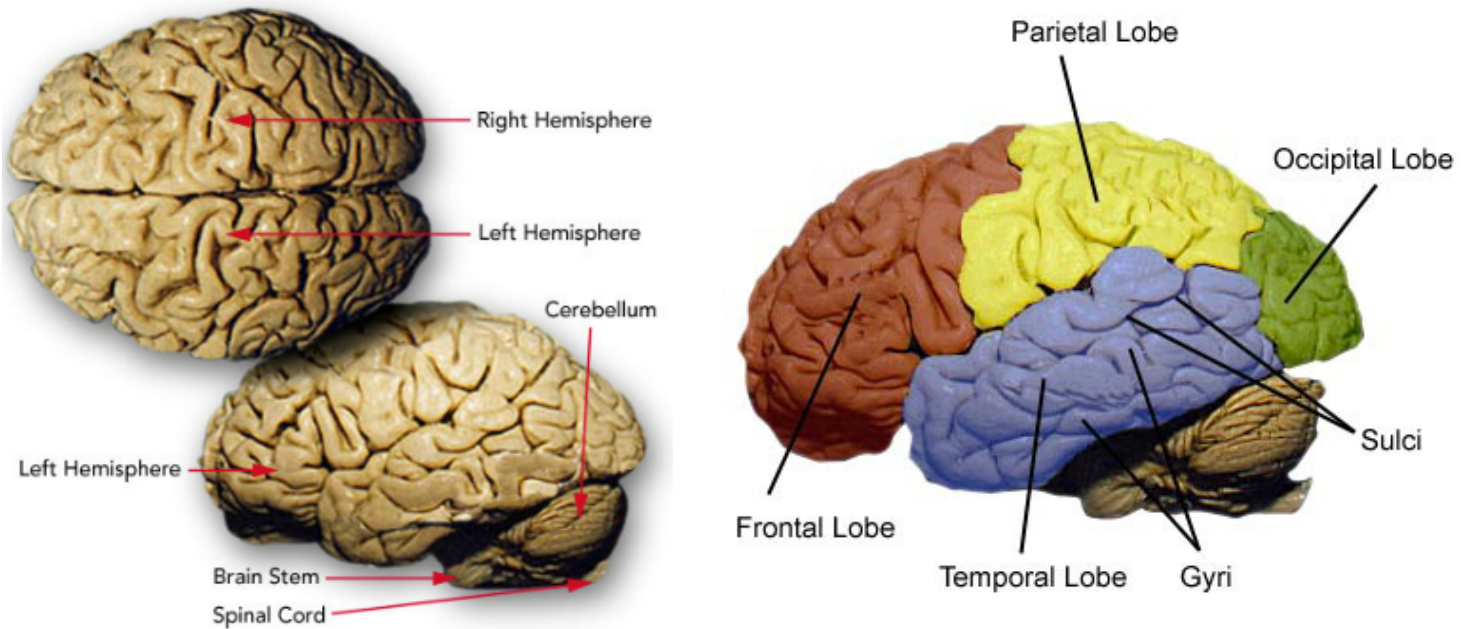


Module 6: Nervous System



Gyri- bumps **Sulci**- grooves

Frontal Lobe

- Contains the primary motor cortex (posterior end) that processes skeletal mm. input. Motor association area (premotor cortex) and the prefrontal cortex integrate mvmt info with other sensory input to generate interpretation of stimuli

Parietal Lobe

- Contains the primary somatosensory cortex (anterior end), which receives sensory input from major sense organs and sensory info from opposite side of the body (pain, temp, touch, vibration). Association areas integrate sensory info with other association areas of the cortex to form meaningful perceptions

Temporal Lobe

- Contains primary auditory cortex and auditory association areas which receive/process signals from the auditory nerve and integrate them with other sensory inputs. Smell and mediating short-term memory storage/recall are also involved

