

Endocrinology General Principles

Introduction

Classification

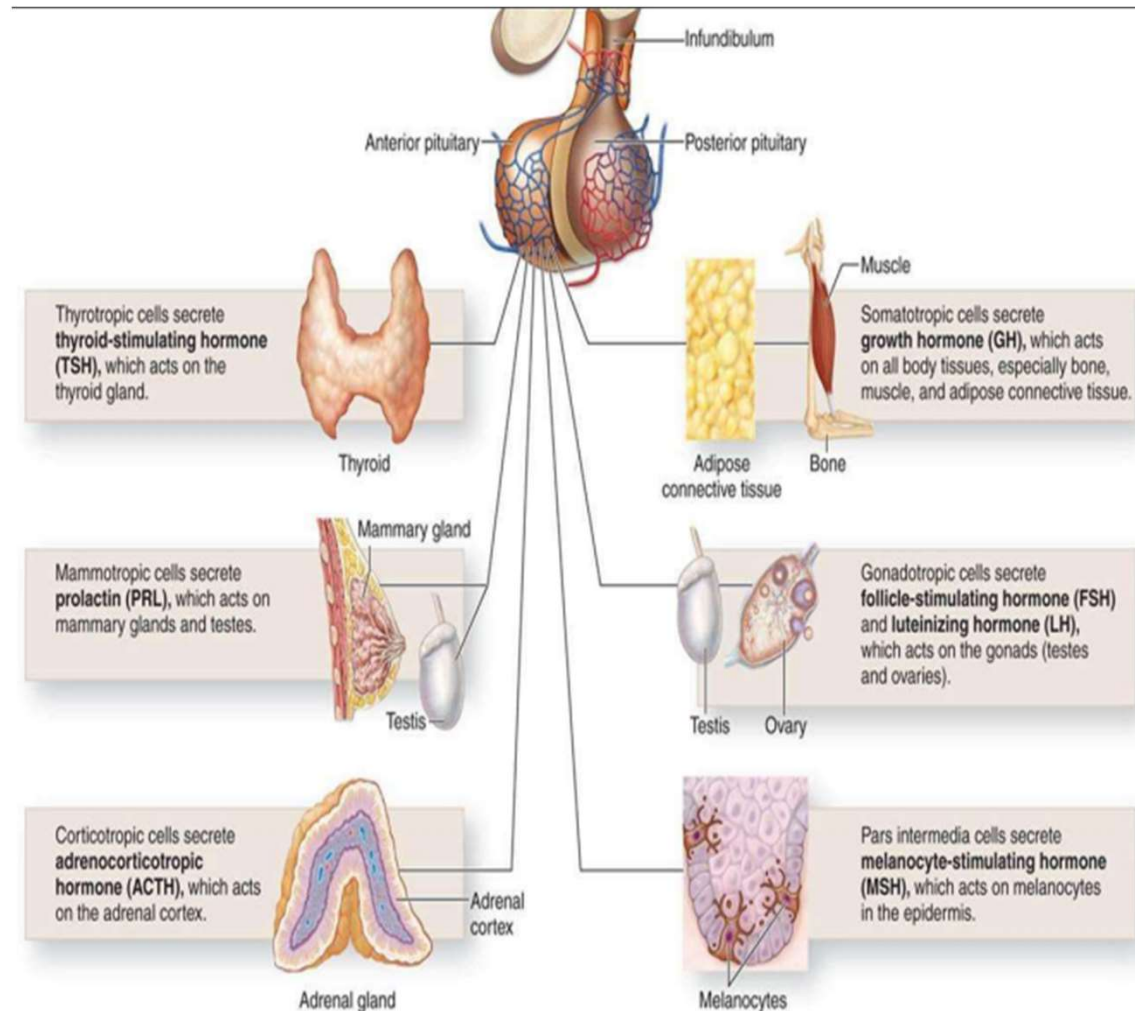
Mechanism of action

Feedback control

Lecture – 01 (physiology – II)

Endocrinology

- The science concerned with the structure and functions of the endocrine glands and the diagnosis and treatment of disorders of the endocrine system is called endocrinology.



Glands and their types:

- **Gland:** a specialized cell, group of cells, or organ of endothelial origin that selectively removes materials from the blood, concentrates or alters them, and secretes them for further use in the body or for elimination from the body
- The body contains two kinds of glands: endocrine and exocrine
- **Exocrine Glands:** (sudoriferous, sebaceous, and digestive) secrete their products through ducts into body cavities or onto body surfaces.
- **Endocrine Glands:** Secrete their products (hormones) into the extracellular spaces around the secretory cells, rather than into ducts (no ducts). The secretion then diffuses into capillaries and is carried away by the blood.

