

Al-Mustaqbal University
College of Engineering and Technologies
Biomedical Engineering Department



Systemic Physiology I

Lecture: 8

Endocrine System

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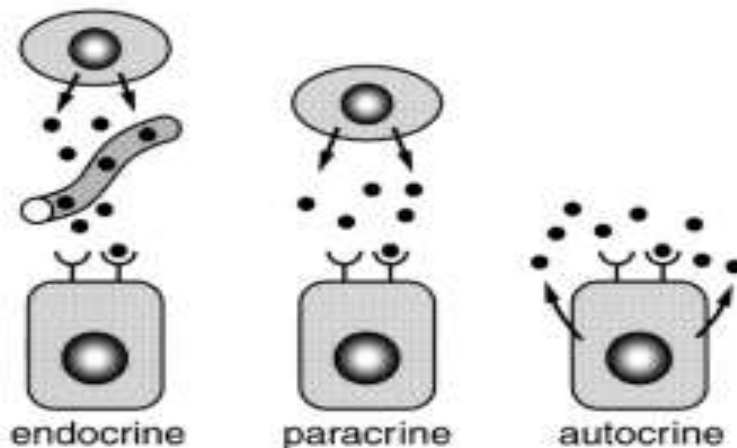
The Endocrine System

Hormones are Chemical Messengers

Exocrine secretion—cells secrete substances into a duct or a body cavity that communicates to the external world (epithelial surfaces).

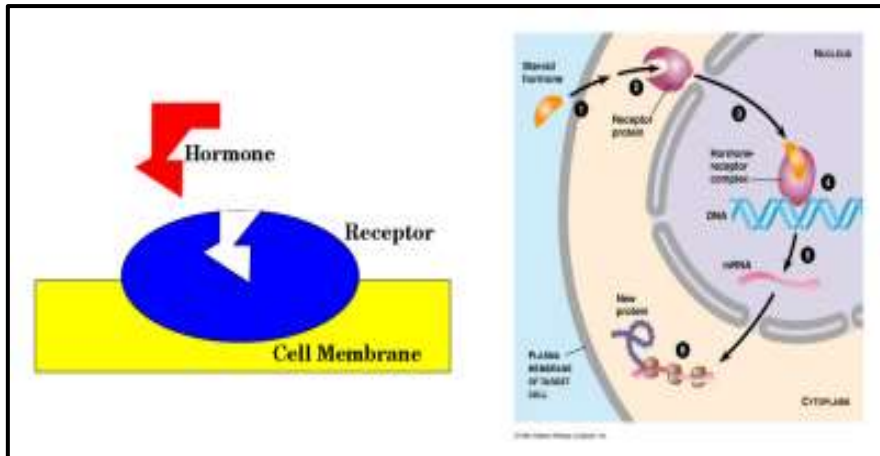
Endocrine secretion—cells secrete substances into the extracellular fluid (blood, lymph, cerebrospinal fluid).

Endocrine signaling molecules are paracrine signals, autocrine signals, or endocrine signals (hormones).



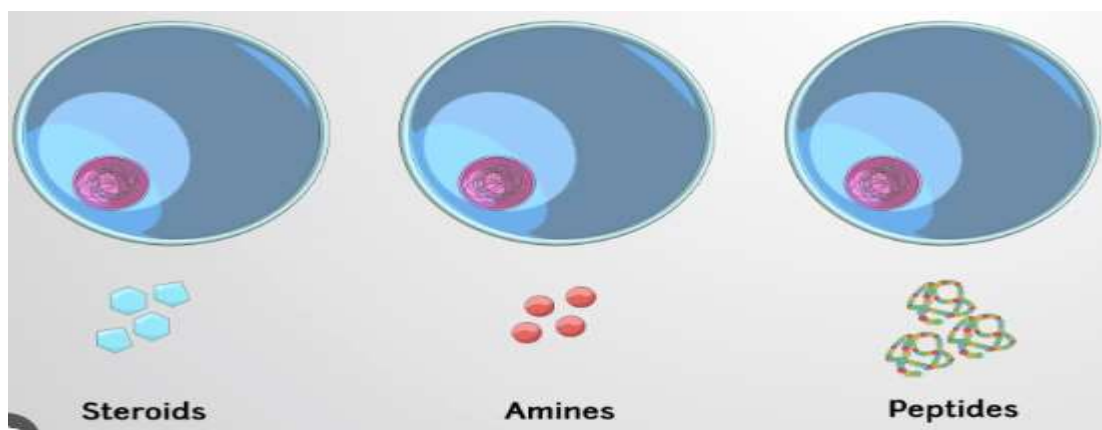
Endocrine signaling molecules.

