

Vinayak Study Junction, BEAWAR

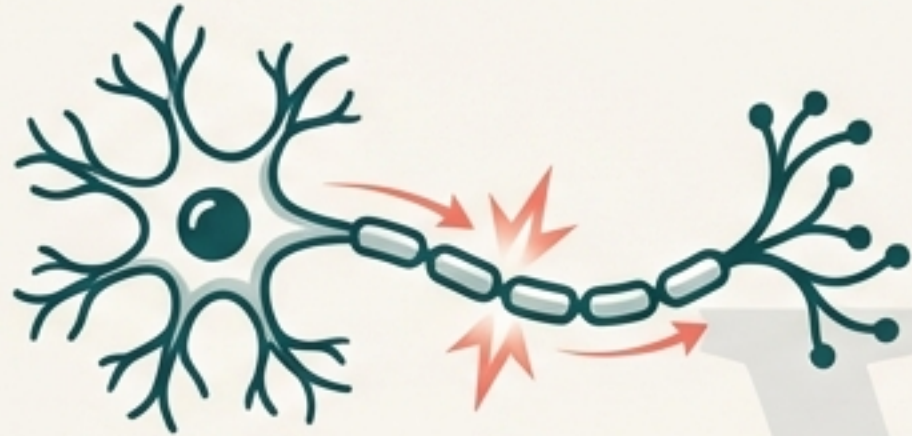


The Body's Wireless Network

An Introduction to Chemical Coordination and Integration

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The Two Communication Systems: Wired vs. Wireless



The Neural System (The Wired Network)

Provides point-to-point, rapid coordination among organs.

- 🚀 **Speed:** Fast
- 🕒 **Duration:** Short-lived



The Endocrine System (The Wireless Network)

Carried out by hormones to continuously regulate cellular functions where nerve fibers do not reach.

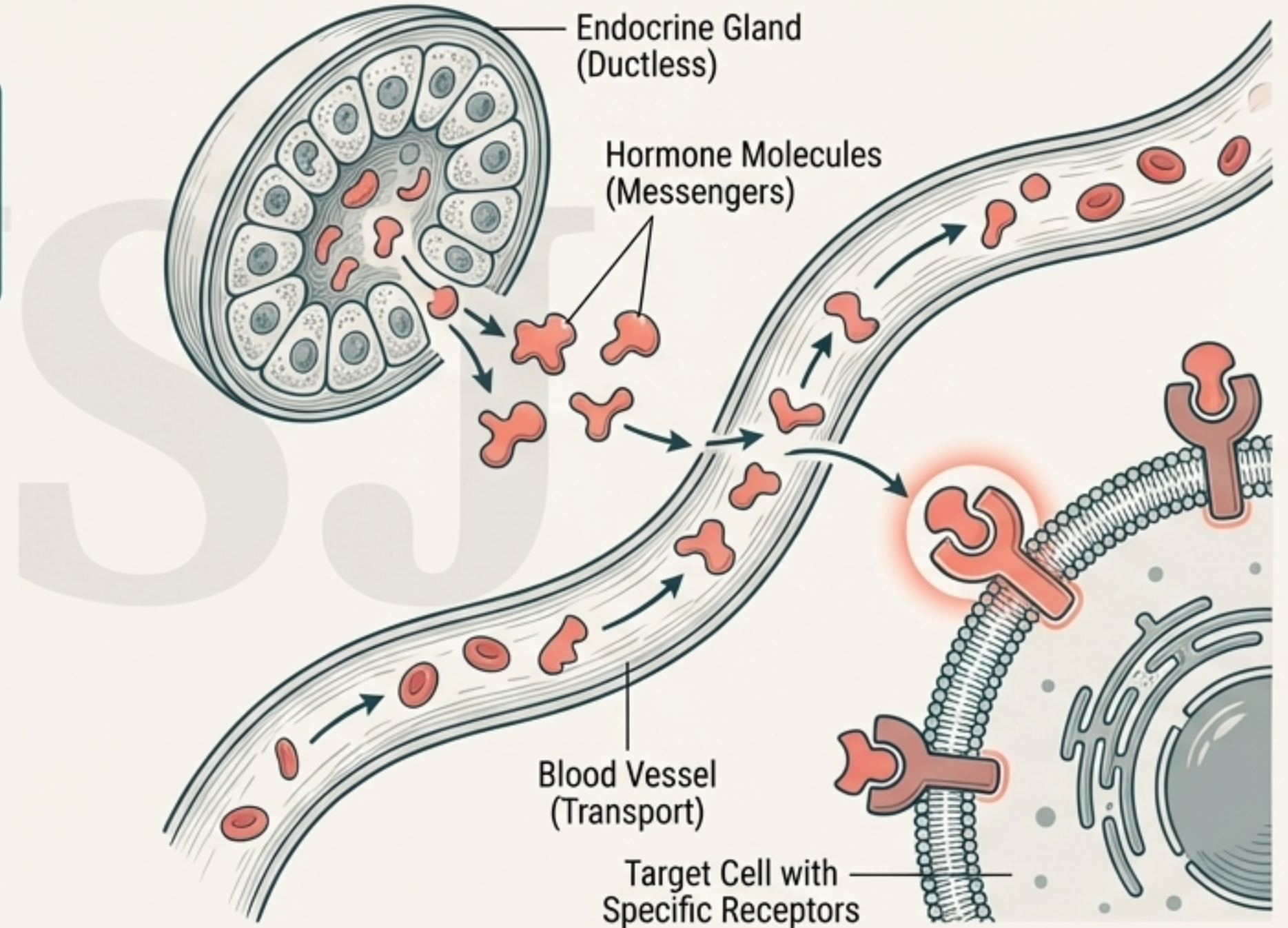
- 🐢 **Speed:** Slower
- 🕒 **Duration:** Sustained, long-lasting effects

The neural system and the endocrine system jointly coordinate and regulate the physiological functions in the body.

