Comparative anatomy
(Chordates)
Endocrine System

1-Human
2-Ruminant
3-Avian
4-Fish

Dr.Omer

Fish endocrine system

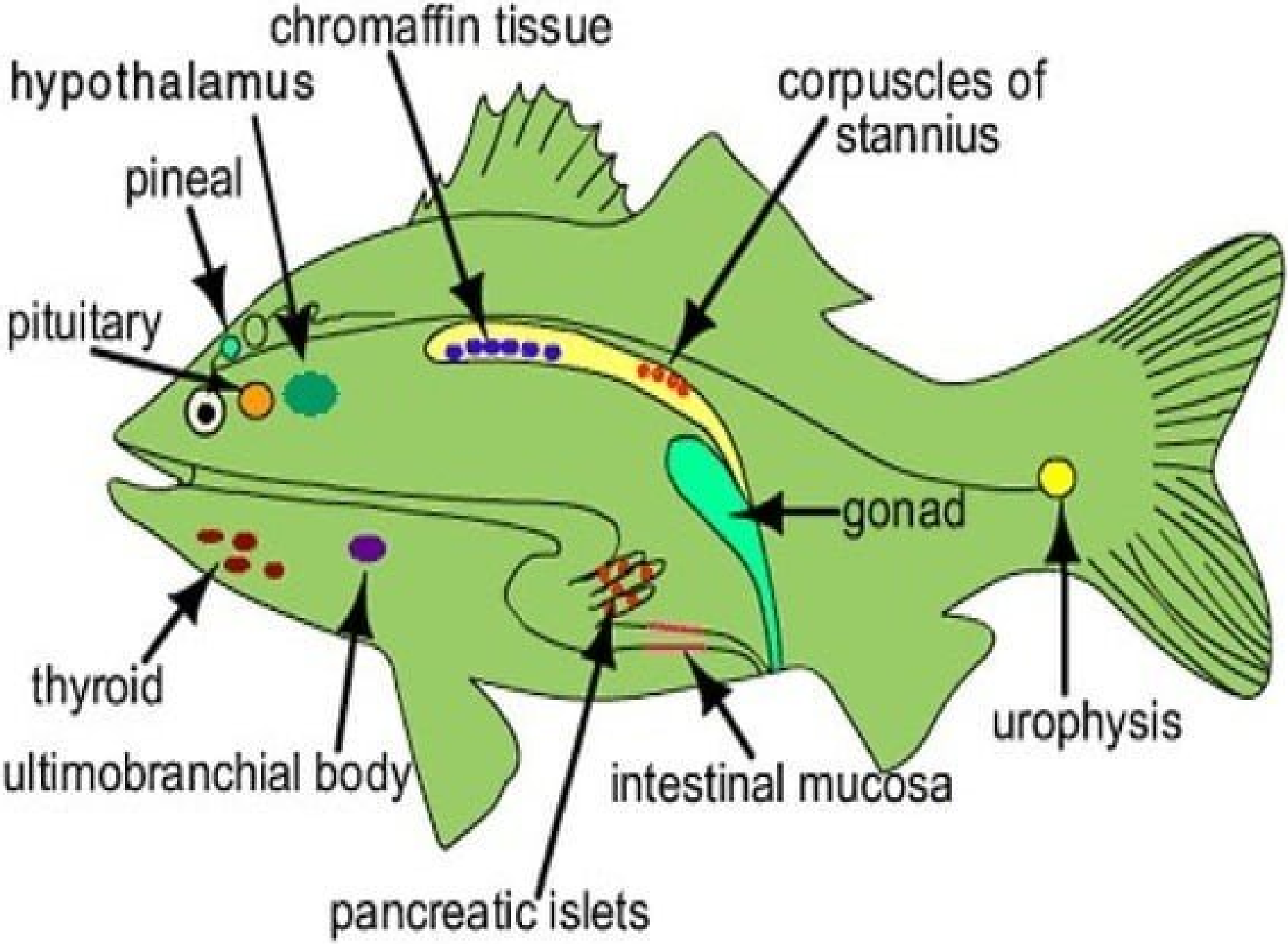
- Fish and humans both have endocrine systems, and their endocrine systems do the same basic functions but there are some differing functions.
- fish have ultimobranchial glands that secrete calcitonin

Fish endocrine system

- Fish also have other glands that aren't present in humans; those are the Corpuscles of Stannius, "sac-like bodies in the kidney ,"
- The corpuscles of Stannius are the sites of production of the hormone called stanniocalcin
- This hormone is responsible for decreasing the blood circulating level of calcium

The urophysis (Caudal neurosecretory System)

- The hormones of urophysis are called "**urotensins**
- **These are urotensin I, II, III and IV**
- **Urotensin I :** Increases the blood pressure
- **Urotensin II :it** is involved in the contraction of smooth muscles such as urinary bladder
- **Urotensin III: it** induces the sodium intake across the gills
- **Urotensin IV :it** shows activity like antidiuretic hormones of pituitary gland



Avian endocrine system

Ultimobranchial bodies

These are 1-3 mm long and are located just posterior to (behind) the parathyroid glands. They produce a hormone called calcitonin that works to reduce the calcium level in the blood stream. .

