

---

# Receptors Functions and Signal Transduction L1- L2

---

Faisal I. Mohammed, MD, PhD

## Introduction to Physiology (0501110) Spring 2026

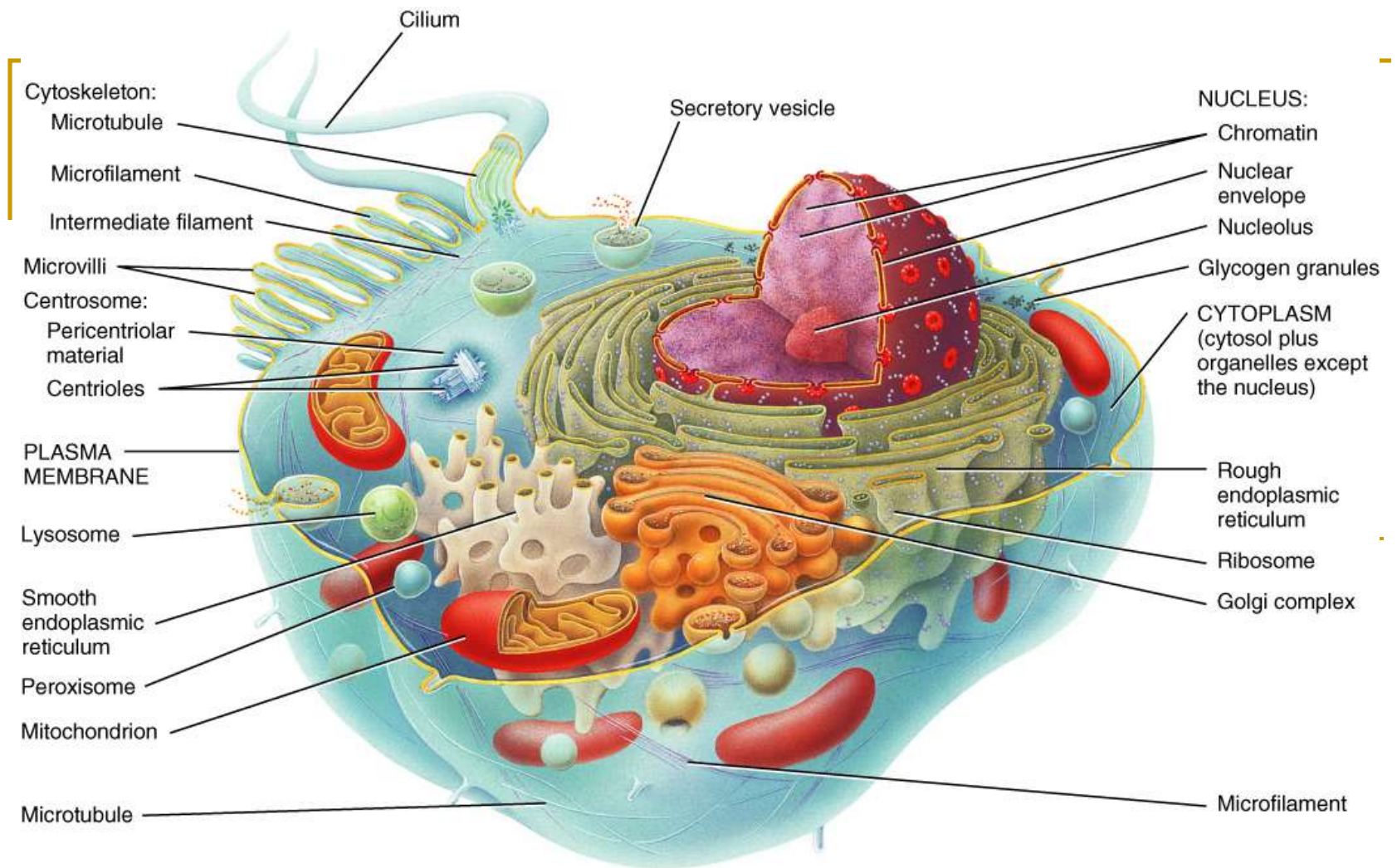
Subject	Lecture No.	Lecturer	Pages in the 13 <sup>th</sup> edition. textbook	Pages in the 14 <sup>th</sup> edition textbook
Receptors: types and adaptation - Membrane or intracellular - Ion channels - G-protein - Enzyme linked - Intracellular - Second messengers - cAMP and cGMP, Phospholipid - Calcium calmodulin and IRS		Dr. Faisal	915-927	925-935
Signal Transduction (Regulation of cellular machinery) Extracellular regulators: nervous, endocrine, paracrine and autocrine		Dr. Faisal	944-946	954-956
Steroids: Their Signal Transduction And Mechanism Of Action		Dr. Faisal	960-961 966-967	970-971 976-977

Textbook: Guyton Medical Textbook of Physiology By: Guyton and Hall 12<sup>th</sup> edition

