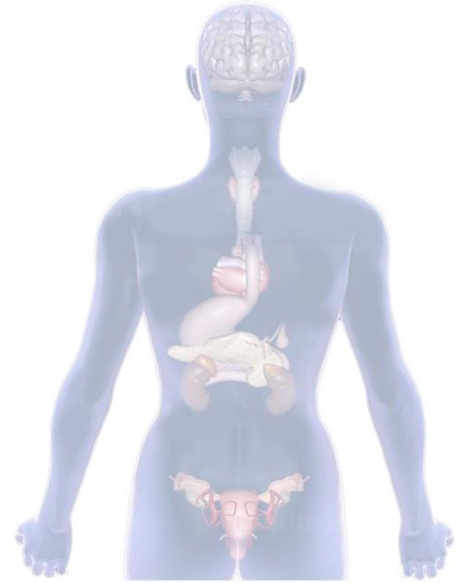


#1 Introduction to Endocrine Physiology

objectives :

- Describe autocrine, paracrine, and endocrine signaling.
- List the endocrine glands in the body and their secreted hormones.
- Define the terms hormone, target cell, and receptor.
- Classify hormones based on their chemical nature.
- Discuss the mechanisms of hormone actions and second messengers.
- Outline regulation of hormone receptors.
- Discuss regulation of hormone secretion.
- Compare and contrast negative and positive feedback control mechanisms in hormone secretion regulation.
- Understand the basis of hormone measurements (RIA and immunometric assays) and their interpretation.



 Female Doctors' notes

 Male Doctors' notes

 Extra

 Important

Resources: 435 Boys' & Girls' slides | Guyton and Hall 12th & 13th edition
[Editing file](#)

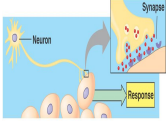
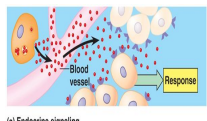
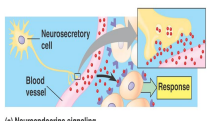
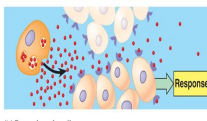
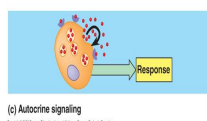
Physiology435@gmail.com

Revised by

خولة العماري & هشام الغفيلي

DEFINITIONS:

❖ The following types of intercellular communication occur by chemical messengers in the extracellular fluid:

Neural	Endocrine	Neuroendocrine (neurocrine)	Paracrine	Autocrine	Cytokine
in which neurotransmitters are released at synaptic junctions and act locally	in which hormones released from specialized glands or cells reach the circulating blood and influence the function of target cells some distance away	in which secretion products from neurons (neurohormones) reach the circulating blood and influence the function of target cells some distance away	in which cell secretion products diffuse into the extracellular fluid and affect neighboring target cells of a different type NOTE: These are not considered hormones since hormones are long-distance chemical signals	in which cell secretion products affect the function of the same cell by binding to cell surface receptors	in which cell proteins are secreted into the extracellular fluid and function as autocrines, paracrines, or endocrines and often act on a broad spectrum of target
					

في شئ جديد اسمه

Introcrine which released inside the cell from certain part and works as hormone release and act inside the cell

ما يطلع برا

يطلع برا السيل ويشغل على الريبستور اللي على السيل نفسه الفرق

ما يطلع برا يشغل جوا Introcrine

Endocrine vs exocrine

Exocrine glands are **glands** that secrete their products into ducts. They are the counterparts to endocrine **glands**, which secrete their products directly into the bloodstream (**Ductless glands**).

Endo = inside, Crine = secretion

Endocrine tem: Overview

Endocrinology:	It is study of homeostatic functions of substances called HORMONES , that are released from glands called endocrine glands distributed throughout the body.
Hormones:	Are secretions of <u>ductless glands</u> that are directly released into the bloodstream. They can act on cells in the vicinity or on distant target cells.
Endocrine glands:	pituitary, thyroid, parathyroid, adrenal, pineal, and thymus
<ul style="list-style-type: none"> •The pancreas and gonads produce both hormones and exocrine products (So considered as Endocrine and Exocrine organs) •The hypothalamus has both neural functions and releases hormone (So has Neuronal and Endocrine parts) •Other tissues and organs that produce hormones – adipose cells, pockets of cells in the walls of the small intestine, stomach, kidneys, and heart 	

► TYPES OF HORMONES:

❖ Hormones Classified According to Chemical Structure into 3 Types:

Derivatives of the amino acid	Proteins and polypeptides	Steroids
<p>-derivative from Tyrosine: Catecholamines and Thyroid hormones</p> <p>-derivative from Tryptophan: Melatonin</p>	<p>including hormones secreted by the anterior and posterior <u>pituitary gland</u>, the <u>pancreas</u> (insulin and glucagon), the <u>parathyroid gland</u> (parathyroid hormone), and many others</p> <p>❖ Their synthesis: the initial protein formed by rough endoplasmic reticulum is larger than the active hormone and is called a prohormone→ The signal sequence of this large protein is cleaved in the endoplasmic reticulum to form a prohormone in the Golgi apparatus the prohormone is packaged in secretion granules along with proteolytic enzymes that cleave the prohormone into → active hormone (it stored in vesicle until needed)</p> <p>polypeptides = less than 100 amino acids protein = more than 100 amino acids</p>	<p>-Derived from Cholesterol: including hormones secreted by the <u>adrenal cortex</u> (cortisol and aldosterone), the <u>ovaries</u> (estrogen and progesterone), the <u>testes</u> (testosterone), and the <u>placenta</u> (estrogen and progesterone).</p> <p>- They are <u>not</u> stored in the body - They are synthesized in demand on Smooth endoplasmic reticulum</p>

► MECHANISM OF ACTION OF HORMONES:

1-Hormones circulate to all tissues but only activate cells referred to as **target cells** *active hormone means free hormone

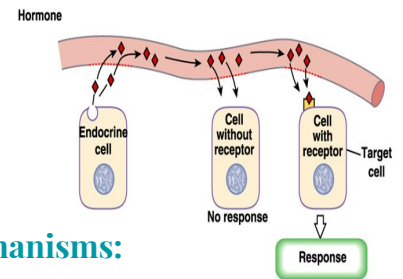
2-Target cells must have specific receptors to which the hormone binds

•These receptors are either:

- On the surface of cell membrane (as in the case of proteins, peptides and catecholamines).

- In the cell cytoplasm (as in the case of Steroids).

-In the cell nucleus (as in the case of thyroid hormones).



3- Hormones alter target cell activity by one of the following mechanisms:

^^ تعبتو من المذاكرة هالجزئية بتاخذونها بالبايوكمستري مع تفاصيل أكثر

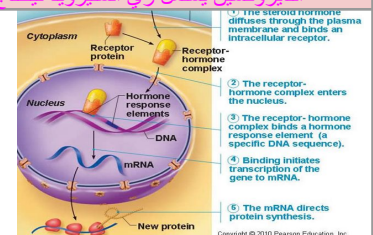
steroids receptors are inside the cell and most of them are transcriptional factor

❖ In case of steroid and thyroid hormones

Intracellular Hormone Receptors and Activation of Genes :

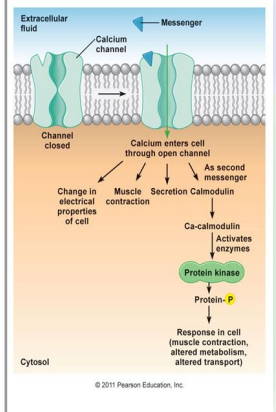
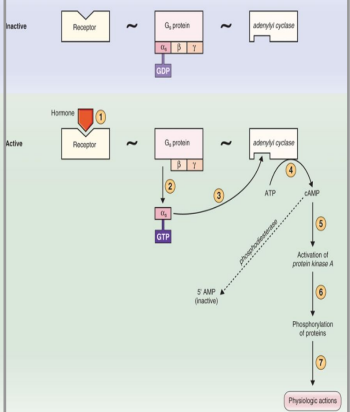
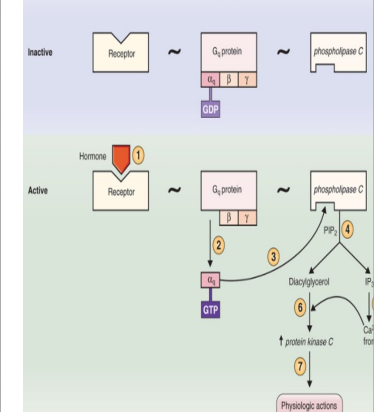
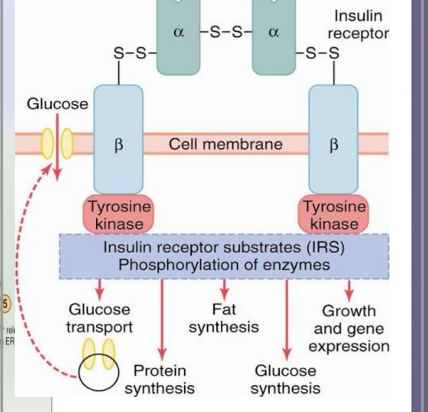
هذي العملية أطول من لو انه بس انزاييم ريكاشن
عادة الستيرويد هرمون تاخذ وقت على ما بال بروديوز ذا اكشن
لو عندي مريض عنده هايونتايروديزم وعطيته تايروكسين رح يحتاج وقت لان
التايروكسين يشتغل زي الستيرويد فيحتاج وقت علشان يستجيب للدواء

- Steroid hormones and thyroid hormone diffuse easily into their target cells.
 - Once inside, they bind and activate a specific intracellular receptor
- The hormone-receptor complex travels to the nucleus and binds a DNA-associated receptor protein This interaction prompts DNA transcription to produce mRNA →The mRNA is translated into→ proteins , which bring about a cellular effect.

