UNIT 4

PART ONE

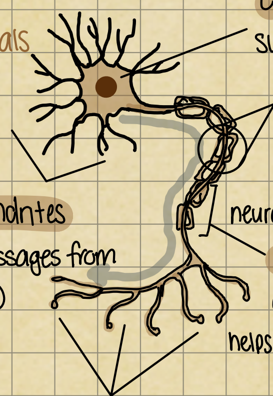
biology of the mind & consciousness

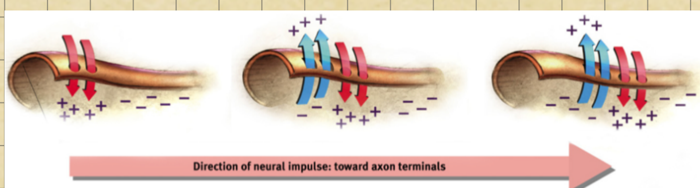
THE BRAIN

- made up of neurons [electrical impulses] + glial cells
- glial cells support neural cells
- brain plasticity
  - ↳ the ability for our brains to form new connections after the neurons are damaged
  - ↳ the younger you are, the more plastic your brain is

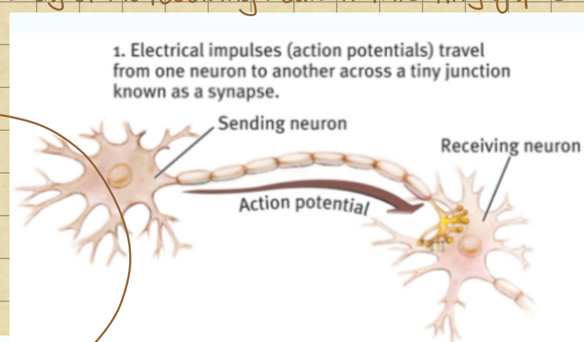
The Nervous System pt 1

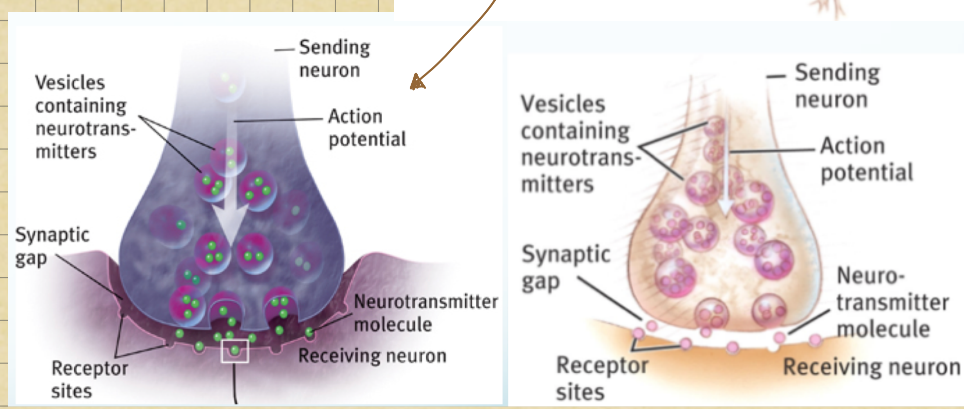
- starts w/ an individual nerve cell = NEURON
- neuronatomy
  - ↳ neurotransmitters (chemicals held in terminal buttons that travel through synaptic gap
- action potential: a neural impulse is a brief electrical charge that travels down an axon, and is generated by the movement of positively charged atoms in and out of channels in the axon's membrane





- action potential properties
  - resting potential: neurons start out in a slightly negative charge
  - threshold: each neuron receives excitatory and inhibitory signals from many neurons when enough transmitters reach dendrites. When the excitatory signals minus the inhibitory signals exceed a minimum intensity (threshold) the neuron fires an action potential.
  - all-or-none response: a strong stimulus can trigger more neurons to fire, and to fire more often, but it does not affect the action potentials strength or speed
  - intensity of an action potential remains the same throughout the length of the axon
- synapse [SIN-aps]
  is a junction between the axon tip of the sending neuron + the dendrite / cell body of the receiving neuron. This tiny gap is the synaptic gap / cleft
- how neurotransmitters influence us
  - neurotransmitters (chemicals) released from the sending neuron travel across the synapse + bind to receptor sites on the receiving neuron, thereby influencing it to generate an action potential
  - neurotransmitters in the synapse are reabsorbed into the sending neurons thru the process of reuptake ⇒ applies the brakes on neurotransmitter action.