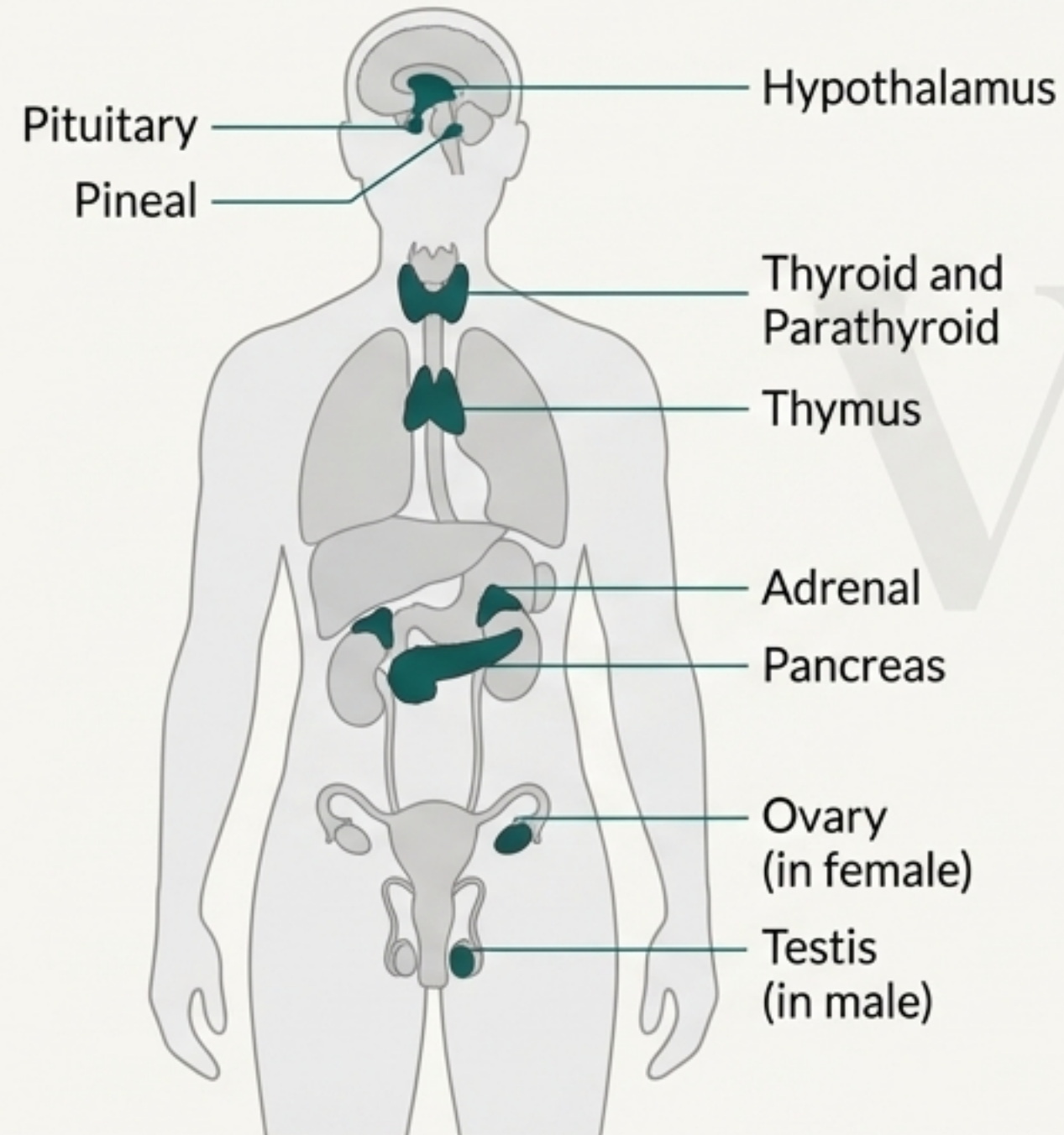
Meet the Messenger: What is a Hormone?

Hormones are non-nutrient chemicals which act as **intercellular messengers** and are produced in trace amounts.

- Endocrine glands that produce hormones are "ductless glands," releasing their secretions directly into the blood.
- This modern definition is broad, covering molecules beyond those from traditional glands.
- Vertebrates, including humans, have a large number of chemicals that act as hormones to provide complex coordination.



The Human Endocrine System: A Nationwide Network



The endocrine glands and hormone-producing diffused tissues/cells located in different parts of our body constitute the endocrine system. This network regulates everything from metabolism and growth to stress response and reproduction.

The Master Controller: The Hypothalamus

Location: The basal part of the diencephalon (forebrain).

Primary Function: Regulates a wide spectrum of body functions by controlling the pituitary gland.

Mechanism of Control:

Contains neurosecretory cells (nuclei) that produce hormones.

