

ENDOCRINE SYSTEM

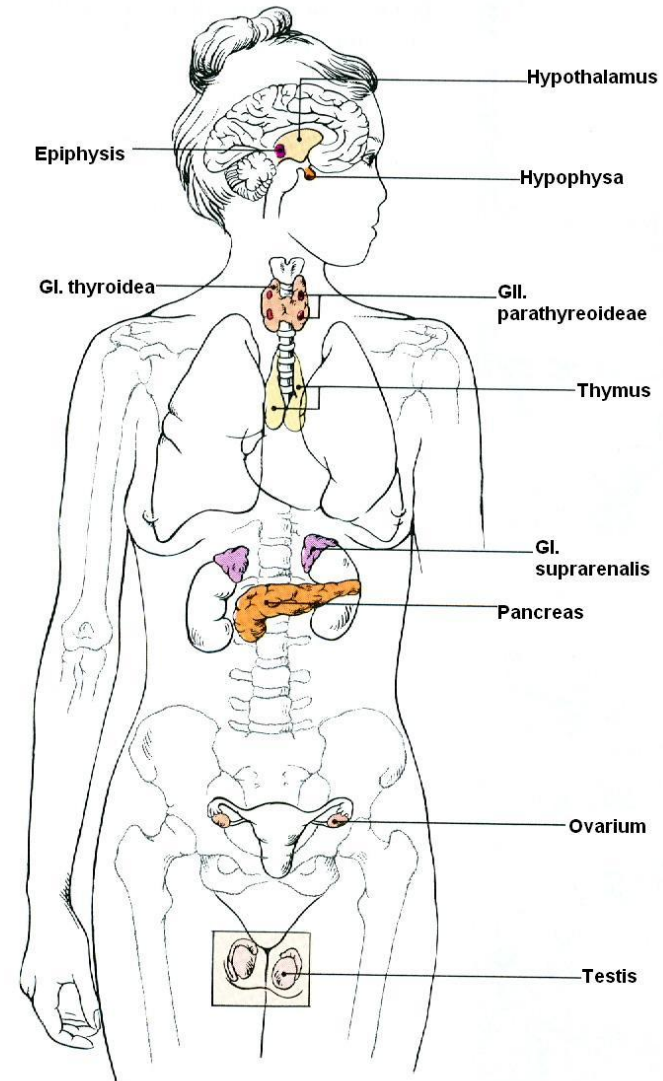
ENDOCRINE GLANDS

Secretory cells release hormones to the blood

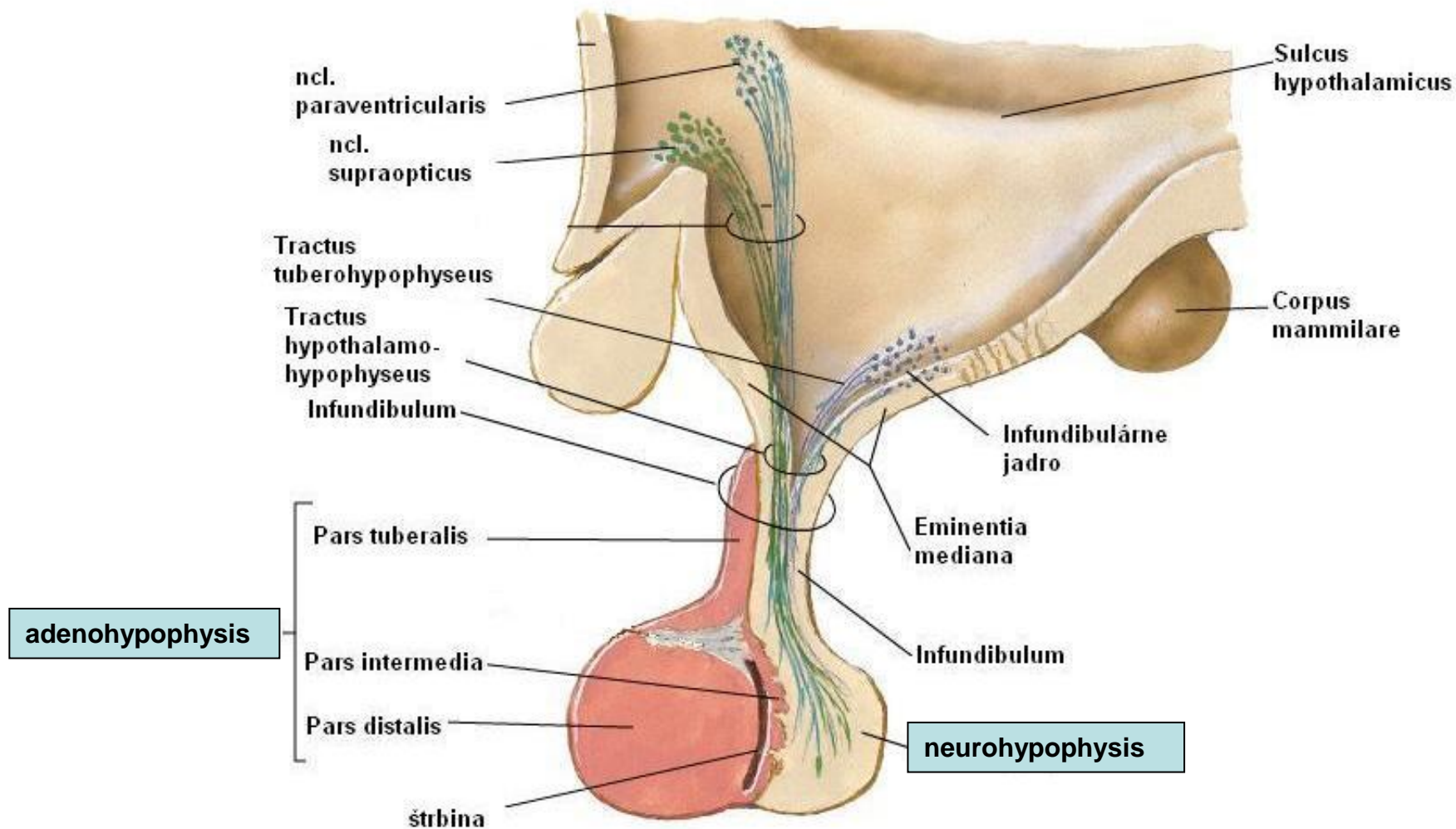
- Hypophysis
- Thyroid gl.
- Parathyroid gl.
- Suprarenal gl.

Organs with dual function:

- **Pancreas** - exocrine and endocrine organ
- **Ovary** - development of female germ cells,
- hormone production: estrogen, progesterone
- **Testis** - development of male germ cells,
- hormone production: testosterone



