Pocket Guide to the Endocrine System
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The endocrine system

The endocrine system is a network of glands that secrete hormones directly into the bloodstream, controlling physiological events throughout the body (Figure 1.1). Endocrine function and hormone action mediate long-term effects by acting on all cellular processes and systems. They influence growth and development, tissue function, metabolism, reproduction, sexual development, fluid and nutrient homeostasis, and behavior.
Hormones

Hormones are chemical messengers that relay signals from one set of cells to another via the bloodstream. Most hormone production and secretion is overseen by endocrine glands along the hypothalamic-pituitary axis in the brain. In response to environmental or physiological stimuli, the hypothalamus secretes releasing neurohormones that stimulate the pituitary gland. The pituitary gland synthesizes and secretes hormones that target distal endocrine glands, which in turn synthesize and secrete peripheral hormones.

Endocrine glands secrete hormones via two mechanisms: hormones may be stored in large amounts within cellular secretory granules and released upon stimulation; alternatively, they are continually synthesi-
ized and secreted. Hormones target distant cells, bind receptors on the same cell (autocrine hormone signaling), or effect neighboring cells (paracrine hormone signaling). Hormone action is cell-specific, and most hormones only target cells in a particular tissue or organ. Hormones bind to specific receptors and activate intercellular pathways that result in altered gene regulation and protein expression, which control tissue and organ function (Figure 1.2).

Figure 1.2 Hormone secretion and action on target cells (taken from LIFE: The Science of Biology, 8th edition, 2007, W. H. Freeman and Co.)

Steroid hormones

Steroid hormones are synthesized from cholesterol and are lipid solu-
ble. They pass through target cell plasma membranes and bind to specific nuclear membrane receptors, forming activated hormone-receptor complexes. These complexes bind DNA and can activate or repress transcription of specific genes (Figure 1.3).

**Figure 1.3 Steroid hormone action**
(taken from http://scienceblogs.com)

![Steroid hormone action](http://scienceblogs.com)

**Protein and peptide hormones**

Protein and peptide hormones (or nonsteroid hormones) are mRNA translational products that are water soluble. They vary in size; as short as three amino acids, or long precursors that must be proteolytically cleaved to become active. These hormones bind to specific receptors embedded in the target cell plasma membranes. Ligand binding causes a conformational change in the receptor, triggering a secondary messenger cascade (Figure 1.4). There are five known secondary messengers: cyclic adenosine monophosphate (cAMP), cyclic guanosine monophosphate (cGMP), inositol triphosphate (IP3), diacylglycerol (DAG), and calcium ions (Ca2+). All elicit biochemical and transcriptional changes that result in altered protein expression, cellular physiology, and tissue and organ function.
The endocrine system and feedback loops

The endocrine system is tightly controlled by complex feedback loops. Although positive feedback loops do occur within the system, negative feedback loops are more common (Figure 1.5). Negative feedback occurs when the rate of the process decreases as the concentration of the product increases. Positive feedback occurs when the rate of a process increases as the concentration of the product increases. Endocrine feedback loops allow for self-correction and adjustment of hormone synthesis and secretion in response to peripheral stimuli.
Endocrine disorders

An endocrine disorder is caused by a hormone imbalance. Endocrine disorders result when hormone secretion, synthesis, or actions have failed to elicit a normal target tissue or organ response via specific receptors. Hormone excess is referred to as a hyperactive state. A hormone deficiency is called a hypoactive state.

Endocrine disorder etiology is multi-faceted. It can be genetic, behavioral, or environmental. Endocrine disorders can range from asymptomatic and mild to life-threatening and requiring immediate
medical intervention. Etiology, proper evaluation, and prompt diagnoses affect endocrine disorder prognoses.

Conclusion

The endocrine system is a network glands or organs that secrete hormones targeting specific cells. Hormone synthesis and secretion are controlled by environmental and physiological cues, as well as feedback loops. Endocrine dysfunction results from hormone excess or deficiency. This can lead to disorders or diseases that affect growth, development, metabolism, and the reproductive system.
Chapter 6: Links

Acromegaly.org www.acromegaly.org
American Diabetes Association www.diabetes.org
American Association of Clinical Endocrinologists www.aace.com
American Thyroid Association www.thyroid.org
American Urological Association www.auanet.org
Asia and Oceania Thyroid Association aothyroid.org
Association of Reproductive Health Professionals www.arhp.org
British Menopause Society www.thebms.org.uk
British Society for Sexual Medicine www.bssm.org.uk
Diabetes UK www.diabetes.org.uk
European Foundation for the Study of Diabetes www.europeandiabetesfoundation.org
European Menopause and Andropause Society www.emas-online.org
European Thyroid Association www.eurothyroid.com
European Society for Sexual Medicine www.essm.org
European Society of Endocrinology www.ese-hormones.org
Hormone Health Network www.hormone.org
International Association for the Study of Obesity www.iaso.org
International Communication Office of Pediatric Endocrine Societies www.copesinternational.org
International Diabetes Federation www.idf.org
International Federation of Gynecology & Obstetrics www.figo.org
International Menopause Society www.imsociety.org
International Obesity Task Force www.iaso.org/iotf
International Osteoporosis Foundation www.iofbonehealth.org
International Premature Ovarian Failure Association www.ipofa.org
International Society for Sexual Medicine www.issm.info
International Society of Endocrinology www.endosociety.com
Latin American Thyroid Society www.lats.org
National Parathyroid Education Foundation www.parathyroidfoundation.org
NIH Office of Rare Diseases Research www.rarediseases.info.nih.gov
North American Menopause Society www.menopause.org
Pediatric Endocrine Society www.lpwpes.org
Pituitary Network Association www.pituitary.org
The Endocrine Society www.endo-society.org
The Global Genes Project globalgenes.org
The Growth Hormone Research Society www.ghresearchsociety.org
The Human Growth Foundation www.hgfound.org
Thyroid Federation International www.thyroid-fed.org
Thyroid Foundation of Canada www.thyroid.ca
World Health Organization www.who.int
WorldWIDE Diabetes www.worldwidediabetes.org

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