

MICROSCOPIC STRUCTURE, HISTOPHYSIOLOGY AND DEVELOPMENT OF ENDOCRINE GLANDS

Hormones – classification

Components of the endocrine system

Principles of humoral regulation

hormones = chemical signals used for communication between cells

more than 60 hormones classified as

- **amino acids analogues and derivatives**
- **peptide or protein hormones**
- **steroid hormones**

receptors are chemically defined sites bound with cell membranes

Endocrine system

- **endocrine glands** - hypophysis, pineal, thyroid, parathyroid, and adrenal

- **endocrine cell groups located within glands with exocrine or other functions** (islets of Langerhans in the pancreas, Leydig cells in testes, granulosa cells in ovaries, juxtaglomerular apparatus of kidneys, trophoblast cells of the placenta)

- **cells with endocrine function that are scattered in nonglandular organs** (as a gut, stomach, trachea, etc.) - **e.g. GEP cells**

Endocrine glands (glandulae sine ductibus)

- have no ducts
- have exceptionally rich blood supply
- secrete hormones that pass into the circulatory system and induce a response of specific target cells, tissues, or organs

- hypophysis
- epiphysis
- thyroid gland
- parathyroid gland
- adrenal gland
- islets of Langerhans

Hypophysis (hypophysis cerebri, glandula pituitaria)

sella turcica
0.6 – 0.7 g

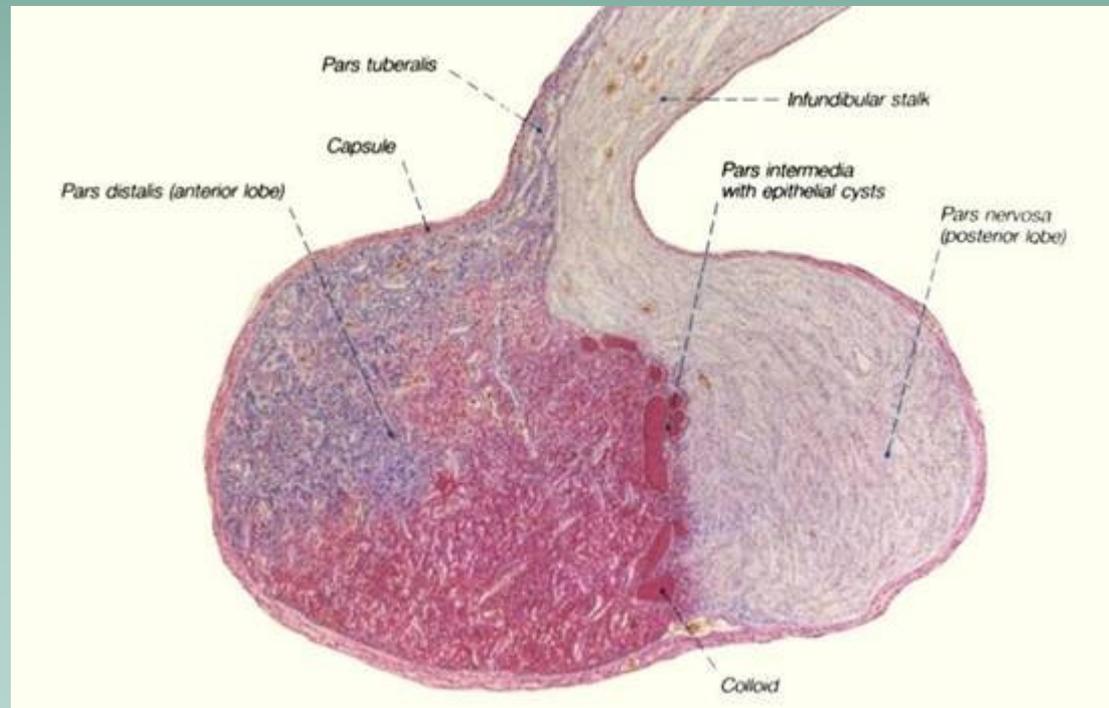
adenohypophysis:
(anterior lobe)

pars distalis (75 %)
pars intermedia
pars tuberalis

neurohypophysis:
(posterior lobe)

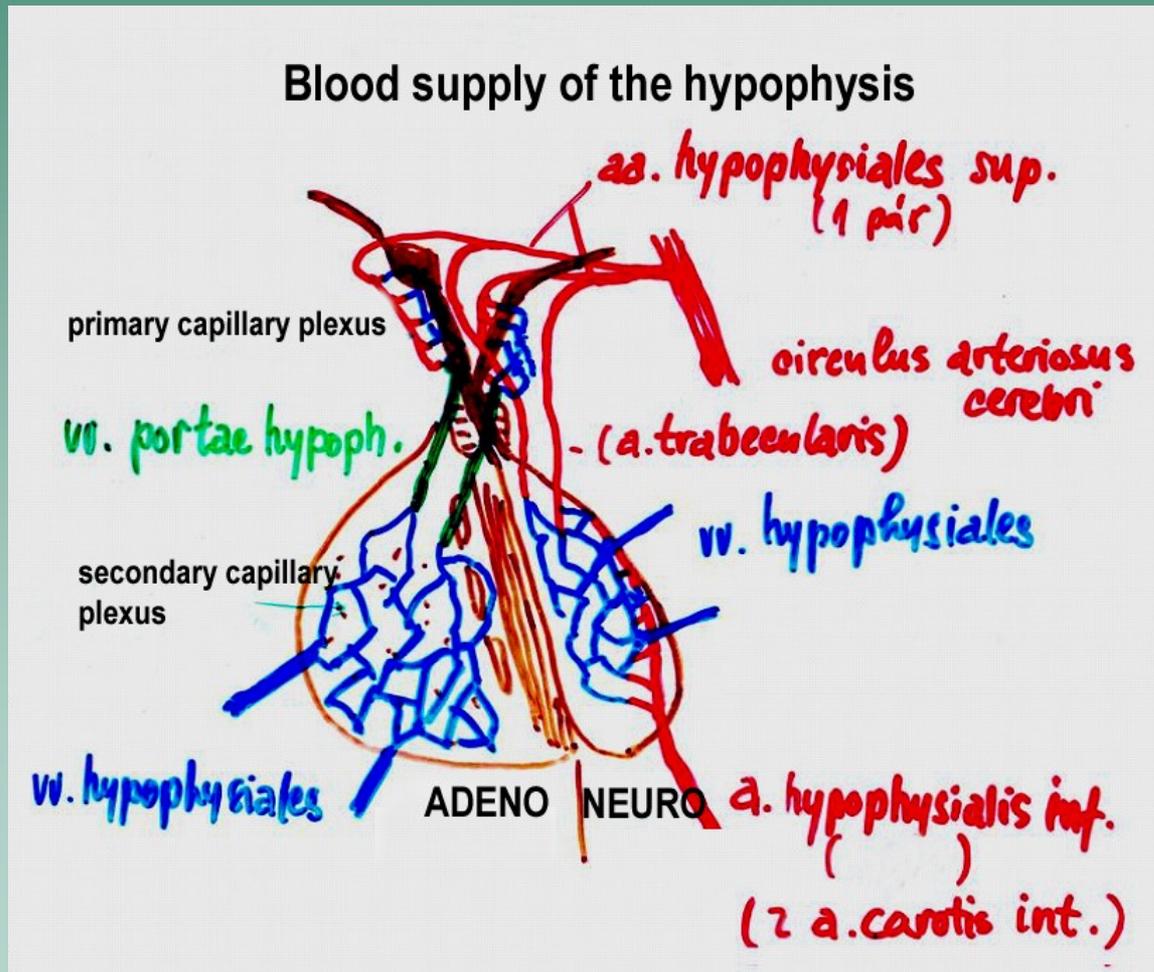
infundibulum (infundibular stem)
pars nervosa

lobes are enveloped by a thin common connective tissue **capsule**, from which delicate septa with blood vessels and nerves project into the **parenchyma**



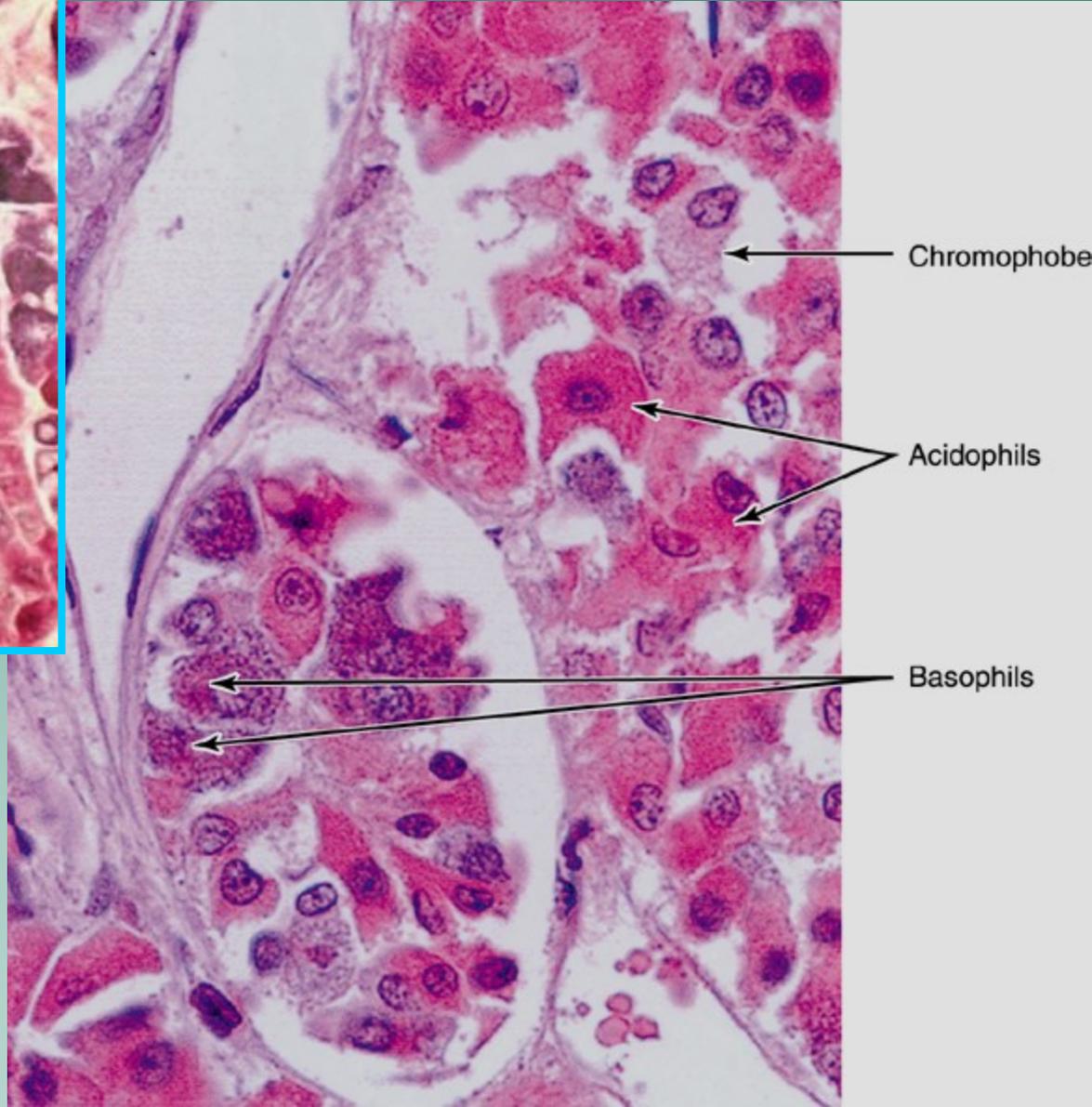
Blood supply: direct arterial supply has only **neurohypophysis** (from two sets of vessels - *superior hypophyseal arteries* and *inferior hypophyseal arteries*).

The adenohypophysis is drained by **hypophyseal portal veins**, which arise from the primary capillary plexus in the region of the median eminence and infundibular stem



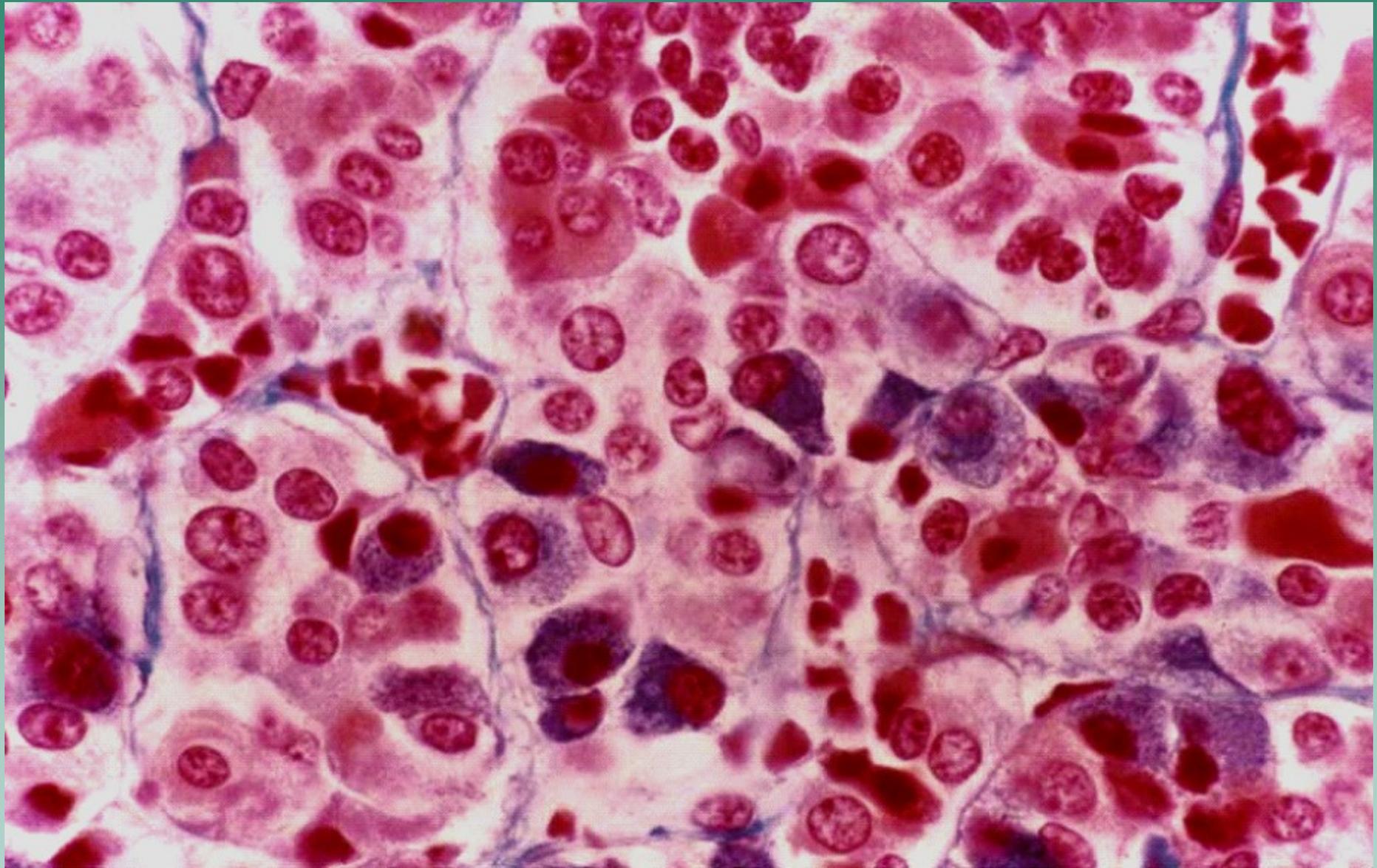
Pars distalis

is made up of cords of glandular cells among them are blood sinusoids



Cells:

- chromophobic cells - 10-15%
- chromophilic cells
 - acidophilic cells - 50 %
 - basophilic cells



