ENDOCRINE MODULE
PHYSIOLOGY(LECTURE 8)
ORGANS WITH ENDOCRINE FUNCTION

BY

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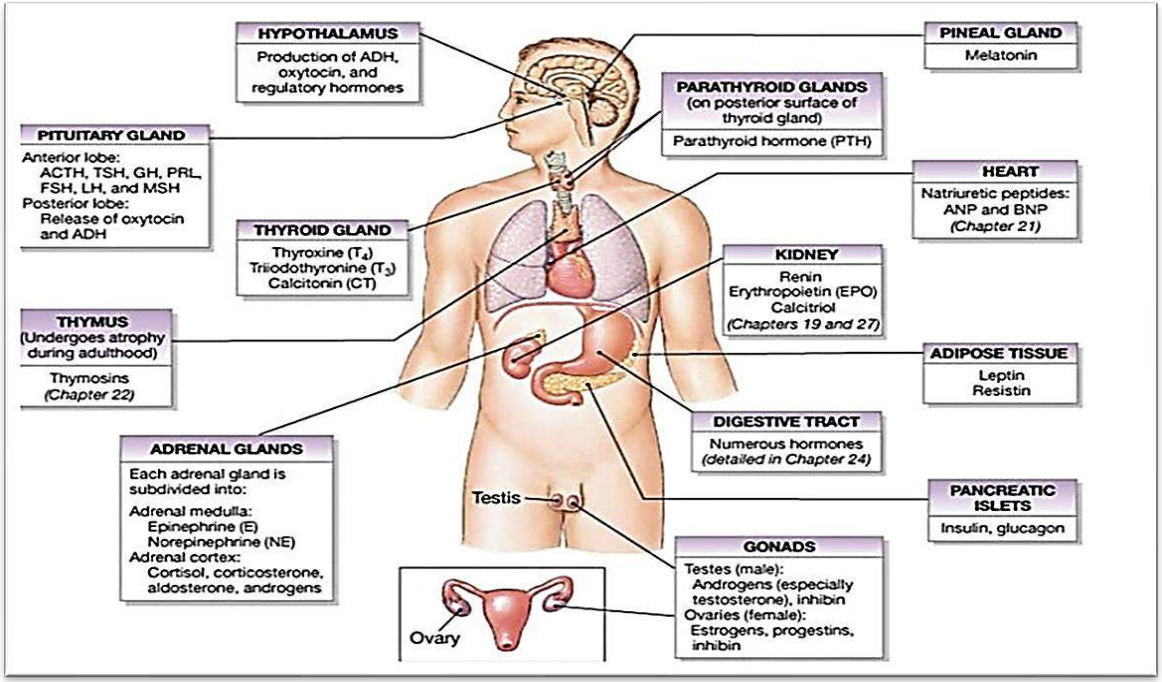


ORGANS WITH ENDOCRINE FUNCTION

In addition to endocrine glands, the following organs also exert endocrine functions besides their original functions:

- **Hypothalamus.**
- **Pineal gland.**
- **Thymus.**
- **Kidneys.**
- **Heart.**
- **Stomach.**
- **Adipose tissue.**
- **Placenta.**

Sites of local hormones secretion:
Digestive tract (e.g. gastrin, secretin and CCK).

