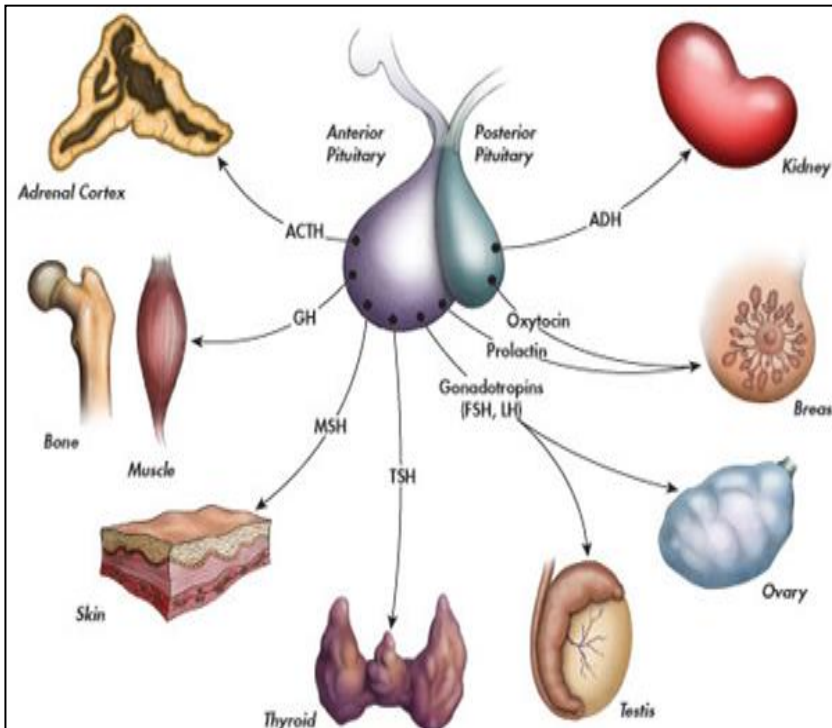




# Physiology (code)-year 2



## Endocrine system

### Lecture 1 (Introduction)

By Haithem Jawad Kadhum

Physiology Department

College of Medicine

University of Basrah

# Objectives

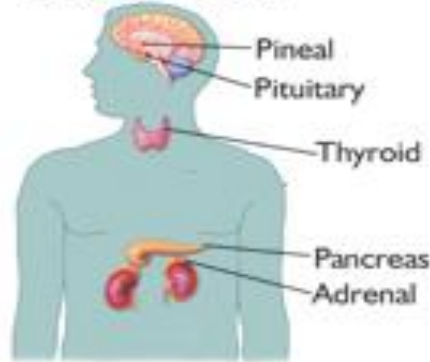
- ⦿ Understand the chemical nature of hormones and how this determines their mechanism.
- ⦿ Define how hormones are synthesized and secreted by cells of endocrine glands, including how peptide hormones are cleaved from longer precursors.
- ⦿ Understand the principles of feedback control for hormone release.
- ⦿ Understand the characteristics of hormone receptors.
- ⦿ Describe the anatomic connections between the hypothalamus and the pituitary gland and the functional significance of each connection.

# ENDOCRINOLOGY

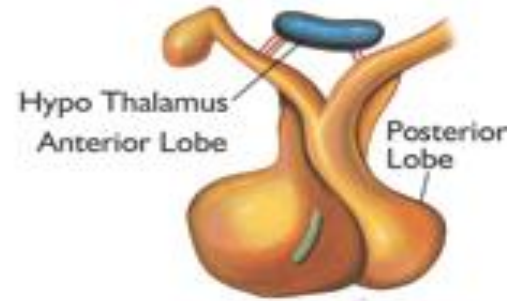
- ◎ The functions of the body are regulated by 2 systems:
  - ☛ The nervous system
  - ☛ The endocrine (hormonal) systemInterrelationship exists between the two systems
- ◎ Endocrine glands are scattered throughout the body and secrete hormones into the circulatory system

