



Lecture title: Hormone

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Hormones

Abbreviations

ACTH	Adrenocorticotrophic hormone	GH	Growth hormone
ANF	Atrial natriuretic factor	IGF-I	Insulin-like growth factor-I
cAMP	Cyclic adenosine monophosphate	LH	Luteotropic hormone
CBG	Corticosteroid-binding globulin	LPH	Lipotropin
CG	Chorionic gonadotropin	MIT	Monoiodotyrosine
cGMP	Cyclic guanosine monophosphate	MSH	Melanocyte-stimulating hormone
CLIP	Corticotropin-like intermediate lobe peptide	OHSD	Hydroxysteroid dehydrogenase
DBH	Dopamine β -hydroxylase	PNMT	Phenylethanolamine-N-methyltransferase
DHEA	Dehydroepiandrosterone	POMC	Pro-opiomelanocortin
DHT	Dihydrotestosterone	SHBG	Sex hormone-binding globulin
DIT	Diiodotyrosine	StAR	Steroidogenic acute regulatory (protein)
DOC	Deoxycorticosterone	TBG	Thyroxine-binding globulin
EGF	Epidermal growth factor	TEBG	Testosterone-estrogen-binding globulin
FSH	Follicle-stimulating hormone	TRH	Thyrotropin-releasing hormone
		TSH	Thyrotropin-stimulating hormone

Hormones are **chemical messengers** secreted by **special cells** in an endocrine gland and transported in the **bloodstream** to the **target cells**. There are about **220** types of differentiated cells in animal body. Only a few produce hormones, but virtually all of the **75** trillion cells in a body are targets of one or more of the over **55** known hormones.

Endocrinology: study of endocrine glands and their secretions (hormones).

Endocrine gland: a group of cells which secrete “messenger” molecules directly into the bloodstream.

Endocrine Glands:

A-Classical:

1. Gonads.
2. Pancreas.
3. Adrenals.



5. Parathyroid.

6. Pituitary.

B- Recently identified:

1. Kidney.

2. Heart/blood.

3. Liver.

4. Brain.

5. Fat (adipose) tissue.

6. Placenta.

Types of chemical messengers :

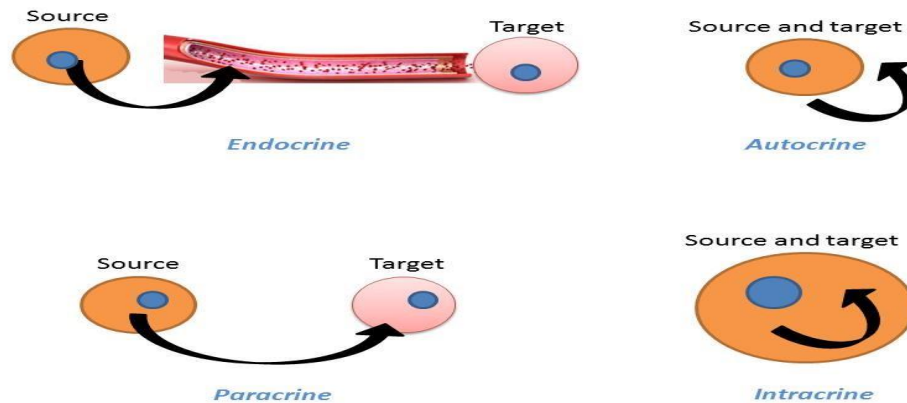
- **True hormones** : are secreted into the blood by endocrine glands. e.g. insulin.
- **Paracrine hormones** : are secreted by regulatory cells and travel to only a short distance to adjacent target cells. e.g : prostaglandins .
- **Pheromones** : are air-borne signals secreted by exocrine glands and stimulate target cells in another animal, usually of the opposite sex. Sex pheromones have been found in insects, mammals, reptiles.
- **Neurotransmitters** : are chemical messengers that are secreted by nerve cells to adjacent cells to signal nerve impulses, e.g: acetylcholine.

According to the **kind of chemical messenger action**, they can be classified into:

Endocrine: molecules act on the target cells at a distance away from their source (usually transmitted by bloodstream).

Paracrine: molecules act on target cells within near area (local action).

Autocrine: molecules act on own cell of source. **Intracrine:** molecules act on the source cell without leaving it. (fig).