- **Hormones** are “long-distance” endocrine signals that are released into the bloodstream and circulate throughout the body.
- Hormones act on **target cells** that have specific receptors for the chemical signals.
- The same hormone can have a variety of different target cells, all distant from the site of release.



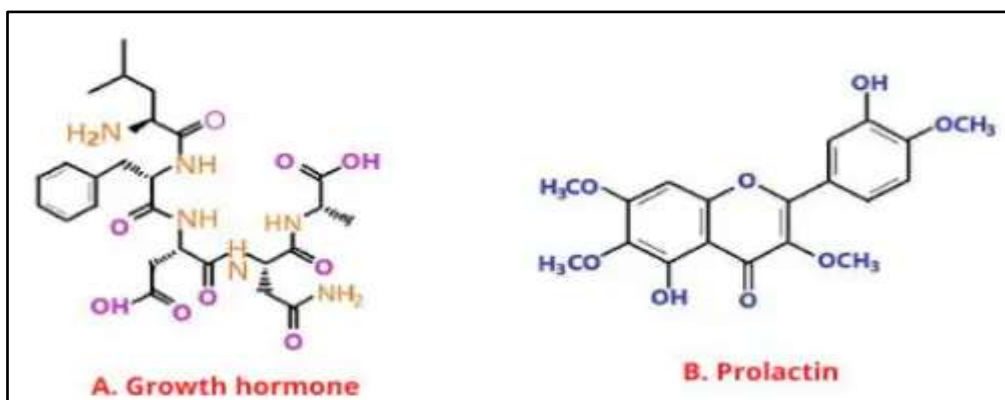
Hormones and Target cells.

3 types of hormones:



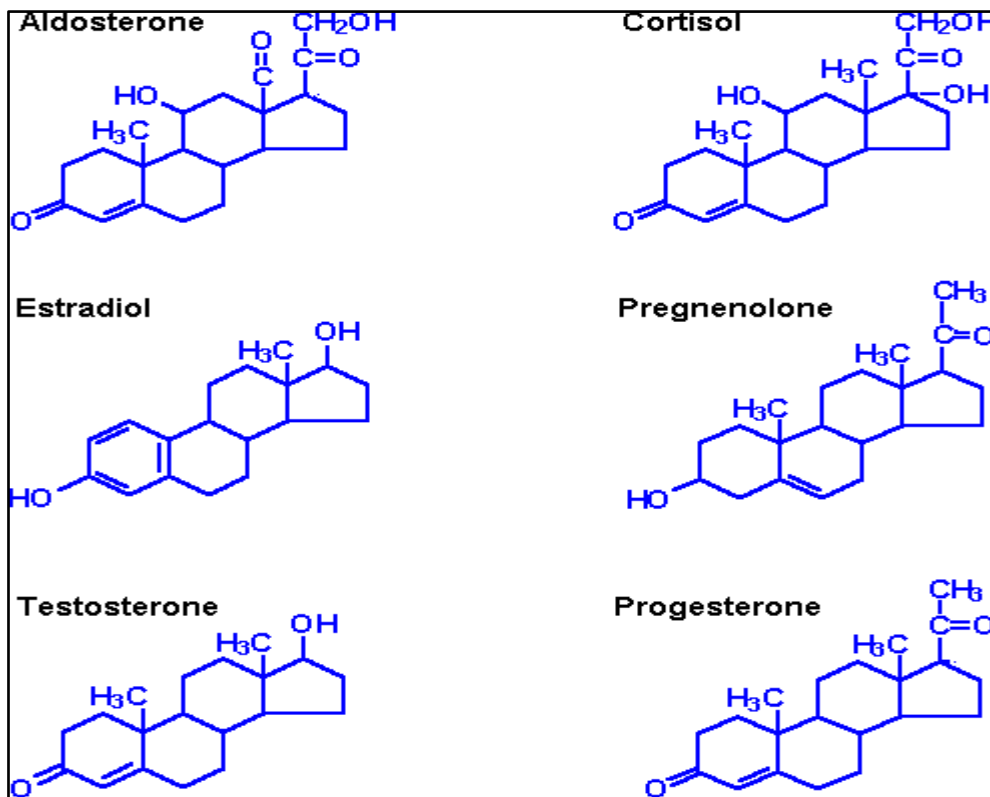
Types of Hormones.

