Chp. 15  Endocrine system

• Mostly comprised of glands

• Secretes hormones that move through the bloodstream to target cells

• Results in a slow but a prolonged response

Endocrine system

What is a target cell?

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Exocrine vs. endocrine glands

- Exocrine glands secrete their products into ducts that carry these products to other organs or outside the body
- Endocrine glands secrete their products directly into the bloodstream

What are hormones?

- Hormones are chemical signals that promote communication between cells, body parts and even individuals

Hormones:
- Prostaglandins: local hormones affect neighboring cells and thus are not carried in the bloodstream
- Pheromones: chemical signals that influence the behavior of other individuals
- Peptide hormones: bind to a receptor in the plasma membrane causing the formation of cAMP which activates a cascade of enzymes
- Steroid hormones: lipids that enter a cell and affect gene activity and thus protein synthesis

Action of peptide hormones
15.1 Endocrine glands

**Action of steroid hormones**

1. Hypothalamus

   - Regulates internal environment through the autonomic nervous system
     - Helps control heartbeat
     - Helps control body temperature
     - Helps control water balance
     - Controls glandular secretions

15.2 Hypothalamus and pituitary gland

1. Hypothalamus

   - Regulates internal environment through the autonomic nervous system
     - Helps control heartbeat
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     - Helps control water balance
     - Controls glandular secretions

2. Posterior pituitary gland

   - Stores antidiuretic hormone (ADH) and oxytocin that are produced by the hypothalamus
     - ADH: regulates water balance by reabsorbing water into the bloodstream
     - Oxytocin: causes uterine contractions during childbirth and allow milk to be released during nursing
3. Anterior pituitary gland

- Controlled by hypothalamic-releasing and hypothalamic-inhibiting hormones

- Hormones produced by the anterior pituitary:
  1. Thyroid-stimulating hormone (TSH): stimulates the thyroid to produce thyroid hormones
  2. Adrenocorticotropic hormone (ACTH): stimulates the adrenal cortex to produce cortisol
  3. Gonadotropic hormones: stimulate gonads to produce sex cells and hormones
  4. Prolactin (PRL): stimulates mammary glands to develop and produce milk only after childbirth
  5. Melanocyte-stimulating hormone (MSH): causes skin cells to produce melanin
  6. Growth hormone (GH): promotes skeletal and muscular growth
15.2 Hypothalamus and pituitary gland

What happens when GH is produced in high amounts during adulthood?

15.3 Thyroid and parathyroid glands

4. Thyroid gland

• A large gland located below the larynx

• Iodine is needed in the diet to allow the thyroid gland to produce its hormones

• It produces:
  – Thyroid hormone (TH): regulates metabolism
  – Calcitonin: helps lower blood Ca^{2+} levels by stimulating the deposition of calcium in the bones

15.3 Thyroid and parathyroid glands

Thyroid abnormalities
5. Parathyroid glands

- Small glands embedded in the surface of the thyroid gland

- Produces parathyroid hormone (PTH):
  - Causes blood Ca\(^{2+}\) level to increase by promoting osteoclast activity
  - Promotes reabsorption of Ca\(^{2+}\) by the kidneys

6. Adrenal glands

- Glands that sit on top of the kidneys

- 2 parts of each gland
  - Adrenal medulla: controlled by the nervous system
  - Adrenal cortex: portions are controlled by ACTH from the anterior pituitary
15.4 Adrenal glands

**Adrenal medulla**

- Inner portion of the adrenal glands
- Hypothalamus initiates stimulation of hormone secretion in the adrenal medulla
- Produces: hormones that allow a short-term response to stress ("fight or flight" response)
  - Epinephrine (adrenaline)
  - Norepinephrine

**Adrenal cortex**

- Outer portion of the adrenal glands
- Produces hormones that provide a long-term response to stress
- 2 major types of hormones:
  - Mineralocorticoids:
    - regulate salt and water balance
    - e.g. aldosterone (targets the kidney)
  - Glucocorticoids:
    - regulate carbohydrate, protein, and fat metabolism
    - Suppress the body's inflammatory response
    - e.g. cortisol and cortisone

**Summary of the adrenal glands**
Adrenal glands can malfunction

- Addison’s disease – hyposecretion of glucocorticoids by the adrenal cortex characterized by bronzing of the skin

- Cushing syndrome – hypersecretion of glucocorticoids by the adrenal cortex characterized by weight gain in the trunk of the body but not arms and legs

7. Pancreas

- Fish-shaped organ behind the stomach
- Composed of 2 tissues:
  - Exocrine: produces and secretes digestive juices
  - Endocrine (islets of Langerhans): produces and secretes hormones

  1. Insulin – secreted when blood glucose is high and stimulates uptake of glucose by cells (muscle and liver)
  2. Glucagon – secreted when blood glucose is low and stimulates the breakdown of glycogen in the liver
Health focus: What is diabetes?

- Inability to control blood glucose levels
- There are two types: Type 1 and Type 2
- 18 million people in the US have diabetes
- General symptoms:
  - Frequent urination
  - Unusual hunger and/or thirst
  - Unexplained change in weight
  - Blurred vision
  - Sores that heal slowly or not at all
  - Excessive fatigue
- Long-term effects are blindness, loss of limbs, nerve deterioration, kidney and cardiovascular disease

Diabetes: Understanding the 2 types

- Type 1:
  - Usually early-onset
  - Autoimmune disorder that tends to run in families
  - Pancreatic cells are attacked and cannot produce insulin
  - Need insulin injections
- Type 2:
  - Usually adult-onset and most common type
  - Tends to occur in obese, sedentary people
  - Cells do not respond to insulin
  - Usually diet and exercise are important for controlling this and may even prevent this!
8. Testes

- Gonads found in males
- Produce androgens (e.g. testosterone)
  - Stimulates growth of the penis and testes
  - Responsible for 2 male sex characteristics such as facial, underarm and pubic hair
  - Prompts the larynx and vocal cords to enlarge resulting in a lower voice
  - Promotes muscular strength

9. Ovaries

- Gonads found in females
- Produce estrogen and progesterone
  - Stimulates growth of the vagina and uterus
  - Responsible for secondary sex characteristics such as female body hair, fat distribution and breast development
  - Responsible for egg maturation
  - Regulates the uterine cycle

10. Thymus gland

- Lies beneath the sternum
- This gland is largest and most active during childhood
- T lymphocytes mature here
- Secretes hormones called thymosins that aid in differentiation of lymphocytes
11. Pineal gland

- Located in the brain
- Secretes melatonin that regulates the sleep/wake cycle (circadian rhythm)
- May also regulate sexual development

Hormones from other tissues

- Erythropoietin: secreted by the kidney to increase red blood cell production
- Leptin: produced by fat cells and acts on the hypothalamus to give a feeling of being satiated
- Prostaglandins:
  - A group of potent chemicals that are not carried in the bloodstream but work locally on neighboring cells
  - Some cause smooth muscle contraction
  - Major impact on reproductive organs
  - Many other roles in the body
  - Aspirin and ibuprofen block the synthesis of these

How the nervous and endocrine systems work with other body systems