HYPOPHYSIS (GLANDULA PITUITARIA) Location: sphenoid bone - the sella turcica



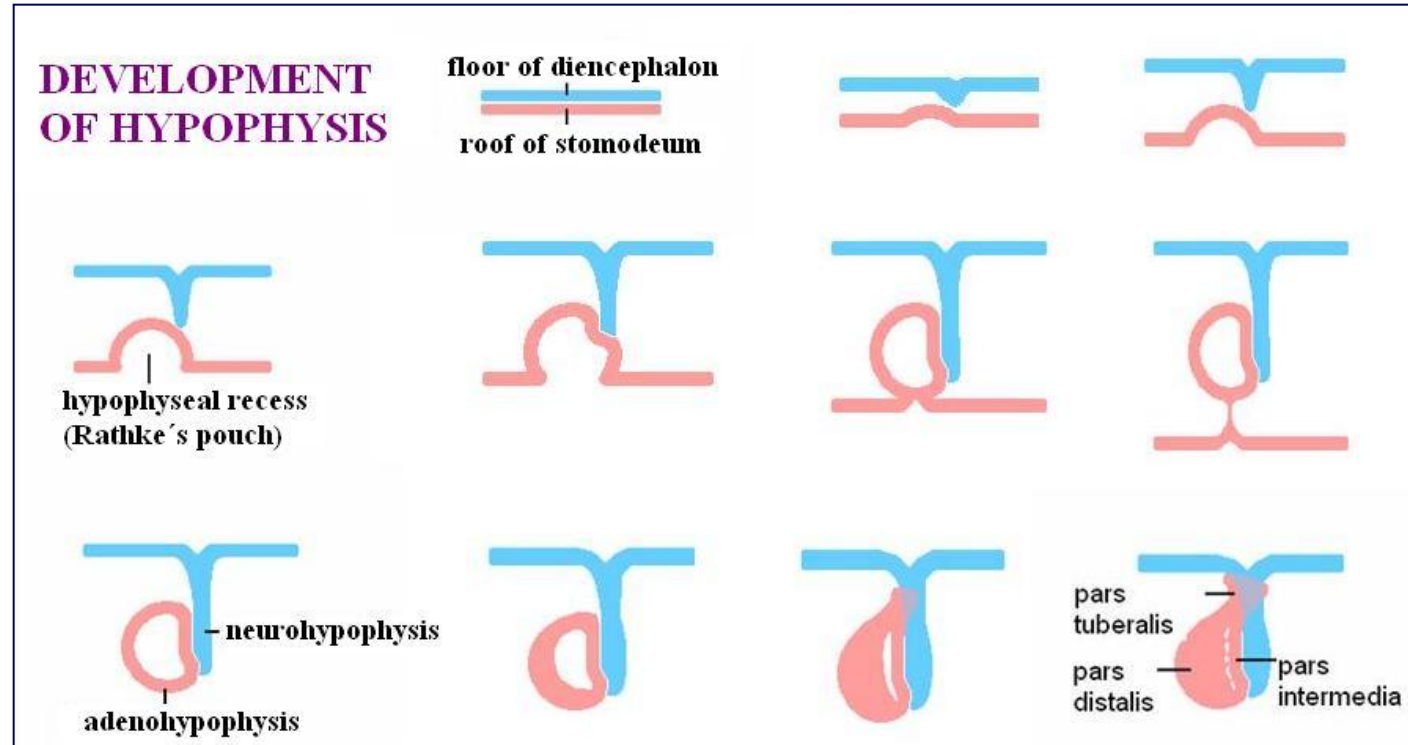
Hypophysis

anterior lobe – adenohypophysis

- pars distalis (70%)
- pars intermedia
- pars tuberalis

posterior lobe - neurohypophysis

- pars nervosa
- infundibulum (neural stalk)



Development of hypophysis

1. **Adenohypophysis** develops from **ectoderm** of the roof of primitive stomodeum (mouth); evagination of the ectoderm = Rathke's pouch (R.p)
 - Connection between R.p. and oral ectoderm later disappears.
2. **Neurohypophysis** develops from **neuroectoderm** after evagination of the floor of diencephalon.
 - Connection between diencephalon and neurohypophysis remains and forms infundibulum of neurohypophysis.

MICROSCOPIC STRUCTURE OF ADENOHYPHYSIS

Cells of adenohypophysis according staining are:

1. **CHROMOPHOBIC CELLS (C)**

2. **CHROMOPHILIC CELLS (A+B):**

(A) - acidophilic

- luteotropic cells

LTH – luteotropic h. (prolactin)

- somatotropic cells

STH – somatotrophic h.

(B) - basophilic

- gonadotropic cells (2 types of hormones):

FSH – follicle-stimulating h.

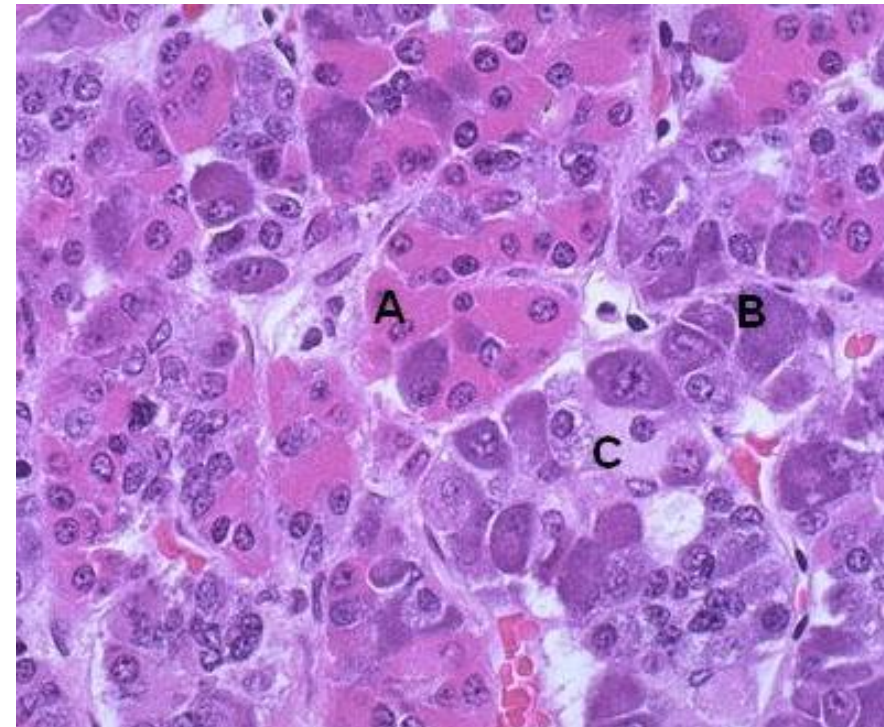
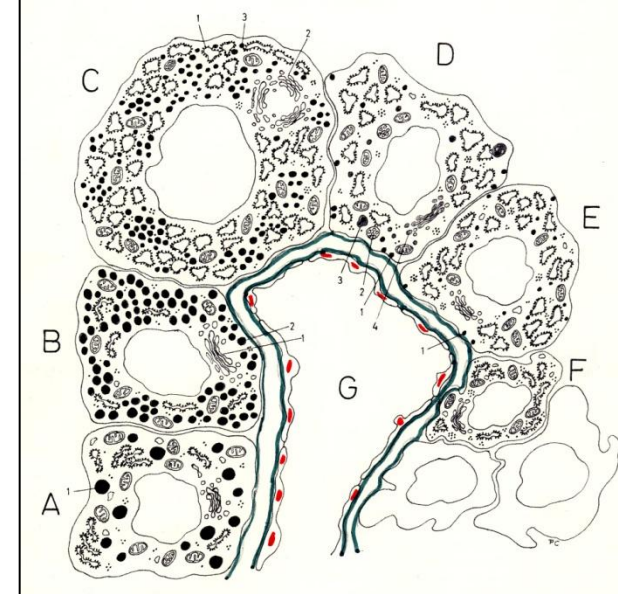
LH – luteinizing h. (ICSH)

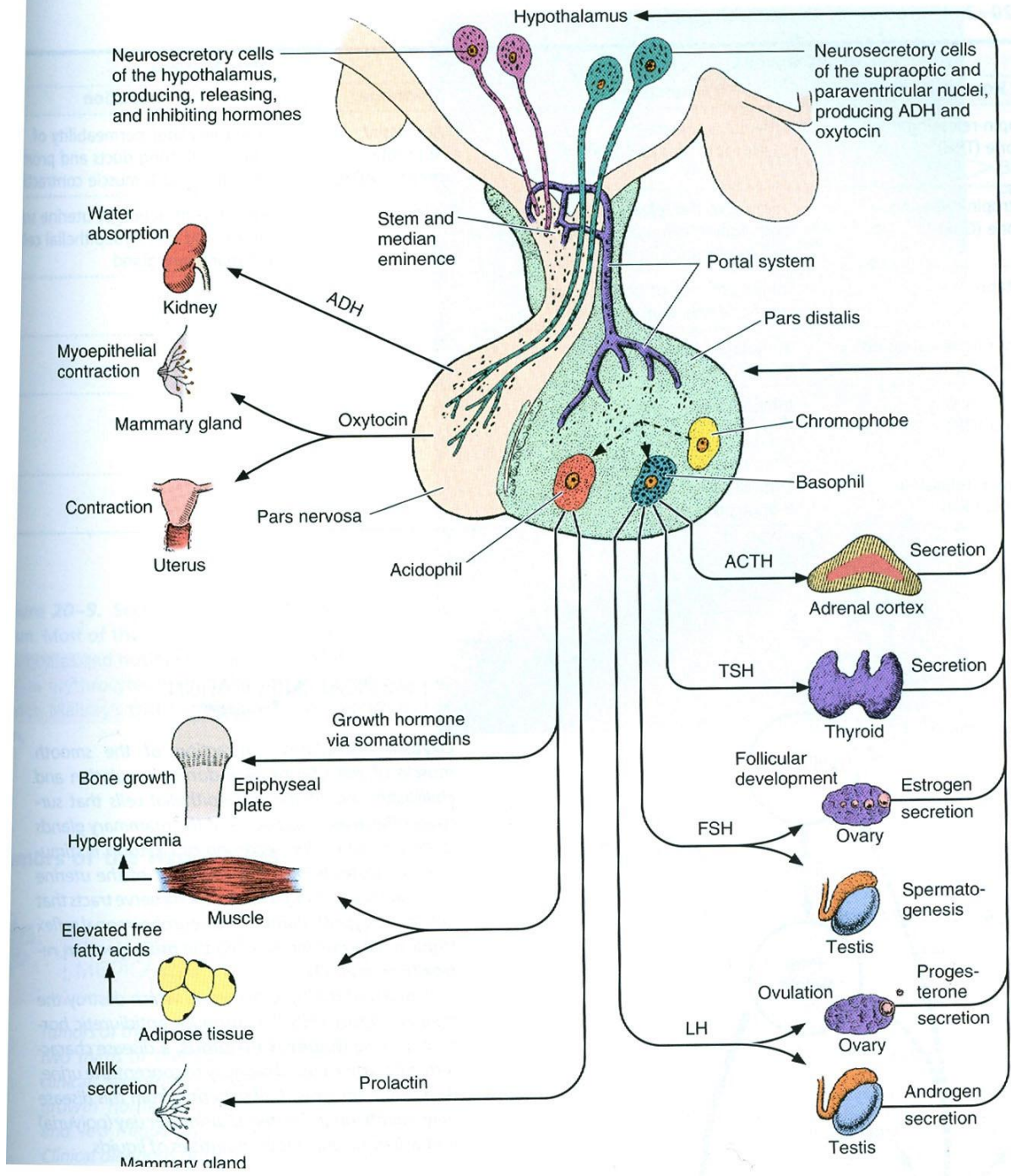
- corticotropic c.

