

ENDOCRINOLOGY (INTRODUCTION)

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INTRODUCTION

- Endocrine vs exocrine gland
- Chemical messengers
- Hormone
 - Definition
 - Chemical structure
 - Paracrine, autocrine, endocrine, neuroendocrine
 - Transport and clearance
- Mechanism of action
 - Receptors, down-regulation and up-regulation
 - Intracellular signaling
 - Second messenger (cAMP, IP3)

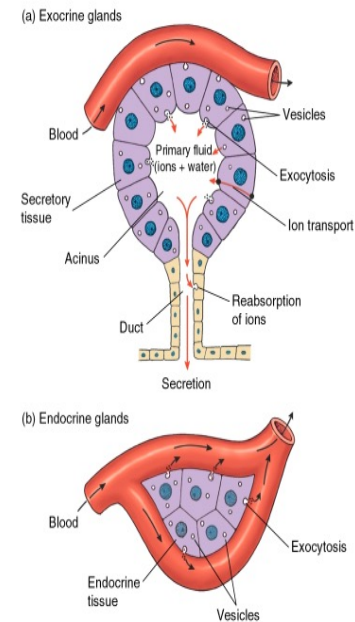
INTRODUCTION

A. Exocrine gland

- Ducts
- Lumen and surfaces

B. Endocrine gland

- Chemical messengers
- Blood stream



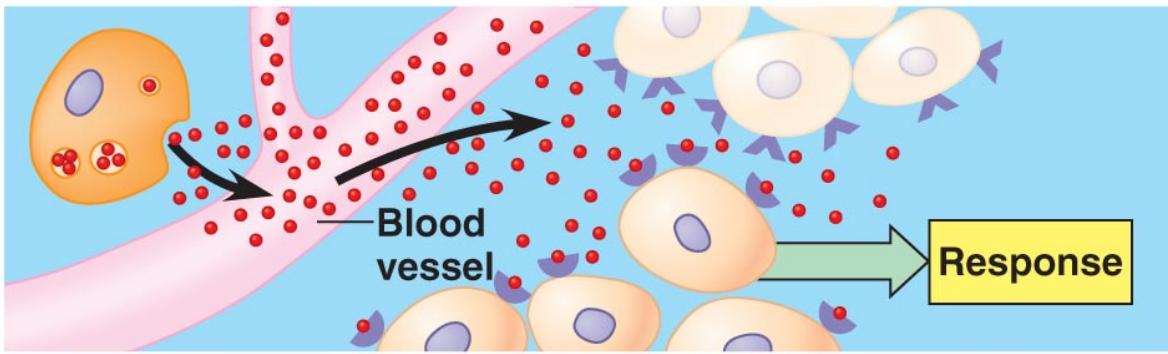
CHEMICAL MESSENGERS

- The activities of cells, tissues and organs are coordinated by chemical messengers
 - Neurotransmitters
 - Endocrine hormones
 - Neuroendocrine hormones
 - Paracrines
 - Autocrines
 - Cytokines

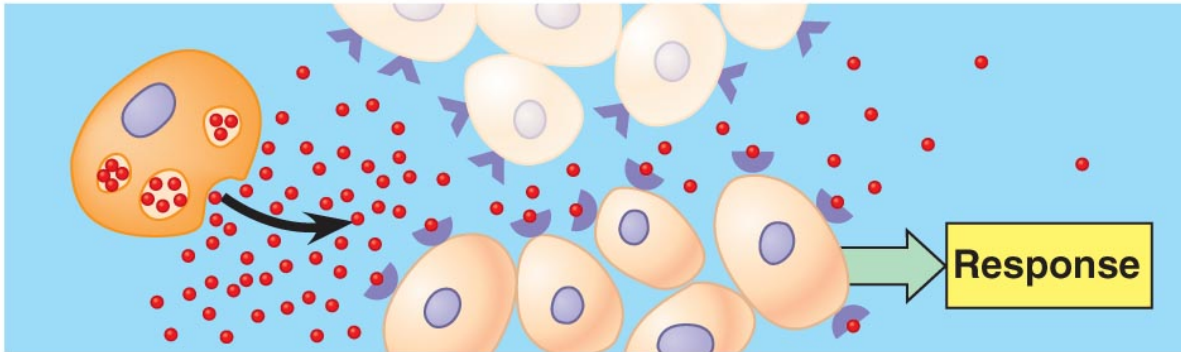
SMALL GROUP ACTIVITY

- ◉ Divide into 6 groups
- ◉ Explain
 - Neurotransmitter
 - Neurondocrine
 - Endocrine
 - Paracrine
 - Autocrine
 - Cytokines

