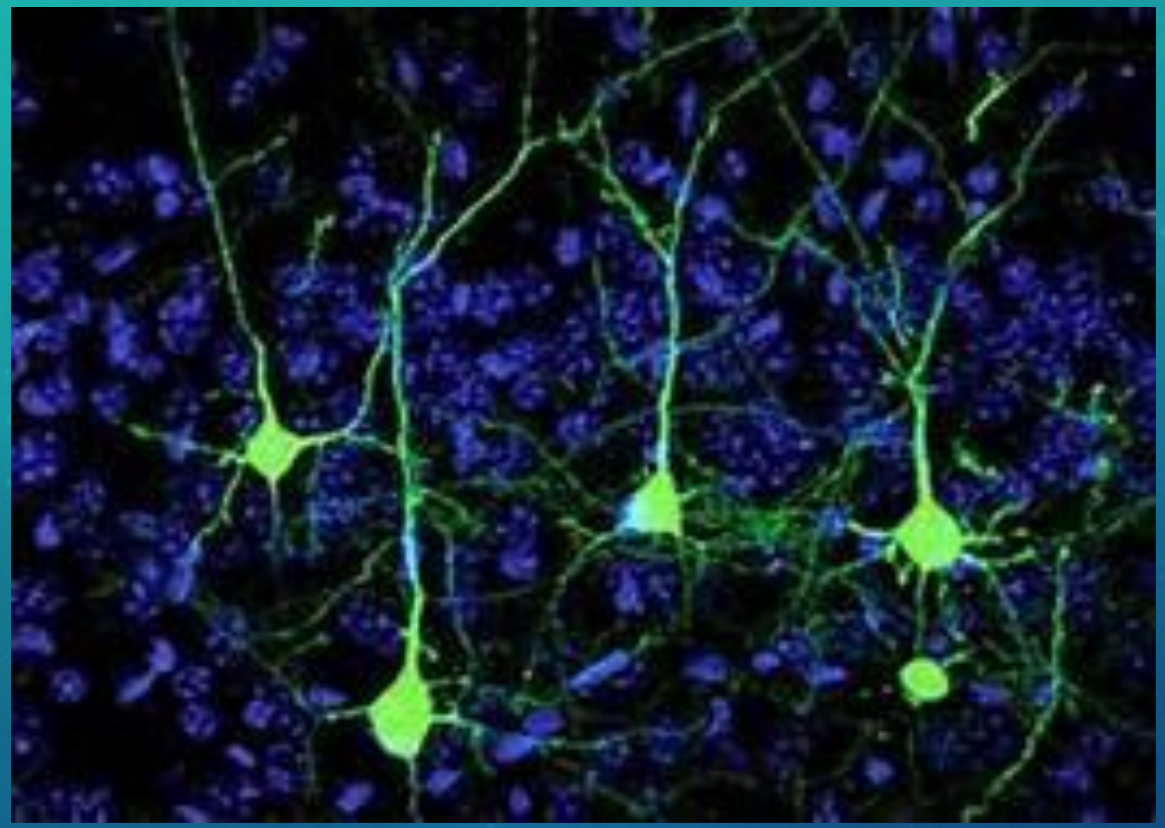
BIO-PSYCHOLOGY

NEURONS AND THE BRAIN



NEURONS

PART I

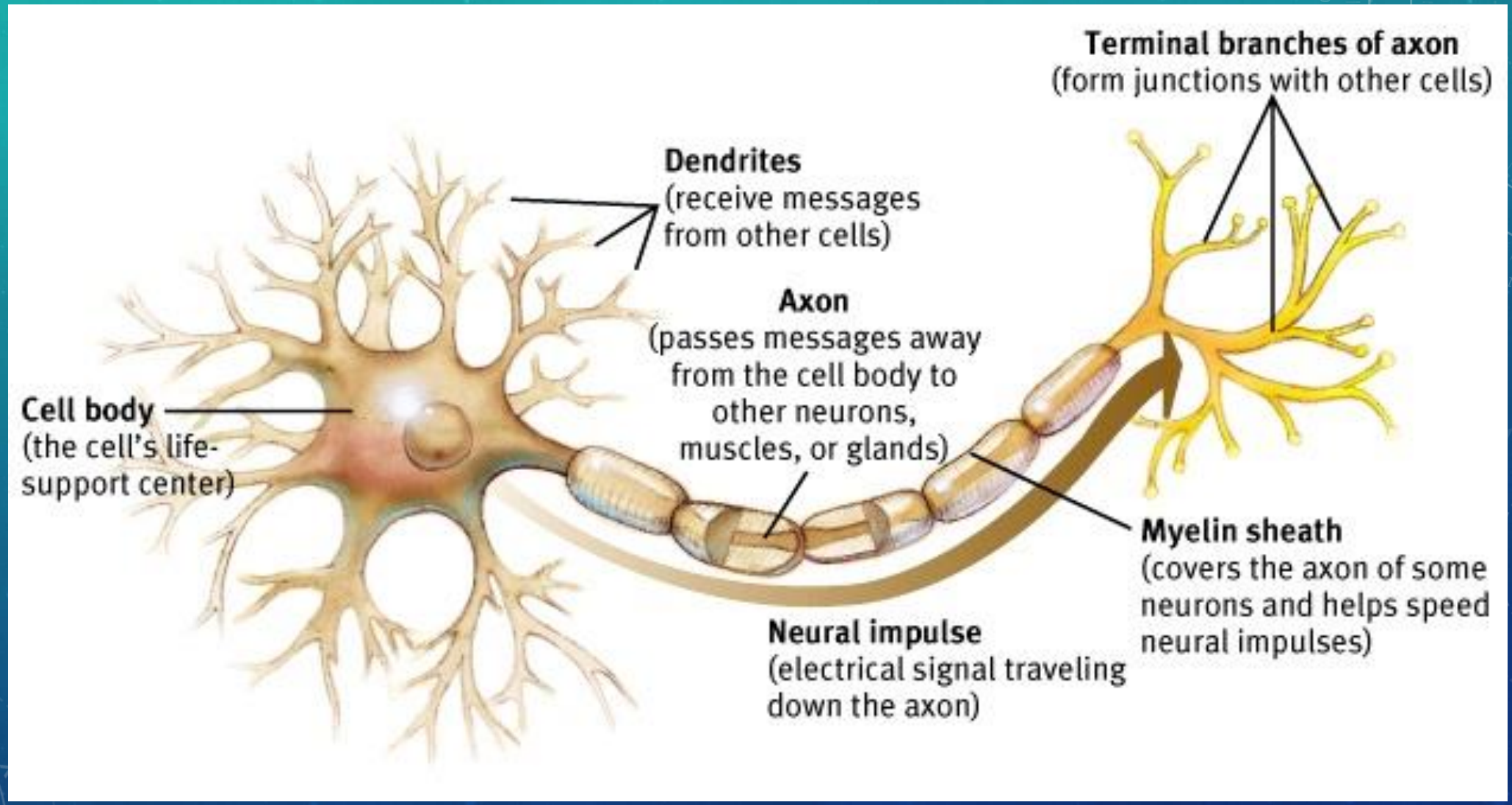
NEURON

- A nerve cell
  - » Sends information signals
  - » Building block of the brain and nervous system
  - » 100 billion neurons in the human brain and CNS! (and 400 trillion synapses!)
  - » A grain of sand-size part of the human brain holds 100,000 neurons!

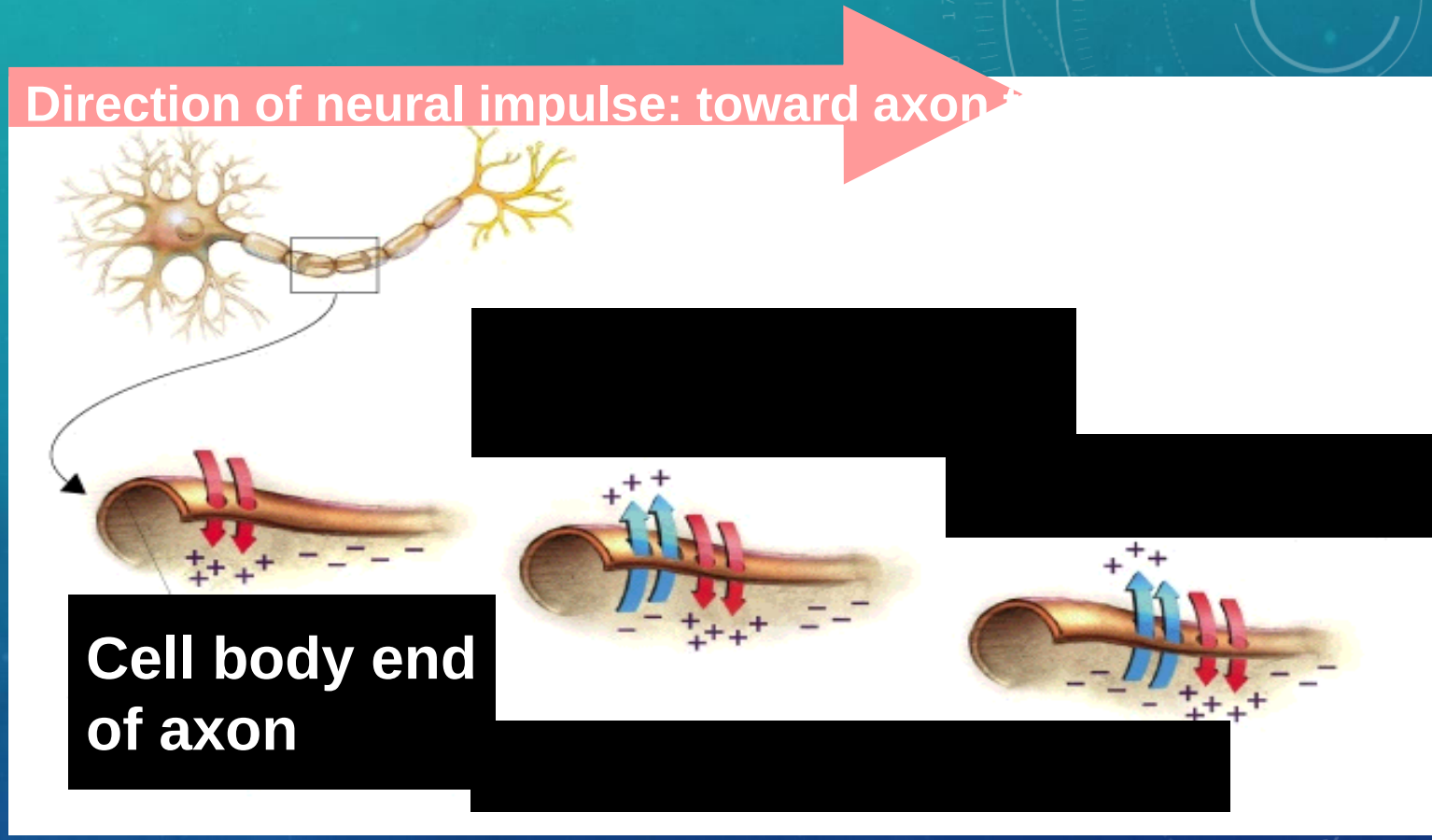
STRUCTURE

- Dendrite (receives impulse)
  - Branching extensions of a neuron
  - Receive messages which it sends to the cell body
- Axon (transmits impulse)
  - Ends in branches
  - Remember: “Axons speak, dendrites listen…”
- Myelin Sheath (speeds impulse)
  - A layer of fatty cells, which surround the fibers of neurons
  - Speeds up the signal
  - When it wears out we see
    - Alzheimer's (impedes transmissions affecting thought process)
    - Multiple sclerosis: interferes with muscle control (as message to muscles is impeded..)

NEURON


Terminal branches of axon
(form junctions with other cells)
Dendrites
(receive messages
from other cells)
Axon
(passes messages away
from the cell body to
other neurons,
muscles, or glands)
Cell body
(the cell's life-
support center)
Myelin sheath
(covers the axon of some
neurons and helps speed
neural impulses)
Neural impulse
(electrical signal traveling
down the axon)

- Action Potential: how signals are sent
  - Neural impulse=a brief electrical charge that travels down an axon
  - Impulse starts when neuron receives signals from the senses
  - Action potential works like electricity: movement of positive and negative charges through the axon



COMMUNICATION

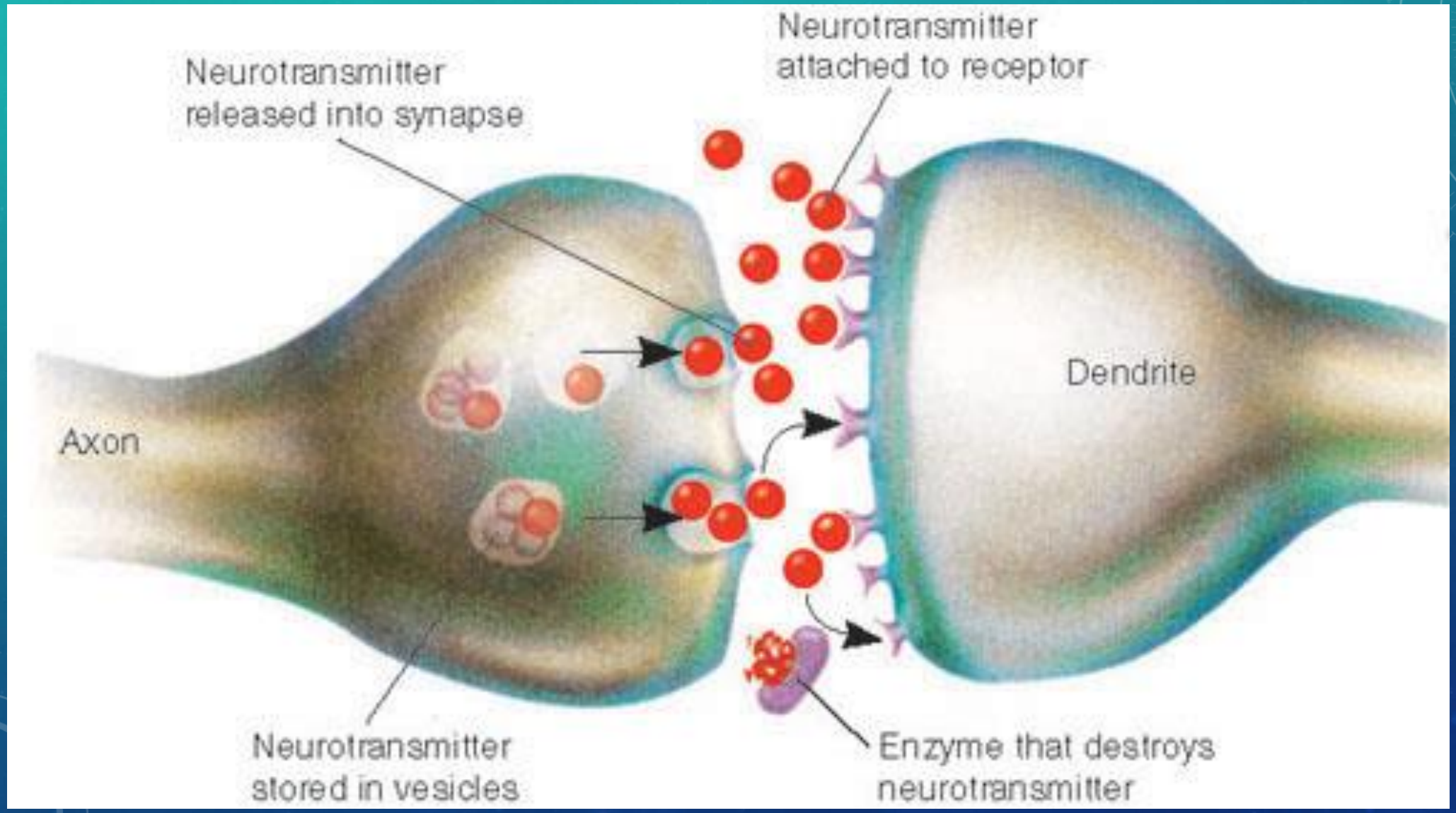
ELECTROCHEMISTRY

- Neurons generate electricity from chemical events (like batteries)
- The chemistry to electricity process involves the exchange of ions
  - Ions=electrically charged atoms

NEURAL COMMUNICATION

- Synapse (Where the action is)
  - Gap between the axon branches of the sending neuron and the dendrite or cell body of the receiving neuron
  - Tiny gap between these structures is called the synaptic gap (less than a millionth of an inch!)
- Neurotransmitters
  - Chemical messengers that cross the synapse
  - Neurotransmitters bind to receptor sites (“lock and key”) on the receiving neuron
    - They tell the next neuron whether or not to keep sending the message
- Reuptake
  - Excess neurotransmitters are reabsorbed by the sending neuron

NEURAL COMMUNICATION



PART II

NEUROTRANSMITTERS AND DRUGS

GABA AND GLUTAMATE

GABA

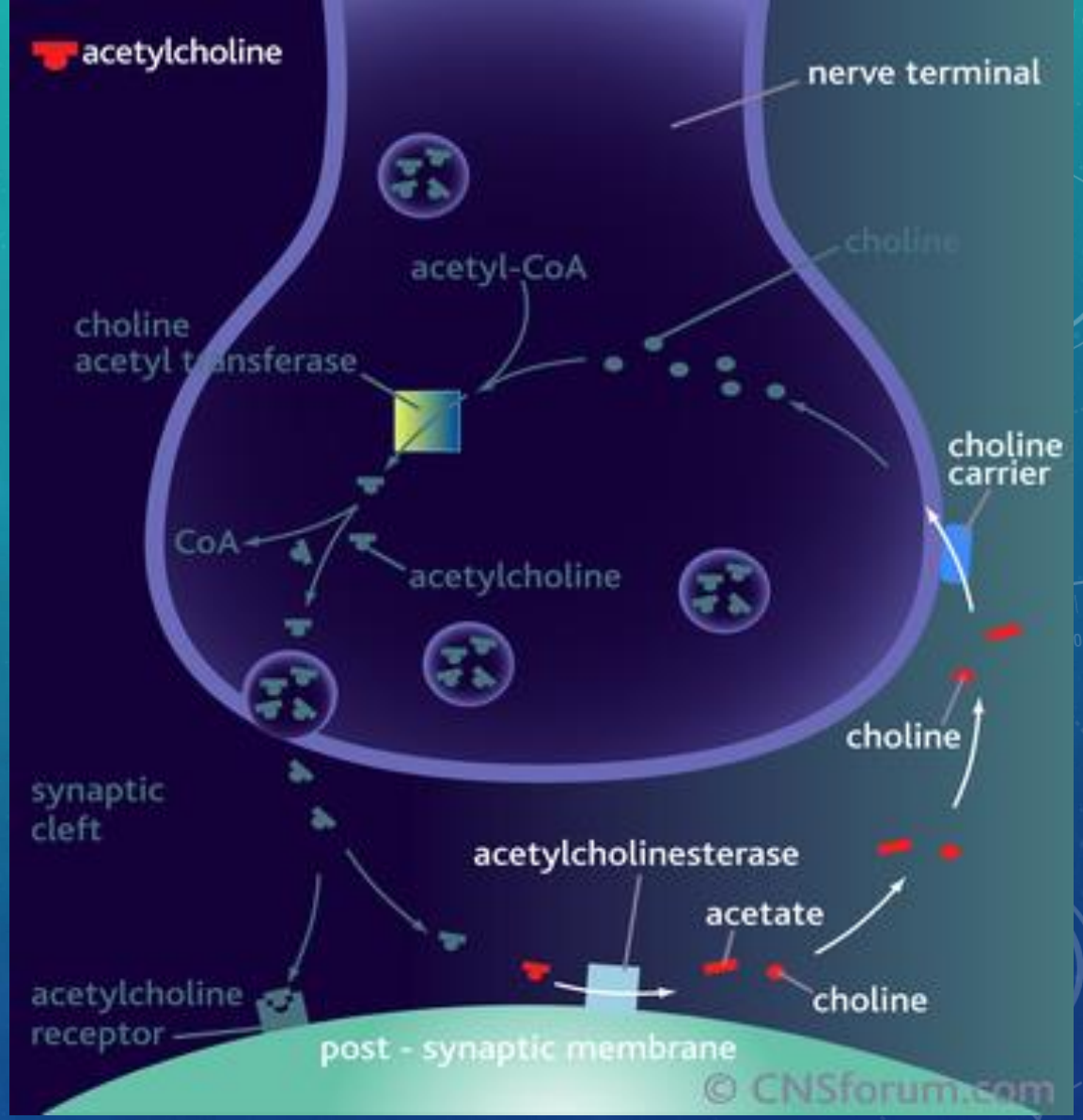
- Inhibitory (slowing) neurotransmitter
- Undersupply = seizures, tremors, insomnia

