

Introduction to endocrine system

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5th class

OBJECTIVES:

- 1. The student should be able to compare the regulatory responses of the nervous and endocrine systems.
- 2. The student should be able to list the functions of the endocrine system.
- 3. The student should be able to describe the basic endocrine glands and associated organs.

- 4. The student should be able to describe the basic role of hormones.
- 5. The student should be able to describe the basic types of hormones
- 6. The student should be able to describe the chemical classes of hormones.
- 7. The student should be able to describe the mechanisms of hormonal actions.

Systemic Control Systems

- How does the endocrine system differ from the ANS?
- A. Nervous System
 1. Effects within a few milliseconds
 2. Action Potentials required
 3. Neurotransmitters may or may not be required
 - a. Excitation
 - b. Inhibition

Systemic Control Systems

B. Endocrine System

1. Acts within seconds to hours
2. Endocrine glands
3. Hormones
4. Receptors

C. Neuroendocrine System

1. Nervous system may stimulate or inhibit release of hormones
2. Hormones may promote or inhibit nerve impulses

Endocrine Glands

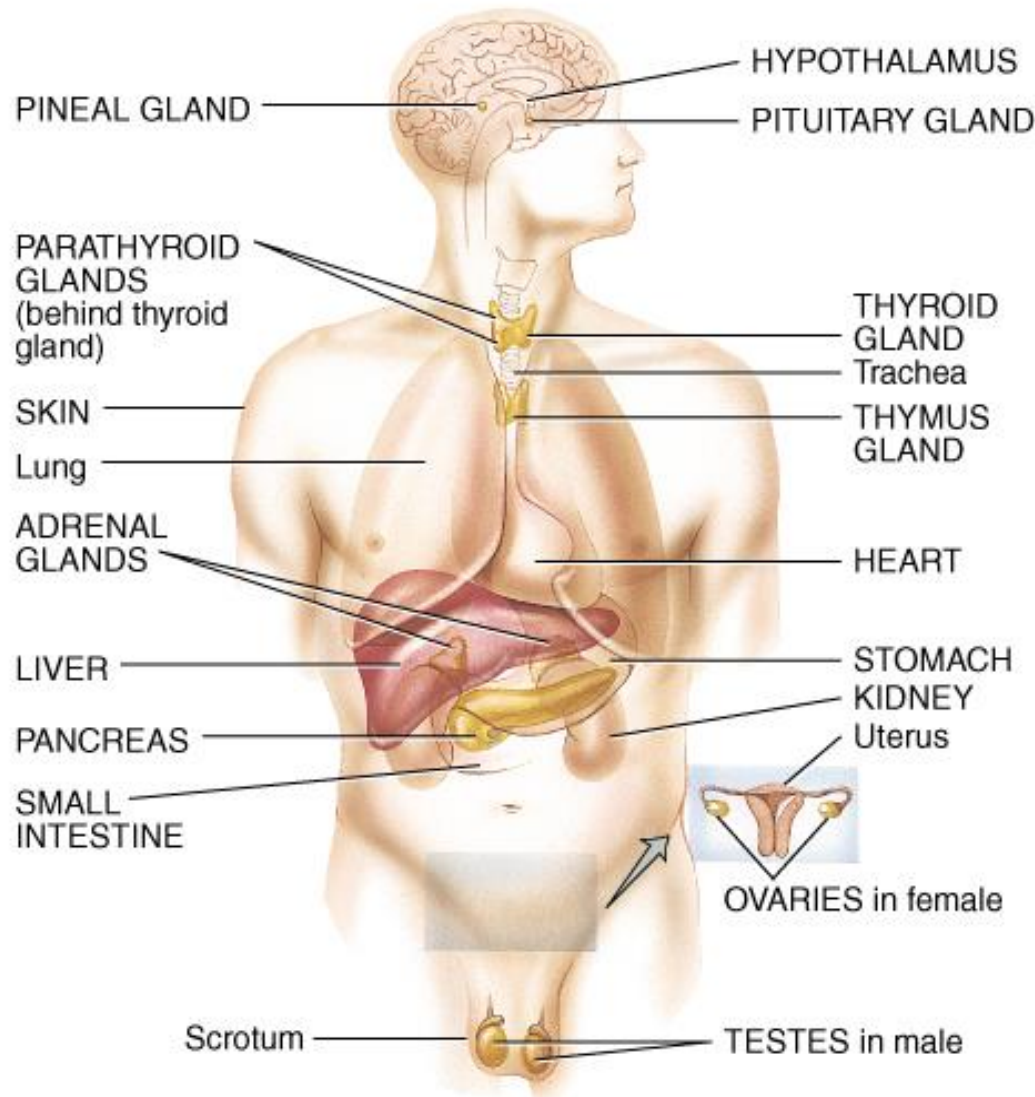
- What constitutes the endocrine system?
- A. Endocrine glands = Ductless
- B. Endocrine system
 1. Pituitary (hypophysis)
 2. Thyroid
 3. Parathyroid
 4. Adrenals (Suprarenals)
 5. Pineal (epiphysis cerebri)
 6. Thymus

Endocrine Glands

C. Other organs that contain endocrine tissue

- | | |
|---------------------|----------------------|
| 1. Pancreas | 8. Brain |
| 2. Ovaries | 9. Skin |
| 3. Testes | 10. Adipose tissue |
| 4. Kidneys | 11. Heart |
| 5. Stomach | 12. Placenta |
| 6. Liver | 13. Ovaries & Testis |
| 7. Small Intestines | |

Introduction to the Endocrine System



FUNCTIONS OF HORMONES

1. Help regulate:
 - chemical composition and volume of internal environment (extracellular fluid)
 - metabolism and energy balance
 - biological clock (circadian rhythms)
 - contraction of smooth and cardiac muscle fibers
 - glandular secretions
 - some immune system activities.
2. Control growth and development.
3. Regulate operation of reproductive systems.

Hormonal Actions

- What are the hormones doing in the human body?
 - A. Regulate chemical composition and volume of internal environment, change permeability of plasma membrane, stimulates transport of substances into or out of target cells
 - B. Help regulate metabolism, energy balance, and synthesis of new molecules

Hormonal Actions

- C. Help to regulate contraction of smooth muscle and cardiac muscle fiber and secretion of glands
- D. Help maintain homeostasis despite; infection, trauma, emotional stress, dehydration, starvation, hemorrhage, and temperature extremes

Hormonal Actions

- E. Regulate certain activities of the immune system
- F. Plays a role in the sequential integration of growth and development
- G. Contribute to the processes of reproduction; gamete production, fertilization, nourishment of embryo and fetus, parturition, and nourishment of the new born

Hormones

- How do hormones accomplish their tasks?
 - A. Produce powerful effects
 - B. Present in low concentrations
 - C. > 50 kinds of hormones
 - D. Affect only a few types of cells (target cells - receptor expression)

Hormone Receptors

A. Target cells - express specific receptors

Receptors - Large proteins or glycoproteins – react to hormone binding

B. Up - Down regulation (property of the target cell)

1. Up - Increase in number of receptors decrease in hormone concentration
2. Down - Decrease in number of receptors increase in hormone concentration

Types of Hormones

A. Circulating hormones = endocrine

1. Pass into blood
2. Act on distant target cells
3. May be found in blood minutes to days after secretion
4. Hormones may be stored on blood proteins for months (Thyroid hormone), blood concentrations remain constant.
5. Active hormone – dissolved in plasma

Types of Hormones

B. Local Hormones

1. Act on target cells close to the site of release
2. Types –
 - Paracrines - act on neighbor cells
 - Autocrines - Act on the releasing cell
 - Endocrine – Act on distant cells
3. Inactivated quickly micro seconds to seconds.