Occipital Lobe

- Contains the primary visual cortex which receives input directly from the optic nerve, as well as visual association areas that further process visual info integrating it with other sensory inputs
- Optic nerve meets at the optic chiasma (cross over) to become optic tracts → lateral geniculate bodies of thalamus → primary visual area

Corpus Callosum

- Pathway cnxn between 2 cerebral hemispheres. Allows whole body coordination (R/L)

Diencephalon

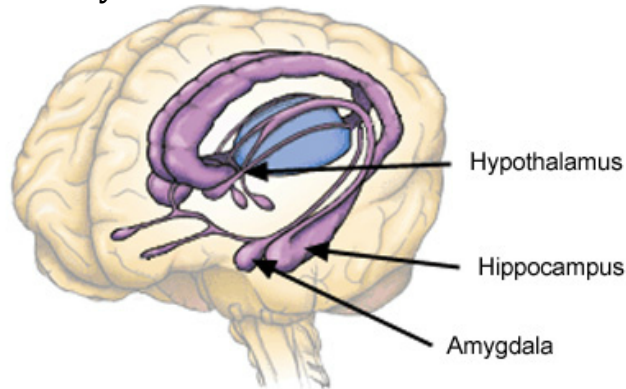
- THALAMUS receives sensory inputs from spinal cord and integrates it before sending it to the cortex

- HYPOTHALAMUS controls endocrine functions (body temp, thirst, food intake, directs release of hormones in Pit G), regulates food intake, CV regulation, circadian rhythm, coordination of emotional behaviors. **Negative feedback!!**

Pituitary Gland

- Regulates other endocrine organs. Ant Pit G derived from epithelial tissue of pharynx, releasing LH, FSH, ACTH, TSH, GH
- Post Pit G. derived from neural tissue, releases vasopressin and oxytocin

Limbic System



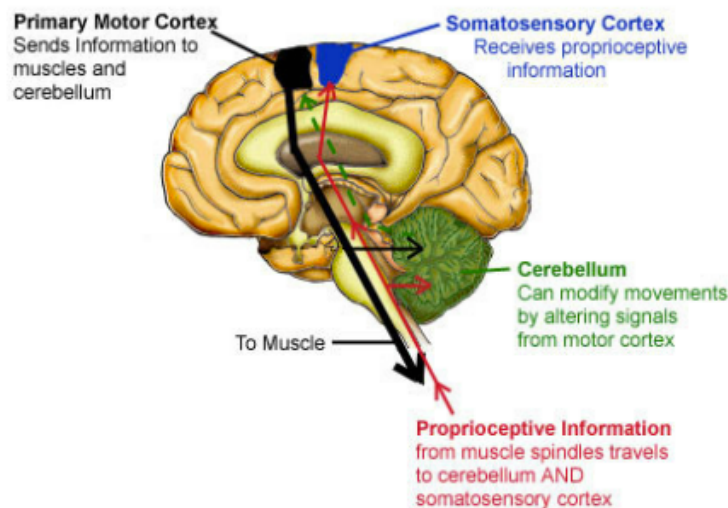
Key Function: link higher thought process with primitive emotional responses of fear, rage, and sexual pleasure. Also involved with feeding, drinking, pain, motivation, learning

