

Al-Mustaqbal University

College of Engineering and Engineering Technologies

Biomedical Engineering Department

Subject: *Systemic Physiology I*

Endocrine System

Class : *3th*

Lecture: *8*

By Assistant Lecturer : Zainab Sattar Jabbar

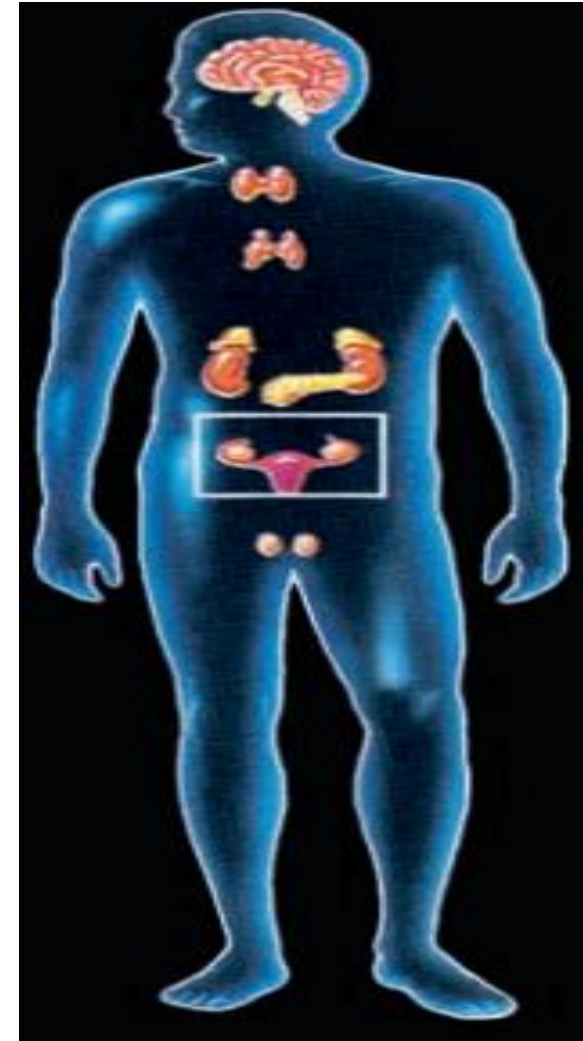


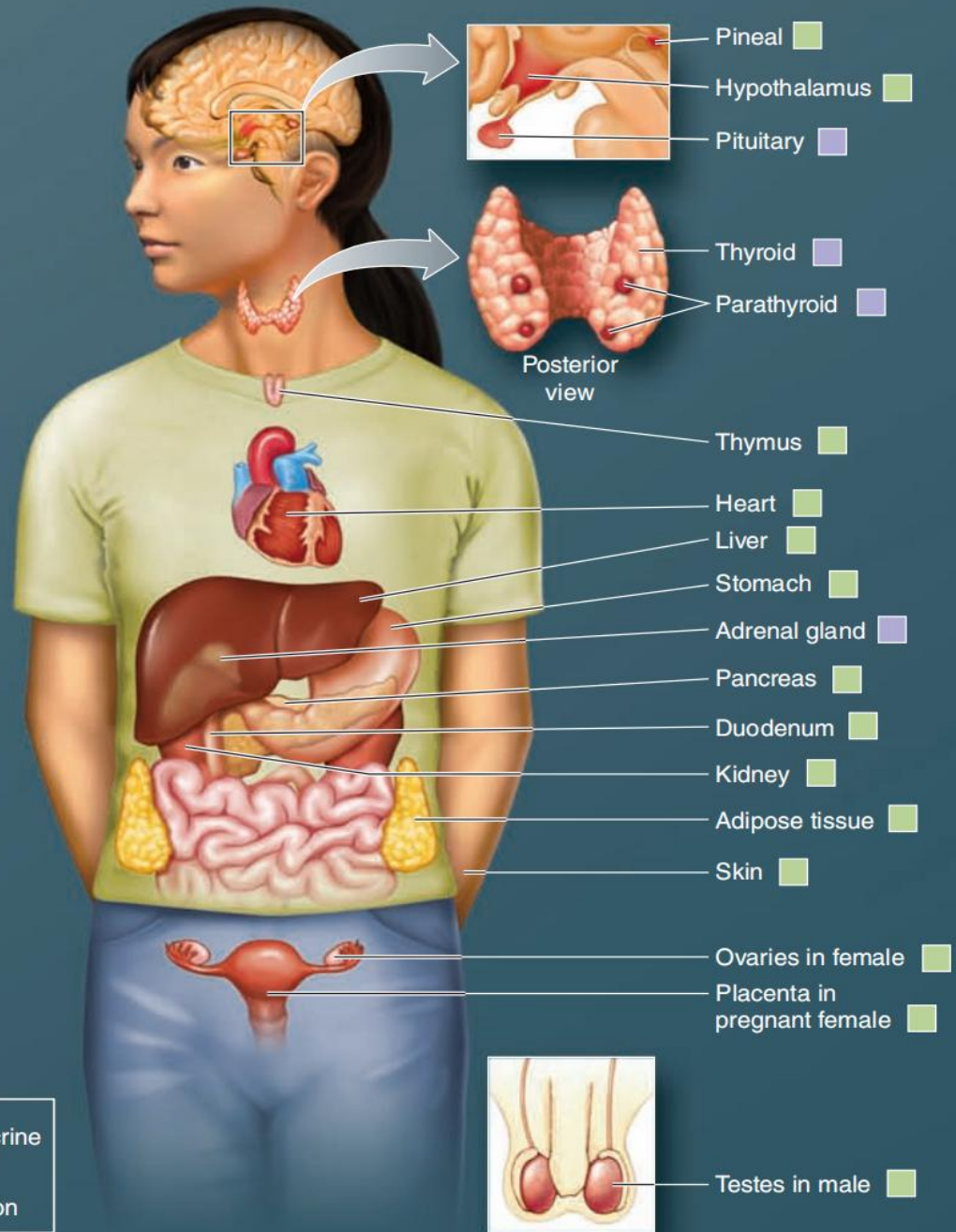
Endocrine System

- The endocrine system consists of the ductless endocrine glands scattered throughout the body.
- They all accomplish their functions by secreting hormones into the blood, and many functional interactions take place among various endocrine glands. Once secreted, a hormone travels in the blood to its distant target cells, where it regulates a particular function.
- Even though the blood distributes hormones throughout the body, only specific target cells can respond to each hormone because only the target cells have receptors for binding with the particular hormone.
- Binding of a hormone with its specific target-cell receptors initiates a chain of events within the target cells to bring about the hormone's final effect.

Endocrine System

- Endocrine glands release hormones, blood-borne **chemical messengers** that act on target cells located a long distance from the endocrine gland.
- Most target-cell activities under hormonal control are directed toward maintaining homeostasis.
- The central endocrine glands, which are in or closely associated with the brain, include the hypothalamus, the pituitary gland, and the pineal gland.



