

Overview of the Nervous System

(some basic concepts)

Steven McLoon
Department of Neuroscience
University of Minnesota

Coffee Hour

Tuesday (Sept 11) 10:00-11:00am

Friday (Sept 14) 8:30-9:30am

Surdyk's Café in Northrop Auditorium

Stop by for a minute or an hour!

Labs start next week!

- Print the lab manual from the course website.
- Labs are in MCB 3-146B.
- Read the manual for lab 1 before arriving at the lab.
- Be sure to bring your lab notebook and the lab manual.

Cells

- Cells are the functional units of an organism
(as people are the functional units of a society)

Cells

- Most multi-cellular organisms, such as humans, have many types of cells.
- Each cell type has specializations for a particular function.

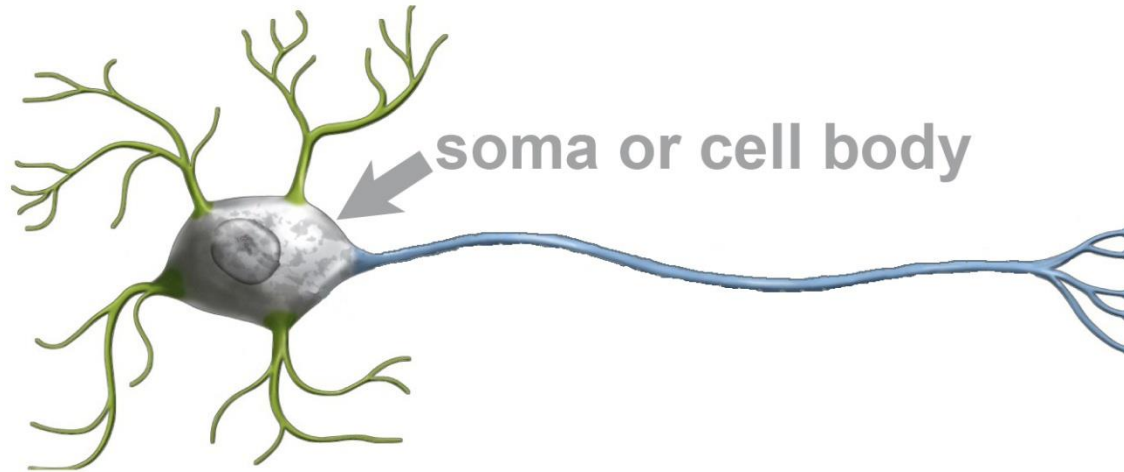
Cells

The nervous system has two broad families of cells types:

- Neurons (nerve cells)
- Glia (glial cells)

(Note: The nervous system also has cells of the vasculature or blood system.)

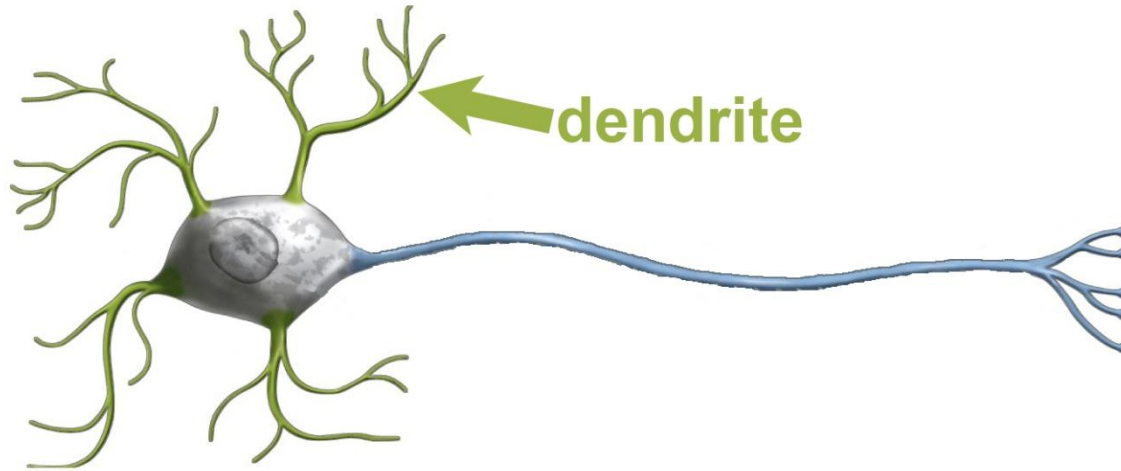
Main Parts of a Generic Neuron



Soma or cell body

- One per neuron
- 10-100 μm in diameter
- Contains the nucleus and certain other organelles

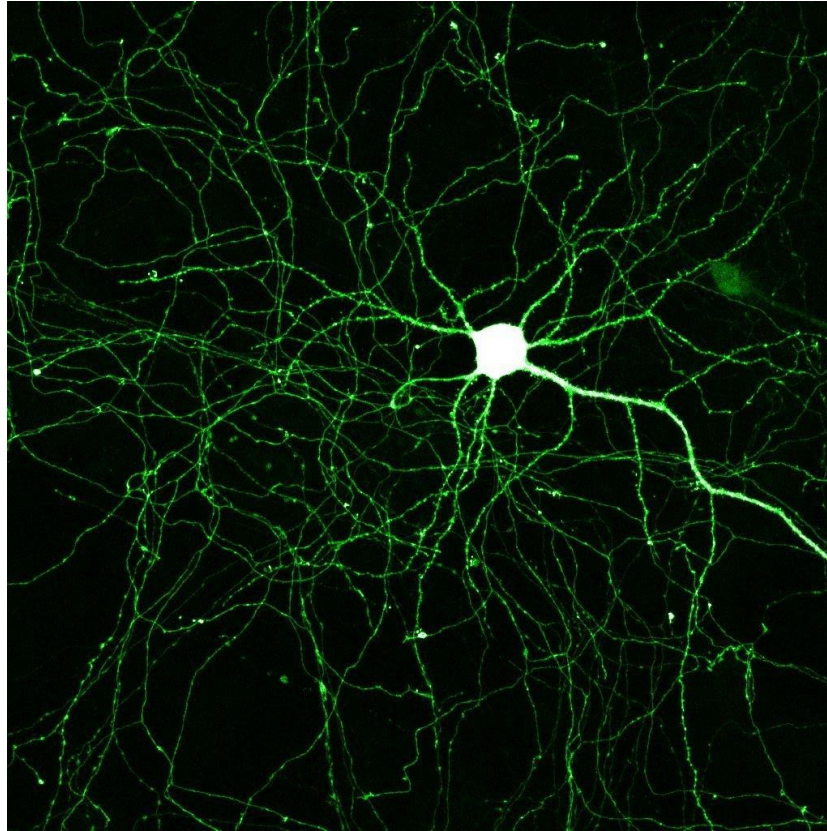
Main Parts of a Generic Neuron



Dendrite

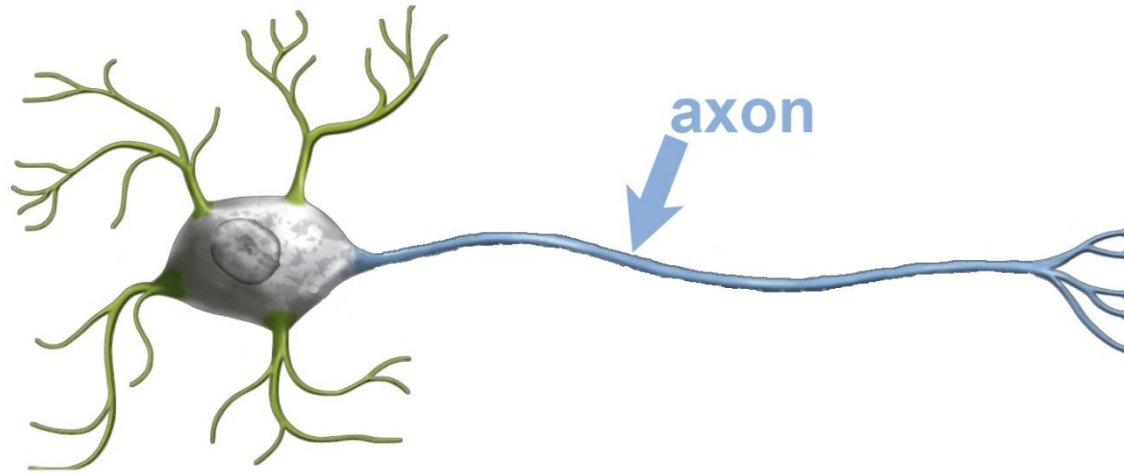
- Zero to many per neuron
- Specialized for receiving information

Main Parts of a Generic Neuron



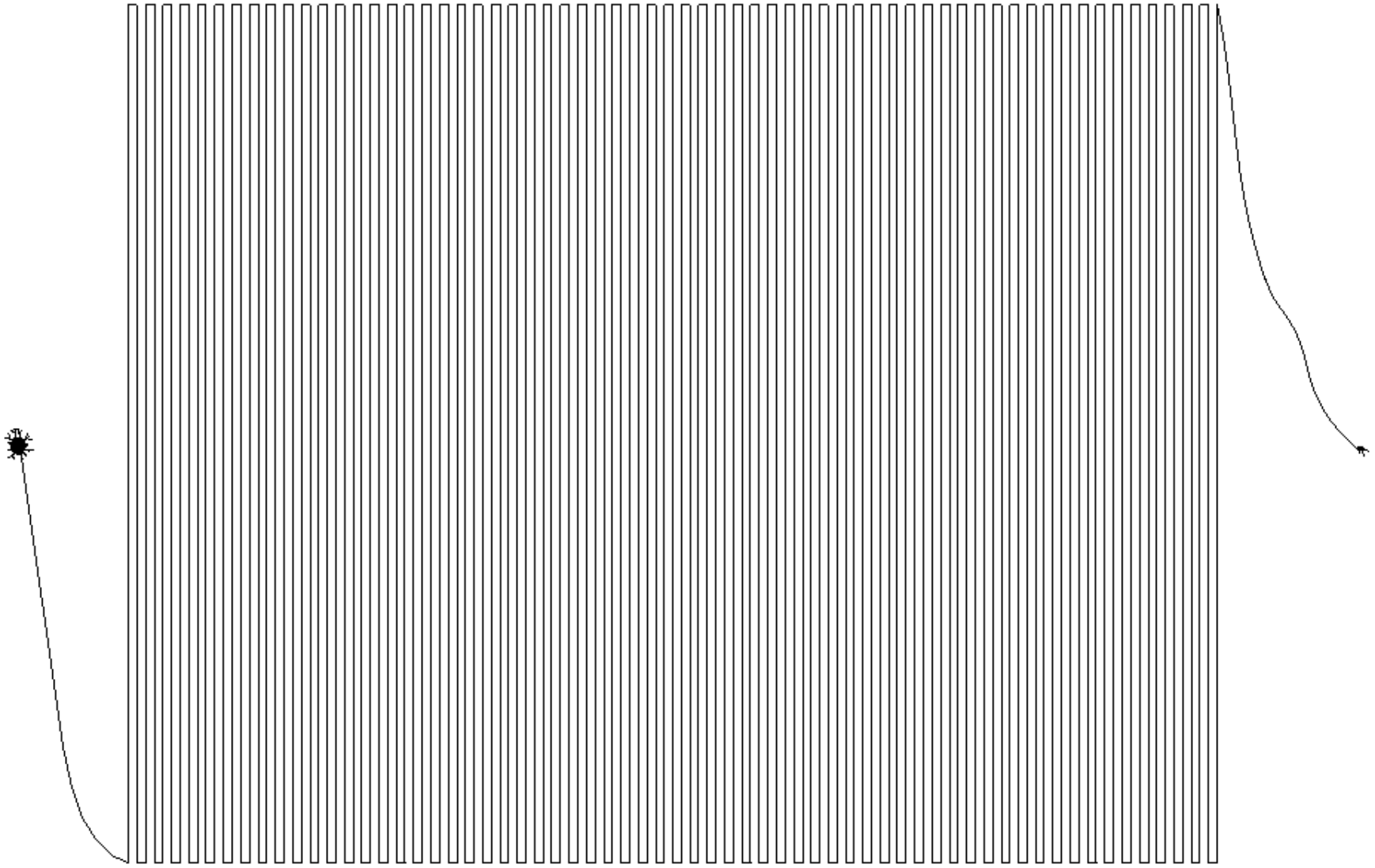
- The 'dendritic tree' of a neuron can be very complex.

Main Parts of a Generic Neuron



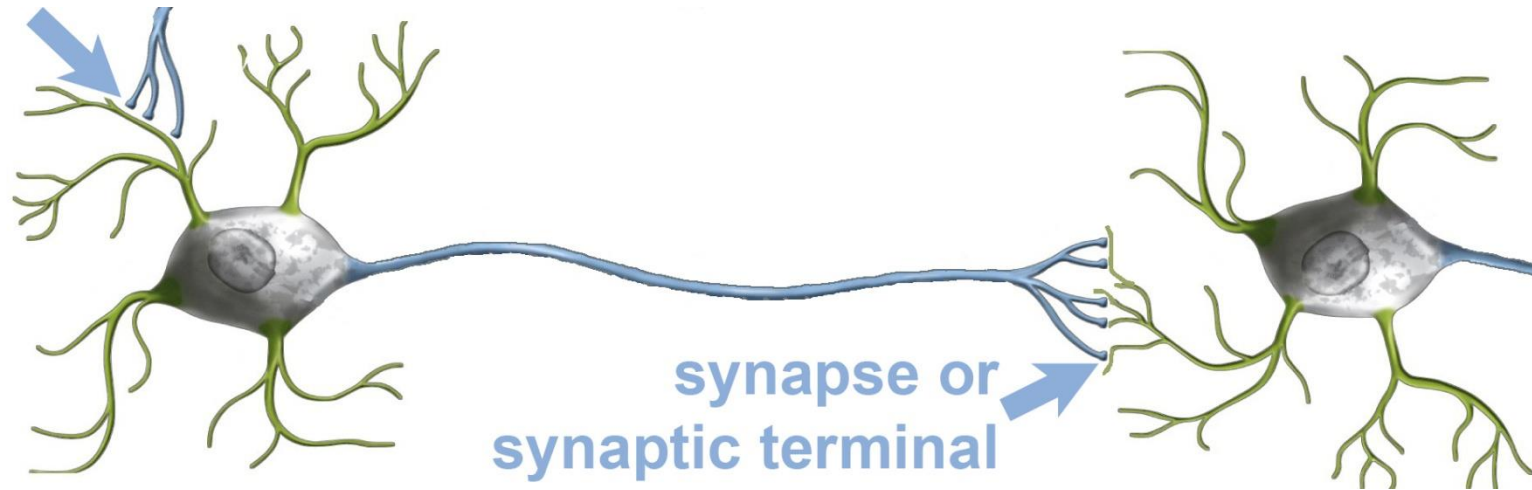
Axon

- One per neuron
- Can have many branches
- 10um to more than a meter in length
- Specialized for relaying information to distant cells



- A motor neuron drawn to scale

Main Parts of a Generic Neuron

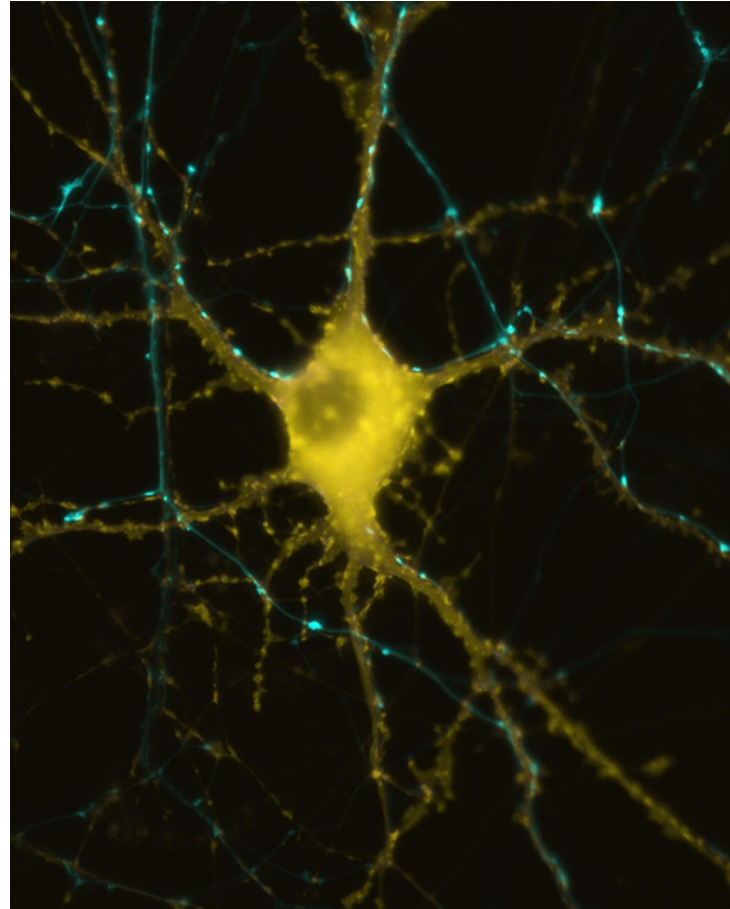


Synapse or synaptic terminal

- Site of communication with another cell
(The presynaptic cell communicates with the postsynaptic cell.)
- Postsynaptic cell can be another neuron or other cell type.