ACTH – adrenocorticotrophic h.

- thyreotropic c.

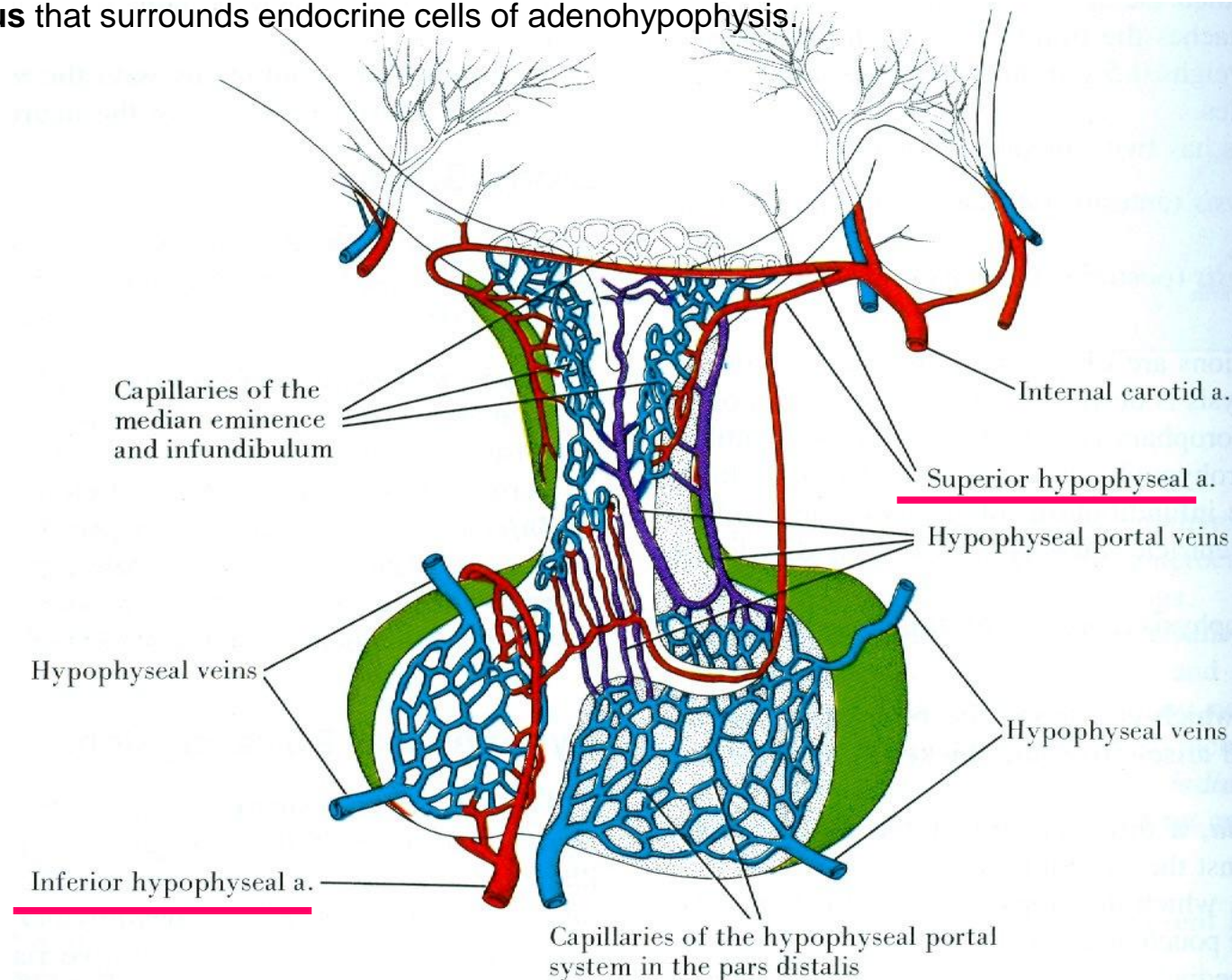
TSH – thyreotropic h.





Blood supply in the adenohypophysis: Hypophyseal portal system

- **Superior hypophyseal a.** near the infundibulum forms:
- **Primary capillary plexus** – nerve endings of hypothalamic neurons release **activating** or **inhibiting factors** to the capillaries. Capillaries fuse to form:
- **Hypophyseal portal veins** that form:
- **Secondary capillary plexus** that surrounds endocrine cells of adenohypophysis.



Neurons of the dorsal medial, ventral medial and infundibular nuclei

Neurons of the supraoptic and paraventricular nuclei

Hypothalamic regulating hormones are produced in neurons situated in infundibular nuclei. Hormones are released to the primary capillary plexus.

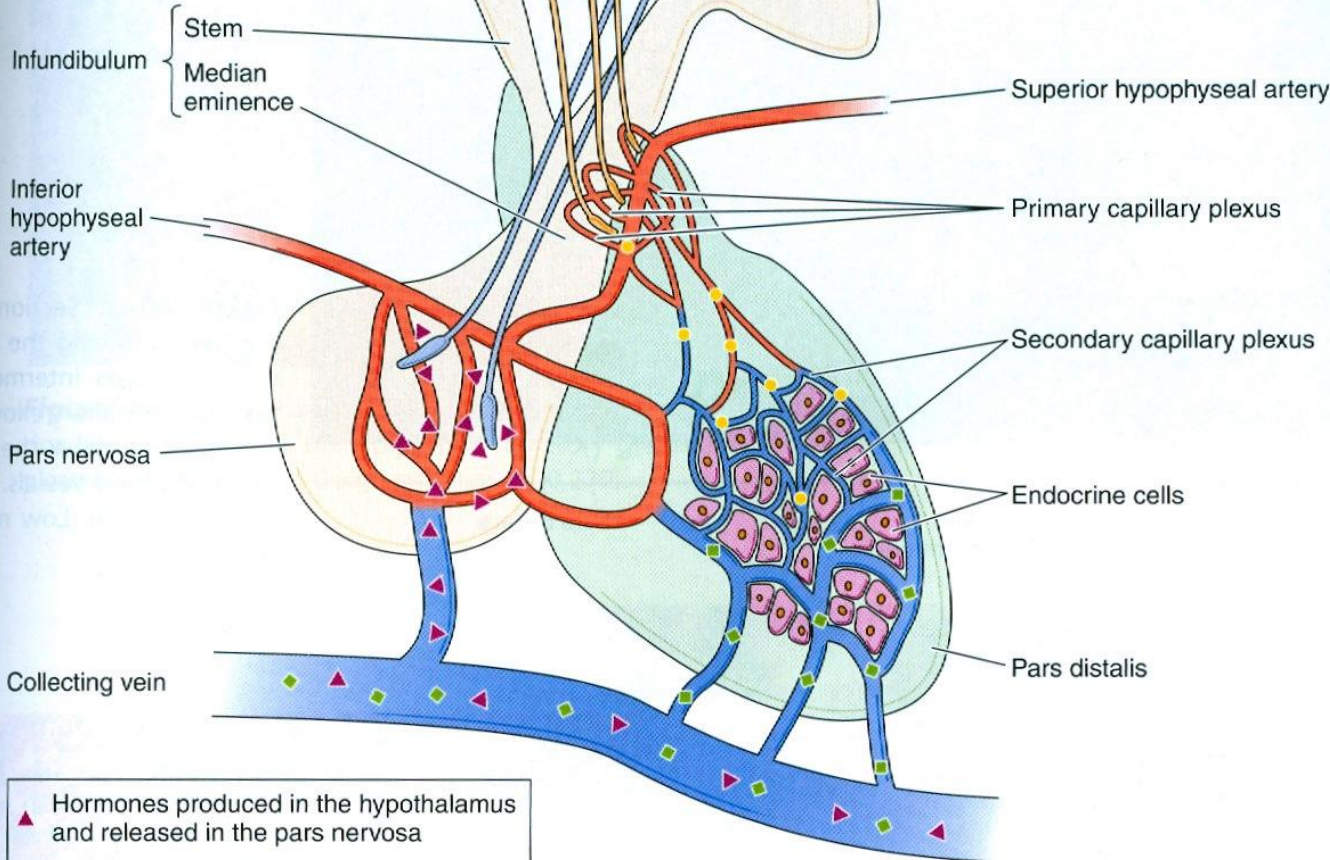
HYPOTHALAMUS

Releasing hormones, e.g.:

- somatotropin-releasing h.
- gonadotropin-releasing h.

