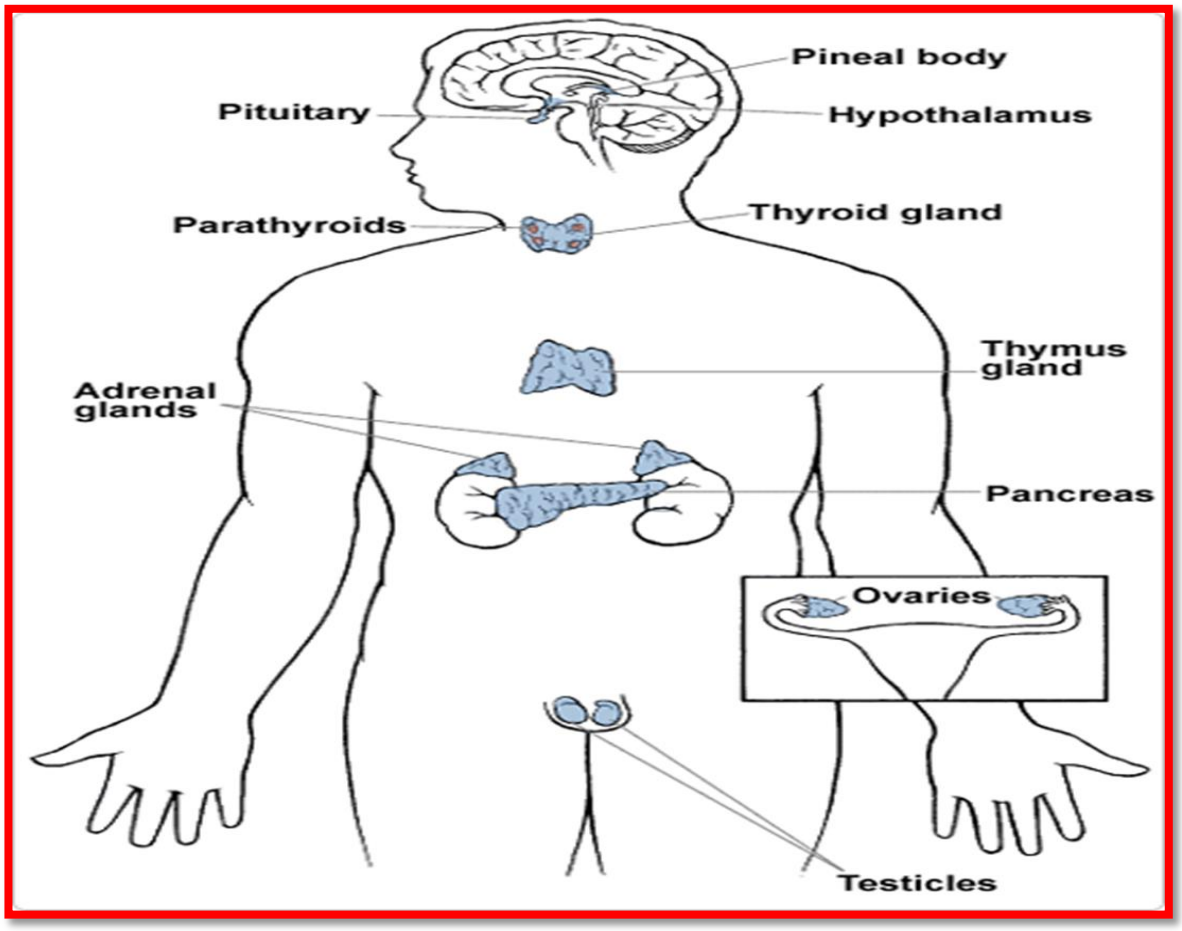
Endocrine system

The **endocrine system** :

is the collection of glands of an organism that secrete hormones directly into the circulatory system to be carried towards distant target organs, The endocrine system is in contrast to the exocrine system, which secretes its hormones to the outside of the body using ducts. The endocrine system is an information signal system like the nervous system, Its' effects are slow to initiate, and prolonged in their response, lasting from a few hours up to weeks.

The major endocrine glands include:

the hypothalamus, pineal gland , pituitary gland, pancreas, ovaries, testes, thyroid gland, parathyroid gland, and adrenal glands.



(**FIGURE 1**) shows the anatomical loci of the major endocrine glands and endocrine tissues of the body, except for the placenta, which is an additional source of the sex hormones.

A ***hormone*** is a signaling molecules produced by glands in multicellular organisms that are transported by the circulatory system to target distant organs to regulate physiology and behaviour, hormone is sometimes extended to include chemicals produced by cells that affect the same cell

(autocrine or intracrine signalling) or nearby cells (paracrine signalling), Hormones are used to communicate between organs and tissues for physiological regulation and behavioral activities, such as **digestion metabolism, respiration, tissue function , sensory perception, sleep, excretion, lactation, stress, growth and development, movement, reproduction, and mood**.

TARGET CELL:

any cell that has a specific receptor for an antigen or antibody or hormone or drug.