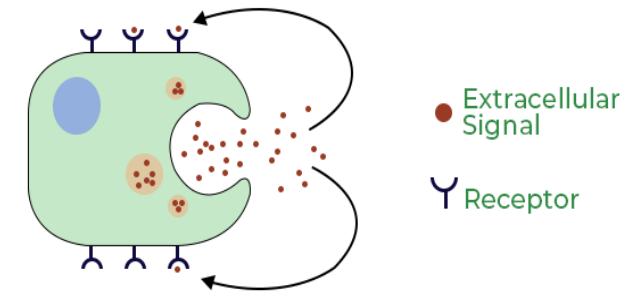


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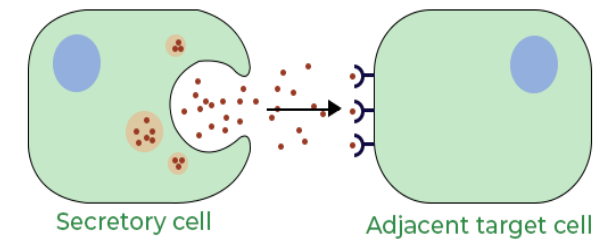
■ Solely endocrine function
■ Mixed function

Hormones

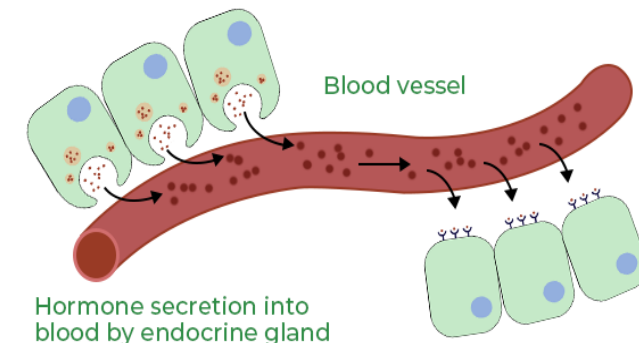
- Hormones are **Chemical Messengers**.
- **Exocrine secretion:** cells secrete substances into a duct or a body cavity that communicates to the external world (epithelial surfaces).
- **Endocrine secretion:** cells secrete substances into the extracellular fluid (blood).
- Endocrine signaling molecules:are
 1. **Paracrine** signals.
 2. **Autocrine** signals.
 3. **Endocrine** signals.