Allows us to respond correctly to changes in environment

Also includes cingulate cortex and septum

Cerebellum

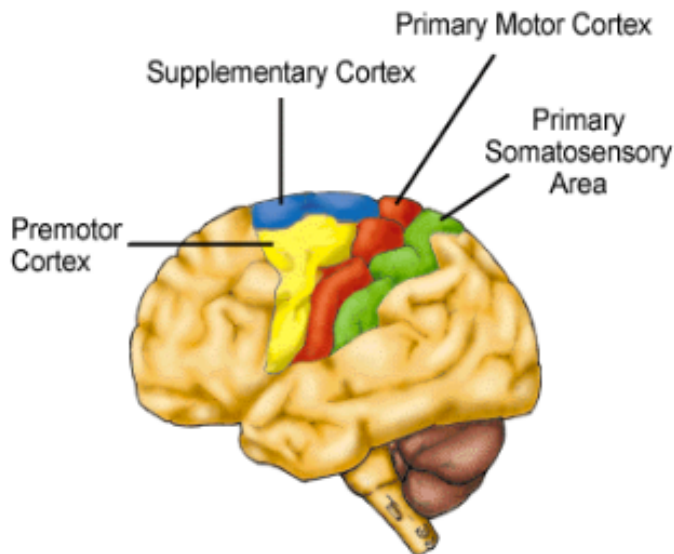
- Processes sensory info and coordinates execution of mvmt in the body. Has the most neurons in the brain, receiving input from somatic receptors for Em, balance, and motor neurons from cortex
- Must receive (efferent) information from the motor cortex that is outgoing to the muscles, and must receive (afferent) proprioceptive info → makes sure muscle is doing what it's supposed to do



Brain Stem

- MIDBRAIN (mesencephalon) connects lower brainstem with diencephalon. Controls eye mvmts, auditory, visual reflexes
- PONS relays info between cerebellum and cerebral cortex. Coordinates/controls breathing
- MEDULLA has primary control over involuntary functions like breathing, BP, and swallowing. Fibers from corticospinal tract decussate here to innervate mm on opposite side of body

Motor System



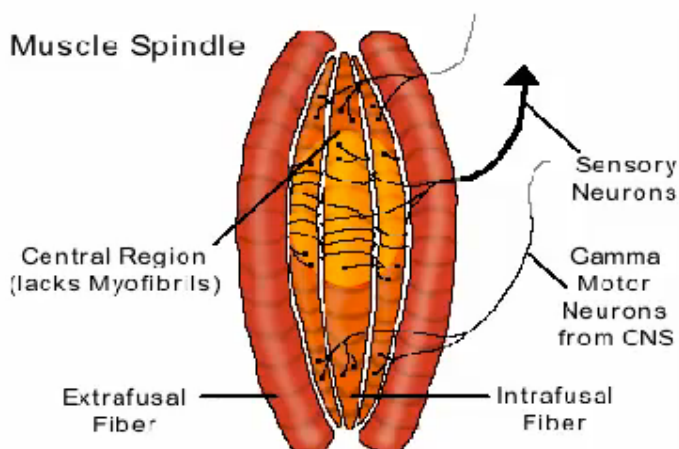
Premotor cortex develops appropriate strategy for movements necessary for the mvmt planned by the prefrontal cortex

Supplementary motor cortex- programs the motor sequences for complex/repetitive mvmts. Eg. When this is damaged, hand is awkward and not oriented appropriately when picking up a peanut

Primary Motor Cortex- Located on the precentral gyrus, it activates the neurons that will activate the appropriate muscles. Motor homunculus maps which parts of the body are innervated where on the primary motor cortex (M→L: foot, ankle, knee, thigh, trunk, shoulder, elbow, wrist, hand, FINGERS, FACE, LIPS, JAW, TOUNGUE). The signals are sent to the spinal cord via the corticospinal tract.

Corticospinal tract- Major motor pathway from the primary motor cortex to the motor neurons. 80% of all nerve fibers cross to the contralateral side of the body, 20% remain ipsilaterally.

Muscle receptors provide proprioception (awareness of limb position and mm. contraction) which include *muscle spindles* that detect **muscle stretch/length/rate of change of mm. length**, and *golgi tendon organs* that detect **muscle tension**



2 sets of gamma motor neurons activate the **intrafusal fibers**.

