19

Hypothalamus

I. Overview — The Hypothalamus

—is a division of the diencephalon.
—lies within the floor and ventral part of the walls of the third ventricle,
—functions primarily in the **maintenance of homeostasis.**
—subserves three systems: the **autonomic nervous system** (ANS), the **endocrine system,** and the **limbic system.**

II. Surface Anatomy — The Hypothalamus (see Figures 1-2 and 1-5)

—is visible only from the ventral aspect of the brain.
—lies between the optic chiasm and the interpeduncular fossa (posterior perforated substance).
—lies below the hypothalamic sulcus.
—includes the following **ventral surface** structures:

A. Infundibulum

-is the stalk of the hypophysis.
-contains the hypophyseal portal vessels.
-contains the supraopticohypophyseal and tuberohypophyseal tracts.

B. Tuber cinereum

-is the prominence between the infundibulum and the mamillary bodies,
-includes the **median eminence,** which contains the **arcuate nucleus** (infundibular nucleus).

C. Mamillary bodies

-contain the **mamillary** nuclei.

D. Optic chiasm

-is the floor of the optic recess of the third ventricle.

E. Arterial circle of Willis

-surrounds the ventral surface of the hypothalamus and provides its blood supply.

III. Hypothalamic Regions and Nuclei

—the hypothalamus is divided into a lateral area and a medial area. These areas are separated by the fornix and the mamillothalamic tract.

A. Lateral hypothalamic area

-is traversed by the **medial forebrain bundle.**

—includes two major nuclei:

1. Lateral preoptic nucleus

-is the anterior telencephalic portion.

2. Lateral hypothalamic nucleus

-when stimulated, induces eating,
-lesions cause anorexia and starvation.

B. Medial hypothalamic area (Figure 19-1)

-includes the periventricular area that borders the third ventricle.
-is divided into four regions, from anterior to posterior:

1. Preoptic region

-is the anterior telencephalic portion.
-contains the **medial preoptic nucleus,** which regulates the release of gonadotropic hormones from the adenohypophysis. The medial preoptic nucleus contains the sexually dimorphic nucleus, whose development is dependent on testosterone levels.

2. Supraoptic region

-lies dorsal to the optic chiasm.

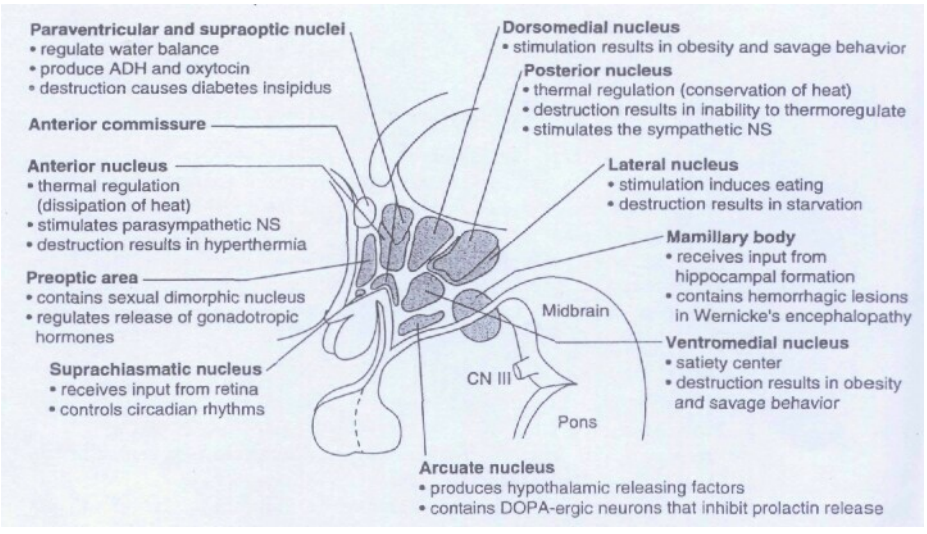

Figure 19-1. Major hypothalamic nuclei and their functions. (Reprinted with permission from Fix JD: *High-Yield Neuroanatomy.* Baltimore, Williams & Wilkins, 1995, p 84.)

a. Suprachiasmatic nucleus
-receives direct input from the retina.
-plays a role in the **control of circadian rhythms.**

b. Anterior nucleus
-plays a role in **temperature regulation.**
-stimulates the parasympathetic nervous system,
-destruction results in hyperthermia.

c. Paraventricular nucleus
-neurosecretory cells synthesize and release antidiuretic hormone (ADH), **oxytocin,** and corticotropin-releasing hormone **(CRH).**
-regulates water balance (conservation of water),
-gives rise to the supraopticohypophyseal tract, which projects to the neurohypophysis.
—destruction results in **diabetes insipidus.**

d. Supraoptic nucleus
-synthesizes **ADH** and **oxytocin.**
-projects to the neurohypophysis via the supraopticohypophyseal tract.