Inhibiting hormones:

- somatostatin
- prolactin-inhibiting h.



Inferior hypophyseal artery

Superior hypophyseal artery

Primary capillary plexus

Secondary capillary plexus

Pars nervosa

Endocrine cells

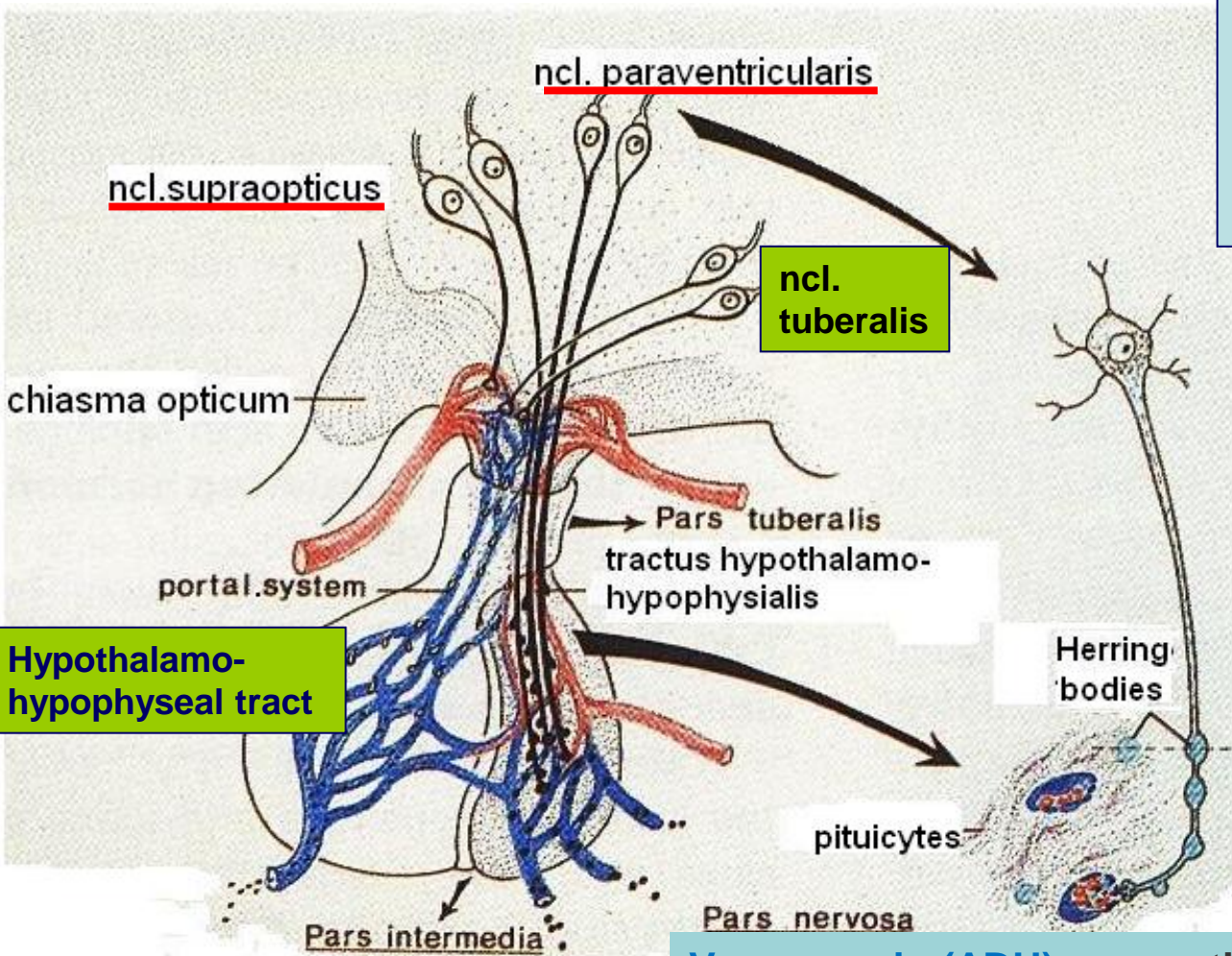
Collecting vein

Pars distalis

- ▲ Hormones produced in the hypothalamus and released in the pars nervosa
- Stimulating (or inhibiting) hormones produced in the hypothalamus
- Hormones produced in the pars distalis

Neurohypophysis

Hypothalamic nuclei (**ncl. supraopticus** and **paraventricularis**) are composed of multipolar secretory neurons. Their axons transport hormones (**oxytocin** and **antidiuretic hormone**) by axons to neurohypophysis.



Microscopic structure of neurohypophysis:

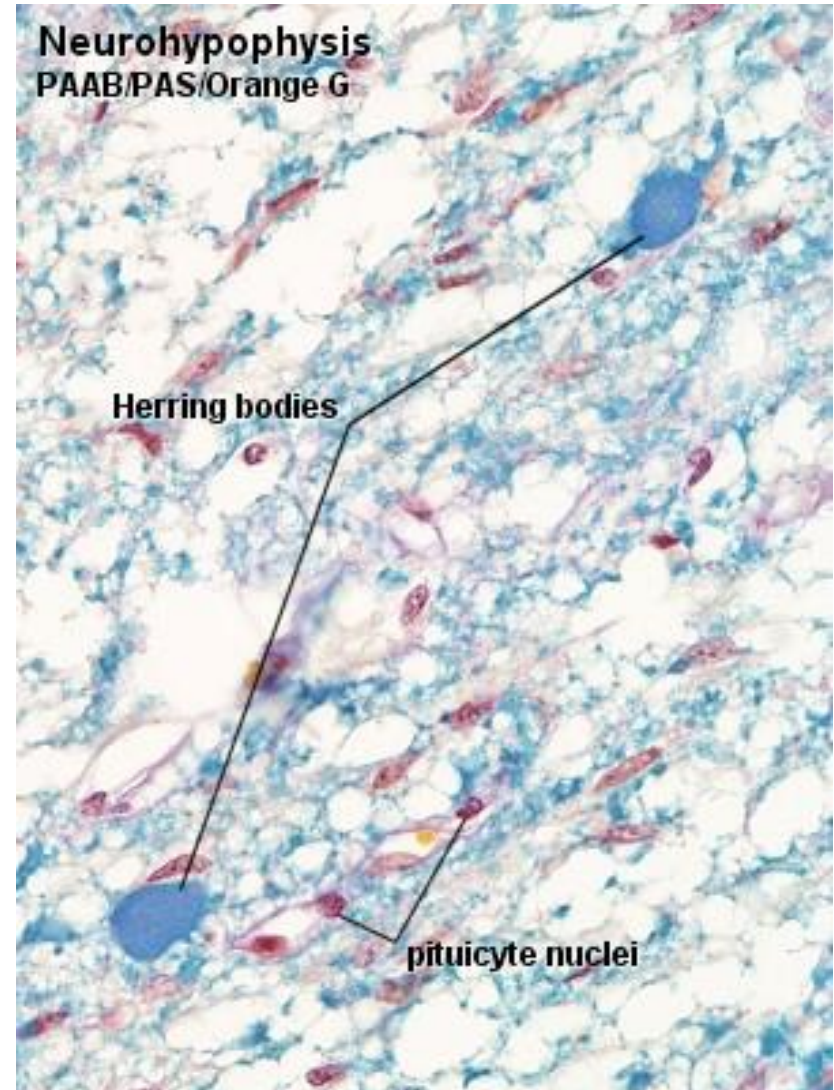
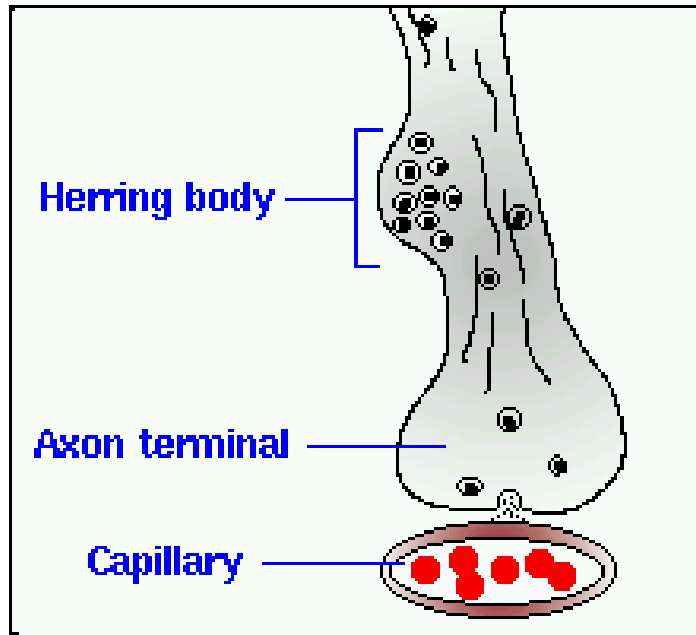
- unmyelinated axons
- pituicytes
- blood capillaries