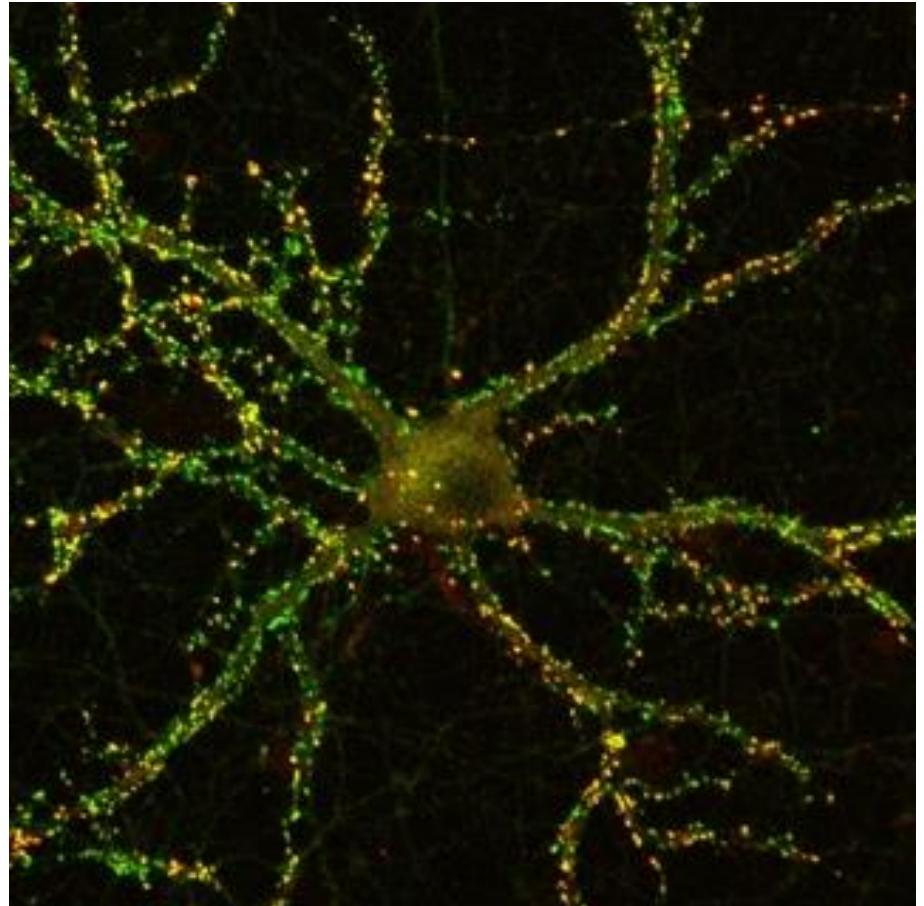
Main Parts of a Generic Neuron

- An axon can make one or more synapses with one or more cells.



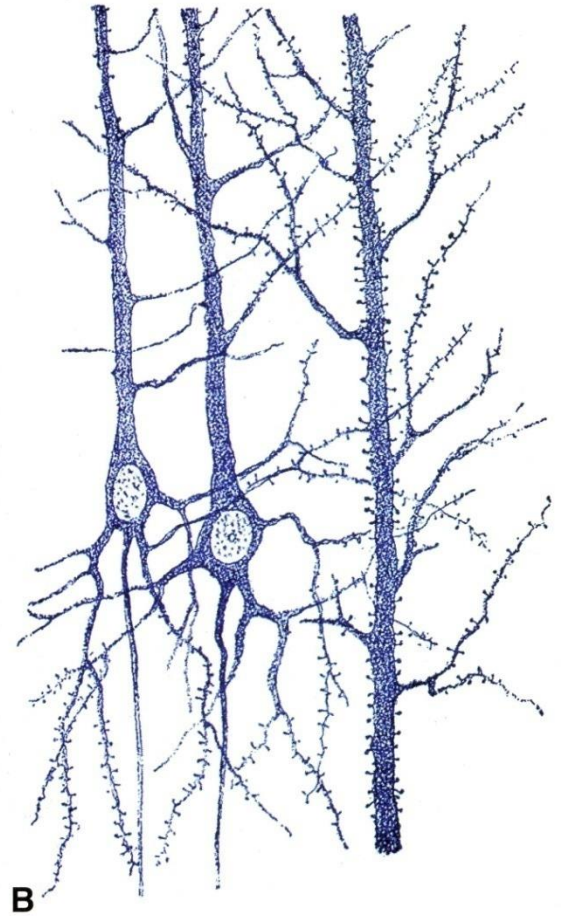
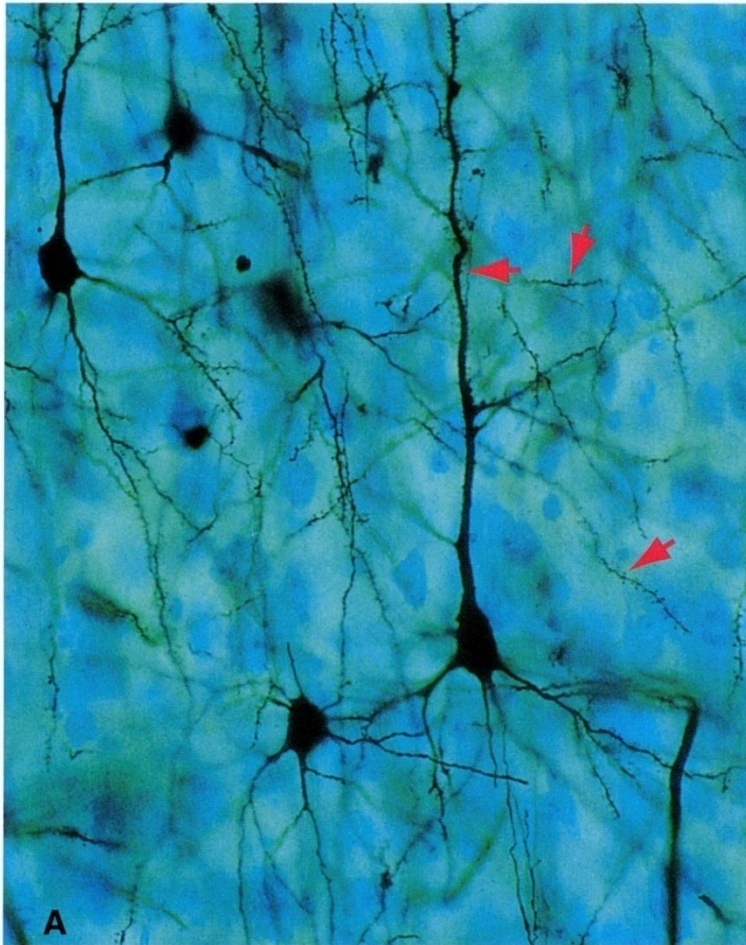
Main Parts of a Generic Neuron

- A single neuron can receive one or more synapses.
- Synapses can be on dendrites, somas, axons or synaptic terminals.

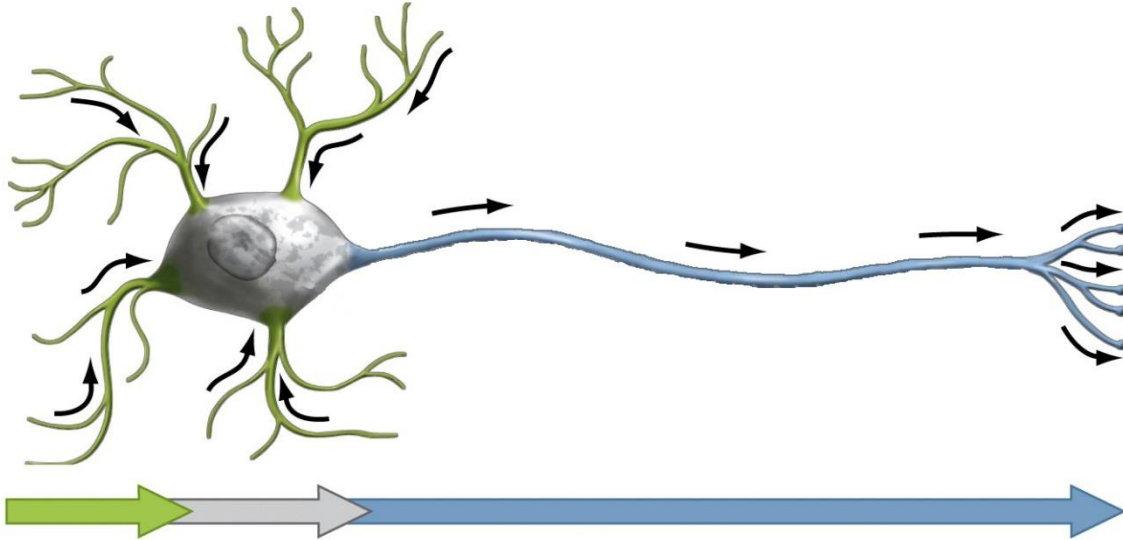


Synapse

- Many neurons have dendritic spines for receiving synapses.



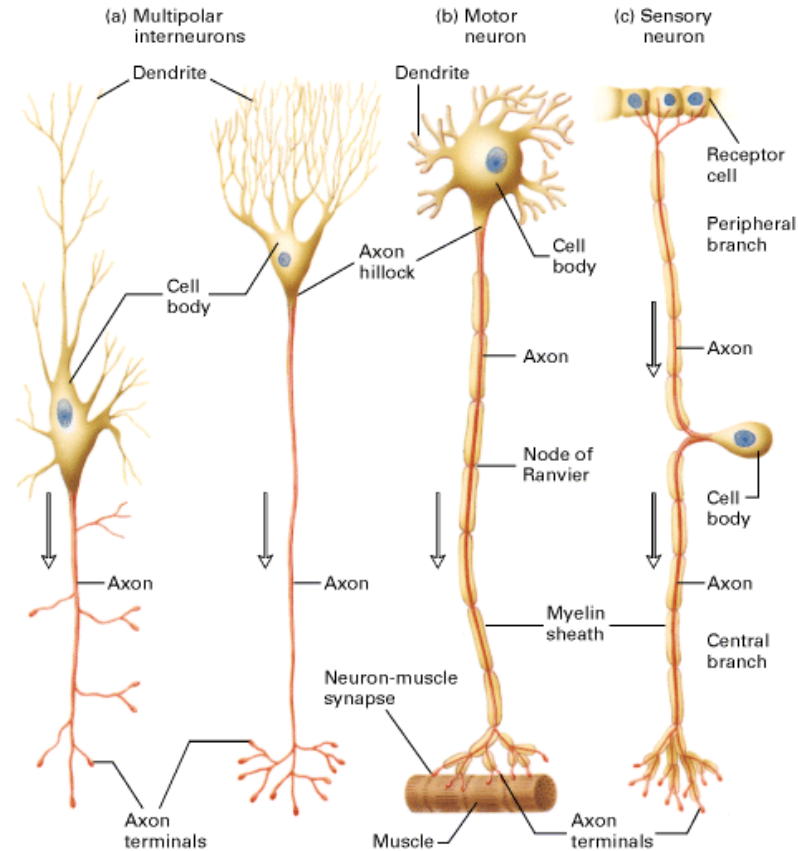
Flow of Information in Neurons



dendrite > soma > axon > synapse

Types of Neurons

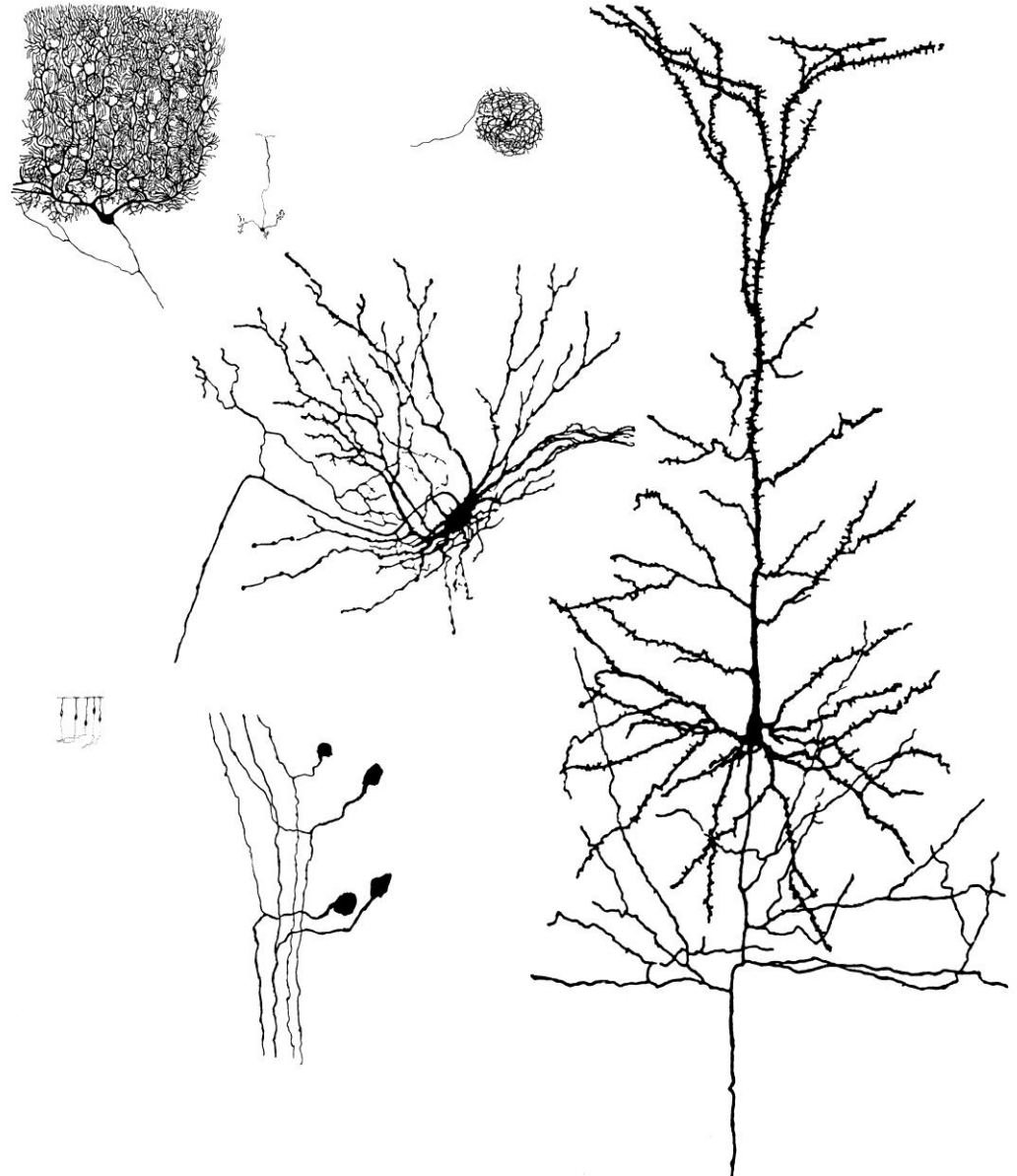
(There is no such thing as a generic neuron.)