Releasing Hormones: Stimulate secretion of pituitary hormones.

Example: Gonadotrophin releasing hormone (GnRH) stimulates the pituitary to release gonadotrophins.

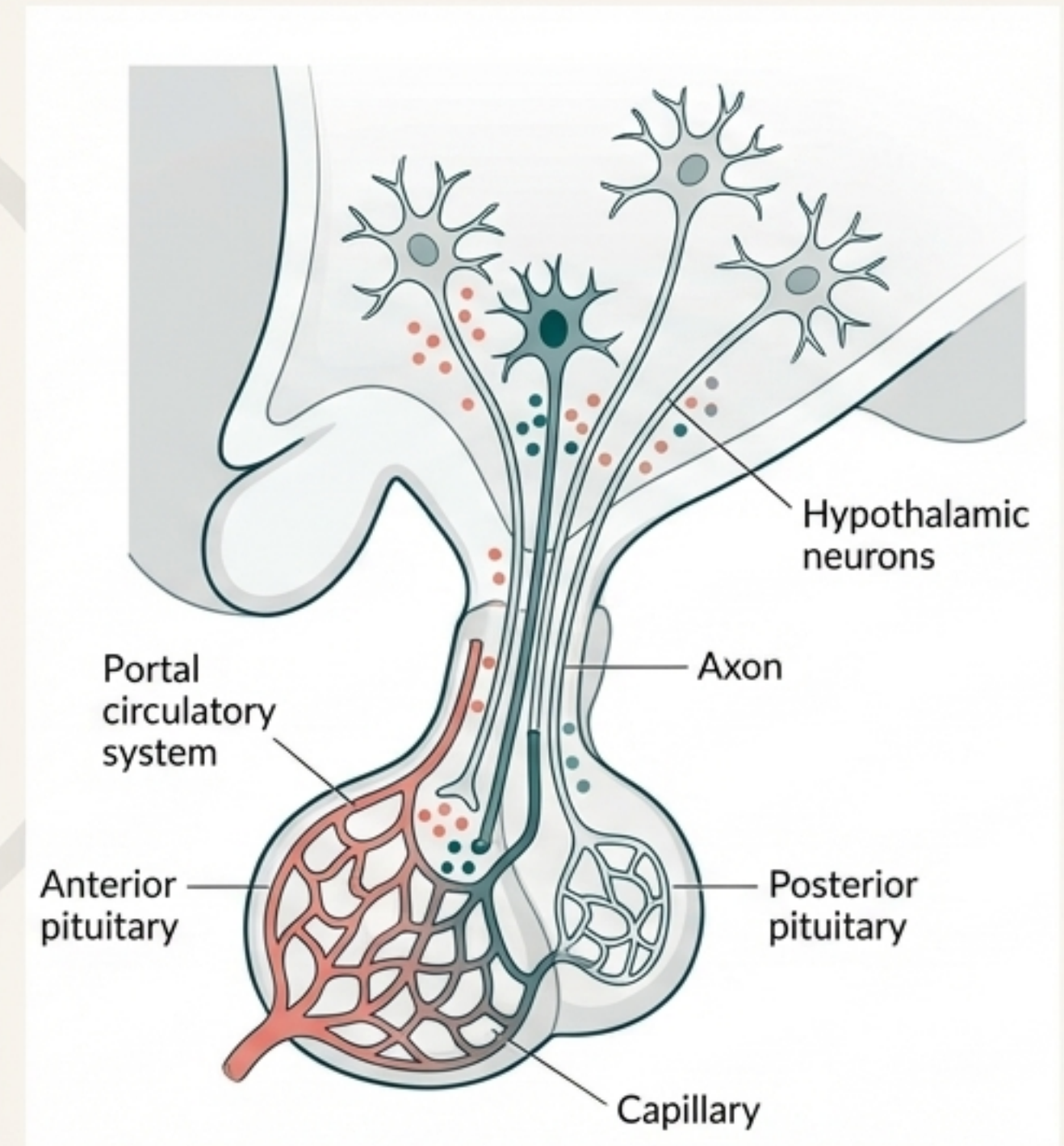
Inhibiting Hormones: Inhibit secretions of pituitary hormones.

Example: Somatostatin inhibits the release of growth hormone from the pituitary.

