Endocrine system

1. General data on endocrine system
2. Morphofunctional characteristic of the endocrine glands
3. Development of the endocrine glands
4. Diseases of endocrine system

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Characteristics of the endocrine system

- The endocrine system functions in the regulation of body activities.

- It acts through chemical messengers called hormones that influence growth, development, metabolic activities.

- Its action is measured in minutes, hours, or weeks & is more generalized than the action of the nervous system.

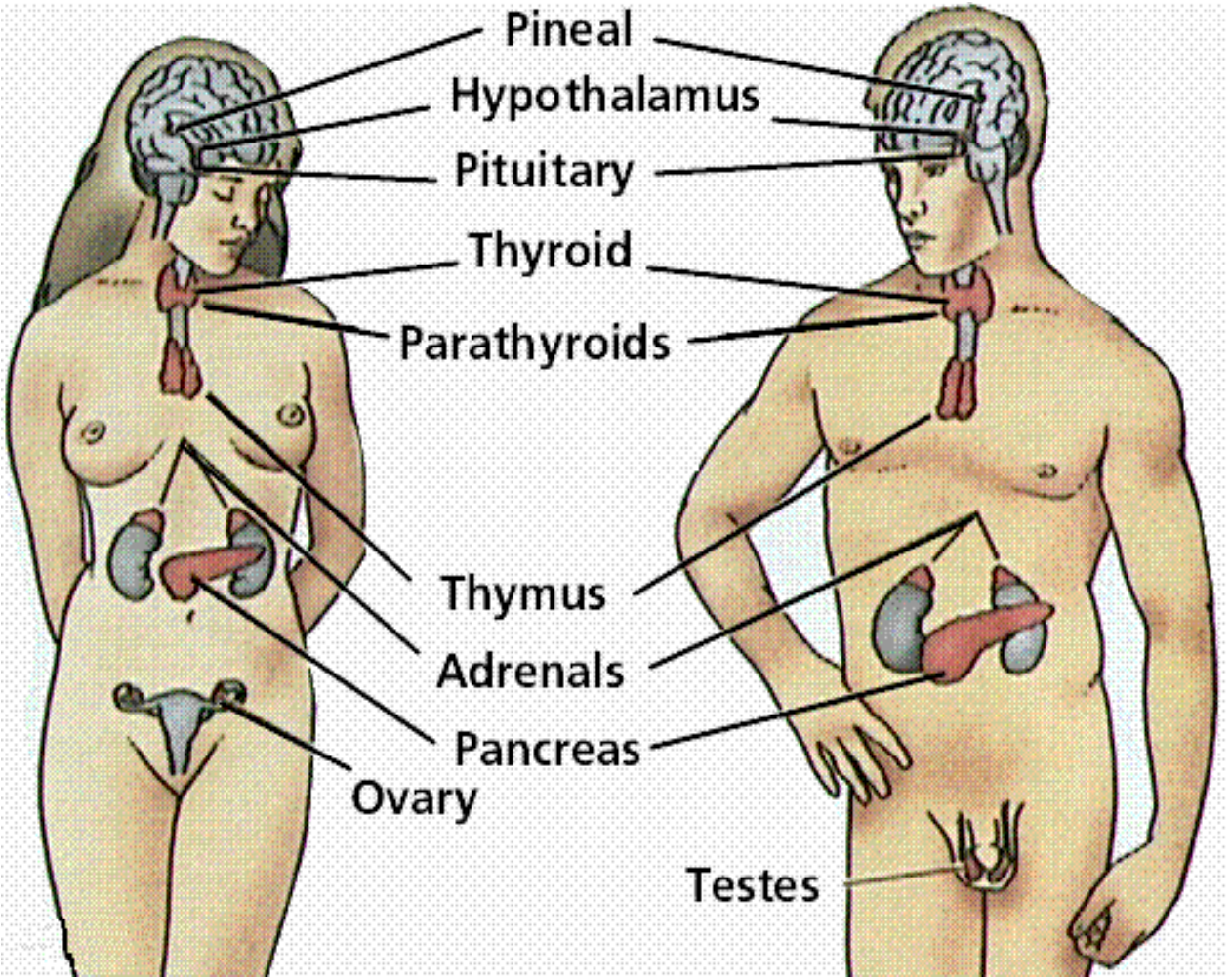
Endocrine system includes two groups of organs:

Discrete organs:

Hypophysis cerebri,
Thyroid gland
Adrenals
Parathyroids
Thymus
Pineal body

Compound organs:

Pancreas
Hypothalamus
Gonads (testes and ovaries)
GI tract
Obscure (placenta, liver, spleen)



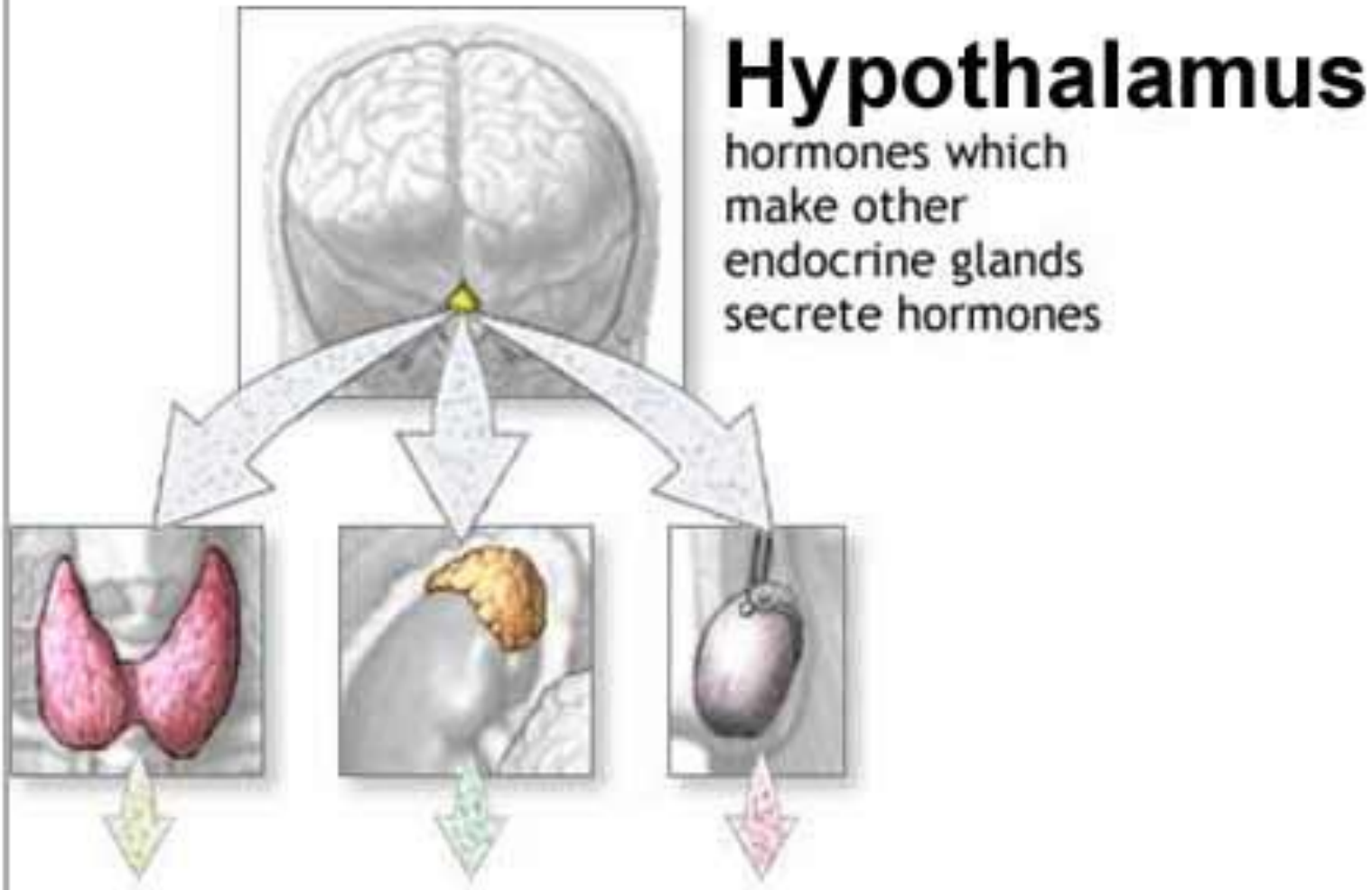
Common features of the endocrine glands

1. Superior blood supply: fenestrated capillaries on at least one side
2. Ductless glands
3. Cells organized in “chuks”: blocks, islets, plates, cords (liver?)
4. Epithelial in origin (two exceptions)
5. Polyhedral cells with round nucleus
6. Plentiful organelle content (indicates syntheis)

Chemical messengers: abridged and reorganized

Amino acid derivatives:
Epinephrine, norepinephrine, thyroxine
Small peptides:
Encephalin, vasopressin, TRH (thyrotropin releasing hormon)
Proteins: nerve growth factor, insulin, parathormone, TSH (Thyroid-stimulating hormone), EGF (Epidermal growth factor)
Steroids: cortisol, progesterone, testosterone, estradial

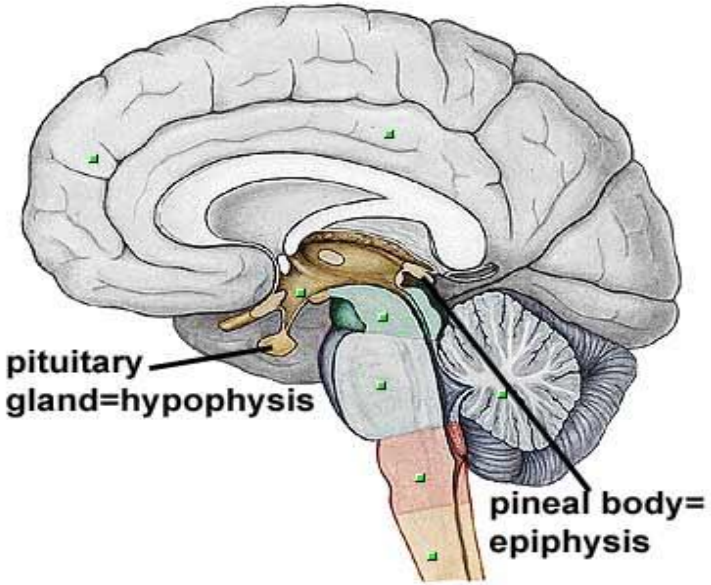
The endocrine system and the nervous system are so closely associated that they are collectively called the neuroendocrine system. Neural control centers in the brain control endocrine glands. The main neural control center is the hypothalamus, also known as the "master switchboard." Suspended from the hypothalamus by a thin stalk is the pituitary gland. The hypothalamus sends messages to the pituitary gland; the pituitary gland, in turn, releases hormones that regulate body functions.



