Cerebral Cortex and Thalamus

Hyperbrain Ch 2

Monica Vetter, PhD

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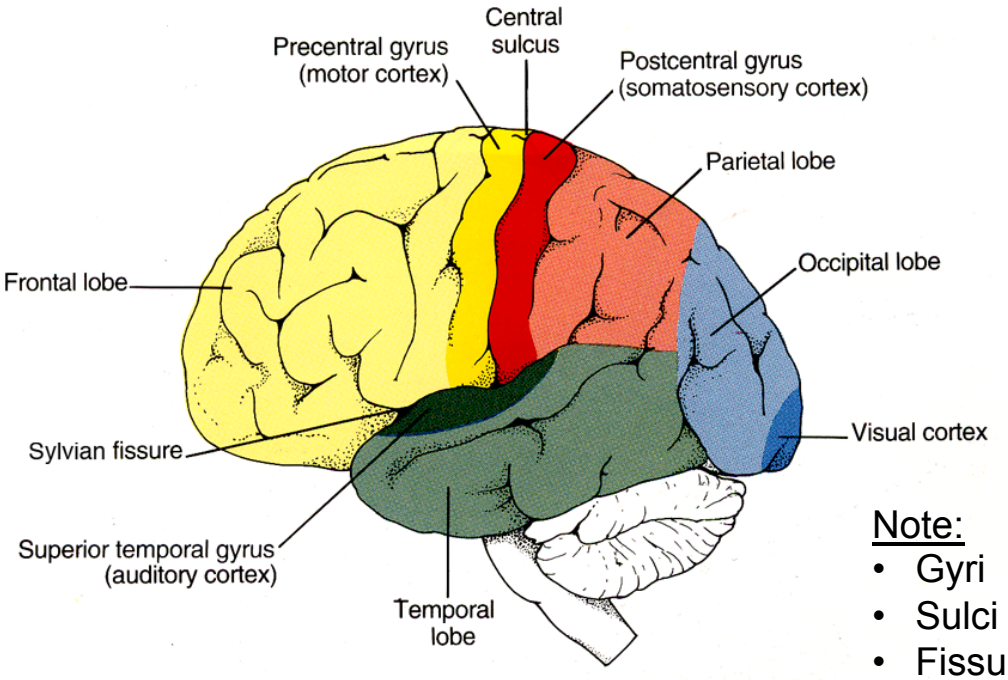
Learning Objectives:

- Anatomy of the lobes of the cortex
- Relationship of thalamus to cortex
- Layers and connectivity of the cortex
- Vascular supply to cortex
- Understand the location and function of hypothalamus and pituitary
- Anatomy of the basal ganglia
- Primary functions of the different lobes/ cortical regions – neurological findings

Types of Cortex

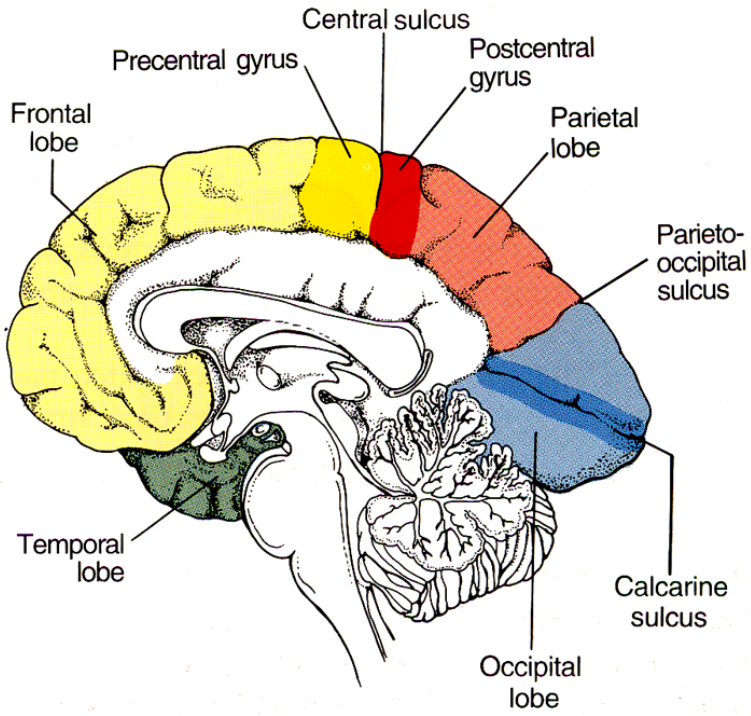
- Sensory (Primary)
- Motor (Primary)
- Unimodal association
- Multimodal association - necessary

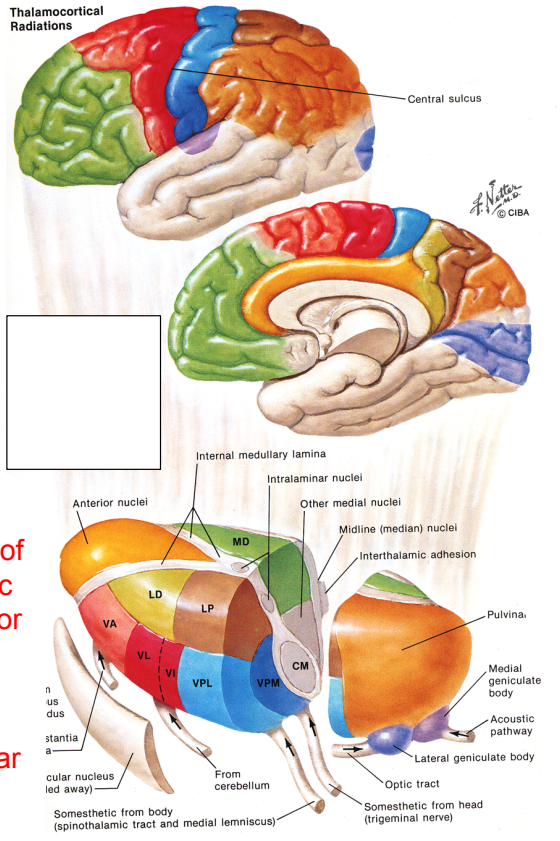
for language, reason, plan, imagine, create



Note:

- Gyri
- Sulci
- Fissures
- Lobes



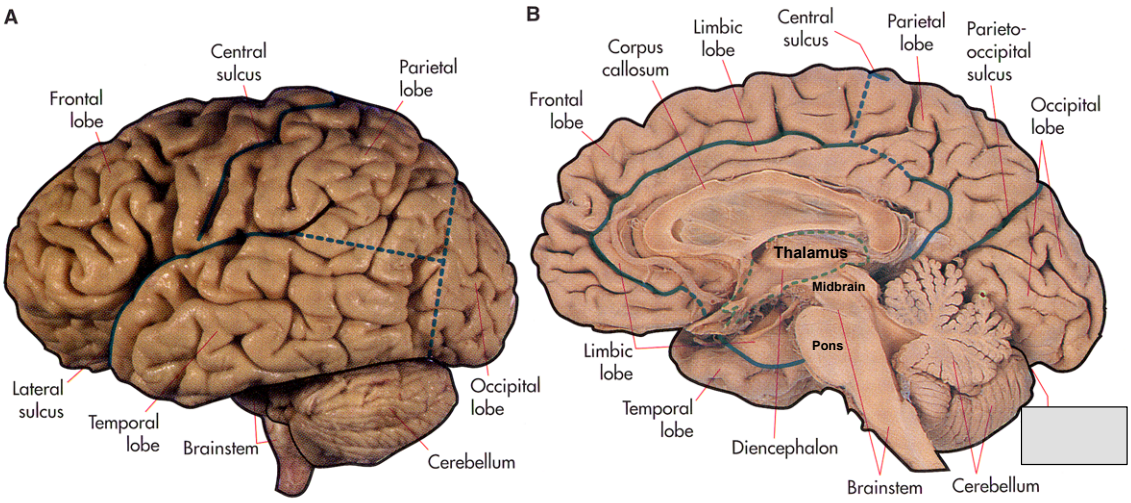


Ignore names of thalamic nuclei for now
- A few will reappear later

The Thalamus is highly interconnected with the cerebral cortex, and handles most information traveling to or from the cortex.