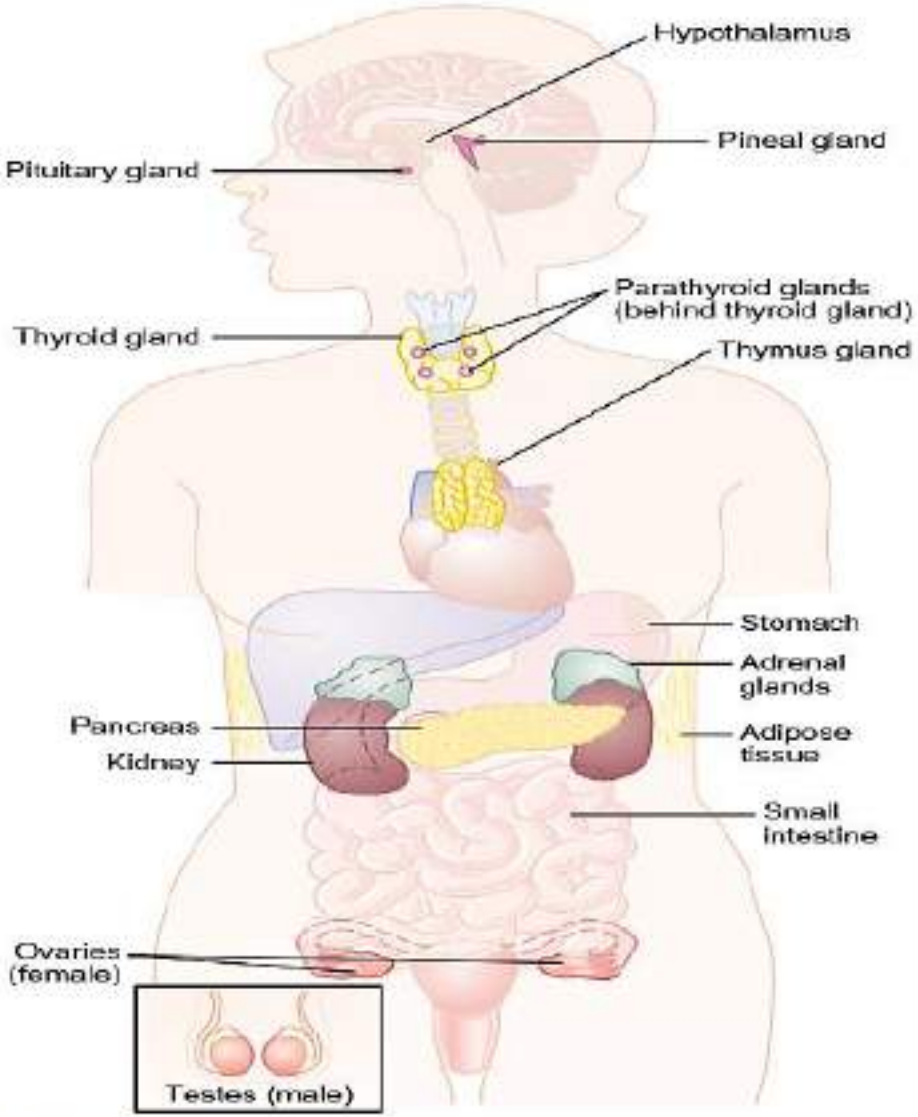


Figure 74–1

Anatomical loci of the principal endocrine glands and tissues of the body.

Hypothalamus

The hypothalamus controls the activity of anterior pituitary gland by releasing hormones called hypophysiotropic hormones.
(Hypophysiotropic hormones)

Releasing hormones:

- Growth hormone-releasing hormone (GHRH).
- Thyrotropin-releasing hormone (TRH).
- Corticotropin-releasing hormone (CRH).
- Gonadotropin-releasing hormone (GnRH).

Inhibiting hormones:

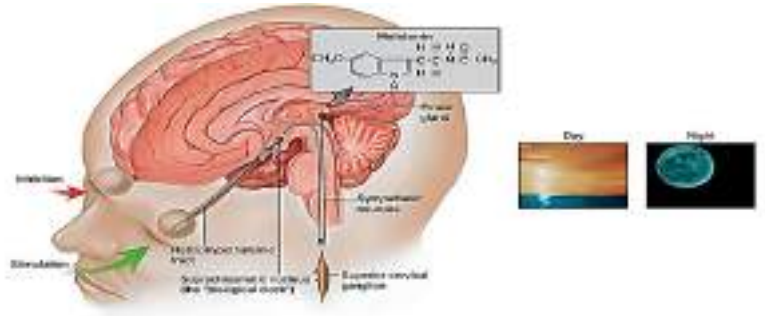
- Growth hormone-inhibiting hormone (GIH or somatostatin).
- Prolactin – inhibiting hormone (PIH; dopamine).

