THE DIENCEPHALON

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THE DIENCEPHALON

- EPITHALAMUS
- THALAMUS
- SUBTHALAMUS
- HYPOTHALAMUS
B Structure of the diencephalon in an embryonic brain
DIENCEPHALON – medial aspect
later found a fiber bundle known as the *striata terminalis* or *striatum semicircularis* (Figs. 260, 15). At first the corpus striatum appears as cortex. These fibers increase in number and finally form a massive bundle, the *internal capsule*, containing all the projection fibers
THE THALAMUS - NUCLEI

- Anterior nuclei
- Medial nuclei (mediodorsal nc.)
- Lateral nuclei – dorsal tier (lateral dorsal nc., lateral posterior nc., posterior ncc., (ncc. of pulvinar)
- ventral tier (ventral anterior – VA, ventral lateral – VL, ventral posterolateral- VPL, ventral posteromedial – VPM, ventral intermediate - VIM,
- Medial geniculate nc.,
- Lateral geniculate nc.,
- Intralaminar nuclei
- Midline nuclei
- Reticular nucleus
SUBTHALAMUS

Zona incerta
Subthalamic nc.
PULVINAR – posterior nuclei

METATHALAMUS = Medial and lateral geniculate bodies
### Table 16-1  Topographical Subdivisions of the Thalamus and Their Principal Nuclei

<table>
<thead>
<tr>
<th>Subdivision</th>
<th>Principal nucleus or nuclei</th>
<th>Common abbreviation</th>
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<tbody>
<tr>
<td>Anterior division</td>
<td>Anterior</td>
<td>DM</td>
</tr>
<tr>
<td>Medial division</td>
<td>Dorsomedial</td>
<td></td>
</tr>
<tr>
<td>Lateral division</td>
<td>Dorsal tier</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Lateral dorsal</td>
<td>LD</td>
</tr>
<tr>
<td></td>
<td>Lateral posterior</td>
<td>LP</td>
</tr>
<tr>
<td></td>
<td>Pulvinar</td>
<td></td>
</tr>
<tr>
<td>Ventral tier</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ventral anterior</td>
<td>VA</td>
</tr>
<tr>
<td></td>
<td>Ventral lateral</td>
<td>VL</td>
</tr>
<tr>
<td></td>
<td>Ventral posterior</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ventral posterolateral</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ventral posteromedial</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Medial geniculate</td>
<td>MGN</td>
</tr>
<tr>
<td></td>
<td>Lateral geniculate</td>
<td>LGN</td>
</tr>
<tr>
<td>Intralaminar nuclei</td>
<td>Centromedian</td>
<td>CM</td>
</tr>
<tr>
<td></td>
<td>Parafascicular</td>
<td>PF</td>
</tr>
<tr>
<td></td>
<td>Others</td>
<td></td>
</tr>
<tr>
<td>Reticular nucleus</td>
<td>Reticular nucleus</td>
<td></td>
</tr>
</tbody>
</table>
Neuronal connections of thalamic nuclei

THALAMOCORTICAL
CORTICO-THALAMIC
THALAMIC NUCLEUS

SPINAL CORD
BRAIN STEM (RF, NUCS OF ORGAN'S NERVES)
CEREBELLUM (DENTATE NO.)
BASAL GANGLIA (GLOBUS PALLIDUS)
Thalamic nuclei

- **Relay nuclei** (relé jádra, přepojovací jádra) — MGN, LGN, VPL, VPM, VL, VA
- Receives input predominantly from a single source
- Processed information is sent to a localized region of cortex
- Are modality specific
- Specific nuclei (after stimulation sharply localized cortical response)
Association nuclei

- MD, LD, LP, Posterior ncc.,
- Receives input from a number of structures or cortical areas
- Sends fibers to the association cortical areas
- Specific nuclei (after stimulation sharply localized response in the cortex)
Nonspecific nuclei

