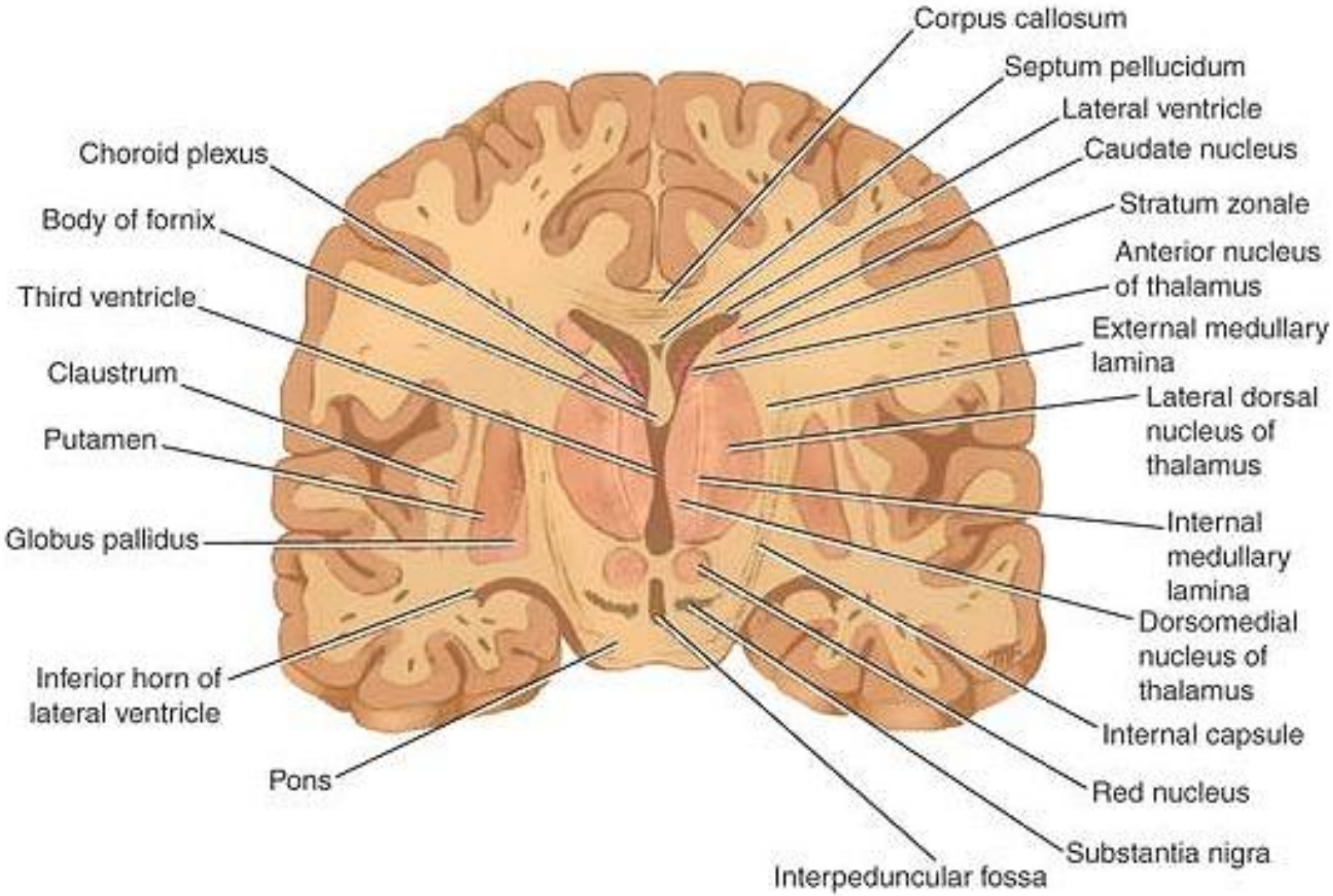
