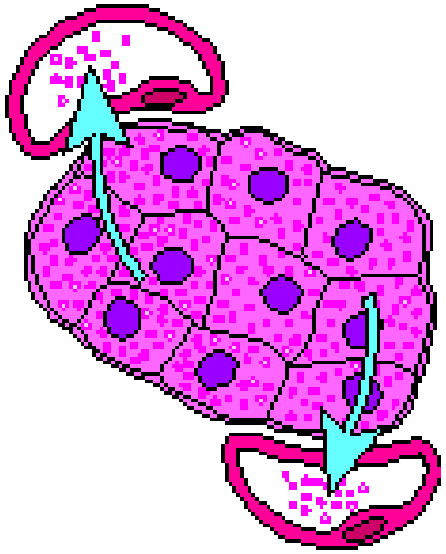
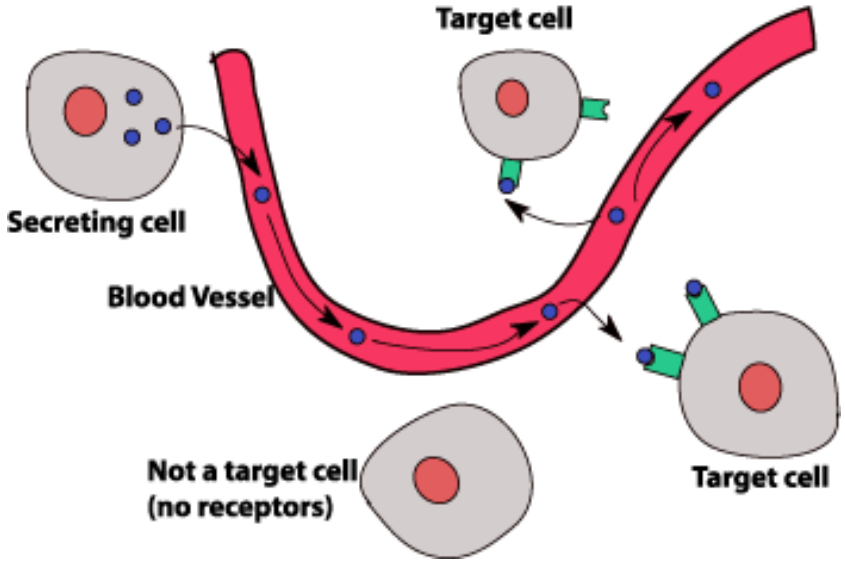
Endocrine system

Regulation of physiological and behavioral activities of the organism

ENDOCRINE SYSTEM

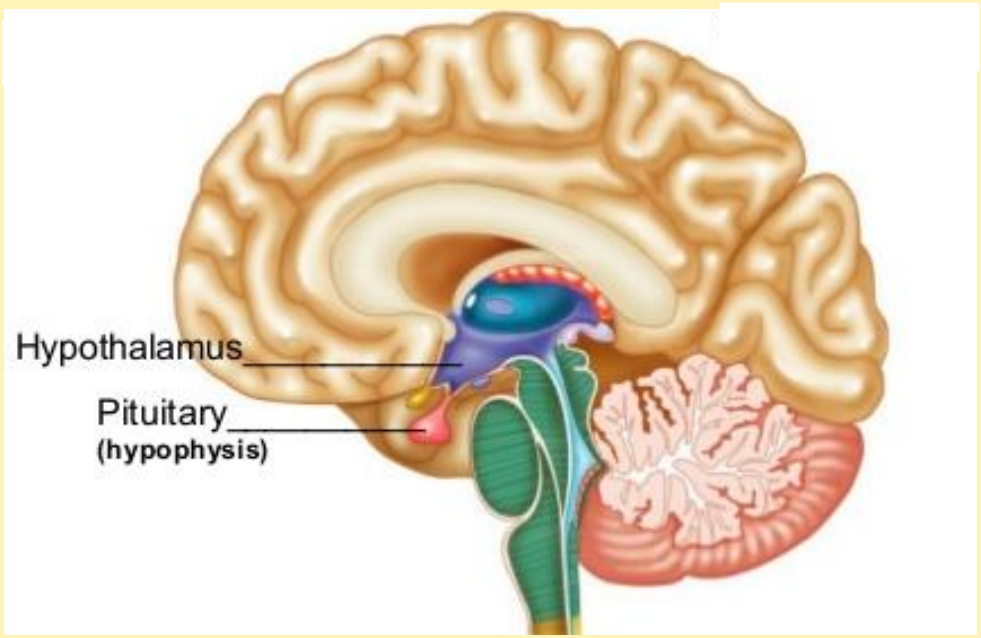


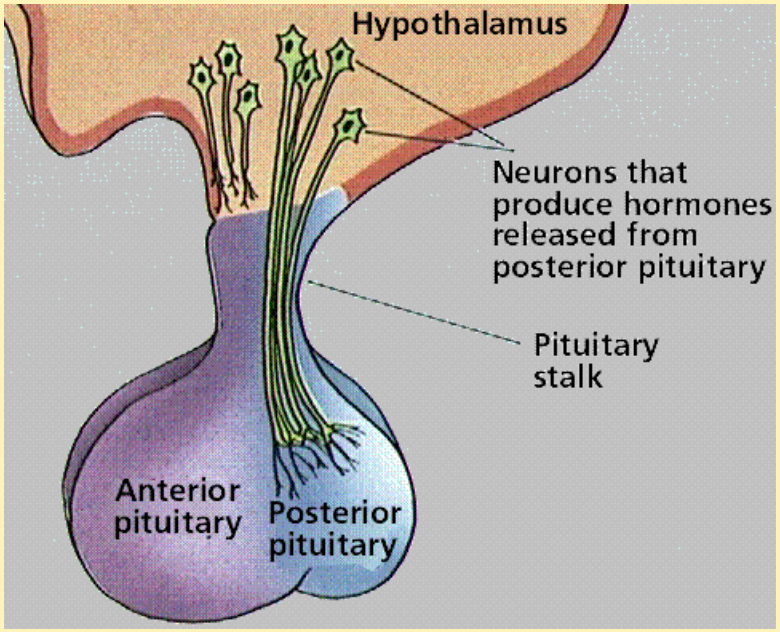
Ductless glands, clusters of cells within certain organs of the body, and **diffuse endocrine cells (in the epithelia of digestive tract and respiratory system) secrete hormones (chemical messengers).**



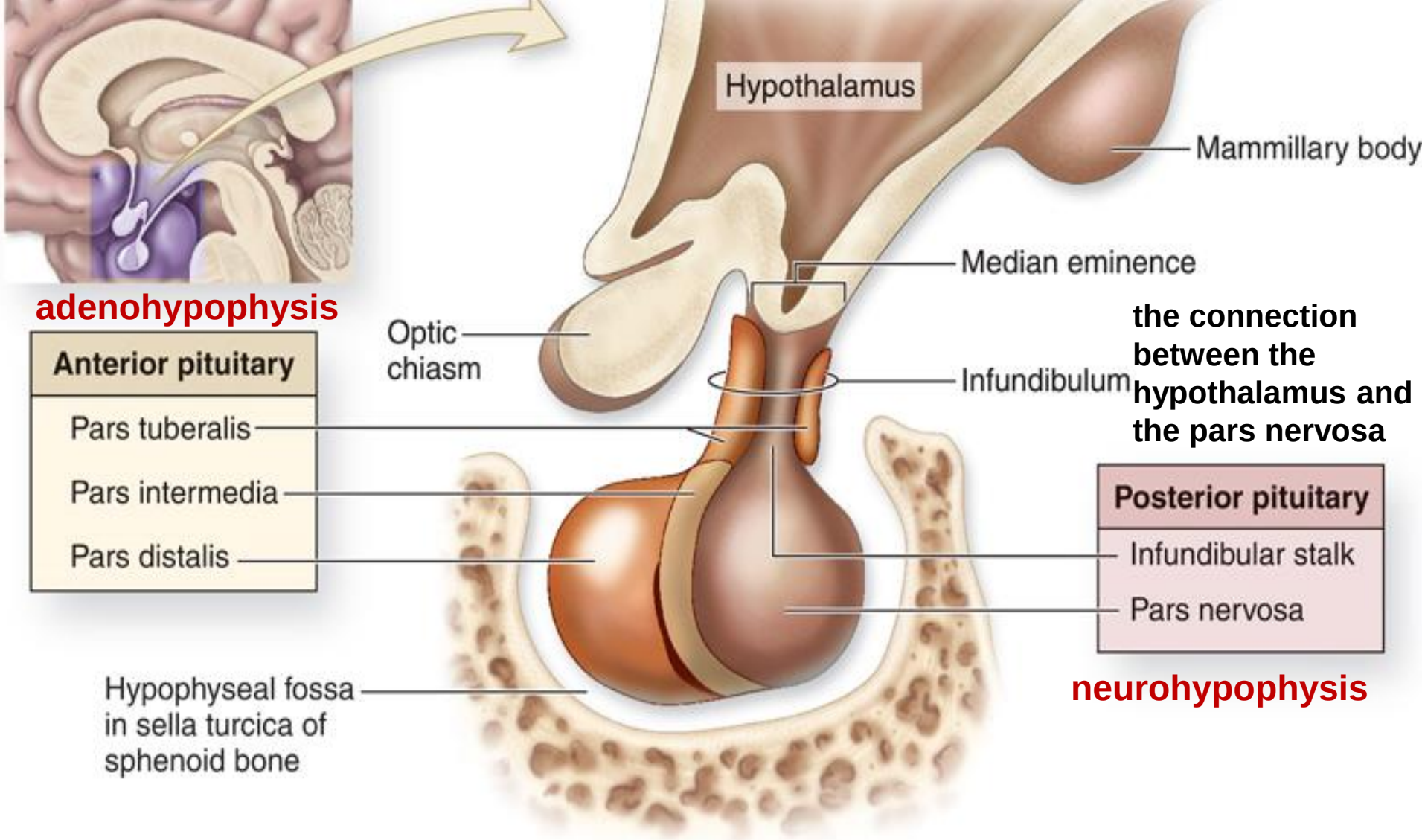
Hormones are secreted to bloodstream to be delivered to target cells. Cells respond to a hormone when they express a specific receptor for that hormone.

PITUITARY GLAND - HYPOHYSIS





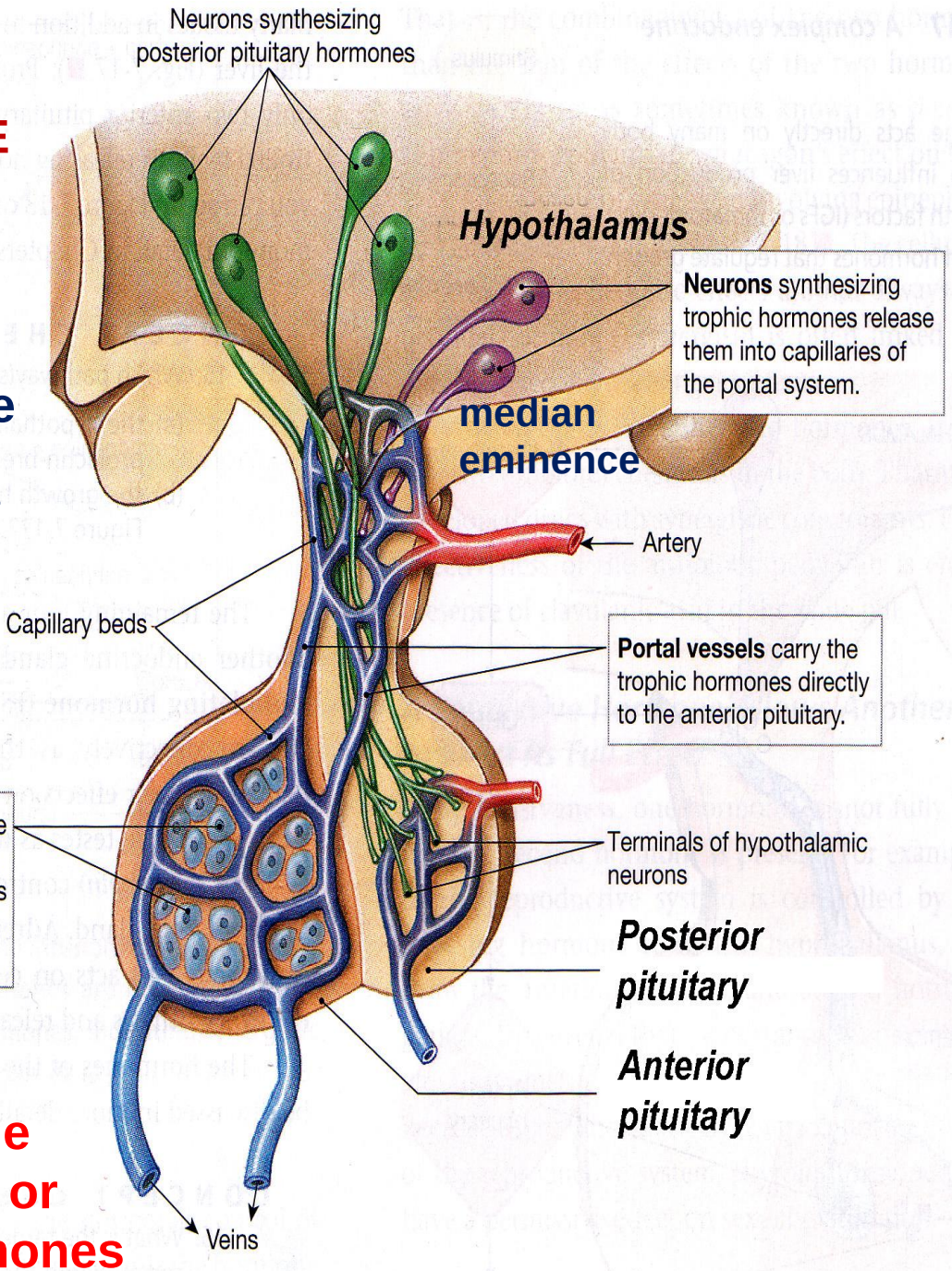
Hypophysis produces hormones responsible for regulation of growth, reproduction and metabolism. It is composed of adenohypophysis (anterior), and neurohypophysis (posterior) and is located below the hypothalamus - portion of the brain also functions as endocrine gland with groups of cell bodies forming small nuclei, responsible for connection of nervous system with endocrine system.



The **pituitary gland (HYPOPHYSIS)** is divided into the **adenohypophysis** (composed of the pars distalis, pars intermedia, and the pars tuberalis) and the **neurohypophysis** (composed of median eminence, infundibular stalk and the pars nervosa).

HYPOTHALAMIC CONTROL OF ANTERIOR PITUITARY HORMONE PRODUCTION

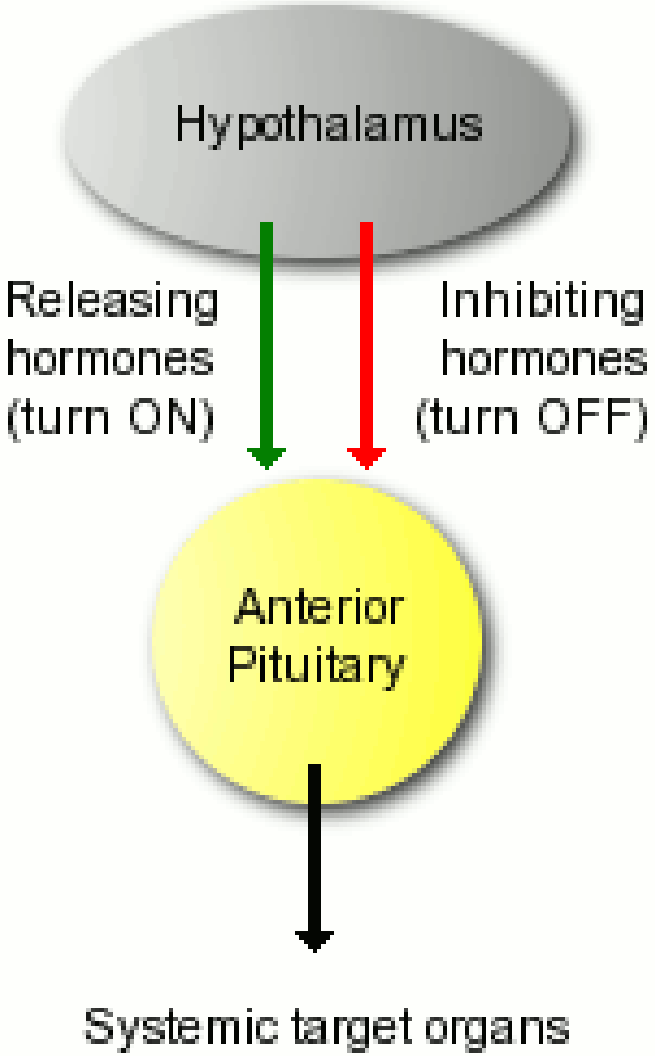
Hypothalamic neurones secrete releasing/inhibiting factors. These hormones diffuse into capillaries at the median eminence and are carried to the anterior pituitary in the portal vessels.



All these hormones act on the adenohypophysis stimulating or inhibiting the production of hormones

The hypothalamo-hypophyseal system

Anterior pituitary receives from the hypothalamus:



Thyrotropin-releasing hormone (TRH) – stimulates the release of TSH

Gonadotropin releasing hormone (GnRH) – also known as Luteinizing-hormone-releasing hormone (LHRH) – stimulates the release of follicle-stimulating hormone (FSH) and luteinizing hormone (LH)

Corticotropin-releasing hormone (CRH) – stimulates the release of adrenocorticotropin (ACTH)

Somatotropin-releasing hormone (SRH)- stimulates the release of somatotropin (growth hormone - GH)

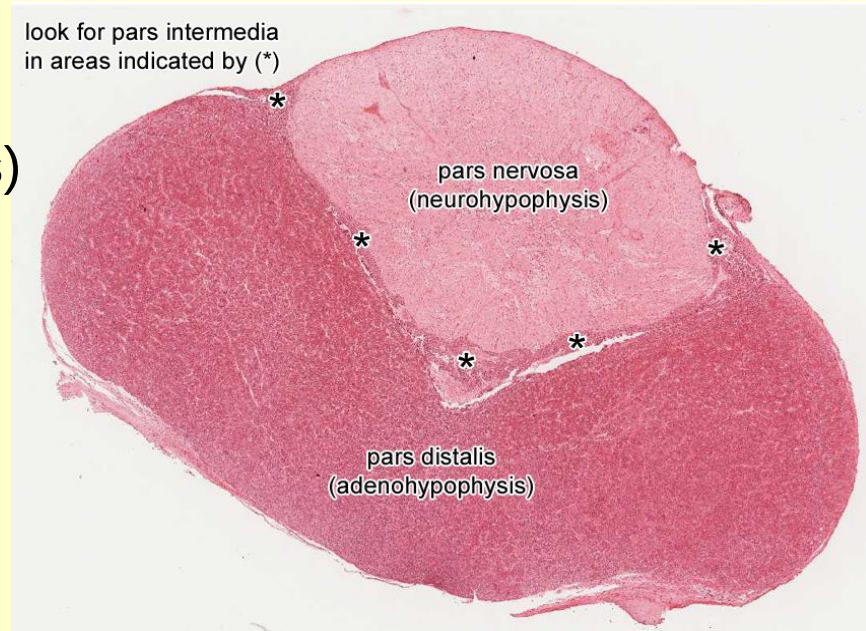
Prolactin-releasing hormone (PRH) - stimulates the release of prolactin

Somatostatin - inhibits release of GH

Prolactin-inhibiting hormone (dopamine)

ADENOHYPOPHYSIS

(pars distalis, pars intermedia, pars tuberalis)

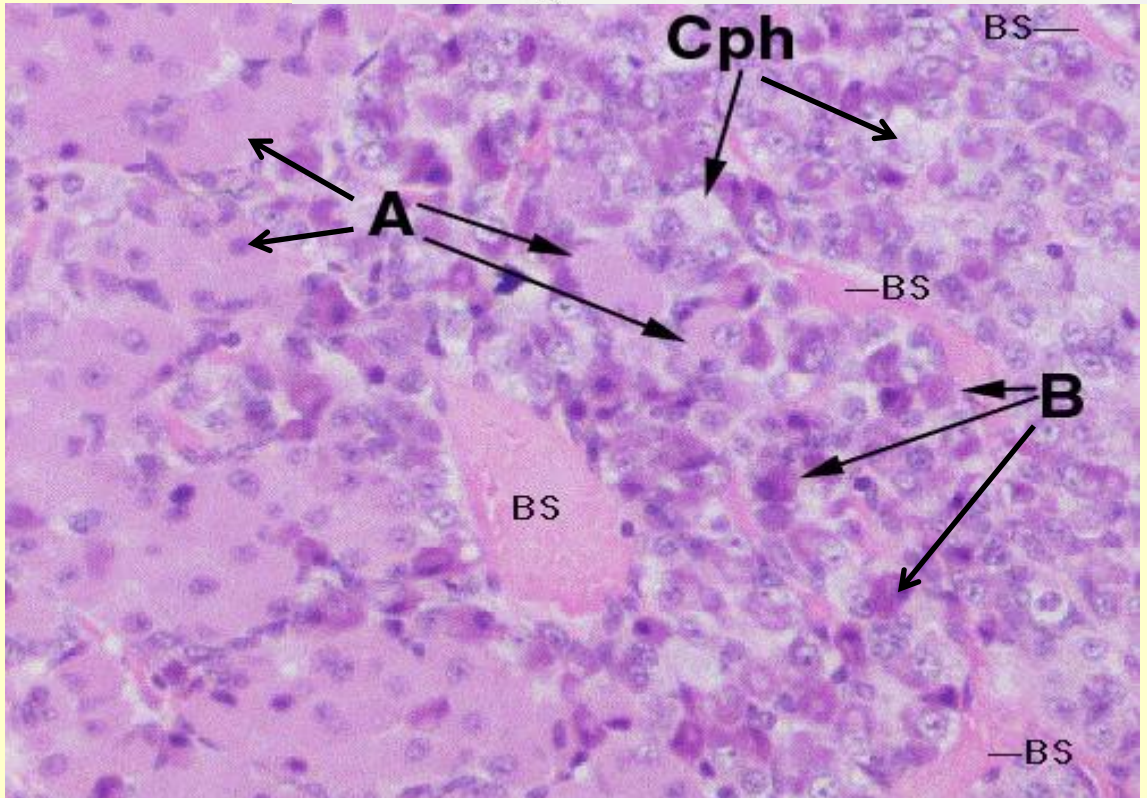


PARS DISTALIS

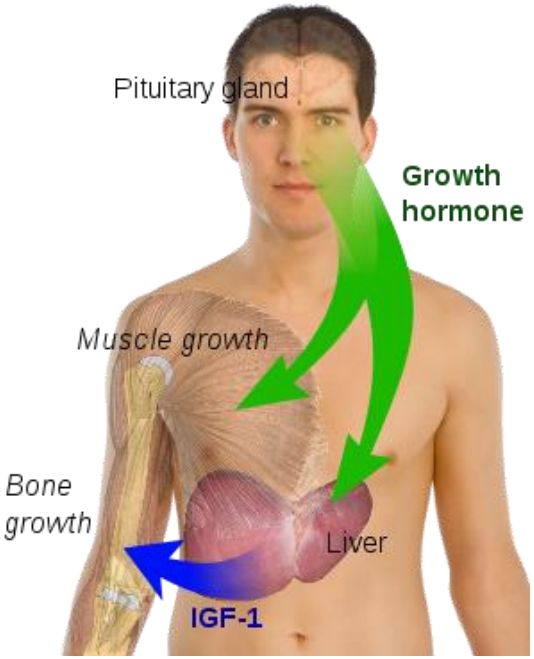
covered by fibrous capsule
houses 3 main types of cells
acidophils and **basophils**
(together known as
chromophils) and
chromophobes.

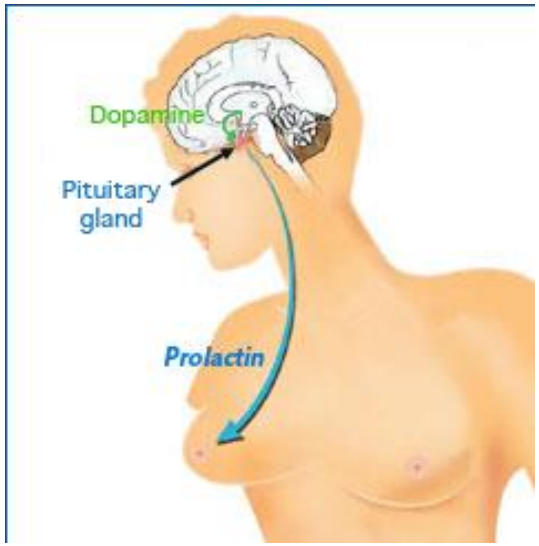
Neurosecretory folliculostellate cells
(stem cells, phagocytes, supporting cells**)**

The most abundant cells are **acidophils**



Adenohypophysis – pars distalis





Two types of **acidophils**

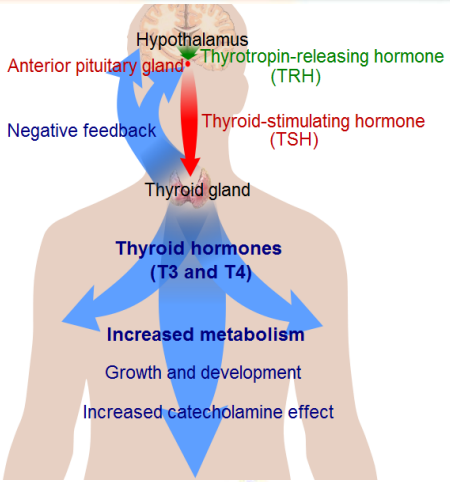
Somatotrophs secrete **somatotropin (growth hormone);**

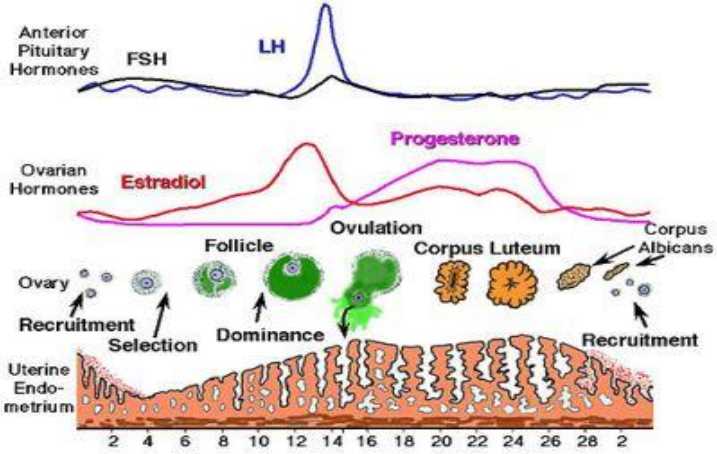
- **Somatotropin** - increases cellular metabolic rates (muscle growth); induces liver cells to produce **somatomedins -insulin-like growth factors I and II** which stimulate the mitotic activity of epiphyseal plate chondrocytes and thus promote growth of long bones.

Mammotrophs release prolactin:

- Prolactin - promotes mammary gland development during pregnancy and lactation after birth, production of testosteron, spermatogenesis.

Cells of the adenohypophysis – pars distalis (cont.)





Three types of **basophils**

Corticotrophs - **adrenocorticotropic hormone (ACTH), melanocyte-stimulating hormone (MSH**), **β-lipotropic hormone (LPH) and β-endorphins**. ACTH stimulates of the adrenal cortex, MSH and β- LPH stimulates melanocytes to produce melanin. β- LPH – lipolysis. β-endorphins – analgesics.

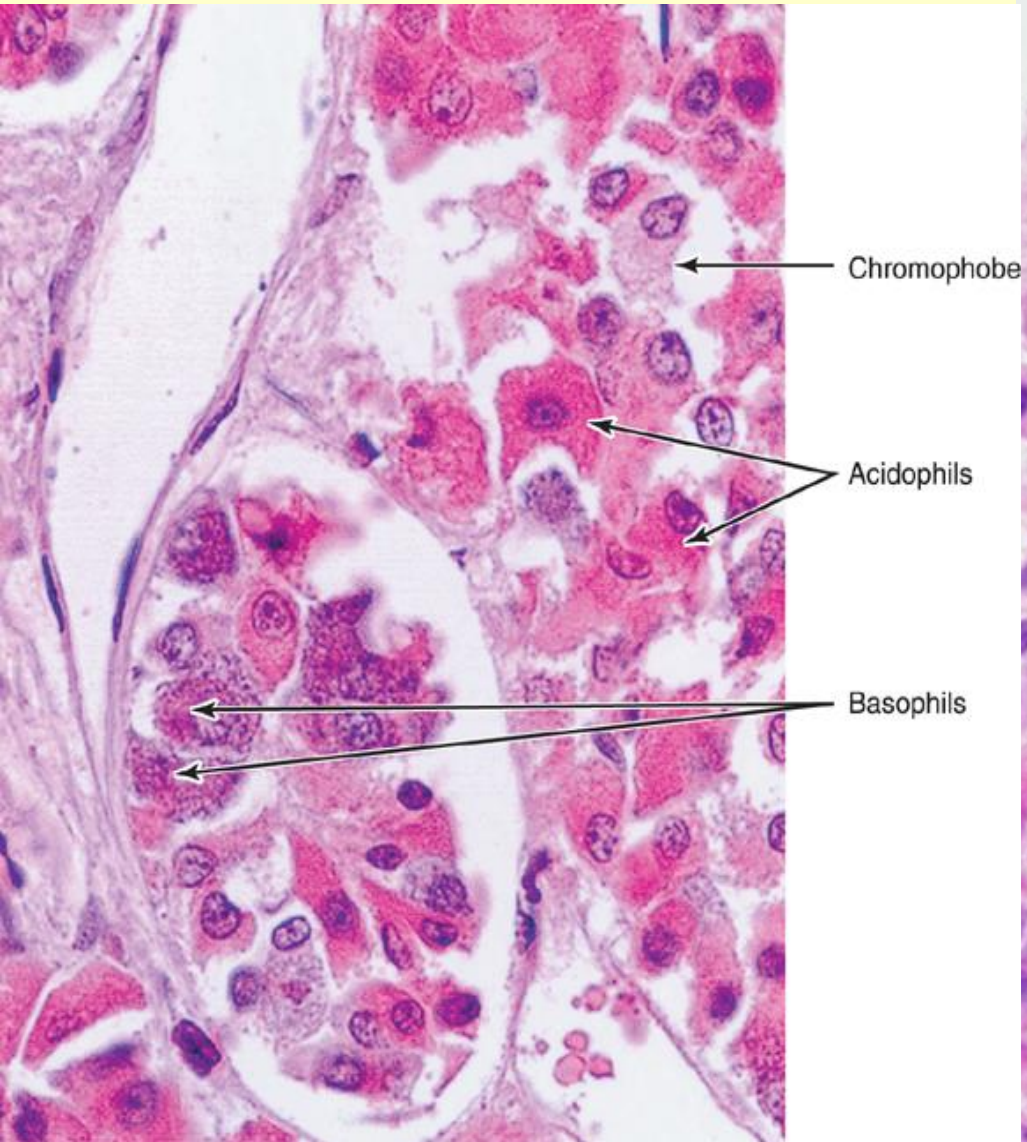
Thyrotrophs - **TSH - thyrotropin** stimulates synthesis and release of thyroid hormones.

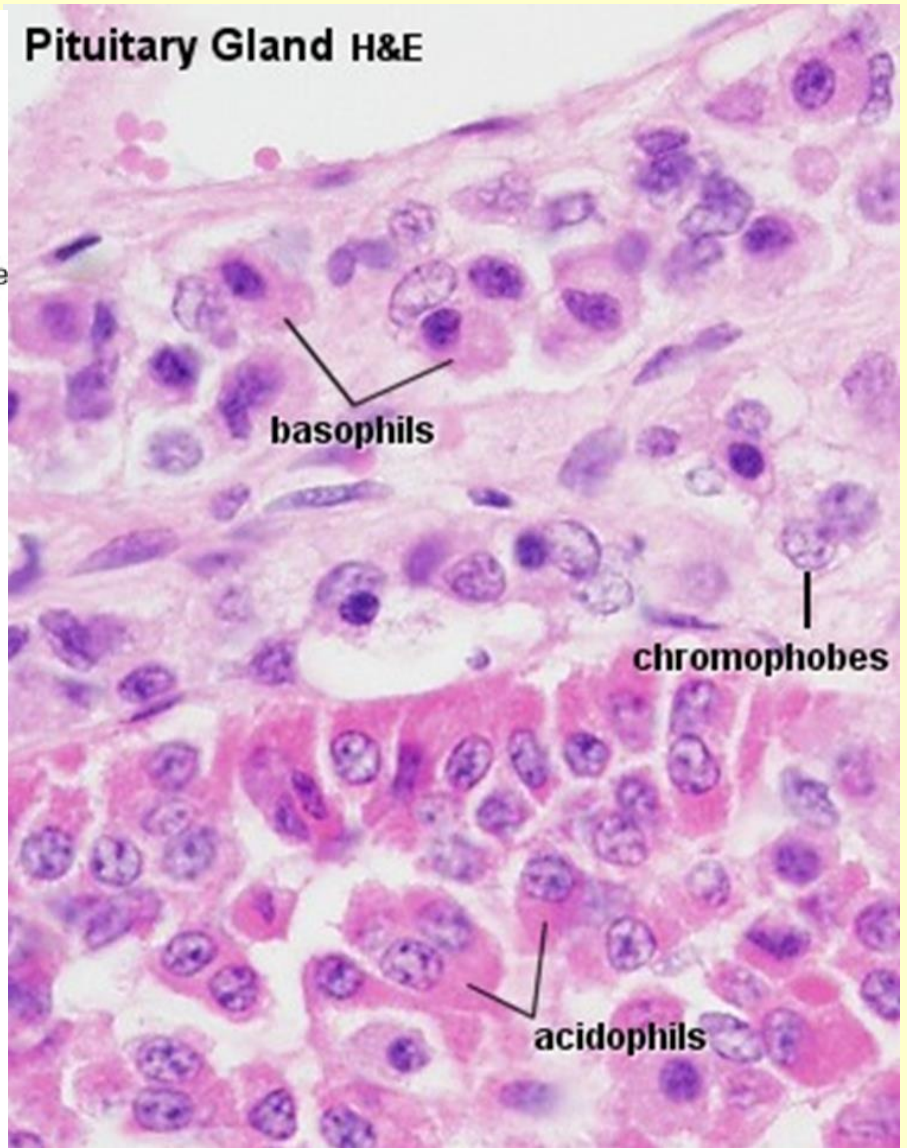
Gonadotrophs - **FSH (follicle-stimulating hormone)** and **LH (luteinizing hormon,** ICSH in males**). LH –** promotes ovulation and development of the corpus luteum, progesteron and estrogen secretion (female), stimulates Leydig cells to secrete testosteron (male), **FSH-** stimulates ovarian follicles growth, estrogen secretion (female),Sertoli cells to produce androgen-binding protein (male).

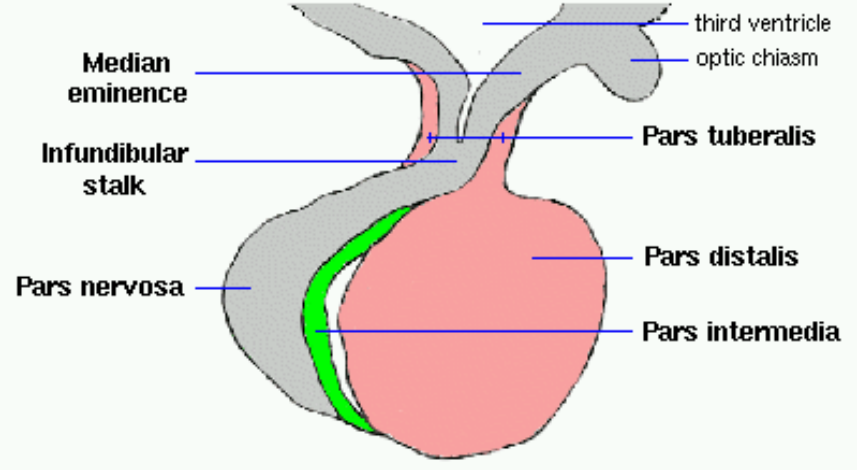
Classical staining of hypophysis pars distalis

Chromophils = acidophils and basophils.

Chromophobes- have less cytoplasm than chromophils, may represent either nonspecific stem cells or degranulated chromophils.







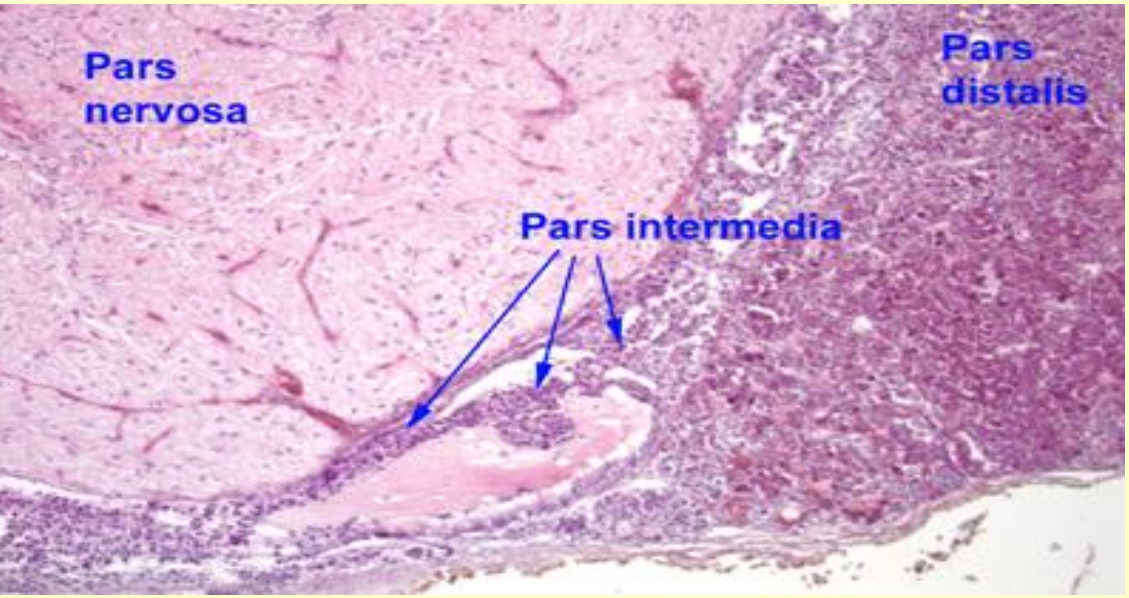
ADENOHYPOPHYSIS

Pars distalis (pars anterior)

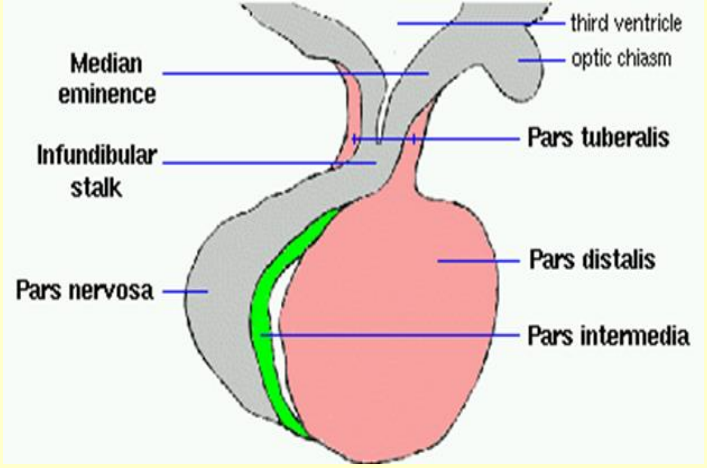
Pars intermedia

Pars tuberalis

Pars intermedia - between the pars distalis and the pars nervosa, contains many cuboidal cell-lined, colloid-filled cysts which are the remnants of Rathke's pouch (Rathke's cysts) and basophils. Anterior pituitary, is derived from oral ectoderm evagination – Rathke pouch.



