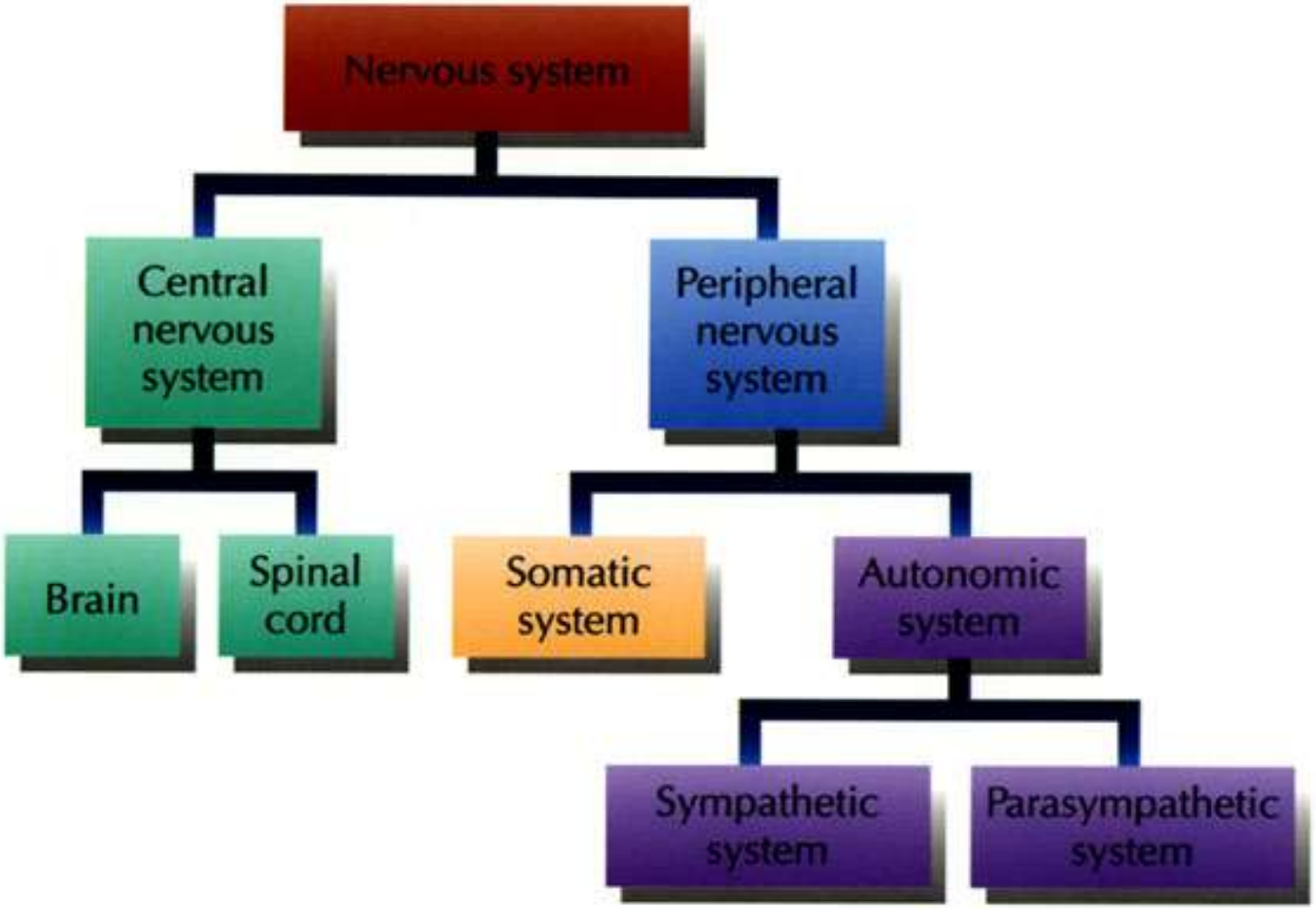
Chapter 2 – Neuroscience and Biological Functions

What let's you … read these words? Write with your pencil? Think about ideas? Walk to your next class?

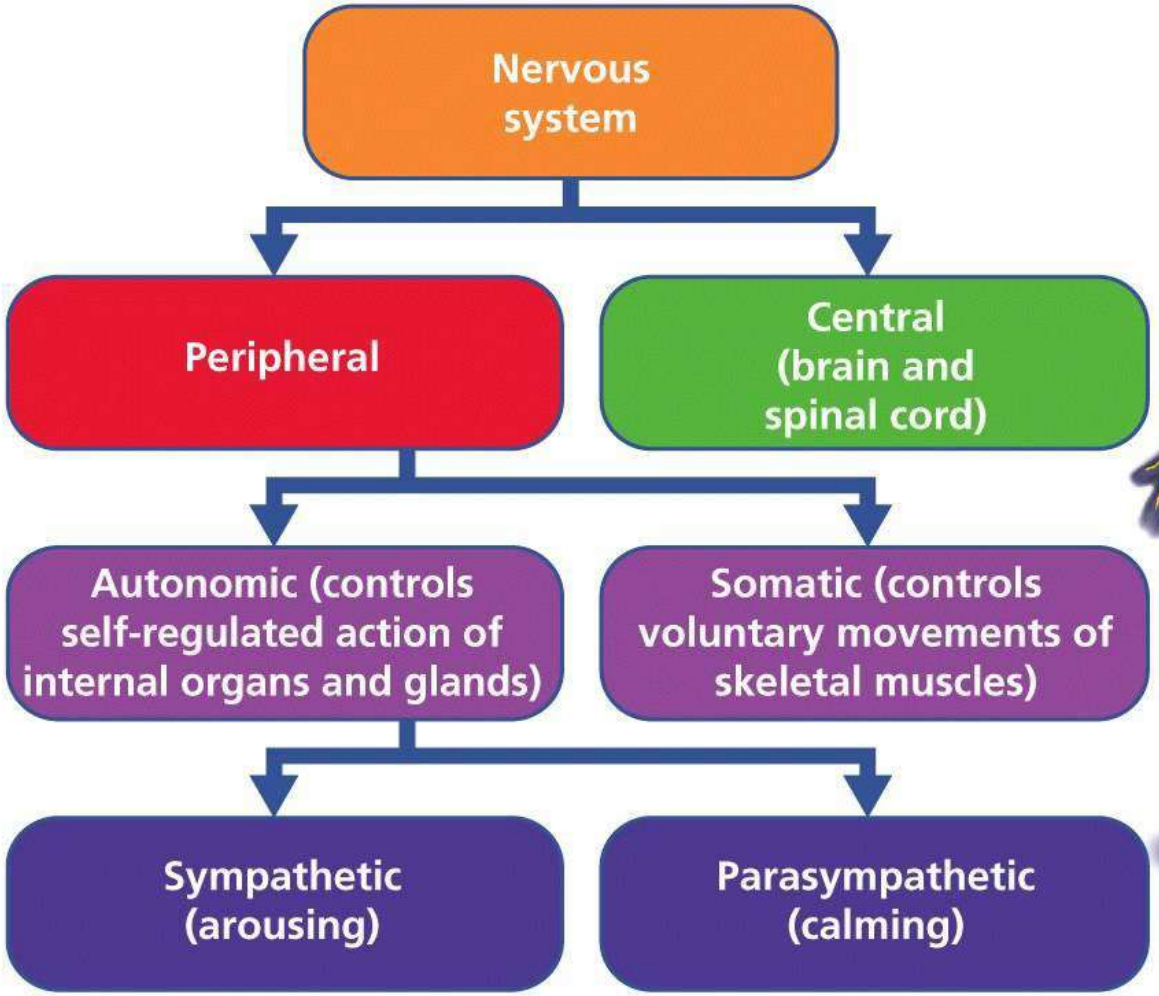
Your brain and nervous system!

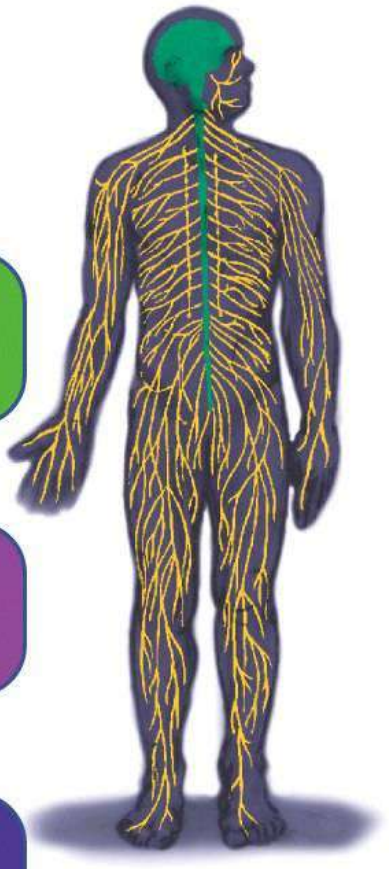
This chapter is about the important and exciting field of neuroscience & biopsychology