- Intralaminar nuclei (centromedian, parafascicular)
- **Afferents** - from RF, spinothalamic fibers, cerebellum, BG
- **Efferents** – extensive areas of the frontal and parietal lobes, basal ganglia (striatum)
- **Function** – influence levels of consciousness and degrees of alertness
Termination of subcortical projections in the thalamus
Figure 15-10. Relationship of the thalamic nuclei with the cerebral cortex as depicted by the patterns of thalamocortical connections. Each thalamic nucleus is pattern-coded or color-coded to match its target area in the cerebral cortex.
<table>
<thead>
<tr>
<th>Type</th>
<th>Nucleus</th>
<th>Specific inputs</th>
<th>Cortical output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relay</td>
<td>Anterior</td>
<td>Mammillothalamic tract, hippocampus</td>
<td>Cingulate gyrus</td>
</tr>
<tr>
<td></td>
<td>Lateral dorsal (LD)</td>
<td>Hippocampus</td>
<td>Cingulate gyrus</td>
</tr>
<tr>
<td></td>
<td>Ventral anterior, ventral lateral (VA/VL)*</td>
<td>Basal ganglia, cerebellum</td>
<td>Motor areas</td>
</tr>
<tr>
<td></td>
<td>Ventral posterolateral (VPL)</td>
<td>Medial lemniscus (body), spinothalamic tract (body)</td>
<td>Somatosensory cortex</td>
</tr>
<tr>
<td></td>
<td>Ventral posteromedial (VPM)</td>
<td>Medial lemniscus (face), spinothalamic tract (face)</td>
<td>Somatosensory cortex</td>
</tr>
<tr>
<td></td>
<td>Medial geniculate (MGN)</td>
<td>Central tegmental tract (taste)</td>
<td>Insula</td>
</tr>
<tr>
<td>Association</td>
<td>Lateral geniculate (LGN)</td>
<td>Brachium of the inferior colliculus</td>
<td>Auditory cortex</td>
</tr>
<tr>
<td></td>
<td>Dorsomedial† (DM)</td>
<td>Optic tract</td>
<td>Visual cortex</td>
</tr>
<tr>
<td></td>
<td>Lateral posterior (LP)</td>
<td>Prefrontal cortex, olfactory and limbic structures</td>
<td>Prefrontal cortex</td>
</tr>
<tr>
<td></td>
<td>Pulvinar</td>
<td>Parietal lobe</td>
<td>Parietal lobe</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parietal, occipital, and temporal lobes</td>
<td>Parietal, occipital, and temporal lobes</td>
</tr>
</tbody>
</table>

*Basal ganglia outputs go mostly to VA and cerebellar outputs mostly to VL, but the two are considered together as a combined motor relay nucleus in this account.

†Also commonly referred to as the *mediodorsal nucleus* (MD).
FIGURE 16-18
Main specific inputs to and outputs from relay nuclei. Thalamic nuclei: *, Ventral posteromedial nucleus; **, lateral dorsal nucleus; A, anterior nucleus; DM, dorsomedial nucleus; LG, lateral geniculate nucleus; MG, medial geniculate nucleus; Pul, pulvinar; VA, ventral anterior nucleus; VL, ventral lateral nucleus; VPL, ventral posterolateral nucleus. Input pathways and structures: AL, Ansa lenticularis (see Chapter 19); CTT, central tegmental tract; IB, brachium of the inferior colliculus; DTT, dorsal trigeminal tract; HC, hippocampus; LF, lenticular fasciculus (see Chapter 19); ML, medial lemniscus; MTT, mammillothalamic tract; OT, optic tract; SCP, superior cerebellar peduncle (see Chapter 20); STT, spinothalamic tract. Cortical destinations: AC, Auditory cortex; Cing, cingulate gyrus; Ins, insula; M, primary motor cortex (precentral gyrus); PM, premotor cortex (see Chapter 18); SC, somatosensory cortex; SM, supplementary motor area (see Chapter 18); VC, visual cortex.
Somatotopic organization of the VPL and VPM ncc. =
termination of the lemniscal system and trigeminothalamic pathway
Termination of subcortical fibers in the thalamus – horizontal section

- VA - GP
- VA - SNr
- VL – cerebellum

- Terminals of subcortical fibers in the thalamus
- VPL + VPM
- Post. Ncc
FIGURE 16-25

