

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ
الْحَمْدُ لِلَّهِ الَّذِي
خَلَقَ السَّمَوَاتِ وَالْأَرْضَ
وَالَّذِي يُرِيهِمْ آيَاتِهِ
وَالَّذِي يُخْرِجُ النَّوْمَ
وَالَّذِي يُخْرِجُ النَّوْمَ



YEOW!







Physical Indications of Fight or Flight Response



dilated pupils

pale or flushed skin

trembling

rapid heart beat
and breathing



Objectives

- Definition of endocrine system
- Types of glands
- Definition of hormones
- Difference between hormones and enzymes
- Describe target cells
- Describe receptors and their classification
- Transport of hormones & clearance.
- Control of hormones release
- Classification of hormones

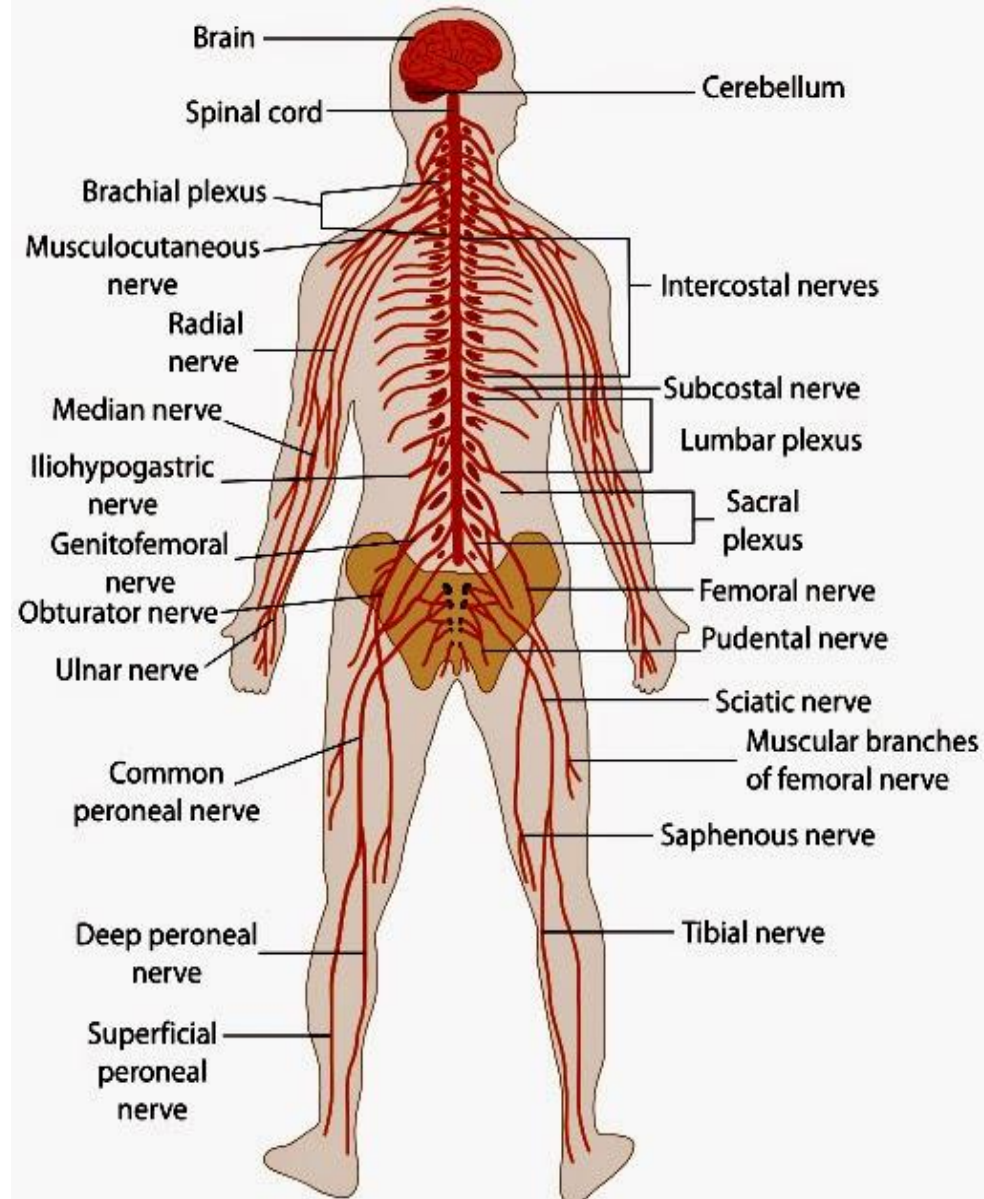
Endocrine system

- Multi cellular organisms have ability to adopt constantly changing environment.
- Intercellular communication mechanism is necessary for this adaptation.
- This communication is provided by two systems.
- Nervous system
- Endocrine system

Endocrine system

- **Nervous system**

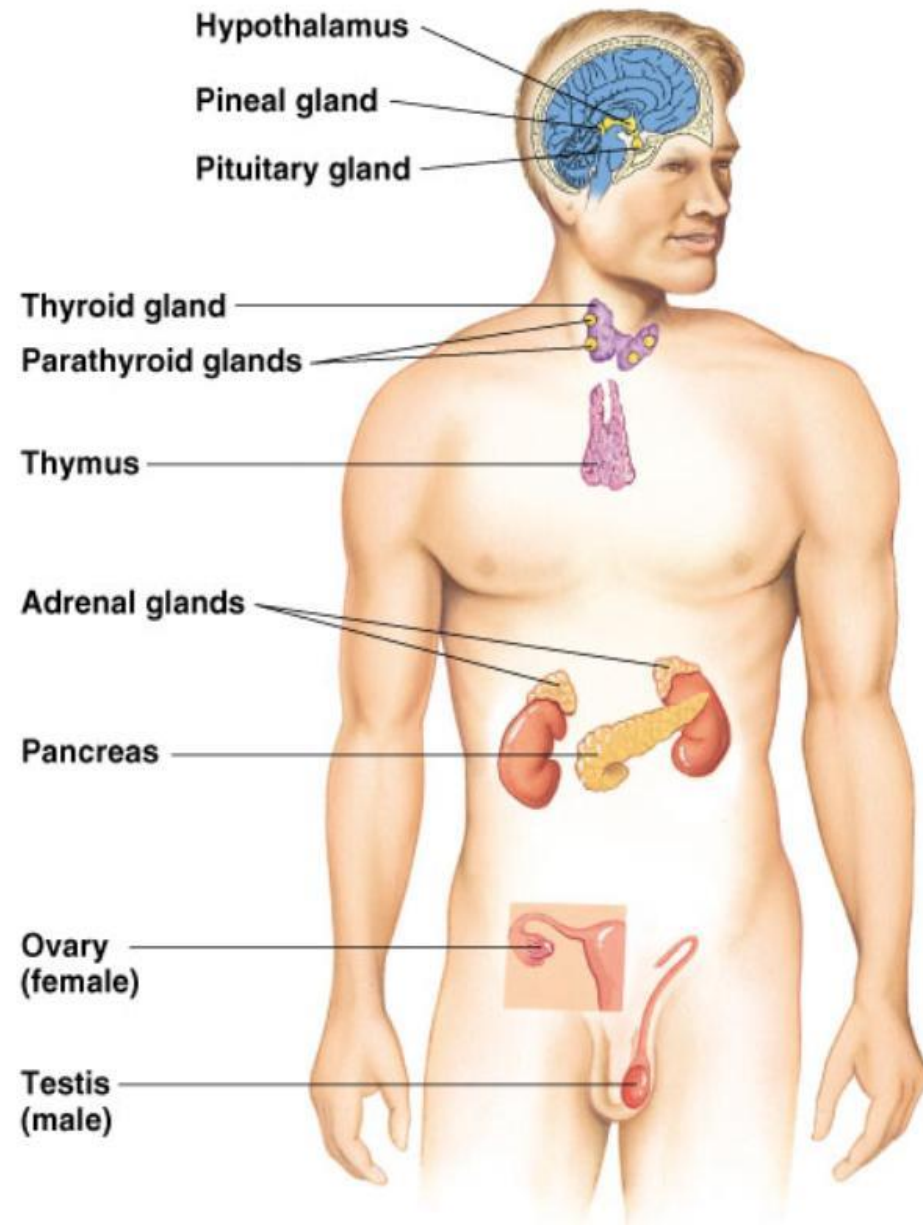
Mediates its activity by the transmission of **electro-chemical impulses** through nerves directly supplying the organs or structures.



Endocrine system

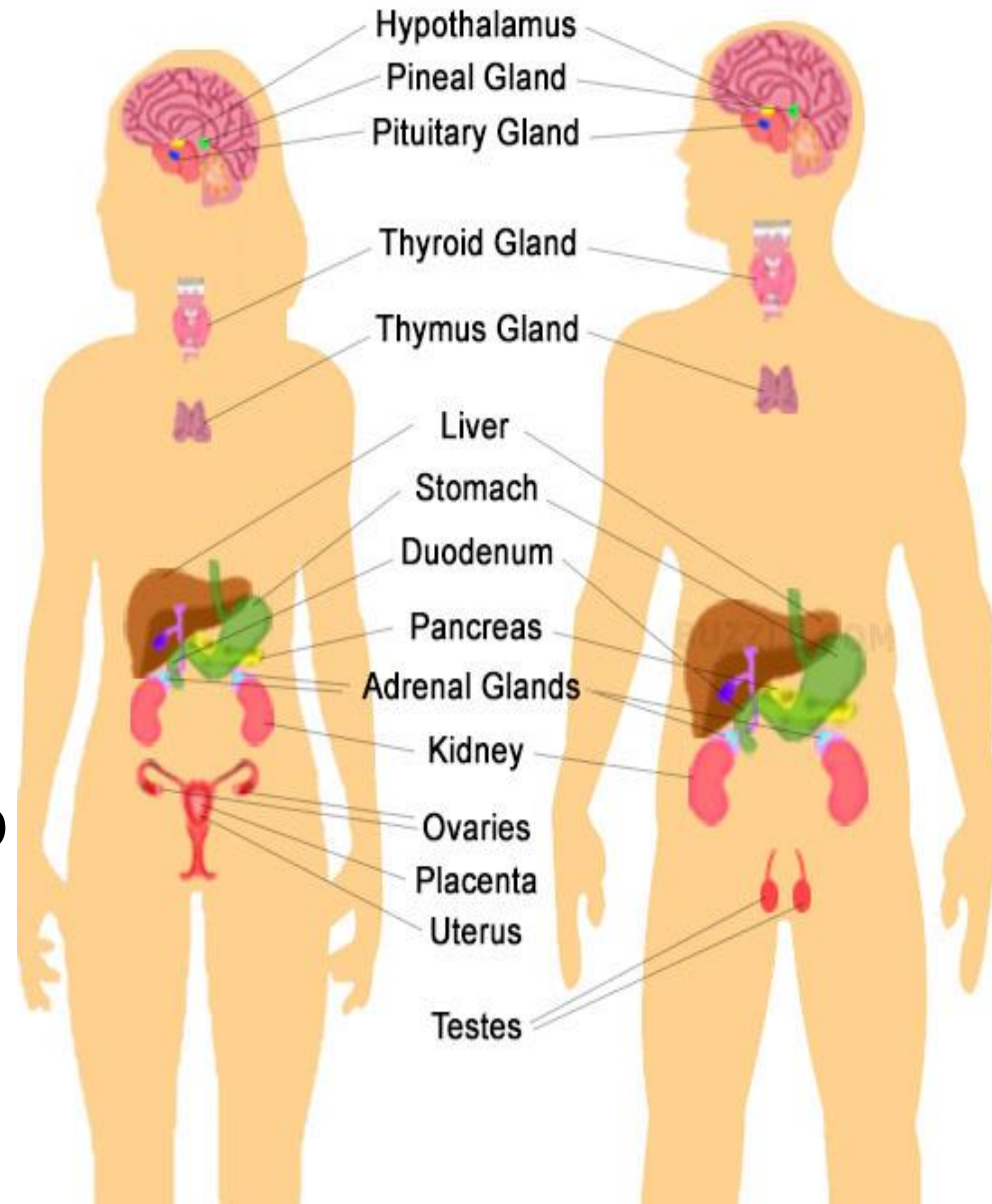
Endocrine system

Operate through chemical messengers (hormones), transported by blood stream to the target organs or tissues. Both systems act in coordination.



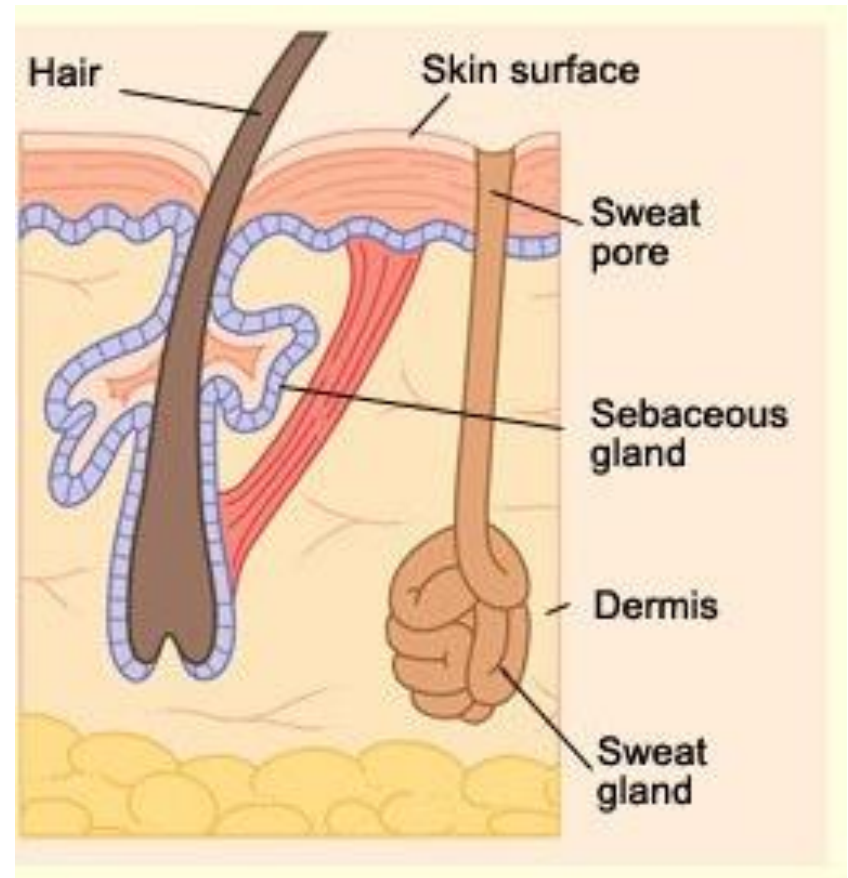
Endocrinology

- Study of endocrine glands and the hormones released by them, imbalance in release of hormones and their related diseases and damage to the glands which produce hormones.



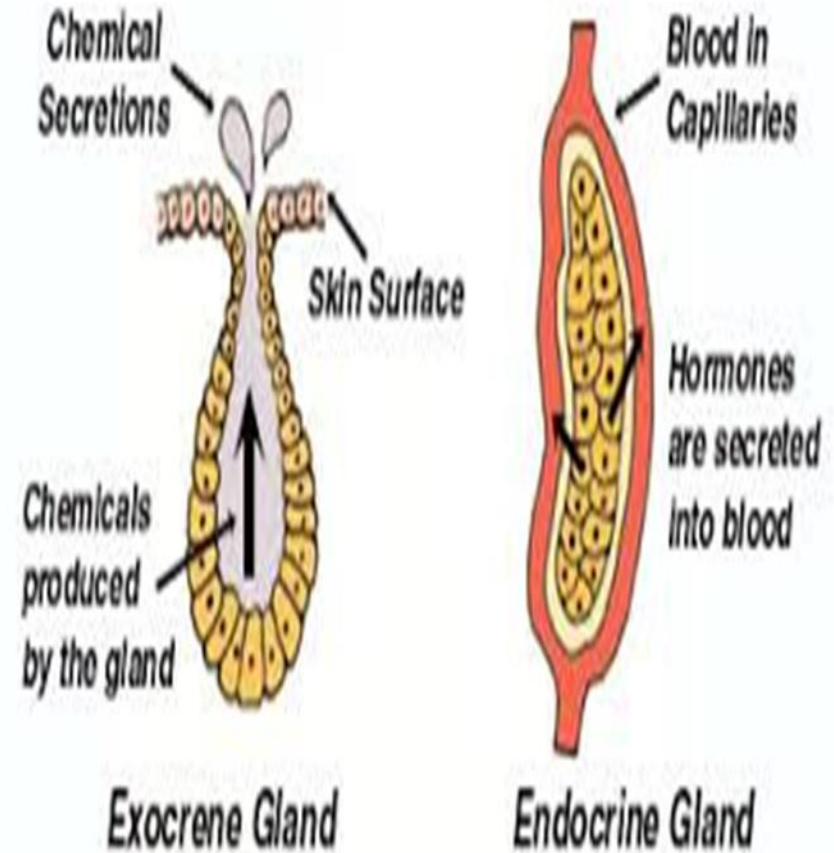
The types of glands

- **Exocrine glands** :
- deliver their secretions by means of ducts.
e.g, sweat glands, mammary glands, salivary glands and liver.



