

Why Neuroanatomy

- Structure-function relationships
 - Localization of function in the CNS
- Non-invasive brain imaging
 - CAT: structure, low resolution
 - MRI: structure, high resolution
 - PET: function, low resolution
 - fMRI: function, high resolution

Dual approach to learning neuroanatomy:

- Functional anatomy
 - Neural structures that serve particular functions; e.g., pain path from skin to cortex for perception
- Regional anatomy
 - Localization of structures in particular brain regions

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- **Localization of function**

Lecture objectives:

- Overview of brain structures to “demystify” anatomical content in Neural Science lectures
- Survey brain structure-function relations to provide background for first labs

First half of lecture:

- Quick review of basic CNS organization
- Use development to understand principles of structural organization of CNS

Second half: Functional localization

CNS Organizational Principles

- 1) Tubular organization of central nervous system
- 2) Columnar/longitudinal organization of spinal and cranial nerve nuclei
- 3) Complex C-shaped organization of cerebral cortex and deep structures

Brief Overview of Mature CNS Neuroanatomy

- Tubular organization of central nervous system

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Brief Overview of Mature CNS

Neuroanatomy

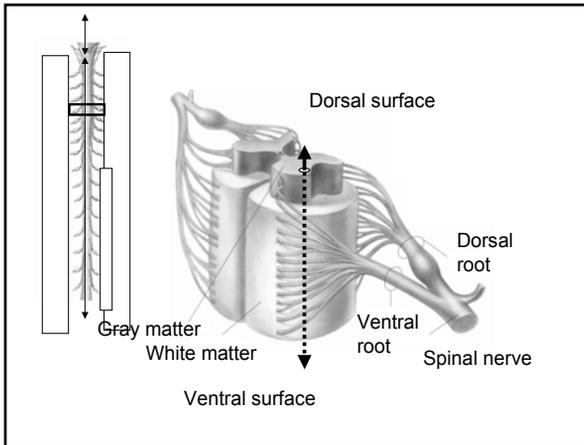
- Tubular organization of central nervous system
- Columnar/longitudinal organization of spinal and cranial nerve nuclei

Nuclei: locations of neuron cell bodies w/in the **central nervous system**

Ganglia: locations of neuron cell bodies in the **periphery**

Tracts: locations of axons w/in the **central nervous system**

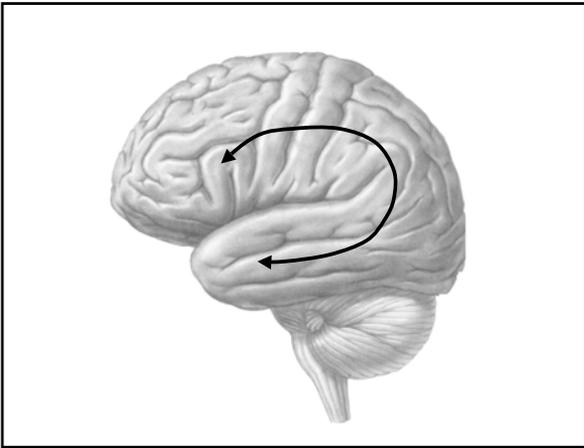
Nerves: locations of axons in the **periphery**



Brief Overview of Mature CNS

Neuroanatomy

- 1) Tubular organization of central nervous system
- 2) Columnar/longitudinal organization of spinal and cranial nerve nuclei
- 3) Complex C-shaped organization of cerebral cortex and nuclei and structures located beneath cortex
 - Lateral ventricle
 - Basal ganglia
 - Hippocampal formation & Fornix