Vasopressin (ADH)- resorption of water in distal tubules
Oxytocin- contraction of smooth muscles (uterus)

In EM:

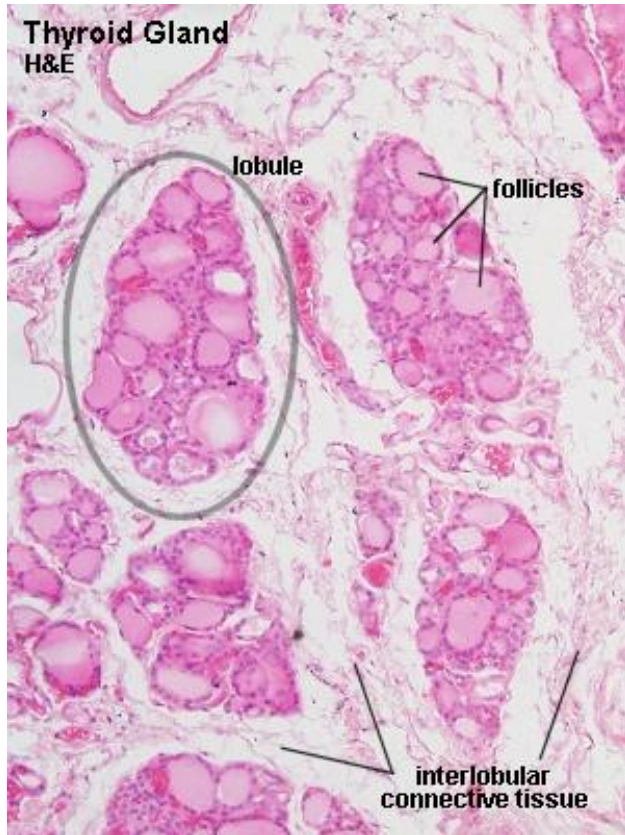
Accumulation of secretory material in the axoplasm caused axonal swellings, called **Herring's bodies**.

Hormones are produced in the hypothalamus and are only released to the capillaries in the neurohypophysis!



Thyroid gland

- located in the anterior neck region, close to the larynx and trachea
- 2 lateral lobes connected by isthmus

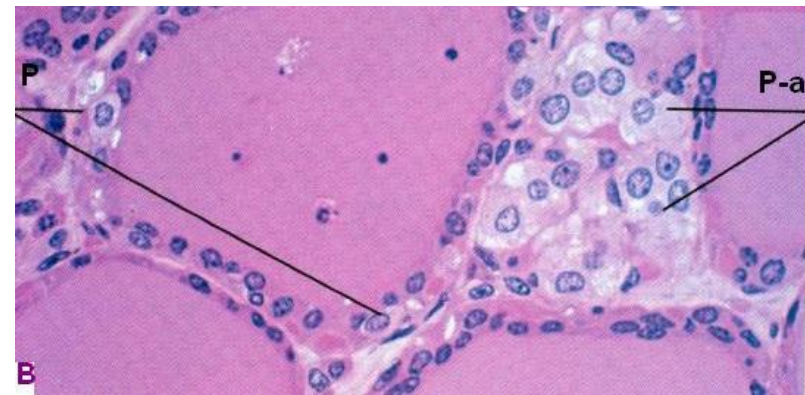
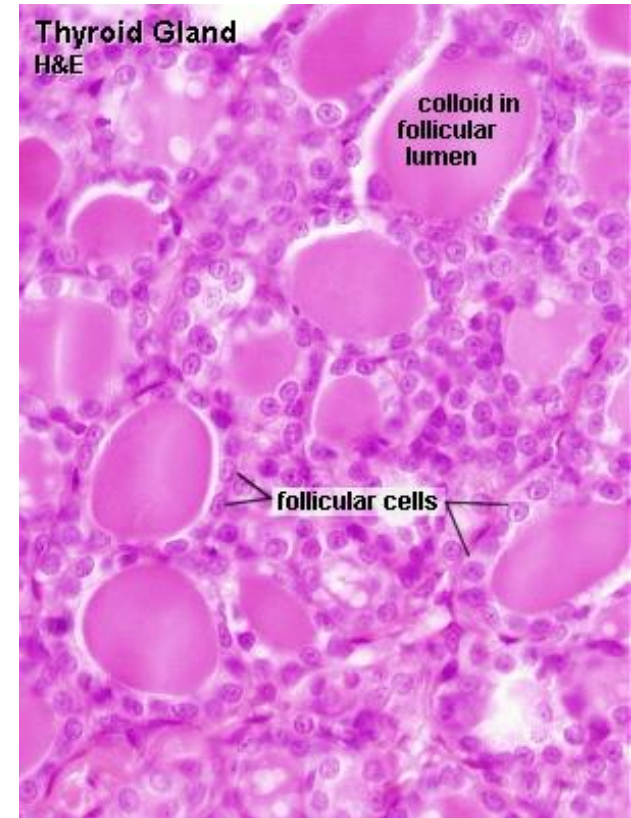


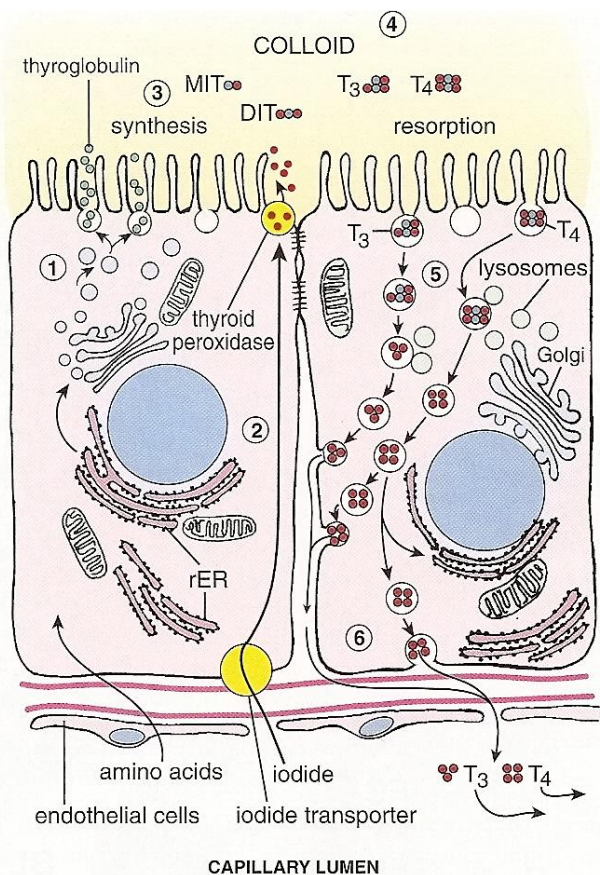
Microscopic structure:

CT - Capsule, septa

Lobules are composed of follicles, lined by **follicular cells** (cuboidal or columnar according to their activity).

parafollicular cells (P) - situated by the follicles, single or like interstitial aggregation (B)





Synthesis of hormones T₃, T₄

1. Synthesis of thyroglobulin (GER, GA), transport to the colloid.
2. Absorption of iodide from capillaries to the cytoplasm (iodide pump).
3. Oxidation of iodide to iodine, transport to the colloid.
4. Iodination of thyroglobulin in the colloid.
5. Resorption of colloid. (Colloidal resorption droplets *).
6. Fusion of pinocytotic vesicles with lysosomes.
7. Degradation of thyroglobulin residues in the cytoplasm and release of free T₃ and T₄.
8. Transport of hormones through the basal pole of the cell to the capillaries.