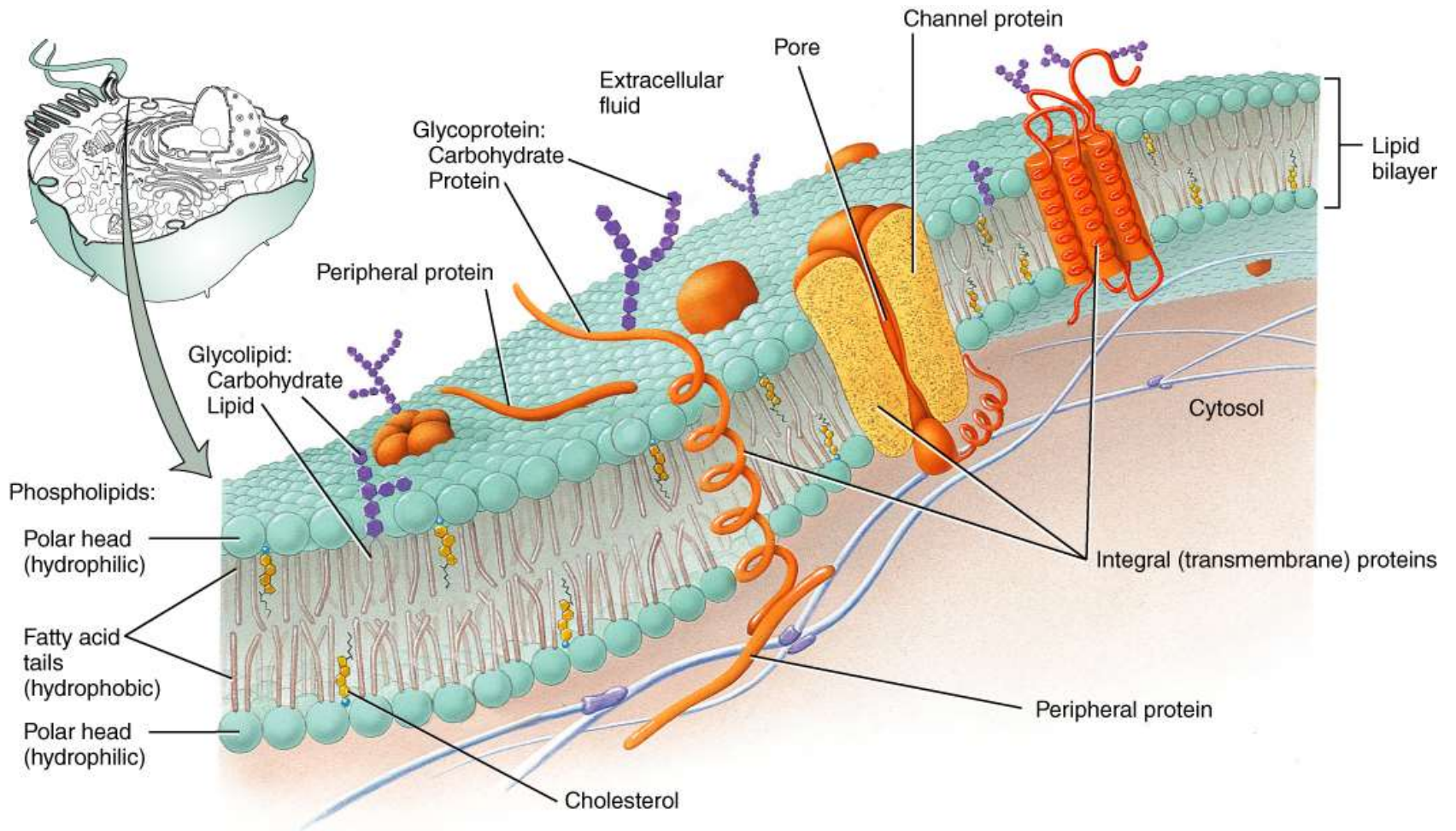
---

# Objectives

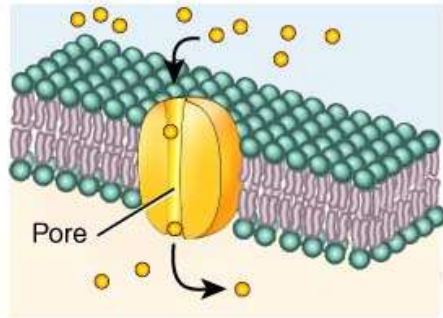
- Define first messenger (Hormones)
- List hormone types
- Describe receptor types
- Outline the hormone receptors interactions
- Describe second messenger mechanism of action
- List second messengers



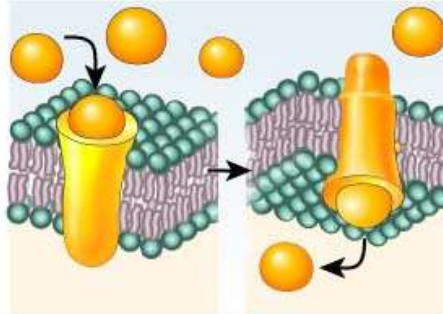
Sectional view



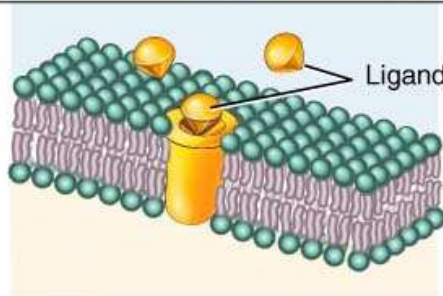
Extracellular fluid
  Plasma membrane
  Cytosol



**Ion channel**  
 Allows specific ion (●) to move through water-filled pore. Most plasma membranes include specific channels for several common ions.

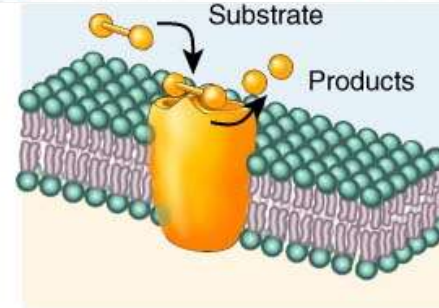


**Transporter**  
 Transports specific substances (●) across membrane by changing shape. For example, amino acids, needed to synthesize new proteins, enter body cells via transporters.

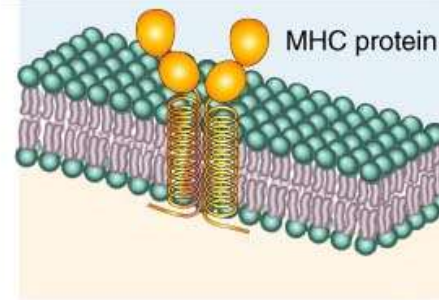


**Receptor**  
 Recognizes specific ligand (◊) and alters cell's function in some way. For example, antidiuretic hormone binds to receptors in the kidneys and changes the water permeability of certain plasma membranes.

