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## Limbic System Lecture Outline and Objectives

### CNS/Head and Neck Sequence

TOPIC: THE LIMBIC SYSTEM

FACULTY: Department of Neurology/Division of Anatomical Sciences

LECTURE: Thursday, March 19, 2009

READING: John H. Martin, *Neuroanatomy, Text and Atlas*, 3rd edition  
pp. 377-405, 416, 417, 478, 479, 486, 487.

### OBJECTIVES:

Know the structure and location of the amygdala and the hippocampal formation in relation to the cerebral cortex.

Know the three subdivisions of the amygdala and the major connections of each of these divisions.

Be able to describe the flow of information through the subdivisions of the hippocampal formation and the two different pathways through which it connects with limbic lobe cortex.

### SAMPLE TEST QUESTION:

Which of the following is a major connection of the fornix?

- A amygdala
- B reticular formation
- C hippocampus
- D olfactory Bulb
- E anterior Pituitary

Answer – C

### LECTURE OUTLINE

#### **Functional Areas of the Cerebral Cortex**

Primary Motor and Primary Sensory Areas:

M1 = primary motor cortex – precentral gyrus

S1 = primary somatosensory cortex – postcentral gyrus

A1 = primary auditory cortex – transverse temporal gyri  
V1 = primary visual cortex – lingual and cuneate gyri

**Unimodal Association Areas:**

Motor association area - frontal lobes  
Somatosensory unimodal area – parietal lobe  
Auditory unimodal area – temporal lobe  
Visual unimodal area – occipital lobe and inferior temporal lobe

**Multimodal Association Areas:**

Posterior multimodal area – parietal and temporal lobes  
Frontal multimodal area (prefrontal cortex) – frontal lobe

## **Limbic System**

Limbic Association Areas form the “Limbic Lobe”

parahippocampal gyrus (“ph”)  
cingulate gyrus (“cg”)  
temporal pole (“tp”)

Limbic Cortex = the Hippocampal Formation and the Amygdala

The Amygdala – A matrix of nuclei in the uncus divided into:

**Corticomedial Division**

Input from the olfactory bulb via the olfactory tract  
Primary output to the medial hypothalamus via the stria terminalis  
Modulates pituitary function and social behaviors

**Central Nucleus**

Reciprocal connections through the ventral amygdalofugal pathway  
Targets are the hypothalamus and brain stem autonomic centers  
(reticular formation and parasympathetic cranial nerve nuclei)

**Basolateral Division**

Anatomically, physiologically and neurochemically this area of the amygdala most resembles other cortical areas.

Reciprocal connections with:

Frontal multimodal association cortex  
Temporal and occipital sensory association areas

## **The Hippocampal Formation**

Composed of three areas that are connected to one another in a cascade of projections.

### Dentate gyrus

The receptive area of the hippocampal formation.

Receives input from the entorhinal cortex (a sub area of the parahippocampal gyrus of the limbic lobe) via the perforant path.

Projects to the hippocampus (CA3)

### Hippocampus

Composed of subdivisions (CA 3 projects to CA 1)

CA1 projects to subiculum

CA1 area also projects out of the hippocampal formation

### Subiculum

Projects out of the hippocampal formation, with fibers of CA1, to the mammillary bodies of hypothalamus and anterior nucleus of thalamus via the fornix

Also projects to entorhinal cortex and multimodal temporal cortex

The Papez Circuit connects the hippocampal formation with the cingulate gyrus through synapses in the hypothalamus and thalamus

The fornix projects to the mammillary bodies

Neurons in the mammillary bodies send axons through the mammillothalamic tract to the anterior nucleus of the thalamus

Anterior nuc. of thalamus projects to the cingulate gyrus

Cingulate gyrus cells project to the entorhinal cortex of the parahippocampal gyrus, providing feedback to the hippocampal formation.

The cingulate gyrus is interconnected with other cortical areas in networks that regulate emotional responses and attention.

The Papez circuit integrates the hippocampal formation into these circuits.