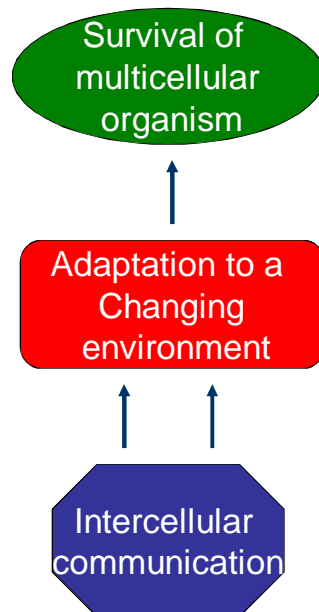
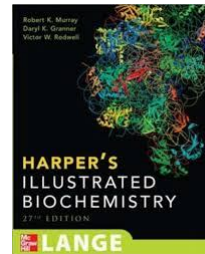
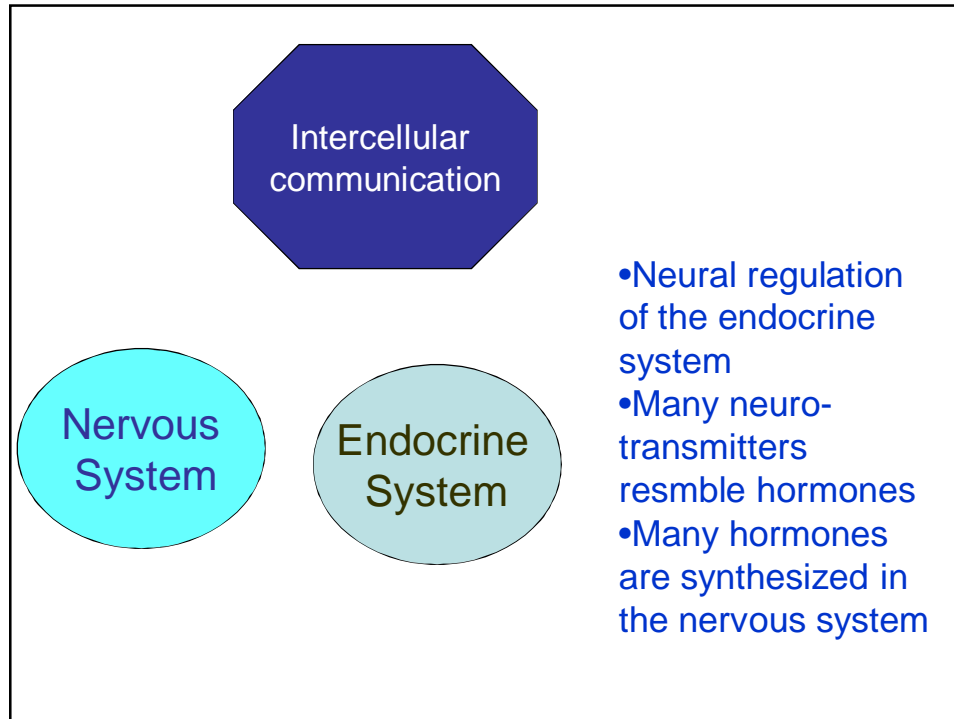


# Hormones

## General features and the Hormonal Cascade System

Harper's Illustrated Biochemistry  
accessmedicine.com





## Hormones:

- Current Definition
  - Any substance produced in an organism
  - that carries a signal to
  - generate a response in a target cell
- Classes:
  - Endocrine hormones
  - Paracrine hormones
  - Autocrine hormones

## Hormones affect cells through interactions with their receptors

~ 200 types of cells.

A few produce hormones.

> 50 hormones.