Structural components of the various parts of the internal capsule, as seen in a horizontal section (A) and in the dissection from Figure 16-24. The thalamocortical connections indicated schematically in B would actually be on the other side of the internal capsule. Not all elements can be seen in both parts of the figure. For example, the anterior nucleus and the pulvinar are not present in the plane of section shown in A, so no cell bodies are indicated; neither cingulate nor auditory cortex is present in the dissection shown in B, so no projections to them are indicated. [A modified from Noble, A., Angevine, J. B. Jr.: The human brain in photographs and diagrams, ed. 2. St. Louis, 2000, Mosby. B modified from Ludwig, H. & Klingler, J.: Atlas der menschlichen Neuroanatomie. Berlin, 1956, J. Liitt. & Brown.]
Posterior Column – Medial Lemniscal System

- Two-point localization
- Vibration sense
- Position sense
Dentato-thalamic projection
EPITHALAMUS

Interventricular foramen
Column of fornix
Anterior commissure
Septum pellucidum
Corpus callosum (genu)
Rostrum of callosum
Lamina terminalis
Optic recess
Optic chiasma
Infundibulum
Hypophysis
Tuber cinereum
Mammillary body

Massa intermedia
Taenia thalami
Corpus callosum
Fornix
Th.
Hy.
N. III
Tegmentum of midbrain
Pons
Medulla
Hypothalamic sulcus
Pulvinar
Habenular commissure
Posterior commissure
Splenium of callosum
Pineal body
Corpus quadrigemina
Iter
Sup. medullary velum
Superior vermis (cerebellum)
Ventricle IV
Inf. vermis (cerebellum)
Chorioid plexus

Fig. 262. Median sagittal section of brain stem. Hy, hypothalamus; Th, thalamus.
EPITHEALAMUS

- Habenular nuclei
  - Afferent fibers – stria medullaris thalami (septum verum, olfactory cortex, hippocampus, hypothalamus, basal ganglia (globus pallidus)
  - Efferent fibers – tractus habenulointerpeduncularis (RF, hypothalamus, ANS)

- Pineal gland – in amphibian and fishes contains light-sensitive cells. In mammals transformed to the endocrine gland
  - Afferent fibers – superior cervical ganglion, hypothalamus, colliculus superior, LGB
  - Pinealocytes produce serotonin – melatonin (night↑),
  - Supresses development of gonads (pinealectomy stimulates growth of the reproductive organs)
SUBTHALAMUS – later, next week
HYPOTHALAMUS
Figure 15-3. Mid-sagittal view of the diencephalon and closely related structures. This is a drawing of the specimen shown Figure 15-5.
**Figure 15–12.** Anterior (ventral) view of the diencephalon illustrating the three zones of the hypothalamus as superimposed on external structures. The colors used for medial and lateral zones correlate with those in Figure 15–13.
MEDIAL ZONE

PERIV. ZONE

NUCLEI

ANT. REG.
CHIASMATIC

PREOPTIC,
SO, PV,
ANT., SCH.

MIDDLE
TUBERAL
REG.

DM, VM
ARCLATE NOC.

(CALDAL)
MAMMILLARY
REG.

POST. NOC.
MAMM. NOC.

LATERAL ZONE

FORNIX
Fig. 15.1. *The hypothalamus.* Median section through the third ventricle. Some of the major hypothalamic nuclei are shown with red dots. The size of the dots indicates the relative size of the neurons of the various nuclei. Redrawn after Le Gros Clark et al. (1936).
Figure 15-13. Mid-sagittal (A) and cross-sectional (B–D) views illustrating the nuclei of medial and lateral hypothalamic zones and the nuclei associated with chiasmatic (B), tuberal (C), and mammillary (D) regions. The colors used here correlate with those in Figure 15-12. (A adapted from Haymaker W, Anderson F, Nauta WJH: The Hypothalamus. Charles C Thomas, Springfield, Ill., 1969, with permission.)
Fig. 15.2. *Main afferent connections of the hypothalamus.* Arrows indicate the direction of impulse conduction.
Fig. 15.3. Main efferent connections of the hypothalamus. The connections to the pituitary gland are not included, nor are the efferent connections of the mammillary nucleus.
Fig. 15.5. The relationship between the hypothalamus and the pituitary gland. A. Connections from the hypothalamus to the posterior lobe. B. Axonal transport of peptide hormones (neuropeptides) from the hypothalamus to the pituitary. C. The portal vessels of the pituitary stalk ensure that releasing hormones (factors) are transported from the median eminence in the upper part of the stalk to the epithelial cells of the anterior lobe.
Figure 30-4. Midsagittal view of the hypothalamus emphasizing the nuclei, which contribute to the tuberoinfundibular, supraopticohypophysial tracts, the hypophysial portal system, and the general relations of the fornix and mammillothalamic tract.
THE HYPOTHALAMUS