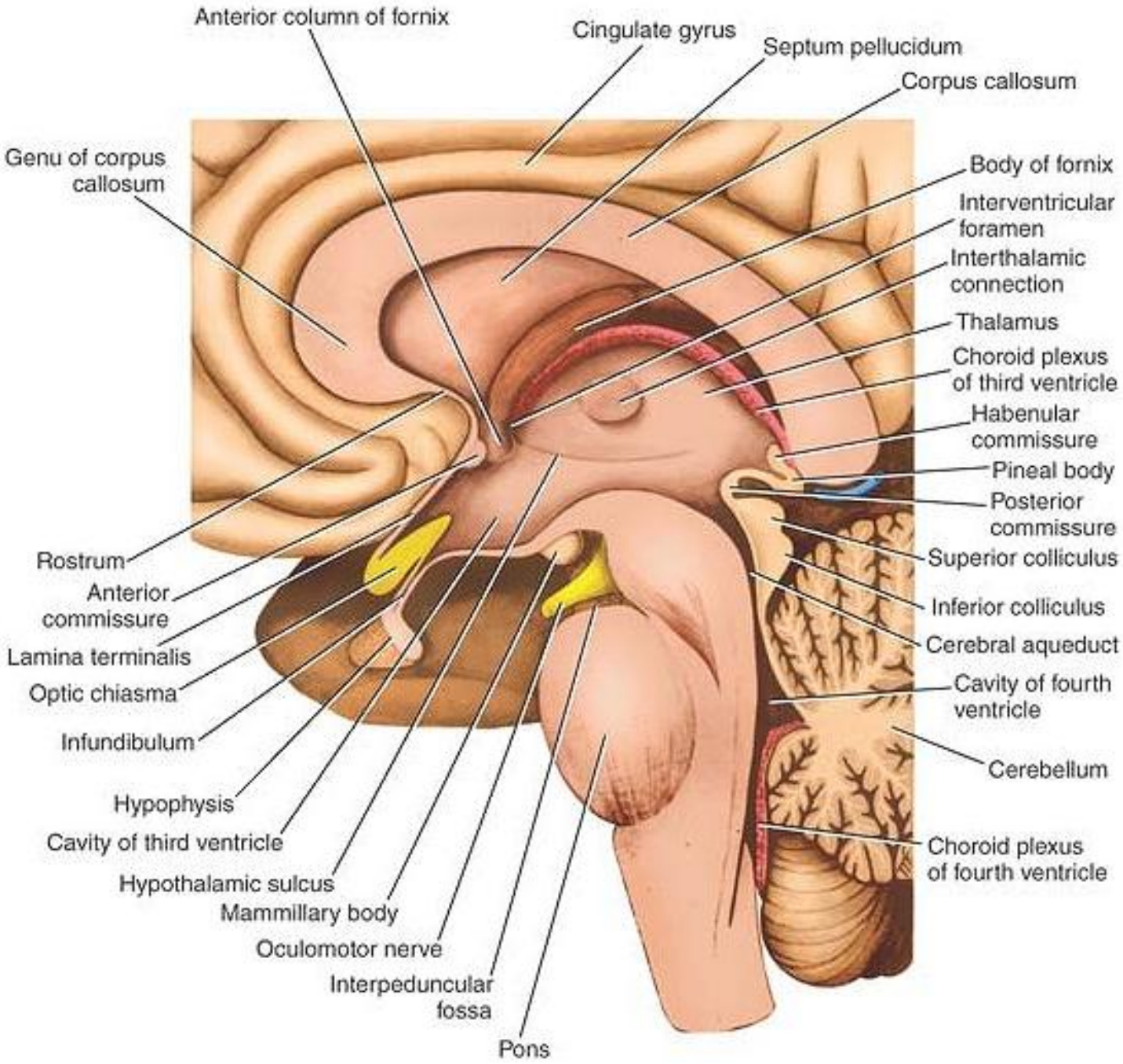
Lecture 14

