

# Hormones

**Hormones**—are chemical signals released from specialized cells that circulate in the body fluids and act on target cells to change their function.

**Endocrine gland**—a ductless gland that releases a hormone into the interstitial fluid which then diffuses into the bloodstream.

**Example:** the pituitary gland.

**Exocrine gland**—a gland that releases its product/hormone through a duct where it empties (often into a cavity) and triggers a response.

**Example:** salivary glands.

**Paracrine gland**—refers to a gland that releases its product/hormone and has an effect in the immediate area where it was released.

**Examples:** cytokines of the immune system and neurotransmitters of the nervous system.

**Hypothalamus**—part of the brain that integrates the nervous and endocrine systems.

**Pituitary gland**—receives signals from the hypothalamus and consists of two parts: the posterior pituitary and the anterior pituitary.

**Posterior pituitary (neurohypophysis)**—an extension of the hypothalamus and stores and secretes two hormones made by the hypothalamus.

**Anti-diuretic hormone (ADH)**—affects the cells of the distal kidney tubules and collecting ducts causing them to reabsorb more water.

**Oxytocin**—stimulates contraction of the uterus and mammary gland cells.

**Anterior pituitary (adenohypophysis)**—receives hormonal signals from the hypothalamus which, in turn, regulate secretion of its hormones. These hormones can have either tropic or non-tropic effects, and growth hormone exhibits both tropic and non-tropic effects. A hormone having a tropic effect is one that regulates the function of endocrine cells or glands. Non-tropic hormones target non-endocrine tissues.

**Tropic hormones:**

**Gonadotropin releasing hormone (GnRH)** from the hypothalamus stimulates the release of LH and FSH from the anterior pituitary.

**In males:** LH and FSH work together with one another at the onset of puberty.

**Follicle stimulating hormone (FSH)**—a gonadotropin that stimulates the activity of Sertoli cells to nourish developing sperm.

**Luteinizing hormone (LH)**—a gonadotropin regulates Leydig cells to secrete testosterone promoting spermatogenesis.

**In females:** FSH and LH work with estradiol. Low levels of estradiol inhibit secretion of LH and FSH, whereas a high level stimulates the hypothalamus to secrete GnRH leading to an increased release of FSH and LH.

**FSH**—stimulates growth and estradiol secretion by the developing follicle within the ovary.

**LH**—a surge of this hormone stimulates the release of the secondary oocyte from the developing follicle. Additionally, the tissue left behind is stimulated by LH to secrete progesterone and estradiol which maintain the growth and development of the uterine lining in preparation for pregnancy. Should fertilization not occur, the corpus luteum will disintegrate and menstruation will occur. If fertilization does occur, the developing fetus will produce human chorionic gonadotropin (which acts like LH) and will keep progesterone levels high preventing menstruation.

**Corpus luteum**—glandular tissue left behind after the ovule has been released which secretes progesterone and estradiol promoting further development of the uterine lining in preparation for pregnancy.

**Thyroid stimulating hormone (TSH)**—stimulates the thyroid gland to release thyroid hormones T<sub>3</sub> and T<sub>4</sub> which have an effect on metabolism.

The thyroid hormones T<sub>3</sub> and T<sub>4</sub> act to increase metabolism.

**Adrenocorticotropic hormone (ACTH)**—promotes production of steroid hormones by the cortex of the adrenal gland in responses to long-term stress. These steroids are the glucocorticoids and the mineralcorticoids and are commonly referred to as corticosteroids.

The “fight-or-flight” response occurs in response to short-term stress and is under nervous control. Here, nervous signals stimulate the cells of the adrenal medulla to release epinephrine and norepinephrine—the hormones collectively referred to as catecholamines.

#### **Nontropic hormones:**

**Prolactin**—has a wide variety of effects, mainly the stimulation of mammary gland growth and milk synthesis in mammals.

**Melanocyte stimulating hormone (MSH)**—regulates the activity of pigment-containing cells (melanocytes).

**Growth hormone**—secreted by the anterior pituitary and stimulates growth and production of insulin-like growth factors in the liver.

#### **Other Glands and Hormones:**

**Thyroid Gland**—secretes T<sub>3</sub> and T<sub>4</sub> in response to TSH from the anterior pituitary and regulates metabolism. The thyroid gland also has cells that sense calcium levels and can secrete the hormone calcitonin in response to a high blood calcium level so as to lower the amount in the blood.

**Parathyroid Glands**—have calcium sensing cells which release parathyroid hormone (PTH) in response to low calcium levels in the blood. When the level gets too low, PTH helps to decompose the mineral matrix in bone and subsequent release of calcium into the blood. PTH acts on the kidney to stimulate the re-uptake of calcium, acts on the liver and kidney to assist in the conversion of vitamin D into the active form that promotes calcium uptake by the intestines.

**Pancreas**—produces insulin and glucagon which regulate sugar concentration in the blood. Insulin is released in response to high blood glucose levels and promotes uptake into cells. Glucagon is released in response to low blood glucose levels and acts on liver cells to convert glycogen into glucose and thus raises the blood glucose level.

**Pineal Gland**—is involved in regulating the circadian rhythms by producing the hormone melatonin when there is no/low light in the environment (think seasonal, and/or rainy days).

**Melatonin**—hormone produced by the pineal gland that induces sleepiness. If it is dark in the environment, the pineal gland produces melatonin which induces sleepiness.

#### **Other Signalling Molecules**

**Serotonin**—a neurotransmitter in the brain that is involved in regulating mood, eating, and sleeping.

**Dopamine**—a neurotransmitter in the brain that is involved in movement, pleasure, attention and learning.

**Acetylcholine**—a main neurotransmitter in the vertebrate nervous system. It is released at cholinergic nerve endings and can be excitatory or inhibitory, and it stimulates muscular contractions at the neuromuscular junction.

**GABA**—the main inhibitory neurotransmitter in the CNS.