Body system made up of all the endocrine (ductless) glands that secrete hormones directly into the bloodstream to control body functions. The endocrine system (together with the nervous system) controls and regulates all body functions. The chief endocrine glands are the pituitary gland (in the brain), the thyroid gland (in the neck), the adrenal gland (in the abdomen), and the sex gland or gonad (in the female abdomen and male testes).

The endocrine glands appear unique in that the hormones they produce do not pass through tubes or ducts. The hormones are secreted directly into the internal environment, where they are transmitted via the bloodstream or by diffusion and act at distant points in the body. In contrast, other glands including sweat glands, salivary glands, and glands of the gastrointestinal system secrete the substances they produce through ducts, and those substances are used in the vicinity of the gland.

The regulation of body functions by the endocrine system depends on the existence of specific receptor cells in target organs that respond in specialized ways to the minute quantities of the hormonal messengers. Some endocrine hormones, such as thyroxine from the thyroid gland, affect nearly all body cells; others, such as progesterone from the female ovary, which regulates the uterine lining, affect only a single organ. The amounts of hormones are maintained by feedback mechanisms that depend on interactions between the endocrine glands, the blood levels of the various hormones, and activities of the target organ. Hormones act by regulating cell metabolism. By accelerating, slowing, or maintaining enzyme activity in receptor cells, hormones control growth and development, metabolic rate, sexual rhythms, and reproduction.

**Pituitary Control**

The master gland, i.e., the gland that regulates many of the other endocrine glands, is the pituitary, located at the base of the brain. Also called the hypophysis, the pituitary secretes at least five hormones that directly affect the other endocrine glands. It secretes thyrotropin, which manages thyroid gland activity, adrenocorticotropic hormone (ACTH), which regulates activity of the adrenal cortex, and three gonadotropic hormones, follicle-stimulating hormone (FSH), luteinizing hormone (LH), and luteotropic hormone (LTH), all of which control the growth and reproductive activities of the sex glands. The pituitary also produces substances that do not act directly on other endocrine glands: somatotropin hormone, or growth hormone, which controls growth in all tissues; antidiuretic hormone.
(ADH), which controls the rate of water excretion in the urine; oxytocin, which stimulates uterine contraction and helps regulate milk production by the breasts; and melanocyte-stimulating hormone, which regulates the activity of the melanocytes, or pigment-producing cells.

**Adrenal Gland**

The adrenal gland is another endocrine gland regulated by the pituitary. The adrenal cortex, the outer part of each of the two adrenal glands, produces aldosterone, cortisol, and other steroids. These substances regulate salt concentration in body fluids and glucose, fat, and protein metabolism. The inner portion of the gland, the adrenal medulla, secretes epinephrine (adrenaline) and norepinephrine, substances connected with the autonomic nervous system that help the body to respond to danger or stress.

**The Thyroid Gland**

The thyroid, located below the larynx and partially surrounding the trachea, produces thyroxine, which controls the metabolic rate of most body cells, and calcitonin, which is responsible for maintaining proper calcium serum levels in the body.

**The Sex Hormones**

The testes produce the male sex hormone testosterone, which controls the development of the male sex organs as well as secondary sex characteristics. The pituitary hormone LH regulates testosterone production, and FSH initiates sperm formation in the testes. In females, FSH, LH, and LTH are integrated into the complex monthly cycles of ovulation, production of the hormones estrogen and progesterone by the ovaries and corpus luteum, and menstruation; LTH also contributes to lactation. Estrogen controls growth of the sex organs and breasts and regulates secondary sex characteristics. The most important function of progesterone is to prepare the uterine lining for implantation of a fertilized egg.

**Other Endocrine Glands**

The other endocrine glands are not directly controlled by the pituitary. The four parathyroid glands, located behind the thyroid, secrete a hormone that regulates calcium and phosphate metabolism. The endocrine portion of the pancreas, called the islets of Langerhans, secretes insulin, which regulates the level of sugar (glucose) in the blood and glucagon, which raises blood sugar level. The thymus, sometimes considered another endocrine gland, processes lymphocytes in newborn animals, seeding the lymph nodes and other lymph tissues; it is partly responsible for the development of the organism's immune system (see immunity). The kidney is sometimes considered an endocrine gland because it secretes the hormone renin which, with other substances, regulates blood pressure. The kidney produces a glycoprotein called erythropoietin, which stimulates red blood cell production. The pineal gland produces a substance called melatonin, which helps regulate the body's internal clock.

**The Hypothalamus**

Physiological processes are under nervous system as well as endocrine control and a gland adjacent to the pituitary, called the hypothalamus, mediates between the two systems. The hypothalamus secretes pituitary-regulating substances in response to nervous system stimuli including smell, taste, pain, and emotions. Thus, stress, cold, heat, and other stimuli release CRF, or adrenocorticotropic hormone-releasing factor, from the hypothalamus, causing ACTH to be produced by the pituitary, which in turn stimulates the production of the adrenal hormone cortisol. Similar chemical regulatory
mechanisms operate in the regulation of the sex and thyroid hormones. Hypothalamic activity is also regulated by other body substances, e.g., cortisol inhibits the production of hypothalamic CRF.