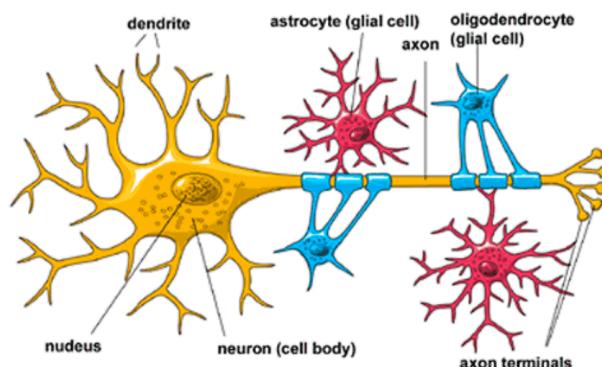


Lecture 3: The Brain

Cellular Components

The Nervous System is composed of cells

- Neurons, or nerve cells, are the most important part of the nervous system
- Glial cells provide support for neurons



The Brain in Numbers

- Contains
 - 100 billion neurons
 - 1 trillion glial cells
- Consumes
 - 25% of body's oxygen

- 70% of body's glucose
- For each neuron, ~5000 synapses
- Is less than 2% of body weight

Neurons have 4 Zones

- **Input zone:** dendrites
 - Receives information from other cells
- **Integration zone:** cell body or soma
 - Region where inputs are combined and transformed
- **Conduction zone:** axon
 - Single axon leads from the cell body and transmits electrical impulses
- **Output zone:** axon terminals
 - Terminals at the end of the axon communicate activity to other cells

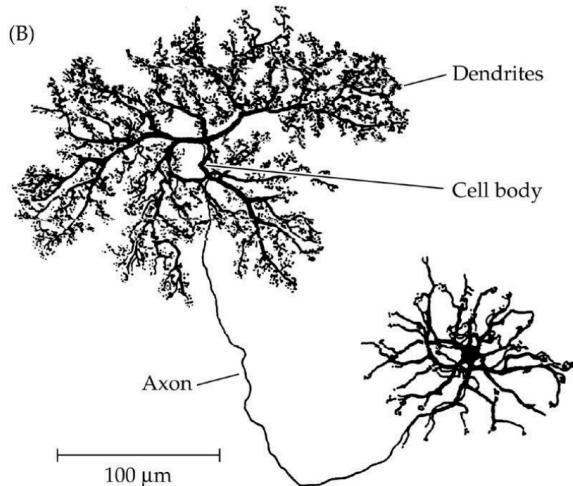
The Neuron Doctrine

- 19th century
 - It was recognized that the cell was the fundamental unit of all living organisms
 - But it wasn't clear whether this was the case for the brain
- Camillo Golgi (1843-1926)
 - Silver stain (Golgi stain)
 - Proposed **reticular theory**
- Santiago Ramon y Cajal

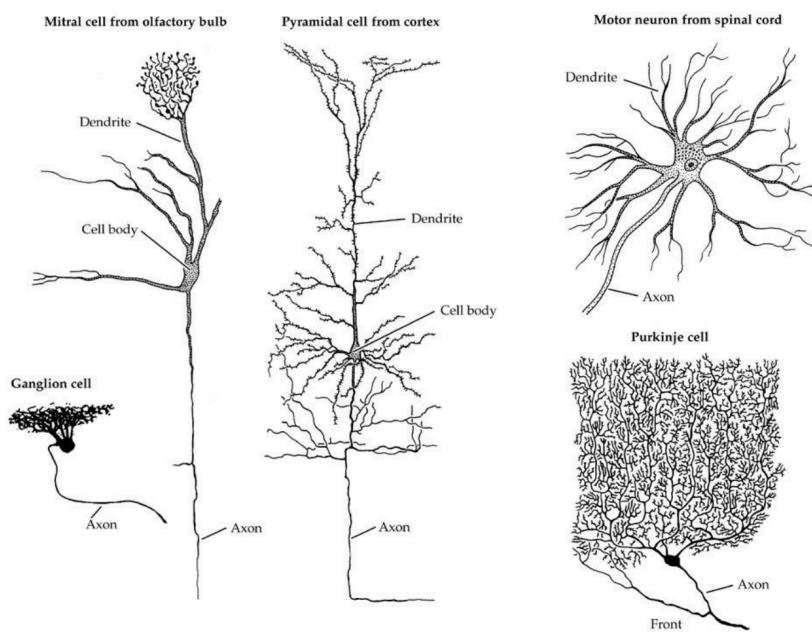
- Also used Golgi's stain
- Proposed the **neuron doctrine**