Target sites on same cell
AUTOCRINE SIGNALING



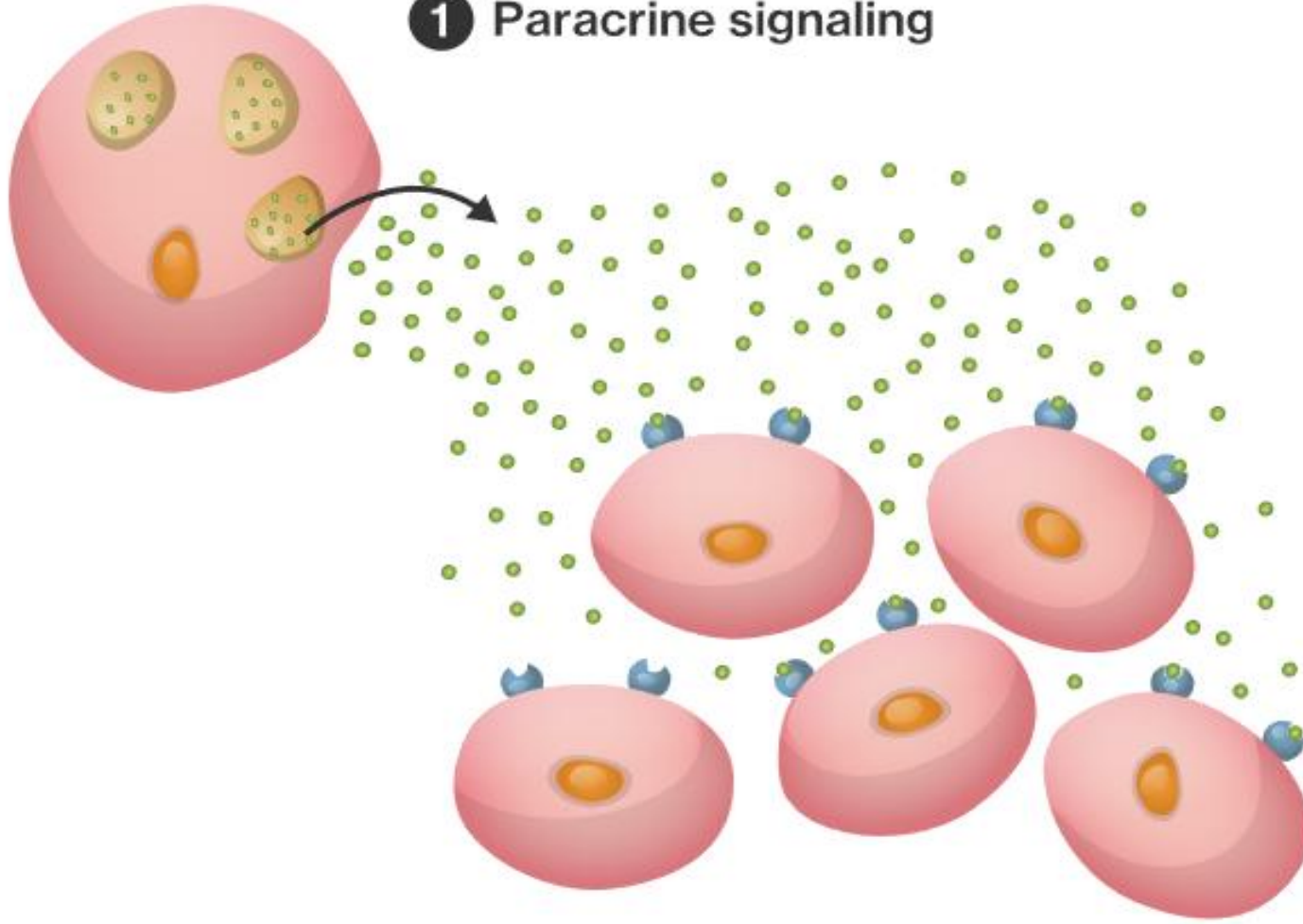
PARACRINE SIGNALING



ENDOCRINE SIGNALING

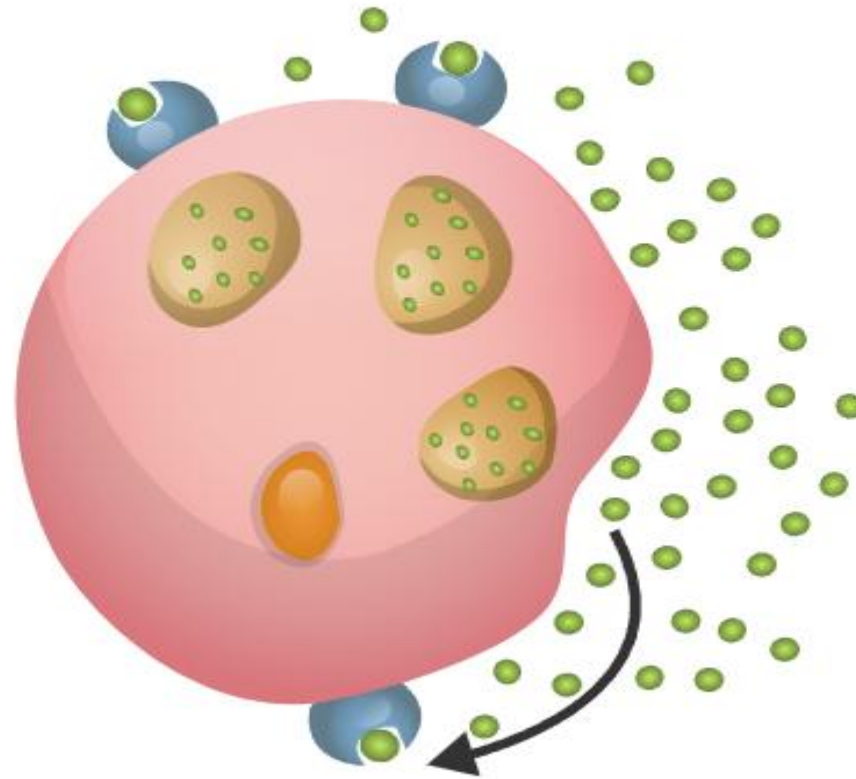
Paracrine signals

1 Paracrine signaling

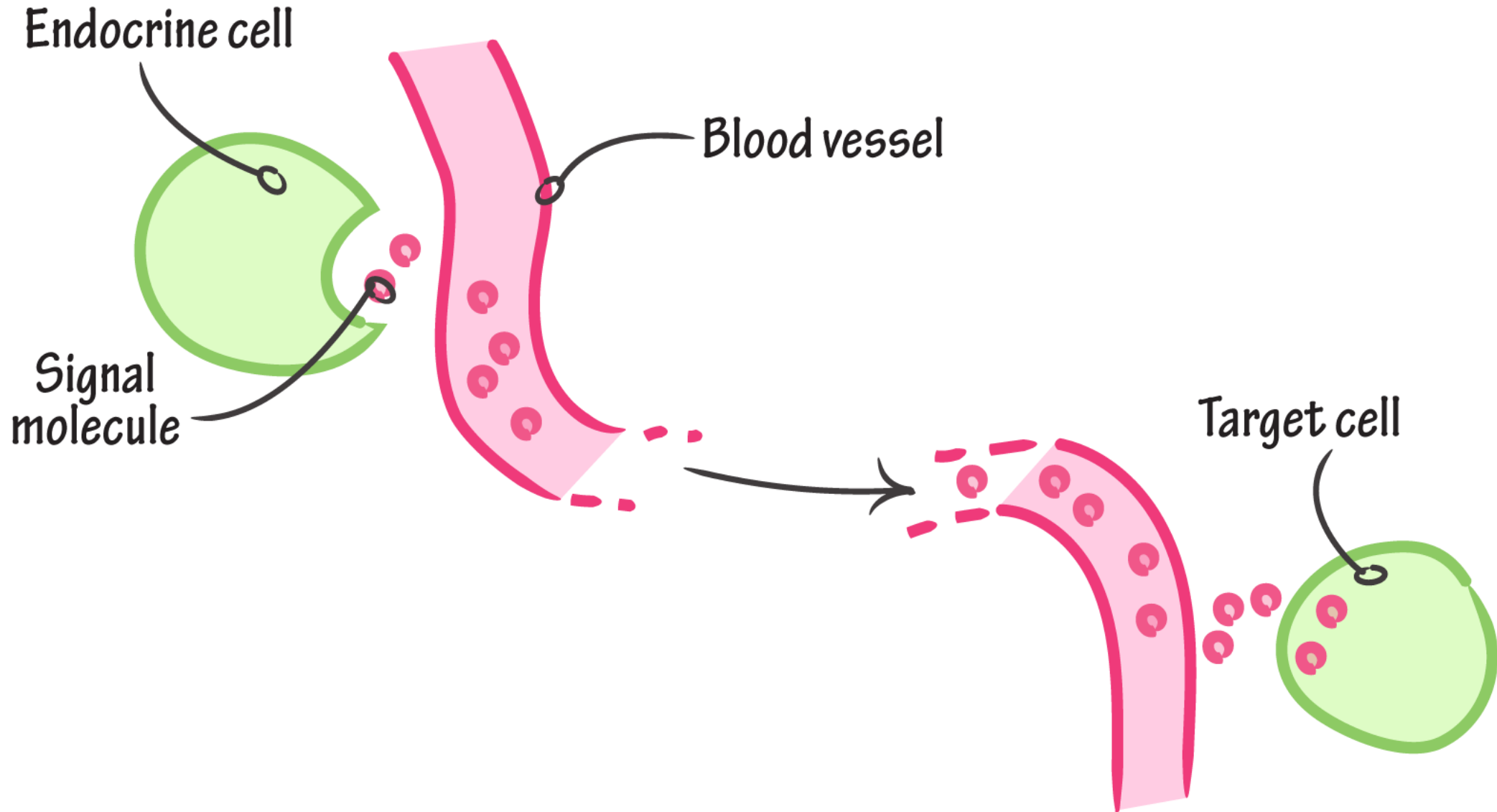


Autocrine signals

2 Autocrine signaling



Endocrine signals



Function of hormones

➤ The endocrine hormones help control mood, growth and development, the way our organs work, metabolism , and reproduction. The endocrine system regulates how much of each hormone is released. This can depend on levels of hormones already in the blood, or on levels of other substances in the blood, like calcium.

- 1. Metabolism**
- 2. Growth and development**
- 3. Water and electrolyte balance**
- 4. Reproduction**
- 5. Behavior**