The types of glands

Endocrine glands:
produce chemical substances that they directly secrete into blood stream for transmission to various target organs, these secretions are called as hormones.



Hormone

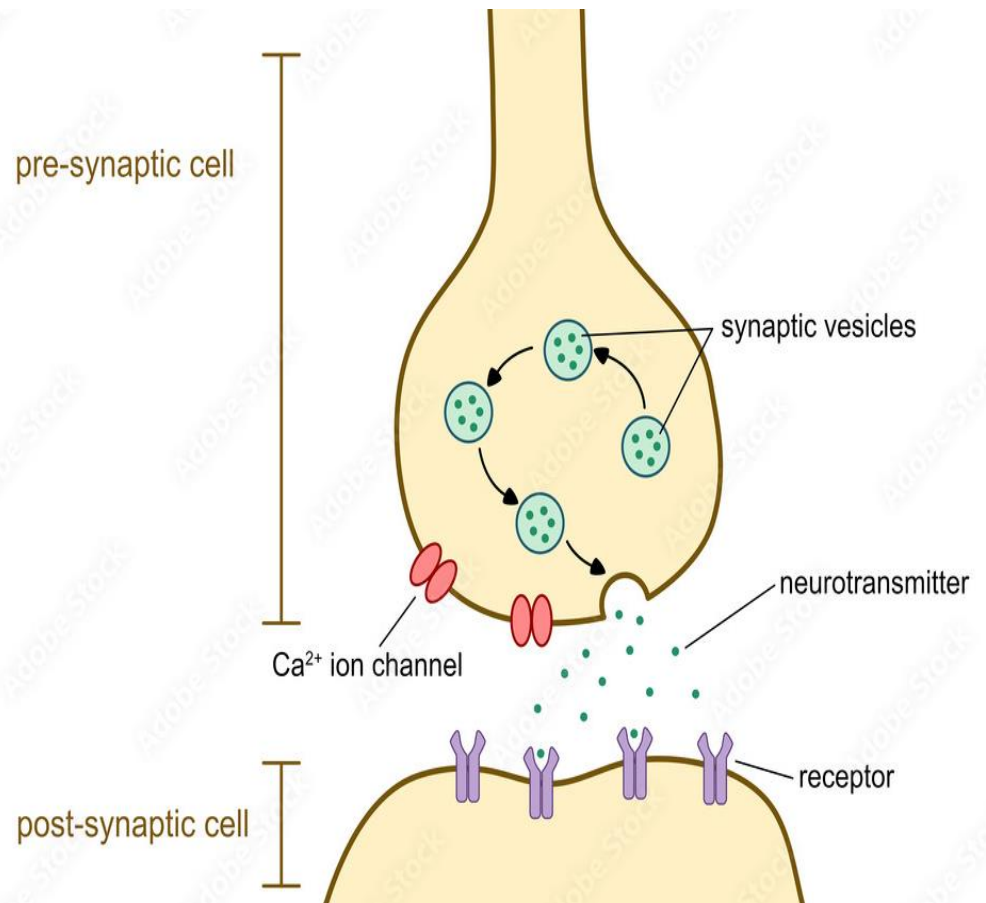
Chemical messengers

secreted by the endocrine glands and transported by circulatory system to the target organs or tissues. However, hormones also have autocrine and paracrine actions.

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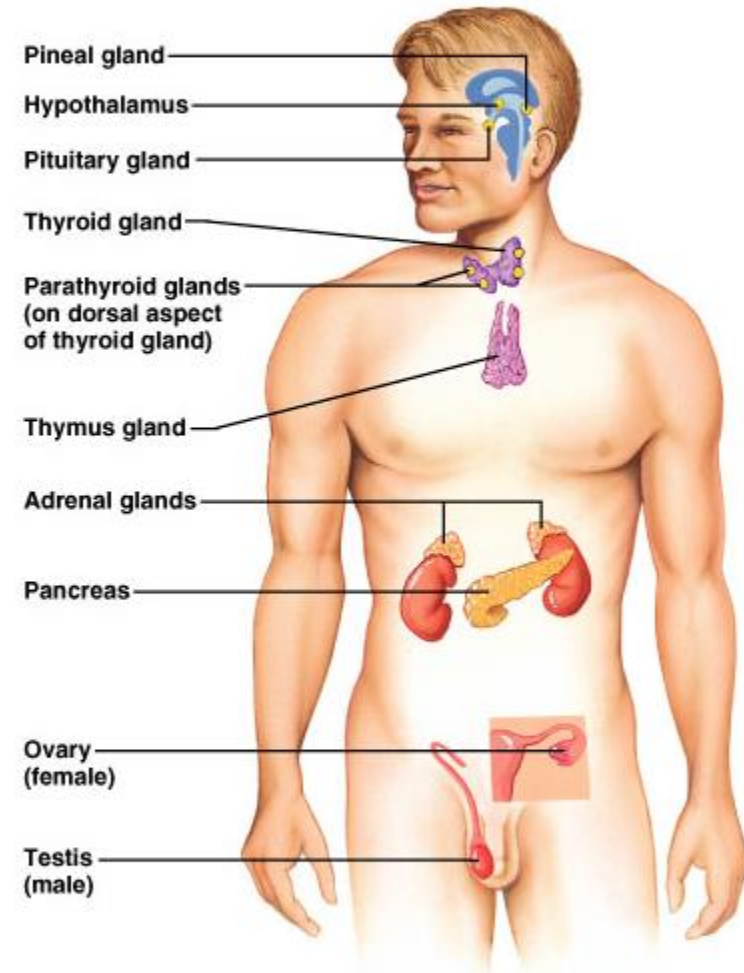
Neurotransmitters

- **Neurotransmitters** are chemical substances secreted by axon terminals of neurons, act locally to control the functions of nerve cells.



Endocrine Organs

- Purely endocrine organs
 - Pituitary gland
 - Thyroid gland
 - Parathyroid glands
 - Adrenal: 2 glands
 - Cortex
 - Medulla
 - Pancreas
 - Gonads
- Endocrine cells in other organs
 - Pineal gland
 - Thymus
 - JG cells of kidney
 - GI tract



Hormones

The word “Hormone” is derived from Greek word “Hormacin” meaning to excite or to arouse activity.

Hormones initiate chemical reaction, catalyze & control metabolic reactions.

They are required in small amount.

Difference b/w enzymes and hormones

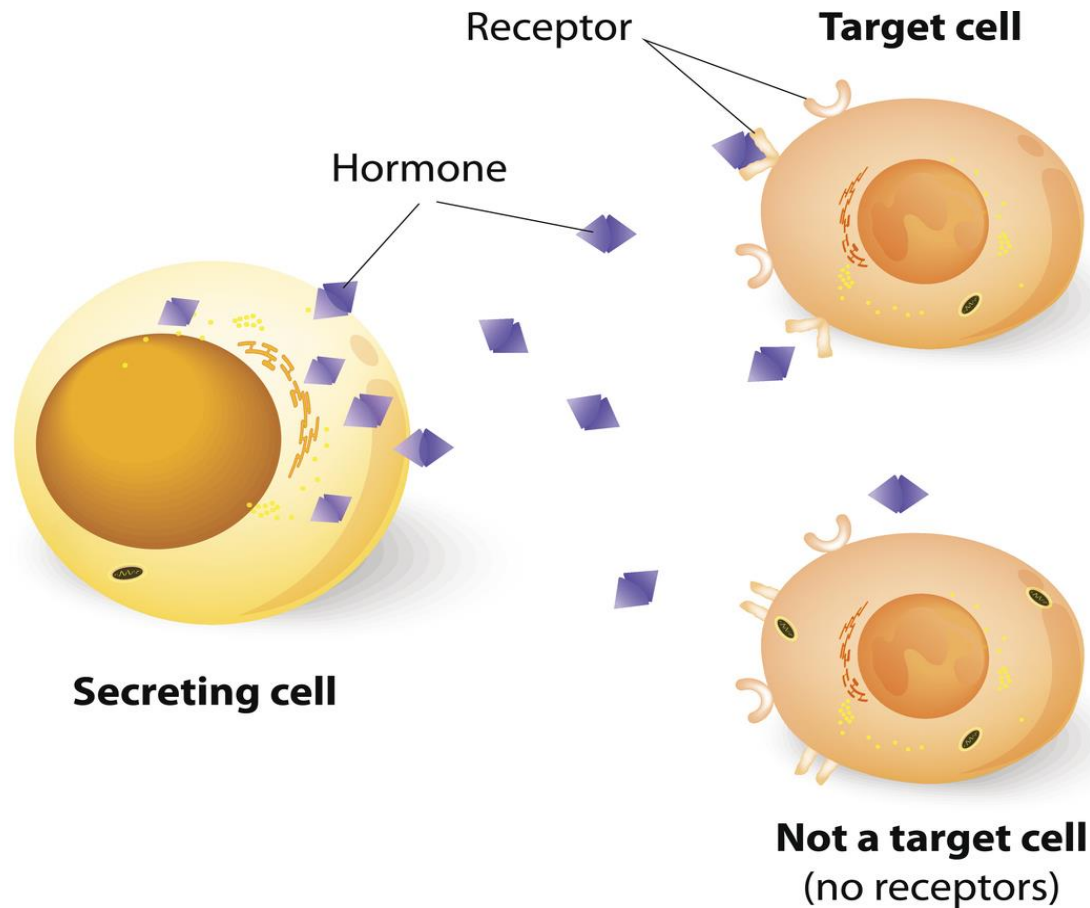
- Hormones are produced in an organ other than that in which they perform function.
 - They are secreted in blood prior to use.
 - They are not always protein in nature. They are peptides, amino acid derivative and steroid in nature.
 - They are used in biological reaction and can not be reutilized.
- They are present in the same tissues where they function.
 - They are already present at the site of action.
 - They are protein in nature.
 - They are not used in biological reaction.

General functions of hormones

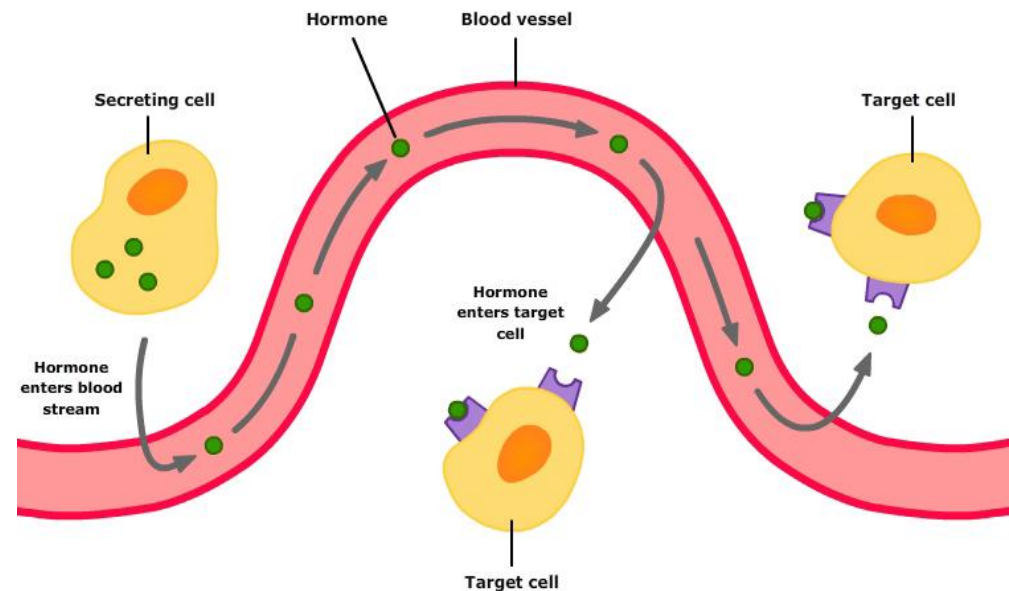
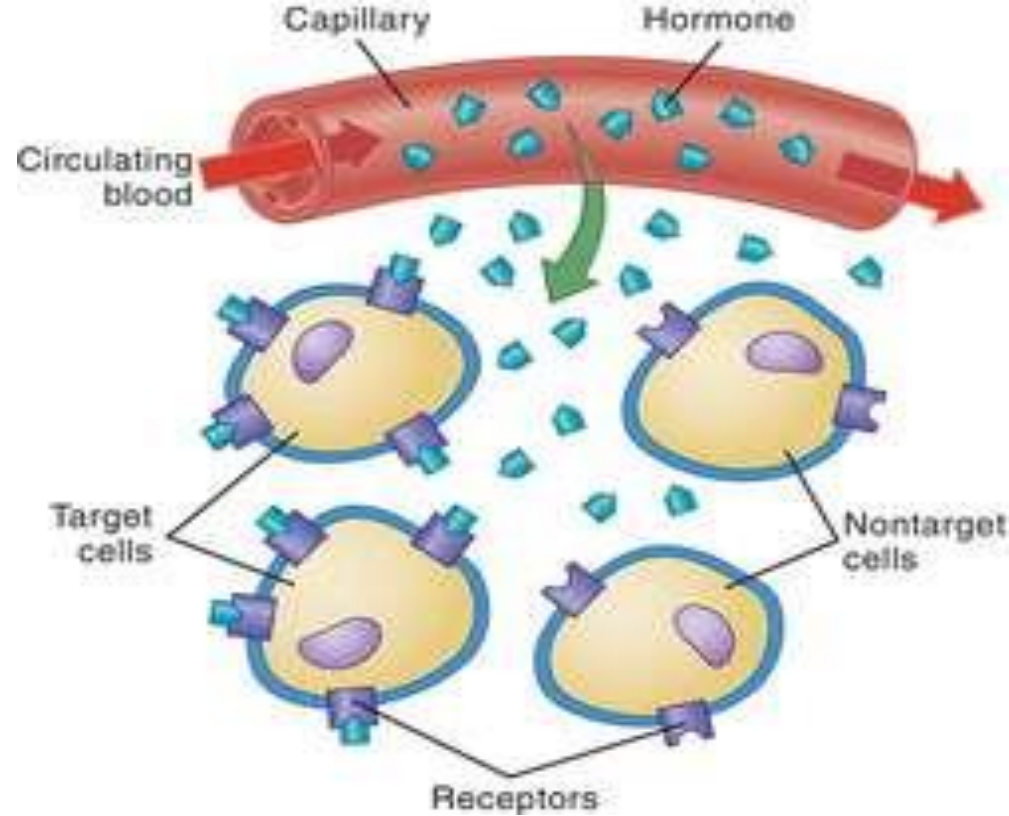
- Maintains the body internal environment.
- Important for controlling
 1. Growth
 2. Reproduction
 3. Puberty
 4. and sexual maturation.

Target cells

- Cells that have receptors to bind the hormone .
- They selectively bound to a given hormone.