The Brain: Cellular Elements

A more realistic neuron

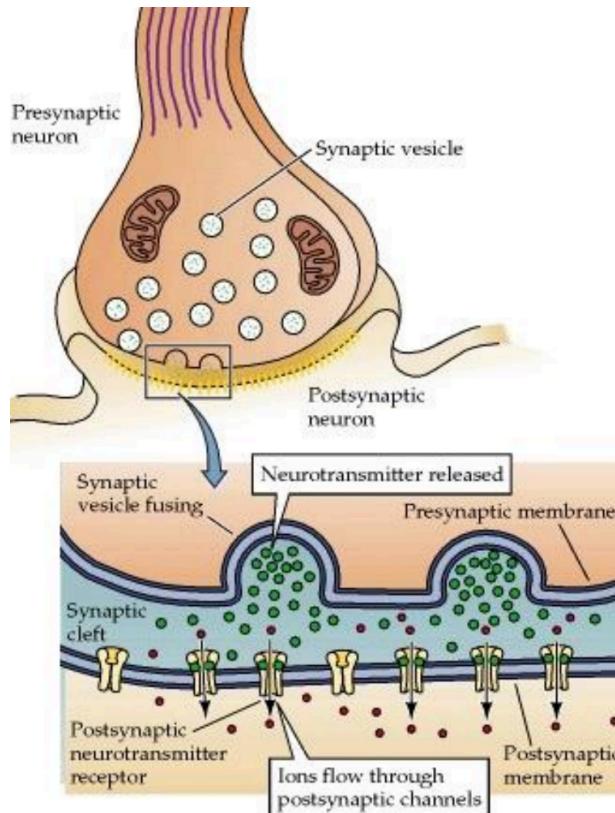


Neuronal Diversity



Synapses

- Neurons communicate with each other through gaps called synapses
- It has been estimated that the human has 10^{15} synapses
- Synapses have 3 components
 - **Presynaptic membrane**
 - On the axon terminal of the presynaptic neuron
 - **Postsynaptic membrane**
 - On the dendrite or cell body of the postsynaptic neuron
 - **Synaptic cleft**
 - A gap that separates the membranes



Glial Cells

Support neuronal activity

- **Astrocytes**

- Star-shaped cells
- Many processes that receive neuronal input and monitor activity
- Localizes in the CNS (Central Nervous System)

- **Microglial cells**

- Small cells
- Remove debris from injured cells
- Localized in the CNS

- **Oligodendrocytes**

- Provide myelination to CNS cells

- **Schwann cells**

- Provide myelination to PNS (Peripheral Nervous System) cells

Myelination

- The process in which glial cells wrap axons with a fatty sheath, myelin, to insulate and speed conduction