Sinusoid

Alpha (α) cell

Epsilon (ϵ)
acidophil cell

Hyperchromatic beta (β) cell

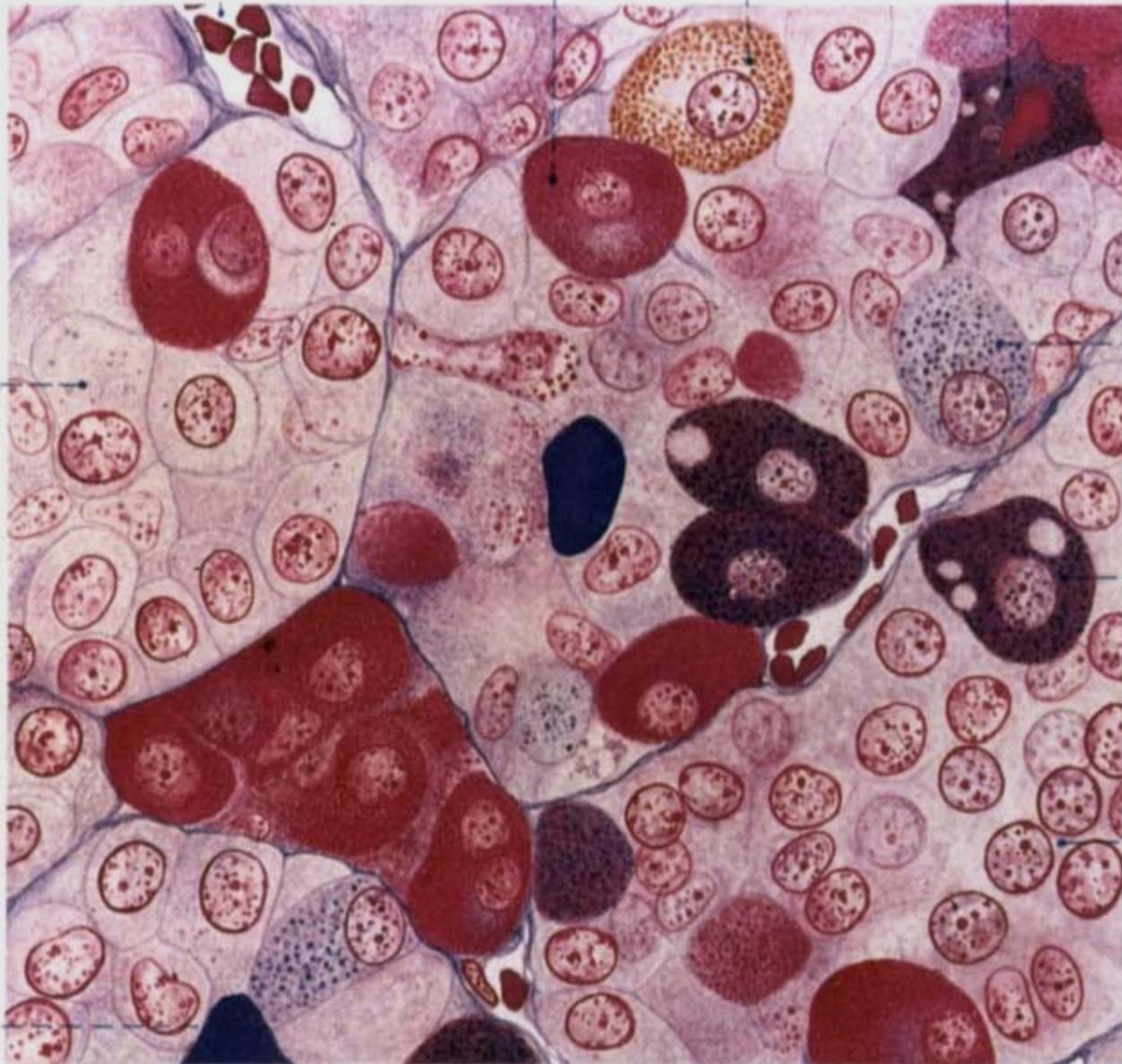
Gamma (γ) cell

Delta (δ) basophil cell

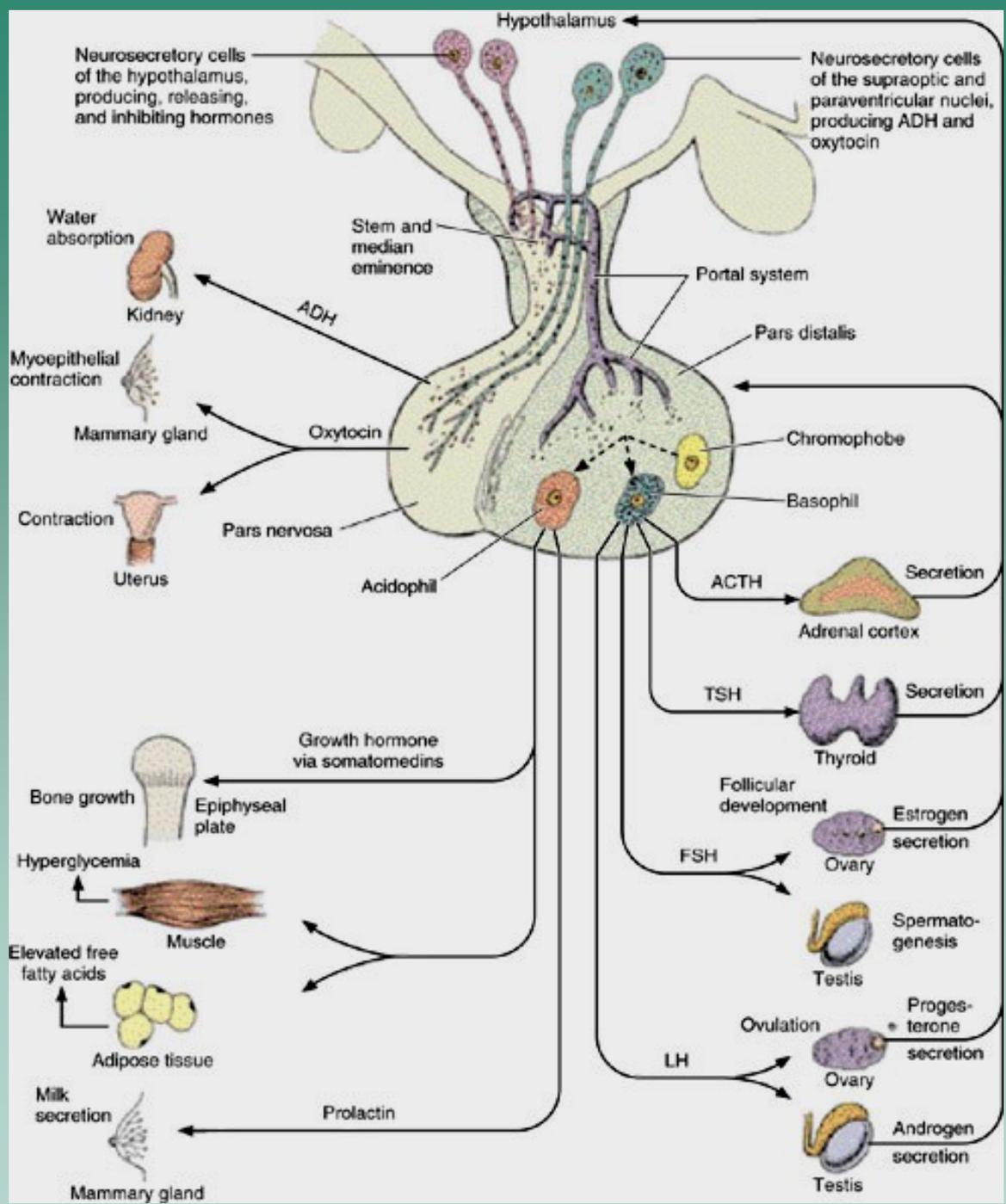
Beta (β) cell

Undifferentiated C cells

Colloid



by immunohistochemistry:



Acidophils

somatotropic cells

lactotropic cells

Basophils

**adrenocortico
tropic cells**

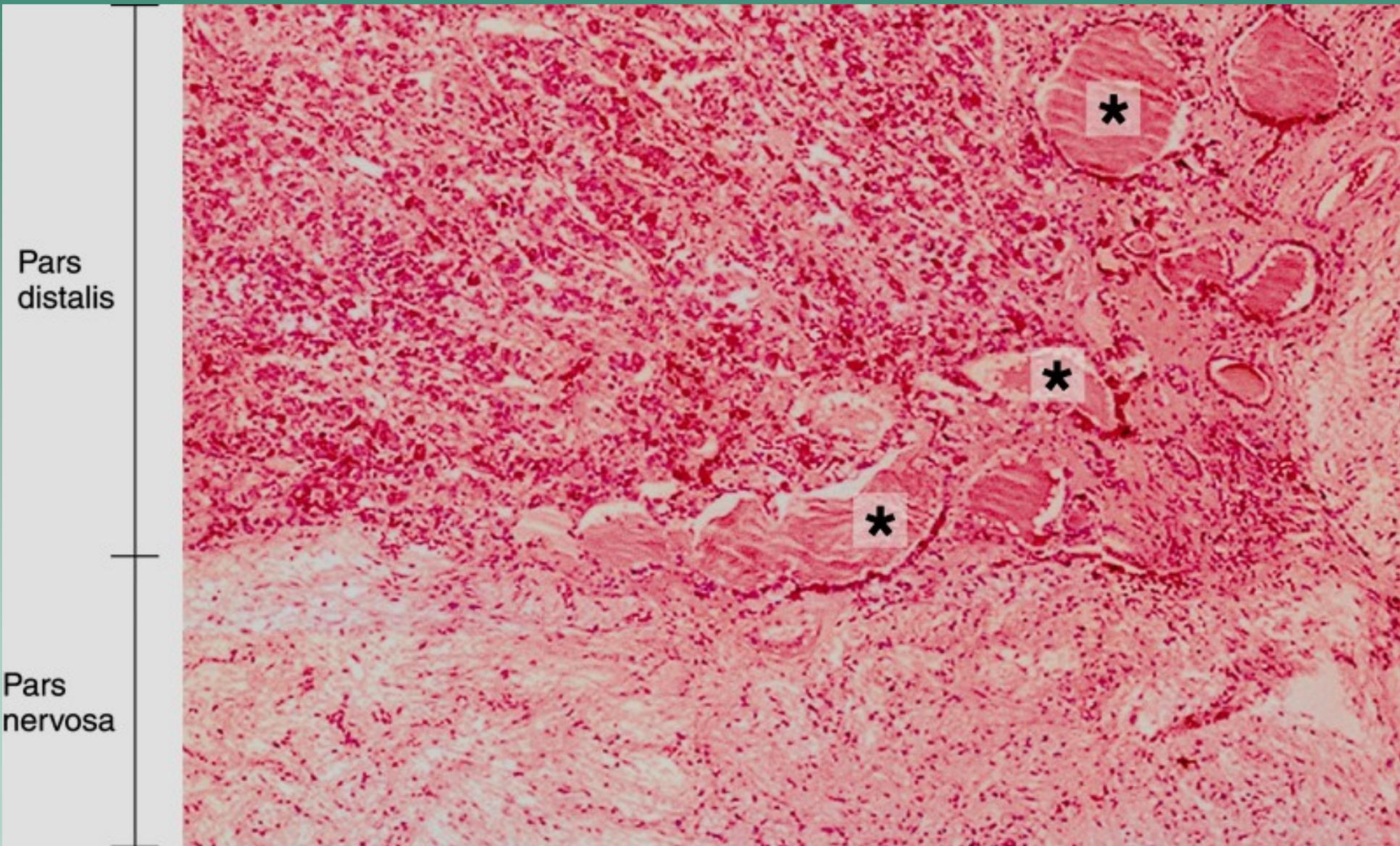
**thyrotropic
cells**

**gonadotropic
FSH cells**

**gonadotropic
LH cells**

Pars intermedia

consists of small cystic cavities (residua of Rathke's pouch) that are limited by **basophilic and chromophobic** cells; basophils produce **MSH - melanocyte-stimulating hormone** (in amphibians) - in the human its function is unclear



Pars tuberalis

surrounds infundibular stem, 25 – 60 μ m thick, is highly vascularized and composed of clusters of basophils and chromophobic cells; basophils are supposed to secrete gonadotropic hormones (FSH, LH)

Neurohypophysis (posterior lobe)

composed of **pars nervosa** and **infundibular stem**

The pars nervosa:

- **pituicytes** - irregular-shaped cells with numerous processes
- **axoterminals** and **nonmyelinated nerve fibers** (whose cell bodies are in the hypothalamus (**nc. supraopticus, nc. paraventricularis, nc. tuberalis**))
- **fenestrated capillaries**

Function:

release site of hormones:

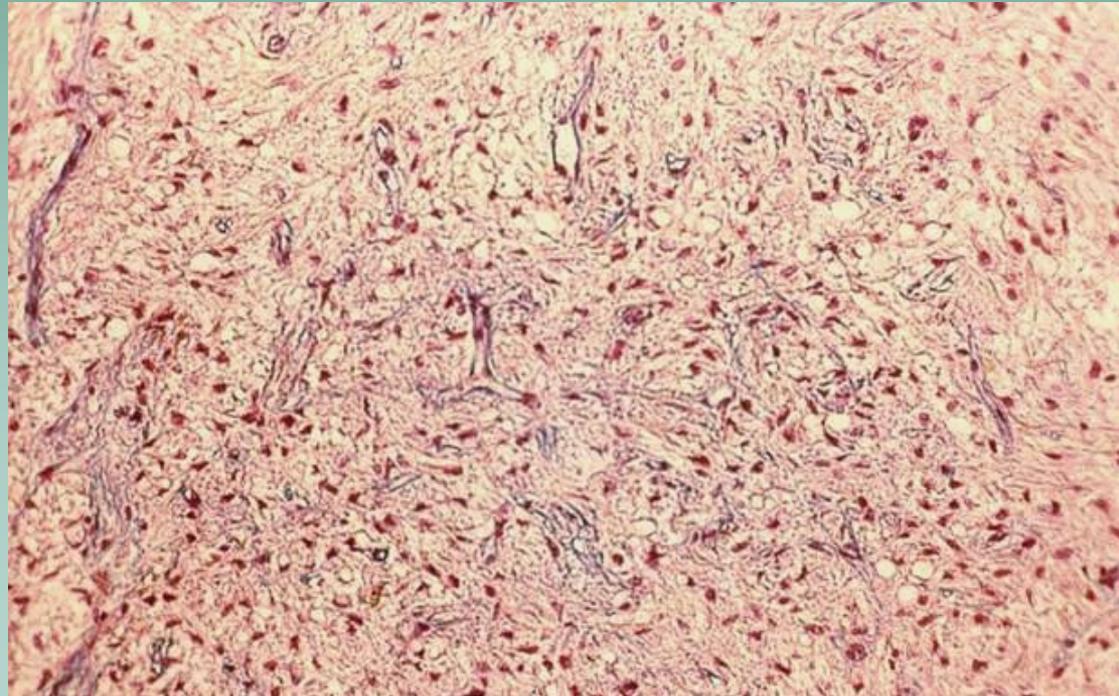
ADH (vasopresin)