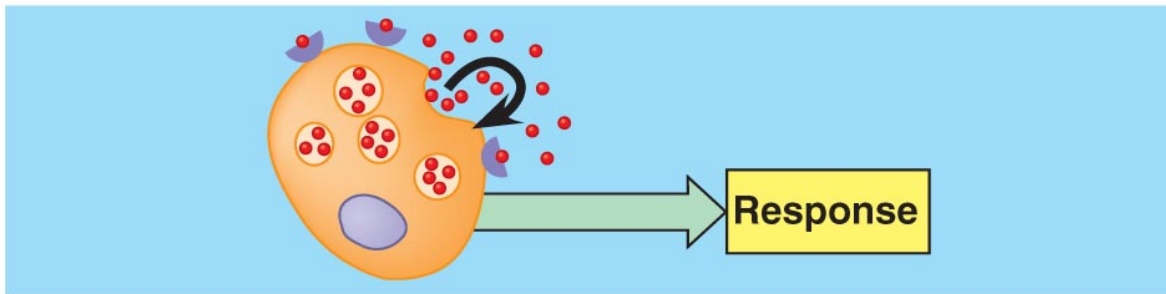




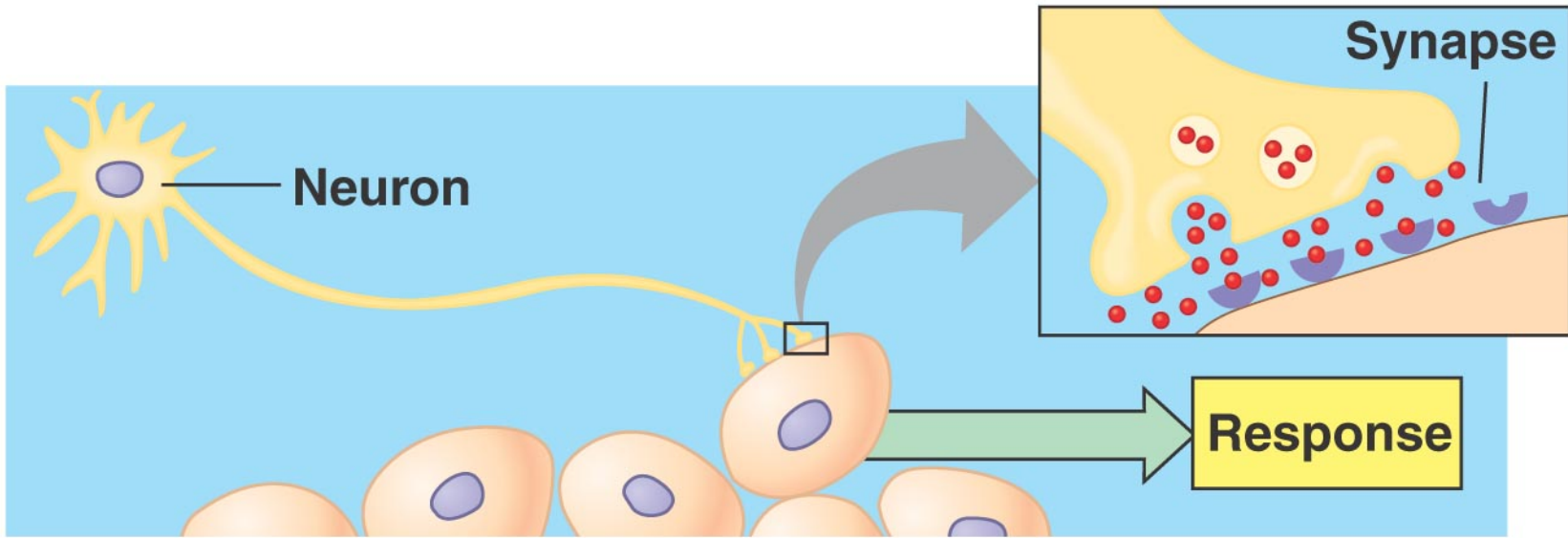
(a) Endocrine signaling



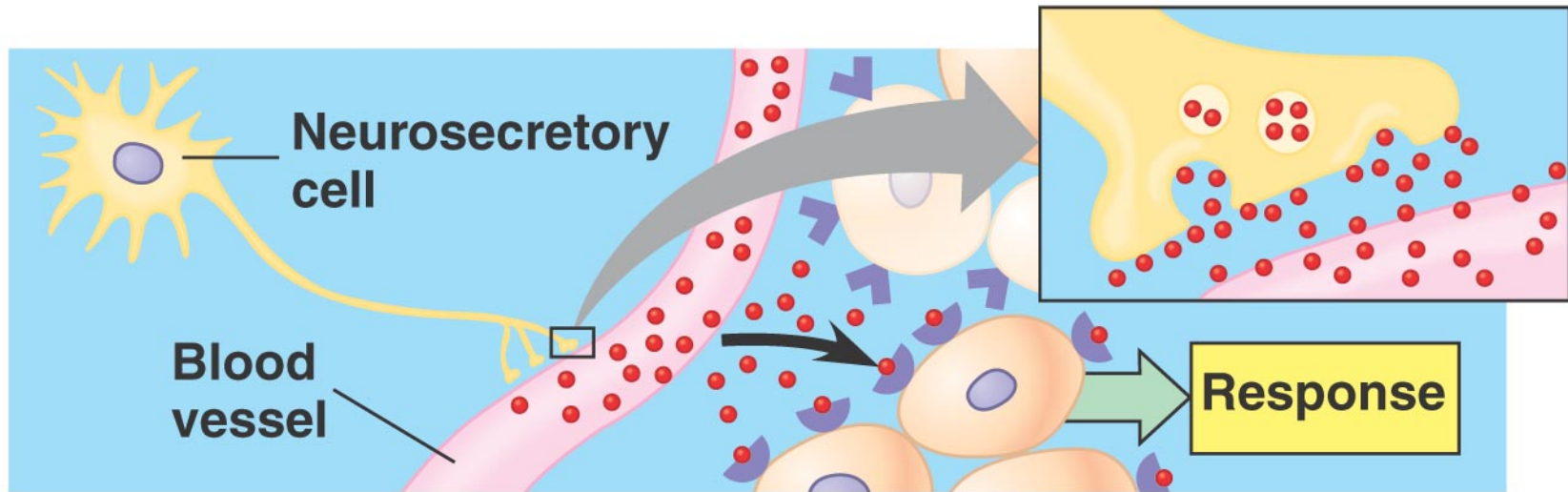
(b) Paracrine signaling



(c) Autocrine signaling



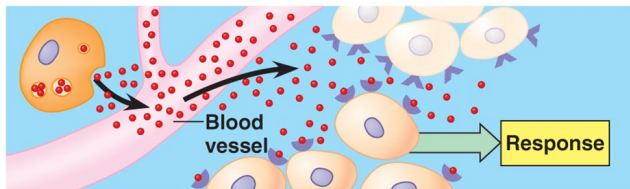
(d) Synaptic signaling



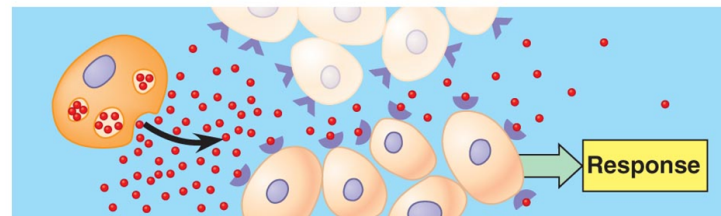
(e) Neuroendocrine signaling

CYTOKINES

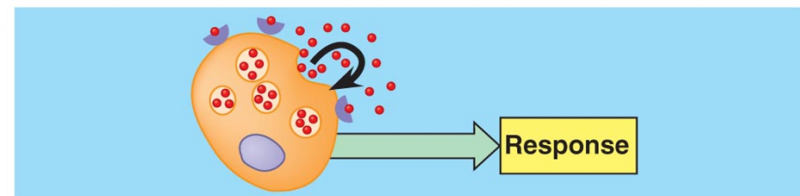
- Peptides (interleukins, lymphokines, adipokines)
- Secreted by cells into extracellular fluid.
- Can function as



(a) Endocrine signaling



(b) Paracrine signaling



(c) Autocrine signaling

LARGE GROUP ACTIVITY

- List the endocrine glands.



INTRODUCTION

○ Endocrine glands:

- Pituitary
- Thyroid
- Parathyroid
- Adrenal
- Pancreas
- Ovaries
- Testes

Major endocrine glands:

Hypothalamus

Pineal gland

Pituitary gland

Thyroid gland

Parathyroid glands

Adrenal glands

Pancreas

Kidney

Ovaries

Organs containing endocrine cells:

