# 18-00
# Endocrine Glands

# 18 Endocrine Glands
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# 18 Endocrine Glands
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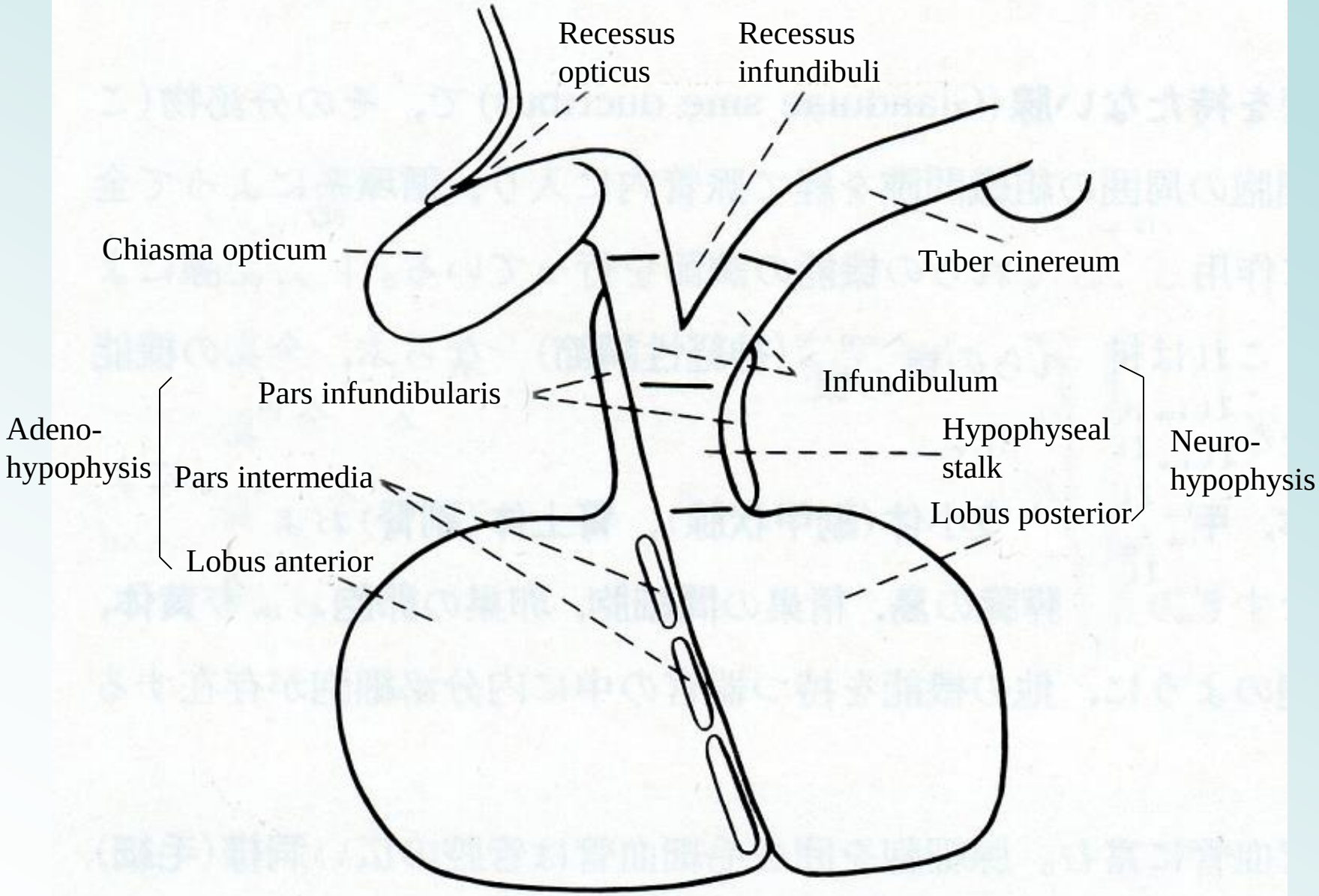
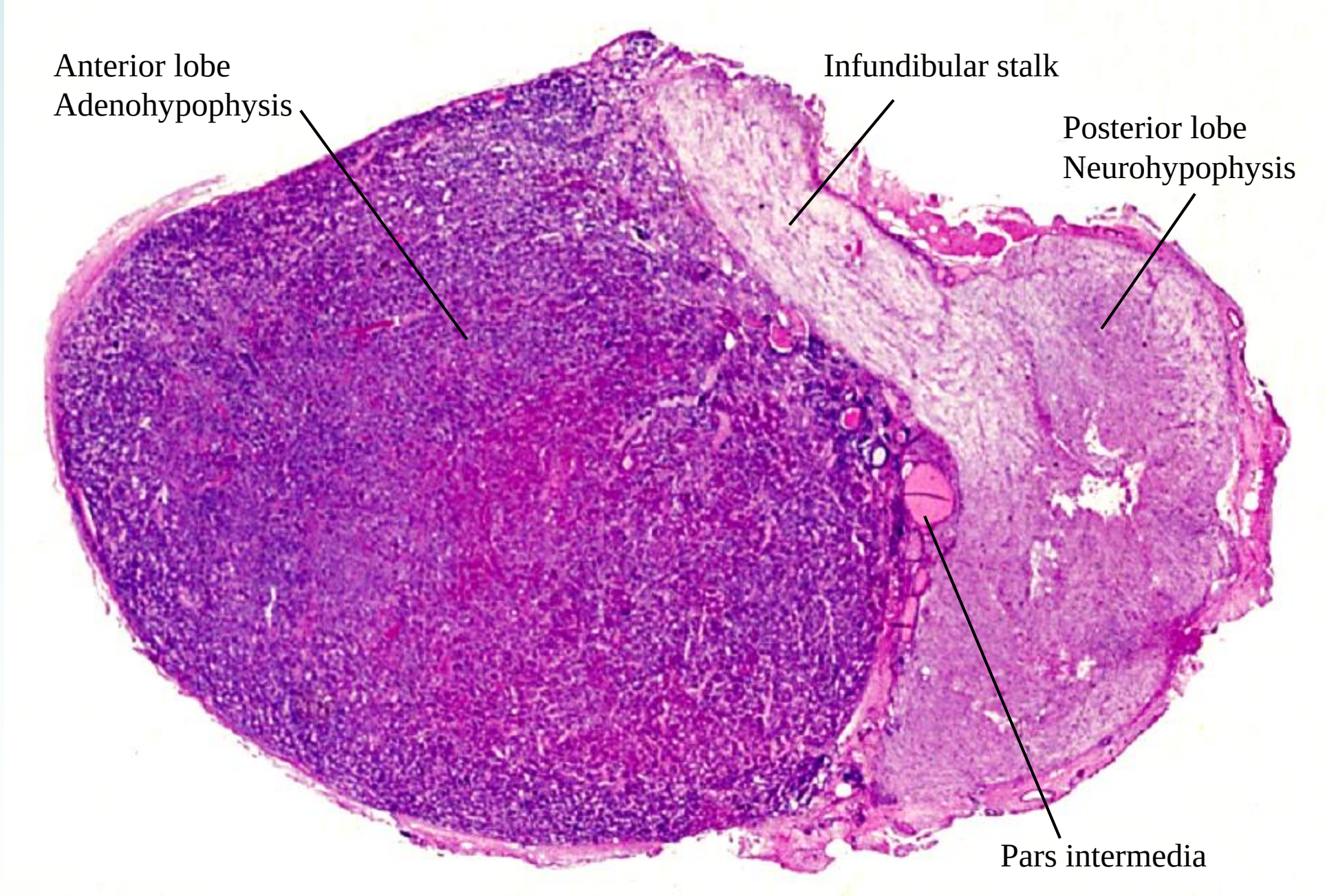
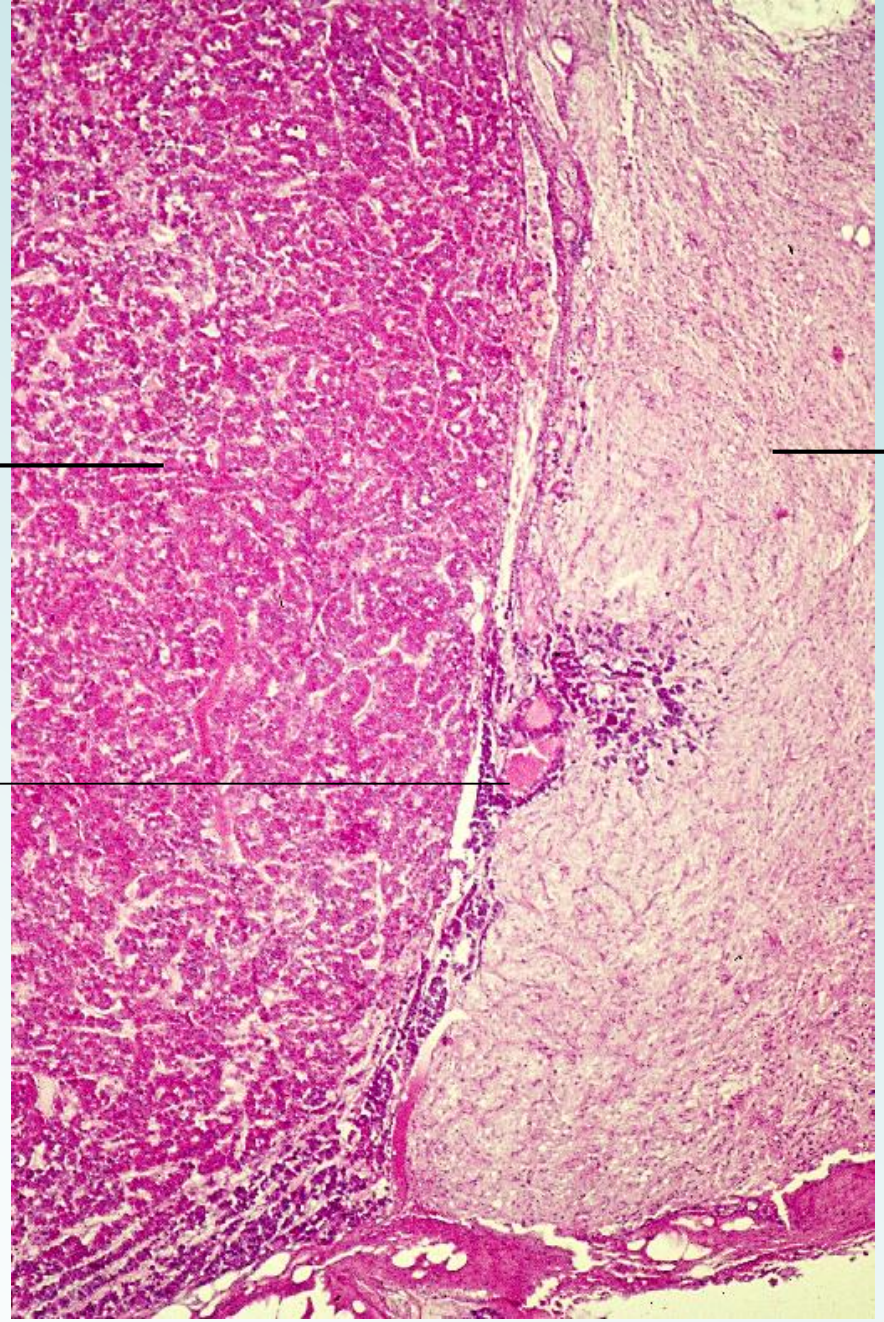
# 18-001 Hypophysis



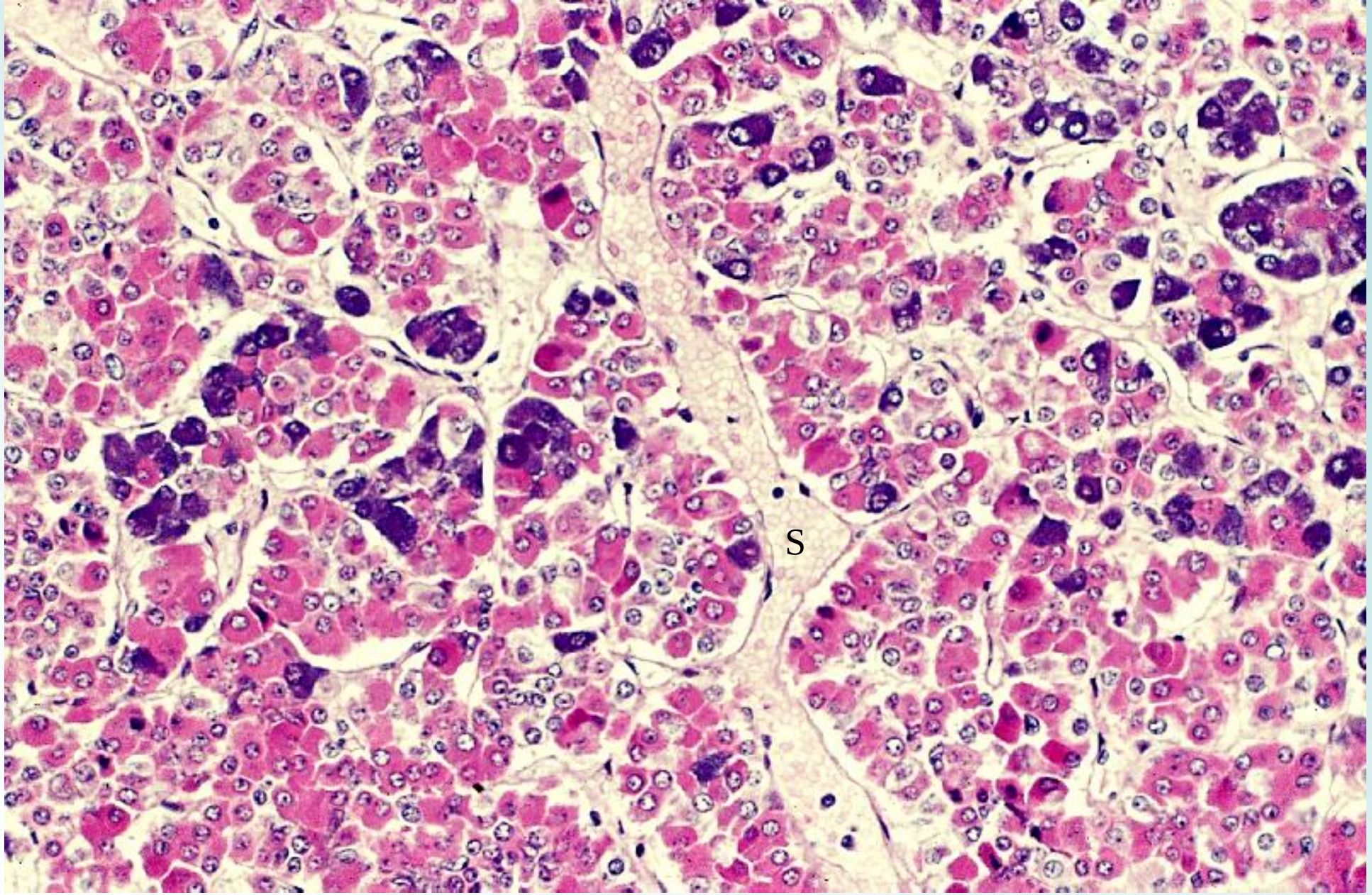

18-01 Hypophyswis, sagittal section. Scheme.



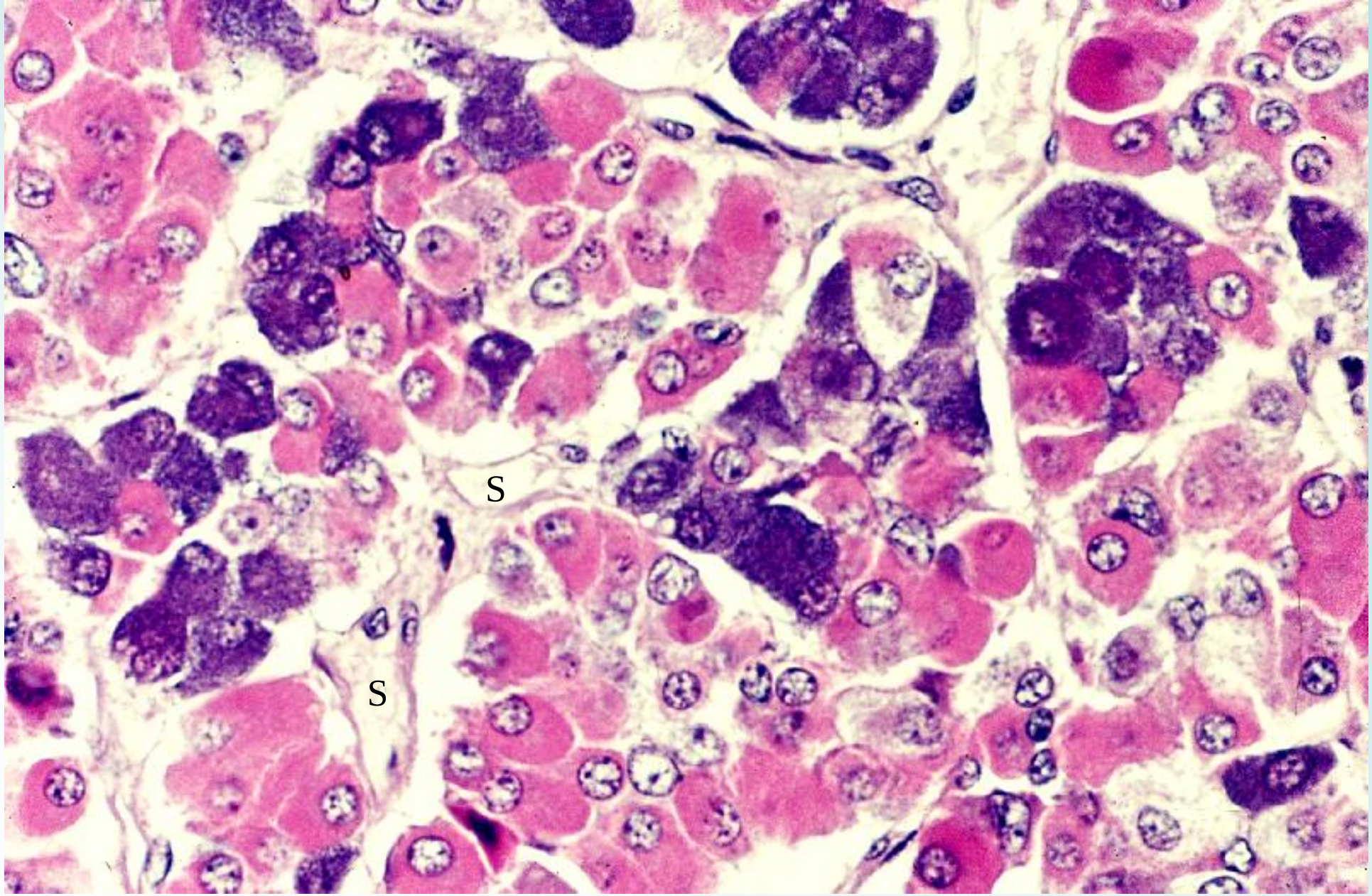

18-02 Hypophysis, sagittal section. General view. Human, H-E stain, x 3.0.



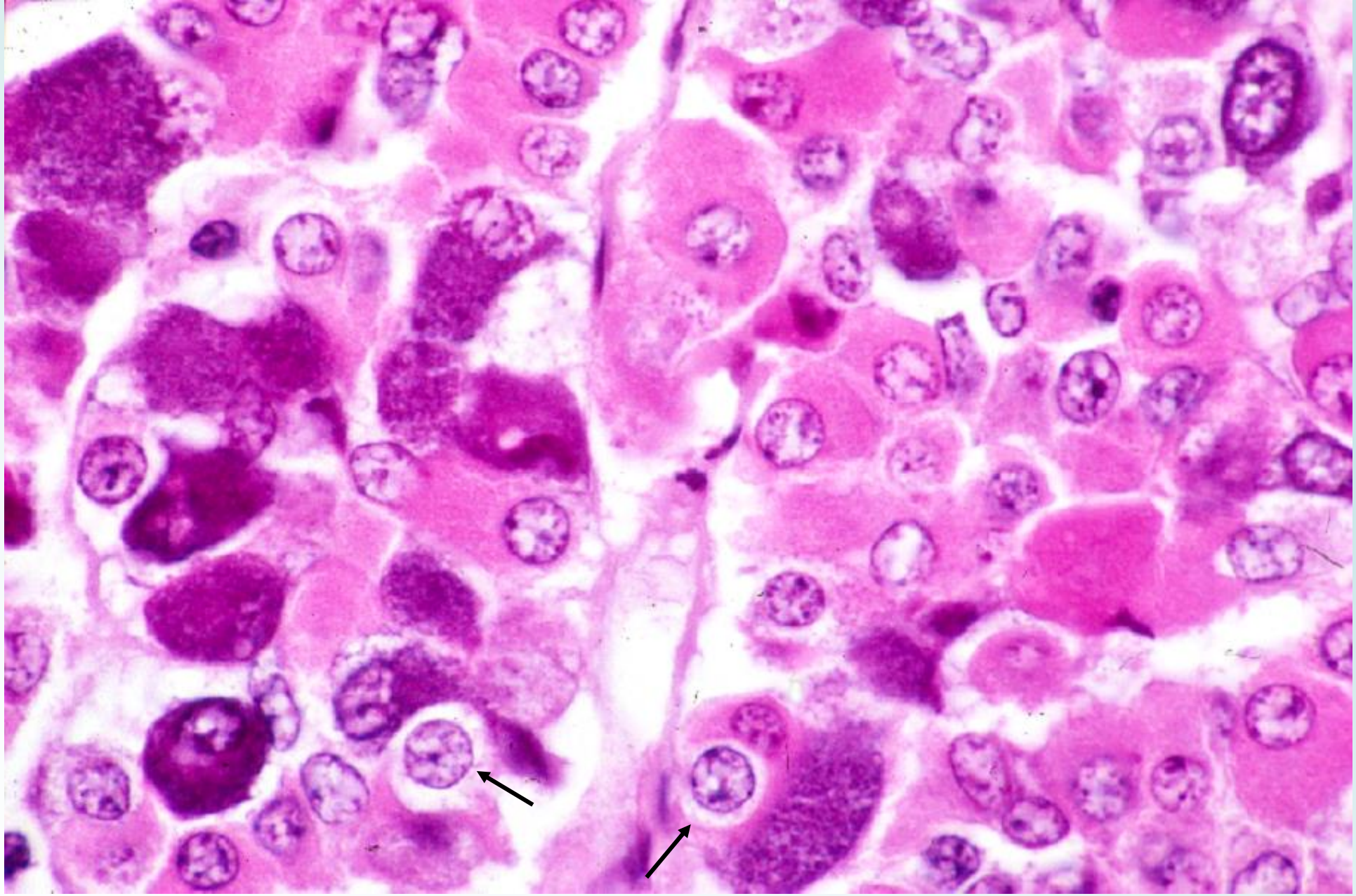

18-03 Hypophysis. Anterior lobe, pars intermedia and posterior lobe. Human, H-E stain, x 10.



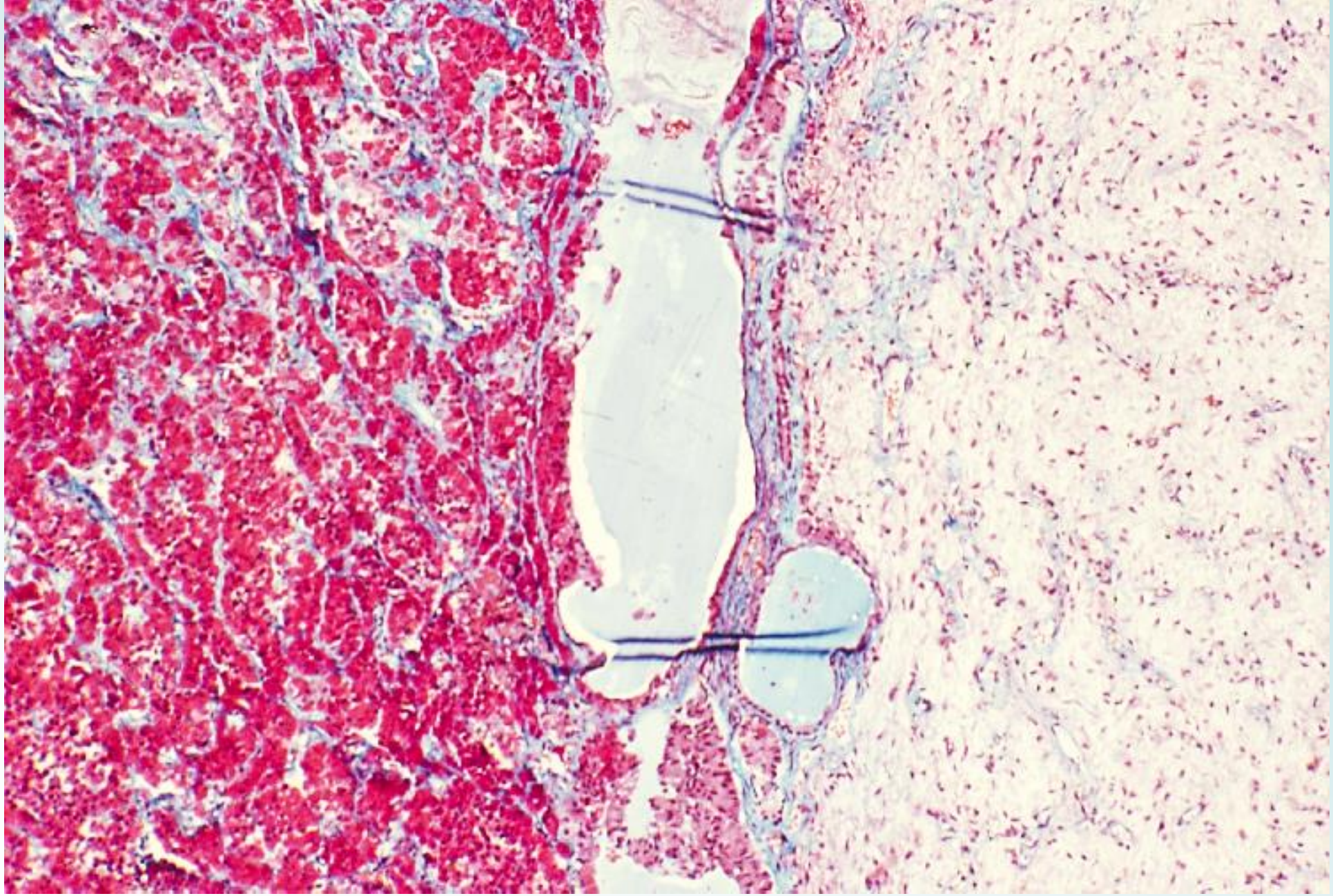

18-04 Hypophysis, anterior lobe 1. Human, H-E stain, x 64.



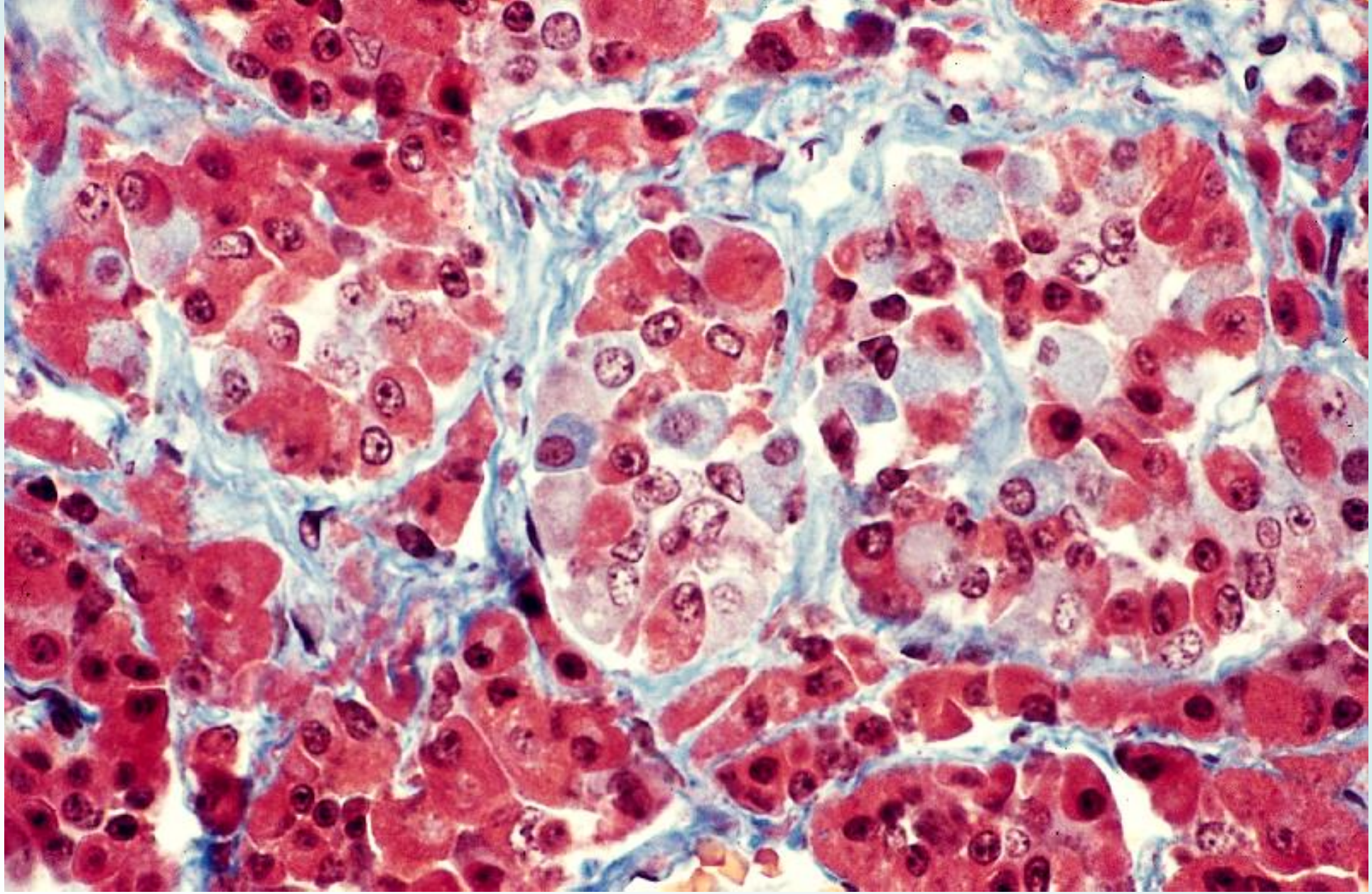

18-05 Hypophysis, anterior lobe 2. Human, H-E stain, x 160.



