

Tikrit University

College of Nursing

Basic Nursing Sciences



1st stage - 2023-2024

Biochemistry

(Lecture (6) Hormones)

by:

MSc. Reemy Marwan Mohammed saleh

Hormones

The definition of a hormone has been expanded over the last several decades. Hormones secreted by glands such as adrenals, ovaries, parathyroids, pituitary, testes and thyroid were originally considered to represent all of the physiologically relevant hormones. Today, the term hormone refers to any substance in an organism that carries a signal to generate some sort of alteration at the cellular level. Thus endocrine hormones represent a class of hormones that arise in one tissue and travel a considerable distance through the circulation to reach a target cell expressing cognate receptors. Paracrine hormones arise from a cell and travel a relatively small distance to interact with their cognate receptor on another neighboring cell. Autocrine hormones are produced by the same cell that functions as the target for that hormone (neighboring cells may also be targets). Thus we can classify hormones based on their mode of action.

Often, endocrine hormones that travel long distances to their target cells may be more stable than autocrine hormones that exert their effects over very short distances. A diverse array of hormones each with distinctive mechanisms of action and properties of biosynthesis, storage, secretion, transport, and metabolism has evolved to provide homeostatic responses.

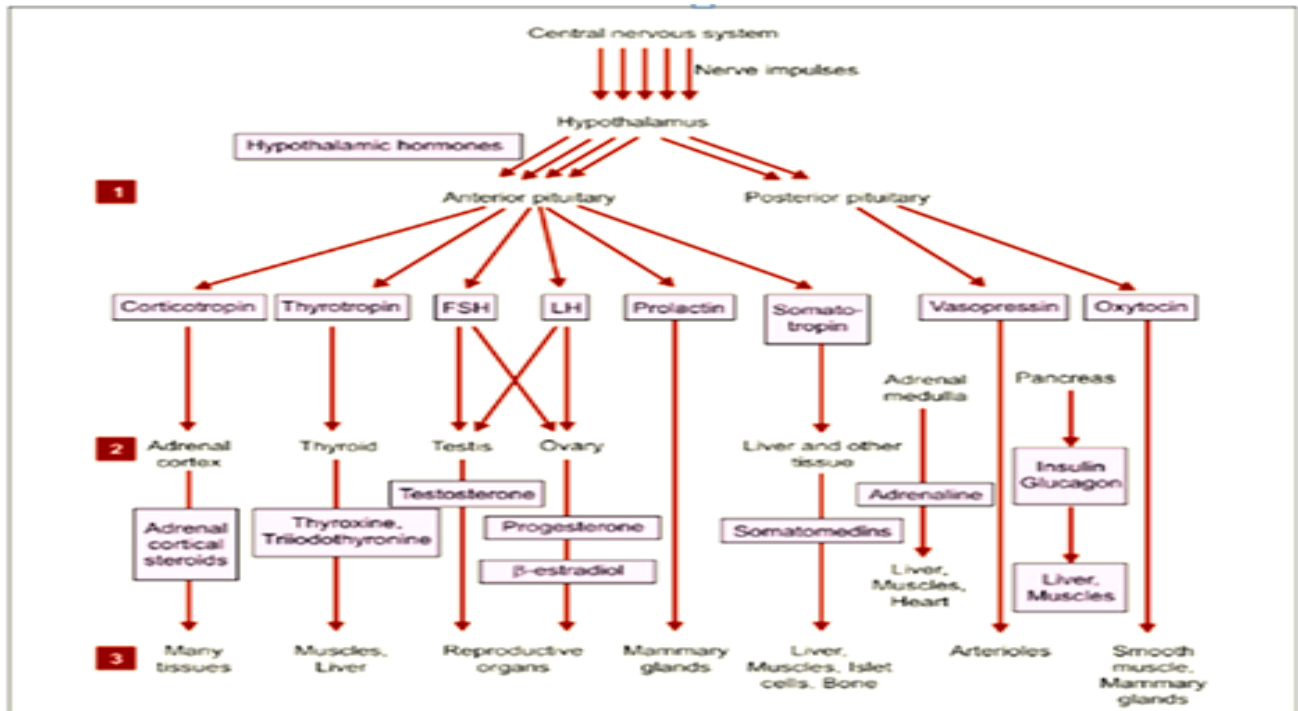
Hormone secretion

- 1- Endocrine hormones are secreted directly into the bloodstream.
- 2- Exocrine hormones are secreted directly into a duct.