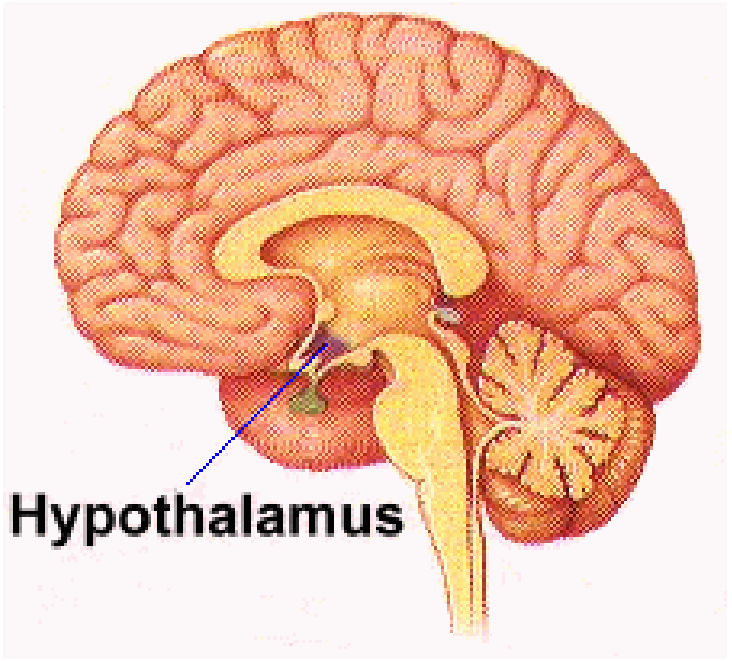
Endocrine glands of the region of the brain

- The **epiphysis cerebri** (also called the ***pineal body,*** is a part of the epithalamus.
- It is a reddish-grey, approximately 5 – 8 mm long, pine cone-like structure.
- It consists in humans of a lobular parenchyma of pinealocytes (but four other cell types have been identified) surrounded by connective tissue spaces.
- The gland's surface is covered by a pial capsule.
- It produces melatonin having various functions in the the central nervous system, the most important of which is to help modulate sleep patterns.

- Research on mice suggests that changes in the function of the pineal gland might affect bone metabolism. Postmenopausal women are significantly more vulnerable to osteoporosis than other groups.
- Melatonin may block the pituitary gland from secreting hormones that play essential roles in the development of the ovaries and testes and regulate functions such as the menstrual cycle.
- Older research suggests that the pineal gland can alter the behavior of the pituitary gland.
- Sleep and mental health are inextricably linked. Sleep deprivation can cause or worsen some mental health conditions.
- Pineal gland function tends to decline with age.

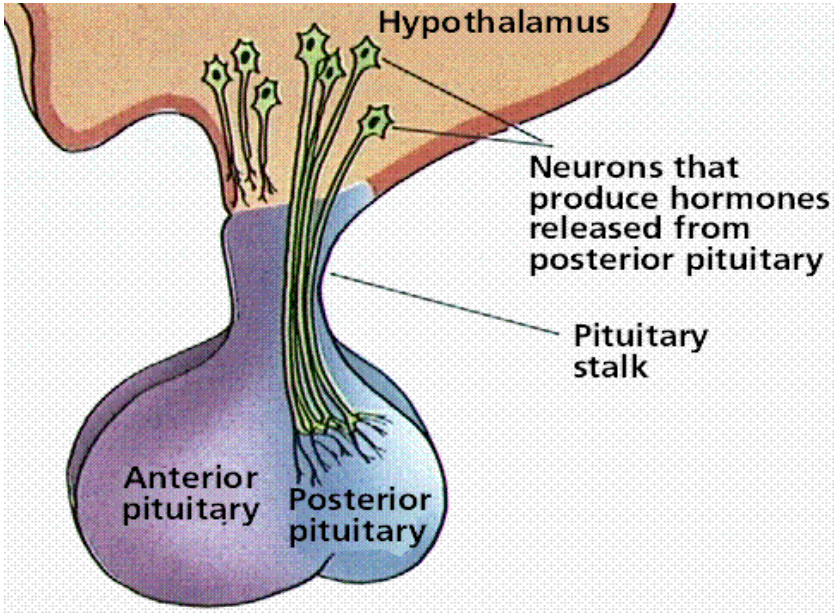


- The **hypothalamus** is a small region of the brain located at the base of the brain.
- While it's very small, the **hypothalamus** plays a crucial role in many important functions, including: releasing hormones, regulating body temperature.
- The hypothalamus controls body temperature, hunger, important aspects of parenting and attachment behaviours, thirst, fatigue, sleep, and circadian rhythms (it is a roughly 24 hour cycle in the physiological processes of living beings).
- One of the most important functions of the hypothalamus is ***to link the nervous system to the endocrine system via the pituitary gland.***
- The hypothalamus regulates the body's water content and the level of glucose in the blood;
- It is involved in motivation of sexual behavior, and in determining mood and emotions.



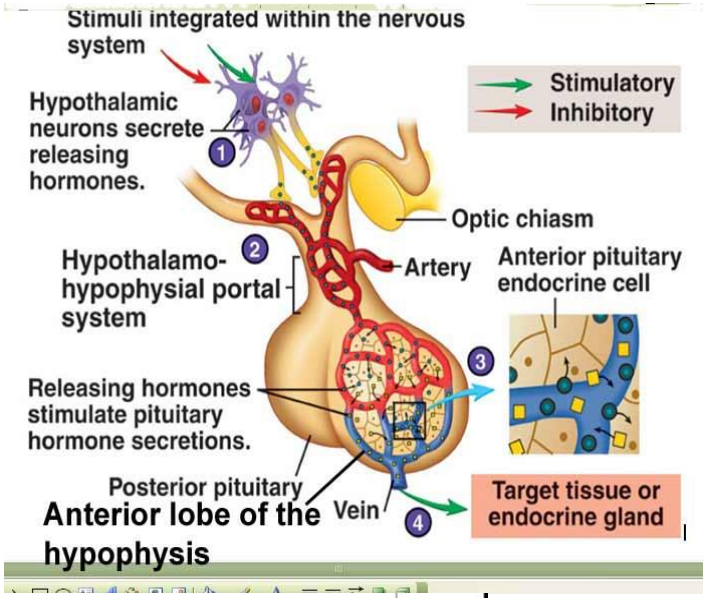
Pituitary gland (hypophysis)

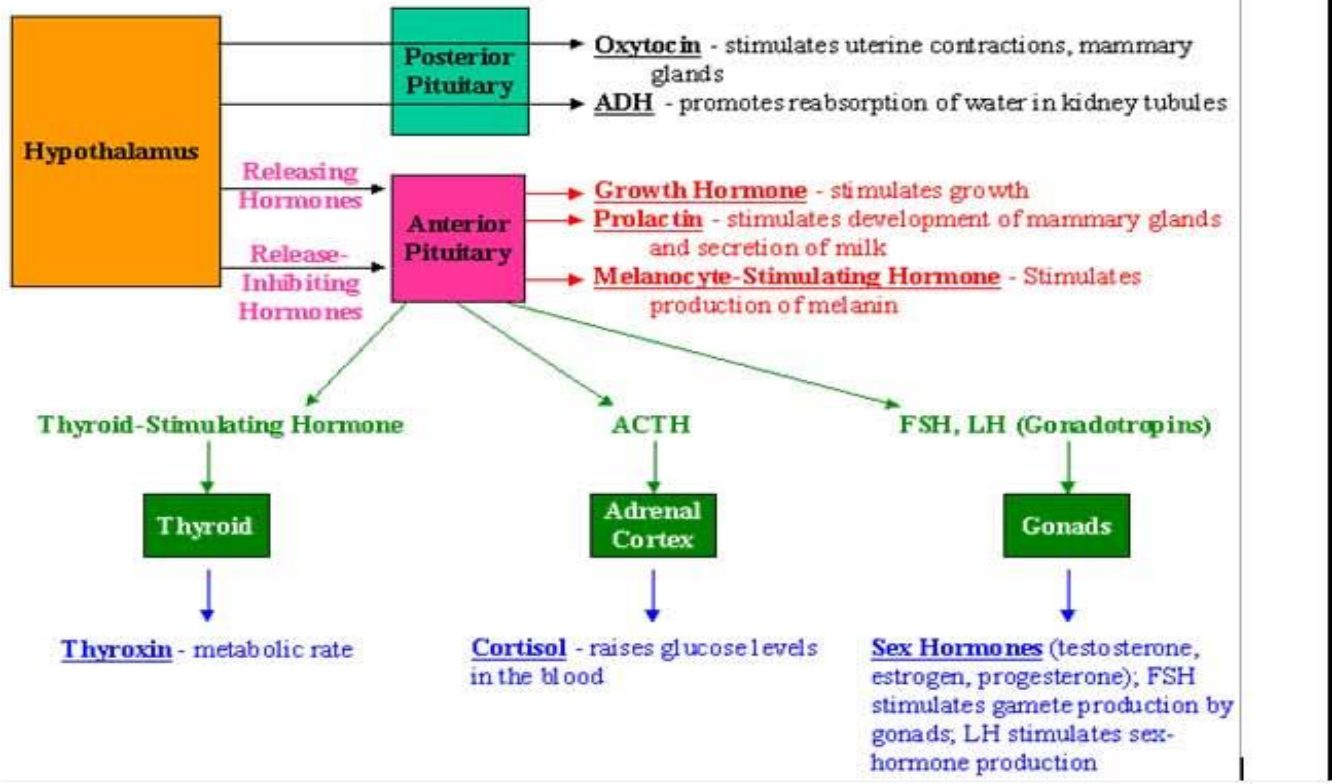
- The **pituitary gland** is a tiny organ, the size of a pea, found at the base of the brain.
- It sits within the sella turcica of the sphenoid bone.
- As the "master **gland**" of the body, it produces many hormones that travel throughout the body, ***directing certain processes*** or ***stimulating other glands*** to produce other hormones.
- Between the ***two lobes*** is ***an intermediate lobe*** (pars intermedia). This intermediate lobe is almost non-existent in the adult, although it may increase in size during pregnancy.



Pituitary gland (hypophysis)

Anterior pituitary	Posterior pituitary
Hormones produced and released:	**Hormones released:**
Thyrotropin Adrenocorticotropin Luteinizing hormone Follicle-stimulating hormone	Oxytocin Vasopressin
Growth hormone Prolactin Melanocyte-stimulating hormone Endorphins Enkephalins	





Two groups of glands are distinguished ***according to relation with hypophysis*.**

I. ***Pituitary dependent glands*** (thyroid, adrenal glands, gonads).

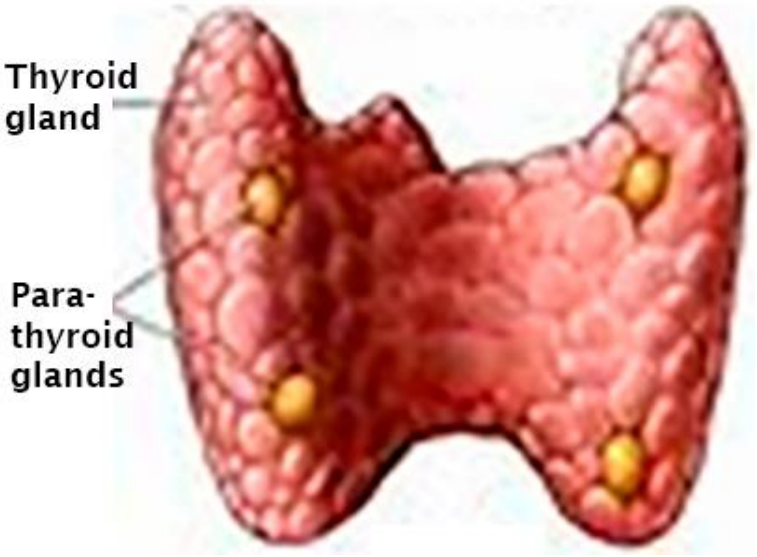
II. ***Pituitary non - dependent glands*** (pineal gland, thymus, pancreas).