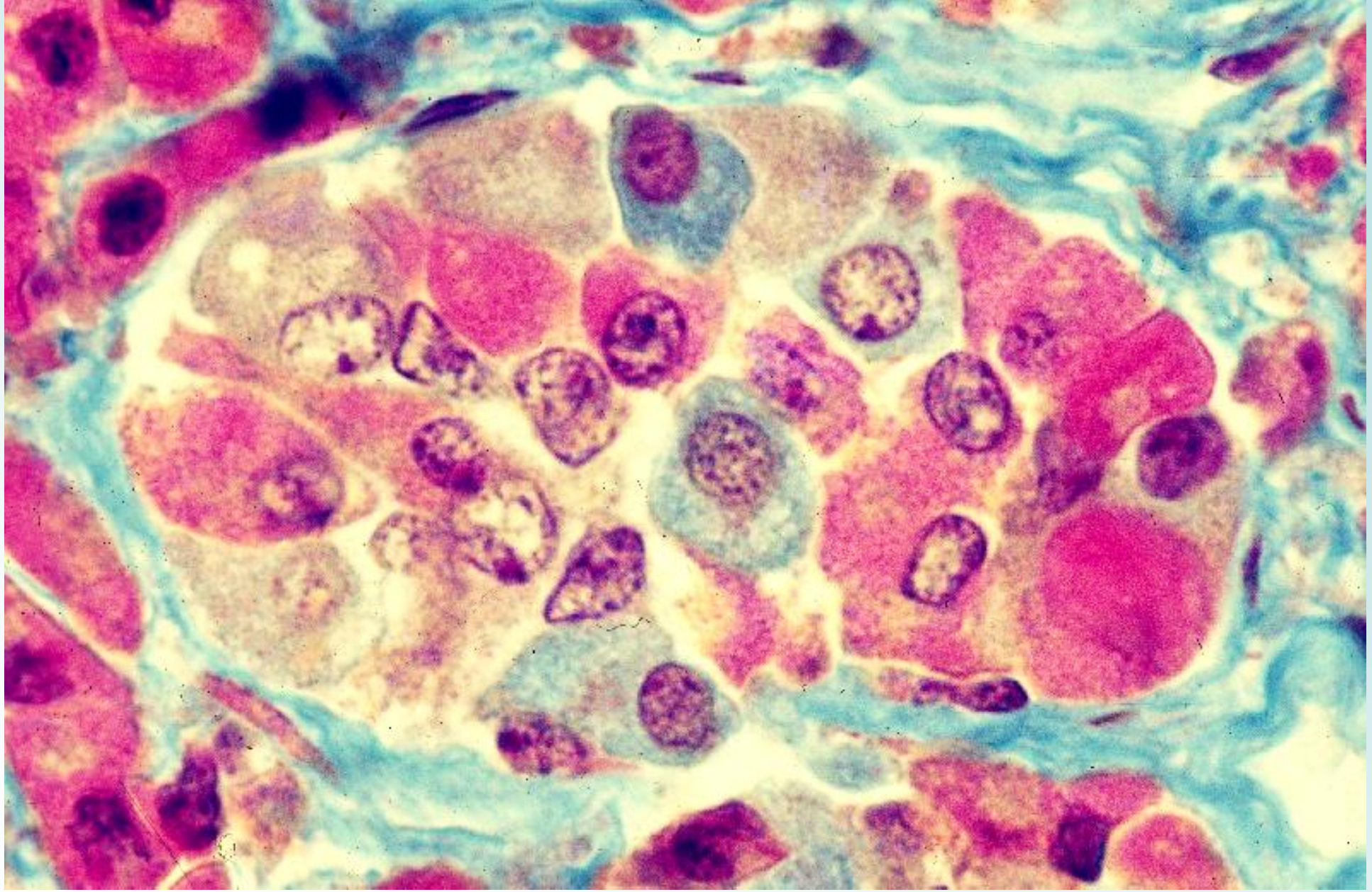
18-06 Hypophysis, anterior lobe 3. Human, H-E stain, x 400.



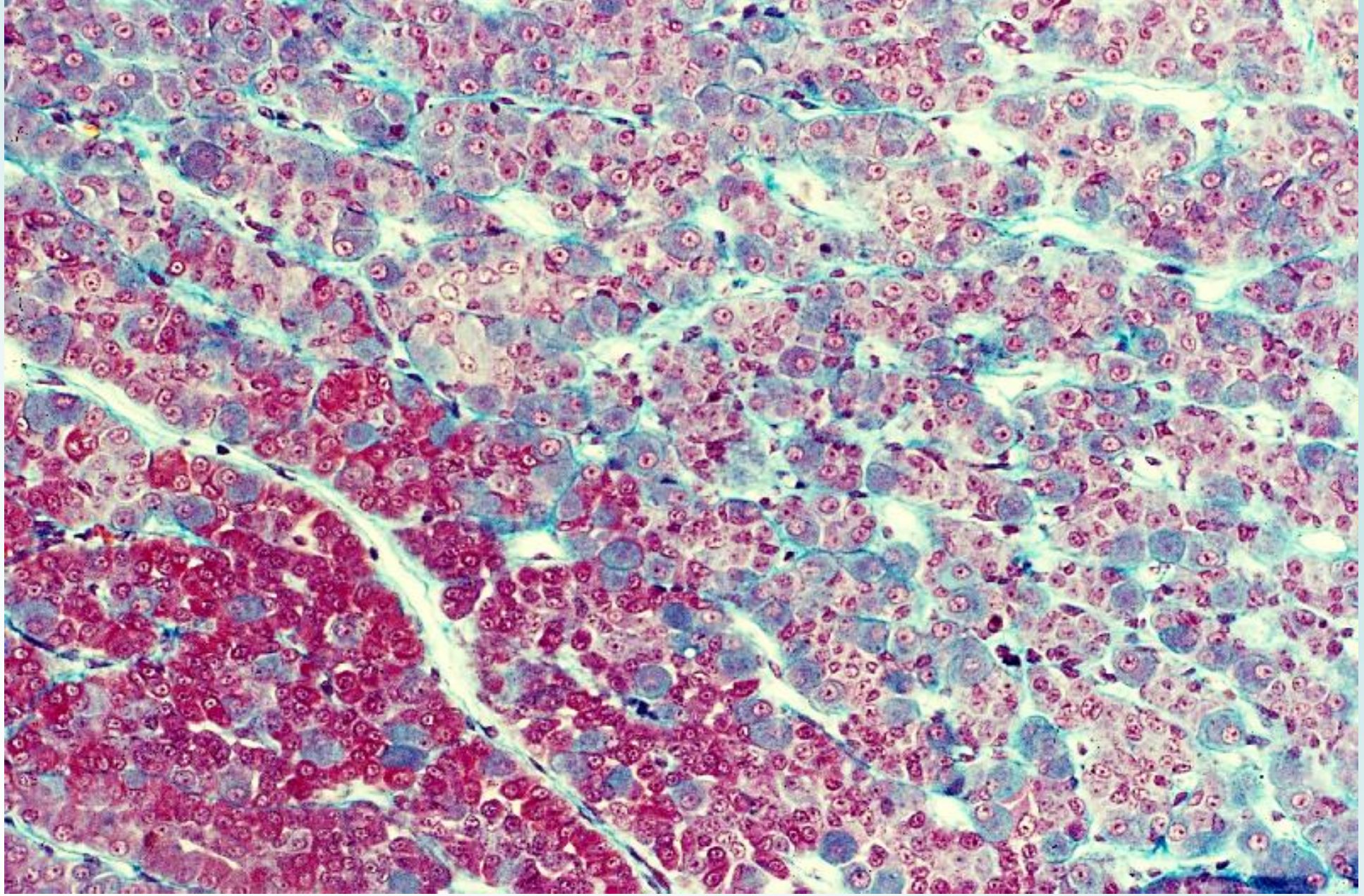
18-07 Hypophysis. Anterior lobe, pars intermedia, and posterior lobes. Human, Masson stain, x 25.



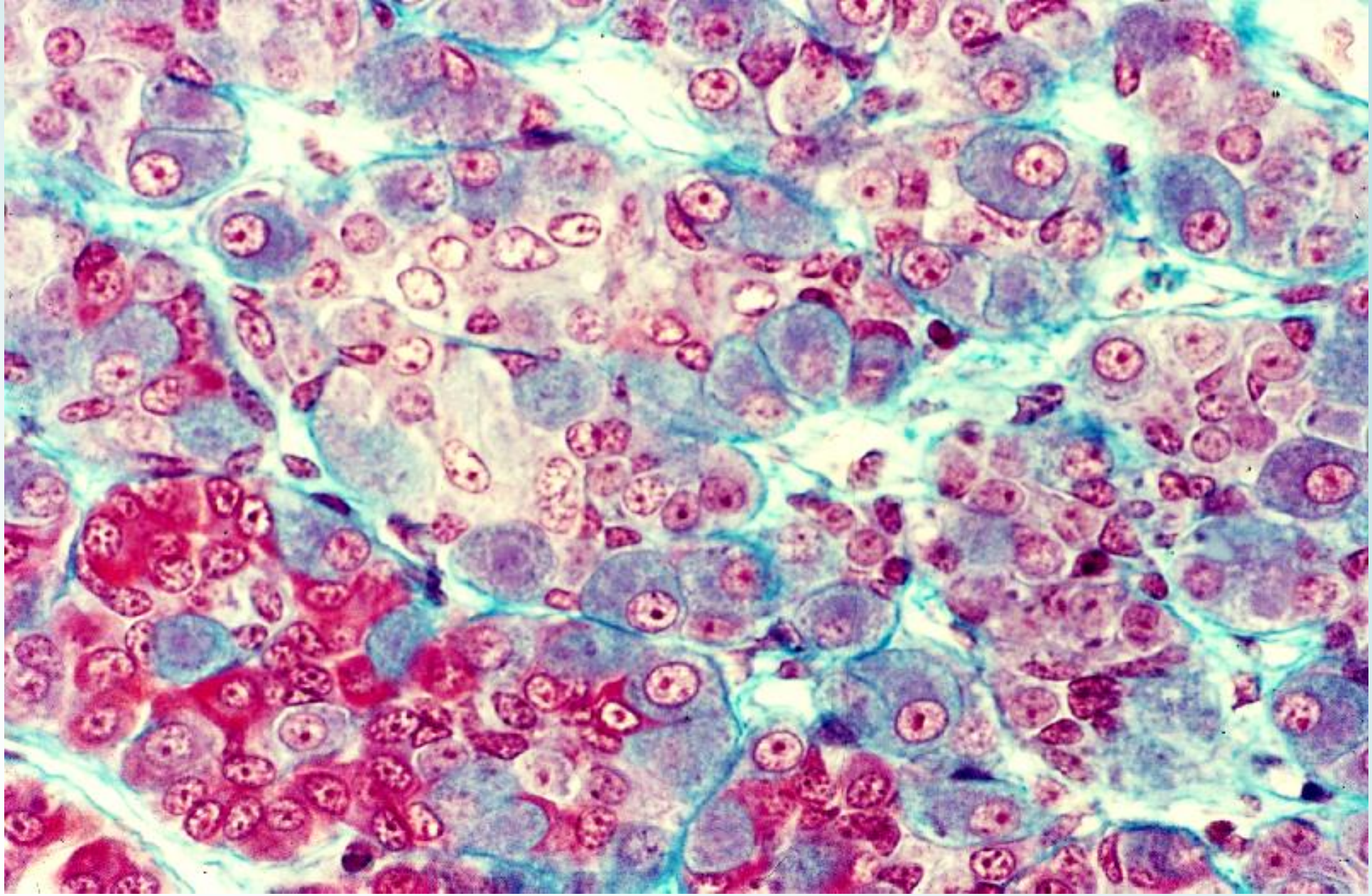
18-08 Hypophysis, anterior lobe 4. Human, Masson stain, x 160.



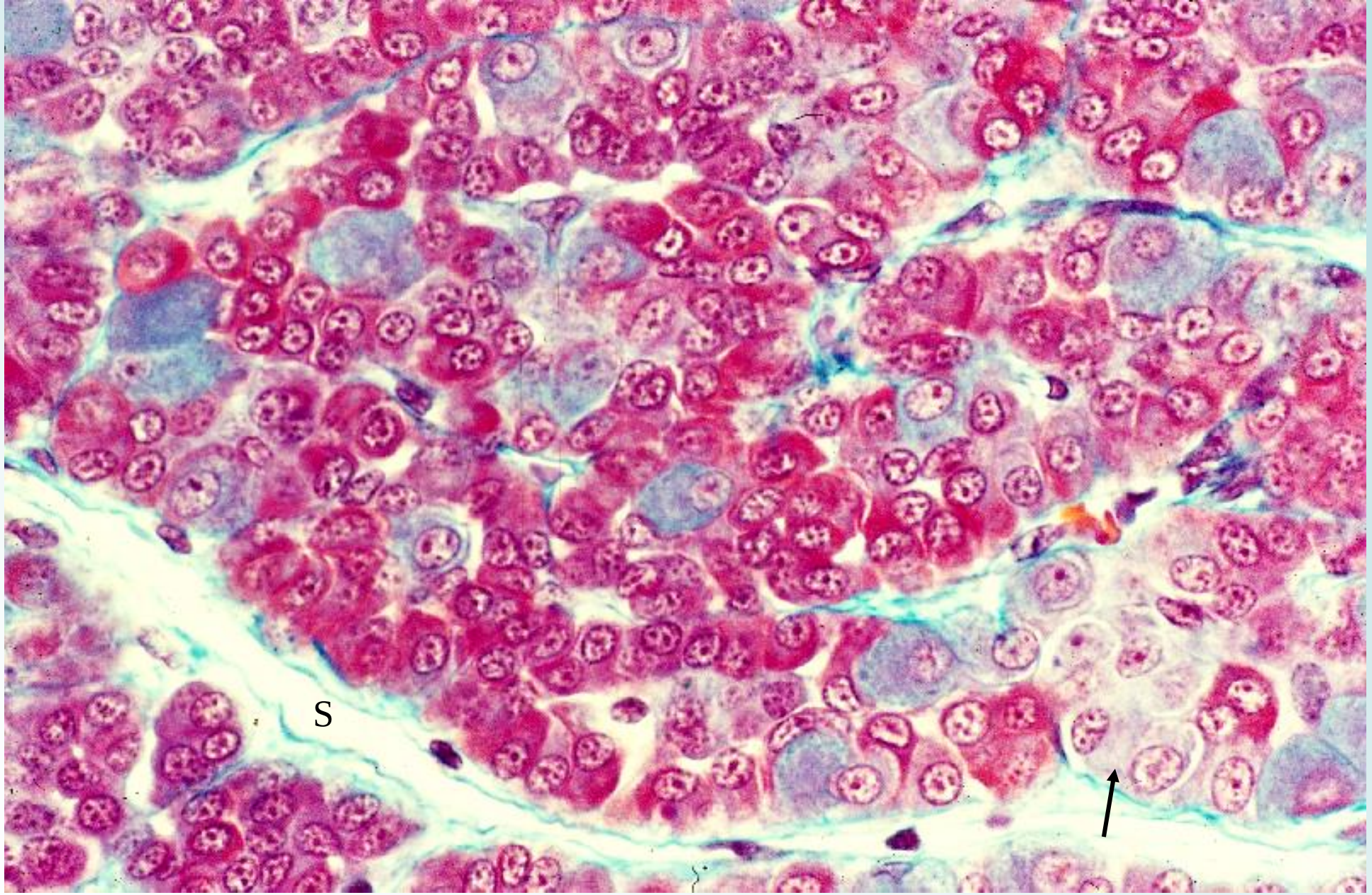
18-09 Hypophysis, anterior lobe 5. Human, Masson stain, x 400.



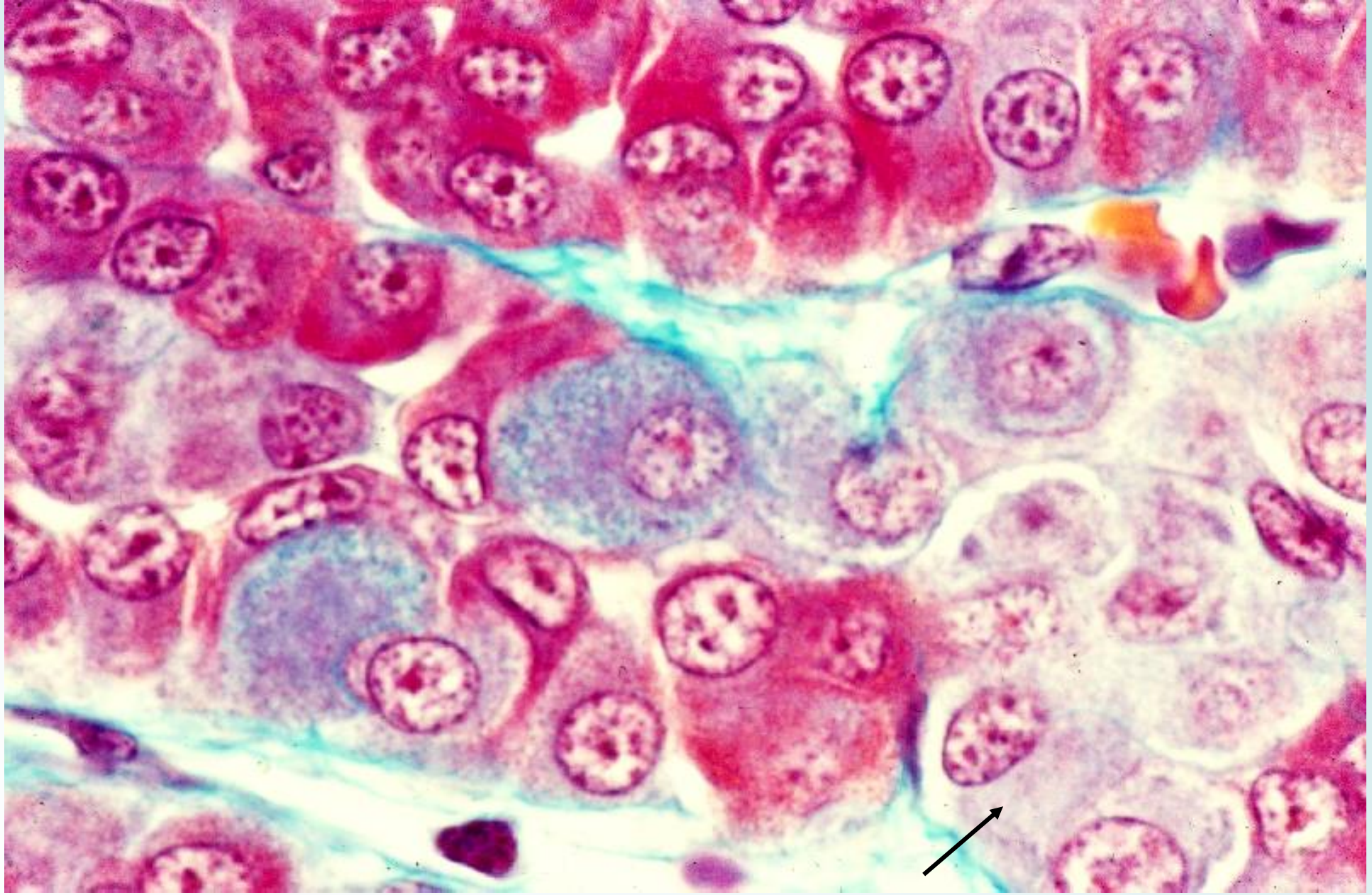
18-10 Hypophysis, anterior lobe 6. Monkey, M-G stain, x 64.



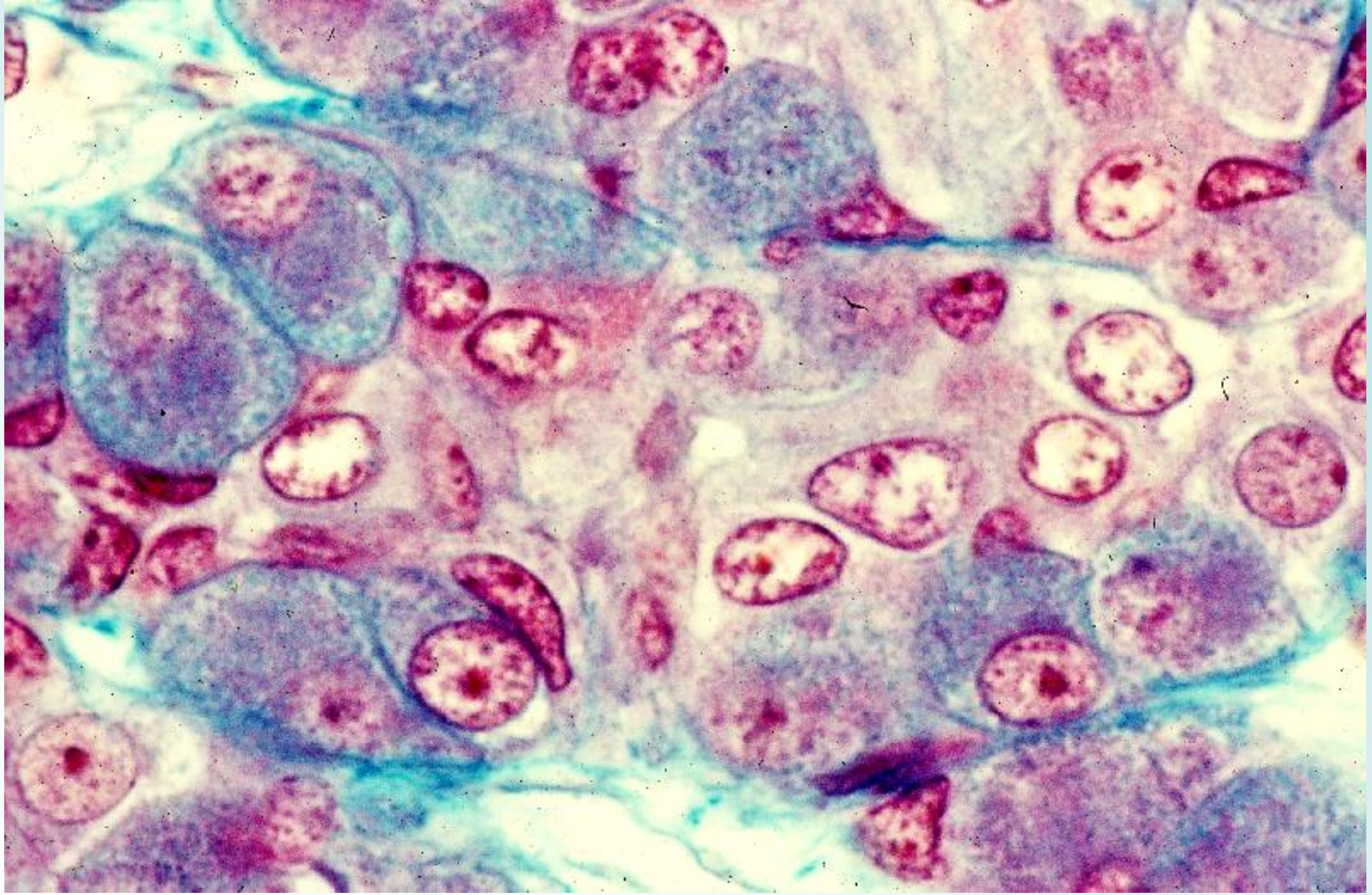
18-11 Hypophysis, anterior lobe 7. Monkey, M-G stain, x 160.



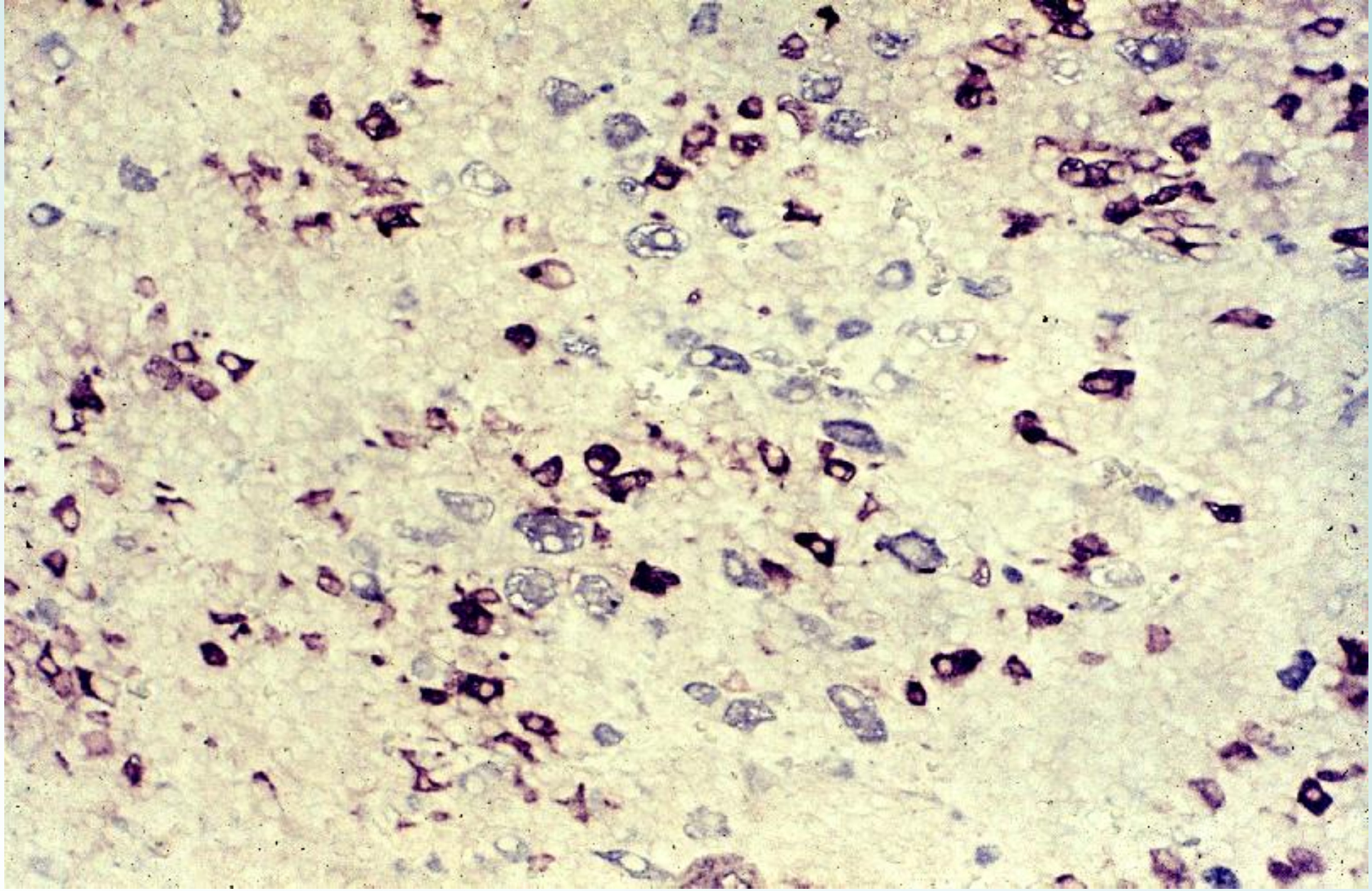

18-12 Hypophysis, anterior lobe 8. Monkey, M-G stain, x 160.



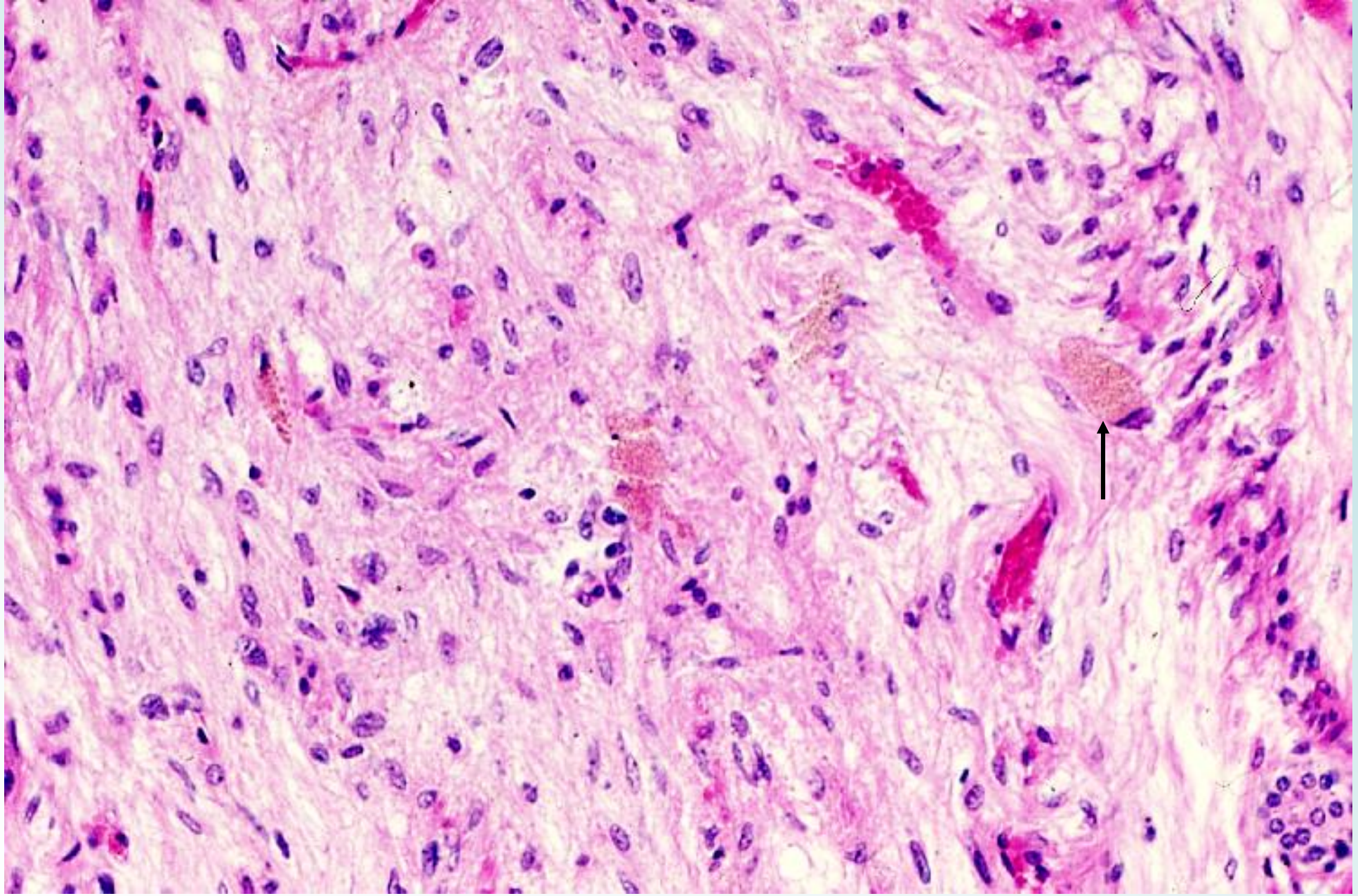
18-13 Hypophysis, anterior lobe 9. Monkey, M-G stain, x 400.