Basophils synthesize prohormone – **pro-opiomelanocortin** – can be cleaved enzymatically into active peptides (**α-melanocyte-stimulating hormone MSH, corticotropin ACTH, β-lipotropin and β-endorphin**

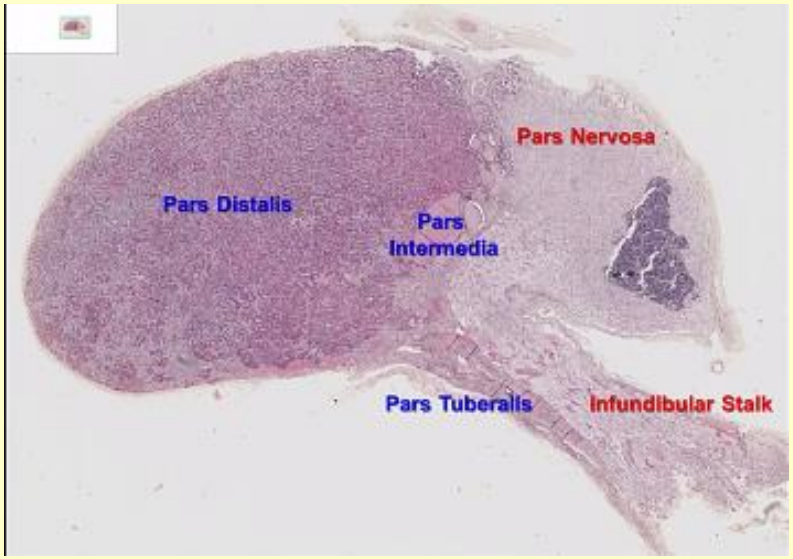


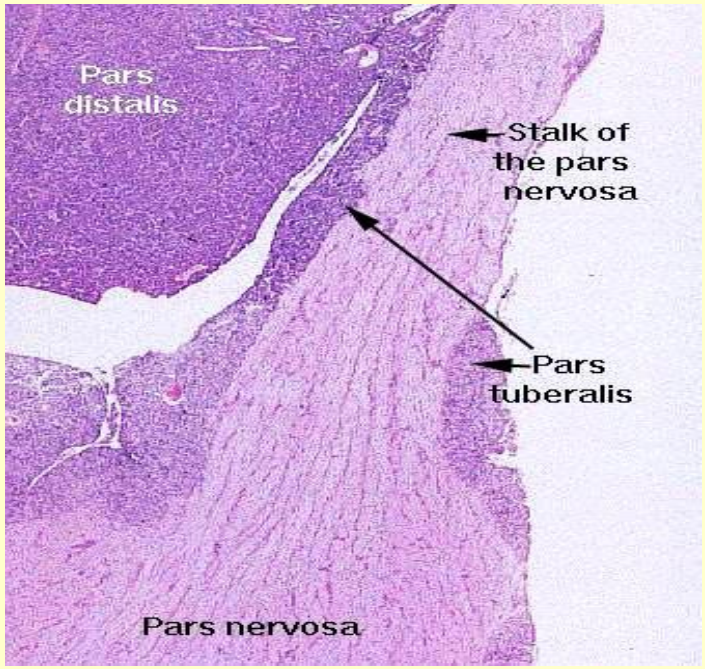
ADENOHYPOPHYSIS

Pars distalis (pars anterior)
Pars intermedia
Pars tuberalis

Pars tuberalis

forms a sleeve which surrounds the stalk of the infundibulum - the connection between the hypothalamus and the pars nervosa



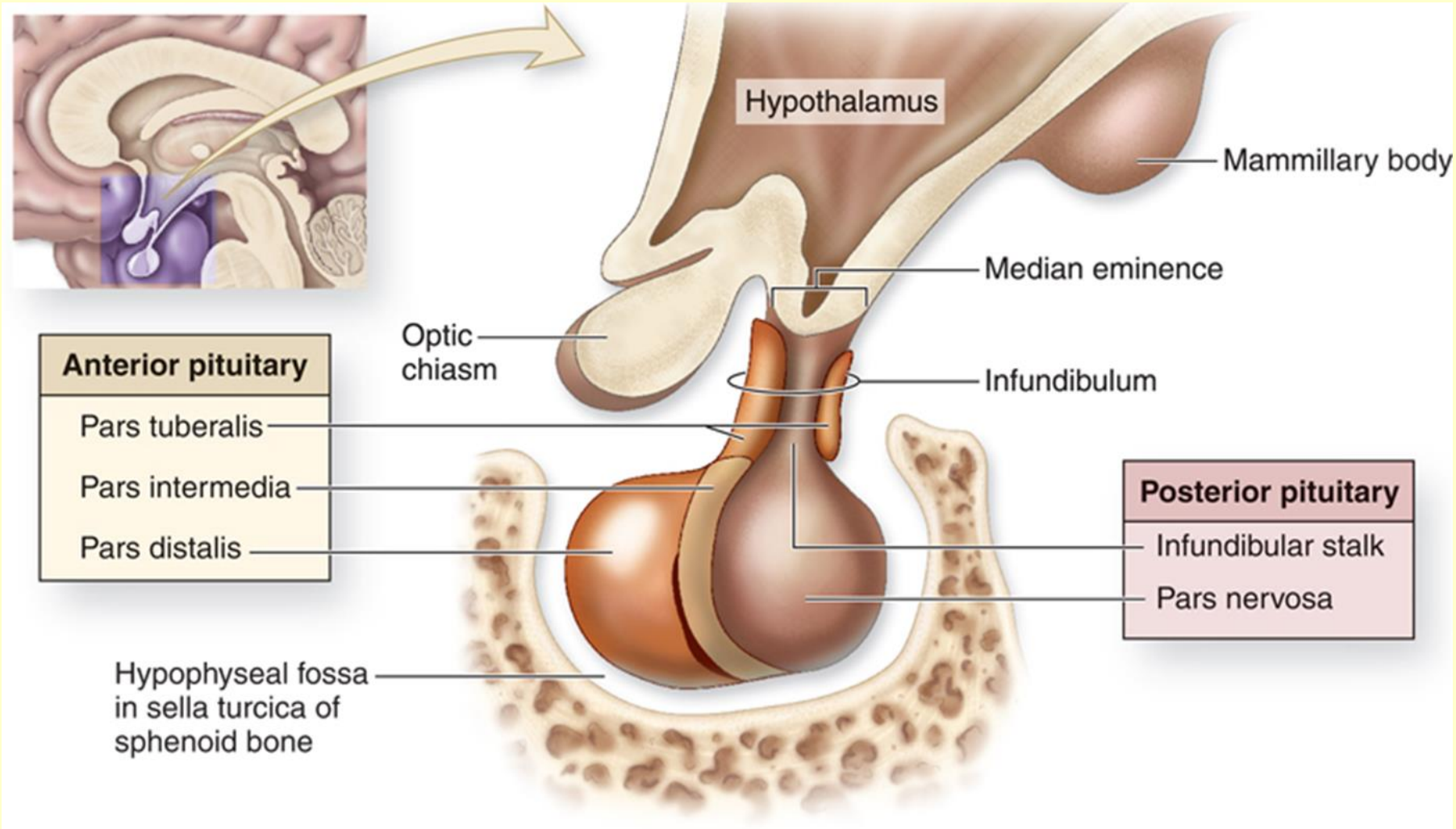


It is highly vascularized sheath with some cells containing granules that contain hormones (FSH, LH), lipid and colloid droplets, and glycogen.

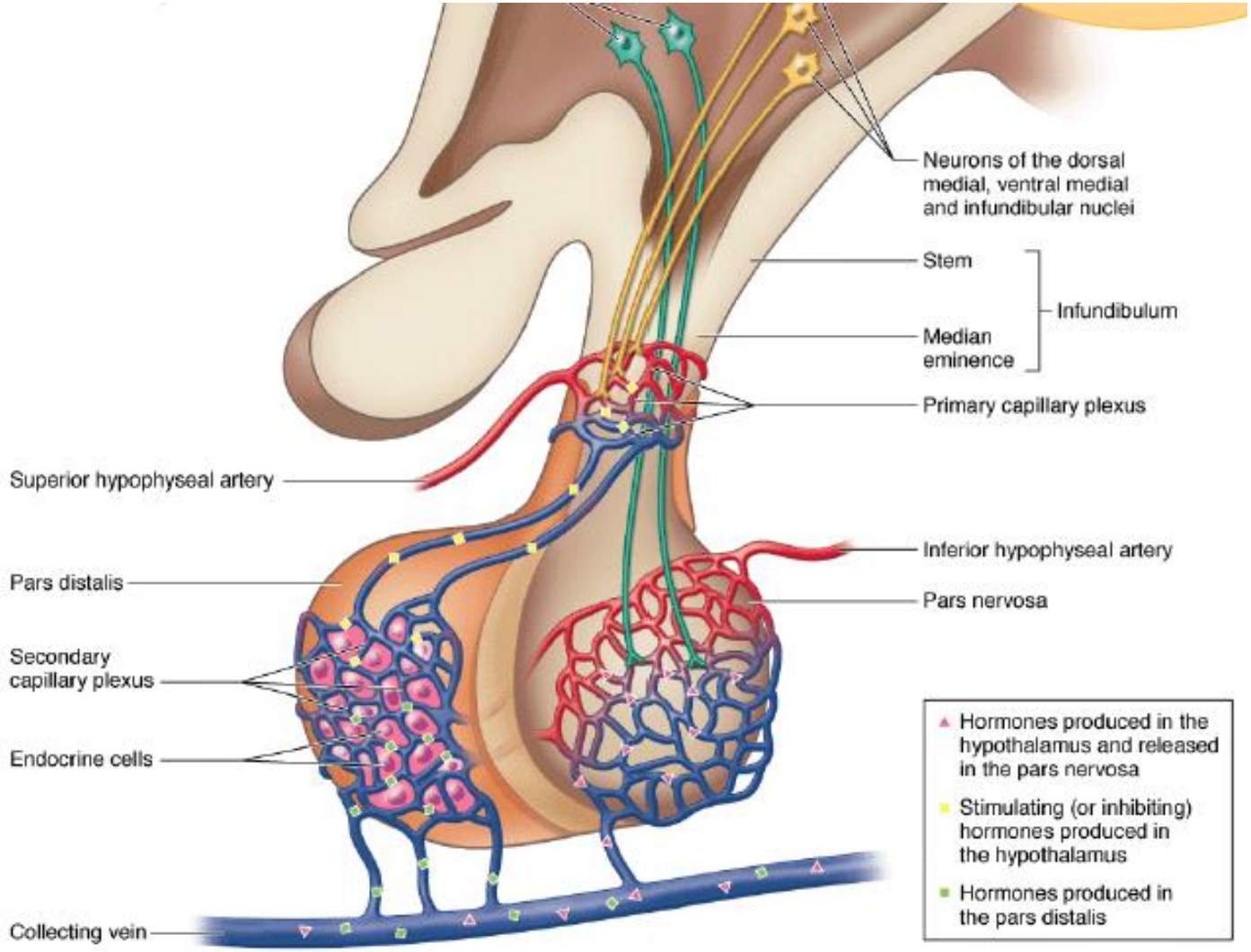
NEUROHYPOPHYSIS

posterior pituitary gland

is composed of median eminence, infundibular stalk (continuation of the hypothalamus) and pars nervosa



Median eminence

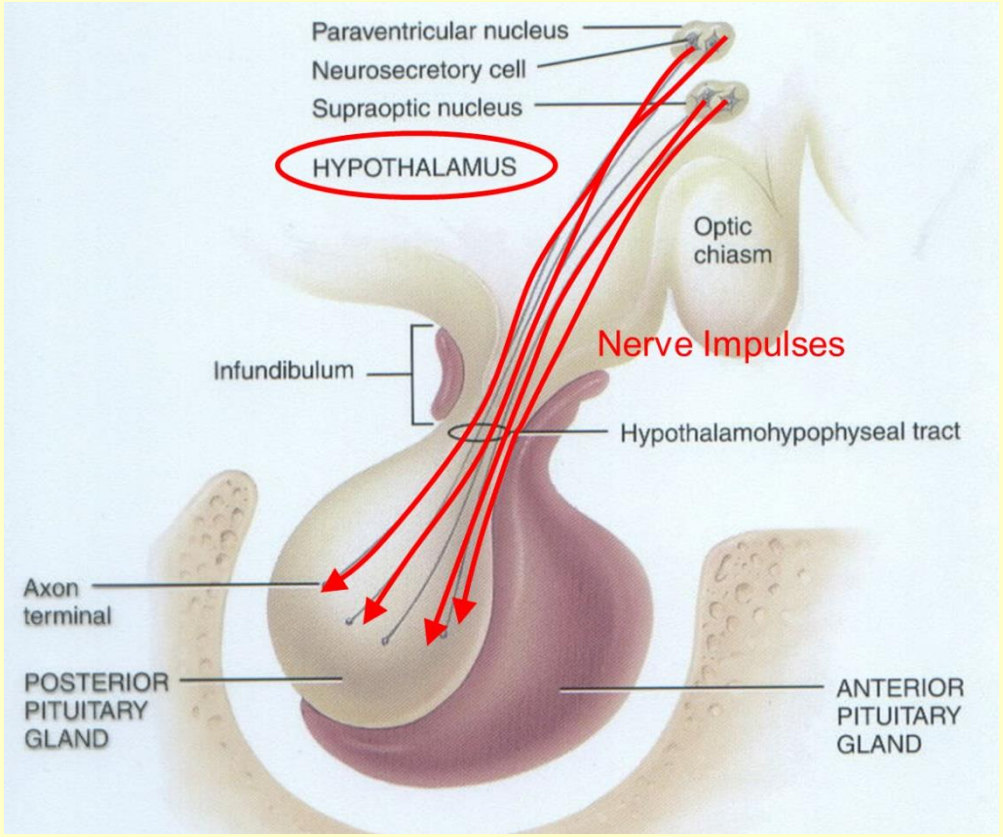


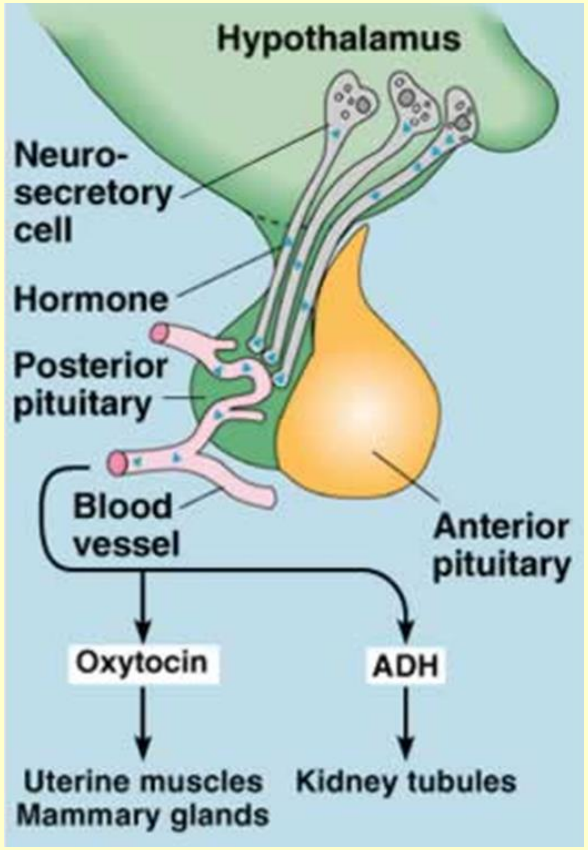
Secretory component of circumventrical organs, which houses primary capillary bed. Lacks the brain – blood barrier.

HYPOTHALAMOHYPOPHYSEAL TRACT

the bridge between the nervous system and the endocrine system

contains axons of neurosecretory cells, which cell bodies form nuclei of hypothalamus



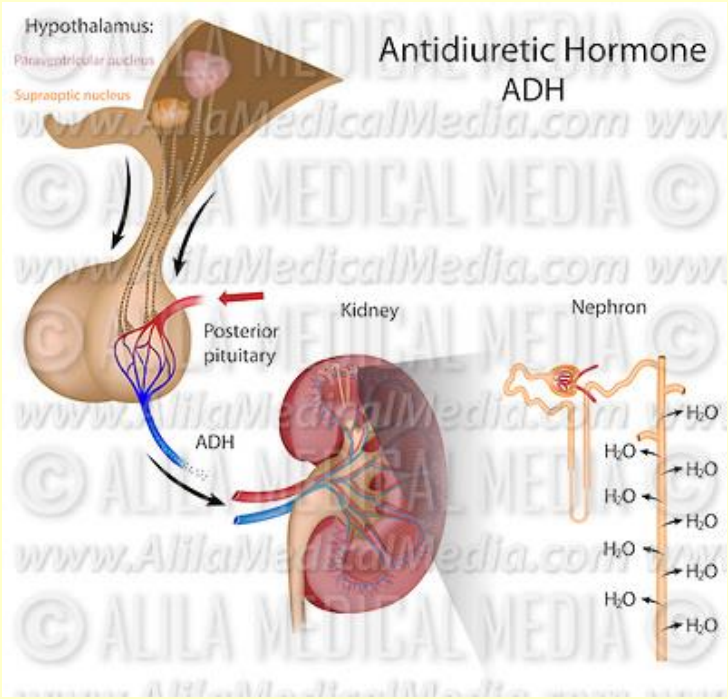


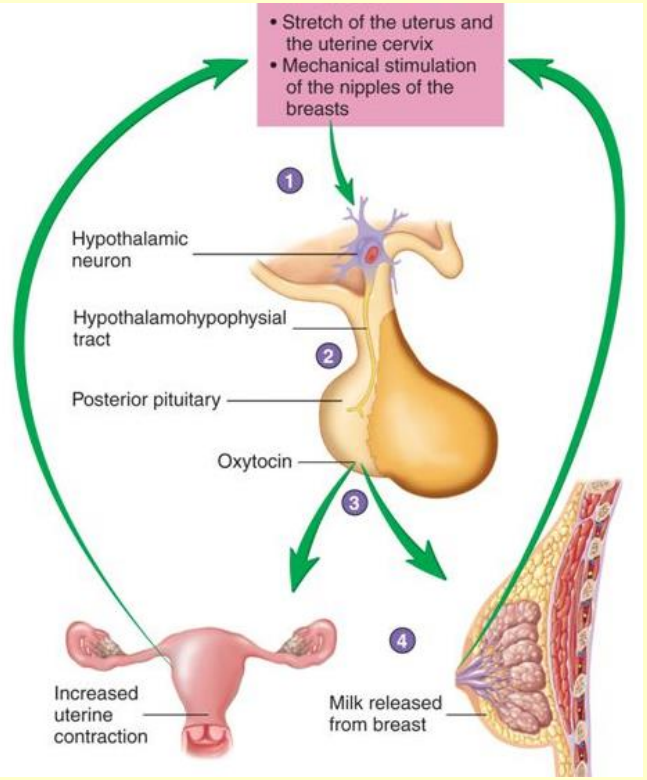
Neurosecretory cells synthesize hormones, which are transported down the axons (after binding with carrier proteins – neurophysins) and released into blood vessels of posterior pituitary.

Neurosecretory cells of the supraoptic and paraventricular hypothalamic nuclei synthesize two hormones:

Vasopressin (antidiuretic hormone [ADH])
supraoptic nucleus

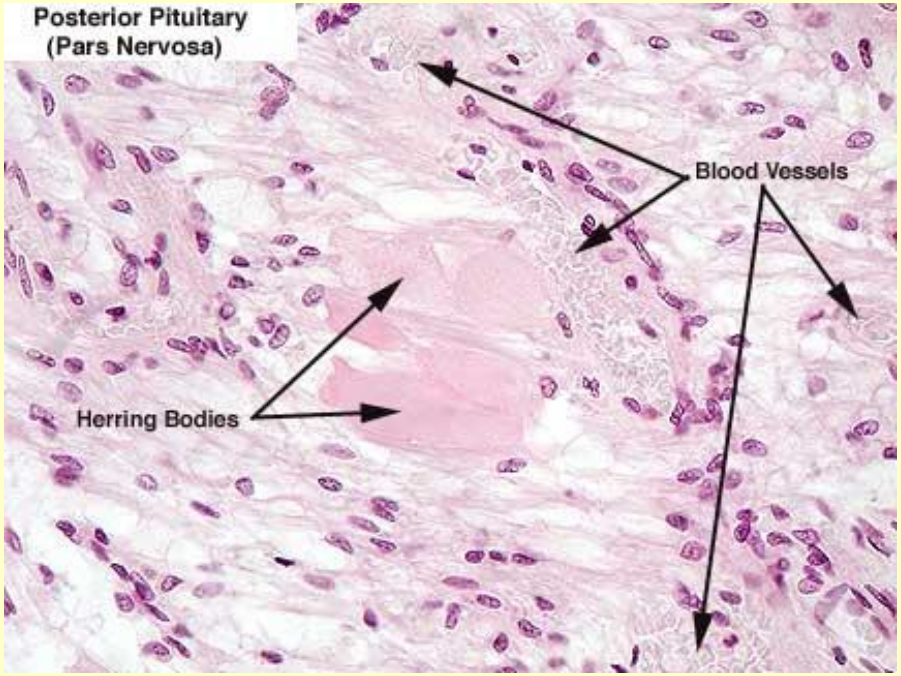
– increases water absorption in the collecting ducts of the kidney and reduces the volume of urine.

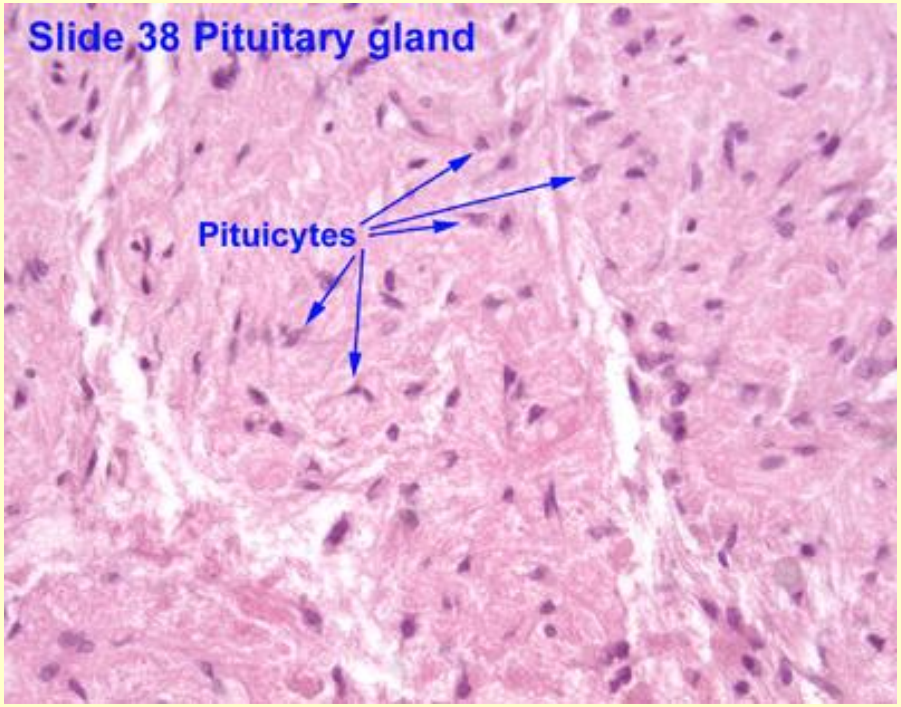




Oxytocin
paraventricular nucleus

is released during labor, stimulates contraction of the smooth muscles of the uterus, seminiferous tubules, epididymis and prostate. Acts in milk ejection from the mammary gland by stimulating contraction of myoepithelial cells of gland.





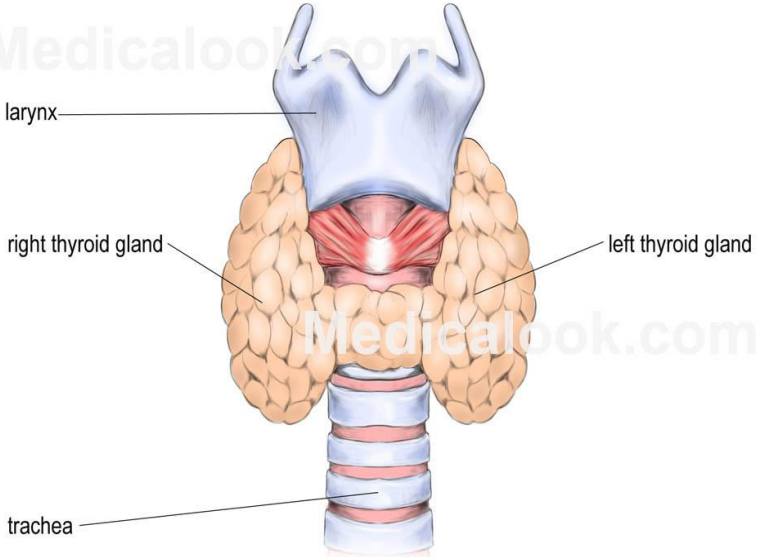
NEUROHYPOPHYSIS
pars nervosa

- consists of unmyelinated nerve fibers derived from neurosecretory cells of the supraoptic and paraventricular hypothalamic nuclei and pituicytes. In this part hormones are released in response to nerve stimulation.

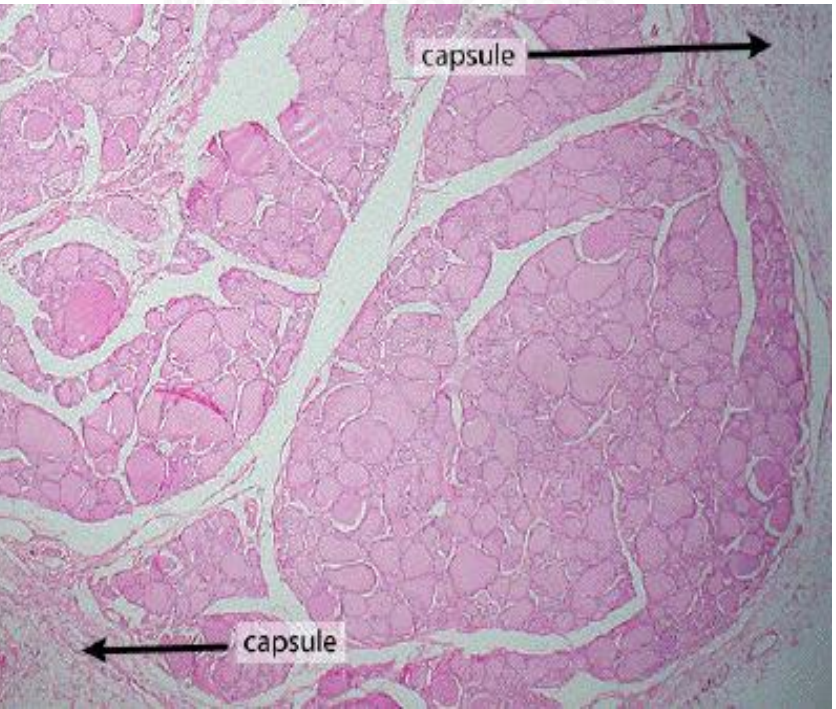
Herring bodies (distensions of the axons) contain neurosecretory granules with vasopressin (ADH) and oxytocin.

Pituicytes are glial cells – support the axons of the pars nervosa

THYROID GLAND

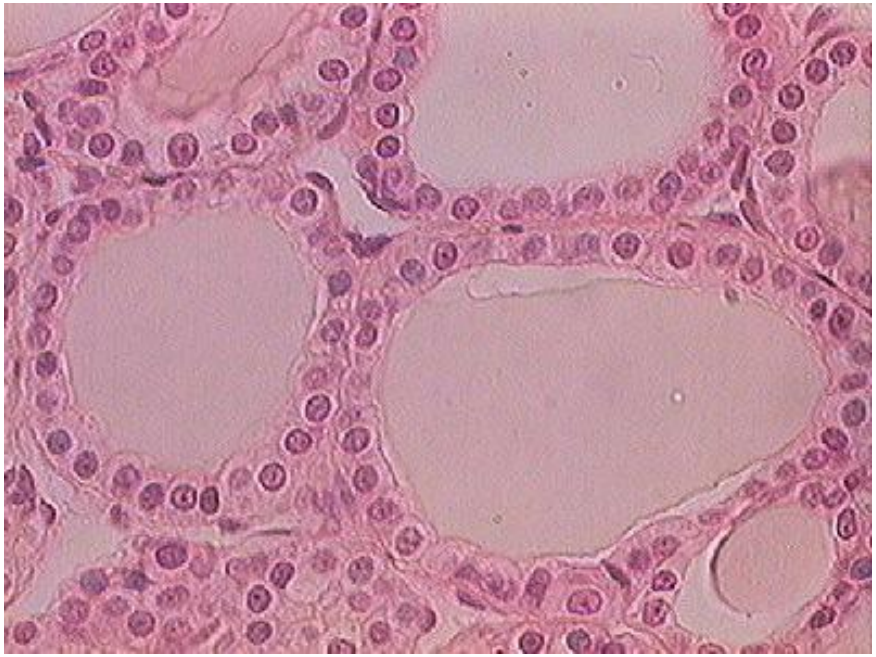


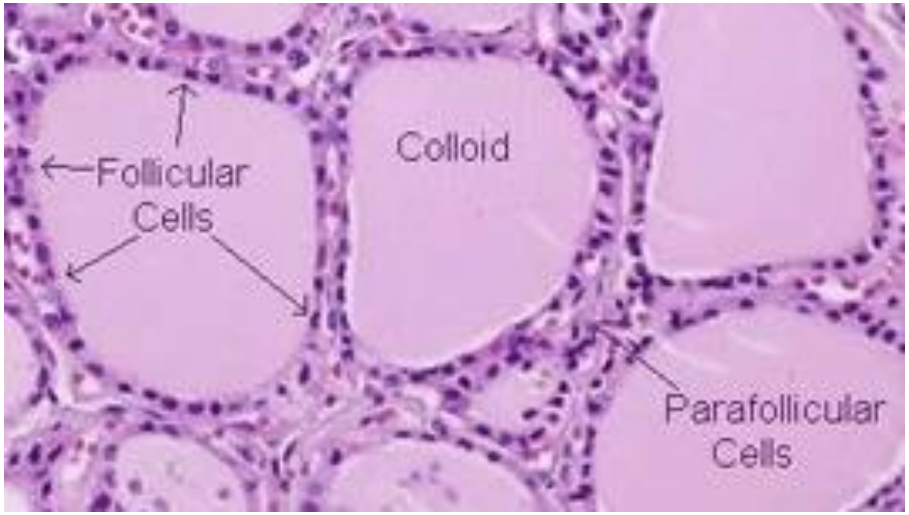
- is a butterfly-shaped organ
- two lobes united by an isthmus.
- situated on the anterior side of the neck, lying against and around the larynx and trachea



The thyroid gland is covered by a slender, dense irregular connective tissue capsule.
Septa derived from the capsule invade the parenchyma and provide a conduit for blood vessels, lymphatic vessels, and nerve fibers

THYROID GLAND



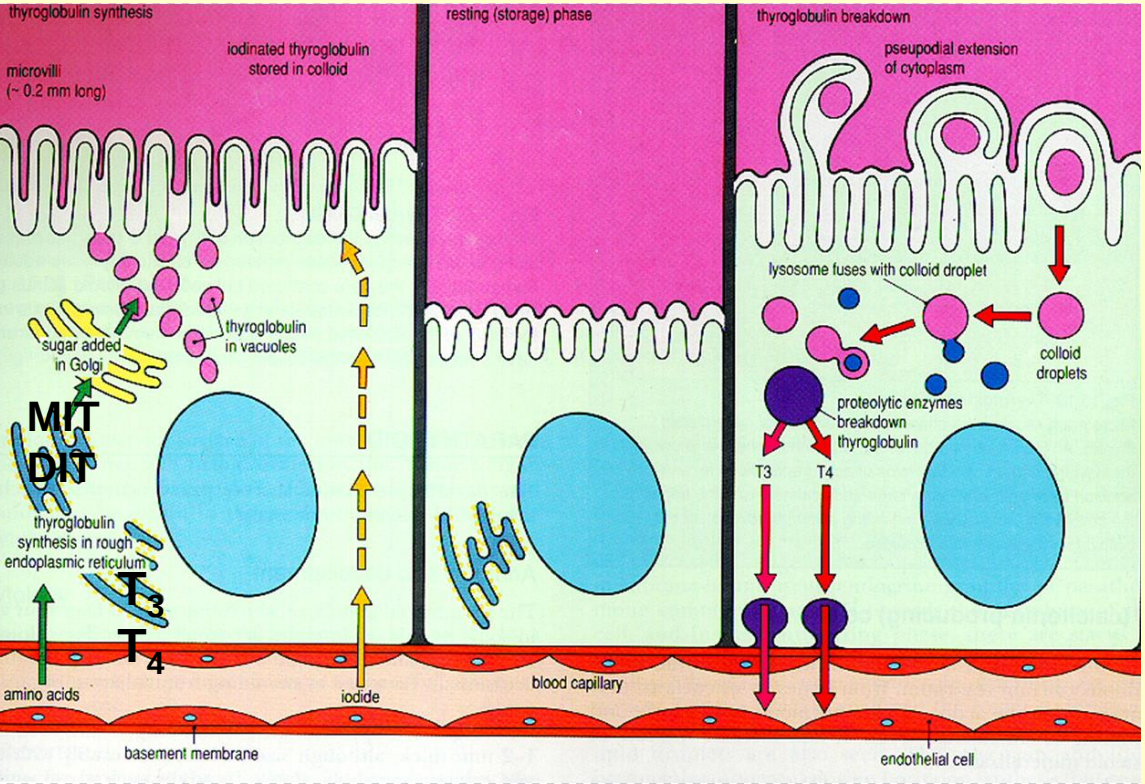


The structural and functional units of the thyroid gland are thyroid follicles composed of a simple cuboidal epithelium containing follicular (principal) cells surrounding a central colloid-filled lumen. This epithelium is separated from connective tissue by basal lamina. Parafollicular cells (C cells) are located individually or in clusters between follicles in the connective tissue. They are also surrounded by basal lamina.

SYNTHESIS OF THYROID HORMONES

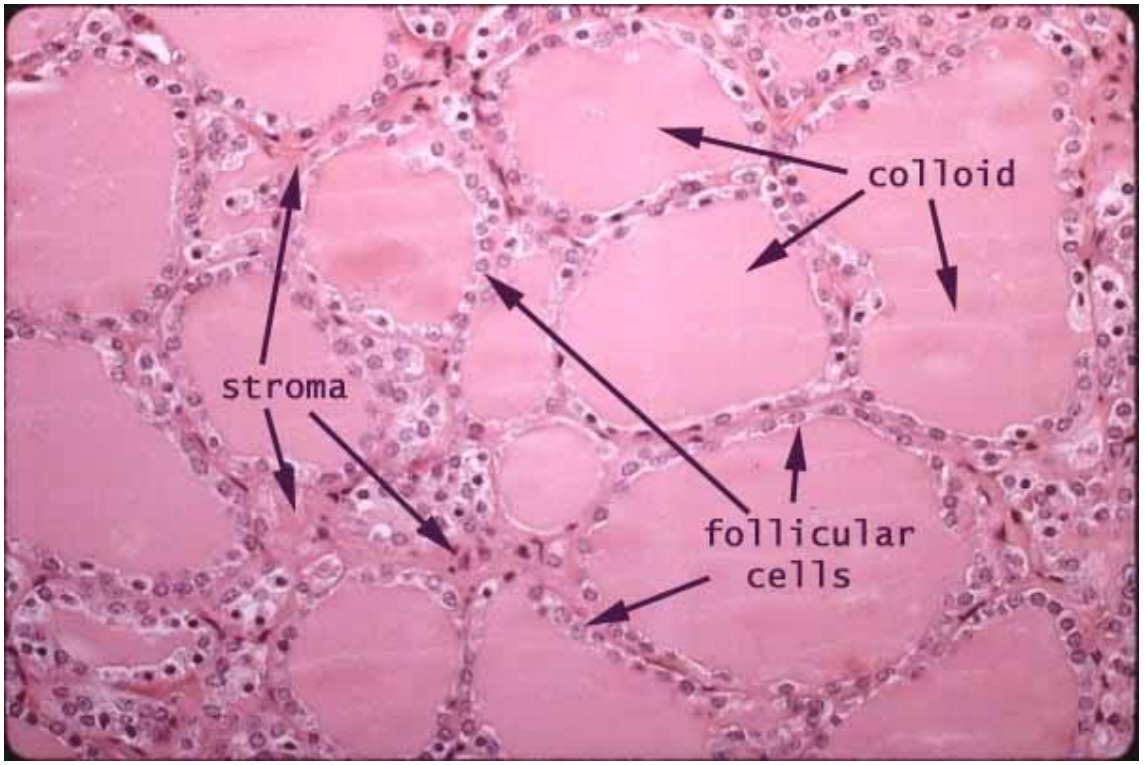
is regulated by the iodide level in the follicular cells and binding of TSH (**thyrotropin)** to TSH receptor of the follicular cells

1. Synthesis and releasing of thyroglobulin into the colloid
2. Iodine is reduced to iodide (I^-) and transported in bloodstream to the follicular cells
3. Iodide oxidized by thyroid peroxidase in cytosol enters the colloid and iodinates tyrosine residues of thyroglobulin forming monoiodinated tyrosine (MIT) and diiodinated tyrosine (DIT).



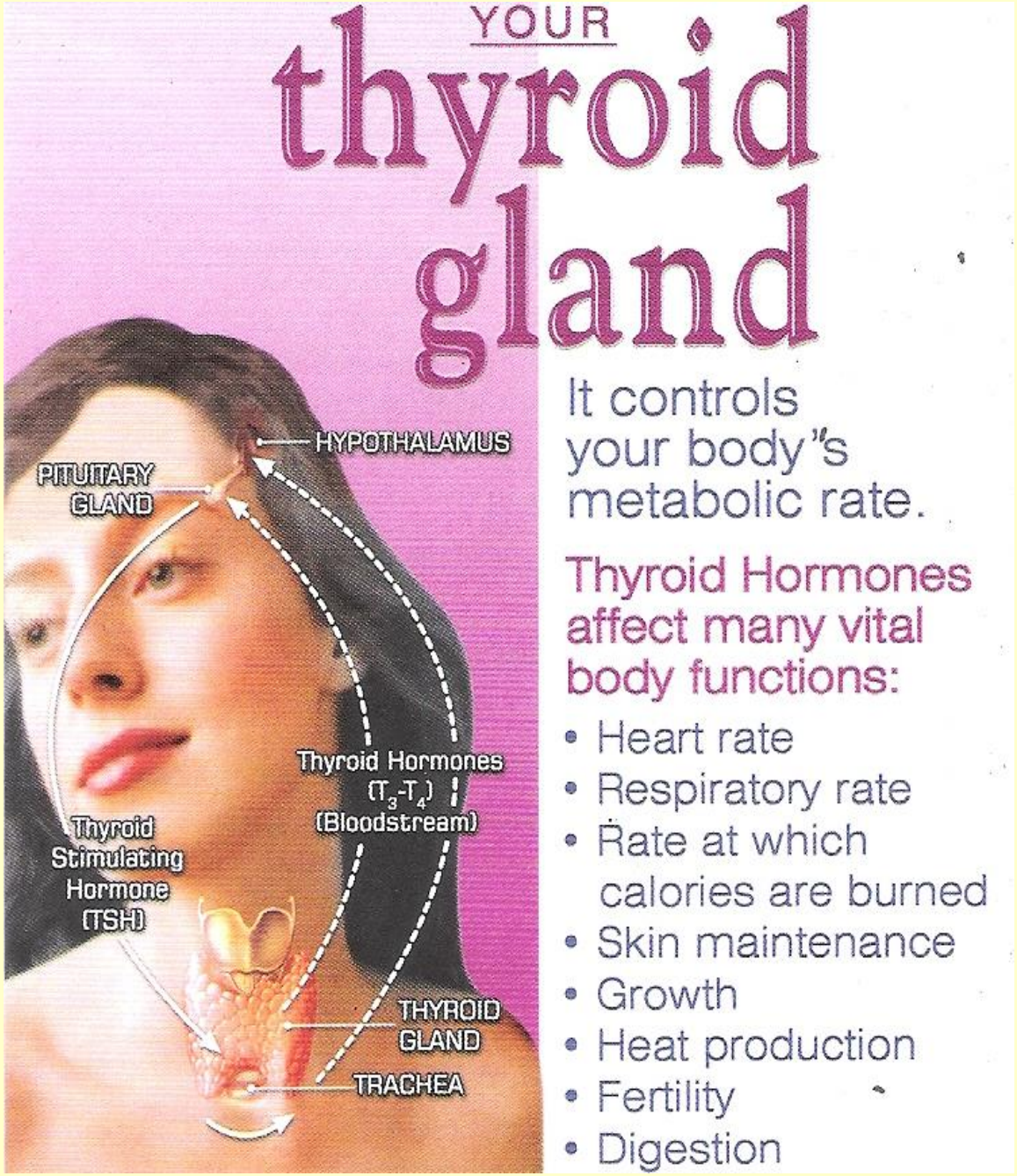
4. Triiodinated (T_3) and tetraiodinateded tyrosine (T_4) are formed by the coupling of MIT and DIT
5. TSH stimulates the endocytosis of the colloid by follicular cells
6. Within the endosomes hormones are cleaved from thyroglobulin and released

THYROID GLAND



The hormones **triiodothyronine (T_3)** and **thyroxine (tetraiodothyronineT_4)** are stored in the colloid, bound to **thyroglobulin -** a large secretory glycoprotein.

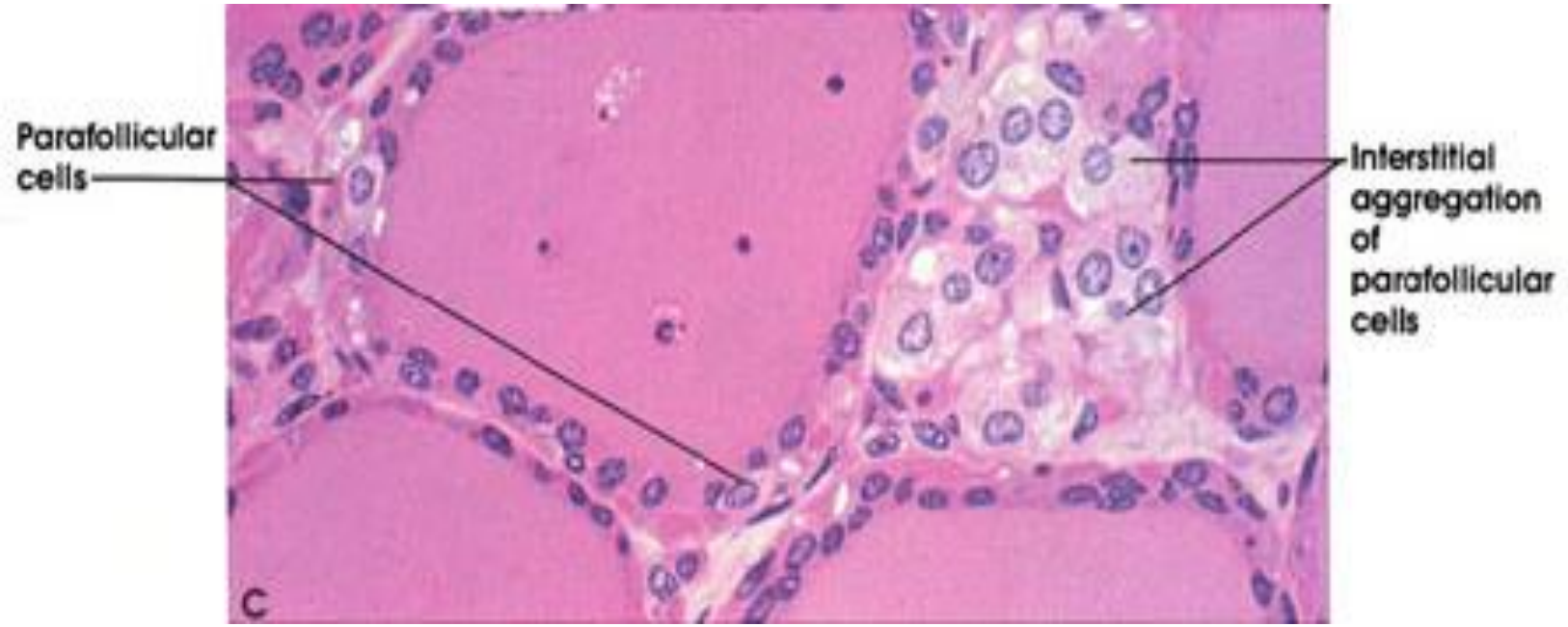
When the hormones are to be released, the hormone-bound thyroglobulin is endocytosed by the follicular cells and the hormones are cleaved from it by **lysosomal proteases**.



T_4 constitutes 90% of the released hormone. They act to increase the basal metabolic rate, help regulate long bone growth (synergy with growth hormone) and neural maturation.