1. Peptide and protein hormones: water-soluble.



Protein Hormones.

2. **Steroid hormones:** synthesized from cholesterol (lipid soluble).



Steroid hormones.

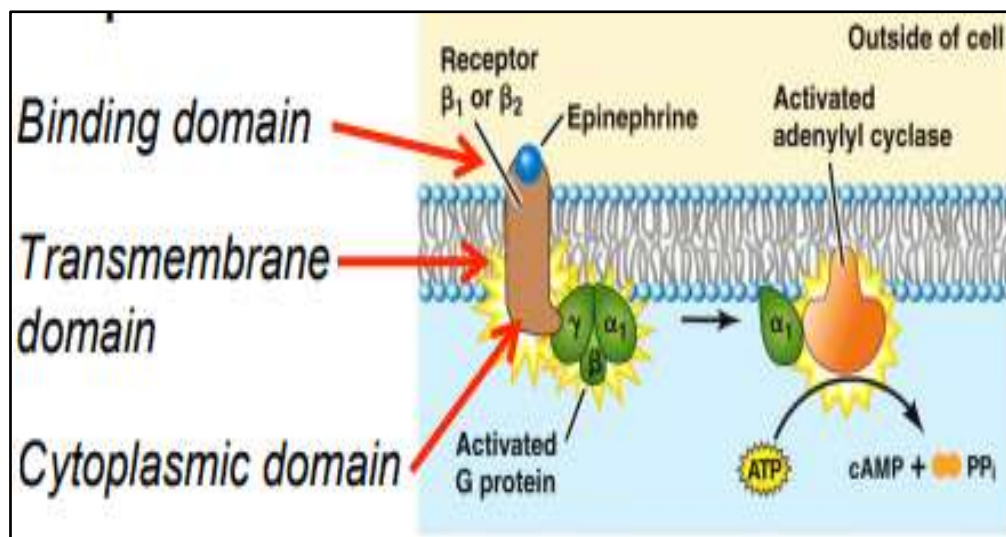
3. **Amine hormones:** synthesized from single amino acids; may be lipid-soluble or water-soluble.



Amine Hormones.

Hormones Act by Binding to Receptors

- The solubility of a hormone affects whether it can pass through the plasma membrane and determines the location of its receptors.
- Water-soluble hormones have **membrane-bound receptors** consisting of three significant domains:
 - Binding domain.
 - Transmembrane domain.
 - Cytoplasmic domain.

