Anterior pituitary gland (I)

By

Dr. Amr Medhat Abbas

Professor of Medical Physiology

Learning outcomes:

- **At the end of the lecture, you will be able to:**

1. Describe the endocrine glands.
2. Describe the hypothalamic connections to the pituitary gland.
3. Explain the hormones secreted by anterior pituitary.
4. Explain the control of secretion of anterior pituitary hormones.
5. Explain the functions, mechanism of action and control of secretion of GH.

Endocrine

- **Endocrine glands** are group of cells that secrete certain chemicals called **hormones**.
- They are also called **ductless glands** because they release their hormones **directly** in the **circulating blood**.

Hormones

- The **secretory product** of endocrine glands.
- Secreted in a **catalytic amount** (very small amounts) into blood stream.
- They reach **specific target cells** (which have a specific hormone **receptors**).
- They produce **physiologic**, **morphologic** and **biochemical** changes.

Endocrine glands

1- Hypothalamus: which has 2 endocrinal functions:

a) Controls the secretion of the anterior pituitary gland, by:

i- Releasing and release inhibiting hormones for: growth hormone, prolactin and melanocyte stimulating hormone.

ii-Releasing hormones for: thyrotropin, corticotropin and gonadotropin.

b) Releases the posterior pituitary hormones: antidiuretic hormone (ADH) and oxytocin.

2- Pituitary gland: which is formed mainly of 2 lobes:

a) Anterior lobe:

i- Its own primary hormones: growth hormone, prolactin and melanocyte stimulating hormone.

ii- Trophic hormones which regulate the functions of all the other endocrine glands **except** parathyroid glands, pancreas and adrenal medulla.

b) Posterior lobe: which releases antidiuretic and oxytocin hormones.

3- The thyroid gland which releases: **thyroxin, tri-iodothyronine** and **calcitonin** hormones.

4- The parathyroid glands which release **parathormone** hormone.

5- The suprarenal glands. Each is formed of **cortex** and **medulla:**

a) **Cortex**, which is the **outer** part of the gland and **releases:**

- **Mineralocorticoid** hormones e.g. aldosterone hormone.
- **Glucocorticoid** hormones e.g. cortisol.
- **Androgenic** corticoids e.g. dehydro-epiandrosterone.

b) Medulla, the **inner** part of the gland, which **releases** the catecholamines (epinephrine, norepinephrine, & dopamine).

6- Endocrine portion of pancreas (islets of Langerhans):

a) Alpha cells release **glucagon** hormone.

b) Beta cells release **insulin** hormone.

c) Delta cells which secrete **somatostatin** hormone.

