CHAPTER 17
FUNCTIONAL ORGANIZATION OF THE ENDOCRINE SYSTEM

CHAPTER OVERVIEW: This chapter introduces the basic concepts of endocrine control and the function of chemical messengers. Negative feedback, amplitude modulation and frequency modulation are reviewed. The cellular mechanisms of endocrine action; membrane-bound receptors, intracellular receptors, second messengers, and up and down regulation are explained in detail. The chemical nature of hormones is used as means of explaining the differences in half-life and mechanism of action among hormones.

OUTLINE (two fifty-min. lectures):
Seeley, A&P, 5/e

Chapt. Object.	Topic Outline, Chapter 17	Figures & Tables	Transparency Acetates
1	I. Introduction, p. 527		
	1. One of the Body's Major Control Systems		
	II. General Characteristics of the Endocrine System		
	A. Endocrine Glands	Fig. 17.1, p. 527	TA-334
2	1. Secretions Called Hormones		
	2. Transported in Blood		
	3. Target Tissue(s) has(have) Response(s)		
	B. Differences Between Endocrine and Nervous Systems	Fig. 17.2, p. 528	TA-335
3	1. Amplitude v. Frequency Modulation	Fig. 17.2a, p.528	
	2. Rate of Target Tissue Response	Fig. 17.2b, p.528	
	3. Duration of Target Tissue Response		
2, 3	C. Continuum of Chemical Messengers	Table 17.1, p. 529	
	1. Hormones		
4	2. Neurohormones		
	3. Intercellular Chemical Signals		
	4. Autocrine Chemical Signals		
	5. Paracrine Chemical Signals		
	6. Pheromones		
	III. Chemical Structure of Hormones, p. 528	Table 17.2, p.530 Fig. 17.3, p.531	TA-335
	A. Protein-based		
	B. Lipids		
	1. Steroids - Estrogens, Testosterone		
5	IV. Control of Secretion Rate, p. 528	Fig. 17.4, p.532	TA-336
	A. Rate Usually Not Constant		
	B. Homeostatic Control of Secretion	Fig. 17.5, p.532	TA-336
	1. Negative Feedback	Fig. 17.7, p.533	TA-337
	2. Auto-Regulation		
	C. Other Control Mechanisms of Hormone Secretion		
	1. Non-hormone Substance		

	2. Nervous Stimulation		
	3. Another Hormone	Fig. 17.6, p.533	TA-337
	4. Positive Feedback	Predict Quest. 1	
		Fig. 17.7, p.533	TA-337
	D. Patterns of Secretion	Fig. 17.8, p.534	TA-338
	1. Chronic Secretion		
	2. Acute Secretion		
	3. Cyclic Secretion		
	V. Transport and Distribution in the Body, p. 531	Fig. 17.9, p.534	TA-339
	A. Dissolved in Plasma		
	B. Bound to Transport Proteins		
	C. Circulate with Blood	Fig. 17.10, p.535	TA-340
	1. Movement of Lipid-Soluble Hormones		
	2. Movement of Water-Soluble Hormones		
	VI. Metabolism and Excretion, p. 534		
6	A. Definition of Hormone Half-Life	Table 17.3, p.535	
		Predict Quest.2	
	B. Water-Soluble Hormones		
	1. Short Half-Lives - Rapid Degradation		
	2. Blood Levels Change Rapidly		
	3. Actions of Rapid Onset & Short Duration		
	C. Lipid-Soluble Hormones		
	1. Longer Half-Lives		
	a. Bound to Plasma Proteins		
	b. Stay in Blood Longer		
	2. Blood Levels Relatively Constant		
7	D. Removal of Hormones from Blood		
	1. Direct Excretion in Urine or Bile		
	2. Modified Before Excretion		
	a. Metabolized		
	b. Conjugation by Liver		
	3. Active Transport and Recycling		
8	VII. Interactions of Hormones With Their Target Tissues, p. 536		
	A. General Role of Hormone Receptors	Fig. 17.11, p.536	TA-341
	1. Made of Protein or Glycoprotein		
	2. Three-Dimensional Shape Confers Specificity		
	3. Specific Response of Target Tissue Depends on Type of Receptor(s) Present	Predict Quest. 3	
8	B. Number of Receptors Affects Response		
	1. Down Regulation Decreases Tissue Responsiveness	Fig. 17.12a, p.537	TA-341
	2. Up Regulation Increases Tissue Responsiveness	Fig. 17.12b, p.537	TA-341
9	VIII. Classes of Hormone Receptors, p. 537		
10	A. Membrane-Bound Hormone Receptors		