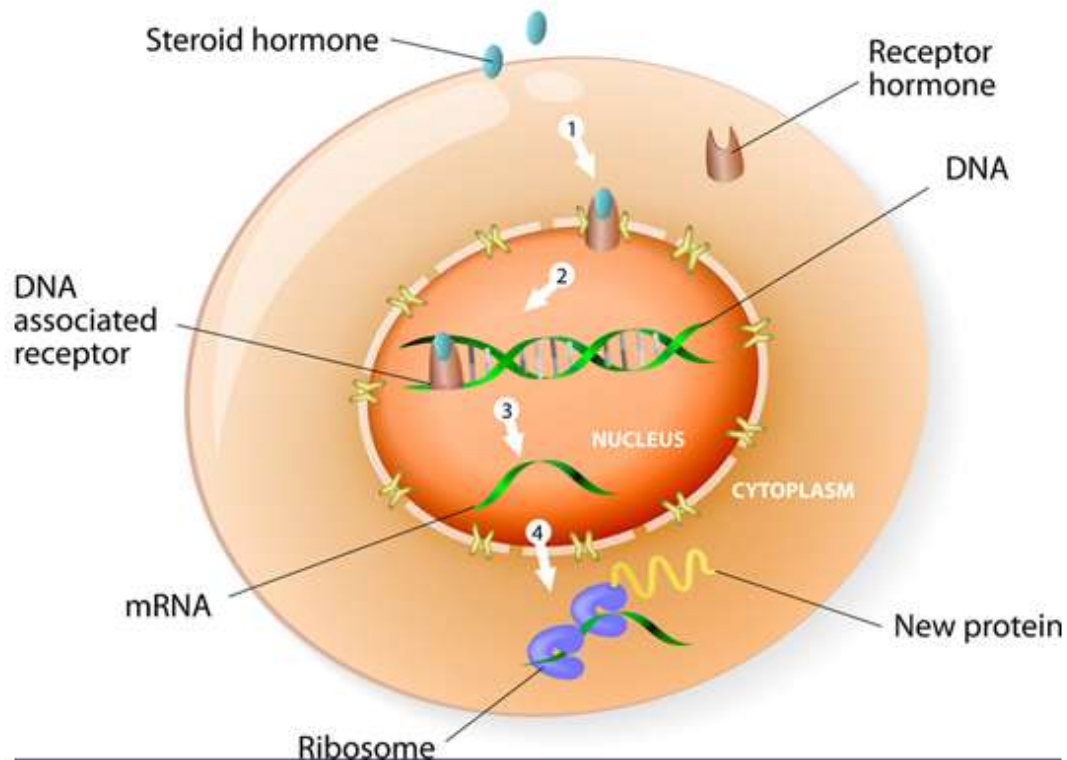


Receptor Domains.

- Lipid soluble hormones have **intracellular receptors**, usually in the cytoplasm.

When hormone binds, the hormone–receptor complex moves into the nucleus and alters gene expression.