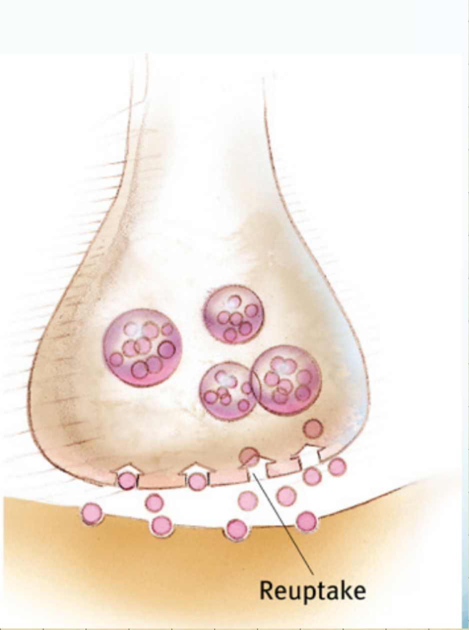




Types of Neurotransmitters

DOPAMINE

- deals w/ motor movement + alertness
- lack of dopamine has been linked to Parkinson's disease
- Too much has been linked to schizophrenia



Acetylcholine (ACh)

- deals w/ motor movement + memory
- too much is linked to overactivity
- too little is linked to memory impairment
  - lack of ACh has been linked to Alzheimer's

Endorphins

- involved in pain control
- many of our most addictive drugs deal w/ endorphins

Serotonin

- involved in mood control
- lack = depression
- Selective Serotonin Reuptake Inhibitors (SSRI)

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).

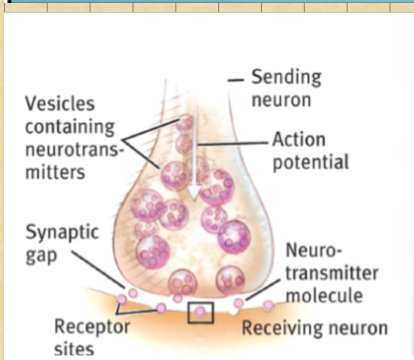
Lock & Key Mechanism

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

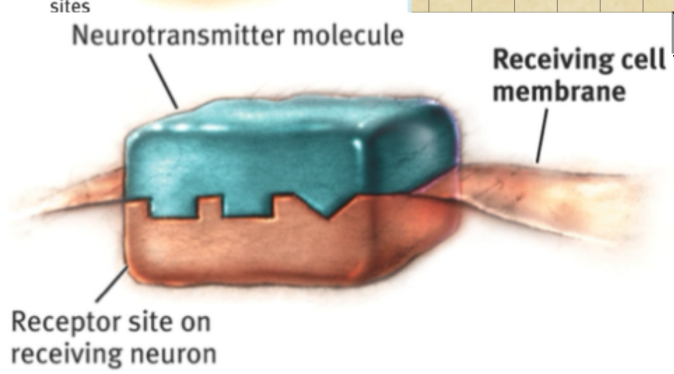
Agonists & Antagonists

"EXCITATORY" FIRES THE ACTION POTENTIAL (NEURONS) WHEREAS "INHIBITORY" (ANTAGONISTS) DOES NOT FIRE, WHICH CAUSES BLOCKAGE

- agonist = mimics neurotransmitter ; antagonist blocks the neurotransmitter
- The agonist molecule excites: It is similar enough in structure to the neurotransmitter molecule that it mimics its effects on the receiving neuron.
  - ↳ [EX] morphine mimics the action of the endorphins by stimulating receptors in brain areas involved in mood + pain sensations
- The antagonist molecule inhibits: It has a structure similar enough to the transmitter to occupy its receptor site and block its action, but not similar enough to stimulate the receptor.
  - ↳ [EX] curare poisoning paralyzes its victims by blocking ACh receptors