Subparts of the nervous system

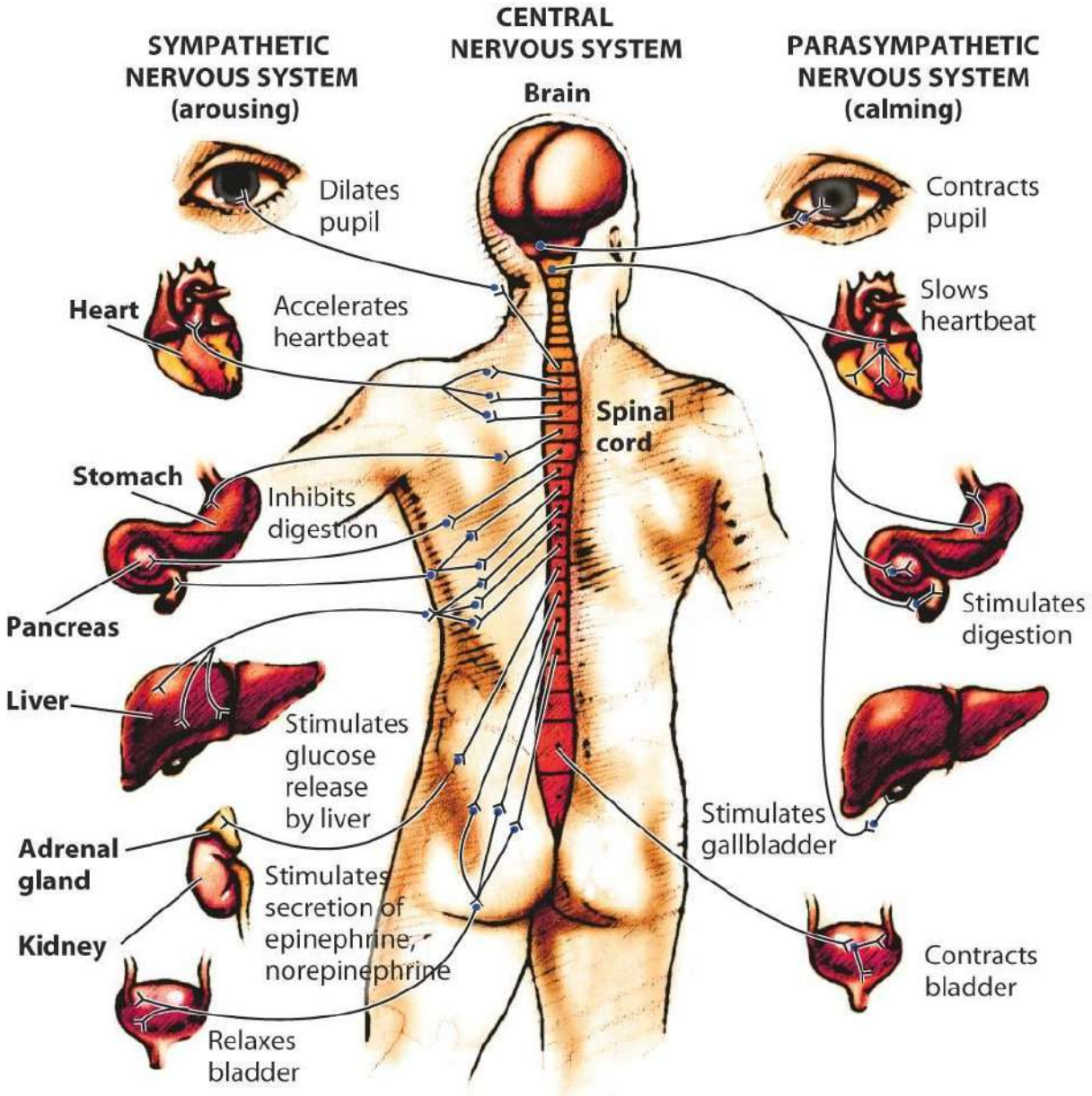


Divisions of the Nervous System

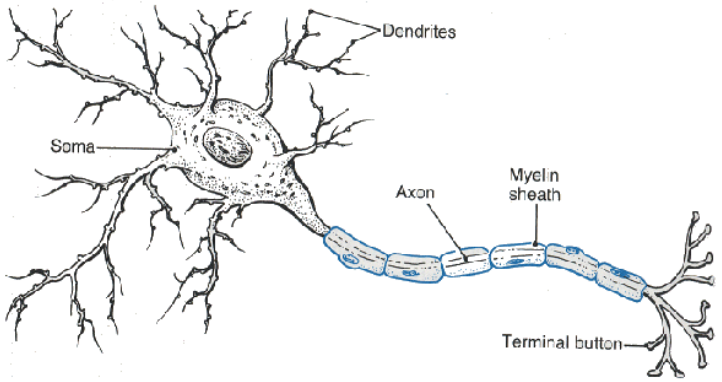




The Sympathetic and Parasympathetic Divisions of the Autonomic Nervous System



Neurons – What are they?



- The basic building block of the nervous system -- a nerve cell

- Neurons perform three basic tasks
  - Receive
  - Carry electrochemical information
  - Pass on to the next neuron

The brain is made up of approximately 100 billion neurons.

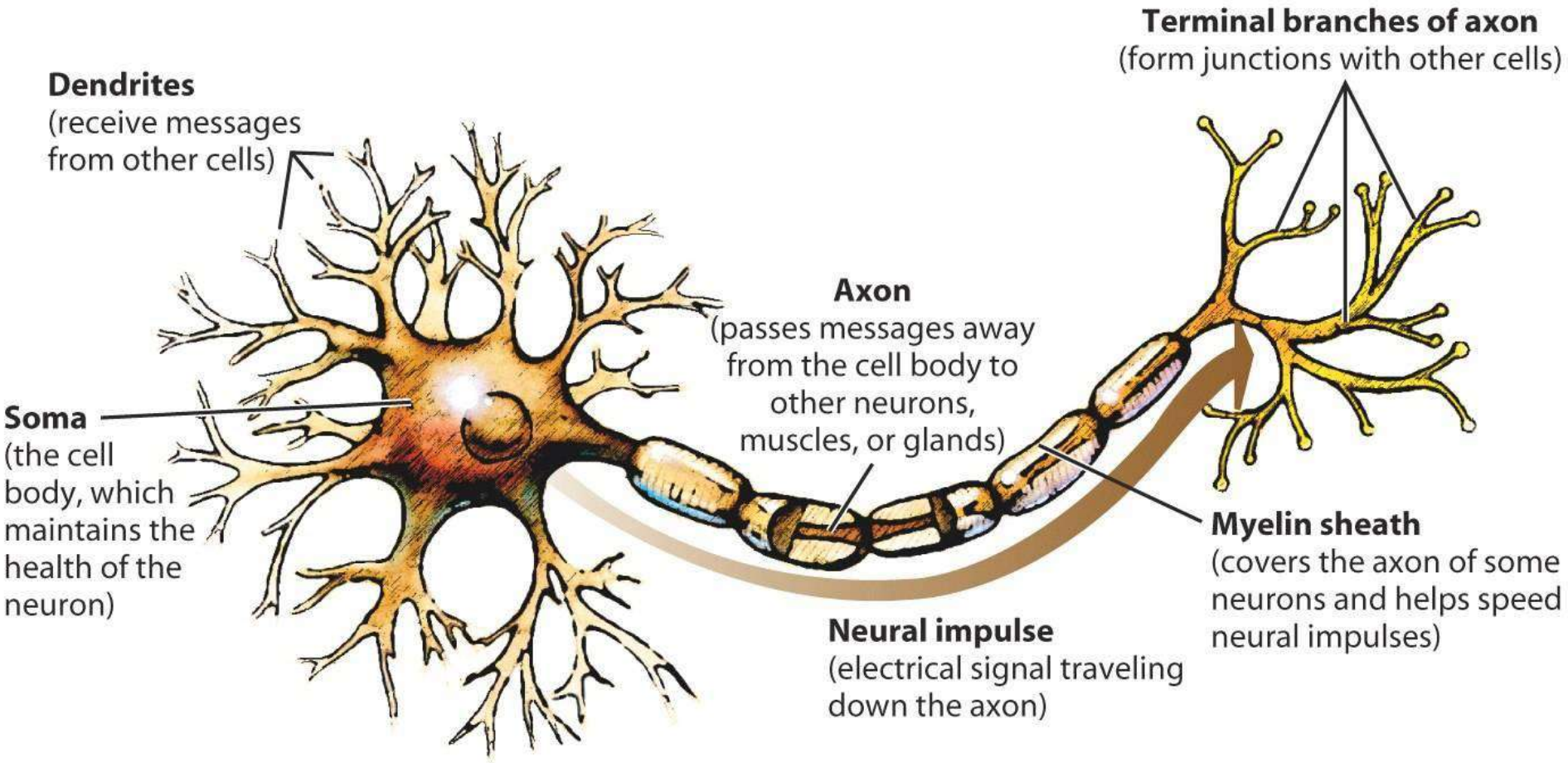
Neurons – How do they work?

- Neurons “fire” - send an impulse down their length - or they don’t “fire”

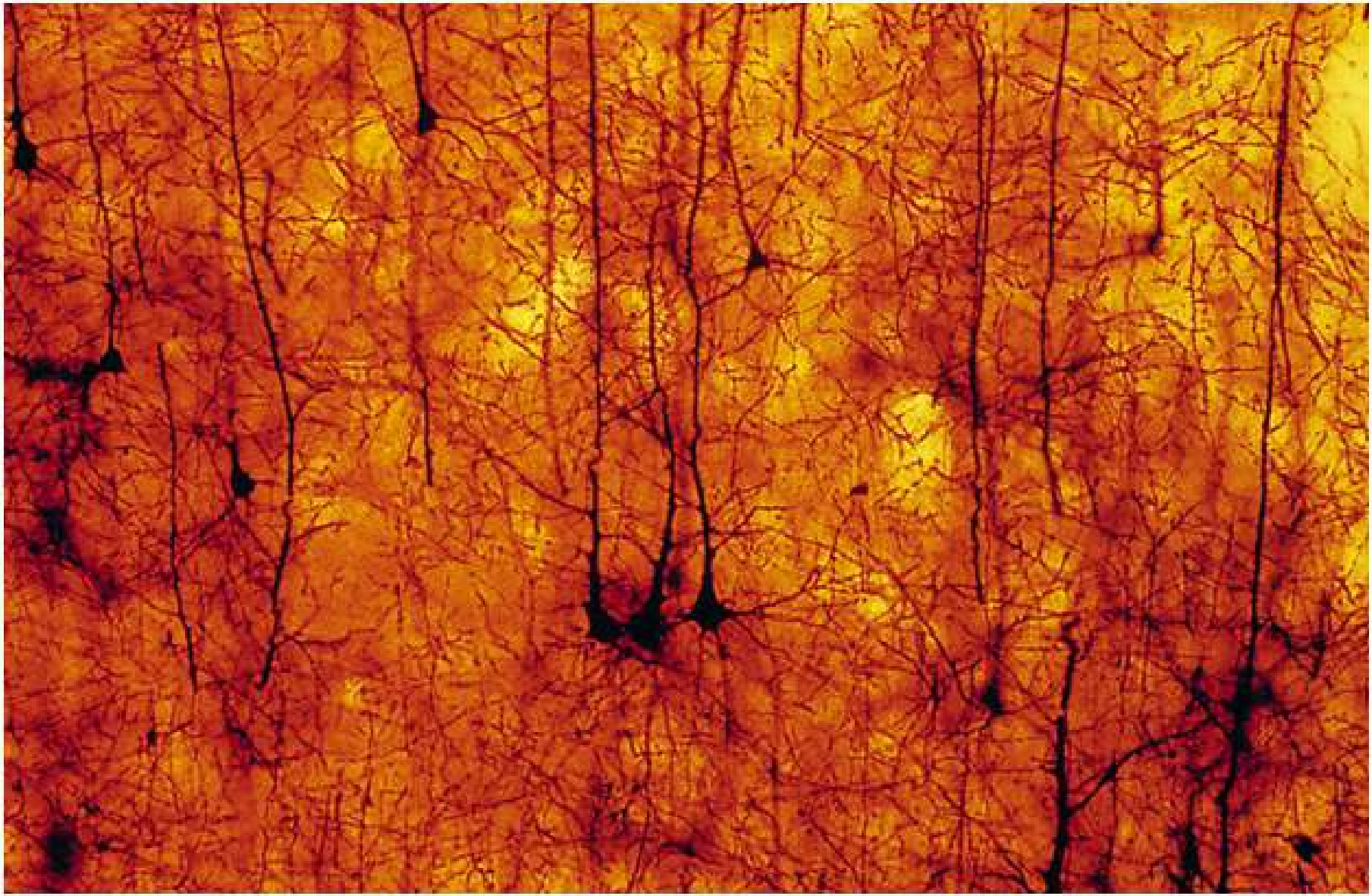
- Neurons come in a variety of shapes, sizes, etc.