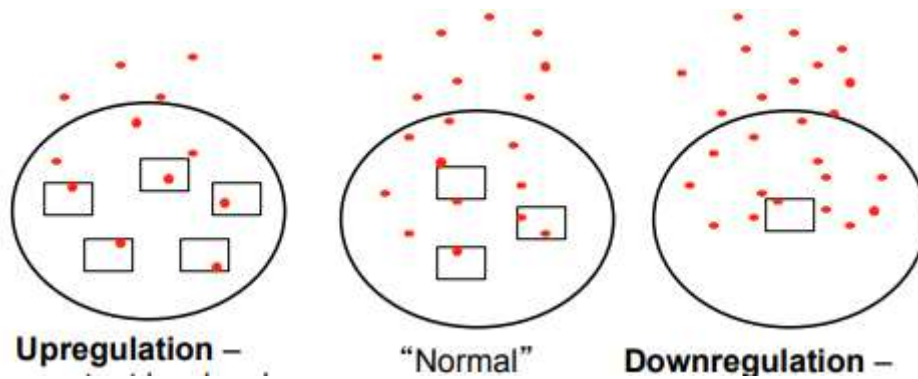
STEROID HORMONES



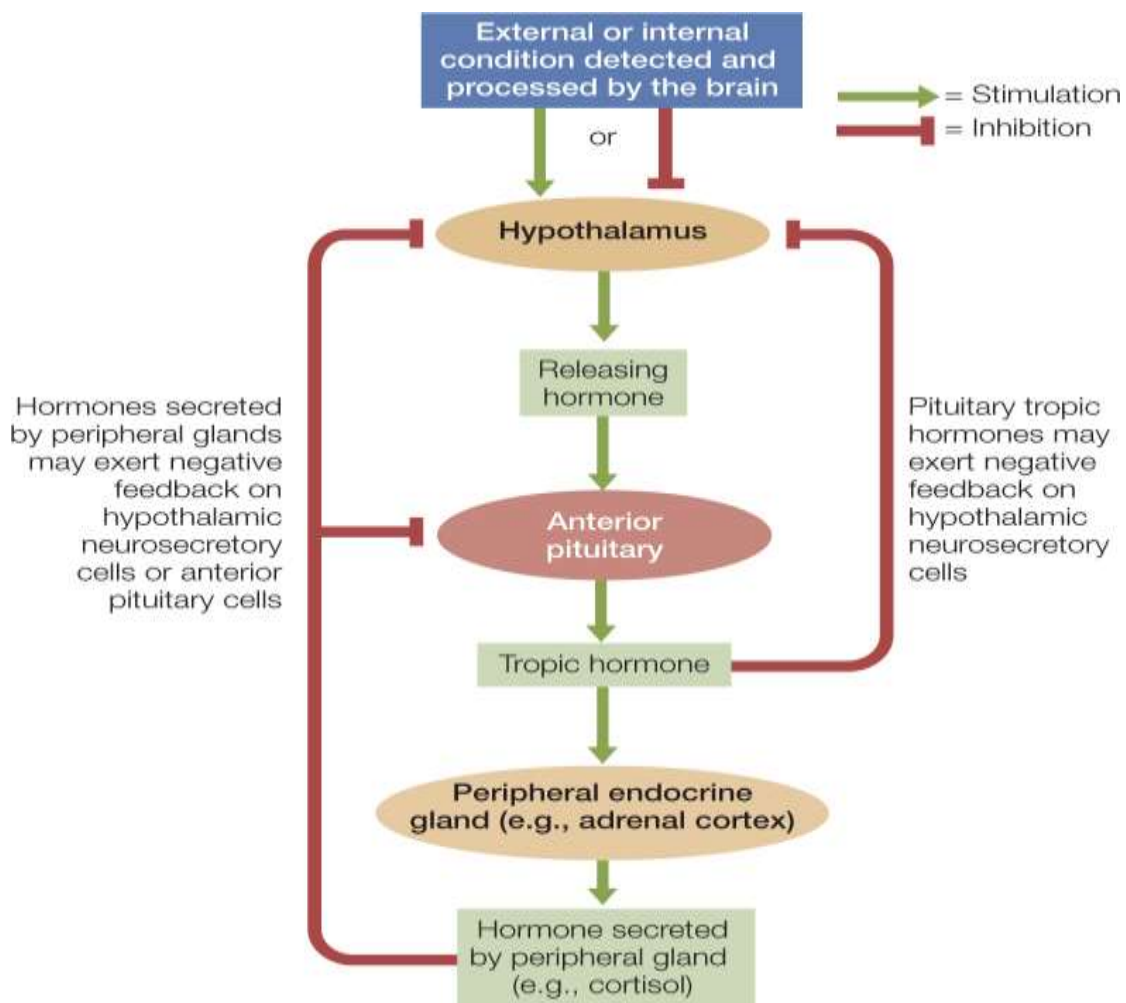
- One hormone can trigger different responses in different types of cells, Depending on the type of receptor or the signal pathway within the cell.
- Abundance of receptors can be regulated by negative feedback.

Upregulation – constant low levels of hormone cause cell to add more receptors.