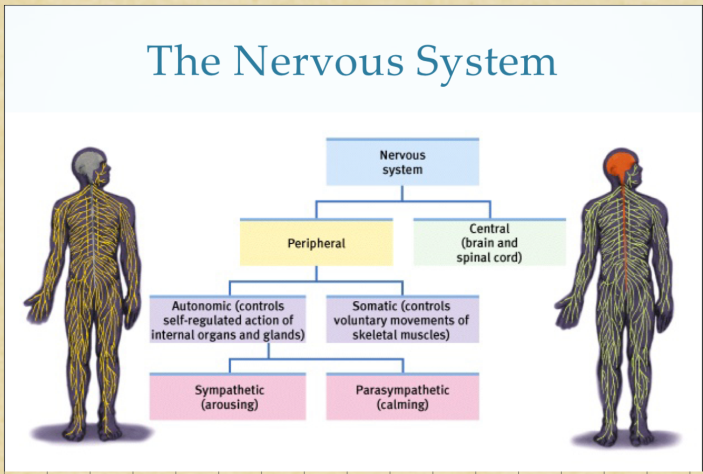
Involved in muscle movement



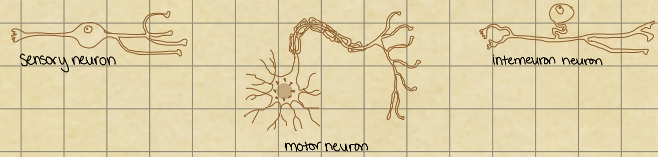
This neurotransmitter molecule has a molecular structure that precisely fits the receptor site on the receiving neuron, much as a key fits a lock.

The Nervous System pt. 2

- 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
- kinds of neurons:
  - ↳ Sensory (afferent) neurons carry incoming info from the sense receptors to the CNS
  - ↳ motor (efferent) neurons carry outgoing info from the CNS to muscles and glands



↳ interneurons connect the two neurons



- the nerves consist of neural "cables" containing many axons. They are part of the PNS and connects muscles, glands, and sense organs to the CNS.
-

Peripheral Nervous System

- All nerves that are not encased in bone
- Everything but the brain and spinal cord
- is divided into 2 categories: somatic & autonomic

→

somatic nervous system: The division of the PNS that controls the body's skeletal muscles

autonomic nervous system: Part of the PNS that controls the glands and other muscles

↓

Somatic Nervous System

- controls voluntary muscle movement
- uses motor (efferent) neurons

←

Autonomic Nervous System (ANS)

- controls the automatic functions of the body
- divided into 2 categories: sympathetic & parasympathetic
- **sympathetic nervous system**: arouses the body, mobilizing its energy in stressful situations
- **parasympathetic nervous system**: calms the body, conserving its energy

↓

Sympathetic Nervous System

- fight or flight response
- automatically accelerates heart rate, breathing, dilates pupils, slows down digestion

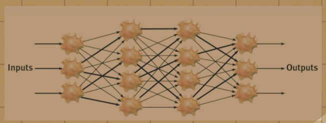
→

Parasympathetic Nervous System

- automatically slows down the body after a stressful event
- heart rate & breathing slow down, pupils construct and digestion speeds up

Central Nervous System

The brain and neural networks interconnected neurons from networks in the brain. These networks are complex and modify w/growth + experience