Cascade System of hormone

For many hormonal systems in higher animals, the signal pathway originates with the brain and culminates with the ultimate target cell. The signal may be transmitted as an electrical pulse (action potential) or as a chemical signal or both. In many cases, but not all, such signals forwarded to the limbic system and subsequently to the hypothalamus, the pituitary or other gland that secretes the final hormone.

This hormone then affects various target cells to a degree that frequently proportional to the number of cognate receptors



Classification of hormone

Hormones can be classified according to:

- Chemical structure
- Mechanism of hormone action.

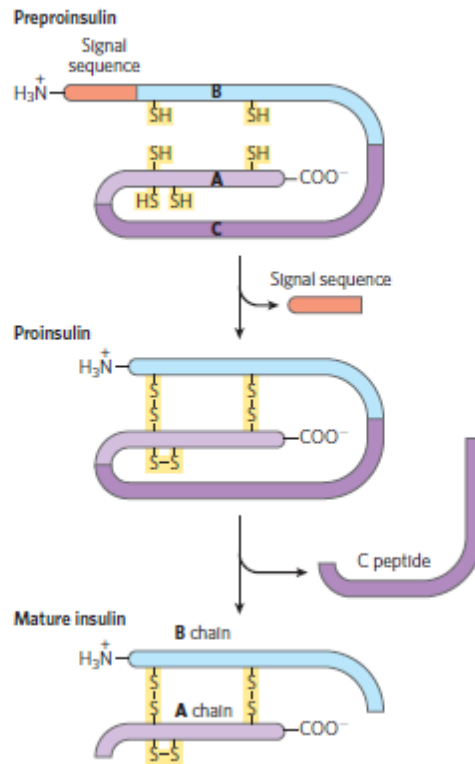
Classification Based on Chemical Structure

Hormones are usually classified into three main groups on the basis of their chemical structure as follows:

1. Peptide or protein hormones.
2. Amine hormones or amino acid derivatives.
3. Steroid hormones.

1-Peptide or Protein Hormones

Most hormones fall into this class. These are water soluble and may have 3 to over 200 amino acid residues, e.g. hormones of the hypothalamus and pituitary. As well as insulin and glucagon of the pancreas. These hormones are synthesized on ribosomes in the form of longer precursor proteins (prohormones), then packaged into secretory vesicles and proteolytically cleaved to form the active peptides. Insulin is a small protein (*Mr* 5,800) with two polypeptide chains, A and B, joined by two disulfide bonds. It is synthesized in the pancreas as an inactive single-chain precursor, proinsulin with an amino-terminal “signal sequence” that directs its passage into secretory vesicles. Proteolytic removal of the signal sequence and formation of three disulfide bonds produces proinsulin, which is stored in secretory granules (membrane vesicles filled with protein synthesized in the endoplasmic reticulum) in pancreatic β cells. When blood glucose is elevated sufficiently to trigger insulin secretion proinsulin is converted to active insulin by specific proteases, which cleave two peptide bonds to form the mature insulin molecule and C peptide, which are released into the blood by exocytosis. as shown in the Figure:



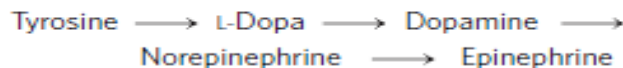
2- Amino Acid Derivatives

These are small, water soluble compounds containing amino groups. For example:

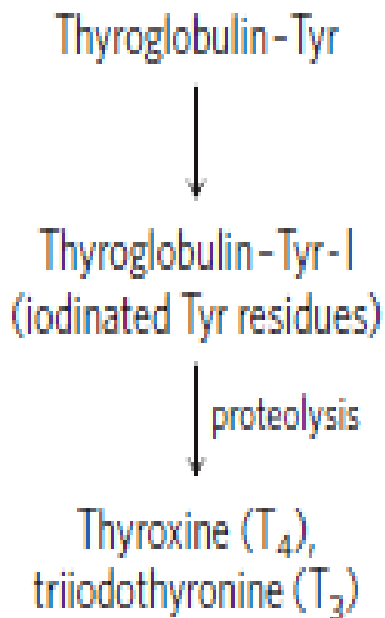
- Adrenaline of the adrenal medulla
- Thyroid hormones.