Thalamus and Hypothalamus



Coronal section of the cerebral hemispheres showing the position and relations of the thalamus.


Anterior column of fornix
Cingulate gyrus
Septum pellucidum
Corpus callosum
Genu of corpus callosum
Body of fornix
Interventricular foramen
Interthalamic connection
Thalamus
Choroid plexus of third ventricle
Habenular commissure
Pineal body
Posterior commissure
Superior colliculus
Inferior colliculus
Cerebral aqueduct
Cavity of fourth ventricle
Cerebellum
Choroid plexus of fourth ventricle
Rostrum
Anterior commissure
Lamina terminalis
Optic chiasma
Infundibulum
Hypophysis
Cavity of third ventricle
Hypothalamic sulcus
Mammillary body
Oculomotor nerve
Interpeduncular fossa
Pons

Thalamus

The thalamus is situated at the rostral end of the brainstem and functions as an important relay and integrative station for information passing to all areas of the cerebral cortex, the basal ganglia, the hypothalamus, and the brainstem

General Appearances of the Thalamus

- a large, egg-shaped mass of gray matter that forms the major part of the diencephalon.
- There are two thalami, one is situated on each side of the third ventricle
- anterior end of the thalamus is narrow and rounded and forms the posterior boundary of the interventricular foramen.
- posterior end is expanded to form the pulvinar, which overhangs the superior colliculus
- inferior surface is continuous with the tegmentum of the midbrain
- The medial surface of the thalamus forms part of the lateral wall of the third ventricle and is usually connected to the opposite thalamus by a band of gray matter, the interthalamic connection (interthalamic adhesion).

Subdivisions of the Thalamus

Anterior Part

contains the anterior thalamic nuclei

Medial Part

contains the large dorsomedial nucleus and several smaller nuclei

Lateral Part

The nuclei are subdivided into:

- a dorsal tier (the lateral dorsal nucleus, the lateral posterior nucleus, and the pulvinar) and
- a ventral tier (consists of Ventral anterior nucleus, Ventral lateral nucleus Ventral posterior nucleus)

Other Nuclei of the Thalamus

the intralaminar nuclei, the midline nuclei, the reticular nucleus, and the medial and lateral geniculate bodies

Table 12-1 The Various Thalamic Nuclei, Their Nervous Connections, and Their Functions

Thalamic Nucleus	Afferent Neuronal Loop	Efferent Neuronal Loop	Function
Anterior	Mammillothalamic tract, cingulate gyrus, hypothalamus	Cingulate gyrus, hypothalamus	Emotional tone, mechanisms of recent memory
Dorsomedial	Prefrontal cortex, hypothalamus, other thalamic nuclei	Prefrontal cortex, hypothalamus, other thalamic nuclei	Integration of somatic, visceral, and olfactory information and relation to emotional feelings and subjective states
Lateral dorsal, lateral posterior, pulvinar	Cerebral cortex, other thalamic nuclei	Cerebral cortex, other thalamic nuclei	Unknown
Ventral anterior	Reticular formation, substantia nigra, corpus striatum, premotor cortex, other thalamic nuclei	Reticular formation, substantia nigra, corpus striatum, premotor cortex, other thalamic nuclei	Influences activity of motor cortex
Ventral lateral	As in ventral anterior nucleus but also major input from cerebellum and minor input from red nucleus		Influences motor activity of motor cortex
Ventral posteromedial (VPM)	Trigeminal lemniscus, gustatory fibers	Primary somatic sensory (areas 3, 1, and 2) cortex	Relays common sensations to consciousness

Ventral posterolateral (VPL)	Medial and spinal lemnisci	Primary somatic sensory (areas 3, 1, and 2) cortex	Relays common sensations to consciousness
Intralaminar	Reticular formation, spinothalamic and trigeminothalamic tracts	To cerebral cortex via other thalamic nuclei, corpus striatum	Influences levels of consciousness and alertness
Midline	Reticular formation	Unknown	Unknown
Reticular	Cerebral cortex, reticular formation	Other thalamic nuclei	? Cerebral cortex regulates thalamus
Medial geniculate body	Inferior colliculus, lateral lemniscus from both ears but predominantly the contralateral ear	Auditory radiation to superior temporal gyrus	Hearing
Lateral geniculate body	Optic tract	Optic radiation to visual cortex of occipital lobe	Visual information from opposite field of vision

Connections of the Thalamus

1) Every thalamic nucleus (except the reticular nucleus) connected to specific parts of the cerebral cortex and every part of the cerebral cortex sends fibers back to the thalamic nuclei
2) is an important relay station for two sensory-motor axonal loops involving the cerebellum and the basal nuclei

