

HUMAN ANATOMY AND PHYSIOLOGY-II

UNIT-IV

Endocrine system

Classification of hormones, mechanism of hormone action



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Endocrine System

- The endocrine system interacts with the nervous system to coordinate and integrate body activities by means of **hormones** .
- Endocrine tissues and organs secrete hormone into body fluids (mainly blood and lymph) **directly** using diffusion.
- Exocrine tissues, such as salivary glands, and sebaceous glands, secrete chemical substances through ducts into an open space.

- Hormones are secreted from the glands of the endocrine system (Which namely endocrine and exocrine glands).
- Endocrine glands are the glands which synthesize and release the classical hormones into the blood. It is also called ductless glands because the hormones secreted by them are released directly into blood without any duct.
- Exocrine glands which release their secretions through ducts.
- Hormones can be grouped into three main types:
 - **amines**, these are simple molecules
 - **proteins and peptides** which are made from chains of amino acids
 - **steroids** which are derived from cholesterol.

Five major functions of hormones

- a) Regulate metabolic processes (e.g. thyroid hormones).
- b) Control the rate of chemical reactions (e.g. growth hormone).
- c) Aid in the transport of substances across the cell membrane of target cells (e.g. insulin and glucagon).
- d) Regulate water and electrolyte balances (e.g. antidiurectic hormone, calcitonin, and aldosterone).
- e) Play a vital role in reproduction, growth and development (e.g. estrogens , progesterone, and testosterone).

TABLE 64.1: Hormones secreted by major endocrine glands

Anterior pituitary	<ol style="list-style-type: none"> 1. Growth hormone (GH) 2. Thyroid-stimulating hormone (TSH) 3. Adrenocorticotrophic hormone (ACTH) 4. Follicle stimulating hormone (FSH) 5. Luteinizing hormone (LH) 6. Prolactin 	Adrenal cortex	<i>Mineralocorticoids</i> <ol style="list-style-type: none"> 1. Aldosterone 2. 11-deoxycorticosterone
Posterior pituitary	<ol style="list-style-type: none"> 1. Antidiuretic hormone (ADH) 2. Oxytocin 		<i>Glucocorticoids</i> <ol style="list-style-type: none"> 1. Cortisol 2. Corticosterone
Thyroid gland	<ol style="list-style-type: none"> 1. Thyroxine (T₄) 2. Triiodothyronine (T₃) 3. Calcitonin 		<i>Sex hormones</i> <ol style="list-style-type: none"> 1. Androgens 2. Estrogen 3. Progesterone
Parathyroid gland	Parathormone	Adrenal medulla	<ol style="list-style-type: none"> 1. Catecholamines 2. Adrenaline (Epinephrine) 3. Noradrenaline (Norepinephrine) 4. Dopamine
Pancreas – Islets of Langerhans	<ol style="list-style-type: none"> 1. Insulin 2. Glucagon 3. Somatostatin 4. Pancreatic polypeptide 		

TABLE 64.2: Hormones secreted by gonads

Testis	<ol style="list-style-type: none"> 1. Testosterone 2. Dihydrotestosterone 3. Androstenedion
Ovary	<ol style="list-style-type: none"> 1. Estrogen 2. Progesterone

TABLE 64.3: Hormones secreted by other organs

Pineal gland	Melatonin
Thymus	1. Thymosin 2. Thymin
Kidney	1. Erythropoietin 2. Thrombopoietin 3. Renin 4. 1,25-dihydroxycholecalciferol (calcitriol) 5. Prostaglandins
Heart	1. Atrial natriuretic peptide 2. Brain natriuretic peptide 3. C-type natriuretic peptide
Placenta	1. Human chorionic gonadotropin (HCG) 2. Human chorionic somatomammotropin 3. Estrogen 4. Progesterone

TABLE 64.4: Local hormones

1. Prostaglandins	7. Serotonin
2. Thromboxanes	8. Histamine
3. Prostacyclin	9. Substance P
4. Leukotrienes	10. Heparin
5. Lipoxins	11. Bradykinin
6. Acetylcholine	12. Gastrointestinal hormones

CLASSIFICATION OF HORMONES:

STEROID HORMONES

Steroid hormones are the hormones synthesized from cholesterol or its derivatives.