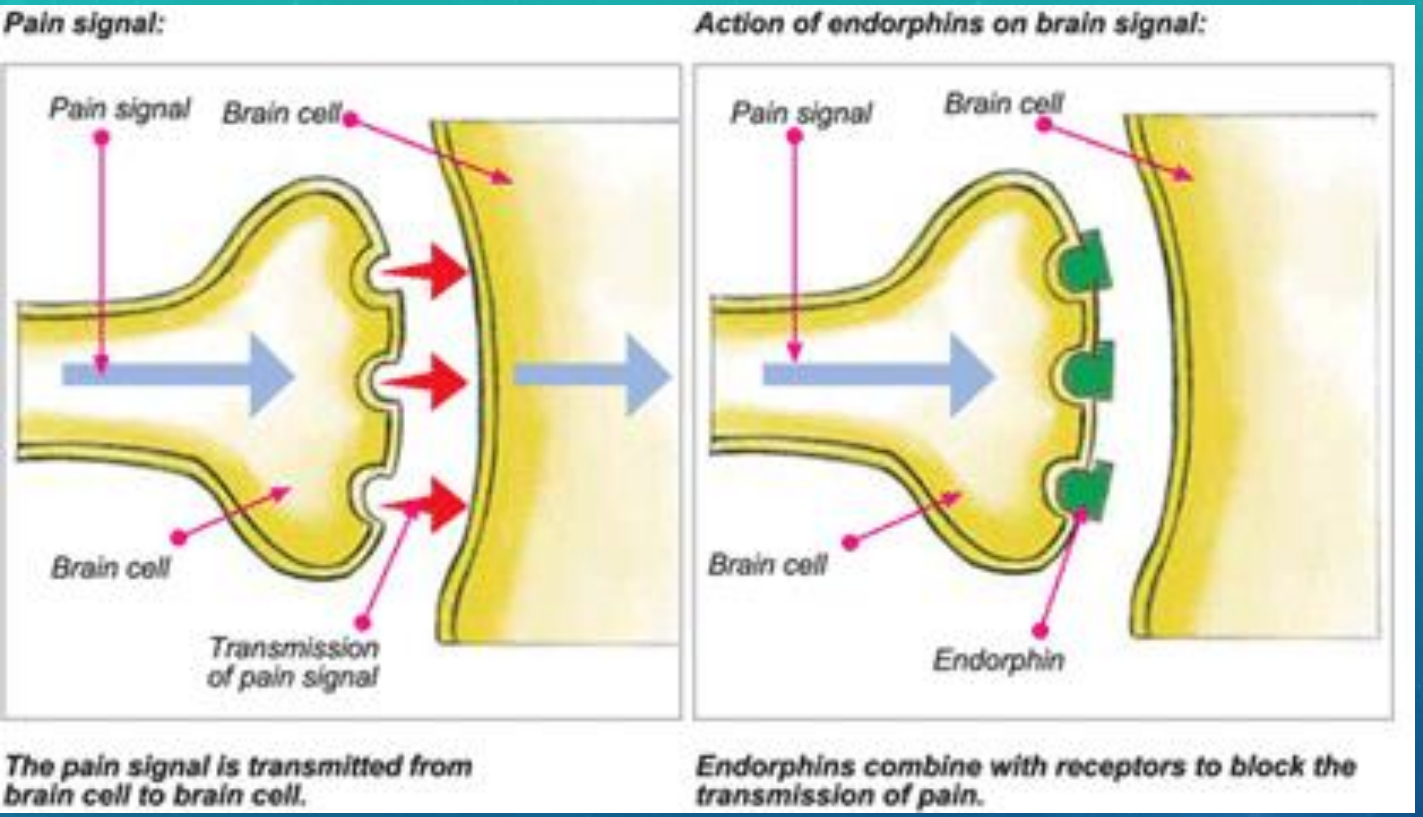
Glutamate

- Excitatory neurotransmitter
- Involved in memory
- Too much = migraines, seizures
- Chinese food has MSG (monosodium glutamate) = headaches

ACETYLCHOLINE

- ACh
- Triggers muscle contraction
  - Movement
  - Learning
  - Memory
- Undersupply = Alzheimer's





» "Endorphins make you happy"

-Legally Blonde

» Natural, opiate-like neurotransmitters

- Body's built in morphine

» Linked to pain control and to pleasure

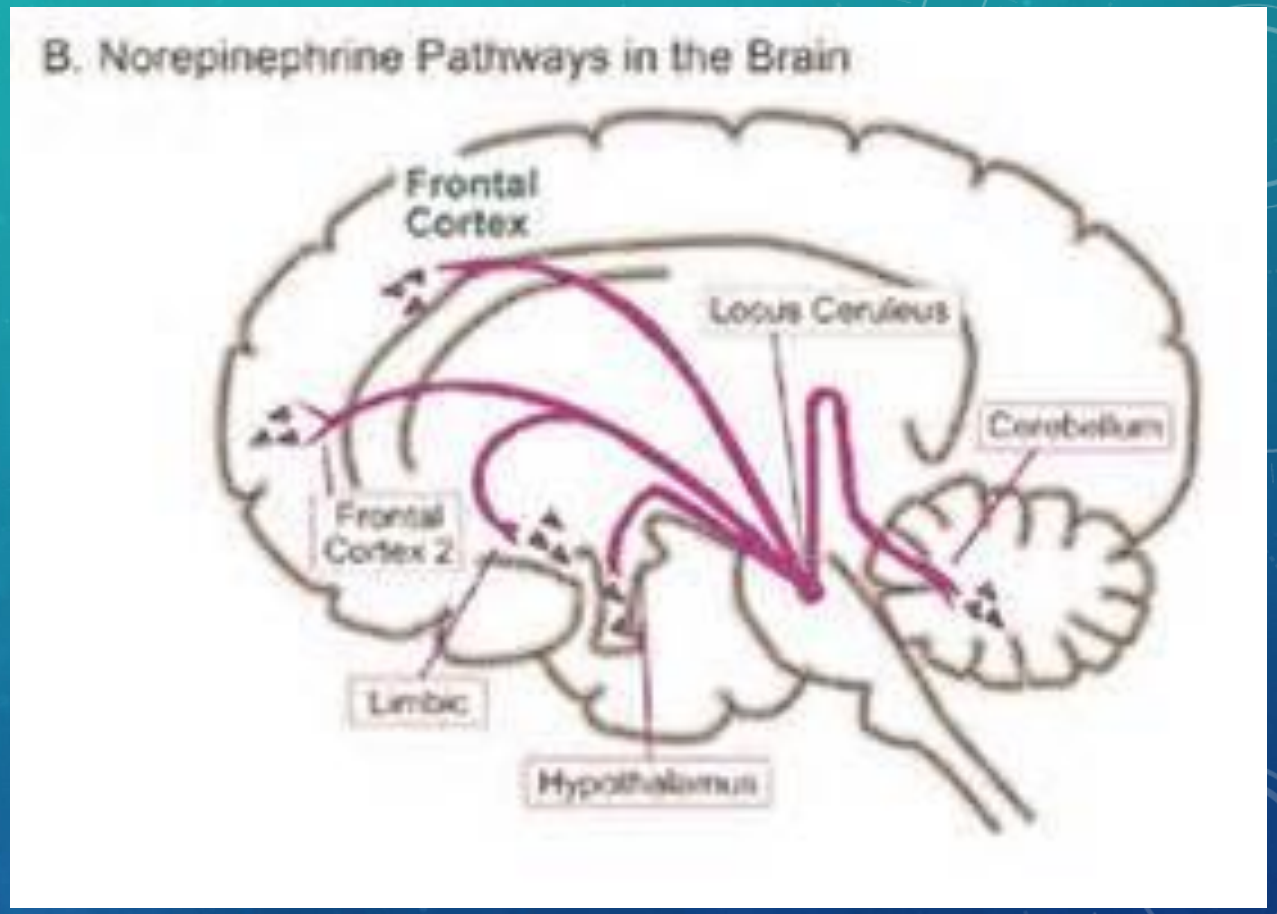
- "Runners high"

» Opium/heroine addicts

- Brain stops producing natural opiates

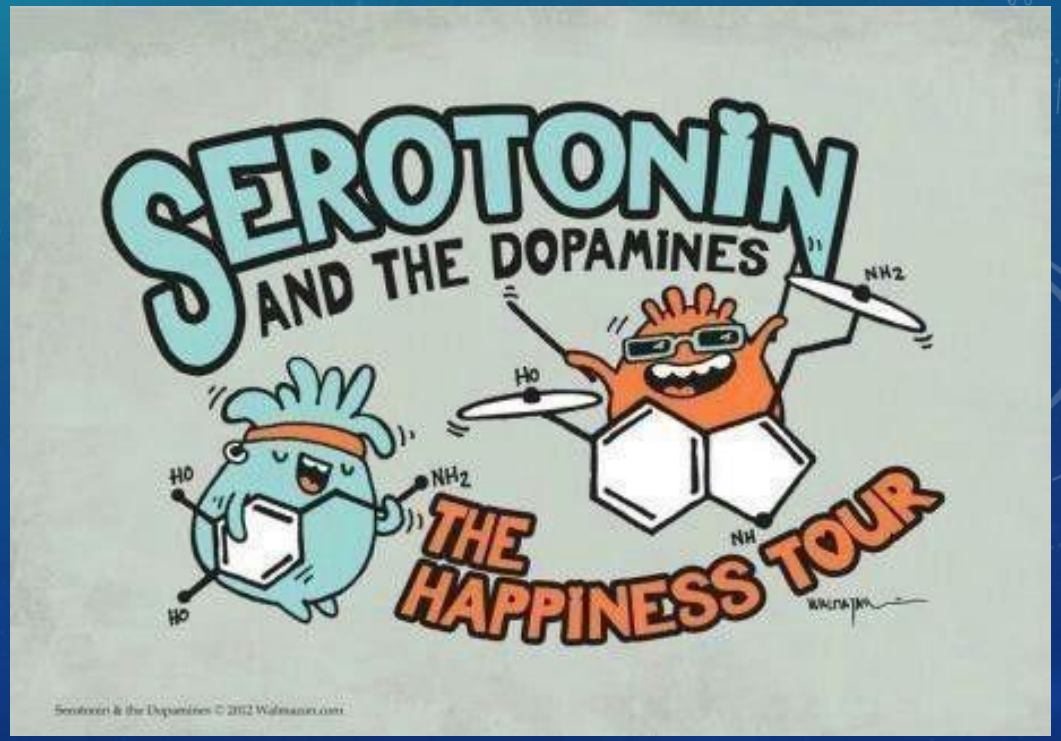
NOREPINEPHRINE

- Regulates Mood
- Too much = mania
- Too little = depression
- Imbalance = bipolar disorder



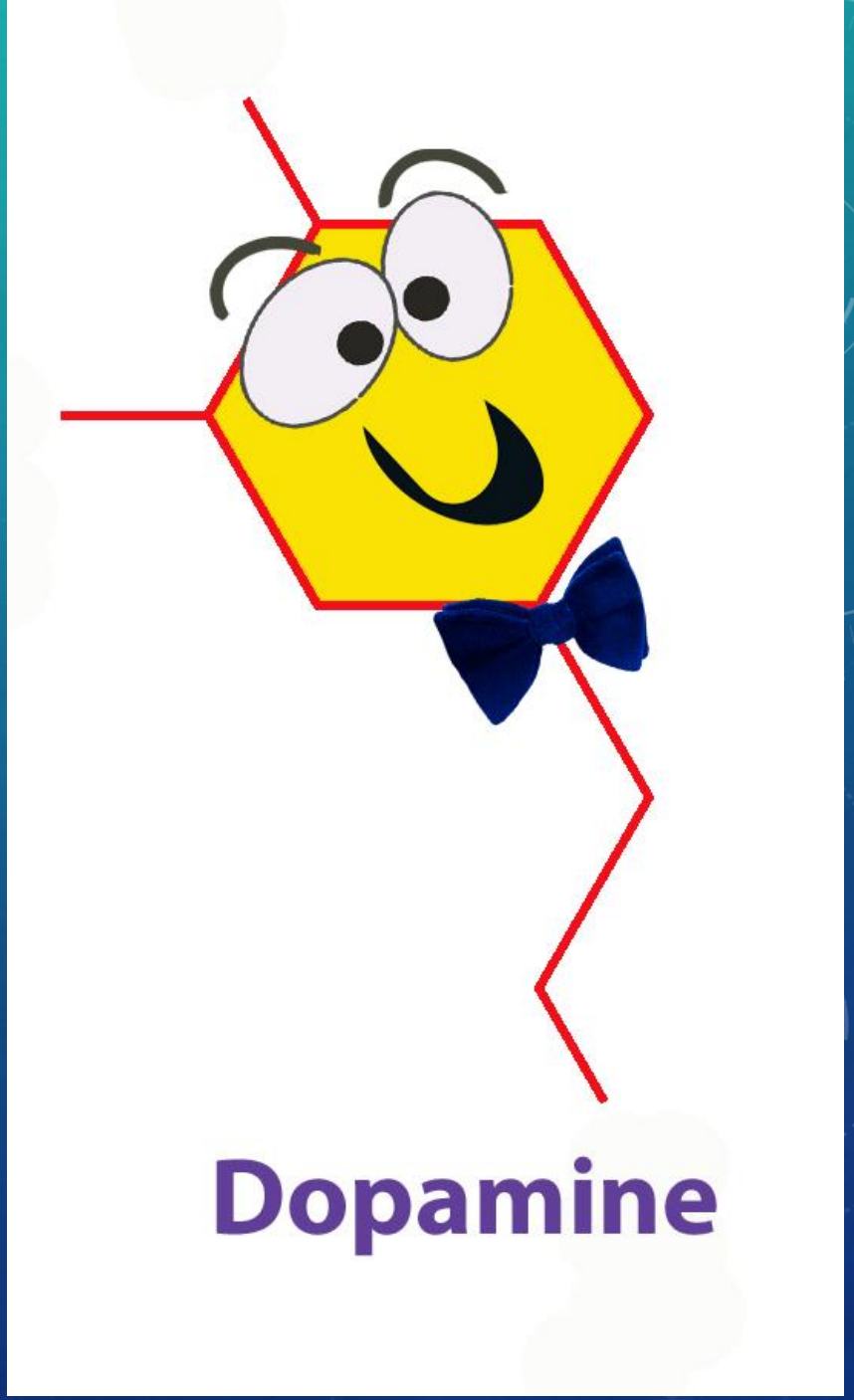
SEROTONIN

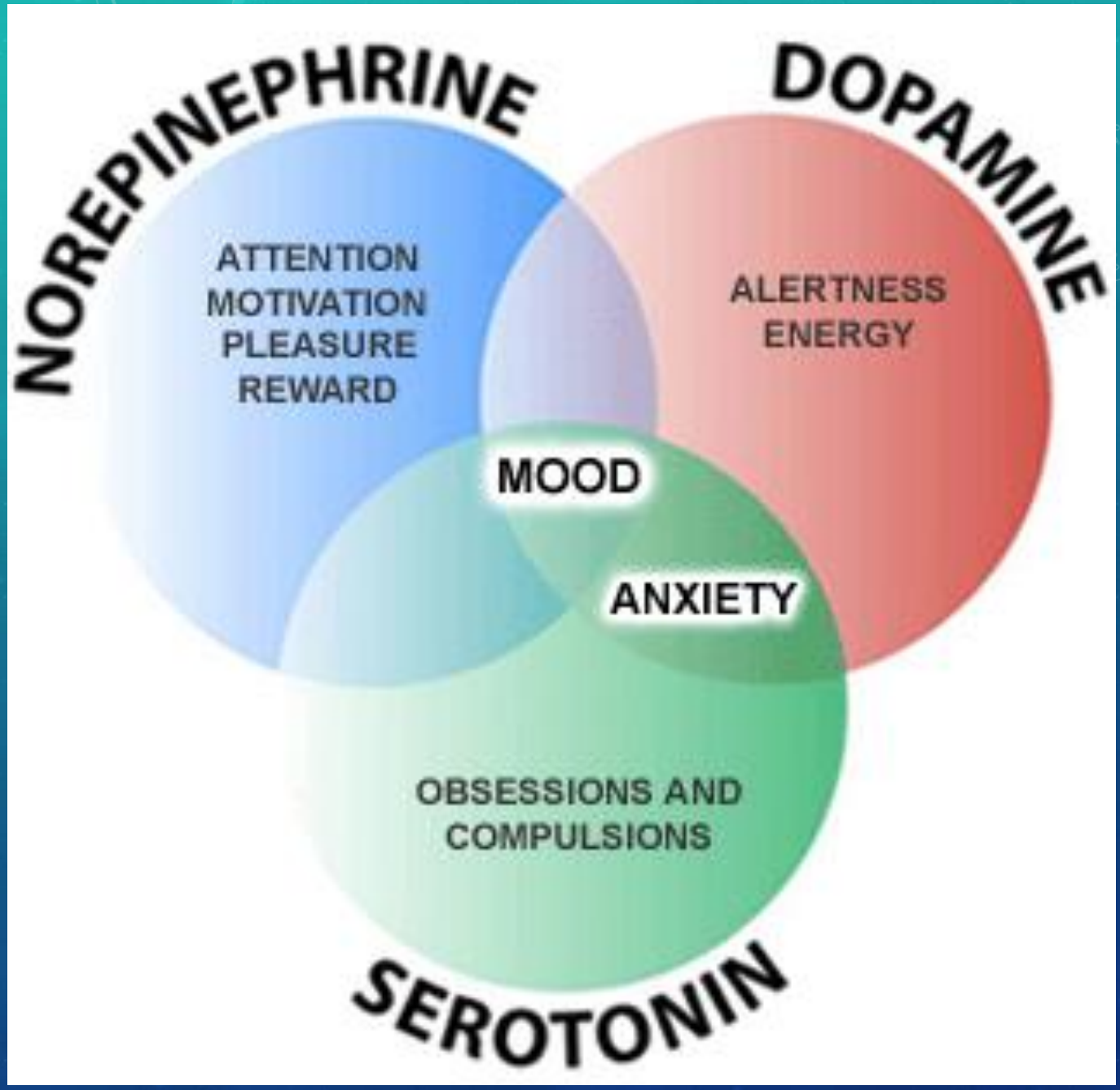
- Sleep, eating, mood
- Related to depression
  - Prozac (anti-depressant drug) raises serotonin levels



DOPAMINE

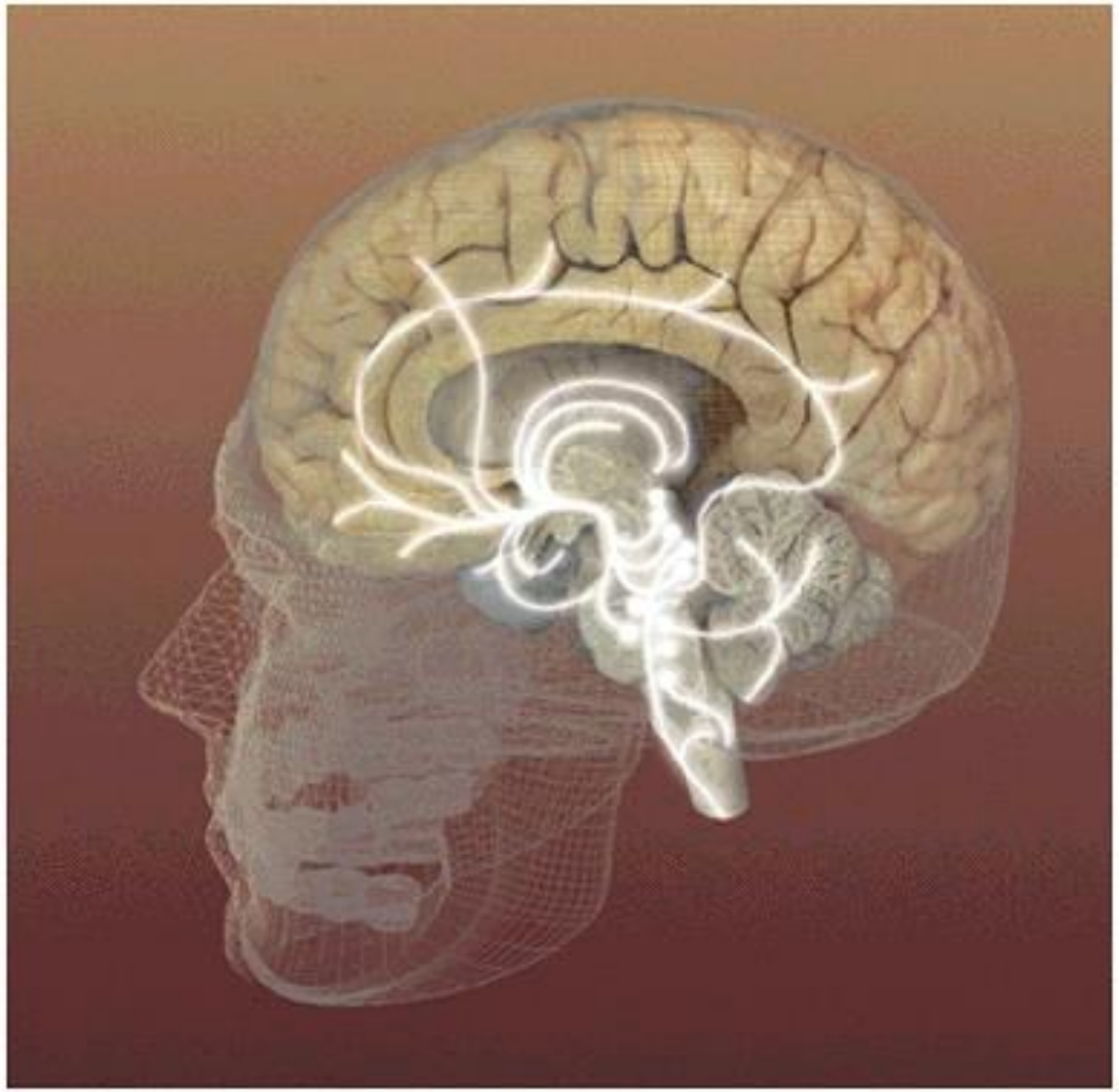
- Perceptual awareness, muscle control
- Connected to addiction
- Too much = Schizophrenia (up to 6x more dopamine)
  - A Beautiful Mind/The Soloist
- Too little = Parkinson's Disease (tremors)
  - Muhammad Ali



