Endocrine System

Endocrine Vs Nervous System

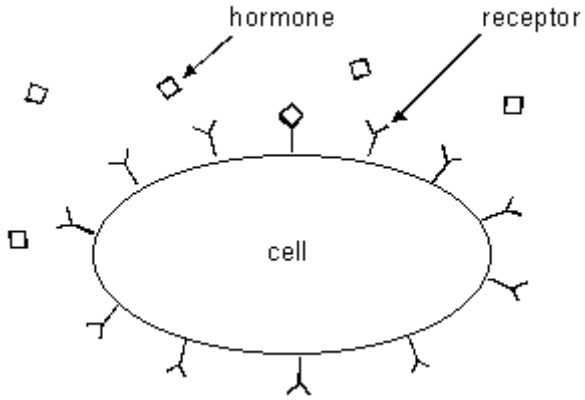
The endocrine system acts with nervous system to coordinate the body's activities.

Both systems enable cells to communicate with others by using chemical messengers.

The endocrine system uses chemical messengers called ***hormones*** that are transported by the circulatory system (blood). They act on target cells that may be anywhere in the body.

The endocrine system is slower than the nervous system because hormones must travel through the circulatory system to reach their target.

Target cells have ***receptors*** that are specific to the signaling molecules. The binding of hormones to the receptors on or within the target cell produces a response by the target cell.



The chemical messengers used by the nervous system are neurotransmitters. Neurotransmitters travel across a narrow space (the synaptic cleft) and bind to receptors on the target cell.

The nervous system conducts signals much quicker than the endocrine system.

Endocrine Vs Exocrine glands

Endocrine glands do not have ducts.

Exocrine glands have ducts that carry their secretions to specific locations. Exocrine examples: mammary gland secrete milk, salivary gland secrete saliva

Two Kinds of Hormones

Protein Hormones

Protein hormones are composed of amino acids.

A protein hormone **binds to a cell-surface receptor**, it does not enter the cell….ARE PROMPT (fast acting)

Steroid Hormones

Steroid hormones **enter the cell** and bind to receptors in the cytoplasm….ARE SLOW acting

Hypothalamus

The hypothalamus is part of the brain(nervous system). It maintains homeostasis (constant internal conditions) by regulating the internal environment (examples: heart rate, body temperature, water balance, and **the secretions of the pituitary gland).**