Glands producing hormones are divided into two groups *according to their structure*:

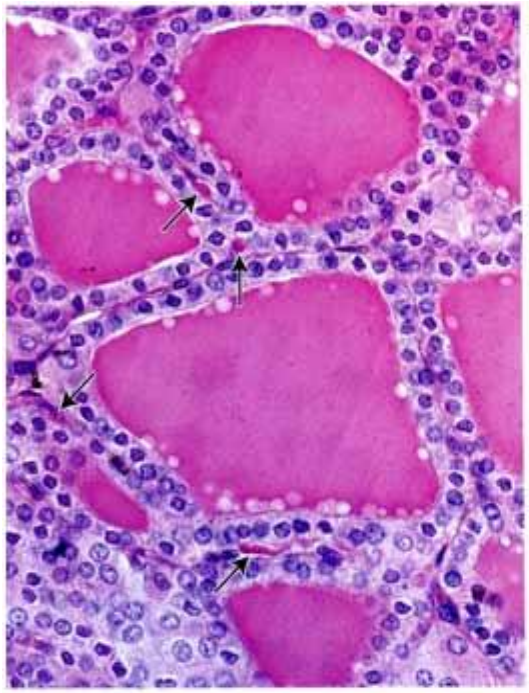
I. ***Endocrine glands*** **–** glands without the ducts (pituitary, thyroid, adrenal etc.).

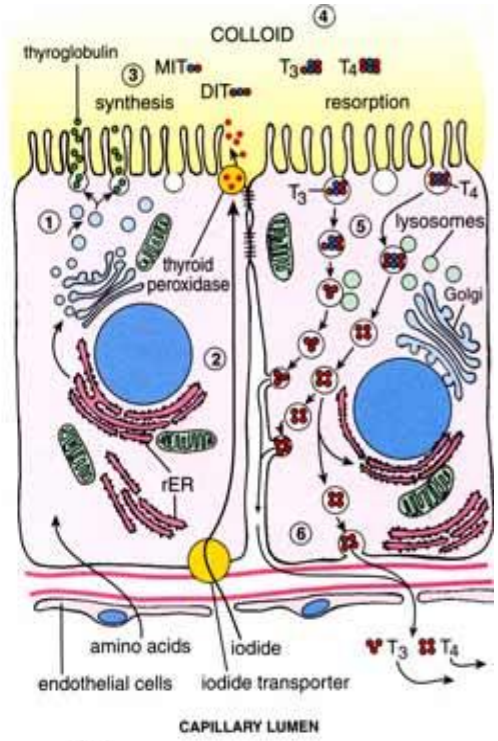
II. Mixed glands **–** glands consisting of two parts: endocrine and exocrine (pancreas).

Thyroid and parathyroid glands



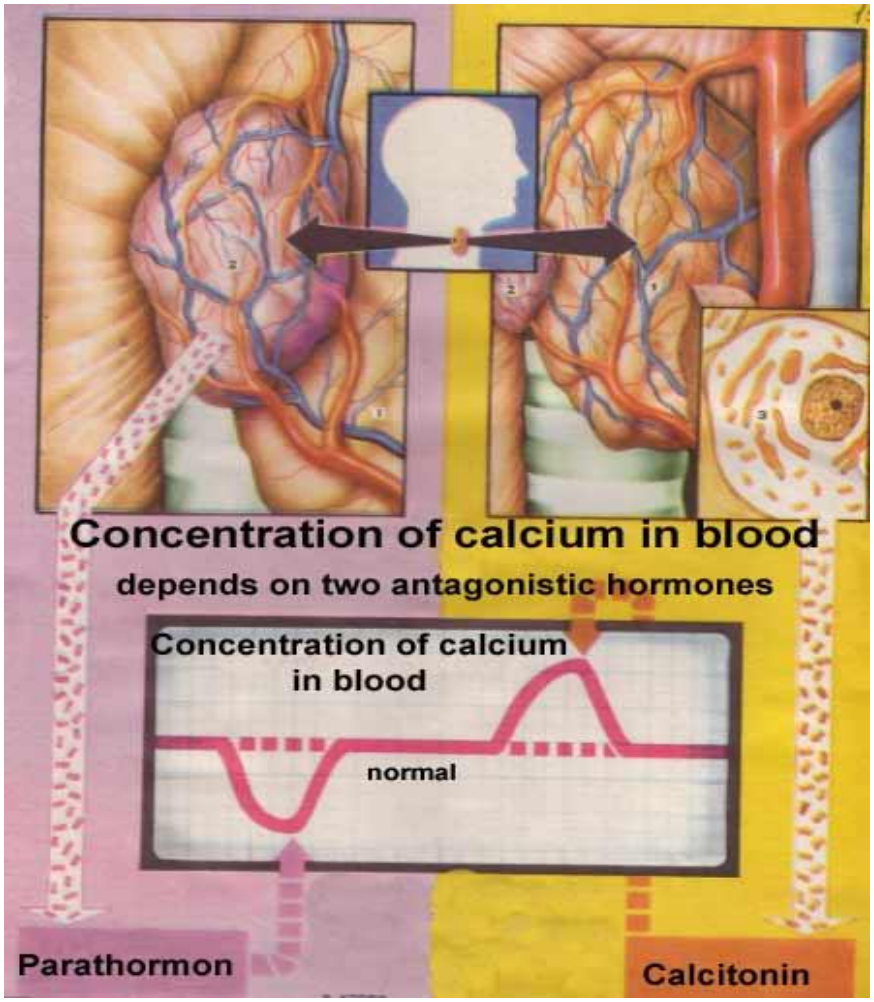
Four disc-like parathyroid glands embedded in the thyroid gland (dorsal surface)





Thyroid gland secretion

Most of the thyroid **tissue** consists of the ***follicular cells***, which secrete the iodine-containing thyroid hormones.
They consist of ***thyroxine (T4) and triiodothyronine (T3).***
The ***parafollicular cells*** secrete the hormone ***calcitonin***. In humans, calcitonin has only a minor role in calcium regulation.



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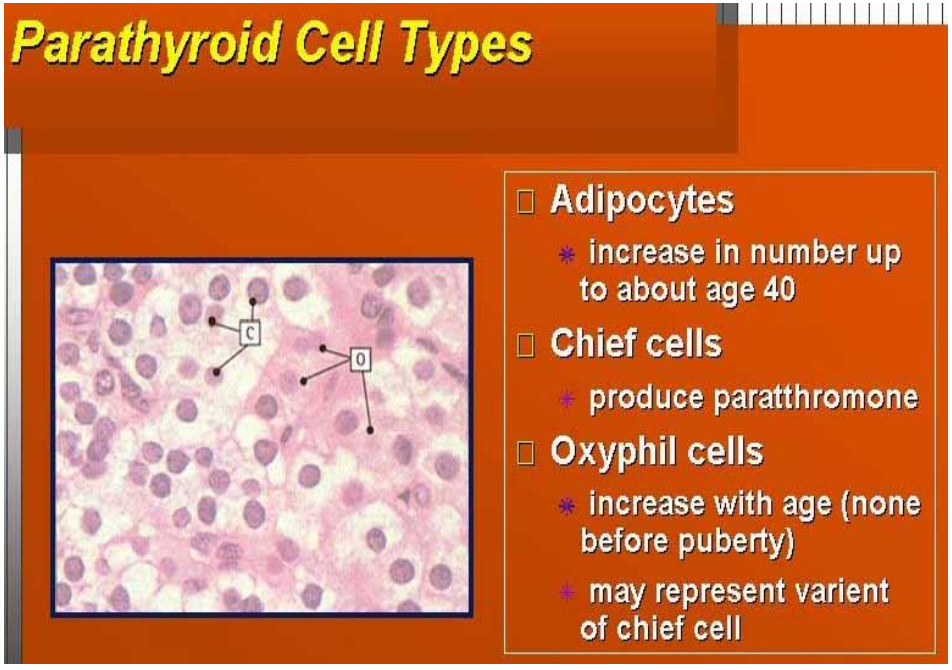
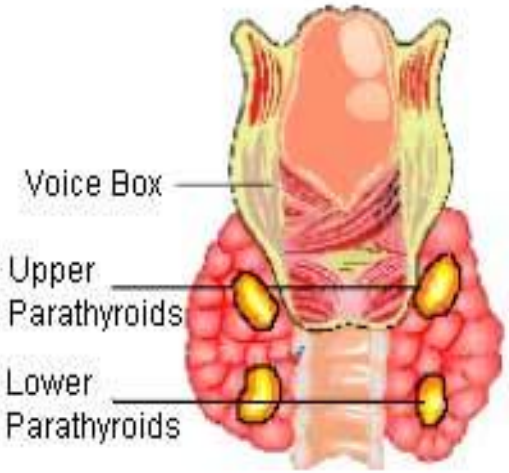
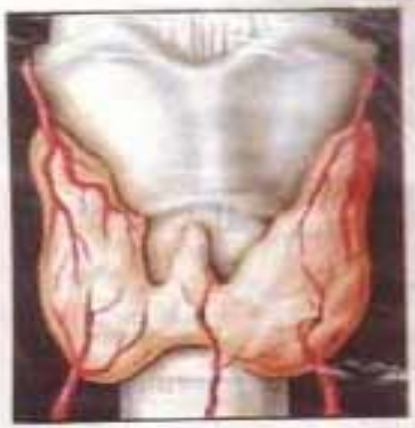
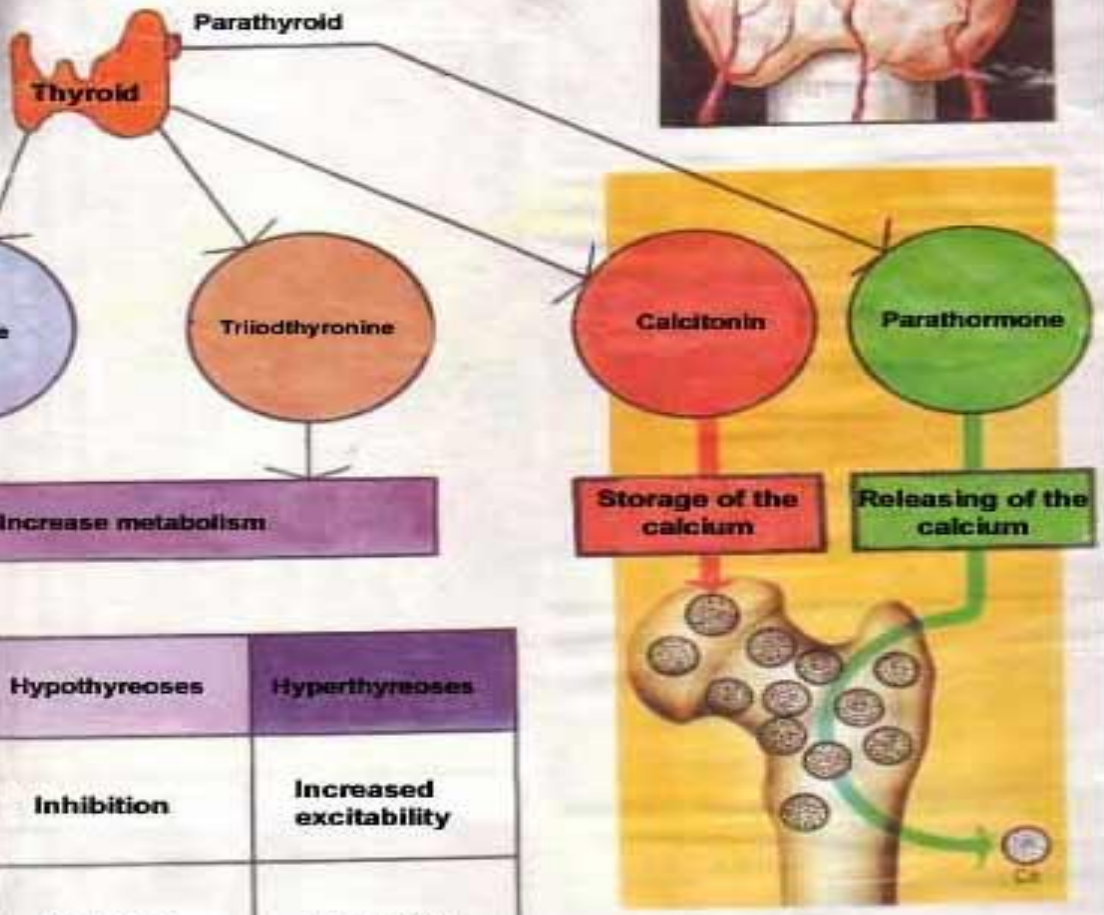