oxytocin

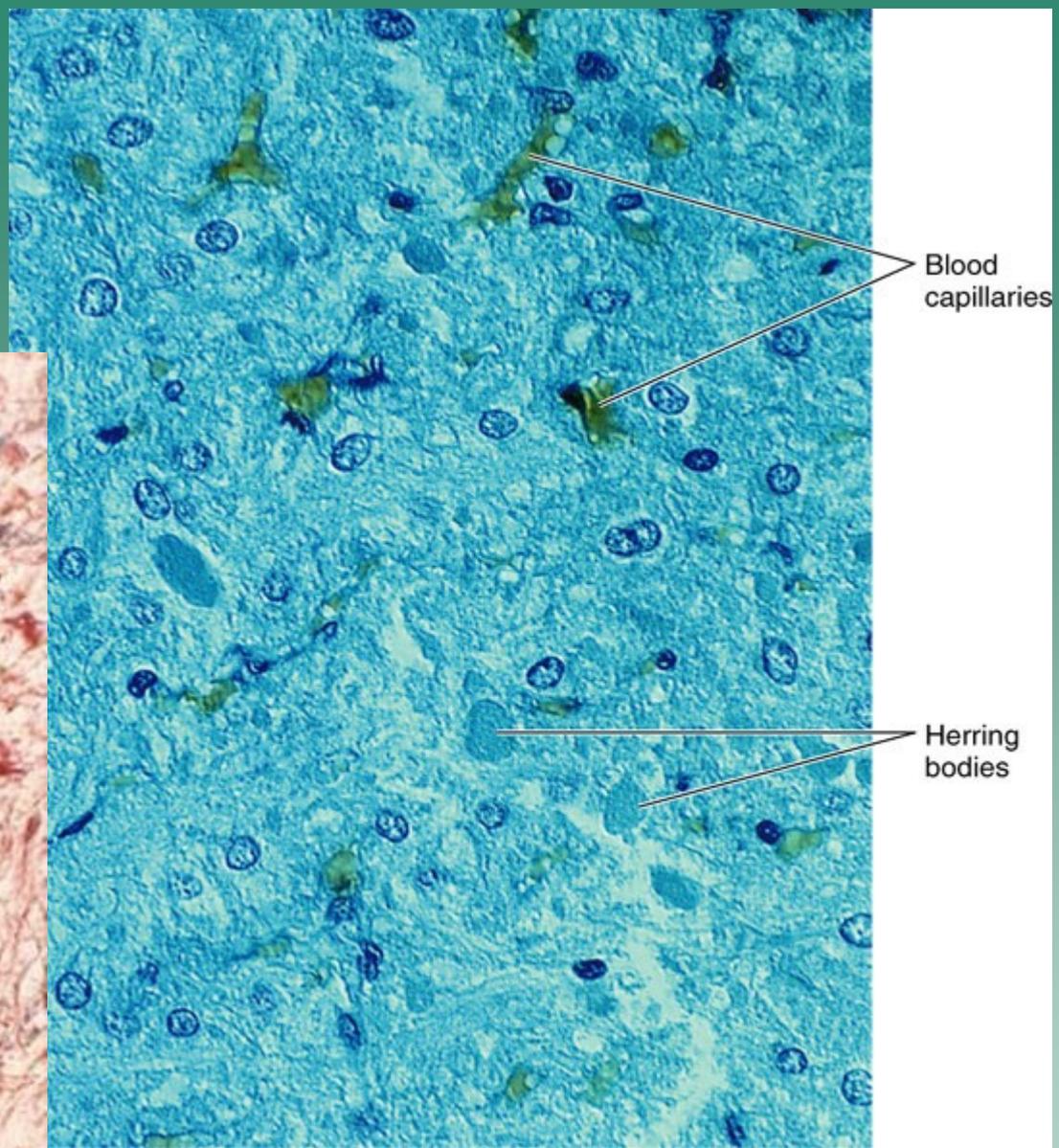
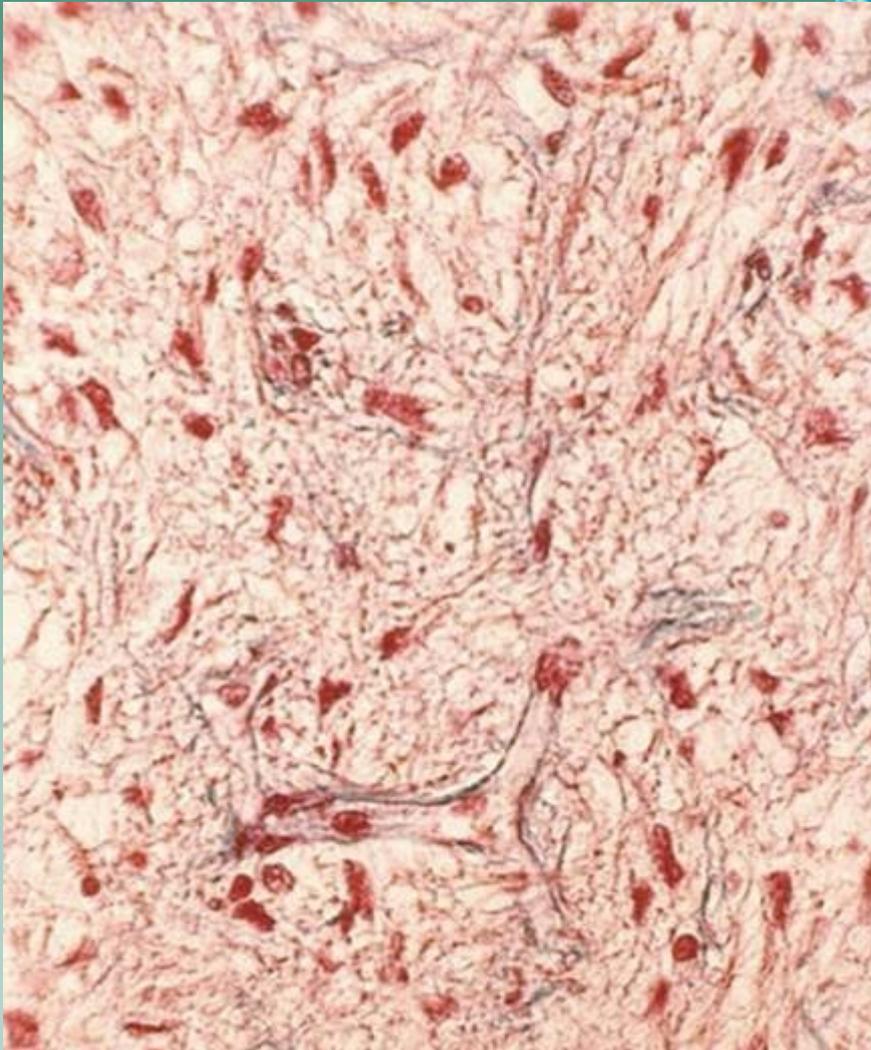
synthesized by nerve cell bodies and are transported by axons in the infundibular stem or pars nervosa

neurosecretion

are seen at preaxoterminal sites as Herring's bodies



Pars nervosa



Infundibular stem:

cca 100 000 neurites of nerve cells hypothalamic nuclei
(tr. hypothalamohypophysealis)

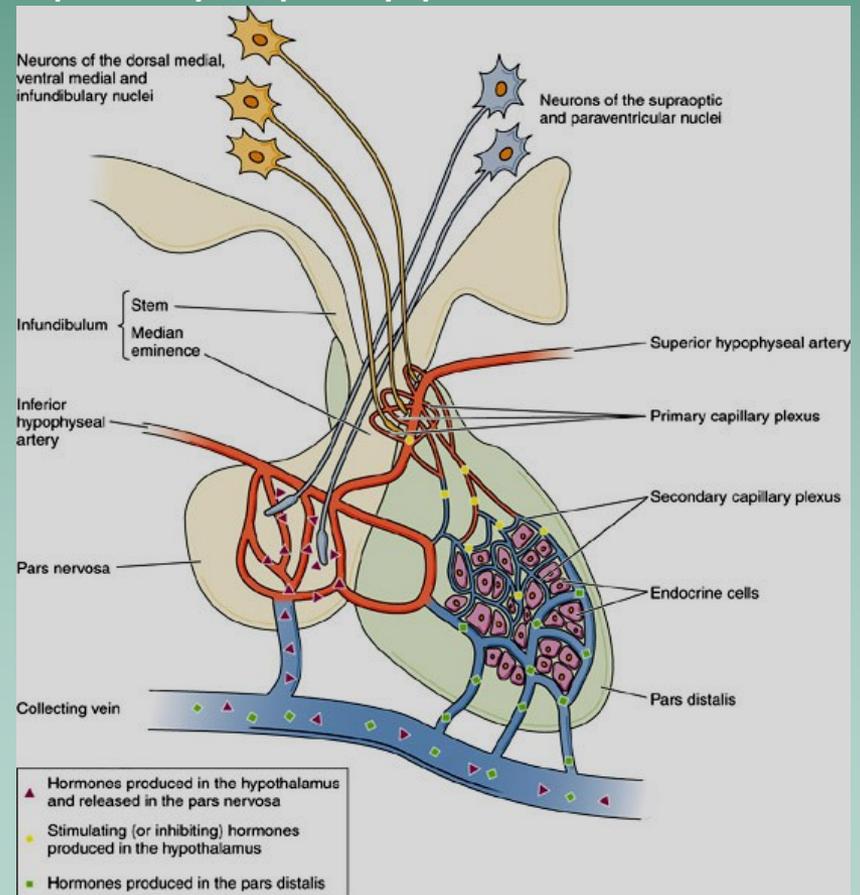
ncl. supraopticus a ncl. paraventricularis (large neurons)

ncl. tuberales (nc.hypothalamicus ventromedialis et dorsomedialis, ncl. infundibularis) - small neurons

axoterminals end near capillaries of the primary capillary plexus

hypothalamic regulatory factors (inhibins and liberins)

are transported via vv. portae hypophysis to the pars distalis

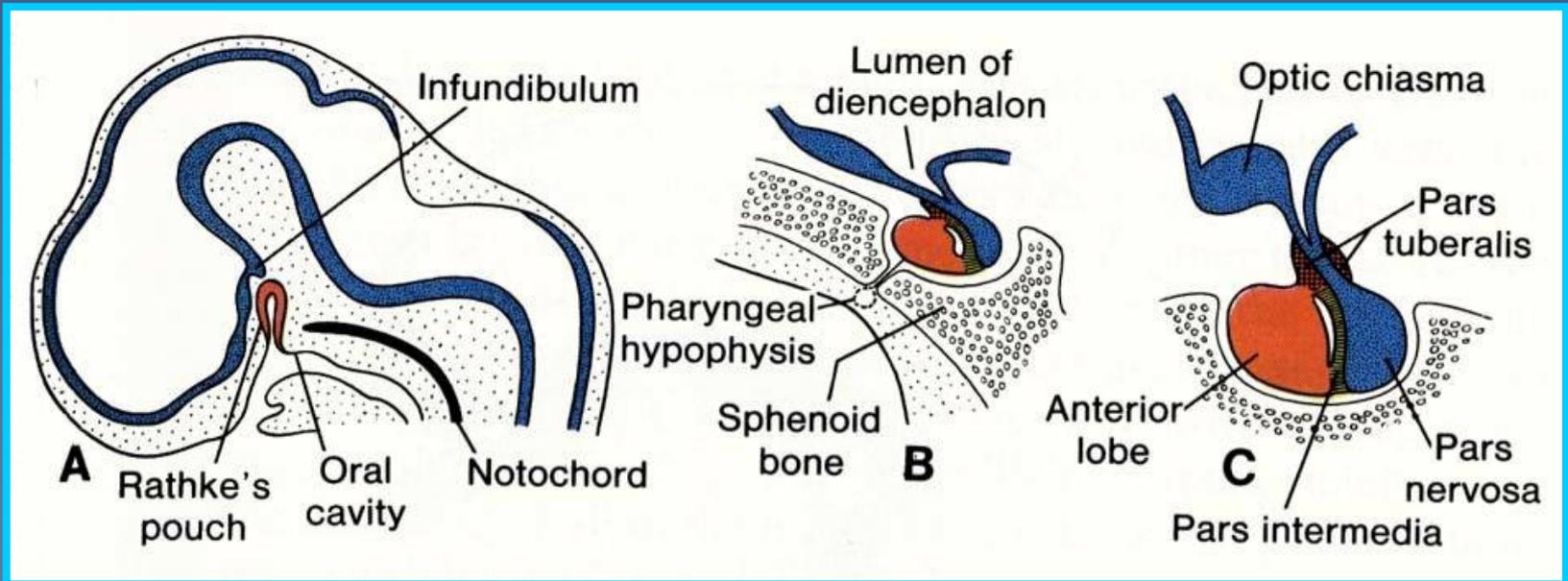


Development of the hypophysis

2 anlagen

adenohypophysis - ectoderm of the Rathke's pouch

neurohypophysis - neuroectoderm of the ventral wall of diencephalon



the Rathke's pouch occurs on day 21 as tubular invagination of the roof of stomodeum growing dorsocranially against the base of diencephalon

at the same time, base of diencephalon proliferates to form resessus infundibuli

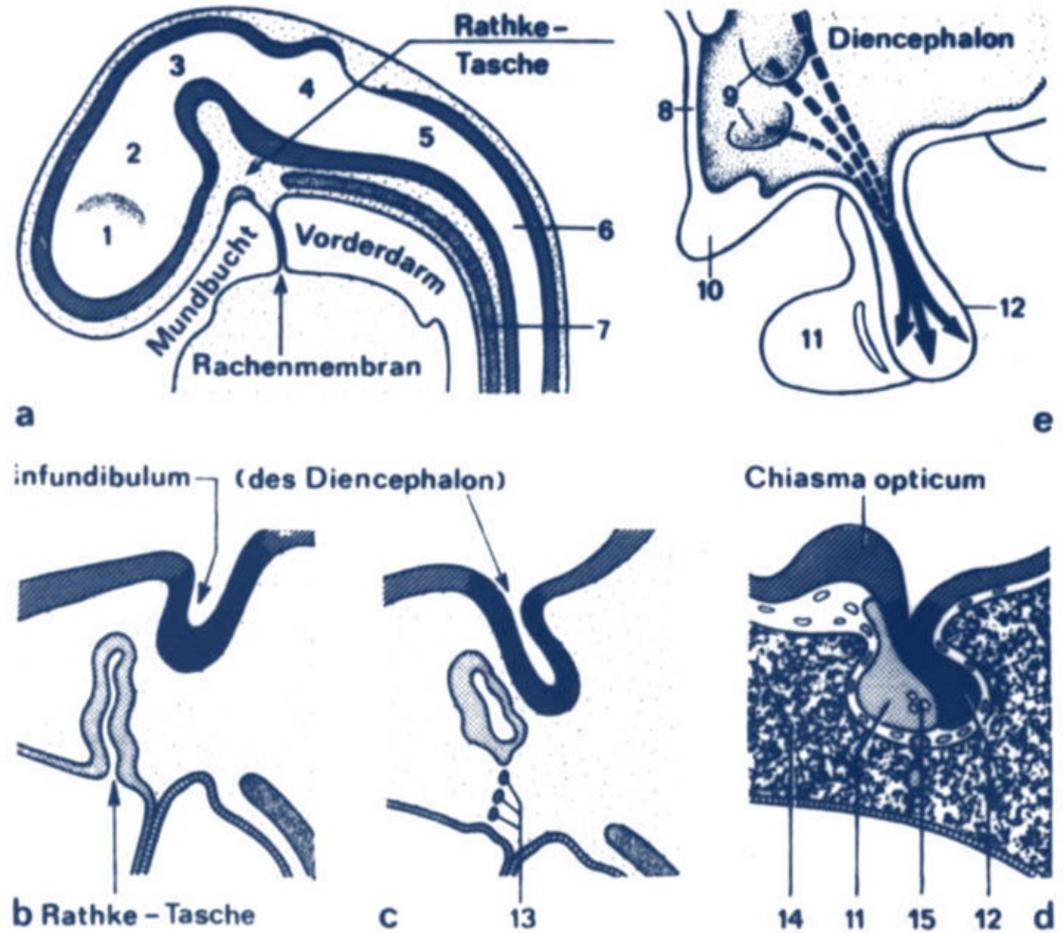
during the 5th week ends of both invaginations meet each other being to enclose by common connective capsule

in the course of the 6th week, Rathke's pouch loses connection with the stomodeum, lumen rests of the pouch persist as **Rathke's cysts filled with colloid** in the pars intermedia

between weeks 12-14 cells start their differentiation

secretion of hormones begins **with the end of the 4th month**

Hypophysis



Epiphysis - pineal gland (corpus pineale)

0.1 – 0.2 g

is of cone-shaped form, 5-8 x 5-5 mm

enveloped by a **thin capsule** with delicate septae dividing the **parenchyma** into **lobules**