- Different types of neurons can have very different dendrites, somas, axons and synapses.
- These differences allow different types of neurons to have different functions.

Types of Neurons

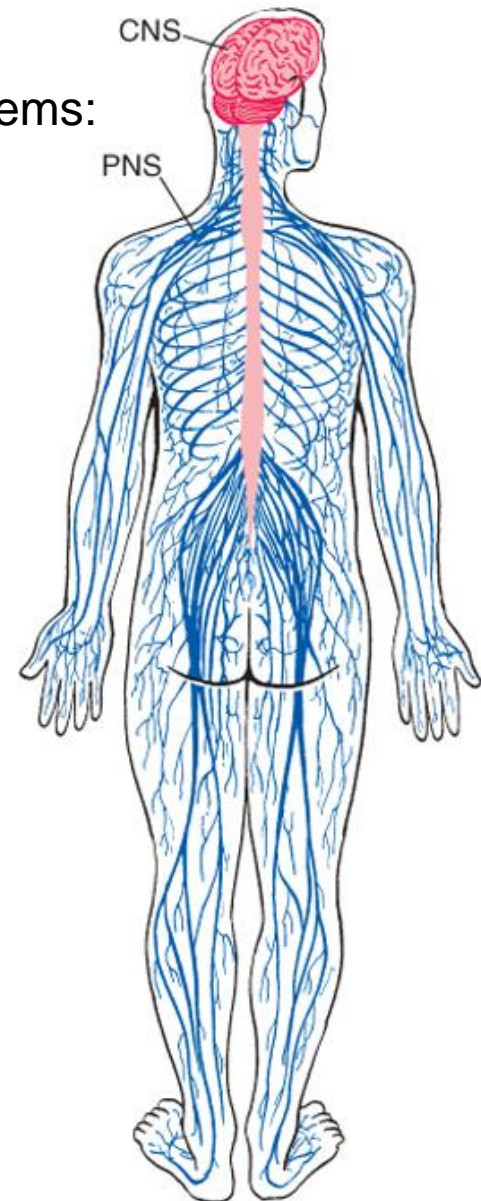
- Humans have ~10,000 different types of neurons based on morphology, position, synaptic partners and biochemical characteristics.



Central vrs. Peripheral Nervous System

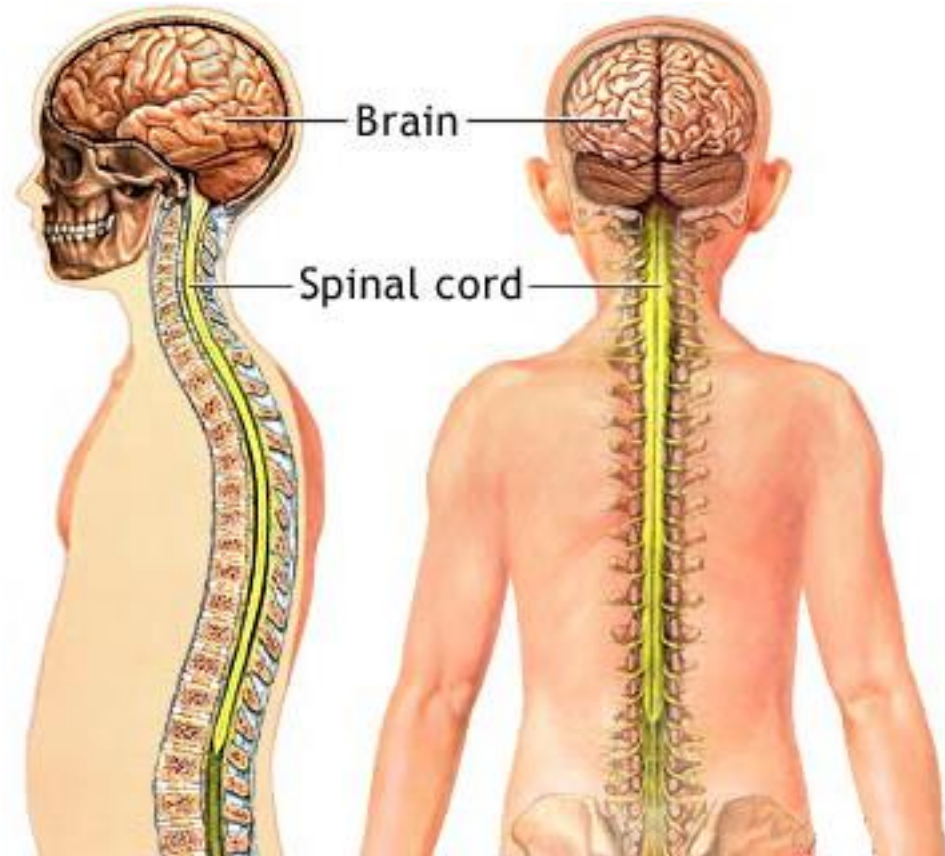
The nervous system is divided into two subsystems:

- Central nervous system (CNS)
- Peripheral nervous system (PNS)



Central vrs. Peripheral Nervous System

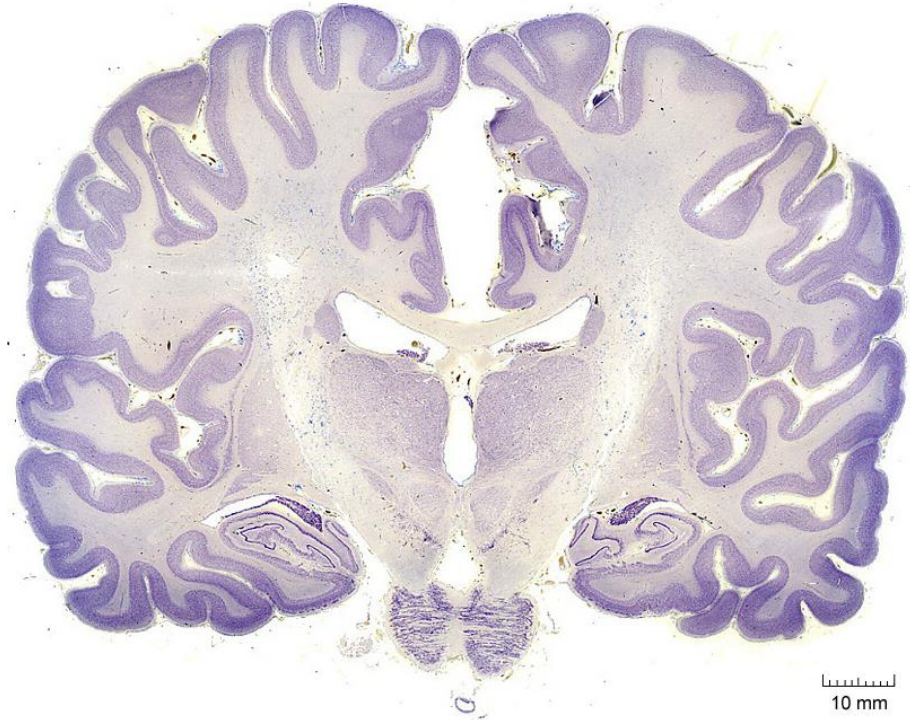
- Central nervous system (CNS) includes the brain, spinal cord and retina.
 - The brain is inside the skull.
 - The spinal cord is inside the vertebral column (spine).
 - The retina is inside the eye.



Central vrs. Peripheral Nervous System

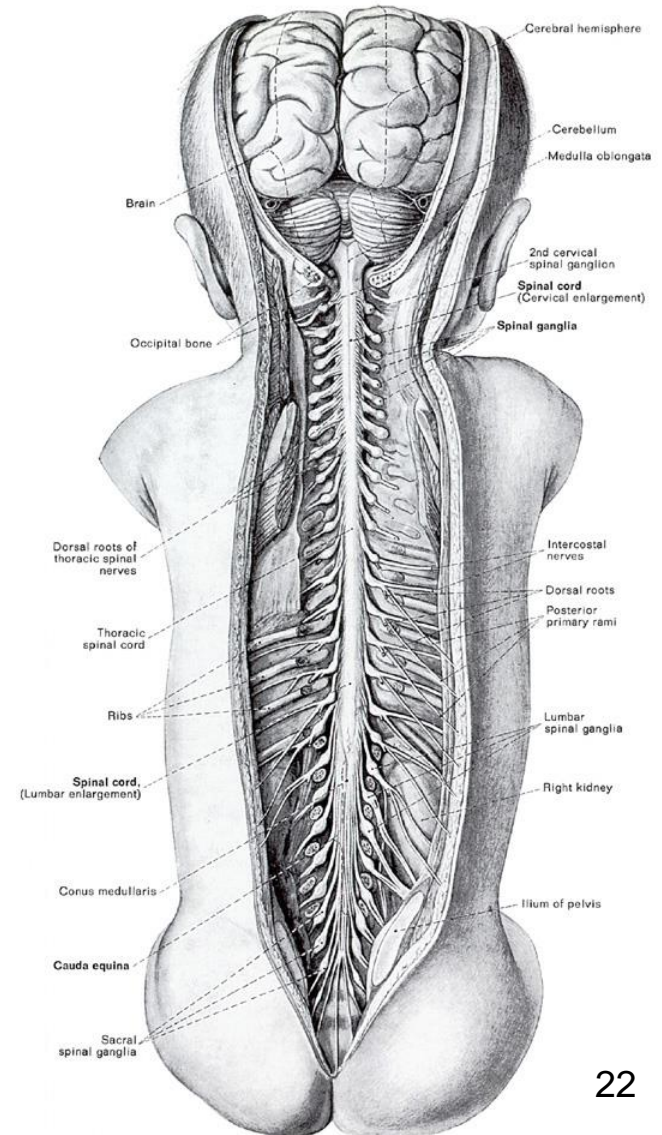
- Within the CNS:
 - Bundles of axons are in tracts or commissures (white matter).

(Axons decussating, that is crossing from one side of the CNS to the other, are in commissures.)
 - Neuronal cell bodies are in nuclei or layered structures (grey matter).

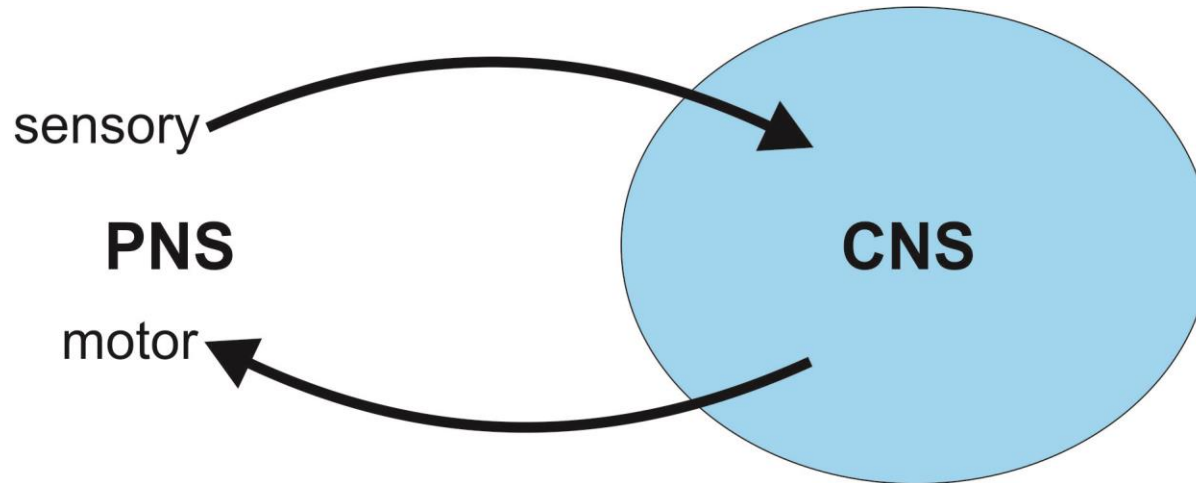


Central vrs. Peripheral Nervous System

- Peripheral nervous system (PNS) includes nerves and ganglia, which are distributed throughout the body.
 - Bundles of axons are in nerves.
 - Nerves connect to the brain (cranial nerves) or spinal cord (spinal nerves).
 - Ganglia are collections of the somas of neurons.



Central vrs. Peripheral Nervous System



Functional systems:

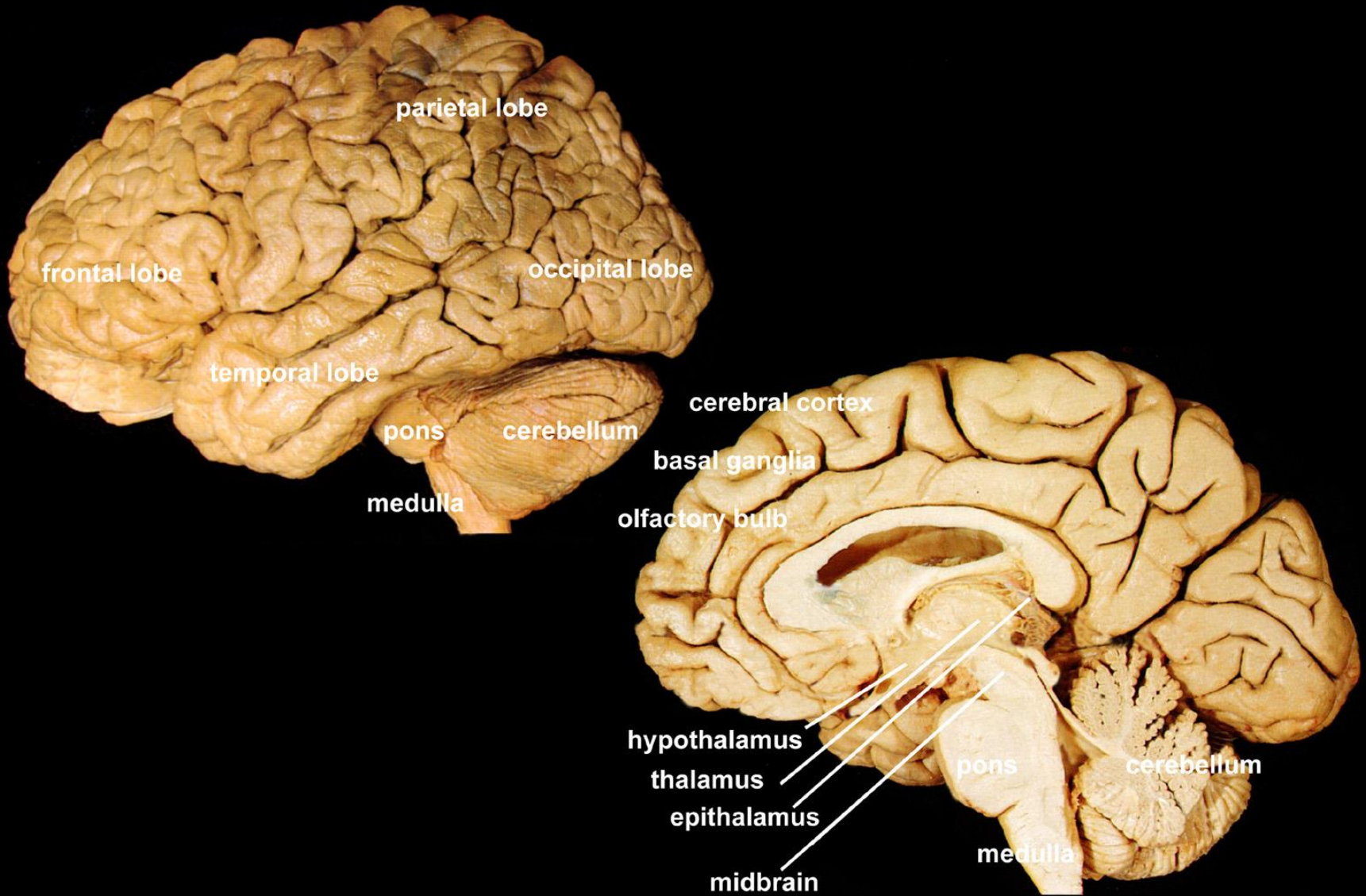
- Sensory systems – elements of the PNS receive various information about our body and environment and relay this information into the CNS for processing.
- Motor systems – elements of the CNS send out instructions via the PNS to alter various bodily functions including muscle contraction, blood flow and gland secretion.