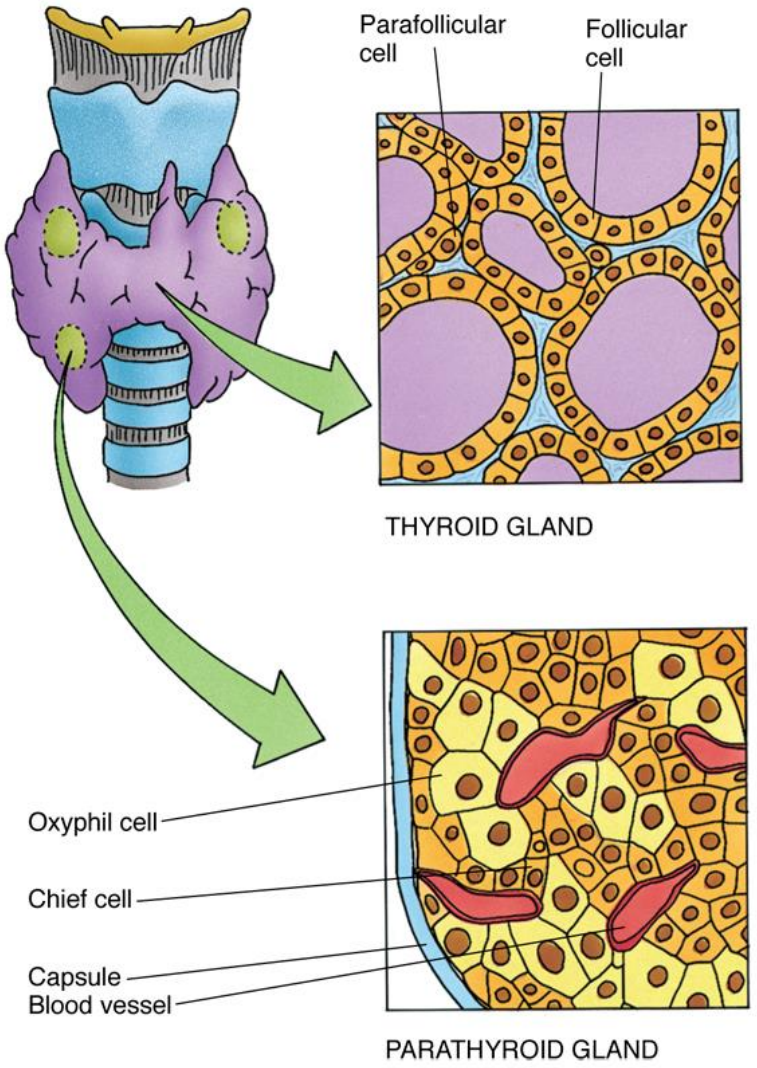
Thyroid hormones also regulate protein, fat, and carbohydrate metabolism.

PARAFOLLICULAR CELLS (CLEAR CELLS, C CELLS)



Parafollicular cells make **calcitonin (thyrocalcitonin),** a peptide hormone that inhibits bone resorption by osteoclasts, thereby lowering calcium concentrations in blood. When the level of calcium ions in circulatory system is high the release of calcitonin is stimulated.

PARATHYROID GLAND



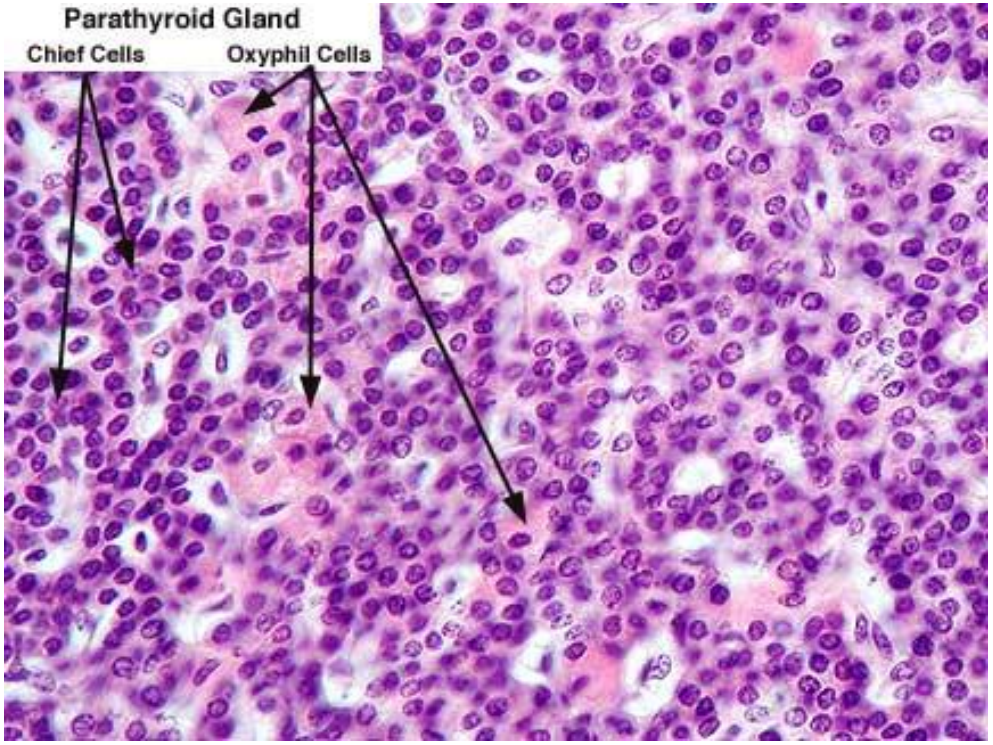
The **parathyroid glands,** usually four in number, are located on the posterior surface of the thyroid gland. Each gland is enveloped in its own thin, collagenous connective tissue capsule, which form septa with blood vessels, lymphatics and nerves entering the gland.

The parenchyma of glands consists of 2 cell types: chief cells and oxyphil cells.

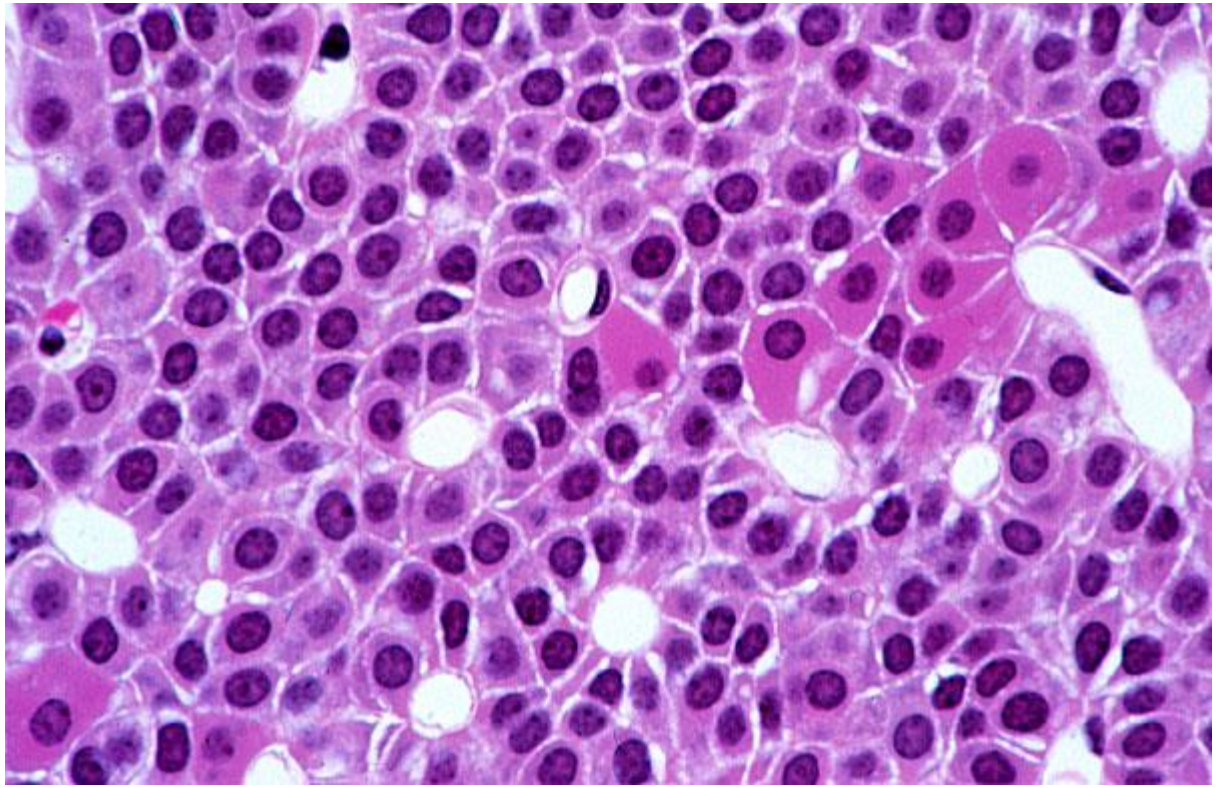
CHIEF CELLS

synthesize **PTH (parathormone)**.

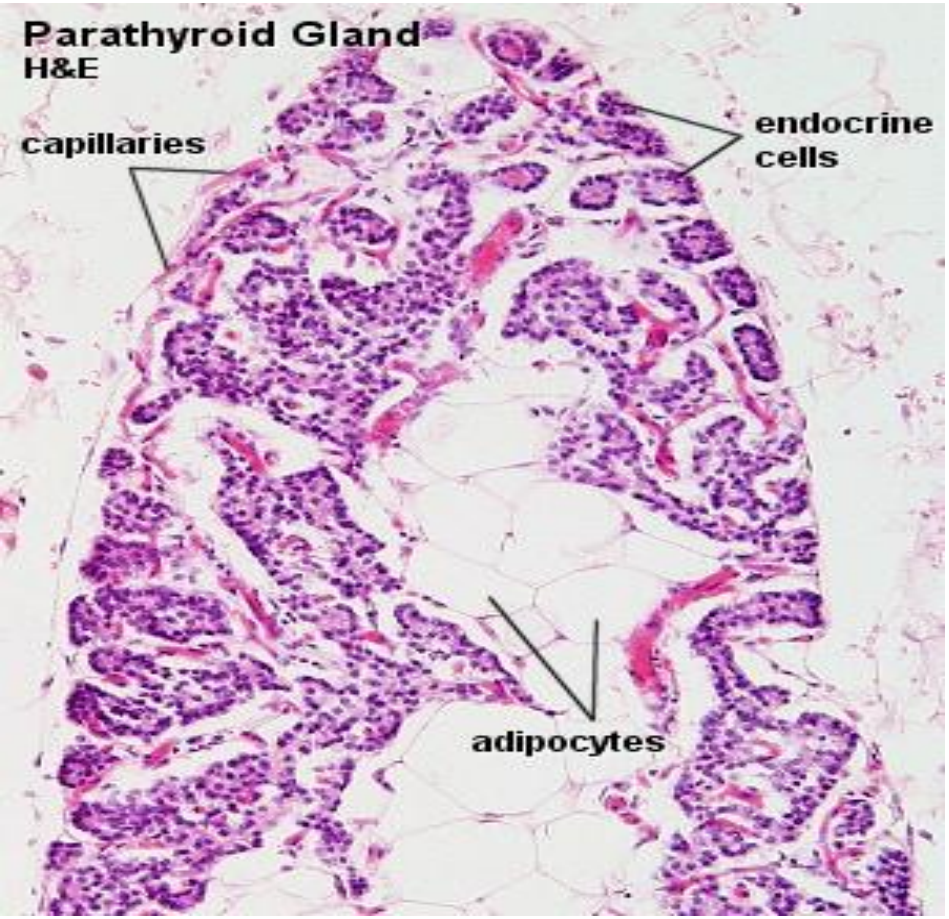
PTH acts on the cells of the bone, the kidneys, and the intestines leading to the increased calcium ions concentrations in body fluids. When calcium ions concentration in in body fluids falls below normal, the chief cells increase the secretion of PTH.

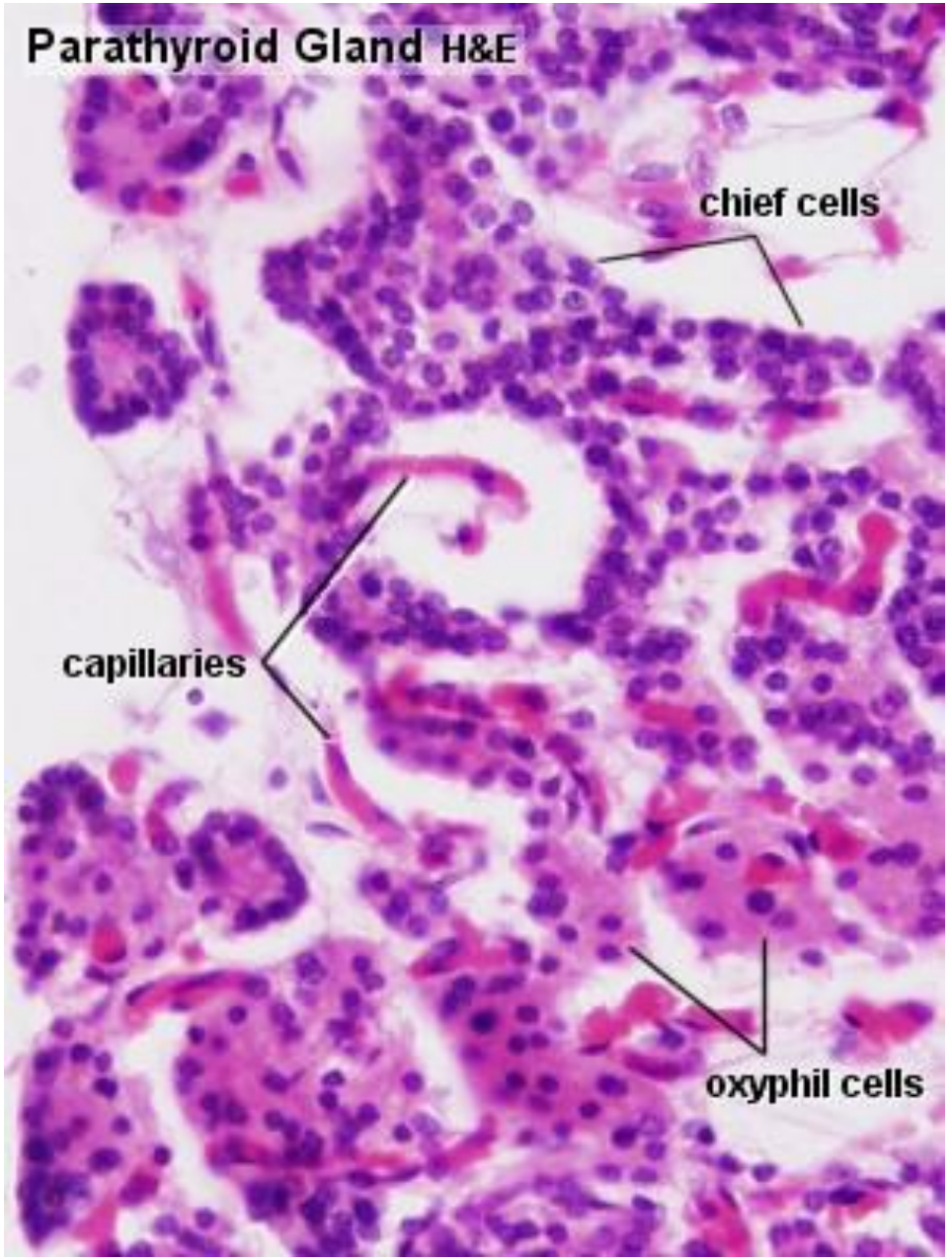


OXYPHIL CELLS



Oxyphil cells - function is unknown, but similarly to the third type of cells **- intermediate cells** - probably represent inactive phases of **chief cells.**

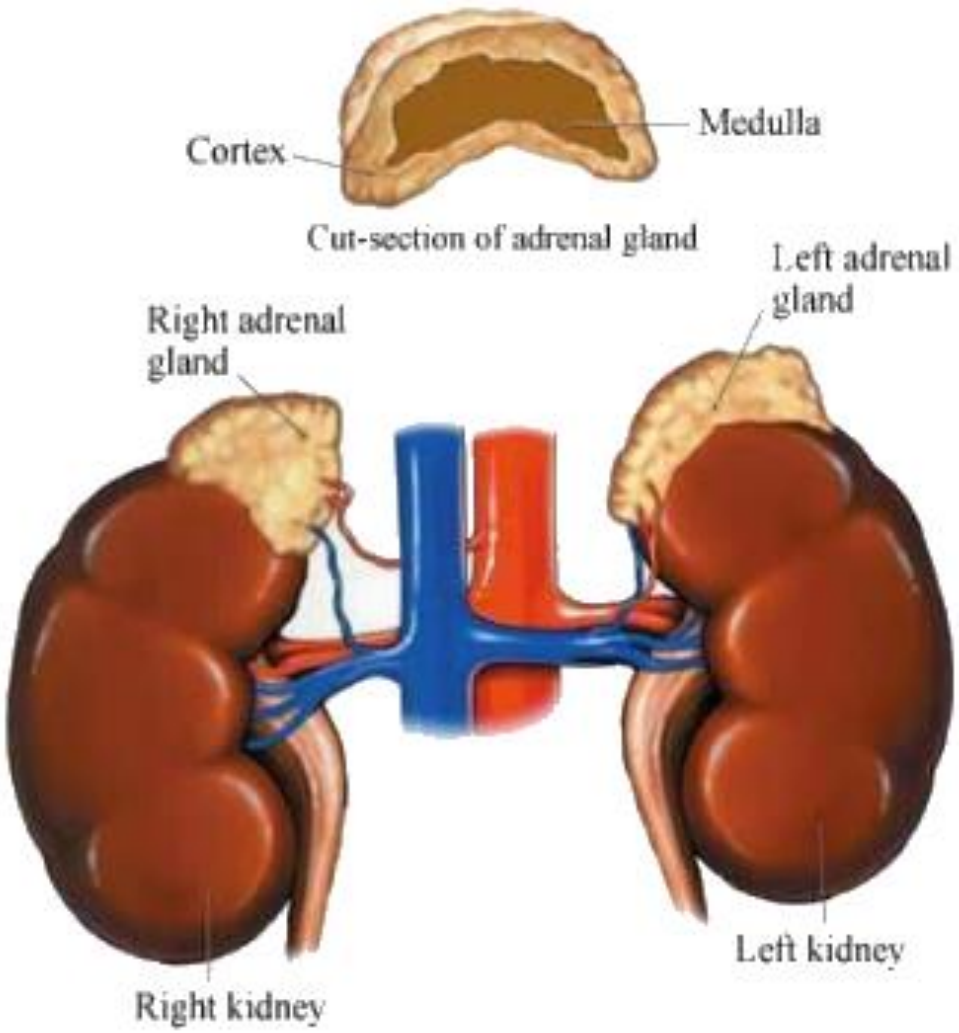




The connective tissue stroma in older adults contains many adipose cells, which may occupy up to 60% of the gland

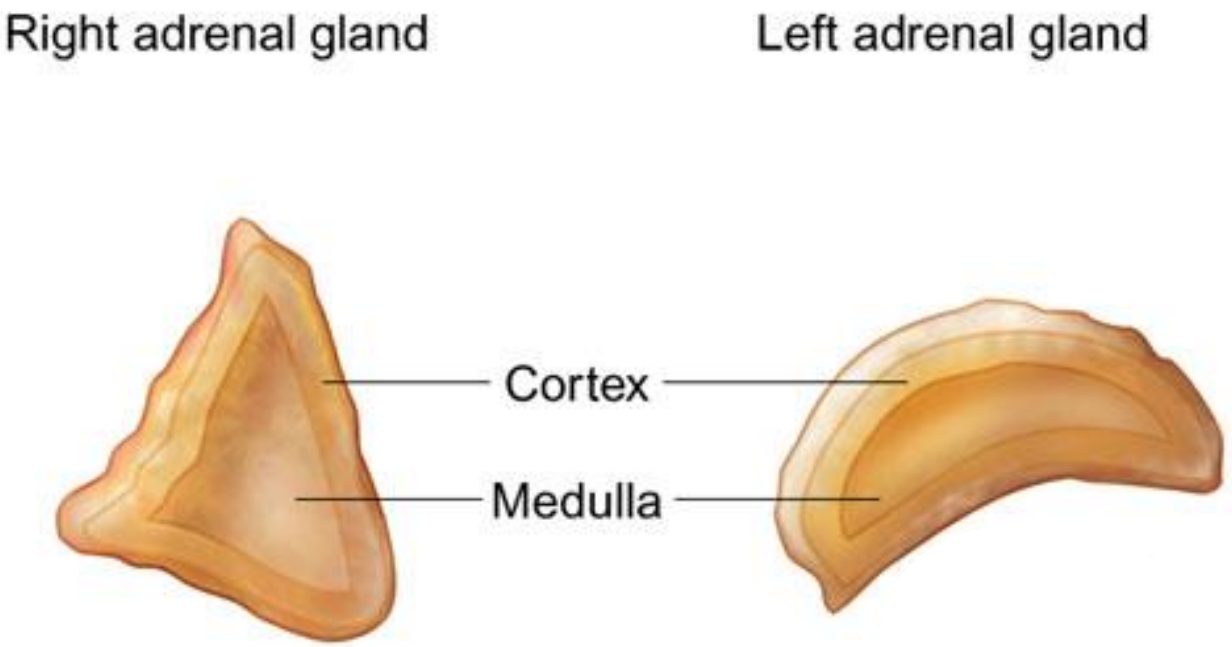
slide 90 Parathyroid gland

SUPRARENAL (ADRENAL) GLANDS



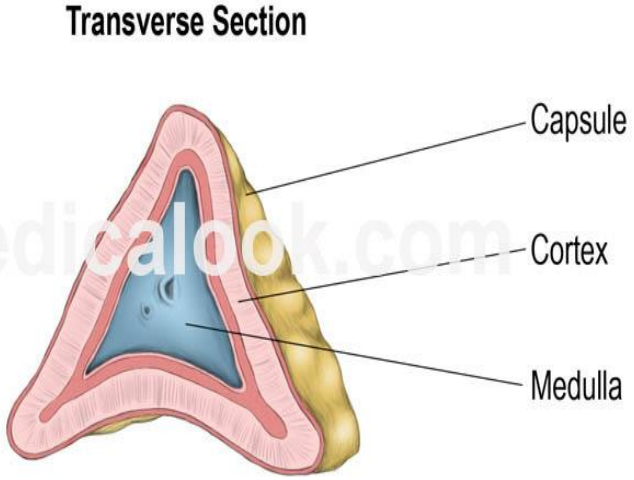
- are located at the superior poles of the kidneys
- are embedded in the adipose tissue
- right and left gland are not mirror images of each other

SUPRARENAL (ADRENAL) GLANDS

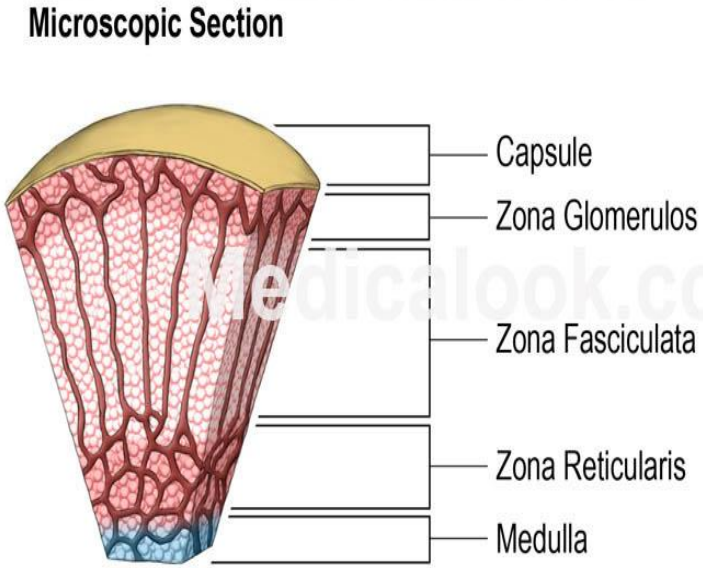


The **suprarenal gland** is divided into two histologically and functionally different regions: an outer portion, called the **suprarenal cortex** (derived from **mesoderm**)**,** and inner portion called the **suprarenal medulla** (derived from neural crest – **ectoderm**).

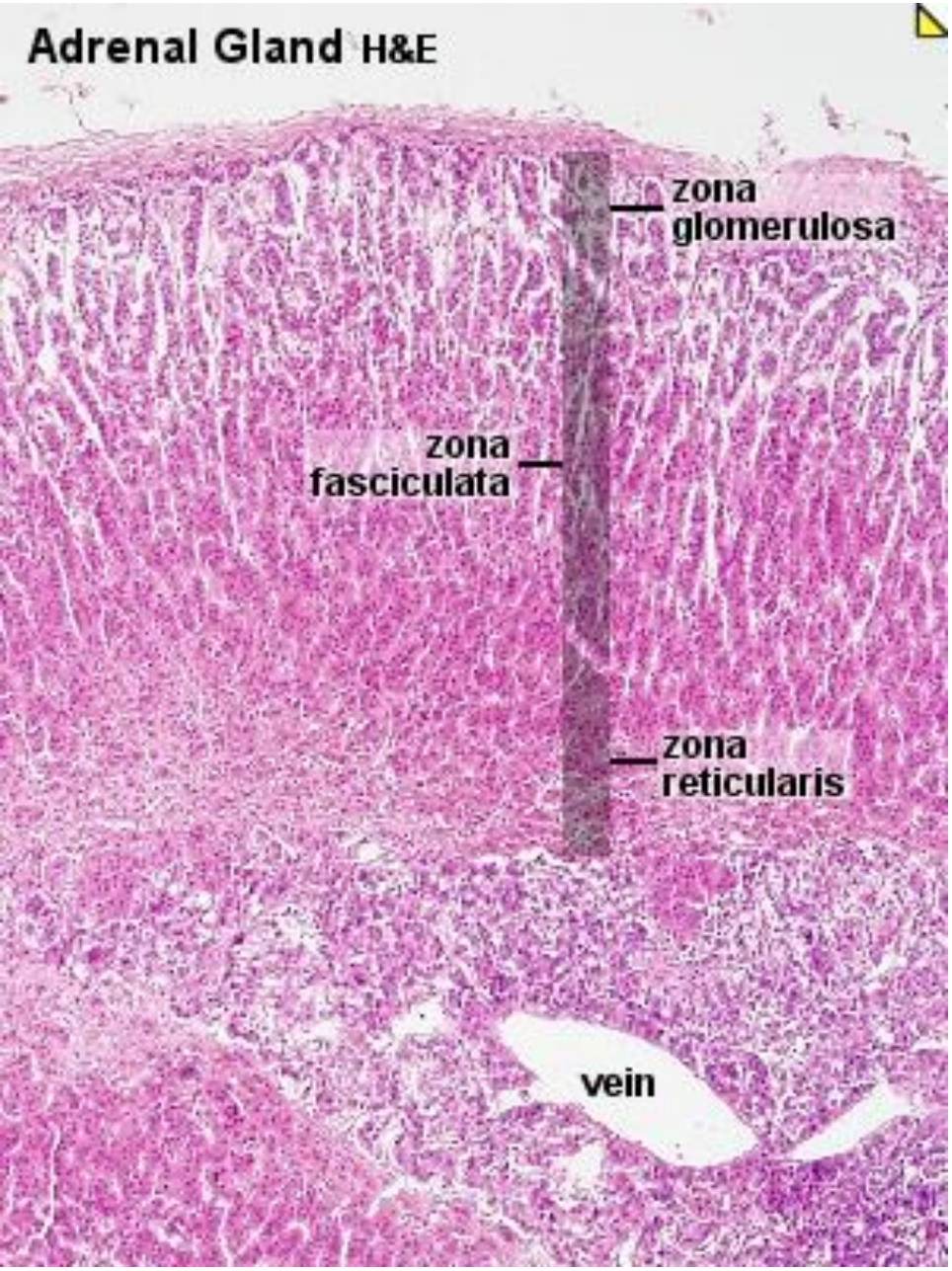
SUPRARENAL (ADRENAL) GLANDS

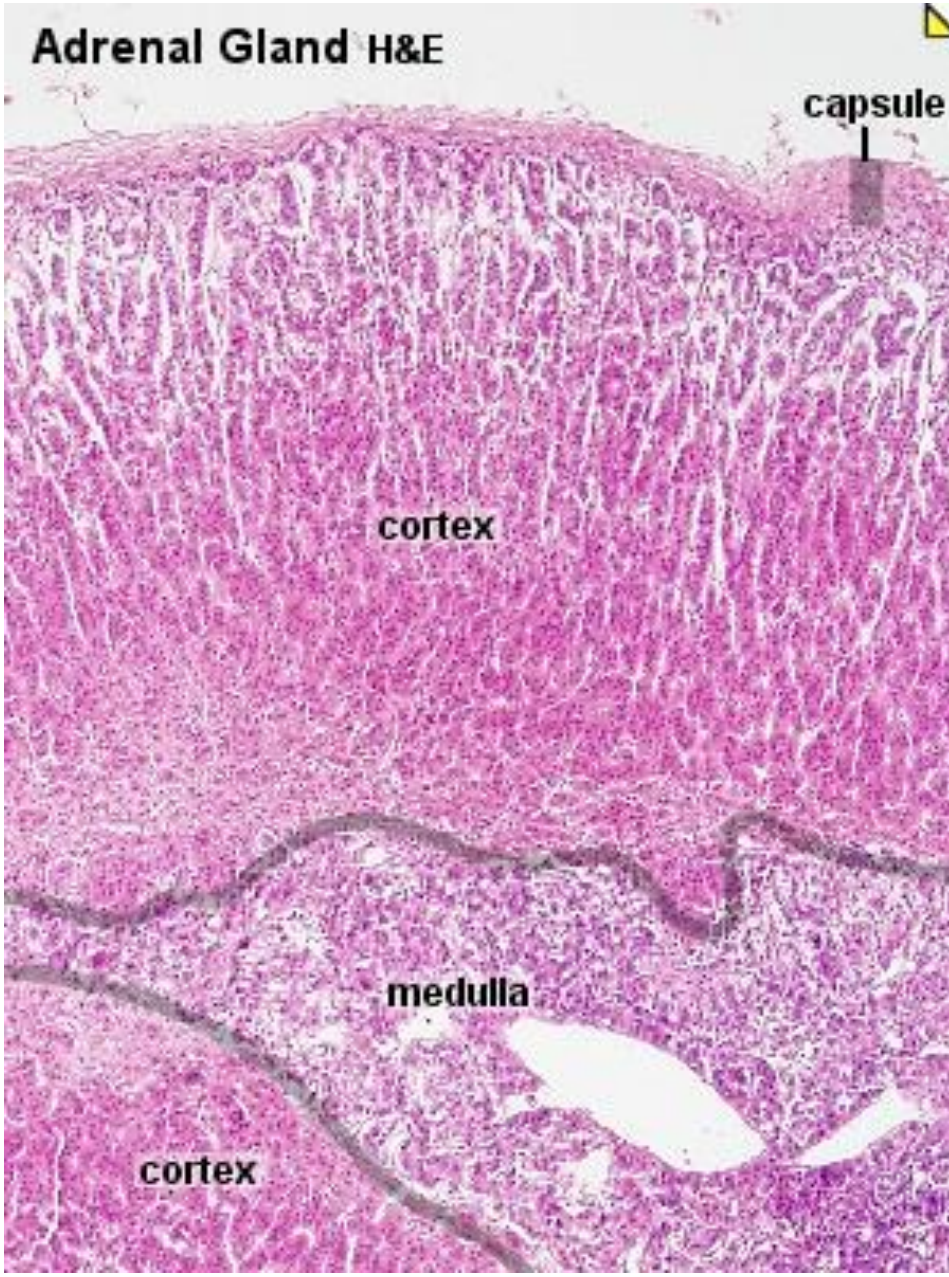


Suprarenal glands are surrounded by a connective tissue capsule (with large amounts of adipose tissue). The capsule sends septa into the parenchyma of the gland with blood vessels and nerves

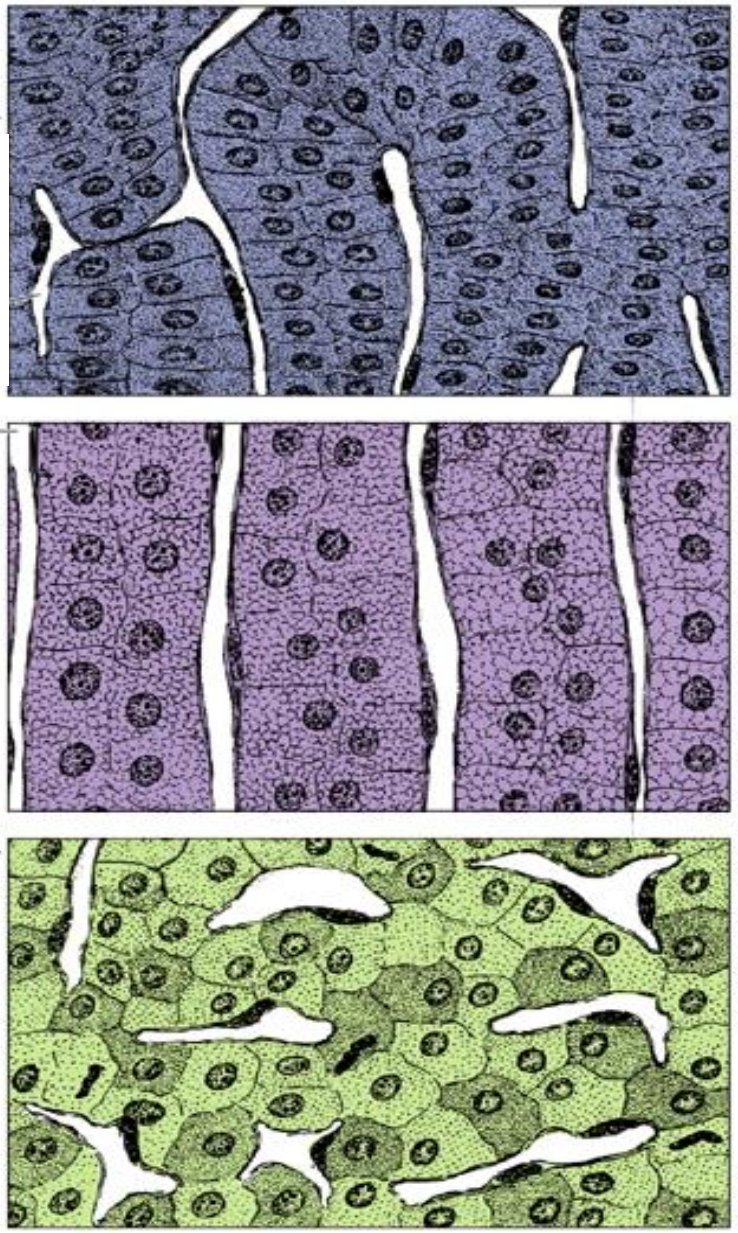


The **suprarenal cortex** is divided into three concentric regions, the outermost **zona glomerulosa**, the middle (and the largest) **zona fasciculata**, and the innermost **zona reticularis**. The suprarenal cortex produces steroid hormones – **CORTICOSTEROIDS.**


Adrenal Gland H&E
zona glomerulosa
zona fasciculata
zona reticularis
vein


Adrenal Gland H&E
capsule
cortex
medulla
cortex

STRUCTURE OF THE ADRENAL CORTEX



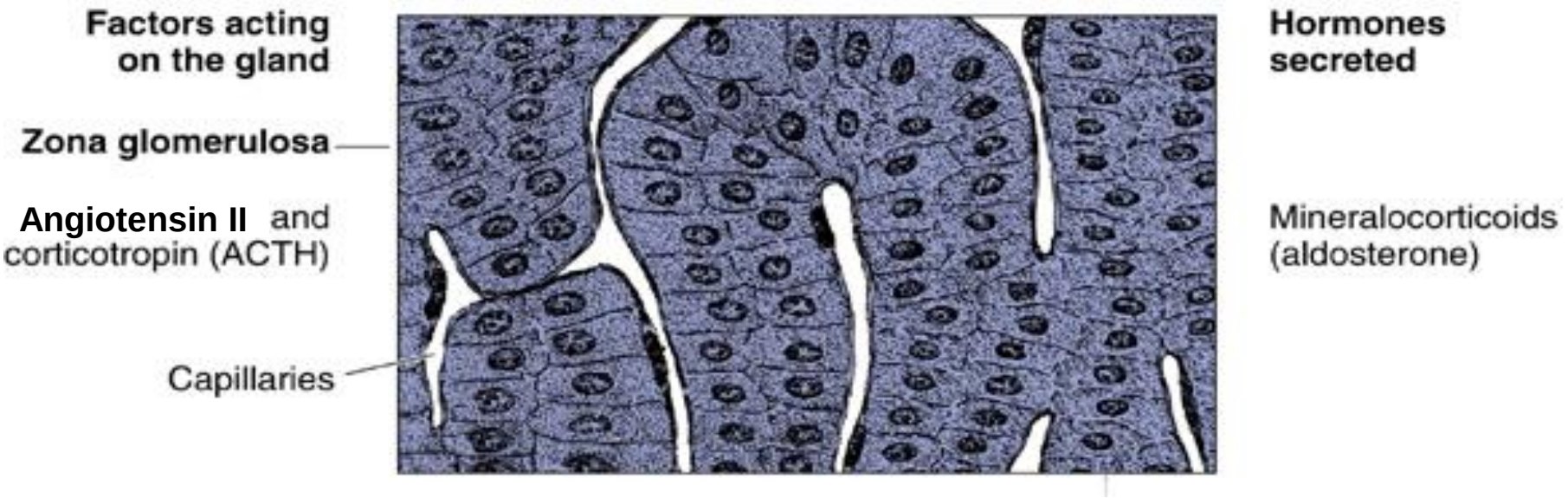
- located just beneath the capsule
- 13% of total adrenal volume
- cells are arranged in cords and clusters

- the intermediate layer
- 80% of total adrenal volume
- cells (spongiocytes) are arranged in columns

- innermost layer
- 7% of total adrenal volume
- cells are arranged in anastomosing cords

PHYSIOLOGY OF THE ADRENAL CORTEX

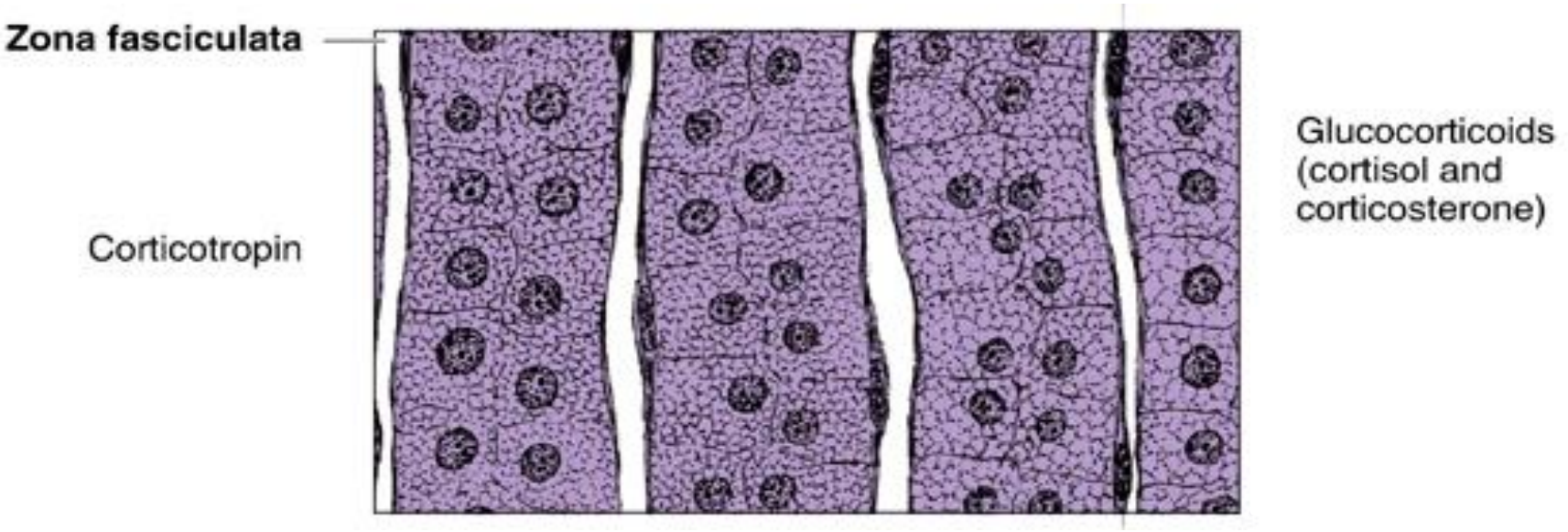
ZONA GLOMERULOSA - MINERALOCORTICOIDS



Mineralocorticoids; mainly aldosterone, and some deoxycorticosterone, which stimulate absorption of Na^+ ions (sweat and salivary glands, gastric mucosa), in kidney stimulate the regulation of water balance and homeostasis of Na^+ and K^+ ions by absorbing Na^+ and excreting K^+ ions.

PHYSIOLOGY OF THE ADRENAL CORTEX

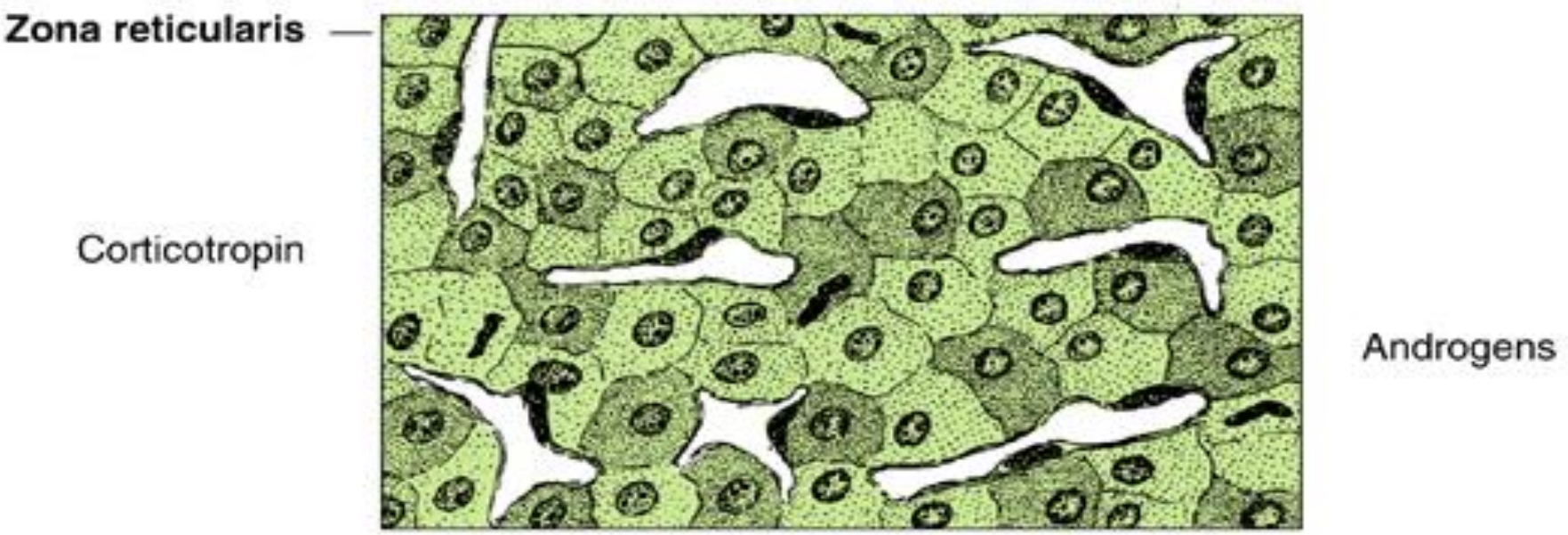
ZONA FASCICULATA- GLUCOCORTICOIDS



Glucocorticoids: mainly cortisol, cortisone and corticosterone exert **anabolic effect** on liver- promote the uptake of fatty acids, amino acids and carbohydrates for glucose synthesis and also **catabolic effect** - stimulate lipolysis (in adipocytes) and proteolysis (in muscle), suppress immune response.

