

Cerebral Cortex 1

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Want to meet?

- Coffee hour
- 10-11am Tuesday 11/27
- Surdyk's

Overview and organization of the cerebral cortex

- What is the cerebral cortex?
- Where is each lobe, and what are its functions?
- How are areas of the cerebral cortex determined?
- What is the typical cellular organization of the cortex?
- What types of cells are in the cortex?
- What is the white matter through which the cortex communicates?
- Brain size & intelligence

What is the cerebral cortex? Where is it?

- The cerebral cortex is the most prominent part of the mammalian brain and consists of the cellular layers on the outer surface of the cerebral hemispheres.
 - divided into two halves: right and left
 - joined by two bundles of axons called the corpus callosum and the anterior commissure.
 - more highly developed in humans than other species.

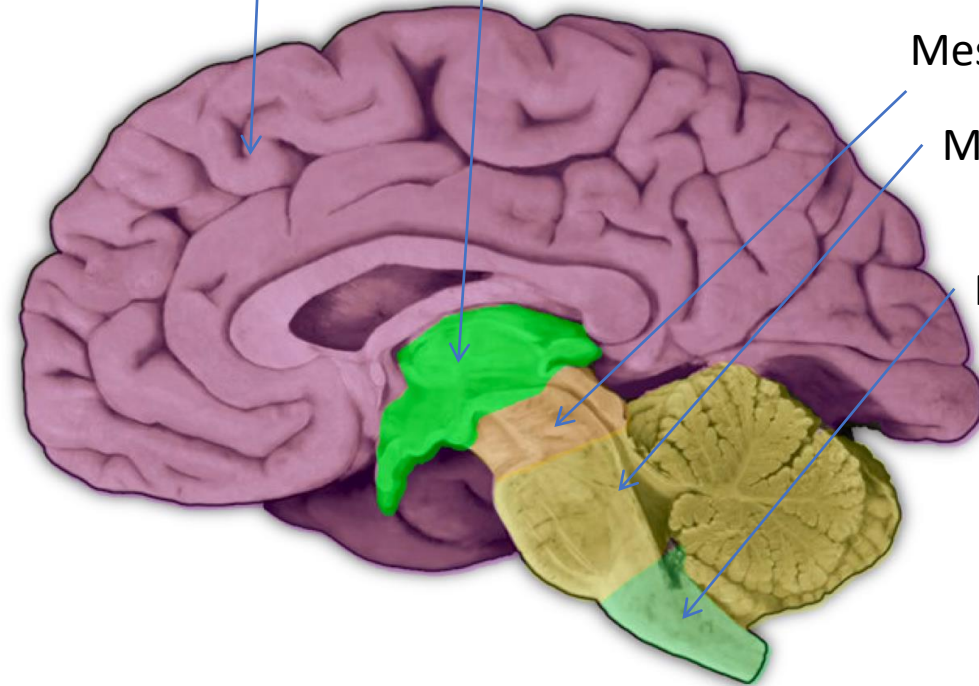
Telencephalon

Diencephalon

Mesencephalon

Metencephalon

Myelencephalon



Reminder: The Cerebral Cortex is in the telencephalon

The telencephalon also contains other structures, like the basal ganglia

Image - Midsagittal - Embryonic Divisions

Diencephalon

Caudal subdivision of the forebrain embryonic vesicle (prosencephalon) that gives rise to the thalamus and hypothalamus, among other structures in the adult nervous system.

