Endocrine System (CH 9)
Endocrine System...

*The endocrine system consists of a range of glands and tissues throughout the body
Functions of the Endocrine System:

1) Maintain balance within body (homeostasis)

2) Integration and regulation of growth and development

3) Controls and maintains reproduction
GLANDS OF THE ENDOCRINE SYSTEM

1) Hypothalamus
2) Adrenal Gland
3) Pituitary Gland
4) Thyroid Gland
5) Thymus
6) Parathyroid Gland
MAJOR TISSUES OF THE ENDOCRINE SYSTEM

1) PANCREAS
2) KIDNEYS
3) HEART
4) DIGESTIVE TRACT
5) PLACENTA
6) TESTES
7) OVARIIES
8) PINEAL GLAND
Maintaining Homeostasis

• Homeostasis = maintaining internal balance
• Two organ systems coordinate to enable body parts to communicate with each other and adjust constantly to incoming signals
  – Endocrine System
  – Nervous System (next unit)
ENDOCRINE AND NERVOUS SYSTEM

• Major communication systems in the body

• Integrate stimuli and responses to changes in external and internal environment

• Both are crucial to coordinated functions of highly differentiated cells, tissues and organs

• Unlike the nervous system, the endocrine system is anatomically discontinuous.
### Overview

<table>
<thead>
<tr>
<th></th>
<th>Nervous*</th>
<th>Endocrine</th>
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</thead>
<tbody>
<tr>
<td>Cells</td>
<td>Neurons</td>
<td>Glandular epithelium</td>
</tr>
<tr>
<td>Chemical Signals</td>
<td>Neurotransmitter</td>
<td>Hormones</td>
</tr>
<tr>
<td>Specificity of action</td>
<td>Receptors on postsynaptic cells</td>
<td>Receptors on target cells</td>
</tr>
<tr>
<td>Speed of onset</td>
<td>Seconds</td>
<td>Seconds to hours</td>
</tr>
<tr>
<td>Duration of action</td>
<td>Very brief unless neuronal activity continues</td>
<td>May be brief or may last for days even if secretions ceases</td>
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*More on this next unit*
Endocrine System

- Endocrine = “internal secretions”
- Derives its name from the fact that various glands release hormones directly into the blood, which in turn transports the hormones to target tissues via ducts.
• Controls many body functions
  – exerts control by releasing special chemical substances into the blood called **HORMONES**

• Hormones affect other endocrine glands or body system
  • communicates regulatory messages within the body
HORMONE ACTION

• “Lock and Key” approach: describes the interaction between the hormone and its specific receptor.
  – Receptors for nonsteroid hormones are located on the cell membrane
  – Receptors for steroid hormones are found in the cell’s cytoplasm or in its nucleus
• **TARGET CELLS** = cells equipped to respond to specific hormones
Steroid hormone (inside cell)  Non-Steroid hormone (surface of cell)
Steroid Hormones

- Located inside the cell
- Lipid soluble
  - Derived from cholesterol
- Influence brain development, reproduction, sexual differentiation, memory, and so on
- Examples: testosterone, estrogen, cortisol
How they work:

- Enter target cells, bind to an intracellular receptor and activate genes that produce new proteins.
- Slower acting than nonsteroid hormones; minutes to hours depending on how long it takes to produce a new protein.
Non-Steroid Hormones

- Water soluble
  - derived from amino acid protein building blocks

- 4 types with examples
  - Amines (Epinephrine)
  - Peptide hormones (oxytocin)
  - Protein hormones (insulin)
  - Prostaglandins (FSH)
• How they work:
  – Bind to receptors on target cell membranes to convert an inactive molecule within the cell into an active molecule. The activated molecule produces a chemical which is called a second messenger.
  – Work through intermediate mechanisms to activate existing enzymes so that even a small amount of hormone can produce a significant cellular change
  – Faster action than steroid hormones, seconds to minutes
1. A non-steroid hormone reaches the target cell,
2. The hormone binds to a membrane receptor
3. Binding to the receptor activates an enzyme in the cell membrane (adenylate cyclase)
4. Adenylate cyclase converts ATP into cyclic adenosine monophosphate (cAMP)
5. cAMP is a second messenger that promotes a series of reactions leading to the cellular changes associated with the hormone’s action.
USE OF FEEDBACK LOOPS

• Feedback loops are used extensively to regulate secretion of hormones
• Example: Production of releasing substance / inhibiting substance
  → Release of hormone from pituitary gland
  → stimulates hormone release by target gland
  → hormone exert normal effect & influence further release of a releasing or inhibiting substance
  → inhibit release of hormone from pituitary gland
Pituitary Gland

- Considered the “middle man”
- Located below the hypothalamus
- Divided into 2 sections: Anterior and Posterior
- Indirectly controls lactation, metabolism, reproduction, and growth
- It is controlled by the hypothalamus
Thyroid Gland

• Butterfly-shaped gland found below larynx
• Controls the rate at which glucose is oxidized (burned)  
  – Regulates metabolism
• Plays role in development of reproductive and nervous systems
Parathyroid Gland

- Located on the posterior surface of the thyroid gland
- Controls calcium and phosphate in blood
Adrenal Gland

• Located on top of each of the kidneys
• Responsible for “fight or flight” response to stress
Pancreas

- Aids in the digestion of carbohydrates, lipids, and proteins
Gonads

- Includes the **ovaries** and the **testes**
- Produces sex hormones similar to the adrenal glands
- Controls the amounts of **hormones** produced
Pineal Gland

• Hangs from roof of third ventricle in the brain
• Endocrine function is a bit of mystery
• Receives input from the eyes; melatonin secretion is higher in the dark
  – Important in synchronizing the body’s rhythms to the daily light/dark cycle (Circadian cycle or rhythm)
Stress And Its Effects

• Factors that change body’s internal and external environment can be potentially life threatening
• Sensory system detects changes then send message to hypothalamus
• Hypothalamus then triggers physiological response to change
• Stressor = factor capable to stimulate response

• Stress = condition produced in body
Types of Stress

• Physical stress
  – Affects tissue
  – Examples: extreme temperatures, oxygen concentrations, loud sounds, excessive exercise
Types of Stress

• Physiological stress
  – Result of thoughts that are real or imagined, personal loss, social interactions
  – Causes: emotions such as fear, anger, anxiety
Responses to Stress

• Hypothalamus controls response to stress

• 2 ways body can respond
  – Autonomic nervous system
    • Immediate fight-or-flight response
    • Hormone balance/body temperature/blood vessel width
  – Endocrine system
    • Short-term and long-term stress response
    • Hormones that regulate physiological functions
Roles of the Hypothalamus and Adrenal Glands in the Stress Response

Short-term stress response:
1. Increased heart rate
2. Increased blood pressure
3. Liver converts glycogen to glucose and releases glucose to blood
4. Dilatation of bronchioles
5. Changes in blood flow patterns, leading to increased alertness and decreased digestive and kidney activity
6. Increased metabolic rate

Long-term stress response:
1. Retention of sodium and water by kidneys
2. Increased blood volume and blood pressure

Both short-term and long-term responses involve the release of hormones like ACTH and glucocorticoids from the adrenal cortex.