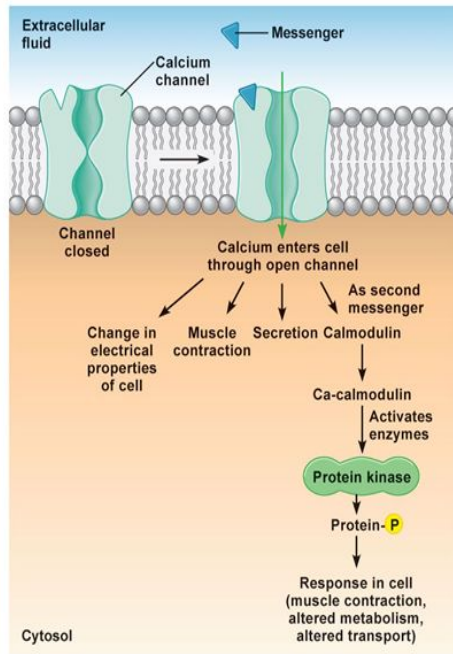


Peptide, Protein and catecholamine hormones are water soluble = Lipophobic = so they can't pass the cell membrane they need a receptor on/in the membrane

❖ In the case of peptide/protein and catecholamine hormones interaction with the receptor often results in generation of a second messenger, which in turn mediates the hormonal response. Second-messenger mechanisms include the following:

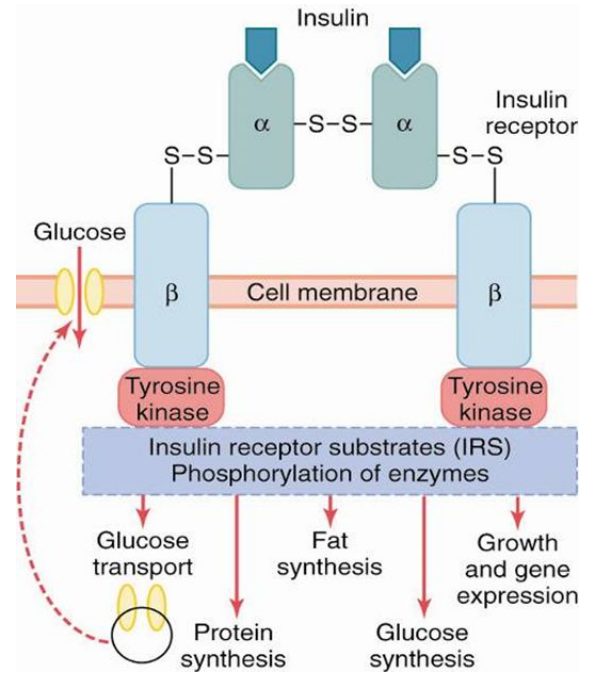
Calcium-Calmodul in Second Messenger System	Adenylyl Cyclase-cAMP Second Messenger System	Cell Membrane Phospholipid Second Messenger System	Tyrosine kinase Second Messenger System (Enzyme-Linked Hormone Receptors)
<p>Hormone-receptor interaction activates calcium channels in the plasma membrane, permitting calcium to enter cells. Calcium may also be mobilized from intercellular stores such as the endoplasmic reticulum. The calcium ions bind with the protein calmodulin; this complex alters the activity of calcium-dependent enzymes and thus intercellular reactions</p>	<p>Hormone (<i>first messenger</i>) binds to its receptor, which then binds to a G protein. The G protein is then activated as it binds GTP, displacing GDP. Activated G protein → activates the effector enzyme adenylyl cyclase → Adenylyl cyclase generates cAMP (<i>second messenger</i>) from ATP. cAMP activates protein kinases, which then cause cellular effects</p>	<p>Hormone binds to the receptor → activates G protein. G protein activates a phospholipase enzyme. Phospholipase splits the phospholipid PIP₂ into diacylglycerol (DAG) and IP₃ (<i>both act as second messengers</i>) → DAG activates protein kinases & → IP₃ triggers release of Ca²⁺ stores Ca²⁺ (<i>third messenger</i>) alters cellular responses</p>	<p>• Is used by insulin & many growth factors to cause cellular effects. • Surface receptor is tyrosine kinase, consists of 2 units that form active dimer when insulin binds. Activated tyrosine kinase phosphorylates signaling molecules → Induction of hormone/growth factor effects</p> <p>في هذي الحالة الريسبتور عبارة عن two dimers separate from each other اول ما يجي الهرمون 1. It will join the two dimers together يسوي لهم dimerization الريسبتور نفسه ولكن البارت اللي جوا الخلية رح يصير له فوسفوريليشن لما يصير للريسبتور دايمرز فوسفوريليشن 2. It will activate other proteins (phosphorylation of signaling molecule) 3. and it will produce cascade of reaction inside مثلا انسولين هذي رح تؤدي الى stimulation of up take of glucose inside the cell</p>
			