Function of hormones

Endocrine Glands



Hypothalamus

Control Center



Pituitary Gland

Master Gland



Thyroid Gland

Controls Metabolism



Parathyroid Gland

Controls Calcium



Adrenal Gland

Controls Steroids & Catecholamines



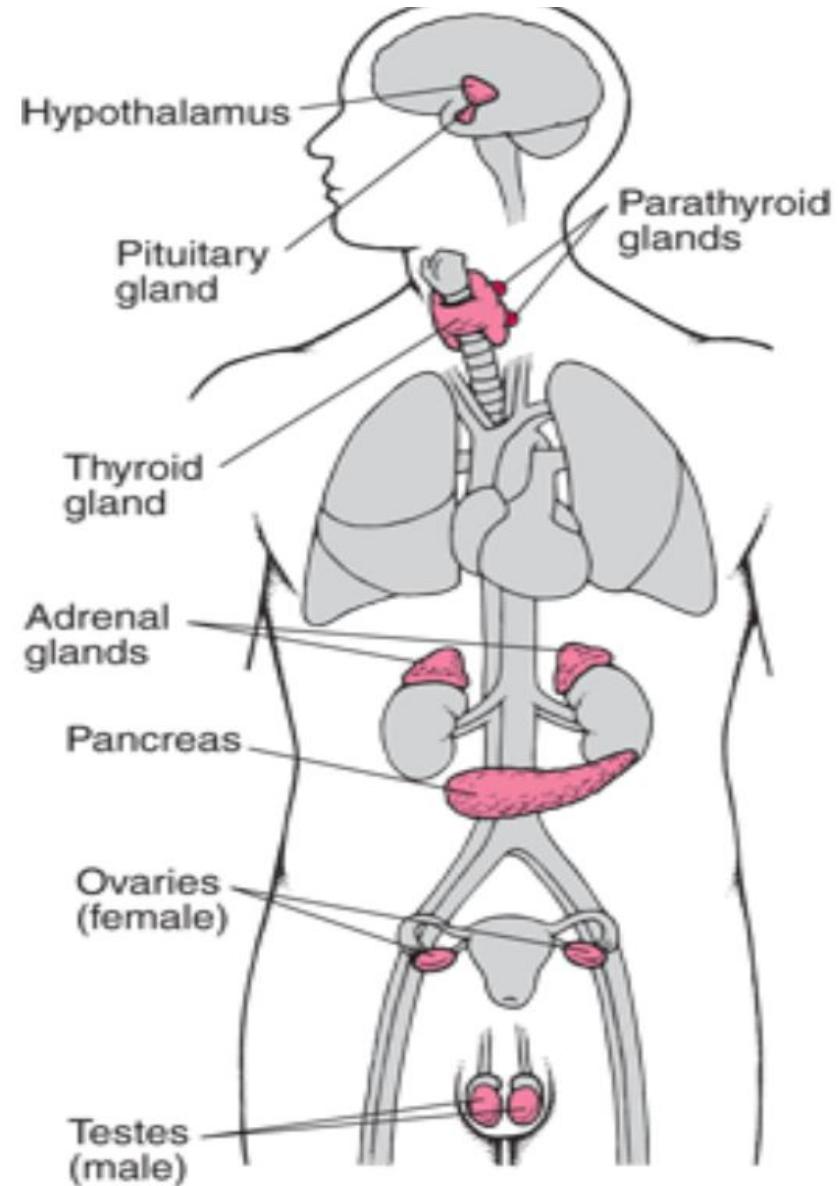
Pancreas

Controls Blood Sugar



Testes & Ovaries

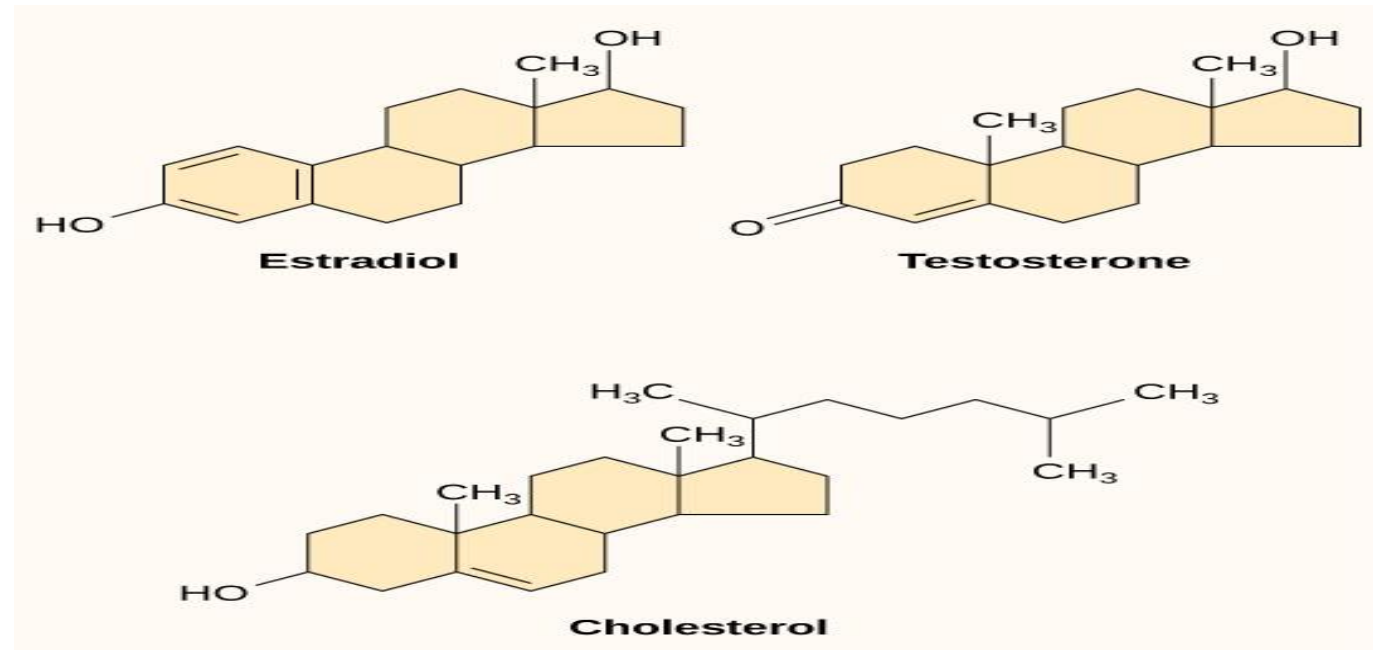
Controls Sex Hormones



Chemical structure and synthesis of hormones

2. **Steroid hormones:** produced by the adrenal cortex and reproductive endocrine glands, are neutral lipids derived from cholesterol which mean synthesized from cholesterol (lipid soluble). Secreted by the

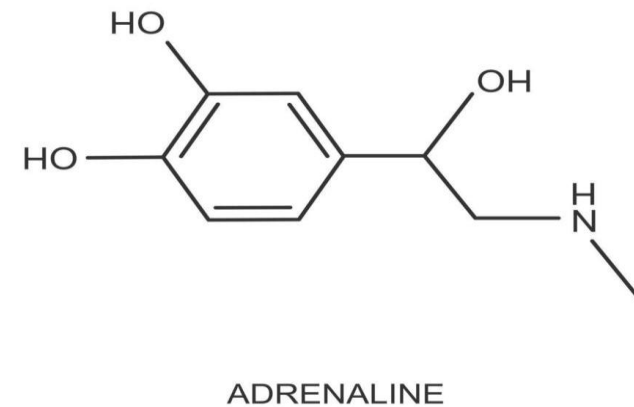
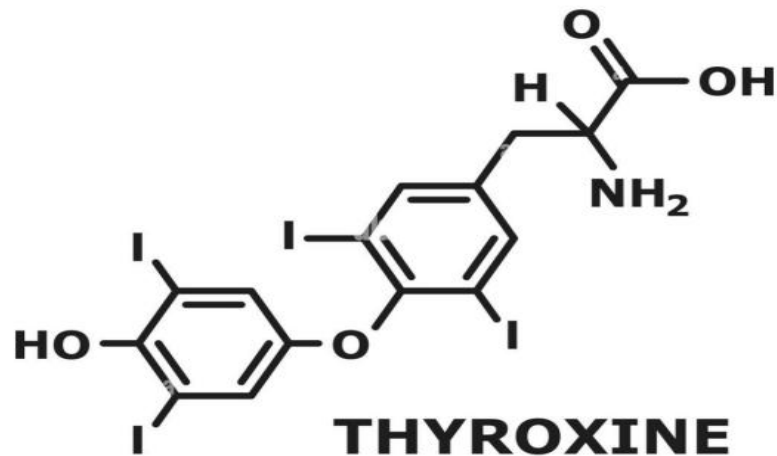
- ✓ adrenal cortex (cortisol and aldosterone)
- ✓ the ovaries (estrogen and progesterone)
- ✓ the testes (testosterone)
- ✓ the placenta (estrogen)



Chemical structure and synthesis of hormones

3. Derivatives of the amino acid tyrosine: secreted by the

- ✓ thyroid (T3,T4)
- ✓ adrenal medullae (epinephrine and norepinephrine)



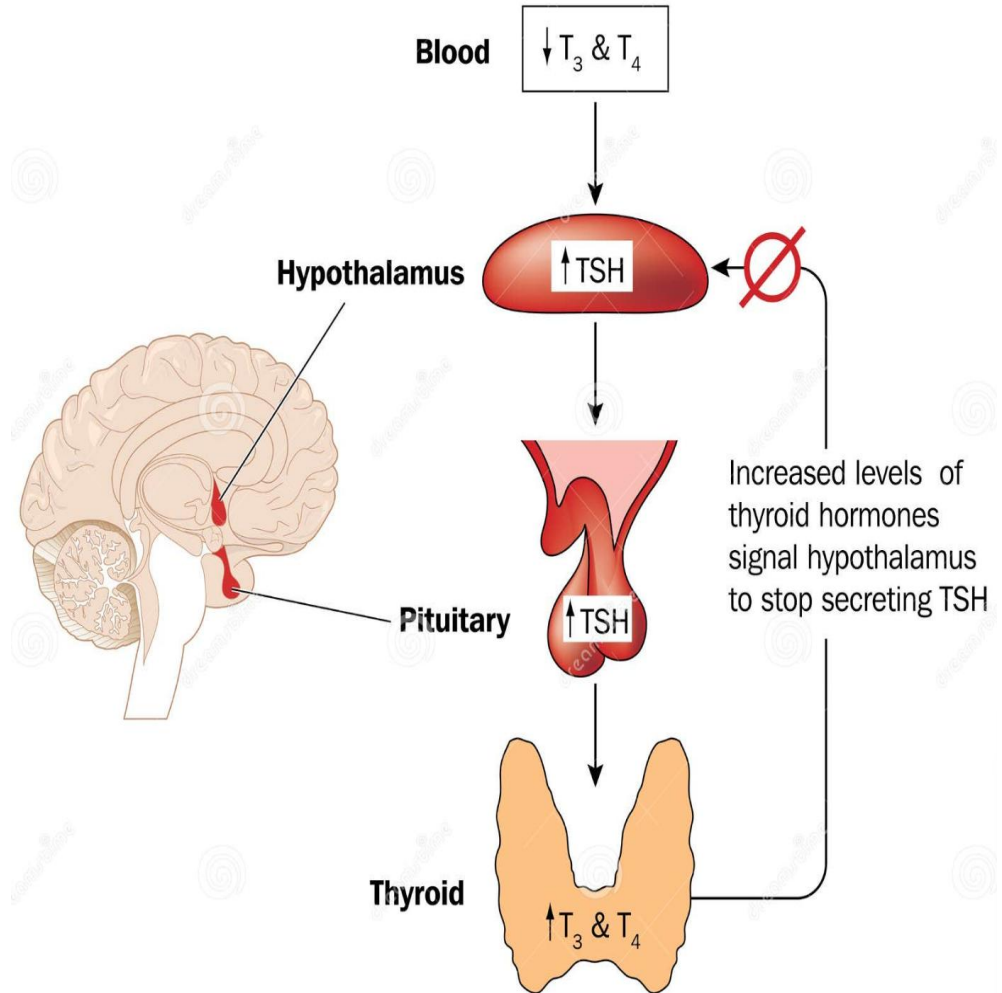
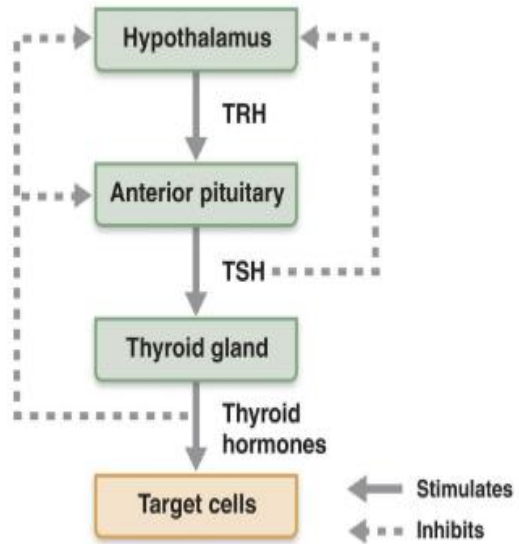
Feedback control of hormone secretion