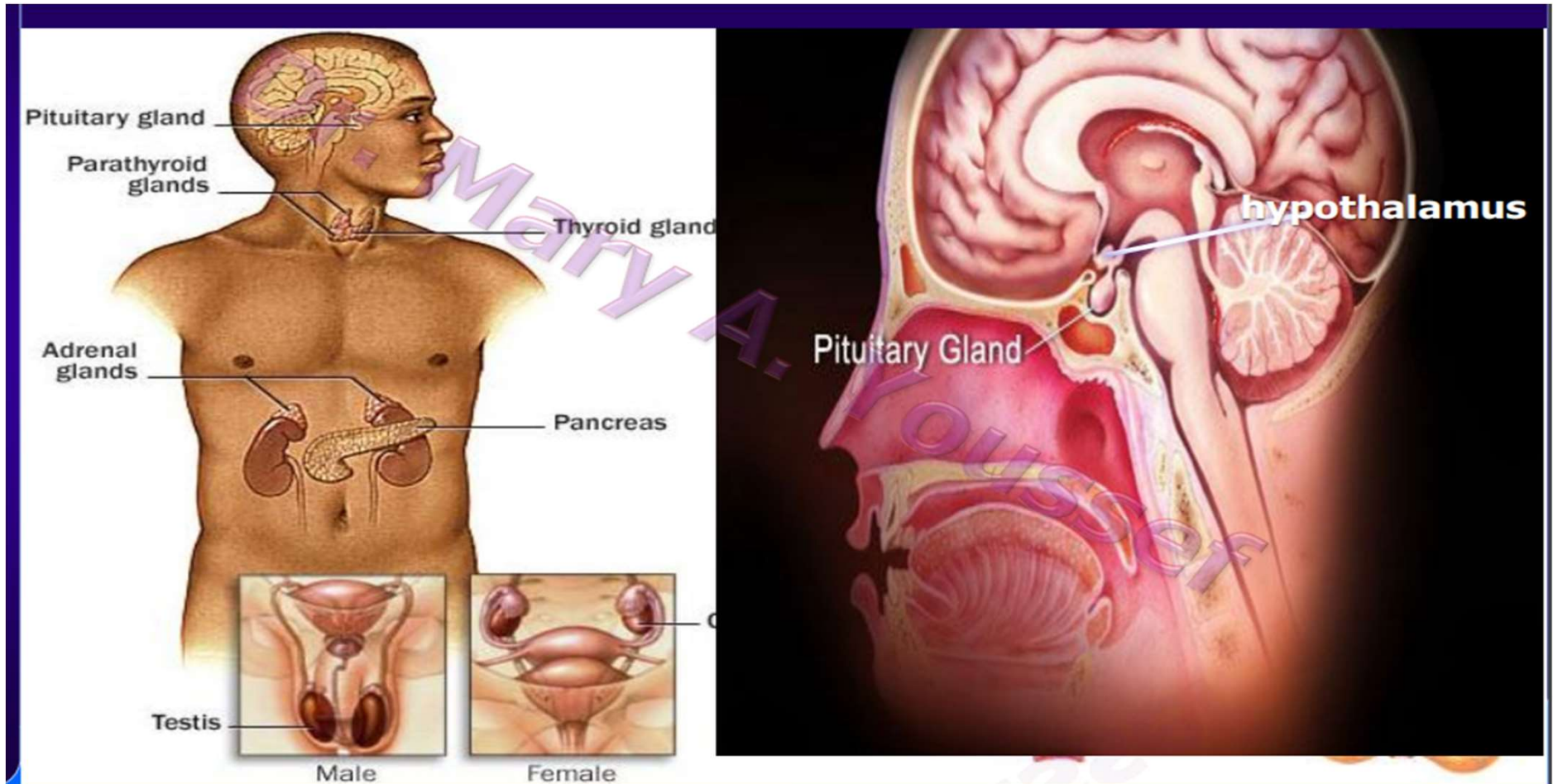
The endocrine system

- **Definition:**
- The endocrine system is a chemical messenger system comprising feedback loops of hormones released by internal glands of an organism directly into the circulatory system, regulating distant target organs
- The endocrine system is the collection of glands that produce hormones that regulate metabolism, growth and development, tissue function
- The word endocrine derives from the Greek words "endo," meaning within, and "crinis," meaning to secrete
- The endocrine system is made up of the pituitary gland, thyroid gland, parathyroid glands, adrenal glands, pancreas, ovaries (in females) and testicles (in males).
- Endocrine system uses hormones as messenger

Functions of the Endocrine System

- Controls the processes involved in movement and physiological equilibrium
- Includes all tissues or glands that secrete hormones into the blood
- Secretion of most hormones is regulated by a negative feedback system
- The number of receptors for a specific hormone can be altered to meet the body's demand

Endocrine system





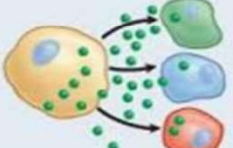
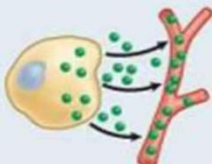
Hormones

- Hormaein-- Greek word means “to execute or to arouse”.
- Def:- Secretary product of ductless glands which are released in catalytic amounts into blood stream & transported to specific target cells where they elicit physiologic, morphologic & biochemical responses.
- Hormones are chemical signals that are secreted into the circulatory system and communicate regulatory messages within the body
- Hormones reach all parts of the body, but only target cells are equipped to respond
- Hormones convey information via the bloodstream to target cells throughout the body

TYPES OF HORMONES

- **Functional classification**
- **ENDOCRINE HORMONES** – Travel through the blood to act at a site distant from the secreting cell or gland
- **PARACRINE HORMONES** – Act on cells near the secreting cell
- **AUTOCRINE HORMONES** – Act on the secreting cell
- **NEUROCRINE HORMONES** – Secreted by neural cells
 - neurotransmitters
 - neurohormones