Affect almost all cells

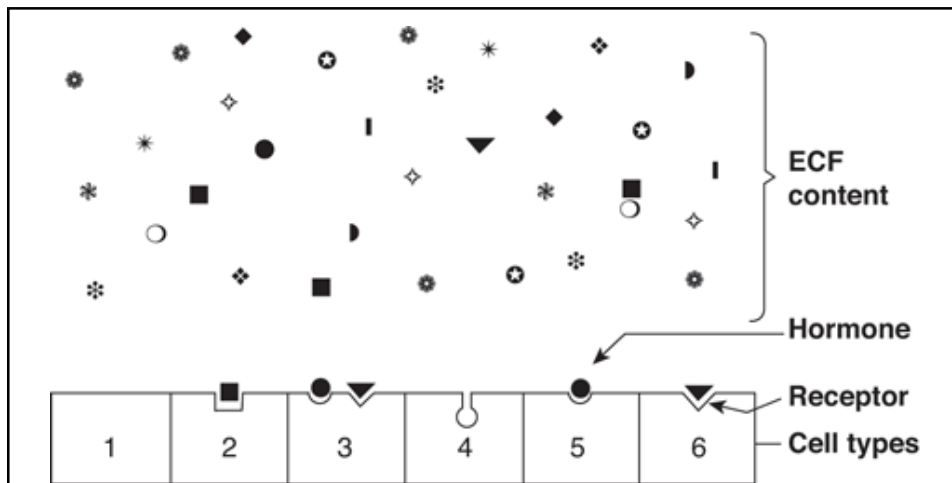
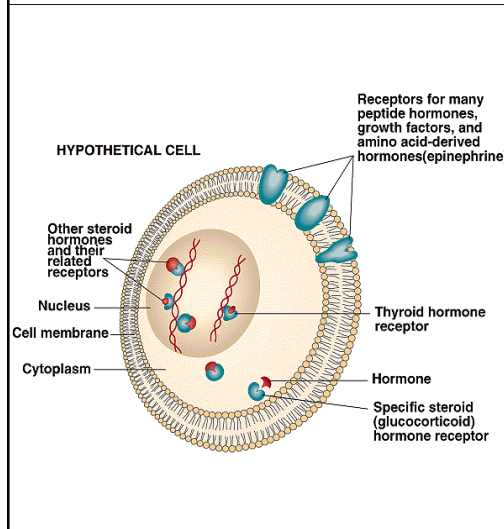
Very low concentration

$10^{-15} - 10^{-9}$  mole/L

can affect more than one cell type,

hormones can exert more than one effect

more than one hormone can affect the same cell.



Target cells can distinguish between

- Different hormones
- A given hormone and other similar molecules present at much higher concentration

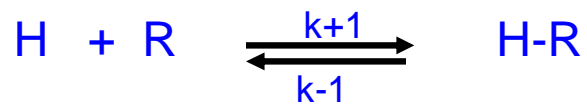
Target Cells: High ability to selectively bind a given hormone

Binding of Hormone to its receptor should be:

- Specific
- Saturable
- Within the concentration range

## Hormone-Receptor Interactions

- Extent of binding depends on hormone concentration



Affinity of receptor toward its hormone can be expressed by

Association constant  $K_a$

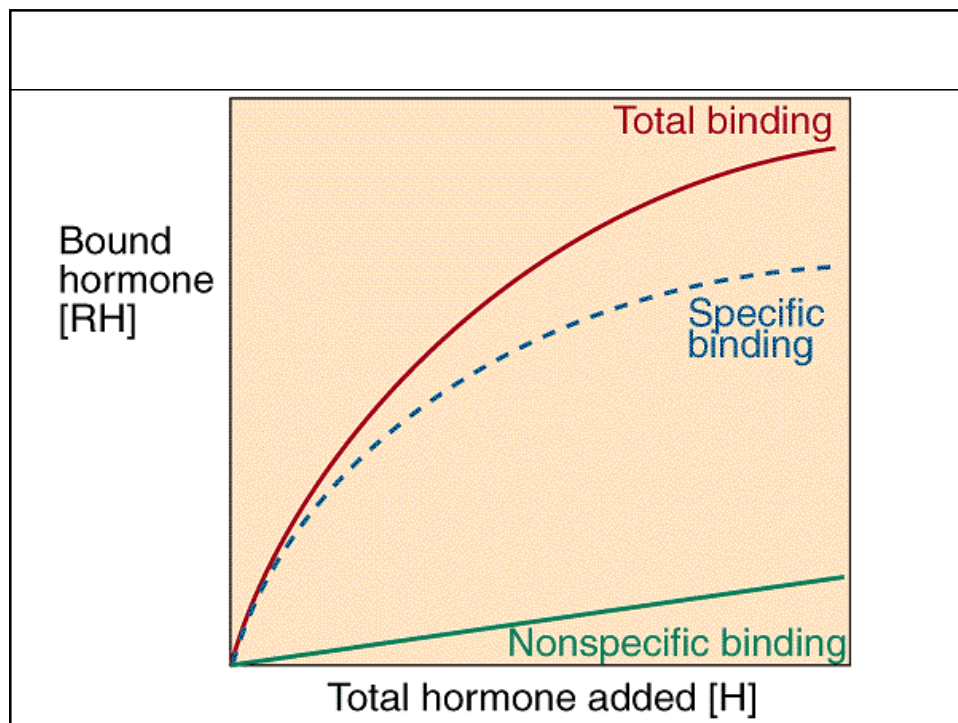
Dissociation constant  $K_d$

## Hormone-Receptor Interactions

Association constant  $K_a = [H-R] / [H]^* [R]$

Dissociation constant  $K_d = [H]^* [R] / [H-R]$

20X dissociation constant is enough to saturate the receptor



## Receptors are proteins

- Several classes have been defined
  - $\alpha_2\beta_2$ : Insulin receptor,
  - One polypeptide chain: epidermal growth factor
  - Seven helices that span the plasma membrane
  - Intracellular receptors: steroid and thyroid hormones
- Receptors are formed from at least 2 domains
  - Recognition domain
  - Coupling: hormone binding → alteration of function
- Can be down or up regulated, or desensitized

## Hormone Types

- Polypeptides
  - Pituitary hormones
  - Hypothalamic releasing hormones
  - Insulin, Growth factors...
- Amino acid derivatives
  - Adrenalin
  - Thyroid hormones
- Steroids

## Classification of hormones by mechanism of action

- Hormones that bind to intracellular receptors
  - Steroids
  - Thyroid hormones
  - Calcitriol, retinoic acid
- Hormones that bind to cell surface receptors  
(According to second messenger):
  - cAMP ( $\beta$  adrenergic factor, glucagon, ACTH)
  - cGMP (atrial natriuretic factor, Nitric oxide)
  - Calcium or phosphatidyl inositol (oxytocin, TRH)
  - Kinase or phosphatase cascade (insulin, GH)

Long Half life  
hours -days

Transport  
protein

## General Features of Hormone Classes

	Group I	Group II
Types	Steroids, iodothyronines, calcitriol, retinoids	Polypeptides, proteins, glycoproteins, catecholamines
Solubility	Lipophilic	Hydrophilic
Transport proteins	Yes	No
Plasma half-life	Long (hours to days)	Short (minutes)
Receptor	Intracellular	Plasma membrane
Mediator	Receptor-hormone complex	cAMP, cGMP, Ca <sup>2+</sup> , metabolites of complex phosphoinositols, kinase cascades

## Action of polypeptide hormones

- May cause the release of other substance
- Increase the flux of ions into cells
- Activation of enzymes or proteins
- Suppression of activities of enzymes or proteins

## Anterior Pituitary Hormones

- **GROWTH HORMONE (GH)**
  - Regulates growth
  - Affects protein, fat and carbohydrate metabolism.
- **THYROID STIMULATING HORMONE (TSH)** – controls secretion of thyroxin.
- **ADRENOCORTICOTROPIC HORMONE (ACTH)**
  - controls secretion of hormones released by adrenal cortex.
- **MELANOCYTE-STIMULATING HORMONE (MSH)**
  - along with ACTH, affects pigment release in skin