Action of thyroid and parathyroid hormons



Parathyroid glands

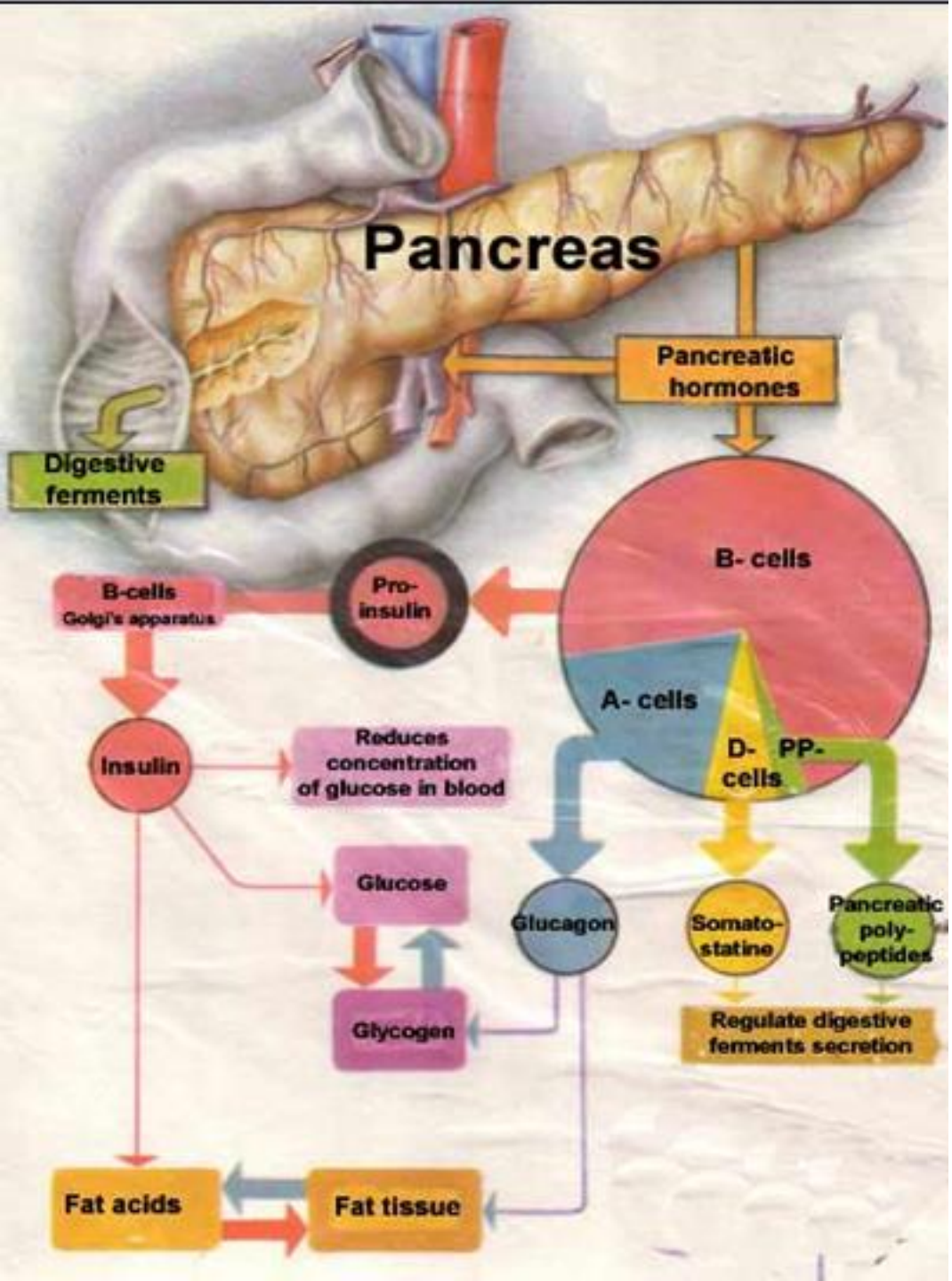




	Hypothyreoses	Hyperthyreoses
CNS	Inhibition	Increased excitability
Temperature	Reduced	Increased
Skin	Drying	Abundent perspiration

Thymus

- ✓ The **thymus** serves a vital role in the training and development of T-lymphocytes or T cells, an extremely important type of white blood cell.
- ✓ T cells defend the body from potentially deadly pathogens such as bacteria, viruses, and fungi.
- ✓ The thymus produces and secretes ***thymosin***, a hormone necessary for T cell development and production.
- ✓ The thymus is special in that, unlike most organs, it is at its largest in children. Once you reach puberty, the thymus starts to slowly shrink and become replaced by **fat**.



Almost all of the pancreas (95%) consists of exocrine tissue that produces pancreatic enzymes for digestion.

The remaining tissue consists of endocrine cells called ***islets of Langerhans.***

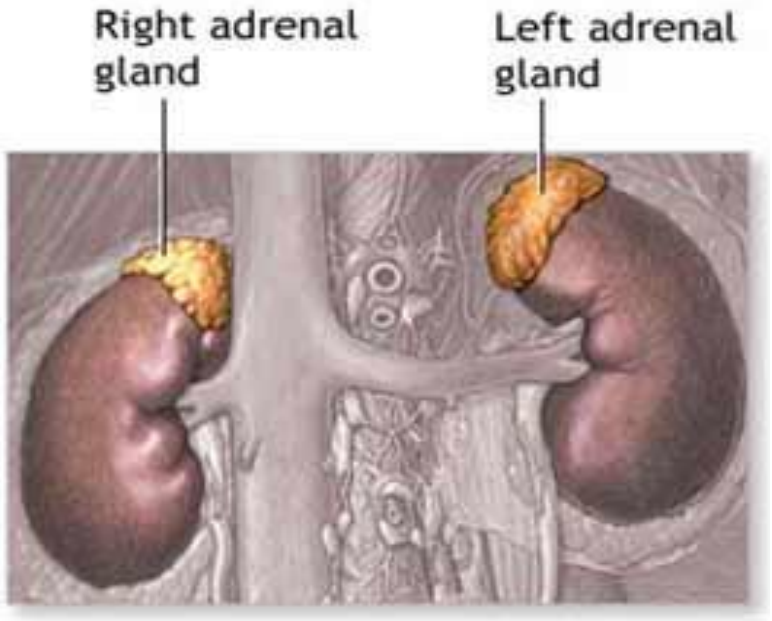
Two of the main pancreatic hormones are ***Insulin*** (B cells), which acts to lower blood sugar, and ***glucagon*** (A cells), which acts to raise blood sugar.

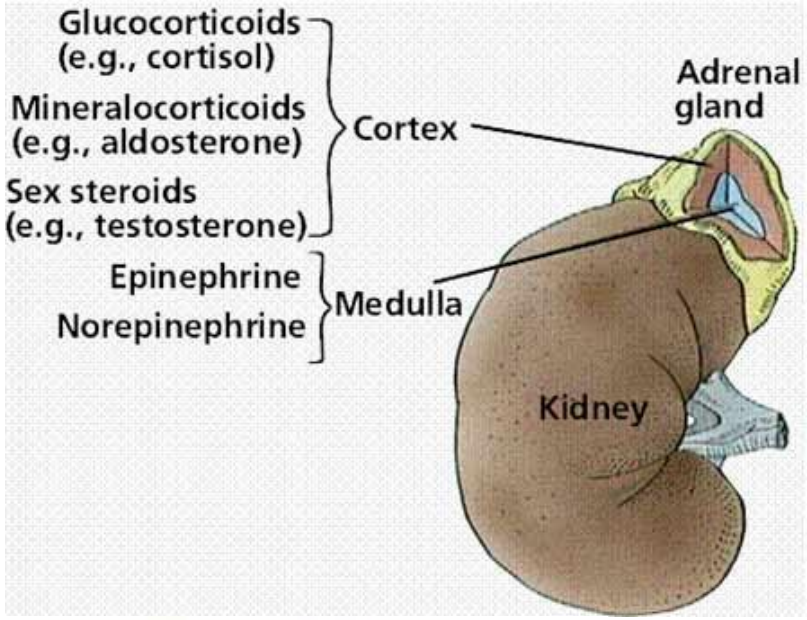
Maintaining proper blood sugar levels is crucial to the functioning of key organs including the brain, liver, and kidneys.

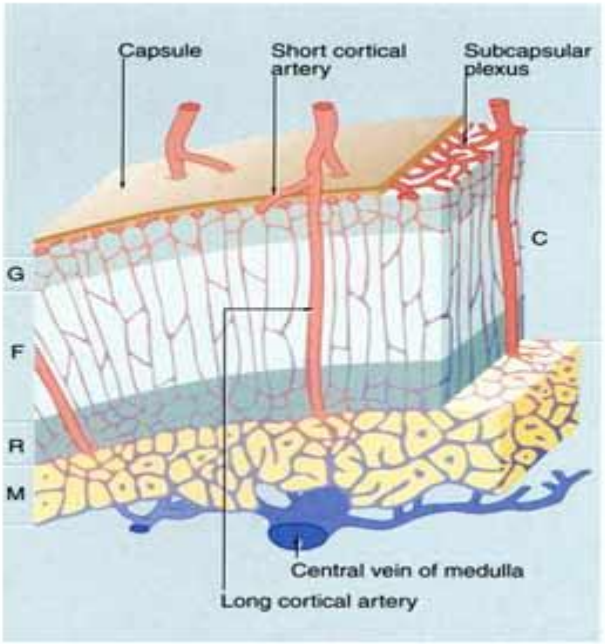
The ***PP cells*** are localized more in the periphery of the islets. PP cells tend to be found in greater quantity in the islets in the head of the **pancreas** rather than the tail.

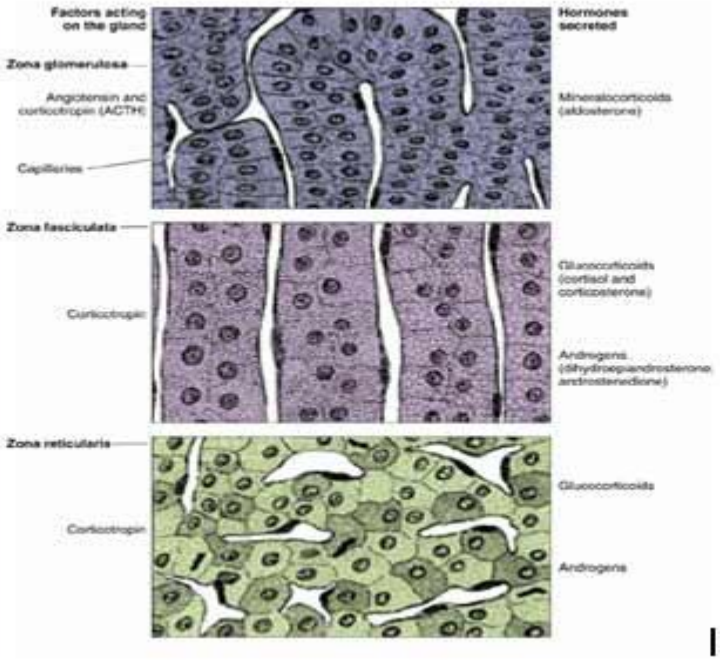
Insulin-induced hypoglycemia induces a sharp increase in **PP** secretion from the **pancreas**.