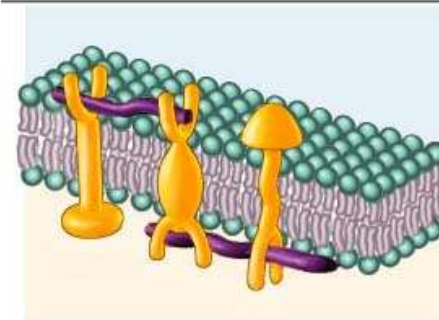
Extracellular fluid
  Plasma membrane
  Cytosol



**Enzyme**  
 Catalyzes reaction inside or outside cell (depending on which direction the active site faces). For example, lactase protruding from epithelial cells lining your small intestine splits the disaccharide lactose in the milk you drink.



**Cell Identity Marker**  
 Distinguishes your cells from anyone else's (unless you are an identical twin). An important class of such markers are the major histocompatibility (MHC) proteins.



**Linker**  
 Anchors filaments inside and outside to the plasma membrane, providing structural stability and shape for the cell. May also participate in movement of the cell or link two cells together.

# Intercellular Communication

**Endocrine**



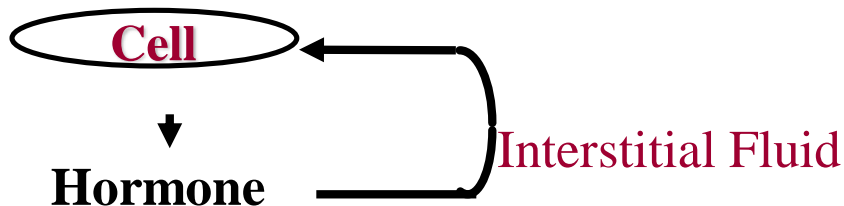
**Neuroendocrine**

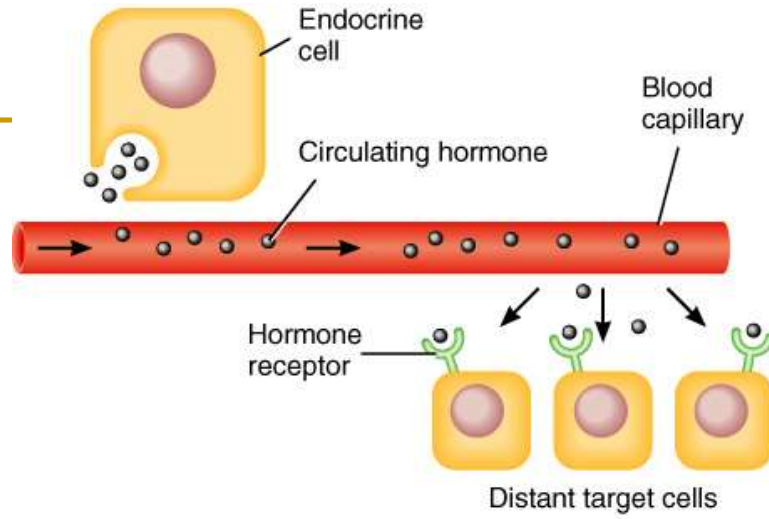


**Paracrine**

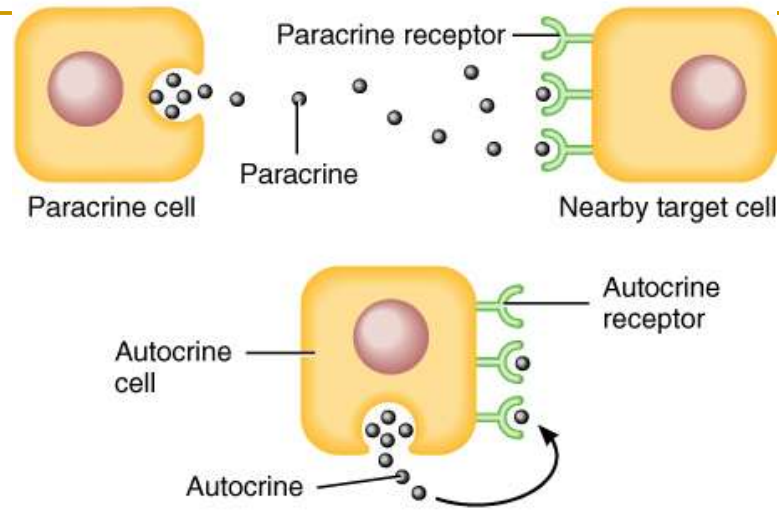


**Autocrine**



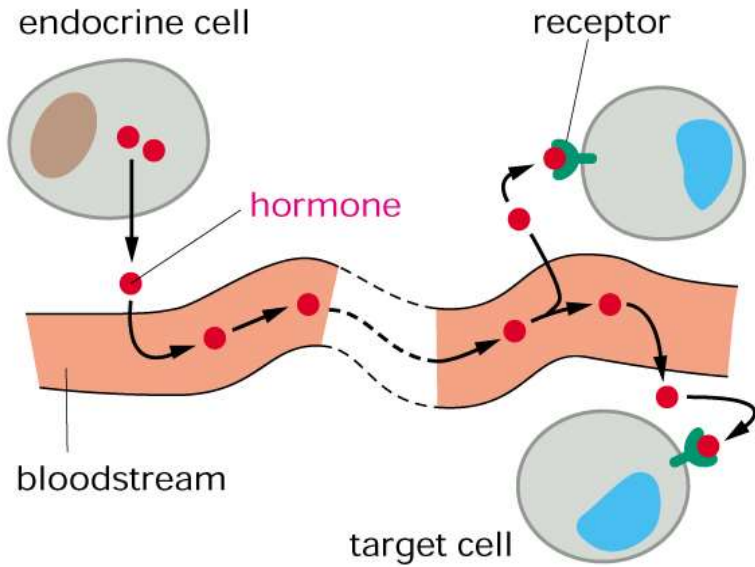


(a) Circulating hormones

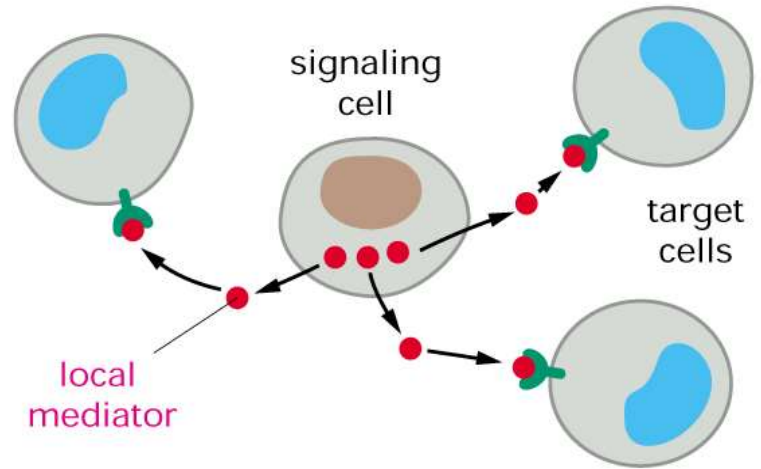


(b) Local hormones (paracrines and autocrines)

