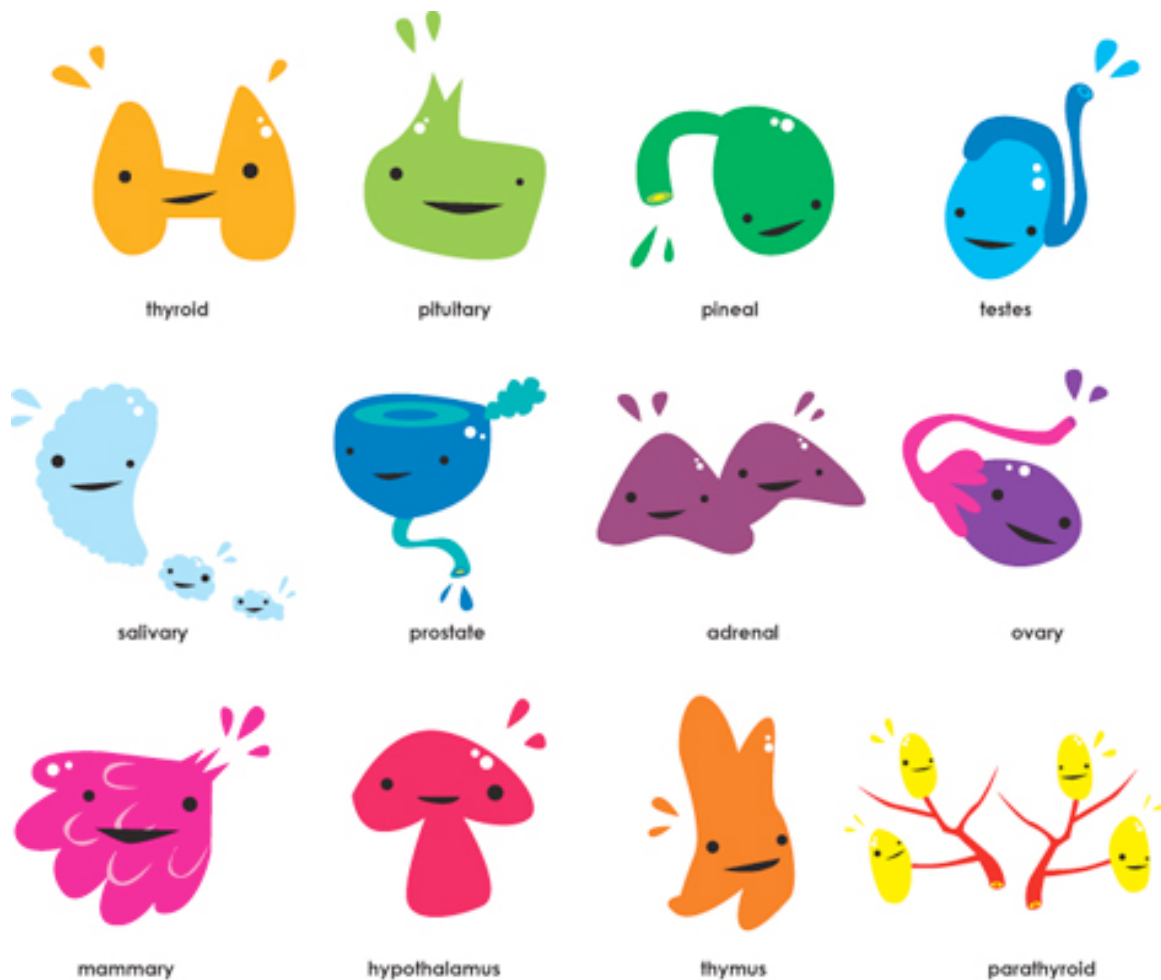


LECTURE 1: INTRODUCTION TO ENDOCRINE SYSTEM

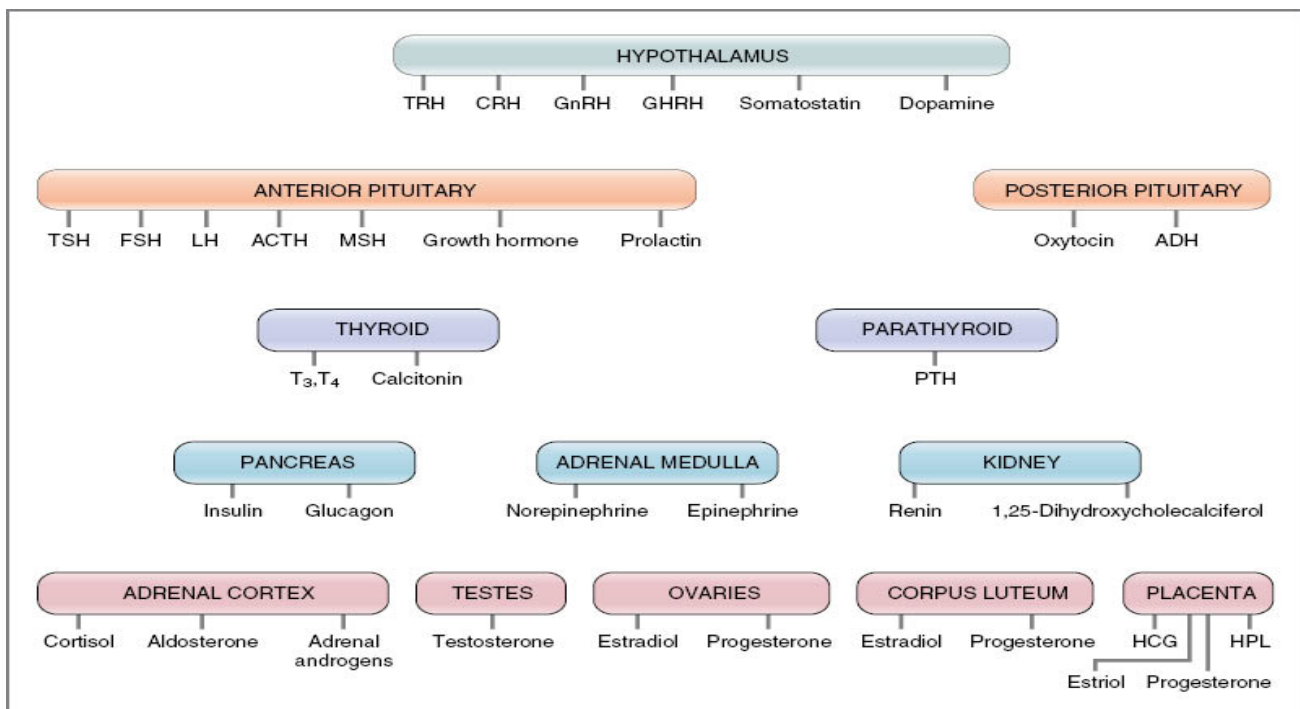
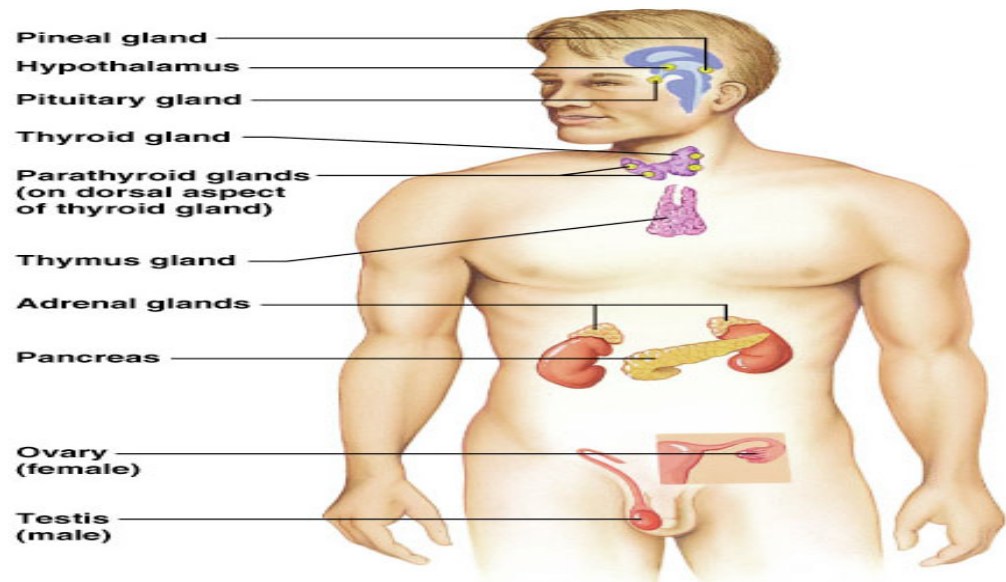


