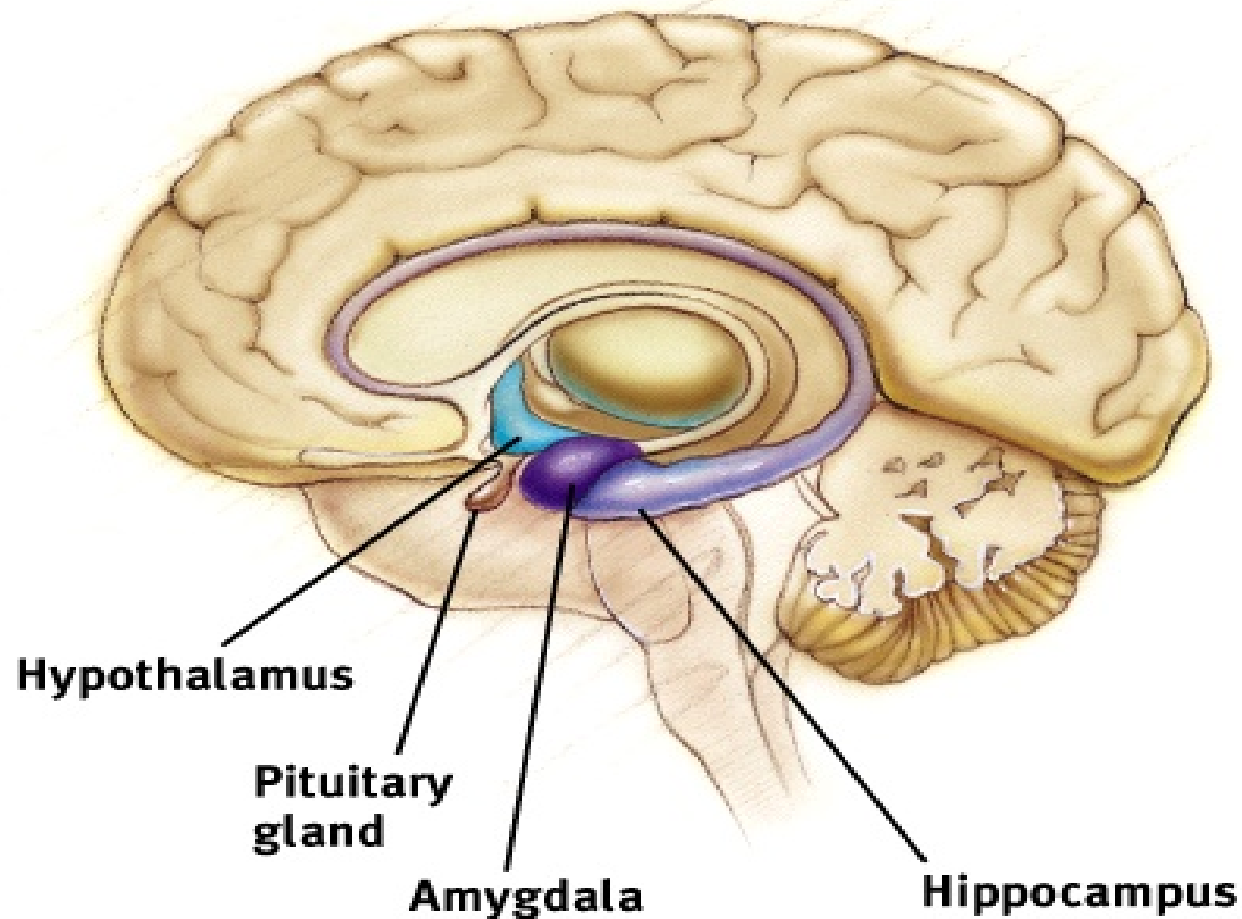


■ Hypothalamus

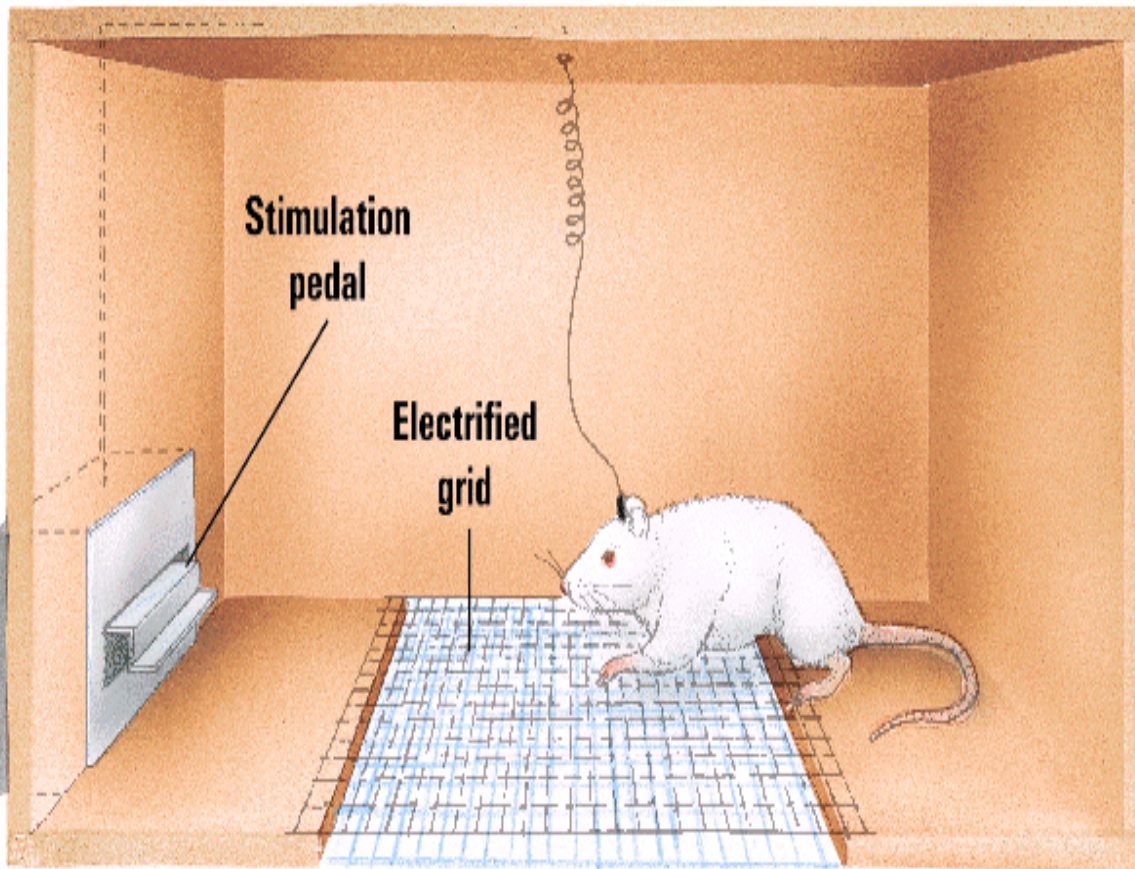
- neural structure lying below (*hypo*) the thalamus; directs several maintenance activities
 - eating
 - drinking
 - body temperature
- helps govern the endocrine system via the pituitary gland
- is linked to emotion



