Endocrine System

Undergraduate – Graduate
Histology Lecture Series

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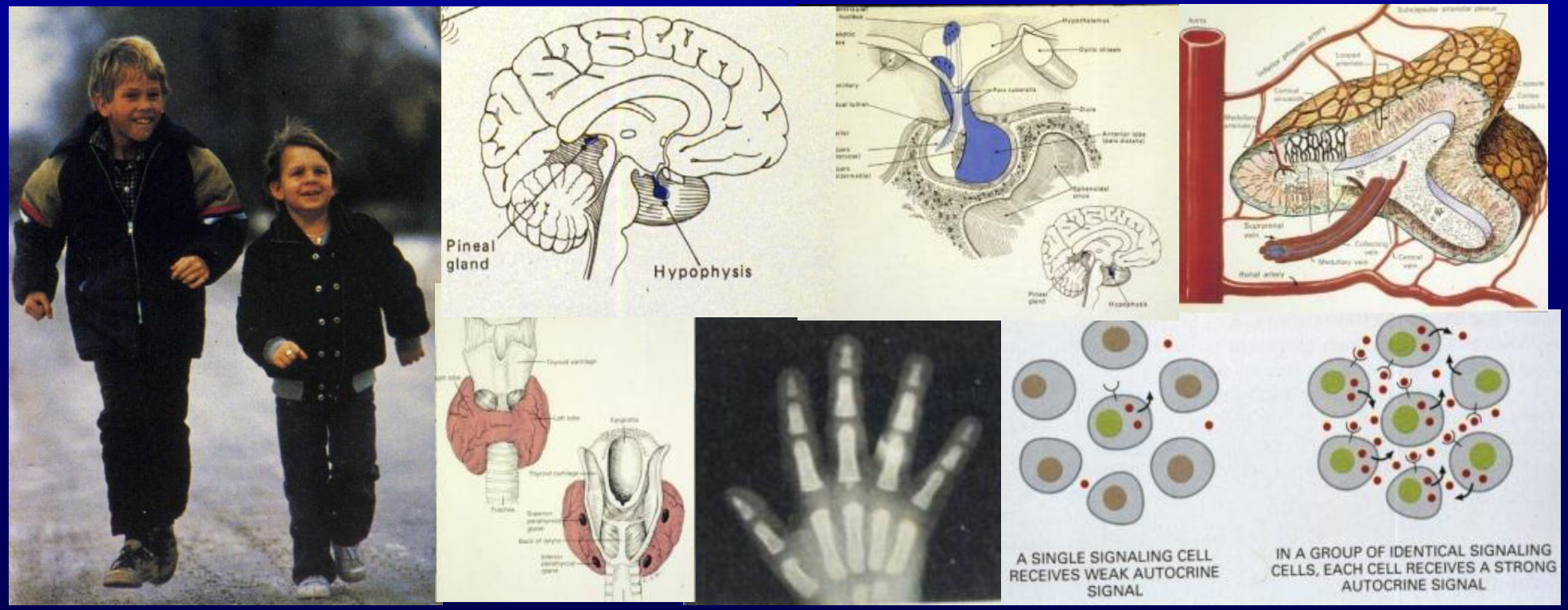
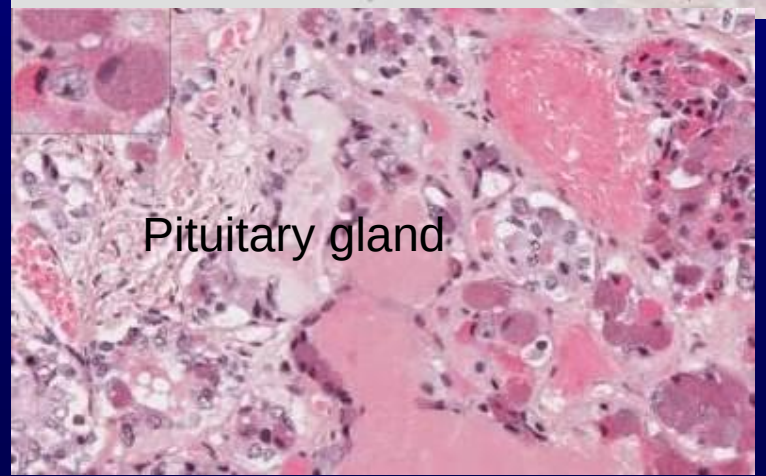


Endocrine system


Pituitary gland

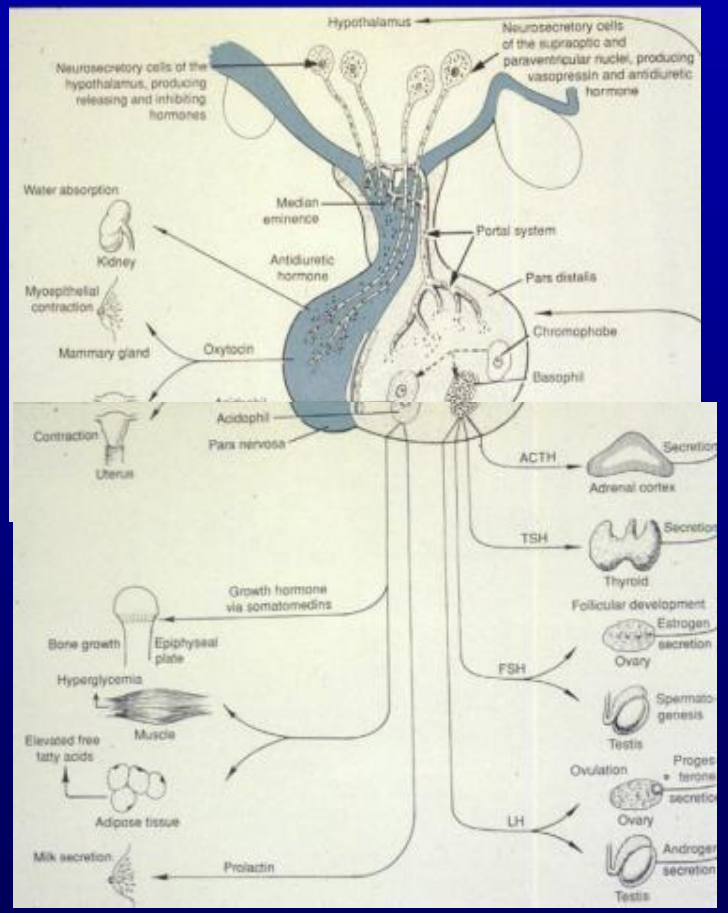

Adrenal gland

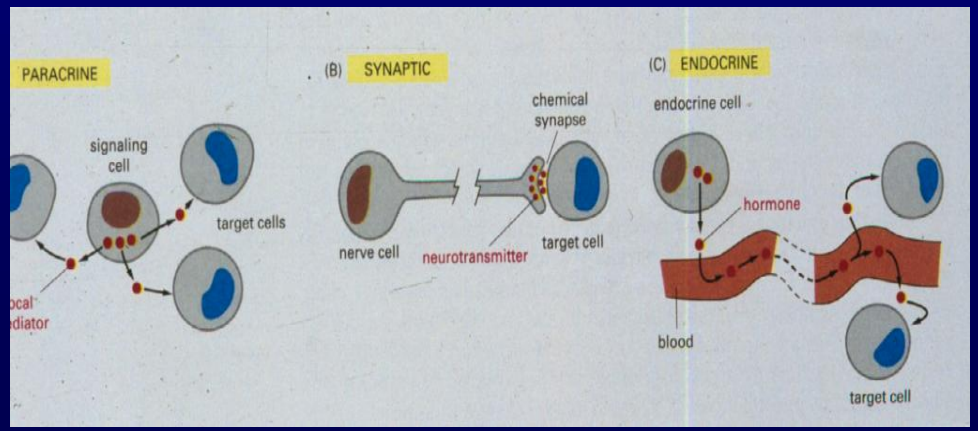

Thyroid gland

Objective

Gain a greater appreciation of the diversity of functions of the endocrine system

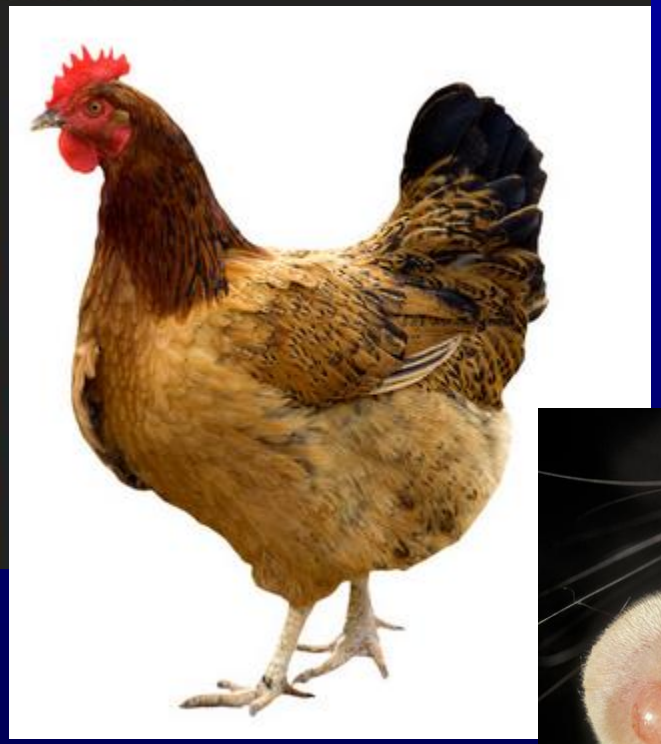
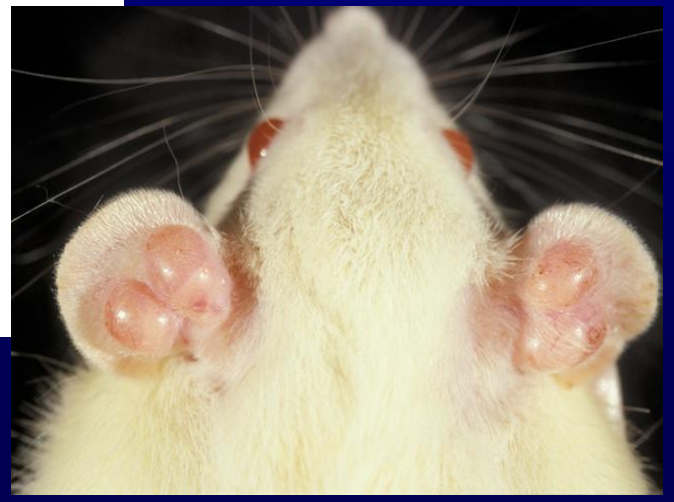
Recognize different organs, unique features of organs, and cells that make the endocrine system



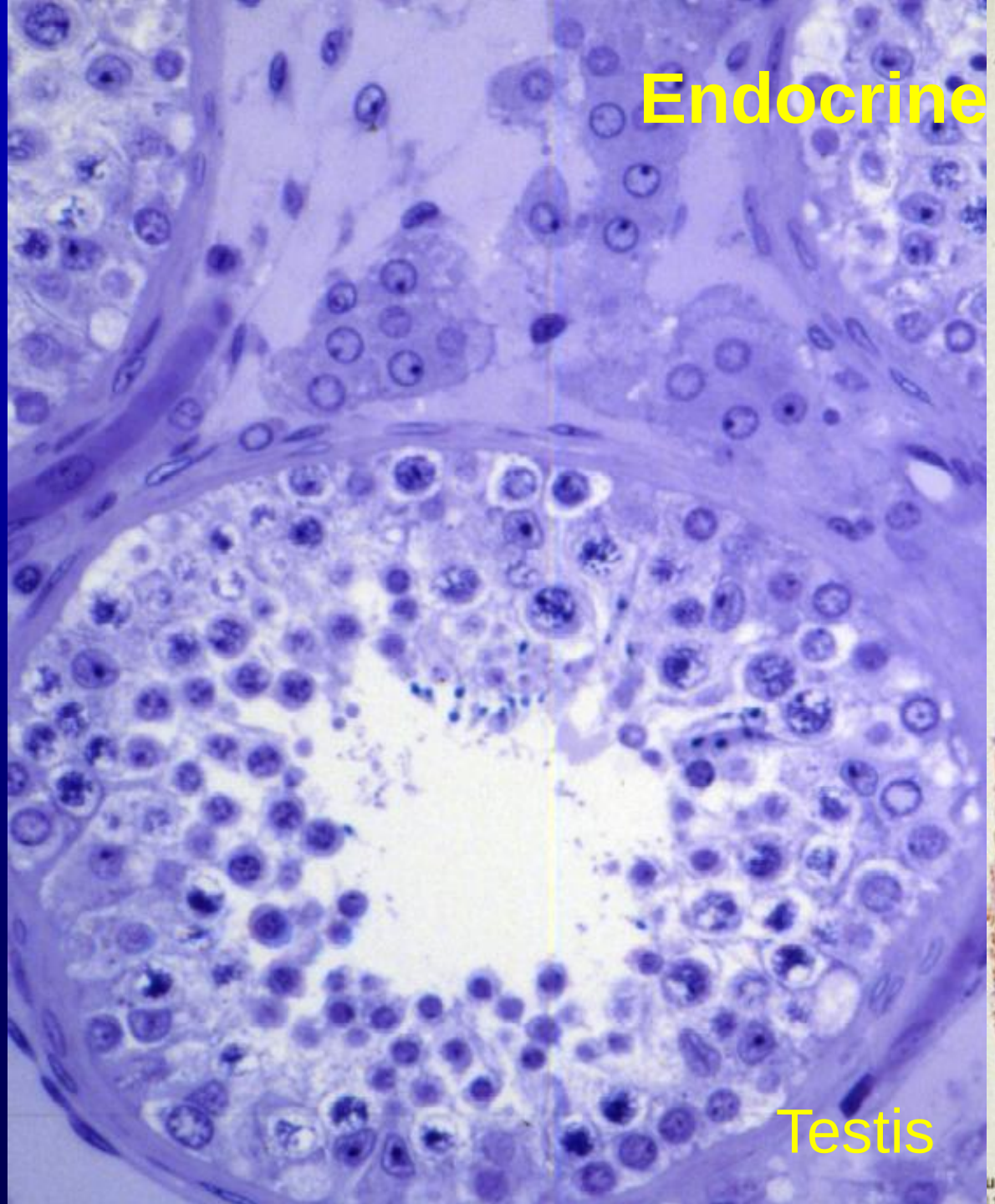




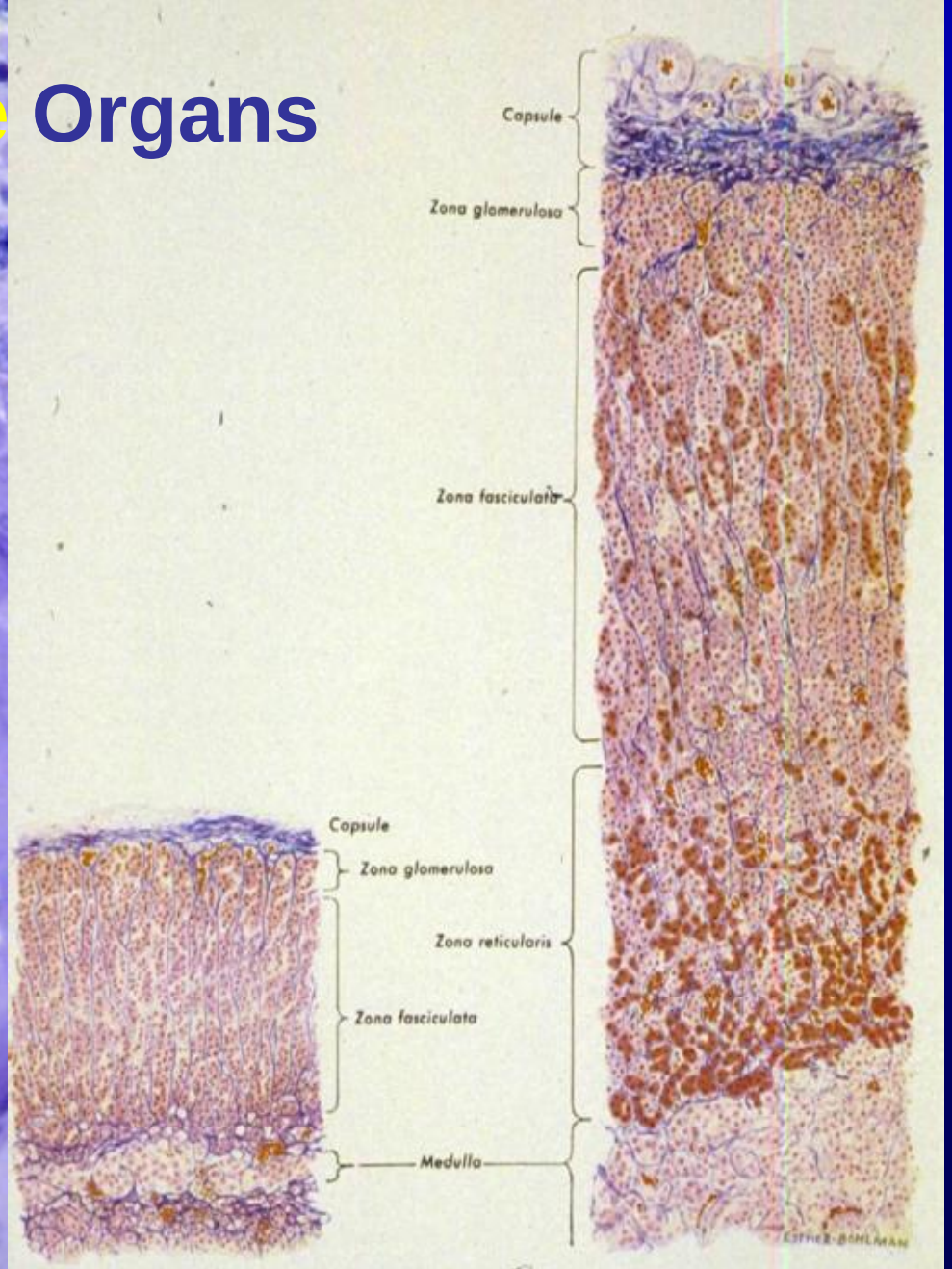


Endocrine Organs



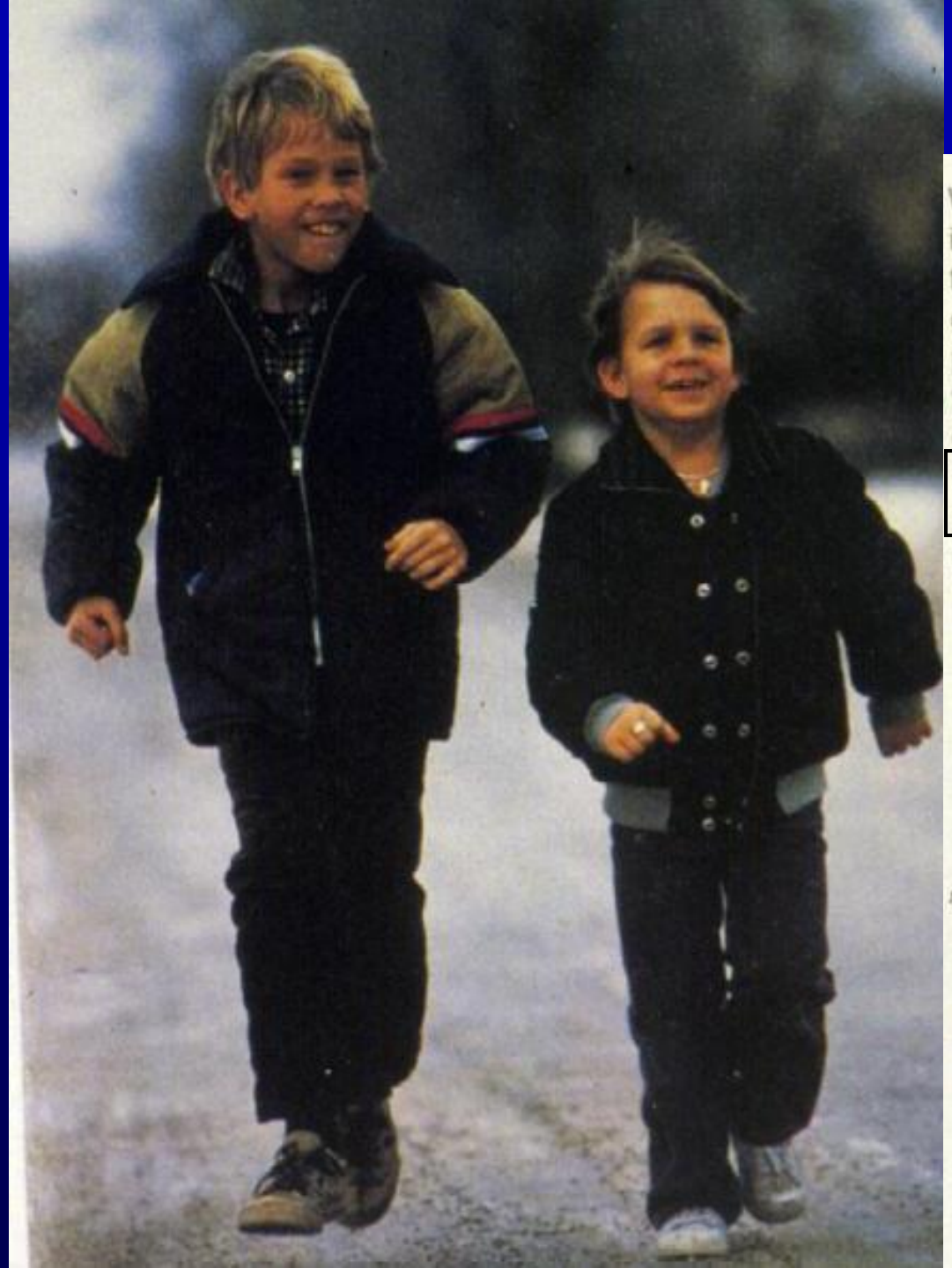
Testis



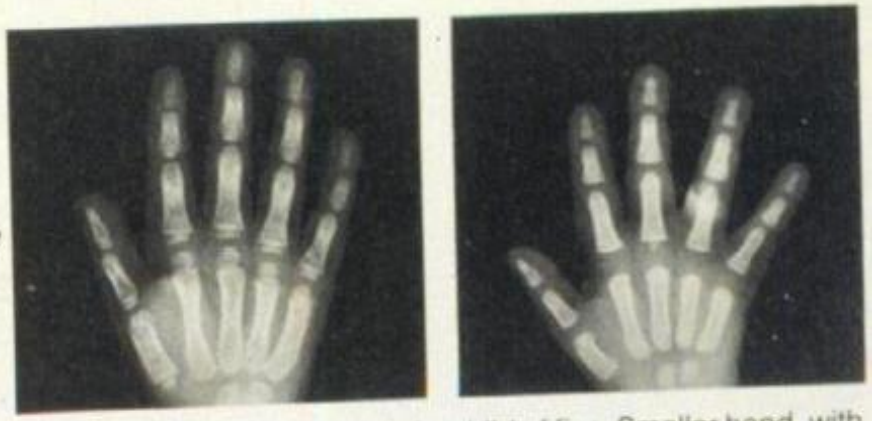
adrenal gland

ure 20–1. Sections through the adrenal glands of a 6-month-old infant *(left)* and of a man *(right)*. Mallory-azan stain

Growth Hormone



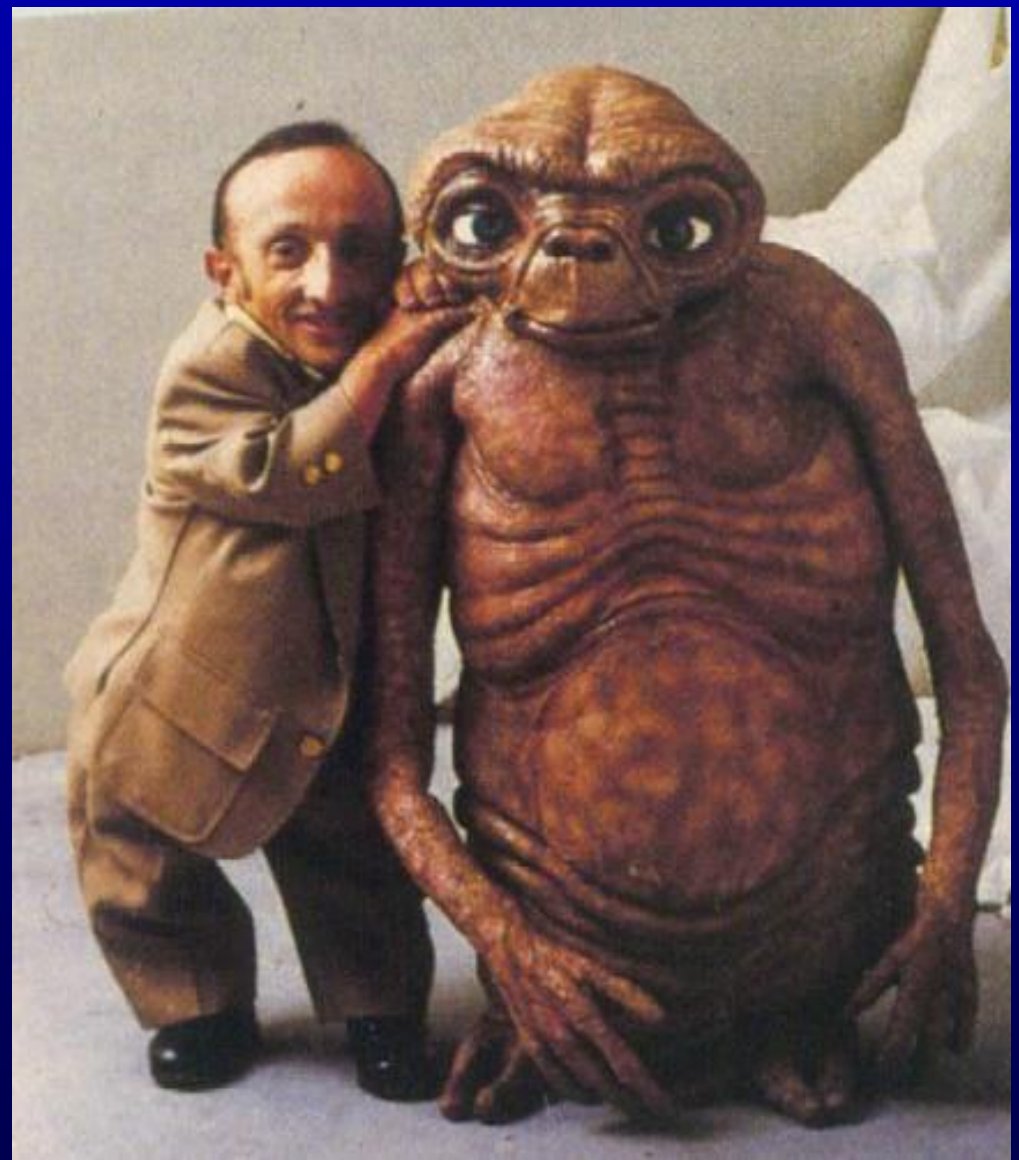
When a child is short for his age, it may be because he has inherited genes for short stature, but it can also be a sign that something is wrong. Possibilities include blood or liver disease, malnutrition, emotional deprivation, or insufficient production of growth hormone by the pituitary gland. One way doctors can determine whether short stature is normal, or a cause for concern, is to chart a child's growth rate. Between the ages of 3 and 9, the average youngster grows about 2 inches (5.1 centimeters) every year. Much slower growth is "a red flag," one specialist says, and signals the need for careful medical study. Injected growth hormone produces growth in some cases.



Each X ray shows the hand of a child of five. Smaller hand, with shorter bones, reveals insufficient growth hormone.

At the age of ten, a hormone-deficient boy (right) is shorter than a nine-year-old (left). Treatment with growth hormone has produced some increase in height.

Dwarf

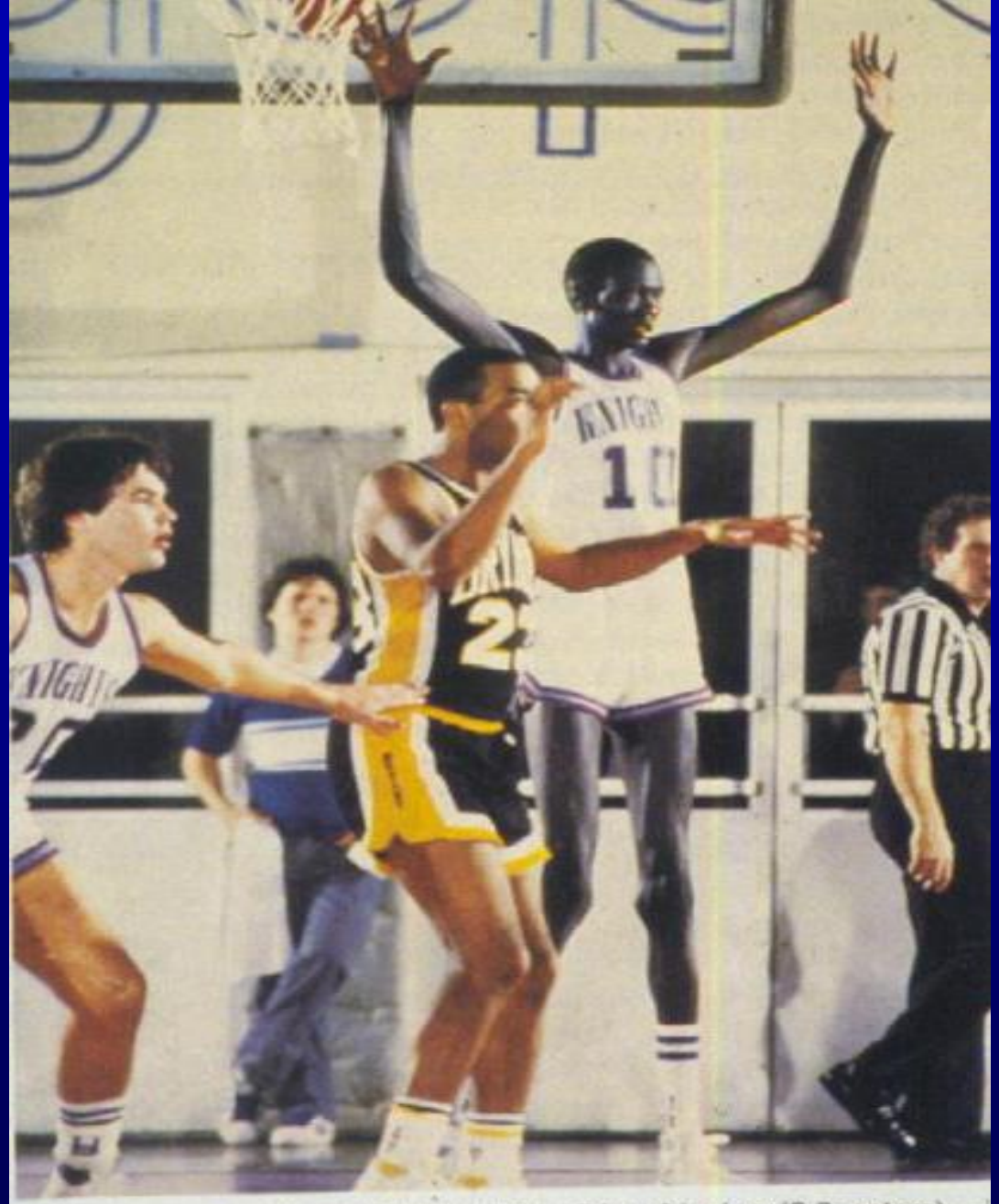


The outer-space being, E.T. the Extra-Terrestrial, in the motion picture of that name, was "played" chiefly by an elaborate piece of machinery, but in some scenes, a dwarf played the role.

Giant

A custom-tailored suit, fitted by a normal-size tailor, was a necessity for the 8-foot-5-inch (2.5-meter) giant Robert Wadlow.

Giant



Basketball player Manute Bol's height — 7 feet 6 inches (2.3 meters) — i
a normal, inherited trait. He is a member of the Sudanese Dinka tribe, on
of the tallest peoples in the world.

Introduction

Overview of endocrine system

Definition of endocrine gland secretions (hormones)

Physiological blood levels of hormones

- Glucose 10^{-2} molar
- Steroid 10^{-9} molar
- Peptide 10^{-12} molar

Growth hormone (blood levels)

- 10^{-13} molar = Dwarf
- 10^{-11} molar = Giant

Control of endocrine glands

Endocrine System Overview

Endocrine glands	• No ducts, highly vascularized, rich blood supply
	  • Secretions (hormones) can be released directly into blood stream
	  • Secretions can be stored in secretory granules
	  • Secretions can be stored extracellularly (e.g., thyroid)

Pituitary gland	• Anterior pituitary = *pars distalis* or *adenohypophysis*
	  • Ectoderm
	• Posterior pituitary = *pars nervosa* or *neurohypophysis*
	  • Midbrain

Thyroid gland	• Lobules and • Colloid filled follicles (extracellular storage)
Parathyroid gland	• Capsule with septa • Cords of epithelial cells supported by reticular fibers

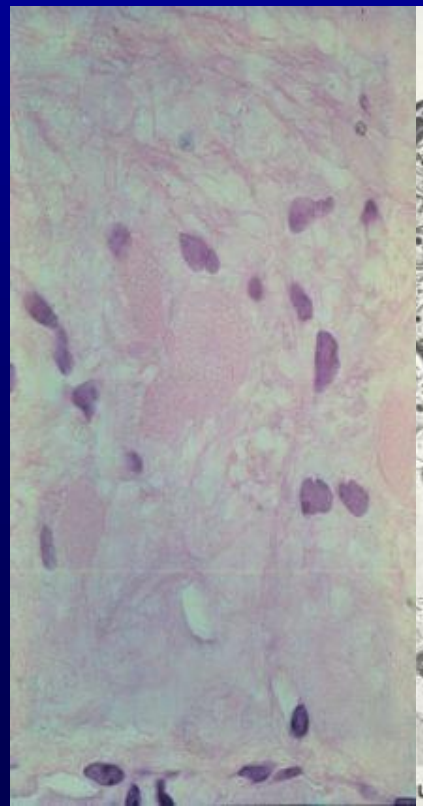
Adrenal gland	• Cortex
	  • Zona glomerulosa = mineralocorticoids
	  • Zona fasciculata = glucocorticoids
	  • Zona reticularis = androgens
	• Medulla
	  • Highly vascular, derived from neural crest

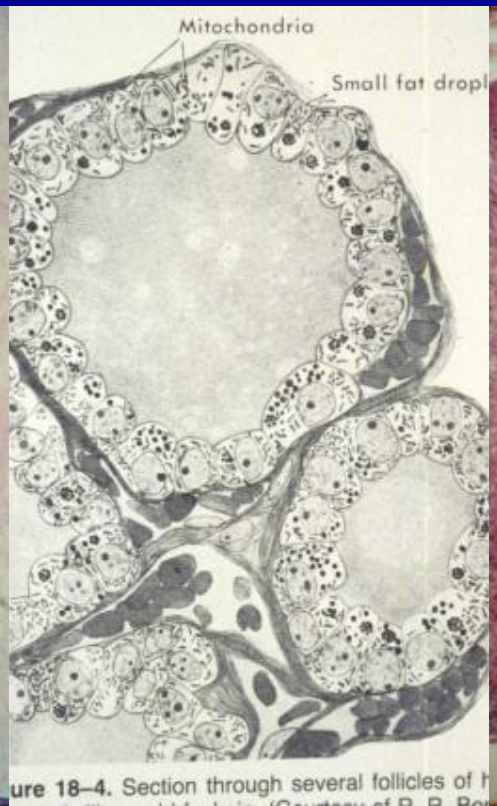
Pineal body	• *Epiphysis cerebri* • Capsule of pia mater • Lobules divided by capsule • Corpora arenacea = brain sand, pineal concretions that accumulate with age

Pancreas	• Both exocrine and endocrine
	  • Endocrine portion = **Islets of Langerhans**
	  • Alpha cells = glucagon
	  • Beta = insulin
	  • Delta = somatostatin

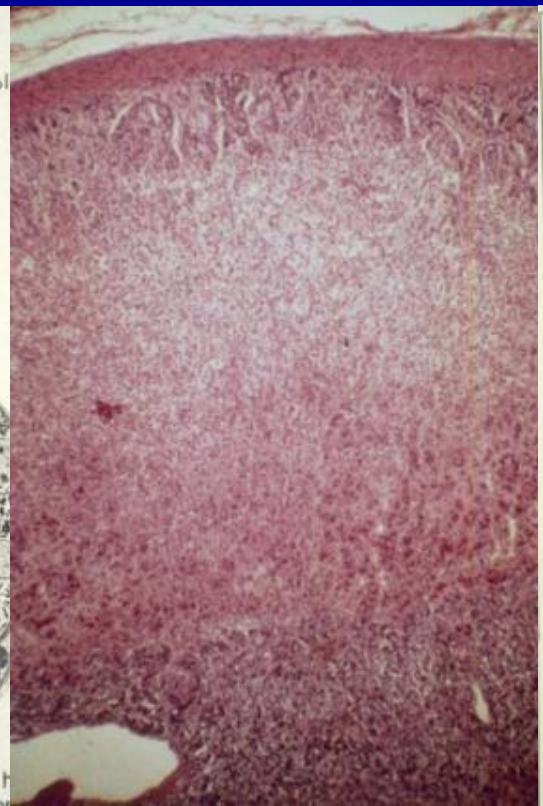
Endocrine = internal secretion
(without ducts and mostly from endoderm)

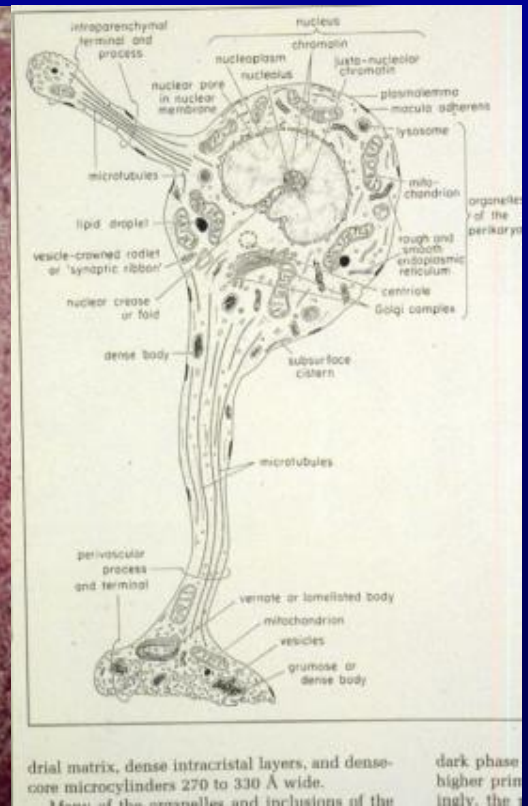
Hormone = to arouse or to set in motion





ure 18–4. Section through several follicles of h



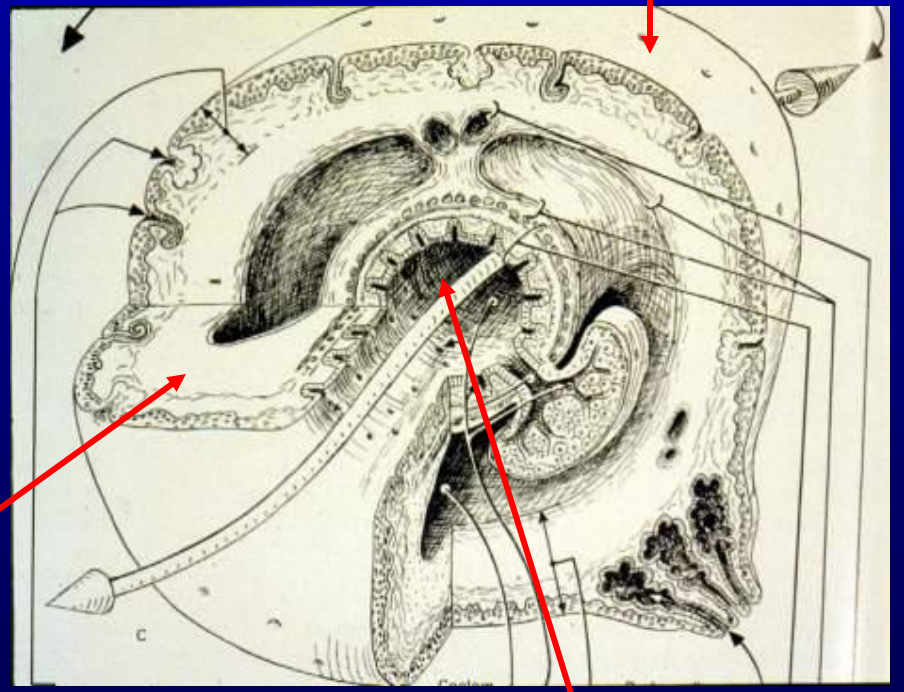


drial matrix, dense intracristal layers, and dense-
core microcylinders 270 to 330 Å wide.

ORIGIN AND DISTRIBUTION OF EPITHELIUM

ECTODERM - EPIDERMIS OF SKIN AND EPITHELIUM OF CORNEA
TOGETHER COVERS THE ENTIRE SURFACE OF THE BODY;
SEBACEOUS AND MAMMARY GLANDS

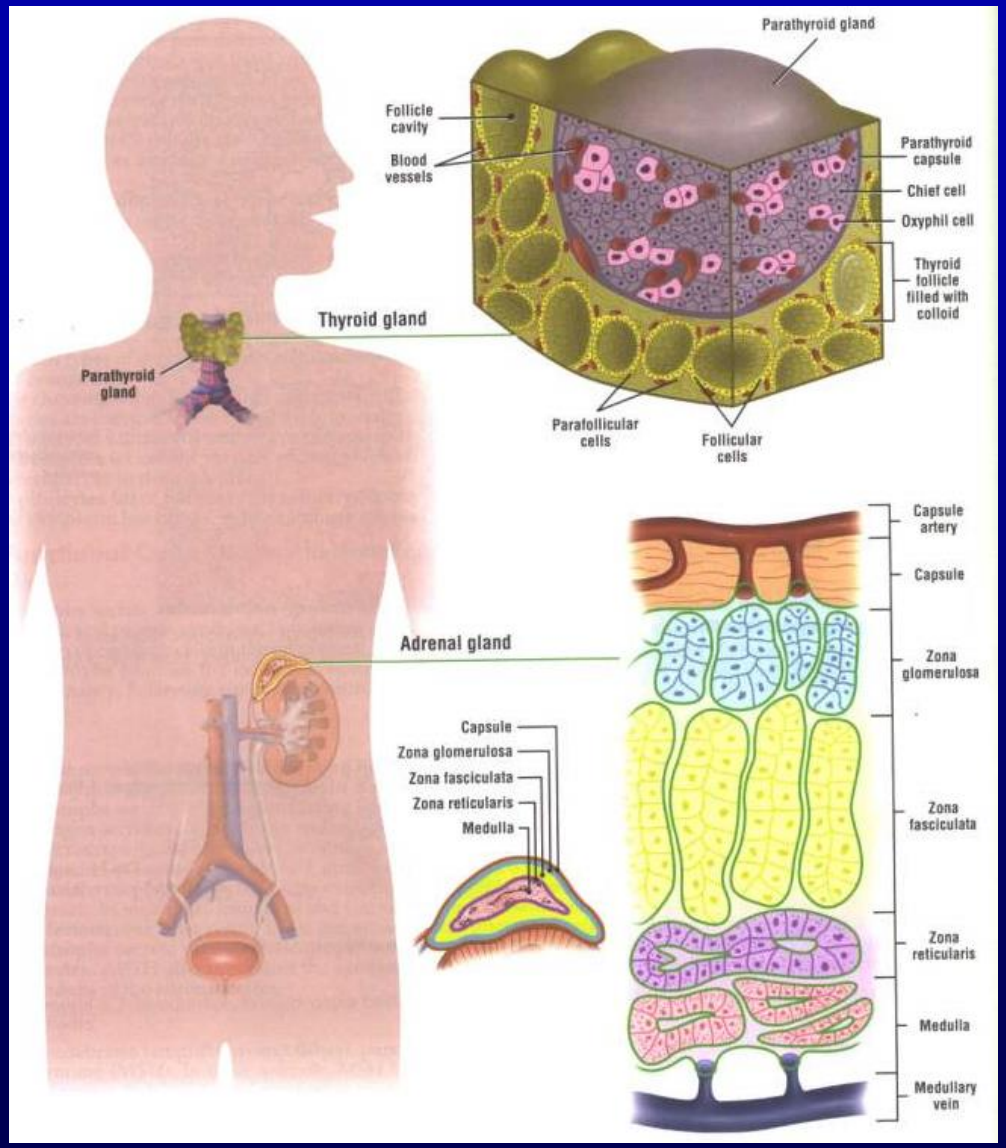
ENDODERM - ALIMENTARY TRACT,
LIVER, PANCREAS, GASTRIC
GLANDS, INTESTINAL GLANDS
ENDOCRINE GLANDS - LOSE
CONNECTION WITH SURFACE



MESODERM

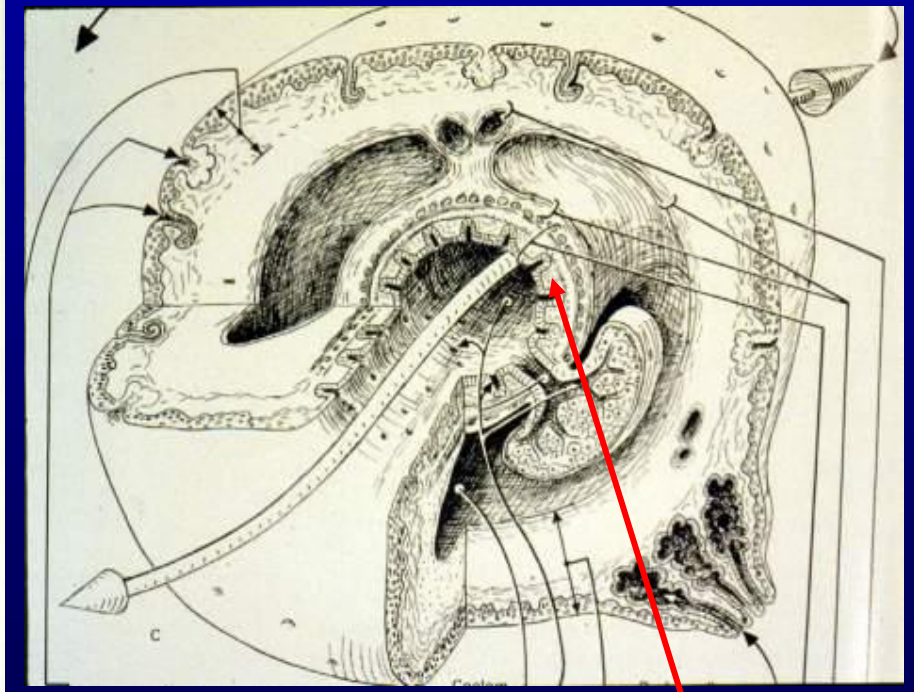
- ENDOTHELIUM - LINING OF BLOOD VESSELS
- MESOTHELIUM - LINING SEROUS CAVITIES

ORIGIN



ENDODERM –

ENDOCRINE GLANDS - LOSE CONNECTION WITH SURFACE



ENDODERM

Releases of Neurons

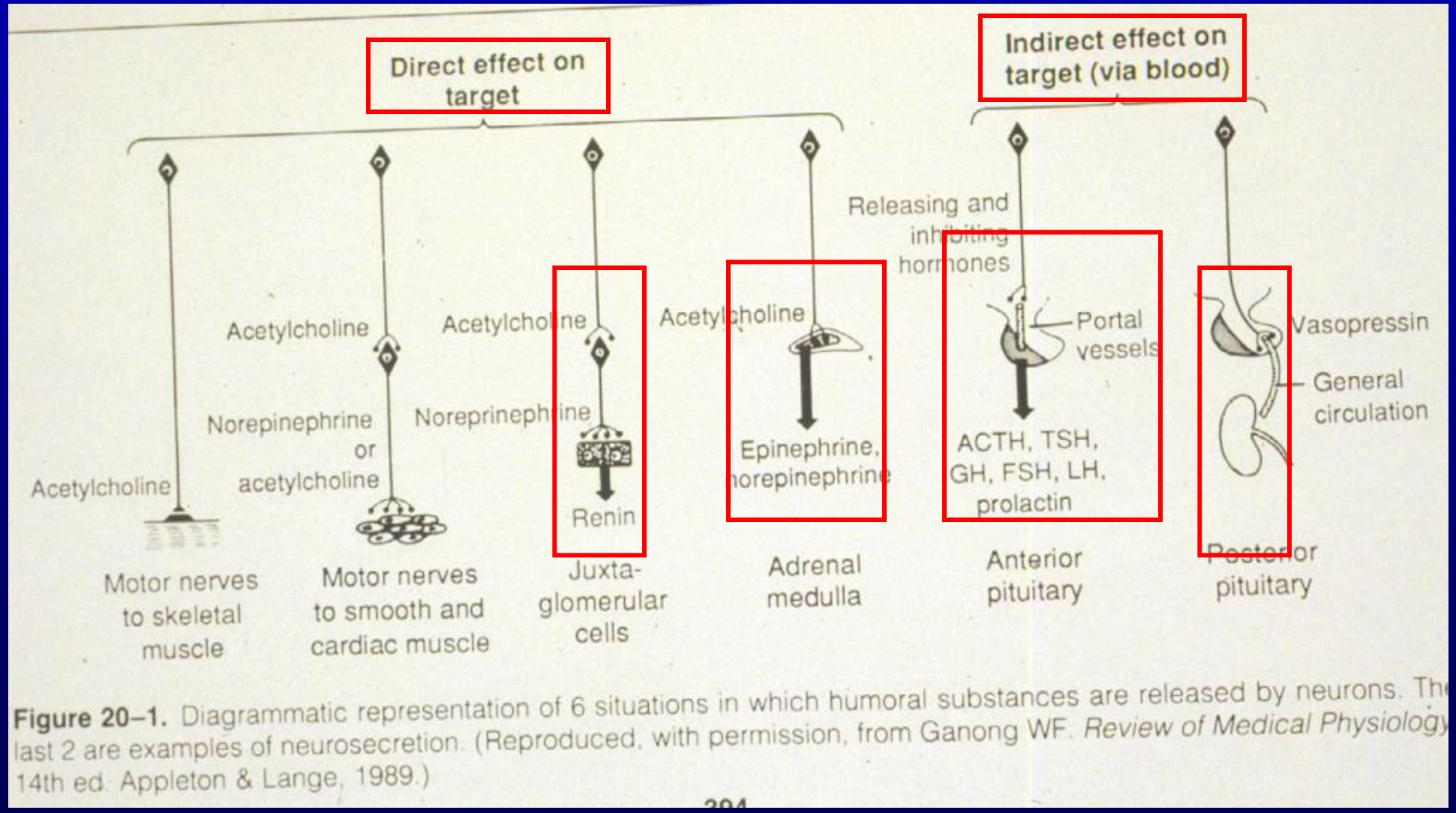
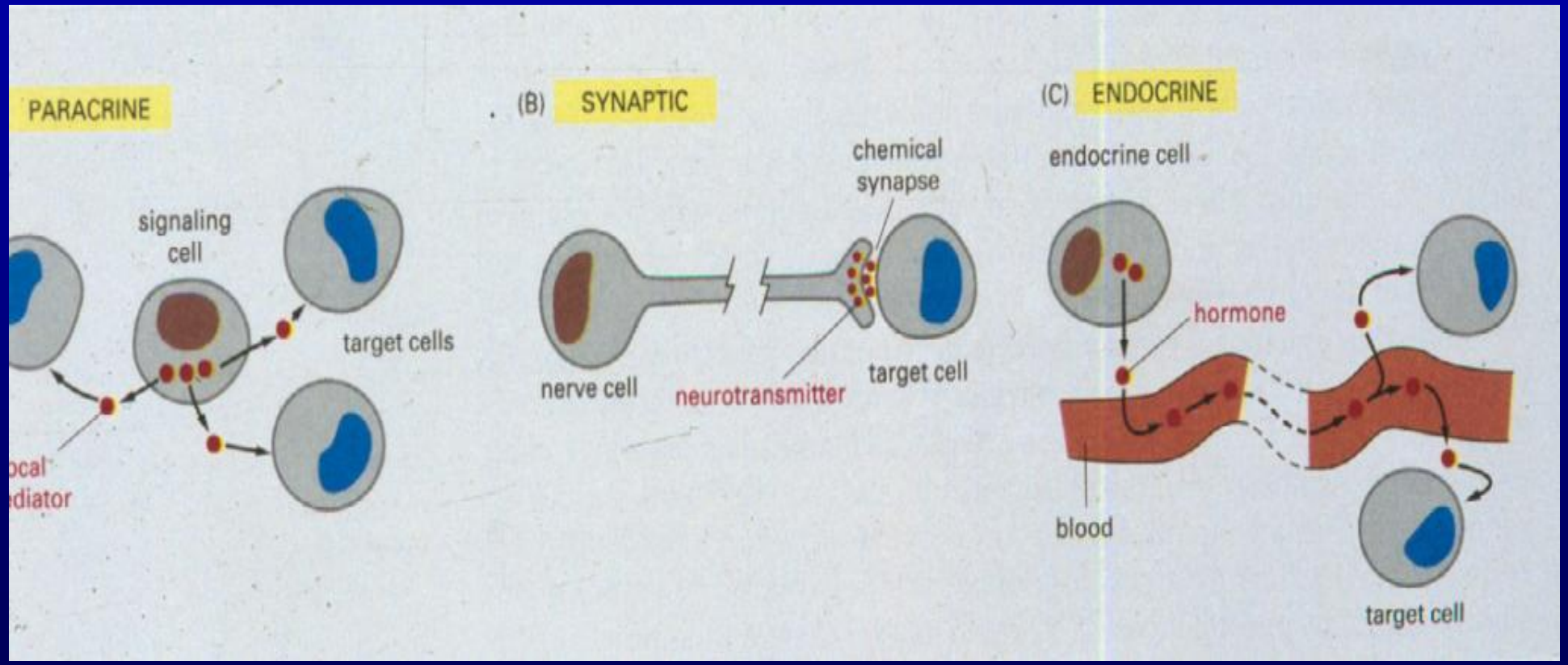
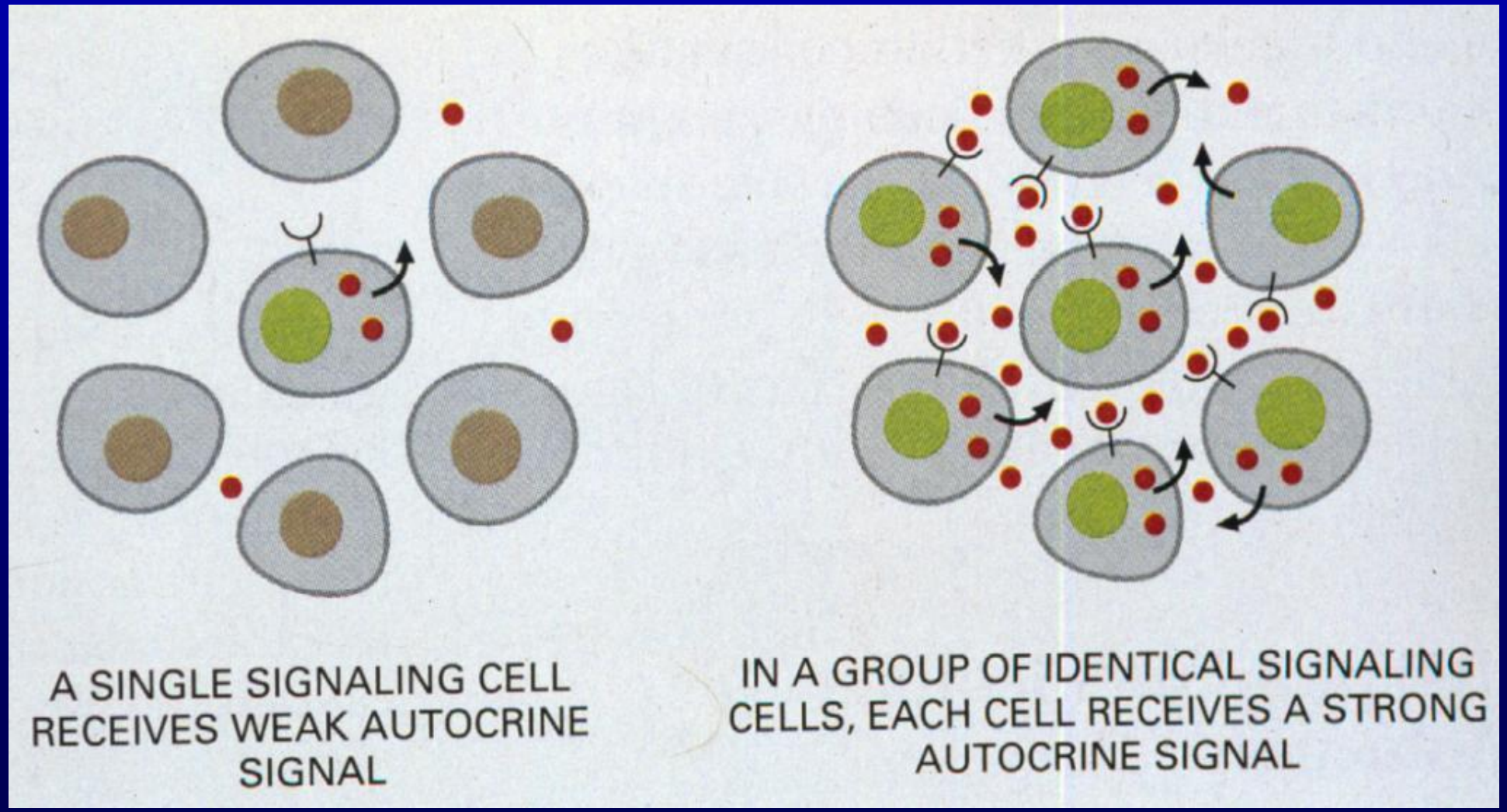


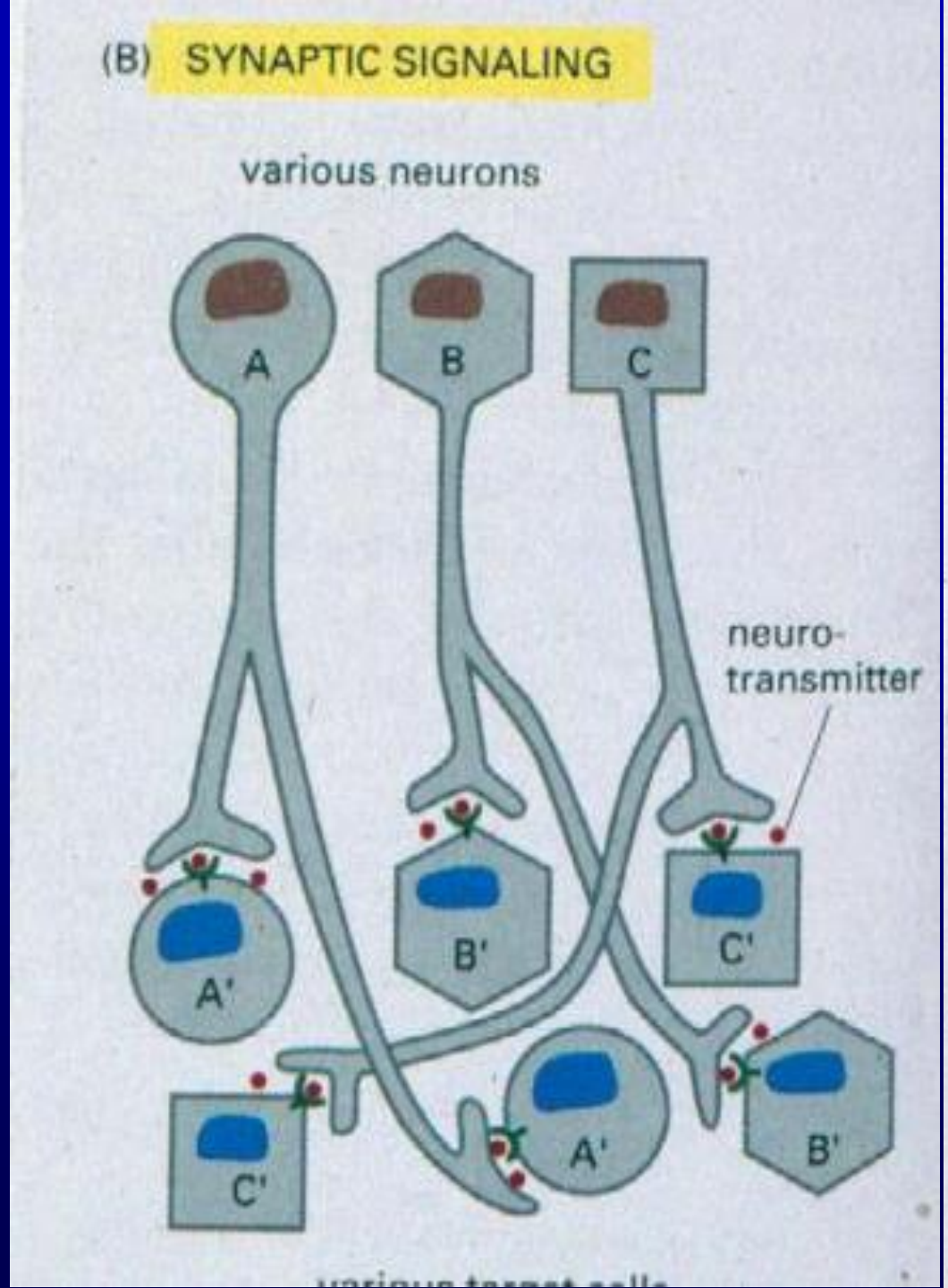
Figure 20–1. Diagrammatic representation of 6 situations in which humoral substances are released by neurons. The last 2 are examples of neurosecretion. (Reproduced, with permission, from Ganong WF. *Review of Medical Physiology*, 14th ed. Appleton & Lange, 1989.)

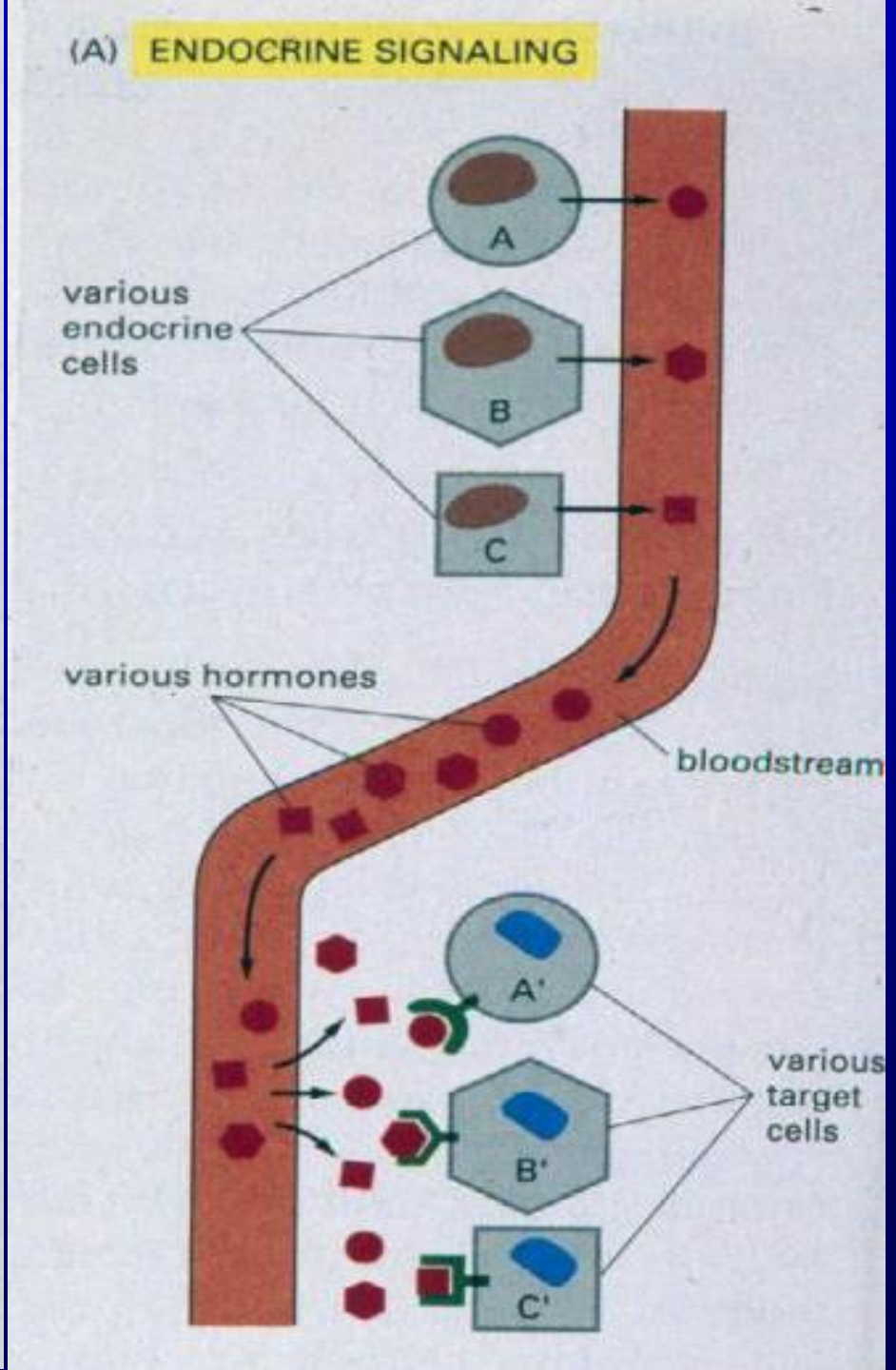
Endocrine


PARACRINE
signaling cell
target cells
ocal
diator
(B) SYNAPTIC
chemical synapse
nerve cell
neurotransmitter
target cell
(C) ENDOCRINE
endocrine cell
hormone
blood
target cell

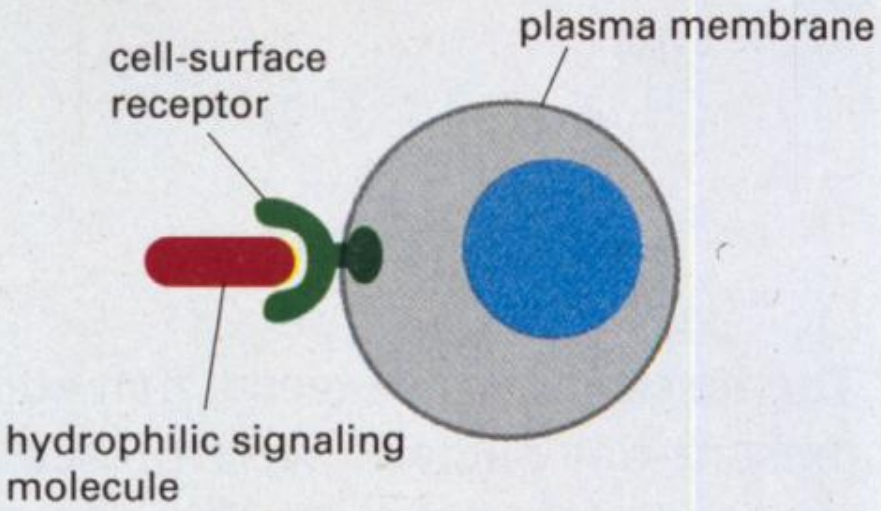
Autocrine


A SINGLE SIGNALING CELL RECEIVES WEAK AUTOCRINE SIGNAL
IN A GROUP OF IDENTICAL SIGNALING CELLS, EACH CELL RECEIVES A STRONG AUTOCRINE SIGNAL


(B) SYNAPTIC SIGNALING
various neurons
A
B
C
neuro-
transmitter
A'
B'
C'
C'
A'
B'


(A) ENDOCRINE SIGNALING
A
various
endocrine
cells
B
C
various hormones
bloodstream
A'
various
target
cells
B'
C'

CELL-SURFACE RECEPTORS



INTRACELLULAR RECEPTORS

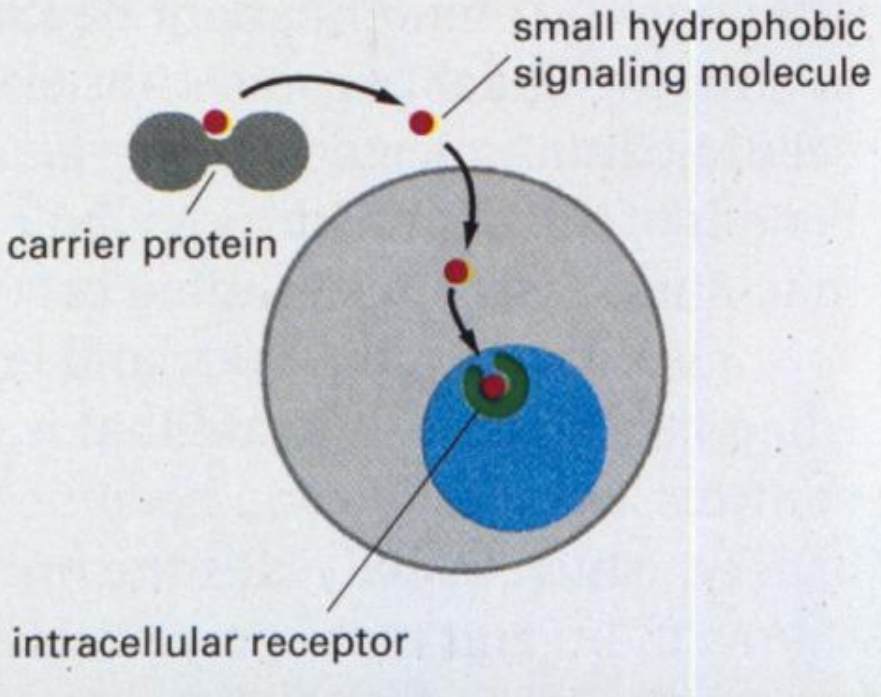
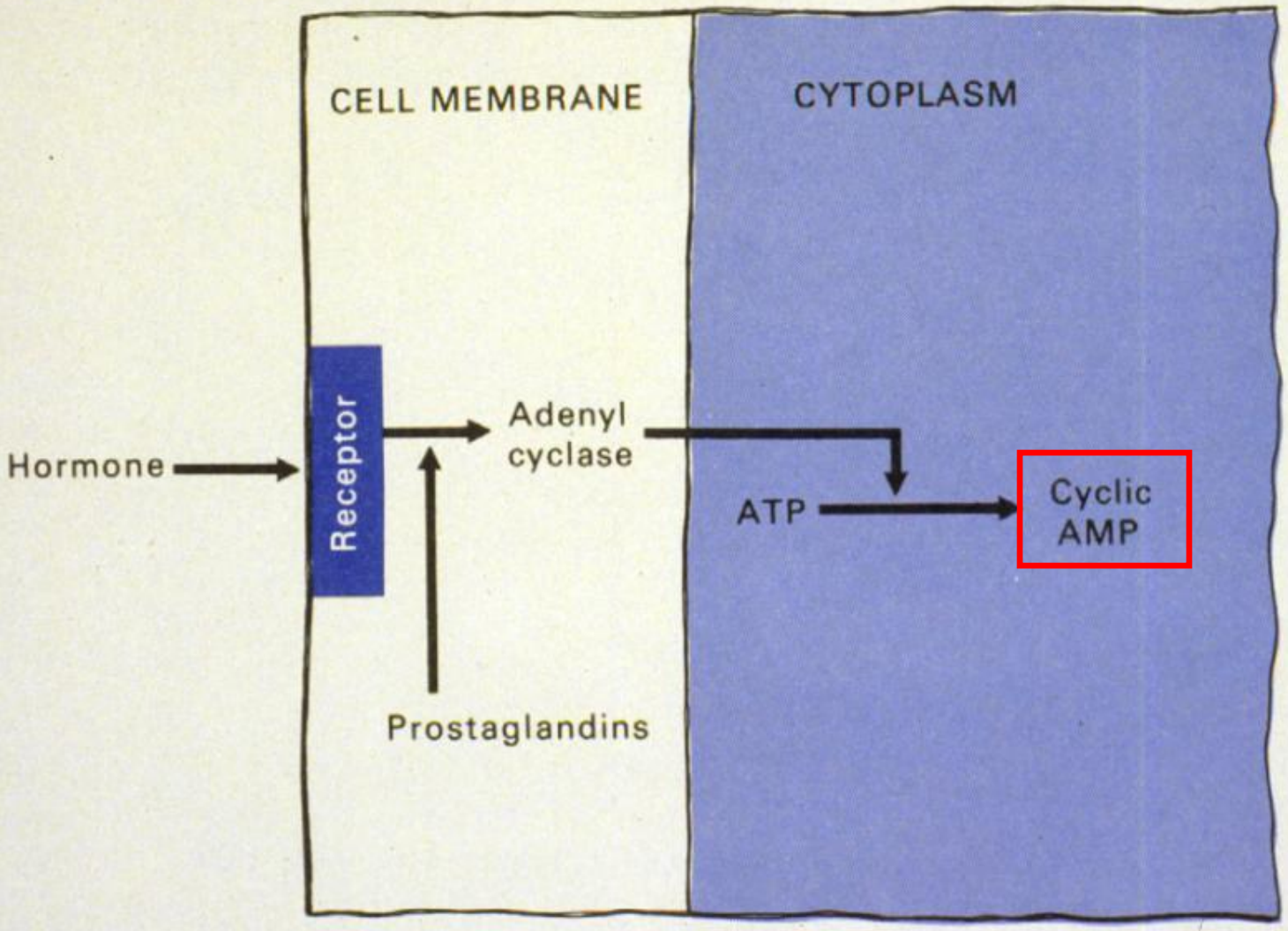


Figure 31-2. The cell membrane contains the enzyme adenyl cyclase essential for the conversion of ATP to cyclic AMP. The hormone initiating the sequence is the first messenger; cyclic AMP the second.



Some hormone-induced cellular responses mediated by cyclic AMP

Target tissue	Hormone	Major response
Thyroid	Thyroid-stimulating hormone (TSH)	Thyroid hormone synthesis and secretion
Adrenal cortex	Adrenocorticotropic hormone (ACTH)	Cortisol secretion
Ovary	Luteinizing hormone (LH)	Progesterone secretion
Muscle, liver	Epinephrine	Glycogen breakdown
Bone	Parathyroid hormone	Bone resorption
Heart	Epinephrine	Increase in heart rate and force of contraction
Kidney	Vasopressin	Water resorption
Fat	Epinephrine, ACTH, glucagon, TSH	Triglyceride breakdown

TABLE 31-2. ACTIONS OF CYCLIC AMP

TISSUE	ACTION
Liver	Increased glycogenolysis Increased phosphorylase Decreased glycogen synthetase Increased protein kinase Induction of tyrosine transaminase Induction of PEP carboxykinase Induction of serine dehydratase Increased amino acid uptake Increased ketogenesis
Adipose	Increased lipolysis Increased amino acid uptake Increased clearing-factor lipase
Anterior hypophysis	Increased release of ACTH, TSH, GH, and LH
Epithelial	Increased permeability to water
Pancreas	Increased release of insulin
Thyroid	Increased release of thyroid hormone
Cardiac muscle	Increased contractility
Smooth muscle	Increased tension Hyperpolarizes membrane potential
Adrenal	Increased steroidogenesis
Bone	Increased calcium resorption
Kidney	Increased phosphaturia Increased renin
Nerve	Increased acetylcholine release
Gastric mucosa	Increased HCl secretion
Leukocytes	Increased histamine release
Platelets	Decreased aggregation
Uterus	Increased amino acid uptake
Parotid	Increased amylase release

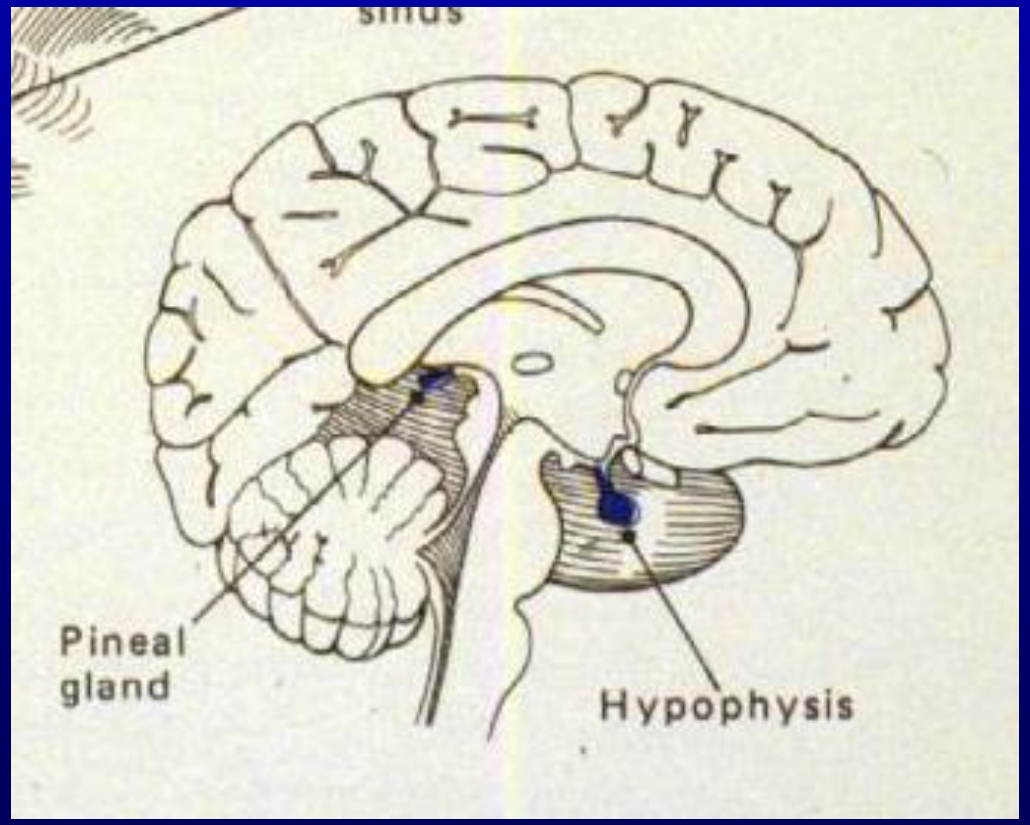
Pituitary Gland (Hypophysis)

Produces 9 hormones

Reciprocal relations to other endocrine organs

Neural and vascular connection to brain

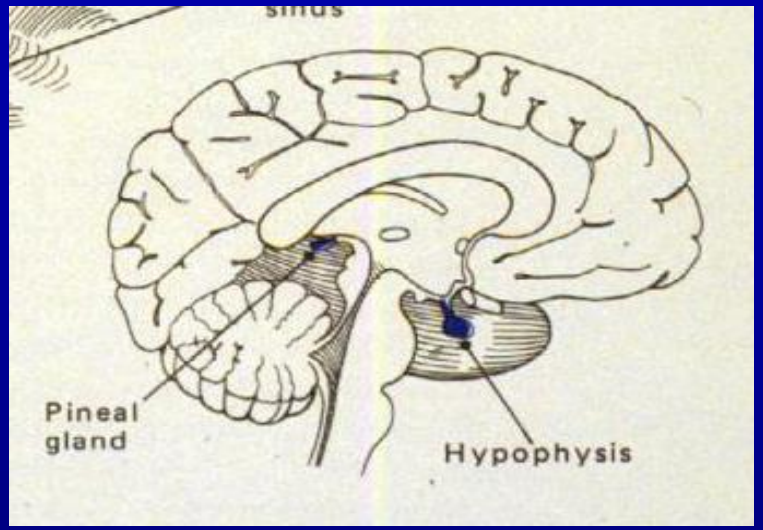
Location is key position for interplay between nervous and endocrine systems and establishment of neuroendocrine system

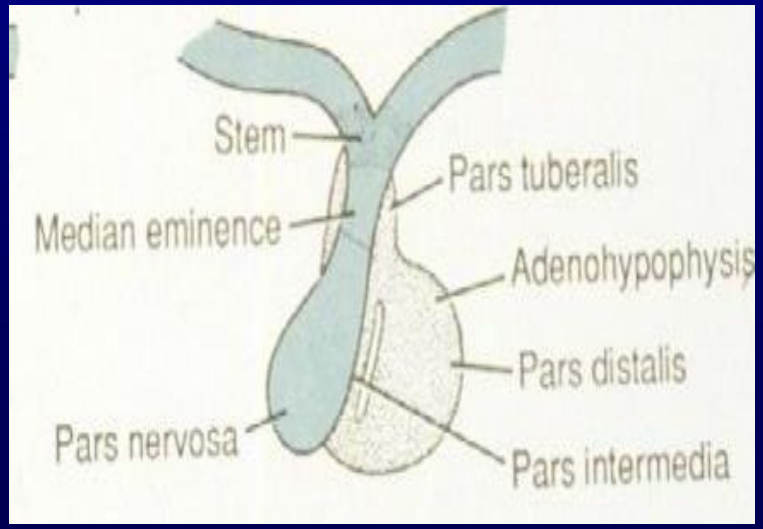


Pituitary Gland (Hypophysis)

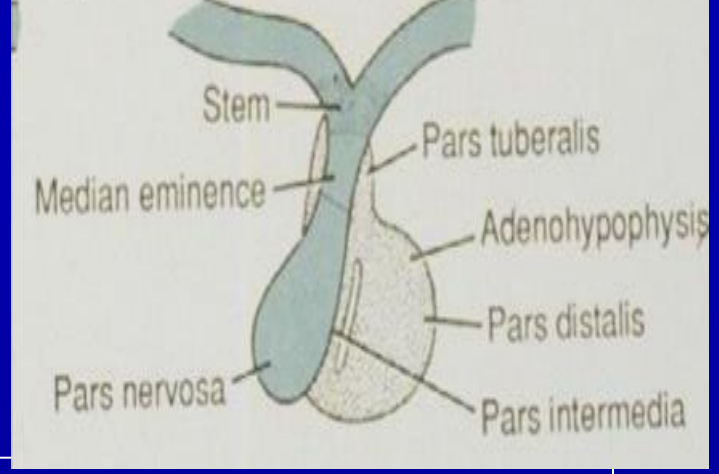
Adenohypophysis

Neurohypophysis





Pituitary Gland

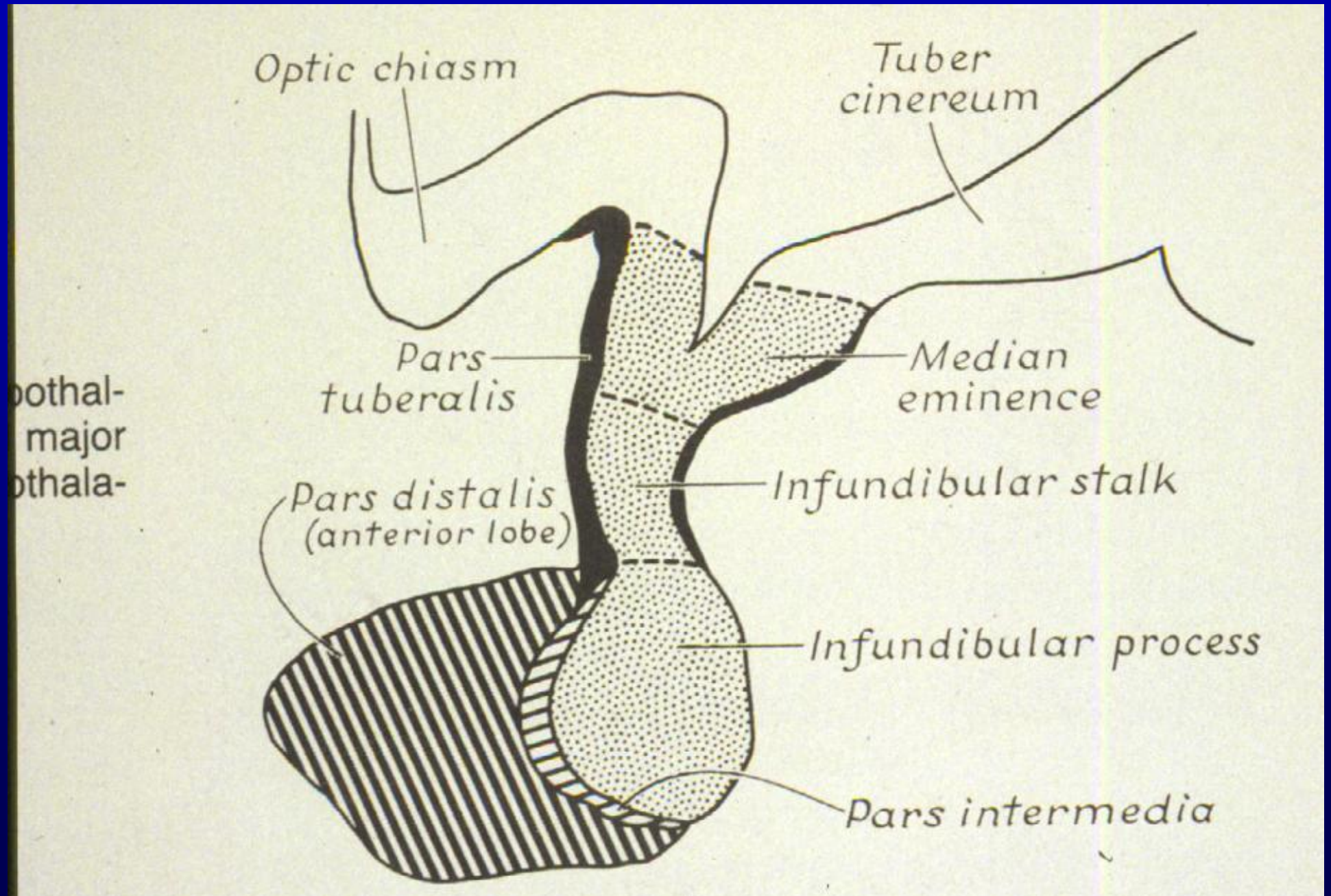


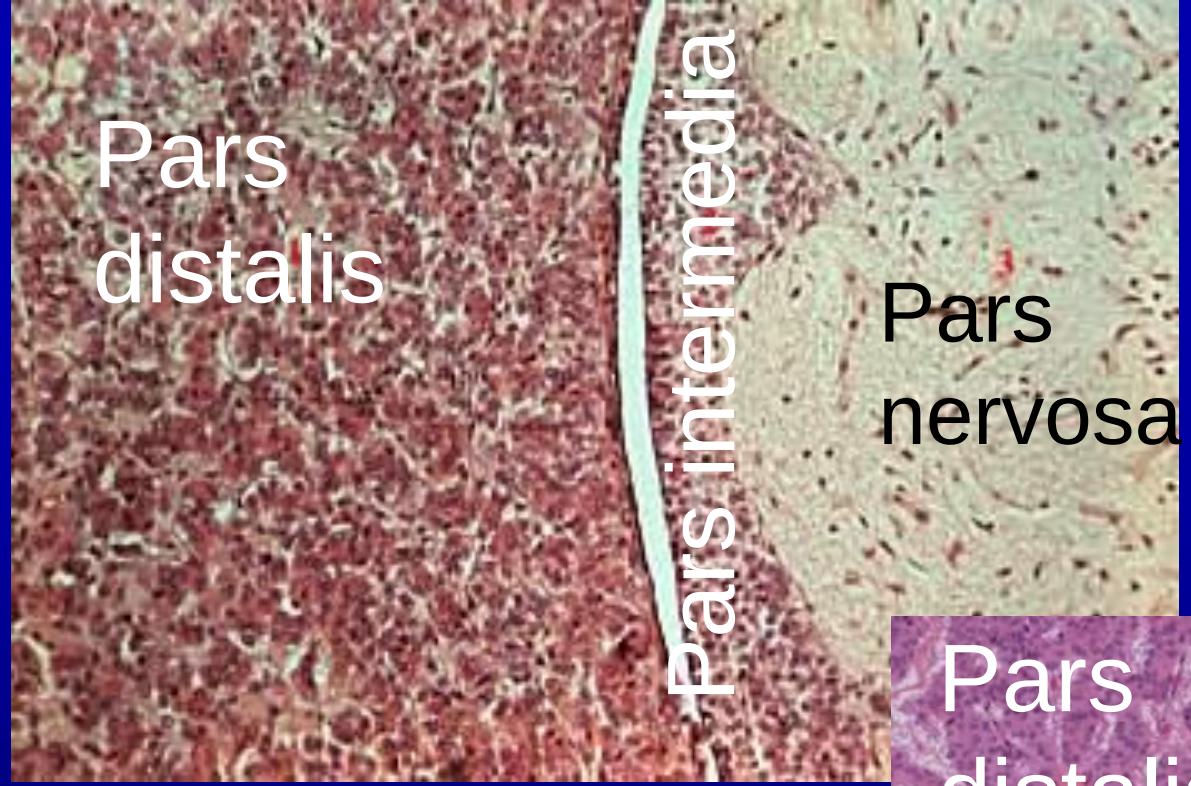
- **Adenohypophysis**
  - Pars Distalis
  - Pars Tuberalis
  - Pars Intermedia
- **Neurohypophysis**
  - Pars Nervosa (Processus Infundibuli)
  - Infundibulum
    - Infundibular Stem/Stalk
    - Median Eminence (of the tuber cinereum)

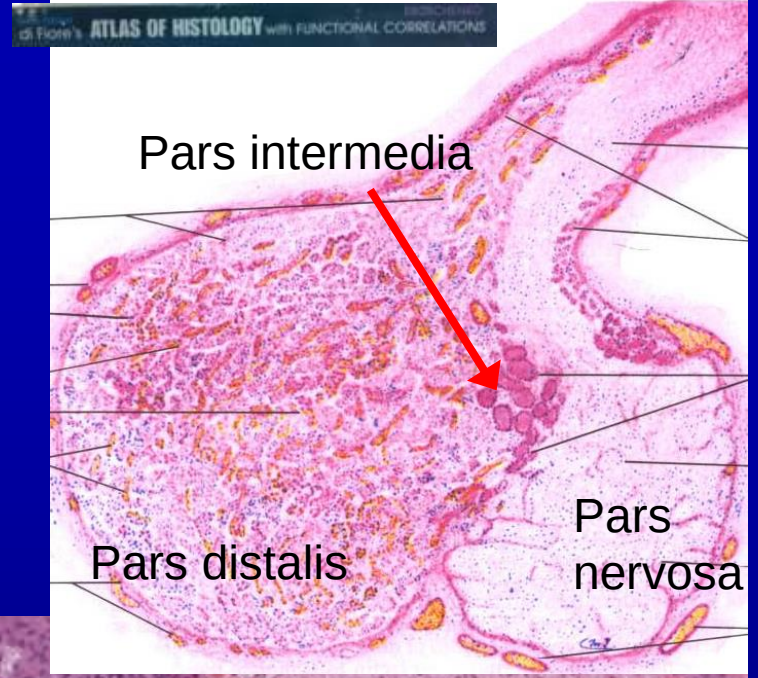
Pituitary Gland

Adenohypophysis

Neurohypophysis

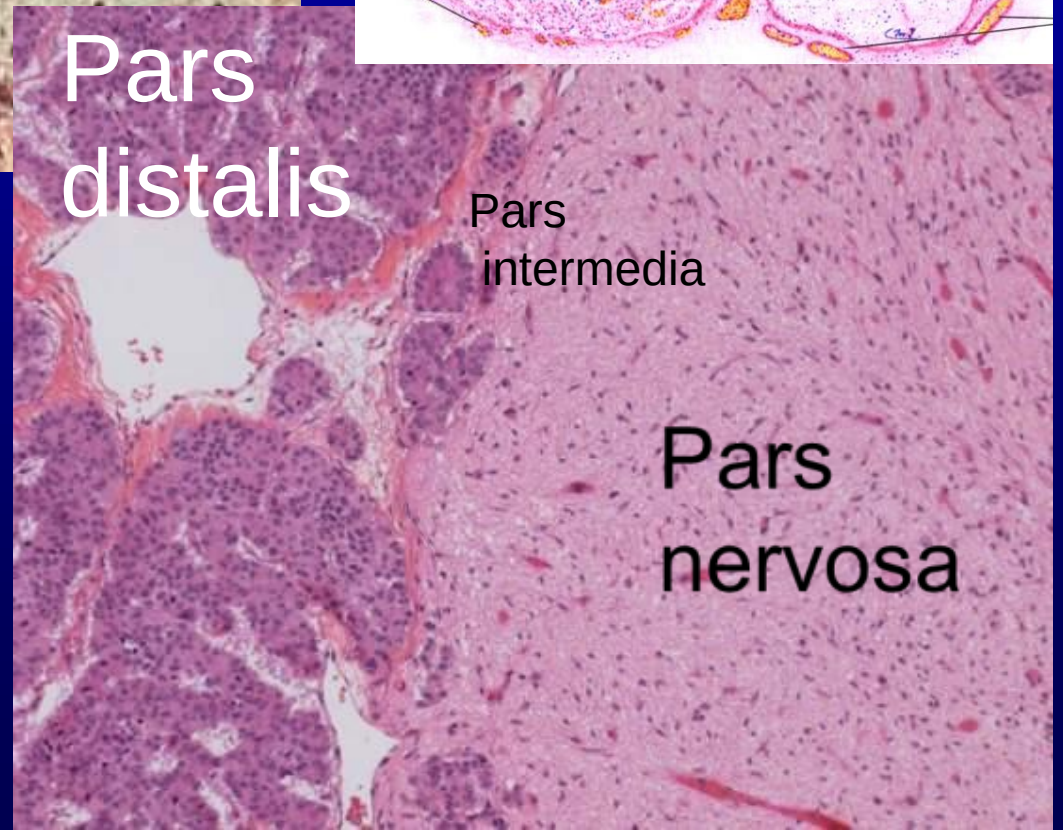






3 divisions of the pituitary gland:

1. Pars distalis
2. Pars intermedia
3. Pars nervosa



Adenohypophysis

Origin

Divisions

I. Pars distalis
Ii. Pars tuberalis
Iii. Pars intermedia

Relation to hypothalamus

Microscopic organization

I. Chromophobe cells
Ii. Chromophil cells
    1. Acidophils
    2. Basophils

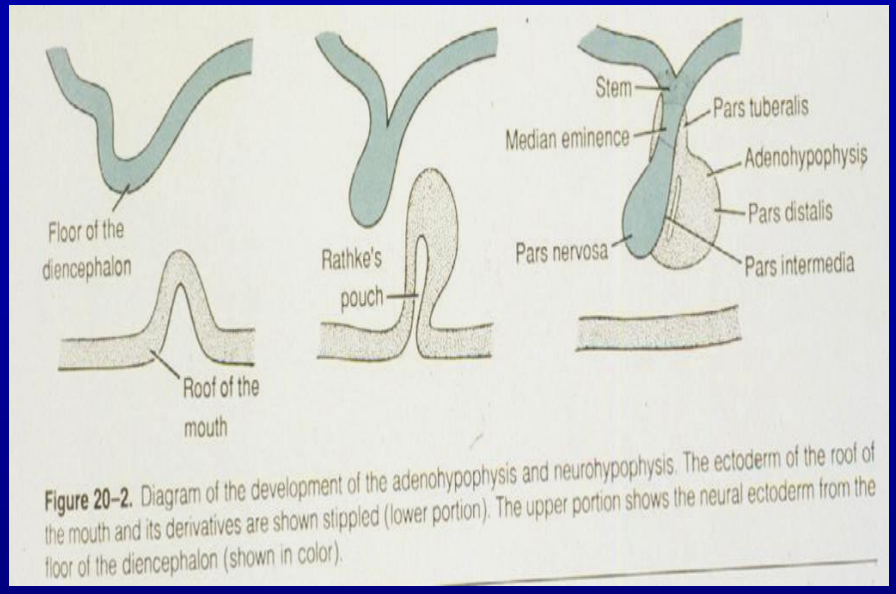
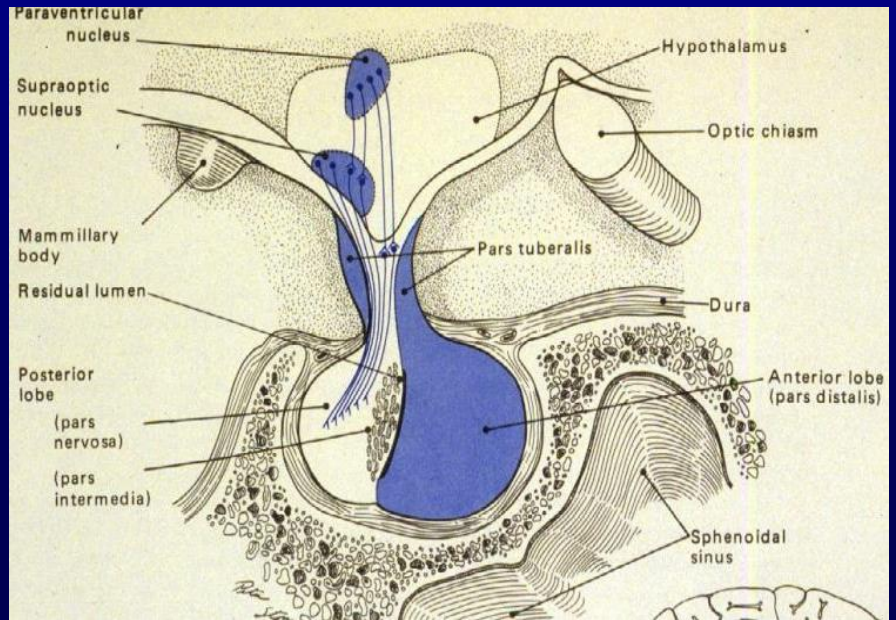
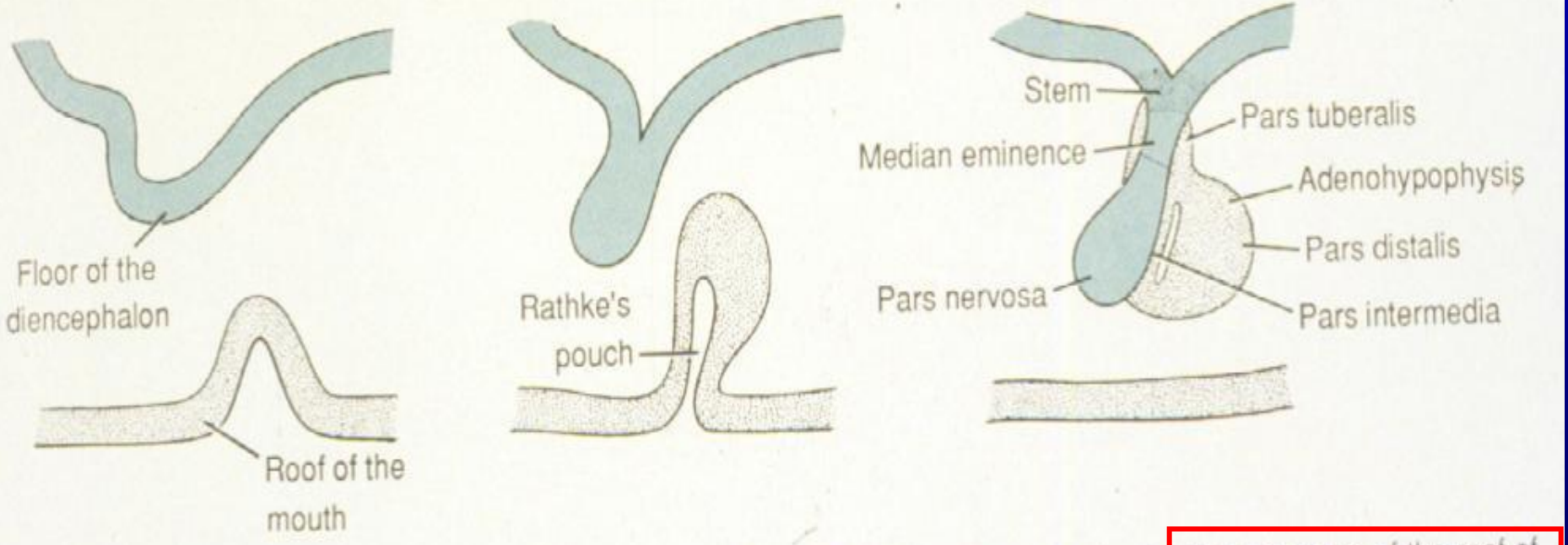


Figure 20–2. Diagram of the development of the adenohypophysis and neurohypophysis. The ectoderm of the roof of the mouth and its derivatives are shown stippled (lower portion). The upper portion shows the neural ectoderm from the floor of the diencephalon (shown in color).