Central vrs. Peripheral Nervous System

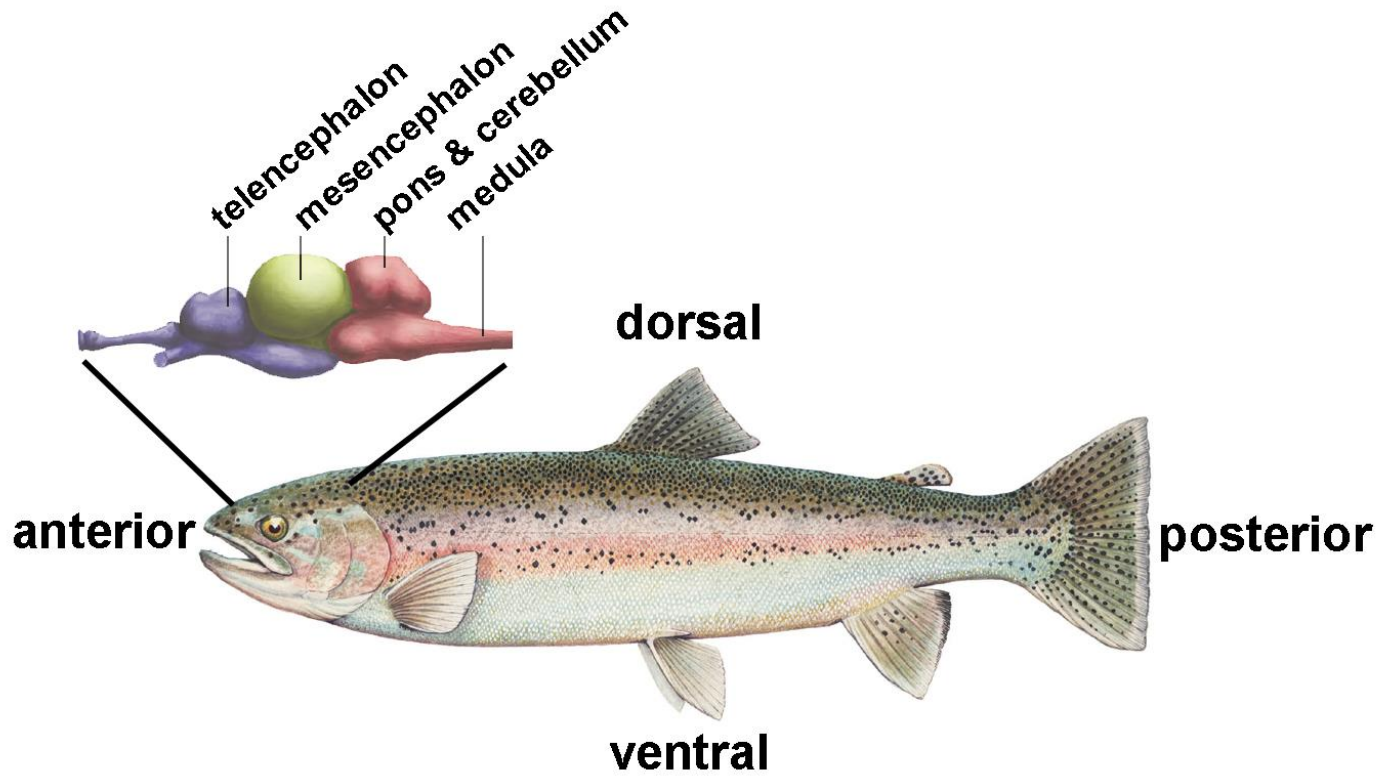
Neurons can ...

- have their somas in the CNS and axons terminating in the PNS.
or
- have their somas in the PNS and their axons terminating in the CNS.
or
- can be completely within the CNS or PNS.

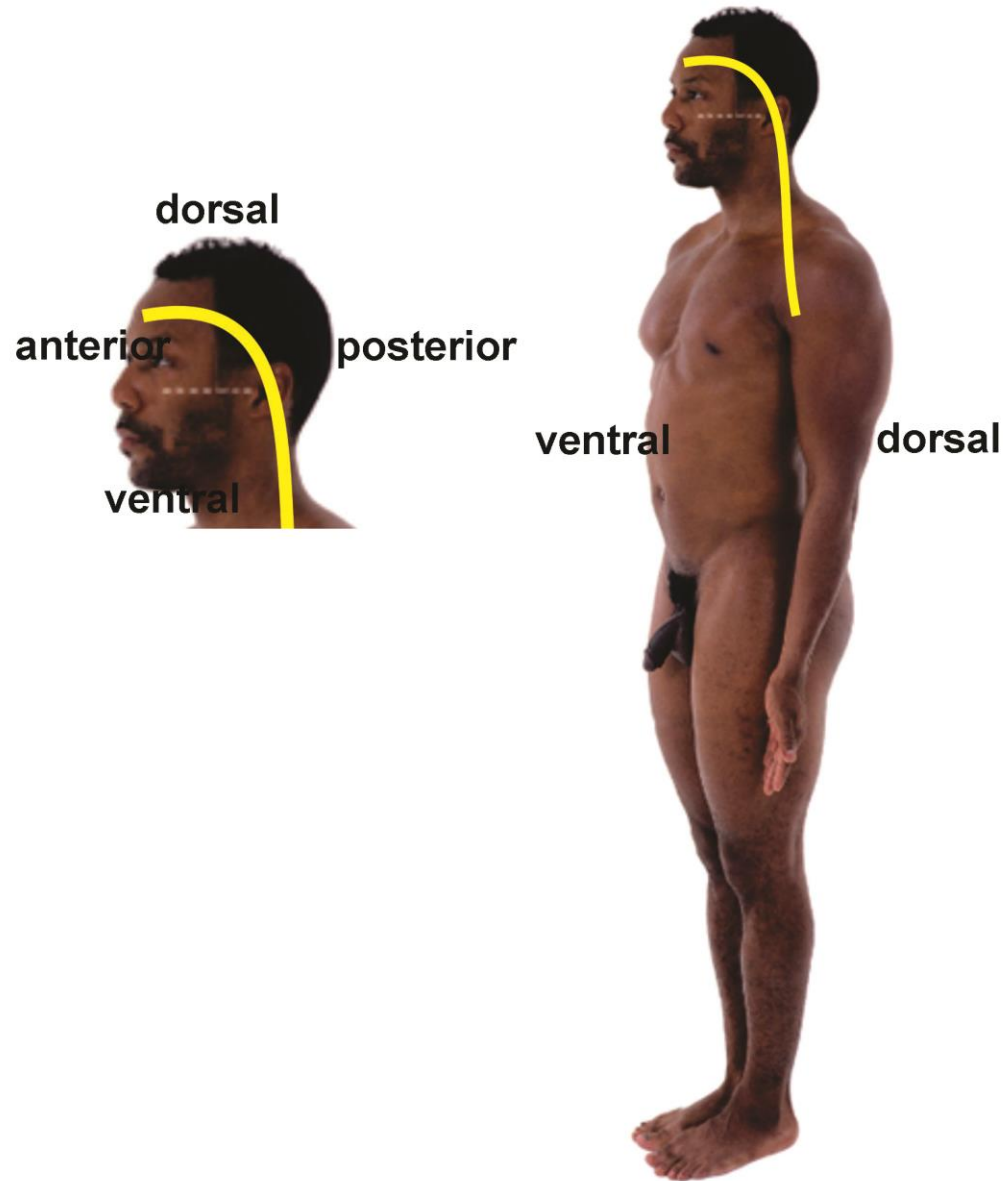
Today we will meet the brain, but first we need orientation.



Fish have it easy.

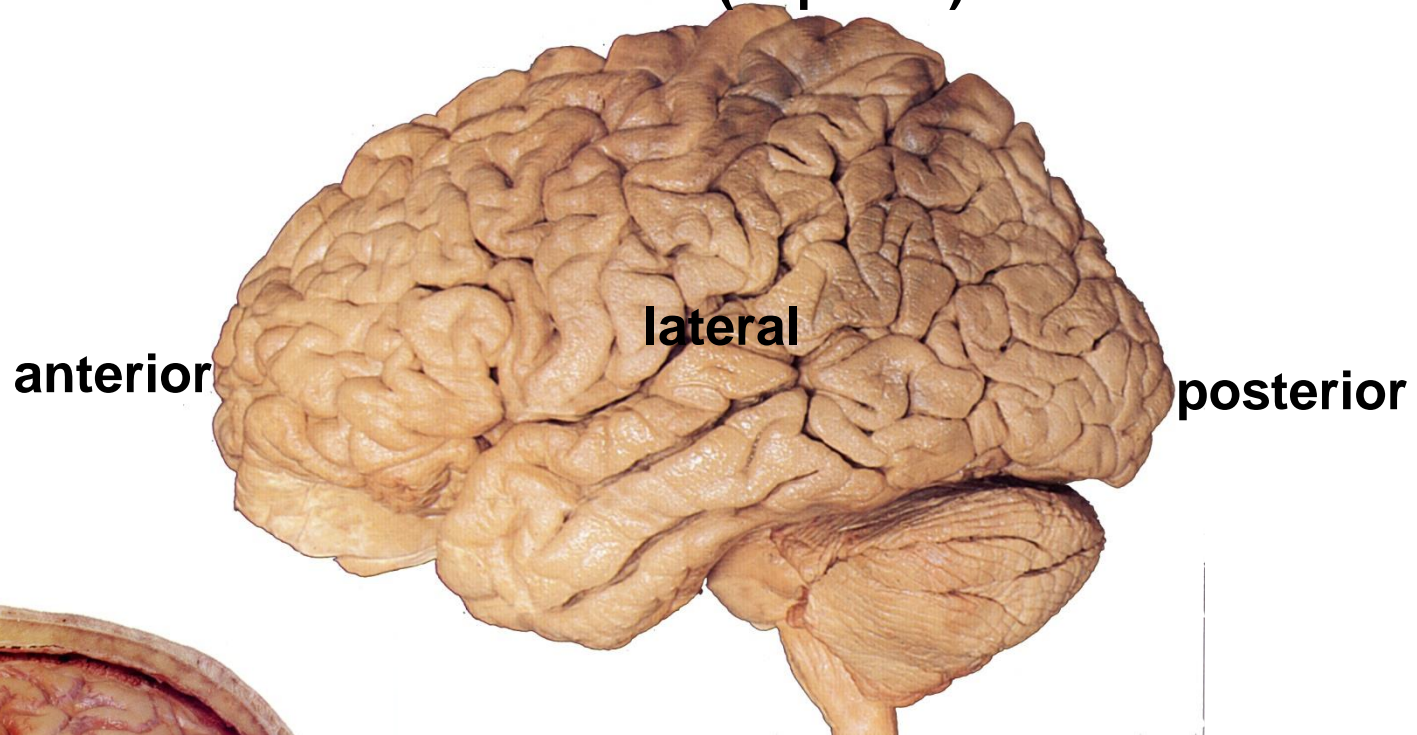


Humans evolved flexures (bends) in the head and brain.



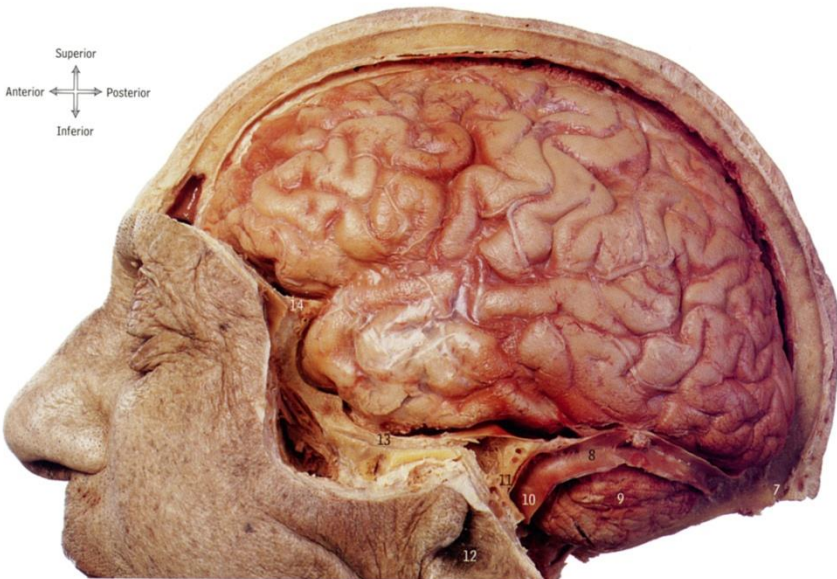
Major Coordinates of the Brain

dorsal (superior)