d) F cells which release **pancreatic polypeptide.**

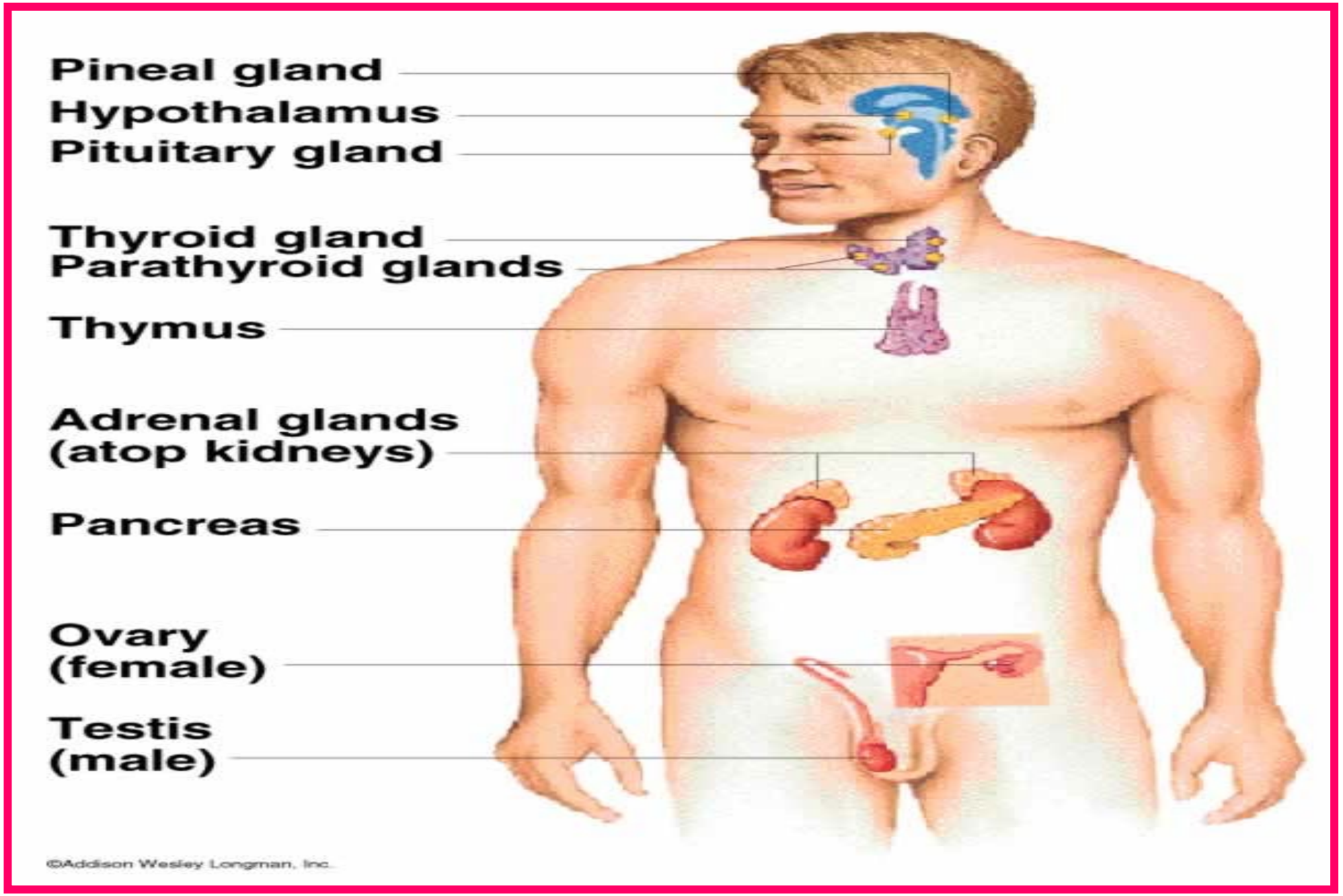
7- The primary sex organs:

a) **Testes (male gonads)** which release the male sex hormone, **testosterone**.

b) **Ovaries (female gonads)** which release **estrogen** and **progesterone** hormones.