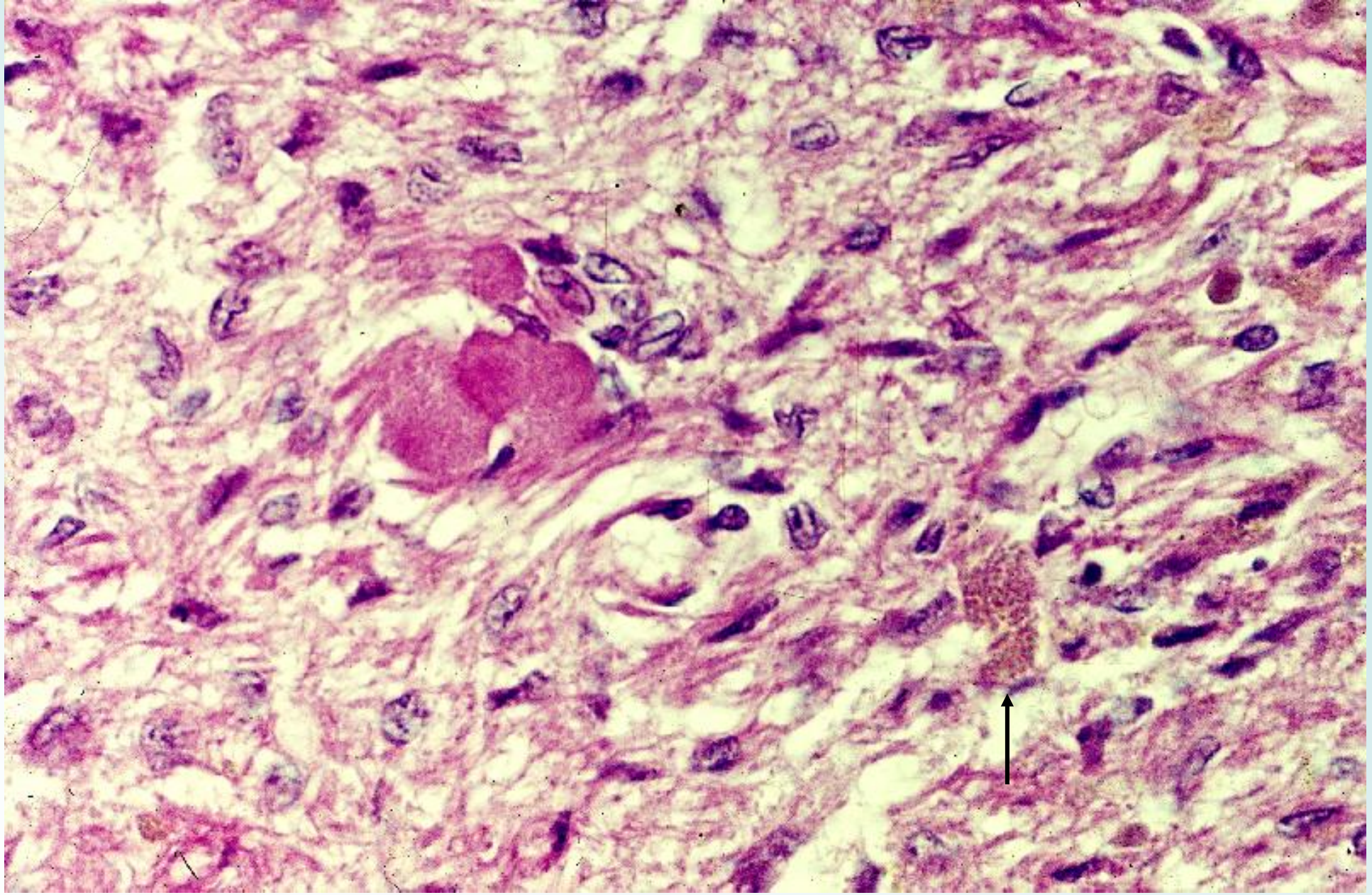
18-14 Hypophysis, anterior lobe 10. Monkey, M-G stain, x 400.



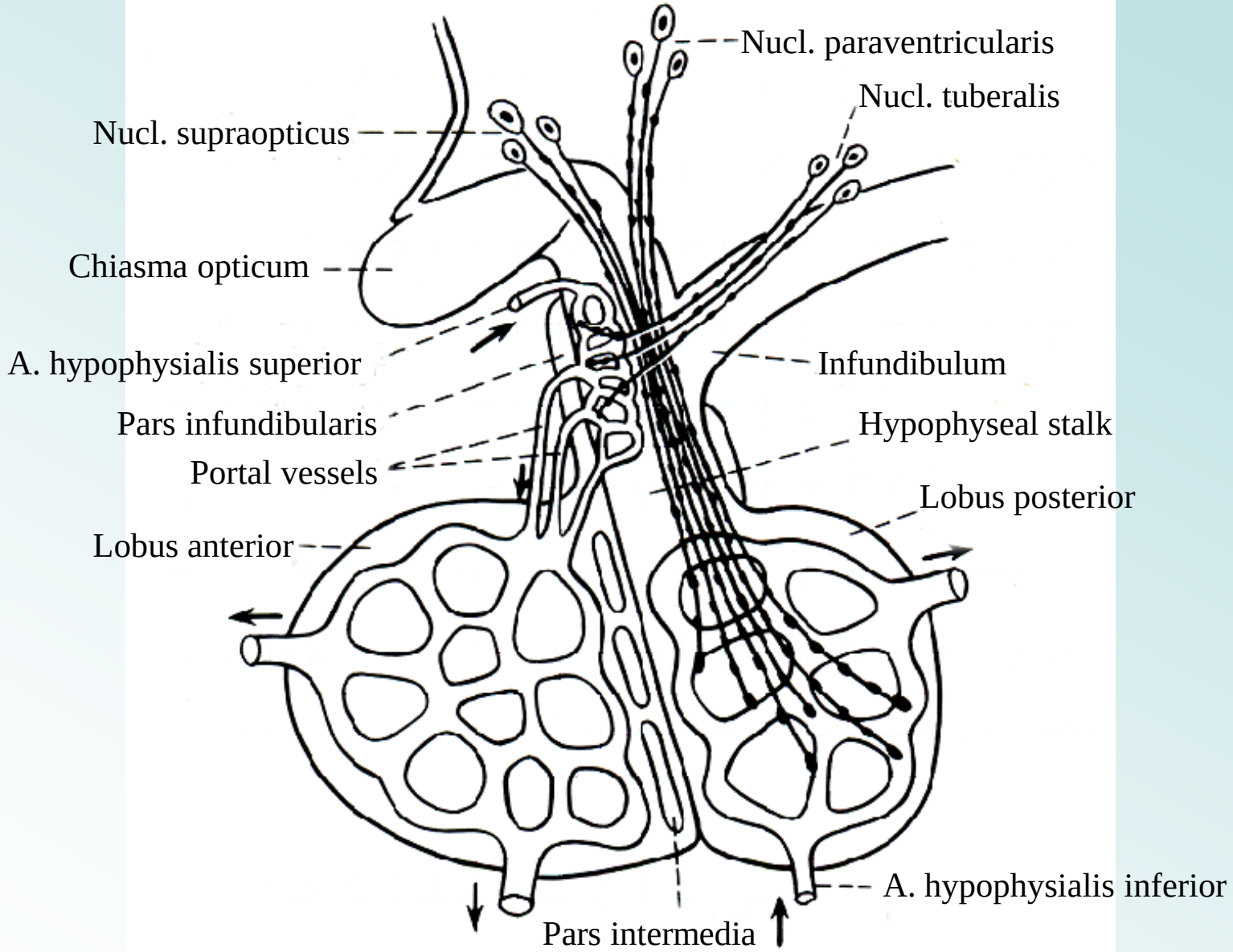
18-15 Hypophysis, anterior lobe 11. Rat, enzyme-antigen method, x 64.



18-16 Hypophysis, posterior lobe 1. Human, H-E stain, x 64.

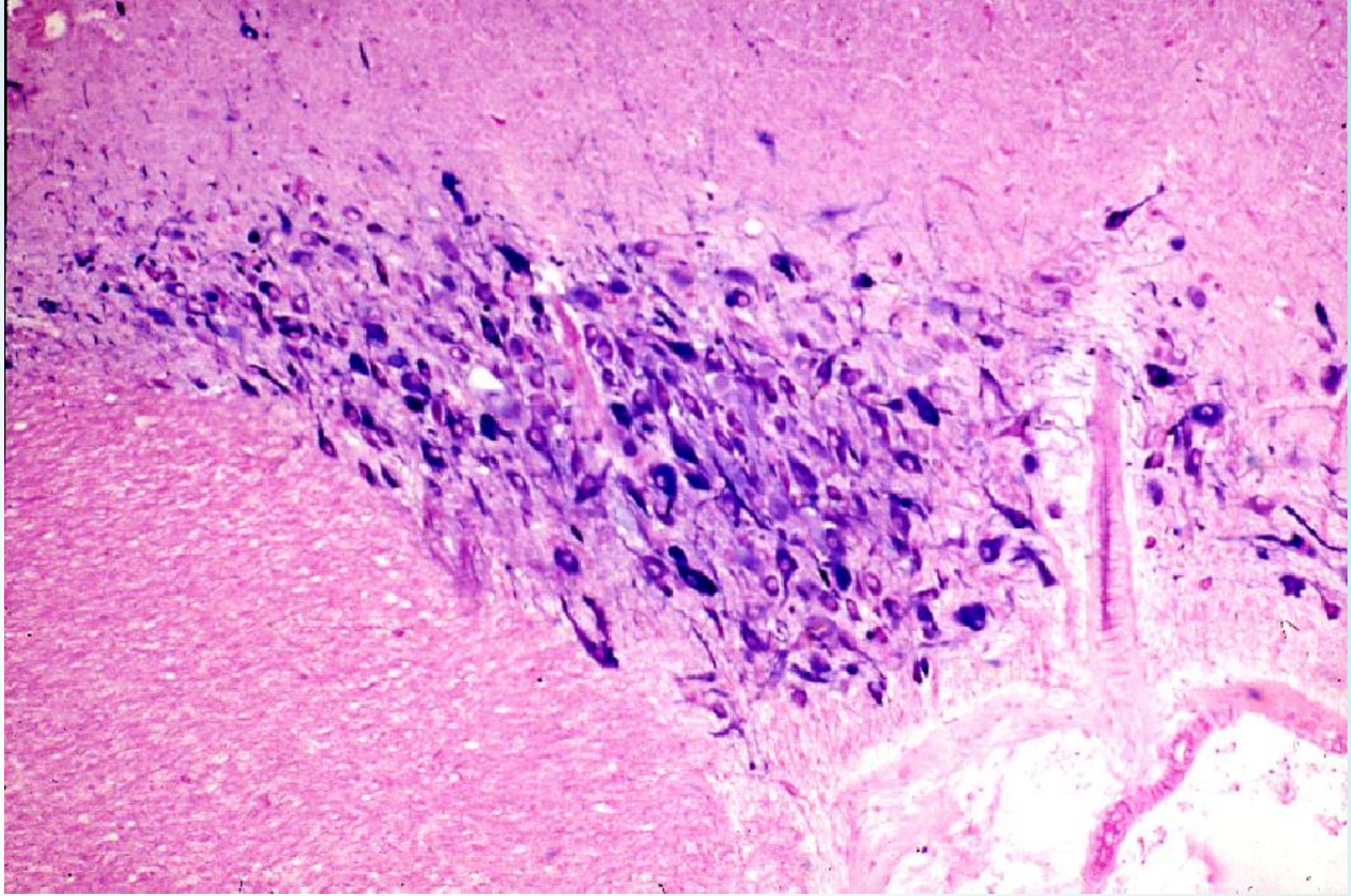


18-17 Hypophysis, posterior lobe 2. Human, H-E stain, x 160.

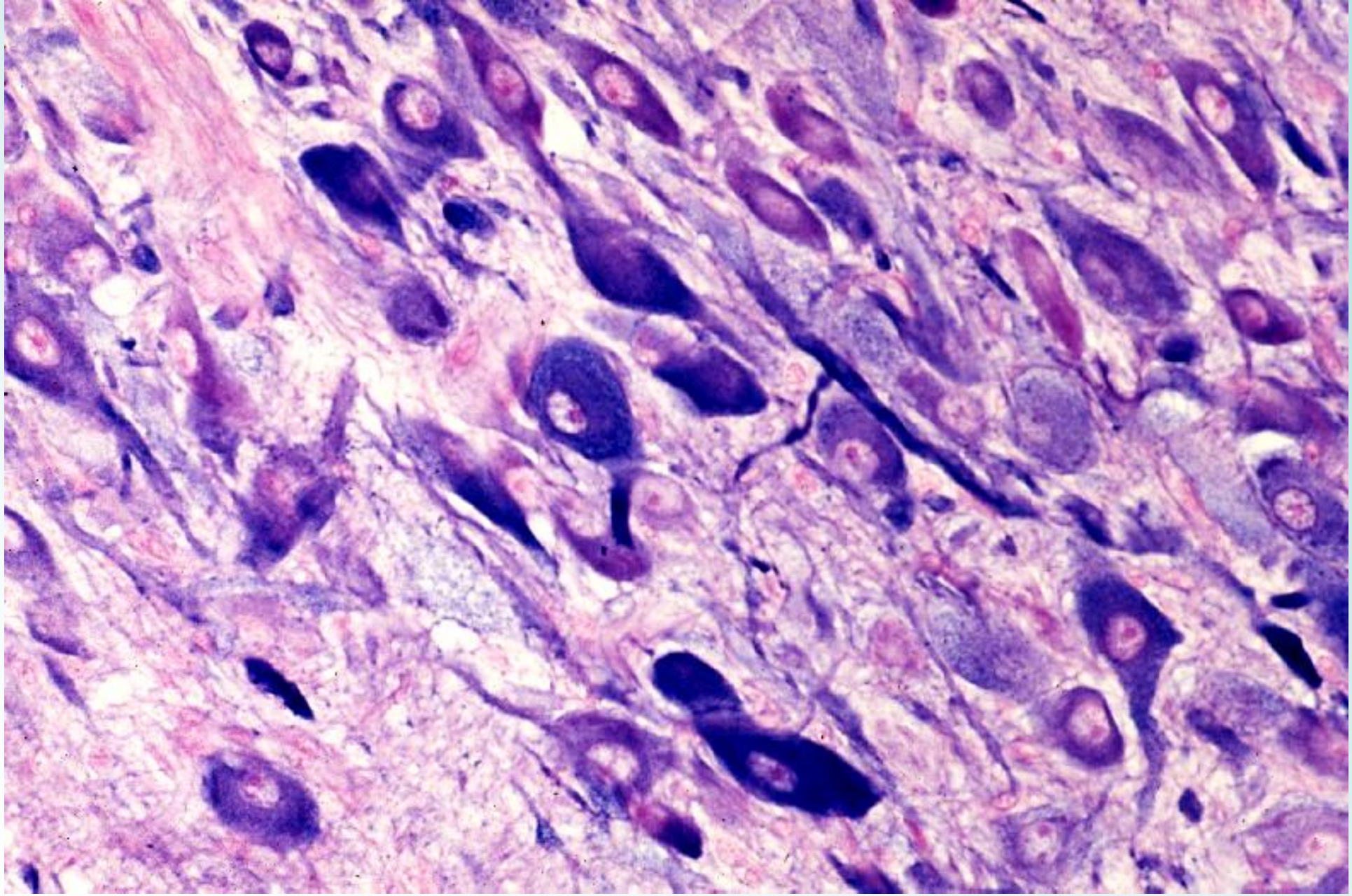



## 18-18 Hypophysis. Vascular system and neurosecretion. Scheme.

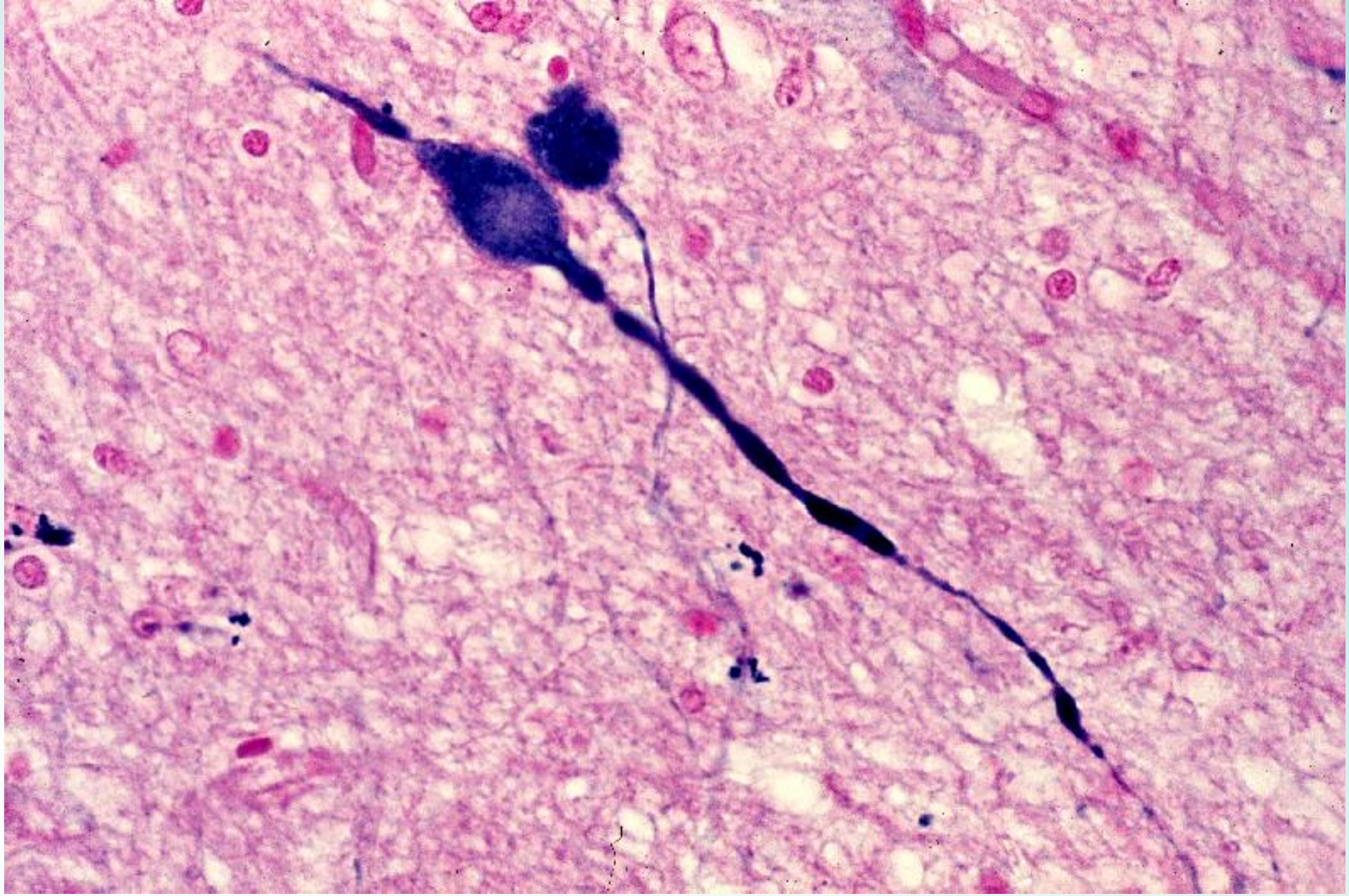

18-19 Hypothalamus, nucleus supraopticus 1. Dog, Bargmann's stain, x 2.6.



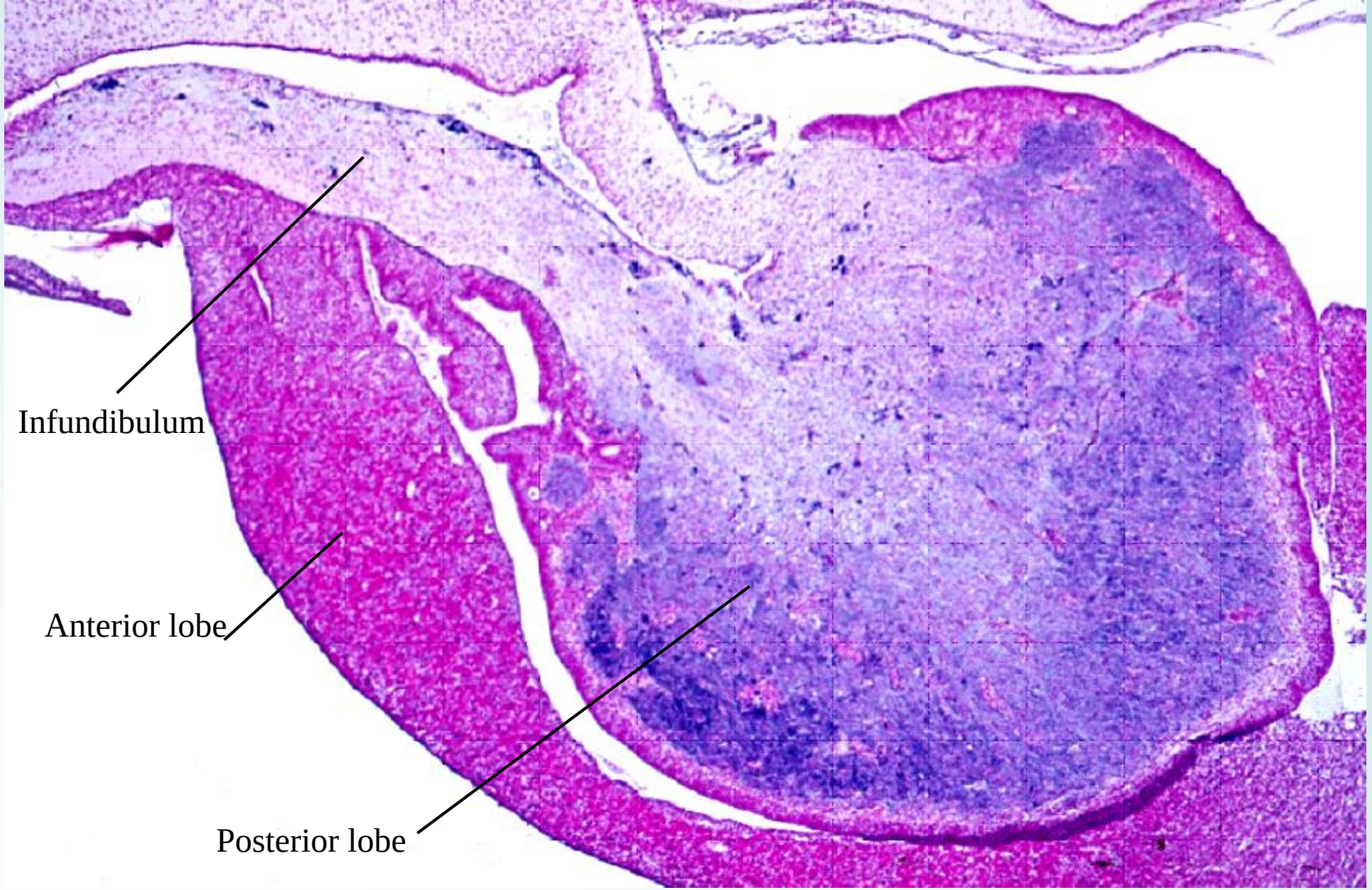
18-20 Hypothalamus, nucleus supraopticus 2. Dog, Bargmann's stain, x 25.



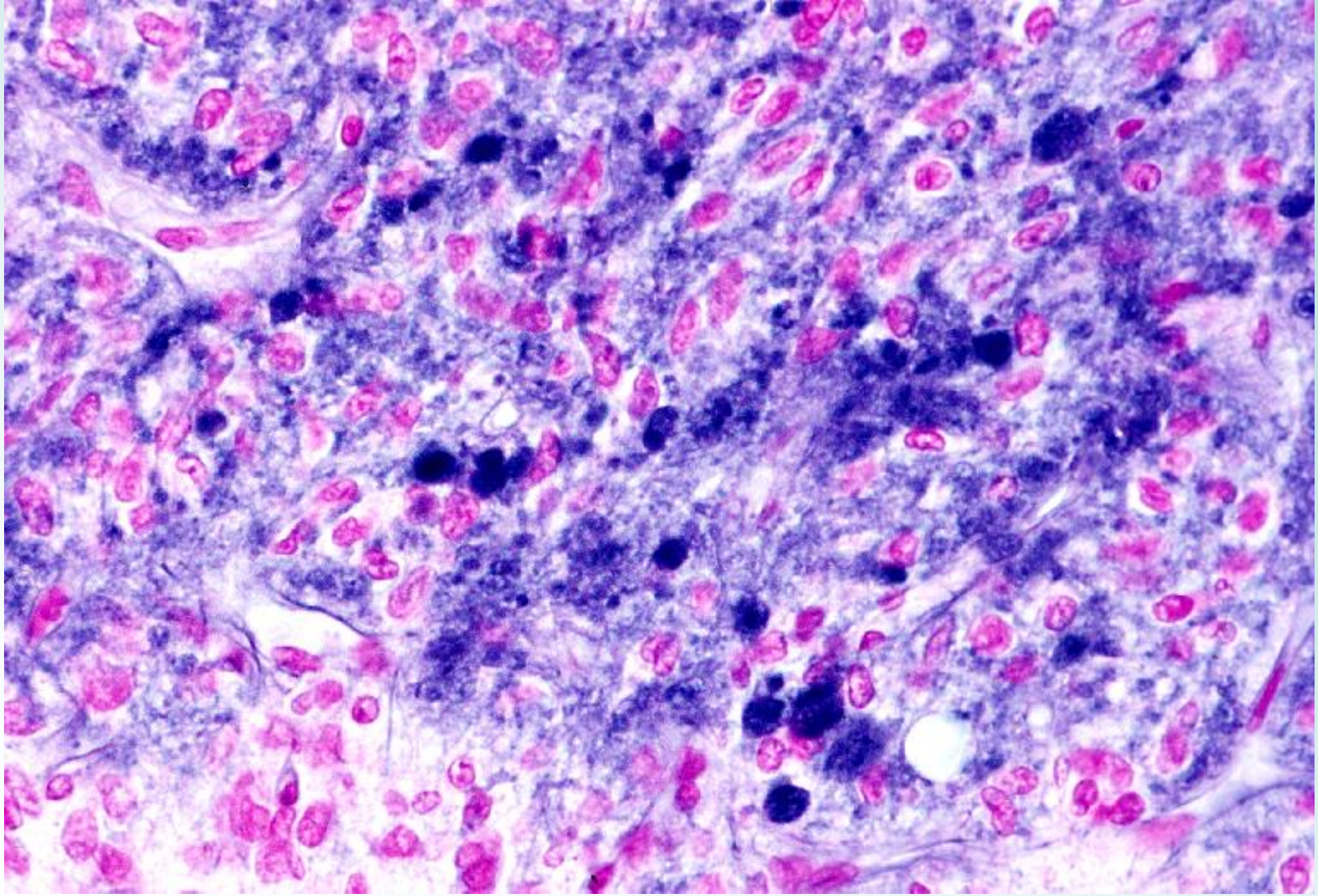
18-21 Hypothalamus, nucleus supraopticus 3. Dog, Bargmann's stain, x 100.



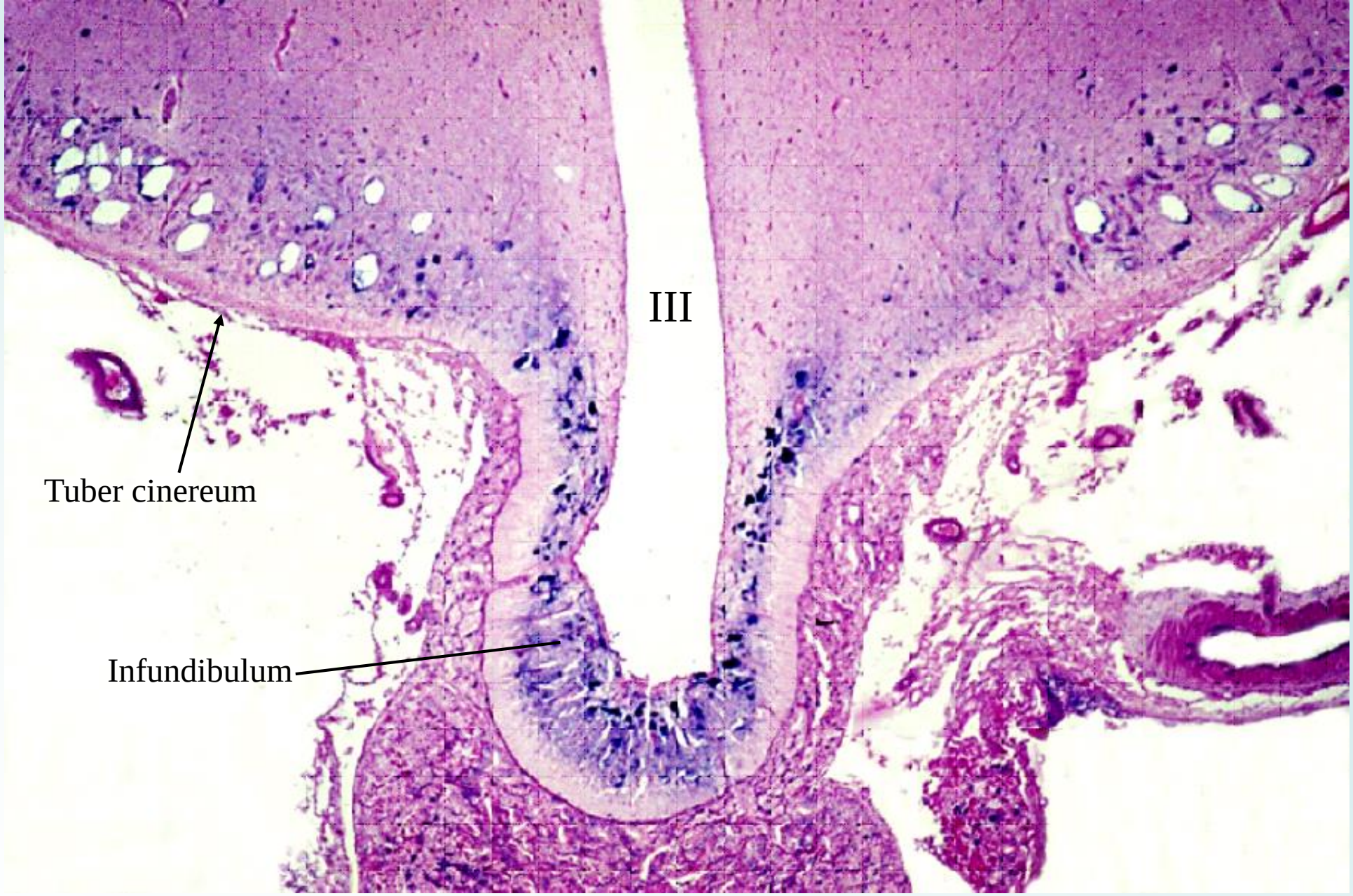
18-22 Hypothalamus. Neurosecretory cells. Dog, Bargmann's stain, x 160.




18-23 Hypophysis. Infundibulum and posterior lobe. Dog, Bargmann's stain, x 10.



18-24 Hypophysis. Posterior lobe. Dog, Bargmann's stain, x 160.