PHYSIOLOGY OF THE ADRENAL CORTEX

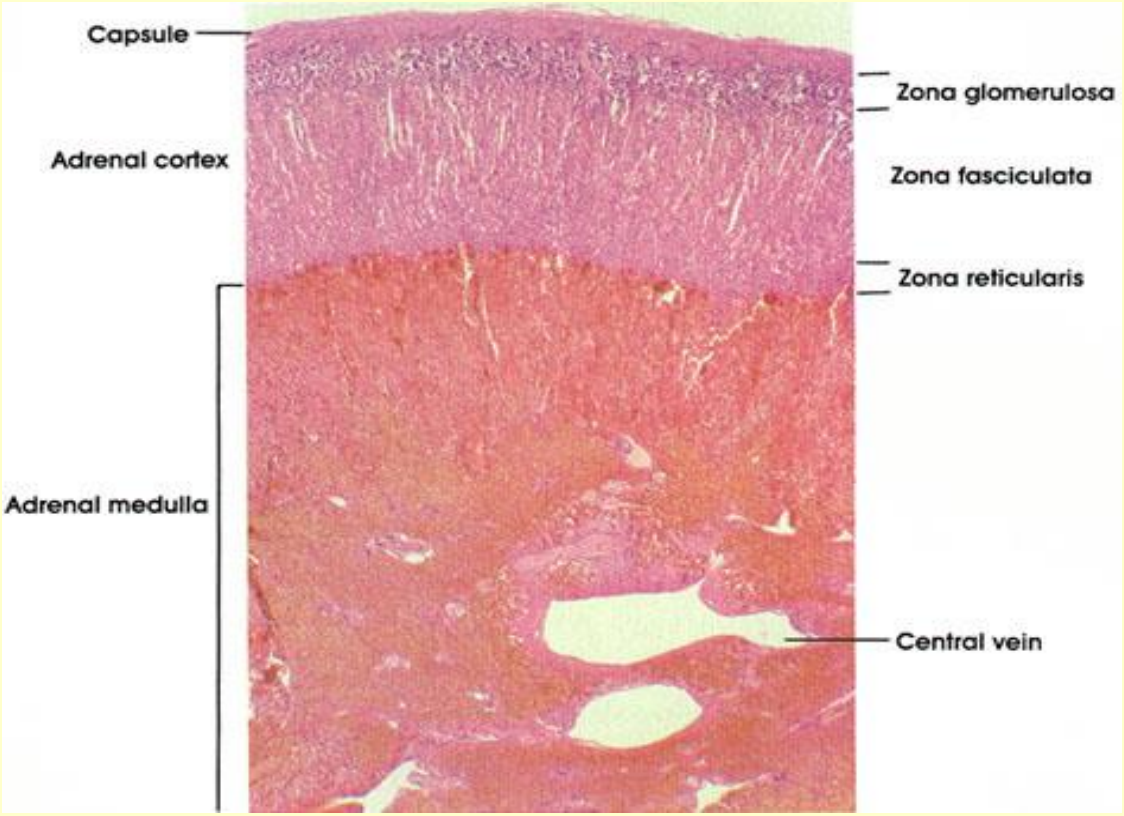
ZONA RETICULARIS - ANDROGENS



Androgens weak, masculinizing sex hormones (dehydroepiandrosteron and androstenedione)

Releasing of ACTH by hypophysis is stimulated by hypothalamic CRH.

SUPRARENAL GLAND – MEDULLA



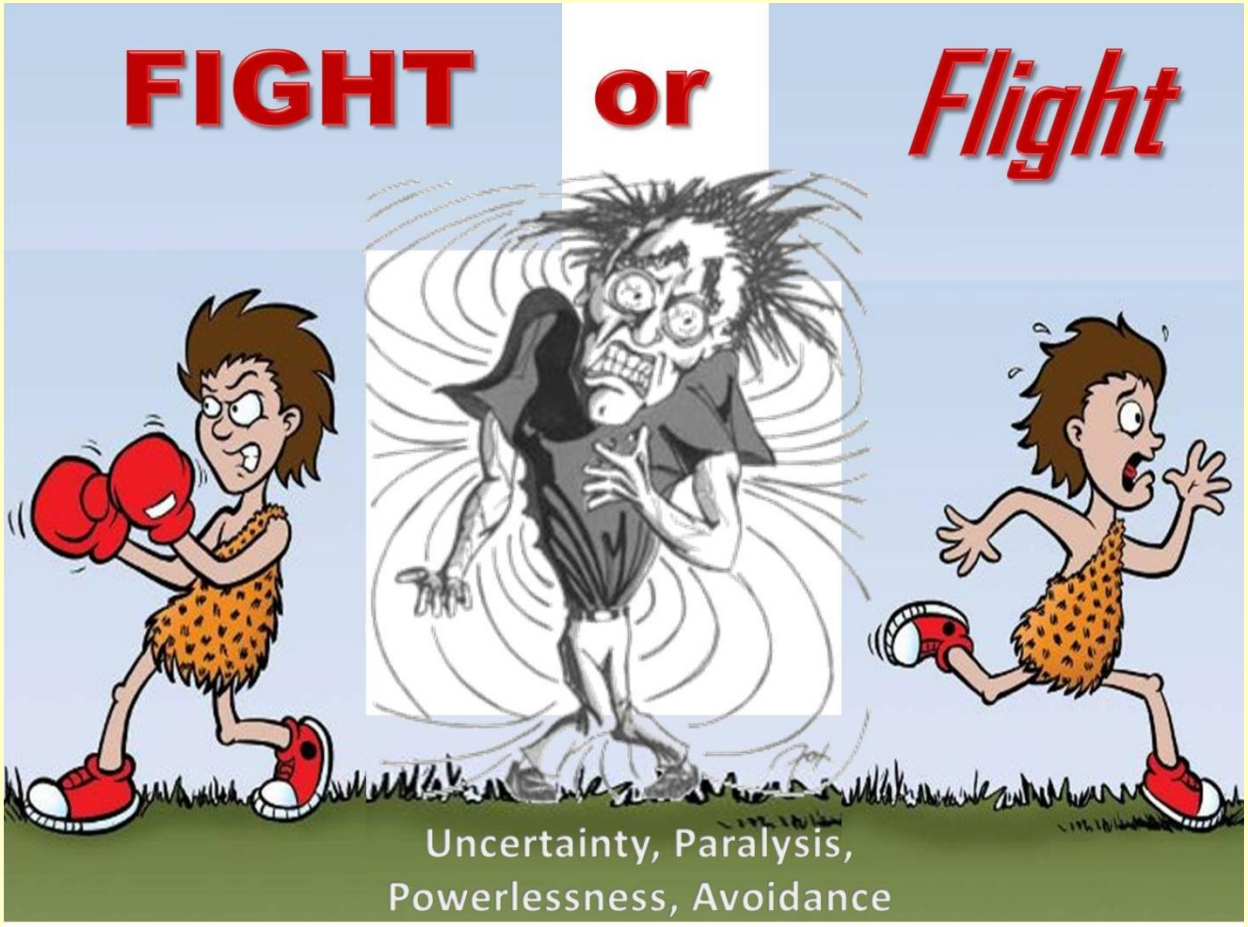
Suprarenal medulla functions as a modified sympathetic ganglion and possesses postganglionic sympathetic cells which lack dendrites and axons and preganglionic autonomic, sympathetic nerve fibers.

Parenchymal cells - **chromaffin cells -** modified postganglionic sympathetic cell bodies manufacture and release the neurotransmitter substances – catecholamines: **epinephrine** and **norepinephrine (**conversion of the amino acid tyrosine into the catecholamines).

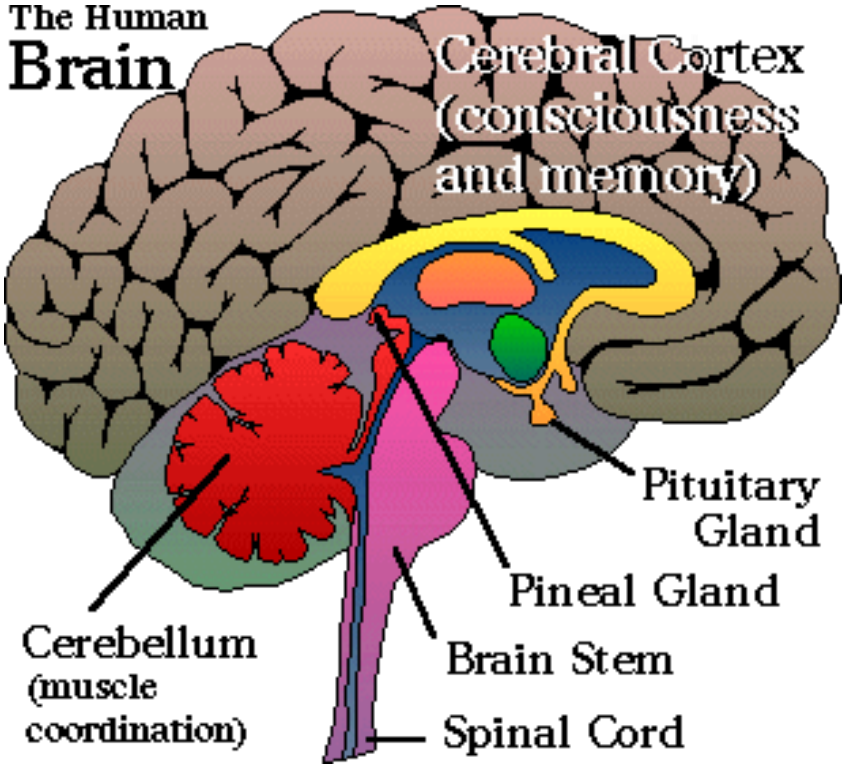
CATECHOLAMINES

emotional stimulus – norepinephrine
physiological stimulus – epinephrine (most effective)

- increase oxygen consumption and heat production
- control heart rate and arterial smooth muscles – increase blood pressure

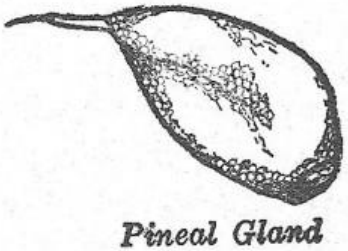


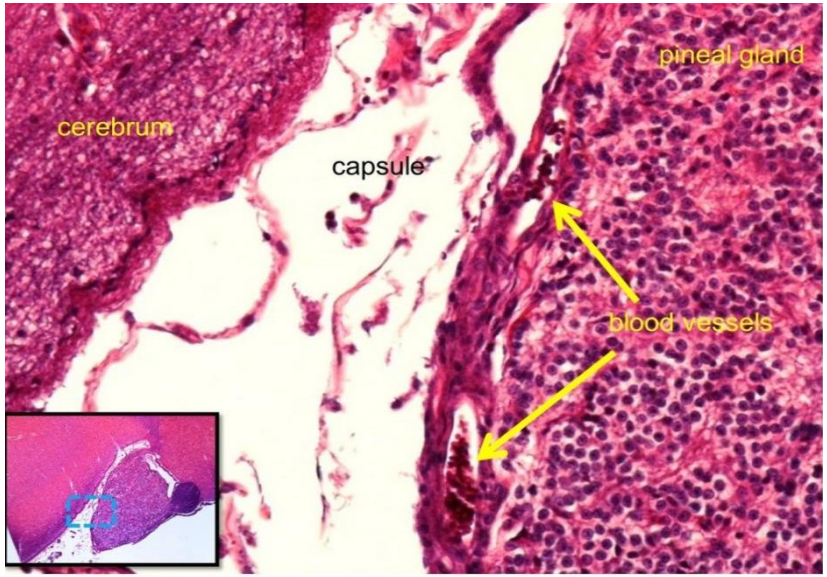
In stress, **epinephrine** is released to prepare the body for **„fight or flight**" increases alertness, cardiac output, heart rate, increases the release of glucose from liver and blood flow through organs



PINEAL GLAND

(**pineal body**) is an endocrine gland whose secretions are influenced by the light and dark periods of the day. Its shape resembles a tiny pine cone (hence its name). It is located near the centre of the brain, between the two hemispheres



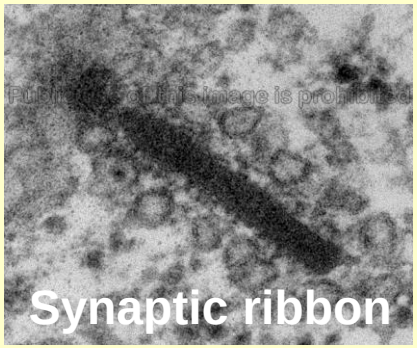


The gland is covered by **pia mater** (delicate innermost layer of the meninges - the membranes surrounding the brain and spinal cord) composed of vascularized fibrous connective tissue, forming a capsule from which septa extend, dividing the pineal gland into incomplete lobules

PINEAL GLAND

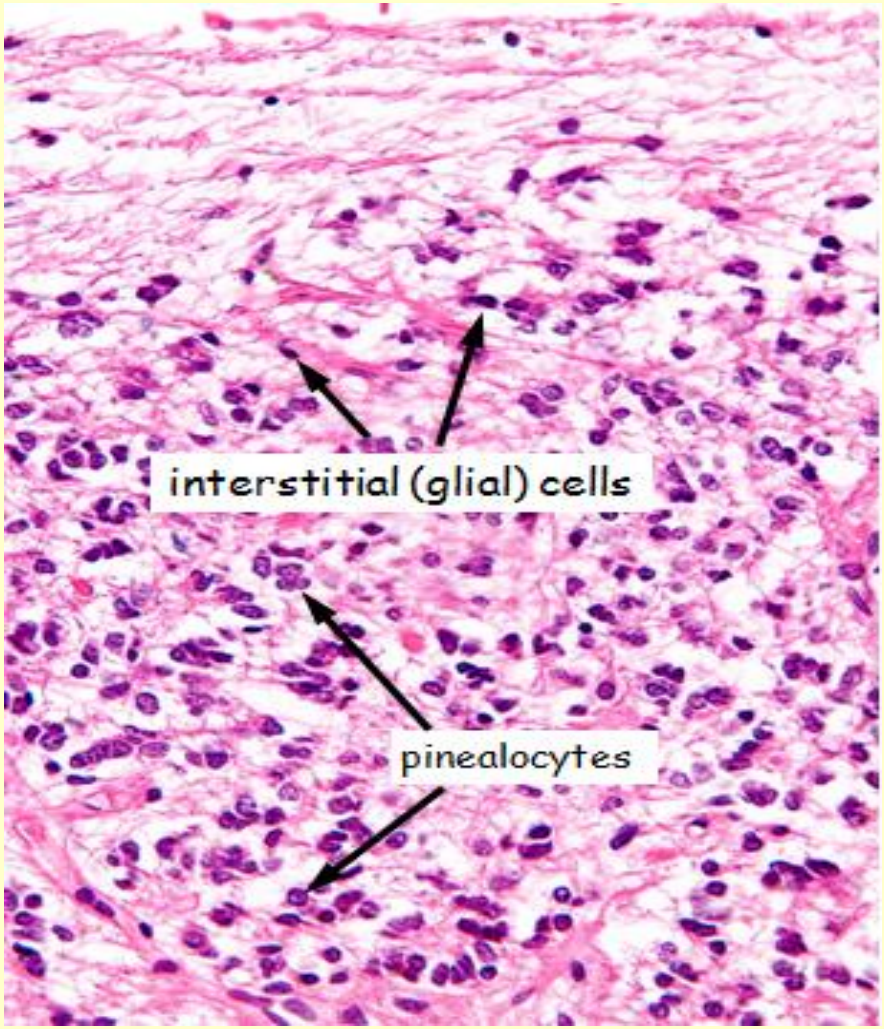
pinealocytes and

interstitial cells



The pinealocytes contain **synaptic ribbons** and produce **melatonin**.

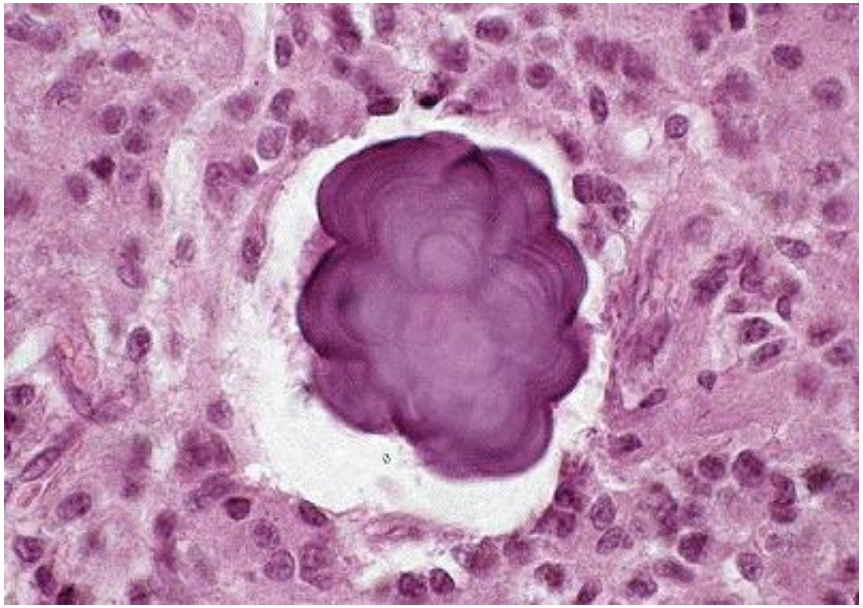
Melatonin is secreted at night and increases the release of growth hormone and inhibits release of LH and FSH by the hypophysis and induces sleepiness.



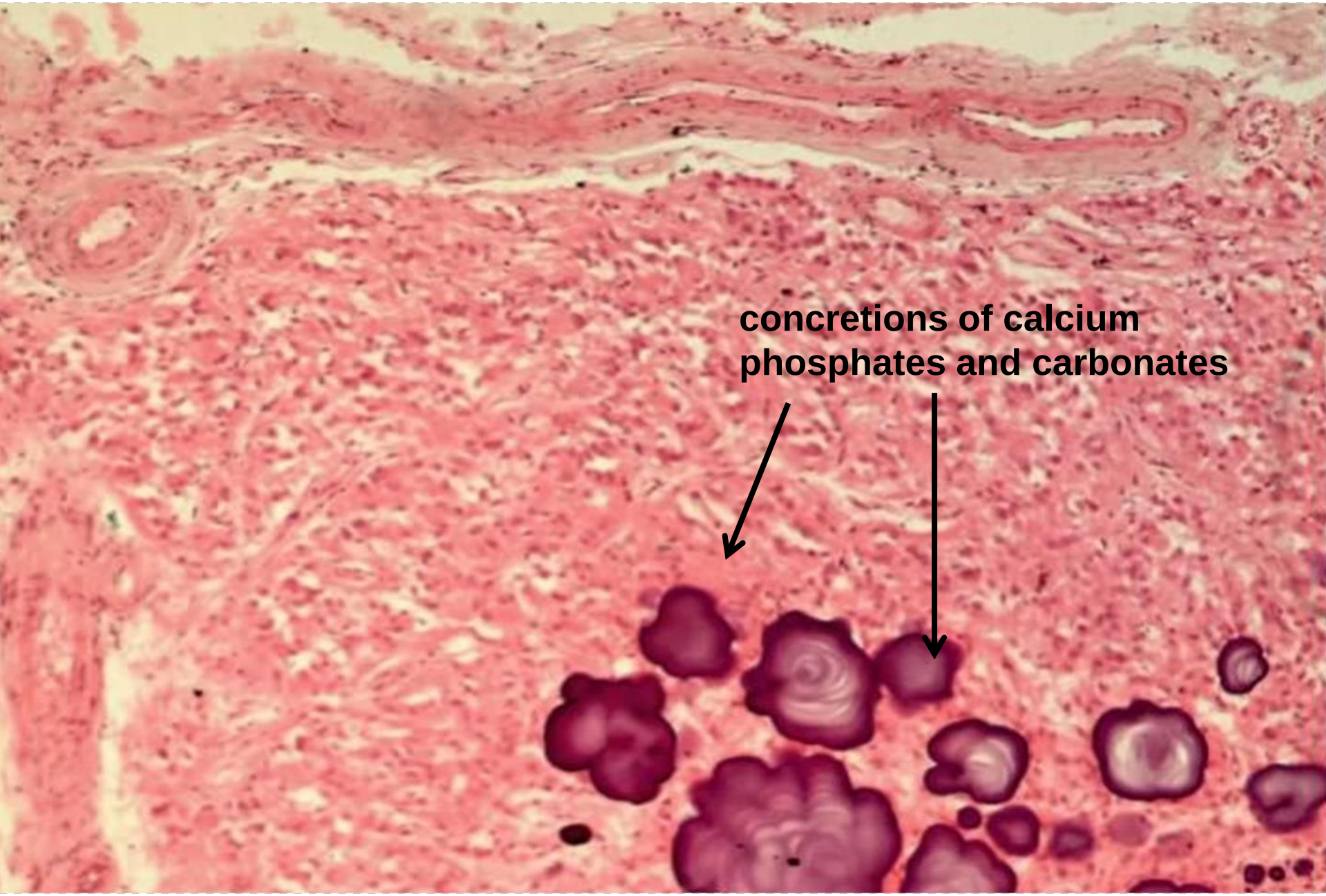
Interstitial cells are believed to be astrocyte-like neuroglia

PINEAL GLAND

CORPORA ARENACEA – BRAIN SAND



Concretions of calcium phosphates and carbonates deposited in concentric rings. They appear in early childhood and increase in size throughout life. Although it is unclear how they are formed or function, they increase during short photoperiods and are reduced as the pineal gland is actively secreting.



slide 49 PINEAL GLAND, Corpora aranacea (brain sand)

What is OXYTOCIN?

Also called the "love hormone' Oxytocin plays an important role in reproduction, feelings of attraction and bonding with our young.

Oxytocin is thought to eliminate fear and encourage TRUST.

What stimulates Oxytocin?

- Sex
- Nipple Stimulation
- Safety
- Chocolate
- Soft music
- Massage

DID YOU KNOW?

Oxytocin was the first polypeptide to be synthesized. Its synthetic version is known today as "Pitocin" and is used in labor inductions.

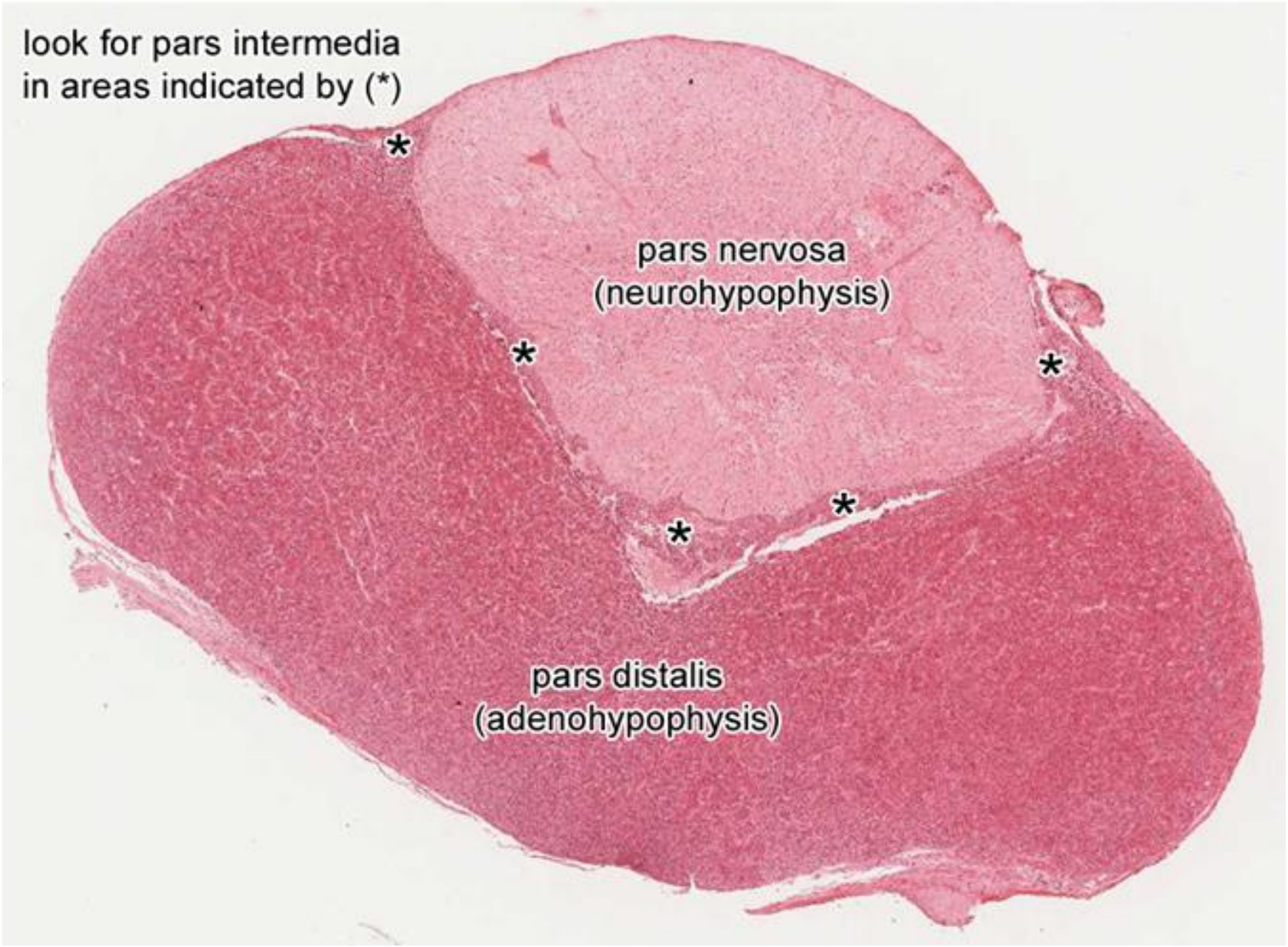
Oxytocin released at birth and during breastfeeding helps contract the uterus and stop bleeding.

Big Oxytocin releases happen during:

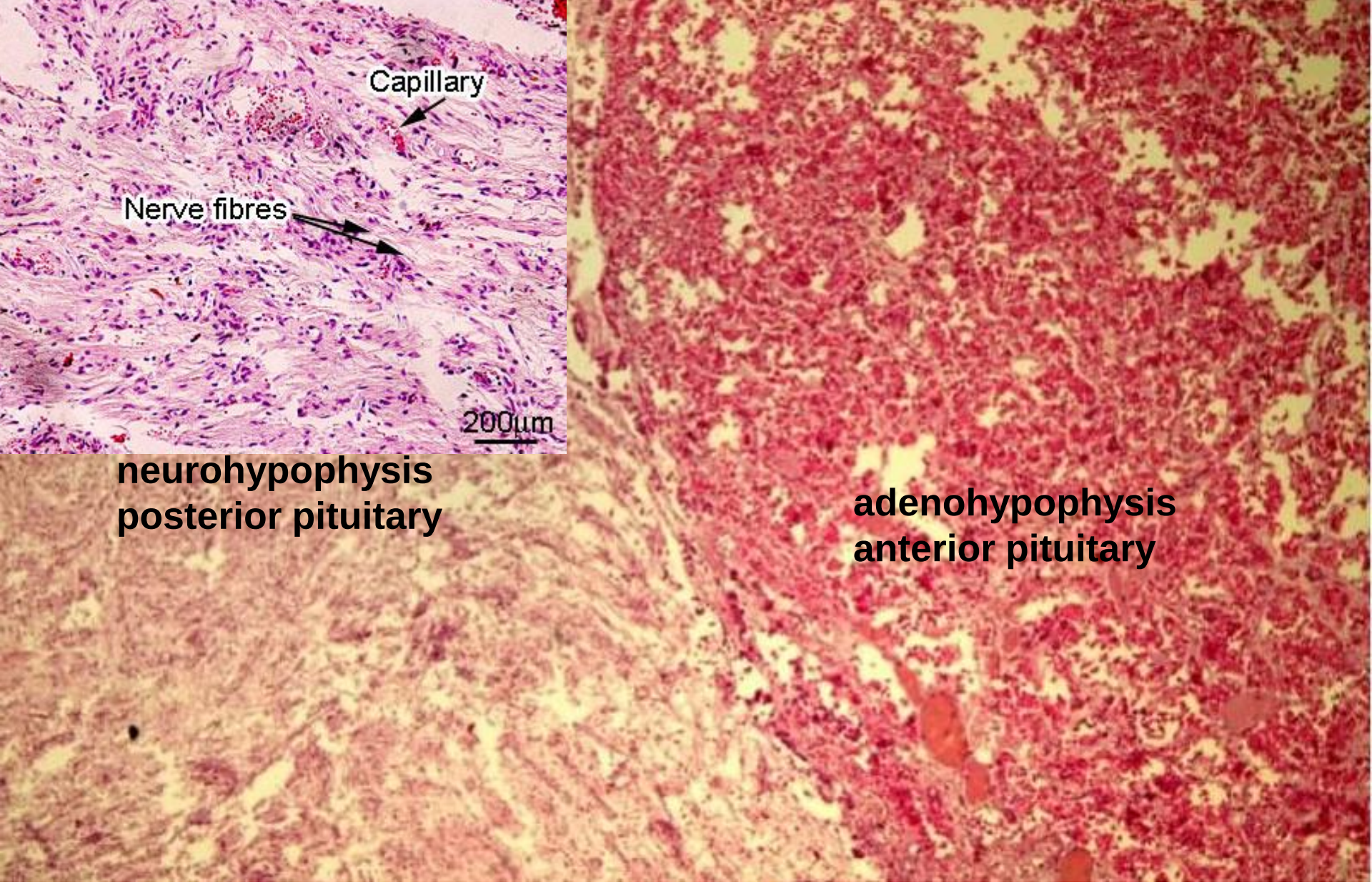
- SEX
- CHILDBIRTH
- BREASTFEEDING

Bonding hormone

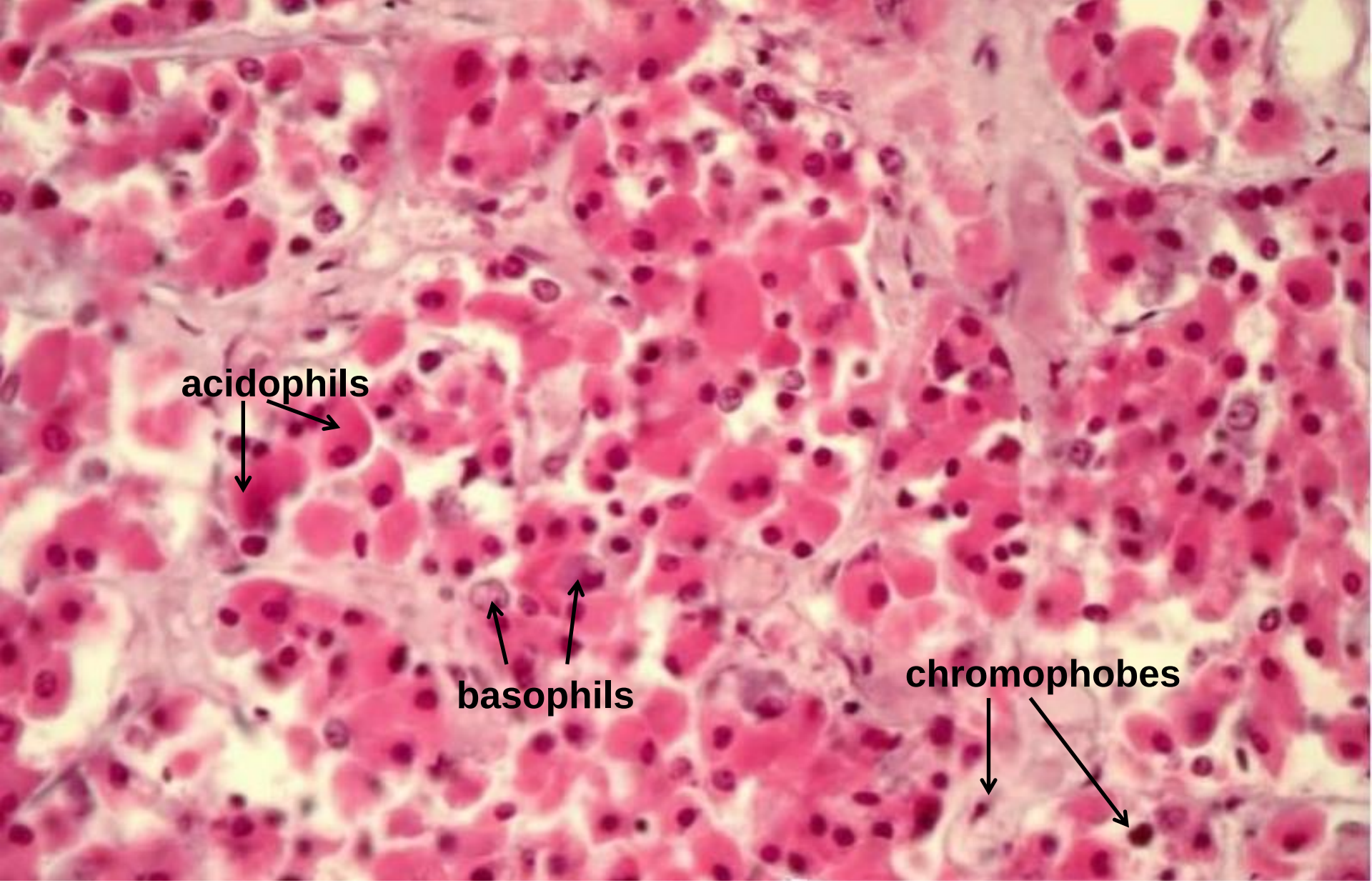
Oxytocin actually means "quick birth."