The Limbic System

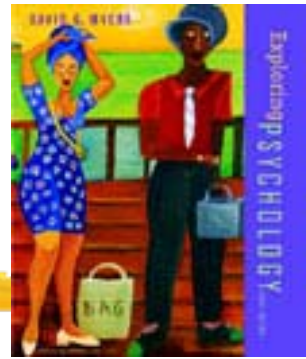


The Limbic System



- Electrode implanted in reward center

The Cerebral Cortex



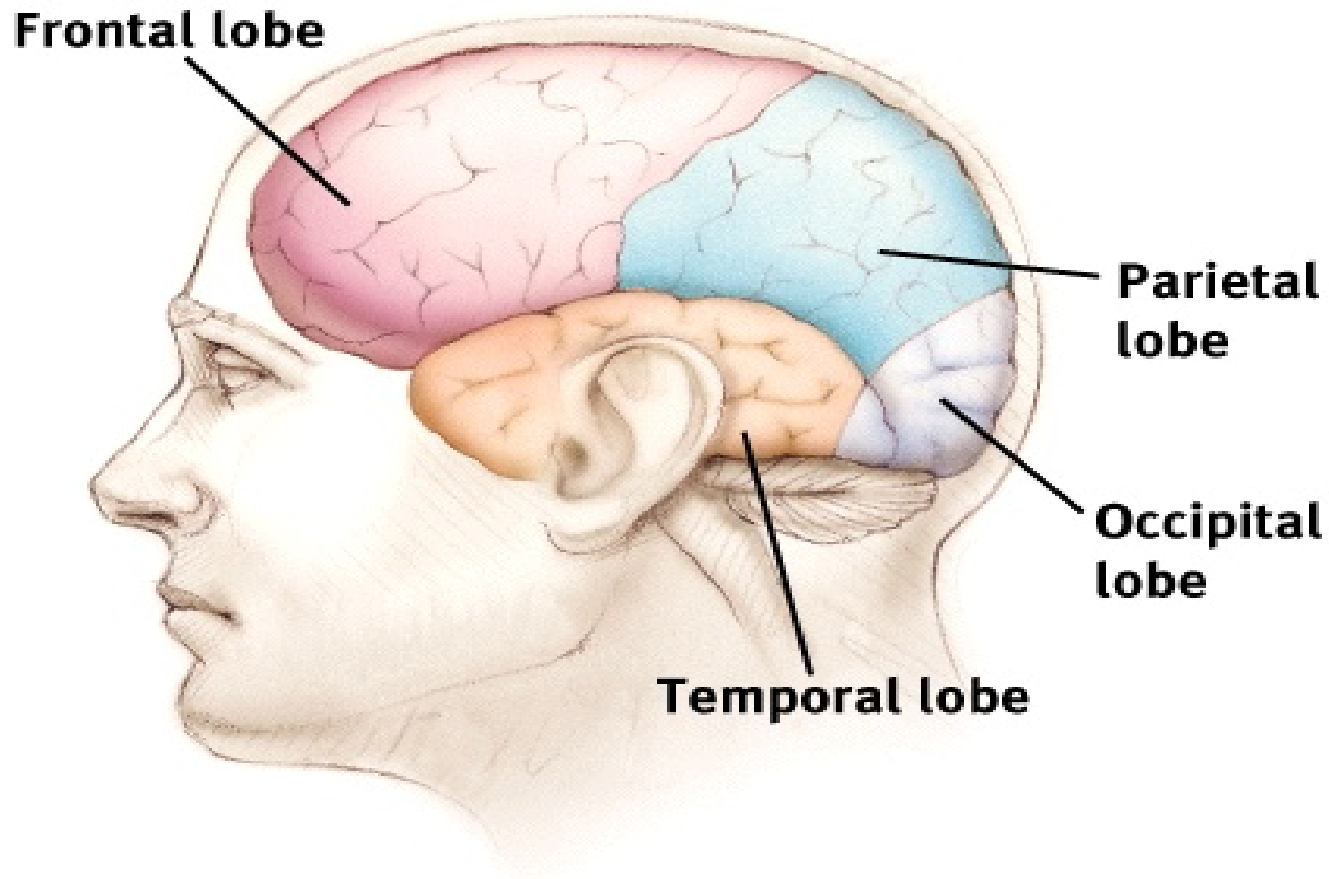
- **Cerebral Cortex**
 - the intricate fabric of interconnected neural cells that covers the cerebral hemispheres
 - the body's ultimate control and information processing center
- **Glial Cells**
 - cells in the nervous system that support, nourish, and protect neurons

The Cerebral Cortex

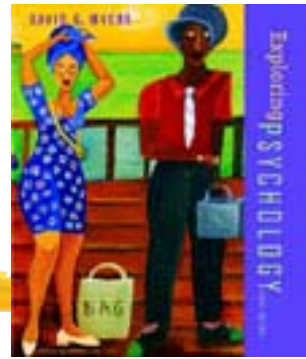


- Frontal Lobes
 - involved in speaking and muscle movements and in making plans and judgments
- Parietal Lobes
 - include the sensory cortex
- Occipital Lobes
 - include the visual areas, which receive visual information from the opposite visual field
- Temporal Lobes
 - include the auditory areas

