Lab Test Findings
Understanding Endocrine Testing

5 CEU’S in Biomedical Science

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What is the Endocrine System?

The endocrine system is made up of different glands located throughout the body. In tandem with the nervous system, which uses nerve impulses as a means of control, the endocrine system controls and regulates all bodily functions with hormones.

Some hormones have a daily or monthly pattern of release. For example:

- Concentrations of the adrenal hormone cortisol are high in the morning and lower late in the evening.
- Levels of the pituitary hormones follicle-stimulating hormone (FSH) and lutenizing hormone (LH) increase and decrease in regular patterns to regulate a woman’s monthly menstrual cycle.

Other hormones are generally present in very small quantities in the blood and are released in specific situations, such as the release of epinephrine (adrenaline) from the adrenal glands in response to stress.

The following list of glands, make up the endocrine system:

- Pituitary Gland
- Hypothalamus
- Thymus
- Pineal Gland
- Testes
- Ovaries
- Thyroid
- Adrenal Glands
- Parathyroid
- Pancreas

The Functions of these glands:

**Pituitary Gland**

The pituitary gland is sometimes called the "master gland" because of its great influence on the other body organs. Its function is complex and important for overall homeostasis.

The pituitary gland is divided into two parts, front (anterior) and back (posterior).

The **anterior pituitary** produces several types of hormones:

- **Prolactin or PRL** - PRL stimulates milk production after childbirth and can affect sex hormone levels from the ovaries in women and the testes in men.
- **Growth hormone or GH** - GH stimulates growth in childhood and is important for maintaining a healthy body composition. In adults it is also important for maintaining muscle mass and bone mass. It can affect fat distribution in the body.
- **Adrenocorticotropin or ACTH** - ACTH stimulates production of cortisol by the adrenal glands. Cortisol, a so-called "stress hormone," is vital to survival. It helps maintain blood pressure and blood glucose levels.
- **Thyroid-stimulating hormone or TSH** - TSH stimulates the thyroid gland to make thyroid hormones, which, in turn, regulate the body’s metabolism, energy, growth and development, and nervous system activity.
- **Luteinizing hormone or LH** - LH regulates testosterone in men and estrogen in women.
- **Follicle-stimulating hormone or FSH** - FSH promotes sperm production in men and stimulates ovulation in women. LH and FSH work together to allow normal function of the ovaries or testes.

The **posterior pituitary** produces two hormones:

- **Oxytocin** - Oxytocin causes contractions during childbirth and milk letdown in nursing mothers
- **Antidiuretic hormone or ADH** - ADH, also called vasopressin, is stored in the back part of the pituitary gland and regulates water balance. If not secreted properly, this can lead to problems of sodium (salt) and water balance, and could also affect the kidneys.

**Hypothalamus**
The hypothalamus is part of the brain that lies just above the pituitary gland. It releases hormones that start and stop the release of pituitary hormones. The hypothalamus controls hormone production in the pituitary gland through several "releasing" hormones. Some of these are growth hormone-releasing hormone, (controls GH release); thyrotropin-releasing hormone, or TRH (controls TSH release); and corticotropin-releasing hormone, or CRH (controls ACTH release). Gonadotropin-releasing hormone (GnRH) tells the pituitary gland to make luteinizing hormone (LH) and follicle-stimulating hormone (FSH), which are important for normal puberty.

**Thymus**
The thymus is a gland needed early in life for normal immune function. It is very large just after a child is born and weighs its greatest when a child reaches puberty. Then its tissue is replaced by fat. The thymus gland secretes hormones called humoral factors. These hormones help to develop the lymph system.

**Pineal Gland**
Produces melatonin, which may inhibit the hormones that produce gonadotropin, which causes the ovaries and testes to develop and function. It may also help to control sleep patterns.

**Testes**
Male reproductive glands that produce testosterone. Testosterone helps to bring about the physical changes that occur at puberty. Throughout adult life, testosterone helps maintain sex drive, sperm production, male hair patterns, muscle mass, and bone mass.

**Ovaries**
The two most important hormones of a woman's reproductive glands, the ovaries, are estrogen and progesterone. These hormones are responsible for developing and maintaining female sexual traits, as well as maintaining a pregnancy. Along with the pituitary gonadotropins (luteinizing hormone or LH and follicle-stimulating hormone or FSH), they also control the menstrual cycle. The ovaries also produce inhibin, a protein that curbs the release of follicle-stimulating hormone from the anterior pituitary and helps control egg development.

The most common change in the ovarian hormones is caused by the start of menopause. It also can occur when ovaries are removed surgically. Loss of ovarian function means loss of estrogen, which can lead to symptoms of menopause.
**Thyroid**

The thyroid is a small gland inside the neck, located in front of the trachea and below the laryngeal prominence. The thyroid hormones control the body’s ability to break down food and store it as energy and the ability to break down food into waste products with a release of energy in the process. The thyroid produces two hormones, T3 (tri-iodothyronine) and T4 (thyroxine).

**Adrenal Glands**

Each adrenal gland is actually two endocrine organs. The outer portion is called the adrenal cortex. The inner portion is called the adrenal medulla. The hormones of the adrenal cortex are essential for life. The hormones secreted by the adrenal medulla are not.

The adrenal cortex produces glucocorticoids (such as cortisol) that help the body control blood sugar, increase the burning of protein and fat, and respond to stressors like fever, major illness, and injury. The mineralcorticoids (such as aldosterone) control blood volume and help to regulate blood pressure by acting on the kidneys to help them hold onto enough sodium and water. The adrenal cortex also produces some sex hormones, which are important for some secondary sex characteristics in both men and women.

The adrenal medulla produces epinephrine (adrenaline), which is secreted by nerve endings and increases the heart rate, opens airways to improve oxygen intake, and increases blood flow to muscles, usually when a person is scared, excited, or under stress.

Norepinephrine also is made by the adrenal medulla, but this hormone is more related to maintaining normal activities as opposed to emergency reactions. Too much norepinephrine can cause high blood pressure.

**Parathyroid**

Located behind the thyroid gland are four tiny parathyroid glands. These make hormones that help control calcium and phosphorous levels in the body. The parathyroid glands are necessary for proper bone development. In response to too little calcium in the diet, the parathyroid glands make parathyroid hormone, or PTH, that takes calcium from bones so that it will be available in the blood for nerve conduction and muscle contraction.

If the parathyroids are removed, low blood calcium will result in symptoms such as irregular heartbeat, muscle spasms, tingling in the hands and feet, and possibly difficulty breathing.

