

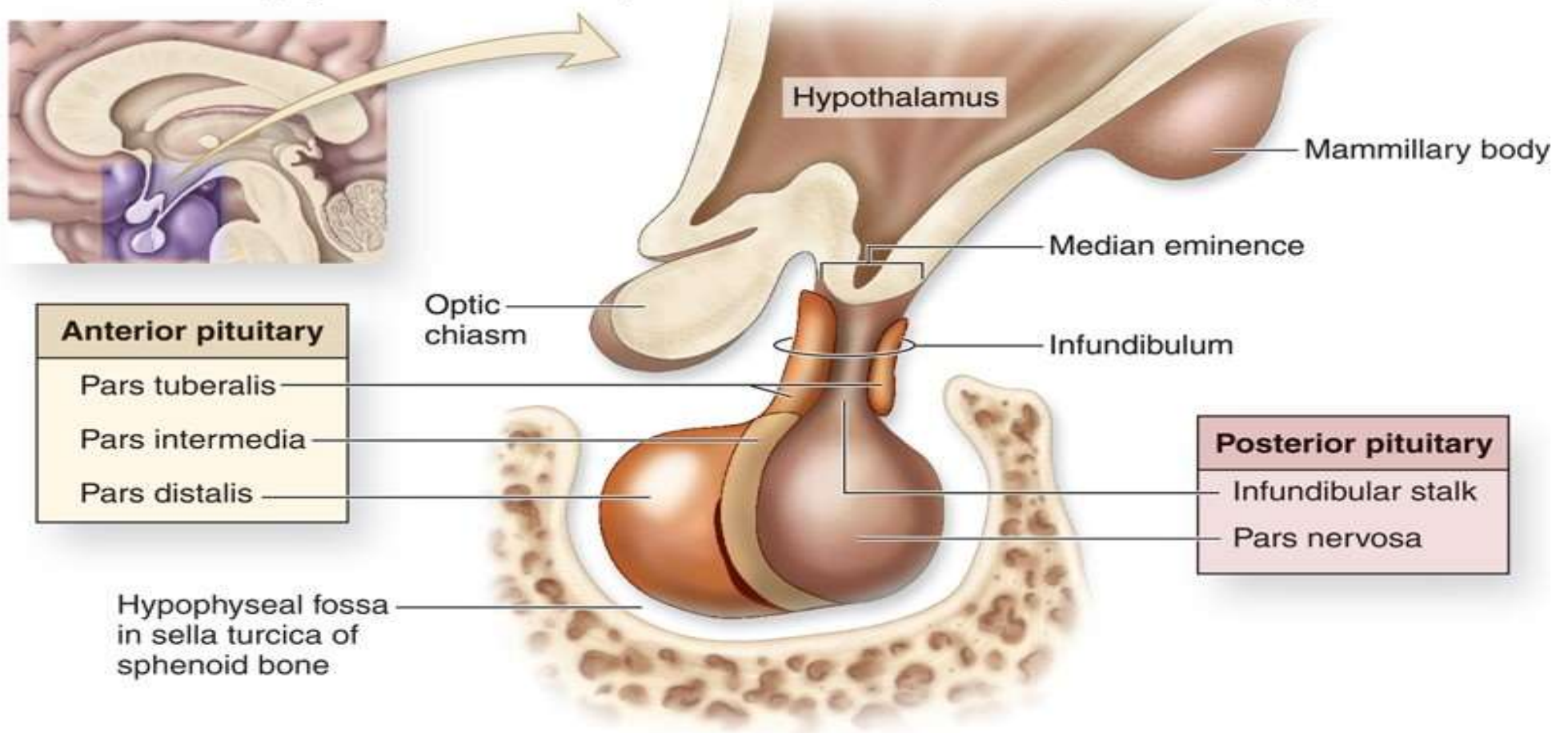
# Hypothalamus & Pituitary

Lecture # 03

# Hypothalamic Control of the Endocrine System

- Master control center of the endocrine system
- Hypothalamus oversees most endocrine activity:
  - special cells in the hypothalamus secrete hormones that influence the secretory activity of the **anterior pituitary gland**
    - called regulatory hormones
    - **releasing hormones (RH)**
    - **inhibiting hormones (IH)**
- Hypothalamus has indirect control over these endocrine organs.

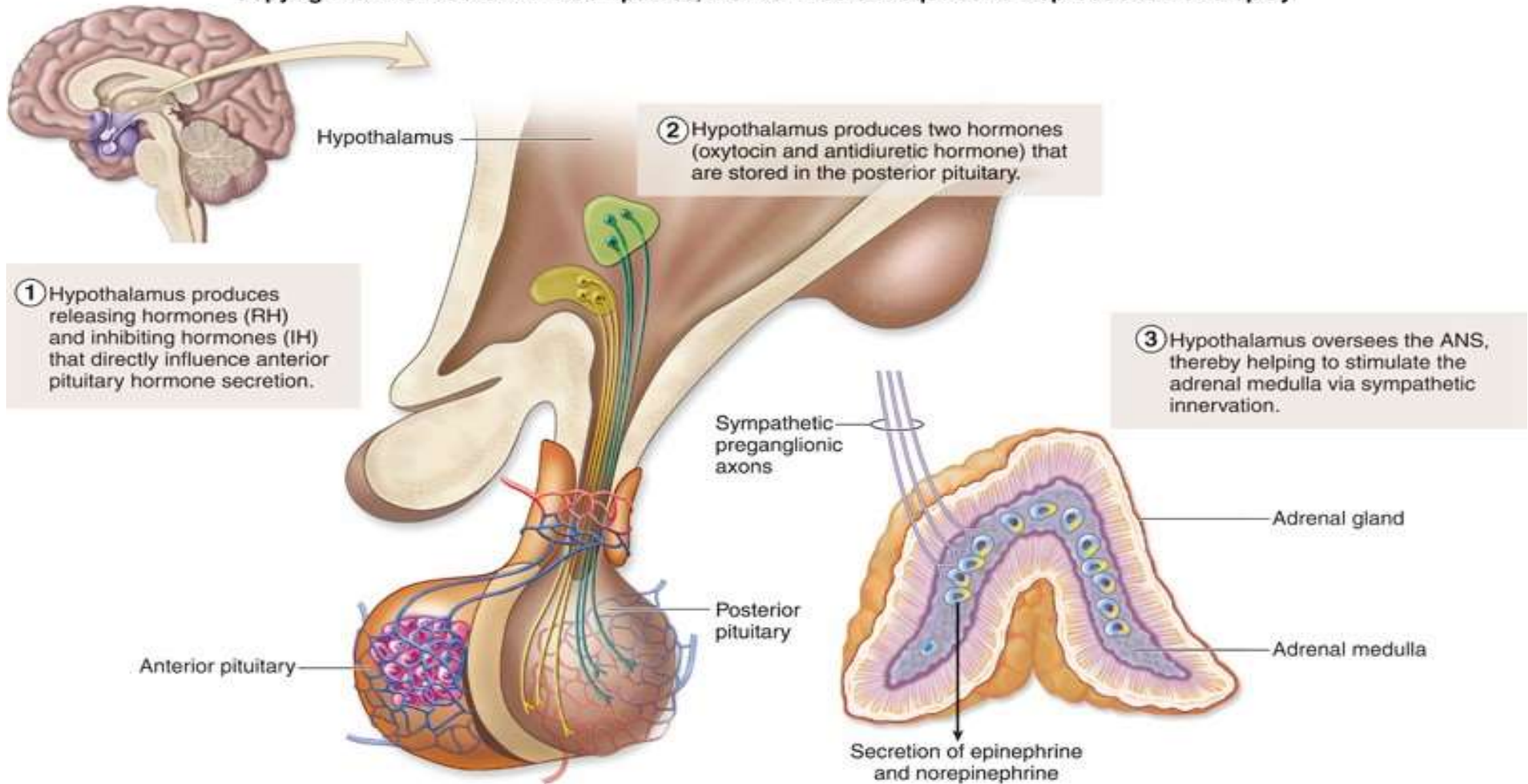
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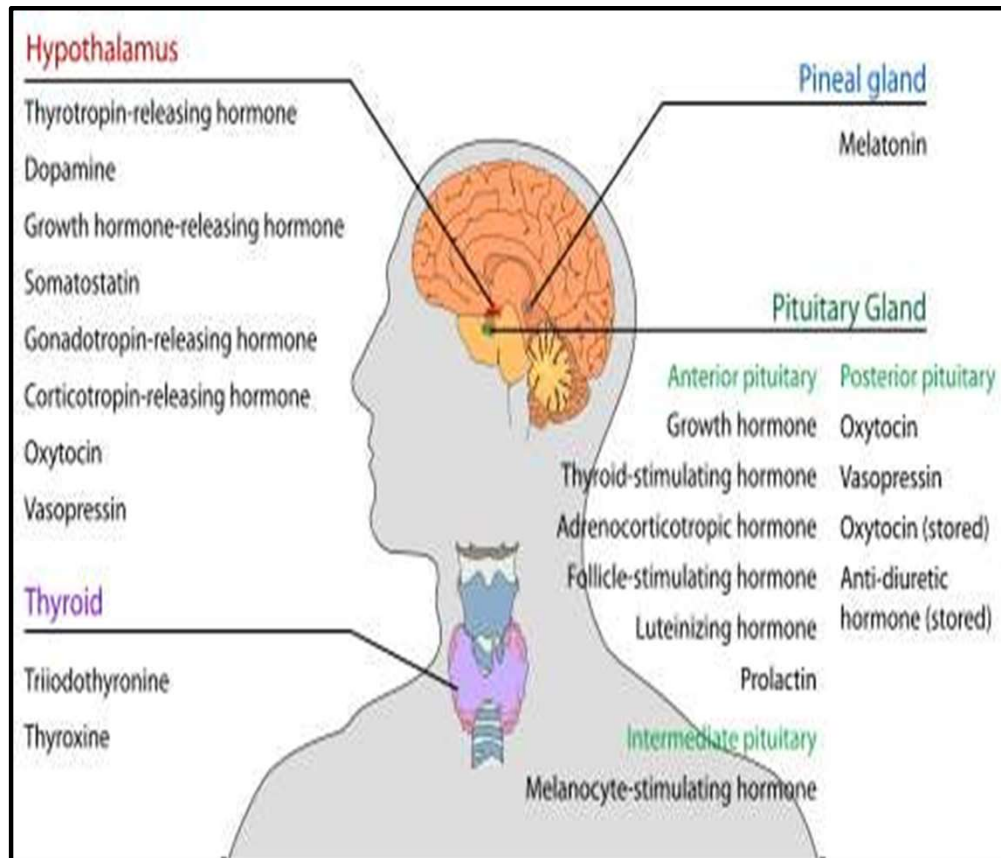
# Hypothalamic Control of the Endocrine System