12	1. Receptors that Directly Control	Fig. 17.13, p.538	TA-342
13	Membrane Channels	Table 17.4, p.538	
11	a. Ligand-Gated Ion Channels	Fig. 17.14, p.539	TA-342
	2. Hormone Receptors that Directly Synthesize Intracellular Mediator Molcules	Fig. 17.15, p.539	TA-343
	3. Hormones that Activate G Proteins		
	a. Alpha Subunit Bound to GTP Alters Cell Activity		
	b. Can Open Ca^{2+} Channels		
	1). Influx of Ca^{2+}		
	2). Calcium Ions Bind to Calmodulin or Other Regulatory Protein		
	3). Ca^{2+}/Calmodulin Complex Alters Cell's Functions		
	c. Can Activate Adenylate Cyclase	Fig. 17.16, p.540 Predict Quest. 4	TA-343
	1). cAMP Produced from ATP		
	2). Activates Protein Kinases (Phosphokinases) Which Alter Cell Function		
	3). cAMP removed by Action of Phosphodiesterase		
	d. Can Activate Phospholipase C	Fig. 17.17, p.541	TA-344
	1). Diacylglycerol (DAG) and Inositol Triphosphate (IP_3) Produced from Phosphoinositol		
	2). DAG Regulates Enzyme Function		
	3). IP_3 Releases Ca^{+2} from Sarcoplasmic Reticulum and Opens Plasma Membrane Ca^{+2} Channels		
	4. Hormone Receptors That Phosphorylate Enzymes	Fig. 17.18, p. 541 Table 17.5, p.538	TA-344
	a. Cascade Effect Magnifies Cell Response in Second Messenger Systems		
9, 14	B. Intracellular Hormone Receptors	Fig. 17.19, p.542 Fig. 17.20, p. 543 Tab1e 17.6, p.541	TA-345 TA-346
	1. Binds with Lipid-Soluble Hormones	Predict Quest. 5	
	a. Receptor in Cytoplasm or Nucleus		
	b. Receptor-Hormone Complex Interacts with DNA in Nucleus		
	2. mRNA Synthesis Increased		
	3. New Protein Synthesis Results		
	4. Latent Period of Hours Between Binding		

of Hormone and Measurable Response
5. Receptor-Hormone Complexes Degraded Within Cell

IMPORTANT CONSIDERATIONS: The logical separation of the material into two presentations occurs between the general issues of hormones (secretion and control) and the detail of the mechanisms of action of hormones at their target cells.

The concept of regulation (especially at the cellular level) is often unfamiliar to students. Presenting the general framework of how control systems operate helps organize both the details of how the nervous and endocrine systems influence the functioning of other cells and the mechanisms which regulate the secretion of hormones. Some sort of organization is needed to keep this information from being simply a meaningless collection of facts for students.

Relate the functions of the endocrine system to those that have already been discussed for the nervous system and the neuronal regulation of body functions. Discuss both the similarities and differences between endocrine and neuronal control and relate these differences to the kind of body functions being regulated; hormonal control of metabolic rate v. neuronal control of the withdrawal reflex, for example. The role of amplitude modulation and frequency modulation can also be related to the difference in type of cell activity being controlled and the mechanism of action at the receptors on the postsynaptic membrane or target tissue.

A clear understanding of the structural differences among the hormones will be helpful to students when differences in mechanism of action are discussed later.

SEE INSTRUCTOR'S MANUAL AND COURSE SOLUTIONS MANUAL FOR ADDITIONAL RESOURCES.