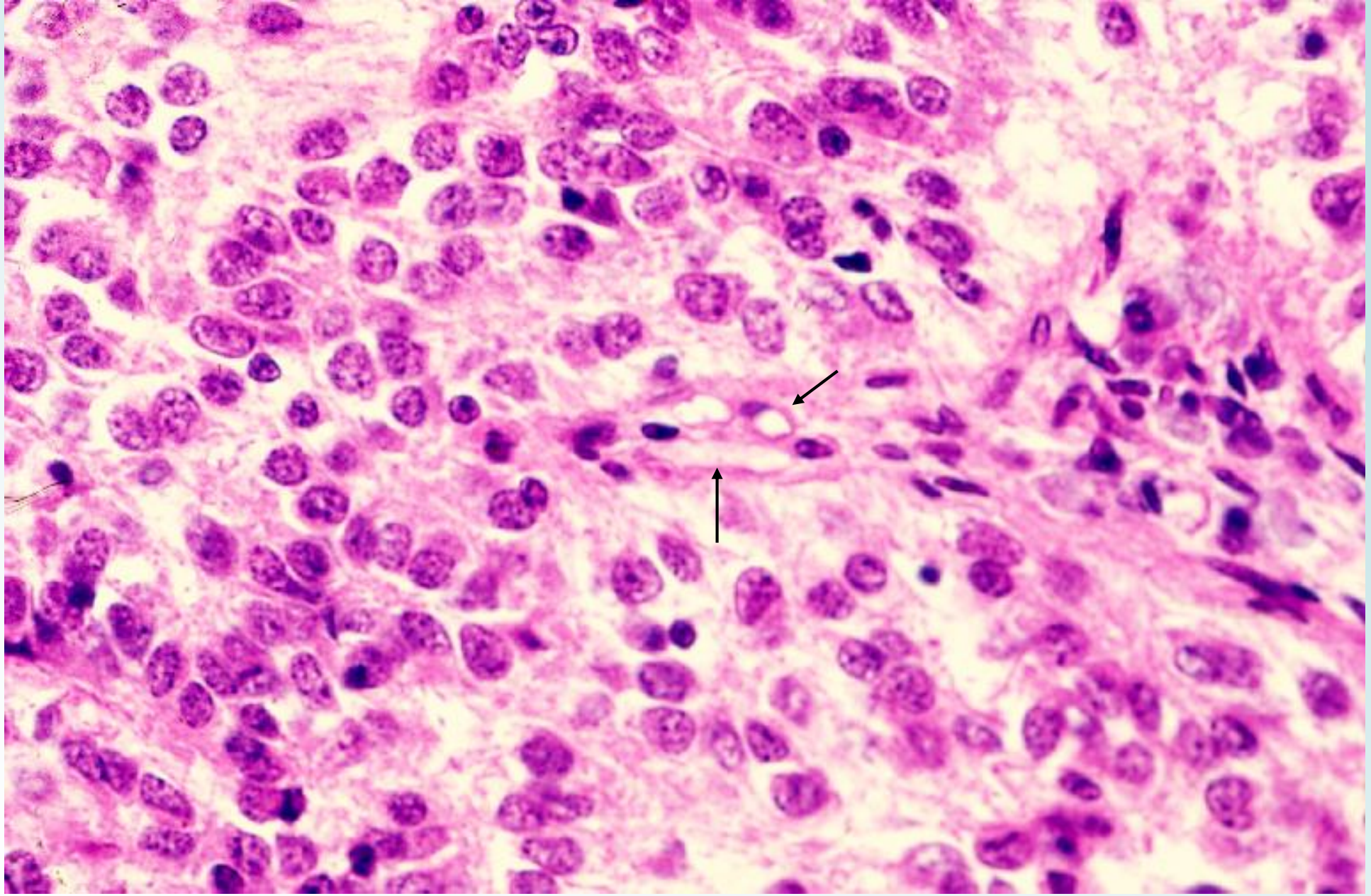



18-25 Hypothalamus and infundibulum. Dog, Bargmann's stain, x10.

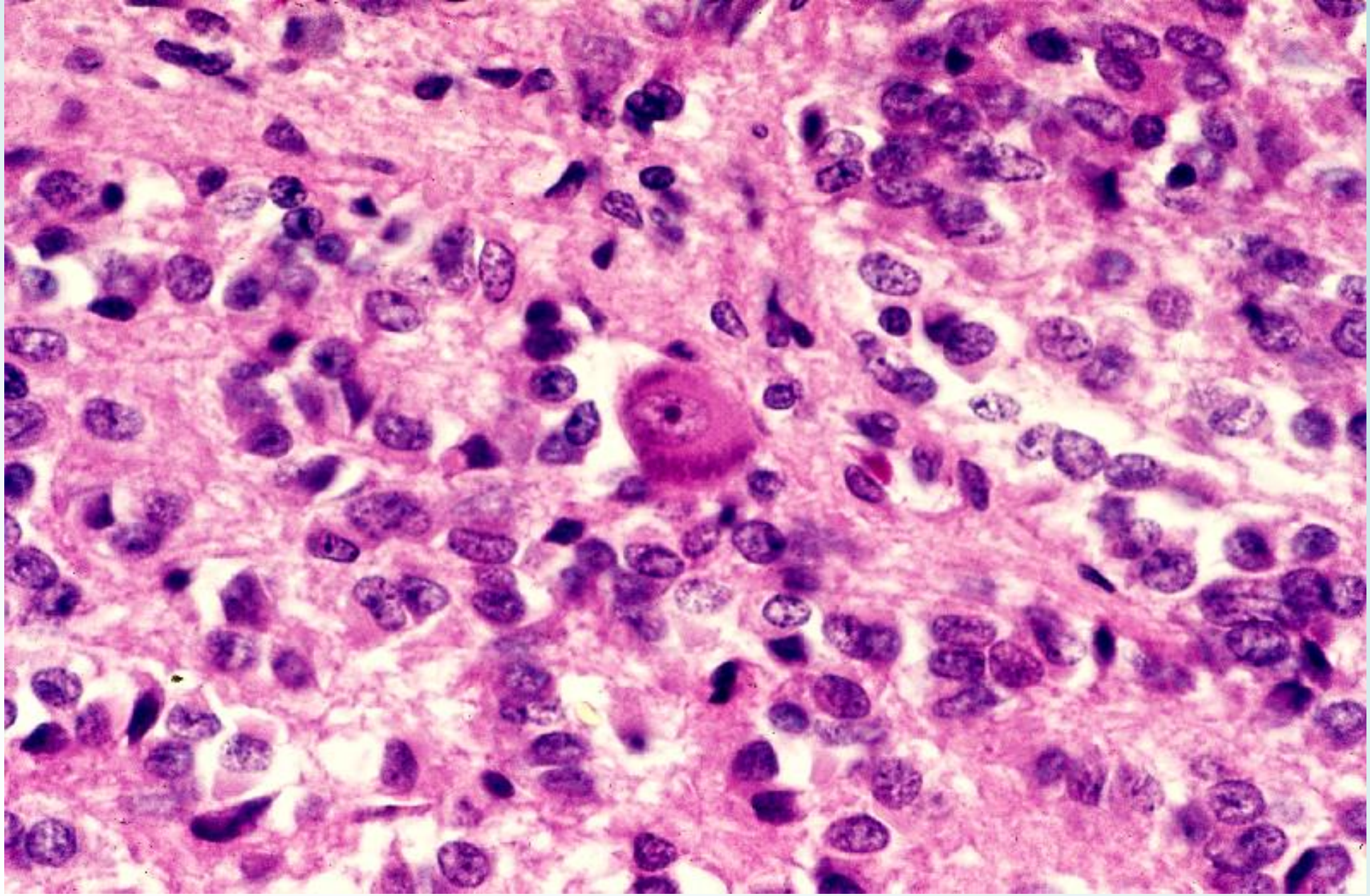
# 18-002
# Pineal Body


❇ : Commissura habenularum

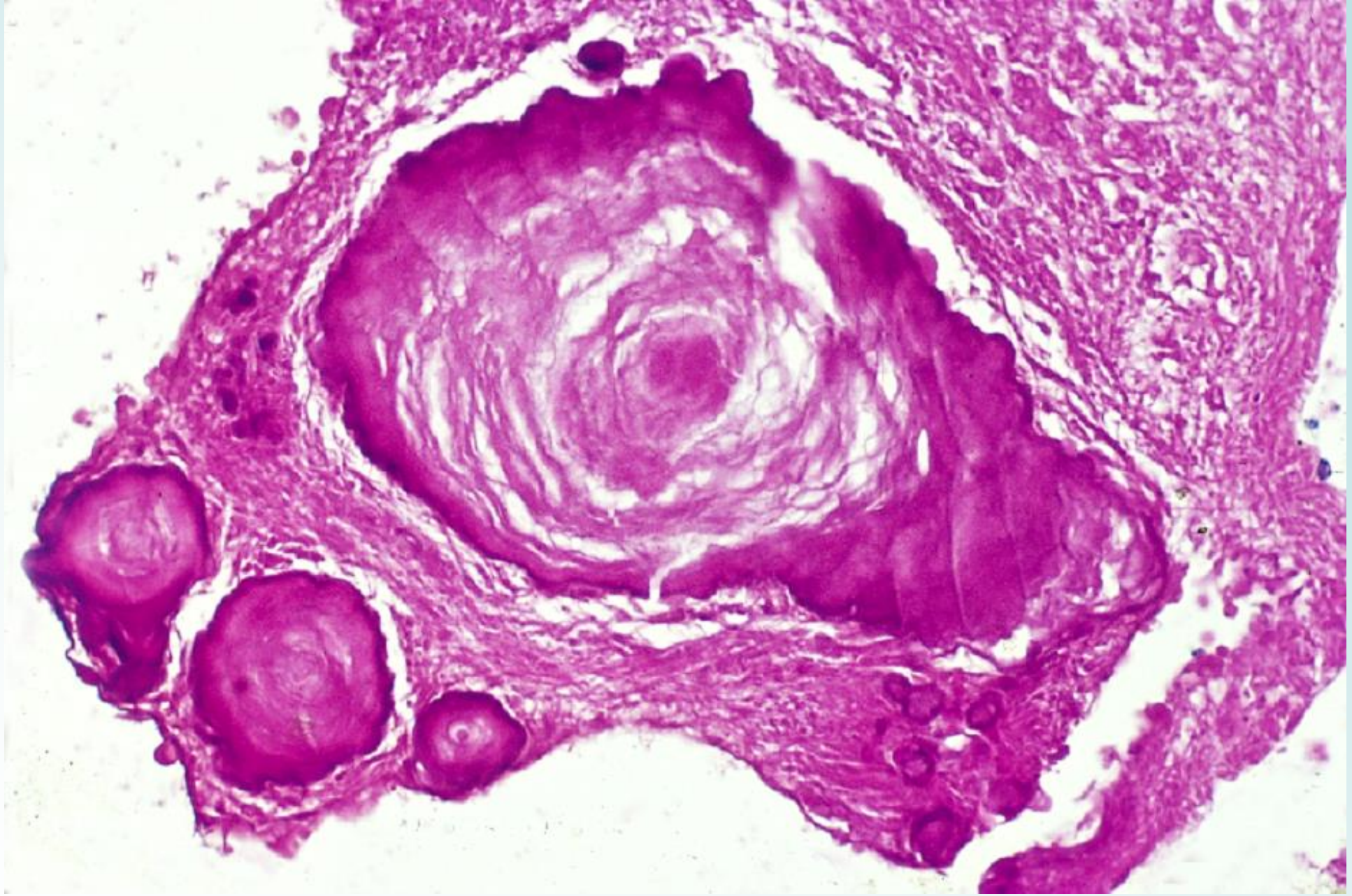
**18-26 Pineal body, sagittal section. Human, H-E stain, x 6.4.**



18-27 Pineal body. Pineal cells. Human, H-E stain, x 160.

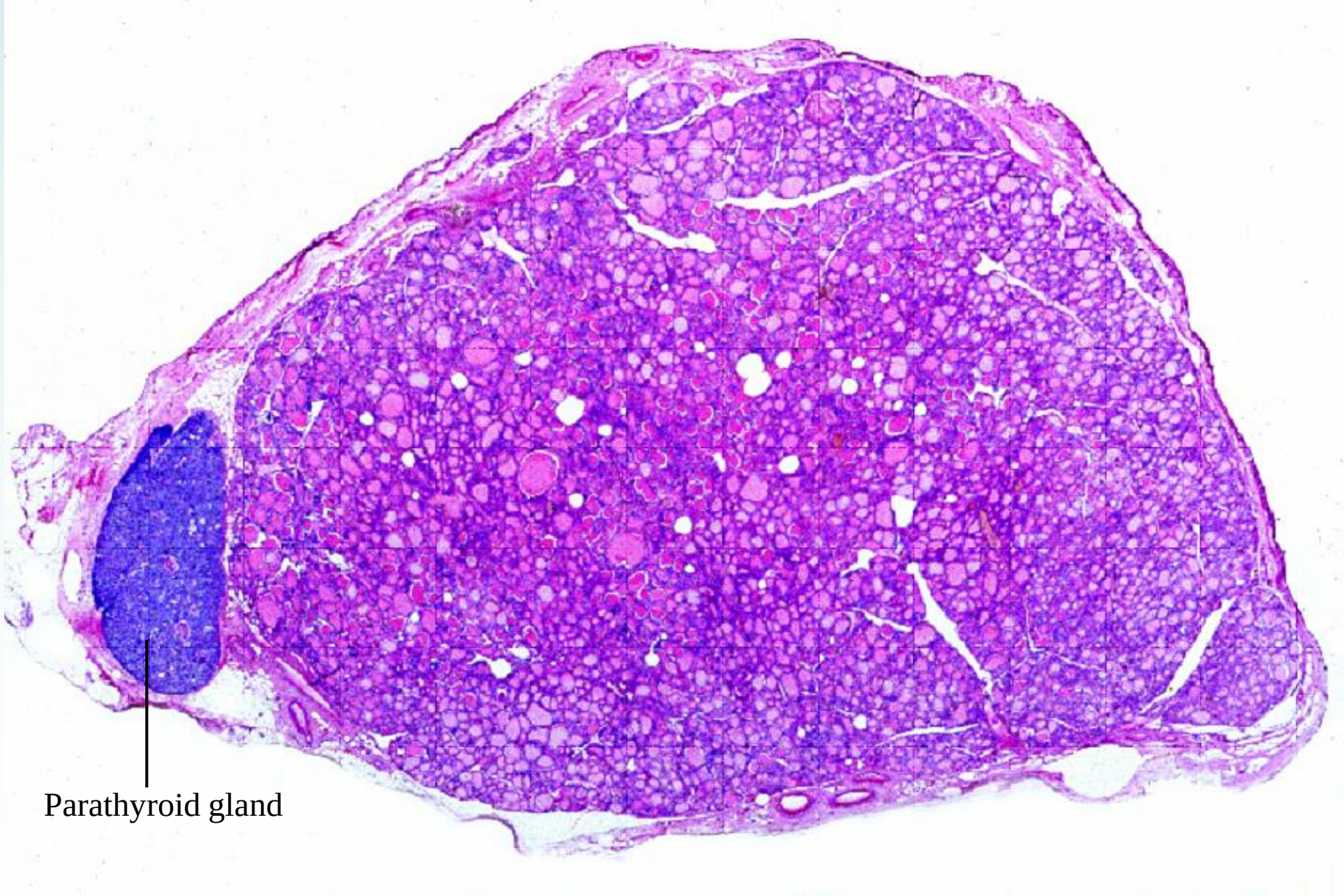


18-28 Pineal body. Pineal cells and a neuron. Human, H-E stain, x 160.

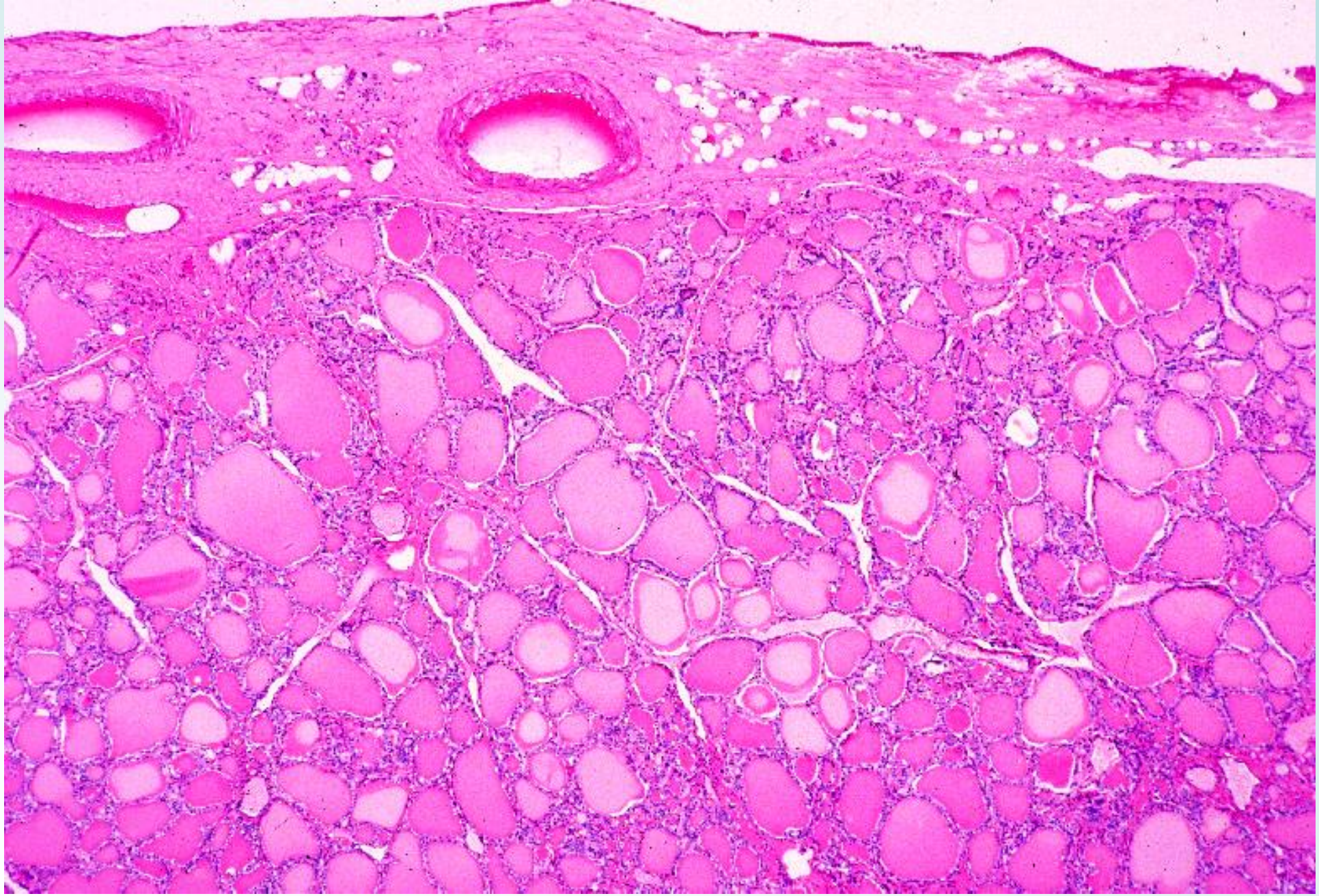


18-29 Pineal body. Acervulus. Human, H-E stain, x 64.

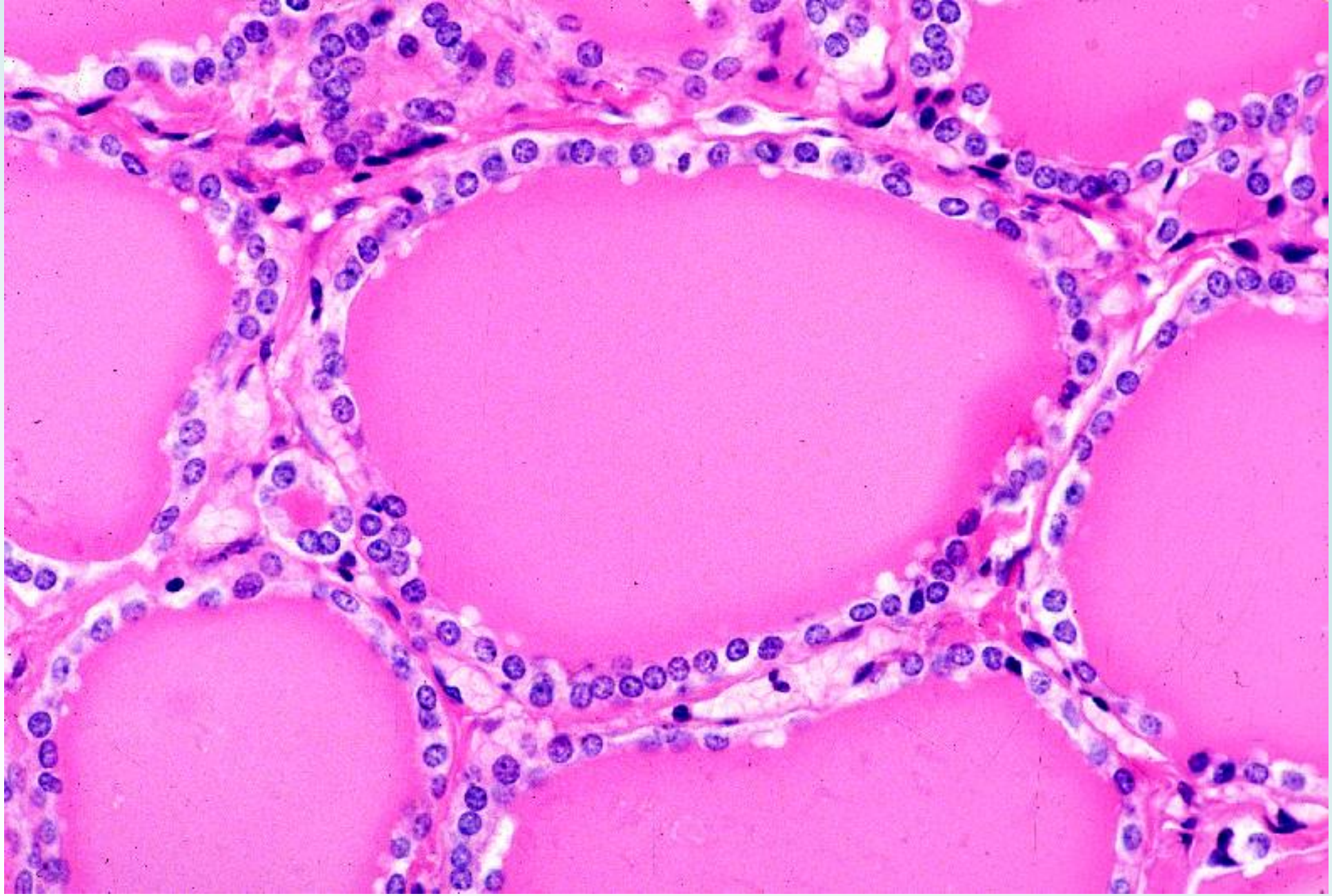
# 18-003
# Thyroid Gland



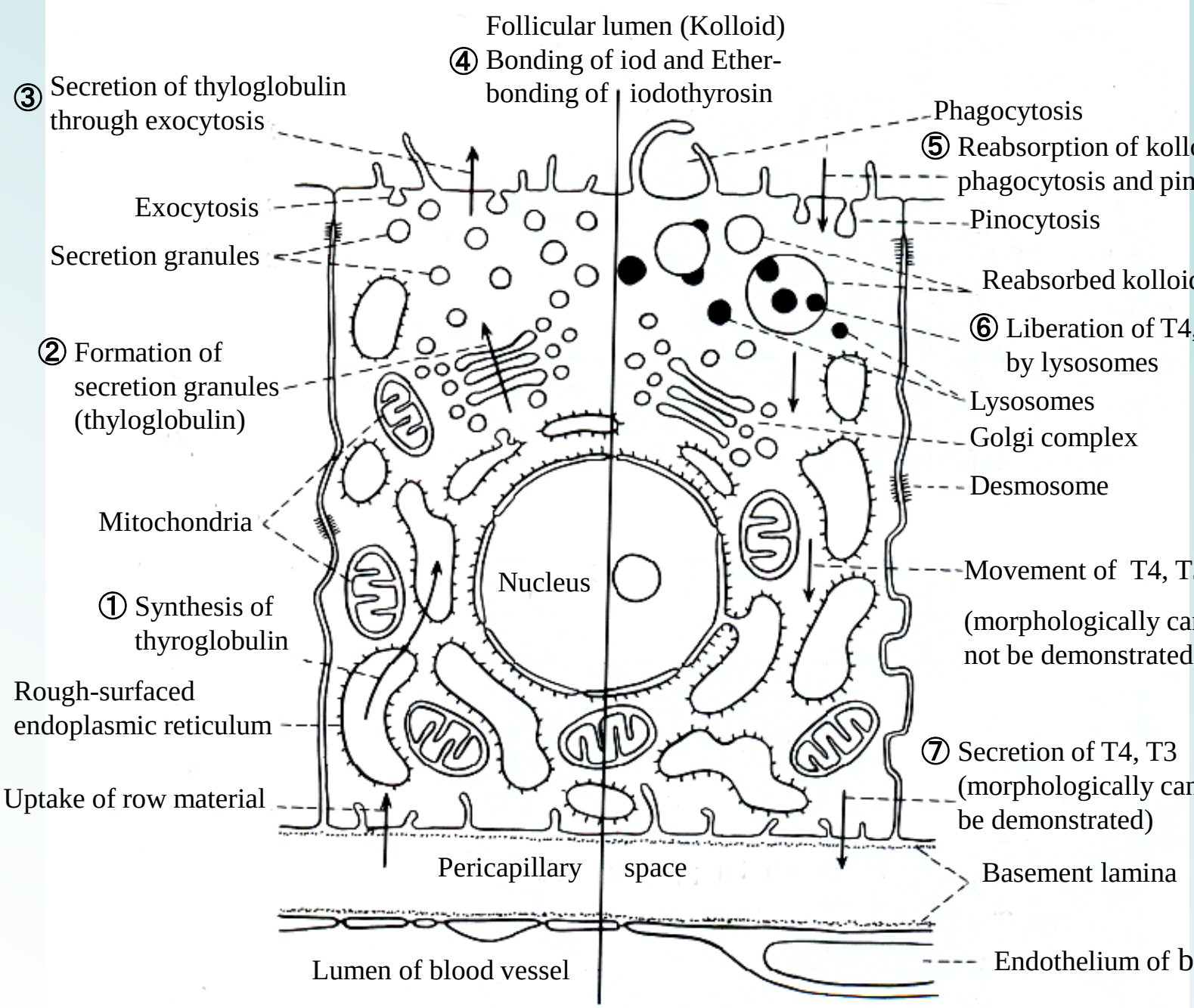

18-30 Thyroid gland and parathyroid gland. Human, H-E stain, x 1.5.



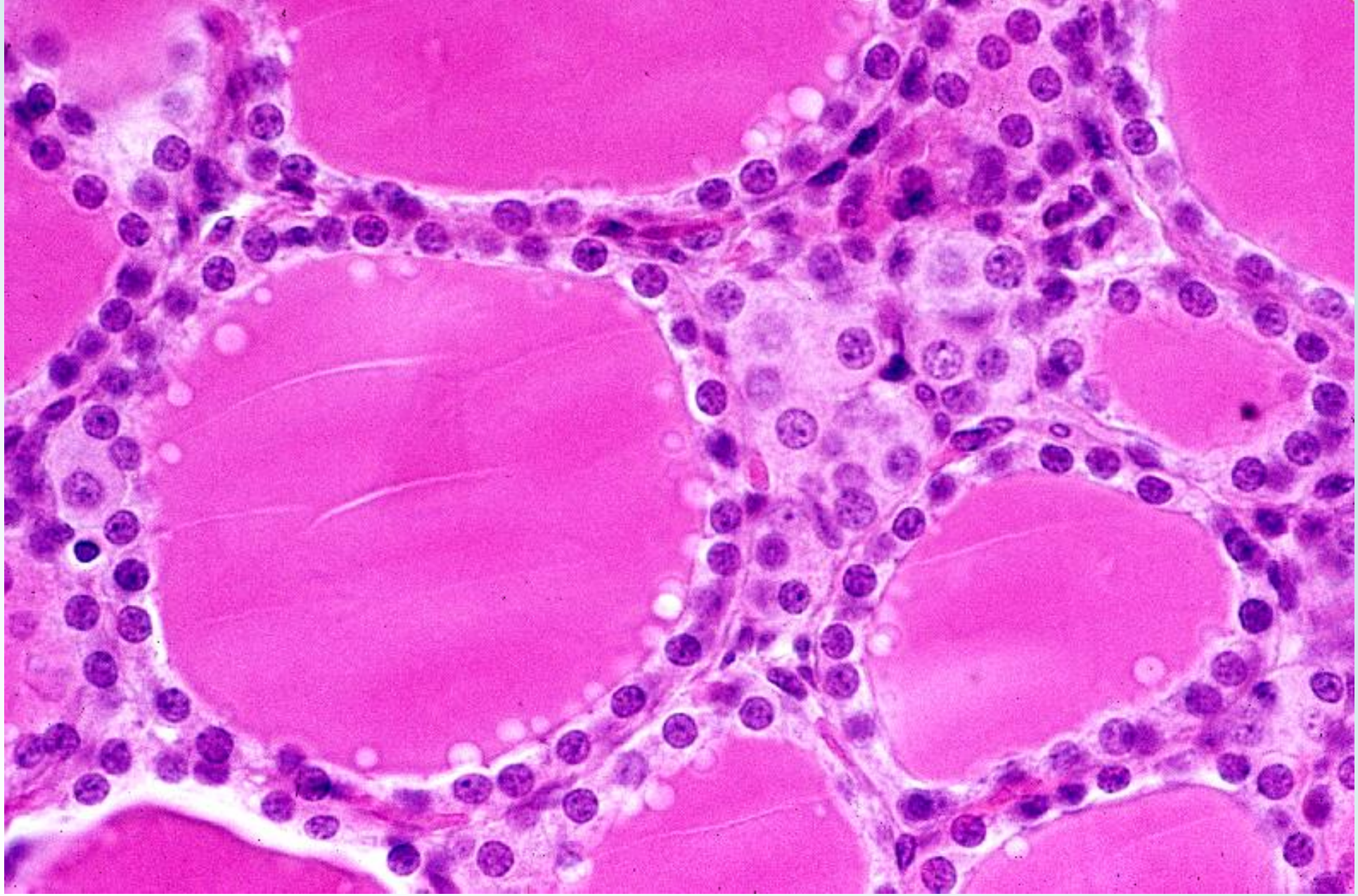
18-31 Thyroid gland. Human, H-E stain, x 10.



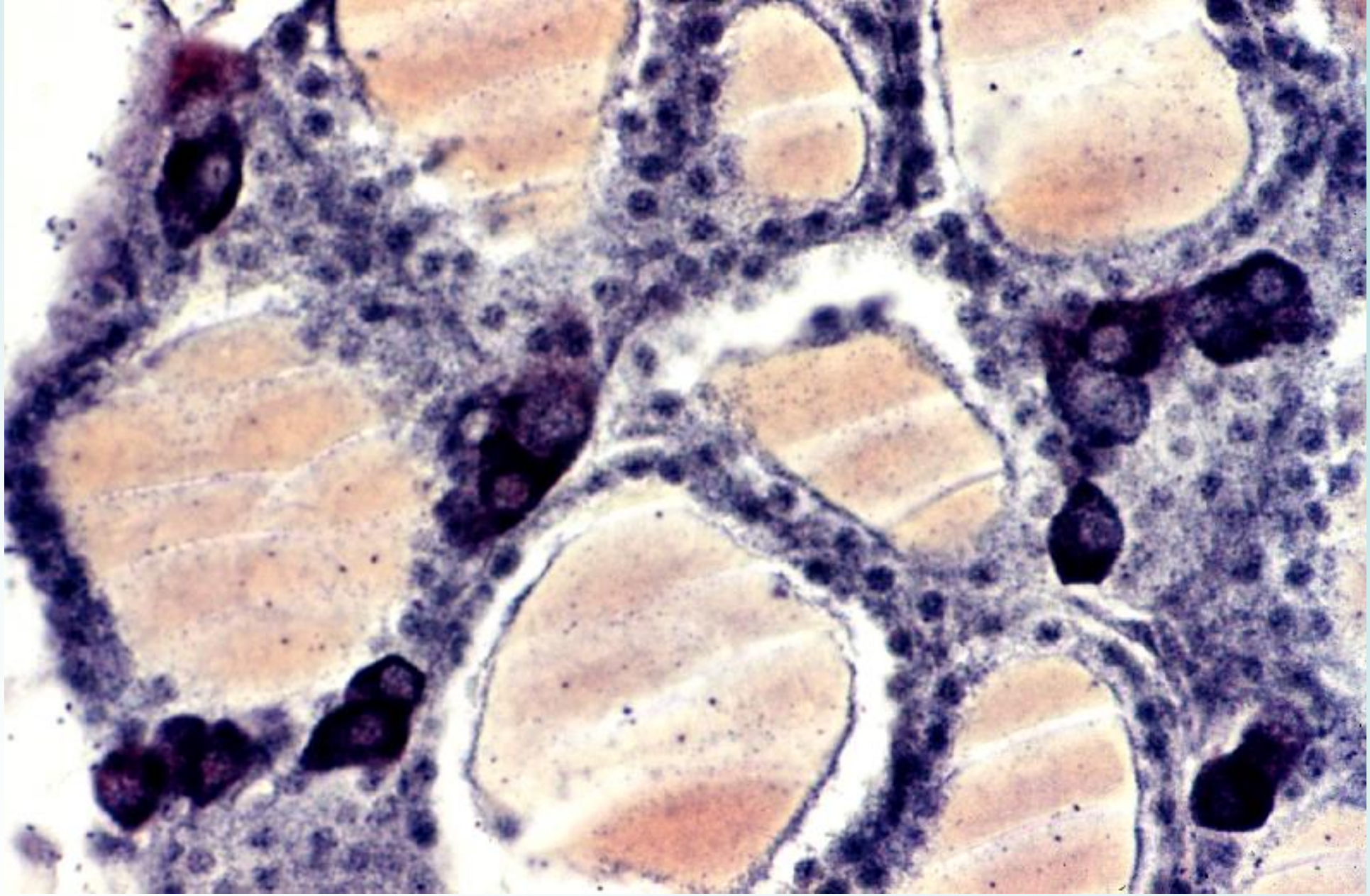
18-32 Thyroid gland, follicles. Human, H-E stain, x 100.