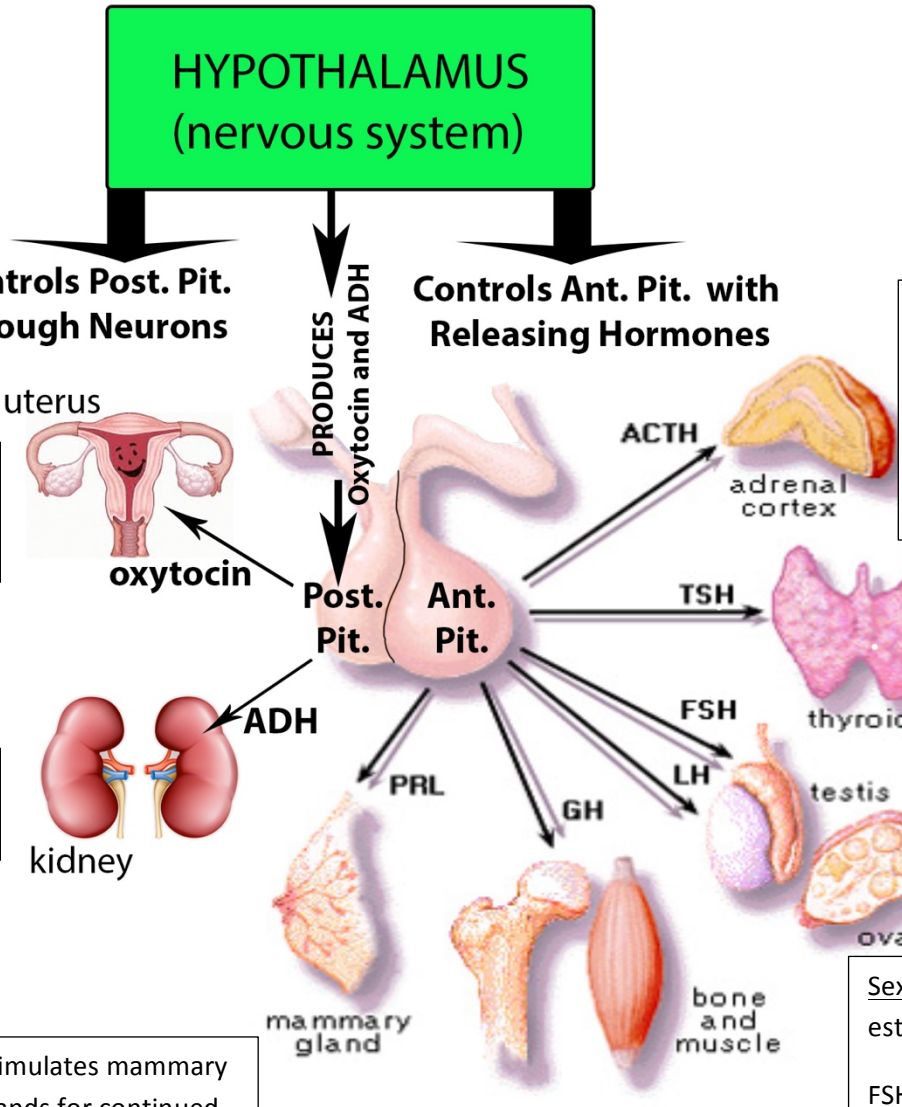
Pituitary Gland

The pituitary contains two lobes.

Posterior lobe **STORES** hormones are **MADE BY** the hypothalamus.

Anterior lobe produces the hormones that it releases.

Refer to the diagram below as you read about the hypothalamus, pituitary, and each of the glands they control.



Releases **cortisol-** long term stress hormone… increases glucose levels and releases **aldosteron** sodium retention and with it, water

Initiates contractions in uterus and initiates milk production

Releases **thyroxine** increases metabolic ra

Promotes Reabsorption of water in kidney

Sex hormones- testosterone, estrogen, progesterone

FSH-gamete production

LH-sex hormone production

Stimulates mammary glands for continued production of milk

Stimulates Growth

POSTERIOR PITUITARY

Neurons extend from the hypothalamus that control the Posterior Pituitary to release oxytocin and/or ADH.

Oxytocin

Oxytocin stimulates the uterine contractions of labor that are needed to move the child out through the birth canal.

The hormone stimulates the release of milk from the mammary glands by causing surrounding cells to contract. After birth, stimulation of the breast by the infant feeding stimulates the posterior pituitary to produce oxyticin.

Antidiuretic Hormone (ADH)

Antidiuretic hormone is release as a response to dehydration. Water is conserved in the kidney and the urine becomes more concentrated with impurities.

The secretion of ADH is controlled by a negative feedback mechanism as follows:

concentrated blood (too little water) → hypothalamus → ADH → kidney → reabsorbs water, makes blood more dilute

The presence of too much blood in the circulatory system stimulates the heart to produce a hormone that inhibits the release of ADH by the posterior pituitary causing the kidneys to excrete excess water.

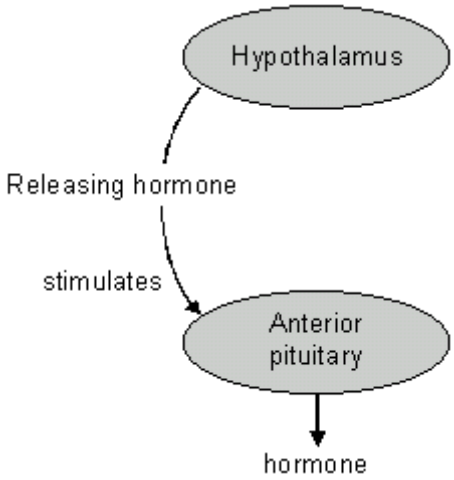
Alcohol inhibits the release of ADH, causing the kidneys to produce dilute urine.