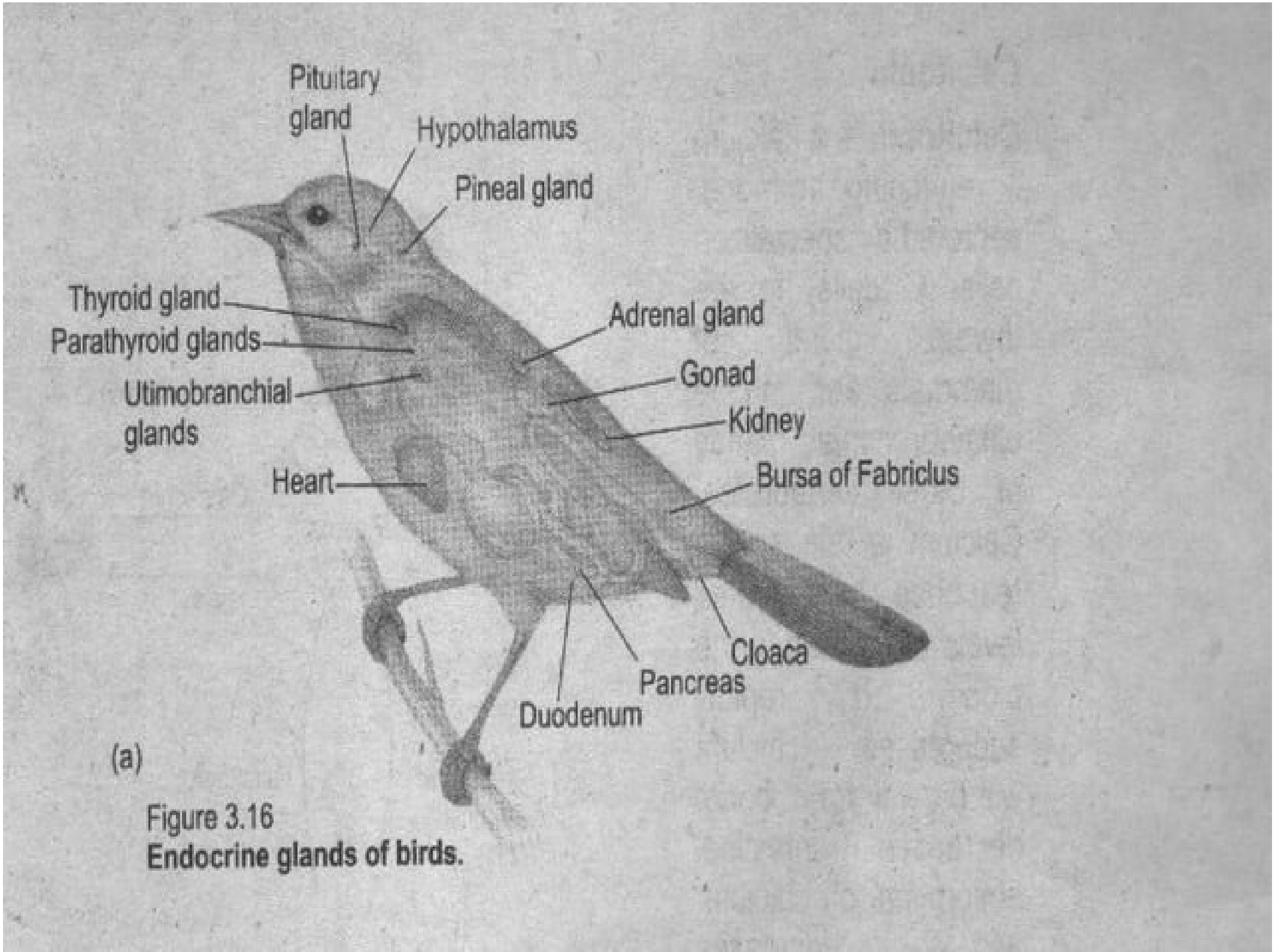


Figure 3.16
Endocrine glands of birds.

Ruminant endocrine gland

Ruminant and humans both have endocrine systems, and their endocrine systems do the same basic functions

Ruminant endocrine gland

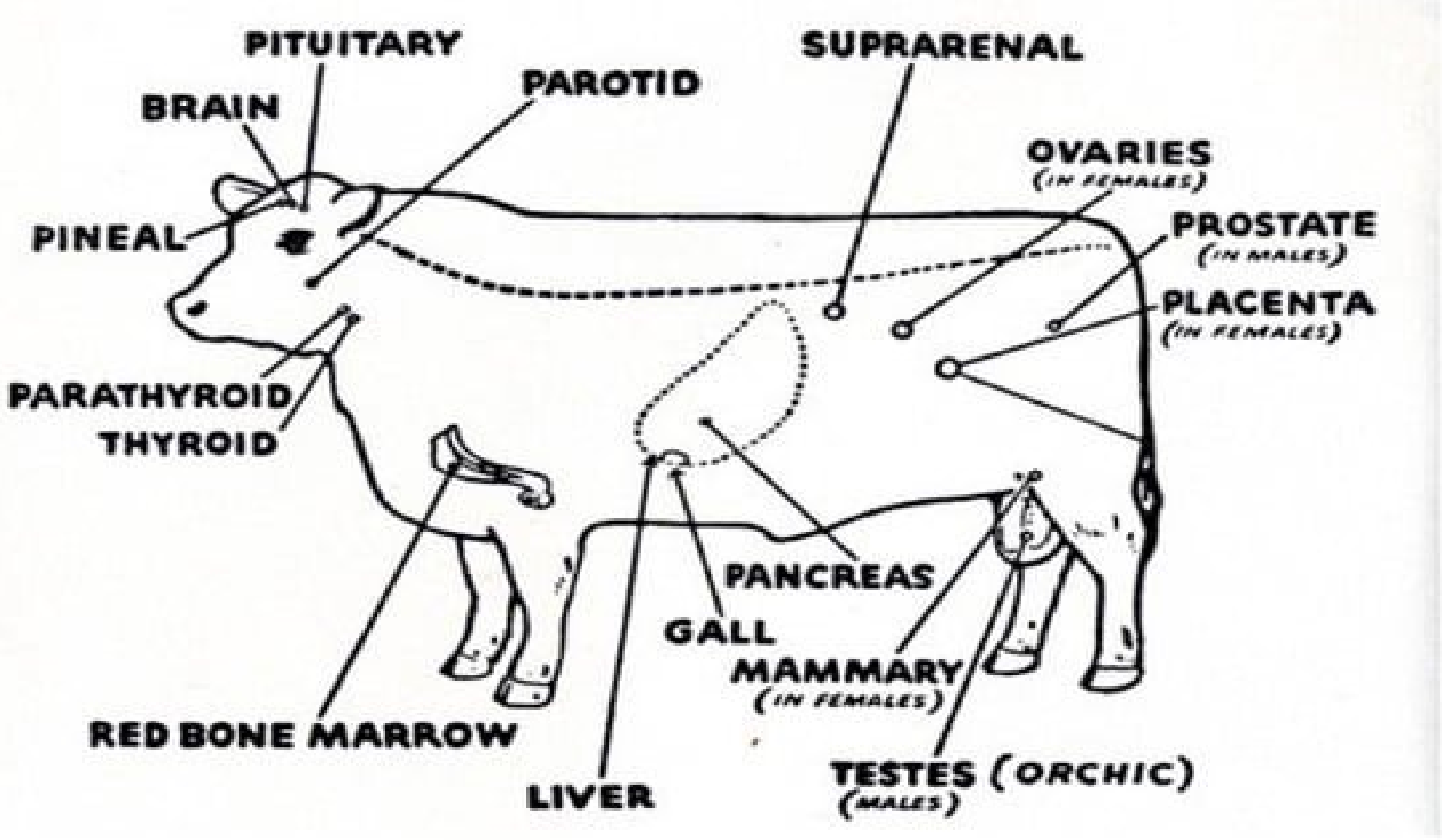


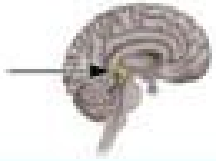
Table 45.1a

Table 45.1 Major Human Endocrine Glands and Some of Their Hormones

Gland		Hormone	Chemical Class	Representative Actions	Regulated By
Hypothalamus		Hormones released from the posterior pituitary and hormones that regulate the anterior pituitary (see below)			
Posterior pituitary gland (releases neurohormones made in hypothalamus)		Oxytocin	Peptide	Stimulates contraction of uterus and mammary gland cells	Nervous system
		Antidiuretic hormone (ADH)	Peptide	Promotes retention of water by kidneys	Water/salt balance
Anterior pituitary gland		Growth hormone (GH)	Protein	Stimulates growth (especially bones) and metabolic functions	Hypothalamic hormones
		Prolactin	Protein	Stimulates milk production and secretion	Hypothalamic hormones
		Follicle-stimulating hormone (FSH)	Glycoprotein	Stimulates production of ova and sperm	Hypothalamic hormones
		Luteinizing hormone (LH)	Glycoprotein	Stimulates ovaries and testes	Hypothalamic hormones
		Thyroid-stimulating hormone (TSH)	Glycoprotein	Stimulates thyroid gland	Hypothalamic hormones
		Adrenocorticotropic hormone (ACTH)	Peptide	Stimulates adrenal cortex to secrete glucocorticoids	Hypothalamic hormones
Thyroid gland		Triiodothyronine (T_3) and thyroxine (T_4)	Amines	Stimulate and maintain metabolic processes	TSH
		Calcitonin	Peptide	Lowers blood calcium level	Calcium in blood
Parathyroid glands		Parathyroid hormone (PTH)	Peptide	Raises blood calcium level	Calcium in blood

Table 45.1b

Table 45.1 Major Human Endocrine Glands and Some of Their Hormones (continued)