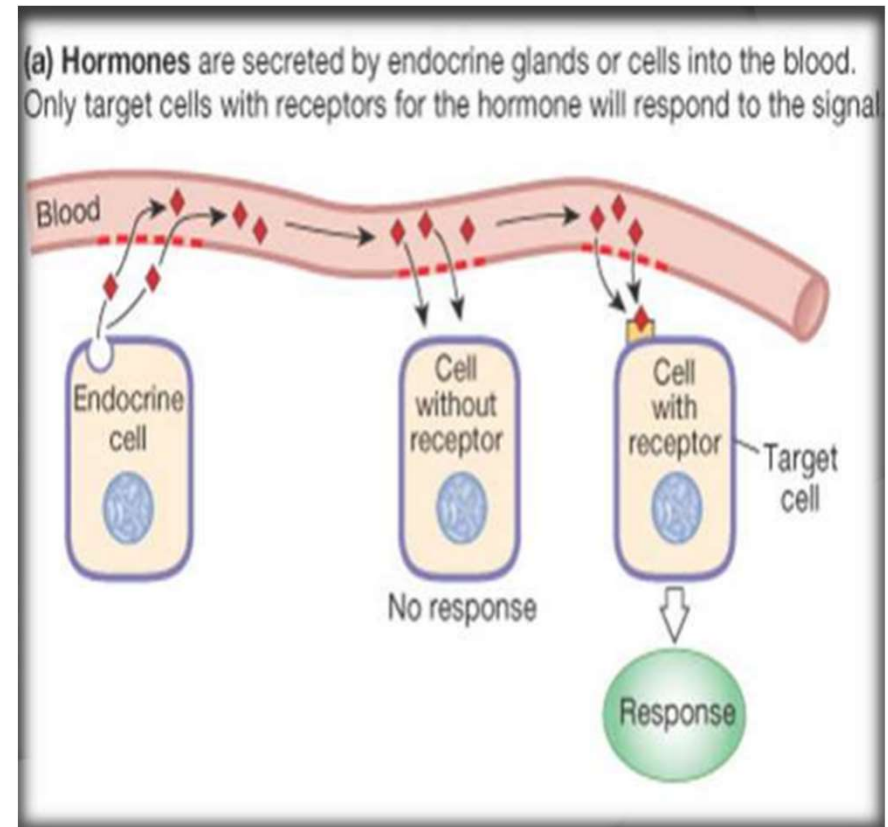
Table 37-1 How Cells Communicate

Communication	Chemical Messengers	Mechanism of Transmission	Examples
Direct 	Ions, small molecules	Direct movement through gap junctions linking the cytoplasm of adjacent cells	Ions flowing between cardiac muscle cells
Synaptic 	Neurotransmitters	Diffusion from a neuron across a narrow space (synaptic cleft) to a cell bearing the appropriate receptors	Acetylcholine
Paracrine 	Local hormones	Diffusion through extracellular fluid to nearby cells bearing the appropriate receptors	Prostaglandins
Endocrine 	Hormones	Carried in the bloodstream to near or distant cells bearing the appropriate receptors	Insulin

Four methods of cell-to-cell communication are found in the human body, ranging from direct to remote communication.

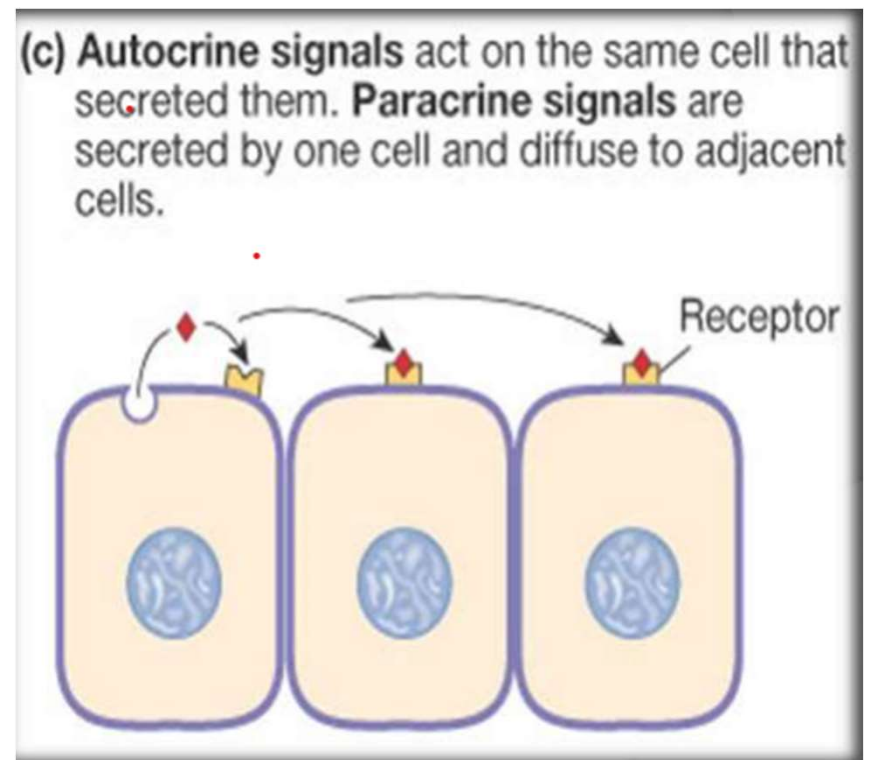
Endocrine Hormones

- Long Distance Communication: Signal Chemicals Made in endocrine cells Transported via blood Receptors on target cells



Paracrine and Autocrine Hormones

- Local communication Signal chemicals diffuse to target
- Example: Cytokines
 - Autocrine—receptor on same cell
 - Paracrine—neighboring cells



