MECHANISM AND MODE OF HORMONE ACTION.

PRESENTED BY MBUNKUR GLORY NKOSI.

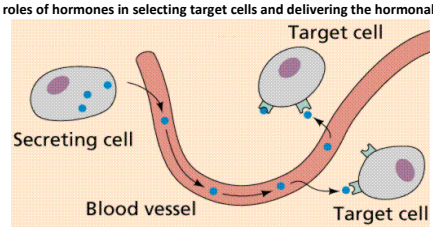
OUTLINE.

- **Introduction**
- **Some definitions**
- **Hormone secretion, transport, and clearance from the blood.**
- **Feedback control of hormone secretion.**
- **Mechanisms of action of hormones.**
  - ➢ **Nonsteroid hormones**
  - ➢ **Steroids**
- **Effects of hormones**

Some definitions

- **The endocrine system: is a collection of glands that secrete chemical messages called hormones. These signals are passed through the blood to arrive at a target organ, which has cells possessing the appropriate receptor.**

The roles of hormones in selecting target cells and delivering the hormonal message



- **Hormones:** One of the chemical messengers produced by endocrine glands, whose secretions are liberated directly into the bloodstream and transported to a distant part or parts of the body, where they exert a specific effect for the benefit of the body as a whole.

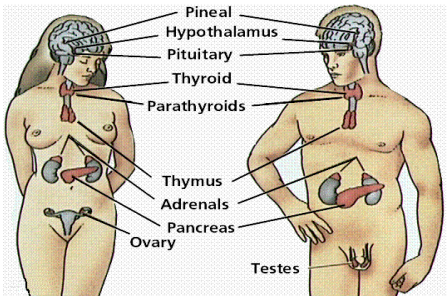
Receptor:

- A hormone receptor is a receptor protein on the surface of a cell or in its interior that binds to a specific hormone. The hormone causes many changes to take place in the cell.
- Protein found on some cells to which hormone molecules will attach.
- A specific molecule of a cell that recognizes and binds with specific hormone molecules

Properties of receptors.

- **Hormone specificity**. A hormone affects only cells that possess receptors specific to that particular hormone, e.g. Adrenocorticotropic hormone (ACTH) and Luteinizing hormone (LH) both increase the secretion of steroid hormones. However, ACTH does so only in the adrenal cortex and LH only in gonadal tissues
- **Hormone activity.** Under normal situations, receptors are not saturated, i.e., extra receptors exist.

The endocrine system in females and males



7

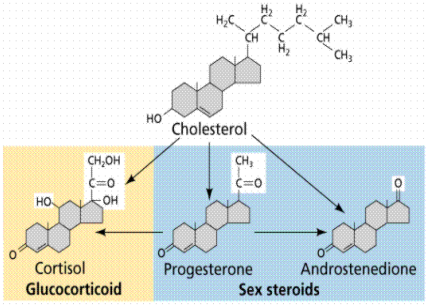
CHEMICAL CLASSES OF HORMONES

Hormones are grouped into three classes based on their structure:

- **Steroids**; Steroid hormones are derived from cholesterol by a biochemical reaction series.
- **Peptides**; Peptide hormones and protein hormones consist of three (thyrotropin-releasing hormone) to more than 200 (follicle-stimulating hormone) amino acid residues
- **Amines**; Amines are derived from the amino acid tyrosine and are secreted from the thyroid and the adrenal medulla

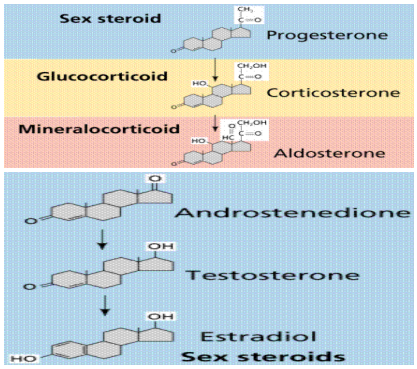
8

Synthesis of steroid hormones.



9

Structure of some steroid hormones and their pathways of formation.



10

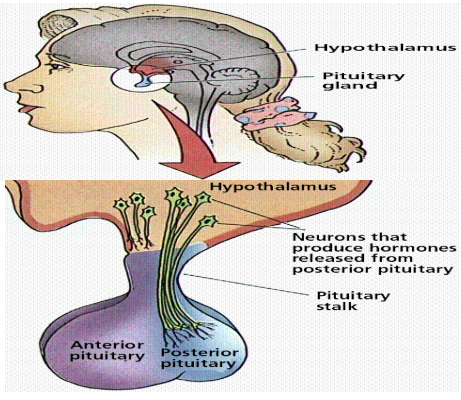
Synthesis of nonsteroid hormones.

•Peptide hormones are synthesized as precursor molecules and processed by the endoplasmic reticulum and Golgi where they are stored in secretory granules. When needed, the granules are dumped into the bloodstream.