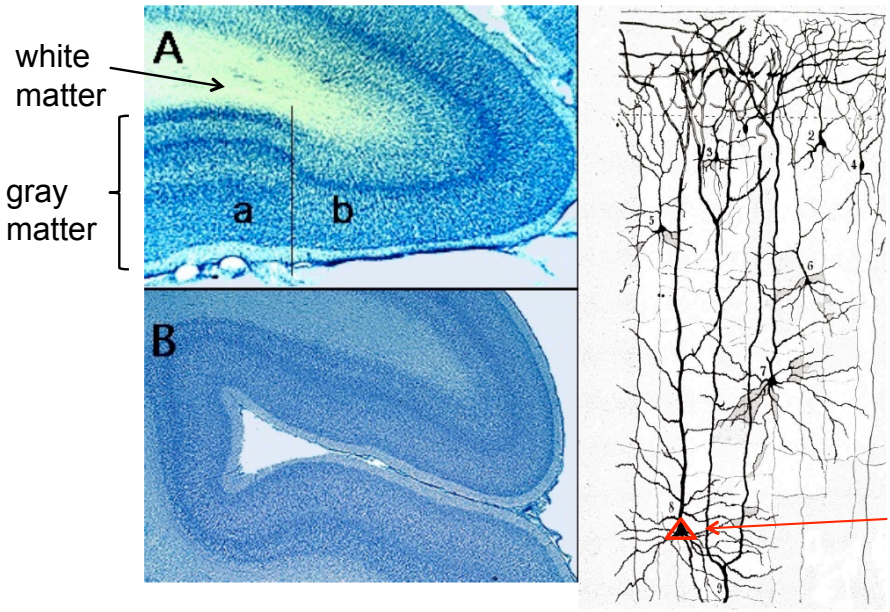
"Specific thalamic nuclei" – have well-defined sensory or motor functions

Other nuclei have more distributed function



Limbic lobe = cingulate gyrus

Structure of Neocortex (6 layers)



Connectivity of neurons in different cortical layers

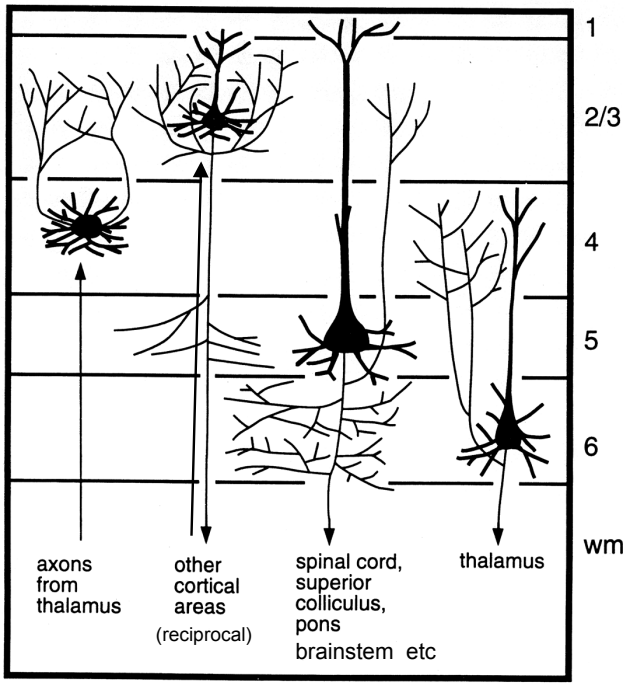
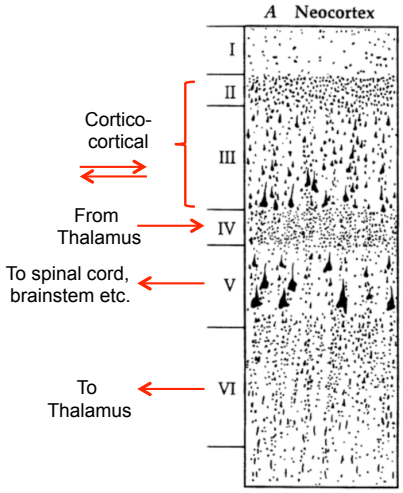


FIGURE 12–6 Local and long-distance axonal targets of the major classes of projection neurons in the primary visual cortex. Abbreviations: wm, white matter (Adapted from Gilbert and Wiesel (1985)).

Afferents = inputs

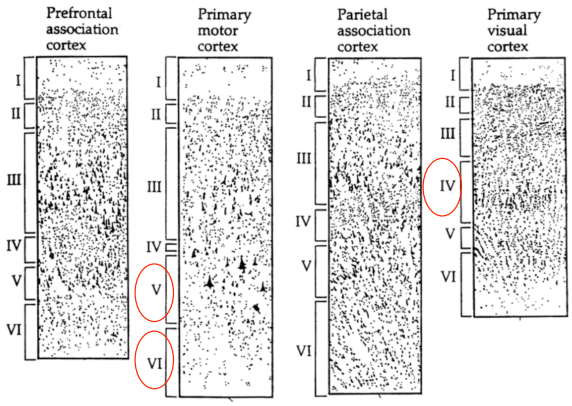
Efferents = outputs



Afferent and efferent connections to different layers of cortex

Eg. Motor – more efferent **output**

Eg. Sensory – more afferent **input**



Different regions of cerebral cortex have different cytoarchitecture

(adapted from Campbell, 1905)

….Depending on whether they have more afferent or efferent connections

Different areas of cortex were defined by differences in layer thickness, and size and density of neurons.

These are now known to correspond to different functional areas.

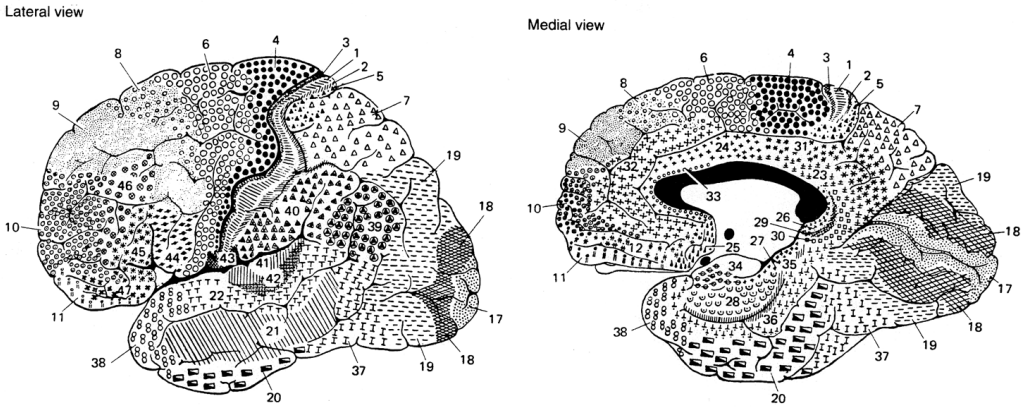
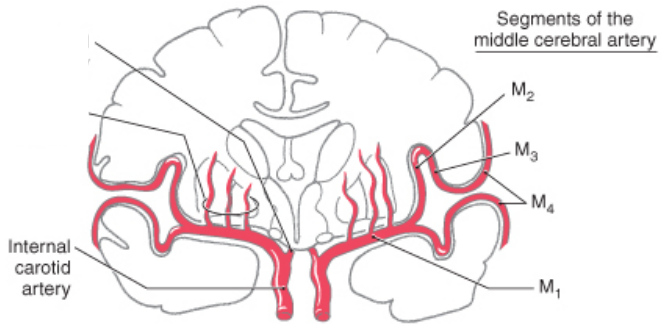
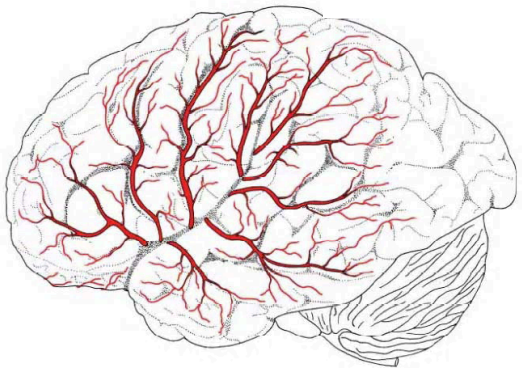


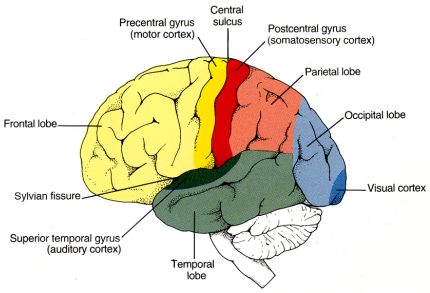
FIGURE 20–11
The human cerebral cortex was divided into about 50 discrete cytoarchitectonic areas more than 80 years ago by Korbinian Brodmann. Distinct areas are represented by different symbols and numbered as shown (there is no rationale for the numbering of the different fields). Brodmann's areas have consistently been found to correspond to distinctive functional fields, each of which has a characteristic pattern of connections.