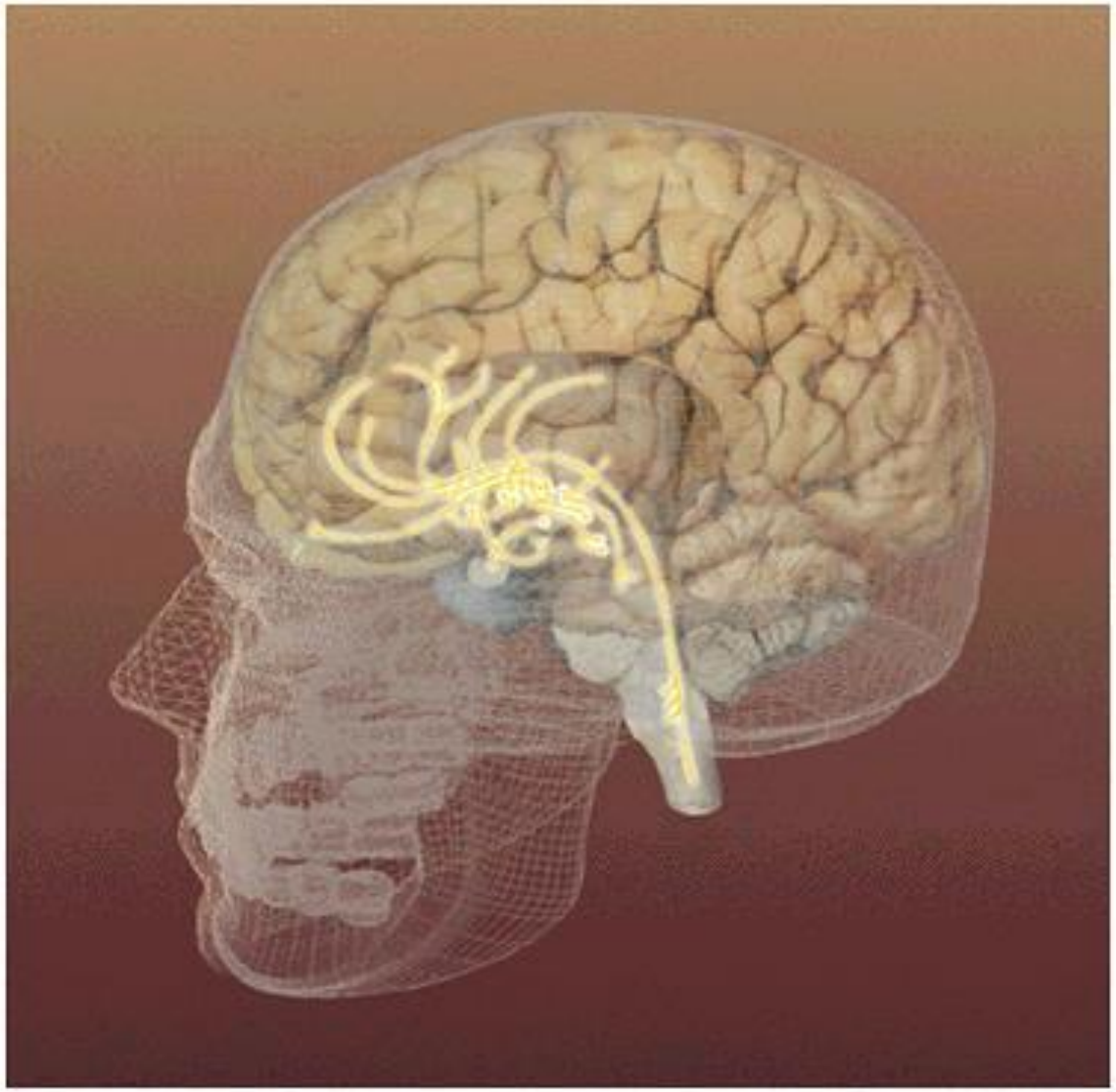

NOREPINEPHRINE
DOPAMINE
ATTENTION
MOTIVATION
PLEASURE
REWARD
ALERTNESS
ENERGY
MOOD
ANXIETY
OBSESSIONS AND
COMPULSIONS
SEROTONIN

DRUGS AFFECT NEUROTRANSMISSION

- Drugs can affect neural communication at the synapse
- **Agonists** excite or mimic the neurotransmitters or block reuptake
  - Drug addicts and withdraw: brain gets used to having more of a certain neurotransmitter
- **Antagonists** block or slow neurotransmitters signal



Serotonin pathways



Dopamine pathways

REMEMBER

- Communication within the neuron is…….
  - Electrical
- Communication between neurons is….
  - Chemical

TABLE 2.1

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)

IMPORTANT NEUROTRANSMITTERS

THE BRAIN-STRUCTURE

PART III

PRE-TEST

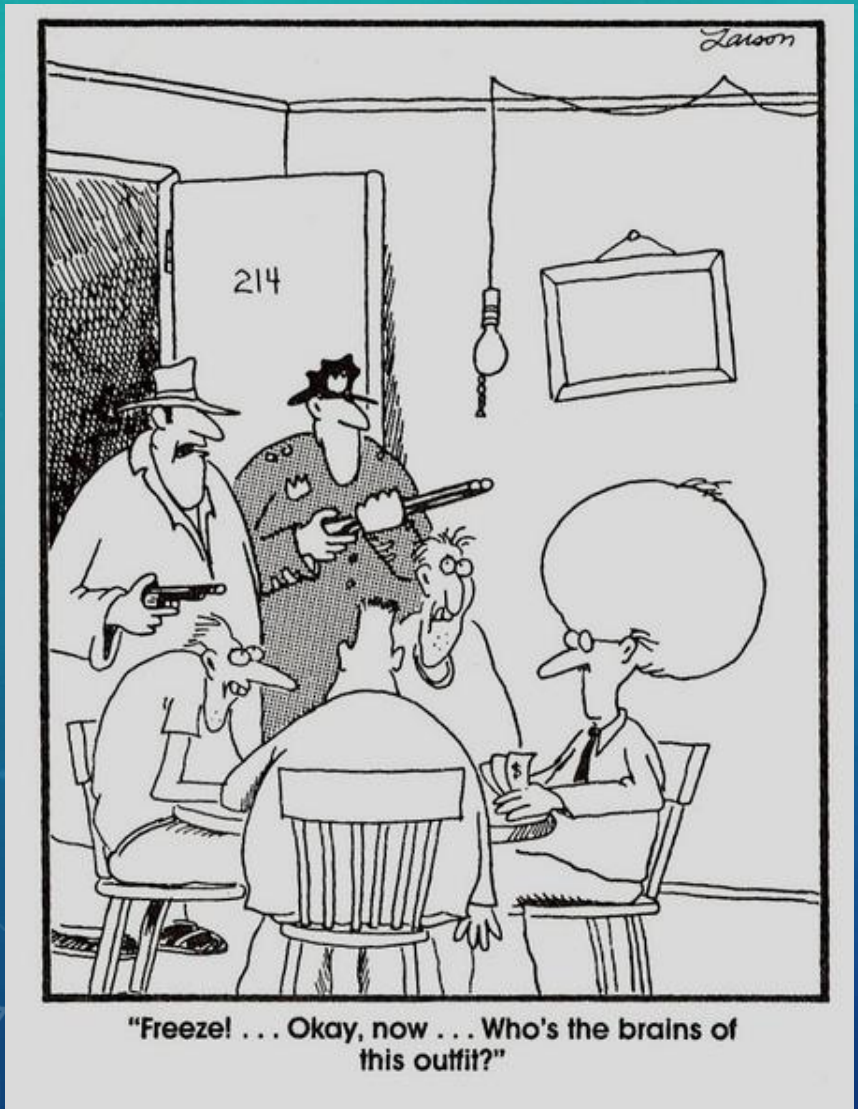
Answer the following as true or false.

1. The larger the brain, the smarter the animal.
2. The brain's structure is a better indicator of intelligence than it's size.
3. The right side of the brain controls the right side of the body, and so on with the left.
4. You fall in love with your heart, not your brain.
5. Your brain uses 20% of your body's energy, but makes up only 2% of your body's weight.

PRE-TEST

6. Your brain is about the size of a cantaloupe and is wrinkled like a walnut.
7. Your brain feels like a ripe avocado and looks pink because of the blood running through it.
8. The baby's brain grows 3x in size during its first year.
9. At birth, the human brain weighs 4/5 of a pound, while an adult's weighs about 3 pounds.
10. Your brain generates about 25 watts of power while awake- or enough to illuminate a light bulb.

A TYPICAL HUMAN BRAIN



- Contains about 100 billion neurons
- Consumes about ¼ of your body's oxygen
- Uses most of your bodies calories
- Is 70% water
- Weighs about 3 pounds

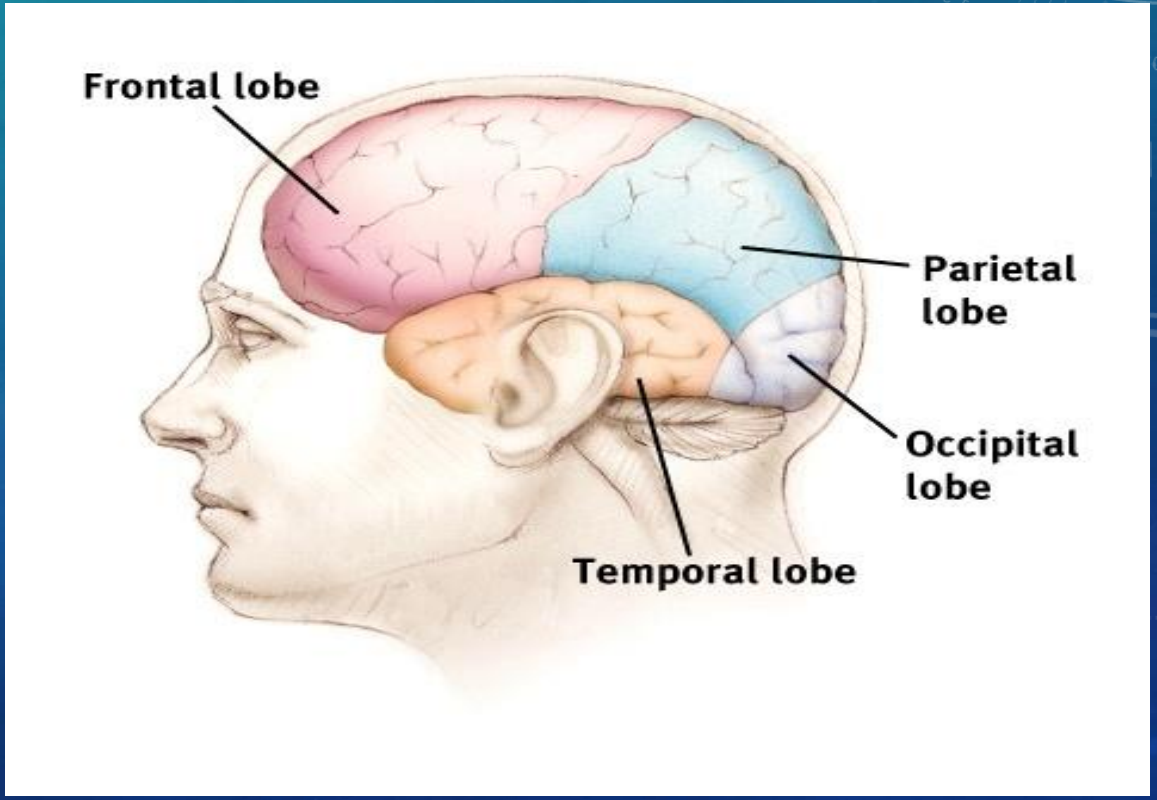
SECTIONS OF THE BRAIN

- There are many ways to organize the brain
  - Lobes of the brain
    - Four Lobes: occipital, temporal, parietal, occipital, frontal
  - Functions
    - Advanced'
      - Limbic System
      - Cerebral Cortex
      - Prefrontal Cortex
    - Basic
      - Brainstem
      - Thalamus

LOBES OF THE BRAIN

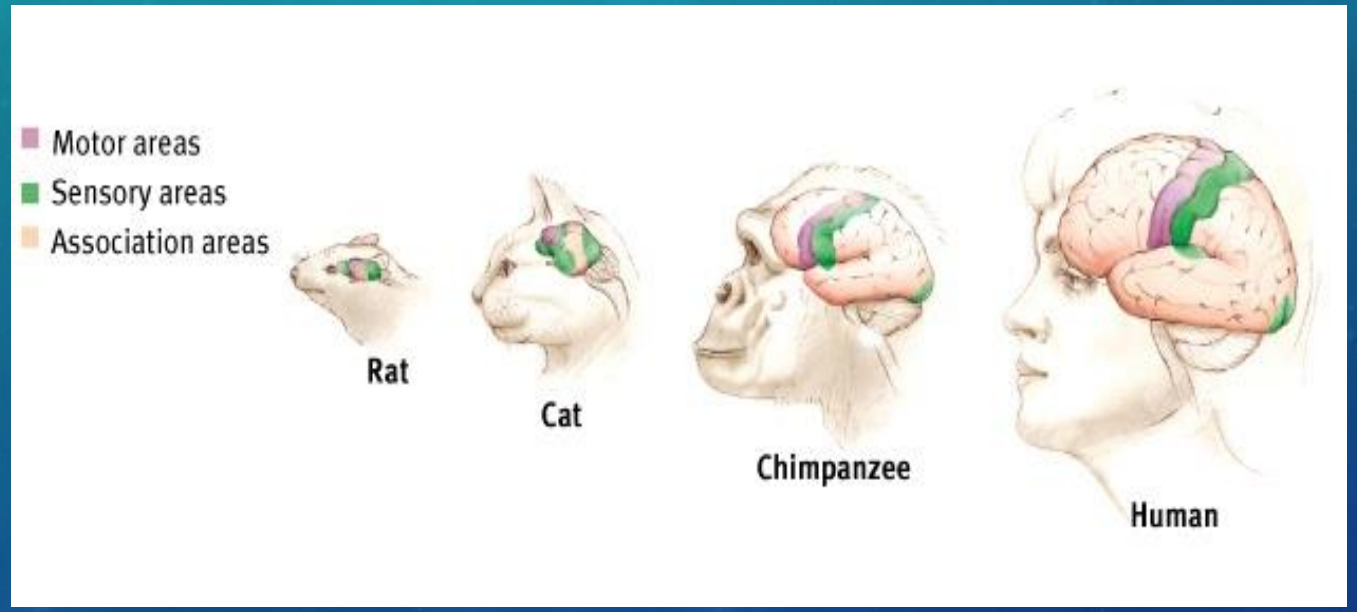
- Cerebral Cortex (processing part of your brain) is divided into four lobes

1. Frontal Lobe
2. Occipital Lobe
3. Parietal Lobe
4. Temporal Lobe

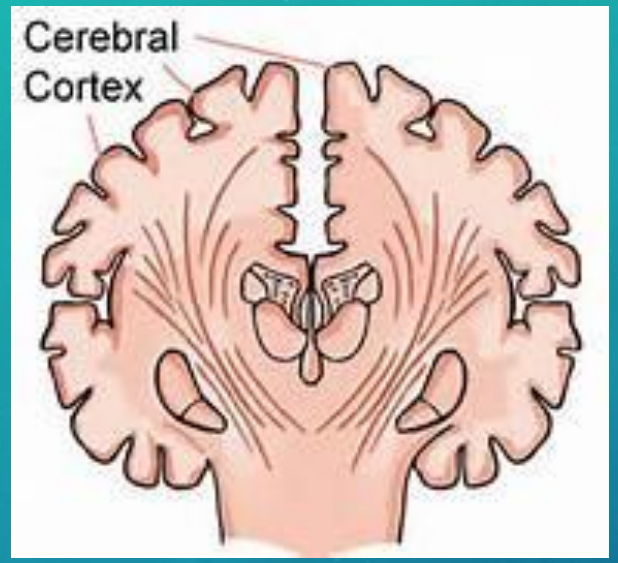


ASSOCIATION AREA

- Remaining sections of the cortex
- Function: pair new info with memories
- This is divided into your lobes



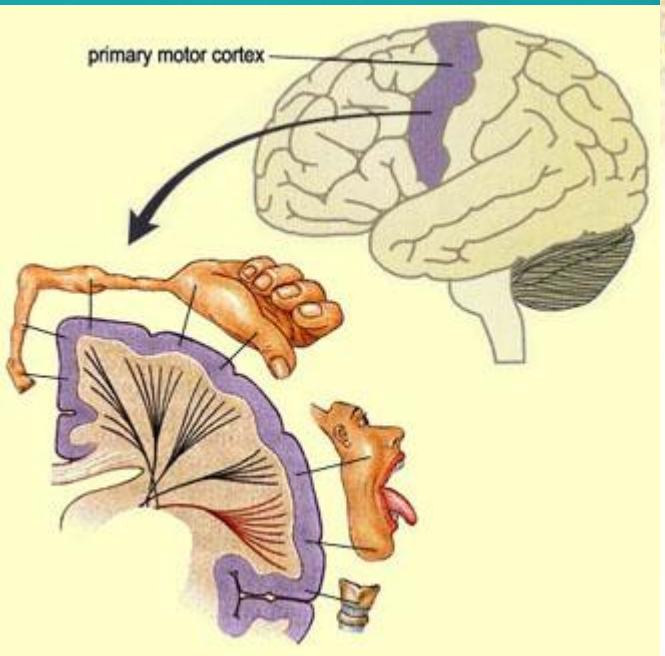
CEREBRAL CORTEX

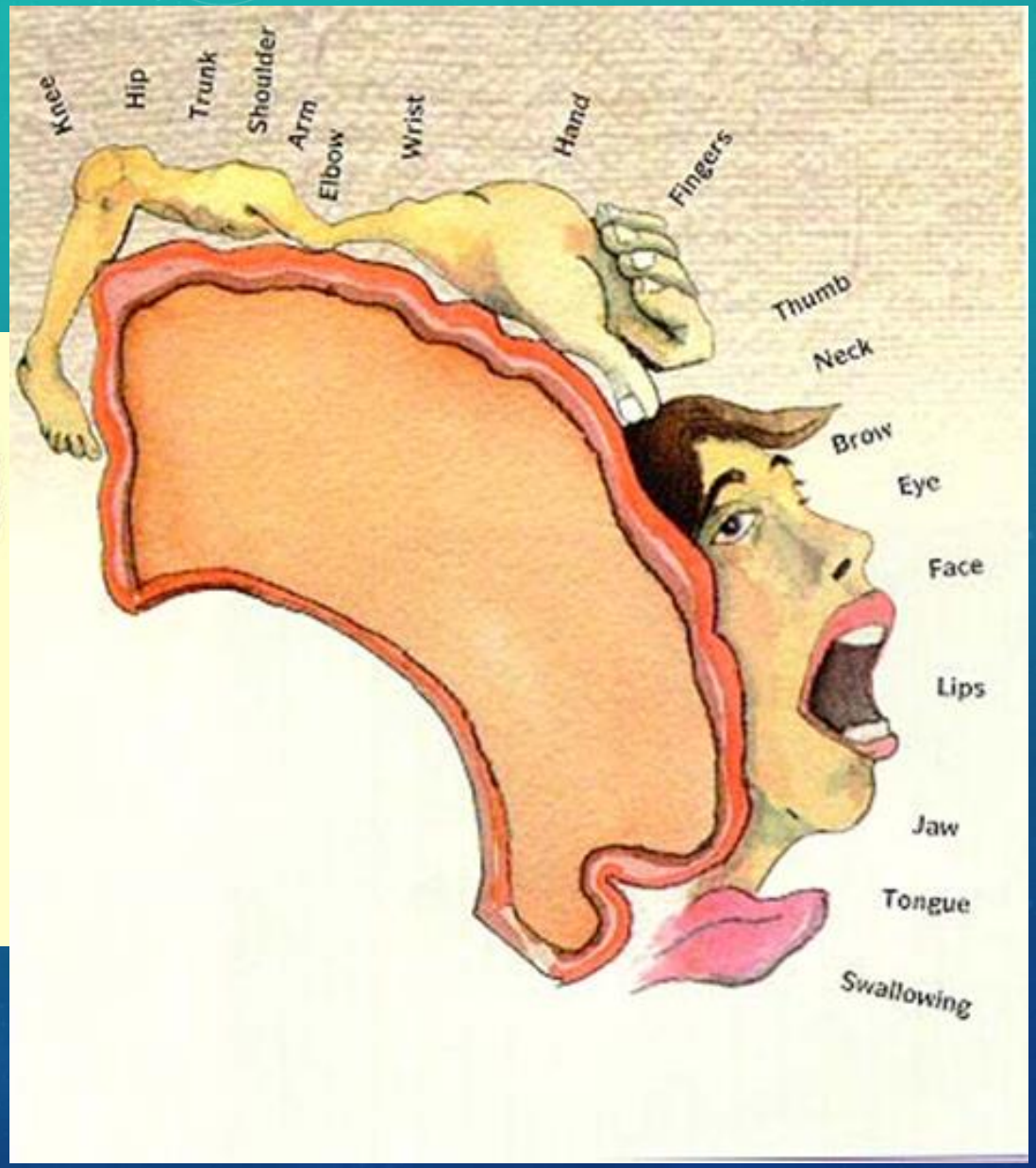


- Enables perception, thought, and speech
- Cerebral cortex is to cerebral hemispheres as bark is to a tree
- Structure: wrinkled, 80% of brain weight, 20-23 billion nerve cells in the cortex!

LOBE FUNCTIONS

- Parietal Lobe - Receiving and processing information from the senses mathematical and spatial reasoning, facial recognition
  - Home to the sensory cortex
- Frontal Lobe - Decision-making, problem solving, and planning; judge, plan, process new memories, inhibition, personality
  - Home to the motor cortex
- Occipital Lobe - Vision.
- Temporal Lobe - Memory, emotion, hearing, and language.



