CHEMICAL COORDINATION

Chapter 18

Major Concept

In this Unit you will learn:

- Hormones :The Chemical Messengers
- Endocrine system of Man
- Feedback Mechanism

CHEMICAL COORDINATION

Evolution of complex multicellular organisms came, the need to coordinate the activities of cells in different parts of the body. Cell-to-cell communication is crucial to the control of movement, growth, reproduction, and the maintenance of homeostasis. Many different mechanisms have evolved by which cells within organisms communicate among themselves. Certain chemicals are involved in communications, which are **neurotransmitters**, **pheromones** and **hormones**. Neurotransmitters are chemical messenger between the neurons discussed in previous chapter. Pheromones are chemicals secreted by an organism in minute amounts to stimulate particular reaction from another organism of the same species.

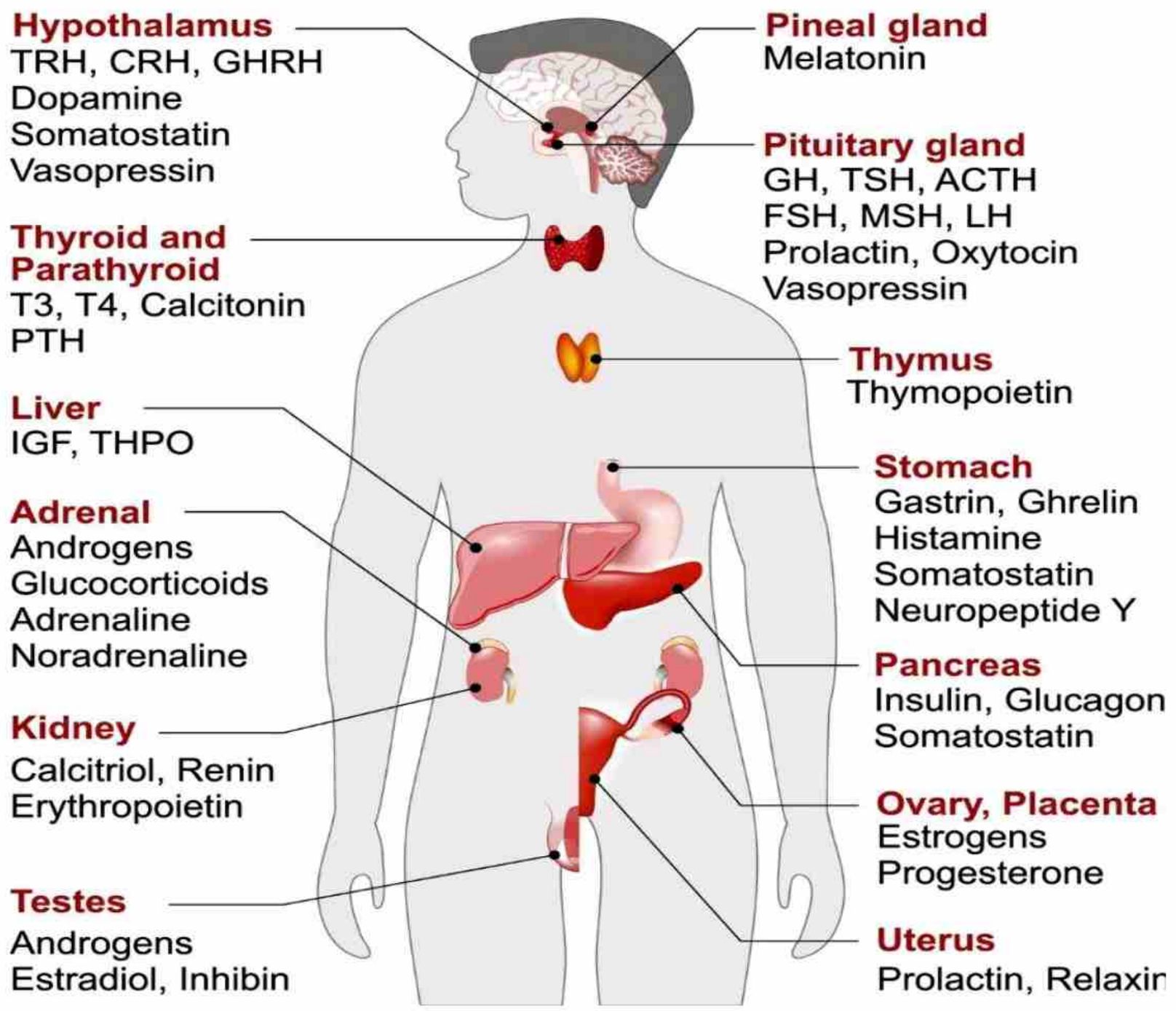


Fig.18.1 Endocrine glands

A hormone (Gr: Hormon: Excite) is a chemical messenger that is secreted by specialized tissues called **glands**, that is transported in the blood stream. Hormones may reach all parts of the body, but only certain types of cells, the **target cells**, are equipped to respond. Thus a given hormone traveling in the blood stream elicits specific response in from selected target cells, while other cell types ignore the particular hormone.

18.1 CHEMICAL NATURE OF HORMONES

Chemicals that function as hormone must exhibit two basic characteristics. First, they must be sufficiently complex to convey regulatory information to their target cells. Second, hormones must be adequately stable to resist destruction prior to reaching their target cells. Three primary chemical categories of hormones are

i) Peptide and Protein hormones

Hormones composed of chains of amino acids ranging from a few to over a hundred amino acids in length. Short chain amino acid hormones are called **peptide hormones** (ADH = Antidiuretic hormone). Long chain amino acid hormones are called **protein hormones** (GH = Growth hormone) and Insulin.

ii) Amino acid derivate hormones

These hormones are manufactured by enzymatic modification of specific amino acids. This group includes **biogenic amines** discussed in previous chapter (nervous co-ordination). They include hormones secreted by the adrenal medulla, thyroid and pineal gland. Those secreted by the adrenal medulla are derived from **tyrosine** (Amino acid) known as **Catecholamines**, they include **epinephrine** (adrenaline) and **nor-epinephrine** (nor-adrenaline) other hormones derived from tyrosine are the thyroid hormones. The pineal gland secretes a different amine hormone, **melatonin** derived from **Tryptophan**.

iii) Steroid hormones

These hormones are manufactured by enzymatic modifications of **cholesterol**. They include the hormones testosterone, estrogen (Estradiol), progesterone, aldosterone and cortisol.

Path of Chemical messenger

In human all cells have a blood supply, once hormones enter the bloodstream, they reach nearly every cell of the body. But in order to exert their precise control, hormones must act only on certain **target cells**. Hormones specificity is determined by **receptors** on target cells. If a cell lacks a specific receptor for a hormone, the hormone will not affect the cell. In addition, the same hormone may have several different effects depending on the nature of the target cell it contacts. Receptors for hormones are found in two general locations on target cells on the cell membrane and inside the cell.

Mode of Hormone Action

Hormone triggers changes in target cells by one of two general mechanisms depending on their chemical nature. Hormones may be categorized as **hydrophilic** (polar) or protein nature hormones and **lipophilic** (non-polar) steroid and thyroid hormones.

Protein hormones (Hydrophilic)

These hormones are soluble in water but insoluble in lipids, hence these hormones cannot cross the cell membrane. Instead they react with protein receptors protruding from the outside surface of target cell membrane. In general hormones (Primary messengers) that bind to surface receptors trigger rapid, short term responses.

More frequently, a second messenger system is used. In this system when the hormone binds to the receptor, the shape of the receptor is altered, triggering a series of biochemical reactions that alter the activity of cell. In many cases, the binding of the hormone on the receptor activate on enzyme. Activated enzyme catalyzes the conversion of ATP to cyclic Adenosine mono phosphate (cAMP).

A mononucleotide that regulates many cellular activities **cAMP** is often called a **second messenger**. Because it transfer the signal from the first messenger, the hormone to molecules within cell. The hormone signal can cause the target cell to react in a number of different ways. The reaction may involve the induction of protein synthesis, the activation or inactivation of enzymes, a change in cell membrane permeability, changing rates of mitosis and cell development, and the induction of product secretion. Furthermore, a

single hormone may be able to cause a number of reactions in a single cell..