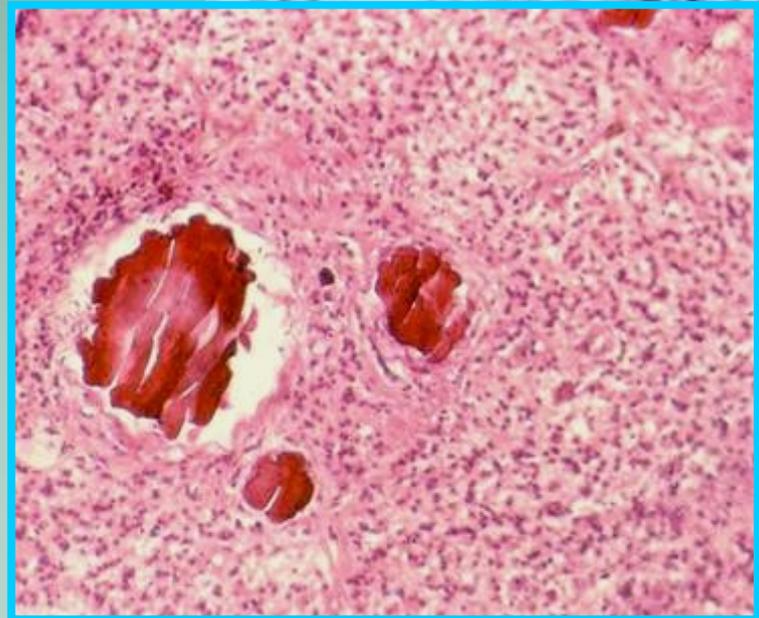
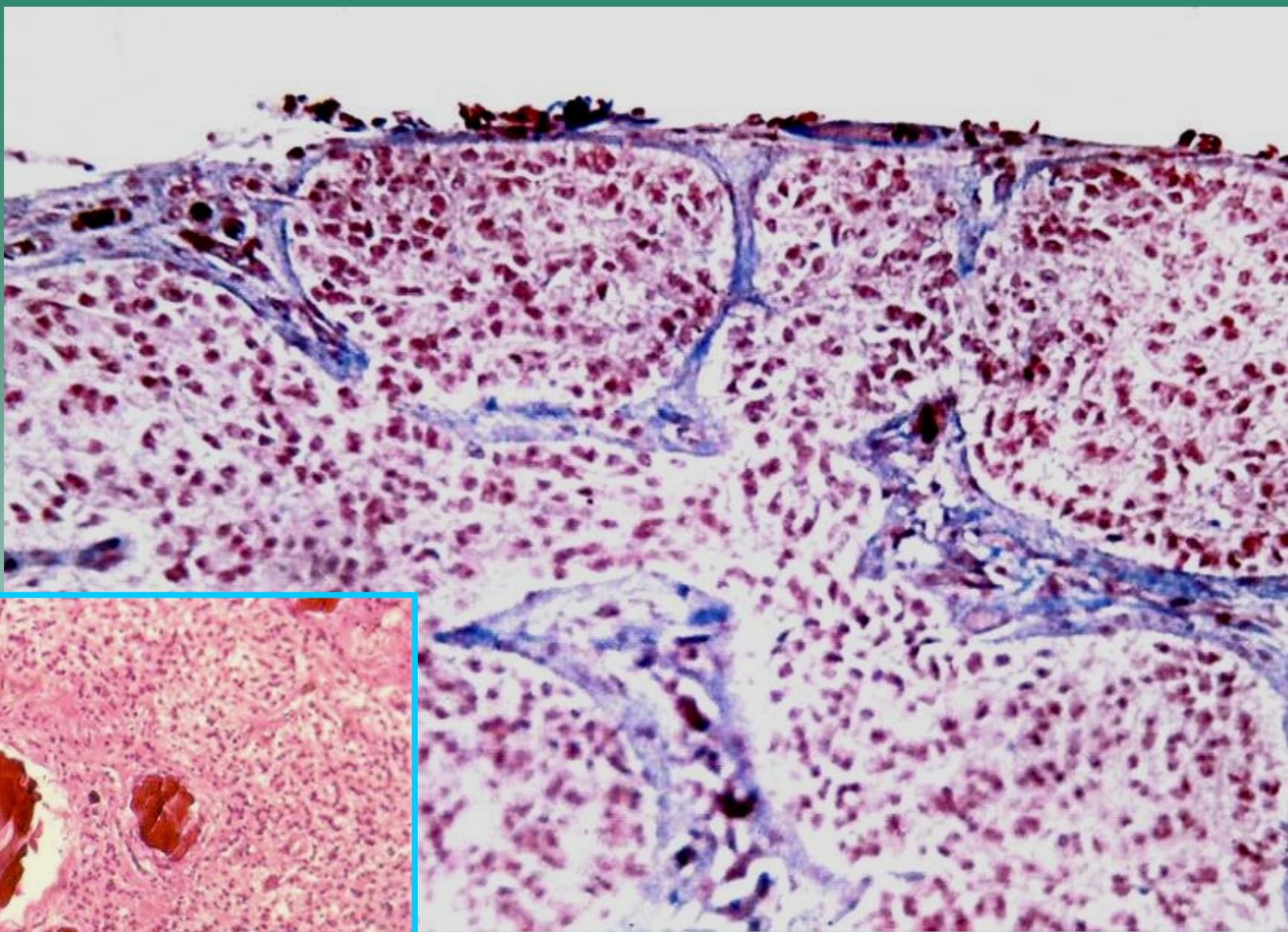
They consist of two cell types:

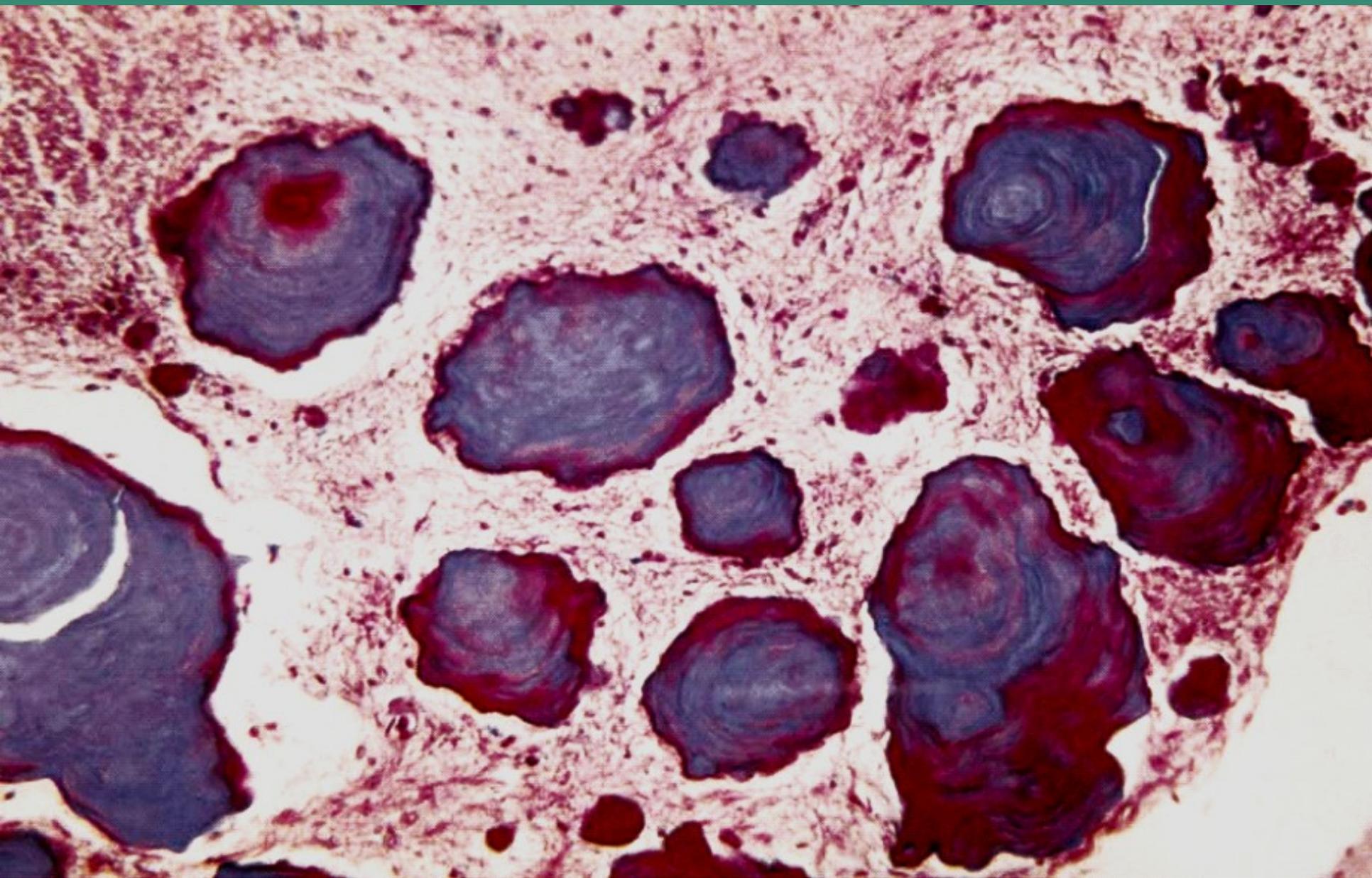
- **pinealocytes** - which are in majority and arranged in clumps or clusters; the cells are characterized by lobulated nucleus, prominent nucleoli, and membrane-bound granules in the cytoplasm
- **interstitial cells** - about 5 % (modified astrocytes of fibrillar type) and
- **non-myelinated nerve fibres and blood capillary plexus**

Pineal gland of adults contains the calcified **concretions** called as **brain sand** or **acervulus cerebri** (corpora arenacea). The concretions differ from their surrounding by deep staining and concentric appearance

Hormone: **melatonin** - inhibits steroidogenic activity of endocrine cells in gonads

Note: the tumours of the pineal are often connected with a failure of gonadal function.

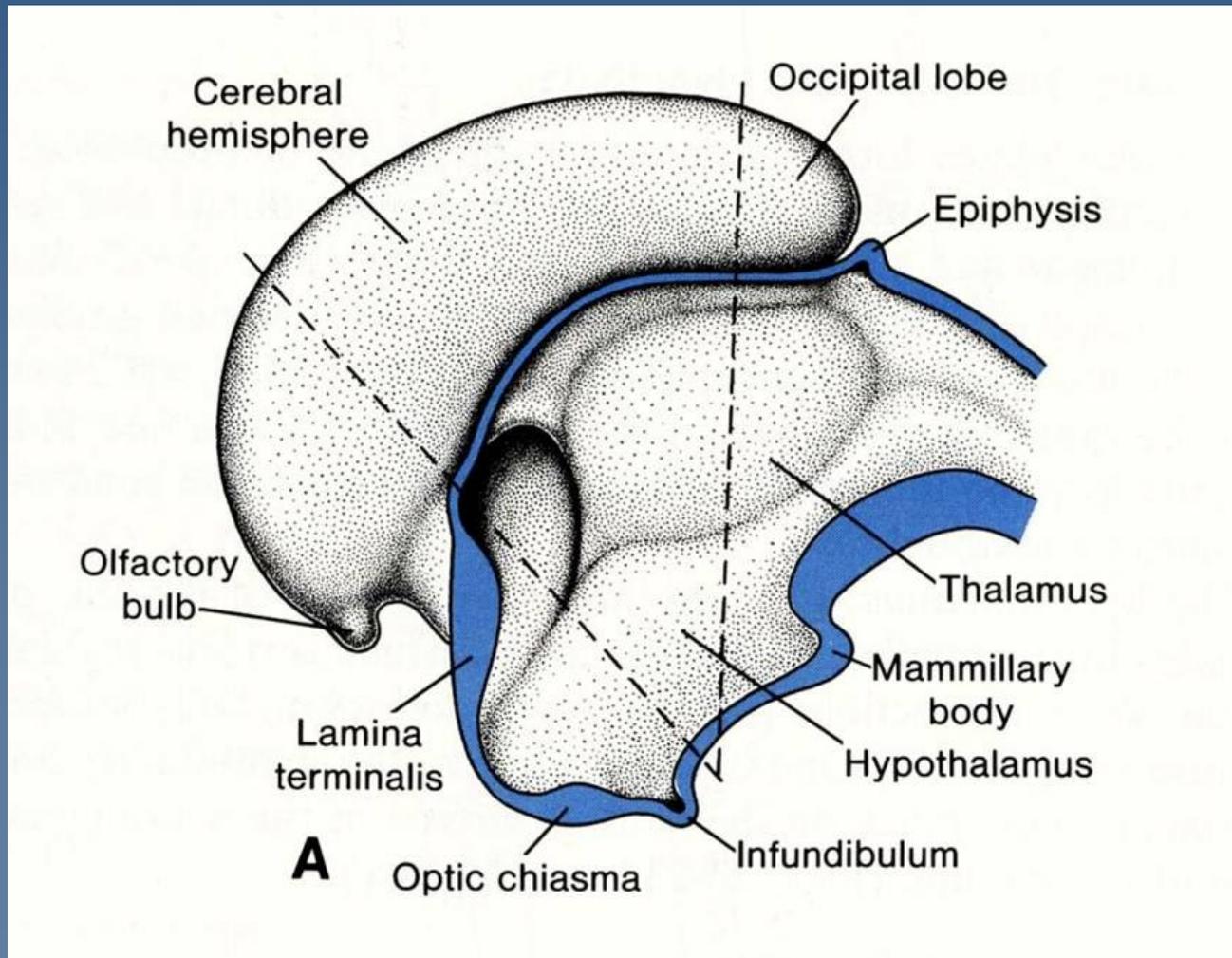




Epiphysis

gland develops from the roof diencephalon (epithalamus) to the end of the 1st month

in the 3rd month first pinealocytes start to differentiate



Glandula thyreoidea (thyroid gland)

25 – 40 g

in the anterior of the neck, below the cricoid cart.

2 lobes + isthmus

in 50 % of cases the **pyramidal lobe** (lobus pyramidalis) is found; it exits from the isthmus cranially

connective tissue capsule + septae
the **parenchyma** organized into the **lobules**

lobules are composed of the **follicles**, which vary considerably in diameter and contain gelatinous material called the **colloid**

the walls of follicles consist of simple epithelium that rests on a thin basal lamina and delicate reticular network

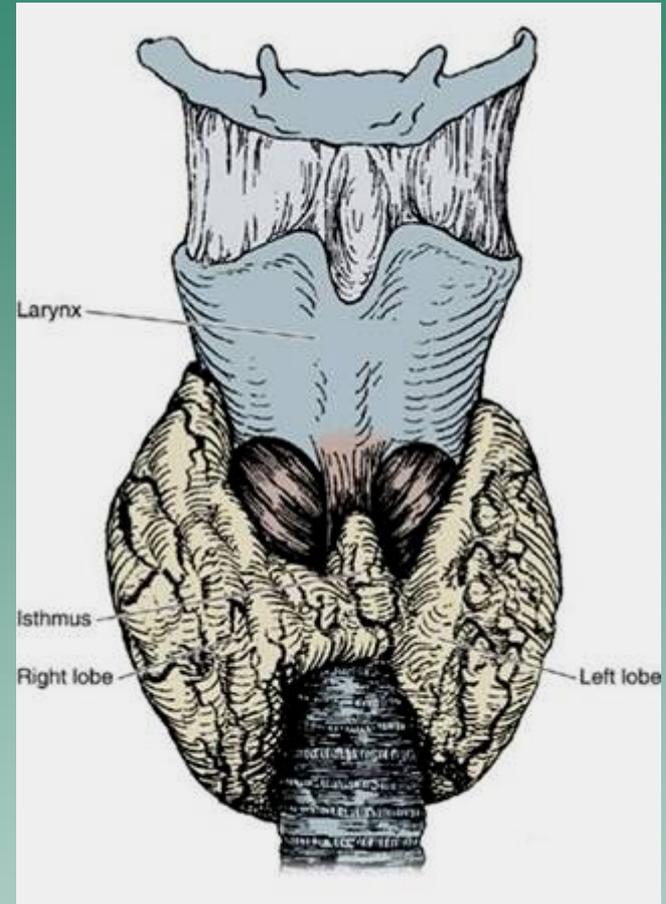
the epithelium involves mainly **follicular cells**,

which are squamous to columnar in dependance on the functional status

the cells produce colloid; it consists of mucoproteins, proteolytic enzymes and a glycoprotein called **thyroglobulin** – primary storage form of thyroid hormone