The Cerebral Cortex



The Cerebral Cortex

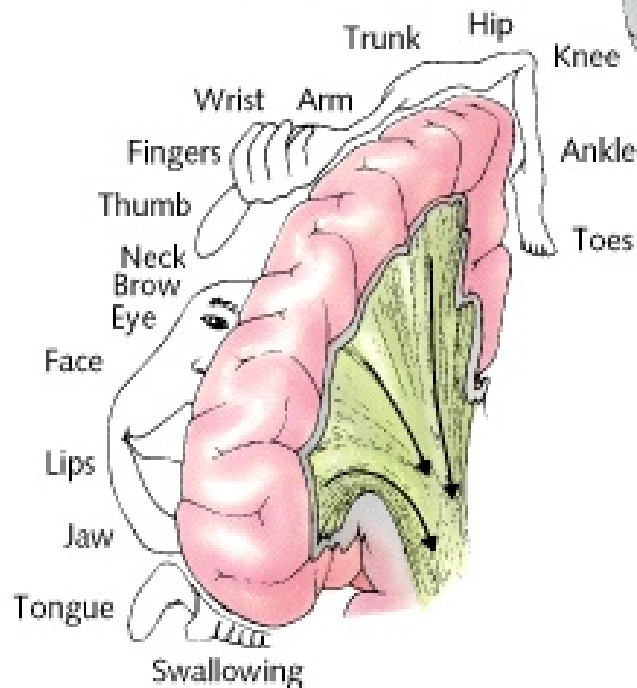


- **Motor Cortex**
 - area at the rear of the frontal lobes that controls voluntary movements
- **Sensory Cortex**
 - area at the front of the parietal lobes that registers and processes body sensations

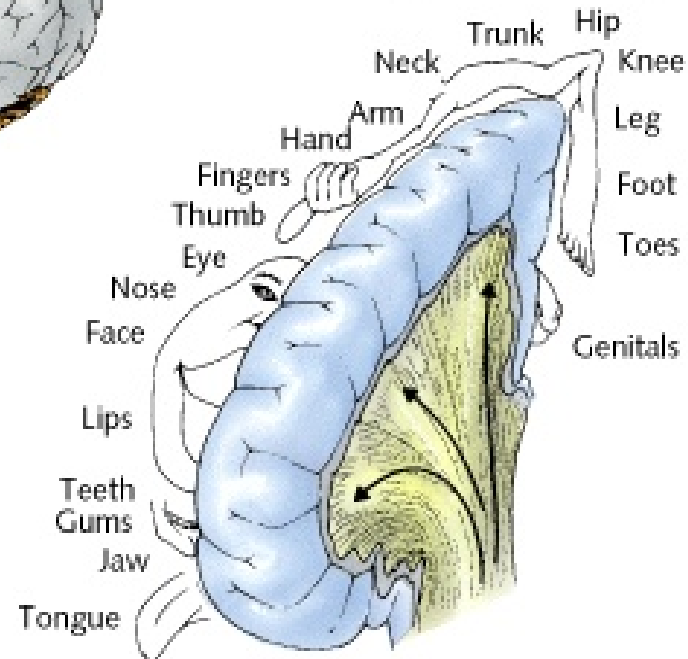
The Cerebral Cortex



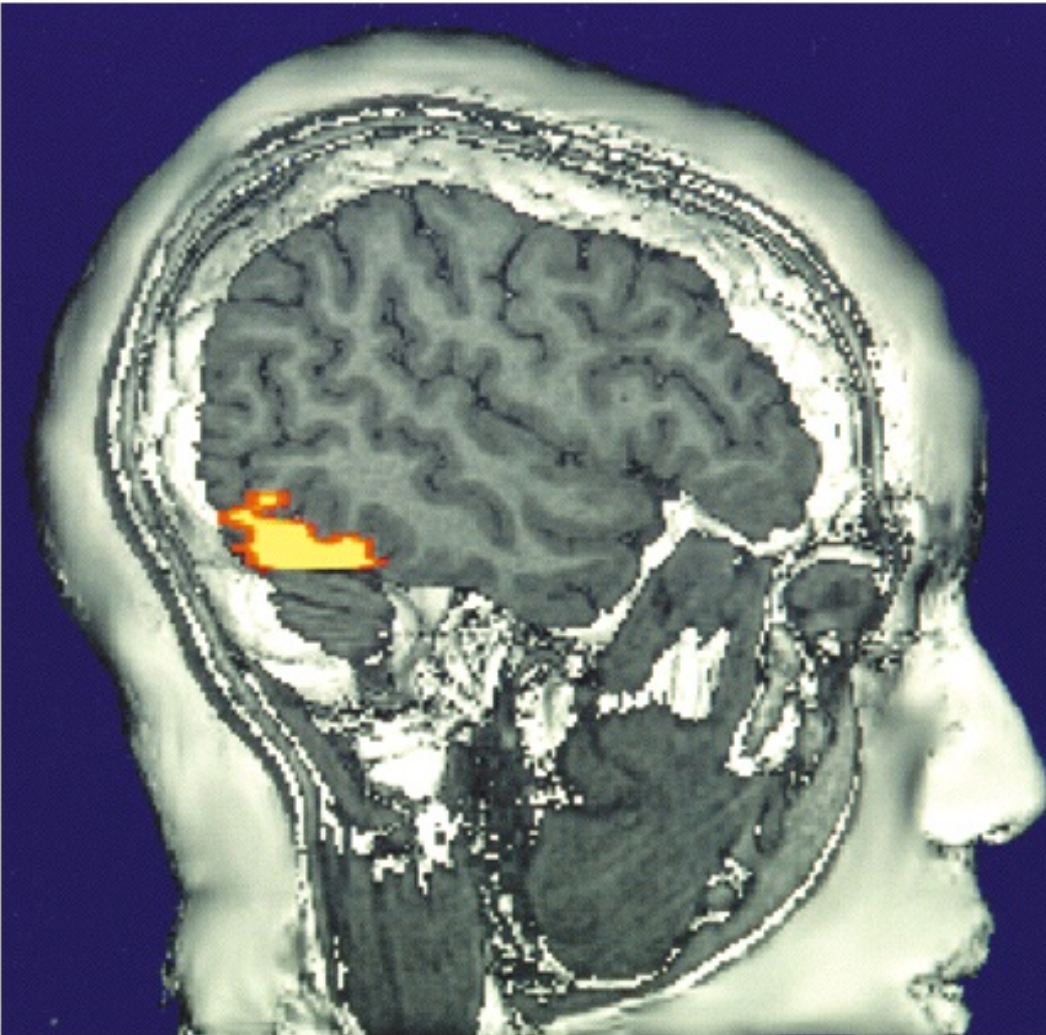
Output: Motor cortex
(Left hemisphere section controls the body's right side)