Thymus

Heart

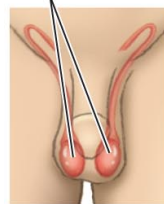
Liver

Stomach

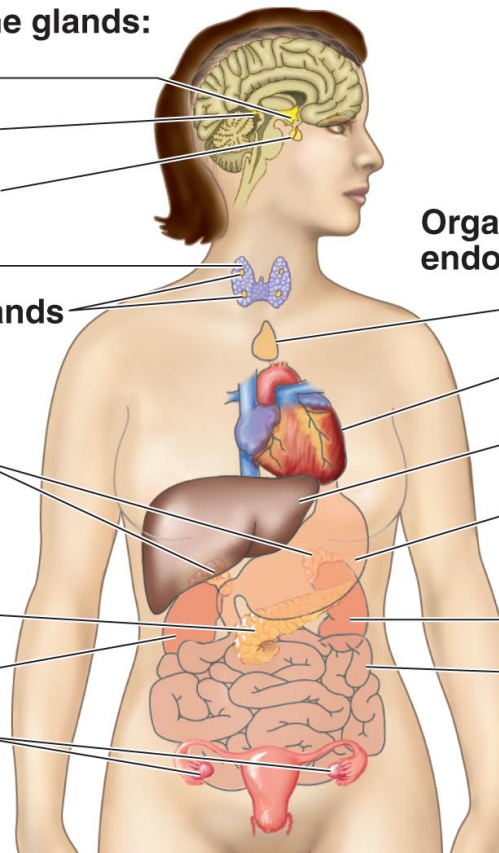
Kidney

Small intestine

Testes

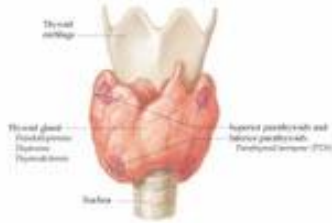


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THE ENDOCRINE SYSTEM

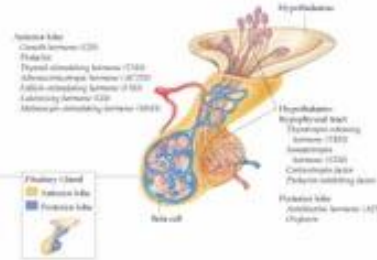
Thyroid and Parathyroid Glands



Pineal Gland



Pituitary Gland and Hypothalamus



Thymus Gland

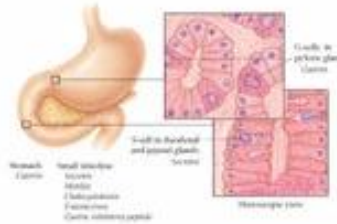


Heart



Coronary vessels (arteries and veins) supply the heart with oxygenated blood.

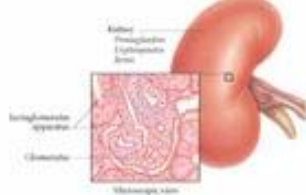
Stomach, Duodenum, and Jejunum



Adrenal Glands



Kidney



Pancreas



Ovary

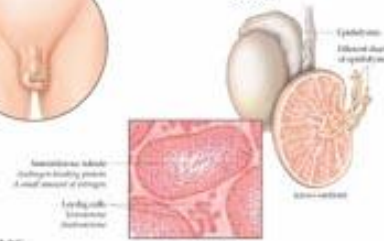


Placental Hormones

(Secreted during pregnancy)

- Human chorionic gonadotropin (HCG)
- Human chorionic somatomedin (HCS)
- Human chorionic gonadotropin (HCG)
- Human chorionic somatomedin (HCS)
- Human chorionic gonadotropin (HCG)
- Human chorionic somatomedin (HCS)

Testes



INTRODUCTION

- The multiple hormone systems play a key role in regulating almost all body functions:
 - Metabolism
 - Growth and development
 - Water and electrolyte balance
 - Reproduction
 - Behavior

INTRODUCTION

○ Definition :

- Hormone is a chemical substance released by group of cells to control the function of other type of cells.

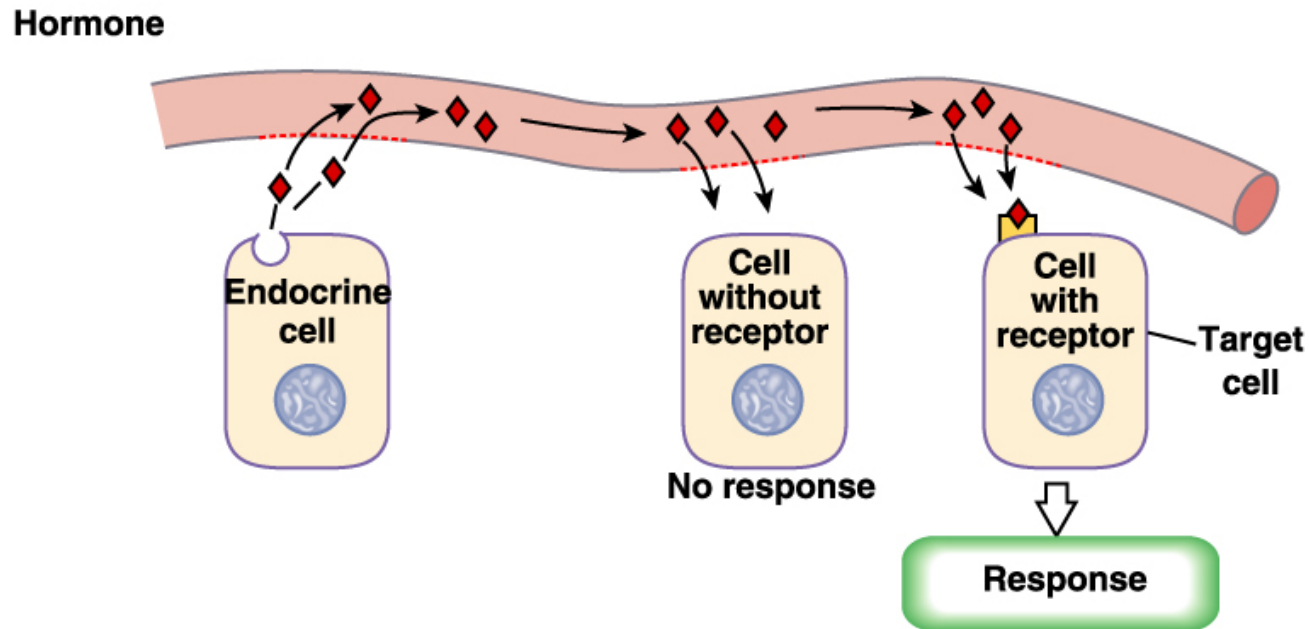
○ Types of hormones

- Affect many different types of cells (eg. GH and Thyroxin)
- Affect only specific target cells (eg. ACTH and estrogen)

INTRODUCTION

- What are **target cells**?

Target cells refer to cells that contain specific receptors (binding sites) for a particular hormone.