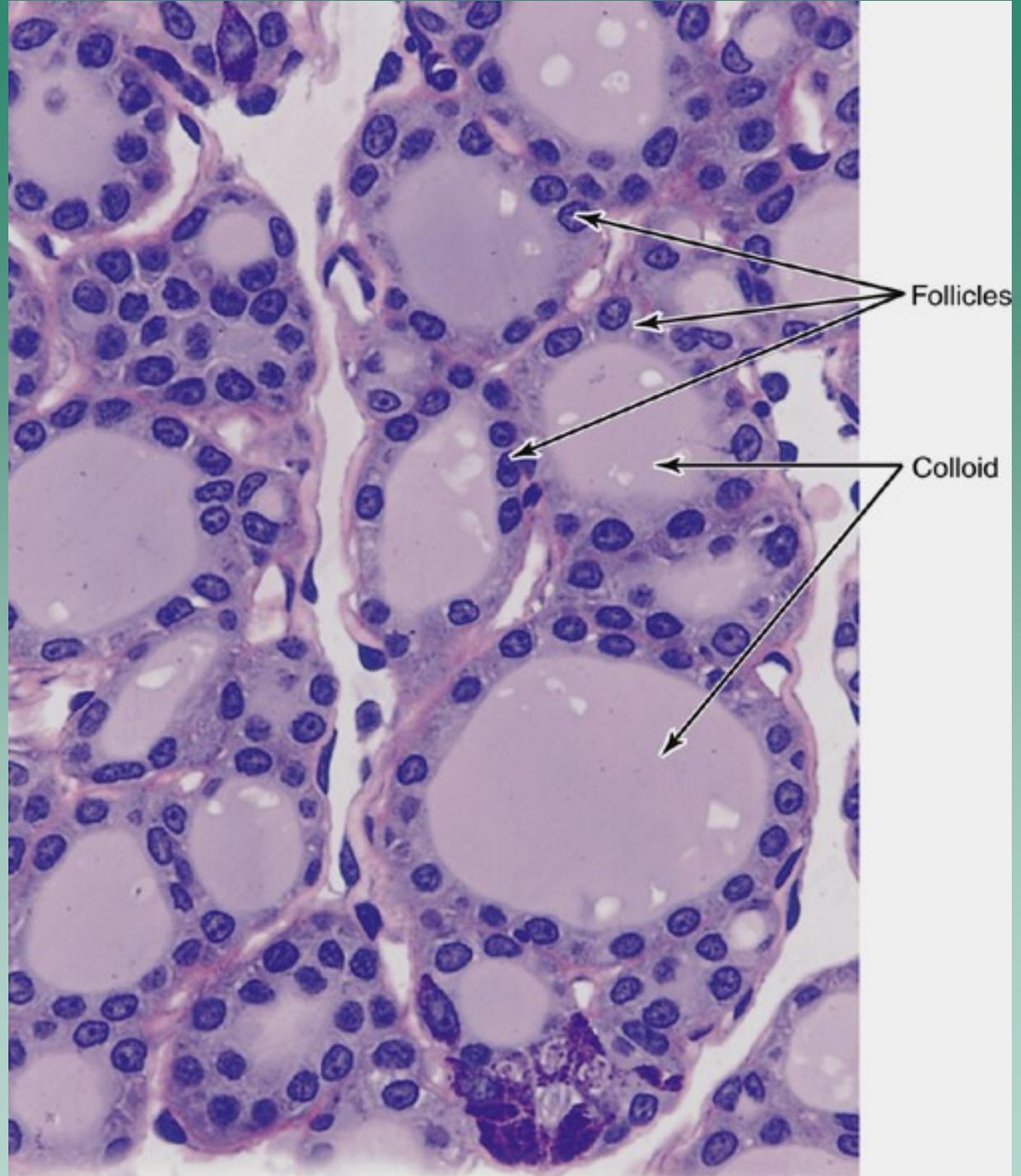
triiodothyronine (T3) + tetraiodothyronine (thyroxin, T4)

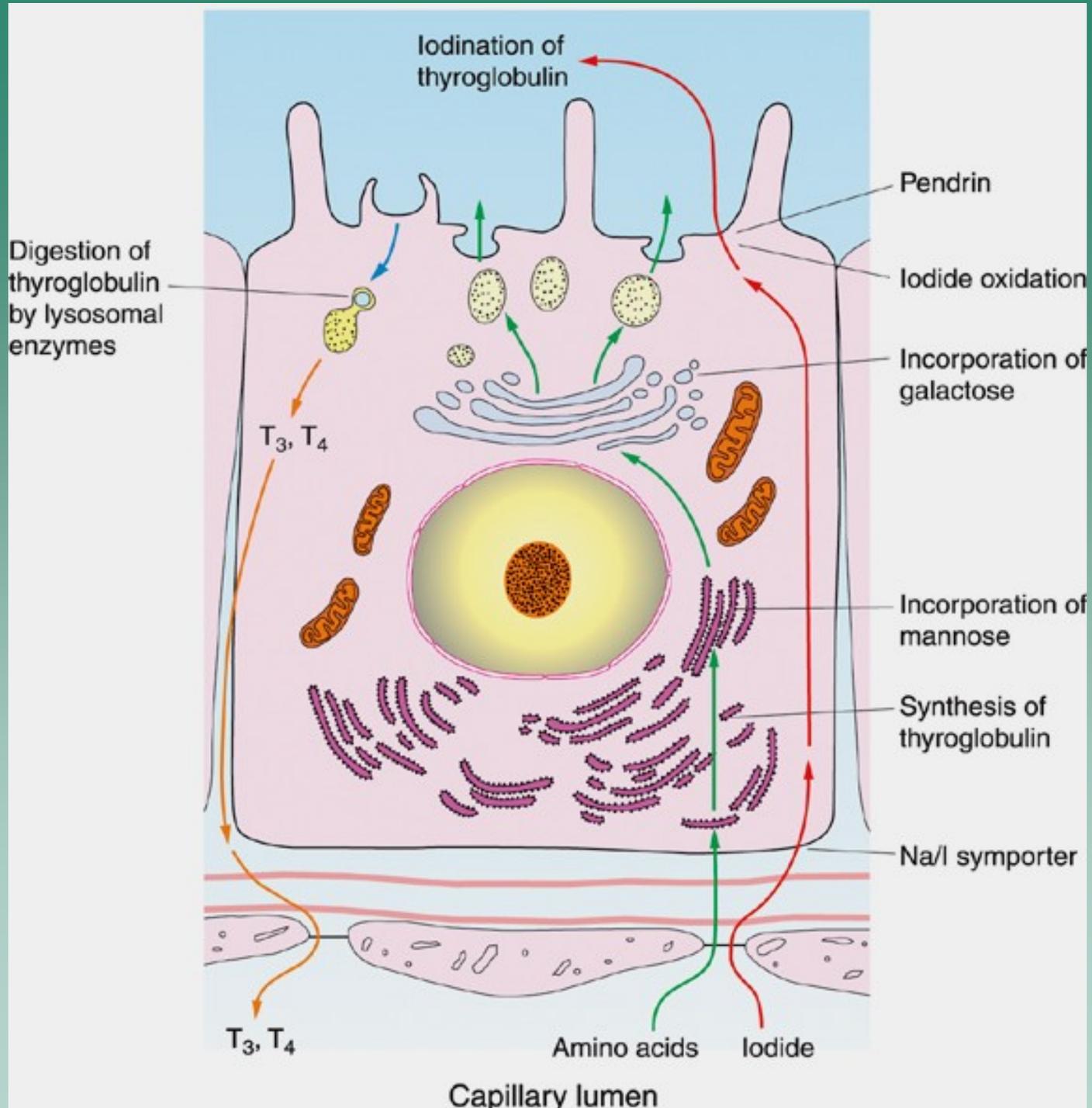
parafollicular, light or C – cells (lie immediately adjacent to basal lamina) - **calcitonin**



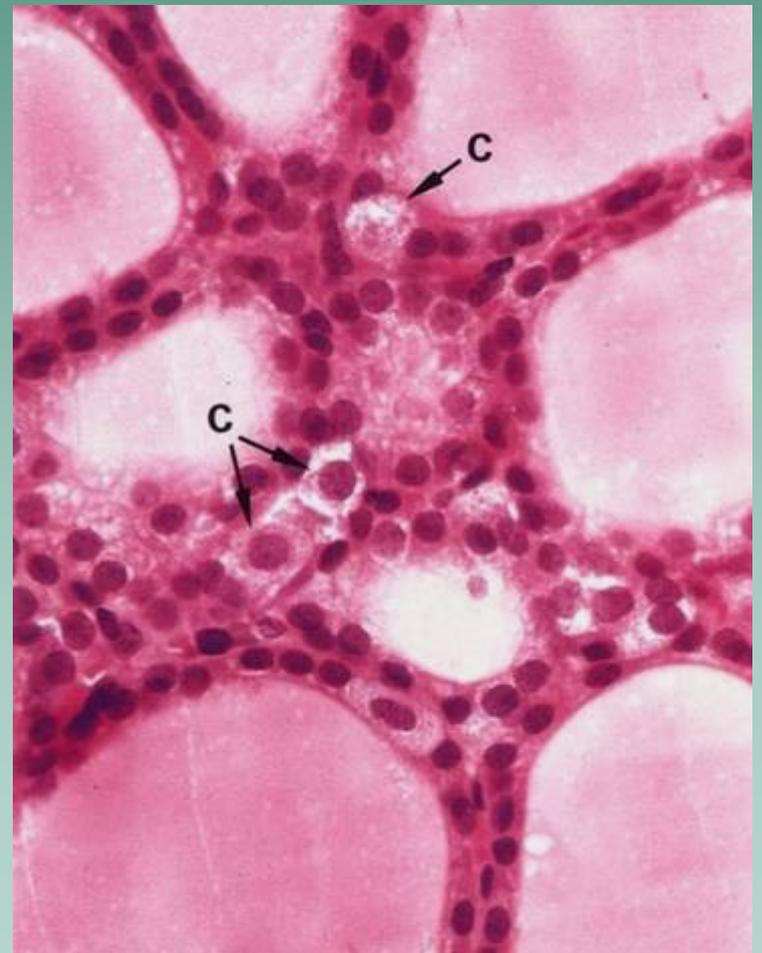
Follicles

follicular cells





parafollicular cells



Thyroid gland

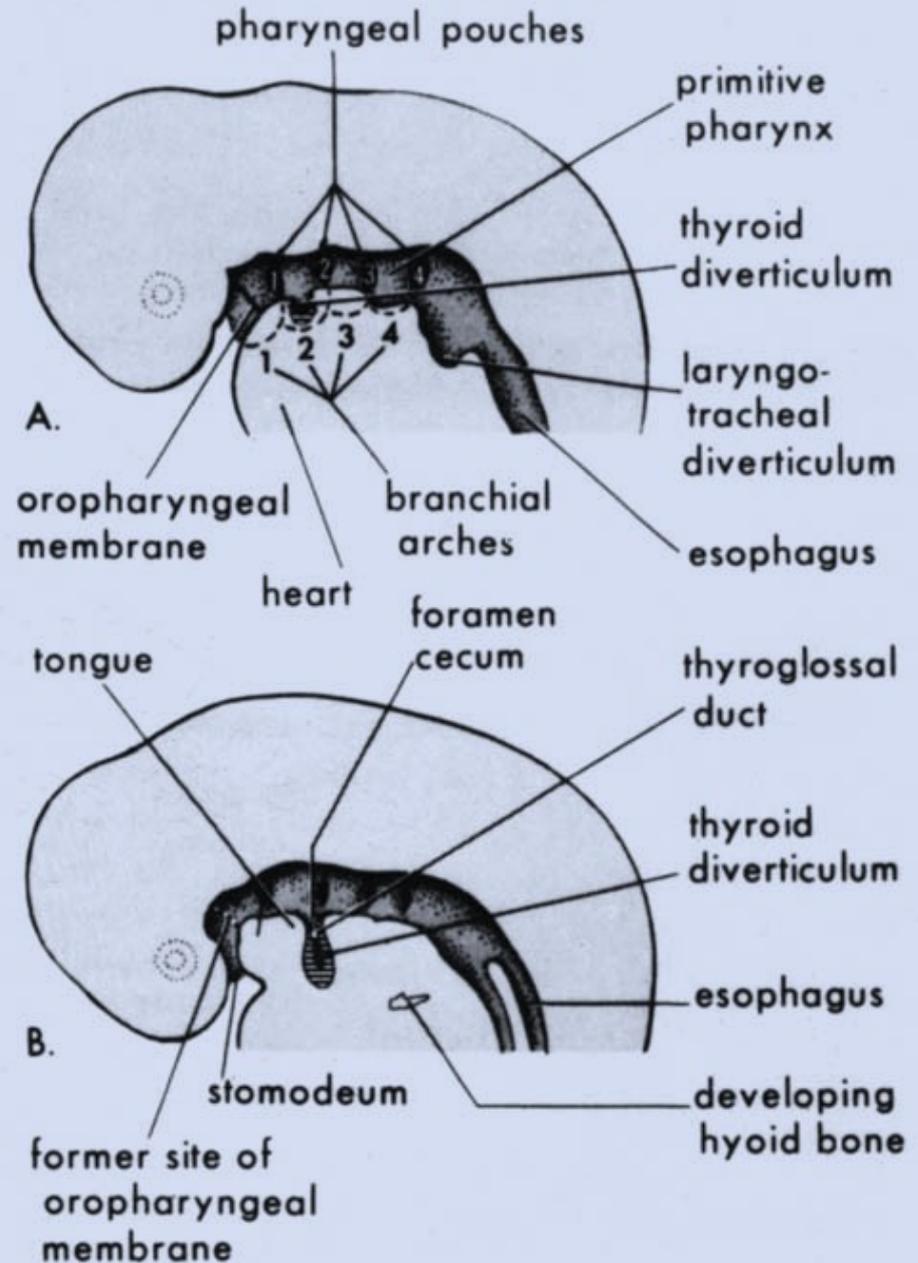
endodermal origin

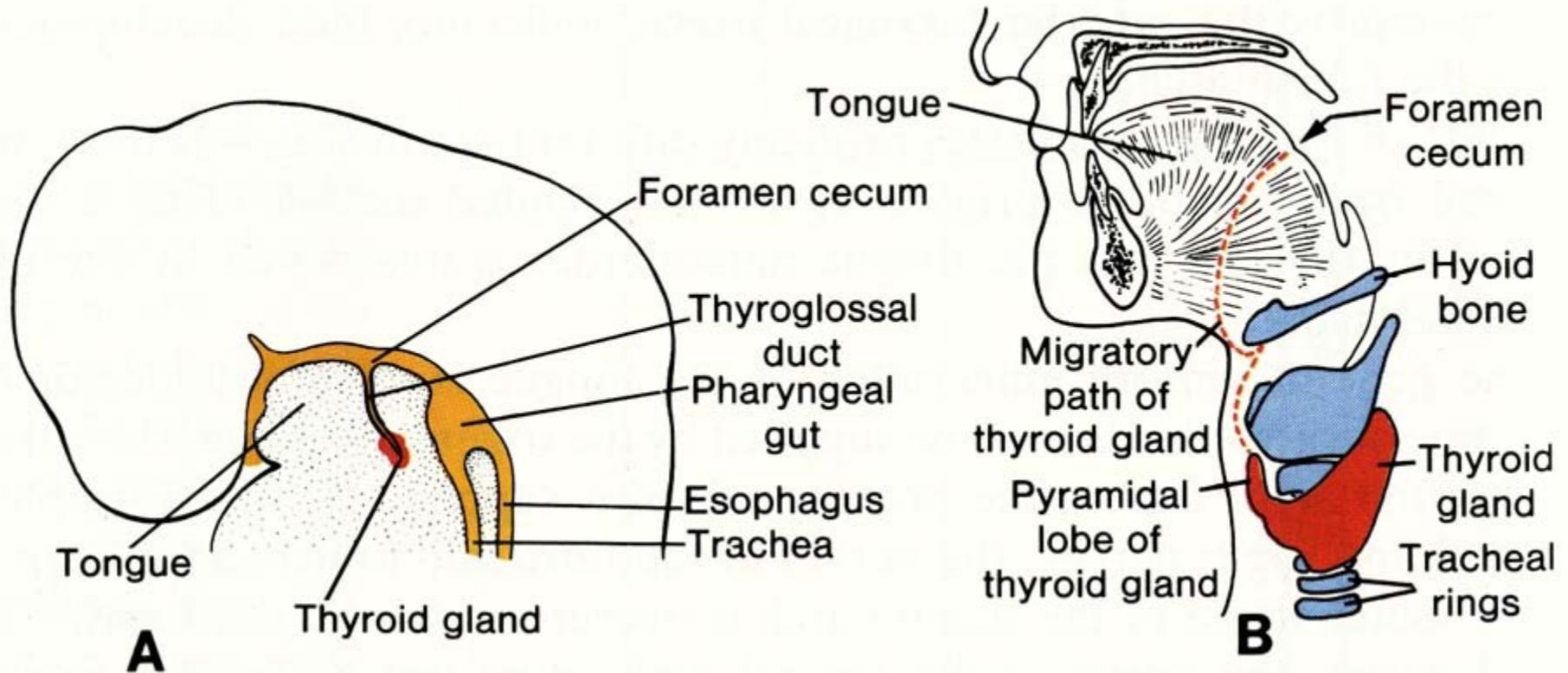
first anlage occurs in embryos with 16 somits on ventral wall of pharynx between the median tongue bud (tuberculum impar) and copula

by proliferation of cells initially **thyroid diverticulum** originates, it is solid and rapidly grows in length, it becomes a lumen - **thyroglossal duct**

duct migrates caudally, its blind end start to proliferate and to form follicles (in the 7th week)