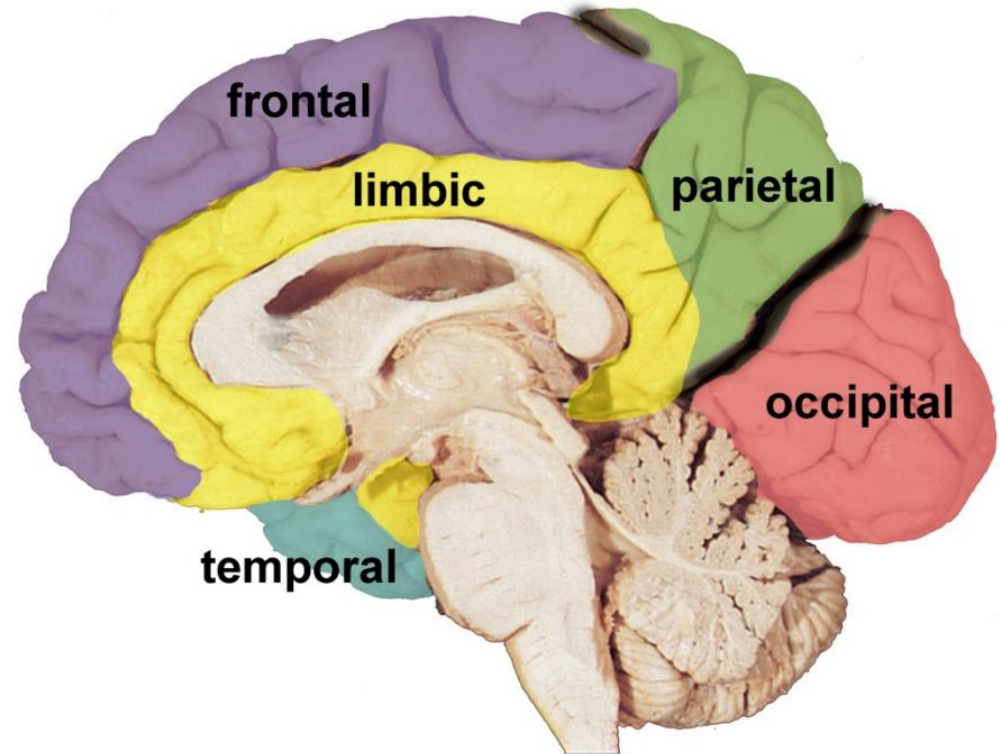
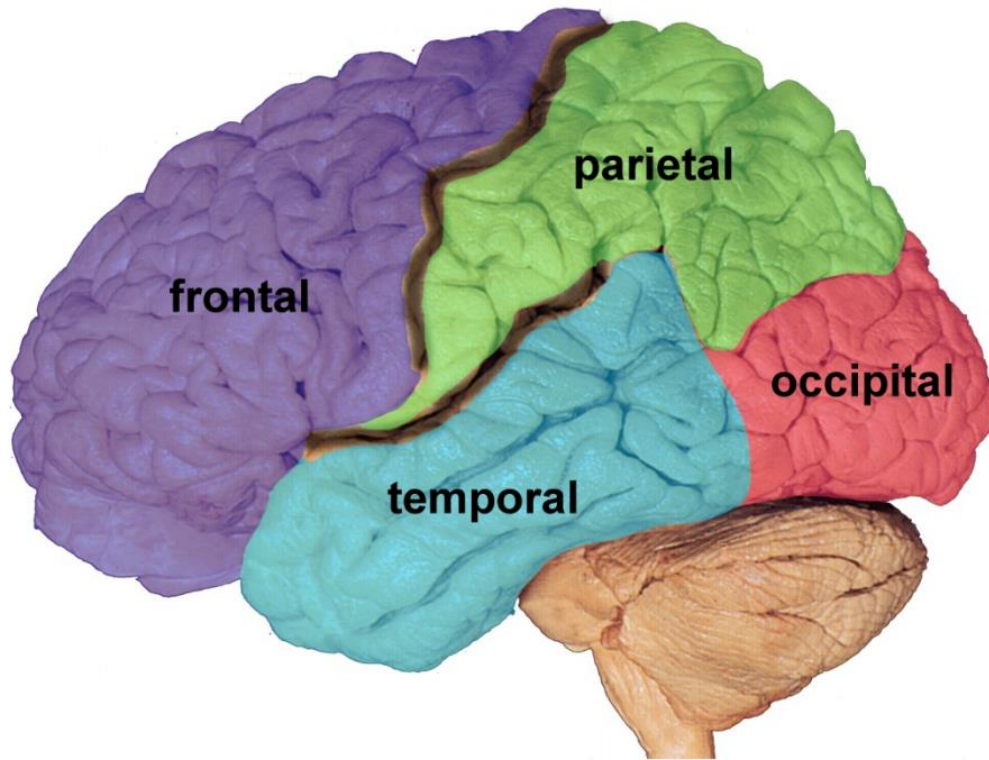
What is the cerebral cortex? Where is it?

- Organization of the Cerebral Cortex:
 - Contains up to six distinct **layers** of cell bodies that are parallel to the surface of the cortex.
 - Cells of the cortex are also divided into **columns** that lie perpendicular to the laminae.
 - Divided into five **lobes**: occipital, parietal, temporal, limbic, and frontal.
 - Each part of the cerebral cortex receives specialized input from a particular area in the thalamus.

Types of cortex

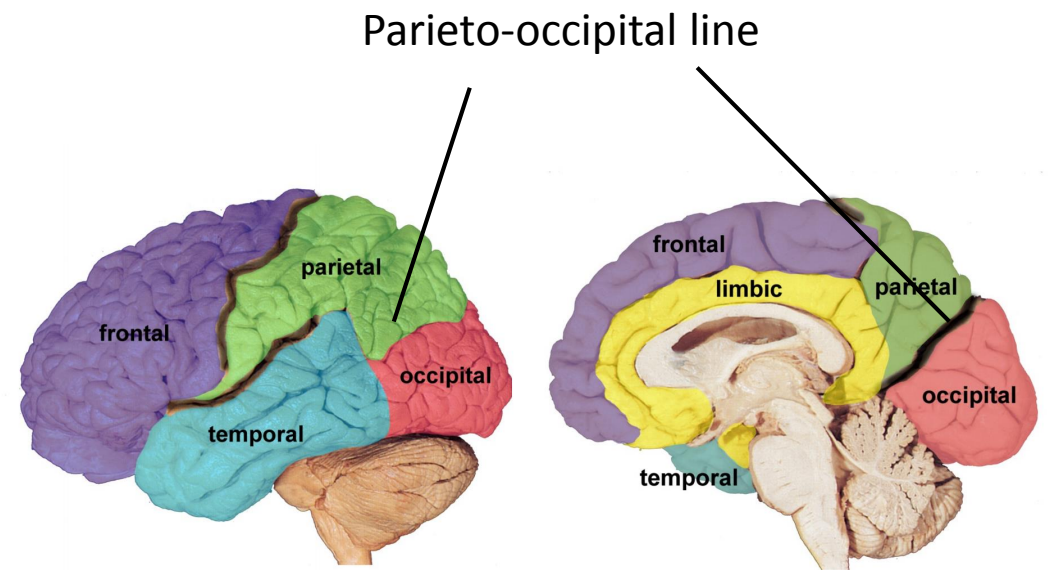
- Neocortex has six layers. Most of the human cerebral cortex is neocortex
- Allocortex has less than six layers
 - Piriform cortex, olfactory tubercle, anterior olfactory nucleus, hippocampus, olfactory bulb, some others
- More layers are thought to reflect more complex processing