**Pancreas**

The pancreas is a large gland behind the stomach that helps maintain healthy blood sugar (glucose) levels. The pancreas secretes insulin, a hormone that helps glucose move from the blood into the cells where it is used for energy. The pancreas also secretes glucagon when the blood sugar is low. Glucagon tells the liver to release glucose, stored in the liver as glycogen, into the bloodstream. that raises blood glucose levels. Glucagon raises blood glucose levels; insulin lowers blood glucose levels.

Low blood sugar stimulates release of epinephrine, glucagon and growth hormone, which help to return the blood sugar to normal.
When things go wrong

Hormones affect systems throughout the body. Endocrine gland dysfunction may be due to either a problem with the gland itself, a problem in the feedback system, and/or due to a lack of response by the target tissues. There may be decreased hormone production related to trauma, disease, infection, crowding of the hormone-producing cells by a tumor, or an inherited gene mutation that affects the quantity, quality, or structure of a hormone. Decreased production may also be due to failure of one gland to produce and release enough hormone to stimulate the target gland to produce and release its hormone. Increased production may be related to a feedback system imbalance such as the pituitary producing too much ACTH, leading to the production of too much cortisol, or increased production may be related to hyperplasia or a tumor of the hormone-producing cells, lack of tissue response, medication use, or an inherited condition.

Tumors are generally small and usually benign. Most of them are located inside the affected gland and produce a single type of hormone. Rarely they may be cancerous. It is also very rare that tumors may be located elsewhere in the body. A tumor may cause symptoms because of the excess hormone it is producing, because its growth crowds out and decreases the production of other hormones in the gland, or because its physical size presses against surrounding nerves and structures.

Most inherited conditions are rare and are usually related to deficient or dysfunctional production of a single hormone or to the hormone production of a particular gland. However, there are genetically-linked conditions that affect the glands themselves. Two that have been identified as affecting several endocrine glands are MEN-1 and MEN-2 (Multiple Endocrine Neoplasia, types 1 and 2). These conditions are related to alterations in specific genes, and they increase the lifetime risk that those affected will develop tumors in one or more of their endocrine glands.

Laboratory Tests

The goals of endocrine testing are to identify the hormone(s) that are being over or under-produced, to determine which gland(s) are involved, and to determine the cause of the hormone imbalance. This may involve measuring hormone levels and their metabolites in the blood and/or urine. Stimulation or suppression testing may be utilized to evaluate hormone production and/or gland interaction with other glands and hormones. If a tumor is suspected, then imaging scans may be used to help locate the tumor. If symptoms are suspected to be due to an inherited condition, then genetic testing may be recommended. Patients often see an endocrinologist (an endocrine gland specialist) to help them determine the appropriate testing and treatment. Related tests may include:

ACTH (Adrenocorticotropic hormone)
Also known as: Corticotropin
Related tests: Cortisol, Cortrosyn (ACTH) stimulation test, Dexamethasone suppression test

Used to help diagnose adrenal and pituitary diseases such as Cushing's disease, Addison's disease, adrenal tumors, and pituitary tumors

This test measures the amount of adrenocorticotropic hormone (ACTH) in the blood. ACTH is a hormone that stimulates the production of cortisol. Cortisol is a steroid hormone important for regulating glucose, protein, and lipid metabolism, suppressing the immune system's response, and maintaining blood pressure. Normally, ACTH levels increase when cortisol is low and fall when cortisol is high.

ACTH is produced by the pituitary gland. When cortisol levels fall in the blood, the hypothalamus produces corticotropin-releasing hormone (CRH). This stimulates the
production of ACTH by the pituitary, which in turn stimulates the production of cortisol by the adrenal glands, small organs located at the top of each kidney. Conditions that affect the pituitary or adrenal glands can increase or decrease the amount of ACTH and cortisol produced and interfere with their regulation. This can cause symptoms associated with an excess or deficiency of cortisol. Some tumors found outside of the pituitary in locations such as the lungs can also increase cortisol concentrations by producing ACTH.

**Aldosterone**

Also known as: Aldosterone and plasma renin activity; PRA
Related tests: Cortisol; Electrolytes; Potassium; Aldosterone/Renin activity calculation or ratio; Aldosterone stimulation test; Aldosterone suppression test

Aldosterone is a hormone that stimulates the retention of sodium (salt) and the excretion of potassium by the kidneys. It plays an important role in maintaining normal sodium and potassium concentrations in blood and in controlling blood volume and blood pressure. Aldosterone is produced by the adrenal cortex, the outer portion of the adrenal glands located at the top of each kidney. Its production is normally regulated by two other proteins, renin and angiotensin. Renin is released from the kidneys when there is a drop in blood pressure, a decrease in sodium concentration, or an increase in potassium concentration. Renin cleaves the blood protein angiotensinogen to form angiotensin I, which is then converted by a second enzyme to angiotensin II. Angiotensin II causes blood vessels to constrict, and it stimulates the production of aldosterone. The overall effect is to raise blood pressure and keep sodium and potassium at normal levels. A variety of conditions can lead to overproduction (hyperaldosteronism) or underproduction (hypoaldosteronism) of aldosterone. Because renin and aldosterone are so closely related, both substances are often tested together to identify the cause of an abnormal aldosterone.

Symptoms associated with increased aldosterone production are; elevated blood pressure, muscle weakness, and low potassium

**Calcitonin**

Also known as: Human calcitonin; Thyrocalcitonin
Related tests: RET oncogene; Calcium

To help diagnose and monitor C-cell hyperplasia and medullary thyroid cancer; to screen those at risk for multiple endocrine neoplasia type 2 (MEN 2)

This test measures the amount of calcitonin in the blood. Calcitonin is a hormone produced by special cells in the thyroid called C-cells. It is involved in the regulation of calcium levels in the blood, and calcitonin inhibits bone breakdown (resorption), although how calcitonin works in the human body is unclear. The thyroid is a small butterfly-shaped gland that lies over and flat against the windpipe in the throat. It produces several hormones that help control the rate of metabolism - primarily thyroxine (T4) and triiodothyronine (T3). In two rare conditions, C-cell hyperplasia and medullary thyroid cancer, excessive amounts of calcitonin are produced. C-cell hyperplasia is a benign condition that may or may not progress to become medullary thyroid cancer. Medullary thyroid cancer is malignant – it can spread beyond the thyroid and can be difficult to treat if it is not discovered early. About 75-80% of medullary thyroid cancer cases are sporadic, but about 20-25% are related to an inherited mutation in the RET gene that leads to multiple endocrine neoplasia type 2 (MEN 2). MEN 2 is a syndrome associated with several related diseases, including medullary thyroid cancer and pheochromocytomas. The altered RET gene is inherited in an autosomal dominant fashion. Only one copy of the mutated gene – from either your father
or mother – is required to have a greatly increased risk of developing medullary thyroid cancer. Most cases of sporadic medullary thyroid cancer develop when patients are in their 40s or 50s. The prevalence is higher in women, but the inherited form affects both sexes equally and can occur at an early age.