- **Lateral zone**
  - No discrete nuclei
  - Regulation of food and water intake

- **Medial zone**
  - Well defined nuclei

- **Chiasmatic region**
  - (SO, PV – hormone release)
  - Cardiovascular function (Ant.)
  - Circadian rhythms (SCH)
  - Body temperature (Preoptic nc.)

- **Tuberal region**
  - VM – satiety center (lesion produces hyperphagia + obesity)
  - Arcuate nc. - delivers peptides to the portal vessels

- **Mamillary region**
  - Posterior nc.- elevating of blood pressure, pupillary dilatation, body heat conservation
  - Mamillary ncc. – memory formation !!!

- **Medial zone**
  - Well defined nuclei

- **Chiasmatic region**
  - (SO, PV – hormone release)
  - Cardiovascular function (Ant.)
  - Circadian rhythms (SCH)
  - Body temperature (Preoptic nc.)
<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>Al</td>
<td>Alveus of Hippocampus</td>
</tr>
<tr>
<td>CblTh</td>
<td>Cerebellothalamic Fibers</td>
</tr>
<tr>
<td>CC</td>
<td>Crus Cerebri</td>
</tr>
<tr>
<td>Cing</td>
<td>Cingulum</td>
</tr>
<tr>
<td>CinGy</td>
<td>Cingulate Gyrus</td>
</tr>
<tr>
<td>CI</td>
<td>Clastrum</td>
</tr>
<tr>
<td>CNu, B</td>
<td>Caudate Nucleus, Body</td>
</tr>
<tr>
<td>CNu, T</td>
<td>Caudate Nucleus, Tail</td>
</tr>
<tr>
<td>CorCl, B</td>
<td>Corpus Callosum, Body</td>
</tr>
<tr>
<td>CP</td>
<td>Choroid Plexus</td>
</tr>
<tr>
<td>DMNu</td>
<td>Dorsomedial Nucleus of Thalamus</td>
</tr>
<tr>
<td>EML</td>
<td>External Medullary Lamina</td>
</tr>
<tr>
<td>Ext</td>
<td>External Capsule</td>
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<tr>
<td>Extrm</td>
<td>Extreme Capsule</td>
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<tr>
<td>For, B</td>
<td>Fornix, Body</td>
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<tr>
<td>GP</td>
<td>Globus Pallidus</td>
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<td>Hip</td>
<td>Hippocampal Formation</td>
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<td>IGr</td>
<td>Indusium griseum</td>
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<td>IML</td>
<td>Internal Medullary Lamina</td>
</tr>
<tr>
<td>Ins</td>
<td>Insula</td>
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<td>Int</td>
<td>Internal Capsule</td>
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<td>LatVen, B</td>
<td>Lateral Ventricle, Body</td>
</tr>
<tr>
<td>LatVen, IH</td>
<td>Lateral Ventricle, Inferior Horn</td>
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<tr>
<td>LDNu</td>
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<tr>
<td>LenFas</td>
<td>Lenticular Fasciculus</td>
</tr>
<tr>
<td>LLSt</td>
<td>Lateral Longitudinal Stria</td>
</tr>
<tr>
<td>MI</td>
<td>Massa Intermedia</td>
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<td>MLSi</td>
<td>Medial Longitudinal Stria</td>
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<td>Optic Tract</td>
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<tr>
<td>Put</td>
<td>Putamen</td>
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<tr>
<td>SMT</td>
<td>Stria Medullaris Thalami</td>
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<td>Substantia Nigra</td>
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<tr>
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<tr>
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