5 lobes of the cerebral cortex



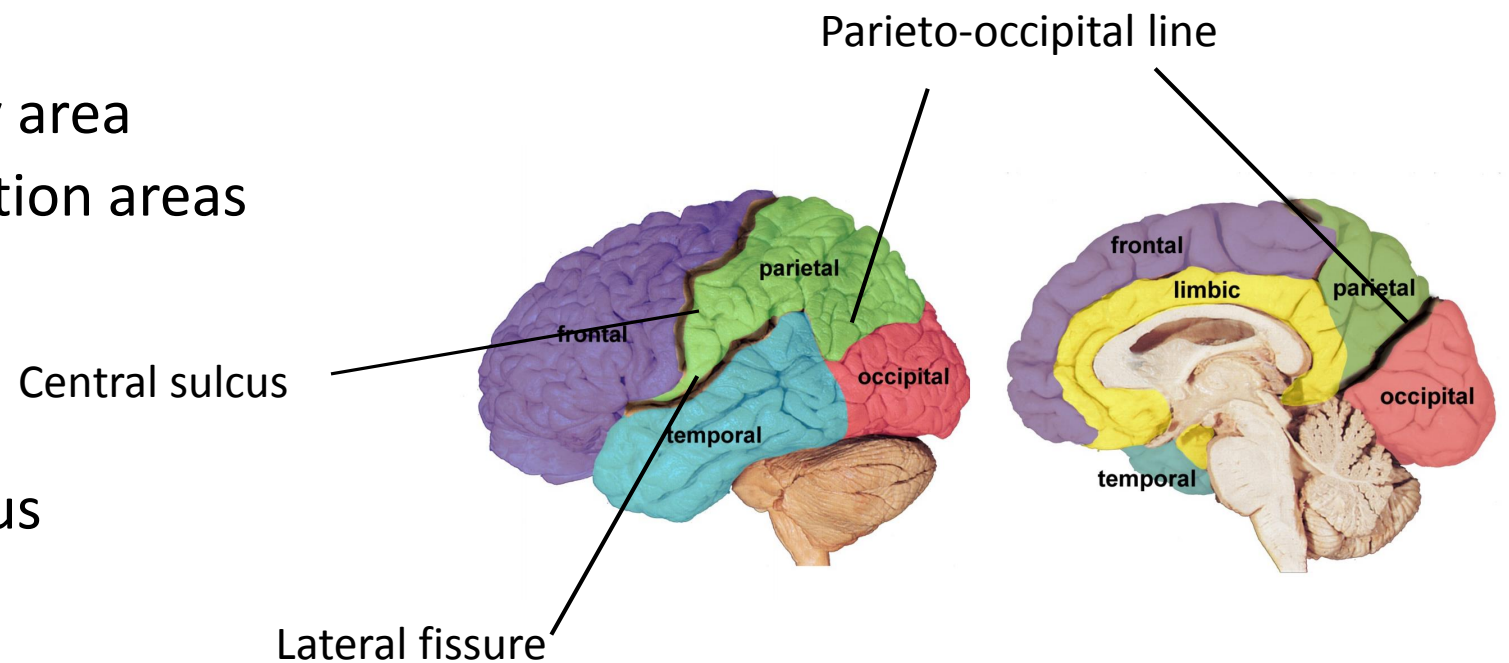
Occipital Lobe

- Bordered by:
 - (imaginary) parieto-occipital line
- Includes:
 - Primary visual area
 - Visual association areas
- Thalamic input from:
 - Lateral geniculate nucleus