**Calcium**
Also known as: Total calcium; Ionized calcium  
Related tests: Phosphorus; Vitamin D; Parathyroid hormone (PTH); Magnesium; Albumin; Comprehensive metabolic panel (CMP)

Calcium is one of the most important minerals in your body. It is essential for the proper functioning of muscles, nerves, and the heart and is required in blood clotting and in formation of bones. About 99% of calcium is found in the bones while the remainder circulates in the blood. Roughly half of the calcium in the blood is "free" and is metabolically active. The remaining half is "bound" calcium. It is attached to albumin and other compounds and is metabolically inactive.  
There are two tests to measure blood calcium. The total calcium test measures both the free and bound forms. The ionized calcium test measures only the free, metabolically active form.  
Some calcium is lost from your body every day, filtered from the blood by the kidneys and excreted into the urine. Measurement of the amount of calcium in the urine is used to determine how much calcium is being eliminated by the kidneys.

**Catecholamines, Plasma and Urine**
Also known as: Dopamine; Epinephrine; Norepinephrine; Free Urine Catecholamines  
Related tests: Plasma Free Metanephrine; Urine Metanephrines; Vanillylmandelic acid (VMA)

To help diagnose or rule out a pheochromocytoma or other neuroendocrine tumor

Catecholamines are a group of similar hormones produced in the adrenal medulla, the interior portion of the adrenal glands. Adrenal glands are small, triangular organs located on top of each kidney. The primary catecholamines are dopamine, epinephrine (adrenaline), and norepinephrine. These hormones are released into the bloodstream in response to physical or emotional stress. They help transmit nerve impulses in the brain, increase glucose and fatty acid release for energy, dilate bronchioles, and dilate the pupils.  
Norepinephrine also constricts blood vessels, increasing blood pressure, and epinephrine increases heart rate and metabolism. After completing their actions, the hormones are metabolized to inactive compounds. Dopamine becomes homovanillic acid (HVA), norepinephrine breaks down into normetanephrine and vanillylmandelic acid (VMA), and epinephrine becomes metanephrine and VMA. Both the hormones and their metabolites are excreted in the urine.  
Normally, catecholamines and their metabolites are present in the body in small, fluctuating amounts that only increase appreciably during and shortly after a bout of stress.  
Pheochromocytomas and other neuroendocrine tumors, however, can produce large amounts of catecholamines, resulting in greatly increased concentrations of the hormones and their metabolites in both the blood and urine. This can cause persistent or episodic bouts of hypertension, which may lead to severe headaches. Other symptoms of catecholamine release include palpitations, sweating, nausea, anxiety, and tingling in the extremities.  
About 90% of pheochromocytomas are located in the adrenal glands. While a few are cancerous, most are benign and they do not spread beyond their original location, although they may continue to grow. Left untreated, the symptoms may worsen as the tumor grows and, over a period of time, the hypertension that the pheochromocytoma causes may damage the kidneys and heart and raise the risk of an affected patient having a stroke or heart attack.
Urine and plasma catecholamine testing can be used to help detect the presence of pheochromocytomas. Although only about 800 cases a year are diagnosed in the U.S. according to the National Cancer Institute, it is important to diagnose and treat these rare tumors because they cause a potentially curable form of hypertension. Catecholamine testing measures the amounts of epinephrine, norepinephrine, and dopamine in the plasma or urine. The plasma test measures the amount of hormone present in the blood at the moment of collection, while the urine test measures the amount excreted over a 24-hour period.

**Cortisol**

Related tests: ACTH, Aldosterone

To help diagnose Cushing's syndrome or Addison's disease

Cortisol is a hormone produced by the adrenal glands. Production and secretion of cortisol is stimulated by ACTH (adrenocorticotropic hormone), a hormone produced by the pituitary gland. Cortisol has a range of roles in the body. It helps break down protein, glucose, and lipids, maintain blood pressure, and regulate the immune system. Heat, cold, infection, trauma, stress, exercise, obesity, and debilitating disease can influence cortisol concentrations. The hormone is secreted in a daily pattern, rising in the early morning, peaking around 8 am, and declining in the evening. This pattern, which is sometimes called the "diurnal variation" or "circadian rhythm," changes if you work irregular shifts (such as the night shift) and sleep at different times of the day.

Inadequate amounts of cortisol can cause nonspecific symptoms such as weight loss, muscle weakness, fatigue, low blood pressure, and abdominal pain. Sometimes decreased production combined with a stressor can cause an adrenal crisis that requires immediate medical attention.

Too much cortisol can cause increased blood pressure, high blood sugar, obesity, fragile skin, purple streaks on the abdomen, muscle weakness, and osteoporosis. Women may have irregular menstrual periods and increased facial hair; children may have delayed development and a short stature.

**DHEAS (Dehydroepiandrosterone Sulfate)**

Also known as: DHEA-SO4; DHEA Sulfate

Related tests: Testosterone; ACTH; FSH; LH; Prolactin; Estrogen Why Get Tested?

To determine if DHEAS concentration is normal and to help evaluate adrenal gland function

Dehydroepiandrosterone sulfate (DHEAS) is an androgen, a male sex hormone that is present in the blood of both men and women. It has a role to play in developing male secondary sexual characteristics at puberty, and it can be metabolized by the body into more potent androgens, such as testosterone and androstenedione, or can be changed into the female hormone estrogen. DHEAS is produced by the adrenal cortex, the outer layer of the adrenal glands, with smaller amounts being produced by the woman's ovaries and man's testes. DHEAS secretion is controlled by the pituitary hormone adrenocorticotropic hormone (ACTH) and by other pituitary factors.

Since DHEAS is primarily produced by the adrenal glands, it is useful as a marker for adrenal function. Adrenal tumors, cancers, and hyperplasia can lead to the overproduction of DHEAS. While elevated levels may not be noticed in adult men, in women they can lead to amenorrhea and visible symptoms of virilization (the abnormal development of male sexual characteristics in a female). These changes vary in severity and may include:
- a deeper voice
- hirsutism (excessive hair)
- male pattern baldness
- muscularity
- acne
- enlargement of the Adam’s apple

Excess levels of DHEAS in children can cause early puberty and ambiguous external genitalia (a rare condition — usually obvious at or shortly after birth — in which an infant’s external genitals don’t appear to be clearly either male or female), excess body hair, and abnormal menstrual periods in girls.