# HUMAN ENDOCRINE GLANDS

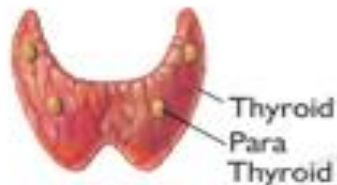
## Glands In Situ



## Pituitary



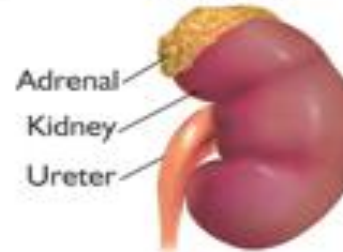
## Thyroid



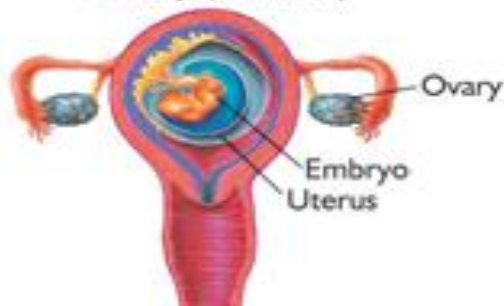
## Pancreas



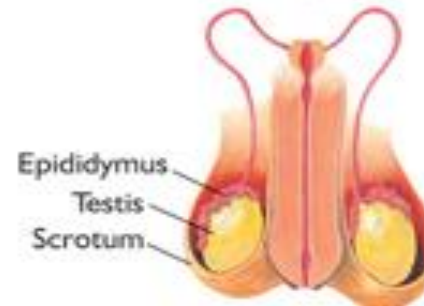
## Adrenal



## Ovary (Female)



## Testis (Male)



# Chemistry of hormones

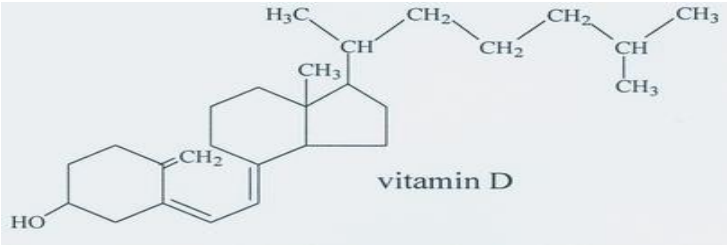
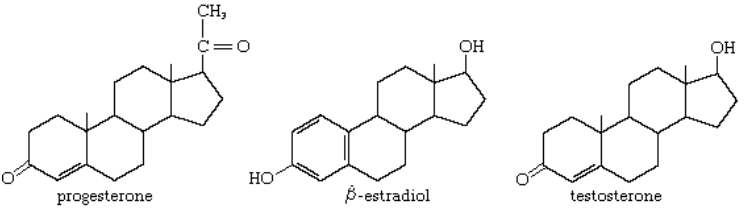
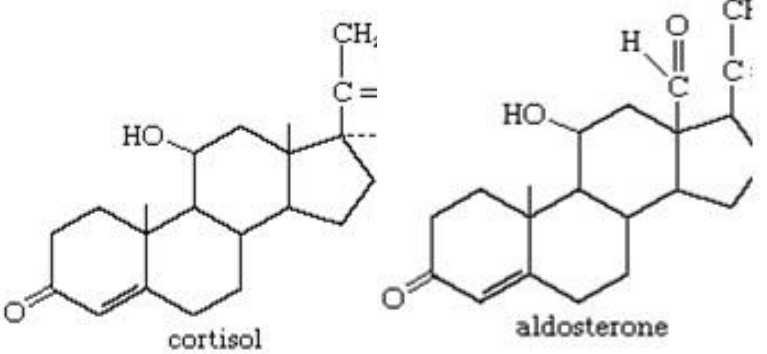
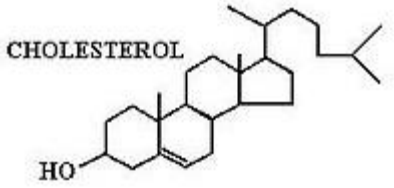
## 1) Steroid hormones

- Have a chemical structure similar to or derived from cholesterol
- Lipid soluble
- Receptors intracellular receptors
- Includes