Classification of hormones:

A. Based on the chemical nature:

1. Protein (peptide) hormones: e.g: oxytocin
2. Steroid hormones: e.g: aldosterone
3. Amino acid derivatives: e.g: Epinephrine

B. Based on mechanism of action:

1. Binds to intracellular receptor: they are lipophilic in nature, and commonly derived from cholesterol, e.g: estrogens.
2. Bind to cell surface (plasma membrane) receptors: stimulate release (or activation) of special substance (**second messengers**), because hormone consider first messenger. This group subdivided into three categories depending on the chemical nature of second messengers.
 1. The second messenger is **cAMP**, e.g: FSH.
 2. The second messenger is **cGMP**, e.g: ANF.
 3. The second messenger is **phosphatidylinositol/calcium**, e.g: TRH.
 4. The second messenger is a **kinase or phosphatase**, e.g: Insulin.

Stages of hormone action:



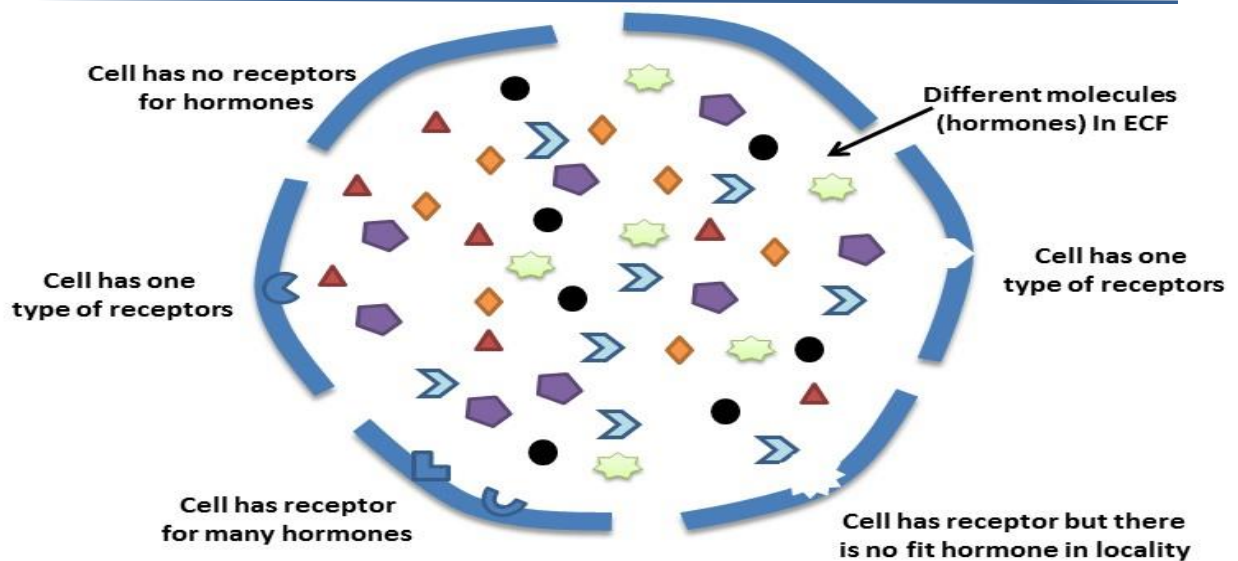
1. Biosynthesis of specific hormone in particular tissue.
2. Storage and/or secretion of the hormone.
3. Transport of the hormone to the target tissue (cell).
4. Recognition of the hormone by specific receptor.
5. Relay and amplification of the received signal causing cellular specific response.
6. Breakdown of the hormone.

Hormone secretion can be stimulated and inhibited by:

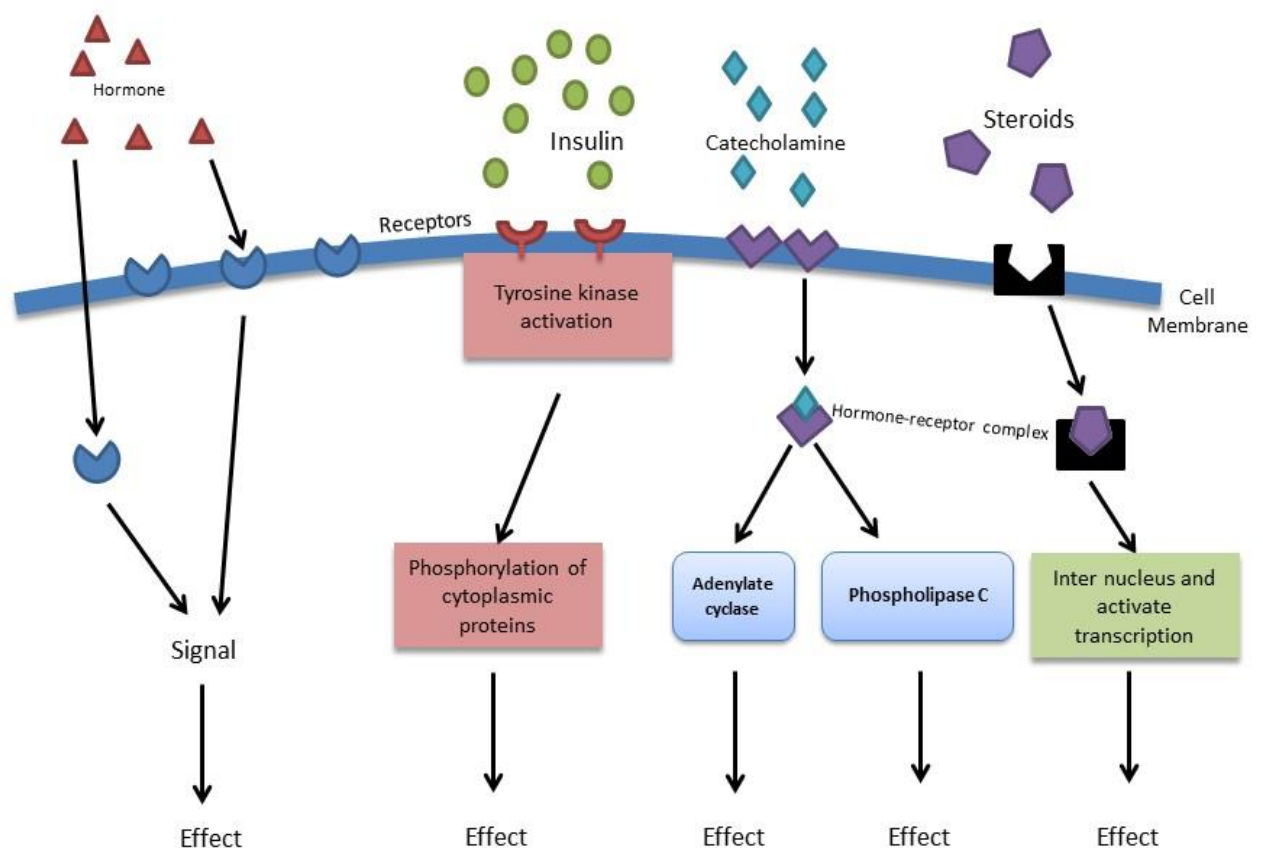
1. Other hormones (stimulating- or releasing -hormones).
2. Plasma concentrations of ions or nutrients, as well as binding [globulins](#).
3. [Neurons](#) and mental activity.
4. Environmental changes, e.g., of light or temperature.

Receptor

Hormones are exists in very low concentration to extracellular fluid, in the range of attomolar (10^{-15}) to nanomolar (10^{-9}) mol/L. At this extra low concentration, target cells must be recognize specific hormone and distinguish between different types of hormones, for more than 220 kind of cells in farm animal body there are at least 55 type of hormones recorded until now.



This high degree of variations is provided by cell-associated recognition molecules, **receptors**. Hormones initiate their biological effects by binding to specific receptors.





Hormones are formed and modified by various ways:

1. Certain hormones are synthesizing in final form and immediately secreted, for example **steroid** hormones.
2. Other hormones are synthesized in the final form and stored in the producing cells, as **catecholamines**.
3. Some hormones are made from precursor molecules in producing cells, and they are processed and secreted according to the physiological demand, as **insulin**.
4. Final kind of hormones are prepared and secreted in inactive form, and it is activation occur after secretion, like **T₃**.

Measurement of hormones:

Hormones are measured by a variety of analytical techniques, including :

1- Bioassay: Bioassays are based on observations of physiological responses specific for the hormone being measured. In vivo bioassays usually involve the injection of test materials (such as blood or urine from a patient) into suitably prepared animals. Target gland responses, such as growth or steroidogenesis, are then measured. In vitro bioassays involve the incubation of tissue, membranes, dispersed cells, or permanent cell lines in a defined culture medium, with subsequent measurement of an appropriate hormone response.

2- Receptor assay: Receptor-based assays depend on the in vitro interaction of a hormone with its biological receptor. In this type of assay, unlabeled hormone displaces trace amounts of radioactively labeled hormone from receptor sites.

3-Immunoassay: hormonal immunoassay is a biochemical test that measures the presence or concentration of a hormone in a solution through the use of an antibody (or immunoglobulin). Possibly one of the most popular labels to use in immunoassays is enzymes.



Immunoassays which employ enzymes are referred to as enzymelinked immunosorbent assay (ELISA) .

Radioimmunoassay (RIA) is a very sensitive *in vitro* assay technique used to measure concentrations of antigens (for example, hormone levels in blood) by use of antibodies.

4- Instrumental techniques: such as mass spectrometry interfaced with either liquid or gas chromatography . Mass spectrometers are powerful qualitative and quantitative analytical tools that are widely used to measure hormones.