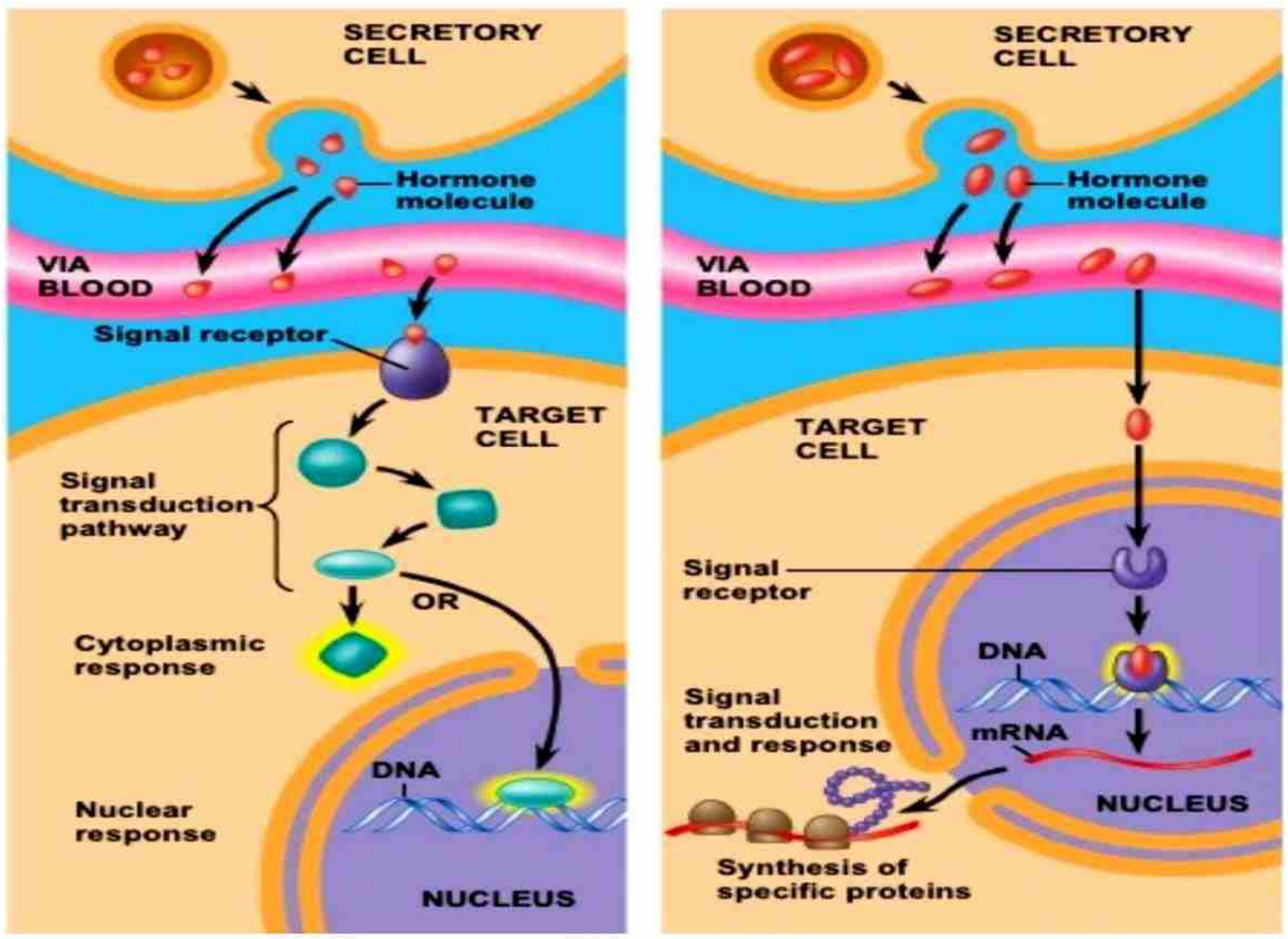


Fig.18.2 Protein and steroid hormone action

Steroid Hormones (Lipophilic)

Steroid hormones and thyroid hormones are lipid soluble and are therefore able to diffuse into the cell membrane and binds to receptors inside the cell, both steroid and thyroid hormones alter the activity of genes. It may take from minutes to days for these hormones to exert their full effects. These hormones bind to protein receptors in the nucleus. The receptors hormone complex binds to DNA and initiates the Transcription of messenger RNA from specific genes. The messenger RNA then moves into the cytoplasm and directs the synthesis of new proteins.

18.2 ENDOCRINE SYSTEM OF MAN

The endocrine system includes all of the glands and patches that secrete hormones, for example pituitary gland, thyroid gland,

adrenal gland and so on. Cells in these glands secrete hormones into extracellular fluid, where it diffuses into surrounding blood capillaries. For this reason, hormones are referred to as endocrine secretions. In contrast cells of some gland excrete their products into particular ducts or into the gut. For example, the pancreases excrete hydrolytic enzymes into the lumen of the small intestine with the help of pancreatic duct. These glands are termed as **exocrine glands**.

18.2.1 Hypothalamus

The hypothalamus is a part of the brain that contains clusters of specialized cells called neurosecretory cells. The hormone releasing cells in the hypothalamus are two sets of neurosecretory cells, whose secretions are stored in or regulate the activity of the pituitary gland. A set of neurosecretory cells in the hypothalamus exerts control over the anterior pituitary lobe by secreting two kinds of hormones into the blood **releasing hormones** make the anterior pituitary lobe to secrete its hormones, and **inhibiting hormones** from the hypothalamus make the anterior pituitary stop secreting hormone. Another set of neurosecretory cells produce two hormones **ADH** and **oxytocin**, which are stored and secreted from posterior pituitary glands.

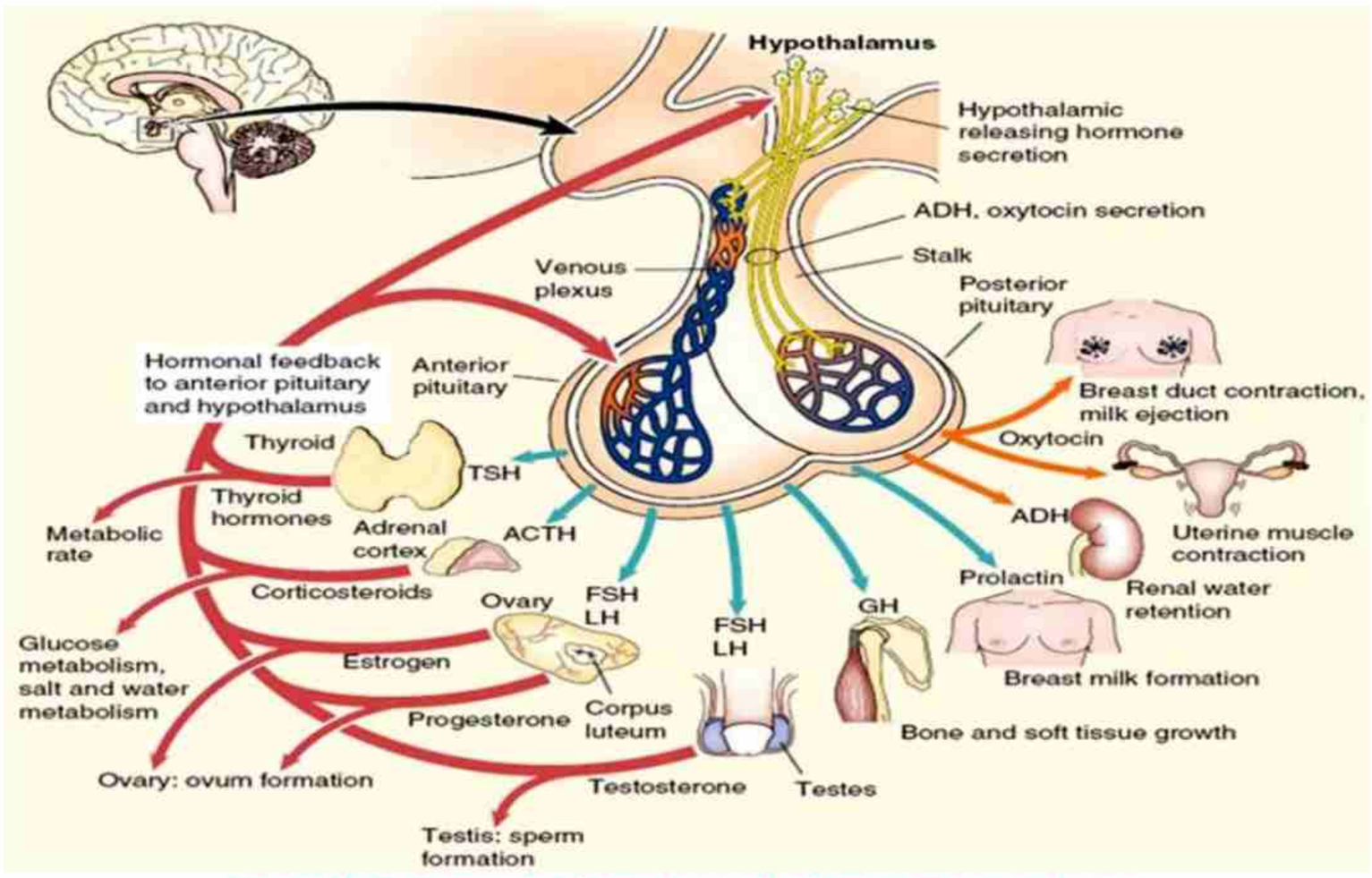


Fig.18.3 Hypothalamus and pituitary response

Table 18.1 Releasing and inhibiting hormones of hypothalamus

Hormone from the hypothalamus	→	Anterior pituitary
Thyrotropin releasing hormone (TRH)		Stimulate the release of thyroid stimulating hormone (TSH)
Corticotropin releasing hormone (CRH)		Stimulate the release of adrenocorticotropin hormone (ACTH)
Gonadotropin releasing hormone (GnRH)		Stimulate the release of LH and FSH
Growth hormone releasing hormone (GHRH)		Stimulate the release of Growth hormone (GH)
Growth hormone inhibiting hormone (GHIH)		Inhibits the secretion of Growth hormone
Prolactin inhibiting hormone (PIH)		Inhibits the secretion of prolactin
Melanocyte inhibiting hormone (MIH)		Inhibits the secretion of MSH

18.2. 2 Pituitary gland

The pituitary gland also known as the **hypophysis**, is a pea-sized gland that dangles from the hypothalamus by a stalk anatomically, the pituitary gland consists of two distinct lobes or parts, one of which appears glandular and is called the anterior pituitary lobe or **adenohypophysis**. The other portion appears fibrous and is called the posterior pituitary lobe or **neurohypophysis**.

Anterior Pituitary (Adenohypophysis)

The anterior pituitary is an independent endocrine gland. It produces at least seven essential hormones, many of which stimulate growth of their target organs, as well as production and secretions of other hormones from additional endocrine glands. Therefore, several hormones of the anterior pituitary are collectively termed as **tropic hormones** or **tropins**. Tropic hormones act on other endocrine glands to stimulate secretion of hormones produced by the target gland.

- **Adrenocorticotropic hormone (ACTH):** Stimulates the adrenal cortex to produce corticosteroids.

- **Melanocyte stimulating hormone (MSH):** Stimulate the synthesis and dispersion of melanin pigment in the skin.
- **Growth hormone (GH) OR Somatotropic hormone (STH):** The growth of muscles, bone and other tissues.
- **Prolactin:** Stimulate the mammary glands to produce milk.
- **Thyroid Stimulating hormone (TSH):** Stimulates thyroid gland to produce thyroxin.
- **Luteinizing hormone (LH):** Stimulate gonads (testes/ovaries) for production of steroid hormone estrogen and progesterone from ovaries and testosterone from testes.
- **Follicle stimulating hormone (FSH):** Stimulate development of ovarian follicles in females. In males it is required for the development of sperm. FSH and LH are called gonadotropins (GnTH) because they stimulate the activities of the male and female gonads.