Origin

Development of the **Adenohypophysis**



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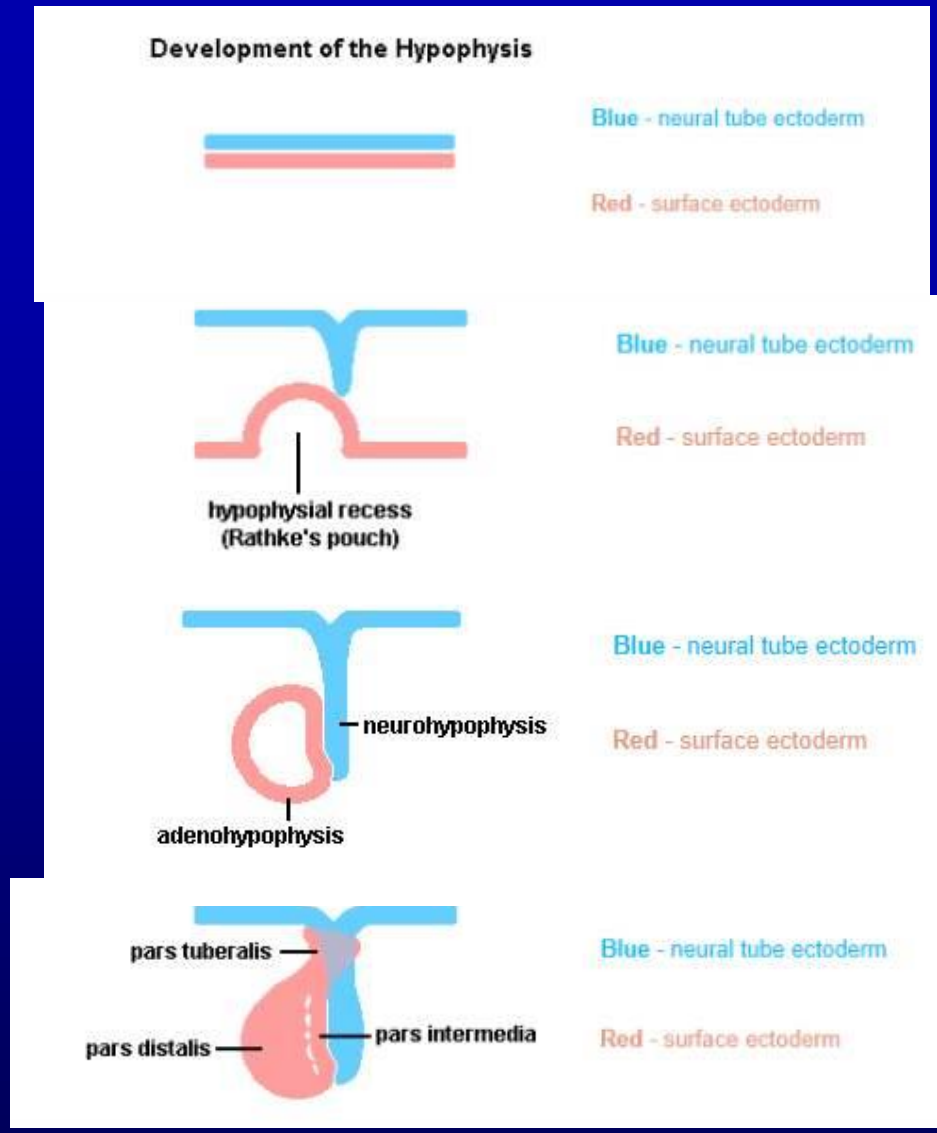
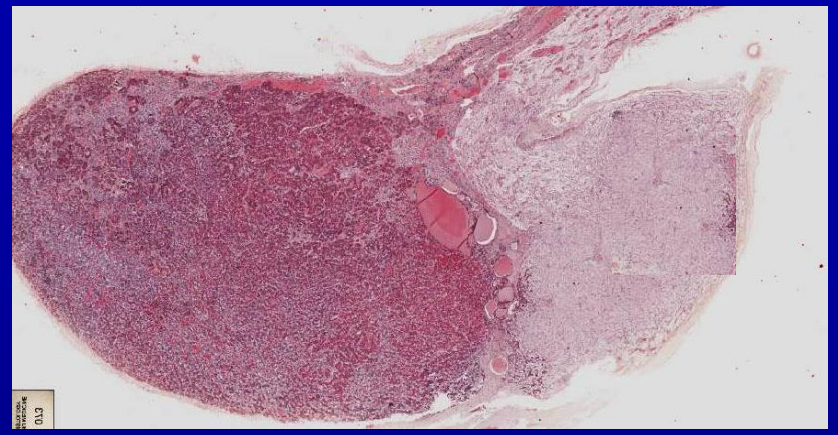
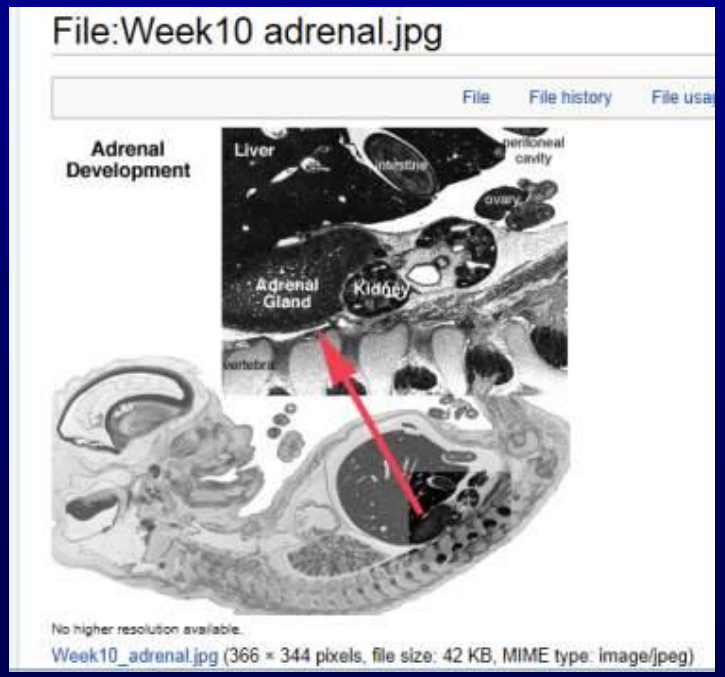
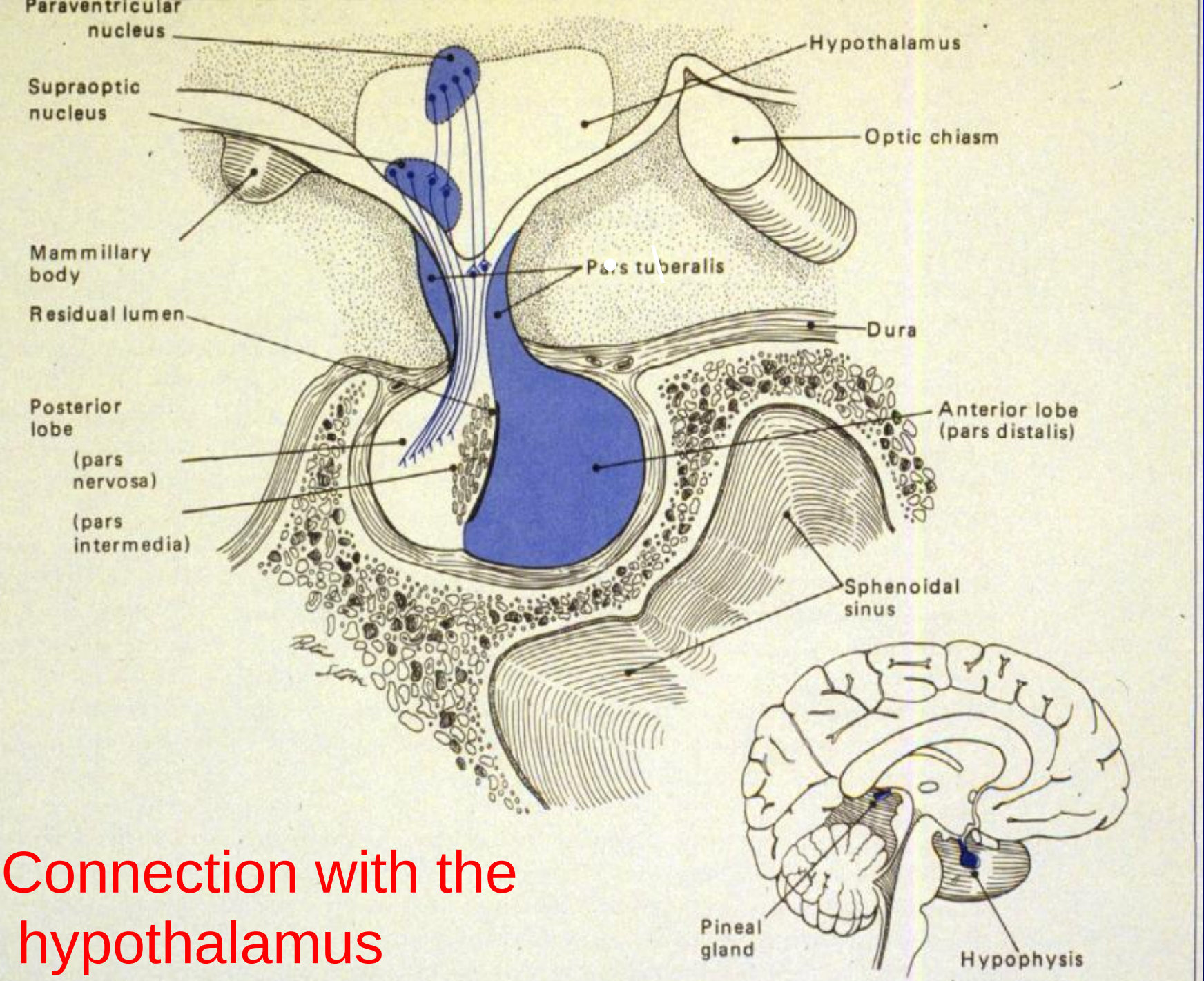
Pituitary development



http://php.med.unsw.edu.au/embryology/index.php?title=Endocrine_System_Development



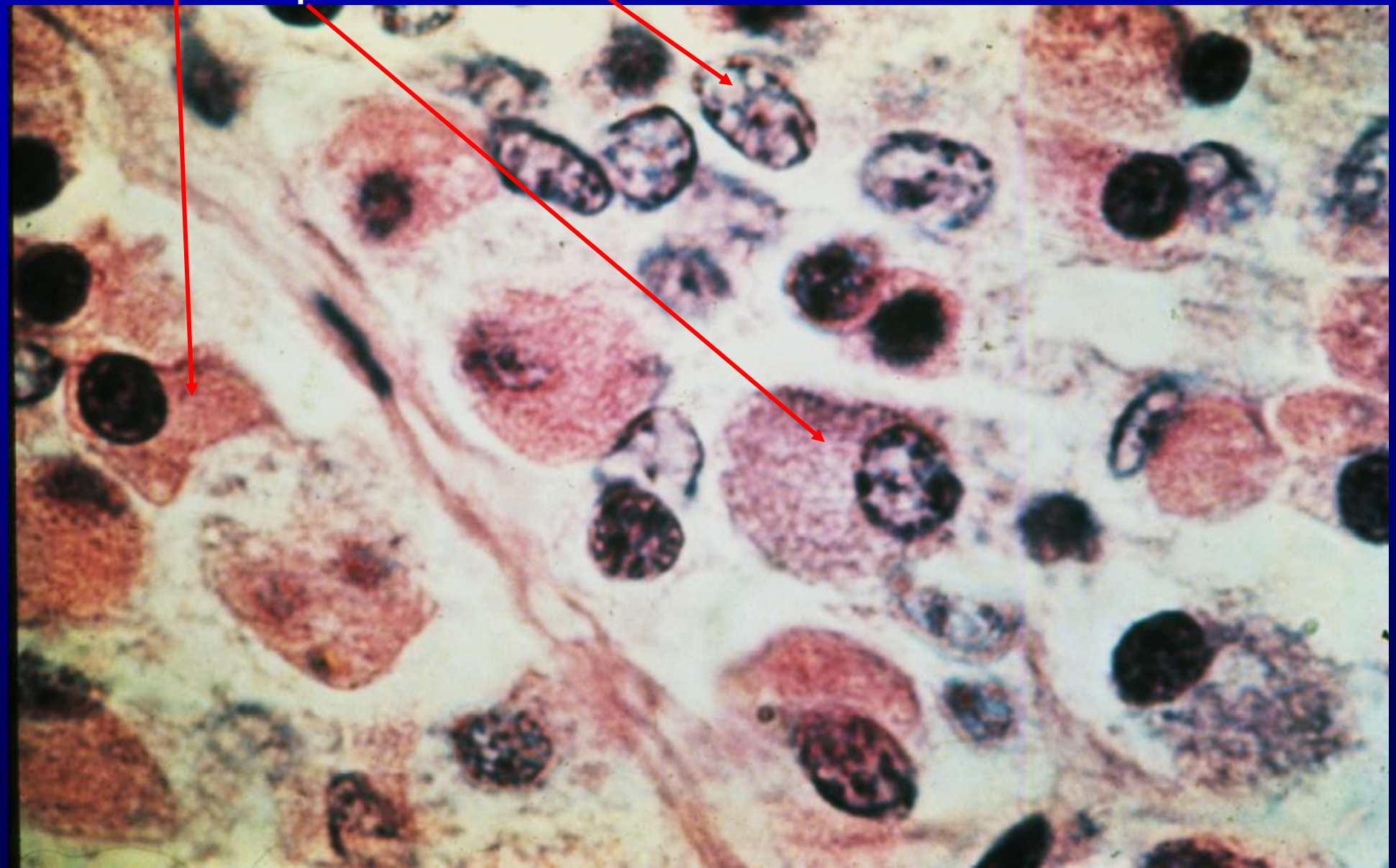




Connection with the hypothalamus

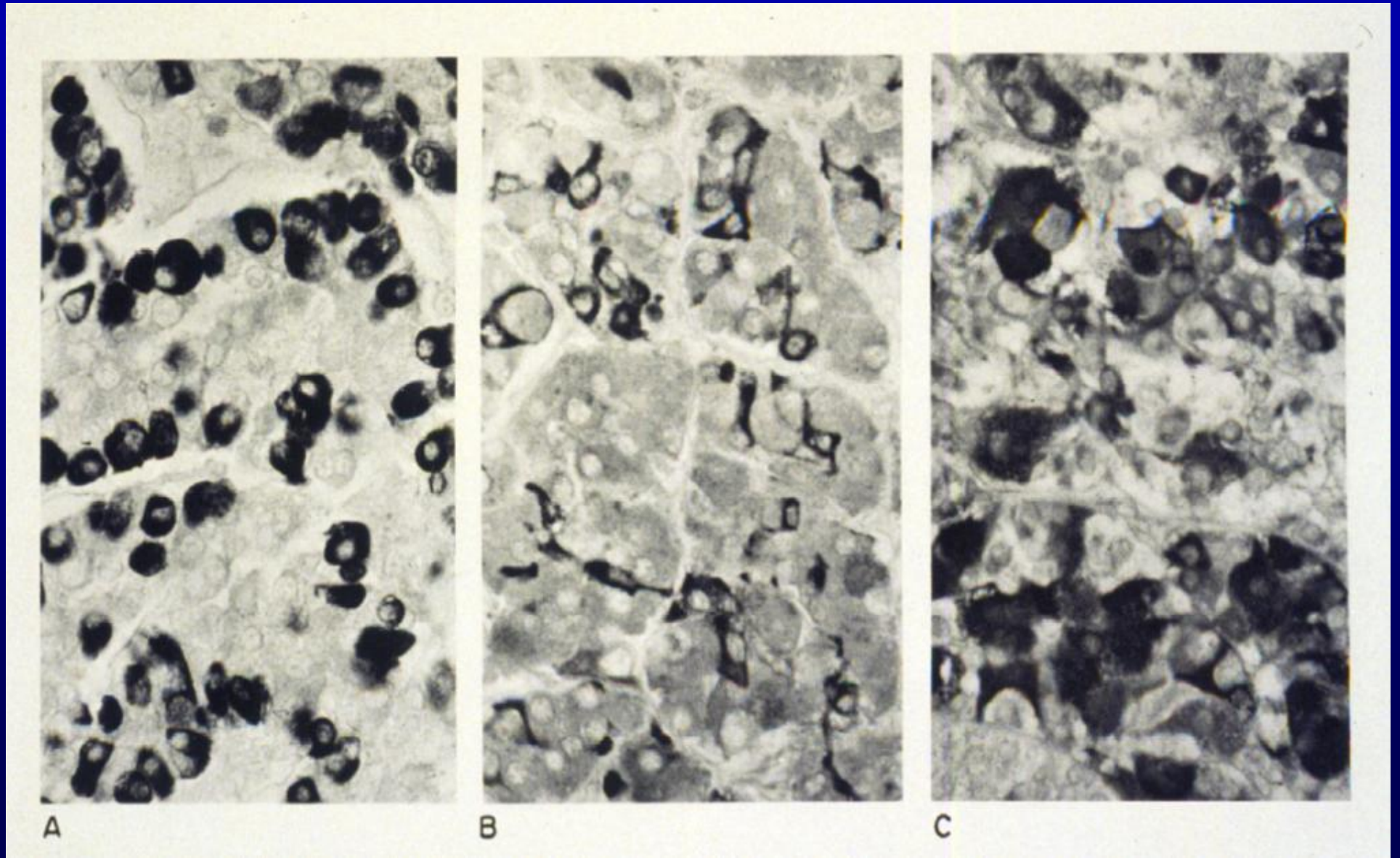
Pars Distalis

Chromophobe cells
Chromophil cells:
Acidophils
Basophils

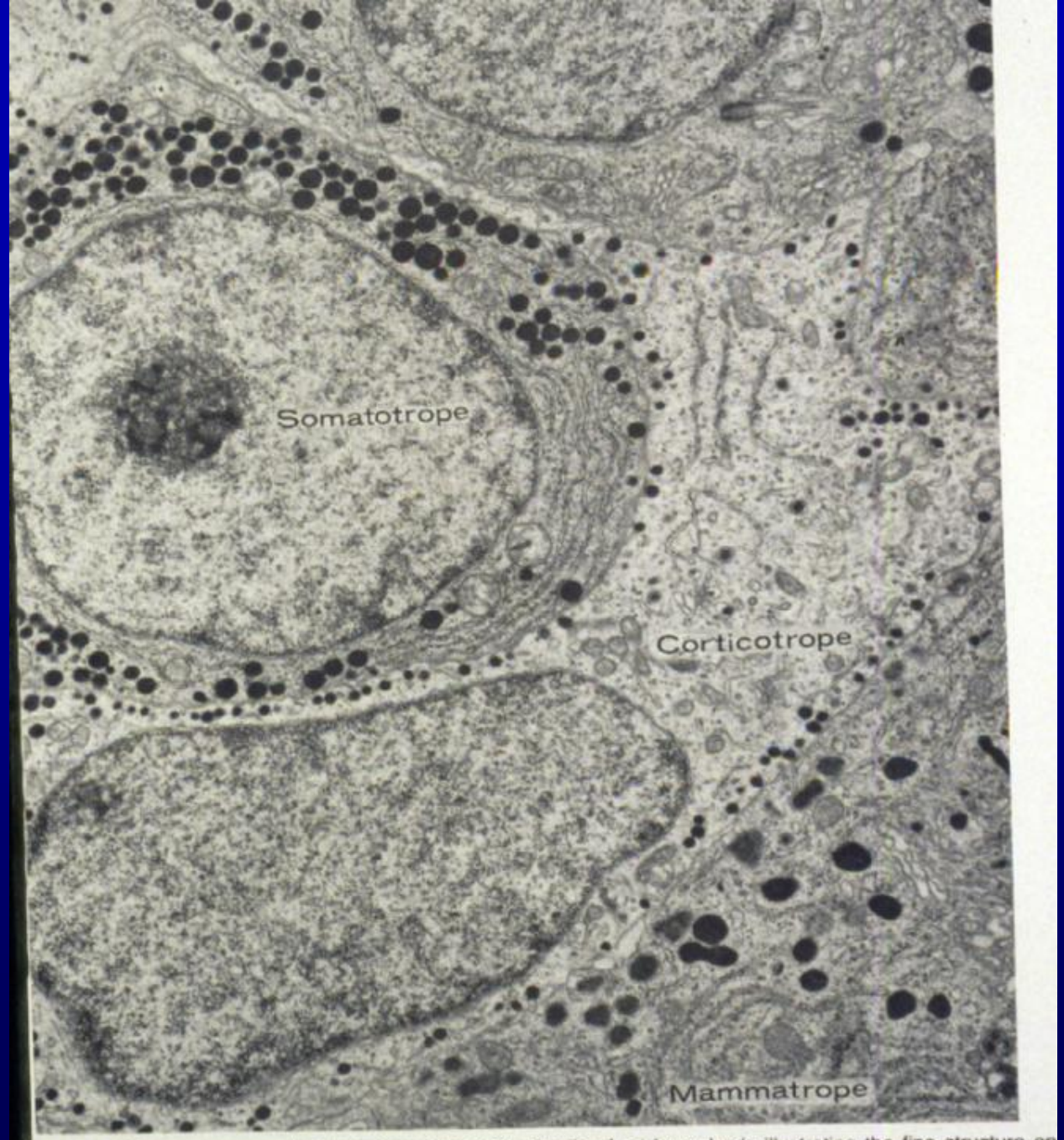


Pars Distalis

Staining for different types of cells



Pars Distalis



re 17–5. Electron micrograph of an area of the pars distalis of rat hypophysis illustrating the fine structure an
ve size of the specific granules of a somatotrope, mammatrope, and corticotrope. (Micrograph from Nakayama,
Nickerson, and F. R. Shelton. Lab. Invest. 21:169, 1969.)

Pars Distalis

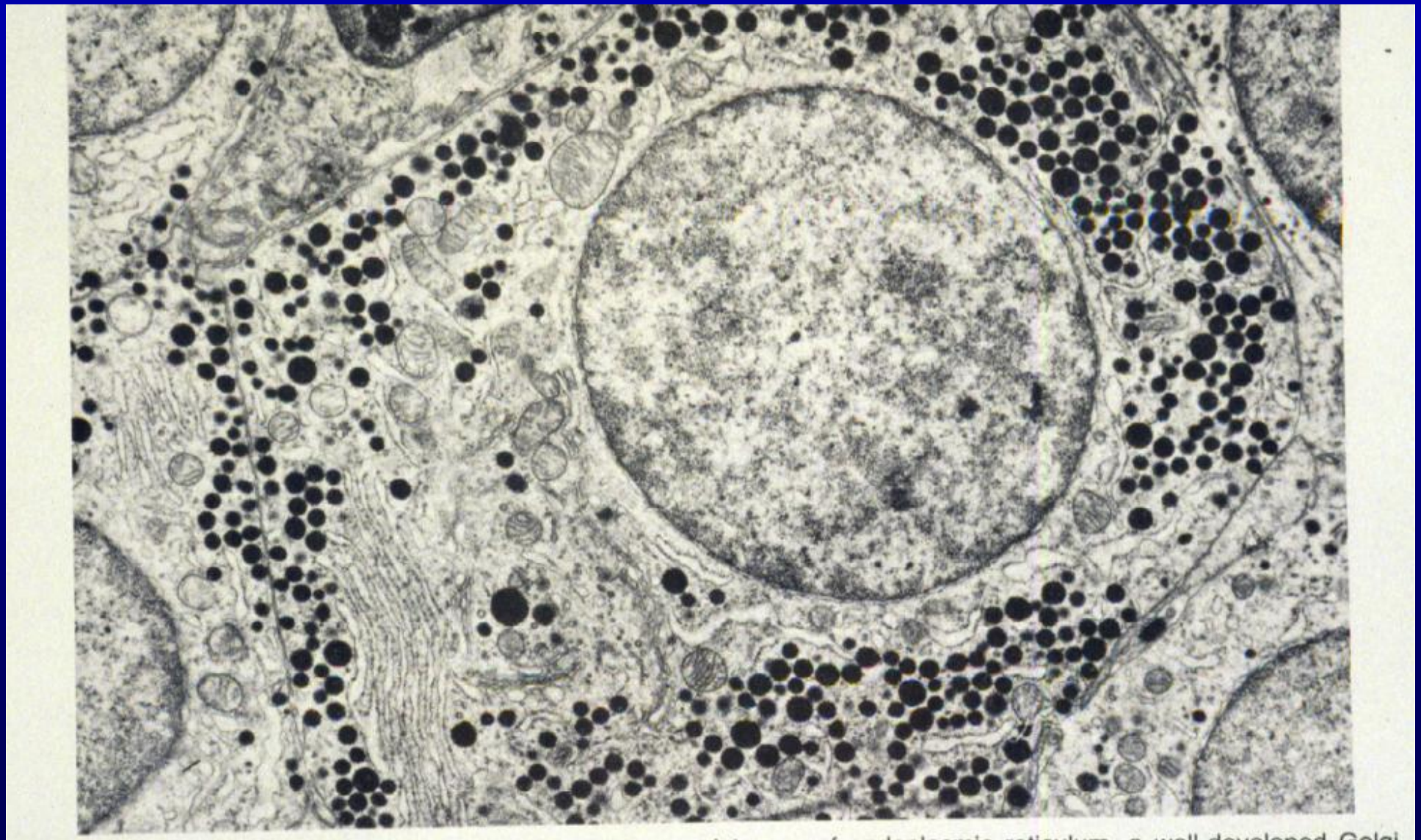


Figure 17–6. A typical somatotrope, showing numerous cisternae of endoplasmic reticulum, a well-developed Golgi complex, and many specific granules about 350 nm in diameter. (Micrograph courtesy of M. Farquhar.)

Pars Distalis

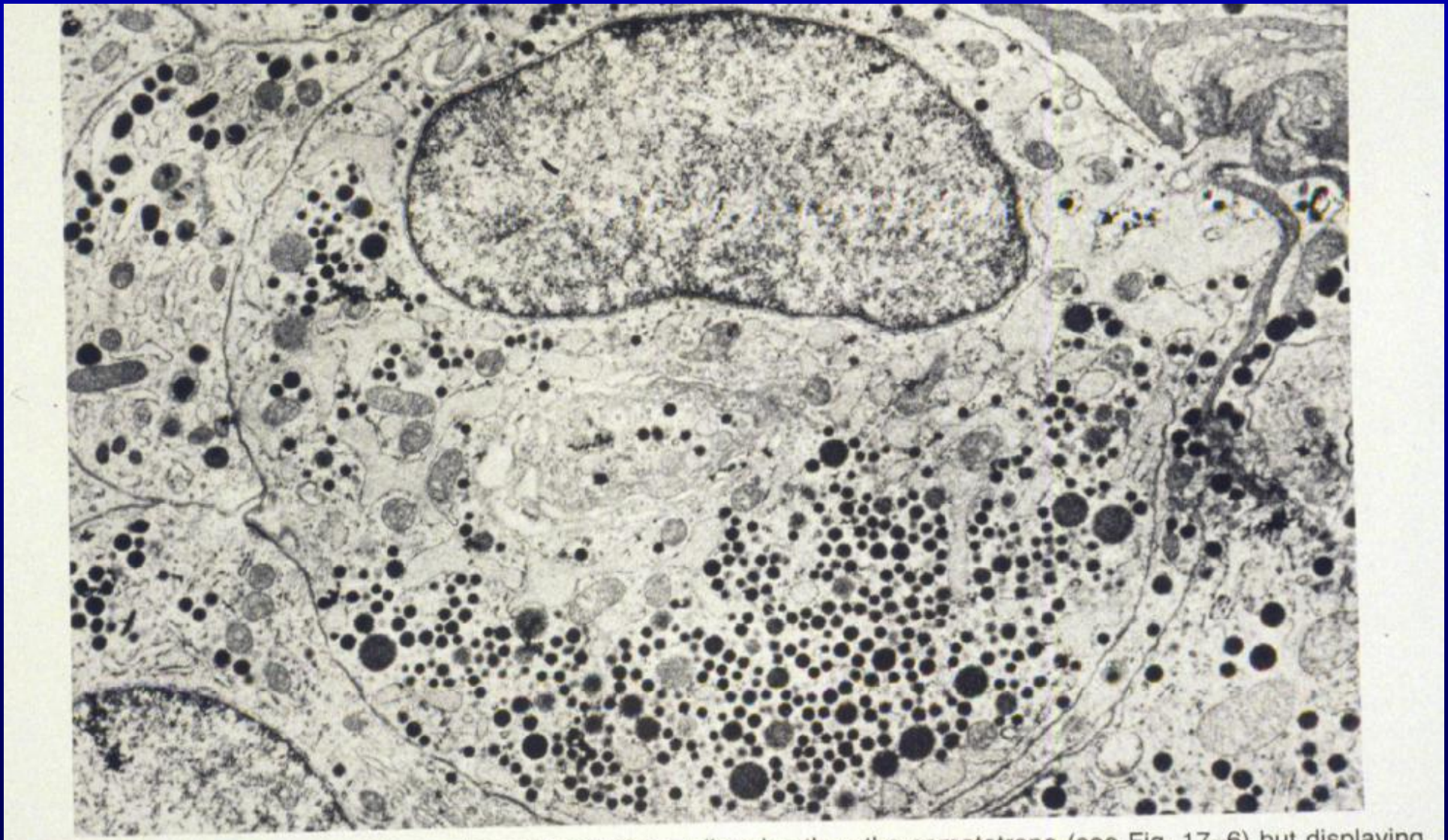


Figure 17–9. Gonadotrope with granules of relatively smaller size than the somatotrope (see Fig. 17–6) but displaying considerable variability. The endoplasmic reticulum is typically distended with an amorphous material of low density. (Micrograph courtesy of M. Farquhar.)

Pars Distalis

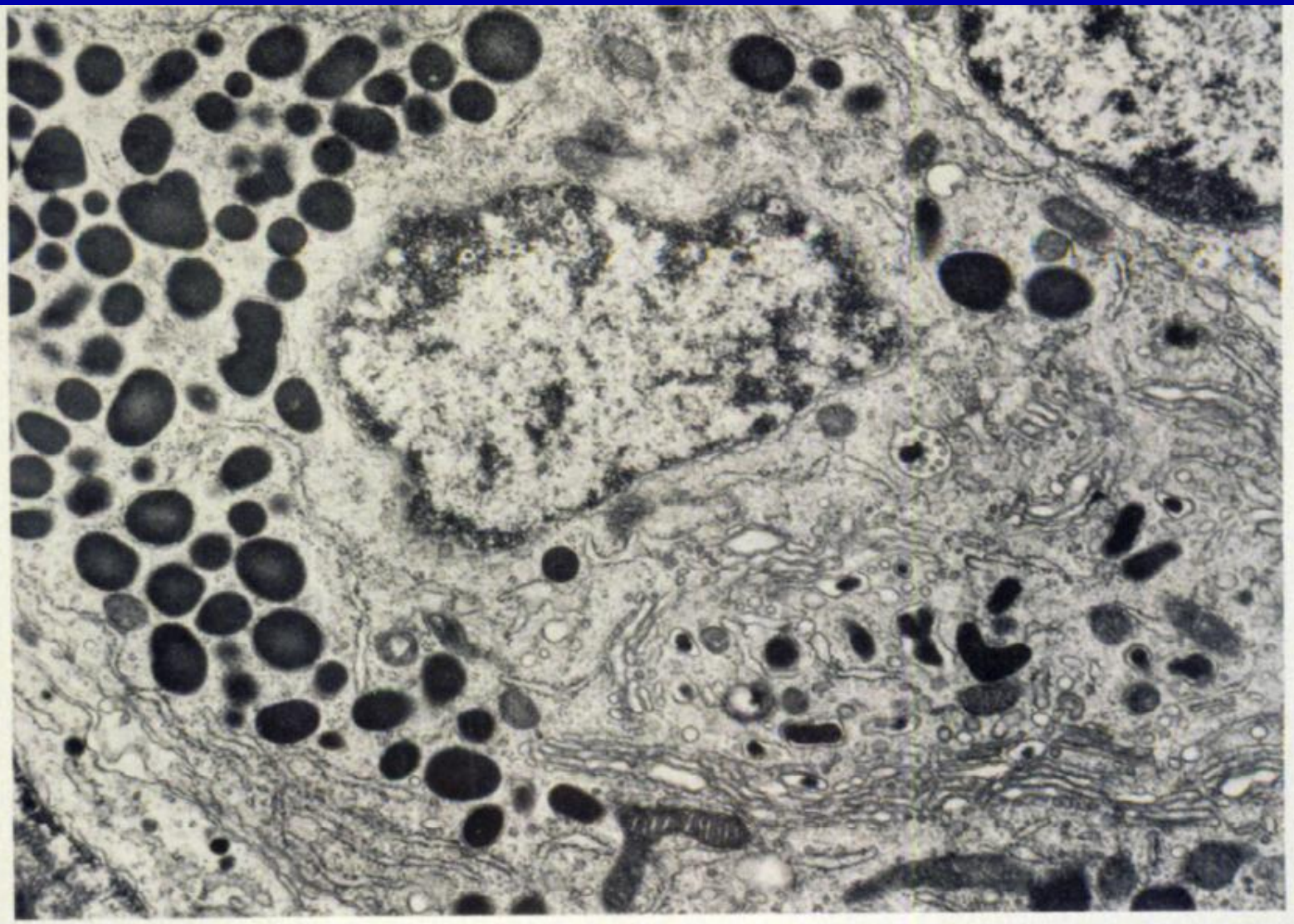
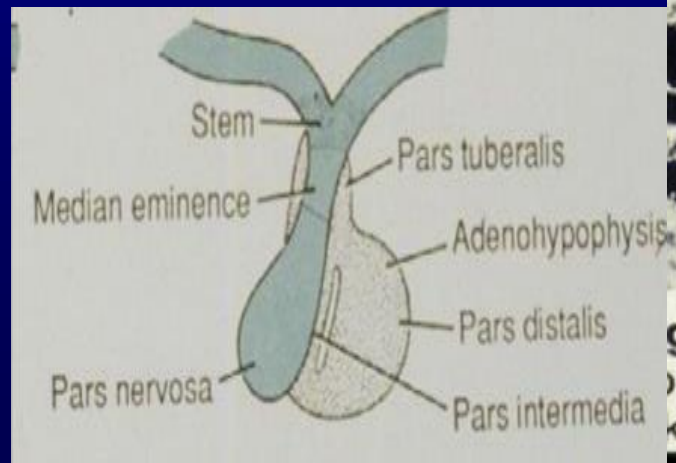
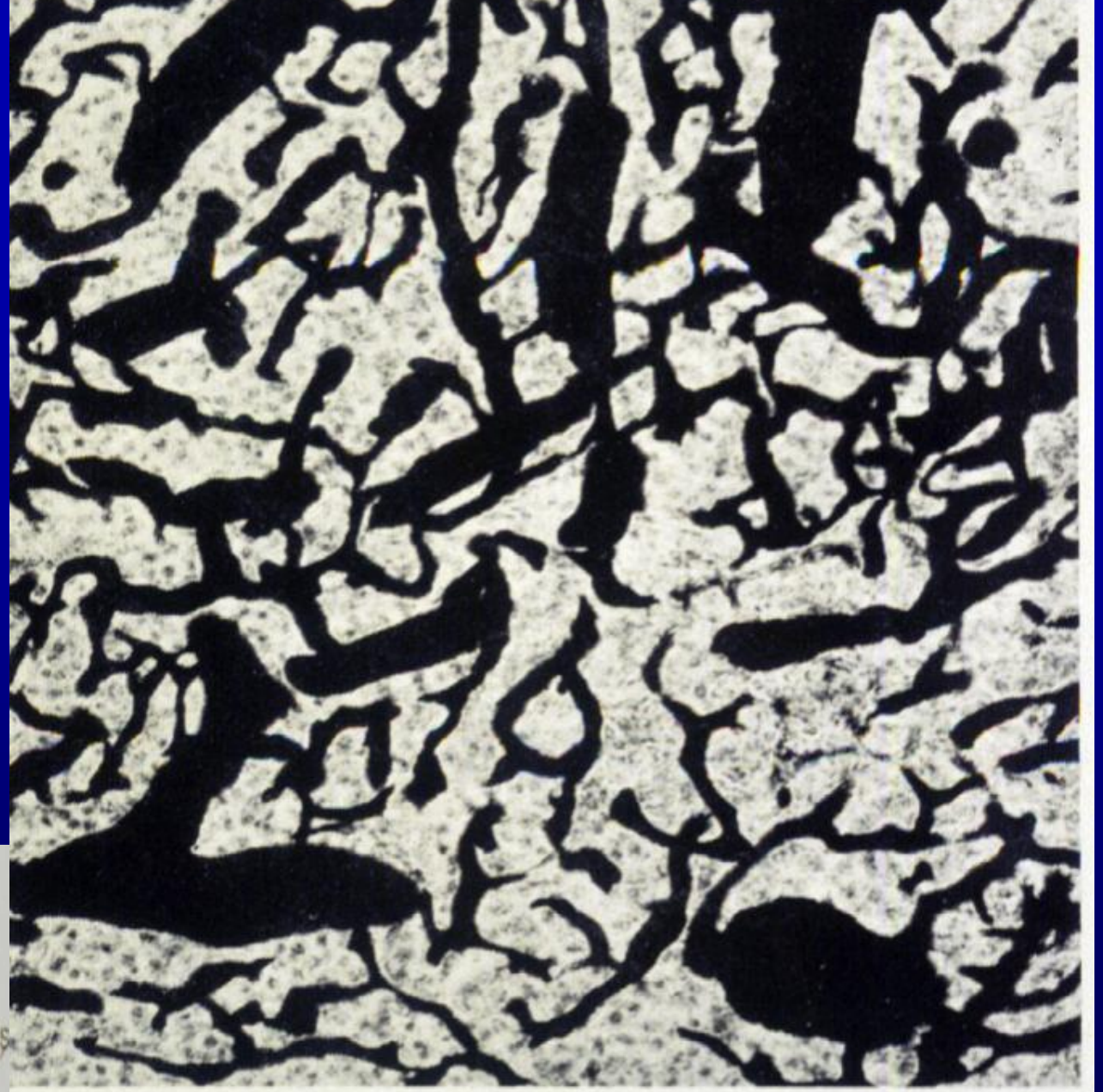


Figure 17–7. Electron micrograph of a rat mammatrope. Notice the relatively large size and irregular shape of the granules. A number of developing granules are associated with a large Golgi complex at lower right of figure. (Micrograph courtesy of M. Farquhar and T. Kanaseki.)

Pars Distalis





gure 17–12. Photomicrograph of anterior lobe of hy
ophysis of monkey injected intravenously with India
k to show the irregular, richly anastomotic sinusoids

Variations in the Microvasculature

Common:

Arteriole ⇨ Capillary ⇨ Venule

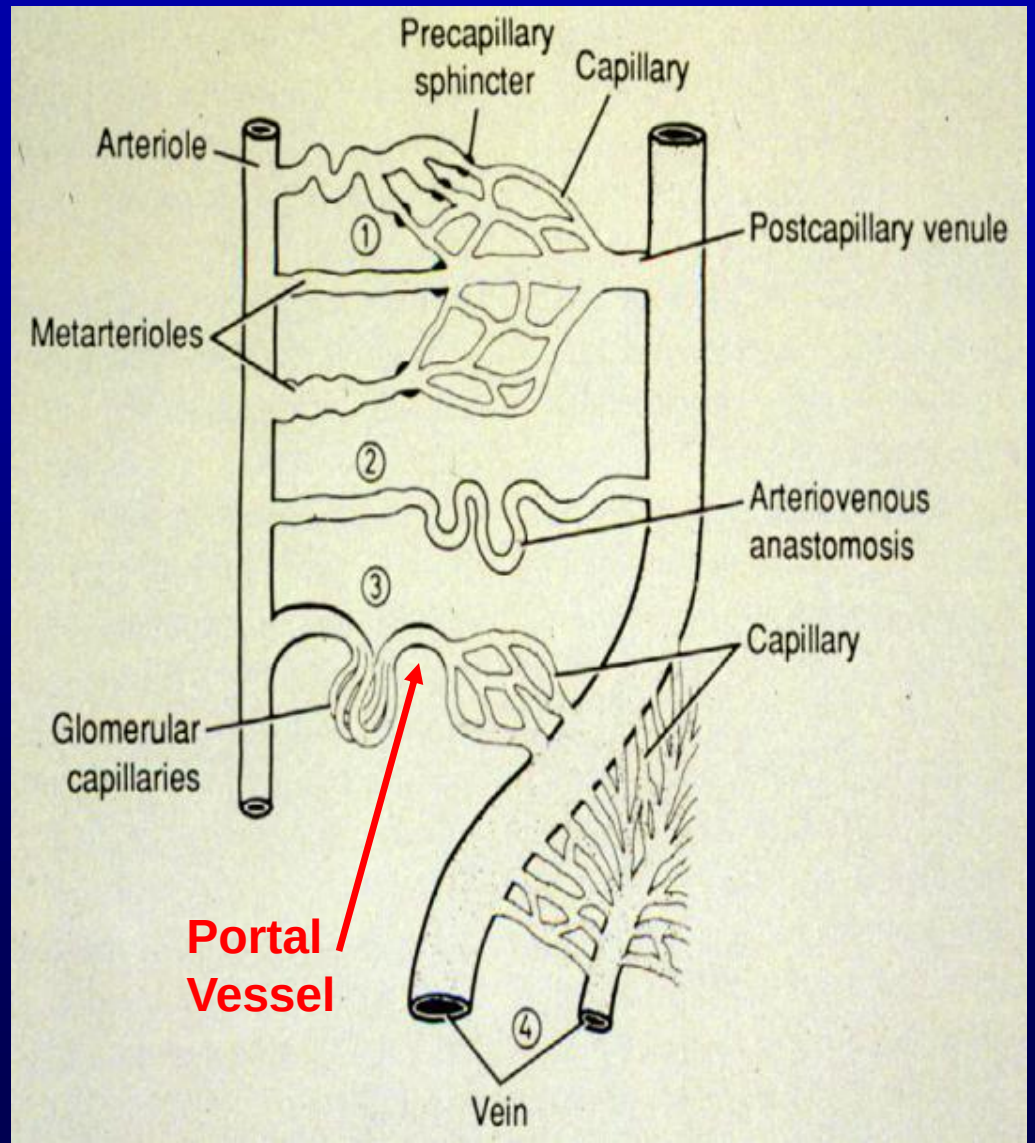
Venous portal system:

Capillary ⇨ Portal vein ⇨ Capillary

Arterial portal system:

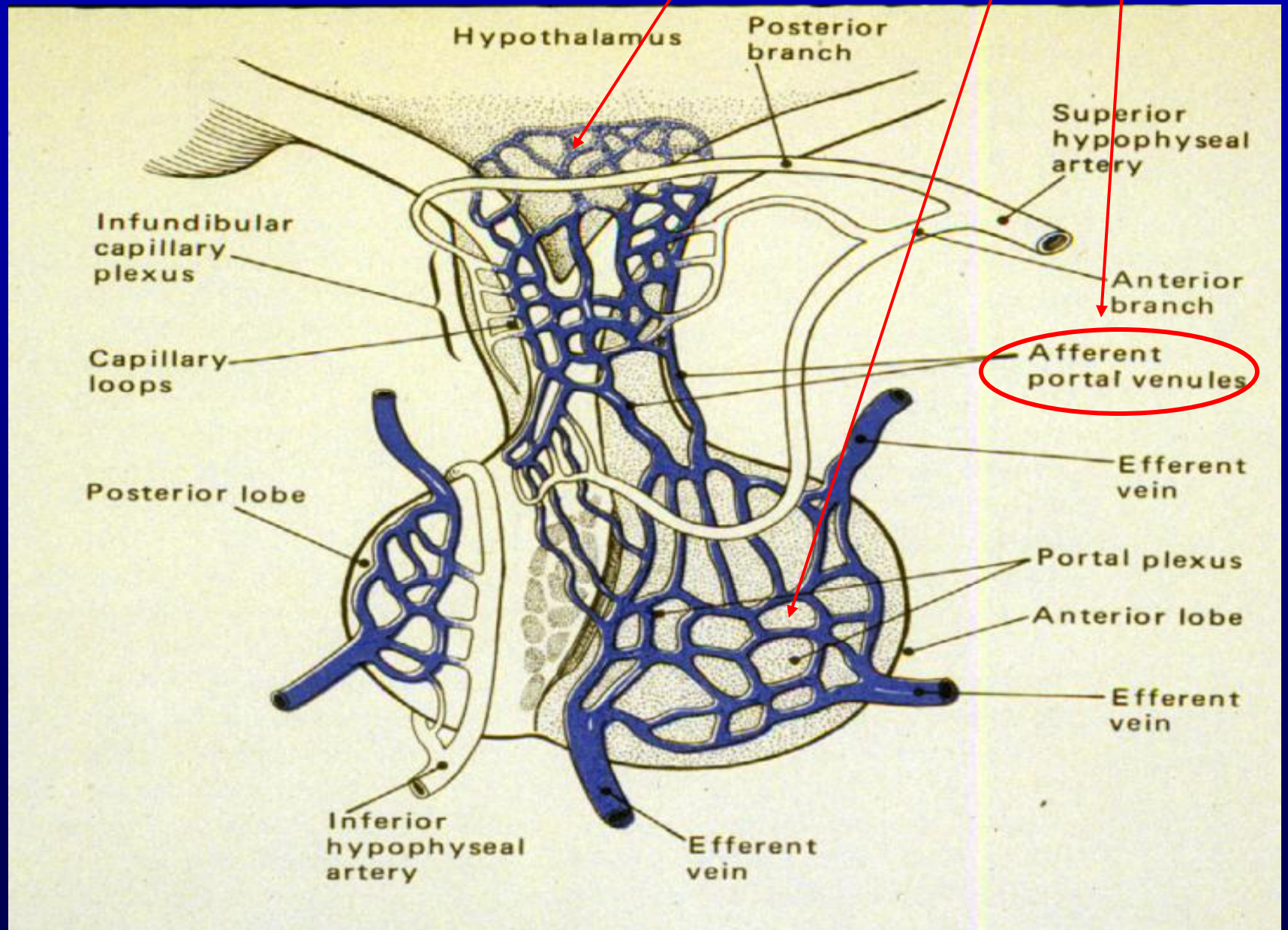
Capillary ⇨ Portal arteriole ⇨ Capillary

Portal system functions to create a local change in blood composition.



Blood supply

Venous portal system:
Capillary ⇨ portal vein
⇨ capillary



Releasing hormones are collected in first capillary bed of venous portal system.

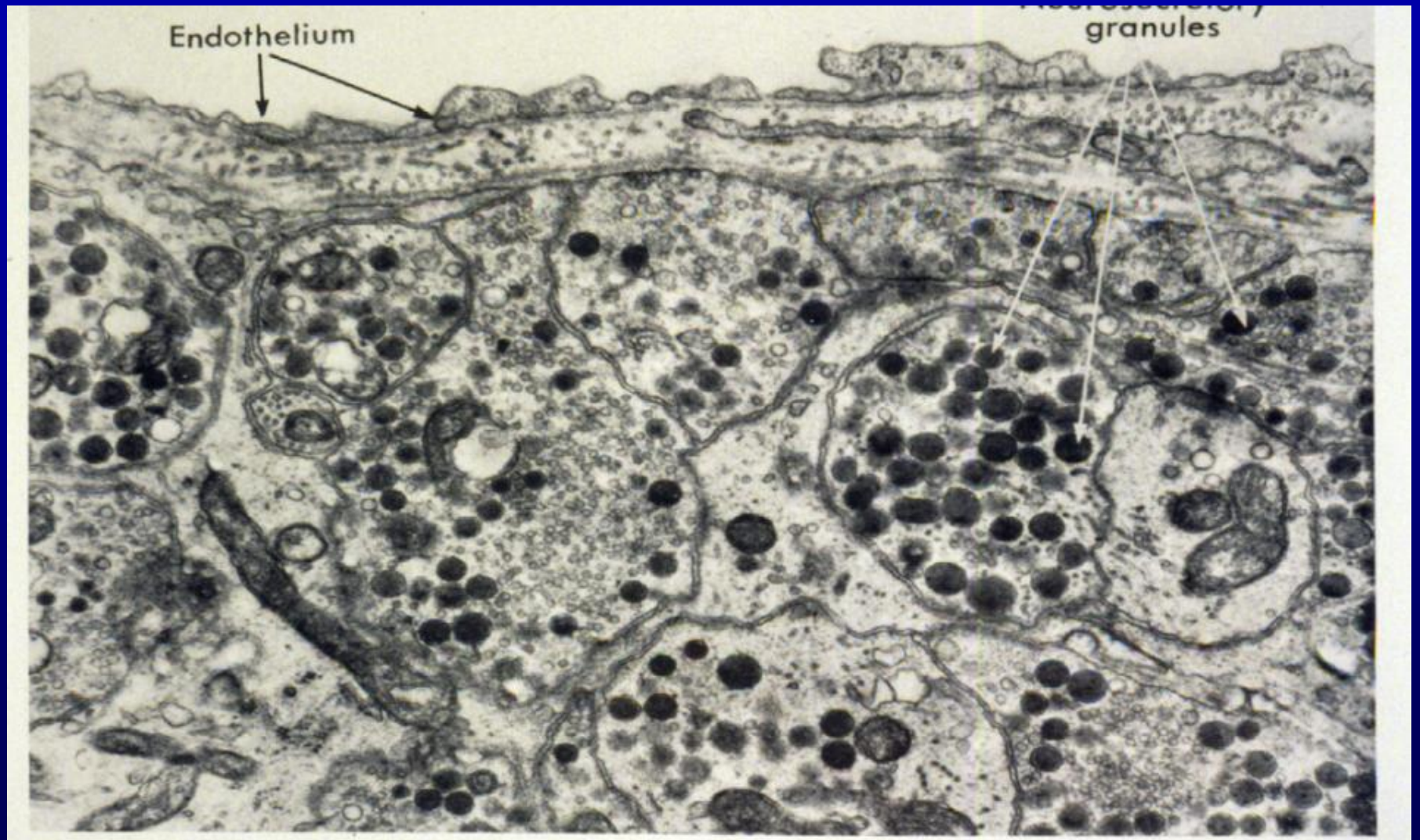
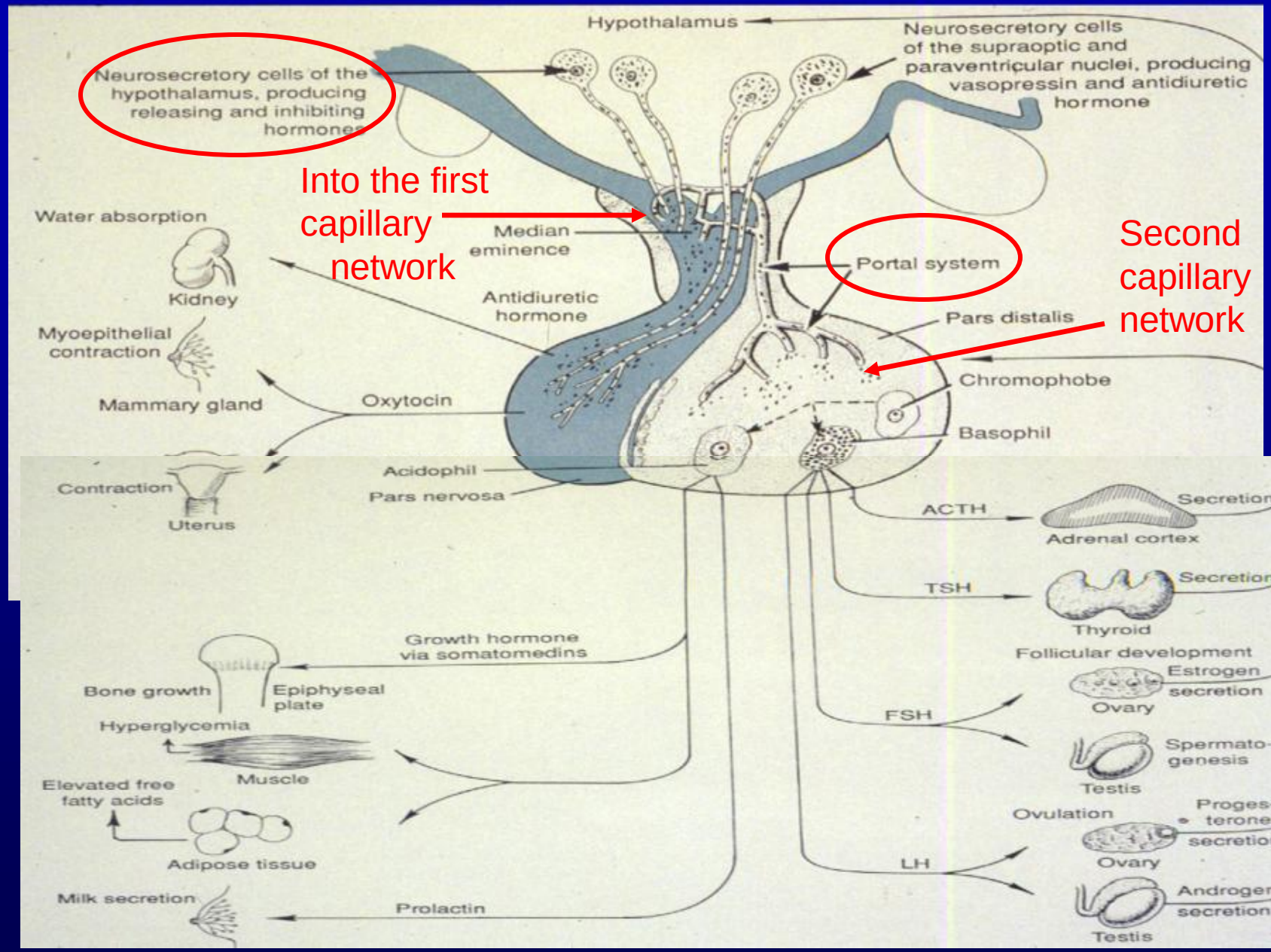
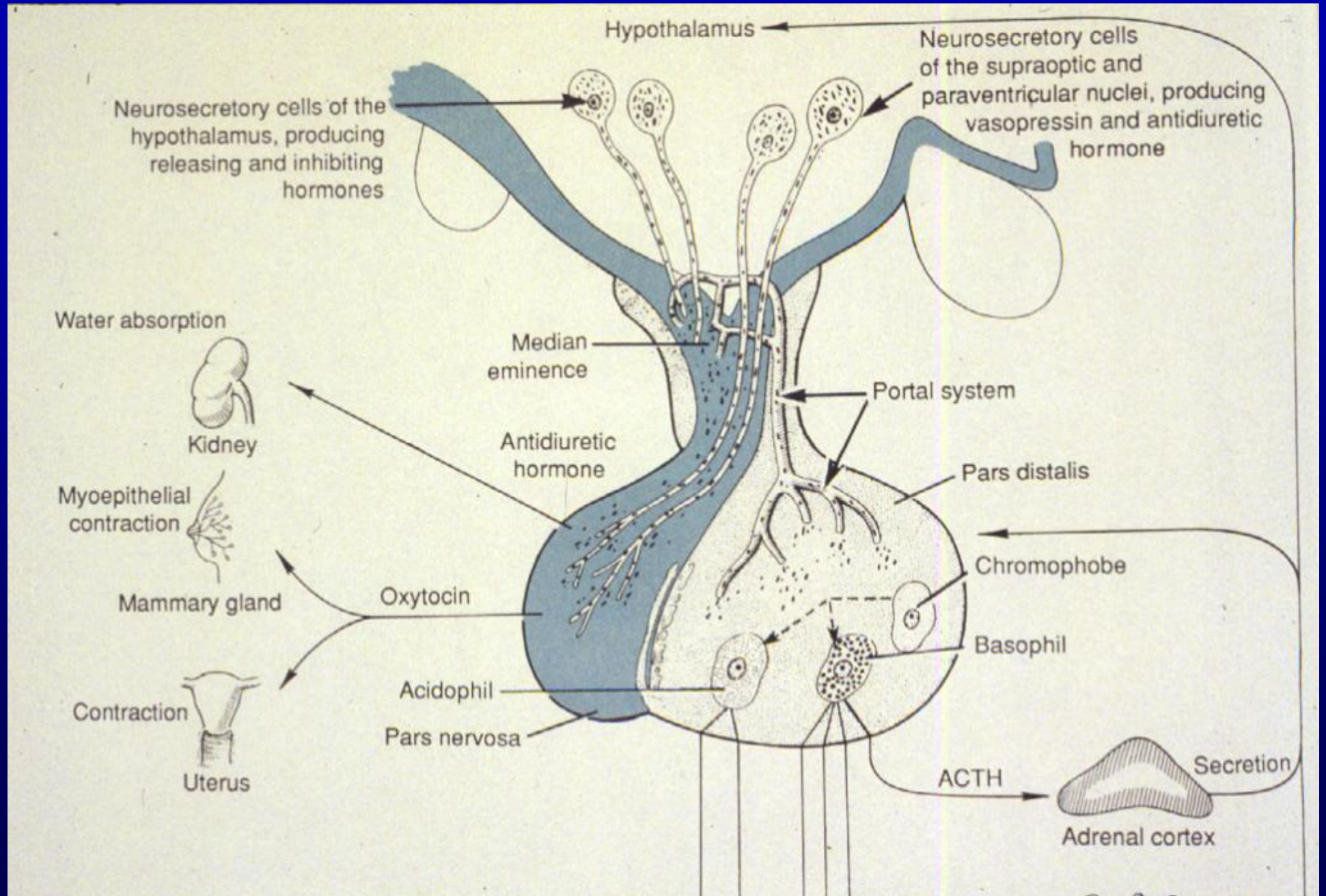


Figure 17–14. Electron micrograph of rat neurohypophysis, showing neurosecretory granules and small vesicles in the axoplasm of fibers of the hypothalamo-hypophyseal tract ending in close relation to a capillary. × 22,000. (Courtesy of

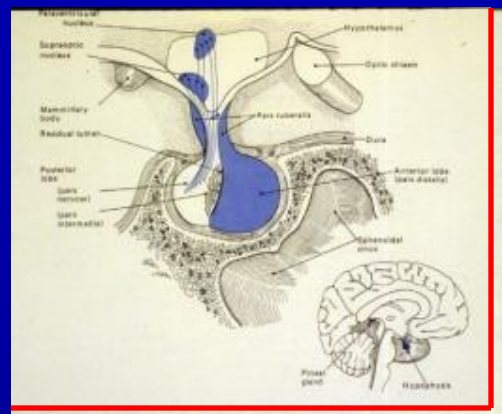
Releasing hormones are distributed in second capillary bed of venous portal system.



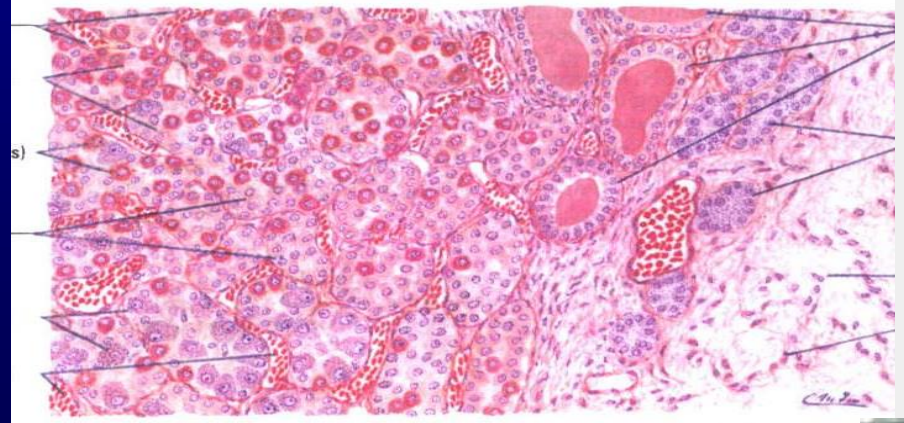
Pituitary – organ interaction



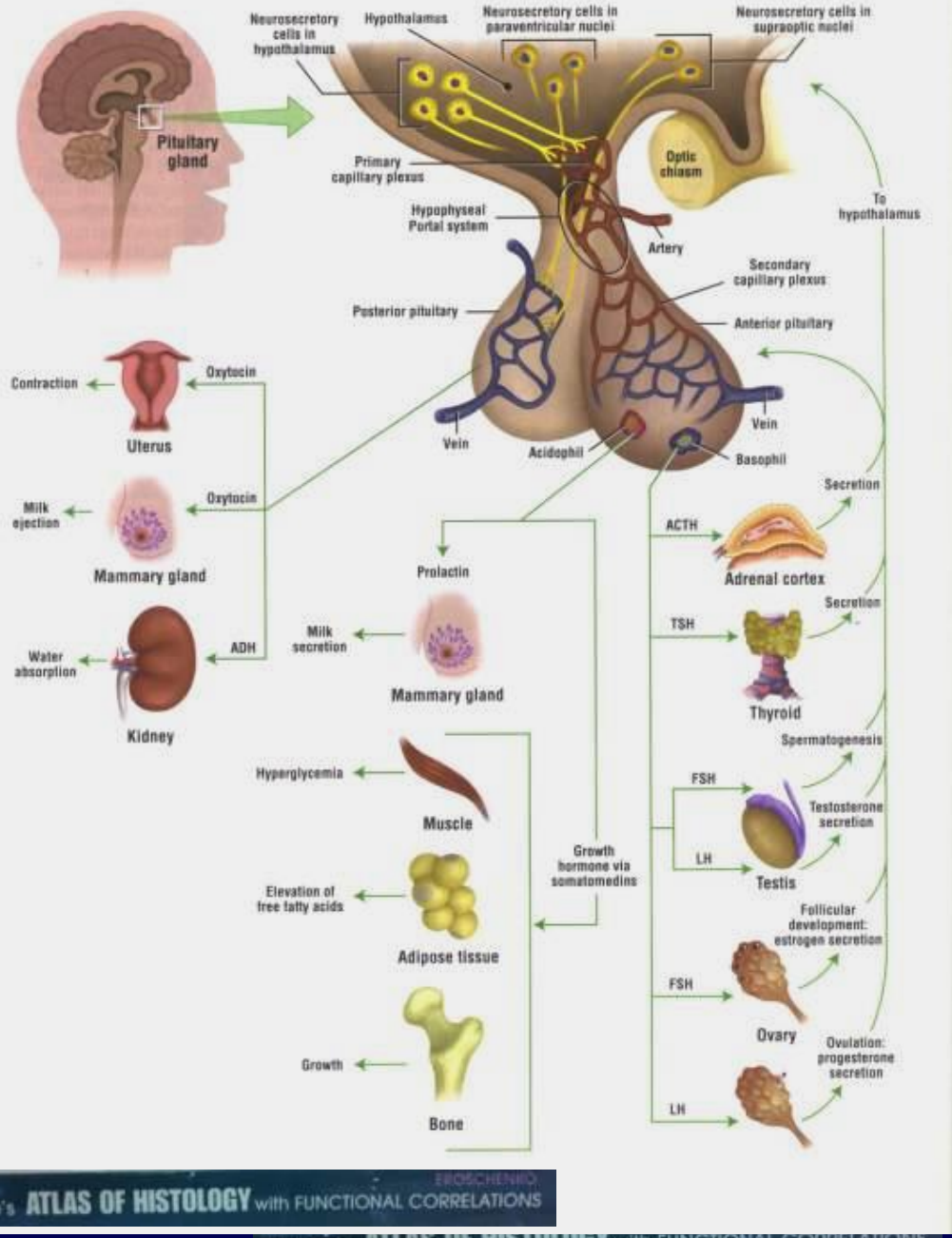
Pituitary – organ interaction



Hypophysis (panoramic view, sagittal section). Stain: hematoxylin-eosin. Low m

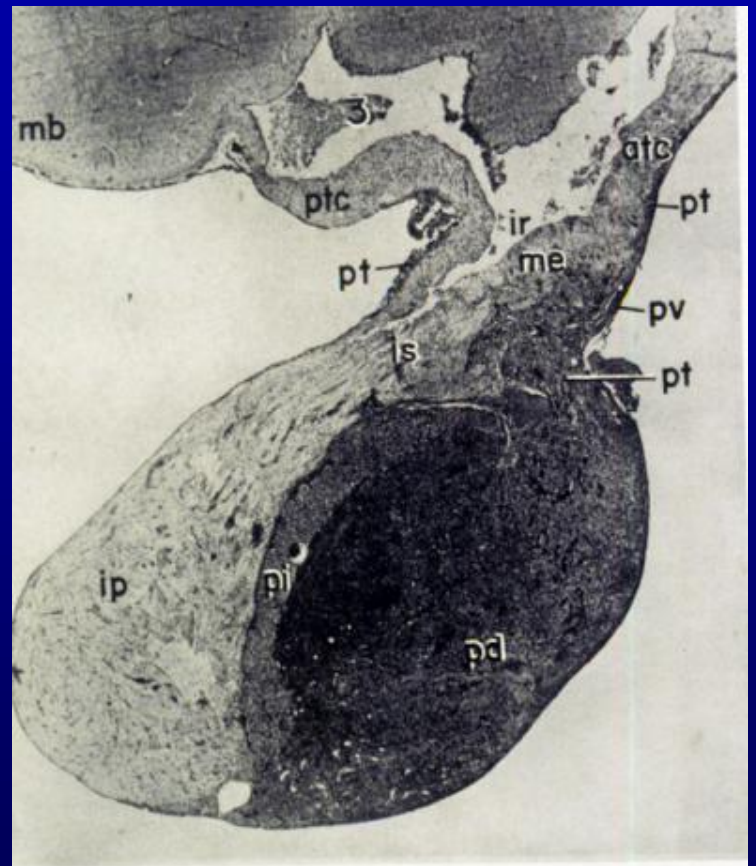


16-2 Hypophysis (sectional view). Stain: hematoxylin-eosin. Medium magn



Neurohypophysis

- Origin
- Divisions
  - I. Pars nervosa
  - Ii. Infundibulum
    - 1) Stem/stalk
    - 2) Median eminence
- Relation to hypothalamus
  - Microscopic organization
    - I. Secreting nerve cells
    - Ii. Neurosecretory granules
    - Iii. Herring bodies
    - Iv. Pituicytes

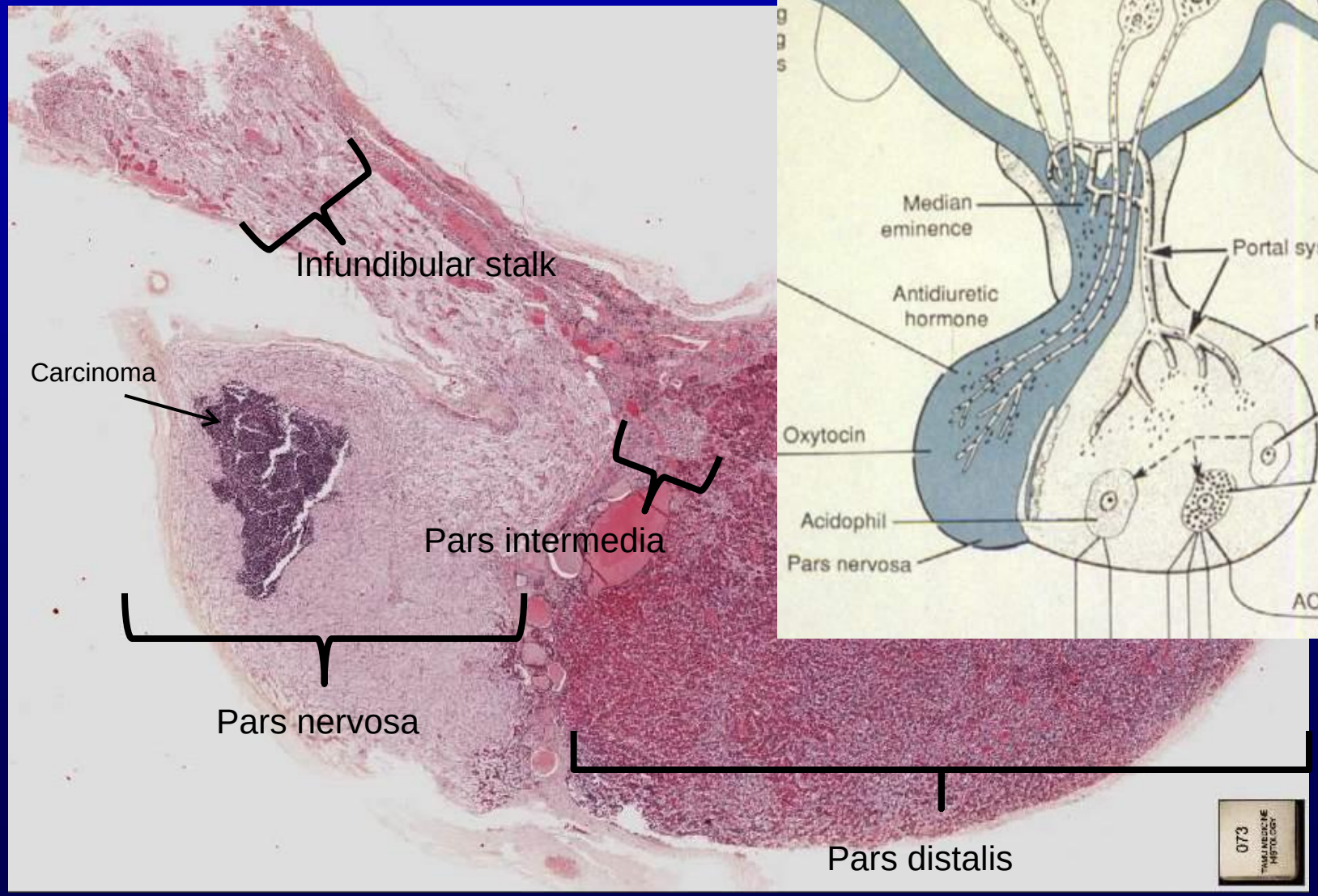


ittal section through a rabbit hypophysis
in connection with the hypothalamus.
e pars distalis (pd), the pars intermedia
dibular process or pars nervosa (ip), the
tem (is), the pars tuberalis (pt), a portal
e median eminence (me), anterior and
ons of the tuber cinereum (atc and ptc),

alis, invests the infundibular stem and
the outer layers of the pituitary stalk.
lationships are shown in Fig. 29–1.

Histogenesis of the Hypophysis

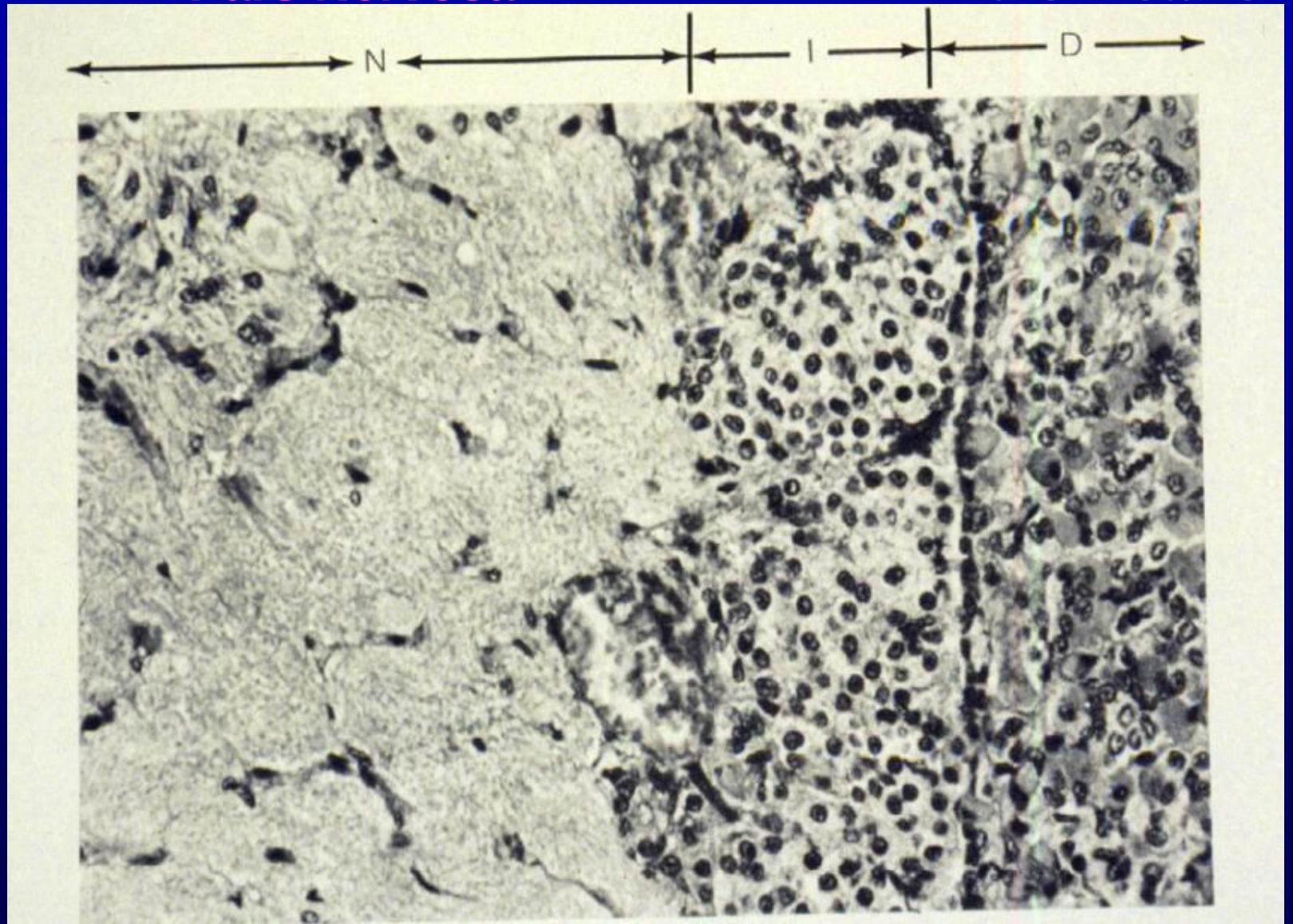
Slide 73: Pituitary (early carcinoma in posterior lobe)



Pars Nervosa

Pars Intermedia

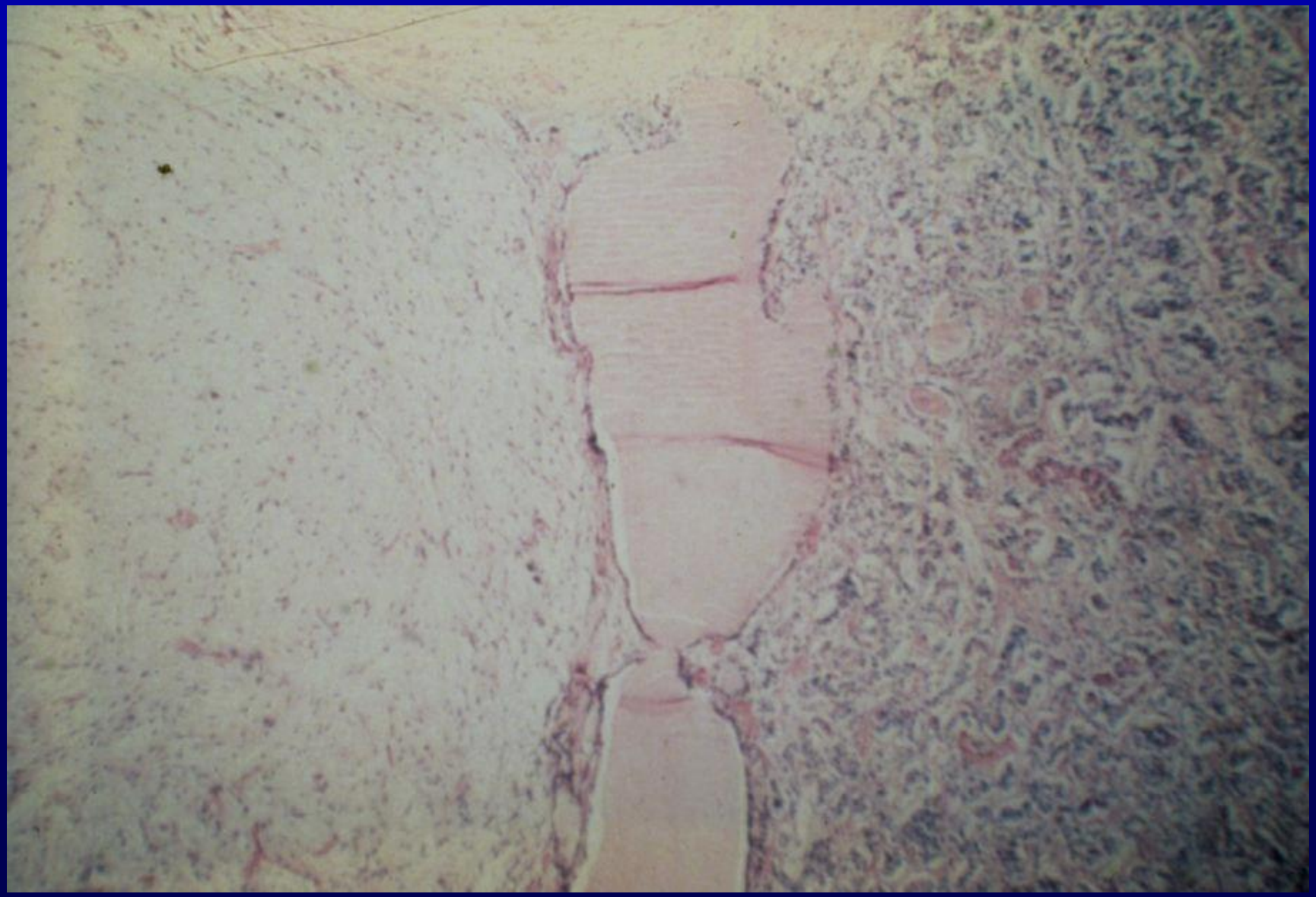
Pars Distalis



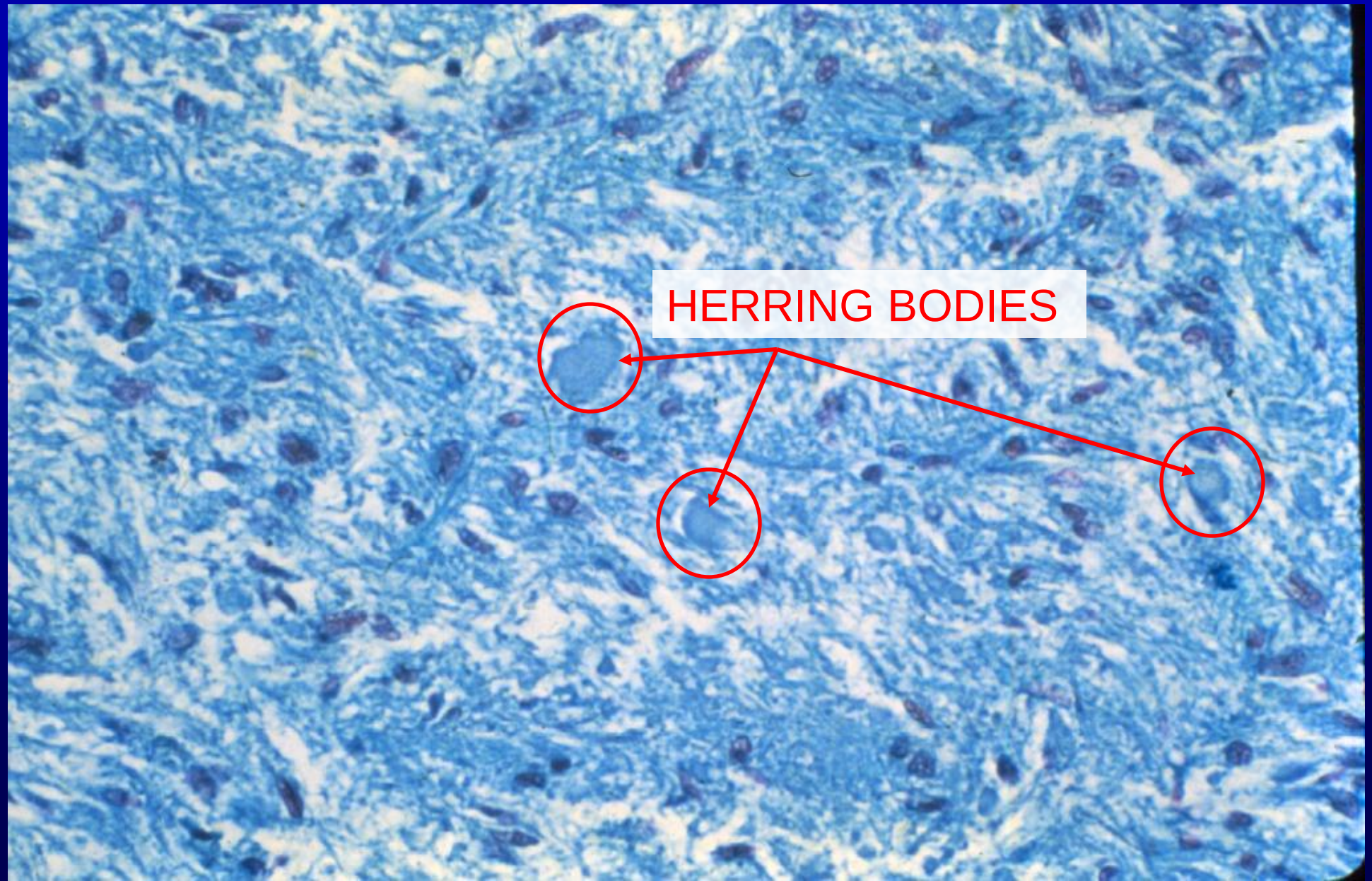
Pars Nervosa

Pars Intermedia

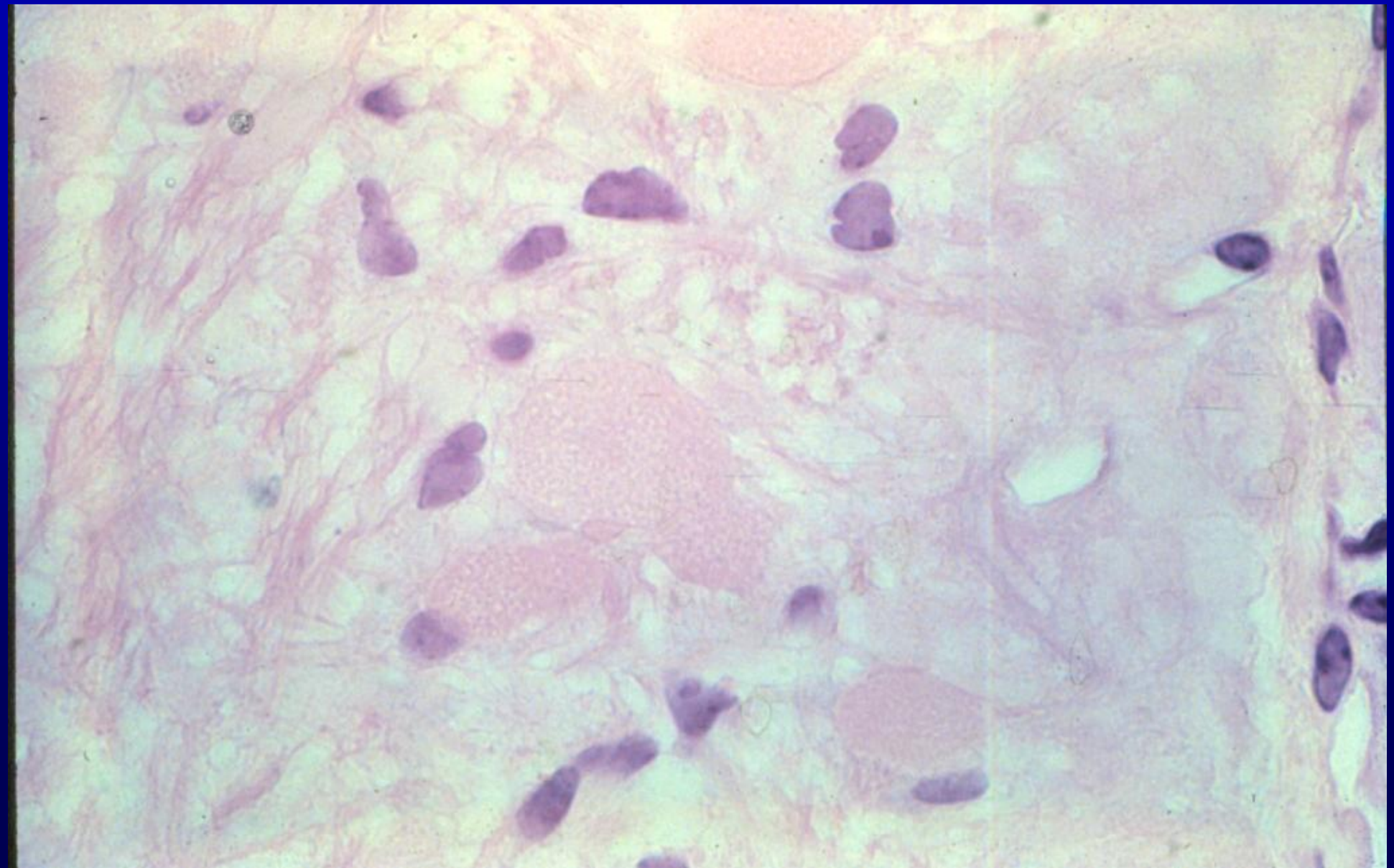
Pars Distalis



Herring Bodies in the Pars Nervosa



Herring Bodies



Herring Bodies

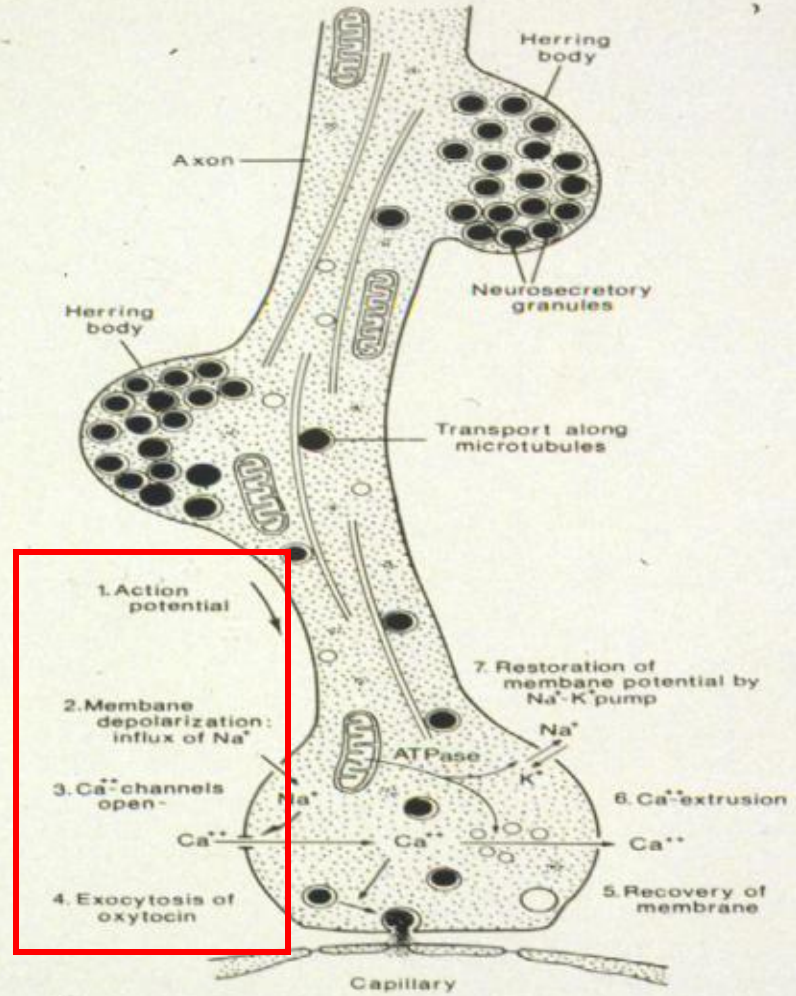


Figure 17–12. Schematic depiction of the terminal portion of an axon of the hypothalamohypophyseal tract in the neurohypophysis. The principal events in stimulus-secretion coupling are indicated. (Modified after Lincoln, D.W. 1984. *In* Hormonal Control of Reproduction. Cambridge, England, Cambridge University Press.)