3. Tuberal region
—lies dorsal to the tuber cinereum.

a. Dorsomedial nucleus
-when stimulated in animals, results in savage behavior.

b. Ventromedial nucleus
—is considered a **satiety center.**
-when stimulated, inhibits the urge to eat.
-bilateral destruction results in hyperphagia, obesity, and savage behavior.

c. Arcuate (infundibular) nucleus
—is located in the tuber cinereum.
-is a periventricular nucleus.
-contains neurons that produce hypothalamic-releasing **factors** and gives rise to the tuberohypophyseal tract, which terminates in the hypophyseal portal system of the infundibulum.
-effects, via hypothalamic-releasing factors, the release—nonrelease of adenohypophyseal hormones into the systemic circulation.
-contains dopaminergic neurons; **dopamine** is the **prolactin-inhibiting factor** (PIF).

4. Mamillary region
-lies dorsal to the mamillary bodies.

a. Mamillary nuclei
-receive input from the hippocampal **formation** (specifically the subiculum) via the **fornix.**
-receive input from the dorsal and ventral tegmental nuclei and the raphe nuclei, via the mamillary peduncle,
-project to the anterior nucleus of the thalamus via the mamillothalamic tract,
-contain hemorrhagic lesions in Wernicke's encephalopathy.

b. Posterior nucleus
-plays a role in **thermal regulation** (i.e., conservation and increased production of heat),
—lesions result in **poikilothermia,** the inability to thermoregulate.

IV. Major Hypothalamic Connections (Figures 19-2 and 19-3)

A. Afferent connections to the hypothalamus
-derive from the following structures:

1. Septal **area and nuclei and** orbitofrontal **cortex**
-via the medial forebrain bundle
2. **Hippocampal formation**
-primarily from the subiculum via the fornix
3. **Amygdaloid complex**
-via the stria terminalis and ventral amygdalofugal pathway
4. **Primary olfactory cortex** (area **34)**
—via the medial forebrain bundle
5. **Mediodorsal nucleus of the** thalamus
-via the inferior thalamic peduncle
6. **Brainstem nuclei**
a. Tegmental nuclei (dorsal and ventral)
-project via the mamillary peduncle.

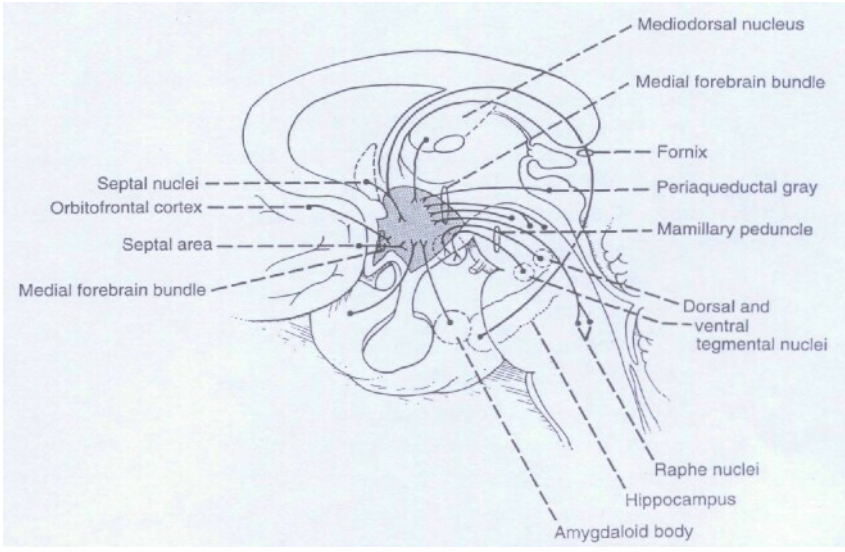

Figure 19-2. Major afferent (input) connections of the hypothalamus. The fornix projects from the hippocampal formation to the mamillary bodies. The medial forebrain bundle conducts afferent and efferent fibers.