Pineal Gland

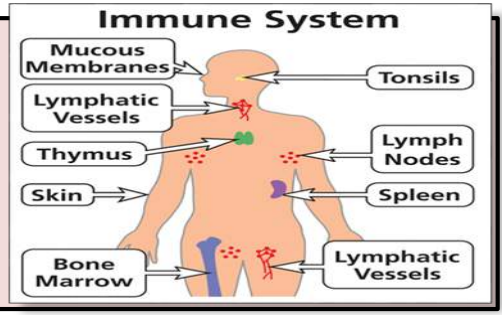
- The pineal gland is a small pinecone-shaped structure located superior and posterior to the thalamus of the brain**.**
- **The pineal gland produces a hormone called melatonin.**
- **Melatonin is thought to decrease the secretion of LH and FSH by either acting on anterior pituitary gland or through decreasing the release of hypothalamic releasing hormone (GnRH).**
- **Thus, melatonin inhibits the functions of reproductive system.**
- **Animal studies have demonstrated that the amount of available light controls the rate of melatonin secretion.**
- **In many animals, short day lengths causes an increase in melatonin secretion. Whereas, longer day length causes a decrease in melatonin secretion.**

Role of melatonin in sleep mechanisms:

- The diurnal change in melatonin secretion may function as a timing signal to coordinate events with the light–dark cycle in the environment.
- **Melatonin synthesis and secretion** are increased during **the dark period of the day** and **maintained at a low level during daylight hours**.
- **This diurnal variation** in secretion is brought about by **norepinephrine secreted by the postganglionic sympathetic nerves that innervate the pineal gland**.
- **The discharge of the sympathetic nerves to the pineal** is entrained to **the light–dark cycle** in the environment via the **retinohypothalamic nerve fibers to the suprachiasmatic nucleus (SCN)**.
- **The nervous pathway involves the passage of light signals from the eyes to the SCN of the hypothalamus and then to the pineal gland, activating pineal secretion.**
- From the **hypothalamus, descending pathways converge onto preganglionic sympathetic neurons that in turn innervate the superior cervical ganglion, the site of origin of the postganglionic neurons to the pineal gland**.



Thymus Gland



- Thymus is a bilobed gland roughly triangular in shape located in the upper part of thoracic cavity.
- **It is important in the function of immune system.**
- **The thymus secrets a hormone called thymosin which aids the development of white blood cells called T- cells.**
- **T- cells help protect the body against infection by foreign organisms.**
- The thymus is most important early in life; if an infant is born without a thymus, the immune system doesn't develop normally and the body is less capable of fighting infection.

Kidneys

The kidneys are endocrine organs:

Through secretion of **renin, erythropoietin**, **prostaglandins, and active form of vitamin D (1,25 dihydroxycholecalciferol; calcitriol).**

1. Renin:

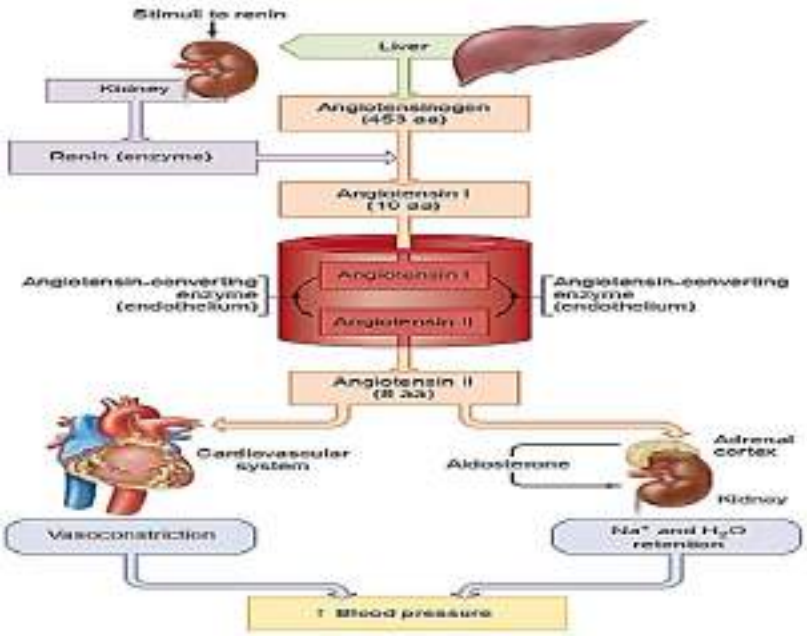
- It is a **proteolytic enzyme** secreted by **juxtaglomerular cells in afferent arteriole**.
- **It acts on angiotensinogen (synthesized by liver) leading to formation of angiotensin I.**
- **Angiotensin I is converted to angiotensin II by ACE (pulmonary circulation).**
- **Angiotensin II produces generalized VC in addition to stimulation of aldosterone secretion.**
- **Renin angiotensin aldosterone system (RAAS)** is critical for **fluid–electrolyte homeostasis and long-term blood pressure regulation**.