Input: Sensory cortex
(Left hemisphere section receives input from the body's right side)

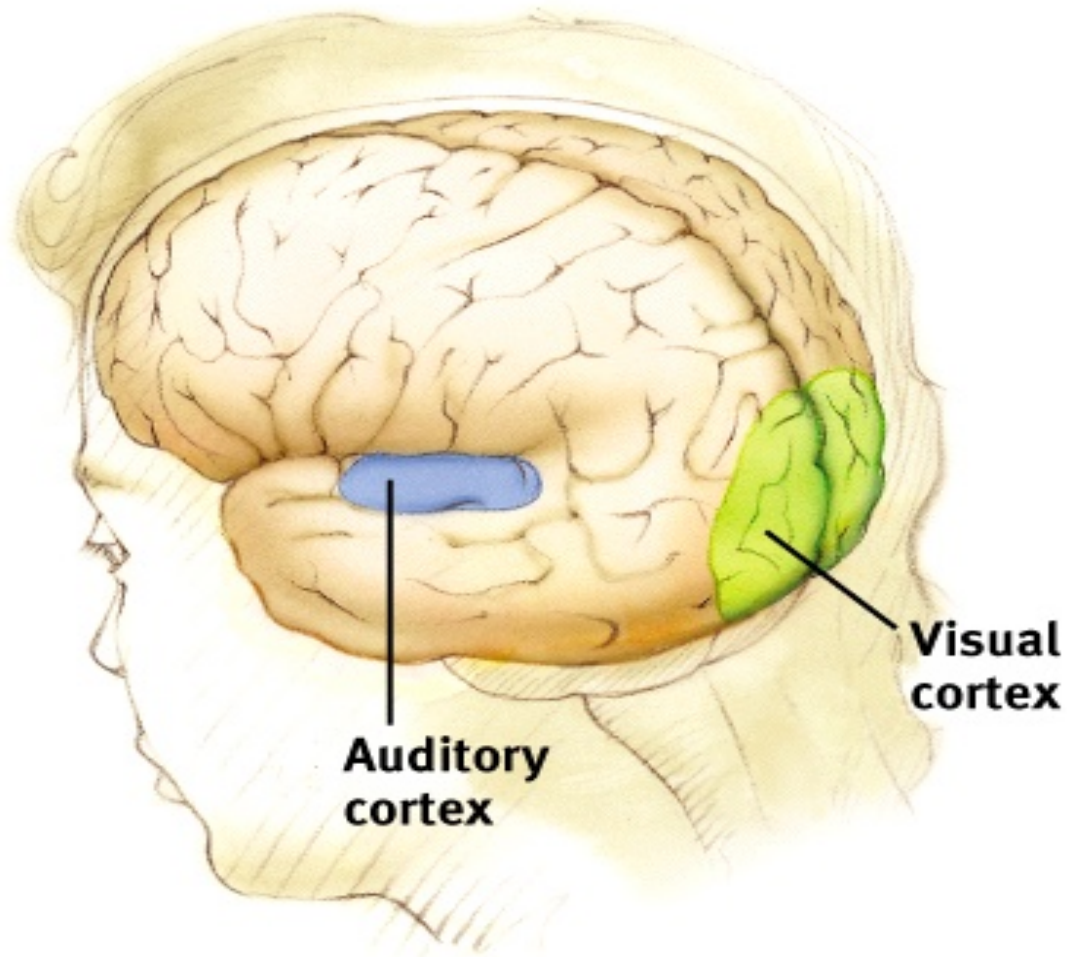


The Cerebral Cortex



- Functional MRI scan shows the visual cortex activated as the subject looks at faces

Visual and Auditory Cortex



Association Areas



- More intelligent animals have increased “uncommitted” or association areas of the cortex

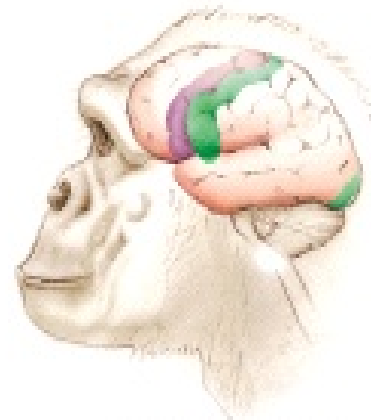
- Motor areas
- Sensory areas
- Association areas