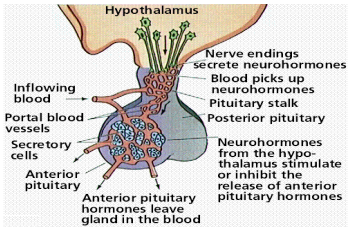
•Amines are derived from the amino acid tyrosine and are secreted from the thyroid and the adrenal medulla. Solubility of the various hormone classes varies. Amine hormones (notably epinephrine) are stored as granules in the cytoplasm until needed.

11

The location and roles of the hypothalamus and pituitary glands.

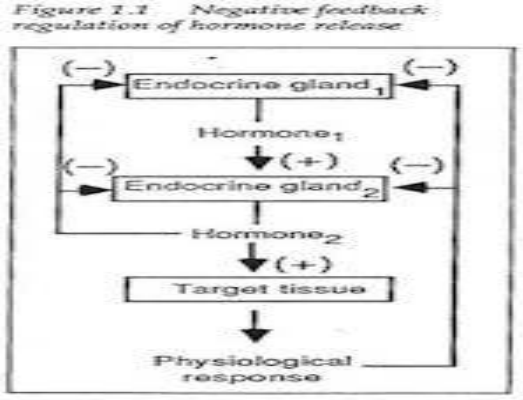


12

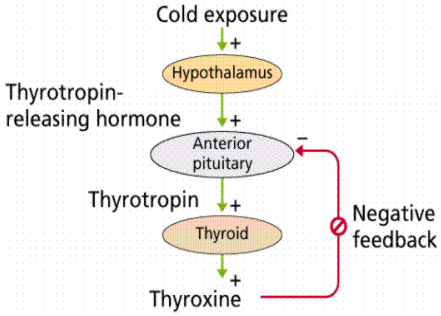


Anterior pituitary	Posterior pituitary
Hormones produced and released:	**Hormones released:**
Thyrotropin Adrenocorticotropin Luteinizing hormone Follicle-stimulating hormone	Oxytocin Vasopressin
Growth hormone Prolactin Melanocyte-stimulating hormone Endorphins Enkephalins	

Regulation of hormone secretion



Example Negative feedback in the thyroxine release reflex



'Clearance' of hormones from the blood.

❖ Two factors can increase or decrease the concentration of a hormone in blood. i.e.

- the rate of hormone secretion into blood
- the rate of removal of the hormone from the blood, which is called metabolic clearance rate.

- Metabolic clearance rate = $\frac{\text{Rate of disappearance of hormone from the plasma}}{\text{concentration of hormone in each milliliter of plasma}}$.

Mechanisms of Hormone Action

-There are two mechanisms of hormone action on all target cells.

A) Nonsteroid Hormones

Nonsteroid hormones (water soluble) do not enter the cell but bind to plasma membrane receptors, generating a chemical signal (second messenger) inside the target cell. Second messengers (cAMP) activate other intracellular chemicals to produce the target cell response.

Proteins, peptides, and modified amino acids

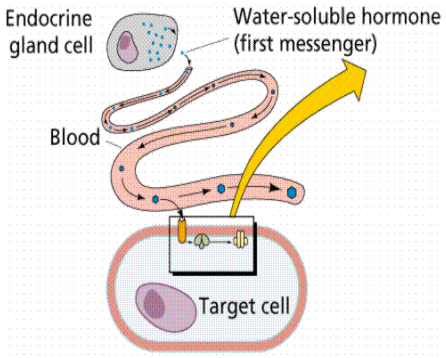
- These hydrophilic (and mostly large) hormone molecules bind to receptors on the surface of "target" cells; that is, cells able to respond to the presence of the hormone.
- Binding of the hormone to its receptor initiates a sequence of intracellular signals that may

-alter the behavior of the cell (such as by opening or closing membrane channels) or

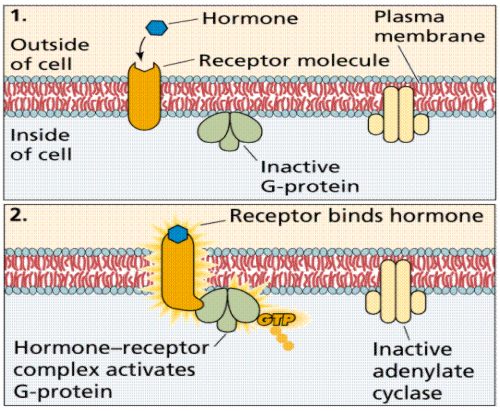
-Stimulate (or repress) gene expression in the nucleus by turning on (or off) the promoters and enhancers of the genes.

The action of nonsteroid hormones.

