

The Endocrine System

Hypothalamus and pituitary gland

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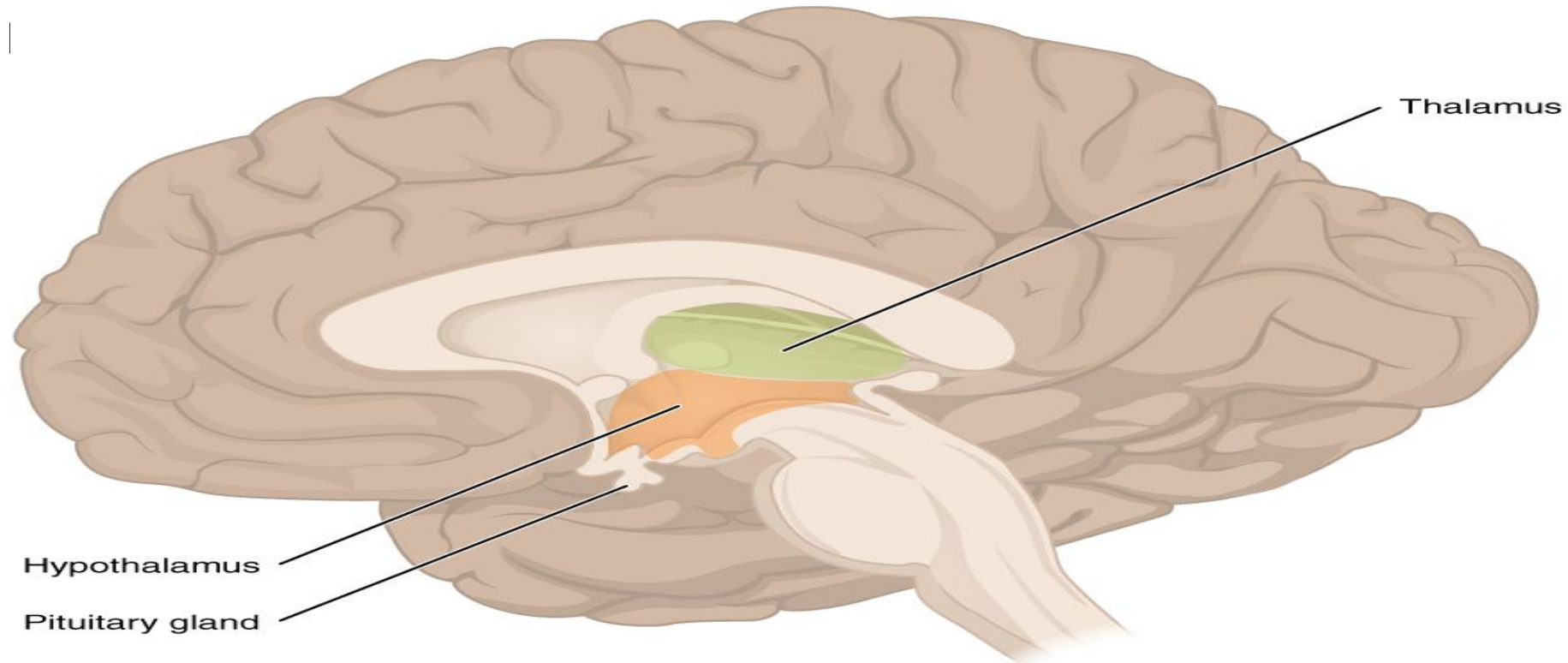


Hypothalamus

- _ The hypothalamus is a collection of various nuclei within the diencephalon in the center of the brain.
- _ The hypothalamus plays a vital role in endocrine regulation as the primary regulator of the pituitary gland, and it is the major point of integration between the central nervous and endocrine systems.
- _ Different nuclei within the hypothalamus play roles in hormone regulation and secretion, autonomic regulation, thermoregulation, food and water intake, sleep and circadian rhythms, memory, and emotional behavior.
- _ The hypothalamus has both neural and circulatory connections with the pituitary gland. Abnormalities in the hypothalamus can lead to a wide range of clinical conditions.