*Note: This is a rearrangement of the slides + Few notes
notes are in purple*

IBRAHIM ALSHIDDI . ISMAIL RASLAN . TAMARA ALHOBAYB
ABDULLAH ALOGAYIL . TARIQ ALZAHAM . MOHAMMED ALMOMI

- GLANDS**
- Exocrine gland: secrete its hormones in specific ducts, e.g. salivary gland.
 - Endocrine gland: secrete its hormones directly in blood [ductless gland]

ENDOCRINE GLANDS



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☼ Definition of hormone.

What is hormone?.

- **Chemical substance** secreted in a small amount from endocrine gland directly to the blood stream in response to **stimulus** to cause **physiological responses at the target tissues**.

Table 9-1 Commonly Used Abbreviations in Endocrine Physiology

Abbreviation	Hormone	Abbreviation	Hormone
ACTH	Adrenocorticotrophic hormone	LH	Luteinizing hormone
ADH	Antidiuretic hormone	MIT	Monoiodotyrosine
CRH	Corticotropin-releasing hormone	MSH	Melanocyte-stimulating hormone
DHEA	Dehydroepiandrosterone	PIF	Prolactin-inhibiting factor
DIT	Diiodotyrosine	POMC	Pro-opiomelanocortin
DOC	11-Deoxycorticosterone	PTH	Parathyroid hormone
FSH	Follicle-stimulating hormone	PTU	Propylthiouracil
GHRH	Growth hormone-releasing hormone	SRIF	Somatotropin release-inhibiting factor
GnRH	Gonadotropin-releasing hormone	T ₃	Triiodothyronine
HCG	Human chorionic gonadotropin	T ₄	Thyroxine
HGH	Human growth hormone	TBG	Thyroxine-binding globulin
HPL	Human placental lactogen	TRH	Thyrotropin-releasing hormone
IGF	Insulin-like growth factor	TSH	Thyroid-stimulating hormone

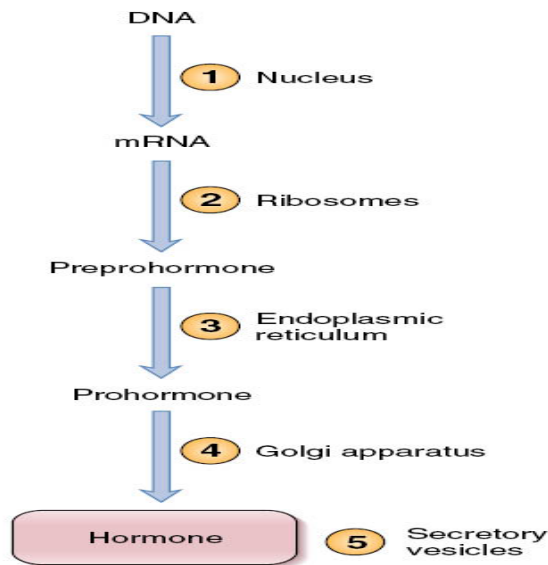
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☼ CHEMICAL CLASSIFICATION OF HORMONES

Peptides or proteins hormones	Steroid hormones	Amine hormones
<ul style="list-style-type: none"> - Most hormones are peptides or proteins. - Example: Prolactin * Memorize steroid and amine hormones & everything else's peptide or protein. * all hypothalamus & pituitary hormones are peptides or proteins. 	<ul style="list-style-type: none"> - Derived from cholesterol - Secreted by adrenal cortex, gonads, corpus luteum & placenta [sex hormones] -Steroid hormones are: <ol style="list-style-type: none"> 1- cortisol 2-aldosterone 3- Estradiol & estriol 4- Progesterone 5- Testosterone 	<ul style="list-style-type: none"> - Derived from the amino acid tyrosine. - Amine hormones are: <ol style="list-style-type: none"> 1- Catecholamine [Epinephrine, norepinephrine & dopamine] 2- Thyroid hormones [T3 & T4]

•Hormone Synthesis:

PEPTIDE HORMONE SYNTHESIS



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Steps of peptide hormone synthesis:

1-In the nucleus, the gene for the hormone is transcribed into a mRNA .

2- The mRNA is then transferred to the cytoplasm and translated on the ribosomes to the first protein product which is called **preprohormone**.

3-In the endoplasmic reticulum , the preprohormone is converted to a **prohormone**. The prohormone contains the complete hormone sequence + other peptide sequences.

