Chapter 13

Endocrine System

- Helps maintain homeostasis
- Regulates metabolic activities
- Cells, tissues, & organs SECRETEE chemical messengers (hormones)
- Assists the CNS with communication & control of the body
- Endocrine glands are effectors
- They are ductless
- They use the bloodstream
- Hormones work on specific cells – target cells

Comparison of Nervous System & Endocrine System

- Neurons release neurotransmitters into synapse
- Glands release hormones into blood
- CNS is rapid responses
- Endocrine slower response

Glandular Epithelia

2 types
- Endocrine glands
  - hormones secreted into extracellular areas, then diffuses into blood
  - ductless
- Exocrine glands
  - NOT part of endocrine system
  - secrete substances into cavities or ducts that exit body (stomach acid, sweat, oil)

Endocrine Glands

- hormones travel through blood to target cells
- target cells have specific receptor sites

Paracrine secretions
- only affect neighboring cells
- don’t travel through blood
- Ex. Clotting factors in blood, histamine

Autocrine secretions
- affect only the secreting cell
- Ex. interleukin

Chemistry of Hormones

Steroid Hormones
- derived from cholesterol (lipids)
- complex ring structure
- differ by atoms attached to ring
- Ex. – sex hormones

Nonsteroid Hormones
- made from amino acids
- 4 types include amines, proteins, peptides, glycoproteins
- includes most hormones
Chemistry of Hormones

Prostaglandins
- made from lipids from cell membrane
- paracrine substances
- regulates cellular responses to hormones

Actions of Steroid Hormones

- insoluble in water; soluble in lipids of cell membrane & diffuses into cell
- hormone combines with receptor (activates gene)
- synthesis of mRNA activated
- mRNA enters cytoplasm to bind with ribosomes & direct synthesis of protein

Actions of Nonsteroid Hormones

- hormone binds to receptor on cell membrane; doesn’t enter cell
- hormone activates G protein
- ATP converted to cAMP
- cAMP activates protein kinase which will change metabolic processes and produce hormone’s effect
- promotes a series of reactions leading to cellular changes

Control of Hormonal Secretions

- controlled by negative feedback mechanism

Hormones and Athletics

- Anabolic Steroids increase muscle strength
  - Negative affect on reproductive system
  - Enlargement of the heart muscles/heart disease
  - Violent, aggressive behavior & mood swings
  - Acne
  - Breast growth in males
  - Muscle aches
- Growth hormones
  - Enlarges muscles, height
- Erythropoietin increases the # of RBC's which carry O_2 to cells
  - Increases endurance

Major Endocrine Glands
**Pituitary Gland (Hypophysis)**
- base of brain; protected by sella turcica w/in sphenoid bone
- attached to hypothalamus by infundibulum
- 2 regions
  - anterior pituitary (adenohypophysis) – glandular tissues
  - posterior pituitary (neurohypophysis) – nervous tissues
- Hypothalamic hormones stimulate cells of anterior pituitary to release hormones
- Nerve impulses from hypothalamus stimulate posterior pituitary to release hormones

**Hypothalamic Hormones**

**Anterior Pituitary Hormones**

Growth Hormone (GH) or somatotropin
- stimulates cell growth
- promotes growth of long bones
- increases protein synthesis
- increases rate that cells use fats

Prolactin (PRL)
- promotes milk production after birth

Adrenocorticotropic Hormone (ACTH)
- controls secretions of adrenal cortex

**Thyroid Stimulating Hormone (TSH) or thyrotropin**
- controls growth & secretions from thyroid gland
- goiter results from ↑↑↑ TSH

Luteinizing hormone (LH)
- Triggers ovulation
- Causes ruptured follicle to form corpus luteum
- Stimulates testosterone production in males

**Follicle-Stimulating Hormone (FSH)**
- stimulates development of ovarian follicles
- stimulates follicles to secrete estrogen
- stimulates production of sperm cells
### Posterior Pituitary Hormones

Nerve fibers & neuroglia originate in hypothalamus. Hormones are produced in the hypothalamus but stored in the posterior pituitary.

**Antidiuretic Hormone (ADH) of vasopressin**
- causes kidneys to reduce water excretion
- high conc. raises blood pressure
- hypothalamus responds to changes in blood conc. & blood volume

**Oxytocin (OT)**
- stimulates uterine contractions
- stimulates mammary glands to release milk
- hypothalamus responds to stretch of uterine & vaginal walls & stimulation of breasts

### Thyroid Gland

- located at base of throat
- 2 lobes joined by a central mass called the isthmus
- follicular cells secrete sticky colloid substance
- 3 major metabolic hormone

### Thyroid Gland Hormones

**Thyroxine (T\textsubscript{4}) & Triiodothyronine (T\textsubscript{3})**
- ↑ rate of energy released from carbs
- ↑ rate of protein synthesis; accelerates growth
- controlled by TSH