Gross Anatomy

- _ Located in the center of the brain
- _ Just superior to the brain stem
- _ Forms part of the walls and floor of the 3rd ventricle
- _ Symmetrical; has |



<u>Boundary</u>	<u>Structures</u>
Superior	•Thalamus •Floor of the 3rd ventricle
Anterior	•Anterior commissure •Lamina terminalis
Lateral	Cerebral hemispheres
Medial	Medial 3rd ventricle
Posterior	•Posterior commissure •Aqueduct of Sylvius
Inferior	•Optic chiasm •Pituitary (hypophyseal) stalk and gland •Brain stem

Connections with the pituitary gland

_ The hypothalamus is the primary regulator of the pituitary. The hypothalamus is therefore key in converting and integrating nerve signals with endocrine signals.

_ The hypothalamus is connected to the pituitary in 2 ways: via nerve fibers and via the circulation.

_ Nerve fiber connections: the hypothalamohypophyseal tract

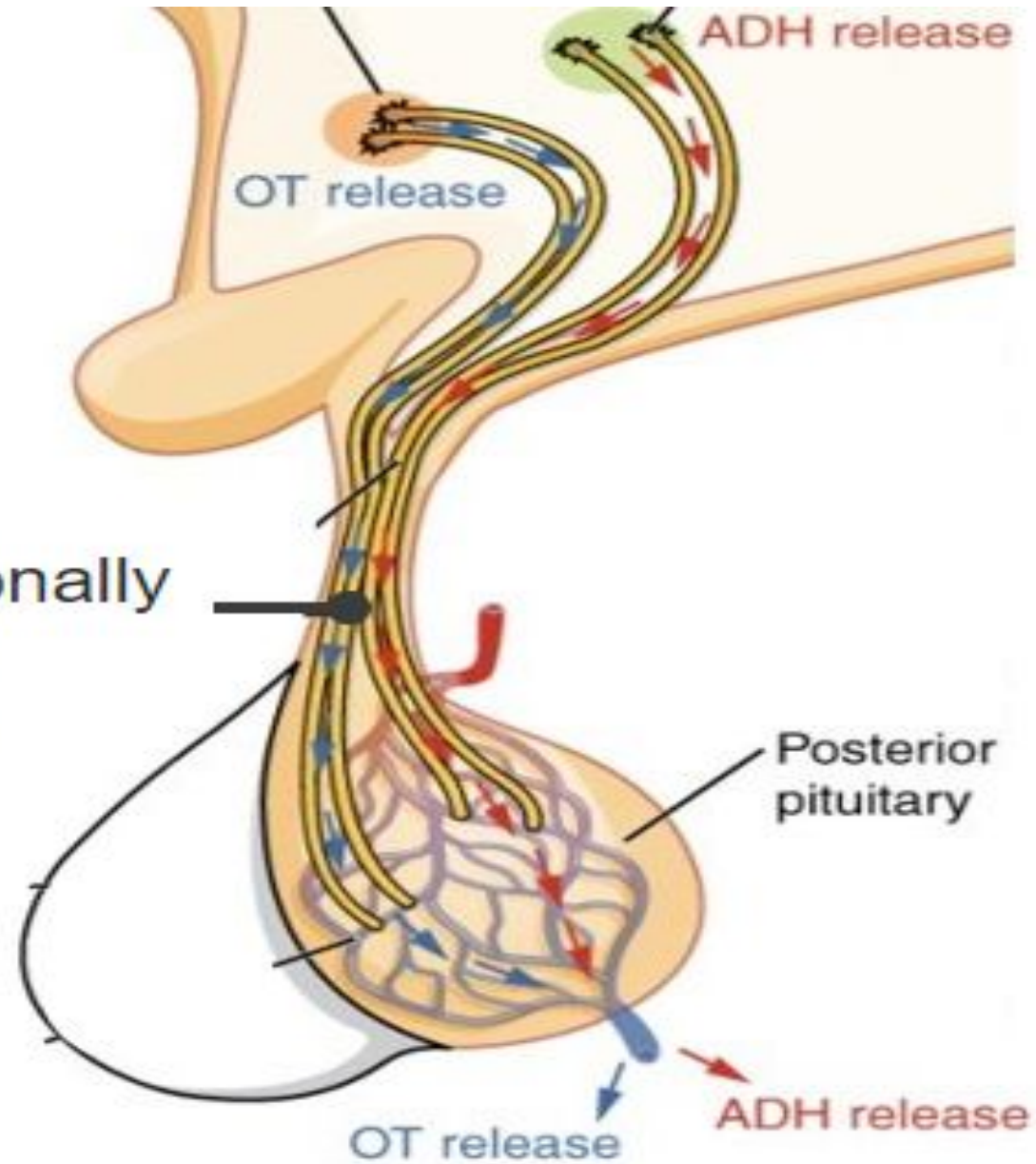
Neurons in the paraventricular and supraoptic nuclei have direct projections that end in the posterior pituitary.