Patterns of Hormone Action

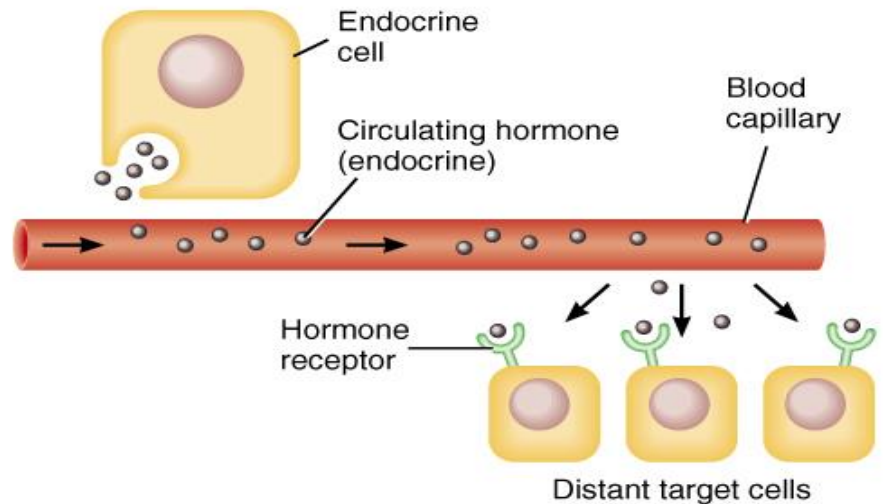
Target cells or tissue:

Specific cells affected by a hormone

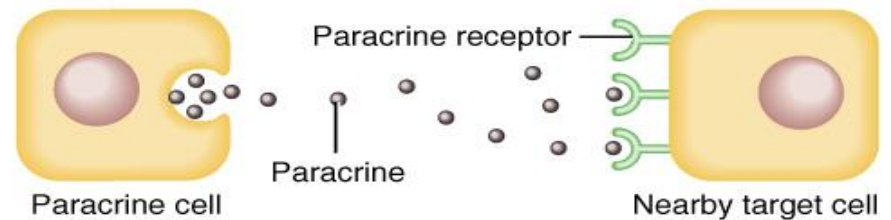
Endocrine: circulated by blood to target cells

Paracrine: Hormones that affect neighboring cells

Autocrine: Hormones that act on the cells that secrete them



(a) Circulating hormones (endocrines)



(b) Local hormones (paracrine and autocrine)

Chemical Classes of Hormones

A. Steroids

1. Derived from cholesterol
2. Have a four ring structure
3. Synthesized in smooth ER
4. Transport in blood bound to blood proteins

Mechanism of Action for lipid-soluble or steroid Endocrine hormones

Lipid-Soluble Hormones

Aldosterone

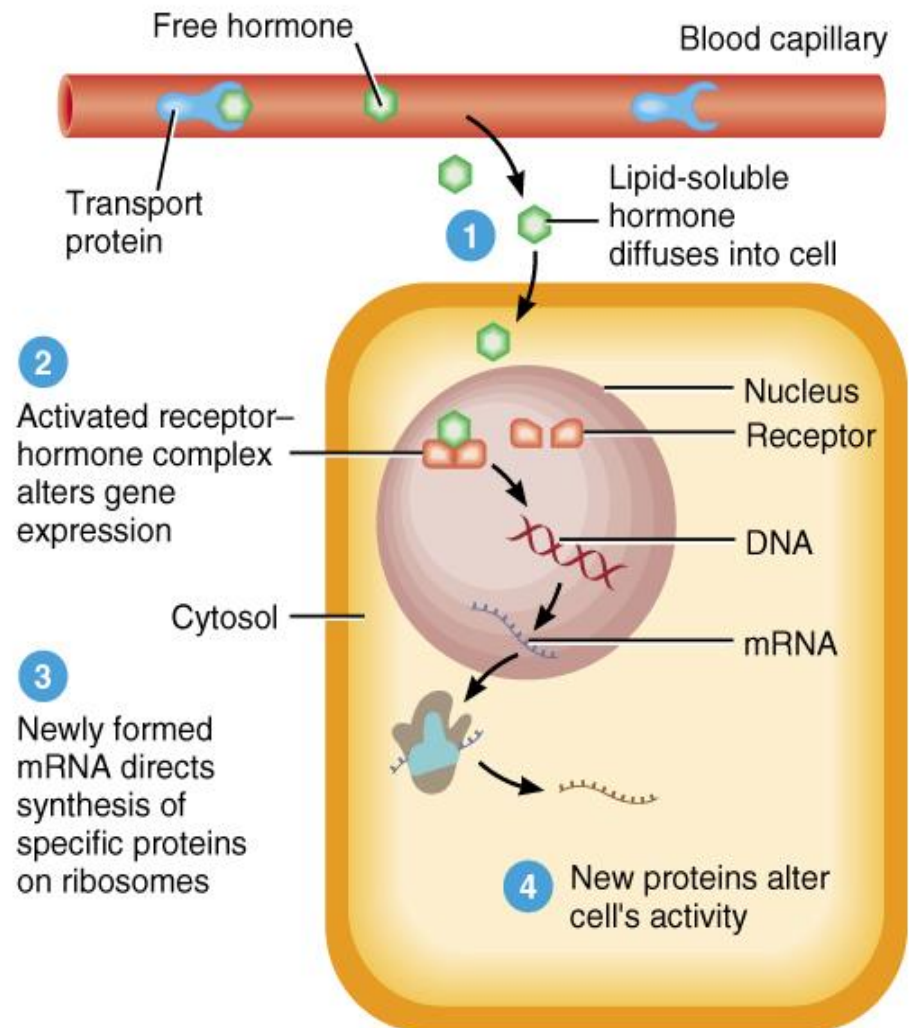
Calcitriol

Testosterone

Estrogen

Progesterone

T3 & T4



Chemical Classes of Hormones

B. Biogenic amines (Derived from amino acids)

1. Synthesized from tyrosine (thyroid hormones T3 & T4, Epinephrine. Norepinephrine)
2. Synthesized from histidine (Mast cells and Platelets) - Histamine
3. Derived from tryptophan (Serotonin, Melatonin)