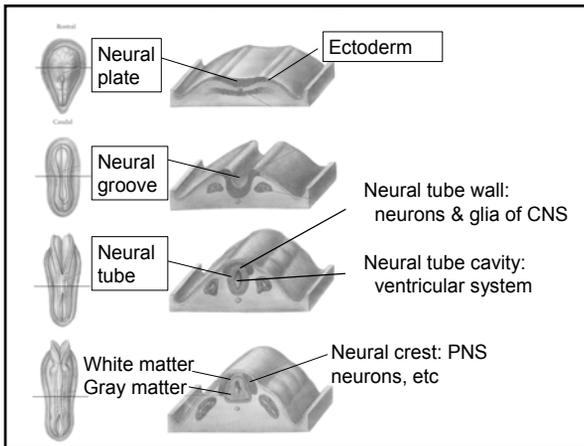
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Development, as a guide to
understanding regional
anatomy of the CNS

Neural Induction

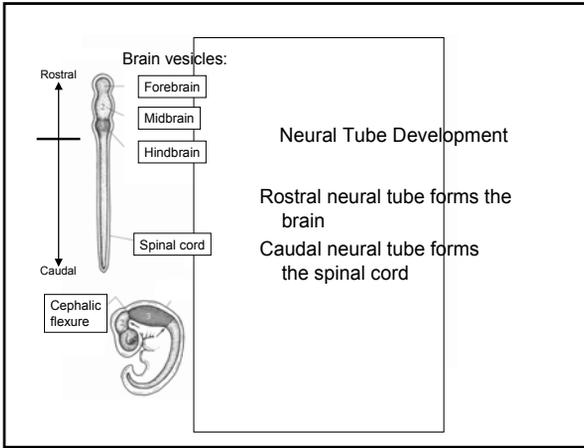
•Portion of the **dorsal ectoderm** becomes committed to become the **nervous system**:

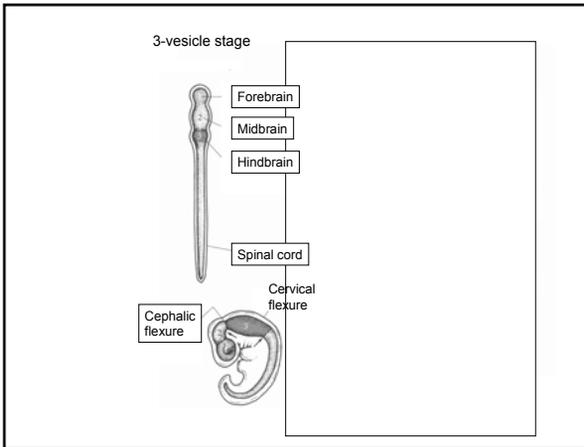
Neural plate

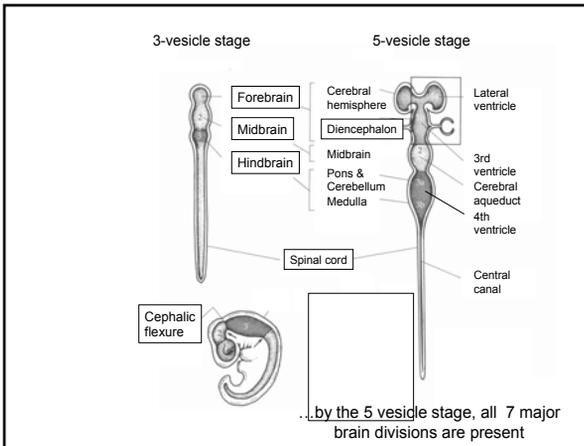


Neural Tube Closure Defects

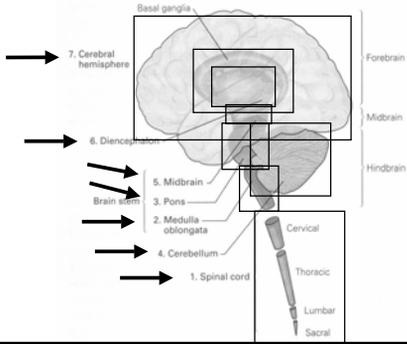
- Spina bifida: caudal neural tube
- Anencephaly: rostral neural tube







7 major brain divisions



7 CNS divisions on MRI:

Cerebral hemispheres

Diencephalon

- Cerebral hemispheres
- Diencephalon
- Midbrain
- Cerebellum
- Pons
- Medulla
- Spinal cord