Factors affecting renin secretion:

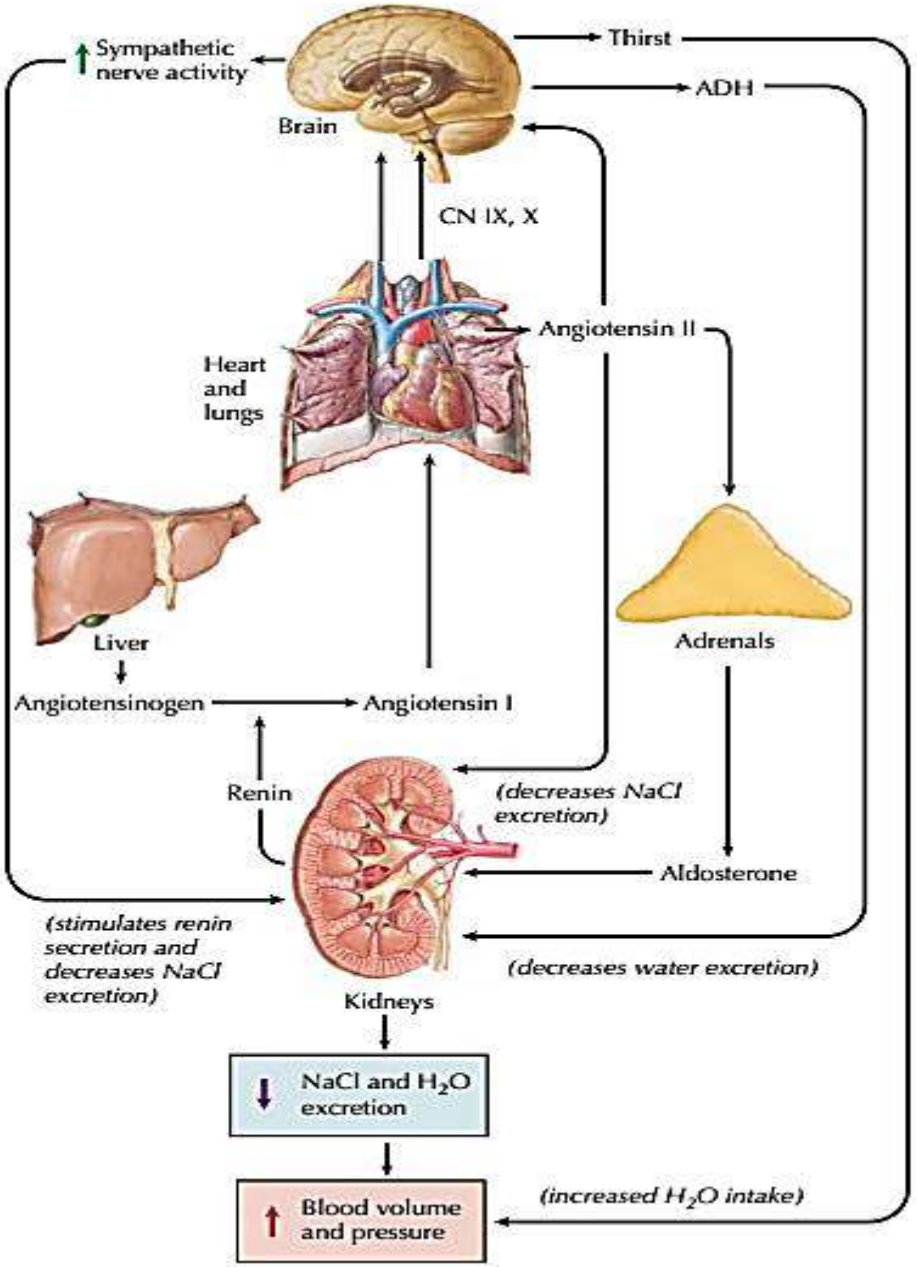
- **Renin secretion is stimulated by : Renal ischemia, increased sympathetic activity and catecholamines.**
- **Renin secretion is inhibited by: Angiotensin II, vasopressin and increased afferent arteriolar pressure.**

Actions of angiotensin II:

- **It is a potent vasoconstrictor.**
- **It facilitates the release of norepinephrine by a direct action on postganglionic sympathetic neurons.**
- **Ang II stimulates sodium (and thus, water) reabsorption in the renal tubule.**
- **It stimulates aldosterone secretion from adrenal cortex which stimulates Na^+ reabsorption from distal convoluted tubules and cortical collecting ducts of renal nephrons.**
- **It stimulates ADH release which increases water reabsorption from collecting ducts.**



Response to Decreased Blood Volume and Pressure



2. Erythropoietin:

- ✓ **The direct control of erythropoiesis is exerted primarily by a hormone called erythropoietin. Erythropoietin is secreted into the blood mainly by the kidneys.**
- ✓ **Erythropoietin acts on the bone marrow to stimulate the proliferation of erythrocyte progenitor cells and their differentiation into mature erythrocytes.**
- ✓ **Erythropoietin is normally secreted in small amounts that stimulate the bone marrow to produce erythrocytes at a rate adequate to replace the usual loss.**
- ✓ **The erythropoietin secretion rate is increased markedly above basal values when there is a decreased oxygen delivery to the kidneys. Situations in which this occurs include:**
  - o **Insufficient pumping of blood by the heart.**
  - o **Lung disease.**
  - o **Anemia (a decrease in number of erythrocytes or in hemoglobin concentration).**
  - o **Prolonged exposure to high altitude.**
- ✓ **As a result of the increase in erythropoietin secretion, plasma erythropoietin concentration, erythrocyte production, and the oxygen-carrying capacity of the blood all increase. Therefore, oxygen delivery to the tissues returns toward normal.**
- ✓ **Testosterone, the male sex hormone, also stimulates the release of erythropoietin. This accounts in part for the higher hematocrit in men than in women.**

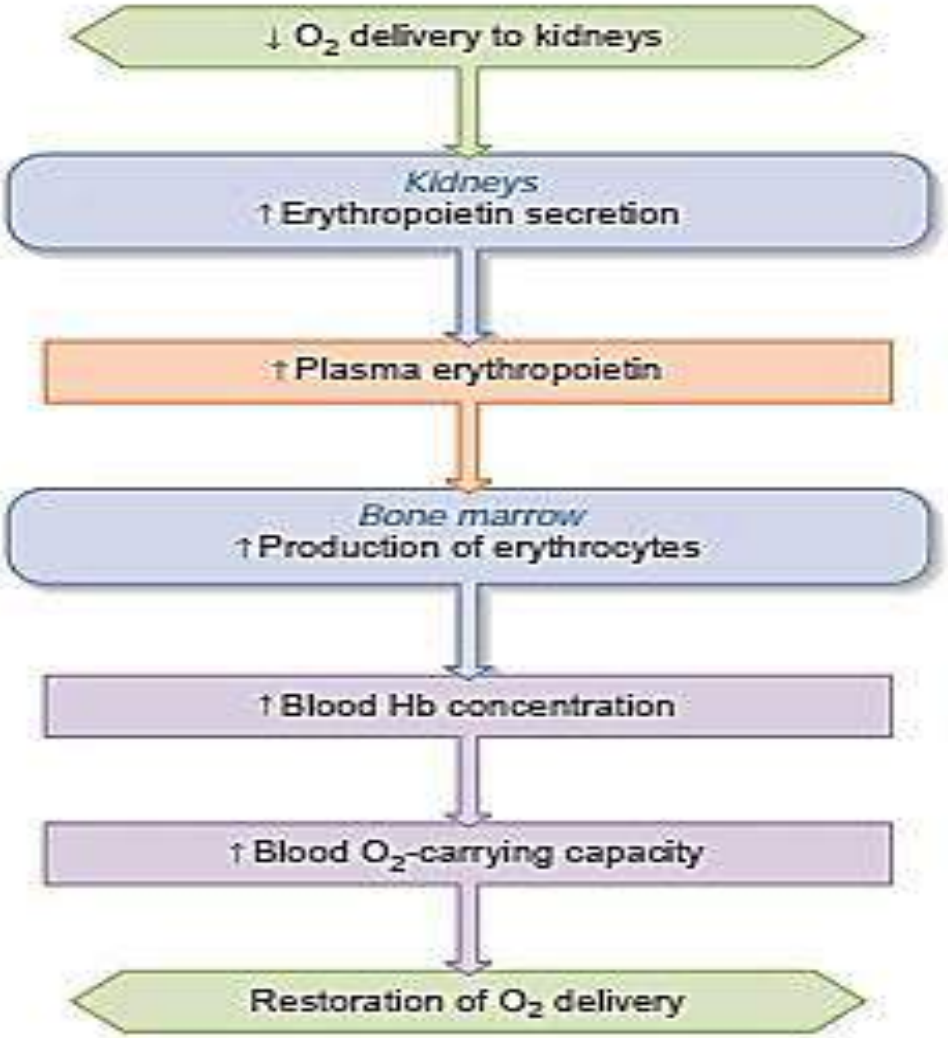


Figure 12.70 Reflex by which decreased oxygen delivery to the kidneys increases erythrocyte production via increased erythropoietin secretion.