- Types:
  - Sensory Neurons
  - Motor Neurons
  - Interneurons- Over 90%, connects nerves

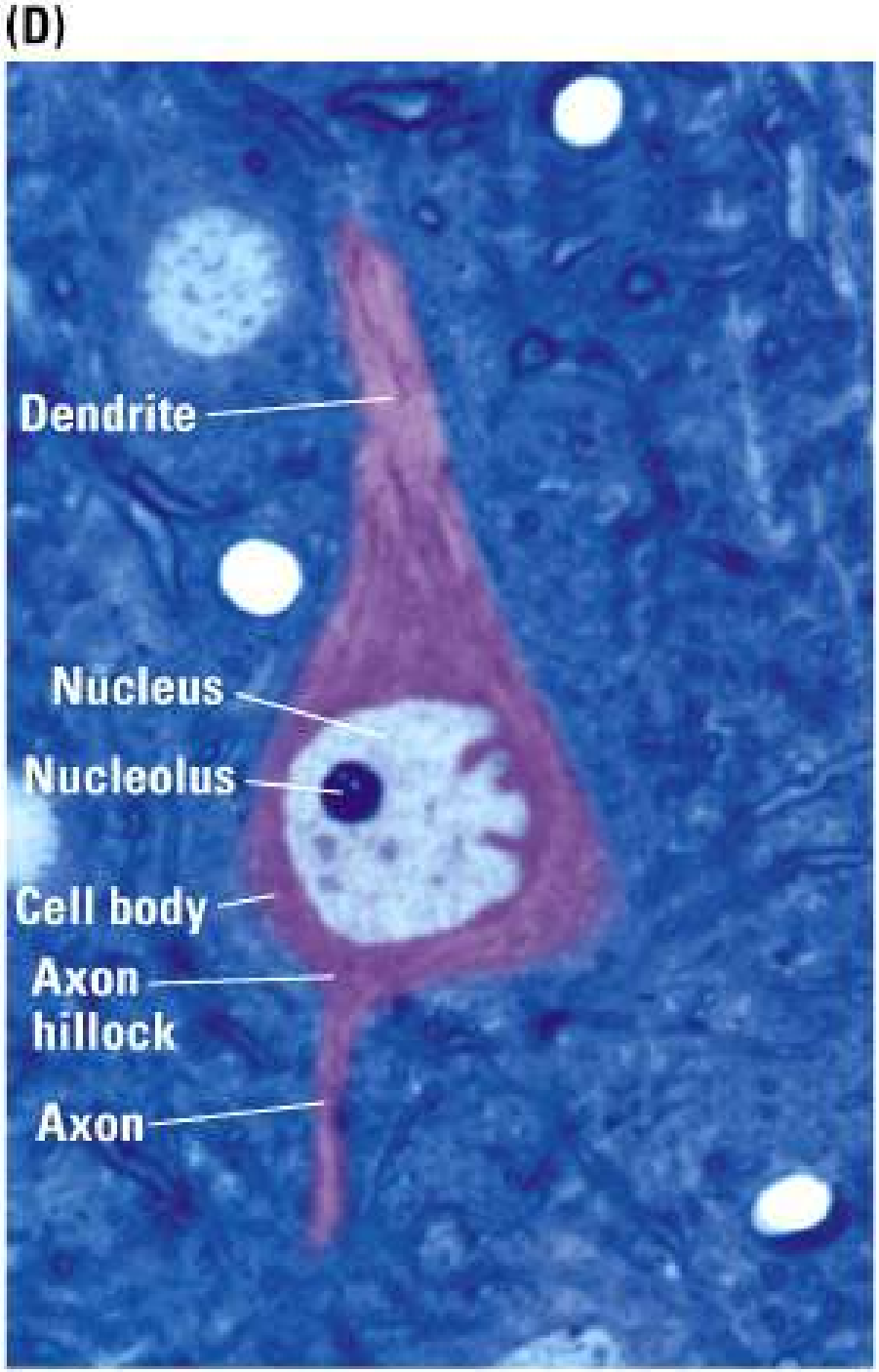
Parts of the Neuron - Terminals

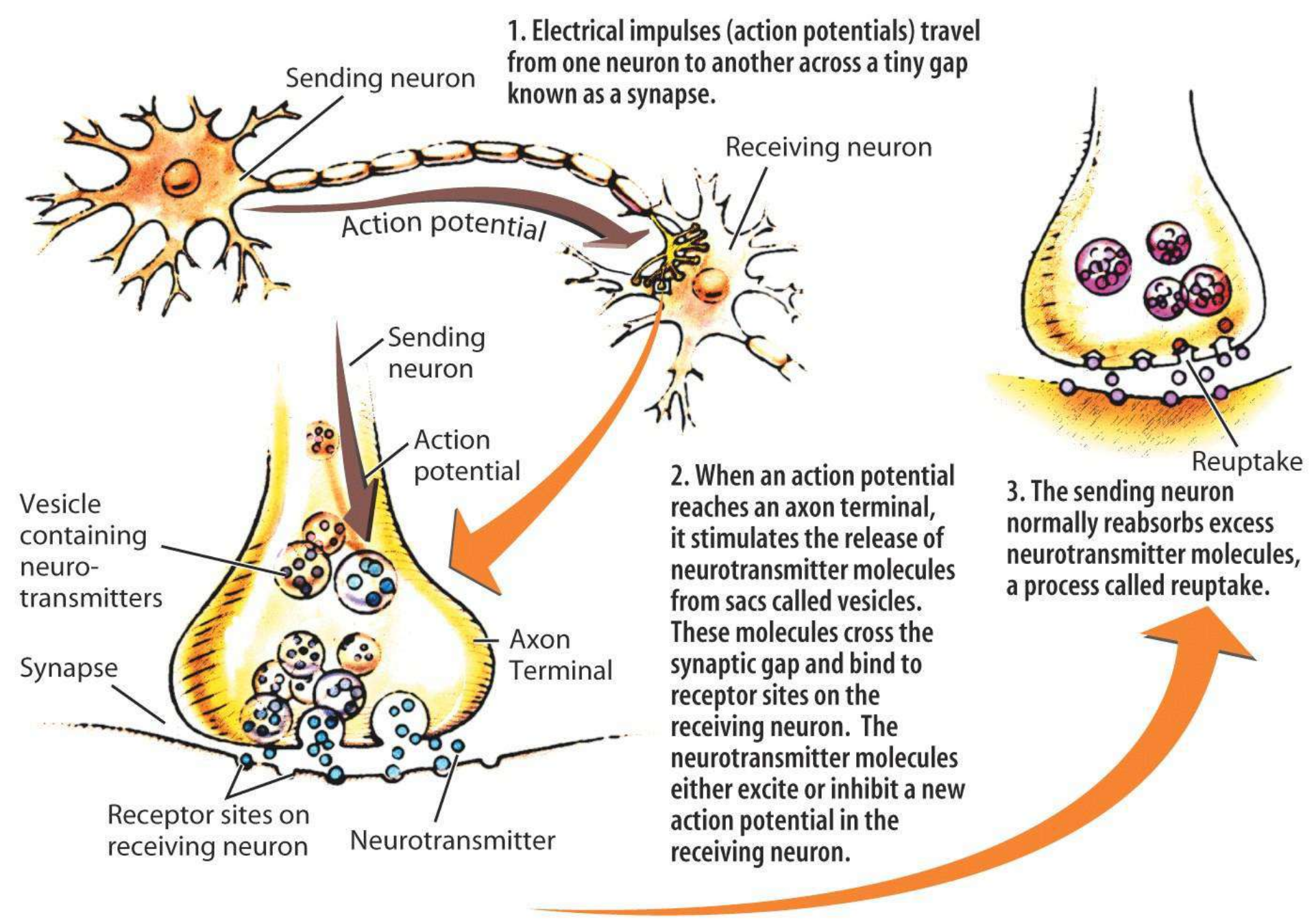


Neurons – magnified view



Neuron –

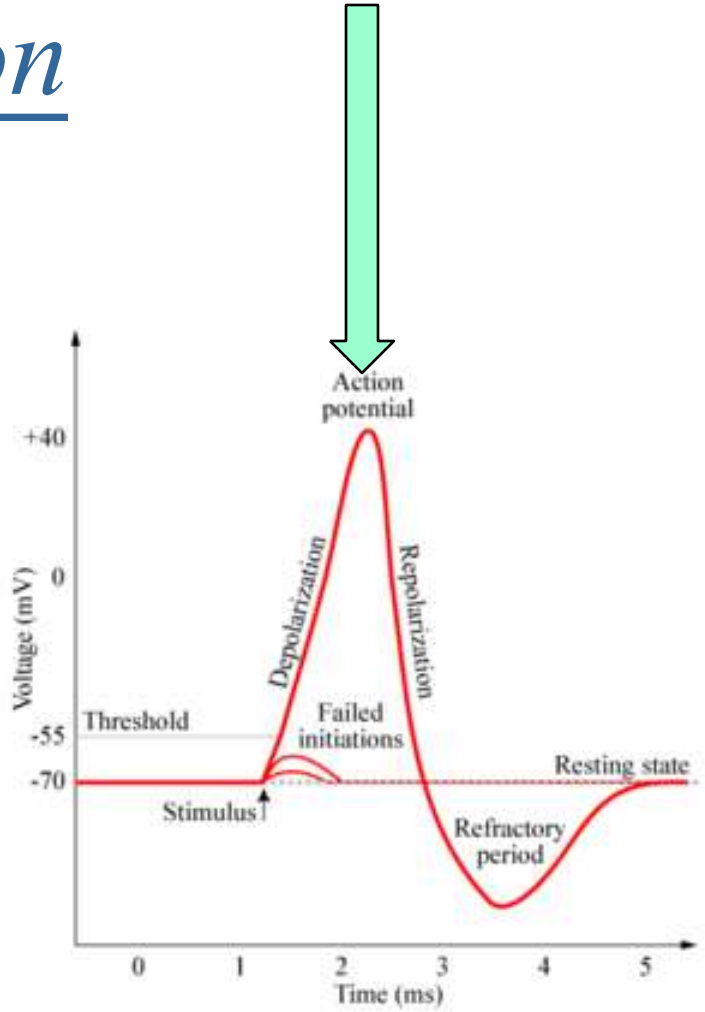



1. Electrical impulses (action potentials) travel from one neuron to another across a tiny gap known as a synapse.
Sending neuron
Receiving neuron
Action potential
Sending neuron
Action potential
Vesicle containing neuro-transmitters
Axon Terminal
Synapse
Receptor sites on receiving neuron
Neurotransmitter
2. When an action potential reaches an axon terminal, it stimulates the release of neurotransmitter molecules from sacs called vesicles. These molecules cross the synaptic gap and bind to receptor sites on the receiving neuron. The neurotransmitter molecules either excite or inhibit a new action potential in the receiving neuron.
Reuptake
3. The sending neuron normally reabsorbs excess neurotransmitter molecules, a process called reuptake.

Neuron Communication

Action Potential