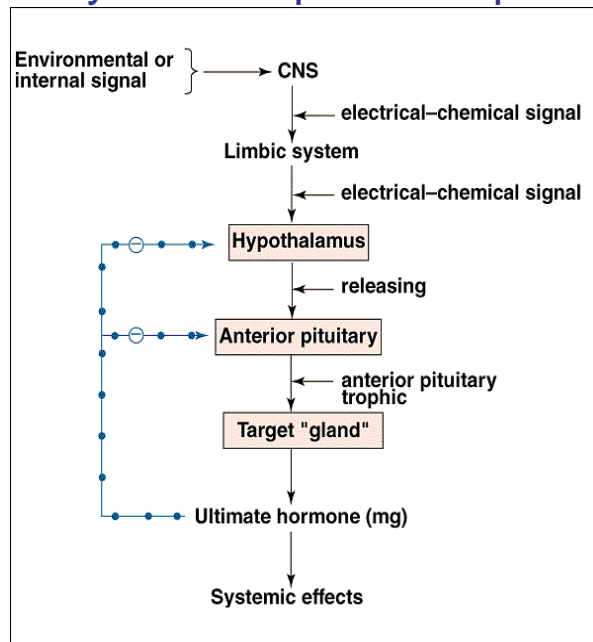
## Anterior Pituitary Hormones Cont.

- FOLLICLE-STIMULATING HORMONE (FSH) –  
In females: stimulates maturation of egg cells  
estrogen secretion by ovaries.  
In males: spermatogenesis
- LUTENIZING HORMONE (LH) –  
In females: stimulates release of ovum by ovary.  
In males: stimulates secretion of testosterone.
- PROLACTIN (PRL) – stimulates milk production.