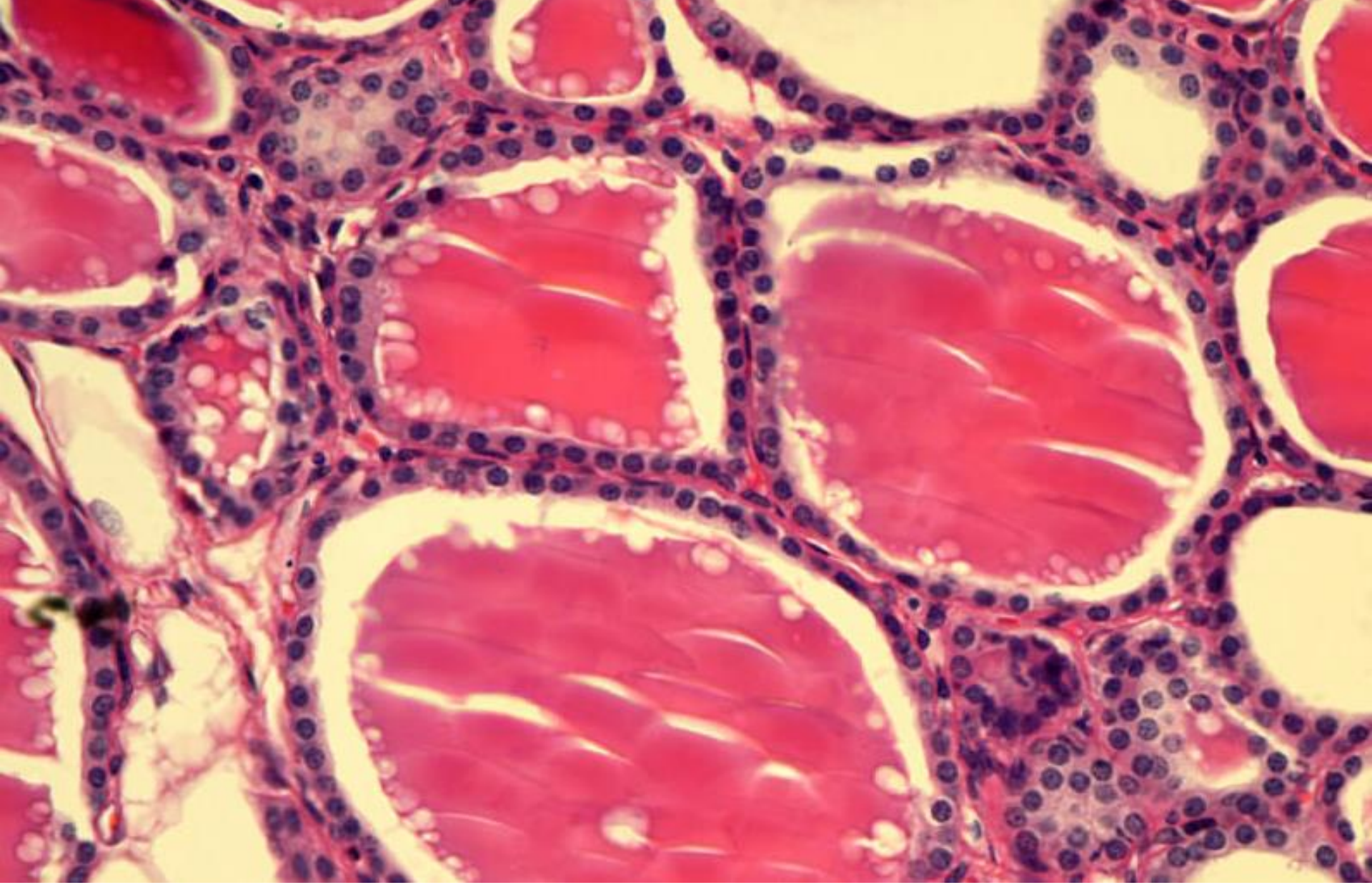
slide 40 Hypophysis



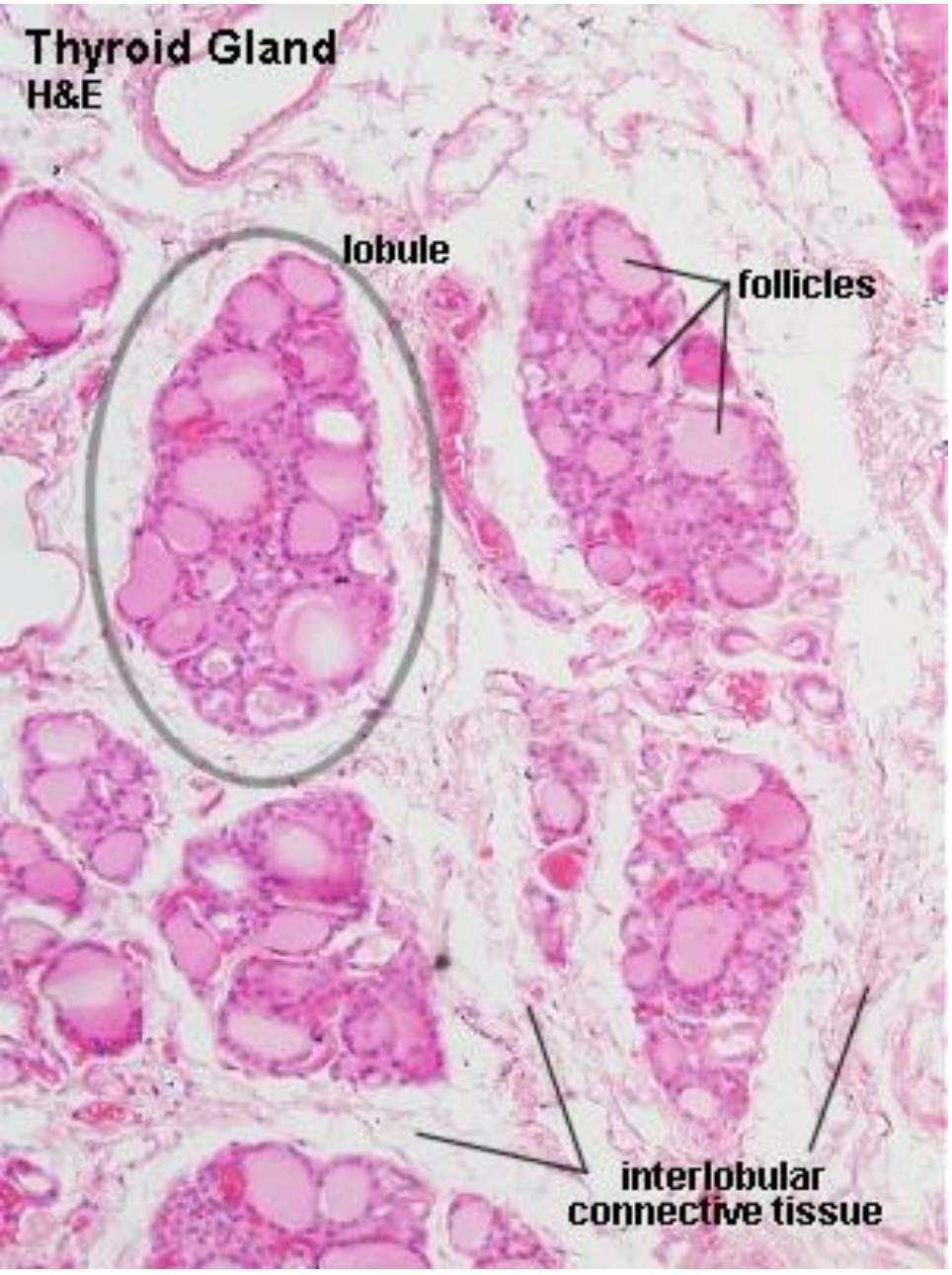
slide 40 Hypophysis

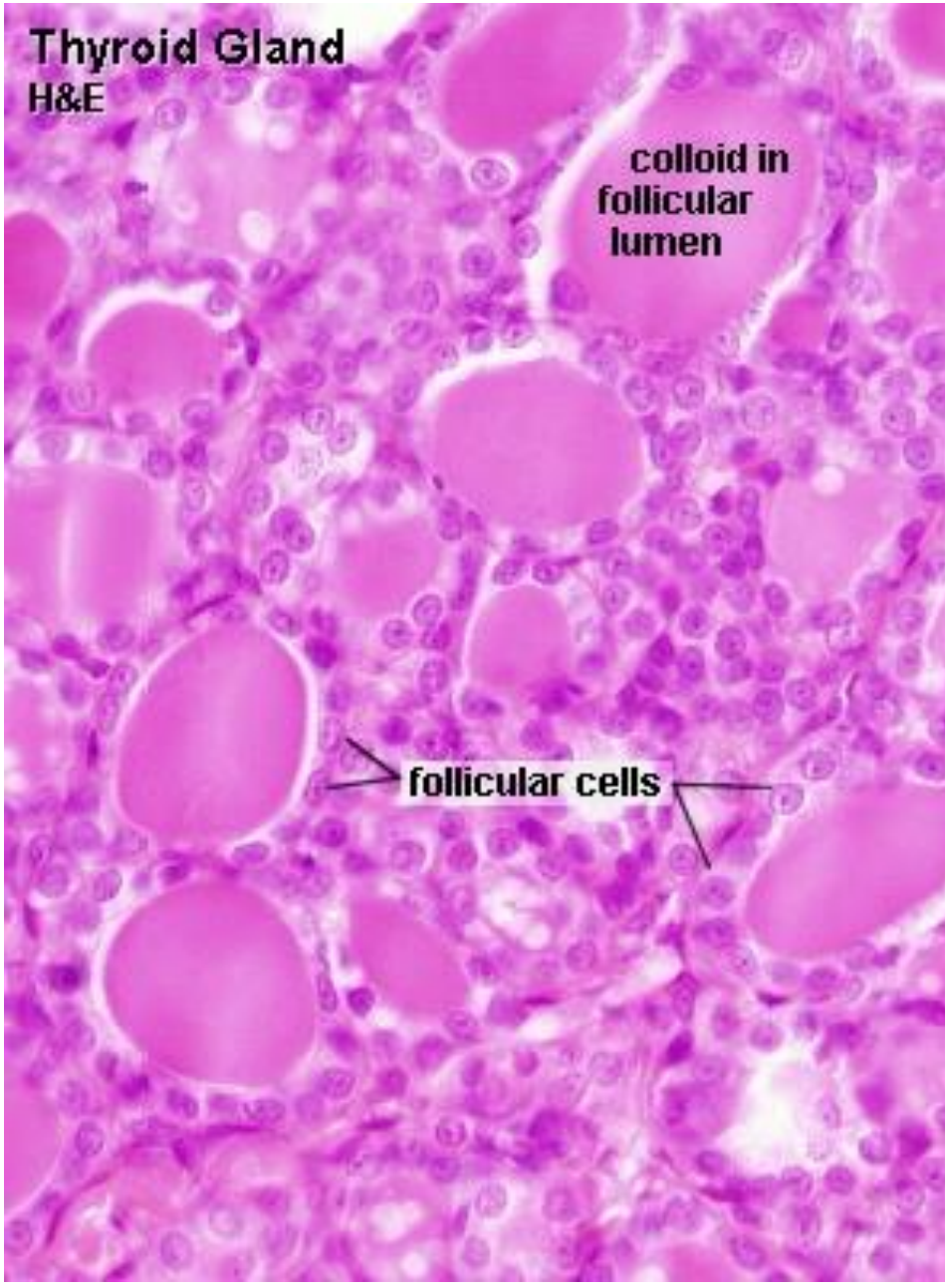


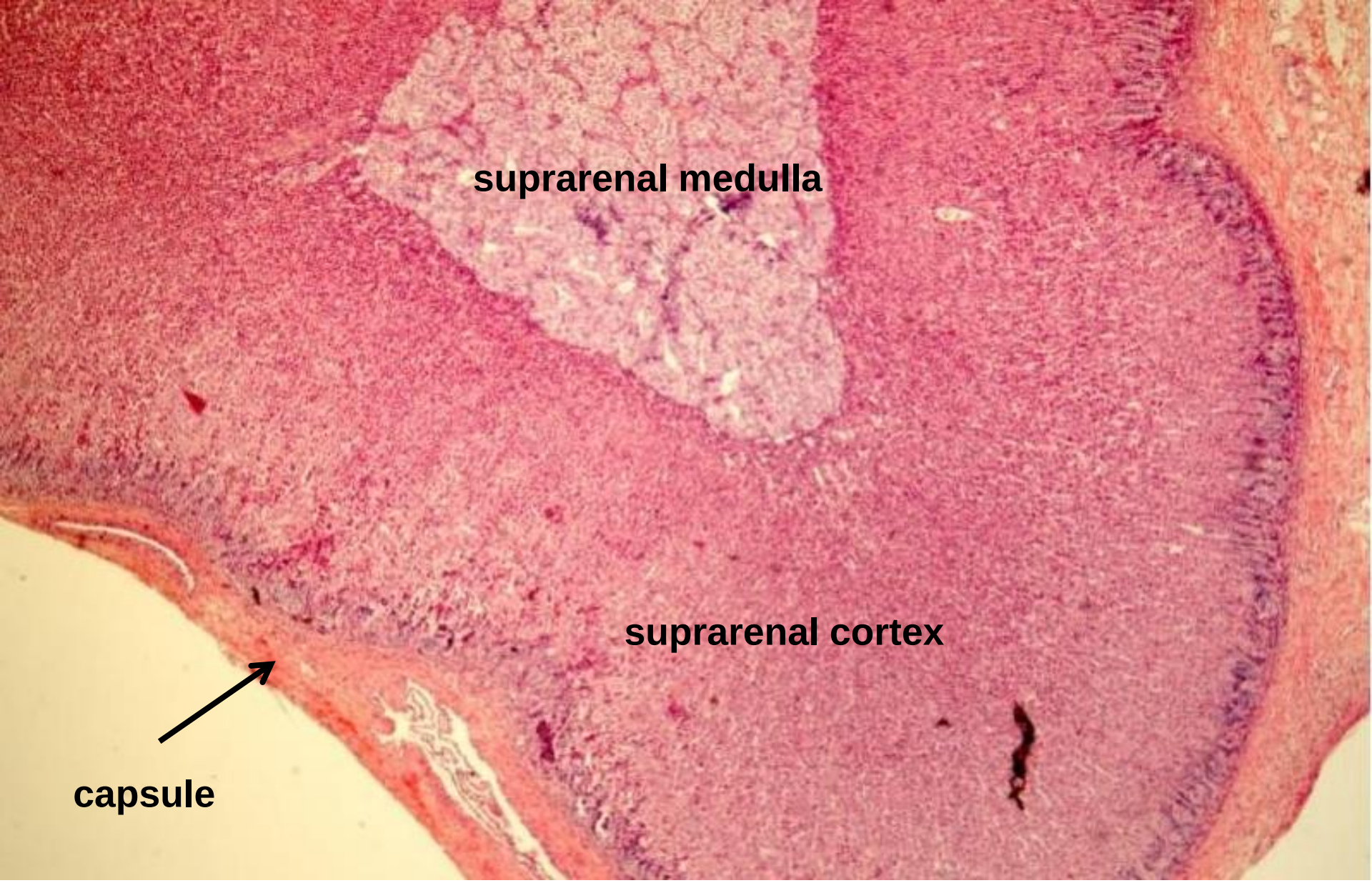
slide 40 Hypophysis, Adenohypophysis



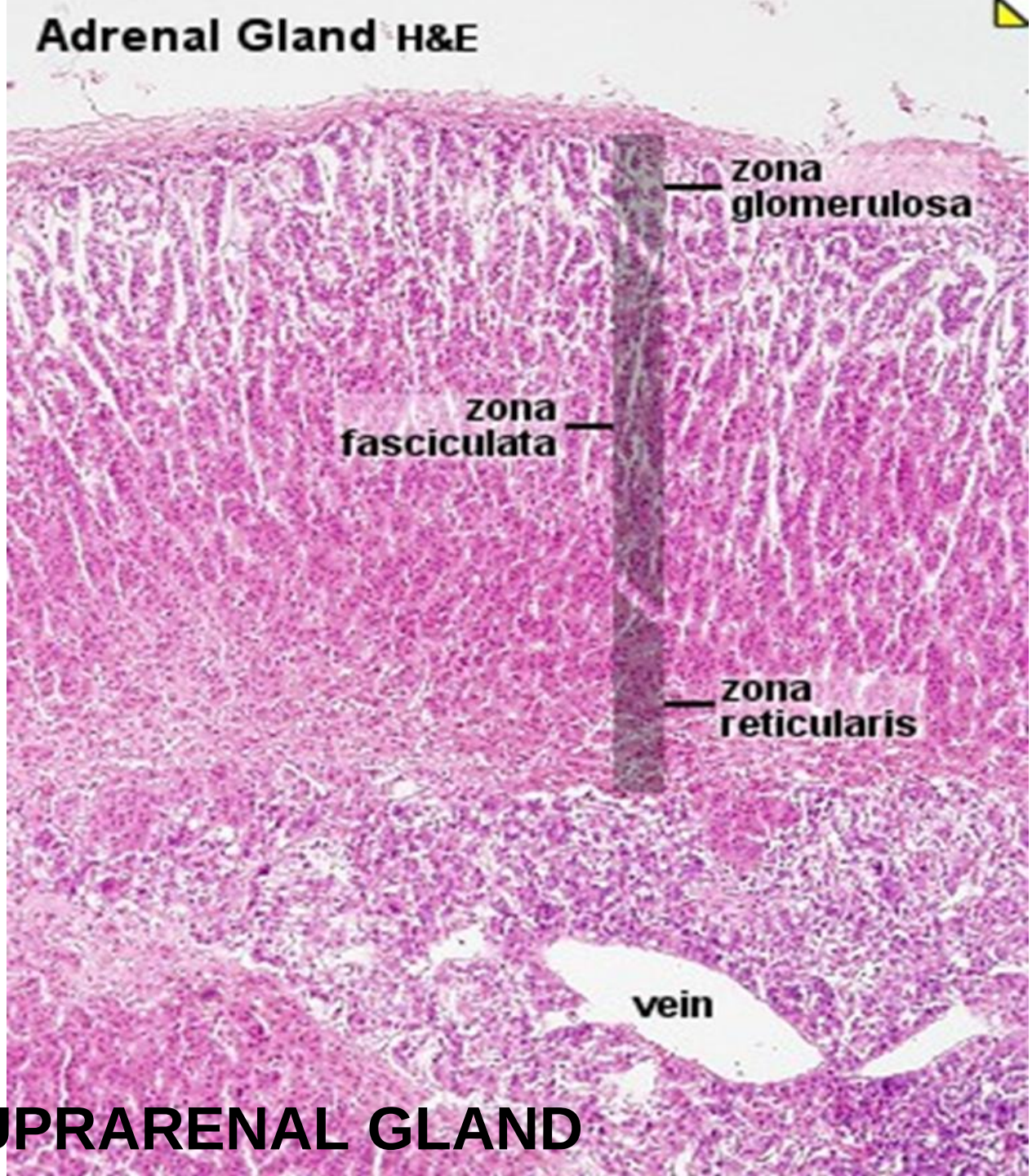
slide 8 Thyroid gland


Thyroid Gland
H&E
lobule
follicles
interlobular
connective tissue

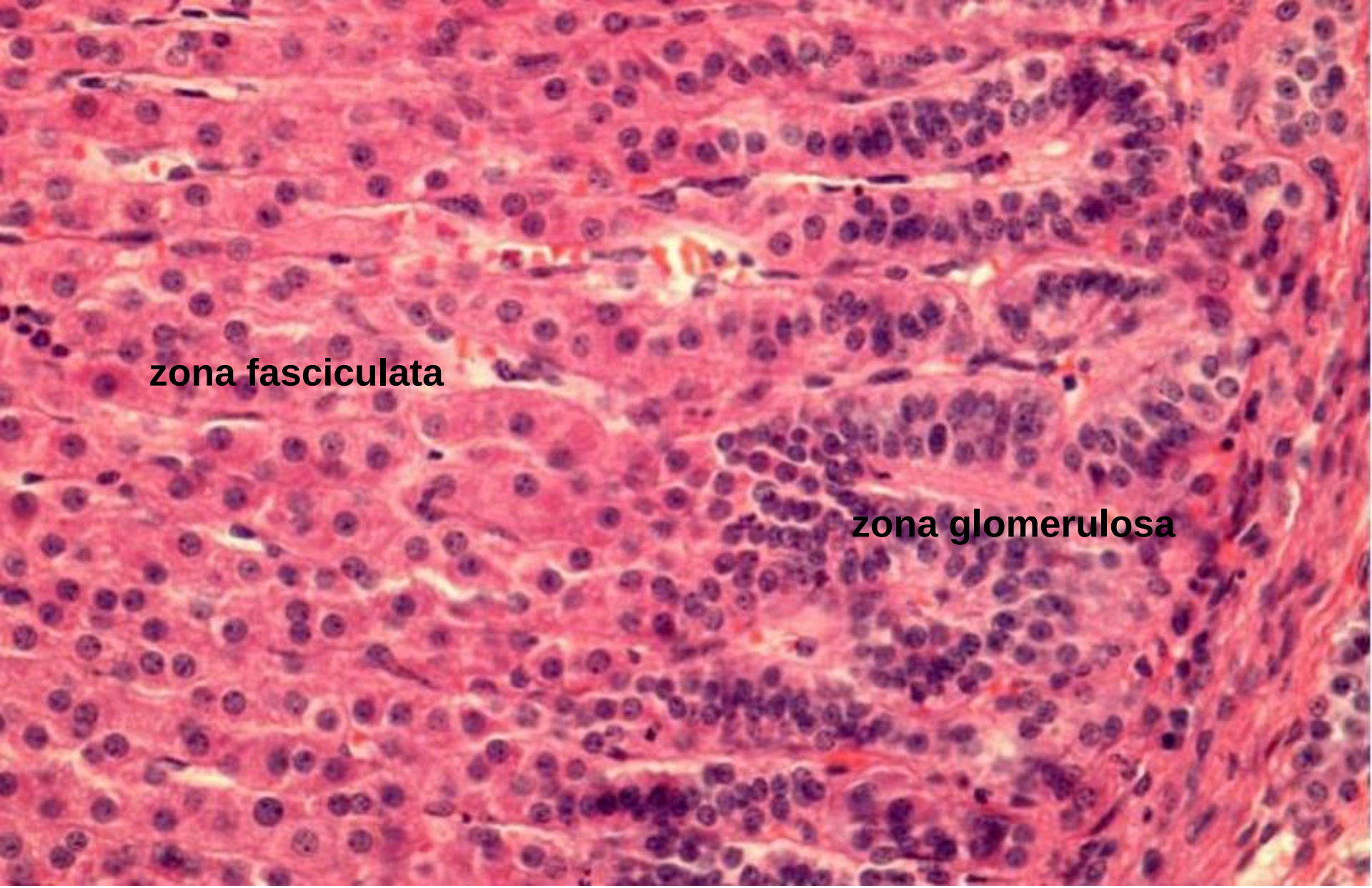

Thyroid Gland
H&E
colloid in
follicular
lumen
follicular cells



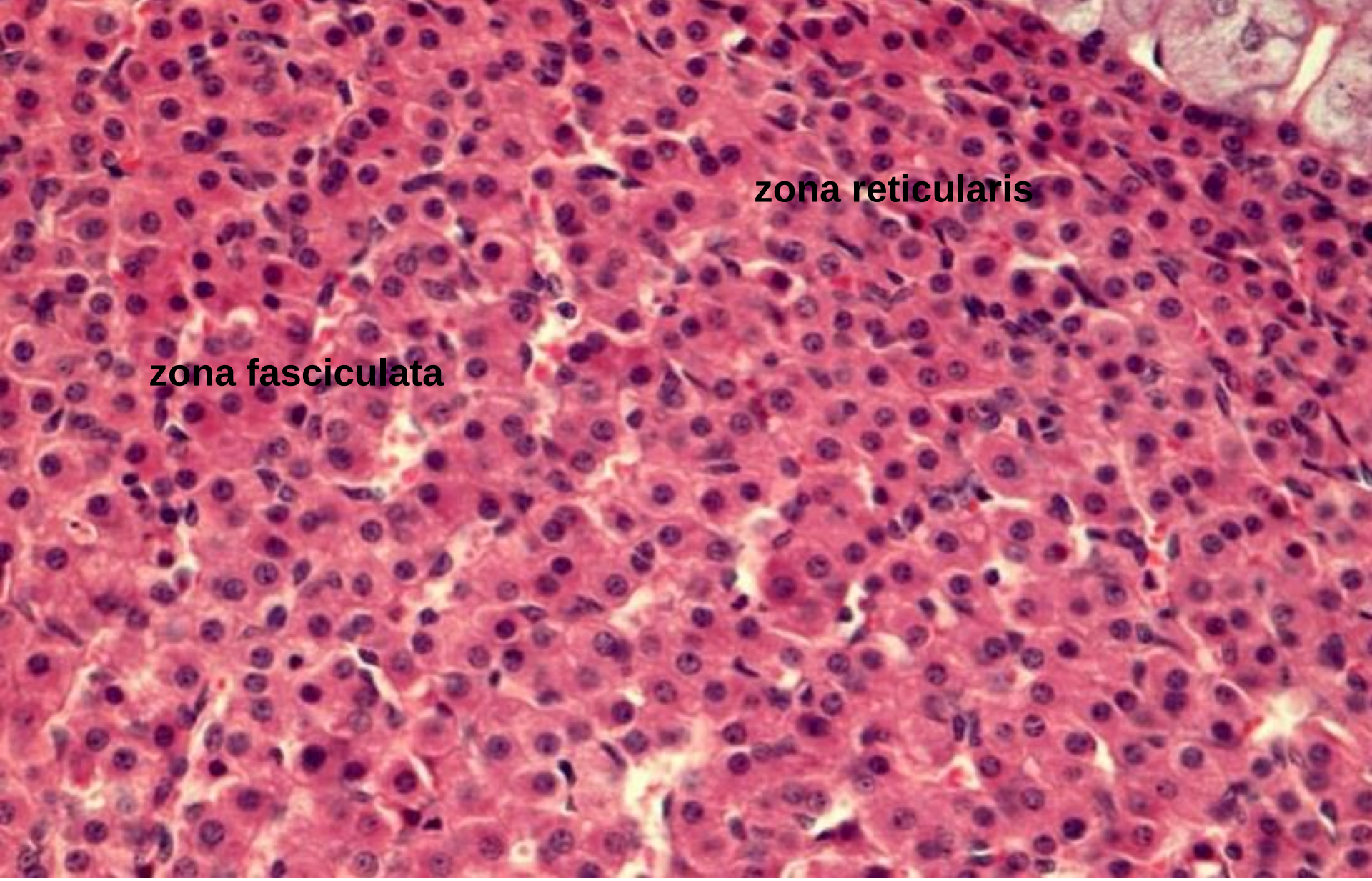
slide 39 SUPRARENAL GLAND



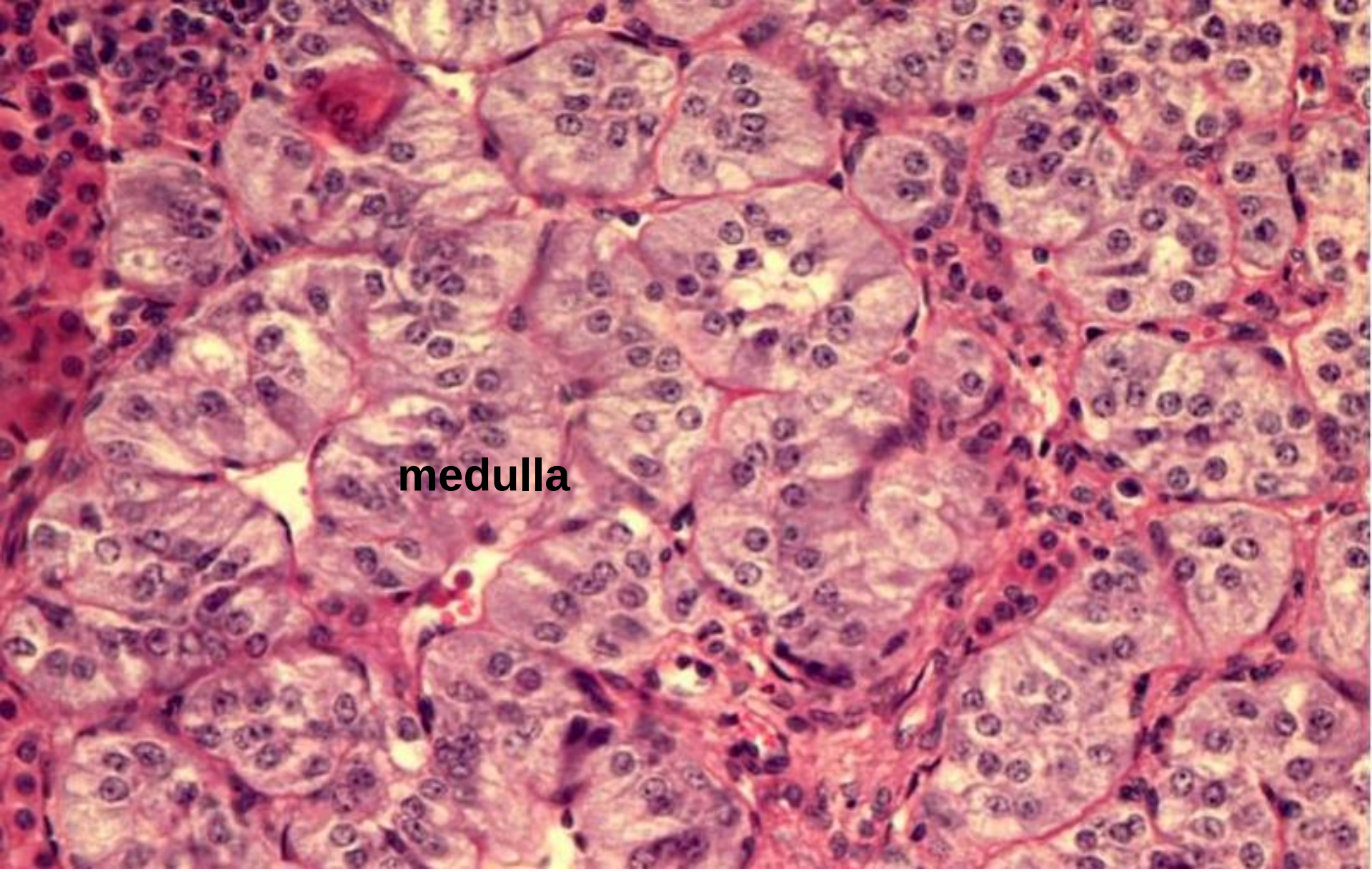
slide 39 SUPRARENAL GLAND



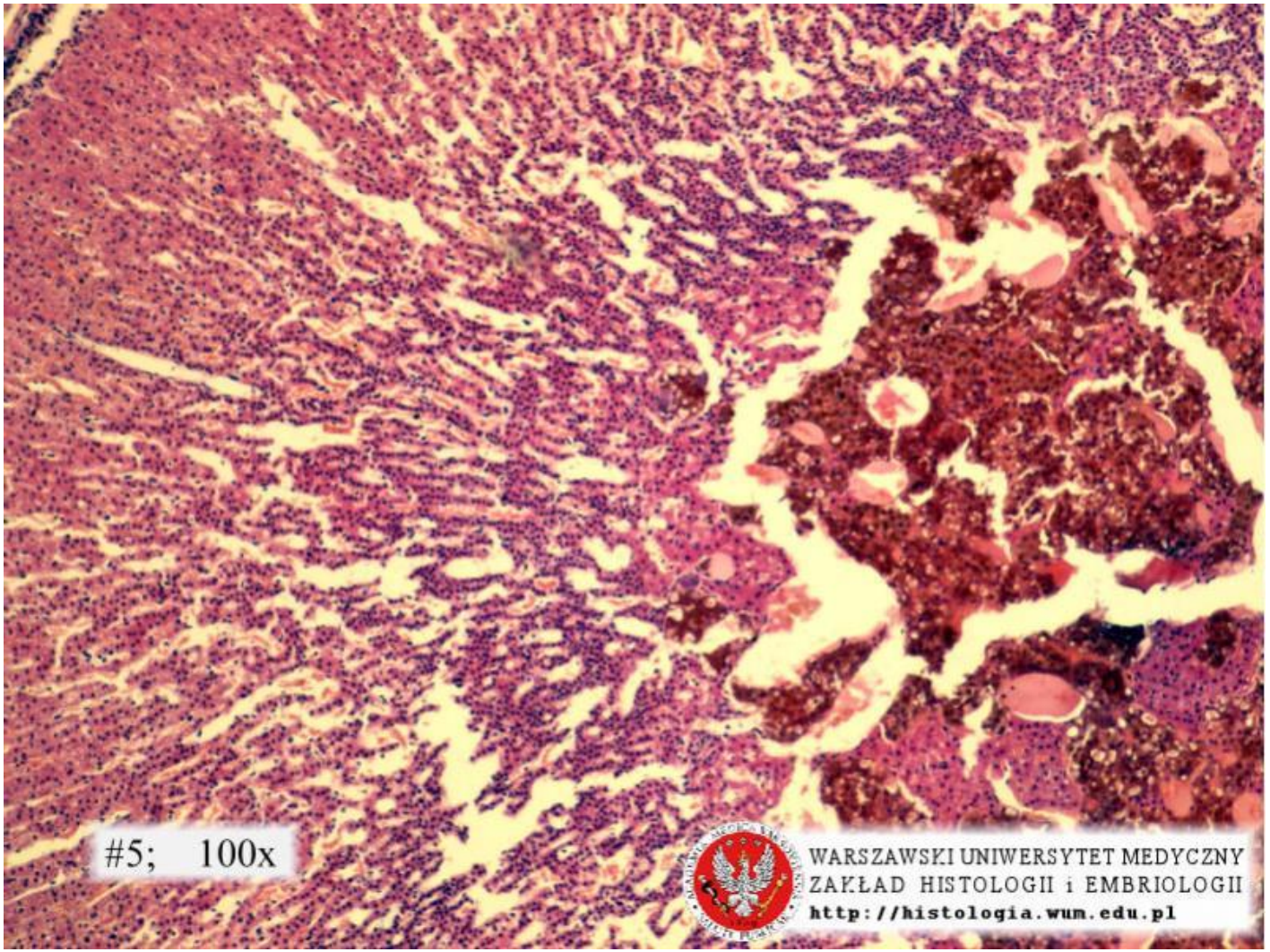
slide 39 **SUPRARENAL GLAND**



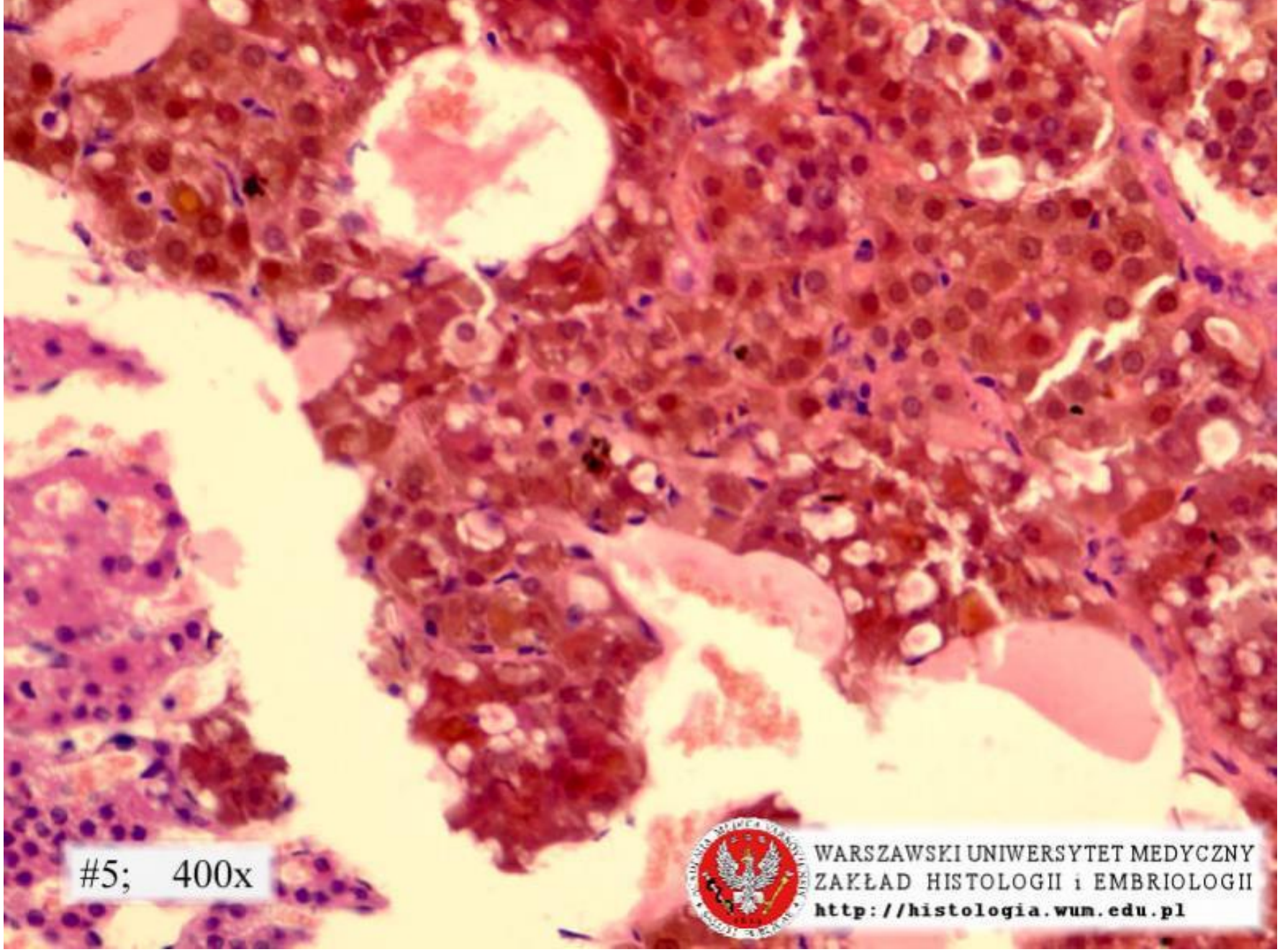
slide 39 SUPRARENAL GLAND



slide 39 Suprarenal gland

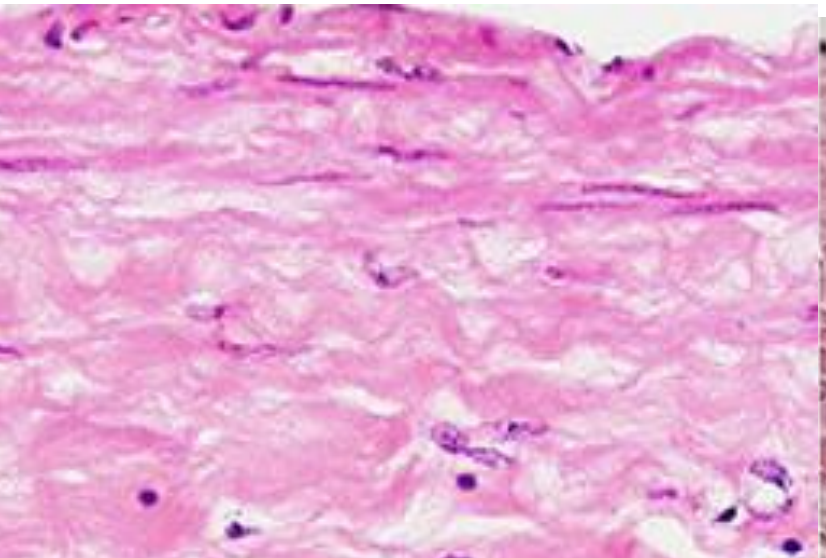


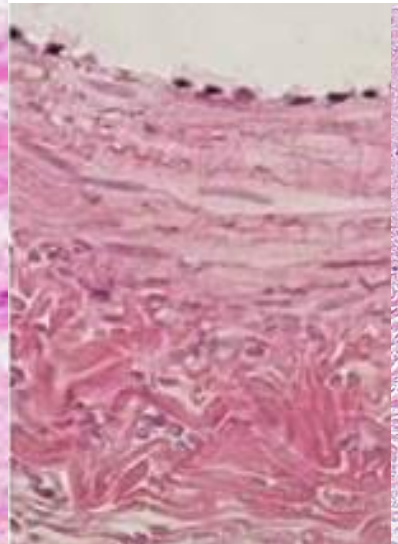
chromaffin reaction in the suprarenal gland (no. 5)
production of a yellow-brown to brown coloration in cells containing catecholamines when fresh tissue slices are placed in a dichromate-chromate mixture

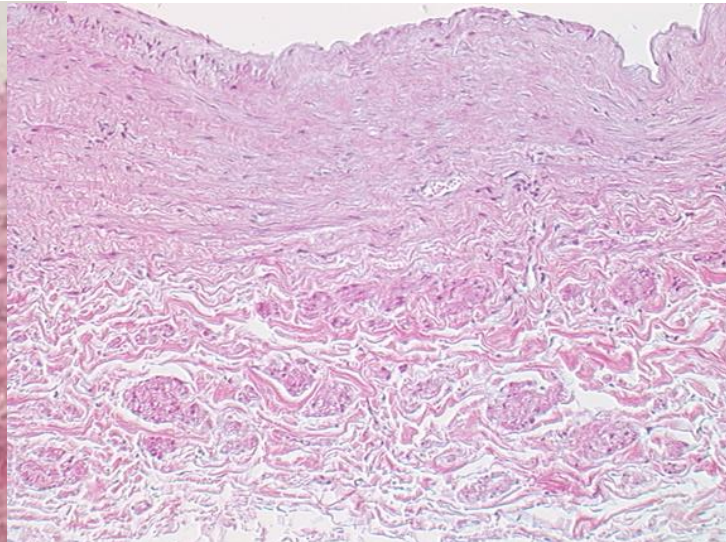


chromaffin reaction in the suprarenal gland (no.5)

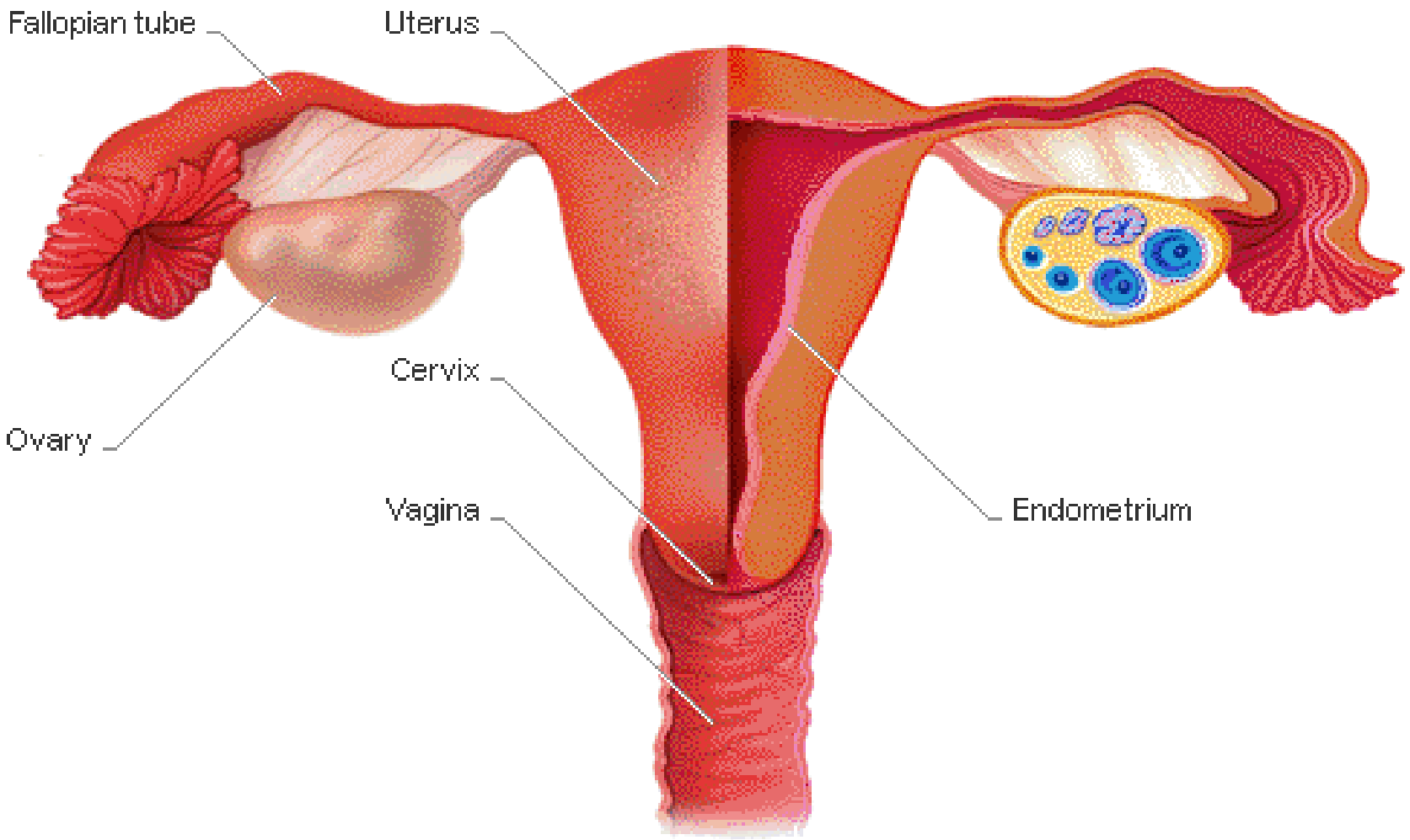
Specimen x (no. 32)
– please, answer the following questions:
Can you recognize in this specimen:
1) epithelium (if the answer is yes what type is it?),
2) glands (if the answer is yes, what type are they?),
3) fibroblasts,
4) adipocytes (fat cells),
5) fibers: a) collagen, b) elastic,
6) striated muscle cells,
7) smooth muscle cells,
8) blood vessels, arterioles, venules,
9) capillaries,
10) nerves

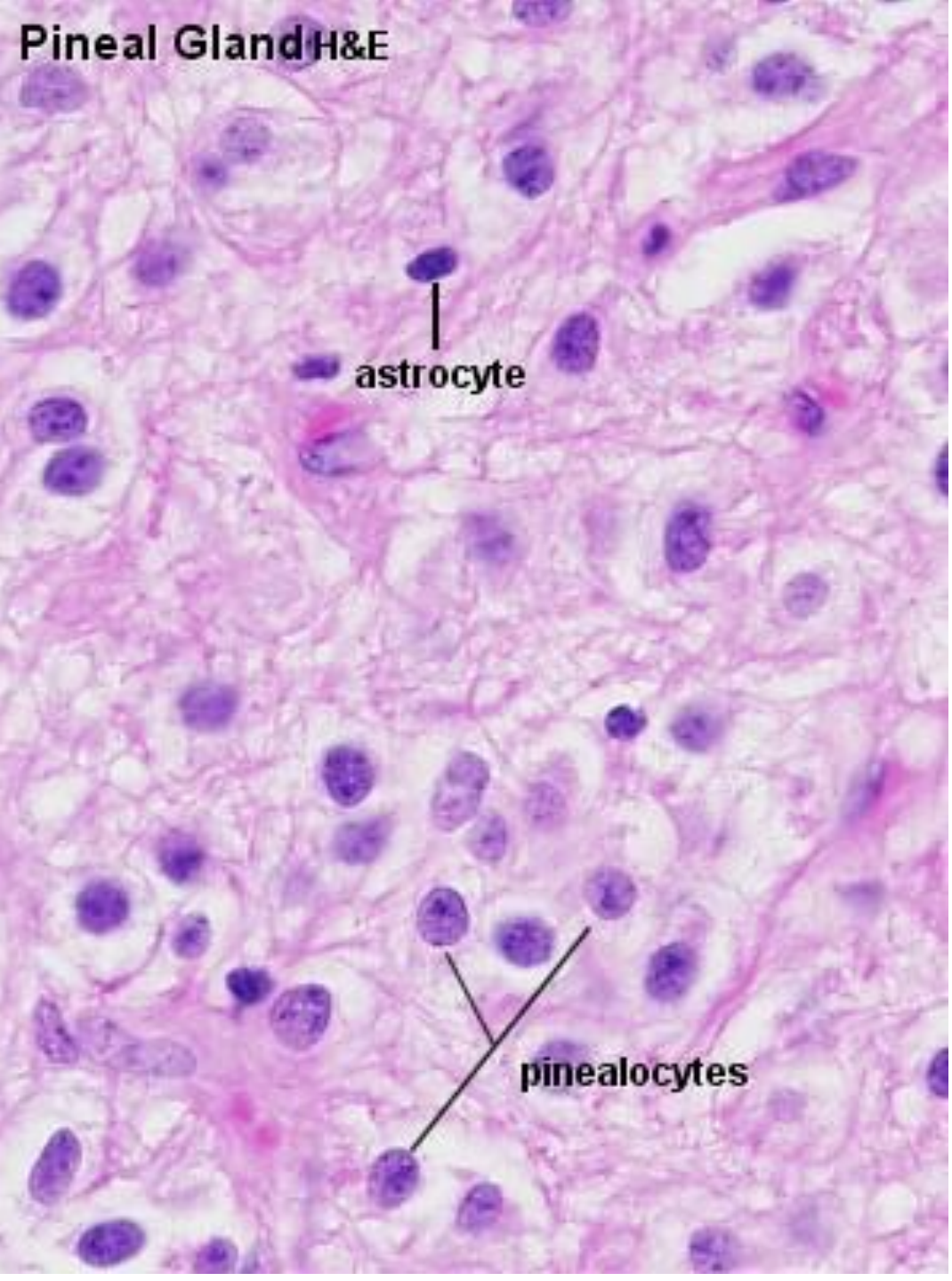






Next class – Female reproductive system, chapter 20

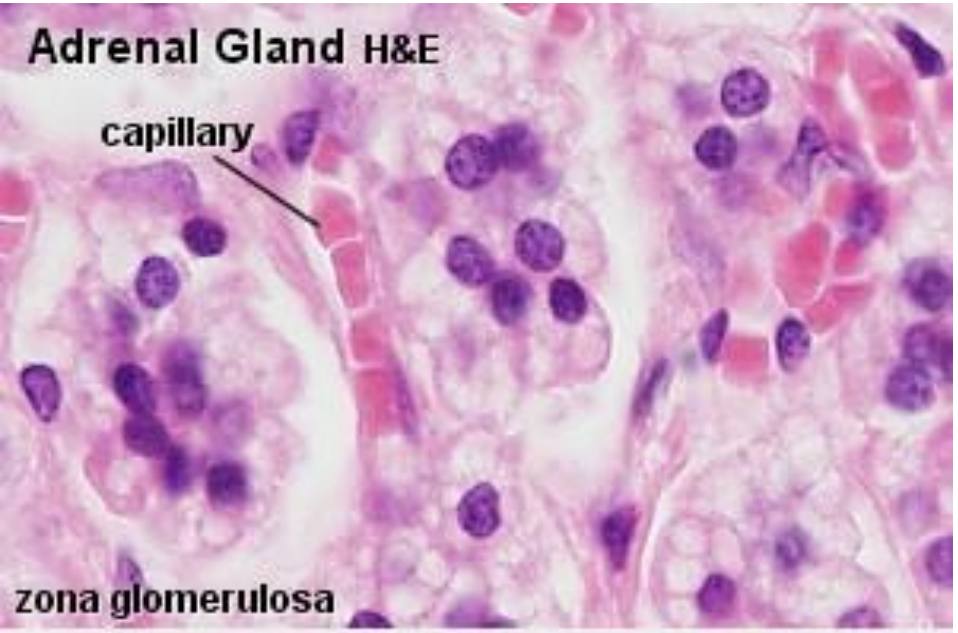




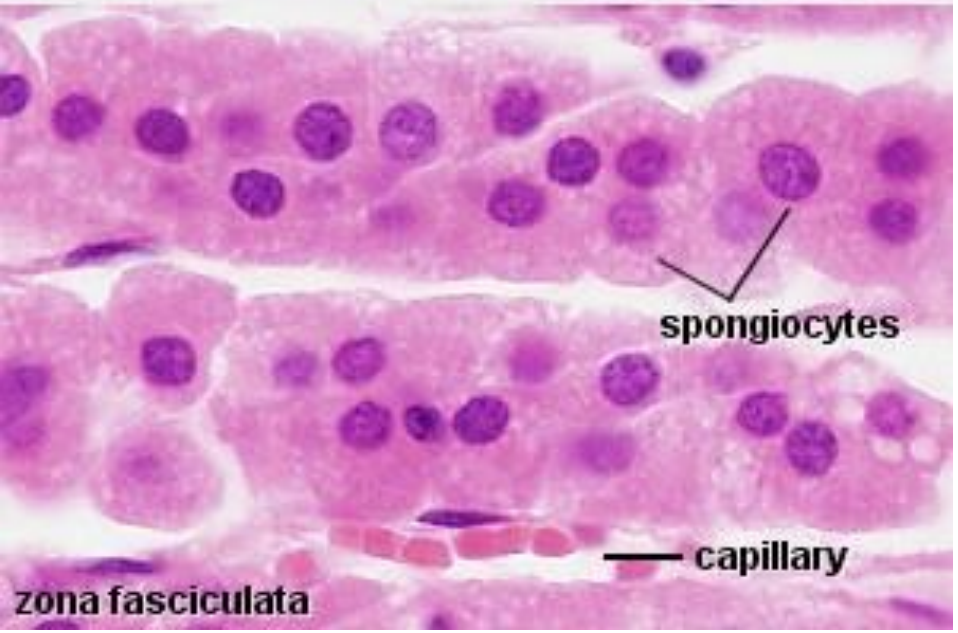
Interstitial cells = astrocyte-like neuroglial cells, small, dark nuclei

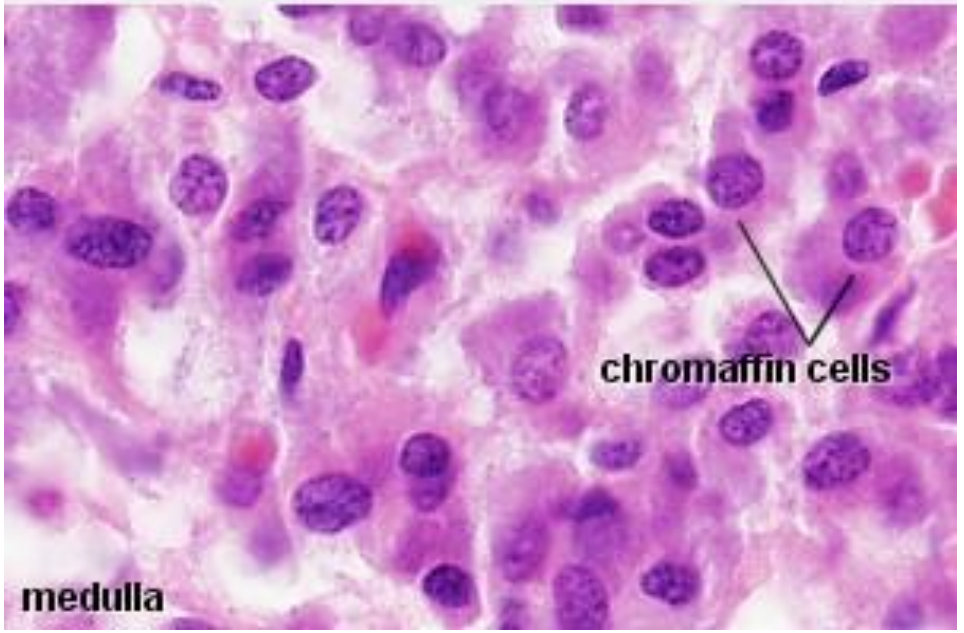
Pinealocytes
Larger, lighter and round nuclei, surrounded by a broad rim of light cytoplasm.