1. Adrenocortical hormones
2. Ovarian and testicular hormones

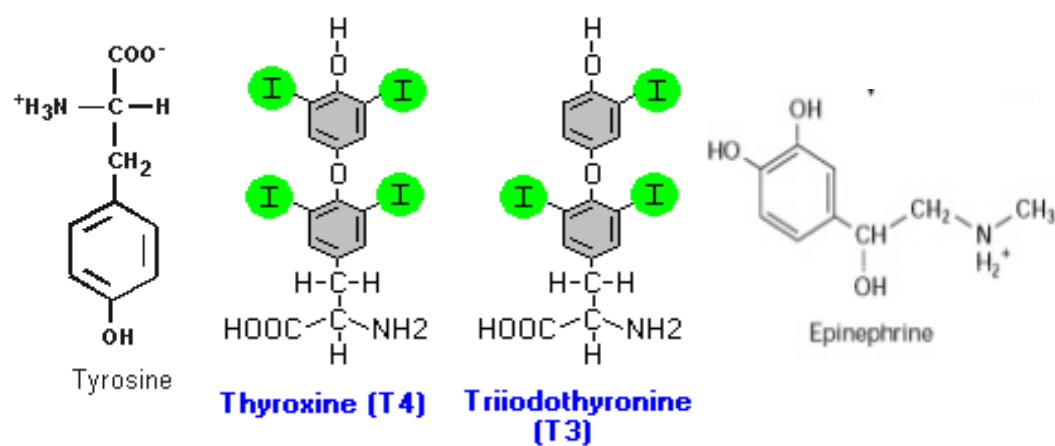
3. Steroid hormones from placenta (pregnancy)

4. Calcitriol (vitamin D)



## 2) Amine hormones

- Derivatives of the AA tyrosine
- Includes:
  - ☛ Thyroid hormones (T<sub>3</sub> and T<sub>4</sub>)
  - ☛ Adrenal medulla hormones

