

TEM of growth hormone producing cell from the pituitary gland. Growth hormone granules are shown in green.

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## Overview of the Endocrine System

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### Overview of the Endocrine System

#### Image Reference

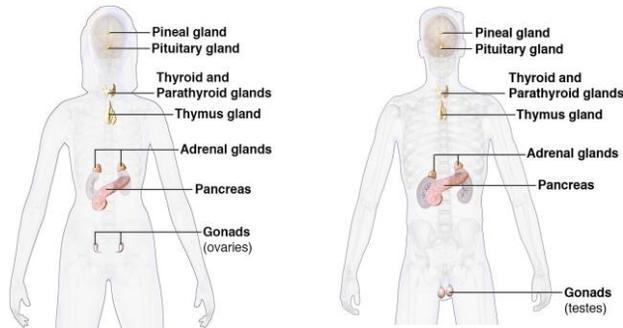
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#### Key Words

endocrine system, human, gland

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## Major Components of the System



- The endocrine system is comprised of ductless glands that produce messengers called hormones.
- The endocrine system interacts and cooperates with the nervous system.



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## Major Components of the System

The endocrine system consists of the pituitary, thyroid, parathyroid, adrenal and pineal glands, along with the pancreas, gonads and thymus. It also includes glands that secrete hormones in addition to other functions.

Hormones are released into extracellular fluid by ductless glands and are carried to target cells via the bloodstream. Only the target cells for a given hormone can respond to it.

The endocrine system also interacts and cooperates with the nervous system to control the activities of other organ systems. Because signaling by neurons can regulate the release of hormones, the nervous and endocrine systems often overlap in function.

## References

1. Campbell, N.A., and Reece, J.B. (2008). *Biology, 8<sup>th</sup> Edition*. San Francisco, CA: Pearson Benjamin Cummings.
2. Raven, P.H. (2005). *Biology, 7<sup>th</sup> Edition*. New York, NY: McGraw-Hill.

## **Image Reference**

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## **Key Words**

endocrine system, human, gland, hormone, pituitary, thyroid, pineal, pancreas

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## Pituitary Gland

- The pituitary gland is divided into two lobes, the posterior and anterior pituitary.
- The hypothalamus stimulates release of certain pituitary hormones.
- The pituitary gland secretes many hormones, including tropic hormones (which stimulate other endocrine glands).

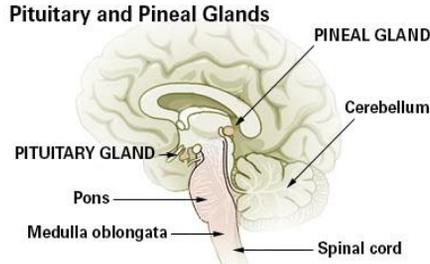


Illustration courtesy of the National Cancer Institute, NIH.

## Pituitary Gland

The pituitary gland is divided into two main parts, the anterior and posterior lobes. The anterior pituitary consists of endocrine cells that synthesize and secrete hormones directly into the blood. The posterior pituitary is an extension of the hypothalamus. It stores and secretes two hormones that are made by a set of neurosecretory cells in the hypothalamus.

The posterior pituitary releases the hormones oxytocin—which acts on muscles of the uterus—and antidiuretic hormone (ADH), which acts on the kidneys. Oxytocin induces contraction of the uterine muscles during childbirth and causes mammary glands to eject milk during nursing. ADH acts on the kidneys, increasing water retention and thus decreasing urine volume.

The anterior pituitary produces six different hormones. Growth hormone affects a wide variety of tissues. The correct level of growth hormone production is essential, as too little or too much can have serious detrimental effects. Prolactin stimulates mammary gland growth and milk synthesis. Follicle stimulating hormone (FSH) stimulates production of ova and sperm, and luteinizing hormone (LH) stimulates the ovaries and testes. LH is needed for ovulation and the formation of a corpus luteum in the female menstrual cycle. LH also stimulates the testes to produce testosterone. FSH and LH are

referred to as gonadotropins because they stimulate the activities of the gonads. Thyroid-stimulating hormone, stimulates the thyroid gland to produce thyroxine. Adenocorticotrophic hormone influences the adrenal cortex to produce and secrete steroid hormones.