Functions of the Thalamus

A vast amount of sensory information of all types (except smell) converges on the thalamus and is integrated through the interconnections between the nuclei

The thalamus possesses certain very important nuclei

The ventroanterior and the ventrolateral nuclei of the thalamus form part of the basal nuclei circuit and thus are involved in the performance of voluntary movements

The intralaminar nuclei are closely connected with the activities of the reticular formation

The Hypothalamus

is the part of the diencephalon that extends from the region of the optic chiasma to the caudal border of the mammillary bodies. It lies below the thalamus and forms the floor and the inferior part of the lateral walls of the third ventricle

the hypothalamus is seen to be related to the following structures, from anterior to posterior:

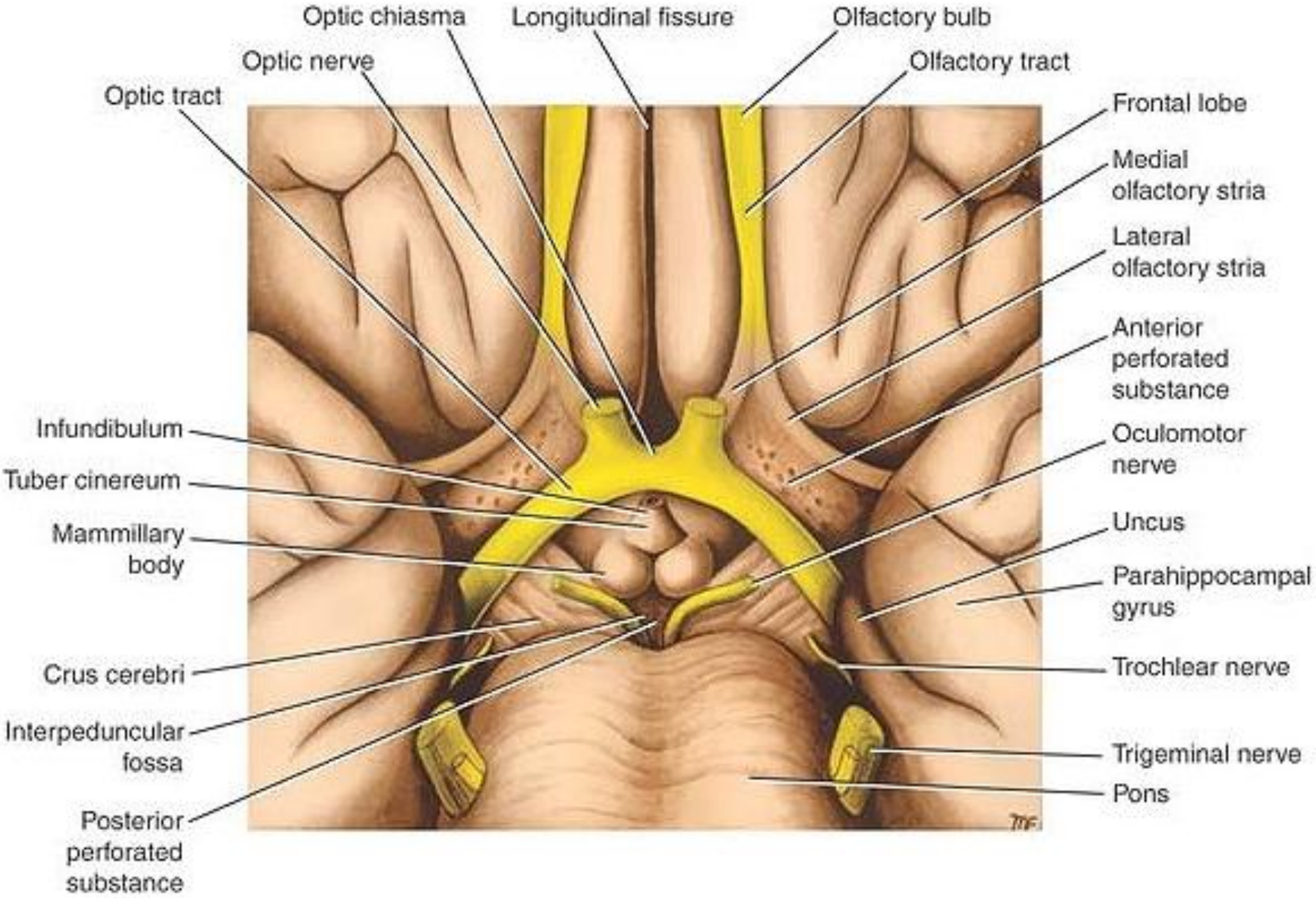
(1) the optic chiasma, (2) the tuber cinereum and infundibulum and (3) the mammillary bodies