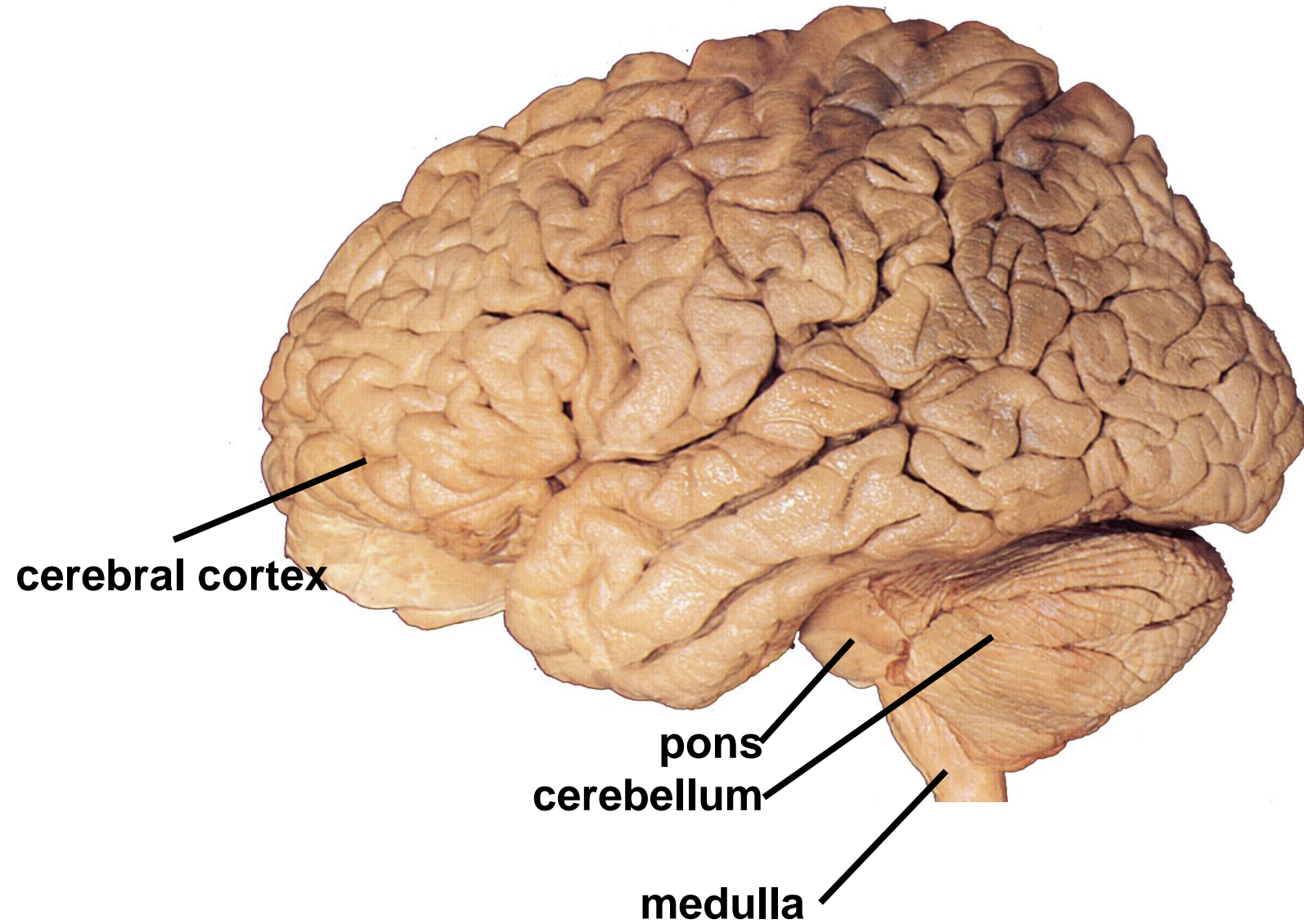


ventral (inferior)

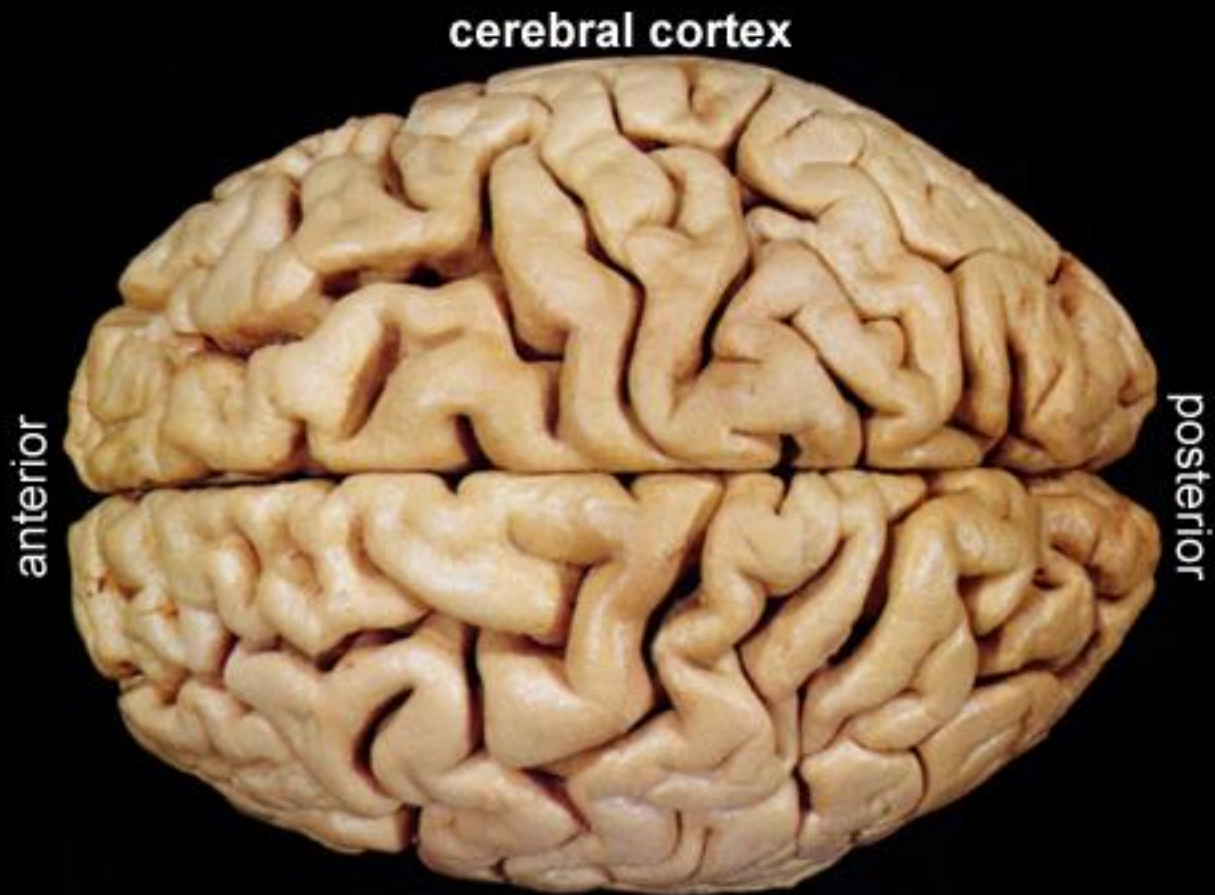
(midline is medial)



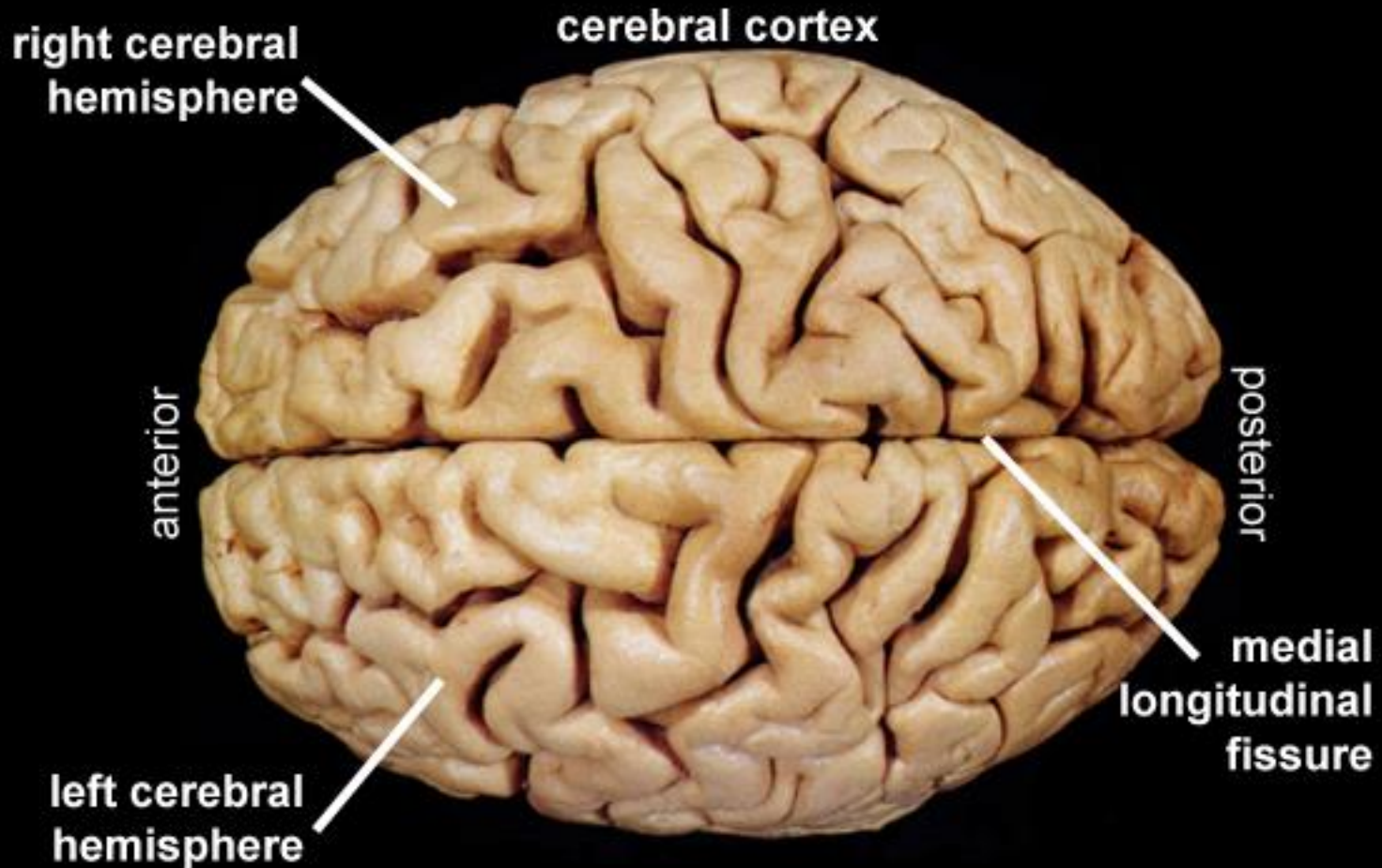
Lateral Surface of the Brain



Dorsal (Superior) Surface of the Brain

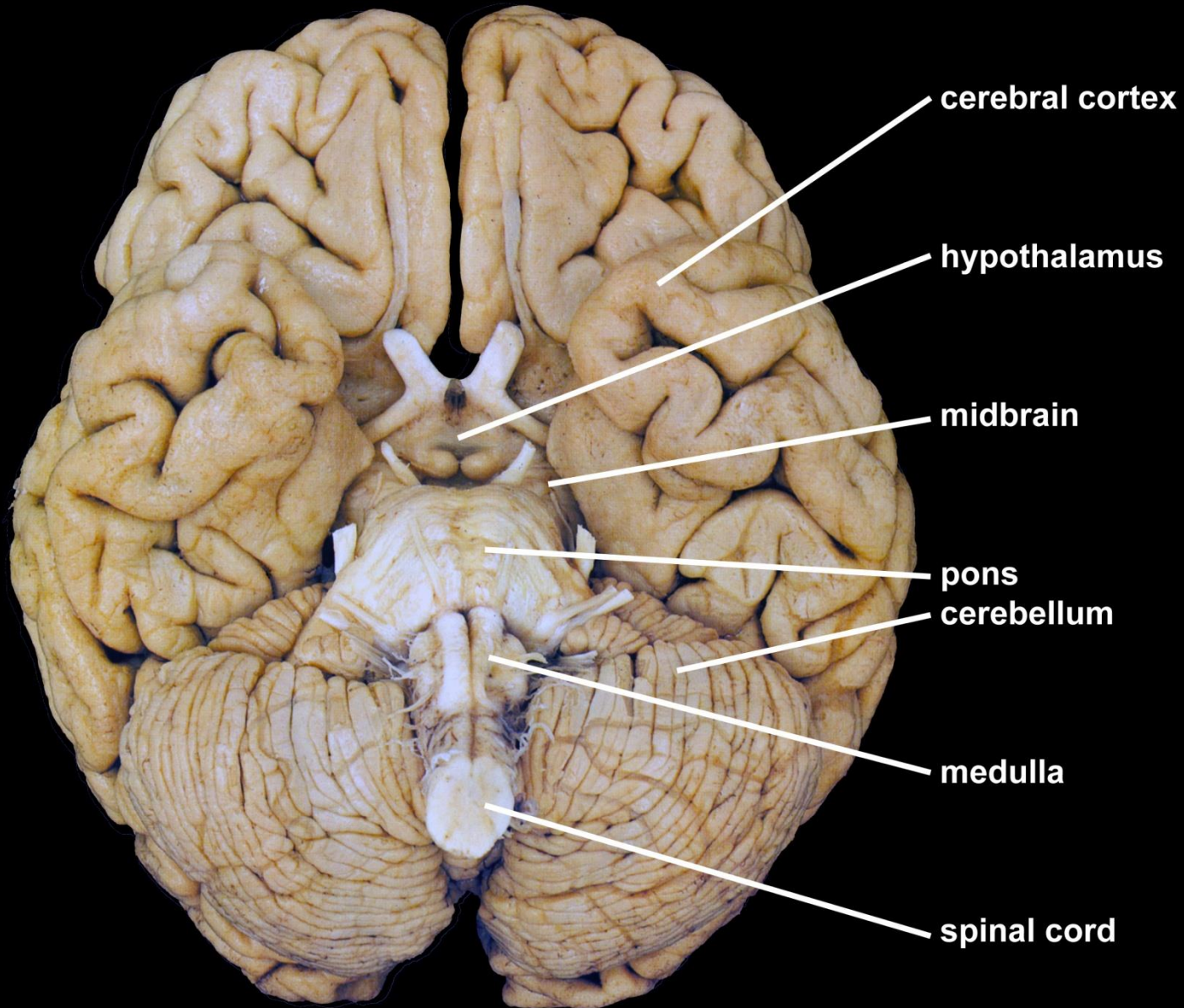


Dorsal (Superior) Surface of the Brain

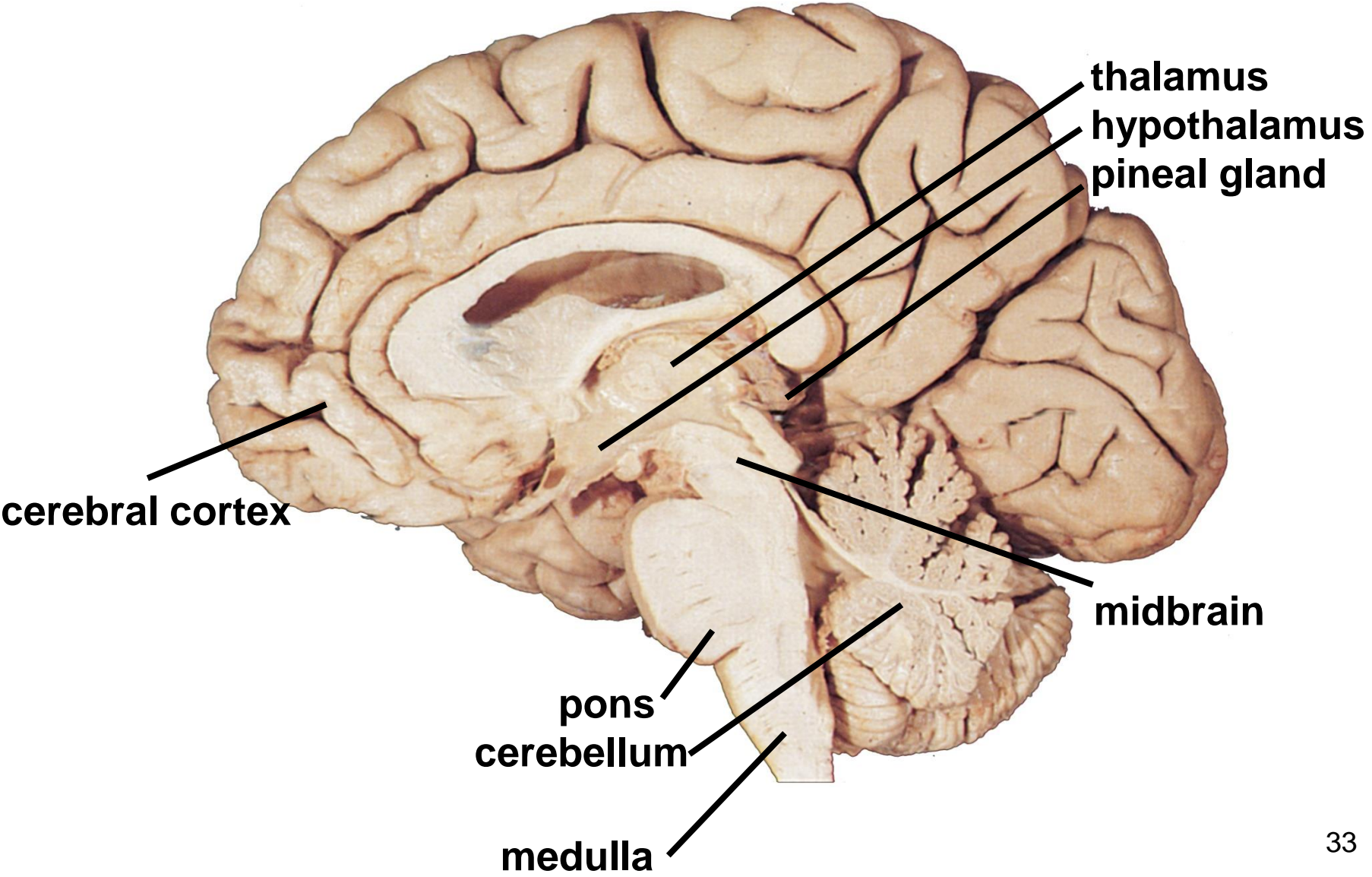


There are two cerebral hemispheres!