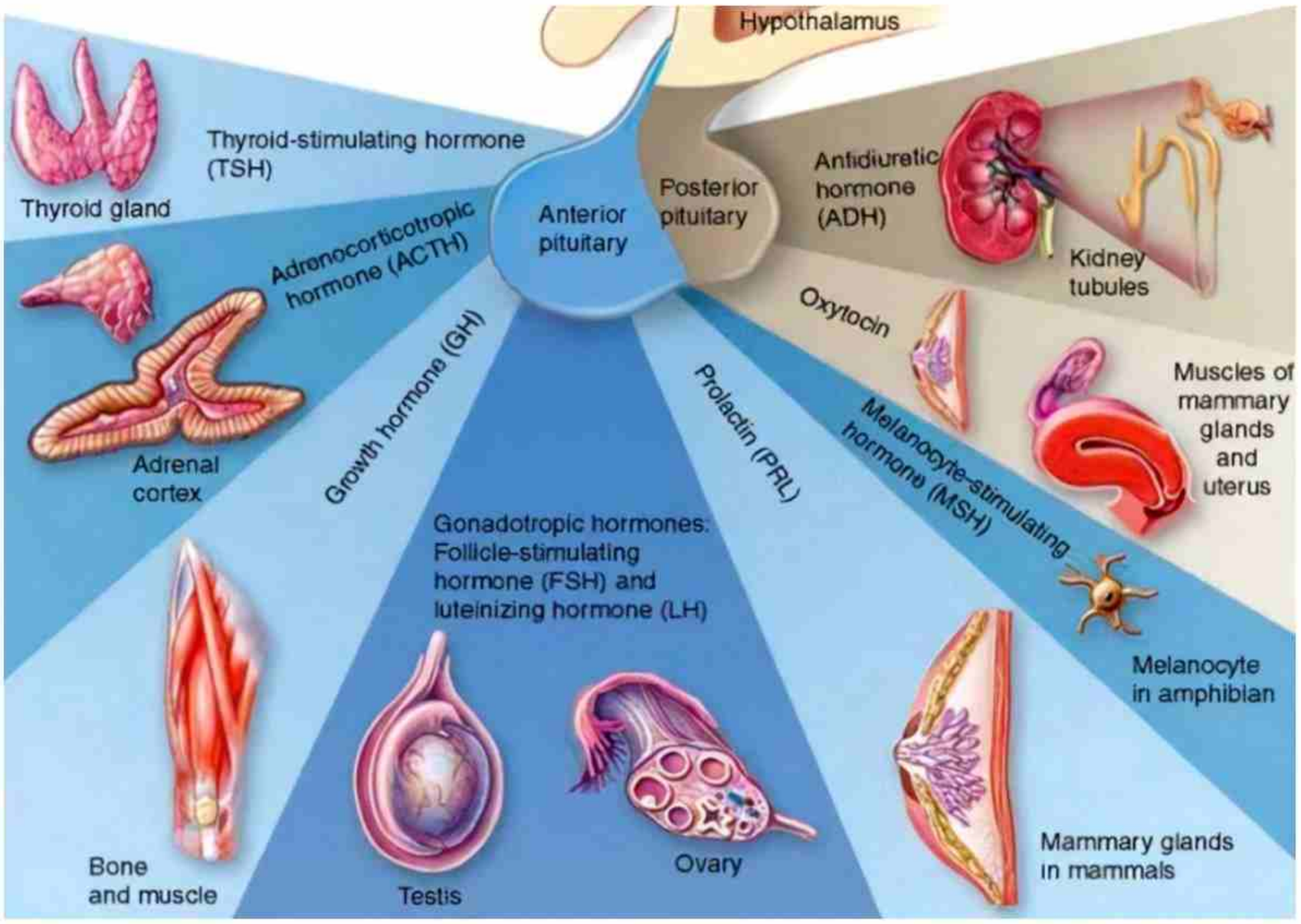


Fig.18.4 Pituitary gland

Posterior Pituitary gland (Neurohypophysis)

The posterior pituitary contains the ending of two types of neurosecretory cells whose cell bodies are found in the hypothalamus. The hormones released from here are actually stored secretion of hypothalamus, Antidiuretic hormone (ADH) and oxytocin. **Antidiuretic hormone** which literally means **"hormone that prevents urination"** helps prevent dehydration. ADH causes more water to be reabsorbed from the urine and retained in the body, by increasing the permeability to water of the collecting ducts of nephrons in the kidney. **Oxytocin** has two primary physiological effects: it stimulates uterine contractions during labour and stimulates breast tissue contractions to promote lactation after childbirth.

Additionally serving as a chemical messenger in the brain, it plays a significant part in social interaction and human behaviour.

18.2.3 Thyroid gland

In human thyroid gland is located at the base of neck in front of tracheae (windpipe). It is comprised of two lobes (bilobed) and the **isthmus** that binds them together. Thyroid gland produces three major hormones. **Tri-iodothyronine (T3)**, **Tetra-iodothyronine (T4)** or **thyroxin** and **calcitonin**. Thyroxin or T4 contains four atoms of iodine, it is secreted in greater amount but is less potent than T3, which has only three atoms of iodine. Thyroxin influences most of the cells in the body elevating their metabolic rate its effects include increasing oxygen consumption and heart rate and stimulating the synthesis of enzymes that breakdown glucose and provide energy.

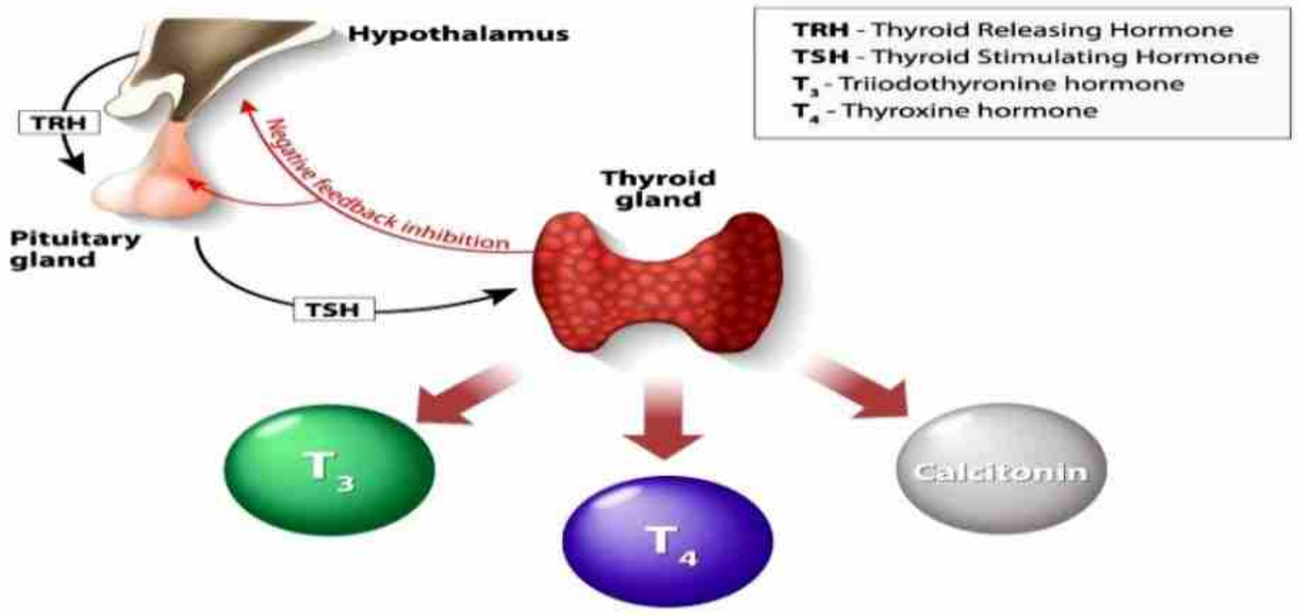


Fig.18.5 Thyroid gland

In adults metabolic rate involved in regulating body temperature and exposure to cold, for example, greatly increases thyroid hormone production level of thyroxin in the blood maintained by feedback loops. Thyroxin release is stimulated by **thyroid stimulating hormone** (TSH) from the anterior pituitary, which in turn is stimulated by releasing hormone from the hypothalamus **thyroid releasing hormone** (TRH). Excessive secretion of thyroid hormone known as **hyperthyroidism** produces such symptoms as profuse sweating, weight loss, heat intolerance, irritability and high blood pressure. Low secretion of thyroid hormone known as **hypothyroidism** produces symptoms such as weight gain, lethargy and cold intolerance in adults. Children born with hypothyroidism are stunted in their growth and suffer severe intellectual disability, a condition called **cretinism**. Another condition associated with a shortage of thyroid hormones is an enlargement of thyroid called **goiter**, often caused by a deficiency of iodine in the diet. **Calcitonin** a peptide hormone that plays role in maintaining proper levels of calcium (Ca^{++}) in the blood. When blood Calcium concentration rises too high, calcitonin stimulates the uptake of calcium into bones, thus lowering its concentration in the blood.

18.2.4 Parathyroid gland

The parathyroid glands are four small glands attached to the back of thyroid gland. The hormone produced by the parathyroid gland is a peptide hormone called **parathormone** or **parathyroid hormone** (PTH). It is synthesized and released in response to falling levels of calcium in the blood. This decline cannot be allowed to continue uncorrected because a significant fall in the blood calcium level can cause severe muscle spasms.

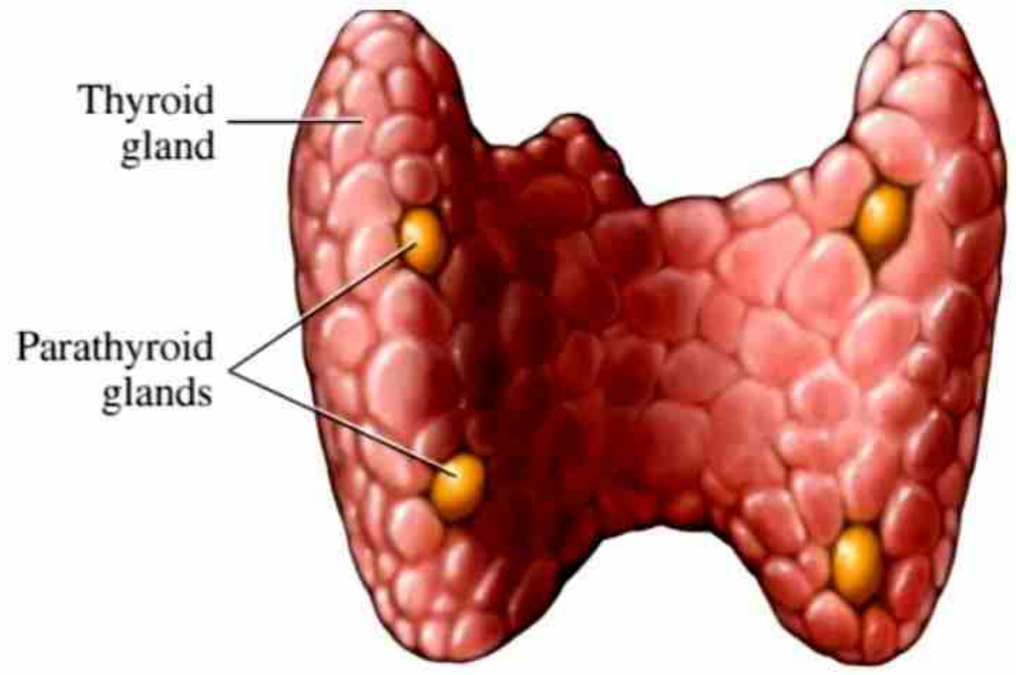


Fig.18.6 Parathyroid gland

A normal blood calcium level is important for the functioning of muscles, including the heart, and for proper functioning of the nervous and endocrine system. PTH stimulates osteoclasts (one of bone cells) in bone to dissolve the calcium phosphate crystal of the bone matrix and release calcium into the blood. It also stimulates kidneys to reabsorb calcium from the urine and leads to the activation of Vitamin-D, needed for the absorption of calcium from food in the intestine.