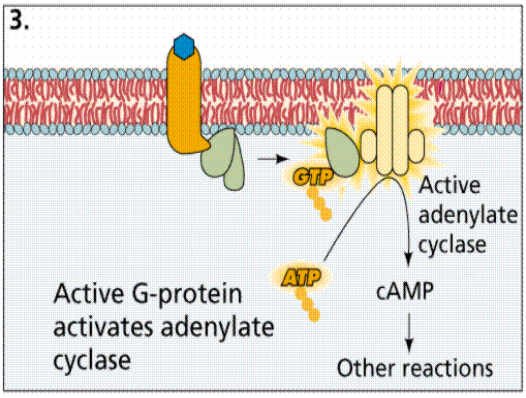
a)



19

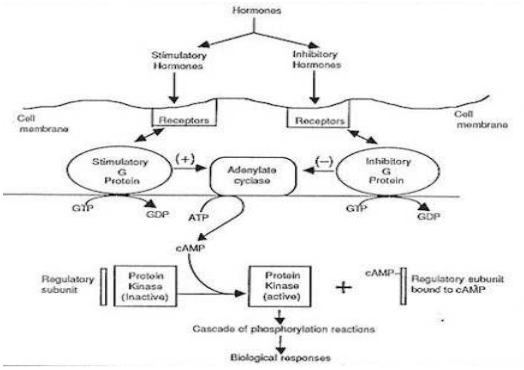


20



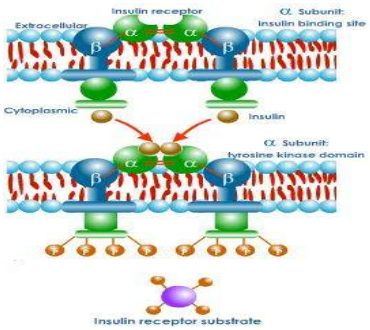
21

Detail of cAMP mechanism



22

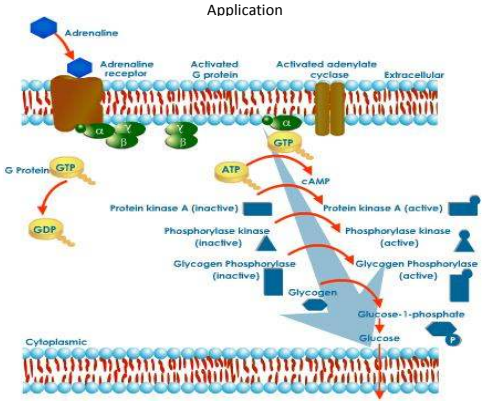
Specific example of mechanism of nonsteroid hormone action.



Insulin Hormone Binding to its Receptor

23

Mode of Hormone Action through the Extracellular Receptor and its Application



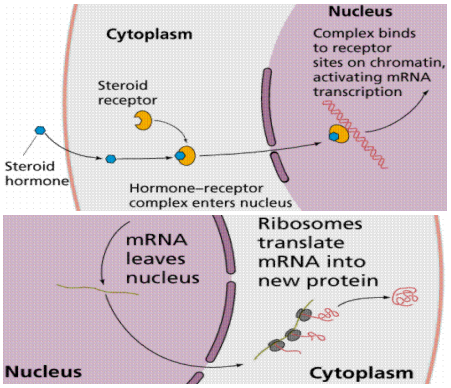
24

B) Steroid Hormones

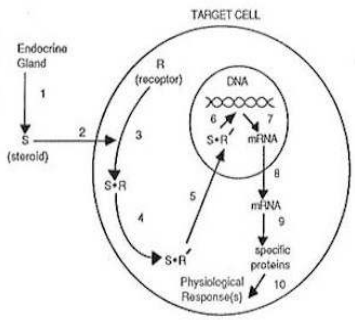
- The second mechanism involves steroid hormones, which pass through the plasma membrane and act in a two step process. Steroid hormones bind, once inside the cell, to the nuclear membrane receptors, producing an activated hormone-receptor complex. The activated hormone-receptor complex binds to DNA and activates specific genes, increasing production of proteins.
- The receptors to which steroid hormones bind are ligand-activated proteins that regulate transcription of selected genes.

•Unlike peptide hormone receptors, that span the plasma membrane and bind ligand outside the cell, steroid hormone receptors are found in the cytosol and the nucleus.
•When these receptors bind ligand they undergo a conformational change that renders them activated to recognize and bind to specific nucleotide sequences.
•Binding of glucocorticoid leads to translocation of the ligand-receptor complex from the cytosol to the nucleus.

The mechanism of steroid hormones action.



Detail of mRNA mechanism



pathophysiology

- Diabetes: results from inadequate levels of insulin.
- Disruption of gastric and renal secretion:
  - Cortisol stimulates gastric acid secretion.
  - Cortisol's only direct effect on the hydrogen ion excretion of the kidneys is to stimulate excretion of ammonium ion by inactivation of renal glutaminase enzyme.Net chloride secretion in the intestines is inversely decreased by cortisol in vitro (methylprednisolone).
- Metabolic problems.

- THANKS FOR LISTENING