ANTERIOR PITUITARY

Control of the Anterior Pituitary

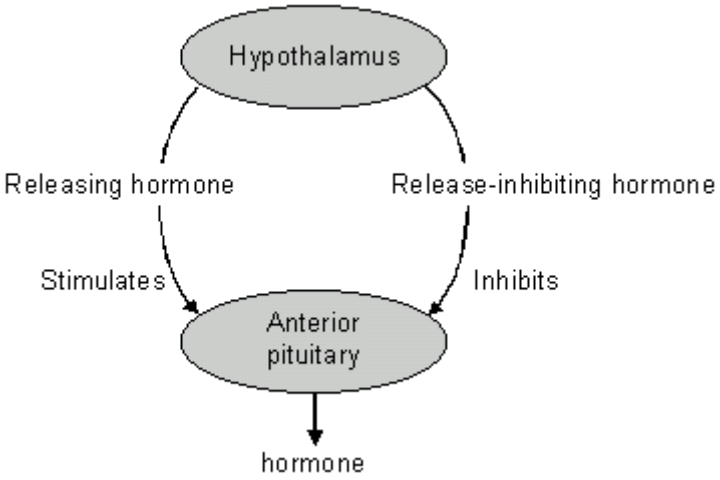
The hypothalamus produces hormones that travel in blood vessels to the anterior pituitary, stimulating it to produce other hormones.

The hormones produced by the hypothalamus are called ***releasing hormones(RH)*** or ***releasing factors(RF)***



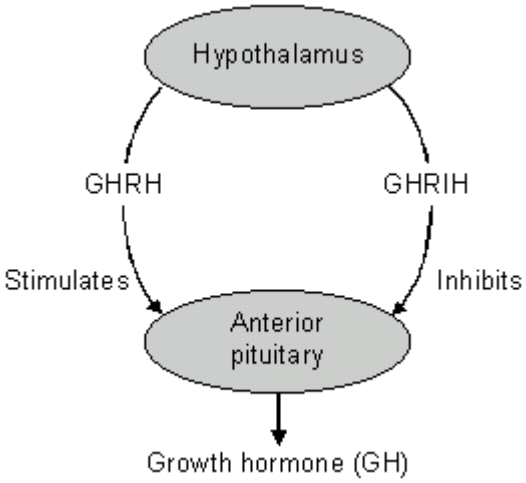
The anterior pituitary produces six hormones at we need to know. Each one is produced in response to a specific hypothalamic-releasing hormone.

As well as ***releasing hormones***, the hypothalamus also produces ***release-inhibiting hormones*** produced by the hypothalamus inhibit the pituitary from secreting its hormones.



Example

The pituitary is stimulated to release growth hormone (hGH) by growth hormone releasing hormone (hGH-RH) produced in the hypothalamus. It is inhibited from releasing growth hormone by growth hormone release-inhibiting hormone(hGH-RIH), also produced by the hypothalamus.



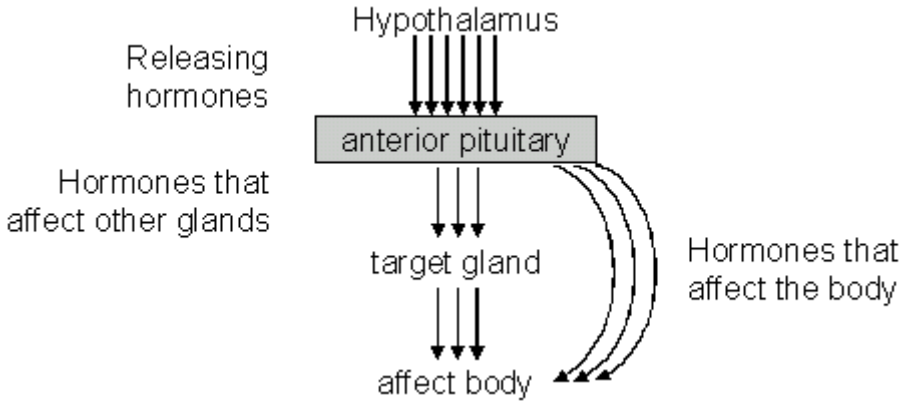
Six different hormones produced by the anterior lobe will be studied here.