Hypothalamic Nuclei

the hypothalamus is composed of small nerve cells that are arranged in groups or nuclei

They devided into:

- Medial Zone
- Lateral Zone


Optic chiasma
Longitudinal fissure
Olfactory bulb
Optic nerve
Olfactory tract
Optic tract
Frontal lobe
Medial olfactory stria
Lateral olfactory stria
Anterior perforated substance
Infundibulum
Oculomotor nerve
Tuber cinereum
Uncus
Mammillary body
Parahippocampal gyrus
Crus cerebri
Trochlear nerve
Interpeduncular fossa
Trigeminal nerve
Pons
Posterior perforated substance

Hypothalamic Lines of Communication

The hypothalamus receives information from the rest of the body through

(1) nervous connections

(2) the blood stream

(3) cerebrospinal fluid

The neurons of the hypothalamic nuclei respond and exert their control via the same routes. The cerebrospinal fluid may serve as a conduit between the neurosecretory cells of the hypothalamus and distant sites of the brain.

Afferent Nervous Connections of the Hypothalamus

- Somatic and visceral afferents
- Visual afferents
- Olfaction travels.
- Auditory afferents.
- Corticohypothalamic fibers
- Hippocampohypothalamic fibers
- Amygdalohypothalamic fibers
- Thalamohypothalamic fibers
- Tegmental fibers

Efferent Nervous Connections of the Hypothalamus

1) Descending fibers to the brainstem and spinal cord
2) The mammillothalamic tract
3) The mammillotegmental tract
4) Multiple pathways to the limbic system

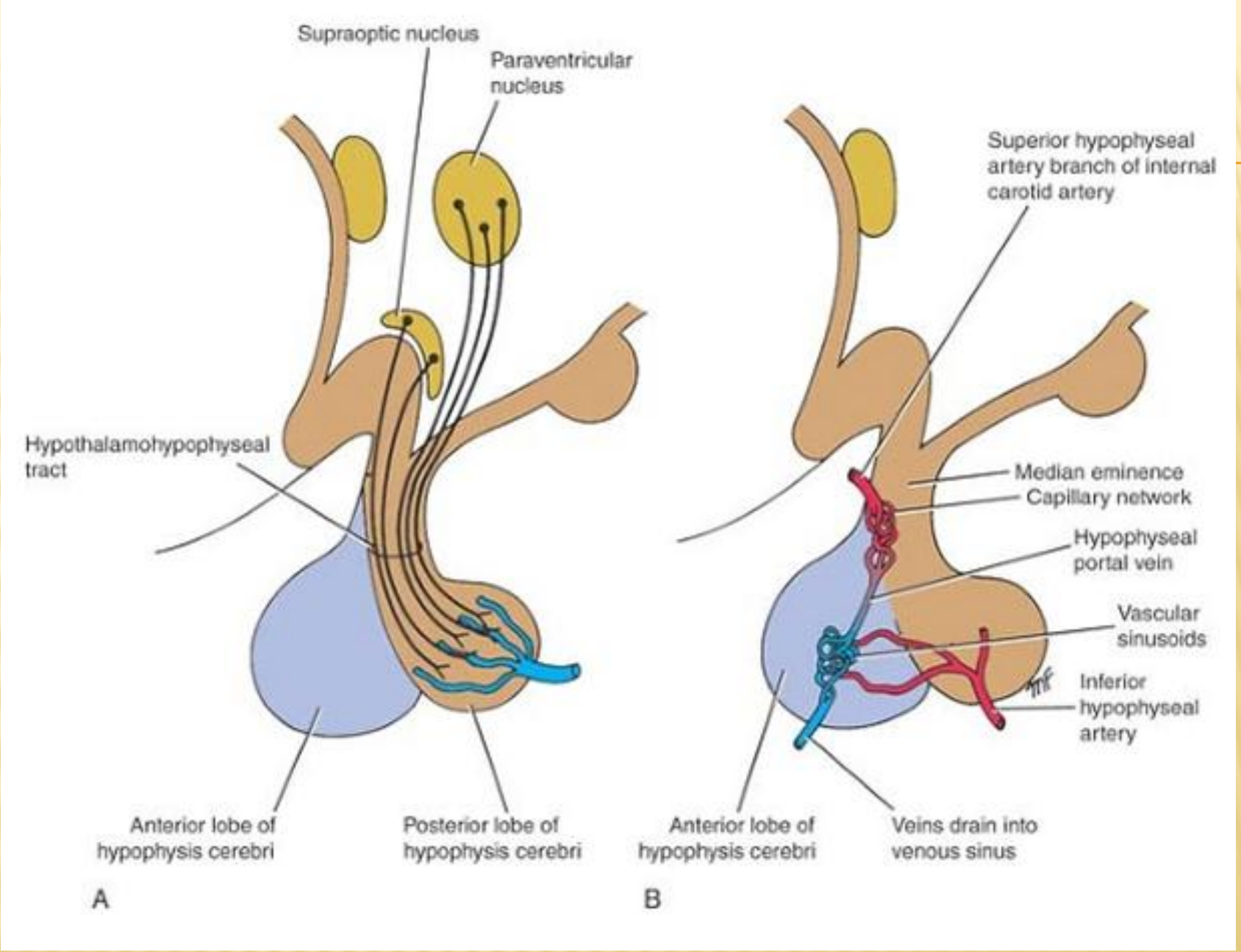
Connections of the Hypothalamus With the Hypophysis Cerebri