- **Multiple sclerosis**

- A demyelinating disease

Gross anatomy of the brain

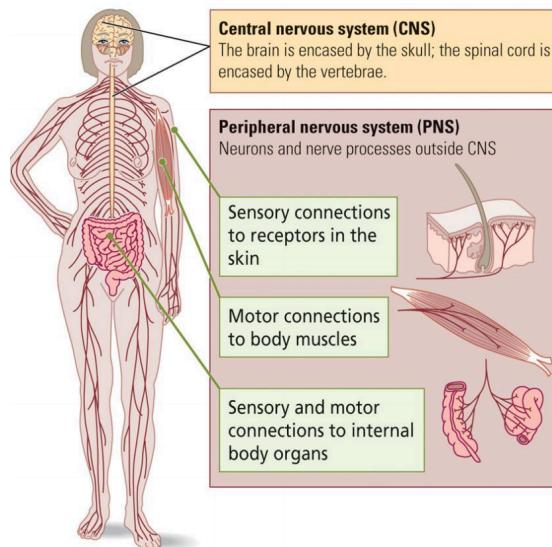
Nervous System

1. Central Nervous System

- Brain and spinal cord

2. Peripheral Nervous System

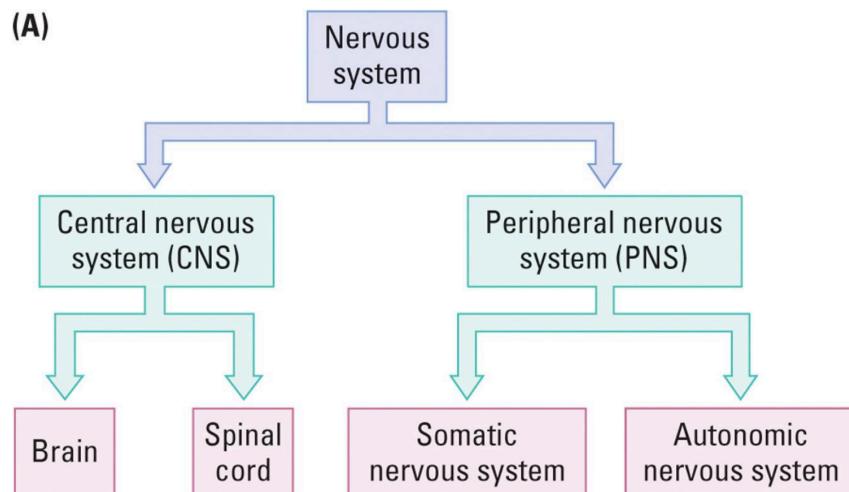
- Neurons and Nerve fibers radiating out beyond the brain and spinal cord



ANS (Autonomic Nervous System)

- 3 major divisions
 - Sympathetic nervous system
 - In charge of the fight or flight response
 - Parasympathetic nervous system
 - Active in relaxed, non dangerous situations
 - Enteric nervous system
 - Regulates digestion

Anatomic Divisions of the Nervous System



Direction of Neural Information Flow

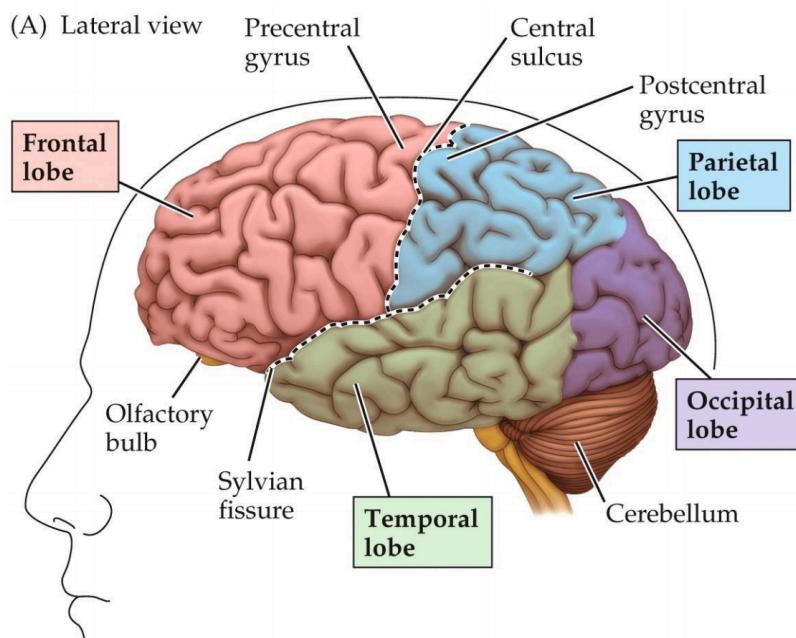
- **Afferent** (Incoming)
 - Coming into CNS
 - Sensory information
- **Efferent** (Outgoing)
 - Leaving the CNS
 - Motor

The Brain

- Dominated by 2 cerebral hemispheres
- **Cerebral Cortex**
 - Outermost layer of the cerebral hemispheres
 - The brain surface has 2 types of areas
 - **Gyrus:** Ridged or raised portion of the convoluted brain

surface

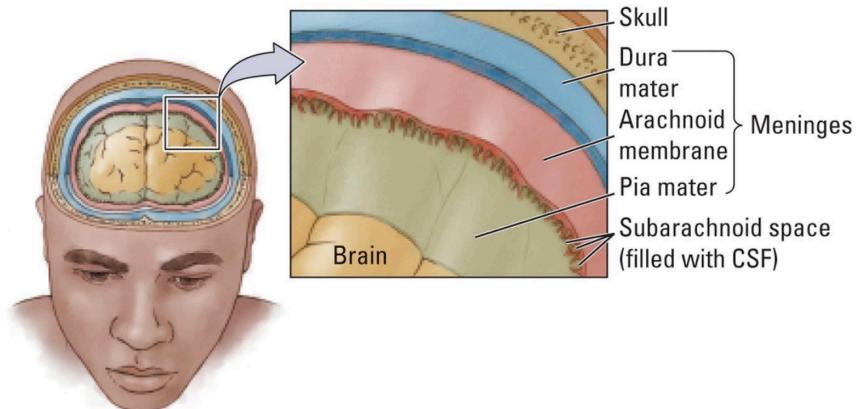
- **Sulcus:** Furrow of the convoluted brain surface
- 4 lobes
 - **Frontal**
 - Impulse control, decision making
 - Contains motor cortex
 - **Parietal**
 - Contains somatosensory cortex (pain, touch temperature)
 - **Occipital**
 - Visual processing
 - **Temporal**
 - Auditory processing and memory