Thyroid gland function is essential to normal growth and development

Follicular cells: thyroid hormones - triiodothyronine (T₃);
- thyroxine (tetraiodothyronine, T₄)

F: Regulation of cell and tissue basal metabolism, heat production, body growth and development

Parafollicular cells:

hormone **calcitonin** – lowers blood calcium levels
- stimulation of osteoblasts



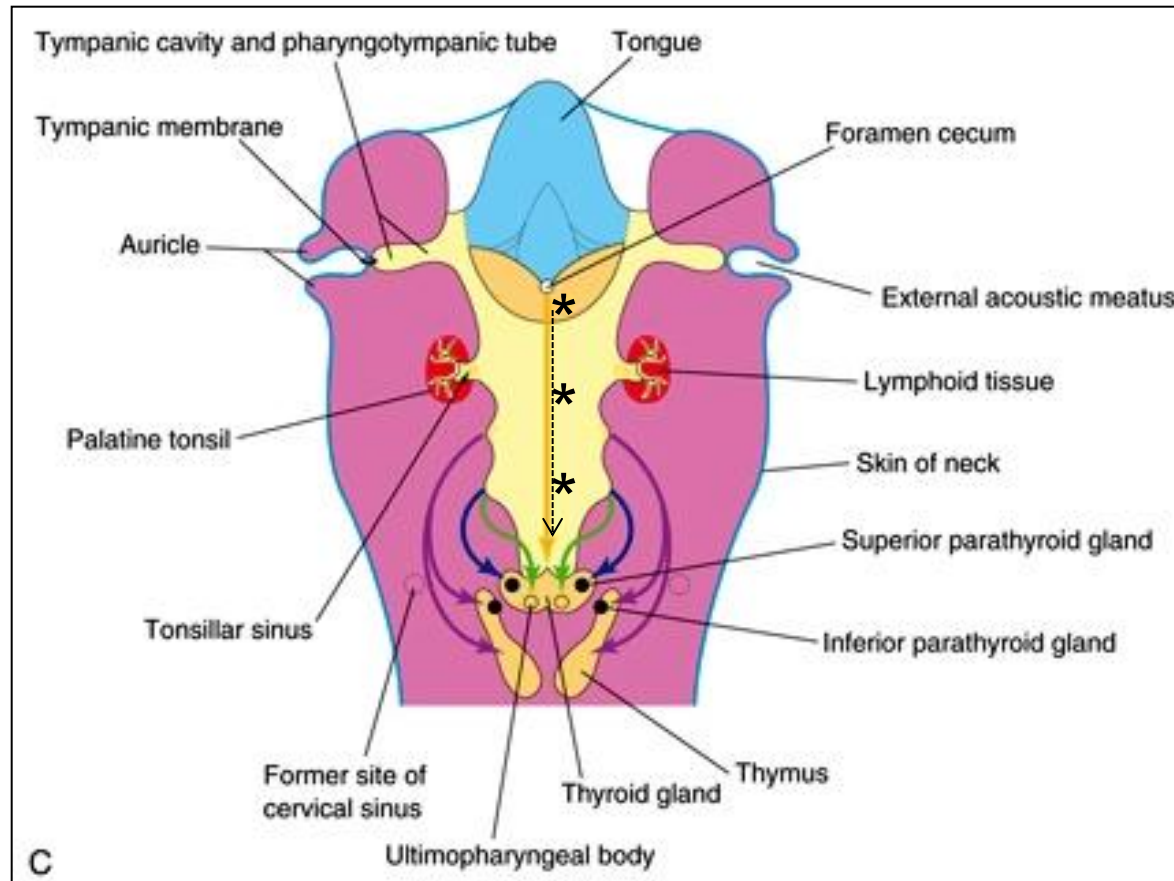
Development of thyroid gl.

4th w.

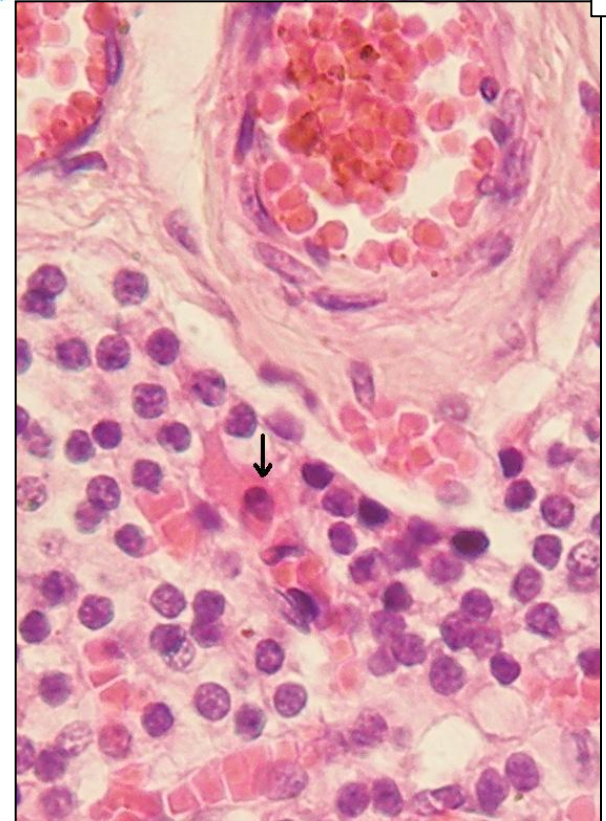
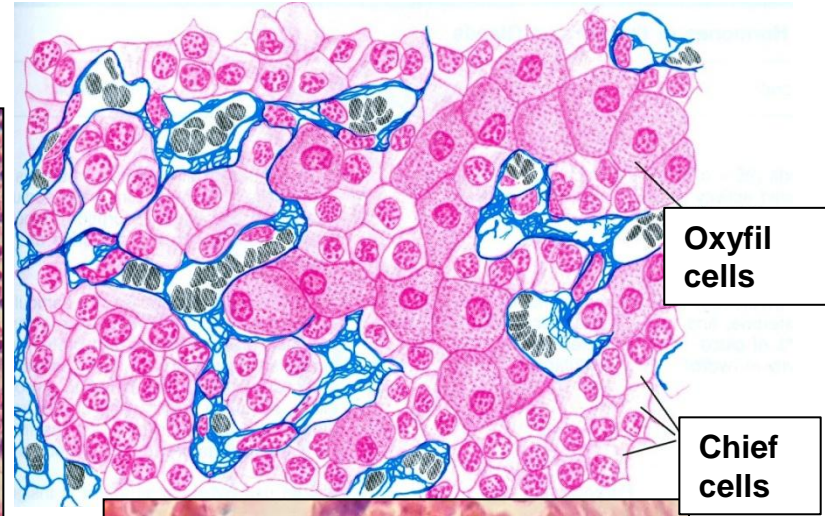
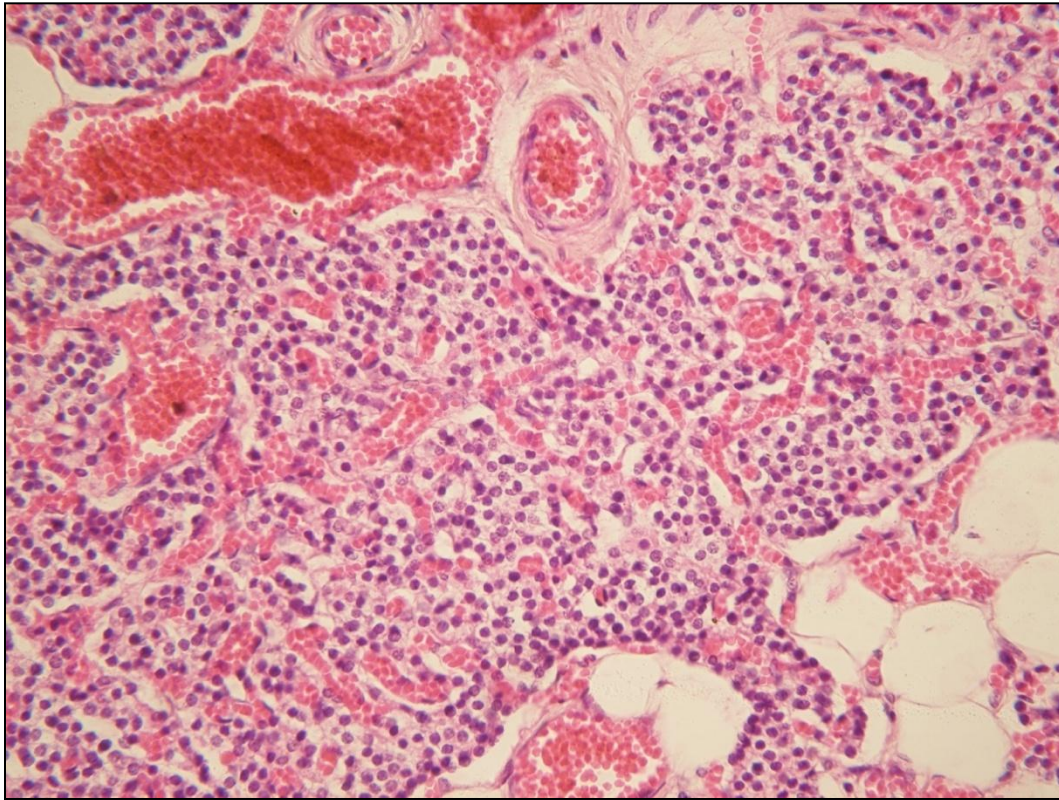
From **endoderm** of the floor of the primitive pharynx **proliferation and migration of cells (*)** to the neck region.
Thyroglossal duct – formation of thyroid lobes, follicles (endoderm), connective tissue capsule and septa (mesenchyme)

9th w. - entodermal cells differentiate into **follicular cells**

parafollicular cells migrate from ultimobranchial body – 4th/5th pharyngeal pouch



Parathyroid gl. – cords of cells: **chief** and **oxyfil** (↑), surrounded by rich capillary network, reticular fibers, adipocytes



PARATHYREOID GL.