- Hypothalamus produces two hormones that are transported to and stored in the **posterior pituitary**.
  - **oxytocin** (paraventricular nucleus)
  - **antidiuretic hormone** (ADH) (supraoptic nucleus)
- Hypothalamus directly oversees the stimulation and hormone secretion of the **adrenal medulla**.
  - An endocrine structure that secretes its hormones in response to stimulation by the **sympathetic** nervous system.
- Some endocrine cells are **not** under direct control of hypothalamus.

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# Hypothalamus & Pituitary

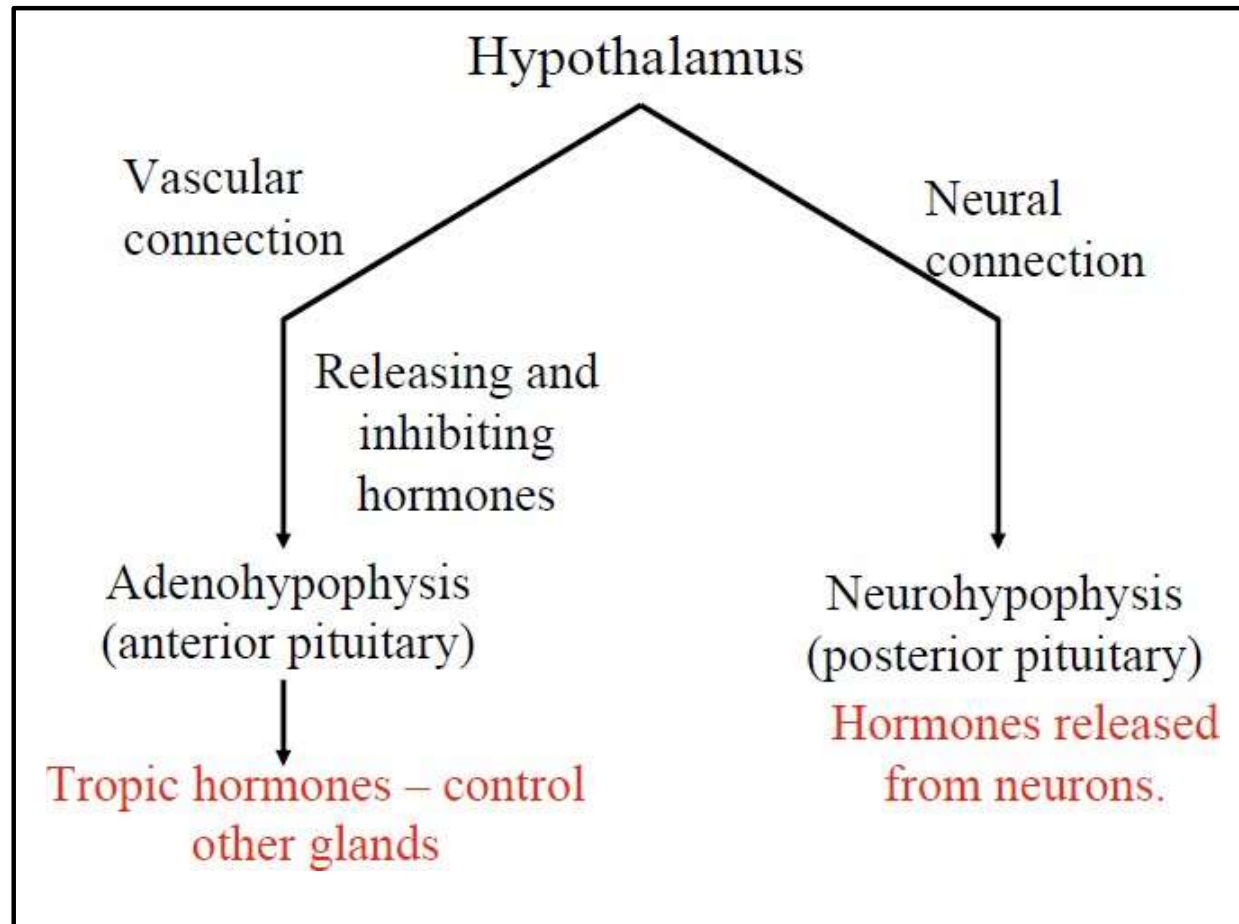


- The hypothalamus and pituitary integrate many functions of the vertebrate endocrine system
- The **hypothalamus** and the **pituitary gland** control much of the endocrine system
- **Tropic hormones**, hormones that regulate endocrine organs
- Tropic hormones are secreted into the blood and transported to the anterior pituitary