Central Nervous System
the spinal cord + reflexes

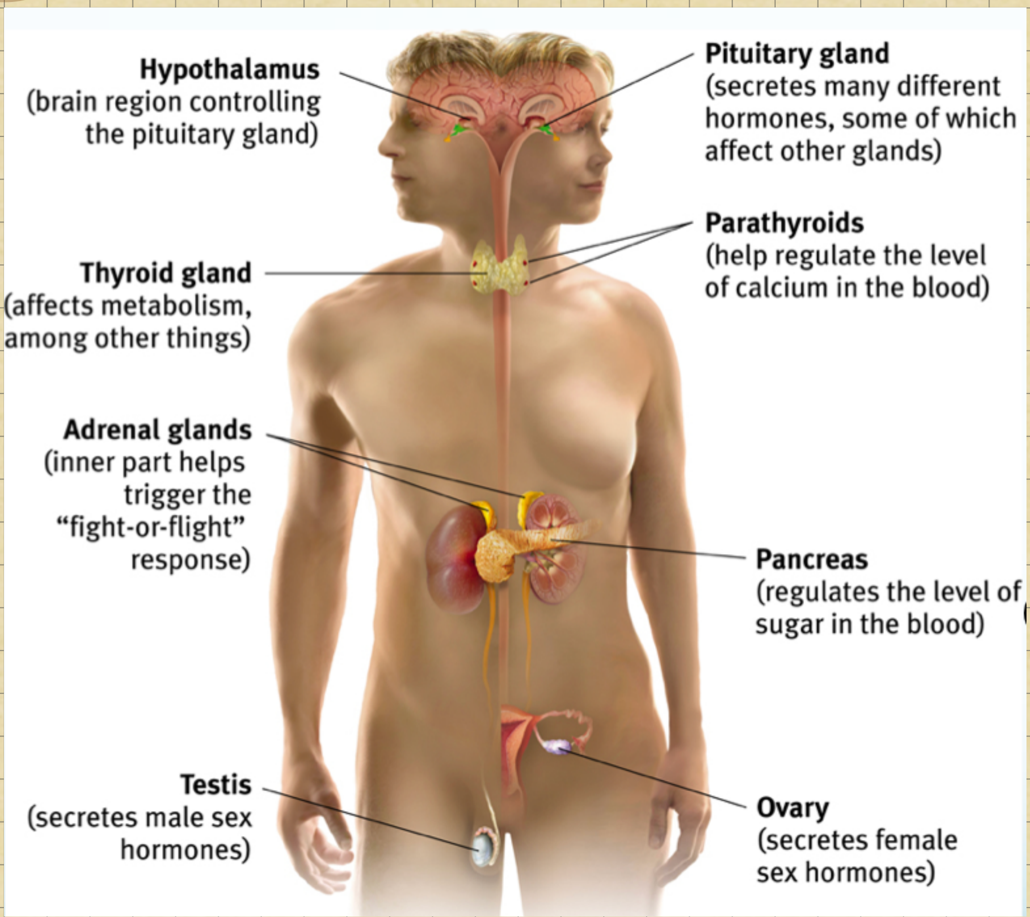
- Info is carried from skin receptors along a sensory neuron to the spinal cord. from here it is passed via interneurons to motor neurons that lead to muscles
- due to some movements involving only the spinal cord, these movements can happen even before info has reached the brain.

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.

Reflexes

- normally, sensory (afferent) neurons take info up thru spine to the brain
- some reactions occur when sensory neurons reach just the spinal cord
- survival adaptation



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

↳ [Ex] epinephrene (adrenaline) increases heart rate, blood pressure, blood sugar, and feelings of excitement during emergency situations.

The pituitary gland, also called the "master gland" releases hormones that regulate other glands. (anterior pituitary lobe). The posterior lobe regulates water + salt balance

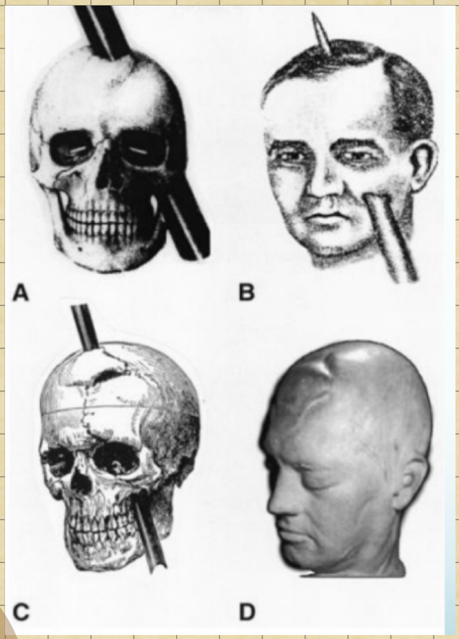
Thyroid and parathyroid glands regulate metabolic + calcium rate.