Downregulation – constant high levels of hormone cause cell to reduce receptors.

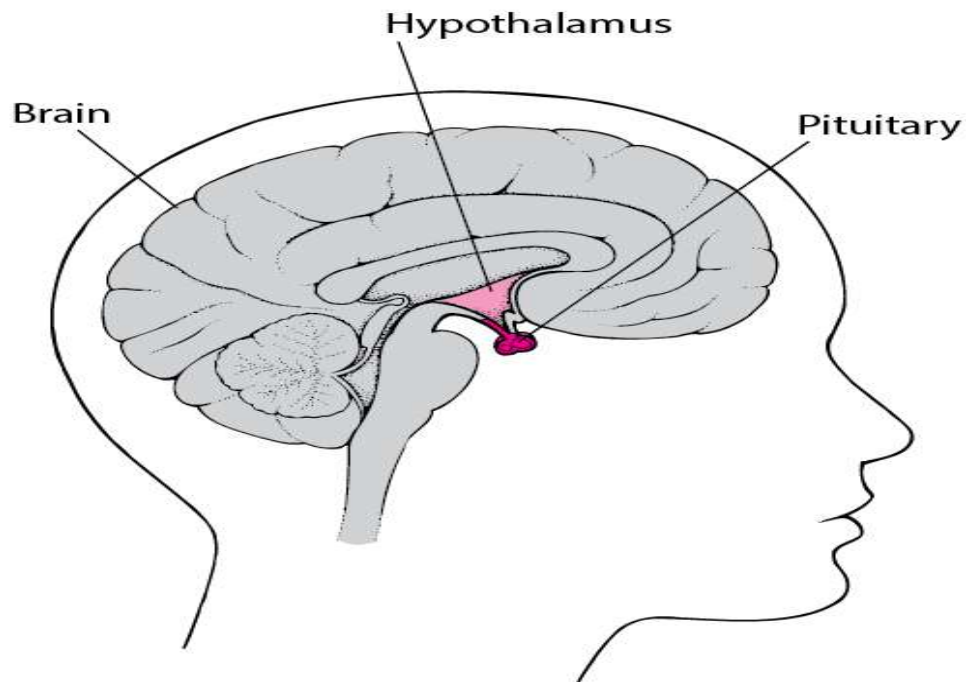


- Most hormones operate in cascades that are regulated by negative feedback.
- Abundance of hormones “further down” the cascade can turn the pathway off.



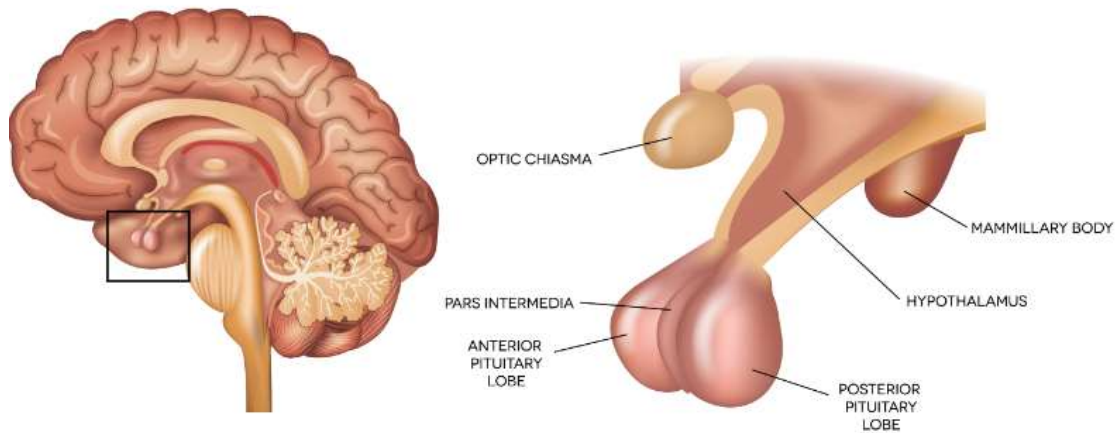
The Pituitary Gland Links the Nervous and Endocrine Systems

- In vertebrates, hypothalamus controls endocrine function .
- The hypothalamus receives information from nerves and brain .
- Initiates signals (hormones) in response, which travel to the pituitary.
- Pituitary releases additional hormones that travel to target cells in body.