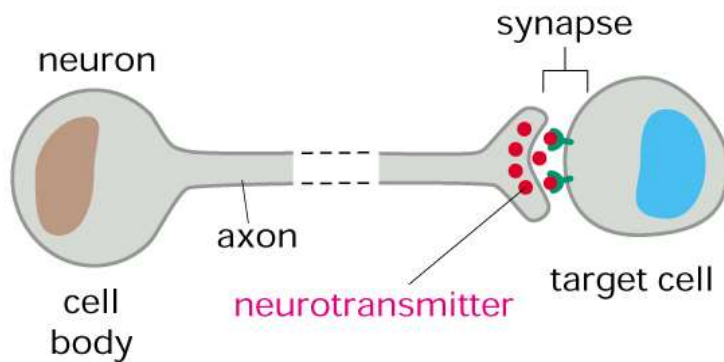
(A) ENDOCRINE



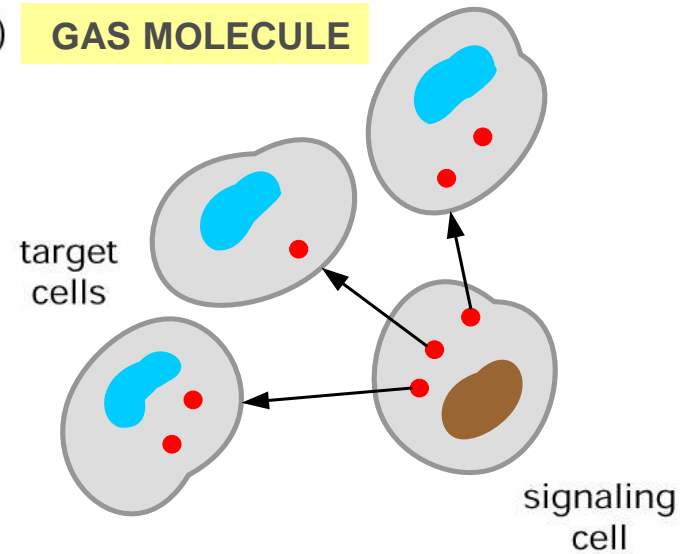
(B) PARACRINE



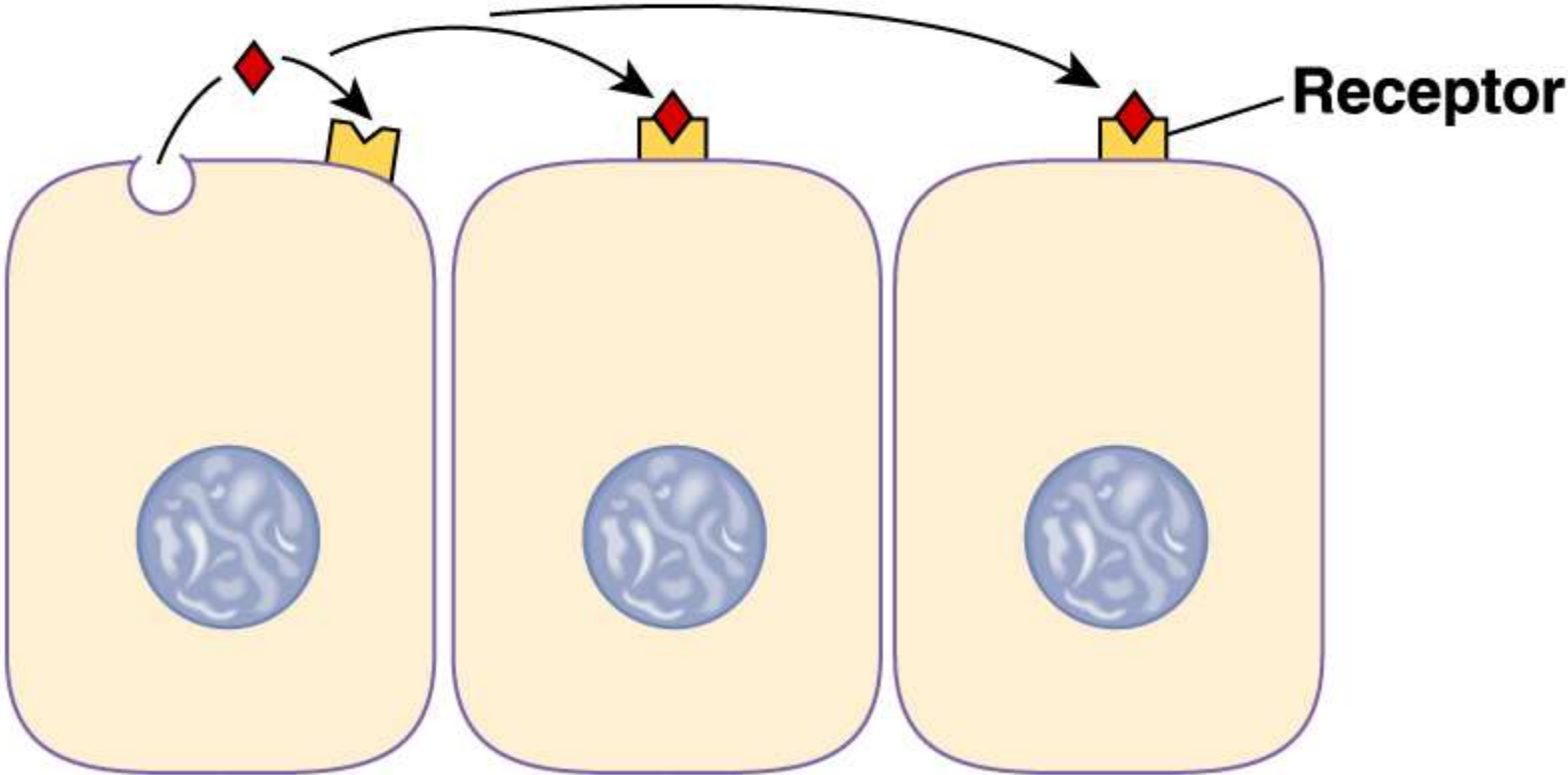
(C) NEURONAL



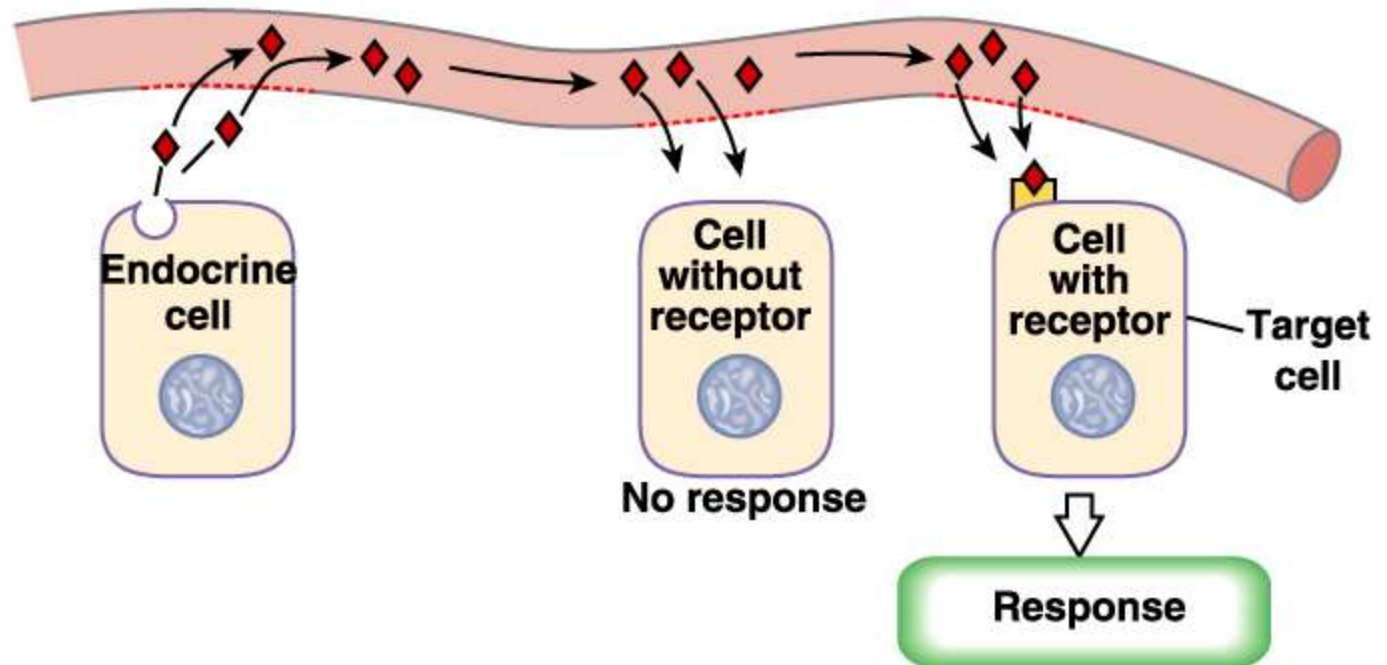
(D) GAS MOLECULE



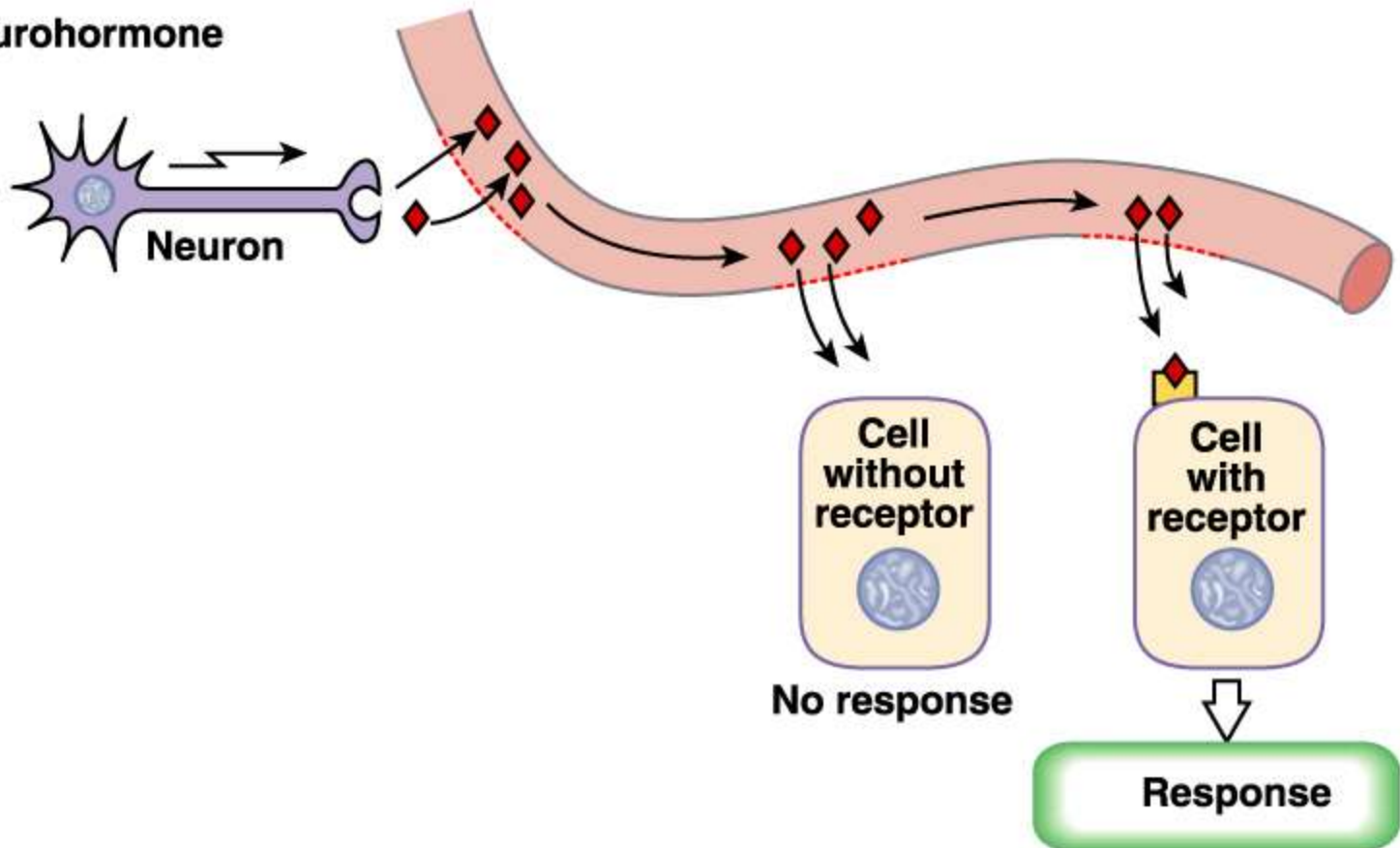