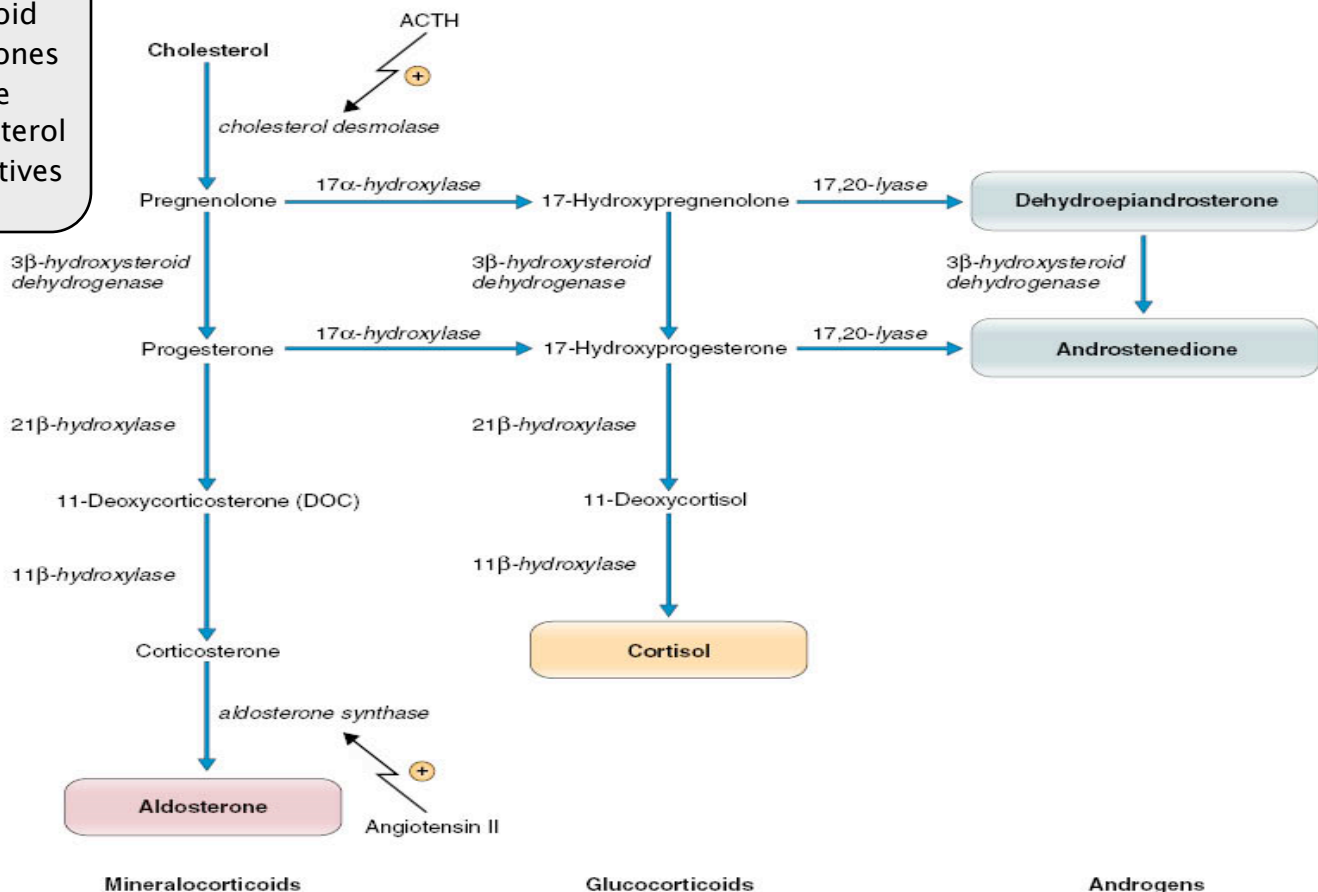
4-The prohormone is transferred to the golgi apparatus, where it is packaged in secretory vesicles. The final hormone will be produced by cleaving the other peptide sequences.

5-The final hormone is stored in secretory vesicles until the endocrine cell is stimulated .

Steroid Hormones

Note all steroid hormones are cholesterol derivatives

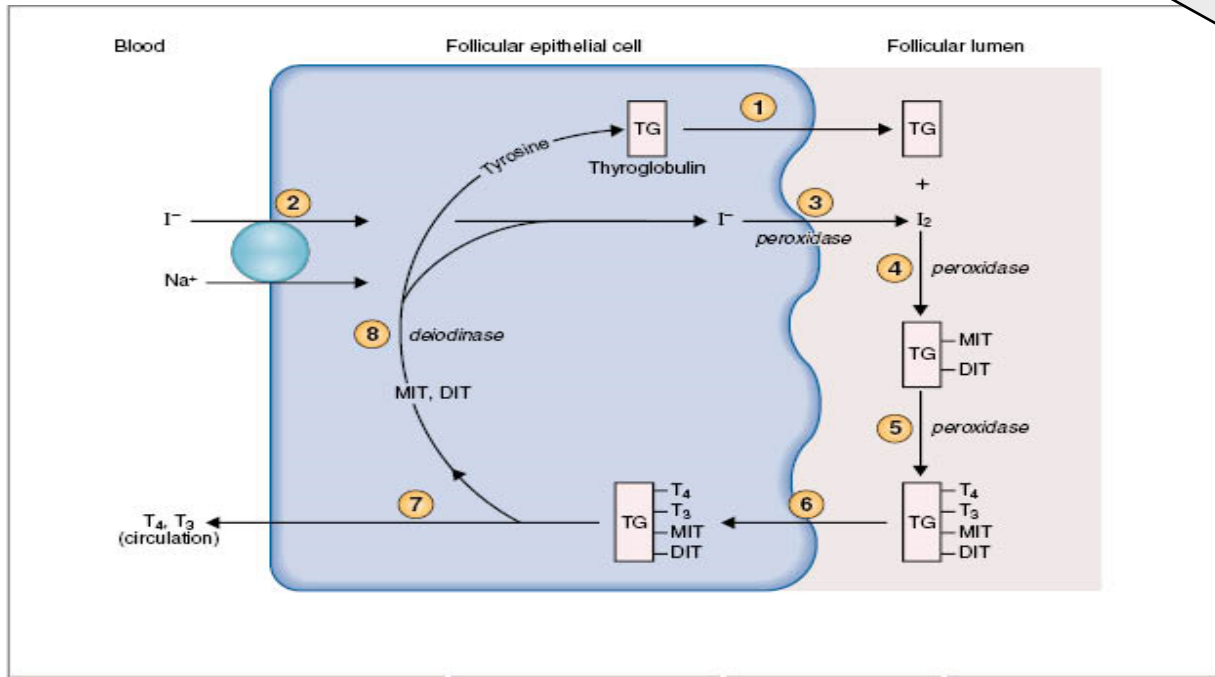
BIOSYNTHESIS OF ADRENOCORTICAL HORMONES



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Probably will be explained in **thyroid** lecture

Amine Hormones



CLASSIFICATION OF STIMULI:

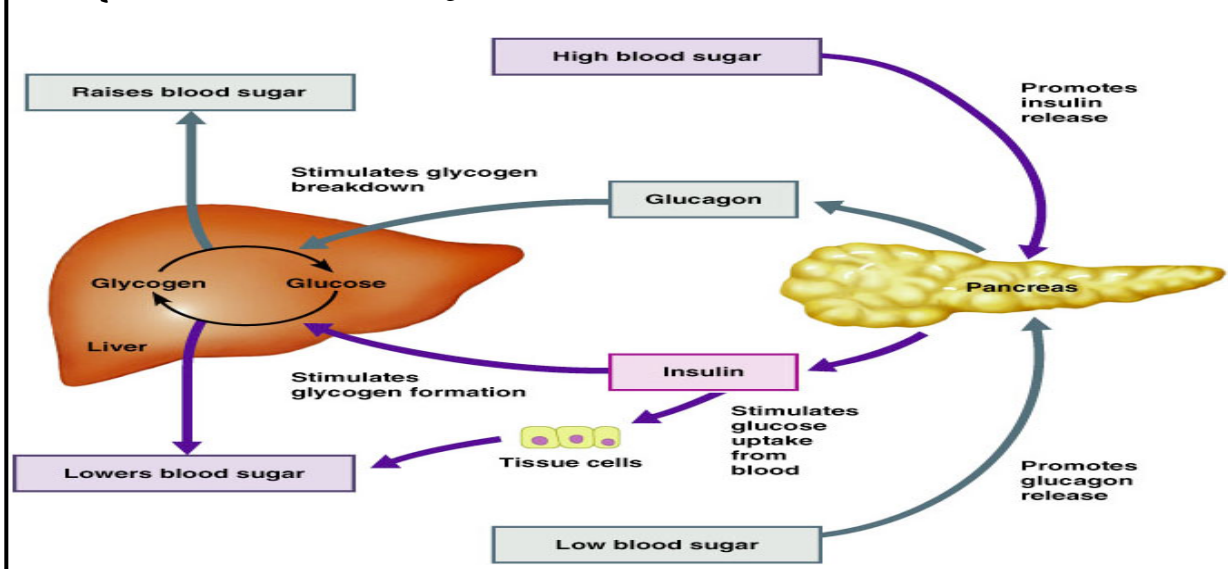
- Humoral Stimuli.
- Neural Stimuli.
- Hormonal Stimuli.

♦ Humoral Stimuli:

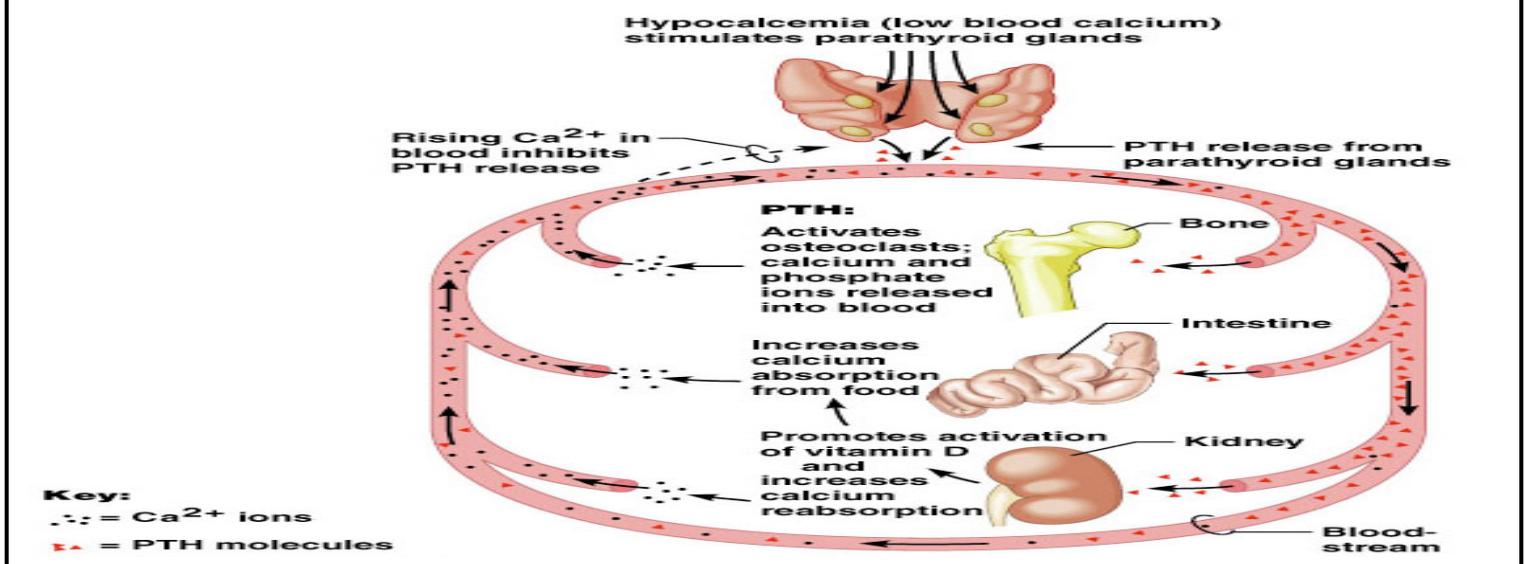
- Secretion of hormones in direct response to changing in blood levels of ions and nutrients

"a change in blood levels of ions and nutrients would directly stimulate the secretions of

Examples: 1) Insulin-Glucagon secretion



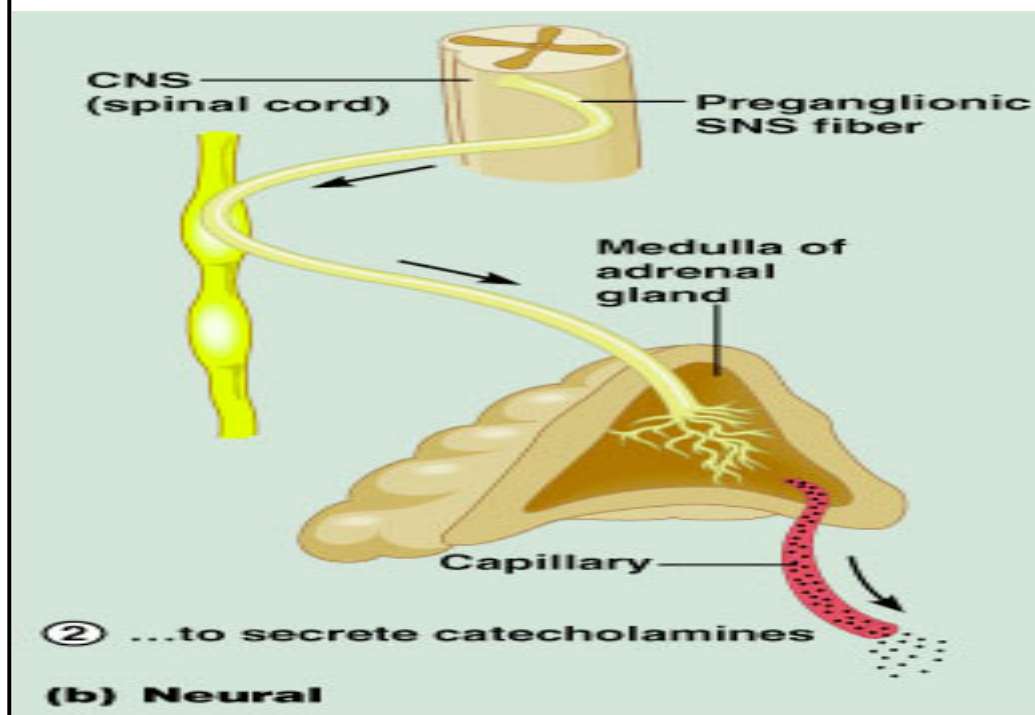
2) Parathyroid Hormone secretion:



♦ Neural Stimuli:

- Nerve fibers stimulate hormone release.