Steroid hormones are secreted by adrenal cortex, gonads and placenta.

PROTEIN HORMONES

Protein hormones are large or small peptides. Protein hormones are secreted by pituitary gland, parathyroid glands, pancreas and placenta ('P's).

TYROSINE DERIVATIVES

Two types of hormones, namely thyroid hormones and adrenal medullary hormones

are derived from the amino acid tyrosine.

TABLE 65.1: Classification of hormones depending upon chemical nature

Steroids	Proteins	Derivatives of tyrosine
Aldosterone 11-deoxycorticosterone Cortisol Corticosterone Testosterone Dihydrotestosterone Dehydroepiandrosterone Androstenedione Estrogen Progesterone	Growth hormone (GH) Thyroid-stimulating hormone (TSH) Adrenocorticotrophic hormone (ACTH) Follicle-stimulating hormone (FSH) Luteinizing hormone (LH) Prolactin Antidiuretic hormone (ADH) Oxytocin Parathormone Calcitonin Insulin Glucagon Somatostatin Pancreatic polypeptide Human chorionic gonadotropin (HCG) Human chorionic somatomammotropin.	Thyroxine (T ₄) Triiodothyronine (T ₃) Adrenaline (Epinephrine) Noradrenaline (Norepinephrine) Dopamine.

MECHANISM OF HORMONAL ACTION

- Hormone does not act on the target cell directly. It combines with receptor to form hormone-receptor complex.
- This complex executes the hormonal action by any one of the following mechanisms:
 1. By altering permeability of cell membrane
 2. By activating intracellular enzyme
 3. By acting on genes.

1. BY ALTERING PERMEABILITY OF CELL MEMBRANE

- ✓ Neurotransmitters in synapse or neuromuscular junction act by changing the permeability of postsynaptic membrane.
- ✓ For example, in a neuromuscular junction, when an impulse (action potential) reaches the axon terminal of the motor nerve, acetylcholine is released from the vesicles. Acetylcholine increases the permeability of the postsynaptic membrane for sodium, by opening the ligand-gated sodium channels. So, sodium ions enter the neuromuscular junction from ECF through the channels and cause the development of endplate potential.

2. BY ACTIVATING INTRACELLULAR ENZYME

- ✓ Protein hormones and the catecholamines act by activating the intracellular enzymes.

First Messenger

- ✓ The hormone which acts on a target cell, is called first messenger or chemical mediator. It combines with the receptor and forms hormone-receptor complex.

Second Messenger

- ✓ Hormone-receptor complex activates the enzymes of the cell and causes the formation of another substance called the second messenger or intracellular hormonal mediator.
- ✓ Second messenger produces the effects of the hormone inside the cells. Protein hormones and the catecholamines act through second messenger. Most common second messenger is cyclic AMP .

3. BY ACTING ON GENES

- ✓ Thyroid and steroid hormones execute their function by acting on genes in the target cells.

Sequence of Events during Activation of Genes

- ✓ Hormone enters the interior of cell and binds with receptor in cytoplasm (steroid hormone) or in nucleus (thyroid hormone) and forms hormone receptor complex
- ✓ Hormone-receptor complex moves towards the DNA and binds with DNA
- ✓ This increases transcription of mRNA
- ✓ The mRNA moves out of nucleus and reaches ribosomes and activates them
- ✓ Activated ribosomes produce large quantities of proteins vi. These proteins produce physiological responses in the target cells.

The endocrine system consists of a number of distinct glands and some tissues in other organs. Although the hypothalamus is classified as a part of the brain and not as an endocrine gland it controls the pituitary gland and has an indirect effect on many others.

The endocrine glands are:

- 1 pituitary gland
 - 1 thyroid gland
 - 4 parathyroid glands
 - 2 adrenal (suprarenal) glands
 - the pancreatic islets (islets of Langerhans)
 - 1 pineal gland or body
 - 1 thymus gland
 - 2 ovaries in the female
 - 2 testes in the male.
- When a hormone arrives at its target cell, it binds to a specific area, the receptor, where it acts as a switch influencing chemical or metabolic reactions inside the cell.
- The receptors for water-soluble hormones are situated on the cell membrane and those for lipid-soluble hormones are inside the cell.