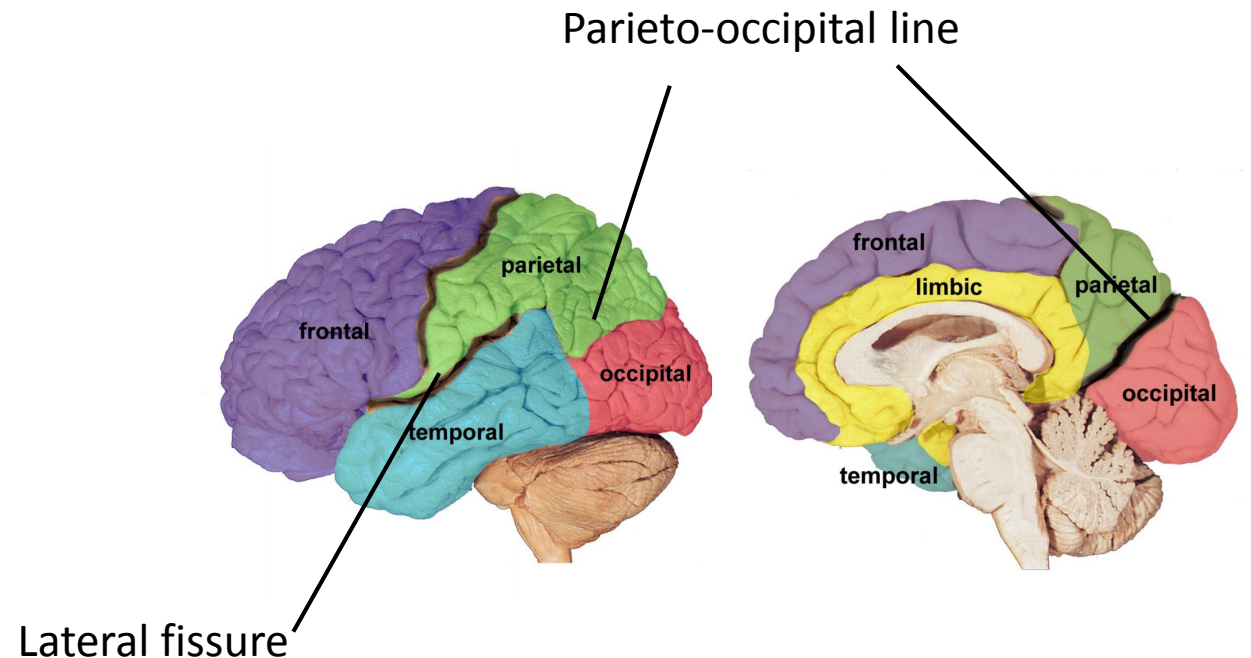
Parietal Lobe

- Bordered by:
 - Lateral fissure
 - Central sulcus
 - (imaginary) parieto-occipital line
- Includes:
 - Primary somatosensory area
 - Somatosensory association areas
- Thalamic input from:
 - Ventral posterior nucleus



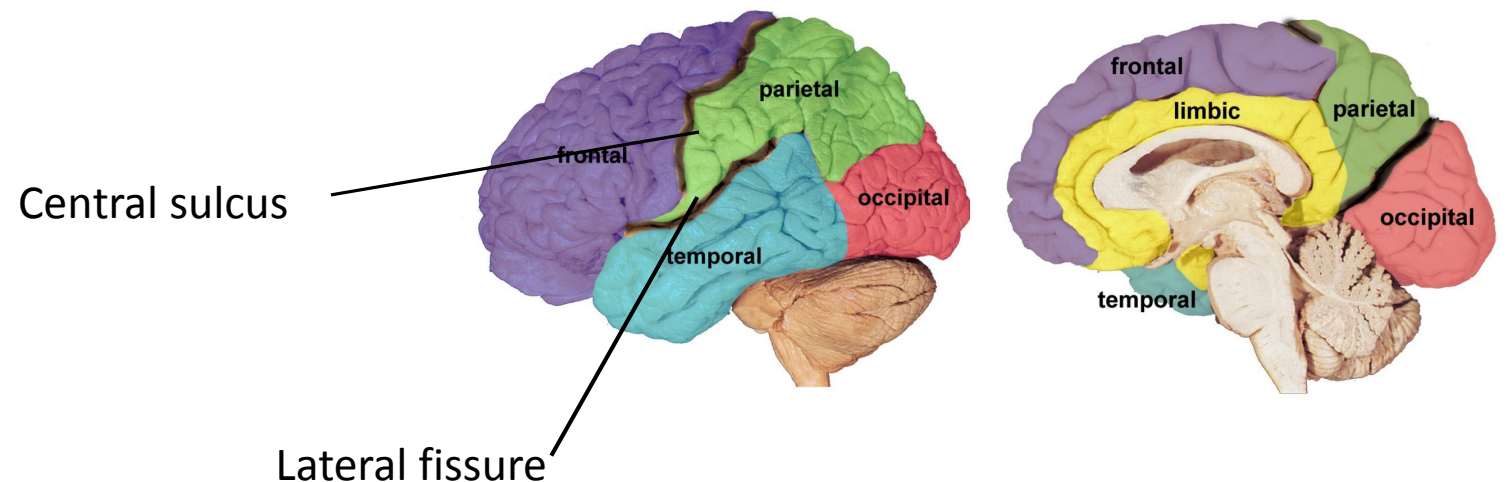
Temporal Lobe

- Bordered by:
 - Lateral fissure
 - (imaginary) parieto-occipital line
- Includes:
 - Primary auditory area
 - Auditory association areas
- Thalamic input from:
 - Medial geniculate nucleus