Adrenal glands

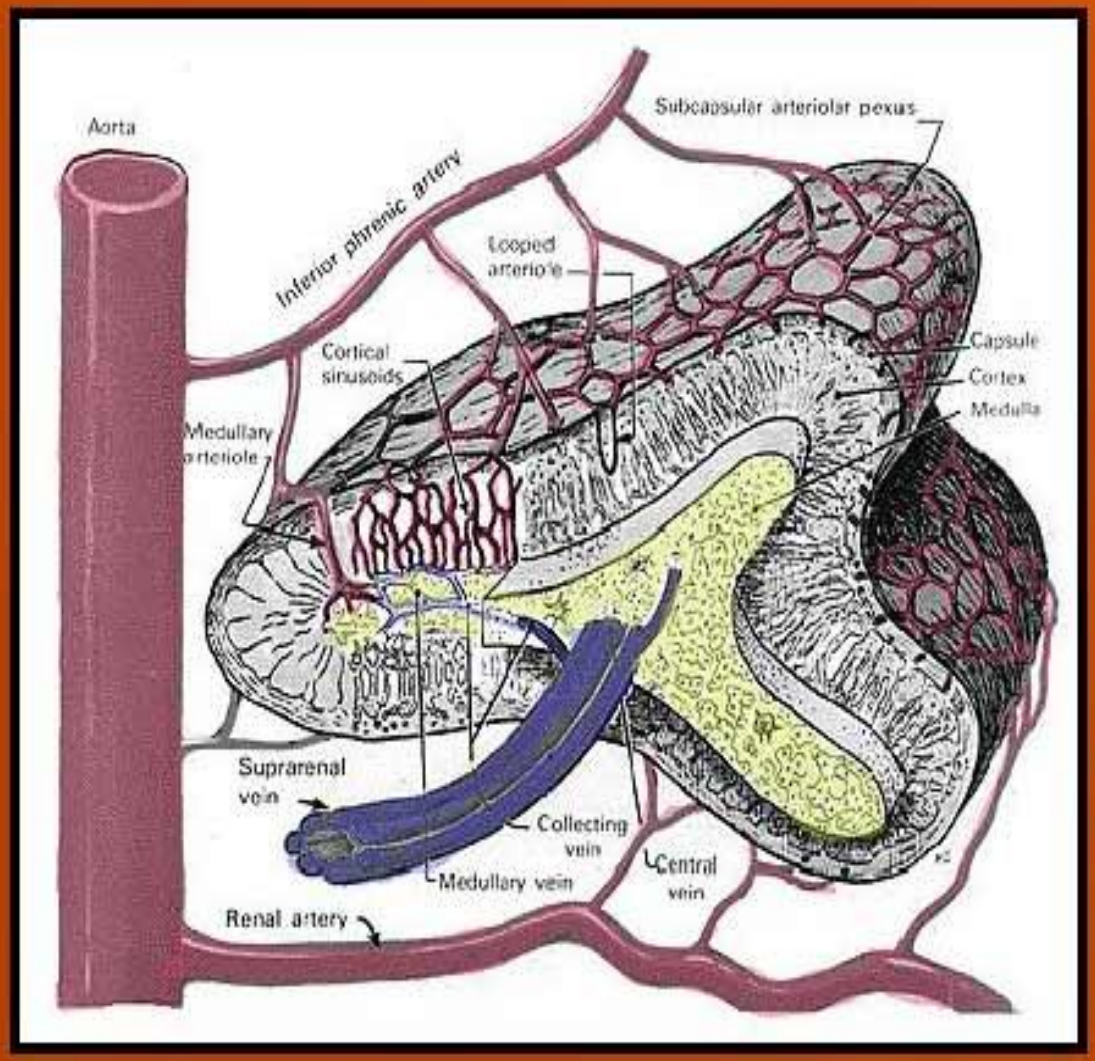






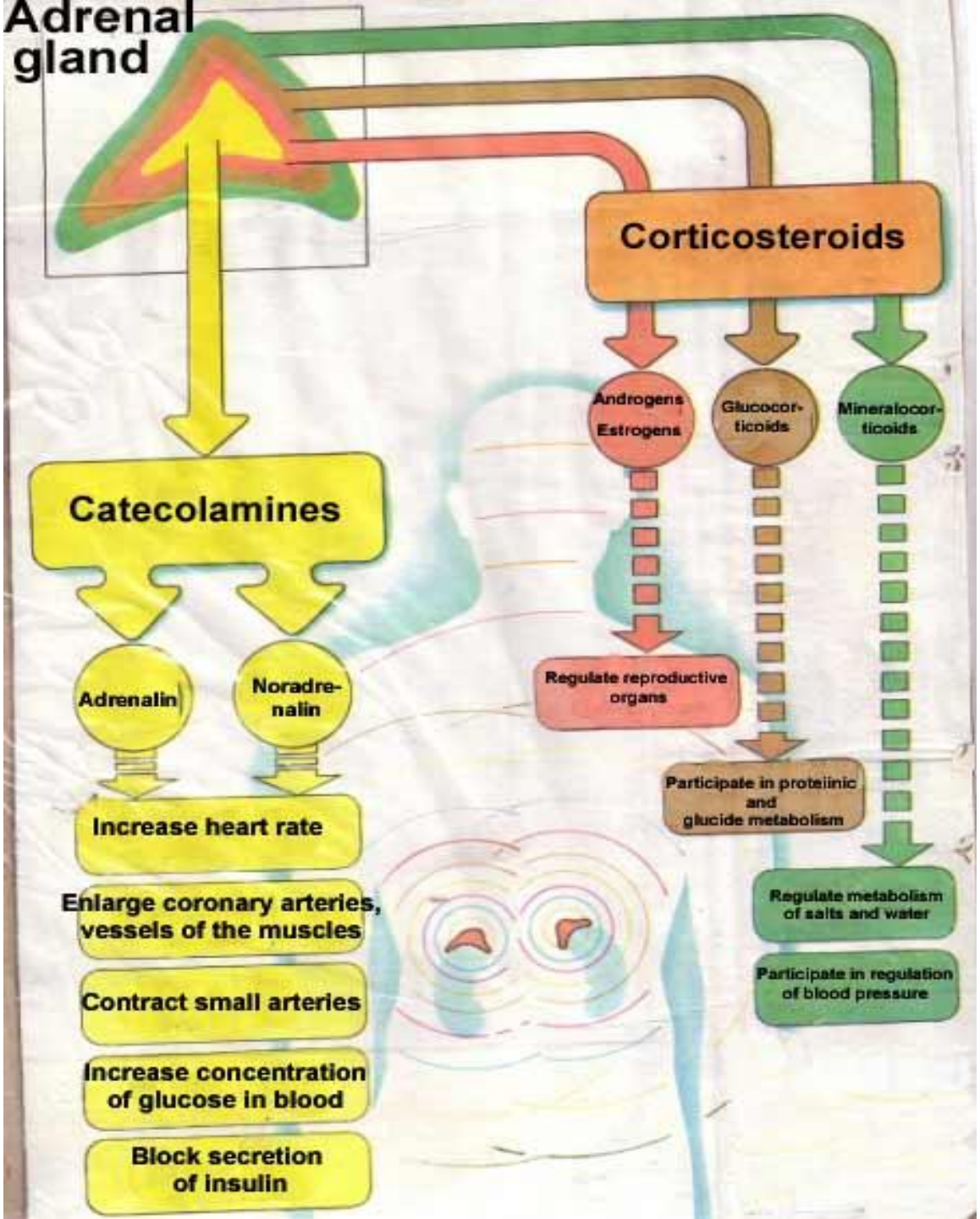


Adrenal Vascularization

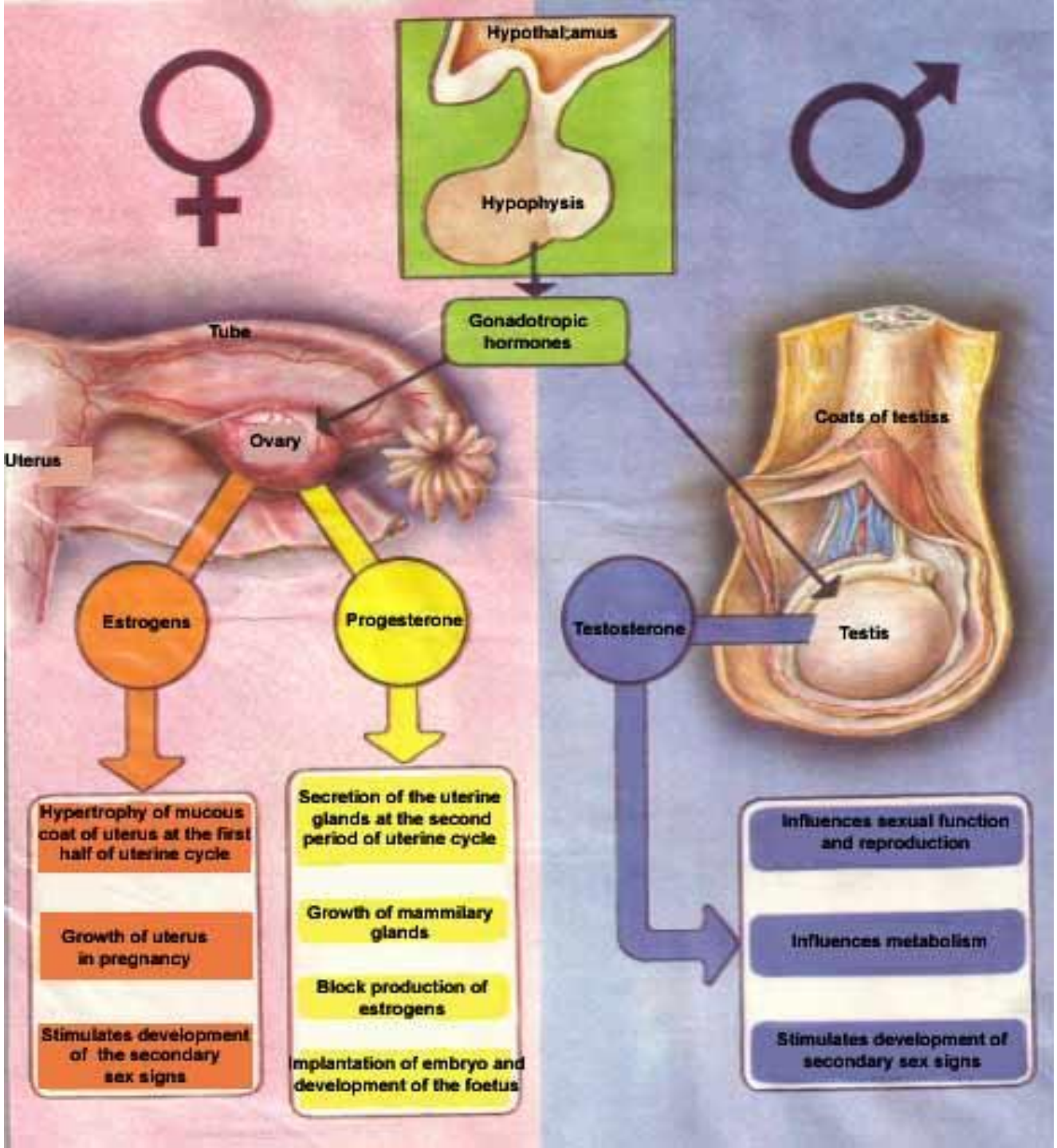


Unique Blood Flow through Cortex - no venous return

Inferior phrenic artery
Renal artery
Subcapsular arteriolar plexus
Medullary arteriole
Cortical sinusoids
Medullary vein
Collecting vein
Suprarenal vein