# HYPOTHALAMUS

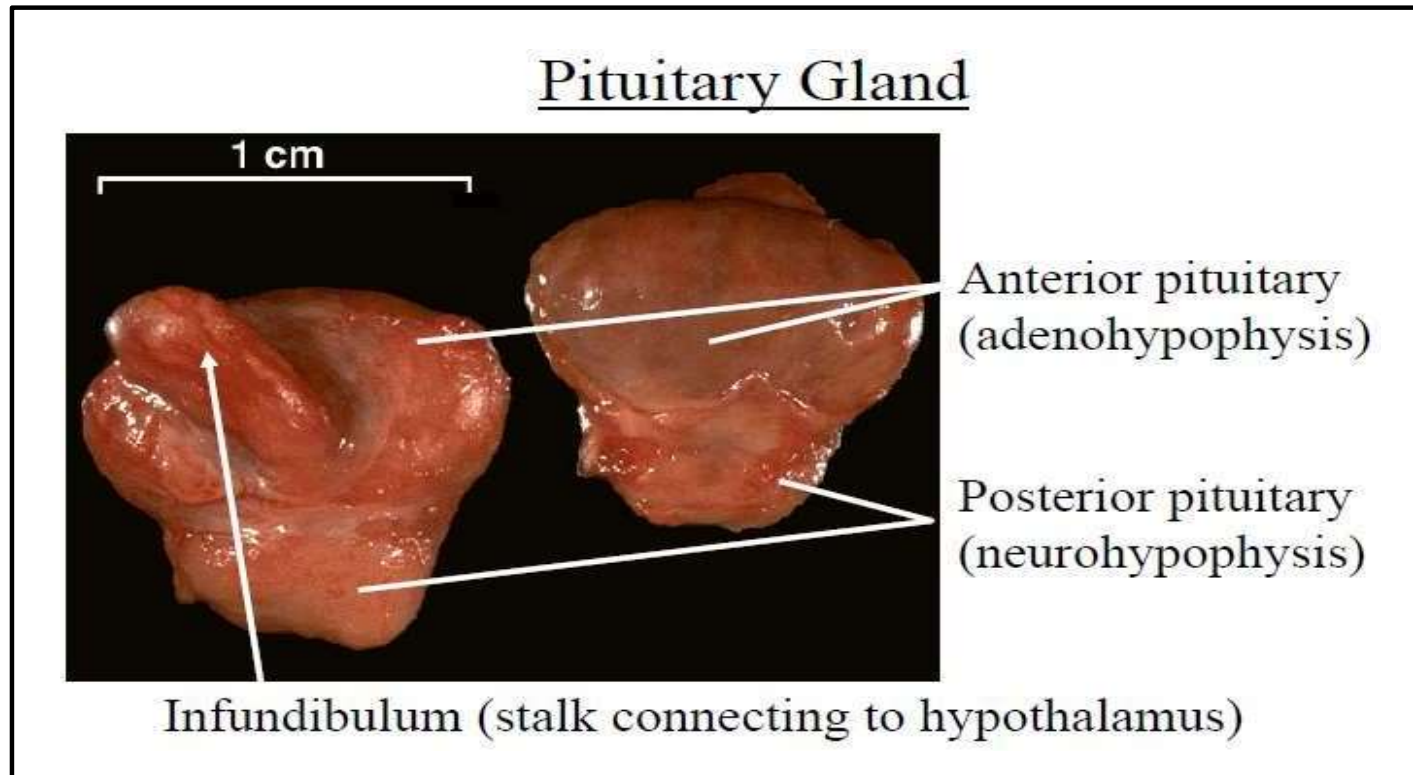
Secreted hormone	Abbreviation	Produced by
Thyrotropin - releasing hormone	TRH	Parvocellular neurosecretory neurons
Dopamine (Prolactin - inhibiting hormone)	DA or PIH	Dopamine neurons of the arcuate nucleus
Growth hormone-releasing hormone	GHRH	Neuroendocrine neurons of the Arcuate nucleus
Somatostatin (growth hormone-inhibiting hormone)	SS, GHIH, or SRIF	Neuroendocrine cells of the Periventricular nucleus
Gonadotropin - releasing hormone	GnRH or LHRH	Neuroendocrine cells of the Preoptic area
Corticotropin - releasing hormone	CRH or CRF	Parvocellular neurosecretory neurons of the Periventricular Nucleus
Oxytocin	OT or OXT	Magnocellular neurosecretory neurons of the Supraoptic nucleus and Para ventricular nucleus
Vasopressin (anti diuretic hormone)	ADH or AVP or VP	Parvocellular neurosecretory neurons, Magnocellular neurosecretory neurons of the Paraventricular nucleus and Supraoptic nucleus



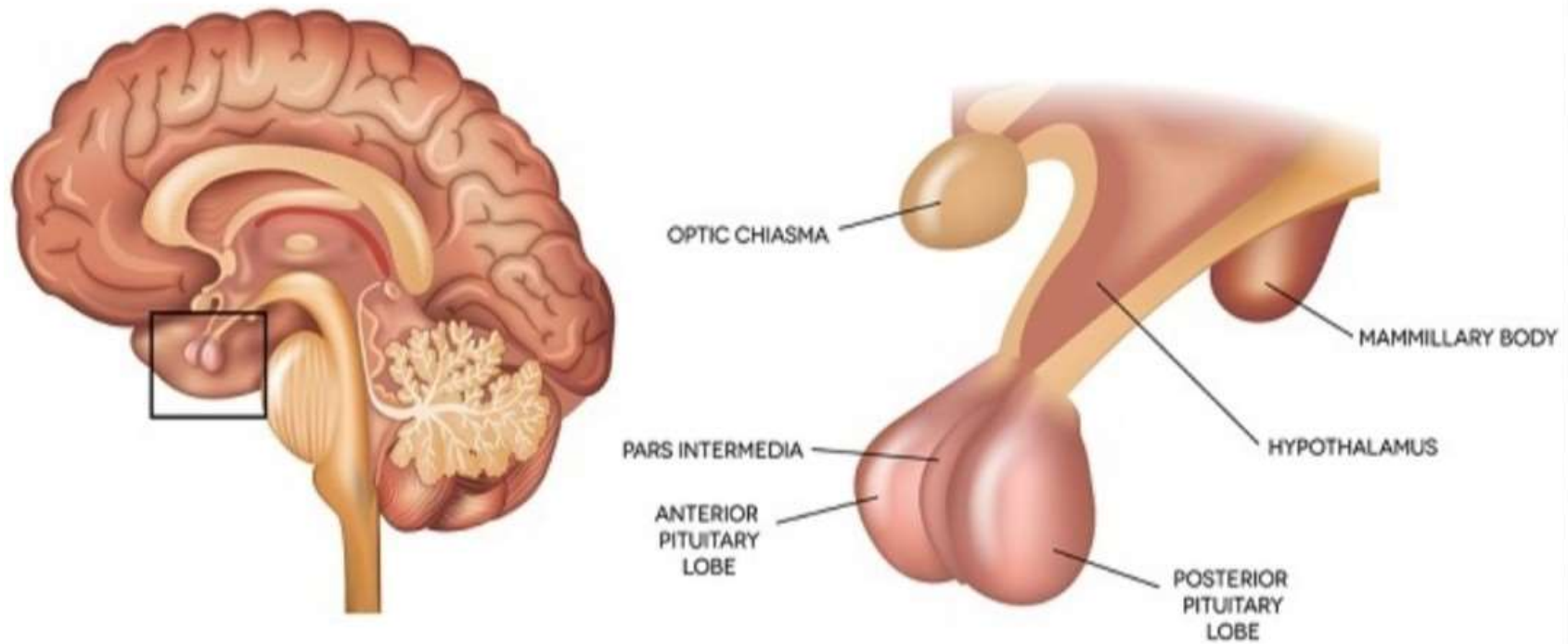




# Pituitary



# THE PITUITARY (HYPOPHYSIS) GLAND



# Anatomy

## Location

- Lies at the base of brain Sella turcica.
- Connected with the hypothalamus by the pituitary stalk or hypophyseal stalk.

## Division

- Anterior lobe ( adenohypophysis)
- Intermediate lobe ( not present or very small in humans dispersed within anterior lobe)
- Posterior lobe ( neurohypophysis)

# **Lobes of pituitary gland**

- Anterior pituitary ( adenohypophysis)

Consists of three divisions

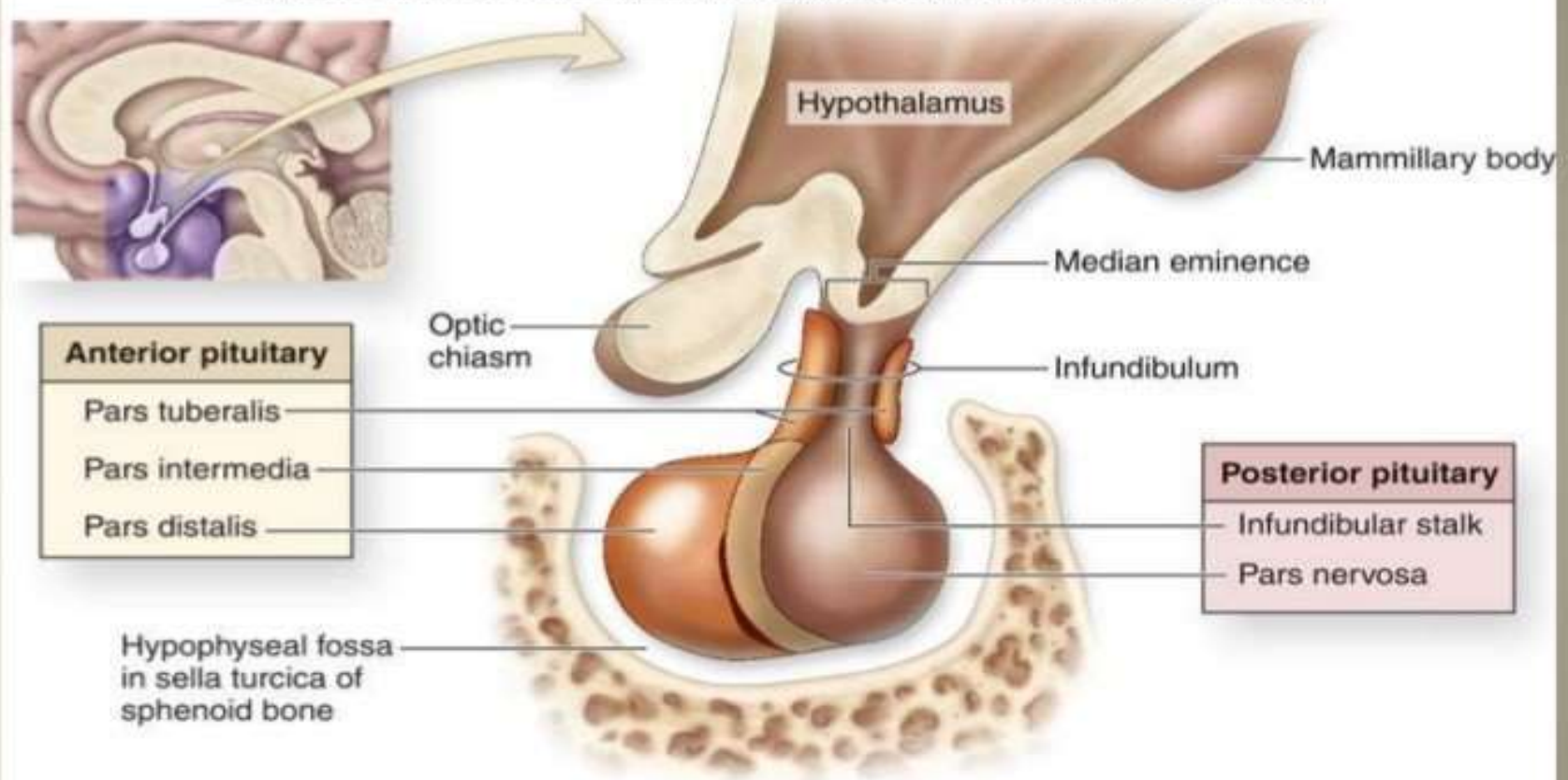
1. Pars distalis
2. Pars tuberalis
3. Pars intermedia