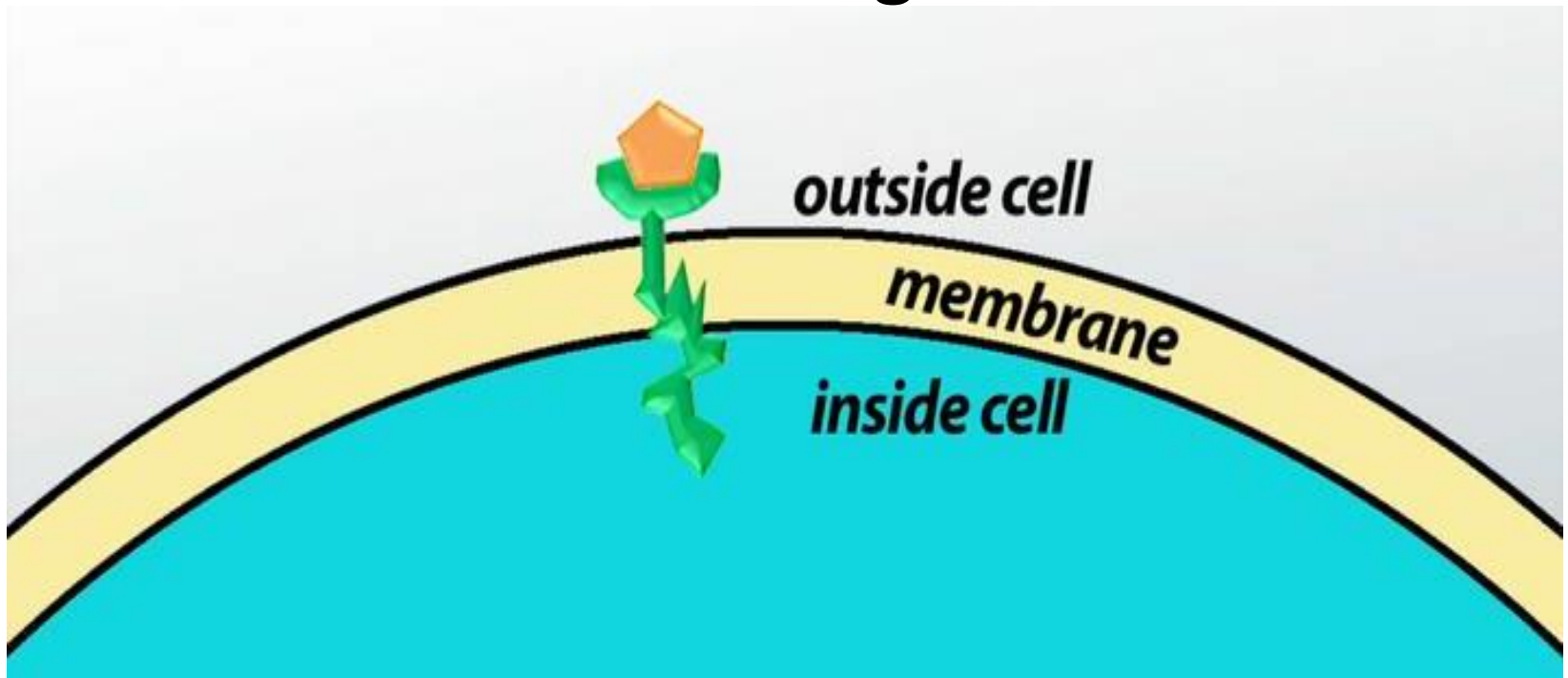
- Single hormone can act on different target cells.
- More than one hormone can effect a single cell type.
- Hormones can exert many different effects in one cell.



What are receptors ?

Receptors are

signal detector (hormone or neurotransmitter) and link b/w extracellular events and chemical changes within cell.

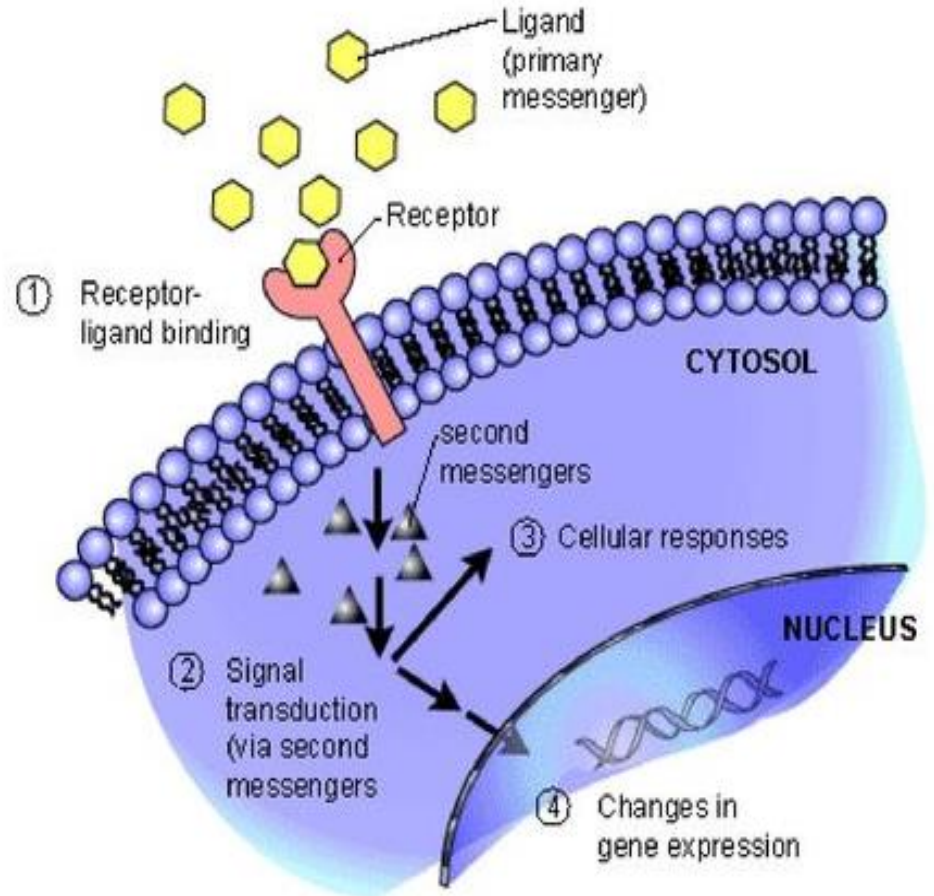


Receptors

Protein in nature.

Two functional domain

- Recognition domain binds hormones.
- Second region generates a signal which is responsible for intracellular function.

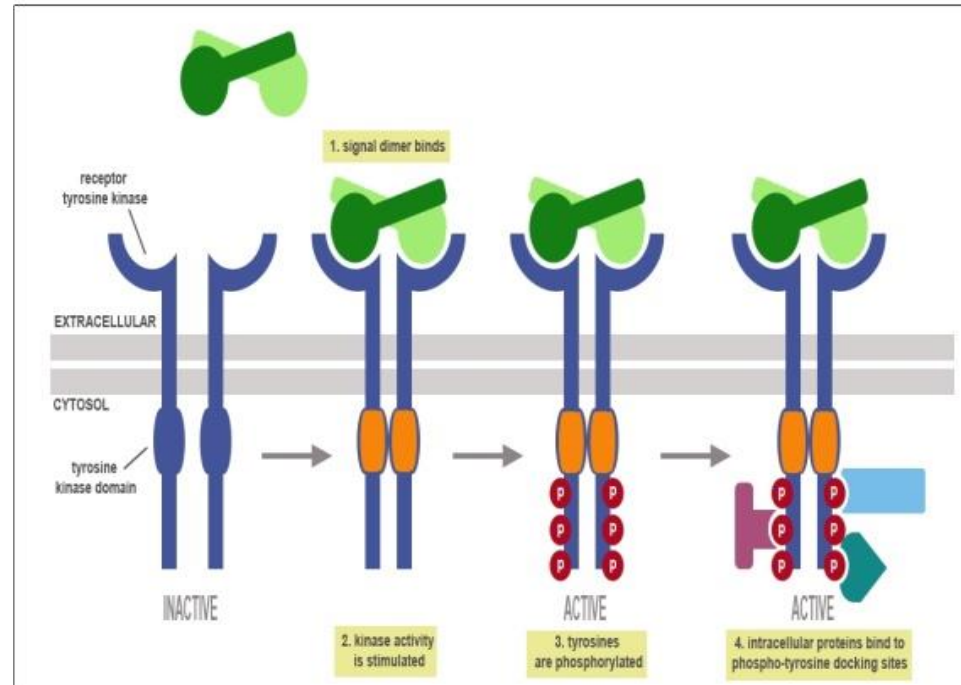


Receptors have

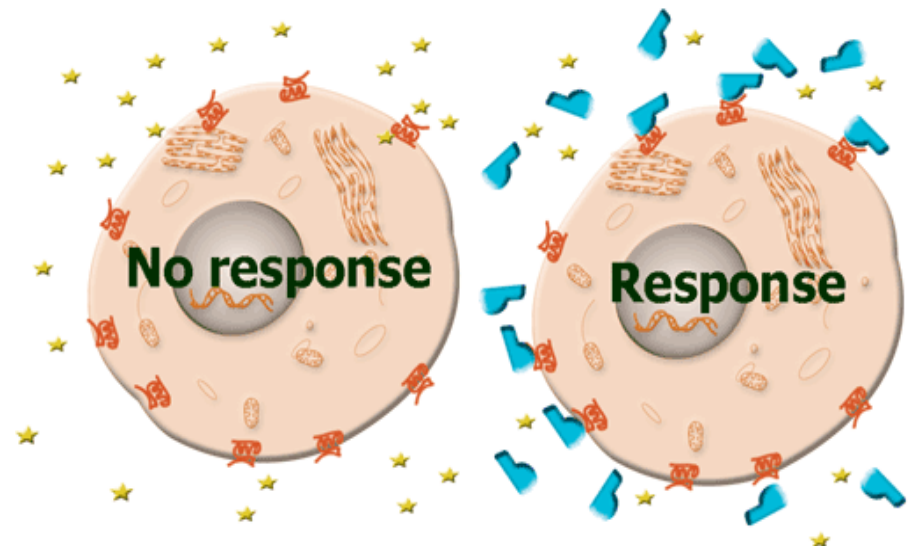
1. Hormonal specificity

2. Tissue specificity

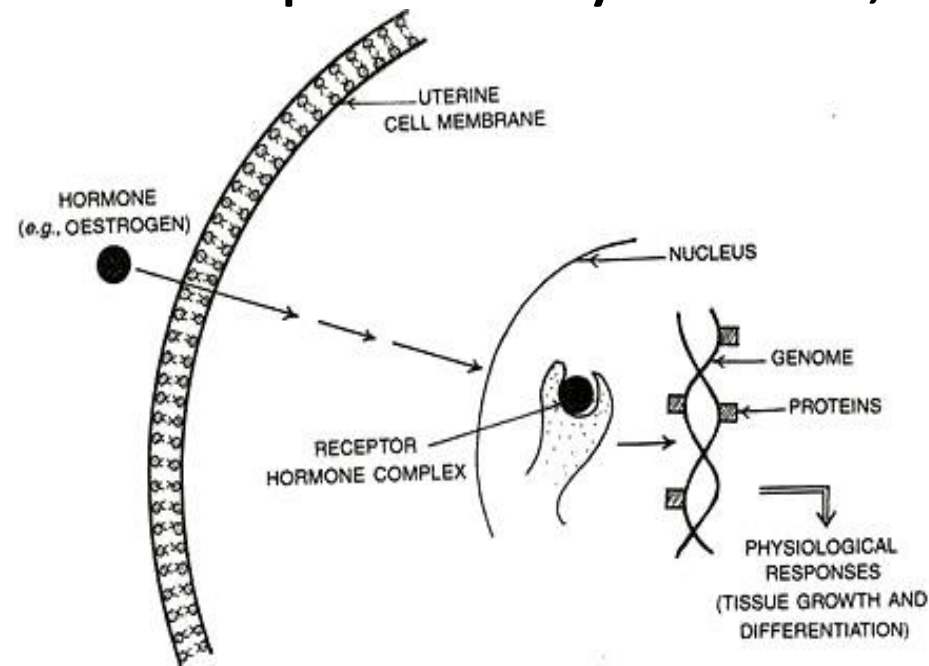
3. High affinity of binding site.



SPECIFICITY OF TISSUE

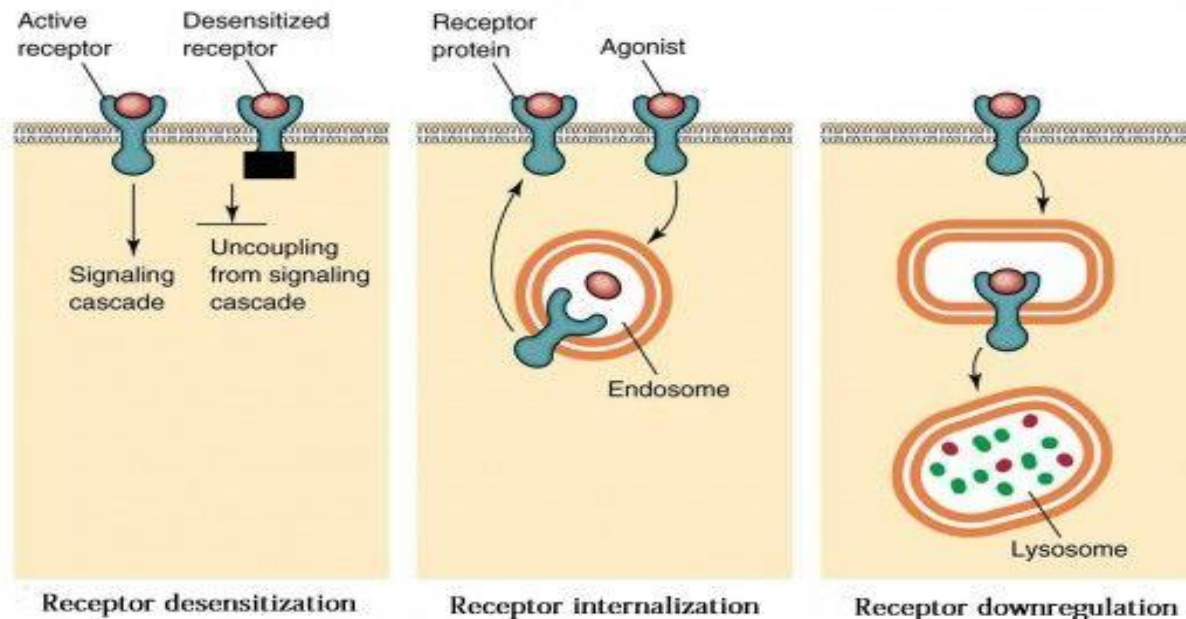


- Hormone receptor interaction generate signals that regulate
- The activity of set of genes by altering the amount of proteins in the target cells.
- The activity of specific proteins like enzymes, transporter or channel proteins.
- Affects general processes such as protein synthesis, cell growth & replication.

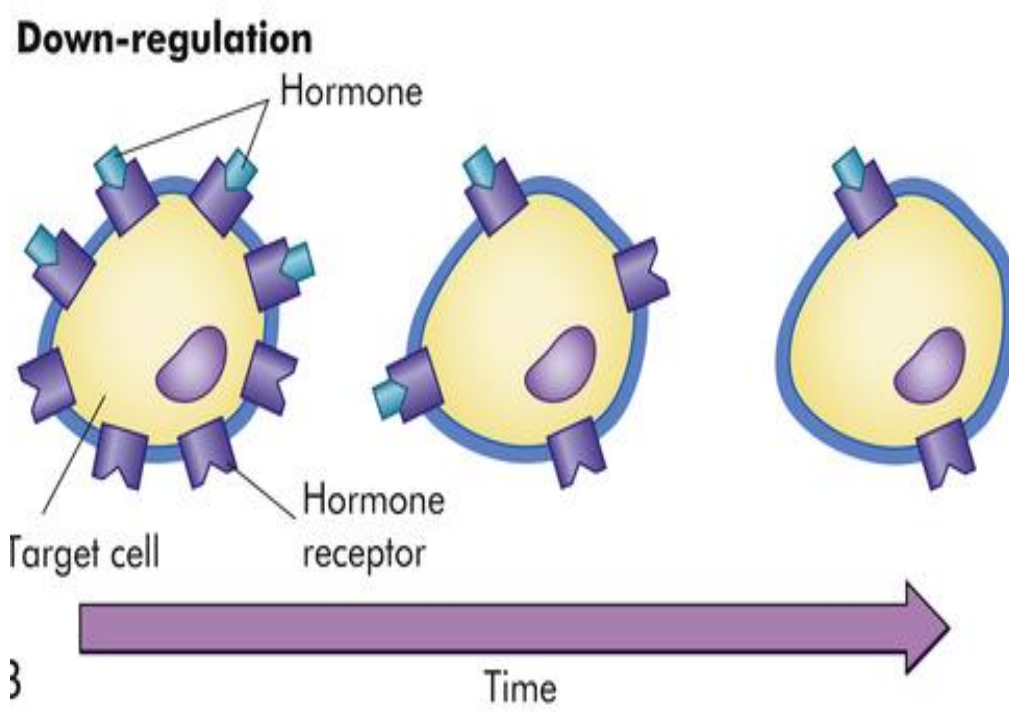


Regulation of receptors

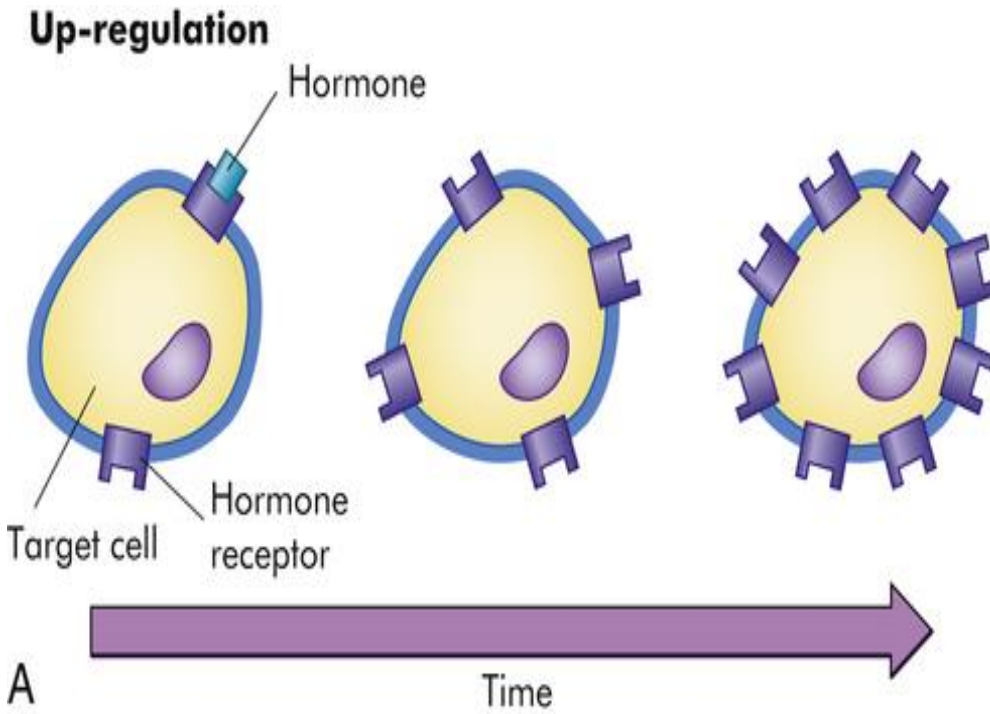
- Number of receptors in target cells does not remain constant. They change from day to day and even from minute to minute. They are synthesized by the protein manufacturing mechanism of the cell and destroyed during the course of their function.