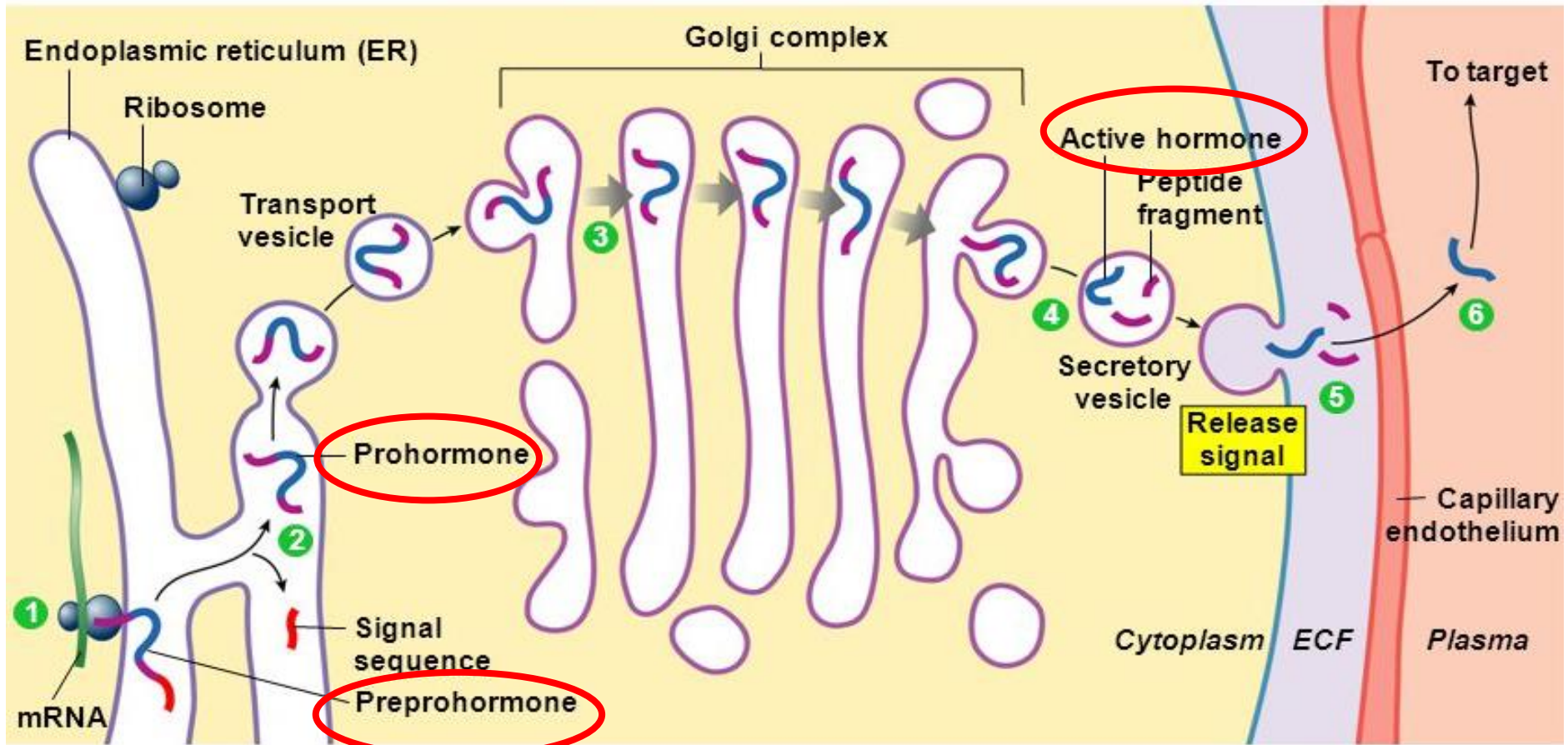


## 3) Proteins or peptides hormones

- Includes all remaining hormones (**p**ituitary, **p**ancreas & **p**arathyroid):
  - Lipid insoluble
  - Receptors → cell membrane
- Tyrosine derived thyroid hormone behaves more like a steroid than a peptide hormone by binding to an intracellular receptor.

# Synthesis and storage of (peptide) hormones

- Transcription of DNA → mRNA (translation in rough ER) → preprohormone
- cleavage in ER → prohormone
- cleavage in Golgi apparatus → hormone (stored)
- secretion (exocytosis)



# Control of secretion

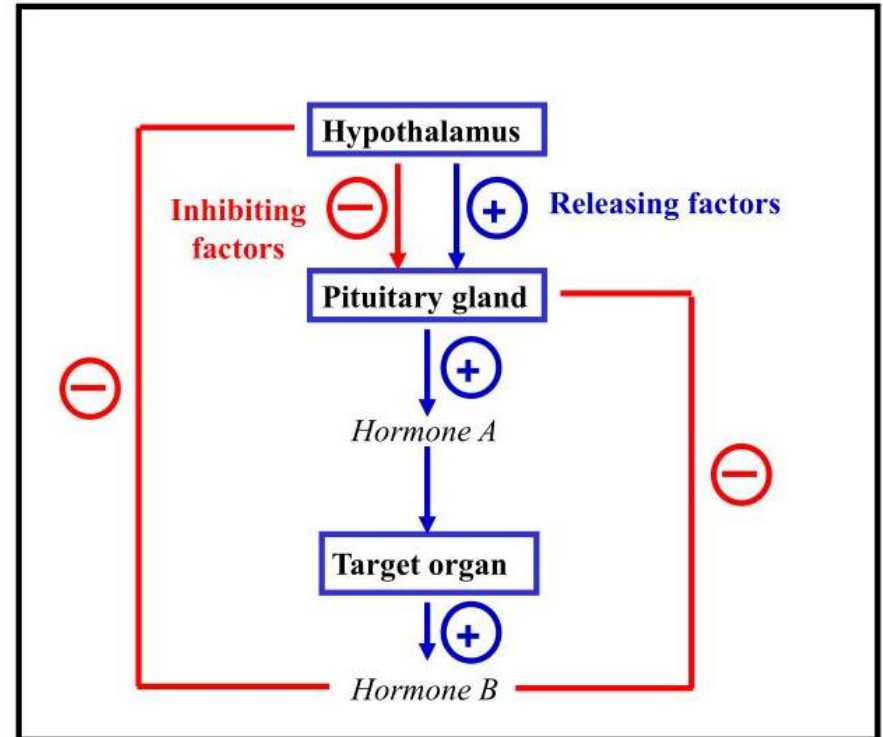
⦿ Neural: adrenal medulla secretion

⦿ Feedback regulation:

- Positive
- Negative

⦿ Regulation by substrate

- Insulin & glucagon (glucose)
- PTH ( $\text{Ca}^{2+}$ )
- Aldosterone ( $\text{K}^+$ )





# Hormone receptors

◎ **Structure:** high M. Wt. protein or glycoprotein

◎ **Location:**

- Cell membrane: catecholamines and insulin receptors
- Cytoplasm: glucocorticoids receptors
- Nucleus: thyroxine receptors

◎ **Specific** for hormone type

◎ **Different** in number and affinity

- Down regulation
  - ☛  $\uparrow$  Insulin  $\rightarrow$   $\downarrow$  number and affinity of receptors (insulin resistance)
- Up regulation
  - ☛  $\beta$ -blockers  $\rightarrow$   $\uparrow$  number and affinity of  $\beta$  adrenoreceptors

# Mechanism of action of hormones

Hormones act through the following mechanisms:

## ⦿ Change in the membrane permeability

- Opening or closing ionic channels
  - ☛ Catecholamines

## ⦿ Activation of gene formation

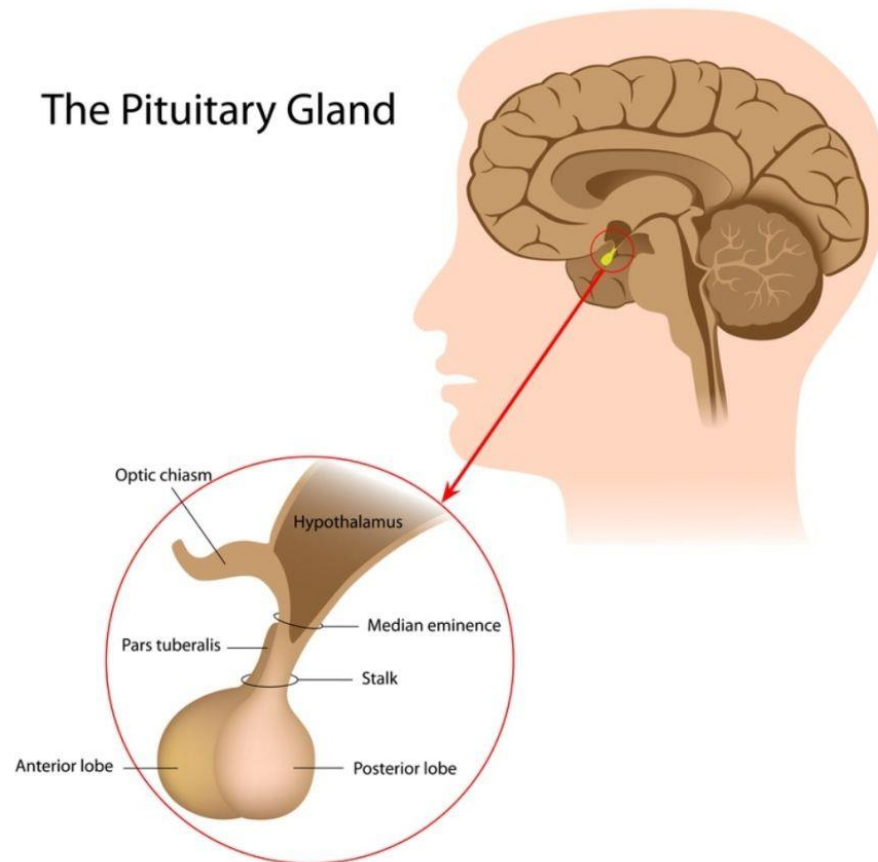
- By the hormone receptors complex which may act on DNA or on the RNA → mRNA → new protein → physiological effect
  - ☛ DNA (thyroid and steroid hormones)
  - ☛ RNA (GH and insulin)

