The Endocrine System

glands and disorders.

Major Endocrine Organs
• Pituitary gland
• Thyroid gland
• Parathyroid glands
• Adrenal glands
• Pineal gland
• Thymus gland
• Pancreas
• Gonads (Ovaries and Testes)
• Hypothalamus

Location of Major Endocrine Organs

Pituitary Gland
• Size of a pea
• Hangs by a stalk from the hypothalamus in the brain
• Protected by the sphenoid bone
• Has two functional lobes
  • Anterior pituitary—glandular tissue
  • Posterior pituitary—nervous tissue
• Often called the “master endocrine gland”

Hormones of the Anterior Pituitary
• Six anterior pituitary hormones
  • Two affect non-endocrine targets
    • Growth hormone
    • Prolactin
  • Four stimulate other endocrine glands (tropic hormones)
    • Thyroid-stimulating hormone (thyrotropic hormone)
    • Adrenocorticotropic hormone
    • Two gonadotropic hormones
Hormones of the Anterior Pituitary

- Characteristics of all anterior pituitary hormones
  - Proteins (or peptides)
  - Act through second-messenger systems
  - Regulated by hormonal stimuli, mostly negative feedback

Growth hormone
- General metabolic hormone
- Major effects are directed to growth of skeletal muscles and long bones
- Plays a role in determining final body size
- Causes amino acids to be built into proteins
- Causes fats to be broken down for a source of energy

Growth hormone (GH) disorders
- Pituitary dwarfism results from hyposecretion of GH during childhood
- Gigantism results from hypersecretion of GH during childhood
- Acromegaly results from hypersecretion of GH during adulthood

Gigantism
Hormones of the Anterior Pituitary

Dwarfism

Figure 9.5b

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Hormones of the Anterior Pituitary

- Prolactin (PRL)
  - Stimulates and maintains milk production following childbirth
  - Function in males is unknown
- Adrenocorticotropic hormone (ACTH)
  - Regulates endocrine activity of the adrenal cortex
- Thyroid-stimulating hormone (TSH)
  - Influences growth and activity of the thyroid gland

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Hormones of the Anterior Pituitary

- Gonadotropic hormones
  - Regulate hormonal activity of the gonads
    - Follicle-stimulating hormone (FSH)
      - Stimulates follicle development in ovaries
      - Stimulates sperm development in testes
    - Luteinizing hormone (LH)
      - Triggers ovulation of an egg in females
      - Stimulates testosterone production in males

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Pituitary–Hypothalamus Relationship

- Hormonal release is regulated by releasing and inhibiting hormones produced by the hypothalamus
- Hypothalamus produces two hormones
  - These hormones are transported to neurosecretory cells of the posterior pituitary
    - Oxytocin
    - Antidiuretic hormone
  - The posterior pituitary is not strictly an endocrine gland, but does release hormones

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Hormones of the Posterior Pituitary

- Oxytocin
  - Stimulates contractions of the uterus during labor, sexual relations, and breastfeeding
  - Causes milk ejection in a nursing woman
Hormones of the Posterior Pituitary

- Antidiuretic hormone (ADH)
  - Inhibits urine production by promoting water reabsorption by the kidneys
  - In large amounts, causes vasoconstriction leading to increased blood pressure
  - Also known as vasopressin

Hormones of the Posterior Pituitary

- Found at the base of the throat
- Consists of two lobes and a connecting isthmus
- Produces two hormones
  - Thyroid hormone
  - Calcitonin

Thyroid Gland

- Thyroid hormone
  - Major metabolic hormone
  - Composed of two active iodine-containing hormones
    - Thyroxine (T4)—secreted by thyroid follicles
    - Triiodothyronine (T3)—conversion of T4 at target tissues
Thyroid Gland

Figure 9.7b

Thyroid hormone disorders
- Goiters
  - Thyroid gland enlarges due to lack of iodine
  - Salt is iodized to prevent goiters
- Cretinism
  - Caused by hyposecretion of thyroxine
  - Results in dwarfism during childhood

Thyroid hormone disorders (continued)
- Myxedema
  - Caused by hypothyroidism in adults
  - Results in physical and mental sluggishness
- Graves' disease
  - Caused by hyperthyroidism
  - Results in increased metabolism, heat intolerance, rapid heartbeat, weight loss, and exophthalmos
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Thyroid Gland

- Calcitonin
  - Decreases blood calcium levels by causing its deposition on bone
  - Antagonistic to parathyroid hormone
  - Produced by parafollicular cells
  - Parafollicular cells are found between the follicles

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Thyroid Gland

Figure 9.7b

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Parathyroid Glands

- Tiny masses on the posterior of the thyroid
- Secrete parathyroid hormone (PTH)
  - Stimulate osteoclasts to remove calcium from bone
  - Stimulate the kidneys and intestine to absorb more calcium
  - Raise calcium levels in the blood