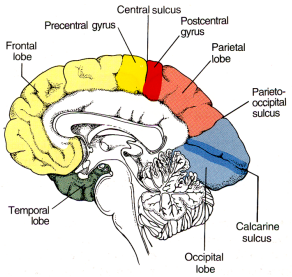
MCA left hemisphere

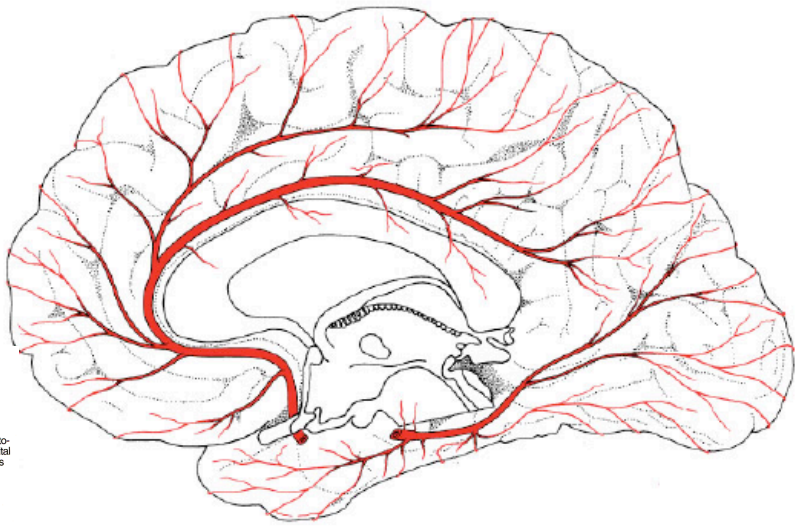
from D.Haines





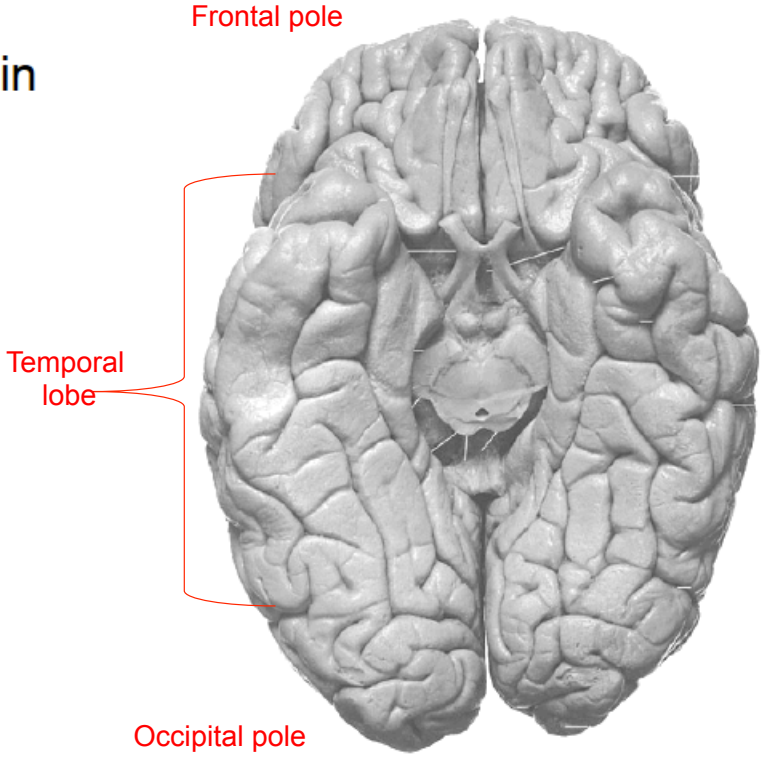
Anterior cerebral artery (ACA)
And Posterior cerebral artery (PCA)





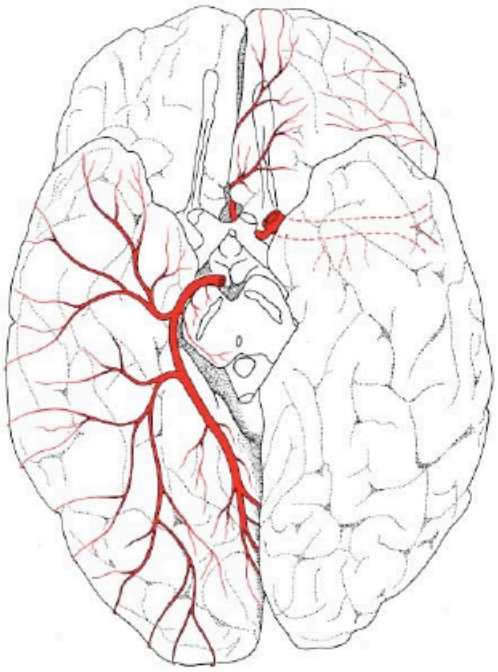
From Haines

Ventral, Gross Brain

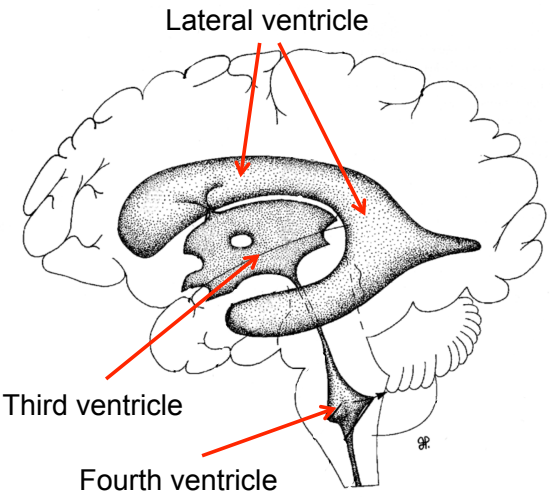


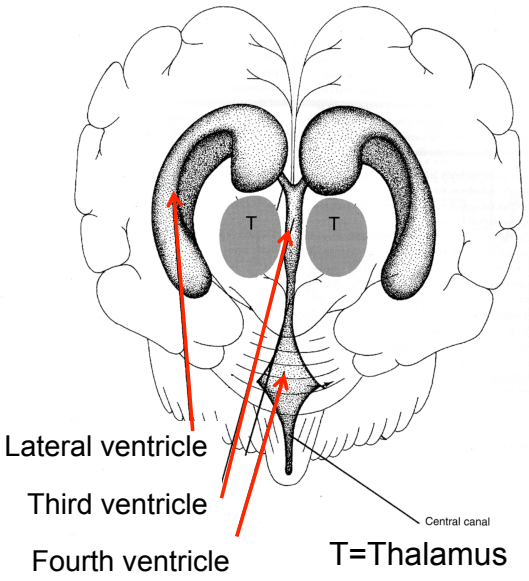
PCA ventral view right hemisphere

from D.Haines



The ventricles





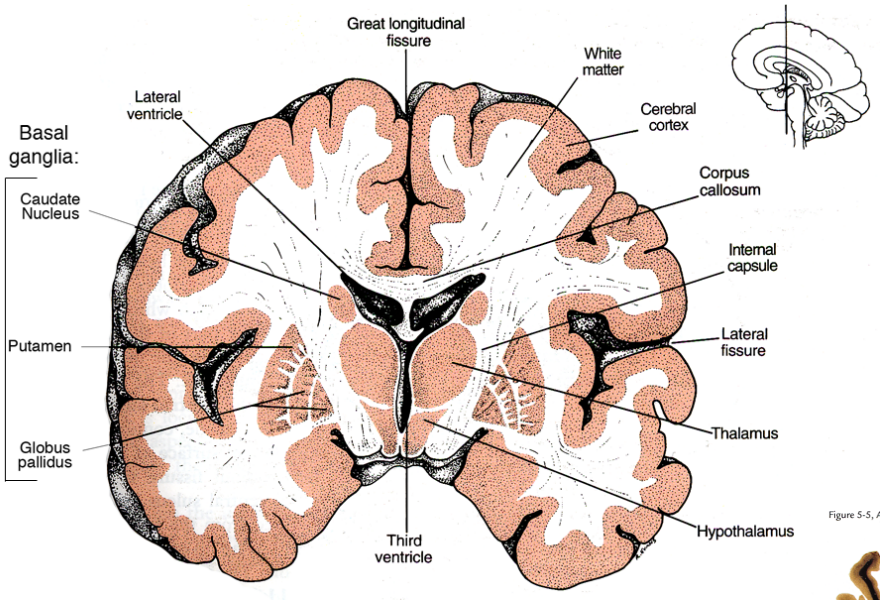
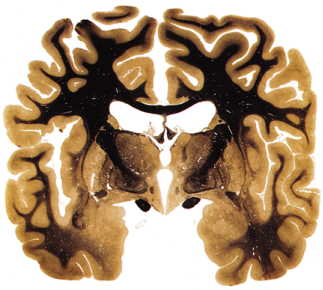


Figure 5-5, A. A coronal section



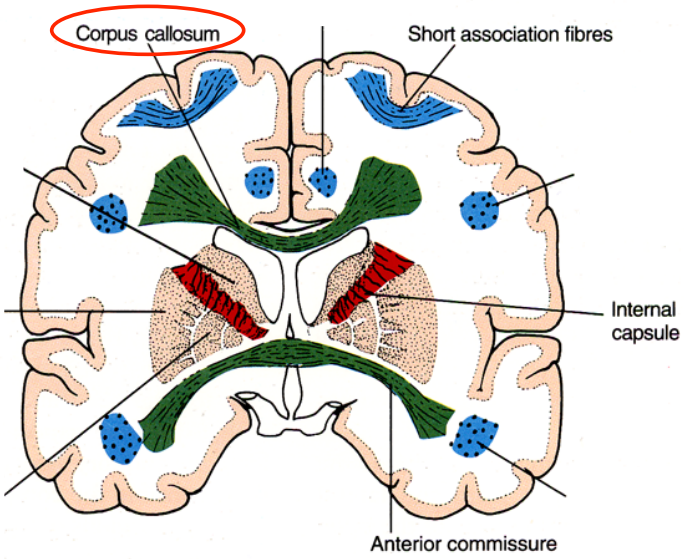
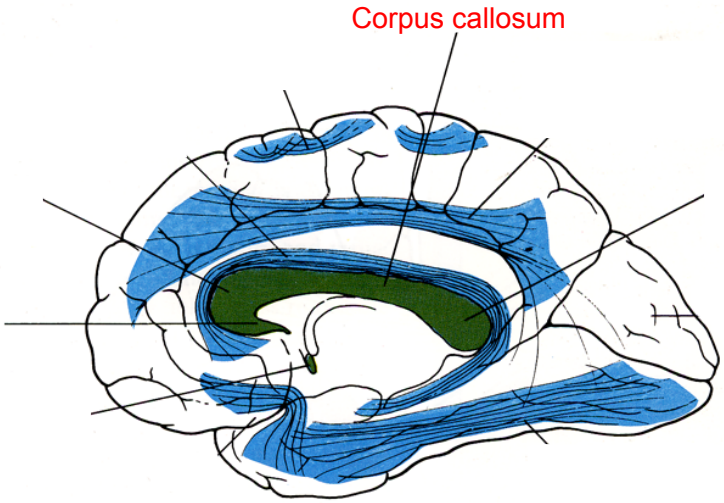


