Endocrine System

Chapter 24

Introduction

• Endocrine system works with nervous system to coordinate body functions
  - Nervous system uses impulses and neurotransmitters
  - Endocrine system uses hormones
• Many cells have receptors for both neurotransmitters and hormones and can be regulated by both chemicals

Anatomy

• Exocrine glands: Secrete products into ducts that open into body cavities
  - Sudoriferous: Secrete sweat
  - Sebaceous: Secrete oil
  - Ceruminous: Secrete ear wax
• Endocrine glands
  - Secrete hormones directly into bloodstream
  - Ductless glands

Physiology

• Hormone production and secretion
• Regulation of metabolism
• Stress adaptation
• Chemical composition and fluid volume regulation
• Reproductive process regulation

Hormones and Regulation

• Chemical messengers that regulate the physiologic activity of other cells
• Have potential to come in contact with every cell type
  - Target cells are chemically compatible with corresponding hormone(s)
  - Lock together with receptor sites
Negative Feedback Regulation

- Movement reverses deviations from homeostasis
- Glands respond to information
  - Secrete more or less hormone
- Positive feedback systems also regulate hormones

Hormonal Regulation

- Hormone from one endocrine gland binds to receptor sites on another endocrine gland
- Tropic hormones stimulate other endocrine glands
  - Most are secreted by anterior pituitary

Neural Regulation

- Neural impulses stimulate release of hormones
- Epinephrine and norepinephrine maintain fight-or-flight response
- These systems have a faster response than other regulation systems

Hypothalamus

- Regulates the autonomic nervous system and controls many behaviors
- Links nervous system to endocrine system through pituitary gland
- Stimulates or inhibits pituitary hormones

Hypothalamic Hormones

- Stimulatory
  - Thyrotropin-releasing hormone, gonadotropin-releasing hormone, growth hormone-releasing hormone, prolactin-releasing hormone, and corticotropin-releasing hormone
- Inhibitory
  - Growth hormone-inhibiting hormone
  - Prolactin-inhibiting hormone

Pituitary

- Lies in sella turcica of sphenoid bone
- Consists of:
  - Anterior lobe: Constitutes 75% of entire gland
  - Posterior lobe: Regulated by the nervous system
Anterior Pituitary Hormones

- Adrenocorticotropic hormone (ACTH)
  - Stimulates hormones of adrenal cortex, especially cortisol
- Growth hormone (GH)
  - Stimulates protein synthesis for muscle and bone growth maintenance, repair, and metabolism
- Thyroid-stimulating hormone (TSH)
  - Stimulates secretion of thyroid hormones
- Follicle-stimulating hormone (FSH)
  - Women: Stimulates estrogen production and development of ovarian follicle
  - Men: Stimulates sperm production in the testes
- Luteinizing hormone (LH)
  - Women: Stimulates estrogens and progesterone, ovulation, and corpus luteum development
  - Men: Stimulates testosterone production
- Prolactin (PRL)
  - Promotes milk production in the breasts
- Melanocyte-stimulating hormone (MSH)
  - Increases skin pigmentation

Posterior Pituitary Hormones

- Antidiuretic hormone (ADH)
  - Decreases urine production
  - Raises blood pressure by vasoconstriction
- Oxytocin (OT)
  - Stimulates uterine contraction
  - Stimulates milk expression

Pineal Gland

- Located posterior aspect of the diencephalon
- Pine nut-shaped
- Chief hormone secreted is melatonin
  - Controls biorhythms
  - Levels remain elevated for 12 hours

Thyroid

- Located below the larynx and around the front and sides of the trachea
- Contains two lobes connected at center by the isthmus
  - Occasionally, a third lobe will arise

Thyroid Hormones

- Triiodothyronine (T3) and thyroxine (T4)
  - Collectively called thyroid hormones (TH)
  - Regulates metabolism
  - Affect growth and development
  - Cannot be made without iodine
Thyroid Hormones

