**Hormones**

A hormone is a class of signaling molecules produced by glands in multicellular organisms that are transported by the circulatory system to target distant organs to regulate physiology and behavior. Hormones have diverse chemical structures that include steroids, eicosanoids, amino acid derivatives, peptides, and proteins. The glands that secrete hormones comprise the endocrine signaling system. The term hormone is sometimes extended to include chemicals produced by cells that affect the same cell (autocrine or intracrine signalling) or nearby cells (paracrine signalling). Different types of hormones are secreted in the body, with different biological roles and functions.

Hormones are used to communicate between organs and tissues to regulate physiological and behavioral activities, such as digestion, metabolism, respiration, tissue function, sensory perception, sleep, excretion, lactation, stress, growth and development, movement, reproduction, and mood. Hormones affect distant cells by binding to specific receptor proteins in the target cell resulting in a change in cell function. When a hormone binds to the receptor, it results in the activation of a signal transduction pathway. This may lead to cell type-specific responses that include rapid non-genomic effects or slower genomic responses where the hormones acting through their receptors activate gene transcription resulting in increased expression of target proteins.

Hormone synthesis may occur in specific tissues of endocrine glands or in other specialized cells. Hormone synthesis occurs in response to specific biochemical signals induced by a wide range of regulatory systems. For instance, glucose concentration affects insulin synthesis. Regulation of hormone synthesis of gonadal, adrenal and thyroid hormones is often dependent on complex sets of direct influence and feedback interactions involving the hypothalamic-pituitary-adrenal (HPA), -gonadal (HPG) and -thyroid (HPT) axes.

Upon secretion, certain hormones, including protein hormones are water soluble and are thus readily transported through the circulatory system. Other hormones, including steroid and thyroid hormones, are lipid soluble. For their widespread distribution, these hormones must bond to carrier plasma glycoproteins (e.g., thyroxine-binding globulin (TBG) to form ligand-protein complexes. Some hormones are completely active when released into the bloodstream (as is the case for insulin and growth hormones), while others must be activated in specific cells through a series of activation steps that are commonly highly regulated. For example, Pepsinogen is inactive and later converted to pepsin for digestion in stomach. The endocrine system secretes hormones directly into the bloodstream typically into capillaries, whereas the exocrine system secretes its hormones indirectly using ducts. Hormones with paracrine function diffuse through the interstitial spaces to nearby target tissue.
Signalling of Hormones:

Hormonal signaling involves the following steps:

1. **Biosynthesis** of a particular hormone in a particular tissue
2. **Storage and secretion** of the hormone
3. **Transport** of the hormone to the target cell(s)
4. **Recognition** of the hormone by an associated cell membrane or intracellular receptor protein
5. **Relay and amplification** of the received hormonal signal via a signal transduction process: This then leads to a cellular response. The reaction of the target cells may then be recognized by the original hormone-producing cells, leading to a down-regulation in hormone production. This is an example of a homeostatic negative feedback loop.
6. **Breakdown** of the hormone.

Regulation of hormones:

The rate of hormone biosynthesis and secretion is often regulated by a homeostatic negative feedback control mechanism. Such a mechanism depends on factors that influence the metabolism and excretion of hormones. Thus, higher hormone concentration alone cannot trigger the negative feedback mechanism. Negative feedback must be triggered by overproduction of an "effect" of the hormone.

Hormone secretion can be stimulated and inhibited by:

- Other hormones (*stimulating* or *releasing* -hormones)
- Plasma concentrations of ions or nutrients, as well as binding globulins
- Neurons and mental activity
- Environmental changes, e.g., of light or temperature

One special group of hormones is the tropic hormones that stimulate the hormone production of other endocrine glands. For example, thyroid-stimulating hormone (TSH) causes growth and increased activity of another endocrine gland, the thyroid, which increases output of thyroid hormones.

To release active hormones quickly into the circulation, hormone biosynthetic cells may produce and store biologically inactive hormones in the form of pre- or prohormones. These can then be quickly converted into their active hormone form in response to a particular stimulus. Eicosanoids are considered to act as local hormones.
Effects of hormones:

A variety of exogenous chemical compounds, both natural and synthetic, have hormone-like effects on both humans and wildlife. Their interference with the synthesis, secretion, transport, binding, action, or elimination of natural hormones in the body can change the homeostasis, reproduction, development, and/or behavior, similar to endogenously produced hormones.

Hormones have the following effects on the body:

- stimulation or inhibition of growth
- wake-sleep cycle
- mood swings
- induction or suppression of apoptosis (programmed cell death)
- activation or inhibition of the immune system
- regulation of metabolism
- preparation of the body for mating, fighting, fleeing, and other activity
- preparation of the body for a new phase of life, such as puberty, parenting, and menopause
- control of the reproductive cycle
- hunger cravings
- sexual arousal

A hormone may also regulate the production and release of other hormones. Hormone signals control the internal environment of the body through homeostasis.

Chemical classes of hormones:

As hormones are defined functionally, not structurally, they may have diverse chemical structures. Hormones occur in multicellular organisms (plants, animals, fungi, brown algae and red algae). These compounds occur also in unicellular organisms, and may act as signaling molecules, but there is no consensus if, in this case, they can be called hormones.

Vertebrate hormones fall into four main chemical classes:

- **Amino acid derived** – Examples include melatonin and thyroxine.
- **Polypeptide and proteins** – Small peptide hormones include TRH and vasopressin. Peptides composed of scores or hundreds of amino acids are referred to as proteins. Examples of protein hormones include insulin and growth hormone. More complex protein hormones bear carbohydrate side-chains and
are called glycoprotein hormones. Luteinizing hormone, follicle-stimulating hormone and thyroid-stimulating hormone are examples of glycoprotein hormones.

- **Eicosanoids** – hormones derive from lipids such as arachidonic acid, lipoxins and prostaglandins.
- **Steroid** – Examples of steroid hormones include the sex hormones estradiol and testosterone as well as the stress hormone cortisol.

Plant hormones include abscisic acid, auxins, cytokinins, ethylene and gibberellins.

**Therapeutic use of hormones**

Many hormones and their analogues are used as medication. The most commonly prescribed hormones are estrogens and progestrons (as methods of hormonal contraception and as HRT), thyroxine (as levothyroxine used for hypothyroidism) and steroids (for autoimmune diseases and several respiratory disorders). Insulin is used by many diabetic patients. Local preparations for use in otolaryngology often contain pharmacologic equivalents of adrenaline, while steroid and vitamin D creams are used extensively in dermatological practice.

**Comparison with neurotransmitters**

There are various clear distinctions between hormones and neurotransmitters:

- A hormone can perform functions over a larger spatial and temporal scale than can a neurotransmitter.
- Hormonal signals can travel virtually anywhere in the circulatory system, whereas neural signals are restricted to pre-existing nerve tracts.
- Hormonal action is slow as compared to neurotransmitters. Assuming the travel distance is equivalent, neural signals can be transmitted much more quickly (in the range of milliseconds) than can hormonal signals (in the range of seconds, minutes, or hours). Neural signals can be sent at speeds up to 100 meters per second.
- Neural signaling is an all-or-nothing (digital) action, whereas hormonal signaling is an action that can be continuously variable as dependent upon hormone concentration.