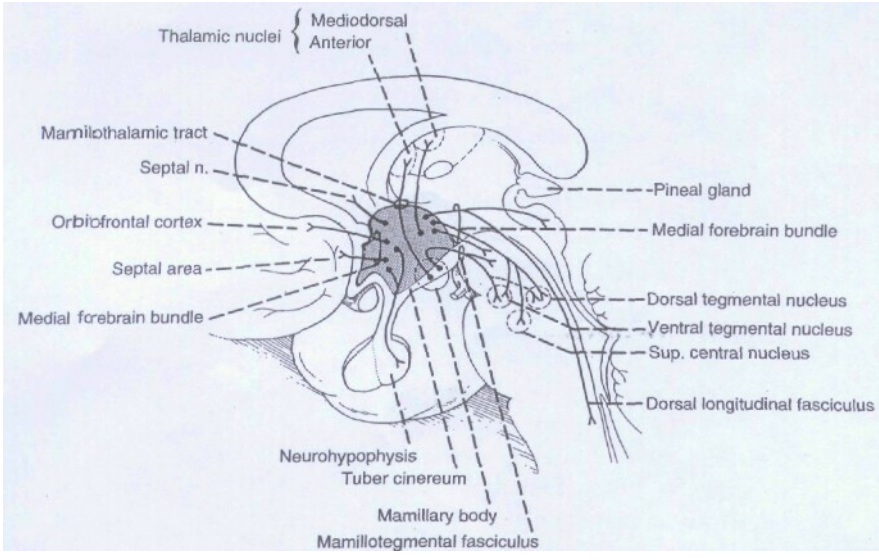

Figure 19-3. Major efferent (output) connections of the hypothalamus. The medial forebrain bundle conducts afferent and efferent fibers. The hypothalamus projects directly to the autonomlc visceral nuclei of the bralnstem and spinal cord.

b. Raphe nuclei (dorsal and superior central)
-project serotonergic fibers via the medial forebrain bundle and the mamillary peduncle (see Figure 22-4).

c. Locus ceruleus
-projects noradrenergic fibers via the medial forebrain bundle (see Figure 22-4).

B. Efferent connections from the hypothalamus

-project to the following structures:

1. **Septal area and nuclei**
   -via the medial forebrain bundle
2. **Anterior nucleus of the** thalamus
   -via the mamillothalamic tract
3. **Mediodorsal nucleus of the** thalamus
   -via the inferior thalamic peduncle
4. **Amygdaloid** complex
   -via the stria terminalis and the ventral amygdalopetal pathway
5. Brainstem nuclei **and spinal cord**
   -via the dorsal longitudinal fasciculus and the medial forebrain bundle
6. **Adenohypophysis**
   -via the tuberohypophyseal tract and hypophyseal portal system

7. Neurohypophysis
-via the supraopticohypophyseal tract

V. Major Fiber Systems

A. Fornix (see Figures 1-4, 1-5, 19-1, 20-3, and 20-5)
-has five parts: the **alveus, fimbria, crus, body, and column.**
-projects from the hippocampal formation to the mamillary nucleus, anterior nucleus of the thalamus, and septal area.
-is the largest projection to the hypothalamus.

B. Medial forebrain bundle (see Figures 19-2 and 19-3)
-traverses the entire lateral hypothalamic area.
—interconnects the septal area and nuclei, the hypothalamus, and the midbrain tegmentum.

C. Mamillothalamic tract (see Figure 20-3)
—projects from the mamillary nuclei to the anterior nucleus of the thalamus.

D. Mamillary peduncle (see Figure 19-2)
-conducts fibers from the dorsal and ventral tegmental nuclei and the raphe nuclei to the mamillary body.

E. Mamillotegmental tract (see Figure 19-3)
-conducts fibers from the mamillary nuclei to the dorsal and ventral tegmental nuclei.

F. Stria terminalis (see Figure 20-3)
-is the most prominent pathway from the amygdaloid complex.
-interconnects the septal area, the hypothalamus, and the amygdaloid complex.
—lies in the sulcus terminalis between the caudate nucleus and the thalamus.

G. Ventral amygdalofugal pathway (see Figure 20-3)
—interconnects the amygdaloid complex and the hypothalamus.

H. Supraopticohypophyseal tract (Figure 19-4)
-conducts fibers from the supraoptic and paraventricular nuclei to the **neurohypophysis** (the release site for ADH and oxytocin).

I. Tuberohypophyseal (tuberoinfundibular) tract (see Figure 19-4)
—conducts fibers from the arcuate nucleus to the hypophyseal portal system of the infundibulum.

J. Dorsal longitudinal fasciculus (see Figure 19-3)
—extends from the hypothalamus to the caudal medulla,
-projects to the parasympathetic nuclei of the brainstem.

K. Hypothalamospinal tract
—contains direct descending autonomic fibers that influence preganglionic sympathetic neurons of the intermediolateral cell column and preganglionic neurons of the sacral parasympathetic nucleus.
-interruption above Tl results in Horner's syndrome.