Midbrain

Cerebellum

Pons

Medulla

Spinal cord

Ventricles

Lateral ventricle

3rd ventricle

4th ventricle

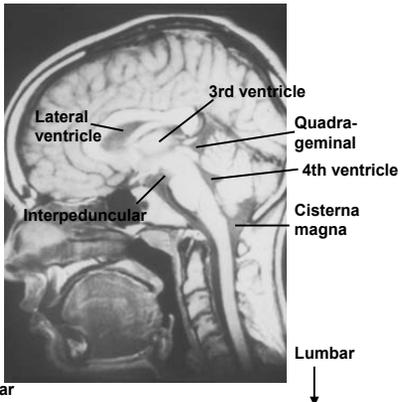
Cisterns

Quadra-geminal

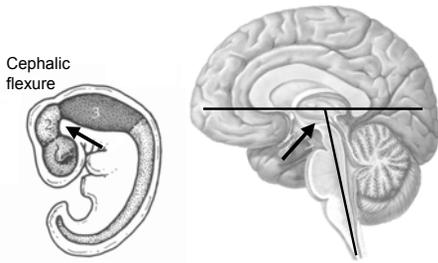
Cisterna magna

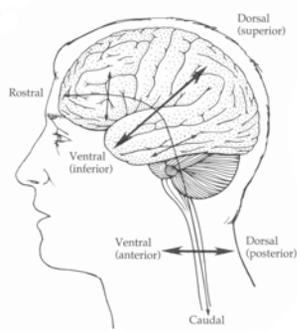
Lumbar

Interpeduncular



The cephalic flexure persists into maturity

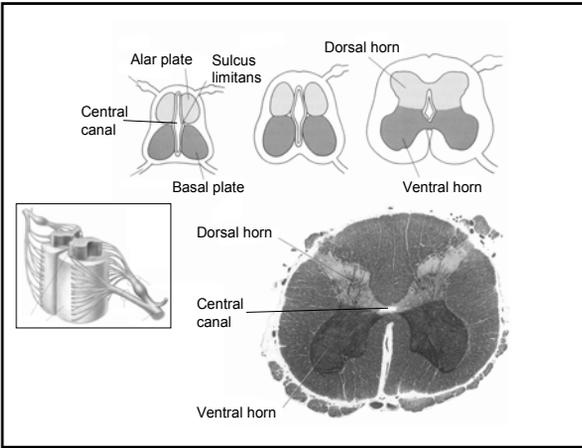


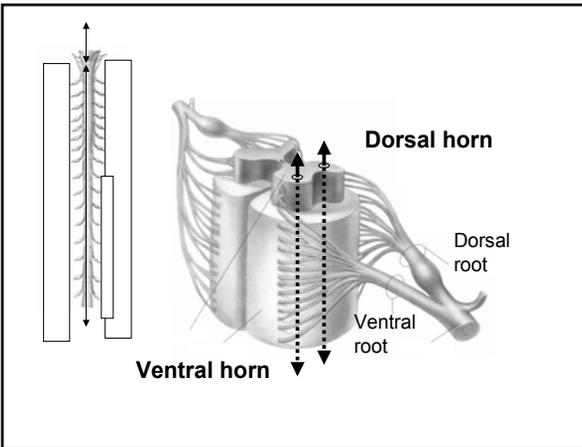


Spinal cord & brain stem have a similar developmental plan

- Segmentation

- Nuclear organization: columnar



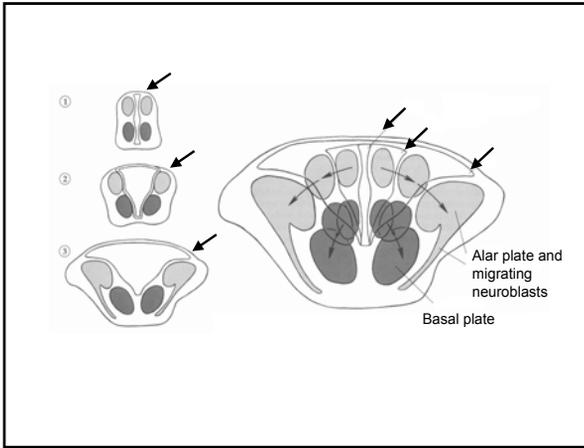


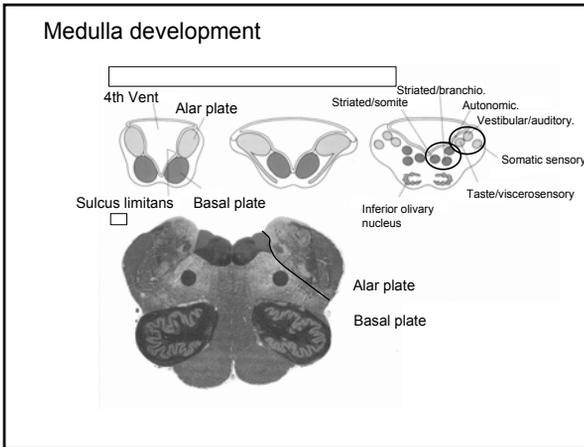
Similarities between SC and brain stem development