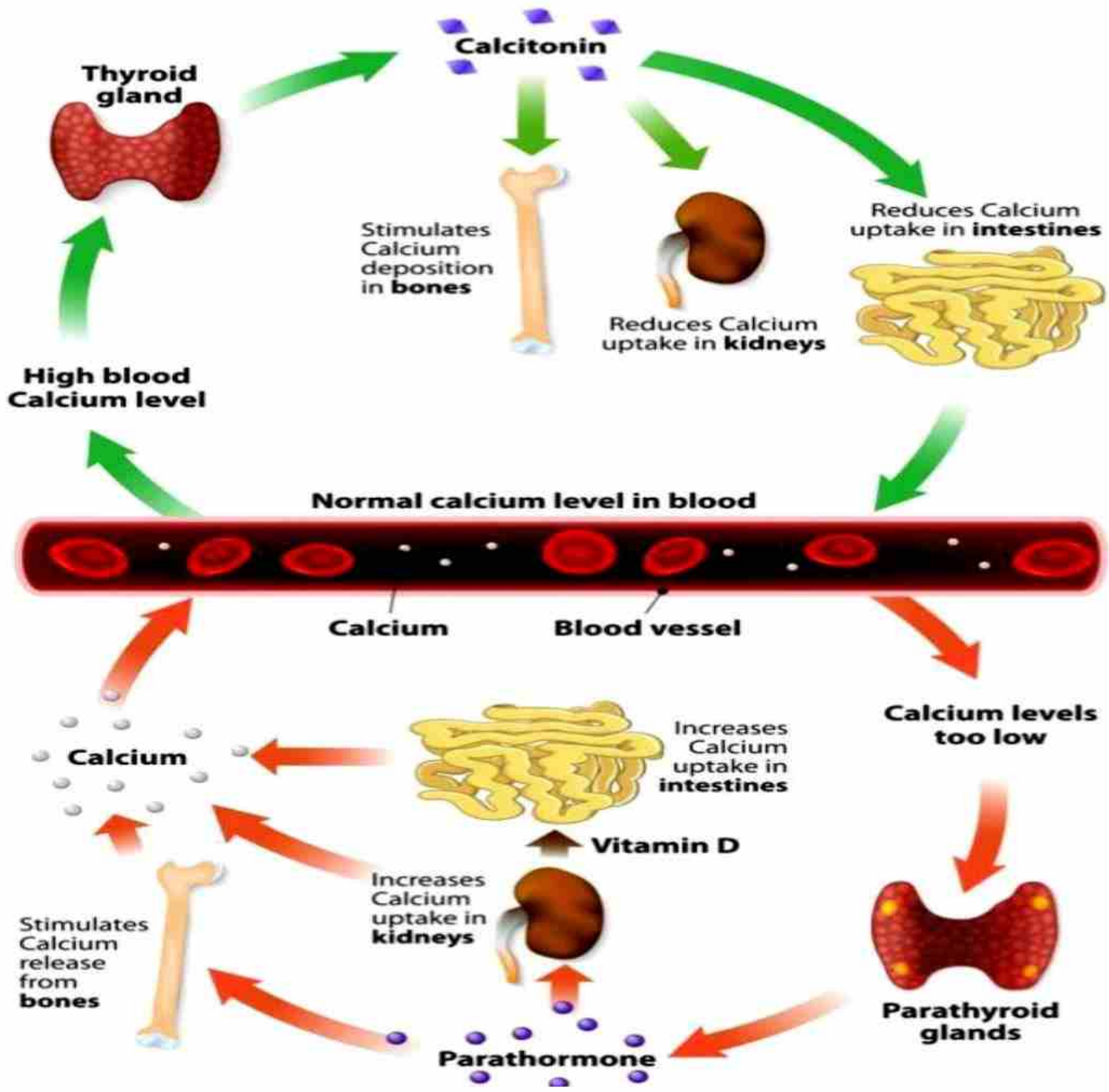


Fig. 18.7 Calcitonin and PTH relationship

18.2.5 Pancreas

The pancreas is located adjacent to the stomach. It performs both endocrine and exocrine functions. Endocrine cells makeup only 2% of the weight of the pancreas, rest of the organ is exocrine tissues

that produce bicarbonate ions and a variety of digestive enzymes that carried to the small intestine via the pancreatic duct. In 1869 a German medical student named Paul Langerhans described some unusual clusters of cells scattered throughout the pancreas, these clusters came to be called **Islets of Langerhans**. Cluster of endocrine cells that secrete two hormones directly into the circulatory system. Each islet has a population of **alpha cells**, which secrete the peptide hormone **glucagon**, and a population of **beta cells**, which secrete the peptide hormone **insulin**. Insulin and glucagon are antagonistic hormones that regulate the concentration of glucose in the blood. When blood glucose rises (for example, after a meal), insulin is released. Insulin causes most of the cells of the body to take up glucose and either metabolizes it for energy or convert it to fat or glycogen for storage. By far the most important storage organ for glycogen is the liver.

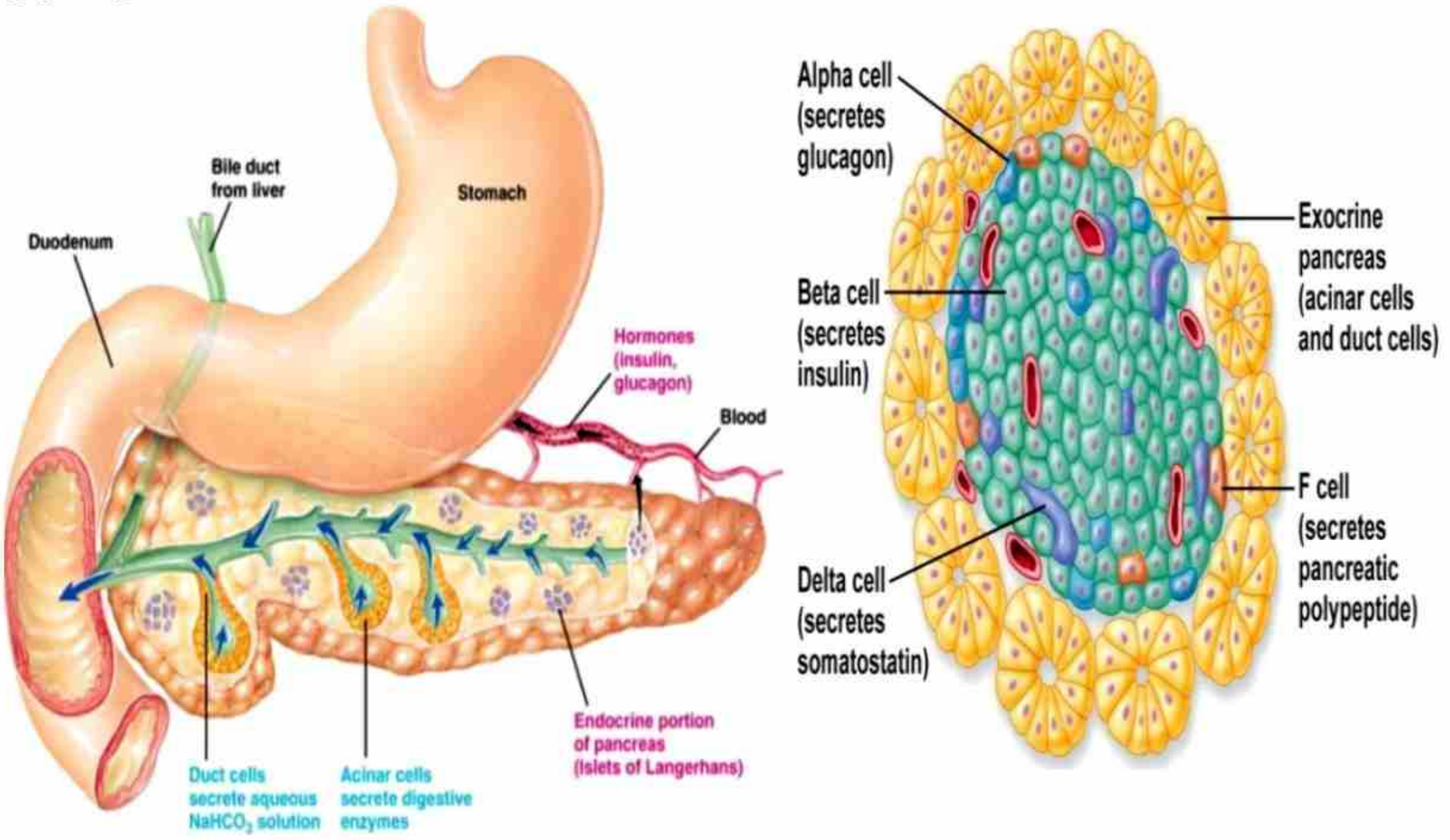


Fig.18.8 Pancreas and pancreatic cells

When blood glucose level drops (for example, after a person skips breakfast). Glucagon is released. It activates a liver enzyme that breakdown glycogen releasing glucose into the blood. It also promotes lipid breakdown, releasing fatty acids that are metabolized

for energy. Defect in insulin production, release or reception by target cells result in **diabetes mellitus**, a condition in which blood glucose levels are high and fluctuate wildly with sugar intake.