- **Down-regulation** of receptors is decreased number of receptors in response to excess of respective hormone.

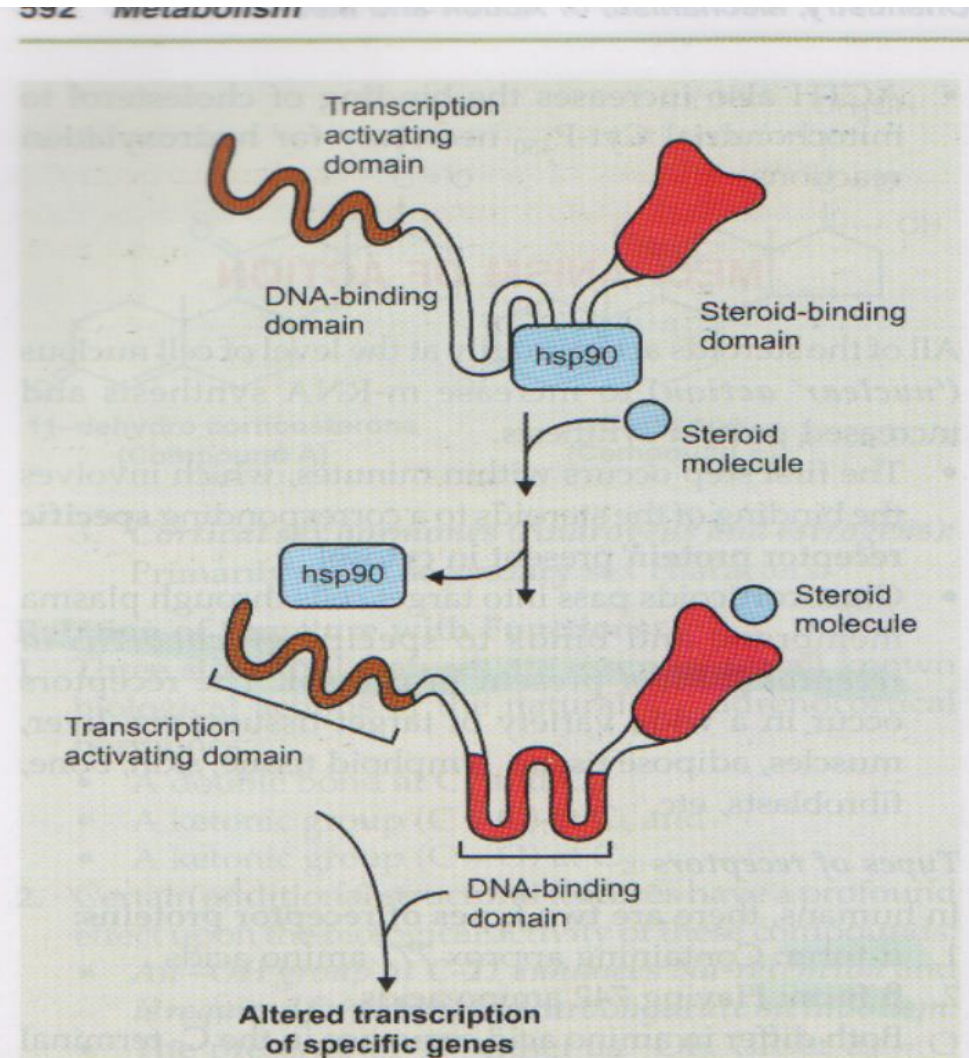
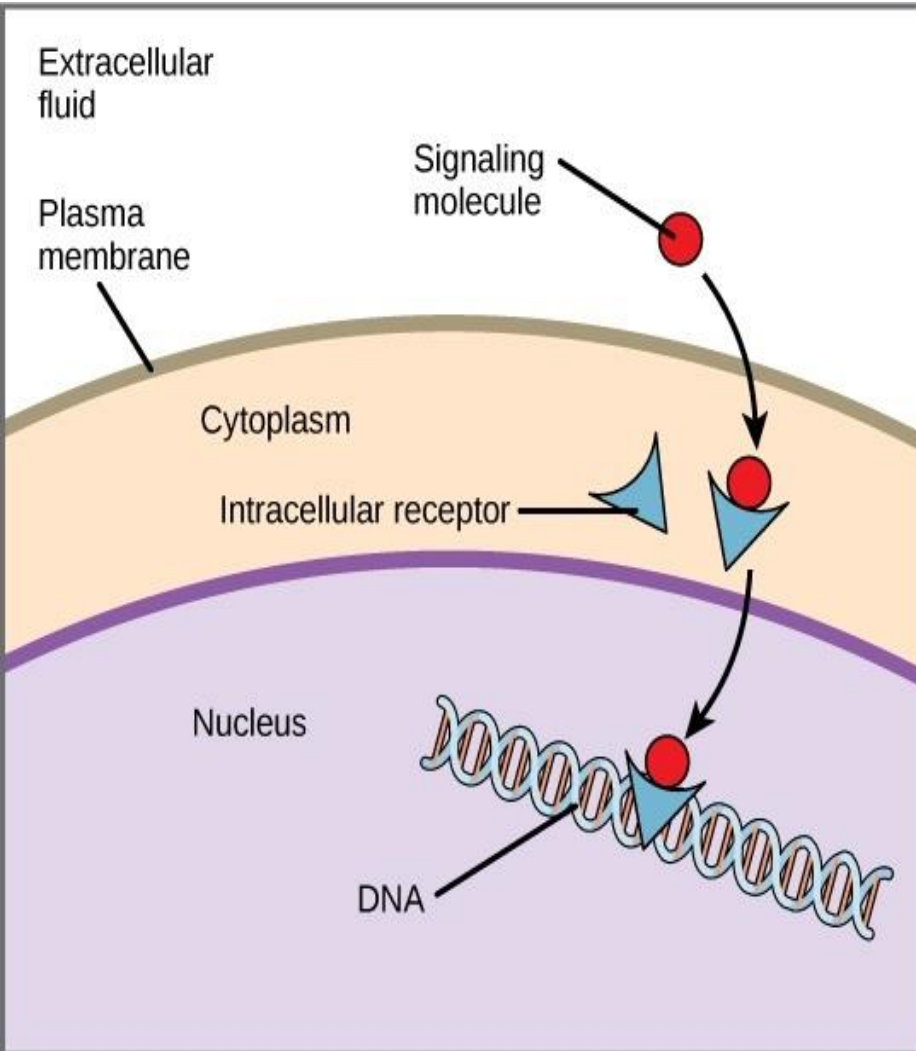


- **Up-regulation** is more production of receptors when hormone is supplied in lesser amount.



Classification of receptors

1. Intracellular receptors



Classification of receptors

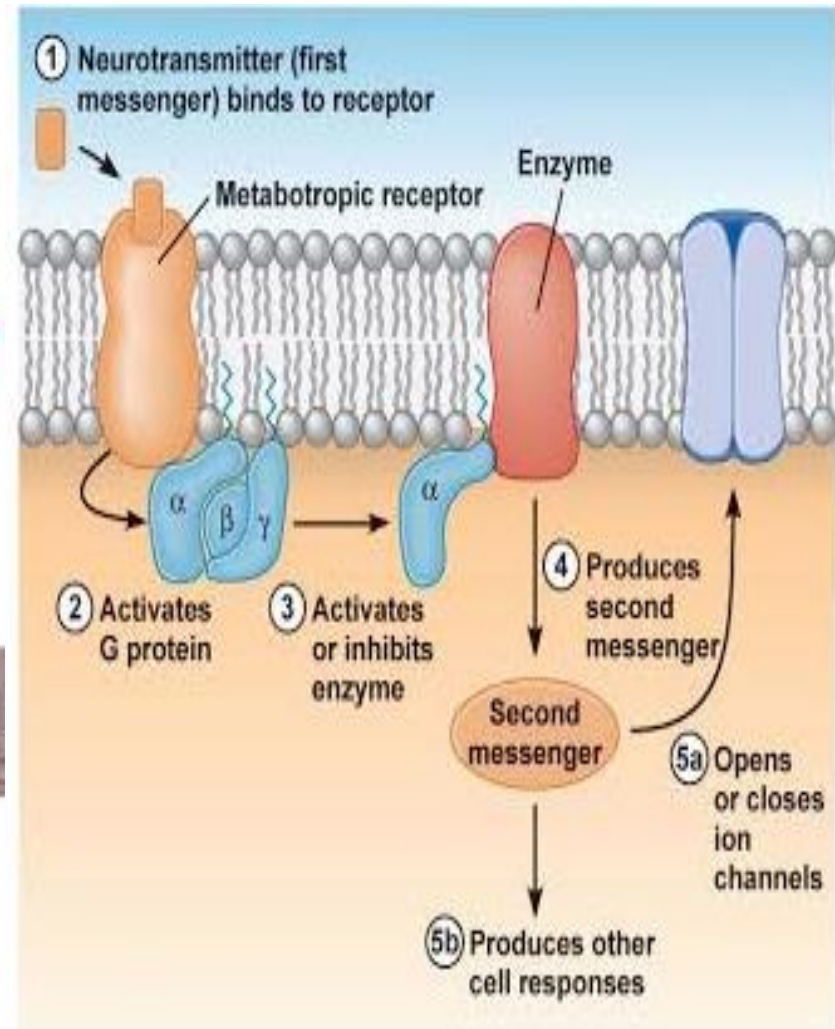
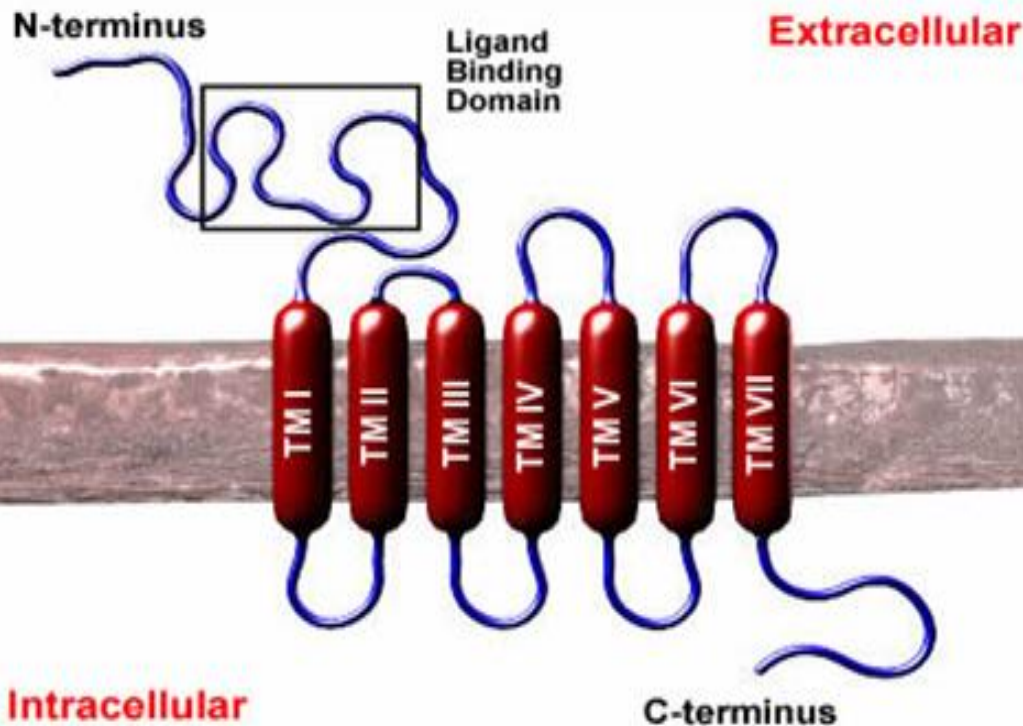
2. Cell membrane receptor

a) G- protein linked receptor,

Surface receptor

Extracellular domain
Membrane spanning
Intracellular region

α , G-linked receptor

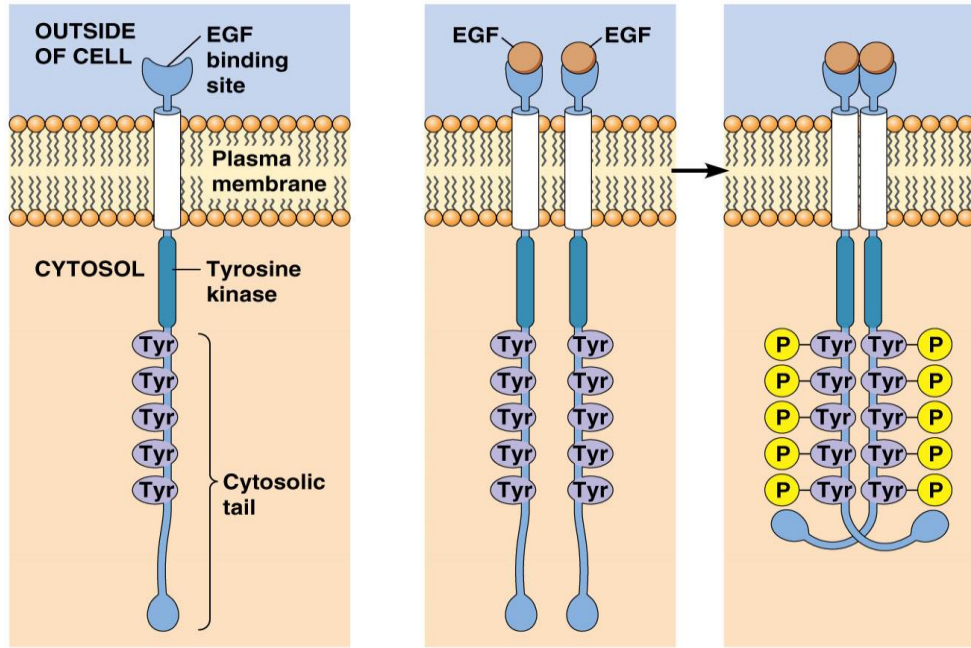


Cell membrane receptor

b) Enzyme-linked receptors
(Receptors with single trans membrane domain)

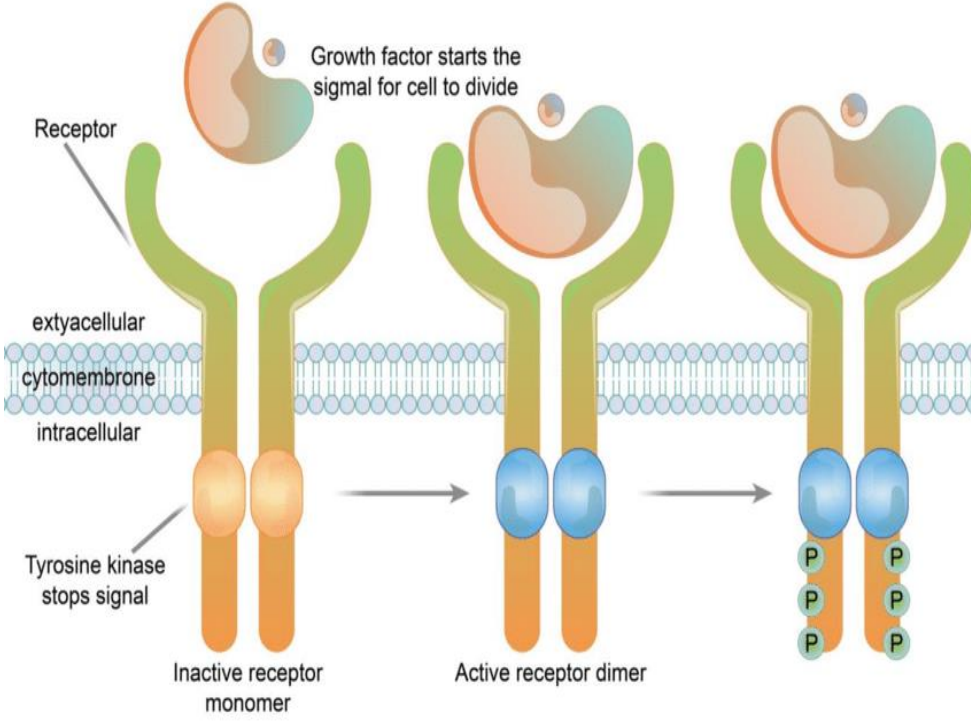
Group 1

posses intrinsic Tyrosine kinase activity
(eg- insulin and epidermal growth factor).