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

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

The Brain

- techniques to study the brain
  - a brain lesion experimentally destroys brain tissue to study animal behaviors after such destruction
    → cutting into the brain and looking for change
  - accidents: Phineas Gage
  - clinical observation: have shed light on a number of brain disorders. Alterations in brain morphology due to neurological and psychiatric diseases are now being catalogued.
- less invasive ways to study the brain
  - electroencephalogram (EEG)
  - computerized axial tomography (CAT)
  - magnetic resonance imaging (MRI)
  - position emission tomography (PET)
  - functional MRI



Electroencephalogram (EEG)

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

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

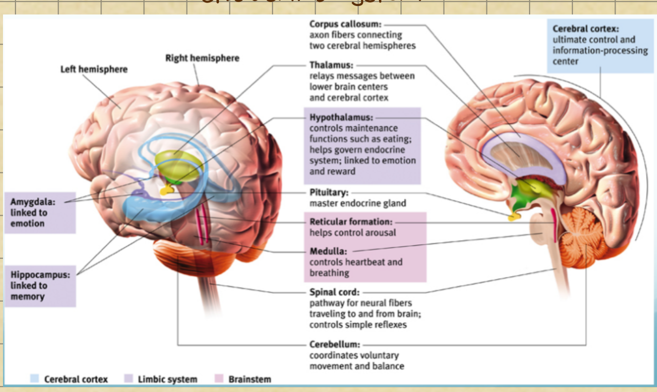
Position Emission Tomography
PET Scan

is a visual display of brain activity that detects a radioactive form of glucose while the brain performs a given task.

- brainstem structures
  - Some scientists divide the brain up into 3 parts

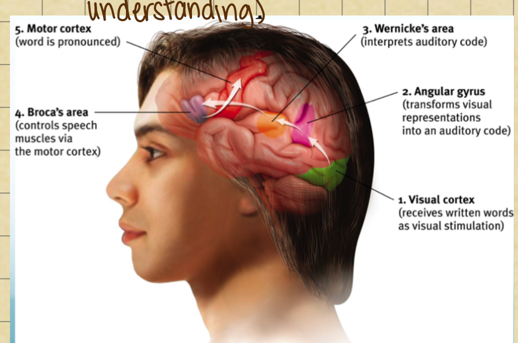
Hindbrain — Midbrain — Forebrain

- the **midbrain** coordinates simple movements w/ sensory information and contains the reticular formation: arousal / weakness and ability to focus attention
- the **thalamus** is the brain's sensory switchboard, located on top of the brainstem (forebrain). It directs messages (except smell) to the sensory areas in the cortex & transmits replies to the cerebellum and medulla
- the **limbic system** is a doughnut-shaped system of neural structures at the border of the brainstem and cerebrum, associated w/ emotions such as fear, aggression and drives for food and sex. It includes the hippocampus, amygdala, and hypothalamus.
  - ↳ **hippocampus** = memory processing
  - ↳ **amygdala** = vital for our basic emotions; consists 2 lima bean-sized neural clusters linked to the emotions of fear and anger
  - ↳ **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.
    - pea sized in brain, but plays a big role
    - body temp
    - hunger
    - thirst
    - sexual arousal (libido)
    - endocrine system

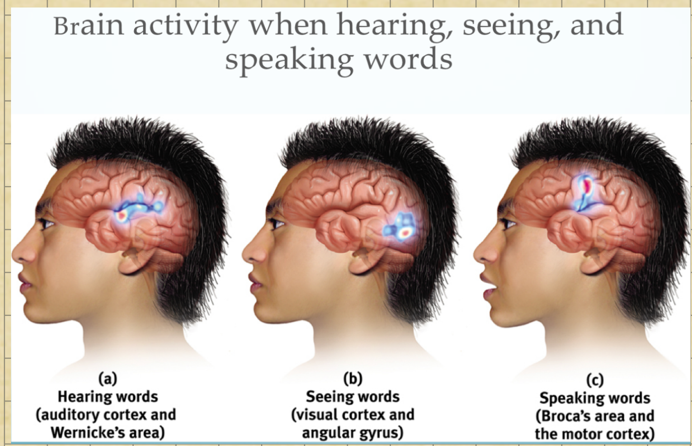


- the **brainstem** is the oldest part of the brain, beginning where the spinal cord swells and enters the skull. It is responsible for the automatic survival functions.
- the **medulla** (muh-dul-uh) is the base of the brainstem that controls heartbeat & breathing
  - ↳ medulla oblongata
    - hind brain
    - heart rate
    - breathing
    - blood pressure
- the **cerebellum or "little brain"** attached to the rear of the brainstem. It helps coordinate voluntary muscle movements and balance, like tracking a moving object