Gland	Hormone	Chemical Class	Representative Actions	Regulated By
Pancreas 	Insulin	Protein	Lowers blood glucose level	Glucose in blood
	Glucagon	Protein	Raises blood glucose level	Glucose in blood
Adrenal glands 				
Adrenal medulla	Epinephrine and norepinephrine	Amines	Raise blood glucose level; increase metabolic activities; constrict certain blood vessels	Nervous system
Adrenal cortex	Glucocorticoids	Steroids	Raise blood glucose level	ACTH
	Mineralocorticoids	Steroids	Promote reabsorption of Na^+ and excretion of K^+ in kidneys	K^+ in blood; angiotensin II
Gonads 				
Testes	Androgens	Steroids	Support sperm formation; promote development and maintenance of male secondary sex characteristics	FSH and LH
Ovaries 	Estrogens	Steroids	Stimulate uterine lining growth; promote development and maintenance of female secondary sex characteristics	FSH and LH
	Progestins	Steroids	Promote uterine lining growth	FSH and LH
Pineal gland 	Melatonin	Amine	Involved in biological rhythms	Light/dark cycles

	HORMONE	ACTION	SOURCE
BODY METABOLISM	T3 and T4	↑ Increases metabolism	Thyroid
BLOOD GLUCOSE	Cortisol	↑ Increases blood glucose (stored glycogen converted to glucose)	Adrenal cortex
	Glucagon	↑ Increases blood glucose	Pancreas
	Epinephrine	↑ Increases blood glucose	Adrenal medulla
	Insulin	↓ Decreases blood glucose (Glucose converted to stored glycogen)	Pancreas
BLOOD CALCIUM	Parathyroid hormone	↑ Increases blood levels	Parathyroid
	Calcitonin	↓ Decreases blood levels	Thyroid
BLOOD SODIUM	Aldosterone	↑ Increases blood levels (more sodium reabsorbed from kidney tubules)	Adrenal cortex

Human Endocrine System

Endocrine System

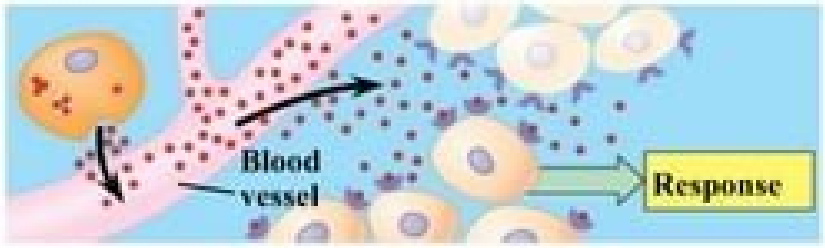
Endocrine System : consists of ductless glands that release hormones that are transported throughout the body by blood vessels which provide chemical control of various functions of the body.

Endocrine glands : secrete chemical compounds called hormones into the blood system.

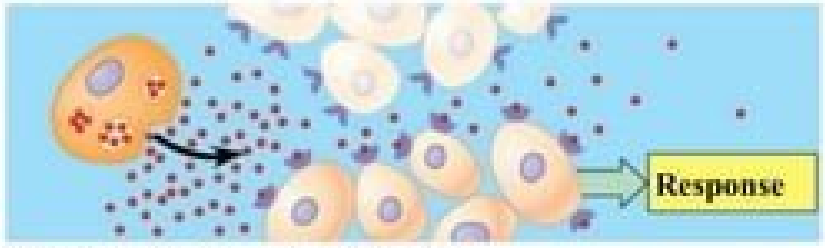
- **Hormones** : are secreted from a secretory cell in a gland and act on a target cell at another part of the body.
- •**Target cells :** must have receptors for the specific hormone.

MECHANISMS OF HORMONE SECRETION

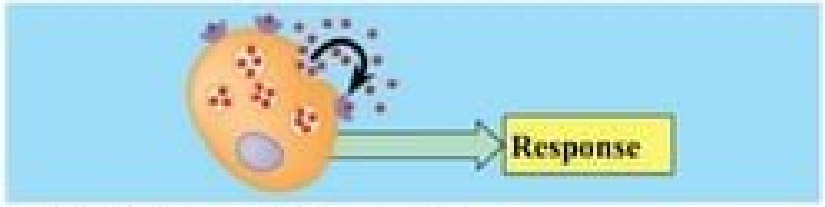
- **Humoral Trigger**
- Something in the blood is being monitored. When the level of that substance is too low, it stimulates the release of the hormone.
- **Neuronal Trigger**
- A neuron directly stimulates the gland to cause secretion of the hormone.
- **Hormonal Trigger**
- One endocrine gland releases a hormone that stimulates another endocrine gland to release its hormone.
- **Endocrine action**: the hormone is distributed in blood and binds to distant target cells.
- **Paracrine action**: the hormone acts locally by diffusing from its source to target cells in the neighborhood.
- **Autocrine action**: the hormone acts on the same cell that produced it.



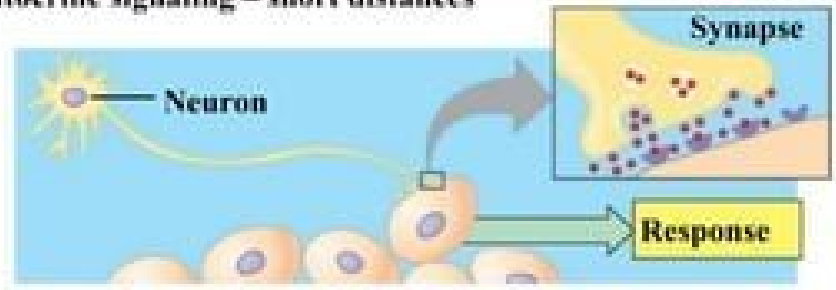
(a) Endocrine signaling



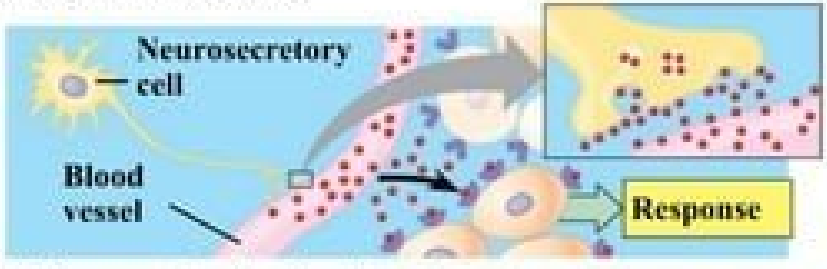
(b) Paracrine signaling – short distances



