General Anatomy

- **Glial cells**: nonexcitable cells that provide support to neurons, release growth factors
  - Schwann cells + oligodendrocytes form myelin to coat axons
  - Astrocytes: a structural and functional link between neurons, non-nervous tissue, + ECF; regenerate damaged axons. Responsible for maintaining normal ECF K^+ levels, removing excess NT, synthesize + store molecules
  - Microglia: protect CNS from foreign matter (bacteria/dead cells) through phagocytosis or release of cytokines

- **Physical support to the CNS**

- Cranium + vertebral column → between the two are 3 connective tissue membranes that seperate soft tissue of CNS from surrounding bone (meninges)
  - dura mater: outer layer (closest to bone), tough + fiberous tissue
  - arachnoid mater: weblike structure → no space exists between the dura and the arachnoid
  - pia mater: next to the nervous tissue, space inbetween → subarachnoid space → filled w/ cerebrospinal fluid (bathes the CNS + cavities in the brain + spinal cord → ventricles)
    - ventricles are continuous with one another: 2 c-shaped lateral ventricles are connected to a 3rd by the interventricular foramen → cerebral aqueduct connects 3rd to 4th → continous w/ central canal (cavity through spinal chord)
    - linings of the ventricles and central canal: composed of ependymal cells (epithelial cells) → forms a tissue called choroid plexis (ependymal cells, capillaries + pia matter) → functions in the synthesis of CSF
  - CSF synthesis: as its produced, it circulates the ventricular system + enters subarachnoid space through the 4th ventricle → reabsorbed into venous blood through arachnoid villi (at top of brain)

- **Blood Supply to the CNS**

- CNS tissue has a high metabolic rate + high demand for glucose + oxygen, not a lot of glycogen
- depends on a steady supply of oxygen + glucose
- Blood-Brain barrier: physical barrier between the blood and CSF → tight junctions between capillary endothelial cells, P. liminatima capillaru pores to restrict diffusion of hydrophilic molecules between cells

↳ Astrocytes stimulate endothelial cells to develop + maintain tight junctions → formation of blood-brain barrier

- **Grey + White matter**

- grey matter: cell bodies, dendrites, axon terminals. 40% of CNS, site of synaptic communication + neural integration
- white matter: myelinated axons specialized for rapid transmission of information through action potential

→ Cerebral cortex: layer of grey matter covering the whole brain

white matter is beneath cerebral cortex w/ small areas of grey matter (subcortical nuclei)

→ the spinal chord is the opposite → white matter on the outside

- projection fibers / tracts: connect the cerebral cortex w/ lower levels of the brain / spinal cord → corticospinal tracts

connect regions of the cortex w/ grey matter in the spinal cord

- Association fibers: connect one area of cerebral cortex to another area on the same side of the brain
- commissural fibers: connect cortical regions on one side to coresponding regions on the other → most are located in

corpus callosum (connects the cerebral hemispheres)

Spinal Cord

Spinal nerves: 31 pairs that branch off the spinal cord between two adjecent vertebrae

- 8 cervical nerves (C1-C8) → neck region, 12 thoracic nerves (T1-T12) → chest region, 5 lumbar nerves (L1-L5) → lower back, 5 sacral nerves (S1-S5) → tailbone/coccyx region, 1 coccygeal nerve (C_o) → emerges from the tip of the c

→ dermatomes: different sensory regions served by a particular spinal nerve

→ cranial nerves: sensory in the face, emerge from the brain

- Grey Matter: contains interneurons, cell bodies + dendrites of efferent neurons + axon terminals of afferent neurons

- dorsal horn: encompases posterior half of grey matter on either side, ventral horn encompases anterior half

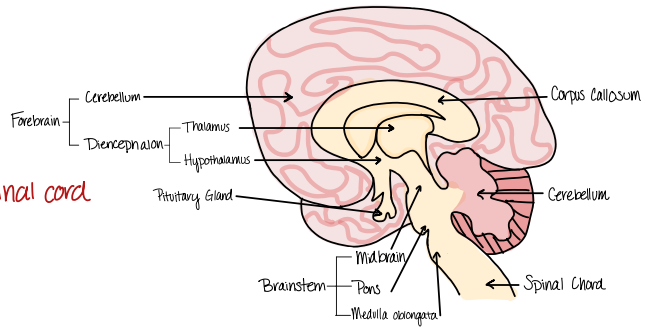
↳ bundles of afferent axons ↳ bundles of efferent axons

- White matter

- ascending tracts: transmit info from spinal cord to the brain
- descending tracts: transmit info from brain to spinal cord, control efferent neurons, modulate sensory info

The Brain

- Forebrain: largest part, divided into hemispheres
  - cerebellum: motor coordination + balance
- Brainstem: connects forebrain + cerebellum to the spinal cord
  - midbrain:
  - reticular formation:

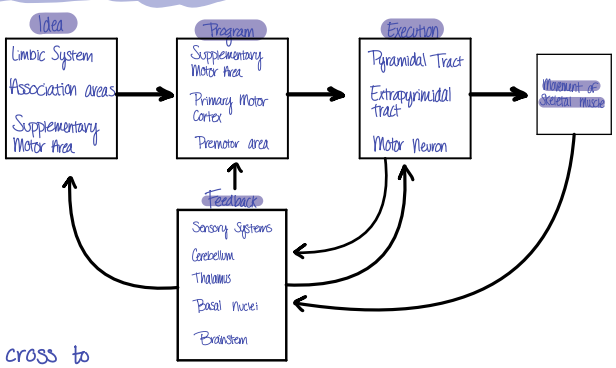


- Cerebral cortex: grooves (sulci) + ridges (gyri), highest level of neural processing → integrating center (outer layer of the brain)
  - Frontal lobe: language, planning + personality, primary motor cortex → voluntary movements + motor control
  - Parietal lobe: somatosensory cortex → processes somesthetic sensations (surface, touch, itch, temp, pain) and proprioception (awareness of muscle tension, joint + limb positions)
  - occipital lobe: visual cortex
  - temporal lobe: auditory cortex,
- Brain Lateralization
  - right brain: spacial orientation, creativity, facial recognition, music, philosophy, intuition
  - left brain: logic + analytical processing, language, math skills
- Diencephalon
  - Thalamus: relays all sensory (except smell) to cerebral cortex
  - hypothalamus: links endocrine + nervous systems, releasing hormones that regulate pituitary gland → controls homeostasis; regulates eating + drinking behaviors, autonomic nervous system
    - suprachiasmatic nucleus: generates circadian rhythems, pineal gland: secretes melatonin
- Limbic System
  - amygdala (aggression + fear), hippocampus (learning + memory), olfactory system

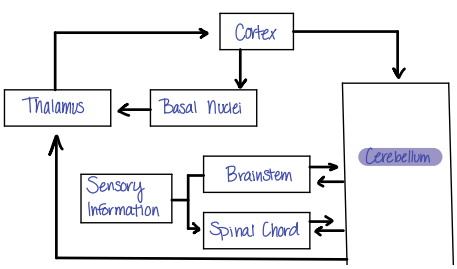
Involuntary Movements

- Reflex: automatic, patterned response to sensory stimulus
- Reflex arcs (neural pathways for reflexes): receptor detects a stimulus → info transmitted from receptor to CNS via afferent neurons → CNS (integrator) sends signal to efferent neuron → transmits signal to effector organ → stimulates a response
- Reflex categories
  - level of neural processing: spinal or cranial
  - efferent division controlling effector: somatic (skeletal muscle) or autonomic (smooth / cardiac muscles or glands)
  - Developmental pattern: innate or conditioned (learned through experience)
  - number of synapses in pathway: monosynaptic or polysynaptic
- Withdrawal reflex: painful stimulus causes an automatic withdrawal → also triggers crossed-extensor reflex

Voluntary Movements



- Lateral Pathways
  - pyrimidal tracts: direct from primary motor cortex to spinal cord
    - upper motor neurons → axons terminate in ventral horn
    - control fine movements of forearms, hands, fingers
  - rubrospinal tracts: originate in the red nuclei of midbrain, axons cross to opposite side and join axons of pyrimidal tract
- Ventromedial Pathways → indirect connections between brain + spinal cord
  - Vestibulospinal tracts: originate in medulla, recieves info from inner ear → maintains posture + balance
  - Tectospinal tracts: originate in superior colliculi of midbrain, recieves input from eyes → controls head + eye movement
  - Reticulospinal tracts: originate from recticular formation (either pons or medulla) → important in balance
- Basal Nuclei: neural damage can cause disease
  - huntingtons chorea: involuntary jerking in limbs + face → caused by overactive motor circuts
  - Parkinsons: loss of input to basal ganalia



Language

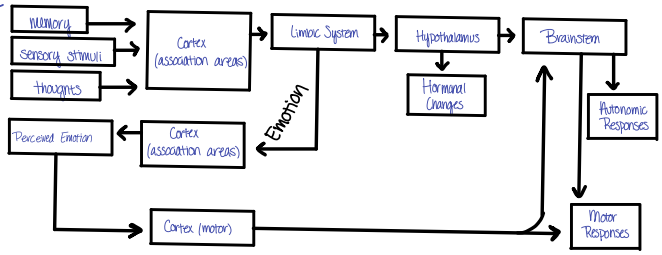
- Wernicke's area: left hemisphere, in the posterior and superior portion of the temporal lobe + inferior parietal lobe
  - involved in language comprehension in sound, written words, sign language
- Broca's area: frontal lobe
  - involved in language expression, speaking + writing
- Aphasia → language disfunction

Sleep

- Electroencephalography: affixed electrodes to the scalp to record electrical activities → brain waves
- EEG's (electroencephalograms): brain waves
  - Slow-wave sleep: slow EEG, movement, slow heart rate, rare dreams → happens in the forebrain
  - REM sleep: fast + low amplitude EEG, no muscle tone (paralysis), increased heart rate, vivid dreams → in the pons
- Sleep Stages: 1) drowsy: alpha waves 2) high amplitudes of K-complexes + sleep spindles → light sleep 3) moderate sleep, delta waves, sleep spindles 4) high amplitude delta waves
  - as period of sleep continues, REM sleep becomes longer + more frequent

Integrated CNS Functions

- Emotions + Motivation
  - left hemisphere → associated w/ positive emotions; right → negative
  - motivation in "pleasure centers": substances can activate the dopaminergic systems of the basal ganglia → project to the limbic system



- Learning
  - Associative: making connections between two or more stimuli
  - Nonassociative: occurs in response to repetition of a single stimulus → either causes habituation (decrease in response

to a repeated stimulus) or sensitization (increase in response)

Memory

- Procedural (implicit): memory of learned motor skills or behaviors → involves the cerebellum, basal nuclei + pons
- declarative (explicit): memory of learned experiences; facts and events → involves the hippocampus
- Short-term: everything goes into short-term memory for seconds to minutes → stored in the frontal lobe →
  - ↳ memories can be consolidated into long-term memory → in temporal lobe + hippocampus

→ Plasticity: synapses can be altered and new ones can develop

- long-term potentiation: repetitive stimulation of a synapse → strengthens the synaptic connection