Mechanism of action for water-soluble Hormones

Anterior Pituitary Hormones

Human Growth hormone

TSH

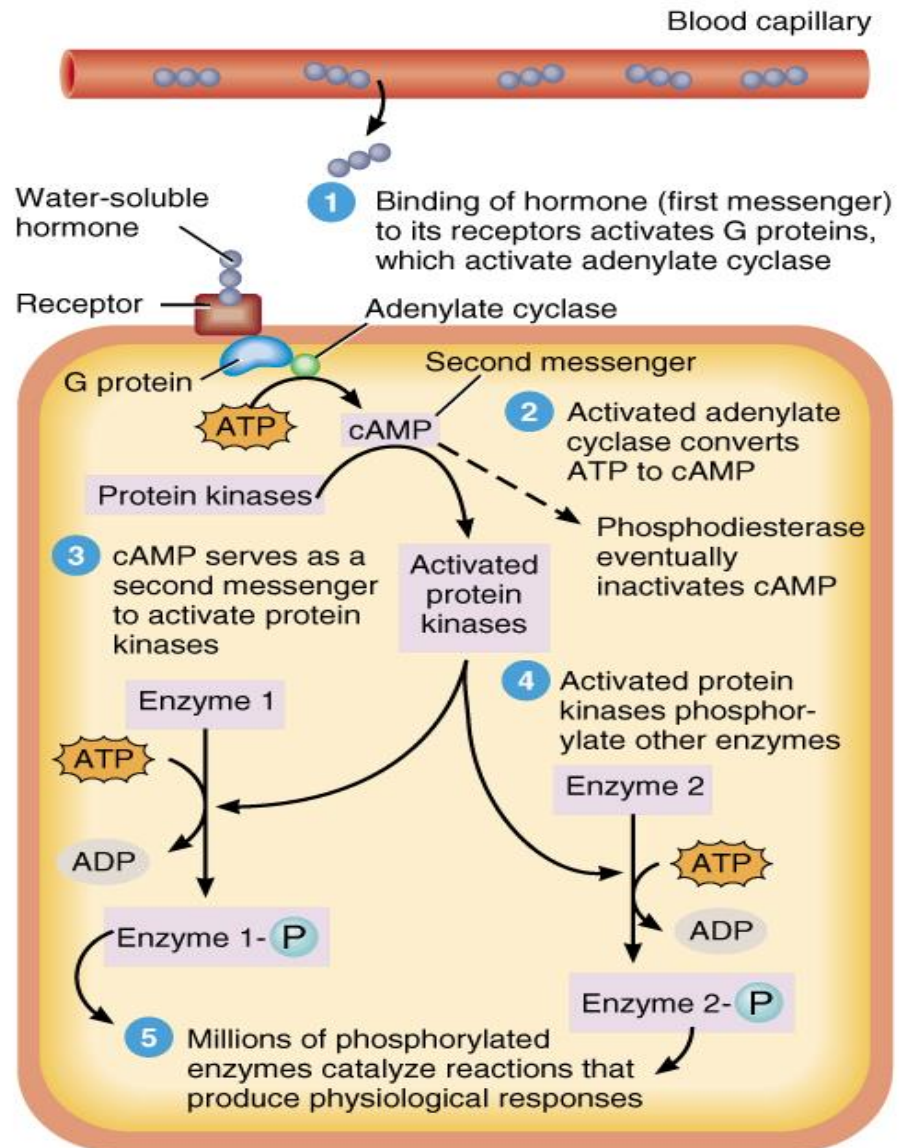
ACTH

FSH

LH

Prolactin

MSH



Mechanism of action for water-soluble Hormones

Parathyroid Hormone

Parathyroid Hormone

Pancreas Hormones

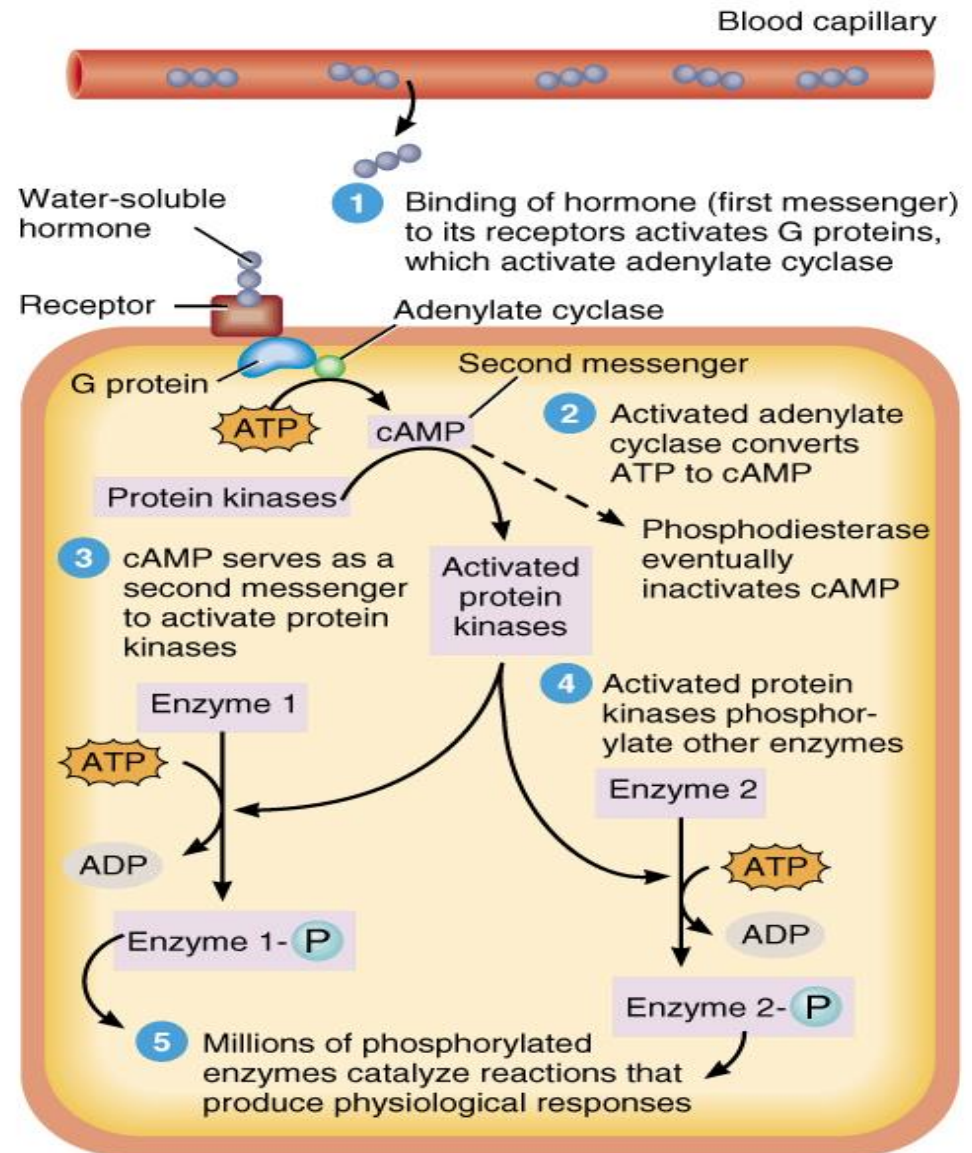
Insulin

Glucagon

Somatostatin

Pancreatic
polypeptide

Calcitonin



Chemical Classes of Hormones

C. Peptides and Proteins

1. Amino acid chains (Consisting of 3 to 200)
2. Synthesized in the rough ER
3. Some have carbohydrate groups (glycoproteins, TSH)

Mechanism of action for water-soluble Hormones

Catecholamines

Epinephrine

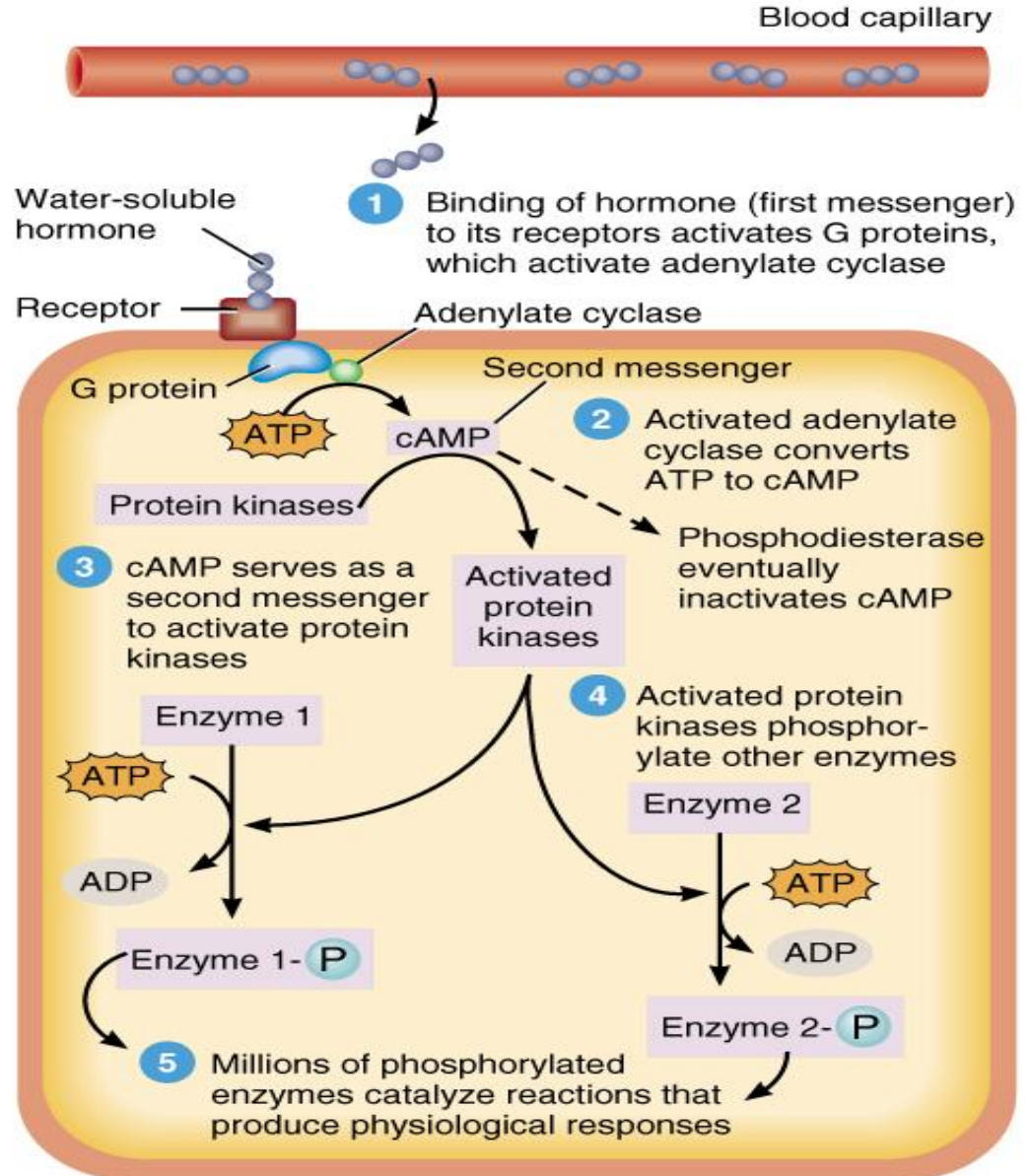
Norepinephrine

Peptides/Proteins

All Hypothalamic
releasing/inhibiting
hormones

Oxytocin

ADH



Chemical Classes of Hormones

D. Eicosanoids

1. Chemical mediators
2. Derived from Arachidonic Acid
3. Local Hormones (May also act as circulating hormones)
4. Types (Prostaglandins, leukotrienes)

Hormone Transport in the Blood

- A. Endocrine glands highly vascularized
- B. Catecholamine's, peptides, and proteins are water soluble (Plasma)
- C. Steroids and Thyroid hormones bind to blood proteins (Albumin, etc.)- extends half life and makes water soluble – plasma concentrations kept constant due to release from blood proteins

Hormone Transport in the Blood

D. Transport Proteins

1. Produced by liver
2. Hydrophobic molecules bind to transport proteins making them soluble in water
3. Retards the rate of hormone loss via the kidney
4. Provides ready reserve in the blood

Mechanisms of Hormonal Actions

A. Activation of intracellular receptors

1. Steroid and thyroid hormones easily pass the membrane barrier
2. Hormone binds to and activates receptor usually in the nucleus
3. Activated receptor alters gene expression
4. New messenger RNA is formed and enters cytosol
5. RNA directs synthesis of new protein