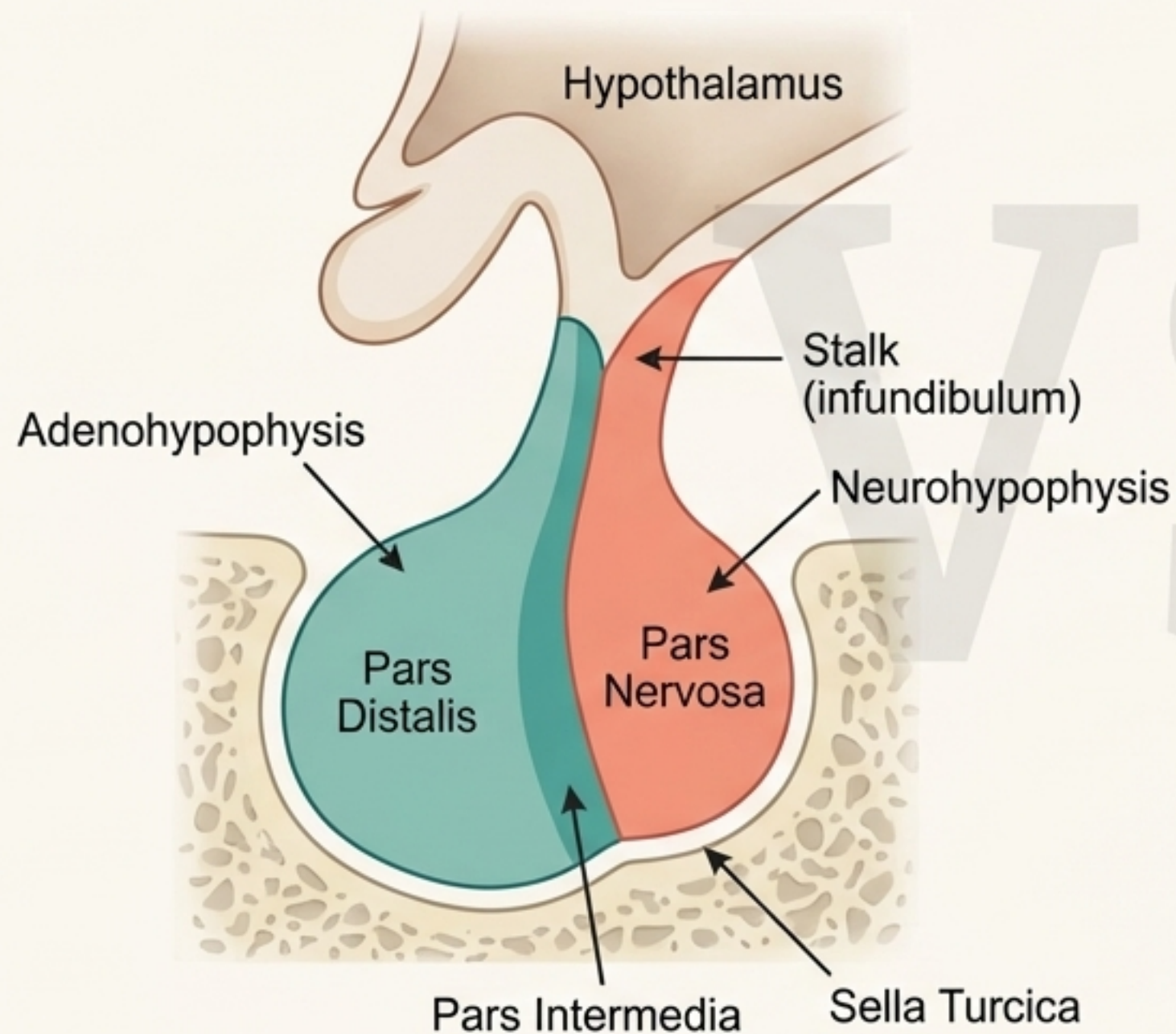
Connection to Pituitary:

Anterior Pituitary: Regulated via a portal circulatory system.

Posterior Pituitary: Under direct neural regulation.



The Senior Manager: The Pituitary Gland



Location:

Located in a bony cavity called sella tursica, attached to the hypothalamus by a stalk.

Anatomical Divisions:

1. Adenohypophysis (Anterior Lobe)

- *Pars Distalis*: Commonly called the anterior pituitary. A major production hub.
- *Pars Intermedia*: Secretes MSH. In humans, it is almost merged with the pars distalis.

2. Neurohypophysis (Posterior Lobe)

- *Pars Nervosa*: Also known as the posterior pituitary. It does not produce hormones but stores and releases them from the hypothalamus.

Pituitary Hormones: The Body's Marching Orders

Anterior Pituitary (Pars Distalis) Productions



Growth Hormone (GH): Controls body growth.



Prolactin (PRL): Regulates mammary gland growth and milk formation.



Thyroid Stimulating Hormone (TSH): Stimulates the thyroid gland.



Adrenocorticotropic Hormone (ACTH): Stimulates the adrenal cortex to produce glucocorticoids.



Luteinizing Hormone (LH) & Follicle Stimulating Hormone (FSH): (Gonadotrophins) Stimulate gonadal activity.

Pars Intermedia Secretion



Melanocyte Stimulating Hormone (MSH): Regulates skin pigmentation.

Posterior Pituitary (Neurohypophysis) Releases

(Synthesized by Hypothalamus)



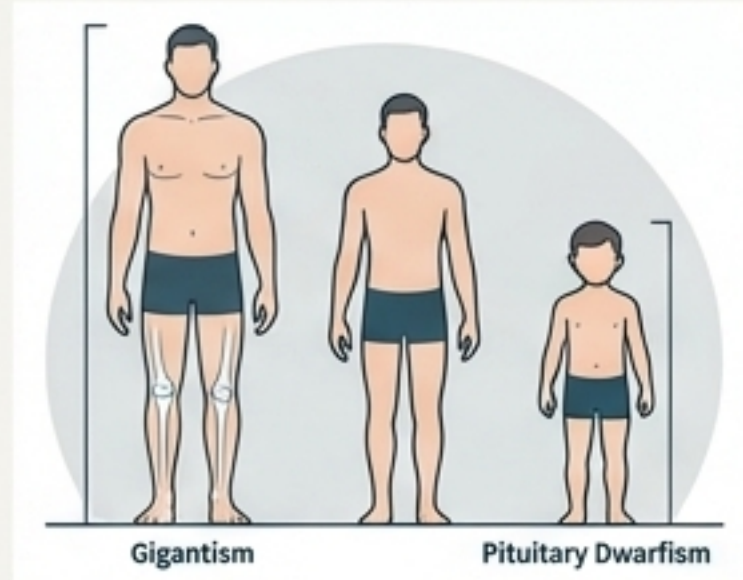
Oxytocin: Stimulates smooth muscle contraction (e.g., uterus during childbirth, milk ejection).