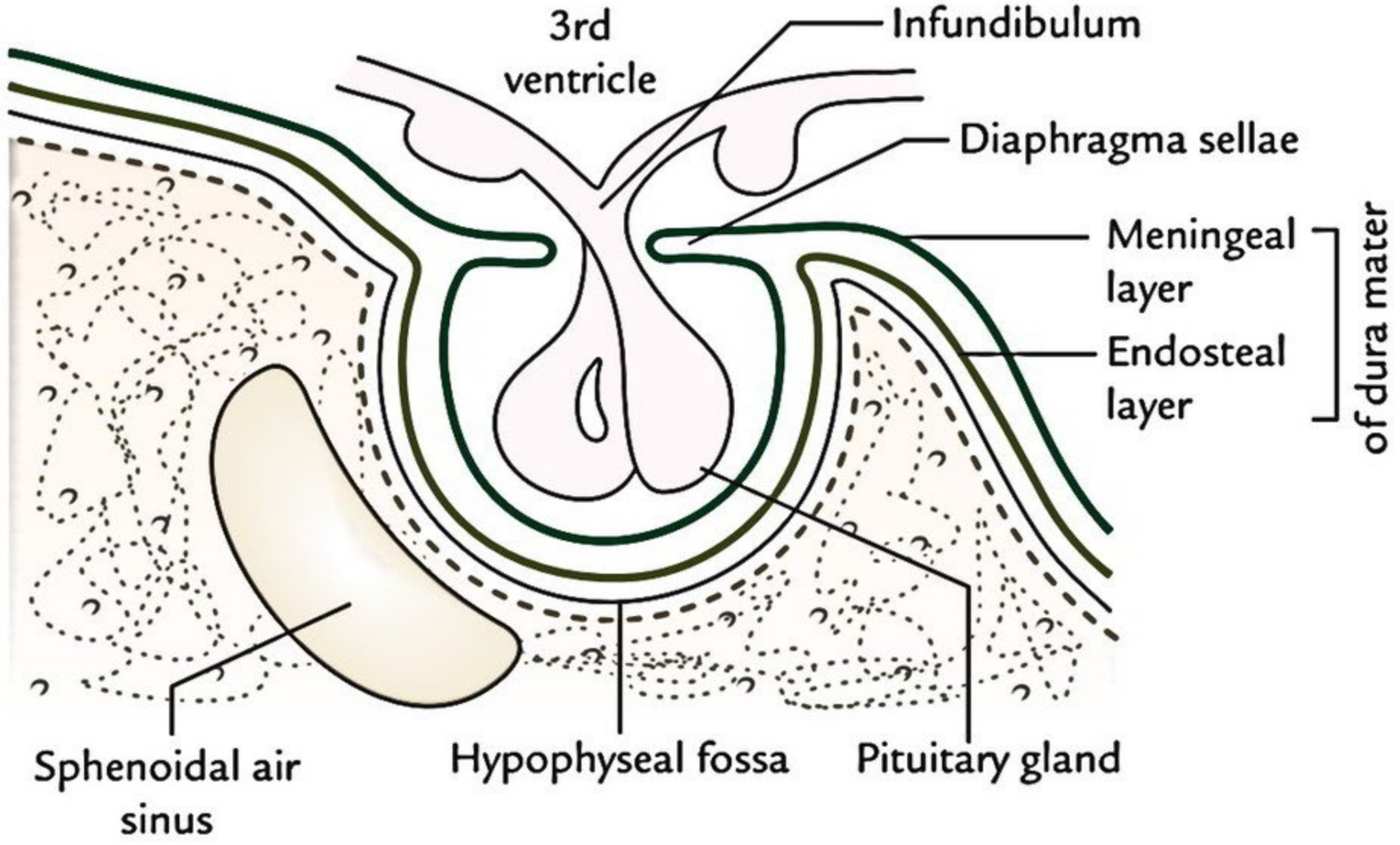
8- Thymus gland which releases **thymosin** hormone.

9- Pineal gland which releases **melatonin** hormone.


Pineal gland
Hypothalamus
Pituitary gland
Thyroid gland
Parathyroid glands
Thymus
Adrenal glands
(atop kidneys)
Pancreas
Ovary
(female)
Testis
(male)
©Addison Wesley Longman, Inc.

Pituitary gland (Hypophysis cerebri)