**18-33 Scheme showing the secretion mechanism of the thyroid gland.**

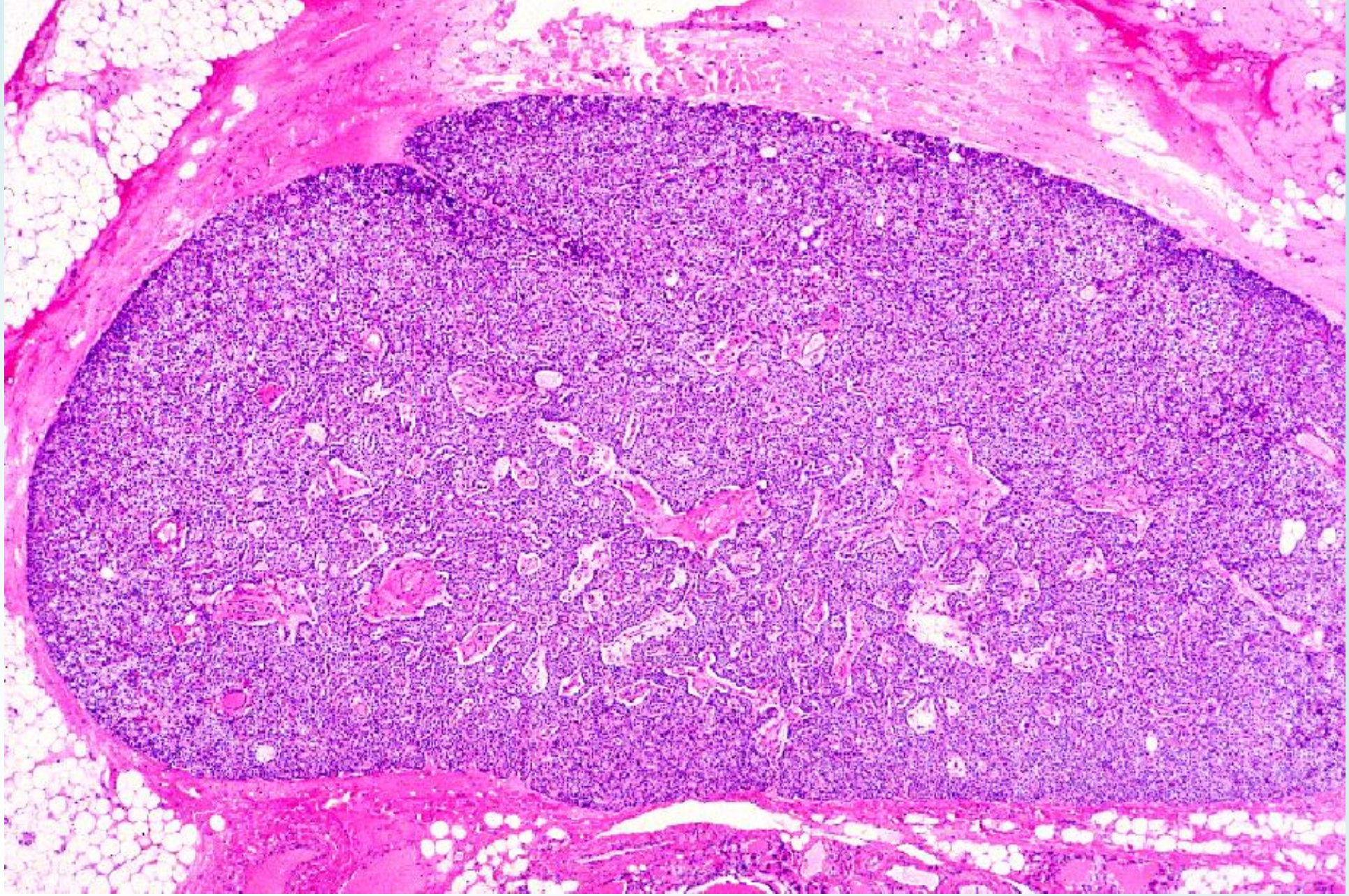


18-34 Thyroid gland, parafollicular cells. Dog, H-E stain, x 160.

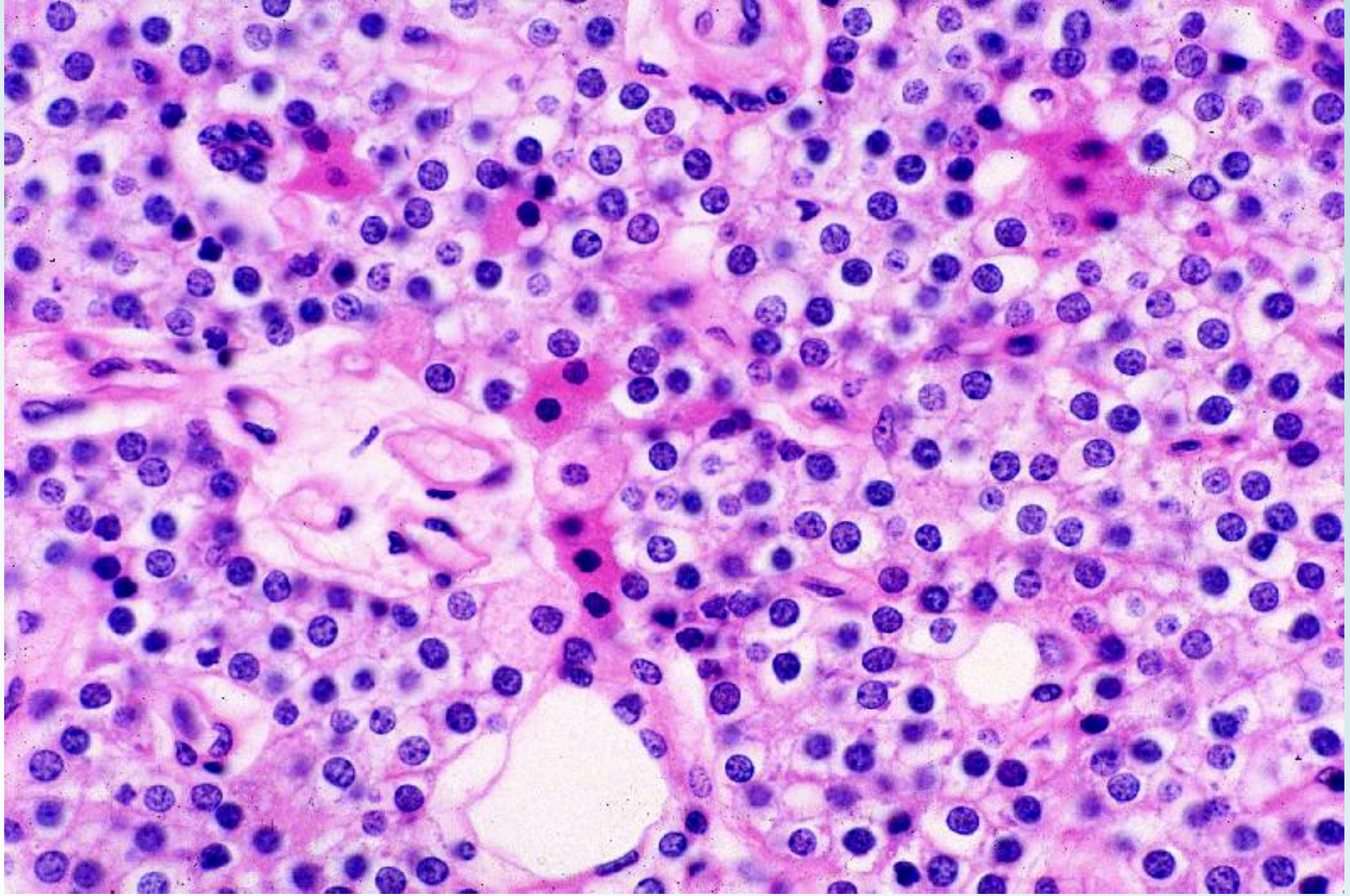


18-35 Thyroid gland, parafollicular cells. Dog, silver impregnation, x 160.

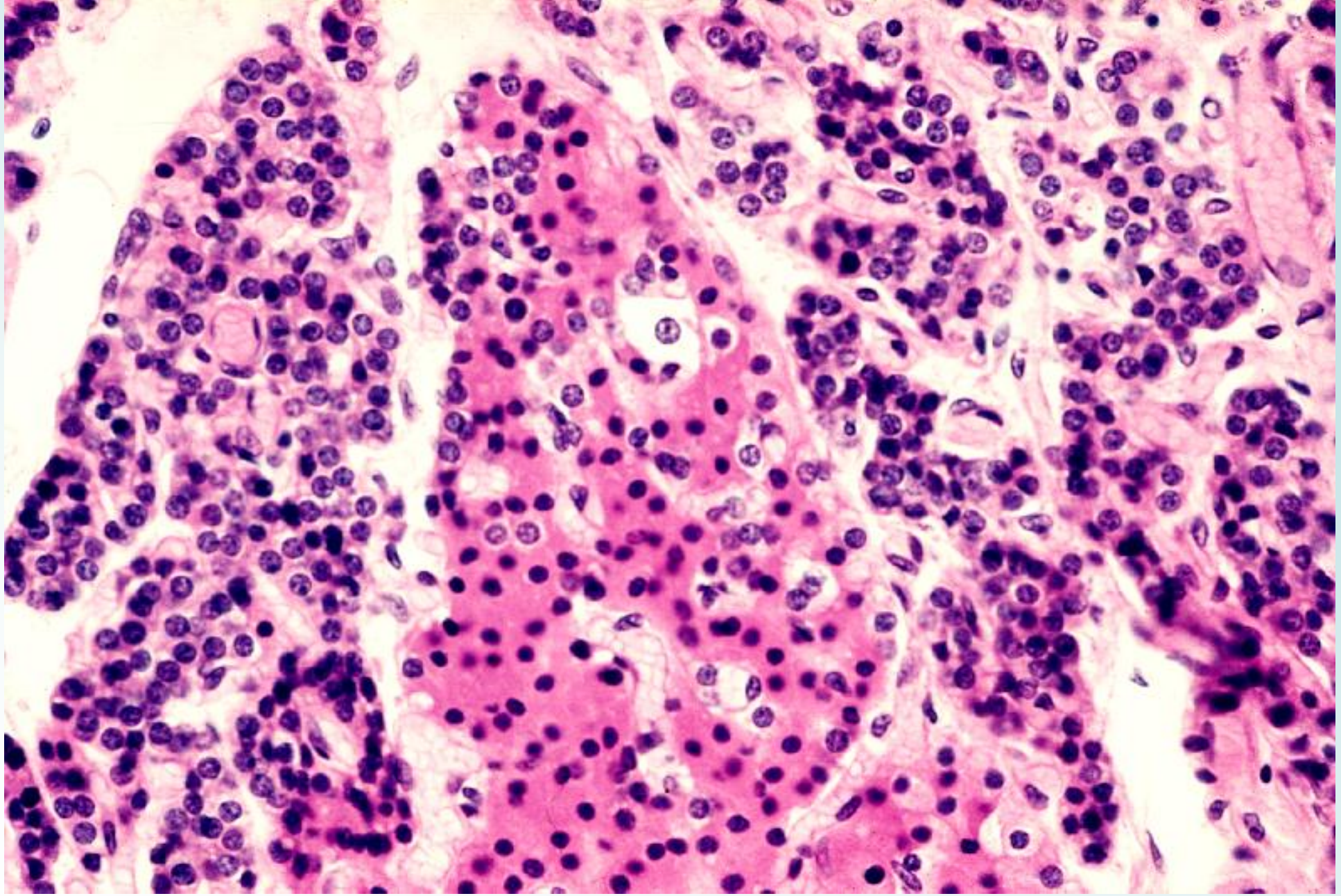
# 18-004 Glandula parathyreoidea



18-36 Glandula parathyreoidea, general view. Human, H-E stain, x 10.

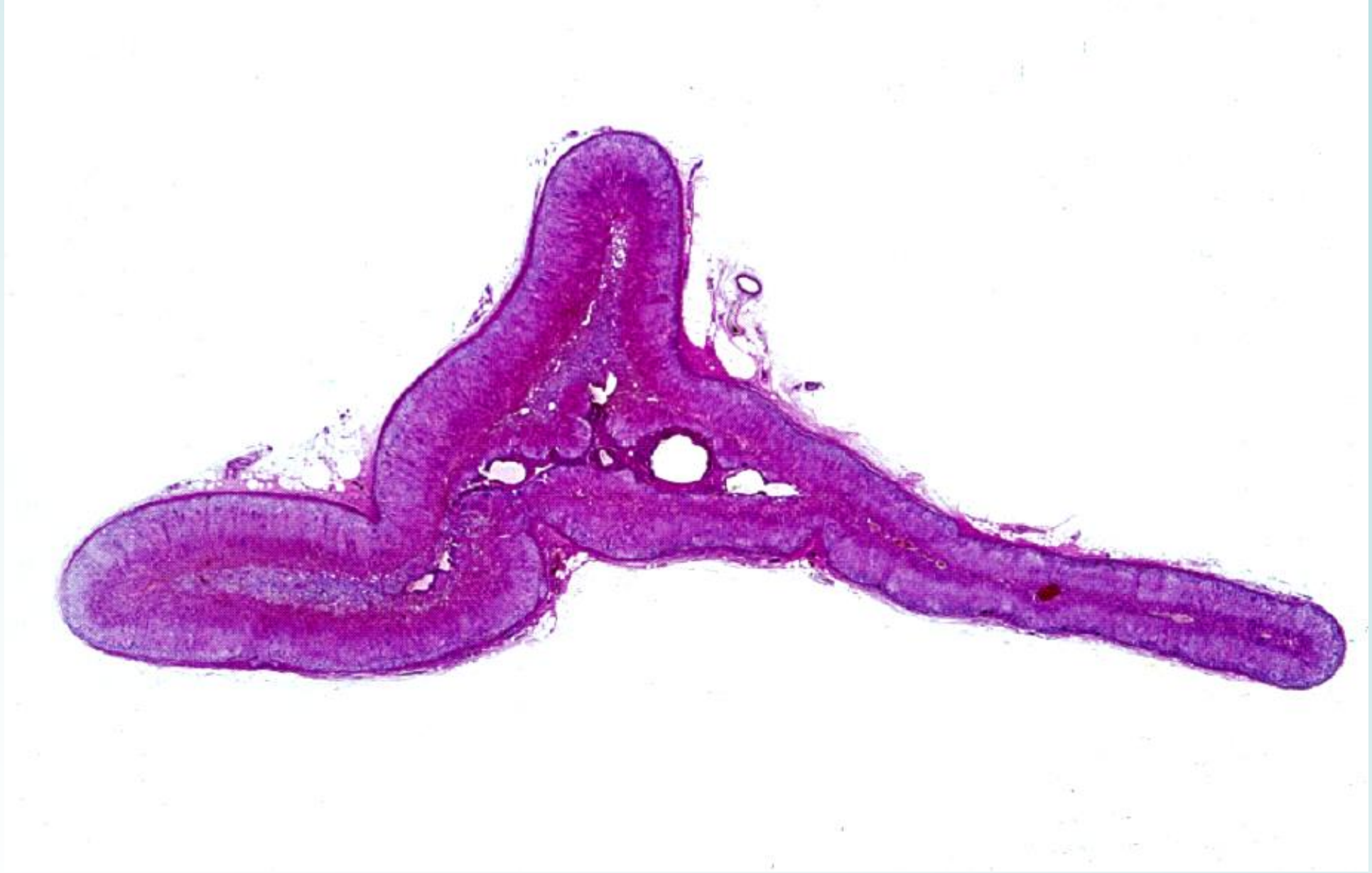


18-37 Glandula parathyreoidea 1. Human, H-E section, x 130.

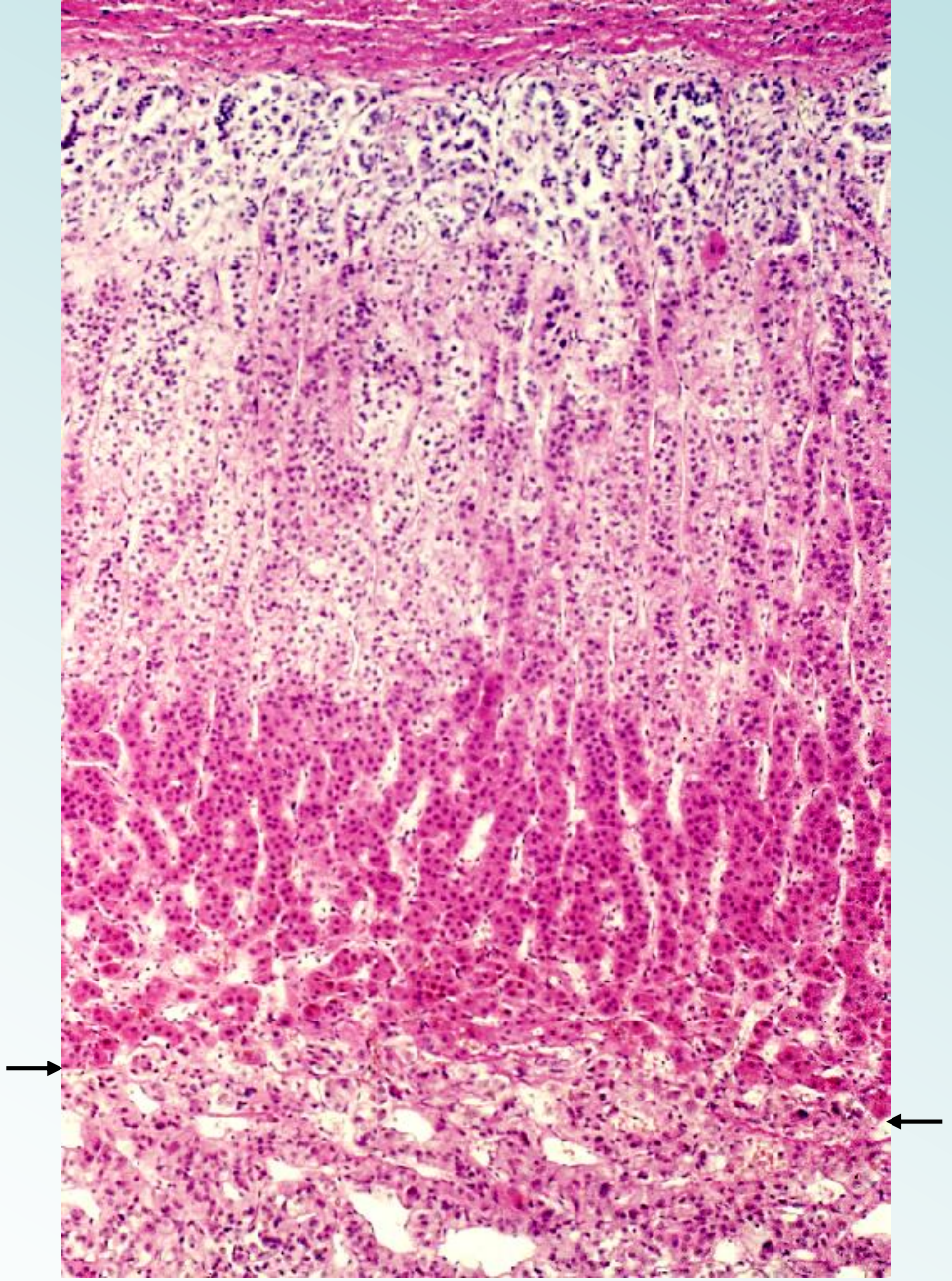


18-38 Glandula parathyroidea 2. Human, H-E stain, x 100.

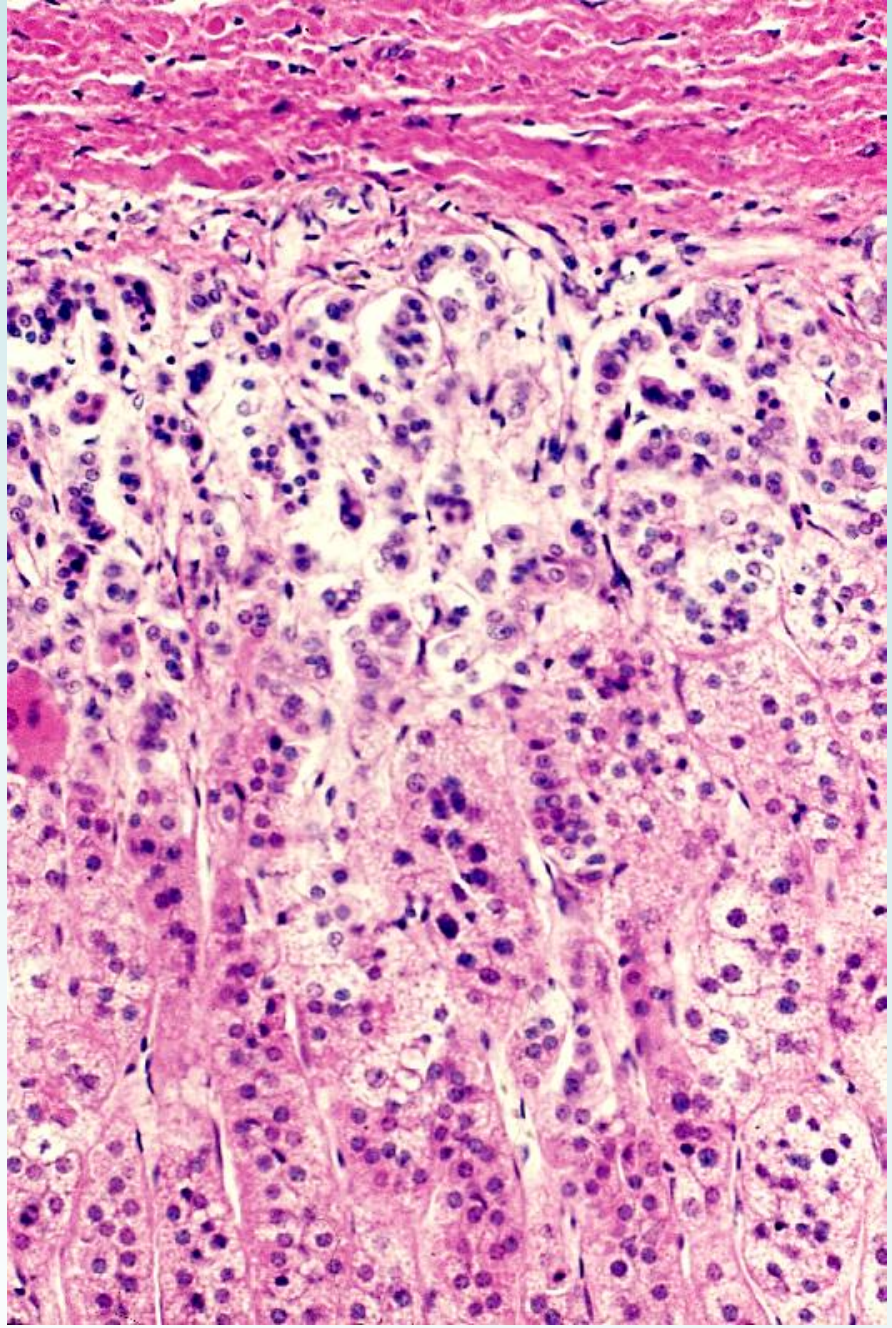
# 18-005
# Adrenal Gland



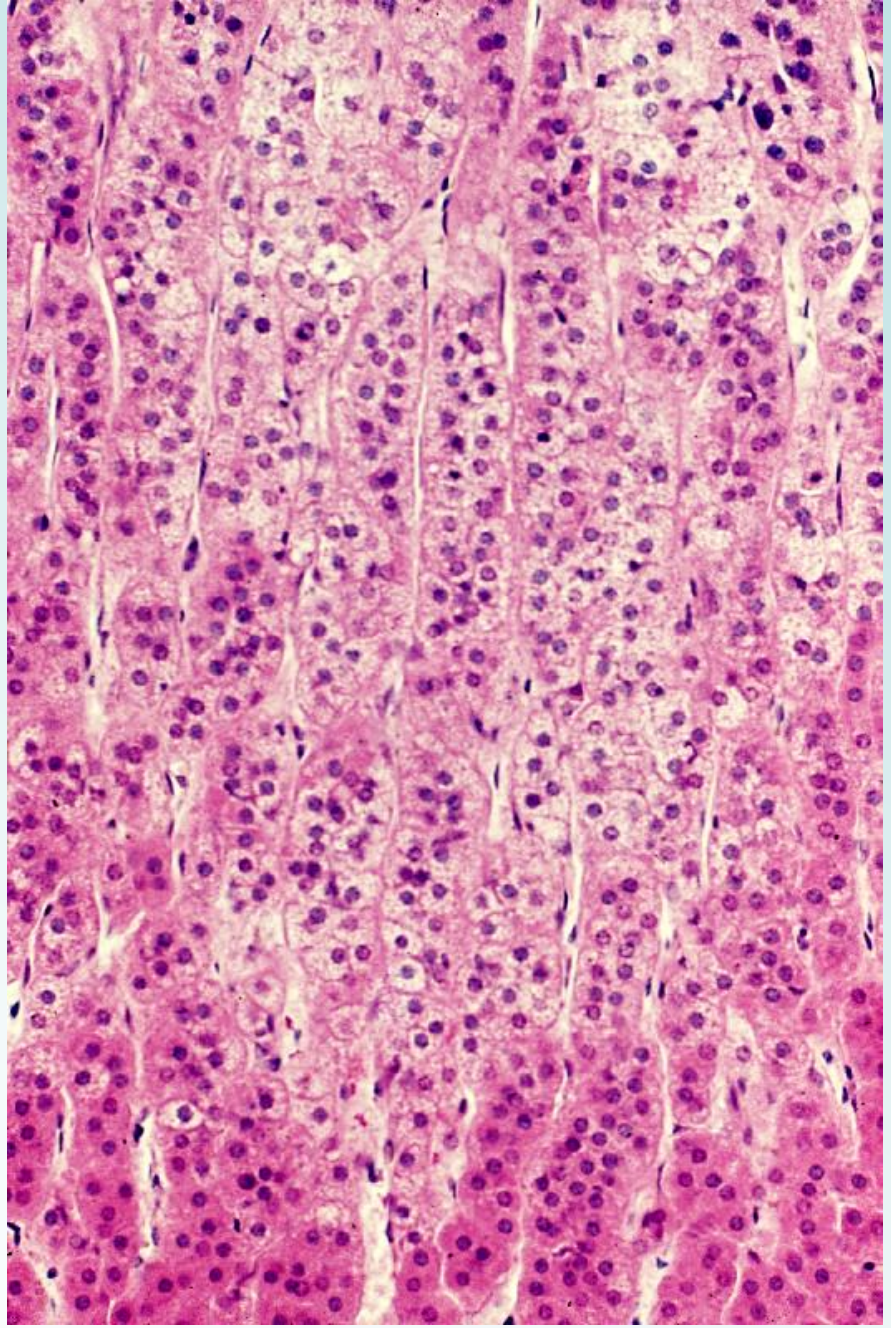
18-39 Adrenal gland, general view. Human, H-E stain, x 1.6.



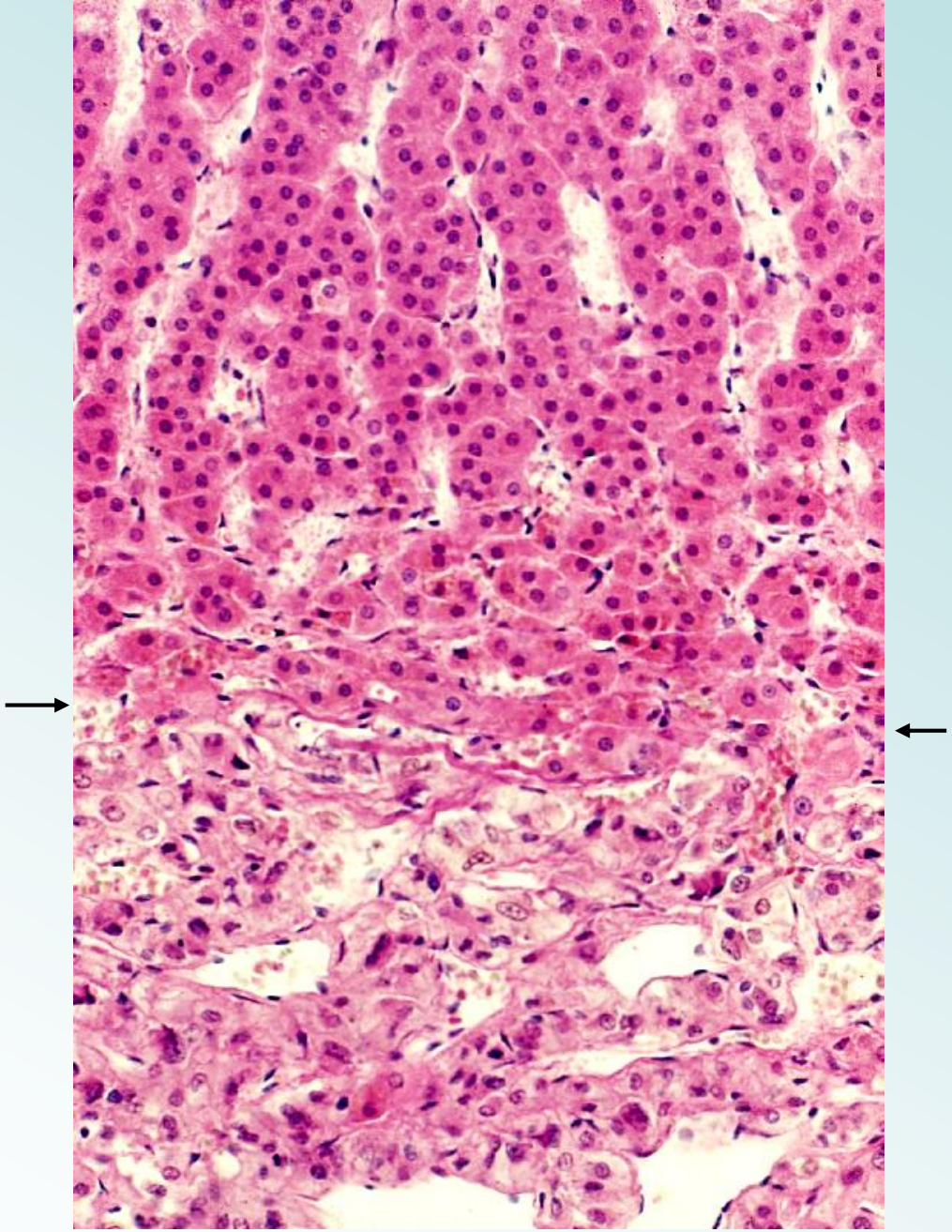
18-40 Adrenal gland. Cortex and medulla. Human, H-E stain, x 25.