(c) Autocrine signaling – short distances



(d) Synaptic signaling

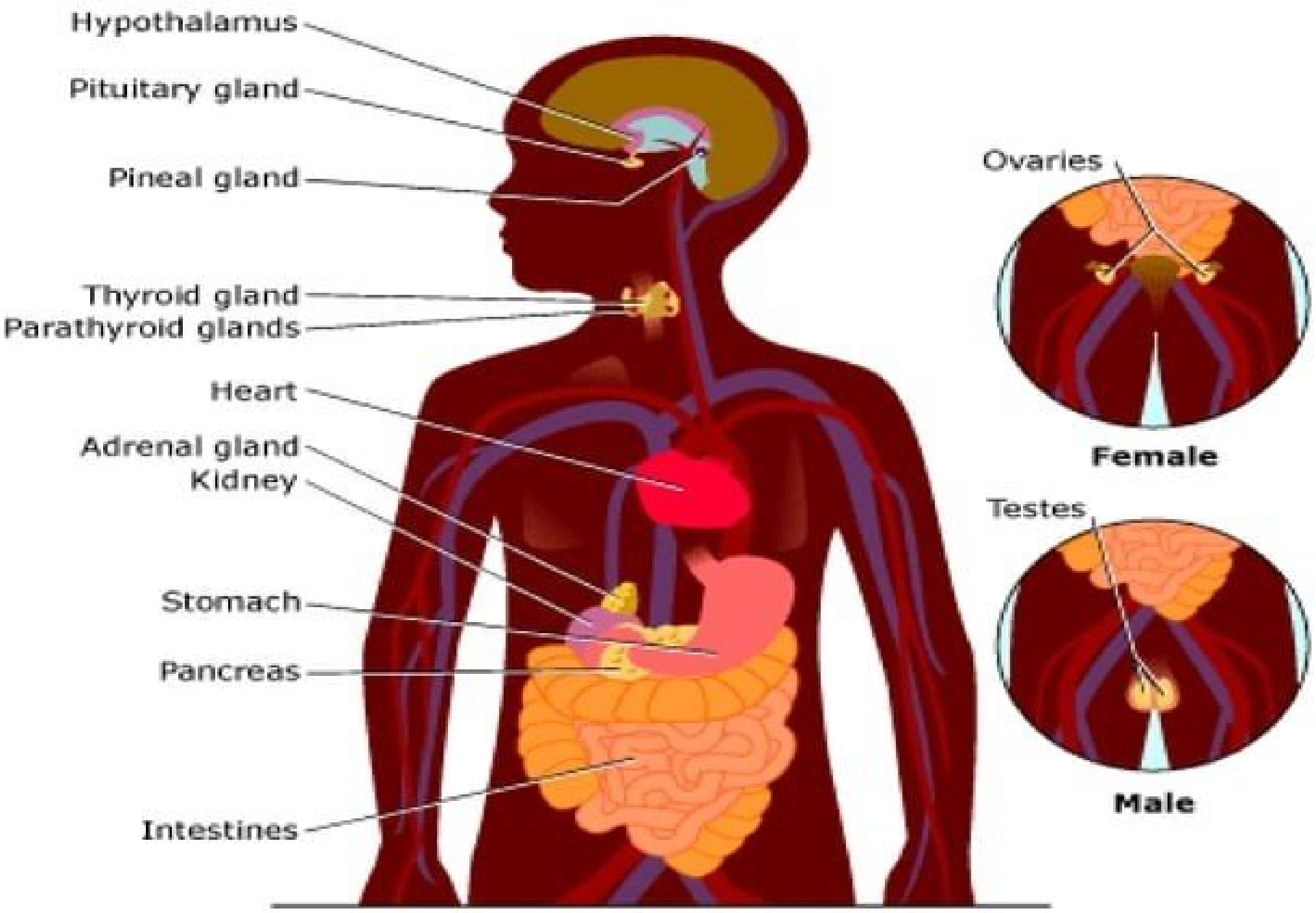


(e) Neuroendocrine signaling

Endocrine system

Endocrine glands :-

- Hypothalamus
- Pituitary gland
- Pineal Gland
- Thyroid gland
- Parathyroid gland
- Thymus
- Adrenal Gland
- Gonads (testes/ovaries)
- Pancreatic Islet
- Heart
- Kidney
- Digestive Tract



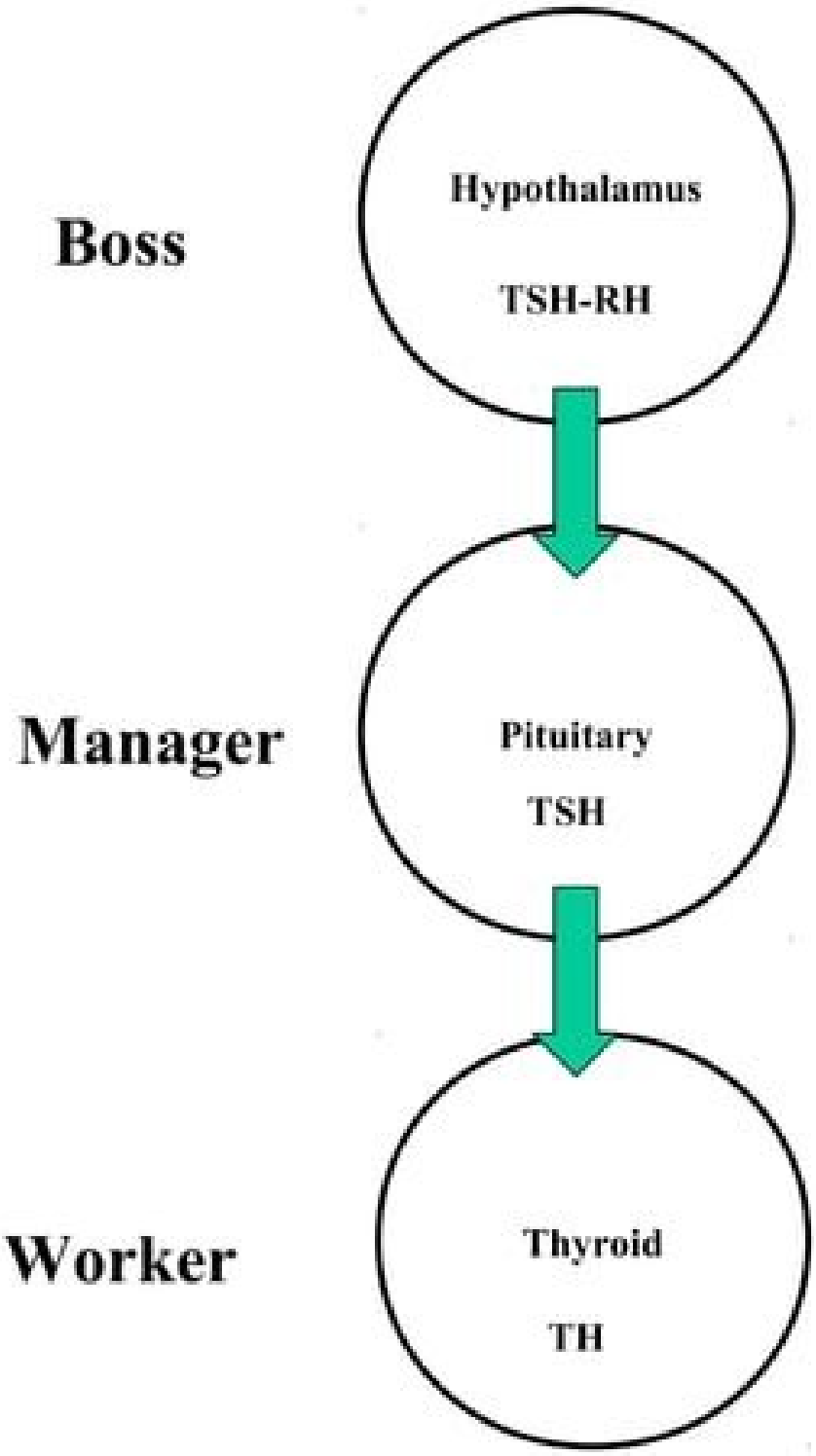
The Endocrine System

Endocrine System Functions

- Metabolism and tissue maturation
- Ion regulation
- Water balance
- Immune system regulation
- Heart rate and blood pressure regulation
- Control of blood glucose and other nutrients
- Control of reproductive functions
- Uterine contractions and milk release

Hypothalamus

- This is located at the base of the brain
- The hypothalamus controls the endocrine system by controlling the pituitary gland.
  - Secretes **releasing hormones** to cause the pituitary to release hormones.
  - Secretes **inhibiting hormones** to turn off secretion of pituitary hormones.