### **References**

- 1.Campbell, N.A., and Reece, J.B. (2002). *Biology, 6<sup>th</sup> Edition*. San Francisco, CA: Pearson Benjamin Cummings.
- 2.Clark, Joe O.E. (1999). *A Visual Guide to the Human Body*. London: Barnes and Noble, Inc.

### **Image Reference**

SEER Training Modules: Pituitary and Pineal Glands. Illustration courtesy of the National Cancer Institute, NIH.  
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### **Key Words**

endocrine system, human, gland, hormone, pituitary, hypothalamus

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## Pineal Gland

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The pineal gland synthesizes and secretes melatonin, which helps regulate the sleep cycle and controls pigmentation.

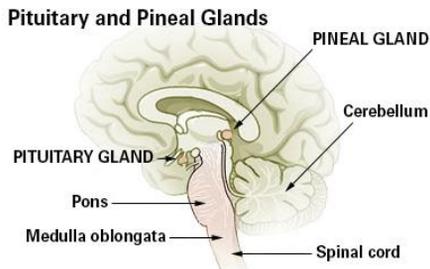


Illustration courtesy of the National Cancer Institute, NIH.

## Pineal Gland

The pineal gland is a small mass of tissue near the center of the brain. It secretes the hormone melatonin, which regulates functions related to light and seasons that are marked by changes in daylight. Melatonin affects skin pigmentation, but most pineal gland functions are related to biological rhythms associated with reproduction. Melatonin is secreted at night, with the amount secreted directly related to the length of the night.

## References

1. Campbell, N.A., and Reece, J.B. (2002). *Biology, 6<sup>th</sup> Edition*. San Francisco, CA: Pearson Benjamin Cummings.
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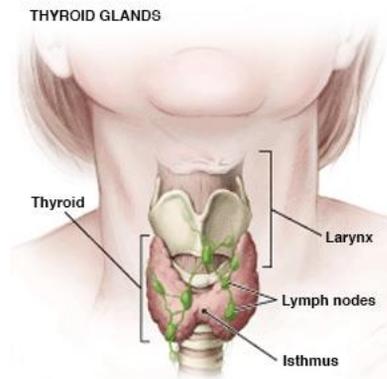
**Key Words**

endocrine system, human, gland, hormone, pineal, melatonin

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## Thyroid Glands

- The thyroid gland has two lobes connected via the isthmus.
- It controls the rate at which the body uses energy and releases the hormones that regulate metabolism.



## Thyroid Glands

The thyroid gland, consisting of two lobes, is located on the ventral surface of the trachea. It produces two very similar hormones—derived from the amino acid tyrosine—that control metabolism: triiodothyronine ( $T_3$ ) and thyroxine ( $T_4$ ). The thyroid gland plays a crucial role in vertebrate development and maturation, and in homeostasis. It also contains endocrine cells, which secrete calcitonin, a hormone that lowers calcium levels in the blood as part of calcium homeostasis.

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1. Campbell, N.A., and Reece, J.B. (2002). *Biology, 6<sup>th</sup> Edition*. San Francisco, CA: Pearson Benjamin Cummings.
2. Clark, Joe O.E. (1999). *A Visual Guide to the Human Body*. London: Barnes and Noble, Inc.

## Image Reference

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<http://www.cancer.gov/cancertopics/wyntk/thyroid/page2>

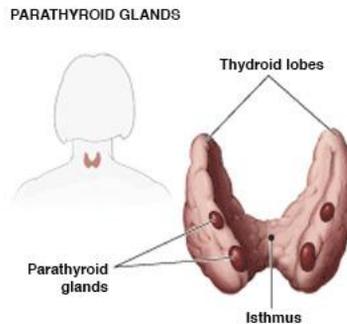
**Key Words**

endocrine system, human, gland, hormone, thyroid, metabolism, homeostasis

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## Parathyroid Glands

- Parathyroid glands produce and secrete parathyroid hormones.
- Parathyroid hormones regulates the body's calcium levels.