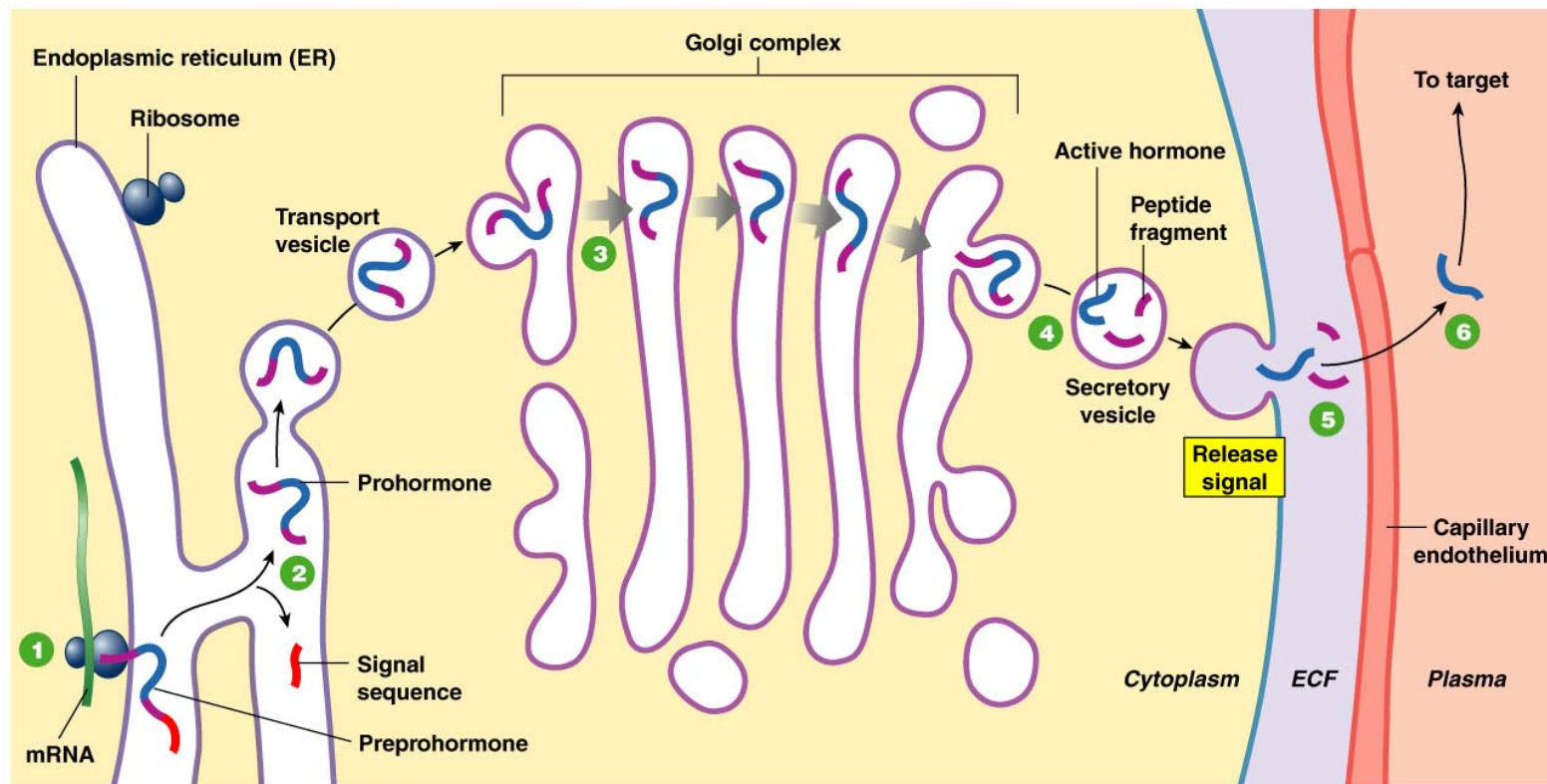


INTRODUCTION

- Chemical structure of hormones
 - Three general classes of hormones:
 - **Proteins** and polypeptides (anterior and posterior pituitary, pancreas and parathyroid hormones) stored in vesicles until needed
 - **Steroids** (adrenal cortex, ovarian and testicular hormones) diffuse across the cell membrane
 - **Derivatives of amino acid tyrosine** (thyroid hormones and catecholamines)

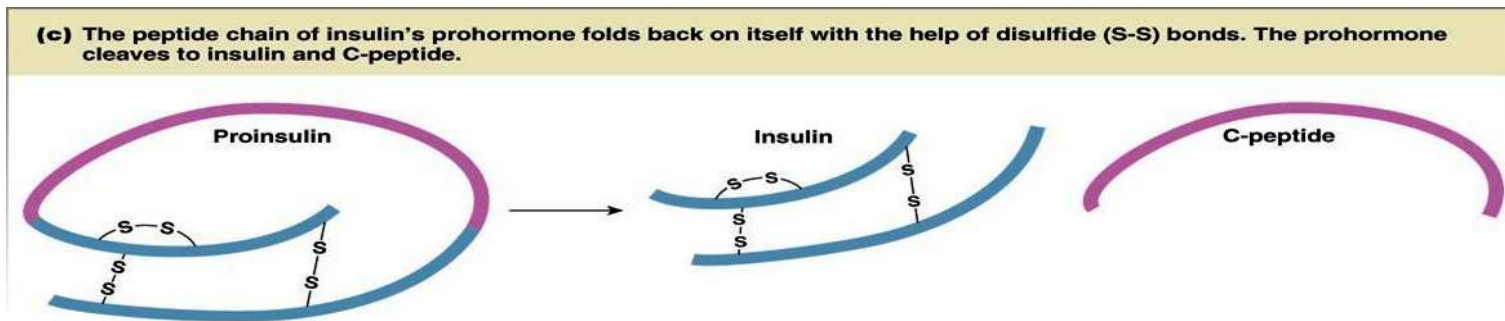
PEPTIDE (PROTEIN) HORMONES

- Synthesized as **preprohormone** → **post-translational modification to prohormone** → then **hormone**



PEPTIDE (PROTEIN) HORMONES

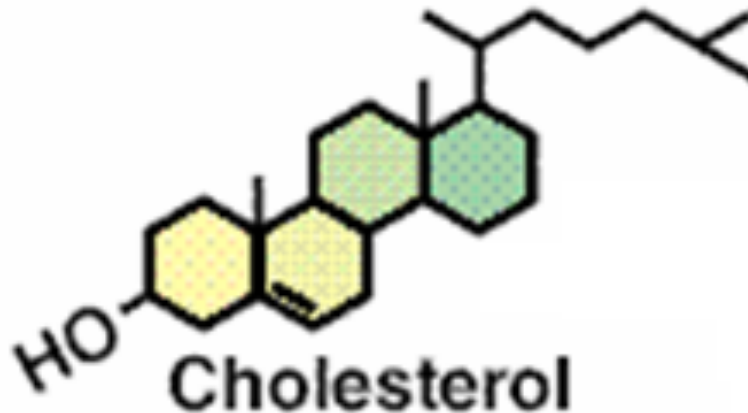
- Example of protein hormone
 - Insulin



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STEROID HORMONES

- Secreted by gonads, adrenals, placenta
- Derived from cholesterol (lipophilic)
 - Cross membranes (no storage)
- On-demand synthesis (SER)
- Usually Bound to **Carrier** proteins