# Autocrine and paracrine signals



**Hormone**



**Neurohormone**



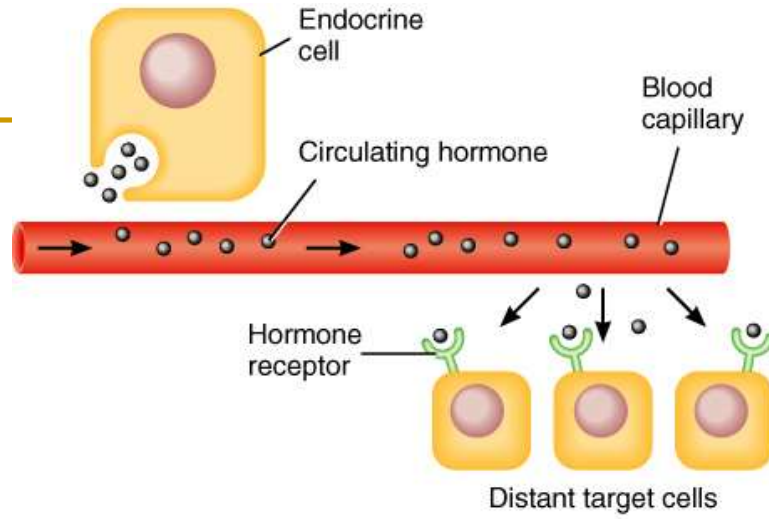
# Endocrine Glands and Hormones

- Neurohormone:
  - Specialized neurons that secrete chemicals into the blood rather than synaptic cleft.
    - Chemical secreted is called neurohormone.
- Hormones:
  - Affect metabolism of target organs.