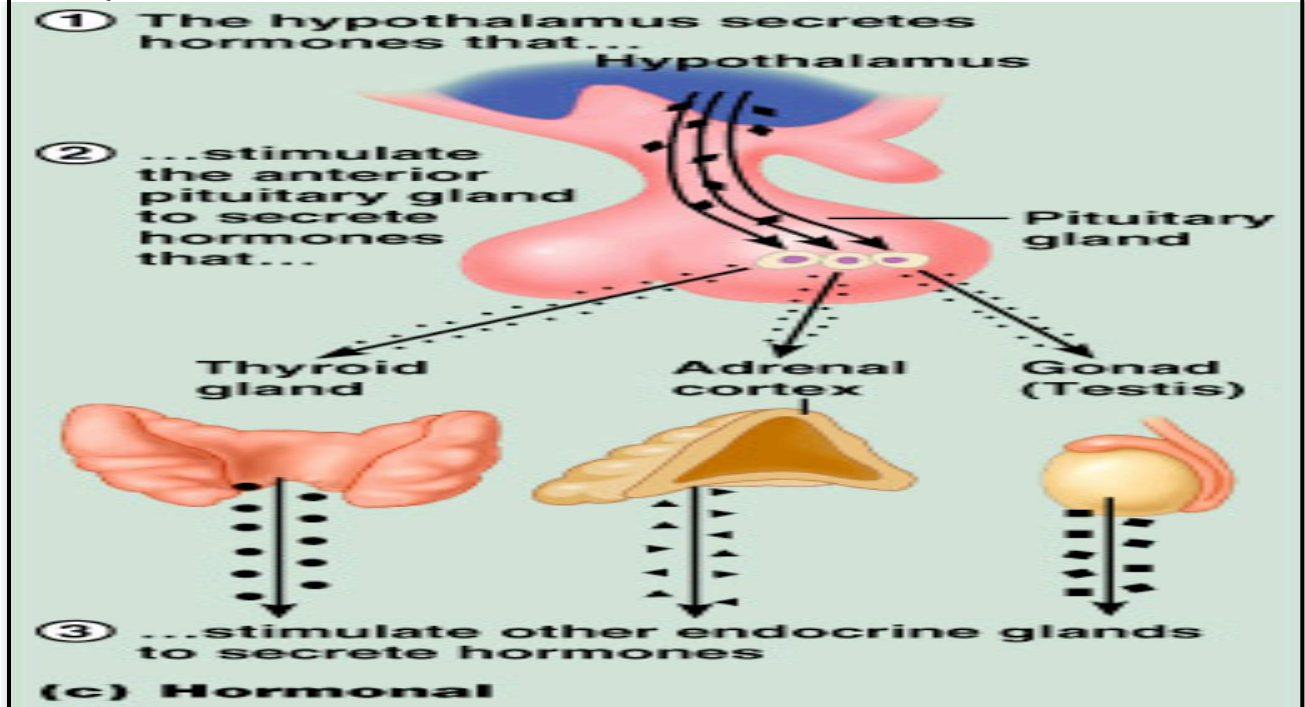
Example: Catecholamine secretion.



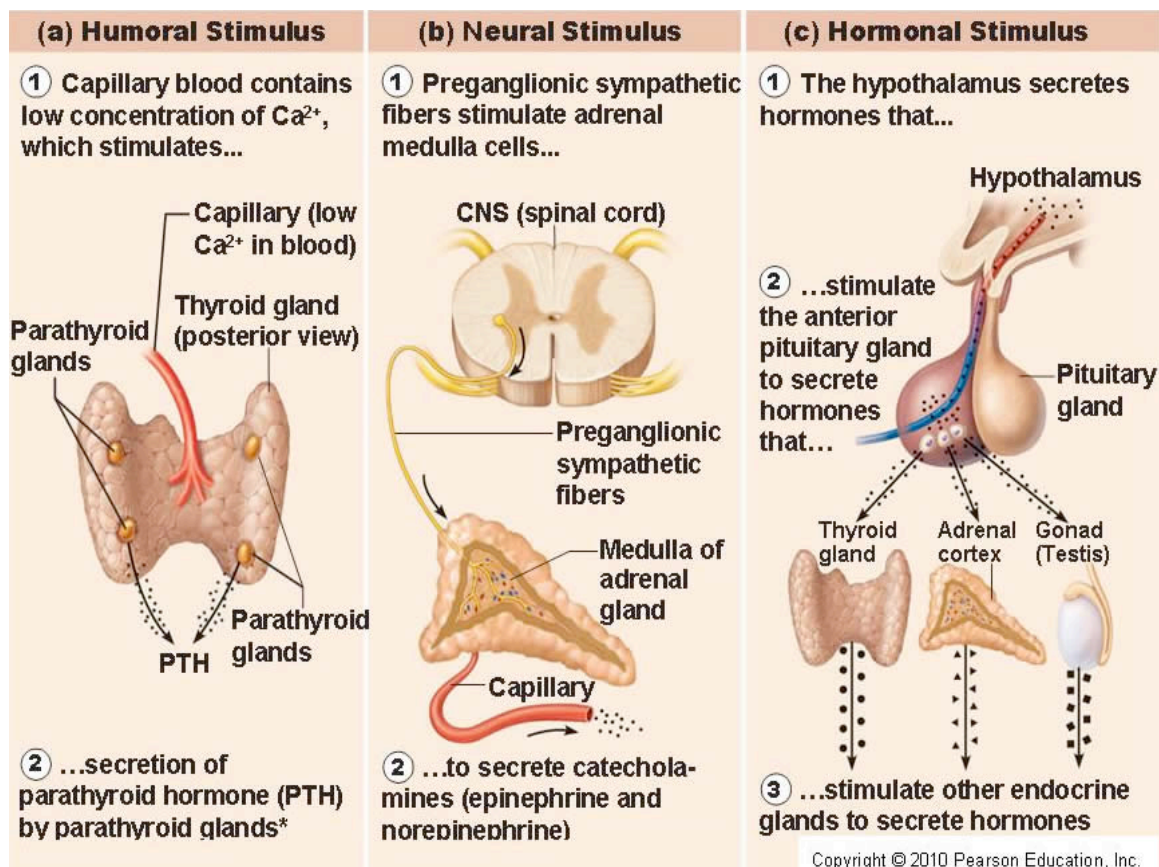
♦ Hormonal Stimuli:

- Release of hormones in response to hormones produced by other endocrine gland.