Classification According to their chemical nature

1. Protein and polypeptide.

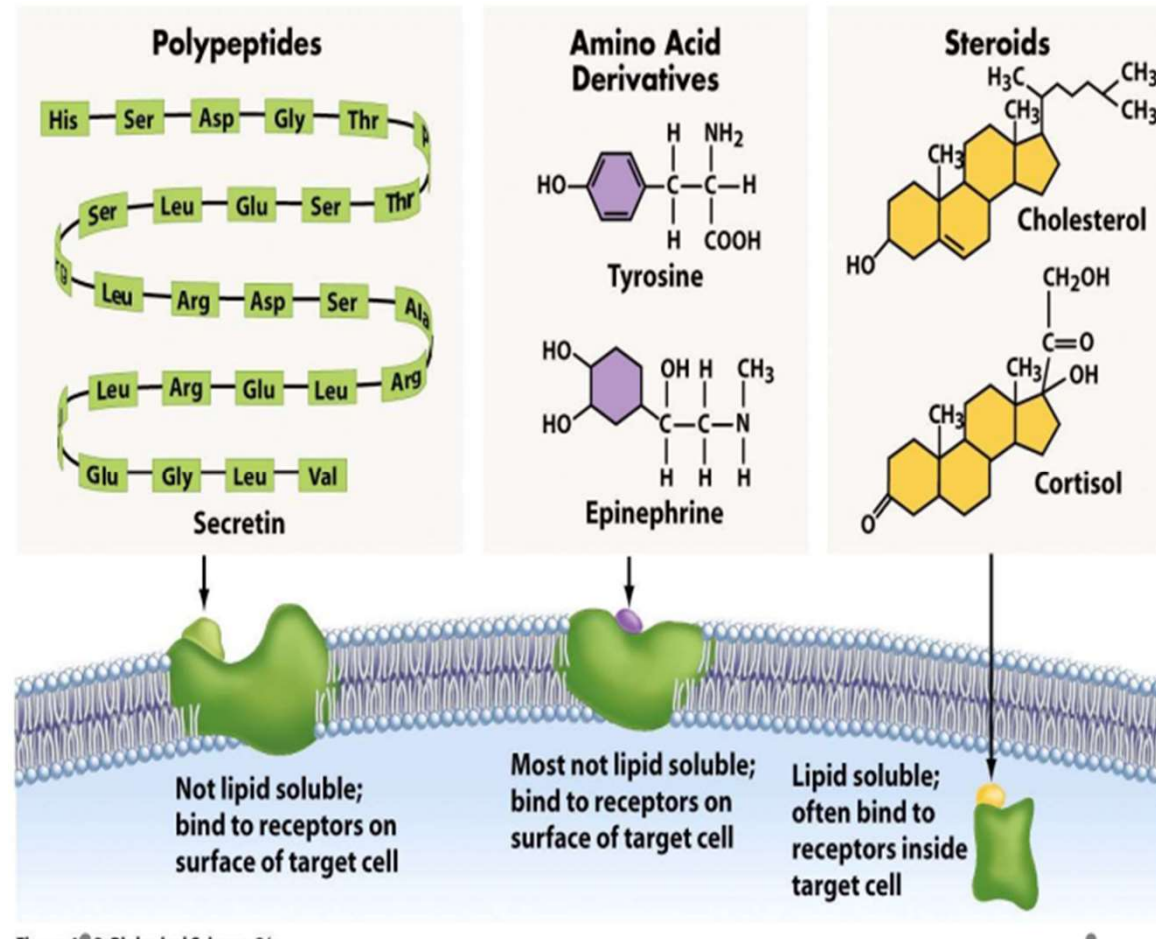
Hypothalamic, pituitary, pancreatic & parathyroid Hormones.

2. Steroid.

Adrenocortical and gonadal Hormones.

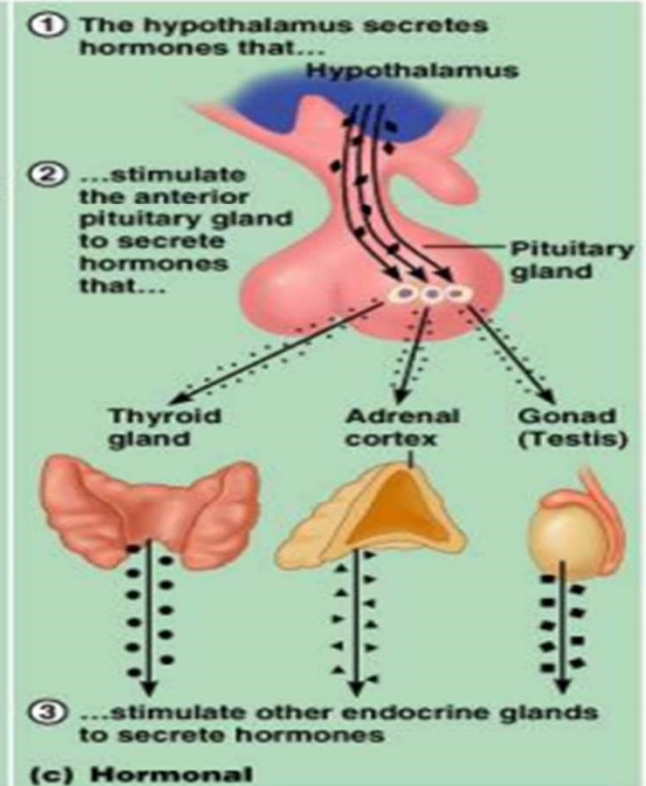
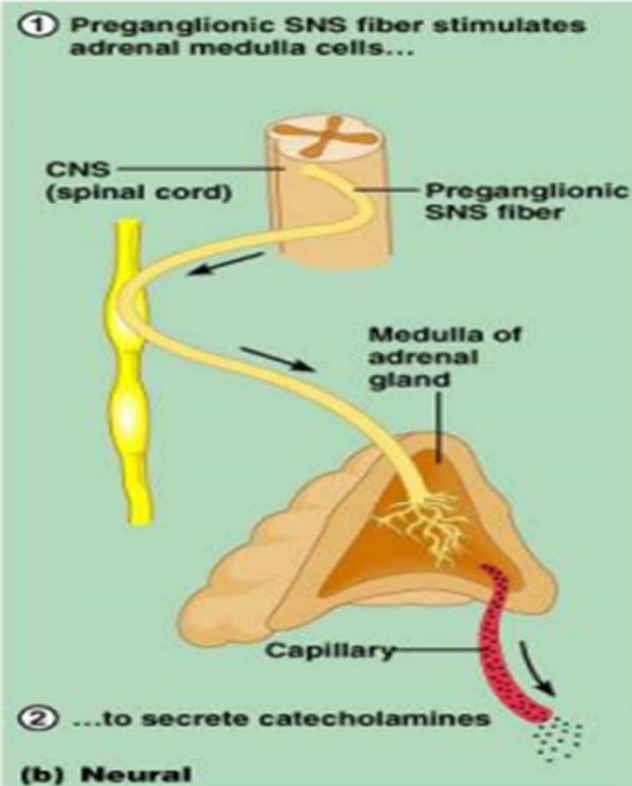
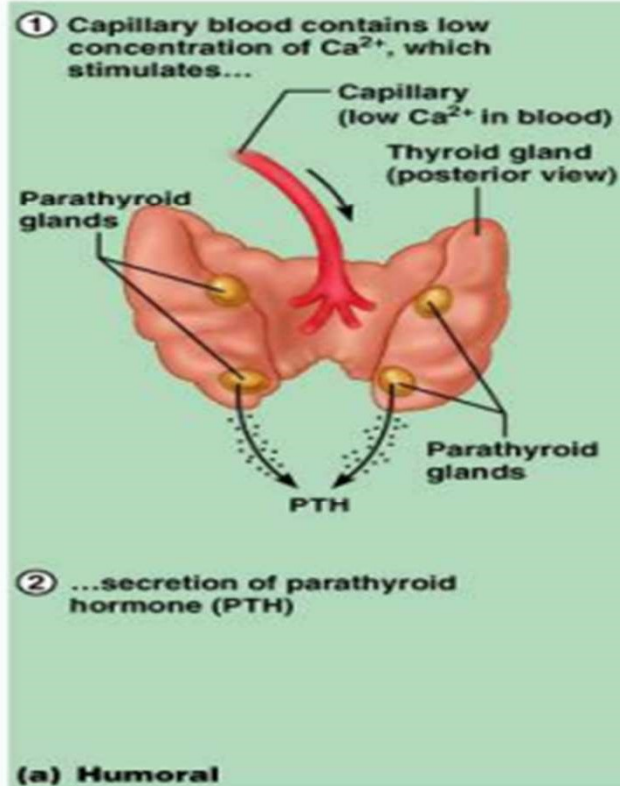
3. Hormones derived from a.a.