Mechanisms of Hormonal Actions

B. Activation of plasma membrane receptors

Catecholamine, peptide, and protein hormones

a. Not lipid soluble

b. Cannot diffuse through the cell membrane

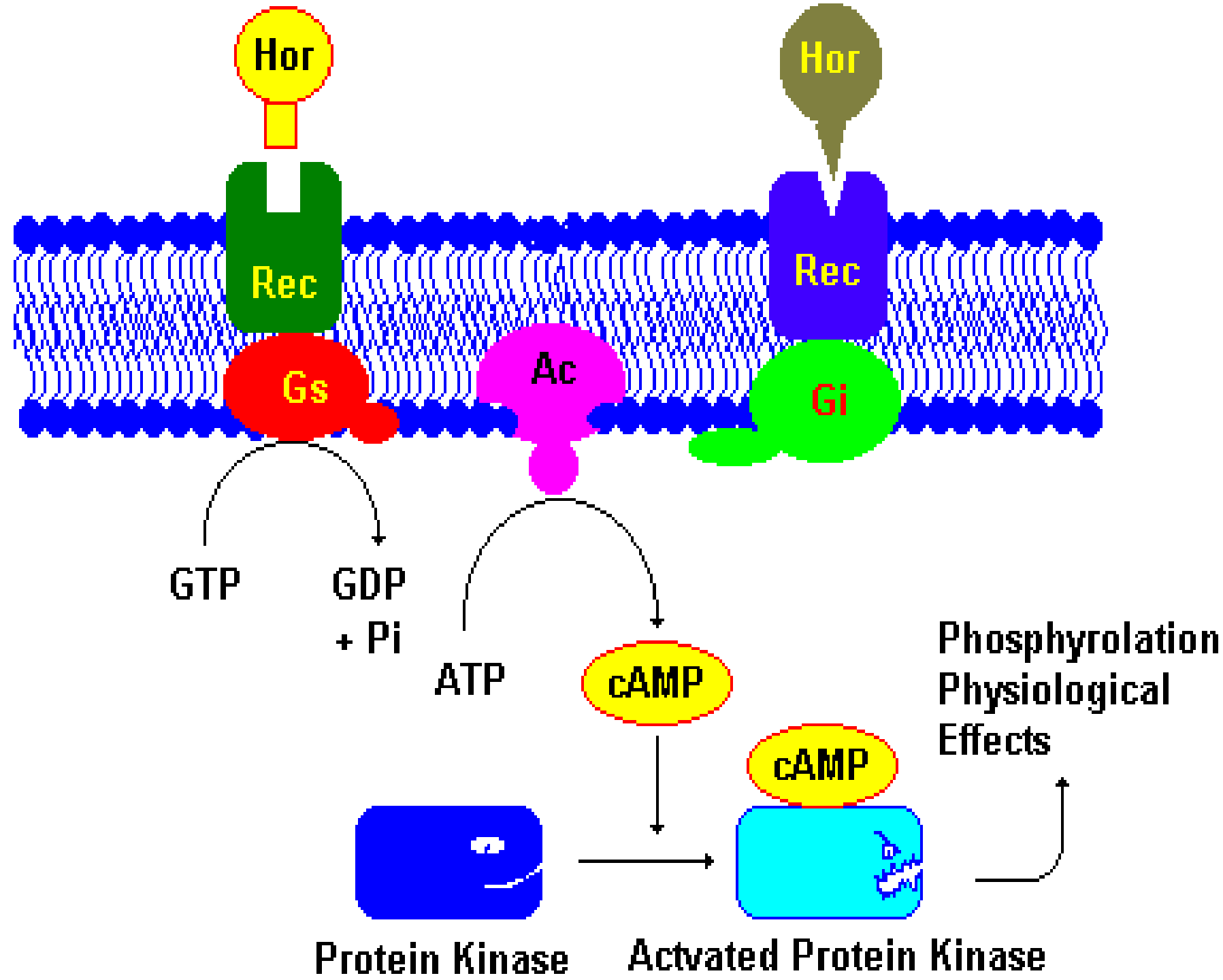
c. Attach to membrane bound receptors

d. Are first messengers need second messenger to relay information into the cell

Mechanisms of Hormonal Actions

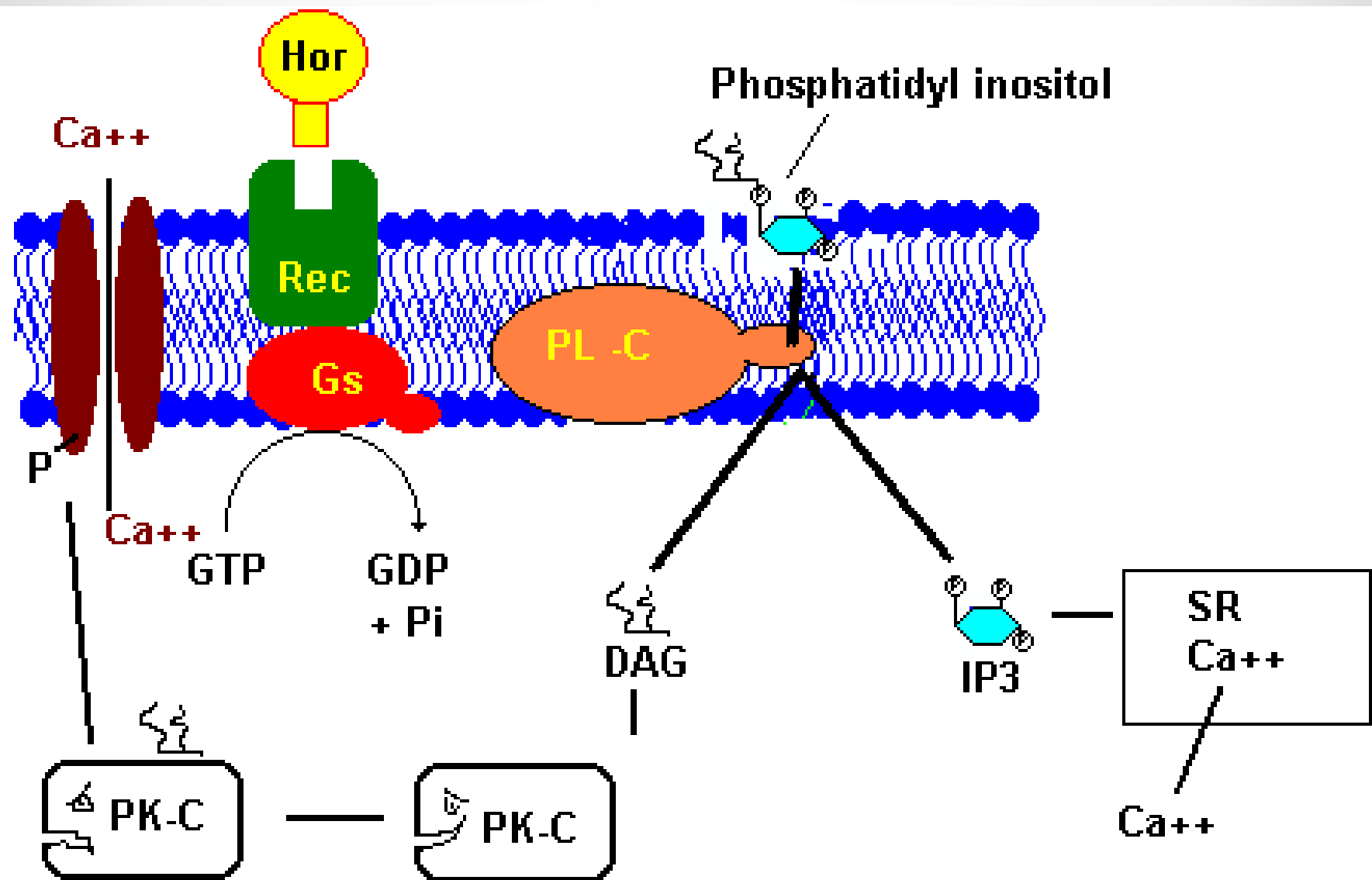
2. Second messengers

a. Cyclic AMP (cAMP)



