**Simple Hormone Pathways**

Hormones are released from an endocrine cell, travel through the bloodstream, and interact with the receptor or a target cell to cause a physiological response.

A negative feedback loop

**Insulin and Glucagon: Control of Blood Glucose**

- Insulin and glucagon are antagonistic hormones that help maintain glucose homeostasis.

The pancreas has clusters of endocrine cells called islets of Langerhans.

**Target Tissues for Insulin and Glucagon**

Insulin reduces blood glucose levels by:

- Promoting the cellular uptake of glucose
- Slowing glycogen breakdown in the liver
- Promoting fat storage

Glucagon increases blood glucose levels by:

- Stimulating conversion of glycogen to glucose in the liver
- Stimulating breakdown of fat and protein into glucose
Diabetes Mellitus

Type I diabetes mellitus (insulin-dependent) is an autoimmune disorder in which the immune system destroys pancreatic beta cells.

Type II diabetes mellitus (non-insulin-dependent) involves insulin deficiency or reduced response of target cells due to change in insulin receptors.

The endocrine and nervous systems act individually and together in regulating animal physiology

• Signals from the nervous system initiate and regulate endocrine signals

The hypothalamus receives information from the nervous system and initiates responses through the endocrine system.

Attached to the hypothalamus is the pituitary gland composed of the posterior pituitary and anterior pituitary.

The posterior pituitary

The anterior pituitary
### Table 45.1 Major Human Endocrine Glands and Some of Their Hormones

<table>
<thead>
<tr>
<th>Gland</th>
<th>Hormone</th>
<th>Chemical Class</th>
<th>Representative Actions</th>
<th>Regulated By</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hypothalamus</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hormones released from the posterior pituitary and hormones that regulate the anterior pituitary (see below)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Oxytocin</td>
<td>Peptide</td>
<td>Stimulates contraction of uterus and mammary gland cells</td>
<td>Nervous system</td>
</tr>
<tr>
<td></td>
<td>Antidiuretic hormone (ADH)</td>
<td>Peptide</td>
<td>Promotes retention of water by kidneys</td>
<td>Water/salt balance</td>
</tr>
<tr>
<td><strong>Anterior pituitary gland</strong></td>
<td>Growth hormone (GH)</td>
<td>Protein</td>
<td>Stimulates growth (especially bones) and metabolic functions</td>
<td>Hypothalamic hormones</td>
</tr>
<tr>
<td></td>
<td>Prolactin (PRL)</td>
<td>Protein</td>
<td>Stimulates milk production and secretion</td>
<td>Hypothalamic hormones</td>
</tr>
<tr>
<td></td>
<td>Follicle-stimulating hormone (FSH)</td>
<td>Glycoprotein</td>
<td>Stimulates production of ova and sperm</td>
<td>Hypothalamic hormones</td>
</tr>
<tr>
<td></td>
<td>Luteinizing hormone (LH)</td>
<td>Glycoprotein</td>
<td>Stimulates ovaries and testes</td>
<td>Hypothalamic hormones</td>
</tr>
<tr>
<td></td>
<td>Thyroid-stimulating hormone (TSH)</td>
<td>Glycoprotein</td>
<td>Stimulates thyroid gland</td>
<td>Hypothalamic hormones</td>
</tr>
<tr>
<td></td>
<td>Adrenocorticotropic hormone (ACTH)</td>
<td>Peptide</td>
<td>Stimulates adrenal cortex to secrete glucocorticoids</td>
<td>Hypothalamic hormones</td>
</tr>
<tr>
<td><strong>Thyroid gland</strong></td>
<td>Triiodothyronine (T₃) and thyroxine (T₄)</td>
<td>Armine</td>
<td>Stimulate and maintain metabolic processes</td>
<td>TSH</td>
</tr>
<tr>
<td></td>
<td>Calcitonin</td>
<td>Peptide</td>
<td>Lowers blood calcium level</td>
<td>Calcium in blood</td>
</tr>
<tr>
<td><strong>Parathyroid glands</strong></td>
<td>Parathyroid hormone (PTH)</td>
<td>Peptide</td>
<td>Raises blood calcium level</td>
<td>Calcium in blood</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gland</th>
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<th>Chemical Class</th>
<th>Representative Actions</th>
<th>Regulated By</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pancreas</strong></td>
<td>Insulin</td>
<td>Protein</td>
<td>Lowers blood glucose level</td>
<td>Glucose in blood</td>
</tr>
<tr>
<td></td>
<td>Glucagon</td>
<td>Protein</td>
<td>Raises blood glucose level</td>
<td>Glucose in blood</td>
</tr>
<tr>
<td><strong>Adrenal glands</strong></td>
<td>Epinephrine and norepinephrine</td>
<td>Amines</td>
<td>Raise blood glucose level; increase metabolic activities; constrict certain blood vessels</td>
<td>Nervous system</td>
</tr>
<tr>
<td>Adrenal medulla</td>
<td>Glucocorticoids</td>
<td>Steroid</td>
<td>Raise blood glucose level</td>
<td>ACTH</td>
</tr>
<tr>
<td></td>
<td>Mineralocorticoids</td>
<td>Steroid</td>
<td>Promote reabsorption of Na⁺ and excretion of K⁺ in kidneys</td>
<td>K⁺ in blood; angiotensin II</td>
</tr>
<tr>
<td>Adrenal cortex</td>
<td>Androgens</td>
<td>Steroid</td>
<td>Support sperm formation; promote development and maintenance of male secondary sex characteristics</td>
<td>FSH and LH</td>
</tr>
<tr>
<td><strong>Gonads</strong></td>
<td>Estrogens</td>
<td>Steroid</td>
<td>Stimulate uterine lining growth; promote development and maintenance of female secondary sex characteristics</td>
<td>FSH and LH</td>
</tr>
<tr>
<td>Testes</td>
<td>Progestins</td>
<td>Steroid</td>
<td>Promote uterine lining growth</td>
<td>FSH and LH</td>
</tr>
<tr>
<td>Ovaries</td>
<td>Melatonin</td>
<td>Amine</td>
<td>Involved in biological rhythms</td>
<td>Light/dark cycles</td>
</tr>
</tbody>
</table>