- Posterior pituitary

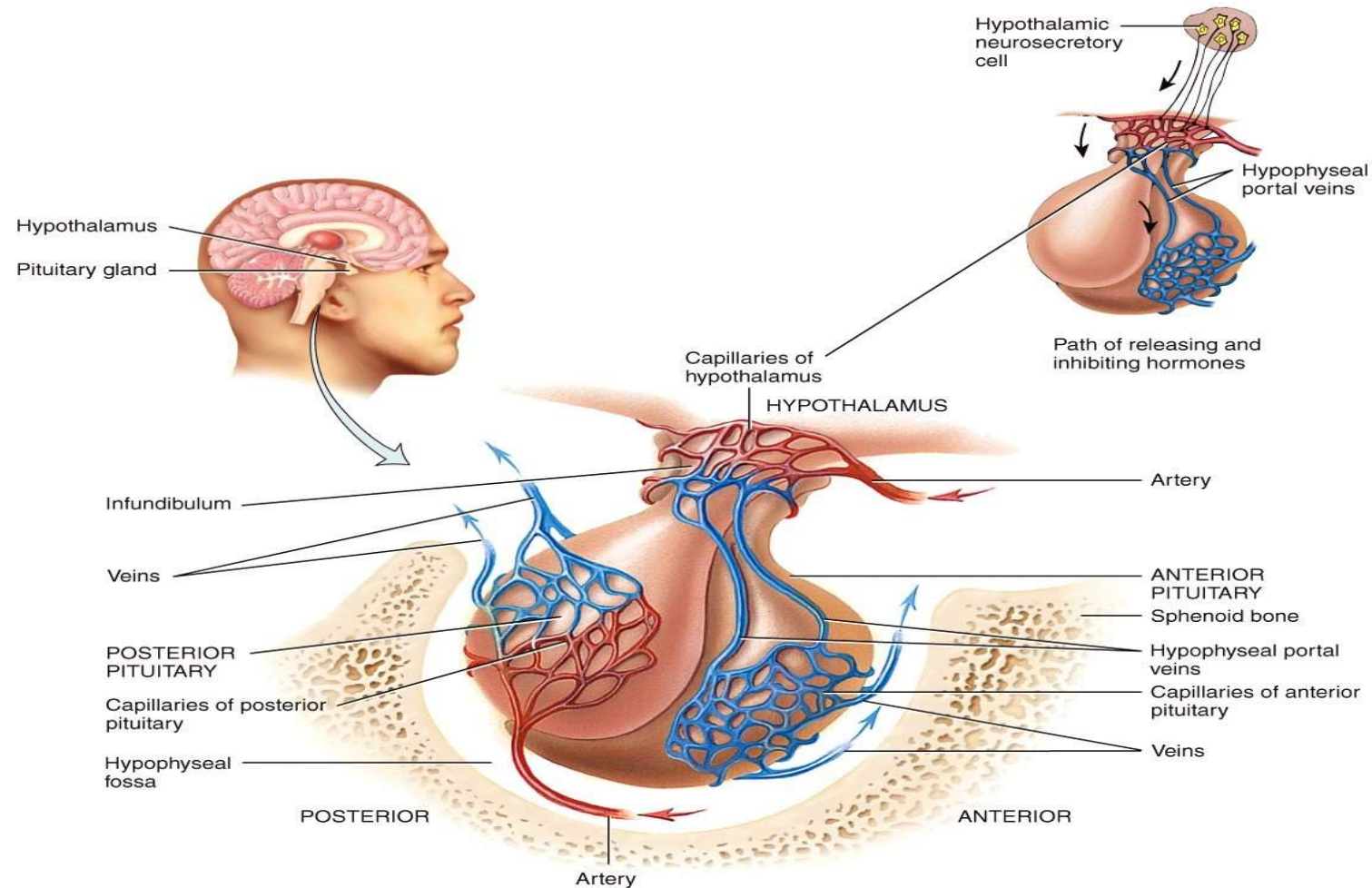
Consist of two parts

1. Infundibular stalks
2. Pars nervosa

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# Pituitary Gland Blood Supply



# The Structure and Function of the Pituitary Gland

⊙ Hypophysis: has two parts

⊙ Anterior = adenohypophysis

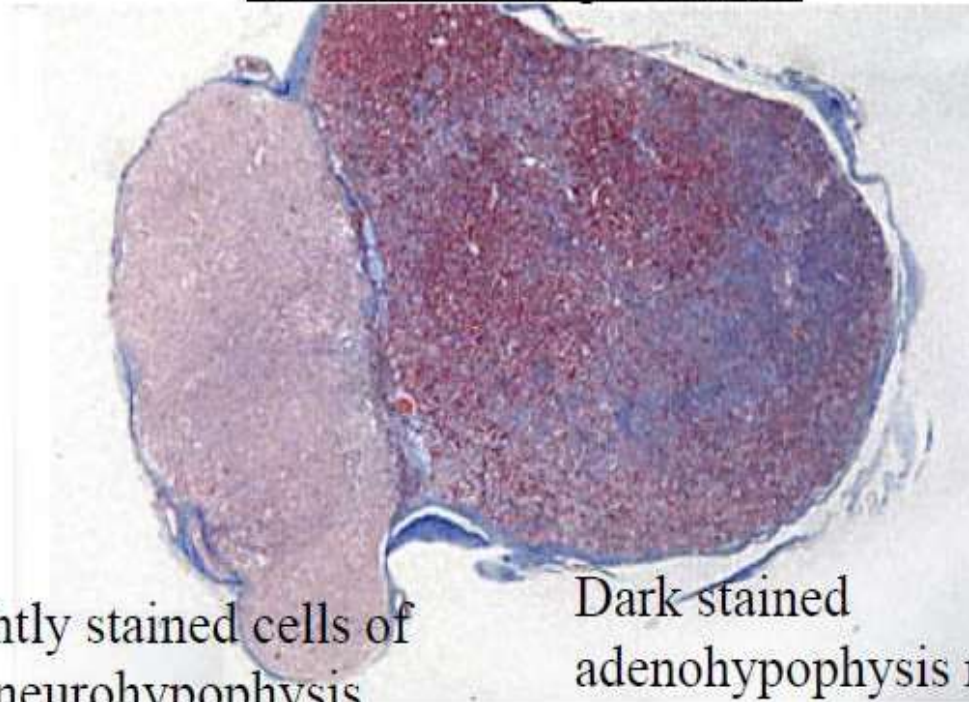
- Activity directed by the hypothalamus
- Secretes six tropic hormones
- Regulates the adrenal gland

⊙ Posterior = neurohypophysis

- Receives hormones secreted by the hypothalamus and then stores them for subsequent release



## The Pituitary Gland



Lightly stained cells of the neurohypophysis reflects the neural nature of this gland.

Dark stained adenohypophysis reflects the epithelial secretory cells of this gland.