Example: Anterior Pituitary hormones secretion



Summary

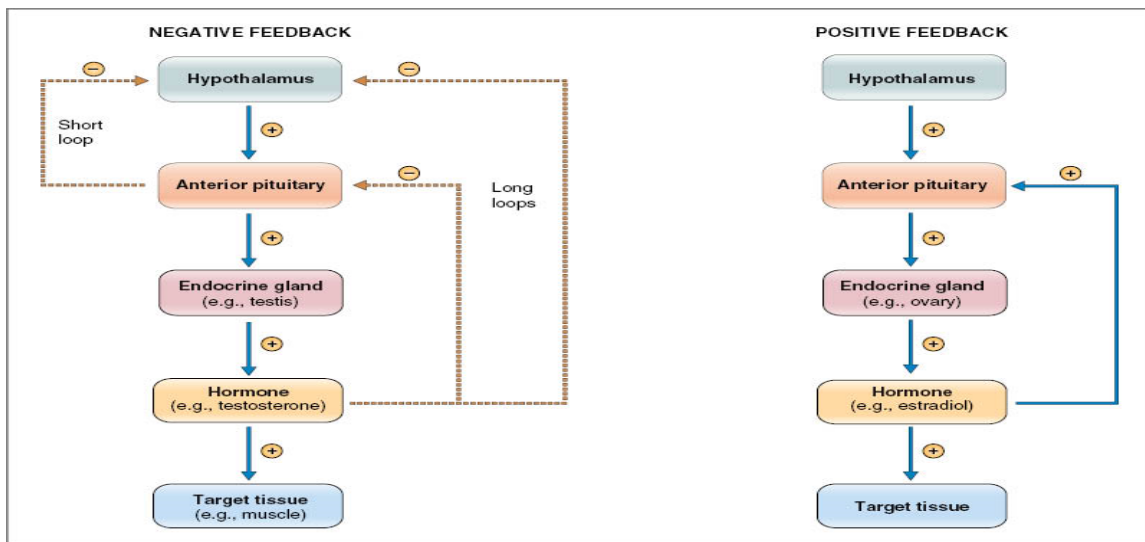


☼ REGULATION OF HORMONE SECRETION:

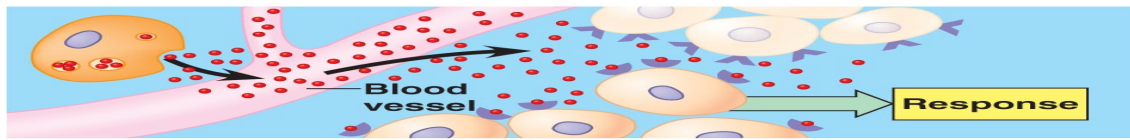
- Neural mechanism.
- Feedback mechanism.

♦ **NEURAL MECHANISM:** neurons stimulate gland to secrete their hormones, e.g. catecholamine secretion from adrenal medulla is stimulated by sympathetic ganglia cells.

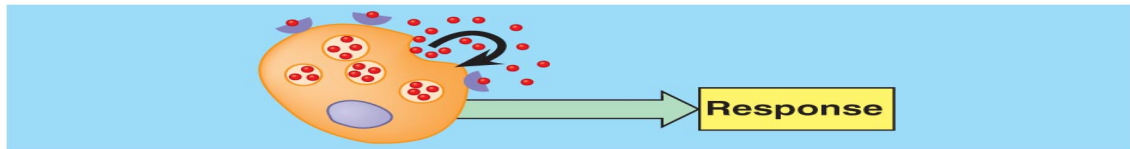
♦ **FEEDBACK MECHANISM:**



- **Autocrines [Ultrashort loop]:** chemicals that exert their effects on the same cells that secrete them. [e.g. GnRH inhibits its secretion from hypothalamus]
- **Paracrines [Short loop]:** locally acting chemicals that affect cells other than those that secrete them. [e.g. FSH & LH inhibit GnRH secretion from hypothalamus]
- **Long loop:** hormones from gland act on the gland directly stimulating or inhibiting it, e.g. Testosterone inhibits secretion of LH from pituitary. Another example is LH inhibiting GnRH secretion from hypothalamus.

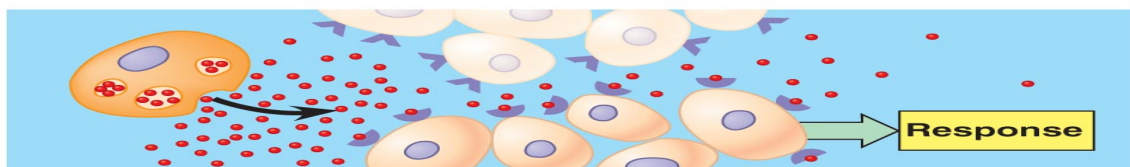


(a) Endocrine signaling



(c) Autocrine signaling

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(b) Paracrine signaling

☼ **TARGET TISSUE:** tissues that have the receptor for certain hormone.

☼ **MECHANISM OF ACTION:**

- Receptors + hormone → conformational changes → ????? → action

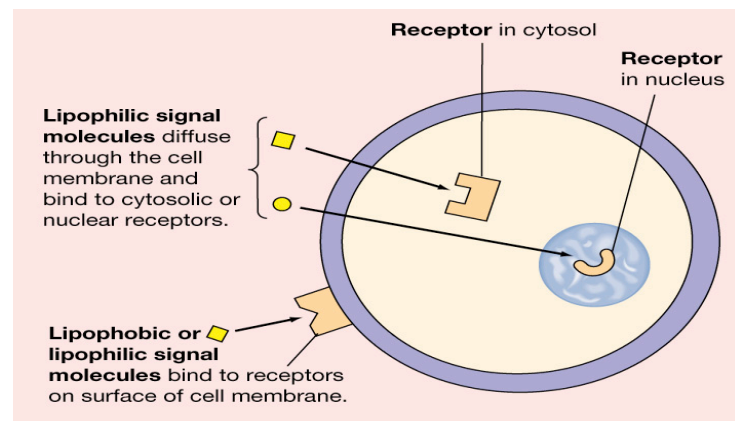
◆ **Receptor Locations:**

- **Cytosolic or Nuclear**

- Lipophilic ligand enters cell
- Often activates gene
- Slower response
- Steroid hormone mechanism

- **Cell membrane**

- Lipophobic ligand can't enter cell
- Outer surface receptor
- Fast response
- Adenyl cyclase, phospholipase C & tyrosine kinase mechanisms



AFTER THE HORMONE BIND TO A RECEPTOR IT DOES ITS EFFECT BY EITHER :

1- DIRECTLY [NUCLEAR RECEPTORS] EXAMPLE: STEROID & AMINE HORMONES

2- BY SECOND MESSENGER

a)Adenylyl Cyclase mechanism [cAMP is the 2nd messenger]

