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 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
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

Simple endocrine 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

Simple neuroendocrine pathway

- The hypothalamus and pituitary are central to endocrine regulation
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 uptake in kidneys and bones, opposing the effects of calcitonin, which decreases blood calcium by stimulating calcium deposition in bones and secretion by kidneys

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
Endocrine disrupters

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

All hormones

- a) are lipid-soluble molecules.
- b) are protein molecules.
- c) elicit the same biological response from all of their target cells.
- d) are carried to target cells in the blood.
- e) are produced by endocrine glands.

Hormones are transported throughout the circulatory system, but they affect only specific tissues or cells because

A. only the capillaries at the target will let the hormones out of the blood.
B. only the target cells have receptors for the hormone.
C. the nontarget tissues catabolize or destroy the hormones.
D. the hormones know where their targets are located.

Oxytocin, the milk-release hormone secreted from nerve endings (axon terminals) in the posterior pituitary gland, is synthesized in

a) the anterior pituitary gland.
b) the hypothalamus.
c) the mammary glands.
d) the posterior pituitary gland.

The role of the pancreas as an endocrine gland that mediates glucose homeostasis is of great importance to health, but a patient whose pancreas has been surgically removed also loses

a) the body’s source of epinephrine.
b) the body’s source of growth hormones.
c) the body’s source of most of its digestive enzymes.
d) the ability to coordinate swallowing and breathing.