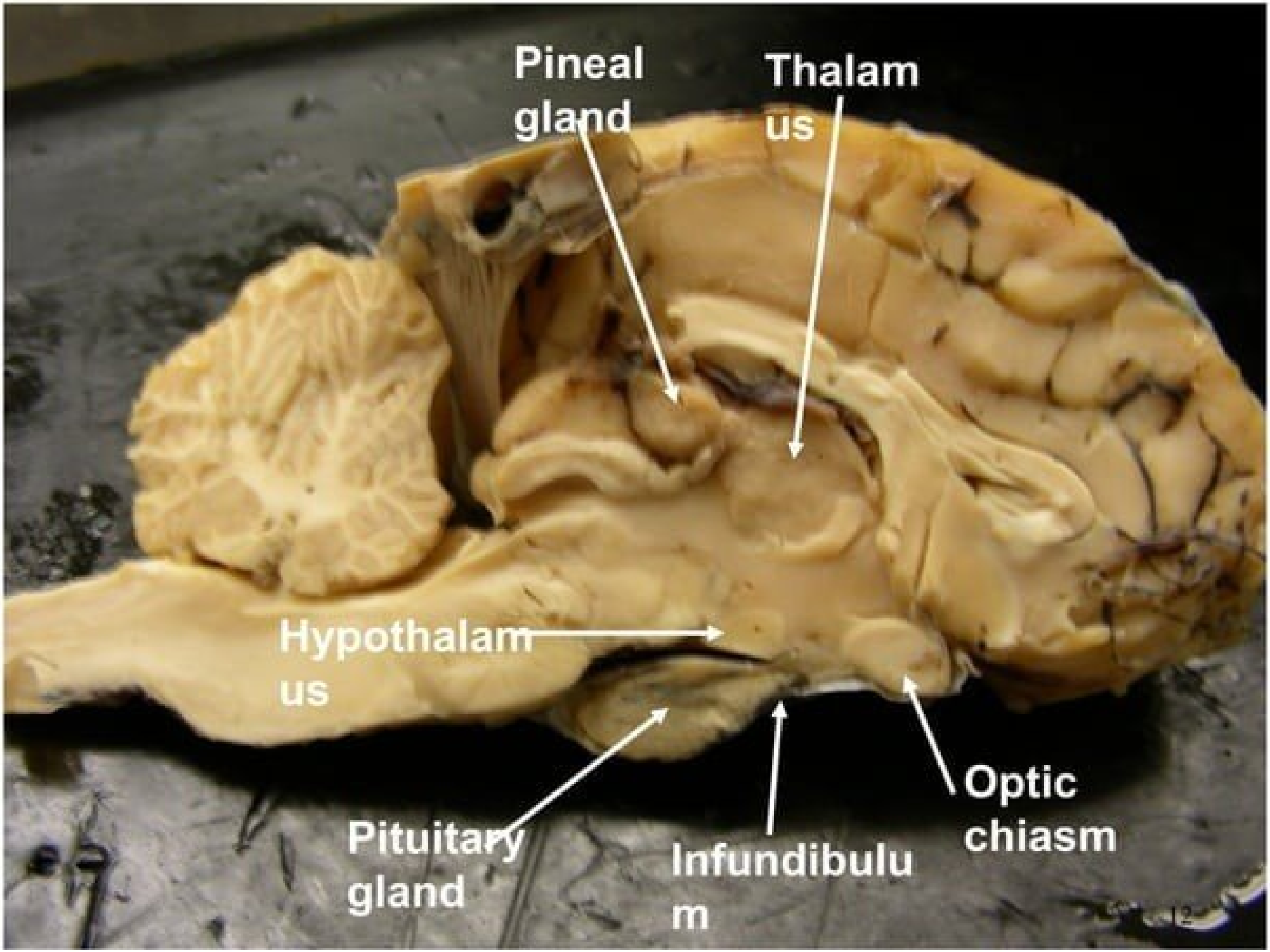


This is what happens in the body:

Hypothalamus (the boss) makes TSH-RH (thyroid stimulating hormone releasing hormone)

Pituitary (the manager) makes TSH (thyroid stimulating hormone)

Thyroid gland (the worker) makes TH (thyroid hormone)



Hypothalamus Regulation

- The hypothalamus produces hormones which affect the pituitary, for example:
- Thyroid Stimulating Hormone Releasing Hormone (TSH-RH)
  - Causes adenohypophysis to secrete TSH
  - TSH affects thyroid gland to secrete TH
- Thyroid Stimulating Hormone Inhibiting Hormone (TSH-IH)
  - Causes adenohypophysis to stop secreting TSH so thyroid gland stops secreting thyroid hormone

Hypothalamus Hormones

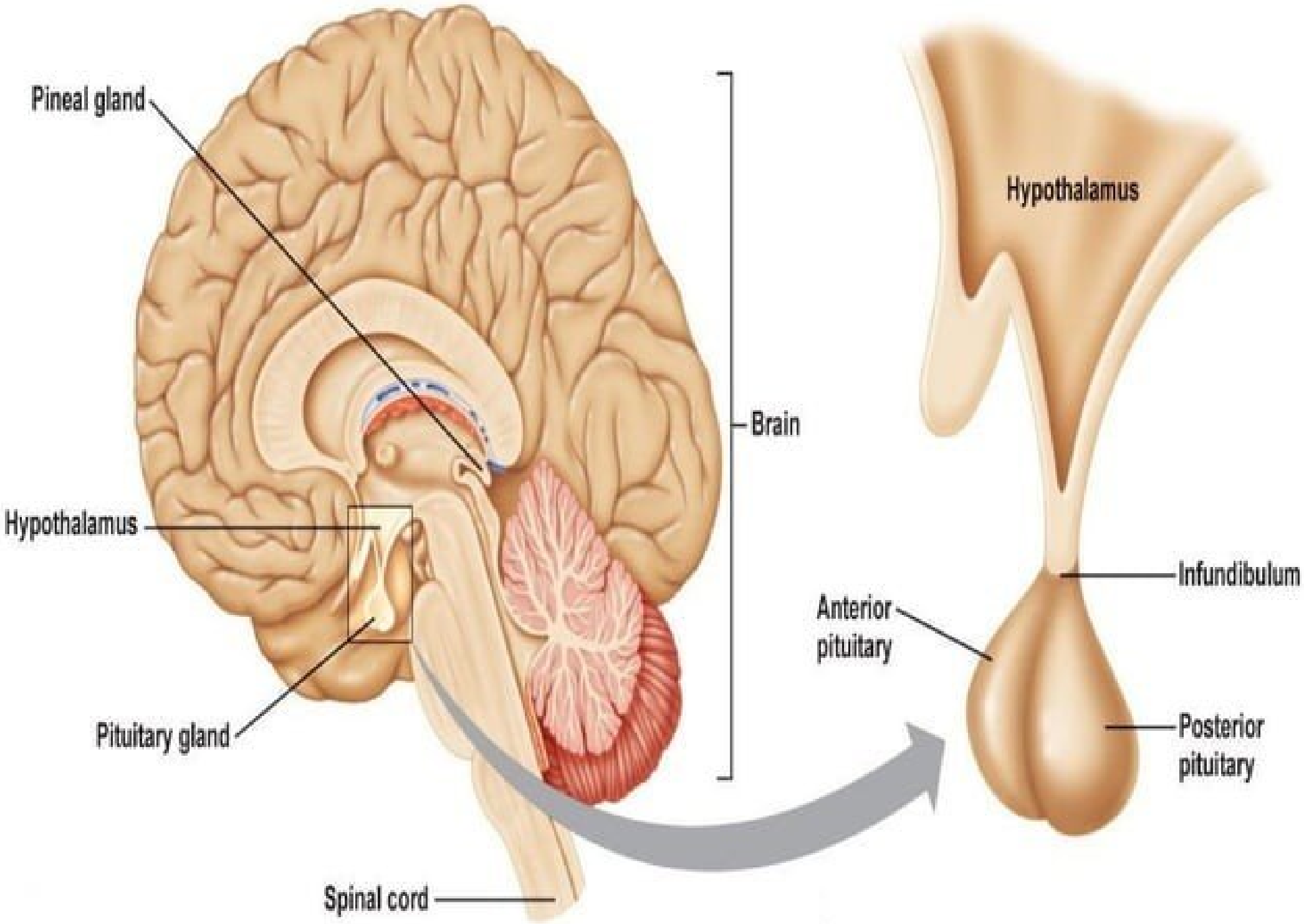
- Growth Hormone Releasing Hormone (GH-RH)
- Prolactin Releasing Hormone (PRL-RH)
- Thyroid Stimulating Hormone Releasing Hormone (TSH-RH)
- Adrenocorticotropic Hormone Releasing Hormone (ACTH-RH)
- Melanocyte Stimulating Hormone Releasing Hormone (MSH-RH)
- Follicle Stimulating Hormone Releasing Hormone (FSH-RH)
- Luteinizing Hormone Releasing Hormone (LH-RH)