Catecholamine Hormones The water-soluble compounds epinephrine (adrenaline) and norepinephrine (noradrenaline) are catecholamines, named for the structurally related compound catechol. They are synthesized from tyrosine. Catecholamines produced in the brain and in other neural tissues function as neurotransmitters, but epinephrine and norepinephrine are also hormones, synthesized and secreted by the adrenal glands. Like the peptide hormones, catecholamines are highly concentrated in secretory vesicles and released by exocytosis, and they act through surface

receptors to generate intracellular second messengers. They mediate a wide variety of physiological responses to acute stress .



The thyroid hormones T₄ (thyroxine) and T₃ (triiodothyronine) are synthesized from the precursor protein thyroglobulin (*Mr* 660,000). Up to 20 Tyr residues in thyroglobulin are enzymatically iodinated in the thyroid gland, then two iodotyrosine residues condense to form the precursor to thyroxine. When needed, thyroxine is released by proteolysis. Condensation of monoiodotyrosine with diiodothyronine produces T₃, which is also an active hormone released by proteolysis.

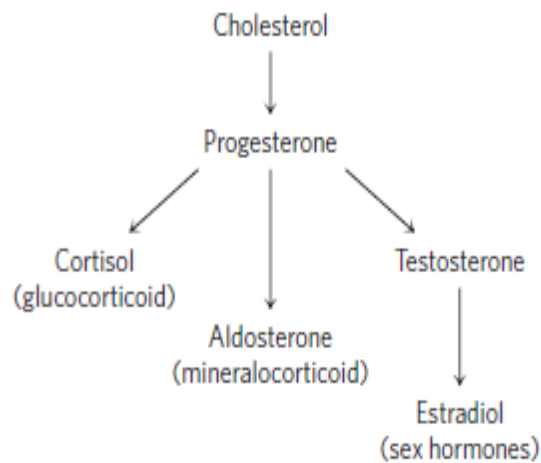


3-Steroid Hormones

These are fat soluble (lipophilic) and all are derivatives of cholesterol. For example:

- Adrenal cortical hormones
- Androgen (male sex hormones)
- Estrogens (female sex hormones)

Steroid Hormones The steroid hormones (adrenocortical hormones and sex hormones) are synthesized from cholesterol in several endocrine tissues.



They travel to their target cells through the bloodstream, bound to carrier proteins. More than 50 corticosteroid hormones are produced in the adrenal cortex by reactions that remove the side chain from the D ring of cholesterol and introduce oxygen to form keto and hydroxyl groups. Many of these reactions involve cytochrome P-450 enzymes. The corticosteroids are of two general types, defined by their actions. Glucocorticoids (such as cortisol) primarily affect the metabolism of carbohydrates; mineralocorticoids (such as aldosterone) regulate the concentrations of electrolytes (K^+ , Na^+ , Ca^{2+} , Cl^-) in the blood. Androgens (such as testosterone) and estrogens are synthesized in the testes and ovaries. They

affect sexual development, sexual behavior, and a variety of other reproductive and nonreproductive functions.

Their synthesis also involves cytochrome P-450 enzymes that cleave the side chain of cholesterol and introduce oxygen atoms. All steroid hormones act through nuclear receptors to change the level of expression of specific genes . They can also have more rapid effects, mediated by receptors in the plasma membrane.

In this Table as shown of classes of Hormones:

Type	Example	Synthetic path	Mode of action
Peptide	Insulin, glucagon	Proteolytic processing of prohormone	Plasma membrane receptors; second messengers
Catecholamine	Epinephrine	From tyrosine	
Eicosanoid	PGE ₁	From arachidonate (20:4 fatty acid)	
Steroid	Testosterone	From cholesterol	Nuclear receptors; transcriptional regulation
Vitamin D	1 α ,25-Dihydroxyvitamin D ₃	From cholesterol	
Retinoid	Retinoic acid	From vitamin A	
Thyroid	Triiodothyronine (T ₃)	From Tyr in thyroglobulin	Cytosolic receptor (guanylyl cyclase) and second messenger (cGMP)
Nitric oxide	Nitric oxide	From arginine + O ₂	