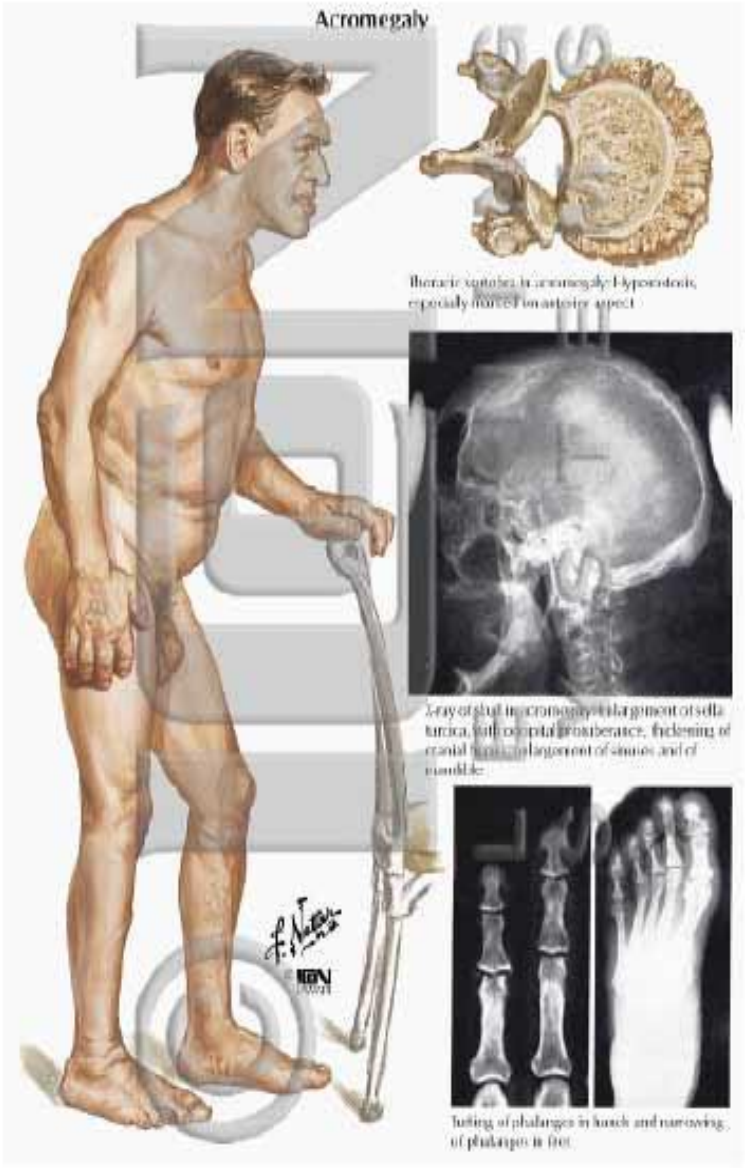


Functions of the adrenal glands

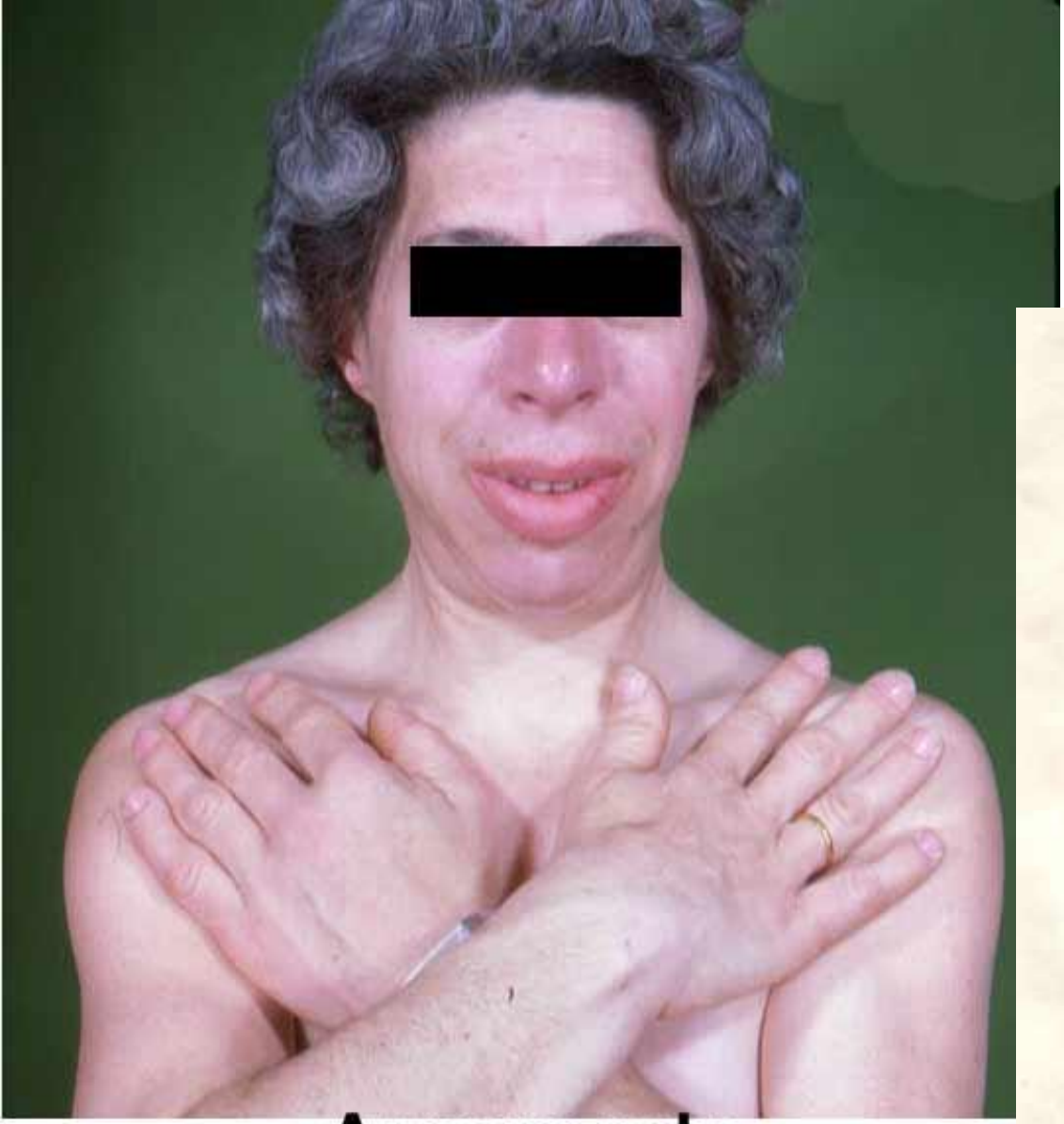


Functions of the gonads

Hypersecretion of pituitary gland



Gigantism



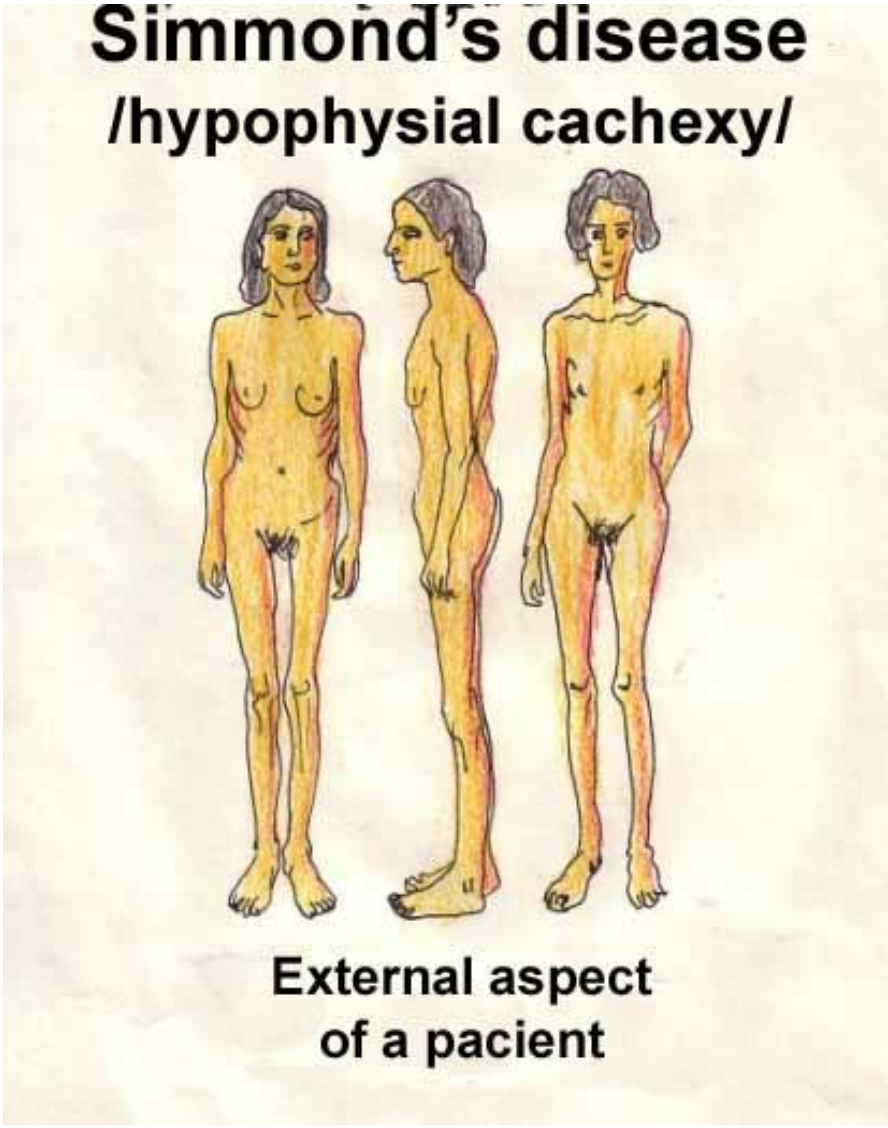
Acromegaly

Acromegaly

a- before disease
b- 2 years of disease
c,d- 5 years of disease

Hyposecretion of the pituitary gland

Dwarfism



Simmond's disease or ***pituitary cachexia*** is characterized by panhypopituitarism that causes progressive emaciation, atrophy of the gonads, thyroid, and adrenal cortex, and loss of body hair and that results from atrophy or destruction of the anterior lobe of the pituitary gland.

Hypersecretion of the thyroid gland at adults

Hyperthyroidism or **thyrotoxicosis** is the condition that occurs due to excessive production of thyroid hormone by the thyroid gland.
Thyrotoxicosis is the condition that occurs due to excessive thyroid hormone of any cause and therefore includes hyperthyroidism.
Some, however, use the terms interchangeably.[4] Signs and symptoms vary between people and may include irritability, muscle weakness, sleeping problems, a fast heartbeat, heat intolerance, diarrhea, enlargement of the thyroid, hand tremor, and weight loss. Symptoms are typically less in the old and during pregnancy.
An uncommon complication is thyroid storm in which an event such as an infection results in worsening symptoms such as confusion and a high temperature and often results in death.

Hyposecretion of the thyroid gland at adults

Myxedema

In this patient with advanced pretibial myxedema, these striking skin changes are due to accumulations of mucopolysaccharides ("myxedema"). These changes are reversible with thyroid hormone.

Along with the signs and symptoms of severe hypothyroidism, symptoms of myxedema crisis can include:

- decreased breathing (**respiratory depression**),
- lower than normal **blood sodium levels**,
- hypothermia (low body temperature),
- **confusion** or **mental slowness**,
- **shock**,
- low **blood oxygen levels**,
- high blood carbon dioxide levels.
- **coma**.