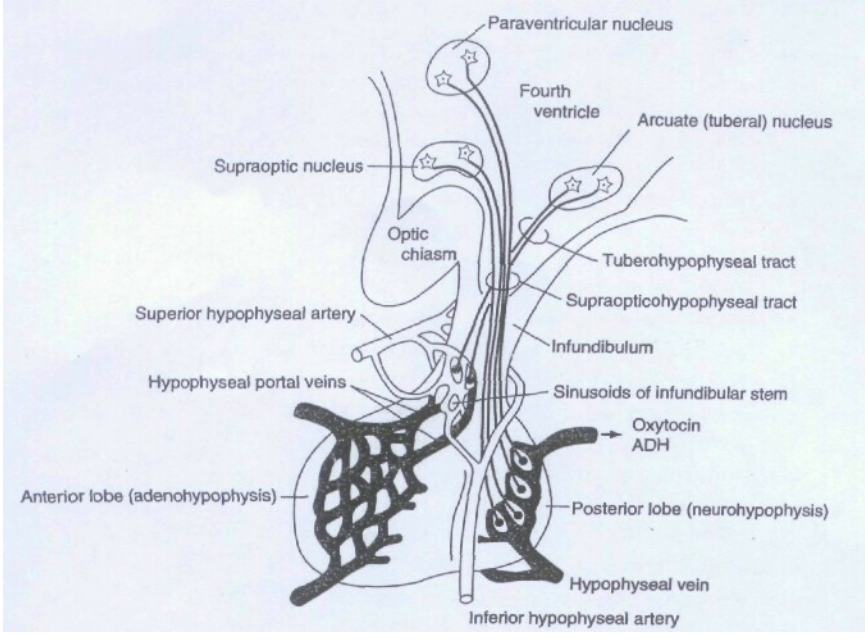

Figure 19-4. The hypophyseal portal system. The paraventricular and supraoptic nuclei produce antidiuretic hormone (ADH) and oxytocin and transport the substances via the supraopticohypophyseal tract to the capillary bed of the neurohypophysis. The arcuate nucleus of the infundibulum transports releasing hormones via the tuberohypophyseal tract to the sinusoids of the infundibular stem, which drain into the secondary capillary plexus in the adenohypophysis. (Reprinted with permission from Fix JD: *High-Yield Neuroanatomy.* Baltimore, Williams & Wilkins. 1995, p 85.)

VI. Functional Considerations

A. Autonomic function

-the ANS is regulated by hypothalamic nuclei.

1. Anterior hypothalamus

-has an excitatory effect on the parasympathetic nervous system.

2. Posterior hypothalamus

-has an excitatory effect on the sympathetic nervous system.

B. Temperature regulation

1. Anterior hypothalamus

-helps **regulate and maintain body temperature.**
-destruction causes **hyperthermia.**

2. Posterior hypothalamus

-helps **produce and conserve heat.**
-destruction causes the **inability to thermoregulate.**

C. Water **balance regulation**

-ADH controls water excretion by the kidneys.

D. Food intake regulation

-two hypothalamic nuclei play roles in the control of appetite:

1. Ventromedial nucleus (see III B 3 b)

2. Lateral hypothalamic nucleus

-is called the **hunger or feeding center.**

-destruction causes **starvation and emaciation.**

E. Hypothalamic-releasing and release-inhibiting factors

-are produced in the **arcuate nucleus** of the median eminence.

-are transported via the tuberohypophyseal tract to the hypophyseal portal system.

—effect the release—nonrelease of adenohypophyseal hormones.

-are, with the exception of dopamine, **peptides** (hypophysiotropins), which include:

1. Thyrotropin-releasing hormone **(TRH)**
2. Gonadotropin-releasing hormone **(GnRH)**
3. **Somatostatin** (growth hormone-inhibiting hormone)
4. Growth hormone-releasing hormone **(GHRH)**
5. Corticotropin-releasing hormone (CRH)
6. Prolactin-inhibiting factor (PIF) and prolactin-releasing factor (PRF) [PIF is dopamine.]

VII. Clinical Considerations

A. Craniopharyngioma

-is a congenital epidermoid tumor thought to originate from remnants of Rathke's pouch,

-is usually calcined.

—is the most common **supratentorial tumor** found in children,

—pressure on the chiasm results in a **bitemporal hemianopia.**

-pressure on the hypothalamus causes **hypothalamic syndrome** with adiposity, diabetes insipidus, disturbance of temperature regulation, and somnolence.

B. Pituitary adenoma

-constitutes 15% of cases of clinically symptomatic **intracranial tumors.**

—is rarely seen in children.

-when endocrine-active, produces endocrine abnormalities (e.g., amenorrhea and galactorrhea from a prolactin-secreting adenoma, the most common type),

—pressure on the chiasm results in a **bitemporal hemianopia** (most cases show asymmetry of field defects),

-pressure on the hypothalamus may cause **hypothalamic syndrome.**

C. Wernicke's encephalopathy

-is due to a thiamine (B_1) deficiency.

-is characterized by the triad: **ocular** palsies, **ataxic gait,** and mental **confusion.**

-lesions are found in the hypothalamus (primarily in the mamillary bodies) and in the periaqueductal gray of the midbrain.