## ⦿ Generation of 2<sup>nd</sup> messenger

- Hormone (polypeptide hormones) + receptor → 2<sup>nd</sup> messenger (cAMP, cGMP, Ca<sup>2+</sup>, PGs, IP3 and G protein) → activation of intra cellular enzymes that initiates a series of events

# PITUITARY GLAND (HYPOPHYSIS)

- Is a small gland (0.5gm)
- Location: midcranial fossa
- Connected to the hypothalamus by pituitary (hypophyseal) stalk



Physiologically it is divided into two parts:

## ◎ The anterior pituitary

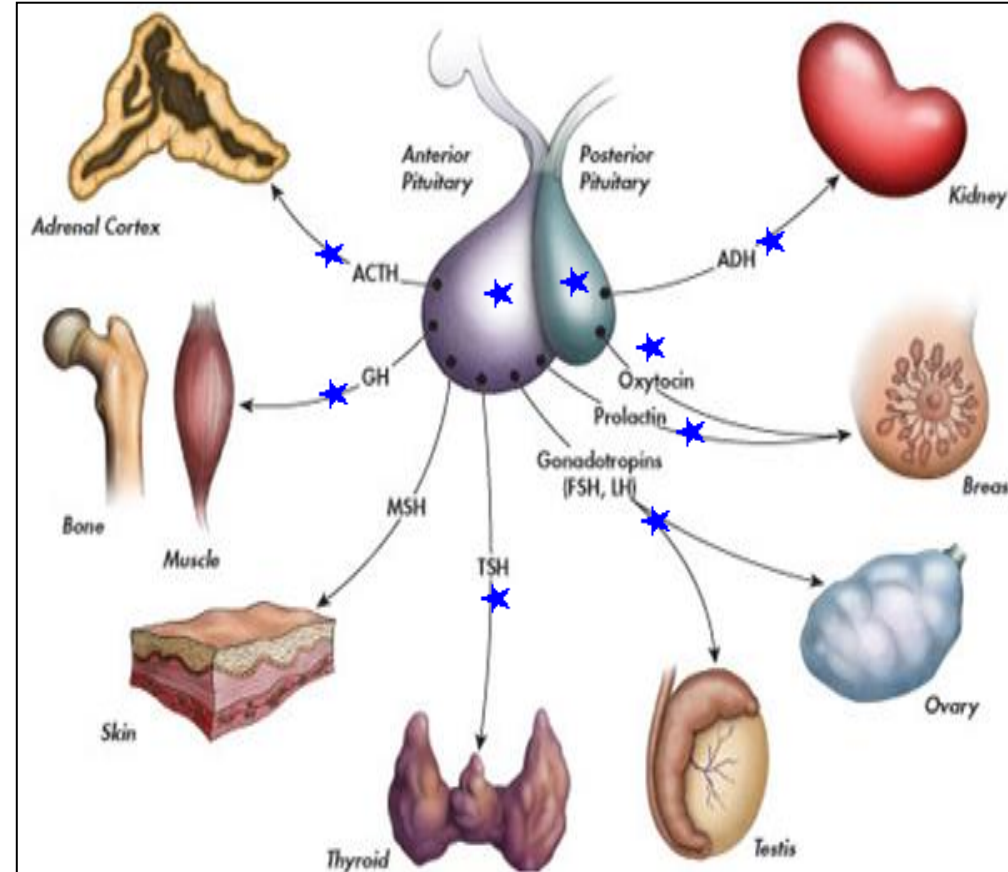
Adenohypophysis-75%

- 1) GH: somatotropin
- 2) ACTH: corticotrophin
- 3) TSH: thyrotropin
- 4) FSH } gonadotropins
- 5) LH }
- 6) PRL: prolactin-mammotropin