(a) Structure of the epidermal

(b) Activation of the EGF receptor



Inactive receptor monomer

Active receptor dimer

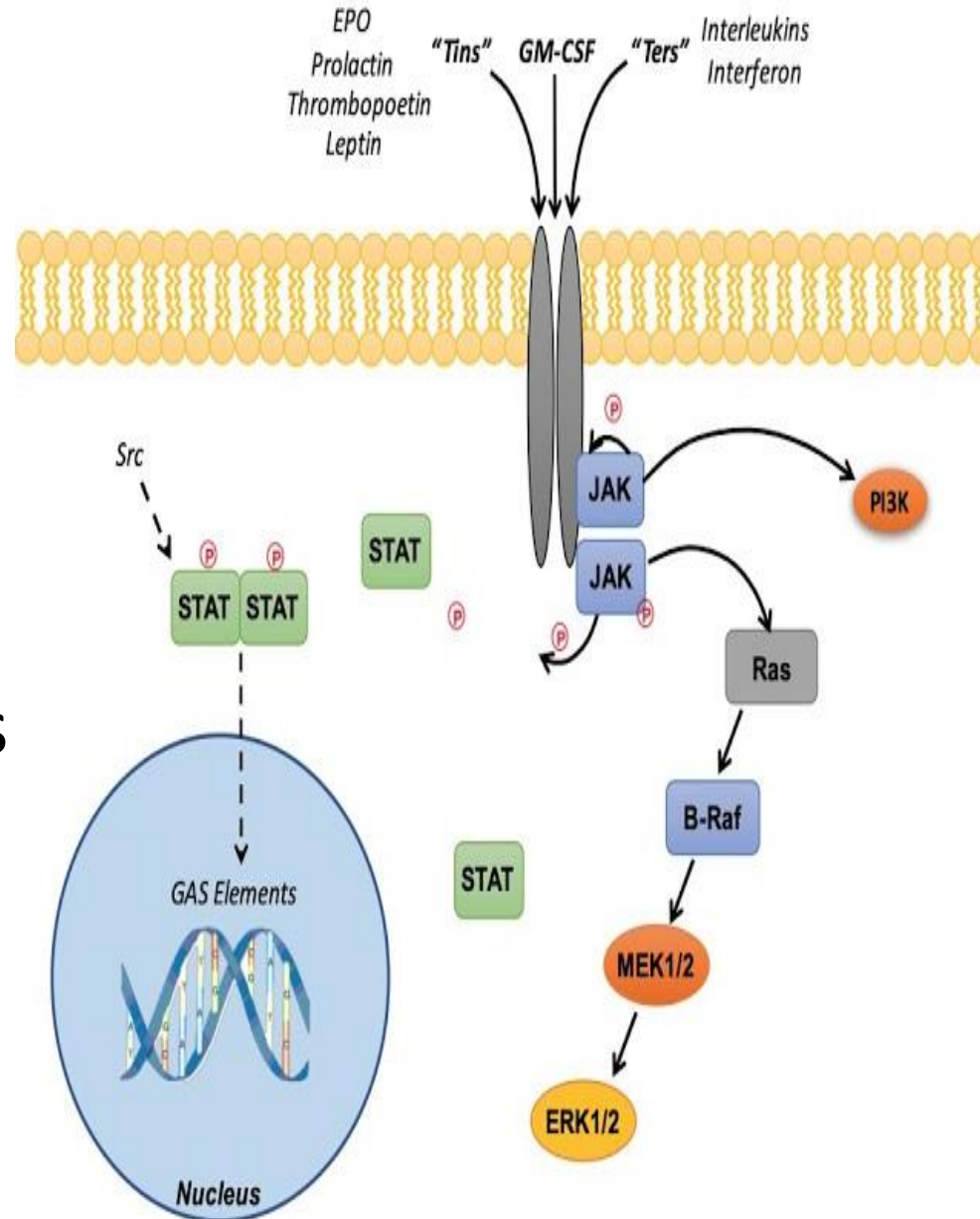
Cell membrane receptor

Enzyme-linked receptors

Group 2

There is no tyrosine kinase attached to receptors,
but they signal through tyrosine kinase of janus kinase family.

(eg – GH, prolactin, and leptin).

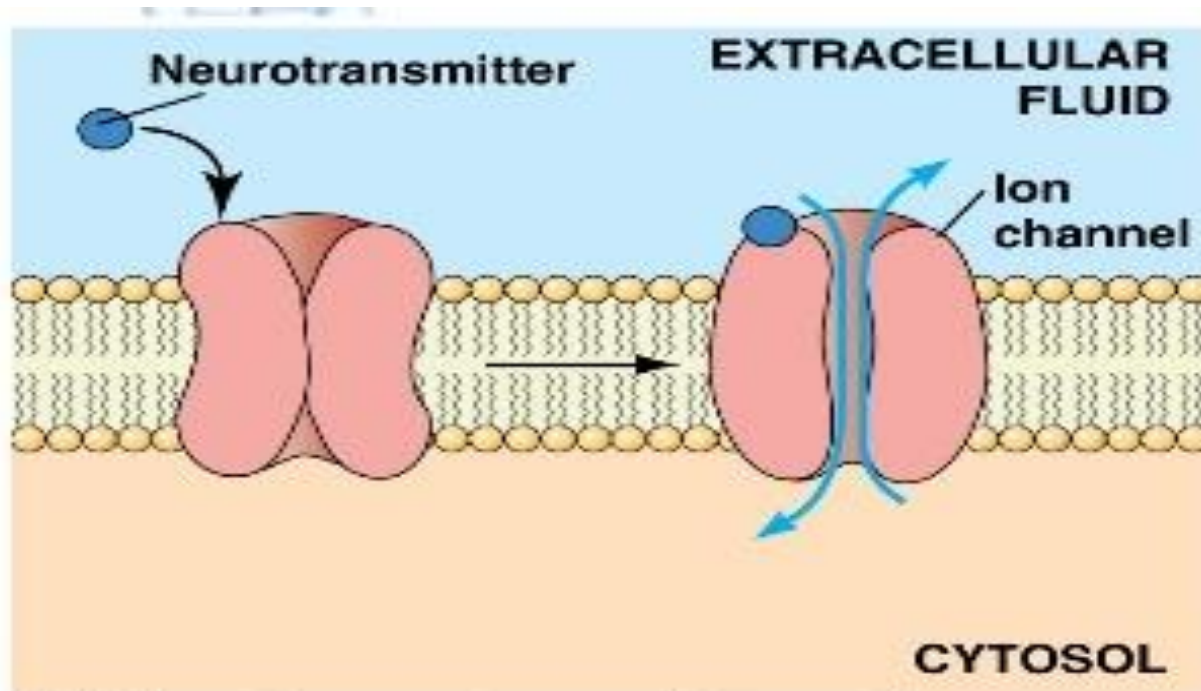


Cell membrane receptor:

c. Ion channel-linked receptors

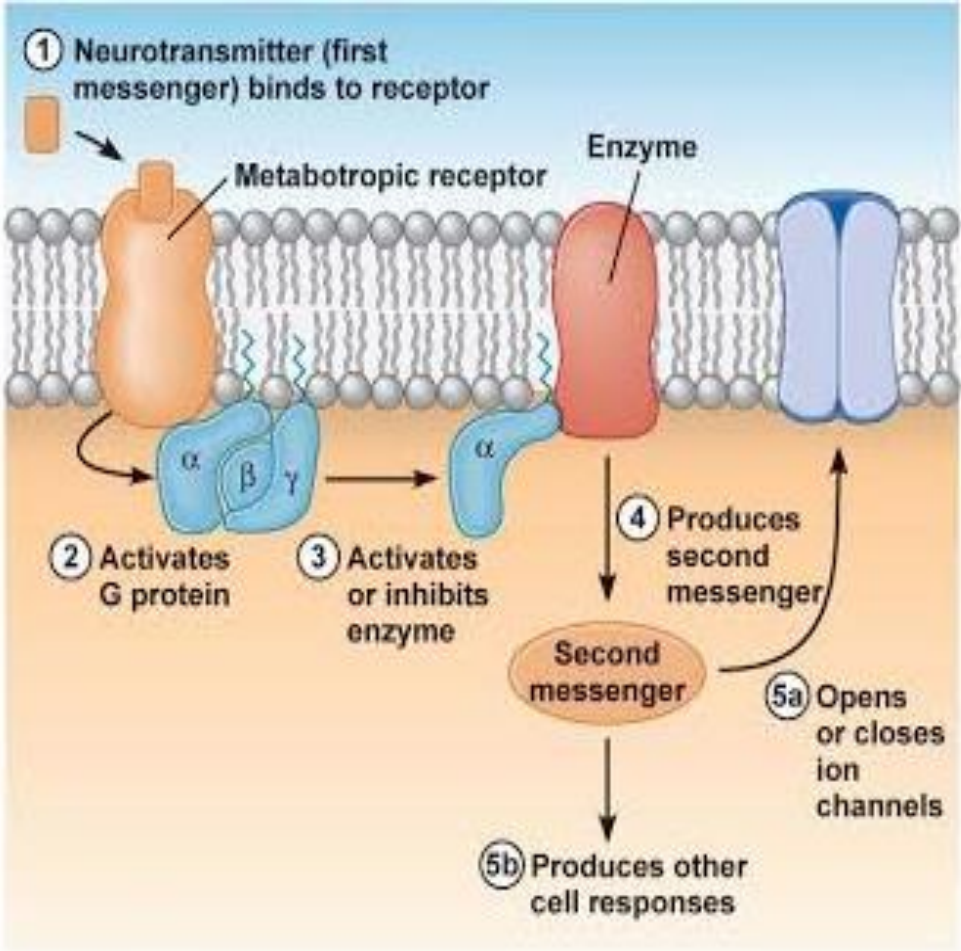
Present mostly in post synaptic membrane.

- **Neurotransmitters** when bind with these receptors cause opening or closing a channel for one or more ions.



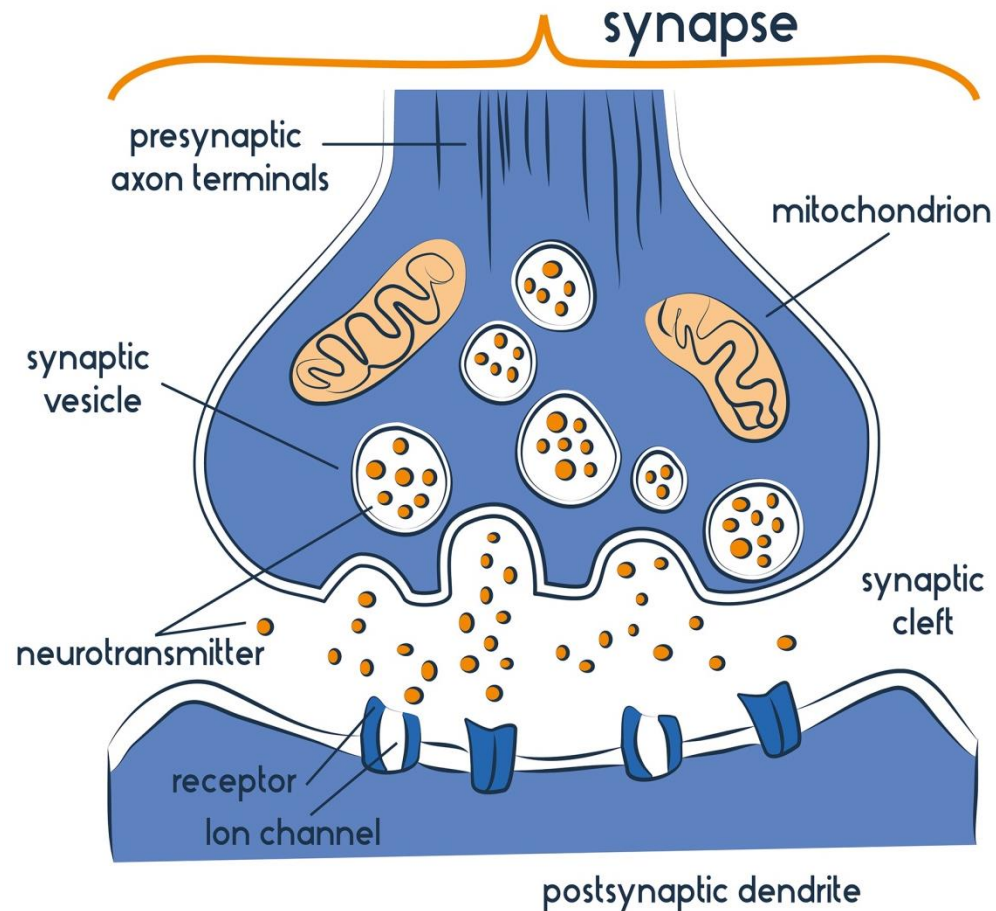
(a) Direct neurotransmitter action (ionotropic receptor)

- Some hormones do this indirectly by binding with G-linked or enzyme-linked receptors.



Transport & clearance of hormones

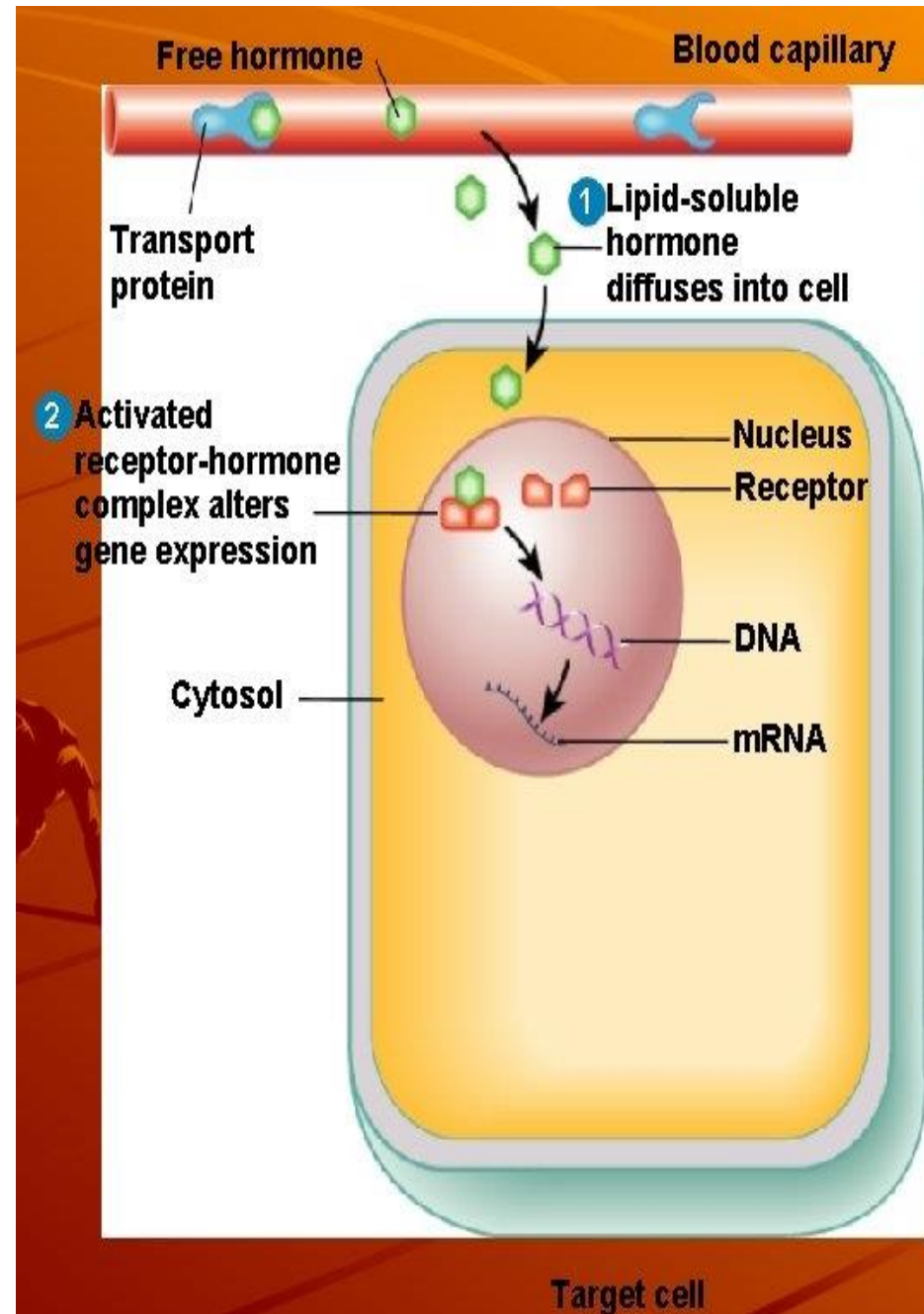
- Rate of synthesis and secretion
- Some hormones are stored in the cells producing them (catecholamine).
- They are released within seconds by stimulus.