- The effective plasma concentration of a hormone is normally regulated by changes in the rate of its secretion.
- The negative feedback mechanisms ensure a proper level of hormone activity at the target tissue.
- After a stimulus causes release of the hormone, conditions or products resulting from the action of the hormone tend to suppress its further release. In other words, the hormone (or one of its products) has a negative feedback effect to prevent oversecretion of the hormone or overactivity at the target tissue.

Feedback control of hormone secretion

- For example, when the plasma concentration of free circulating thyroid hormone falls below a given set point, the anterior pituitary secretes thyroid-stimulating hormone (TSH), which stimulates the thyroid to increase its secretion of thyroid hormone (T₃, T₄). Thyroid hormone, in turn, inhibits further secretion of TSH by the anterior pituitary. Negative feedback ensures that once thyroid gland secretion has been “turned on” by TSH, it will not continue unabated but will be “turned off” when the appropriate level of free circulating thyroid hormone has been achieved. Thus, the effect of a particular hormone’s actions can inhibit its own secretion. The feedback loops often become quite complex.

Feedback control of hormone secretion



Hormones Receptors

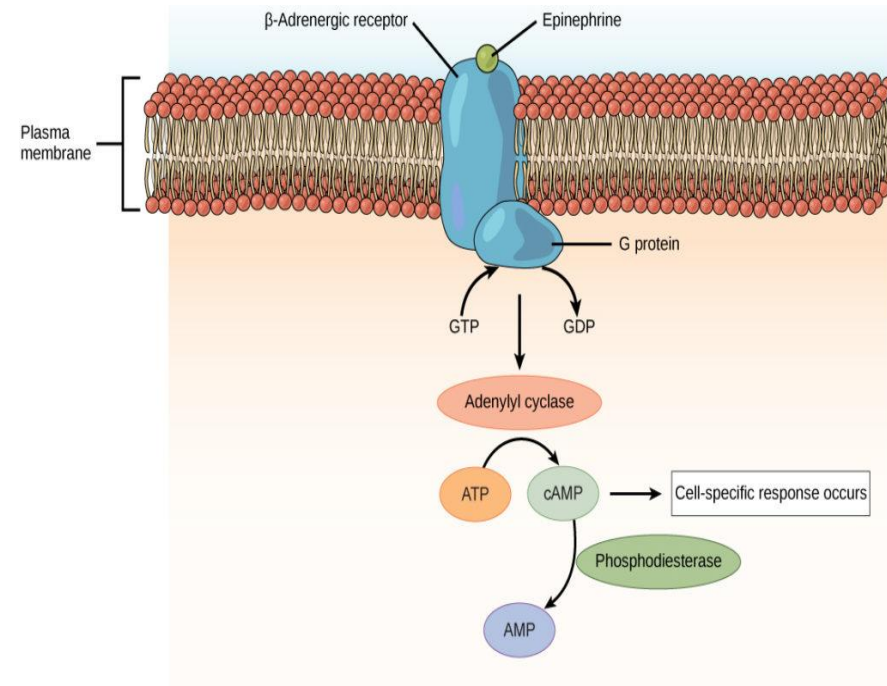
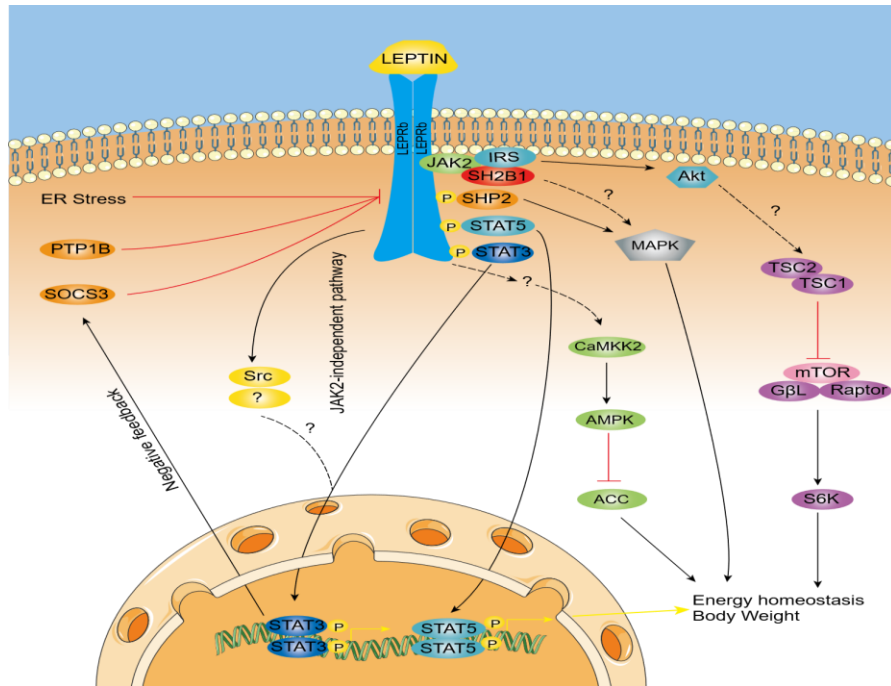
- The first step of a hormones action is to bind to specific receptor at the target cell.
- ✓ large protien
- ✓ highly specific for a single hormone
- ✓ cell to be stimulated usually has 2000 to 100000 receptors
- when the hormone combines with its receptor, this action usually initiates a cascade of reaction in the cell.
- Most hormones operate in cascades that are regulated by negative feedback.

