ENDOCRINOLOGY

Introduction

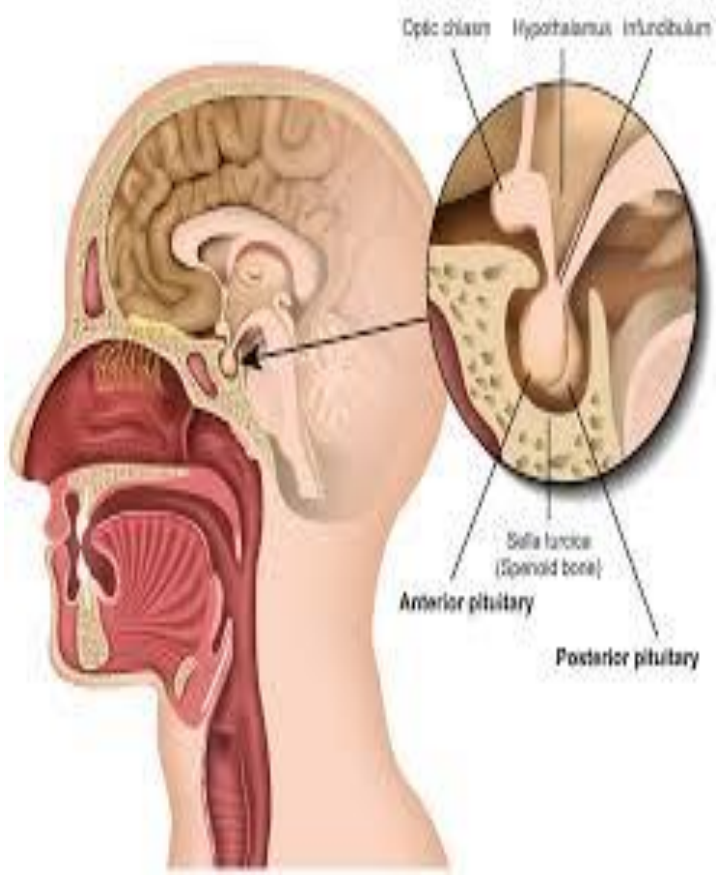
The functions of the body are regulated by two systems:

1. the nervous system
2. the endocrine (hormonal) system.

The hormonal system exerts its function through secretion of hormones:

Which are chemical messengers produces by ductless glands and transported in the circulation to the target cells where they regulate the metabolic functions of the body.

THE ENDOCRINE GLANDS AND THEIR HORMONES



Anterior pituitary hormones

1. Growth hormone (GH).
2. Adrenocorticotropic hormone (ACTH).
3. Thyroid stimulating hormone (TSH).
4. Follicle stimulating hormone (FSH).
5. Luteinizing hormone (LH).
6. Prolactin (PRL)

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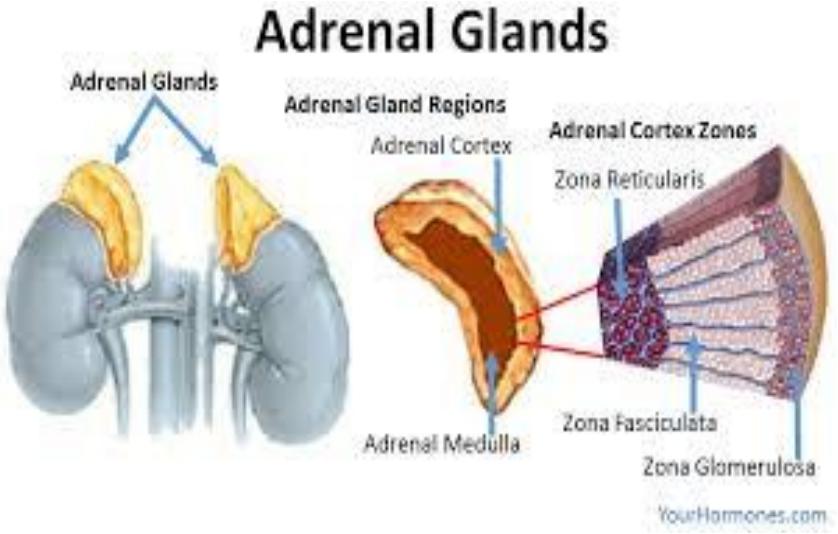
Posterior pituitary hormones