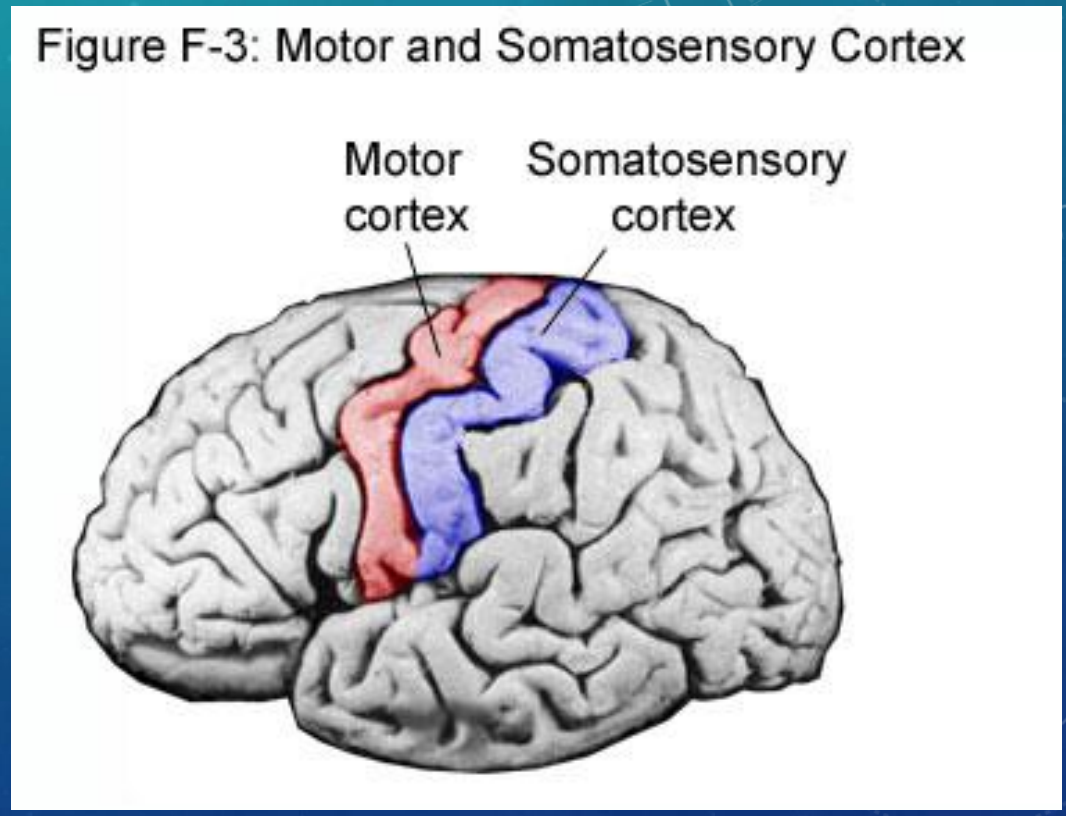


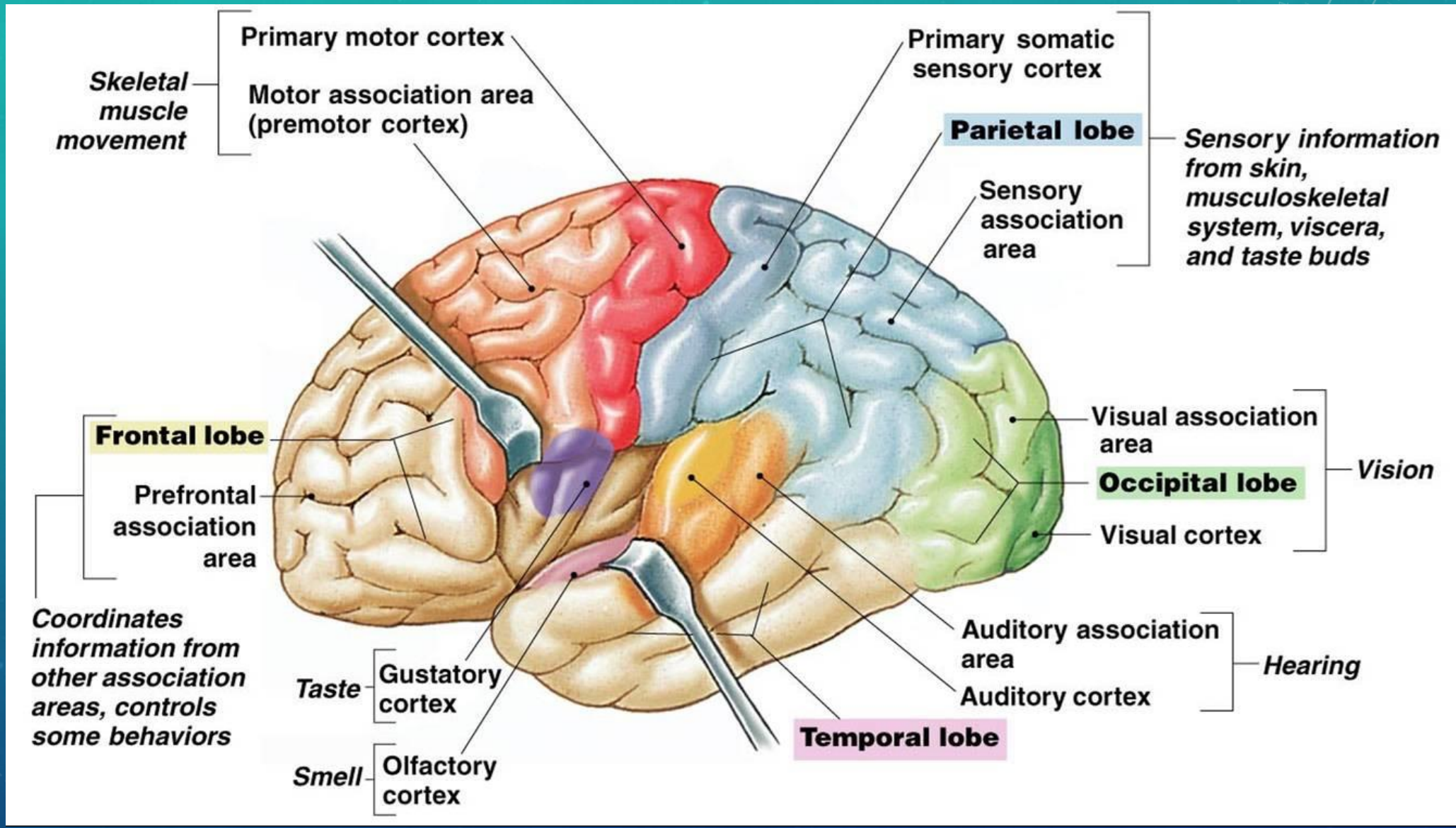
- Arc shaped area in the back of the frontal lobe
- Runs from ear to ear
- Stimulating the left brain moves right side of the body and vice versa

MOTOR CORTEX

SENSORY CORTEX

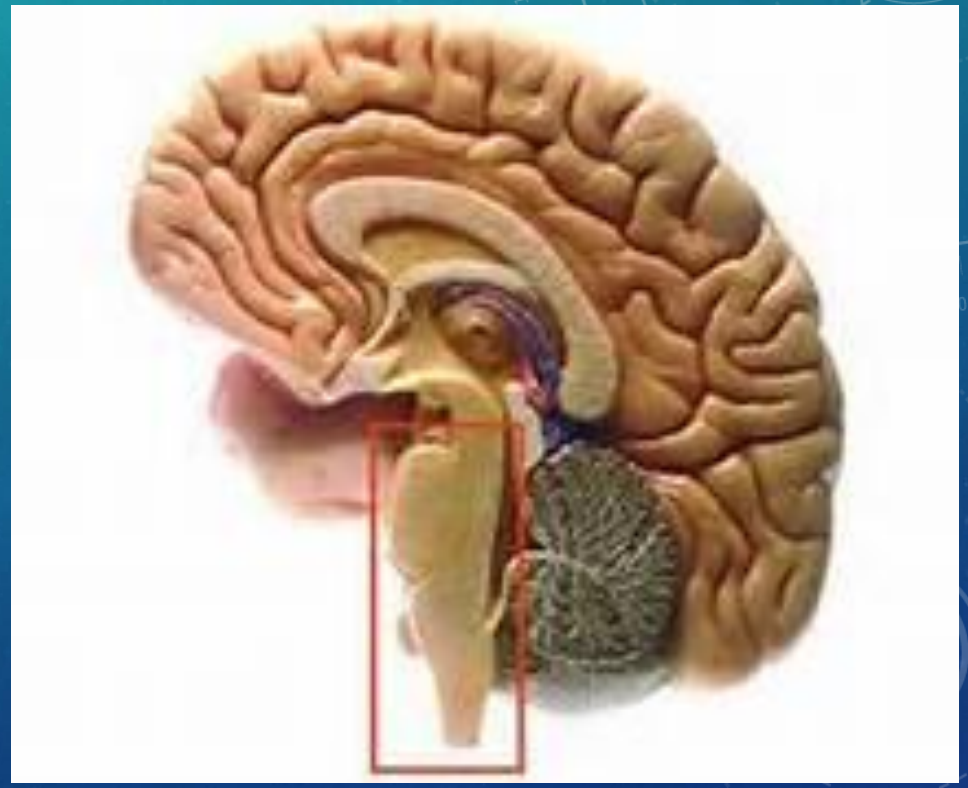
- Looks just like the motor cortex, but farther back
- Body areas that are more sensitive=larger brain area
- Two other spots for sensation
  - Occipital Lobe: back of brain, receive visual information
  - Auditory Cortex in the Temporal Lobe: thumb shaped and above the ear, receive auditory information.




Primary motor cortex
Skeletal muscle movement
Motor association area (premotor cortex)
Primary somatic sensory cortex
Parietal lobe
Sensory association area
Sensory information from skin, musculoskeletal system, viscera, and taste buds
Frontal lobe
Prefrontal association area
Coordinates information from other association areas, controls some behaviors
Visual association area
Occipital lobe
Visual cortex
Vision
Taste
Gustatory cortex
Smell
Olfactory cortex
Auditory association area
Auditory cortex
Hearing
Temporal lobe

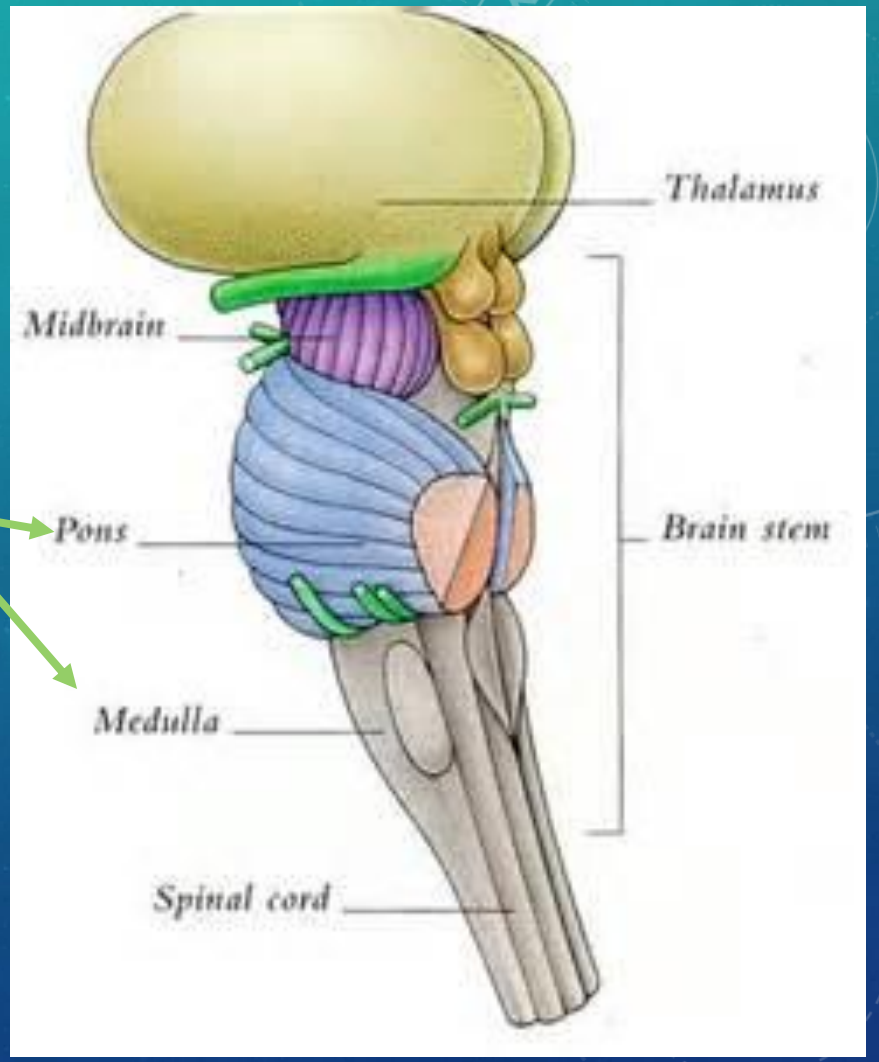
BRAINSTEM

- Oldest section of the human brain
- Central core of the brain
- Begins where the spinal cord swells as it enters the skull
- Responsible for automatic survival functions



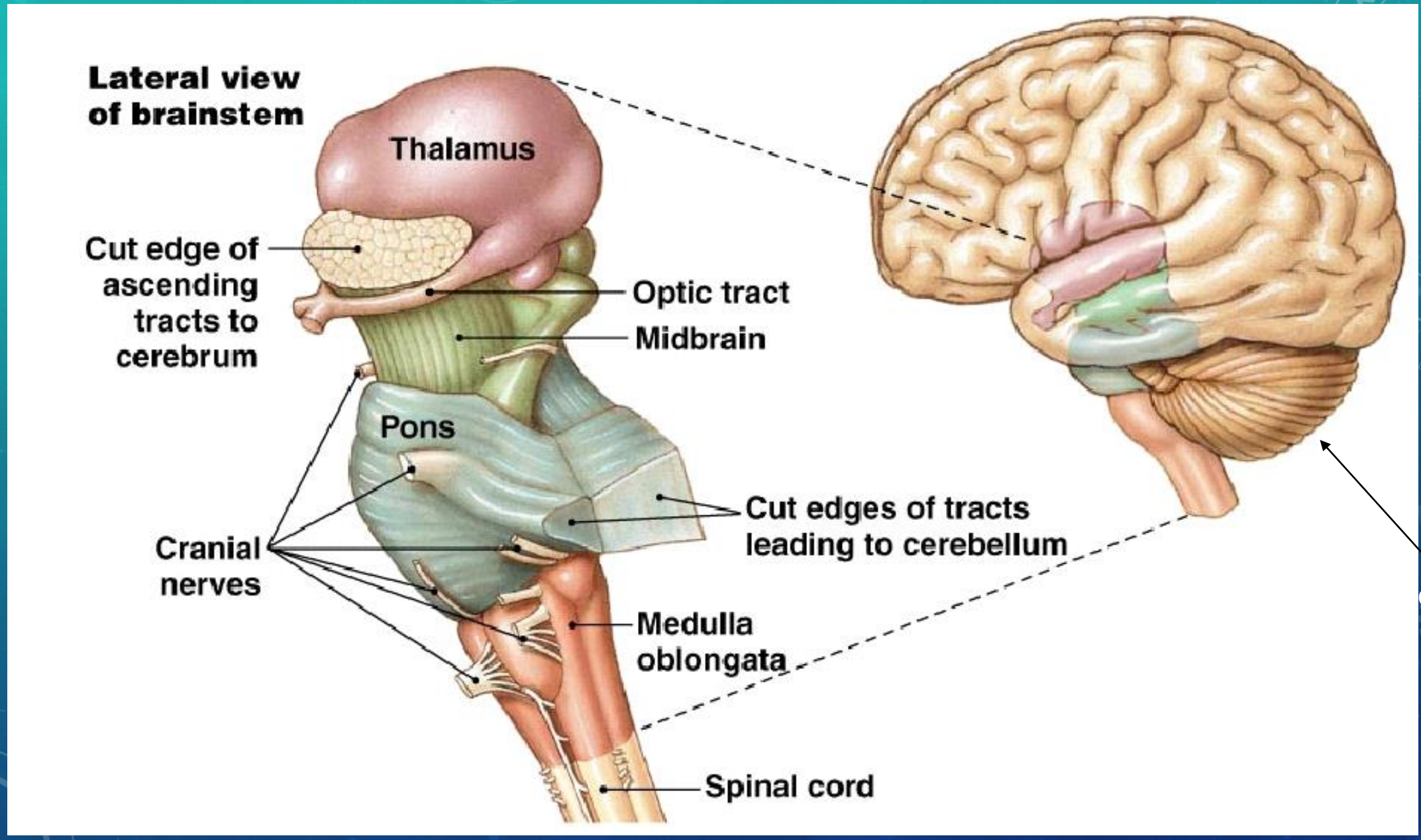
THE BRAIN STEM

- Medulla: first piece of the brainstem
  - Location: base of the brain above the spinal cord
  - Controls heartbeat and breathing
- Pons
  - Above the medulla
  - Helps coordinate movement and facial expression
  - Connects midbrain to hindbrain
- Reticular Formation
  - Structure: Finger shaped network of neurons
  - Location: From the spinal cord to the thalamus
  - Filters info from the spinal cord, essential for arousal and sleep



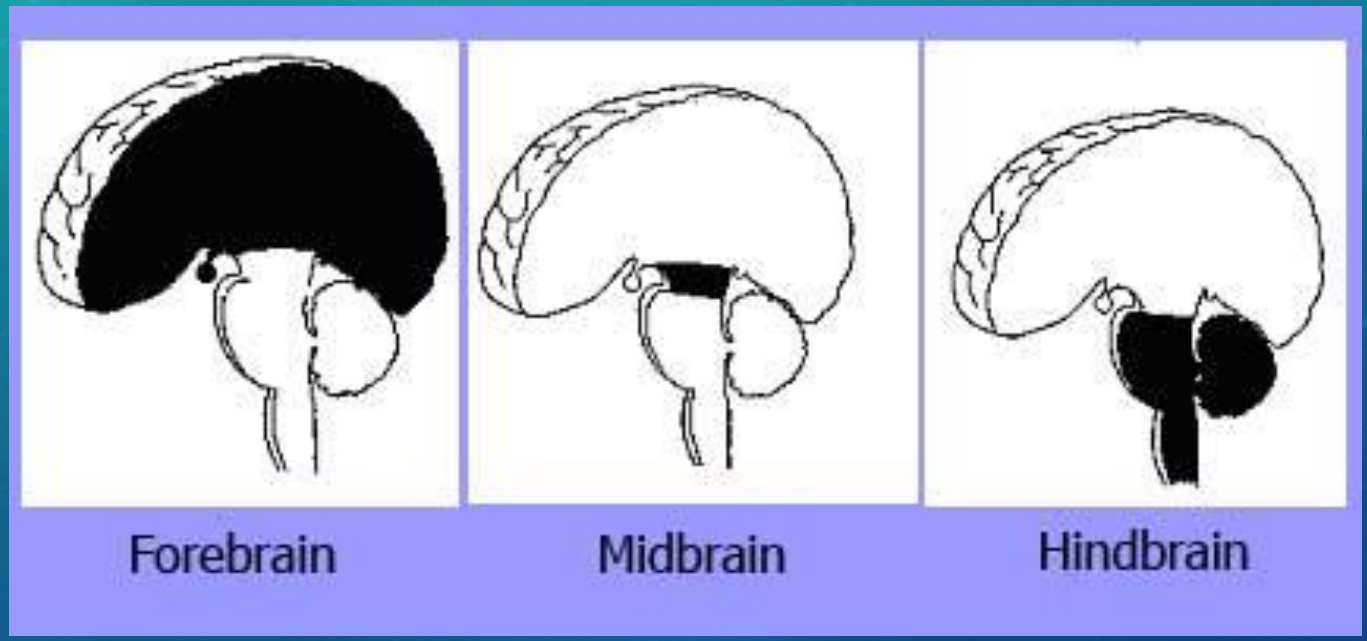
THE BRAIN STEM CONTINUED

- The Cerebellum
  - Location: Rear of the brainstem
  - Structure: Baseball sized
  - Functions: nonverbal learning and memory, judge time, regulate emotions, discriminate sound and texture, coordinates voluntary movement, and maintains balance
- Thalamus
  - Location: Top of the brain stem
  - Structure: Egg-shaped
  - Function: gets info from the senses (minus smell), sends it to the cortex, gets replies and sends it to the medulla and cerebellum. **Sensory switch board**


Lateral view of brainstem
Thalamus
Cut edge of ascending tracts to cerebrum
Optic tract
Midbrain
Pons
Cut edges of tracts leading to cerebellum
Cranial nerves
Medulla oblongata
Spinal cord
ebellum

Useful place: http://www.columbia.edu/cu/psychology/courses/1010/mangels/neuro/anatomy/structure.html