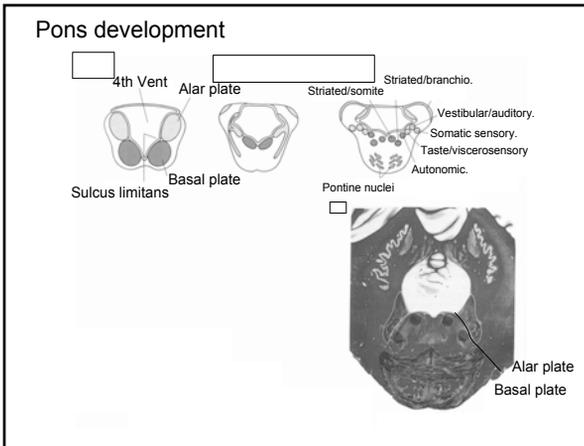
- Sulcus limitans separates sensory and motor nuclei
- Nuclei have columnar shape

Key differences

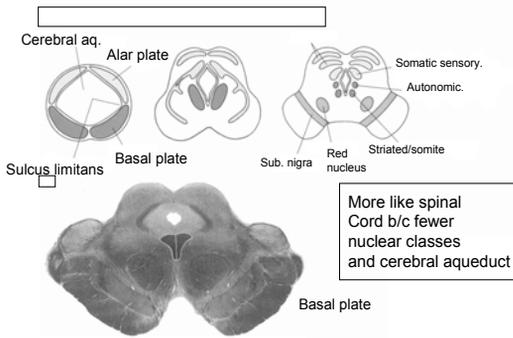
- 1) central canal enlargement □ motor medial and sensory lateral
- 2) migration away from ventricle
- 3) >> sensory and motor







Midbrain development



Similarities between forebrain and hindbrain/spinal development

- Tubular

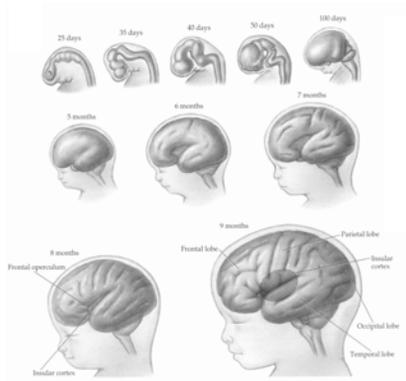
Key differences

- 1) CH more complex than BS/SC
- 2) Cortical gyri more complex anatomy than nuclei
- 3) Subcortical nuclei are C-shaped
 - Confusing: structure in two places on image