1. Antidiuretic hormone (ADH) also called vasopressin.
2. Oxytocin.

Adrenal cortex

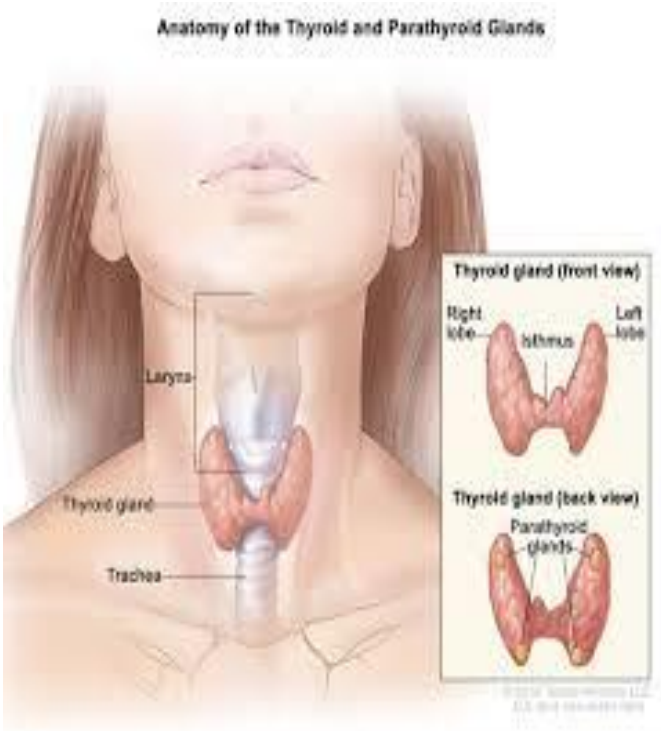
1. Glucocorticoids (cortisol).
2. Mineralocorticoids (aldosterone).
3. Adrenal androgens.



Adrenal medulla: Catecholamines (adrenaline, noradrenaline, and dopamine).

Thyroid gland

1. Follicular cells→ thyroxine (T4) and triiodothyronine (T3).
2. Parafollicular cells → calcitonin.



Islets of Langerhans in the pancreas

1. A cells →insulin
2. B cells →glucagon
3. D cells → somatostatin
4. F cells → pancreatic polypeptide

Ovaries

1. Estrogens.
2. Progesterone.

Testes

Testosterone→ stimulates growth of male sex organs; also promotes the development of male secondary sex characteristics.

Parathyroid glands

Parathyroid hormone (PTH) → controls the concentration of calcium ion in the ECF.(extracellular fluid)

Placenta

1. Human chorionic gonadotropin
2. Estrogens
3. Progesterone
4. Human somatomammotropin

<u>Chemistry of hormone</u>: chemically, the hormones are of three basic types:

1. **Steroid hormones:** have a chemical structure similar to or derived from cholesterol e.g. adrenal cortex, ovarian, and testicular hormones.
2. **Tyrosine derived hormones**: such as thyroid hormones (T3and T4) and adrenal medulla hormones (catecholamines).
3. **Proteins or peptides hormones:** includes all remaining hormones**:**

   A. Anterior pituitary hormones (proteins or large polypeptides).

   B. Posterior pituitary hormones (peptides containing 9 AA).

   C.Insulin, glucagon, and PTH (large polypeptides).

Hormone receptors

The biological effects of hormones are dependent upon hormone binding to tissue receptors. These receptors are characterized by being:

1. Made up of high molecular weight *protein* or *glycoprotein*.
2. Located in *different sites* in the cell:
    a. On the cell membrane(catecholamine and insulin receptors)
    b. In the cytoplasm (glucocorticoids receptors)
    c. In the nucleus (thyroxine receptors)
3. *Specific* for hormone type
4. *Different in number* and *affinity* depending on the hormone effective level such as decrease in number and affinity if the hormone level is high (down regulation) or increase in number and affinity if the hormone level is low (up regulation).

PITUITARY GLAND (HYPOPHYSIS)

Pituitary gland is a small gland (0.5-1 gm in weight) that lies at the base of the brain and it is controlled by the hypothalamus.
Physiologically the pituitary gland is divided into two distinct parts:

1. The anterior pituitary (*adenohypophysis*)→ (GH, ACTH, TSH, FSH, LH, and PRL)
2. Posterior pituitary (*neurohypophysis*) → (ADH, and Oxytocin)

Posterior pituitary hormones:

Antidiuretic hormone **ADH and oxytocin** are formed by the supraoptic and paraventricular nuclei of the hypothalamus and carried to the posterior lobe by nerve tract along the pituitary stalk and secreted at nerve endings

ADH (vasopressin):

It is a peptide consists of 9 amino acids (AA).

Effects of ADH:

1. (ADH) as its principle action is retention of water by the kidney.
2. V*asoconstriction*: The moderate to high concentration of ADH cause vasoconstriction and increase blood pressure.