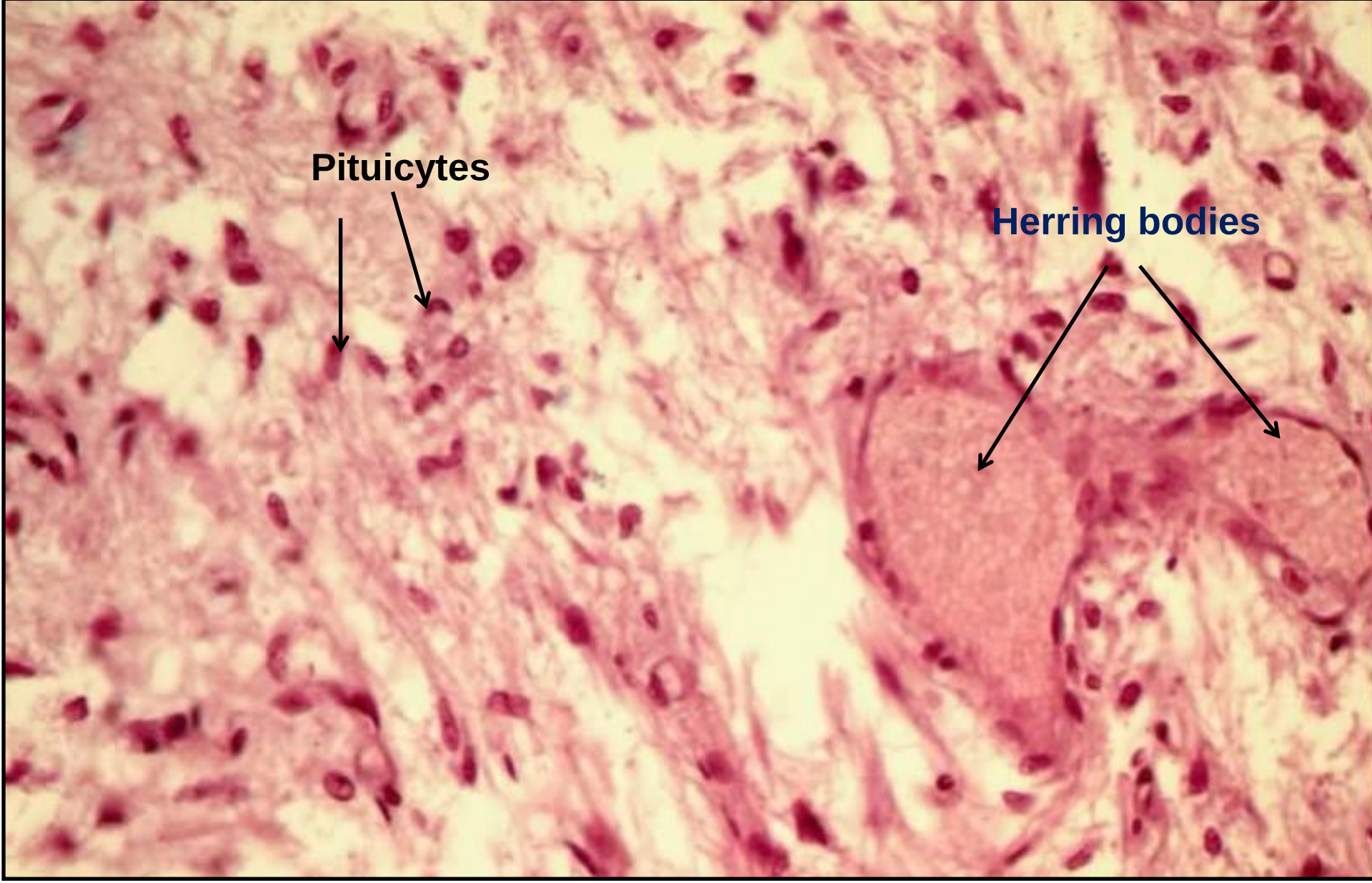
Both pinealocytes and astrocytes have long processes which give the tissue between the nuclei its "stringy" appearance.


Adrenal Gland H&E
capillary
zona glomerulosa

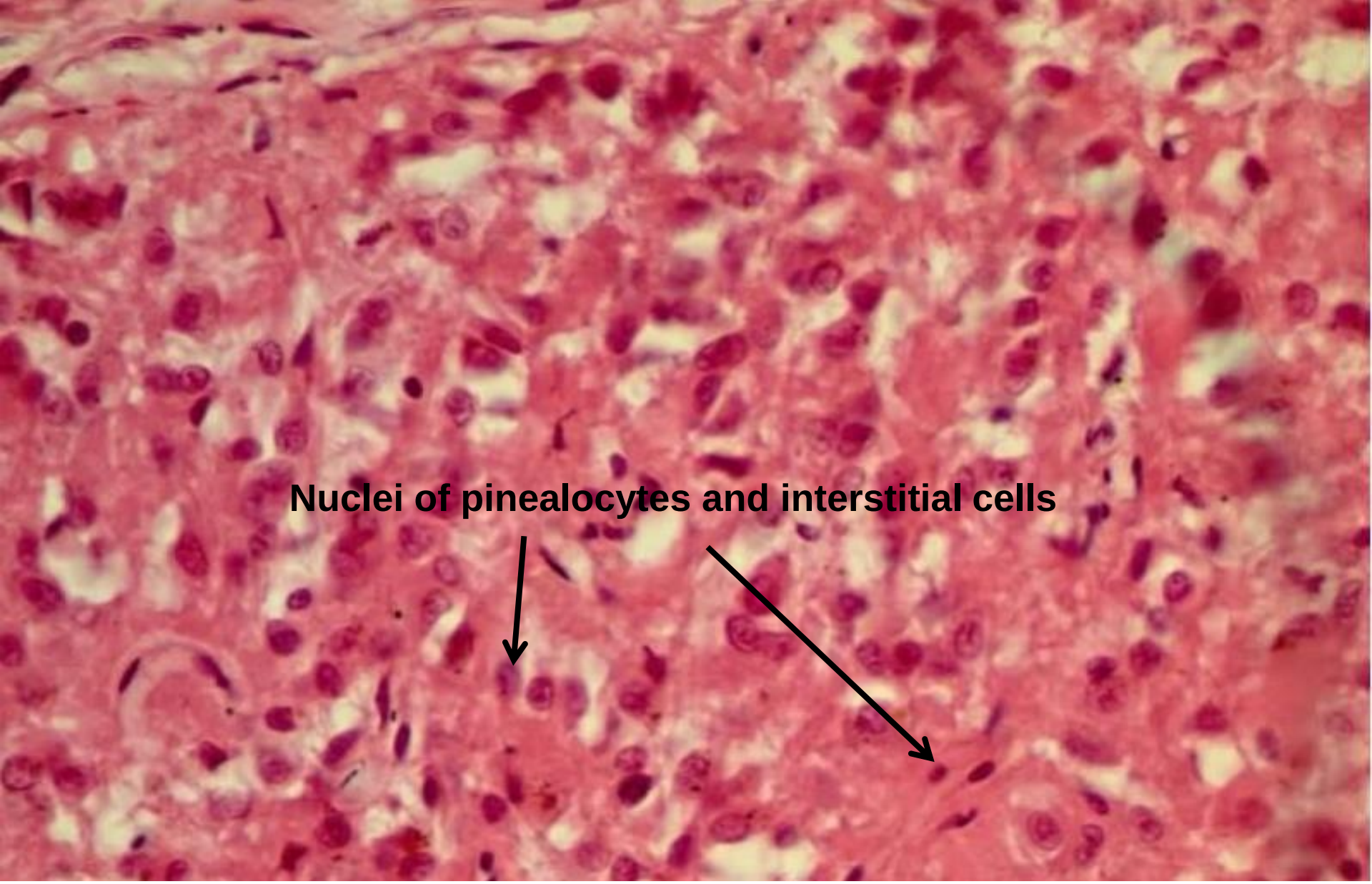

Adrenal Gland H&E
zona reticularis


spongiocytes
capillary
zona fasciculata

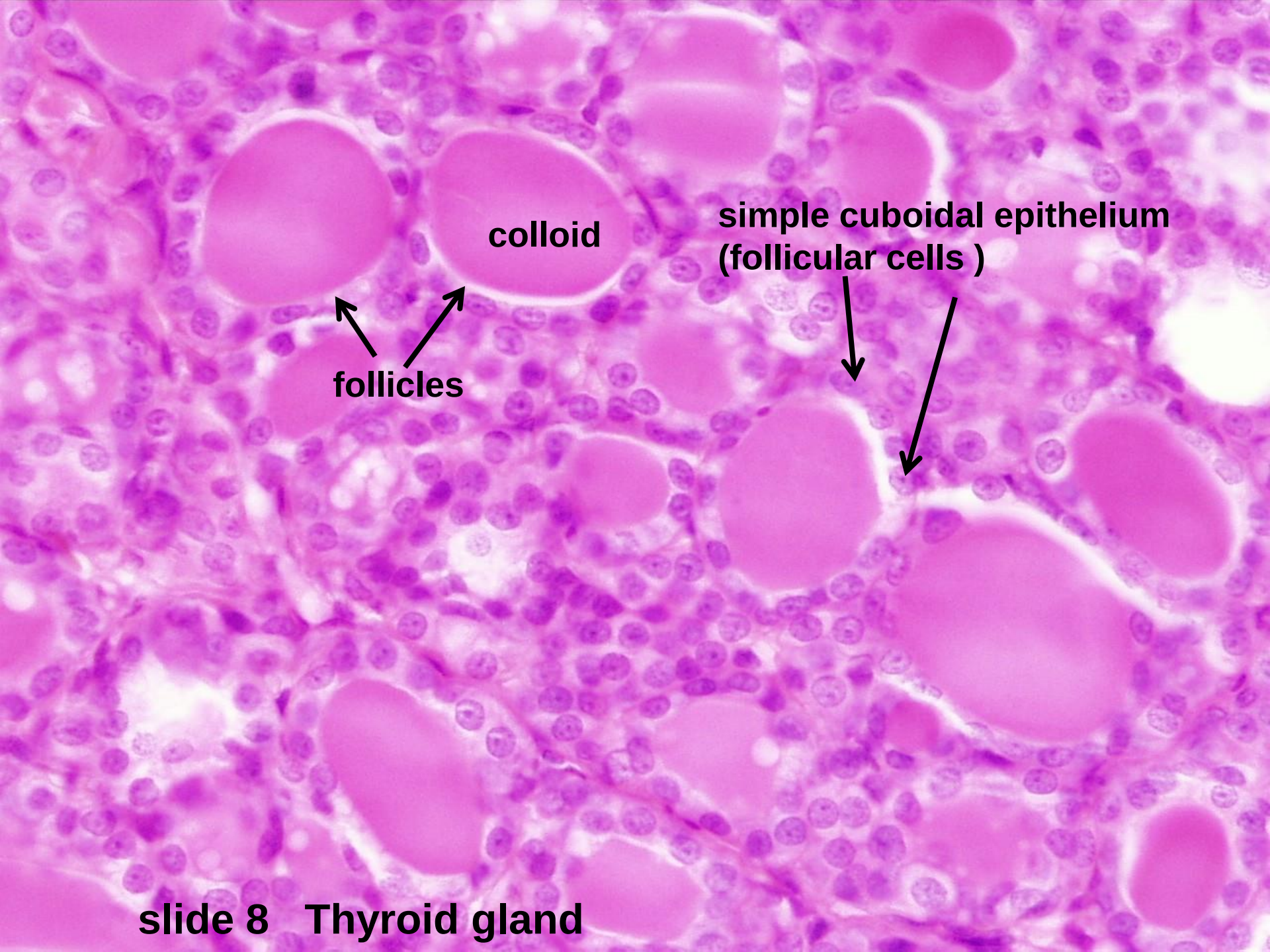

chromaffin cells
medulla



slide 40 Hypophysis, pars nervosa

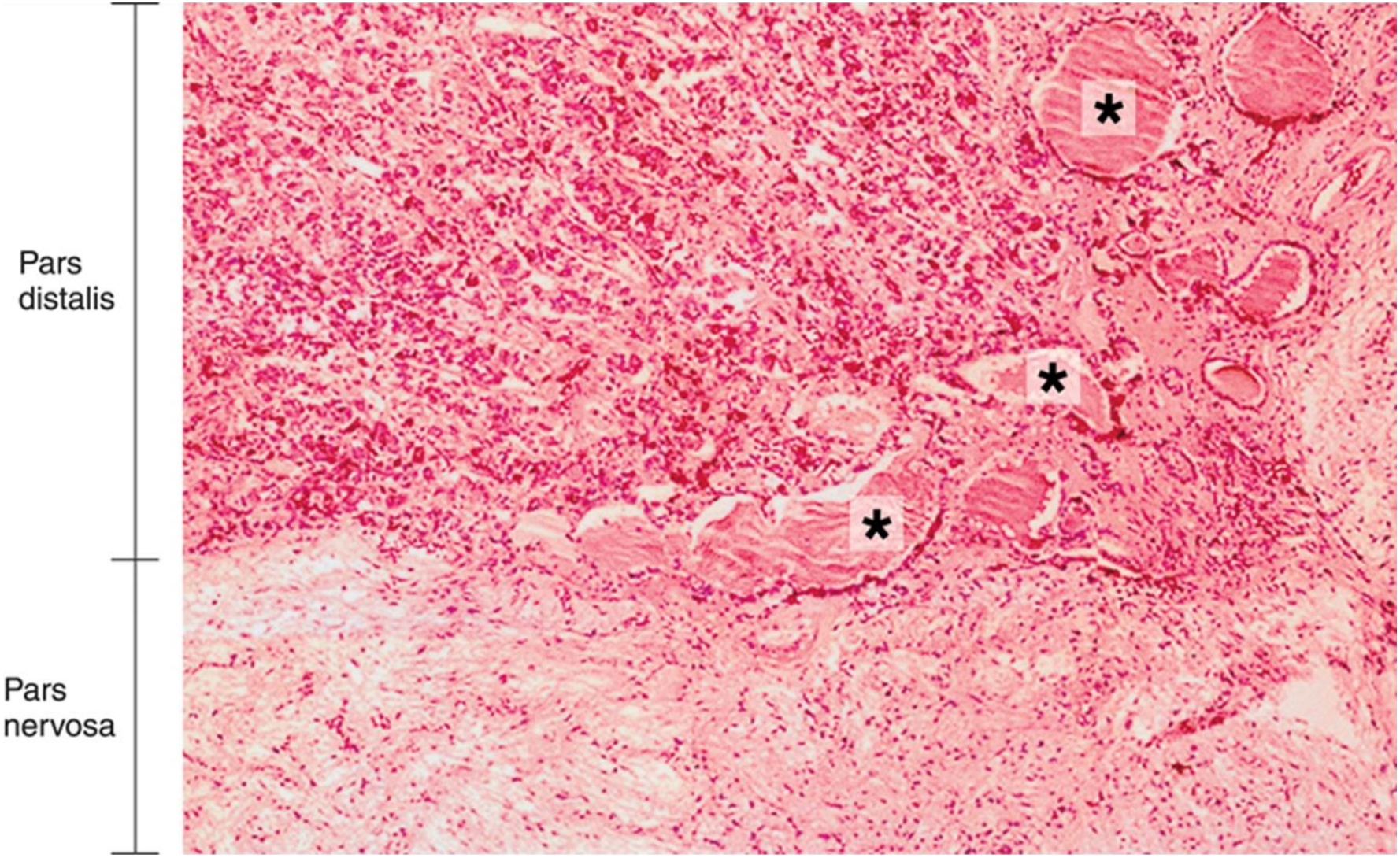


slide 49 PINEAL GLAND



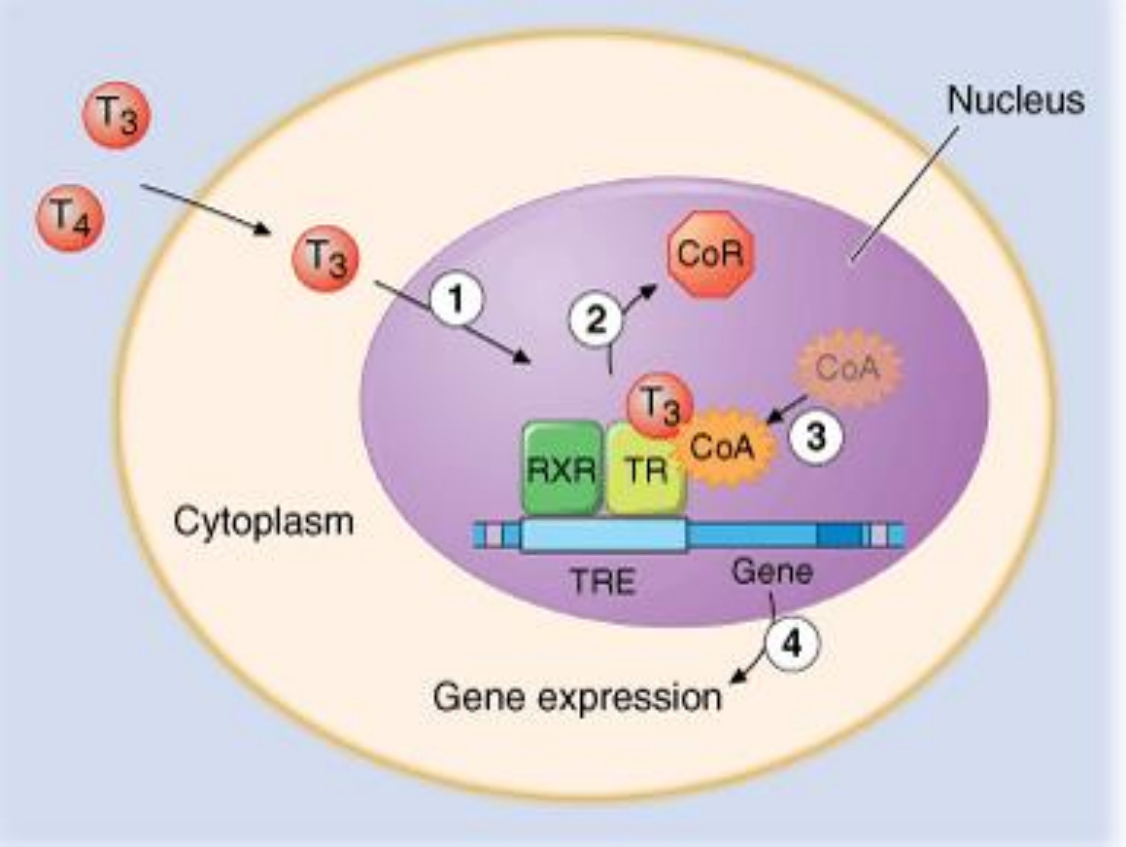
slide 8 Thyroid gland

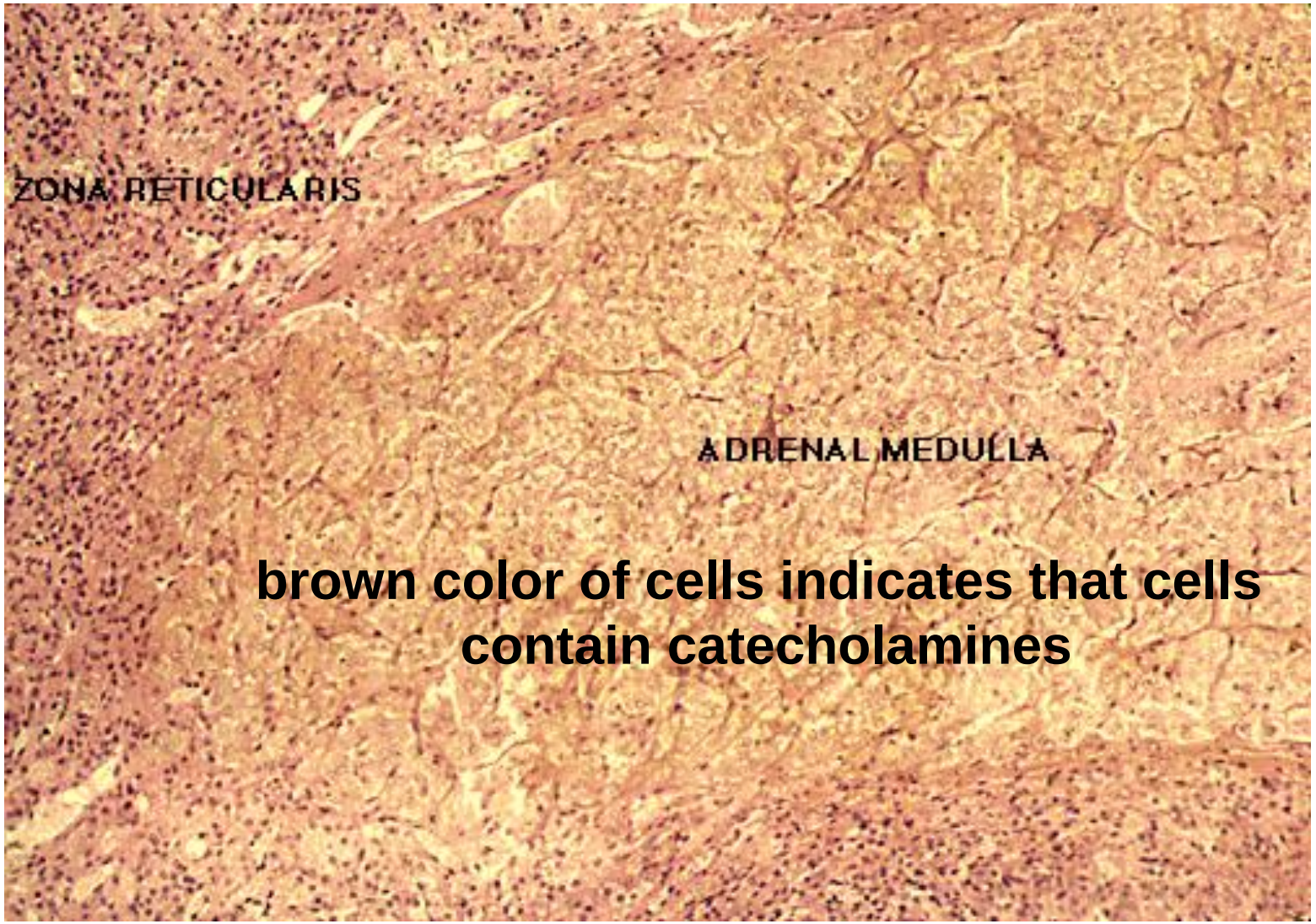
HYPOPHYSIS



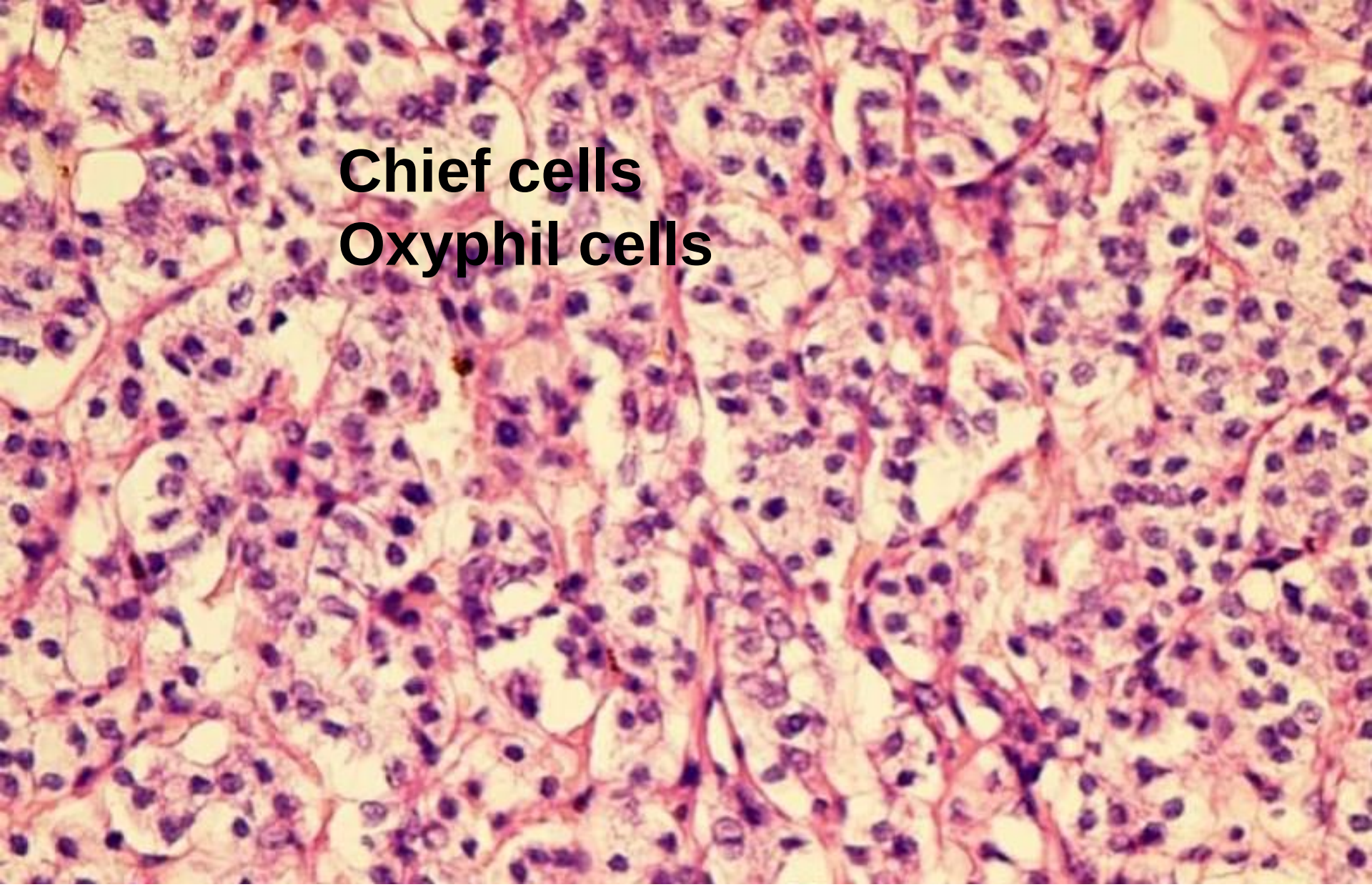
Pars intermedia (indicated by stars) in humans is underdeveloped and formed by dispersed cells and follicles

Thyroid hormones thyroxine (T_4) and triiodothyronine (T_3) play a major role in multiple biological and metabolic processes. They act by binding to nuclear thyroid receptors. This process regulates gene transcription and the subsequent production of various proteins that are involved in development, growth, and cellular metabolism





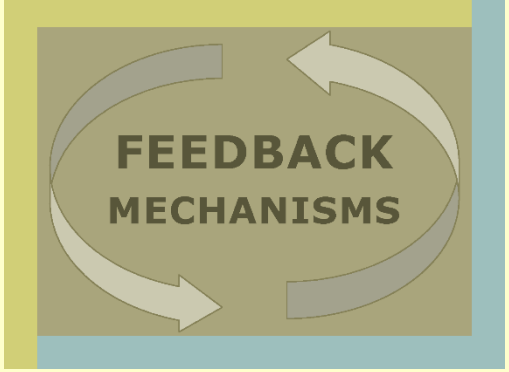
Chromaffin reaction in the suprarenal gland (no.5)
production of a yellow-brown to brown coloration in cells containing catecholamines when fresh tissue slices are placed in a dichromate-chromate mixture overnight.



slide 90 Parathyroid gland

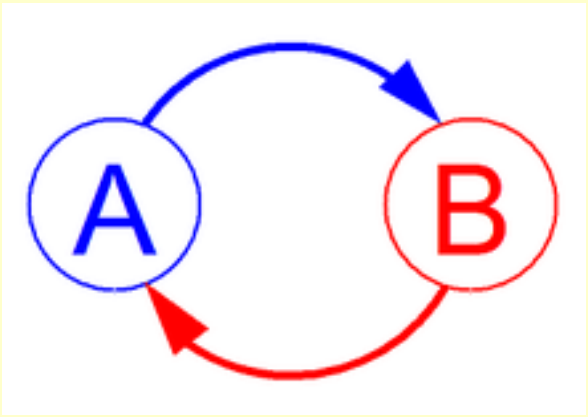
Production of hormones is regulated by

Feedback mechanism



Negative feedback mechanism

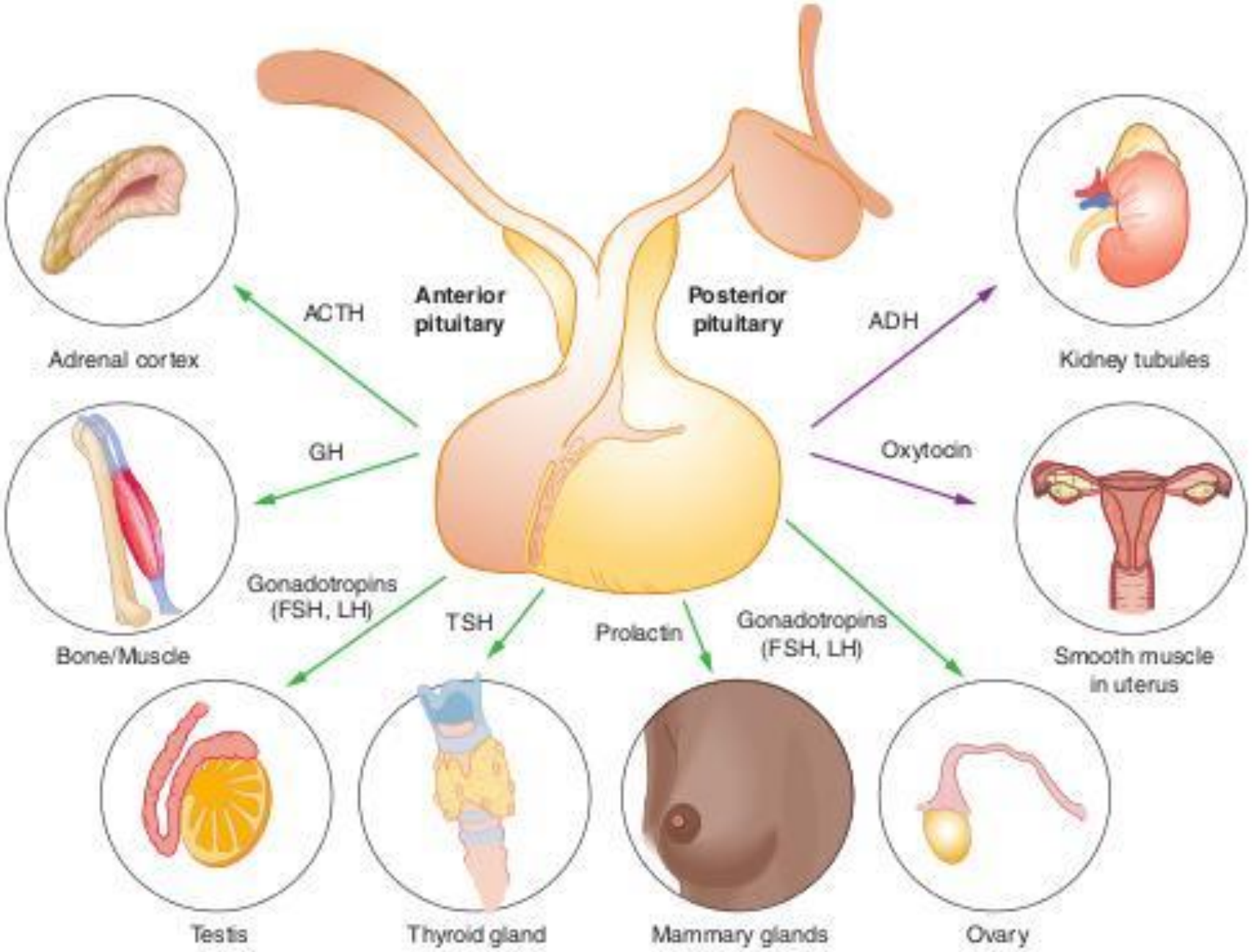
1. **Hormone activates its target cell**
2. **Inhibitory signal is generated and returned to the endocrine gland to halt hormone secretion**



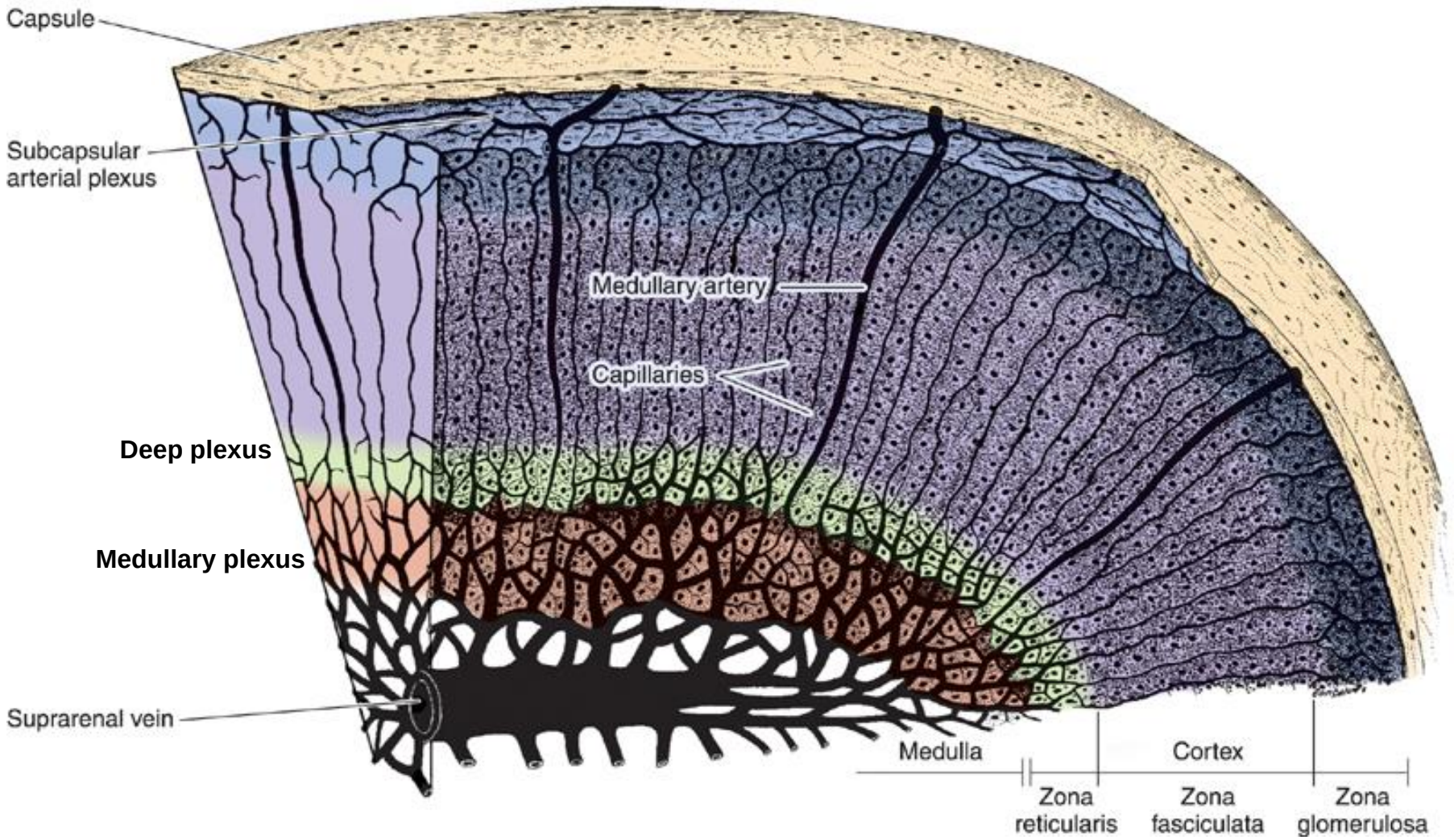
Positive feedback mechanism

1. **Hormone level is insufficient**
2. **Positive signal is released and transmitted to the endocrine gland**
3. **Signal initiates an increase in hormone production**

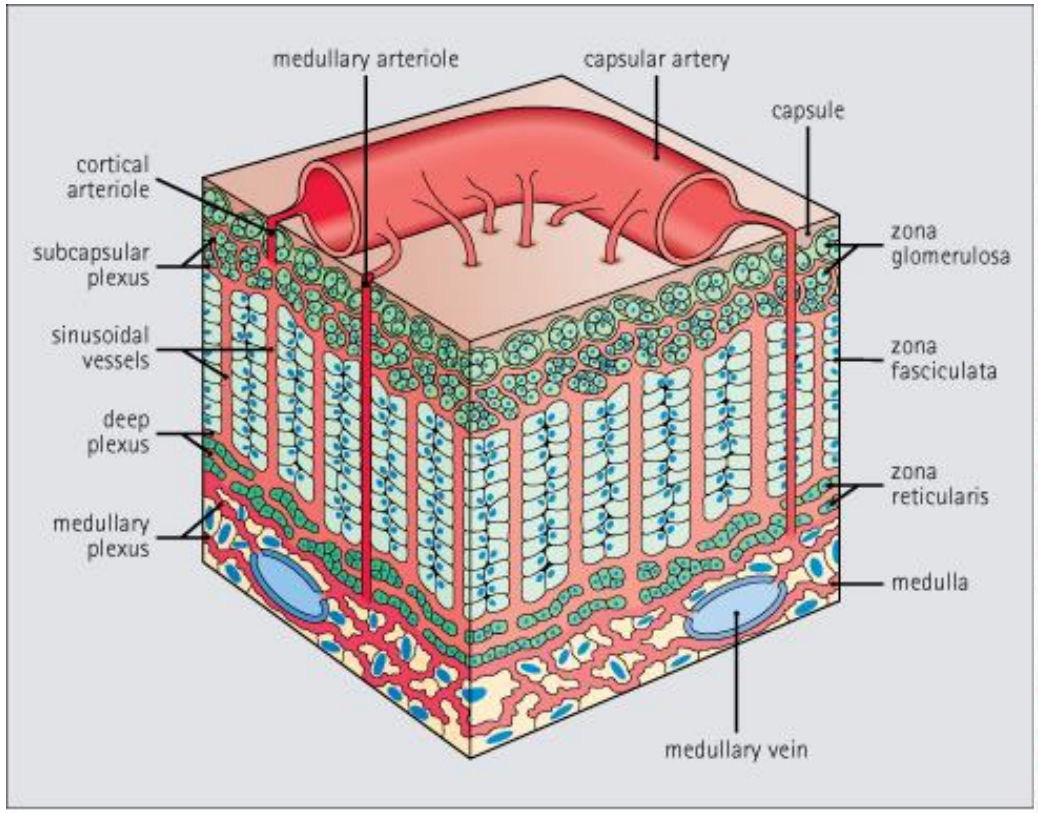
Through the feedback mechanism endocrine system maintains homeostasis