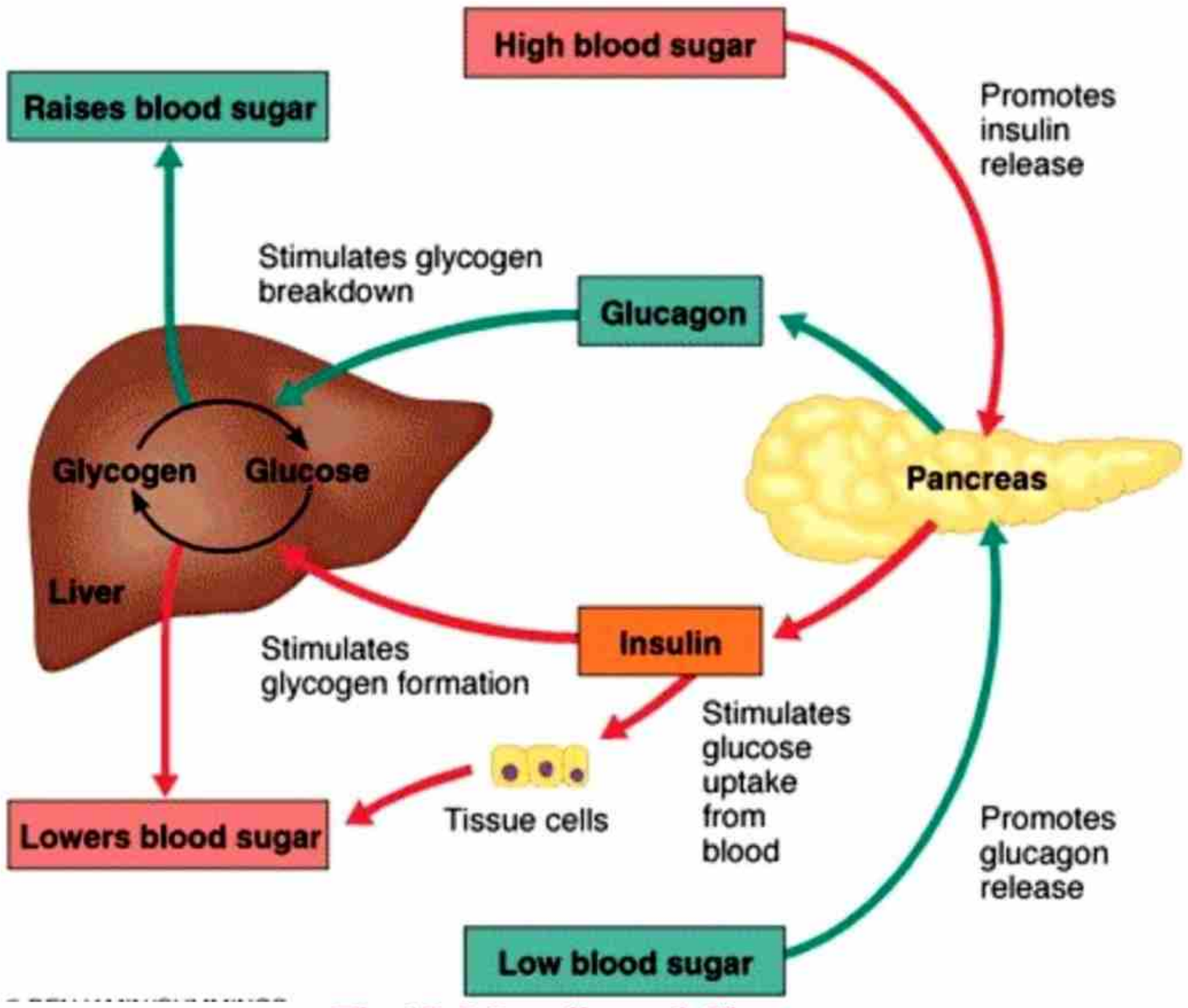


Fig.18.9 Insulin and Glucagon

The lack of functional insulin in diabetics causes the body to relay much more heavily on fats as an energy source, leading to high circulating level of lipids, including cholesterol. Severe diabetes causes fat deposits in the blood vessels, resulting in high blood pressure and heart disease. Fatty deposition in small vessels can also cause damage the retina of the eye, leading to blindness and the kidneys, leading to kidney failure.

Diabetes type-I: It is an autoimmune disorder i.e. the immune system attacks and destroys its own beta (β) cells, so that little or no insulin is produced, usually caused by body producing antibodies against β cells in islets of Langerhans. It is treated by using insulin injections to control blood sugar level.

Diabetes type-II: It is associated with genetic history, obesity, stress, lack of exercise and old age. In type II insulin is produced but the body cells (Target cells) do not respond to insulin, it can be controlled by adopting a low carbohydrate diet.

18.2.6 Adrenal gland

The adrenal glands are located just above each kidney. Each adrenal gland is composed to an inner portion, the **adrenal medulla** and an outer portion the **adrenal cortex**.

Adrenal medulla

The adrenal medulla (central part) produces two hormones **epinephrine** (adrenaline) and **nor-epinephrine** (nor-adrenaline) in response to stress. The actions of these hormones trigger "alarm" responses similar to those elicited by the sympathetic nervous system helping to prepare the body for extreme efforts among the effect of these hormones are an increased heart rate, increased blood pressure, dilation of bronchioles, elevation in blood glucose reduced blood flow to the skin and digestive organs and increased blood flow to the heart and muscles. The adrenal medulla is activated by the sympathetic nervous system which prepares the body to respond to emergencies.

Adrenal cortex

The hormones from the adrenal cortex are all steroids and are referred to collectively as corticosteroids. Many corticosteroids have been isolated from the adrenal cortex, the three main types are **glucocorticoids** such as cortisol, and the **mineralocorticoids** such as aldosterone and **Androgen**. Glucocorticoids or cortisol stimulates the breakdown of muscle protein into amino acids which are carried by the blood to

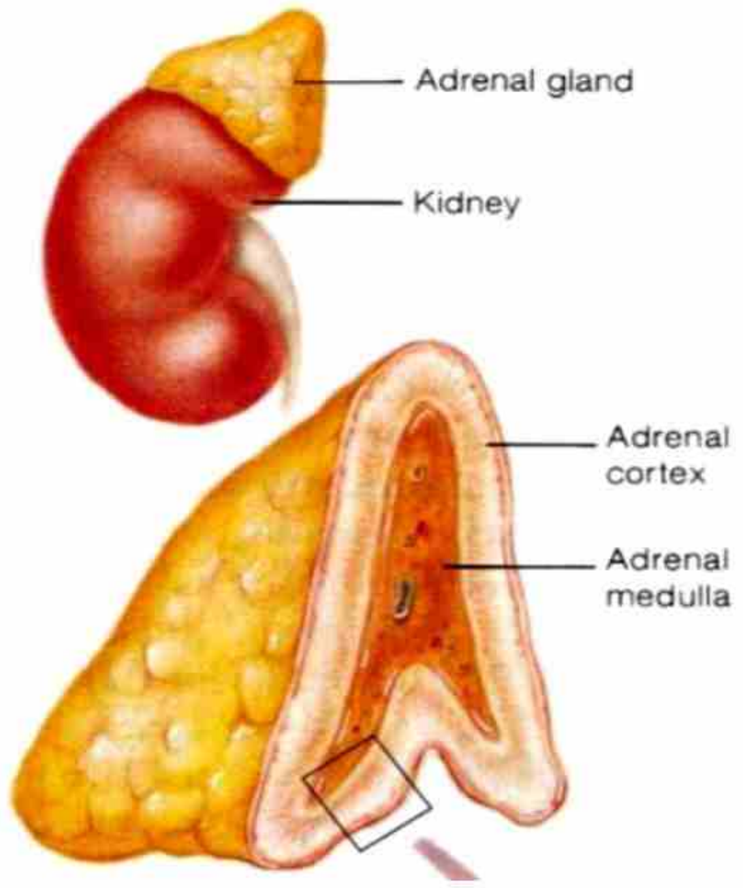


Fig.18.10 Adrenal gland

the liver. They also stimulate the liver to produce the enzymes needed for **gluconeogenesis** i.e. convert amino acids into glucose. Glucocorticoid release is stimulated by ACTH from anterior pituitary.

Cortico-releasing hormone (CRH), which is produced by the hypothalamus in response to stressful events including trauma, infection, or exposure to severe temperatures, in turn stimulates ACTH release. The glucocorticoid acts somewhat similarly to glucagon in that it stimulates the synthesis of glucose while encouraging the utilization of lipids rather than glucose for energy production. You may have observed that a variety of hormones, including thyroxin, insulin, glucagon, epinephrine, and glucocorticoids, are involved in the metabolism of glucose. This is likely due to the brain's need for certain nutrients during metabolism. While the majority of bodily cells can use both carbohydrates and fats and proteins to make energy, brain cells can only use glucose. Thus blood glucose levels cannot be allowed to fall too low, or brain cells rapidly starve leading to unconsciousness and death. Over secretion of cortisol cause **Cushing's syndrome** (Hypercortisolism). Symptoms of Cushing's syndrome are high blood pressure, weight gain, muscle wasting, weakened bones and mood swings. Low secretions of adrenal cortex hormone cause **Addison's disease**. Lack of cortisol results in a drop of glucose and high susceptibility to any kind of stress due to insufficient energy supply even a mild infection can cause death.

Aldosterone the other major corticosteroid is classified as a **mineralocorticoid** because it helps to regulate mineral balance. A primary action of aldosterone is to stimulate the kidneys to reabsorb sodium (Na^+) from the urine. Na^+ is needed to maintain blood volume and blood pressure. During low blood sodium level, the kidneys secrete an enzyme, the renin, which converts a plasma protein angiotensinogen to angiotensin-I. The latter is converted into angiotensin in the lungs, which stimulates adrenal cortex to release aldosterone this is called **Renin angiotensin-aldosterone system (RAAS)**. It affects the blood pressure in two ways, the angiotensin constricts the arteries and the aldosterone causes increased absorption of sodium.

