Anatomy and Physiology

3. The Endocrine System

The Endocrine System

Tour of the System

The endocrine system is an amazingly complex system with many important roles throughout the body. It works alongside the nervous system to coordinate functions of of the different body systems.

The endocrine system contains endocrine glands that release their products (known as hormones) directly into the bloodstream.

Hormones are substances that arouse the body into activity. Hormones are often dependent on one another in their action. That is, the secretion of one hormone will often excite another gland to produce its hormone too. The balance that the body strikes with these hormones is unique for each individual.

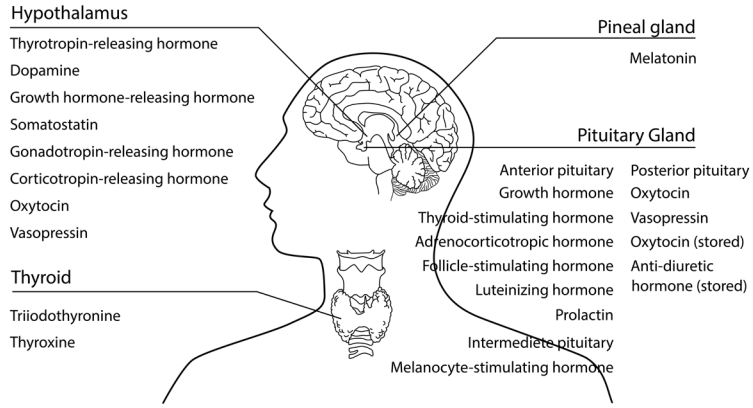
Although hormones travel around the body in the bloodstream, they only affect certain cells, which are their target cells. Only target cells will contain the correct molecular information that will allow a hormone to bind to that particular cell.

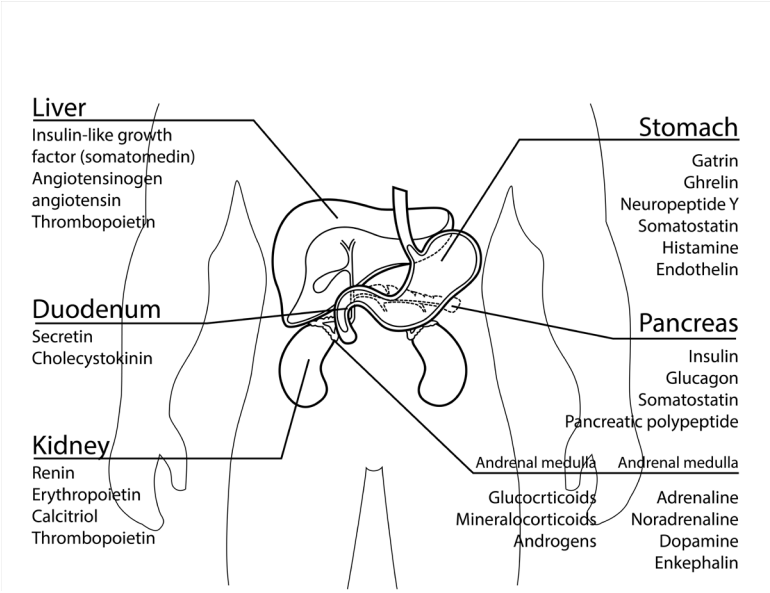
How cells respond to hormones depends on the cell itself as well as the hormone. One hormone may synthesize (make) a product in one type of cell and make a completely different product in another type of cell.

The easiest way, when touring this complex system, is to look at where endocrine glands are and what hormones they secrete.

The diagrams below show endocrine glands and their hormones.

Hormones produced in the head and neck





Functions

The endocrine system secretes hormones into the bloodstream to regulate the body, helping to maintain homeostasis.

Components

Hypothalamus

This is the 'master' endocrine gland, located in the brain. The hypothalamus links the

endocrine and nervous system. The hypothalamus receives information about pain, stress etc. It also regulates the autonomic nervous system that controls body temperature, hunger, thirst etc. The hypothalamus regulates the release of several hormones that act on other glands.

The pituitary gland

The pituitary gland is in the center of the skull, attached to the hypothalamus. The hypothalamus controls the release or suppression of pituitary hormones. As well as having its own unique effects, it can influence the performance of the other endocrine glands.

It has two parts, a posterior pituitary gland and the anterior pituitary gland.

The posterior pituitary gland tends to store oxytocin, used for uterine contractions and anti-diuretic hormone (ADH), which stimulates water retention.

Hormones released from the *anterior pituitary gland*

Hormone group	Function	Example	How it works
Somatotrophs	Stimulate the thyroid gland.	Growth hormone (GH)	If growth hormone is produced for too long, gigantism occurs. If growth hormone is produced after the epiphyseal disks have calcified in the skeleton, acromegaly occurs, causing abnormally large hands, feet and mandible (jaw). If not enough growth hormone is produced, the child will not grow and artificial growth hormone is usually administered to correct this.
Thyrotrophs	These hormones stimulate activity in other glands.	Thyroid-stimulating hormone (TSH)	This controls secretion of other hormones in the thyroid gland.