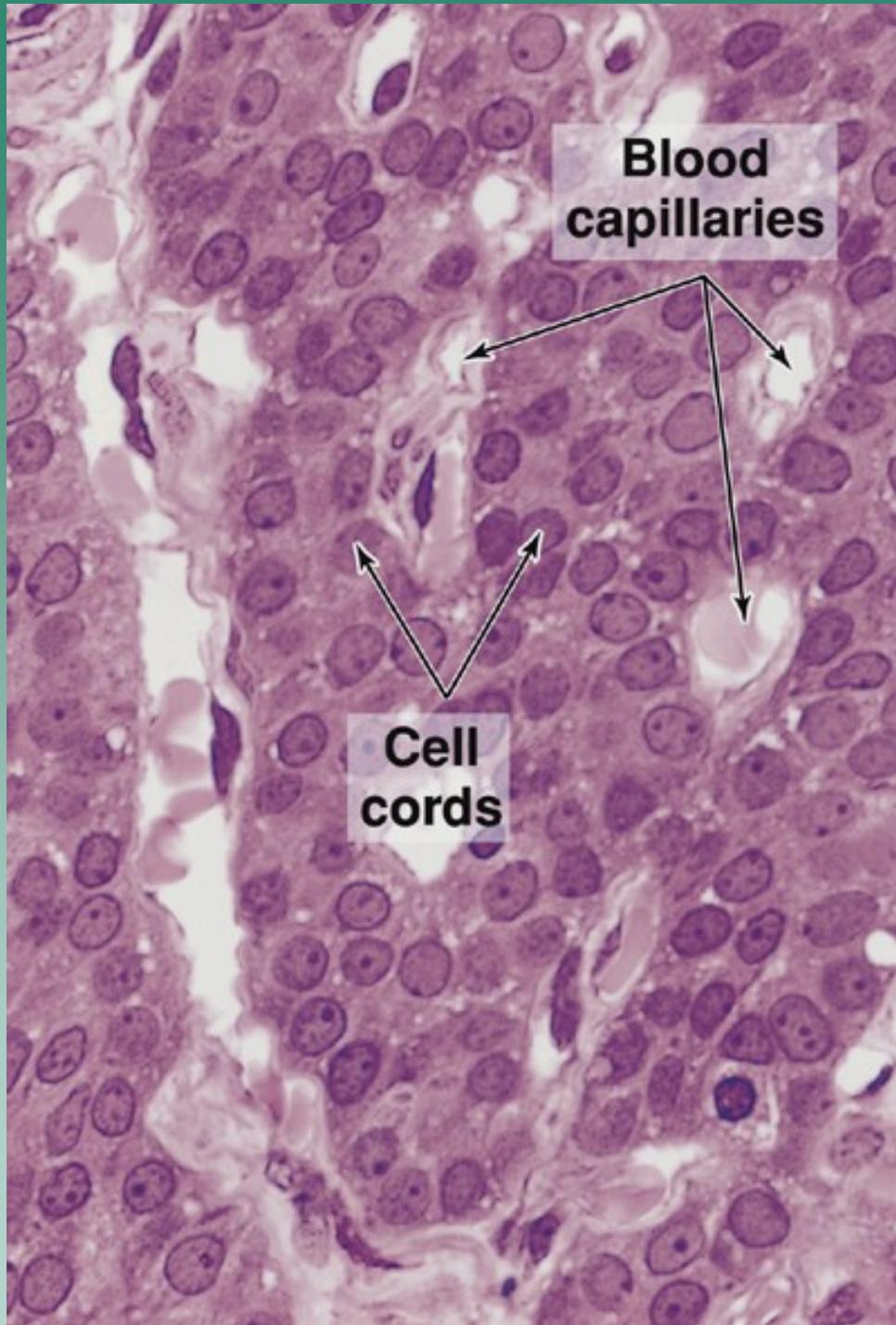
secretion of colloid starts during the 11th week





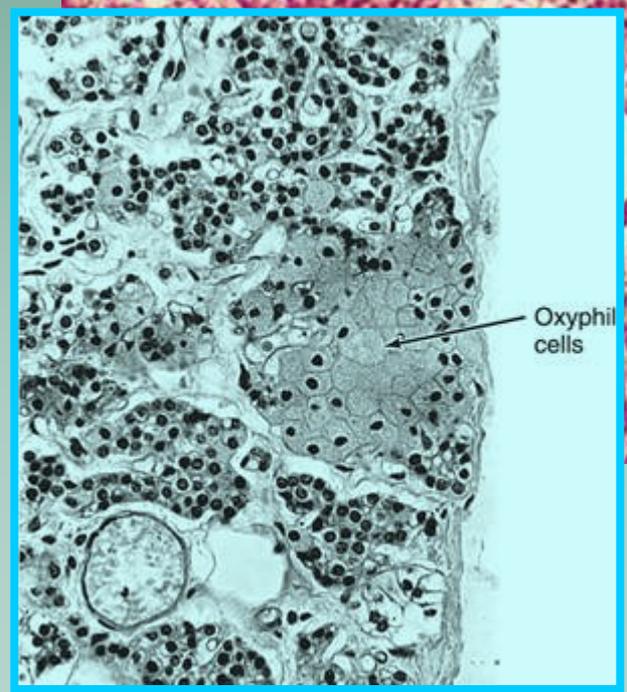
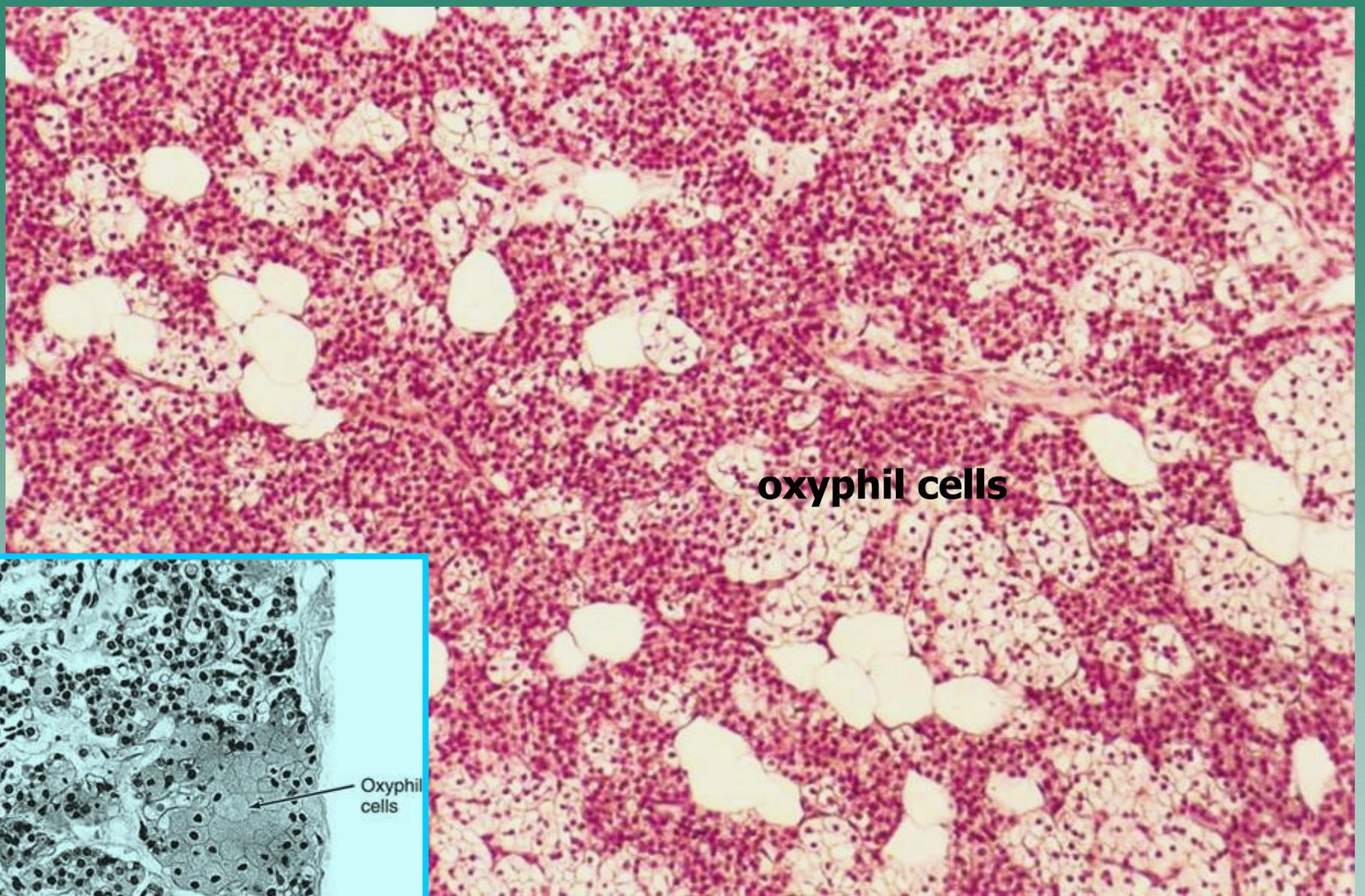
rests of the thyroglossal duct: **foramen cecum** on the tongue (cranially)
: **pyramidal lobe** (caudally)