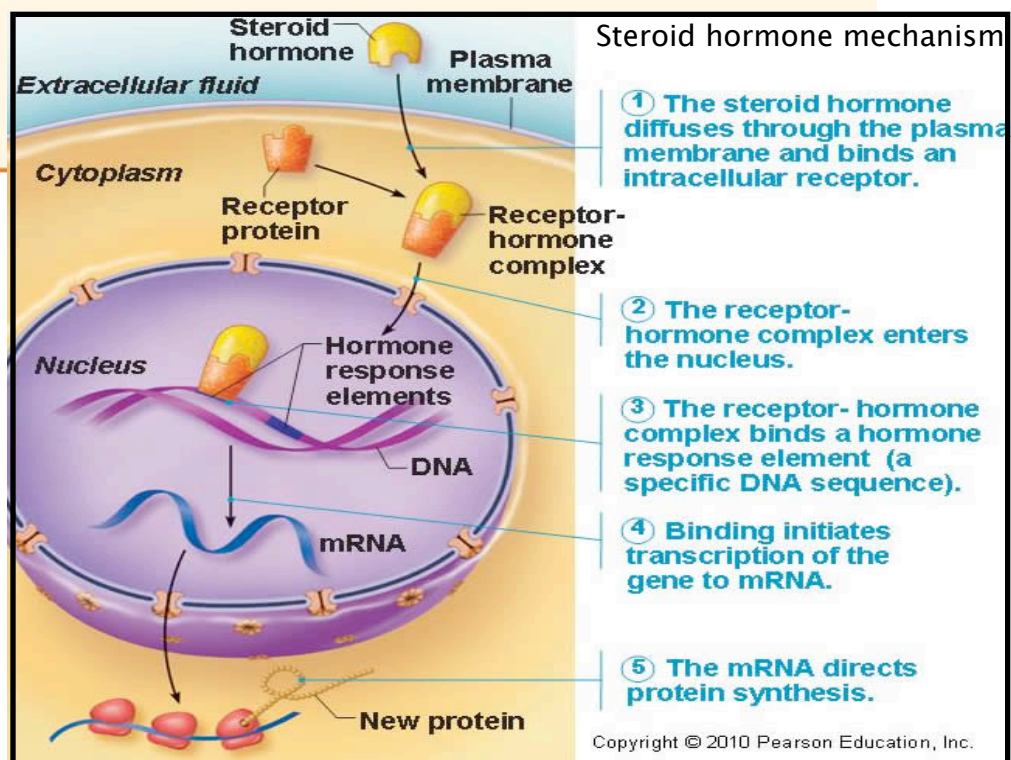
b)Phospholipase C mechanism [Ca^{2+} \ IP3 are the 2nd messengers]


c)Tyrosine kinase system (mainly used by Insulin)

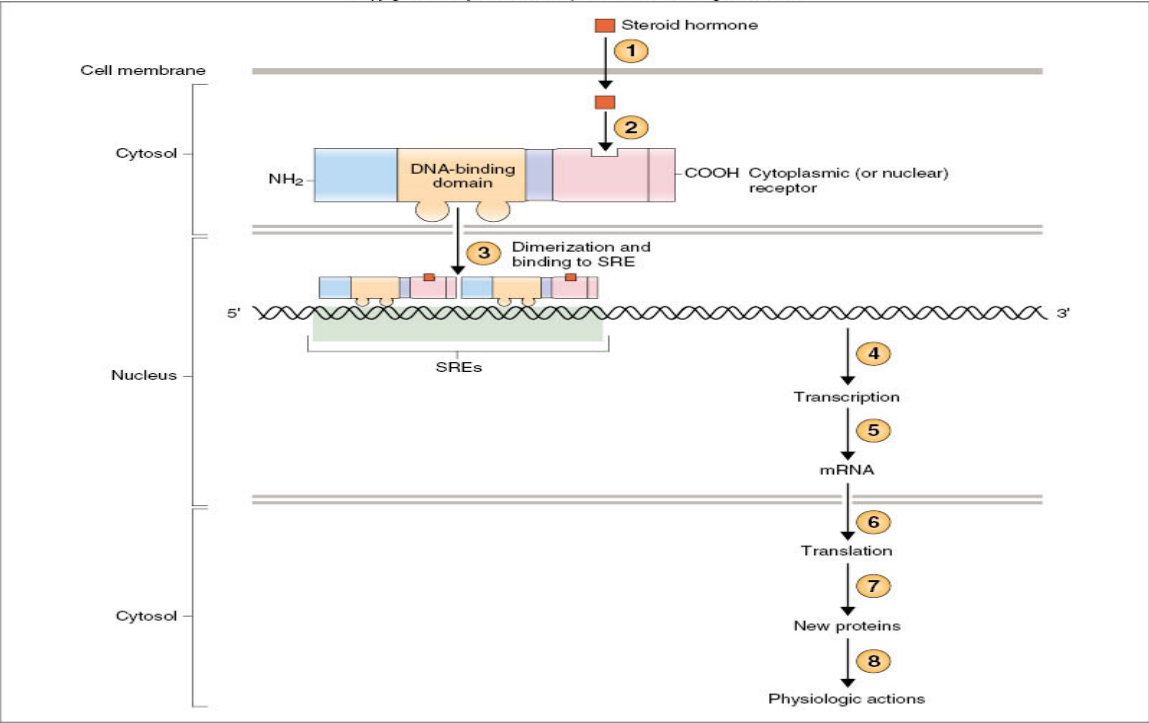
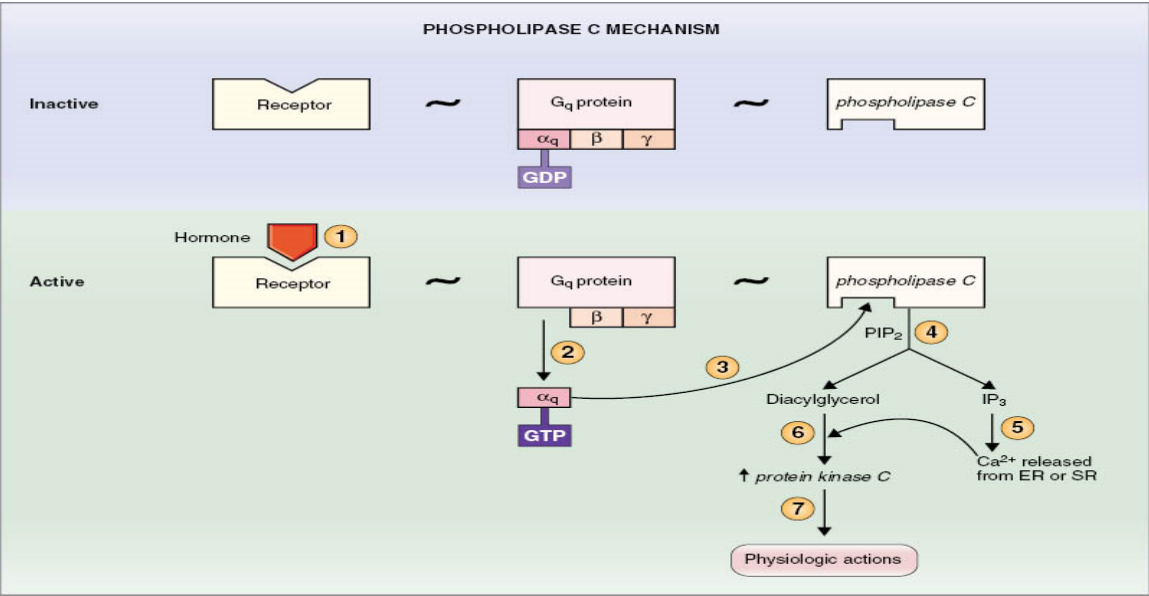
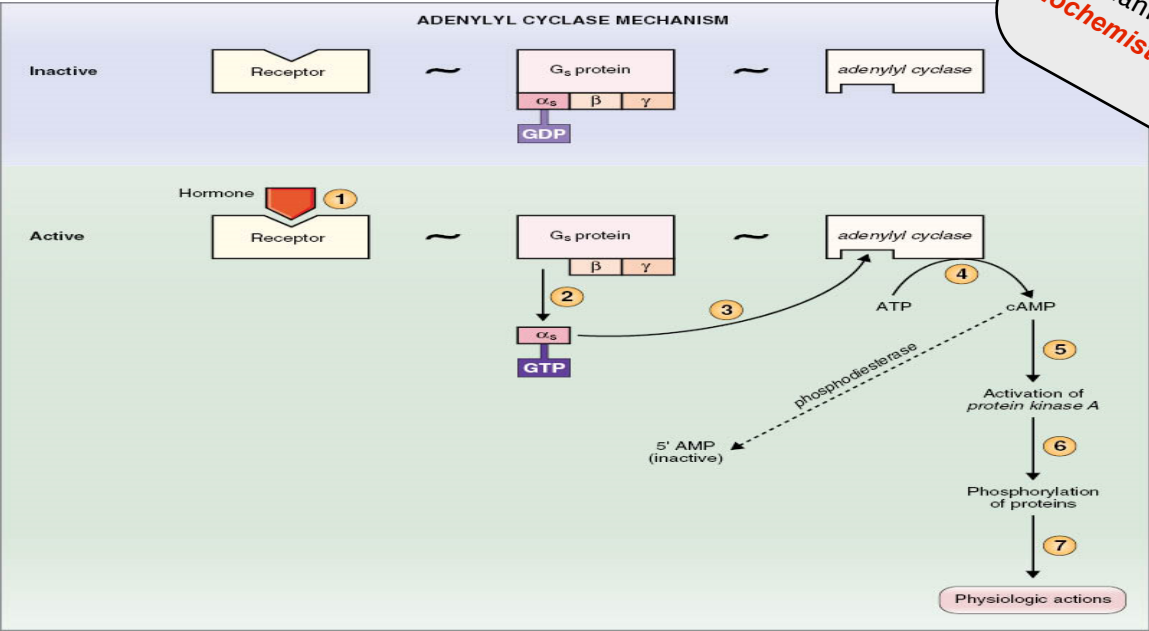
d)Guanylate cyclase mechanism [cGMP is the 2nd messenger]