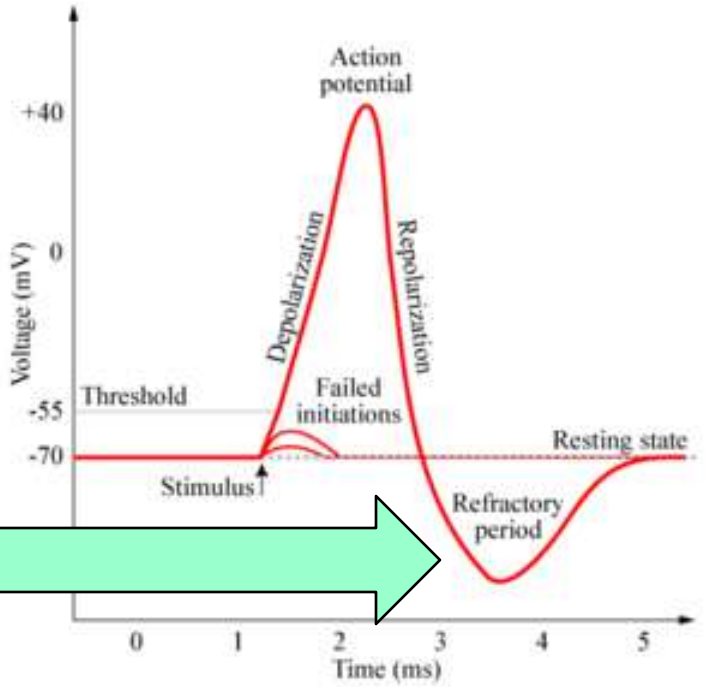
- A brief electrical charge that travels down the axon of the neuron.
- A neural impulse
- Considered an “on” condition of the neuron



Neuron Communication

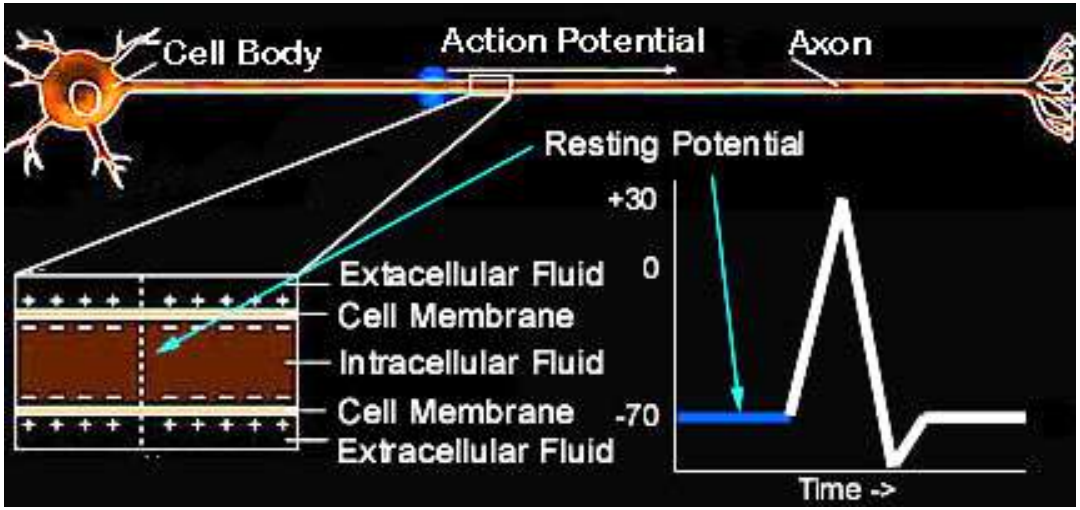
Refractory Period

- The "recharging phase" when a neuron, after firing, cannot generate another action potential



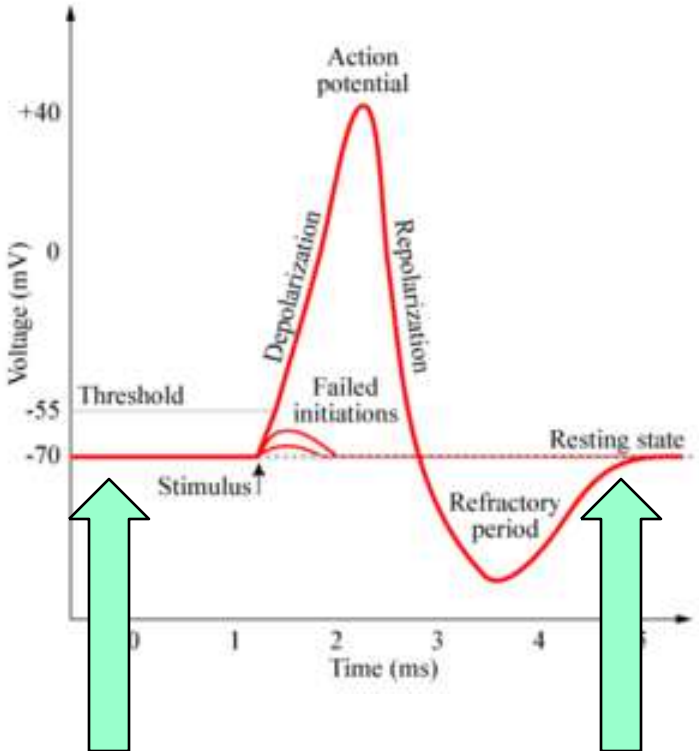
Neuron Communication

Resting Potential



The state of a neuron when it is at rest and capable of generating an action potential

- At rest, the inside of the cell is at -70 microvolts.
- With inputs to dendrites, the inside becomes more positive.
- If resting potential rises above threshold, an action potential starts to travel from cell body down the axon.
- Figure shows resting axon being approached by an AP.



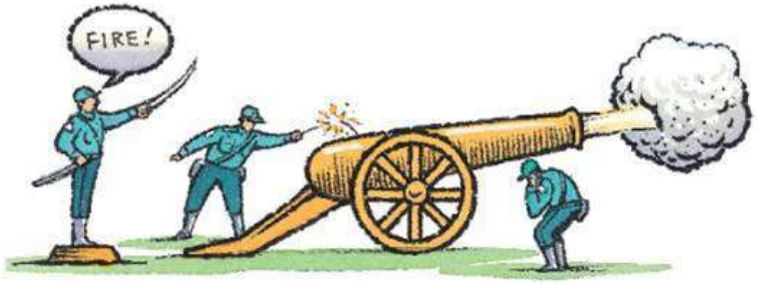
Neuron Communication

All-or-None Principle

- The principle that if a neuron fires it will always fire at the same intensity
- All action potentials are of the same strength.
- A neuron does NOT fire at 30%, 45% or 90% but at 100% each time it fires.