**Estrogen**

Also known as: Estrogen fractions/fractionated; Estrone (E1); Estradiol (E2); Estriol (E3); (over 20 different forms of estrogen have been described)

Related tests: Follicle stimulating hormone (FSH); Luteinizing hormone (LH); Progesterone; Testosterone; Triple or Quad screen; Sex hormone binding globulin

To measure or monitor estrogen levels in a woman who has unexplained abnormal menstrual cycles, abnormal or heavy bleeding, infertility, symptoms of menopause, or any other hormonal alterations; also used to test for fetal-placental status during early stages of pregnancy and to evaluate feminization, the presence of female-like characteristics in males

Estrogens are a group of steroids that regulate the menstrual cycle and function as the main female sex hormones. The most common forms of estrogens tested are estrone (E1), estradiol (estradiol-17 beta, E2), and estriol (E3). Total estrogens are most commonly measured in blood or urine.

Estrogens are responsible for the development of female sex organs and secondary sex characteristics and are tied to the menstrual cycle and pregnancy. They are considered the main sex hormones in women and are present in small quantities in men. E1 and E2 are the two main estrogens in non-pregnant females, while E3 is the main pregnancy hormone.

**Estrone (E1)** is derived from metabolites from the adrenal gland and is often made in adipose tissue (fat). Estrone can be converted into estradiol or estriol when needed. Estrone is present in small amounts in children prior to puberty and then increases slightly at puberty for both males and females. While levels remain constant in adult males, it will increase and fluctuate for females during the menstrual cycle. After menopause, it becomes the major estrogen, with E2 and E3 levels diminishing greatly.

**Estradiol (E2)** is the predominant form and is produced primarily in the ovaries with additional amounts produced by the adrenal glands in women and in the testes and adrenal glands in men. In menstruating women, levels vary throughout the month, rising and falling in tandem with FSH (follicle-stimulating hormone), LH (luteinizing hormone), and progesterone as follicles are stimulated in the ovaries, an egg is released, and the uterus prepares for a potential pregnancy. The level is lowest at the beginning of the menstrual cycle and rise to their highest level just before the release of an egg from the ovary (ovulation). Normal levels of estradiol provide for proper ovulation, fertilization of the egg (conception), and pregnancy, in addition to promoting healthy bone structure and regulating cholesterol levels.

**Estriol (E3)** is the major estrogen in pregnancy, with relatively large amounts produced by the developing placenta. Estriol levels start to rise in the eighth week of pregnancy and continue to rise until shortly before delivery. Estriol circulating in maternal blood is quickly cleared out of the body. Each measurement of estriol is a snapshot of what is happening with the placenta and fetus, but there is also natural daily variation in estriol concentrations.
**FSH (Follicle-stimulating hormone)**
Also known as: Follicle-stimulating hormone
Related tests: Total estrogens, Estradiol, LH, Testosterone, Progesterone

To evaluate pituitary function, especially as it relates to fertility issues, gonadal failure, maturation concerns, or pituitary tumors

Follicle-stimulating hormone (FSH) is made by the pituitary gland in the brain. Control of FSH production is a complex system involving hormones produced by the gonads (ovaries or testes), the pituitary, and the hypothalamus.

In women, FSH stimulates the growth and maturation of eggs in the ovaries during the follicular phase of the menstrual cycle. The menstrual cycle is divided into the follicular and the luteal phases, characterized by a mid-cycle surge of FSH and luteinizing hormone (LH). Ovulation occurs shortly after this mid-cycle surge of hormones. During the follicular phase, FSH initiates the production of estradiol by the follicle, and the two hormones work together in the further development of the egg follicle. During the luteal phase, FSH stimulates the production of progesterone. Both estradiol and progesterone help the pituitary control the amount of FSH produced. FSH also facilitates the ability of the ovary to respond to LH. At the time of menopause, the ovaries stop functioning and FSH levels rise. In men, FSH stimulates the testes to produce mature sperm and also promotes the production of androgen binding proteins. FSH levels are relatively constant in males after puberty.

In infants and children, FSH levels rise shortly after birth and then fall to very low levels by 6 months in boys and 1-2 years in girls. Concentrations begin to rise again before the beginning of puberty and the development of secondary sexual characteristics.

**GH (Growth Hormone)**

Also known as: GH; Human Growth Hormone; HGH; Somatotropin
Related tests: IGF-1 (Insulin-like growth factor 1, also called Somatomedin C); GHRH (Growth Hormone Releasing Hormone); Glucose Tolerance Test; Cortisol; ACTH; TSH; Glucose; Prolactin

To identify diseases and conditions caused by either a deficiency or overproduction of growth hormone (GH), to evaluate pituitary function, and to monitor the effectiveness of GH treatment

Growth hormone (GH) is essential for a child's normal growth and development and promotes proper linear bone growth from birth through puberty. Children with insufficient GH production grow more slowly and are smaller in size for their age, one of the first symptoms of growth hormone deficiency (GHD). It should be noted that short stature in itself can also be related to familial traits or other genetic disorders. Excess GH is most often due to a GH-secreting pituitary tumor (usually benign). Too much GH can cause children's long bones to continue to grow beyond puberty, resulting in gigantism with heights of 7 or more feet tall. Those with excess GH may also have thickening of facial features, general weakness, delayed puberty, and headaches.

Although GH is not as active in adults, it does play a role in regulating bone density, muscle mass, and lipid metabolism. Deficiencies can lead to decreased bone densities, less muscle mass, and altered lipid levels. Excess GH in adults can lead to acromegaly, marked not by bone lengthening but by bone thickening. Although symptoms such as skin thickening, sweating, fatigue, headaches, and joint pain can be subtle at first, increased GH levels can lead to enlarged hands and feet, enlarged facial bones, carpal tunnel syndrome, and abnormally enlarged internal organs. If untreated, acromegaly (and gigantism in children)
can lead to complications such as type 2 diabetes, increased cardiovascular disease risk, high blood pressure, arthritis, and in general, a decreased life span.

GH stimulation and suppression tests are most often used to diagnose GH abnormalities. Since growth hormone is released by the pituitary gland in bursts throughout the day, random measurements of GH levels are not usually clinically useful.