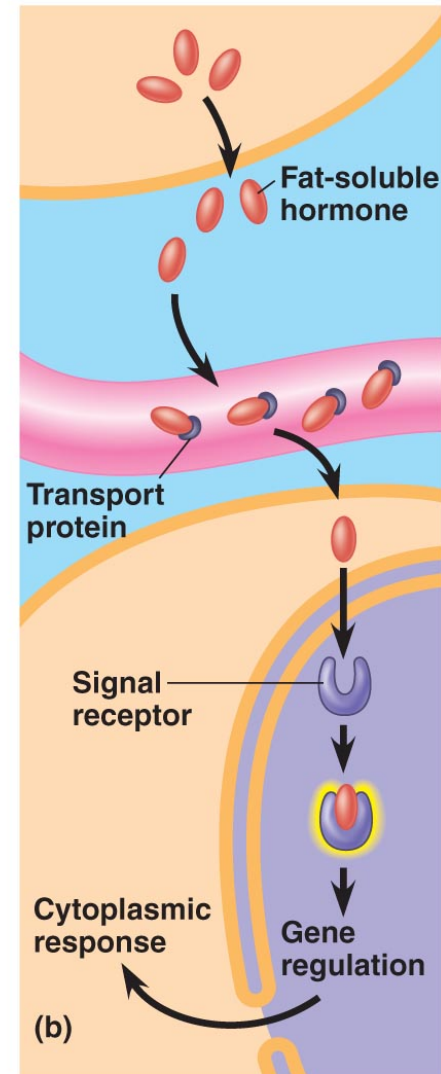
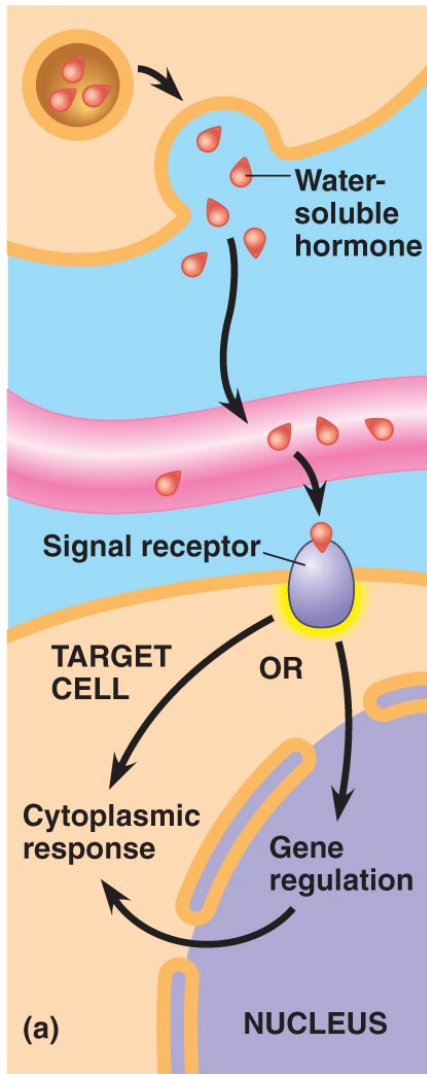
AMINE HORMONES

- ◉ Derived from tyrosine or tryptophan
- ◉ 3 groups
 - Tryptophan ⇒ Melatonin
 - Tyrosine ⇒ Catecholamines
behave like peptide hormones
 - Tyrosine ⇒ Thyroid hormones
behave like steroid hormones

TRANSPORT OF HORMONES

- ◉ 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

DIFFERENCES BETWEEN WATER AND FAT SOLUBLE HORMONES



MECHANISM OF ACTION OF HORMONES

⦿ Mechanism of action :

1. Hormone-receptor interaction (1st messenger)
2. Enzyme activation
3. Release of the second messenger
4. Effects on cellular function

HORMONES & RECEPTORS

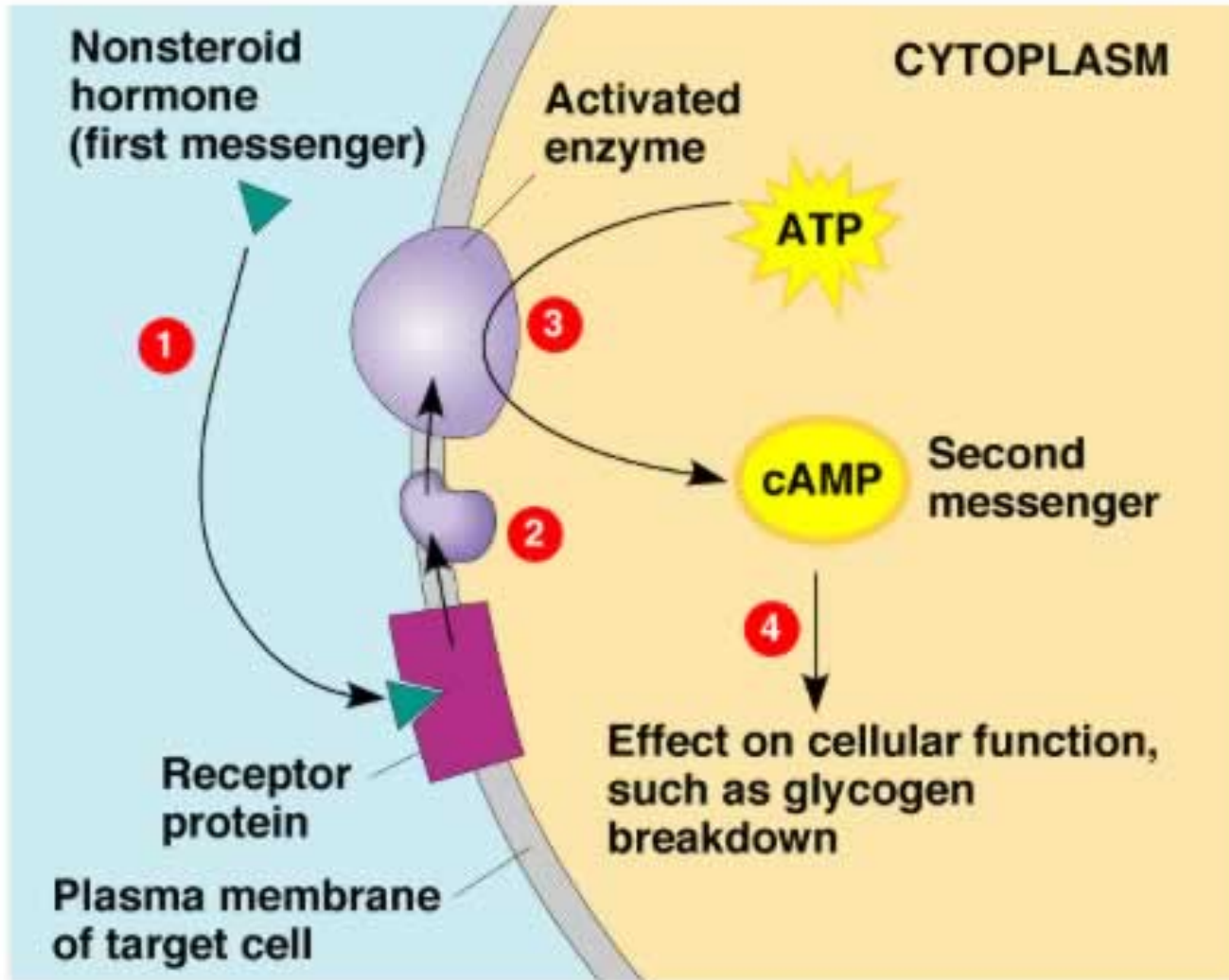
⦿ Receptors:

- Hormonal receptors are large proteins
- 2000-100,000 receptors/cell
- Receptors are highly specific for a single hormone