# Pituitary Hormones

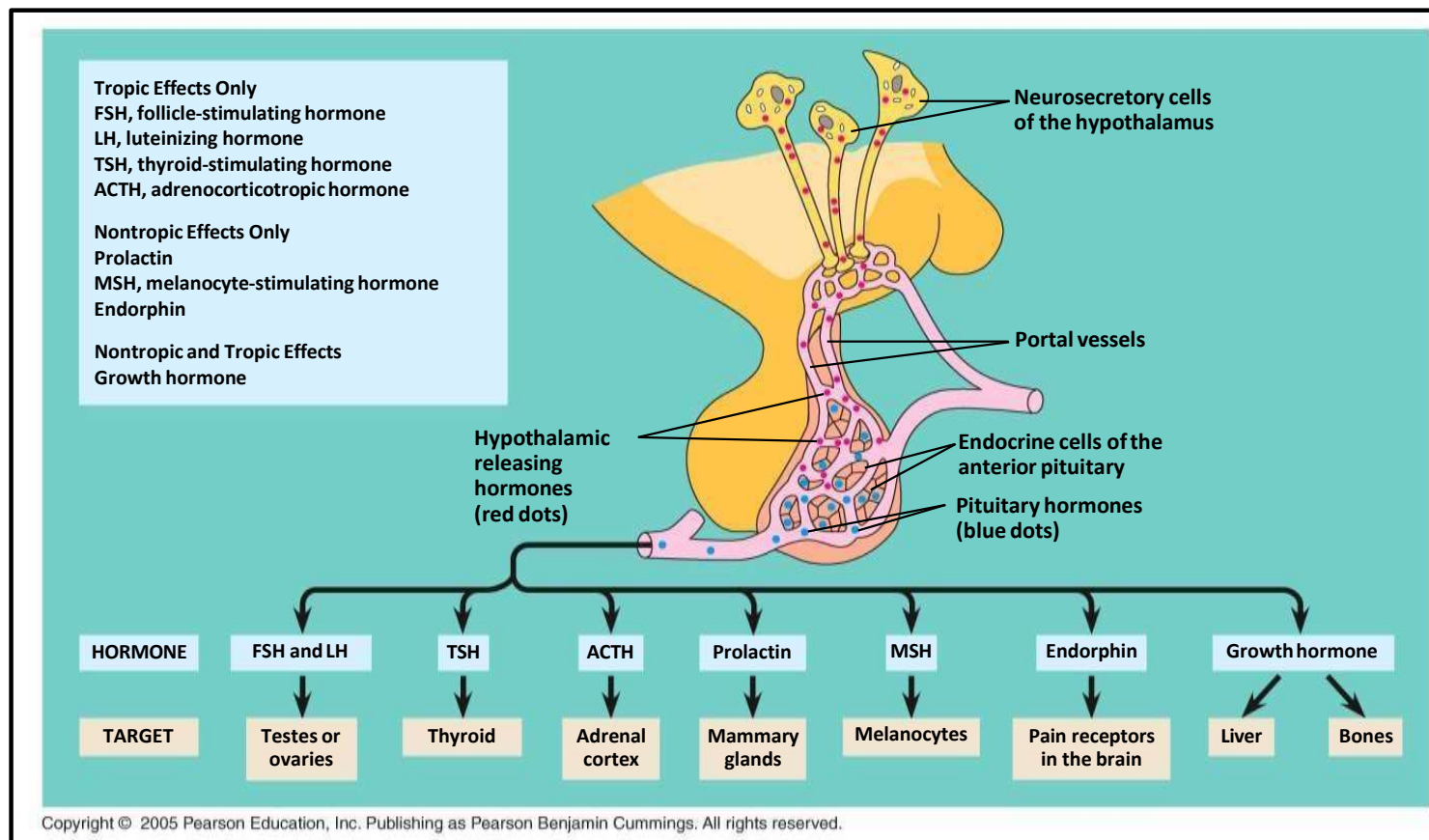
Pituitary Hormone	Functions
Follicle-stimulating hormone	Stimulates egg maturation in the ovary and release of sex hormones.
Luteinizing hormone	Stimulates maturation of egg and of the corpus luteum surrounding the egg, which affects female sex hormones and the menstrual cycle.
Thyroid-stimulating hormone	Stimulates the thyroid to release thyroxin.
Adreno corticotropic hormone	Causes the adrenal gland to release cortisol.
Melanocyte-stimulating hormone	Stimulates synthesis of skin pigments.
Growth hormone	Stimulates growth during infancy and puberty.
Antidiuretic hormone	Signals the kidney to conserve more water.
Oxytocin	Affects childbirth, lactation, and some behaviors.

- The pituitary is the “master gland” that signals other glands to produce their hormones when needed.
- The anterior lobe of the pituitary receives signals from the hypothalamus, and responds by sending out the appropriate hormone to other endocrine glands.
- The posterior pituitary receives oxytocin or antidiuretic hormone (ADH) from the hypothalamus, relays them to the body as necessary.
- Located on the underneath side of the brain.
- Small pea-sized gland is divided into an anterior lobe and a posterior lobe.
- Both lobes are controlled by the hypothalamus in the brain

# The Anterior Pituitary

## **Secretes seven hormones**

- ⊙ Growth hormone (GH), also called somatotropin, promotes growth of the body by stimulating cells to rapidly increase in size and divide.
- ⊙ Thyroid-stimulating hormone (TSH) regulates the function of the thyroid gland.
- ⊙ Adrenocorticotropin hormone (ACTH) regulates the function of the adrenal cortex.
- ⊙ Prolactin (PRL) stimulates milk production in the breast following pregnancy and birth.
- ⊙ Follicle-stimulating hormone (FSH) responsible for the development of ova in ovaries and sperm in testes; also stimulates the ovary to secrete estrogen.
- ⊙ Luteinizing hormone (LH) stimulates secretion of sex hormones in both males and females and plays a role in releasing ova in females.
- ⊙ Melanocyte-stimulating hormone (MSH) stimulates melanocytes to produce more melanin, darkening the skin.



## ***PITUITARY HORMONES***

<b>HYPOTHALAMUS</b>	<b>ANTERIOR PITUITARY</b>	<b>TARGET TISSUE</b>	<b>PRINCIPAL ACTIONS</b>
Growth hormone-releasing hormone (GHRH)	Human Growth Hormone (hGH) Somatotropin	Liver, muscle, cartilage, bone, and other tissues	Synthesize & secrete IGFs Promotes growth of body cells, protein synthesis, tissue repair, lipolysis, & elevation of blood glucose concentration
Thyrotropin-releasing hormone (TRH)	Thyroid-stimulating hormone (TSH)	Thyroid Gland	Synthesis and secretion of thyroid hormones
Gonadotropic-releasing hormone (GnRH)	Follicle-stimulating hormone	Ovaries Testes	Development of oocytes & production of sperm
Gonadotropic-releasing hormone (GnRH)	Luteinizing hormone (LH)	Ovaries Testes	Secretion of estrogen & progesterone Develop & produce testosterone
Prolactin-releasing hormone (PRH)	Prolactin (PRL)	Mammary glands	Promotes milk secretion by the mammary glands
Corticotropin-releasing hormone (CRH)	Adrenocorticotrophic hormone (ACTH)	Adrenal Cortex	Secretion of glucocorticoids (cortisol)
Corticotropin-releasing hormone (CRH)	Melanocyte-stimulating hormone	Brain	Darkening of the skin