Secretions include:

_ Paraventricular nuclei: primarily produce oxytocin (stimulate uterine contractions in labor and milk release during lactation)

_ Supraoptic nuclei: primarily produce antidiuretic hormone (ADH; a vasoconstrictor that stimulates ↑ absorption of water from the renal tubules)

Hormones are transported axonally to the posterior pituitary via the pituitary stalk.



_ **Bloodstream connections: the hypothalamohypophyseal portal system**

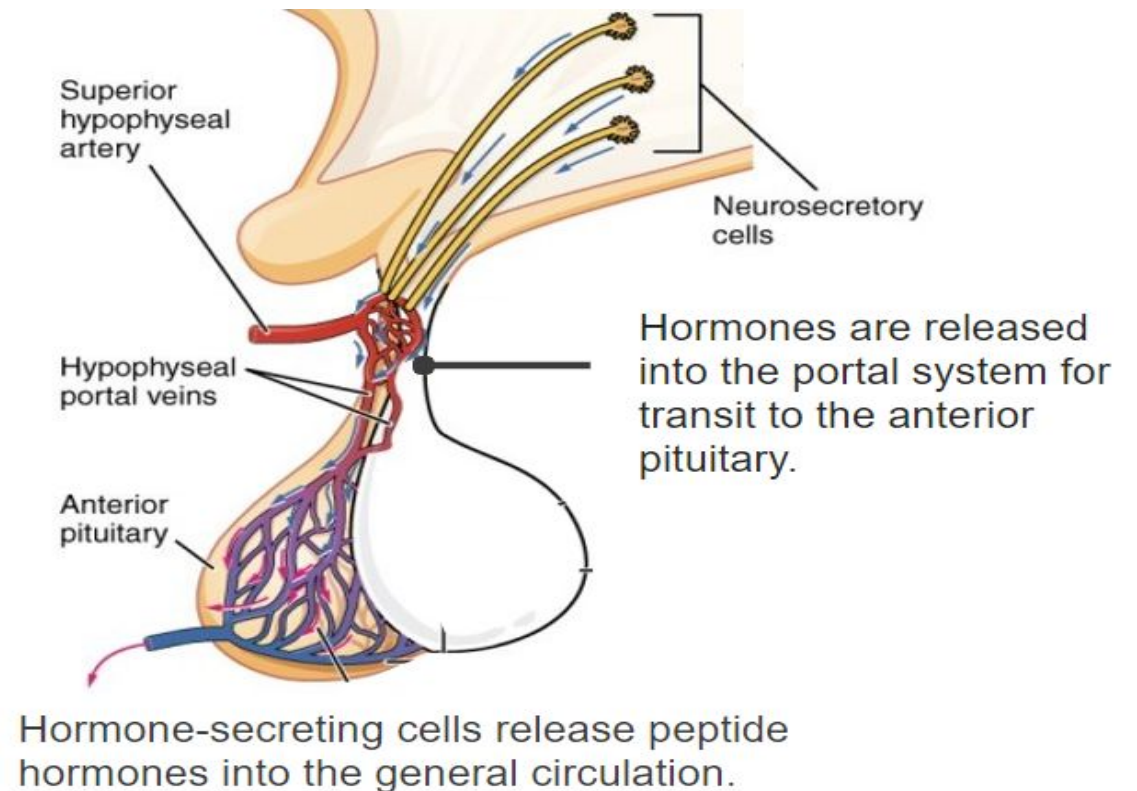
- _ Formed from branches off the internal carotid arteries
- _ Arteries travel through the median eminence (the pituitary “stalk”) → capillaries
- _ Capillaries surround cells within the anterior lobe of the pituitary.