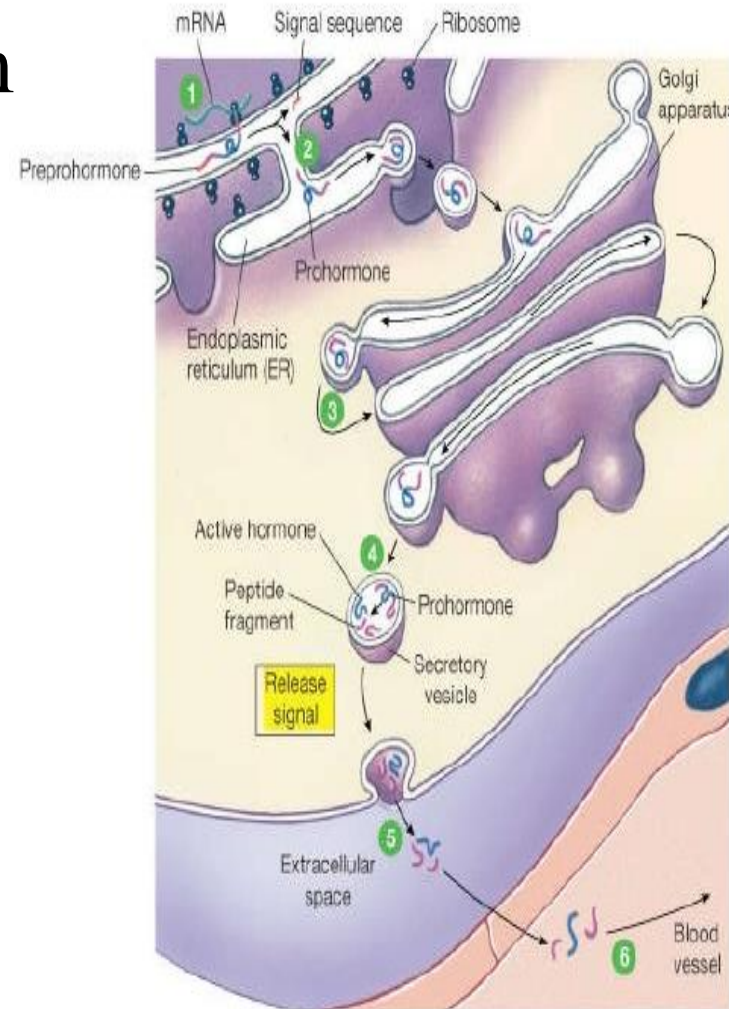
Some synthesized in final form and secreted e.g steroid hormones (cholesterol derivative).

They take months & years for synthesis by stimulus.

They are lipid soluble so they can easily diffuse across cell membrane and enter circulation.



Some synthesized from precursor molecule(insulin).



1 Messenger RNA on the ribosomes of the ER binds amino acids into a peptide chain called a **preprohormone**. The chain is directed into the ER lumen by a **signal sequence** of amino acids.

2 Enzymes in the ER chop off the signal sequence, creating an inactive **prohormone**.

3 The prohormone passes from the ER through the Golgi apparatus.

4 Secretory vesicles containing enzymes and prohormone bud off the Golgi. The enzymes chop the prohormone into one or more active peptides plus additional peptide fragments.

5 The secretory vesicle releases its contents by exocytosis into the extracellular space.

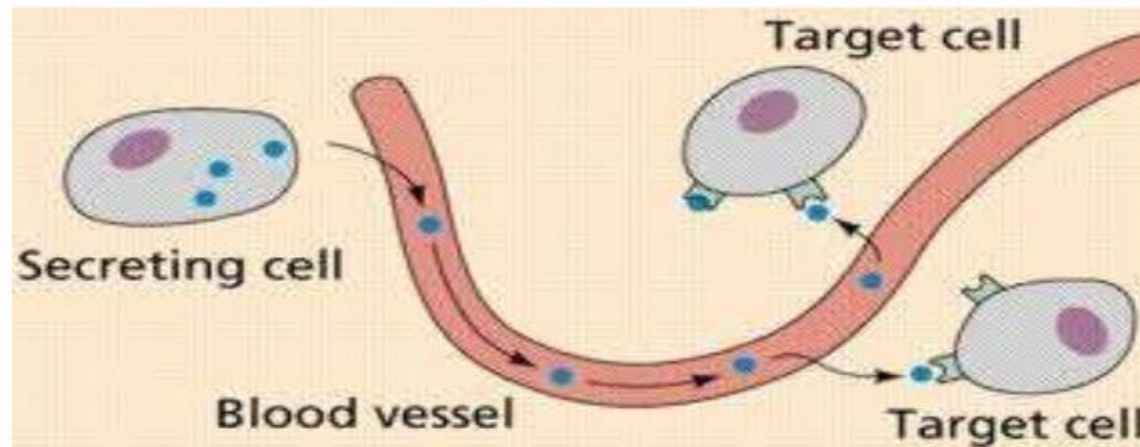
6 The hormone moves into the circulation for transport to its target.

Specific transport system in plasma.

1. Water soluble hormones:

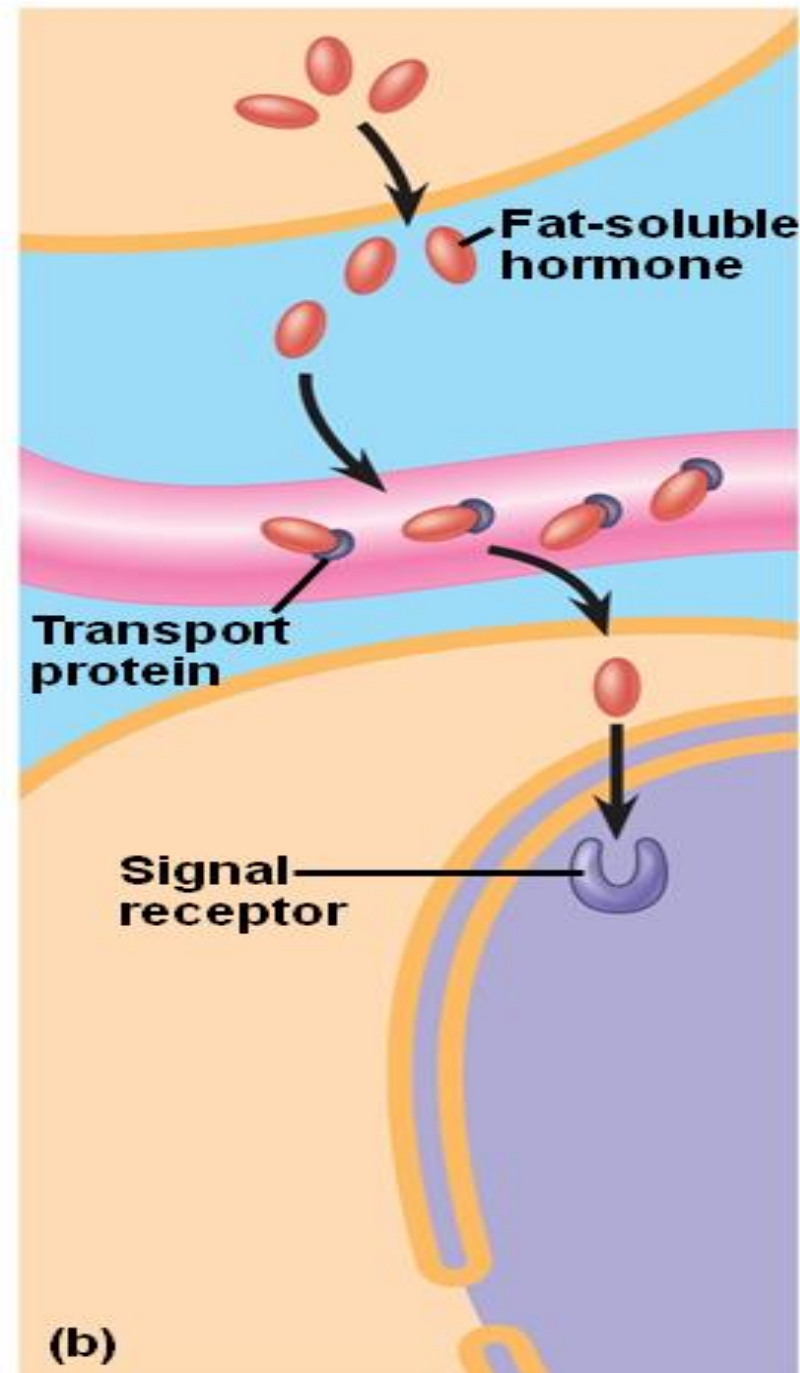
- Dissolved in plasma & transported from site of synthesis to target tissues.
- They diffuses out of capillaries into interstitial fluids & than to target organs .

Hormone Transport in the Blood,

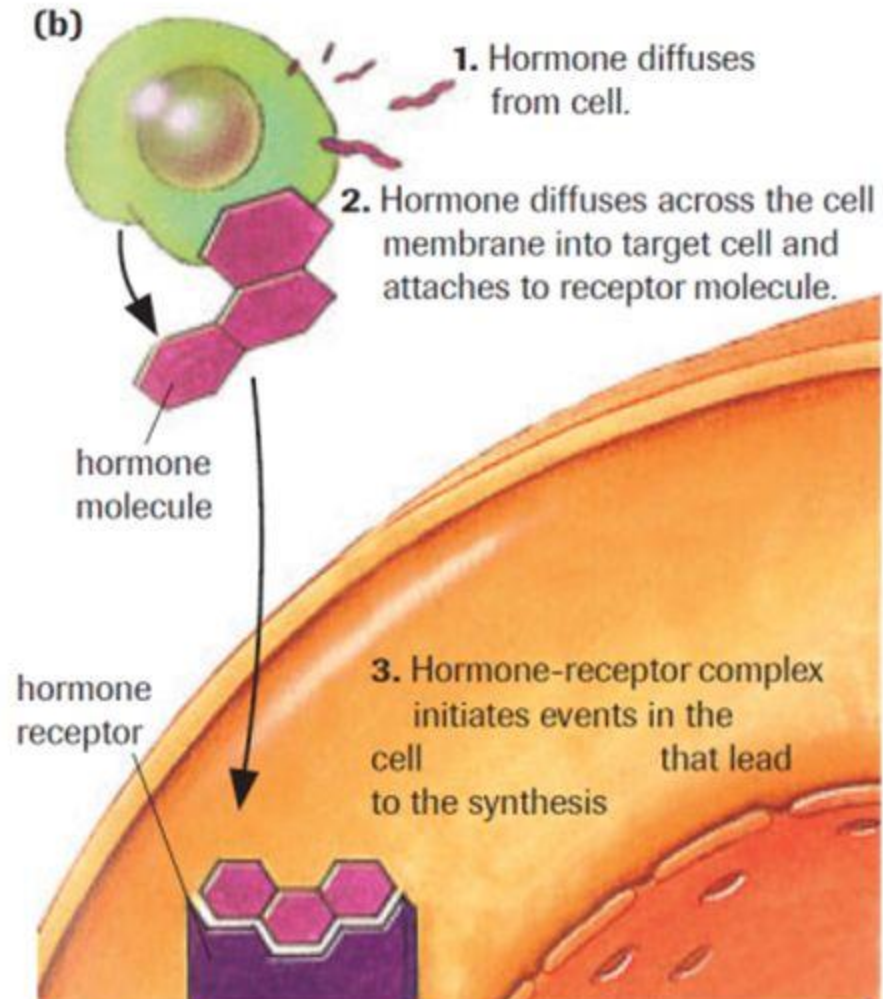
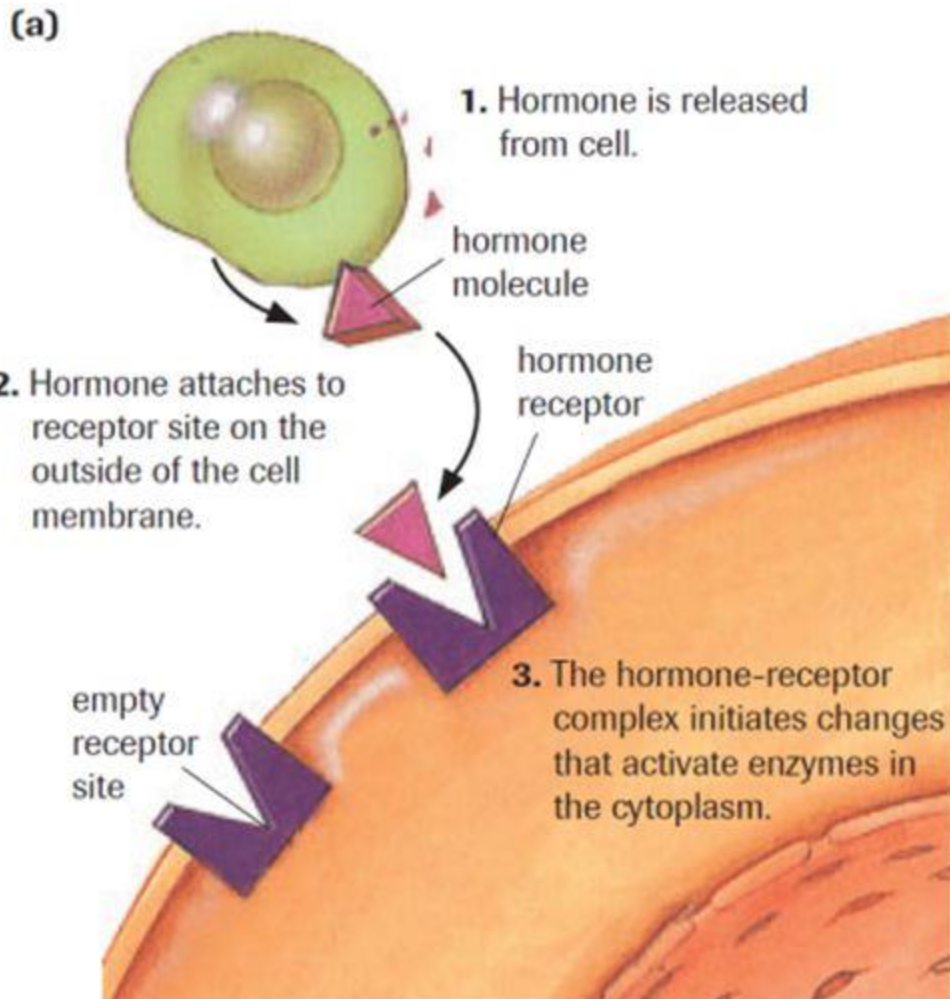


2. Steroid hormones:

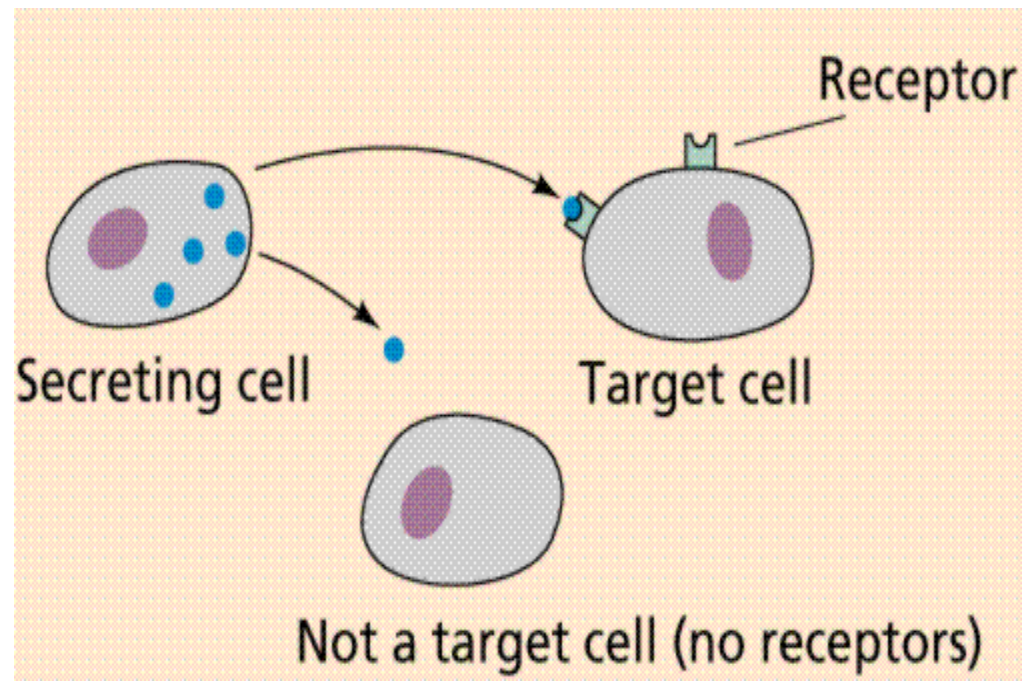
- Steroid hormones are less soluble in aqueous solution and over 90% circulate in blood as complexes bound to specific plasma globulins or albumin.
- In bound state they are biologically inactive, until they dissociate from plasma proteins.