    - Help regulate total body metabolism, growth, and reproduction.

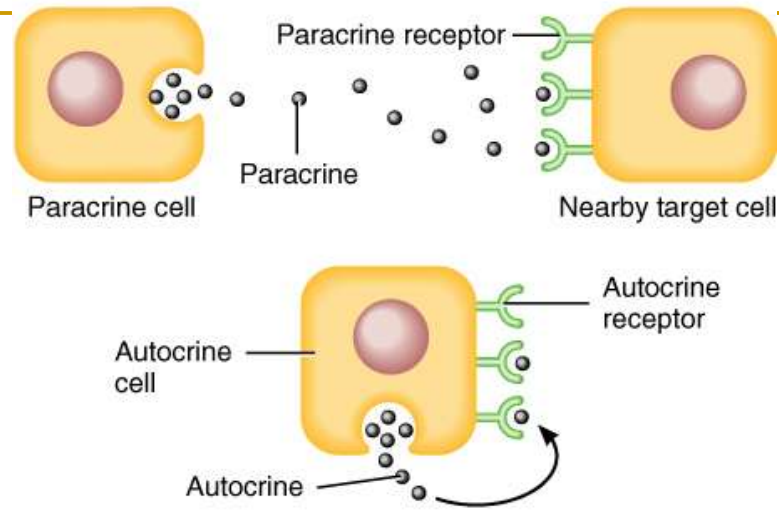
# Classes of Hormones

- Peptide and Protein Hormones (amino acid chain)
- Steroid Hormones (derived from cholesterol)
- Amine Hormones (derived from amino acid e.g tyrosin)
- Gas – Nitric Oxide (NO)