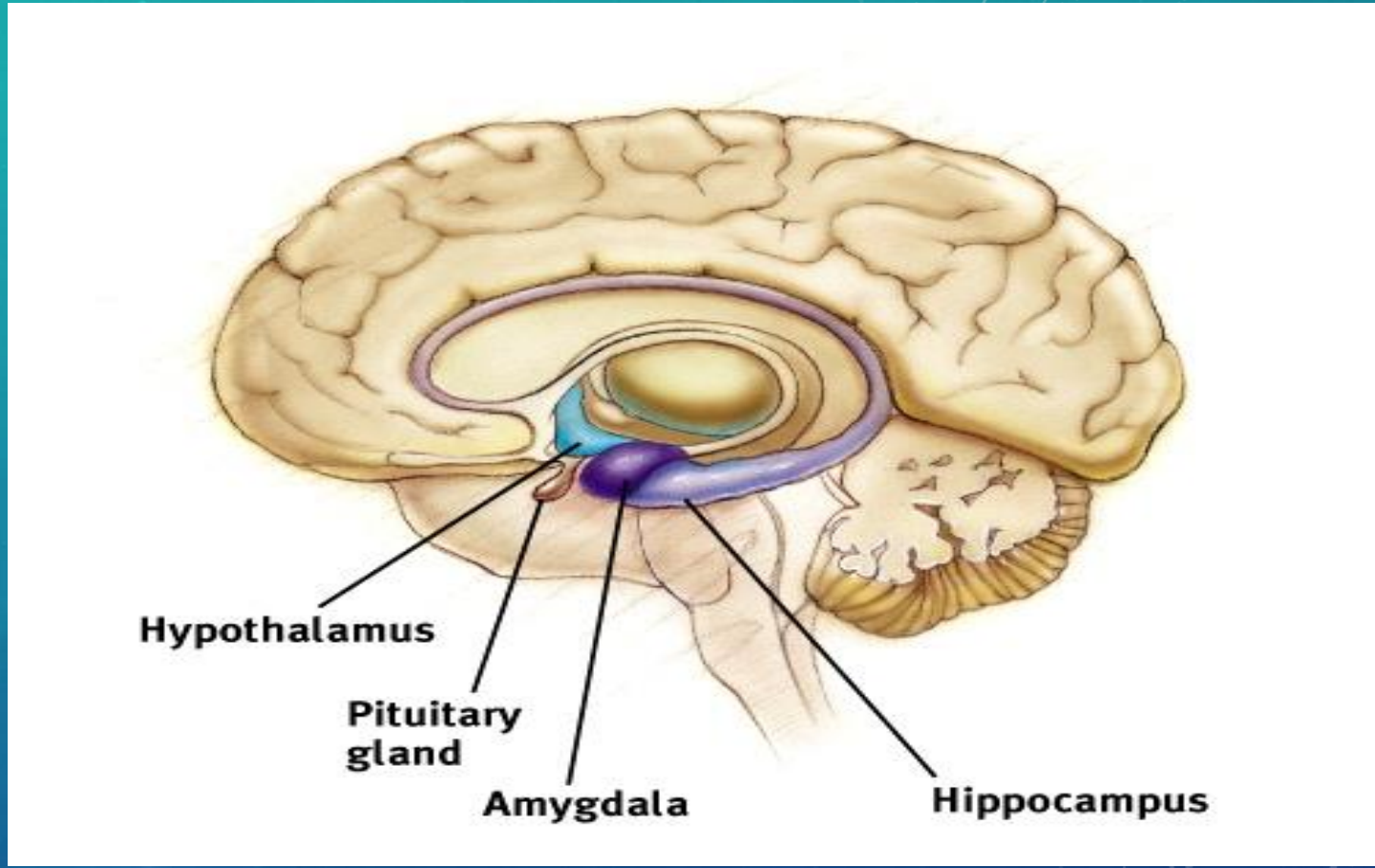
- Controls thoughts and reasoning
- Thalamus is technically part of the forebrain

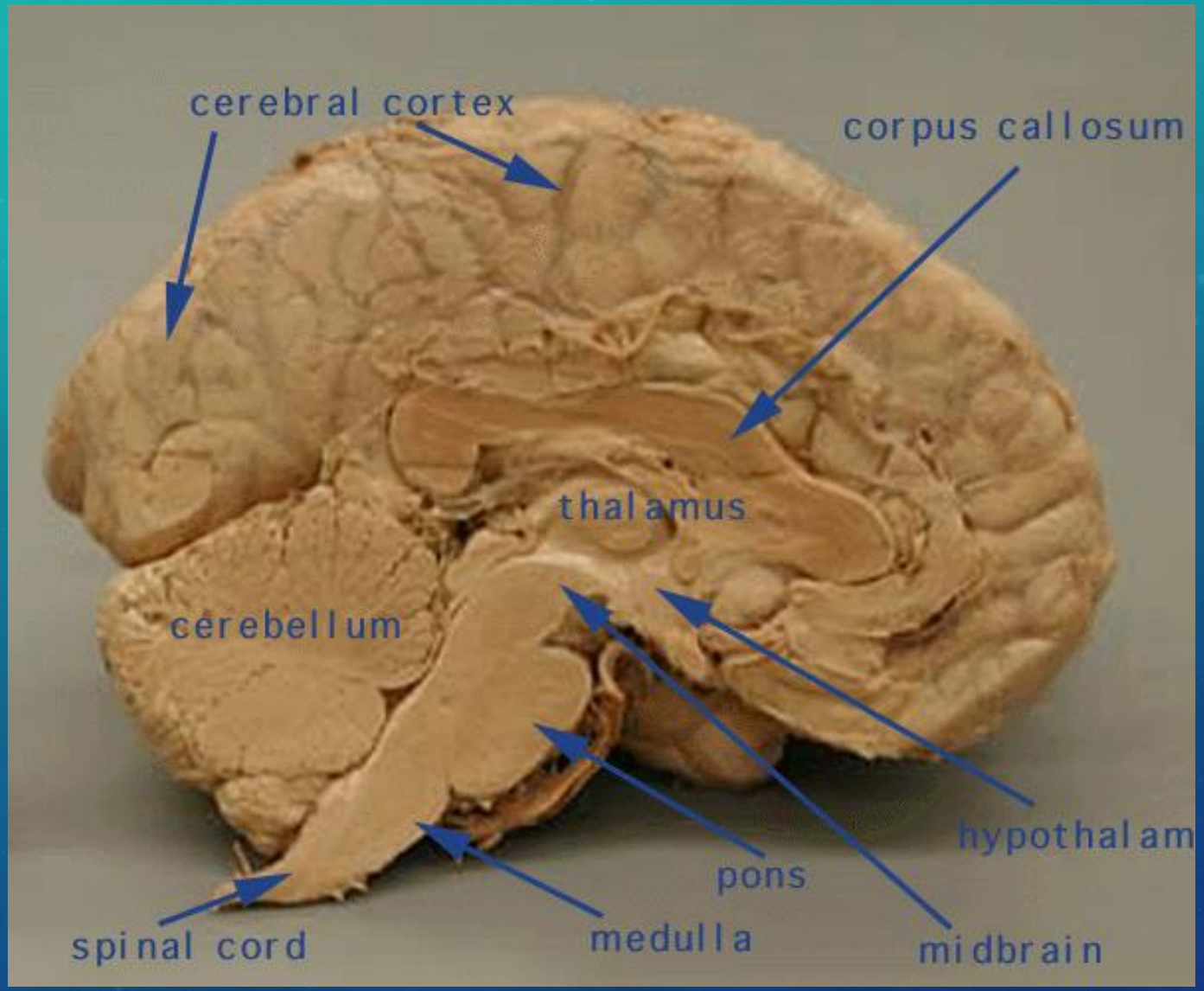


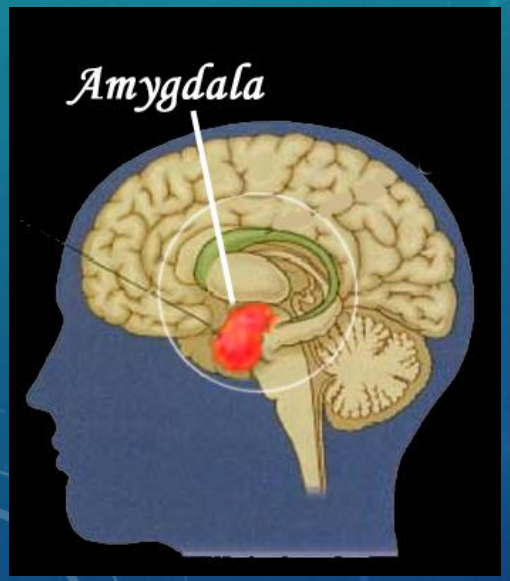
THE FOREBRAIN (ADVANCED) BRAIN

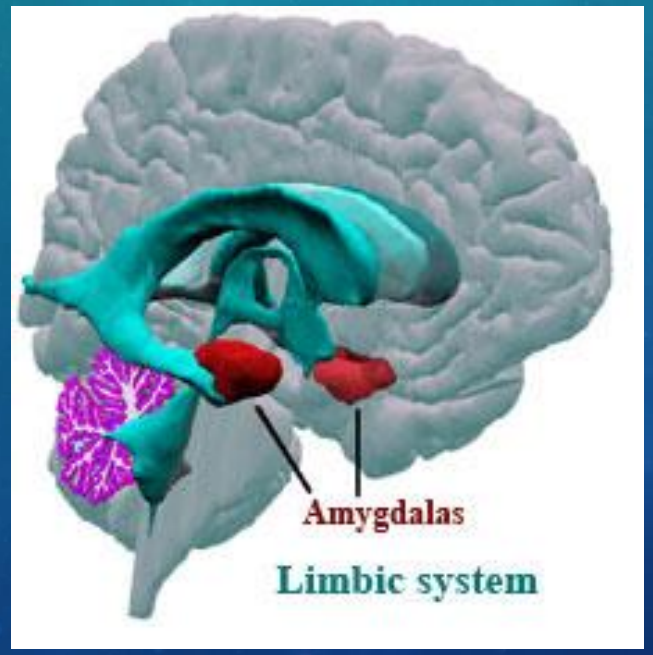
LIMBIC SYSTEM

- Structure: Donut shaped system of neural networks
- Components: hippocampus, amygdala, and hypothalamus
- Location: right above the brainstem
- Associated with emotions(fear and aggression) and drives(hunger and sex)




cerebral cortex
corpus callosum
thalamus
cerebellum
hypothalam
pons
spinal cord
medulla
midbrain



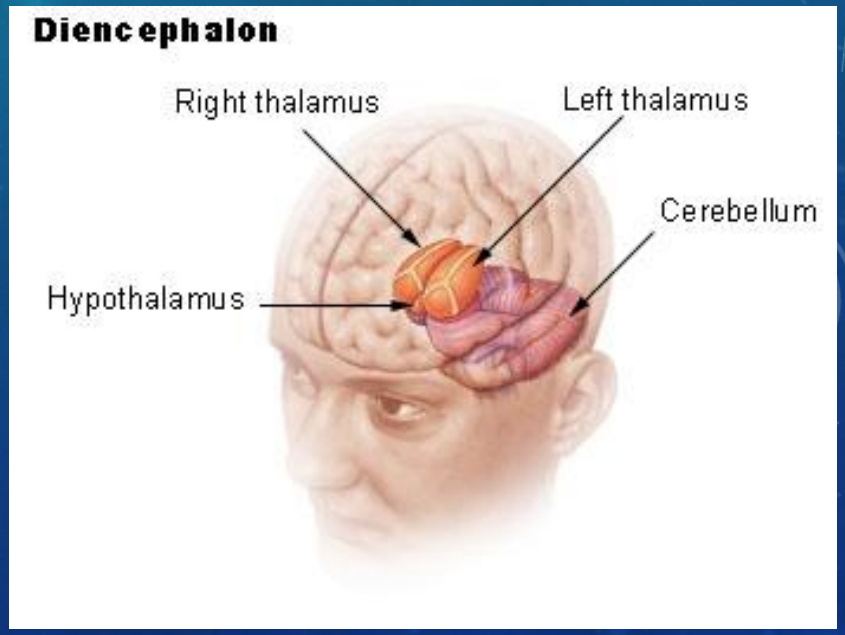


- Part of the limbic system
- Structure: almond shaped neural clusters
- Influence aggression and fear
  - Processing memory and perception of these emotions

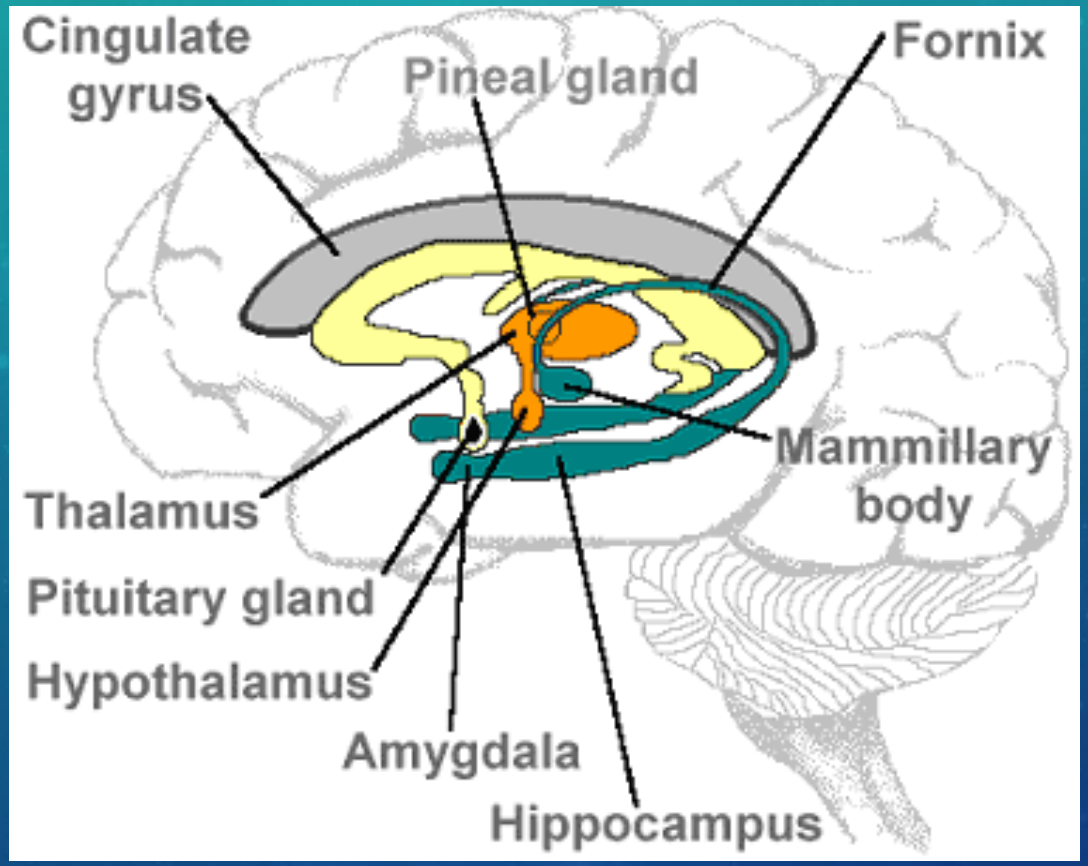
AMYGDALA

- Part of the limbic system
- Location: Below the thalamus; think hypo=below (as in hypothermia)
- Functions
  - Performs body maintenance: influence hunger, thirst, body temp, sexual behavior
  - Controls the pituitary
  - Closely linked to emotion
- Hypothalamus secretes hormones
- Reward center

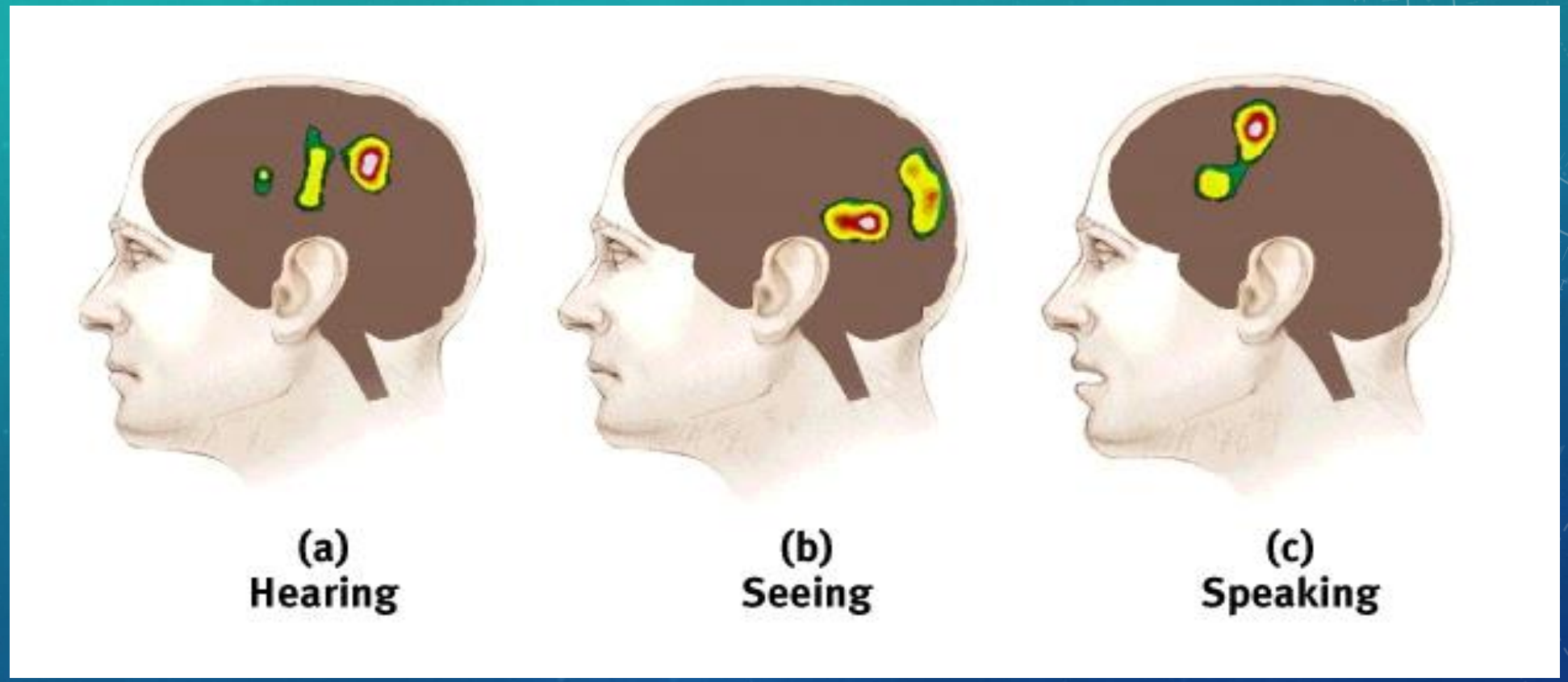
HYPOTHALAMUS



- Part of the limbic system
- Predominant function is memory
- When suffering from Alzheimer's this is the first area to show damage

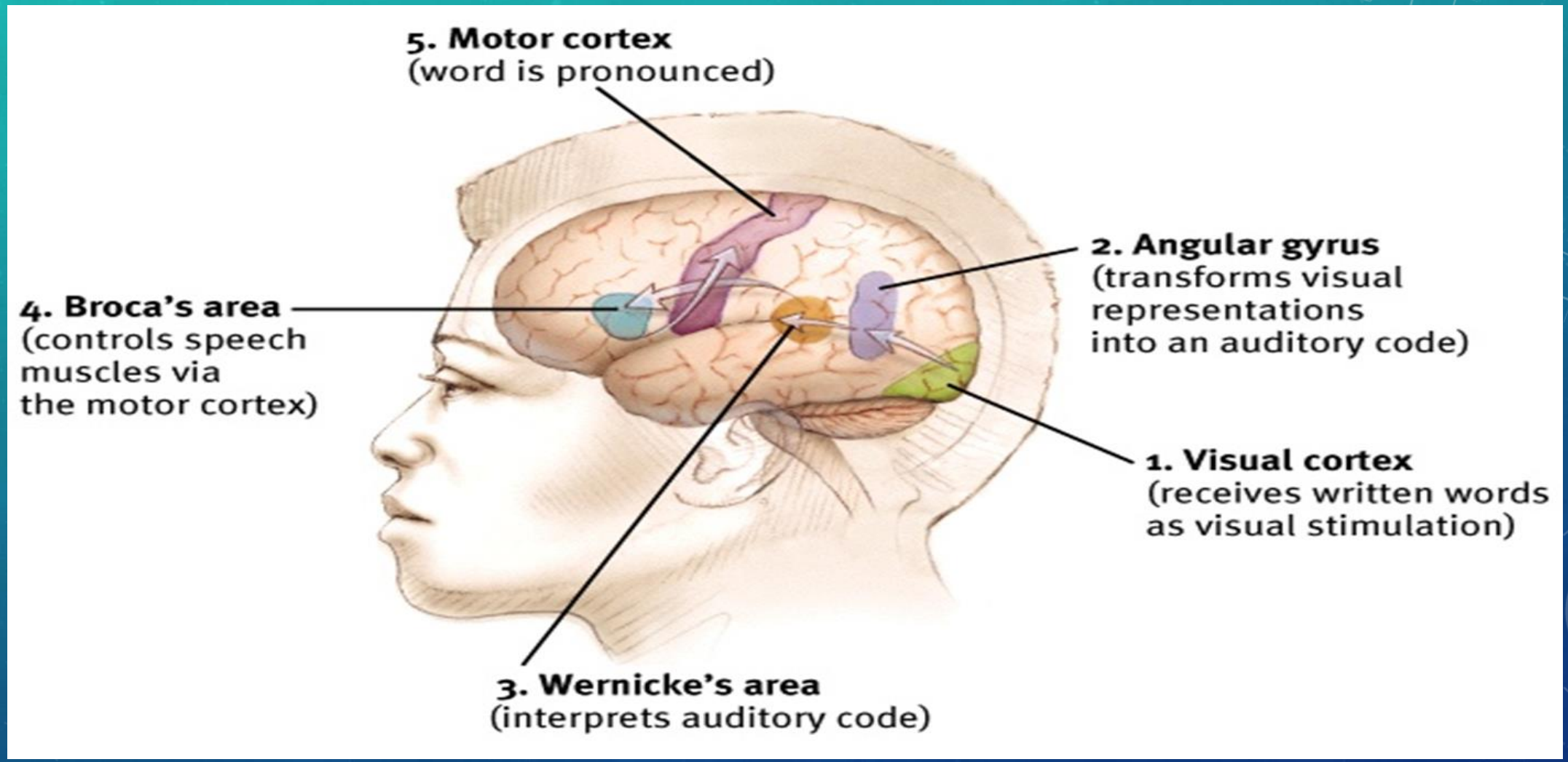


HIPPOCAMPUS


(a)
Hearing
(b)
Seeing
(c)
Speaking

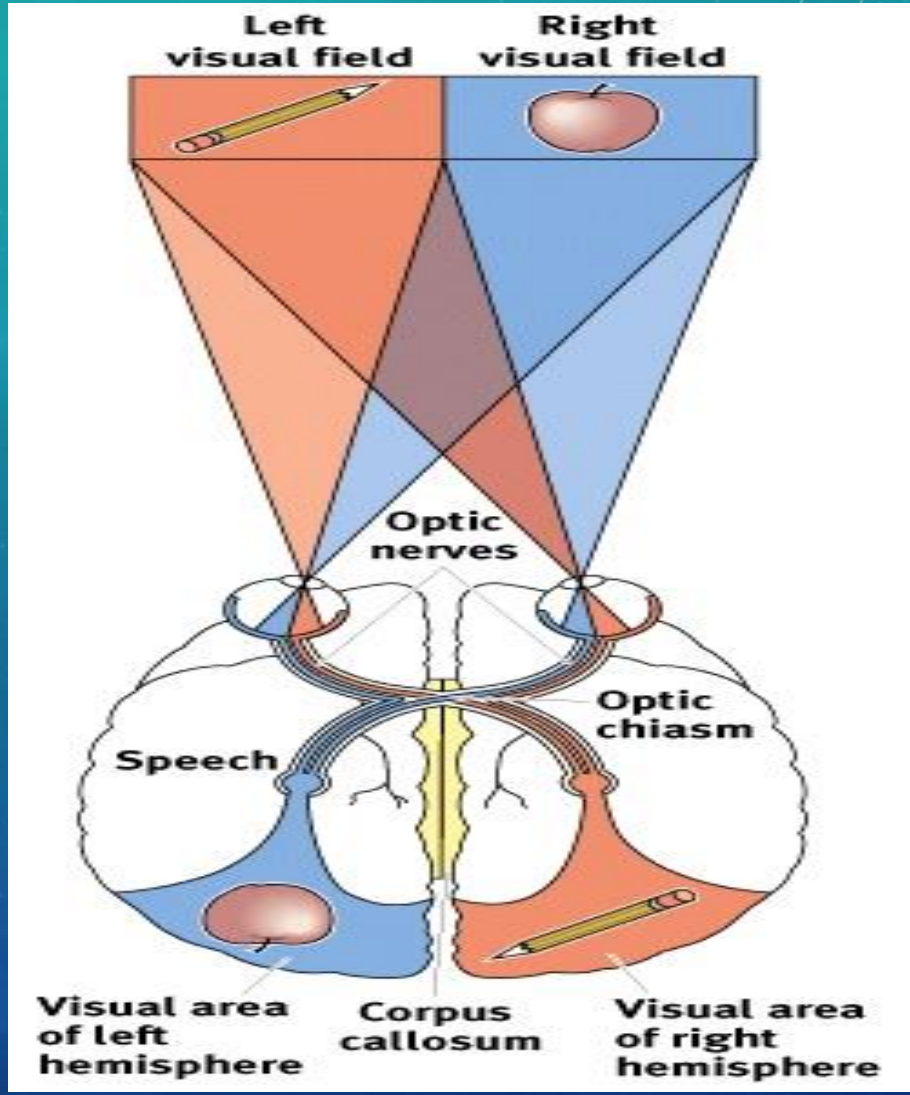
LANGUAGE

- Broca's Area: Psychically peaking
  - If damaged, can still sing and understand speech
- Wernicker's Area: Speech comprehension and expression
  - If damaged, can still make gibberish noise
- Angular Gyrus: Process visual and auditory input and coordinates the two
  - E.g.: Reading allowed requires visual info, turned into auditory info, then made into meaning, then spoken