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Posterior Pituitary Hormones

• The two hormones released from the posterior pituitary act directly on nonendocrine tissues

Oxytocin

• This is an example of positive feedback, where the stimulus leads to an even greater response

Antidiuretic hormone (ADH) or vasopressin
Anterior Pituitary Hormones

- Hormone production in the anterior pituitary is controlled by releasing and inhibiting hormones from the hypothalamus.

Hormone Cascade Pathways

- A hormone can stimulate the release of a series of other hormones, the last of which activates a nonendocrine target cell; this is called a hormone cascade pathway.

The release of thyroid hormone results from a hormone cascade pathway involving the hypothalamus, anterior pituitary, and thyroid gland.

- Hormone cascade pathways are usually regulated by negative feedback.
Tropic Hormones

A tropic hormone

The four strictly tropic hormones are

- **Thyroid-stimulating hormone (TSH)**
- **Follicle-stimulating hormone (FSH)**
- **Luteinizing hormone (LH)**
- **Adrenocorticotropic hormone (ACTH)**

**Follicle-stimulating hormone (FSH) and Luteinizing hormone (LH)**

Stimulate the activities of the male and female gonads, the testes and the ovaries, respectively.

**Adrenocorticotropic hormone (ACTH)**

- stimulates the production and secretion of steroid hormones by the adrenal cortex.