## ◎ Posterior pituitary

Neurohypophysis-25%

- 1) ADH (vasopressin)
- 2) Oxytocin



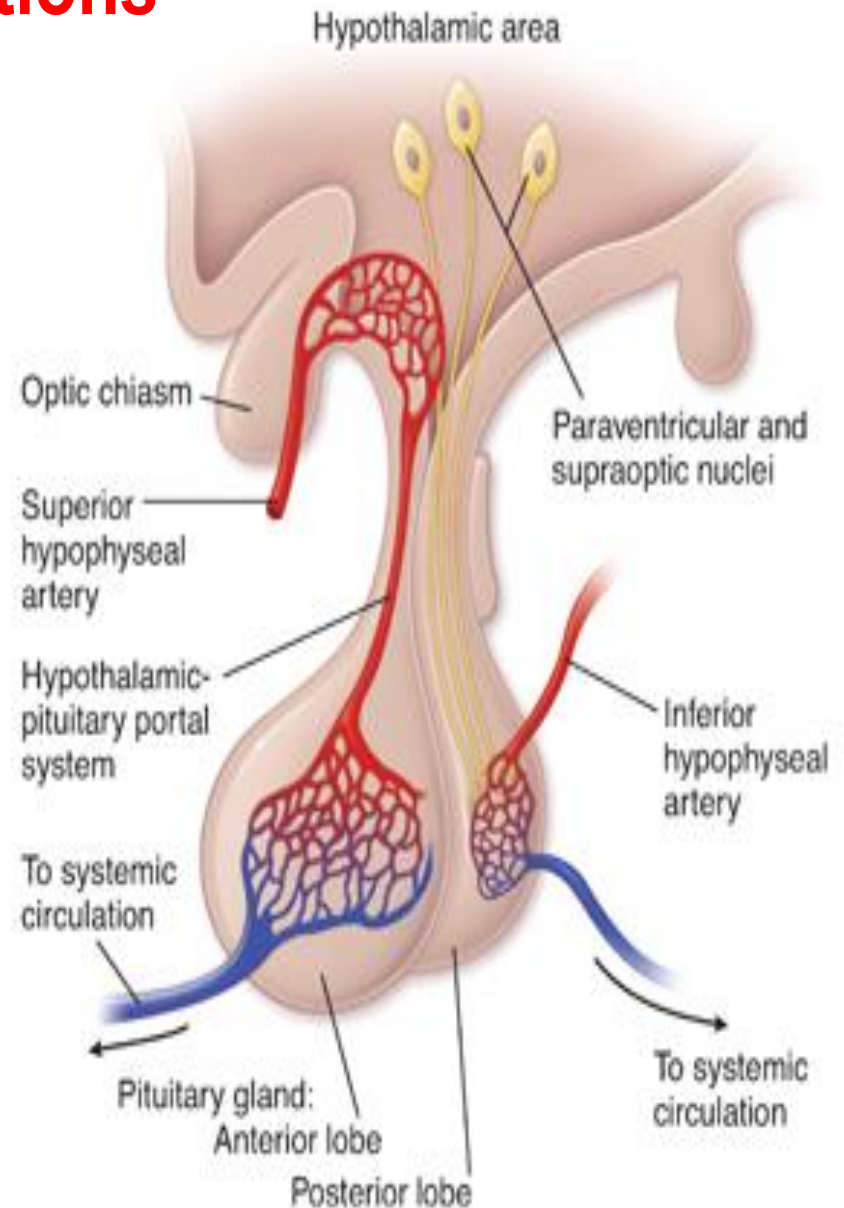
# Hypothalamic pituitary connections

## Neural connection

- Between hypothalamus & post. pituitary
- Axon of supraoptic and paraventricular nuclei → hypothalamic hypophyseal tract → posterior pituitary

## ⊙ Vascular connection

- Between hypothalamus & ant. pituitary
- The hypothalamic-hypophyseal (pituitary) portal vessels form a direct link between the hypothalamus and the anterior pituitary.



# Recap

- 1) Hormones are either steroid, amine derivative, protein or peptide.
- 2) Synthesis of peptide hormones is similar to the synthesis of protein anywhere in the body.
- 3) Hormone secretion undergoes feedback regulation which are either positive or negative feedback mechanism
- 4) Hormone receptors are high molecular weight protein or glycoprotein, located in different parts of cells, specific for hormone type, and their number and affinity are affected by plasma level of the hormone.
- 5) There is a neural connection between posterior pituitary and the hypothalamus and vascular connection between anterior pituitary and the hypothalamus. These connections play an important role in regulation of pituitary secretion.