_ Releasing hormones:

Corticotropin-releasing hormone (CRH)
Thyrotropin-releasing hormone (TRH)
Gonadotropin-releasing hormone (GnRH)
Growth hormone–releasing hormone (GHRH)

_ Release-inhibiting hormones:

Somatostatin
Dopamine



table

7.1

Master List of Hormones

Hormone	Abbreviation	Gland of Origin	Major Action*
Thyrotropin-releasing hormone	TRH	Hypothalamus	Stimulates secretion of TSH and prolactin
Corticotropin-releasing hormone	CRH	Hypothalamus	Stimulates secretion of ACTH
Gonadotropin-releasing hormone	GnRH	Hypothalamus	Stimulates secretion of LH and FSH
Growth hormone–releasing hormone	GHRH	Hypothalamus	Stimulates secretion of growth hormone
Somatotropin release–inhibiting hormone (somatostatin)	SRIF	Hypothalamus	Inhibits secretion of growth hormone
Prolactin-inhibiting factor (dopamine)	PIF	Hypothalamus	Inhibits secretion of prolactin

Hypothalamic control of the anterior pituitary

_ The hypothalamus secretes **releasing factors** that are transported to the anterior pituitary via the **hypophyseal portal system** (a vascular complex connecting the hypothalamus to the pituitary).

Stimulatory hypothalamic hormones:

- _ **TRH** → stimulates pituitary thyrotropic cells to release TSH
- _ **Corticotropin-releasing hormone (CRH)** → stimulates pituitary corticotropic cells to release adrenocorticotrophic hormone (ACTH)
- _ **Gonadotropin-releasing hormone (GnRH)** → stimulates pituitary gonadotropic cells to release:
 - _ Follicle-stimulating hormone (FSH)
 - _ Luteinizing hormone (LH)
- _ **Growth hormone-releasing hormone (GHRH)** → stimulates pituitary somatotropic cells to release growth hormone (GH)

Inhibitory hypothalamic hormones:

Somatostatin:

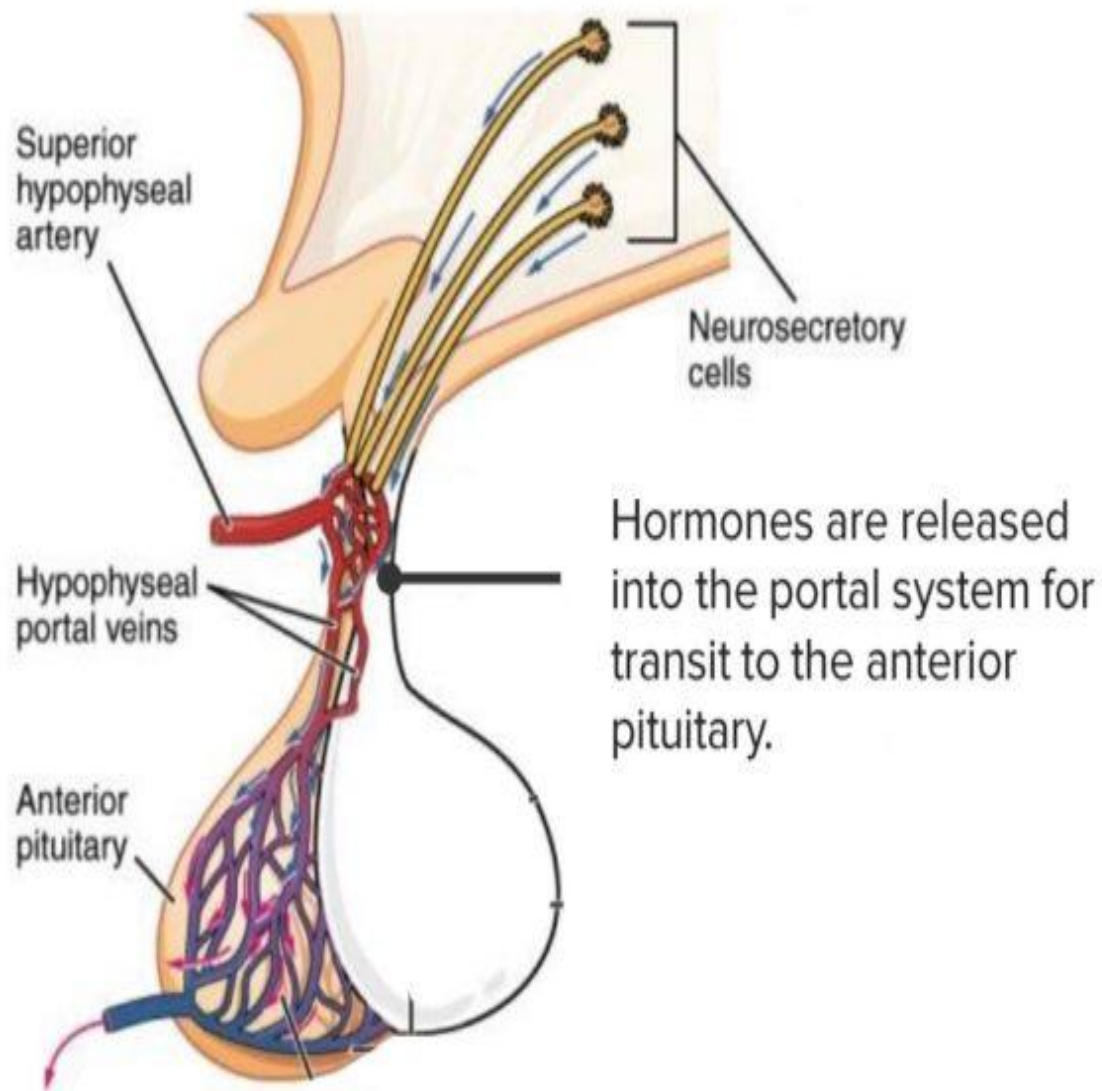
- _ At the anterior pituitary gland, somatostatin inhibits:
 - GH
 - TSH

Dopamine:

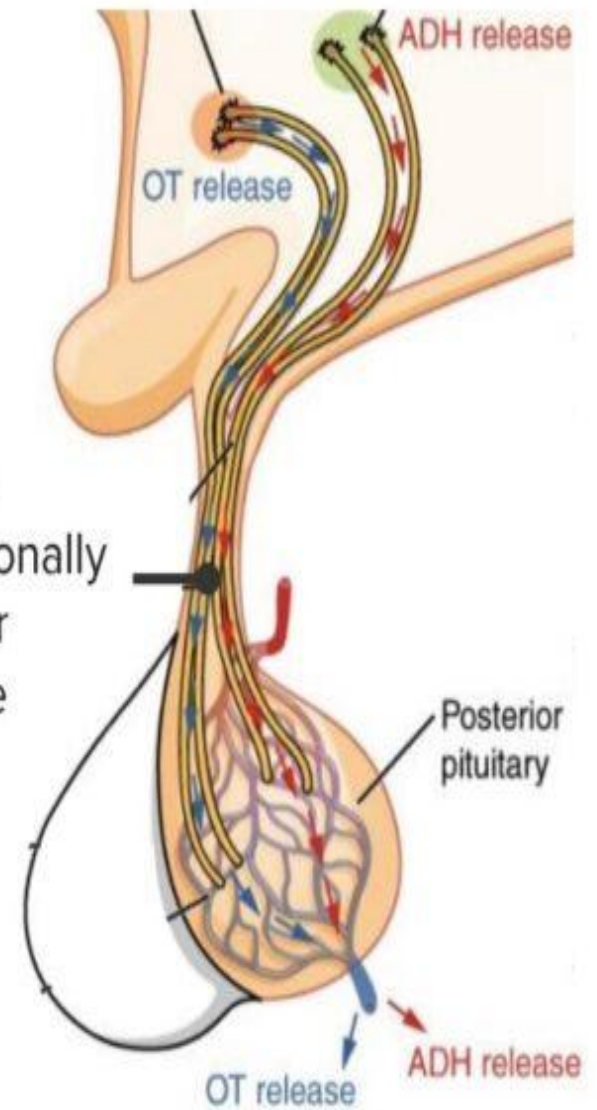
- Inhibits prolactin (PRL) release

Hypothalamic control of the posterior pituitary

- _ Unlike the anterior pituitary, there are no hypothalamic hormones released into the circulation to stimulate the posterior pituitary. Rather, the hypothalamus has axons directly connected to the posterior pituitary.
- _ Posterior pituitary hormones are synthesized within the neuronal cell bodies in the hypothalamus.
- _ Posterior pituitary hormones are transported down the neuronal axons, through the hypophyseal stalk, to the posterior pituitary.
- _ The hormones are released into the circulation within the posterior pituitary.



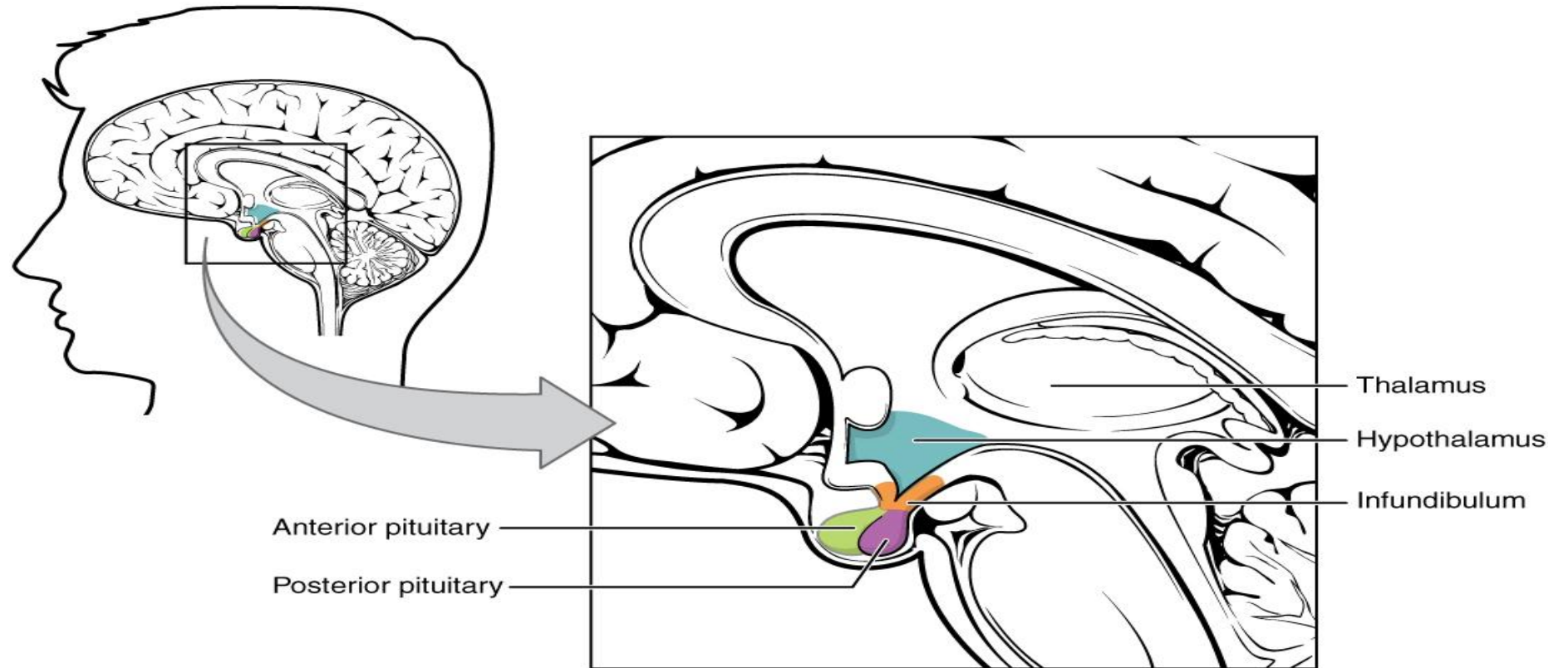
Hormones are transported axonally to the posterior pituitary via the pituitary stalk.