3. Active vitamin D:

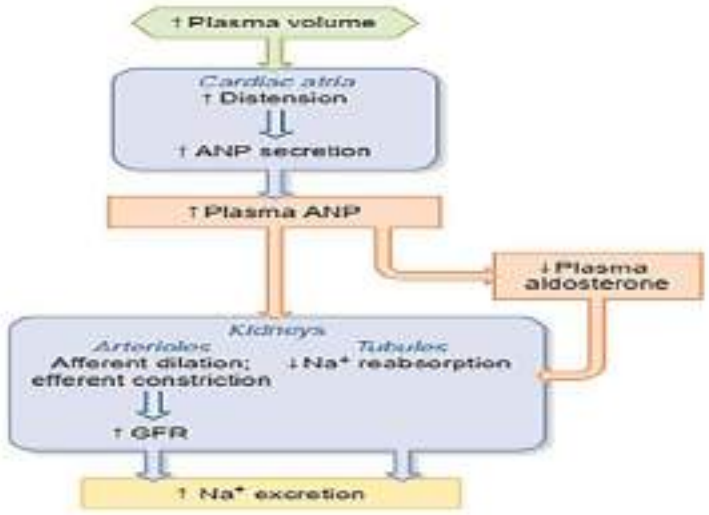
(1,25 dihydroxycholecalciferol):

Active form of vitamin D is formed in kidney from inactive 25-hydroxycholecalciferol in cells of **PCT by activity of 1α-hydroxylase enzyme** under control of **parathormone; PTH**. **It regulates calcium homeostasis.**

HEART

Atrial Natriuretic Peptide (ANP):

- **Cells in the cardiac atria synthesize and secrete ANP in response to stretch; atrial distension (at high blood volume).**
- **ANP acts on several tubular segments to inhibit Na^+ reabsorption.**
- **ANP also directly inhibits aldosterone secretion, which leads to an increase in Na^+ excretion.**
- **ANP causes natriuresis and diuresis, reducing ECF volume.**
- **ANP also causes VD of renal afferent arteriole and VC of efferent arteriole increasing glomerular capillary pressure, and thus, GFR. The enhanced flow increases sodium and water excretion, reducing blood volume.**



Stomach

- ✓ **Ghrelin** is a 28-amino-acid peptide synthesized and released primarily from endocrine cells in the **stomach**.
- ✓ Ghrelin is also produced in smaller amounts from other gastrointestinal and non-gastrointestinal tissues.
- ✓ Ghrelin **is a fast-acting orexin that stimulates food intake**. Circulating ghrelin levels increase preprandially, then decrease after a meal.
- ✓ Ghrelin has several major functions:
- o It **increases growth hormone release** from the anterior pituitary gland (by acting directly on receptors in the pituitary).
- o The **major function of ghrelin** is to **increase hunger** by increasing synthesis and/or release of **central orexins**, including **neuropeptide Y(NPY)** and other neuropeptides in the feeding centers in the **hypothalamus**.
- o It also **suppresses the ability of leptin to stimulate the anorexigenic factors. Its secretion may also be inhibited by leptin**, underscoring the reciprocity of these hormones.
- o Ghrelin **also increases gastric motility and acid production**.
- ✓ It makes sense, then, that the major stimuli to ghrelin are fasting and a low-calorie diet.