Thyroid & adrenal medullary hormones.



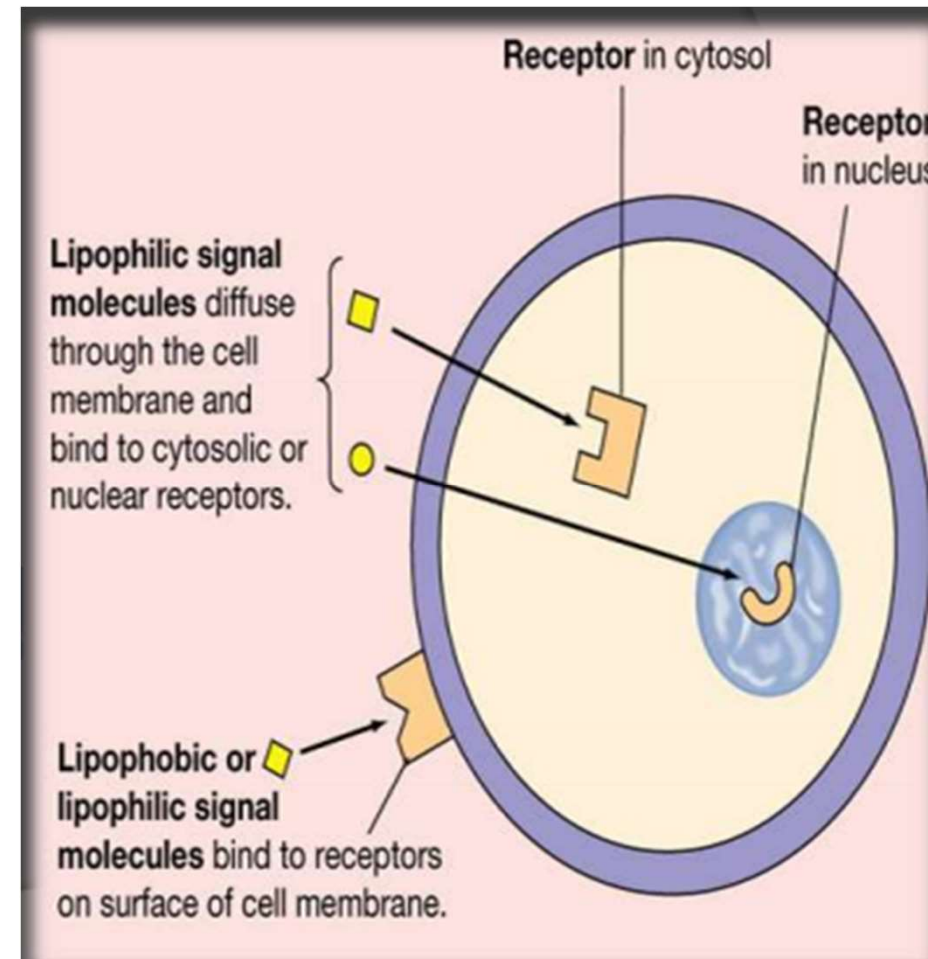
Mechanisms of hormone release

- (a) Humoral:** in response to changing levels of ions or nutrients in the blood
- (b) Neural:** stimulation by nerves
- (c) Hormonal:** stimulation received from other hormones



Hormone Mechanism of Actions

- “Lock and Key” approach:
describes the interaction between the **hormone** and its **specific receptor**.
- Receptors for nonsteroid hormones are located on the cell membrane
- Receptors for steroid hormones are found in the cell’s cytoplasm or in its nucleus



HORMONES RECEPTORS.

Characteristics:

- Specificity .
- Location: Internal External .
- Regulation in the Number of Receptors:
- Down-regulation: is the decrease of hormone receptors which decreases the sensitivity to that hormone
- Up-regulation: is the increase in the number of receptors which causes the cell to be more sensitive to a particular hormone