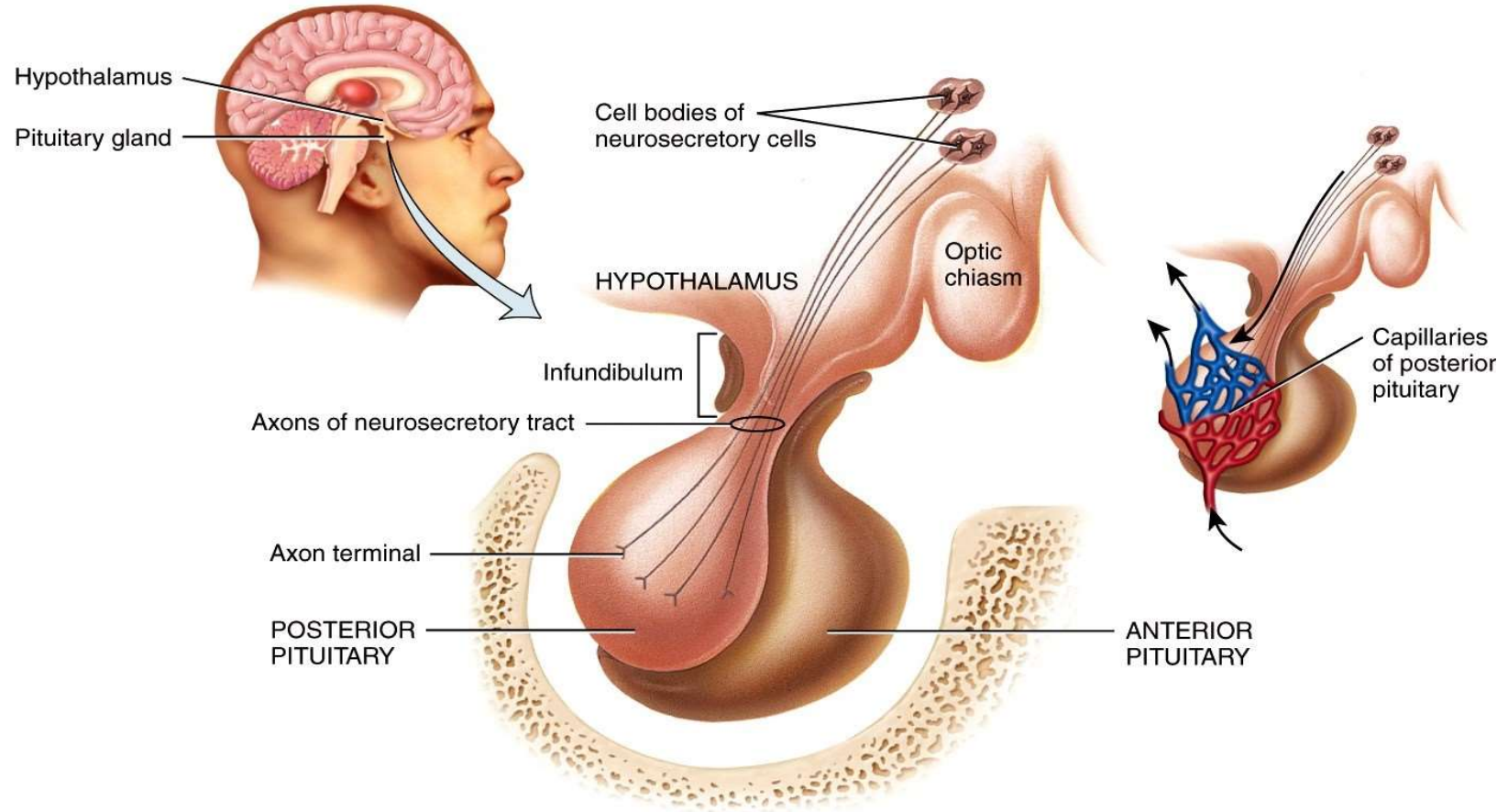
# The Posterior Pituitary

## **Secretes two hormones**

- ⊙ Antidiuretic hormone (ADH), also called vasopressin, promotes water reabsorption by the kidney tubules.
- ⊙ Oxytocin stimulates uterine contractions during labor and delivery, and after birth the release of milk from the mammary glands.



# Posterior Pituitary



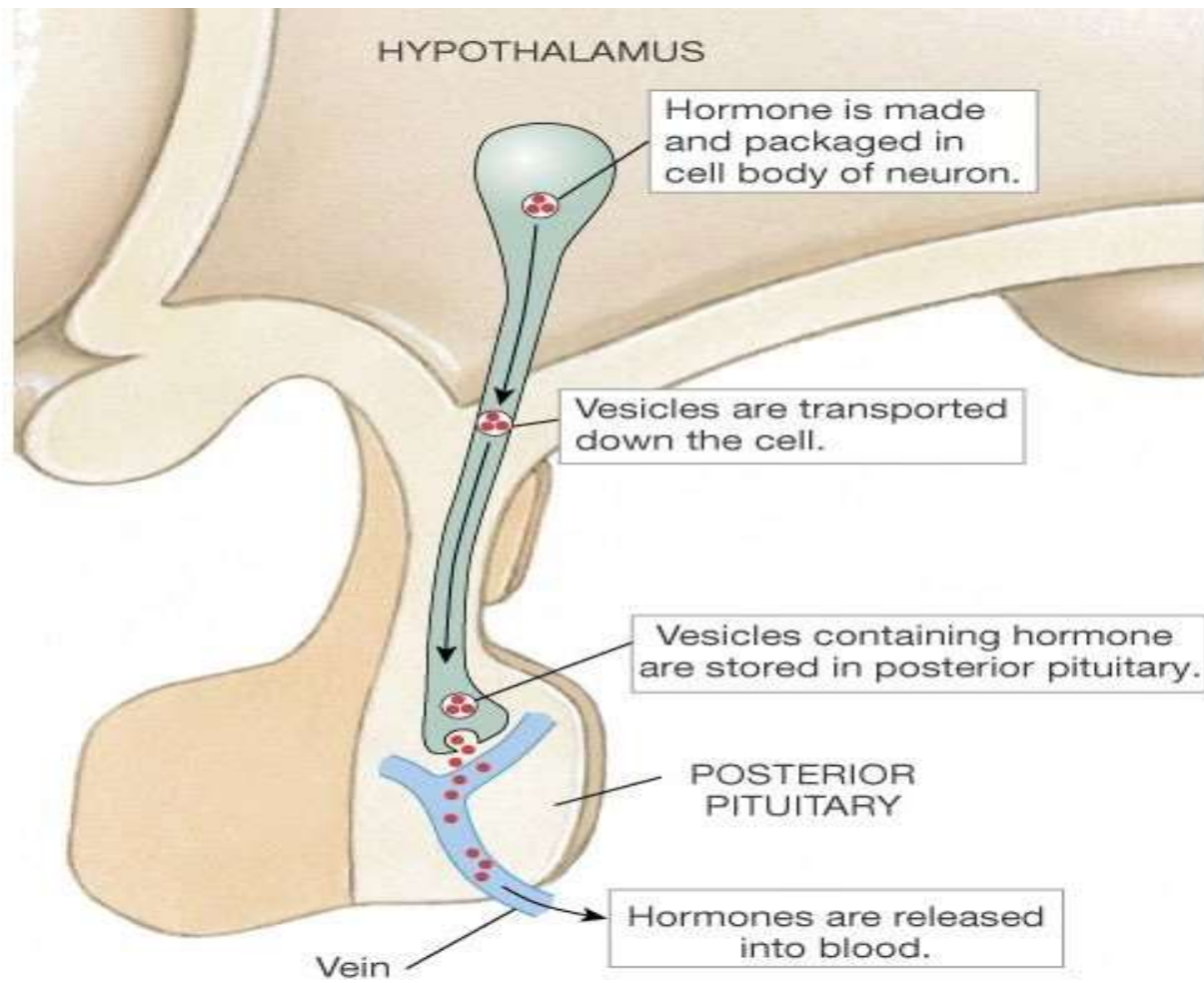
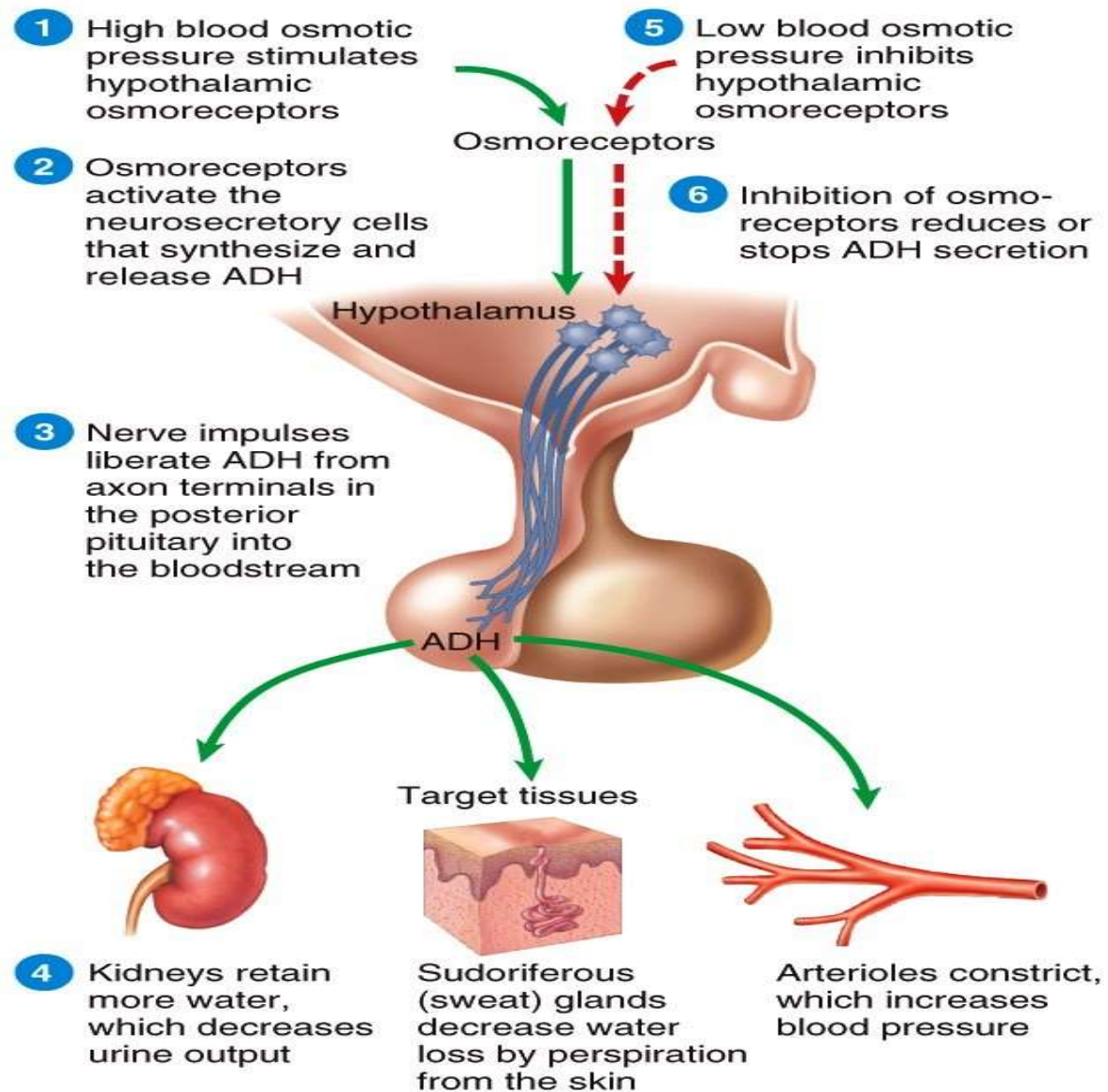