Table 9-3 Mechanisms of Hormone Action

Adenylyl Cyclase Mechanism (cAMP)	Phospholipase C Mechanism ($\text{IP}_3/\text{Ca}^{2+}$)	Steroid Hormone Mechanism	Tyrosine Kinase Mechanism	Guanylate Cyclase Mechanism (cGMP)
ACTH	GnRH	Glucocorticoids	Insulin	Atrial natriuretic peptide (ANP)
LH	TRH	Estrogen	IGF-1	Endothelial-derived relaxing factor (EDRF)
FSH	GHRH	Progesterone		Nitric oxide (NO)
TSH	Angiotensin II	Testosterone		
ADH (V_2 receptor)	ADH (V_1 receptor)	Aldosterone		
HCG	Oxytocin	1,25-Dihydroxycholecalciferol		
MSH	α_1 Receptors	Thyroid hormones		
CRH				
Calcitonin				
PTH				
Glucagon				
β_1 and β_2 receptors				




 Mechanisms are explained in
biochemistry lecture



☼ REGULATION OF HORMONE RECEPTORS

- **Dose-response relationship.** [\uparrow dose \gg \uparrow effect until maximum effect is reached]
- **Sensitivity.** [hormone concentration that produce 50% of the maximum effect. If low concentration is needed to reach max. effect, it means more sensitivity of that receptor to that hormone]
 - Sensitivity depends on **Number of receptors** and **Affinity of the receptor for the hormone.**

◆ DOWN-REGULATION [decrease in the number or affinity of receptors]

- It's achieved by either:

- **Decrease synthesis of receptors. or**
- **Increase degradation of receptors.**
- **Inactivation .**
- **Examples:** 1) T3 [\downarrow sensitivity of TRH receptors in anterior pituitary]
2) progesterone [\downarrow sensitivity of its own receptors in the uterus]

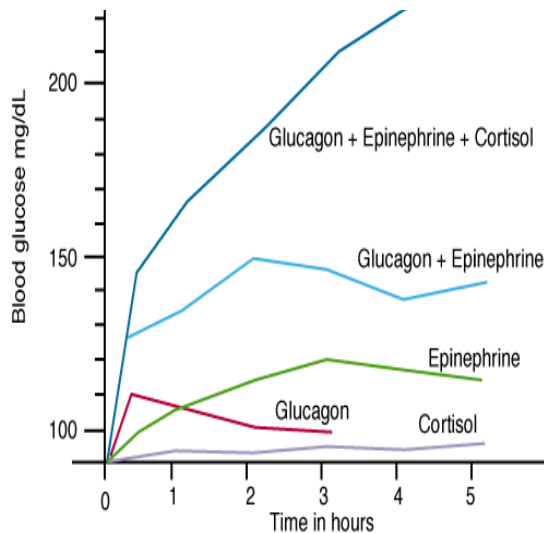
◆ UP-REGULATION [increase in the number or affinity of receptors]

- It's achieved by either:

- **Increase synthesis of receptors. or**
- **Decrease degradation of receptors.**
- **activation .**
- **Examples:** 1) Estrogen [\uparrow sensitivity of its own receptors in the uterus] ,
2) GH [\uparrow sensitivity of its own receptors in skeletal muscle] ,
3) prolactin [\uparrow sensitivity of its own receptors in breast]

☼ INTERACTION OF HORMONES AT TARGET CELLS:

- **Permissiveness** (Thyroid hormone have permissive effect on growth hormone action = GH only functions when thyroid hormone is there)
- **Synergism** (glucagon, cortisol and epinephrine increase the effect of each other, see graph) Think of it as $1+1=3$ or $2+2=5$;P
- **Antagonism** (Glucagon /insulin)



☼ HORMONE CONCENTRATIONS IN THE BLOOD:

- Concentrations of circulating hormone reflect:
 - Rate of release.
 - Speed of inactivation and removal from the body.
- Hormones are removed from the blood by:
 - Degrading enzymes
 - The kidneys
 - Liver enzyme systems

Source: Physiology by Linda Costanzo

Doctor's Handouts