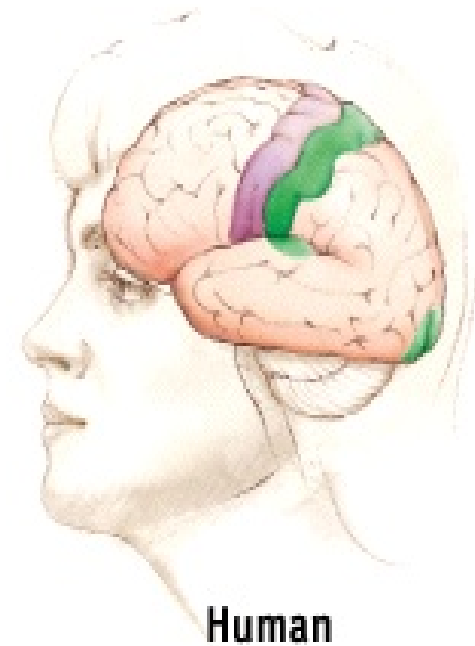
Rat



Cat



Chimpanzee



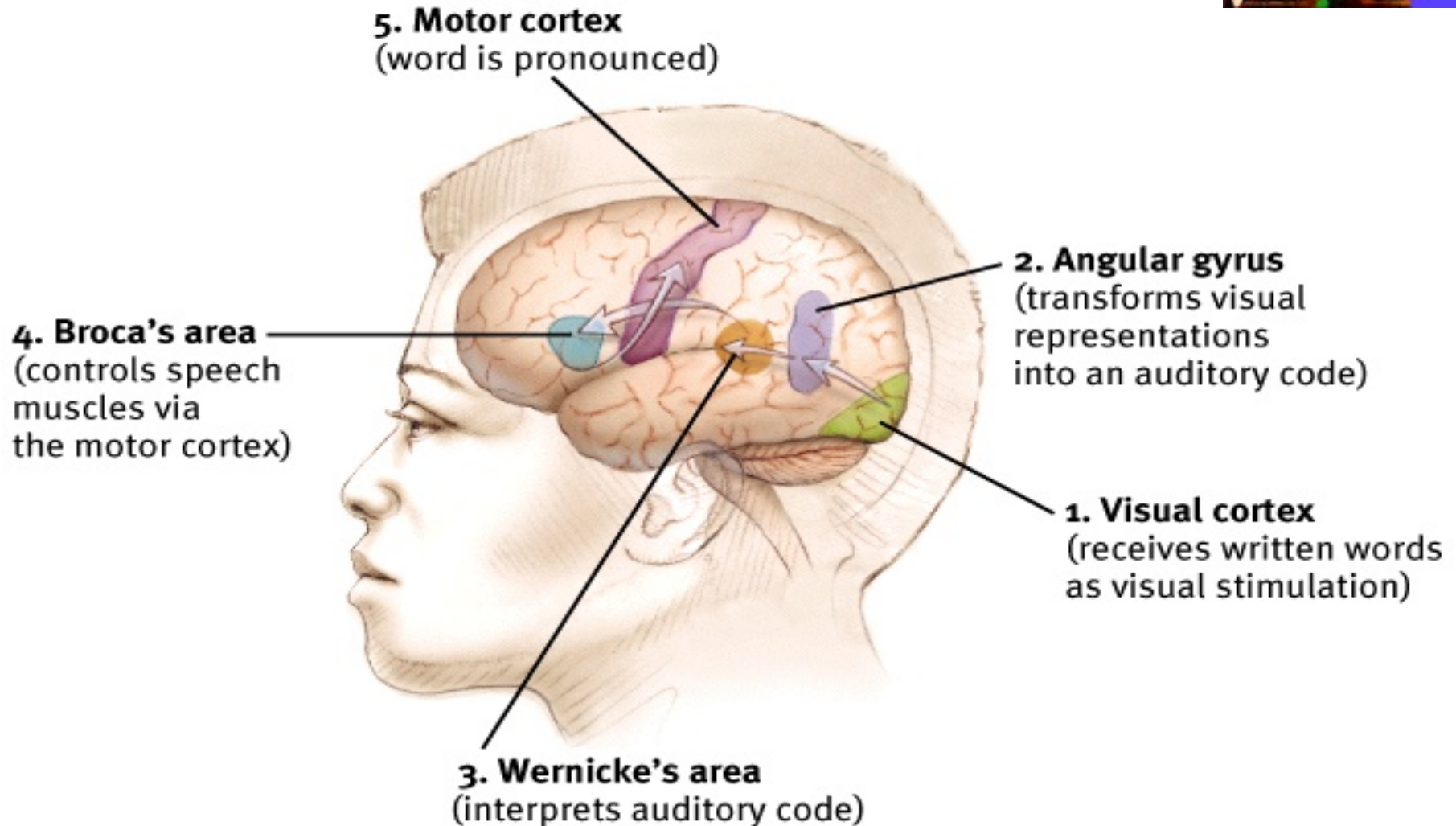
Human

The Cerebral Cortex



- **Aphasia**
 - impairment of language, usually caused by left hemisphere damage either to Broca's area (impairing speaking) or to Wernicke's area (impairing understanding)
- **Broca's Area**
 - an area of the left frontal lobe that directs the muscle movements involved in speech
- **Wernicke's Area**
 - an area of the left temporal lobe involved in language comprehension and expression