- 
- Hormone types
    - Circulating – circulate in blood throughout body
    - Local hormones – act locally
      - Paracrine – act on neighboring cells
      - Autocrine – act on the same cell that secreted them



(a) Circulating hormones



(b) Local hormones (paracrines and autocrines)

# Chemical classes of hormones

- ❑ Lipid-soluble hormones- use transport proteins in the plasma
- ❑ Steroid: Lipids derived from cholesterol.
  - ❑ Are lipophilic hormones.
    - ❑ Testosterone.
    - ❑ Estradiol.
    - ❑ Cortisol.
    - ❑ Progesterone.
- ❑ Eicosanoid (prostaglandins) derived from arachidonic acid (20 carbon 4 double bonds)- lipid soluble

# Chemical classes of hormones ...cont

- ❑ Water-soluble – circulate in “free” form in the plasma
  - ❑ Amines:
    - ❑ Hormones derived from tyrosine and tryptophan.
  - ❑ Polypeptides and proteins:
    - ❑ Polypeptides:
      - ❑ Chains of  $< 100$  amino acids in length.
        - ❑ ADH.
    - ❑ Protein hormones:
      - ❑ Polypeptide chains with  $> 100$  amino acids.
      - ❑ Growth hormone.

# Chemical Classification of Hormones ...cont

- Glycoproteins:
  - Long polypeptides (>100) bound to 1 or more carbohydrate (CHO) groups.
    - FSH and LH, TSH and hCG (human chorionic gonadotropin)  
They have  $\alpha$  and  $\beta$  subunits ( $\alpha$  is common and  $\beta$  is specific)
- Hormones can also be divided into:
  - Polar:
    - H<sub>2</sub>O soluble.
  - Nonpolar (lipophilic):
    - H<sub>2</sub>O insoluble.
      - Can gain entry into target cells.
      - Steroid hormones and T<sub>4</sub> (thyroxine –tetraiodothyronine))

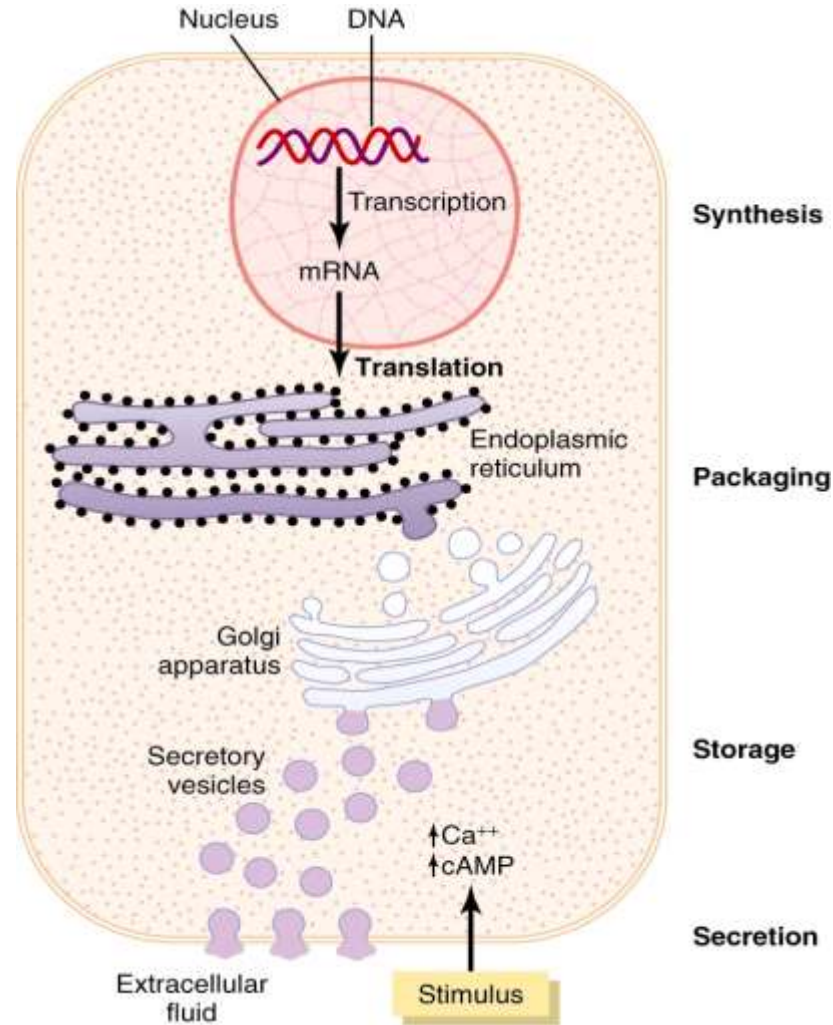
# Prohormones and Prehormones

- Prohormone:
  - Precursor is a longer chained polypeptide that is cut and spliced together to make the hormone.
    - Proinsulin – gives insulin
- Preprohormone:
  - Prohormone derived from larger precursor molecule.
    - Preproinsulin.
- Prehormone:
  - Molecules secreted by endocrine glands that are inactive until changed into hormones by target cells.
    - $T_4$  converted to  $T_3$  (tri-iodothyronin).