MECHANISM OF ACTION OF HORMONES

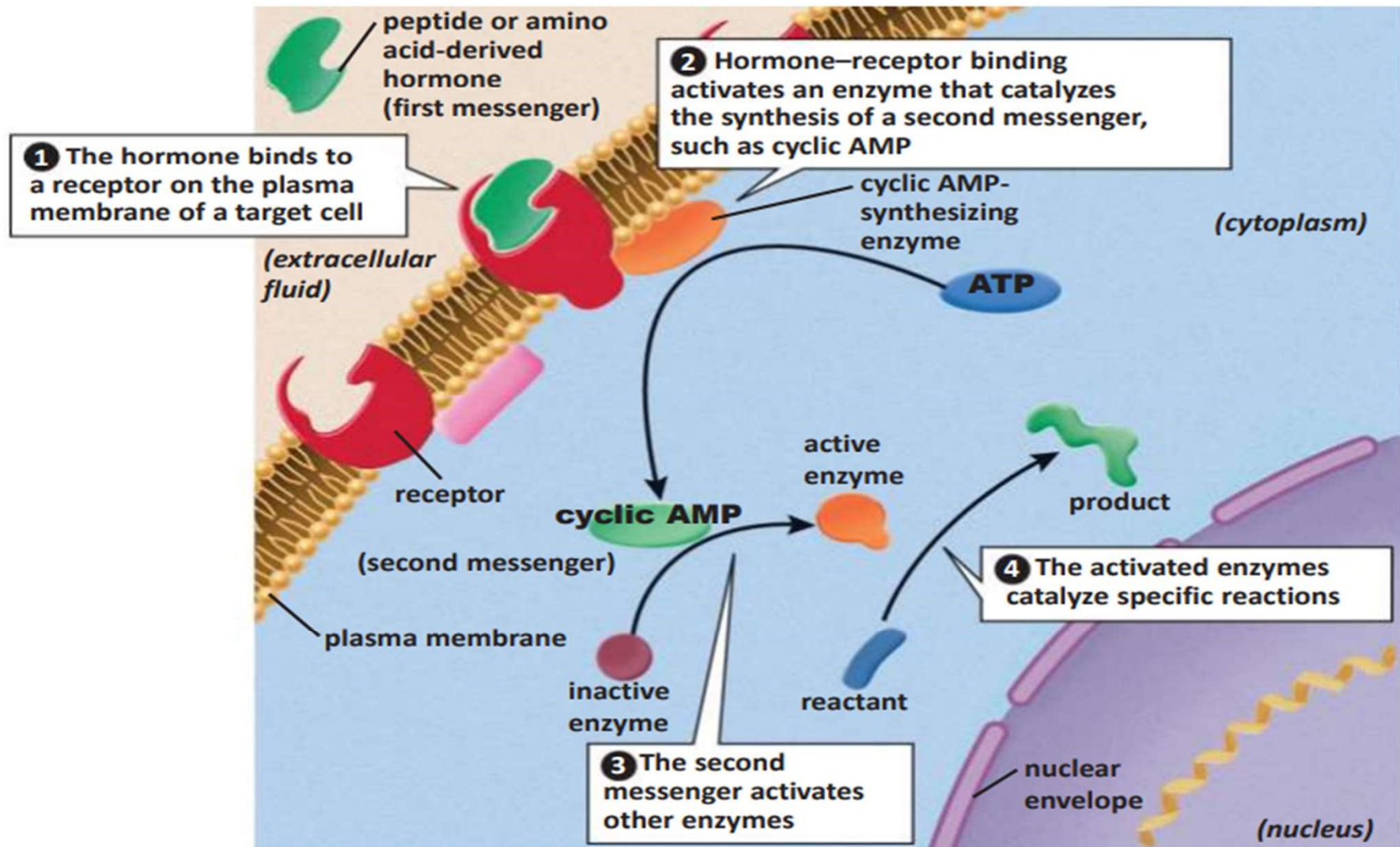
- Through change in membrane permeability.
- Through effect on gene expression.
- Through second messengers.
- Through tyrosine kinase activation

THROUGH CHANGE IN MEMBRANE PERMEABILITY.

- Hormones bind with external receptors.
- Conformational change in protein of receptors.
- Opening of Na, K, Ca channel leads to Movement of ions.
- Binding of a hormone to its receptor initiates a signal transduction pathway leading to responses in the cytoplasm or a change in gene expression • The same hormone may have different effects on target cells that have – Different receptors for the hormone – Different signal transduction pathways – Different proteins for carrying out the response

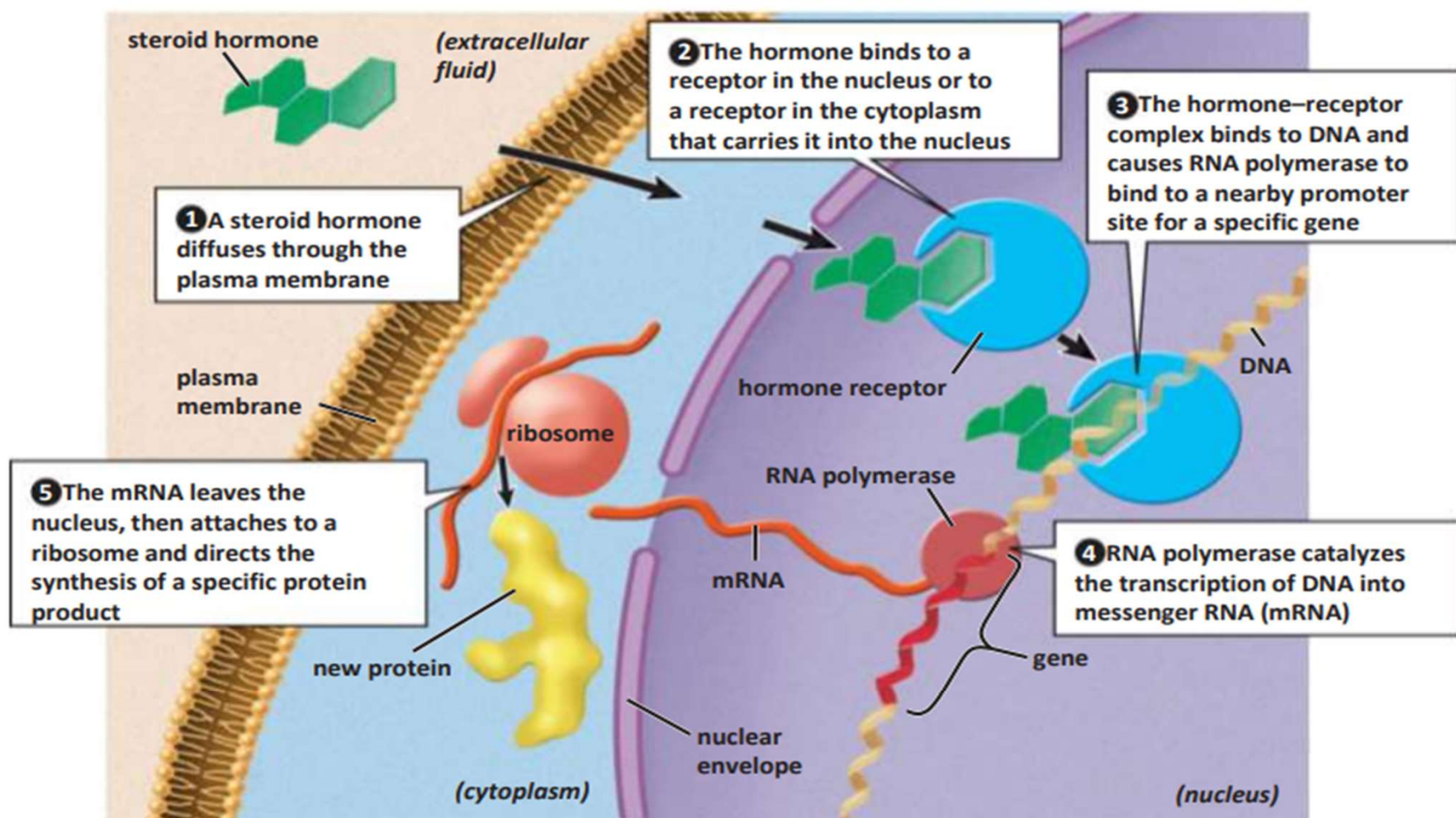
Second Messengers (Non steroid/ Peptide Hormones)