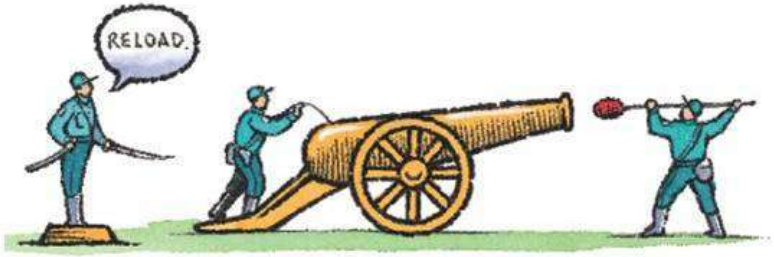
THREE PHASES OF COMMUNICATION WITHIN A NEURON

Action potential



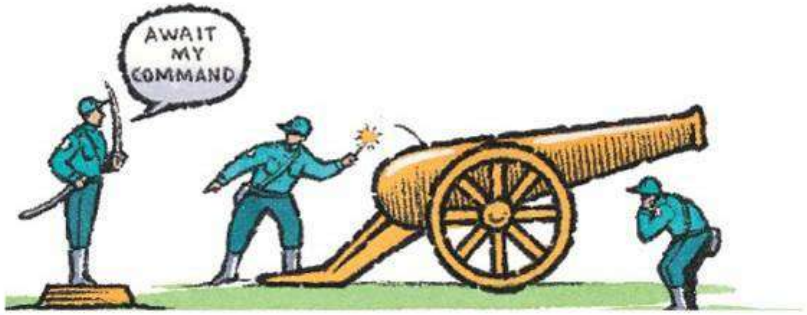
The neural impulse created when a neuron "fires." The impulse travels from the dendrites down the axon to the terminal branches.

Refractory period



The brief instant when a new action potential cannot be generated because the neuron is "recharging" after the previous action potential.

Resting potential



The state of a neuron when it is "charged" but waiting for the next action potential to be generated.

Neurotransmitters

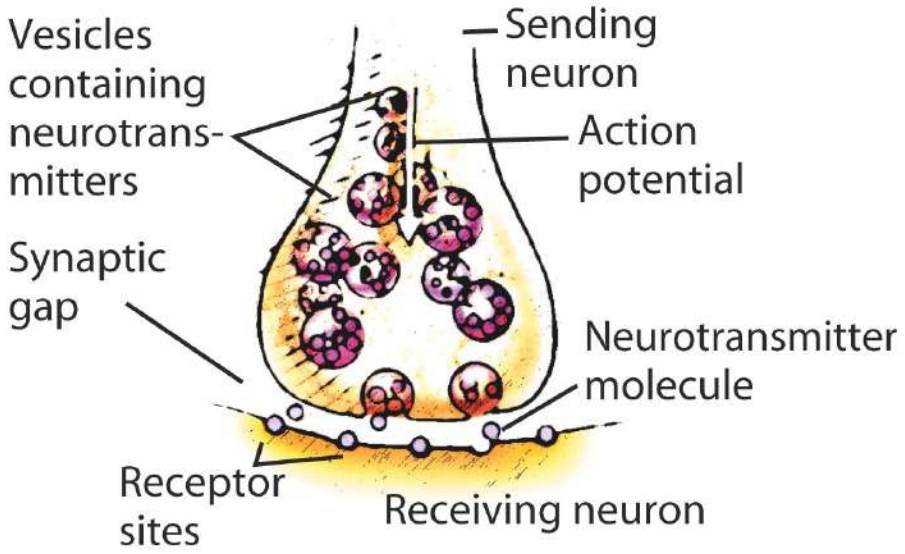
A chemical messenger that travels across the synapse from one neuron to the next

Can influence whether the second neuron will generate an action potential or not

Researchers have discovered hundreds of substances known to function as neurotransmitters

…they help promote sleep, alertness, learning and memory, motivation and emotions

…they can also influence or cause psychological disorders including depression & schizophrenia



Neurotransmitters carry a message from a sending neuron across a synapse to receptor sites on a receiving neuron.

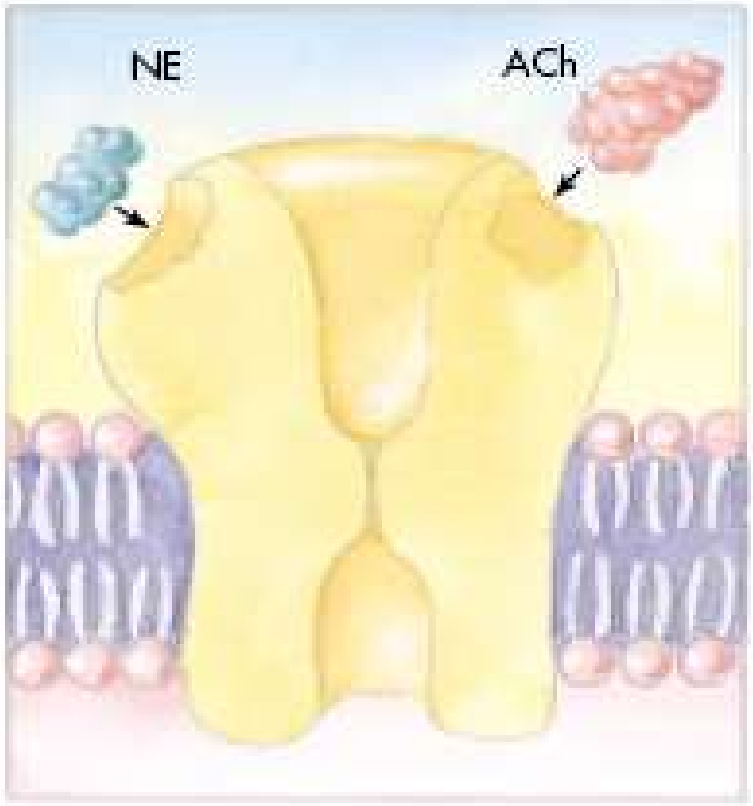
Neurotransmitters

Locks and Keys

- Neurotransmitter molecules have specific shapes.

Receptor molecules have binding sites.

When NT binds to receptor, ions enter.



Combining Within & Between Cell Communication

- Excitatory Postsynaptic Potentials: binds at receptor and makes the neuron more positive

- Inhibitory Postsynaptic Potentials: binds at receptor and makes the neuron more negative

Neurotransmitters - _____

Agonist: Mimics the action of a NT

Antagonist: Opposes the action of a NT

Endorphins: elevate pleasure/mood and reduce pain, act by either increasing or decreasing specific NT activity, mimic effects of opium based drugs like morphine

Curare: Paralyzing poison.

Select Neurotransmitters

Acetylcholine (Ach)

- Involved in muscle movement and memory- ALZ

Serotonin

- Involved in mood and sleep- Depression

Dopamine

- Involved in movement and reward systems Schizophrenia, Parkinson‘s

GABA (gamma-aminobutyric acid)

- Inhibitory NT

Norepinephrine

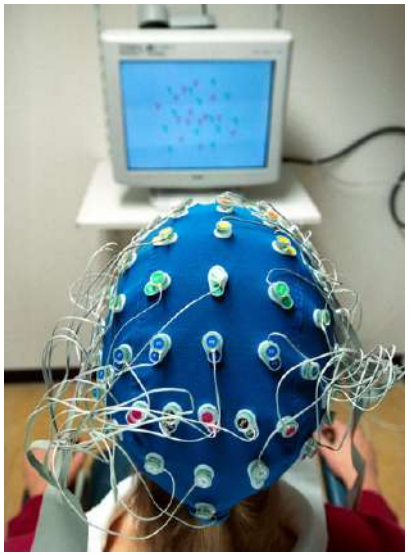
- Involved in arousal, mood, and sympathetic nervous system activation- Bipolar

Opioids

- Involved in pathways that reduce pain

Studying the brain

- EEG - Electroencephalograph:
- Electrical activity (brain waves)

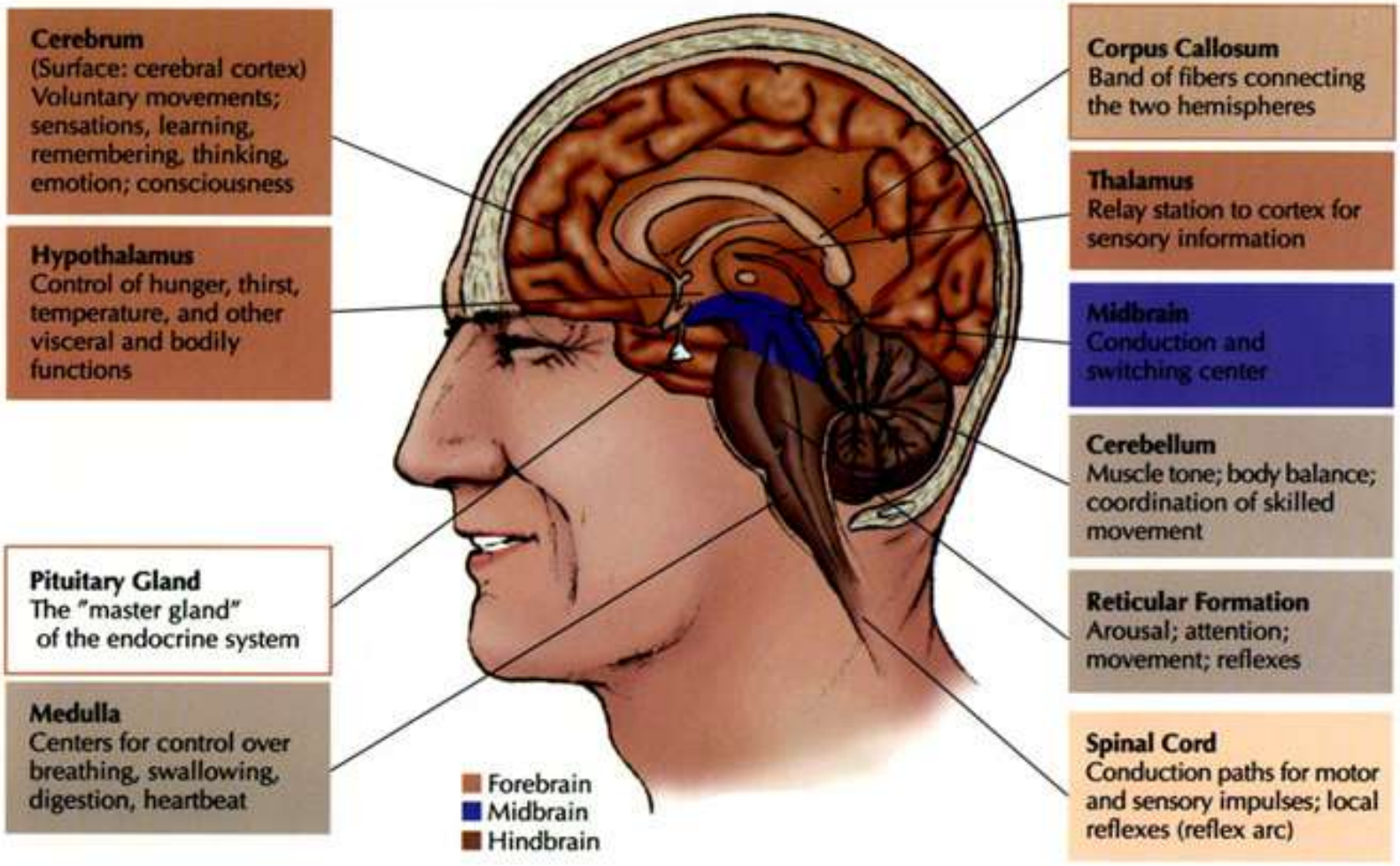


- Lesioning: Destroying a part of the brain
- Electrical stimulation: brain surgery
- Brain imaging
  - PET - maps brain activity (heat-glucose)
  - MRI - picture of brain from many angles
  - CT ("Cat") Scan - X-ray