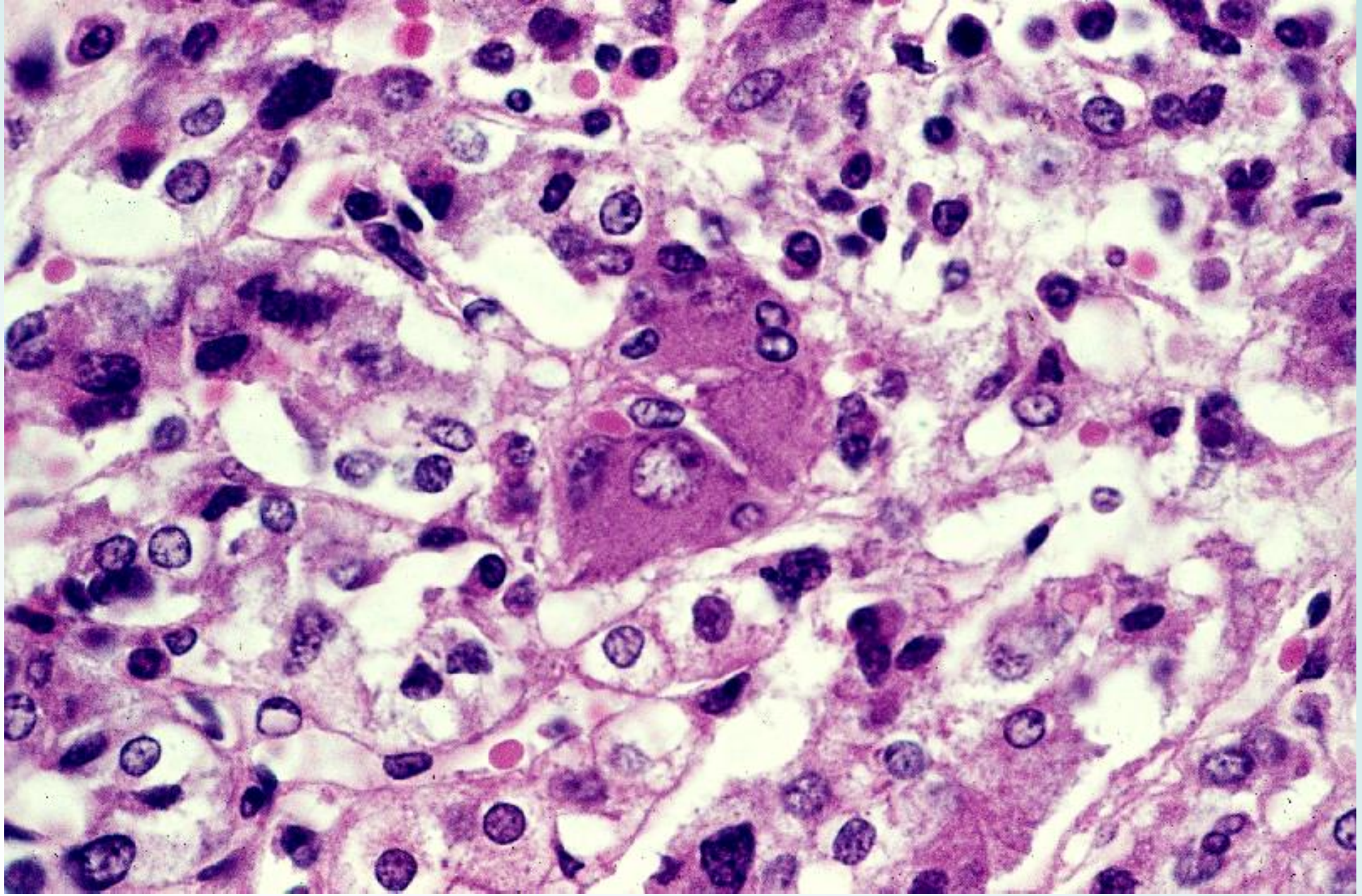
18-41 Adrenal gland. Zona glomerulosa and zona fasciculata. Human, H-E stain, x 64.



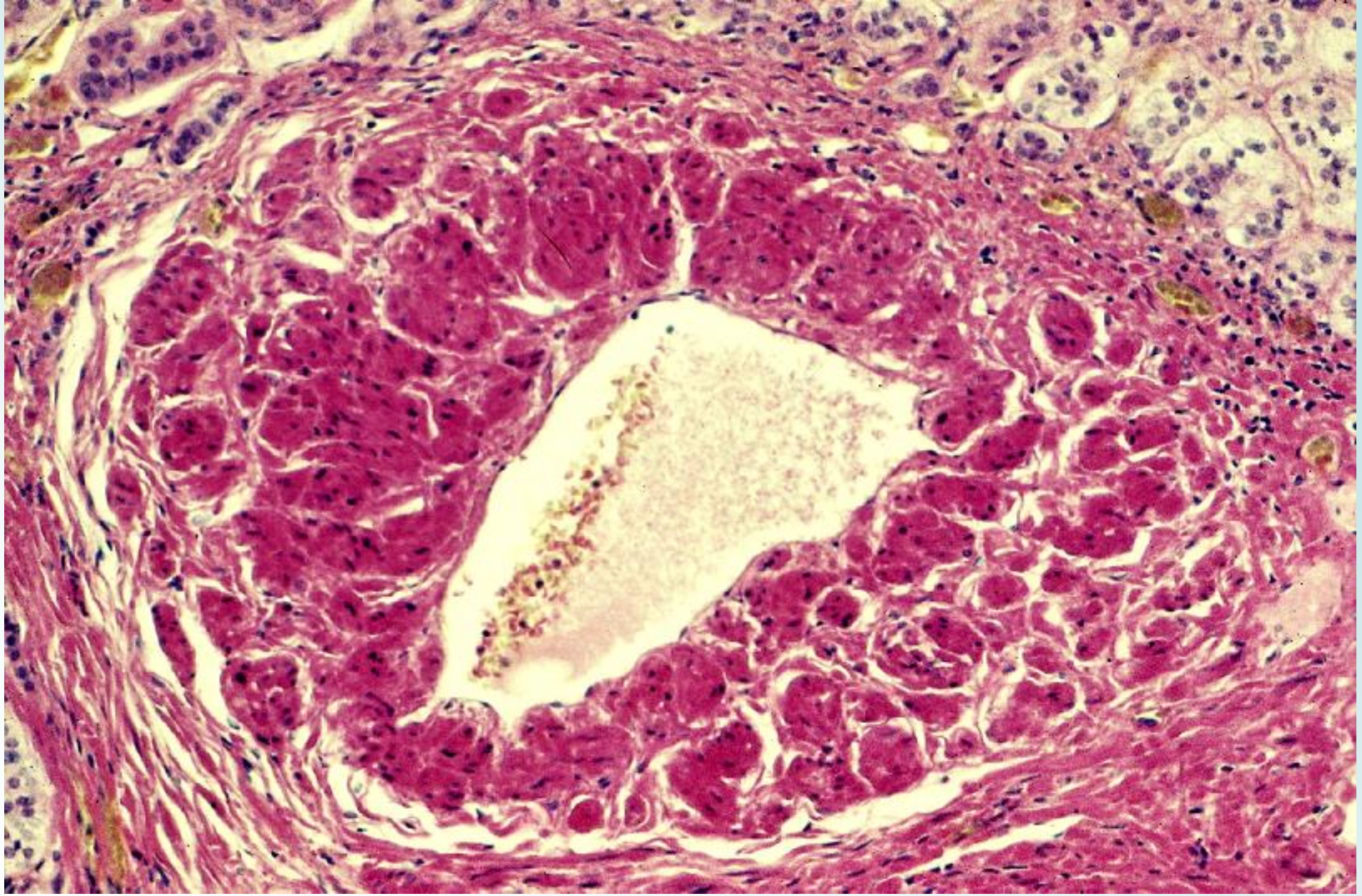
18-42 Adrenal gland. Zona fasciculata and zona reticularis. Human, H-E stain, x 64.



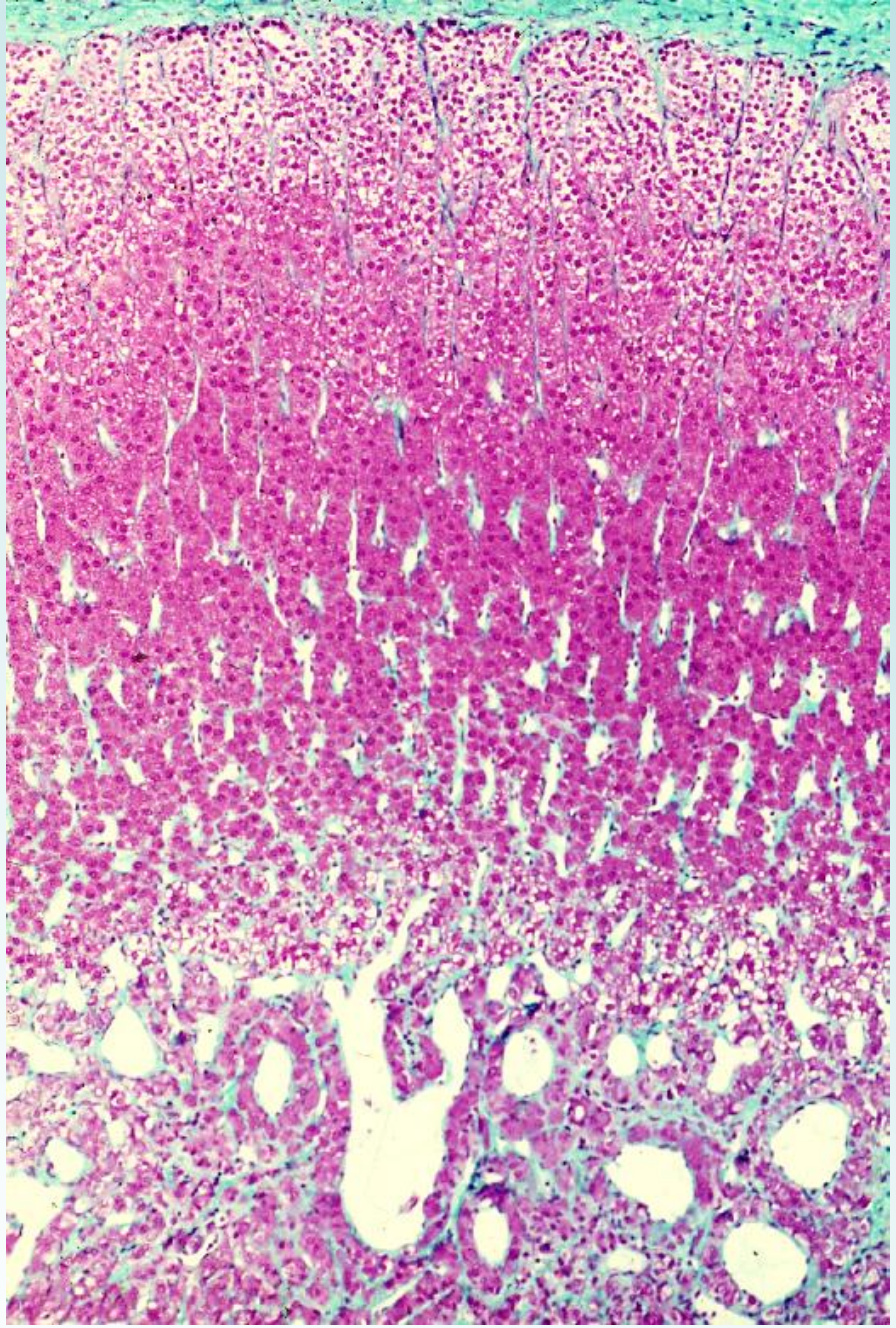
18-43 Adrenal gland. Zona reticularis and medulla. Human, H-E stain, x 64.



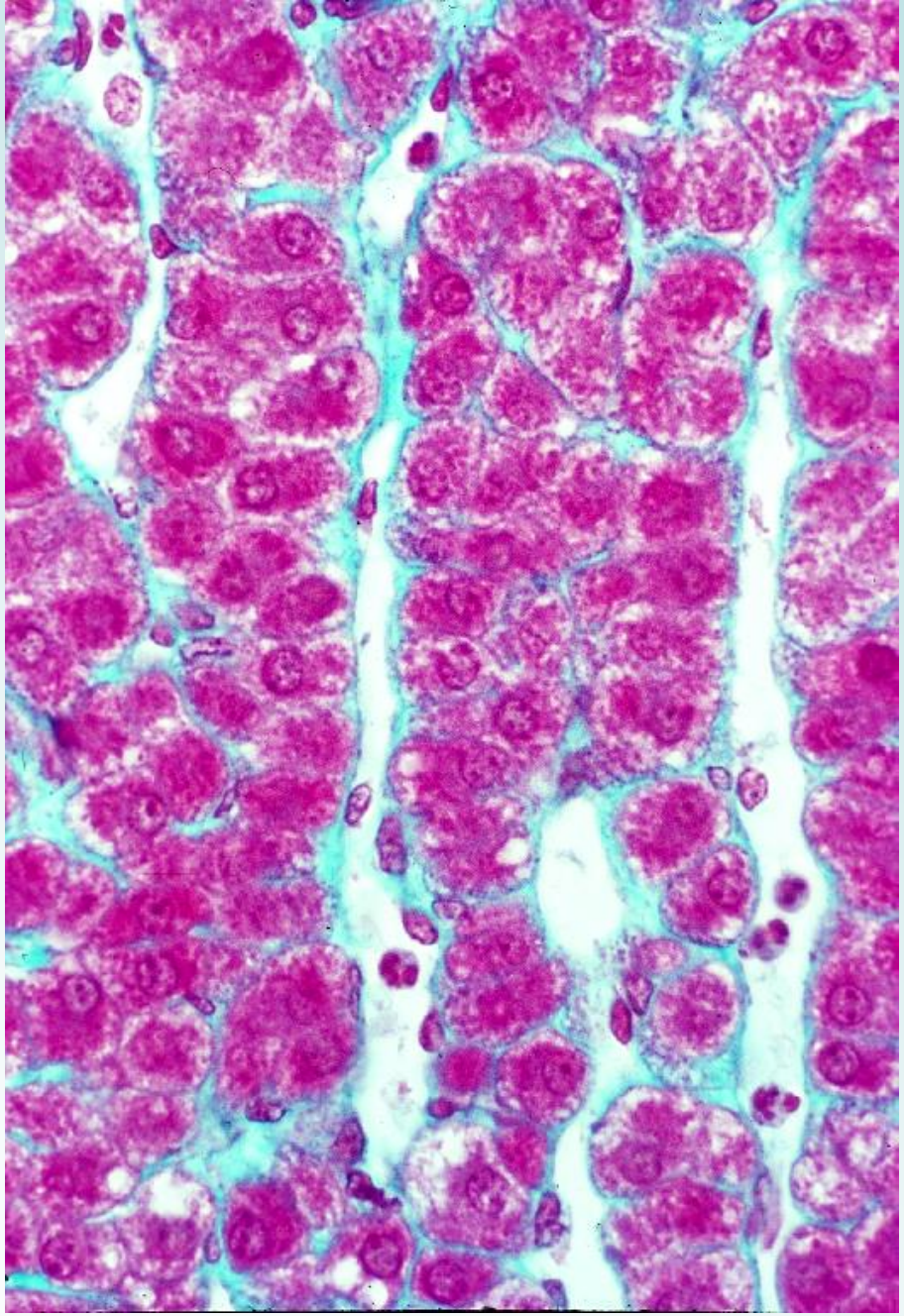
18-44 Adrenal gland, medulla. Human, H-E stain, x 160.



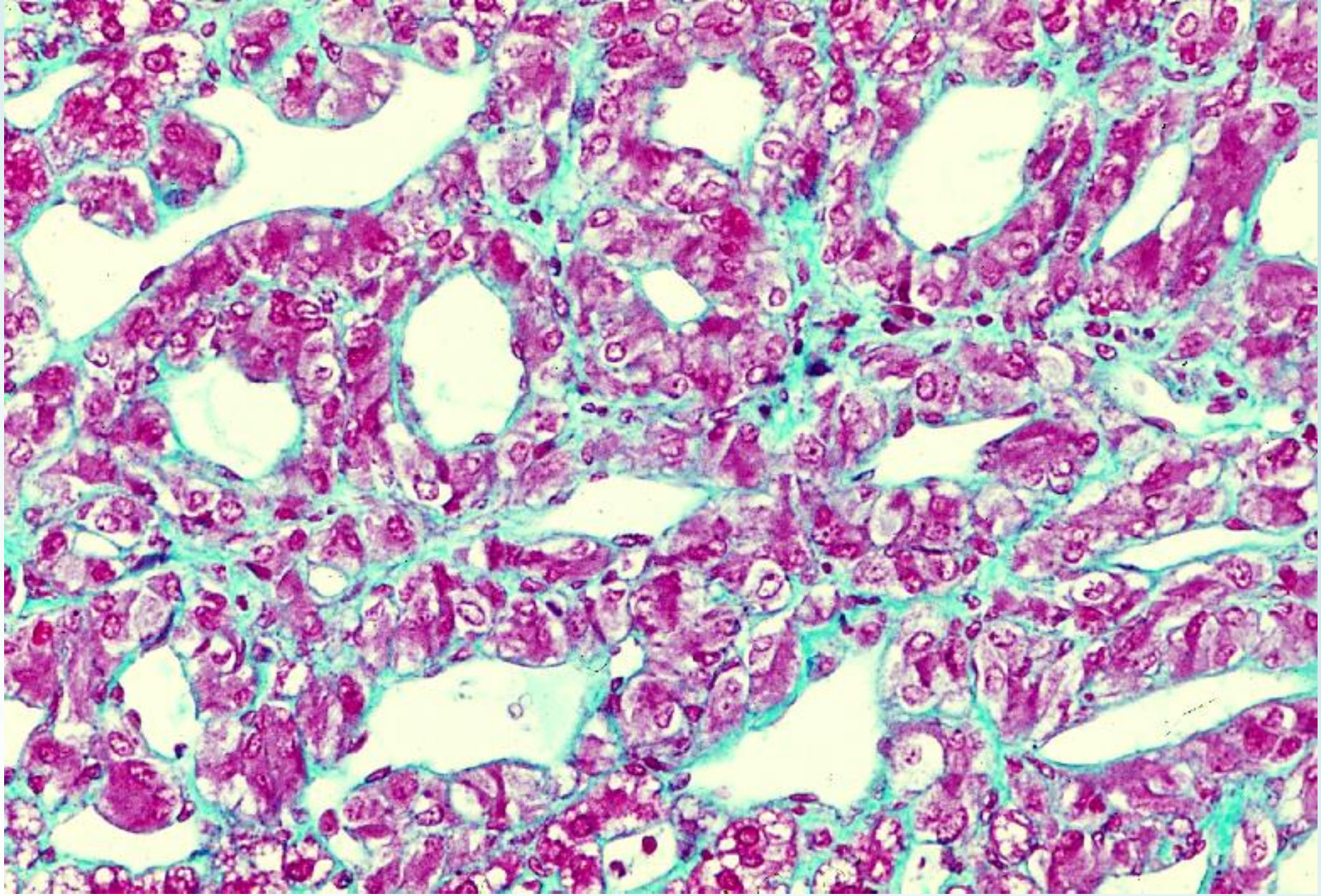
18-45 Central vein in the adrenal medulla. Human, H-E stain, x 40.



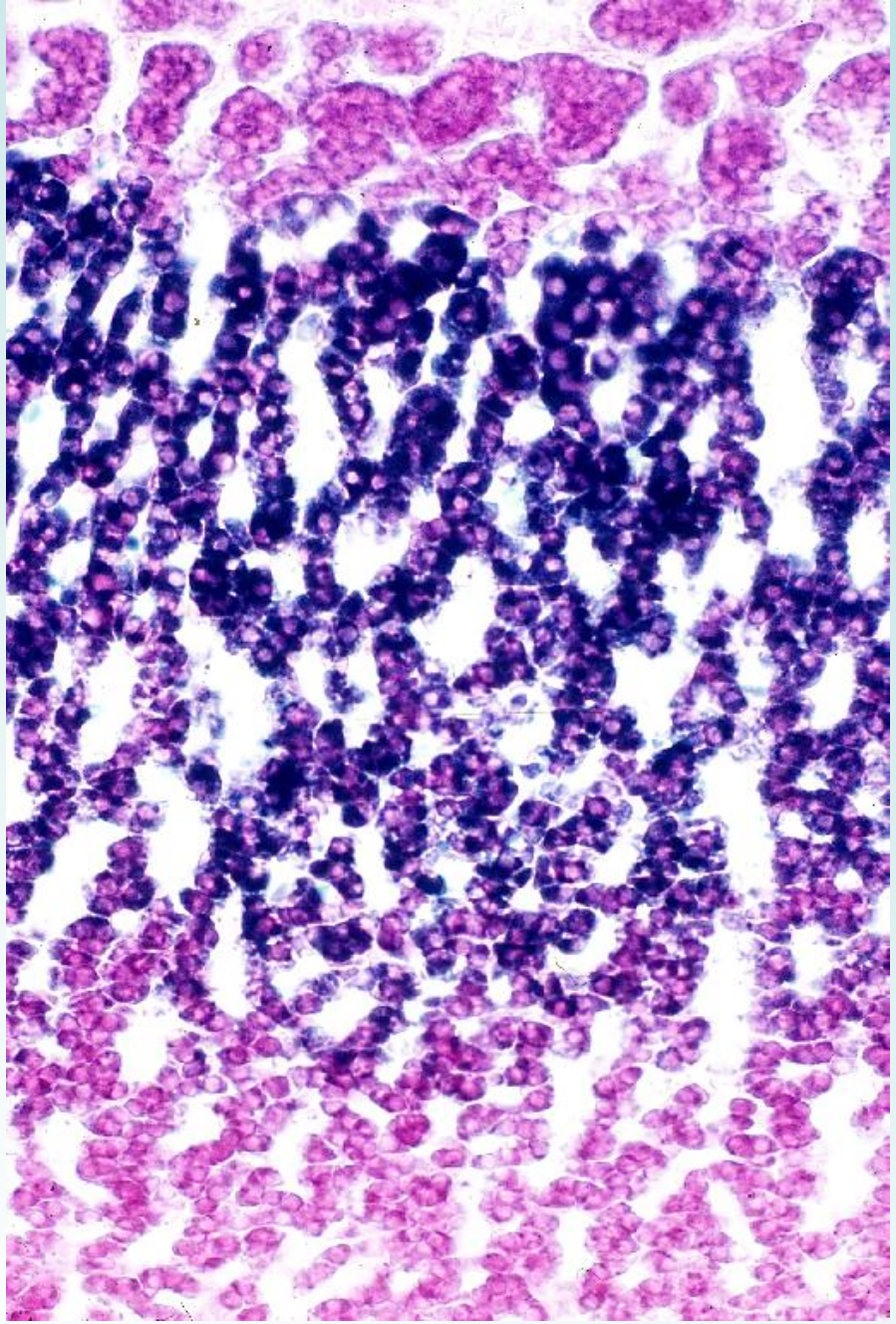
18-46 Adrenal gland, cortex and medulla. Human, M-G stain, x 25.



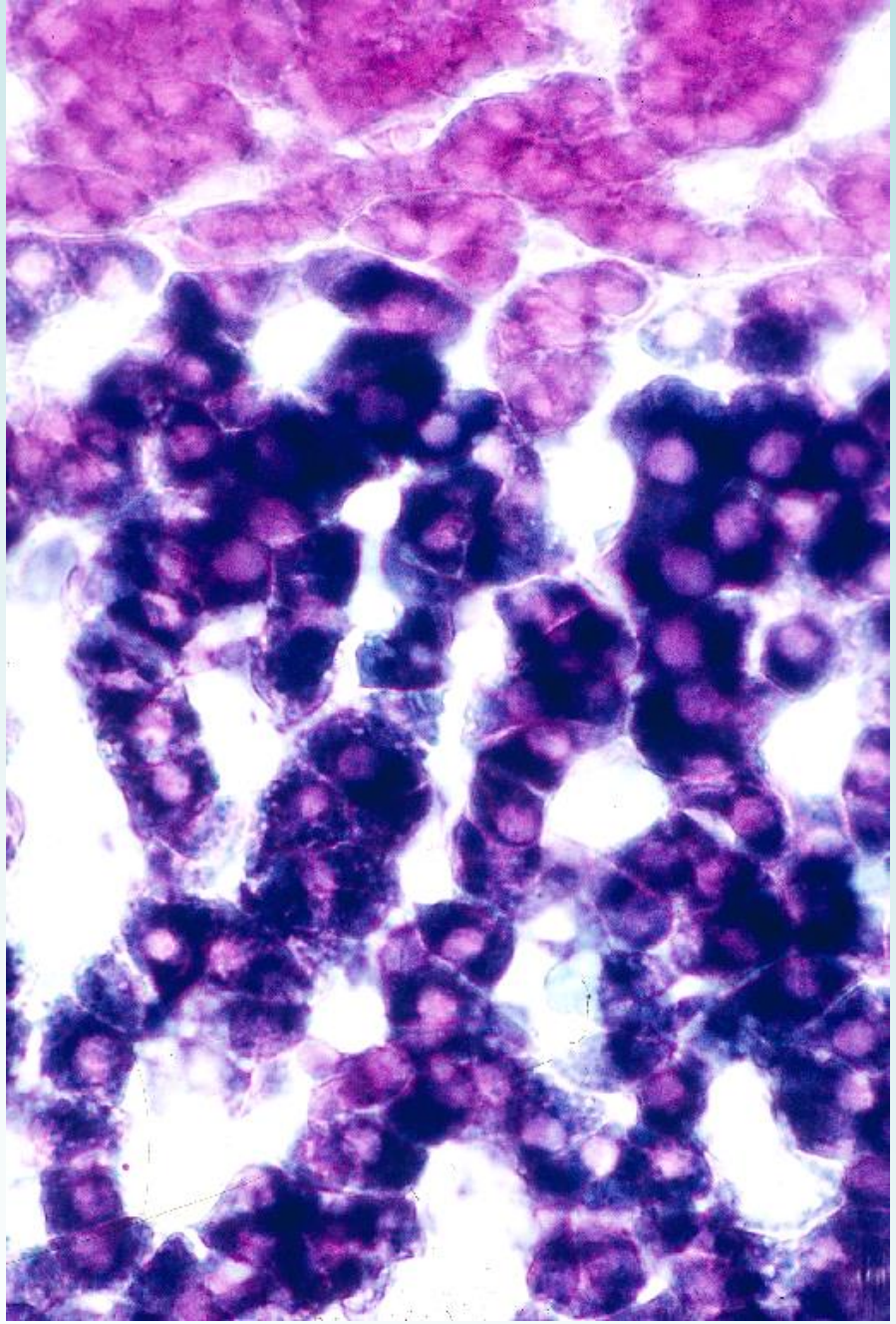
18-47 Zona fasciculate. Human, M-G stain, x 160.



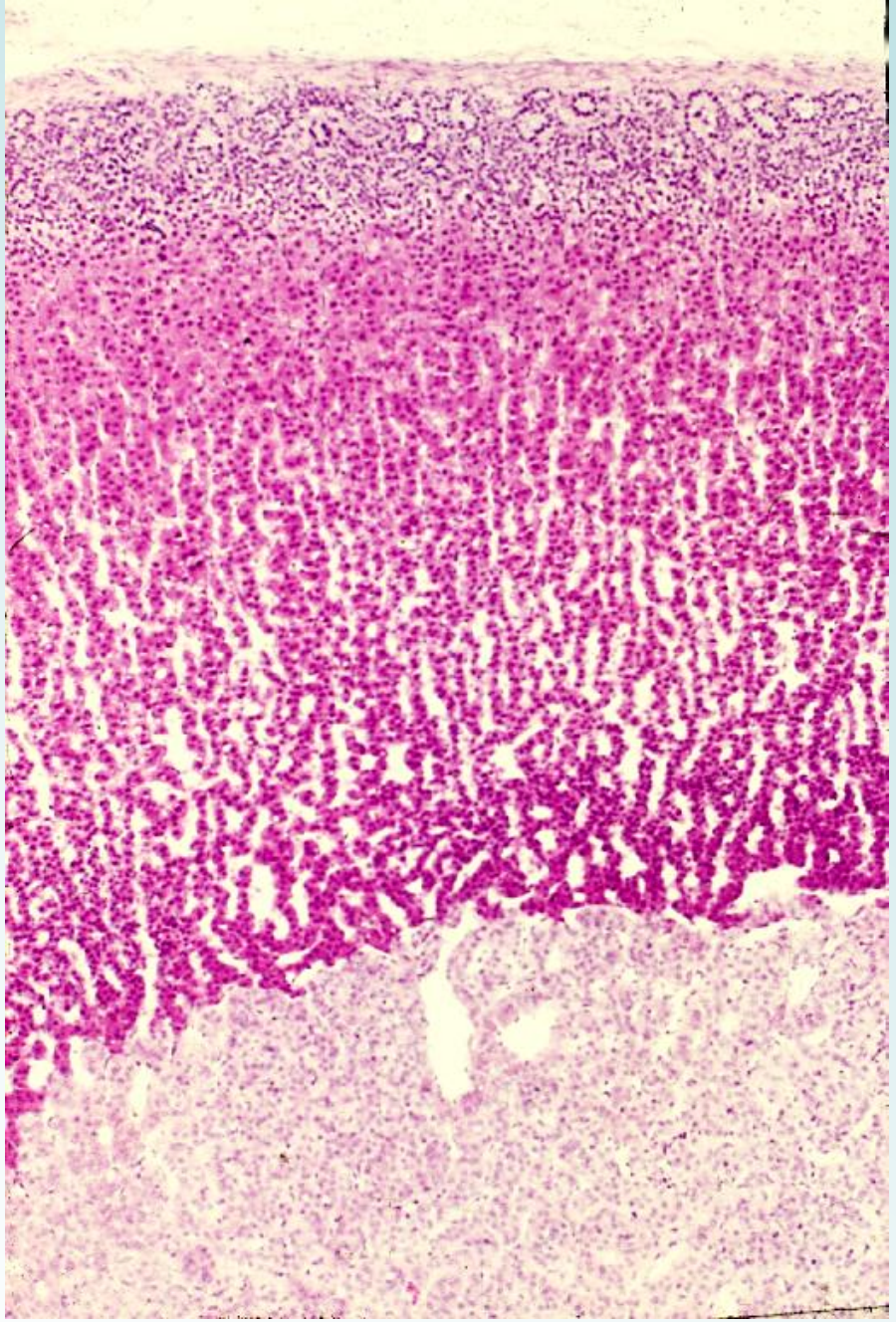
18-48 Adrenal medulla. Human, H-E stain, x 80.