When whole mm. stretches, sensory region of the spindles stretch → depolarization → AP in sensory nerve → signal to brain

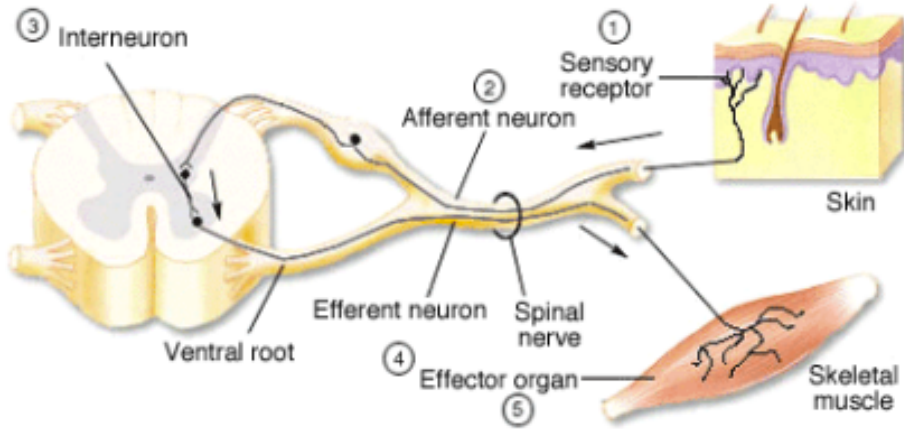
The more the mm is stretched, the more it is depolarized, and more APs are sent to the CNS → proprioceptive info

When extrafusal mm. fibers contract, intrafusal mm. relax → mm spindle info stops sending

Alpha-Gamma Coactivation

To keep mm spindles operating, commands are simultaneously sent through gamma motor neurons to the intrafusal fibers to contract them, maintaining the stretch on the central region (stretch receptor location). This coactivation ensures that the mm spindles continue to send proprioceptive info to the brain

Reflex Arc doesn't require output by brain to cause the effector to contract

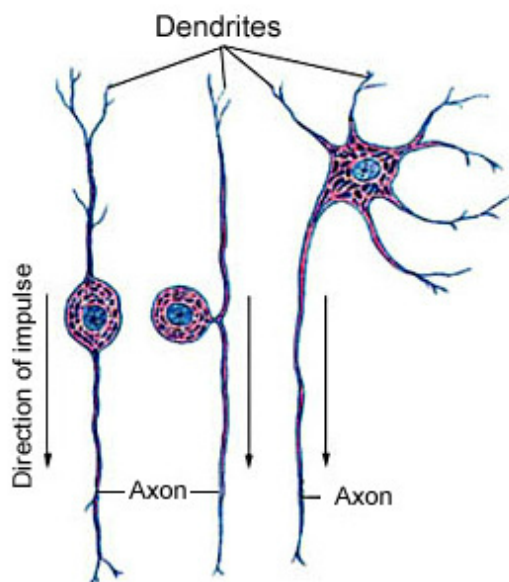


Stretch Reflex (knee jerk)

1. Tapping of quadriceps tendon produces small stretch of quad muscles
2. Muscle spindles are stretched
3. AP triggered by mm spindle → afferent neuron → spinal cord
4. Motor nerve of quads are activated while hamstrings are inhibited
5. Quads contract and hamstring relaxes → kick out

