

Chemical Coordination and Integration

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Limitation of Neural Coordination

- The **neural system** provides rapid, point-to-point **coordination** among different organs of the body.
- This coordination is:
 - Fast-acting
 - Short-lived
- However, it has certain limitations:
 - **Nerve fibres** do not reach all cells in the body.
 - Many cellular functions require continuous and long-term regulation, which neural signals cannot provide efficiently.

Need for Chemical Coordination

- To maintain long-term and widespread regulation, the body requires another system of control.
- This is achieved through chemical messengers known as **hormones**.

Role of Hormones and the Endocrine System

- **Hormones** are secreted by endocrine glands and released directly into the bloodstream.
- They regulate metabolic and physiological activities in a sustained manner.
- This system is known as the **endocrine system**.

Integrated Regulation

- The **neural system** and the endocrine system work jointly to:
 - Coordinate complex body functions
 - Maintain homeostasis
 - Respond to internal and external stimuli effectively

Endocrine Glands and Hormones

Nature of Endocrine Glands

- **Endocrine glands** are specialized glands that lack ducts, which is why they are also known as **ductless glands**.
- These glands release their secretions (hormones) directly into the **bloodstream**.

Definition of Hormones

Classical Definition

- A **hormone** is a **chemical substance**:
 - Produced by endocrine glands
 - Released into the bloodstream
 - Transported to a distantly located target organ
 - Where it **exerts a specific physiological effect**

Modern Scientific Definition

- Hormones are **non-nutrient chemical messengers** that:
 - Are produced in trace amounts
 - Act as intercellular messengers
 - Regulate various physiological processes such as growth, metabolism, development, and homeostasis

Scope of the New Definition

- The modern definition expands the concept of hormones to include:
 - Several **newly discovered molecules**
 - Substances not necessarily secreted by classical endocrine glands, but still functioning as **chemical messengers**

Endocrine Systems in Organisms

A. Invertebrates:

- Possess simple endocrine systems
- Secrete fewer types of hormones

B. Vertebrates:

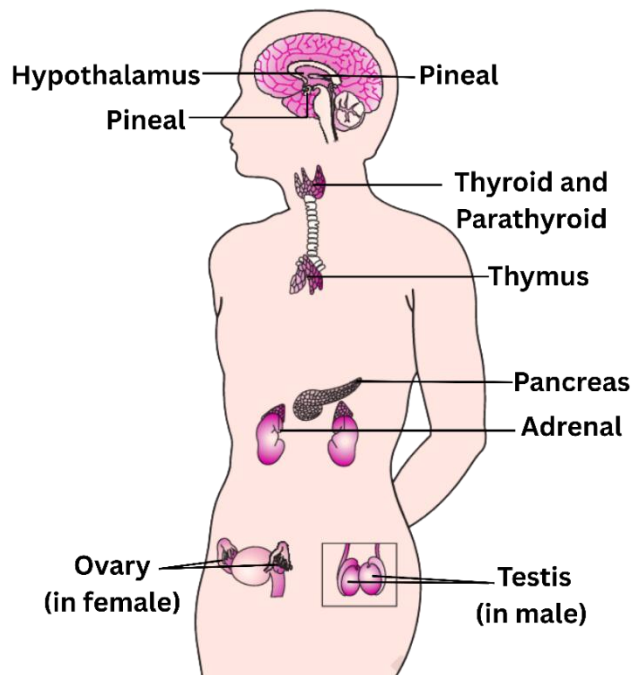
- Have complex endocrine systems
- Utilize a wide variety of hormones for coordination and regulation of body functions

Human Endocrine System

- The **endocrine system** consists of specialized endocrine glands and hormone-producing diffused tissues or cells located in various parts of the human body.
- These components work together to regulate a wide range of physiological processes through the secretion of **chemical messengers called hormones**.

Major Endocrine Glands

- The organized endocrine glands of the human body include:
 - Pituitary gland
 - Pineal gland
 - Thyroid gland
 - Parathyroid glands
 - Adrenal glands
 - Pancreas (endocrine part)
 - Thymus gland
 - Gonads
 - *Testes* in males
 - *Ovaries* in females



Location of endocrine glands

Other Hormone-Producing Organs

- In addition to the major endocrine glands, several other organs and tissues also function as **diffuse endocrine tissues** by secreting hormones.