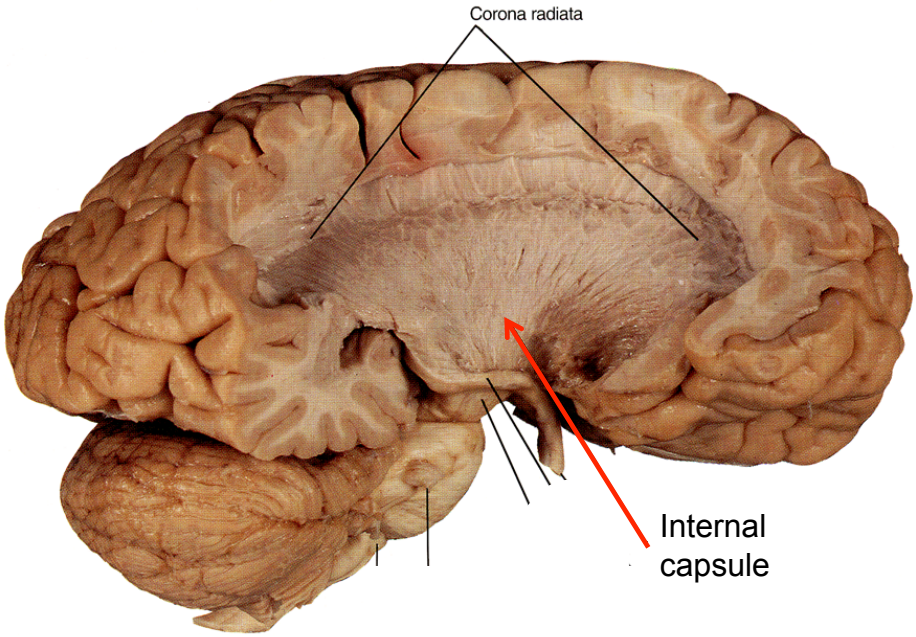
Fig. 10.22 **Coronal section of the cerebral hemisphere.**
The diagram shows the location of the principal association, commissural and projection fibres.

Association fibers – connect within a hemisphere
Commissural fibers – connect across the hemispheres
Projection fibers – connect cortex to subcortical structures

The Corpus Callosum is the main Commissural bundle – connecting the two hemispheres



The Internal Capsule is the main Projection bundle – connecting cortex to thalamus and other subcortical structures



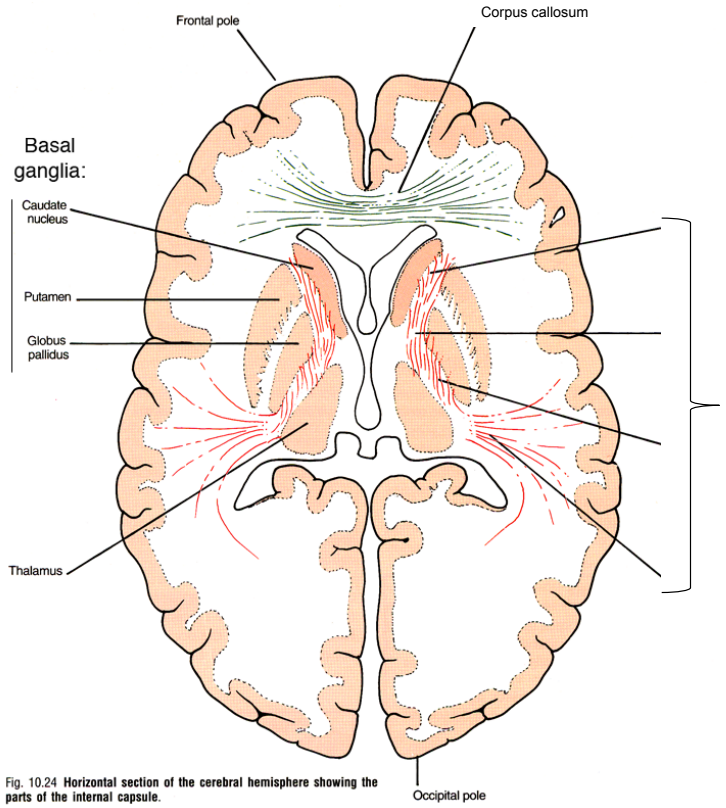
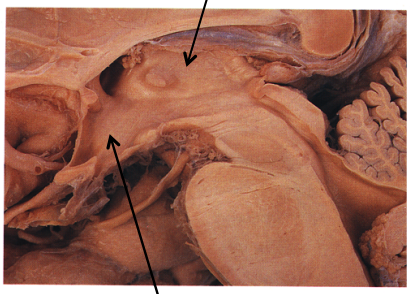
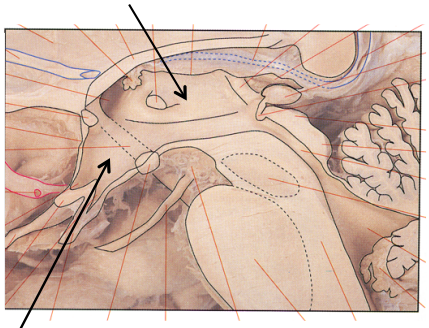


Fig. 10.24 **Horizontal section of the cerebral hemisphere showing the parts of the internal capsule.**

Medial View of the Diencephalon

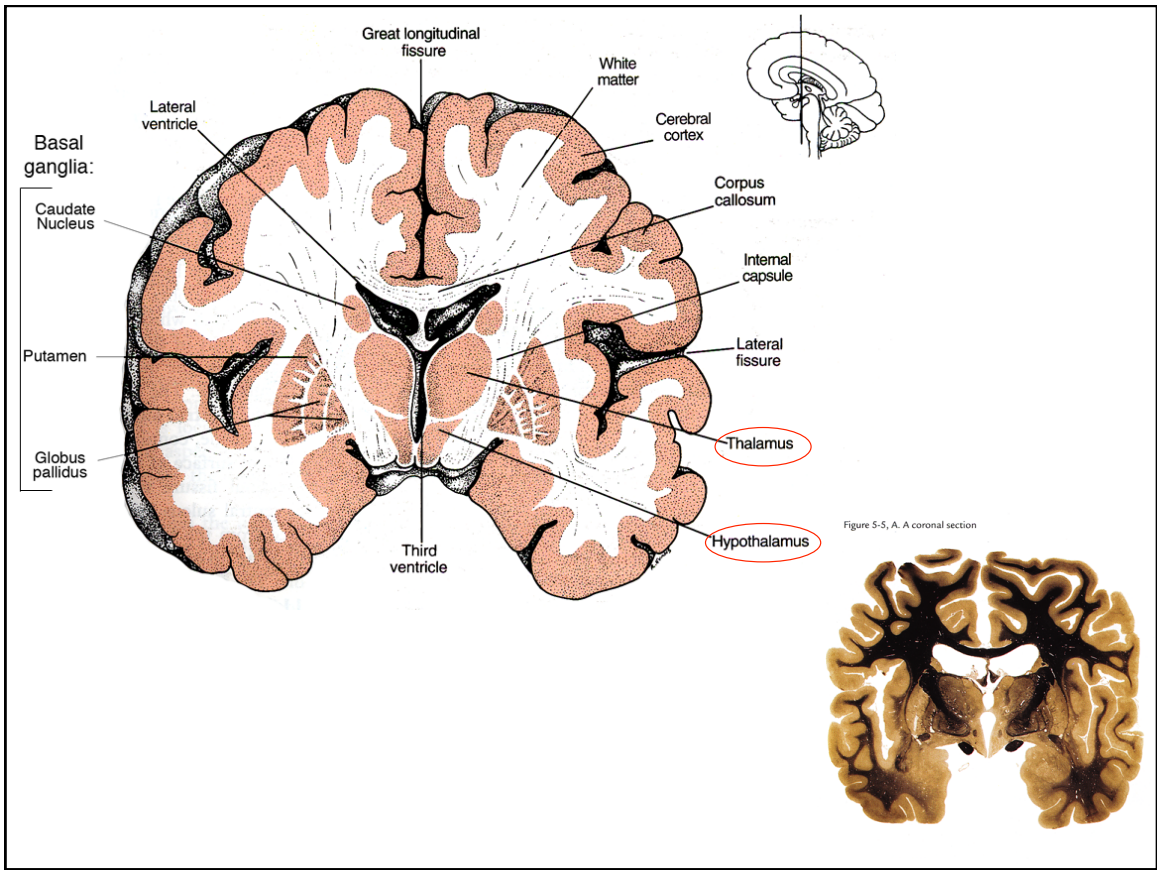
Thalamus – resides in the walls of the 3rd ventricle