Ventral (Inferior) Surface of the Brain



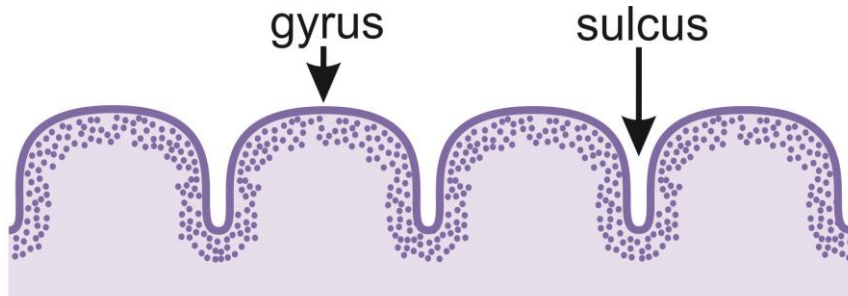
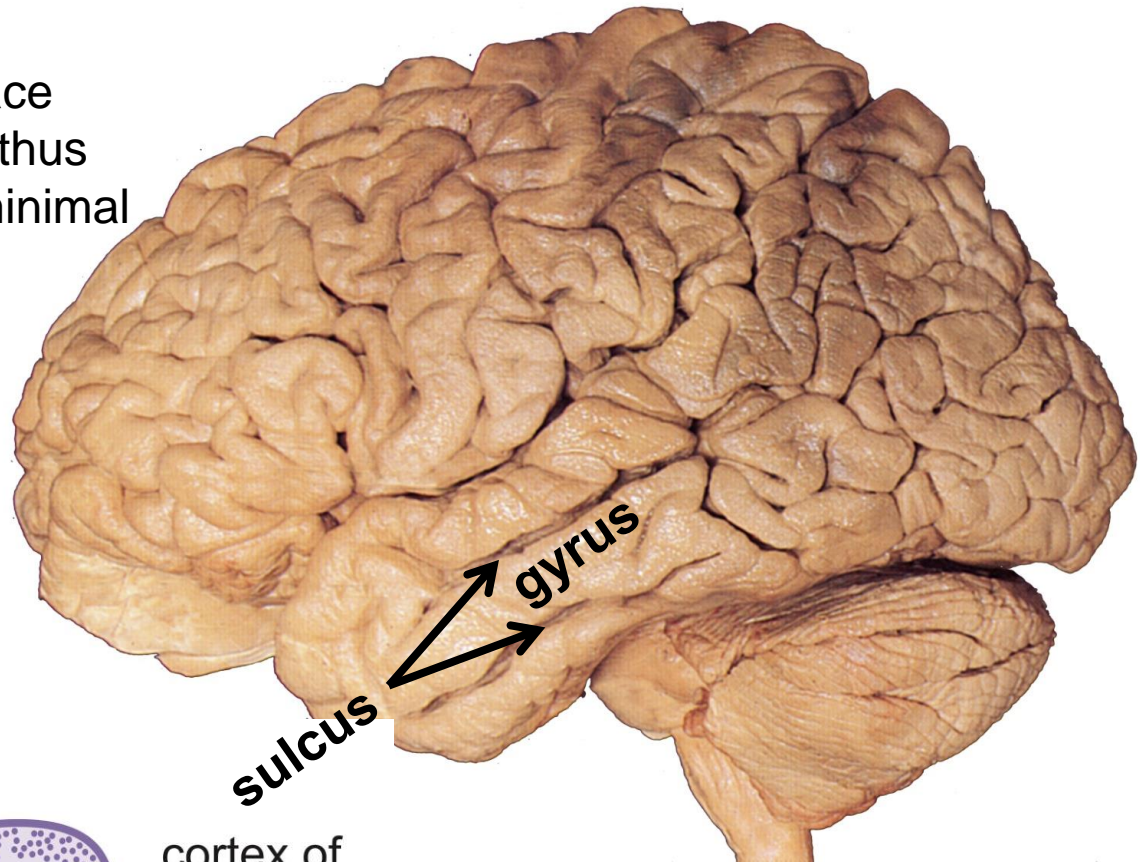
Medial Surface of the Brain
(brain cut in sagittal plane through medial longitudinal fissure)



Gyri and Sulci of Cerebral Cortex

Gyri and sulci increase the surface area of the cerebral cortex, and thus the number of neurons, with a minimal increase in brain volume.

A deep sulcus is a fissure.



cortex of
higher
vertebrates



cortex of
lower
vertebrates

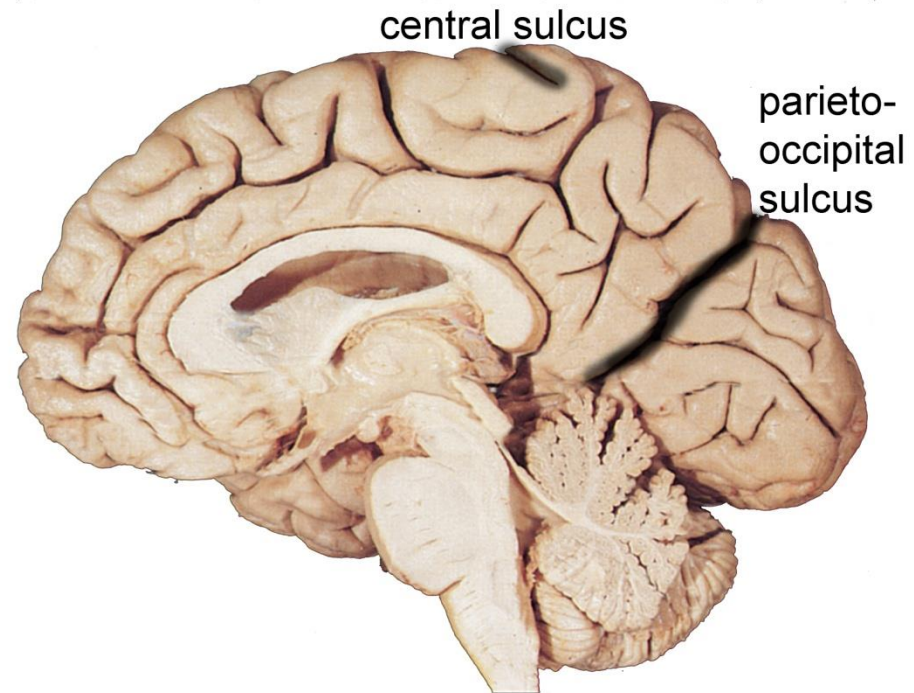
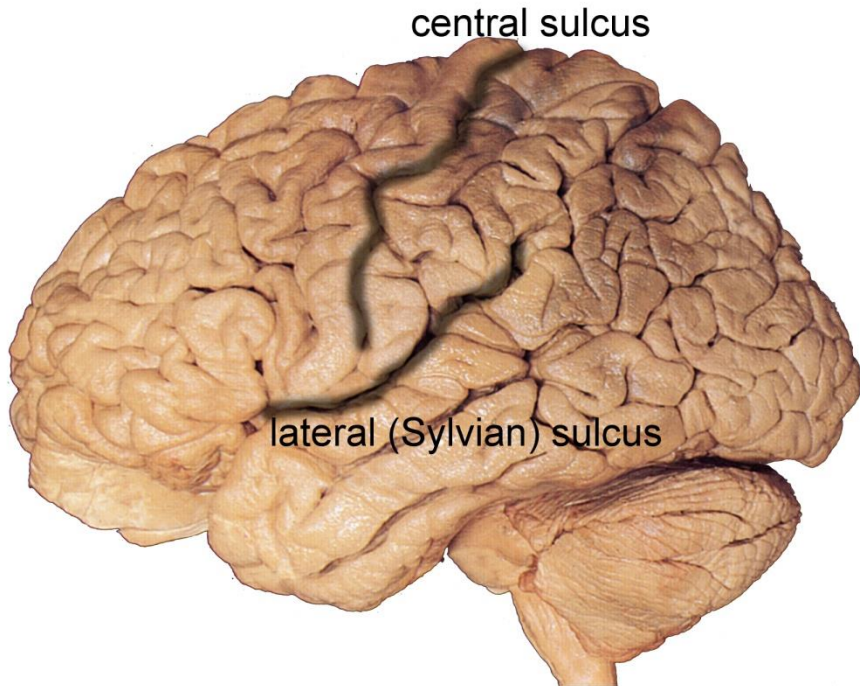
Gyri and Sulci of Cerebral Cortex

Poor generation or migration of neurons in the cortex during embryonic development results in lissencephaly (smooth cortex) and mental retardation.

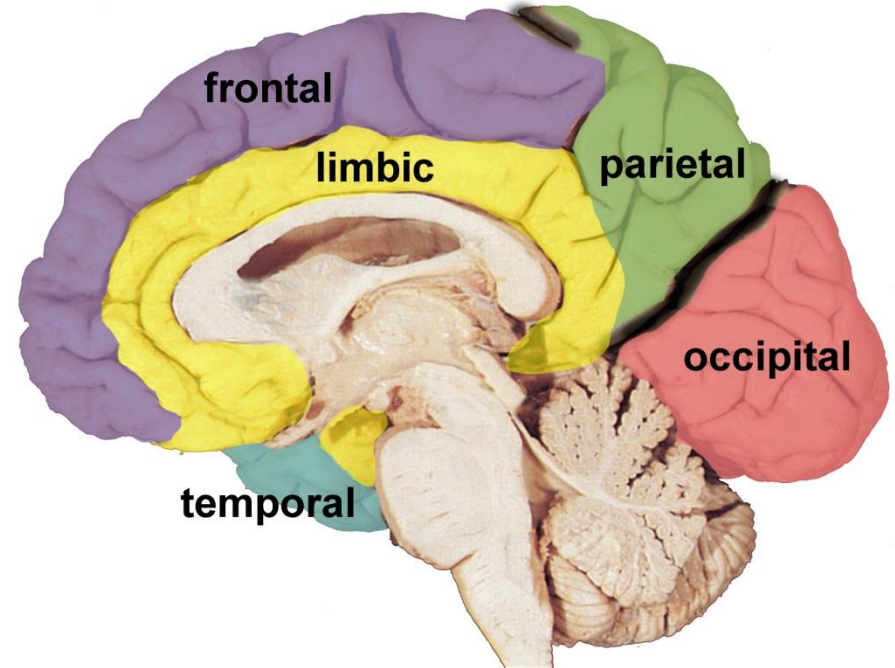
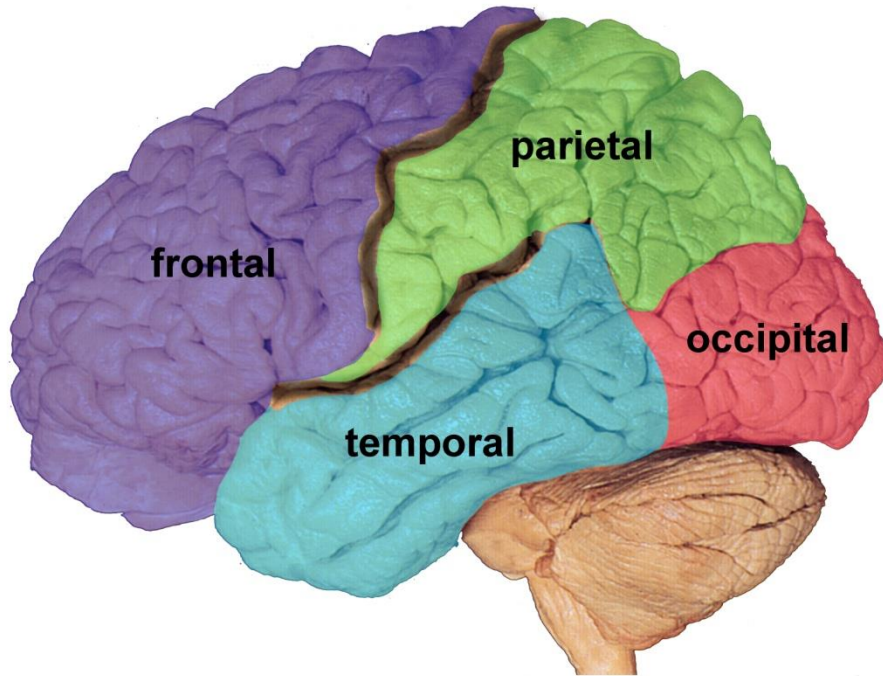


Gyri and Sulci of Cerebral Cortex

Deep & consistently present sulci are useful landmarks :



Cerebral Cortex is divided into five lobes.