Hyposecretion of the thyroid gland in childhood

Cretinism

Cretinism

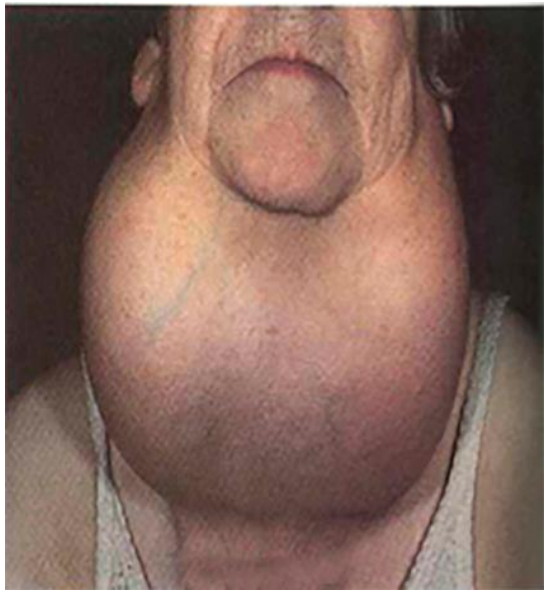
The three characteristic features of neurological endemic cretinism in its fully developed form are extremely severe mental deficiency together with squint, deaf mutism and motor spasticity with disorders of the arms and legs of a characteristic nature.

Done

Goiter and Cretinism

Hyposecretion of the thyroid gland

Goiter



The most common cause of goiters worldwide is a lack of iodine in the diet.
In Moldova, where the use of iodized salt is common, a goiter is more often due to the over- or underproduction of thyroid hormones or to nodules that develop in the gland itself.

Symptoms

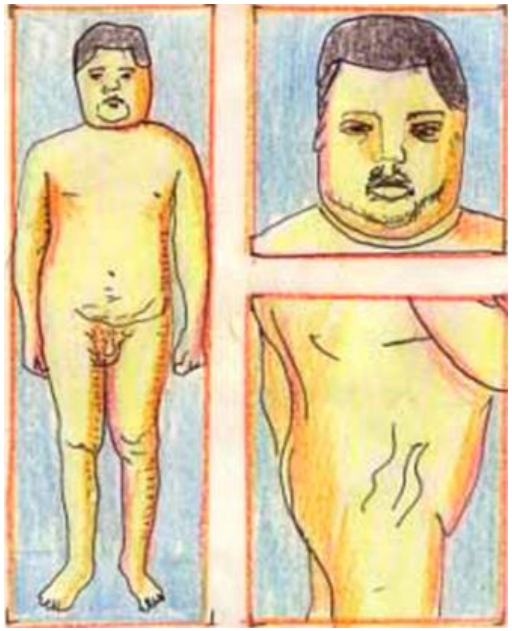
Not all goiters cause signs and symptoms. When signs and symptoms do occur they may include:

- A visible swelling at the base of the neck that may be particularly obvious when you shave or put on makeup
- A tight feeling in your throat
- Coughing
- Hoarseness
- Difficulty swallowing
- Difficulty breathing

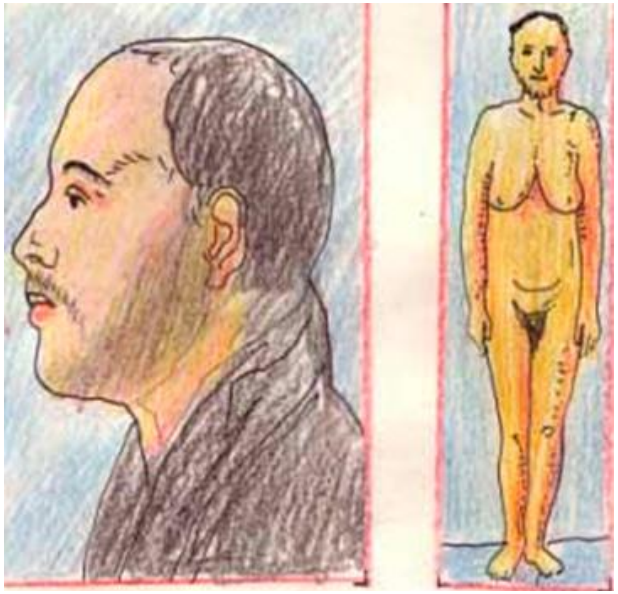
Cronical hypopara-thyroidism

Cushing disease

- **It is an excessive production of glucocorticoids**
- **More often is caused by overstimulation of adrenal gland by the pituitary gland**



External aspect of a 13-years old child



Aspect of a sick women

Cushing's disease

Cushing's disease is the collection of symptoms and signs resulting from prolonged exposure to ***high levels of cortisol***.

In **Cushing's disease**, the cause of the excessive cortisol relates to a benign tumor of the pituitary gland.

Symptoms of Cushing syndrome

- ***weight gain;***
- ***obesity*** (fatty deposits, especially in the midsection, the face (causing a round, moon-shaped face), and between the shoulders and the upper back (causing a buffalo hump);
- purple **stretch marks** on the breasts,, **arms**, abdomen, and **thighs**;
- thinning skin that **bruises** easily.

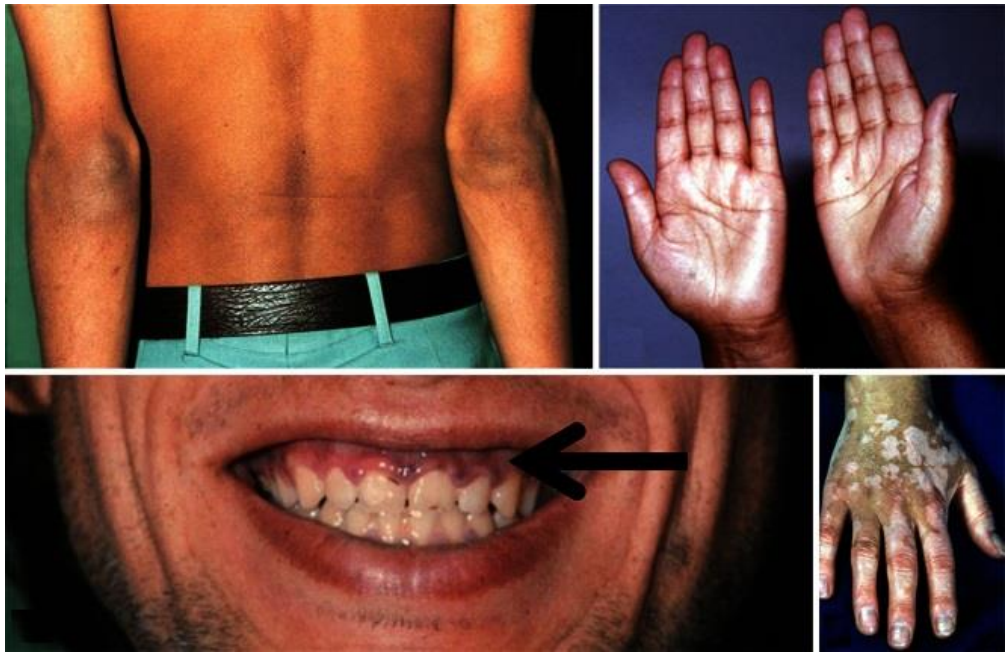
Addison’s disease

Addison's disease, also known as ***primary adrenal insufficiency*** and ***hypocortisolism***, is a long-term endocrine disorder in which the adrenal glands do not produce enough steroid hormones.

Addison's disease symptoms usually develop so slowly (often over several months) that symptoms are ignored until a stress, such as illness or injury, occurs and makes symptoms worse.

Signs and symptoms may include:

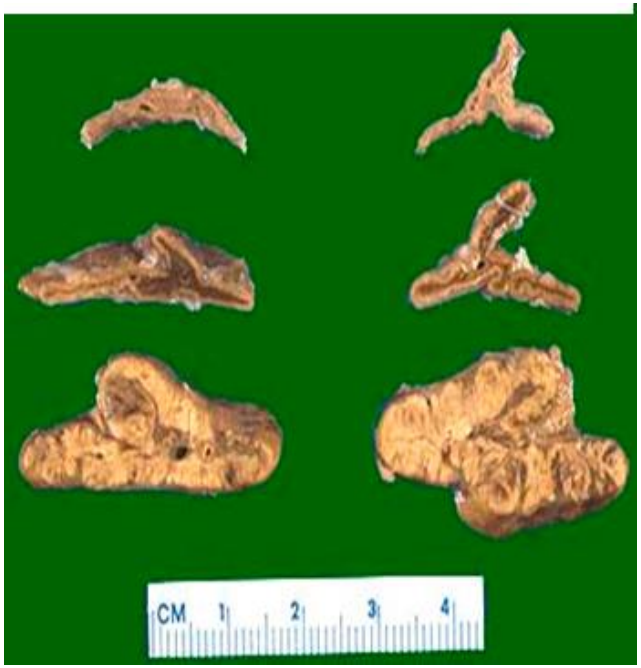
- Extreme fatigue
- Weight loss and decreased appetite
- Darkening of the skin (hyperpigmentation)
- Low blood pressure, even fainting
- Salt craving
- Low blood sugar (hypoglycemia)
- Nausea, diarrhea or vomiting (gastrointestinal symptoms)
- Muscle or joint pains,
- Irritability
- Body hair loss or sexual dysfunction in women



Addison's disease

Addison's disease – it is hypoadrenocorticism caused by destruction of adrenal cortex: deficiency of both glucocorticoids and mineralocorticoids.

Generalised skin pigmentation but ispecially the deposition in the palmer skin, nails & gums.



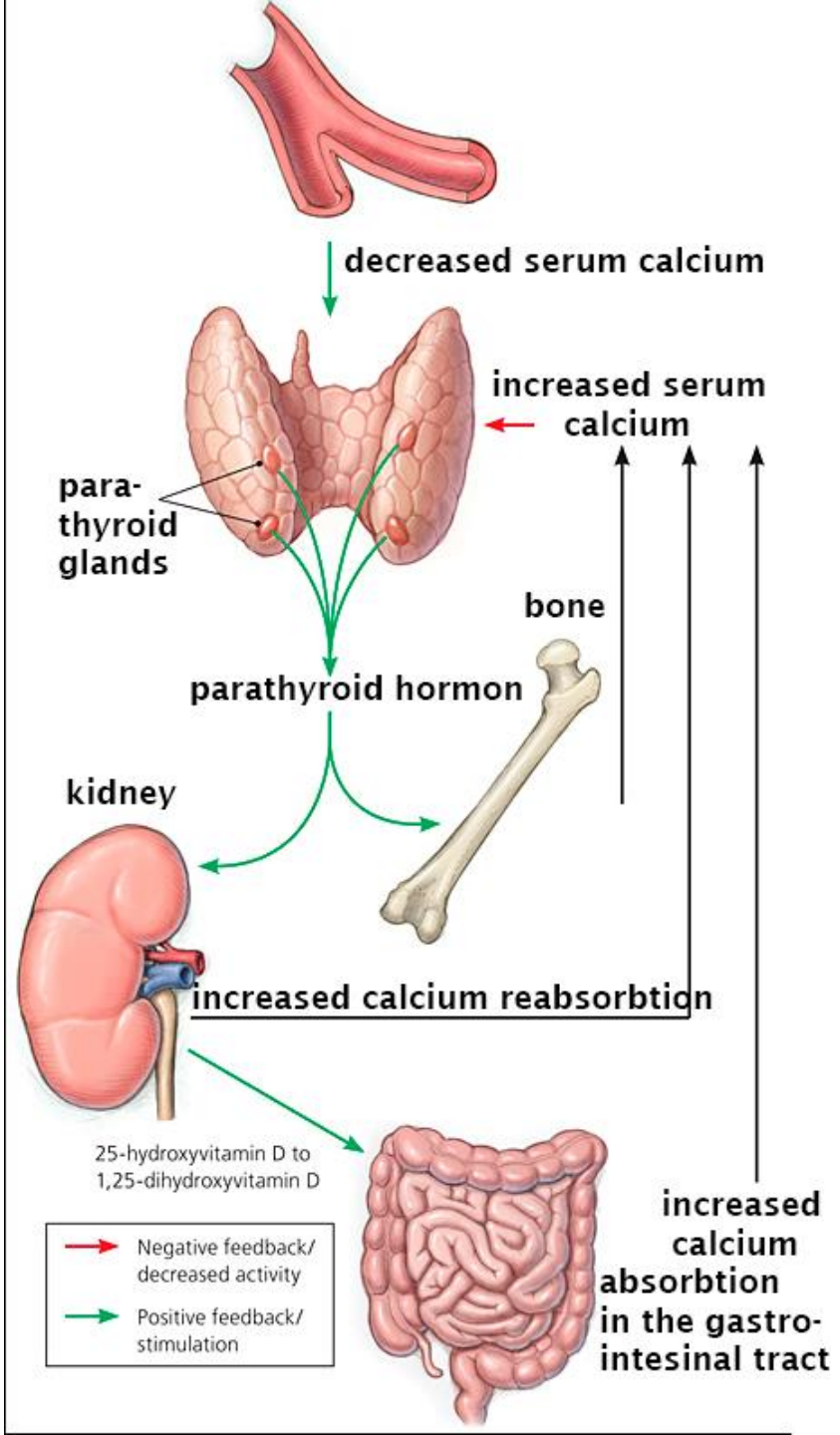
Size of the adrenal gland in Addison's disease