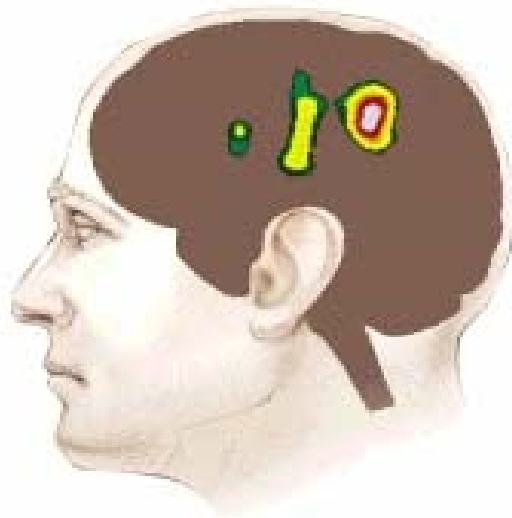
Specialization and Integration



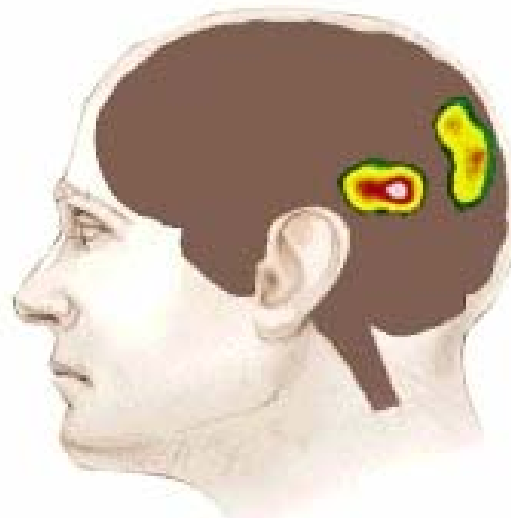
Specialization and Integration



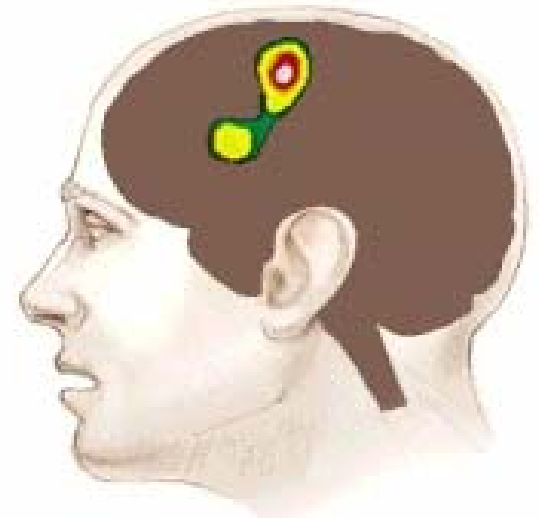
- Brain activity when hearing, seeing, and speaking words



(a)
Hearing

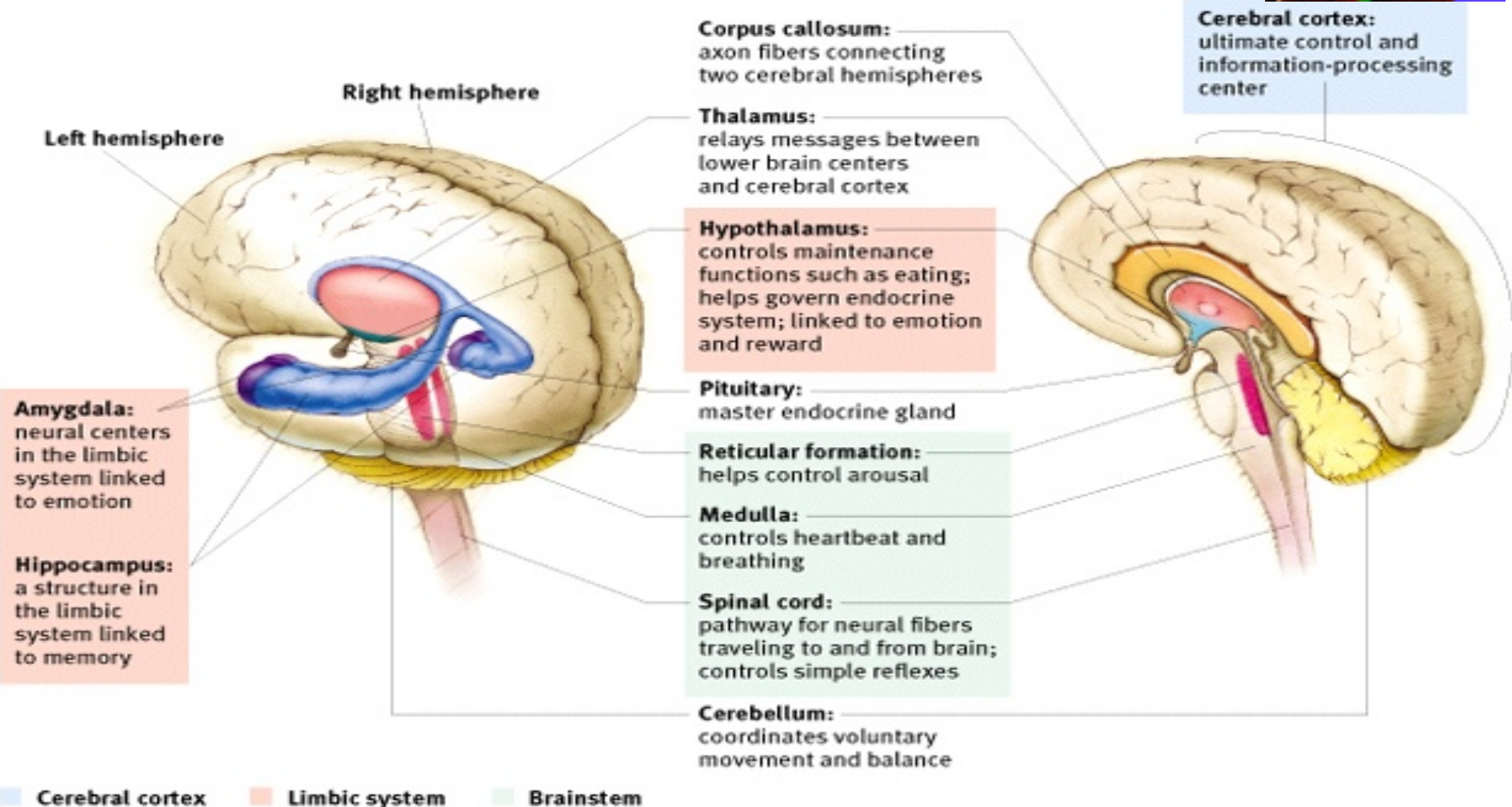
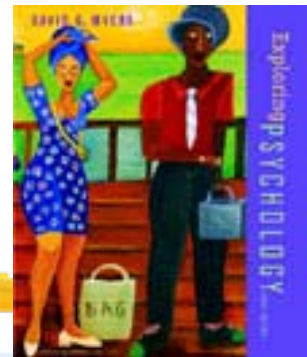