5. Motor cortex
(word is pronounced)
2. Angular gyrus
(transforms visual representations into an auditory code)
4. Broca's area
(controls speech muscles via the motor cortex)
1. Visual cortex
(receives written words as visual stimulation)
3. Wernicke's area
(interprets auditory code)

THE DIVIDED BRAIN

PART IIIB



SPLIT BRAIN

- Corpus Callosum: network of nerves connecting brian hemispheres
  - Help communicate information from one hemisphere to the other
- Right Brain: facial recognition, emotion, simple requests, perception, intuitive responses, drawing, emotions
  - Figurative, subtle
- Left Brain: deliberate, logical reasoning, calculating, speech
  - Literal

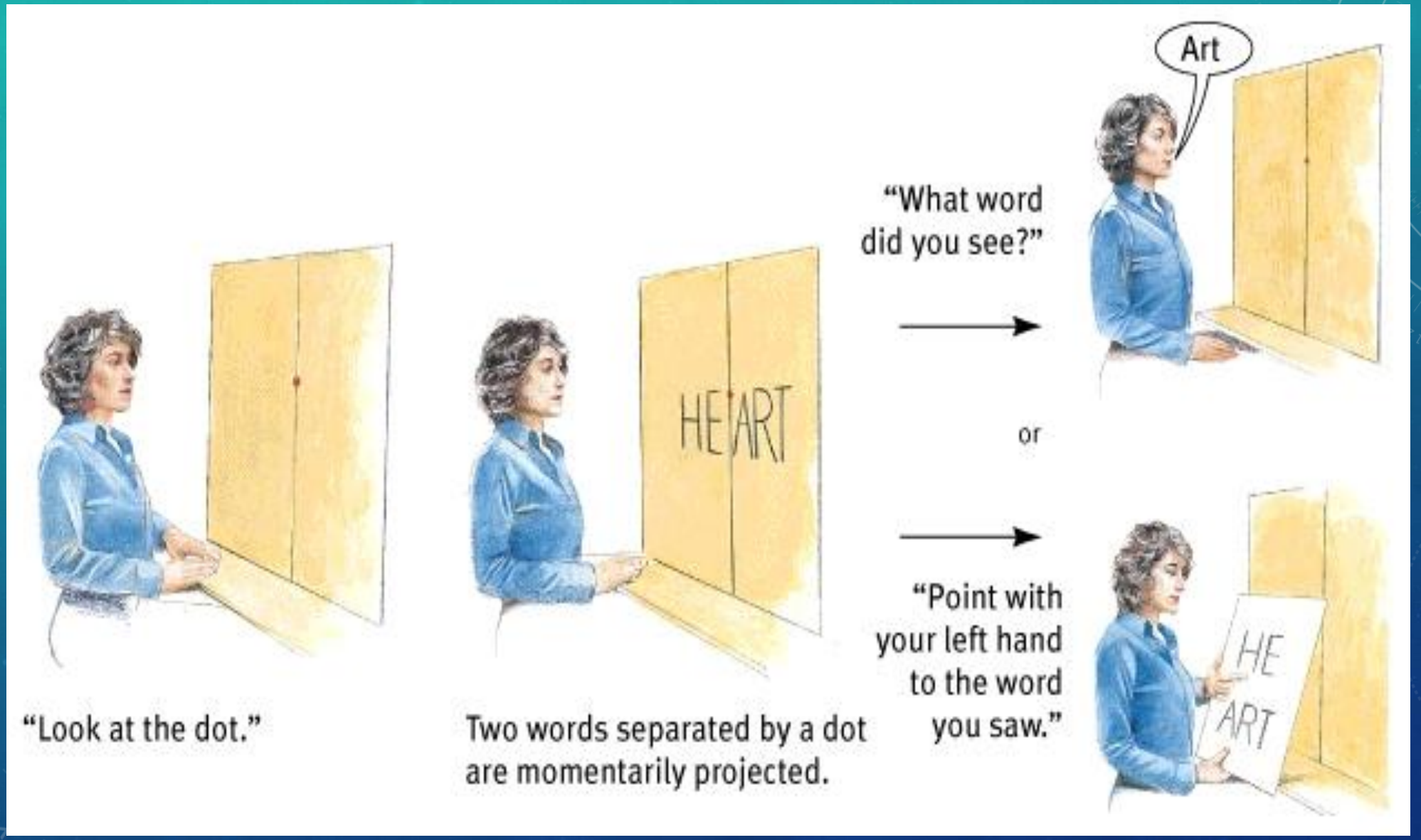
SPLIT BRAIN RESEARCH

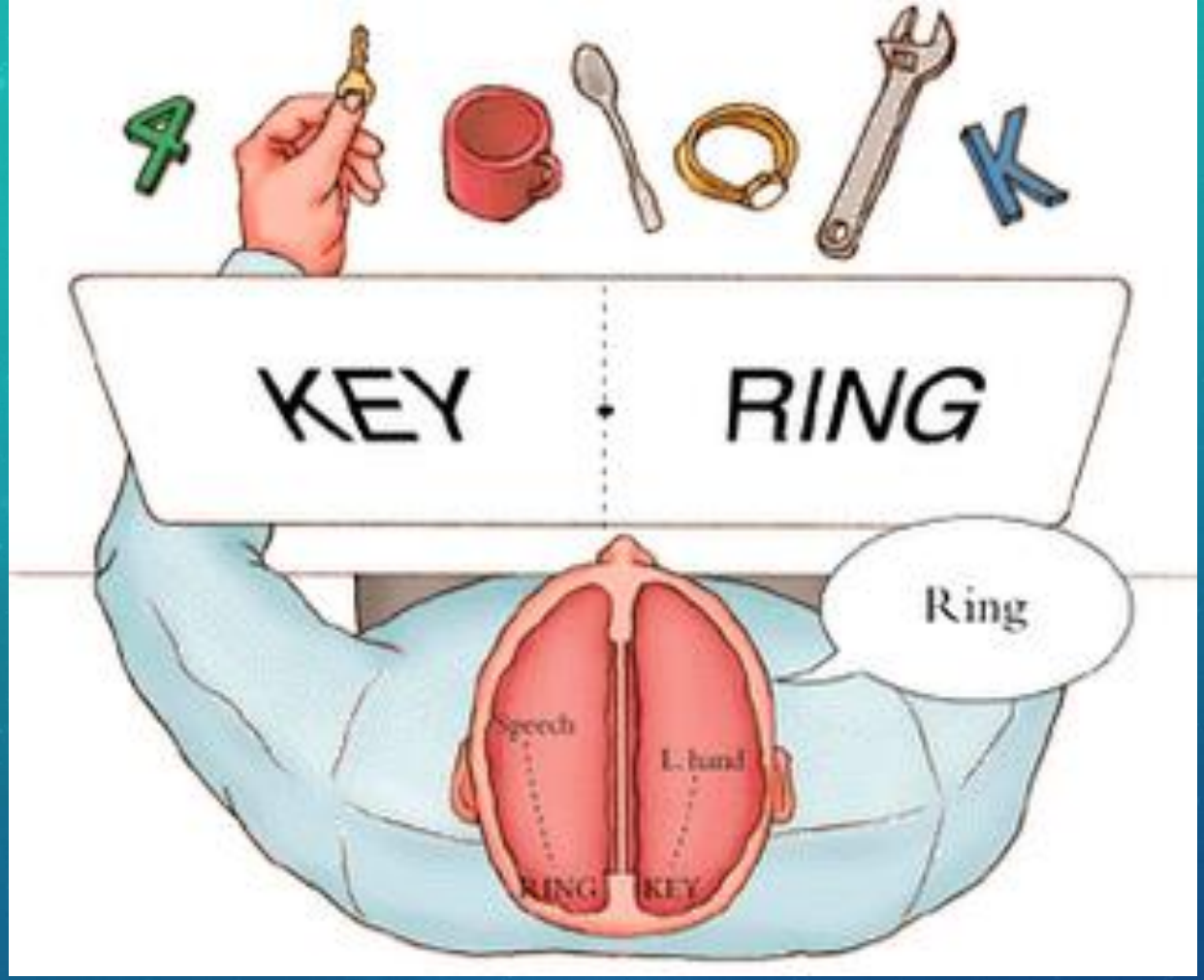
- Separate the two hemispheres by cutting the corpus callosum
  - Goal: control epileptic seizures
- Testing the “split brain” proves specific functions of each hemisphere

THE SPLIT BRAIN EXPERIMENT
DR. GAZZANIGA- 1967
STARE AT THE DOT…..

he.art

1. Which word would the split-brain patient verbalize seeing? Why?
2. Which word, when asked to point with his left hand, would he report seeing? Why?


"Look at the dot."
HEART
Two words separated by a dot are momentarily projected.
"What word did you see?"
Art
or
"Point with your left hand to the word you saw."
HE
ART



SPLIT BRAIN
EXPLAIN THE FOLLOWING…

THE SPLIT BRAIN

If this visual was shown to the right hemisphere of a split brain patient, how might the patient identify the object?

FUN FACTS

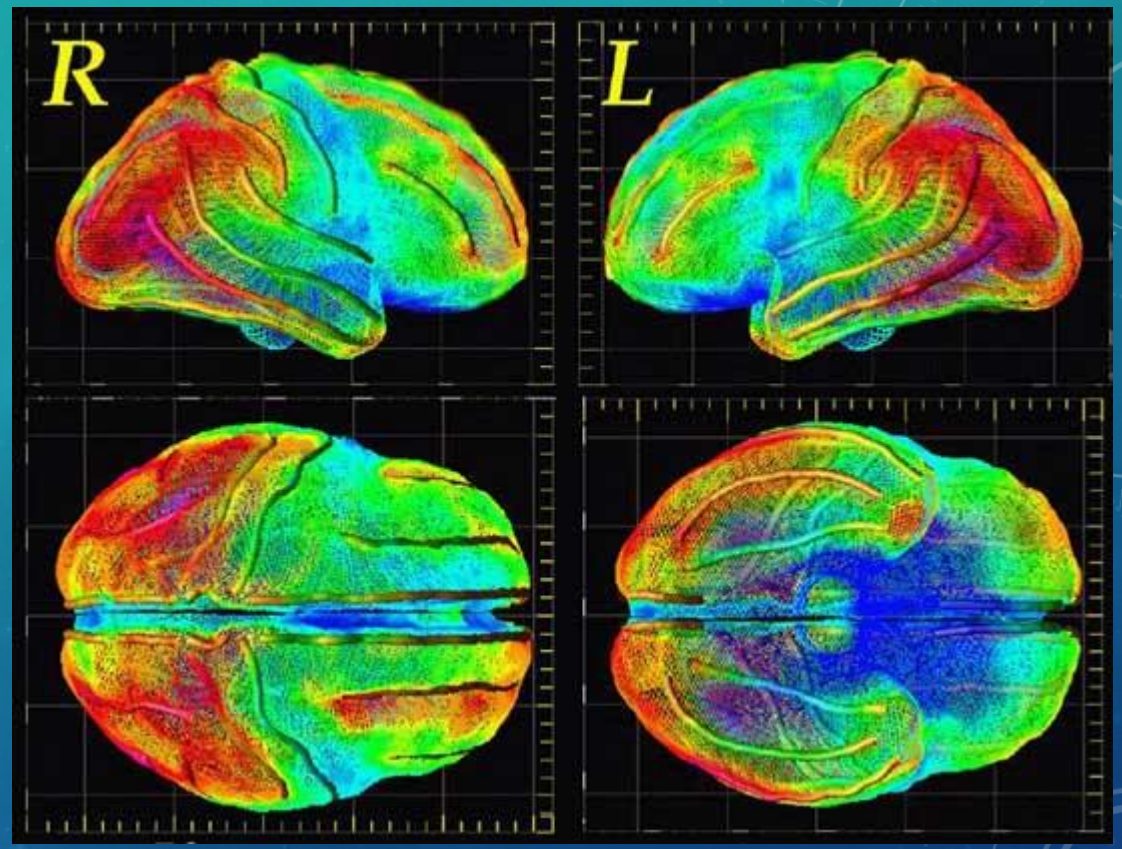
- Subjects can simultaneously draw different figures with the left and right hand.
- When the two hemispheres are at odds, the left will rationalize reactions it doesn't understand.
- The hemispheres are an "odd couple", each with "a mind of its own."

HANDEDNESS

- More people are right handed
- Left handedness is more common in males
- Lefties
  - Process speech in either side of brain (versus righties who process in the left)
  - More often have reading disabilities, allergies, and migraines
  - More common among musicians, mathematicians, pro baseball players, architects, and artists
  - Decline with age…
- Prenatal or genetic

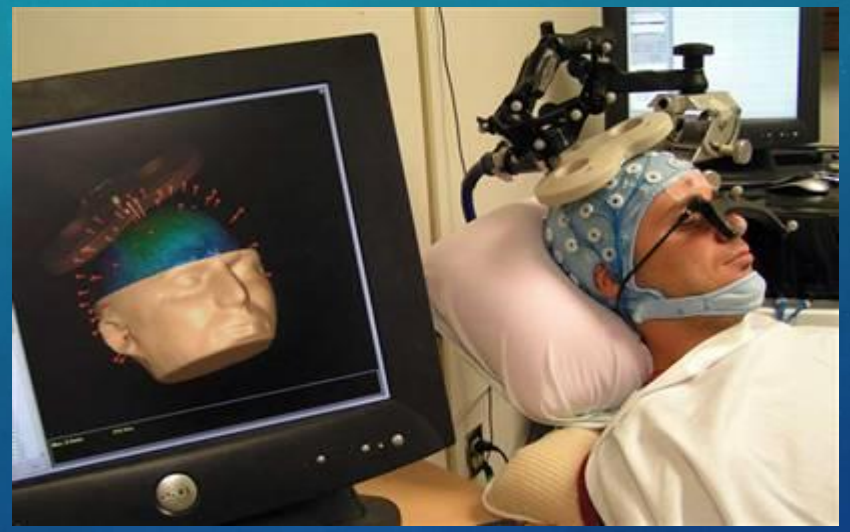
STUDYING THE BRAIN

PART IIIC



ELECTROENCEPHALOGRAM (EEG) DETECTS BRAIN WAVES

- Measures electrical activity across brain by applying electrodes
- Can specify waves to specific stimulus
- Sleep research

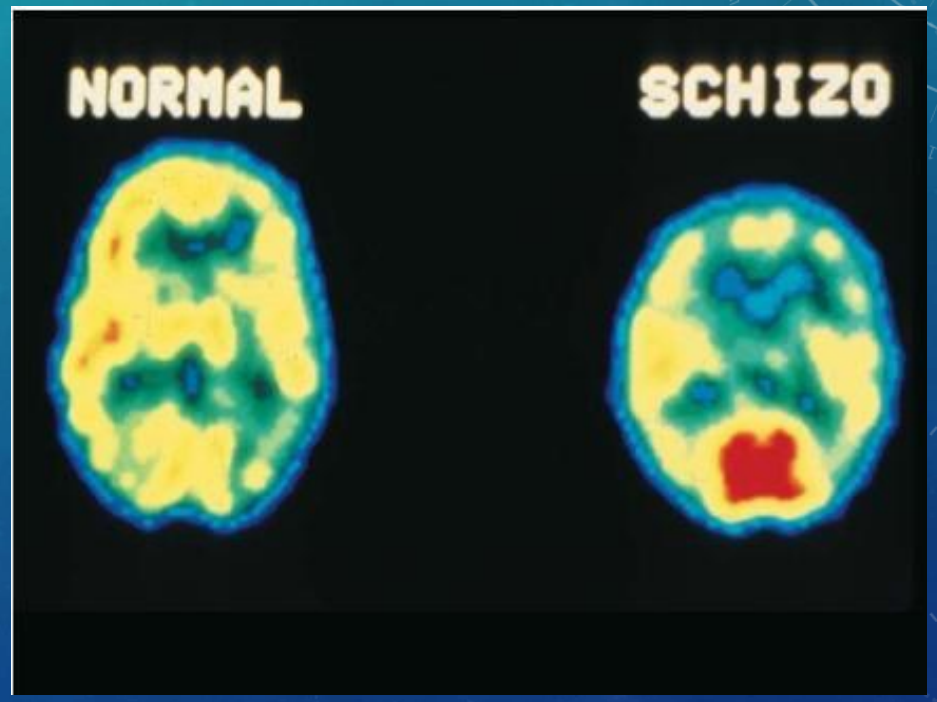


COMPUTED TOMOGRAPHY (CAT) SCAN

- Multiple x-ray pictures = 3D image of brain structure
- Structure only- not function
- Tumors, physical abnormalities

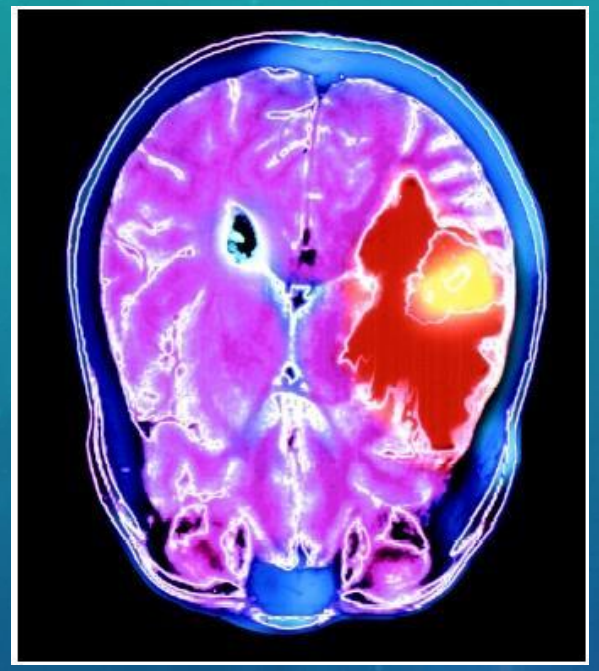
- Can measure amount and movement of chemical fuel, glucose, in the brain
- Clues on brain's activity: the more glucose used, the more activity
- Neurotransmitters and drugs