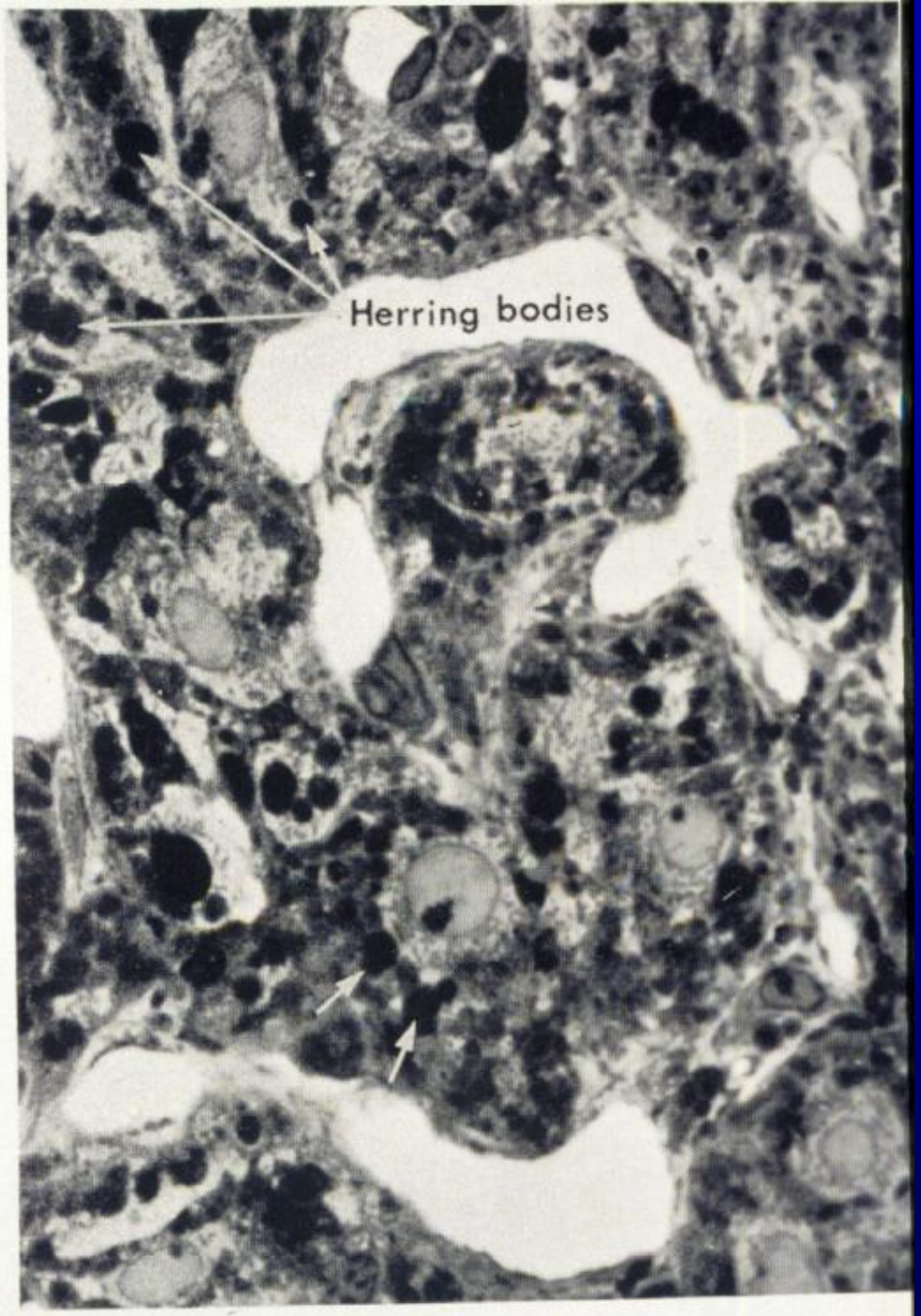
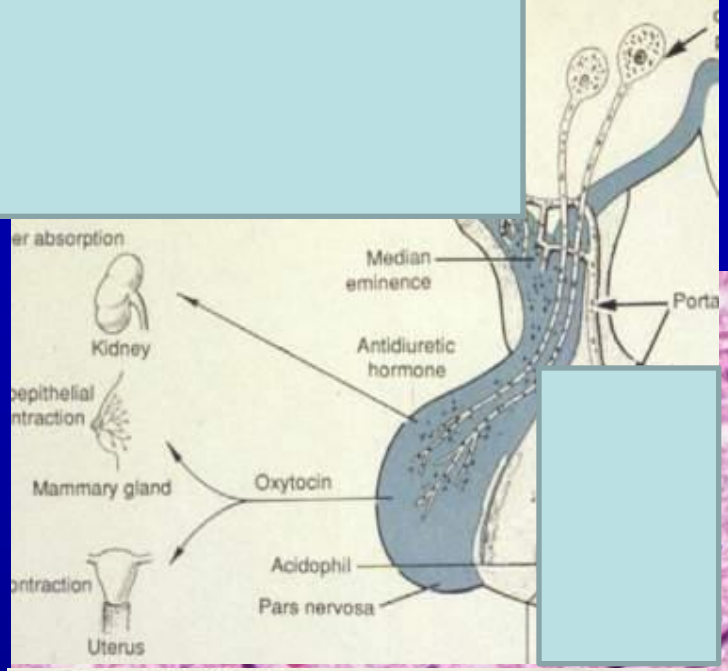
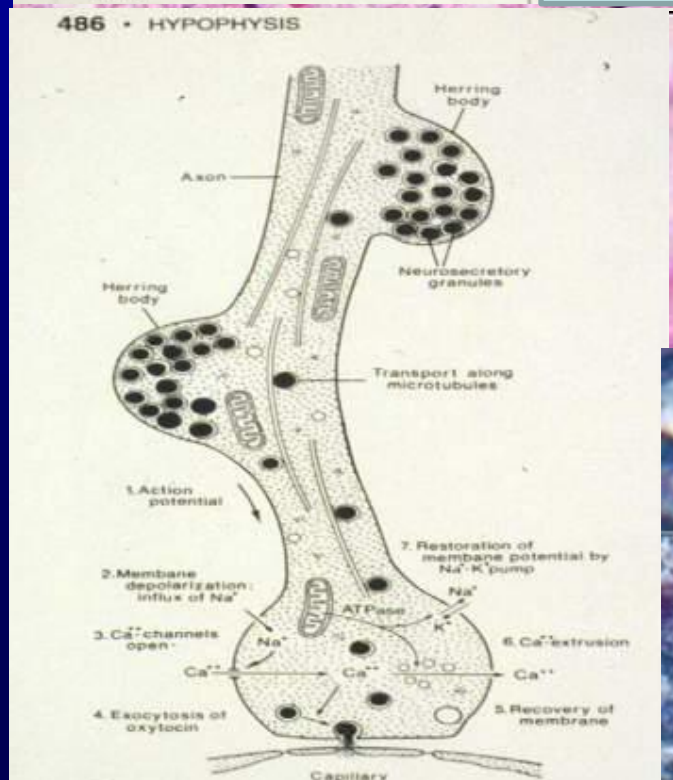


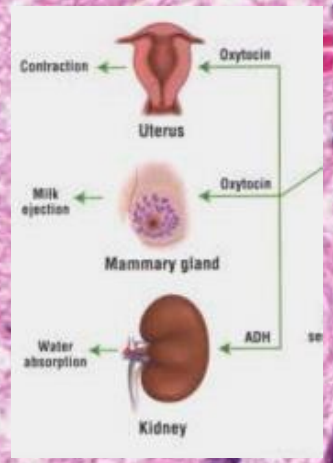
Figure 17–13. Photomicrograph of rat neurohypophys

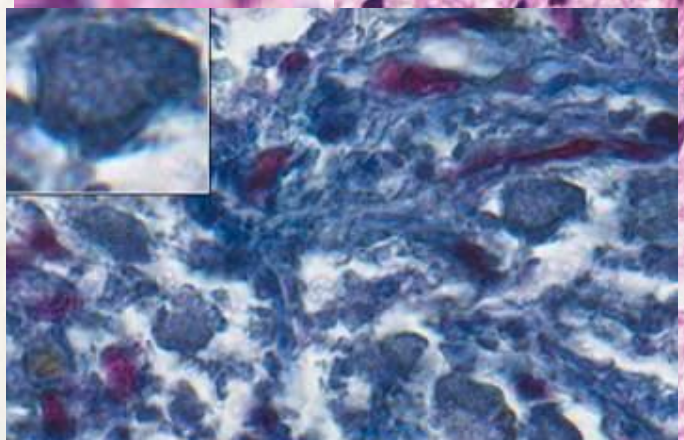
Herring Bodies in the Pars Nervosa

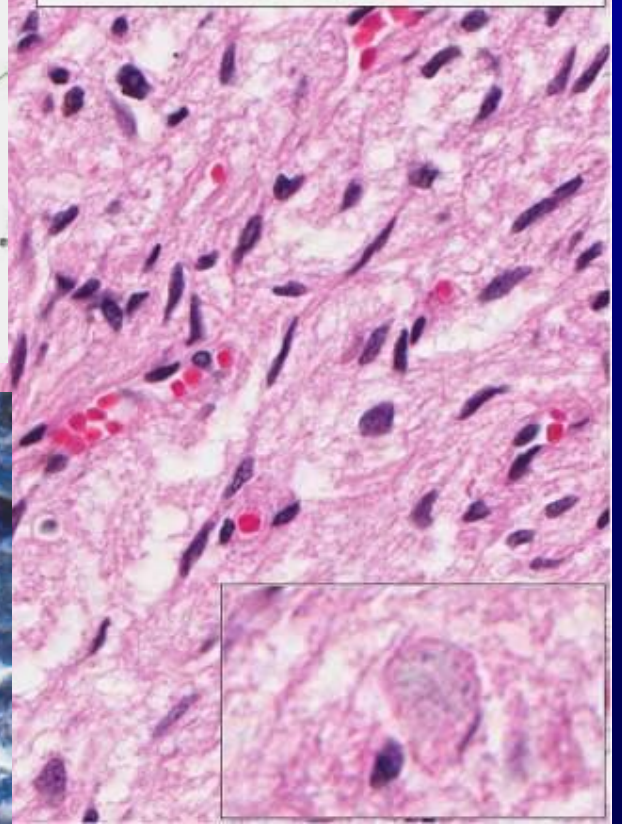
Herring bodies in pars nervosa of Hypophysis



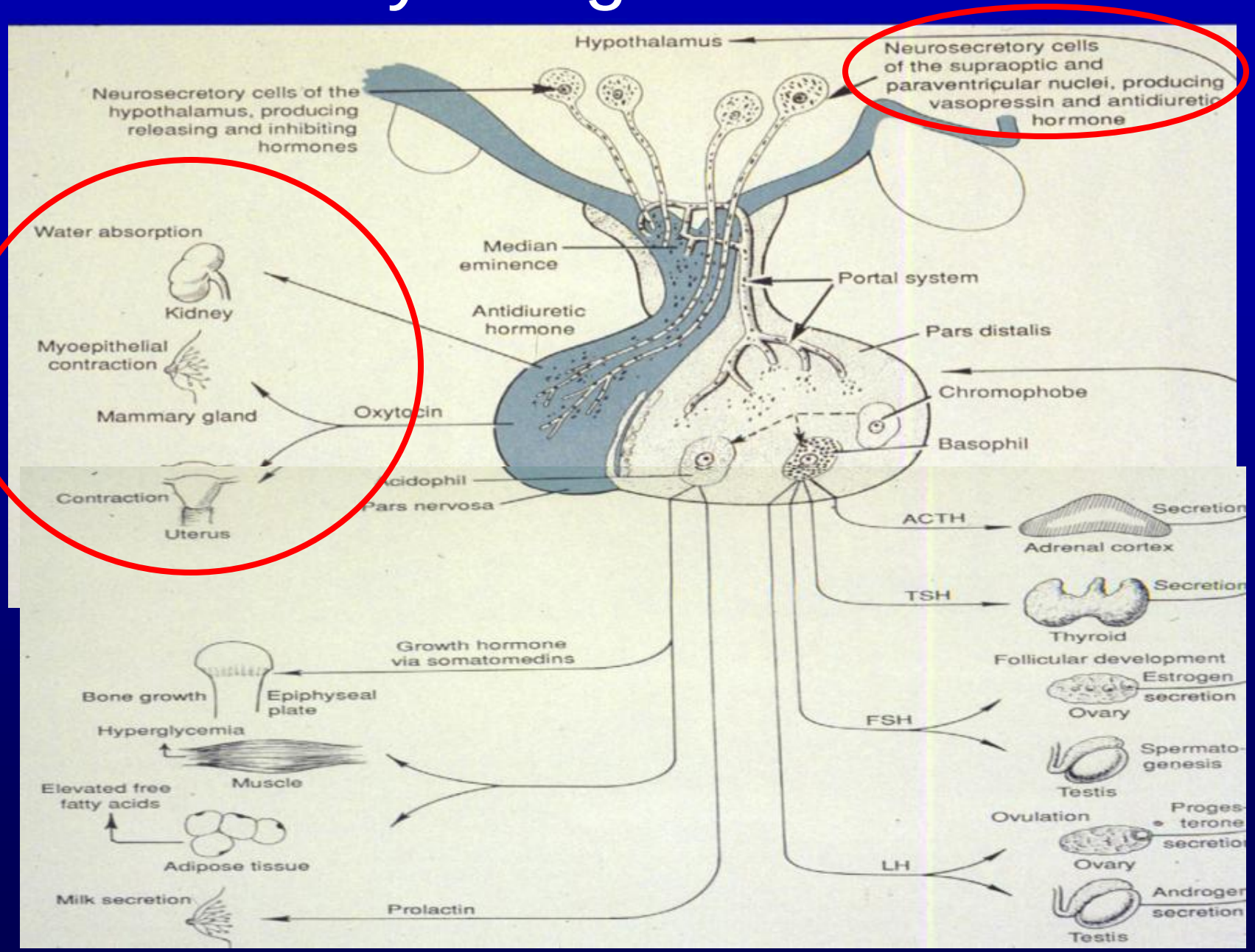




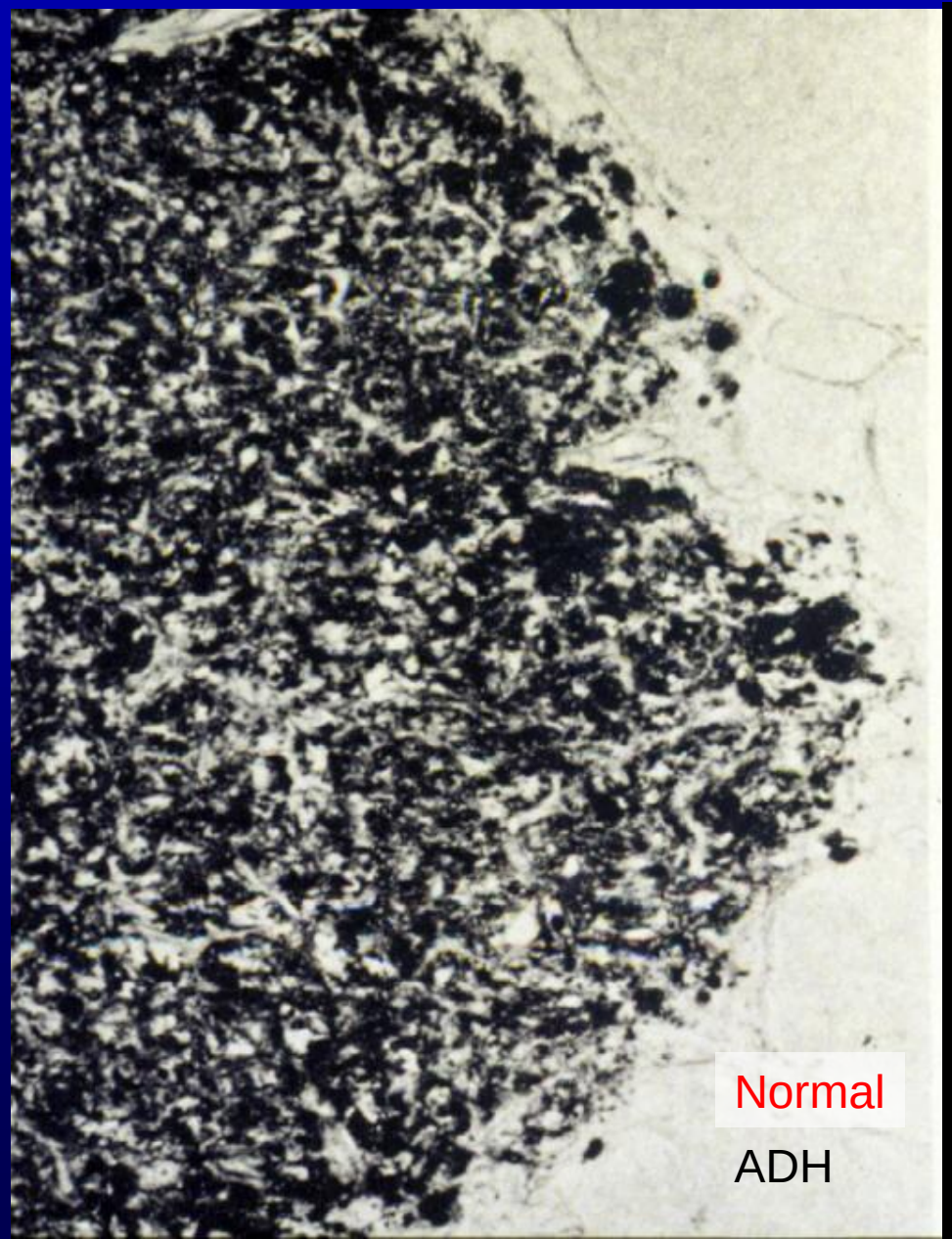




Pituitary – organ interaction

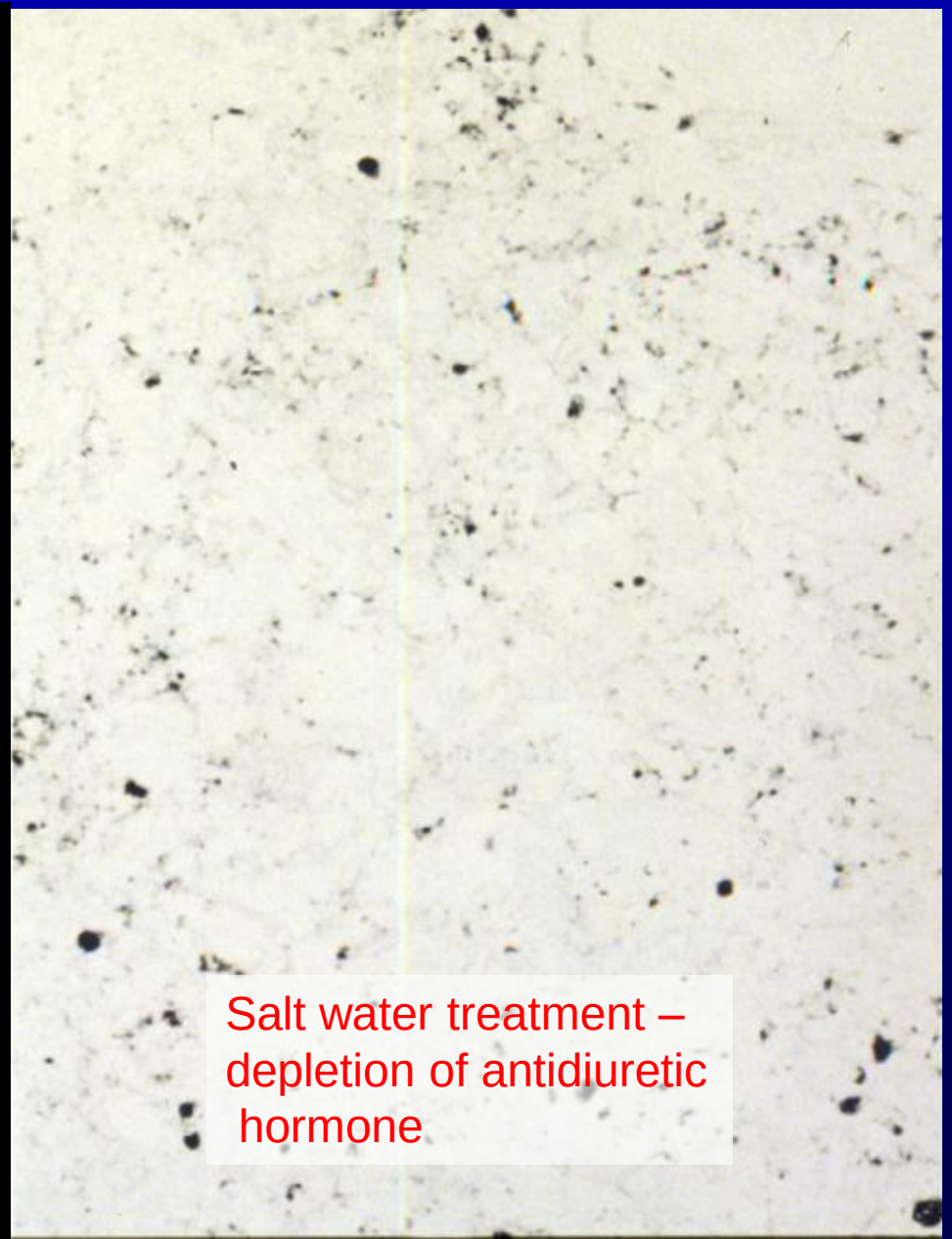


Pars Nervosa



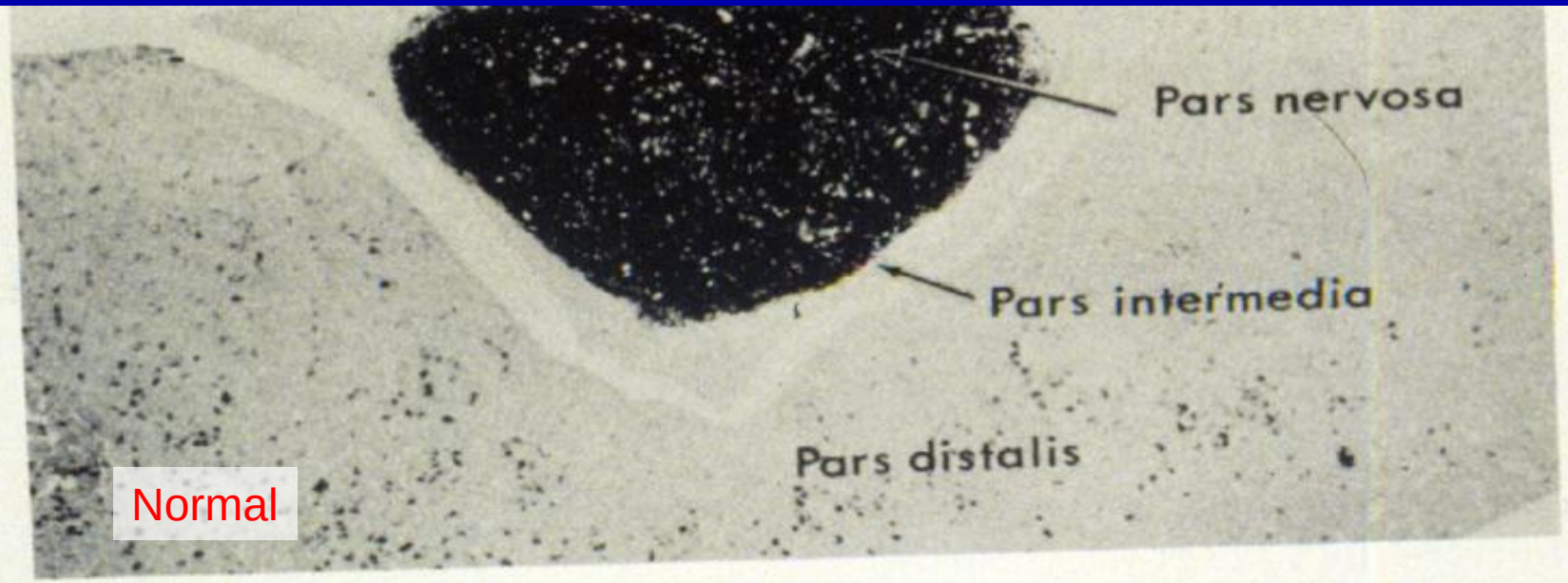
Normal

ADH



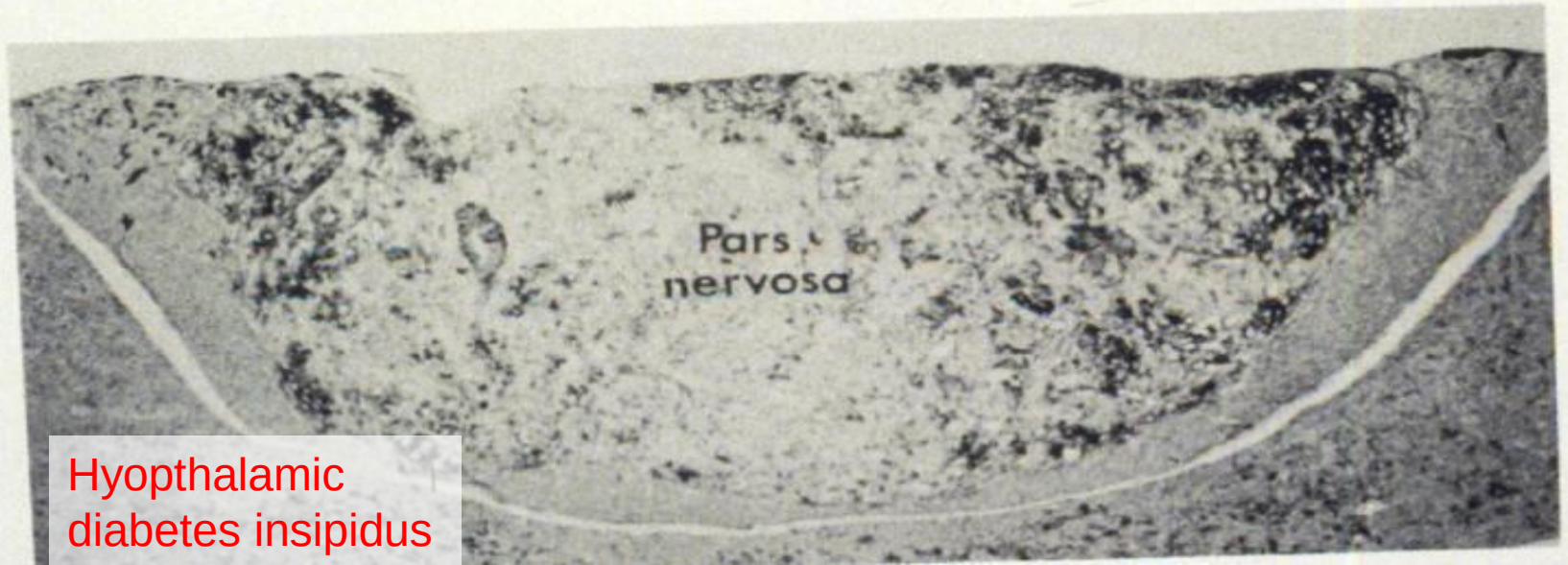
Salt water treatment – depletion of antidiuretic hormone

Pars Nervosa

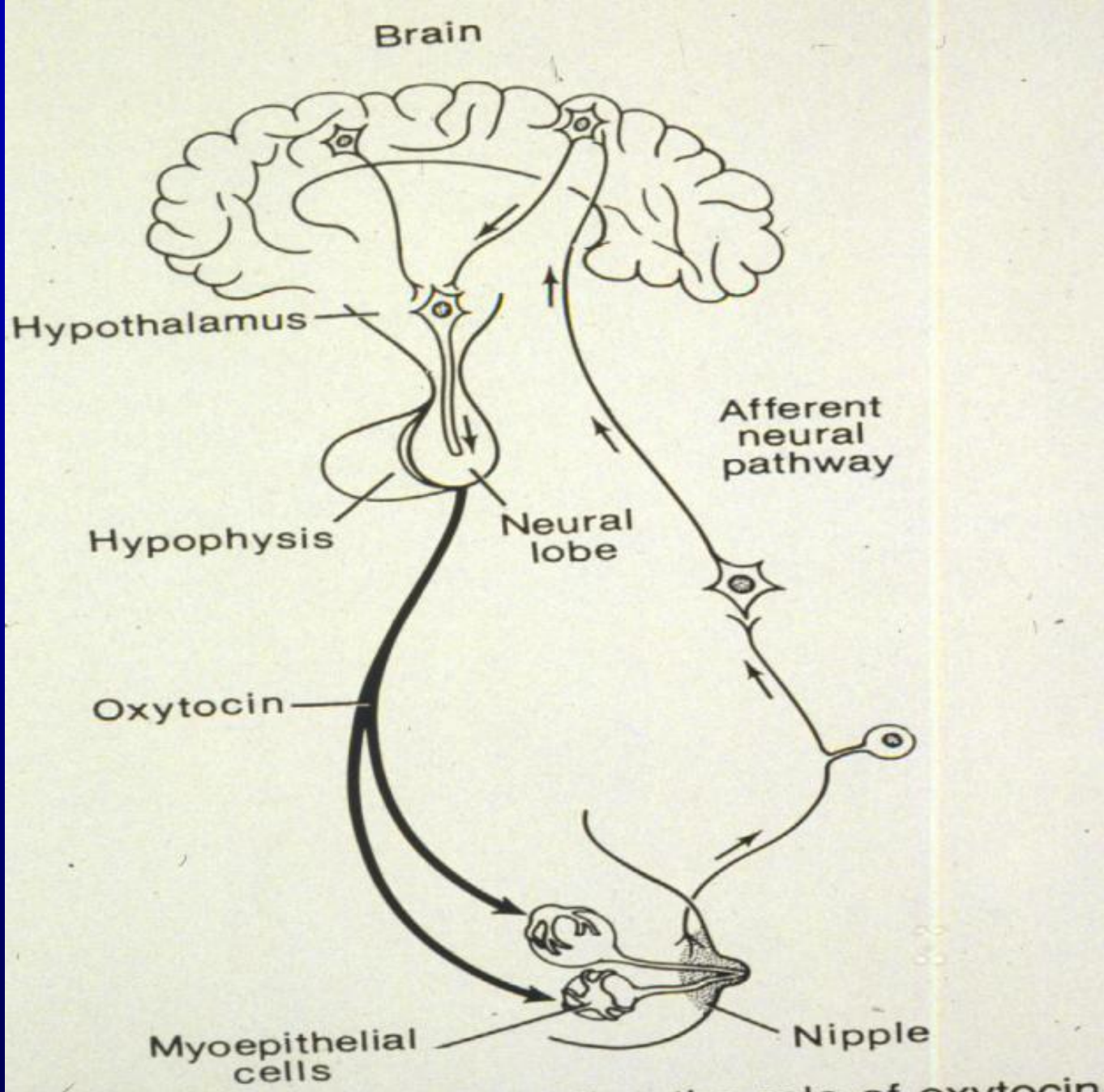


Normal

A



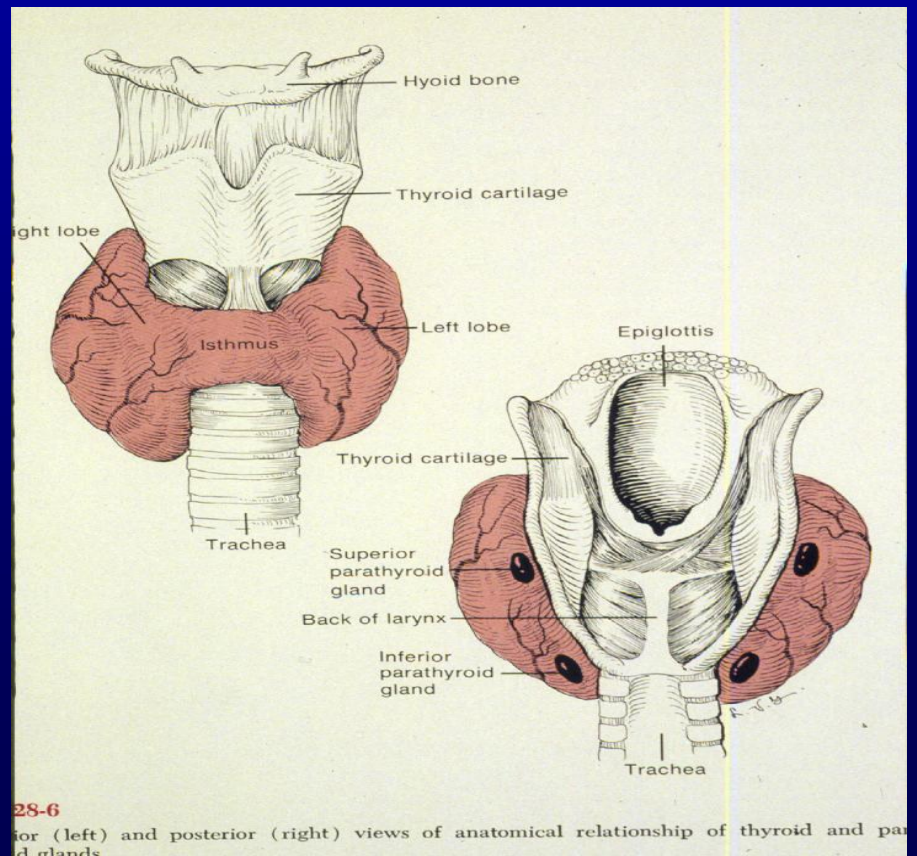
Hyopthalamic diabetes insipidus



re 17–17. Diagram illustrating the role of oxytocin
uckling reflex. Stimulation of the nipples generat

Thyroid Stimulating Hormone (TSH)

Physiological significance



28-6
ior (left) and posterior (right) views of anatomical relationship of thyroid and pa
d glands

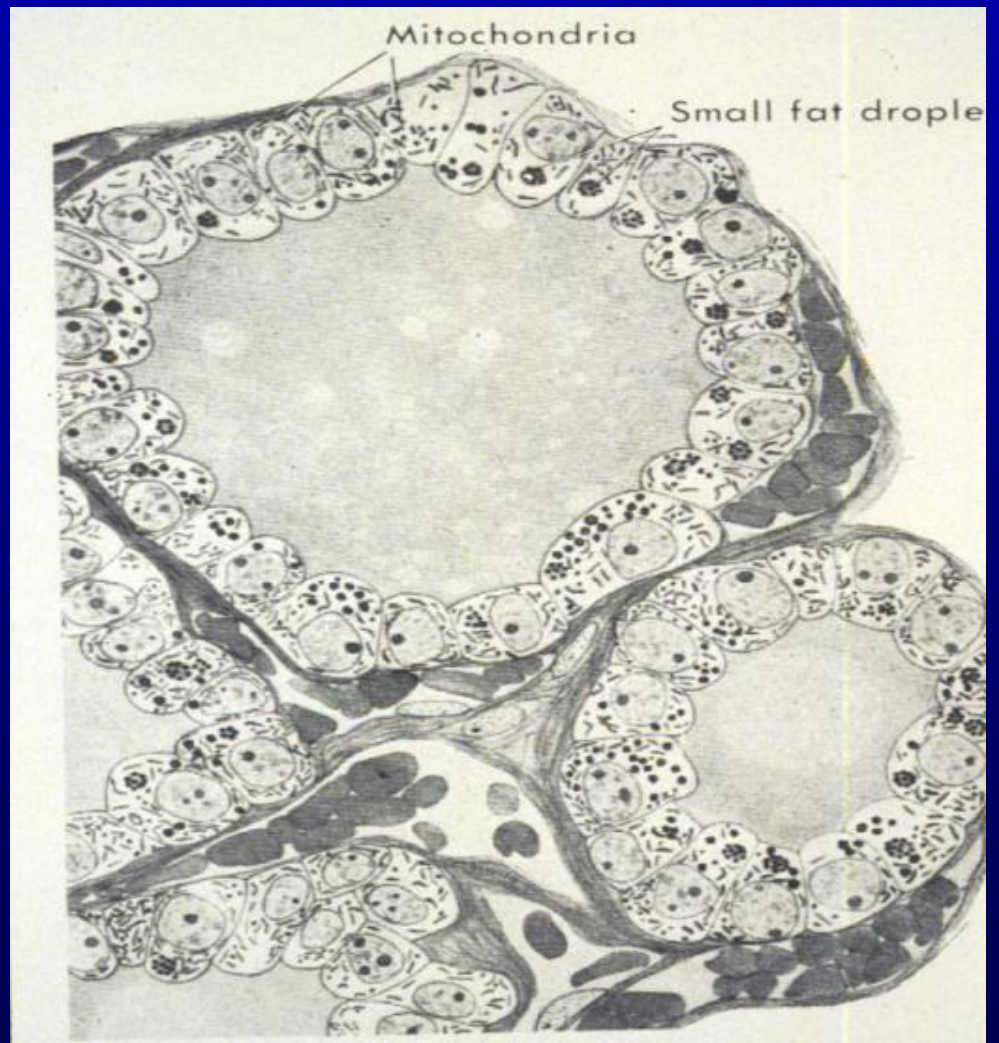
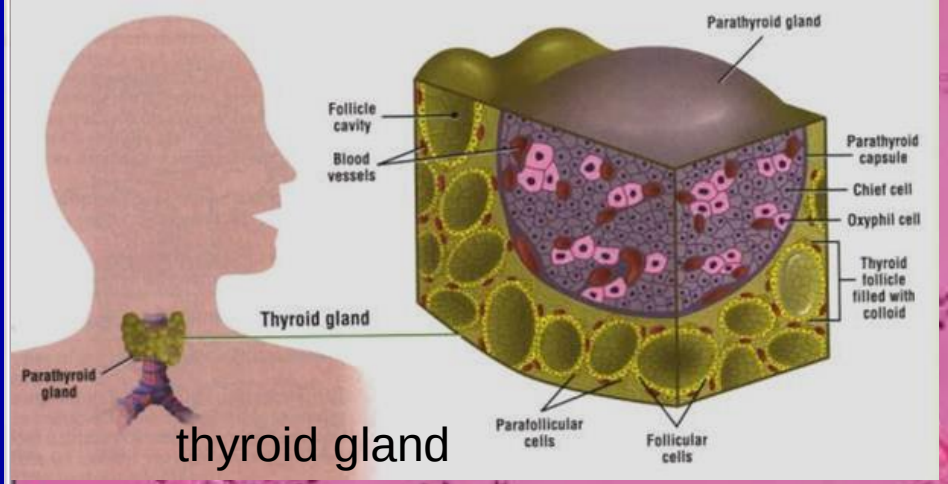


Figure 18–4. Section through several follicles of hu

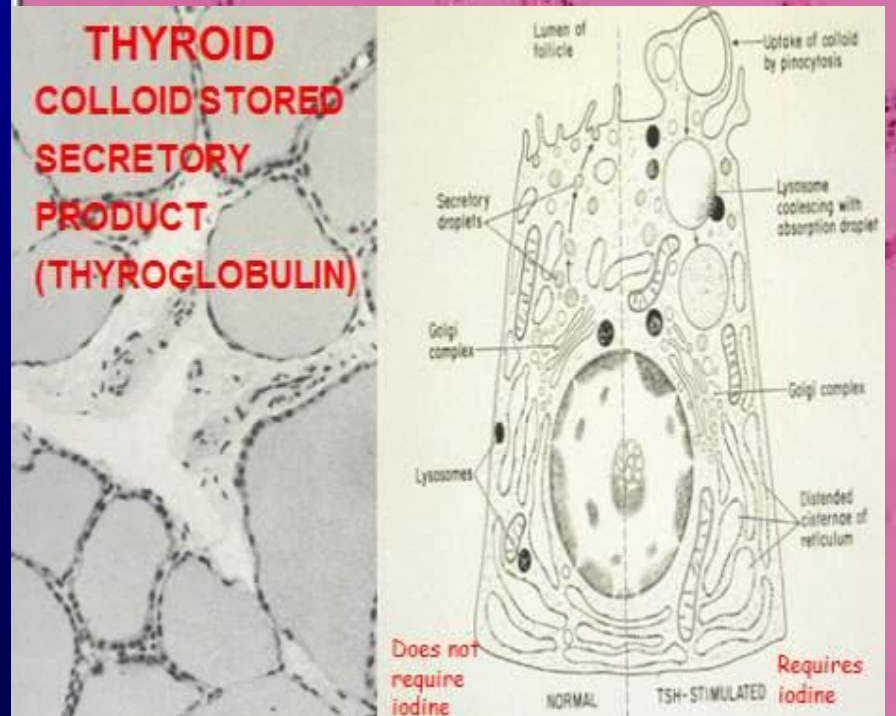
Thyroid gland

Follicle – no outlet

1. Colloid
2. Follicular cells
3. Capillaries in CT around follicle



thyroid gland

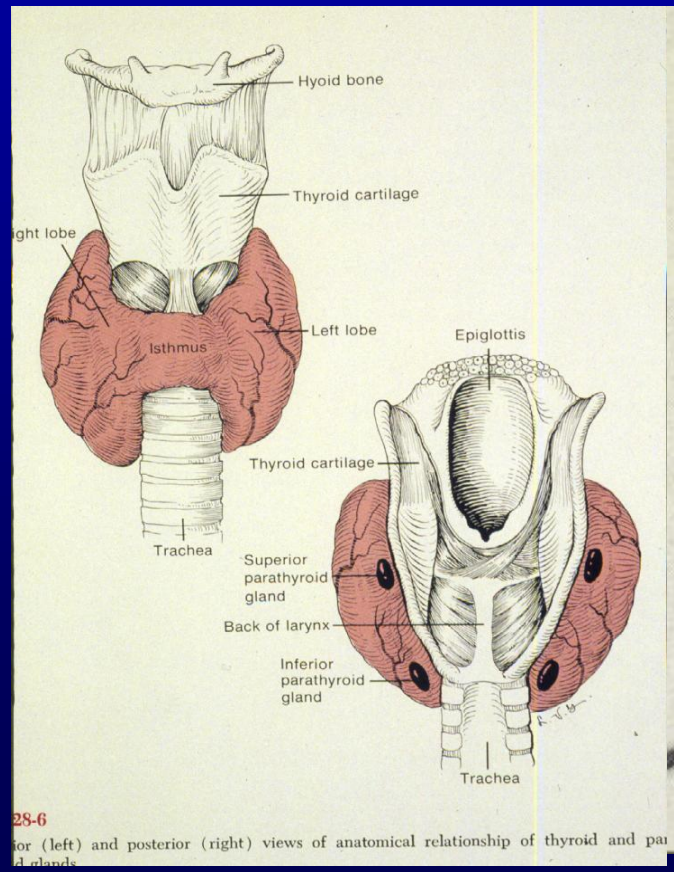


Colloid

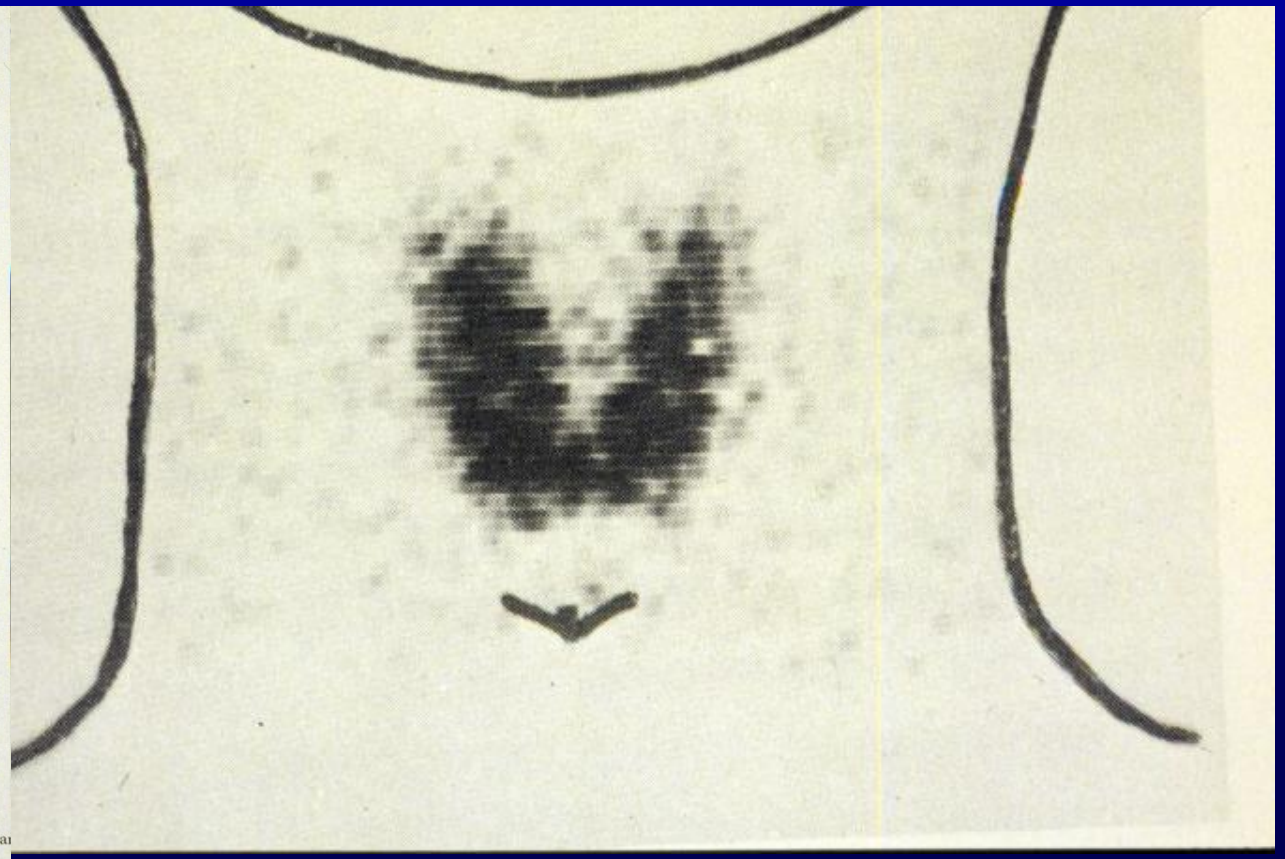
Capillary

Follicular cells

Thyroid



28-6
ior (left) and posterior (right) views of anatomical relationship of thyroid and pa
d glands



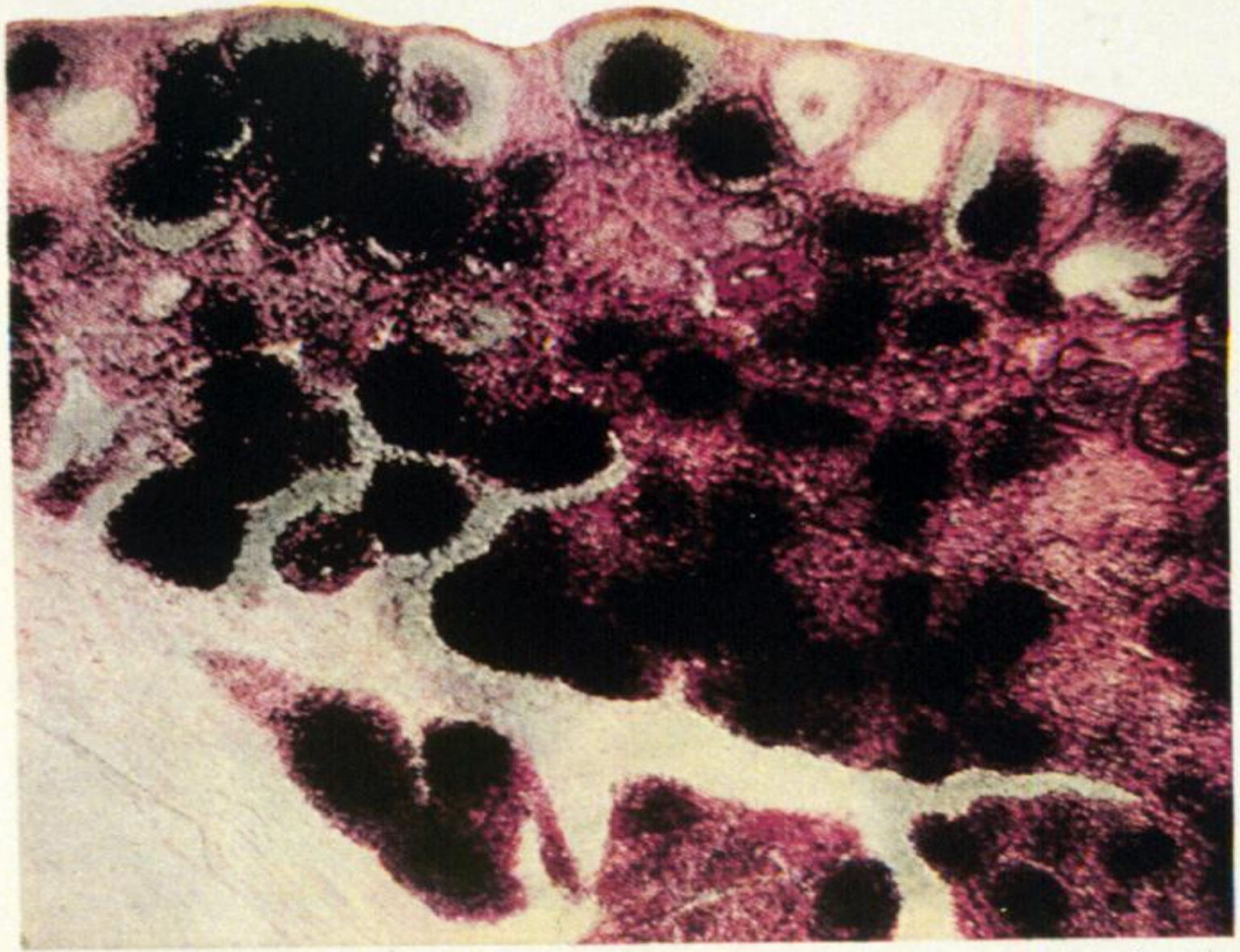
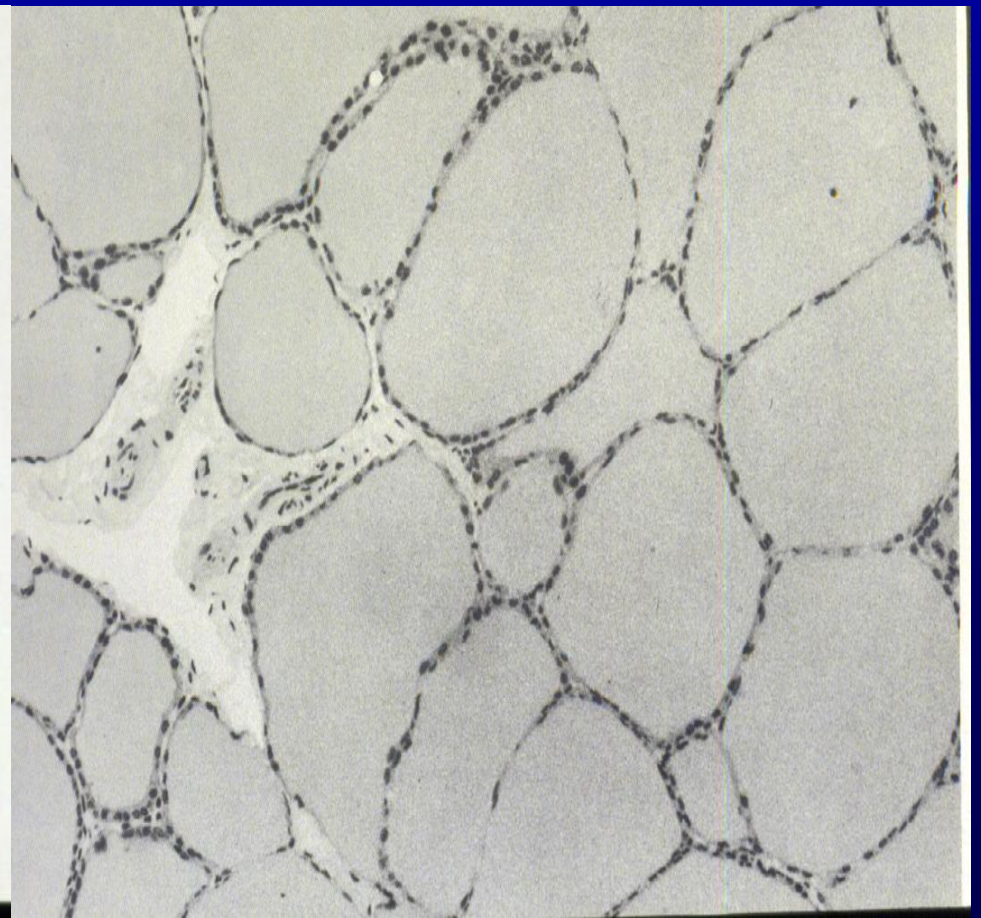


Figure 18–6. Low-power photomicrograph of thyroid gland of a rat previously injected with ^{131}I. The blackened areas represent sites of deposition of radioactive isotope in the colloid. There is great variation in the content of the isotope

Thyroid

Thyroid gland microanatomy

Follicles



Mechanism for release of secretory products

Merocrine secretion – exocytosis w/o loss of surface membrane

Apocrine secretion – loss of part of apical cytoplasm and some plasma membrane

Holocrine secretion – release of whole cell

Cytocrine secretion –

melanin granules transferred from melanocyte to keratinocytes

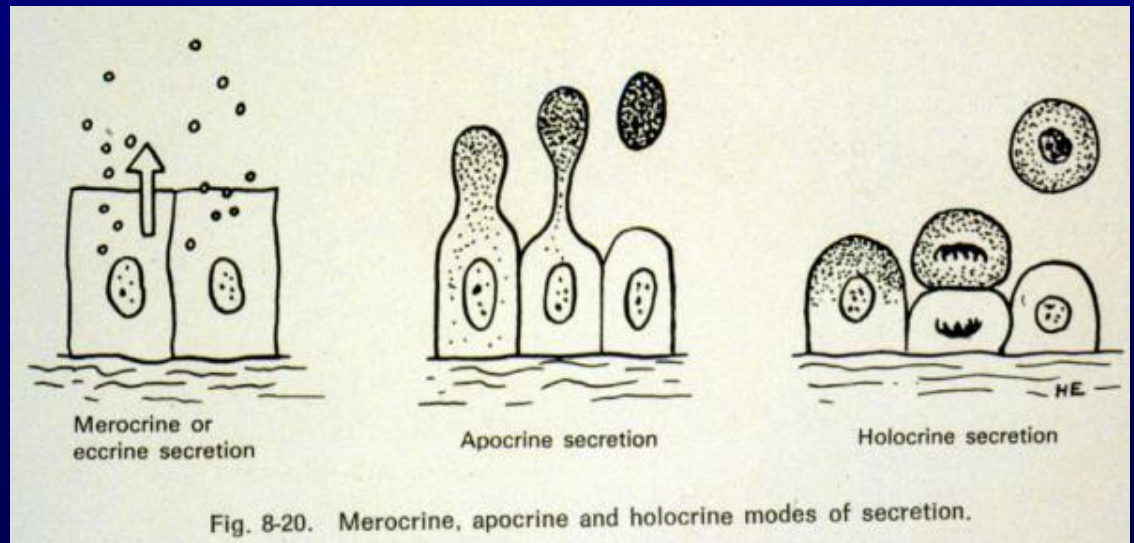
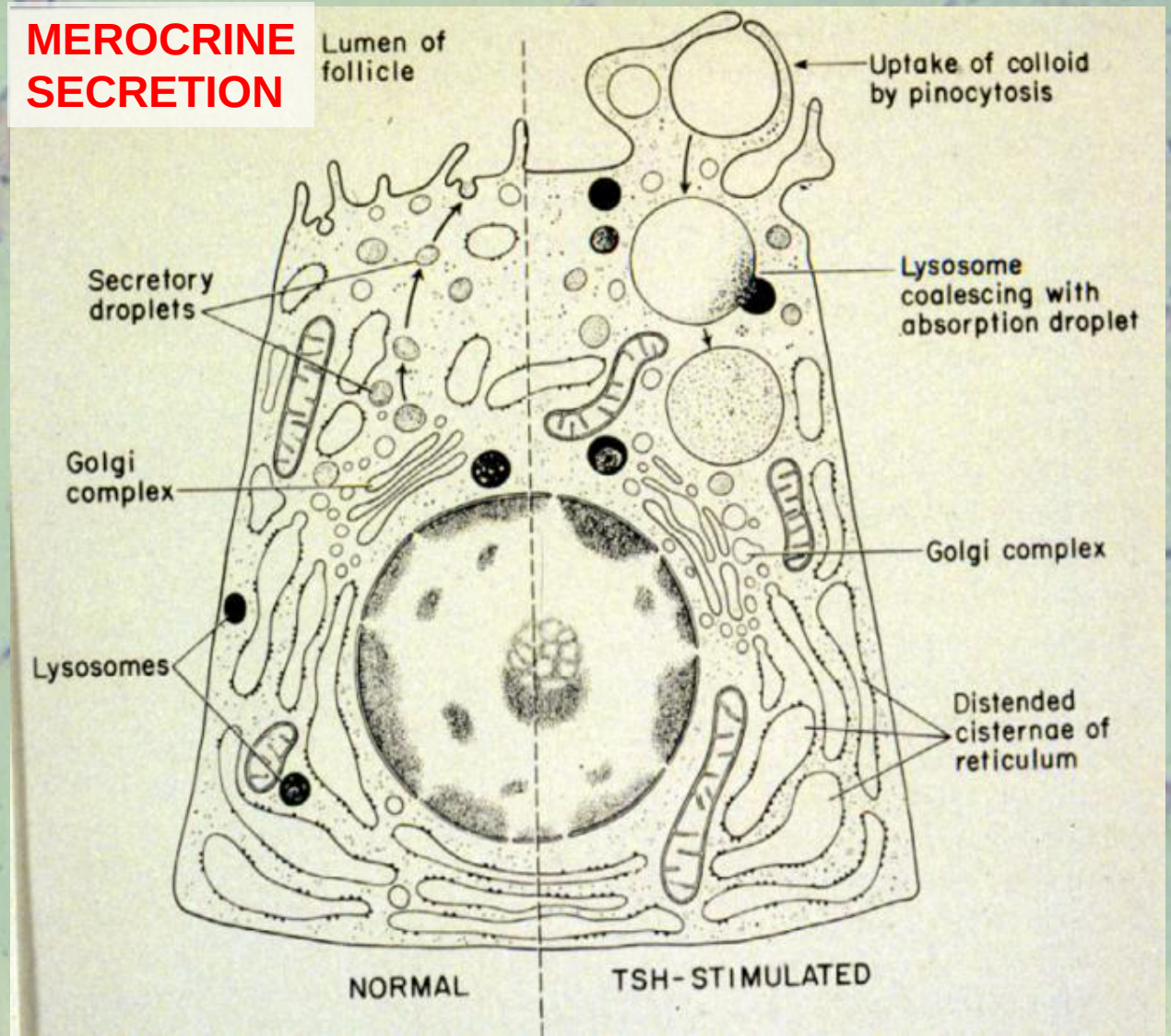


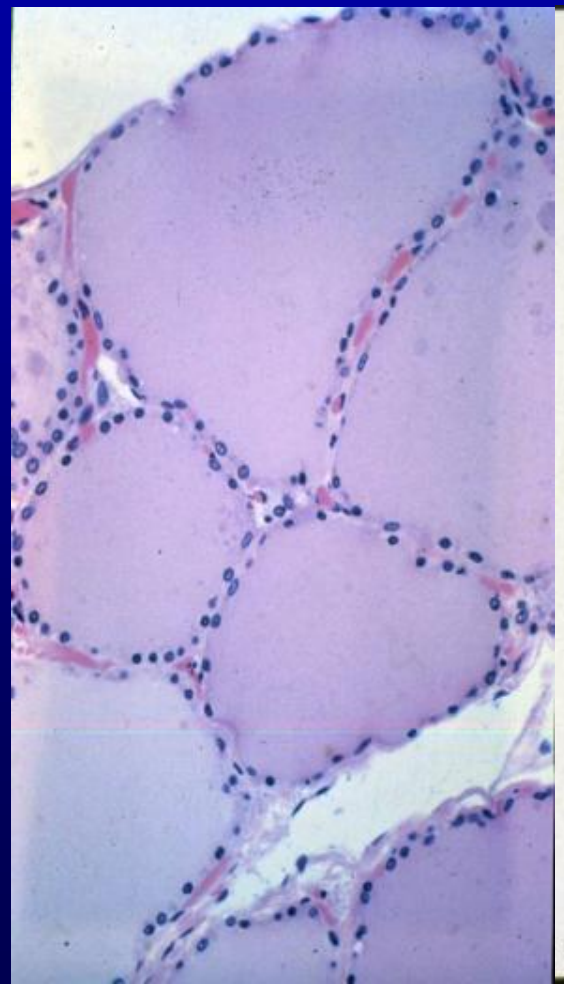
Fig. 8-20. Merocrine, apocrine and holocrine modes of secretion.

MEROCRINE SECRETION



Thyroid

Colloid stored secretory product (thyroglobulin)



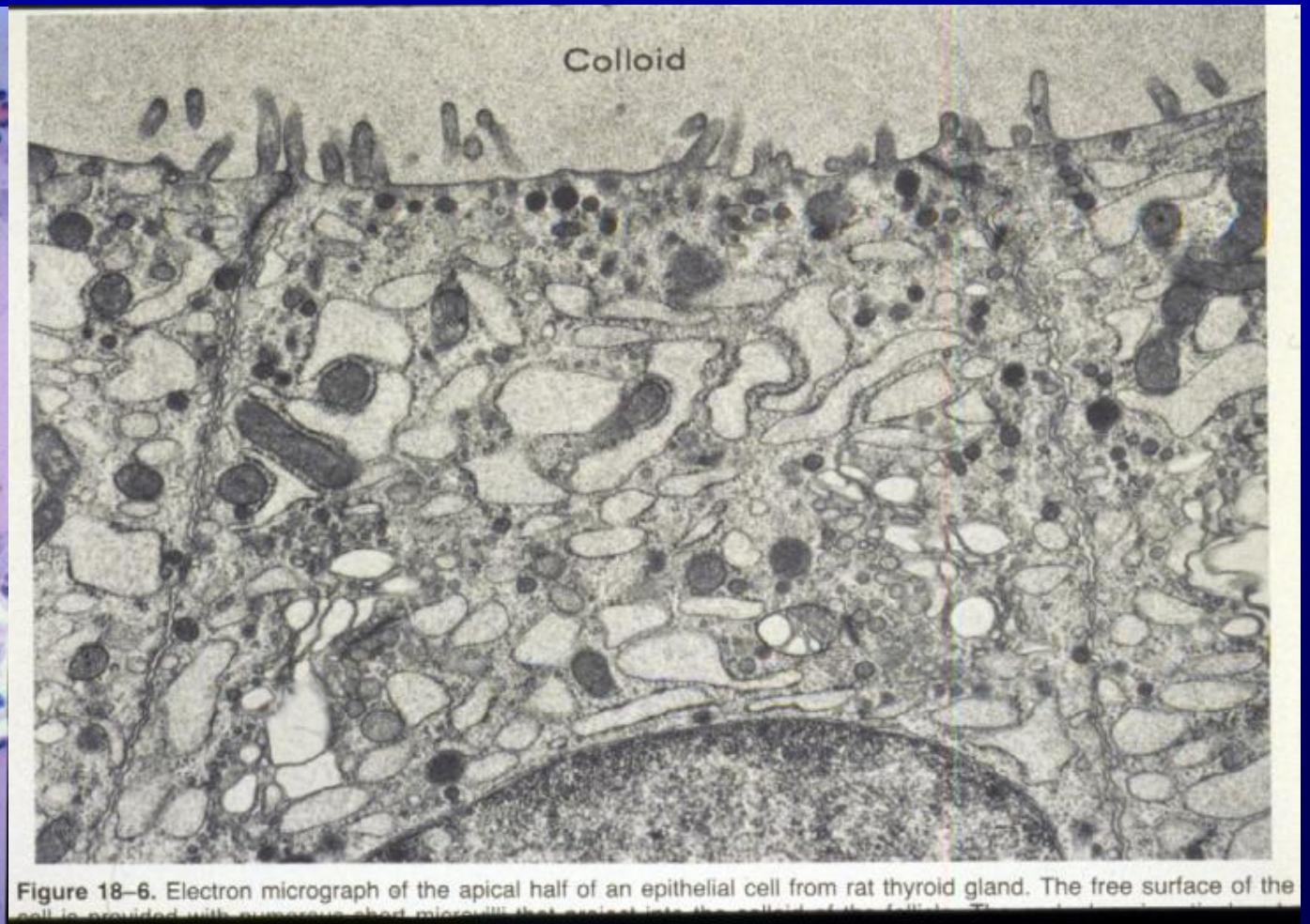
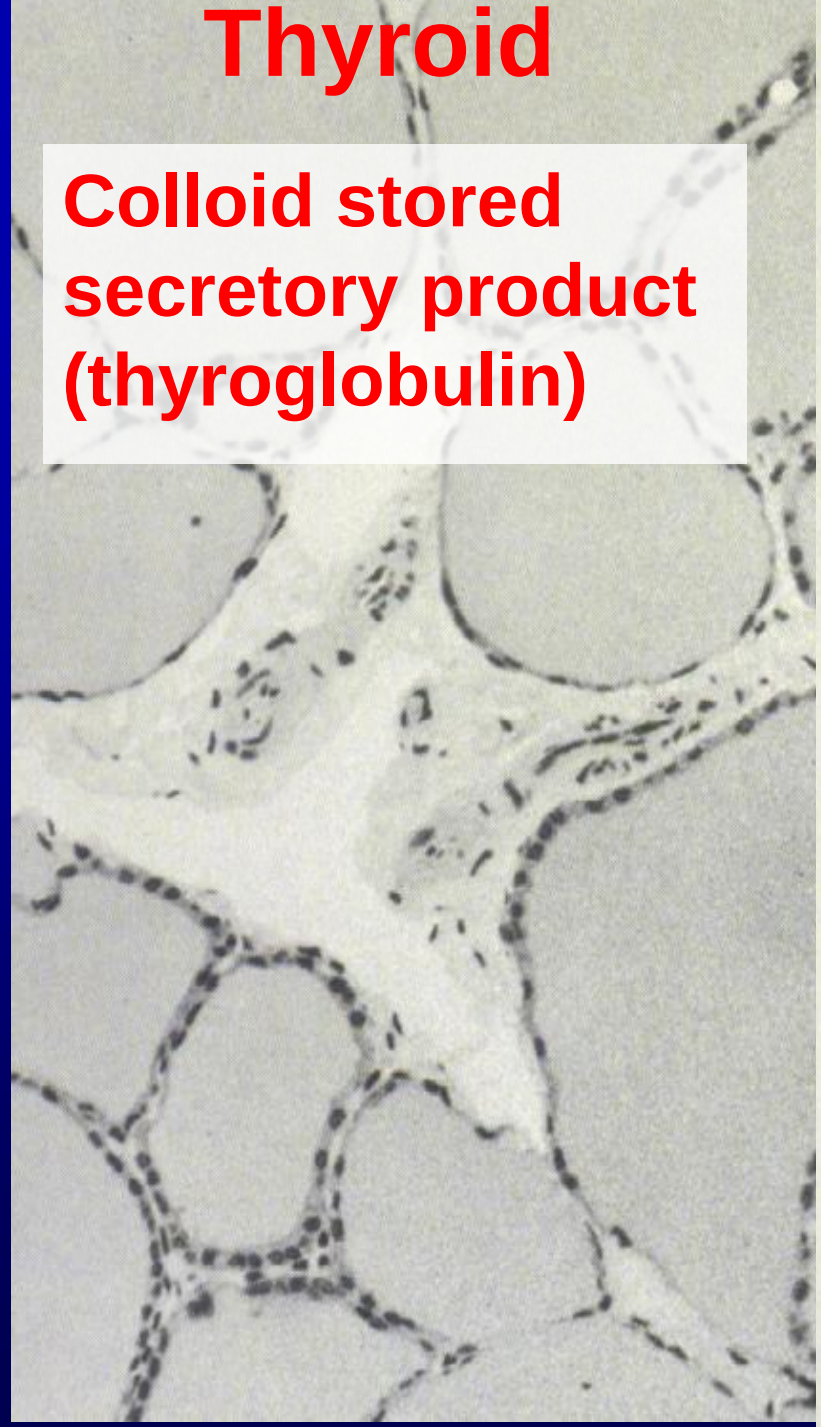
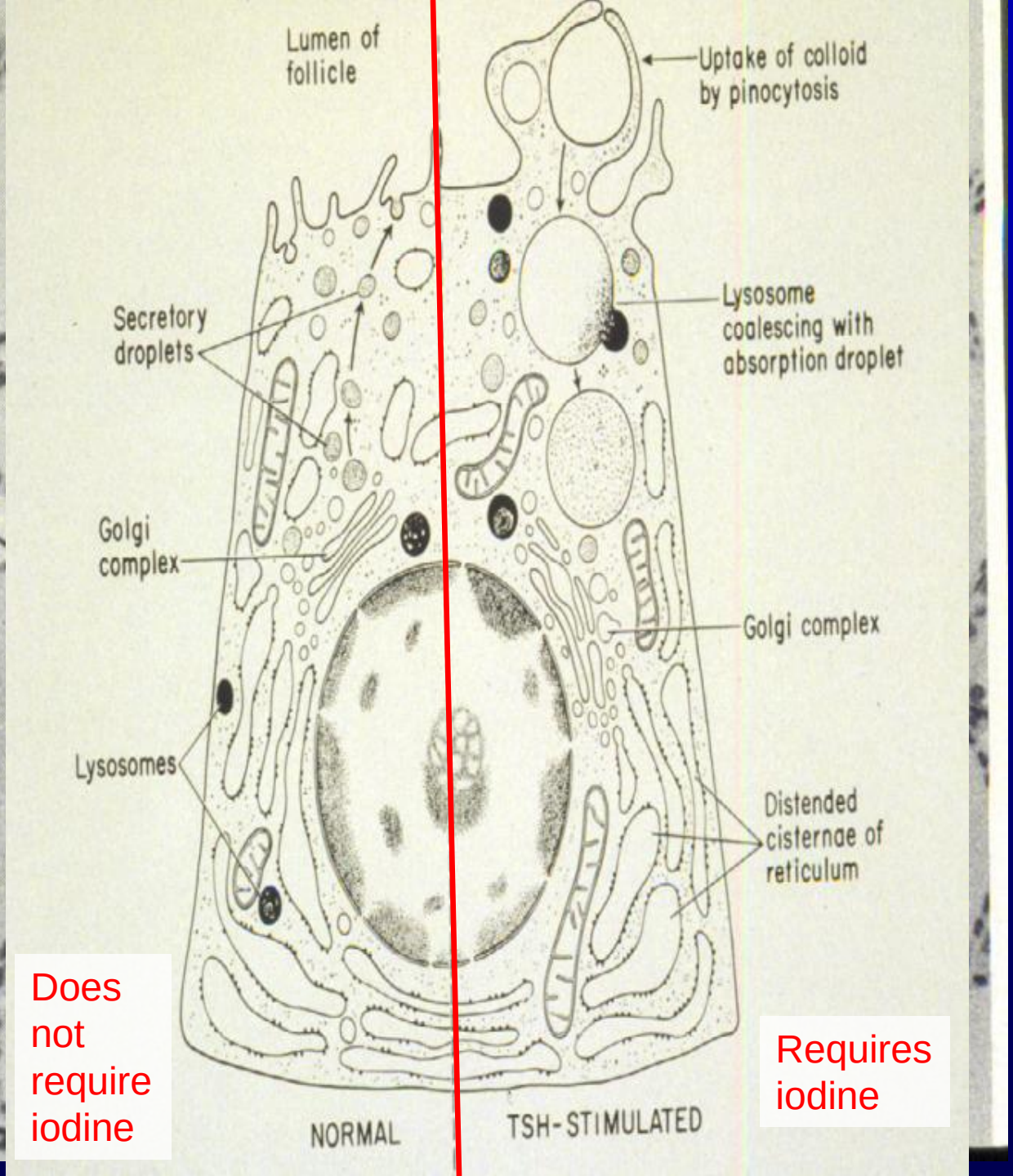


Figure 18–6. Electron micrograph of the apical half of an epithelial cell from rat thyroid gland. The free surface of the

Thyroid

Colloid stored secretory product (thyroglobulin)





Does not require iodine

Requires iodine

Thyroid Gland Diseases

Goiter - accumulation of thyroglobulin with iodine deficiency

Graves disease – hyperthyroidism IgG immunoglobulin with long-acting thyroid stimulation

Figure 18–4. Section through several follicles of hu

Thyroid stimulating hormone (TSH)

Physiological significance

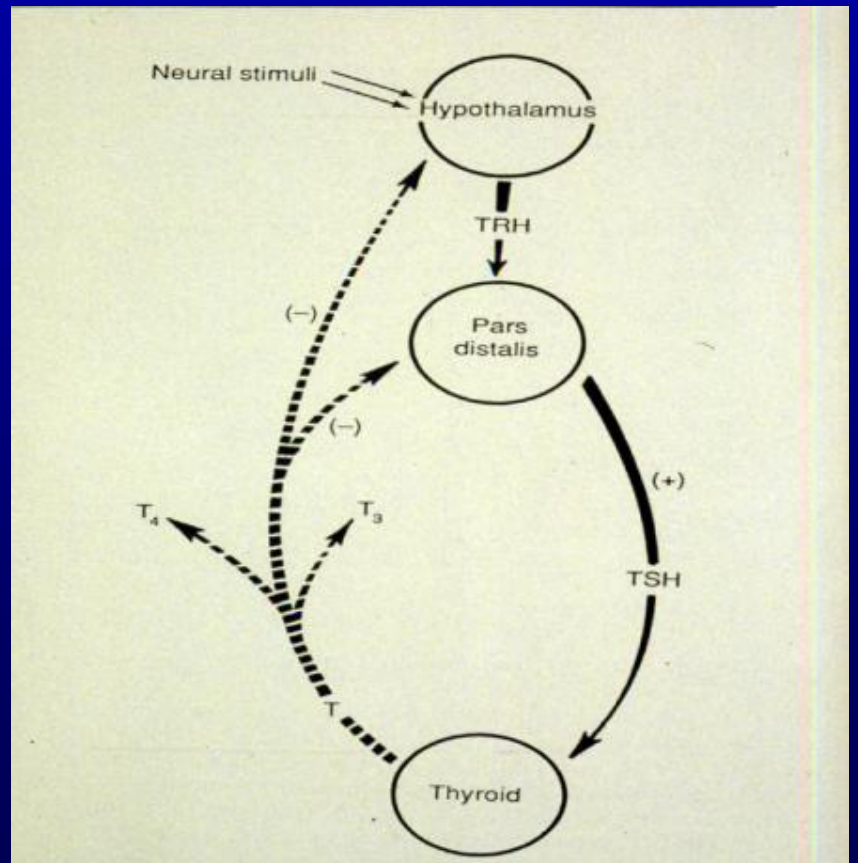


Figure 20–7. Relationship between the hypothalamus, the hypophysis, and the thyroid. Thyrotropin-releasing hormone (TRH) promotes secretion of thyrotropin (TSH), which regulates the synthesis and secretion of

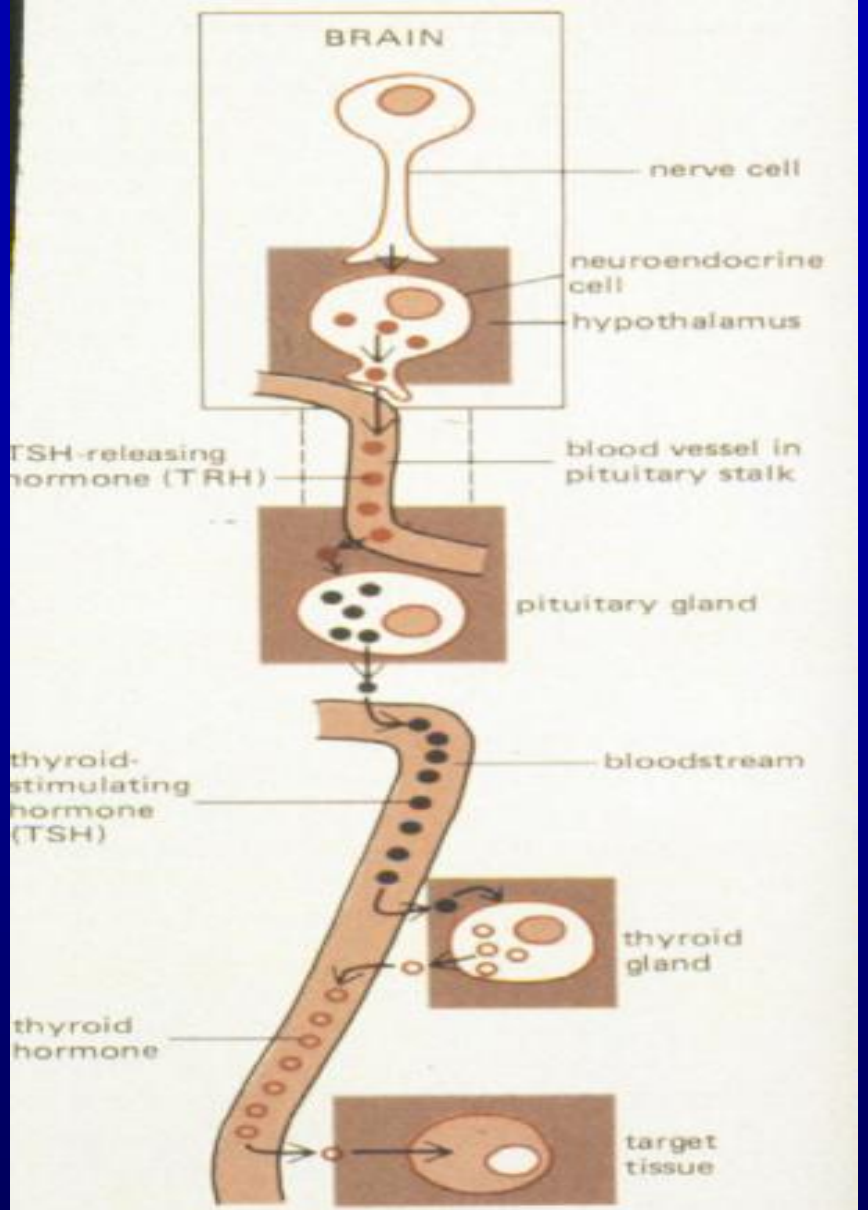
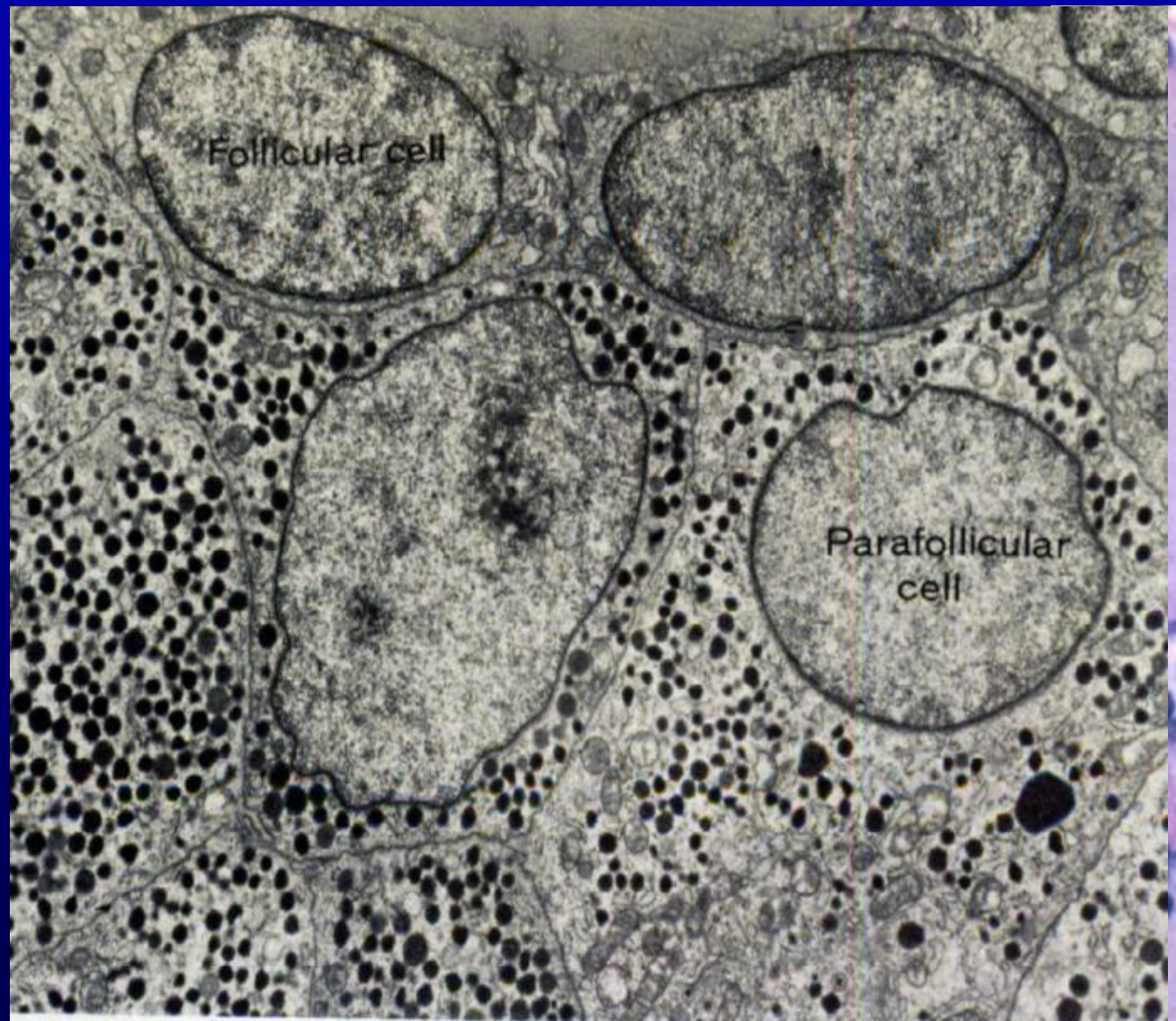
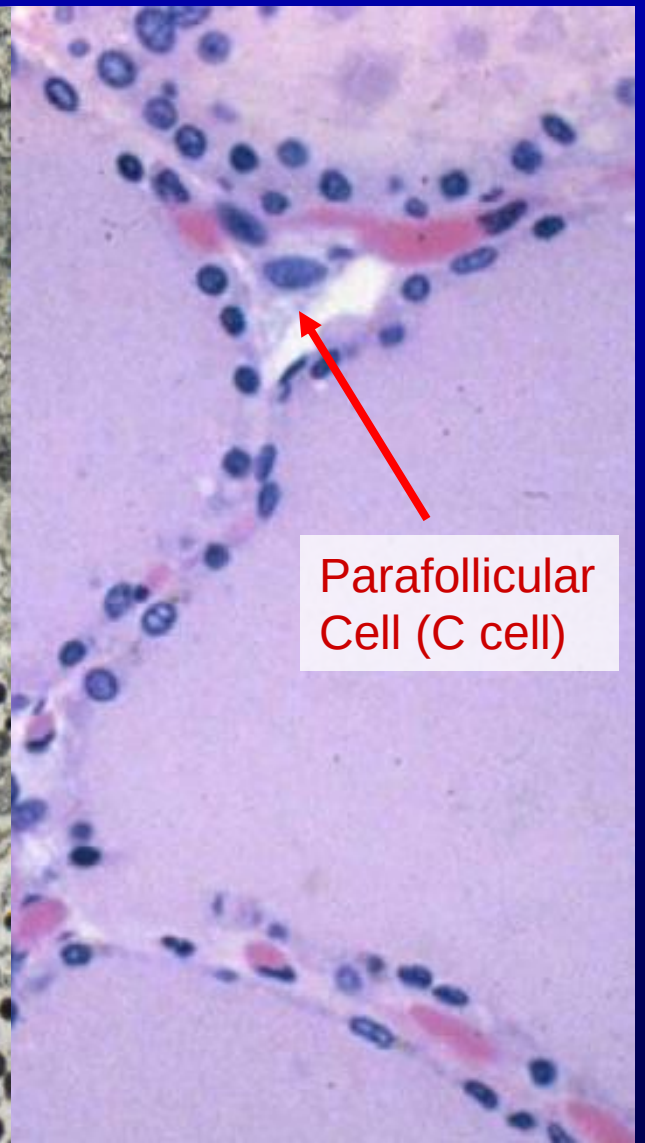


Figure 12–4 Thyroid hormone secretion is regulated indirectly by the nervous system. When stimulated by nerve cells in higher centers of the brain, specific neuroendocrine cells in the hypothalamus secrete TSH-releasing

Parafollicular cells

Calcitonin





Thyroid –parafollicular cells

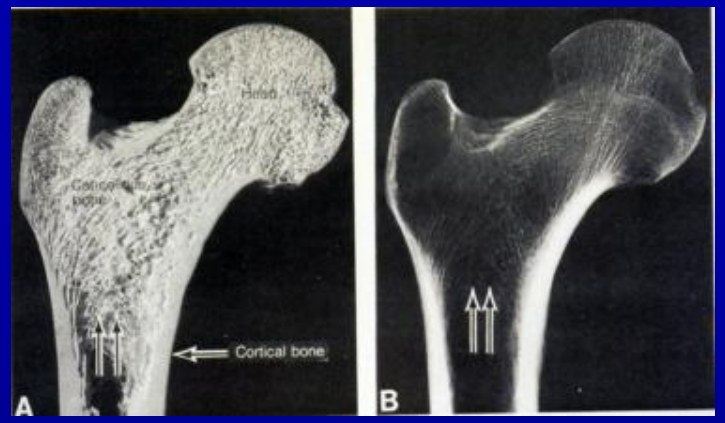
Functions of Bone

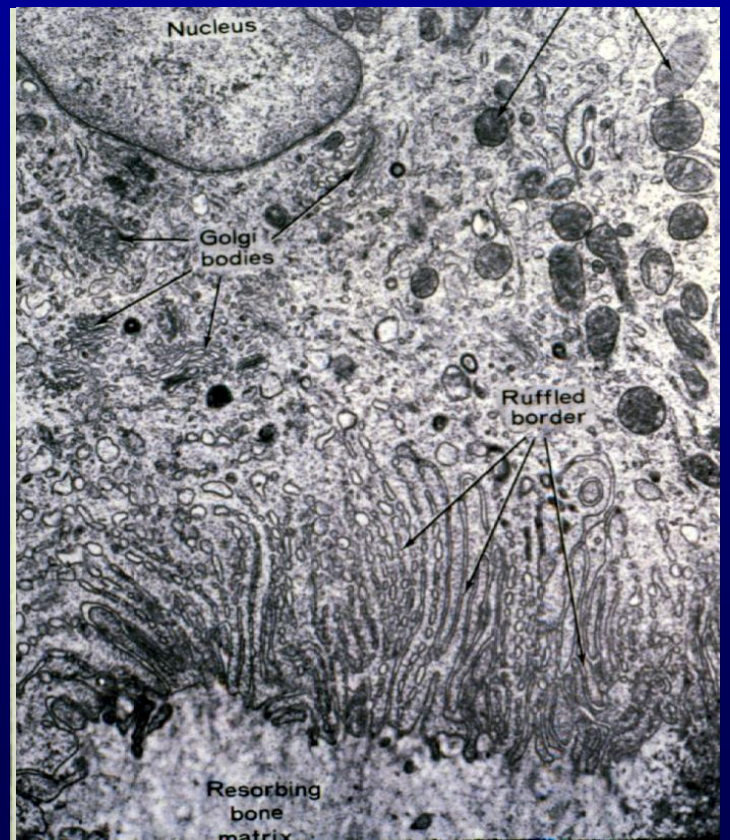
Calcium Regulation

Parathyroid hormone (stimulates osteoclast production)

Calcitonin (removes osteoclast's ruffled boarder which prevents resorption

Remember that these hormones are involved in tight regulation of free Ca^{++} as 1/4 of free Ca^{++} in blood is exchanged each minute.