Calcium-Calmodulin Second Messenger System

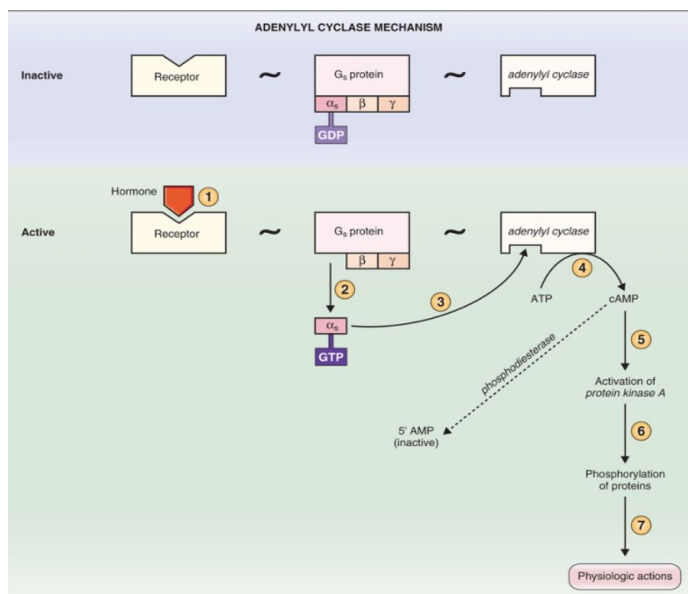


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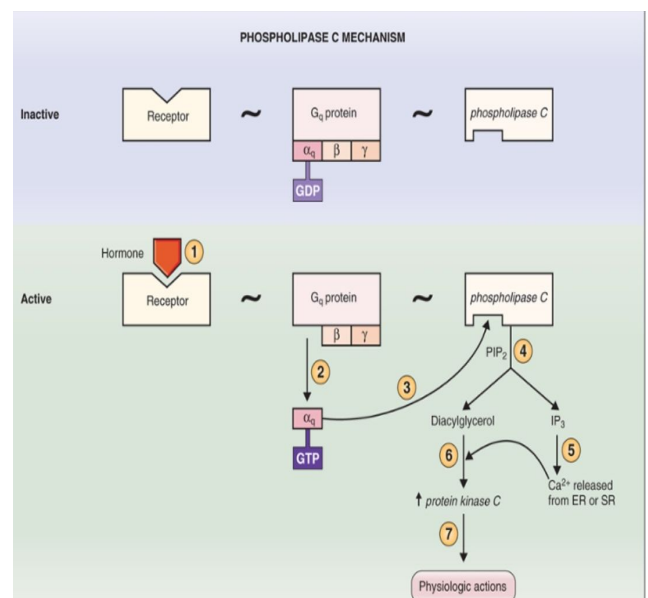
Tyrosine kinase Second Messenger System (Enzyme-Linked Hormone Receptors)



Adenylyl Cyclase-cAMP Second Messenger System



Cell Membrane Phospholipid Second Messenger System



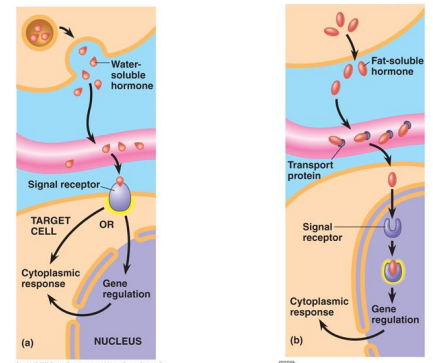
► Regulation of hormonal receptors:

❖ Target cell activation depends on three factors:		
Blood levels of the hormone	Relative number of receptors on the target cell	The affinity of those receptors for the hormone
	<p><i>(Receptors does not remain constant)they undergo:</i></p> <ul style="list-style-type: none"> •Up-regulation – target cells form more receptors in response to the hormone •Down-regulation – target cells lose receptors in response to the hormone <p>-Most peptide hormones have pulsatile secretion which prevents downregulation.</p> <p>يقولك عشان مايخلص الهرمون، الهرمون مايفرز طول الوقت يفرز على شكل نبضي : كيف، مثلا عندك الكورتزول اعلى افراز له يكون في (: الصباح ثم ينزل باقي اليوم عشان مايخلص</p>	

► TRANSPORT OF HORMONES IN BLOOD:

❖ Hormones circulate in the blood in two forms –free or bound:

- Water soluble hormones- hydrophilic (peptides & catecholamines) dissolved in plasma
 - Fat soluble hormones – hydrophobic Steroids and thyroid hormones transported bound to plasma proteins (90%) binding to proteins helps to Provide reservoirs & Slow hormones clearance
- Proteins don't need carrier because they are water soluble
- Steroids &thyroid need carrier because they are lipid soluble
- The more binding the more half life



► Clearance of hormones from the blood:

❖ Two factors control the concentration of a hormone in the blood:

- 1-Rate of release
- 2-Speed of inactivation and removal from the body

- ❖ Hormones are “cleared” from the plasma in several ways, including : (1) metabolic destruction by the tissues, (2) binding with the tissues, (3) excretion by the liver into the bile, and (4) excretion by the kidneys into the urine

Control of Hormone Release:

Blood levels of hormones are controlled by negative and positive feedback systems:

• **Negative feedback** is most common: negative feedback means that *some feature of hormone action, directly or indirectly, inhibits further secretion of the hormone*. Release of hormone A stimulates the release of hormone B → Hormone B inhibits the release of hormone A.
for example, LH from pituitary stimulates the testes to produce testosterone which in turn feeds back and inhibits LH secretion

NOTICE: **Long-loop feedback** means that the hormone feeds back *all the way* to the hypothalamic-pituitary axis. **Short-loop feedback** means that the anterior pituitary hormone feeds back on the hypothalamus to inhibit secretion of hypothalamic-releasing hormone.

EXAMPLE: of negative feedback **Stimulus: rising blood sugar.**

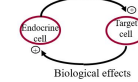
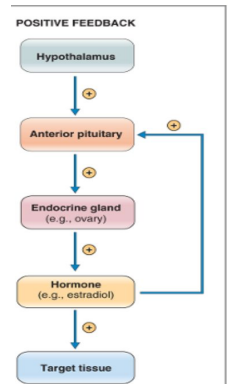
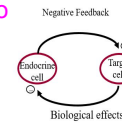
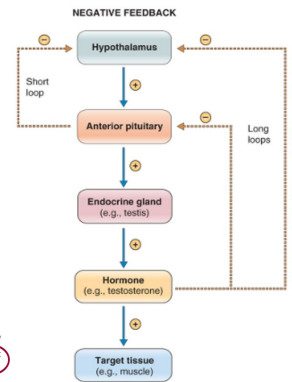
Action: pancreas releases insulin.

Insulin action: causes the liver cells to take up glucose and store it as glycogen, also causes most body cells to take glucose and store it.

• **Positive feedback** is less common: means that some feature of hormone action causes *more* secretion of the hormone. Release of hormone A stimulates the release of hormone B → Hormone B stimulates further release of hormone A.

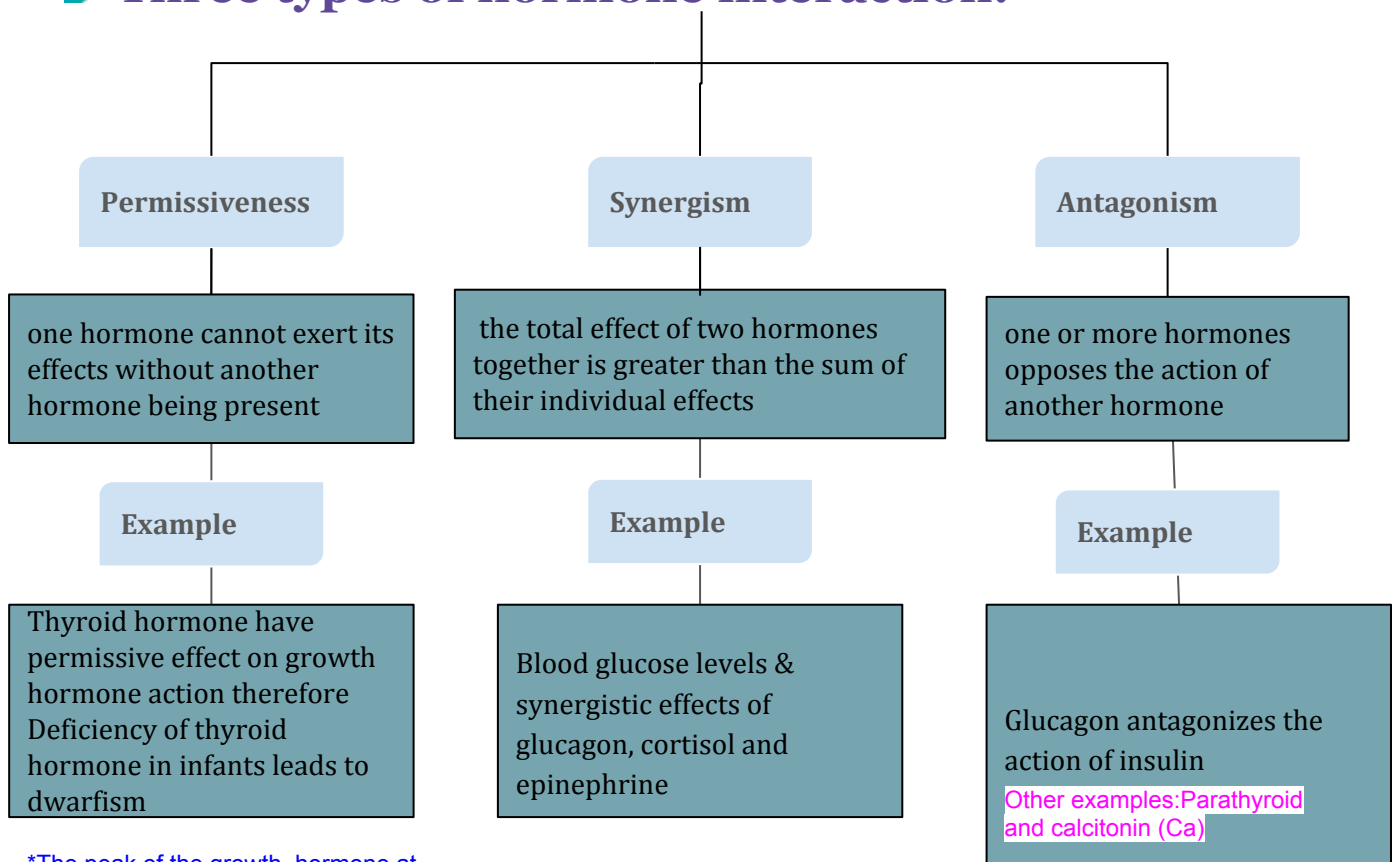
examples include LH stimulation of estrogen which stimulates LH surge at **ovulation** (, while after and before ovulation: negative feedback!)