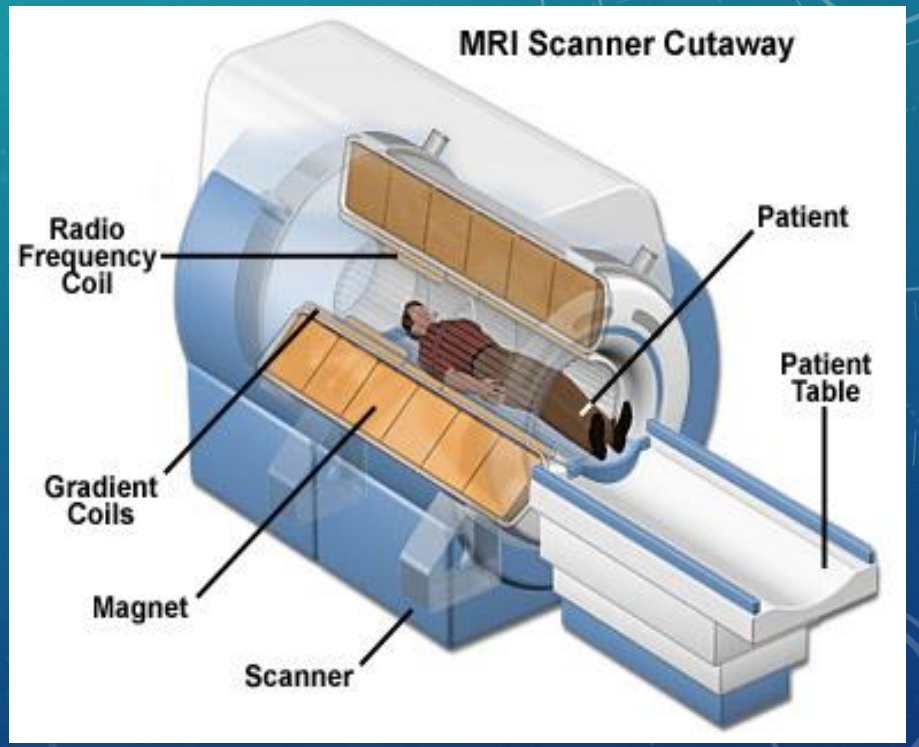
POSITRON EMISSION TOMOGRAPHY (PET) SCAN



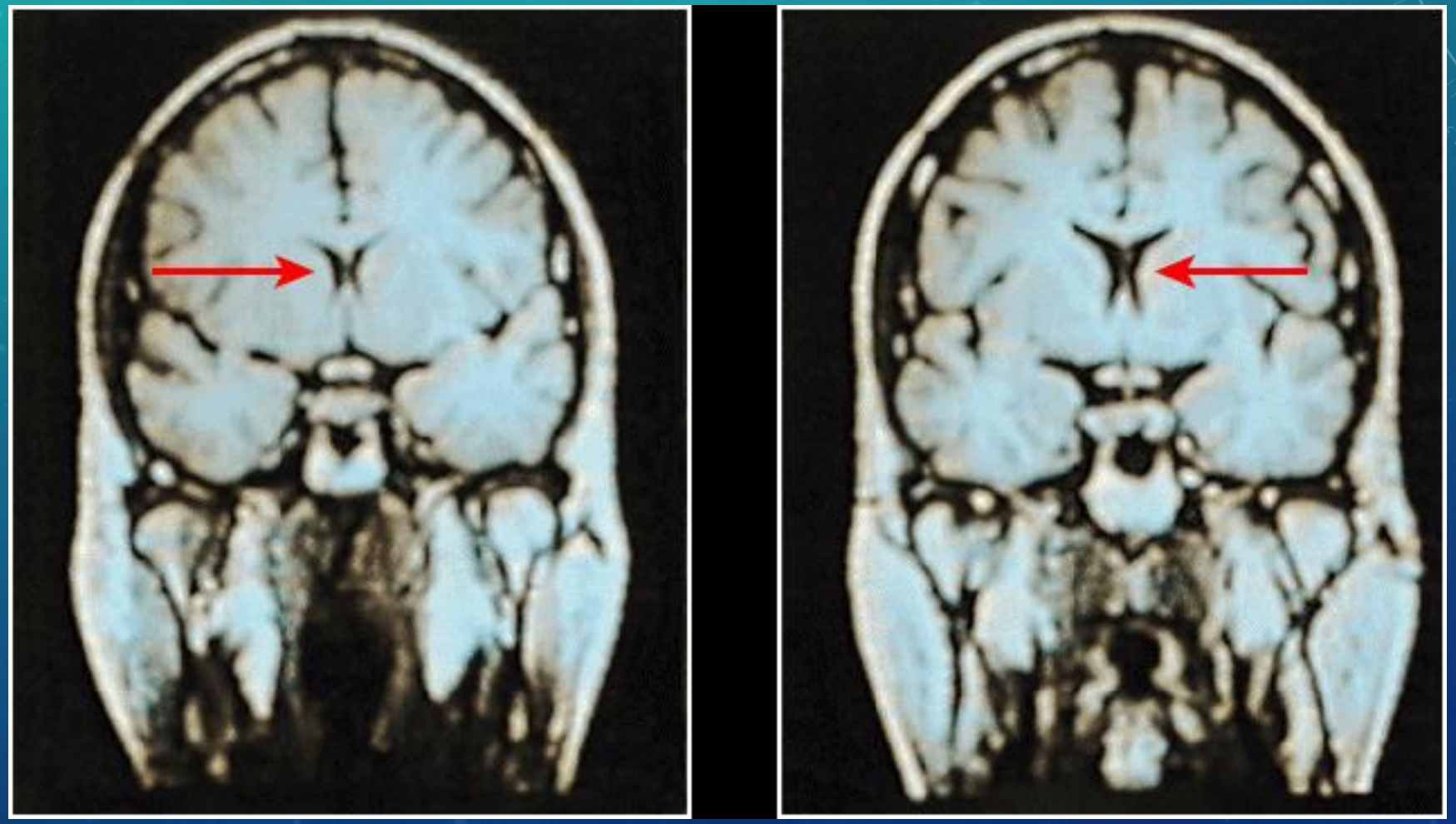
MAGNETIC RESONANCE IMAGING (MRI)

- Like CAT, but used magnetic fields to measure density and location of brain material
- Soft tissue; allows us to see structures within the brain

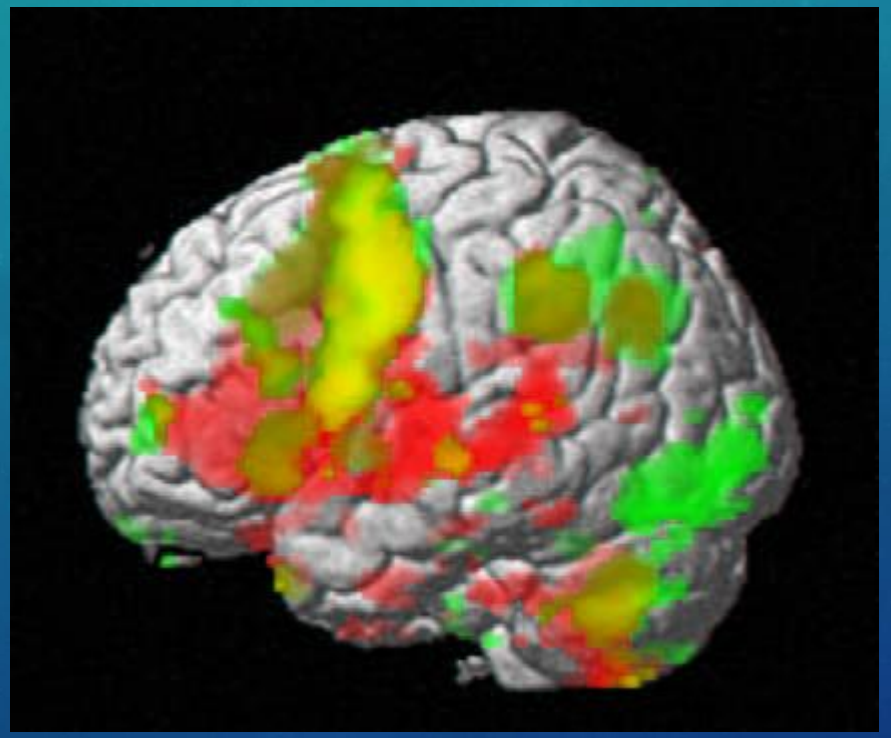


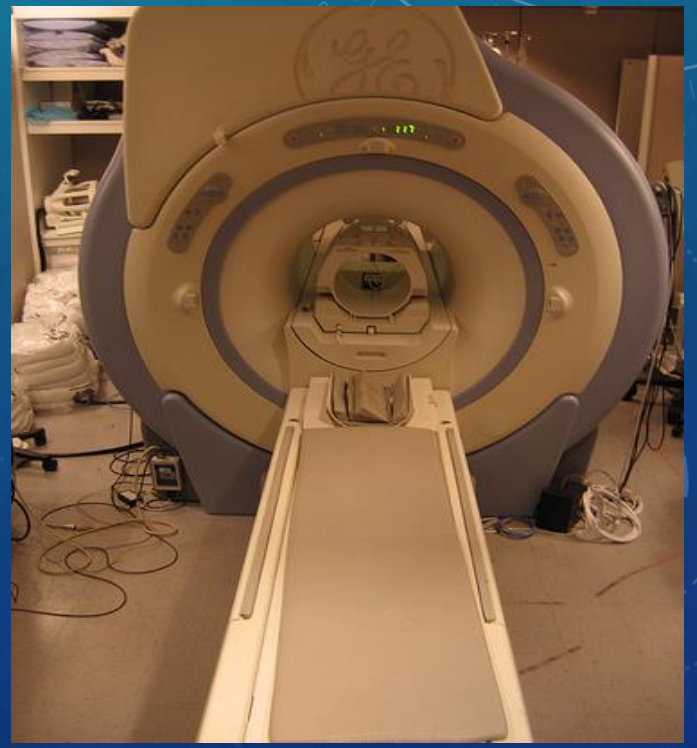


MRI SCAN



- Reveals brains' functioning as well as its structure (MRI + PET)
- Compares multiple closely sequenced MRIs
- Watches brain "light up" by concentrations of blood flow to specific areas

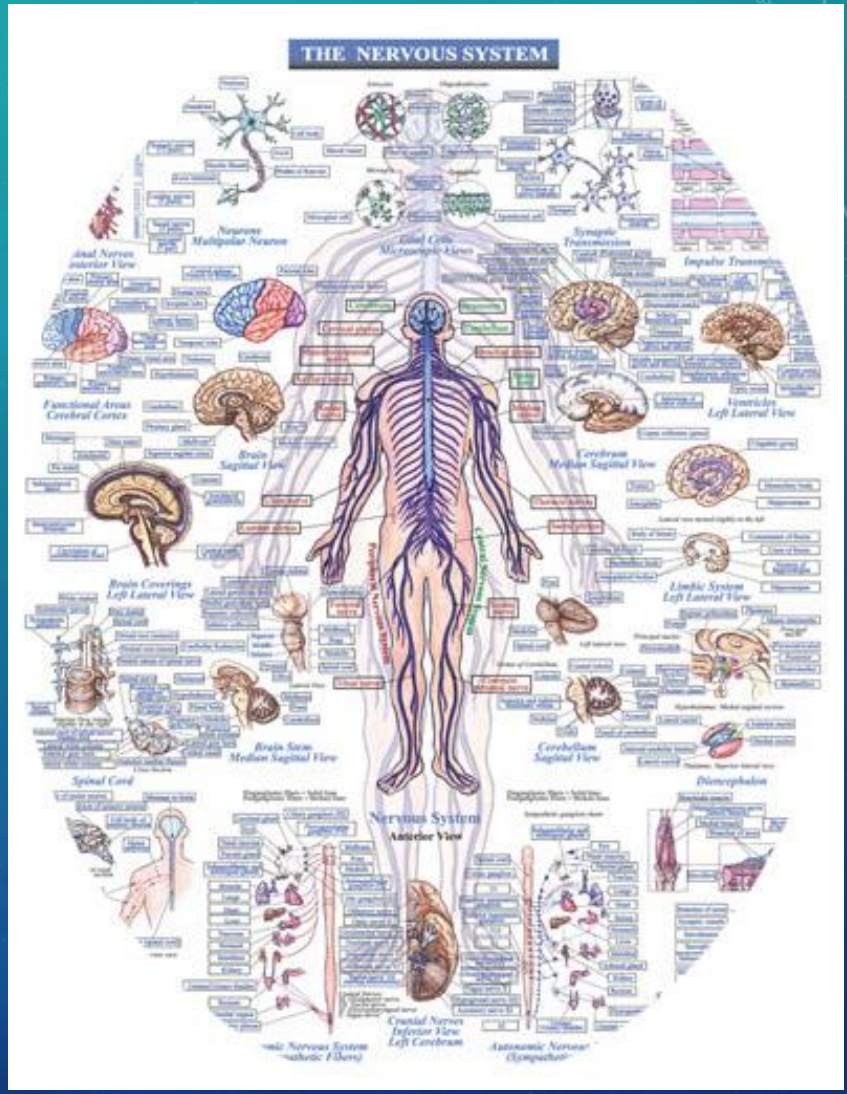




FUNCTIONAL MRI (FMRI)

NERVOUS SYSTEM

PART II

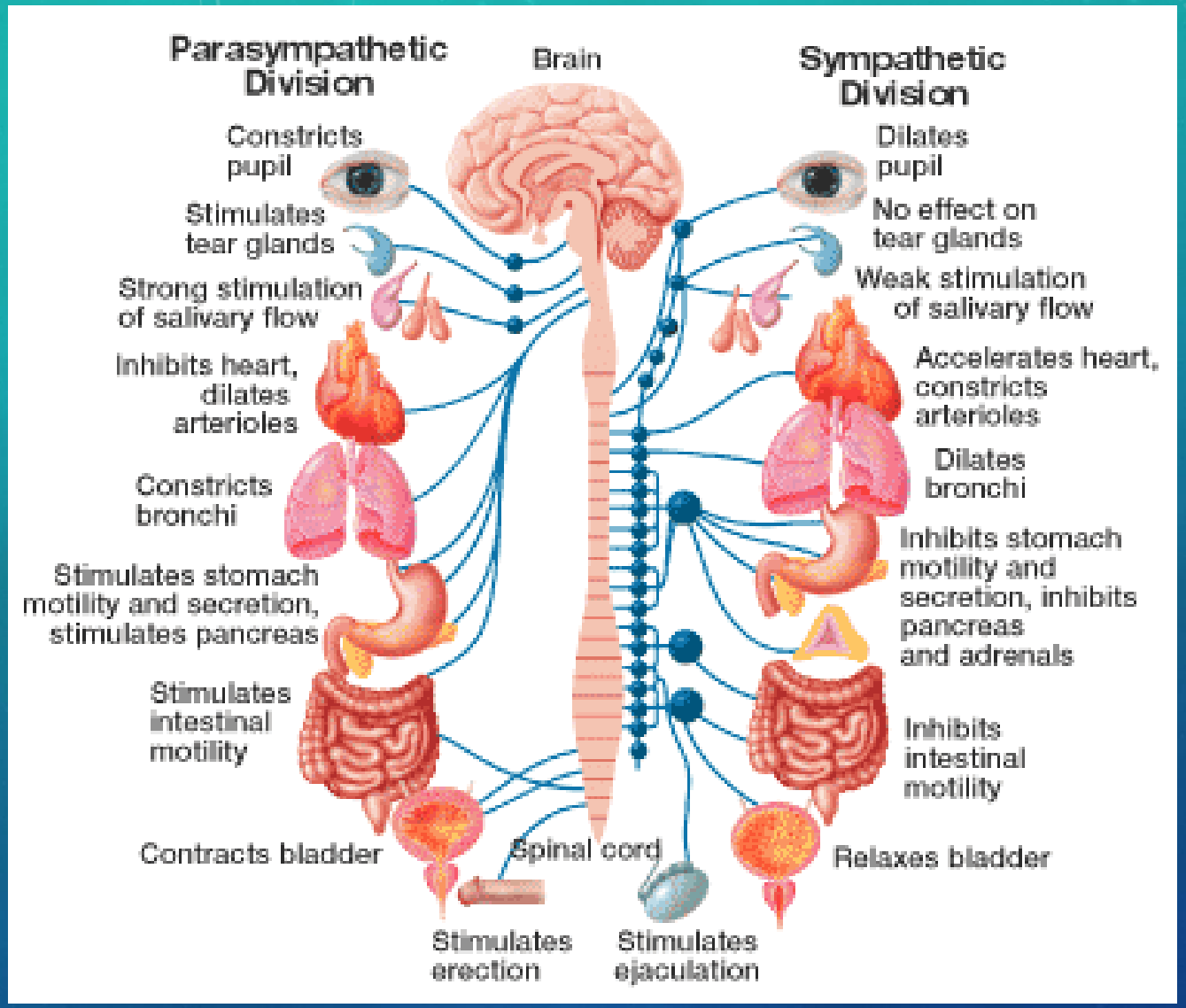


THE NERVOUS SYSTEM

- Nervous System: the body's electrochemical information network
- Components of the Nervous System
  - Central Nervous System (CNS)-Internal command center made up of the brain and spinal cord
  - Peripheral Nervous System (PNS)-Connects CNS with sense receptors, muscles, and glands
- Nerves: large bundles of neurons
  - Sensory Neurons: Info from tissues and organs to the CNS for processing
  - Interneurons: Complex system of neurons that processes info in the CNS
  - Motor Neurons: Info from CNS back out to the body
  - Reflex: Single sensory neuron+single motor neuron+interneuron

PERIPHERAL NERVOUS SYSTEM

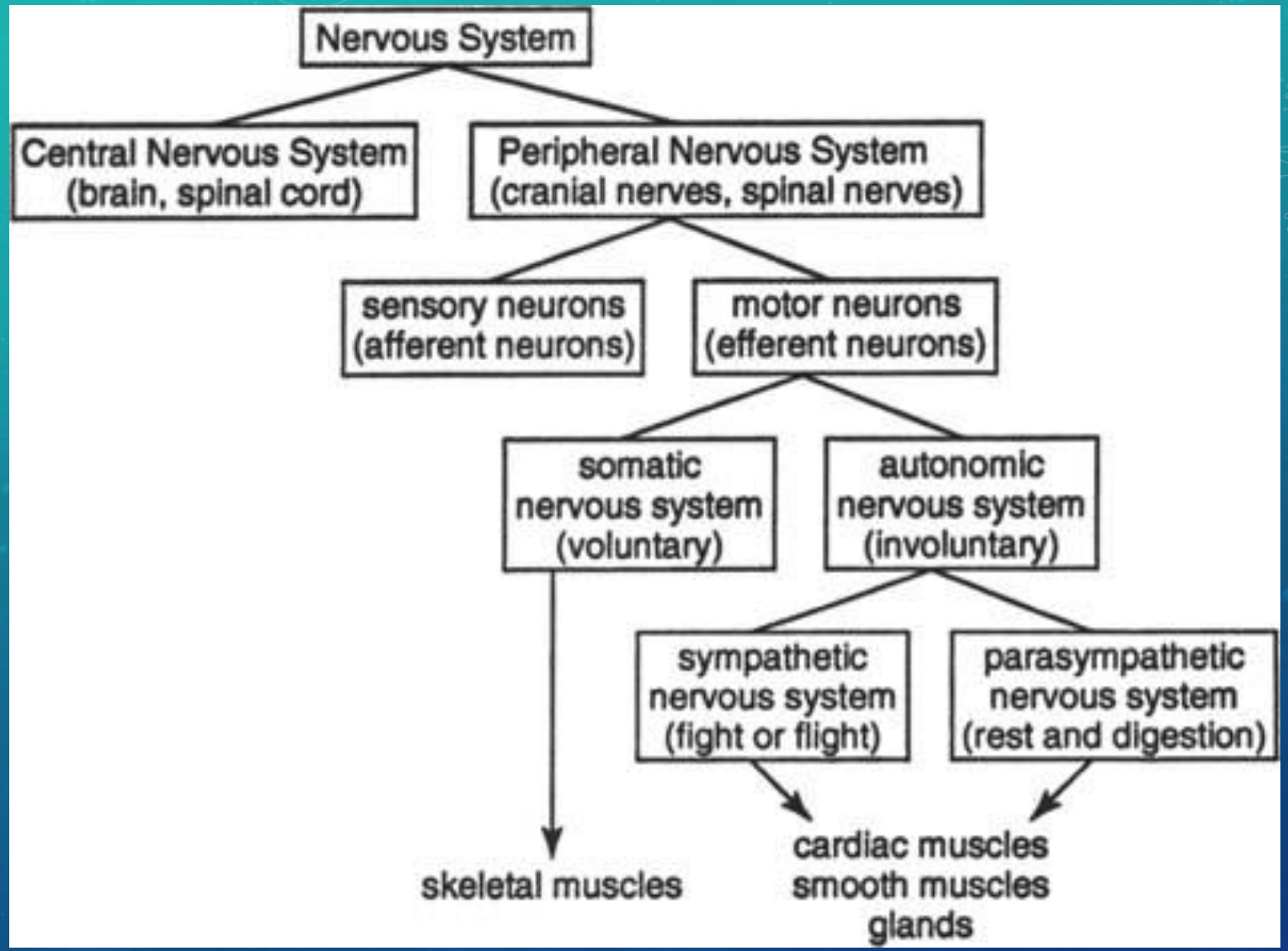
- Two components: somatic and autonomic
  - Somatic: Allows us to move our skeletal muscles
  - Autonomic: Controls glands and muscles of our internal organs (e.g. heartbeat)
    - Operates on its own (but can be consciously overridden)
- Autonomic Nervous System also has two components
  - Sympathetic: Arouses (reaction to stress—fight or flight)
  - Parasympathetic: Calms (when stress subsides)
  - Sympathetic and parasympathetic systems work together to keep us at a steady state



PERIPHERAL NERVOUS SYSTEM

SOMATIC OR AUTONOMIC?

- Sneezing
- Turning the page
- High-fiving your friend
- Kissing a date
- Coughing
- Digesting



http://www.youtube.com/watch?feature=player_embedded&v=ivk_irrH1WY

NERVOUS SYSTEM BREAKDOWN

CENTRAL NERVOUS SYSTEM

- Brain and Spinal Cord
- Reflexes rely on the CNS
  - Action occurs without feeling: message stops at the spinal cord and never reaches the brain!
  - “Feeling” hits when the message reaches the brain
- Brain is the computer of the body
  - Collection of neural networks
  - Learning allows us to build neural networks (think foreign languages!)