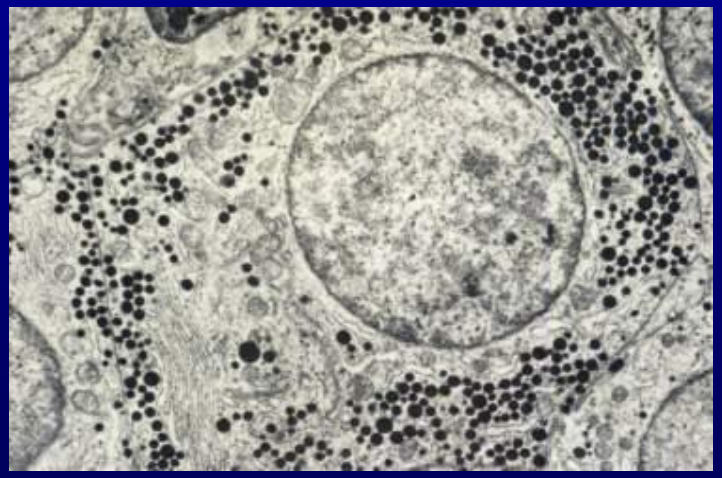


Endocrine secretions

Stored in granules

Stored extracellularly

Immediate release with no storage



pituitary

Protein in cell

Figure 18–4. Section through several follicles of h

thyroid

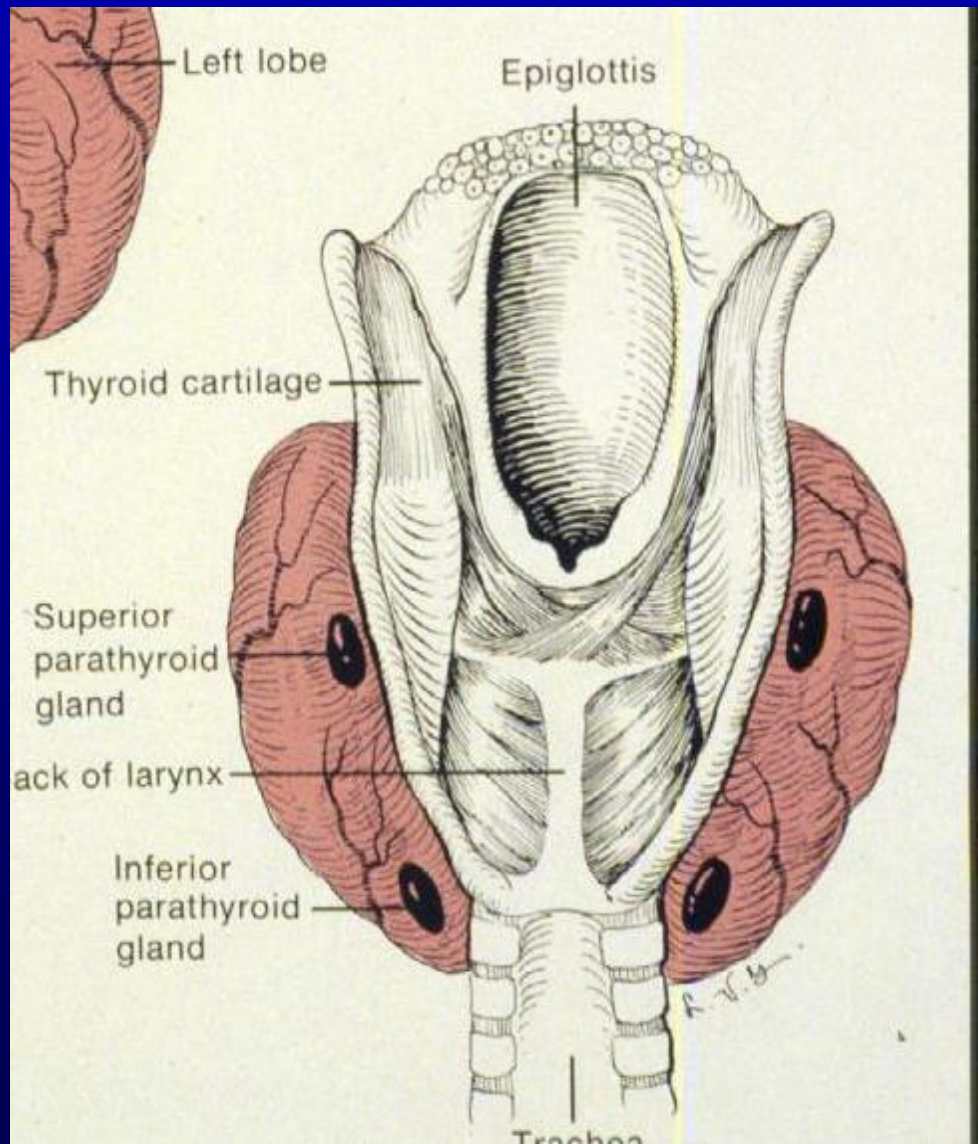
Thyroglobulin outside cell in colloid of follicle

adrenal

Steroid pass through cell

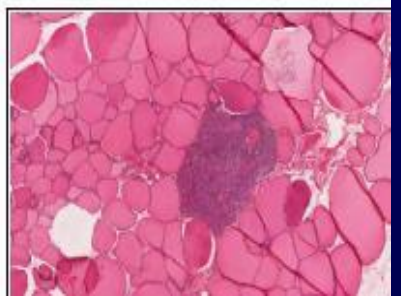
Parathyroid Gland

- Gross anatomy
- Physiological significance
- Microanatomy
  - Chief cells
    - Parathyroid hormone
    - Secretion control
  - Oxyphil cells



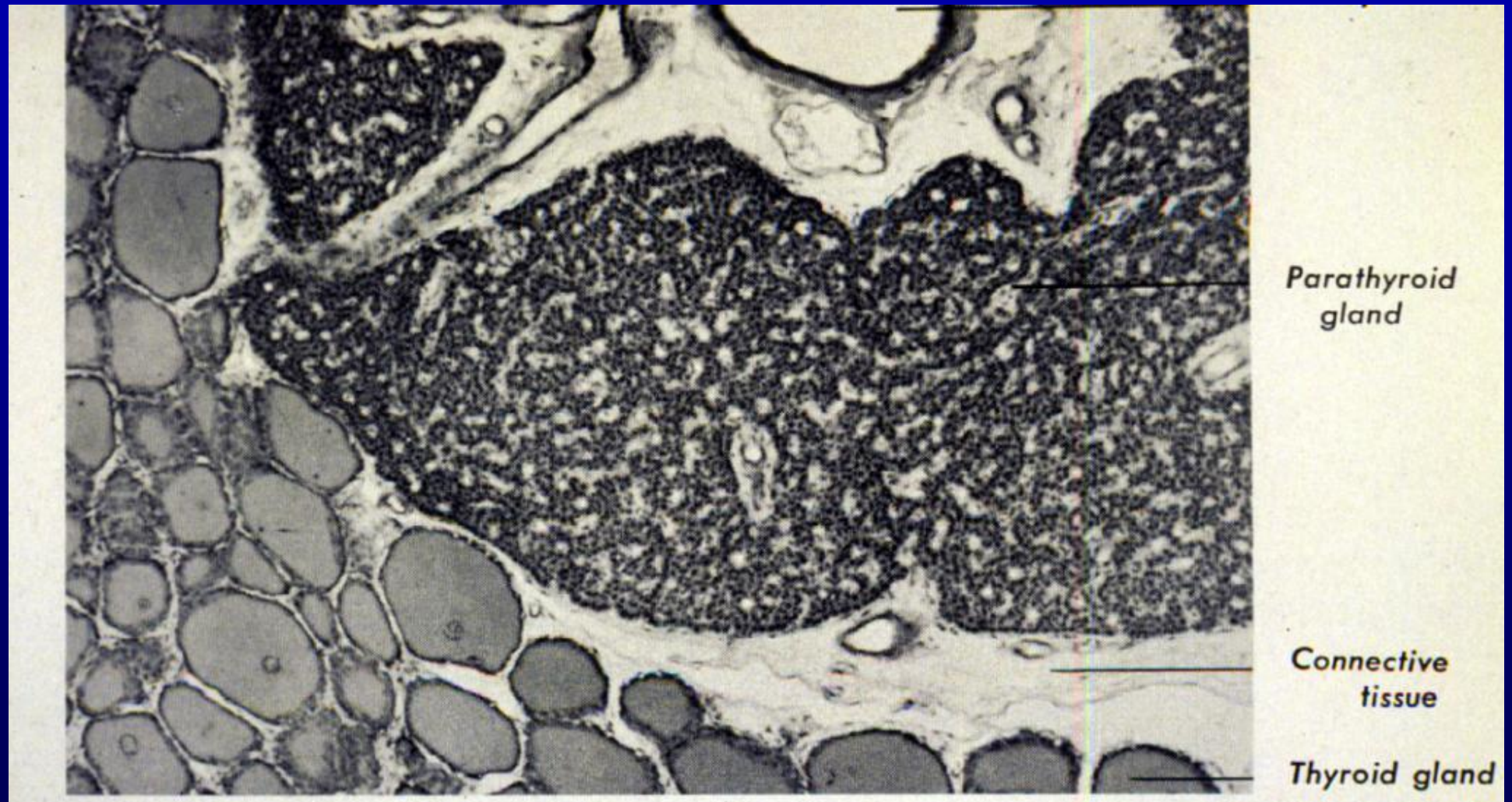
Parathyroid Gland

Parathyroid Gland



Parathyroid Gland

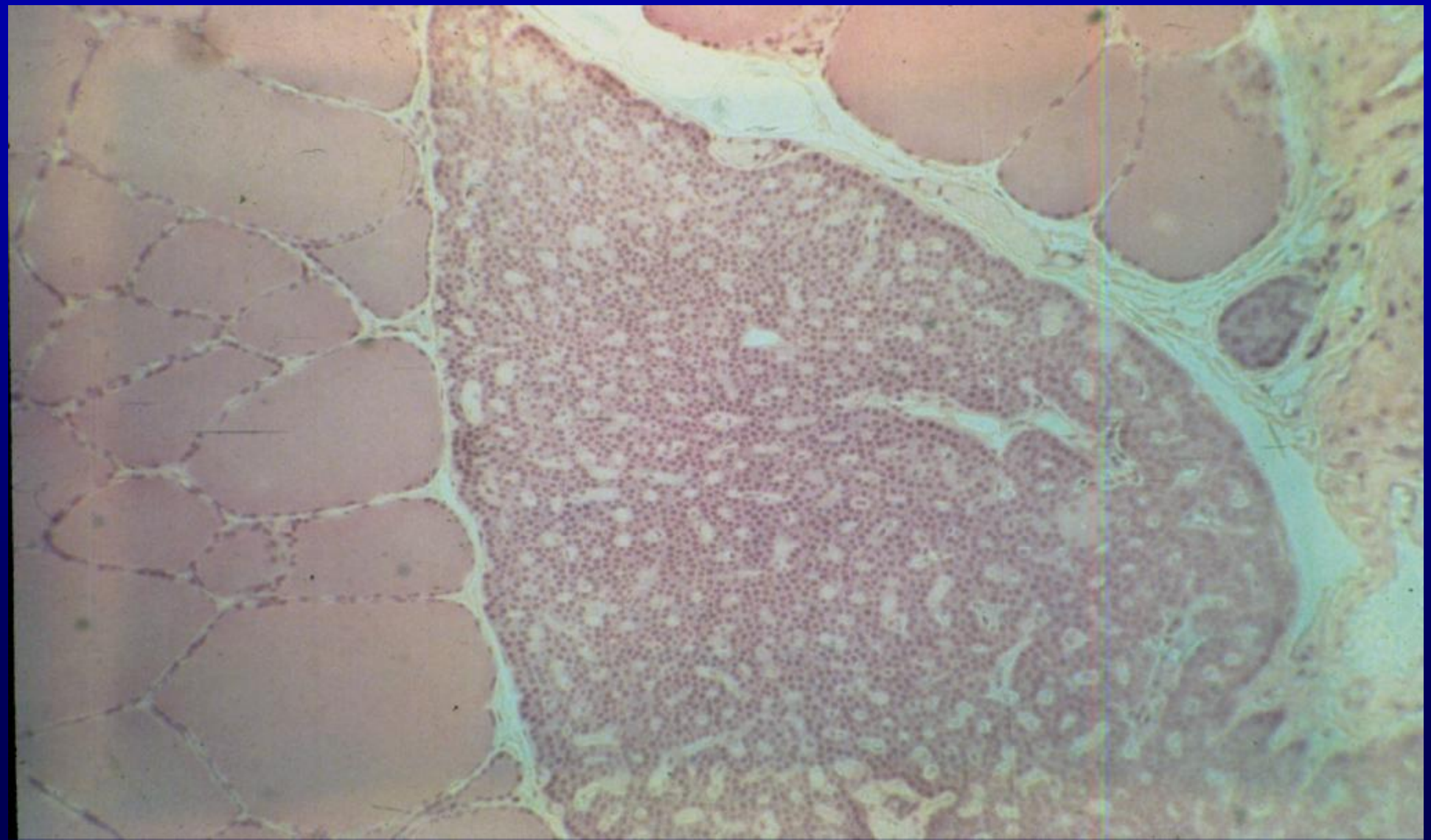
Microanatomy



re 19–1. Photomicrograph of section of thyroid and parathyroid glands of *Macacus rhesu*

Parathyroid Gland

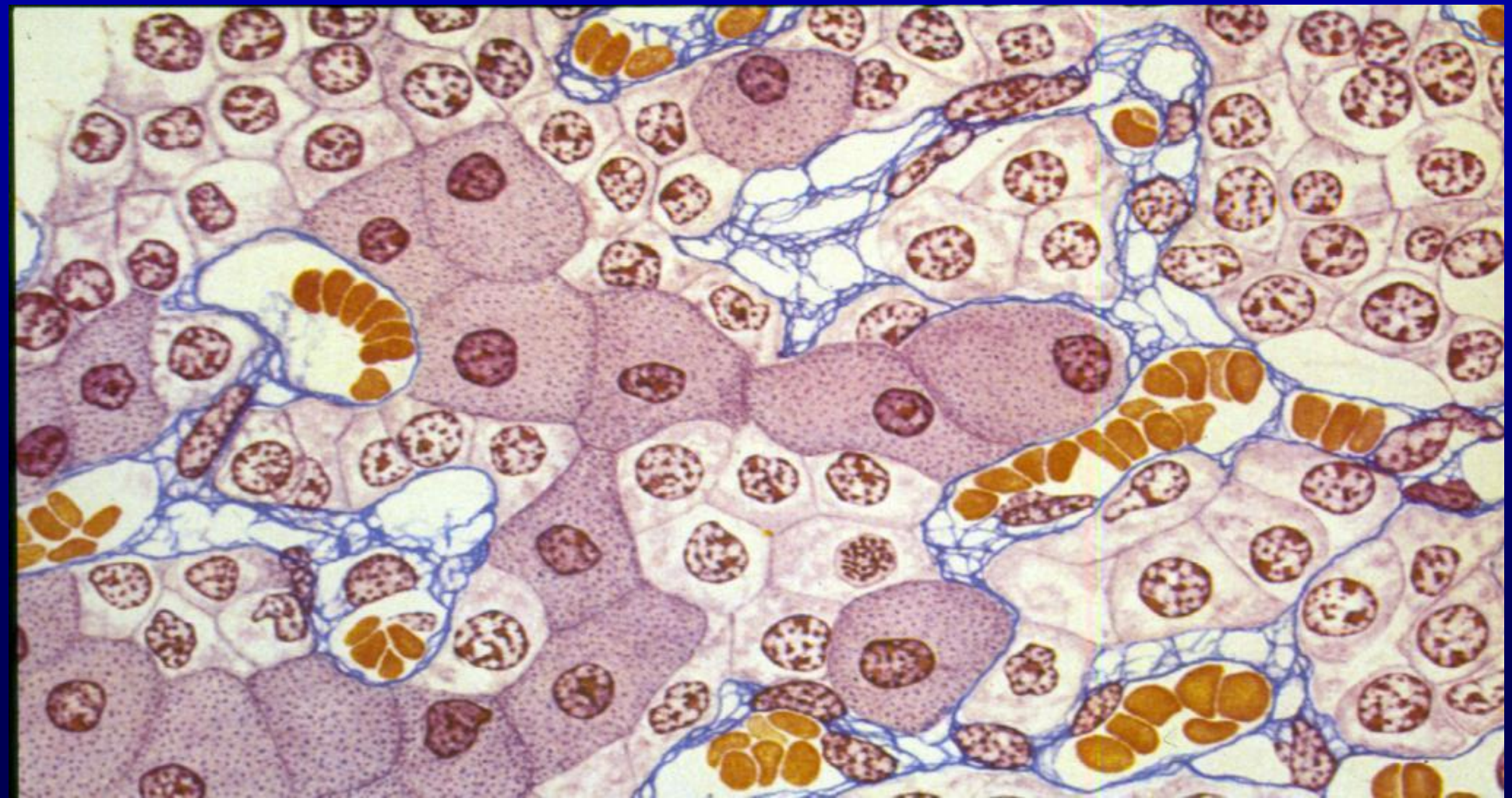
Microanatomy



Chief cells of the Parathyroid Gland

- Parathyroid Hormone
- Secretion control

Oxyphil cells

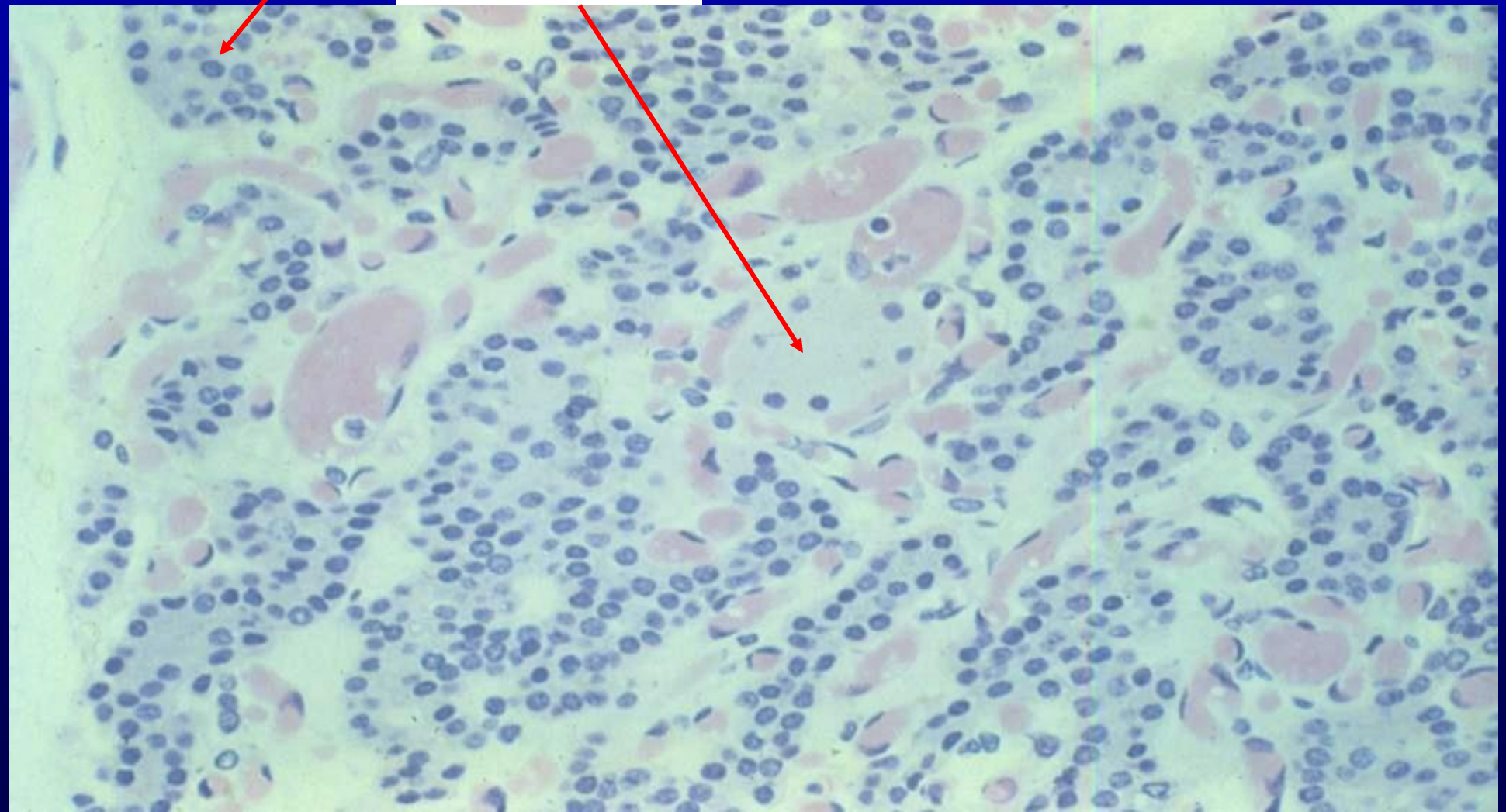


Chief cells of the parathyroid gland

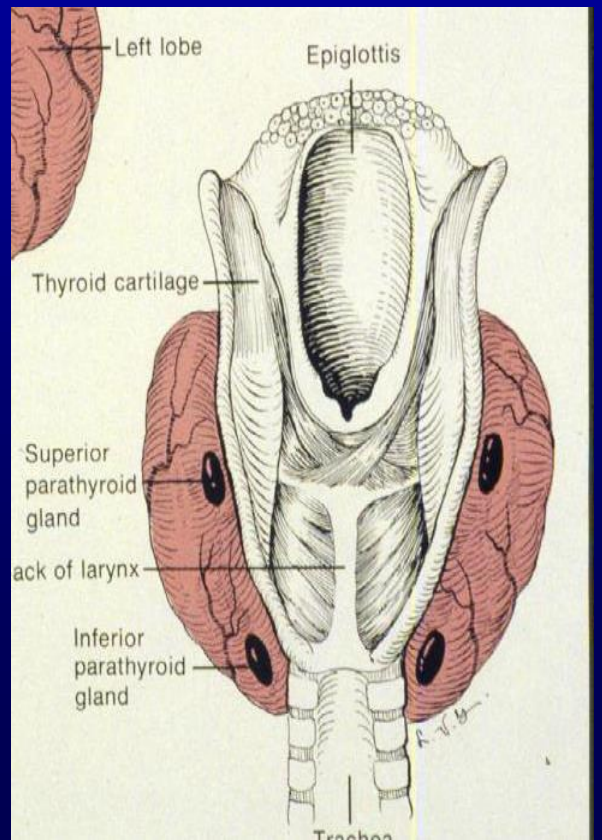
parathyroid hormone

secretion control

Oxyphil cells



Parathyroid Gland



e 19–5. Photomicrograph of parathyroid glan
ey injected intravenously with India ink to show

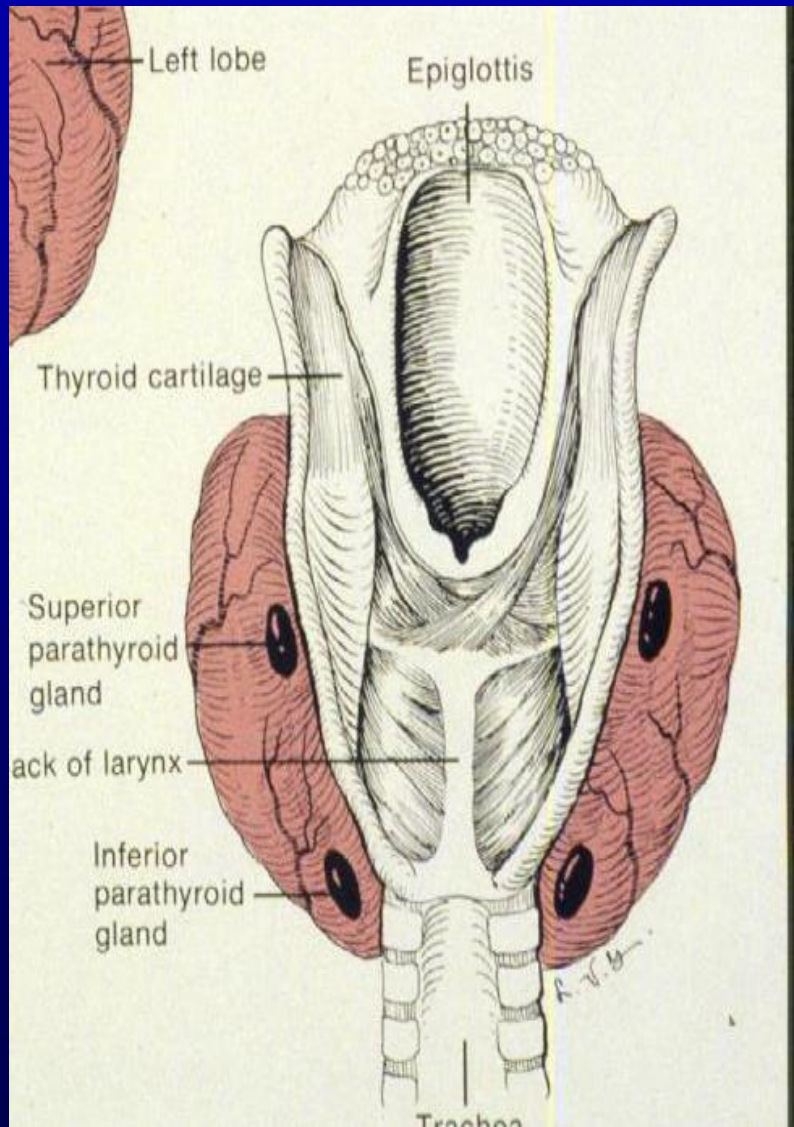
Parathyroid Glands

Parathyroid hormone (PTH) acts on

bones (*osteocytes / osteoclasts*), kidneys (*increase reabsorption of distal tubules*), and intestines (*increase calcium absorption*) to maintain tight control of calcium concentrations in the extracellular fluid (8.5 – 10.5 mg/100 ml).

Calcium necessary for muscle contractions, glandular secretions, blood coagulation, and key enzymes of intermediary metabolism.

Removal of gland results in violent spasm of skeletal muscle (tetany) and ultimately death.

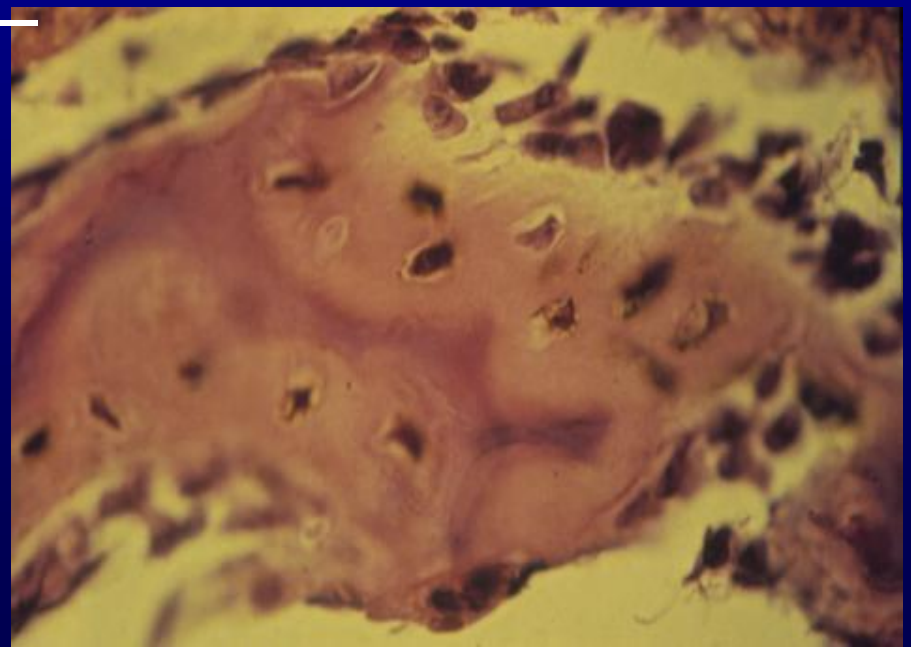


Parathyroid Glands

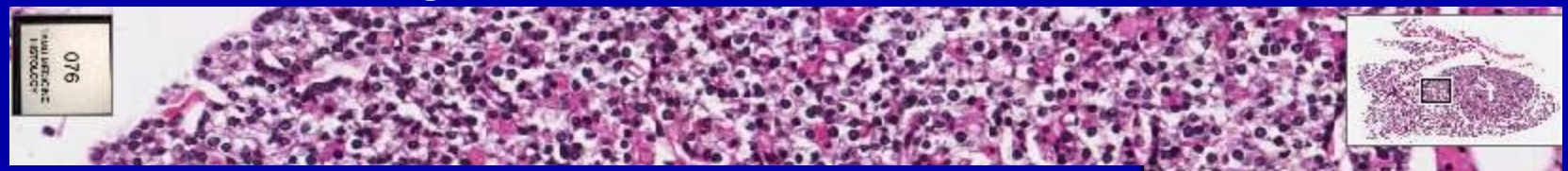
Parathyroid hormone (PTH) acts on bones

Osteocytic osteolysis: mobilize calcium by osteocytes – increase calcium concentrations in minutes

Osteoclastic bone resorption: caused by prolonged hypocalcemia – coalescence of precursor cells to form additional osteoclasts– many hours to reach effective levels of calcium released



Parathyroid – chief cells



Functions of Bone

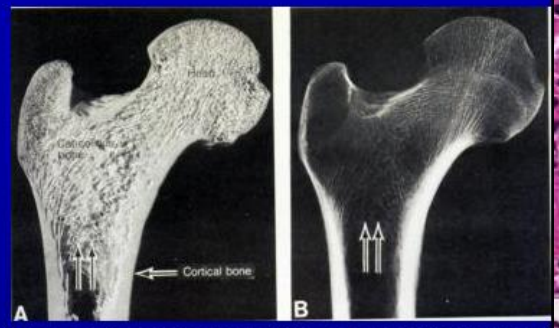
Calcium Regulation

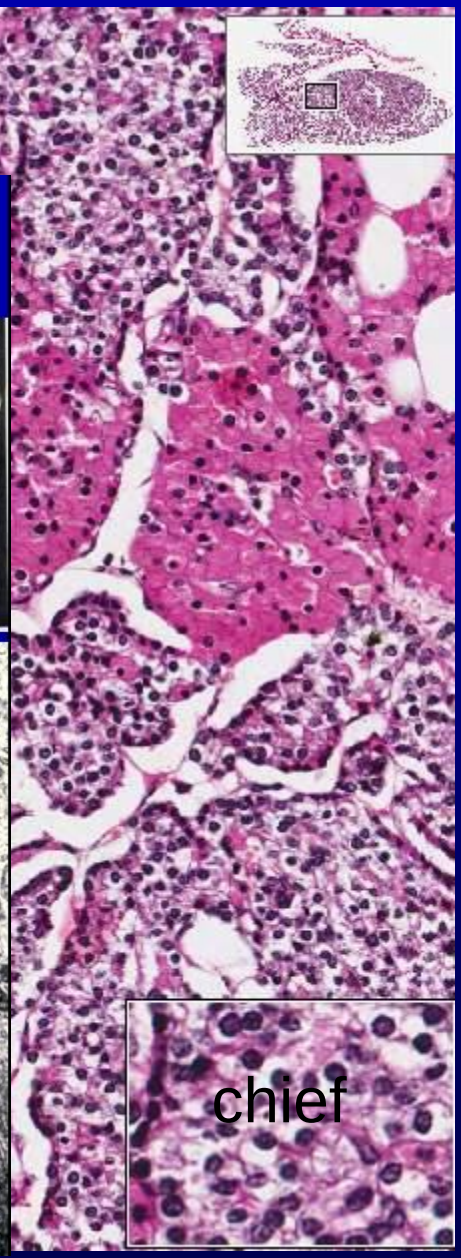
Parathyroid hormone (stimulates osteoclast production)

Calcitonin (removes osteoclast's ruffled boarder which prevents resorption

Remember that these hormones are involved in tight regulation of free Ca^{++} as 1/4 of free Ca^{++} in blood is exchanged each minute.

Osteoporosis due to hyperparathyroidism

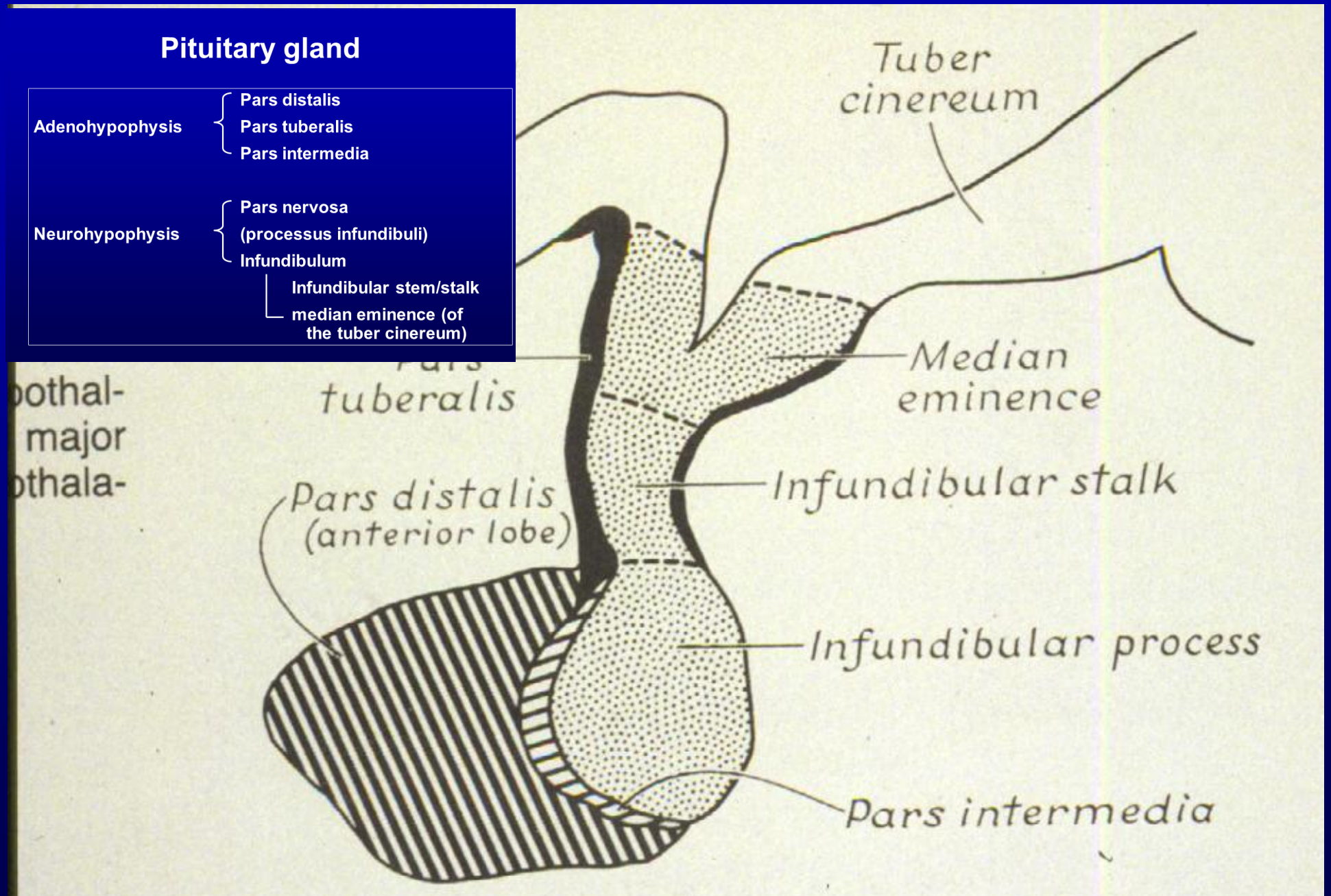


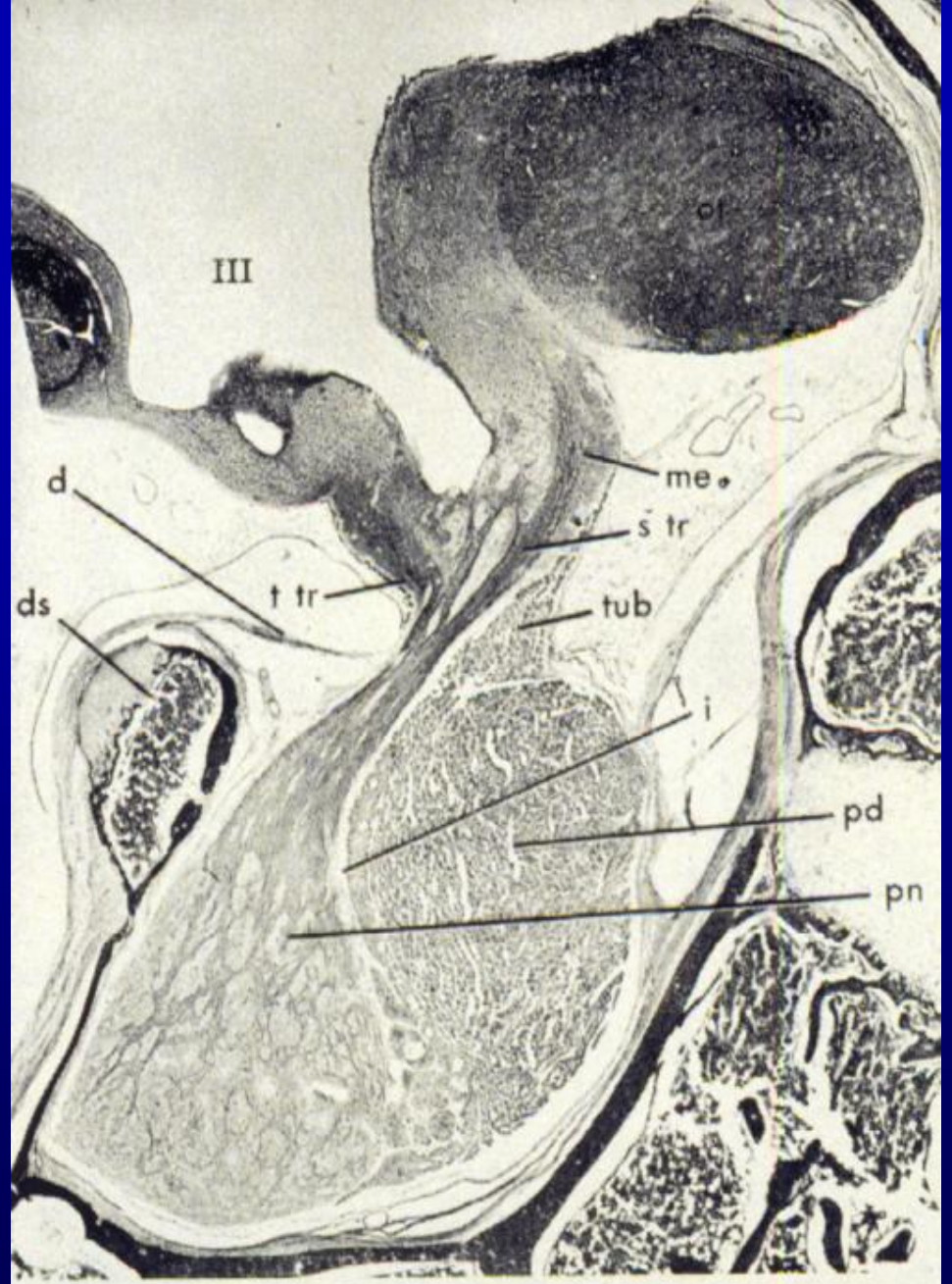


Adenohypophysis Pituitary Gland Neurohypophysis

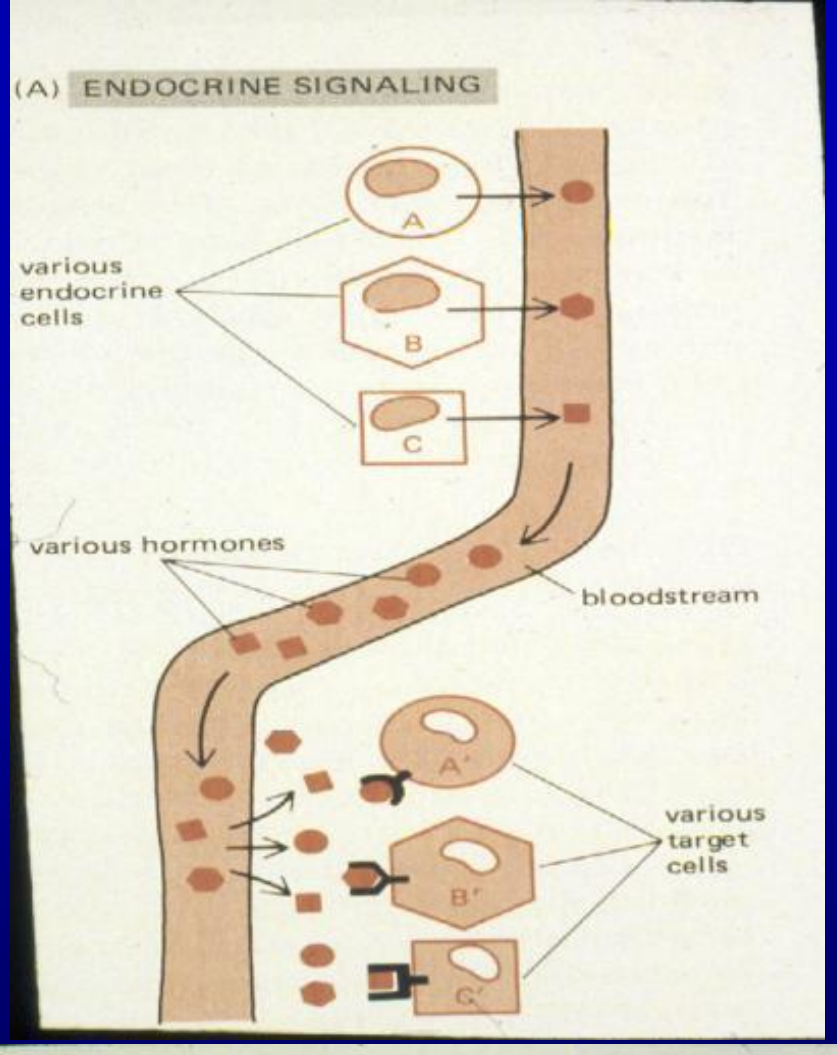
Pituitary gland

- Adenohypophysis
  - Pars distalis
  - Pars tuberalis
  - Pars intermedia
- Neurohypophysis
  - Pars nervosa
  - (processus infundibuli)
  - Infundibulum
    - Infundibular stem/stalk
    - median eminence (of the tuber cinereum)





29–14 The primate neurohypophysis. Sagittal section of the neurohypophysis of a



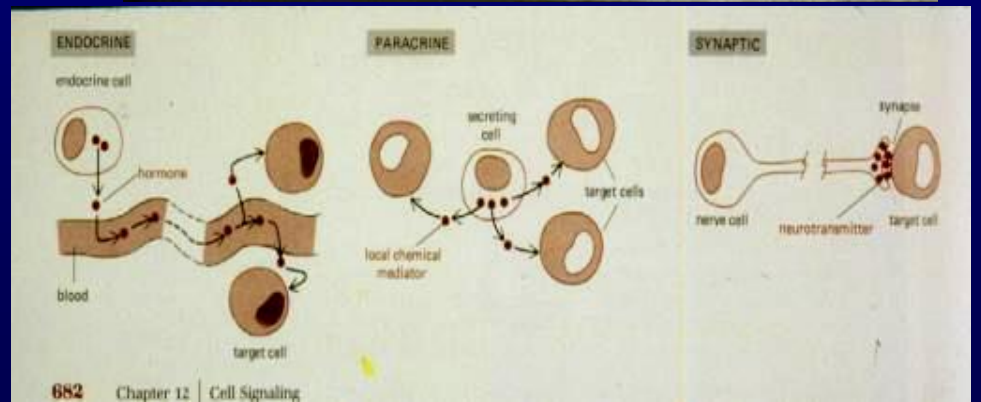
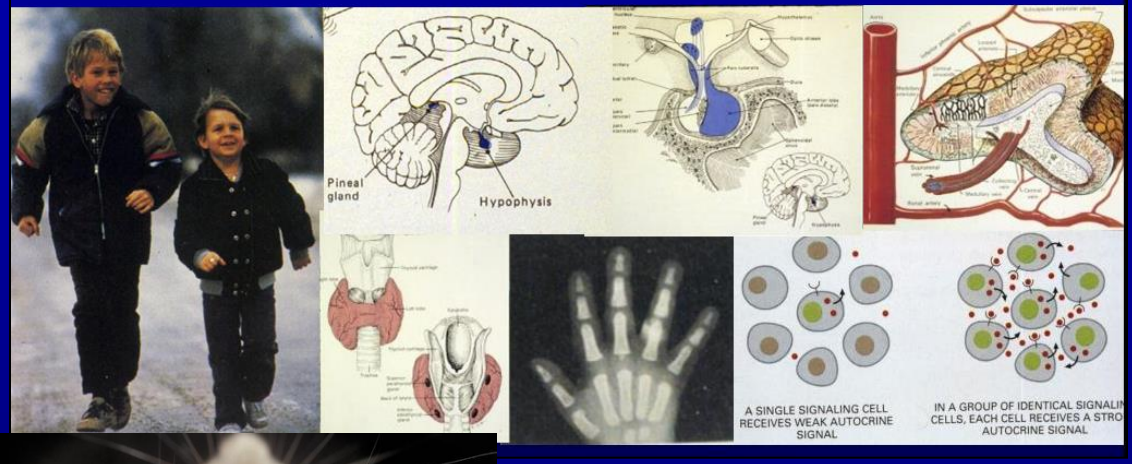


Table 20–1. Secretory cells of the pars distalis.

Cell Type	Stain Affinity	Hormone Produced	Main Physiologic Activity	Secretory Granules in Humans	Hypothalamic Releasing Hormones	Hypothalamic Inhibiting Hormones
Somatotropic cell	Acidophilic	Somatotropin (growth hormone).	Acts on growth of long bones via somatomedins synthesized in liver.	Numerous, round or oval; 300–400 nm diameter.	Somatotropin-releasing hormone (SRH).	Somatostatin.
Mammotropic cell	Acidophilic	Prolactin.	Promotes milk secretion.	200 nm; increases in size during pregnancy and lactation (600 nm).	Prolactin-releasing hormone (PRH).	Prolactin-inhibiting hormone (PIH).
Gonadotropic cell	Basophilic	Follicle-stimulating hormone (FSH) and luteinizing hormone (LH) in same cell type.	FSH promotes ovarian follicle development and estrogen secretion in female and stimulates spermatogenesis in male. LH promotes ovarian follicle maturation and progesterone secretion in female, Leydig cell stimulation and androgen secretion in male.	250–400 nm.	Gonadotropin-releasing hormone (GnRH). According to some authors there are 2 releasing hormones: FRH and LRH (follicle- and lutein-releasing, respectively).	
Thyrotropic cell	Basophilic	Thyrotropin (TSH).	Stimulates thyroid hormone synthesis, storage, and liberation.	Small granules, 120–200 nm.	Thyrotropin-releasing hormone (TRH).	
Corticotropic cell	Basophilic	Corticotropin (ACTH).	Stimulates secretion of adrenal cortex hormones.	Large granules, 400–550 nm.	Corticotropin-releasing hormone (CRH).	

Next time

Endocrine System continued



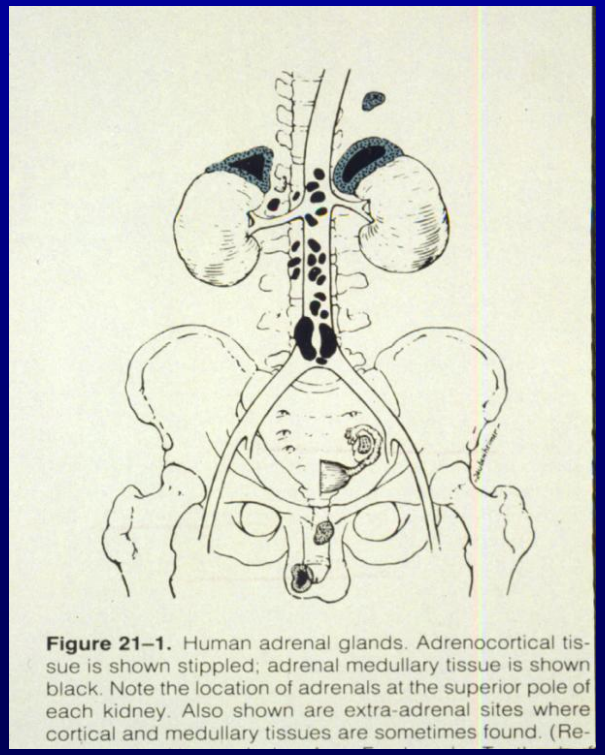
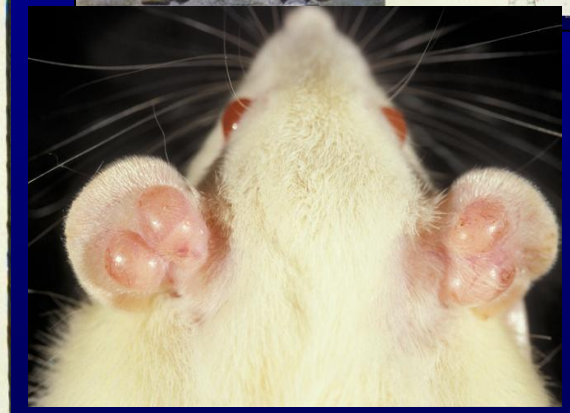
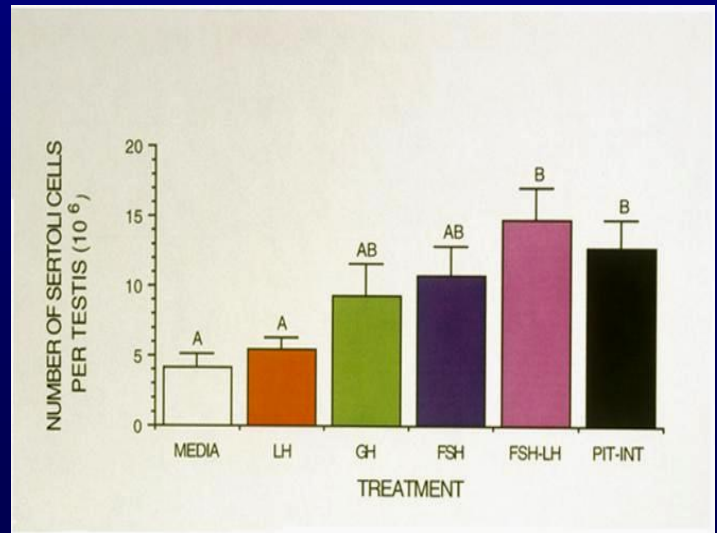


Figure 21–1. Human adrenal glands. Adrenocortical tissue is shown stippled; adrenal medullary tissue is shown black. Note the location of adrenals at the superior pole of each kidney. Also shown are extra-adrenal sites where cortical and medullary tissues are sometimes found. (Re-





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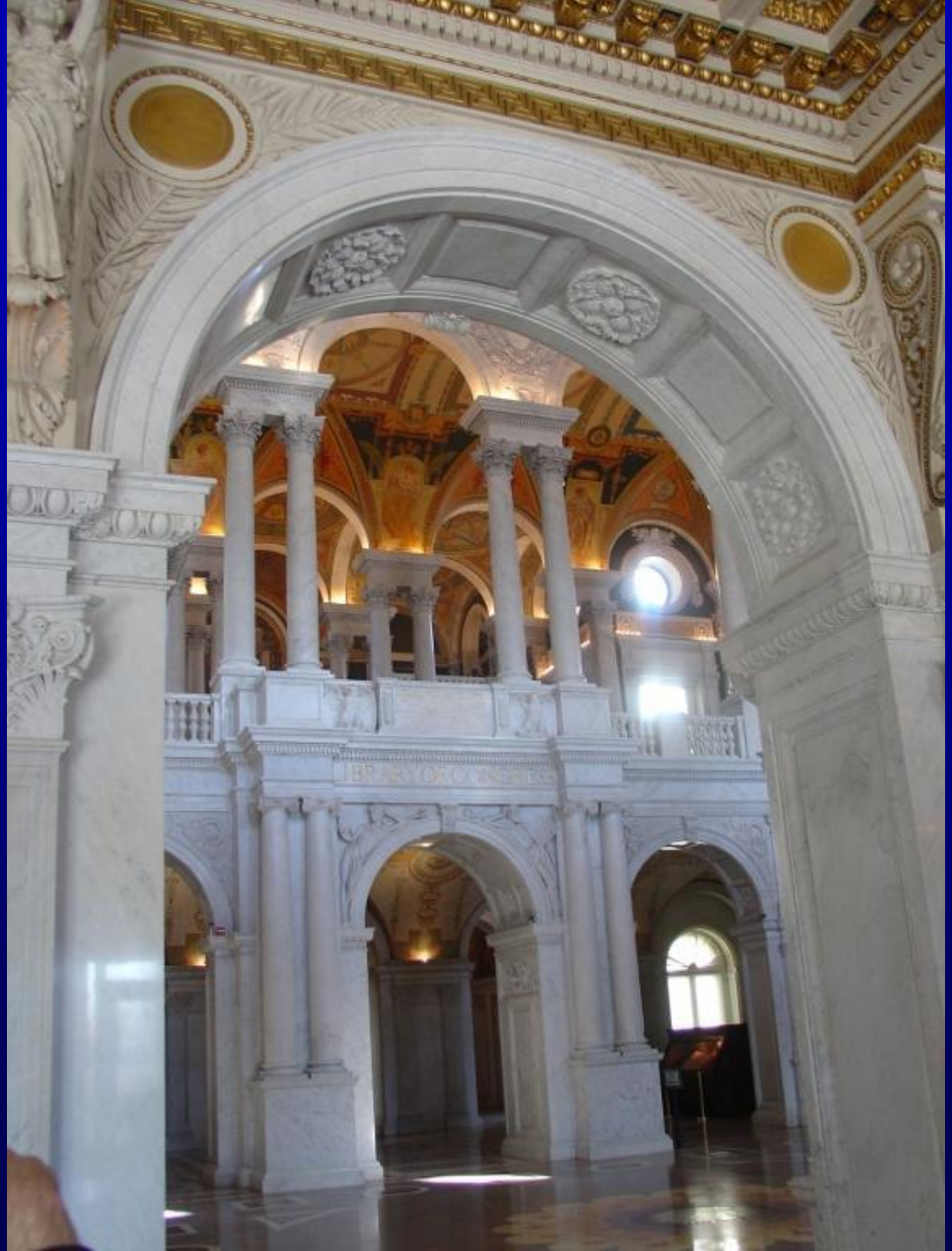
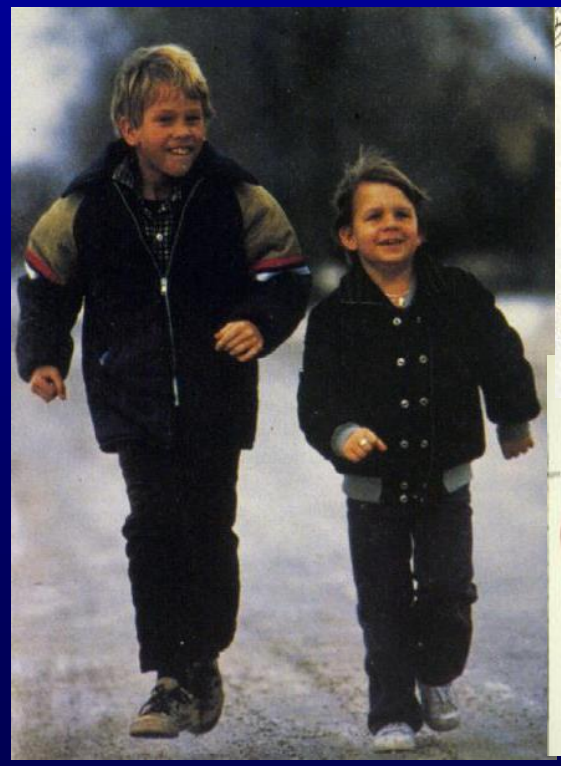
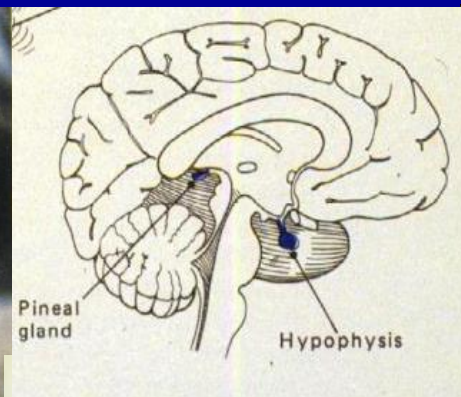
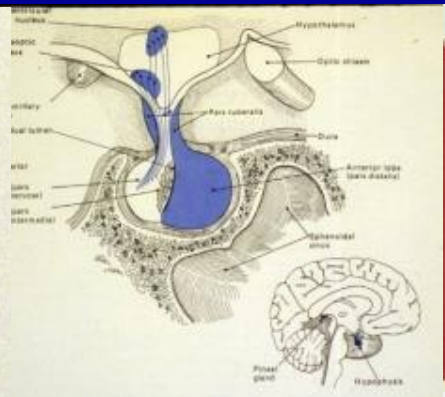
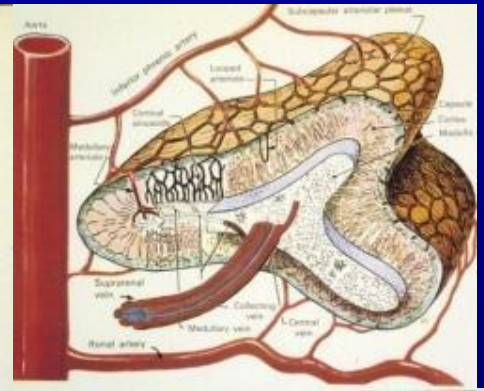


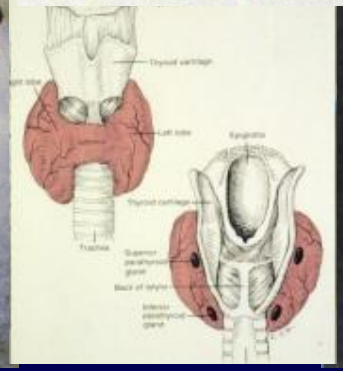
Endocrine System continued

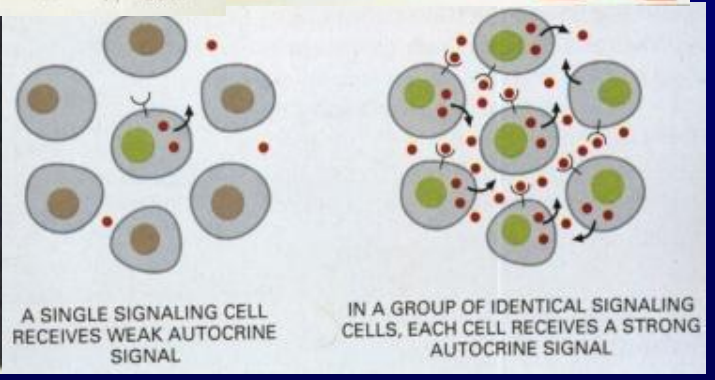












This time
continue on with the
adrenal gland
and other organs
as well as present
some research on
application of the
endocrine system.

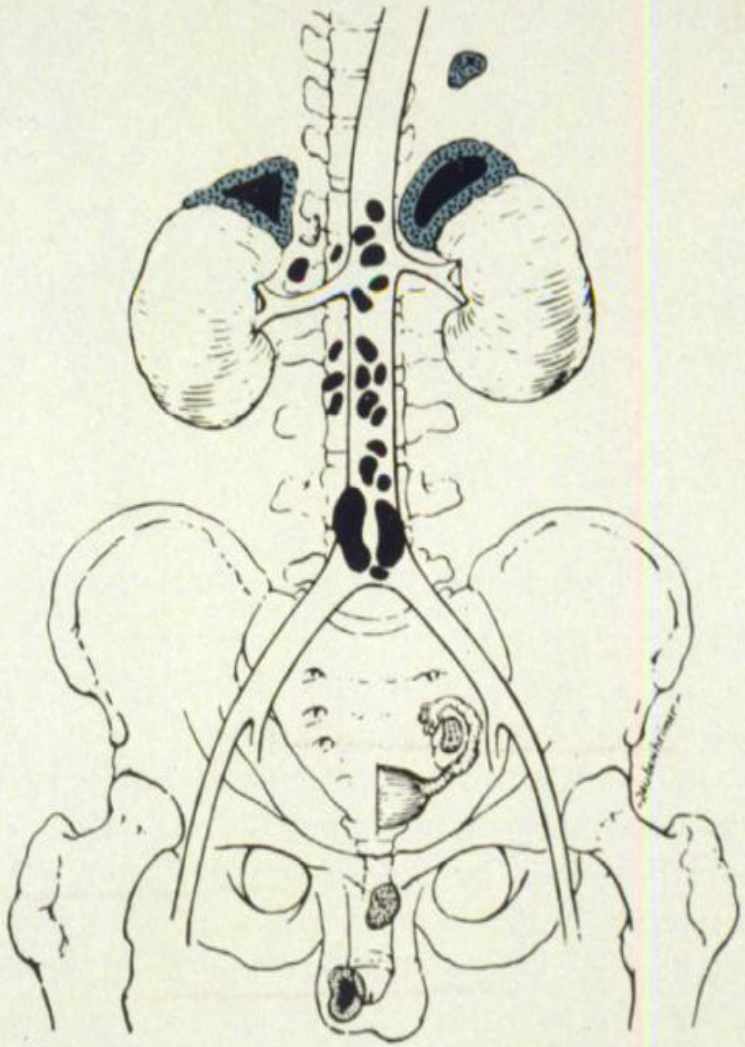
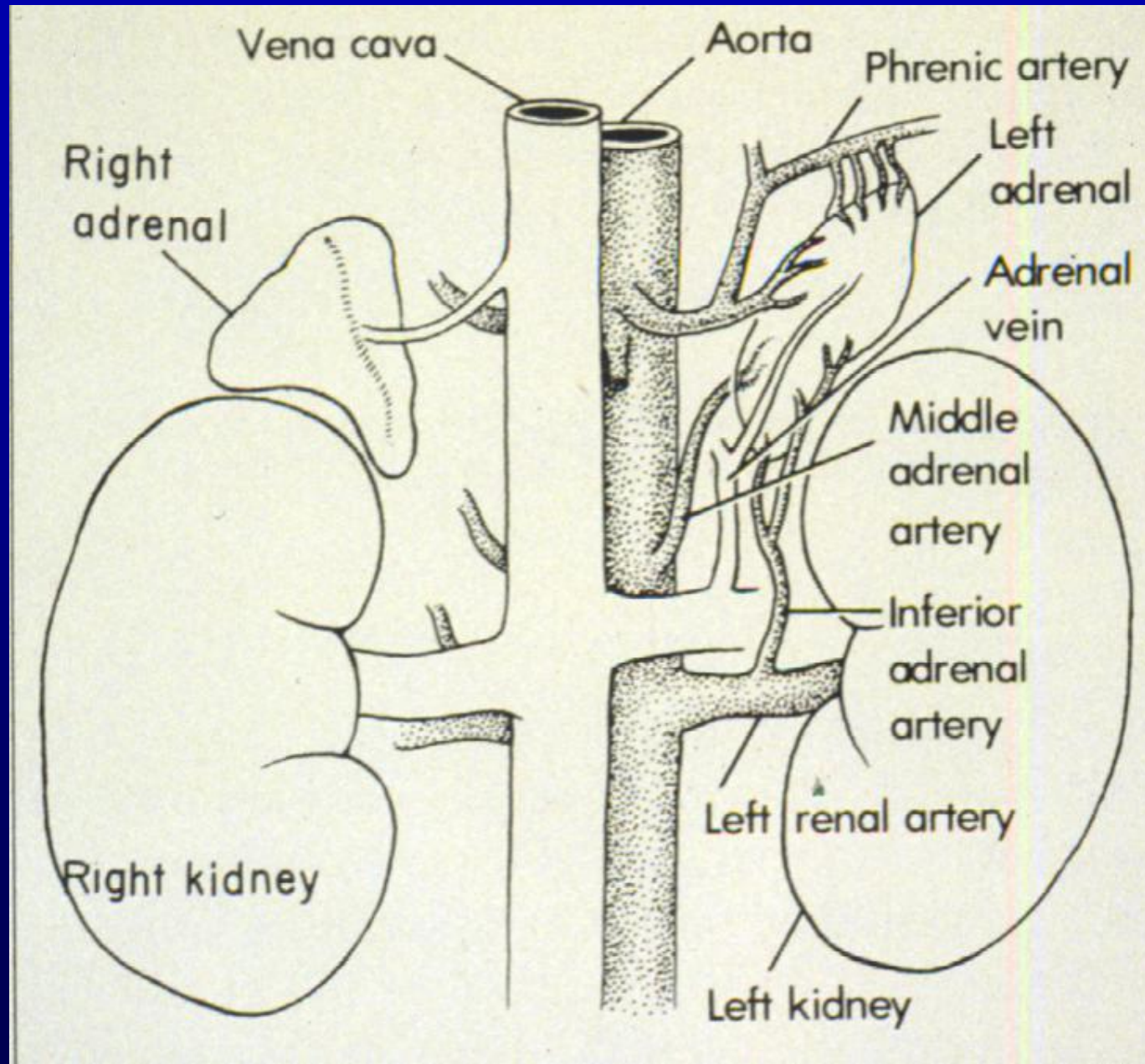


Figure 21–1. Human adrenal glands. Adrenocortical tissue is shown stippled; adrenal medullary tissue is shown black. Note the location of adrenals at the superior pole of each kidney. Also shown are extra-adrenal sites where cortical and medullary tissues are sometimes found. (Re-

Adrenal (from “ad” = near and “ren” = kidney)



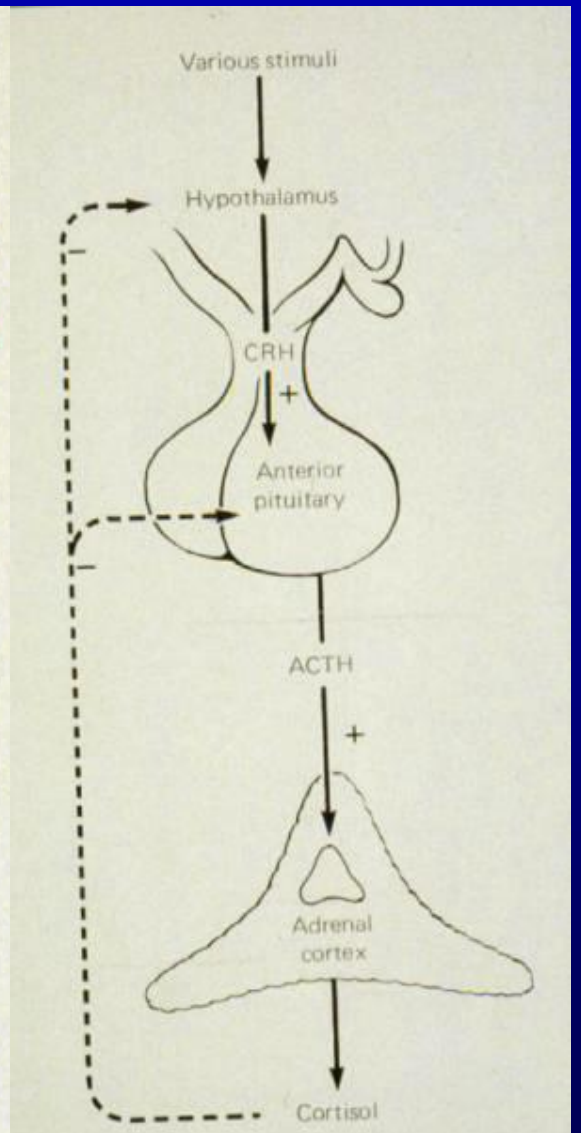
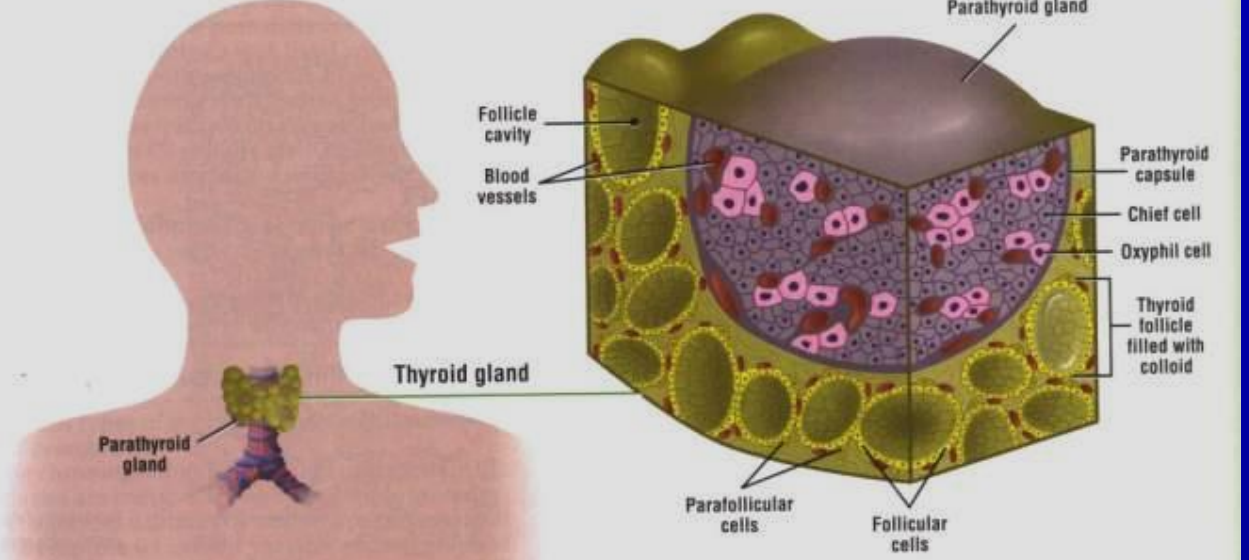
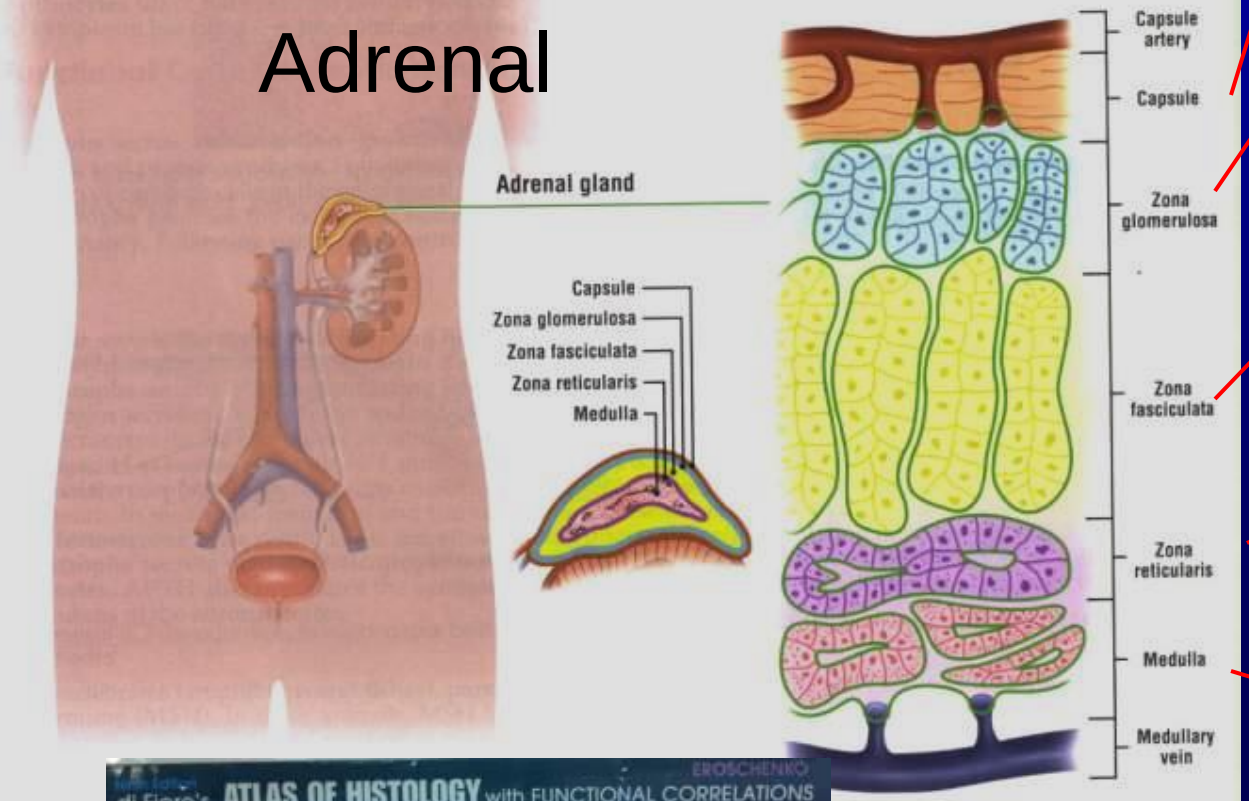
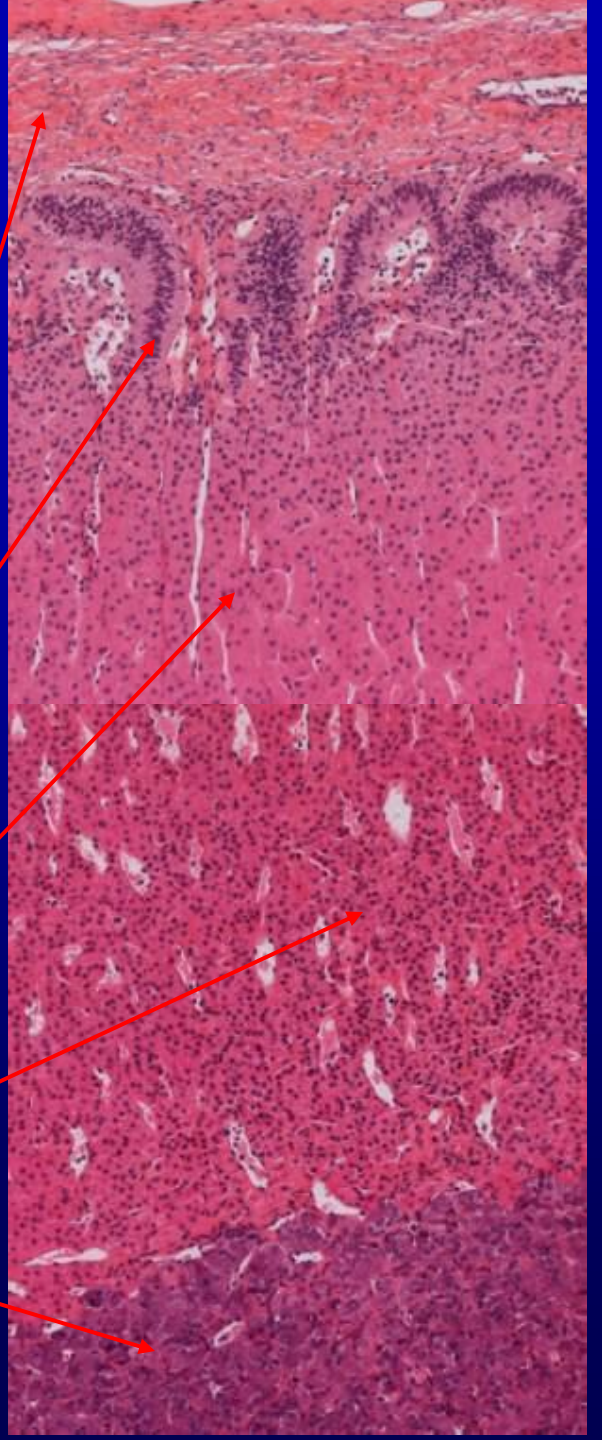


Figure 21–6. Feedback mechanism of ACTH-glucoc
ticoid secretion. Solid arrows indicate stimulation; dash
arrows, inhibition.


Parathyroid gland
Follicle cavity
Blood vessels
Parathyroid capsule
Chief cell
Oxyphil cell
Thyroid follicle filled with colloid
Thyroid gland
Parathyroid gland
Parafollicular cells
Follicular cells

Adrenal


Capsule artery
Capsule
Zona glomerulosa
Zona fasciculata
Zona reticularis
Medulla
Medullary vein
Adrenal gland
Capsule
Zona glomerulosa
Zona fasciculata
Zona reticularis
Medulla
di Fiore's ATLAS OF HISTOLOGY with FUNCTIONAL CORRELATIONS
EROSCHENKO



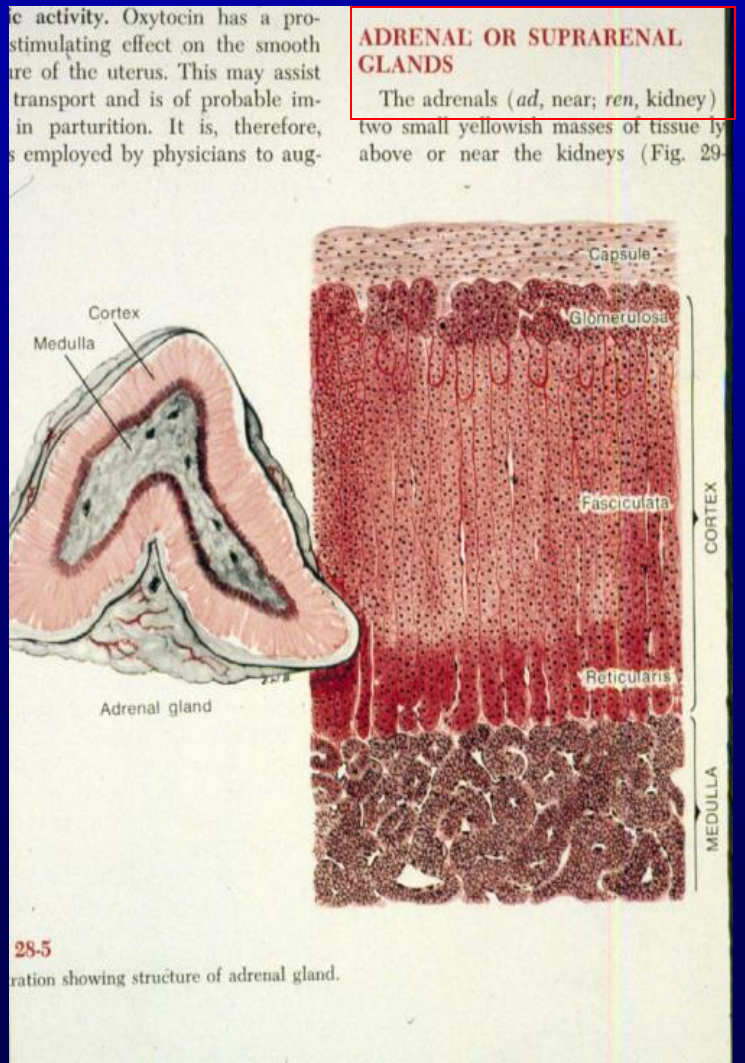
Adrenocorticotropic Hormone (ACTH)

Physiological significance

Adrenal gland microanatomy

- **Adrenal cortex**
  - **Zona Glomerulosa**
    - **Mineralocorticoids**
    - **(e.g., aldosterone)**
  - **Zona Fasciculata**
    - **Glucocorticoids**
    - **(e.g., cortisol)**
  - **Zona Reticularis (e.g., androgens)**
- **Adrenal medulla**
  - **Chromaffin cells**

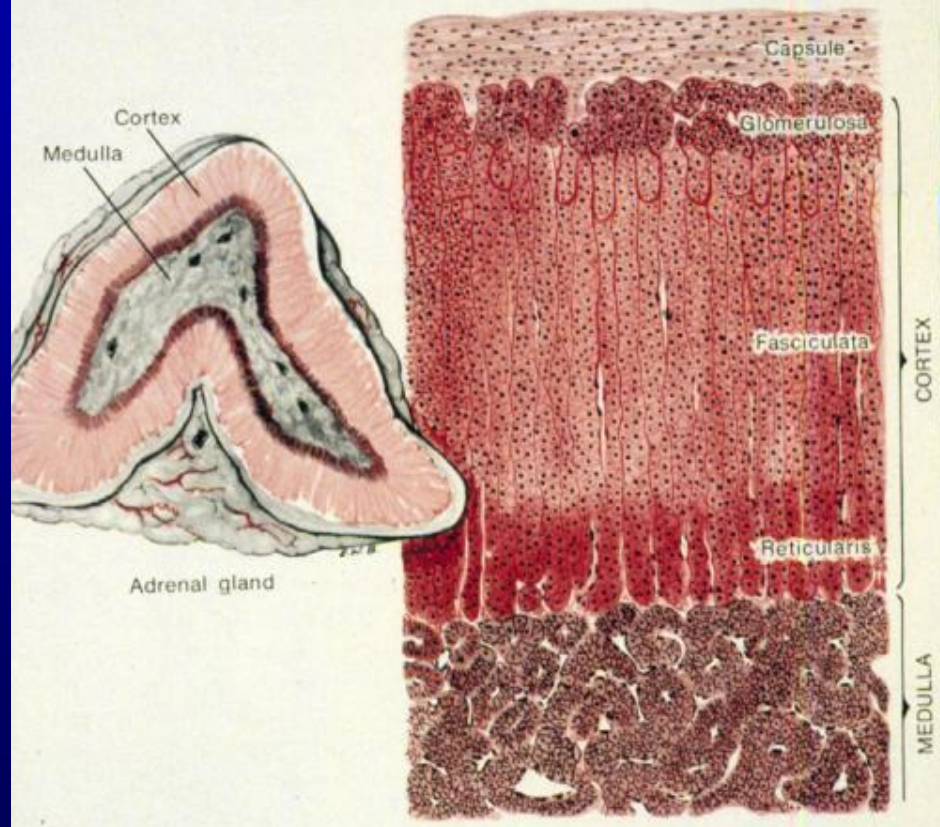
Regulation of secretion



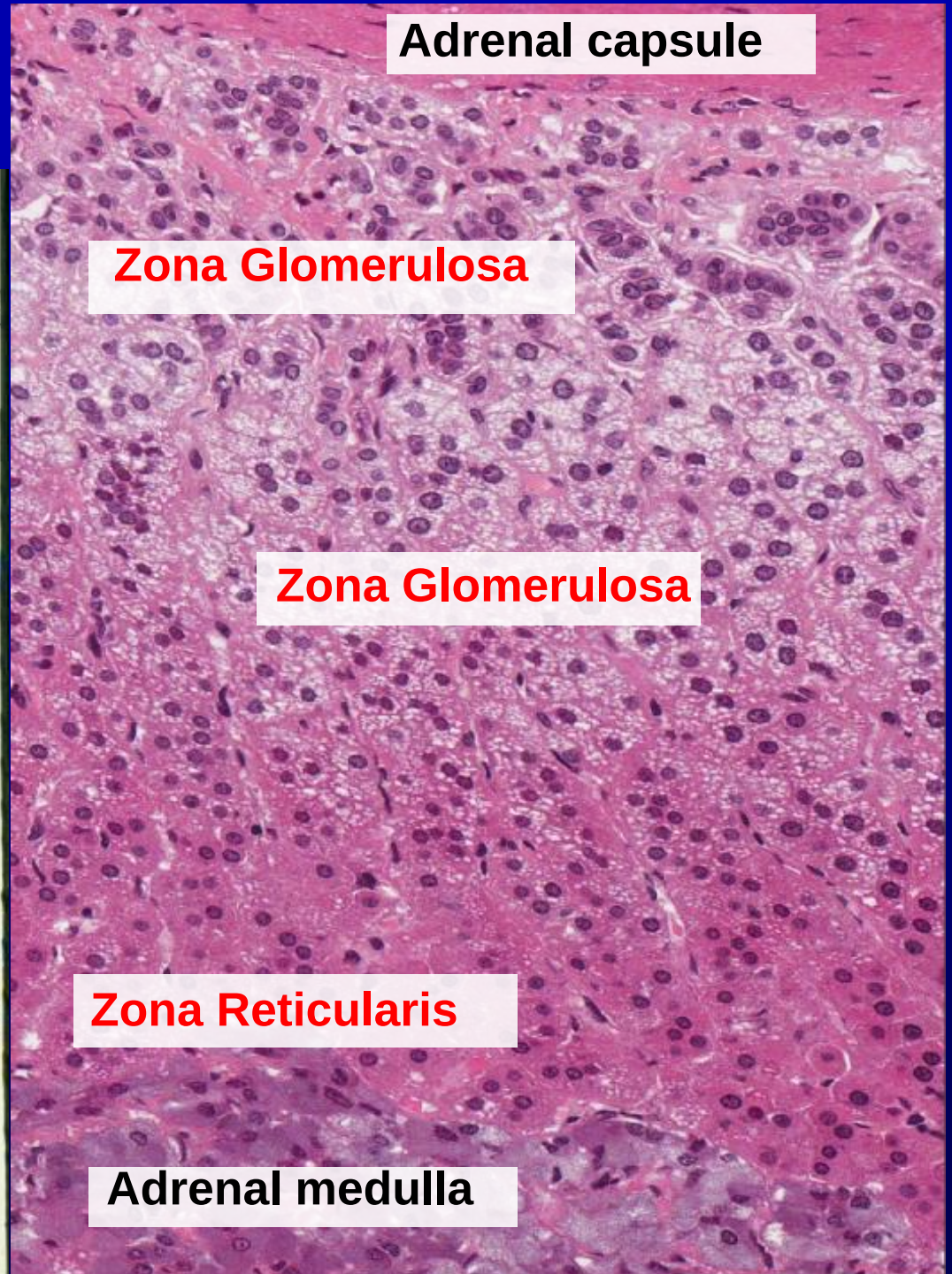
c activity. Oxytocin has a pro-
stimulating effect on the smooth
re of the uterus. This may assist
transport and is of probable im-
in parturition. It is, therefore,
employed by physicians to aug-

ADRENAL OR SUPRARENAL GLANDS

The adrenals (*ad*, near; *ren*, kidney)
two small yellowish masses of tissue ly
above or near the kidneys (Fig. 29-

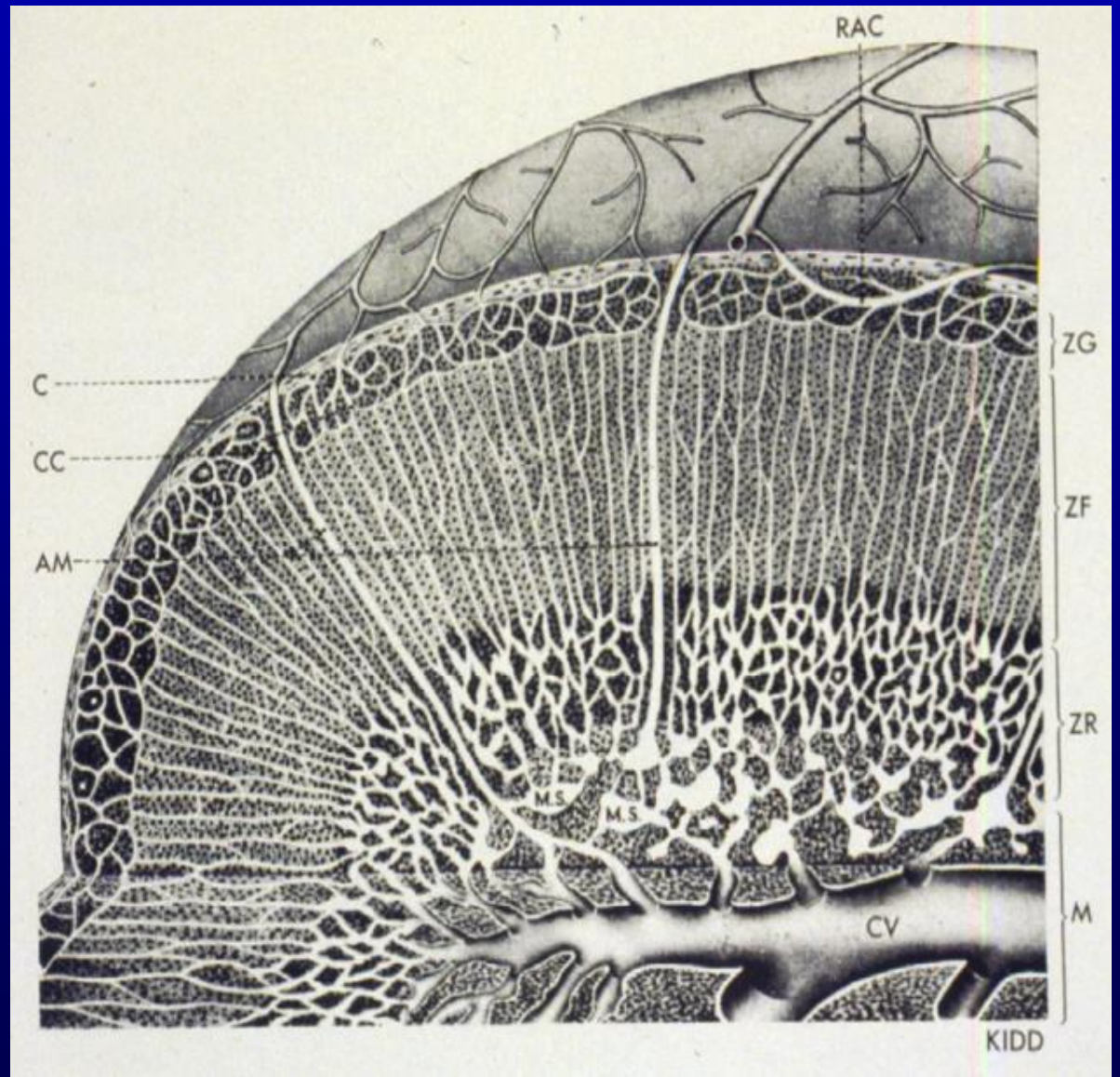


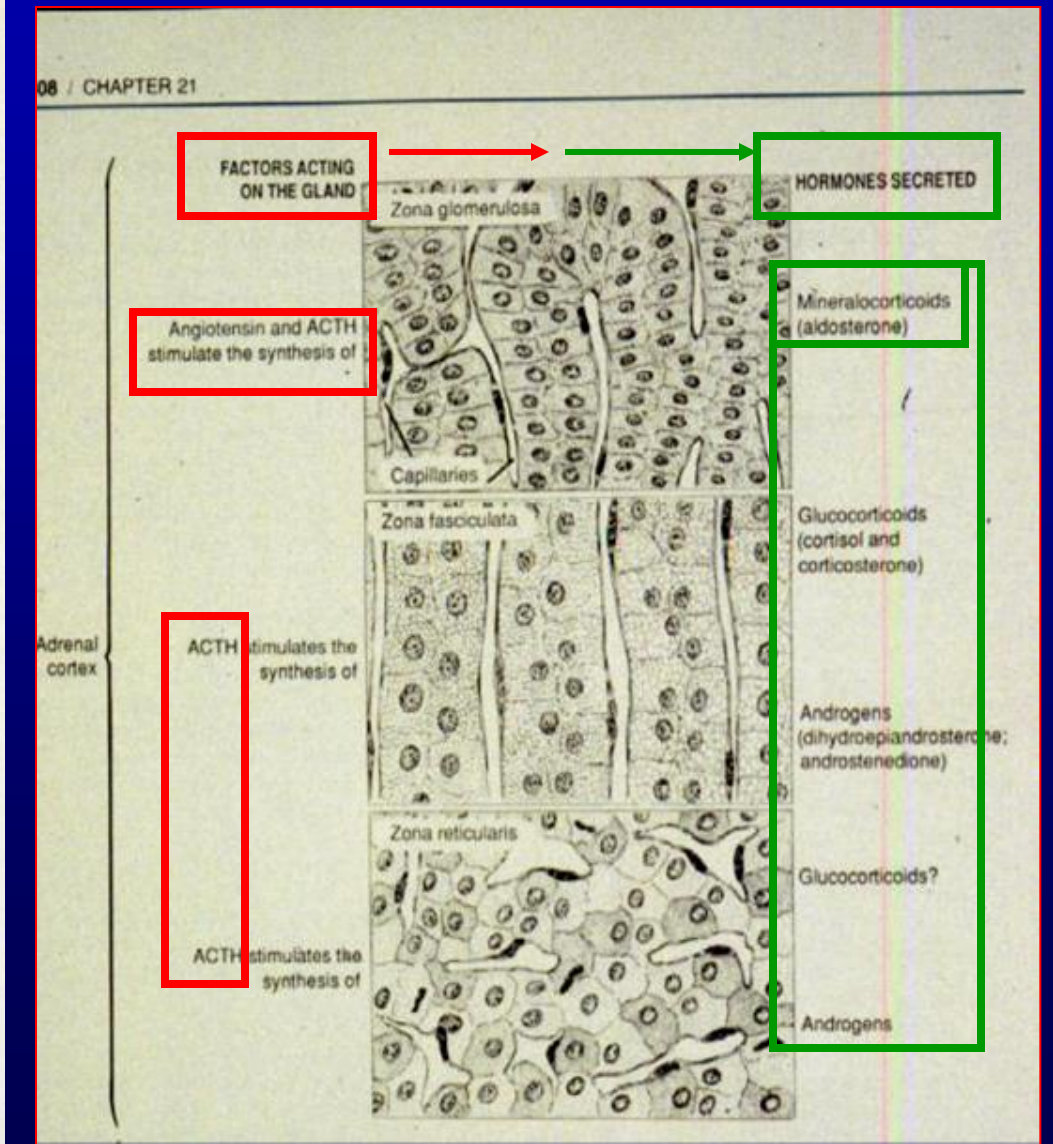
28-5
ration showing structure of adrenal gland.



Adrenal Cortex

Zona glomerulosa
Zona fasciculata
Zona reticularis

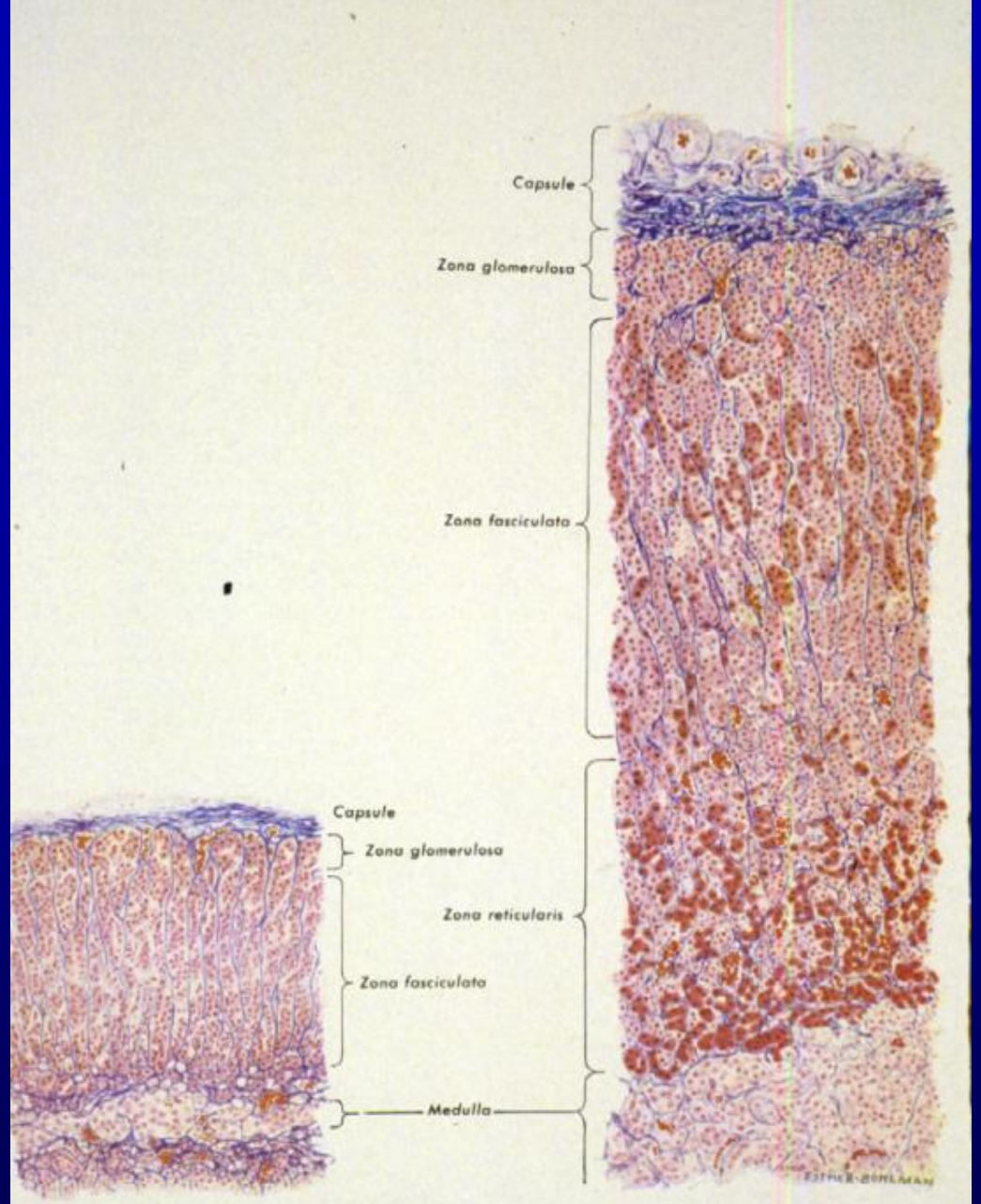




Adrenal Cortex

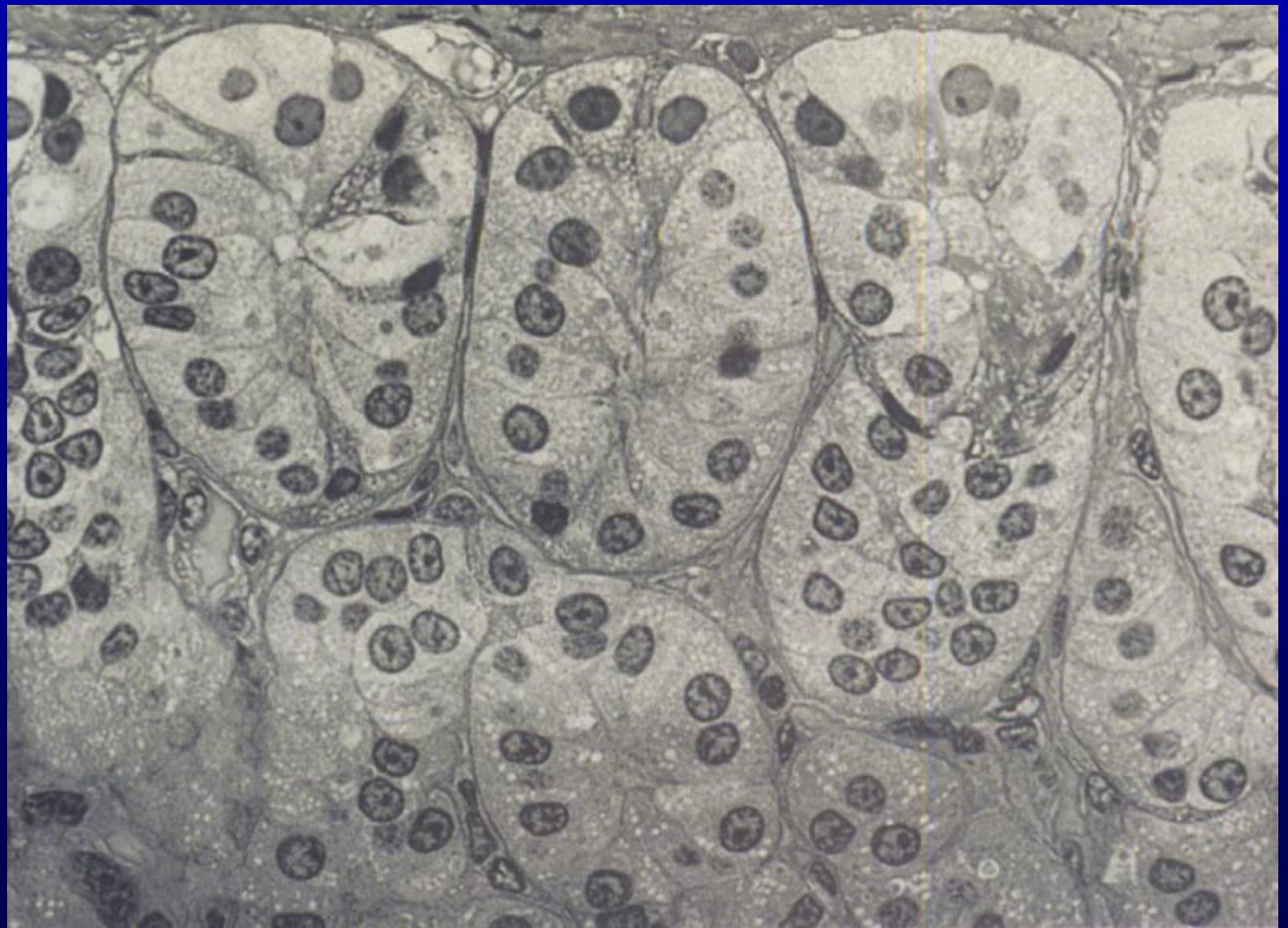
Zona Glomerulosa
Zona Fasciculata
Zona Reticularis

Size varies with age

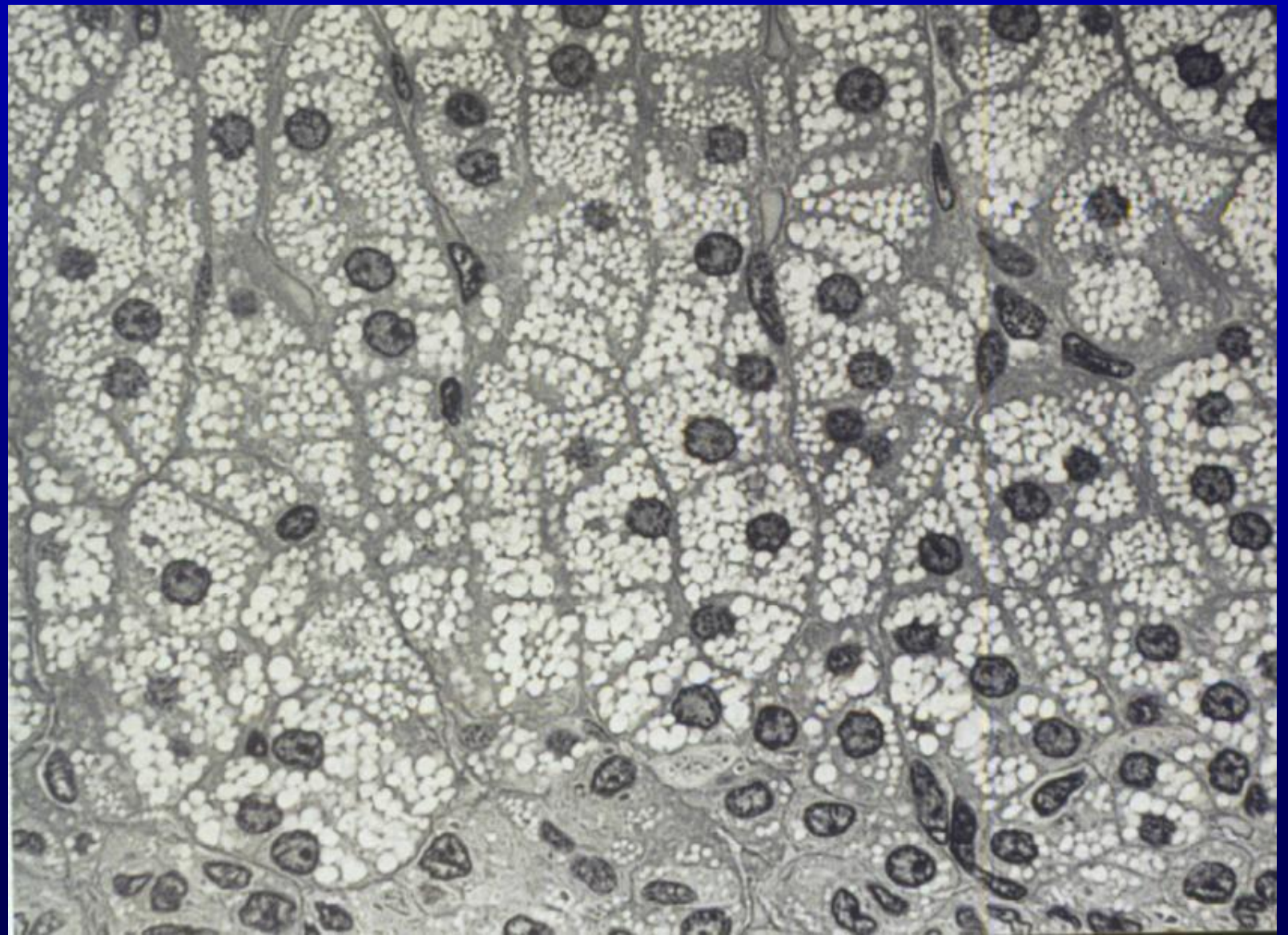


re 20–1. Sections through the adrenal glands of a 6-month-old infant *(left)* and of a man *(right)*. Mallory-azan stain
10.