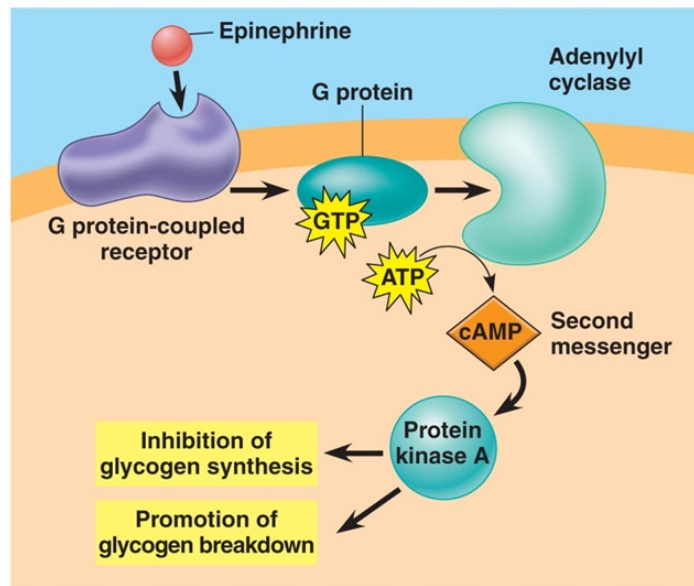
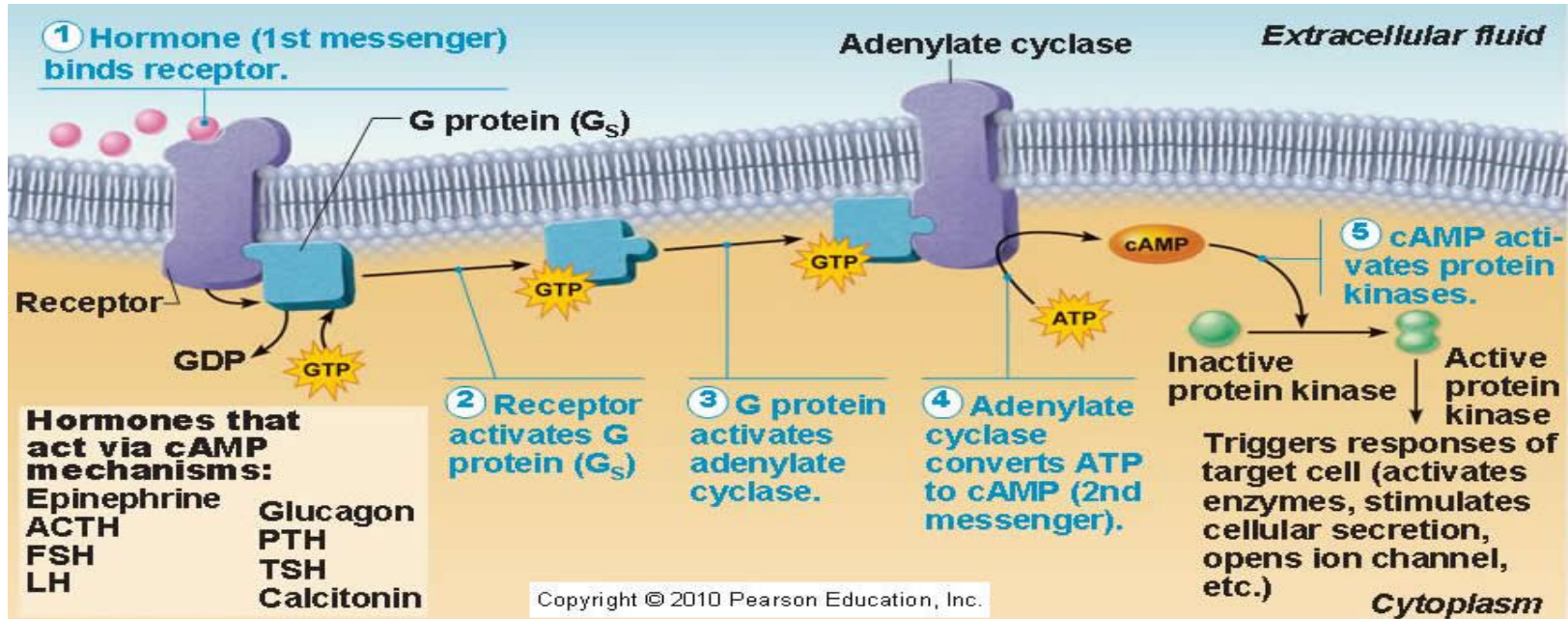
⦿ Receptor's Location:

- On the surface of cell membrane (proteins, peptides and catecholamines)
- In the cell cytoplasm (Steroids)
- In the cell nucleus (thyroid hormones)

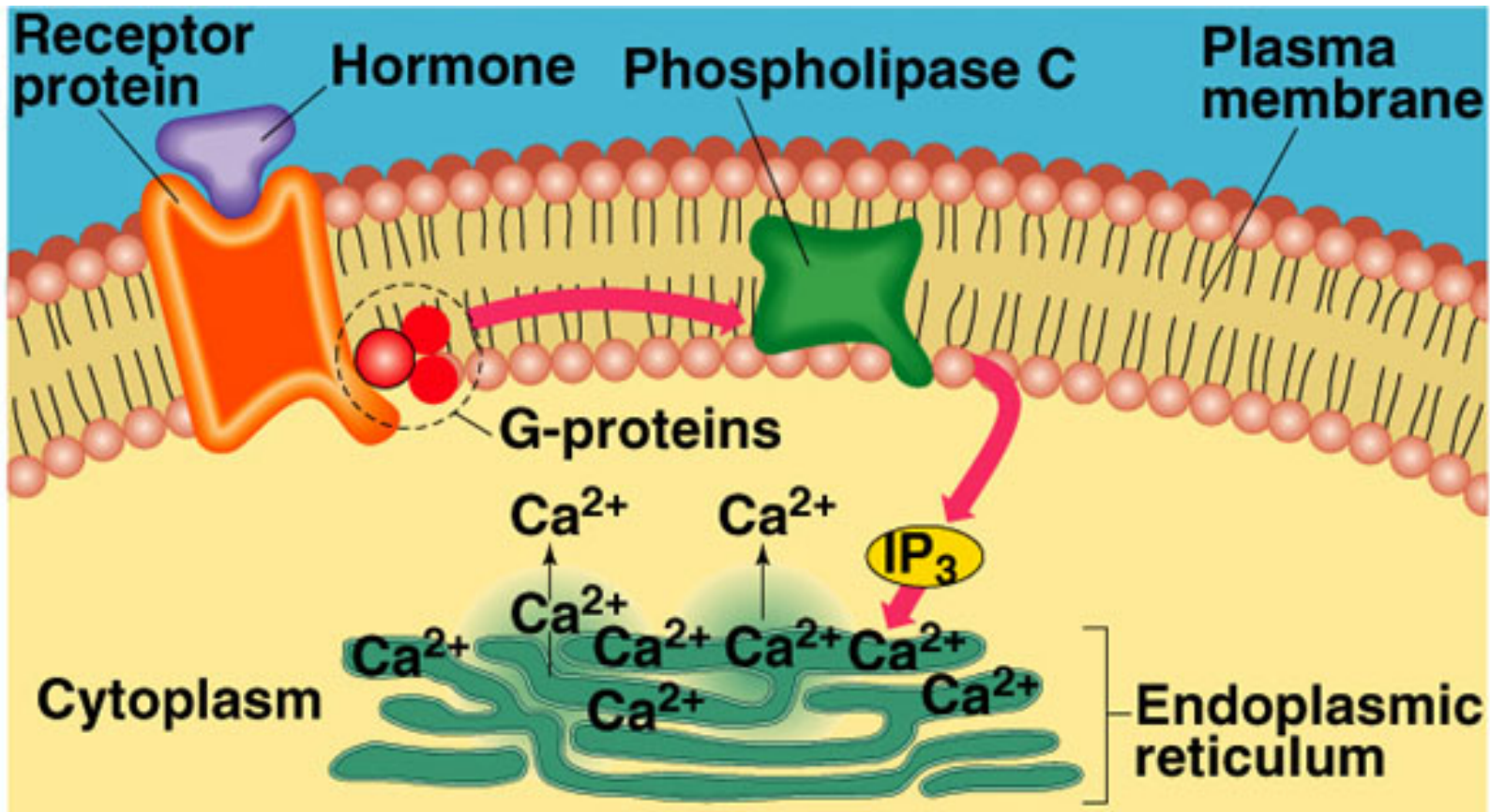
MECHANISM OF ACTION (PEPTIDES AND PROTEIN HORMONES)