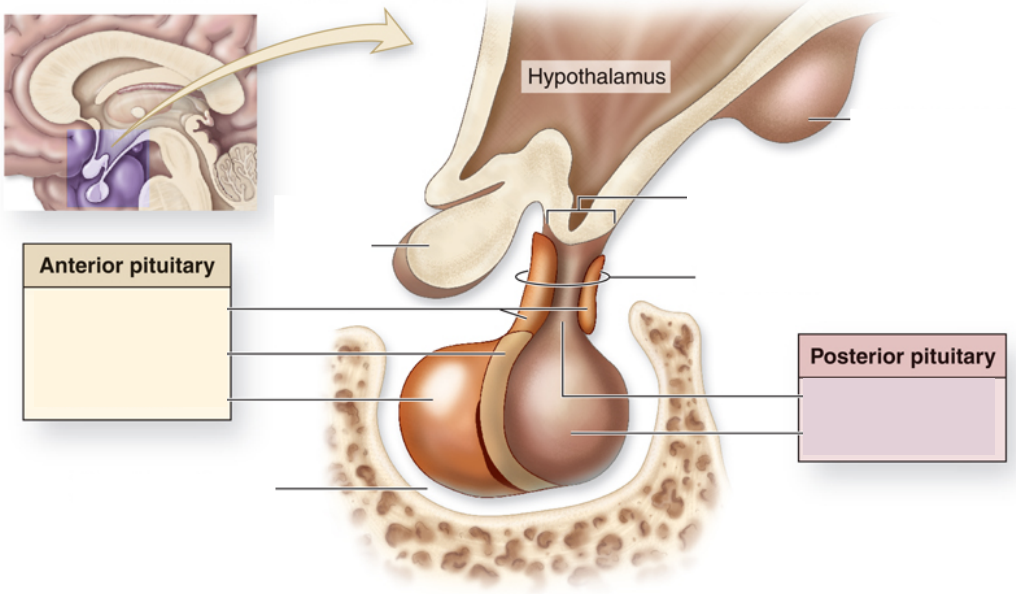




Hypothalamus – directly below the thalamus

Major structures of the diencephalon:
Thalamus, hypothalamus, (subthalamus and epithalamus)





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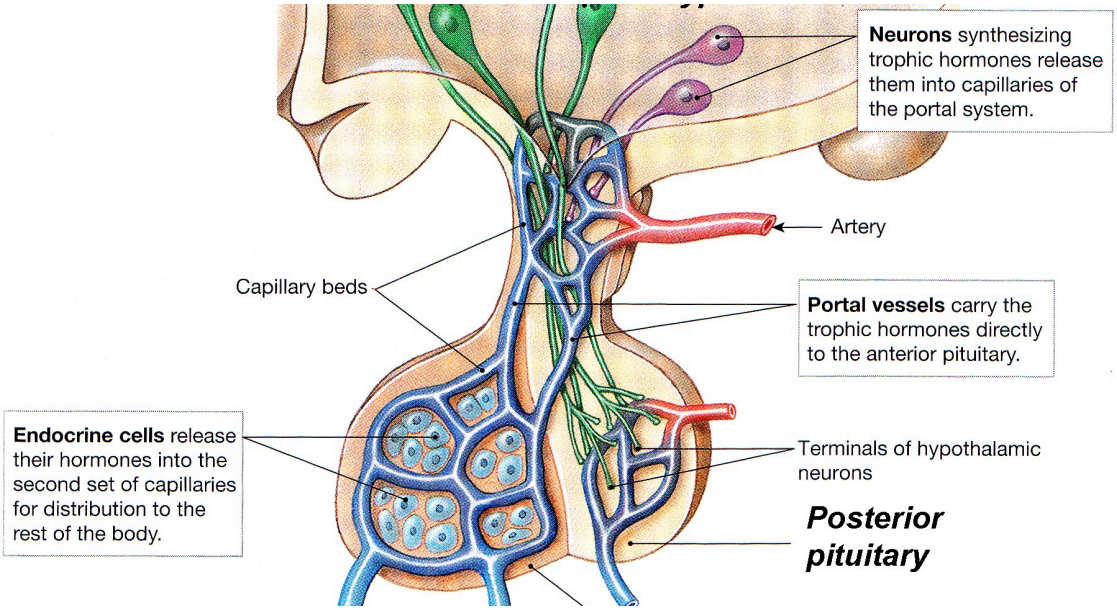
The hypothalamic-pituitary system



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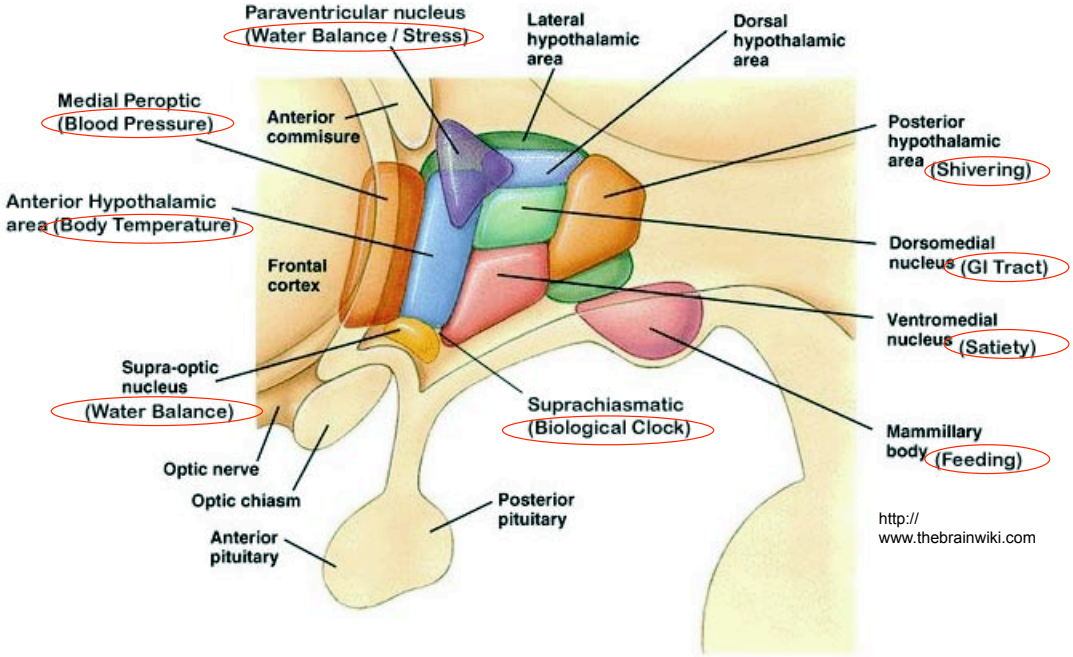
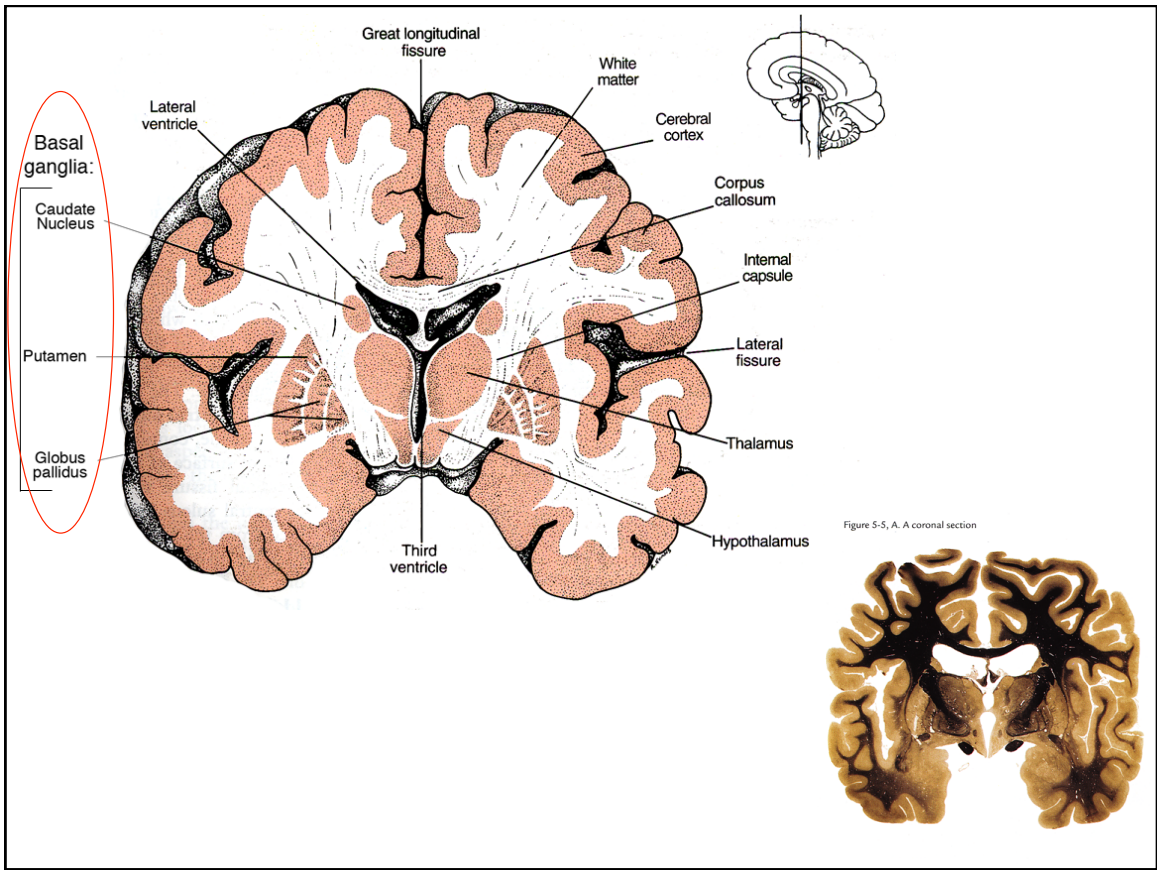
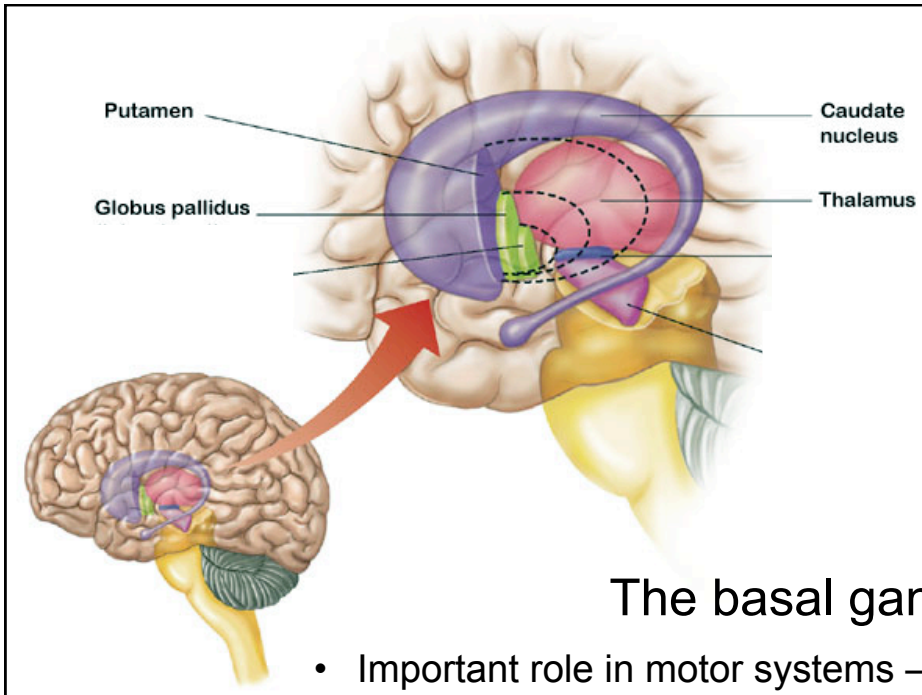
Ignore names of hypothalamic nuclei - Just appreciate the types of functions that the hypothalamus regulates