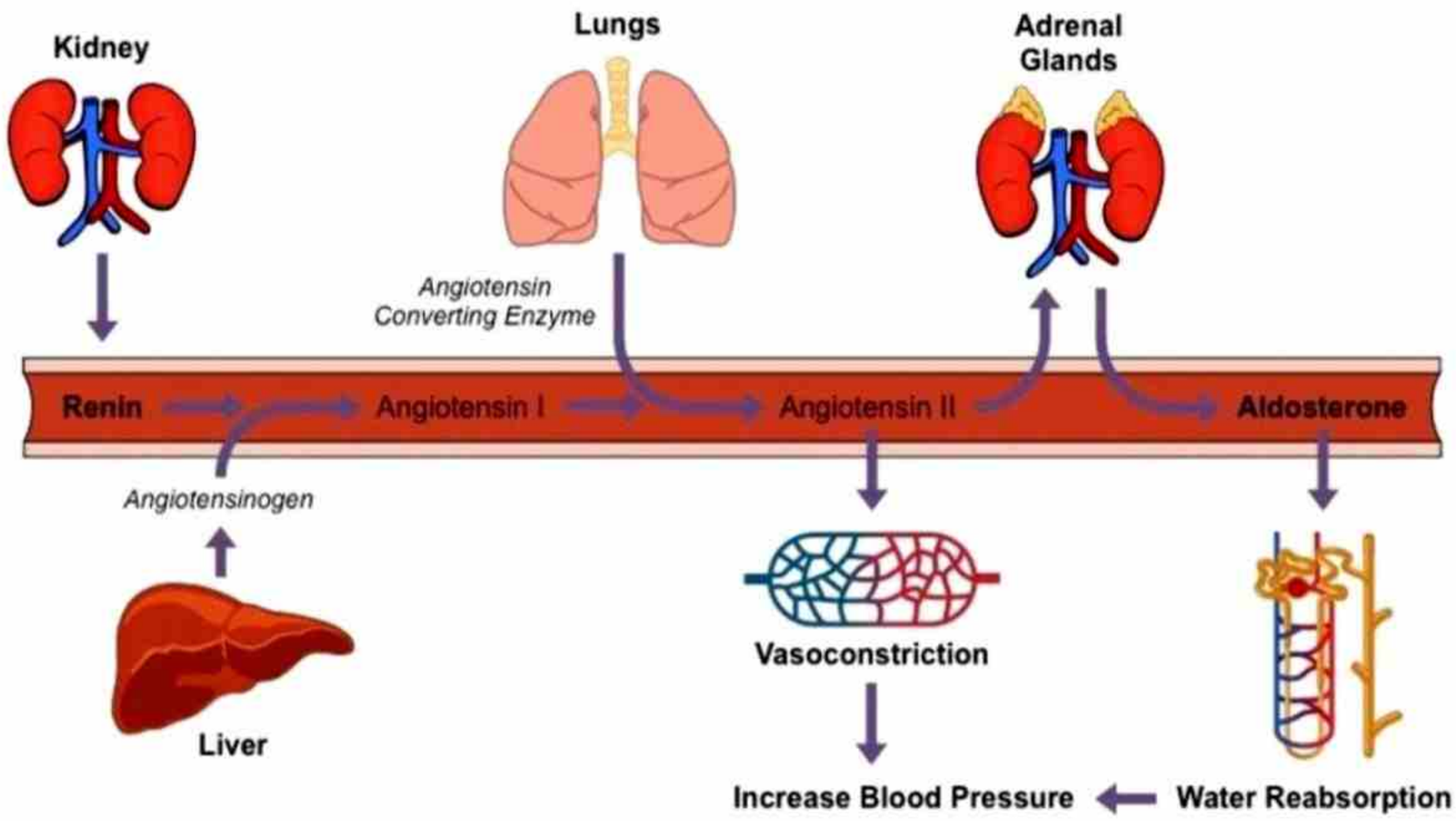


Fig.18.11 Renin- Angiotensin-Aldosterone system (RAAS)

A third group of corticosteroid are sex hormone mainly **androgen** similar to testosterone present in both male and female bodies. During adolescence level of androgen increases in both male and females, promote secondary sex characters in human male.

Extra Reading Material

Stress kicks the endocrine system into high gear

In response to stress, the endocrine system quickly secretes various hormones at higher-than-normal levels in order to help the body mobilize more energy and adapt to new circumstances. For example, the pituitary-adrenal axis starts releasing adrenaline to increase the volume of blood pumped out by the heart and the blood flowing to the skeletal muscles. And during acute physical stress, the pituitary gland may also ramp up the secretion of the growth hormone, which enhances metabolic activity. But prolonged or frequent stressful events can lead to a number of endocrine disorders, including Graves's disease, gonadal dysfunction and obesity.

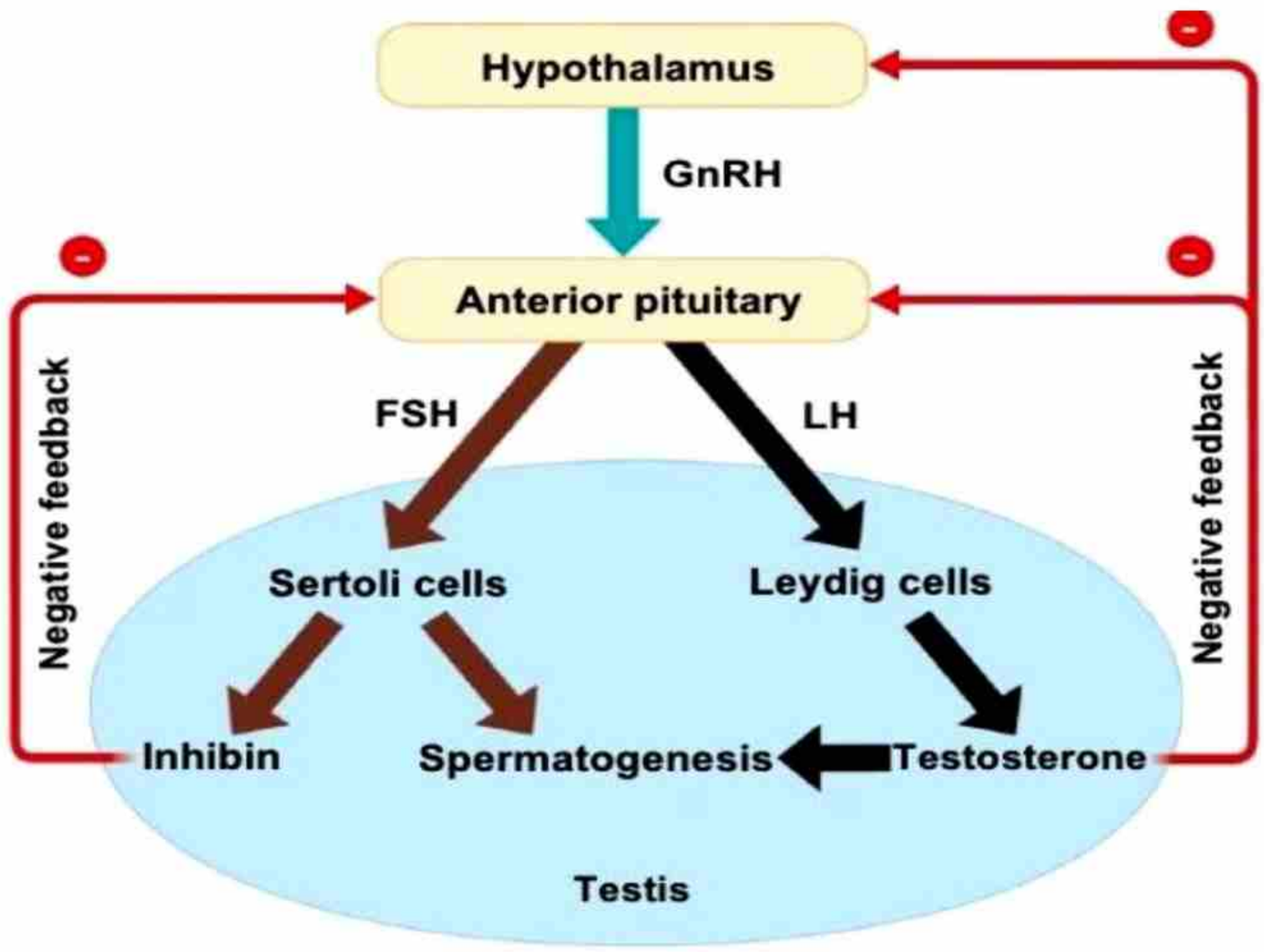
18.2.7 Gonads

The gonads produce and secrete three major categories of steroid hormones, a testosterone, estrogen and progesterone. All

three types are found in both males and females but in different proportions.

Testes

The testes are male gonads produce both sperm and male sex hormones. The anterior pituitary gland secretes gonadotropins, follicle stimulating hormone (FSH) and Luteinizing hormone (LH). FSH stimulates **sertoli cells** of testes to facilitate sperm development and LH stimulates **Leydig cells** of testes to release **testosterone**. Leydig cells of testes located in the interstitial tissues between the seminiferous tubules (site of sperm production) begin to secrete testosterone. It is produced early in the development of an embryo determine that fetus will develop as male rather than a female.



Testosterone produces both anabolic and androgenic effects in human males. Anabolic effects of testosterone include muscle mass, muscle strength, increased bone density, bone strength, linear growth and bone maturation. Androgenic effects of testosterone include maturation of sex organs, formation of scrotum in fetus, deepening of voice and growth of facial and axillary hairs.

Ovaries

The ovaries are female gonads, lie in the abdominal cavity produce both egg (ova) and female sex hormones. Ovaries secrete two lipophilic hormones **estrogen** and **progesterone**.

Estrogen contributes to the development and function of the female reproductive organs and promotes secondary sex characters which include development of breasts, fats distribution in hips, legs and breast, armpit and pubic hairs and **menarche** (start of menstrual cycle). Change in estrogen levels is encountered in various phases and involvement in female reproductive life and period of low estrogen are associated with mood swings, depression, headaches, and irregular periods and sleep problems.

Progesterone hormone of ovary helps in regulating menstruation and maintaining pregnancy in human females.

Extra Reading Material

Estrogen has about 400 functions in a woman's body. Such as regulate body temperature, improves blood flow, increases concentration, decreases wrinkling, risk of colon cancer, Parkinson's disease and Alzheimer's disease etc.