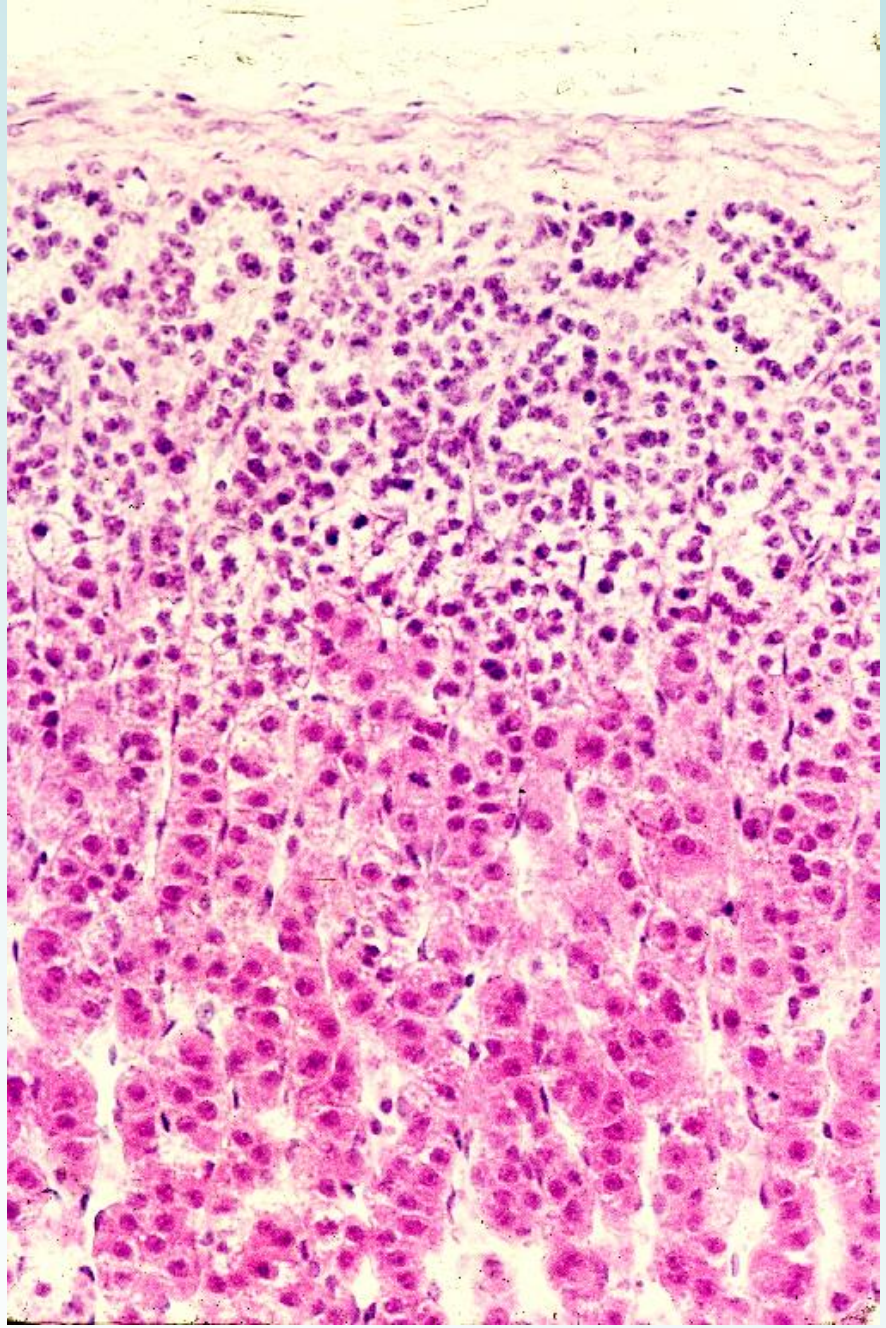
18-49 Cortex of adrenal gland. Monkey, Sudan black stain, x 64.



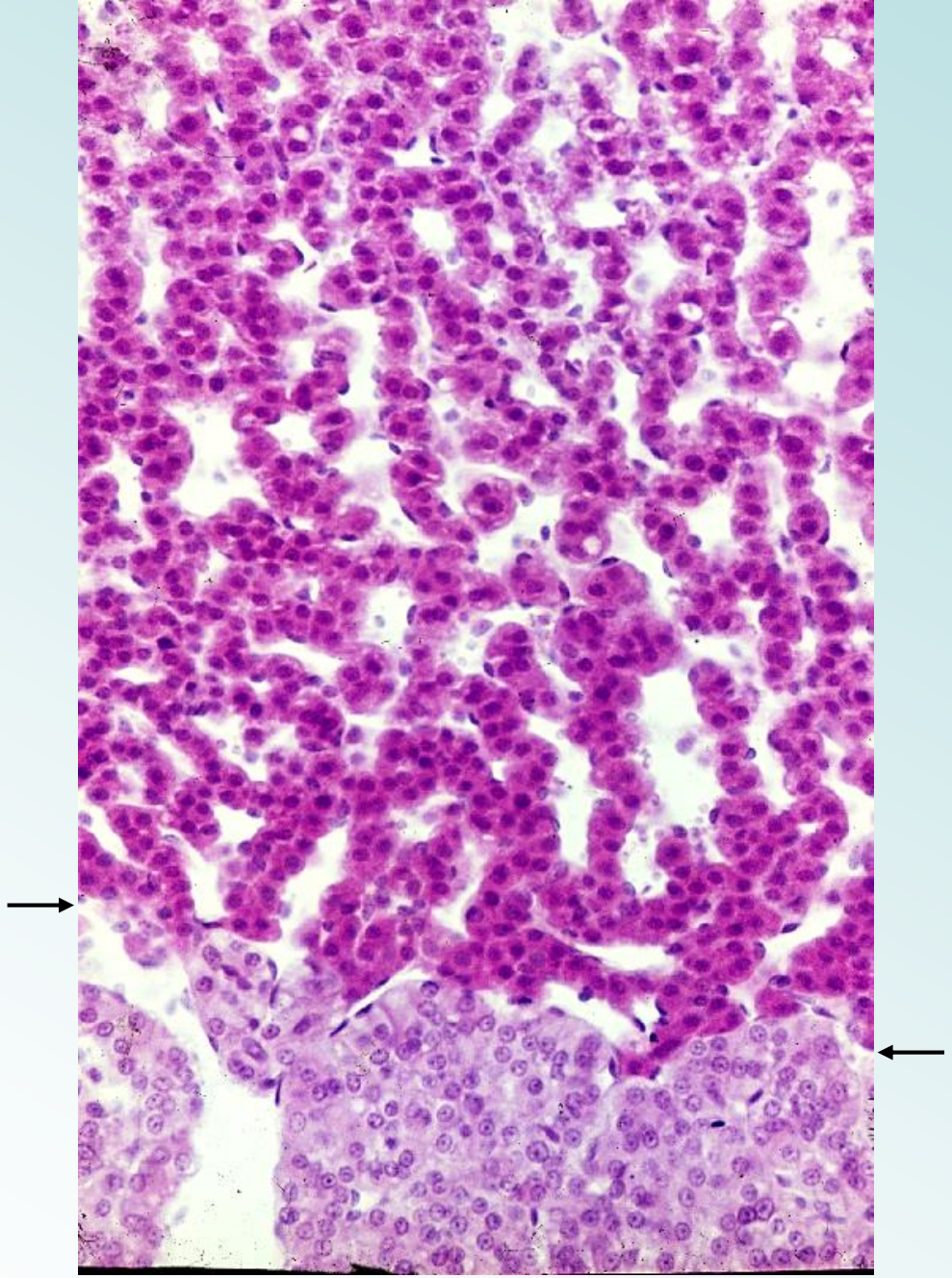
18-50 Zona glomerulosa and zona fasciculate. Monkey, Sudan black stain, x 160.



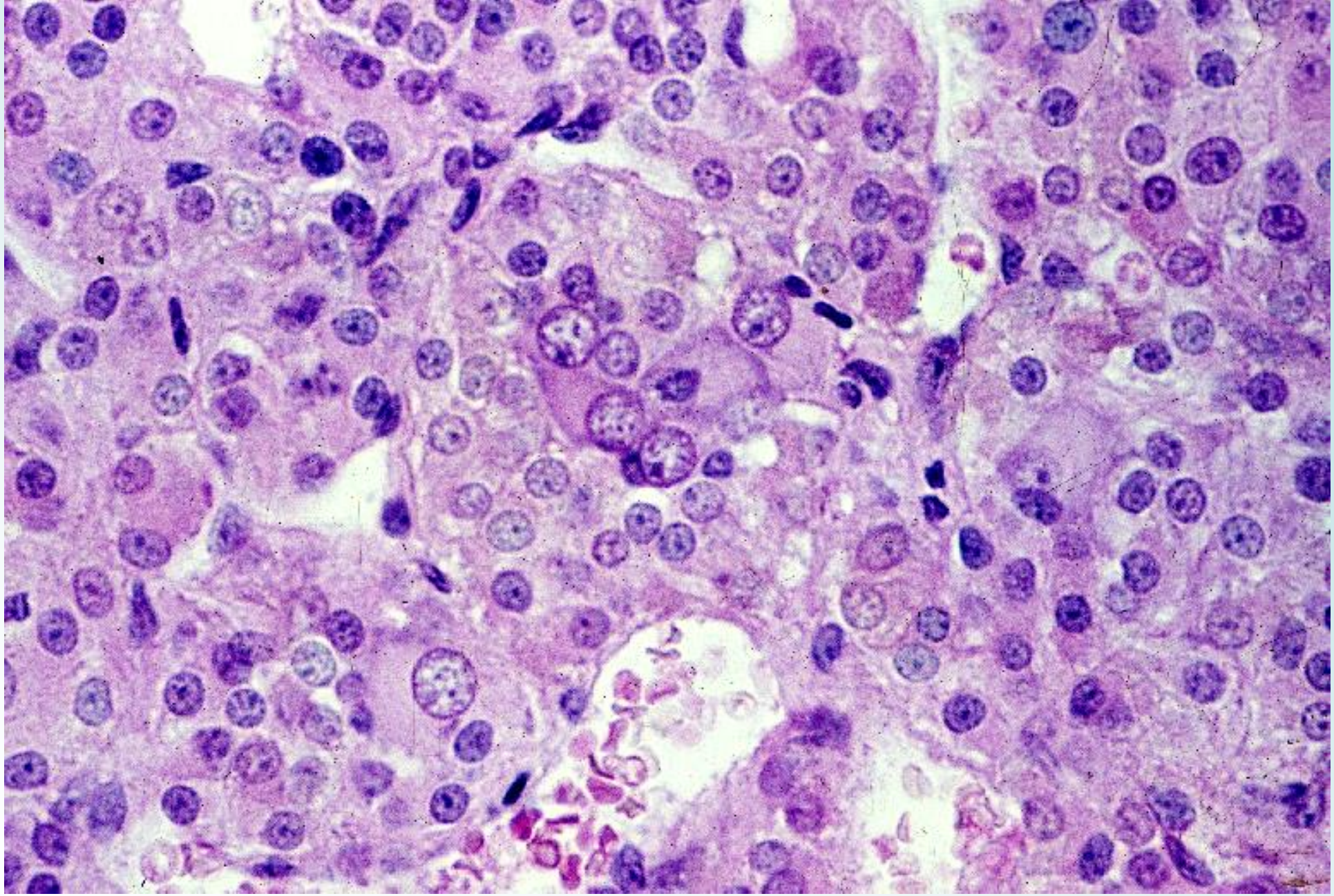
18-51 Adrenal gland. Cortex and medulla. Monkey, H-E stain, x 25.



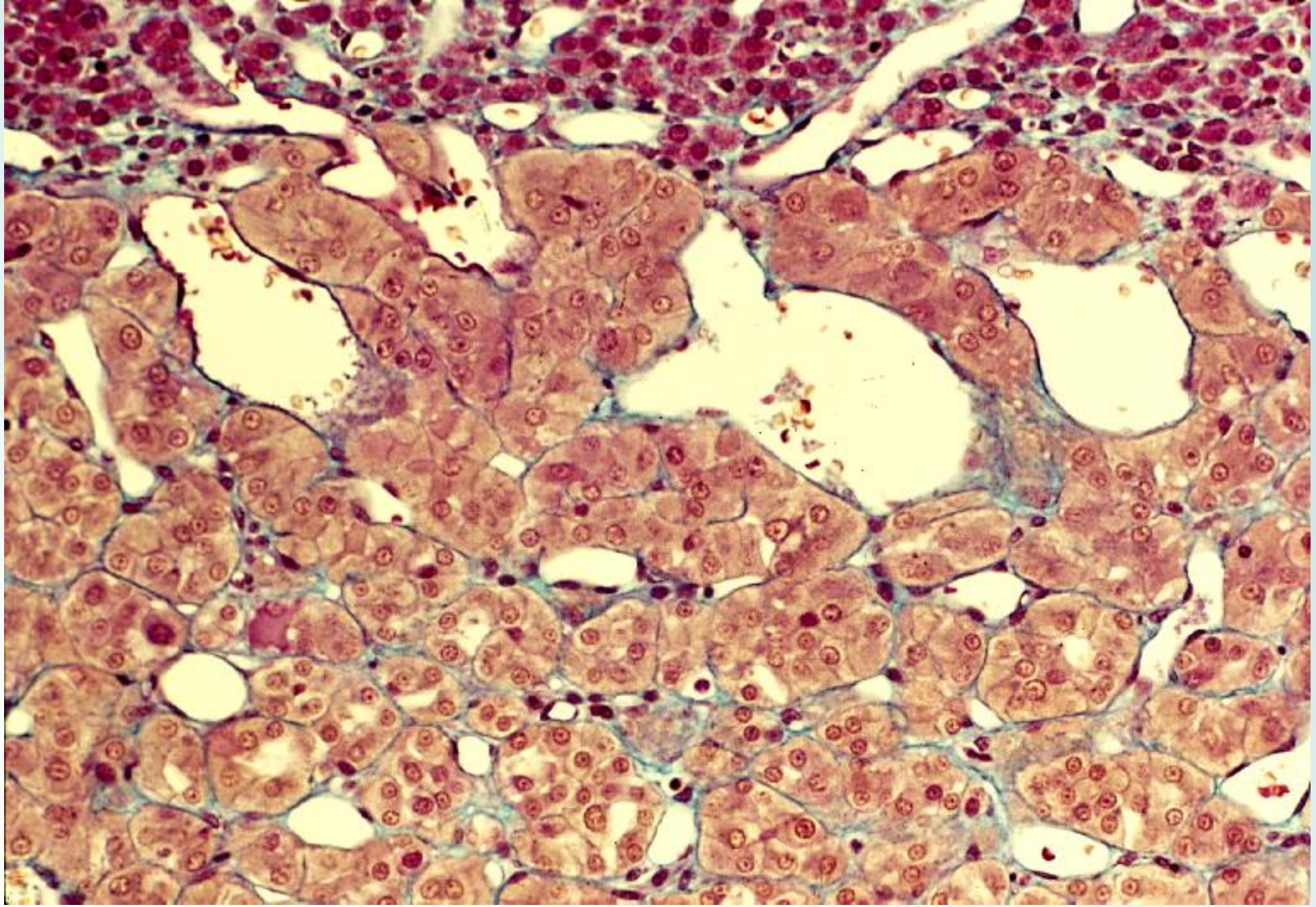
18-52 Adrenal gland. Zona glomerulosa and zona fasciculate. Monkey, H-E stain, x 80.



18-53 Adrenal gland. Zona fasciculata, zona reticularis, and medulla. Monkey, H-E stain, x 80.



18-54 Adrenal gland. Medulla. Monkey, H-E stain, x 160.



18-55 Adrenal gland, medulla. Chromaffine reaction. Monkey, M-G stain, x 64.

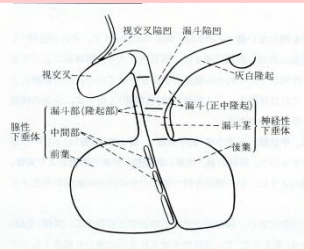
# 18-00 Endocrine Glands

- The endocrine glands are the glands without duct system (Glandulae sine ductibus).
- In the evolution of multicellular organisms, it became necessary to develop mecha- nismus for coordinating functions of various organs. Two mechanisms were evolved for achieving this integration---the **nervous system** and the **endocrine system**. The nervous system generates electrochemical signals that are transmitted over long cell processes that synapse on the cells being regulated. The endocrine glands secrete chemical agents, called **hormones**, that are transported in the blood-stream to distant target cells that have specific surface receptors which bind the hormone and induce an intracellular response.
- As to the endocrine glands, there are the pypophysis, the pineal body, the thyroid gland, the parathyroid glands, the adrenal glands, and the pancreatic islets.

# 18-001 Hypophysis

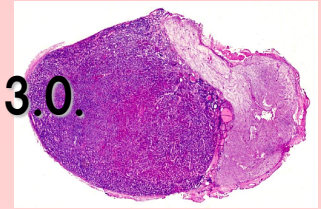
- The hypophysis, or pituitary gland, is about little finger tip large organ, about 1 cm in antero-posterior diameter, 1～1.5 cm wide and 1 cm high, and locates at the base of the brain and fits into a recess in the sphenoid bone, sella turcica. The hypophysis is connected with the hypothalamus by a stalk, called infundibular stalk.
- The hypophysis consists of two components, originated form the separate anlages: the one, adenohypophysis or anterior lobe originates as a dorsal evagination from the roof of the embryonic oral cavity, and the other, neurohypophysis or posterior lobe develops as a downgrowth from the floor of the diencephalon of the brain.

# 18-01 Hypophyswis, sagittal section. Scheme.



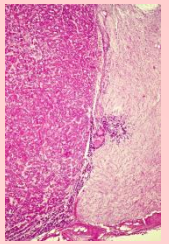

- This is to show the general construction of the hypophysis, consisting of the adeno- hypophysis and the neurohypophysis. The adenohypohysis is constituted by large lobus anterior, pars intermedia, which is a narrow area attaching to the posterior surface of the lobus anterior, and pars tuberalis which embraces the infundibulum of the neuro- hypophysis. These portions are composed by the epithelial cells originated from the roof of the embryonic oral cavity. The neurohypophysis consists of a large lobus posterior, composed of non-myelinated nerve fibers and neuroglia cells, and the infundibulum, which connects the posterior lobe with the hypothalamus. The funnel-shaped infundibulum has two wall i.e. the anterior wall is continuous with the floor of the hypothalamus directly posterior to the optic chiasma, and the posterior wall is continued with the floor of the hypothalamus at the anterior portion of the tuber cinereum. The inferior half of the infundibulum is the infundibular stalk, consisting of non-myelinated nerve fibers, being continuous to the antero-upper portion of the posterior lobe.

# 18-02 Hypophysis, sagittal section. General view. Human, H-E stain, x 3.0.



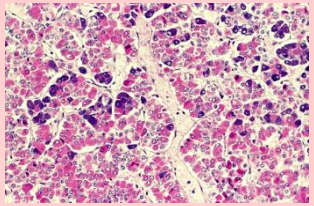
- This figure shows a general view of a human pituitary gland. The anterior lobe stained deep violet, occupies about the left three fourths of the figure, posterior to that is the pars intermedia, a narrow band-like region consisting of several small and large follicles. The posterior lobe occupies the right one third of the figure, stained light violet. From its upper-left corner extend the thick infundibular stalk which is continuous with the floor of the hypothalamus.

# 18-03 Hypophysis. Anterior lobe, pars intermedia and posterior lobe. Human, H-E stain, x 10.



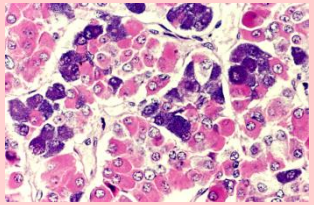
- The adenohypophysis ( anterior lobe, the left half ), the neurohypophysis ( posterior lobe, the right half ), and the pars intermedia, a narrow band-like area, locating bet- ween them, are shown .

# 18-04 Hypophysis, anterior lobe 1. Human, H-E stain, x 64.



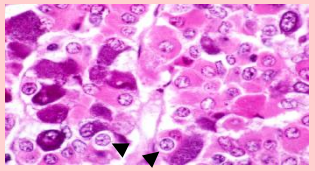
- The anterior lobe is composed of irregular cords or clusters of glandular cells, that are intermingled densely with the network of the sinusoidal capillaries. The glandular cells have been traditionally classified as acidophilic, basophilic, and chromophobic, on the basis of their affinity for the dyes commonly used in the routine staining of histological sections. In the middle of this figure runs a large sinusoid from top downward.
- The acidophiles, $\alpha$-cells, contain the secretion granules staining deep reddish-pink with eosin and large enough to be resolved with the light microscope. They are most numerous in the posterolateral portion of the anterior lobe.
- The basophiles, $\beta$-cells, whose secretion granules stain with hematoxylin dark blue and light blue with aniline blue.
- The chromophobes, $\gamma$-cells, appear colorless in H-E stained sections.
- In this figure, glandular cell cords and cell clusters consisting of the three kinds of cells and with them intermingled sinusoidal capillaries are clearly observed.
- As more hypophyseal hormones were discovered, it became evident that there were more cell types than $\alpha$-cells, $\beta$-cells, and $\gamma$-cells, and this was confirmed by the studies with electron microscope. Using immunocytochemical methods much the detail of the hormone secreting mechanism of each cell group has been clarified..

# 18-05 Hypophysis, anterior lobe 2. Human, H-E stain, x 160.



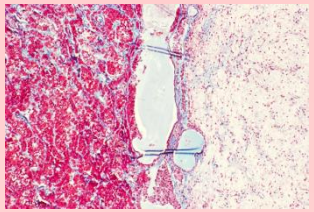
- Higher magnification of 18-04. The $\alpha$-cells and $\beta$-cells are clearly distinguished. S indicates the sinusoid.

# 18-06 Hypophysis, anterior lobe 3. Human, H-E stain, x 400.



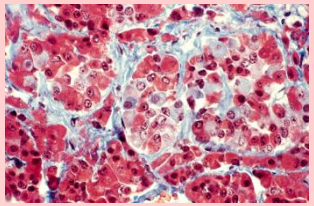
- Higher magnification of 18-04. Two $\gamma$-cells ( arrows ) are evidently distinguished. $\alpha$-cells, stained red, and $\beta$-cells, stained dark violet, are also easily identified.

# 18-07 Hypophysis. Anterior lobe, pars intermedia, and posterior lobes. Human, Masson stain, x 25.



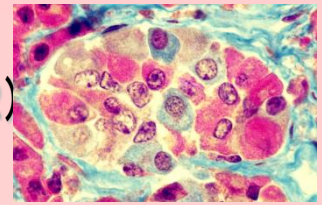
- This is a human hypophysis stained with Masson's trichrome method. The anterior lobe, the posterior lobe, and pars intermedia, consisting of follicles, are evident.

# 18-08 Hypophysis, anterior lobe 4. Human, Masson stain, x 160.



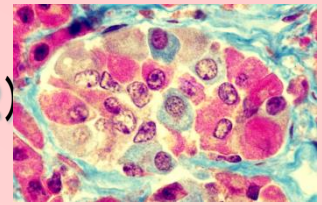
- In this specimen connective tissue fibers stain blue. The cell clusters consisting of three kinds of cells are enclosed by blue stained connective tissue fibers.

# 18-09 Hypophysis, anterior lobe 5. Human, Masson stain, x 400. (1/2)



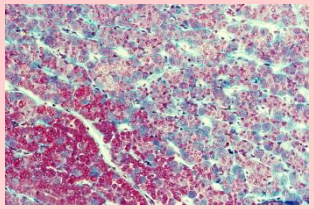
- Higher magnification of 18-08. The red stained acidophils, the blue stained basophils, and brownish stained chromophobes are evidently distinguished. This cell cluster is enclosed by blue stained connective tissue fibers.
- The specimen of 18-07, 18-08 and 18-09 was made by Prof. Dr. I. Asami.
- Among the acidophils, two kinds of cells are classified into two according to the secreting hormone: ① Somatotrophs or STH cells, secreting the growth hormone, somatotrophin, and ② Mammotrophs or lactotrophs, secreting prolactin.
- The basophils are classified into three according to the secreting hormone: ① Thy- rotrophs, ② Corticotrophs, and ③ Gonadotrophs.
- The somatotrophin, a protein with a molecular weight about 22, 000, does not have a specific target organ but has a generalized effect on cells throughout the body, increas- ing their uptake of amino acids and protein synthesis. The most conspicuous effect of somatotrophin is on the rate of growth of young animals. This effect is mediated by smaller proteins, somatomedins, synthesized in the liver in response to growth hormone. The somatomedins, in turn, stimulate the proliferation of cartilage cells that is neces- sary for the growth in length of long bone.
- The mammotrophs secrete the lactogenic hormone, prolactin, a protein of 23, 000 molecular weight, that prompotes mammary gland development during pregnancy and subsequent lactation. They are relatively easy to identify, owing to their distinctive large dense granules, ranging in size from 500 to 900 nm in diameter. During pregnancy, the anterior pituitary undergoes a twofold enlargement, due in large measure to hyper- trophy and hyperplasia of the mammotrophs.

# 18-09 Hypophysis, anterior lobe 5. Human, Masson stain, x 400. (2/2)



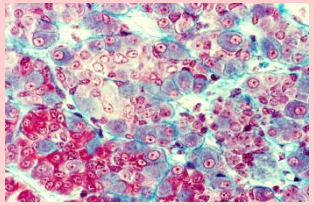
- The thyrotrophs tend to be deeply stained in the cords of parenchymal cells and , therefore, are usually not in contact with sinusoids. At the light microscopic level they are distinguished by their staining with aldehyde thionin. They secrete thyroid-stimu- lating hormone ( TSH ), a glycoprotein of 28, 000 molecular weight. This acts by binding to specific receptors on the cells of thyroid follicles, stimulating their secretion of thyroid hormones, thyroxine and triiodothyronine.
- The corticotrophs secrete adrenocorticotrophin ( ACTH ), a small peptide of molecular weight 4, 500, which, circulating in the blood, binds to receptors on the cells of the adrenal cortex and stimulates their secretion of the hormone, cortisol.
- The gonadotrophs are rounded cells, usually situated close to sinusoids. They secrete follicle-stimulating hormone ( FSH ) and luteinizing hormone ( LH ), both are glycopro- tein of about 30, 000 molecular weight. In the female, there is a cyclic increase and decrease of FSH each month. The rising level stimulates the development of follicles in the ovary in preparation for ovulation. A midcycle surge in LH production triggers ovulation. After ovulation, it is necessary for developmemt of the corpus luteum.
- Chromophobes show little affinity for dyes in histological sections . They have usually less cytoplasm. Studies of the pituitary with the electron microscope revealed that there are relatively few cells with no specific granules. The cells of adenohypophysis are believed to have cyclic secretory activity, first accumulating and then releasing their product. It is likely that formerly identified as chromophobes are actually partially degranulated acidophils or basophils.

# 18-10 Hypophysis, anterior lobe 6. Monkey, M-G stain, x 64.



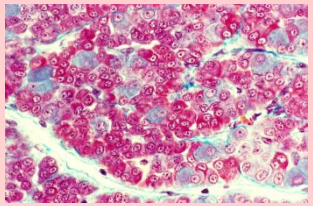
- The lower left one third of this figure consists of mainly red stained acidophils, whereas the upper right two thirds consists of basophils and chromophobes. The cleft- like spaces among the cell cords and clusters are all sinusoidal capillaries.

# 18-11 Hypophysis, anterior lobe 7. Monkey, M-G stain, x 160.



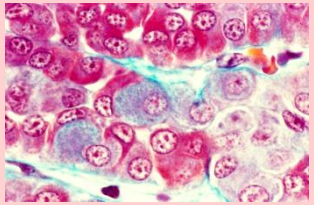
- The acidophils, basophils, and chromophobes are easily recognized. The sinusoidal capillaries are all underlain by reticular fibers.

# 18-12 Hypophysis, anterior lobe 8. Monkey, M-G stain, x 160.



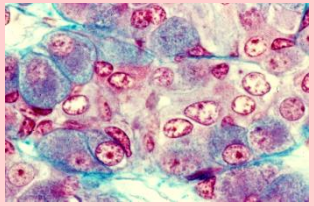
- This field consists mainly of acidophils, intermingled by small number of basophils. An arrow indicates a cluster of chromophobes, and S sinusoid.

# 18-13 Hypophysis, anterior lobe 9. Monkey, M-G stain, x 400.



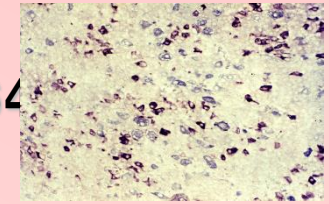
- Higher magnification of 18-12. The acidophils and basophils are clearly distinguished. An arrow indicates a cluster of chromophobes. S indicates the sinusoidal capillaries.

# 18-14 Hypophysis, anterior lobe 10. Monkey, M-G stain, x 400.



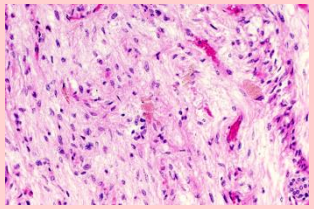
- A cluster consisting of basophils and chromophobes is shown. S indicates the sinus- oids.

# 18-15 Hypophysis, anterior lobe 11. Rat, enzyme-antigen method, x 64



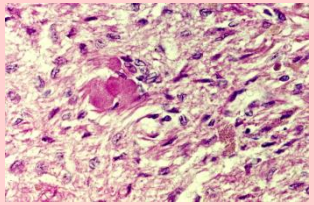
- This preparation was made by enzyme-antigen method according to the Nakane. ACTH cells stain dark blue and LH cells dark brown.
- This preparation was made by Dr. S. Fujii.

# 18-16 Hypophysis, posterior lobe 1. Human, H-E stain, x 64.



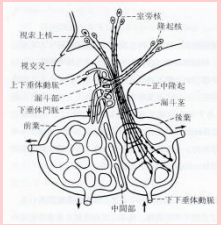
- The posterior lobe consists of axons, axon terminals of neurons and glial elements. The cell bodies of these axons and axon terminals locate in the hypothalamus.
- This figure shows the general structure of the neurohypophysis consisting of un- myelinated nerve fibers and nuclei of glia cells. Some of the glia cells are large and their cytoplasm is filled by brown granules (arrow). They were formerly named pituicytes which secrete the hormones of the posterior lobe. This idea has been denied since 1949, when Prof. Bargman found the neurosecretory phenomena.

# 18-17 Hypophysis, posterior lobe 2. Human, H-E stain, x 160.



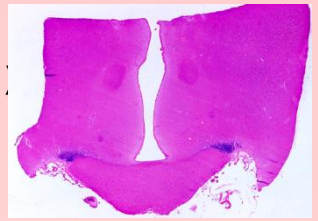
- At the center of this figure there are several Herring bodies that are stained deep red. Around them are un-myelinated nerve fibers and nuclei of glia cells. A pituicyte contain- ing brown granules is indicated by an arrow.