Hormones that specifically affect an endocrine gland are called TROPIC hormones. (FSH, LH, ACTH, TSH)

(eg) TSH specifically targets another gland…the thyroid which in turn then releases thyroxin

Hormones that affect other cells of the body are called NON-TROPIC hormones. (hGH, PRL, calcitonin, PTH, insulin, glucagon)

(eg). PRL (prolactin) is used to stimulate mammary gland to secrete milk. PRL is non-tropic because the mammary glands are exocrine and secrete milk into a duct.



Anterior Pituitary Hormones that Directly Affect the Body

Growth Hormone (hGH or Somatotropic Hormone)

Growth hormone stimulates body cells to grow. If too little hormone is produced, pituitary dwarfism results. The secretion of too much hormone results in a pituitary giant.

Acromegaly is a genetic disease in which growth hormone is produced throughout a persons lifetime and creates most notably, enlarged hands, face and feet.

Prolactin

Prolactin is produced in quantity after childbirth.

It stimulates the development of the mammary glands and the continued production of milk.

It is also involved in the metabolism of fats and carbohydrates.

Anterior Pituitary Hormones that Regulate Other Glands

The pituitary also controls other glands and is often referred to as the "master gland" as it controls other glands

Three kinds of pituitary hormones that regulate other glands are discussed below. The glands that they regulate will be discussed in the following section.

Thyroid Stimulating Hormone (TSH) →€ thyroid → thyroxin

Adrenocorticotropic Hormone (ACTH) → adrenal cortex → cortisol and aldosterone

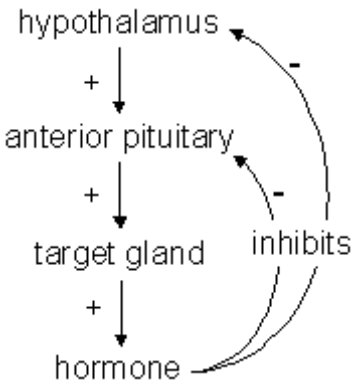
Gonadotropic Hormones (FSH and LH) → ovaries and testes → sex hormones; controls gamete production

Negative Feedback Inhibition

Hormone secretions by glands that are under the control of the hypothalamus are controlled by ***negative feedback.***

Negative feedback is the body trying to get back to a "NORMAL".

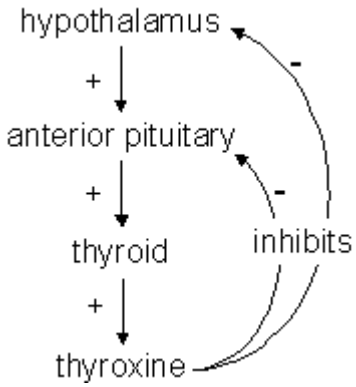
When the hormone levels are high, they inhibit the hypothalamus and anterior pituitary, resulting in a decline in their levels.



Thyroid gland

The thyroid produces ***thyroxin***. It influences metabolic rate, growth, and development.

Thyroxin production is regulated by a negative feedback mechanism in which it inhibits the hypothalamus from stimulating the thyroid.



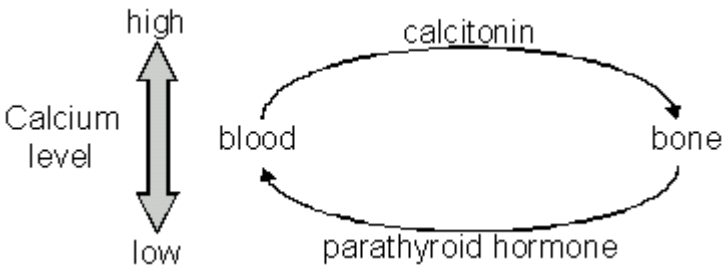
Hypothyroidism occurs when the thyroids produce too little hormone. In adults, it results in lethargy and weight gain. In infants, it causes cretinism, which is characterized by dwarfism, mental retardation, and lack of sexual maturity. Administering thyroid hormones treats these affects.

Too much thyroxin (hyperthyroidism) increases heart rate and blood pressure, and causes weight loss.