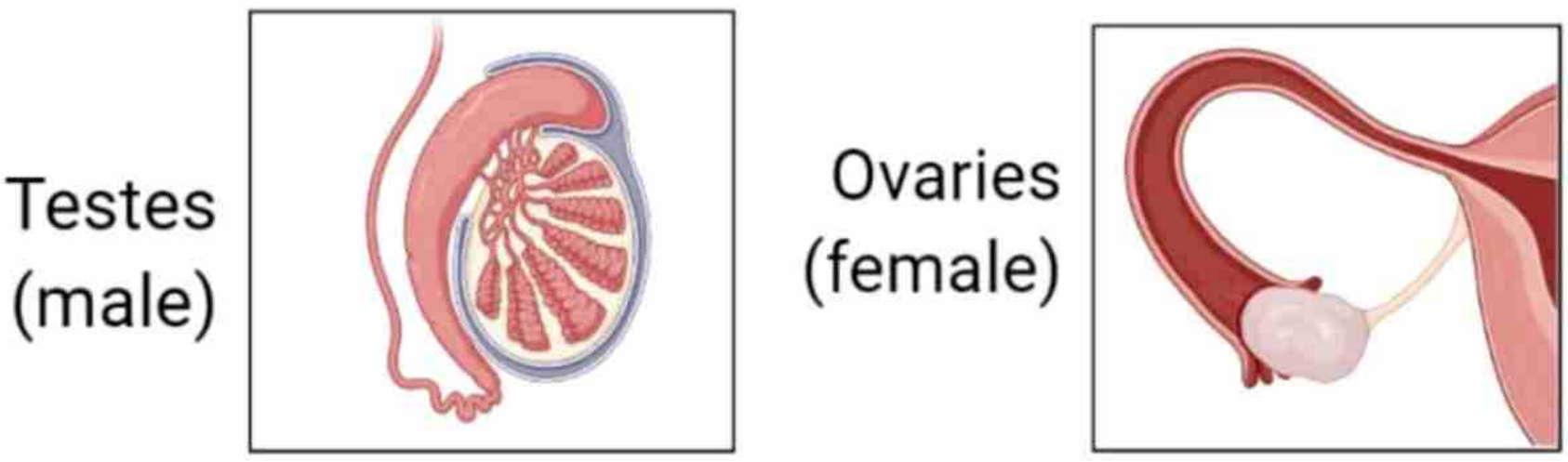


Fig.18.12. Gonads

18.2.7. Other endocrine tissues.

A variety of hormones produce from tissues within the body like digestive tract, kidney, heart and placenta. **Gastrin** a peptide hormone responsible for enhancing mucosal growth, gastric motility and secretion of hydrochloric acid (HCL) from walls of stomach.

Secretin a peptide hormone from duodenum regulates environment of stomach, pancreas and liver maintain pH to a more neutral to the basic state of the duodenum.

Cholecystokinin a peptide hormone from duodenum that stimulates gall bladder to contract and stimulates pancreas to release digestive enzymes. Some hormones are produce in kidney such as angiotensin and erythropoietin. **Angiotensin** regulates blood pressure. **Erythropoietin** stimulates red blood cell synthesis in bone marrow. Human heart also produce hormone like **atrial natriuretic hormone**. It increases salt and water excretion to reduce blood pressure. **Prostaglandins** are lipophilic hormone from every tissue of the body involved in dealing with inflammation, blood flow and protection from injury. Placenta an endocrine tissue release variety of hormones during pregnancy like **human chorionic gonadotropin (HCG)** and **progesterone**. Human brain releases endorphins hormone involved in pain relief.

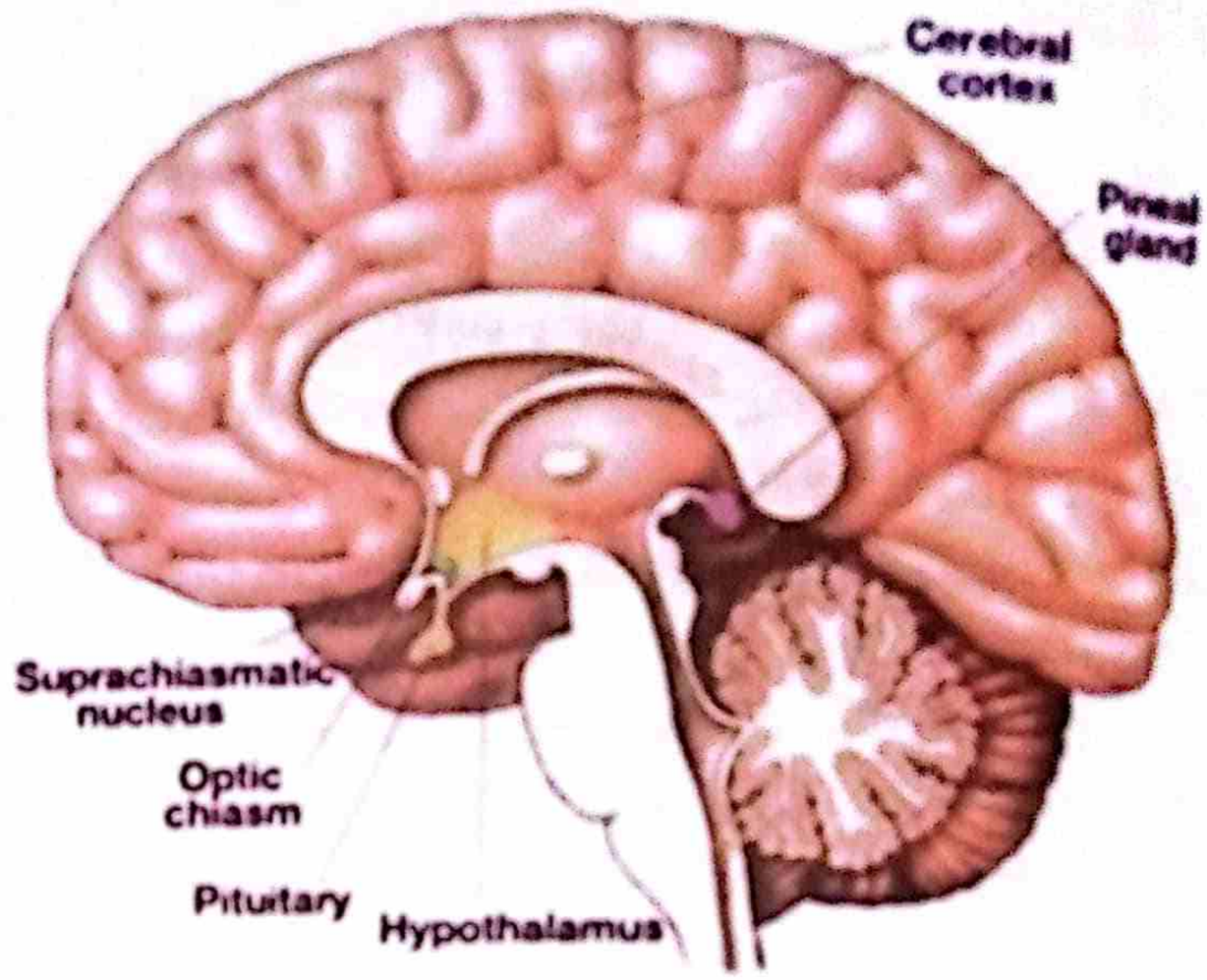


Fig.18.13 Pineal gland

18.3 FEEDBACK MECHANISM

Chemical co-ordination or most of bodily functions are regulated by a series of complex feedback mechanism. These mechanism works like a thermostat that responds to temperature

Extra Reading Material

The pineal gland evolved from medial light-sensitive eye (sometimes called a "Third Eye" although it could not form images). It is located between the two hemispheres of the brain. Just above and behind the brainstem. Named for its resemblance to a pine cone, the pineal is smaller than a pea. In 1646, the Philosopher Rene Descartes described it as the seat of "the rational soul". It secretes melatonin a modified amino acid hormone that regulates circadian rhythms.

changes by telling a furnace to turn on and off. Endocrine gland reacts to changes in hormonal level in the blood in much the same way that a thermostat reacts to temperature changes. If there are not enough hormones circulating in the blood, the gland makes more, increasing blood hormonal level. If there is too much hormone, the glands stop producing it leading to lower blood hormone levels. There are two mechanisms exist to maintain blood hormonal level positive and negative feedback mechanism.

18.3.1 Positive feedback mechanism

Positive feedback mechanism is rare in endocrine system, only few hormones are regulated by positive feedback. A positive feedback mechanism in endocrine system is when release of a hormone initiates action that leads to an additional release of that hormone. **Oxytocin** is one of the few hormones regulated by a positive feedback mechanism. In both childbirth and breastfeeding, oxytocin is released and causes additional release of oxytocin. During childbirth, release of oxytocin results in uterine contractions, and uterine contractions causes additional oxytocin to be released. During breastfeeding, oxytocin is released which allows for milk ejection. Milk ejection causes more oxytocin to be released.

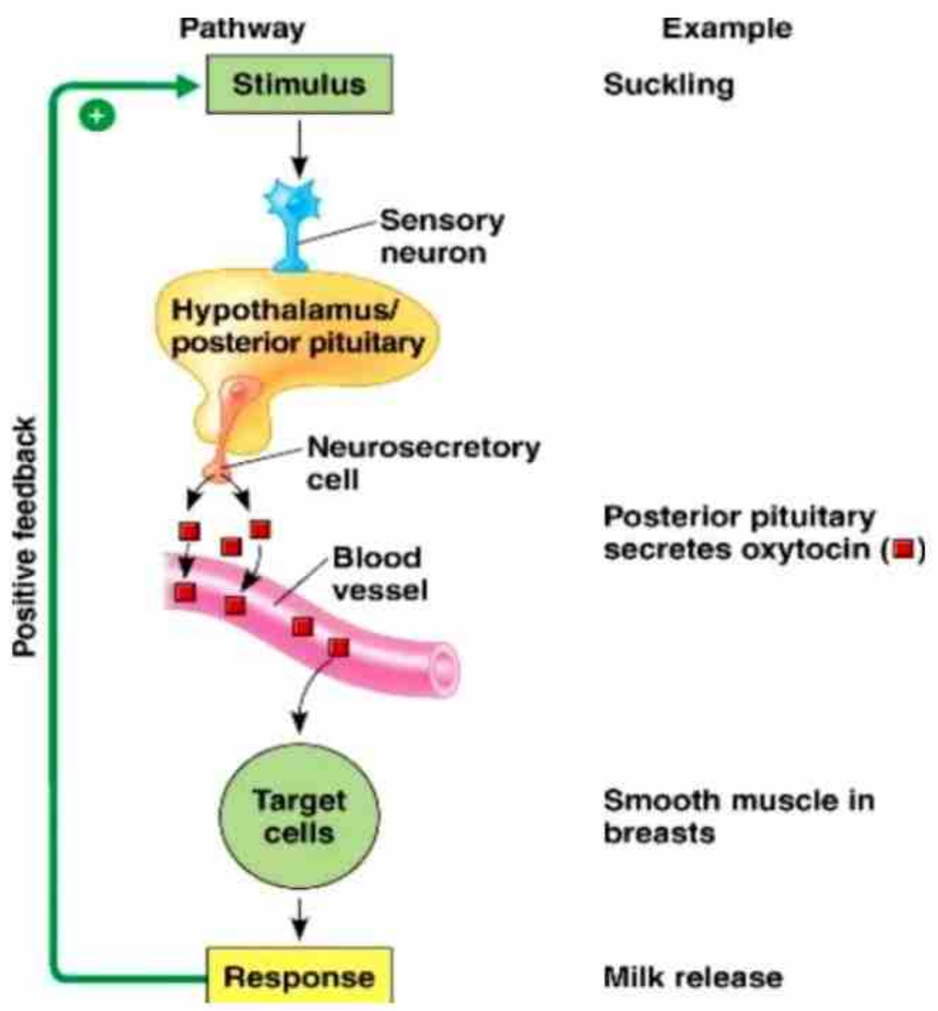


Fig.18.14. Positive feedback

18.3.2 Negative feedback mechanism

A negative feedback mechanism is one way that the endocrine system tries to keep homeostasis (stability) in the body. If an endocrine gland senses that there is too much of one hormone in the body, it will initiate changes to decrease production of that hormone,

and if there's not enough of the hormone, the body will increase production of that hormone.

