Hormones and the Endocrine System
Chapter 45

Intercellular communication
• Endocrine signaling
• Local regulators
  – Paracrine and autocrine signaling
• Neuron signaling
  – Synaptic and neuroendocrine signaling

Paracrine and Autocrine Signaling
• Local regulators are molecules that act over short distances, reaching target cells solely by diffusion
• In paracrine signaling, the target cells lie near the secreting cells
• In autocrine signaling, the target cell is also the secreting cell

Signaling by local regulators
• Local regulators are secreted molecules that link neighboring cells or directly regulate the secreting cell
• Types of local regulators
  – Cytokines and growth factors
  – Nitric oxide (NO)
  – Prostaglandins
Signaling by pheromones

- Chemical signals can be released into the environment

Chemical classes of hormones

- Three major classes of molecules function as hormones in vertebrates
  - Polypeptides (proteins and peptides)
  - Amines derived from amino acids
  - Steroid hormones
- Lipid-soluble hormones (steroid hormones) pass easily through cell membranes, while water-soluble hormones (polypeptides and amines) do not
Multiple effects of hormones

Simple endocrine pathway

Simple neuroendocrine pathway

Feedback regulation: blood glucose control
Diabetes mellitus

- Well-known endocrine disorder causing elevated blood glucose levels
- Caused by a deficiency of insulin or a decreased response to insulin in target tissues
- Type 1 diabetes mellitus (insulin-dependent) is an autoimmune disorder in which the immune system destroys pancreatic beta cells
- Type 2 diabetes mellitus (non-insulin-dependent) involves reduced response of target cells due to change in insulin receptors

The hypothalamus and pituitary are central to endocrine regulation

- The hypothalamus receives information from the nervous system and initiates responses through the endocrine system
- Attached to the hypothalamus is the pituitary gland, composed of the posterior pituitary and anterior pituitary
  - The posterior pituitary stores and secretes hormones that are made in the hypothalamus
  - The anterior pituitary makes and releases hormones under regulation of the hypothalamus

Posterior pituitary hormones

Thyroid regulation: A hormone cascade pathway

- A hormone can stimulate the release of a series of other hormones, the last of which activates a nonendocrine target cell; this is called a hormone cascade pathway
- The release of thyroid hormone results from a hormone cascade pathway involving the hypothalamus, anterior pituitary, and thyroid gland
- Hormone cascade pathways typically involve negative feedback
Evolution of hormone function

- Function of a given hormone may diverge between species
- Thyroid hormone plays a role in metabolism across many lineages, but in frogs has taken on a unique function: stimulating the resorption of the tadpole tail during metamorphosis

Tropic and nontropic hormones

- A tropic hormone regulates the function of endocrine cells or glands
- Three primarily tropic hormones are
  - Follicle-stimulating hormone (FSH)
  - Luteinizing hormone (LH)
  - Adrenocorticotropic hormone (ACTH)
- Growth hormone (GH) is secreted by the anterior pituitary gland and has tropic and nontropic actions

Parathyroid hormone and vitamin D: control of blood calcium

- Parathyroid hormone (PTH) stimulates calcium (Ca) release from bones and increases vitamin D activity.
- Vitamin D increases Ca absorption in the intestines.

Adrenal Hormones: Response to Stress

- The adrenal glands are adjacent to the kidneys
  - The adrenal medulla (inner portion)
  - The adrenal cortex (outer portion)
Catecholamines from the adrenal medulla
- The adrenal medulla secretes epinephrine (adrenaline) and norepinephrine (noradrenaline)
- Mediate various fight-or-flight responses

Long-term stress response
- Glucocorticoids, such as cortisol, influence glucose metabolism and the immune system
- Mineralocorticoids, such as aldosterone, affect salt and water balance
- The adrenal cortex also produces small amounts of steroid hormones that function as sex hormones

Gonadal sex hormones
- The gonads, testes and ovaries, produce most of the sex hormones: androgens, estrogens, and progestins
- All three sex hormones are found in both males and females, but in significantly different proportions

Androgens
- The testes primarily synthesize androgens, mainly testosterone, which stimulate development and maintenance of the male reproductive system
- Testosterone causes an increase in muscle and bone mass and is often taken as a supplement to cause muscle growth, which carries health risks

Estrogens
- Estrogens, most importantly estradiol, are responsible for maintenance of the female reproductive system and the development of female secondary sex characteristics
- In mammals, progestins, which include progesterone, are primarily involved in preparing and maintaining the uterus
- Synthesis of the sex hormones is controlled by FSH and LH from the anterior pituitary
**Endocrine disruptors**

- A molecule that interrupts the normal function of a hormone pathway

**Melatonin and biorhythms**

- The pineal gland, located in the brain, secretes melatonin
- Light/dark cycles control release of melatonin
- Primary functions of melatonin appear to relate to biological rhythms associated with reproduction