Iodine is needed to manufacture thyroid hormones. A deficiency in iodine prevents the synthesis of thyroid hormones which, in turn, results in an excess of thyroid stimulating hormone being produced by the anterior pituitary. A **goiter** results when constant stimulation of the thyroid causes it to enlarge.

Calcitonin

The thyroid gland also secretes ***calcitonin***, which stimulates calcium deposition in the bones. This is the opposite of the action of parathyroid hormone (see below).



Calcitonin production ***IS NOT*** regulated by the anterior pituitary. It's secretion is stimulated by high calcium levels in the blood.

Parathyroid glands

The parathyroid glands are 4 small glands embedded in posterior surface of the thyroid gland.

They secrete ***parathyroid hormone (PTH)***, which increases blood levels of Ca^{++}.

Bone tissue acts as a storage reservoir for calcium; PTH stimulates the removal of calcium from the bone to increase levels in the blood.

PTH also increases the kidney's reabsorption of Ca^{++} so that less is lost in urine and it enhances Ca^{++} absorption from food in the gut.

Secretion is regulated by the Ca^{++} level in the blood, **(not hypothalamic or pituitary hormones).**

Adrenal Cortex (outer layer of adrenal glands)

The **outer layer** of an adrenal gland is the adrenal cortex.

It produces ***cortisol*** and ***aldosterone***.

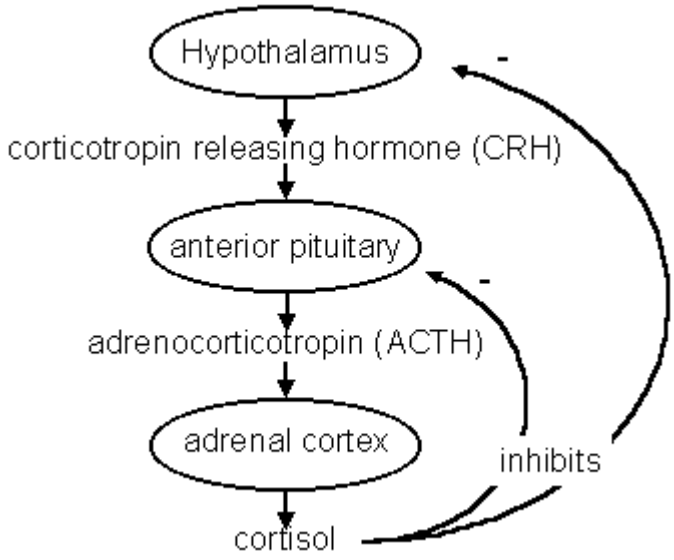
Cortisol (long term stress)

Cortisol is produced in response to stress.

Cortisol raises the level of glucose in the blood by stimulating the liver to produce glucose from stored non-carbohydrate sources such as proteins and lipids and to release it into the blood.

Cortisol reduces swelling by inhibiting the immune system.

Negative feedback control of cortisol level is diagrammed below.



Aldosterone (some ACTH stimulation)

It acts primarily as a response to low blood pressure and/or loss of blood. Its effect on the kidney is to promote reabsorption of sodium and with it, water.

Increased sodium levels contributes to the retention of water and thus increased blood volume. In the absence of aldosterone, sodium is excreted and the lower sodium levels result in decreased blood volume and lower blood pressure.

Adrenal Medulla- (inner part of adrenal)

The adrenal medulla is composed of modified neurons that secrete epinephrine and norepinephrine (adrenaline and noradrenaline) under IMMEDIATE conditions of stress.

These hormones are released in response to a variety of stresses and stimulate the fight- or- flight response of the **sympathetic nervous system**. It results in a faster heart rate, faster blood flow, and dilated airways to facilitate oxygen flow to the lungs. In addition, the level of glucose in the blood is increased to make energy more available.

Their secretion is controlled by brain centers (including hypothalamus) via sympathetic nerves, ***NOT by pituitary hormones.***

Gonads

LH and ***FSH*** from the anterior pituitary stimulate the gonads (ovaries and testes).