Hormones Receptors

- The first step of a hormones action is to bind to specific **receptor** at the target cell.
- The solubility of a hormone affects whether it can pass through the plasma membrane and determines the location of its receptors.
- Receptors for some hormones are located on the target **cell membrane**, whereas other hormone receptors are located in the **cytoplasm** or the **nucleus**.
- ✓ **large protien**
- ✓ **highly specific for a single hormone**
- ✓ **cell to be stimulated usually has 2000 to 100000 receptors**
- when the hormone combines with its receptor, this action usually initiates a cascade of reaction in the cell.
- Most hormones operate in cascades that are regulated by negative feedback.

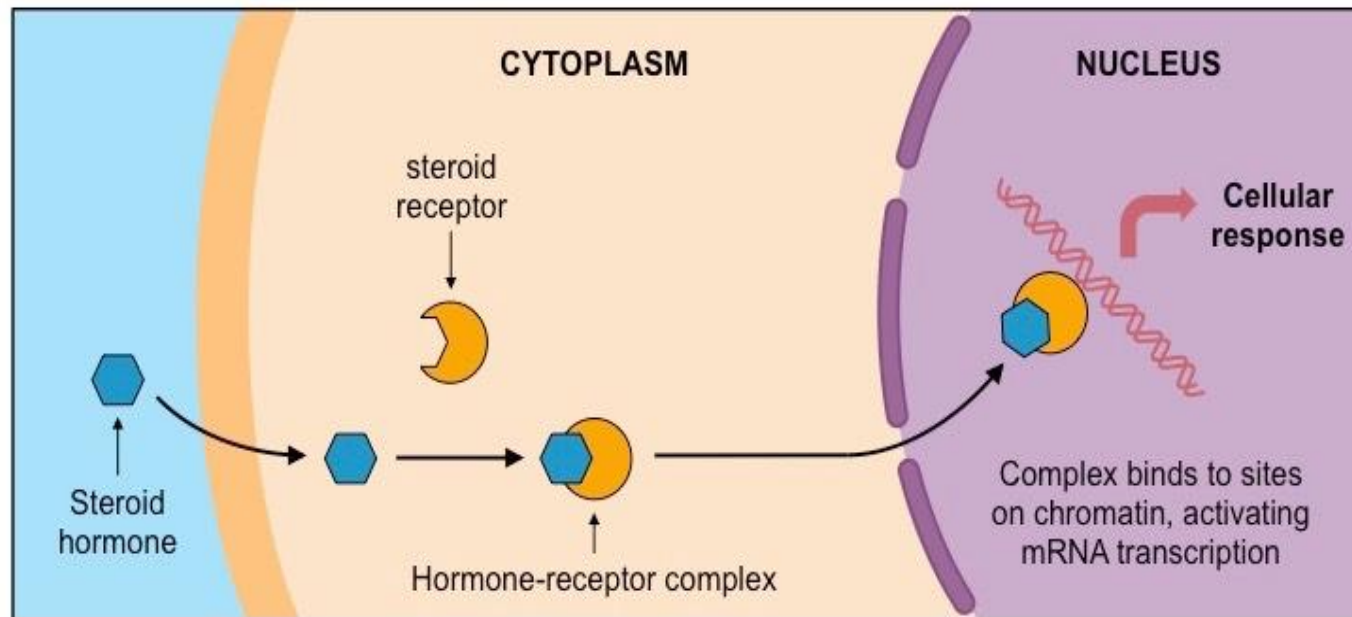
Hormones Receptors

- The locations for the different types of hormone receptors are generally the following:
- ✓ **In or on the surface of the cell membrane.** The membrane receptors are specific mostly for the protein, peptide, and catecholamine hormones



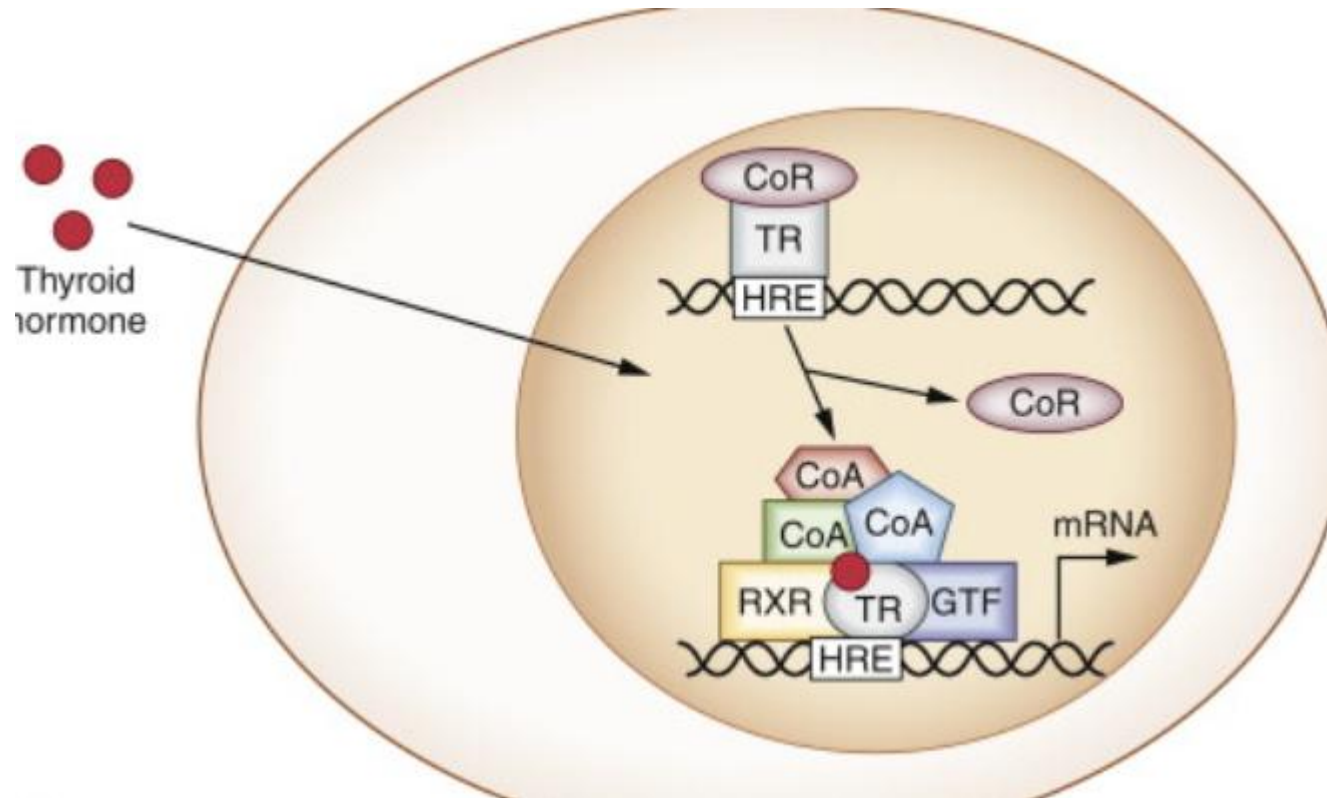
Hormones Receptors

- ✓ **In the cell cytoplasm.** The primary receptors for the different steroid hormones are found mainly in the cytoplasm.