The Pituitary Gland

Location

- _ Located in the sella turcica of the sphenoid bone
- _ Just below the optic chiasm
- _ Connected to the hypothalamus by the pituitary stalk
- _ Lies outside the dura



General structure

_ The pituitary gland is divided into 2 primary components:

- Adenohypophysis (also known as the anterior pituitary)
- Neurohypophysis (also known as the posterior pituitary)

_ The 2 halves function independently, as 2 separate glands, each with their own:

- Embryologic origins
- Anatomy
- Connections to the hypothalamus
- Regulatory controls
- Functions

Histology Of Pituitary Gland

1 Adenohypophysis (anterior pituitary)

General characteristics:

- Glandular portion of the pituitary
- Consists of endocrine cells and dense capillary networks
- Endocrine cells get their stimulation from hypothalamic hormones secreted into the primary capillaries of the hypothalamohypophyseal portal system.

Chromophils:

•Basophils:

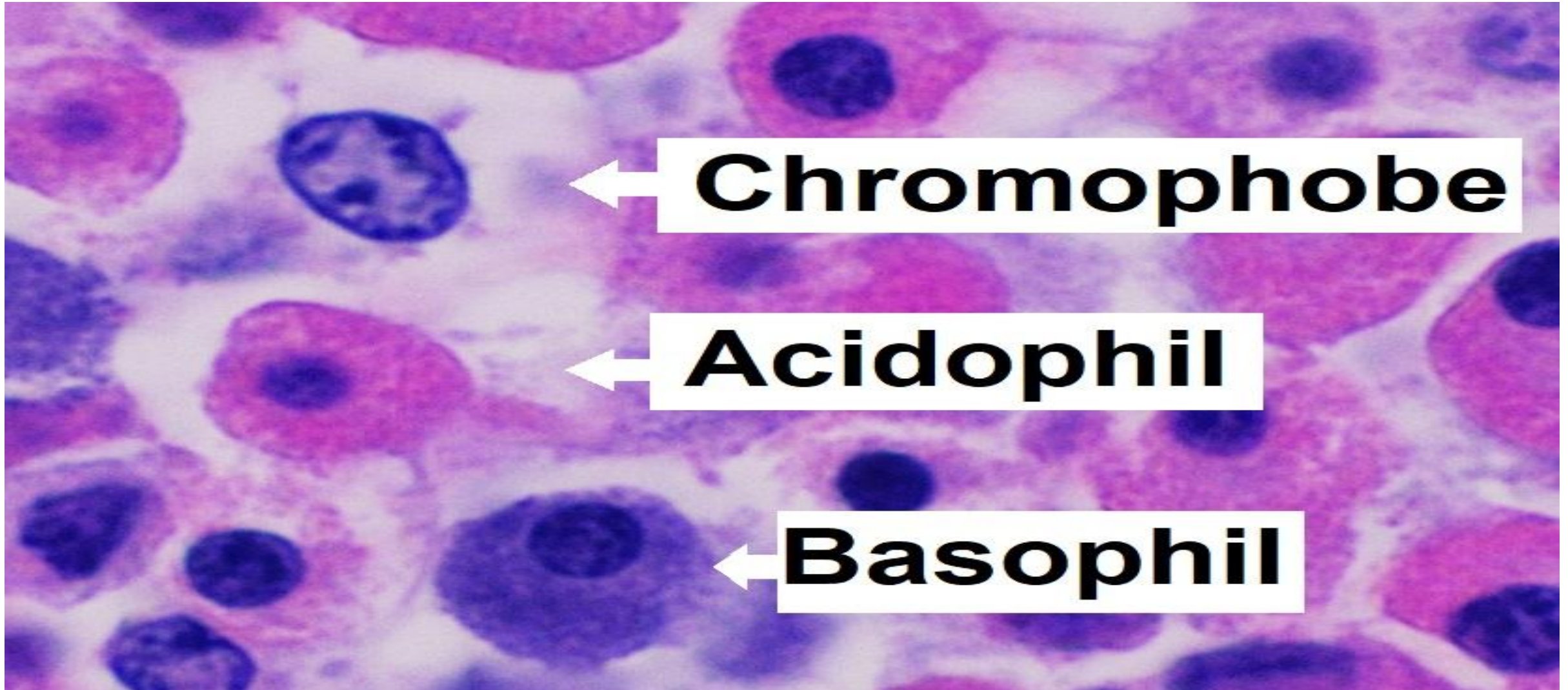
- Corticotropes:
 - Release adrenocorticotrophic hormone (ACTH)
 - 15%–20% of endocrine cells
- Thyrotropes:
 - Release thyroid-stimulating hormone (TSH)
 - 5% of endocrine cells
- Gonadotropes:
 - Release luteinizing hormone (LH) and follicle-stimulating hormone (FSH)
 - 10% of endocrine cells