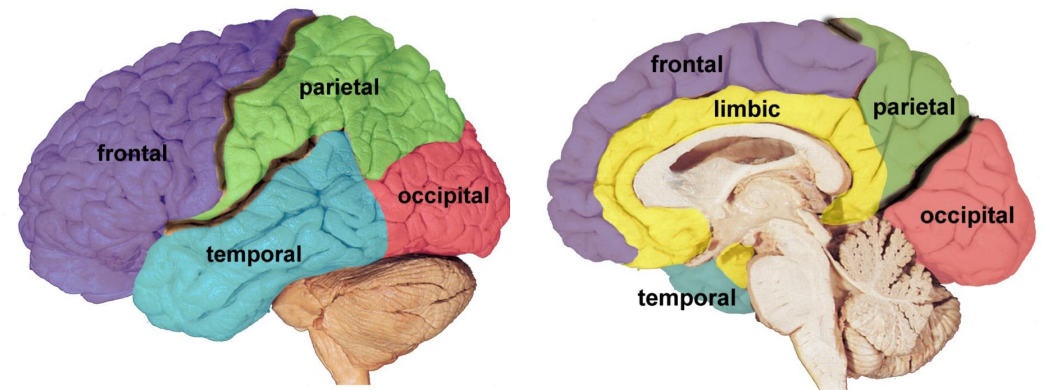
Frontal Lobe

- Bordered by:
 - Lateral fissure
 - Central sulcus
- Includes
 - Primary motor area: just in front of the central sulcus.
 - Other motor areas: premotor, supplementary motor, frontal eye fields, Broca's area
 - Prefrontal cortex
- Thalamic input from:
 - Mediodorsal nucleus
 - Ventroanterior nucleus
 - Ventrolateral nucleus



Limbic Lobe

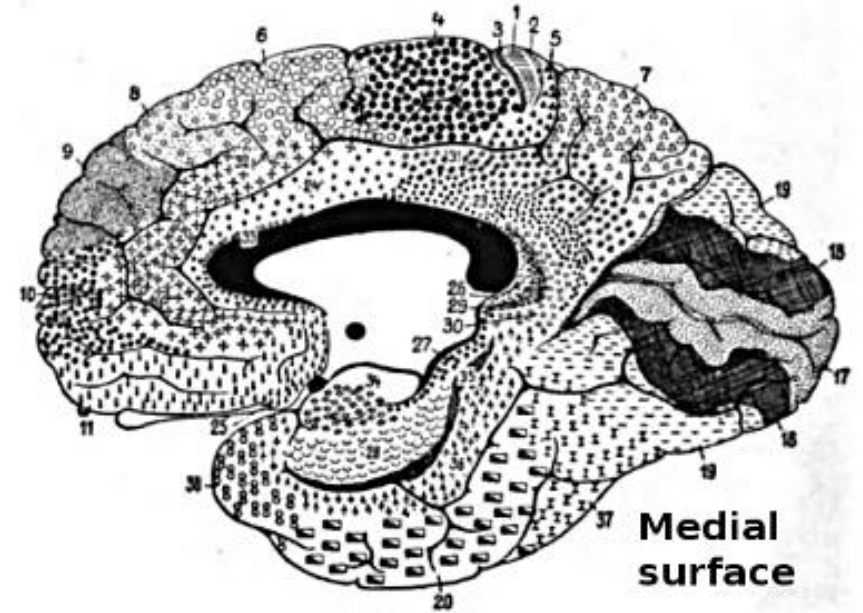
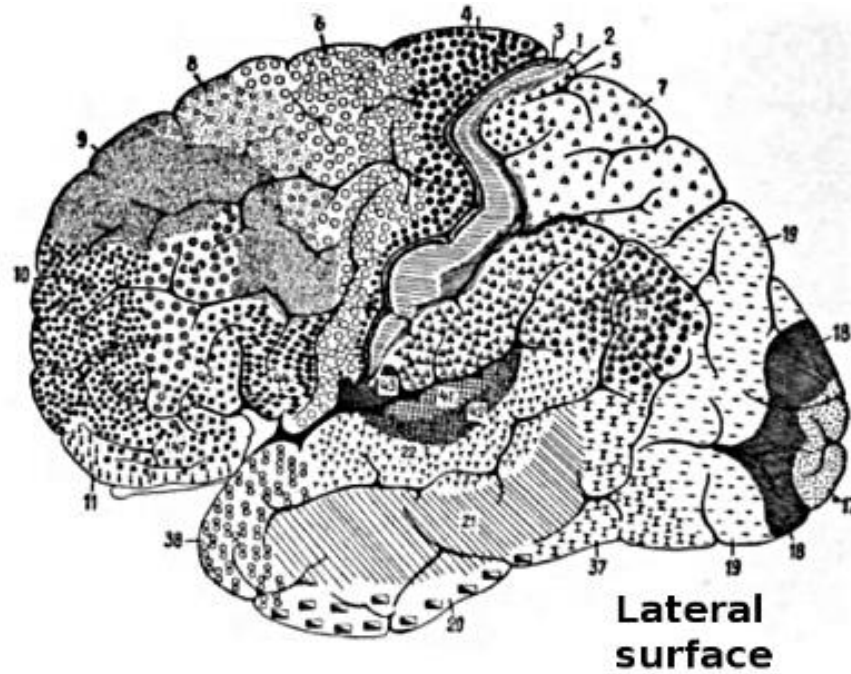
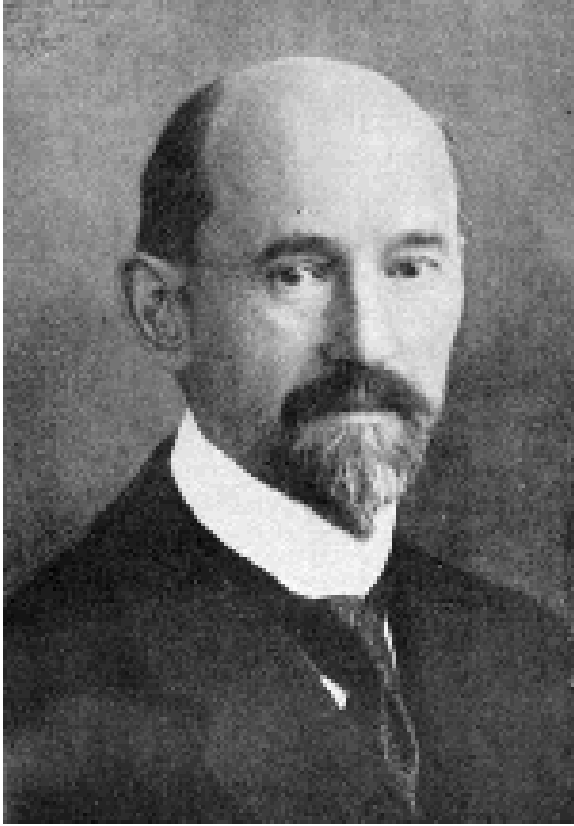
- Located on the medial surface of the cerebral cortex
- Includes:
 - Hippocampus
 - Amygdala
 - Parahippocampal gyrus
 - Cingulate gyrus
- Thalamic input from:
 - Anterior thalamic nuclei