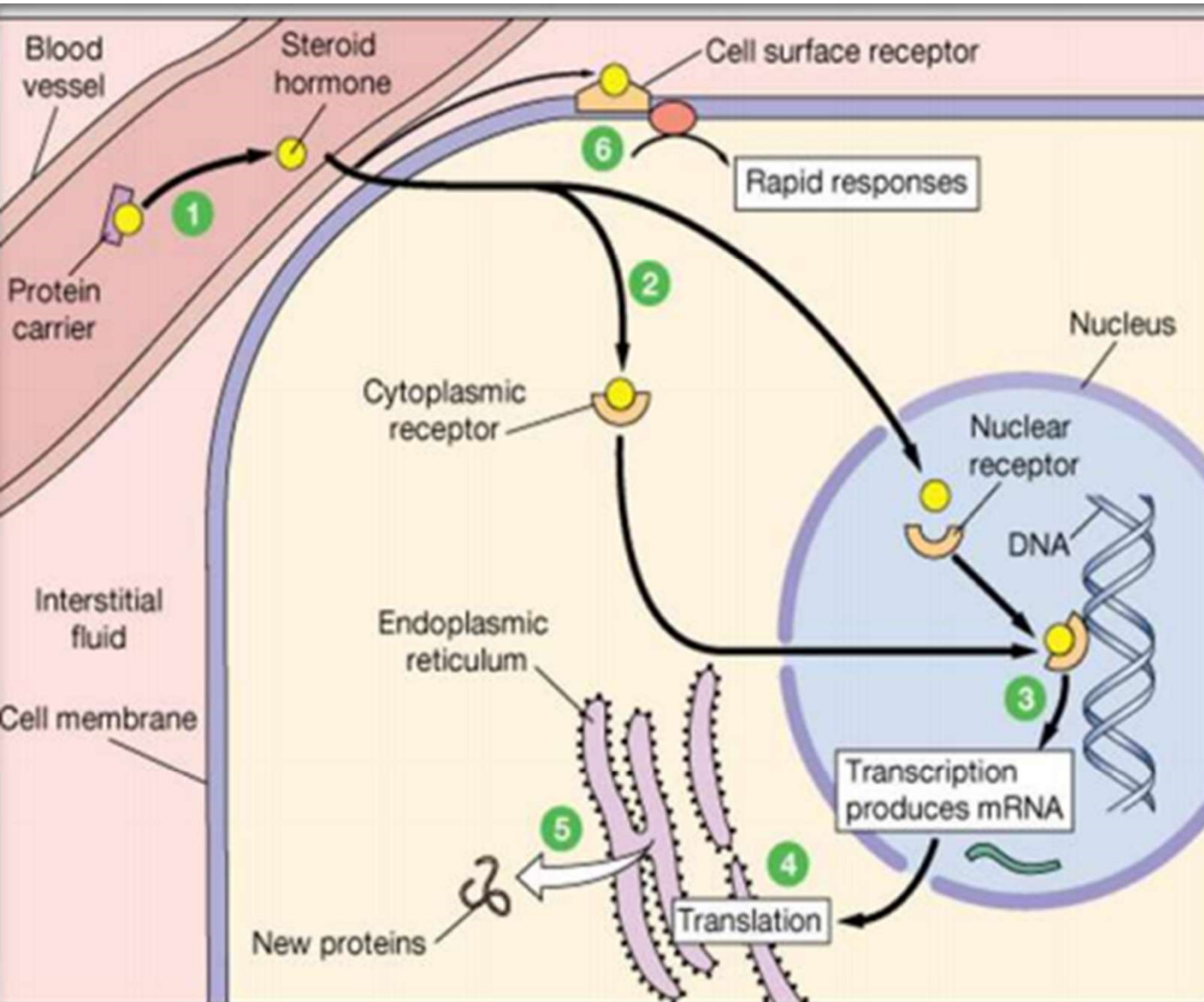
- **Nonsteroid/ Peptide Hormones** – React with specific receptors outside the cell – This triggers an enzyme reaction which lead to the formation of a second messenger (c AMP). – c AMP can produce specific intracellular functions:
 - Activates cell enzymes
 - Change in membrane permeability
 - Promote protein synthesis
 - Change in cell metabolism
 - Stimulation of cell secretions
- **Properties:**
 - Peptide hormones do not enter the cell directly. These hormones bind to receptor proteins in the cell membrane.
 - When the hormone binds with the receptor protein, a secondary messenger molecule initiates the cell response.
 - Because peptide hormones are water soluble, they often produce fast responses.