Nontropic Hormones

-Nontropic hormones produced by the anterior pituitary are: **Prolactin (PRL)**

**Melanocyte-stimulating hormone (MSH)**

- regulates fat metabolism and reproduction in birds
- delays metamorphosis in amphibians
- regulates salt and water balance in freshwater fishes

**MSH** influences skin pigmentation in some vertebrates and fat metabolism in mammals

**Growth Hormone**

-Growth hormone (GH) is secreted by the anterior pituitary gland and has tropic and nontropic actions

It promotes growth directly and has diverse metabolic effects
Endocrine glands respond to diverse stimuli in regulating metabolism, homeostasis, development, and behavior.

- Endocrine signaling regulates metabolism, homeostasis, development, and behavior.

**Thyroid Hormone: Control of Metabolism and Development**

- Thyroid hormones stimulate metabolism and influence development and maturation.

**It produces two iodine-containing hormones:** triiodothyronine ($T_3$) and thyroxine ($T_4$).

**Hyperthyroidism**

- Hyperthyroidism, excessive secretion of thyroid hormones,

- Graves’ disease is a form of hyperthyroidism in humans.

**Hypothyroidism**

- Proper thyroid function requires dietary iodine for hormone production.

- Iodine deficiency in the diet.

- Graves’ disease is a form of hyperthyroidism in humans.
Parathyroid Hormone and Vitamin D: Control of Blood Calcium

Two antagonistic hormones regulate the homeostasis of calcium (Ca^{2+}) in the blood of mammals.

Parathyroid hormone (PTH)

PTH increases the level of blood Ca^{2+}

It releases Ca^{2+} from bone and stimulates reabsorption of Ca^{2+} in the kidneys.

It also has an indirect effect, stimulating the kidneys to activate vitamin D, which promotes intestinal uptake of Ca^{2+} from food.

• Calcitonin decreases the level of blood Ca^{2+}

It stimulates Ca^{2+} deposition in bones and secretion by kidneys.

Study outline—Chapter 45—Hormones and the Endocrine System

Understand simple hormone pathways and negative feedback
Ex: insulin and glucagon: control of blood glucose

Differentiate between Type I diabetes mellitus (insulin-dependent) and Type II diabetes mellitus (non-insulin dependent)

Understand the coordination of endocrine and nervous systems in vertebrates
- How is the hypothalamus involved? How are the posterior and anterior pituitary involved?
What 2 hormones are released from the posterior pituitary that act directly on nonendocrine tissue?

Understand the process of positive feedback.
Ex: oxytocin

What are the functions of antidiuretic hormone (ADH)?
Understand the hormone cascade pathway
Differentiate between tropic and nontropic hormones.
- Name the 4 tropic hormones and their functions.
- Name the 2 tropic hormones and their functions.

What is the function of growth hormone (GH)?
Differentiate between gigantism and dwarfism.
Understand thyroid hormone.
- Name the two iodine-containing hormones.
- Differentiate between hyperthyroidism and hypothyroidism.

Understand how the parathyroid hormone and vitamin D control blood calcium.
Give examples of multiple effects of hormones.

Name the different types of local regulators and their functions.

Describe the general structure of a hormone pathway using the figure provided.

Using the same figure, explain the concept of negative feedback.

Use the example of insulin and glucagon in the control of blood glucose to explain the arrangement of paired hormone pathways. Use the figure provided.

Describe diabetes mellitus.

Describe Type I and Type II diabetes mellitus.

The endocrine and nervous systems act together to regulate animal physiology. How does the hypothalamus and pituitary gland (anterior and posterior pituitary) function in this process?
Name the two hormones that are released from the posterior pituitary and their function.

Use the figure provided to explain the concept of positive feedback.

Name the hormones that are released from the anterior pituitary.

Describe the hormone cascade pathway using the figure provided.

Differentiate between tropic and nontropic hormones.

Name the four strictly tropic hormones and their functions.

Name the two strictly nontropic hormones and their functions.

Describe growth hormone (GH) and its functions.

Define gigantism and pituitary dwarfism.
Using the figure provided describe the function and pathway of thyroid hormone.

Define hyperthyroidism. Describe Grave’s disease

Using the figure provided, explain how parathyroid hormone and calcitonin control blood calcium.