Graduate School Systems Neuroscience, MEDS 5371

2013

**Diencephalon anatomy**

**1. READING**

**Purves, 4th Ed.**

**INTRODUCTION**

**The diencephalon** is positioned on both sides of the third ventricle, and can be identified by the third ventricle, thalamus, optic chiasm, and mammillary bodies. The diencephalon is divided into several parts: dorsal thalamus (largest part), hypothalamus, epithalamus, metathalamus (MGN, LGN), and subthalamus. The ventral and medial part of the diencephalon is the **hypothalamus** that contains numerous nuclei; they maintain homeostasis through regulating the function of the autonomic nervous system. On the base of the brain (ventral side) parts of diencephalon, from rostral to caudal direction, can be identified: optic chiasm, infundibulum (for the hypophysis or pituitary gland) and mammilary bodies. The ventral and lateral part of the diencephalon is the **subthalamic nucleus**, functionally a part of Basal ganglia circuitry and will be discussed with Basal ganglia. **Epithalamus** is the posterior wall of the third ventricle and consists of pineal gland, habenula, posterior commissure. Pineal gland has a role in circadian cycle. Habenula (habenular nuclei) receive inputs through stria medullaris from septal region; outputs are sent to many [midbrain](http://en.wikipedia.org/wiki/Midbrain) areas involved in releasing [dopamine](http://en.wikipedia.org/wiki/Dopamine), [norepinephrine](http://en.wikipedia.org/wiki/Norepinephrine), and serotonin. Habenula has a role in pain processing, sleep-wake cycles, stress responses, and processing negative rewards.

During development optic vesicles which form the eyes are parts of the diencephalon. Thus, neural portion of the retina is a part of CNS.

**Thalamus**, also called the dorsal thalamus, is the largest part of the diencephalon. It is often considered a gateway to cerebral cortex. All pathways coming from lower parts of the CNS before reaching cerebral cortex stop in the thalamus. Thalamus is an integration center- it receives reciprocal connections from the cortex, cerebellum and basal ganglia. It contains several groups of nuclei that are designated for various functions (see Table at the end of the syllabus).

Nuclei Related to sensory function

**VPL- Ventro-posterior-lateral nucleus-** receivessensory information from the body and conveys them to somato-sensory cortex (postcentral gyrus). These sensations are for touch, two point discrimination, and vibration coming through Medial Lemniscus, as well as for pain and temperature coming through ALS (spino-thalamic tr). Since both of these pathways are crossed they convey information from the opposite side of the body to the somato-sensory cortex.

**VPM –Ventro-posterior- medial nucleus** has similar function for head and face. Sensory informations are coming mainly through the ventral trigemino-thalamic tract, which is crossed.

Special sensory nuclei- Metathalamus

**Lateral geniculate nucleus** (**LGN**) is a relay station in the visual pathway, receiving fibers from the optic nerve (II cranial nerve) and projecting as the visual radiation to the visual cortex in the occipital lobe.

**Medial geniculate nucleus** (**MGN)**  is a relay station in the auditory pathway receiving auditory signals from ears through cochlear nerve (part of VIII cranial nerve) and lateral lemniscus. From the MGN this information is conveyed to the auditory cortex in the temporal lobe.

Nuclei Related to Motor function

**VA and VL** (ventro-anterior and ventro-lateral) nuclei receive inputs from the cerebellum and the basal ganglia and connect to the motor and premotor cortex, having a role in motor function.

Nuclei Related to the Limbic System

**MD**- Mediodorsal nucleus is positioned medially, close to ventricular surface and is connected to prefrontal cortex; it receives connections from the amygdala, globus pallidus and midbrain reticular formation. It has a function in memory (see below).

**AN**-Anterior nucleus is a part of limbic system. It receives inputs from the mammilary bodies and sends fibers to the cingulate gyrus.

**Centrum medianum (CM)**- receives inputs from from Globus Pallidus and sends outputs to the Motor cortex. It is also included in a pain pathway.

**Pulvinar**- is the most caudal thalamic nucleus. It receives projections from the auditory, somatosensory and visual cortex regions. It is involved in visual attention, suppression of irrelevant stimuli and utilizing information to initiate eye movements.

Reticular and interlaminar nuclei- connected to reticular formation and cerebral cortex, thus they can act as part of ascending activation system (influence level of alertness & consciousness). Damage to the thalamus can lead to permanent [coma](http://en.wikipedia.org/wiki/Coma).

Intralaminar nuclei are in the pain pathway.

**Mammilary bodies** are part of the limbic system and will be discussed again later. They receive information from the hippocampus via fornix (fiber bundle) and from the amygdala. Information is transferred from the mammilary bodies by Mammilothalamic tract to the Anterior nucleus of the thalamus (AN). This nucleus also receives branches from the Fornix, and further projects to the prefrontal cortex and cingulum (all parts of Limbic system).

**Subthalamic Nucleus** is position bellow the thalamus. Functionally it is a part of Basal ganglia.

**Thalamic nuclei, their connections & functions**

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| --- | --- | --- | --- |
| **Part of the thalamus** | **Nuclei** | **Connections** | **Functions** |
| Anterior part | Anterior thalamic nuclei | 1. Mammillo – thalamic tract 2. Hypothalamus 3. Cingulate gyrus | Emotional tone  Mechanism of recent memory |
| Medial part | Dorso – medial | 1. Prefrontal cortex 2. Hypothalamus | Integration of somatic, visceral & olfactory information and relate those information to one’s emotional feelings & subjective states |
| Lateral part |  | | |
|  |  |  |
| **Ventral tier** | | |
| 1.Ventralanterior  **VA** | 1. RF 2. Substantia nigra 3. Corpus striatum 4. Premotor cortex | Influence the activities of the motor cortex |
| 2.Ventral lateral  **VL** | 1. Cerebellum 2. Red nuclei 3. RF 4. Substantia nigra 5. Corpus striatum 6. Premotor cortex |
| **3. VPM** | 1. **Trigeminal lemnisci** | Relays common sensations to consciousness |
| **4. VPL** | 1. **Medial & spinal lemnisci** 2. **cortex (3, 2 & 1)** |
| Other nuclei | 1. Intra laminar | 1. RF 2. Spino – thalamic tract 3. Trigemino – thalamic tract | Influence the level of alertness & consciousness |
| 2.Midline | RF | Unknown |
| 3. Reticular |
| **4. Medial geniculate body**  **MGB** | 1. Inferior colliculus 2. Lateral lemnisci from both ears (Predominantly from the contra lateral ear) 3. Efferent – Auditory radiation to superior temporal gyrus | Hearing |
| **5.Lateral geniculate body**  **LGB** | 1. Optic tract 2. Efferent – Optic radiation to visual cortex of the occipital lobe | Visual information from the opposite visual field |