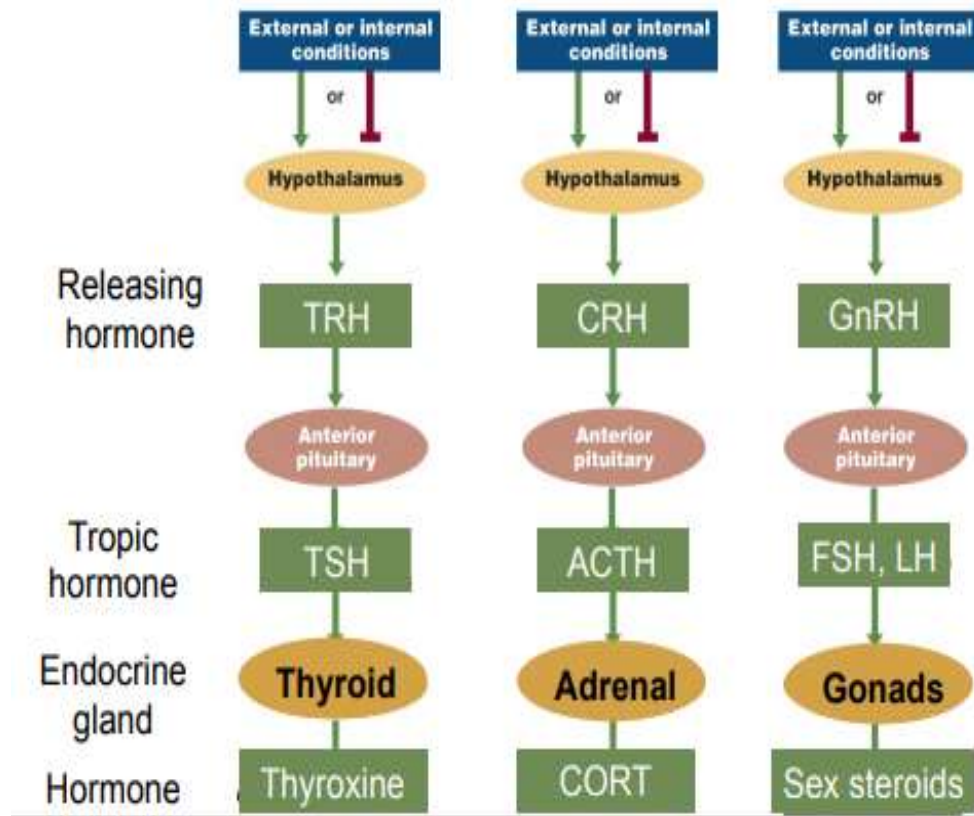
- The **pituitary gland** connects the nervous and endocrine systems.
- Two parts—the **anterior pituitary** and **posterior pituitary**.

THE PITUITARY (HYPOPHYSIS) GLAND



- The posterior pituitary secretes two **Neurohormones** that were produced by cells in the hypothalamus .
- **Antidiuretic hormone (ADH)**, also called **vasopressin**, serves to increase the water retained by the kidneys .
- **Oxytocin** stimulates contractions, milk flow, promotes social bonding.
- The **anterior pituitary** produces its own hormones, but is regulated by neurohormones from the hypothalamus.
- The hypothalamus sends **releasing hormones** to the anterior pituitary via the portal blood vessels.
 - Gonadotropin-releasing Hormone (GnRH)
 - Corticotropin-releasing hormone (CRH)
 - Thyrotropin-releasing hormone (TRH)
- The anterior pituitary secretes four **tropic hormones** that control other endocrine glands:
 - Thyroid-stimulating hormone (TSH)

- Luteinizing hormone (LH)
- Follicle-stimulating hormone (FSH)
- Adrenocorticotropin hormone (ACTH).