The hypothalamus controls autonomic, endocrine, emotional, and somatic functions. Its nuclei connect with the limbic system, the pituitary and various visceral and somatic nuclei.



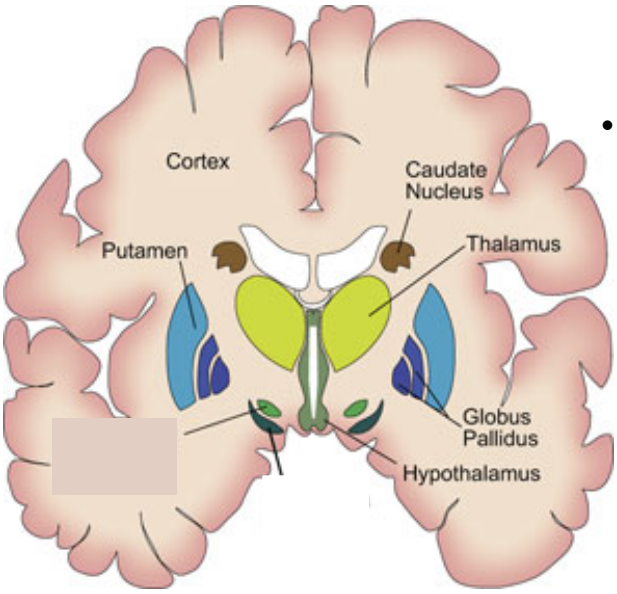


The basal ganglia

- Important role in motor systems – control of movement
- Damage to basal ganglia can cause problems with speech, movement and posture

www.physio-pedia

The basal ganglia



- Strongly connected with cortex, thalamus and other brain areas
- Involved in movements disorders, including Parkinson's disease (substantia nigra) and Huntington's disease (striatum)

Issues of Functional Localization

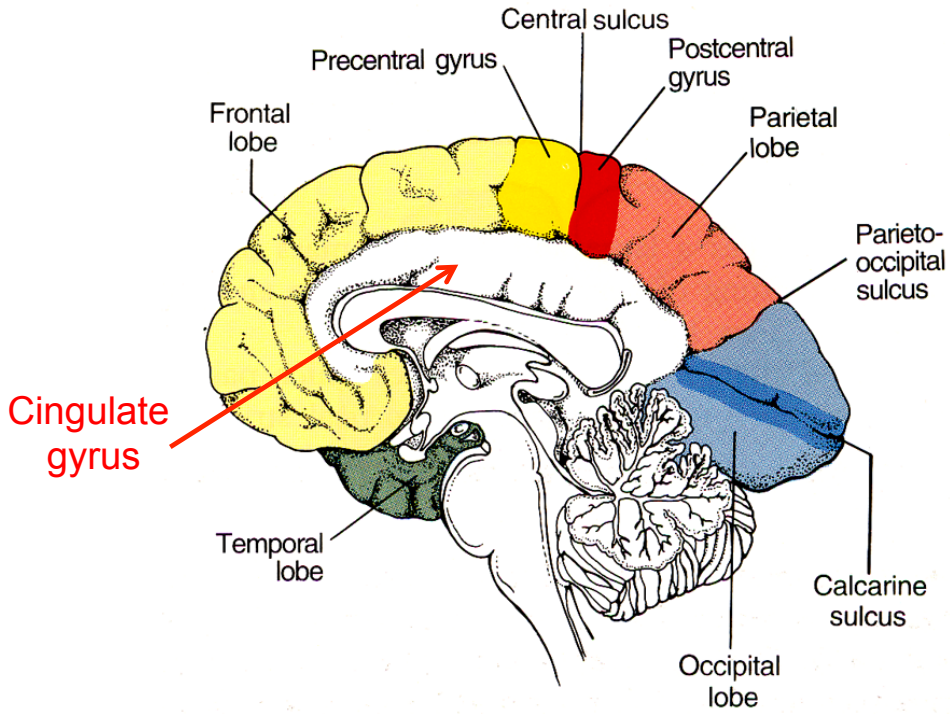
- Earliest studies -Signs, symptoms and note location at autopsy
- Electrical discharge (epilepsy) suggested function
- Ablation - deficit suggest function
- Reappearance of infant functions suggest loss of inhibition (disinhibition), i.e. grasp, suck, Babinski
- Linked networks of afferent and efferent neurons in several regions working to accomplish a task (attention)
- Functional imaging does not always equate with abnormal function associated with location of lesion
- fMRI activation of several cortical regions
- Same sign from lesions in different areas – i.e.paraphasias
- Notion of the right hemisphere as "emotional" in contrast to the left one as "logical" has no basis in fact.

Details of this slide are not important. Next we think about what functions localize to each of the lobes – limbic, frontal, parietal, temporal, occipital and use aspects of language and speech to highlight how they function

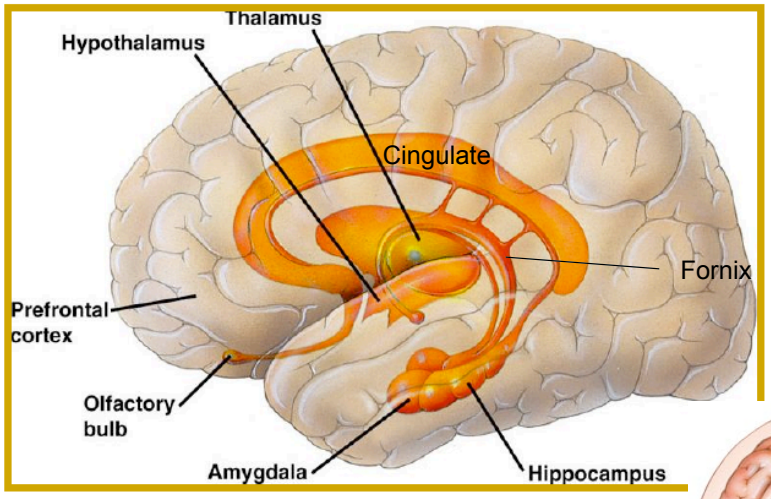
Limbic System (not a true lobe) involves

- Cingulate gyrus - affect, pain, memory
- Hippocampus- short term memory
- Amygdala- fear, agression, mating
- Fornix pathway to hypothalamus
- Hypothalamus- ANS & endocr control
- Prefrontal Cortex- appropriate behavior

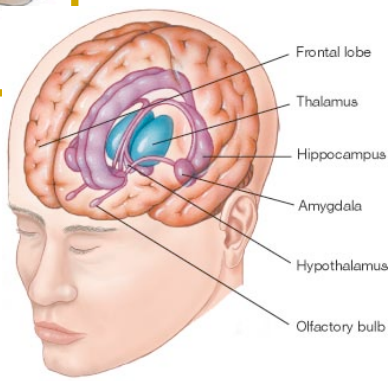
ANS = autonomic nervous system (controls visceral function)



Schematic Diagram of principal limbic areas



From College of DuPage Biology 1152 Syllabus



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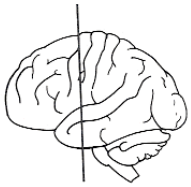