Hypothalamus Hormones

- Growth Hormone Inhibiting Hormone (GH-IH)
- Prolactin Inhibiting Hormone (PRL-IH)
- Thyroid Stimulating Hormone Inhibiting Hormone (TSH-IH)
- Adrenocorticotropic Hormone Inhibiting Hormone (ACTH-IH)
- Melanocyte Stimulating Hormone Inhibiting Hormone (MSH-IH)
- Follicle Stimulating Hormone Inhibiting Hormone (FSH-IH)
- Luteinizing Hormone Inhibiting Hormone (LH-IH)

The Pituitary Gland

- Secretes nine major hormones
- Attached to the hypothalamus by the infundibulum (stalk)
- Two basic divisions of the pituitary gland
  - Adenohypophysis (anterior lobe)
  - Neurohypophysis (posterior lobe)



The hormones secreted by the anterior pituitary gland

- Growth Hormone (GH)
- Melanocyte stimulating hormone (MSH)
- Adrenal corticotropic Hormone (ACTH)
- Prolactin (PRL)
- Thyroid stimulating hormone (TSH)
- Luteinizing Hormone (LH)
- Follicle stimulating Hormone (FSH)

Growth Hormone (Somatotropin)

- Growth hormone travels through the blood and stimulates the liver to produce a protein called insulin-like growth factor (IGF-1)
- In children, IGF-1 stimulates chondrocytes to multiply in the cartilage at the ends of long bones (epiphyseal plate)
  - This leads to growth in the length of the bones and increases the child's height
- In adults, growth hormone plays an important role in repair and maintenance of the body's tissues
- IGF-1 also acts on immature muscle cells to increase muscle mass

Growth Hormone (Somatotropin)

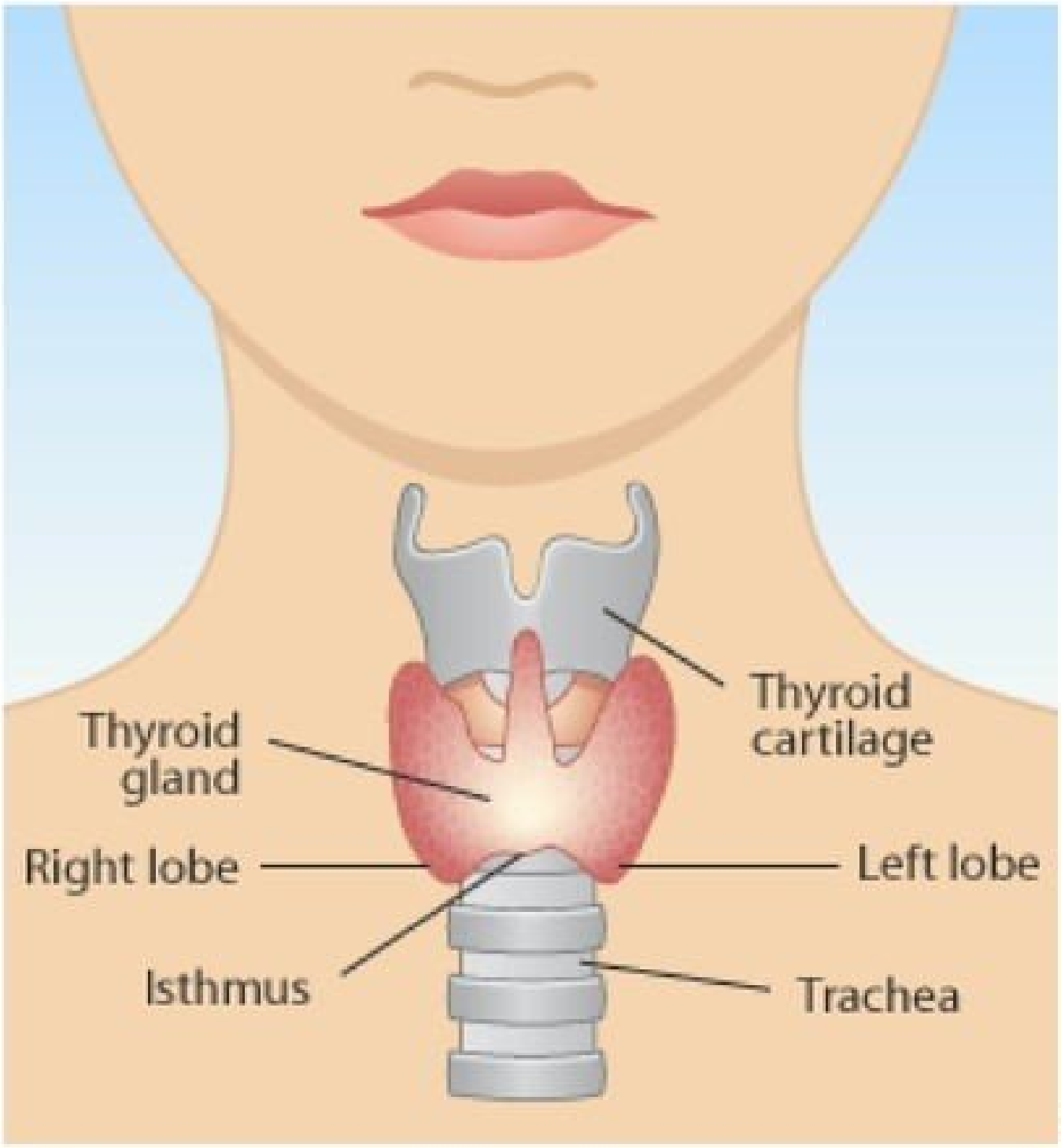
- **Hypersecretion** of GH in children (Gigantism) (overall growth)
- **Hypersecretion** of GH in adults (Acromegaly): enlarged hands , feet, big chin, nose, and forehead.
- **Hyposecretion** of GH (dwarfism)

Prolactin (PRL)

- Stimulates lacrimation (desire to cry)
- Decreased in adolescent males so it decreases desire to cry
- Enlarges the mammary glands and stimulates milk production
- **Hyperscretion** - over production of milk and enlargement of breasts (also occurs in men)
- **Hyposcretion** - under production or no production of milk

The Thyroid Gland

- Located in the anterior neck, inferior to thyroid cartilage



The Thyroid Gland

- **Thyroid Stimulating Hormone (TSH)**

Causes the thyroid gland to release thyroid hormone

- Produces two hormones
  - Thyroid hormone (TH)
  - Calcitonin

The Thyroid Gland

- Thyroid hormone (TH)
  - Acts on most cells of the body
  - Increases metabolic rate
  - Controlled by hormonal mechanism
  - Iodine is needed to make TH
- Calcitonin
  - Lowers blood calcium levels; especially secreted in children
  - Slows osteoclasts to allow osteoblasts to deposit bone in the skeleton.