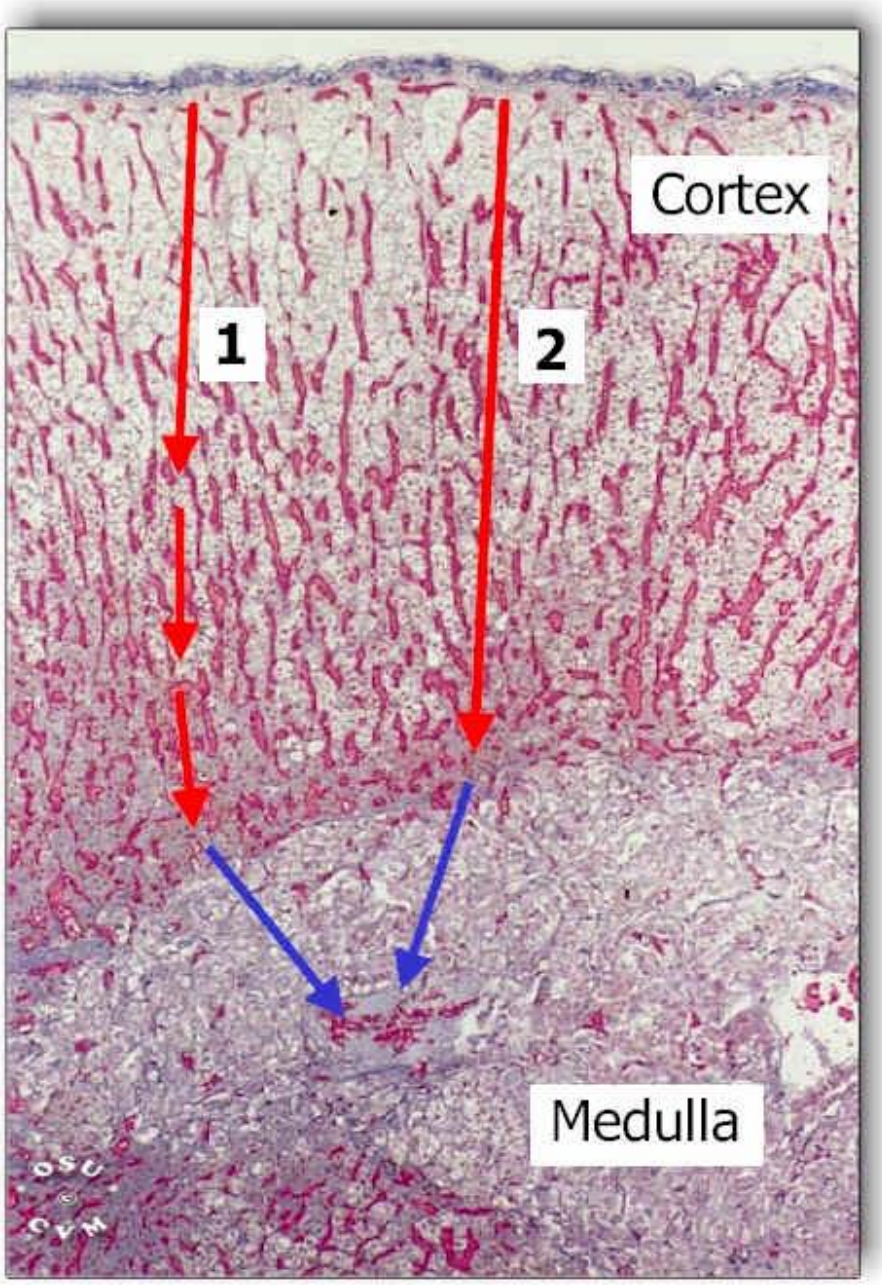

Anterior pituitary
Posterior pituitary
ACTH
ADH
GH
Oxytocin
Gonadotropins (FSH, LH)
TSH
Prolactin
Gonadotropins (FSH, LH)
Adrenal cortex
Kidney tubules
Bone/Muscle
Smooth muscle in uterus
Testis
Thyroid gland
Mammary glands
Ovary
Anterior pituitary hormones
Posterior pituitary hormones

General structure and blood circulation in the adrenal gland



General structure and blood circulation in the adrenal gland

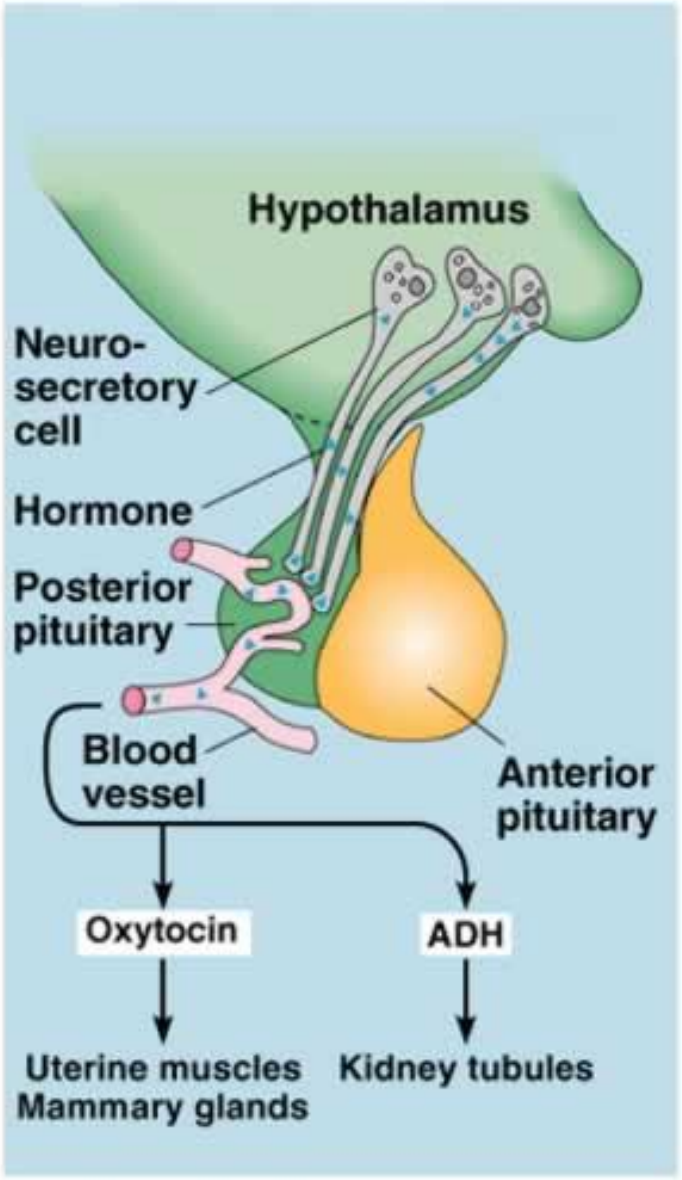


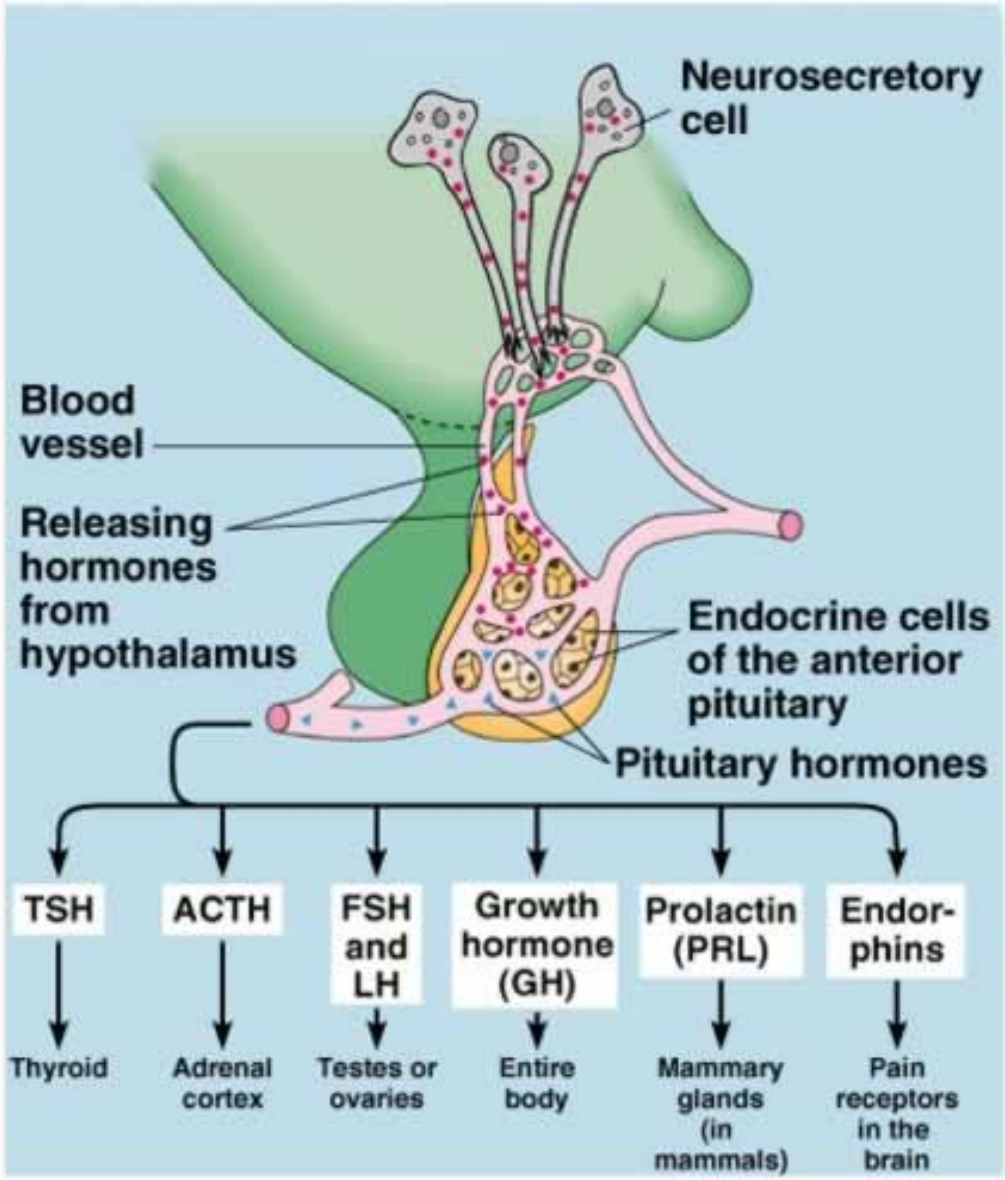


The medulla receives a dual blood supply:

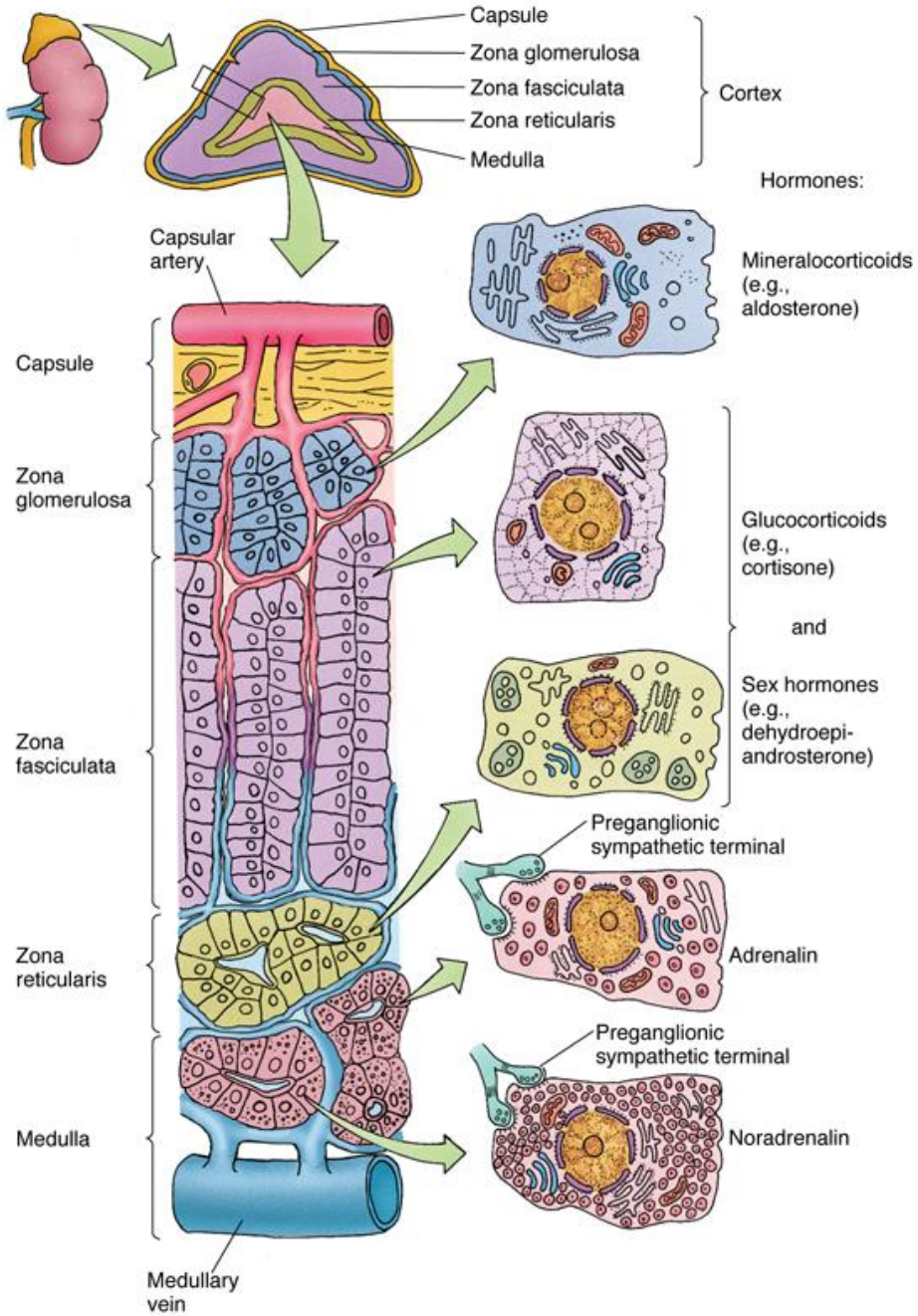
1. numerous vessels from the cortical capillary beds
2. an arterial supply from the long cortical arteries

Hypophyseal hormones and their target organs





SUPRARENAL GLAND – CORTEX



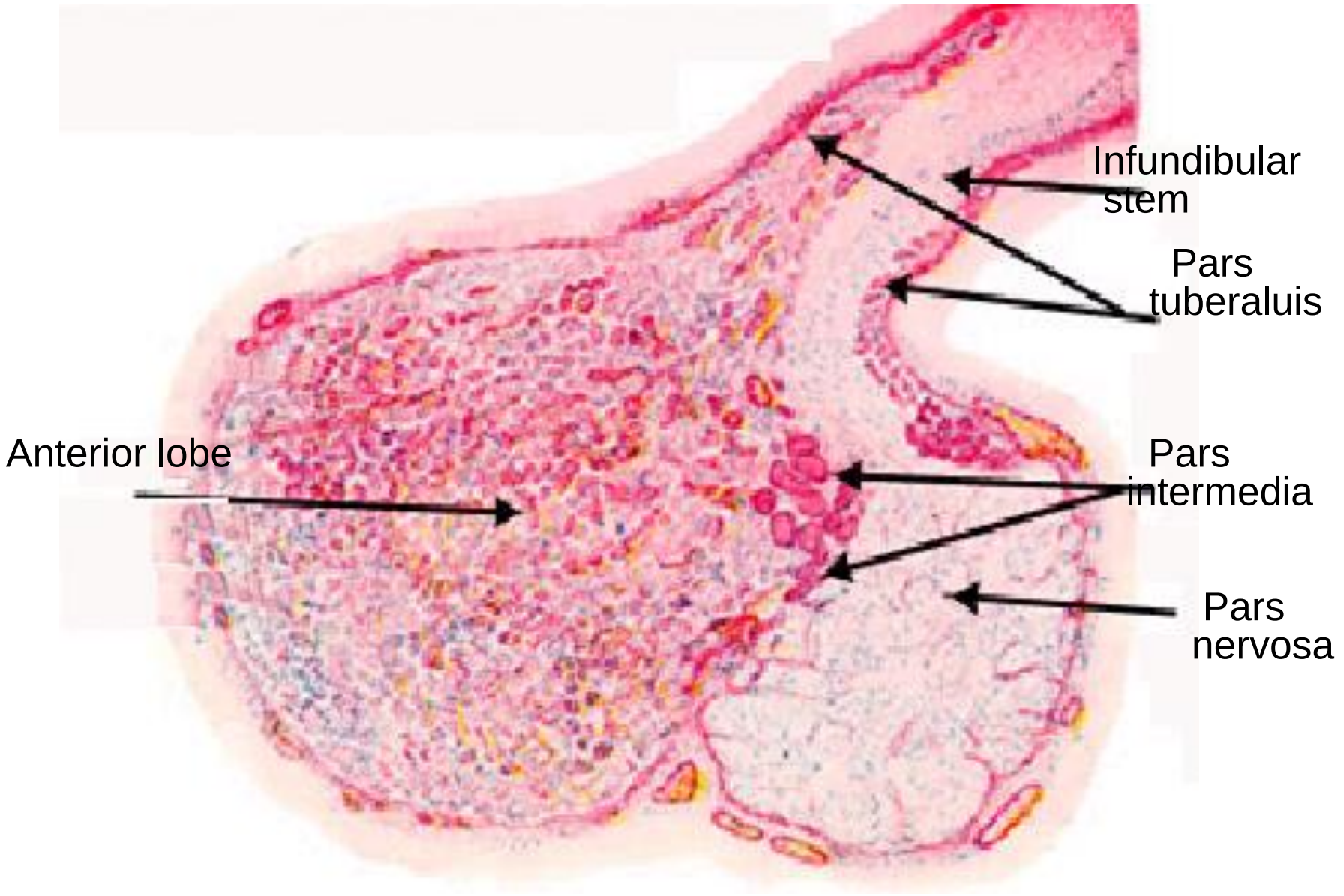
The cortex produces corticosteroid hormones from cholesterol and is stimulated by ACTH (corticotropin)

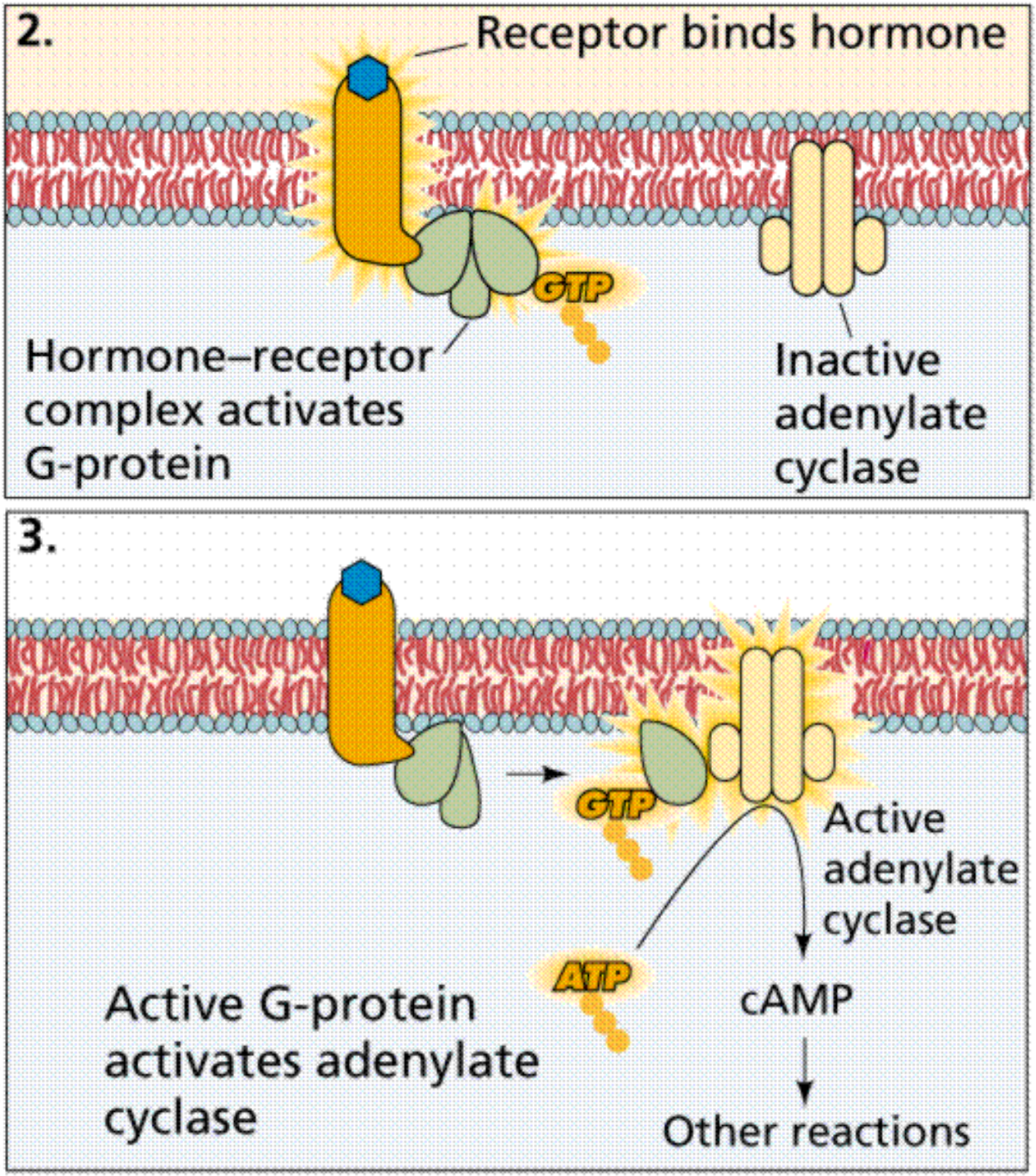
Cells of **zona glomerulosa**, synthesize and release the hormones called **mineralocorticoids**: **aldosterone and deoxycorticosterone.**

Cells of **zona fasciculata,** whose cells are referred to as **spongiocytes**, synthesize and release the hormones called **glucocorticoids**: **cortisol, cortisone and corticosterone**.

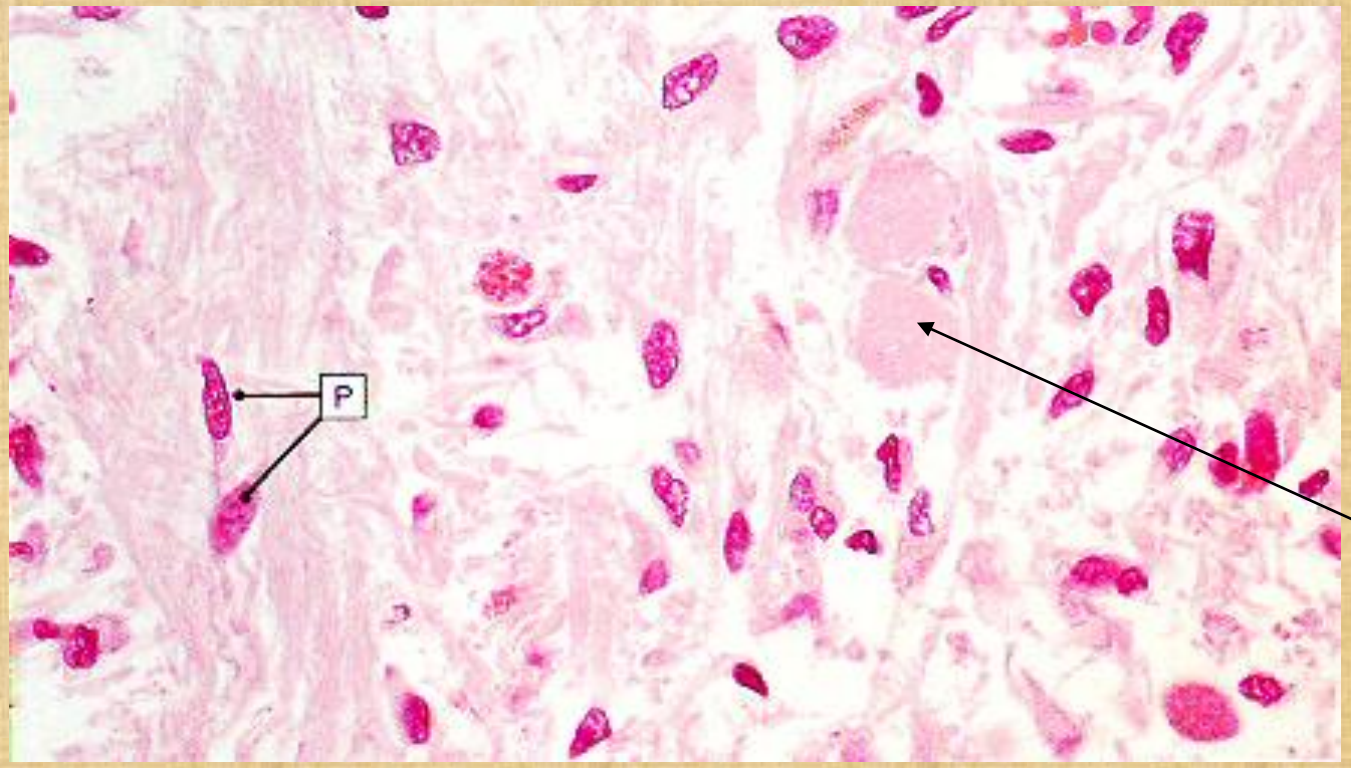
Cells of **zona reticularis**, synthesize and release **androgens: dehydroepiandrosterone and androstenedione.**

Pituitary

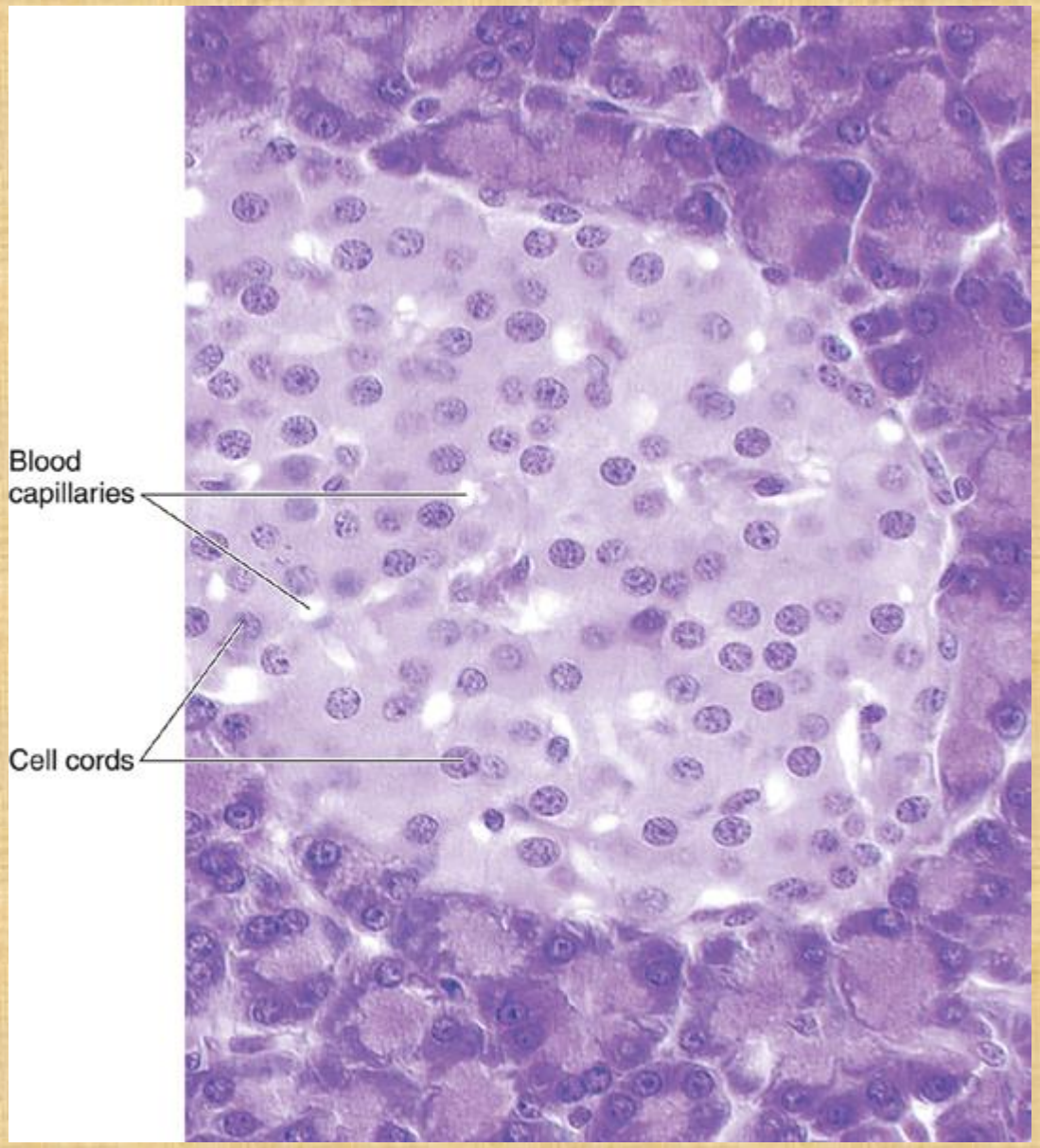

Infundibular stem
Pars tuberaluis
Anterior lobe
Pars intermedia
Pars nervosa


2.
Receptor binds hormone
GTP
Hormone–receptor complex activates G-protein
Inactive adenylate cyclase
3.
GTP
Active adenylate cyclase
ATP
cAMP
Active G-protein activates adenylate cyclase
Other reactions

PARS NERVOSA



It is formed by pituicytes, nerve fibers and Herring bodies.

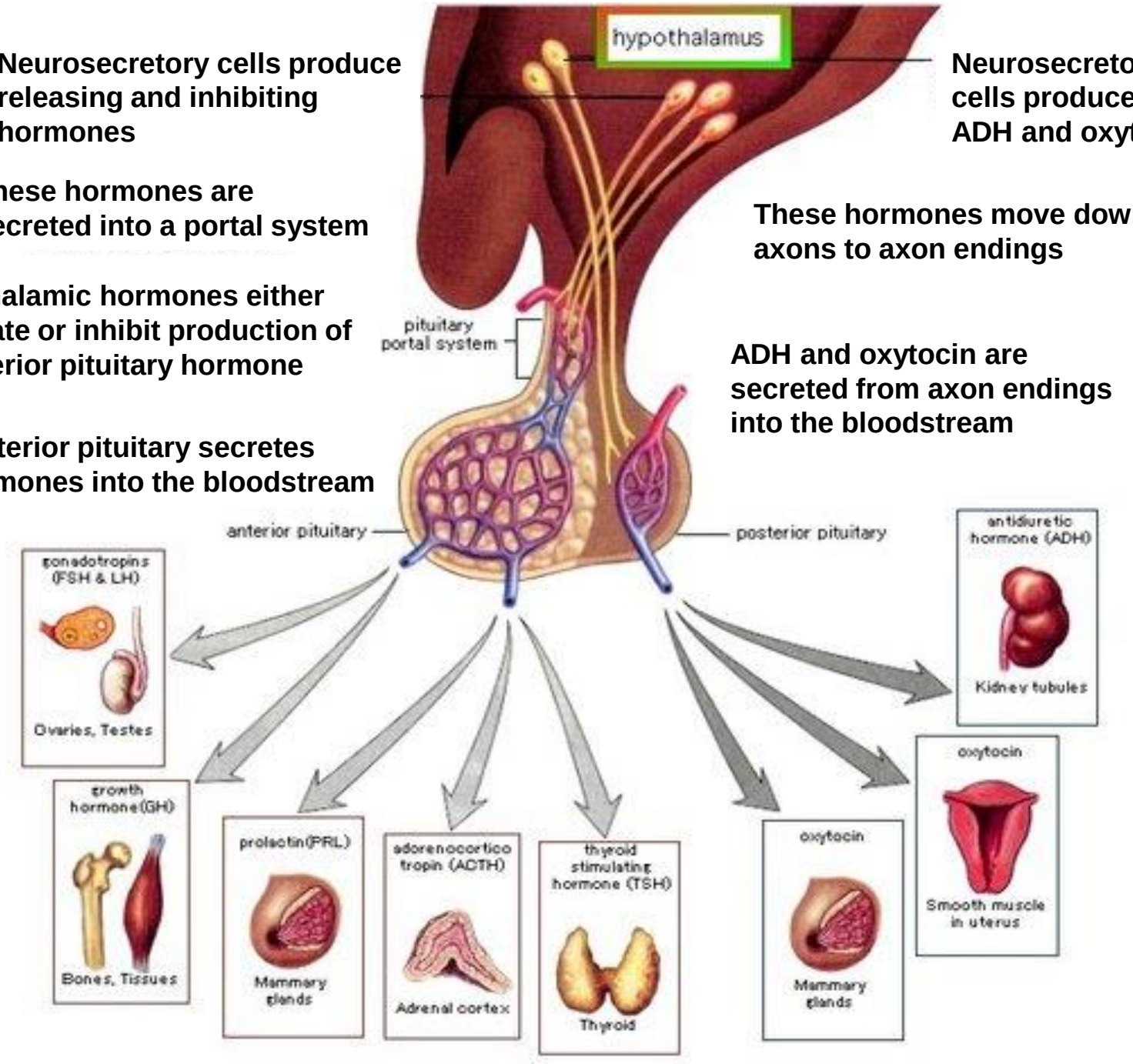

Blood capillaries
Cell cords

Neurosecretory cells produce releasing and inhibiting hormones

These hormones are secreted into a portal system

Hypothalamic hormones either stimulate or inhibit production of an anterior pituitary hormone

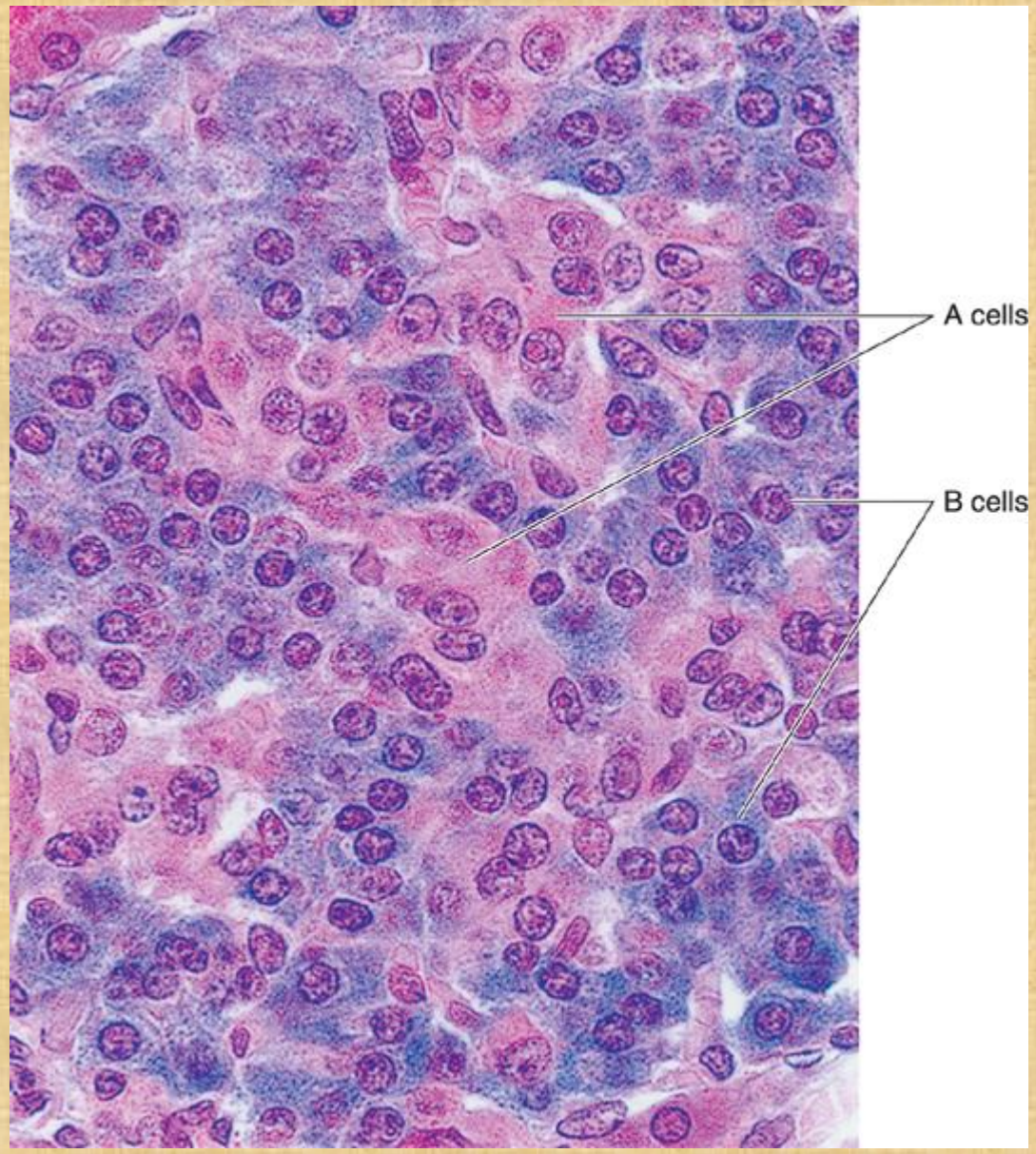
The anterior pituitary secretes its hormones into the bloodstream

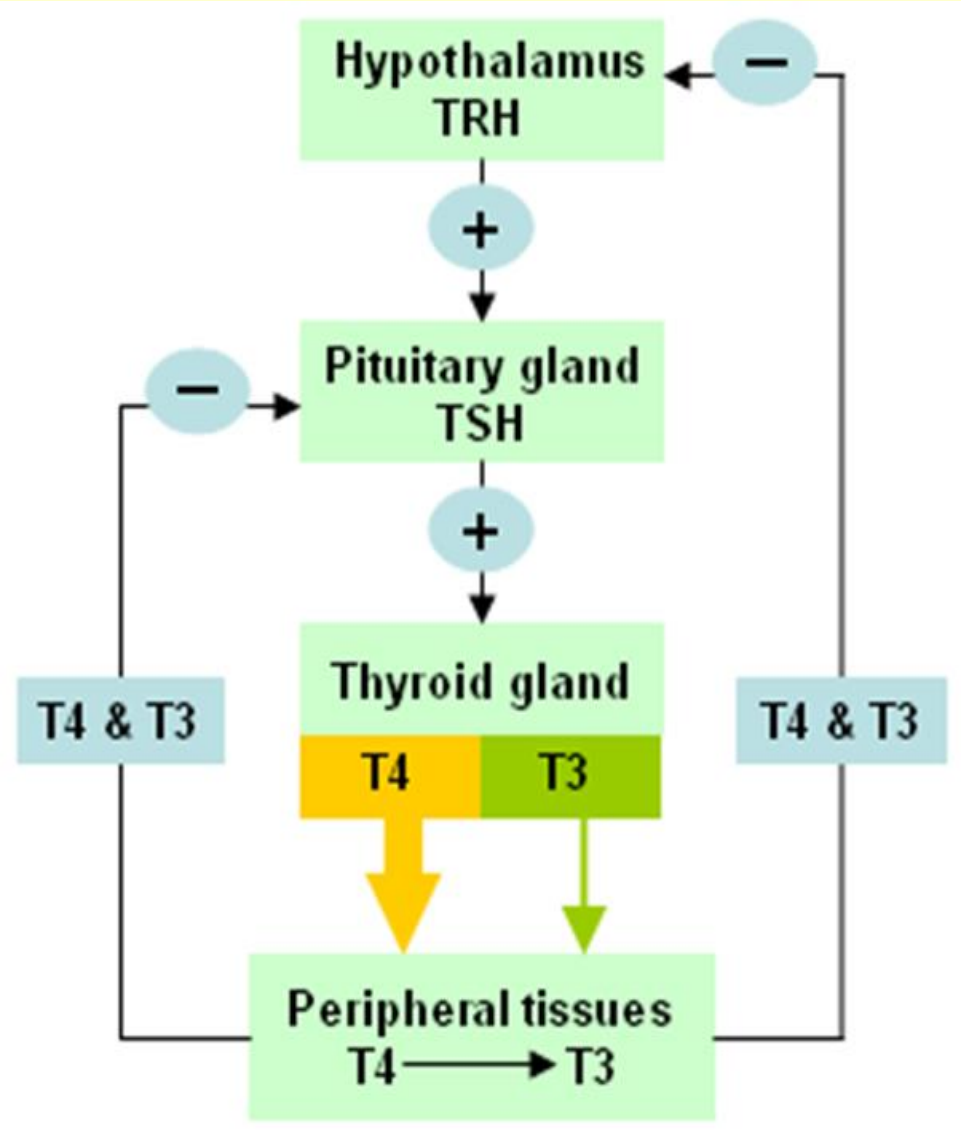


Neurosecretory cells produce ADH and oxytocin

These hormones move down axons to axon endings

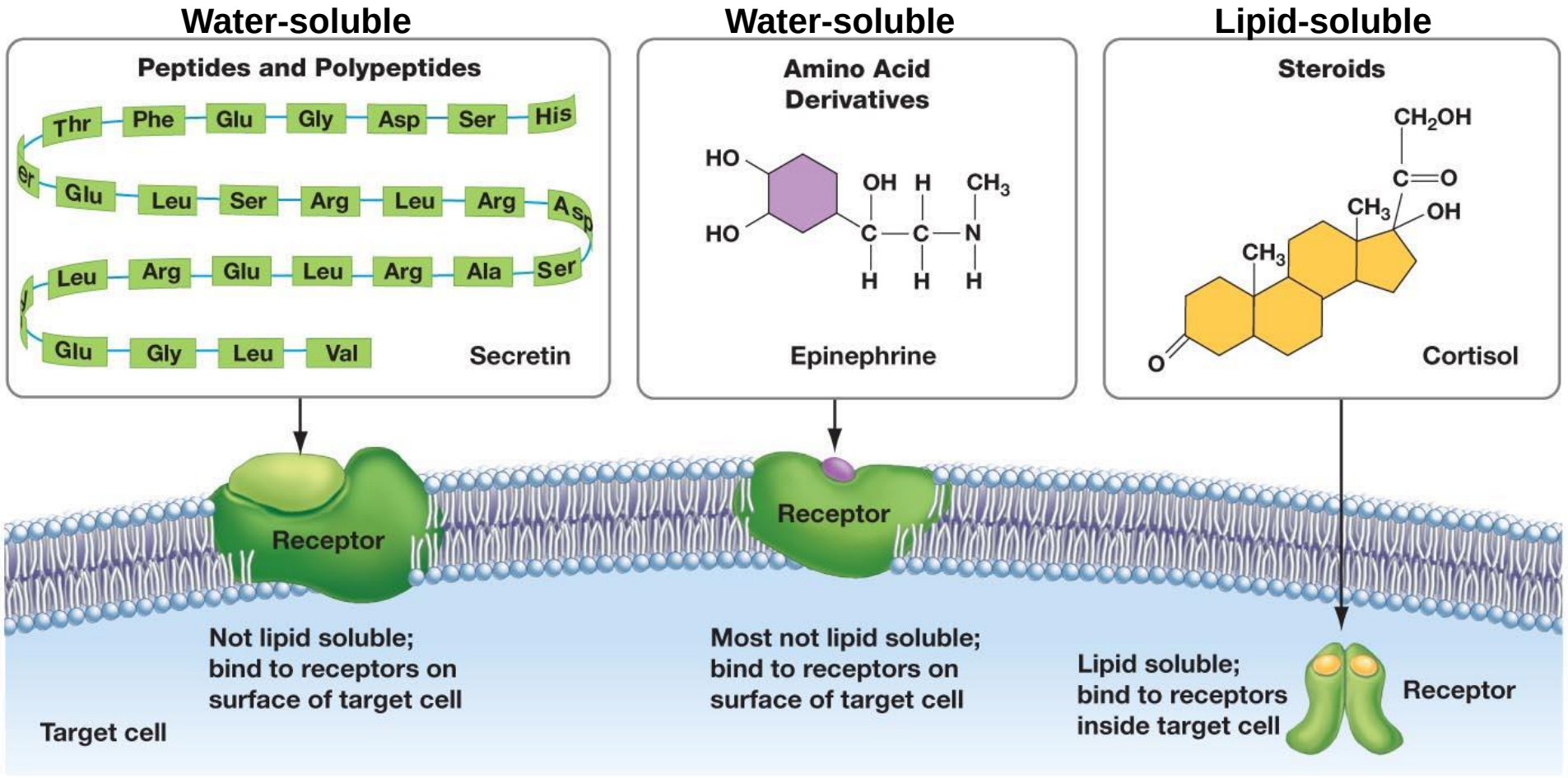
ADH and oxytocin are secreted from axon endings into the bloodstream


A cells
B cells



Thyroid hormone production is regulated by the hypothalamus and pituitary gland. Hypothalamic thyrotropin-releasing hormone (TRH) stimulates pituitary thyrotropin (TSH) synthesis and secretion. In turn, TSH stimulates production and release of T_4 and T_3 from the thyroid gland. Once released, T_4 and T_3 exert a negative feedback mechanism on the production of TRH and TSH.