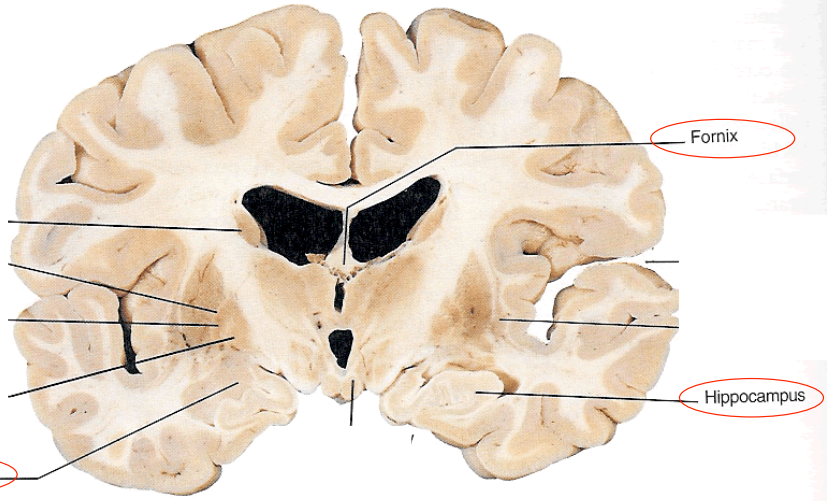
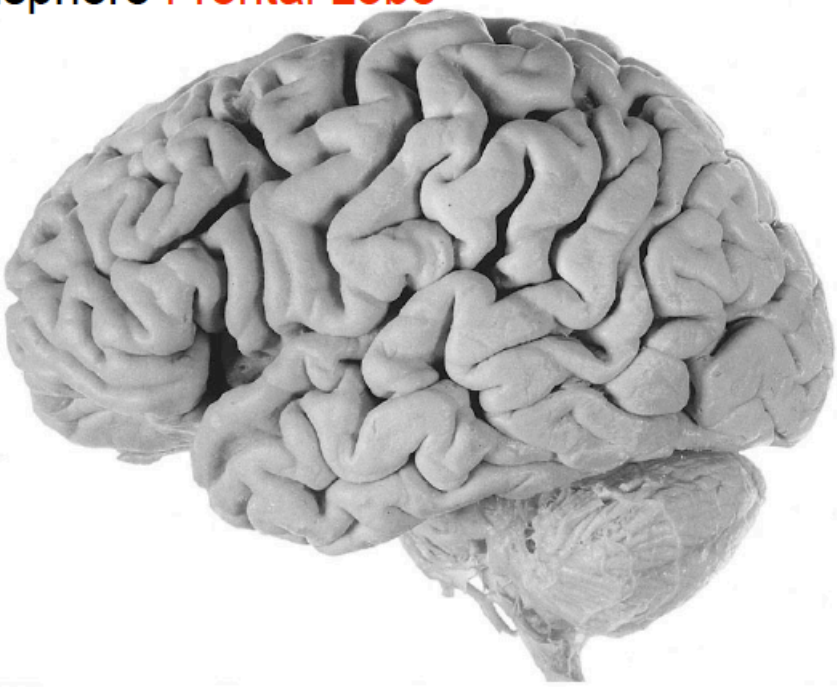
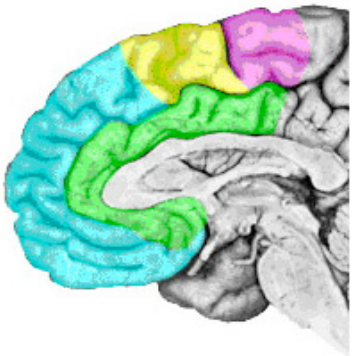


Fig. 10.8 **Coronal section.**

From: homepage.smc.edu

Lateral view gross brain. Left hemisphere Frontal Lobe





Frontal lobe

- Motor
- Premotor
- Prefrontal
- Limbic (cingulate gyrus)

Frontal Lobe Motor areas

The frontal lobe is critical for the control of movement

- Contralateral weakness or paralysis — Caused by damage of primary motor cortex
- Premotor planning of action
- Frontal eye fields for moving eyes to opposite side

- Speech production (Broca's area
- Prefrontal areas

Apraxia

(Error in execution of learned movements without coexisting weakness)

Ie. muscle function OK

- Damage to dominant parietal, premotor, and supplementary motor areas
- Dominant hemisphere association areas
- Parietal - integrates motor sequences with vision and somatic sensory info
- Frontal lobe - execution of act

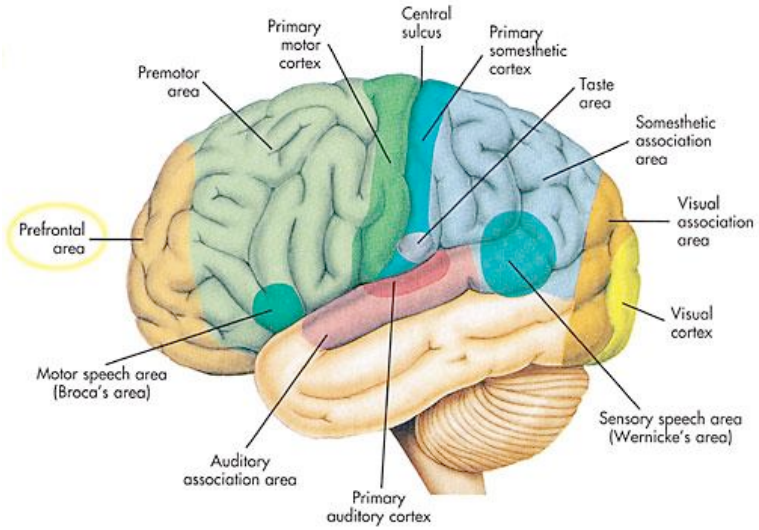
Frontal Lobe prefrontal association cortex

The frontal lobe (prefrontal area) is important for planning complex cognitive behavior, personality, decision making and regulating social behavior"

- Bilateral prefrontal damage
  - distractible, apathetic
  - lack foresight, abstract reasoning, initiative
  - stubborn,
  - perseverate,
  - lack ambition, responsibility, judgment or social graces

Parietal Lobe functions:

- Primary somatosensory cortex, somatosensory association cortex – so important for sensation
- Integration of auditory, visual and somatic sensory information



Parietal Lobe

Damage causes:

- Somatosensory Cortex-paresthesias ie. Abnormal sensation
- Dominant Parietal lobe-reading, writing, naming

Agraphia - impairment or loss of the ability to write

- Agraphia can be frontal or parietal

Frontal – causes motor issues ie. movements needed for writing
Parietal – disrupts comprehension and expression of language

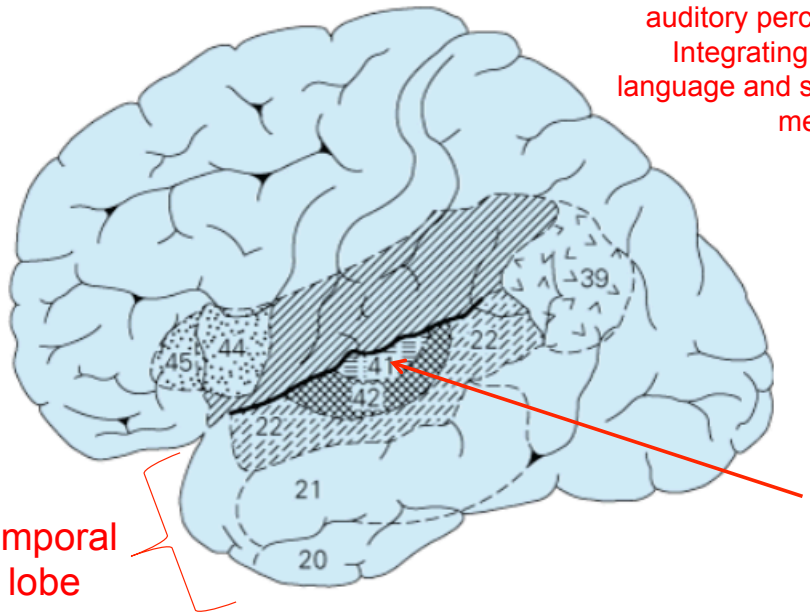
Contralateral Neglect

(asomatognosia)

- Right parietal
- Right side is dominant for attention - do not attend to opposite side, ie. Dressing apraxia
- Severe - failure to recognize one's opposite limb
- Impaired visuospatial ability (drawing, copying, 3D, manipulate objects in space

Temporal Lobe

- Association auditory cortex
- Speech comprehension
- Important in naming
- Memory - bilateral medial temporal lobe near hippocampus
- Superior part of contralateral visual field