The Meninges

- Surround the brain and spinal cord, protecting them

- The cerebrospinal fluid (CSF) circulates within the subarachnoid space



The Ventricular System

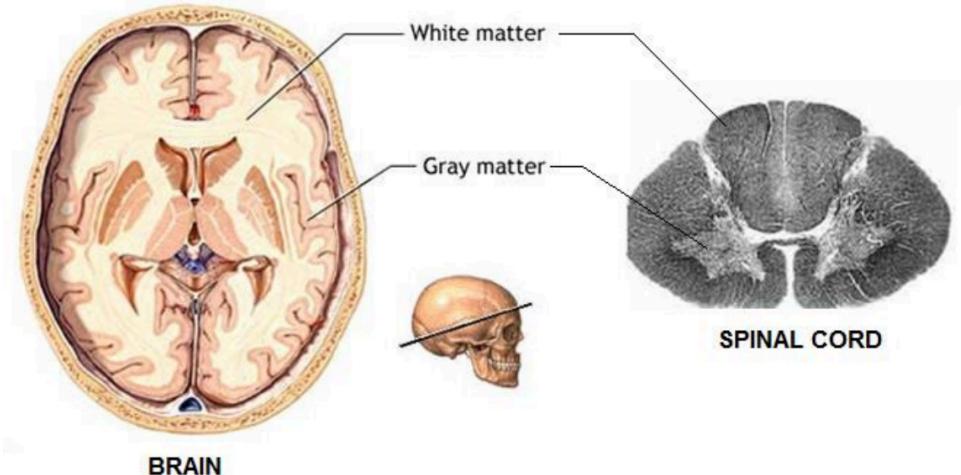
- Series of chambers filled with CSF (cerebrospinal fluid)
- CSF has 2 main functions
 - Acts as a shock absorber
 - Provides an exchange medium between blood and brain

Structure of the cortex

Gray Matter vs White Matter

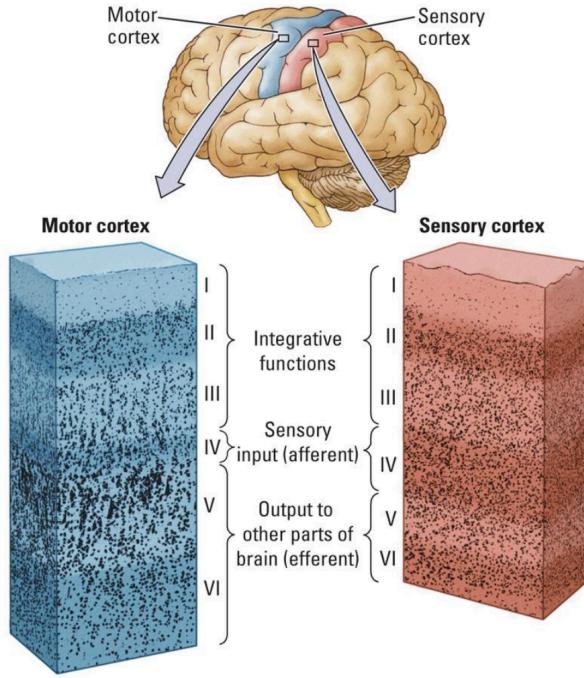
- 2 colors of brain tissue
 - White matter:** consists mostly of axons with white myelin sheaths
 - Gray matter:** contains more cell bodies and dendrites, which

lack myelin



Layers of Cerebral Cortex

- **Neocortex** (a.k.a. cortex)
 - 6 distinct layers
- Cortical layers are distinguished by
 - Type of neuron
 - Pattern of dendrites or axons
- There are other cortices with 3-4 layers or unlayered



Cytoarchitectonic Map

- Brodmann defined areas by organization and characteristic of cells
- The simplest sensory perceptions of touch (red), vision (purple), and hearing (orange)