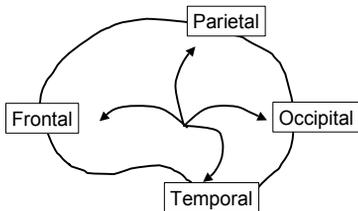
Diencephalon

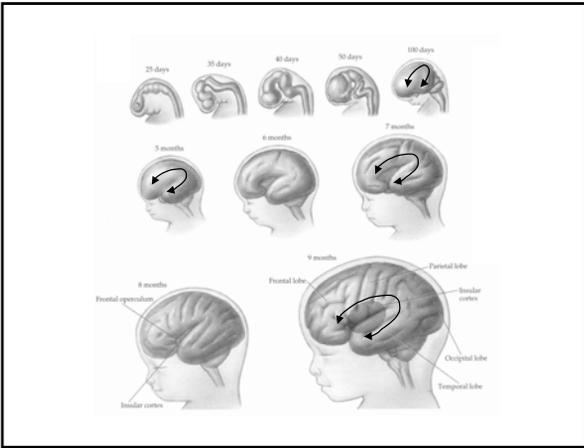
- Thalamus
 - Gateway to cortex
- Hypothalamus
 - Control of endocrine and bodily functions
 - Circadian rhythms
 - Etc.

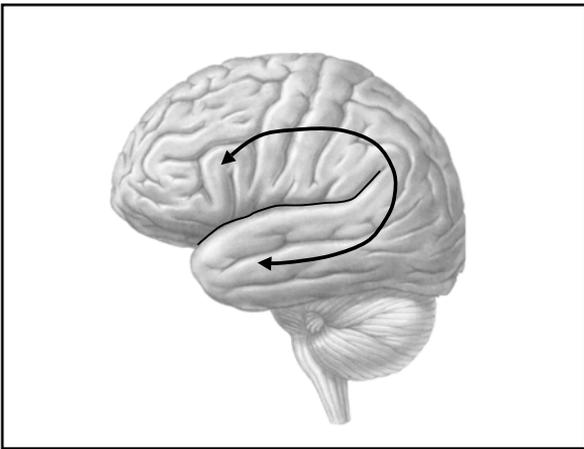
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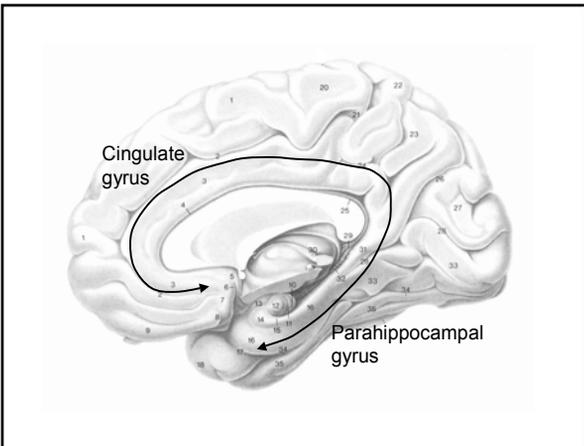


Cerebral Cortex Development



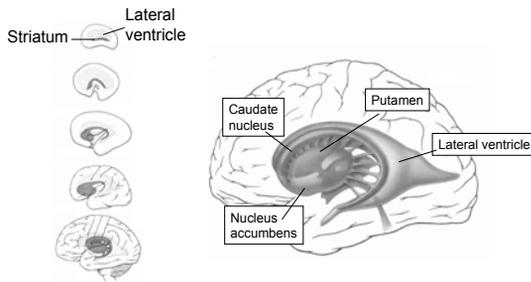






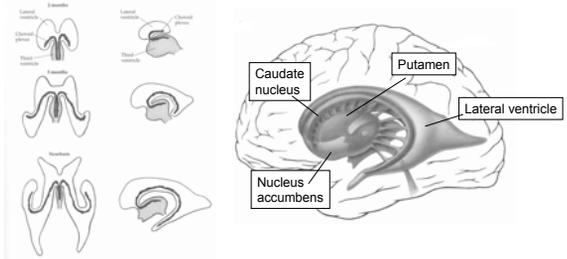
Forebrain Development & C-shaped Structures