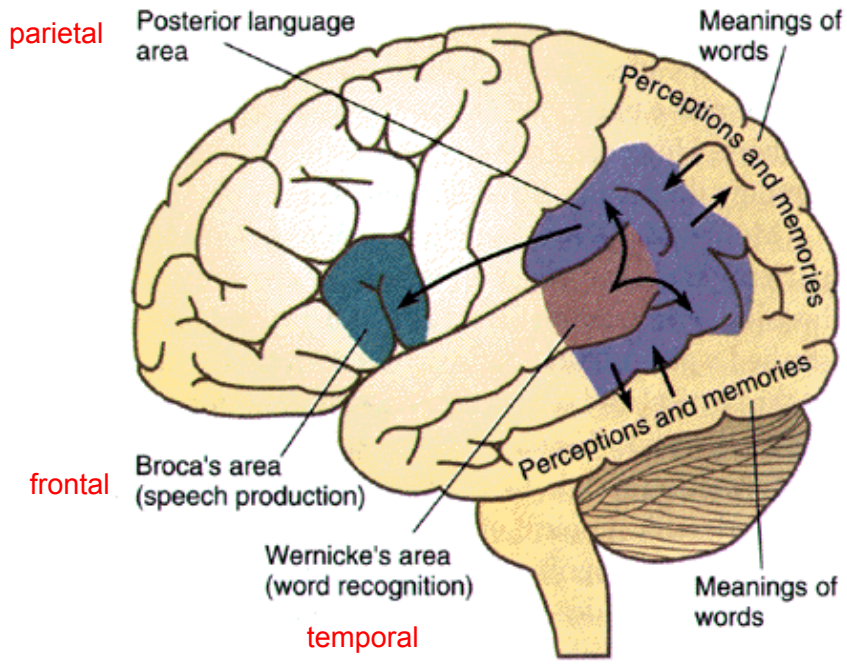
Temporal Lobe Functions:
auditory perception (hearing)
Integrating sensory input
language and speech production
memory

Primary auditory cortex

Temporal lobe

Source: Ropper AH, Brown RH: *Adams and Victor's Principles of Neurology*, 8th Edition: http://www.accessmedicine.com

Language areas



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Temporal Lobe Functions

- Wernicke speech comprehension - dominant side
- Verbal learning- dominant

- Lyrics in dominant lobe
- Harmony and melody is impaired by lesions of the nondominant,
- Visual learning- nondominant
- Visual agnosia dominant, auditory agnosia nondominant hemisphere
- Bilateral: cortical deafness. Otherwise subtle
- Bilateral: psychic blindness,

- Bilateral hippocampal formation : Amnesia

Global aphasia

- Dominant hemisphere
- Frontal
- Temporal
- Parietal

Loss of language ability (expression and comprehension) – due to extensive damage to brain's language networks

Caused by:

- Internal carotid or proximal MCA, hemorrhage, or large tumor

Aphasias-Sensory

- **Wernicke's** (word recognition area)
- Dominant (left usually) hemisphere
- Fluent, paraphasias, poor comprehension,
- Naming, repetition, reading and writing impaired
- Less aware and less frustrated than motor aphasias

People with sensory aphasia can speak with normal grammar etc, but they are unable to understand language in its written or spoken form.

Right hemisphere and aphasia

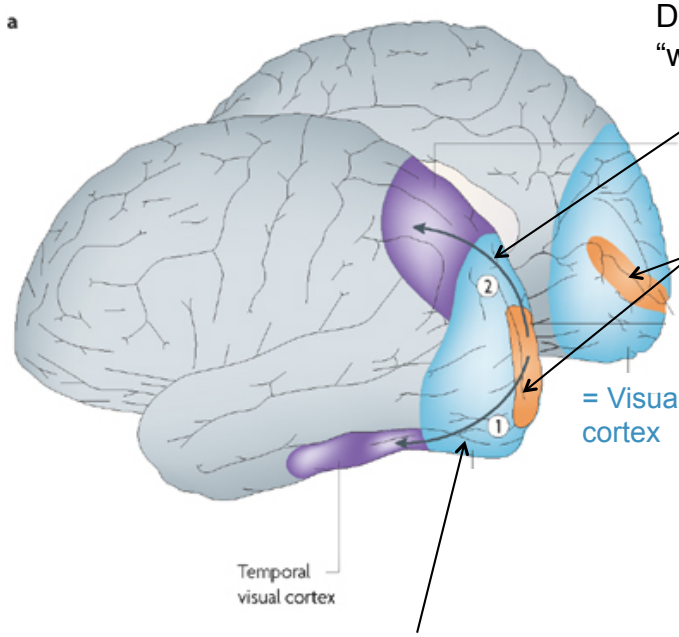
- Emotional tone modulation
- Propositional prosody
- Body language gestures

ignore

Agnosia-impaired perception or recognition with OK vision, hearing, sensation , attention, intelligence

- Visual: colors, faces, letters
- Auditory: tunes, spoken words, pure word deafness
- Somatosensory - stereognosis, graphesthesia
- May not have other signs: aphasia, apraxia
- Atrophy or metastatic disease
- Disconnections of specific sensory association areas
- Corpus callosum, deep white matter near main sensory areas

Occipital Cortex - Visual cortex



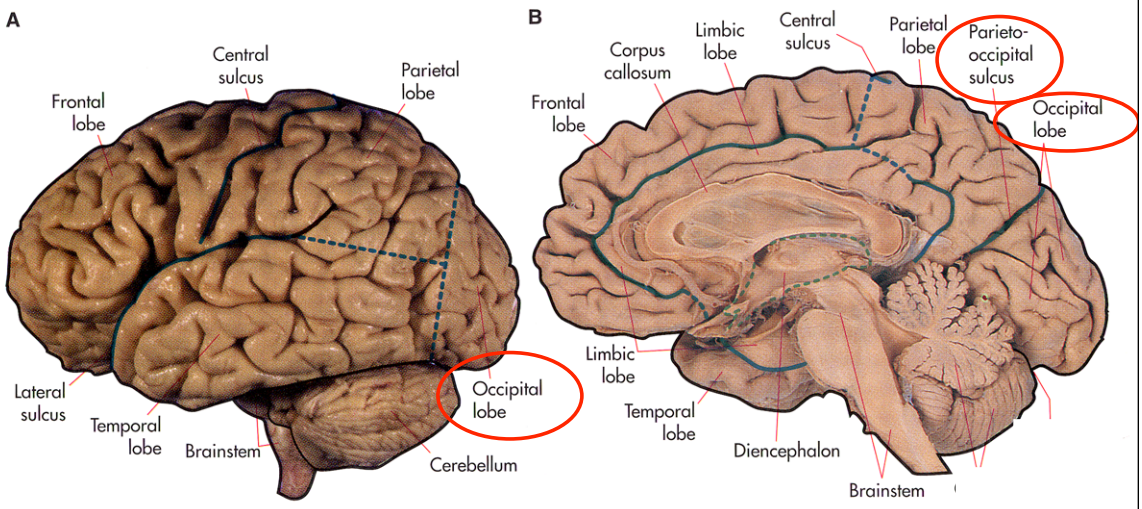
Dorsal pathway = "where" pathway

Primary visual cortex

= Visual association cortex

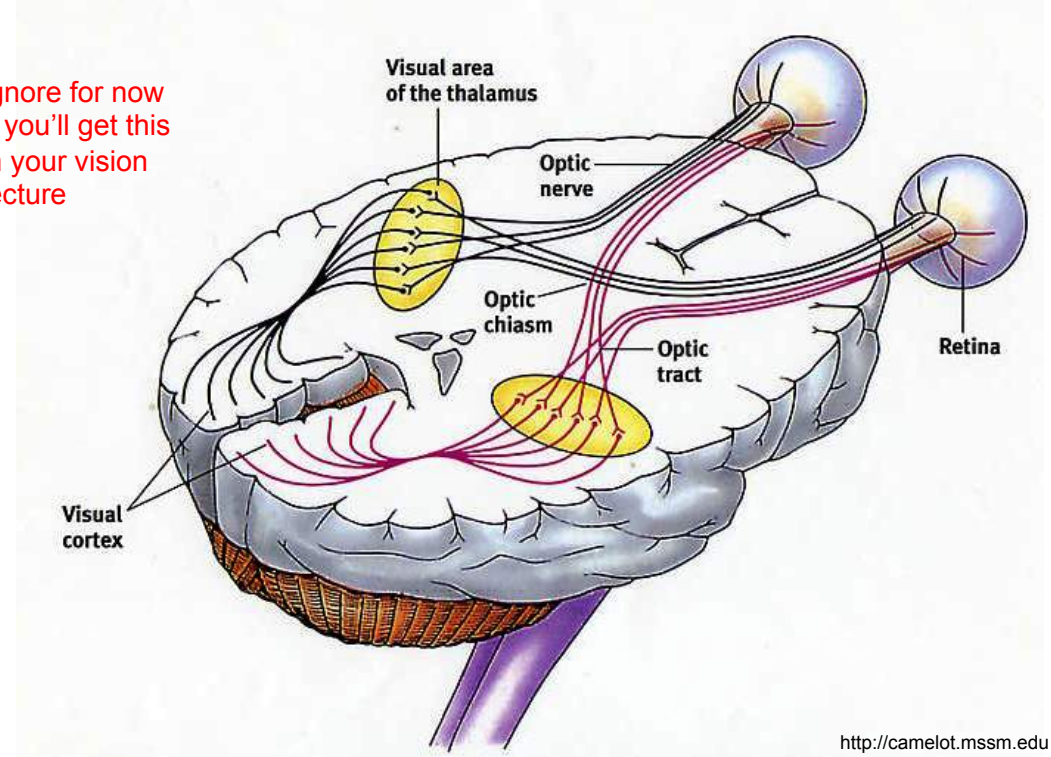
Ventral pathway = "what" pathway

From: Nature Reviews Neuroscience 9, 123-135 (February 2008)



Visual Pathway to the cortex

Ignore for now – you'll get this in your vision lecture



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