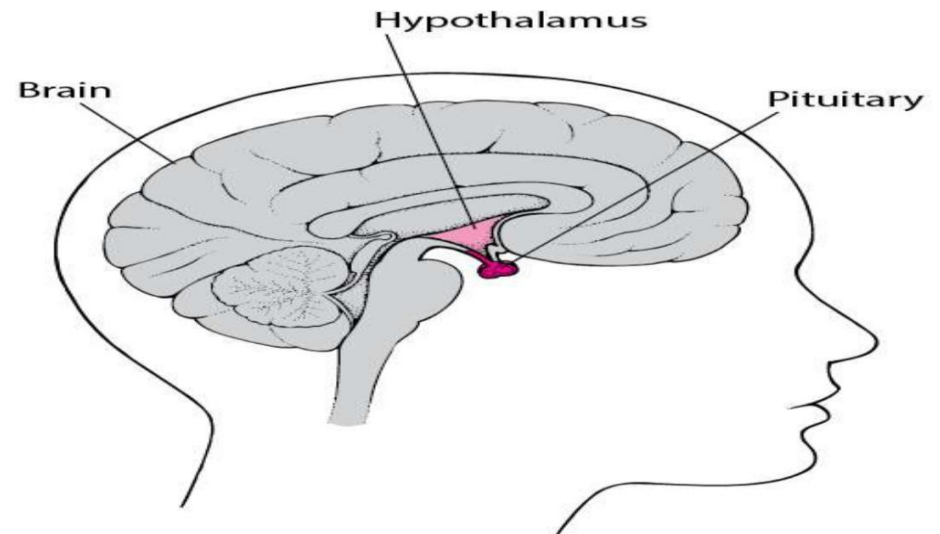
Hormones Receptors

- ✓ **In the cell nucleus.** The receptors for the thyroid hormones are found in the nucleus and are believed to be located in direct association with one or more of the chromosomes.



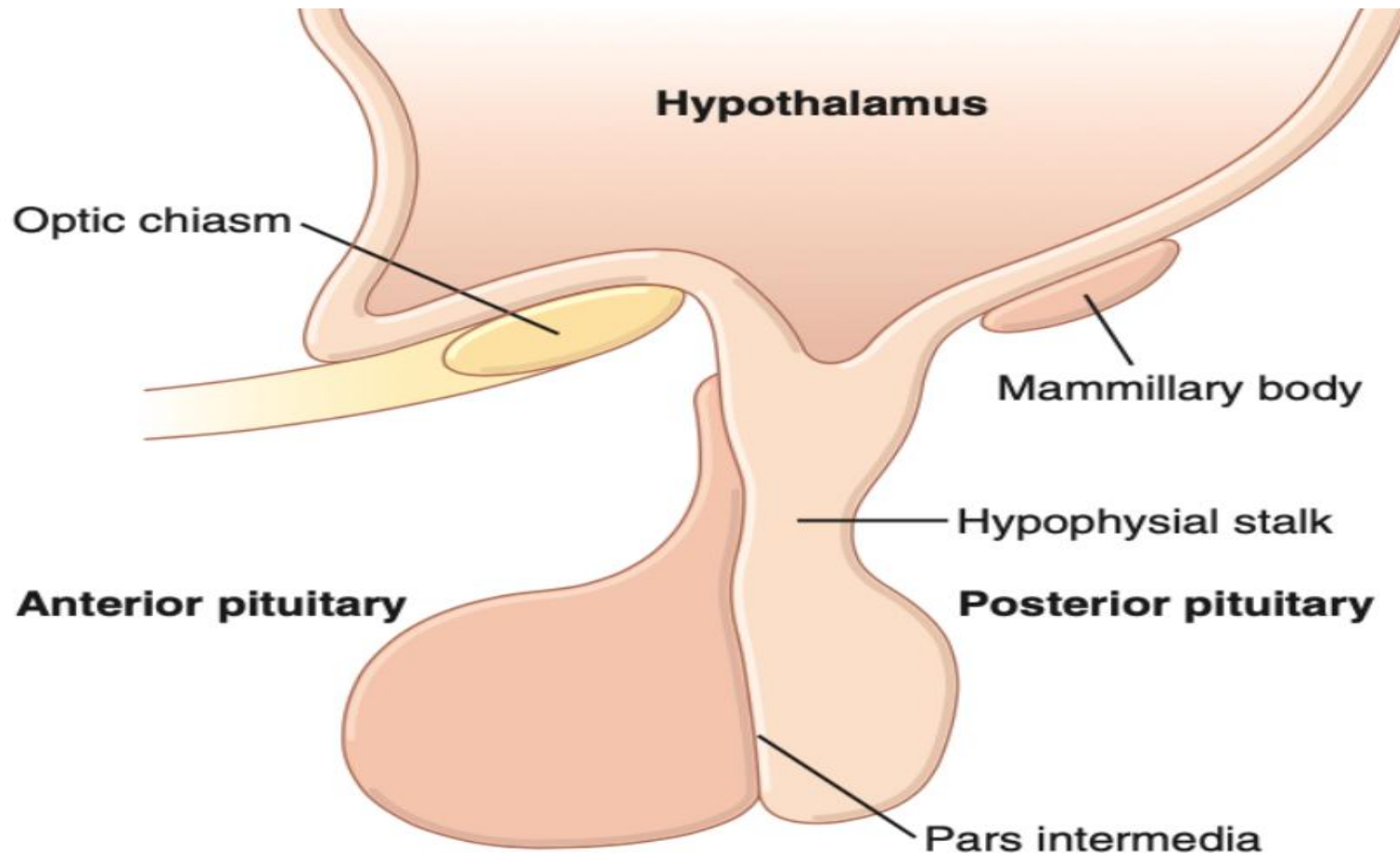
Pituitary gland and hypothalamus

- The Pituitary Gland Links the Nervous and Endocrine Systems.
- The hypothalamus receives information from nerves and brain then it initiates signals (hormones) in response, which travel to the pituitary. Pituitary releases additional hormones that travel to target cells in body.
- The **pituitary gland**, also called the **hypophysis**, is a small gland about 1 centimeter in diameter and 0.5 to 1 gram in weight.
- Physiologically, the pituitary gland is divisible into **two** distinct portions: the **anterior pituitary**, also known as the **adenohypophysis**, and the **posterior pituitary**, also known as the **neurohypophysis**.



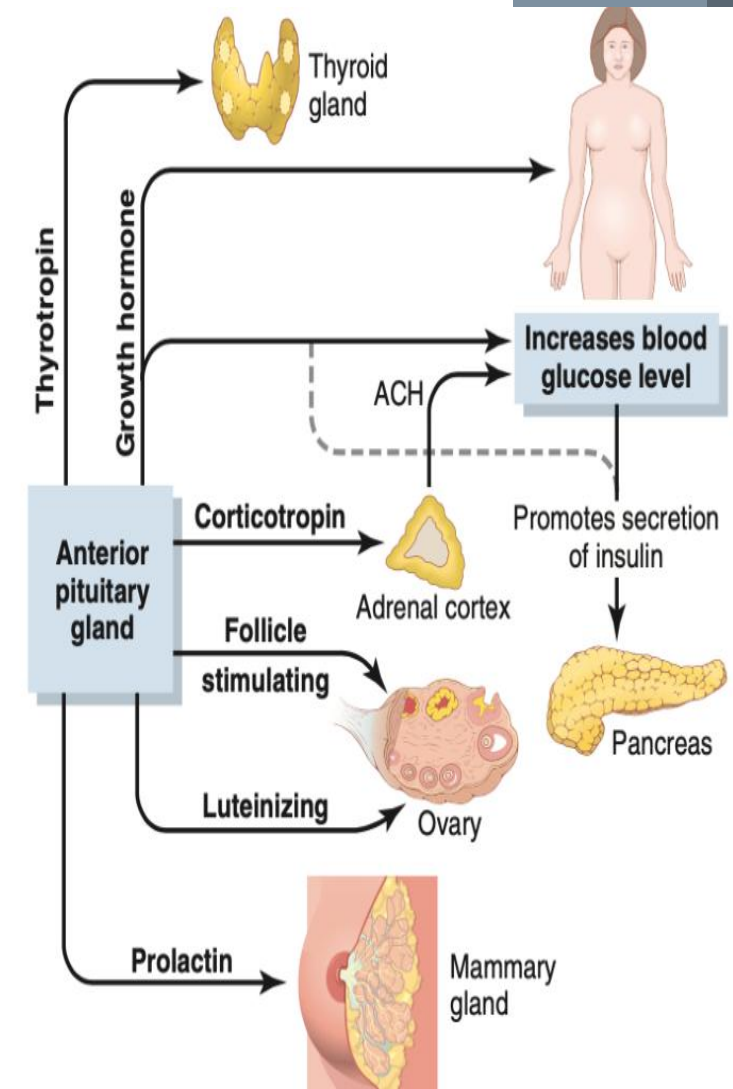
Pituitary gland and hypothalamus

- Six major peptide hormones plus several other hormones of lesser importance are secreted by the anterior pituitary, and two important peptide hormones are secreted by the posterior pituitary.