- Cerebral cortex
- Lateral ventricles
- Striatum
- Hippocampal formation and fornix



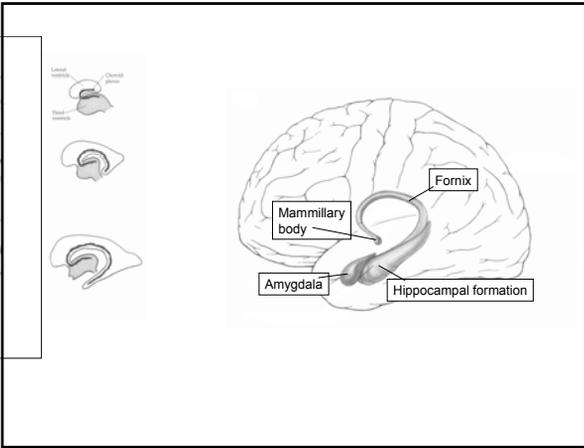
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LV and CP



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Summary

- 7 Major components of the central nervous system & Ventricles
- All present from ~ 1st prenatal month
- Longitudinal organization of SC and BS nuclei
 - Columns
 - Anatomical and functional divisions
- C-shape organization of cerebral hemisphere structures and diencephalic
 - Cerebral cortex
 - Lateral ventricle
 - Striatum
 - Hippocampal formation and fornix

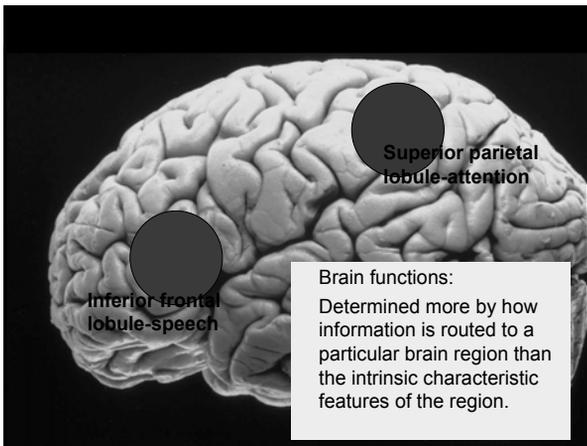
Functional Anatomy

- **Regional neuroanatomy:** spatial relations between brain structures within a portion of the nervous system
- **Functional neuroanatomy:** those parts of the nervous system that work together to accomplish a particular task, for example, visual perception

Functional Localization

How does structure relate to function?

- Heart structure predicts pumping function
- Muscle structure--with particular bone attachments--predicts function
- Brain??



Overall Aims of Lecture

- Functional localization of neural systems
- Functional organization of the thalamo-cortical systems
- Cortical circuitry

Topics cut across all lectures

- add to preparation for lab
- basis for better understanding of lectures on neural systems

Specifics...

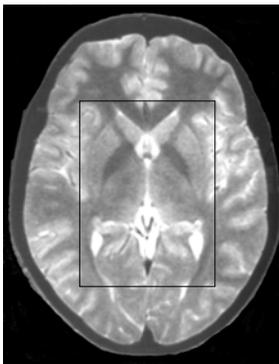
- Functional localization of touch pathway in brain stem
 - To understand hierarchical organization of a neural system
 - To begin to become familiar with internal brain structure
- Organization of visual pathway
 - Segue into...
- Functional organization of the thalamo-cortical systems
- Cortical circuitry



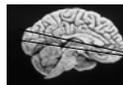
Dorsal column-medial lemniscal system for touch

- Sensory receptor neurons
- Dorsal column of spinal cord
- Medial lemniscus in brain stem
- Thalamus
- Cortex