REFLEXES

Pain Reflex: sensory neuron, interneuron, motor neuron=simple, inborn response

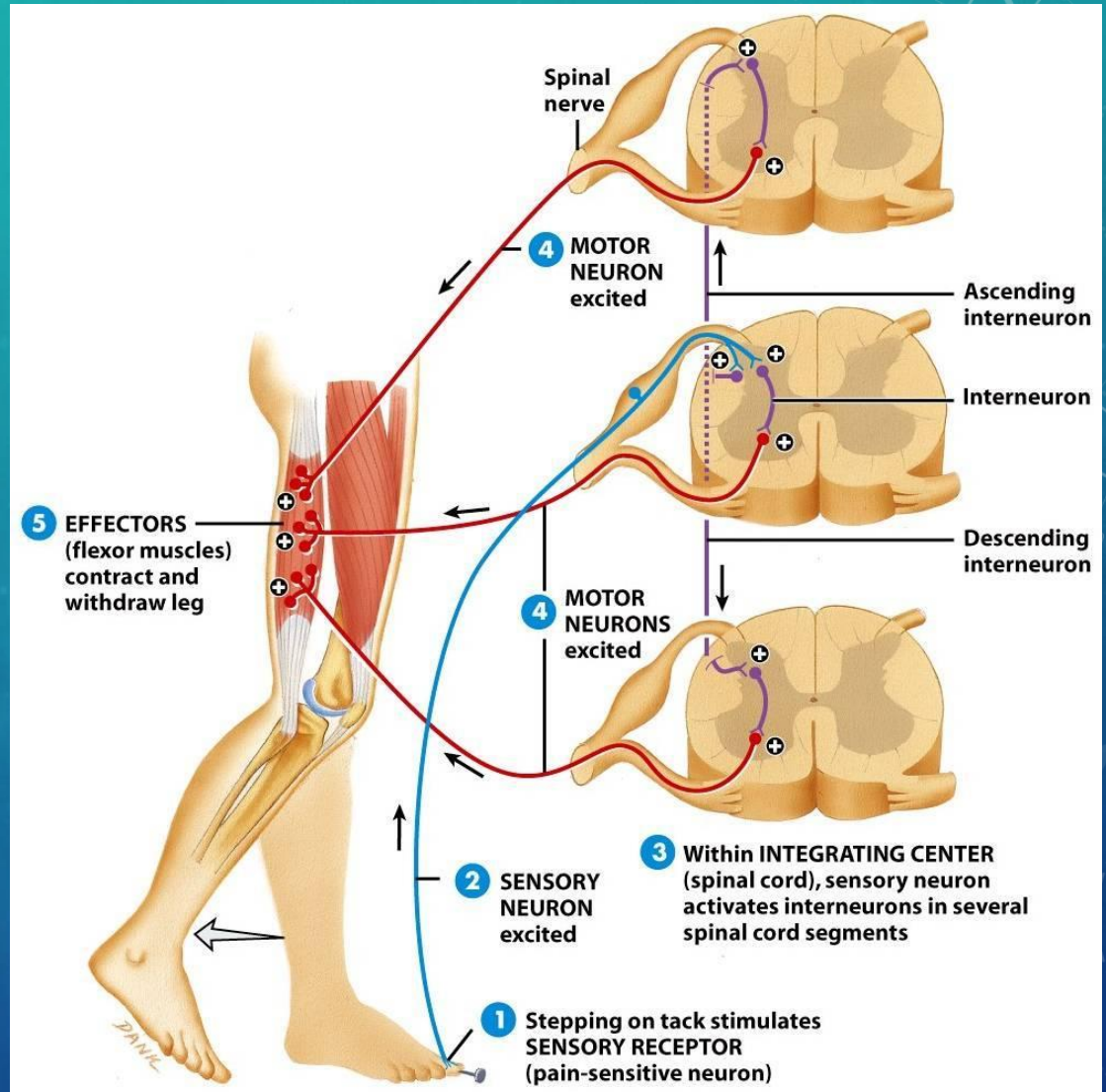
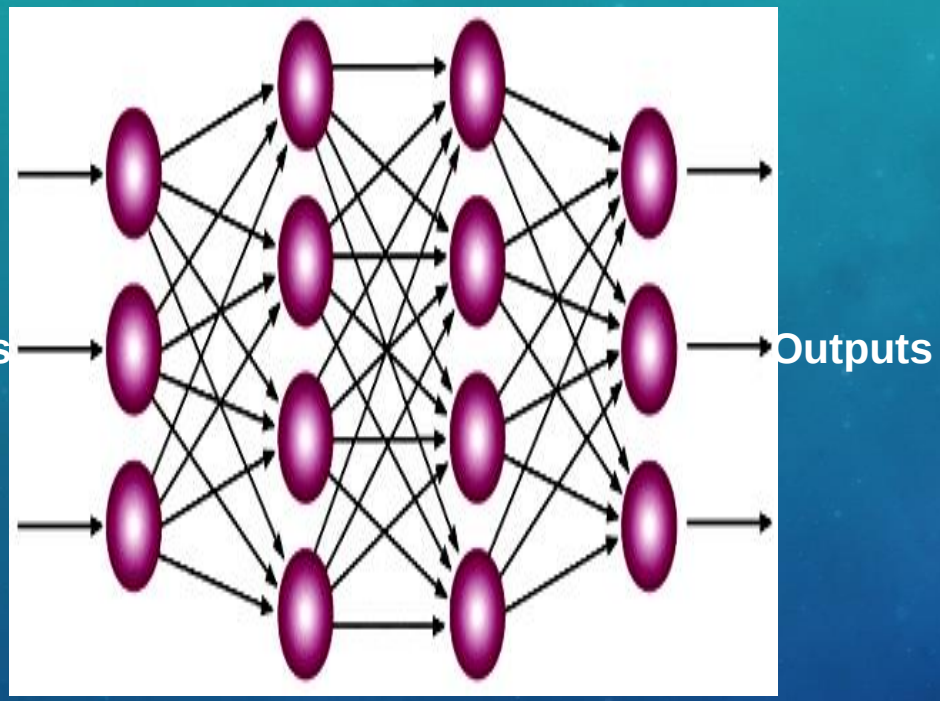


Figure 14-21 Anatomy and Physiology: From Science to Life

NEURAL NETWORK

Neurons in the brain connect with one another to form networks

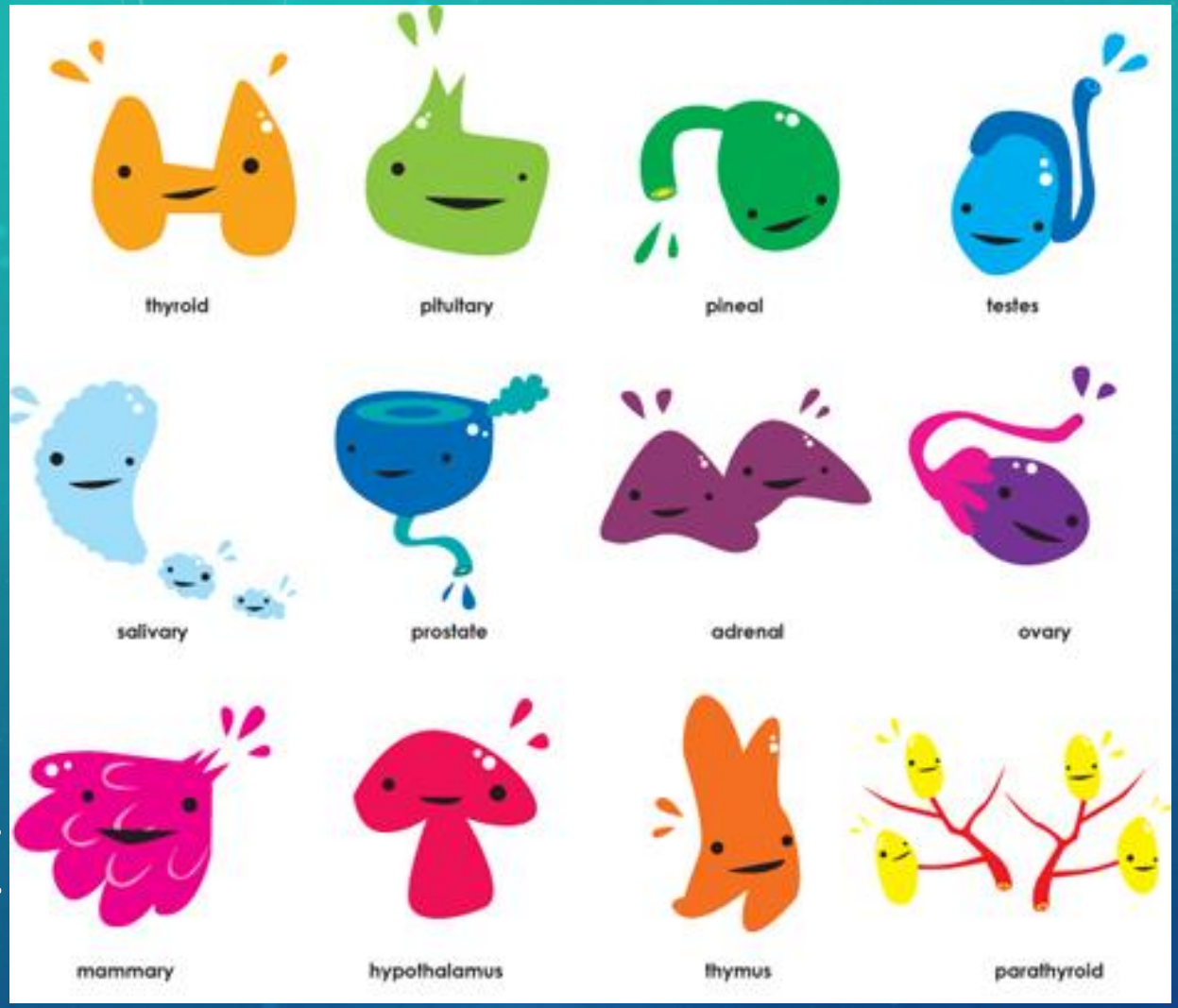


The brain learns by modifying certain connections in response to feedback

- Learning builds connections
  - Feedback! Output affects the process
- Computer simulations using these networks also learn!

ENDOCRINE

PART II B

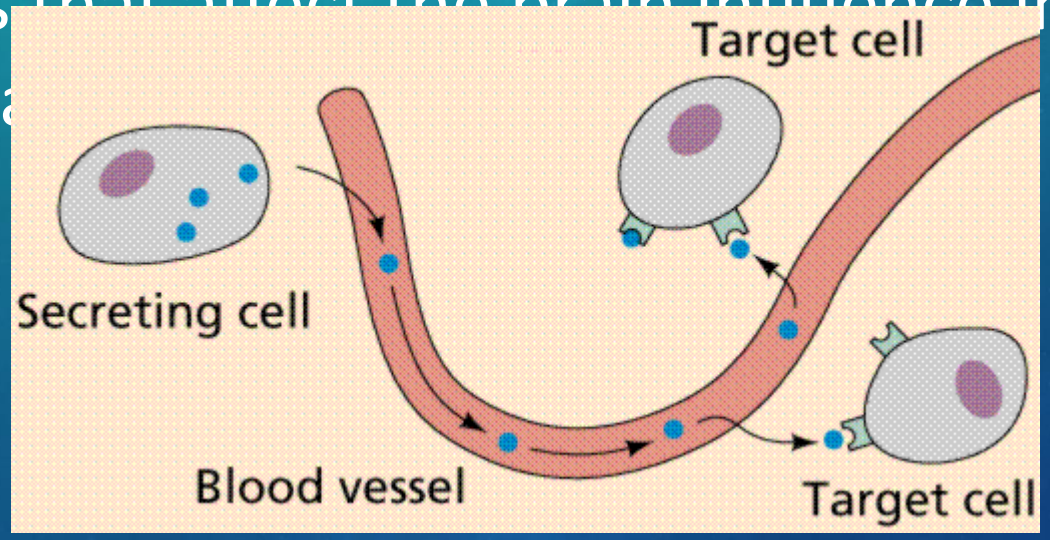


THE ENDOCRINE SYSTEM

- Communication method #2
- Chemical communication
  - Hormones
  - Tissue→blood→Tissue
  - Hormones that affect the brain
- Speed: slooooooow. Messages are slower *and* effects last longer

HORMONES

- Chemical Messengers
- Move from tissue to tissue through the blood stream
- Hormones that affect the brain influence interest in sex, food, and a



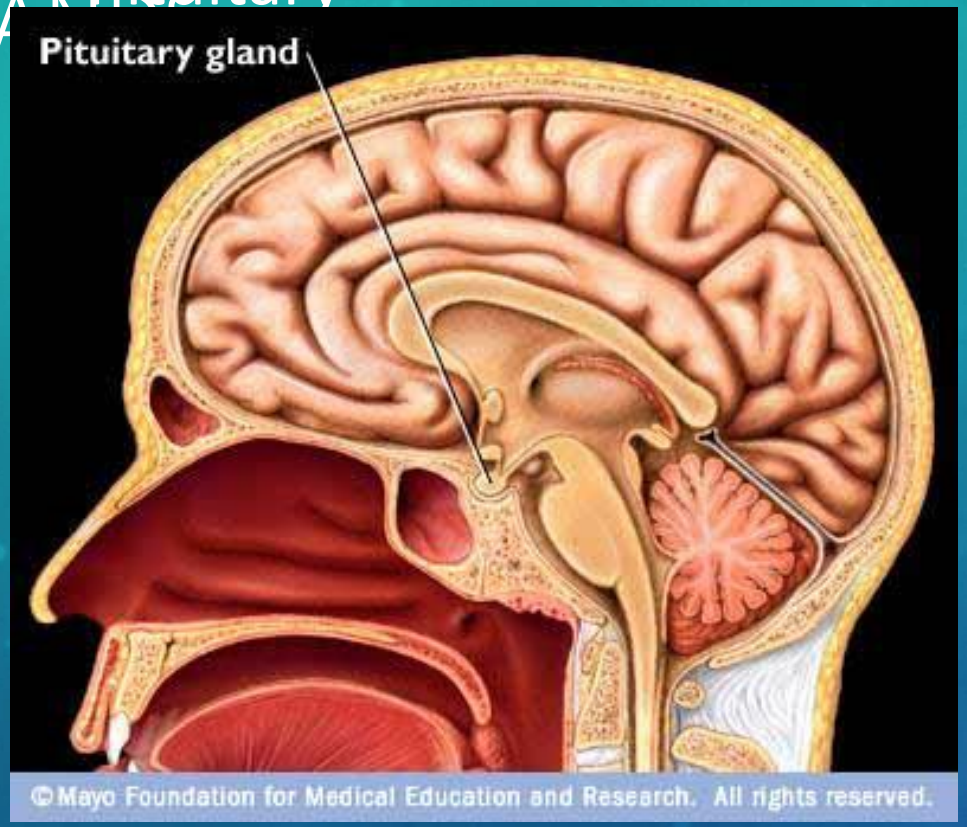
MAJOR GLANDS

- Adrenal: DANGER! Gland
  - Fight or flight response
  - Acrivitated by the autonomic nervous system
  - Location: top of kidney
  - Hormones: epinephrine (adrenal)/norepinephrine (non adrenal)
  - Effects: increased heart rate, blood pressure, blood sugar (energy!)
- Pituitary: Master Gland
  - Sex Gland
  - Location: core of the brain, pea size
  - Controlled by the hypothalamus (part of the brain)
  - Hormones: Various sex hormones
  - Effects: Puberty, reproduction

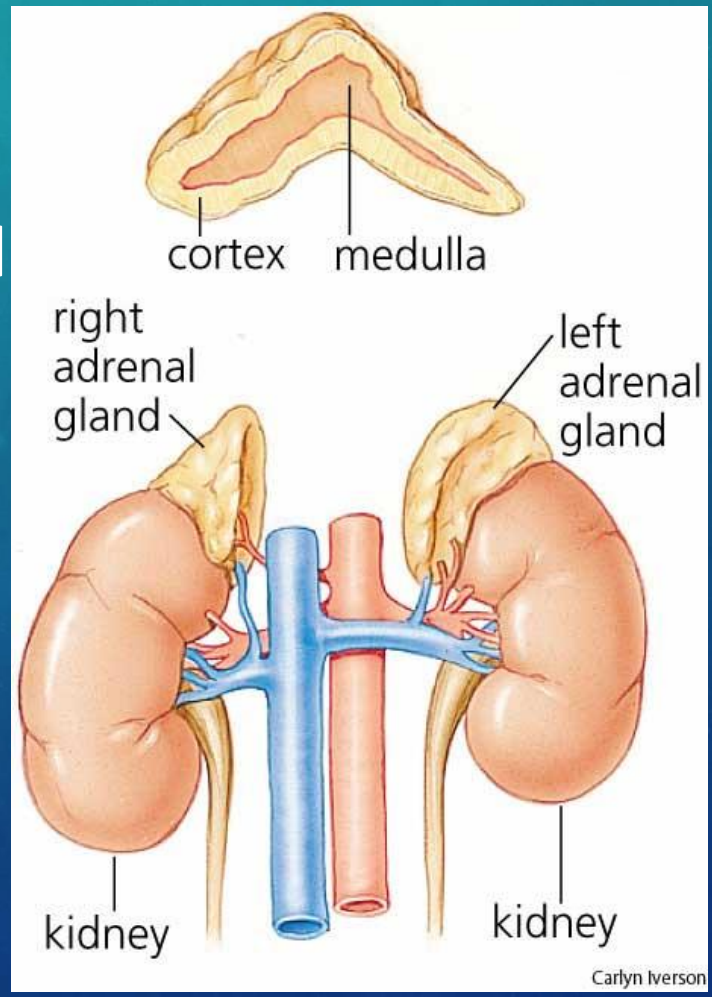
Useful place: http://www.hormone.org/hormones-and-health/what-is-the-endocrine-system/endocrine-glands-and-types-of-hormones

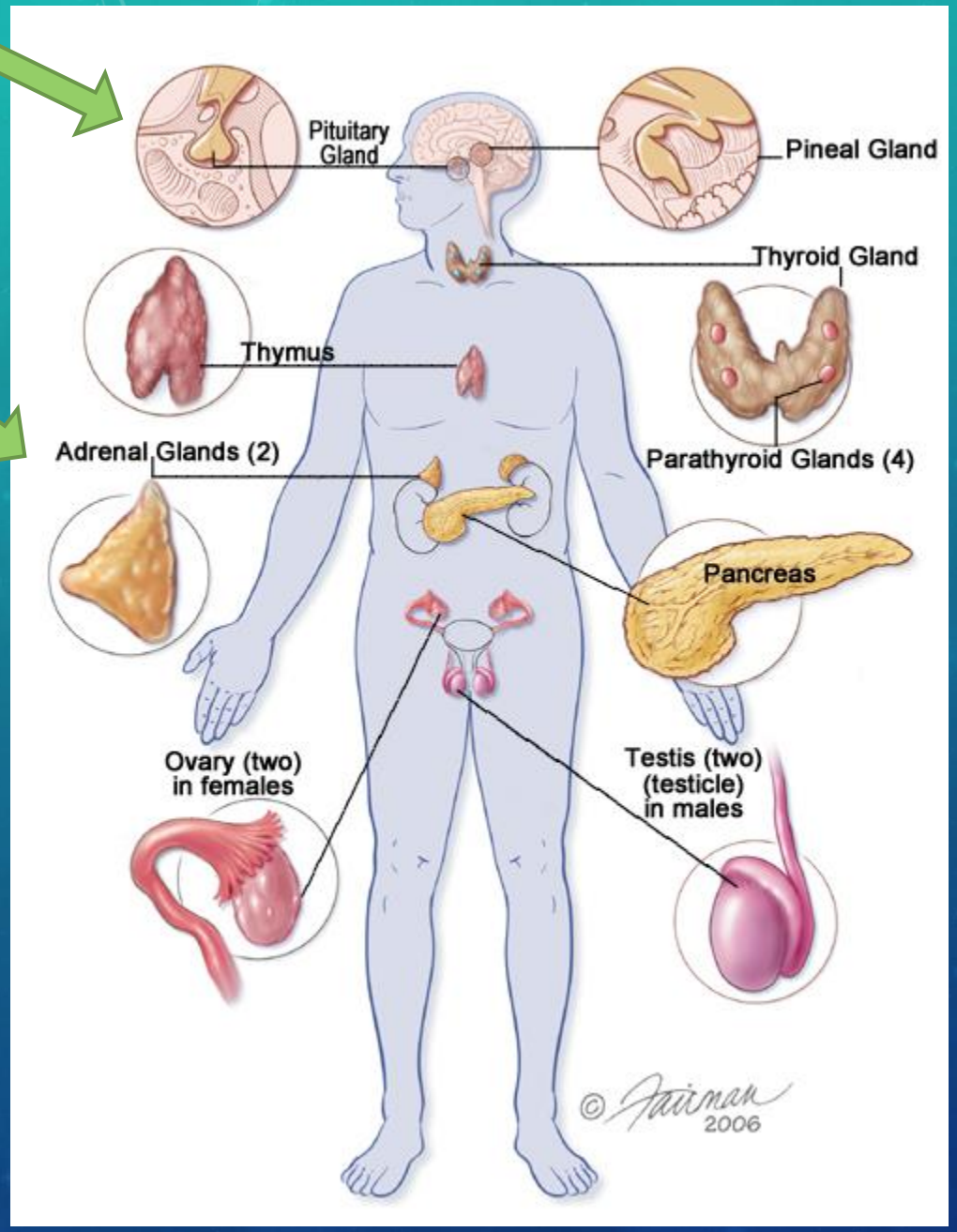
GLANDS

Pituitary



Adrenal




Pituitary Gland
Pineal Gland
Thyroid Gland
Thymus
Adrenal Glands (2)
Parathyroid Glands (4)
Pancreas
Ovary (two) in females
Testis (two) (testicle) in males
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