-The anterior pituitary also secretes other peptide hormones that target non-endocrine tissues:

1. **Prolactin** – mammary gland growth & milk synthesis, reproduction in birds, salt-water balance in fish
2. **Growth hormone** – stimulates cells to take up amino acids; liver to produce growth factors.
3. **Melanocyte-stimulating hormone** – regulates pigment-containing cells in some amphibians/fish/reptiles.

Hormones Regulate Mammalian Physiological Systems

- The **thyroid gland** contains two cell types that produce two different hormones, **thyroxine** and **calcitonin**.

- **Thyroxine (T4)** is synthesized from the amino acid tyrosine and iodine. **T3** is a similar hormone that is more active.

- Accelerates oxidative metabolism in endotherms.

- Crucial during development, regulates metamorphosis in amphibians.

- Calcium levels are regulated by calcitonin from the thyroid and **parathyroid hormone** from the parathyroid glands.

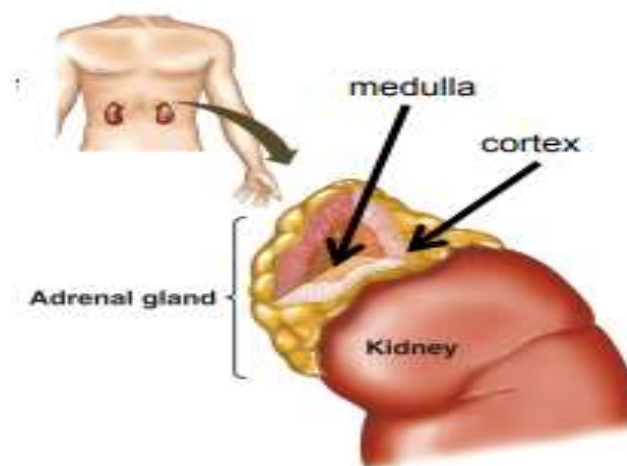
- If calcium levels are low, parathyroid hormone causes release of stored calcium from bone, reabsorption of calcium in kidneys, digestive tract .

- If levels are too high, calcitonin inhibits bone resorption and enhances calcium release by kidney.

Each of the two adrenal glands is a gland within a gland .

- The core, or **adrenal medulla**, produces **epinephrine** and **norepinephrine** .

- Release of these hormones is under control of the nervous system and is very rapid in the stress response.



The **outer adrenal cortex** produces two types of corticosteroid hormones:

- **Mineralocorticoids** influence salt and water balance, increase blood pressure
- **Glucocorticoids** influence blood glucose concentration by breaking down fat and protein
- **Cortisol** is the main glucocorticoid in mammals, mediates metabolic stress response.
- After a stressful stimulus, blood cortisol rises.
- Cells not critical for action decrease their use of blood glucose—immune system reactions are also blocked.

Gonads are the ovaries and the testes. Gonads secrete sex hormones:

- **Androgens**—male steroids, testosterone
- **Estrogens and progesterone**—female steroids
- Affect growth, development, reproductive cycles and sexual behavior.
- Sex hormones determine the sex of the fetus during development.
- All embryos start off female, but testosterone stimulates development of the male structures.
- Androgens also responsible for development of male **secondary sex characteristics**.
- **Estrogens** are necessary for females to mature.
- **Estradiol** most important estrogen – responsible for maintenance of female reproductive system and development of secondary sexual characteristics.

- **Progesterone** needed for maintenance of uterus and growth/development of an embryo.

The pineal gland:

- Small, median structure near center of brain that secretes **melatonin** and is involved in regulating functions related to light and seasons (day length).
- Circadian rhythm of melatonin secretion can be disrupted by light, travel.