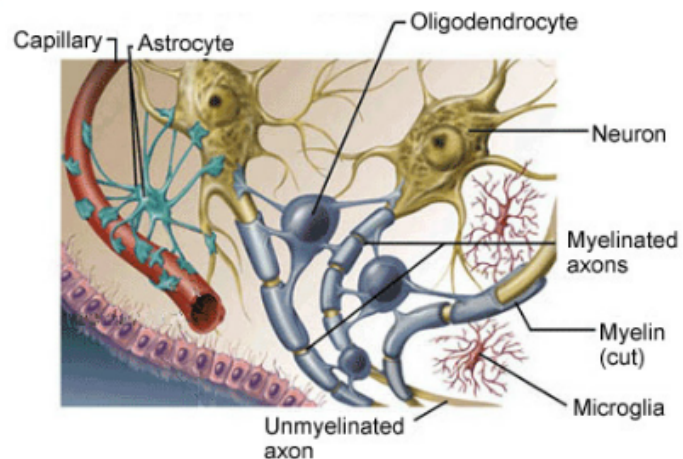
Neurons and Glial Cells

Nervous System Cells



(a) Bipolar (b) Unipolar (c) Multipolar

Neuroglia of the CNS



Bipolar Neurons are specialized neurons often found in the retina of the eye

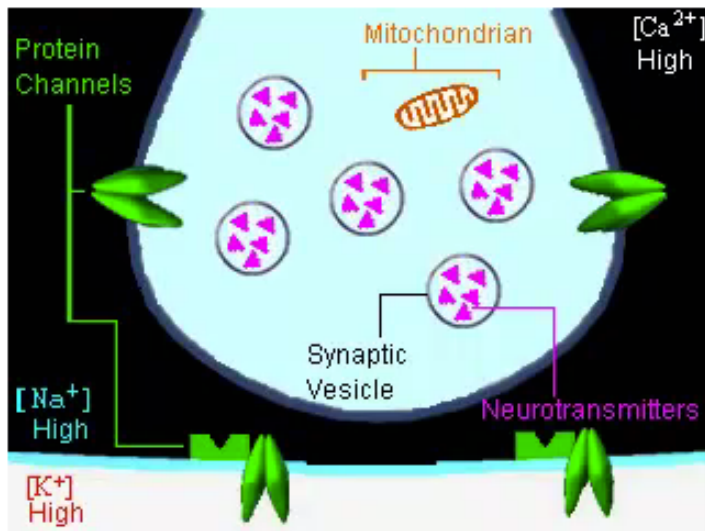
Unipolar neurons are located in peripheral nerves outside the CNS, usually sensory, transmitting signals to/from the spinal cord

Multipolar neurons are most common in the CNS (conventional Nerve Cell module)

Glial cells are the “support” cells of the brain (taking up 90%) and maintain delicate internal environment of the CNS. Structural role – glueing things together; Functional role – regulate nutrients and specific interstitial environment of the brain by regulating BBB

- several types, including: astrocytes, microglia, and oligodendrocytes (myelin)

Synaptic Transmission



PreSyn cell has voltage-gated Ca²⁺ channels

PostSyn cell has chemically gated (ligand-gated) ion channels that open when an NT attaches to it

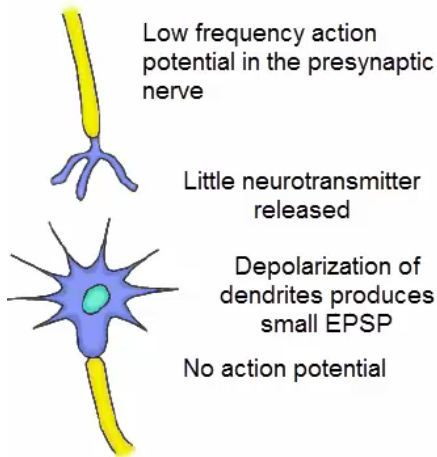
Sequence of Events at a Chemical Synapse

1. PreSyn neurons synthesize NTs stored in synaptic vesicles
2. AP in PreSyn neuron depolarizes the membrane, activating the voltage-gated Ca²⁺ channels, so Ca²⁺ flows into the axon terminal
3. Ca²⁺ causes the synaptic vesicles to fuse to the wall of the synaptic terminal → exocytosis of NT
4. NT diffuses across synaptic cleft and binds to chemical receptors found on the PostSyn Cell
5. Bound receptors → chemically gated ion channels open
6. PostSyn membrane potential changes (either depolarization or hyperpolarization) depending whether the NT is excitatory or inhibitory.
7. NT gets taken up again by the PreSyn cell to recycle the NT

4 kinds of Neurotransmitters

1. **Acetylcholine (ACh)**
2. **Biogenic Amines** (catecholamines like dopamine, NorEpi, Epi)
3. **Amino Acids** (excitatory- glutamate, aspartate; inhibitory- GABA, glycine)
4. **Neuropeptides** (endogenous opioids like endorphin; vasoactive intestinal peptide of VIP)