The control of blood sugar (glucose) by **insulin** is a good example of a negative feedback mechanism. When blood glucose rises, receptors in the blood vessels sense a change. In turn the control center stimulates pancreas to secrete insulin into the blood effectively lowering blood glucose levels. Once blood glucose level reaches homeostasis, the pancreas stops releasing insulin.

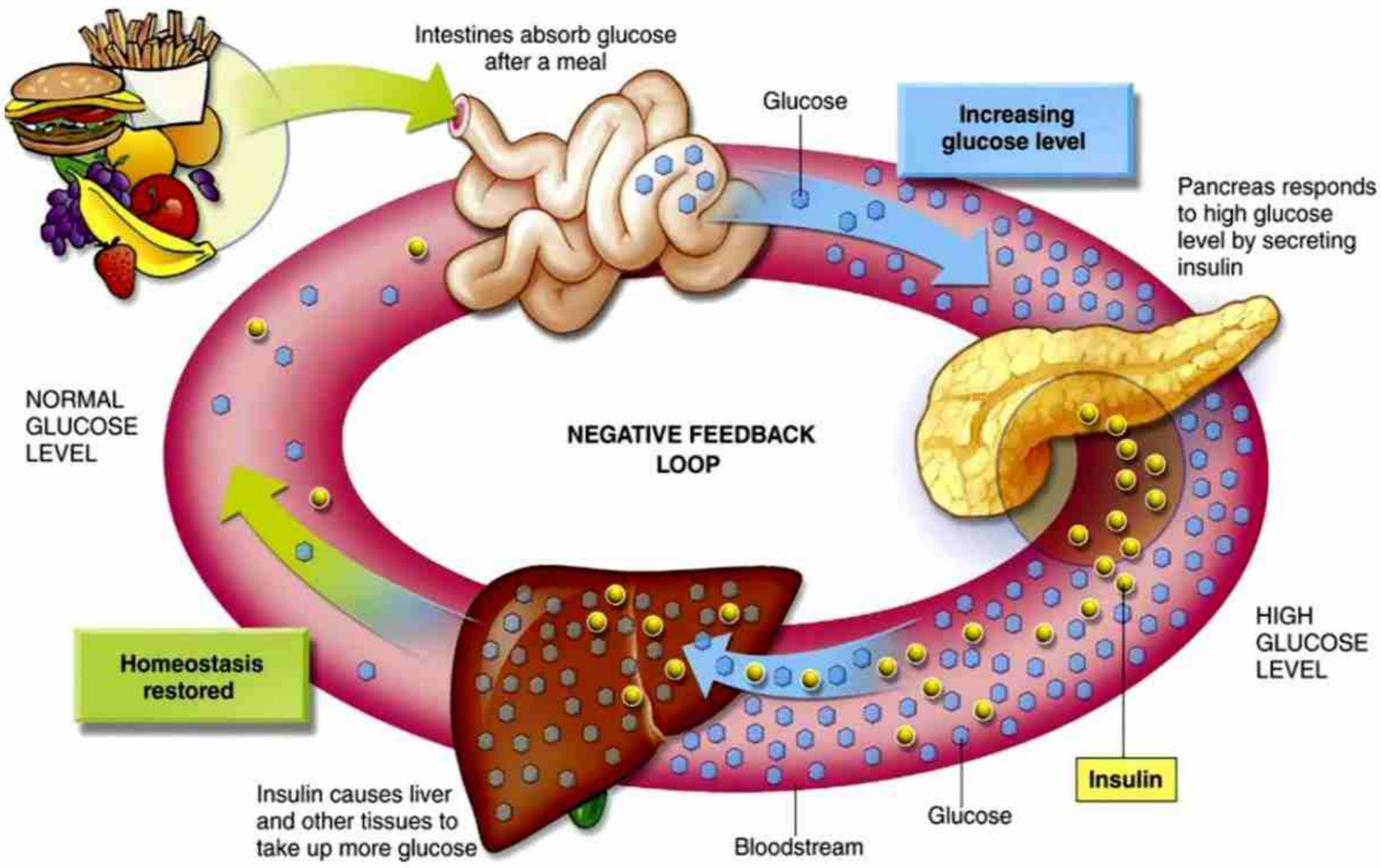


Fig.18.15. Negative feed back

SUMMARY

- Cell-to-cell communication is crucial to the control of movement, growth, reproduction, and the maintenance of homeostasis.
- A hormone is a chemical messenger that is secreted by specialized tissues called glands.
- Short chain amino acid hormones are called peptide hormones and Long chain amino acid hormones are called protein hormones.
- Hormones specificity is determined by receptors on target cells.
- Hormones may be categorized as hydrophilic and lipophilic.
- Hypothalamus is a part of the brain that contains clusters of specialized cells called neurosecretory cells.
- Thyroid gland is located at the base of neck in front of tracheae.
- Isthmus binds the two lobes of thyroid gland.
- Thyroid gland produce three major hormones T3, T4 and calcitonin.
- Parathyroid glands are four small glands attached to the back of thyroid gland.
- Pancreas is located adjacent to the stomach; it performs both endocrine and exocrine functions.
- Defect in insulin production release or reception by target cells result in diabetes mellitus.
- Lack of functional insulin in diabetes causes the body to relay much more heavily on fats as an energy source, leading to high circulating level of cholesterol.
- Adrenal glands are located just above each kidney. Each adrenal gland is composed to an inner portion, the adrenal medulla and an outer portion the adrenal cortex.
- Adrenal medulla produces two hormones epinephrine and nor epinephrine in response to stress.
- Hormones from the adrenal cortex are all steroids and are referred to collectively as corticosteroids.
- Testes are male gonads produce both sperm and male sex hormones.
- Testosterone produces both anabolic and androgenic effects in human males.

- Ovaries are female gonads produce both egg and female sex hormones.
- Placenta an endocrine tissue release variety of hormones during pregnancy like HCG and progesterone.

EXERCISE

1. Encircle the correct choice.

i) Which of the following statements about hormones is incorrect?
(a) They are produced by endocrine glands.
(b) They are modified amino acids, peptides or steroid molecules.
(c) They are carried by the circulatory system.
(d) They are used to communicate between different organisms.

ii) Oxytocin and ADH are produced by the _____ and stored in the ____.
(a) Hypothalamus; Neurohypophysis
(b) Adenohypophysis; Kidneys
(c) Adrenal cortex; Adrenal medulla
(d) Posterior pituitary; Anterior pituitary

iii) Tropic hormones from the anterior pituitary directly affect the release of which of the following?
(a) Parathyroid hormone (b) Calcitonin
(c) Epinephrine (d) Thyroxine

iv) Which of the following endocrine disorders is /are not correctly matched with the malfunctioning gland?
(a) Diabetes → Pancreas (b) Giantism → Pituitary
(c) Goiter → Adrenal medulla (d) Tetany → Parathyroid

v) Which hormone exerts antagonistic action to PTH?
(a) Thyroxin (b) Calcitonin
(c) Growth hormone (d) Epinephrine

vi) Which of the following are synthesized from the amino acid tyrosine?
(a) Epinephrine (b) Catecholamines
(c) Thyroxin (d) All of the following

vii) If the adrenal cortex were removed, which group of hormones would be most affected?
(a) Steroid (b) Peptide
(c) Tropic (d) Amino acid derived

viii) Which of the following hormones is (are) secreted by the adrenal gland in response to stress and promote(s) the synthesis of glucose from non-carbohydrate substrates?
(a) Glucagon (b) Glucocorticoids
(c) Epinephrine (d) Thyroxin

ix) Which of the following stimulates the contraction of uterine muscle?
(a) Oxytocin (b) Thyroxin
(c) Growth hormone (d) Insulin

x) A distinctive feature of the mechanism of action of thyroid hormones and steroid hormones is that
(a) These hormones are regulated by feedback loop
(b) These hormones bind with specific receptor protein on the plasma membrane of target cells.
(c) These hormones bind to receptors inside cells
(d) Target cells react more rapidly to these hormones than to local regulators.

2. Write short answers of the following questions:

i) Why hydrophilic hormones need secondary messengers?
ii) Why hormones are called chemical messengers?
iii) Why posterior pituitary is called neurohypophysis?
iv) Enlist hormones of anterior pituitary?
v) Why pancreas is called as exocrine and endocrine gland?
vi) Why secretions of adrenal cortex are called corticosteroids?
vii) Differentiate between following
(a) Hypothyroidism and Hyperthyroidism
(b) Insulin and glucagon
(c) Calcitonin and Parathyroid hormone
(d) Lipophilic and hydrophilic hormones
viii) Define following terms
(a) Hormones (b) Goiter (c) Thymosin
(d) GnTH (e) Atrial natriuretic hormone (f) Erythropoietin

3. Write detailed answers of the following questions:

i) Define hormone? Describes hormone action with the help of suitable diagram.

ii) Explain pituitary gland their lobes and hormones of pituitary glands.

iii) Explain position and physiology of adrenal gland.

iv) Describe hormones and their functions of other endocrine tissues.

v) Describe mechanism of positive feedback.