Chief cells

Shape: small, polygonal

Number: the most numerous

Cytoplasm: LM: light or basophil (!!)

Nucleus: oval, lighter

Function: PARATHORMON

increase level of blood calcium
(stimulate osteoclasts)

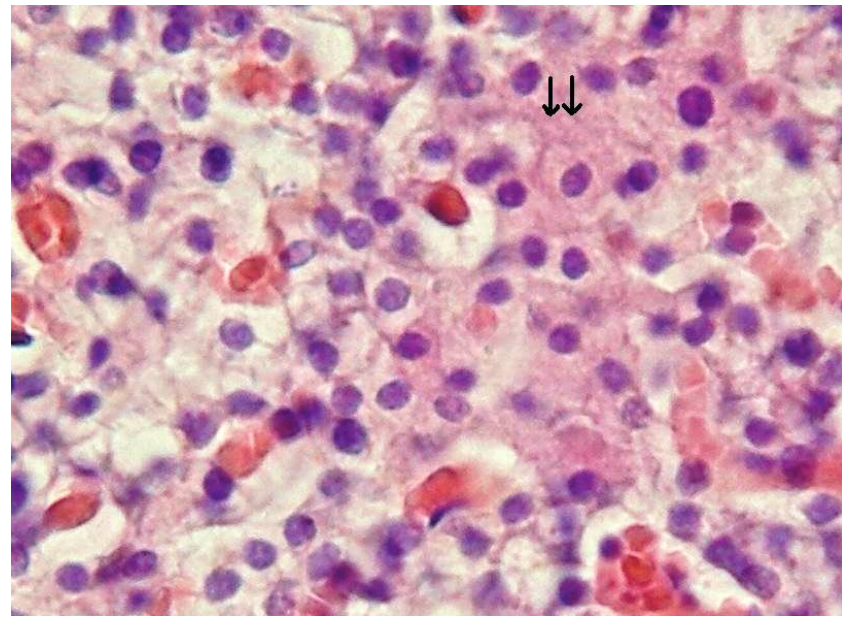
(!!) EM:

- light cells

high content of glycogene; (LM light cytoplasm)

- dark cells = active secretory phase

(rER, dense granules, no glycogene granules)



Oxyphil cells (chromophil) ↓↓

Shape: large, polygonal

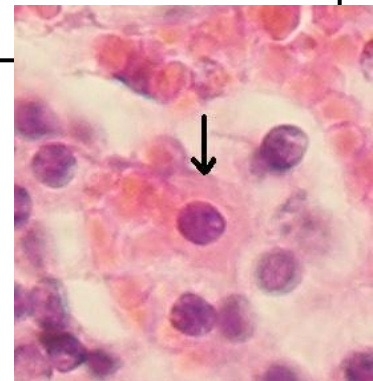
Number: less frequent, single or in groups

Cytoplasm: eosinophilic

Nucleus: small, dark - pycnotic

Appear at 10 - year

Function: not known

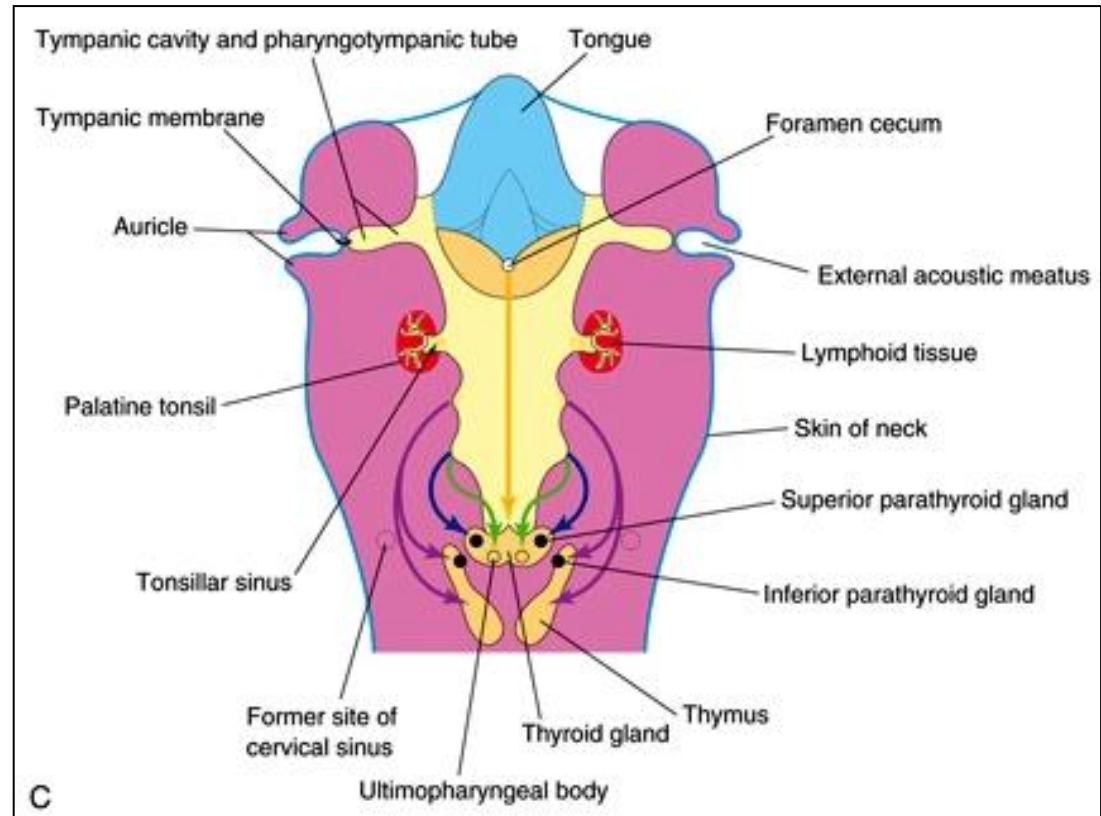
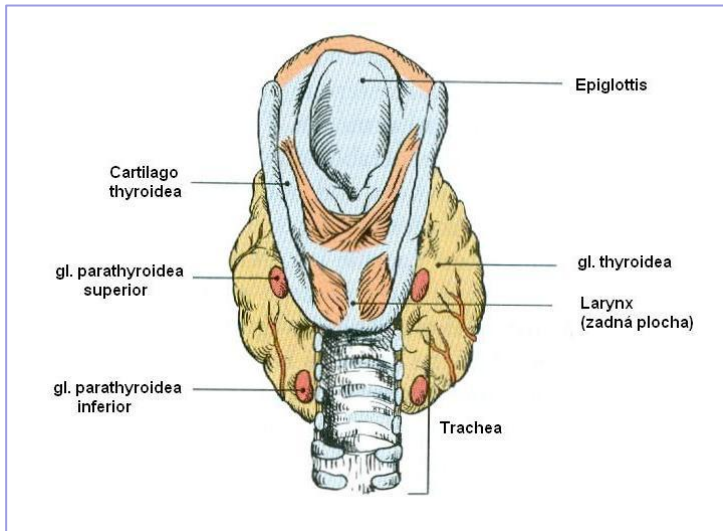


Development of parathyroid gland

Glandulae parathyreoideae → superior - from 4th pharyngeal pouch
→ inferior - from 3rd pharyngeal pouch

Chief cells - from endoderm; cells produce parathormone during fetal life.

Oxyphil cells - differentiation after birth.



ADRENAL GLAND (suprarenal gli.)

1. CONNECTIVE TISSUE CAPSULE

2. CORTEX (steroid producing cells)

➤ Zona glomerulosa

H: **aldosterone**

F: reabsorption of sodium ions in the kidney,
regulation of the blood pressure

➤ Zona fasciculata

H: **glucocorticoids** (cortisol, corticosterone)

F: increase of blood glucose
by gluconeogenesis

➤ Zona reticularis

H: androgens, glucocorticoids

F: control of male
secondary sex characteristics

3. MEDULLA (secretion of catecholamines)

a. **Chromaffine cells**, they are modified sympathetic neurons, which lost their processes during development.