Anatomy of the Brain

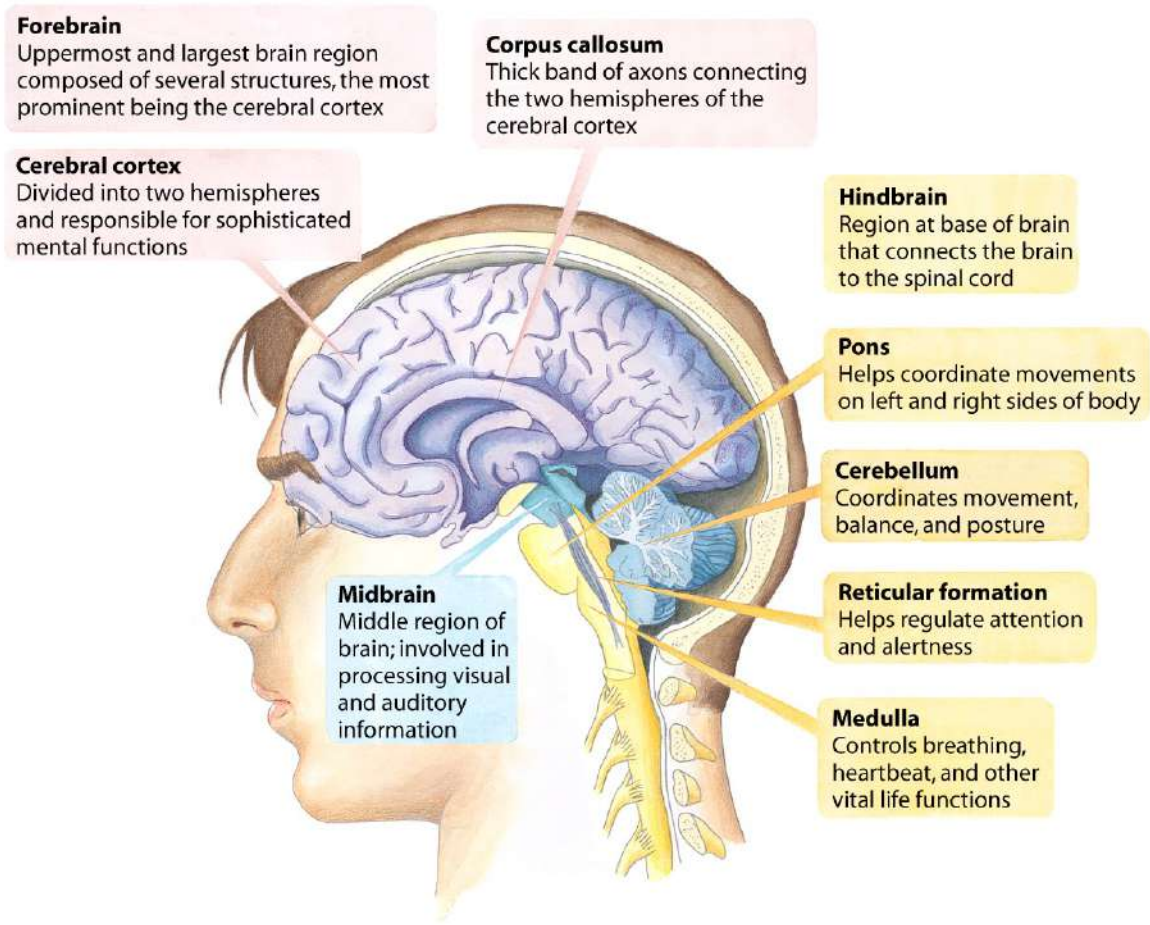
- **Hindbrain**
  - Medulla: controls vegetative function
  - Pons: sleep and wake-fullness
  - Cerebellum: coordination of movement and postural reflex
- **Midbrain**
  - Reticular Formation: oversees arousal and attentional processes
- **Forebrain**
  - Limbic System: controls emotions and memory
  - Hippocampus
  - Hypothalamus
  - Amygdala
  - Thalamus: primary relay station for the senses
  - Cortex: Lobes of brain, upper, wrinkled area
  - Corpus Collusum: nerve cells connecting the hemispheres of the brain