(b)
Seeing



(c)
Speaking

Brain Structures and their Functions



Brain Reorganization



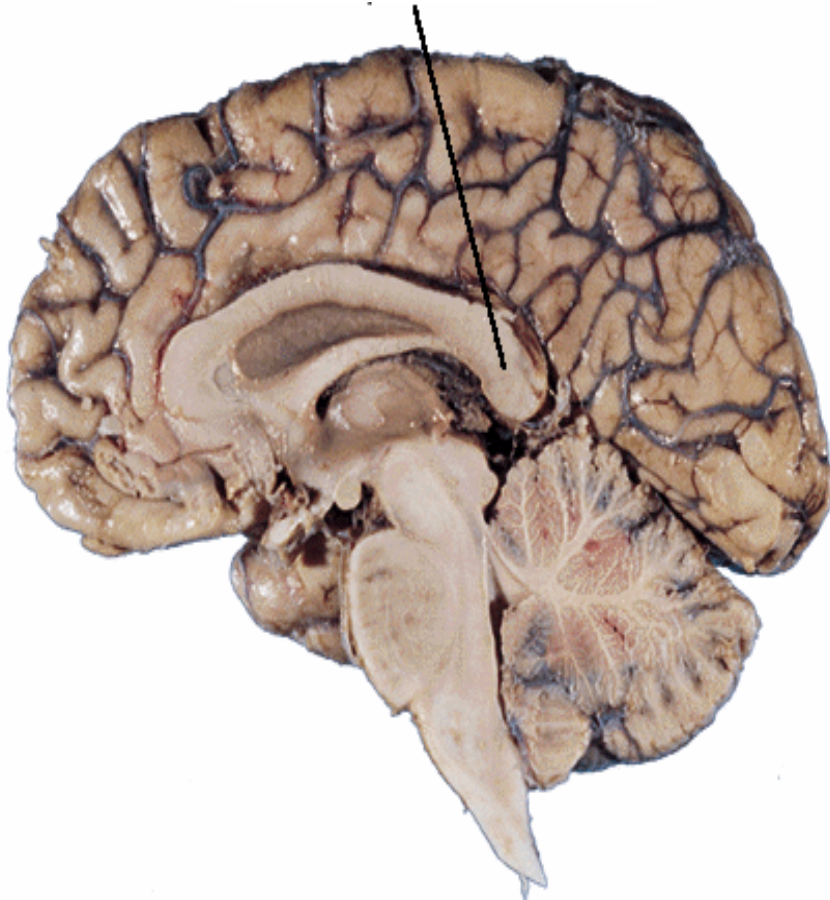
- Plasticity

- the brain's capacity for modification, as evident in brain reorganization following damage (especially in children) and in experiments on the effects of experience on brain development

Our Divided Brain

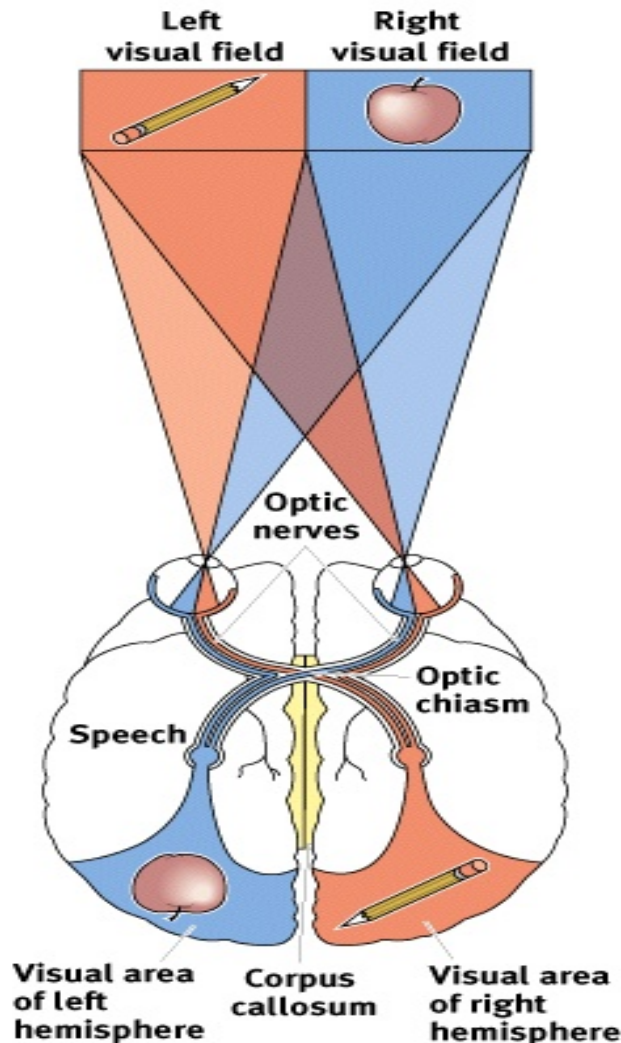


Corpus callosum



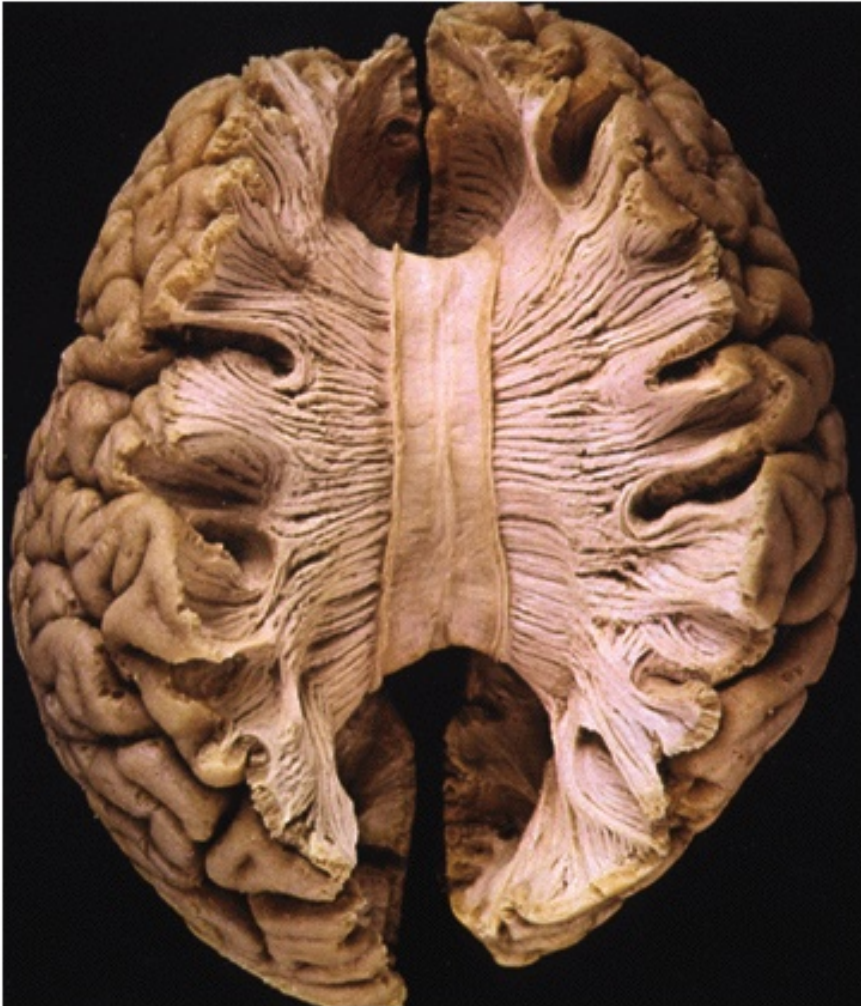
- **Corpus Callosum**
 - large band of neural fibers
 - connects the two brain hemispheres
 - carries messages between the hemispheres