chief cells

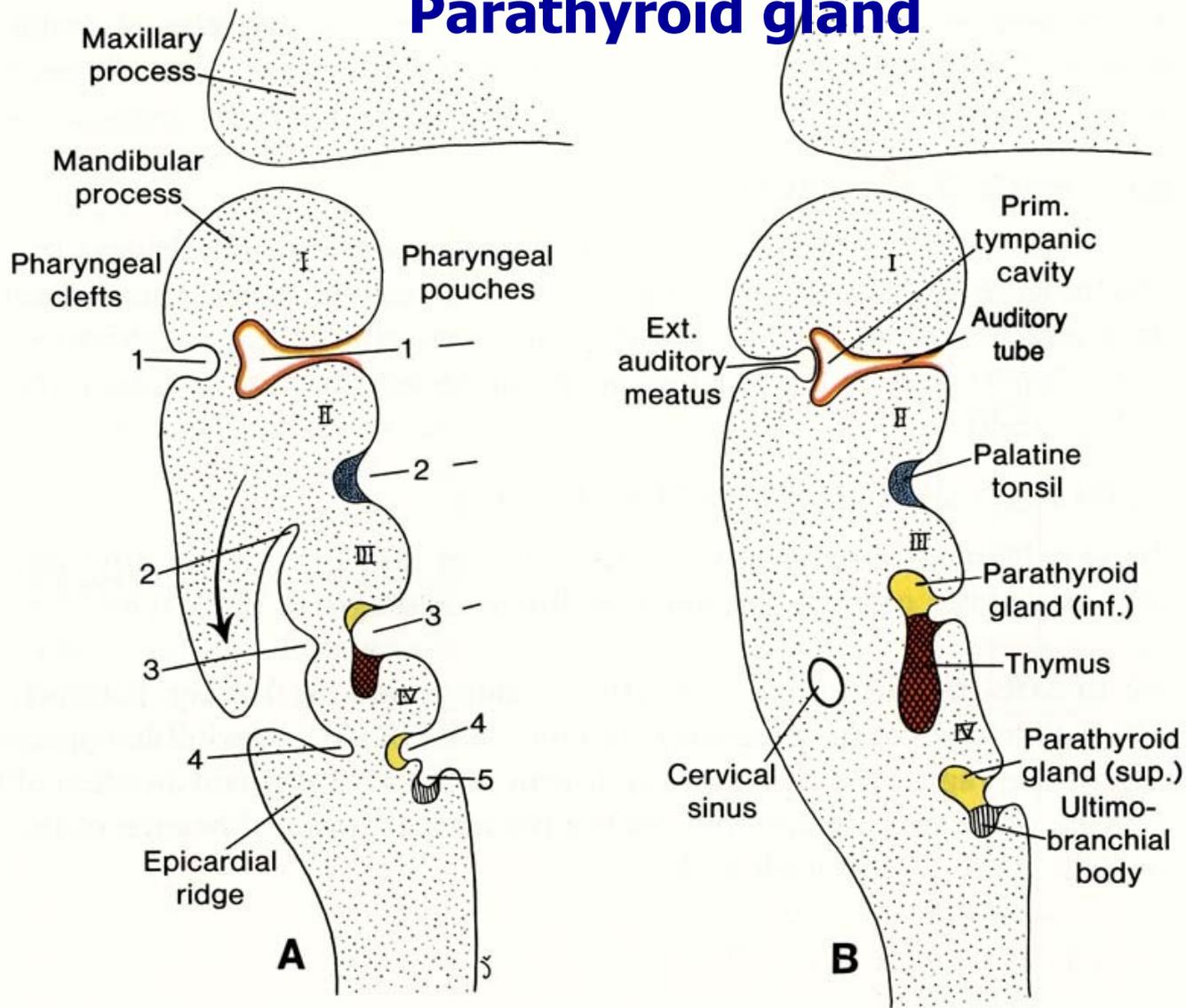


Blood capillaries

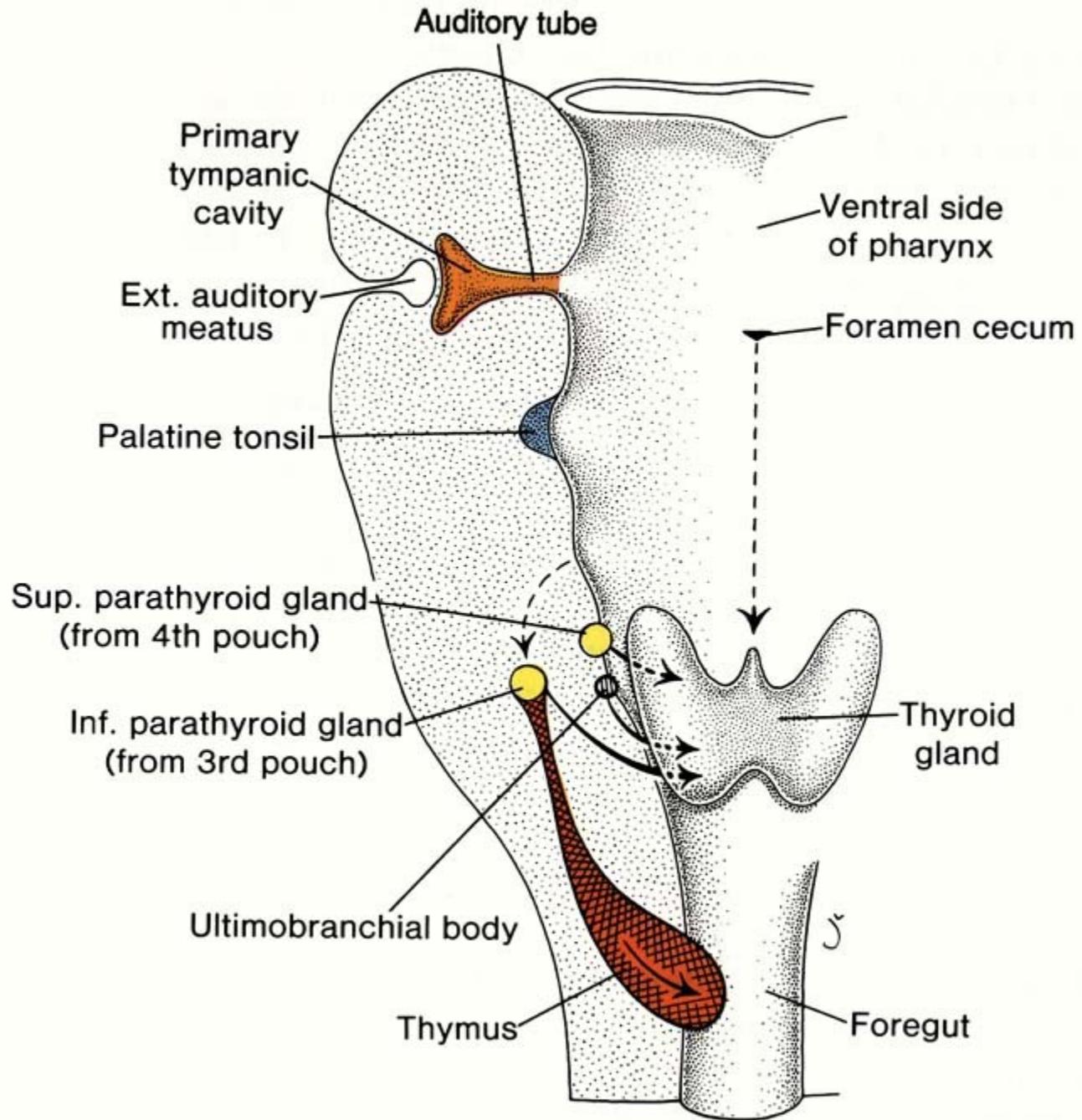
Cell cords



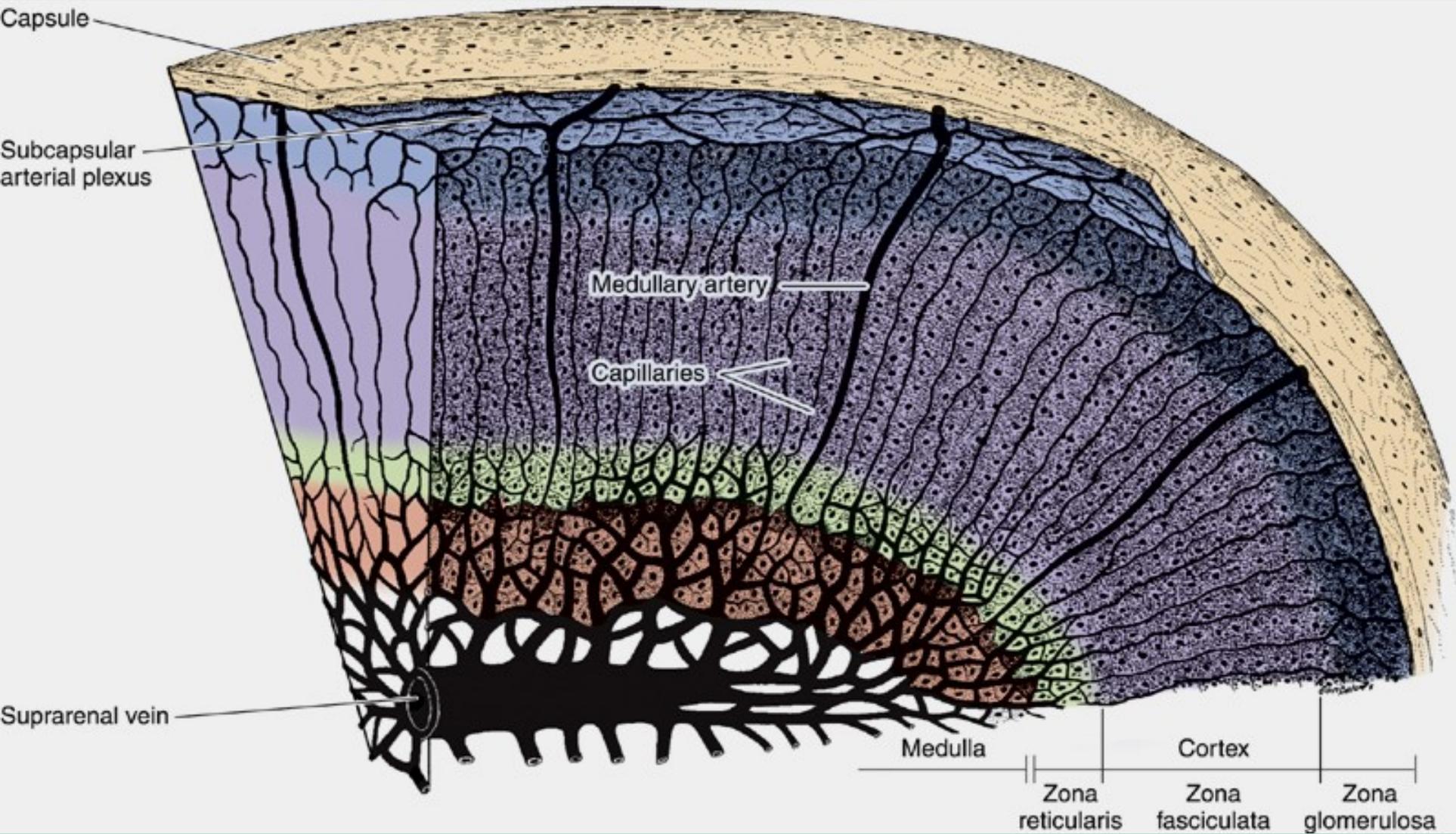
Parathyroid gland



superior pair of glands – from the 4th pharyngeal pouches
 inferior pair of glands – from the 3rd pharyngeal pouches



A schema of the adrenal gland



The adrenal cortex:

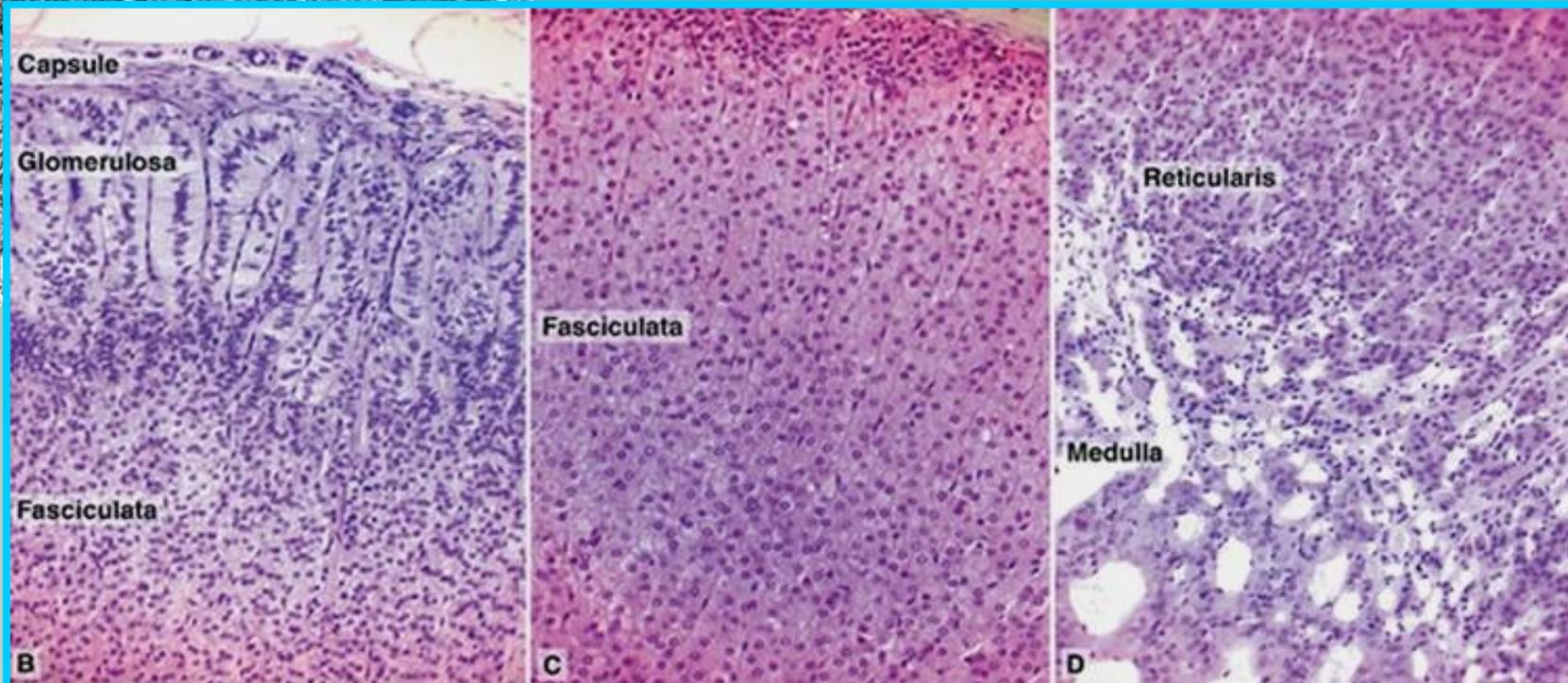
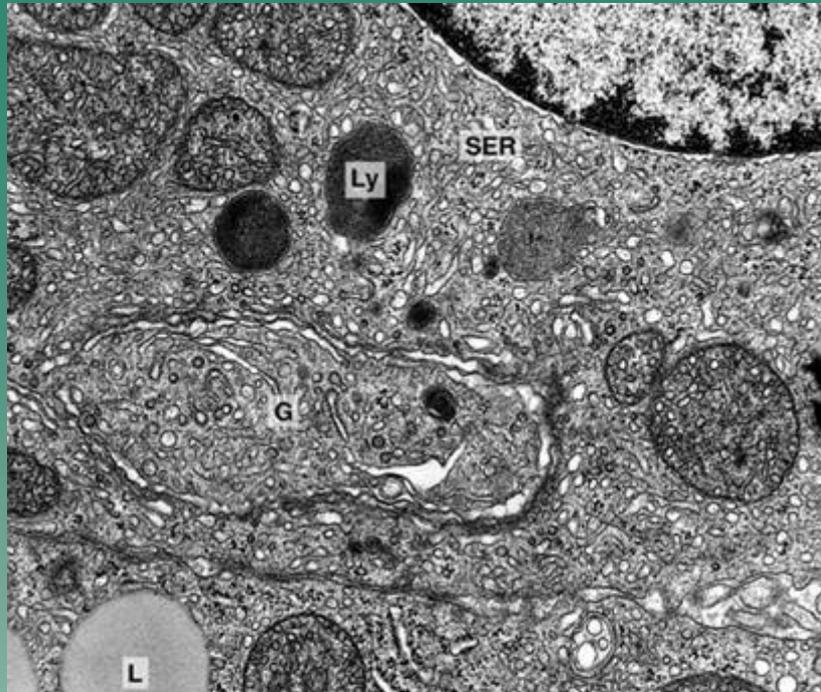
is composed of cord of glandular cells separated by blood sinusoids

according to the arrangement of cells in cords - 3 layers of the cortex are distinguished

zona glomerulosa

zona fasciculata

zona reticularis

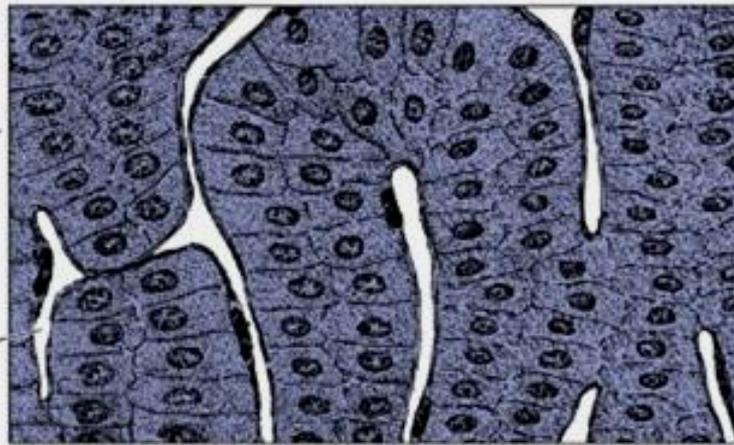


Factors acting on the gland

Zona glomerulosa

Angiotensin and corticotropin (ACTH)

Capillaries

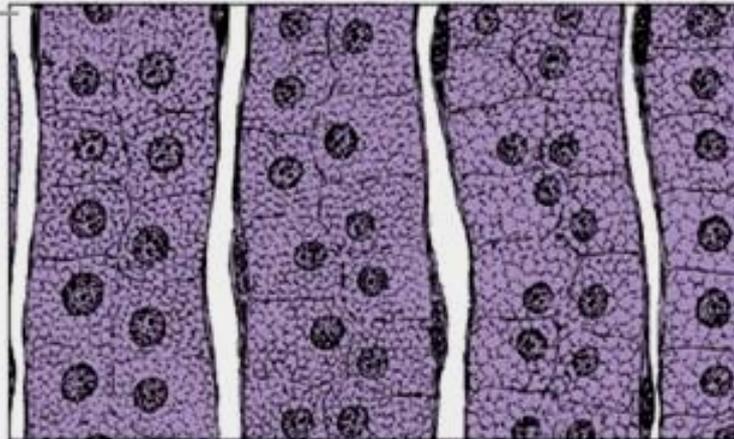


Hormones secreted

Mineralocorticoids (aldosterone)

Zona fasciculata

Corticotropin

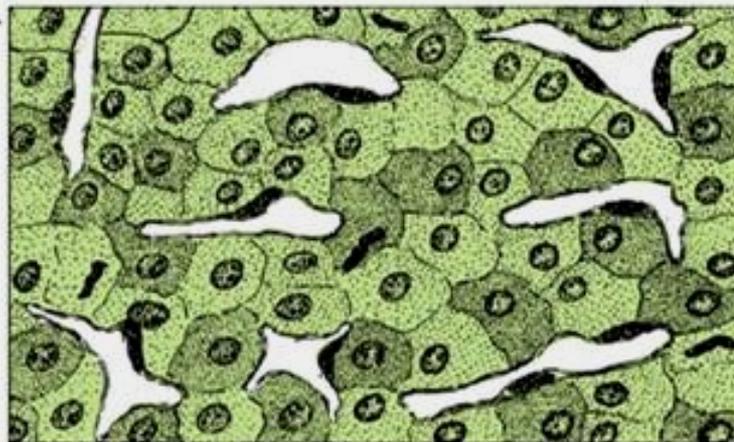


Glucocorticoids (cortisol and corticosterone)

Androgens? (dihydroepiandrosterone; androstenedione)

Zona reticularis

Corticotropin



Glucocorticoids?