**hCG (Human chorionic gonadotropin)**

Also known as: Pregnancy test; Qualitatitve hCG; Quantitative hCG; Beta hCG; Total hCG; Total beta hCG
Related tests: Triple Screen or Quad Screen; First Trimester Down Syndrome Screen

To confirm and monitor pregnancy or to help diagnose and monitor trophoblastic disease (the placenta develops into an abnormal mass of cysts rather than becoming a viable pregnancy), or germ cell tumors

hCG is a protein produced in the placenta of a pregnant woman. A pregnancy test is a specific blood or urine test that can detect hCG and confirm pregnancy. This hormone can be detected 10 days after a missed menstrual period, the time period when the fertilized egg is implanted in the woman’s uterus. With some methods, hCG can be detected even earlier, at one week after conception.

During the early weeks of pregnancy, hCG is important in maintaining function of the corpus luteum. Production of hCG increases steadily during the first trimester (8–10 weeks), peaking around the 10th week after the last menstrual cycle. Levels then fall slowly during the remainder of the pregnancy. hCG is no longer detectable within a few weeks after delivery. hCG is also produced by some germ cell tumors and increased levels are seen in trophoblastic disease.

**IGF-1 (Insulin-like Growth Factor – 1)**

Also known as: Somatomedin C
Related tests: Growth Hormone (GH), Glucose, Glucose Tolerance Test

To identify diseases and conditions caused by deficiencies and overproduction of growth hormone (GH), to evaluate pituitary function, and to monitor the effectiveness of GH treatment

The insulin-like growth factor-1 (IGF-1) test is an indirect measure of the average amount of growth hormone (GH) being produced by the body. IGF-1 and GH are peptide hormones, small proteins that are vital for normal bone and tissue growth and development. GH is produced by the pituitary gland, a grape-sized gland located at the base of the brain behind the bridge of the nose. GH is secreted into the bloodstream in pulses throughout the day and night with peaks that occur mostly during the night. IGF-1 is produced by the liver and to a lesser degree by skeletal muscles, primarily in response to GH stimulation. It mediates many of the actions of GH, stimulating the growth of bones and other tissues and promoting the production of lean muscle mass. IGF-1 mirrors GH excesses and deficiencies, but its level is stable throughout the day, making it a useful indicator of average GH levels. Like GH, IGF-1 levels are normally low in early childhood, increase gradually during childhood, peak during puberty, and then decline in adult life. Deficiencies in GH and IGF-1 may be caused by conditions such as hypopituitarism or by the presence of a non-GH-producing pituitary tumor that damages hormone-producing cells. Deficiencies in IGF-1 also occur where there is a lack of responsiveness to GH. This insensitivity may be primary (genetic) or secondary to conditions such as malnutrition and chronic diseases.
Deficiencies early in life can inhibit bone growth and overall development and can result in a child with a shorter than normal stature. In adults, decreased production can lead to low bone densities, less muscle mass, and altered lipids. Excess GH and IGF-1 can cause abnormal growth of the skeleton and other signs and symptoms characteristic of gigantism and acromegaly. In children, gigantism causes bones to grow longer, resulting in a very tall person with large feet and hands. In adults, acromegaly causes bones to thicken and soft tissues, such as the nose, to swell. Both conditions can lead to enlarged organs, such as the heart, and to other complications such as type 2 diabetes, increased cardiovascular disease risk, high blood pressure, arthritis, and a decreased life span. The most common reason for the pituitary to secrete excessive amounts of GH is a GH-producing pituitary tumor (usually benign).

**LH (Lutenizing hormone)**

Also known as: Luteinizing hormone; Interstitial Cell Stimulating Hormone; ICSH
Related tests: FSH; Testosterone; Progesterone; Estradiol; Total estrogens

To evaluate your pituitary function, including fertility issues, gonadal failure, maturation concerns, or pituitary tumors

Luteinizing hormone (LH) is produced by the pituitary gland in the brain. Control of LH production is a complex system involving hormones produced by the gonads (ovaries or testes), the pituitary, and the hypothalamus. Women's menstrual cycles are divided into the follicular and luteal phases, characterized by a mid-cycle surge of follicle-stimulating hormone (FSH) and LH. The high level of LH (and FSH) at mid-cycle triggers ovulation. LH also stimulates the ovaries to produce steroids, primarily estradiol. Estradiol and other steroids help the pituitary to regulate the production of LH. At the time of menopause, the ovaries stop functioning and LH levels rise. In men, LH stimulates a certain cell type (Leydig cells) in the testes to produce testosterone. LH (or sometimes referred to as Interstitial Cell Stimulating Hormone or ICSH in males) levels are relatively constant in men after puberty. An increasing testosterone level provides negative feedback to the pituitary gland and the hypothalamus, thus decreasing the amount of LH secreted.

In infants and children, LH levels rise shortly after birth and then fall to very low levels (by 6 months in boys and 1-2 years in girls). At about 6-8 years, levels again rise before the beginning of puberty and the development of secondary sexual characteristics.

**Metanephrines, Plasma Free**

Also known as: Plasma Metanephrines, Fractionated plasma free metanephrines (normetanephrine and metanephrine)
Related tests: Catecholamines, Plasma and Urine; Urine Metanephrines; Vanillylmandelic acid (VMA)

To help diagnose or rule out a pheochromocytoma (tumors of the adrenal glands)

The plasma free metanephrines test measures the amount of metanephrine and normetanephrine in the blood. These substances are metabolites of epinephrine and norepinephrine. Epinephrine and norepinephrine are catecholamine hormones that help regulate the flow and pressure of blood throughout the body and play important roles in the body's response to stress. They are produced in the medulla – the interior portion of the adrenal glands. The catecholamines that the adrenal glands produce, and their metabolites, metanephrine and normetanephrine, are normally found in small fluctuating quantities in both the blood and urine.
A rare tumor called a pheochromocytoma can produce large amounts of catecholamines, resulting in significantly increased concentrations of metanephrine and normetanephrine in both the blood and urine. About 90% of pheochromocytomas form in the adrenal glands and, while a few are cancerous, most are benign – they continue to grow but usually do not spread beyond their original location. The catecholamines produced by pheochromocytomas can cause persistent hypertension and/or paroxysms (bouts) of severe high blood pressure. This can cause symptoms such as headaches, palpitations, sweating, nausea, anxiety, and tingling in the extremities. Left untreated, the symptoms may worsen as the pheochromocytoma grows. Over time, hypertension caused by the tumor may damage organs such as the kidneys and heart and raise the risk of an affected patient having a stroke or heart attack.