# Peptide & Protein Hormones

<b>Gland/Tissue</b>	<b>Hormones</b>	<b>Gland/Tissue</b>	<b>Hormones</b>
Hypothalamus	■ TRH, GnRH, CRH GHRH, Somatostatin,	Placenta	■ HCG, HCS or HPL
Anterior pituitary	■ ACTH, TSH, FSH, LH, PRL, GH	Kidney	■ Renin
Posterior pituitary	■ Oxytocin, ADH	Heart	■ ANP
Thyroid	■ Calcitonin	G.I. tract	■ Gastrin, CCK, Secretin, GIP, Somatostatin
Pancreas	■ Insulin, Glucagon, Somatostatin		
Liver	■ Somatomedin C (IGF-1)	Adipocyte	■ Leptin
Parathyroid	■ PTH	Adrenal medulla	■ Norepinephrine, epinephrine

# Synthesis and secretion of peptide hormones



# Amine Hormones

## Gland/Tissue

## Hormones

Hypothalamus

■ Dopamine

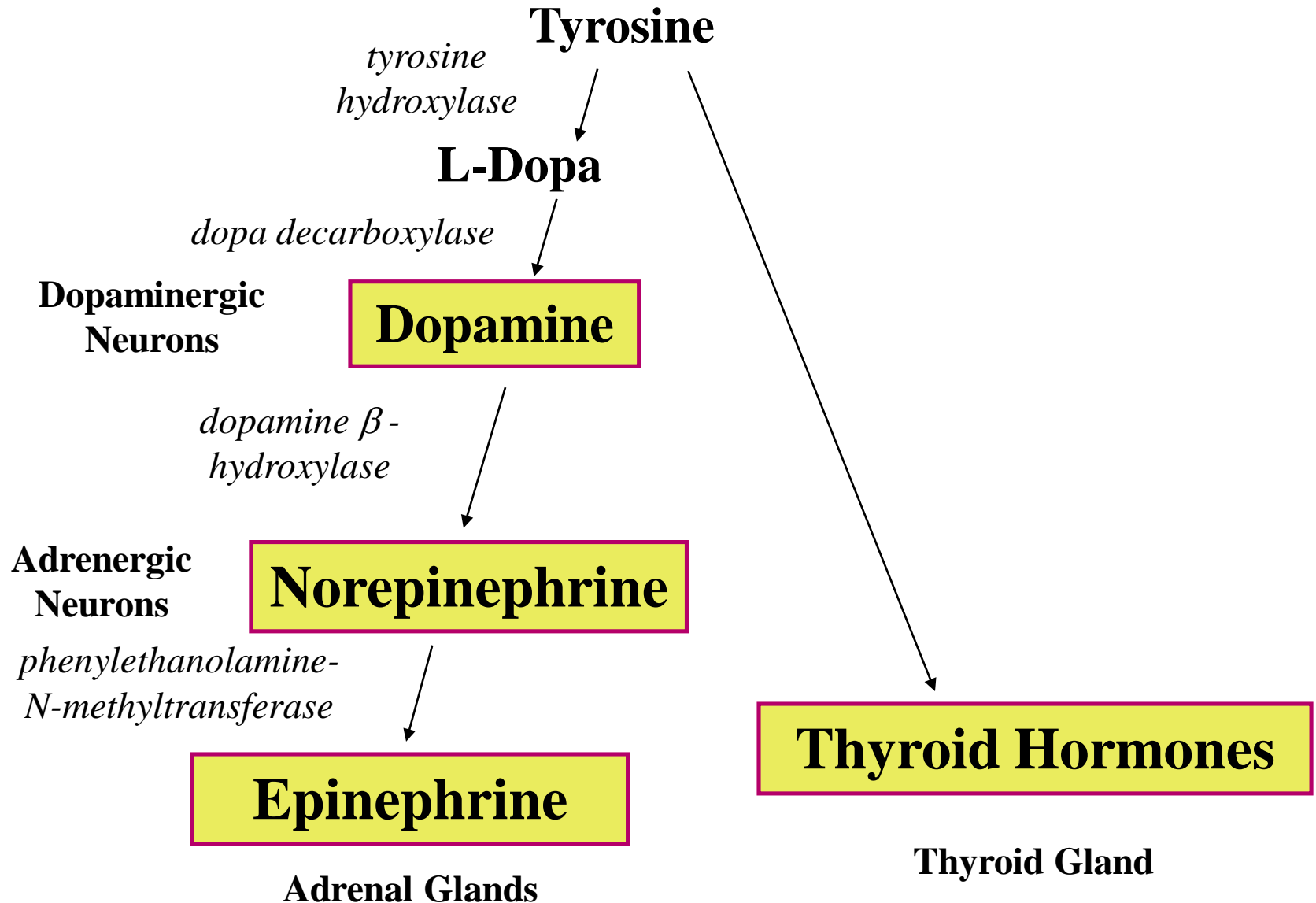
Thyroid

■ T<sub>3</sub>, T<sub>4</sub>

Adrenal medulla

■ Epinephrine and  
Norepinephrine  
(NE, EPI)

# Synthesis of Amine Hormones



# Steroid Hormones

## Gland/Tissue

## Hormones

Adrenal Cortex

■ Cortisol, Aldosterone, Androgens

Testes

■ Testosterone

Ovaries

■ Estrogens, Progesterone

Corpus Luteum

■ Estrogens, Progesterone

Placenta

■ Estrogens, Progesterone

Kidney

■ 1,25-Dihydroxycholecalciferol (calcitriol)

Thank you



---

# Receptors Functions and Signal Transduction L2

---

Faisal I. Mohammed, MD, PhD

# Hormone Activity

- Hormones affect only specific target tissues with specific receptors
- Receptors are dynamic and constantly synthesized and broken down
  - Down-regulation- decrease in receptor number or response may be due to internalization of receptors
  - Up-regulation- increase in receptor number or activity, may be due to externalization of receptors or synthesis of new receptors.