Hormones are synthesized and released in response to humoral, neural, and hormonal stimuli:



stimula	Humoral stimuli	Neural stimuli	Hormonal stimuli
definition	secretion of hormones in direct response to changing blood levels of ions and nutrients	nerve fibers stimulate hormone release	release of hormones in response to hormones produced by other endocrine organs
example	<p>concentration of calcium ions in the blood</p> <ul style="list-style-type: none"> Declining blood Ca^{2+} concentration stimulates the parathyroid glands to secrete PTH (parathyroid hormone) then PTH causes Ca^{2+} concentrations to rise and the stimulus is removed <p>(a) Humoral</p>	<p>Preganglionic sympathetic nervous system (SNS) fibers stimulate the adrenal medulla to secrete catecholamines</p> <p>(b) Neural</p>	<p>The hypothalamic hormones stimulate the anterior pituitary</p> <ul style="list-style-type: none"> In turn, pituitary hormones stimulate targets to secrete still more hormones <p>(c) Hormonal</p>

► Three types of hormone interaction:

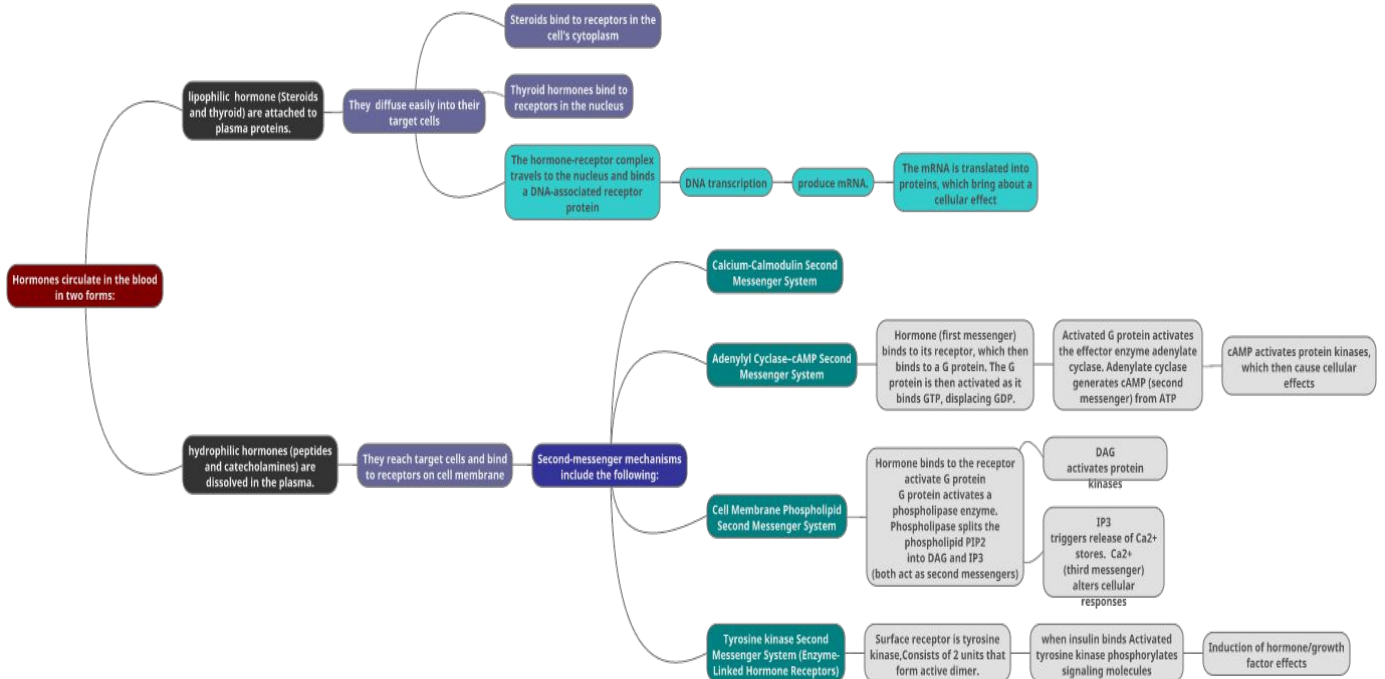
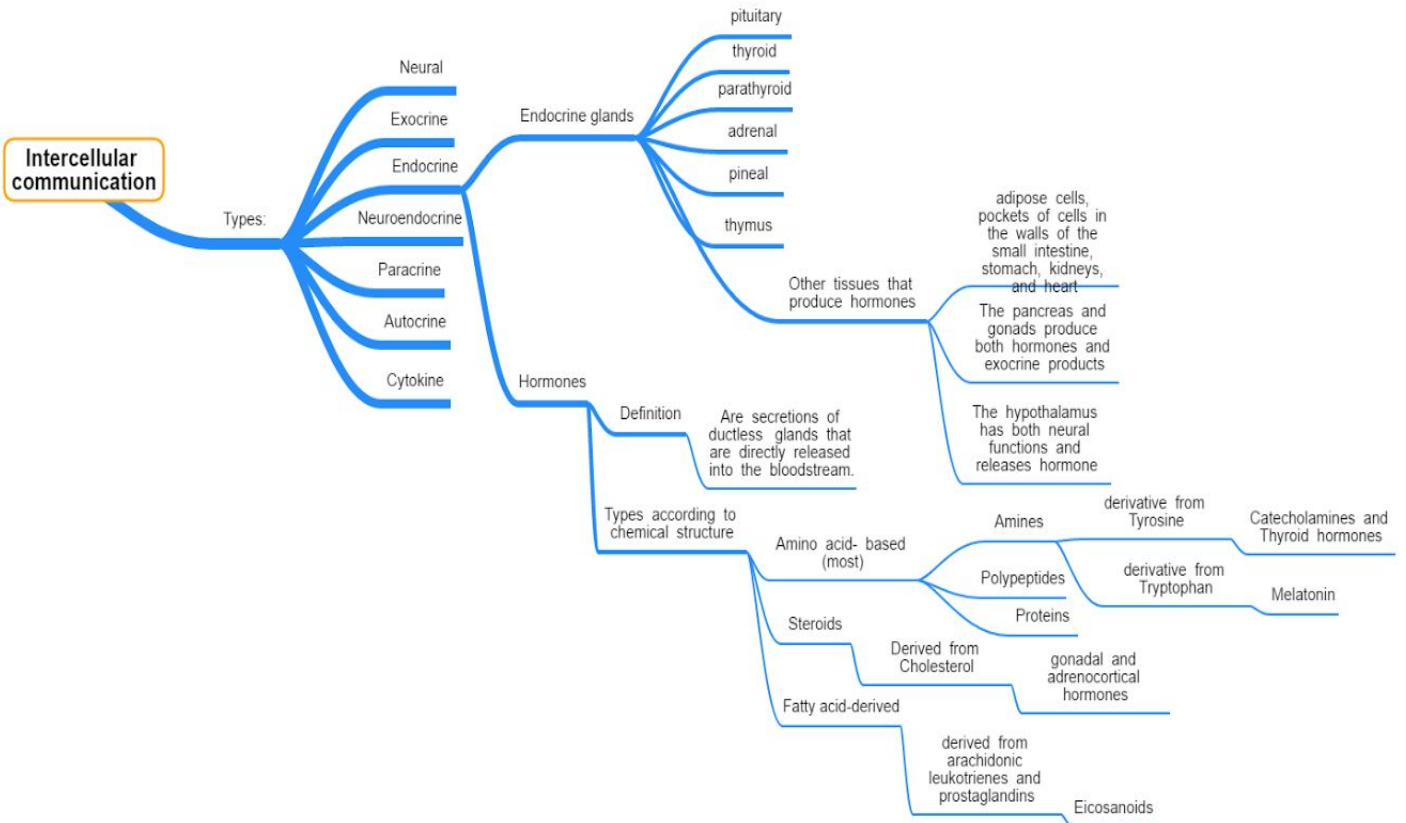


*The peak of the growth hormone at puberty

► Measurement of Hormone Concentrations: (Boys' slides but within the objectives)

- Radioimmunoassay (RIA) (First discovered)
- Enzyme-Linked Immunosorbent Assay (ELISA)

SUMMARY



for clear version click [here](#)