Gonadotrophs	These are involved in ovulation, although they are present in both males and females.	Follicle stimulating hormone (FSH) and luteinizing hormone (LH)	FSH and LH are needed to secrete estrogens and progesterone and assists in reproduction,
Lactotrophs	Lactotrophs are involved in growth and regulation of mammary glands.	Prolactin	Initiates milk production in mammary glands
Corticotrophs	Synthesize ACTH	Adrenocorticot-rophin (ACTH)	ACTH stimulates the adrenal cortex to produce glucocorticoids (required in glucose metabolism).

There are also several other hormones secreted from the pituitary gland.

The Thyroid gland

Situated at the base of the larynx, its middle part, the isthmus, covers the second and third cartilaginous rings of the trachea.

It secretes the thyroid hormones thyroxin and triiodothyronine. These have an important role in controlling metabolism (including energy or ATP production) throughout the body.

It also secretes calcitonin that alters calcium levels in the blood.

The Parathyroid glands

There are usually four parathyroid glands, two on each side of the thyroid gland. Although they are very small, they control the quantity of calcium and magnesium in the blood stream.

Without them, there is not enough calcium in the blood for the nervous system to function properly. Those who have *hyperparathyroidism* have de-mineralized bones and the calcium in their bones is urinated away.

Adrenal or Suprarenal glands

These are located on the top of the kidneys. The adrenal glands produce three types of steroids. *Steroid* hormones are fat (lipid) hormones.

The exterior of the adrenal glands (*adrenal cortex*) produces three types of hormones:

- **Mineralocorticoids** - control sodium and potassium levels in the body
- **Glucocorticoids** – involved in metabolism and resistance to stress. One of these is cortisone, a hormone that has a variety of functions in the body
- **Androgens** – These have little effect on the body as significant amounts of androgens are produced in the testes. In women, these contribute to sex drive.

The inner of the adrenal glands, the *adrenal medulla* produces **epinephrine** and **norepinephrine** (noradrenalin). These hormones prepare the body to either "fight or flight." Epinephrine (adrenalin) increases the heart rate and breathing rate, adjusts blood supply to the extremities and causes the blood to clot more readily. Therefore, if you are suddenly startled, you notice these changes in the body.

Pancreas

The pancreas contains special cells called *islets of Langerhans*. These secrete several hormones:

Insulin - controls the amount of glucose in the blood stream. Insulin causes removal and storage of glucose from the blood.

Glucagon – Raises blood sugar levels by breaking down glycogen in the liver. This causes the release of glucose into the blood.

The other two hormones, **somatostatin** and **pancreatic polypeptides** assist insulin and glucagon with their actions.

Pineal gland

This gland is located in the brain and secretes **melatonin,** a hormone that play an important role in the sleep and wake cycle. The cause of jet lag is through melatonin disruption.

Thymus gland

This plays a key role in immunity, helping white blood cells to mature.

There are also hormones produced throughout other tissues and organs in the body, including erythropoietin from the kidney, which helps to increase the rate of erythrocyte (red blood cell) production.

Common Diseases and Disorders

Cretinism: Caused by a lack of thyroid hormones produced during development. The severe hormone deficiency causes a hard form of edema, called myxedema.

Diabetes: An insufficiency of insulin production causes diabetes. For those who suffer from type 1 diabetes, it means that the cells in their pancreas have stopped producing insulin, or produce very little. Those with Type 2 diabetes are able to produce some insulin, but not enough to regulate blood glucose levels. Type 2 diabetes is often seen in obese patients.

Goiter: This is an enlargement of the thyroid gland, often caused by iodine deficiency.

Hyperthyroidism: Is caused by too much thyroxin, resulting in a higher than normal metabolic rate.

Hypothyroidism: Is a lack of thyroxin.

Polycystic ovary syndrome: This is a common female endocrine disorder. Although it may have genetic causes, hormone imbalances play a key role in this syndrome.

Medical Terminology

Autonomic nervous system: This is part of the nervous system. It helps to control the body. It is usually unconscious and controls actions such as the heart rate, digestion and respiratory rate.

Endocrinology: Is the study of the endocrine system and the resulting hormone balance.

Homeostasis: This is the ability of the human body to maintain a stable internal environment, when dealing with both internal and external environmental changes.

Negative feedback: Helps to maintain homeostasis in the body. If a gland is producing too much of one hormone, signals are sent to the brain and an opposing hormone is released. This reduces the levels of the first hormone. For example, glucagon and insulin, regulating blood glucose levels.

Positive feedback: Rarely seen in the body, a positive feedback loop is the secretion of oxytocin during delivery. This increases contractions to allow delivery of the baby.

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