Figure : Synthesis, storage, and release of posterior pituitary hormones

# Posterior Pituitary

- Antidiuretic Hormone (ADH)
  - Causes kidneys to retain more water
  - Causes vasoconstriction → increases blood pressure
  - Dehydration, pain, stress → increase ADH secretion
- Oxytocin causes
  - Smooth muscle contraction of uterus during childbirth
  - Causes “letdown” of milk from glands to ducts

# Posterior Pituitary



## ***PITUITARY HORMONES***

<b>HYPOTHALAMUS</b>	<b>POSTERIOR PITUITARY (STORAGE)</b>	<b>CONTROL OF SECRETION</b>	<b>TARGET TISSUE</b>	<b>PRINCIPAL ACTIONS</b>
Oxytocin (OT)		Uterine distention and stimulation of nipples (suckling)	Uterus Mammary glands	Contraction of smooth muscle during childbirth Milk ejection
Antidiuretic Hormone (ADH)		Secreted in response to elevated blood osmotic pressure, dehydration, loss of blood volume, pain, stress	Kidneys Suderiferous glands Arterioles	Conserves body water Decreases water loss Raises blood pressure by constricting arterioles

# Diseases of the Anterior Pituitary

## ⊙Hyperpituitarism

- Giantism
- Acromegaly

## ⊙Hypopituitarism

- Absence of tropic hormones
- Pituitary dwarf

# Hyperpituitarism – Anterior Pituitary

- ⊙Giantism: hypersecretion of growth hormone prior to puberty
  - Retards normal closure of bone seal
  - Decreased sexual development
  - Mental development normal or retarded
- ⊙Etiology: adenoma
- ⊙Treatment: removal of adenoma or radiation to reduce the size of the tumor



# Gigantism

Characterized signs and symptoms :

- Excess Growth of body
- Average height is approximately 7-8 feet
- Headache due to tumor of pituitary
- Hyperglycemia, visual disturbance and pituitary diabetes mellitus.



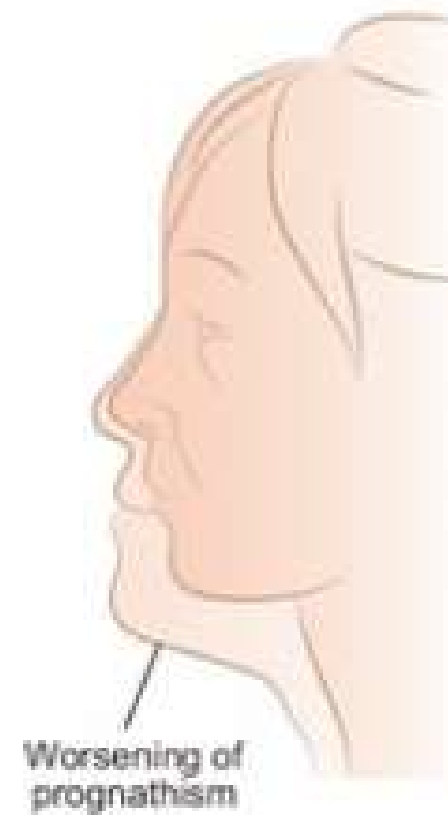
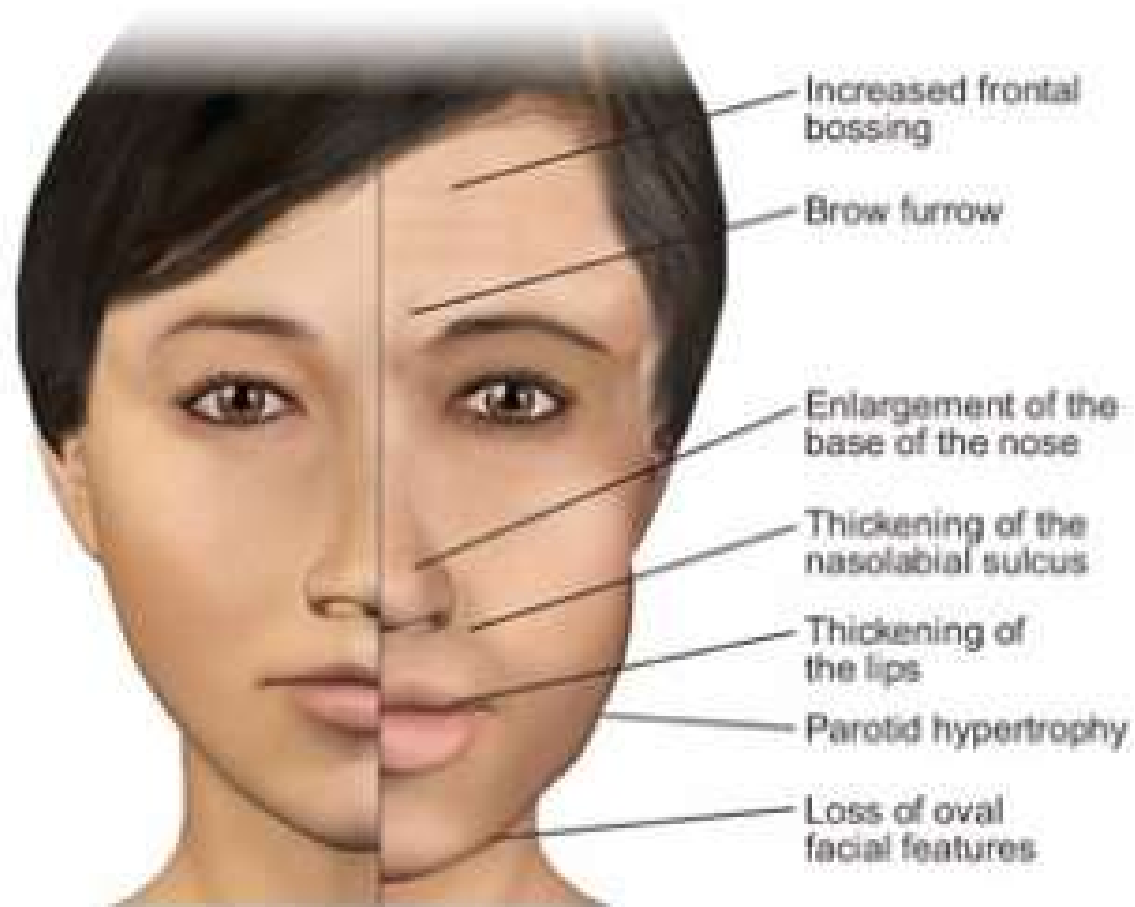
# Hyperpituitarism – Anterior Pituitary

## ⊙ Acromegaly

- Hypersecretion of growth hormone after puberty
- Long bones no longer grow
- Excessive growth of soft tissue
- Enlargement of the face with coarse facial features
- Protrusion of the tongue
- Curvature of the spine

## ⊙ Etiology: adenoma

## ⊙ Treatment: surgical removal, radiation, supportive treatments



# Hypopituitarism – Pituitary

## ⊙ Etiology

- Damage to the anterior lobe of the pituitary gland
  - Fracture at the base of the skull, tumor, ischemia
  - Inadequate secretion of hormones

## ⊙ Mild or severe

## ⊙ Panhypopituitarism: entire anterior lobe is destroyed

- No pituitary hormones are secreted

## ⊙ Pituitary dwarf

# Abnormalities – Absence of Tropic Hormones

- ⊙ Lack of thyroid hormone: lethargy
- ⊙ Lack of ACTH: salt imbalance, improper metabolism of nutrients
  - ACTH essential for life
- ⊙ Absence of gonadotropic hormones
  - Depresses sexual function
  - Before puberty – impaired sexual development
  - After puberty
    - Cessation of menstruation
    - Aspermia in males

# Pituitary Dwarf

⊙ May occur in children

- Inadequate growth hormone
- Mentally bright but small and underdeveloped sexually
- All growth processes are retarded; teeth are late in erupting.
- Replacement therapy with injections of growth hormone is currently used to treat children with pituitary dwarfism.