Our Divided Brain



- The information highway from the eye to the brain

Split Brain



- a condition in which the two hemispheres of the brain are isolated by cutting the connecting fibers (mainly those of the corpus callosum) between them

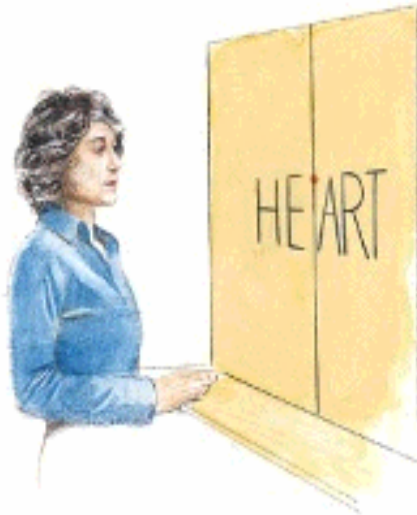
Split Brain



“Look at the dot.”



Two words separated by a dot are momentarily projected.



“What word did you see?”



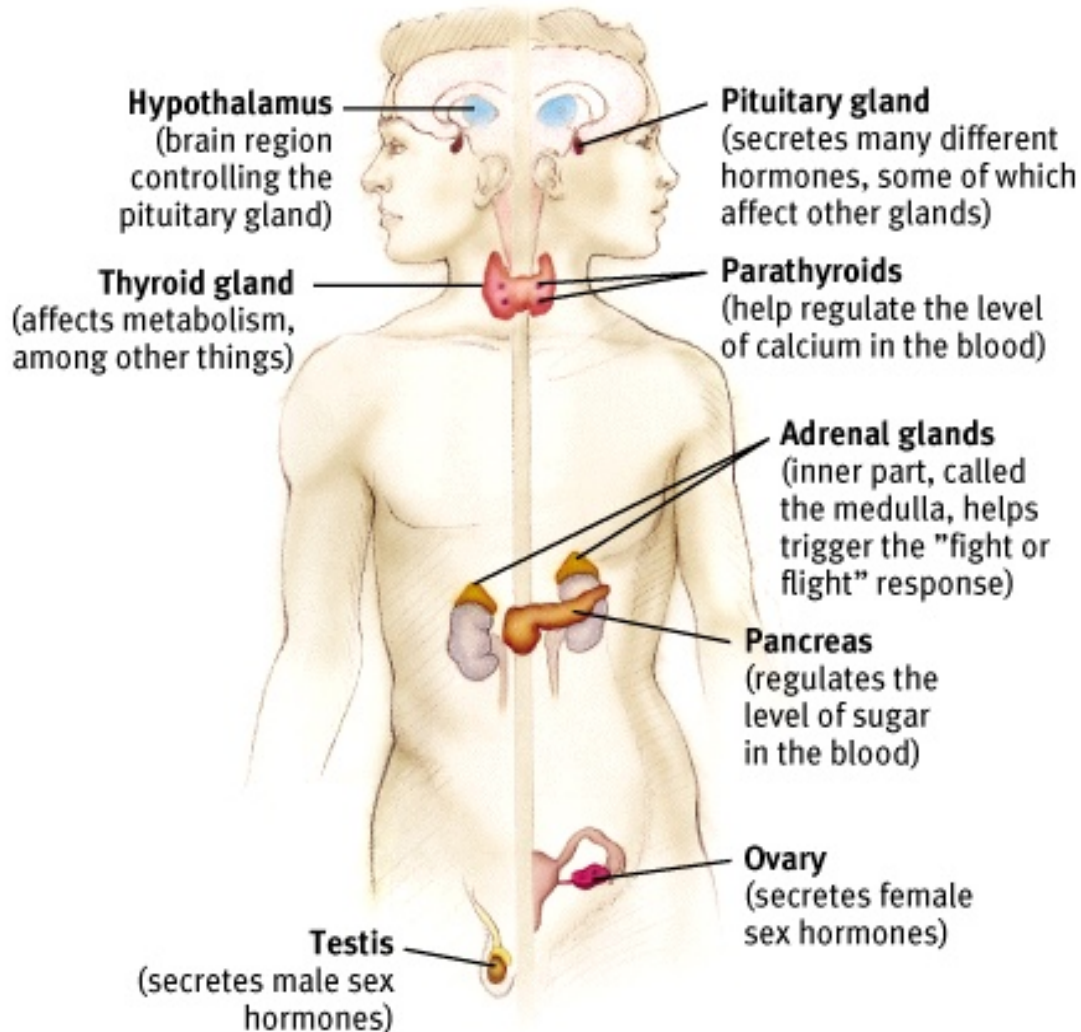
or



“Point with your left hand to the word you saw.”



The Endocrine System



- **Endocrine System**
 - the body's "slow" chemical communication system
 - a set of glands that secrete hormones into the bloodstream

Neural and Hormonal Systems



■ Hormones

- chemical messengers, mostly those manufactured by the endocrine glands, that are produced in one tissue and affect another

■ Adrenal [ah-DREEN-eɪ] Glands

- a pair of endocrine glands just above the kidneys
- secrete the hormones epinephrine (adrenaline) and norepinephrine (noradrenaline), which help to arouse the body in times of stress

■ Pituitary Gland

- under the influence of the hypothalamus, the pituitary regulates growth and controls other endocrine glands