Microscopic anatomy of the cortex

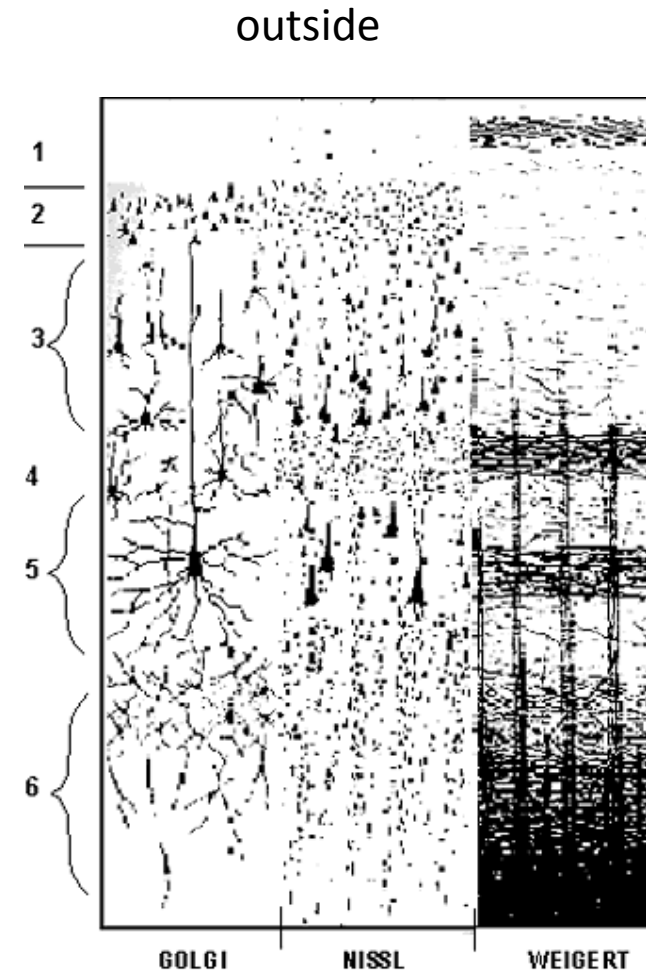
- Radially organized into layers
- Each layer contains a specific subset of neurons that have a unique pattern of input and output projections
- The density and arrangement of neurons in each layer (this results in the microscopic appearance called cytoarchitecture) differ between areas

52 "Brodmann" areas



Cellular Organization of Cortex

- Mammalian cortex has six layers.
- Layer 1 contains few cell bodies
- Layers 2/3 contain many pyramidal neurons that connect to other areas of the neocortex
- Layer 4 contains many neurons that receive sensory information from thalamus
- Layer 5 contains many large pyramidal neurons that connect to the brainstem & spinal cord
- Layer 6 contains many pyramidal neurons that project to the thalamus.