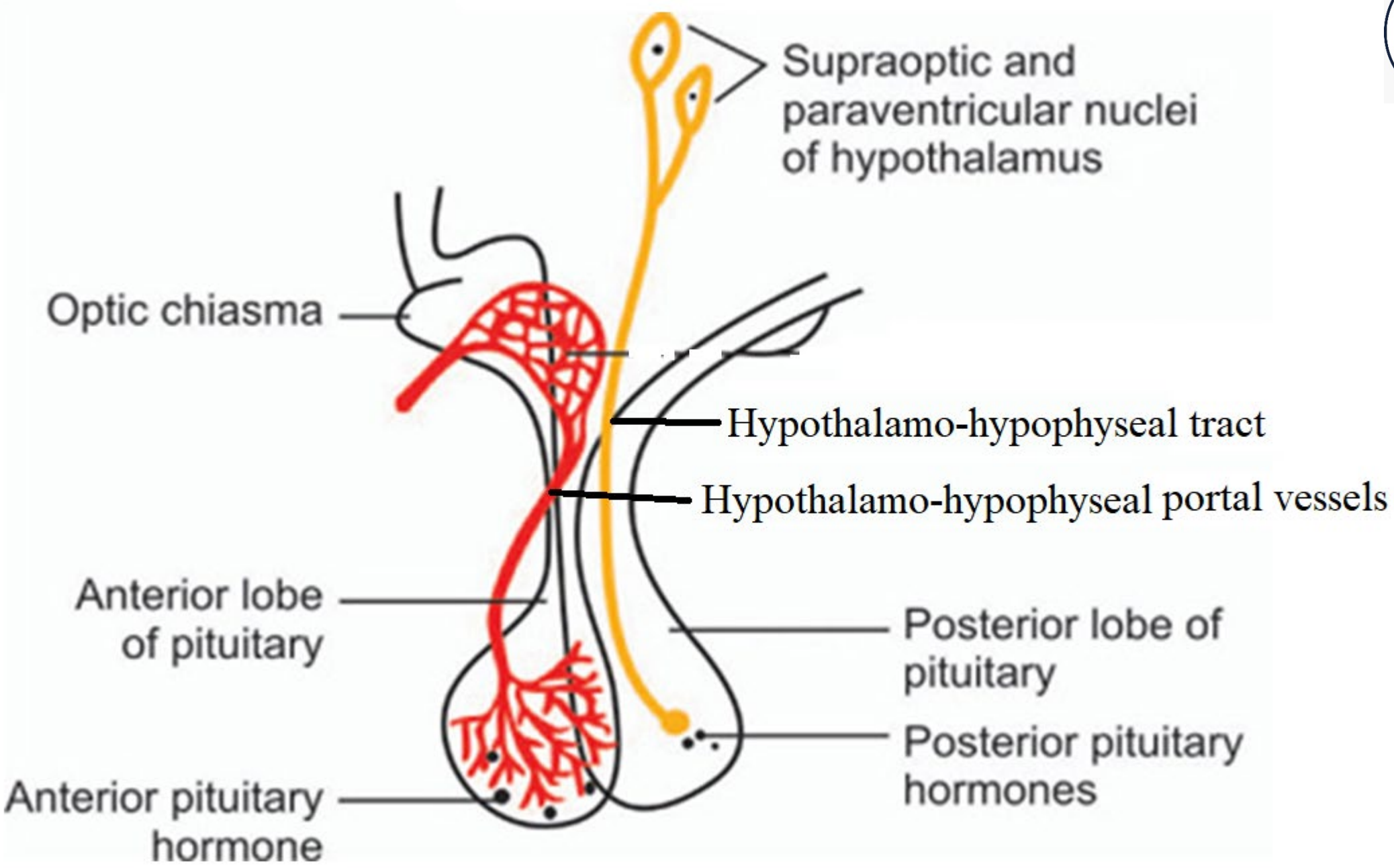
- **Shape:** ovoid.
- **Weight:** 500 – 600mg.
- **Site:** at the base of brain in a small cavity called ***sella tursica*** (***pituitary fossa***), which is covered by extension of the dura matter (***the diaphragma sellae***), through which the ***pituitary stalk*** passes connecting the gland to **hypothalamus**.


3rd ventricle
Infundibulum
Diaphragma sellae
Meningeal layer
Endosteal layer
of dura mater
Sphenoidal air sinus
Hypophyseal fossa
Pituitary gland

Hypothalamic connections to pituitary gland

1-Vascular connection: hypothalamo-hypophyseal portal circulation between **hypothalamus** & **anterior pituitary**.

2-Neural connection: hypothalamo-hypophyseal tract between **hypothalamus** & **posterior pituitary**.


Supraoptic and
paraventricular nuclei
of hypothalamus
Optic chiasma
Hypothalamo-hypophyseal tract
Hypothalamo-hypophyseal portal vessels
Anterior lobe
of pituitary
Posterior lobe of
pituitary
Posterior pituitary
hormones
Anterior pituitary
hormone

Anterior pituitary gland (adenohypophysis)

-Weight: **75%** of weight of pituitary gland.

-Color: **dark red** color.

- Hormones:

A) Primary hormones:

1-growth hormone. **2-Prolactin.**

3-Melanocyte stimulating hormone (MSH).

B) Trophic hormones:

1-Thyroid stimulating hormone (TSH) **(Thyrotropin).**

2-Adrenocorticotropic hormone (ACTH) **(Corticotropin).**

3-Gonadotropins:

a)Follicle stimulating hormone (F.S.H).

b)Luteinizing hormone (L.H).

- **N.B.:**

The anterior pituitary gland is called the **master gland** as it secretes **trophic** hormones that control all other endocrine glands **except parathyroid, supra-renal medulla & pancreas**.

- Cells:

1- Chromophils (50%):

a) Acidophil cells (30-40%)➔

- **Somatotropes** that secrete Growth hormone.
- **Mamotropes** that secrete Prolactin.

b)Basophil cells (10-20%)➔

- **Thyrotropes** that secrete T.S.H.
- **Gonadotropes** that secrete F.S.H & LH.
- **Corticotropes** that secrete ACTH and γ-M.S.H.

2- Chromophobes (50%): Small cells with no granules (inactive).