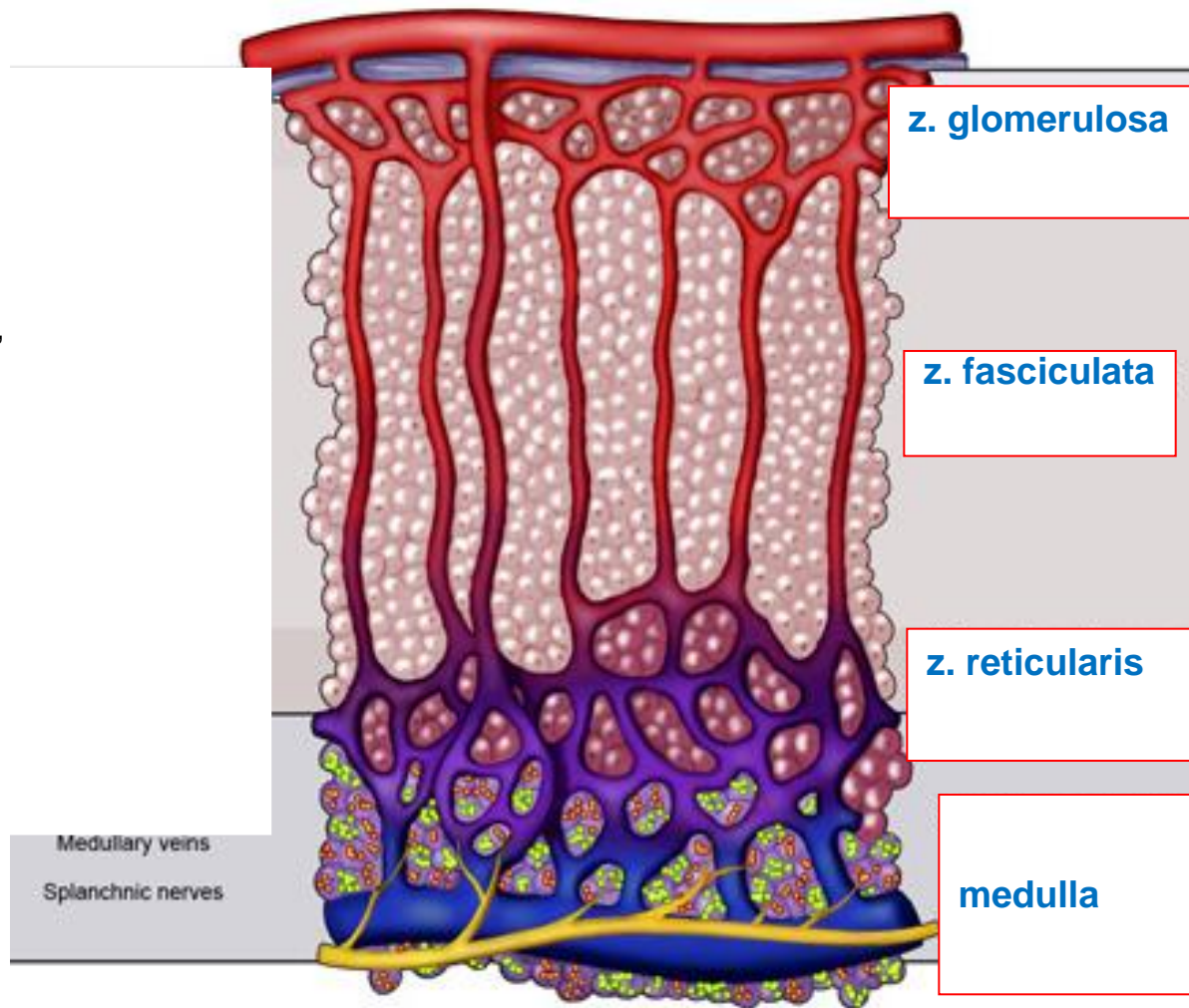
b. blood vessels and capillaries

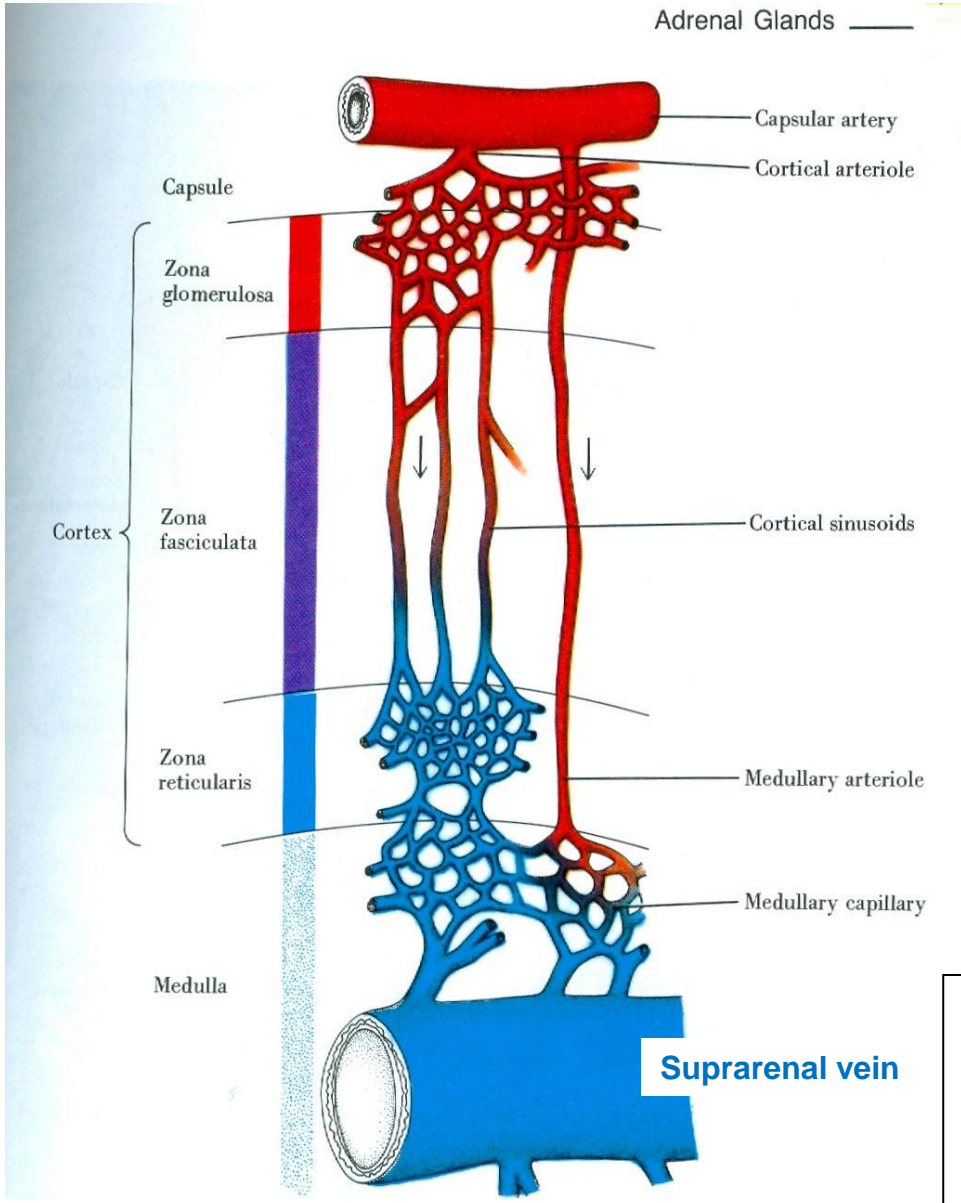
c. sympathetic ganglia cells

FUNCTION: Release catecholamines: **epinephrine** and **norepinephrine**.

Stimulate glycogenolysis, increase of blood pressure, heart beat, vasodilation

Endocrine cells in the cortex and medulla are arranged in cords, surrounded by reticular fibers and capillaries.





Blood circulation in adrenal gl.

- capsular artery
- cortical arteries form capillary network around cords of cells
- medullary aa.
 - straight,
 - cross the cortex;
 - in the medulla start to branch to medullary capillaries
- suprarenal vein – in the medulla medullary capillaries

DEVELOPMENT OF ADRENAL GLAND

Cortical cells develop from intermediate mesoderm.

Medullary cells originate from neural crest cells that migrate from neighboring sympathetic ganglion.

- 7th month of development fetal cortex forms about 70%
- the permanent cortex develops outside of the fetal cortex
- at the 4th month permanent cortex with typical zones replaces fetal cortex

PANCREAS

Exocrine gl. – serous acini

Endocrine part (1%) – Langerhans islets

Endocrine cells arranged in cords, rich capillary network

- A cells (glucagon) on periphery of islet
- B cells (insulin), 60-80 %, centrally
- C cells - undifferentiated
- D cells (somatostatin)
- F cells (PP- pancreatic polypeptide)
- E cells (ghrelin) - hormone of hunger?

DEVELOPMENT : endodermal origin