Chronic hypoparathyroidism *(hypopara)*

is a rare and debilitating condition in some patients, which has no cure.
It leads to low blood calcium levels.

Signs and symptoms:

- Tingling or burning (paresthesia) in fingertips, toes and lips
- Muscle aches or cramps in the legs, feet, abdomen or face
- Twitching or spasms of the muscles, particularly around the mouth, but also in the hands, arms and throat
- Fatigue or weakness
- Painful menstruation
- Patchy hair loss
- Dry, coarse skin
- Brittle nails
- Depression or anxiety
- Memory loss



Classification of endocrine glands according their development

Five groups of the endocrine glands can, therefore, be distinguished *according to the site of their development.*

I. ***Brachiogenic group*** - endodermal glands arising from the pharynx and branchial pouches of the embryo (***thyroid, parathyroid, thymus glands***).

II. ***Endodermal glands*** of the intestinal tube – the ***islets of Langerhans*** in the pancreas.

III. ***Mesodermal glands*** – ***the cortex of adrenal gland*** and ***gonads***.

IV. ***Neurogenic group*** - ectodermal glands originating from the diencephalon (***epiphysis, hypophysis***).

V. ***Group of the adrenal system*** - ectodermal glands arising from the sympathetic elements (***adrenal medulla and paraganglia***).

Note. Endocrine glands which consist of two different parts (morphofunctional, phylo- and ontogenetic parts) are, as follows: the thyroid gland, hypophysis and suprarenal glands.

Development Overview

Parathyroid and Thymus

Endoderm of 3,4,5 pharyngeal pouches form dorsal and ventral cell masses.

Dorsal 3rd and 4th pouch form parathyroid.

Ventral cells move medially to form thymus.

The ectoderm endoderm boundary in the pharynx forms 2 glands.

Thyroid

The boundary endoderm in the floor region forms a pocket that separates from the surface and forms the thyroid.

Pituitary Gland

The boundary epitheilal ectoderm in the roof of the pharynx forms a pocket (Rathke's pouch) that comes into contact with the ectoderm of developing brain.

The anterior pituitary originates from the epitheilal ectoderm.

The posterior pituitary originates from the brain neuroectoderm.

Adrenal Gland

Neural crest cells migrate toward the coelomic cavity wall and form the adrenal medulla.

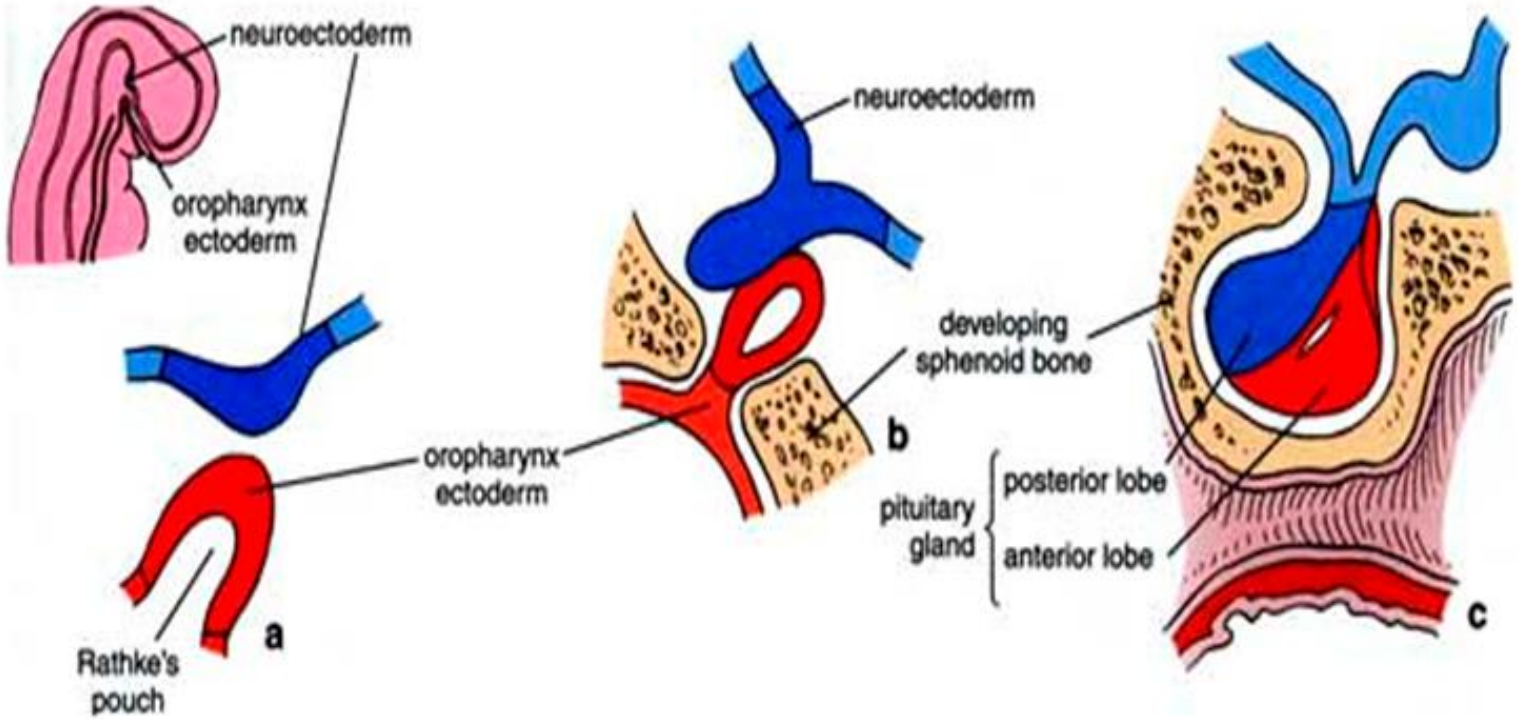
Overlying epithelial cells proliferate and form a capsule that will form the adrenal cortex.

Embryogenesis of the pituitary gland

1.neurohypophysis derived from neuroectoderm

-nerve tissue /axon terminals/and support cells

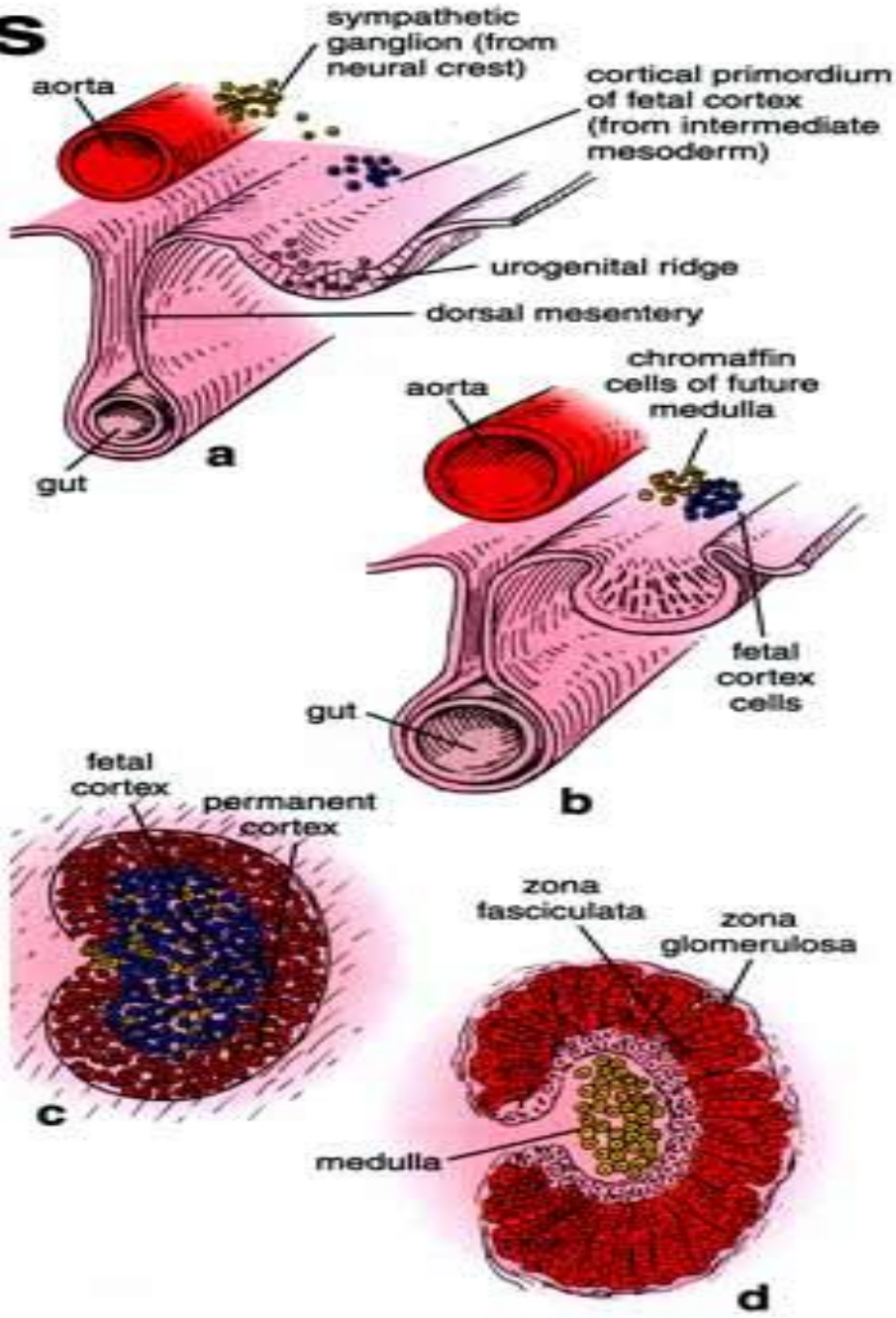
2. adenohypophysis derived from oral ectoderm



Embryogenesis
of adrenal glands

1.adrenal cortex
derived from
coelomic intermediate
mesoderm

2.adrenal medulla
derived from
the neural crest
ectoderm



- **End**