**Calcitonin**
- lowers blood Ca & PO\textsubscript{4} ion conc. by inhibiting release of Ca & PO\textsubscript{4} from bones
- ↑ rate at which Ca & PO\textsubscript{4} are deposited in bones

### Parathyroid Glands

- 4 tiny, bean shaped masses on posterior surface of thyroid

#### Parathyroid Gland Disorders

**Hyperparathyroidism**
- weak bones
- fatigue
- muscular weakness

**Hypoparathyroidism**
- caused by injury or removal of gland
- muscle cramps & seizures
Adrenal Glands

- 2 bean shaped structures located on top of kidneys
- 2 divisions
  - Cortex – outer glandular region (3 layers)
  - Medulla – inner neural region

Adrenal Cortex Hormones

- Cortisol
  - ↓ protein synthesis
  - ↑ fatty acid release
  - stimulates glucose synthesis from noncarbohydrates

Adrenal Medulla Hormones

Epinephrine & Norepinephrine
- sympathetic nervous system
- ↑ heart rate & blood pressure
- dilates respiratory airways
- ↑ blood glucose levels

Adrenal sex hormones
- supplement sex hormones from gonads
- androgens – male hormones
- estrogen – female hormones

Pancreas

- Located below left side of stomach
- Ducts lead to duodenum
- Mixed gland (endocrine & exocrine)
- Pancreatic islets release 2 hormones
  - Insulin
  - Glucagon

- PAGE 513
Pancreatic Hormones

Glucagon
- secreted by alpha cells of pancreatic islets
- controlled by blood glucose conc.
- stimulated by fasting; ↓ blood glucose
- stimulates liver to break down glycogen & convert noncarbs into glucose
- stimulates break down of fats

Insulin
- secreted by beta cells of pancreatic islets
- controlled by blood glucose conc.
- stimulated after eating; ↑
- promotes formation of glycogen from glucose
- inhibits conversion of noncarbohydrates into glucose
- enhances movement of glucose into adipose & muscle cells
- decreases blood glucose conc.

Pancreatic Hormones & Glucagon
Function together to stabilize blood glucose concs.

Other Endocrine Glands

Pineal Gland
- attached to midbrain
- secretes melatonin which helps regulates circadian rhythms (night & day)
- may control onset of puberty
- helps regulate female cycle
- SAD & PMS

Thymus Gland
- mediastinum; between lungs & behind sternum
- secretes thymosins
- promotes development of T lymphocytes; immunity

Reproductive Glands
- ovaries secrete estrogen & progesterone
- testes secrete testosterone
- placenta secretes estrogen, progesterone, & gonadotropins

Life-Span Changes
- endocrine glands shrink
- GH levels even out, muscular strength ↓
- ADH levels ↑ due to slow break down
- calcitonin levels ↓
- PTH ↑, osteoporosis risk ↑
- insulin resistance may develop
- changes in melatonin secretion affect the body clock
- thymosin production ↓ increasing risk of infections
Diseases & Disorders

Growth Hormone Disorders
• Acromegaly – hypersecretion of GH in adults
• Gigantism - hypersecretion of GH in children
• Dwarfism – hyposecretion of GH in children

Thyroid Gland Disorders

Hyperthyroidism
• high metabolic rate
• hyperactivity
• weight loss
• protruding eyes

Cretinism
• hypothyroidism in infants
• leads to small stature & retardation

Myxedema
• adult hypothyroidism
• low metabolic rate; obesity
• sluggishness

Simple Goiter
• deficiency of iodine leads to deficiency of thyroid hormones
• gland enlarged

Grave's disease
• overstimulation of gland by antibodies; autoimmune disease

Adrenal Cortex Imbalances
• Addison's disease
• Hyopsecretion
• Anorexia, wt. loss
• Nausea
• Arrhythmia, cardiac arrest
• Cushing’s syndrome
• Hypersecretion
• Redistribution of fat; (buffalo hump, beer belly)
• Wasting of muscles

Diseases & Disorders

Diabetes
• Hyopsecretion of insulin
• ↑ blood sugar

3 signs
• Polyuria
  • excess sugar in urine
  • prevents H2O reabsorption
• Polydipsia
  • excess thirst
• Polyphagia
  • Excess hunger

Seasonal affective disorder – SAD
• ↓ melatonin secretions from pineal gland

Diabetes insipidus
• Hyopsecretion of ADH
• Diuresis; (dehydration, thirst)
**Diseases & Disorders**

- Diabetes mellitus – Type 1 (insulin dependent)
  - insulin deficient
  - develops suddenly in juveniles
  - long term vascular problems
  - loss of sensation in lower limbs
- Type II (non-insulin dependent)
  - occurs midlife (over forty)
  - strong genetics
  - Wt. gain can be controlled by diet/exercise

**Diseases & Disorders**

- Hyperinsulinism
  - Excess secretion of insulin results in hypoglycemia
    - (low blood sugar)
    - tremors, weakness