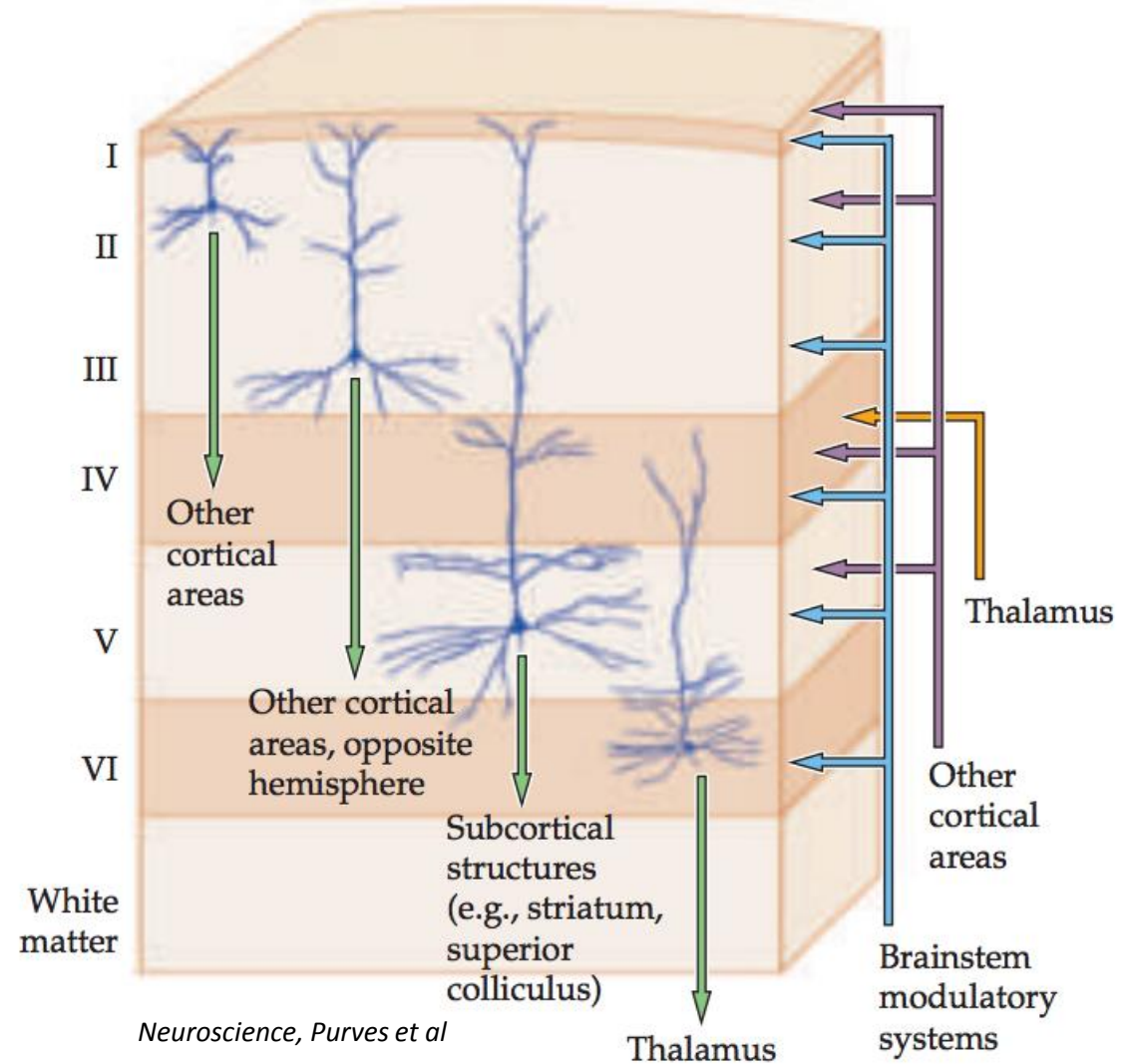


Adapted from Ransom & Clark (1959). *The Anatomy of the Nervous System* (10th ed). Philadelphia: Saunders.

inside

Cellular Organization of Cortex

Green arrows indicate outputs to the major targets of each of the neocortical layers in humans; orange arrow indicates thalamic input (primarily to layer IV); purple arrows indicate input from other cortical areas; and blue arrows indicate input from the brainstem modulatory systems to each layer.

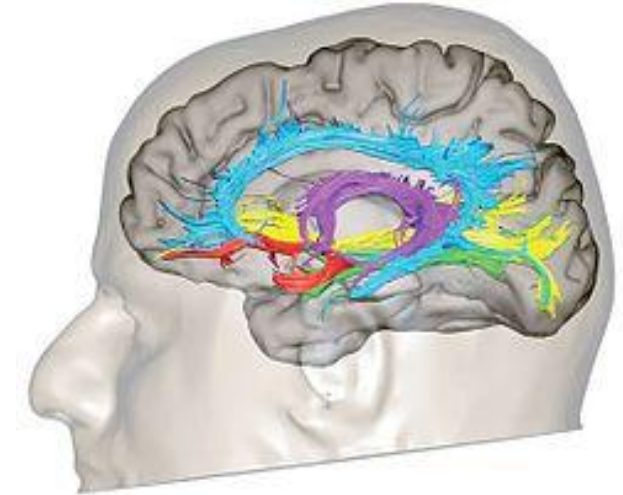


Main cell types in the cerebral cortex

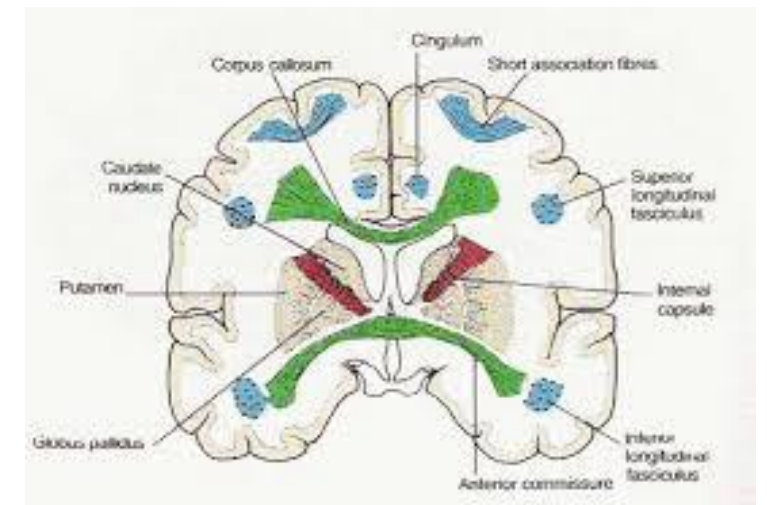
- Pyramidal neurons
 - Large
 - Long dendrites
 - Primary source of axons that leave the cortex
- Spiny stellate neurons
 - Small and star-shaped
 - No apical dendrites
 - Exclusively located in layer 4 of primary sensory areas of the cortex
- Local circuit interneurons

