
Endocrine System: Overview

Endocrine system – the body's **second** great controlling system which influences metabolic activities of cells by means of hormones

Endocrine glands – pituitary, thyroid, parathyroid, adrenal, pineal, and thymus

The pancreas and gonads produce both hormones and exocrine products

Endocrine System: Overview

The hypothalamus has both neural functions and releases hormones

Other tissues and organs that produce hormones – adipose cells, pockets of cells in the walls of the small intestine, stomach, kidneys, and heart

PLAY

InterActive Physiology®: Endocrine System Review

Major Endocrine Organs

See book for figure 16.1

Autocrines and Paracrines

Autocrines – chemicals that exert effects on the same cells that secrete them

Paracrines – locally acting chemicals that affect cells other than those that secrete them

These are not considered hormones since hormones are long-distance chemical signals

Hormones

Hormones – chemical substances secreted by cells into the extracellular fluids

Regulate the metabolic function of other cells

Have lag times ranging from seconds to hours

Tend to have prolonged effects

Are classified as amino acid-based hormones, or steroids

Eicosanoids – biologically active lipids with local hormone–like activity

Types of Hormones

Amino acid based

Amines, thyroxine, peptide, and protein hormones

Steroids – gonadal and adrenocortical hormones

Eicosanoids – leukotrienes and prostaglandins



InterActive Physiology®:
Biochemistry, Secretion, and Transport of Hormones

Hormone Action

Hormones alter target cell activity by one of two mechanisms

Second messengers:

Regulatory G proteins

Amino acid–based hormones

Direct gene activation

Steroid hormones

The precise response depends on the type of the target cell

Mechanism of Hormone Action

Hormones produce one or more of the following cellular changes in target cells

Alter plasma membrane permeability

Stimulate protein synthesis

Activate or deactivate enzyme systems

Induce secretory activity

Stimulate mitosis



InterActive Physiology®:
The Actions of Hormones on Target Cells

Amino Acid-Based Hormone Action: cAMP Second Messenger

Hormone (first messenger) binds to its receptor, which then binds to a G protein

The G protein is then activated as it binds GTP, displacing GDP

Activated G protein activates the effector enzyme adenylate cyclase

Adenylate cyclase generates cAMP (second messenger) from ATP

cAMP activates protein kinases, which then cause cellular effects

Amino Acid-Based Hormone Action: cAMP Second Messenger

See book for figure 16.2

Amino Acid-Based Hormone Action: PIP-Calcium

Hormone binds to the receptor and activates G protein

G protein binds and activates phospholipase

Phospholipase splits the phospholipid PIP_2 into diacylglycerol (DAG) and IP_3 (both act as second messengers)

DAG activates protein kinases; IP_3 triggers release of Ca^{2+} stores

Ca^{2+} (third messenger) alters cellular responses

Amino Acid-Based Hormone Action: PIP Mechanism

See book for figure 16.3

Steroid Hormones

This interaction prompts DNA transcription to produce mRNA

The mRNA is translated into proteins, which bring about a cellular effect

Mechanisms

See book for figure 16.4

Target Cell Specificity

Hormones circulate to all tissues but only activate cells referred to as target cells

Target cells must have specific receptors to which the hormone binds

These receptors may be intracellular or located on the plasma membrane

Target Cell Specificity

Examples of hormone activity

ACTH receptors are only found on certain cells of the adrenal cortex

Thyroxin receptors are found on nearly all cells of the body

Target Cell Activation

Target cell activation depends on three factors

Blood levels of the hormone

Relative number of receptors on the target cell

The affinity of those receptors for the hormone

Up-regulation – target cells form more receptors in response to the hormone

Down-regulation – target cells lose receptors in response to the hormone

Hormone Concentrations in the Blood

Hormones circulate in the blood in two forms – free or bound

Steroids and thyroid hormone are attached to plasma proteins

All others are unencumbered

Hormone Concentrations in the Blood

Concentrations of circulating hormone reflect:

- Rate of release

- Speed of inactivation and removal from the body

Hormones are removed from the blood by:

- Degrading enzymes

- The kidneys

- Liver enzyme systems

Interaction of Hormones at Target Cells

Three types of hormone interaction

Permissiveness – one hormone cannot exert its effects without another hormone being present

Synergism – more than one hormone produces the same effects on a target cell

Antagonism – one or more hormones opposes the action of another hormone

Control of Hormone Release

Blood levels of hormones:

Are controlled by negative feedback systems

Vary only within a narrow desirable range

Hormones are synthesized and released in response to:

Humoral stimuli

Neural stimuli

Hormonal stimuli