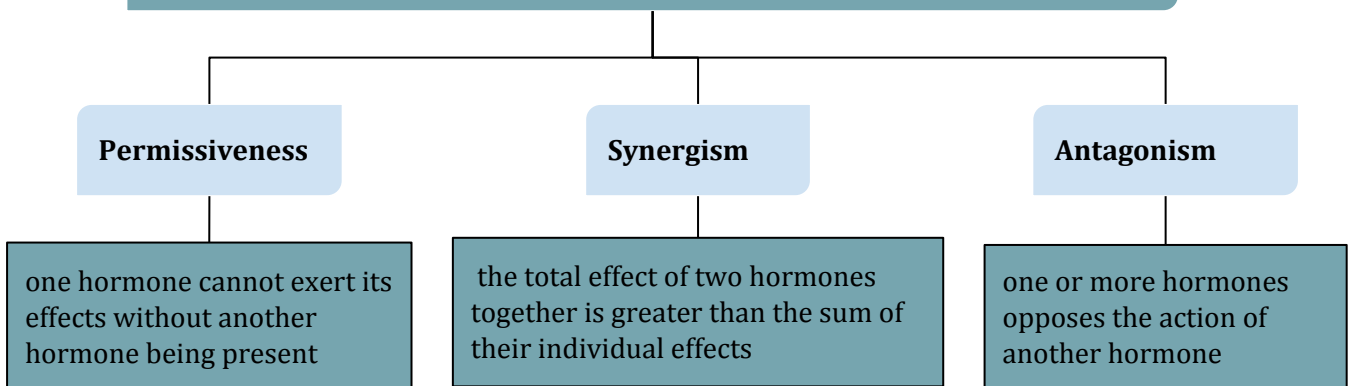
SUMMARY

► Regulation of hormonal receptors:

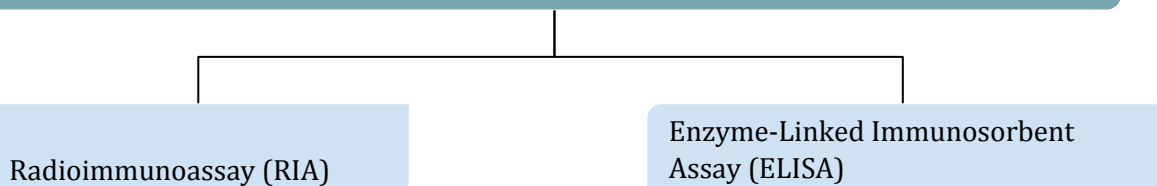
◆ Target cell activation depends on three factors:

1. Blood levels of the hormone	2. Relative number of receptors on the target cell	3. The affinity of those receptors for the hormone
<p>◆ Factors that control the concentration of a hormone in the blood:</p> <p>1-Rate of release</p> <p>2-Speed of inactivation and removal from the body (by degrading enzymes, The kidneys/ Liver enzyme systems)</p> <p>3- negative and positive feedback systems:</p> <ul style="list-style-type: none"> •Negative feedback is most common: e.g. LH from pituitary stimulates the testes to produce testosterone which in turn feeds back and inhibits LH secretion •Positive feedback is less common: e.g. LH stimulation of estrogen which stimulates LH surge at ovulation 	<ul style="list-style-type: none"> •Up-regulation – target cells form more receptors in response to the hormone •Down-regulation – target cells lose receptors in response to the hormone 	

Three types of hormone interaction:



Measurement of Hormone Concentrations:



MCQs

1- the most appropriate option that represents an exocrine gland:

- A- Duct B- Blood
C- Hormone D- Secretory vesicle

2-What of the following acts as first messenger:

- A. C-AMP B.C-GMP
C. Calcium D. Calcitonin

3-The enzyme required for the synthesis of c-AMP is:

- A- Tyrosine Kinase B- Phospholipase C
C- Adenylatecyclase D- ATPase

4- Find the mis-match:

- A- Pancreas :somatostatin B- Thyroid gland : calcitonin
C- Anterior pituitary :thyrotropin releasing hormone D- Adrenal medulla :catecholamines

5- It has receptor in the cytoplasm:

- A- Growth hormone B- Cortisol
C- Insulin D- Oxytocin

6- It has receptor in the nucleus:

- A- FSH B- TSH
C- Calcitonin D- Thyroxine

7- Thyroid hormone and catecholamines :

- A- Cholesterol B- Tryptophan
C- Tyrosine D- Alcohol

8-Hormones that are lipids that are synthesized from cholesterol:

- A- Protein B- Amino acid- derived
C-Eicosanoids D-Steroid

9-this type of hormone must bind to a receptor protein on the plasma membrane of the cell:

- A- water soluble B- Lipid soluble
C- Polypeptide D- A&C

10- Endocrine glands release hormones in response to:

- A- Hormones from other endocrine glands B- Chemical characteristics of the blood
C- Neural stimulation D- All of them

عمر آل سليمان
إبراهيم النفيسه
محمد البشر
محمد السحيباني

روان الضويحي
لولوه الصغير
ريما اللحيان