White matter of the cerebral cortex

- Corpus callosum and anterior commissure are the primary white matter bundles connecting the two hemispheres
- Uncinate fasciculus connects the frontal and temporal lobes
- Cingulum bundle and longitudinal fasciculi run rostral-caudal and connect the frontal, parietal, and occipital lobes
- Internal capsule connects cortical regions with thalamus, subthalamic nucleus, and brainstem

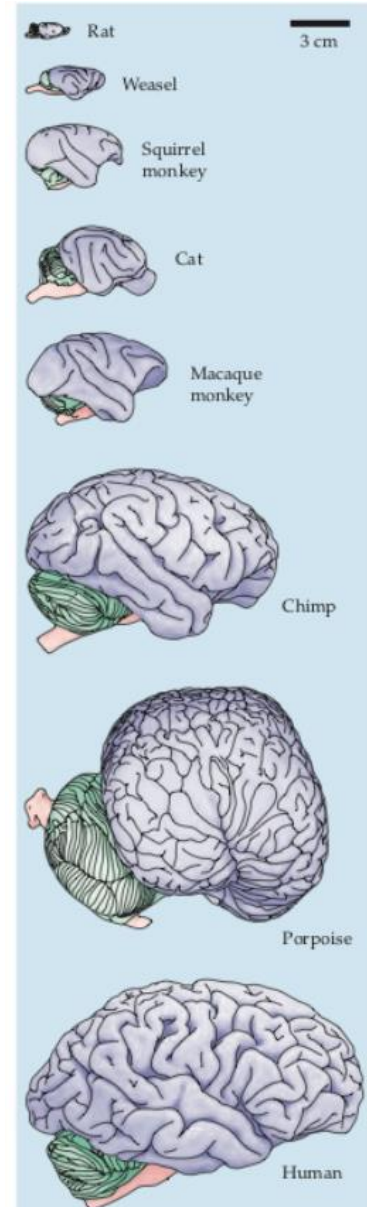


■ Uncinate ■ Inferior fronto-occipital
■ Inferior longitudinal ■ Fornix ■ Cingulum



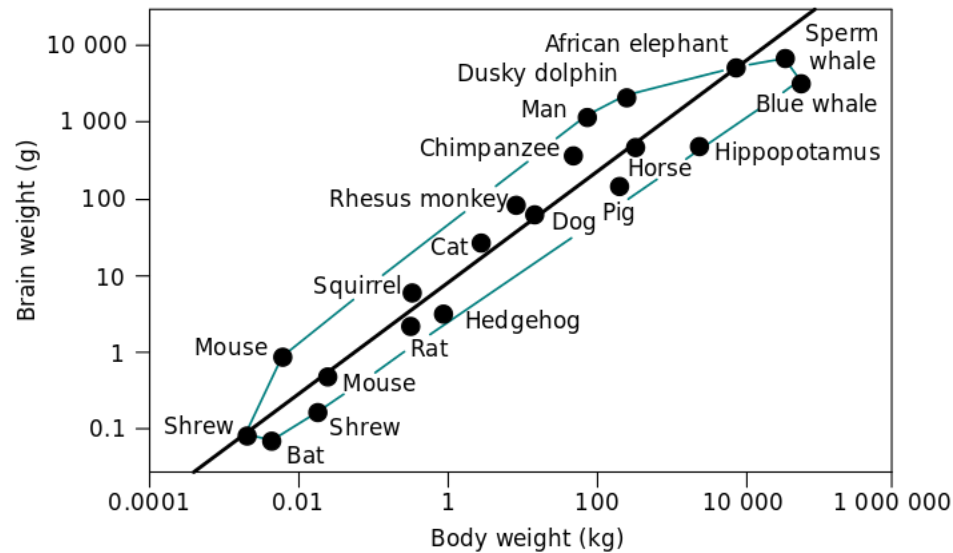
The cerebral cortex and intelligence across species

- Does size of the brain, or size of the cerebral cortex more specifically, correlate with general intelligence across species?
- Lots of problems with this:
 - Cerebral cortex size tends to scale with body size
 - Measuring intelligence across species is hard!



The cerebral cortex and intelligence across species

- What if you divide by body size, and figure out deviations from the average relationship?



Neuroscience, Purves et al

The cerebral cortex and intelligence across species

- What if you divide by body size, and figure out deviations from the average relationship?
- Fast selection on body size can throw these measurements off: “Chihuahua effect”



The cerebral cortex and intelligence across species

- Specialization of brain areas means each species may have enlarged areas according to evolutionary niches
- For example, songbirds have enlarged song production nuclei. The number of songs correlates with size of the nucleus across species



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