Androgens

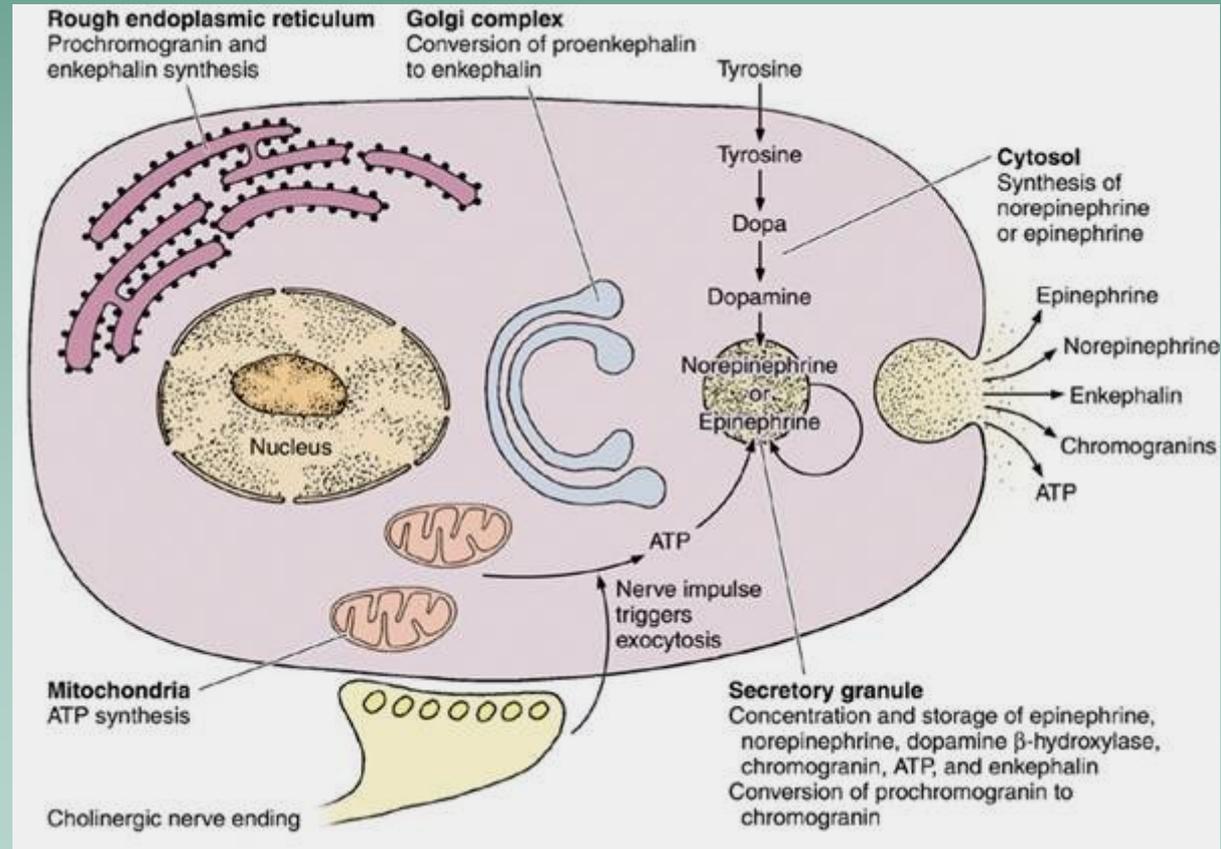
The adrenal medulla

composed of large round or polyhedral cells arranged in clumps or short cords surrounded with framework of reticular fibers, containing numerous capillaries with fenestrae, venules, nerve fibers and solitary sympathetic neurones

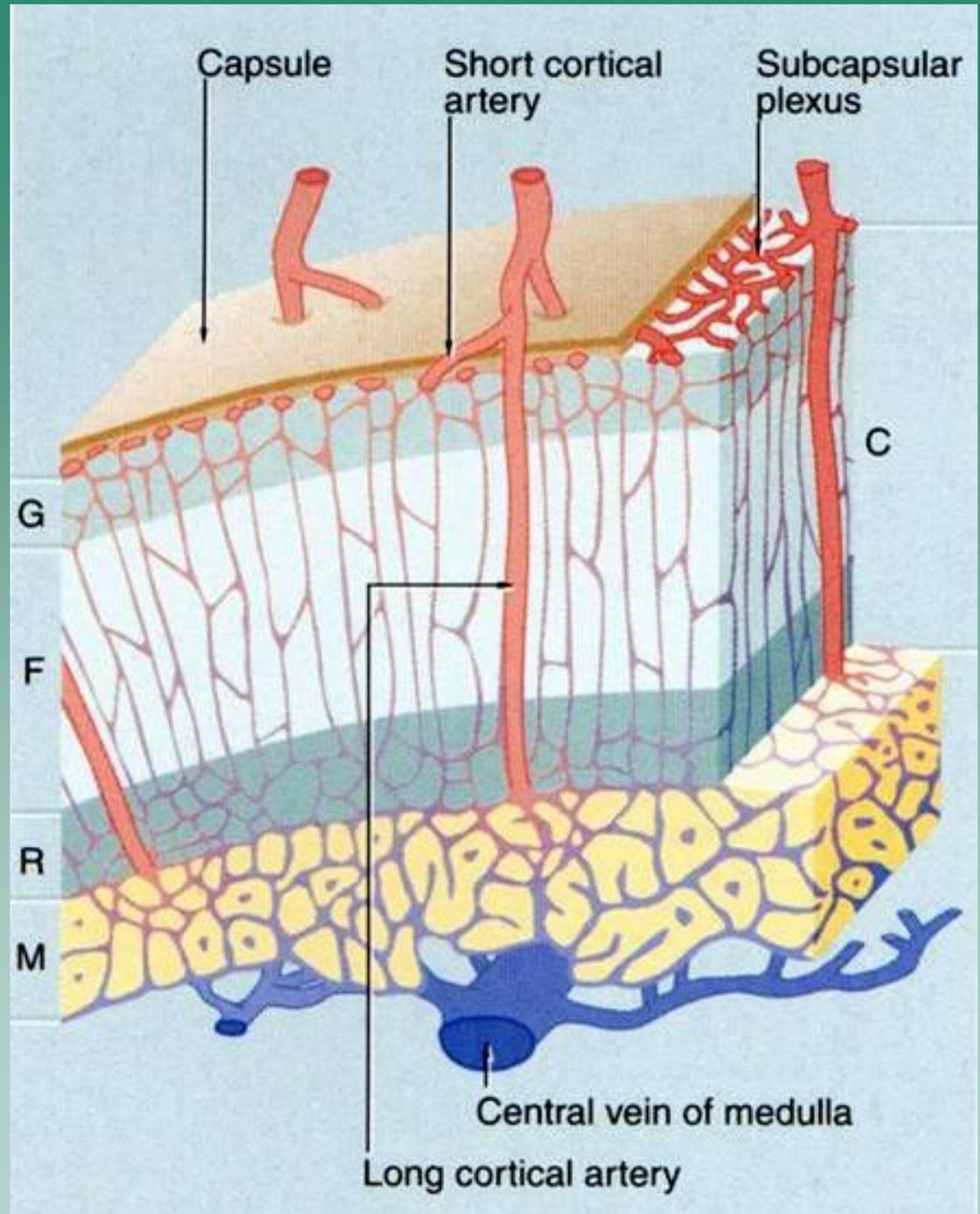
glandular cells called as **chromaffin cells** contain fine granular cytoplasm and secrete **catecholamines**

2 types of chromaffin cells:

- secreting adrenalin or epinephrine (most - 96%)
- secreting noradrenalin or norepinephrine (the rest)



Blood supply of the adrenal gland



Adrenal gland

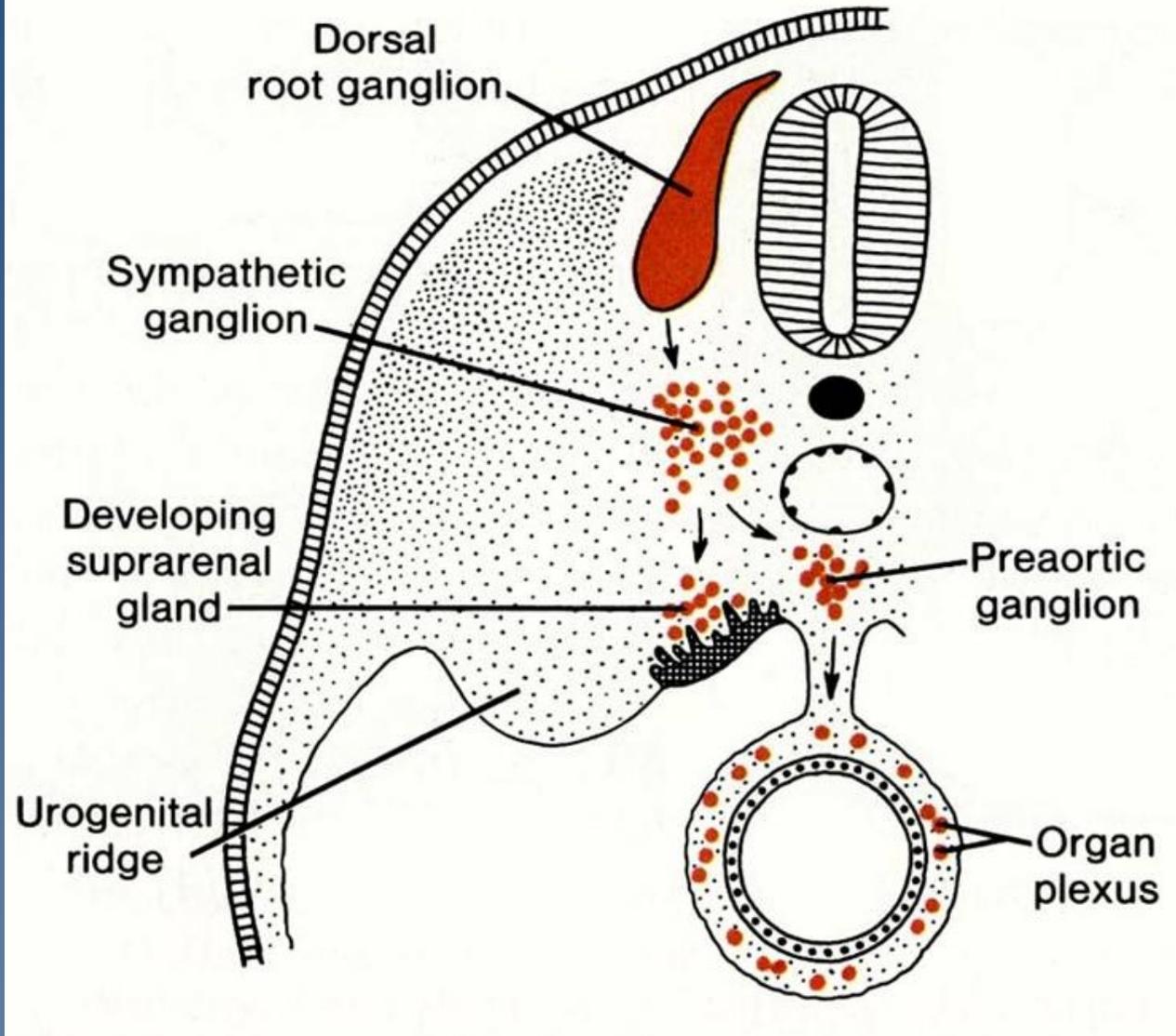
its development begins during the 5th week

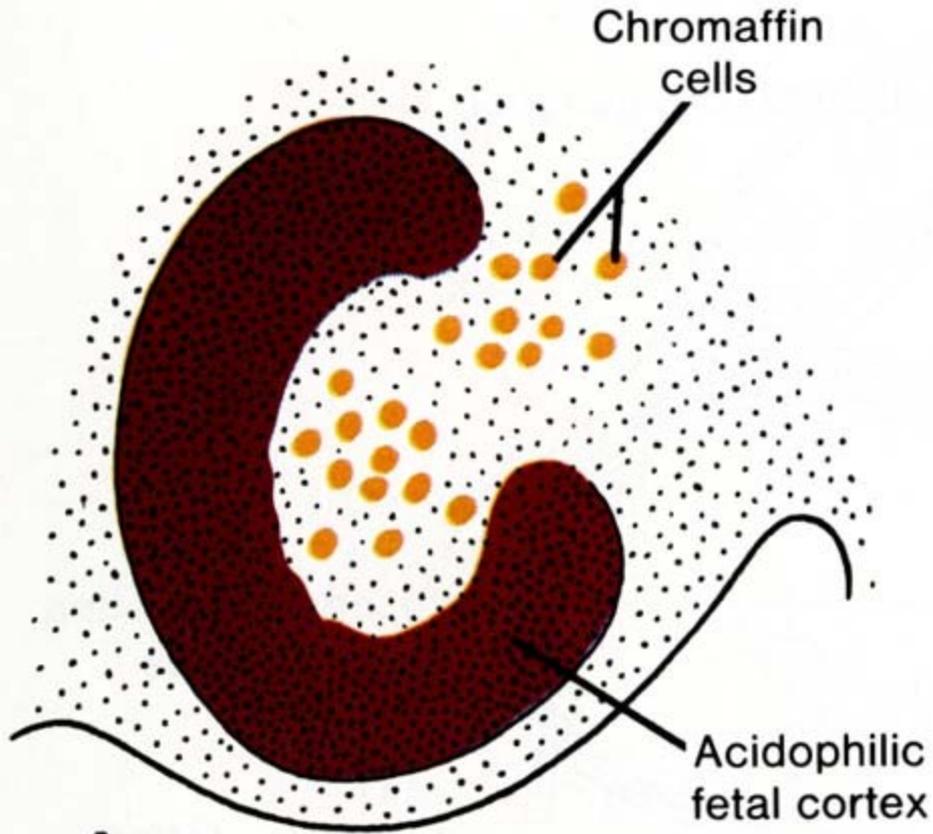
cortex - **coelomic mesoderm**

medulla - **crista neuralis**

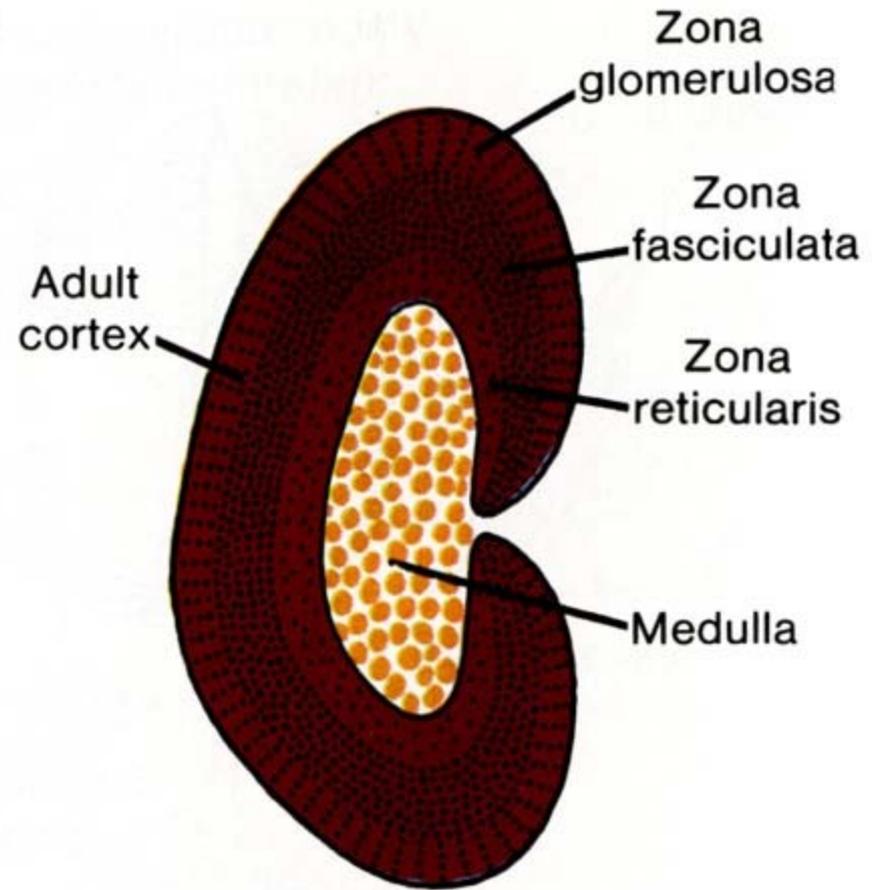
zona glomerulosa and fasciculata are developed at birth

zona reticularis occurs around the 3rd postnatal year





A



B

Endocrine glands- summary

hypophysis: adenohypophysis - **ectoderm of the stomodeum**

neurohypophysis - **neuroectoderm of the
diencephalon (base)**

epiphysis - **neuroectoderm of the diencephalon (roof)**

thyroid gland - **endoderm of the primitive pharynx**

parathyroid glands - **endoderm of pharyngeal pouches (3rd, 4th)**

adrenal gland: cortex - **coelomic mesoderm**

medulla - **neural crest (crista neuralis)**

Langerhans islets - **endoderm of the foregut (duodenum)**