(Vitamin D is synthesized and secreted by the dermis)

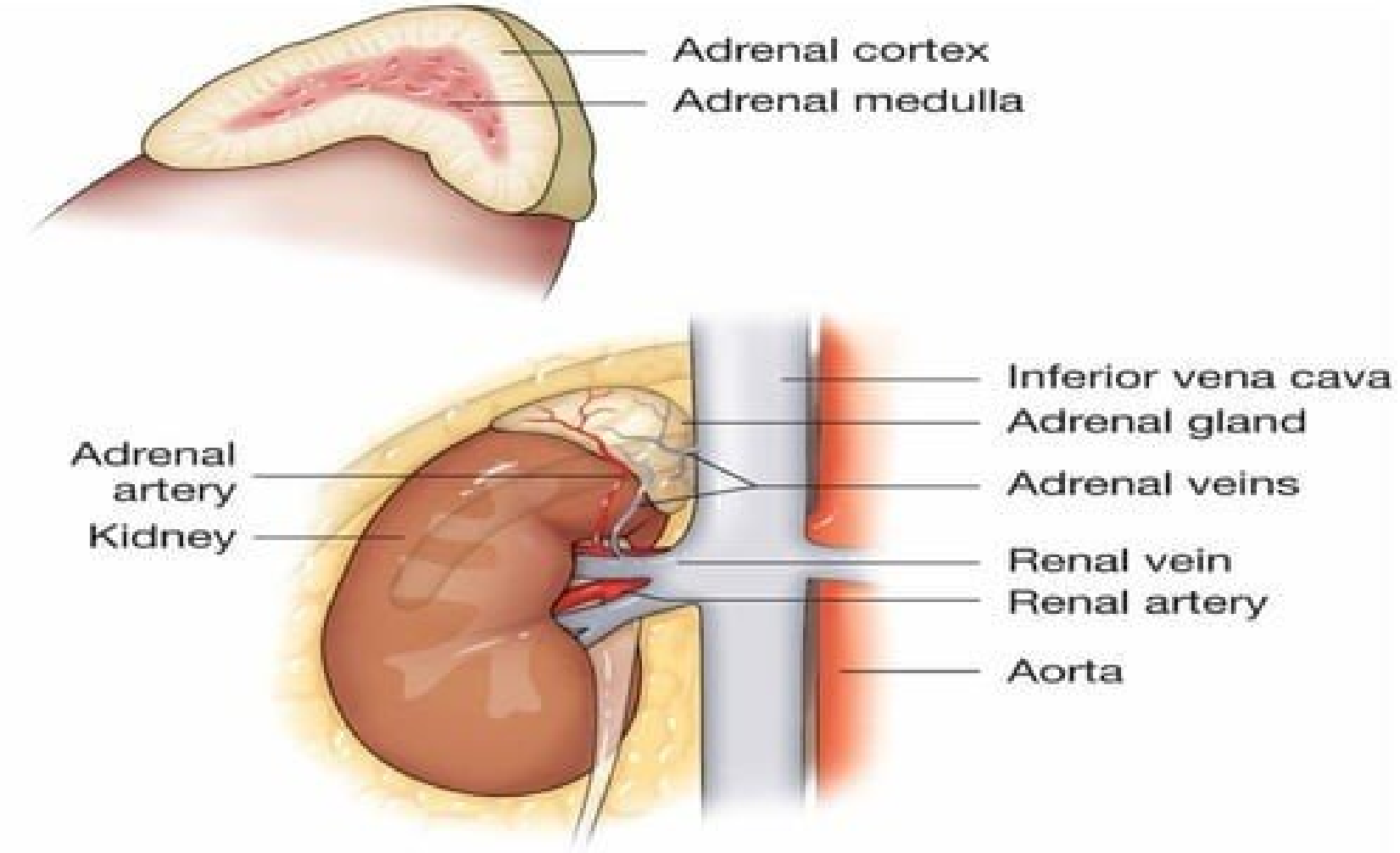
Melanocyte Stimulating Hormone (MSH)

- Stimulates the production and release of melanin by melanocytes in skin
- **Hypersecretion** - unnaturally dark skin
- **Hyposecretion** - prone to sunburn

Adrenal corticotropic Hormone (ACTH)

- also called corticotropin or adrenocorticotropin, a polypeptide hormone formed in the pituitary gland that regulates the activity of the outer region (cortex) of the adrenal glands.

Adrenal gland



Adrenal Glands:

- located on top of kidneys
- **Adrenal medula:**

- **Epinephrine**
- That is secreted mainly by the medulla of the adrenal glands
- Functions primarily to increase cardiac output .
- To raise glucose levels in the blood.
- Epinephrine typically is released during acute stress, and its prepare an individual for either "fight or flight"
- **Norepinephrine**
- Norepinephrine is a neurotransmitter and hormone that also is part of the fight-or-flight response in the body
- It raises the heart rate, which causes glucose to be released as energy and blood to flow to the muscles.

Adrenal Glands

- **Adrenal cortex** : synthesizes and secretes corticosteroids as directed by ACTH from the anterior pituitary
  - **Mineralocorticoids** : affect salt and water balance
  - **Aldosterone :** stimulates kidney cells to reabsorb sodium ions and water
  - **Glucocorticoids** – promote glucose synthesis from noncarbohydrate substances such as proteins
  - **Androgens and Estrogens**
    - **Male sex hormones (Androgens)**
    - **Female sex hormones (estrogen)**

Gonadotropins

FSH and LH are called gonadotropins because they act on the gonads and regulate reproductive function.

Follicle-stimulating hormone (FSH)

- Regulates the development of ovarian follicles and secretion of oestrogen
- Regulates the production of sperm in men

Luteinizing hormone (LH)

- Induces ovulation in females
- Induces testosterone in males
- Stimulates ovulation and formation of the corpus luteum that secretes oestrogen and progesterone.

The Gonads

Ovaries

Progesterone

- Prepares the endometrium for implantation and pregnancy

Oestrogen

- Matures the ovum for release.
- Responsible for the secondary female characteristics

Testes

Testosterone

- Regulates the production and maturation of sperm;
- Responsible for the secondary male sexual characteristics

The Posterior Pituitary Hormones (The Neurohypophysis)

Oxytocin

- Regulates the release of milk in lactating women
- Induces uterine contractions in labour
- Has a role in orgasm and inducing 'pair bonding'...ie. Love!)

Vasopressin

Anti Diuretic Hormone (ADH)

- Regulates the body fluids.
- To increase water reabsorption .

