CHAPTER 22
The Endocrine System

Endocrine vs. Exocrine

- **Endocrine**
  - Secretes a chemical/substance into the bloodstream

- **Exocrine**
  - Secretes a chemical/substance into ducts

Primary and Secondary Endocrine Glands

- **Primary**
  - Pituitary
  - Adrenal
  - Thyroid
  - Pineal
  - Parathyroid

- **Secondary (not exclusively endocrine)**
  - Hypothalamus
  - Liver
  - Thymus
  - Small intestine
  - Pancreas
  - Skin
  - Gonads
  - Heart
  - Kidneys
  - WAT
  - Stomach
  - Placenta

Hormones & Target Cells

- **Hormones**
  - Substance/chemical released into the bloodstream that has its effect on target cells somewhere else in the body.

- **Target Cells**
  - Any cell that has receptors for the hormone.
  - 2000-100,000 receptors per cell.
  - Can potentially be every cell in the body.

Down & Up Regulation

- **Down regulation**
  - Increased hormone levels
  - Decreased receptor number
    - Receptor mediated endocytosis
  - Decreased hormone sensitivity or response

- **Up regulation**
  - Decreased hormone levels
  - Increased receptor number
  - Increased sensitivity or responsiveness to hormone
Nervous vs. Endocrine Systems

<table>
<thead>
<tr>
<th>CHARACTERISTIC</th>
<th>NERVOUS SYSTEM</th>
<th>ENDOCRINE SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mediator molecules</td>
<td>Neurotransmitters released locally in response to nervous impulses.</td>
<td>Hormones delivered by tissues throughout the body by the blood.</td>
</tr>
<tr>
<td>Site of mediator action</td>
<td>Close to site of release, at a synapse, binds to receptor in postsynaptic membrane.</td>
<td>Far from site of release (mainly), binds to receptors on or in target cell.</td>
</tr>
<tr>
<td>Type of target cells</td>
<td>Muscles, smooth, cardiac, and skeletal cells, with gland cells, other neurons.</td>
<td>Gland throughout the body.</td>
</tr>
<tr>
<td>Time to onset of action</td>
<td>Typically within microseconds (millions of a second).</td>
<td>Generally longer (seconds to days).</td>
</tr>
<tr>
<td>Location of action</td>
<td>Generally localized (in the CNS).</td>
<td>Generally broader (in the PNS).</td>
</tr>
</tbody>
</table>

Hypothalamus
- Controls much of the secretion of the pituitary
- Major integrating link between the nervous and endocrine systems
- Receives input from
  - Limbic system
    - Pain stress, emotions
- Releases at least 9 hormones
- Releases 7 hormones that act on pituitary
- Unique anatomical relationship between hypothalamus and pituitary

Hypothalamic-hypophyseal Portal System
- 2 capillary beds in succession
- Releasing hormones (RH) enter primary plexus
  - Very small amounts
- Secondary plexus allows for RH to have their effect on the anterior pituitary (adenohypophysis).
**Thyroid Gland**

**Parathyroid Glands**

**Sex Hormones**
Adrenal Glands

Posteriors Pituitary

- Neurohypophysis
  - Does not synthesize hormones
  - Does store and release hormones
  - Axon terminals of hypothalamic secretory cells located in neurohypophysis
  - Hypothalamohypophyseal tract
  - Two major hormones released
    - Oxytocin
    - Antidiuretic hormone – vasopressin
Neurohypophyseal hormones

**TABLE 23.3**

<table>
<thead>
<tr>
<th>Summary of Neurohypophyseal Hormones</th>
<th>Hormone and Tissues</th>
<th>Principal Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oxytocin (O)</td>
<td>Uterus</td>
<td>Stimulates contraction of smooth muscular coat of uterine arteries; release of milk by mammary glands; causes milk ejection.</td>
</tr>
<tr>
<td>Antidiuretic hormone (ADH or vasopressin)</td>
<td>Kidneys</td>
<td>Increases blood volume by decreasing renal blood flow, decreasing urine output, raising blood pressure by contracting arterioles.</td>
</tr>
</tbody>
</table>

Pancreas

- Mostly exocrine (98%)
- Pancreatic islets – Islets of Langerhans (2%)
- 4 cell types secrete 4 different hormones

**Insulin Actions**

<table>
<thead>
<tr>
<th>Site/tissue in the body</th>
<th>Process</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver</td>
<td></td>
<td><strong>CARBOHYDRATE METABOLISM</strong></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>glucose transport ↑ blood glucose</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>glycogen synthesis ↑ glucose usage</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>gluconeogenesis</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td><strong>LIPID METABOLISM</strong></td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>lipogenesis ↓ plasma FFA</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>lipolysis ↓ ketogenesis</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>** PROTEIN METABOLISM**</td>
</tr>
<tr>
<td>X</td>
<td>X</td>
<td>amino acid uptake (active) → plasma amino acids</td>
</tr>
<tr>
<td>X</td>
<td>x</td>
<td>protein synthesis ↓ urinary nitrogen</td>
</tr>
<tr>
<td>x</td>
<td></td>
<td>gluconeogenesis* ↑ nitrogen balance</td>
</tr>
</tbody>
</table>
Glucagon Actions

LIVER
- increases glycogenolysis
- inhibits protein synthesis
- increases gluconeogenesis
- increases lipolysis
- increases ketogenesis

ADIPOSE TISSUE
- stimulates lipolysis

PANCREAS
- stimulates insulin secretion

SKELETAL MUSCLE
- NO GLUCAGON RECEPTORS IN SKELETAL MUSCLE!!!!!!

Other Hormones

- Pineal Gland
  - Melatonin
    - Increases during sleep
    - Decreases before you wake up
    - Inhibits reproduction in animals w/ breeding seasons
    - Associated with SAD (Seasonal Affective Disorder)

- Thymus Gland
  - Thymosin = Thymic Humoral Factor
  - Thymopoietin = Thymic Factor
  - Promotes Proliferation & Maturation of T-Cells

Learning Objectives

- Discuss hypothalamic regulation of the pituitary gland
- Discuss the hypothalamic-hypophyseal portal system
- Define a tropic hormone
- Name the anterior pituitary hormones and their target tissues and functions
- Discuss the posterior pituitary hormones, target tissues and functions
Learning Objectives

- Discuss the different areas of the adrenal glands and their hormones/targets/functions
- Discuss the pancreatic islets their hormones/targets/functions
- Discuss what stimulates pancreatic hormone secretion
- Discuss the thyroid glands, (hormones/targets/functions)

- Discuss the parathyroid glands and their hormone functions targets/functions
- What is the function of the thymus and pineal glands
- What hormone does white fat secrete