Mechanisms of Hormonal Actions

b. Inositol triphosphate (IP₃)



Mechanisms of Hormonal Actions

C. Calcium ion can be a second messenger

Mechanisms of Hormonal Actions

C. Amplification

1. Receptor activates many G-proteins
2. Activated Adenylate cyclase and phospholipase C produce many cAMP, IP3, and DAG molecules
3. Effects of hormone binding to receptor are multiplied many fold

Hormonal Interactions

A. Permissive effects

1. Previous exposure enhances the response of a target cell
2. Usually up-regulation of receptors

B. Synergistic effect (aid) - Two or more hormones are required for full expression of effects

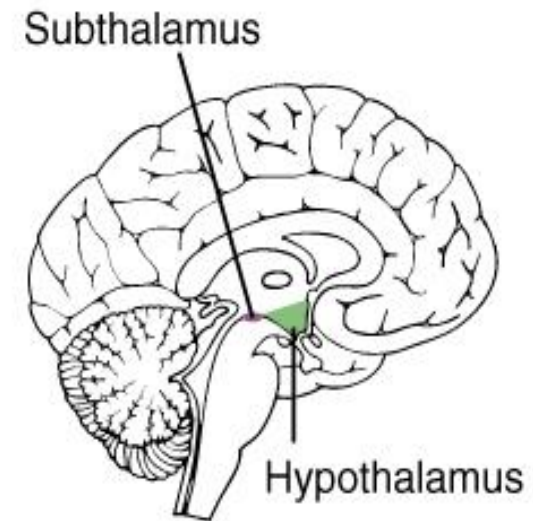
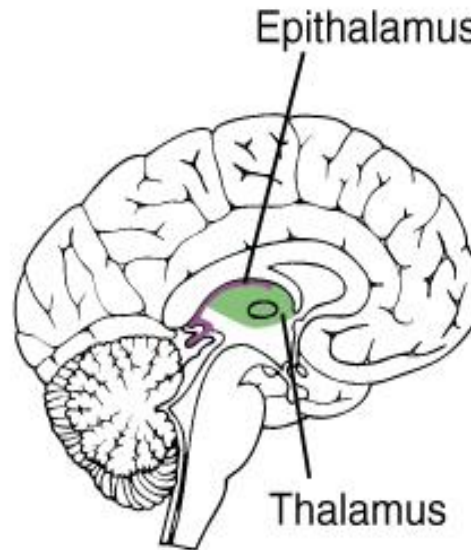
C. Antagonistic effects- One hormone opposes the actions of another

Control of Hormonal Secretions

- A. Signals from nervous system
- B. Chemical changes in the blood
- C. Other hormones
- D. Positive and Negative Feedback

Action of the Hypothalamus as the “Master” Gland

- **Hypothalamus:**
Controls the activity of the pituitary gland by releasing hormones called releasing or inhibiting hormones



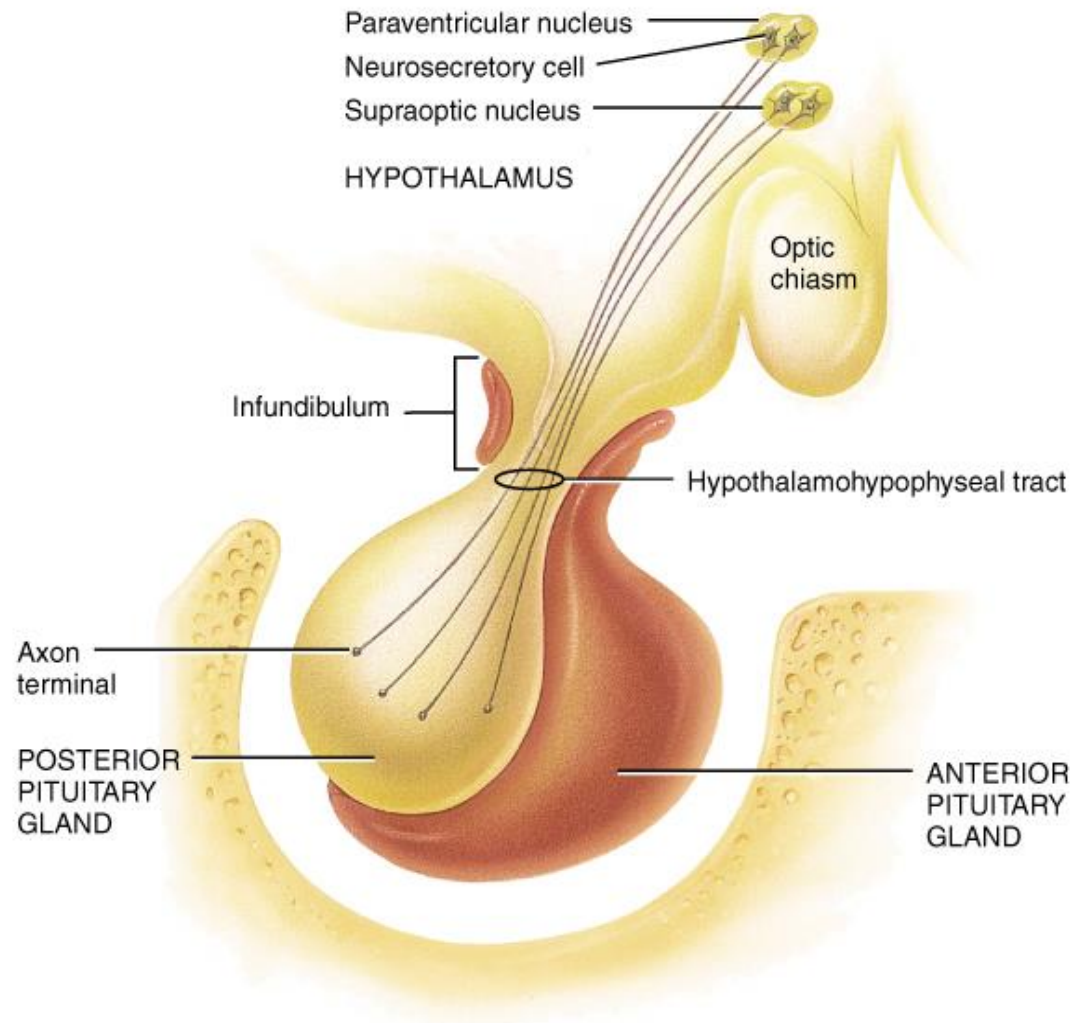
(c) Diencephalon

Actions of the Posterior Pituitary or Neurohypophysis

Neurohypophysis

does not synthesize hormones, however, it stores and releases two hormones produced by the neurosecretory cells of the hypothalamus