Control of secretion:

1. ***Osmotic stimuli*:** normal plasma osmolality is about 290 mosm/L. The changes in the osmolality of 1% affect ADH secretion through the osmoreceptors found in anterior hypothalamus:
   - ↑plasma osmolality→ shrinkage of osmoreceptors →stimulation of ADH secreting nuclei →secretion of ADH →water retention → decrease in plasma osmolality
2. ***Volume effect:*** changes in blood volume and pressure affect vasopressin secretion, independent of osmoregulation. These changes are recognized by baroreceptors (pressure-sensitive receptors in the carotid and aortic arch). Hypovolemia and hypotension (hemorrhage) → secretion of ADH.
3. **Other stimuli:**

   ↑ Secretion (pain, nausea, surgical stress)

   ↓ Secretion (alcohol)

Diabetes insipidus:

Diabetes insipidus is the syndrome that results from ADH deficiency called:

1-Neurogenic (central) diabetes insipidus.

or the target organ (kidney) fails to respond to the hormone called:

2- Nephrogenic diabetes insipidus

The disease is characterized by polyuria and polydipsia provided that the thirst mechanism is intact, and it’s the polyuria that keeps the patient healthy.

Anterior pituitary hormones:

Control of secretion of anterior pituitary hormones: secretion of anterior pituitary hormones is controlled by hormones secreted by the hypothalamus and carried to the anterior pituitary by the portal hypophysial vessels called hypothalamic releasing and hypothalamic inhibitory hormones (or factors):

1.↑(GH) → by growth hormone releasing hormone (GHRH).

↓(GH) → by growth hormone inhibitory hormone (GHIH)

2.↑ (ACTH) → by corticotropin releasing factor (CRF)

3.↑(TSH) → by thyroid releasing hormone (TRH)

4.↑(LH and FSH)→ by Luteinizing hormone releasing hormone (LRH) also called gonadotropin releasing hormone(GnRH)

3.↓ PRL→ by Prolactin inhibitory factor(PIF)

<u>OXYTOCIN</u>: (peptide-9AA)

<u>Effects of Oxytocin:</u> Oxytocin acts specifically on

1) uterine smooth muscle
2) the smooth muscle cells that surround the distal portion of the mammary gland duct system.

- In the pregnant uterus muscle contraction → (delivery of the baby?). Responsiveness of the uterus to oxytocin is dependent on many factors including the presence of estrogen (which enhances contraction) and progesterone (which inhibits contraction).

EFFECTS OF GROWTH HORMONE

1. Effects on growth: GH↑ the size and mitotic activity of cells of most tissues. The most effected tissues are the bones, before epiphysial closure, GH increases the length of long bone
2. Effects on CHO: ↓glucose utilization for energy and ↓glucose uptake by the cells → increase plasma glucose→ pituitary diabetes.
3. Effects on fat: GH ↑FFA(free fatty acid) and ketone body formation → (used for energy production). In addition, GH ↓ cholesterol (↓ body fat).
4. Effects on protein: GH has anabolic effect on protein. GH enhances AA uptake and protein synthesis by cells, while at the same time reducing the breakdown of protein.

Growth effects of GH are not attributed to GH directly but by *insulin-like growth factors* (IGF). IGFs are synthesized under the control of GH.

(IGF-1) is produced in several tissues, but the liver is the most important source**.**

Abnormalities of GH secretion

Dwarfism:

Features:

- Deficiency of anterior pituitary hormones greatly cause:

1) ↓ the rate of development (child who has reached the age of 10 years may have the bodily development of a child of 4 or 5 years.
2) Does not pass through puberty and never secrete a sufficient quantity of gonadotropic hormones to develop adult sexual functions.

- One third of the dwarfs (isolated GH deficiency) → mature sexually and occasionally reproduces.
- Rarely (Lorain dwarf) GH secretion is normal or high but there is a hereditary inability to form *insulin-like growth factors* in response to stimulation by GH.

Acromegaly

- **Cause:** acidophilic tumors affect adult (after the epiphyses of long bones have fused with the shaft. the person can not grow taller. Soft tissues continue to grow, and bone can grow in thickness. Enlargement is especially marked in the small bones of hands and feet and in the membranous bones (cranium, nose, lower jaw bones, and vertebrae).
- **Features:**
  1. Enlargement of hands and feet(acral parts)→ acromegaly
  2. Forward protrusion of lower jaw (prognathism)
  3. Soft tissue hypertrophy(cardiomegaly, hepatosplenomegaly, and enlargement of kidneys

Maxillary prognathism

Jaw without prognathism

Mandibular prognathism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