Hypersecretion - high blood pressure

Hyposecretion- low blood pressure

Parathyroid Glands

- Four glands imbedded on the posterior surface of the thyroid gland

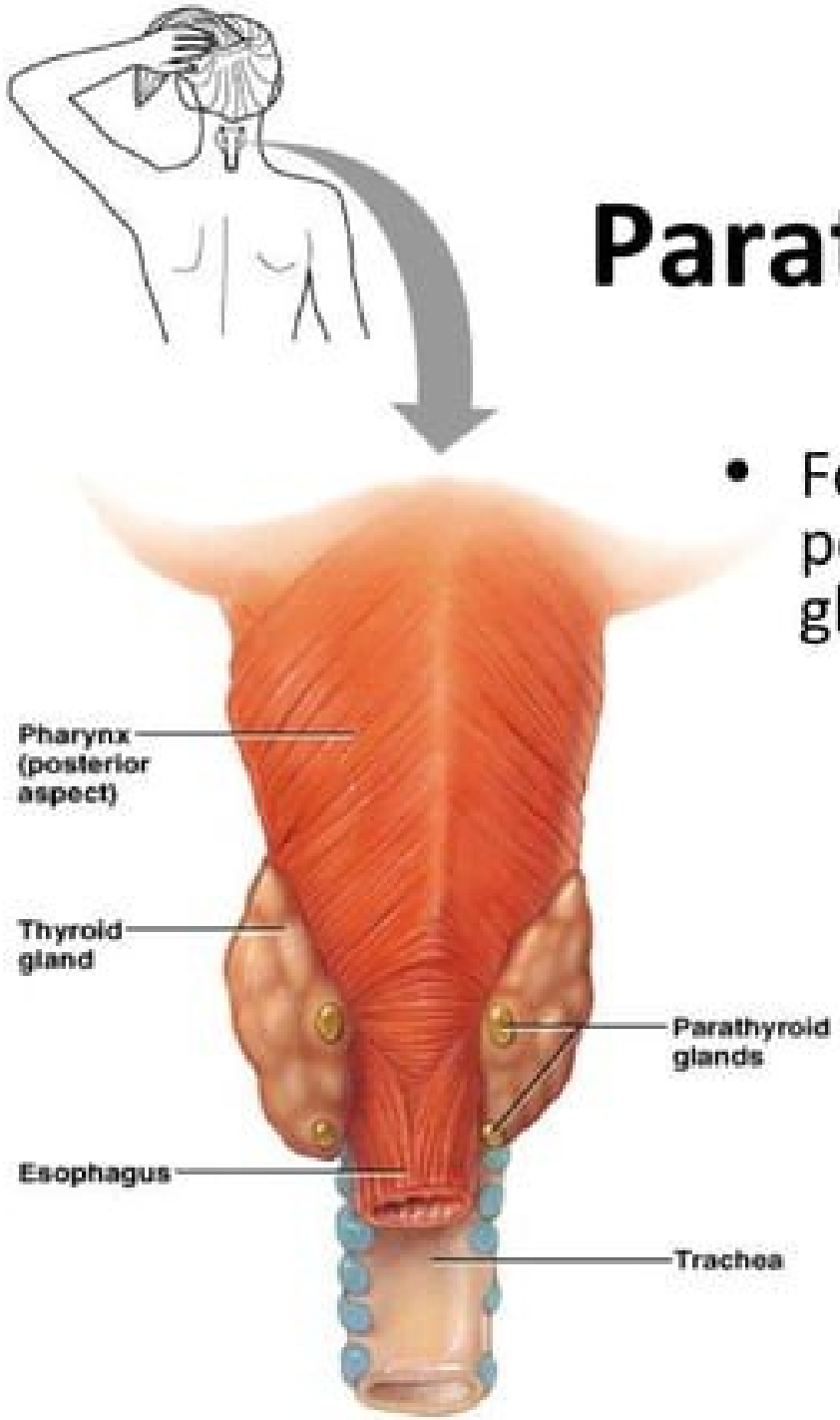
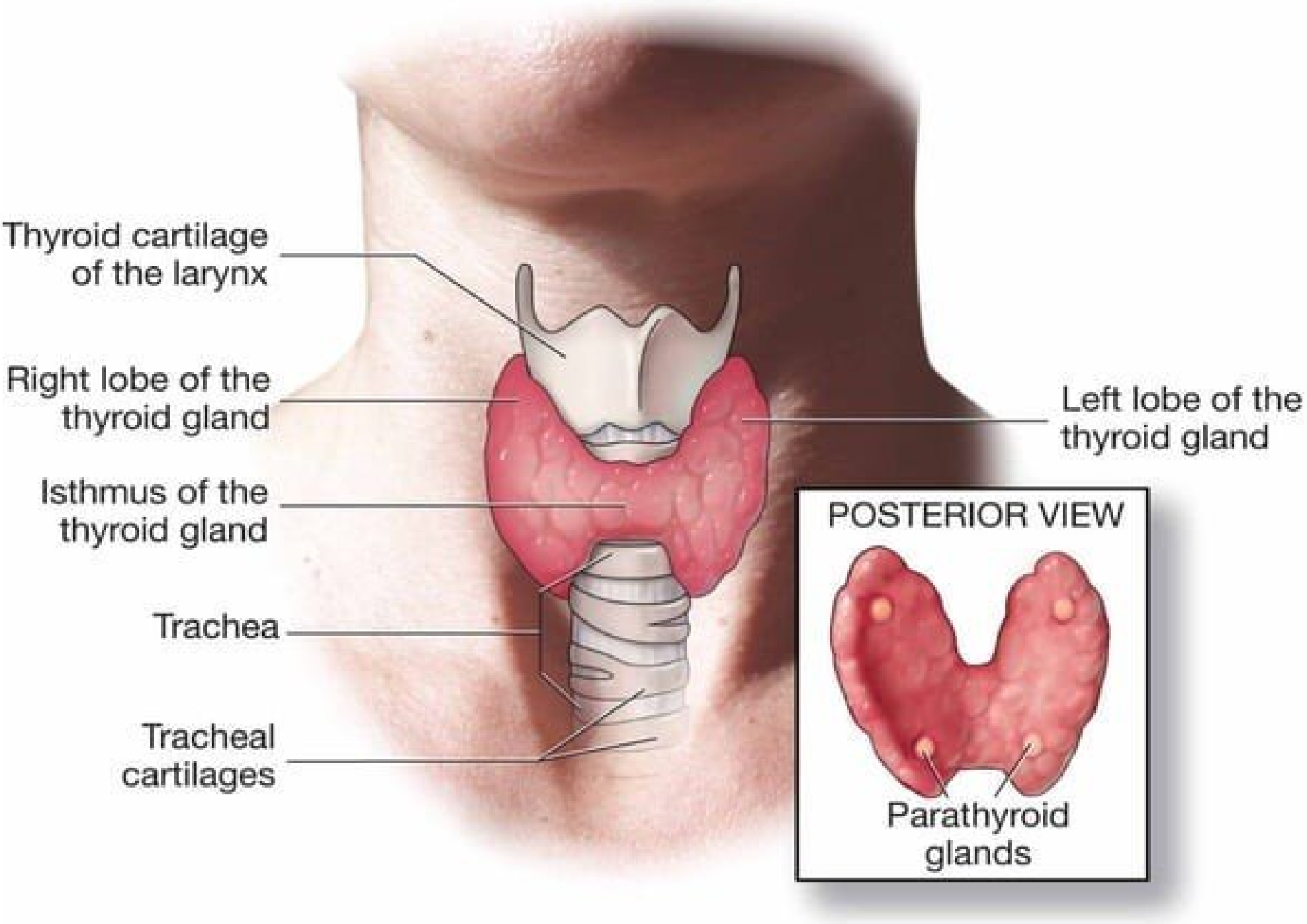


Figure 25.8a



- **Thymus Gland**
  - A pink gland with two lobes located in the thoracic cavity posterior to the sternum
  - Large during childhood and puberty but shrinks during adulthood
  - Functions as part of both the body's immune response and the endocrine system

➢ Secretes thymosin

➢ Involved in the activation of T lymphocytes (T-cells)

HYPOSECRETION - increased susceptibility to disease

The Pineal Hormones

- Pineal Gland
  - Located between the two lobes of the thalamus
  - Secretes the hormone melatonin
  - Maintains the body's internal clock and regulates the onset and duration of sleep
  - Stimulated by darkness and inhibited by light