Vasopressin (Anti-diuretic Hormone, ADH): Stimulates water reabsorption by the kidneys.

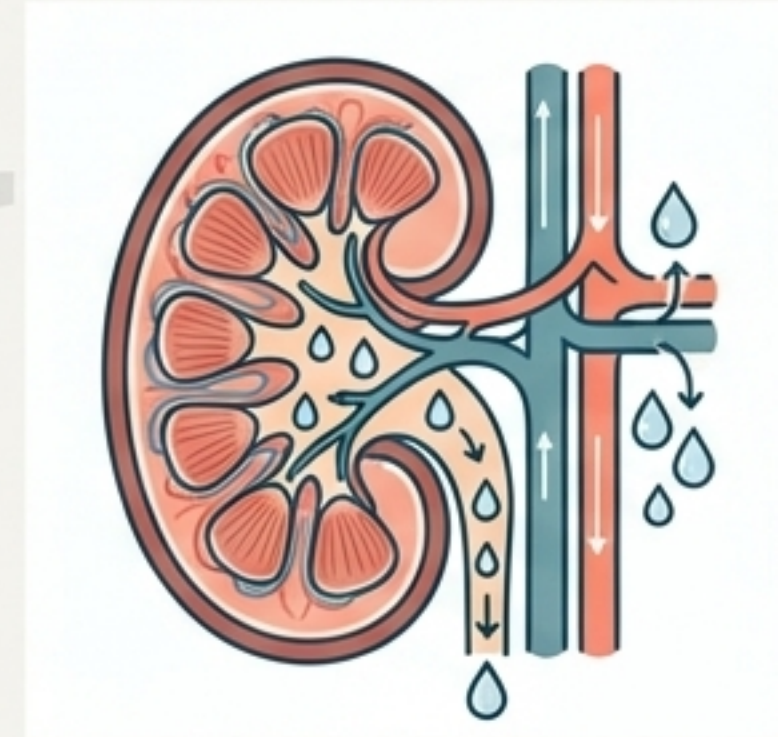
Case Files: When Pituitary Regulation Fails

Growth Hormone (GH) Imbalance



- **Over-secretion** (childhood) → **Gigantism:** Abnormal growth of the body.
- **Low secretion** (childhood) → **Pituitary Dwarfism:** Stunted growth.
- **Excess secretion** (adulthood) → **Acromegaly:** Severe disfigurement (especially of the face), which can lead to premature death if unchecked.

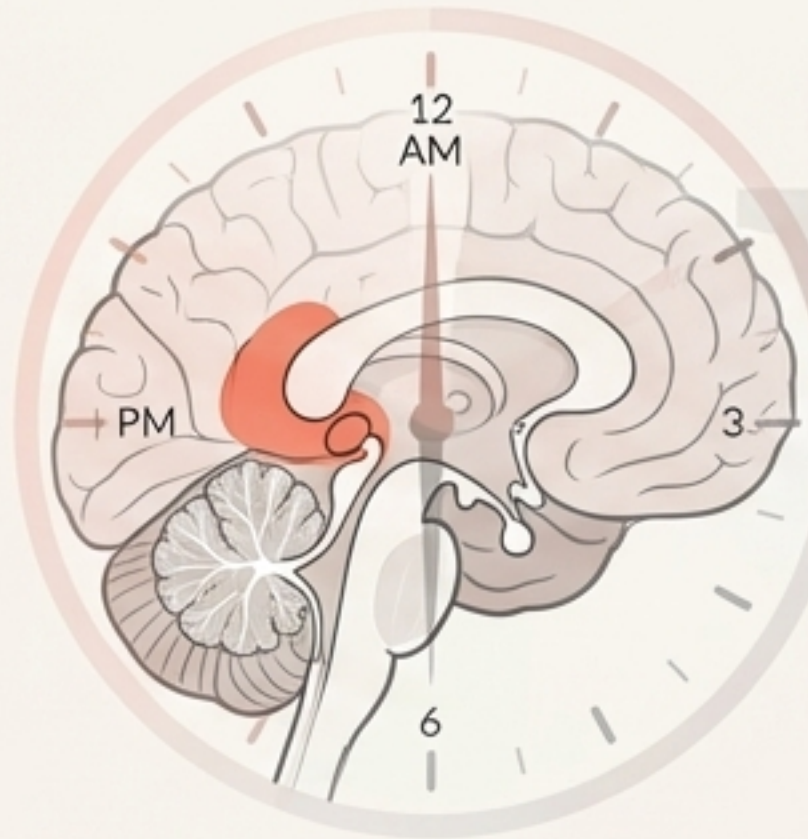
Anti-diuretic Hormone (ADH) Impairment



- **Deficiency of ADH** → **Diabetes Insipidus:** Diminished ability of the kidney to conserve water, leading to significant water loss and dehydration. (Note: Not to be confused with Diabetes Mellitus).