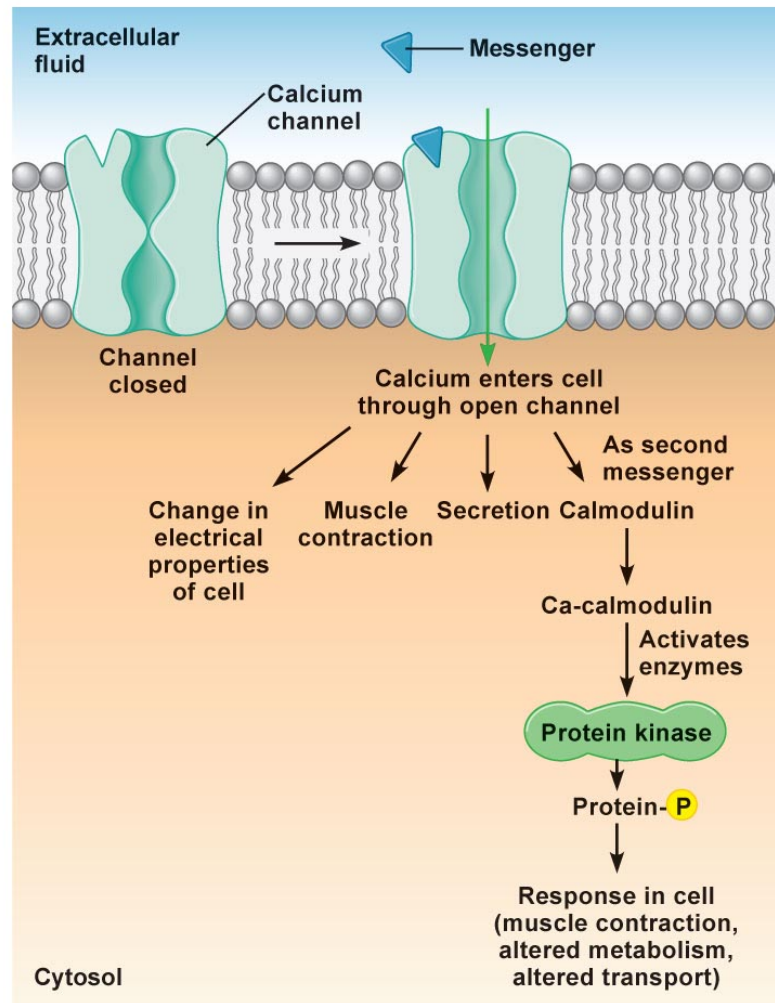
SECOND MESSENGER (ADENYLYLATE CYCLASE-CAMP)



SECOND MESSENGER (PHOSPHOLIPASE C-IP₃)

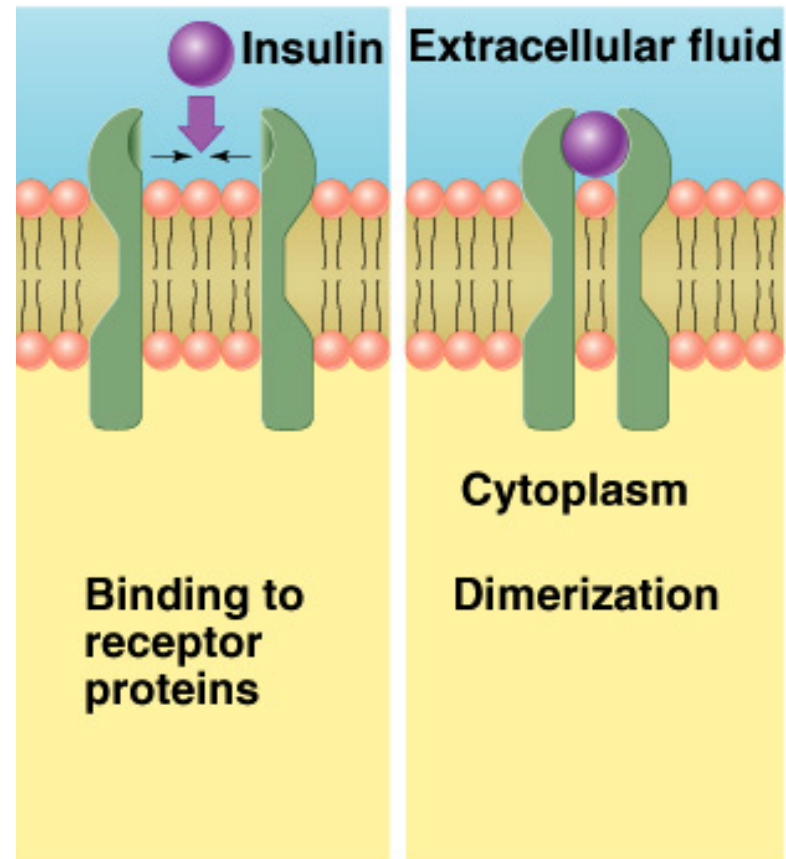


SECOND MESSENGER (CALCIUM-CALMODULIN COMPLEX)



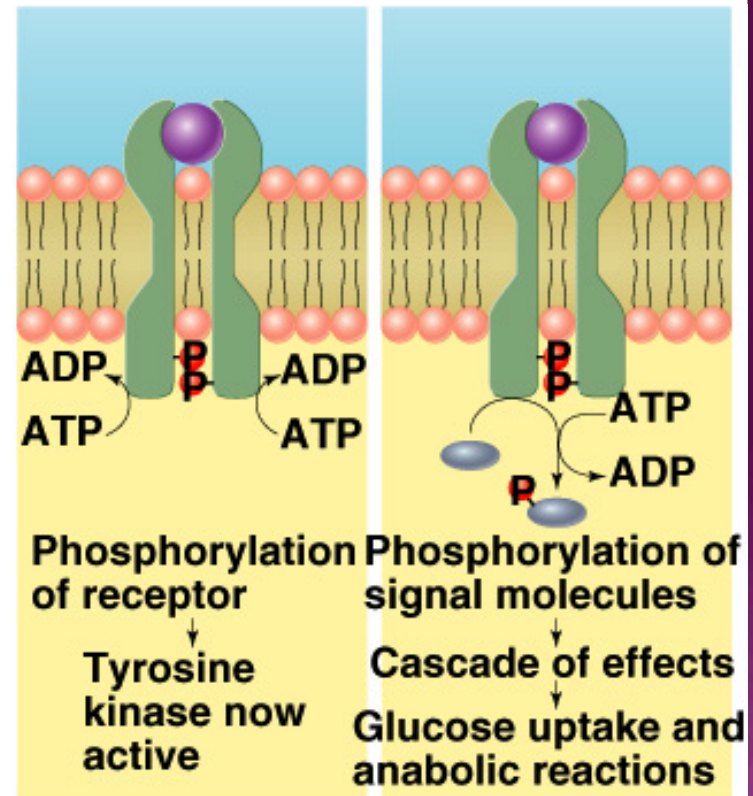
SECOND MESSENGER (TYROSINE KINASE SYSTEM)