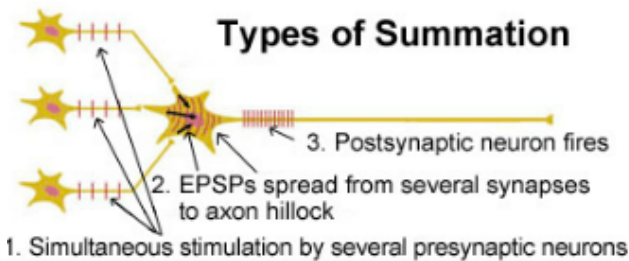
EPSPs (Excitatory Postsynaptic Potential)



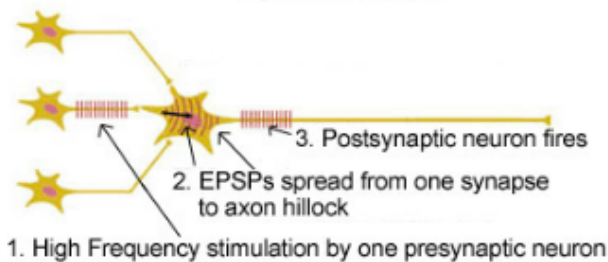
EPSP opens chemically gated channels to allow for Na⁺ influx → depolarization locally, as it diminishes with time and distance → graded potential. ONLY OCCURS ON DENDRITE AND CELL BODY

No voltage-gated channels on the dendrites/cell body of the neuron, so no AP. EPSP must be strong enough spread, depolarizing at the axon hillock where there is the highest conc. of voltage-gated channels.

Types of Summation



Spatial summation



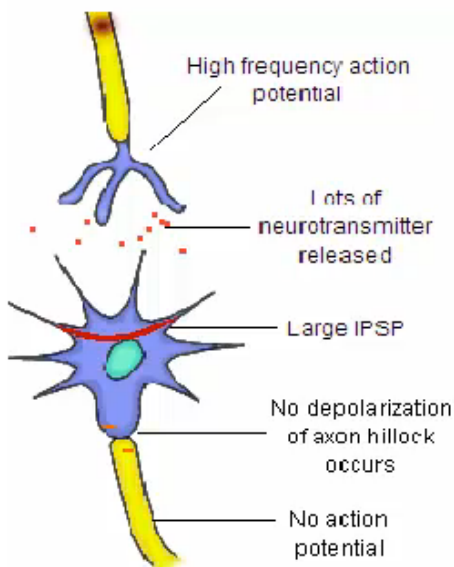
Temporal summation

Spatial summation is the additive effect caused by many EPSPs being generated at the same time on the postsynaptic neuron on different synapses

Temporal summation is the additive effect caused by many EPSPs being generated at the same synapse by a series of high-freq. APs

Graded potentials can be added on top of each other!

IPSPs (Inhibitory Postsynaptic Potential)



IPSPs produce **HYPERPOLARIZATION** by opening chemically gated channels on the PostSyn cell that either cause an influx of Cl⁻ (to make it more negative) or cause an efflux of K⁺ (to make it less positive).

Goal is to stop an AP from happening by moving the membrane potential further away from the threshold

Temporal and spatial summations can happen too, except it produces larger hyperpolarizations instead of depolarizations

Autonomic Nervous System - involuntary!

SYN- fight or flight: increase HR & BP, dilate airways, pupils, and blood vessels, shuts down digestive system. Exit through thoracic to lumbar regions. Preganglionic neurons → postganglionic neuron in ganglia → target organ/effector

PSYN- rest and relaxation: slow down HR and decrease BP, promote digestion. Exit at the brain stem and lower sacral region. Preganglionic nerves → postganglionic nerve very near to effector → target organ/effector

Autonomic System: Neurotransmitters and Receptors