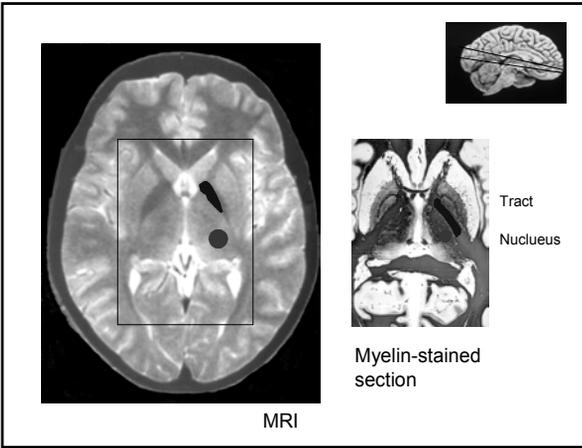
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MRI

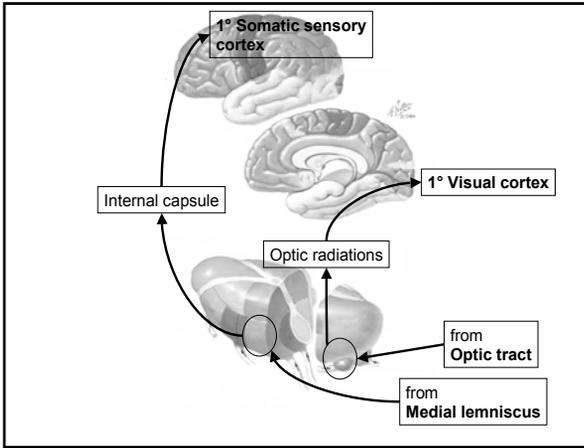


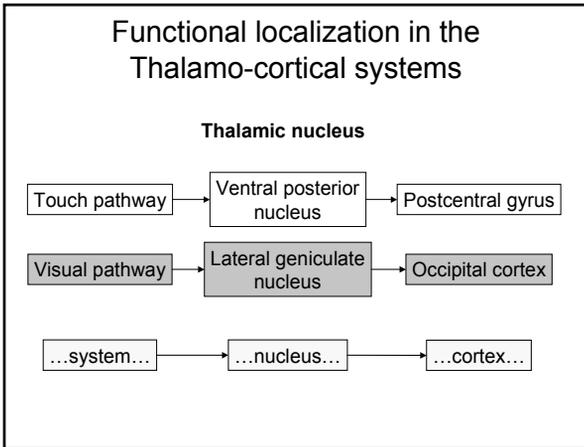
Myelin-stained section

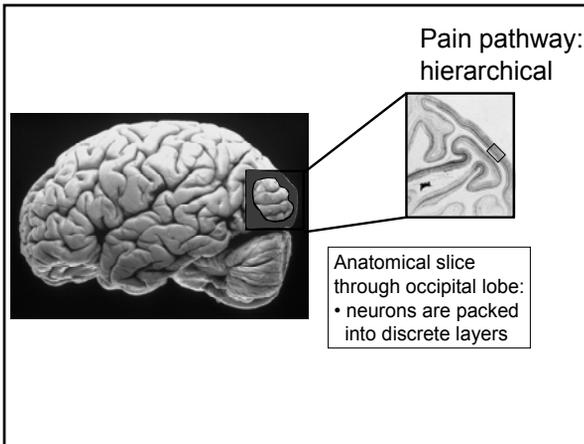


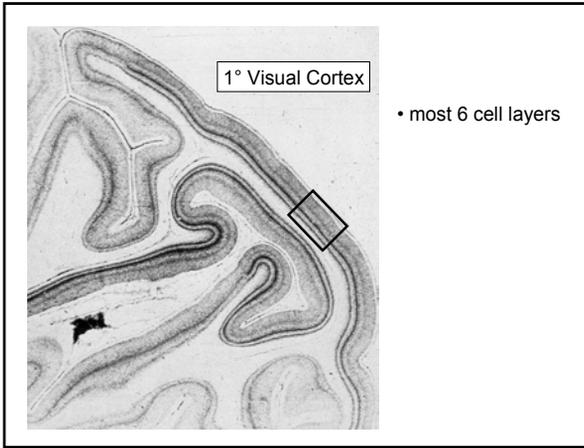
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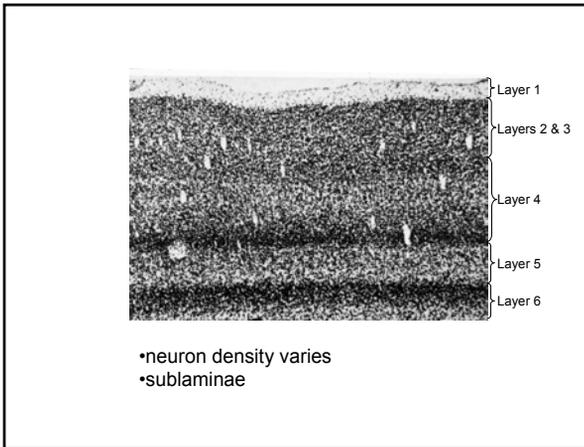
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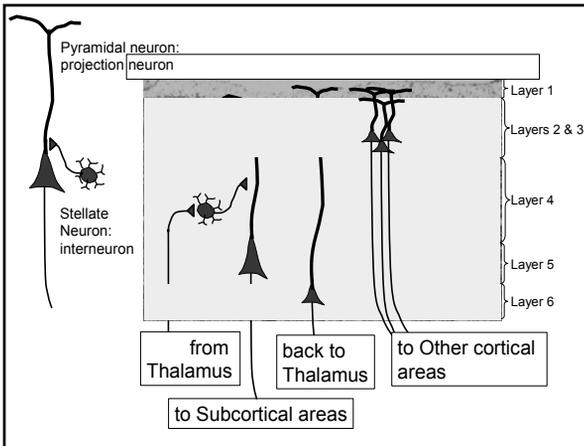


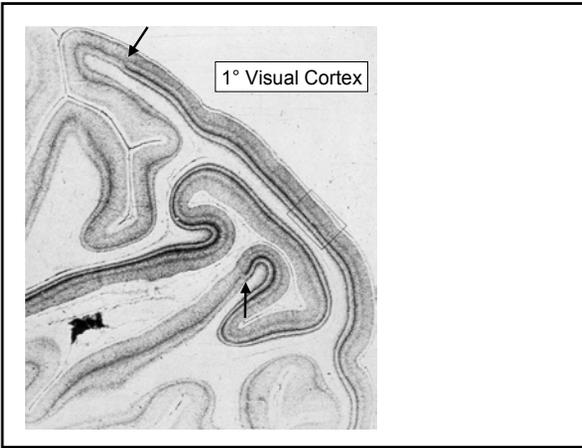


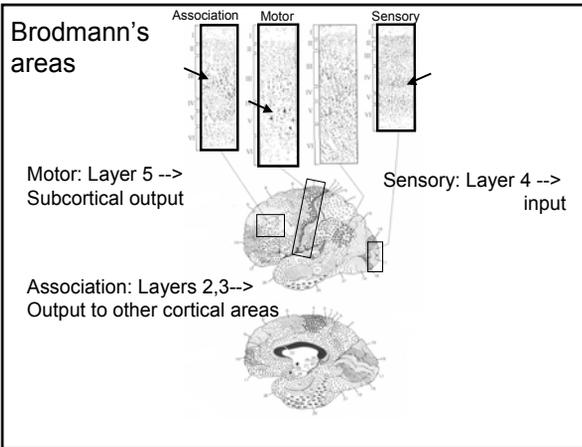












Summary

- Principle of functional localization
- Neural pathways carry specific information
 - Ascending sensory; descending motor
- Different thalamic nuclei serve different sensory and motor functions
 - More differences in inputs than intrinsic organization
- Different sensory and motor functions served by different cortical areas
- Structural specialization in cortex augments functional differences produced by different inputs