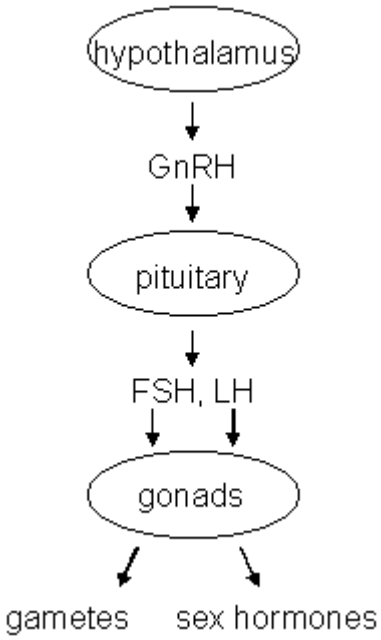
LH stimulates the testes to produce several kinds of steroid hormones called ***androgens***. One of these androgens is ***testosterone***, the main sex hormone in males.

LH stimulates the ovaries produce ***estrogen*** and ***progesterone***, the female sex hormones.

Sex hormones are responsible for the development of ***secondary sex characteristics***, which develop at puberty. Some examples of secondary sex characteristics in males are deepening of the voice (due to a large larynx), growth of facial hair, and muscle development. Some secondary sex characteristics in females are development of

the breasts and broadening of the pelvis. Both sexes show increased activity of sweat glands and sebaceous glands (oil glands in the skin), and growth of pubic and axillary (armpit) hair.

FSH controls gamete (egg or sperm) production.



Pancreas(endocrine and exocrine)

The pancreas is a exocrine gland because it secretes digestive enzymes into the intestine.

The ***islets of Langerhans*** are groups of cells within the pancreas that secrete ***insulin*** and ***glucagon***. The islets are endocrine glands because they are ductless; the circulatory system carries their hormones to target cells.

Insulin

Insulin promotes the ***removal of glucose from the blood*** for storage as glycogen (muscle, liver), fats (fat cells), and protein. Is secreted after meals when blood glucose levels spike.

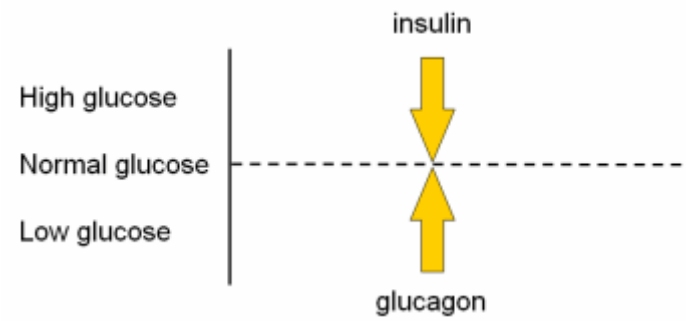
It promotes the buildup of fats and proteins and inhibits their use as an energy source.

Glucagon

Glucagon is produced in the islets of Langerhans but by different cells than those that produce insulin.

The effects of glucagon are opposite those of insulin. ***It raises the level of glucose in the blood***.

It is normally secreted between meals (or during fasting) to maintain the concentration of glucose in the blood.



Diabetes Mellitus

Diabetes mellitus is a disease in which glucose is not sufficiently metabolized. This results in high glucose levels in blood and glucose in the urine.

Cells can starve because glucose is not being metabolized.

Type I

Type I diabetes is also called "juvenile-onset diabetes" or "insulin-dependent diabetes" because the symptoms usually appear during childhood and insulin injections are necessary to treat it.

It usually occurs after a viral infection triggers an immune response that results in the body destroying its own insulin-producing cells.

Because the disease is caused by a lack of insulin, it can be treated with insulin injections.

Type II

Type II diabetes is more common than type I.

Type II diabetes is caused by a deficiency in insulin production or by changes in insulin receptors on the target cells. In either case, blood glucose level may be high because cells do not receive the message to metabolize glucose.

This form of diabetes usually becomes noticeable in middle age.

It is treated with a low fat, low sugar diet, regular exercise, weight control. Another treatment is oral medications that make the cells more sensitive to the effects of insulin or that stimulate more insulin production.