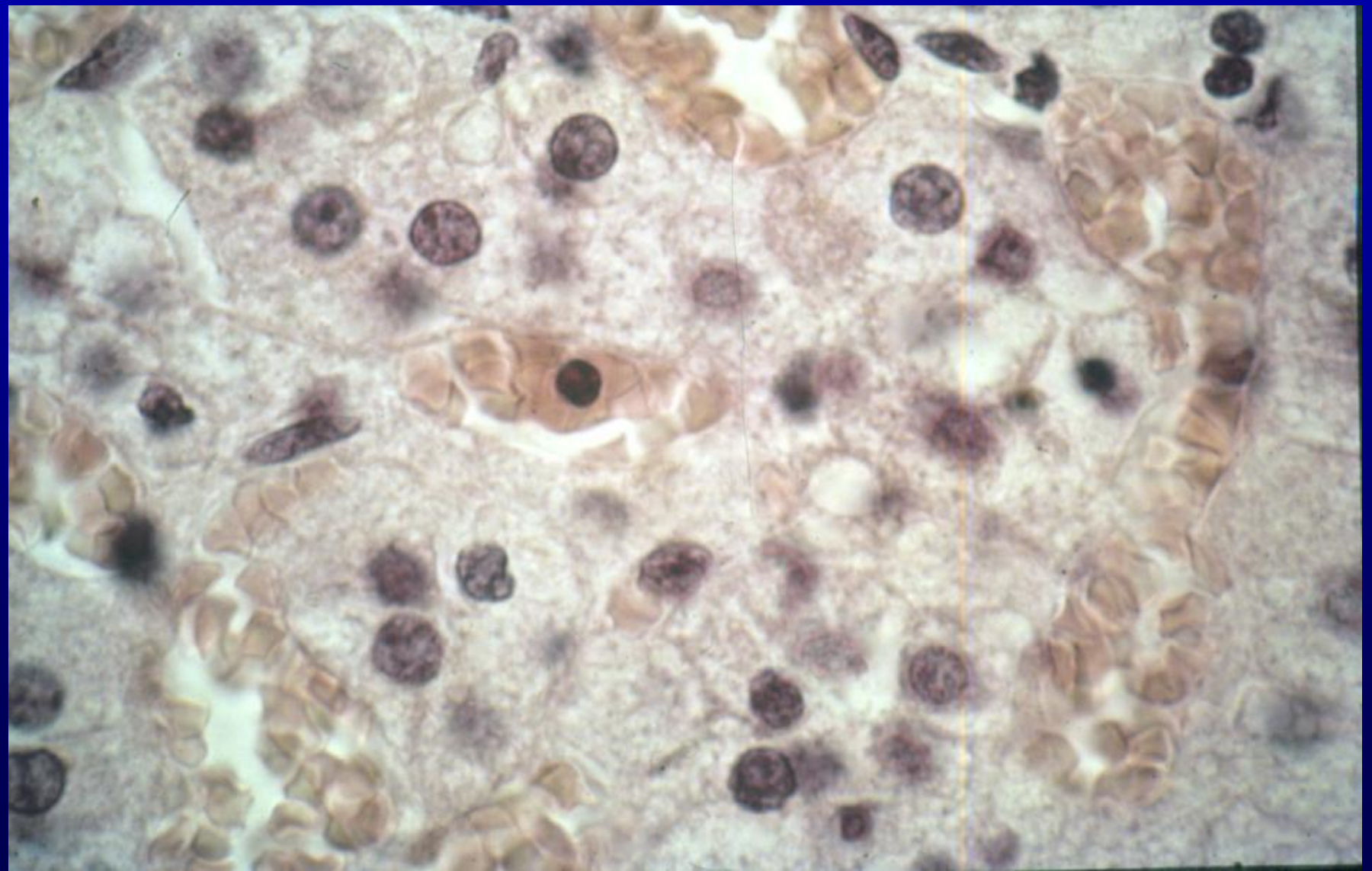
Adrenal Cortex
Zona Glomerulosa



Adrenal Cortex
Zona Fasciculata

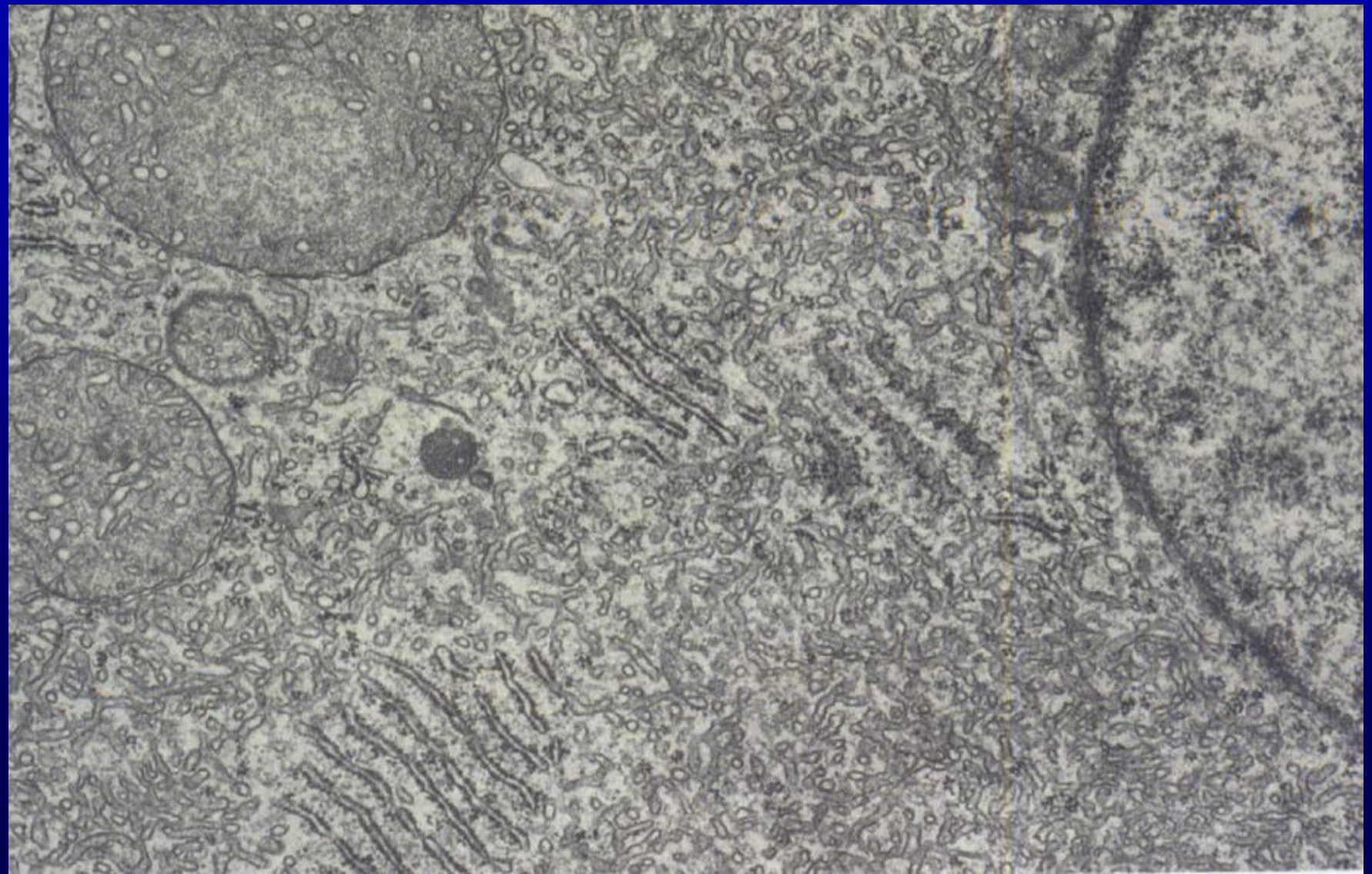


Adrenal Cortex
Zona Reticularis



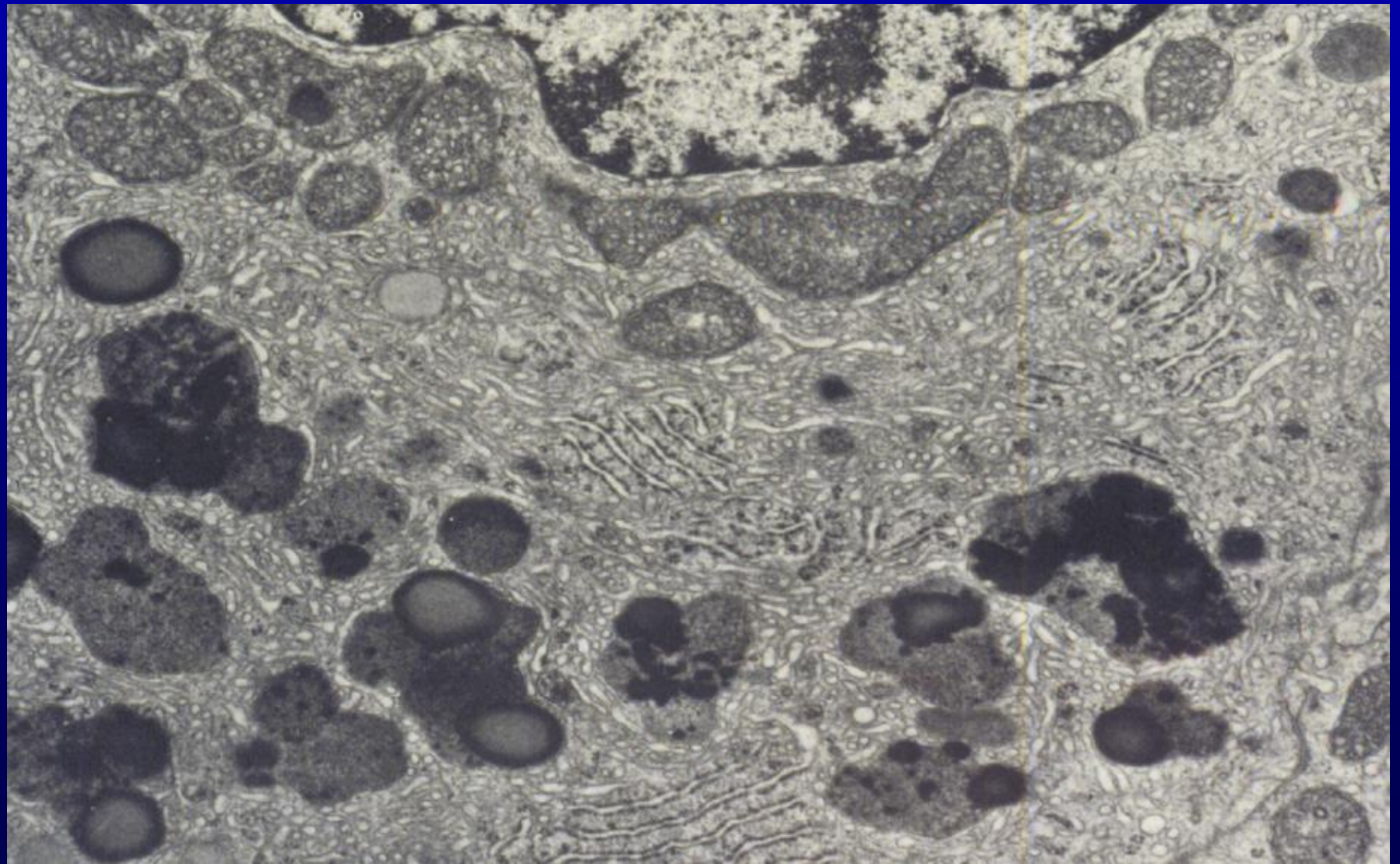
Human fetal adrenal cortical cell

with lots of SER and large spherical mitochondria with tubular cristae

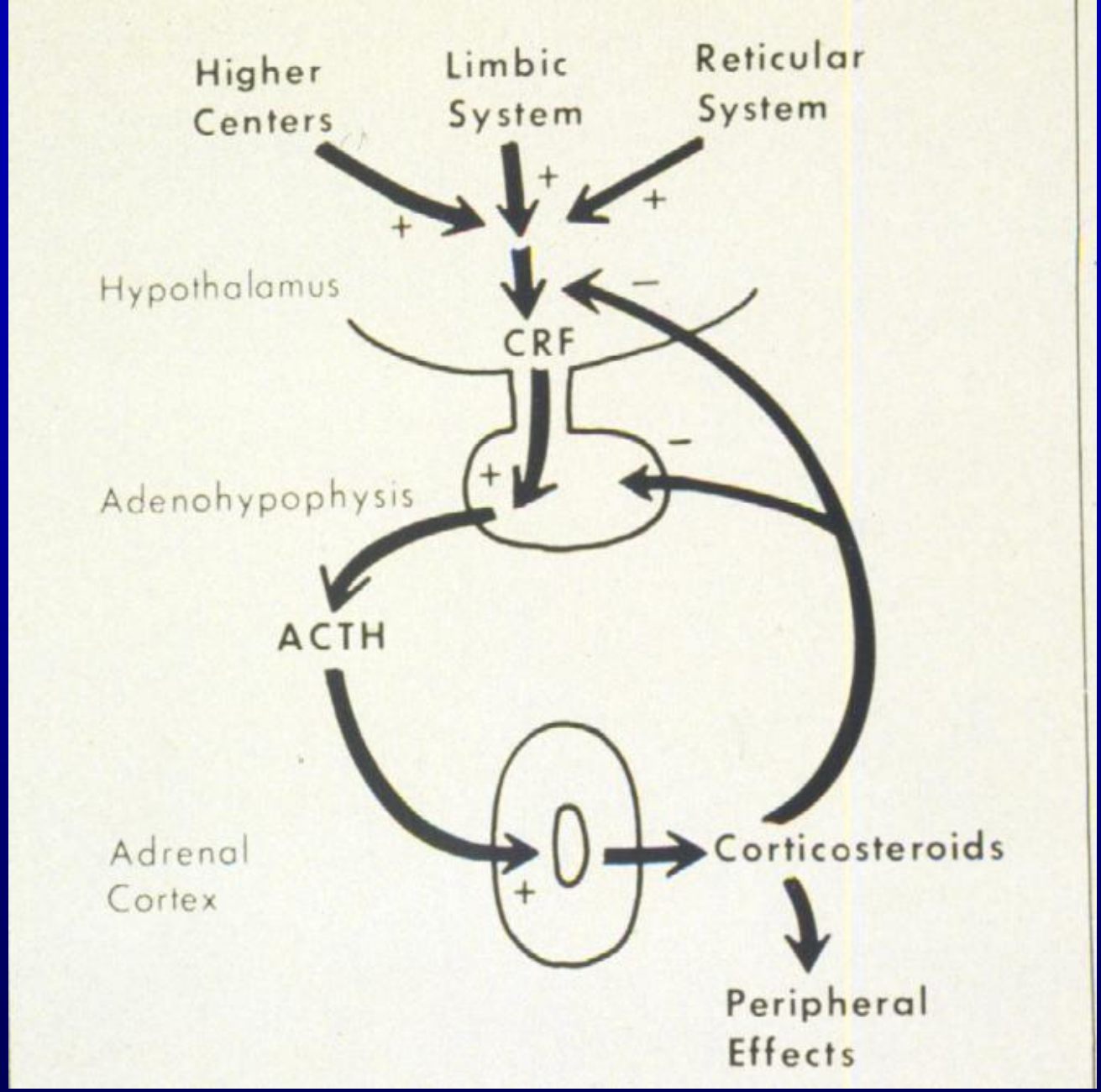


Human adult adrenal cortical cell

with lots of SER, large mitochondria with tubular cristae, and accumulation of lipofuscin

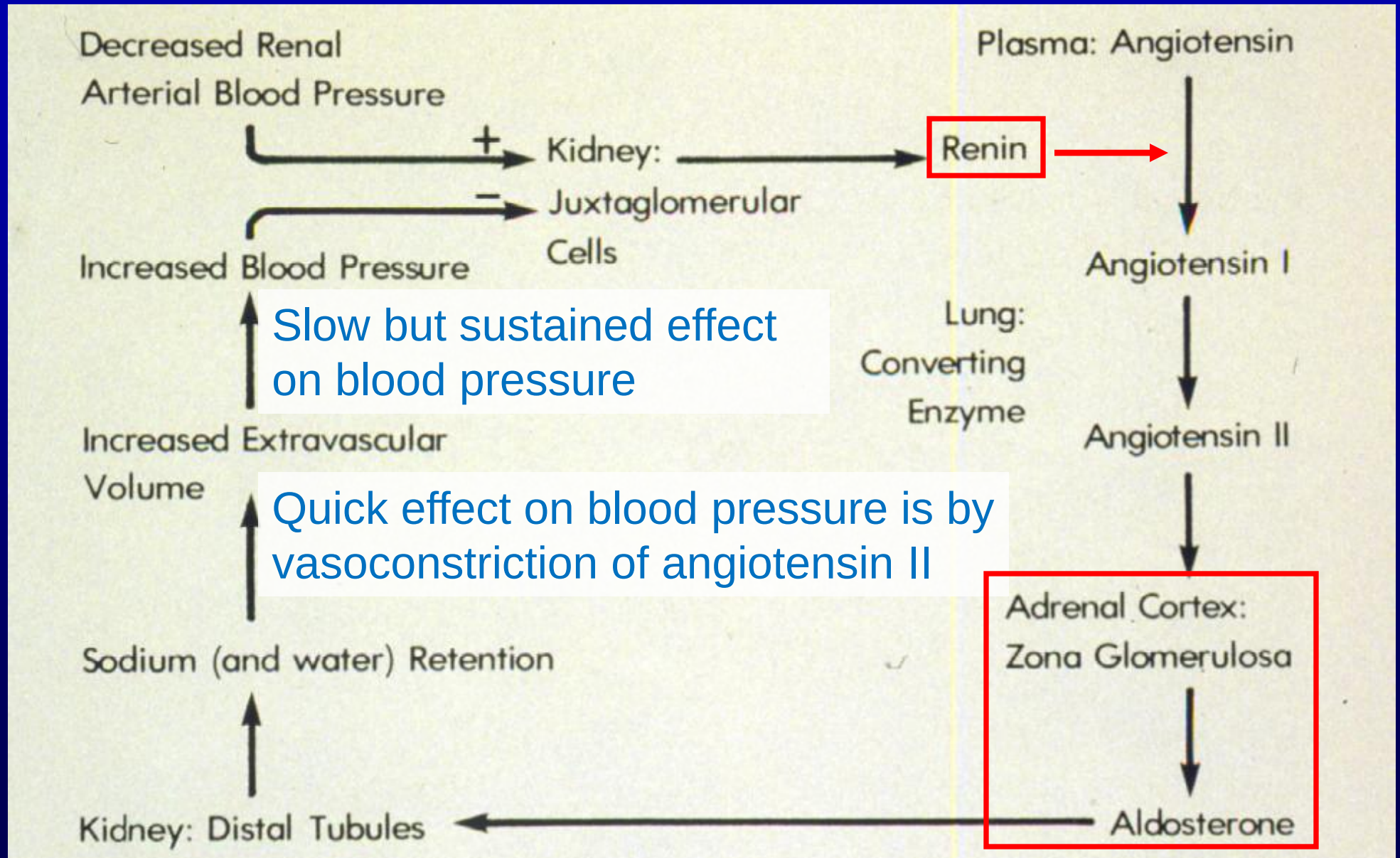


Adrenal function



Limbic system =
group of interconnected deep brain structures, common in mammals, involved in olfaction, emotion, motivation, behavior, and various autonomic functions.

Adrenal function: blood pressure



Adrenal Function

Aldosterone stimulates Na^+ reabsorption in:

- distal tubule of kidney
- gastric mucosa
- salivary glands
- sweat glands

Cortisol –

- anti-inflammatory effects
- stabilizes lysomsomal membranes
- causes atrophy of lymphoid tissues throughout body
- decreases # of circulating lymphocytes

Releases of Neurons

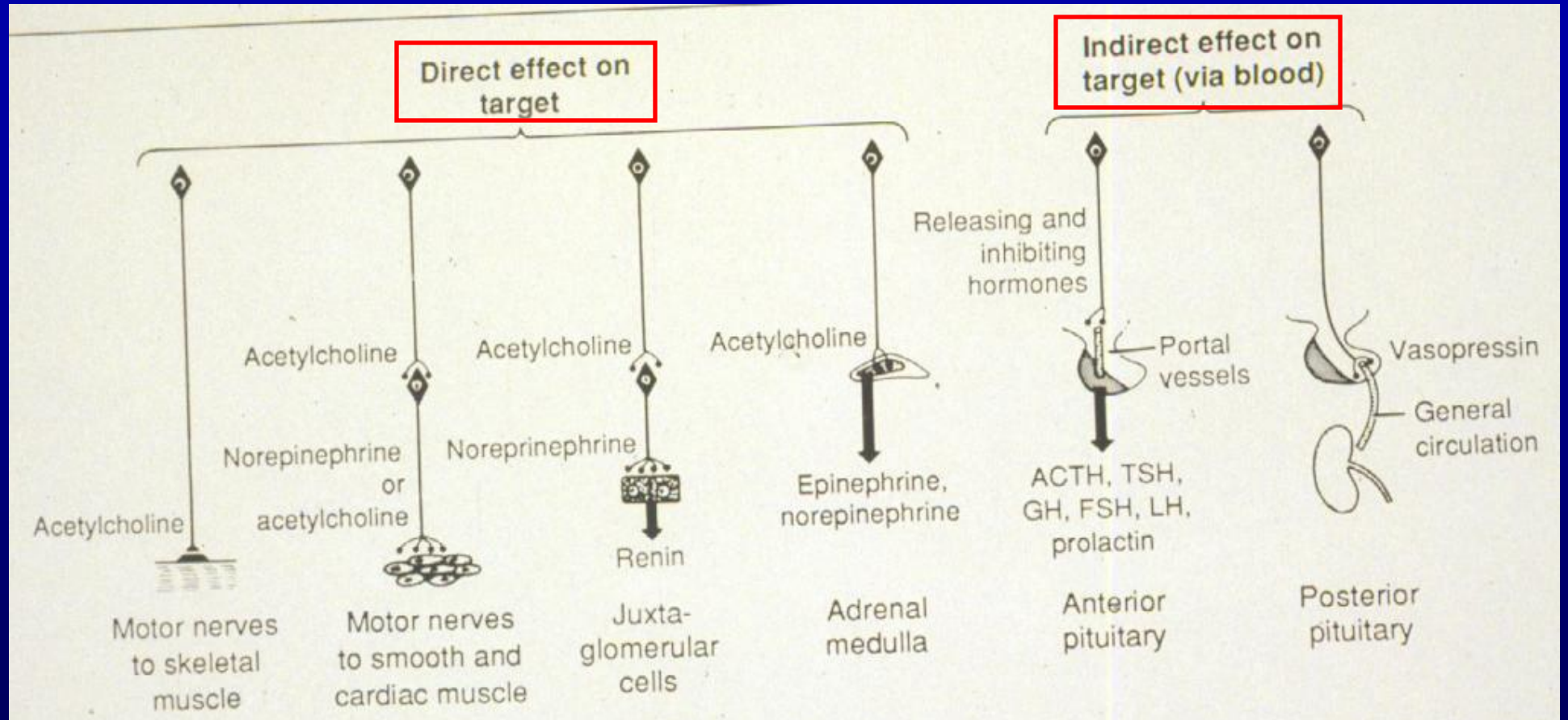
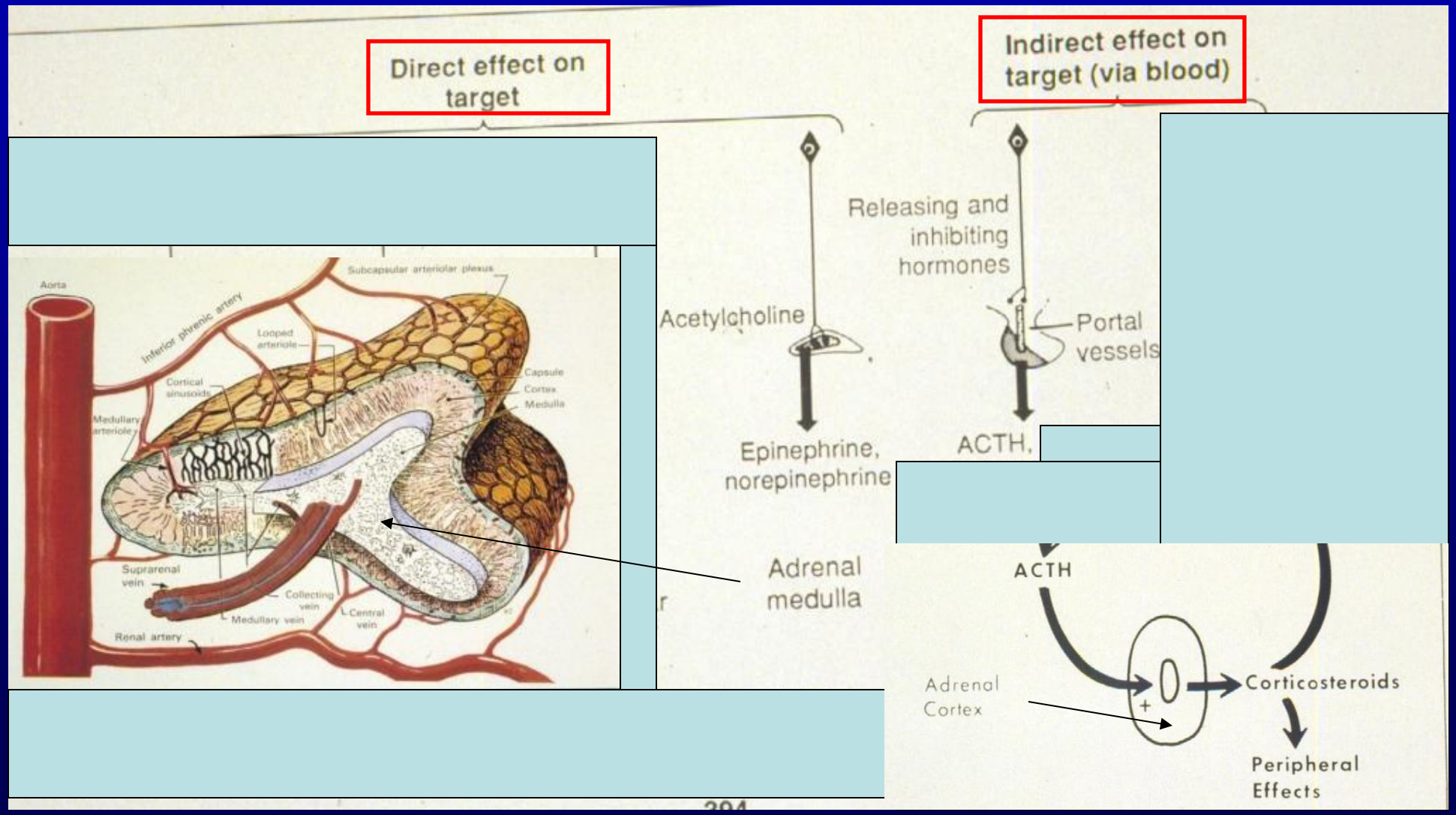
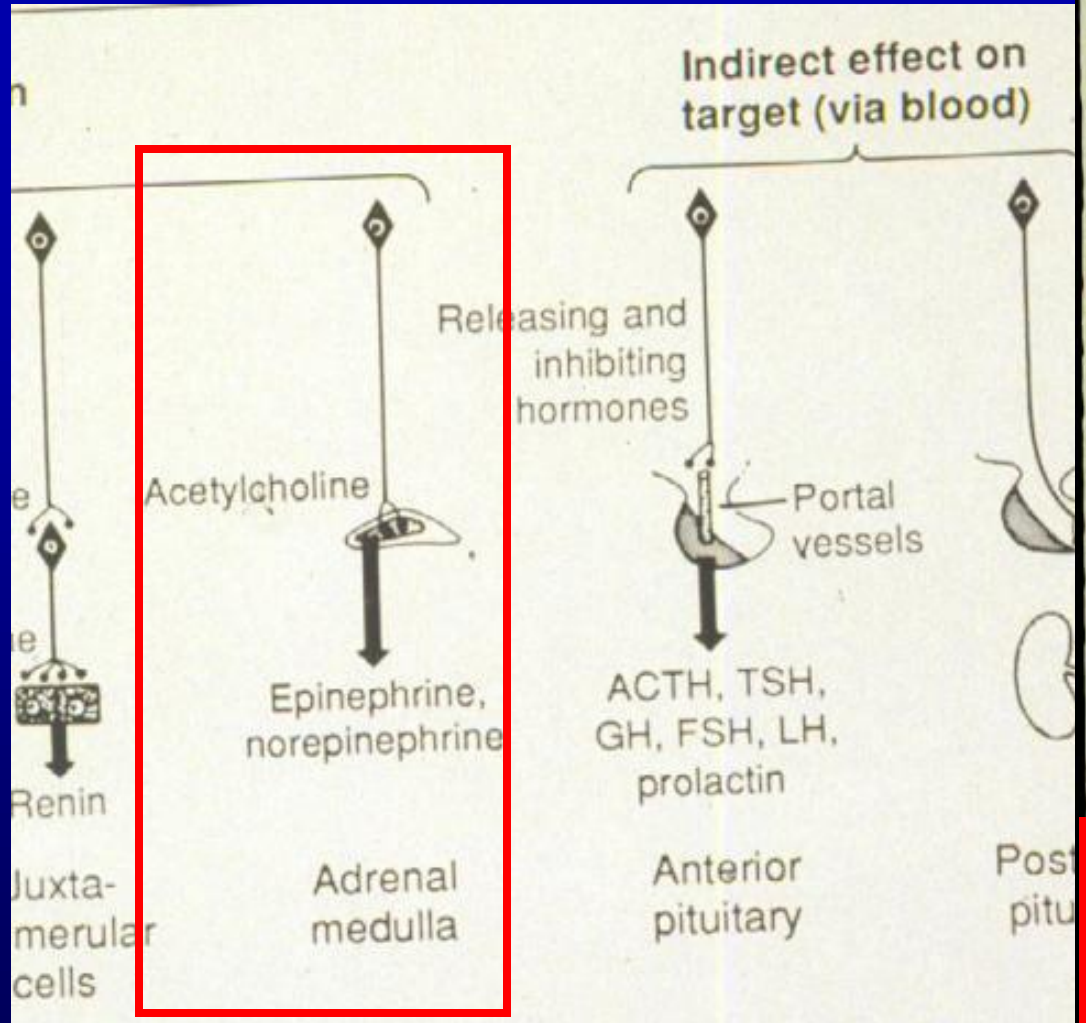


Figure 20–1. Diagrammatic representation of 6 situations in which humoral substances are released by neurons. The last 2 are examples of neurosecretion. (Reproduced, with permission, from Ganong WF. *Review of Medical Physiology*, 14th ed. Appleton & Lange, 1989.)

Releases of neurons associated with the adrenals (both direct and indirect)



Releases of Neurons



6 situations in which humoral substances are released
uced, with permission, from Ganong WF. *Review of Me*

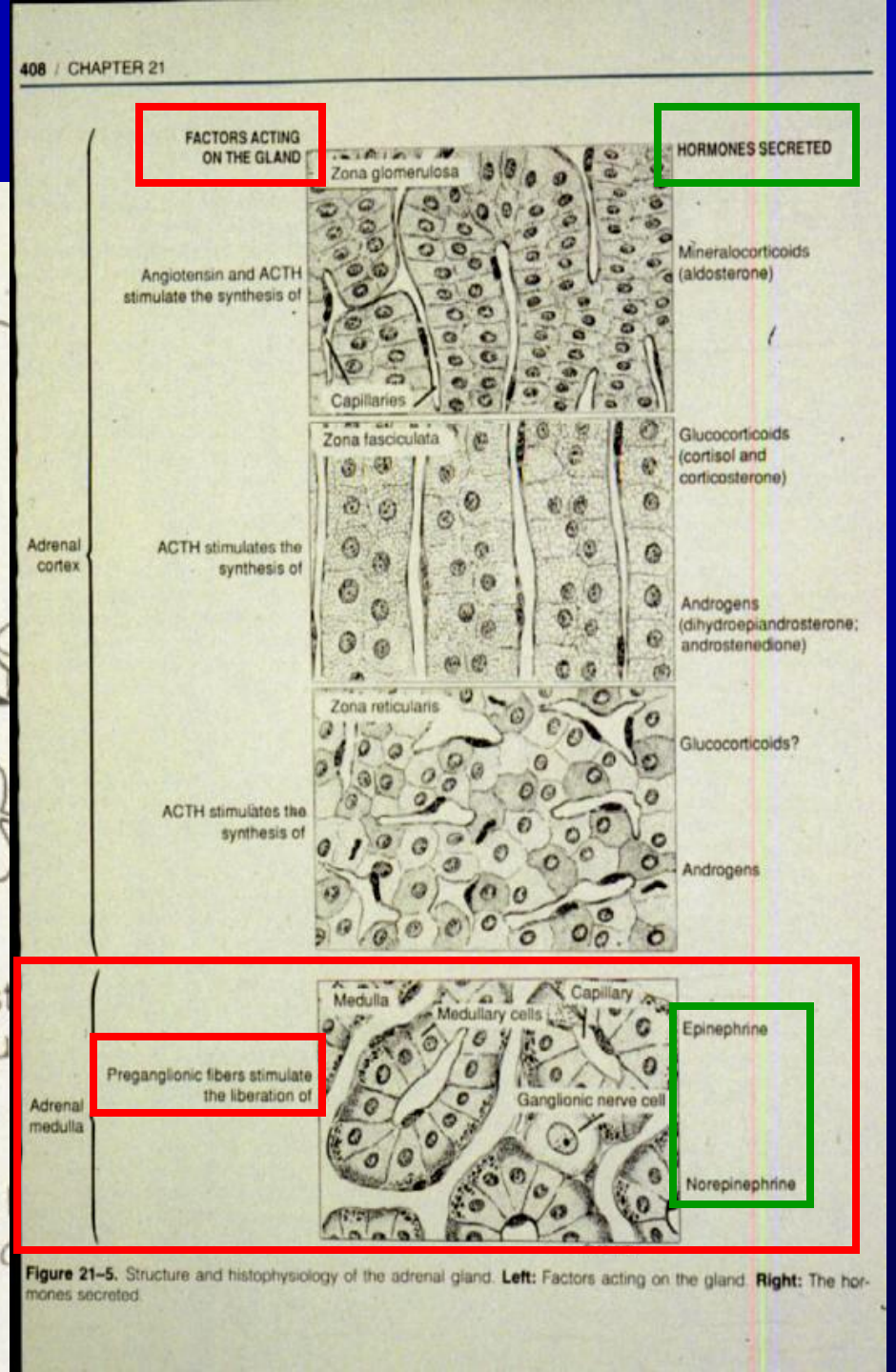


Figure 21–5. Structure and histophysiology of the adrenal gland. **Left:** Factors acting on the gland. **Right:** The hormones secreted.

Why do people like to frighten themselves? *During a roller coaster ride, the sensation of racing headlong toward a precipitous fall turns on the body's "get ready for danger" hormones, from the adrenal gland. But even as the*

Adrenal function

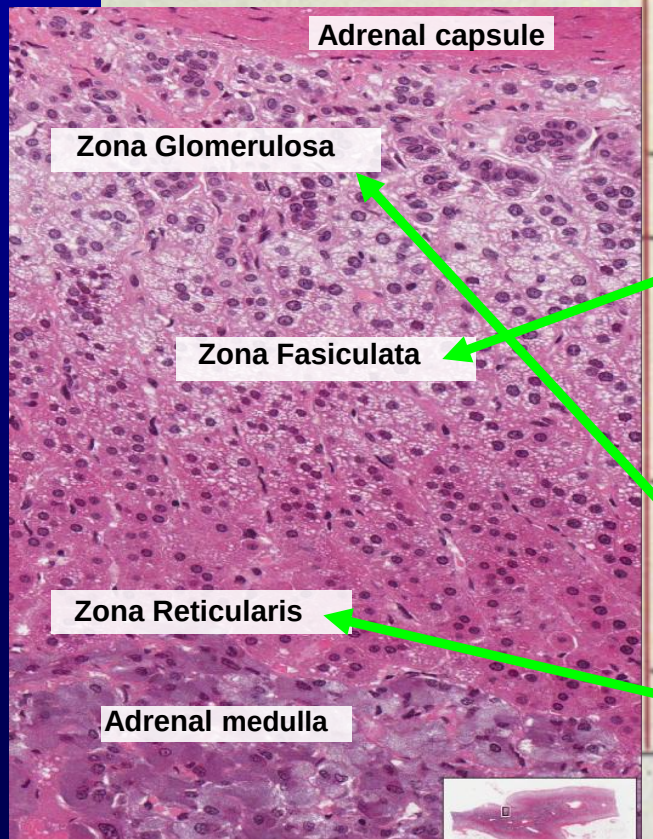


Table 28-1. Hormones of the adrenal gland and their function

Anatomical division	*Hormone*	*Function*
Medulla	Epinephrine	Affects skeletal muscles Cardiovascular effects Metabolism of carbohydrates and fats
	Norepinephrine	Vasoconstrictor
	Glucocorticoids	Essential to fat, protein, and carbohydrate metabolism Increases liver gluconeogenesis Resistance to stress
	Mineralocorticoids	Proper kidney function Regulation of fluid and electrolyte balance
	Sex hormones	Influence sexual characteristics

Adrenal medulla

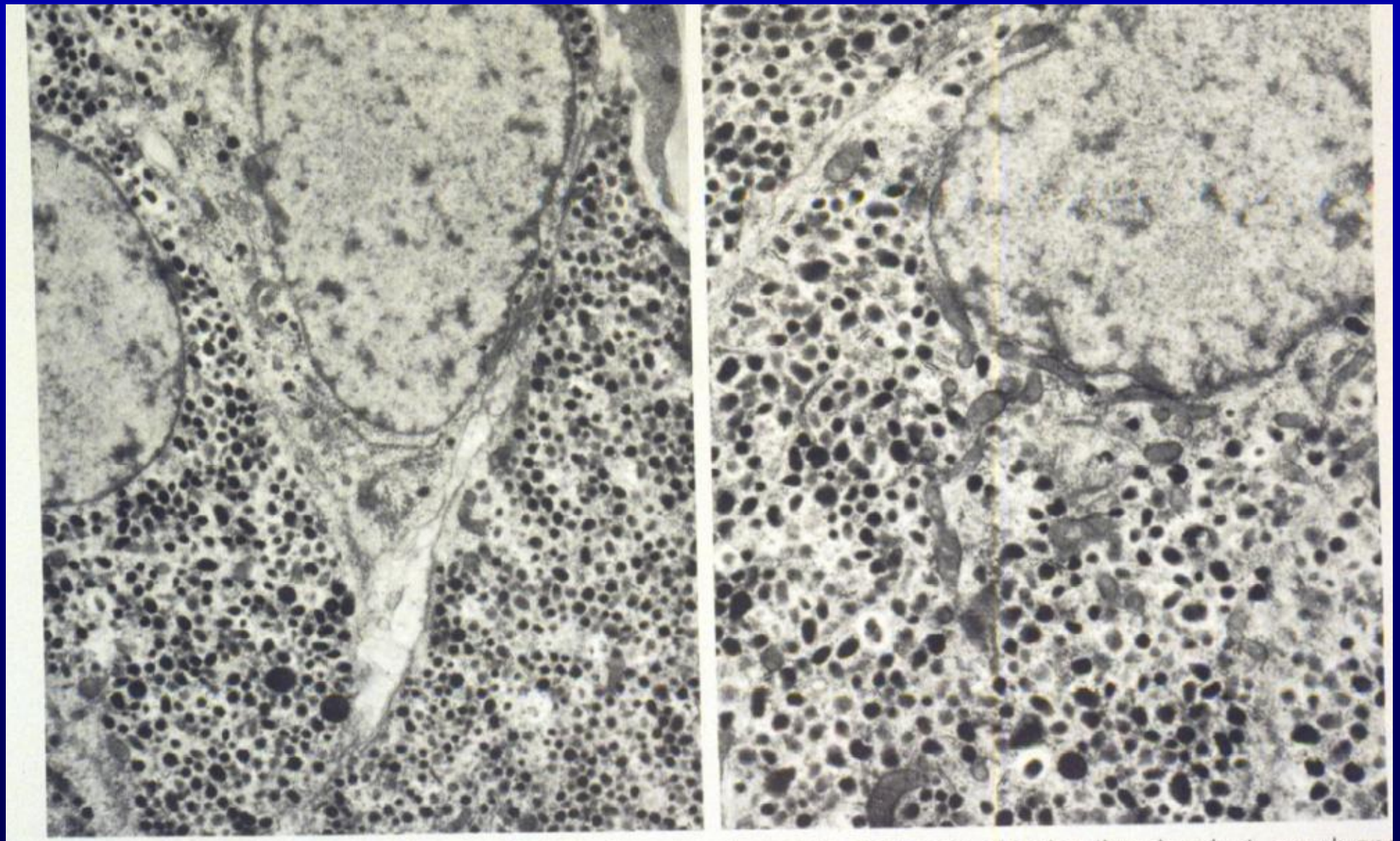
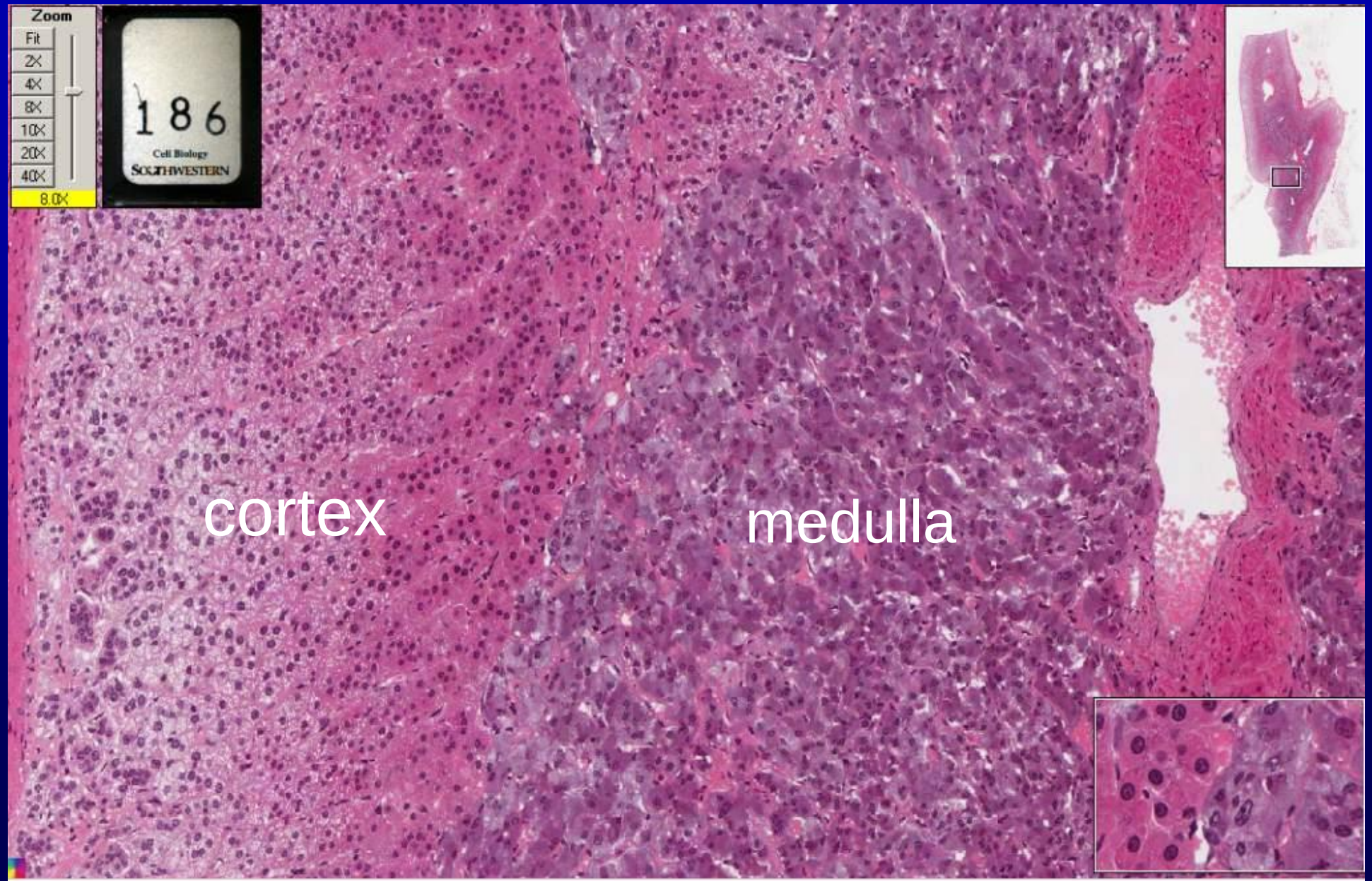
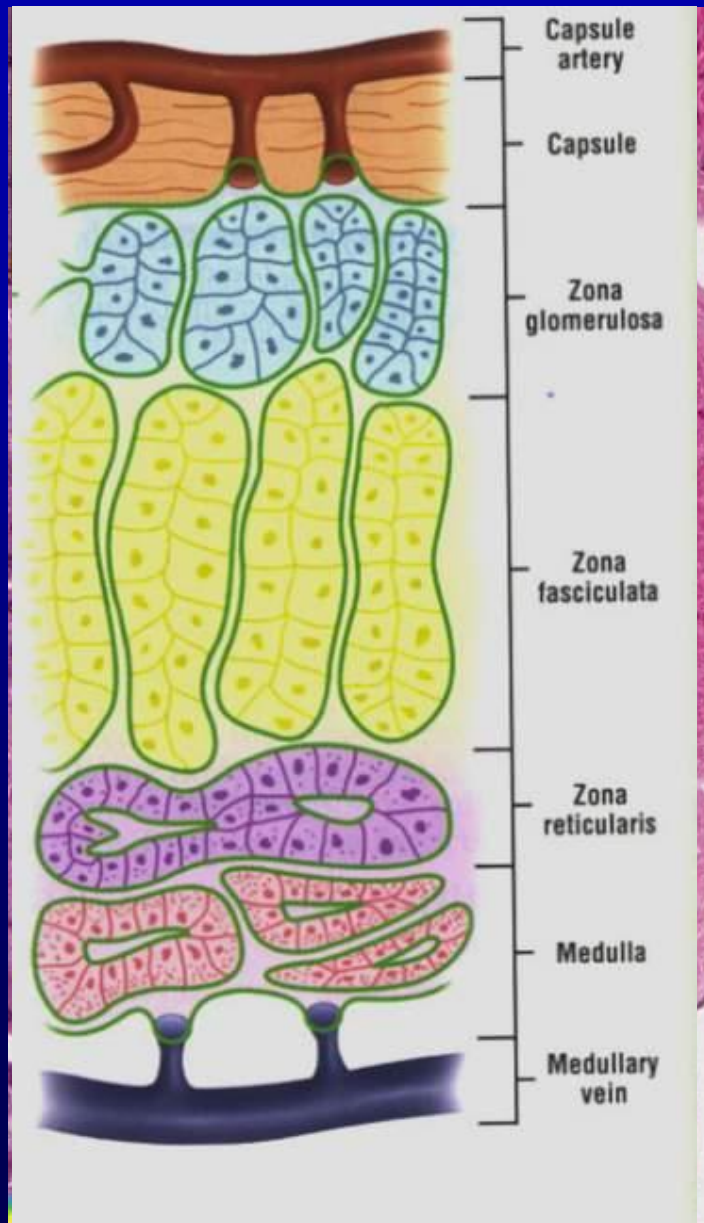


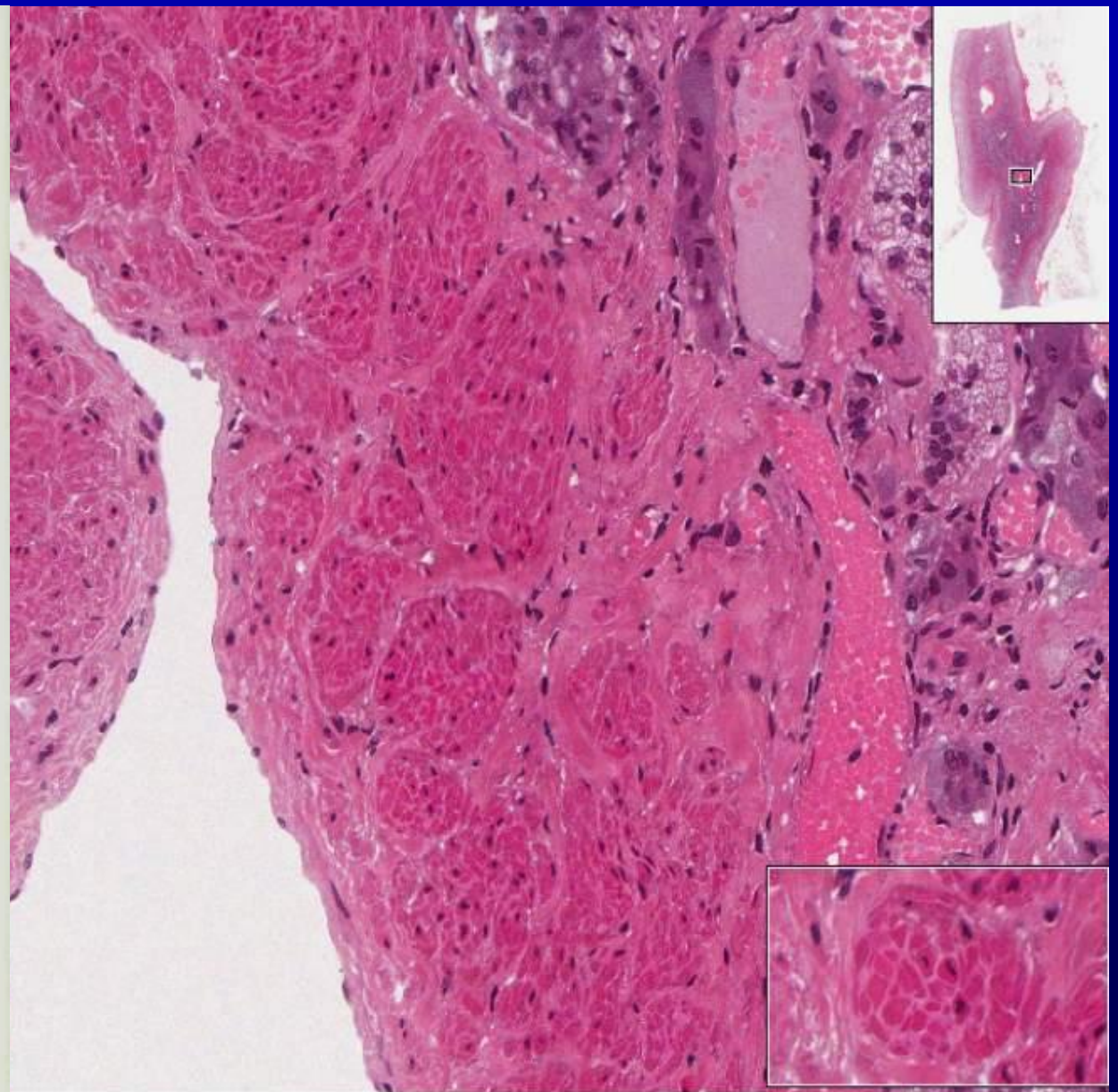
Figure 20–9. Electron micrographs of cells from the adrenal medulla of the cat, showing the abundant, membrane
bounded, dense granules that are the sites of storage of catecholamines. × 9600 and × 13,600. (Courtesy or F

Adrenal -cortex and medulla

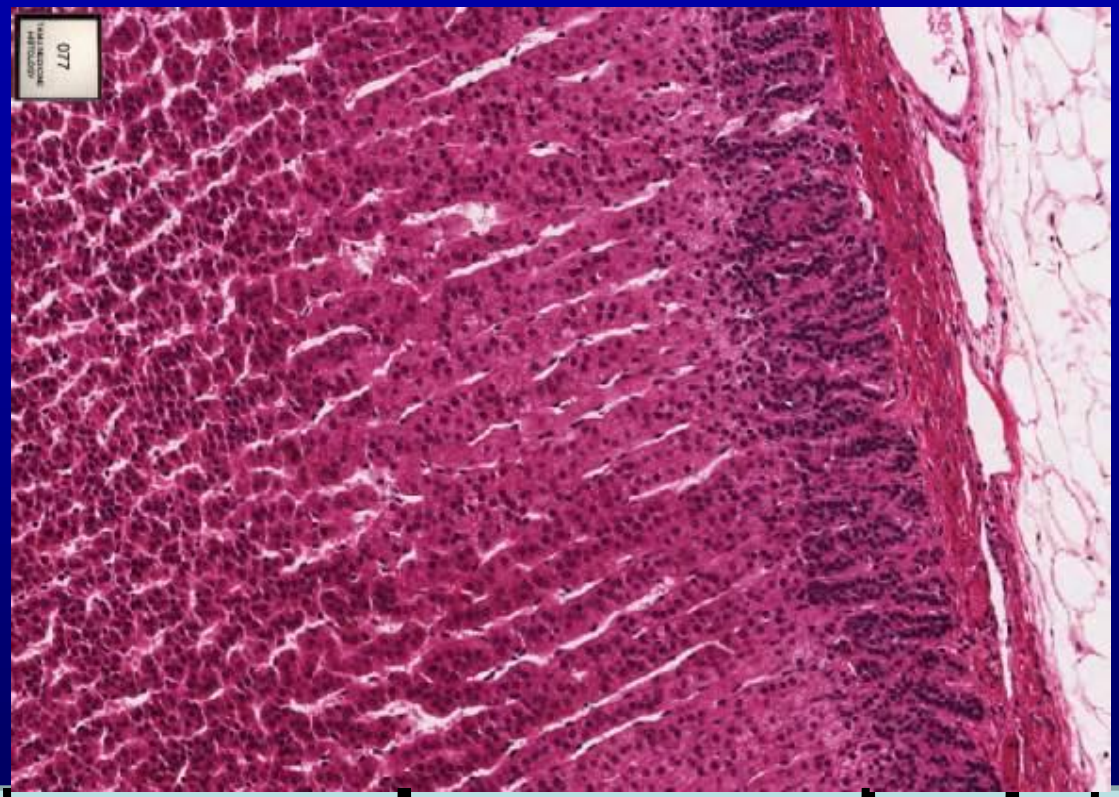


Adrenal - central vein



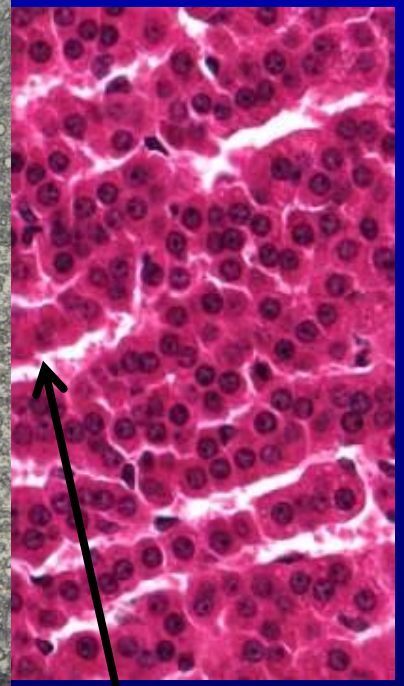


Slide 77: Adrenal gland

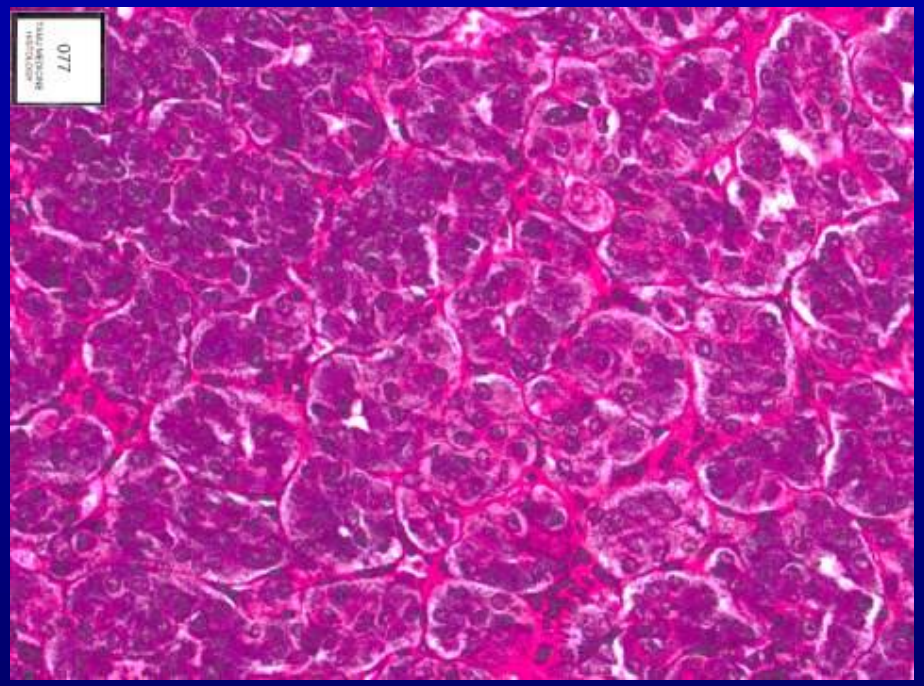


The cortex is regulated by pituitary adrenocorticotrophin hormone (ACTH).

Slide 77: Adrenal gland



Sinusoidal blood channels

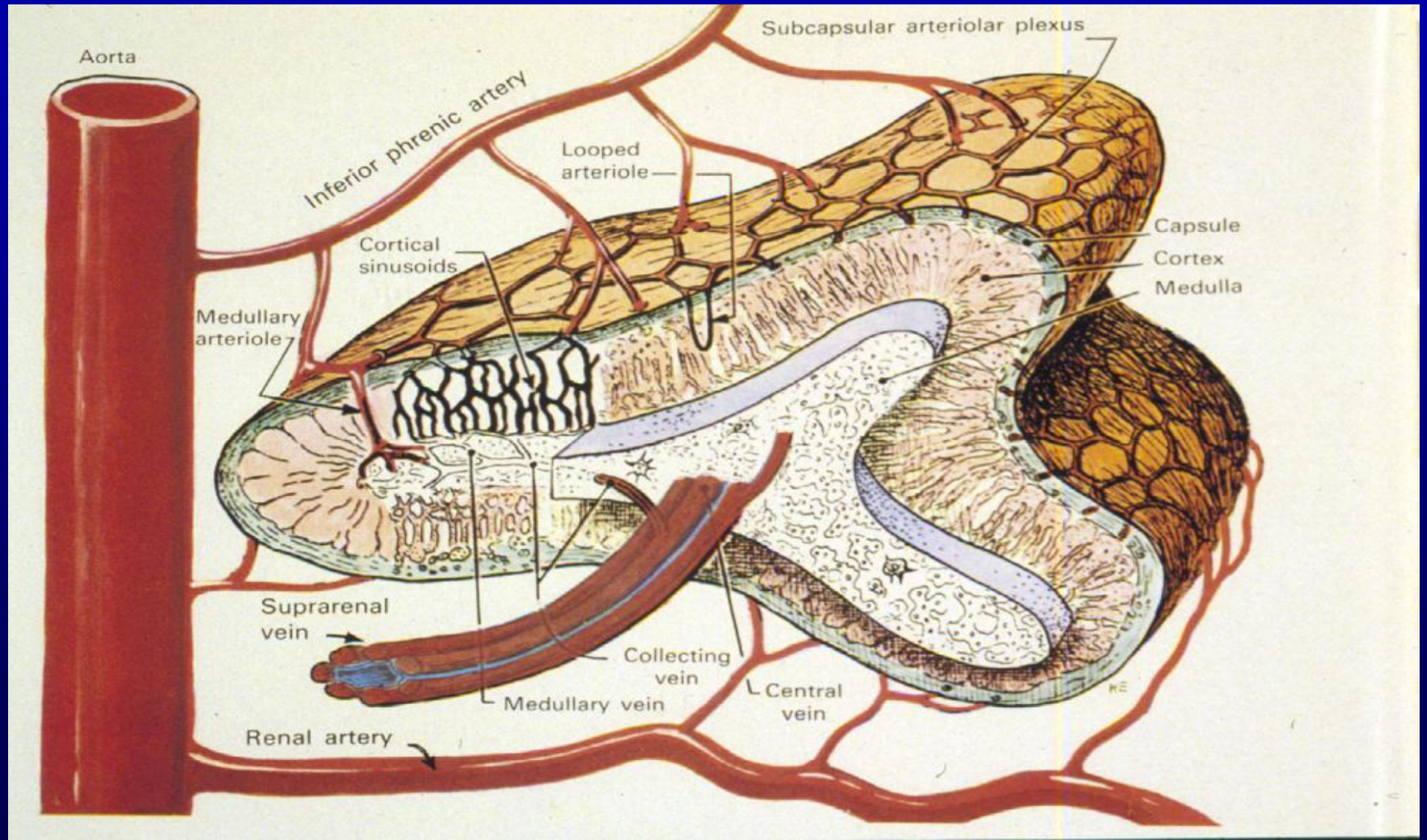


Chromaffin cells of medulla

Lipid droplets are abundant in these steroid-secreting cells. Cholesterol precursors for steroid hormones are stored in lipid droplets. Also SER would be abundant in these cells to provide the enzymes for steroid production.

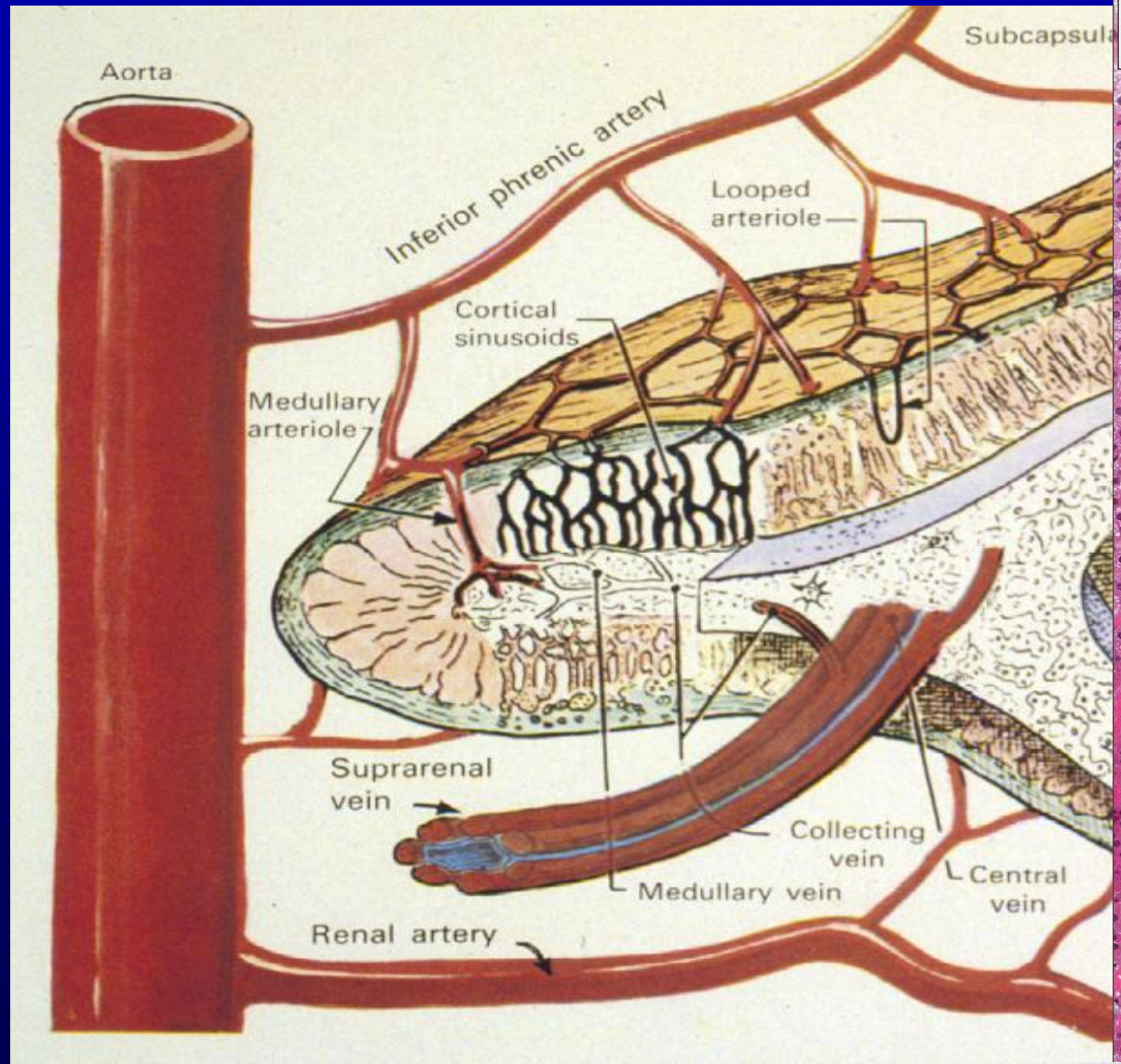
Blood Supply

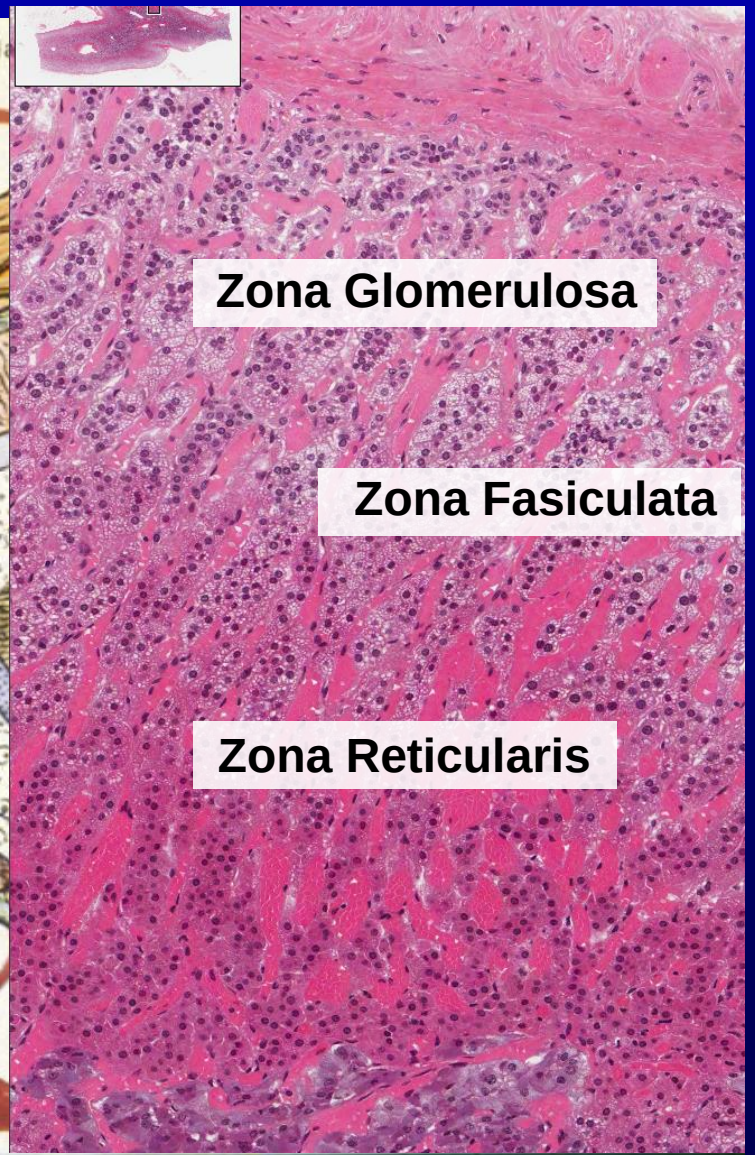
Sinusoids, Medullary Arteries, Adrenal Vein

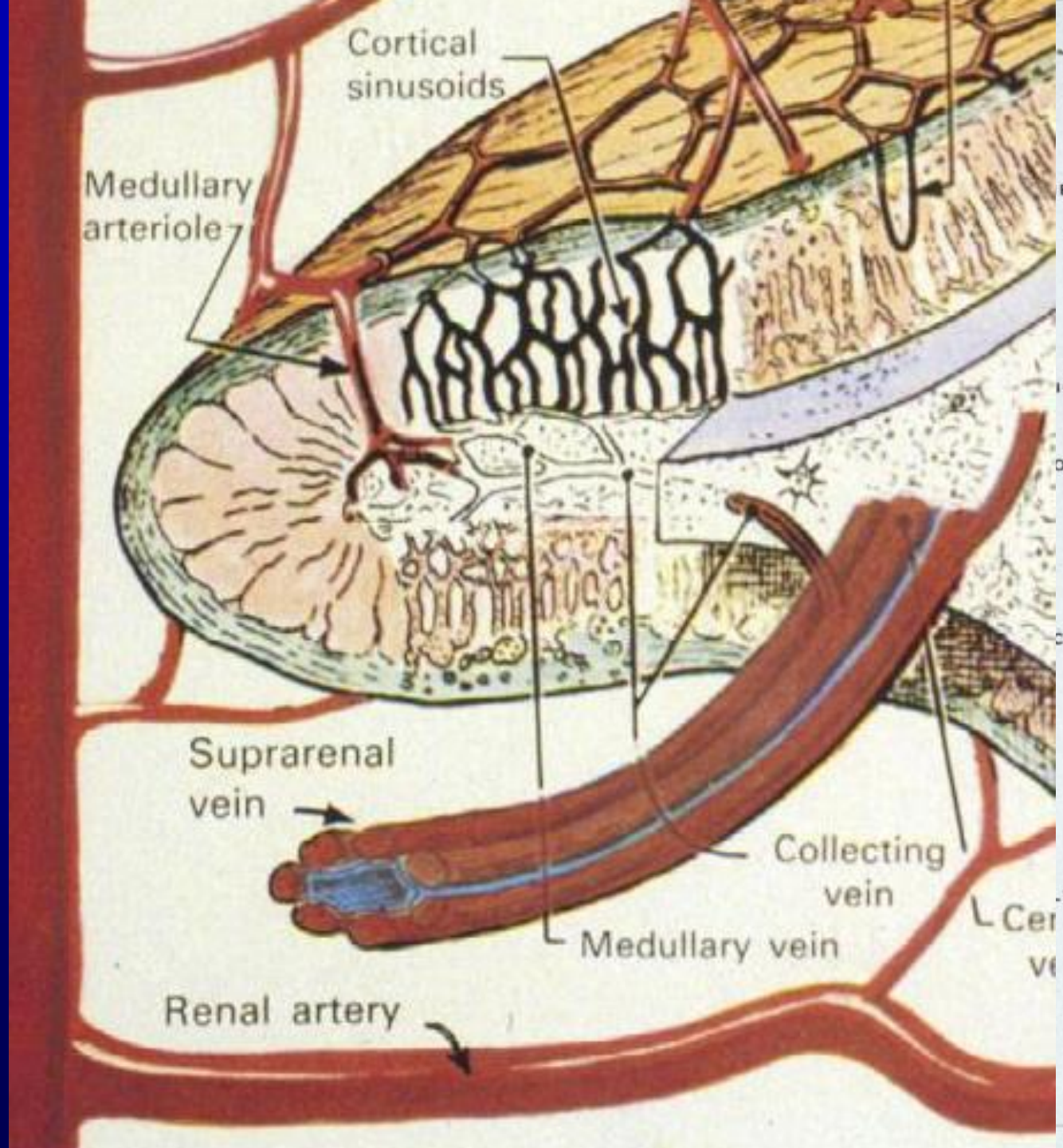


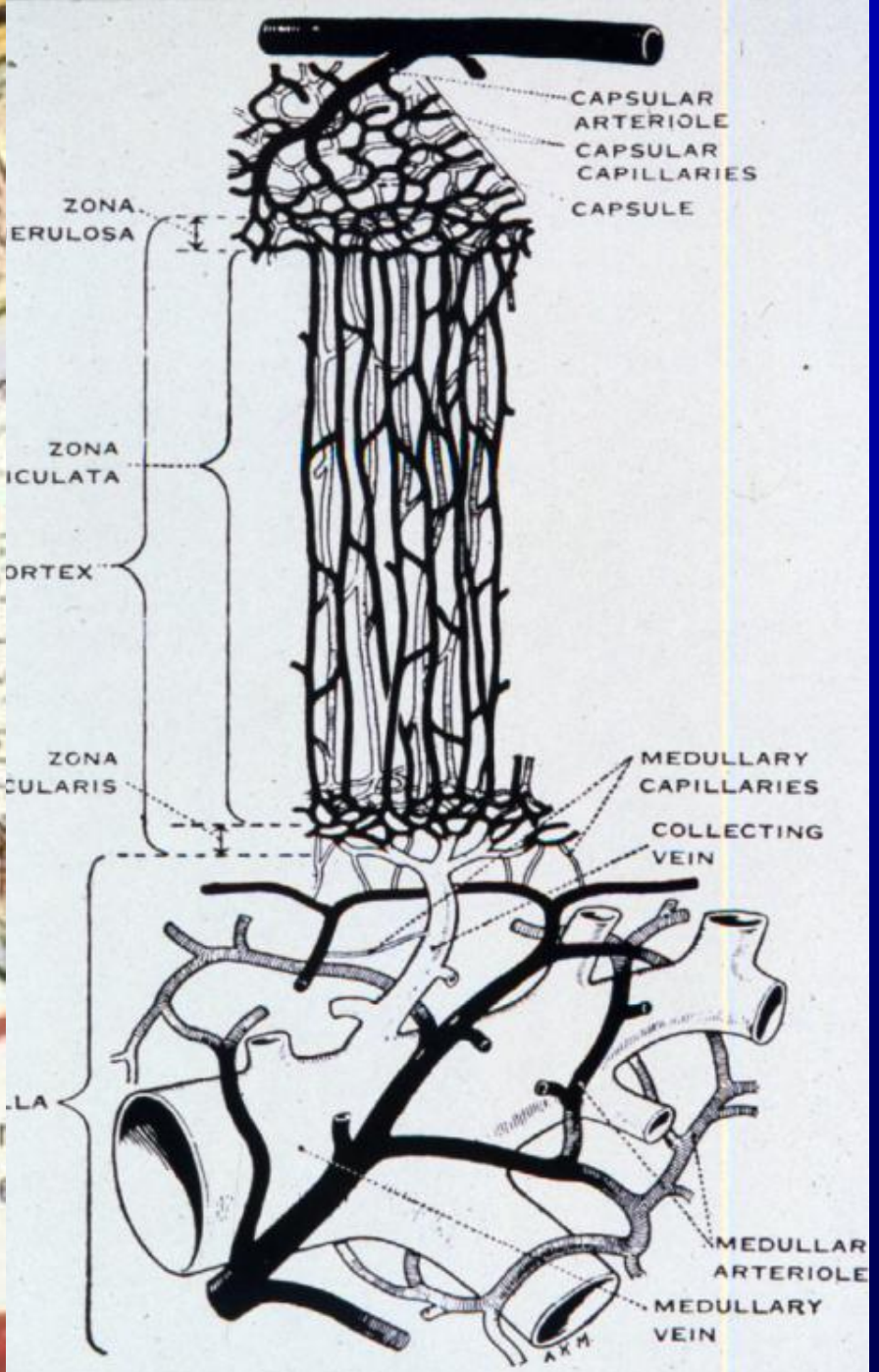
Blood Supply

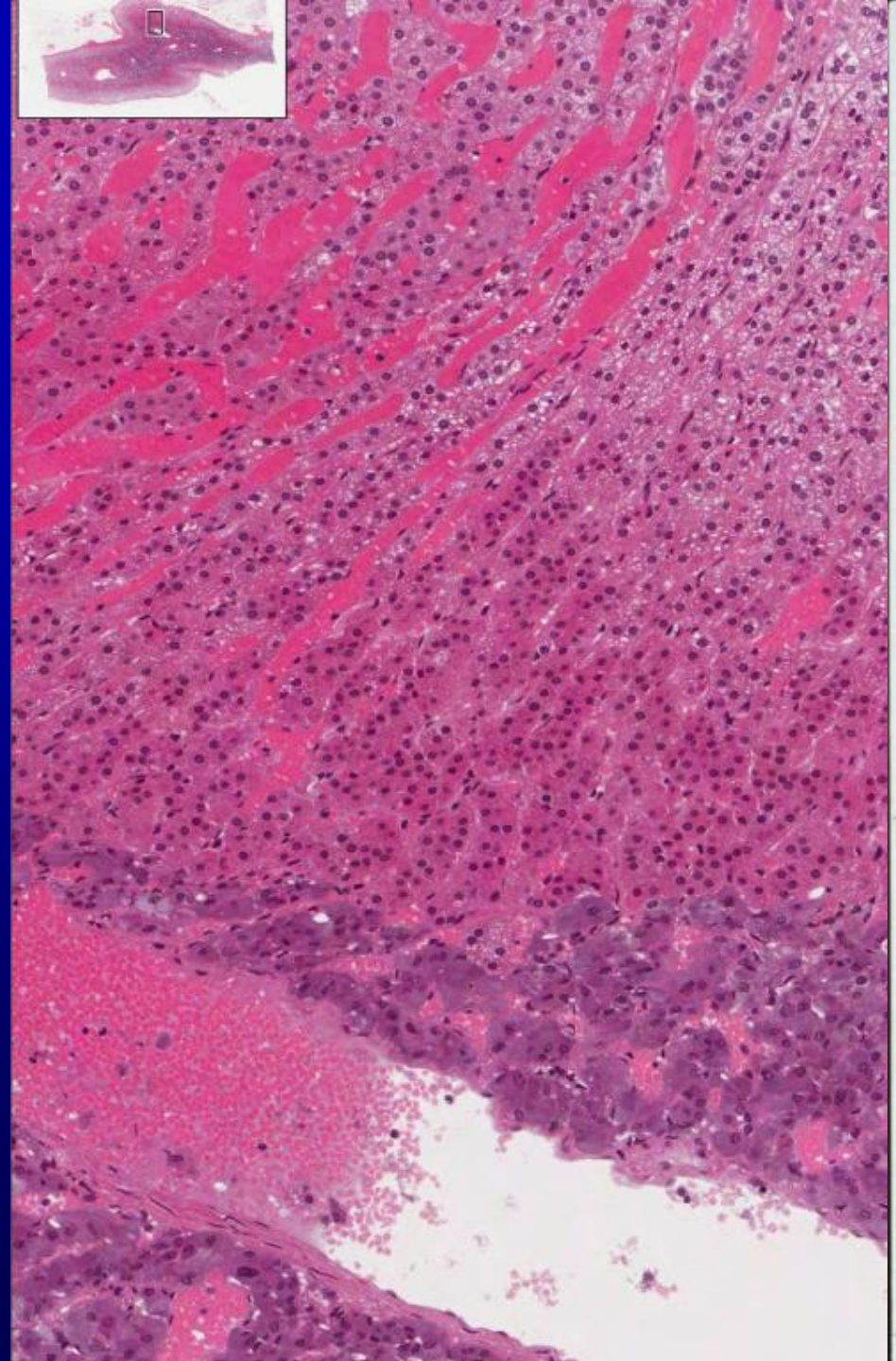
Sinusoids, Medullary Arteries, Adrenal Vein

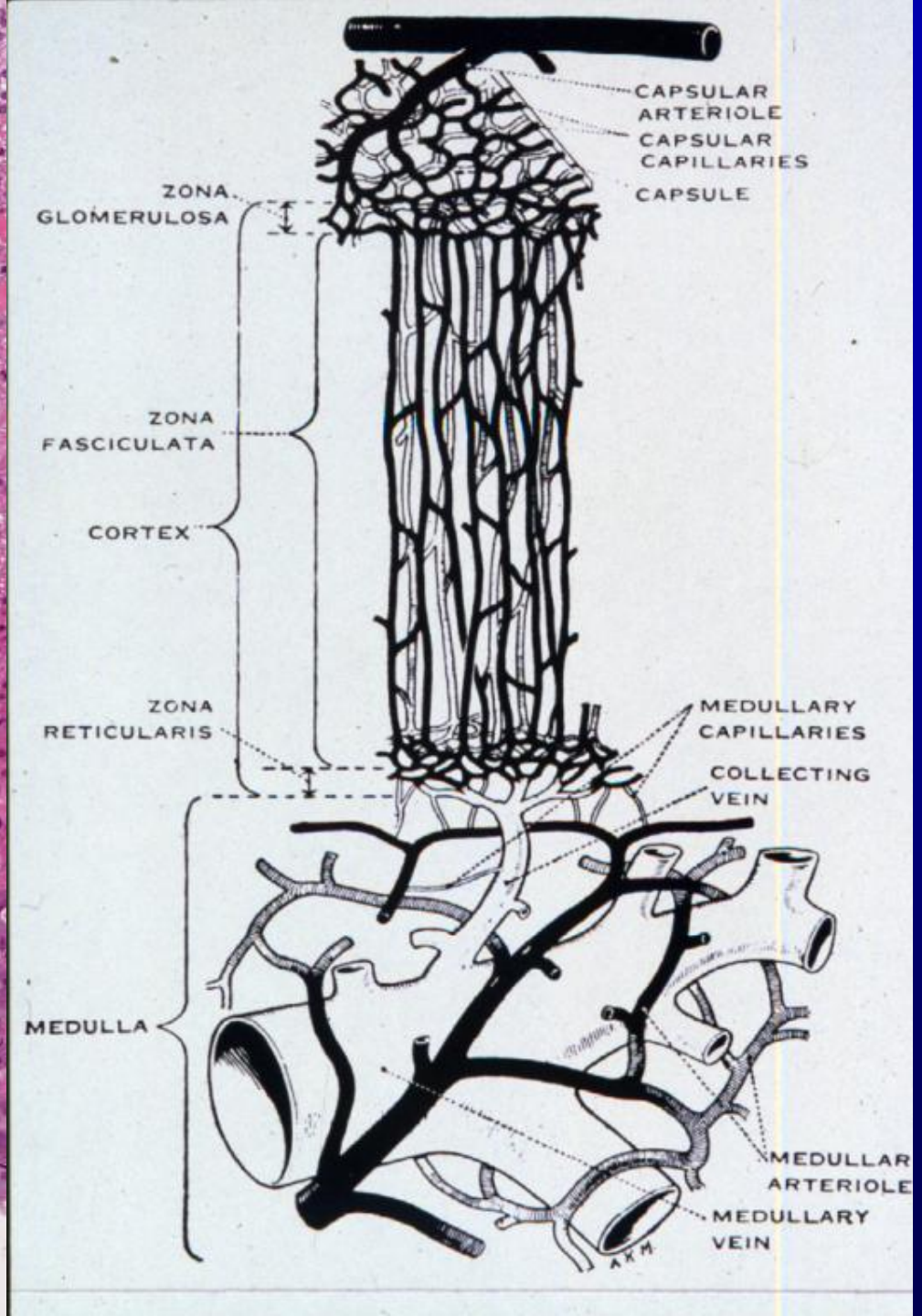





Cortical sinusoids
Medullary arteriole
Suprarenal vein
Collecting vein
Medullary vein
Renal artery


CAPSULAR ARTERIOLE
CAPSULAR CAPILLARIES
CAPSULE
ZONA
ERULOSA
ZONA
ICULATA
ORTEX
ZONA
CULARIS
MEDULLARY CAPILLARIES
COLLECTING VEIN
LA
MEDULLAR ARTERIOLE
MEDULLARY VEIN



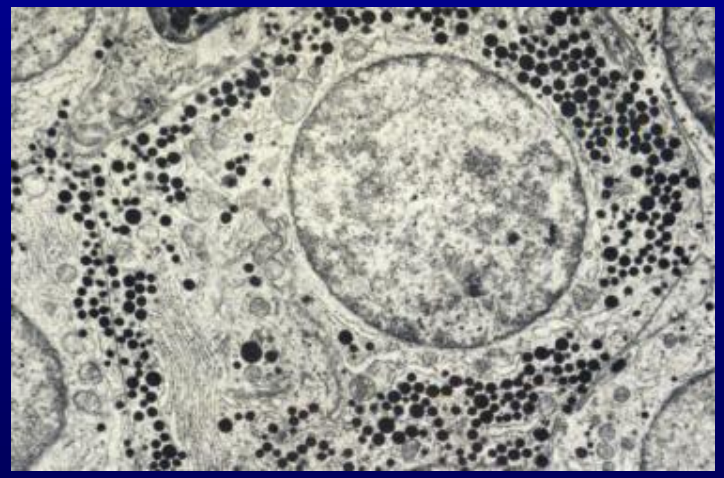

CAPSULAR ARTERIOLE
CAPSULAR CAPILLARIES
CAPSULE
ZONA GLOMERULOSA
ZONA FASCICULATA
CORTEX
ZONA RETICULARIS
MEDULLARY CAPILLARIES
COLLECTING VEIN
MEDULLA
MEDULLAR ARTERIOLE
MEDULLARY VEIN
AHM

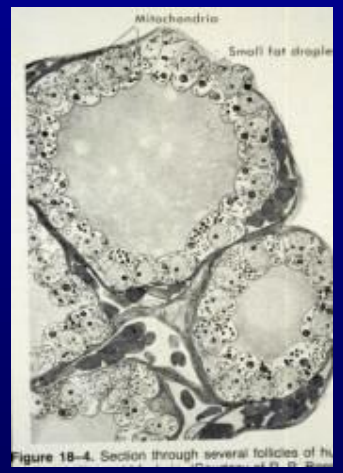
Endocrine Secretions

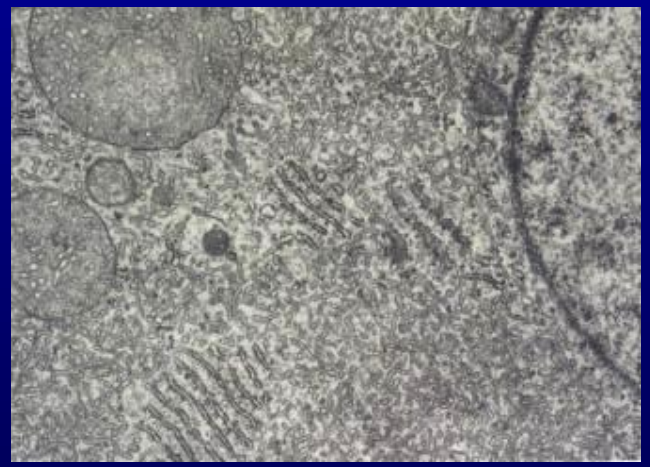
Stored in granules

Stored extracellularly

Immediate release with no storage







Pituitary

Protein in cell

Thyroid

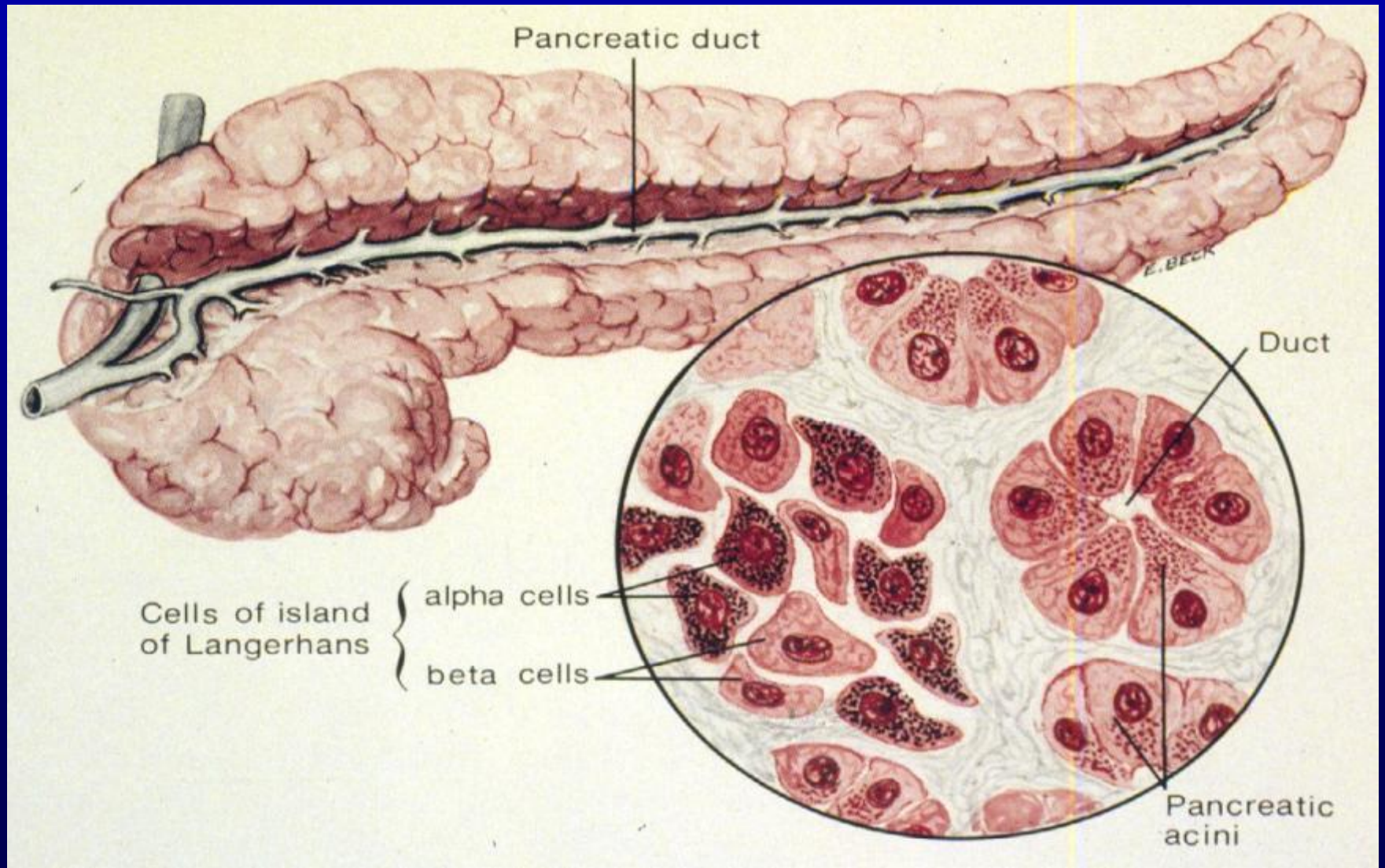
Thyroglobulin outside cell in follicle

Adrenal

Steroids pass through cell

The Endocrine Pancreas

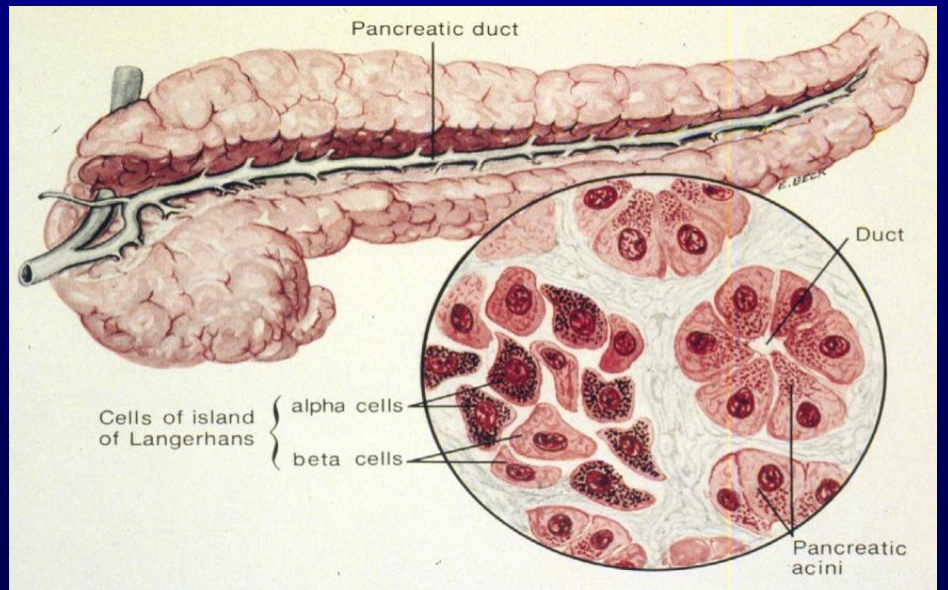
Islets of Langerhans



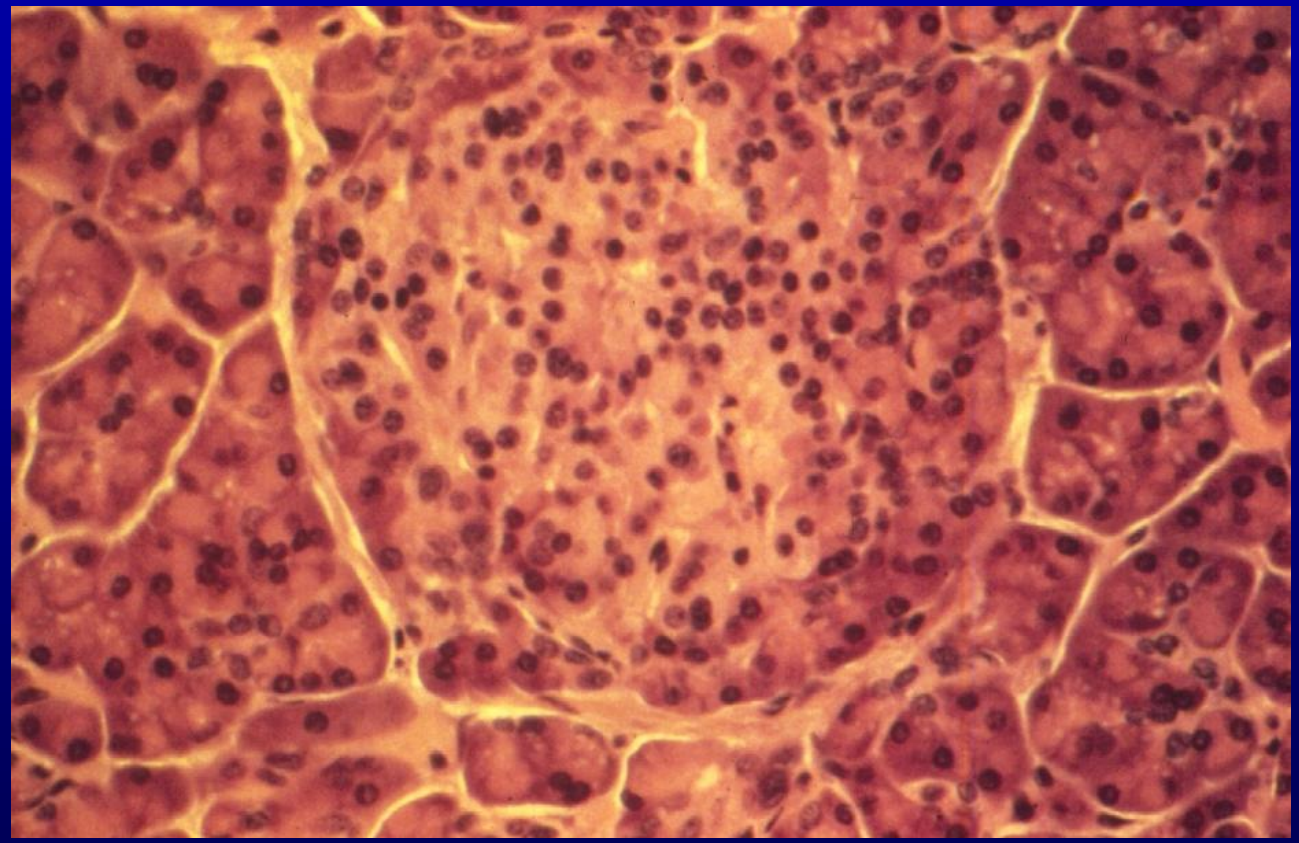
The Endocrine Pancreas

Islets of Langerhans

Beta cells produce **insulin** (regulation of glucose uptake of cells)
Alpha cells produce **glucagon**
Delta cells produce **somatostatin**



Islets of Langerhans



Variations in the Microvasculature

Common:

Arteriole ⇨ Capillary ⇨ Venule

Venous Portal System:

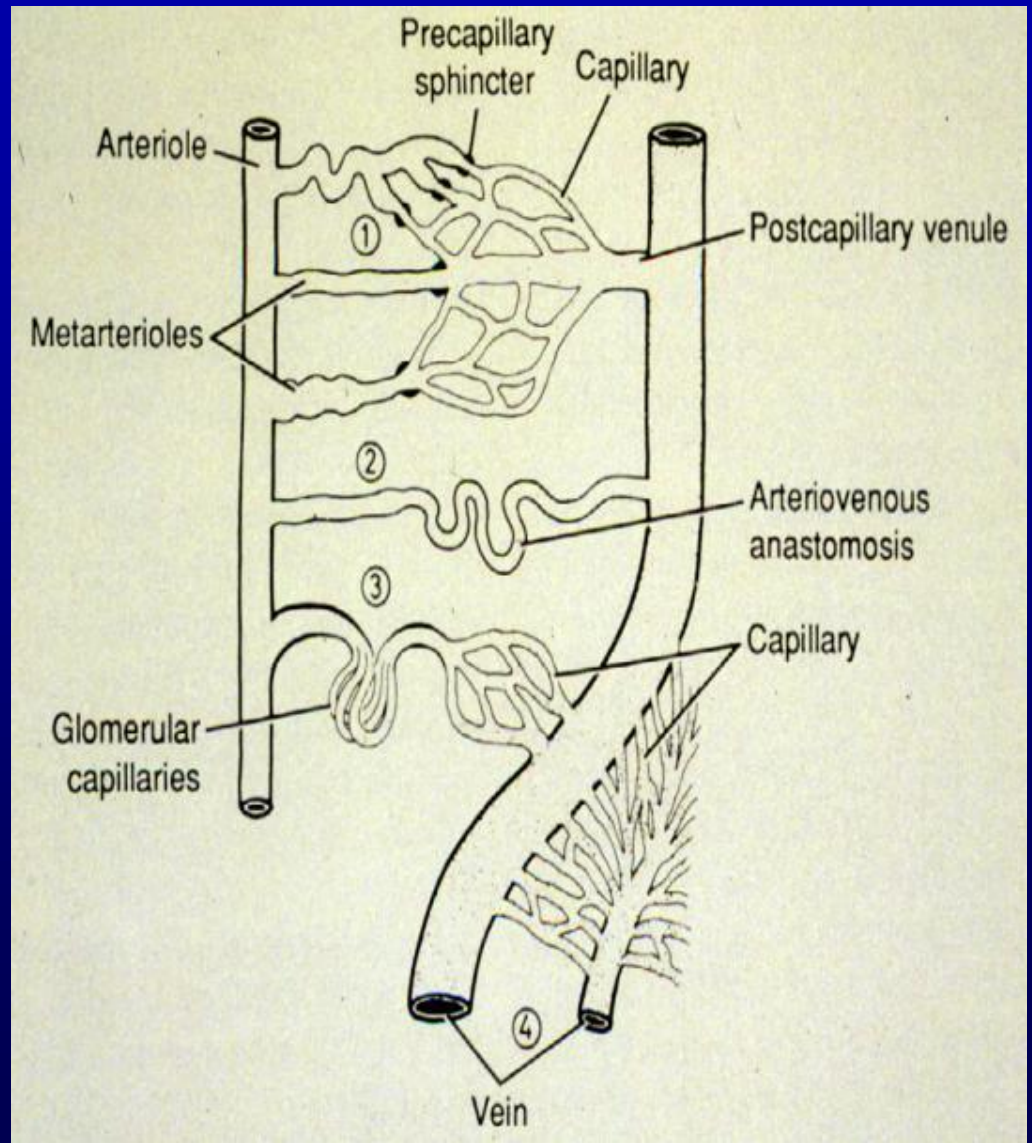
Capillary ⇨ Portal Vein ⇨ Capillary

(Endocrine Example ?)