- Control of secretion of anterior pituitary:

1) Hypothalamic control:

*The hypothalamus influences the release and synthesis of anterior pituitary hormones by **hypothalamo-hypophyseal portal circulation**.

Hormone	Hypothalamic control
• Growth hormone (GH).	• GH releasing hormone (GHRH). • GH release inhibitory hormone (GHRIH)
• Prolactin.	• Prolactin releasing hormone (PRH). • Prolactin release inhibitory hormone (PRIH) = (dopamine)
• Melanocyte stimulating hormone (MSH) (Melanotropin)	• Melanotropin releasing hormone (MRH). • Melanotropin release inhibitory hormone (MRIH).

Hormone	Hypothalamic control
• Thyroid stimulating hormone or thyrotropin.	• Thyrotropin releasing hormone (TRH).
• Adrenocortico trophic hormone (ACTH) or corticotropin.	• Corticotropin releasing hormone (CRH).
• Gonadotropins: Follicle stimulating hormone (F.S.H) & luteinizing hormone (LH).	• Gonadotropin releasing hormone (GRH).

2) Negative feedback control:

- ***Thyroxine*** ➔ inhibit TSH secretion from A. pit. and TRH secretion from hypothalamus **(mainly A. Pit.)**.
- ***Estrogen or cortisol*** ➔ inhibit gonadotropin or ACTH secretion from A. pit and Gn.RH or CRH secretion from hypothalamus **(mainly hypoth.)**.

Growth hormone (Somatotropic hormone) (Somatotropin)

- **Source:** acidophil somatotrop cells.
- **Nature:** protein hormone (190 aa).
- **Blood levels:**

- **3 ng/ml.**
- High in newborn
- Total amount secreted/day = **0.5 mg**

• Functions:

1- On growth: Responsible for **50% of linear growth** of the body.

a) **↑ weight & bulk of soft tissues** by powerful protein anabolic effect (***except gonads, adrenals and thyroid***, which are controlled by A. pit. trophic hormones).

b) ↑ length of bones by:

- Stimulating proliferation of epiphyseal cartilage.
- Formation of more protein bone matrix.
- Increase the precipitation of minerals in bones.

* **Anabolic effect is promoted by insulin** → glucose oxidation → energy needed for building up tissue proteins.

2- On metabolism:

a)Protein metabolism:

- ↑ amino acids transport across cell membrane.
- ↑ protein synthesis by ribosomes.
- ↑ RNA formation.
- Inhibit protein catabolism.

b) **Carbohydrate metabolism:** GH has an **anti-insulin action:**

- It inhibit hexokinase enzyme ➔ ↓ glucose uptake by tissues.
- ↑ gluconeogenesis.
- Stimulate glucagon release ➔ ↑ glycogenolysis.

c) Fat metabolism:

- Lipolysis ➔ ↑ FFA ➔ energy during stress e.g. starvation & hypoglycemia.

d) Electrolyte metabolism:

- ↑ Ca^{2+} absorption from GIT.
- ↓ Na^{+}, K^{+} & $PO_4^{=}$ excretion by kidney.

• Mechanism of action of GH:

- GH has **no direct anabolic actions**.
- Growth promoting actions of GH are mediated by a group of intermediary polypeptide substances called **somatomedins**.
- Somatomedins are formed in the **liver** and **bone**.