Water-soluble vs. Lipid-soluble



- **Hormone specific receptors in target cell membrane and cytoplasm.**
- Receptors are highly specific for a single hormone, e.g estrogen concentrates in the specific receptor tissue of uterus.
- Target cell response.



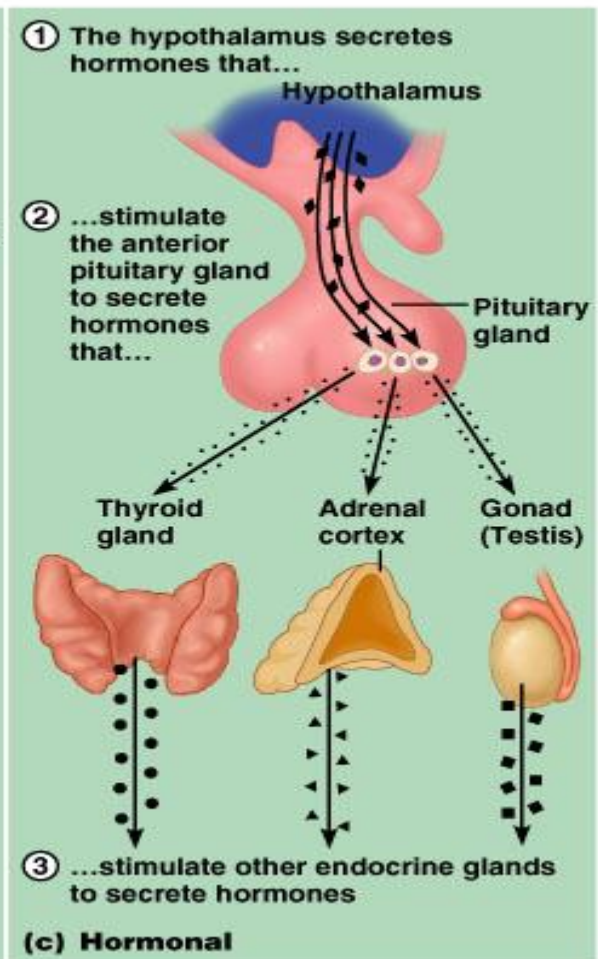
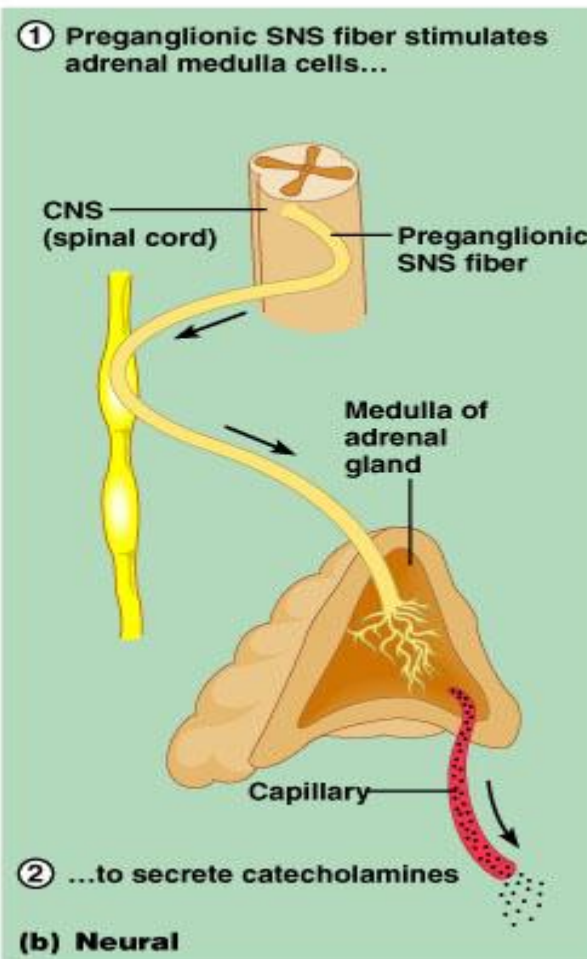
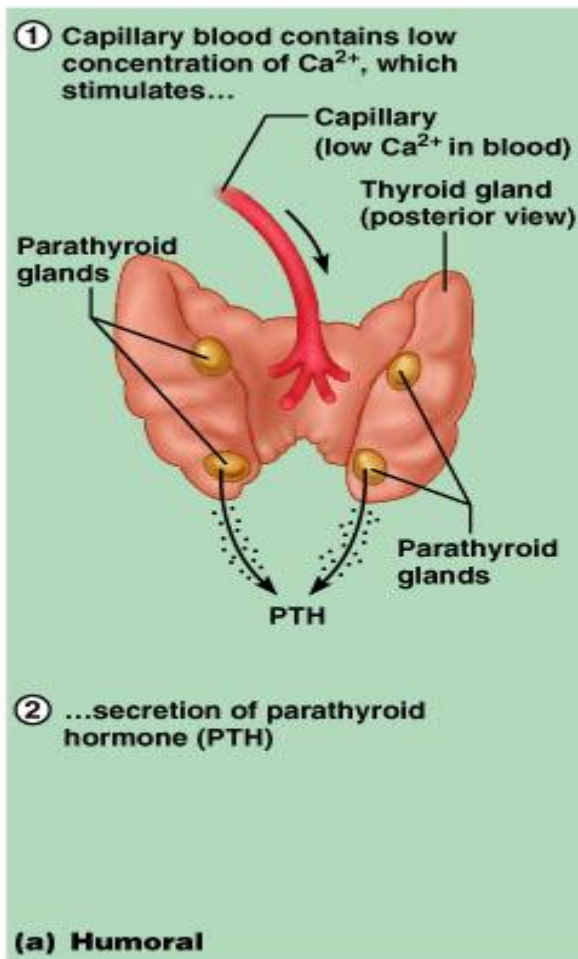
Clearance of hormones

- Metabolic destruction by the tissues.
- Binding with tissues.
- Excretion by liver into bile.
- Excretion by kidneys into urine.
- Sometimes degraded at their target cells by enzymatic process.

Regulation of hormone release

1. Neuroendocrinal control

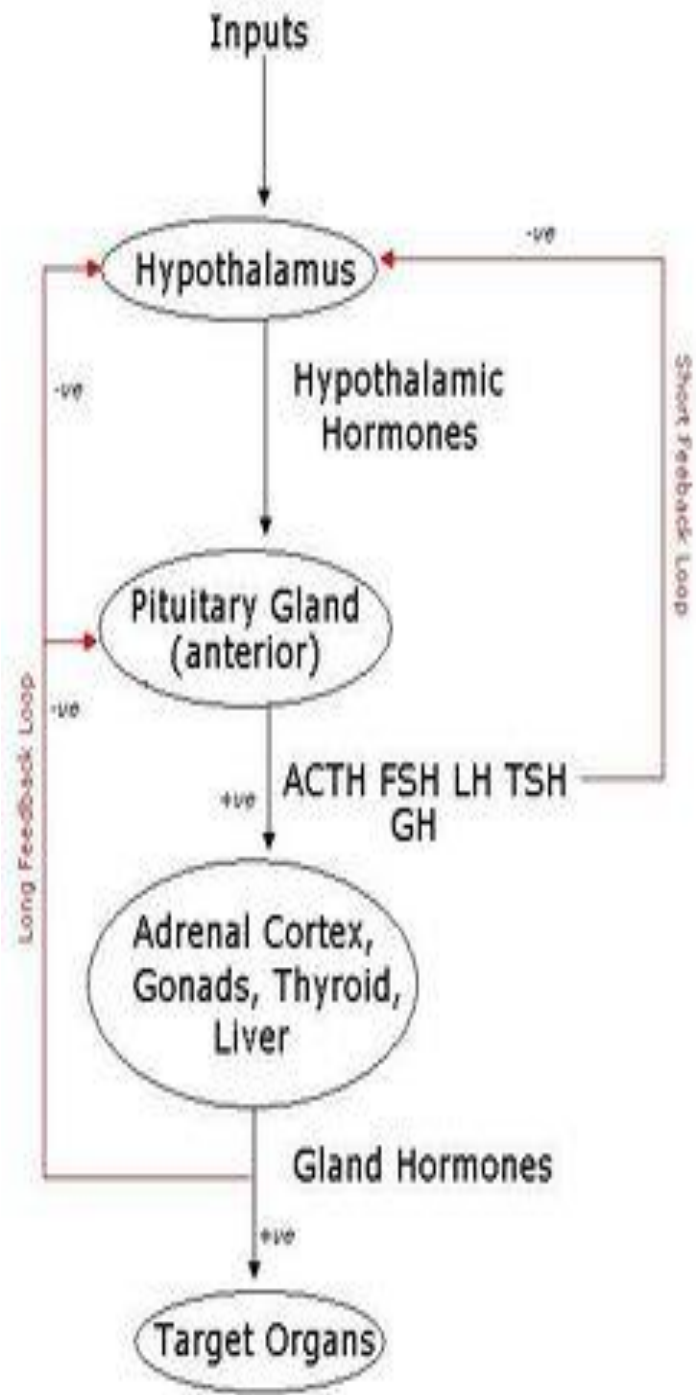
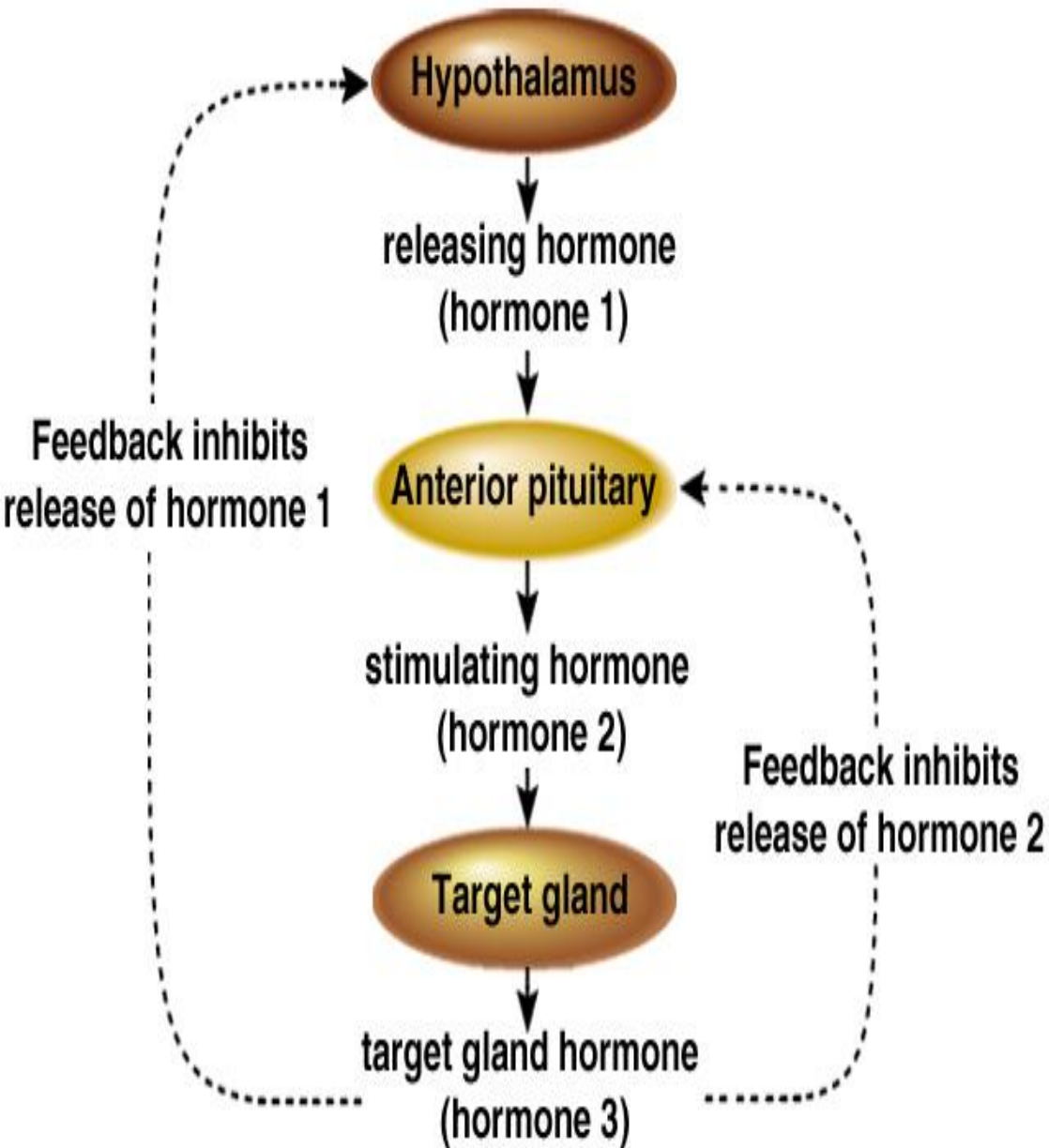
- (a) **Humoral:** in response to changing levels of ions or nutrients in the blood
- (b) **Neural:** stimulation by nerves
- (c) **Hormonal:** stimulation received from other hormones



2. Feedback control mechanism

- High blood level of target gland hormones, inhibit the secretion of the tropic hormone stimulating that gland.
- Adrenal cortex secrete cortisol which bring about the inhibition of secretion of corticotropin from ant. Pituitary and corticotropin releasing hormone from Hypothalamus.

Endocrine Glands



3. Endocrine rhythms

Circadian rhythm

Cyclic periodicity of 24 hrs

Infradian rhythm

More than 24 hrs

Ultradian rhythm

Less than 24 hrs.

Classification of hormones

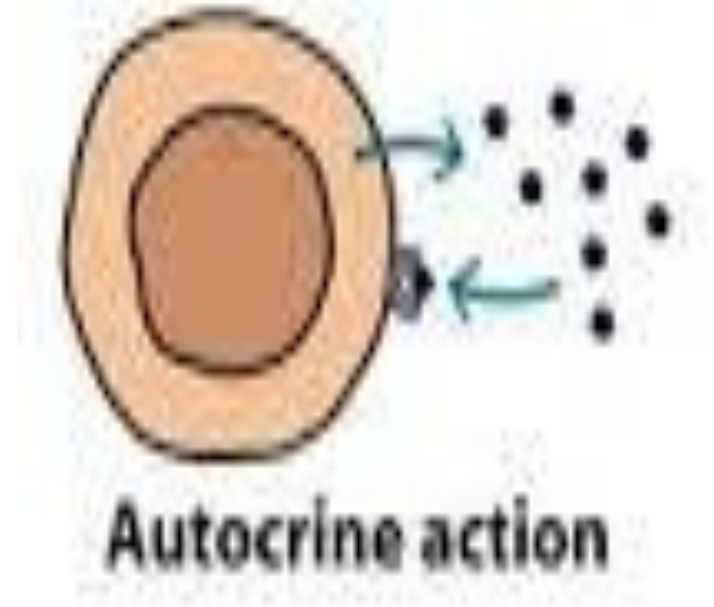
- Hormones are classified by various criteria:
 1. • By Proximity of their site of synthesis to their site of action.
 2. • By their chemical structure.
 3. • By their mechanism of action.
 4. By their site of production.