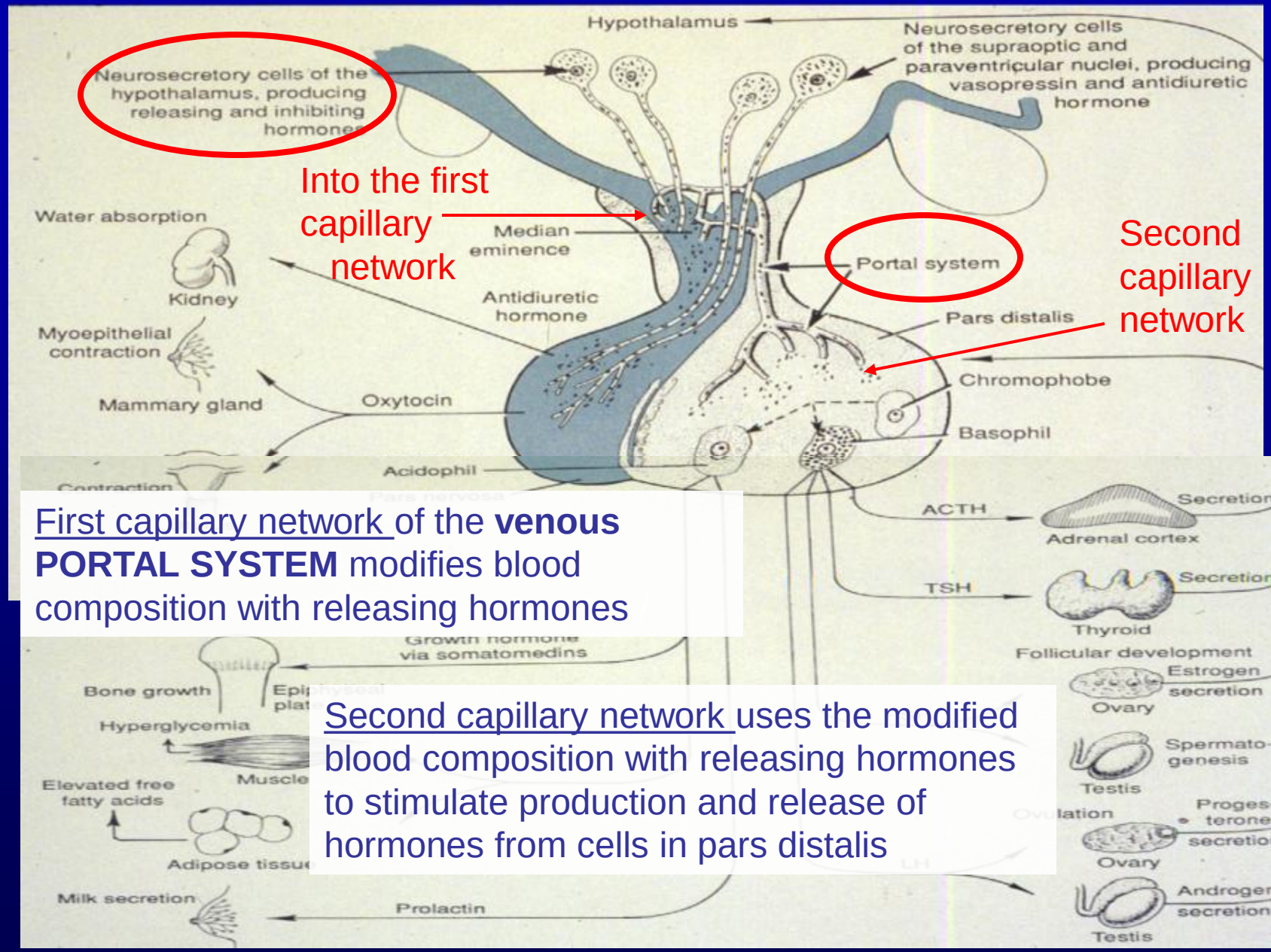
Arterial Portal System:

Capillary ⇨ Portal Arteriole ⇨ Capillary

(Endocrine Example ?)



Venous Portal System

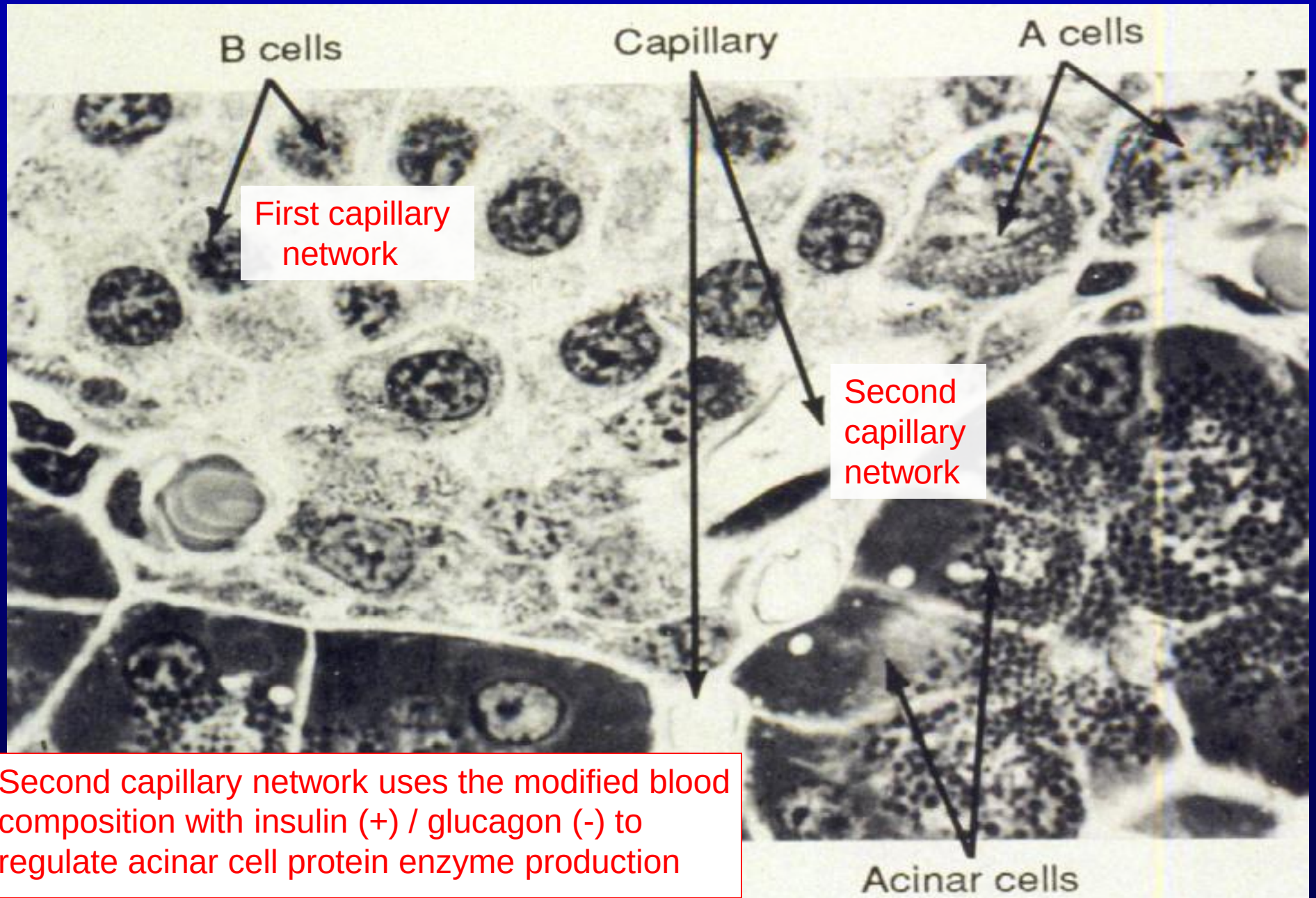


First capillary network of the **venous PORTAL SYSTEM** modifies blood composition with releasing hormones

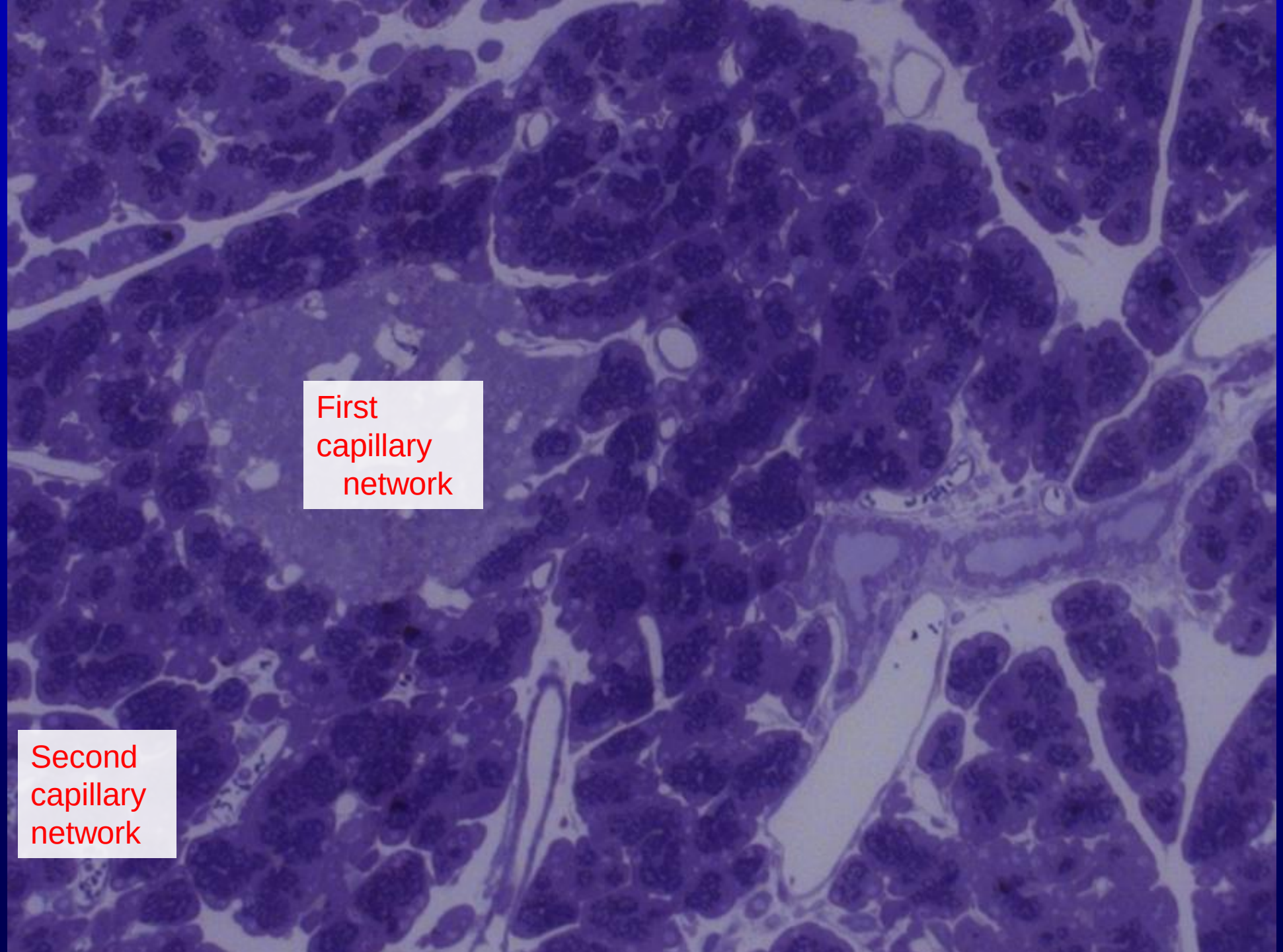
Second capillary network uses the modified blood composition with releasing hormones to stimulate production and release of hormones from cells in pars distalis

ISLETS of Langerhans

First capillary network of the **ARTERIAL PORTAL SYSTEM** modifies blood composition with insulin / glucagon



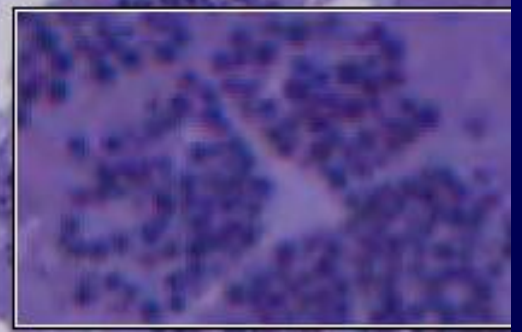
Second capillary network uses the modified blood composition with insulin (+) / glucagon (-) to regulate acinar cell protein enzyme production

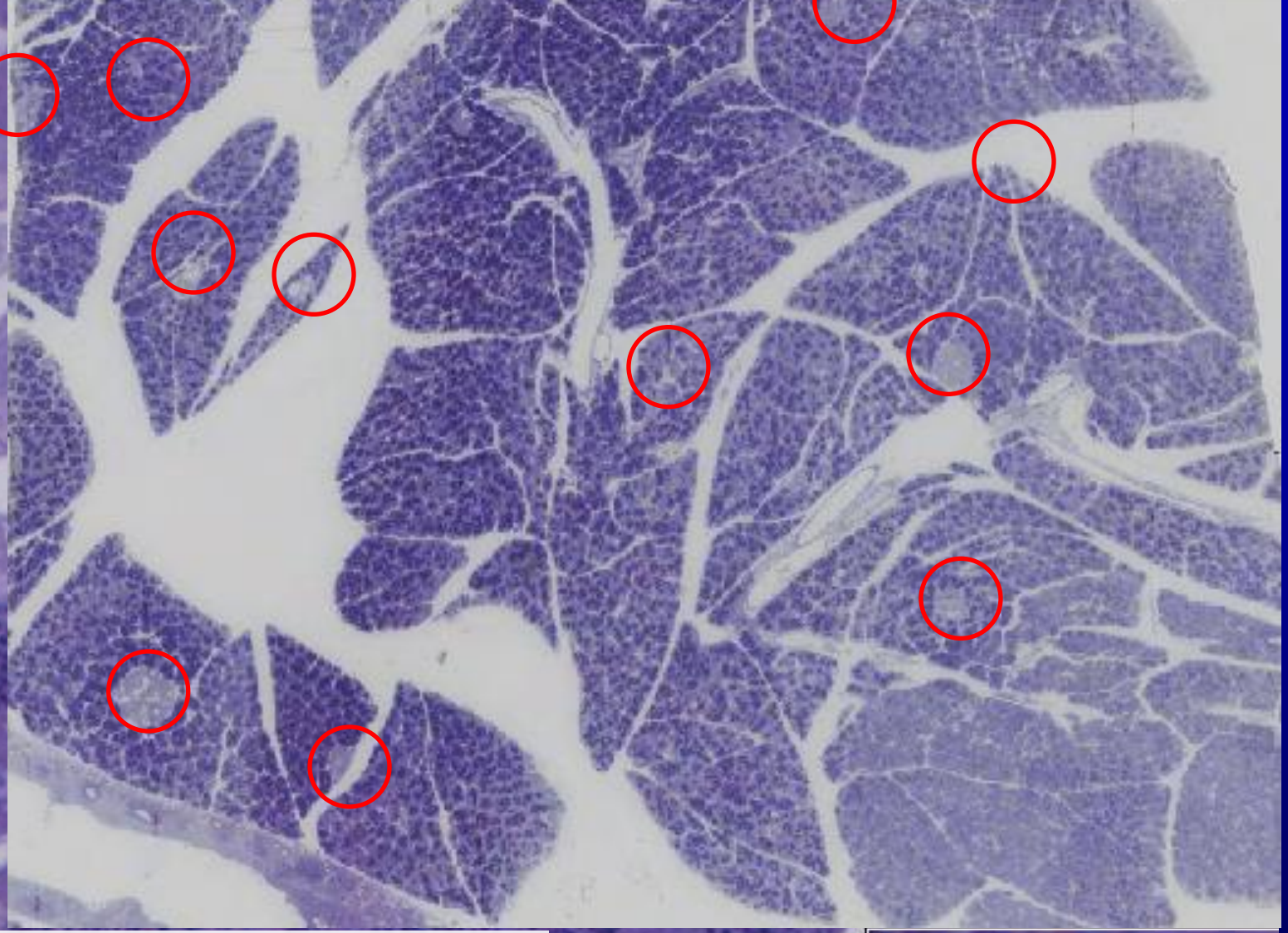

First capillary network
Second capillary network

First capillary network

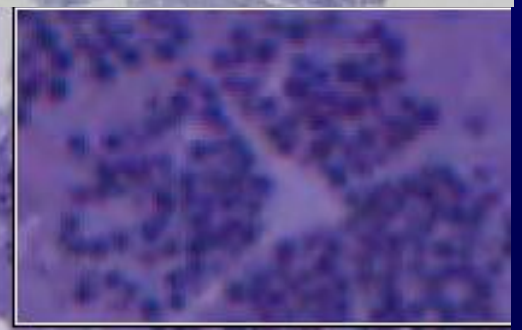
Second capillary network

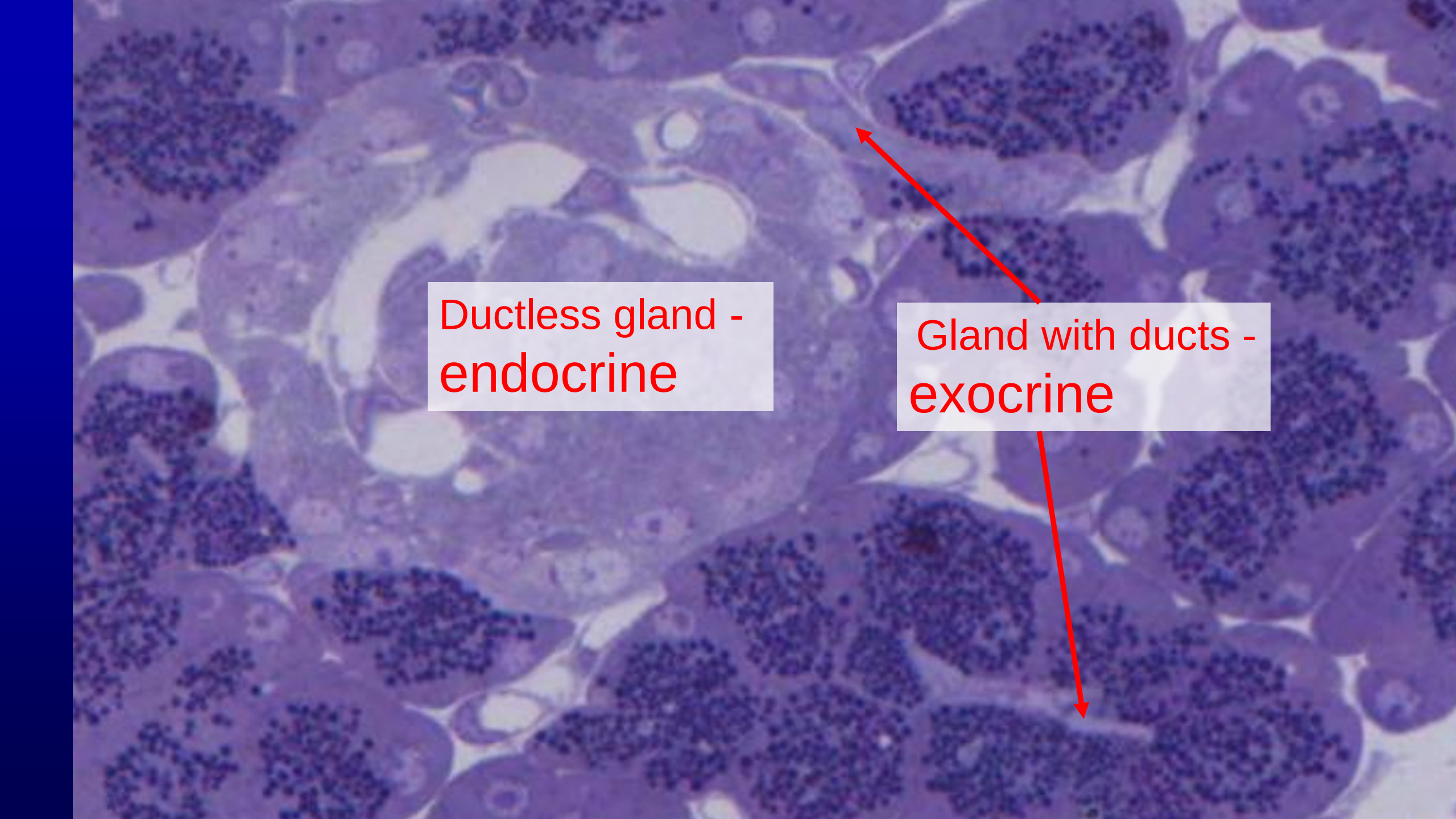
These arterial portal systems (locally connecting the islets with surrounding acinar cells) are the reason why the islets are distributed throughout the pancreas.

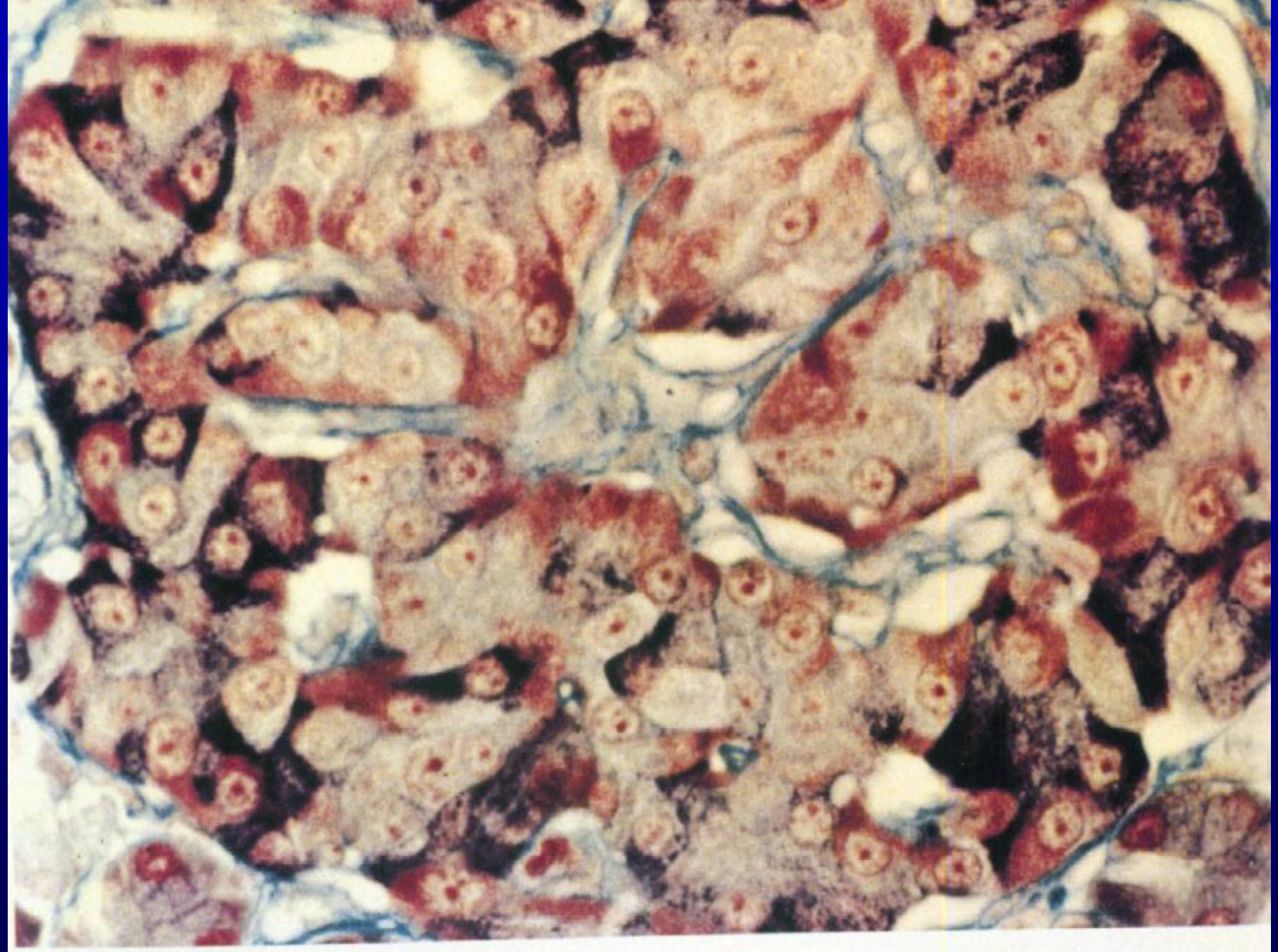




These arterial portal systems (locally connecting the islets with surrounding acinar cells) are the reason why the islets are distributed throughout the pancreas.

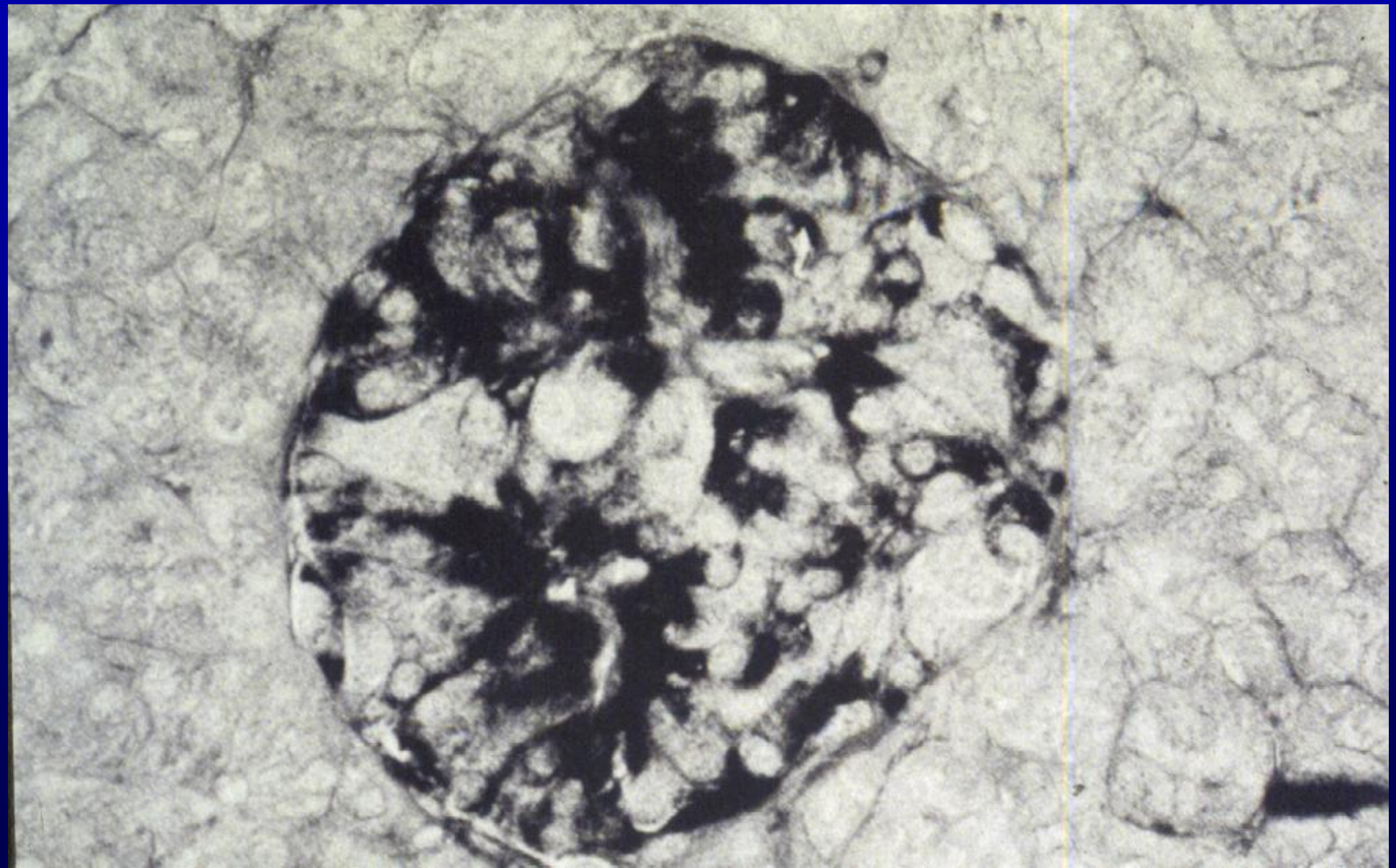



Ductless gland -
endocrine
Gland with ducts -
exocrine



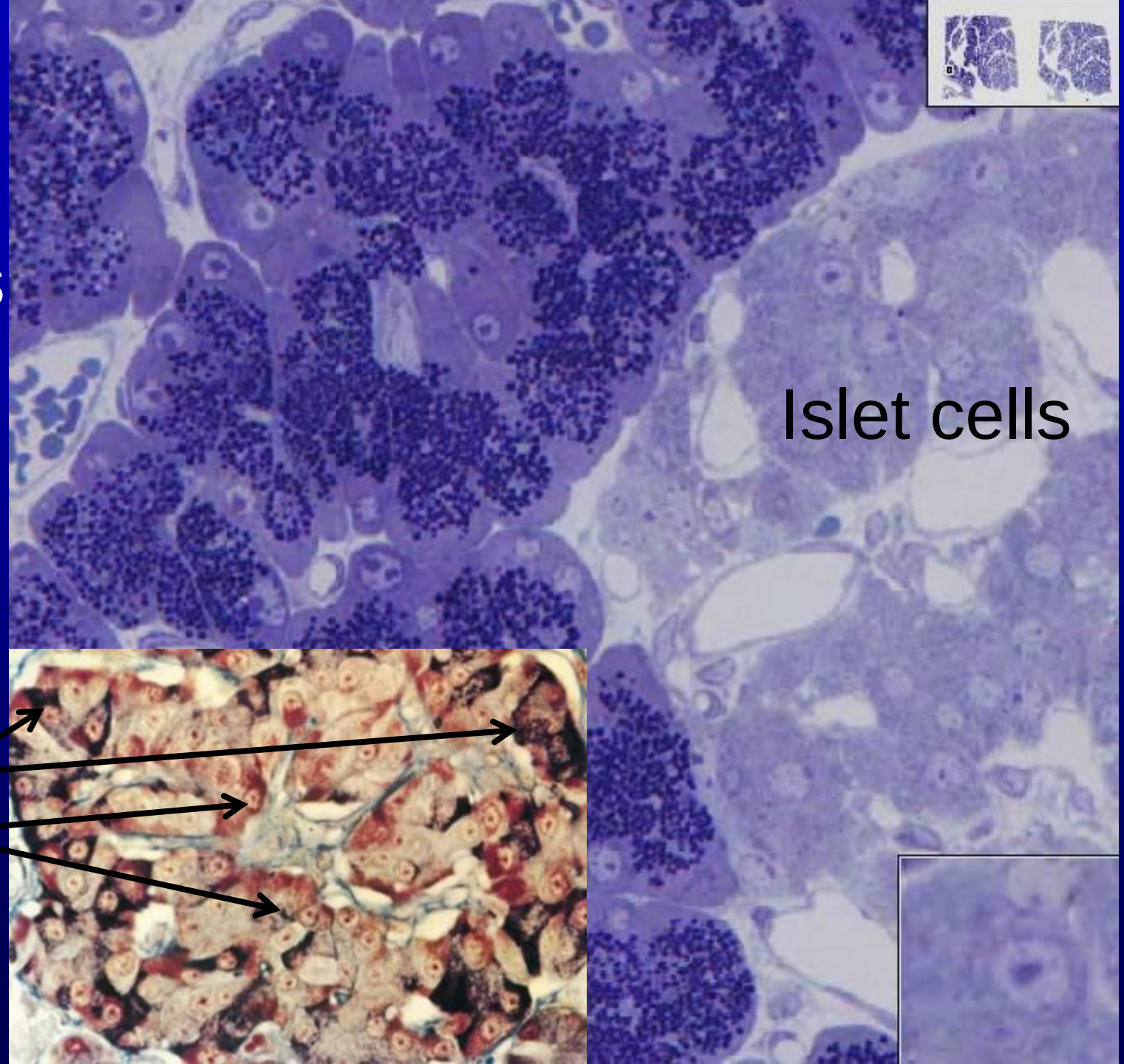
∧ **FIGURE 20-10** A photomicrograph of a human pancreatic islet stained with aldehyde fuchsin and light-green counterstain. T

Islets of Langerhans stained with aldehyde-fuchsin, which selectively stains secretory granules of insulin-secreting Beta cells



34218 Rat pancreas

Alpha cells are generally on the border of islets of Langerhans and Beta cells are located more centrally in the islets.



Alpha cells

Beta cells

Immunocytochemistry with antibodies against hormones of the alpha and beta cells.

Pineal Gland

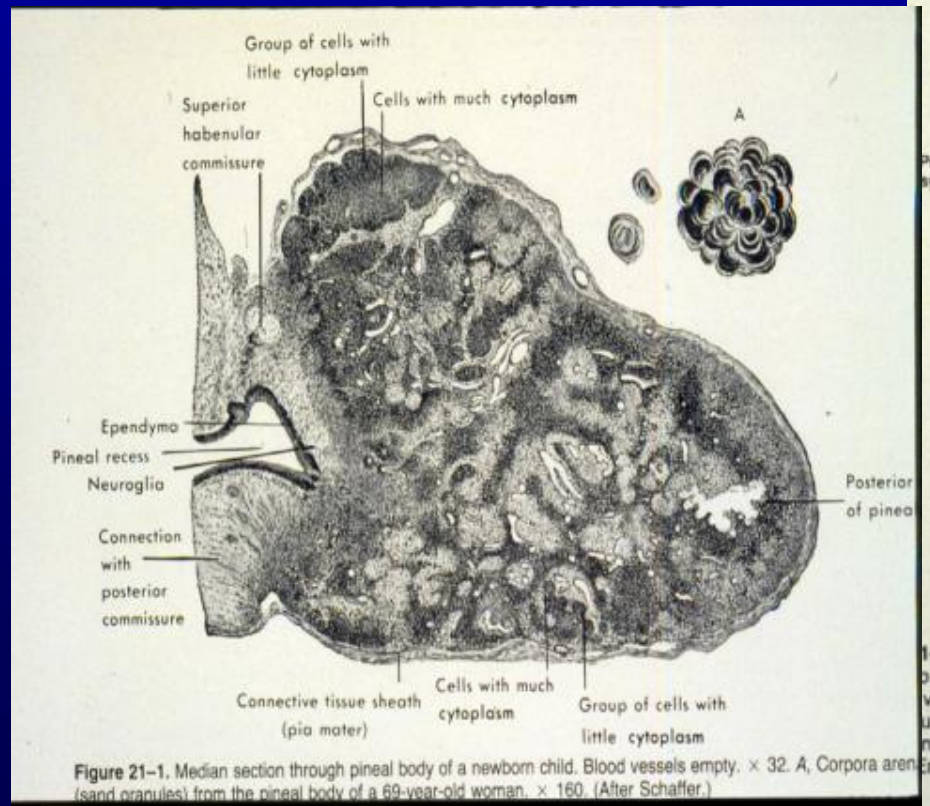
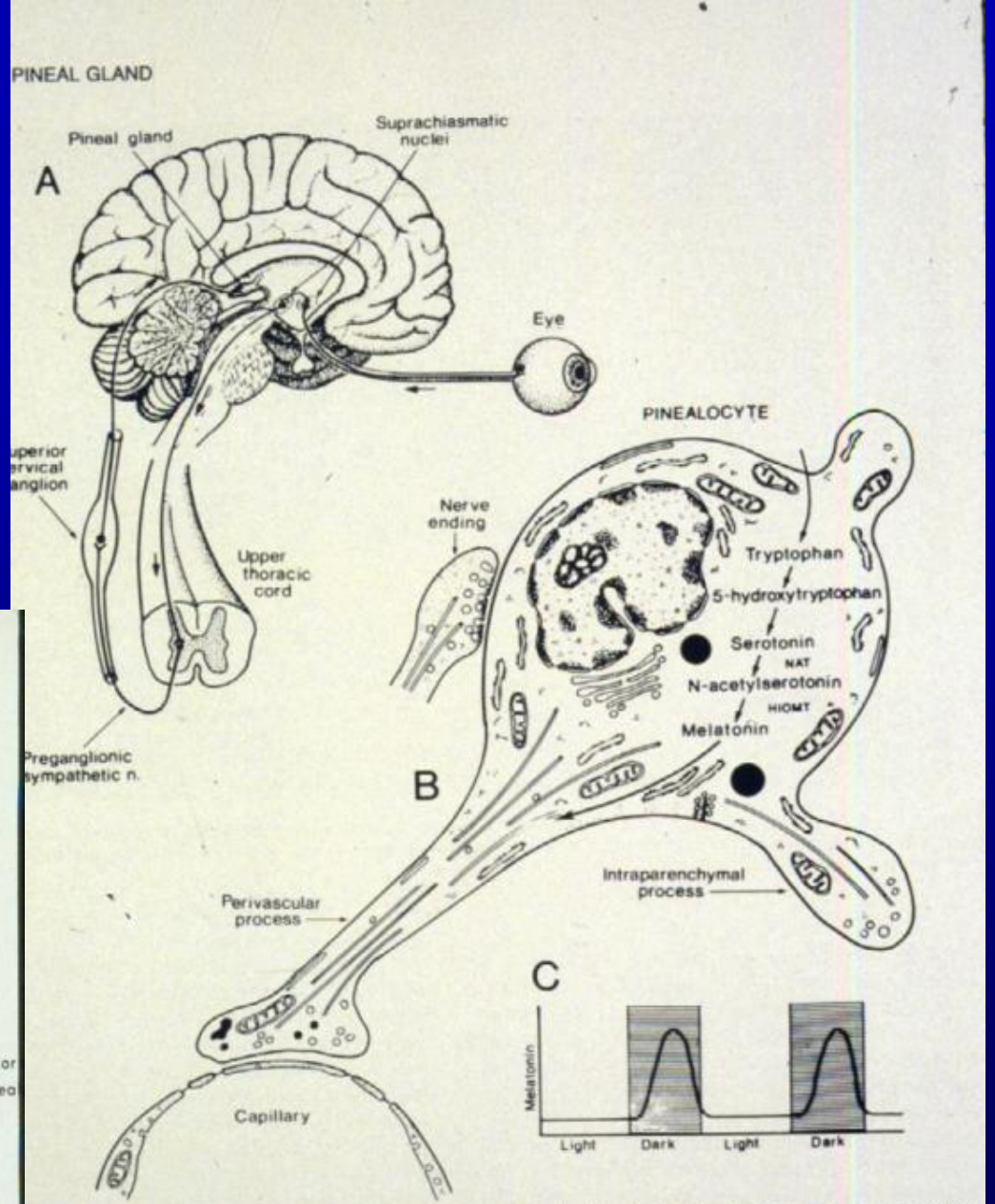


Figure 21–1. Median section through pineal body of a newborn child. Blood vessels empty. × 32. *A*, Corpora arenacea (sand granules) from the pineal body of a 69-year-old woman. × 160. (After Schaffer.)



1–6. (A) Path of information transfer from eyes to pineal: via retinohypothalamic tracts to suprachiasmatic nuclei; intermediolateral column of spinal cord; then via preganglionic sympathetic fibers to superior cervical ganglion; via postganglionic sympathetic fibers to the pineal. (B) On sympathetic stimulation of the pinealocytes, tryptophan up from the blood and converted to melatonin, which is transported to the ends of perivascular processes for nto the blood. (C) Graph of the light–dark cycle of melatonin concentration in the blood. (After R. J. Reiter, Endocrinology, Vol. I pp. 240–253, W. B. Saunders, Philadelphia, 1989.)

Pineal Gland

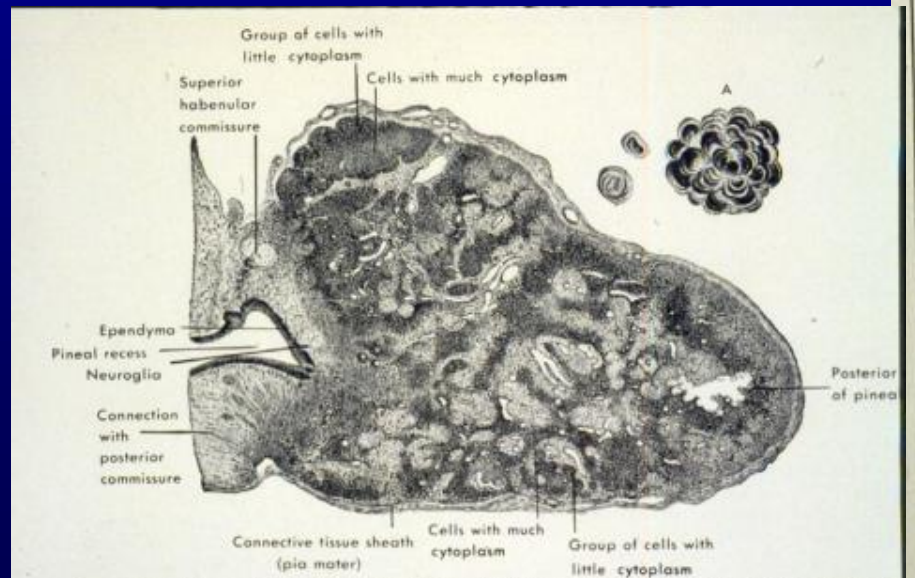
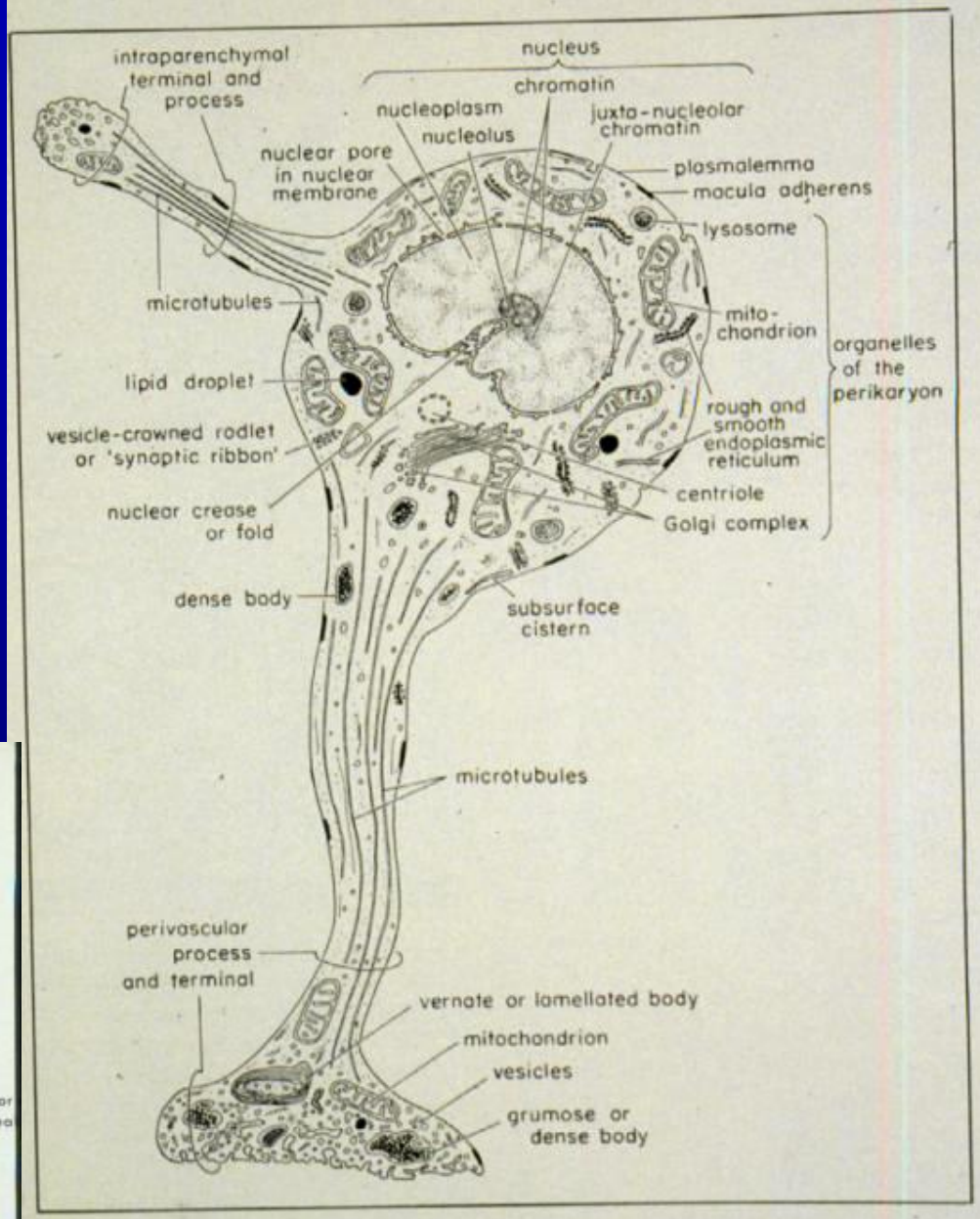


Figure 21–1. Median section through pineal body of a newborn child. Blood vessels empty. × 32. *A*, Corpora arenacea (sand granules) from the pineal body of a 69-year-old woman. × 160. (After Schaffer.)



drial matrix, dense intracristal layers, and dense-core microcylinders 270 to 330 Å wide.

dark phase of the higher primates a ingly, the phase

Pineal Gland

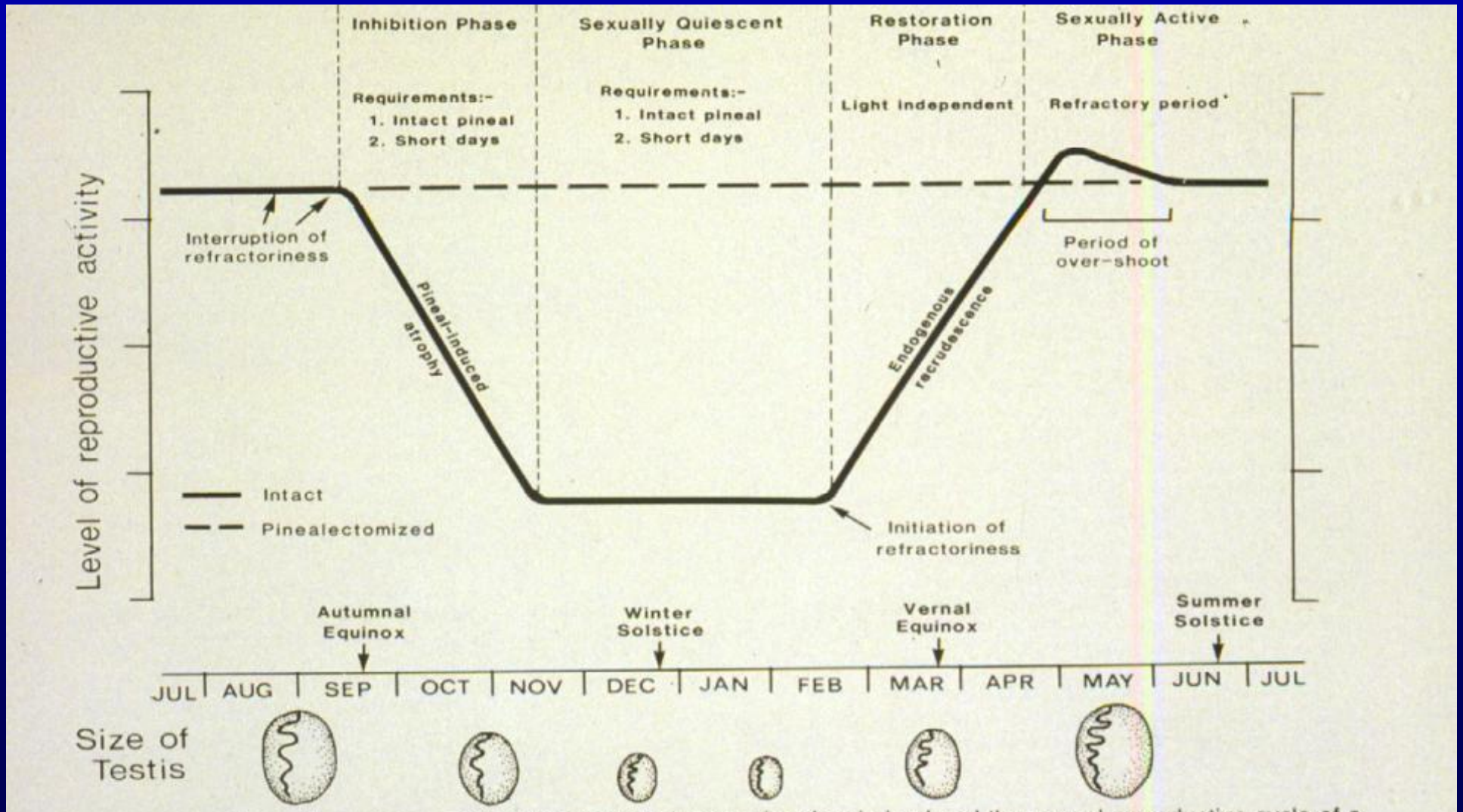


Figure 21–7. Schematic depiction of the relationships between the pineal gland and the annual reproductive cycle of a seasonal breeding species such as the hamster. (From Reiter, R. J. Endocr. Rev. *1*:109, 1980.)

Endocrine System Worksheet

Hormone	Source	Target(s)	Action(s)
GnRH (Gonadotropin-releasing hormone)	Hypothalamus	Adenohypophyisis (anterior pituitary)	Stimulates the release of both follicle-stimulating hormone (FSH) and luteinizing hormone (LH)
TRH (Thyrotropin-releasing hormone)	Hypothalamus	Adenohypophyisis (anterior pituitary)	Stimulates the release of thyrotropin (TSH)
CRH (Corticotropin-releasing hormone)	Hypothalamus	Adenohypophyisis (anterior pituitary)	• Stimulates synthesis of pro-opiomelanocortin (POMC) • Stimulates release of both b-lipotropin (b-LPH) and corticotropin (ACTH)
GH (Growth hormone)	Adenohypophyisis (anterior pituitary; acidophils)	Muscle, adipose tissue, bone (whole body effects)	• Stimulates cellular metabolism, uptake of AA, and protein synthesis. • Stimulates growth in epiphyseal plates of long bones via insulin-like growth factors (IGFs) produced in liver. • Increases growth of skeletal muscle and increases release of FA from adipose cells for energy production by body cells

Endocrine System Worksheet

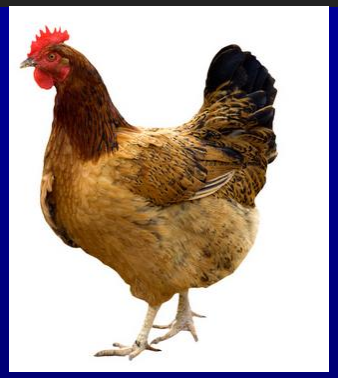
Hormone	Source	Target(s)	Action(s)
PRL (Prolactin)	Adenohypophyisis (anterior pituitary; acidophils)	Mammary glands	Promotes milk secretion
ACTH (Adrenal corticotropin)	Adenohypophyisis (anterior pituitary; basophils)	Adrenal cortex	Stimulates secretion of adrenal cortex hormones
TSH (Thyrotropin)	Adenohypophyisis (anterior pituitary; basophils)	Thyroid	Stimulates thyroid hormone synthesis, storage, and liberation
FSH (Follicle-stimulating hormone)	Adenohypophyisis (anterior pituitary; basophils)	Testis / Ovaries	• Promotes spermatogenesis in men • Promotes ovarian follicle development and estrogen secretion in women
MSH (Melanocyte-stimulating hormone)	Intermediate lobe of pituitary (pars intermedia)	Melanocytes of skin	Promotes production of melanin resulting in darkening of the skin
ADH (Vasopressin/ antidiuretic hormone)	Neurohypophysis (posterior pituitary)	Kidney	Increases water permeability of renal collecting ducts

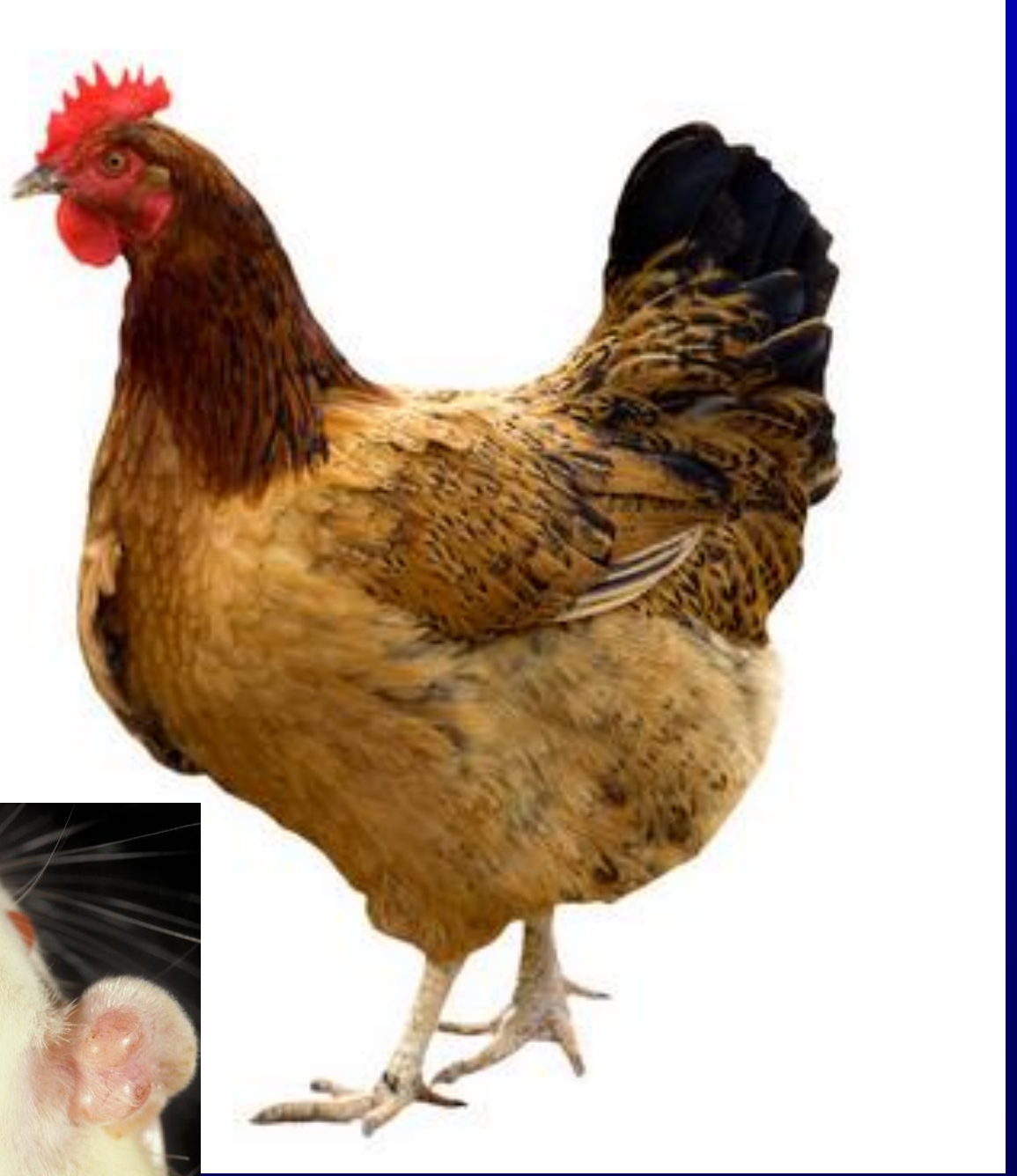
Endocrine System Worksheet

Hormone	Source	Target(s)	Action(s)
Melatonin	Pineal gland	Hypothalamus, pituitary gland, and other endocrine tissues	Maintains circadium rhythm of physological functions and behaviors.
Aldosterone	Adrenal cortex (zona glomerulosa)	Kidney	• Stimulates Na+ reabsorption in the distal convoluted tubules. • Major regulator of salt balance
Cortisol	Adrenal cortex (zona fasciculata)	Liver, immune system, lipids, muscle, cells of body	• Involved in stress response • Increases circulating blood glucose levels by stimulating gluconeogenesis in many cells and glycogen synthesis in the liver • Induces fat mobilization and muscle proteolysis • Suppresses many immune functions
Catecholamines (Norepinephrine. Epinephrine)	Adrenal medulla	Nervous system and circulatory system	• Released during intense emotional reactions (such as fright) • 80% catecholamines released from adrenal is epinephrine • Increased blood pressure • Vasoconstriction • Changes in heart rate • Elevated blood glucose levels
Thyroglobulin	Thyroid	Cells of body	• Precursor for active thyroid hormones (T_4 and T_3) • Controls basal metabolic rate in cells throughout the body

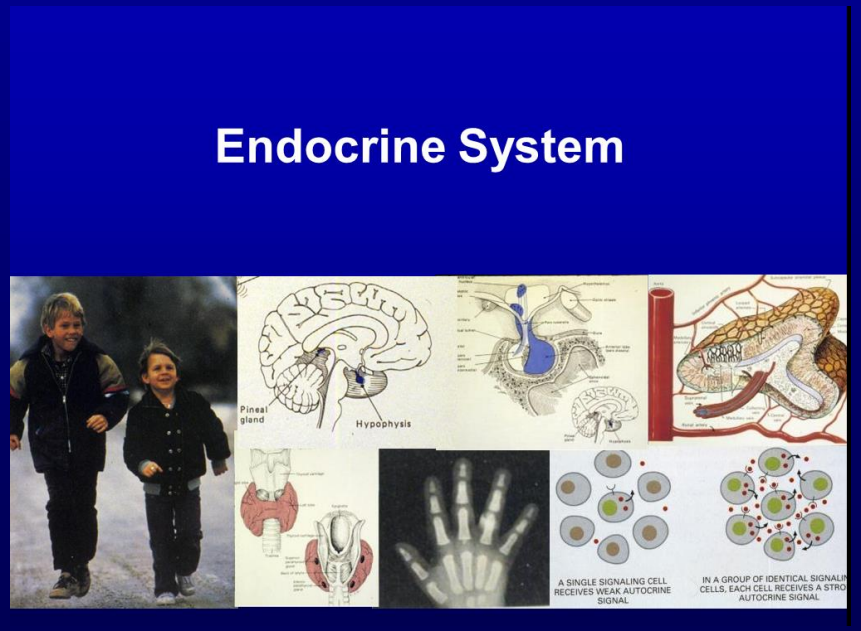
Endocrine System Worksheet

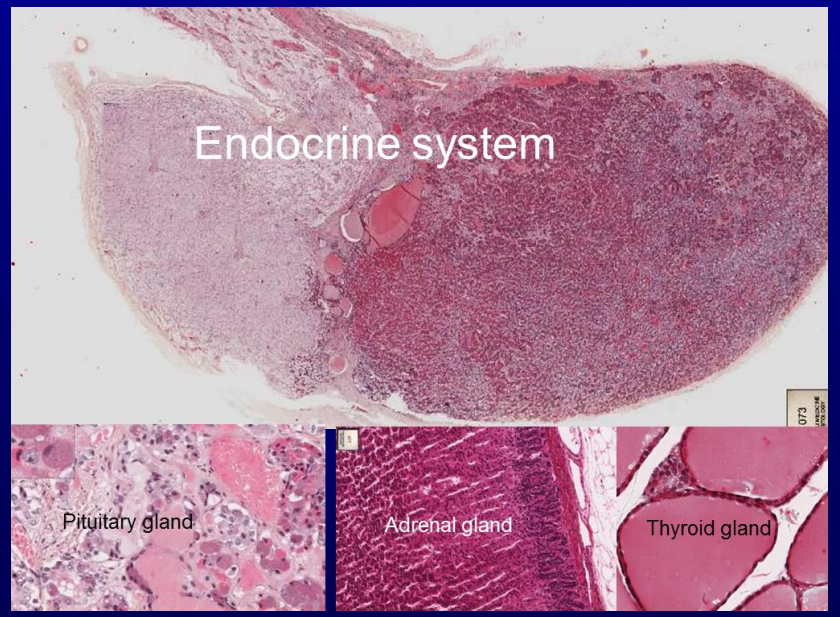
Hormone	Source	Target(s)	Action(s)
Calcitonin	Thyroid (Parafollicular cells)	Osteoclasts in bone	• Triggered by elevated blood Ca2+ • Inhibits osteoclast activity
PTH (Parathyroid hormone)	Parathyroid	• Osteoblasts • Distal convoluted tubules of renal cortex • Small intestine	• Stimulates osteoblasts to produce osteoclast-stimulating factor that increases the number and activity of osteoclasts • Stimulates Ca2+ reabsorption in the distal convoluted tubules of renal cortex • Increases Ca2+ absorption in the small intestine by stimulating vitamin D activation
Glucagon	Pancreatic islets (alpha cells)	Liver, muscle, and adipose cells	• Elevates blood glucose levels • Accelerates conversion of glycogen, AA, and FA in the liver cells into glucose, which is then released into bloodstream
Insulin	Pancreatic islets (beta cells)	Liver, muscle, and adipose cells	• Lowers blood glucose levels • Accelerates membrane transport of glucose into liver cells, muscle cells, and adipose cells • Accelerates conversion of glucose into glycogen in liver cells





This time
continue with research application of the endocrine system





La transplantation hétérotopique: un modèle d'étude de la régulation de la spermatogénèse. Existe-t-il des arguments histomorphologiques en faveur d'un déclin de la spermatogénèse chez l'homme?

Heterotopic transplantation as a model to study the regulation of spermatogenesis: some histomorphologic considerations about the decline in spermatogenic potential in the human?

History of Testicular Transplantation

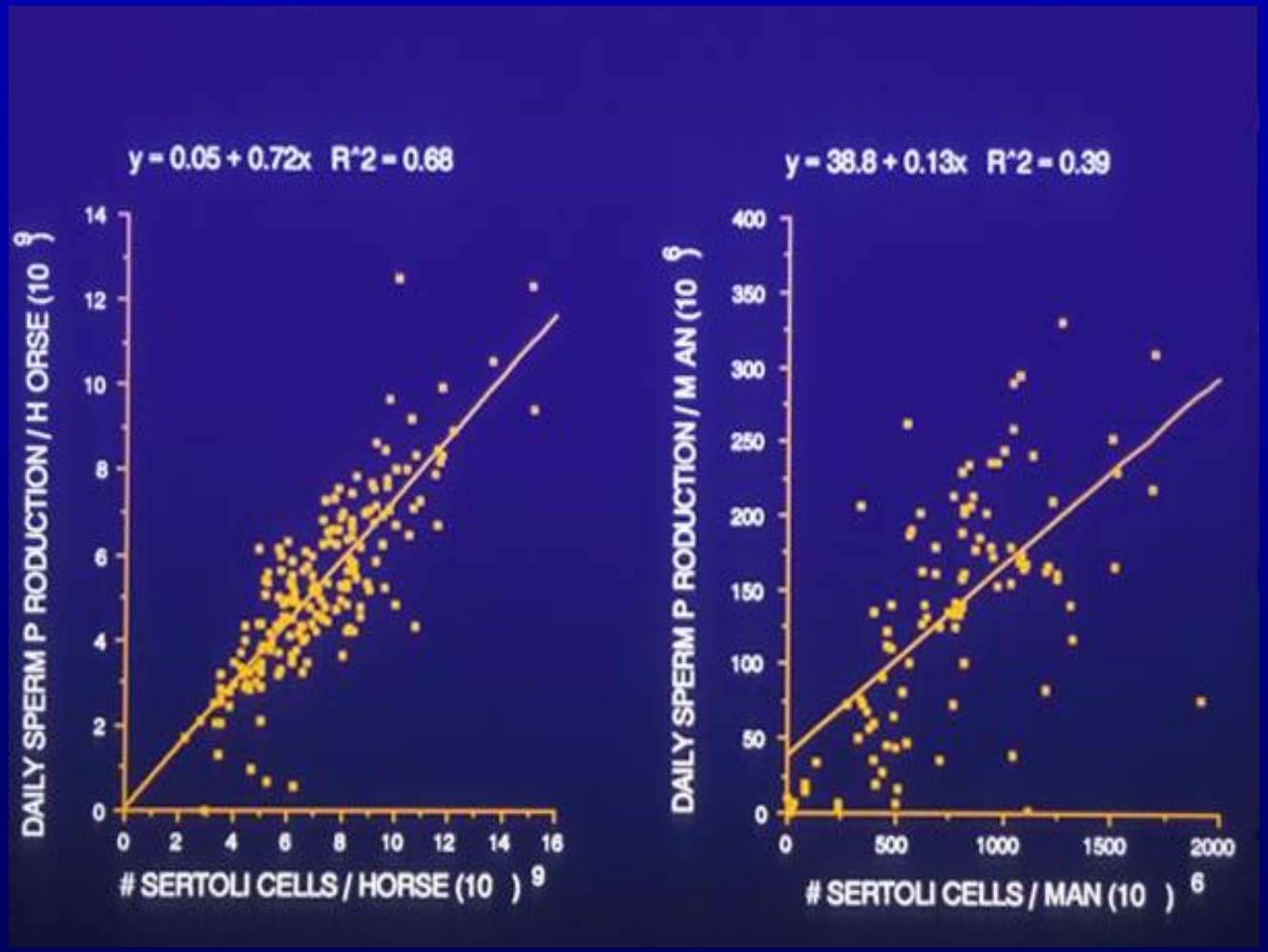
John Hunter - First to describe testicular transplantation.

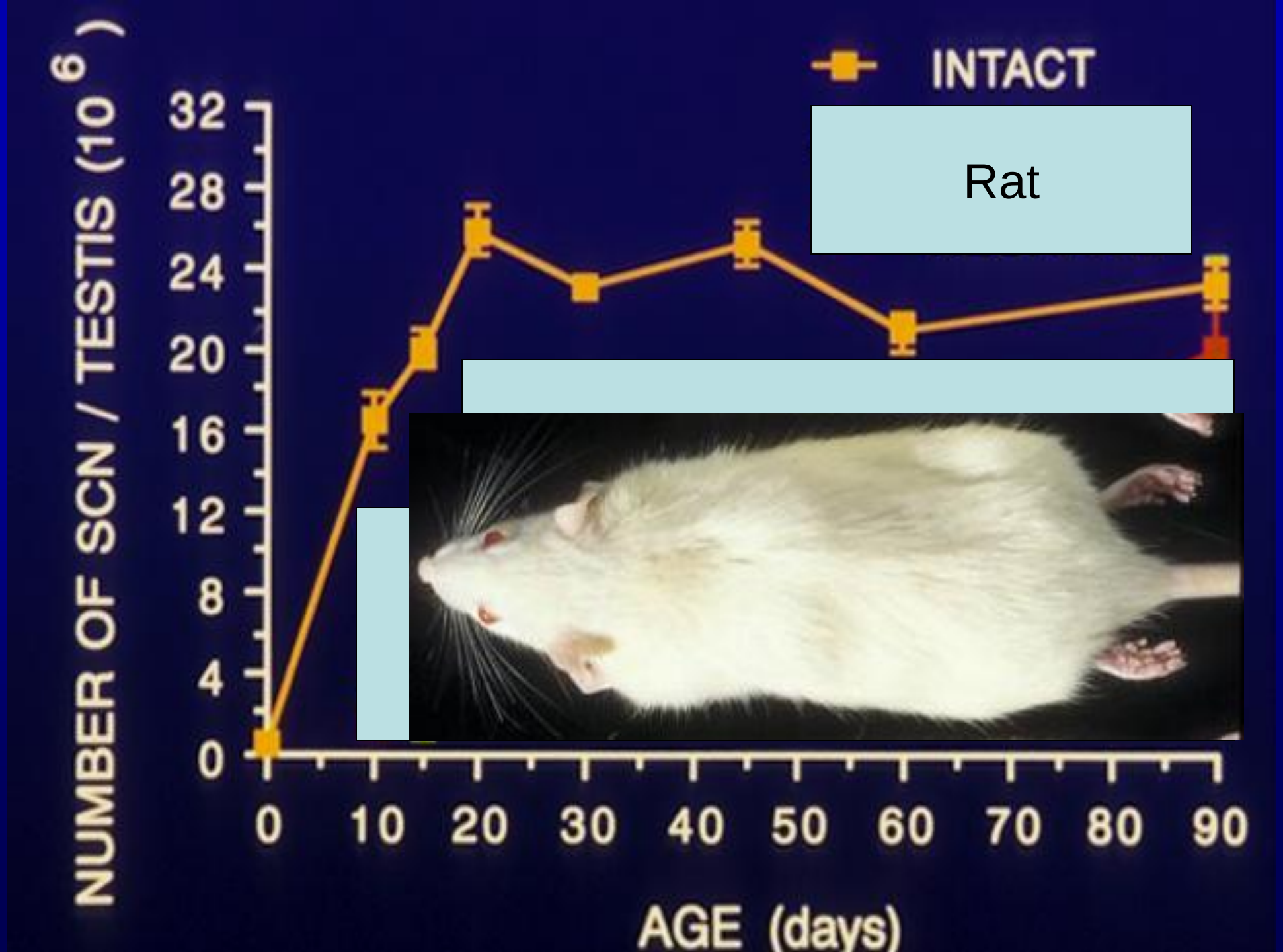
Berthold, 1849 - Formal description of transplantation of testis into abdominal cavity of castrated rooster - maintained secondary sex characteristics.

Voronoff and Alexandrescu, 1905 - Transplanted fragments of monkey testes into the internal surface of tunica vaginalis of humans - abundant vascular network and temperature regulation.
- By 1923, 44 patients including six doctors were recipients.

Transplantation of Testes Continued

Knauer	Rabbit
Shattuck and Seligman, 1904	Fowl
Ugarov, 1938	Rat
Attaran, et al., 1966	Dog
Guthrie, 1910	Vascular reunion
Hammond and Sutton, 1912	Human testis transplanted via vascular reunion
Lydston, 1919	Several humans, some donors deceased from San Quentin Prison
Lee et al., 1971	Allografts vs isografts
Turner, 1938	Rat testes placed in anterior chamber of eye, into muscle, under the skin of thoracic region or scrotum
Chan et al., 1969	Rat testes in tips of outer ear
Goldstein et al., 1983	Microsurgical transplantation of rat testes into isogenic rat hosts.
Jiang and Short, 1995	Rat primordial cells/gonocytes into rat - no donor off-

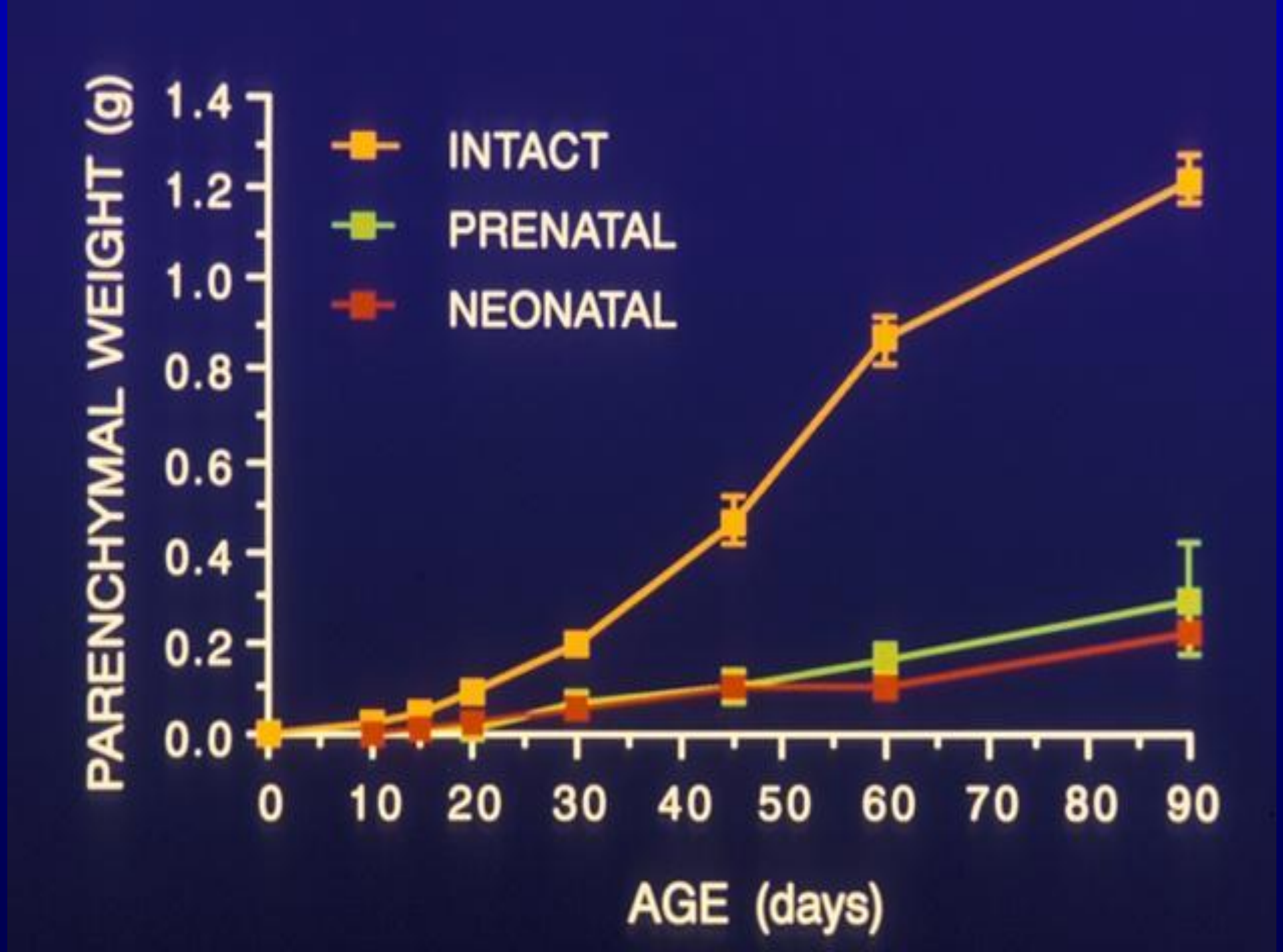

y = 0.05 + 0.72x R^2 = 0.68
DAILY SPERM P RODUCTION / H ORSE (10 9)
SERTOLI CELLS / HORSE (10 9)
0
2
4
6
8
10
12
14
16
y = 38.8 + 0.13x R^2 = 0.39
DAILY SPERM P RODUCTION / M AN (10 6)
SERTOLI CELLS / MAN (10 6)
0
50
100
150
200
250
300
350
400
500
1000
1500
2000

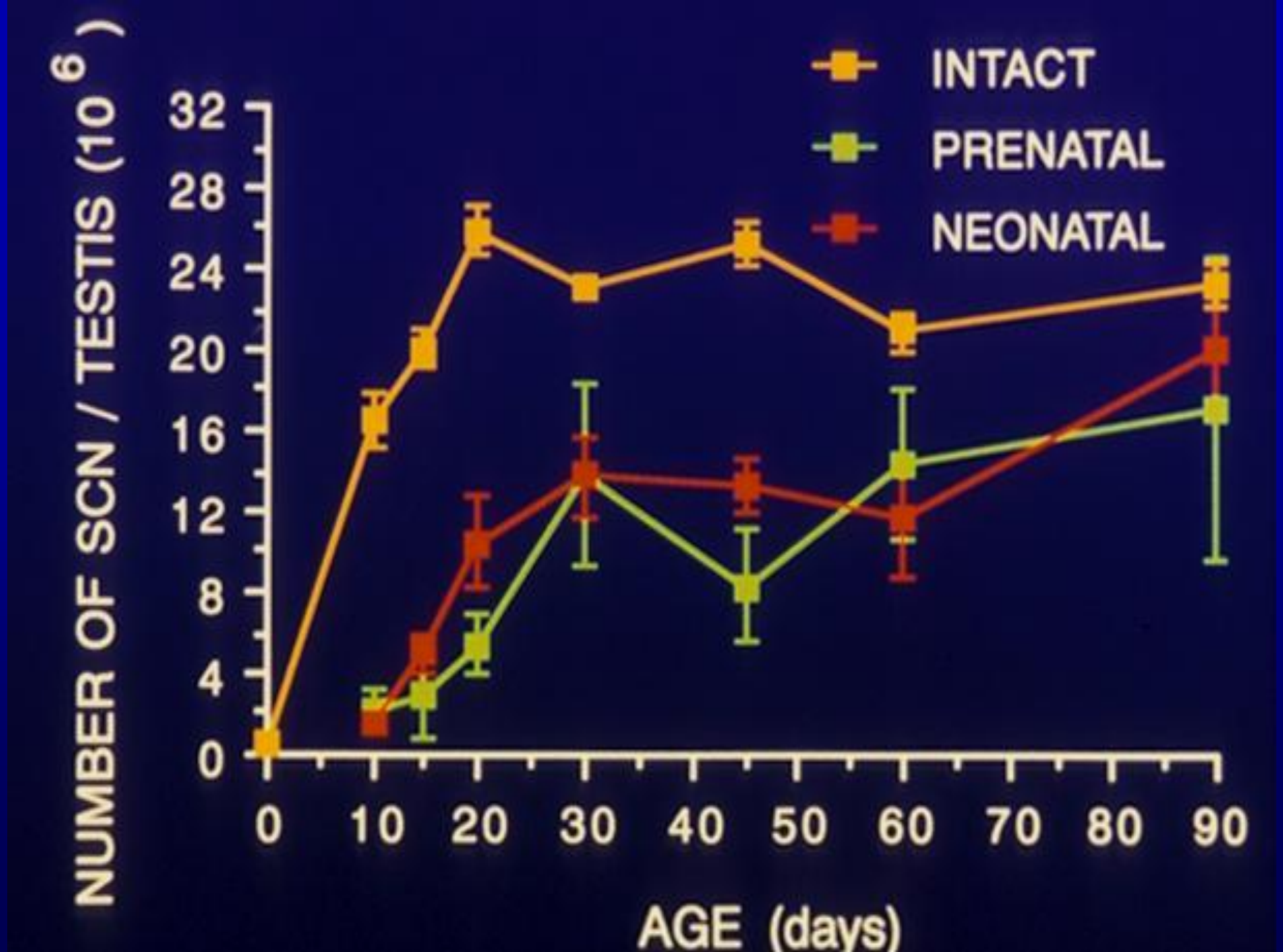

INTACT
Rat
NUMBER OF SCN / TESTIS (10 6)
32
28
24
20
16
12
8
4
0
0 10 20 30 40 50 60 70 80 90
AGE (days)

MODEL

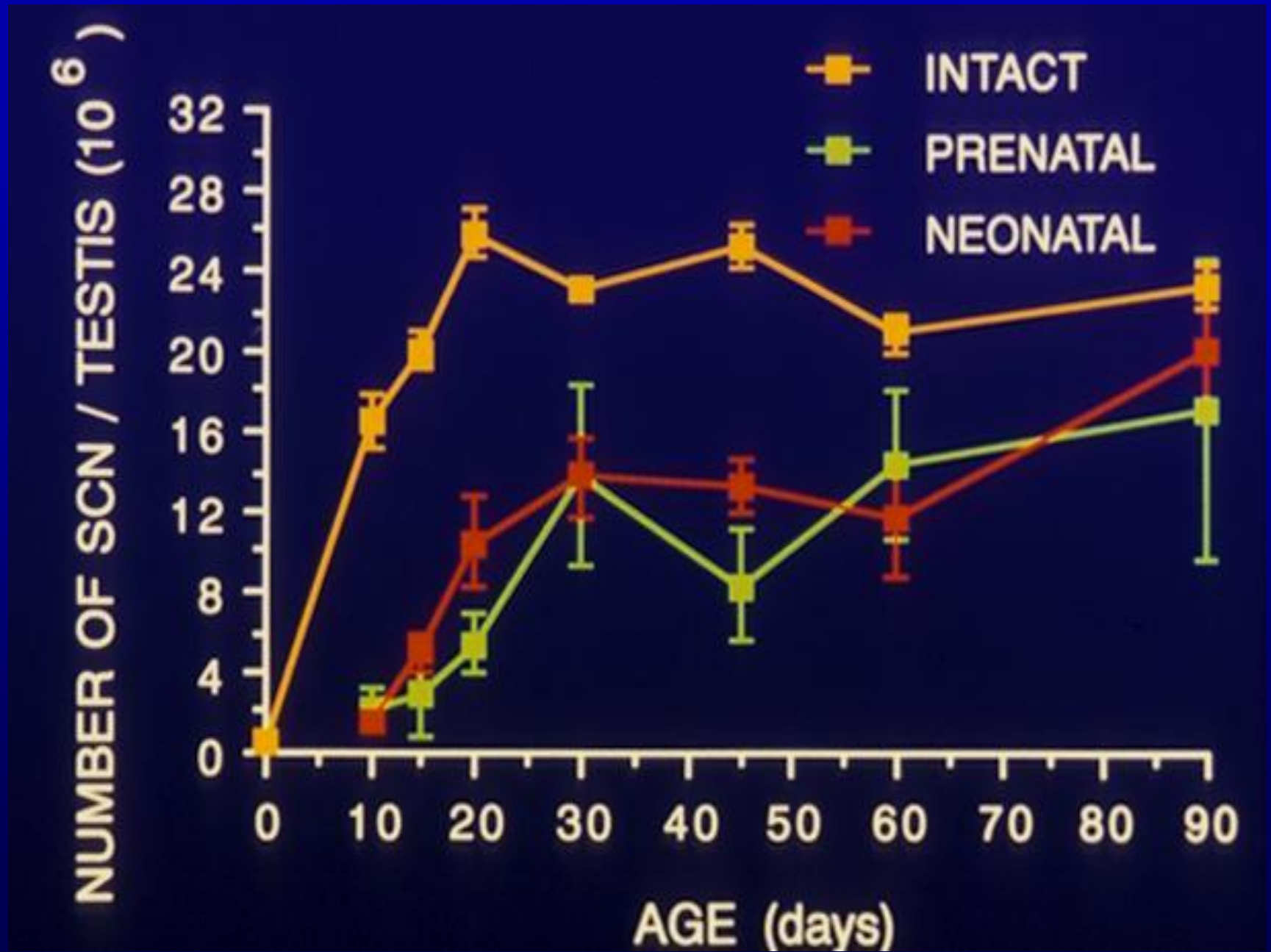
THIS MODEL PLACES IMMATURE TESTES CAPABLE OF RAPID SERTOLI CELL DIVISION IN AN ADULT HOST THAT CAN BE CASTRATED, HYPOPHYSECTOMIZED, AND/OR SUBJECTED TO REPLACEMENT THERAPY.

HENCE, MECHANISMS REGULATING SERTOLI CELL KINETICS AND HORMONAL REQUIREMENTS CAN BE CONDUCTED WITH END POINTS TO INCLUDE SERTOLI CELL PROLIFERATION RATE, TESTICULAR GROWTH, DAILY SPERM PRODUCTION, AND NUMBER OF SERTOLI CELLS IN MATURE TESTES.