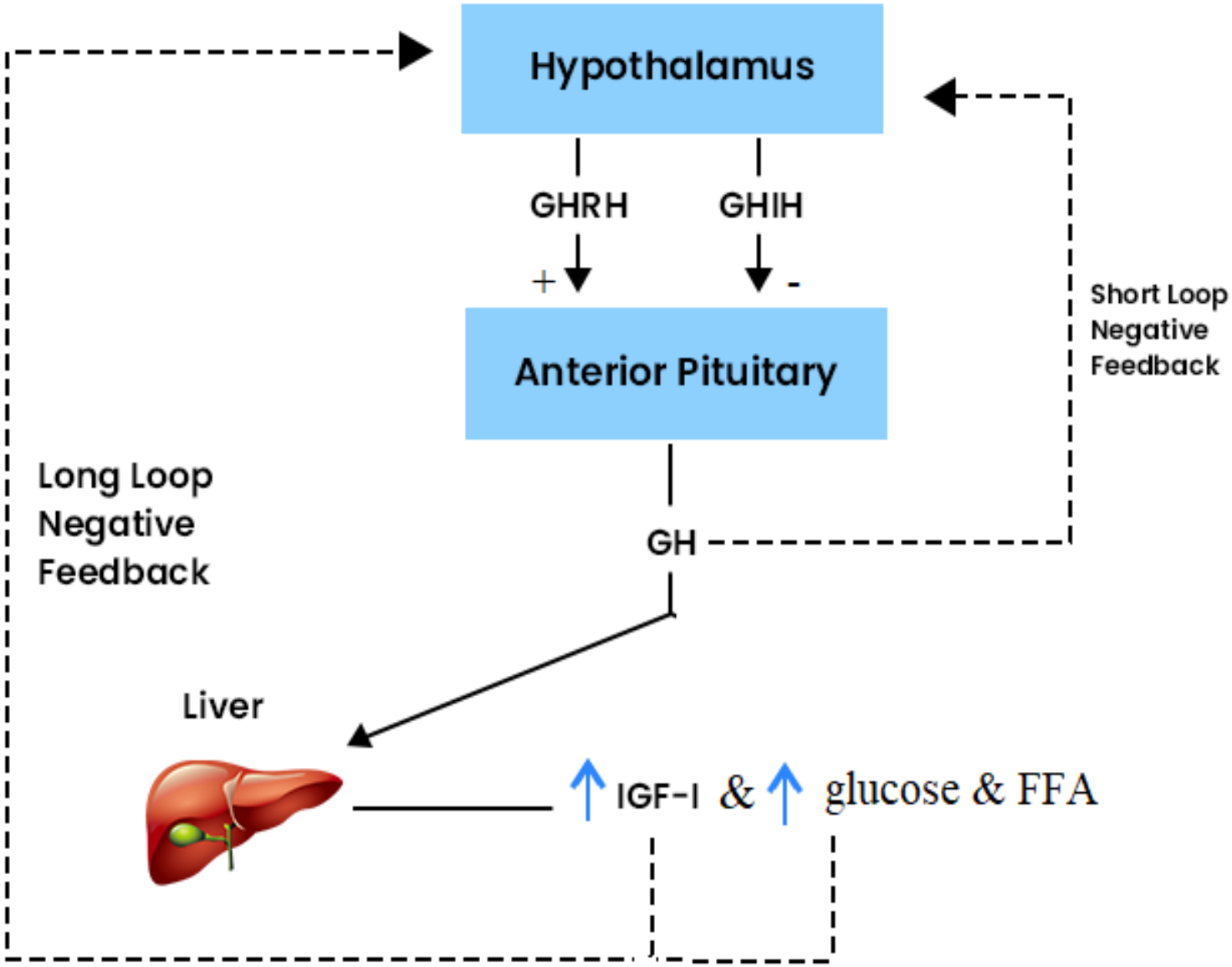
- Structurally **similar to proinsulin**, so called **insulin like growth factors (IGF)**, **e.g.** IGF-I (somatomedin-C) & IGF-II.
- They bind to **specific membrane receptors**. These receptors can also bind insulin and proinsulin but with much less affinities.

• Control of GH secretion:

(1) Hypothalamus releases:

- GH releasing hormone ➔ ↑ GH secretion.
- GH release inhibiting hormone ➔ ↓ GH secretion.

(2) –ve feedback: GH ➔ inhibition of secretion of GHRH from hypothalamus (– ve Feedback).


Hypothalamus
GHRH
GHIH
+
-
Anterior Pituitary
Short Loop
Negative
Feedback
Long Loop
Negative
Feedback
GH
Liver
IGF-I & glucose & FFA

(3) Other factors:

Stimulators	Inhibitors
- Hypoglycemia.	- Hyperglycemia.
- ↓ FFA.	- Increase FFA
- ↑ aa e.g. arginine.	- ↑ cortisol
- Stress	- ↑ GH.
- Starvation.	- Obesity.
- Sleep.	
- Exercise	
- Estrogen and dopamine	
α – adrenergic agonists	

- **NB:**

GH has a ***regular nocturnal peak*** which occurs ***1- 2 hours after the onset of deep sleep***.

References

1. Costanzo, Linda S. "BRS Physiology (Board Review Series)." (2018).
2. Ganong, William F. "Review of medical physiology." (2020).
3. Hall, John E and Hall, Micheal E. “Guyton and Hall Textbook of medical physiology." (2021).