Regulation: The Body's Clock and Metabolic Engine

The Pineal Gland (The Body Clock)



Location: Dorsal side of forebrain.

Hormone: Melatonin.

Mission: Regulates the 24-hour (diurnal) rhythm of the body, including the sleep-wake cycle and body temperature. Also influences metabolism, pigmentation, and defense capability.

The Thyroid Gland (The Metabolic Engine)



Location: Two lobes on either side of the trachea, connected by an isthmus.

Hormones: Thyroxine (T4) and Triiodothyronine (T3).

Mission: Regulates basal metabolic rate (BMR), supports red blood cell formation, and controls the metabolism of carbohydrates, proteins, and fats. Iodine is essential for hormone synthesis.

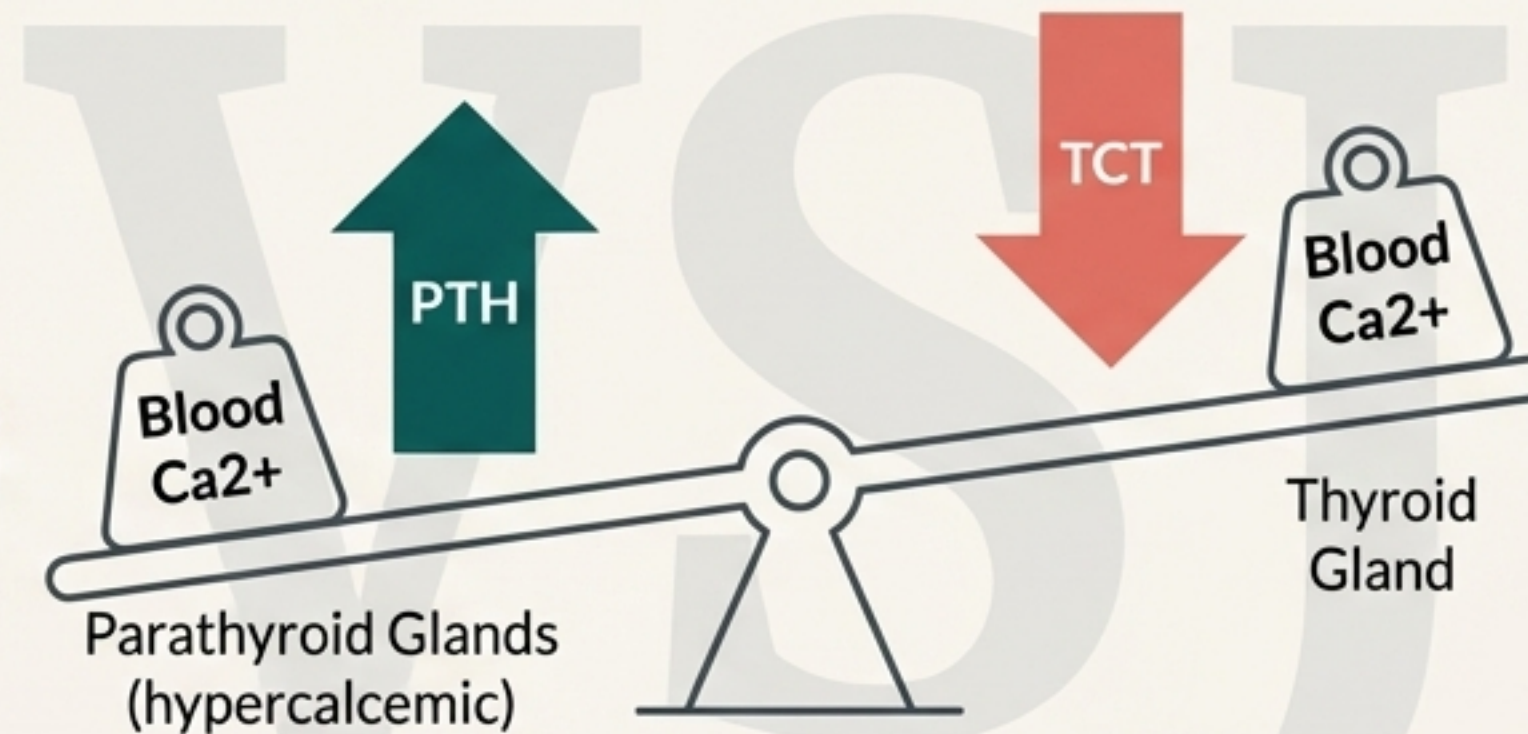
The Calcium Balancing Act: Thyroid & Parathyroid

The Players

Parathyroid Glands: Four glands on the back side of the thyroid.

Hormone: Parathyroid Hormone (PTH).

Action: Increases blood Ca^{2+} levels by stimulating bone resorption and reabsorption of Ca^{2+} by kidneys and intestines.



Thyroid Gland (second role):
Hormone: Thyrocalcitonin (TCT).

Action: Regulates (decreases) blood calcium levels.

Key Concept:

PTH and TCT play a significant role in calcium balance in the body.

Thyroid Malfunctions

- **Goitre:** Enlargement of the thyroid due to iodine deficiency.
- **Cretinism:** Stunted growth and mental retardation in infants due to hypothyroidism during pregnancy.
- **Hyperthyroidism (Graves' Disease):** Characterized by enlarged thyroid, protrusion of eyeballs, increased BMR, and weight loss.