**Metanephrines, Urine**

Also known as: Metanephrine and Normetanephrine
Related tests: Catecholamines, Plasma and Urine, Plasma Free Metanephrine, Vanillylmandelic acid (VMA)

To help diagnose or rule out a pheochromocytoma or other neuroendocrine tumor

This test measures the amount of metanephrines that are excreted in the urine over a 24-hour period. Metanephrines are the inactive metabolites of the catecholamines epinephrine (adrenaline) and norepinephrine. Catecholamines are a group of similar hormones produced in the nervous system and in the medulla (central portion) of the adrenal glands. The primary catecholamines are dopamine, epinephrine (adrenaline), and norepinephrine. These hormones are released into the bloodstream in response to physical or emotional stress. They help transmit nerve impulses in the brain, increase glucose and fatty acid release for energy, dilate bronchioles, and dilate the pupils. Norepinephrine also constricts blood vessels, which increases blood pressure, and epinephrine increases heart rate and metabolism. After completing their actions, the catecholamines are metabolized to form inactive compounds. Dopamine becomes homovanillic acid (HVA), norepinephrine breaks down into normetanephrine and vanillylmandelic acid (VMA), and epinephrine becomes metanephrine and VMA. Both the hormones and their metabolites are excreted in the urine. Urine metanephrine testing measures the amount of both metanephrine and normetanephrine. These metabolites are usually present in the urine in small fluctuating amounts that increase appreciably during and shortly after the body is exposed to a stressor. Pheochromocytomas and other neuroendocrine tumors, however, can produce large amounts of catecholamines, resulting in greatly increased concentrations of the hormones and their metabolites in both the blood and urine. The catecholamines that a pheochromocytoma produces can cause persistent hypertension (high blood pressure) and/or bouts or episodes of severe hypertension. Other symptoms of catecholamine release include headaches, palpitations, sweating, nausea, anxiety, and tingling in the extremities.

About 90% of pheochromocytomas are located in the adrenal glands. While a few are cancerous, most are benign – they do not spread beyond their original location - although most do continue to grow. Left untreated, the symptoms may worsen as the tumor grows and, over a period of time, the hypertension that the pheochromocytoma causes may damage body organs, such as the kidneys and heart, and raise the risk of an affected patient having a stroke or heart attack.
**Progesterone**

Related tests: Estrogens, hCG, FSH, LH

To help determine the cause of infertility, track ovulation, help diagnose an ectopic or failing pregnancy, monitor the health of a pregnancy, and help diagnose the cause of abnormal uterine bleeding

This test measures the level of progesterone in the blood. Progesterone is a steroid hormone whose main role is to help prepare a woman's body for pregnancy; it works in conjunction with several other female hormones.

On a monthly basis, the hormone estrogen causes the lining of the uterus, the endometrium, to grow and replenish itself, while a surge in luteinizing hormone (LH) leads to the release of an egg from one of two ovaries. A corpus luteum then forms in the ovary at the site where the egg was released and begins to produce progesterone. This progesterone, supplemented by small amounts produced by the adrenal glands, stops endometrial growth and readies the uterus for the possible implantation of a fertilized egg. If fertilization does not occur, the corpus luteum degenerates, progesterone levels drop, and menstrual bleeding begins. If a fertilized egg is implanted in the uterus, the corpus luteum continues to produce progesterone. After several weeks, the placenta replaces the corpus luteum as the main source of progesterone, creating relatively large amounts of the hormone throughout the rest of a normal pregnancy.

**Prolactin**

Also known as: PRL
Related tests: FSH, LH, Testosterone, DHEAS, Estrogen, Progesterone

To determine whether your prolactin levels are higher (or occasionally, lower) than normal Prolactin is a hormone produced by the anterior portion of the pituitary gland, a grape-sized organ found at the base of the brain. Prolactin secretion is regulated and inhibited by the brain chemical dopamine. Normally present in low amounts in men and non-pregnant women, prolactin's primary role is to promote lactation (breast milk production).

Prolactin levels are usually high throughout pregnancy and just after childbirth. During pregnancy, the hormones prolactin, estrogen, and progesterone stimulate breast milk development. Following childbirth, prolactin helps initiate and maintain the breast milk supply. If a woman does not breastfeed, her prolactin level soon drops back to pre-pregnancy levels. If she does, suckling by the infant plays an important role in the release of prolactin. There is a feedback mechanism between how often the baby nurses and the amount of prolactin secreted by the pituitary as well as the amount of milk produced.

Another common cause of elevated prolactin levels is a prolactinoma, a prolactin-producing tumor of the pituitary gland. Prolactinomas are the most common type of pituitary tumor and are usually benign. They develop more frequently in women but are also found in men. Problems resulting from them can arise both from the unintended effects of excess prolactin, such as milk production in the non-pregnant woman (and rarely, man) and from the size and location of the tumor.

If the anterior pituitary gland and/or the tumor enlarge significantly, it can put pressure on the optic nerve, causing headaches and visual disturbances, and it can interfere with the other hormones that the pituitary gland produces. In women, prolactinomas can cause infertility and irregularities in menstruation; in men, these tumors can cause a gradual loss in
sexual function and libido. If left untreated, prolactinomas may eventually damage the tissues around them.

**PTH (Parathyroid hormone)**
Also known as: Intact PTH; "Biointact" PTH; Parathormone
Related tests: Calcium; Phosphate; Magnesium; Vitamin D

To determine whether PTH levels are responding normally to changes in blood calcium levels; to distinguish the cause of calcium imbalances; to evaluate parathyroid function; during surgery for hyperparathyroidism, to confirm removal of the gland(s) causing the problem.

Parathyroid hormone (PTH) helps the body maintain stable levels of calcium in the blood. It is part of a feedback loop that includes calcium, PTH, vitamin D, and, to some extent, phosphorous (phosphate) and magnesium. Conditions and diseases that disrupt this feedback loop can cause inappropriate elevations or decreases in calcium and PTH levels and lead to symptoms of hypercalcemia or hypocalcemia.

PTH is produced by four parathyroid glands that are located in the neck behind the thyroid gland. Normally, these glands secrete PTH into the bloodstream in response to low blood calcium levels. Parathyroid hormone then works in three ways to help raise blood calcium levels back to normal. It takes calcium from the body's bone, stimulates the activation of vitamin D in the kidney (which in turn increases the absorption of calcium from the intestines), and suppresses the excretion of calcium in the urine (while encouraging excretion of phosphate). As calcium levels begin to increase in the blood, PTH normally decreases.

