Overview of Basal Ganglion, Thalamus, Hypothalamus, Brainstem, and Spinal Cord – Neuroanatomy and MR Anatomy

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Major Structures of Central Nervous System

* Diencephalon: thalamus, hypothalamus, epithalamus, and subthalamus

The Brain Anatomy and Function

Berlit P. Memorix of Neurology. 1996.
Basal Ganglion and Thalamus

Hanes DE. Neuroanatomy, an atlas of structures, sections, and system, 1995.
Basal Ganglion and Thalamus-MR View

Hanes DE. Neuroanatomy, an atlas of structures, sections, and system, 1995.
Basal Ganglion Function and Disorder

• Function: conversion of motor planning into movement pattern programming, e.g. strength, direction, speed, and amplitude of movement

• Example of disorders or symptoms:
  – Parkinson’s disease: neuronal cell loss in Substantia Nigra and degeneration of nigrostriatal pathway. Symptoms of resting tremor, cogwheel rigidity, hypokinesia, impaired postural reflexes
  – Hemiballism: contralateral subthalamic nucleus. Irregular flailing and writhing movements of the limbs on one side of the body
  – Chorea: caudate nucleus. Irregular, random, jerky movements.

Berlit P. Memorix of Neurology. 1996.
Subdivision of Thalamus

Thalamus Function

- Anterior thalamic nucleus (A): Receives fibers from mammillothalamicus tract and hippocampal formation, related to attention, memory, and learning.
- Centromedian nucleus (CM): receives fibers from GP, projects to putamen and caudate nucleus
- Ventral anterior nucleus (VA): Receives fibers from substantia nigra and globus pallidus, projects to premotor cortex and supplementary motor cortex.
- Ventral posterior nucleus complex (VP): receives fibers from medial lemniscus, the gustatory pathways, the secondary trigeminal tracts, and part of the spinothalamic system; projects to the postcentral gyrus areas 3,2,1 or primary somatosensory cortex. Regulate the somatosensory and taste function.
  - Ventral posteriorlateral nucleus (VPL): whole body sensory except the head
  - Ventral posteriormedial nucleus (VPM): sensory of the head, taste fibers from the nucleus of the solitary tract.
- Medial geniculate body (MGB): receives auditory impulses from inferior colliculus, projects to auditory cortex of the superior temporal gyrus.
- Lateral geniculate body (LGB): connected with optic radiations via geniculocalcarine tract and visual cortex.

Schematic View of Basal Ganglion, Thalamus, Hypothalamus

- Thalamic pain syndrome: e.g. tumor in the thalamus, causing a vague sense of pain without the ability to accurately localize it.
- Central Pain: involving the lesion of spinothalamic or trigeminothalamic tracts, resulting in spontaneous pain.
- Thalamic syndrome: e.g. stroke, combination of hemianesthesia with spontaneous pain and hemi...
Basal Ganglion, Thalamus, Hypothalamus

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Basal Ganglion, Thalamus, Hypothalamus – MR View

Hanes DE. Neuroanatomy, an atlas of structures, sections, and system, 1995.
Hypothalamus Connections

• Hypothalamus:
  – forms the floor and ventral part of the walls of the 3rd ventricle.
  – Major nuclei:
    • Suprachiasmatic nucleus: dorsal to the optic chiasm, receives input from the retina
    • Supraoptic and paraventricular nuclei: terminate in the posterior pituitary, where they secrete oxytocin and vasopressin into the systemic circulation.
    • Arcuate nucleus: regulating the anterior pituitary function.
  – Major connections:
    • limbic system (stria terminalis, ventral amygdalofugal pathway, fornix)
    • Autonomic system: fibers from paraventricular nucleus and lateral hypothalamus descend through medial forebrain bundle to visceral sensory neurons (nucleus solitarius) and preganglionic parasympathetic nuclei in the brainstem (dorsal motor nucleus of the vagus and nucleus ambiguus) and to both sympathetic and parasympathetic cell groups in the spinal cord.
    • Reticular formation: to regulate the sleep-wakefulness rhythm.

Hypothalamus Function

- **Endocrine: hypothalamic-pituitary relationships**
  - Supraoptic and paraventricular nuclei: producing peptide hormones oxytocin and vasopressin, transported via hypothalamohypophyseal tract, and secreted from posterior pituitary (neurohypophysis)

- **Reproductive physiology and behavior**
  - Arcuate nucleus and other parts of the periventricular zone of the hypothalamus producing peptide-releasing or inhibiting hormone, transported to the anterior pituitary, stimulate the release of ACTH, TSH, FSH, LH, GH, prolactin; inhibit the release of GH (somatostatin), prolactin.

- **Body temperature:**
  - Preoptic region and anterior hypothalamic area, integrate the autonomic reflexes (e.g. peripheral vasoconstriction, vasodilation and sweating), and somatic motor or behavioral response (e.g., shivering, seeking a warmer or cooler environment) to regulate body temperature at 37°C.

- **Food intake:**
  - Ventromedial nucleus: the satiety center, lesion of it causes obese due to overeating
  - Lateral hypothalamus: the feeding center for eating and drinking, lesion of it causes death due to lack of water and nourishment.

- **Emotion:**
  - Involving connection to cerebral cortex, amygdala or the hippocampal formation.
  - Regulating the autonomic discharge: acceleration of the heart rate, elevation of blood pressure, flushing or pallor of the skin, sweating, dryness of the mouth, disturbances of the gastrointestinal tract.


*Berlit P. Memorix of Neurology. 1996.*

*UCLA Orofacial Pain Lecture Series # 2 – March 17th 2011*
Hypothalamus – Pituitary Axis
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The anterior lobe is site of formation and storage of 6 hormones: 4 messenger hormones that act on other endocrine glands:

- ACTH (→ adrenals; ↑ Cushing’s syndrome, ↓ Addison’s disease)
- TSH (→ thyroid: hyper-, hypothyroidism)
- FSH (→ gonads)
- LH (→ gonads)

The two direct acting hormones act on other systems or whole organism:

- GH (→ all cells of body: ↑ gigantism or acromegaly)
- Prolactin (→ many cells: ↑ galactorrhoea, secondary amenorrhoea; impotence, gynaecomastia)

Control of release of all anterior lobe hormones is exclusively humoral via 6 hypothalamic neurohormones (table below)

ACTH: adrenocorticotropic hormone (corticotrophin); TSH: thyroid stimulating hormone (thyrotrophin); FSH: follicle stimulating hormone; LH: luteinising hormone (both FSH and LH are gonadotrophins); GH: growth hormone, also STH: somatotropic hormone (somatotropin)

Berlit P. Memorix of Neurology. 1996.
Cerebellum Anatomy and MR View

Cerebellar Function

- Postural supporting (posture, tone, equilibration)
- Slower aimed movements and coordination with supportive postural measures
- Articulation, eye movement saccades, music performance, sport
Brainstem CT and MR View

Hanes DE. Neuroanatomy, an atlas of structures, sections, and system, 1995.
Brainstem Anatomy

Schematic View of Spinal Cord
Spinal Cord Traverse Section

C1  C7  T4

L4  Sacral

Hanes DE. Neuroanatomy, an atlas of structures, sections, and system, 1995.
Spine Anatomy and MR Saggital View


Osborn AG. Diagnostic neuroradiology 1994.