- ADH
- Oxytocin



Major Actions of Oxytocin

- **Stimulates contraction of smooth muscle cells of the uterus during childbirth**
- **Stimulates contraction of myoepithelial cells in the breast to cause milk letdown**



Hormones Released from the Anterior Pituitary or Adenohypophysis

Somatotrophs:

Human growth hormone or somatotrophin (hGH)

Hypothalamic control:

hGH releasing hormone (GHRH)

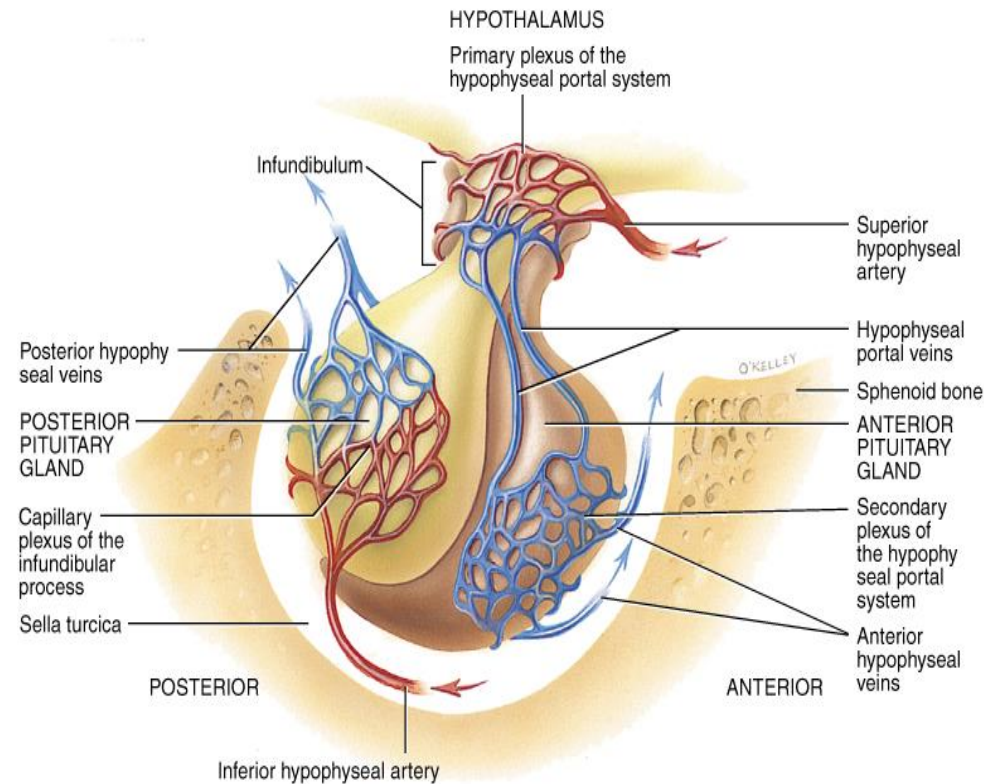
hGH inhibiting hormone (GHIH)

Thyrotrophs:

Thyroid-stimulating hormone (TSH)

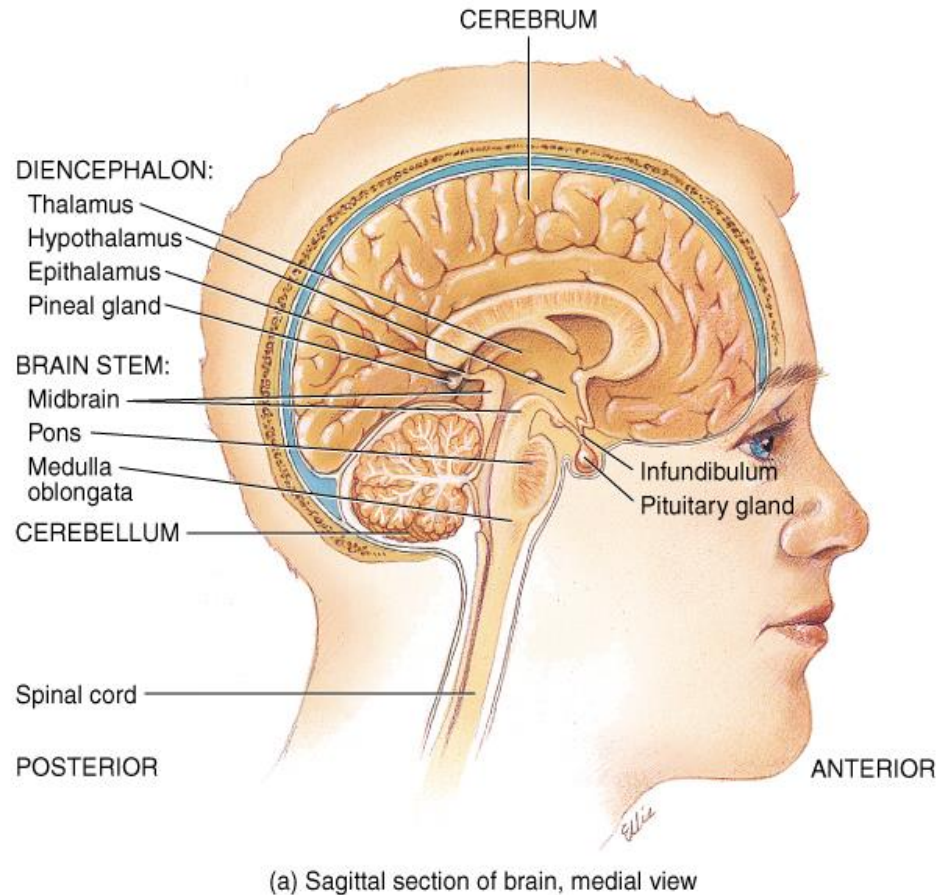
Hypothalamic control:

Thyrotropin releasing hormone (TRH)
(GHIH)



Hormones Released from the Anterior Pituitary or Adenohypophysis

- **Gonadotrophs:**
Follicle-stimulating hormone (FSH)
Luteinizing hormone (LH)
Hypothalamic control:
Gonadotropic releasing hormone (GnRH)
- **Lactotrophs:**
Prolactin (PRL)
Hypothalamic control:
Prolactin releasing hormone (PRH) and TRH
Prolactin inhibiting hormone PIH or dopamine