•Acidophils:

- Lactotropes:
 - Release prolactin
 - 15%–20% of endocrine cells
- Somatotropes:
 - Release growth hormone (GH)
 - 50% of endocrine cells

Chromophobes:

- Cells that do not take up stain well
- Function is unclear.



2 Neurohypophysis (posterior pituitary)

_ The neurohypophysis is filled with the terminal axons of neurosecretory cells, supporting cells known as pituicytes, and dense networks of fenestrated capillaries.

- Neurosecretory cells (nerve cells):

- Cell bodies are within the hypothalamus.
- Unmyelinated axons travel down the pituitary stalk.
- Axon terminals are located within the posterior pituitary.

- Herring bodies:

- The axon terminals containing vesicles of stored secretory products (oxytocin and ADH) waiting to be released
- Appear histologically as eosinophilic swellings

- Pituicytes:

- Nerve cells similar to astrocytes found in the CNS
- Supporting cells that wrap around the axons and capillary vessels
- Maintain the integrity of the blood-brain barrier
- Assist in regulating hormone release from the axons

Physiology Of Pituitary Gland

<u>Hypothalamic hormone</u>	<u>Pituitary target cell</u>	<u>Pituitary hormone</u>	<u>Target organ</u>	<u>End effects</u>
Corticotropin-releasing hormone (CRH)	Corticotropes	ACTH	Adrenal cortex	Release of corticosteroids
Thyrotropin-releasing hormone (TRH)	Thyrotropes	TSH	Thyroid gland	Release of thyroid hormones
Gonadotropin-releasing hormone (GnRH)	Gonadotropes	FSH	•Gonads •Ovaries •Testes	Development of ovarian follicles and sperm production
		LH	• Gonads •Ovaries •Testes	•Androgen production (both sexes) •Stimulates ovulation (females)
Growth hormone–releasing hormone (GHRH)	Somatotropes	GH	Many organs	Anabolic effects
Somatostatin (inhibitor)	Somatotropes	GH (inhibited)	Many organs	Anabolic effects inhibited with somatostatin
Dopamine (inhibitor)	Lactotropes	Prolactin (inhibited)	Mammary glands	Milk production inhibited with dopamine

Post. Pituitary

Hormone	Synthesis	Target organ	Function
Antidiuretic hormone (ADH)	Supraoptic nuclei of hypothalamus	Kidney	•Water reabsorption from kidney •Vasoconstriction •Increase blood pressure
Oxytocin	Paraventricular nuclei of hypothalamus	Breast	Stimulates milk ejection during lactation
		Uterus	Stimulates uterine contractions during labor