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Hormonal Regulation of Calcium in Blood

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Adrenal Glands

- Sit on top of the kidneys
- Two regions
  - Adrenal cortex—outer glandular region has three layers
    - Mineralocorticoids secreting area
    - Glucocorticoids secreting area
    - Sex hormones secreting area
  - Adrenal medulla—inner neural tissue region
Hormones of the Adrenal Cortex

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Hormones of the Adrenal Cortex

- Mineralocorticoids (mainly aldosterone)
  - Produced in outer adrenal cortex
  - Regulate mineral content in blood
  - Regulate water and electrolyte balance
  - Target organ is the kidney
  - Production stimulated by renin and aldosterone
  - Production inhibited by atrial natriuretic peptide (ANP)

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Hormones of the Adrenal Cortex

- Glucocorticoids (including cortisone and cortisol)
  - Produced in the middle layer of the adrenal cortex
  - Promote normal cell metabolism
  - Help resist long-term stressors
  - Released in response to increased blood levels of ACTH

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Roles of the Hypothalamus and Adrenal Glands in the Stress Response
Hormones of the Adrenal Cortex

- Sex hormones
  - Produced in the inner layer of the adrenal cortex
  - Small amounts are made throughout life
  - Mostly androgens (male sex hormones) are made but some estrogens (female sex hormones) are also formed

Adrenal Glands

- Adrenal cortex disorders
  - Addison’s disease
    - Results from hyposecretion of all adrenal cortex hormones
    - Bronze skin tone, muscles are weak, burnout, susceptibility to infection
  - Hyperaldosteronism
    - May result from an ACTH-releasing tumor
    - Excess water and sodium are retained leading to high blood pressure and edema

Adrenal Glands

- Adrenal cortex disorders
  - Cushing’s syndrome
    - Results from a tumor in the middle cortical area of the adrenal cortex
    - “Moon face,” “buffalo hump” on the upper back, high blood pressure, hyperglycemia, weakening of bones, depression
  - Masculinization
    - Results from hypersecretion of sex hormones
    - Beard and male distribution of hair growth

Hormones of the Adrenal Medulla

- Produces two similar hormones (catecholamines)
  - Epinephrine (adrenaline)
  - Norepinephrine (noradrenaline)
- These hormones prepare the body to deal with short-term stress (“fight or flight”) by
  - Increasing heart rate, blood pressure, blood glucose levels
  - Dilating small passageways of lungs
Pancreatic Islets

- The pancreas is a mixed gland and has both endocrine and exocrine functions.
- The pancreatic islets produce hormones.
  - Insulin—allows glucose to cross plasma membranes into cells from beta cells.
  - Glucagon—allows glucose to enter the blood from alpha cells.
- These hormones are antagonists that maintain blood sugar homeostasis.

Pineal Gland

- Found on the third ventricle of the brain.
- Secretes melatonin.
  - Helps establish the body’s wake and sleep cycles.
  - Believed to coordinate the hormones of fertility in humans.
  - Secretion controlled by exposure to light.
Thymus Gland
- Located posterior to the sternum
- Largest in infants and children
- Produces thymosin
- Matures some types of white blood cells
- Important in developing the immune system

Gonads
- Ovaries
  - Produce eggs
  - Produce two groups of steroid hormone
    - Estrogens
    - Progesterone
- Testes
  - Produce sperm
  - Produce androgens, such as testosterone

Hormones of the Ovaries
- Estrogens
  - Stimulate the development of secondary female characteristics
  - Mature female reproductive organs
  - With progesterone, estrogens also
    - Promote breast development
    - Regulate menstrual cycle
Hormones of the Ovaries

- Progesterone
  - Acts with estrogen to bring about the menstrual cycle
  - Helps in the implantation of an embryo in the uterus
  - Helps prepare breasts for lactation

Hormones of the Testes

- Produce several androgens
- Testosterone is the most important androgen
  - Responsible for adult male secondary sex characteristics
  - Promotes growth and maturation of male reproductive system
  - Required for sperm cell production

Other Hormone-Producing Tissues and Organs

- Parts of the small intestine
- Parts of the stomach
- Kidneys
- Heart
- Many other areas have scattered endocrine cells
Endocrine Function of the Placenta

- Produces hormones that maintain the pregnancy
- Some hormones play a part in the delivery of the baby
- Produces human chorionic gonadotropin (hCG) in addition to estrogen, progesterone, and other hormones

Developmental Aspects of the Endocrine System

- Most endocrine organs operate smoothly until old age
- Menopause is brought about by lack of efficiency of the ovaries
- Problems associated with reduced estrogen are common
- Growth hormone production declines with age
- Many endocrine glands decrease output with age