## Parathyroid Glands

Calcium is a mineral, vital to the formation of bone and teeth, blood clotting, and proper functioning of the brain nerves and muscles. The four parathyroid glands embedded in the thyroid gland function in the homeostasis of calcium, secreting parathyroid hormone (PTH), which raises blood levels of calcium, an effect opposite to that produced by the thyroid hormone, calcitonin. (PTH and calcitonin balance each other's effects and minimize fluctuations in blood calcium concentration.) Specifically, parathyroid hormone causes mineralized bone to decompose and release calcium into the blood. Specialized cells, called osteoclasts, actually break down the bone. Parathyroid hormone also stimulates the uptake of calcium through the renal tubules.

## References

1. Campbell, N.A., and Reece, J.B. (2002). *Biology, 6<sup>th</sup> Edition*. San Francisco, CA: Pearson Benjamin Cummings.
2. Clark, Joe O.E. (1999). *A Visual Guide to the Human Body*. London: Barnes and Noble, Inc.

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**Key Words**

endocrine system, human, gland, hormone, parathyroid, homeostasis, osteoclast, calcium

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## Pancreas

- The pancreas is an organ with both exocrine and endocrine functions.
- The islets of Langerhans are the endocrine regions of the pancreas. They produce insulin and glucagon (hormones that work in opposite ways to regulate glucose concentrations in blood).

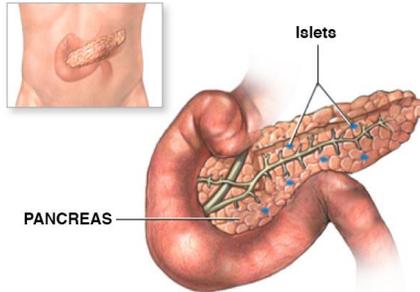


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## Pancreas

The pancreas is one of many organs with both endocrine and exocrine functions. Islets of Langerhans are regions of the pancreas made of clusters of endocrine cells that secrete two major hormones. Each islet has alpha cells, which secrete glucagon, and a population of beta cells, which secrete insulin. Insulin and glucagon are antagonistic hormones that regulate the concentration of glucose in the blood. When blood glucose is too high, insulin is released. This lowers the glucose levels by stimulating all body cells, except those of the brain, to take up glucose from the blood. When blood glucose is too low, glucagon increases glucose concentration by stimulating liver cells to break down glycogen into glucose.

## References

1. Campbell, N.A., and Reece, J.B. (2002). *Biology, 6<sup>th</sup> Edition*. San Francisco, CA: Pearson Benjamin Cummings.
2. Clark, Joe O.E. (1999). *A Visual Guide to the Human Body*. London: Barnes and Noble, Inc.

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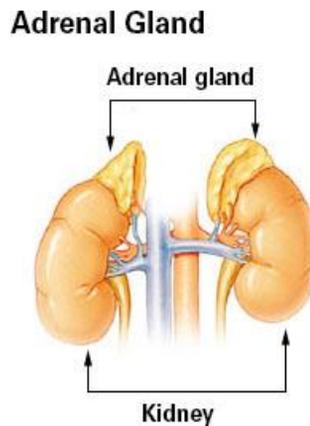
**Key Words**

endocrine system, human, pancreas, insulin, glucagon, islets of Langerhans, hormone

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## Adrenal Glands

- The adrenal glands, which sit atop each kidney, are comprised of the adrenal medulla and adrenal cortex.
- They release hormones, such as epinephrine, in response to stress.



## Adrenal Glands

The adrenal glands, which sit above the kidneys, are made up of two regions: the outer adrenal cortex and central adrenal medulla. The adrenal medulla secretes epinephrine and norepinephrine, which give the body a rapid energy boost as part of the “fight-or-flight” response. Specific effects of epinephrine and norepinephrine include: increased blood glucose due to glycogen breakdown, increased blood pressure, increased breathing rate, and a change in blood flow patterns that increases alertness and decreases digestive activity.

