

Endocrine Control Systems

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This lecture covers general principles of endocrine control systems.

This lecture covers the following pages in the textbook: 12; 121-124; 319-332 ¹

¹ E Widmaier, H. Raff, and K. Strang. *Vander's Human Physiology: The Mechanisms of Body Function*. McGraw-Hill Science/Engineering/Math, 13th edition, 2013. ISBN 0073378305

Learning Objectives

- Define endocrine, paracrine, autocrine, and exocrine systems, define neuro-secretory cells by giving a few examples.
- List major categories of hormones and give several examples that belong to each class.
- List important factors that determine hormone levels in circulation.
- Describe four general functions of hormones.
- Explain with examples neuroendocrine integration.
- Explain cellular actions of hormones via membrane receptors.
- Explain cellular action of hormones via protein synthesis.
- Discuss major categories of cellular signal pathways of hormones via membrane receptors.
- Discuss major categories of cellular signal pathways of hormones via cytosolic/nuclear receptors.
- Define basal secretion and stimulated secretion of endocrine glands.
- Describe negative and positive feedback system using an example.

General Hormonal Principles

A MAJOR ADVANTAGE OF MULTICELLULARITY, is that biological roles are divided into specialized organs and tissues. In a single cellular organism, such as *Saccharomyces cerevisiae*², all cells need to autonomously be able to sense the environment, cellular conditions and respond appropriately. Multicellular organisms are able to use more sophisticated mechanisms to sense the environment and make these decisions. Essential to this division of labor is the ability of these

² also known as brewer's yeast

organ systems to communicate efficiently and effectively with each other. This is accomplished through hormones, which are secreted from one organ to another.

Hormonal Classification

There are hundreds, if not thousands hormones, if defined loosely to mean *chemicals derived from one cell that can affect another cell*. Remembering what these all do, how they are made, where they come from can be a challenge. To simplify this, these can be grouped several ways including chemically, anatomically or functionally.

CHEMICALLY, hormones can be small molecules such as amino acids or lipids, or can be small polypeptides, or even large proteins with three dimensional structures (see Figure 1). Often, an endocrine organ only releases hormones of a particular chemical class. An example of this is the adrenal gland which secretes several steroid hormones, each of which have different roles and target tissues.

ANATOMICALLY, hormones can be grouped based on where they are secreted from. Some major exocrine organs include the pancreas, the adrenal gland and the brain. Another way of considering anatomical classification of hormones is the relationship between the secreting cell and the target cell. Hormones can act on the secreting cell, or a very close cell or a cell in a (relatively) far away tissue. These are known as autocrine, paracrine and endocrine actions (see Table 1).

Type	Target	Example
Autocrine	Secreting cell	Monocyte IL-1
Paracrine	Nearby cell	Hedgehog
Endocrine	Far away cell	Insulin

FUNCTIONALLY, one can group hormones together based on collective regulation of a set of organs. These are often considered *axes* and some examples include the hypothalamic-pituitary-adrenal (HPA) axis, gut-liver-brain axis or the sympathetic -adrenal-medullary (SAM) axis.


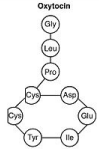

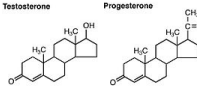
Hormone Class	Components	Example(s)
Amine Hormone	Amino acids with modified groups (e.g. norepinephrine's carboxyl group is replaced with a benzene ring)	Norepinephrine 
Peptide Hormone	Short chains of linked amino acids	Oxytocin 
Protein Hormone	Long chains of linked amino acids	Human Growth Hormone 
Steroid Hormones	Derived from the lipid cholesterol	Testosterone Progesterone 

Figure 1: Chemical classification of hormones. From Anatomy & Physiology, Connexions Web site. <http://cnx.org/content/col11496/1.6/>, Jun 19, 2013. OpenStax College.

Table 1: Types of hormones, based on the proximity of target and secreting cells

Neuroendocrine Regulation

Hormonal Signaling Concepts

Principles of Hormone Receptors

Regulation of Hormone Levels

Negative and Positive Feedback of Hormones

References

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