The Stress Responders: The Adrenal Glands

Location: One pair, located one above each kidney.

Structure: Composed of two tissues: an outer **Adrenal Cortex** and a centrally located **Adrenal Medulla**.

Focus: The Adrenal Medulla (Emergency Response)

- **Hormones:** Adrenaline (Epinephrine) and Noradrenaline (Norepinephrine). Collectively called Catecholamines.
- **Nickname:** "Emergency Hormones" or "Hormones of Fight or Flight".
- **Trigger:** Secreted rapidly in response to stress of any kind.
- **Effects:** Increases alertness, pupillary dilation, piloerection (raising of hairs), sweating. Increases heart beat, strength of heart contraction, and rate of respiration. Stimulates the breakdown of glycogen, lipids, and proteins.

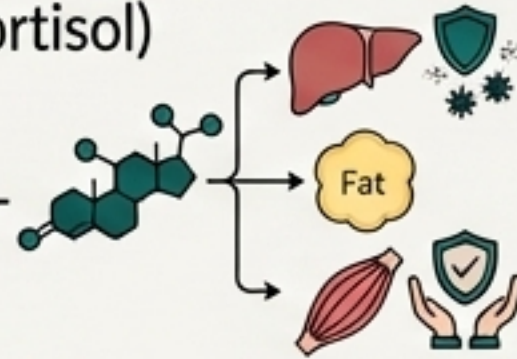


Resource Management: Adrenal Cortex & Pancreas

Section 1: The Adrenal Cortex (Long-Term Regulation)

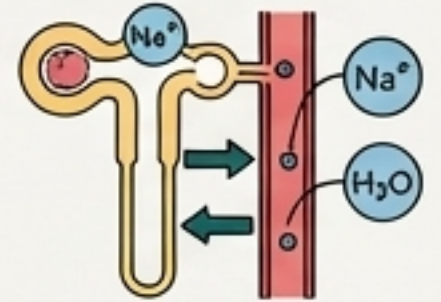
- **Hormone Class 1:** Glucocorticoids (Mainly Cortisol)

Function: Stimulate gluconeogenesis, lipolysis, proteolysis. Produce anti-inflammatory reactions and suppress the immune response.



- **Hormone Class 2:** Mineralocorticoids (Mainly Aldosterone)

Function: Regulate water and electrolyte balance (stimulates reabsorption of Na⁺ and water).



Disorder: Addison's disease (underproduction) leads to acute weakness and fatigue.

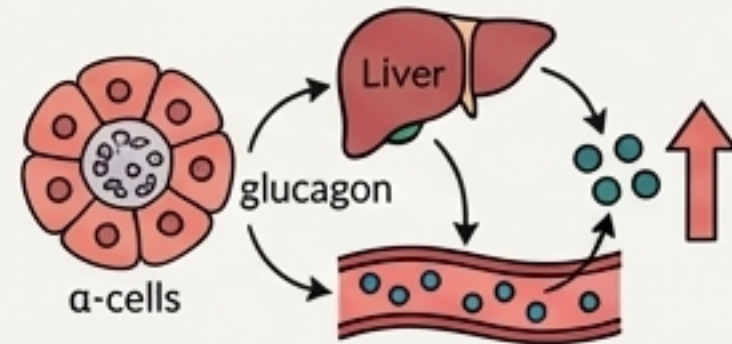


Section 2: The Pancreas (Glucose Homeostasis)

Endocrine part consists of 'Islets of Langerhans'.

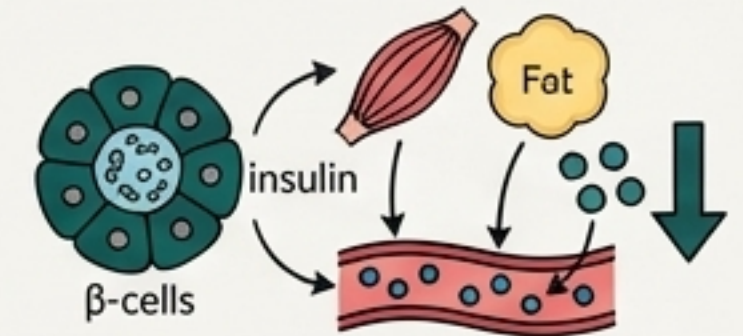
- **Glucagon** (from α -cells): A **hyperglycemic** hormone.

Increases blood glucose by stimulating glycogenolysis.

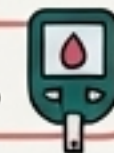


- **Insulin** (from β -cells): A **hypoglycemic** hormone.

Decreases blood glucose by enhancing cellular uptake.



Disorder: Prolonged hyperglycemia leads to **Diabetes Mellitus**.



The Blueprint for Reproduction: The Gonads



Testis (Male)

Hormones: Androgens (mainly Testosterone), produced by Leydig cells.

Functions:

- Development and maturation of male accessory sex organs.
- Stimulate muscular growth, facial/axillary hair, low pitch of voice (secondary sex characteristics).
- Play a major role in spermatogenesis.
- Influence male sexual behavior (libido).



Ovary (Female)

Hormones: Estrogen and Progesterone.

Estrogen (from growing ovarian follicles): Stimulates growth of female secondary sex organs, development of follicles, secondary sex characters (e.g., high pitch of voice), and regulates female sexual behavior.