# 18-18 Hypophysis. Vascular system and neurosecretion. Scheme.



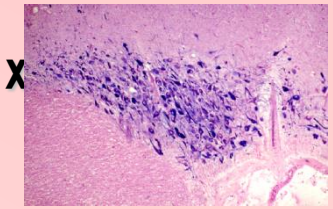
- The hormones secreted by the neurohypophysis or posterior lobe, oxitocin and vaso- pressin, are not produced in the posterior lobe but in the neurons locating in the hypo- thalamus. The cell bodies of these neurons are in the **supraoptic nucleus** and in the **paraventricular nucleus**. Unmyelinated axons of these neurons form the hypothalamo- hypohyseal tract , which descends into, and makes up the bulk of, the substance of the posterior lobe. The oxitosin and vasopressin are transported through the axons from these nuclei into the posterior lobe and stored here. According to the circumstances they are released into the fenestrated capillaries via pericapillary spaces.
- The secretory activity of the adenohypophysis depends on activation of its cells by neurohumors, called **releasing factors**, produced by neurons in the median eminence and carried to the anterior lobe by a portal system of veins, called **hypophyseoportal system**, This atypical vascular architecture of the hypophysis is of cardinal importance to its function.
- Two **inferior hypophyseal arteries**, branches of the internal carotid artery, arborize in the capsule of the gland sending branches into the posterior lobe, and to a lesser extent into the anterior lobe. Several **superior hypophyseal arteries**, also arising from the int- ernal carotid, anastomose freely around the median eminence. Capillaries arising from these vessels penetrate into the median eminence, forming the so called **primary plexus**. These capillaries then return to the surface where they confluent to form venules that course downward around the hypophyseal stalk to join an extensive network of thin- walled sinusoids within the anterior lobe. The venules connecting the primary plexus in the median eminence with the secondary plexus of sinusoids in the anterior lobe consti- tute the **hypophyseoportal system**. It supplies the major portion of the blood circulating in the anterior lobe and carries the releasing factors that stimulate its cells to secrete their hormones. The venous drainage of the hypophysis is mainly via vessels that run in the vascular layer of the capsule toward the diaphragma sellae and then to the neighboring dural sinuses.
- Around the primary plexus there are numerous endings of the neurons locating in the nucleus tuberalis of the hypothalamus. These neurons produce the hormones, hormone- releasing factors and hormone-release-inhibiting factors. They are released via perica- pillary space into the fenestrated capillaries and transported into the anterior lobe, where they influence the activity of the cells of the anterior lobe.

# 18-19 Hypothalamus, nucleus supraopticus 1. Dog, Bargmann's stain, 2.6.



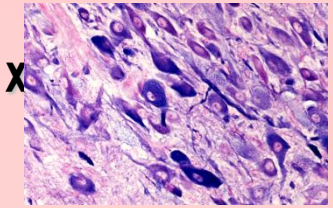
- This is a frontal section of the dog diencephalon showing the supraoptic nucleus. After the Bargmann's stain, the section was counterstained with Kernechtrot.

# 18-20 Hypothalamus, nucleus supraopticus 2. Dog, Bargmann's stain, x 25.



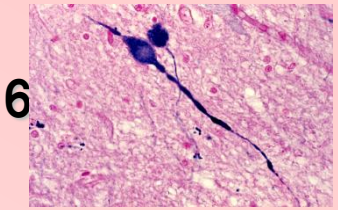
- Higher magnification of 18-19. The neurosecretory neurons are stained dark blue by this staining.

# 18-21 Hypothalamus, nucleus supraopticus 3. Dog, Bargmann's stain, x 100.



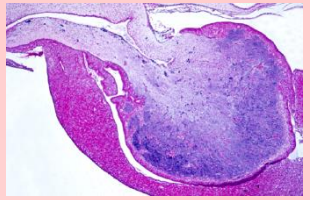
- Higher magnification of 18-20. The neurosecretory neurons are stained deep blue, not only their cytoplasm but also their axon filled by the neurosecretory substances.

# 18-22 Hypothalamus. Neurosecretory cells. Dog, Bargmann's stain, x 16



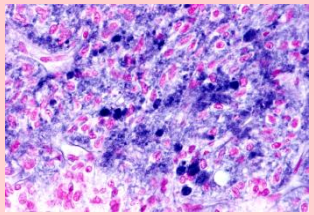
- Two neurosecretory cells are shown. The cytoplasm and axon are both filled by neuro- secretory substances. An axon shows partial thickenings which are local accumulation of the neurosecretory substances.

# 18-23 Hypophysis. Infundibulum and posterior lobe. Dog, Bargmann's stain, x 10.



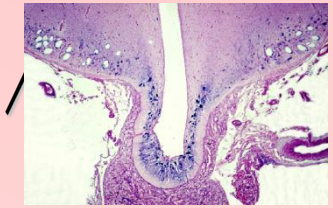
- This is a sagittal section of a dog hypophysis. At the upper left corner is the infun- dibulum and from here continues the neurohypophysis, posterior lobe right-downward. Anterior to this is the anterior lobe separated by a narrow space. The posterior lobe stains as a whole dark blue due to the presence of neurosecretory substances. Within the anterior wall of the infundibulin and also within the posterior lobe there are nume- rous spots stained dark blue. They are local accumulations of the neurosecretory substances.

# 18-24 Hypophysis. Posterior lobe. Dog, Bargmann's stain, x 160.



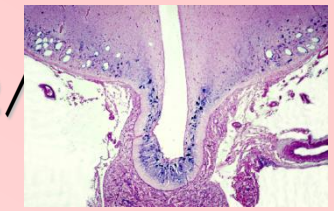
- This field is filled by fine and coarse granules stained dark blue, that are neuro- secretory substances. The coarse granules are so called Herring bodies. The nuclei are stained pink with Kernechtrot.

# 18-25 Hypothalamus and infundibulum. Dog, Bargmann's stain, x10. (1/



- This is a frontal section of hypothalamus and infundibulum. In the middle the third ventricle ( III ) runs vertically, the floor of which is the infunfibulum. In the wall of the infundibulum there are a lot of neurosecretory granules, fine as well as coarse. Right and left to the infundibulum there are areas where numerous dark blue granules and perforated by numerous blood vessels. This areas are called the tuber cinereum and neurosecretory neurons are called as a whole nucleus tuberalis.
- The posterior lobe secrete two hormones, oxitocin ( OT ) and vasopressin ( VP ), that is called also antidiuretic hormone ( ADH ). They were formerly thought to be produced in the different hypothalamic nuclei, i.e. oxitocin in the paraventricular nucleus and vaso- pressin in the supraoptic nucleus. The two hormones are now known to be synthesized in different types of neurons, but these are present in both the supraoptic and para- ventricular nucleus. The hormones are similar polypeptides, consisting of nine amino acids and differing from one another in only two amino acids.
- The principal target of oxitocin is the myometrium of the pregnant uterus. Its con- centration in the blood inceases deuring the late stage of labor and it is believed to have a significant role in parturition, stimulating contraction of the uterine smooth muscle.It is also responsible for milk ejectionfrom the lactating mammary gland. Stimulating of the nipple by the suckling infant sends afferent impulses to the brain that are relayed to the supraoptic and paraventricular nuclei, which respond by releasing oxitocin into the capillaries of the neurohypophysis.Blood-borne oxitosin then stimulates contraction of myoepitherial cells around the alveoli of the mammary gland, ejecting milk into the ducts.

# 18-25 Hypothalamus and infundibulum. Dog, Bargmann's stain, x10. (2/

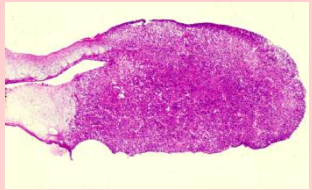


- A major target of vasopressin ( VP ) is the collecting ducts of the kidneys. The inter- stitium of the renal medullais hypertonic to the glomerular filtrate in the lumen of the collecting ducts, creating anosmotic gradient that is nexessary for conversation of water and concentration of the urine. Circulating vasopressin binds to specific receptors in the vasolateral membranes of the cells lining the distal convoluted tubules and collecting ducts and stimulates cyclic AMP activity.. This, in turn, activates a protein kinase that acts on the membrane protein to increase the permeability of the apical plasma mem- brane to water. This permits diffusion of water from the lumen of the tubules up the concentration gradient to the interstitium, thus decreasing the volume of urine and increasing its concentration. This effect of VP is the basis for its name, antidiuretic hormone ( ADH ).

# 18-002 Pineal Body

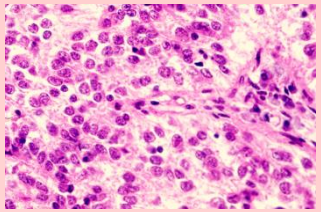
- The pineal body is a small organ in the midline projecting from the posterior end of roof of the diencephalons. A shallow recess of the third ventricle extends into its short stalk, recessus pinealis. It is a flat elliptic body measuring 8 ～10 mm long, 3 ～5 mm wide and about 1 mm thick. Its activity is influenced by the daily cycle of light and dark and responding to annual changes in day-length it influences gonadal activity.
- The pineal body is enclosed by the connective tissue coat of the pia mater and the parenchyma consists of pail-staining epitheloid cells. Their nuclei are spherical and the cytoplasm shows slight basophilia. The contour of these cells is difficult to discern in routine histological preparations but with the silver impregnation methods one or more long processes can be demonstrated that terminate in bulbous expansions on or near capillaries.
- The principal hormone of the pineal body is the indolamine **melatonin** but several biologically active peptides were detected, some of that may influence reproduction.

# 18-26 Pineal body, sagittal section. Human, H-E stain, x 6.4.



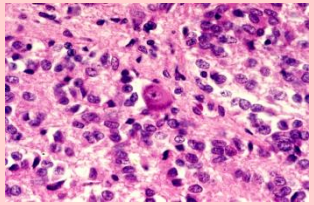
- This shows the general view of the sagittal section of the pineal body. The paren- chyma consists of densely packed pineal cells. In the lower wall of the pineal recess is a large area of the transversely sectioned nerve fiber bundles, the commissural posterior, whereas in the upper wall of the pineal recess, a thin layer of transversely sectioned nerve fiber bundles, the commissural habelnarum.

# 18-27 Pineal body. Pineal cells. Human, H-E stain, x 160.



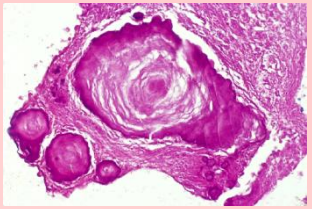
- The pineal cells are arranged here randomly; they have a spherical nucleus and rela- tively abundant cytoplasm but their contour is not discernible. Arrows indicate capilla- ries.

# 18-28 Pineal body. Pineal cells and a neuron. Human, H-E stain, x 160.



- At the center among the pineal cells there is a nerve cell. The contour of the pineal cells is not discernible in H-E stained specimen.

# 18-29 Pineal body. Acervulus. Human, H-E stain, x 64.

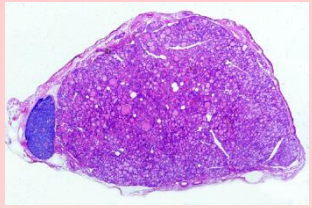


- The human pineqal body contains peculiar extracellular concretion called acervulus or brain sand. These bodies consist of calcium phosphate3s and carbonates in an organic matrix deposited in concentric layers. Their significance is poorly known.
- In this figure one large and several small acervulus are seen.

# 18-003 Thyroid Gland

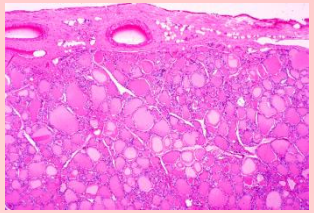
- The thyroid gland is situated below the larynx in the anterior portion of the neck. It weighs 25～40 g, and consists of two lateral lobes connected by a narrow median portion, isthmus, showing, as a whole, a configulation of a butterfly.
- The hormones of the thyroid gland are **thyroxin** and **triiodthyronine;** they are essen- tial for normal growth and development, and in the adult regulate the rate of metabolism in cells throughout the body. Thyroid function, in turn, is controlled by the hypophyseal hormone, thyroid stimulating hormone ( FSH ).
- The thyroid gland is enclosed by connective tissue capsule that is continuous with the cervical fascia. On its posterior surface attach four parathyroid glands.

# 18-30 Thyroid gland and parathyroid gland. Human, H-E stain, x 1.5.



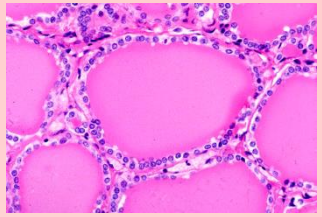
- This figure shows the general view of the thyroid gland and the parathyroid gland, attaching to the thyroid gland. They are commonly enclosed by a connective tissue cap- sule. This specimen was very freshly fixed so that histological features of two organs are well preserved.

# 18-31 Thyroid gland. Human, H-E stain, x 10.



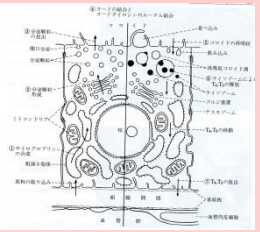
- The upper edge of this figure is the connective tissue capsule, containing some blood vessels and fat cells. The parenchyma of the gland consists of innumerable large and small follicles filled by homogeneously deep pink stained colloid.

# 18-32 Thyroid gland, follicles. Human, H-E stain, x 100.



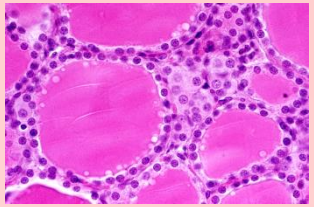
- Higher magnification of 18-31. The parenchyma of the thyroid gland consists of in- numerable large and small follicles. Each follicle is encircled by a dense network of blood capillaries and lined by a simple cuboidal epithelium and its lumen is filled by homogeneously deep pink stained colloid which shows positive PAS reaction. The epithelial cells have a spherical nucleus at the center of the cytoplasm which is colorless or faintly stained by eosin. Between the apical surface of the epithelial cells and colloid large and small vacuoles are usually numerously observed but in this specimen they are very few because of the fresh fixation.
- The colloid is the secretion of the follicular epithelial cells containing the thyro- globulin, glycoprotein of about 6.6 x 105 molecular weight. The hormones of the thyroid gland are thyroxin( tetraiodothyronine , T4 ) and triiodethyronine ( T3 ).

# 18-33 Scheme showing the secretion mechanism of the thyroid gland.



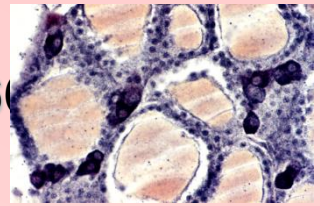
- The hormones of thyroid gland, T4 and T3 , consist of two thyrosins bonded together in ether form (－O－). ① The follicular epithelial cells take up the row material at the basal surface from the blood via pericapillary space and synthesize the precursors of the thyroblobulin in rER. ② The Golgi complex adds them glycogen and forms the secretion granules. ③ They are ecrinely secreted into the lumen of the follicle, ④ where bonding of iod and ether bonding of iodothyrosin takes place and T4 and T3 are established. ⑤ The colloid containing T4 and T3 is re-absorbed by pinocytosis and phagocytosis into the epithelial cell. Re-absorbed colloid droplets coalesce becoming larger and then ⑥ they are decomposed by lysosomes resulting in the liberation of the T4 and T3. The T4 and T3 move basalward and ⑦ finally are released from the basal surface of the cell into the capillary via pericapillary space. The T4 and T3 can not be visualized by the morphological methods.

# 18-34 Thyroid gland, parafollicular cells. Dog, H-E stain, x 160.



- In dogs and rats, the second type cells are found attaching the follicular cells and in the interfollicular spaces, the parafollicular cells. They are round or elliptic cells, two or three times larger than the follicular dpithelial cells. The hormone secreted by these cells is **calcitonin**. At upper right to the centrally located follicle there is a cluster of the parafollicular cells that have spherical nuclei and abundant cytoplasm.
- In human they are very few, comprising only 0.1% of the epithelial cells, and difficult to be found in the usual sections.

# 18-35 Thyroid gland, parafollicular cells. Dog, silver impregnation, x 16

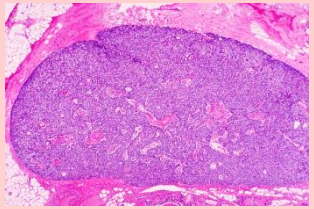


- Employing the Davenport's silver impregnation method the parafollicular cells are specifically blackened as in this figure.

# 18-004 Glandula parathyreoidea

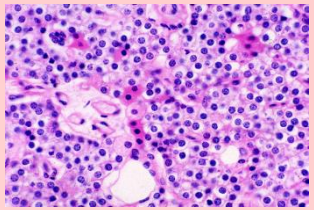
- The glandula parathyreoidea are two pairs of small bodies adhering to the posterior surface of the thyroid gland and secrete the parathyroid hormone ( PTH ). They mea- sure about 5 mm in length. 4 mm in width, and 2 mm in thickness. Each parathyroid gland is enclosed in a thin connective tissue capsule from which trabeculae extend inward carrying the blood vessels, nerves and lymphatics. The parenchyma of the gland consists of anastomosing cords and clusters of epithelial cells.supported by a delicate framework of reticular fibers. Two types of epithelial cells are found in the human para- thyroid gland: **chief cells** and **oxyphil cells**..

# 18-36 Glandula parathyreoidea, general view. Human, H-E stain, x 10.



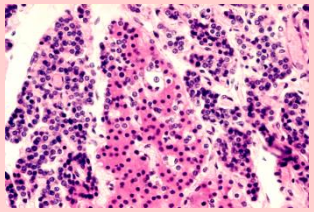
- This is a general view of a human parathyroid gland, higher magnification of 18-30. The parenchyma of the gland consists of densely packed epithelial cells staining deep violet, intermingled by the trabeculae carrying the blood vessels.
- The hormone of the parathyroid gloand is called parathormone, polypeptide of about 9.000 molecular weight, which maintains and controls the concentration of calcium ions in the body fluid.

# 18-37 Glandula parathyreoidea 1. Human, H-E section, x 130.



- Higher magnification of 18-36. The parenchyma of the parathyroid gland consists mainly of chief cells intermingled by less numerous oxyphil cells.
- The chief cells are round or polyhedral, 7 to 10 μm in diameter, and have a spherical nucleus at the center. Their cytoplasm is clear and colorless or stained faintly by eosin. Intermingled with these cells there are numerous cells with cytoplasm steined by hematoxylin light violet.
- The oxyphil cells are large polyhedral cells extending cytoplasmic processes into the intercellular spaces of the chief cells. Their abundant cytoplasm is stained by eosin deep red and their spherical nucleus stains dark blue. The eosinophilic granulation of the oxyphil cell cytoplasm is now attributed to their abundant mitochondria.
- The principal function of parathyroid hormone is to maintain the concentration of calcium ions in the body fluids within the narrow limits of 8.5 ～10.5 mg /100ml. When calcium falls below this level, the parathyroids rapidly increase their secretion of parathyroid hormone to 5 to 10 times the basal rate. Parathyroid hormone acts on the osteocytes of bone, causing them to mobilize calcium ions from the bone mineral forming the walls of the lacunae that they occupy — a process called osteocytic osteolysis.

# 18-38 Glandula parathyroidea 2. Human, H-E stain, x 100.



- In the aged persons, large clusters of the oxyphil cells are sometimes encountered. In this specimen of 69 years male such a cluster of oxyphil cells was observed.

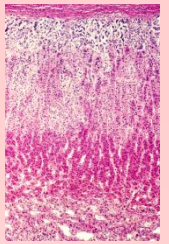
# 18-005 Adrenal Gland

- The adrenal glands are embedded in adipose tissue at the cranial pole of each kidney. They consist of two components of different origins. The cortex, making up 80~90% of the volume of the gland, is of mesodermal origin, whereas the medulla, constituting 10~20%, arises from ectoderm of the embryonic neural crest. On the cut surface of a transverse section of the gland, the cortex looks yellow and clearly distinguishable from the medulla looking reddish-gray.
- The principal functions of the adrenal glands are to maintain the constancy of the internal environment of the organism and to make appropriate changes in its physiology in response to acute stress, injury, or prolonged deprivation of food and water. The cortex is controlled by the adrenocorticotrophic hormone (ACTH) of the anterior pituitary and secretes steroid hormones ( **aldosterone**, **cortisol**, and **dehydroepi- androsterone** ). These hormones have multiple reguratory effects on carbohydrate and protein metabolism and electrolyte balance. The medulla is controlled by preganglionic sympathetic nerves and secretes catechoramines ( **noradrenaline** and **adrenaline** ) which increase heart rate and blood pressure and mobilize glucose and fatty acids as energy sources in stressful emergency situations.

# 18-39 Adrenal gland, general view. Human, H-E stain, x 1.6.

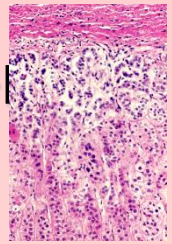
- This is a general view of human adrenal gland, sagittally sectioned. The surface of the gland is covered by connective tissue capsule and beneath it the thick cortex encloses the thin medulla in which large and small sections of the blood vessels are seen.

# 18-40 Adrenal gland. Cortex and medulla. Human, H-E stain, x 25.



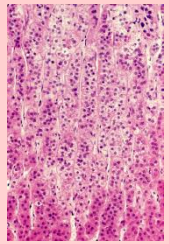
- The general construction of the adrenal gland is shown. The cortex consists of three concentric zones: outer zona glomerulosa, intermediate zona fasciculata, and inner zona reticularis. The transition from zone to zone is gradual in histological sections, but that from the cortex to the medulla is evident although there is no boundary by the connective tissue.

# 18-41 Adrenal gland. Zona glomerulosa and zona fasciculata. Human, H-E stain, x 64.



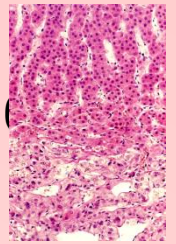
- The zona glomerulosa consists of columnar epithelial cells which form closely spaced arcades that bear a similar appearance to acini of exocrine glands. These are separated by thin connective tissue septa that extend inward from the capsule. The cells have darkly stained nuclei and their cytoplasm is stained lightly by hematoxylin. This bluish hue fades inward. A few lipid droplets are present in the cytoplasm. The cells of zona glomerulosa secrete the mineralcorticoid, aldosterone.
- The zona fasciculata is the thickest zone and made up of pale staining polyhedral cells arranged in long columns that are oriented radially in relation to the medulla. The columns are one or two cells thick and separated from one another by capillaries of similar prevailing orientation. The faintly acidophilic cytoplasm of the cells are filled by abundant lipid droplets. As these are extracted during the preparation procedures, the cells are seen highly vacuolated in usual specimens. Each cells are larger than that of zona glomerulosa and zona reticularis.

# 18-42 Adrenal gland. Zona fasciculata and zona reticularis. Human, H-E stain, x 64.



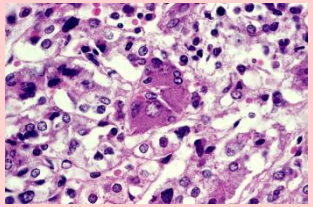
- The zona fasciculate occupies about half of the width of the cortex and consists of cell columns of two cell thick, arranged parallel to one another, radially to the medulla, and separated from one another by the sinusoidar capillaries ( S ). The cells have deeply stained spherical nuclei and their cytoplasm, faintly acidophilic, is densely filled by lipid droplets. As these lipid droplets are extracted by the preparation making procedures the cells of the zona fasciculate appear highly vacuolated in usual specimens.
- In the zona reticularis cells are somewhat smaller and their cytoplasm stains deep red. Cell columns branch and anastomose one another forming a coarse meshwork.

# 18-43 Adrenal gland. Zona reticularis and medulla. Human, H-E stain, x (



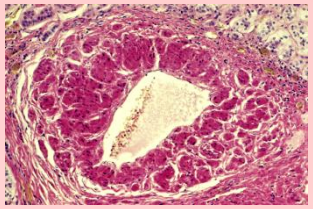
- The boundary of the zona reticularis to the medulla is indicated by arrows. Although there is no separation by the connective tissue, the boundary between these two is distinct. The parallel cell columns of the zona fasciculata give way to a three-dimensional network of anastomosing cell cords, in the zona reticularis. The cells are somewhat smaller and stain more deeply because their cytoplasm contains fewer lipid droplets. Intracellular accumulation of brown pigment are common.
- The medulla is composed of large epithelioid cells, ranging 15 x 20 $\mu$m～20 x 30 $\mu$m, arranged in rounded clusters or short cords that branch and anastomose forming a coarse meshwork intermingled by capillaries and venules. The cytoplasm of these cells stains light pink or light violet in usual H-E staining, easily distinguishable from the cells of the zona reticularis. When the specimen is freshly fixed in a solution containing potassium dichromate, fine brownish yellow granules appear in the cytoplasm abundantly.. This phenomenon is called chromaffin reaction. Two kinds of cells are distinguished: the ones have the cytoplasm showing the moderate chromaffin reaction and distinct basophilia. They secrete adrenarline. The others have the cytoplasm showing the intense chromaffin reaction. They secrete noradrenaline.

# 18-44 Adrenal gland, medulla. Human, H-E stain, x 160.



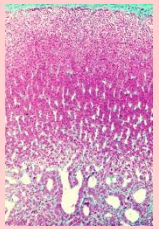
- At the center three nerve cells are seen. The adrenal medulla developed from the embryonal neural crest cells, so that it has an intimate relationship with sympathetic nervous system. The cells of the adrenal medulla fall into autolysis soon after the stop of blood circulation. The medullary cells of this figure show the autolytic changes.

# 18-45 Central vein in the adrenal medulla. Human, H-E stain, x 40.



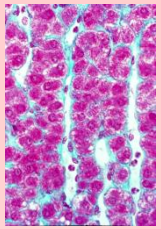
- The central vein runs longitudinally through the medulla. This vein has a thick wall consisting exclusively of longitudinally oriented smooth muscle fiber bundles.

# 18-46 Adrenal gland, cortex and medulla. Human, M-G stain, x 25.



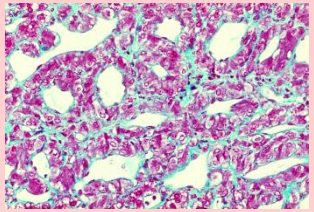
- In this M-G stained specimen the collagen and reticular fibers, enclosing the cell columns and underlying the sinusoid endothelium, appear green, so that differentiation of parenchymal cell columns from the sinusoids is evident.

# 18-47 Zona fasciculate. Human, M-G stain, x 160.



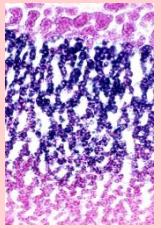
- Higher magnification of 18-46. The intimate relationship of the cell columns with the sinusoids ( S ) is evident.

# 18-48 Adrenal medulla. Human, H-E stain, x 80.



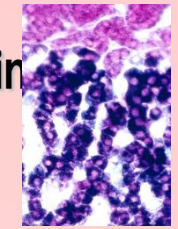
- In the medulla, parenchymal cells form cell clusters and cell cords that branch and anastomose composing the coarse meshwork. The meshes are filled by sinusoids ( S ) of large caliber. The reticular fibers, encircling the cell cords and underlying the suinusoidal endothelium, stain green.

# 18-49 Cortex of adrenal gland. Monkey, Sudan black stain, x 64.



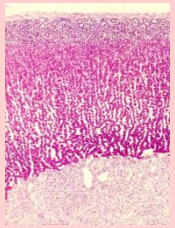
- Sudan black stains lipid dark blue. This is a frozen section stained by Sudan black. The cells of the zona fasciculate contain much lipid droplets that stain dark blue, whereas the cells of the zona glomerulosa and zona reticularis contain them only a few.

## 18-50 Zona glomerulosa and zona fasciculate. Monkey, Sudan black stain x 160.



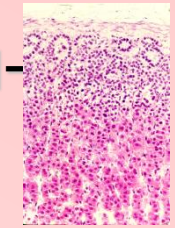
- Higher magnification of 18-48. The cytoplasm of the cells of the zona fasciculata is filled densely by the lipid droplets, whereas that of the zona glomerulosa contains them only a few.

# 18-51 Adrenal gland. Cortex and medulla. Monkey, H-E stain, x 25.



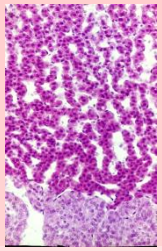
- This specimen was freshly fixed in a SUSA solution, so that the general staining is very good. The zona glomerulosa shows the distinct basophilic hue, whereas the zona fasciculata stains deep pink or red. Cells of the zona reticularis contain brownish granules and stain dark red.
- Cells of the medulla, on the contrary, stain light violet, so that the differentiation of the zona reticularis and medulla is evident.

# 18-52 Adrenal gland. Zona glomerulosa and zona fasciculate. Monkey, H-stain, x 80.



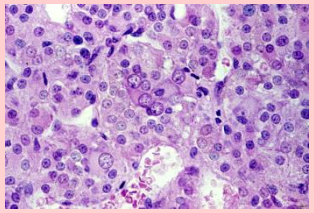
- Directly beneath the capsula fibrosa columnar epithelial cells of the zona glomerulosa form closely spaced arcades that are somewhat resemble to the acini of exocrine glands. Their cytoplasm stains faintly hematoxylin ( basophilic ). Proceeding inward this basophilic hue fades and then appears the acidophilc ( pink ) hue of the cells of the zona fasciculata. In the zona fasciculata cells form one or two cell thick long columns, that are oriented radially in relation to the medulla. Their cytoplasm stains with eosin deep pink or red and shows highly vacuolated appearance owing to the extraction of abundant lipid droplets during specimen preparation. Each cell column is separated from one another by sinusoidal capillaries of similar orientation.

# 18-53 Adrenal gland. Zona fasciculata, zona reticularis, and medulla. Monkey, H-E stain, x 80.



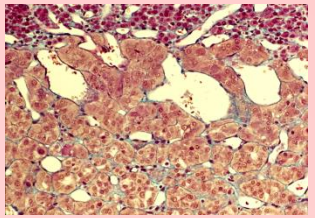
- Proceeding inward, the cell columns become slender and branch and anastomose one another to form the coarse meshwork and the zona fasciculata shifts into the zona reticularis. The cells of the zona reticularis are smaller than that of the zona fasciculata and contain brownish granules. The sinusoidal capillaries intermingling with them are of larger caliber. The cells of the medulla shows distinct violet ( basophilic ) hue so that differentiation of medulla from the zona reticularis is evident although there is no boundary layer of collagen fibers between them.

# 18-54 Adrenal gland. Medulla. Monkey, H-E stain, x 160.



- Higher magnification of 18-51 and 18-53. Two kind of cells are distinguished among the medullary cells: the ones show distinct basophilia and secrete adrenalin; the others show moderate basophilia but their chromaffin reaction is intense; they secrete nor-adrenalin. In this figure differentiation of these cells is distinct. At the center four neurons having a large spherical nucleus and large basophilic cytoplasm are seen. The medullary cells form cell clusters and cell cords that branch and anastomose with one another establishing a coarse meshwork which intermingles with sinusoidal capillaries of large caliber ( S ).

# 18-55 Adrenal gland, medulla. Chromaffine reaction. Monkey, M-G stain, x 64.



- This specimen was fixed by perfusion with a solution containing potassium dichromate. All the medullary cells show the chromaffine reaction, but cells of intense reaction can be identified from the cells of moderate reaction. Sinusoidal capillaries are all widened by the perfusion and tightly attach to the medullary cell cords.
- The upper one fifth of this figure is occupied by the zona reticularis of the cortex. At the boundary between the cortex and medulla, there is no connective tissue layer. The sinusoids of the cortex drain directly into that of the medulla.