1- nerve fibers that travel from the supraoptic and paraventricular nuclei to the posterior lobe of the hypophysis

2- long and short portal blood vessels that connect sinusoids in the median eminence and infundibulum with capillary plexuses in the anterior lobe of the hypophysis

Table 13-2 The Hypothalamic Releasing and Inhibitory Hormones and Their Effects on the Anterior Lobe of the Hypophysis (Pituitary)

Hypothalamic Regulatory Hormone	Anterior Pituitary Hormone	Functional Result
Growth hormone-releasing hormone (GHRH)	Growth hormone (GH)	Stimulates linear growth in epiphyseal cartilages
Growth hormone-inhibiting hormone (GHIH) or somatostatin	Growth hormone (reduced production)	Reduces linear growth in epiphyseal cartilages
Prolactin-releasing hormone (PRH)	Prolactin (luteotropic hormone, LTH)	Stimulates lactogenesis
Prolactin-inhibiting hormone (PIH), dopamine	Prolactin (luteotropic hormone, LTH) (reduced production)	Reduces lactogenesis
Corticotropin-releasing hormone (CRH)	Adrenocorticotropic hormone (ACTH)	Stimulates adrenal gland to produce corticosteroids and sex hormones
Thyrotropin-releasing hormone (TRH)	Thyroid-stimulating hormone (TSH)	Stimulates thyroid gland to produce thyroxine
Luteinizing hormone-releasing hormone (LHRH), ? follicle-stimulating releasing hormone (FRH)	Luteinizing hormone (LH) and follicle-stimulating hormone (FSH)	Stimulates ovarian follicles and production of estrogen and progesterone



A: Hypothalamohypophyseal tract. B: Hypophyseal portal system

Functions of the Hypothalamus

- Autonomic Control, has a controlling influence on the autonomic nervous system and appears to integrate the autonomic and neuroendocrine systems
- Endocrine Control, by producing the releasing factors or release-inhibiting factors
- Neurosecretion, secretion of vasopressin and oxytocin
- Temperature Regulation
- Regulation of Food and Water Intake
- Emotion and Behavior, Emotion and behavior are a function of the hypothalamus, the limbic system, and the prefrontal cortex
- Control of Circadian Rhythms