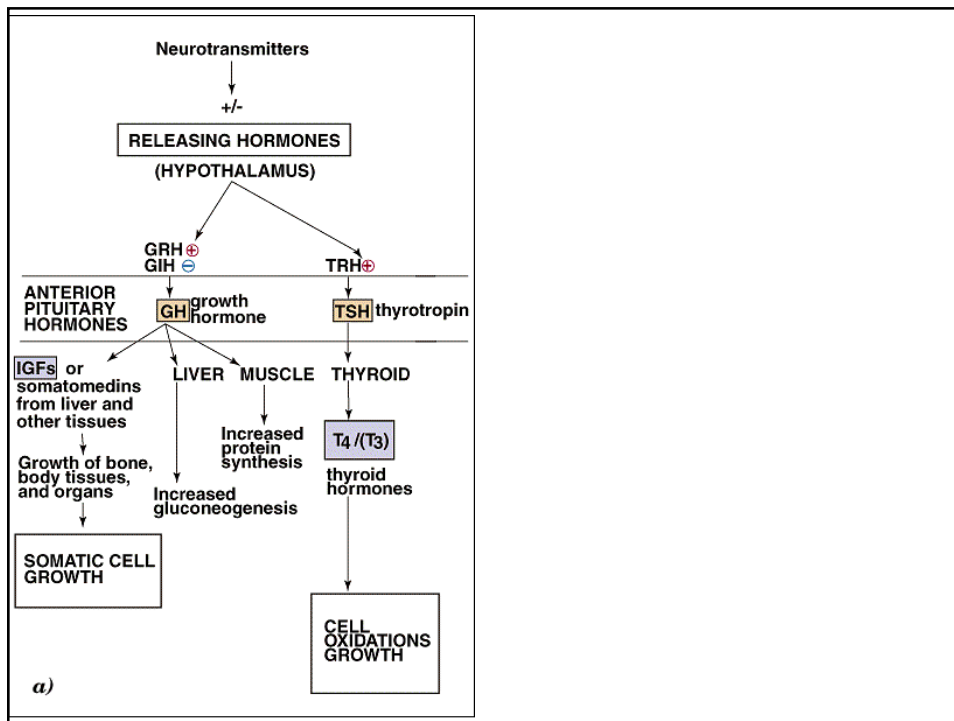
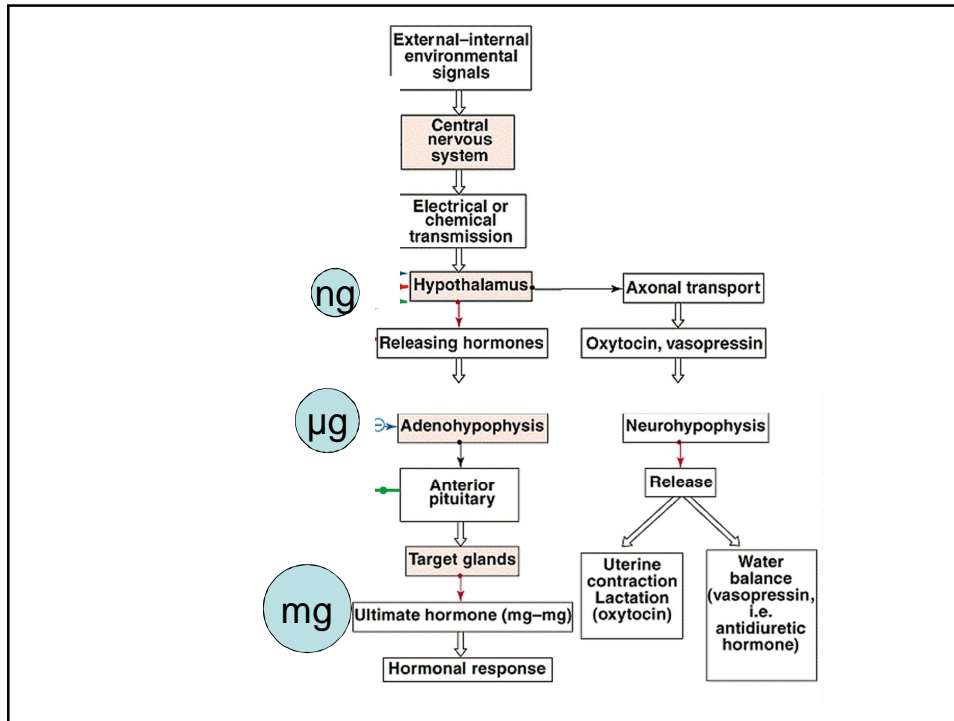
## Some Hypothalamic Releasing Hormones