RECEPTOR:

a molecule on the cell surface (cell-surface or membrane receptor) or within a cell, usually in its nucleus (nuclear receptor) that recognizes and binds with specific molecules, producing some effect in the cell; e.g., the cell-surface

receptors of immunocompetent cells that recognize antigens, complement components, or lymphokines; or those of neurons and target organs that recognize neurotransmitters or hormones.

Chemical Structures

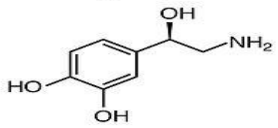
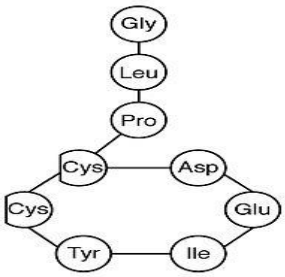
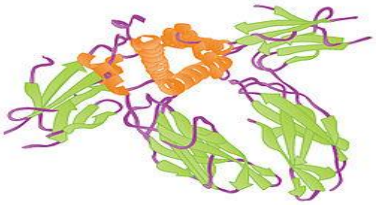
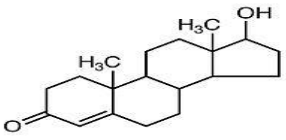
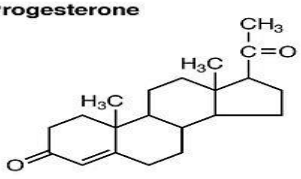
Hormones can be grouped according to chemical structure, Structures dictate if the hormone prefers to be surrounded by water or fat (water or fat soluble):

1. Steroid hormones are fat-soluble molecules made from cholesterol. Among these are the three major sex hormones groups: estrogens, androgens and progesterones. Males and females make all three, just in different amounts. Steroids pass into a cell's nucleus, bind to specific receptors and genes and trigger the cell to make proteins.

2. Amino acid derivatives, such as epinephrine, are water-soluble molecules derived from amino acids (the building blocks of protein). These hormones are stored in endocrine cells until needed. They act by binding to protein receptors on the outside surface of the cell. The binding alerts a second messenger molecule inside the cell that activates enzymes and other cellular proteins or influences gene expression.

3. polypeptide hormones such as Insulin, growth hormone, prolactin and other water-soluble consist of long chains of amino acids, from **several** to **200** amino acids long. They are

stored in endocrine cells until needed to regulate such processes as metabolism, lactation, growth and reproduction.

Hormone Class	Components	Example(s)
Amine Hormone	Amino acids with modified groups (e.g. norepinephrine's carboxyl group is replaced with a benzene ring)	Norepinephrine 
Peptide Hormone	Short chains of linked amino acids	Oxytocin 
Protein Hormone	Long chains of linked amino acids	Human Growth Hormone 
Steroid Hormones	Derived from the lipid cholesterol	Testosterone  Progesterone 

Type of receptors depending on the location:

Hormone receptors are large proteins, and each cell that is to be stimulated usually has some 2000 to 100,000 receptors. Also, each receptor is usually highly specific for a single hormone, which determines the type of hormone that will act on a particular tissue. The

target tissues that are affected by a hormone are those that contain its specific receptors.

The locations for the different types of hormone receptors are generally the following:

1. In or on the surface of the cell membrane. The membrane receptors are specific mostly for the protein, peptide, and catecholamine hormones.
2. In the cell cytoplasm. The primary receptors for the different steroid hormones are found mainly in the cytoplasm.
3. In the cell nucleus. The receptors for the thyroid hormones are found in the nucleus and are believed to be located in direct association with one or more of the chromosomes.

FEEDBACK CONTROL OF HORMONE SECRETION:

Negative Feedback: Prevents Overactivity of Hormone Systems. Although the plasma concentrations of many hormones fluctuate in response to various stimuli that occur throughout the day, all hormones studied thus far appear to be closely controlled. In most instances, this control is exerted through **negative feedback mechanisms** that ensure a proper level of hormone activity at the target tissue. After a stimulus causes release of the hormone, conditions or products resulting from the action of the hormone tend to

suppress its further release. In other words, the hormone has a negative feedback effect to prevent oversecretion of the hormone or overactivity at the target tissue, only when the target tissue activity rises to an appropriate level will feedback signals to the endocrine gland become powerful enough to slow further
secretion of the hormone. The control of blood sugar(glucose) by insulin is a good example of a **negative feedback mechanism**. When blood sugar rises, receptors in the body sense a change.

In turn, the control center (pancreas) secretes insulin into the blood effectively lowering blood sugar levels. Once blood sugar levels reach homeostasis, the pancreas stops releasing insulin.

Positive feedback: occurs when the biological action of the hormone causes additional secretion of the hormone. One example of positive feedback is the surge of luteinizing hormone (LH) that occurs as a result of the stimulatory effect of estrogen on the anterior pituitary before ovulation. The secreted LH then acts on the ovaries to stimulate additional secretion of estrogen, which in turn causes more secretion of LH. Eventually, LH reaches an appropriate concentration and

typical negative feedback control of hormone secretion is then exerted.