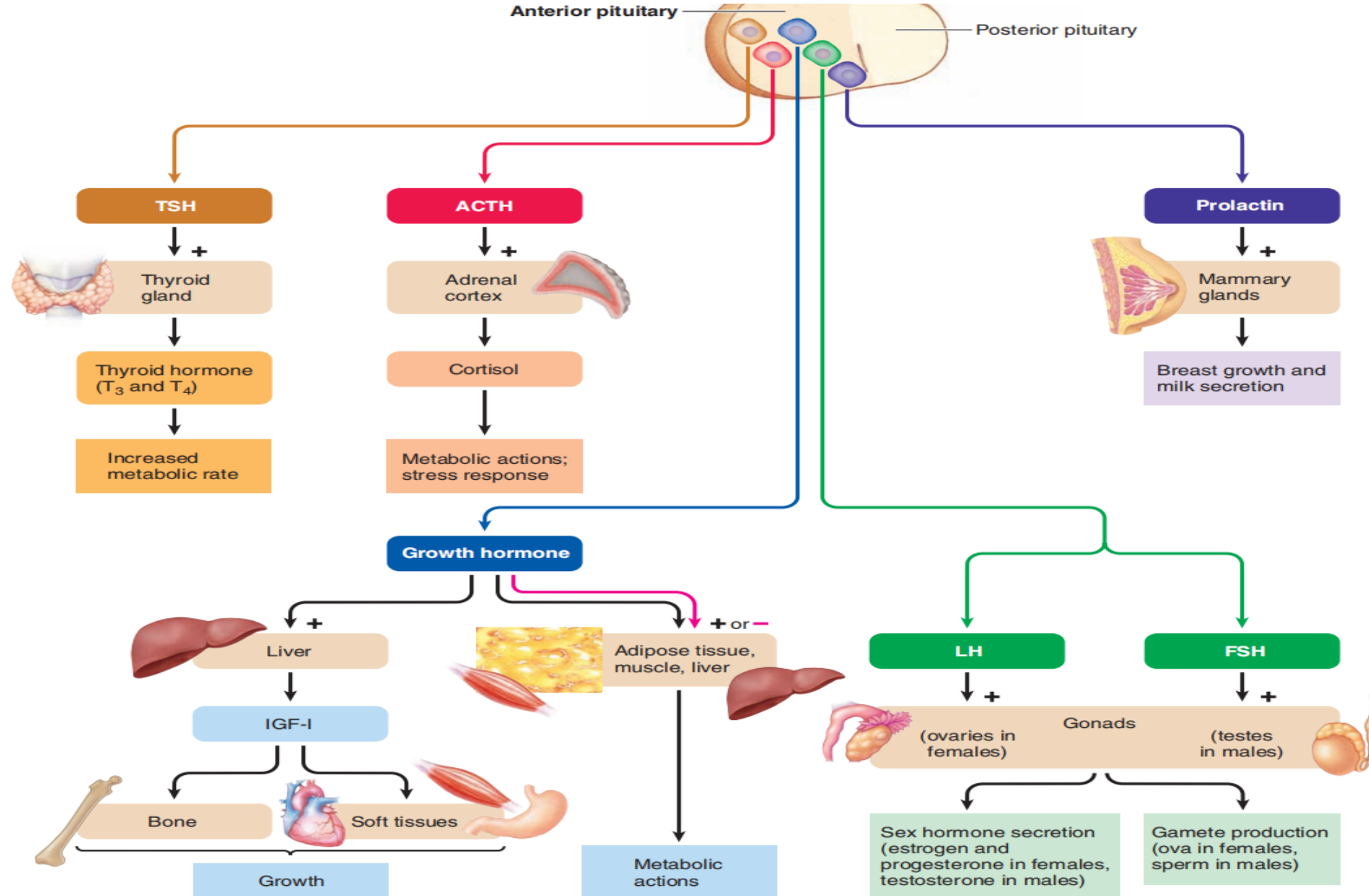


The hormones of the anterior pituitary

1. **Growth hormone (hGH)** promotes growth of the entire body by affecting protein formation, cell multiplication, and cell differentiation.
2. **Adrenocorticotropin (corticotropin) (ACTH)** controls the secretion of some of the adrenocortical hormones, which affect metabolism of glucose, proteins, and fats.
3. **Thyroid-stimulating hormone (thyrotropin) (TSH)** controls the secretion rate of thyroxine and triiodothyronine by the thyroid gland, and these hormones control the rates of most intracellular chemical reactions in the body.
4. **Prolactin (PRL)** promotes mammary gland development and milk production.
5. **Two separate gonadotropic hormones**, follicle stimulating hormone (FSH) and luteinizing hormone (LH), control growth of the ovaries and testes, as well as their hormonal and reproductive activities.



The hormones of the anterior pituitary



The hormones of the posterior pituitary

- The two hormones secreted by the posterior pituitary play other roles.
 1. **Antidiuretic hormone** controls the rate of water excretion into the urine, thus helping to control the concentration of water in the body fluids.
 2. **Oxytocin** helps express milk from the glands of the breast to the nipples during suckling and helps in the delivery of the baby at the end of gestation.

Hormones Regulate Mammalian Physiological System

- Each of the two adrenal glands is a gland within a gland .
- The **thyroid gland** contains two cell types that produce two different hormones, **thyroxine** and **calcitonin**.
- Thyroxine (**T4**) is synthesized from the amino acid tyrosine and iodine. **T3** is a similar hormone that is more active.
- **Calcium levels** are regulated by calcitonin from the thyroid and parathyroid hormone from the **parathyroid glands**.
- If calcium levels are low, parathyroid hormone causes release of stored calcium from bone, reabsorption of calcium in kidneys, digestive tract .
- If levels are too high, calcitonin inhibits bone resorption and enhances calcium release by kidney.
- The **adrenal glands**:The core, or **adrenal medulla**, produces **epinephrine** and **norepinephrine** .Release of these hormones is under control of the nervous system and is very rapid in the stress response.

Hormones Regulate Mammalian Physiological System

- The **outer adrenal cortex** produces two types of corticosteroid hormones: **Mineralo corti coids** influence salt and water balance, increase blood pressure and **Gluco corti coids** influence blood glucose concentration by breaking down fat and protein.
- Cortisol is the main glucocorticoid in mammals, mediates metabolic stress response.
- After a stressful stimulus, blood cortisol rises.
- Cells not critical for action decrease their use of blood glucose immune system reactions are also blocked
- The pineal gland: Small, median structure near center of brain that secretes melatonin and is involved in regulating functions related to light and seasons (day length).
- Circadian rhythm of melatonin secretion can be disrupted by light, travel.

Hormones Regulate Mammalian Physiological System

- **Gonads** are the ovaries and the testes. Gonads secrete sex hormones:
- **Androgens**—male steroids, testosterone
- **Estrogens and progesterone**— female steroids
- Affect growth, development, reproductive cycles and sexual behavior.
- Sex hormones determine the sex of the fetus during development.
- All embryos start off female, but testosterone stimulates development of the male structures.
- **Androgens** also responsible for development of male secondary sex characteristics.
- **Estrogens** are necessary for females to mature.
- **Estradiol** most important estrogen – responsible for maintenance of female reproductive system and development of secondary sexual characteristics.
- **Progesterone** needed for maintenance of uterus and growth/development of an embryo.

Thank you