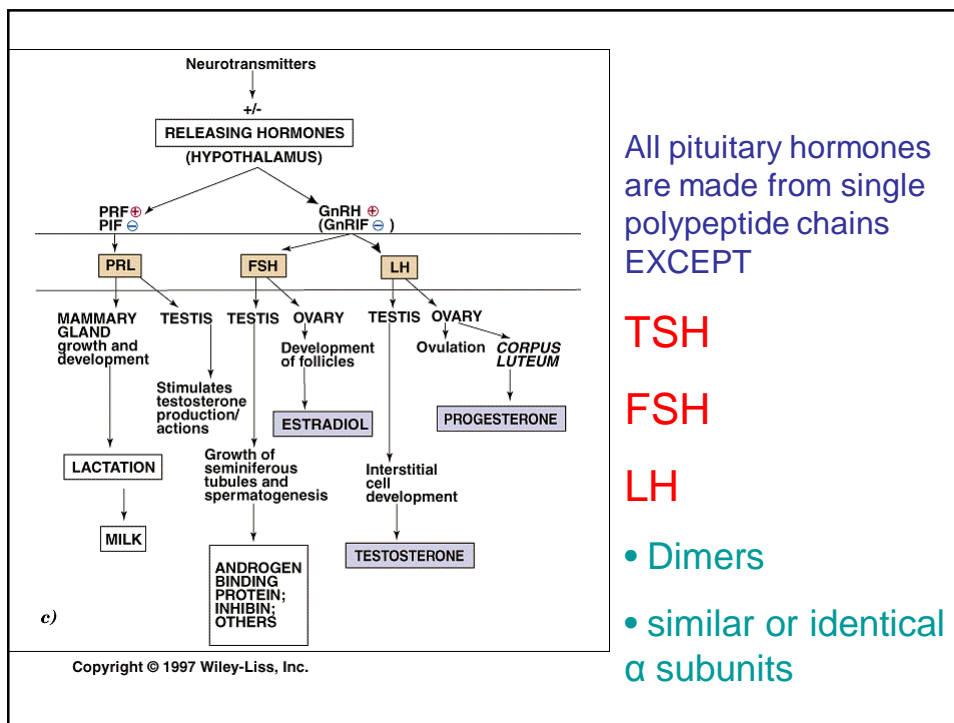
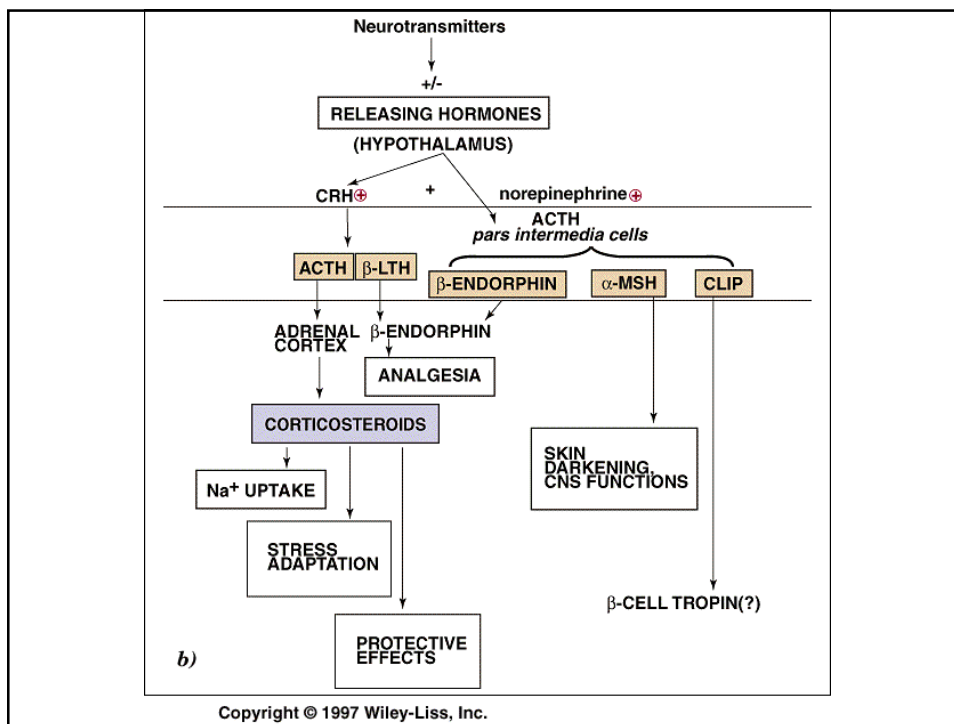
<u>Hormone</u>		<u>A.Acids</u>
Thyrotropin Releasing Hormone	(TRH)	3
Gonadotropin Releasing Hormone	(GnRH)	10
Gonadotropin Release-inhibiting Factor	(GnRIF)	12kDa
Corticotropin- Releasing Hormone	(CRH)	41
Arginine Vasopressine	(AVP)	9
Angiotensin II	(All)	8
Prolactin-Releasing Factor	(PRF)	
Prolactin-Release Inhibiting Factor	(PIF)	

## Cascade system amplifies a specific signal



- Final hormone affects many types of target cells  $\longrightarrow$  Systemic effect.
- Increasing amounts of hormones are generated at successive levels.
- Longer half life