The main structures of the human brain



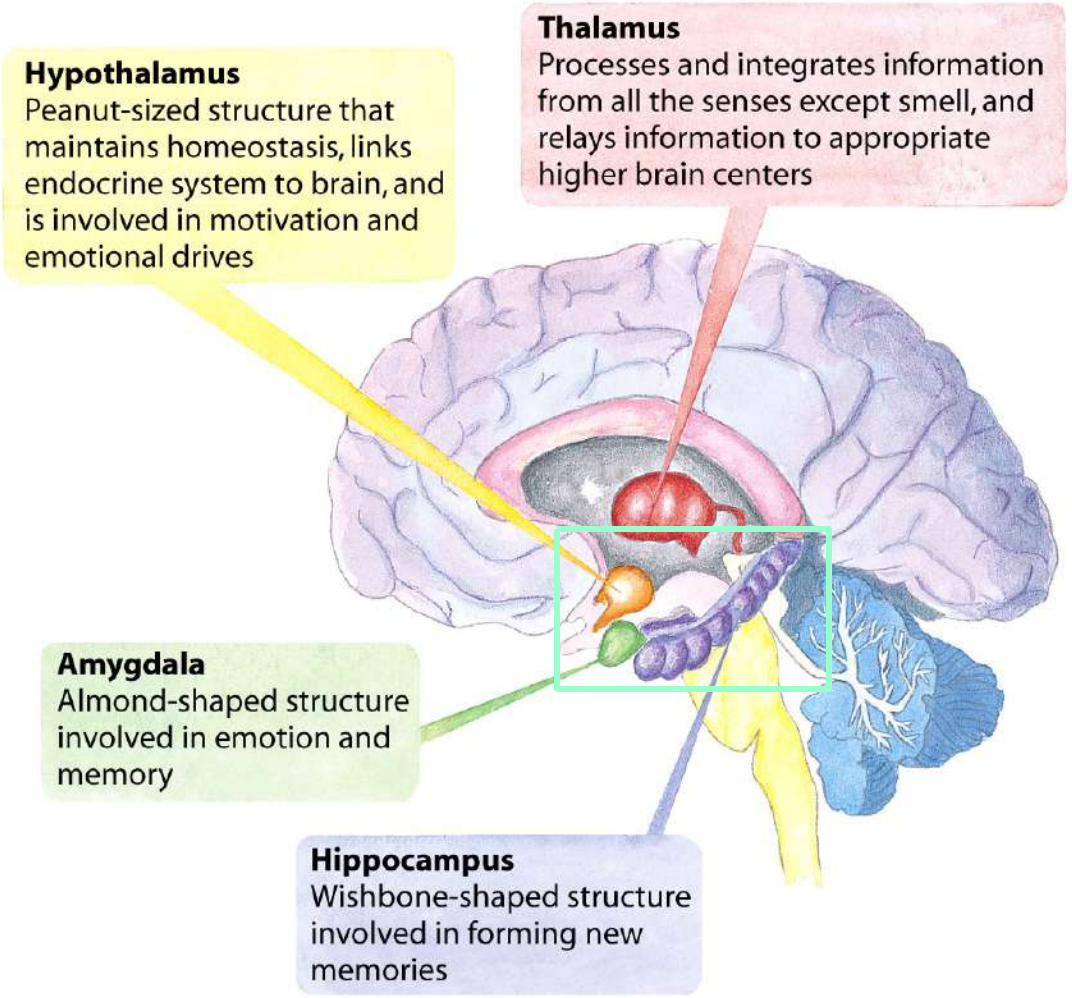
Hindbrain Structures

- Cerebellum
- Brainstem
  - medulla
  - reticular formation
  - pons

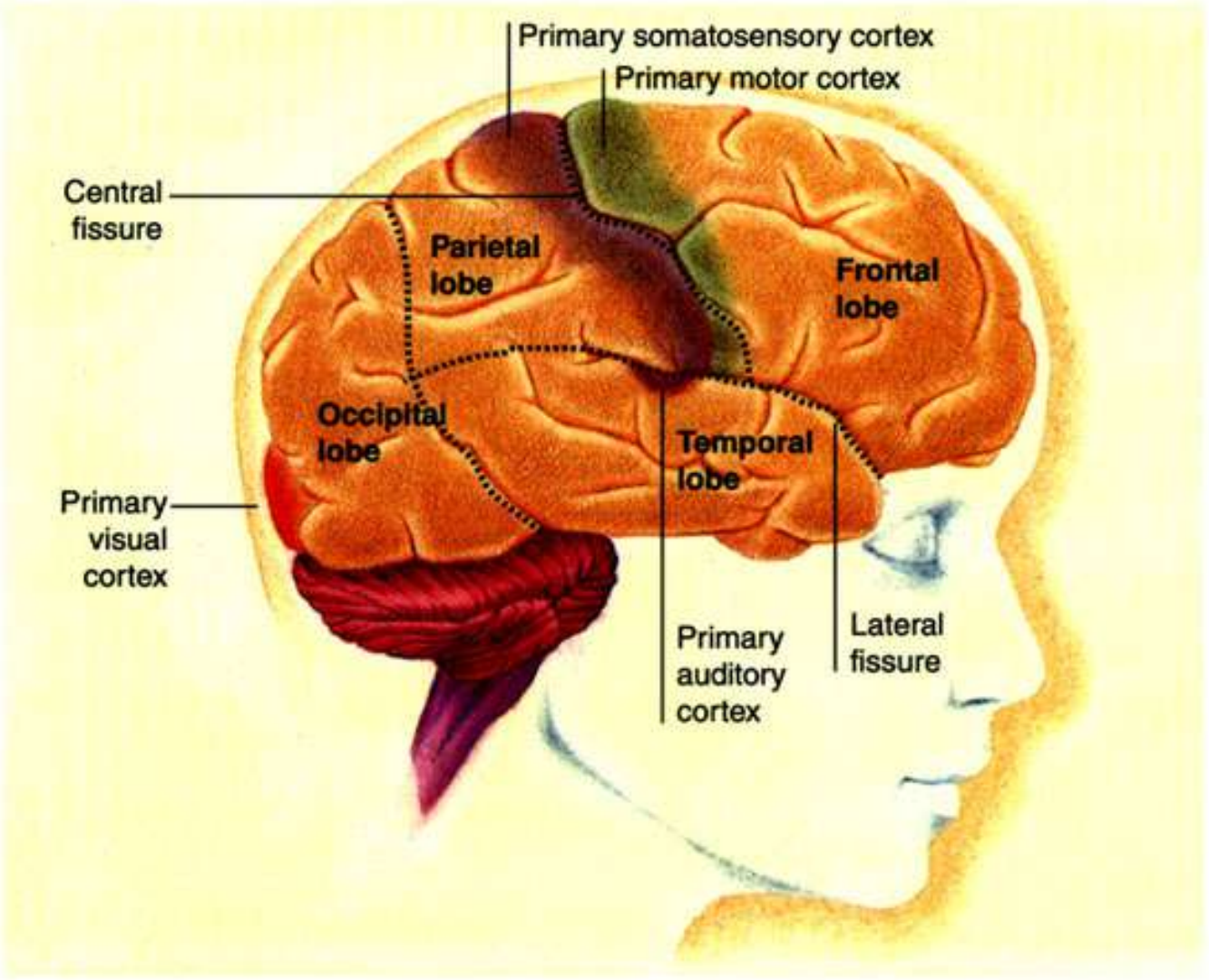


Forebrain's Limbic System

- Hypothalamus
- Amygdala
- Hippocampus

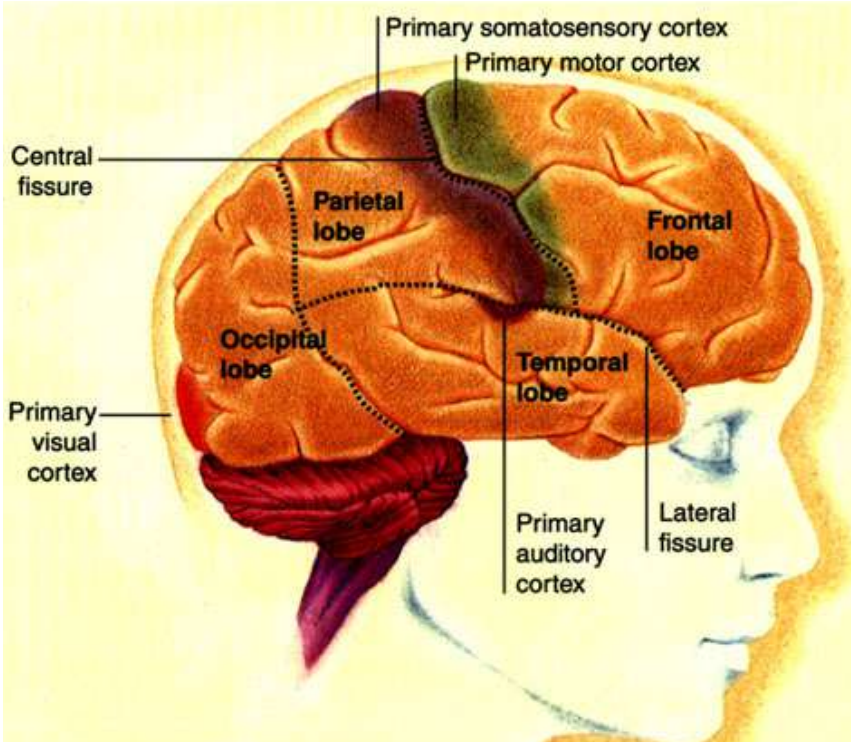


Cerebral cortex



Cerebral Cortex

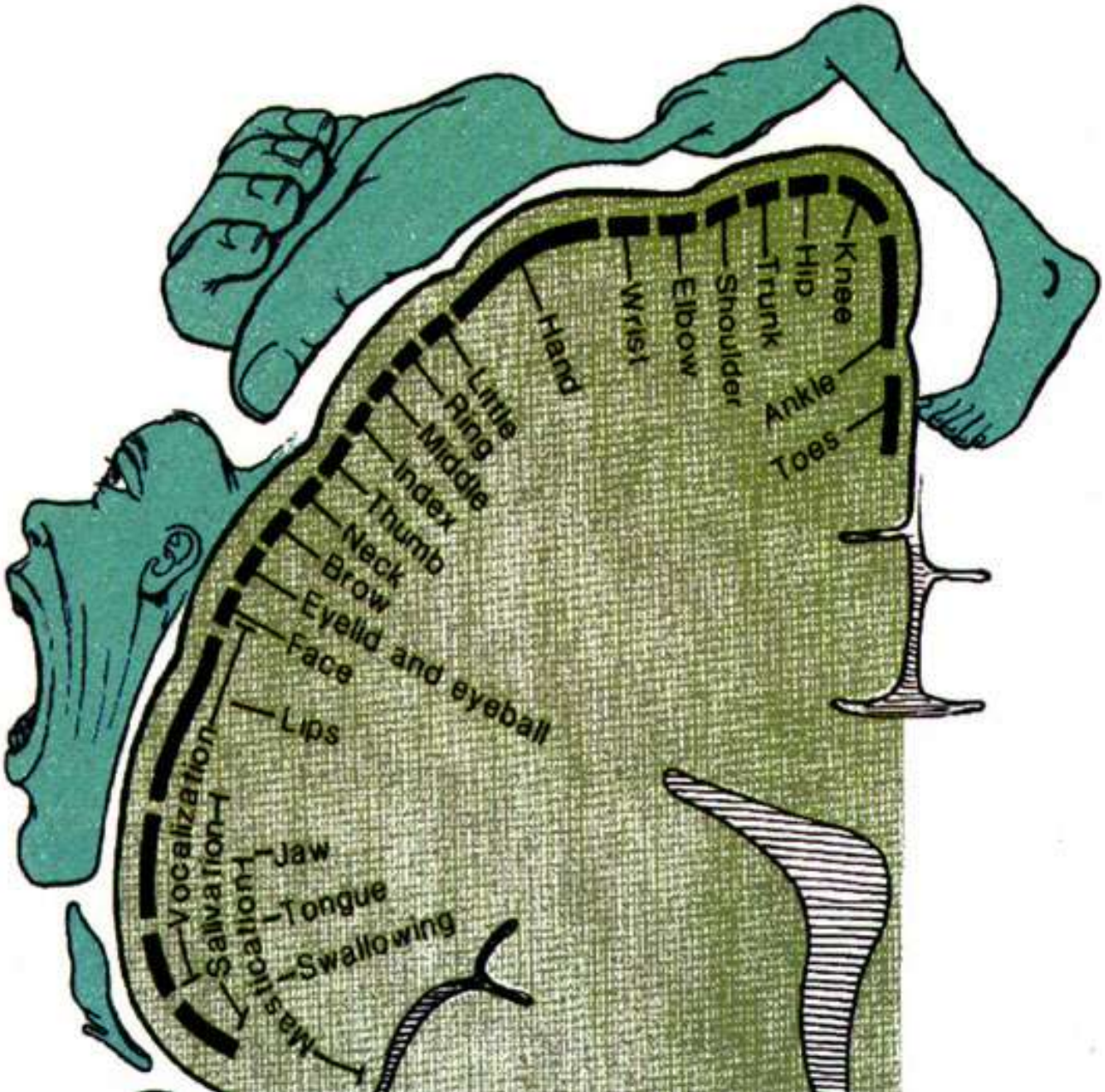
- Frontal Lobes
  - decision making
- Temporal Lobes
  - critical for hearing & balance
  - important in memory
- Occipital Lobes
  - responsible for visual processes
- Parietal Lobes
  - receives sensory information