- 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

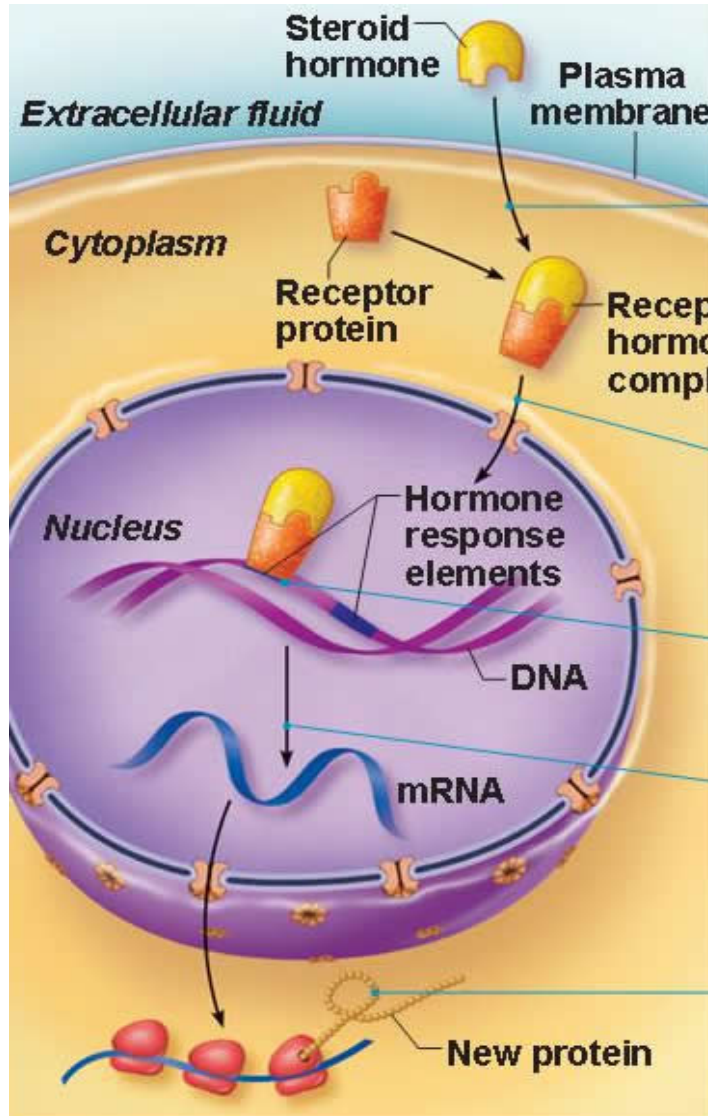


SECOND MESSENGER (TYROSINE KINASE SYSTEM)

- Activated tyrosine kinase phosphorylates signaling molecules
- Induction of hormone/growth factor effects



MECHANISM OF ACTION (STEROID HORMONES)



① The steroid hormone diffuses through the plasma membrane and binds an intracellular receptor.

② The receptor-hormone complex enters the nucleus.

③ The receptor-hormone complex binds a hormone response element (a specific DNA sequence).

④ Binding initiates transcription of the gene to mRNA.

⑤ The mRNA directs protein synthesis.

REGULATION OF HORMONAL RECEPTORS

- Receptors does not remain constant
 - Inactivated or destroyed
 - Reactivated or manufactured
- Downregulation
 - Increase hormone concentration leads to decrease in the number of active receptors
 - Most peptide hormones have pulsatile secretion which prevents downregulation
- Upregulation
 - The hormone induces greater than normal formation of a receptor or intracellular signaling proteins

CLEARANCE OF HORMONES

- Two factors control the concentration of a hormone in the blood:
 - The rate of its secretion
 - The rate of its removal (metabolic clearance)
- Hormones are cleared by:
 - Metabolic destruction by tissues
 - Binding with tissues
 - Excretion by the liver into bile
 - Excretion by the kidney into urine
- Clearance of protein bound hormones is slower than clearance of peptide hormones

HORMONE INTERACTIONS

- Multiple hormones can affect a single target simultaneously
- Three types of hormone interactions:
 1. Synergism
 2. Permissiveness
 3. Antagonism

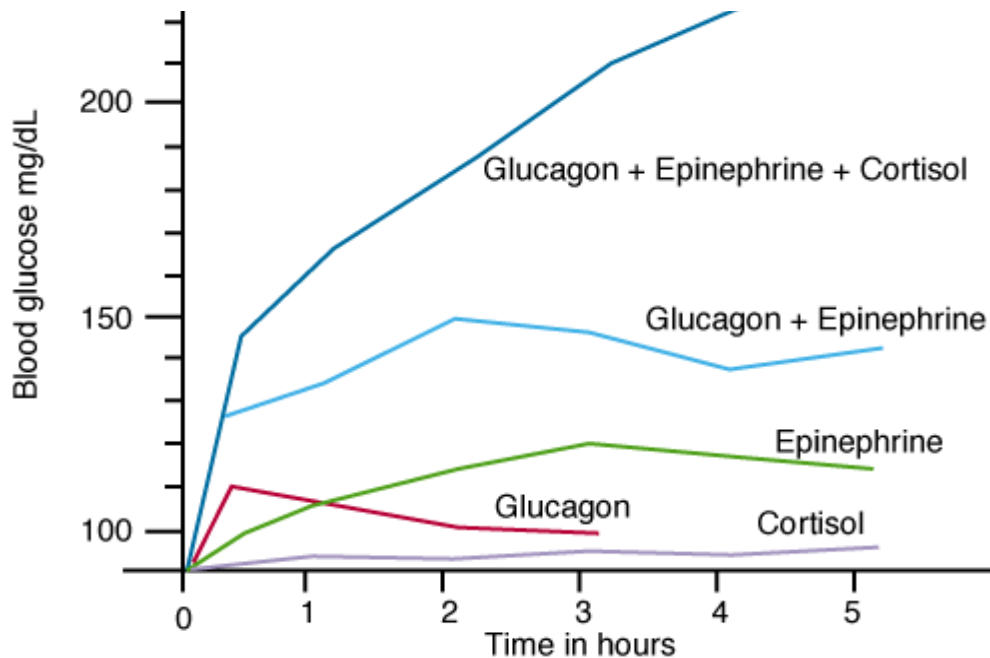
What is Synergism?

What is permissiveness?

What is antagonism?

SYNERGISM

- ◉ Combined action of hormones is more than just additive!
- ◉ Example: Blood glucose levels & synergistic effects of glucagon, cortisol and epinephrine



PERMISSIVENESS

- **One hormone allows another hormone to have its full effect**
 - Especially during growth
- **Example**
 - Thyroid hormone have permissive effect on growth hormone action
 - Deficiency of thyroid hormone in infants leads to dwarfism.

ANTAGONISM

- Antagonistic hormones have opposing physiological actions -
 - Hormone B diminishes the effect of hormone A
- Example
 - Glucagon antagonizes the action of insulin
 - **Can you mention another example?**