All pituitary hormones are made from single polypeptide chains EXCEPT

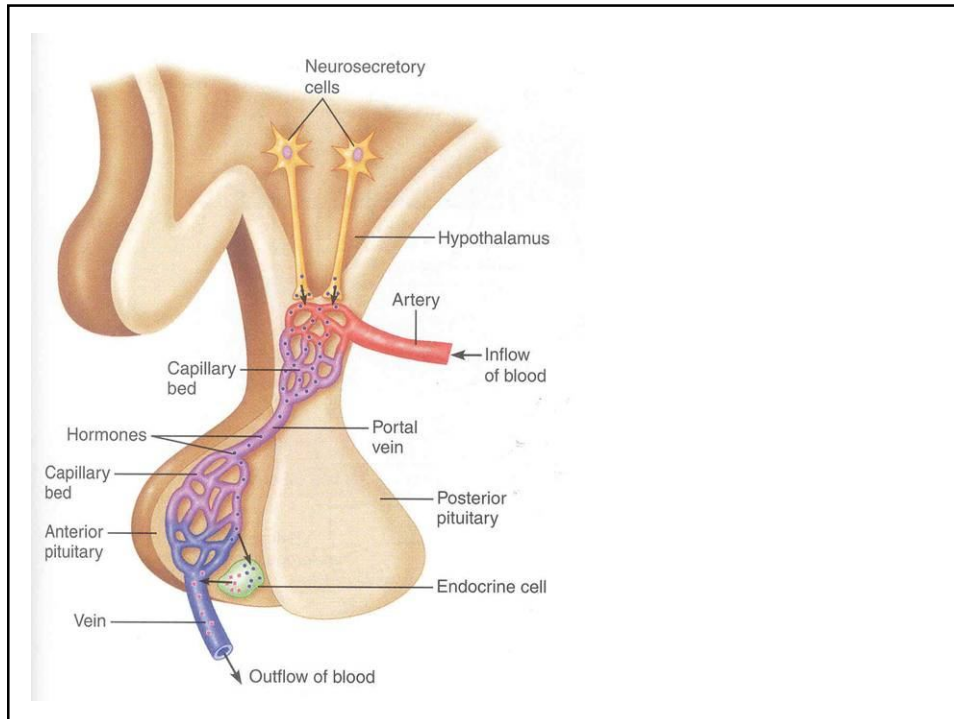
TSH

FSH

LH

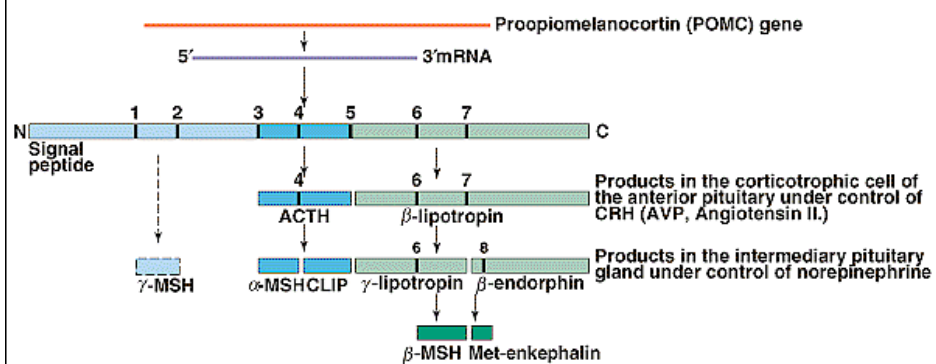
- Dimers

- similar or identical  $\alpha$  subunits



## Genes and formation of polypeptide hormones

One gene may code more than one hormone



## One gene may code more than one peptide

- Vasopressin and oxytocin
- Synthesis in separate cell bodies of hypothalamic neurons
- Release from posterior pituitary along with accompanying peptide (neurophysin)
- Vasopressin in response to baroreceptors or osmoreceptors
- Oxytocin in response to suckling