PARENCHYMAL WEIGHT (g)
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
INTACT
PRENATAL
NEONATAL
0
10
20
30
40
50
60
70
80
90
AGE (days)


INTACT
PRENATAL
NEONATAL
NUMBER OF SCN / TESTIS (10 6)
32
28
24
20
16
12
8
4
0
0
10
20
30
40
50
60
70
80
90
AGE (days)

Intact rat has 24 X 2 testes = 48 million Sertoli cells total



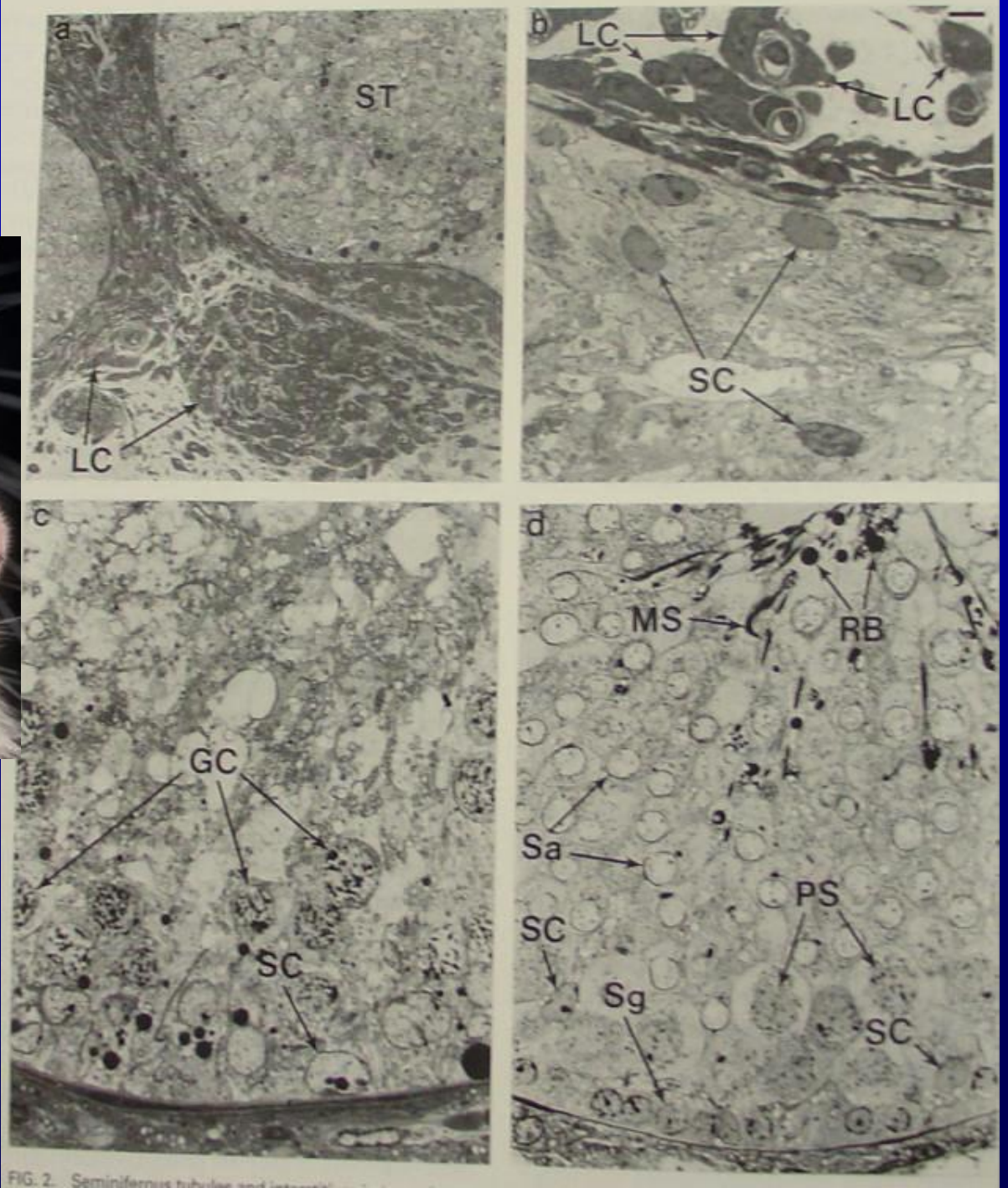
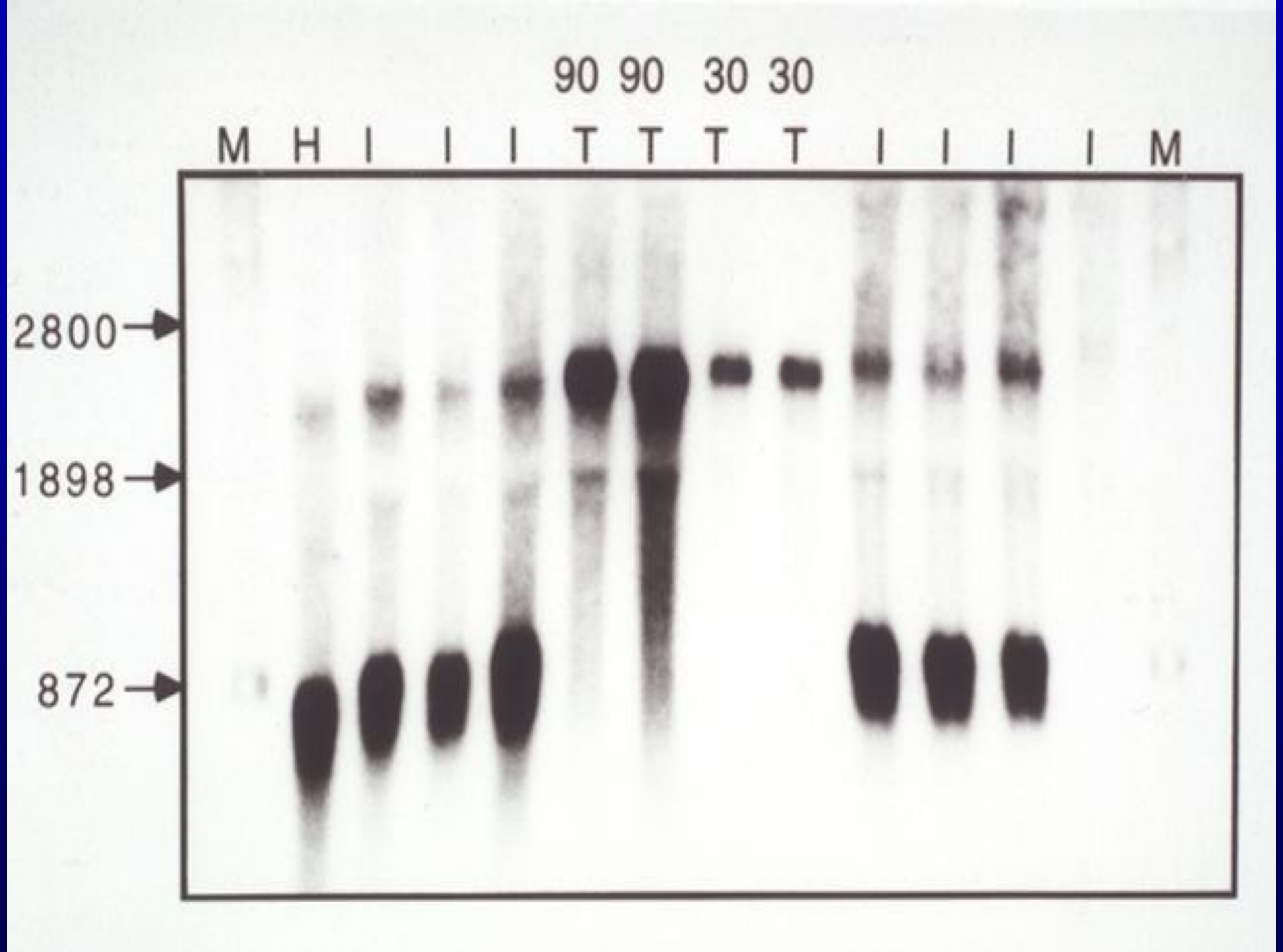
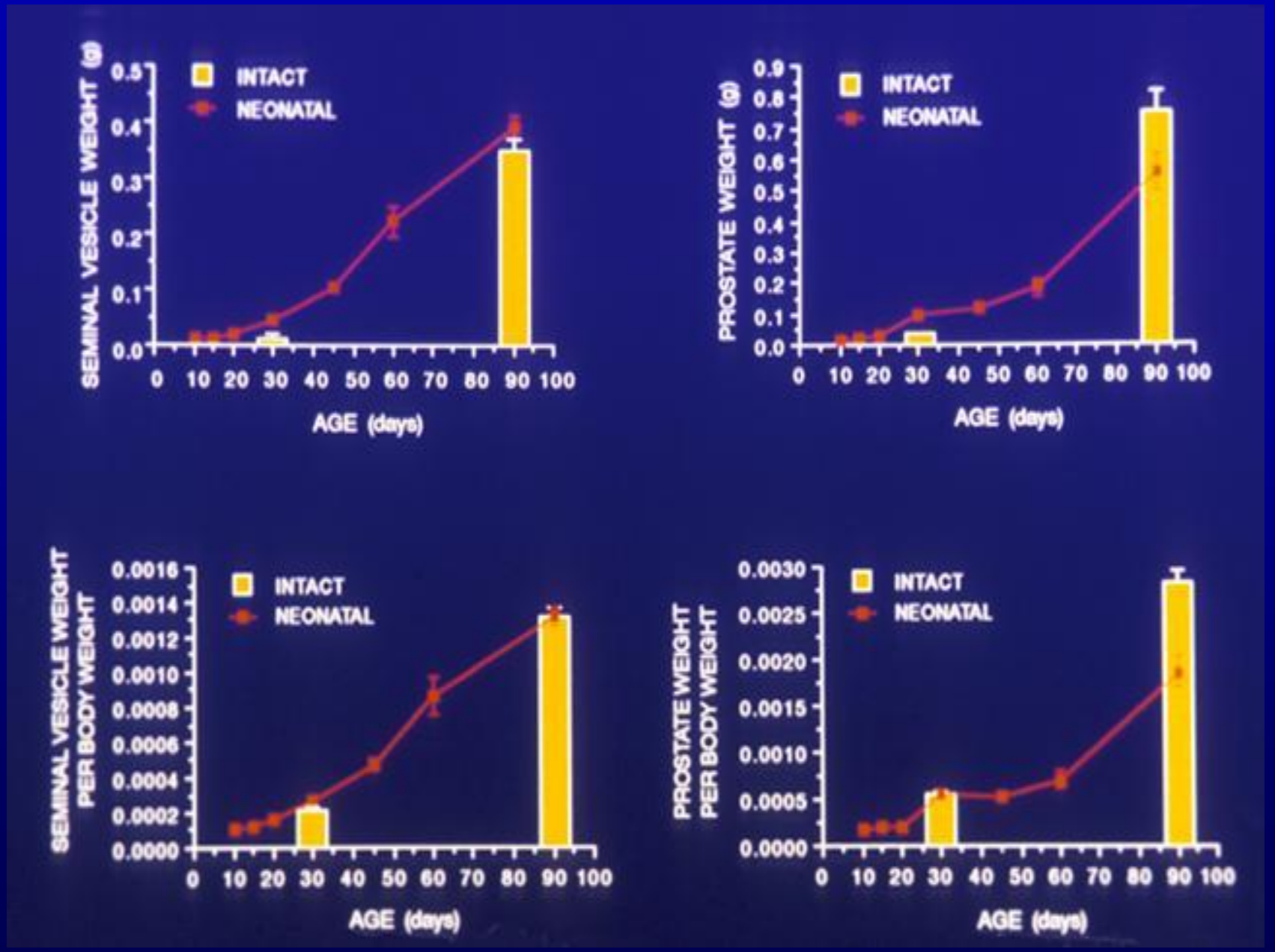
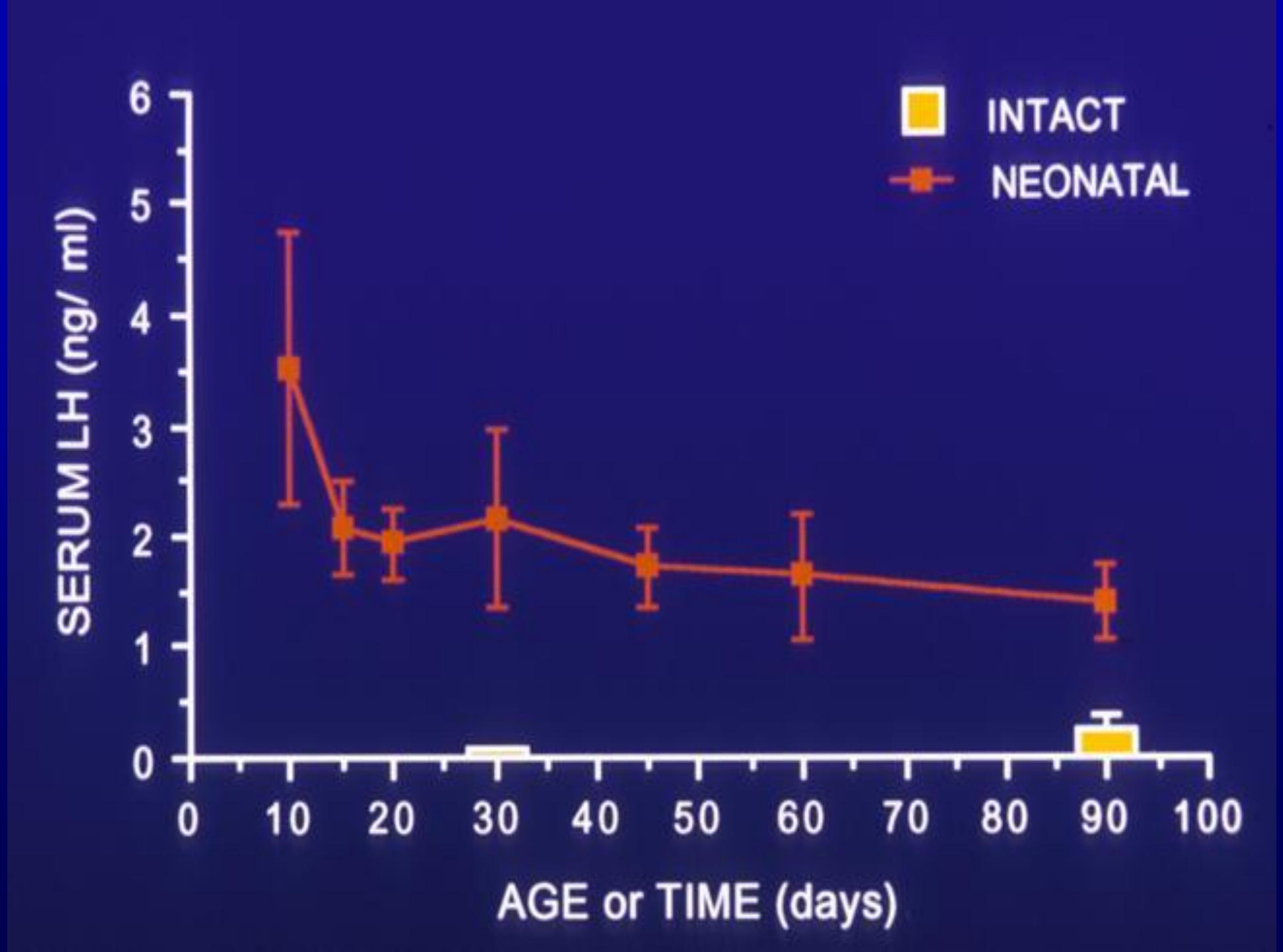
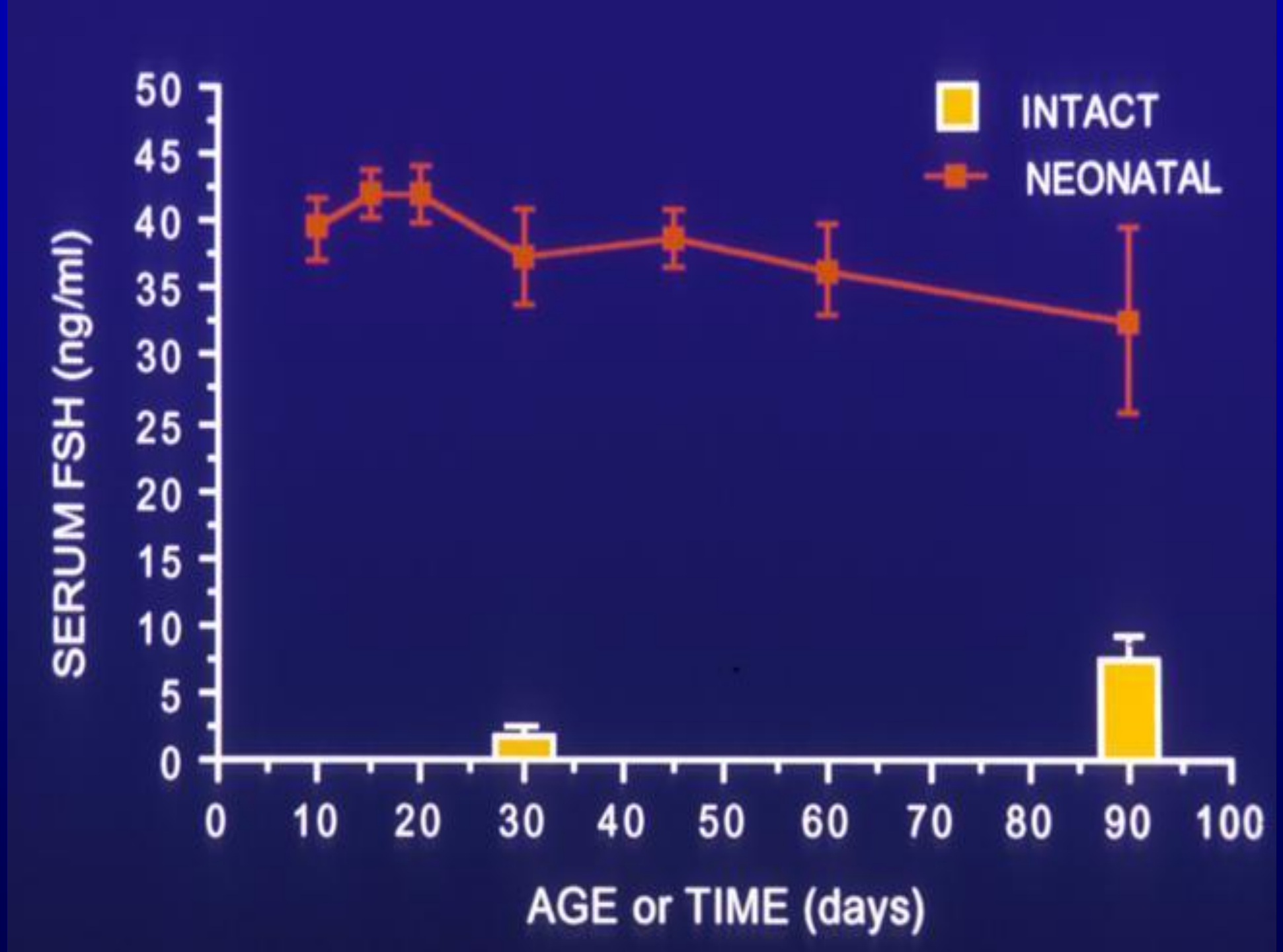


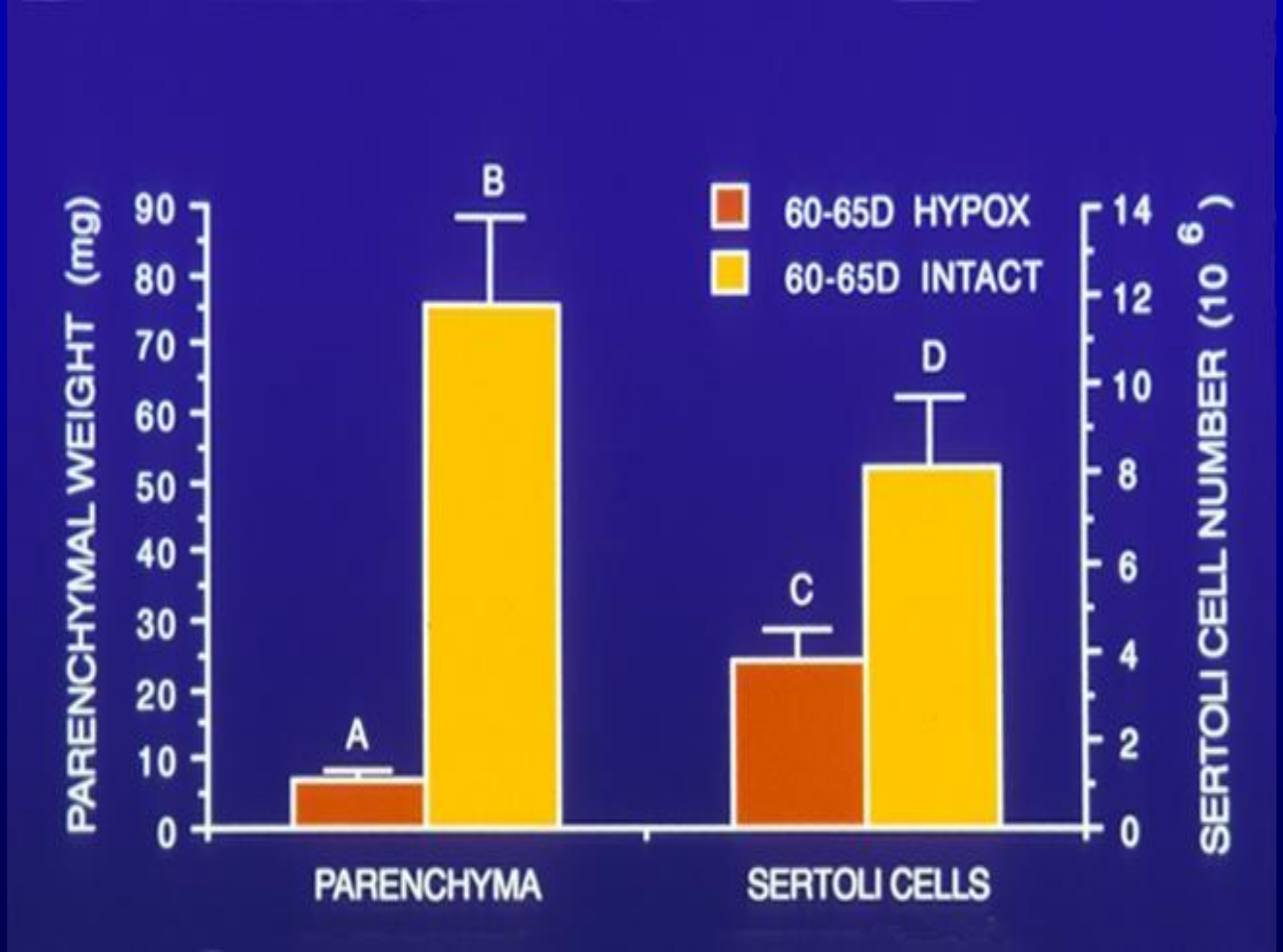
FIG. 2. Seminiferous tubules and interstiti

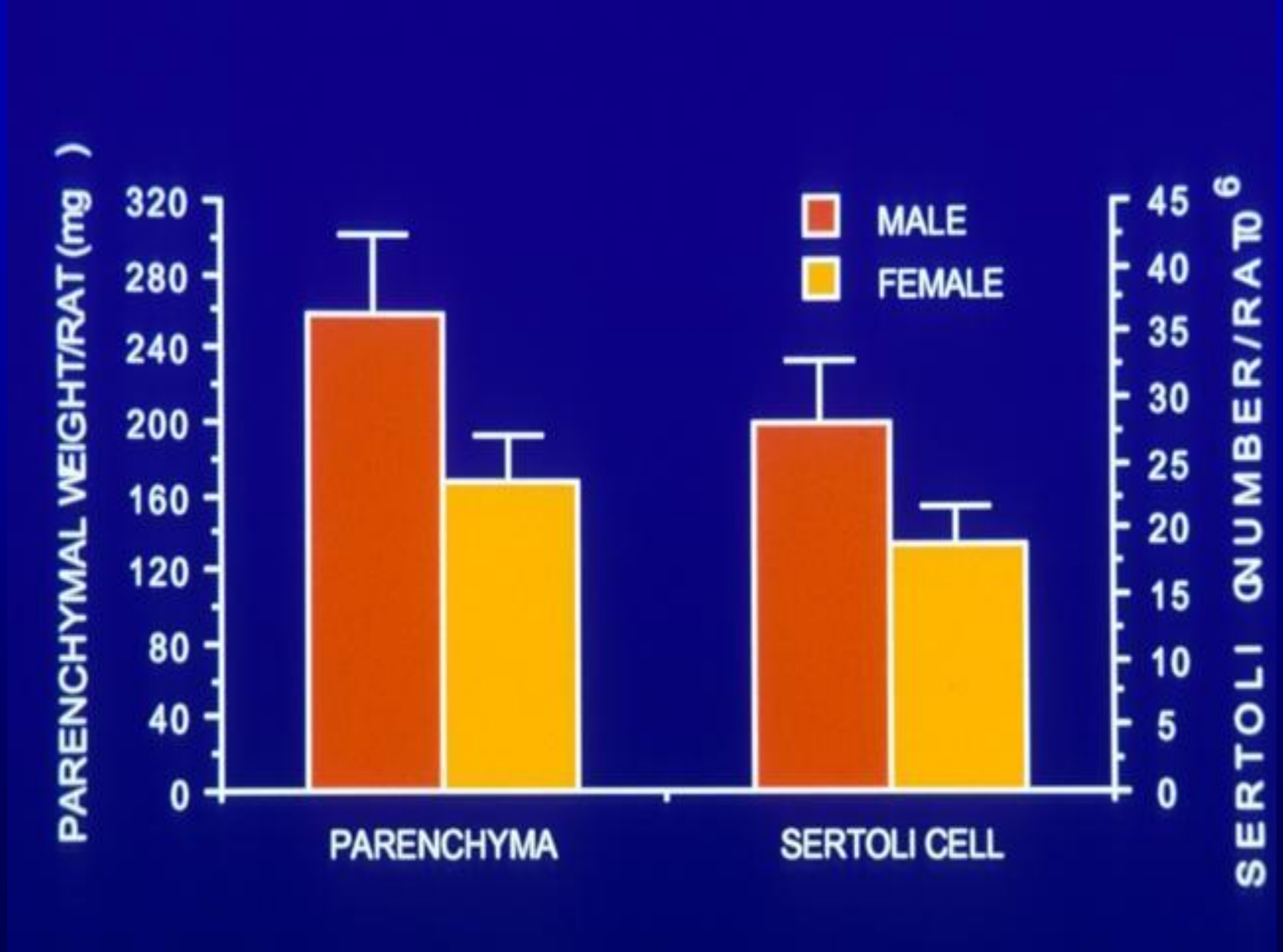

90 90 30 30
M H I I I T T T T I I I I M
2800
1898
872

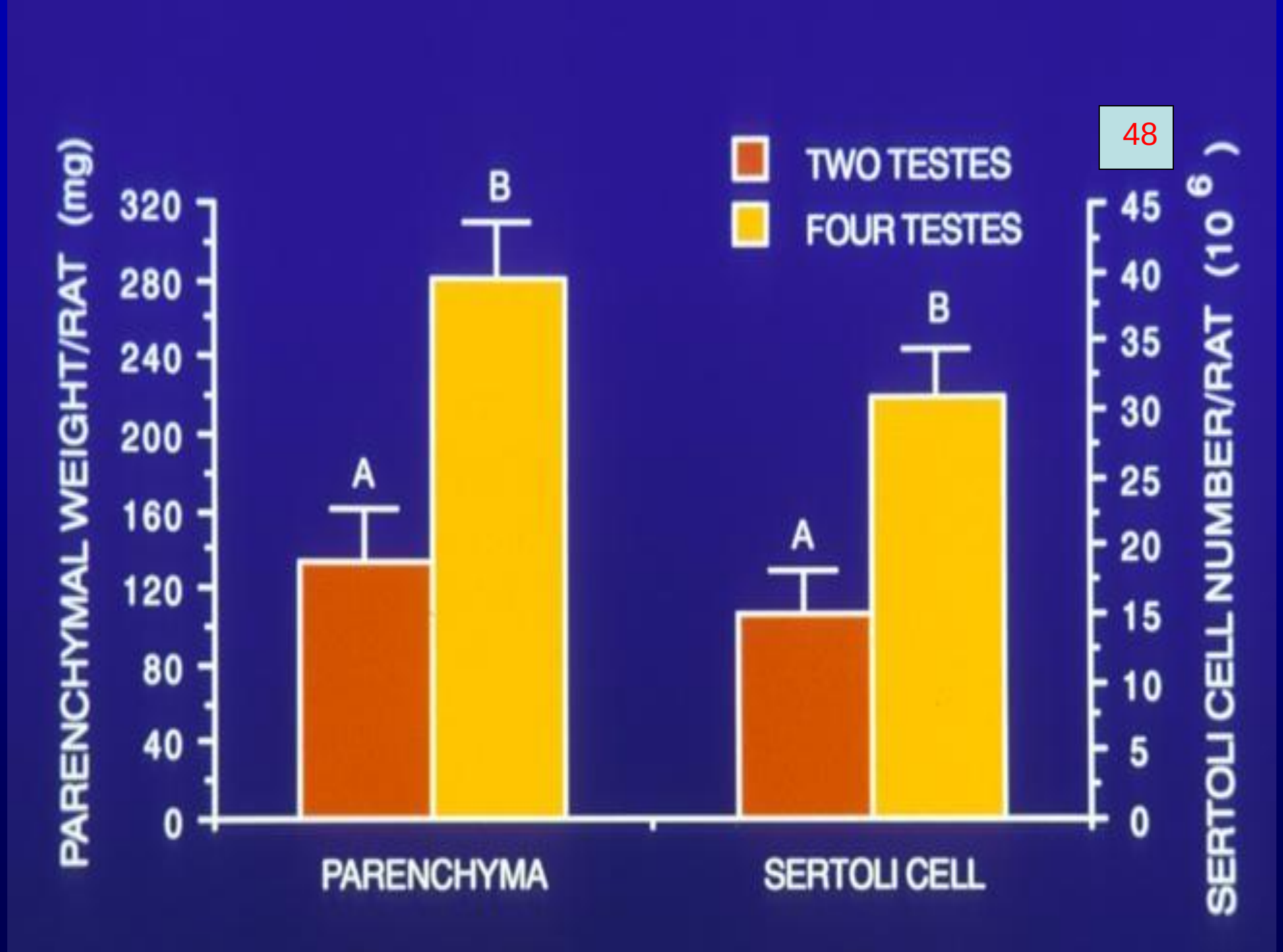

SEMINAL VESICLE WEIGHT (g)
0.0
0.1
0.2
0.3
0.4
0.5
INTACT
NEONATAL
0 10 20 30 40 50 60 70 80 90 100
AGE (days)
PROSTATE WEIGHT (g)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
INTACT
NEONATAL
0 10 20 30 40 50 60 70 80 90 100
AGE (days)
SEMINAL VESICLE WEIGHT PER BODY WEIGHT
0.0000
0.0002
0.0004
0.0006
0.0008
0.0010
0.0012
0.0014
0.0016
INTACT
NEONATAL
0 10 20 30 40 50 60 70 80 90 100
AGE (days)
PROSTATE WEIGHT PER BODY WEIGHT
0.0000
0.0005
0.0010
0.0015
0.0020
0.0025
0.0030
INTACT
NEONATAL
0 10 20 30 40 50 60 70 80 90 100
AGE (days)

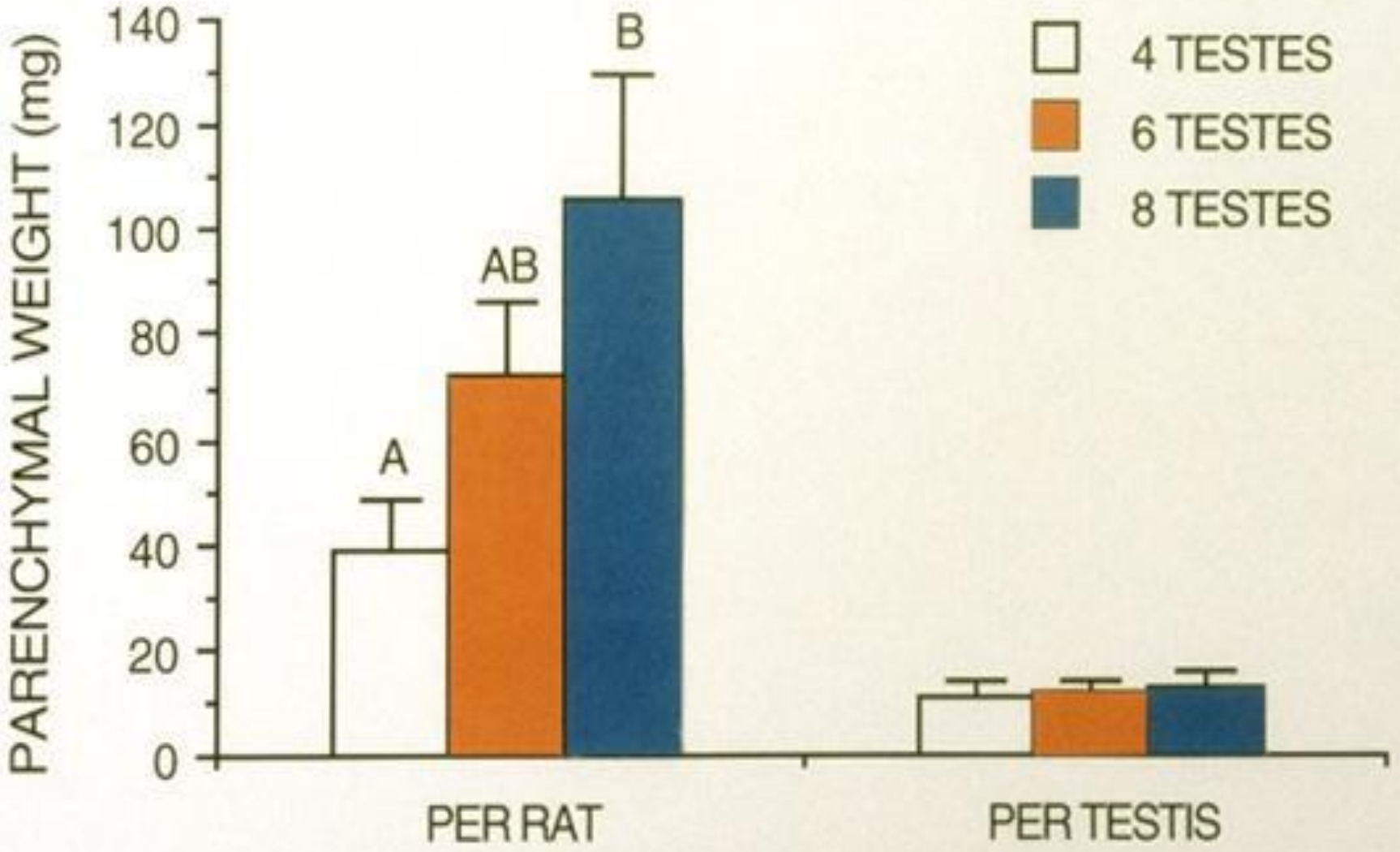

INTACT
NEONATAL
SERUM LH (ng/ ml)
6
5
4
3
2
1
0
0
10
20
30
40
50
60
70
80
90
100
AGE or TIME (days)

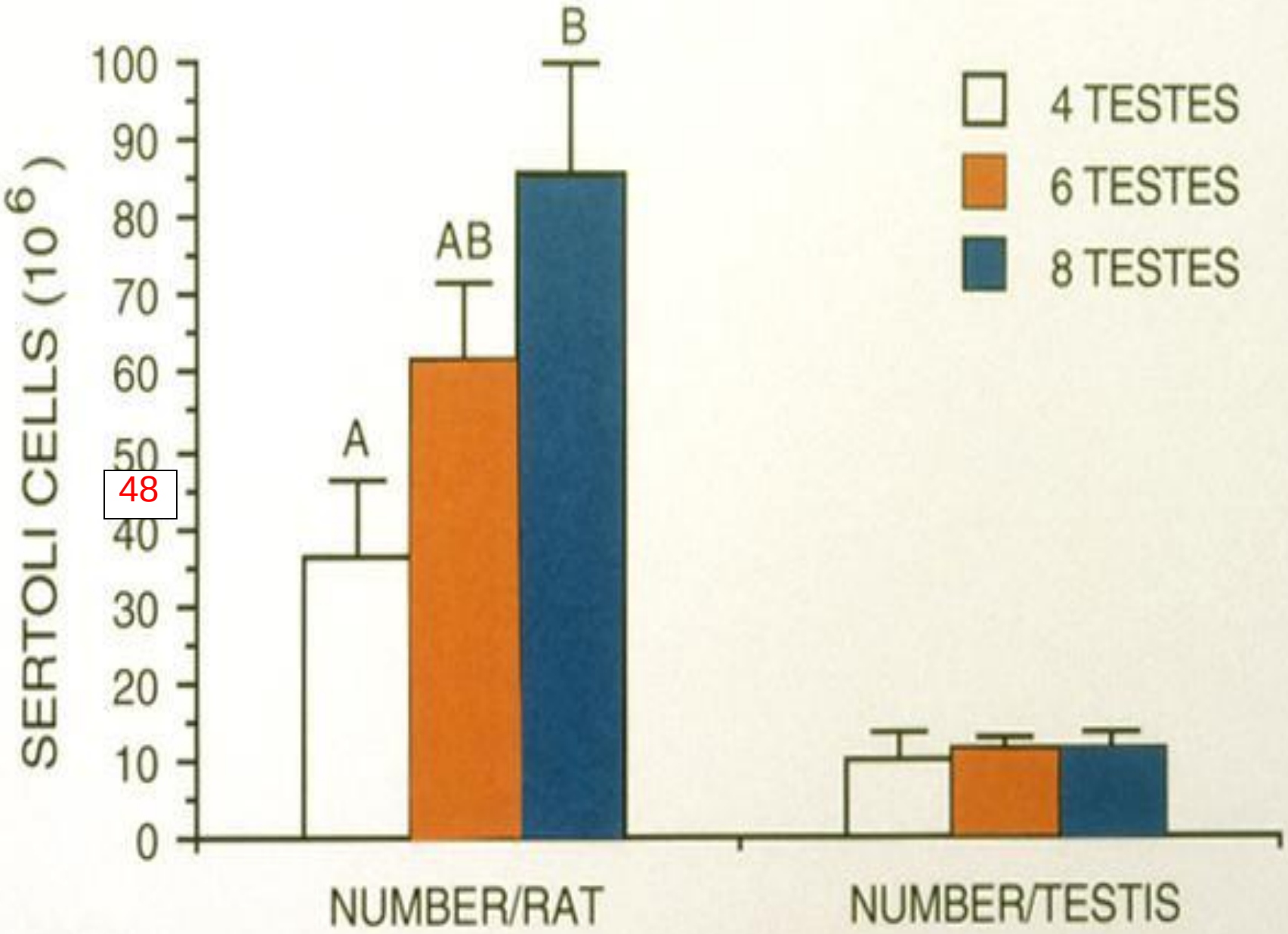

INTACT
NEONATAL
SERUM FSH (ng/ml)
50
45
40
35
30
25
20
15
10
5
0
0
10
20
30
40
50
60
70
80
90
100
AGE or TIME (days)

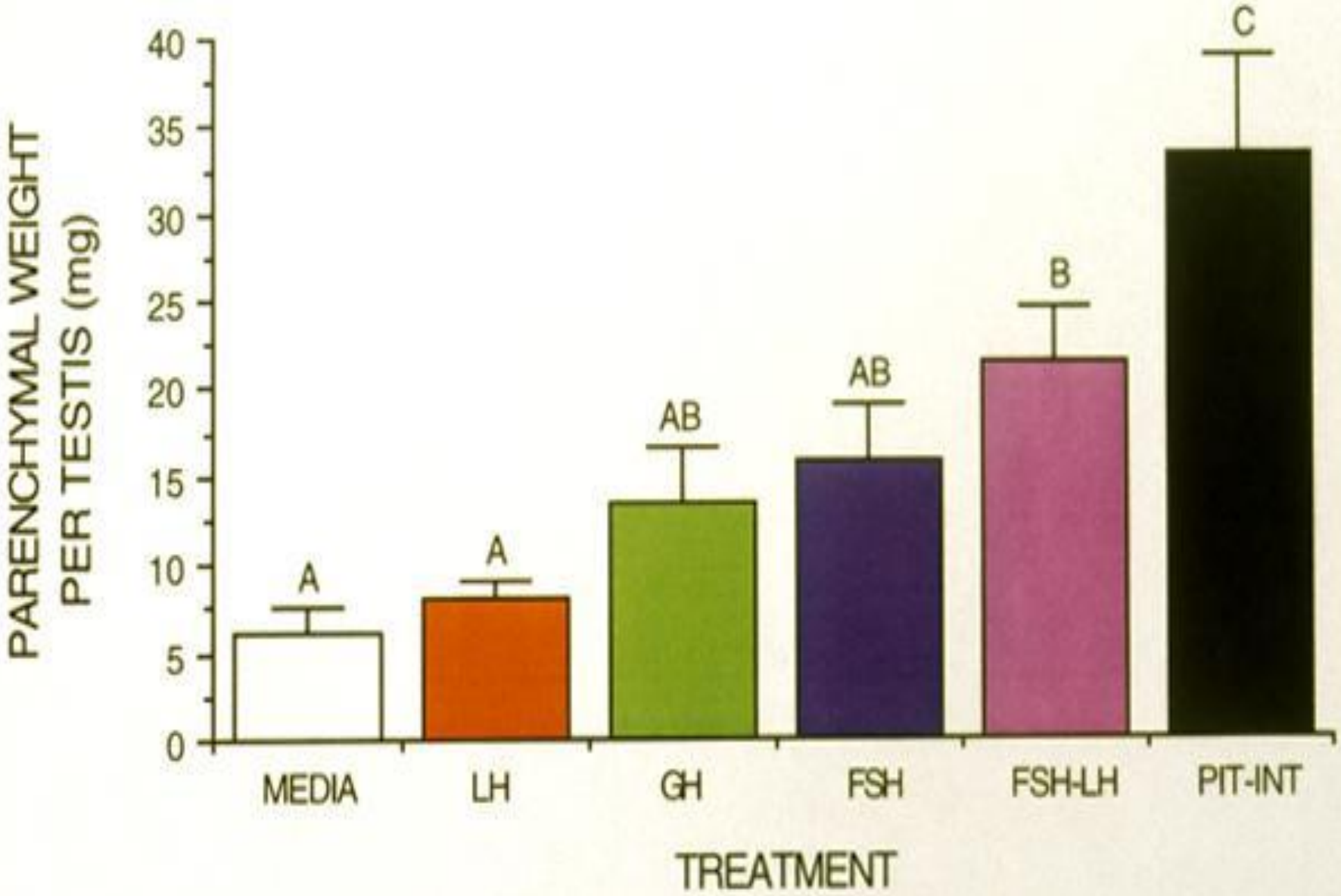

PARENCHYMAL WEIGHT (mg)
90
80
70
60
50
40
30
20
10
0
A
B
C
D
60-65D HYPOX
60-65D INTACT
14
12
10
8
6
4
2
0
SERTOLI CELL NUMBER (10 6)
PARENCHYMA
SERTOLI CELLS

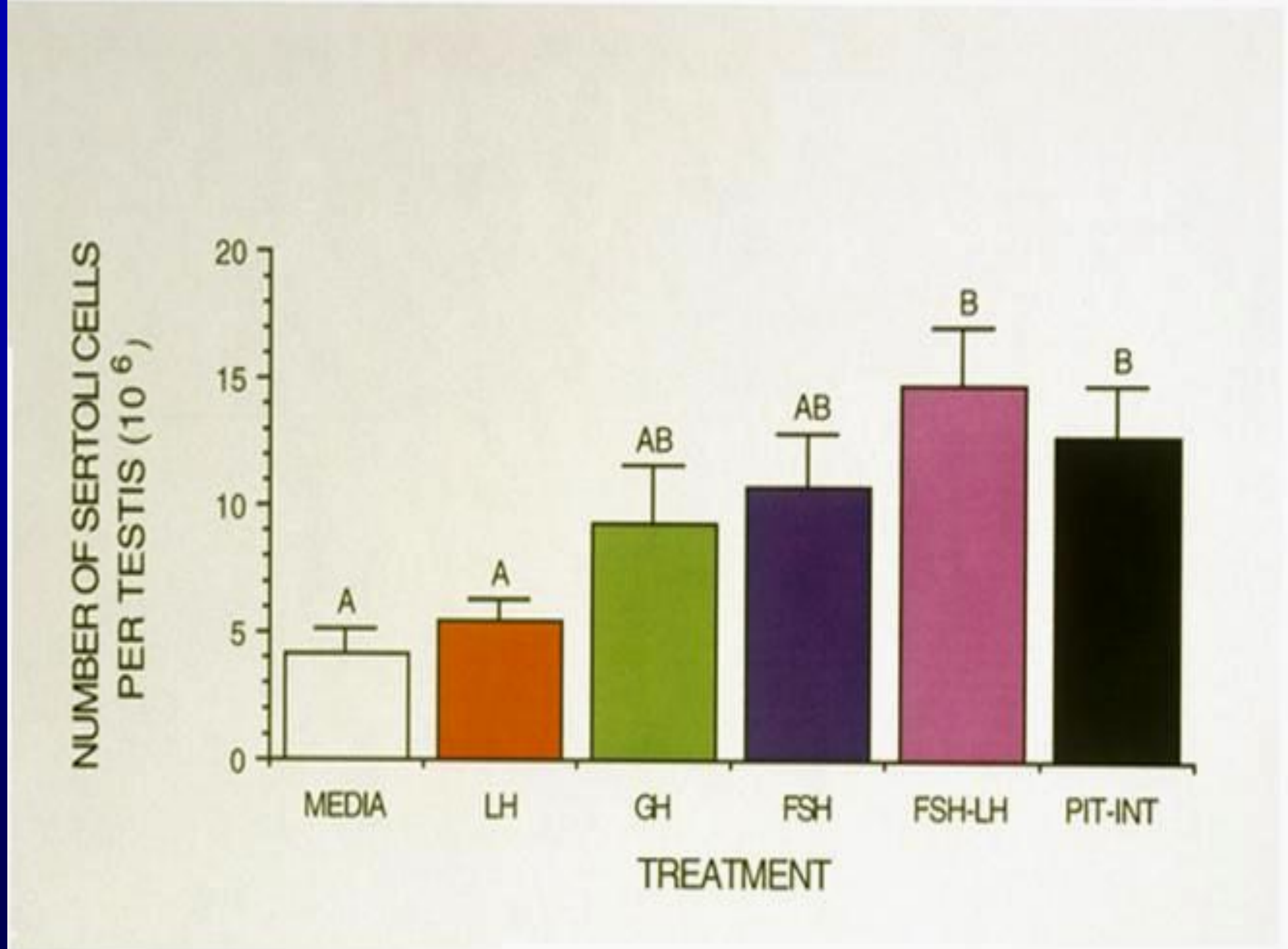

PARENCHYMAL WEIGHT/RAT (mg)
320
280
240
200
160
120
80
40
0
MALE
FEMALE
45
40
35
30
25
20
15
10
5
0
SERTOLI NUMBER/RAT $\times 10^6$
PARENCHYMA
SERTOLI CELL


TWO TESTES
FOUR TESTES
PARENCHYMAL WEIGHT/RAT (mg)
320
280
240
200
160
120
80
40
0
A
B
A
B
PARENCHYMA
SERTOLI CELL
45
40
35
30
25
20
15
10
5
0
SERTOLI CELL NUMBER/RAT (10 6)

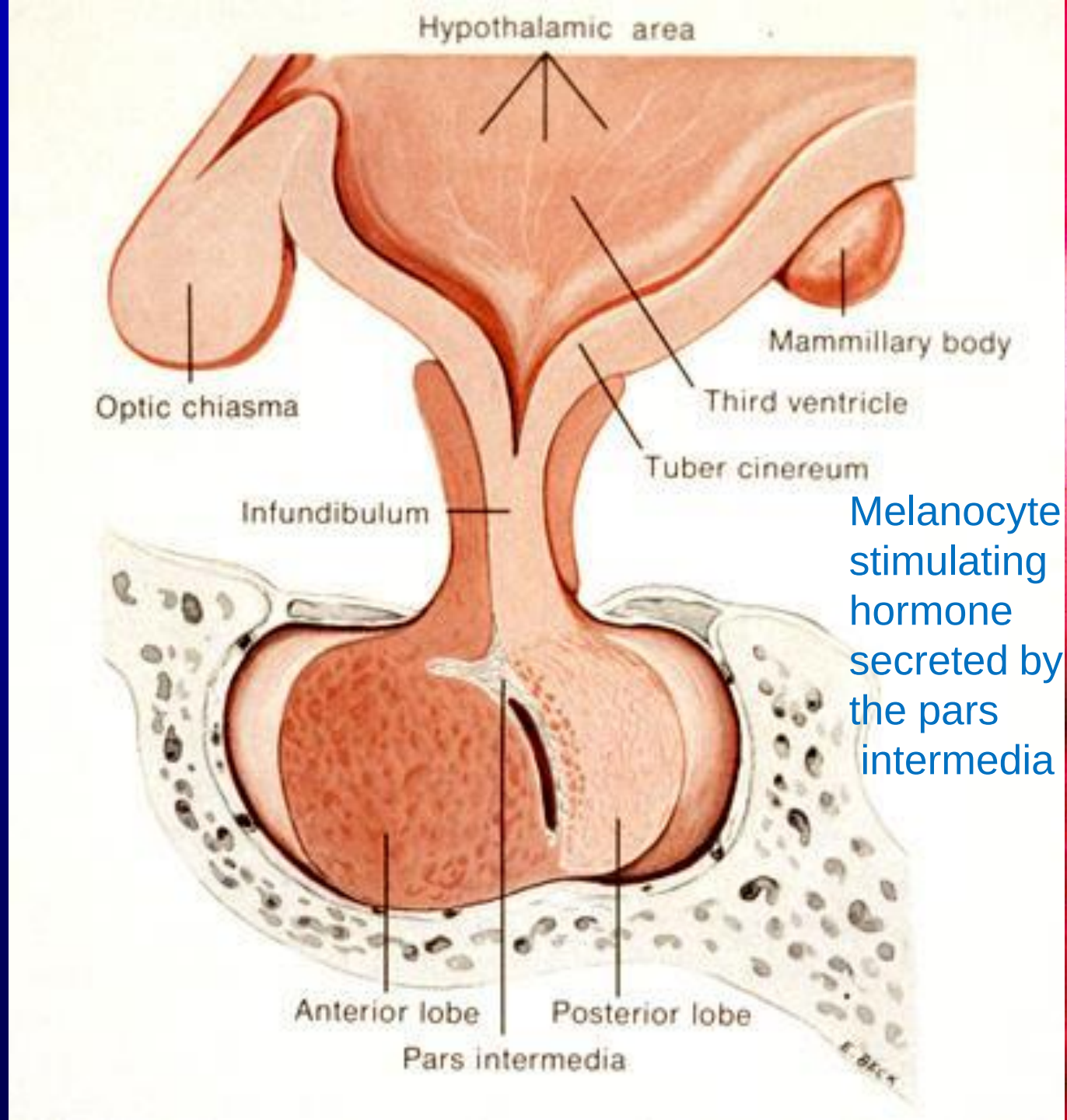

PARENCHYMAL WEIGHT (mg)
140
120
100
80
60
40
20
0
A
AB
B
4 TESTES
6 TESTES
8 TESTES
PER RAT
PER TESTIS


SERTOLI CELLS (10^6)
100
90
80
70
60
50
40
30
20
10
0
48
A
AB
B
4 TESTES
6 TESTES
8 TESTES
NUMBER/RAT
NUMBER/TESTIS


PARENCHYMAL WEIGHT
PER TESTIS (mg)
40
35
30
25
20
15
10
5
0
A
A
AB
AB
B
C
MEDIA
LH
GH
FSH
FSH-LH
PIT-INT
TREATMENT


NUMBER OF SERTOLI CELLS PER TESTIS (10^6)
20
15
10
5
0
A
A
AB
AB
B
B
MEDIA
LH
GH
FSH
FSH-LH
PIT-INT
TREATMENT

Aging study



Melanocyte stimulating hormone secreted by the pars intermedia

Physiological blood levels of hormones

- **Glucose 10 $-^{2}$ molar**
- **Steroid 10 $-^{9}$ molar**
- **Peptide 10 $-^{12}$ molar**

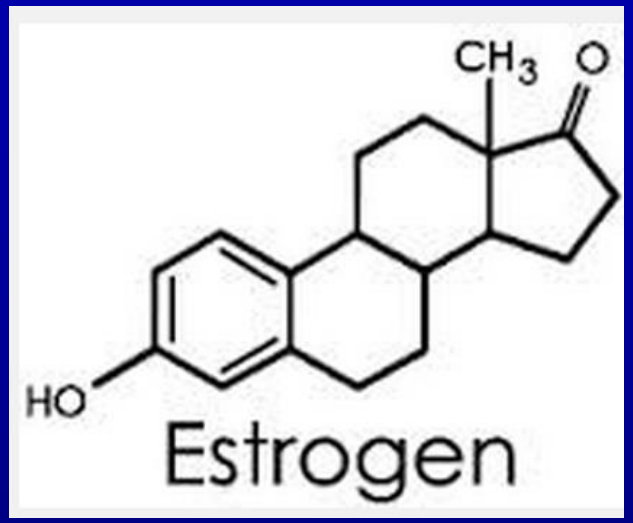
Growth hormone (blood levels)

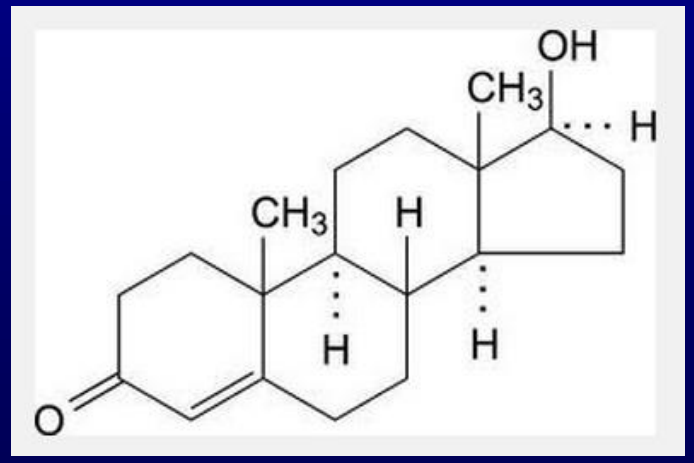
- **10 $-^{13}$ molar = Dwarf**
- **10 $-^{11}$ molar = Giant**

Effects of the

Endocrine system

Effects of the Endocrine system





Many illustrations in these VIBS Histology YouTube videos were modified from the following books and sources: Many thanks to original sources!

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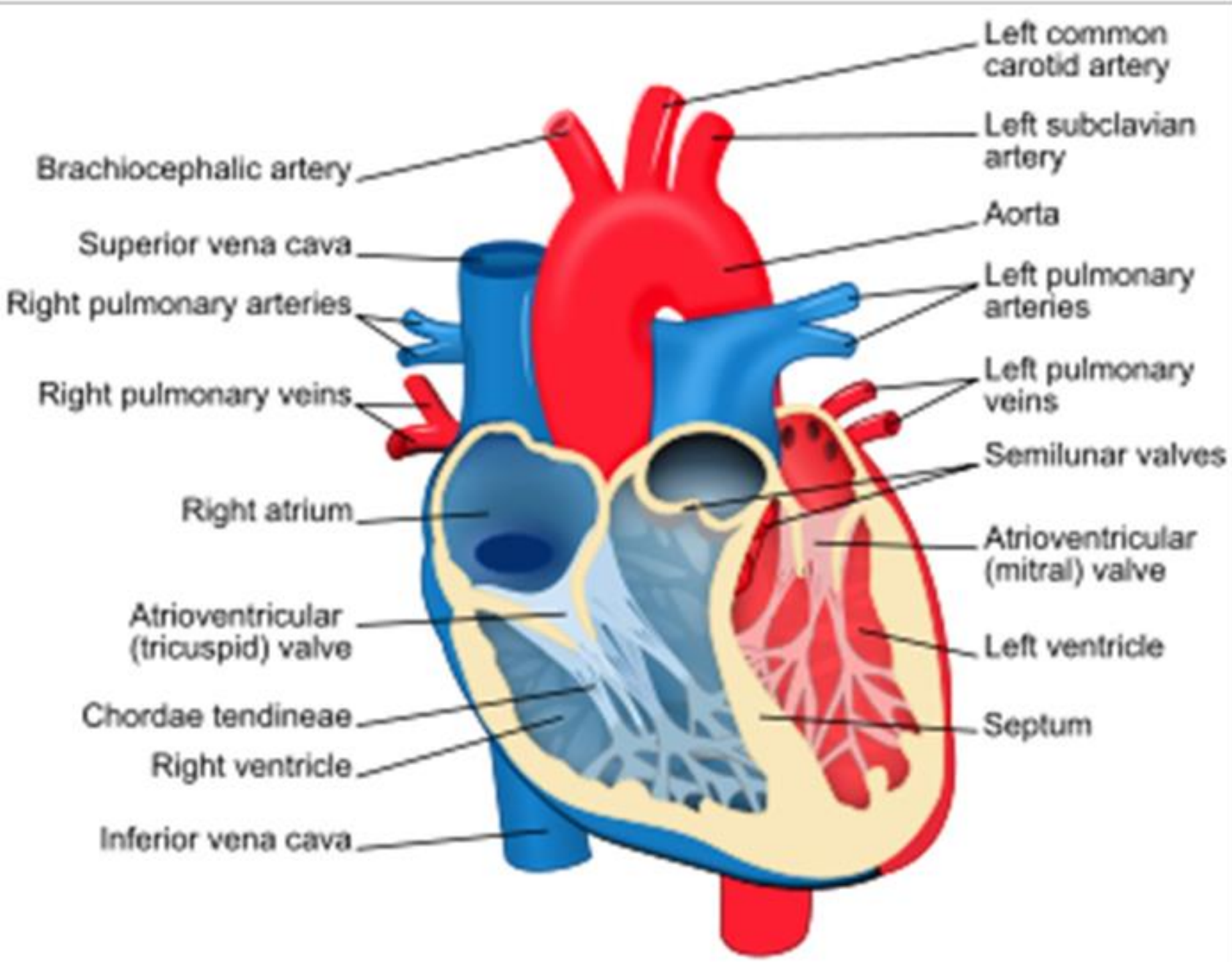
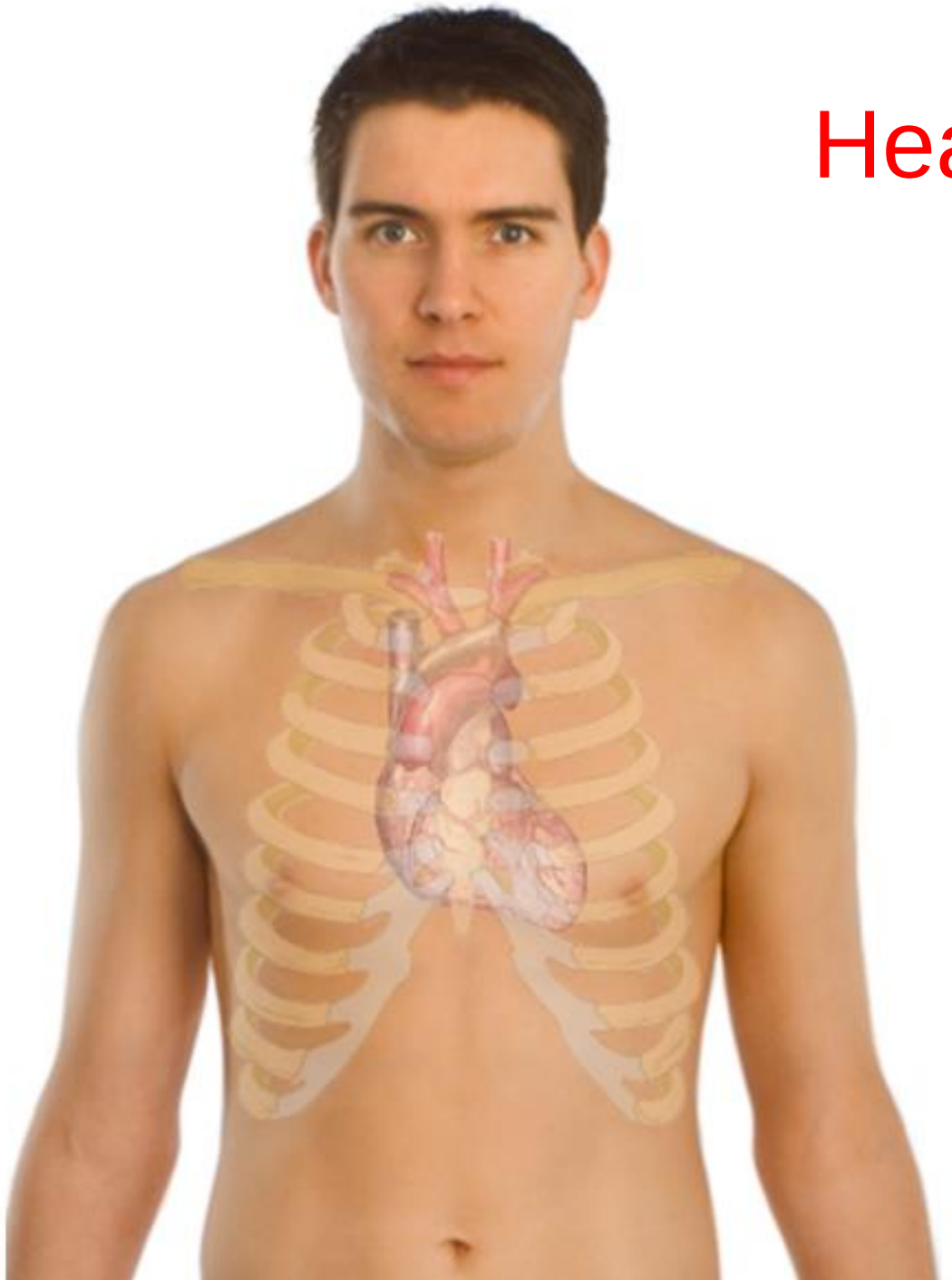
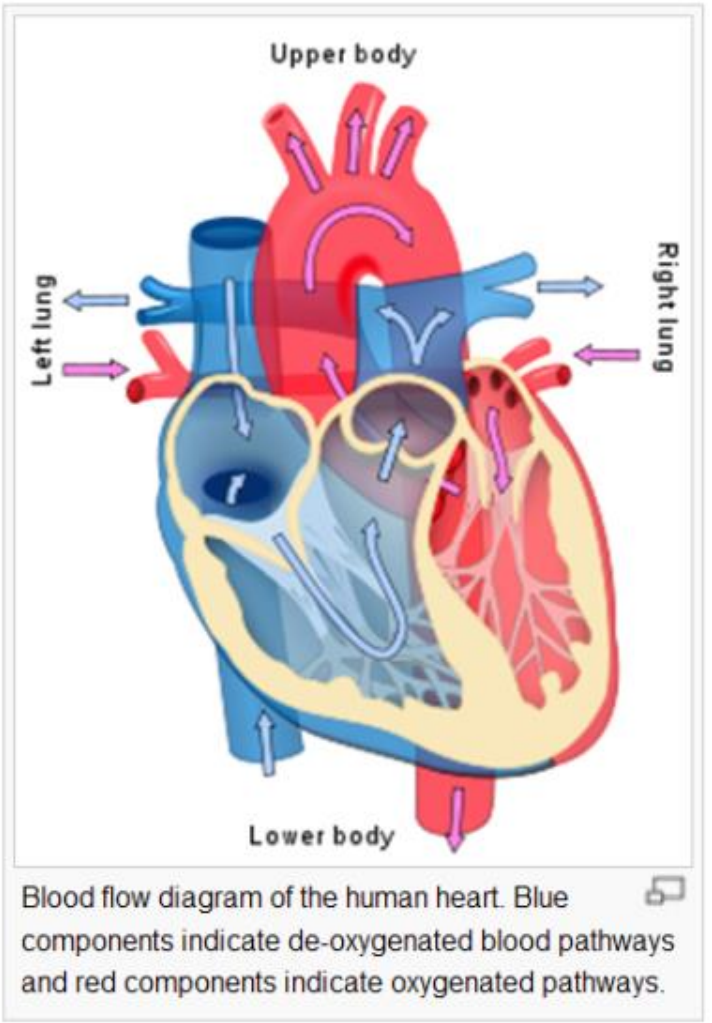
- Internet images and videos on biological presentations


WORLD WAR II MEMORIAL

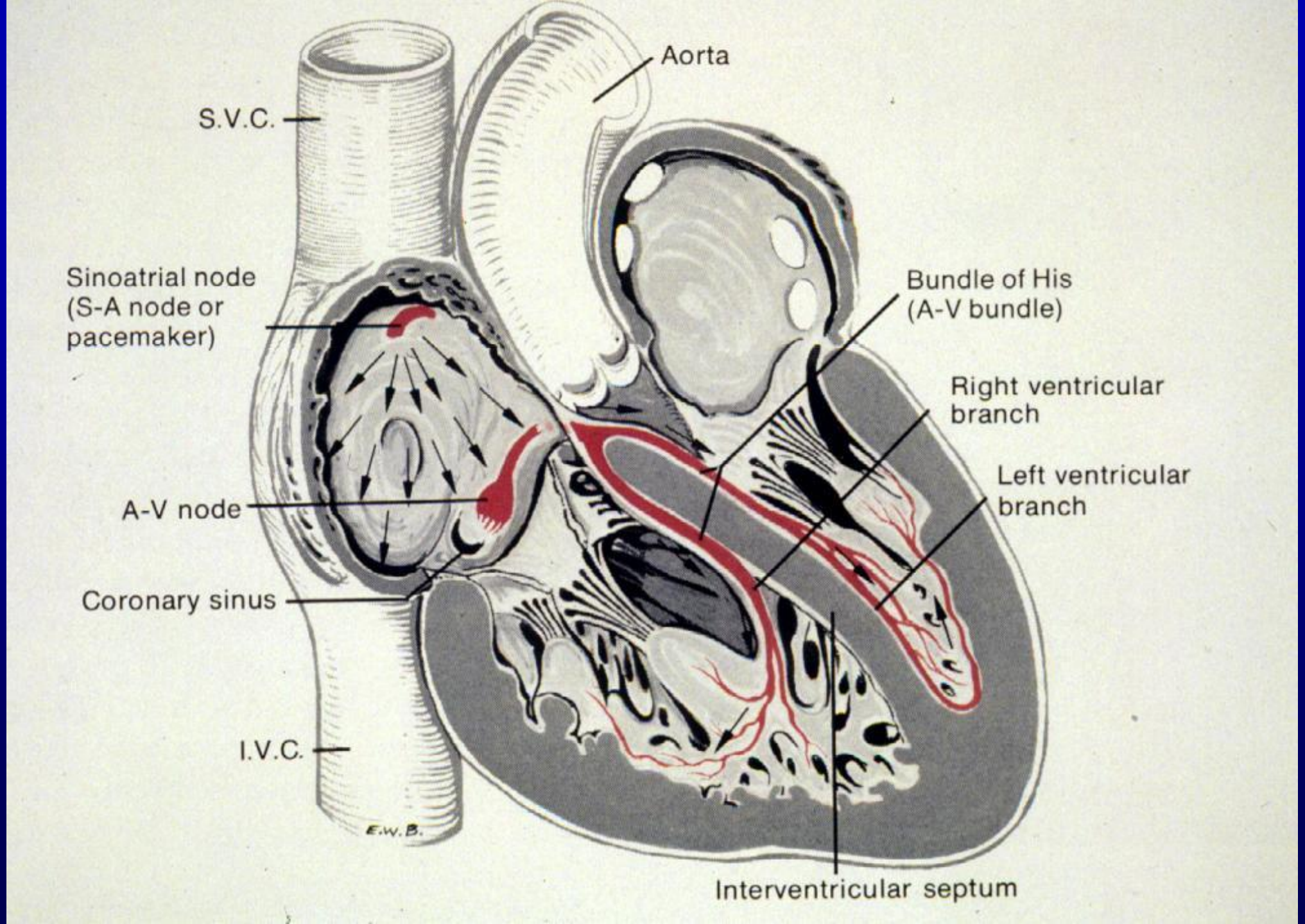

Left common carotid artery
Left subclavian artery
Aorta
Left pulmonary arteries
Left pulmonary veins
Semilunar valves
Atrioventricular (mitral) valve
Left ventricle
Septum
Brachiocephalic artery
Superior vena cava
Right pulmonary arteries
Right pulmonary veins
Right atrium
Atrioventricular (tricuspid) valve
Chordae tendineae
Right ventricle
Inferior vena cava

Heart

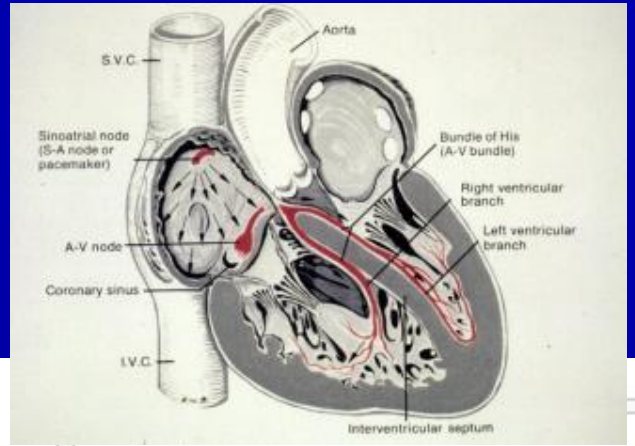


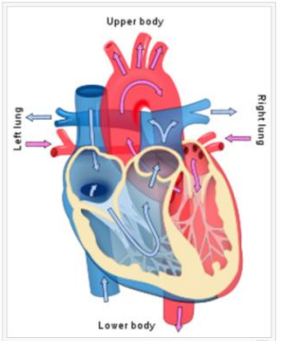


Blood flow diagram of the human heart. Blue components indicate de-oxygenated blood pathways and red components indicate oxygenated pathways.


Aorta
S.V.C.
Sinoatrial node
(S-A node or
pacemaker)
Bundle of His
(A-V bundle)
Right ventricular
branch
Left ventricular
branch
A-V node
Coronary sinus
I.V.C.
E.W.B.
Interventricular septum

Heart





Blood flow diagram of the human heart. Blue components indicate de-oxygenated blood pathways and red components indicate oxygenated pathways.

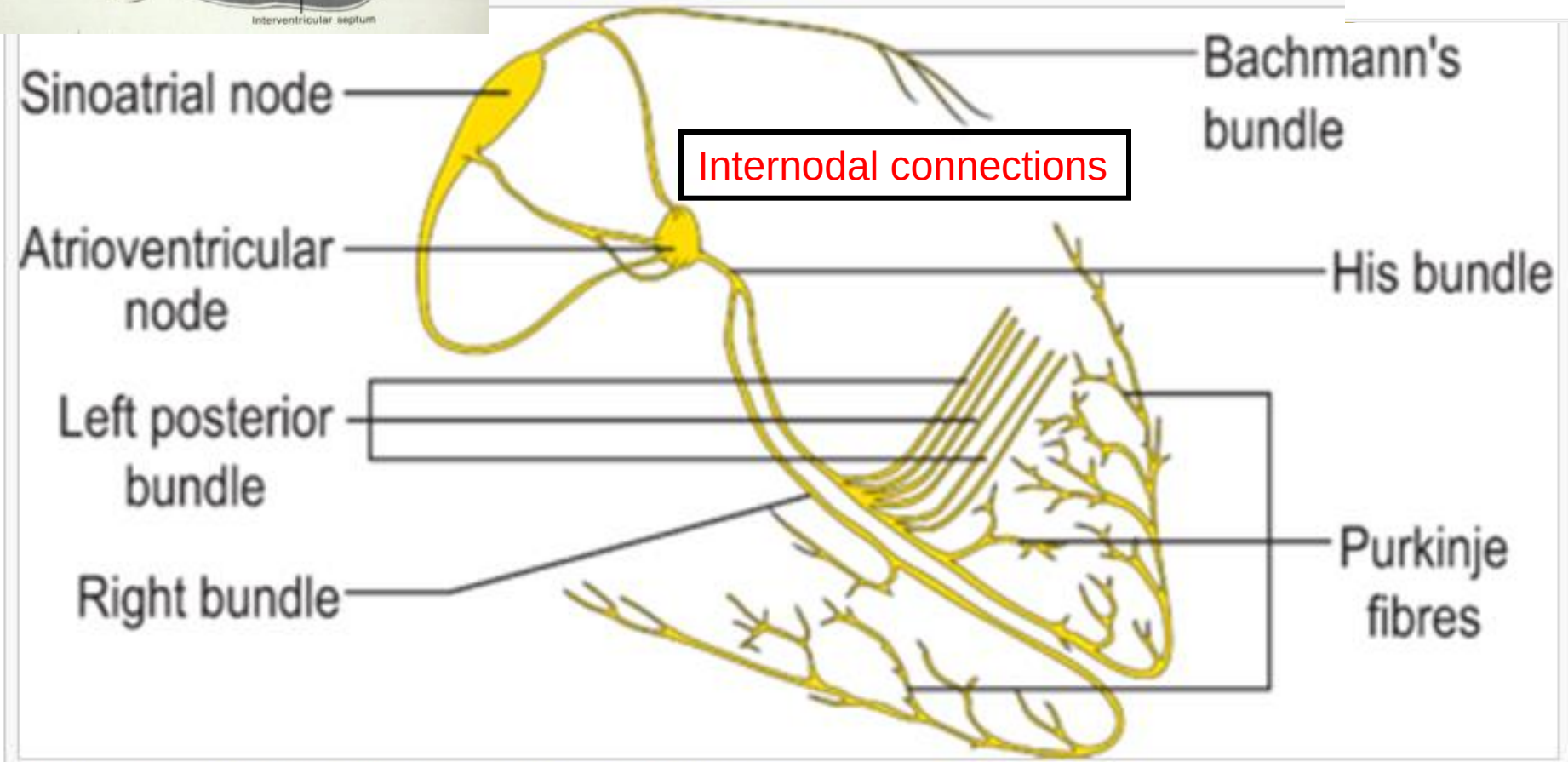
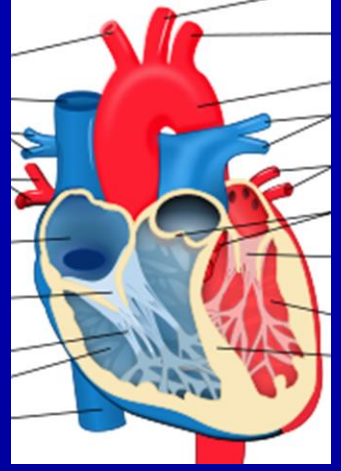


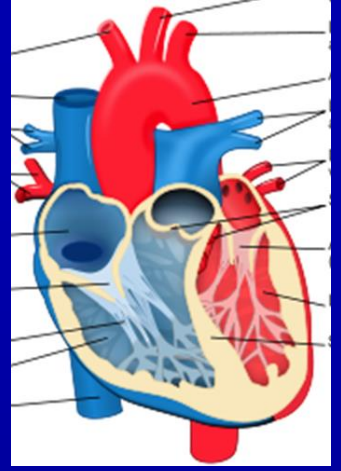
Image showing the conduction system of the heart



Congestive Heart Failure

Congestive heart failure (CHF), or heart failure, is a condition in which the heart can't pump enough blood to the body's other organs. This can result from narrowed arteries that supply blood to the heart muscle — coronary artery disease.

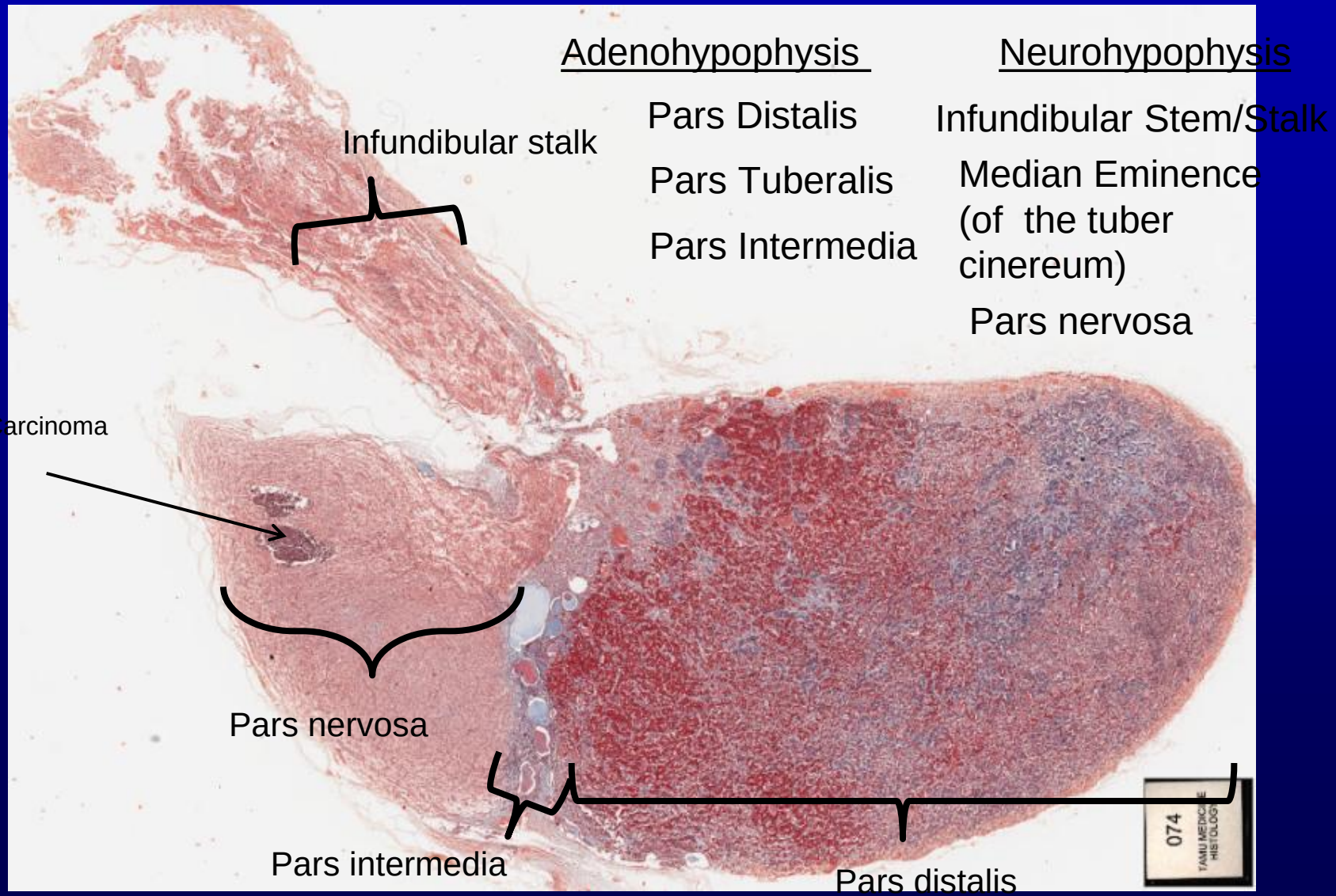
- Past heart attack, or myocardial infarction, with scar tissue that interferes with the heart muscle's normal work.
- High blood pressure
- Heart valve disease due to past rheumatic fever or other causes
- Primary disease of the heart muscle itself, called cardiomyopathy.
- Heart defects present at birth — congenital heart defects.



Congestive Heart Failure

- infection of the heart valves and/or heart muscle itself — endocarditis and/or myocarditis
- The "failing" heart keeps working but not as efficiently as it should. People with heart failure can't exert themselves because they become short of breath and tired.
- As blood flow out of the heart slows, blood returning to the heart through the veins backs up, causing congestion in the tissues. Often swelling (edema) results. Most often there's swelling in the legs and ankles, but it can happen in other parts of the body, too. Sometimes fluid collects in the lungs and interferes with breathing, causing shortness of breath, especially when a person is lying down.
- Heart failure also affects the kidneys' ability to dispose of sodium and water. The retained water increases the edema.

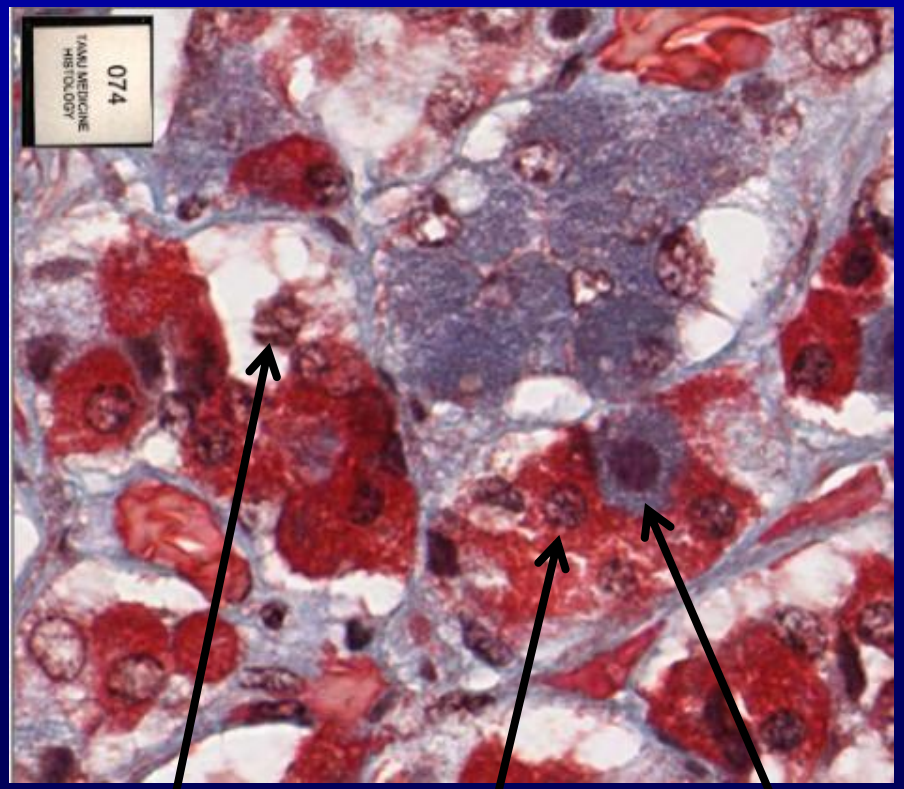
Histo074 Slide 74: Pituitary (Masson's trichrome)



Slide 74: Pituitary (early carcinoma in posterior lobe)

Histo074

Pars distalis

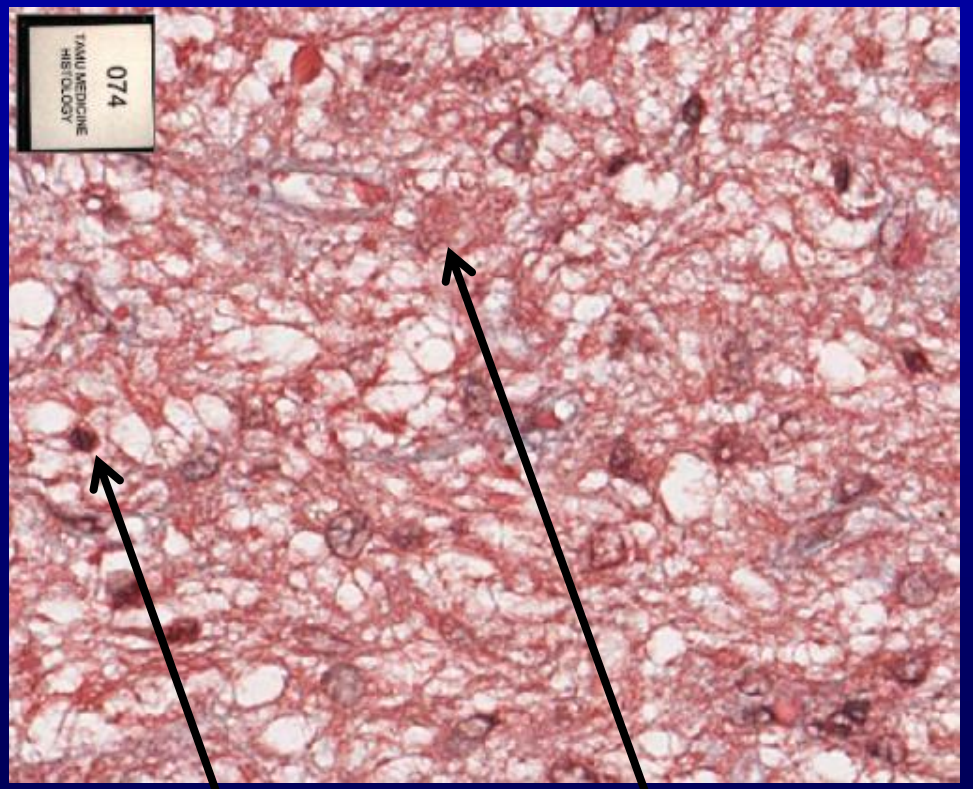


Chromophobes

Acidophils

Basophil

Pars nervosa

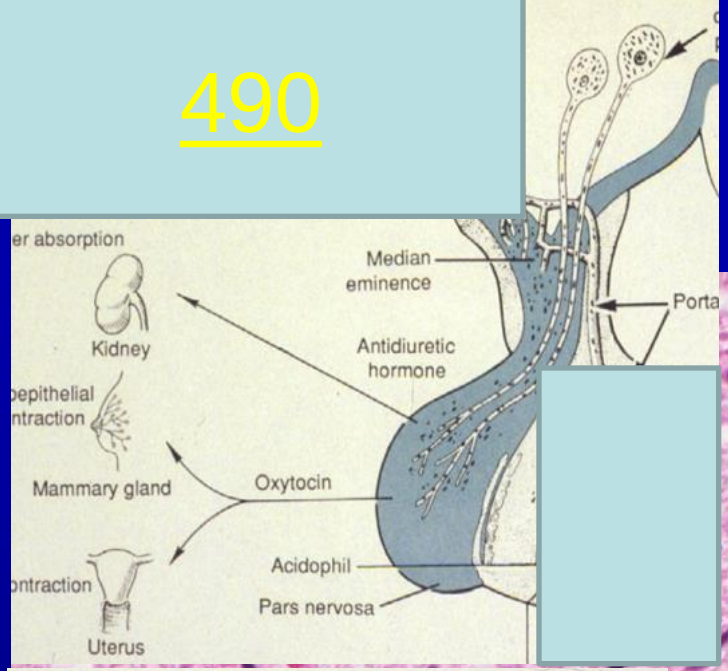


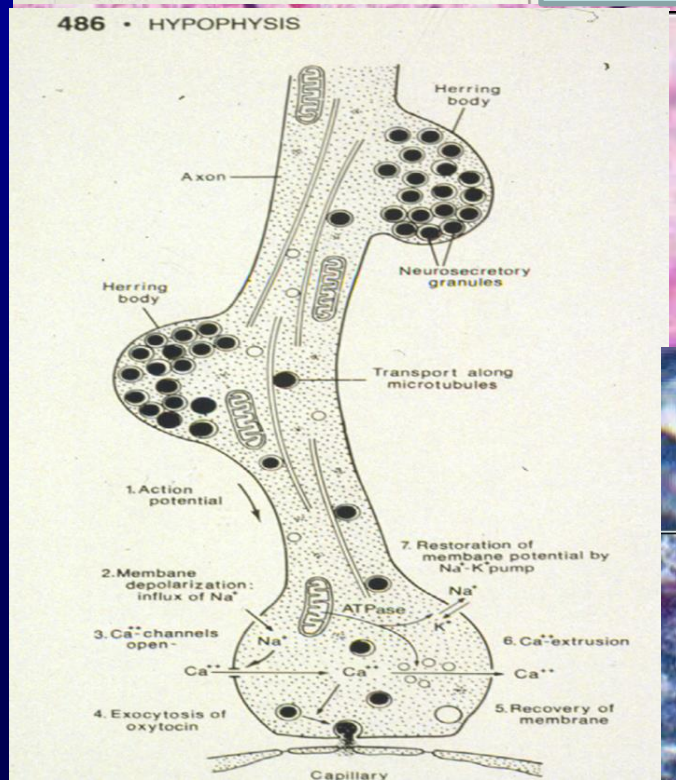
Pituicyte nuclei

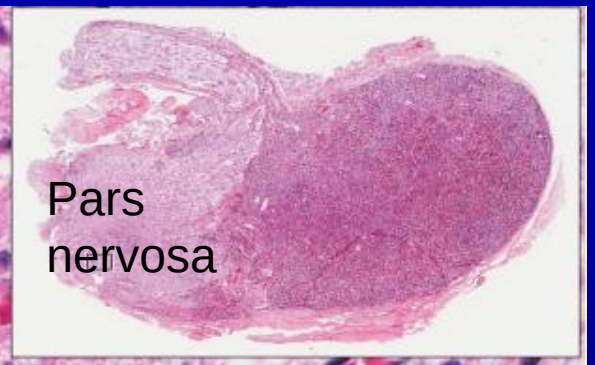
Herring body

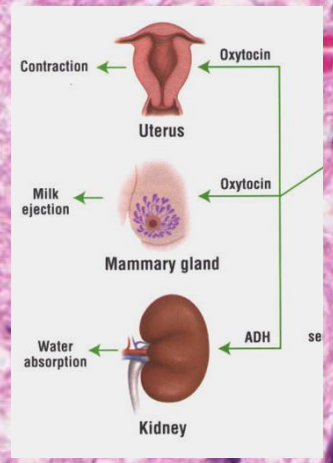
Herring bodies in pars nervosa of Hypophysis

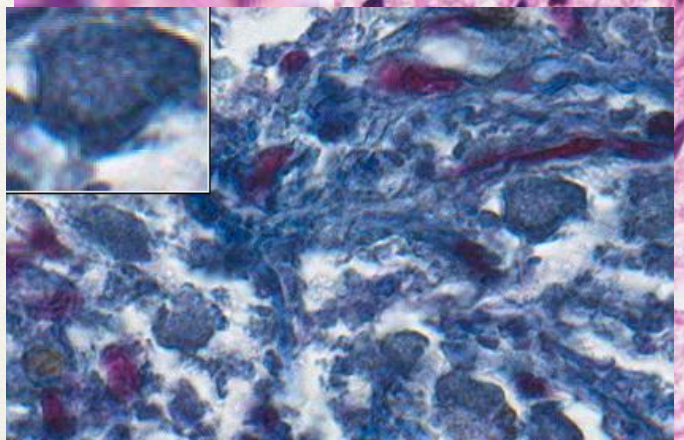
490

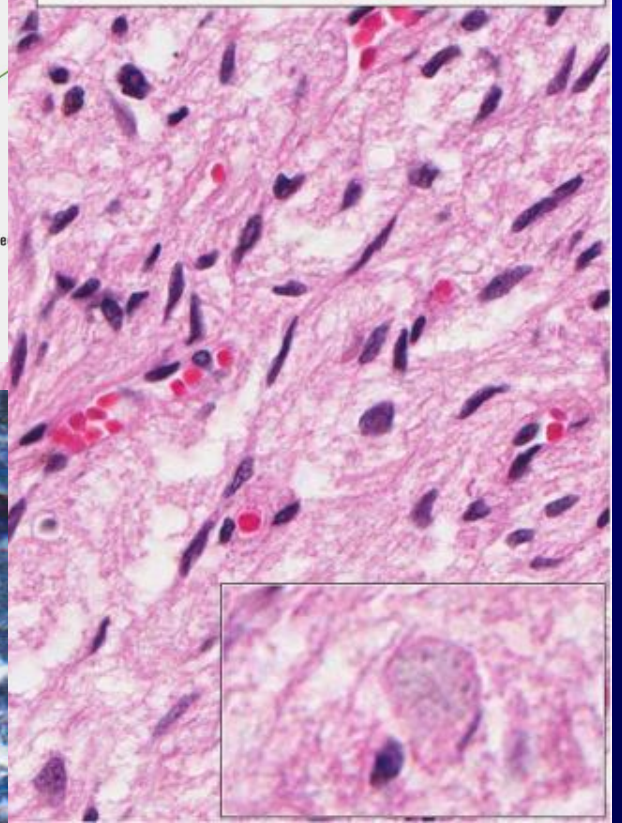






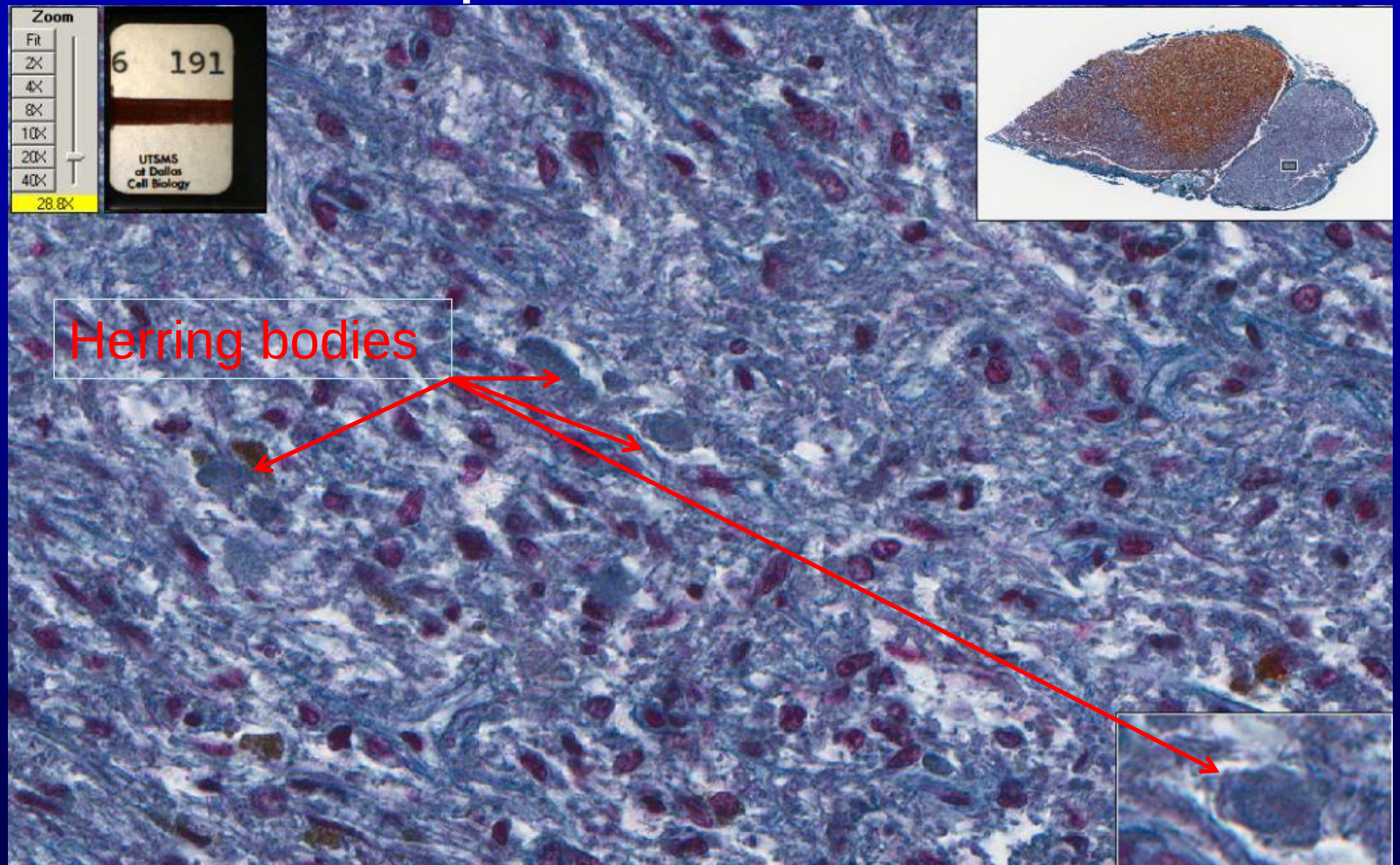






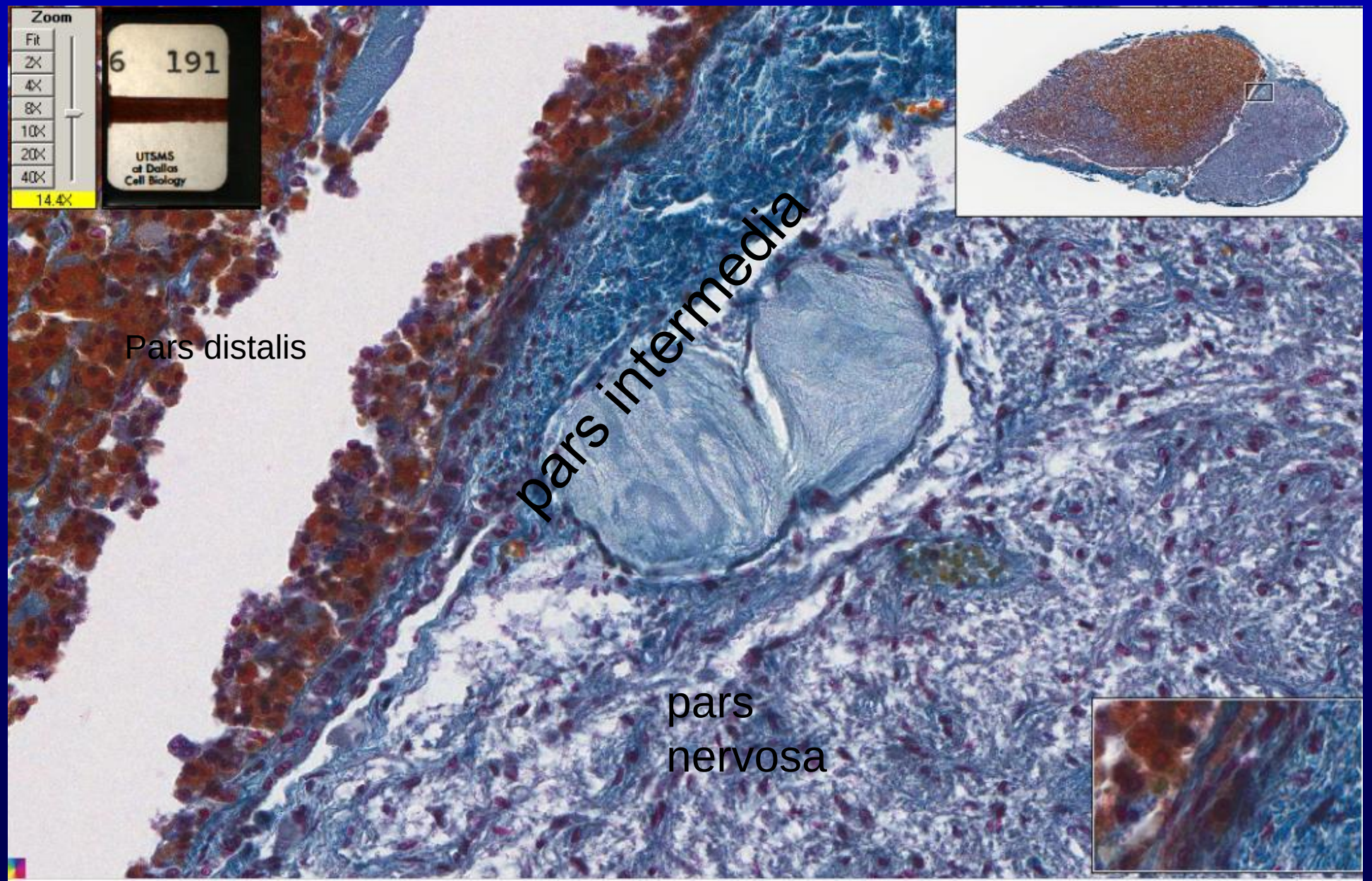
Pituitary (Herlant's stain) pars nervosa

191



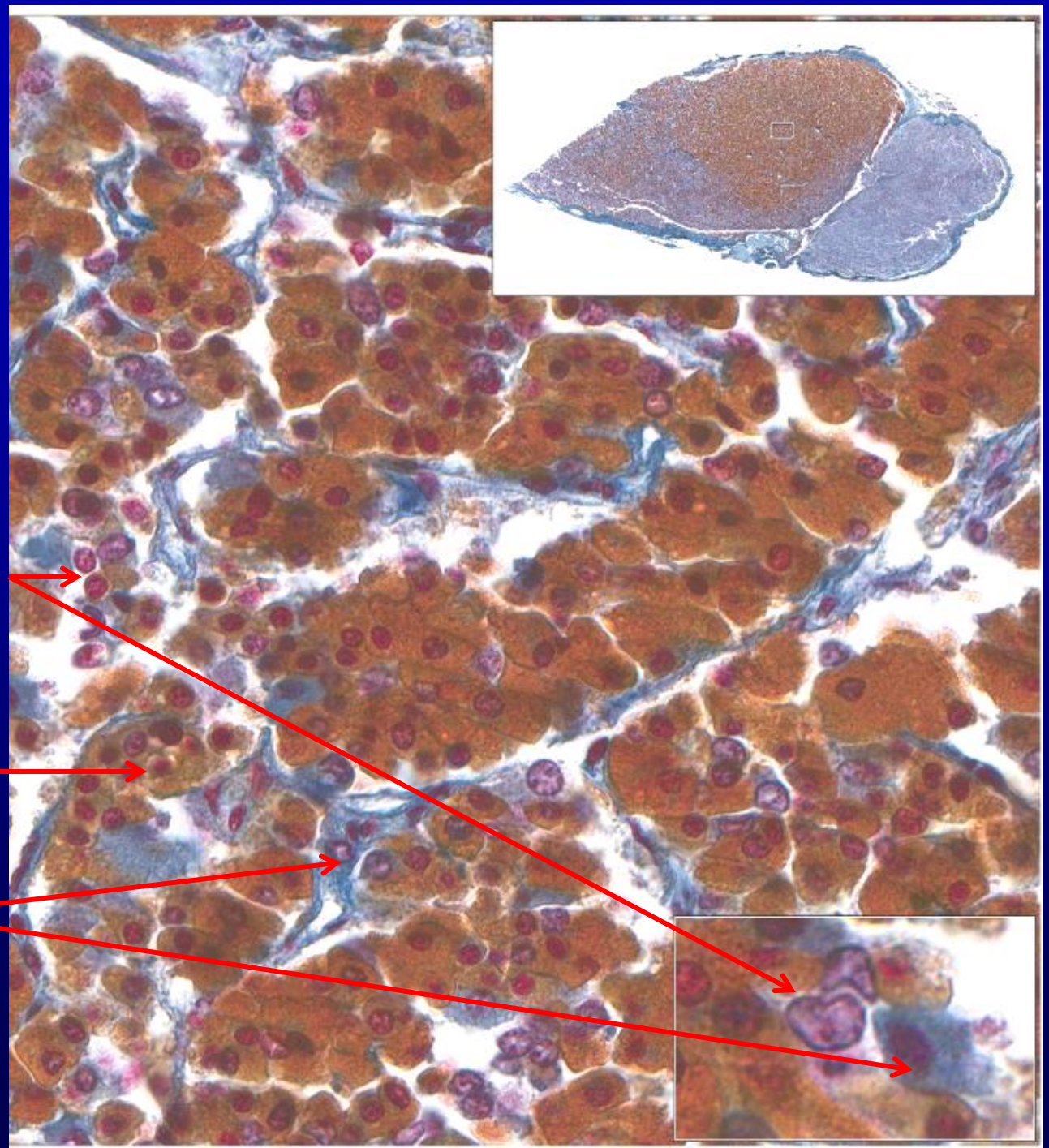
Pituitary (Herlant's stain) pars intermedia

191



191

Pars distalis of Pituitary (Herlant's stain) with chromophobe cells , acidophils, and basophils



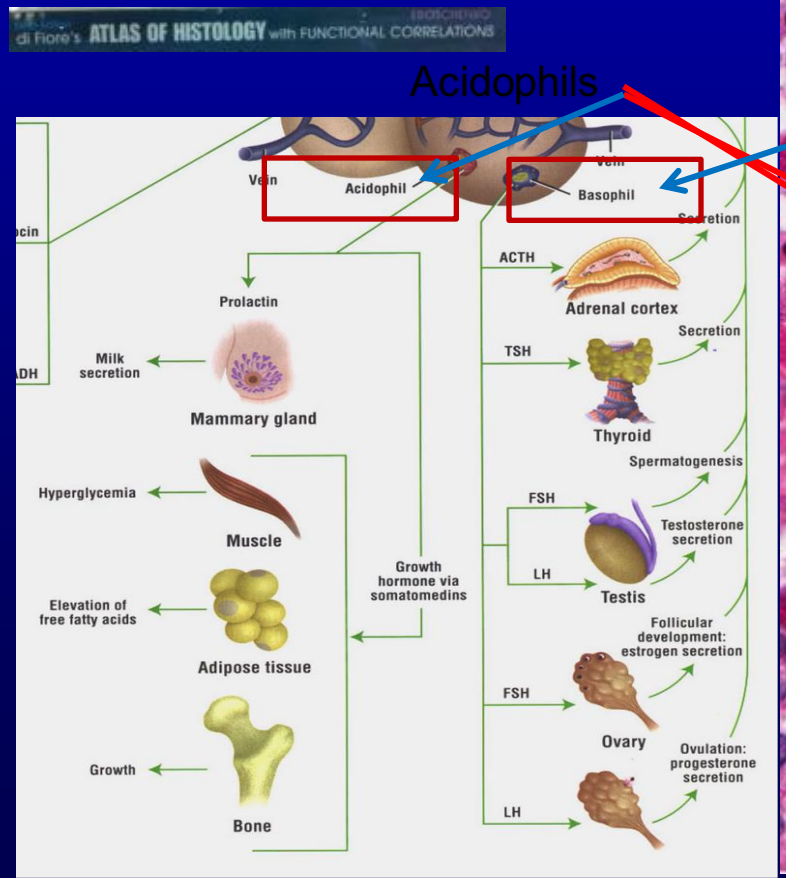
490

Pars distalis of Hypophysis

Chromophobes

Acidophils

Basophils



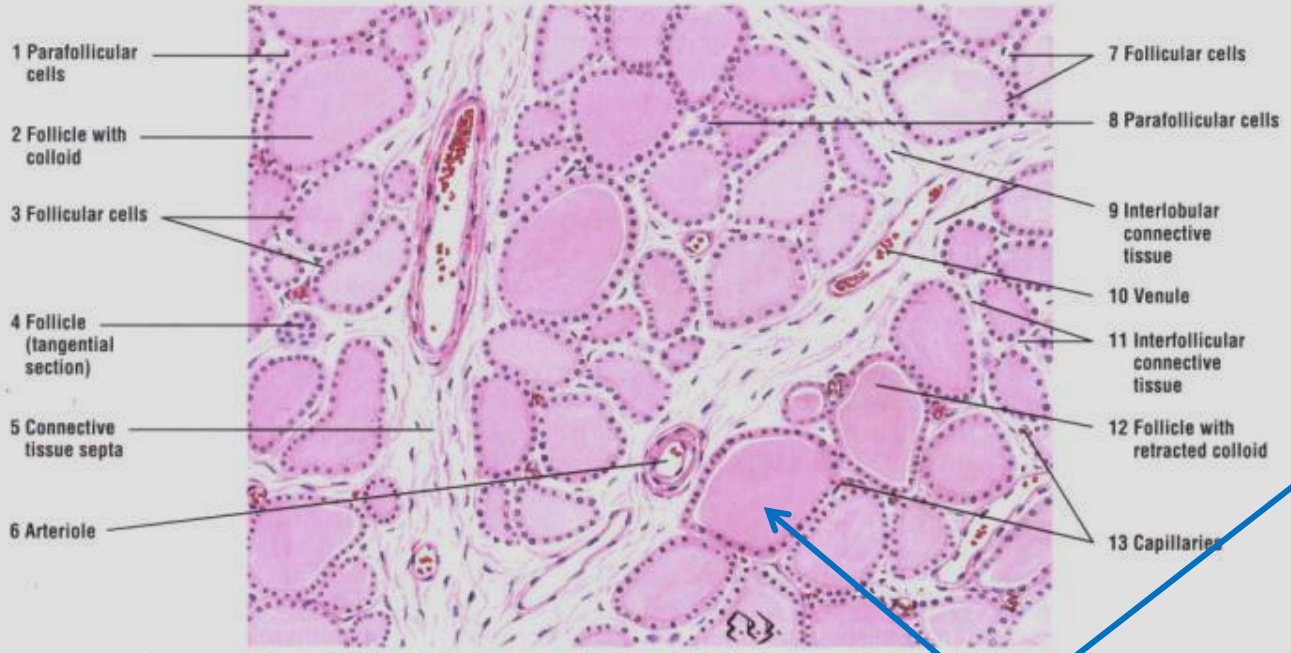


Fig. 16-5 **Thyroid Gland: Canine (general view).** Stain: hematoxylin-eosin. Low magnification.