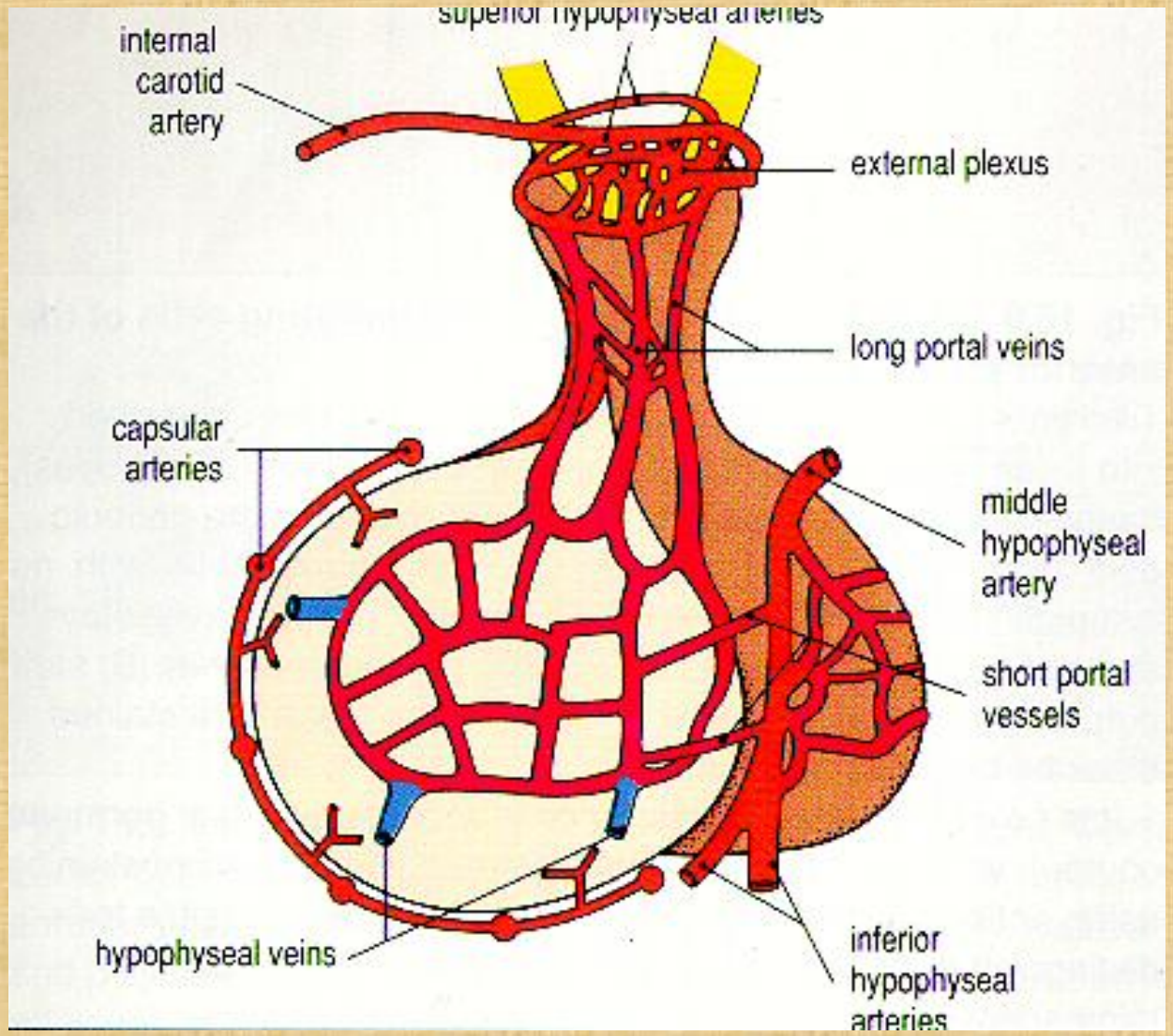
The **hormone** binds to the receptor, resulting in the activation of a **signal transduction** mechanism that ultimately leads to cell type-specific responses.



Insulin
Follicle-stimulating Hormone (FSH)

Epinephrine

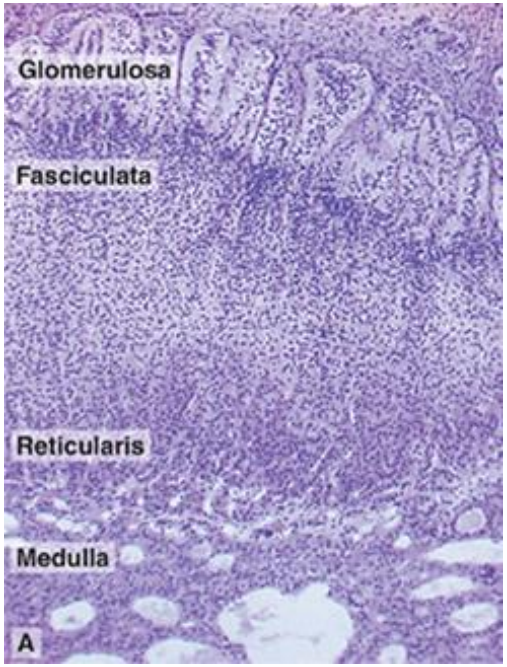
Progesterone
Testosterone

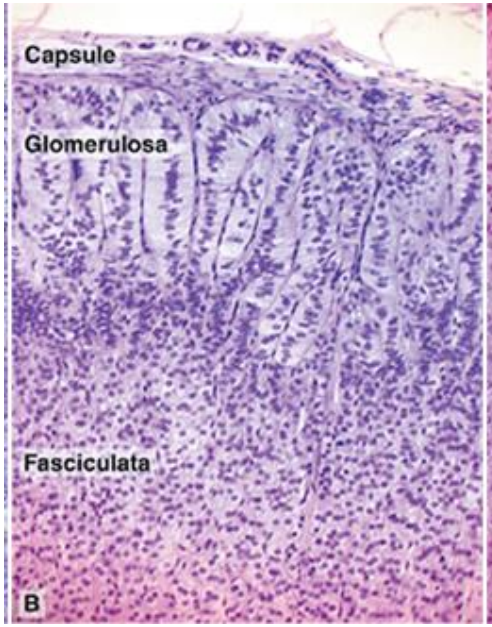


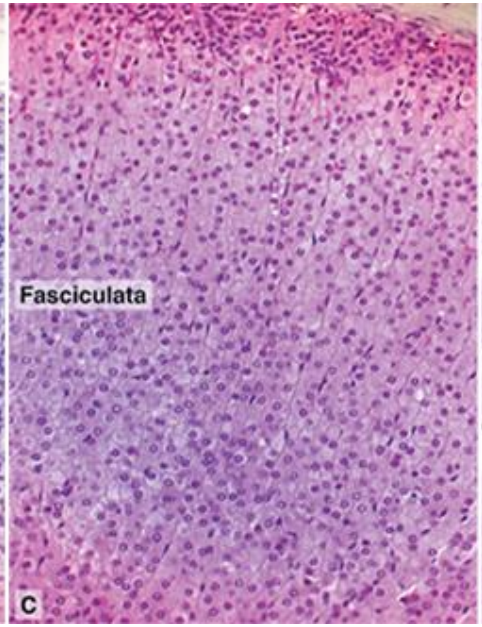
Arterial supply of the pituitary.

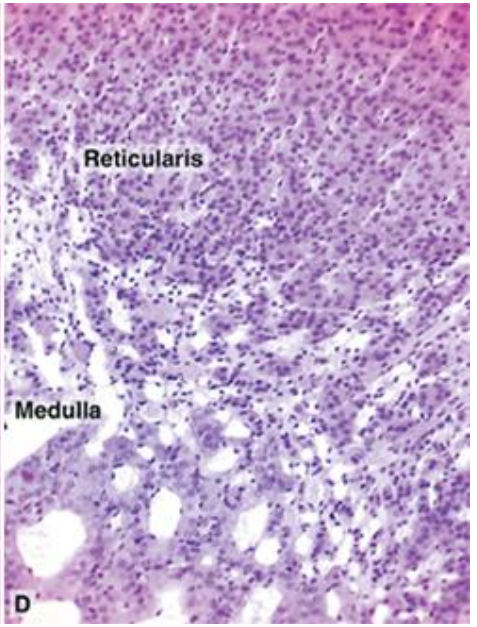
Superior hypophyseal arteries enter the median eminence and form the external plexus close to nerve endings from neuroendocrine cells of the hypothalamus. From this plexus forms long portal vessels which run down the pituitary stalk and then form capillary vessels going into anterior pituitary. Thus, there is a direct vascular link between hypothalamus and endocrine pituitary cells.

Organization of the adrenal cortex





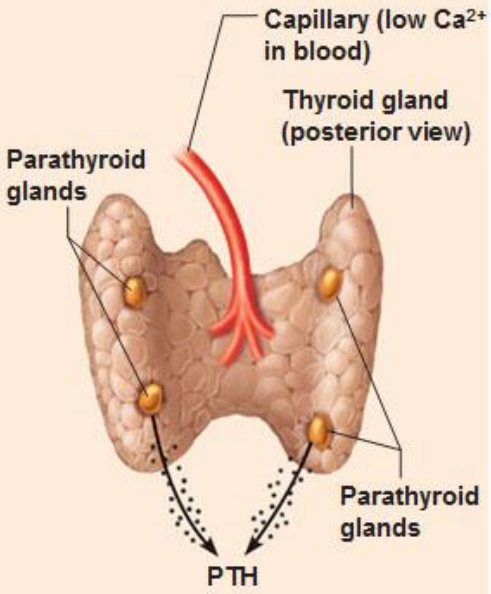




Types of Endocrine Gland Stimuli

(a) Humoral stimulus

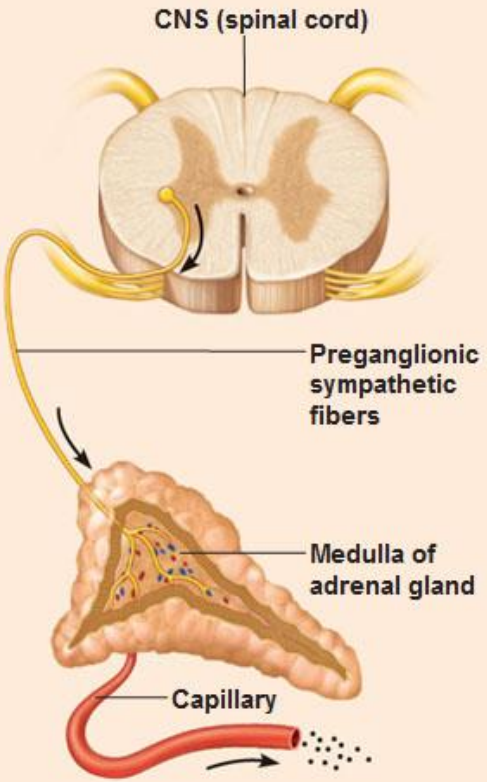
① Capillary blood contains low concentration of Ca^{2+}, which stimulates…



② …secretion of parathyroid hormone (PTH) by parathyroid glands. PTH acts to increase blood Ca^{2+}.

(b) Neural stimulus

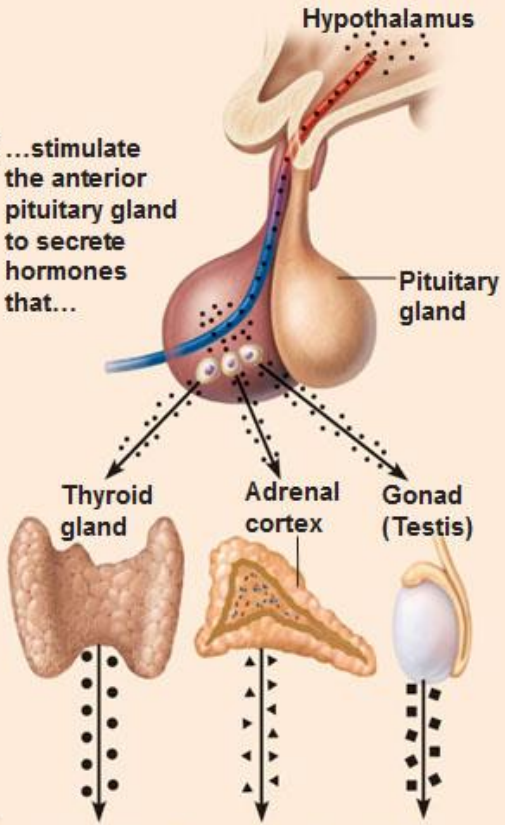
① Preganglionic sympathetic fibers stimulate adrenal medulla cells…



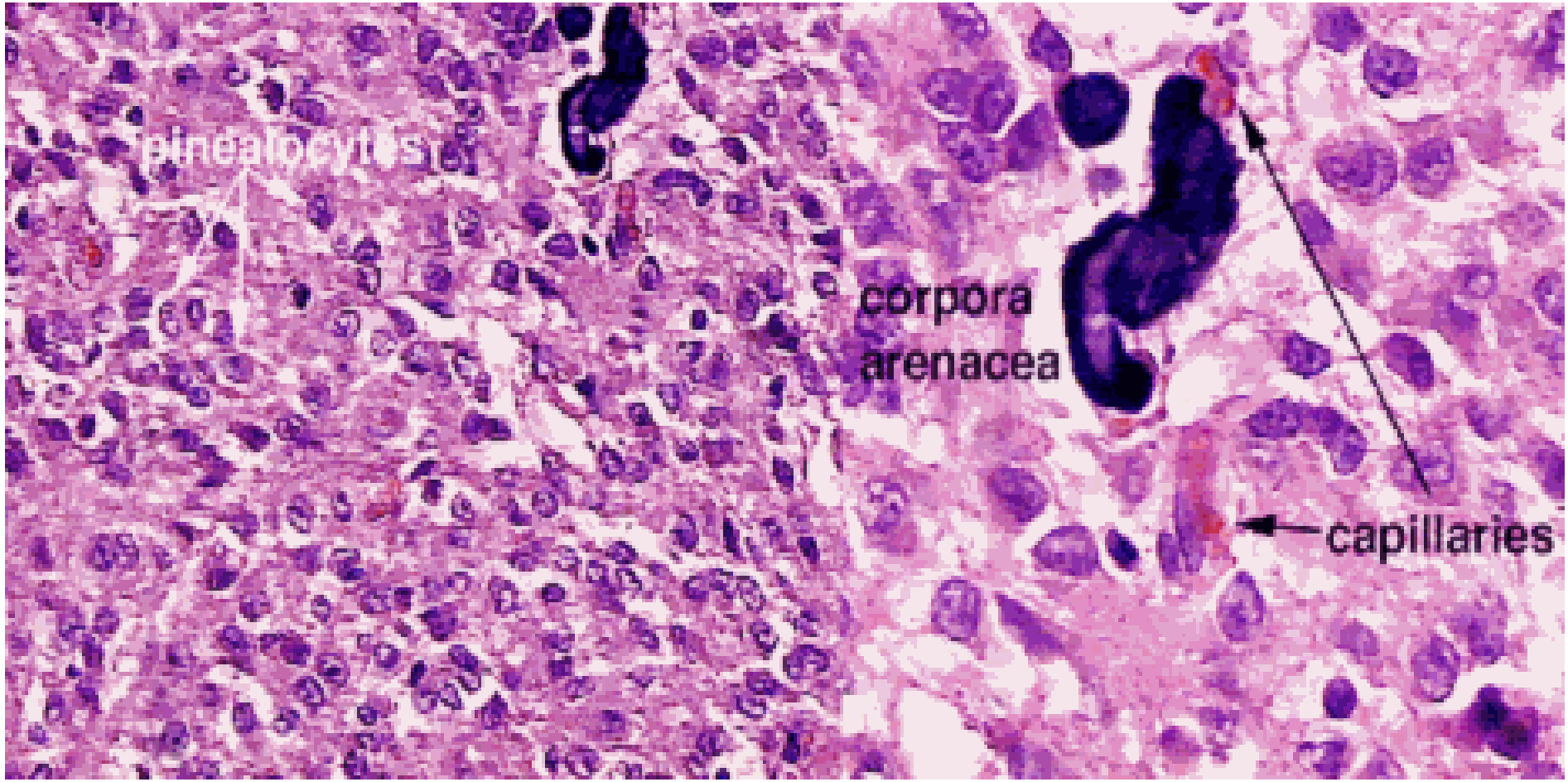
② …to secrete catecholamines (epinephrine and norepinephrine)

(c) Hormonal stimulus

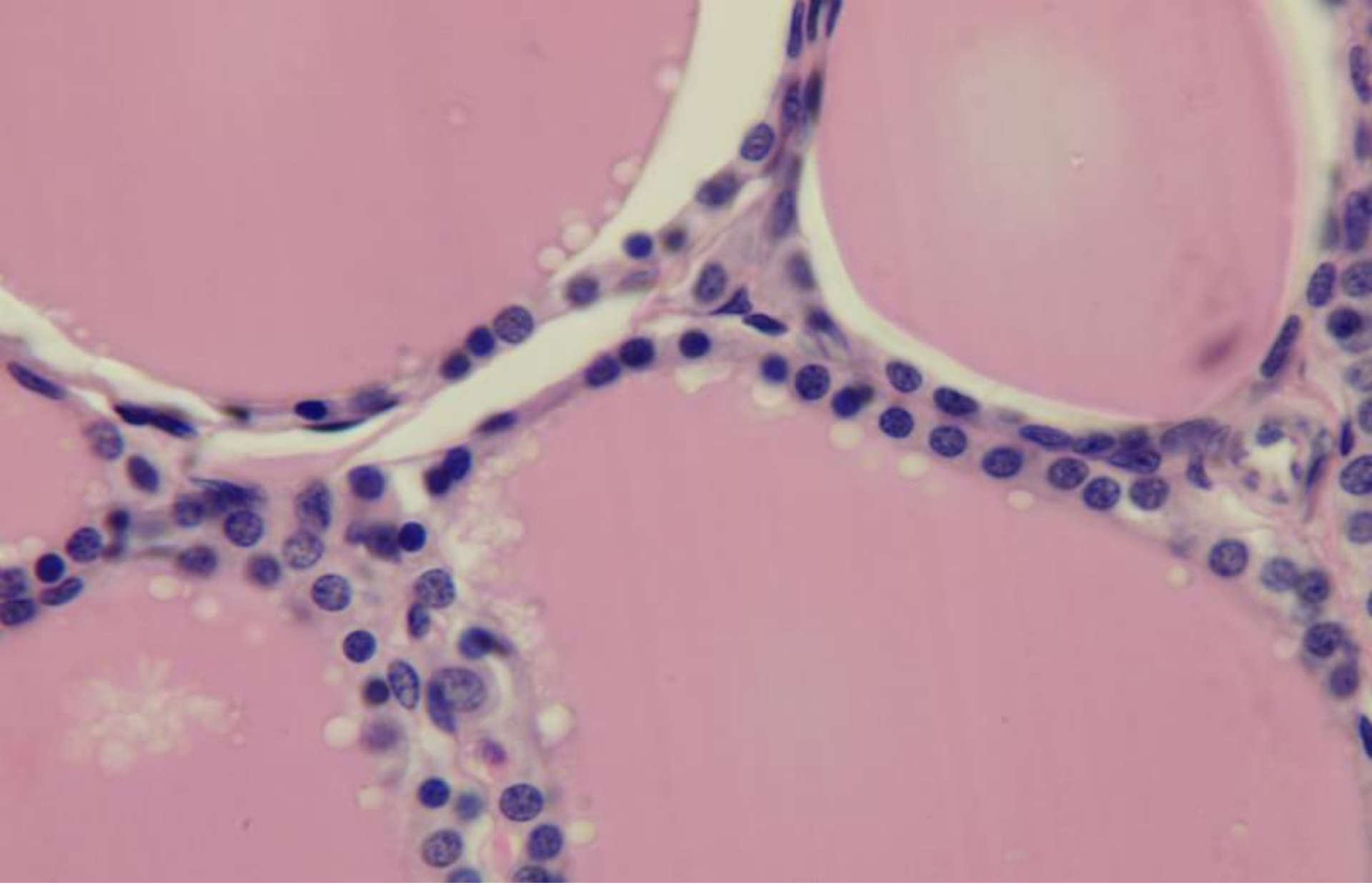
① The hypothalamus secretes hormones that…



③ …stimulate other endocrine glands to secrete hormones



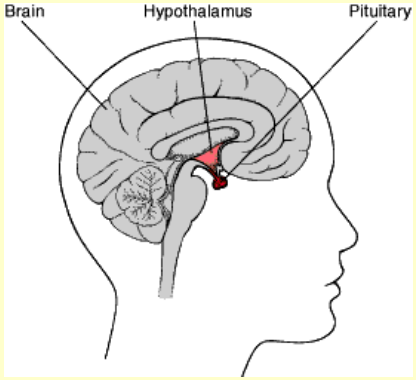
slide 49 **PINEAL GLAND**



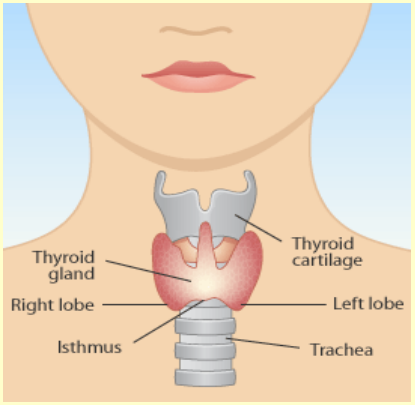
slide 8 Thyroid gland

ENDOCRINE GLANDS

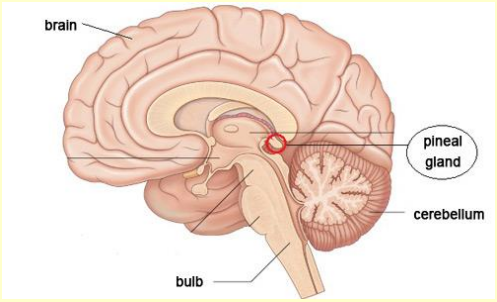
Pituitary gland



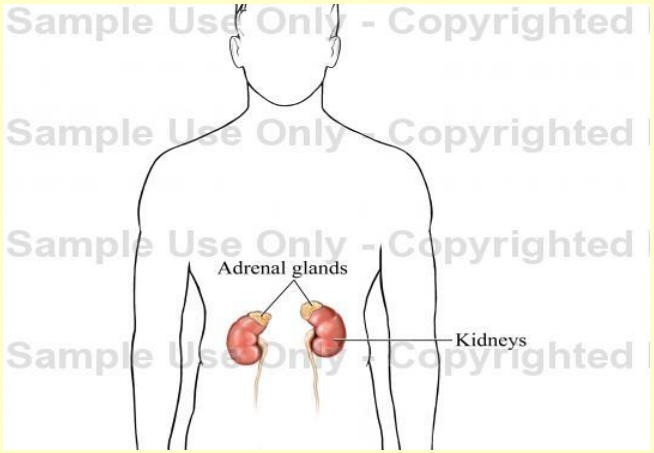
Thyroid gland



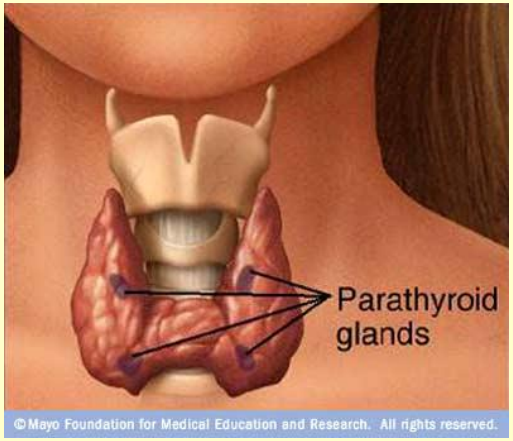
Pineal gland



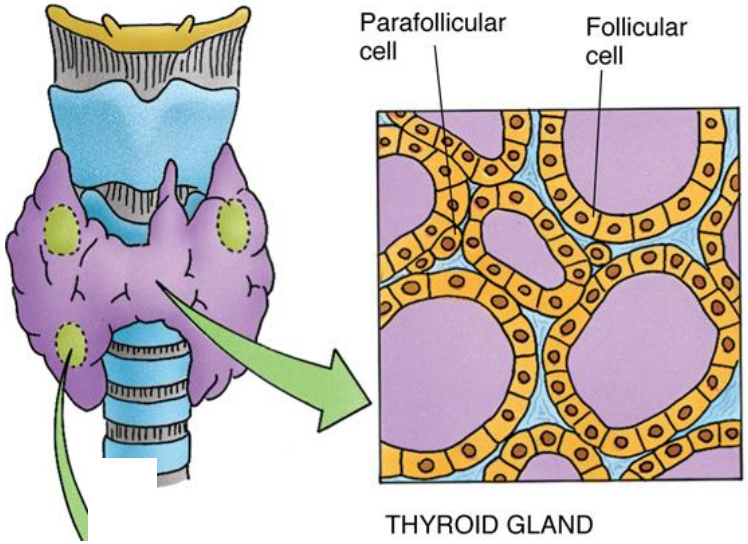
Suprarenal (adrenal gland) gland

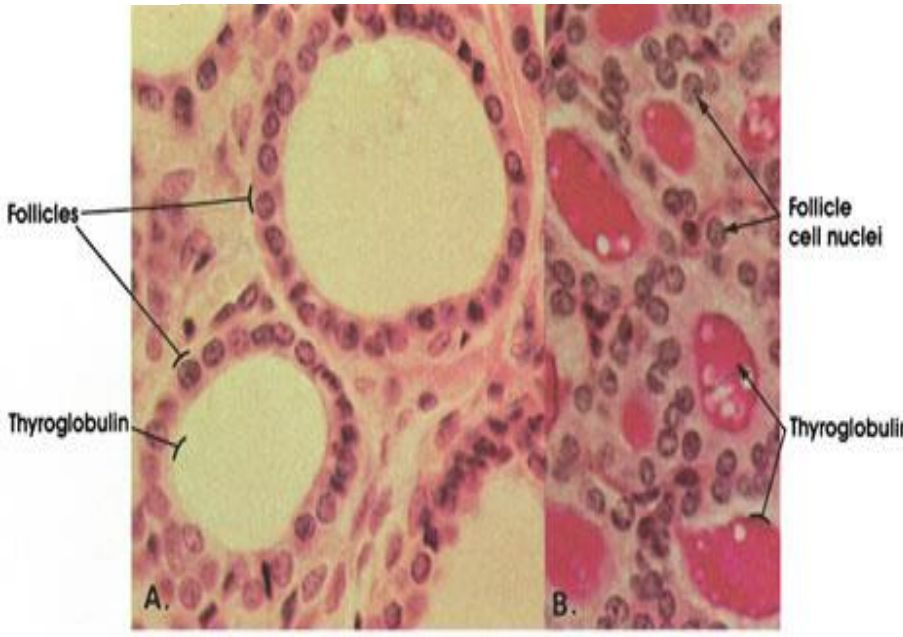


Parathyroid gland

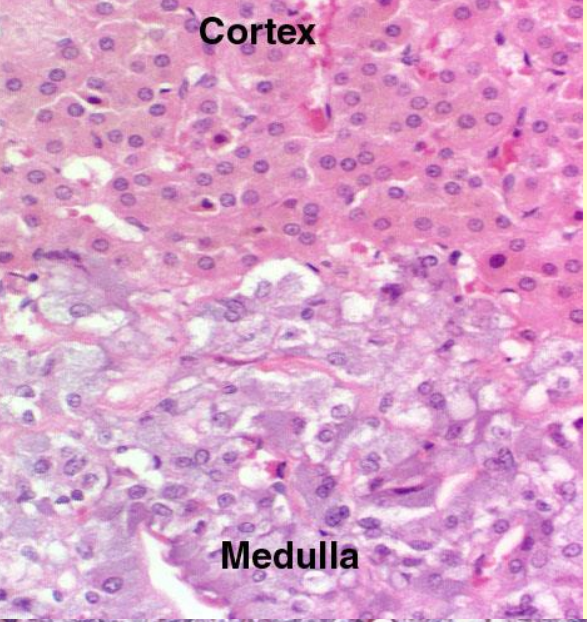


THYROID GLAND



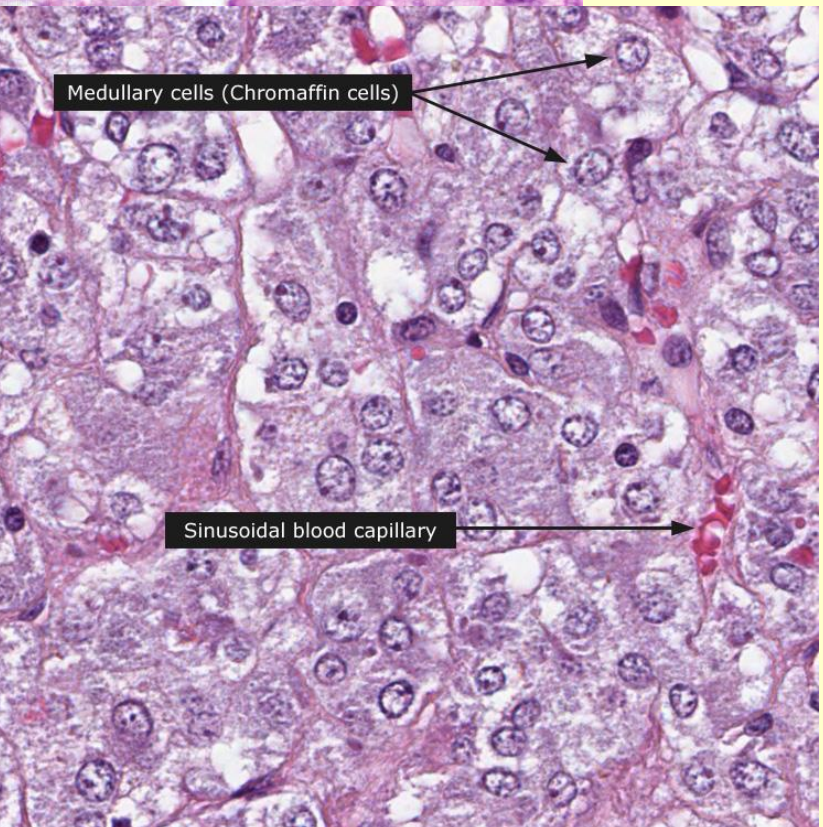


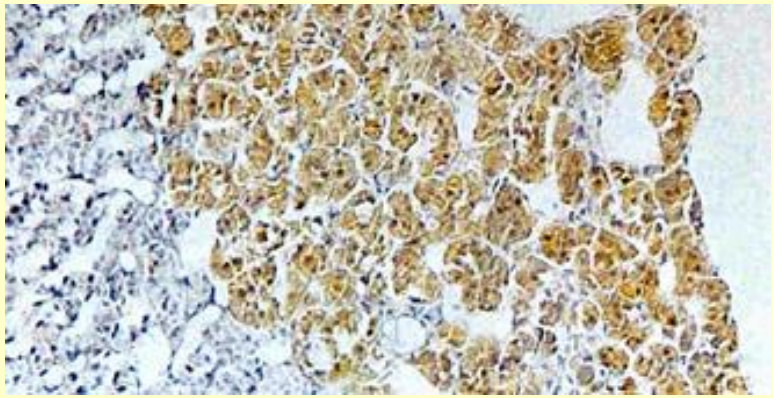
Unlike most of the endocrine glands, which store their secretory substances within the parenchymal cells, the thyroid gland stores its secretory substances in the lumina of **follicles**. Each follicle can store several weeks' supply of hormone within the **colloid.**



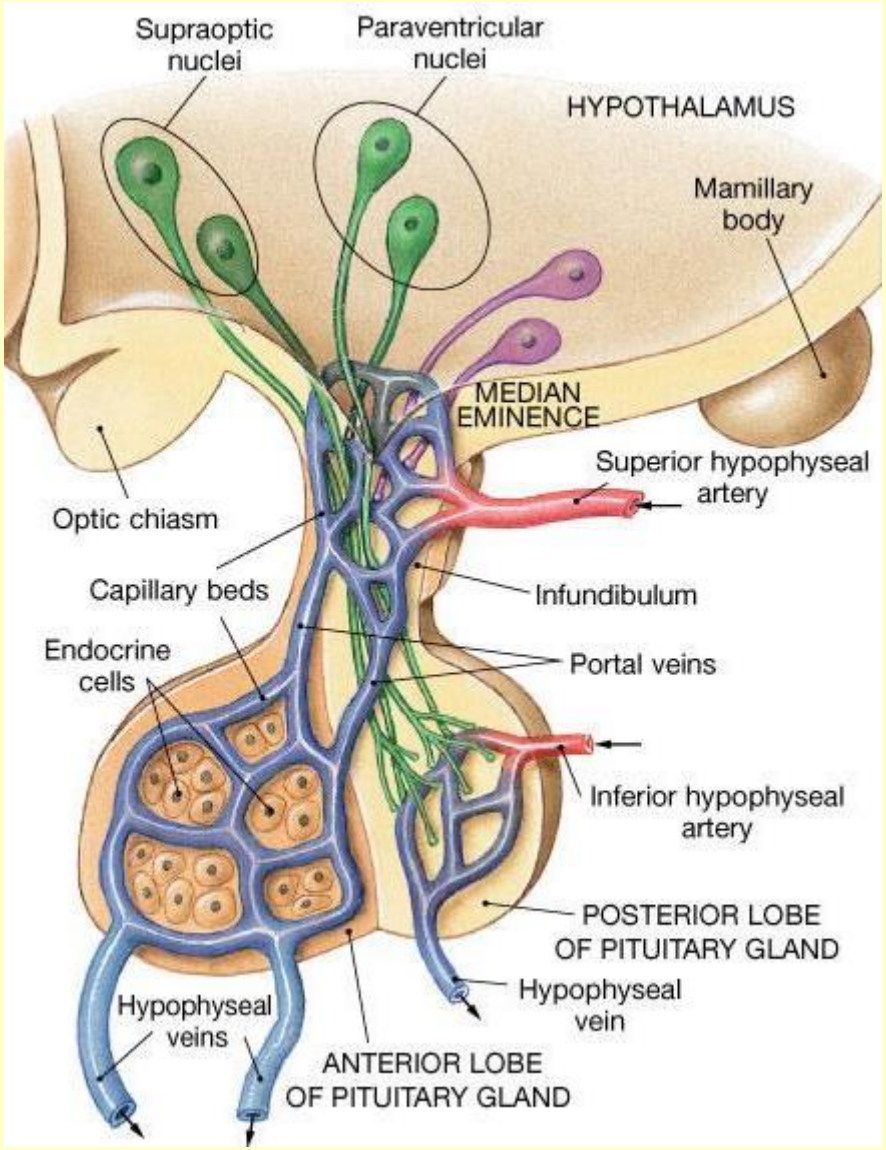
CHROMAFFIN CELLS

- are arranged in clusters and cords
- stain intensely chromaffin salts
- synthesize **epinephrine** (adrenaline) and **norepinephrine** (noradrenaline) **and contain granules with catecholamines**
- the release of catecholamines is controlled by the splanchnic nerves (acetylcholine)





chromaffin reaction in the suprarenal gland-brown color of cells indicates that cells contain catecholamines

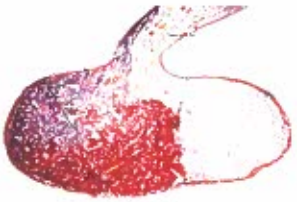


The **pituitary gland** is connected to the brain by neural pathways; it has also rich vascular supply from vessels that supply the brain, attesting to the intercoordination of the two systems in maintaining a physiological balance.

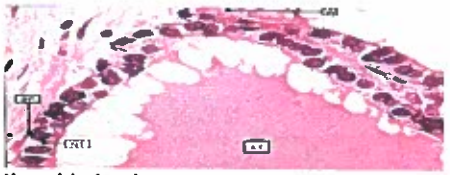
Secretion of the hormones produced by the pituitary gland is controlled by hormonal or nerve signals from the hypothalamus

Seminar: Hormones produces by the hypophysis, regulation by the hypothalamus.
Practical class: Endocrine glands.

- **hypophysis (no. 40),**
- **thyroid gland (no. 8),**
- **parathyroid gland (no. 90),**
- **suprarenal gland (no. 39),**
- **pineal gland (no. 49),**
- **chromaffin reaction in the suprarenal gland (no. 5),**
- **specimen x (no. 32) – please, answer the following questions:**



hypophysis



thyroid gland

Can you recognise in this specimen:
1) epithelium (if the answer is yes what type is it?),
2) glands (if the answer is yes, what type are they?),
3) fibroblasts,
4) adipocytes (fat cells),
5) fibers: a)collagen, b)elastic,
6) stratified muscle cells,
7) smooth muscle cells,
8) blood vessels, arterioles, venules,
9) capillaries,
10) nerves.

- **primary hyperparathyroidis (text & fig. 85),**
- **photograph of a patient with a thyroglossal cyst (photo. 87),**

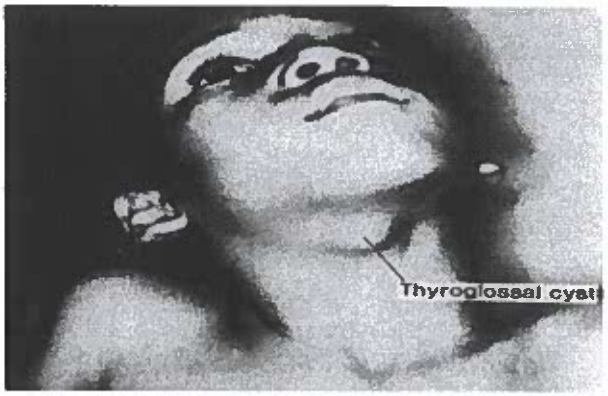


photo. no 87

Photograph of a patient with a thyroglossal cyst. These cysts are remnants of the thyroglossal duct and may be located at any place along the migration pathway of the thyroid gland. They are frequently located behind the arch of the hyoid bone.
An important diagnostic characteristic is their midline location.

Text Nr 85 Primary hyperparathyroidis

67-year-old female patient was admitted to the hospital with severe right leg contusion. X-ray examination showed a fracture of femoral bone corpus and significant decrease of bone mineral density, especially in upper limb (radius and ulna) bones. In addition, multiple fracture of left radial bone occurred during the stay in the hospital. Biochemical analysis revealed significant (approx. 3,8 mM)[1] hypercalcemia (elevated calcium level in serum) and hypercalciuria (high calcium level in urine). Clinical symptoms were typical for hyperparathyroidis, which could be caused by parathyroid adenoma – a benign neoplasm of this organ. Secretion activity of such neoplasm is independent of regulatory influence of other factors (so-called "autonomous" secretion). The parathyroid adenoma releases huge amount of parathormone (PTH), a hormone responsible for remodeling of bone tissue, e.g. calcium release from the bone mineral [2].
Further diagnostic procedures confirmed preliminary diagnosis. The ultrasound scan (USG) of the neck showed the presence of small (12 x 7 mm), hypoechogenic area on the posterior surface of left thyroid lobe, which could correspond to an enlarged parathyroid gland. During the operation, surgeons confirmed the presence of enlarged gland in the above localization, which was removed and sent for microscopic analysis. A histological examination result was as follows: "benign parathyroid neoplasm of adenoma type".
Within few hours after operation calcium level in serum decreased to the normal range. Moreover, some symptoms of hypocalcemia (serum level 1,98 mM) with tetany and facial muscle numbness appeared 1 day after operation. This symptoms, usually observed after similar operations are called „hungry bone syndrome". They are a result of intensified calcium incorporation to the bone mineral after a decrease of PTH level. The further treatment required supplementation of calcium and phosphates deficiency and immobilization of bone fractures.

Fig. 85 - a. X-ray picture of femoral bone fracture (left arrow). Also is visible significant osteolysis of distal epyphysis (right arrow). Control picture shows a knee joint with normal density of femoral epyphysis.

Fig. 85 - b. X-ray picture of antebrachial bones with focal decrease of bone density (arrows). Control picture shows X-ray picture of healthy individual's antebrachium.

Fig. 85 - c. X-ray picture of antebrachial bones with multiple fracture (arrows). Possible spiral fracture of ulna. Antebrachium immobilized in a Krammer's „ladder".

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[1] Normal calcium range in serum is 2.2 – 2.8 mM (mmol/l)

[2] It has been reported, that PTH, if administrated in "pulse mega-doses", e.g. once per day, may exert anabolic influence on osteoblasts. Thus, it is used in osteoporosis therapy trials.

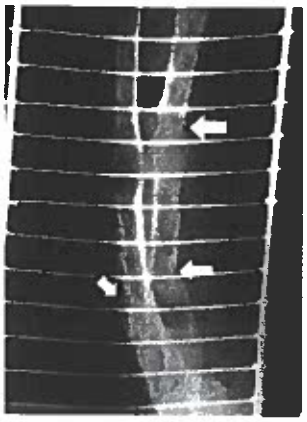
Fig. 85 - d. Ultrasound scan of patient's neck. Tch - trachea, T - thyroid gland - left lobe, A - parathyroid adenoma (showed in border).

Fot. 85 a

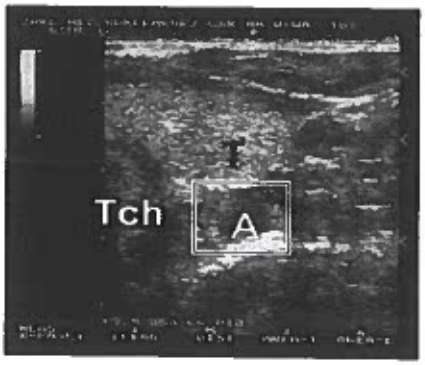
Photo control

Fot. 85 b

Photo control



Fot. 85 c



Fot. 85 d