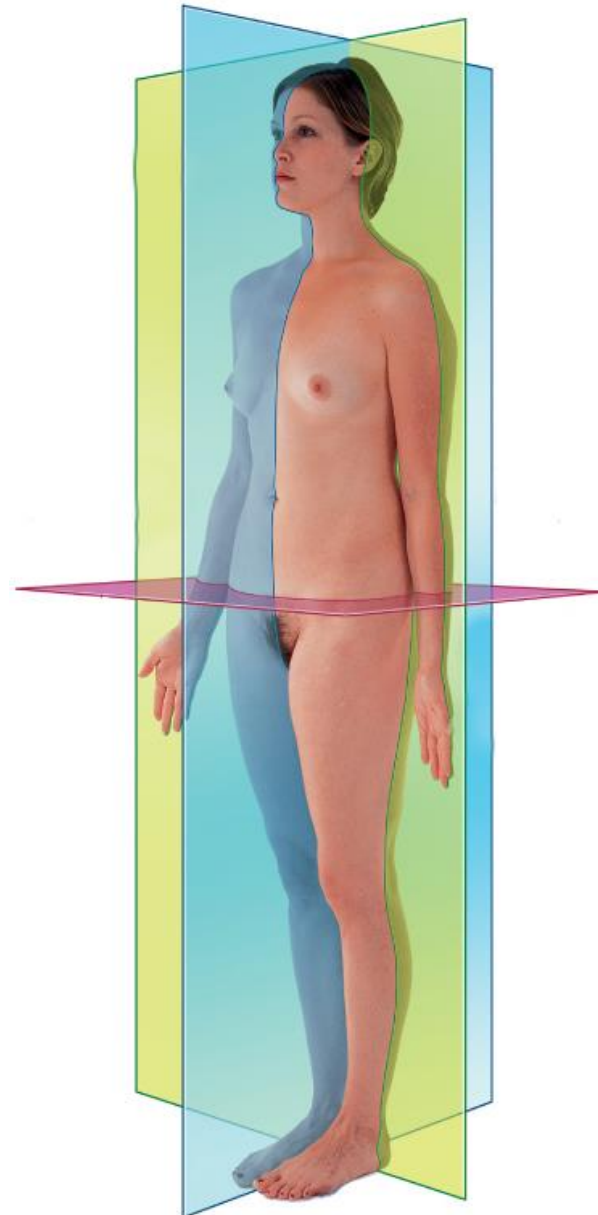


Major Planes of the Body

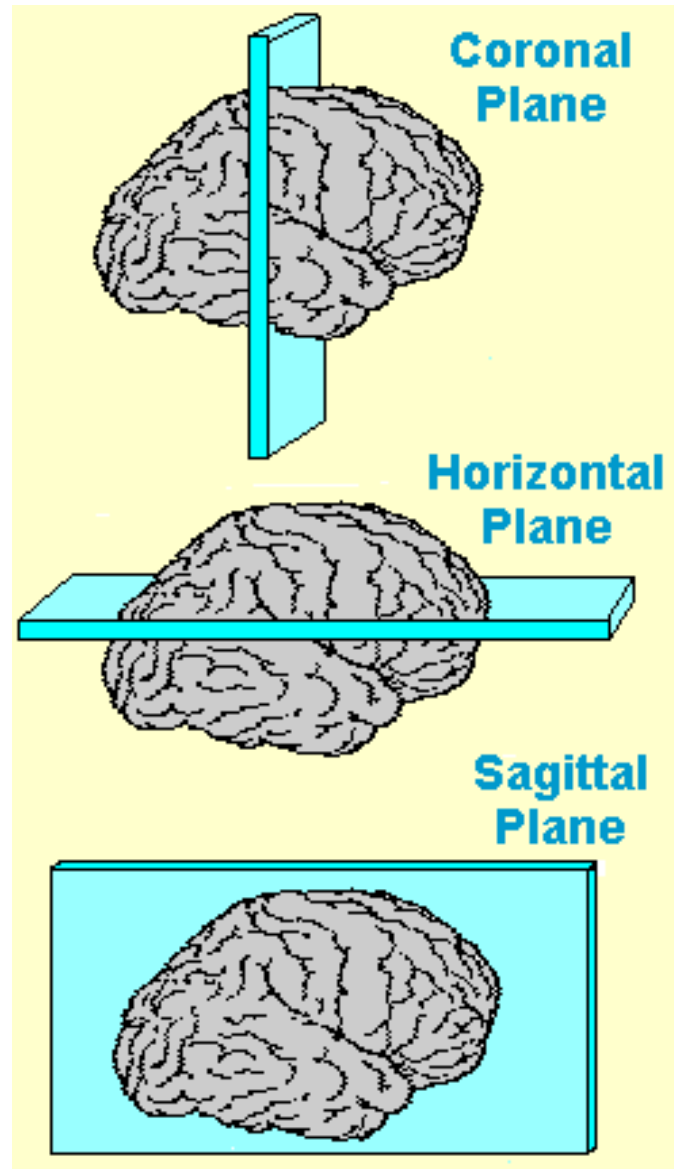
(blue) sagittal or median

(green) coronal or frontal

(pink) horizontal or transverse

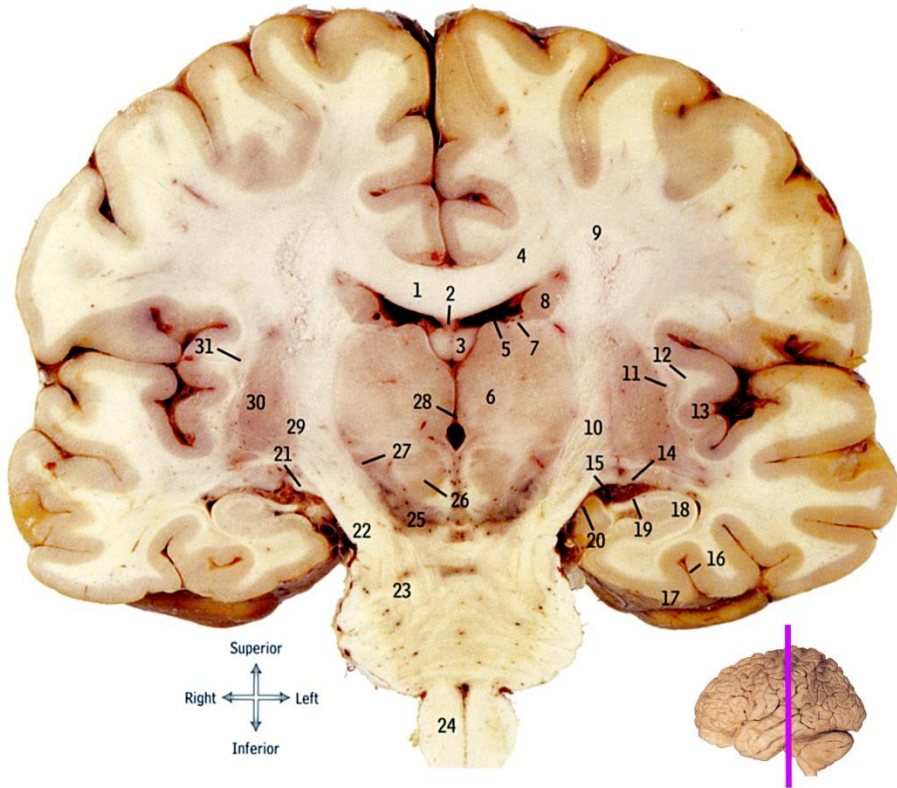


Major Planes of the Brain

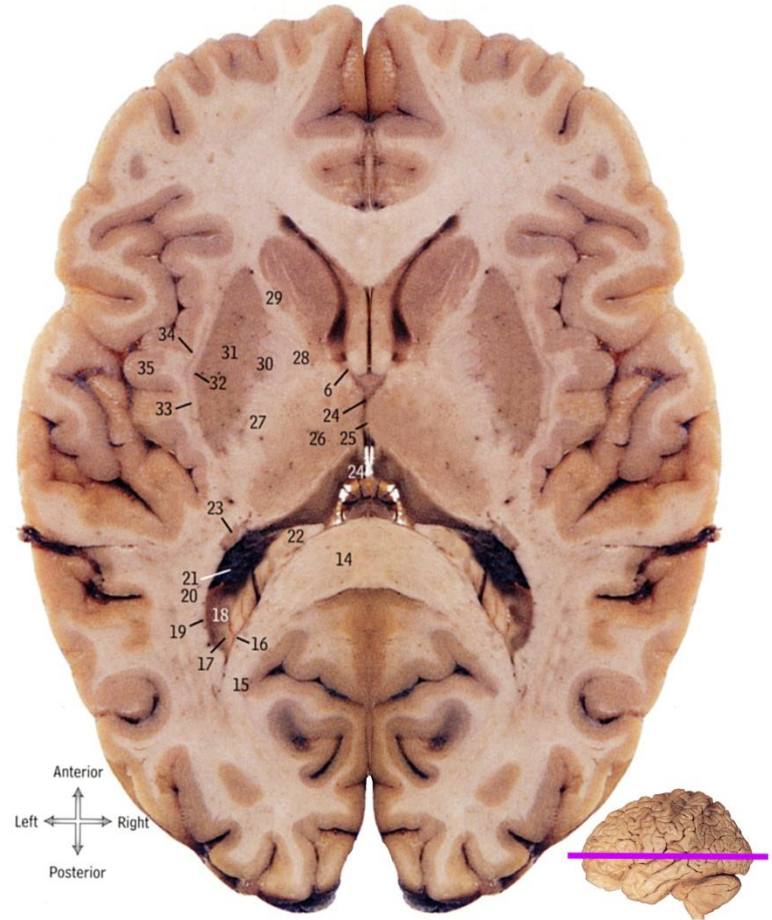


Coronal, horizontal and sagittal sections reveal internal structures.

coronal plane

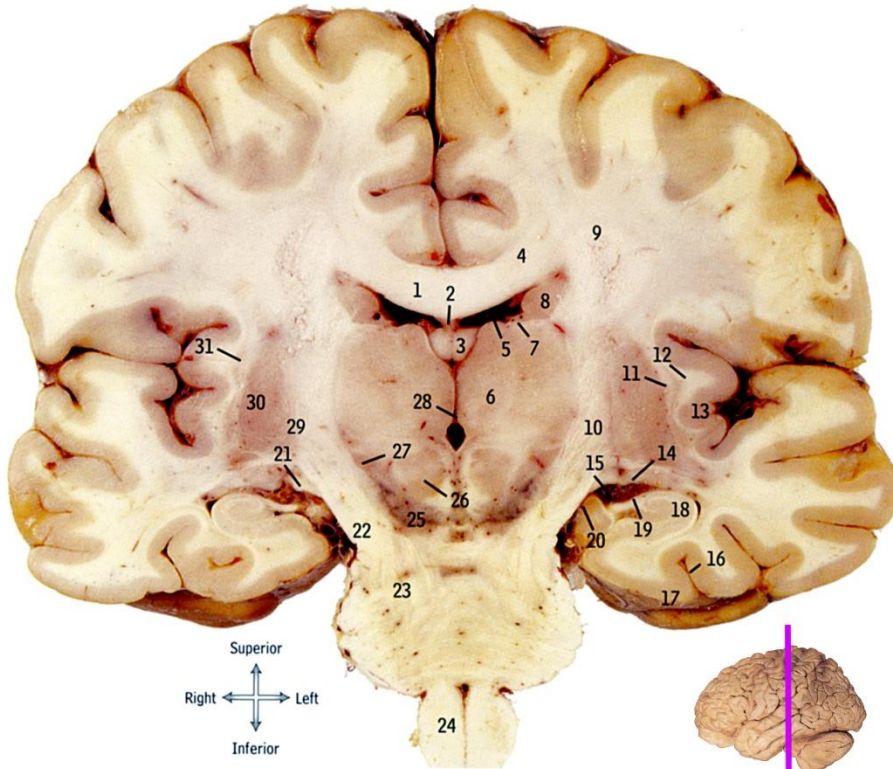


horizontal plane

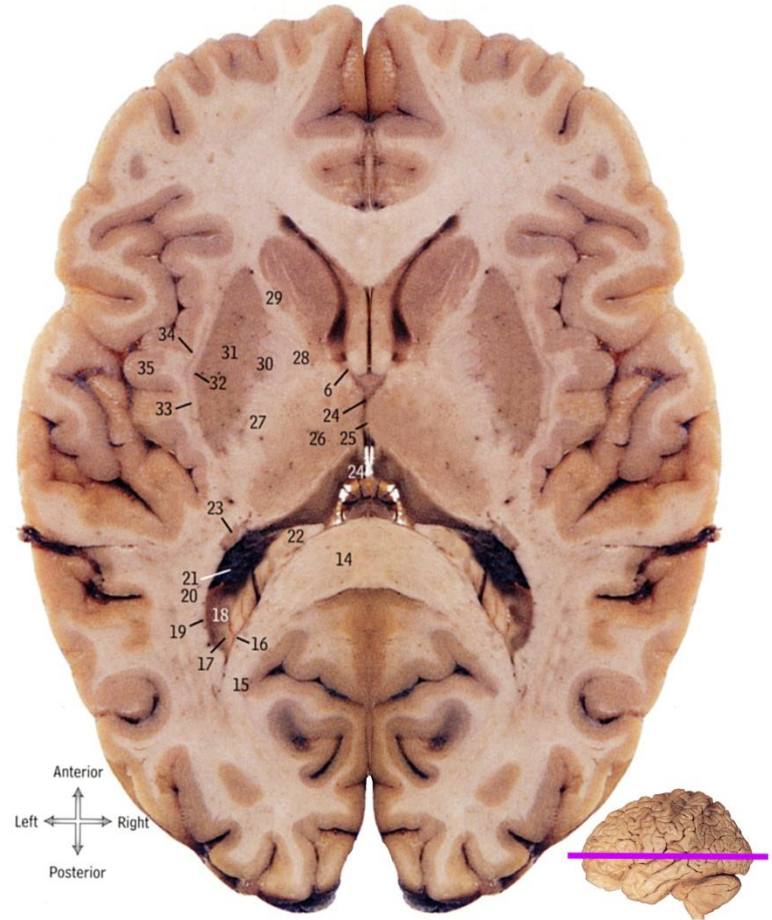


For example, the basal ganglia are seen only in sections.