Effect On Gene Expression (Steroid Hormones)

- **Steroid Hormones** – Pass through the cell membrane – Binds to specific receptors – Then enters the nucleus to bind with the cells DNA which then activates certain genes (Direct gene activation). – mRNA is synthesized in the nucleus and enters the cytoplasm and promotes protein synthesis for:
 - Enzymes as catalysts
 - Tissue growth and repair
 - Regulate enzyme function
- **Properties:**
- Steroid hormones enter through the cell membrane and bind to receptors inside of the target cell.
- These hormones may directly stimulate transcription of genes to make certain proteins.
- Because steroids work by triggering gene activity, the response is slower than peptide hormones.





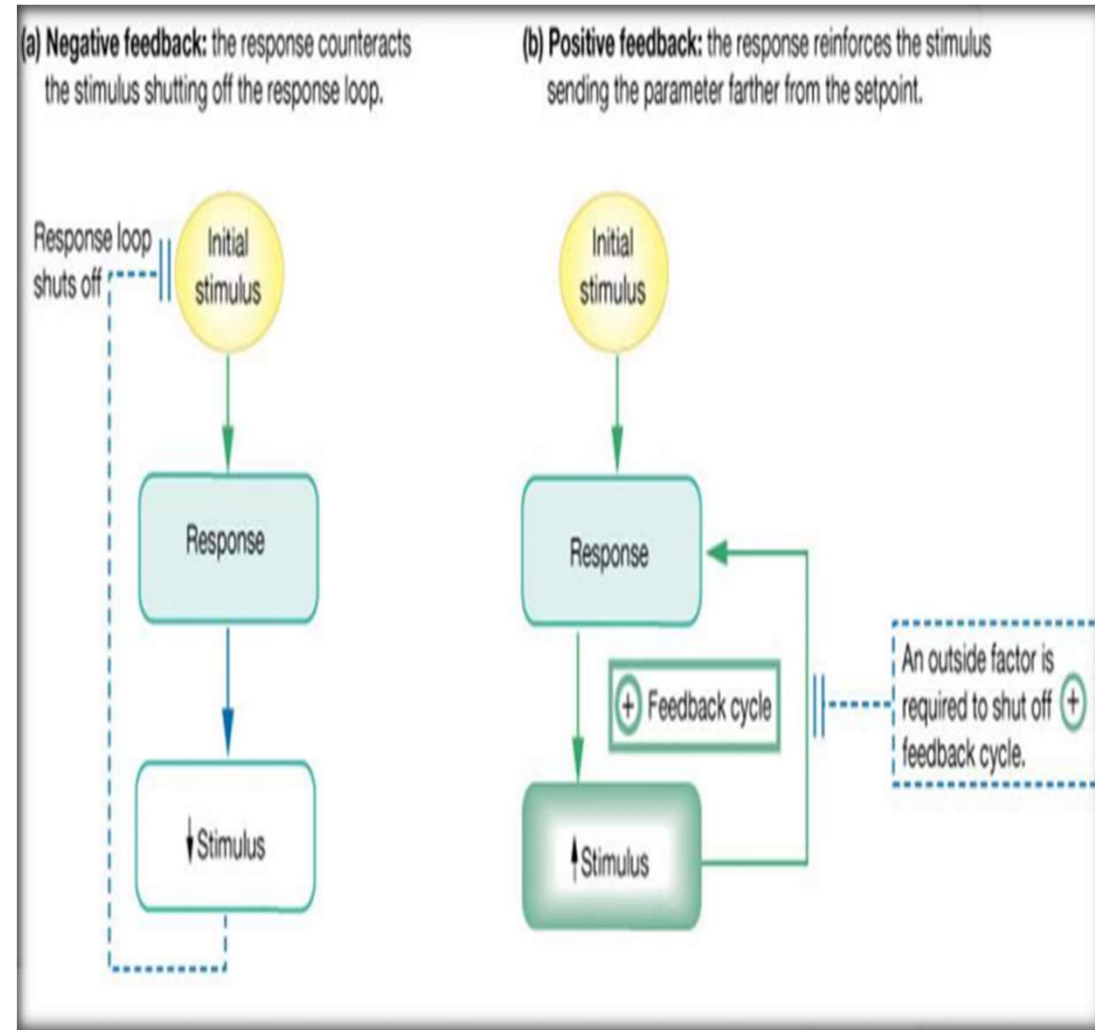
- 1 Most hydrophobic steroids are bound to plasma protein carriers. Only unbound hormones can diffuse into the target cell.
- 2 Steroid hormone receptors are in the cytoplasm or nucleus.
- 3 The receptor-hormone complex binds to DNA and activates or represses one or more genes.
- 4 Activated genes create new mRNA that moves back to the cytoplasm.
- 5 Translation produces new proteins for cell processes.
- 6 Some steroid hormones also bind to membrane receptors that use second messenger systems to create rapid cellular responses.

Control Pathways and Feedback Loops

- REGULATION OF HORMONE SECRETION:
 - Feedback control
 - Neural control
 - Chronotropic control
- The endocrine system secretes hormones that coordinate slower but longer-acting responses including reproduction, development, energy metabolism, growth, and behavior
- A common feature is a feedback loop connecting the response to the initial stimulus
- Negative feedback regulates many hormonal pathways involved in homeostasis
- Signaling by any of these hormones involves three key events: – Reception – Signal transduction – Response

Negative Feedback

- Negative feedback is the primary mechanism through which your endocrine system maintains homeostasis
- Secretion of a specific hormone is turned on or off by specific physiological changes (similar to a thermostat)
- **EXAMPLE:** plasma glucose levels and insulin response



HORMONE TRANSPORT, HALF LIFE.

- Hormone transport through plasma:
 - Unbound.
 - Bound .
- Half life:
 - Peptide hormone – short
 - Steroid, & thyroid – long.
- FUNCTIONS OF HORMONES: Regulation of biochemical reaction, Regulation of bodily process.
- HORMONE DISPOSAL: Target cell uptake & intracellular degradation. Metabolic degradation / inactivation. Urinary / biliary secretions. Metabolic clearance rate (MCR):- volume of plasma cleared per unit time