## Dwarfism

Deficiency of growth hormone in children before growth is completed resulting retarded growth.

- Short stature.



# Hypopituitarism – Treatment

## ⊙ Hormonal supplements

- Thyroxine, cortisone, growth hormone, and sex hormones can compensate for the dysfunctional glands.

# Function of the Posterior Pituitary Gland

- ⊙ Posterior pituitary, or neurohypophysis
  - Secretes oxytocin, and vasopressin (ADH)
- ⊙ Oxytocin: causes smooth muscle contraction of the uterine muscles
- ⊙ ADH: prevents excessive water loss through the kidneys

# Hyposecretion of the Posterior Pituitary Gland

## ⊙ Diabetes insipidus

- Deficiency of ADH
- In the absence of ADH, water is not reabsorbed by the kidney and is lost in the urine. Extreme thirst or polydipsia and excessive production of diluted urine or polyuria results.

## ⊙ A central diabetes insipidus can result from inadequate production of ADH by the hypothalamus or failure of the pituitary gland to release ADH into the bloodstream.

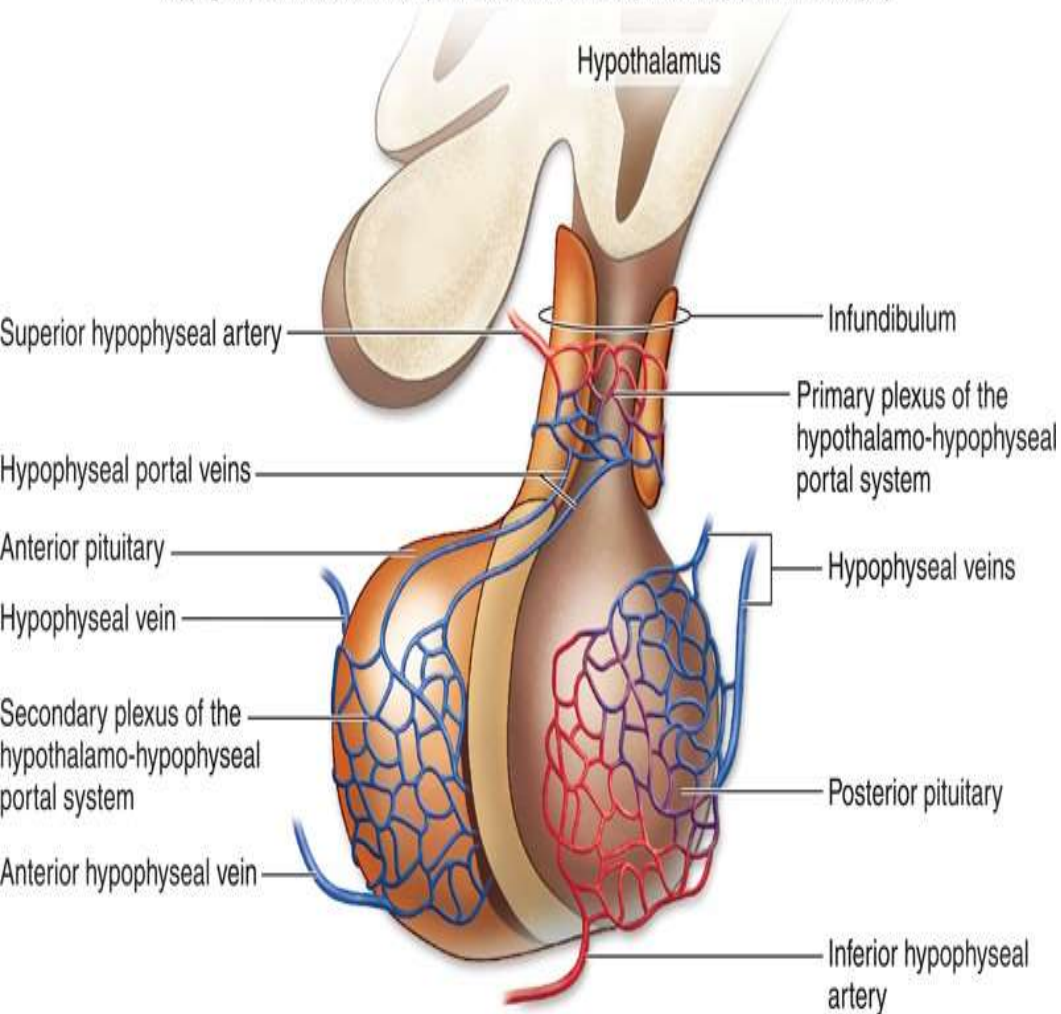
## Hyposecretion of the Posterior Pituitary Gland (continued)

- ⊙ Nephrogenic diabetes insipidus: ADH levels are normal
  - Involves a defect in the kidney; the kidney fails to concentrate urine in response to the instructions of ADH.
- ⊙ Excessive water loss can quickly lead to dehydration.
- ⊙ Treatment: the underlying cause of diabetes insipidus must be corrected. Modified forms of ADH may be taken orally, by injection, or by nasal spray to maintain normal urine output.

# Control of Anterior Pituitary Gland Secretions

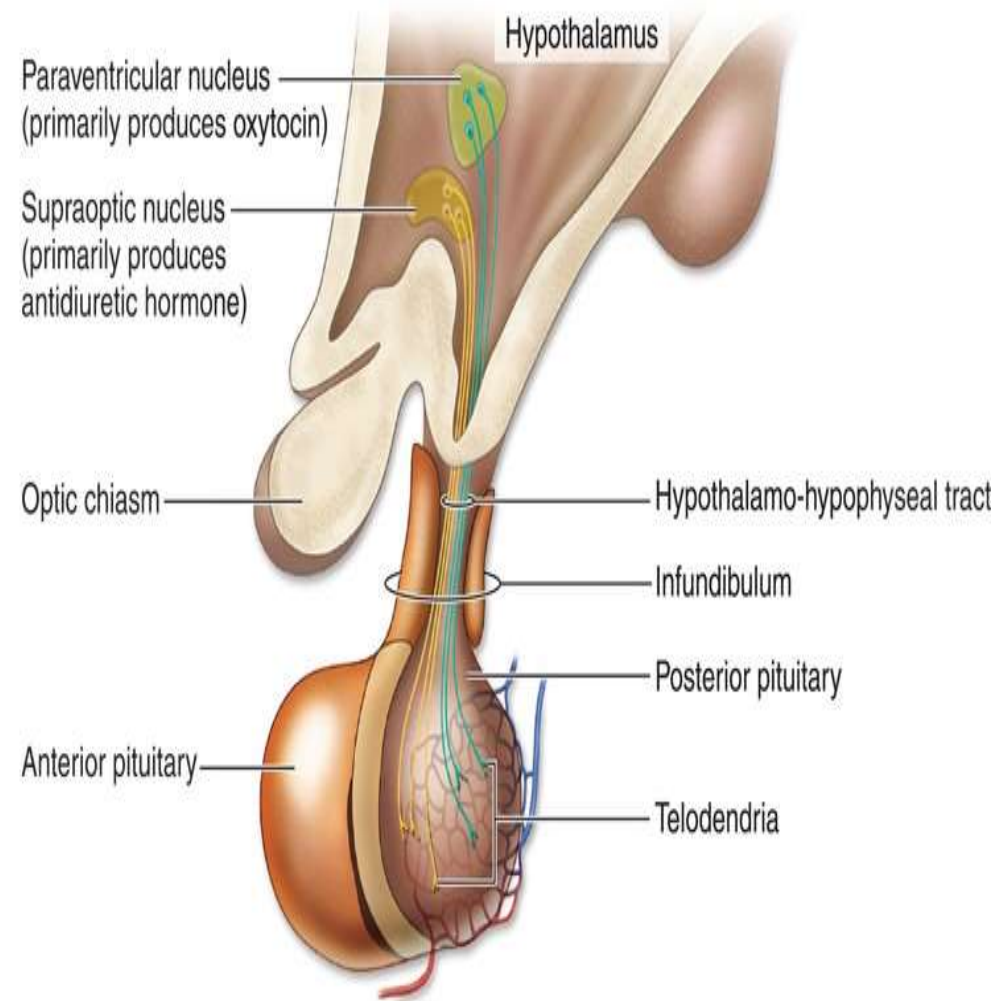
- Anterior pituitary gland is controlled by regulatory hormones secreted by the hypothalamus.
- Hormones reach the anterior pituitary via **hypothalamo- hypophyseal portal system**.
  - essentially a “shunt”
  - takes venous blood carrying regulatory hormones from the hypothalamus directly to the anterior pituitary

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(a) Hypothalamo-hypophyseal portal system

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(b) Hypothalamo-hypophyseal tract

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