- These include:
 - Gastrointestinal tract
 - Liver
 - Kidneys
 - Heart
-

Hypothalamus

- The **hypothalamus** is a key neuroendocrine structure located at the basal part of the diencephalon in the forebrain.
- It plays a central role in regulating a wide range of physiological processes by linking the **nervous system** to the **endocrine system** via the **pituitary gland**.

Structure and Location

- Located in the **basal part of the diencephalon** (forebrain).
- Composed of several clusters of **neurosecretory cells**, known as **nuclei**.

Functions

- Regulates a broad spectrum of body functions such as:
 - Body temperature
 - Hunger and thirst
 - Sleep-wake cycles
 - Emotional responses
 - Endocrine activities via pituitary regulation

Hypothalamic Hormones

The hypothalamus produces **two types of hormones** that regulate the secretion of hormones from the **anterior pituitary**:

1. Releasing Hormones

- Stimulate the secretion of specific anterior pituitary hormones.
- Example:
 - **Gonadotrophin-Releasing Hormone (GnRH)**
 - Stimulates the synthesis and secretion of gonadotrophins (LH and FSH) from the anterior pituitary.

2. Inhibiting Hormones

- Suppress the secretion of specific anterior pituitary hormones.
- Example:

- **Somatostatin**

- Inhibits the release of growth hormone (GH) from the anterior pituitary.

Hormone Transport Pathway

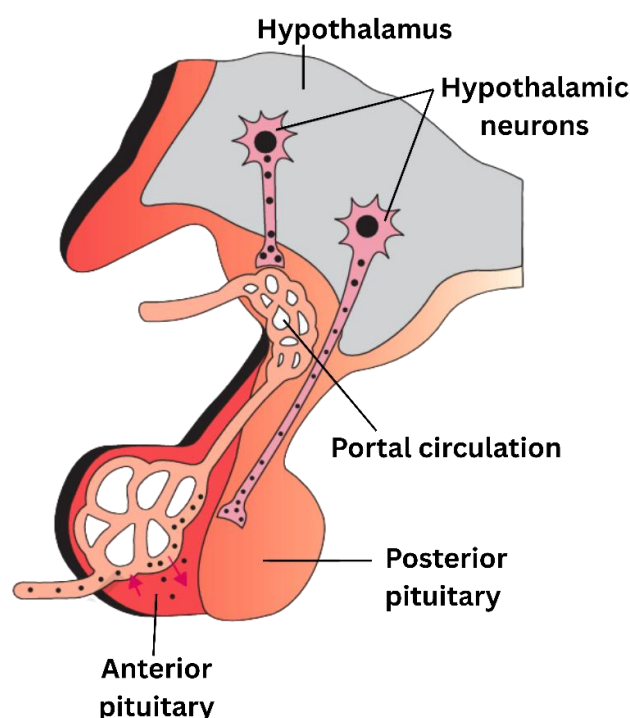
- Hormones are synthesized by hypothalamic neurons.
- Transported through their **axons** and released at **nerve endings**.
- Carried to the **anterior pituitary** via the hypothalamo-hypophyseal portal system (a specialized vascular connection).
- This allows precise hormonal control of the anterior pituitary.

Posterior Pituitary Regulation

- The **posterior pituitary** is not regulated by blood-borne hormones.
- Instead, it is under direct neural control from the hypothalamus.
- Hormones such as **oxytocin** and **vasopressin (ADH)** are:
 - Synthesized in hypothalamic neurons
 - Stored and released from the posterior pituitary

The Pituitary Gland

- The **pituitary gland**, also known as the **master gland**, plays a vital role in regulating the activity of several other endocrine glands.
- It is located in a bony cavity called the **sella turcica** and is connected to the hypothalamus by a stalk known as the **infundibulum**.



Diagrammatic representation of pituitary and its relationship with hypothalamus

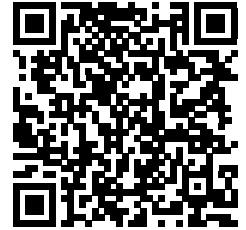


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