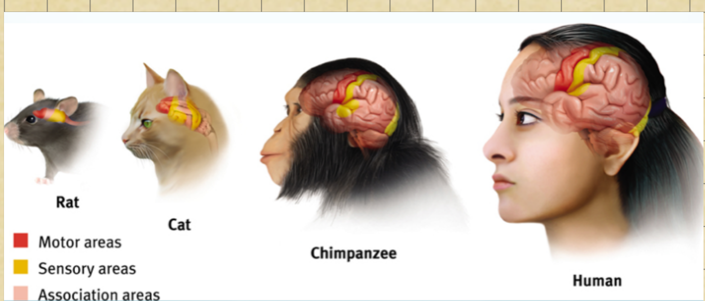
- the cerebral cortex
  - divided into 8 lobes, 4 in each hemisphere (frontal, parietal, occipital, and temporal)
  - any area not associated w/ our senses or muscle movements = **association areas**
  - top layer of our brain
  - contains wrinkles called fissures
    - ↳ increase surface area of our brain
  - * the intricate fabric of interconnected neural cells that covers the cerebral hemispheres. It is the body's ultimate control & information processing center.
  - frontal lobe:
    - deals w/ planning, maintaining emotional control and abstract thought
    - contains Broca's Area, Broca's Aphasia, and the motor cortex
      - aphasia is an impairment of language, usually caused by left hemisphere damage to Broca's Area (impaired speaking) or to Wernicke's Area (impaired understanding)



- specialization & integration

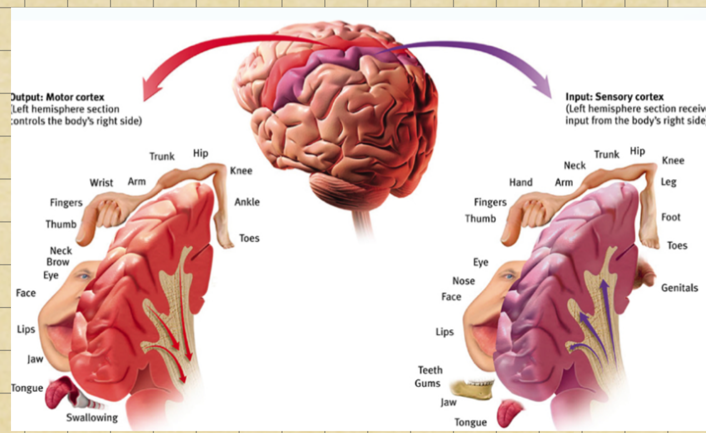


- occipital lobes
  - in the back of our head
  - handles visual input from eyes
  - right half of each retina goes to left occipital lobe and vice versa
- temporal lobes
  - process sound sensed by ears
  - not lateralized
  - contains Wernicke's area and aphasia
- association areas
  - more intelligent animals have increased "uncommitted" or association areas of the cortex



- right-left differences in the intact brain
  - people w/ intact brains also show left-right hemispheric differences in mental abilities
  - many 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.
- splitting the brain
  - a procedure in which the 2 hemispheres of the brain are isolated by cutting the connecting fibers (mainly those of the corpus callosum) between them.
  - when the corpus callosum is severed, objects presented in the right visual field can be named; objects in the left visual field cannot.

- parietal lobes
  - located at the top of our head
  - contains the somato-sensory cortex
  - rest are association areas
- functions of the cortex
  - the motor cortex is the area at the rear of the frontal lobes
  - the sensory cortex (parietal cortex) receives info from skin surface + sense organs

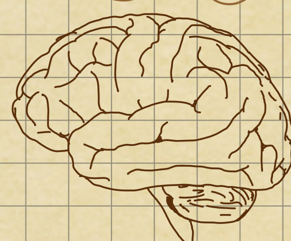


- our divided brain
  - our brain is divided into 2 hemispheres

left hemisphere

- better at creative and spatial sparks
- processes reading, writing, speaking, math, and comprehension skills. In the 1960s, it was termed as the dominant brain

right hemisphere



- better at logic