Motor Homunculus

Motor Cortex

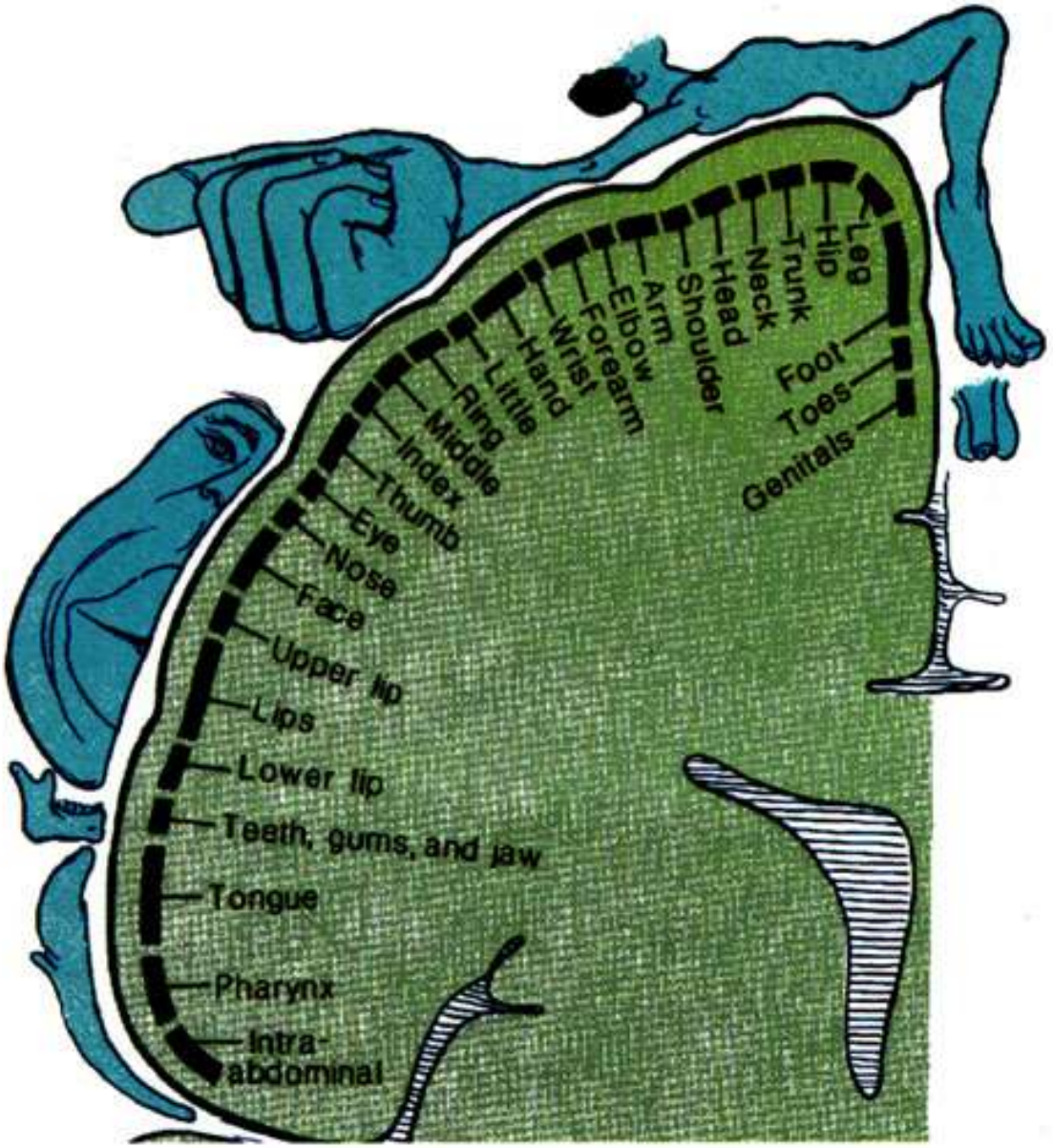
The size of the body part indicates the amount of area on the motor cortex and the degree to which complex movements can be performed.



Somatosensory Homunculus

Somato-sensory Cortex

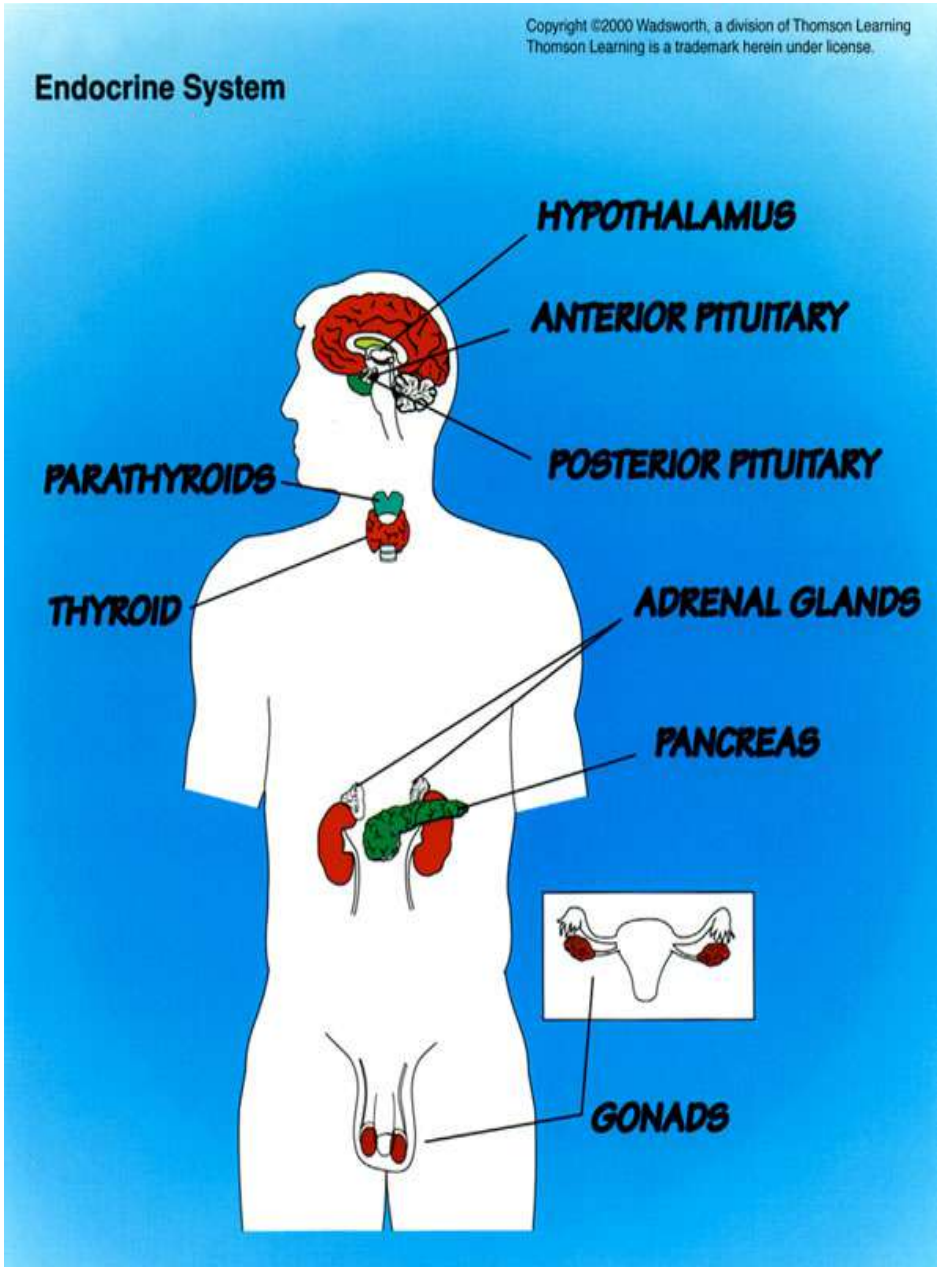
The size of the body part indicates the amount of area on the somatosensory cortex and the degree of sensitivity to external stimulation.



Endocrine System

A second type of communication system in the body made up of a network of glands

- Hypothalamus signals to the pituitary
- Pituitary signals other glands of the endocrine system to secrete hormones
- Examples of hormones:
  - Estrogen/testosterone
  - Thyroid
  - growth hormone
  - follicle-stimulating hormone

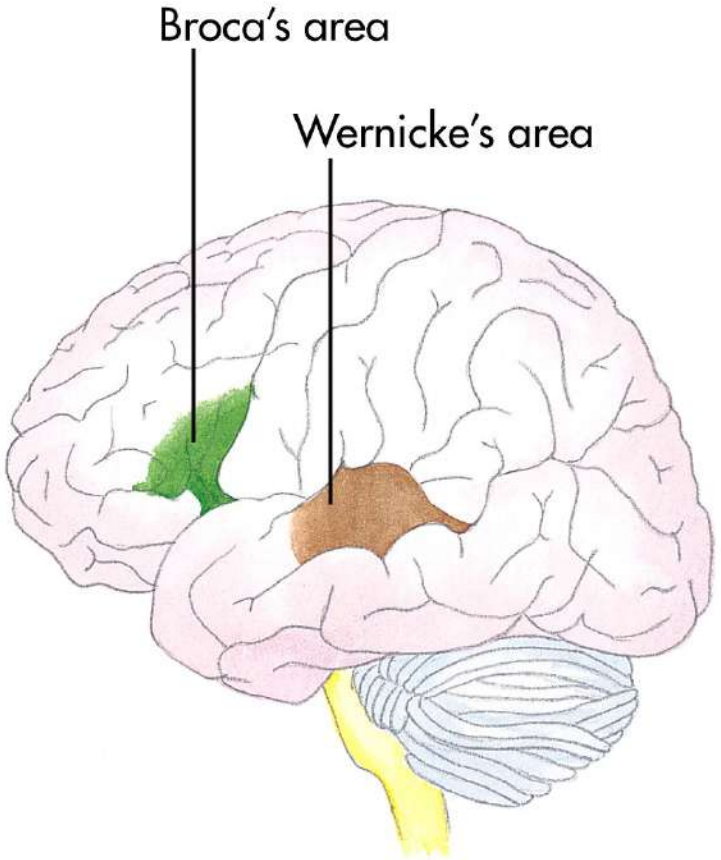


Language and the Brain

- Aphasia — partial or complete inability to articulate ideas or understand language because of brain injury or damage

- Broca's area —speech production

- Wernike's area — plays role understanding speech



Genetics

Behavioral Genetics – how heredity and environment affect us

Evolutionary Psychology – how the natural process of adapting to our environment affects us

Chromosomes: threadlike molecule of DNA that carries genetic information

Genes: Thousands of genes are on each chromosome. They carry the codes for hereditary transmission.

Dominant and Recessive Traits:

Polygenic:

Methods for Studying Inheritance: twin studies, family studies, adoption studies, and genetic abnormality studies