Parathyroid hormone itself is composed of 84 amino acids (sometimes called PTH (1-84)). Once it is released from the parathyroid gland into the blood stream, it has a very short lifespan; levels fall by half in less than 5 minutes. The fall is caused primarily by the breakdown of PTH to smaller fragments, mainly PTH (35-84) and PTH (7-84). Although it was originally thought that these fragments are inactive, they are, in fact, active but have different actions than PTH (1-84). These fragments, (especially PTH (7-84)), seem to do the opposite of PTH: they lower serum calcium and prevent removal of calcium from the bone.

**T3 (Triiodothyronine)**

Also known as: Total T3; Free T3; FT3
Related tests: TSH; T4; Thyroid Antibodies

To help diagnose hyperthyroidism

This test measures the amount of triiodothyronine, or T3, in the blood. T3 is one of two major hormones produced by the thyroid gland (the other hormone is called thyroxine, or T4). The thyroid gland is a small butterfly-shaped organ that lies flat across your windpipe. The hormones it produces control the rate at which the body uses energy. Their production is regulated by a feedback system. When blood levels of thyroid hormones decline, the hypothalamus releases thyrotropin releasing hormone, which stimulates the pituitary to produce and release thyroid-stimulating hormone (TSH). TSH then stimulates the thyroid gland to produce and/or release more thyroid hormones. Most of the thyroid hormone produced is T4. This hormone is relatively inactive, but it is converted into the much more active T3 in the liver and other tissues.
If the thyroid gland produces excessive amounts of T4 and T3, then the patient may have symptoms associated with hyperthyroidism, such as nervousness, tremors of the hands, weight loss, insomnia, and puffiness around dry, irritated eyes. In some cases, the patient’s eyes cannot move normally and they may appear to be staring. In other cases, the patient’s eyes may appear to bulge.

If the thyroid gland produces insufficient amounts of thyroid hormones, then the patient may have symptoms associated with hypothyroidism and a slowed metabolism, such as weight gain, dry skin, fatigue, and constipation. Blood levels of hormones may be increased or decreased because of insufficient or excessive production by the thyroid gland, due to thyroid dysfunction, or due to insufficient or excessive TSH production related to pituitary dysfunction.

About 99.7% of the T3 found in the blood is attached to a protein (primarily thyroxine-binding globulin but also several other proteins) and the rest is free (unattached). Separate blood tests can be performed to measure either the total (both bound and unattached) or free (unattached) T3 hormone in the blood.

**T4 (Thyroxine)**

Also known as: Total T4; Free T4
Related tests: TSH; T3; Thyroid Antibodies

To help evaluate thyroid gland function; to help diagnose hypothyroidism or hyperthyroidism; to screen for hypothyroidism in newborns

This test measures the amount of thyroxine, or T4, in your blood. T4 is one of two major hormones produced by the thyroid gland (the other is called triiodothyronine, or T3). The body has a feedback system that turns thyroid hormone production on and off. When the level of T4 in the bloodstream decreases, the hypothalamus releases thyrotropin releasing hormone, which stimulates the pituitary gland to release thyroid-stimulating hormone (TSH), which in turn stimulates the thyroid gland to release more T4. As blood concentrations of T4 increase, TSH release is inhibited.

T4 makes up nearly 90% of thyroid hormones, while T3 makes up less than 10%. Inside the thyroid gland, T4 is bound to a protein called thyroglobulin. When the body requires thyroid hormone, the thyroid gland releases stored T4 into circulation. In the blood, T4 is either free (not bound) or protein-bound (primarily bound to thyroxine-binding globulin). The concentration of free T4 is only about 0.1% of that of total T4. T4 is converted into T3 in the liver or other tissues. T3, like T4, is also highly protein-bound, but it is the free forms of T3 and T4 that are biologically active. Free T3 is also 4 to 5 times more active than free T4 in circulation.

If the thyroid gland does not produce sufficient T4, due to thyroid dysfunction or to insufficient TSH, then the affected patient experiences symptoms of hypothyroidism such as weight gain, dry skin, cold intolerance, irregular menstruation, and fatigue. If the thyroid gland produces too much T4, the rate of the patient’s body functions will increase and cause symptoms associated with hyperthyroidism such as increased heart rate, anxiety, weight loss, difficulty sleeping, tremors in the hands, and puffiness around dry, irritated eyes.

The most common causes of thyroid dysfunction are autoimmune-related. Graves' disease causes hyperthyroidism and Hashimoto's thyroiditis causes hypothyroidism. Both hyper- and hypothyroidism can also be caused by thyroiditis, thyroid cancer, and excessive or deficient...
production of TSH. The effect of these conditions on thyroid hormone production can be detected and monitored by measuring the total T4 (includes bound and free portion) or the free T4 (unbound form).

**Testosterone**

Also known as: Total testosterone  
Related tests: Follicle stimulating hormone (FSH), Luteneizing hormone (LH), Sex hormone binding globulin (SHBG), Free and bioavailable testosterone (see FAQ section), Dihydrotestosterone (DHT), Estradiol (see Estrogen), Gonadotropin-releasing hormone, Dehydroepiandrosterone sulfate (DHEAS)

To determine abnormal testosterone level in males and females; in males, an abnormal level may help to explain difficulty getting an erection (erectile dysfunction), inability of your partner to get pregnant (infertility), or premature or delayed puberty; in females, to explain the appearance of masculine physical features (virilization), inability to get pregnant, and as a marker for polycystic ovary syndrome (PCOS)

Testosterone is a steroid hormone (androgen) produced by special endocrine tissue (the Leydig cells) in the male testes. Its production is stimulated and controlled by luteinizing hormone (LH), which is manufactured in the pituitary gland. Testosterone works within a negative feedback mechanism: as testosterone increases, LH decreases, whereas increased LH causes decreased testosterone. Testosterone levels are diurnal, peaking in the early morning hours (about 4:00 to 8:00 am), with the lowest levels in the evening (about 4:00 to 8:00 pm). Levels also increase after exercise, but decrease with age. About two-thirds of testosterone circulates in the blood bound to sex-hormone binding protein and slightly less than one-third bound to albumin. A small percent (about 1-4%) circulates as free testosterone.  
In males, testosterone stimulates development of secondary sex characteristics, including enlargement of the penis, growth of body hair, muscle development, and a deepening voice. It is present in large amounts in males during puberty and in adult males to regulate the sex drive and maintain muscle mass. Testosterone is also produced by the adrenal glands in both males and females and, in small amounts, by the ovaries in females. In women, testosterone is converted to estradiol, the main sex hormone in females.