- Calcitonin (CT)
  - Decreases blood calcium levels (hypocalcemic) by stimulating osteoblast activity
  - Decreases with advancing age

Parathyroid

- Located on posterolateral surface of thyroid lobes
- Usually four in number
- Parathyroid hormone (PTH)
  - Increases blood calcium levels (hypercalcemic) by stimulating osteoclastic activity
  - Increases calcium absorption in intestines

Adrenals

- Cortex is outer region
  - Produces three steroid hormones:
    - Mineralocorticoids
    - Glucocorticoids
    - Sex hormones (adrenal estrogens and adrenal androgens)
- Medulla is the inner region
  - Produces epinephrine and norepinephrine

Adrenal Cortex and Adrenal Medulla Hormones

- Cortisol (Hydrocortisone)
  - Influences the metabolism of food molecules, such as carbohydrates, proteins, and fats
  - Has antiinflammatory effect in large amounts
  - Aldosterone maintains sodium levels in the blood
- Epinephrine or adrenaline and norepinephrine or noradrenaline bind to receptors of sympathetic effectors

Pancreatic Islets

- Also called islets of Langerhans
- Contains:
  - Alpha cells: Secrete glucagon
  - Beta cells: Secrete insulin
  - Delta cells: Secrete somatostatin and pancreatic polypeptides

Pancreatic Hormones

- Insulin
  - Decreases blood glucose levels by moving glucose into cells
  - Secreted by pancreatic beta cells
  - Cannot be given orally
Pancreatic Hormones

- **Glucagon**
  - Increases blood glucose levels by moving stored glucose to the blood
  - Secreted by pancreatic alpha cells

Ovaries

- Located in female abdominopelvic area
- Secretes estrogens and progesterone
- Regulate menstrual cycle and secondary sex characteristics
- Other hormones are relaxin and inhibin

Ovarian Hormones

- **Estrogens**
  - Responsible for secondary sex characteristics in females
  - Promote the proper sequence of events of the menstrual cycle
- **Progesterone**
  - Maintains uterine lining for implantation and gestation
  - Slightly elevates temperature for incubating effect

Testes

- Located in male scrotum
- Contains interstitial cells of Leydig
  - Produce androgens
    - Principal androgen is testosterone

Testicular Hormones

- **Testosterone**
  - Stimulates sperm production
  - Responsible for secondary sex characteristics in males
  - Involved in increasing libido

Organs That Possess Endocrine Cells

- **Kidneys**
  - **Erythropoietin**
    - Secreted when blood oxygen levels decline
    - Stimulates production of additional red blood cells in bone marrow
  - **Renin**
    - Secreted when blood pressure in kidneys drops below a certain level
    - Stimulates a negative feedback system called the renin-angiotensin-aldosterone system, which increases blood pressure
Thymus: Hormones

- Thymosin and thymopoietin
  - Stimulates T-cell maturation
  - Involved in immune responses

Placenta: Hormones

- Human chorionic gonadotropin (HCG)
  - Pregnancy hormone, present in blood and urine of pregnant women
  - Stimulates ovaries to secrete estrogens and progesterone
  - Decreases lymphocyte activity
- Relaxin
  - Facilitates implantation by relaxing uterus
  - Softens connective tissue and dilates cervix for fetal delivery

Gastric and Intestinal Mucosa: Hormones

- Gastrin
  - Initiates secretion of bile, gastric juices, and pancreatic enzymes
- Cholecystokinin
  - Stimulates gallbladder to release bile and pancreas to secrete its enzymes
- Secretin
  - Stimulates pancreas to secrete alkaline liquid to neutralize acidic chyme

Heart: Hormones

- Atrial natriuretic hormone (ANH)
  - Released when right atrium is overstretched
  - Triggers urine production
  - Decreases blood volume in attempt to reduce blood pressure

Fat Cells: Hormones

- Leptin
  - Regulates appetite and metabolism
- Resistin
  - Increases blood glucose levels by increasing insulin resistance