Like the adrenal medulla, the adrenal cortex also reacts to stress. Stressful stimuli cause the anterior pituitary to release ACTH, which stimulates the adrenal cortex to synthesize a family of steroids, called corticosteroids. The two main types of corticosteroids in humans are glucocorticoids (e.g., cortisol) and mineralocorticoids (e.g., aldosterone). Glucocorticoids effect the breakdown and conversion of proteins and fats to glucose, leading to increased blood glucose, and in some cases suppressing the immune system. Mineralocorticoids promote retention of sodium and water by the kidneys, and increased blood volume and blood pressure.

## References

1. Campbell, N.A., and Reece, J.B. (2002). *Biology, 6<sup>th</sup> Edition*. San Francisco, CA: Pearson Benjamin Cummings.
2. Clark, Joe O.E. (1999). *A Visual Guide to the Human Body*. London: Barnes and Noble, Inc.

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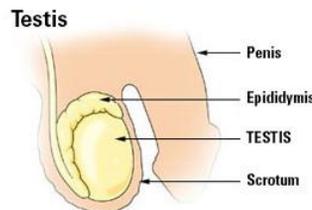
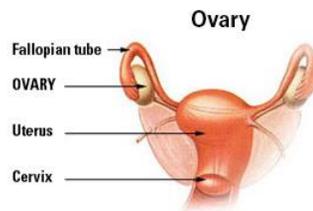
### **Key Words**

endocrine system, human, gland, hormone, adrenal, stress, corticosteroid, glucocorticoid, mineralocorticoid

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## Gonads

- The gonads consist of the ovaries in females and the testes in males.
- The gonads release hormones that stimulate reproductive maturation and produce gametes.



Illustrations courtesy of the National Cancer Institute, NIH.

## Gonads

The gonads produce and secrete three major categories of steroid hormones: androgens, estrogens, and progestins. (The synthesis of estrogens and androgens is controlled by FSH and LH from the anterior pituitary gland.) All three hormones are found in both male and females, but in different proportions. Produced in the testes in males and ovaries in females, these steroids affect growth and development, and also regulate reproductive cycles and sexual behavior.

The testes synthesize androgens, such as testosterone. In general, androgens stimulate the development and maintenance of the male reproductive system and are responsible for male secondary sex characteristics. Estrogens, the most important of which is estradiol, maintain the female reproductive system and promote development of female secondary sex characteristics. Progestins, which include progesterone, are involved primarily in preparing and maintaining the uterus to support the growth and development of an embryo.

## References

1. Campbell, N.A., and Reece, J.B. (2002). *Biology, 6<sup>th</sup> Edition*. San Francisco, CA: Pearson Benjamin Cummings.
2. Clark, Joe O.E. (1999). *A Visual Guide to the Human Body*. London: Barnes and Noble, Inc.

### **Image Reference**

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### **Key Words**

endocrine system, human, gland, hormone, gonad, testes, ovary, reproduction, steroid

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## Functions of the System

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- Hormones released by the endocrine system regulate many functions, such as mood, growth, reproduction, tissue function and metabolism.
- Hormones are molecules produced in one part of the body that trigger a specific cellular response in another tissue or organ of the body.



### Functions of the System

One hormone may have different effects on target cells that have different receptors or different signal transduction pathways. Hormones secreted by endocrine cells regulate reproduction, development, energy metabolism, growth and behavior.

### References

1. Campbell, N.A., and Reece, J.B. (2008). *Biology, 8<sup>th</sup> Edition*. San Francisco, CA: Pearson Benjamin Cummings.
2. Raven, P.H. (2005). *Biology, 7<sup>th</sup> Edition*. New York, NY: McGraw-Hill.

### Key Words

endocrine system, human, gland, hormone, function, mood, growth, metabolism

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