**TSH (Thyroid-stimulating hormone)**

Also known as: Thyrotropin  
Related tests: T4, T3, Thyroid Antibodies

To screen for and help diagnose thyroid disorders; to monitor treatment of hypothyroidism and hyperthyroidism

This test measures the amount of thyroid-stimulating hormone (TSH) in blood. TSH is produced by the pituitary gland. It is part of the body’s feedback system to maintain stable amounts of the thyroid hormones thyroxine (T4) and triiodothyronine (T3) in the blood. Thyroid hormones help control the rate at which the body uses energy. When concentrations decrease in the blood, the hypothalamus releases thyrotropin releasing hormone (TRH). This stimulates the release of TSH by the pituitary gland. The TSH in turn stimulates the production and release of T4 and T3 by the thyroid gland. When all three organs are functioning normally, thyroid production turns on and off to maintain constant blood thyroid hormone levels.

If there is pituitary dysfunction, then increased or decreased amounts of TSH may result. When TSH concentrations are increased, the thyroid will make and release inappropriate
amounts of T4 and T3 and the patient may experience symptoms associated with hyperthyroidism, such as rapid heart rate, weight loss, nervousness, hand tremors, irritated eyes, and difficulty sleeping. If there is decreased production of thyroid hormones (hypothyroidism), the patient may experience symptoms such as weight gain, dry skin, constipation, cold intolerance, and fatigue. In addition to pituitary dysfunction, hyper- or hypothyroidism can occur if there is a problem with the hypothalamus (insufficient or excessive TRH). Thyroid hormone levels may also be altered by a variety of thyroid diseases regardless of the amount of TSH present in the blood.

<table>
<thead>
<tr>
<th>Endocrine Gland</th>
<th>Location/Description</th>
<th>Hormones Gland Produces</th>
<th>Gland/Hormone Function</th>
<th>Examples of Diseases and Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypothalamus</td>
<td>Lower middle of the brain</td>
<td>Growth hormone-releasing hormone (GHRH)</td>
<td>Communicates with both nervous and endocrine systems; Stimulates (GHRH, TRH, CRH, GnRH) or inhibits (PIF) hormone production in the pituitary</td>
<td>Precocious puberty (early GnRH production) Kallman syndrome (inadequate GnRH production) Thyroid diseases</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thyrotropin-releasing hormone (TRH)</td>
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<tr>
<td></td>
<td></td>
<td>Corticotropin-releasing hormone (CRH)</td>
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<td>Gonadotropin-releasing hormone (GnRH)</td>
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<td></td>
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<td>Prolactin Inhibitory Factor (PIF, dopamine)</td>
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<td></td>
<td></td>
<td>Oxytocin</td>
<td>Uterine contraction during labor</td>
<td>Diabetes insipidus (inadequate AVP production)</td>
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<tr>
<td></td>
<td></td>
<td>Arginine vasopressin (AVP), also called antidiurectic hormone (ADH)</td>
<td>Water balance</td>
<td></td>
</tr>
<tr>
<td>Pituitary</td>
<td>Below hypothalamus, behind sinus cavity</td>
<td>Prolactin</td>
<td>Milk production</td>
<td>Hypopituitarism Empty Sella Syndrome Galactorrhea (milk production not during pregnancy due to high prolactin)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Growth Hormone (GH)</td>
<td>Bone growth</td>
<td>Acromegaly or Gigantism (excess GH) Growth Hormone Deficiency (GHD)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ACTH</td>
<td>Stimulates cortisol</td>
<td>Cushing's disease (excess ACTH)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>TSH</td>
<td>Stimulates thyroid hormone</td>
<td>Hyper/hypothyroidism</td>
</tr>
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<td></td>
<td></td>
<td>LH, FSH</td>
<td>Regulation of testosterone and estrogen, fertility</td>
<td>Loss of menstrual period Loss of sex drive Infertility</td>
</tr>
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<tr>
<td><strong>Thymus</strong></td>
<td></td>
<td>T4 (thyroxine)</td>
<td>Helps regulate the rate of metabolism</td>
<td>Thyroid diseases (including hypo and hyperthyroidism)</td>
</tr>
<tr>
<td><strong>Thyroid</strong></td>
<td>Butterfly-shaped; lies flat against windpipe in the throat</td>
<td>T3 (thyroid hormone A)</td>
<td>Helps regulate bone status, blood calcium</td>
<td></td>
</tr>
<tr>
<td><strong>Parathyroid</strong></td>
<td>4 tiny glands located behind, next to, or below the thyroid</td>
<td>Parathyroid hormone (PTH)</td>
<td>Regulates blood calcium</td>
<td>Hyperparathyroidism, Hypoparathyroidism, MEN1</td>
</tr>
<tr>
<td><strong>Adrenal</strong></td>
<td>2 triangular organs, on top of each kidney</td>
<td>Epinephrine (adrenaline) norepinephrine</td>
<td>Blood pressure regulation, stress reaction</td>
<td>Pheochromocytoma (MEN2)</td>
</tr>
<tr>
<td><strong>Adrenal</strong></td>
<td></td>
<td>Aldosterone</td>
<td>Salt, water balance</td>
<td>Conn's Syndrome</td>
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<tr>
<td><strong>Adrenal</strong></td>
<td></td>
<td>Cortisol</td>
<td>Stress reaction</td>
<td>Cushing's Syndrome, Addison's Disease</td>
</tr>
<tr>
<td><strong>Adrenal</strong></td>
<td></td>
<td>DHEA-S</td>
<td>Body hair development at puberty</td>
<td>Cancer, Adrenal Hyperplasia</td>
</tr>
<tr>
<td><strong>Ovaries</strong> (females only)</td>
<td>2, located in the pelvis</td>
<td>Estrogen</td>
<td>Female sexual characteristics</td>
<td>Polycystic ovary syndrome (PCOS)</td>
</tr>
<tr>
<td><strong>Testes</strong> (males only)</td>
<td>2, located in the groin</td>
<td>Testosterone</td>
<td>Male sexual characteristics</td>
<td>Hypogonadism</td>
</tr>
<tr>
<td><strong>Pancreas</strong></td>
<td>Large, gourd-shaped gland, located behind the stomach</td>
<td>Insulin, Glucagon</td>
<td>Glucose regulation</td>
<td>Diabetes mellitus, MEN1, Zollinger-Ellison syndrome</td>
</tr>
<tr>
<td><strong>Pineal</strong></td>
<td>Lower side of the brain</td>
<td>Melatonin</td>
<td>Not well understood; Helps control sleep patterns, affects reproduction</td>
<td></td>
</tr>
</tbody>
</table>

Endocrine glands, the hormones they produce, and the diseases and conditions associated with them.
Original illustration created by Diane Abeloff, 2002.