1. By Proximity of their site of synthesis to their site of action

Autocrine hormones

Act on the same cells from which they are synthesized.

e.g,interleuken2
(proteins that regulates the activities of leukocytes).



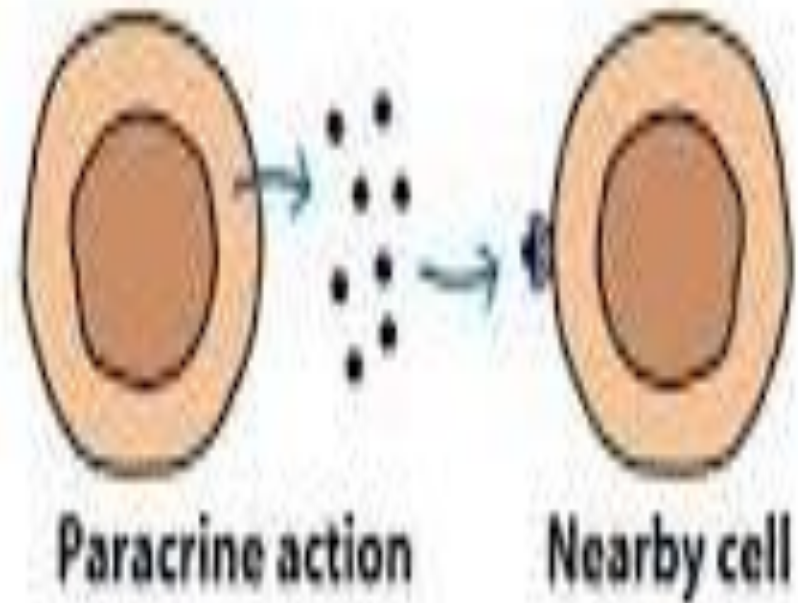
1. By Proximity of their site of synthesis to their site of action

Paracrines hormones

Act on the cell adjacent to the cells from where they are synthesized

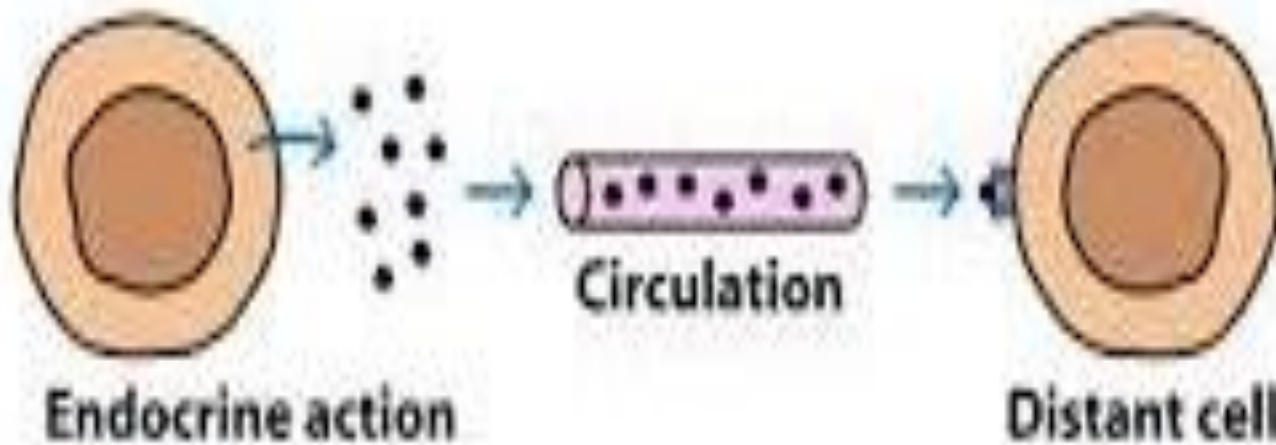
e.g. prostaglandins that cause inflammatory response.

Release of neurotransmitters at synapses in nervous system.



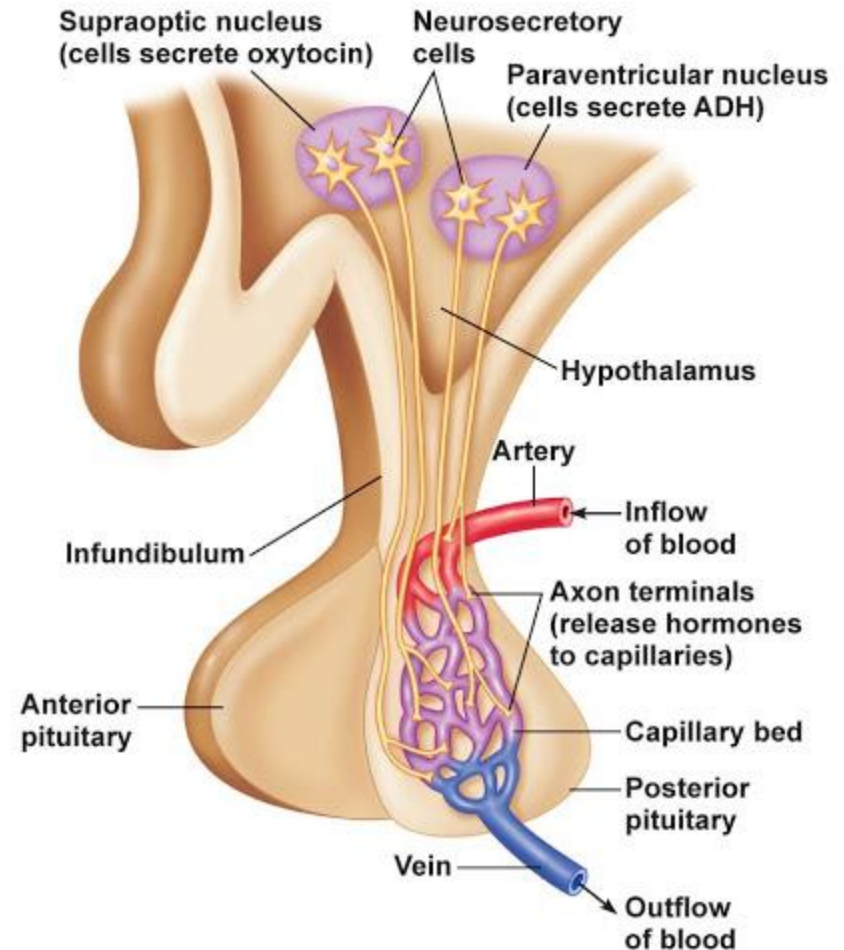
1. By Proximity of their site of synthesis to their site of action

- Endocrine hormone
- Produced by ductless endocrine glands.
- Mix to blood
- Have target organs e.g, LH, FSH, TSH.



1. By Proximity of their site of synthesis to their site of action

- Neuro endocrines
- Secreted by neurons into the circulating blood and influences the functions of target cells in other locations in the body.



2. Classification according to chemical nature

Peptides

- TRH (3 a.a)
- Secretin [34 a.a]
- Gastrin [34 a.a]
- ACTH {39 a.a}
- PTH [84a.a]
- Growth hormone {191 a.a}
- Oxytocin
- Vasopressin
- Calcitonin
- insulin

Glycoproteins

FSH
LH
TSH

common alpha different beta chain

peptide chains with disulfide bonds

2. Classification according to chemical nature

Steroids

Estrogen
testosterone
Cortisol
calcitriol

Aldosterone
corticosterone
Progesterone

Amino acid derivatives

Epinephrine
norepinephrine
dopamine

Thyroxine, T3 and T4
Melatonin
Serotonin

3. BASED ON MECHANISM OF ACTION

GROUP I: intracellular receptor (Lipophilic)

- Hormones bind to intracellular receptors (HRE in DNA) to form receptor hormone complexes to carry out the biochemical functions. They are derivatives of cholesterol, lipophilic in nature and possess long half lives.

GROUP II: surface receptor (Hydrophilic)

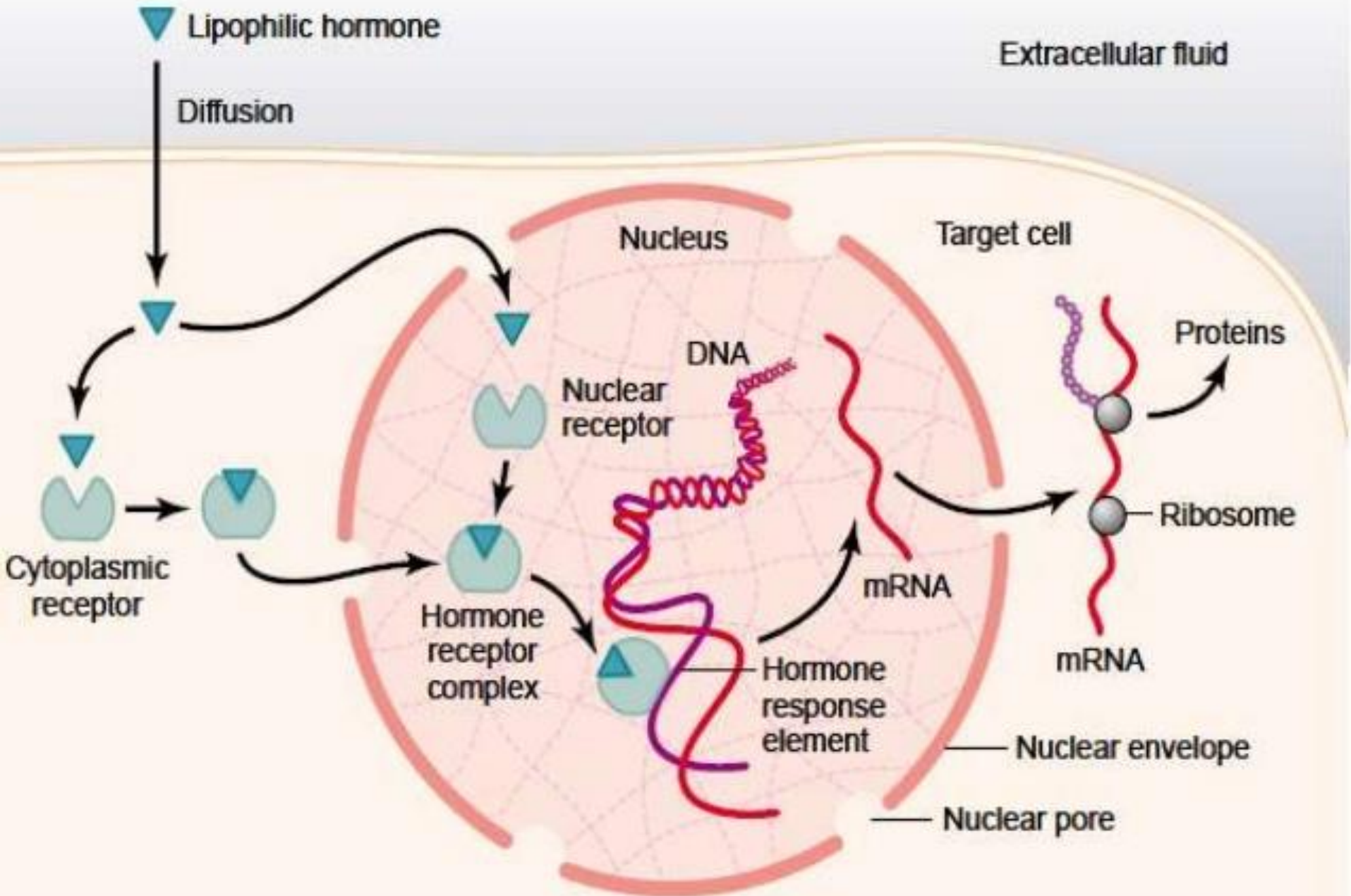
- These hormones bind to cell surface receptors and stimulate the release of second messengers which in turn perform the biochemical function. They are hydrophilic in nature and possess short half lives.

3. BASED ON MECHANISM OF ACTION

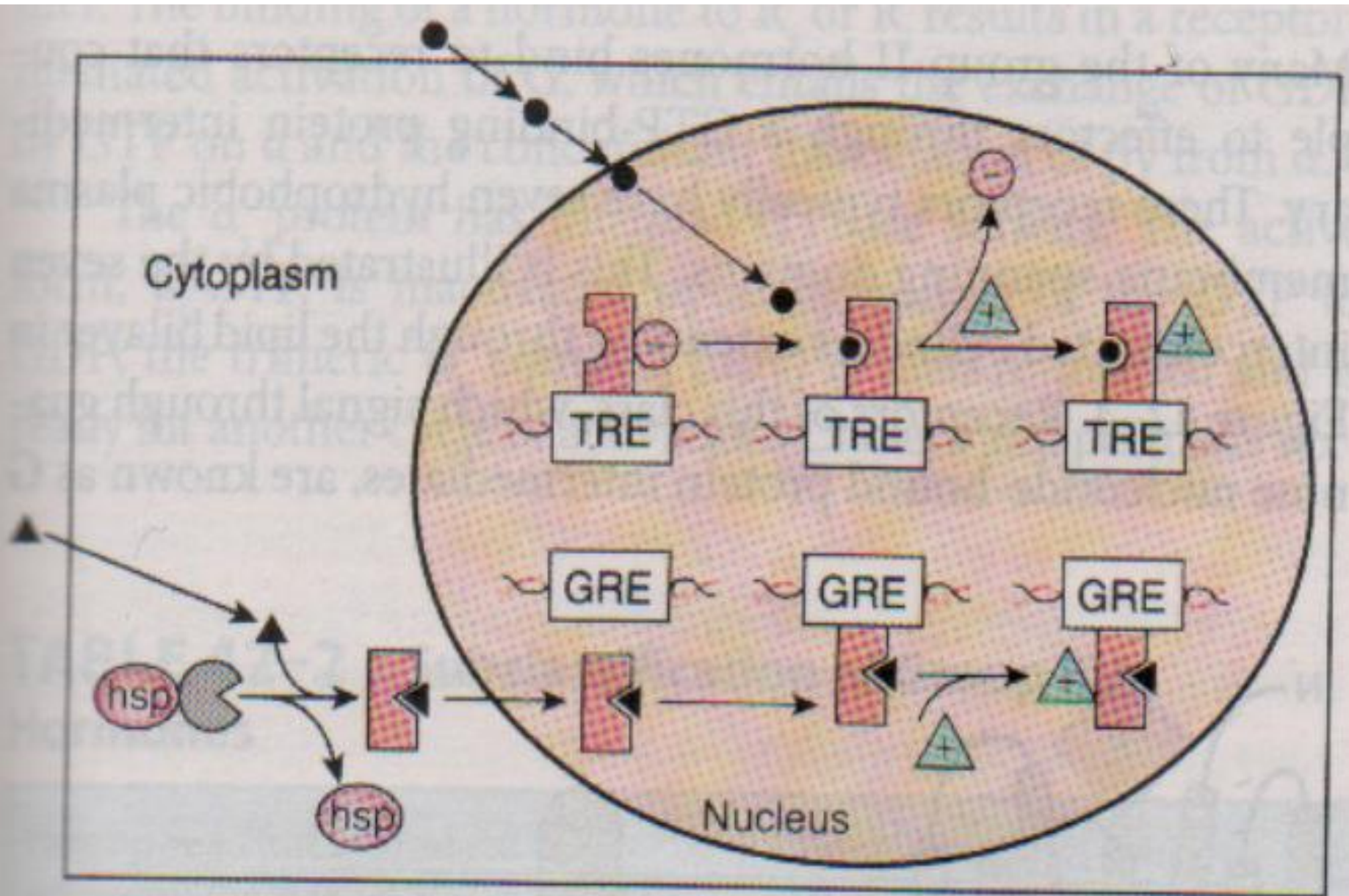
Group I Hormones

- Lipophilic in nature → cross plasma membrane by diffusion
- Act through intracellular receptors located either in cytosol or nucleus
- Duration of action is hours to days
- Hormone first binds with receptor → forms HR-complex → binds with the specific region on the DNA called hormone responsive element (HRE) → causes increased expression of specific genes → transcription → translation → production of specific proteins → carries biochemical action of hormone

Group 1 hormones



Group I hormones



3. BASED ON MECHANISM OF ACTION

Group-I hormones

Hormones bind with HRE in DNA

- Estrogens
- Progestin
- Androgens
- Glucocorticoids
- Mineralocorticoids
- Calcitriol
- Thyroid Hormones

Mechanism of Hormone action of group II hormones

GROUP II HORMONES

- These hormones are considered as first messenger
- Hormone binds to surface receptors
- Carry the action through mediatory molecules (second messengers)
- Hormones → First messenger → Second messenger → Activation of protein kinase → phosphorylation of enzyme → biochemical action.

THANK

YOU!!!

Recommended books

- Chatterjea
- lippencott,s
- Harper