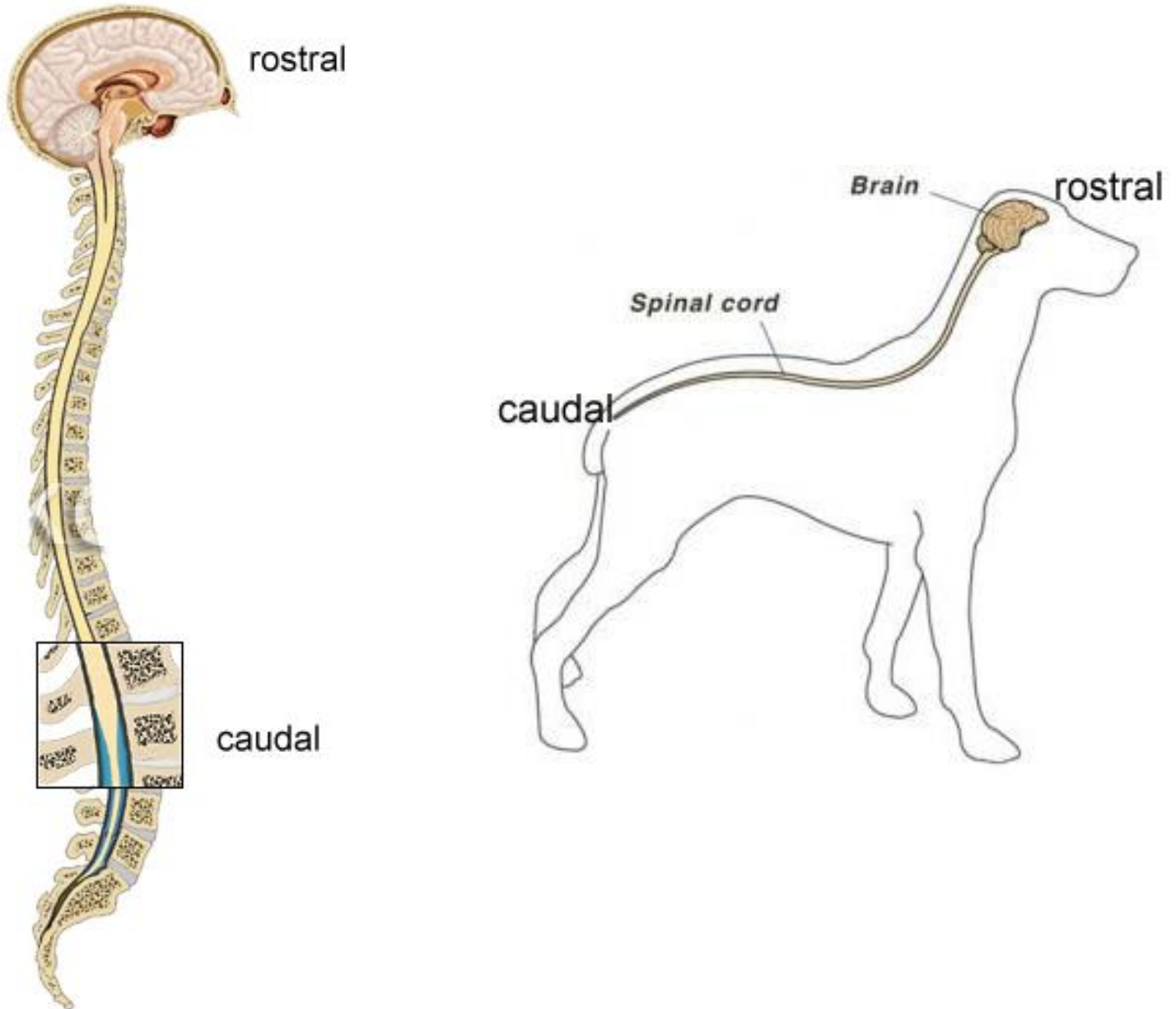
coronal plane



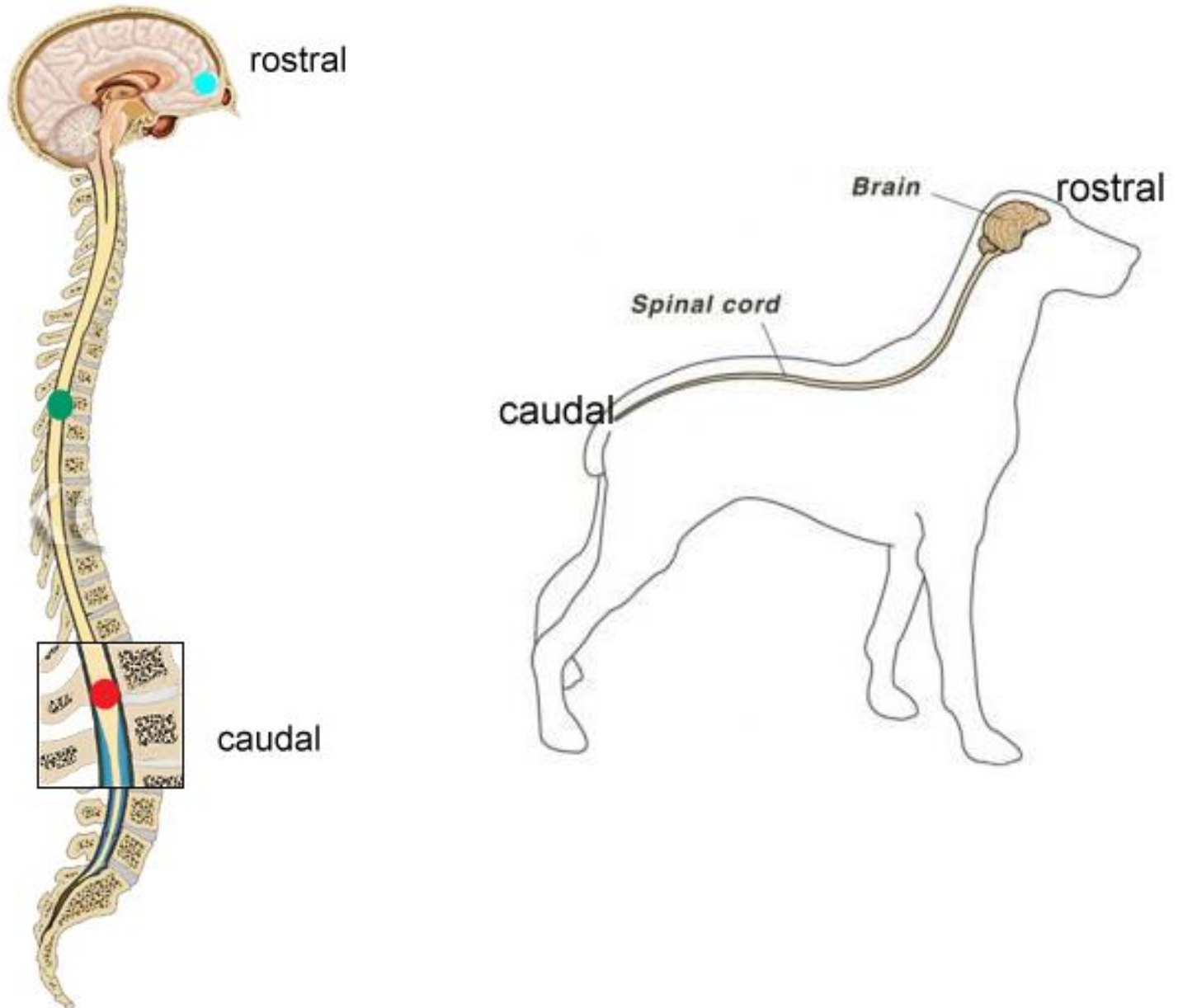
horizontal plane



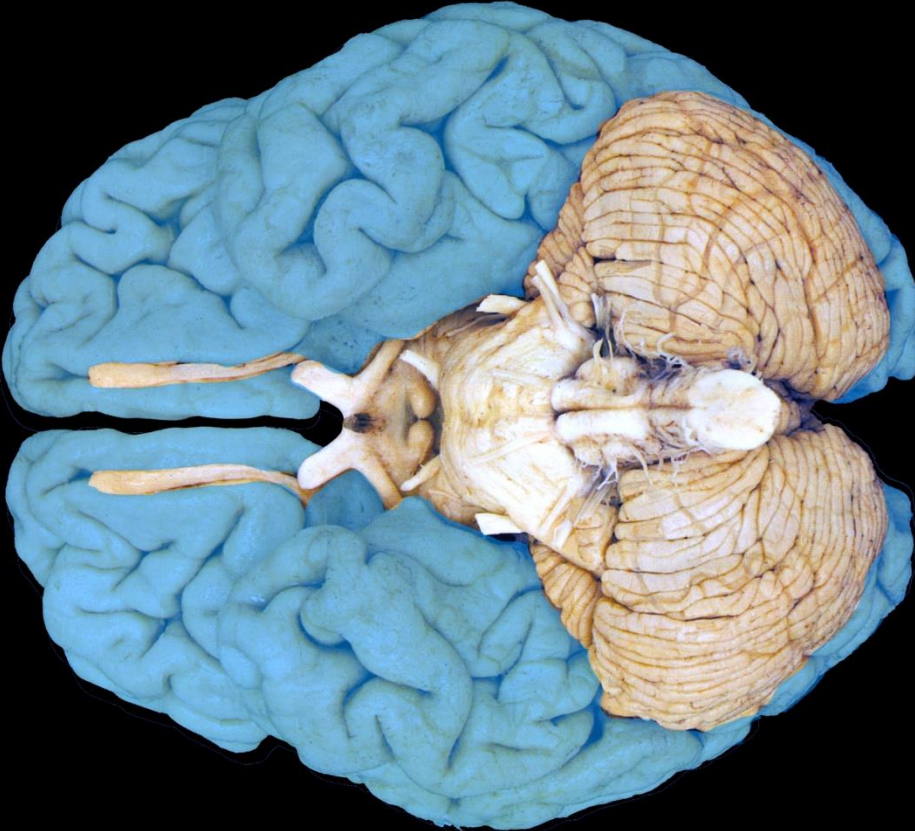
Rostral vrs. Caudal



Rostral vrs. Caudal



Cerebral Cortex



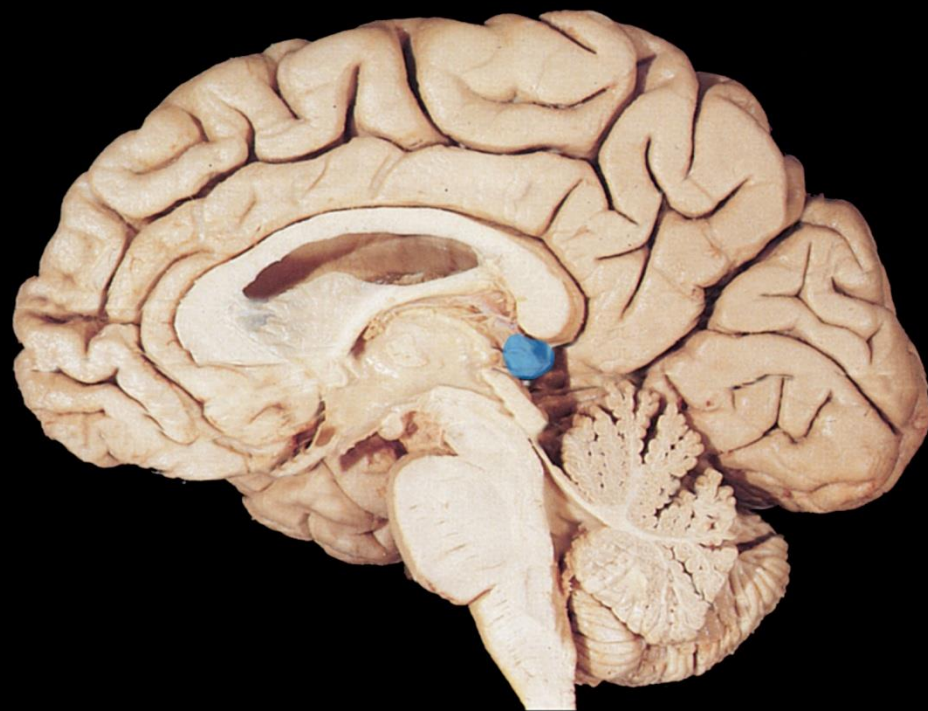
Hypothalamus



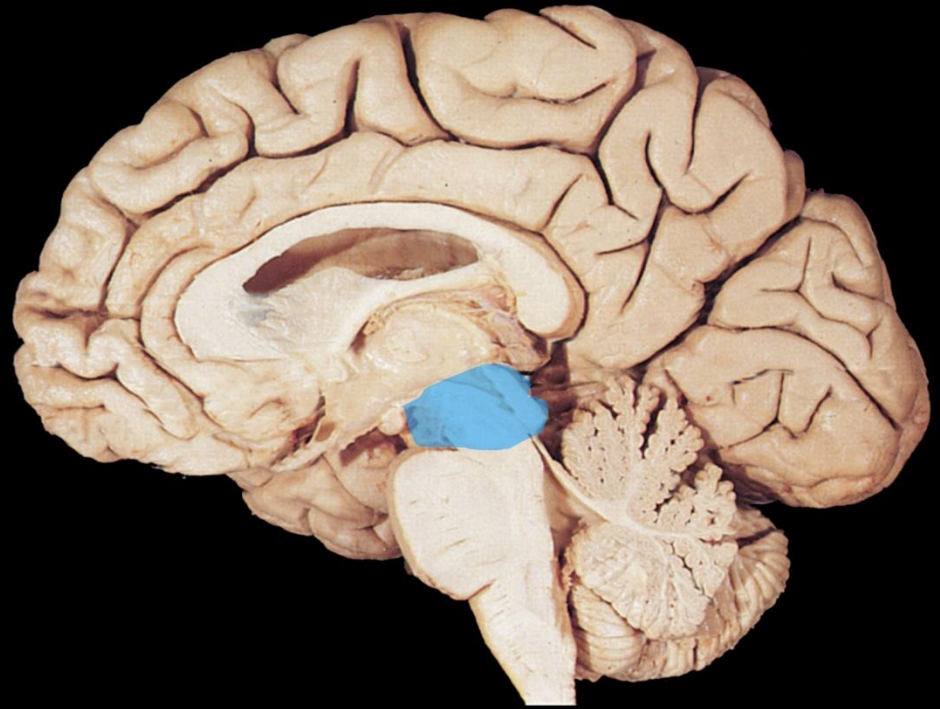
Thalamus



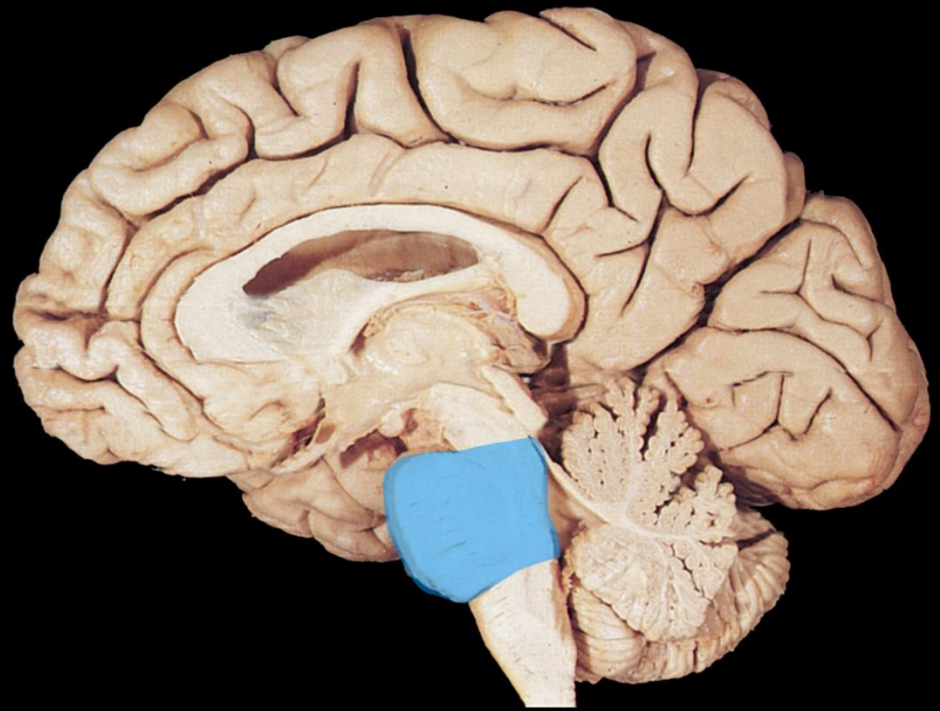
Pineal Body



Midbrain



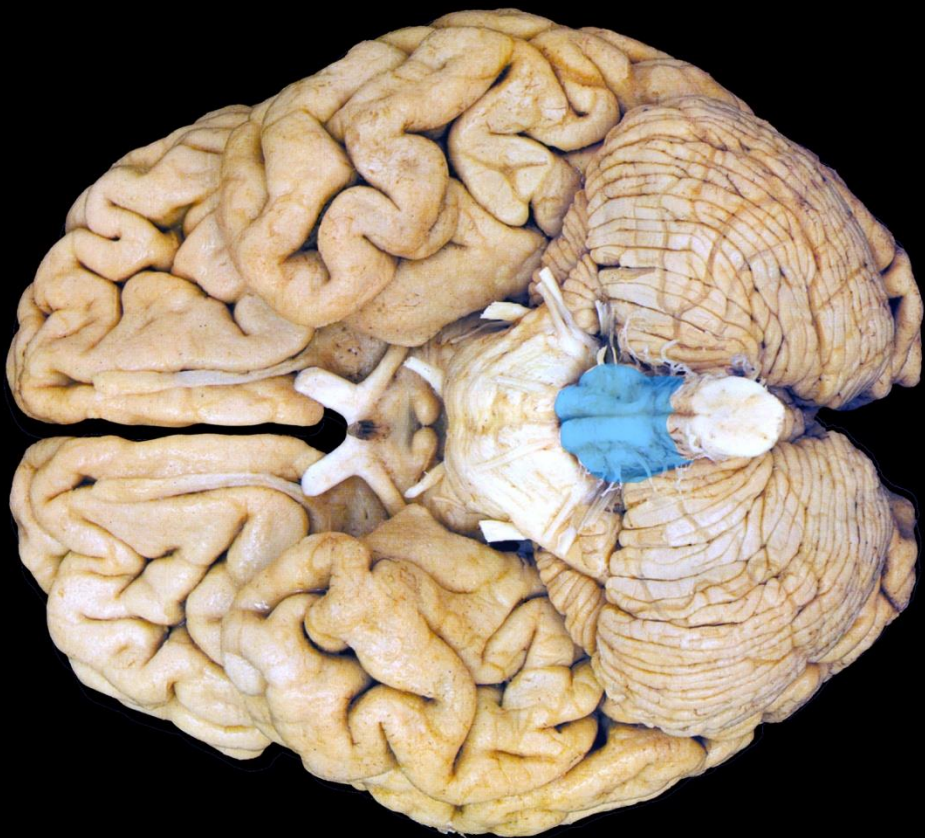
Pons



Cerebellum



Medulla



Spinal Cord

