**Graduate School Systems Neuroscience, MEDS 5371**

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 **Limbic System - Anatomy**

Limbic system is physiological more than anatomical concept, and the name has been coined by Broca in 1878, to include first only cingulate and parahippocampal gyri. In 1937 Papez revised this to include more structures. Limbic system derives its name from limbus- rim, since it is position in medial structure around the lateral ventricles and on both sides of the thalamus, right under the cerebrum. Its main function is in emotions and formation of memories, but this will be discussed in more detail in the next lecture.

Anatomically Limbic system consists of several structures that are interconnected.

**Hippocampus** and **Amygdala** are located in the temporal pole. From hippocampus the axonal bundle named **fornix** emerges and curves around the ventricle, touches corpus callosum and then continues rostrally and downwards to end in **mammillary bodies** and **septal region** with the branches to hypothalamus. Mammilary bodies are part of the diencephalon and they are connected with the **anterior nucleus** of the Thalamus, which in turn sends axons to the **prefrontal cortex**. Another thalamic nucleus, the **medio-dorsal (MD) nucleus** which is connected to prefrontal cortex is often mentioned in relation to the limbic system.

Limbic cortex is term used for three cortical areas: hippocampus, cingulum and orbitofrontal cortex.

**Amygdala**, located in the temporal lobe, consists of several nuclei: medial group, central group and basal-lateral group of nuclei. Medial group connects to olfactory bulb and cortex; central group to hypothalamus and brain stem; basal-lateral group connects to the orbitofrontal, prefrontal and association areas of temporal cortex. Amygdala is connected, through the **stria terminalis** with the septal region and hypothalamus. It is also connected with **Nucleus Accumbens** or ventral striatum and with medio-dorsal (MD) nucleus of the thalamus and orbital and medial prefrontal cortex.

**Hippocampus**- located in the temporal horn contains Cornu Ammon’s (from ram’s horn, CA1-4) and Dentate gyrus. Hipp belongs to the old- or archicortex (only 3 cortical layers). Hippocampus has a role in short term memory and spatial orientation (place cells); it is a part of a limbic system.

This is one of the best studied synpatic circuits important for generating LTP- long term potentiation (the increase of synaptic strength after a train of stimuli). Information from different cortical areas is collected in the entorhinal cortex in the perihippocampal gyrus. Axons from this region in a form of a perforant path contact granular cells in the dentate gyrus > which sends further axons (mossy fibers) to synapse on CA3 pyramidal cells which send axons- Shaffer collaterals to CA1 pyramidal cells. These cells give an output through **fimbria** and further **fornix** to mammilary bodies.

Thus the main structures in the Limbic system are:

Amygdala- emotions, fear

Hippocampus and parahippocampal gyrus-memory

Fornix

Mammilary Bodies

Two thalamic nuclei- Anterior and Mediodorsal (MD)

(projects to Prefrontal cortex)

Orbitofrontal cortex

**Cingulum** (connects to Amygdala)- role in emotional interpretation of pain (anguish)

**Nucleus Accumbens** (connects to Amygdala) – role in drug addiction.

Connections of Amygdala to hypothalamus is important since it influences autonomic nervous system (the effect of emotions on the autovegetative status).

In some textbooks **Habenula or habenular nucleus**- located in the posterior wall of the III ventricle near pineal gland, is included in the Limbic system. This structure is connected to septal region via stria medullaris thalamy. Its role has been reported in pain processing and reward process.