Progesterone (from corpus luteum): Supports pregnancy. Acts on mammary glands to stimulate alveoli formation and milk secretion.

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The Decentralized Network: Hormones from Unexpected Tissues



Heart (Atrial Wall)

Hormone: Atrial Natriuretic Factor (ANF)

Function: Decreases blood pressure by causing dilation of blood vessels when BP is high.



Kidney (Juxtaglomerular cells)

Hormone: Erythropoietin

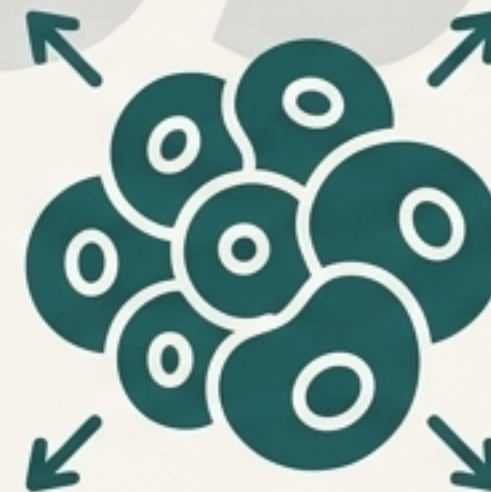
Function: Stimulates erythropoiesis (formation of RBCs).



Gastrointestinal (GI) Tract

Hormones: Gastrin, Secretin, Cholecystinin (CCK), Gastric Inhibitory Peptide (GIP).

Function: Regulate secretion of digestive juices and help in digestion.



Other Tissues

Hormones: Growth Factors

Function: Essential for normal tissue growth and their repairing/regeneration.

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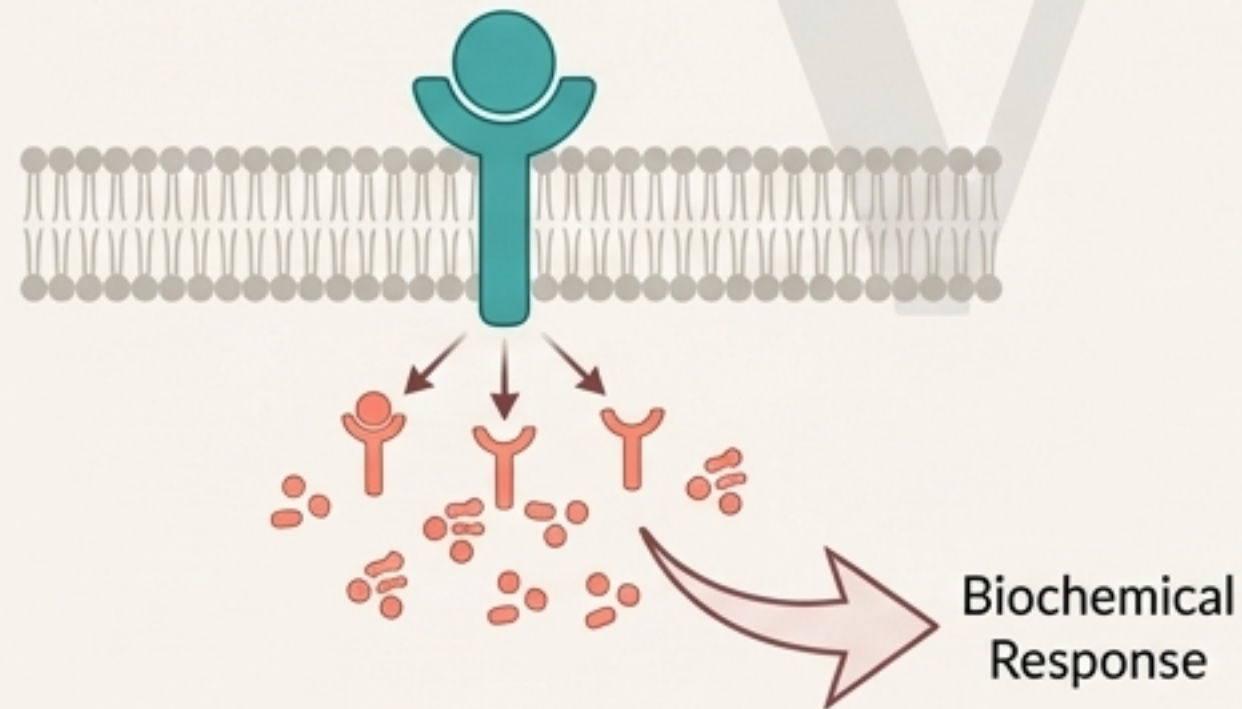
Mission Accomplished: How Hormones Deliver Their Message

Hormones bind to specific Hormone Receptors on or in target cells, forming a hormone-receptor complex. Each receptor is specific to one hormone.

Membrane-Bound Receptors

(For Protein/Peptide Hormones like Insulin, FSH)

Hormone does not enter the target cell. It binds to a receptor on the cell membrane. This generates second messengers (e.g., cyclic AMP, Ca^{++}) inside the cell, which regulate cellular metabolism.



Intracellular Receptors

(For Steroid & Thyroid Hormones like Cortisol, Estrogen)

Hormone enters the target cell. It binds to a receptor inside the cell (usually in the nucleus). The hormone-receptor complex interacts with the genome to regulate gene expression and chromosome function.