Hormones Released from the Anterior Pituitary or Adenohypophysis

Corticotrophs:

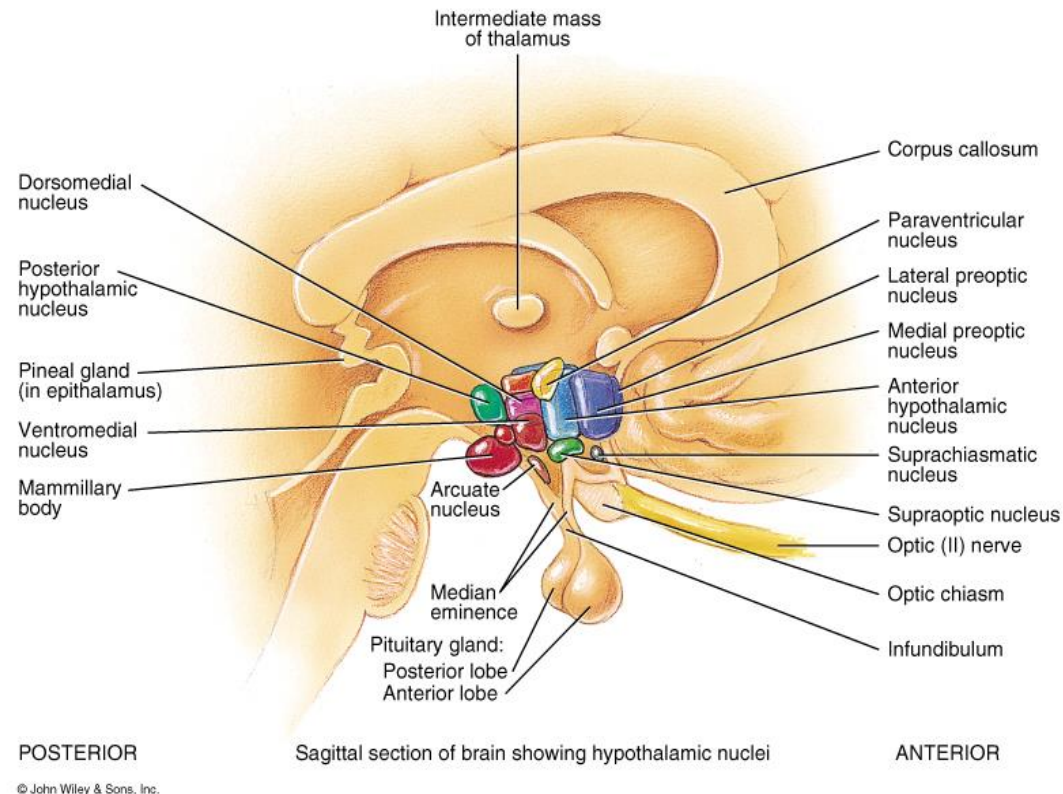
**Adrenocorticotrophic
hormone (ACTH)**

**Melanocyte-stimulating
hormone (MSH)**

Hypothalamic control:

**Corticotrophic releasing
hormone (CRH)**

**For MSH inhibition
dopamine**



Actions of Prolactin

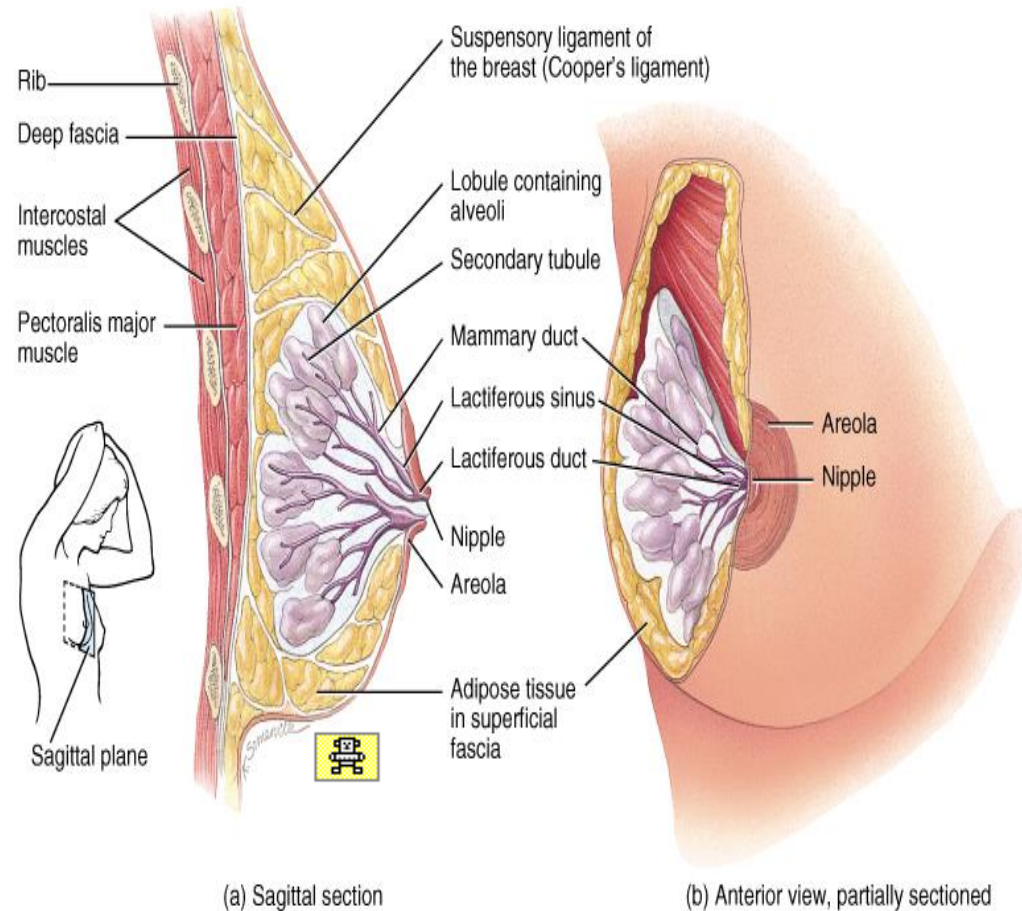
Hypothalamic control:

PRH, PIH

- Released by lactotrophs of the adenohypophysis

Target Tissue: Lactiferous cells for the breast

Effect: Initiates and maintains milk production in breasts that have been prepared by other hormones



Actions of Prolactin

- **Also along with progesterone causes breast tenderness before menstruation.**
- **Hyposecretion: Decreased milk production**
- **Hypersecretion:**
Females: galactorrhea and amenorrhea
Males: erectile dysfunction or impotence and production of fluid from the nipple