Adipose Tissue

- ✓ The peptide hormone **leptin** is synthesized by adipocytes and released from the cells in proportion to the amount of fat they contain.
- ✓ Leptin acts on **the hypothalamus to cause a decrease in food intake, in part by inhibiting the release of neuropeptide Y, a hypothalamic neurotransmitter that stimulates appetite.**
- ✓ **Leptin tends to decrease food intake, in part by increasing the expression of other anorexigenic factors in the hypothalamus** such as proopiomelanocortin (POMC), cocaine- and amphetamine-regulated transcript (CART), neurotensin, and **corticotropin-releasing hormone (CRH)**.
- ✓ **Leptin also increases BMR** and, therefore, plays an important role in the changes in energy expenditure.
- ✓ Thus, leptin functions in a negative feedback system to maintain a stable total-body energy content by signaling to the brain how much fat is stored.
- ✓ Animal studies have shown that it is possible to become resistant to the effects of leptin, however, and in this setting, food intake persists despite adequate (or even growing) adipose stores—obesity therefore results.
- ✓ Both leptin and ghrelin are peripheral factors that act reciprocally on food intake.

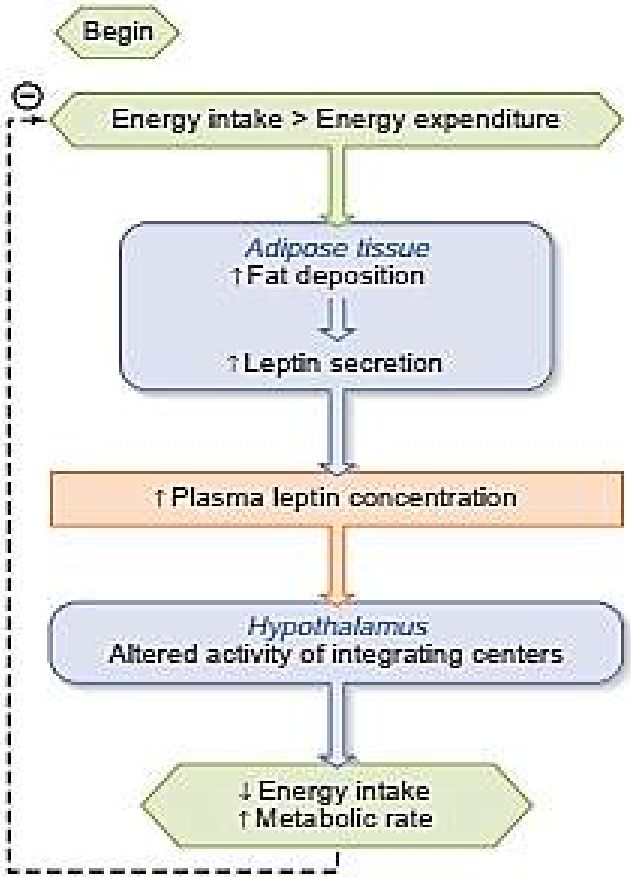


Figure 16.14 Postulated role of leptin in the control of total-body energy stores. Note that the direction of the arrows within the boxes would be reversed if energy (food) intake were less than energy expenditure.

Placenta

In pregnant women, placenta is an important source of hormones that maintain pregnancy and stimulate breast development.

1. Human chorionic gonadotropin (hCG):

- It is luteinizing and luteotropic (like pituitary LH). It induces growth of corpus luteum and stimulates it to secret estrogen, progesterone and relaxin for the first few weeks of pregnancy.
- It also exerts TSH activity and in male fetus stimulates testosterone secretion by Leydig cells.
- It also participates in development of breast during pregnancy.

2. Relaxin:

- It relaxes symphysis pubis and other pelvic joints and softens and dilates the uterine cervix thus facilitating delivery.
- It also inhibits uterine contractions.

3. Estrogens: They promote:

- ✓ Enlargement of uterus and increase in its blood supply.
- ✓ Growth of mammary glands and development of their duct system.
- ✓ Enlargement of external genitalia.
- ✓ Sensitization of myometrium to action of oxytocin.
- ✓ Relaxation of pelvic ligaments and joints (like relaxin).

4. Progesterone:

Essential for maintenance of pregnancy by:

- ✓ Progestational changes in the endometrium.
- ✓ Decreasing sensitivity of myometrium to oxytocin.
- ✓ Promotes maturation of mammary glands and development of their secretory alveoli.

5. Human chorionic somatomammotropin (hCS):

It is also called **chorionic growth hormone – prolactin** because it exerts:

- ✓ Mammotropin (prolactin) like action: it stimulates milk secretion from mammary gland.
- ✓ Somatrotropin like action: it exerts most actions of somatotropin (retention of elements required for growth, increasing lipolysis and antagonizing insulin action).

Thank You