Table 75-1 Endocrine Glands, Hormones, and Their Functions and Structure

Gland/Tissue	Hormones	Major Functions	Chemical Structure
Hypothalamus (Chapter 76)	Thyrotropin-releasing hormone	Stimulates secretion of thyroid-stimulating hormone and prolactin	Peptide
	Corticotropin-releasing hormone	Causes release of adrenocorticotropic hormone	Peptide
	Growth hormone–releasing hormone	Causes release of growth hormone	Peptide
	Growth hormone inhibitory hormone (somatostatin)	Inhibits release of growth hormone	Peptide
	Gonadotropin-releasing hormone	Causes release of luteinizing hormone and follicle-stimulating hormone	
	Dopamine or prolactin-inhibiting factor	Inhibits release of prolactin	Amine
Anterior pituitary (Chapter 76)	Growth hormone	Stimulates protein synthesis and overall growth of most cells and tissues	Peptide
	Thyroid-stimulating hormone	Stimulates synthesis and secretion of thyroid hormones (thyroxine and triiodothyronine)	Peptide
	Adrenocorticotropic hormone	Stimulates synthesis and secretion of adrenocortical hormones (cortisol, androgens, and aldosterone)	Peptide
	Prolactin	Promotes development of the female breasts and secretion of milk	Peptide
	Follicle-stimulating hormone	Causes growth of follicles in the ovaries and sperm maturation in Sertoli cells of testes	Peptide
	Luteinizing hormone	Stimulates testosterone synthesis in Leydig cells of testes; stimulates ovulation, formation of corpus luteum, and estrogen and progesterone synthesis in ovaries	Peptide
Posterior pituitary (Chapter 76)	Antidiuretic hormone (also called *vasopressin*)	Increases water reabsorption by the kidneys and causes vasoconstriction and increased blood pressure	Peptide
	Oxytocin	Stimulates milk ejection from breasts and uterine contractions	Peptide

Thyroid (Chapter 77)	Thyroxine (T_4) and triiodothyronine (T_3)	Increases the rates of chemical reactions in most cells, thus increasing body metabolic rate	Amine
	Calcitonin	Promotes deposition of calcium in the bones and decreases extracellular fluid calcium ion concentration	Peptide
Adrenal cortex (Chapter 78)	Cortisol	Has multiple metabolic functions for controlling metabolism of proteins, carbohydrates, and fats; also has anti-inflammatory effects	Steroid
	Aldosterone	Increases renal sodium reabsorption, potassium secretion, and hydrogen ion secretion	Steroid
Adrenal medulla (Chapter 61)	Norepinephrine, epinephrine	Same effects as sympathetic stimulation	Amine
Pancreas (Chapter 79)	Insulin (β cells)	Promotes glucose entry in many cells, and in this way controls carbohydrate metabolism	Peptide
	Glucagon (α cells)	Increases synthesis and release of glucose from the liver into the body fluids	Peptide
Parathyroid (Chapter 80)	Parathyroid hormone	Controls serum calcium ion concentration by increasing calcium absorption by the gut and kidneys and releasing calcium from bones	Peptide
Testes (Chapter 81)	Testosterone	Promotes development of male reproductive system and male secondary sexual characteristics	Steroid
Ovaries (Chapter 82)	Estrogens	Promotes growth and development of female reproductive system, female breasts, and female secondary sexual characteristics	Steroid
	Progesterone	Stimulates secretion of "uterine milk" by the uterine endometrial glands and promotes development of secretory apparatus of breasts	Steroid

Table 75-1 Endocrine Glands, Hormones, and Their Functions and Structure (Continued)

Gland/Tissue	Hormones	Major Functions	Chemical Structure
Placenta (Chapter 83)	Human chorionic gonadotropin	Promotes growth of corpus luteum and secretion of estrogens and progesterone by corpus luteum	Peptide
	Human somatomammotropin	Probably helps promote development of some fetal tissues, as well as the mother's breasts	Peptide
	Estrogens	See actions of estrogens from ovaries	Steroid
	Progesterone	See actions of progesterone from ovaries	Steroid
Kidney (Chapter 26)	Renin	Catalyzes conversion of angiotensinogen to angiotensin I (acts as an enzyme)	Peptide
	1,25-Dihydroxycholecalciferol	Increases intestinal absorption of calcium and bone mineralization	Steroid
	Erythropoietin	Increases erythrocyte production	Peptide
Heart (Chapter 22)	Atrial natriuretic peptide	Increases sodium excretion by kidneys, reduces blood pressure	Peptide
Stomach (Chapter 65)	Gastrin	Stimulates hydrogen chloride secretion by parietal cells	Peptide
Small intestine (Chapter 65)	Secretin	Stimulates pancreatic acinar cells to release bicarbonate and water	Peptide
	Cholecystokinin	Stimulates gallbladder contraction and release of pancreatic enzymes	Peptide
Adipocytes (Chapter 72)	Leptin	Inhibits appetite, stimulates thermogenesis	Peptide