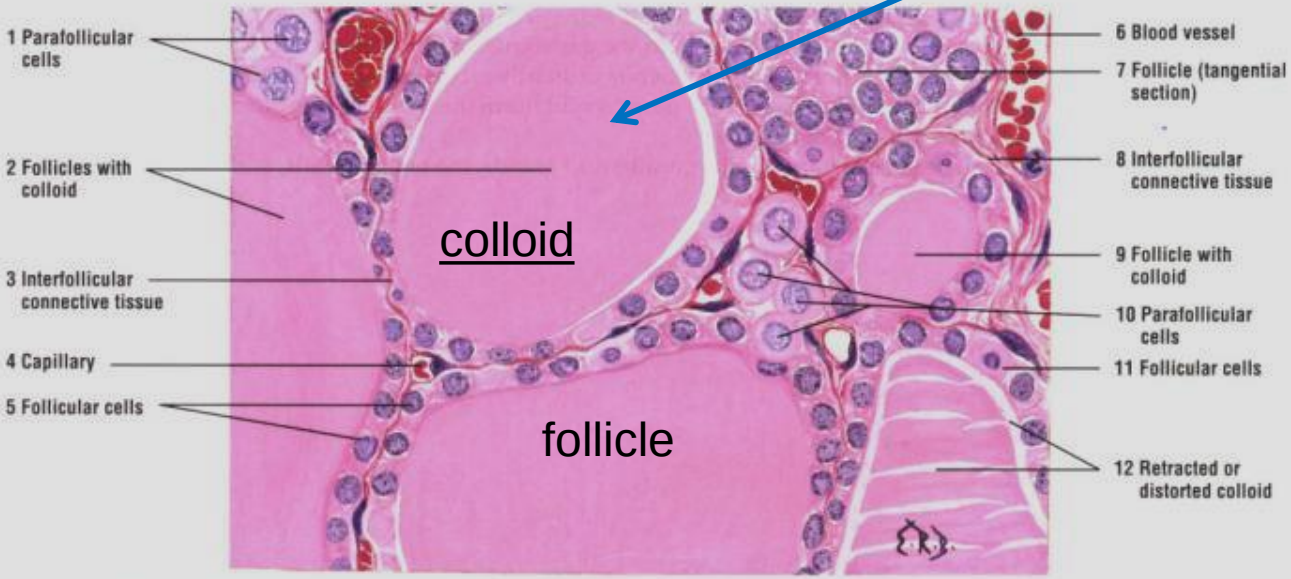
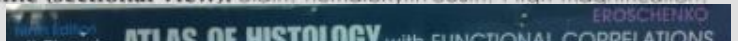
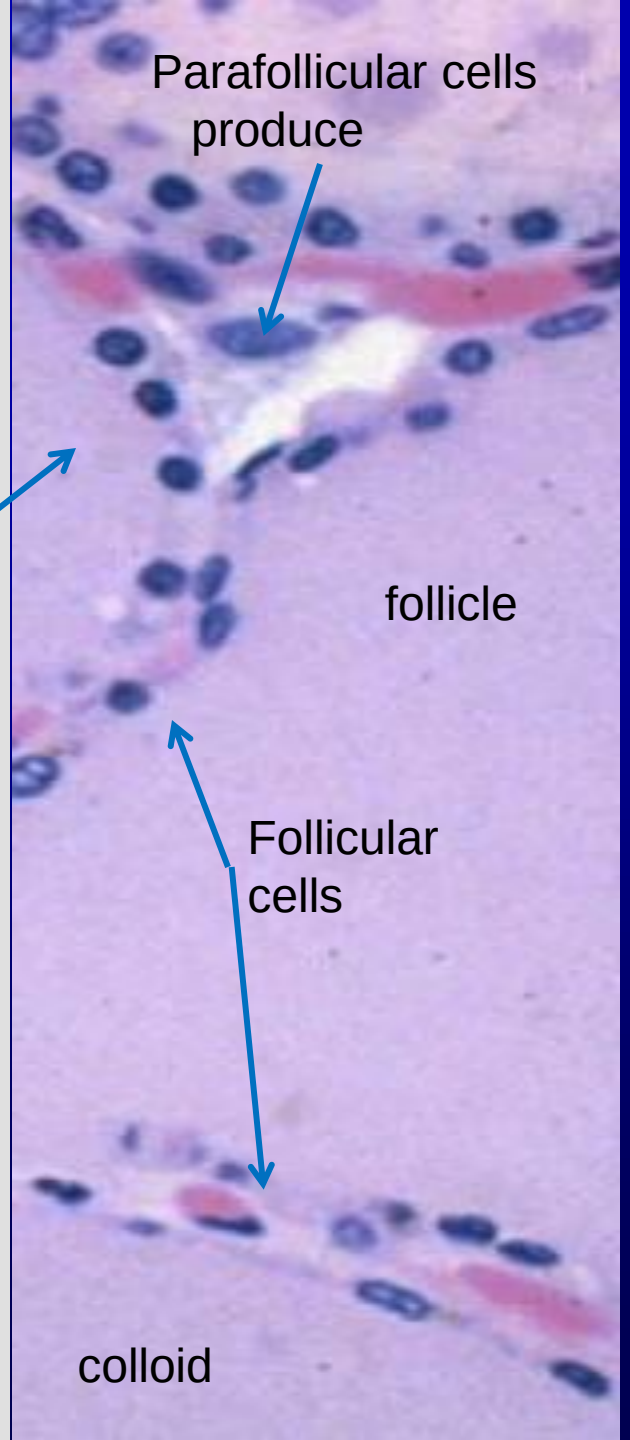


Fig. 16-6 **Thyroid Gland Follicles: Canine (sectional view).** Stain: hematoxylin-eosin. High magnification.



Follicles



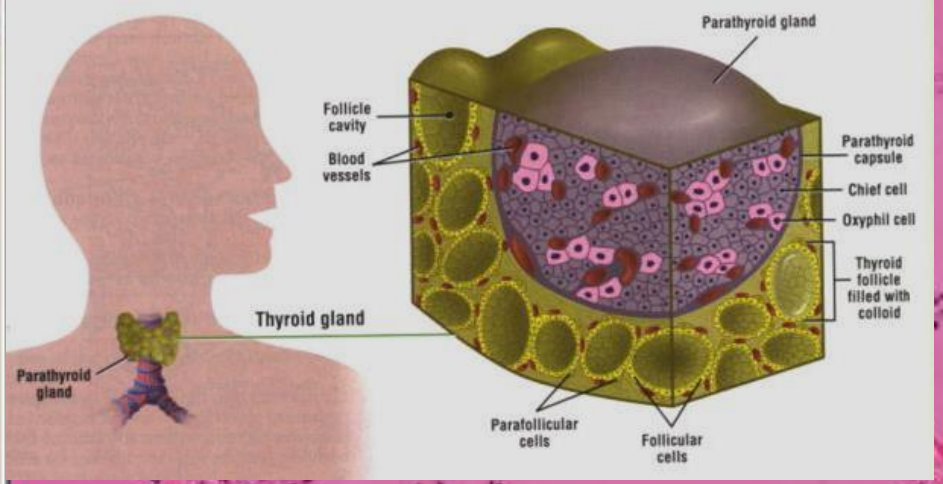
Thyroid gland

Components of a thyroid gland:

thyroid gland

1. Colloid
2. Follicular cells
3. Capillary

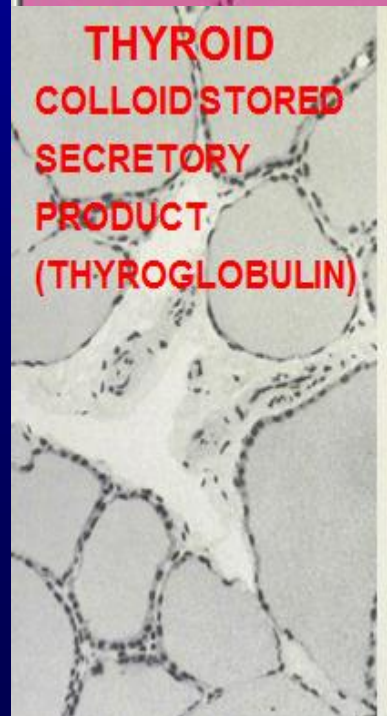
184

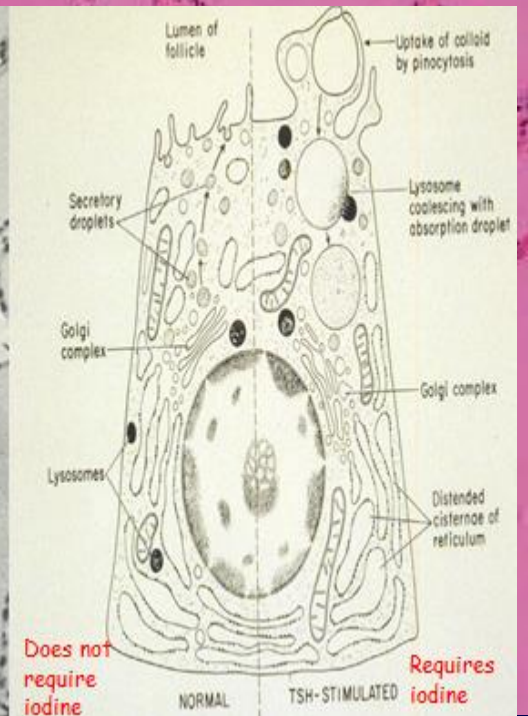


Follicular cells

Colloid

Capillary





184 Thyroid – follicular cells

184

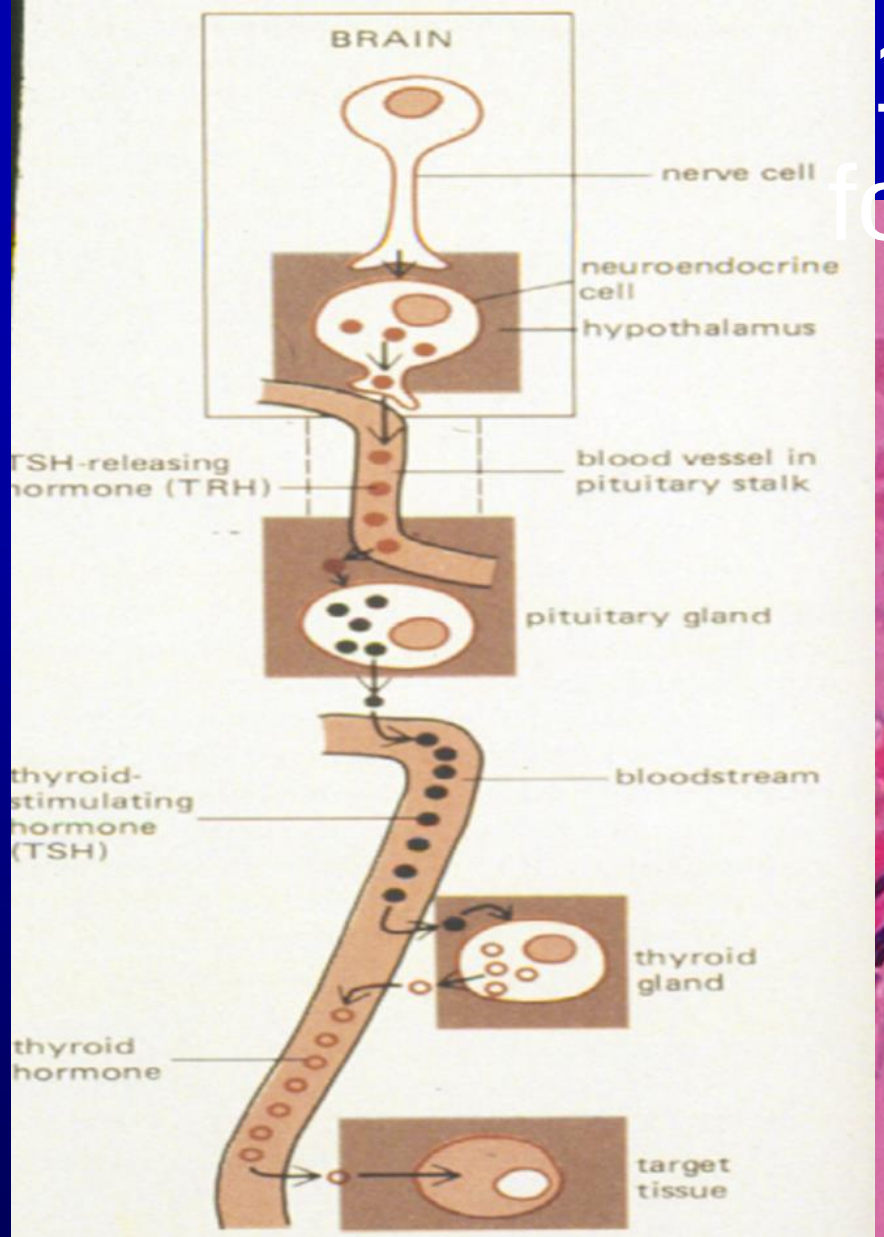
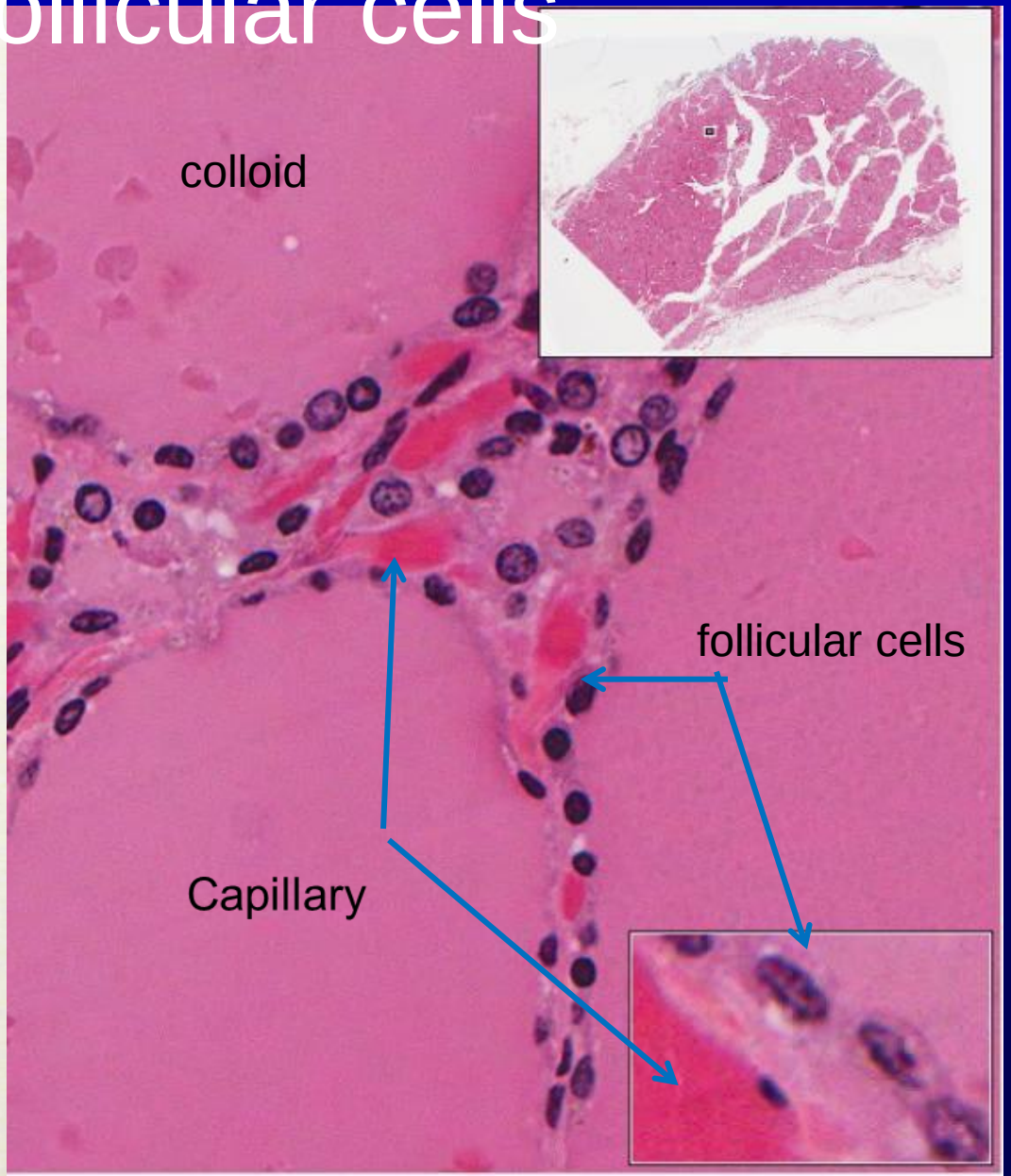
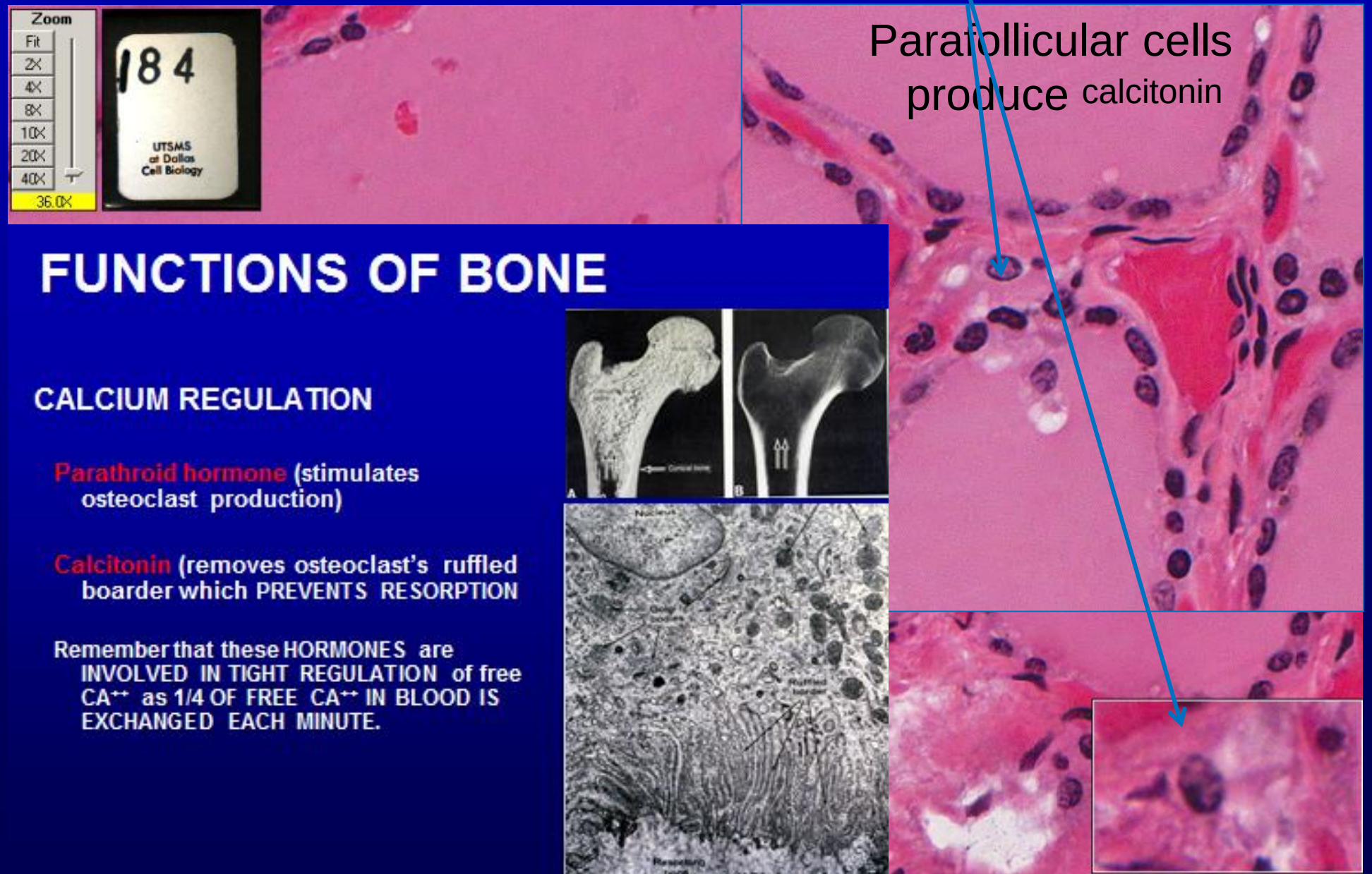


Figure 12–4 Thyroid hormone secretion is regulated indirectly by the nervous system. When stimulated by nerve cells in higher centers of the brain, specific neuroendocrine cells in the hypothalamus secrete TSH-releasing



184 Thyroid –parafollicular cells



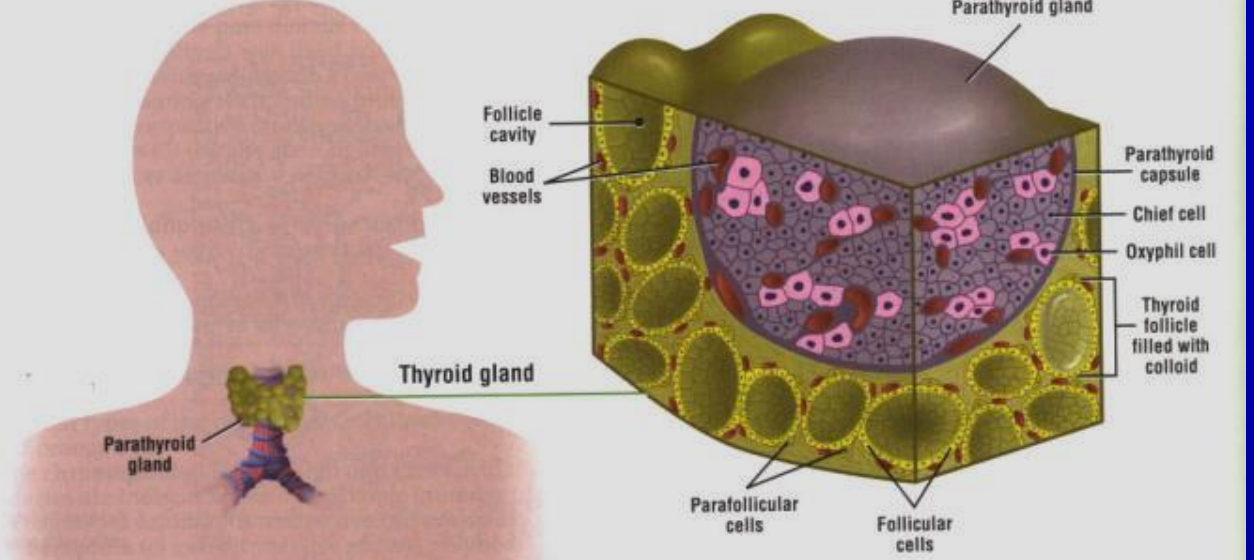
FUNCTIONS OF BONE

CALCIUM REGULATION

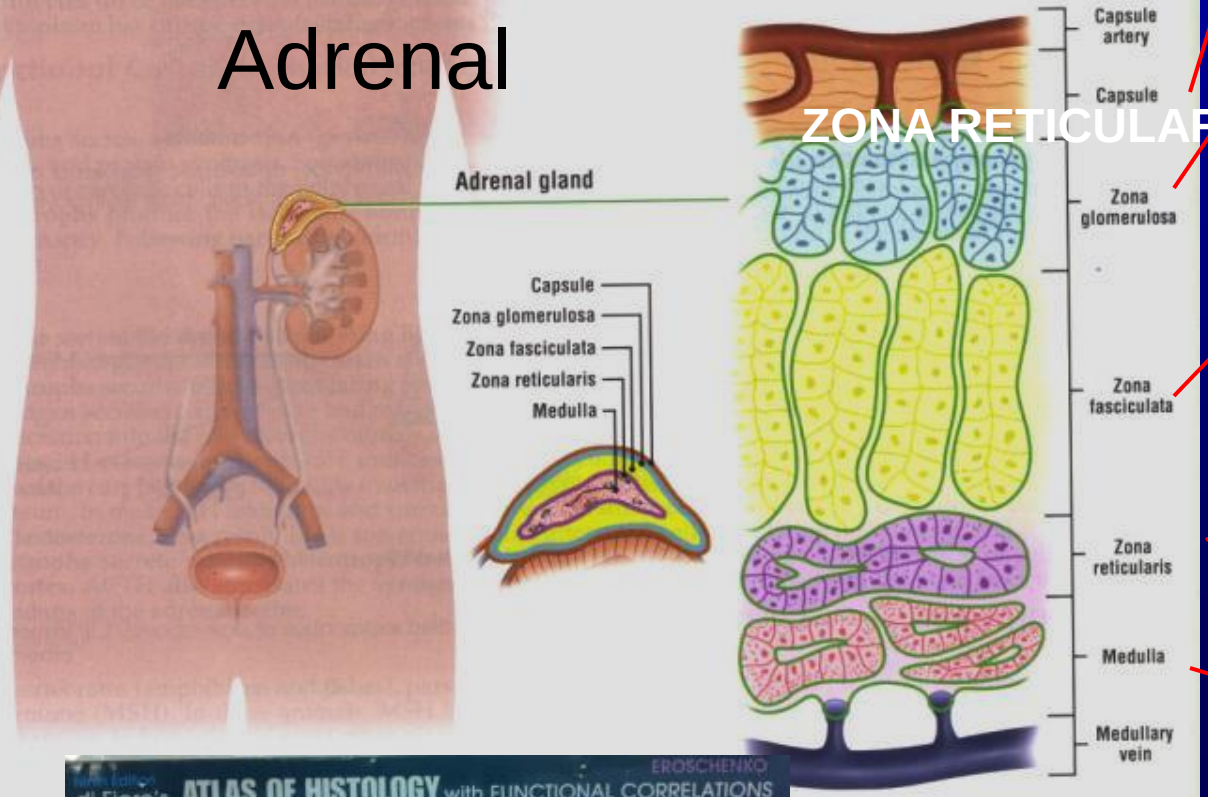
Parathroid hormone (stimulates osteoclast production)

Calcitonin (removes osteoclast's ruffled boarder which PREVENTS RESORPTION

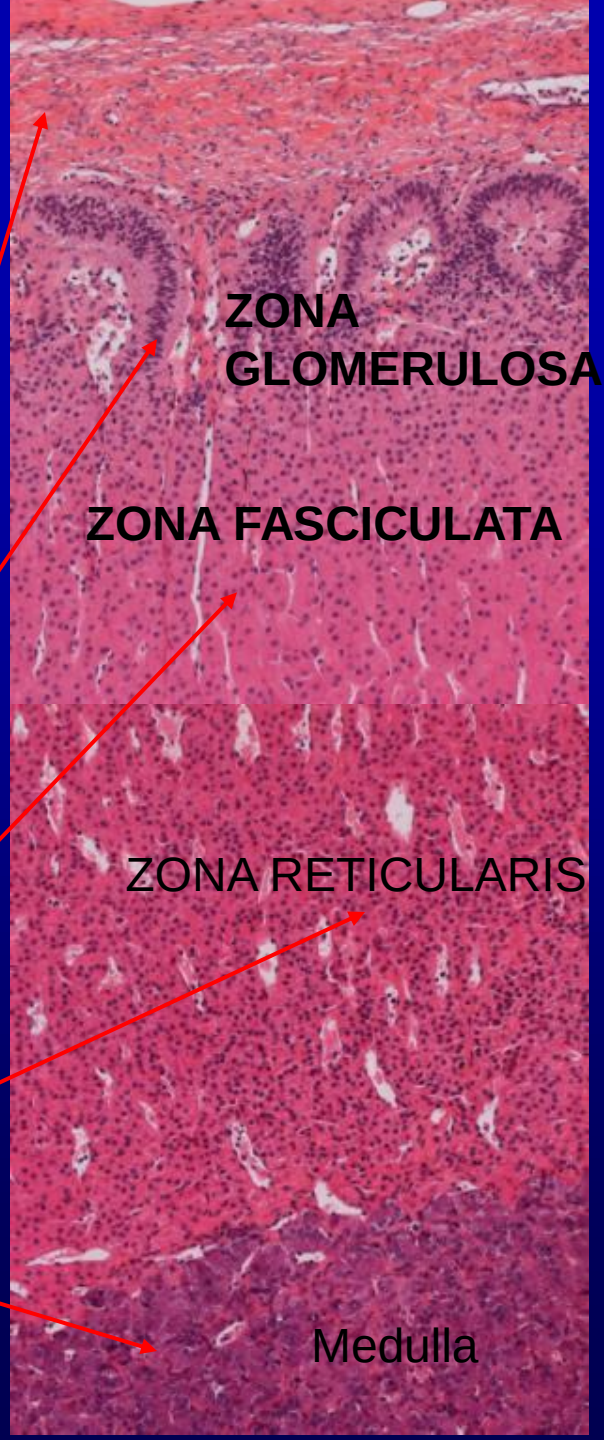
Remember that these HORMONES are INVOLVED IN TIGHT REGULATION of free CA^{++} as 1/4 OF FREE CA^{++} IN BLOOD IS EXCHANGED EACH MINUTE.



Adrenal



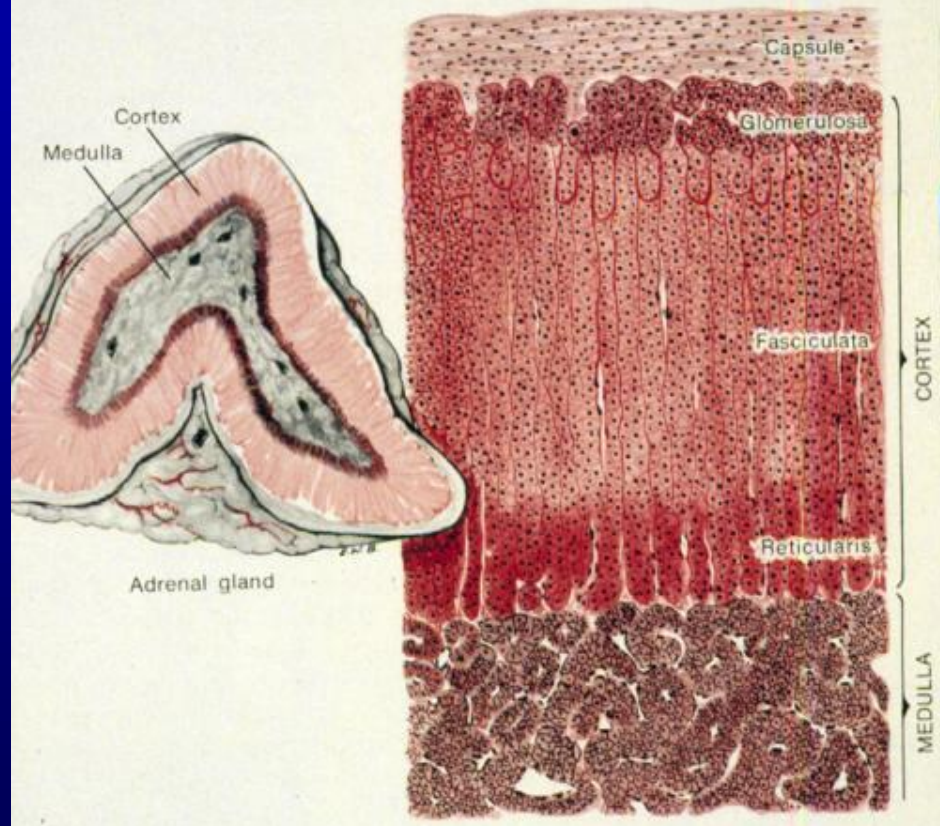
ZONA RETICULARIS



c activity. Oxytocin has a pro-
stimulating effect on the smooth
re of the uterus. This may assist
transport and is of probable im-
in parturition. It is, therefore,
employed by physicians to aug-

ADRENAL OR SUPRARENAL GLANDS

The adrenals (*ad*, near; *ren*, kidney)
two small yellowish masses of tissue ly
above or near the kidneys (Fig. 29-



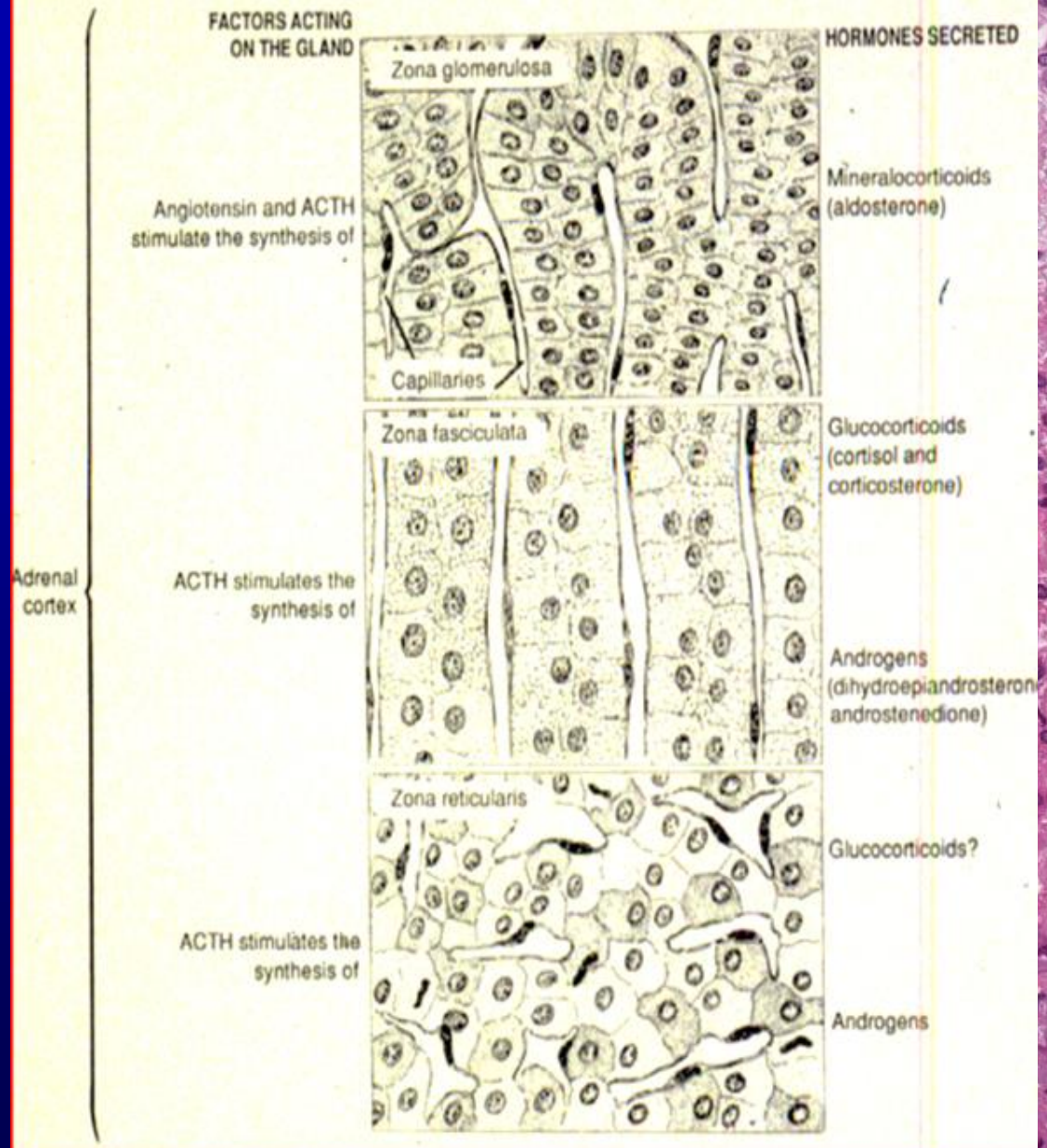
28-5
ration showing structure of adrenal gland.

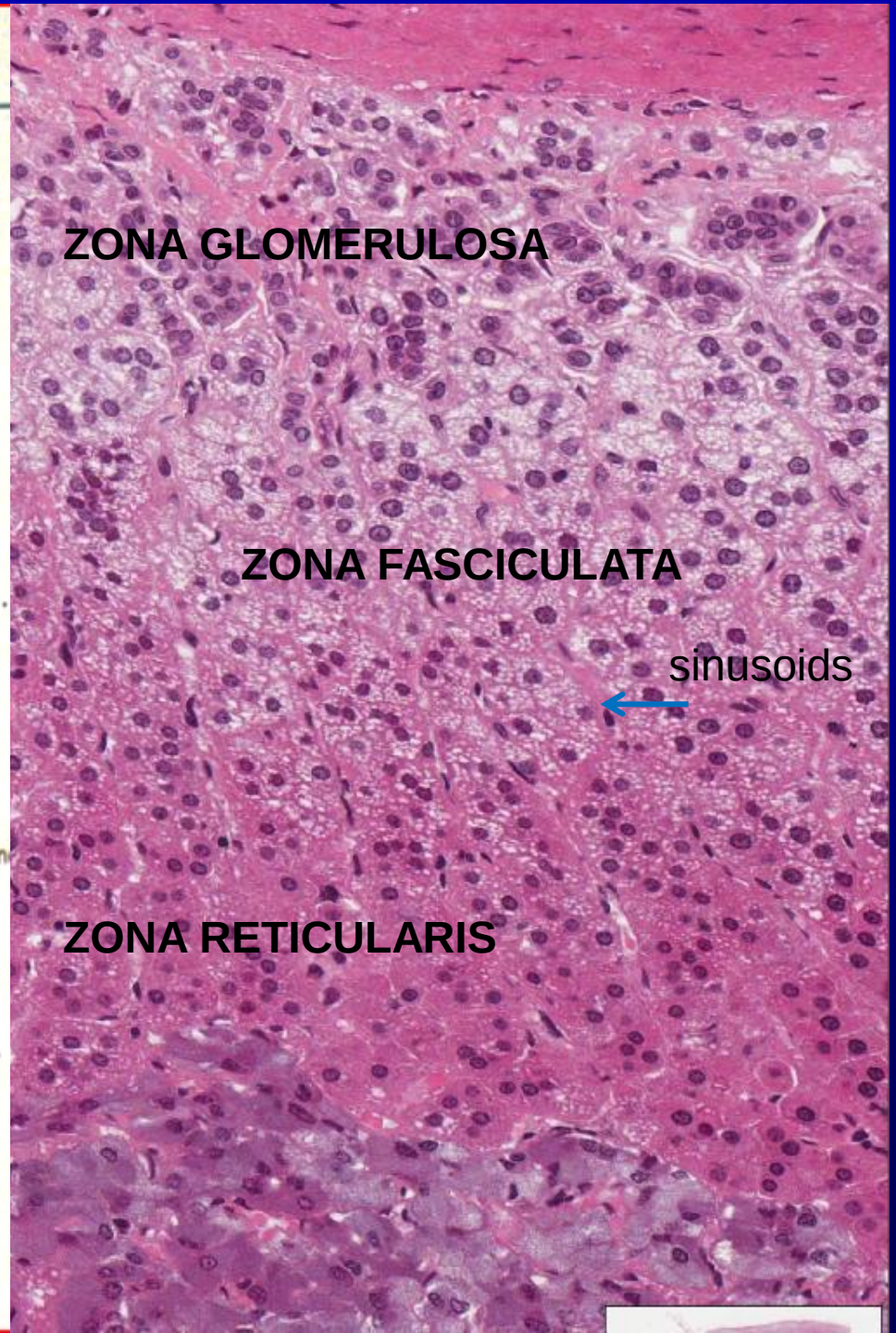
ZONA GLOMERULOSA

ZONA FASCICULATA

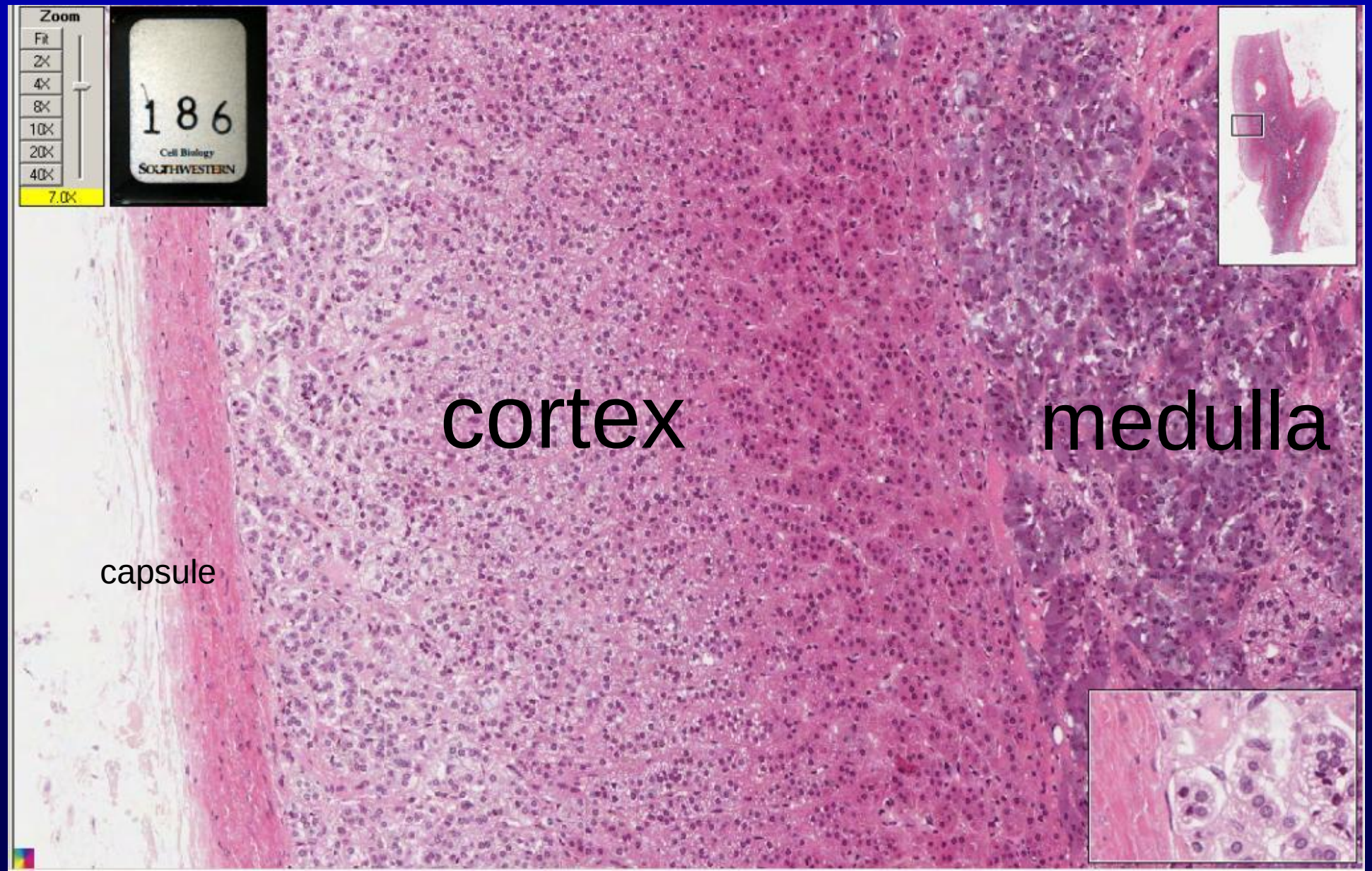
ZONA RETICULARIS

Medulla


FACTORS ACTING ON THE GLAND
HORMONES SECRETED
Zona glomerulosa
Angiotensin and ACTH stimulate the synthesis of
Mineralocorticoids (aldosterone)
Capillaries
Zona fasciculata
Glucocorticoids (cortisol and corticosterone)
Adrenal cortex
ACTH stimulates the synthesis of
Androgens (dihydroepiandrosteron androstenedione)
Zona reticularis
Glucocorticoids?
ACTH stimulates the synthesis of
Androgens

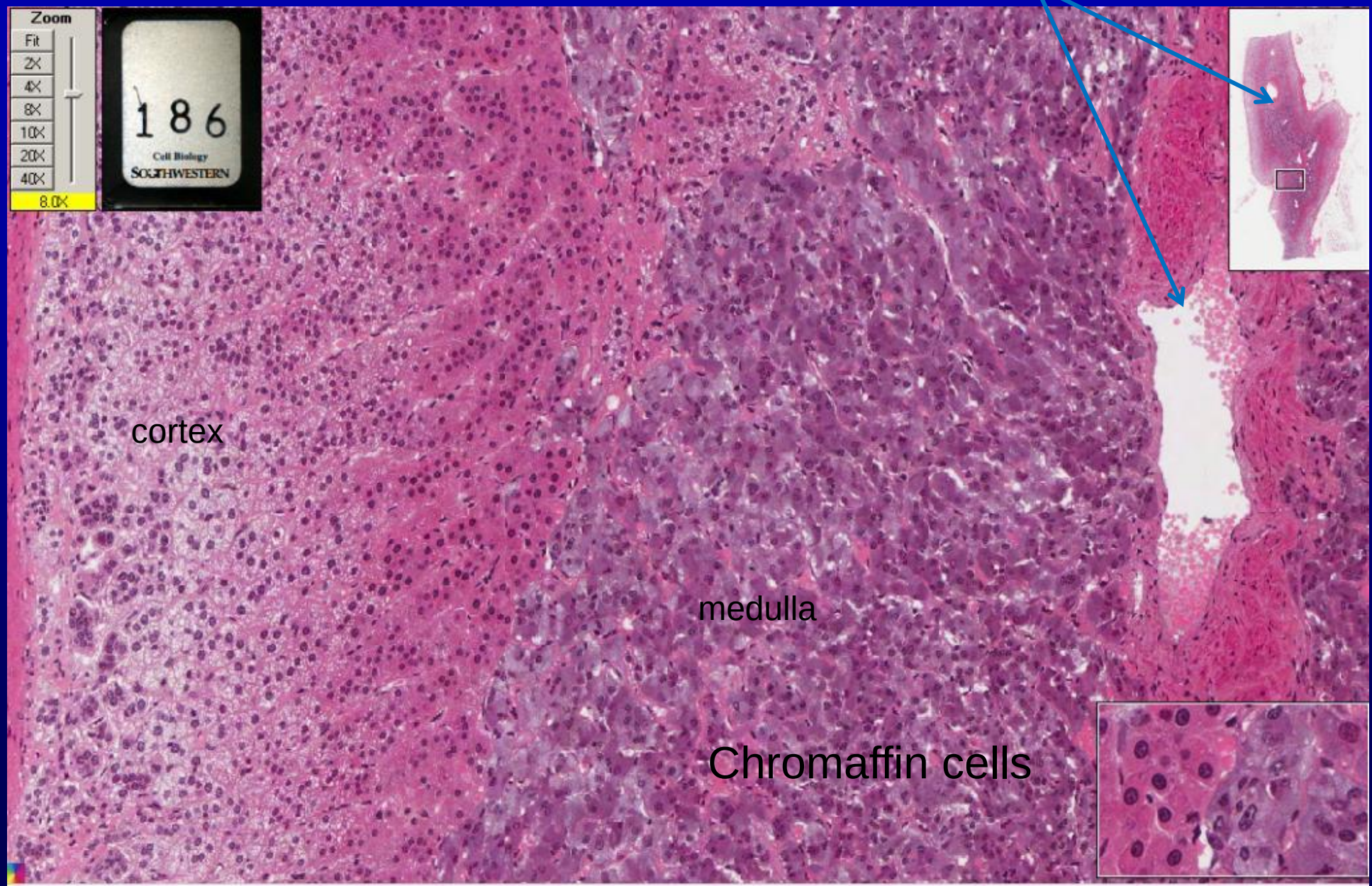

ZONA GLOMERULOSA
ZONA FASCICULATA
sinusoids
ZONA RETICULARIS

186 Adrenal -cortex and medulla



Adrenal -cortex and medulla

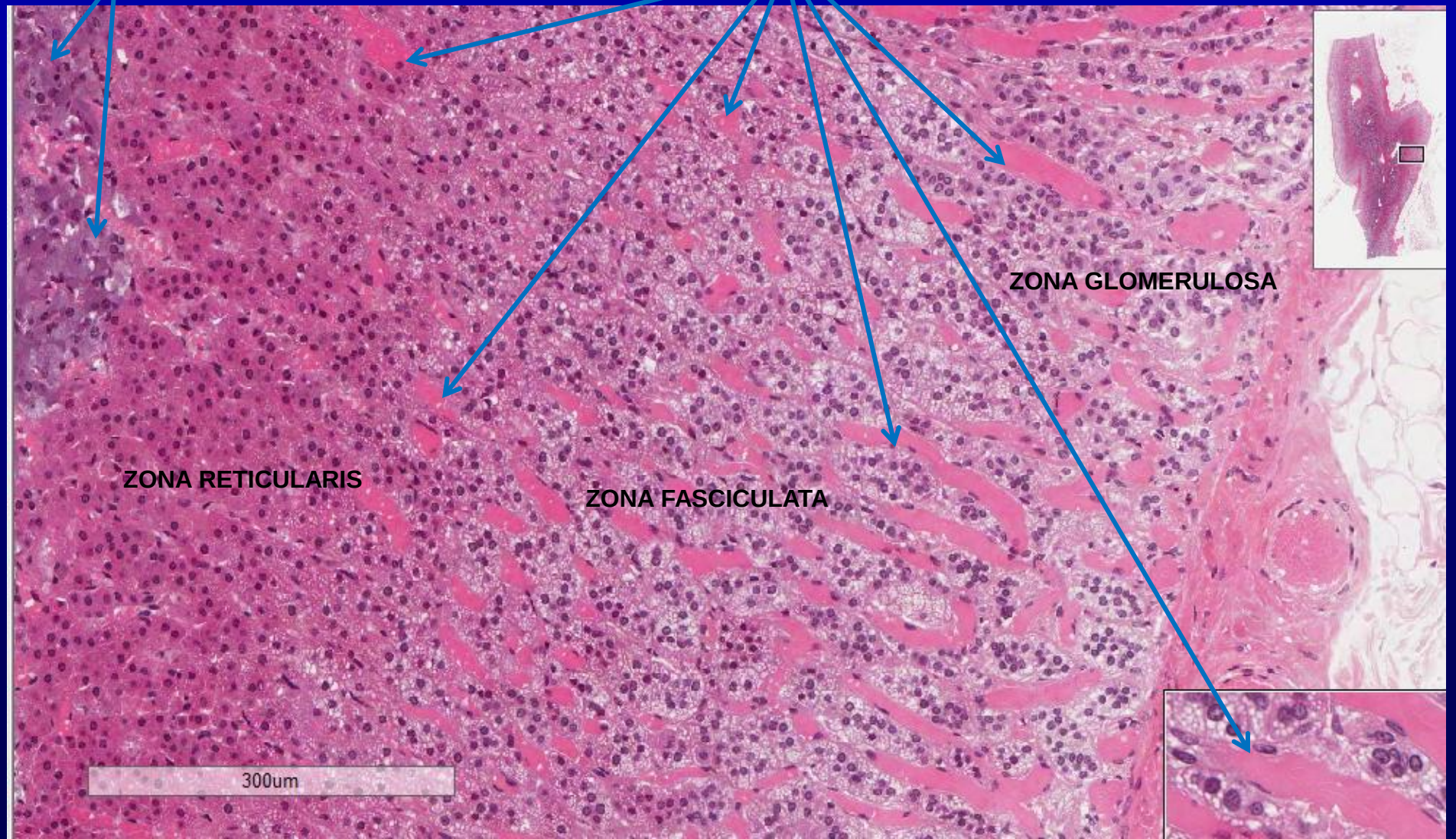
186



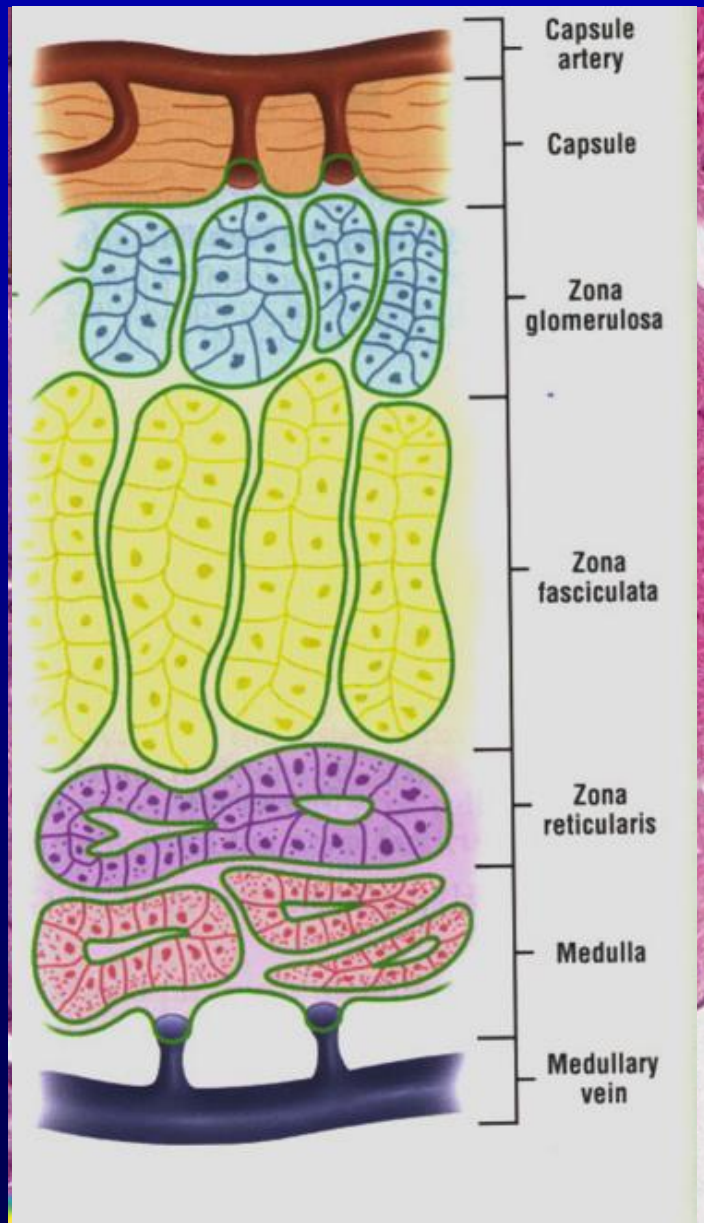
186 Adrenal -cortex and medulla

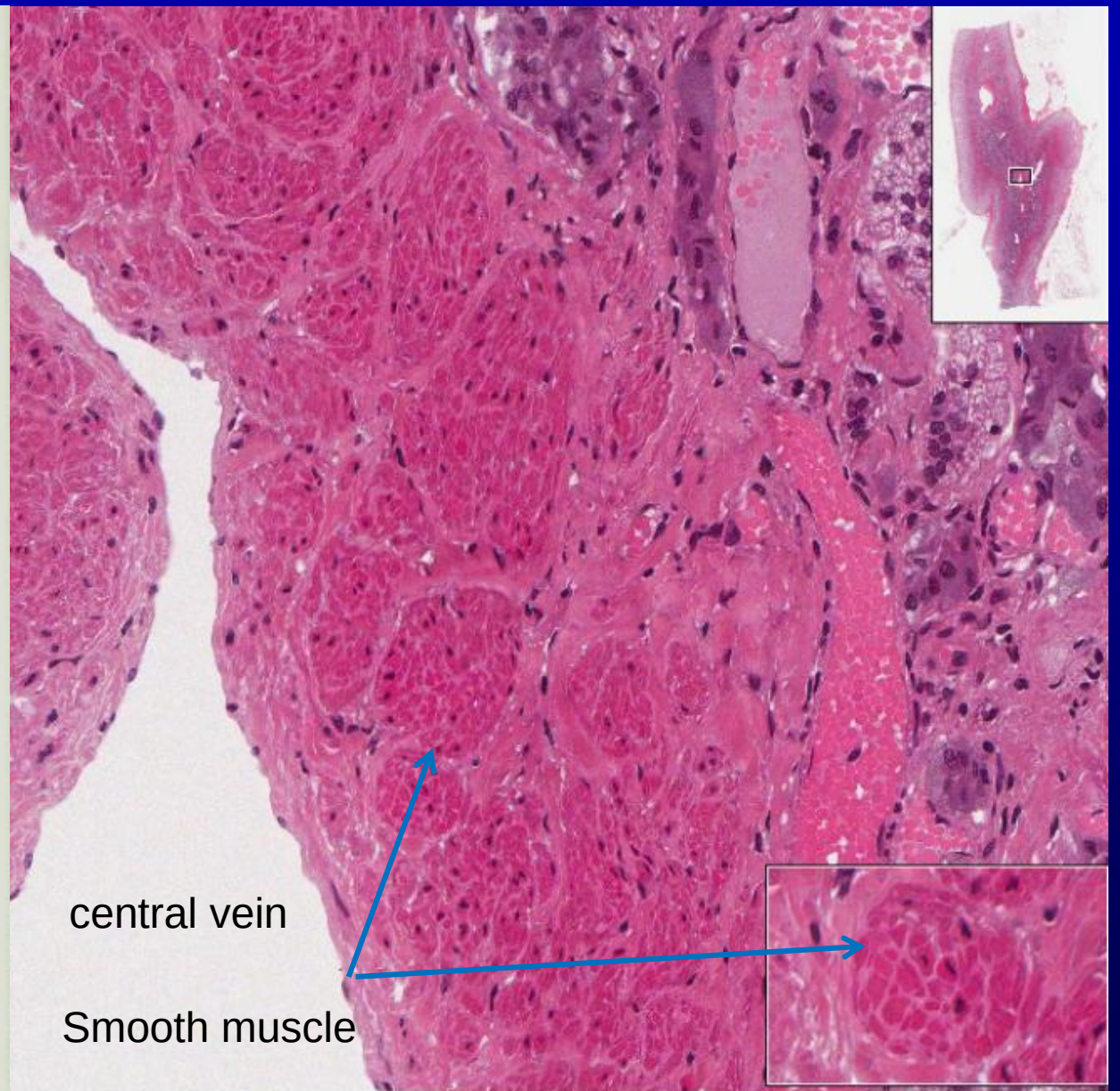
Chromaffin cells are basophilic

Sinusoids



186 Adrenal - central vein





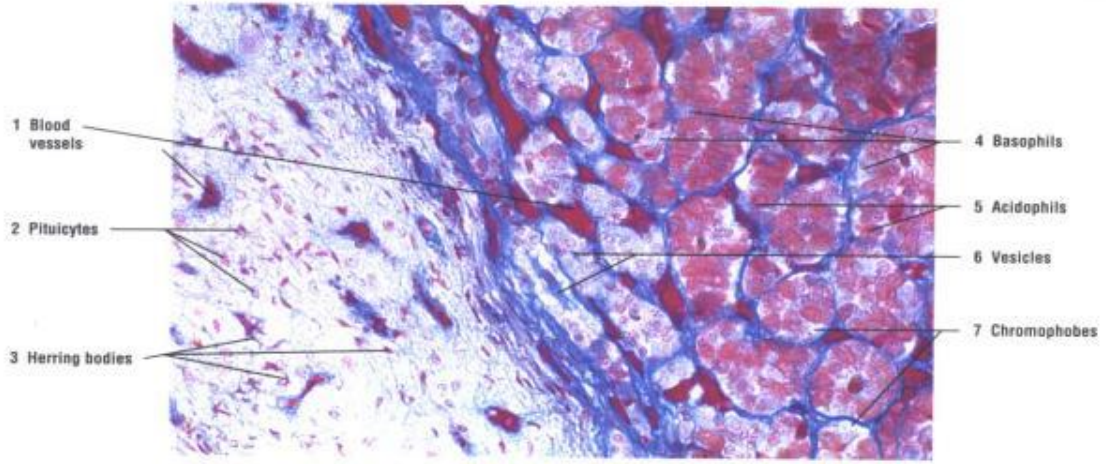


Fig. 16-9 Hypophysis: Pars distalis, Pars Intermedia, and Pars Nervosa (Human). Stain: Mallory-azan and orange G. 80×

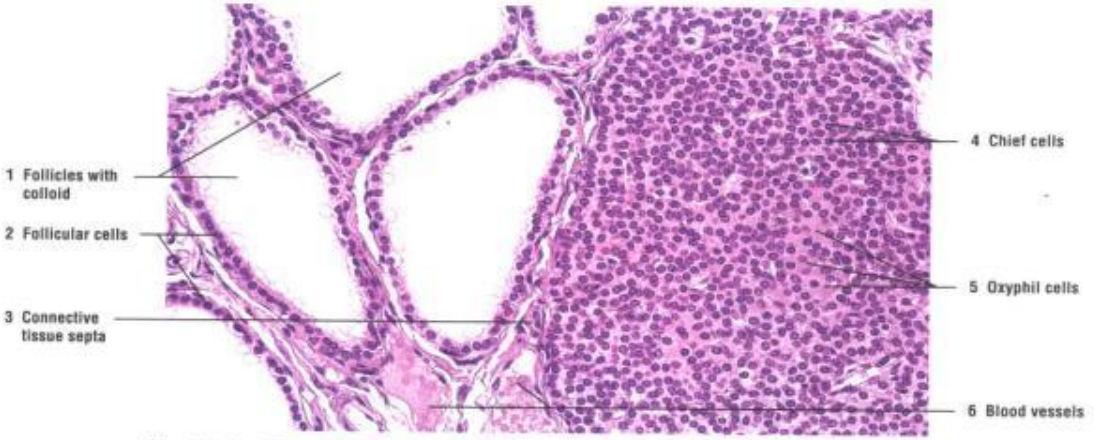


Fig. 16-10 Thyroid Gland and Parathryoid Gland. Stain: hematoxylin-eosin. 80×

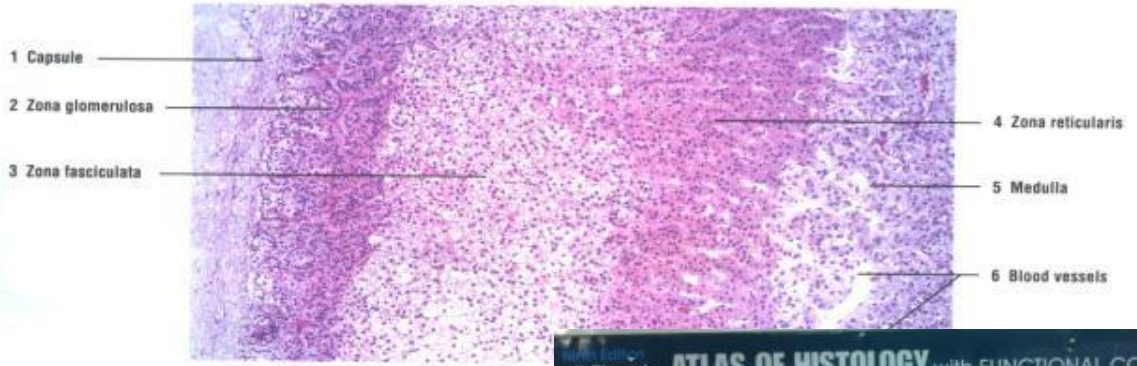
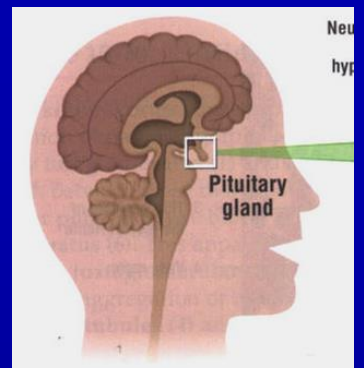
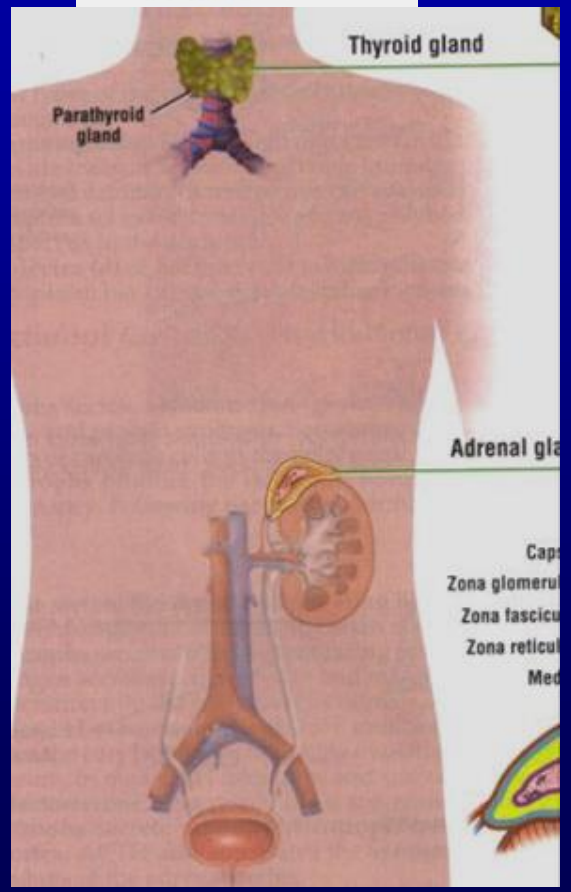


Fig. 16-11 Adrenal (Suprarenal) Gland: Cortex and





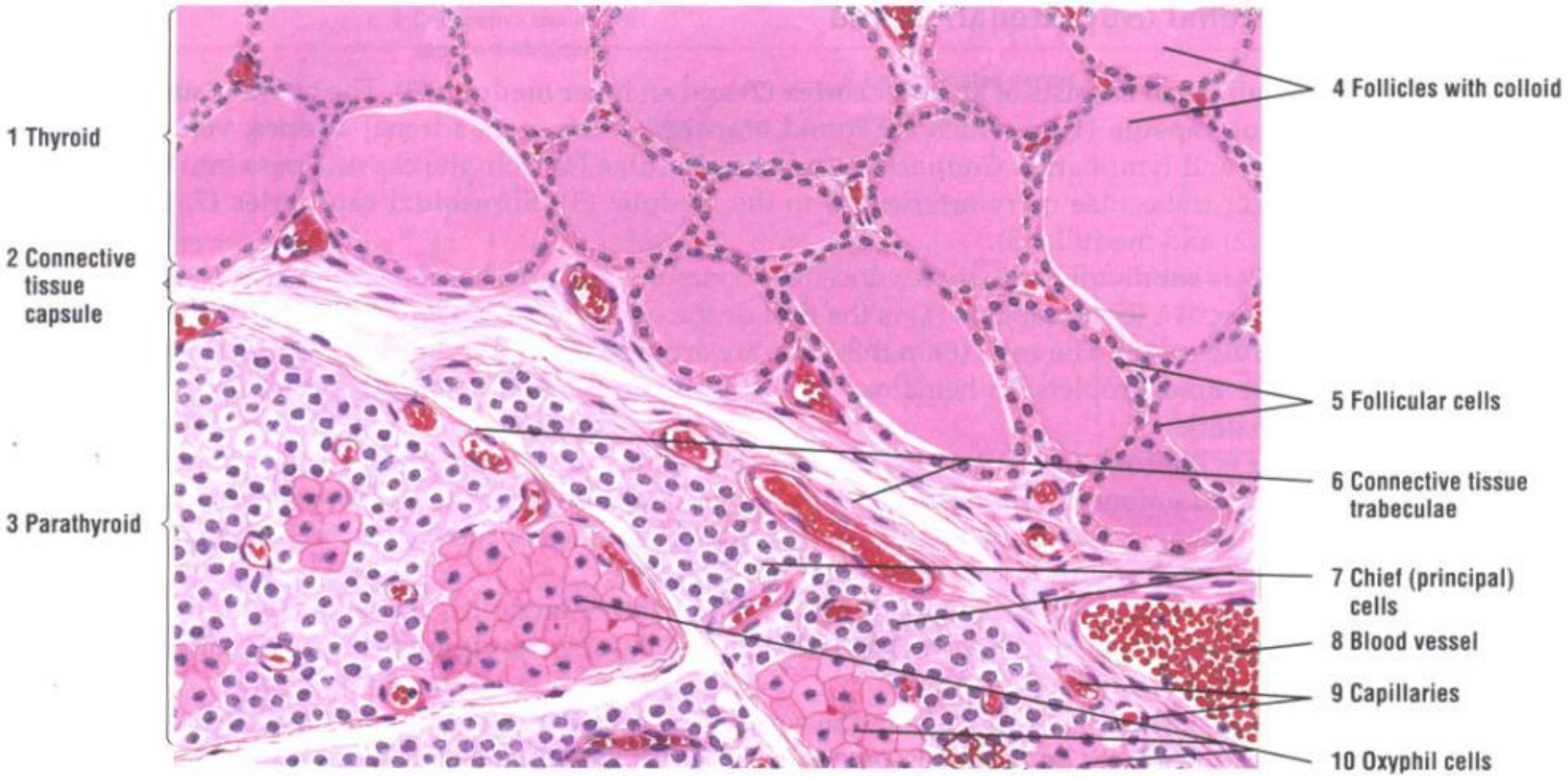
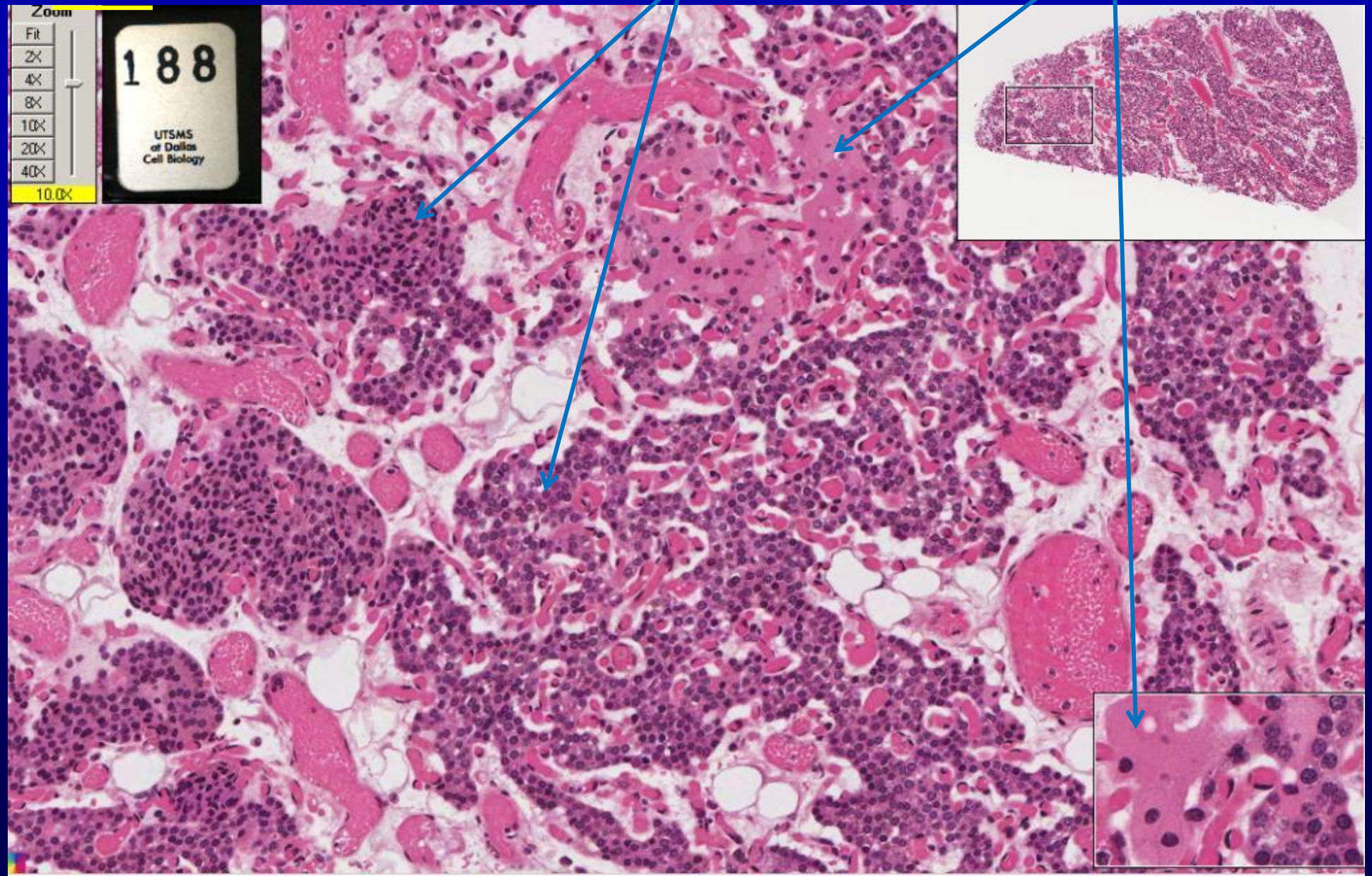


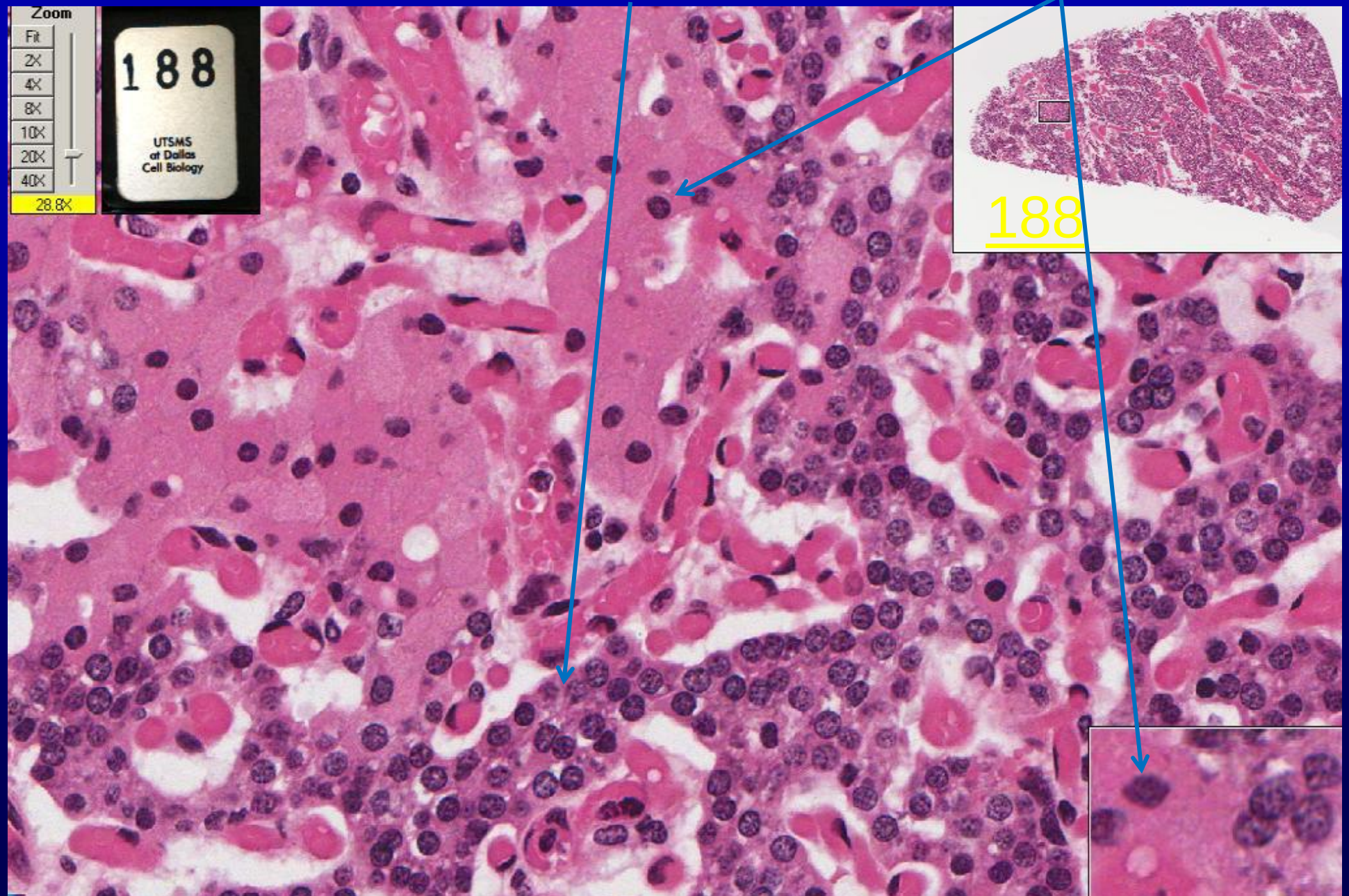
Fig. 16-7 Thyroid and Parathyroid Glands: Canine (sectional view). Stain: hematoxylin-eosin. Low magnification.

Parathyroid – chief cells and oxyphils

188



Parathyroid – chief cells and oxyphils



484 Parathyroid – chief cells and oxyphils

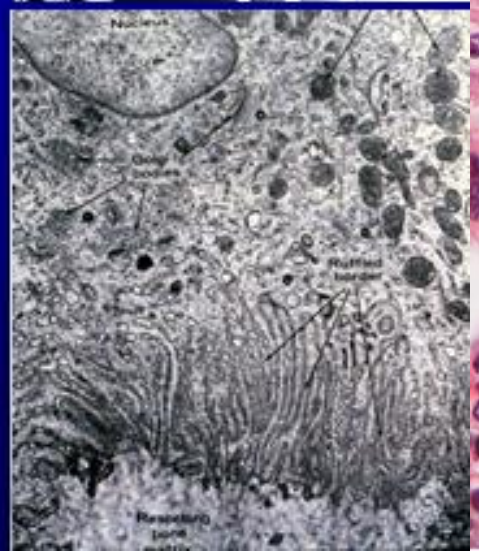
FUNCTIONS OF BONE

CALCIUM REGULATION

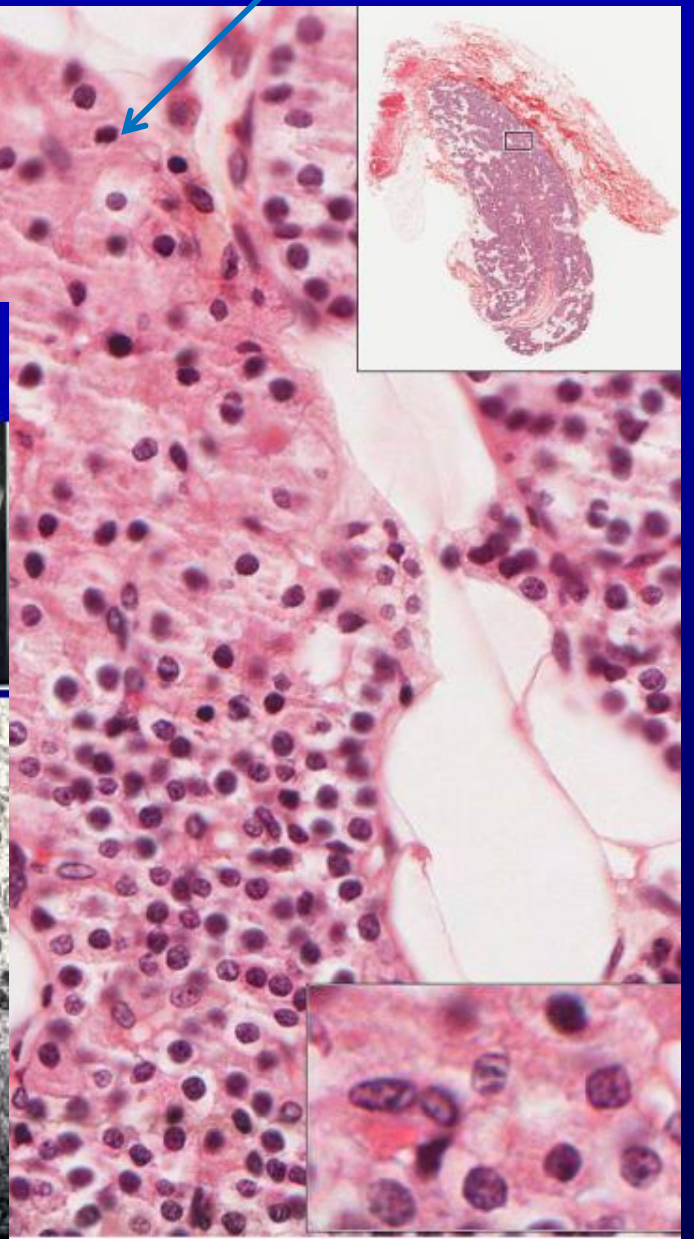
Parathroid hormone (stimulates osteoclast production)

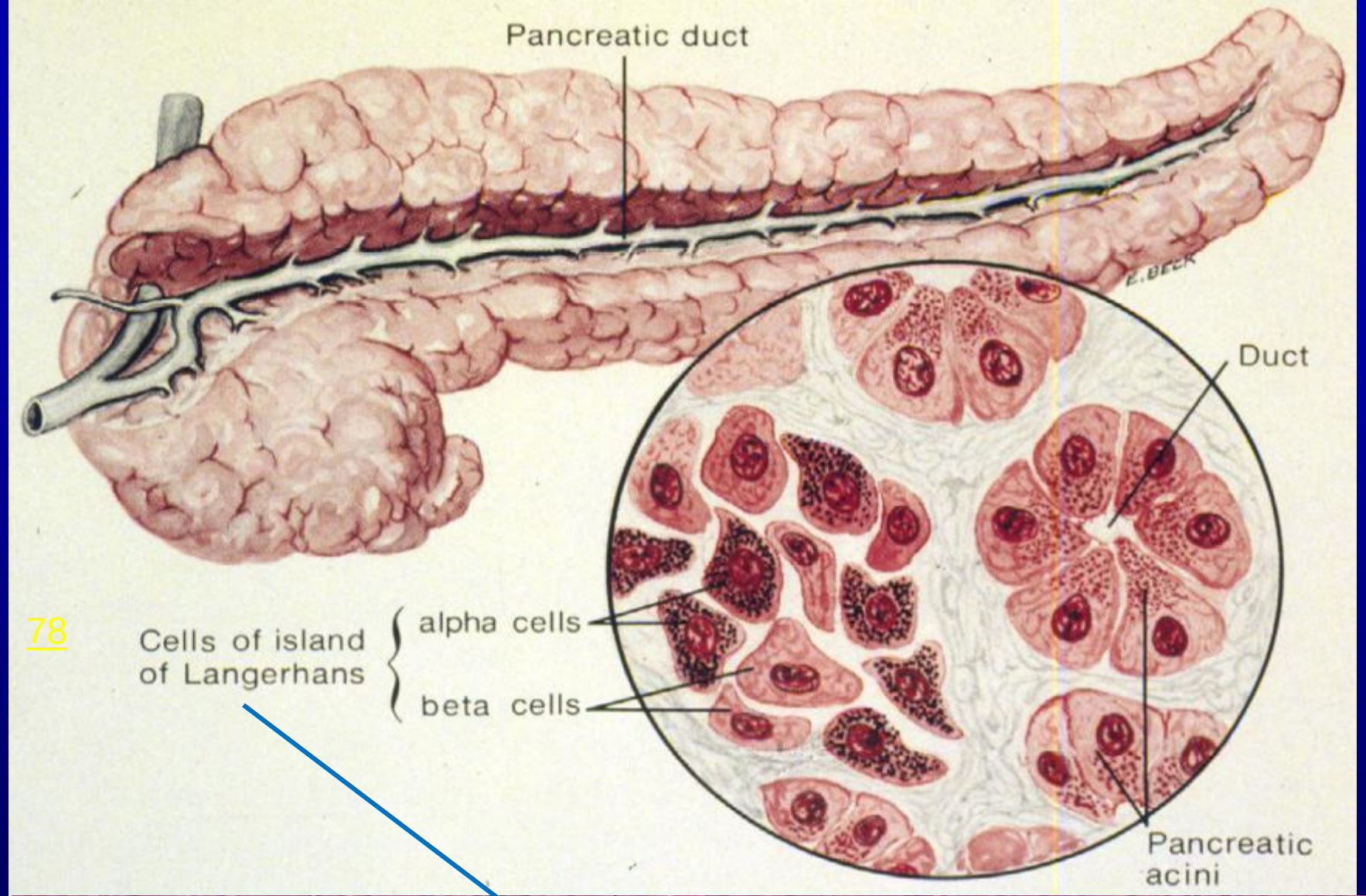
Calcitonin (removes osteoclast's ruffled boarder which PREVENTS RESORPTION

Remember that these HORMONES are INVOLVED IN TIGHT REGULATION of free CA^{++} as 1/4 OF FREE CA^{++} IN BLOOD IS EXCHANGED EACH MINUTE.

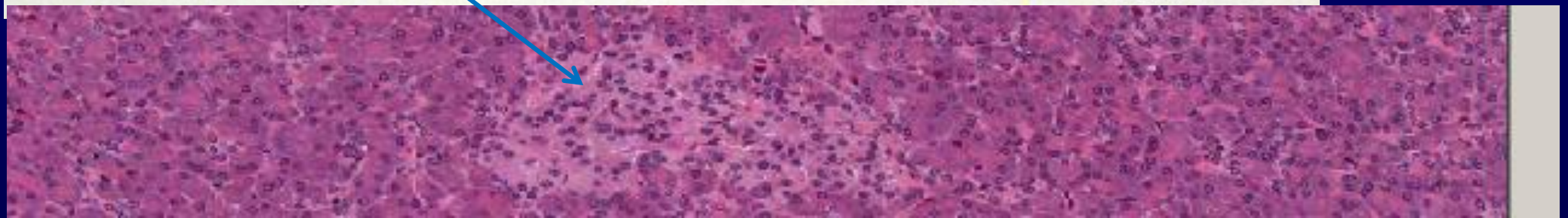


Osteoporosis due to hyperparathyroidism



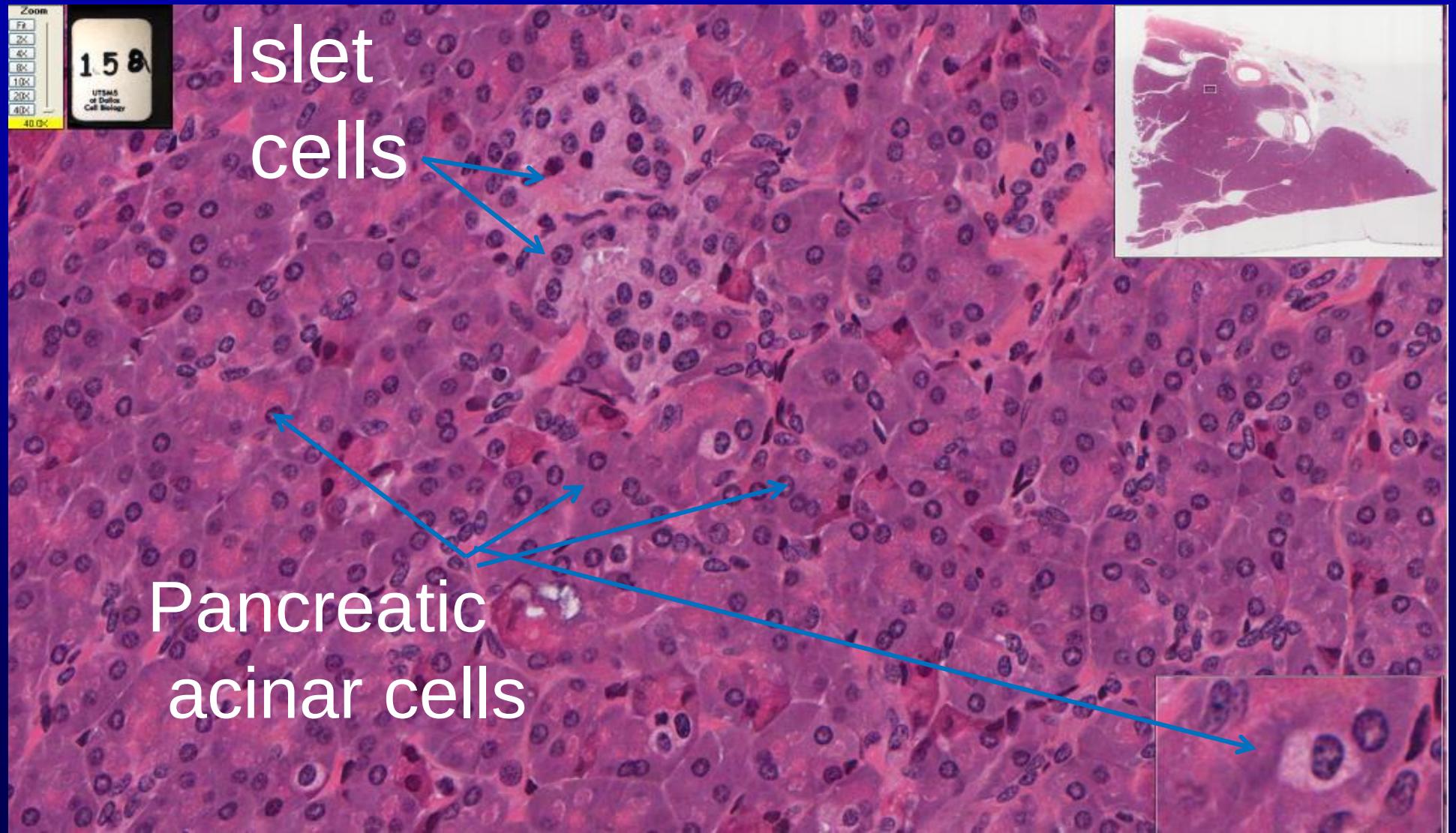

Pancreatic duct
Duct
Cells of island of Langerhans
alpha cells
beta cells
Pancreatic acini

78



Pancreas - Islets of Langerhans

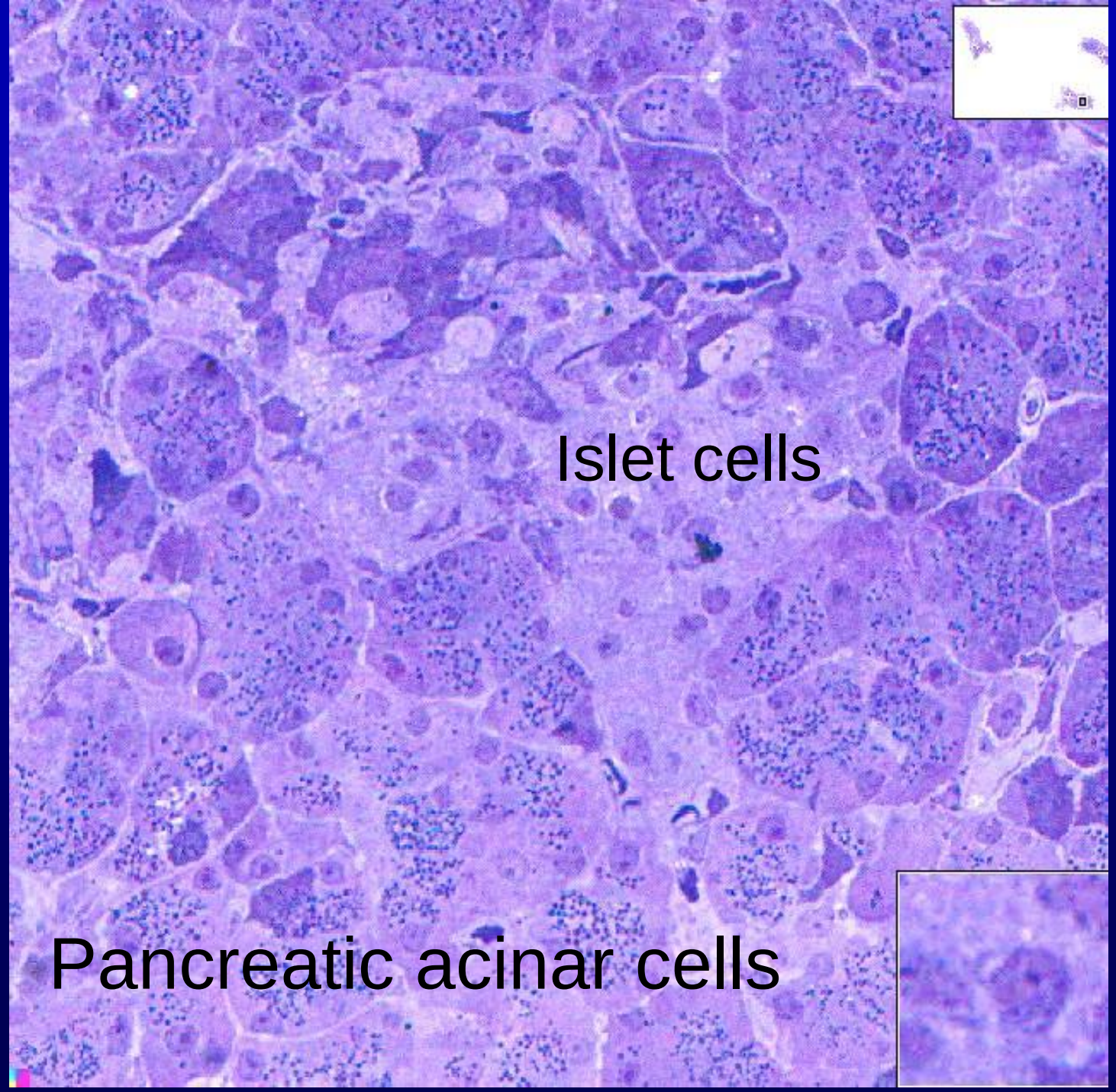
158



156

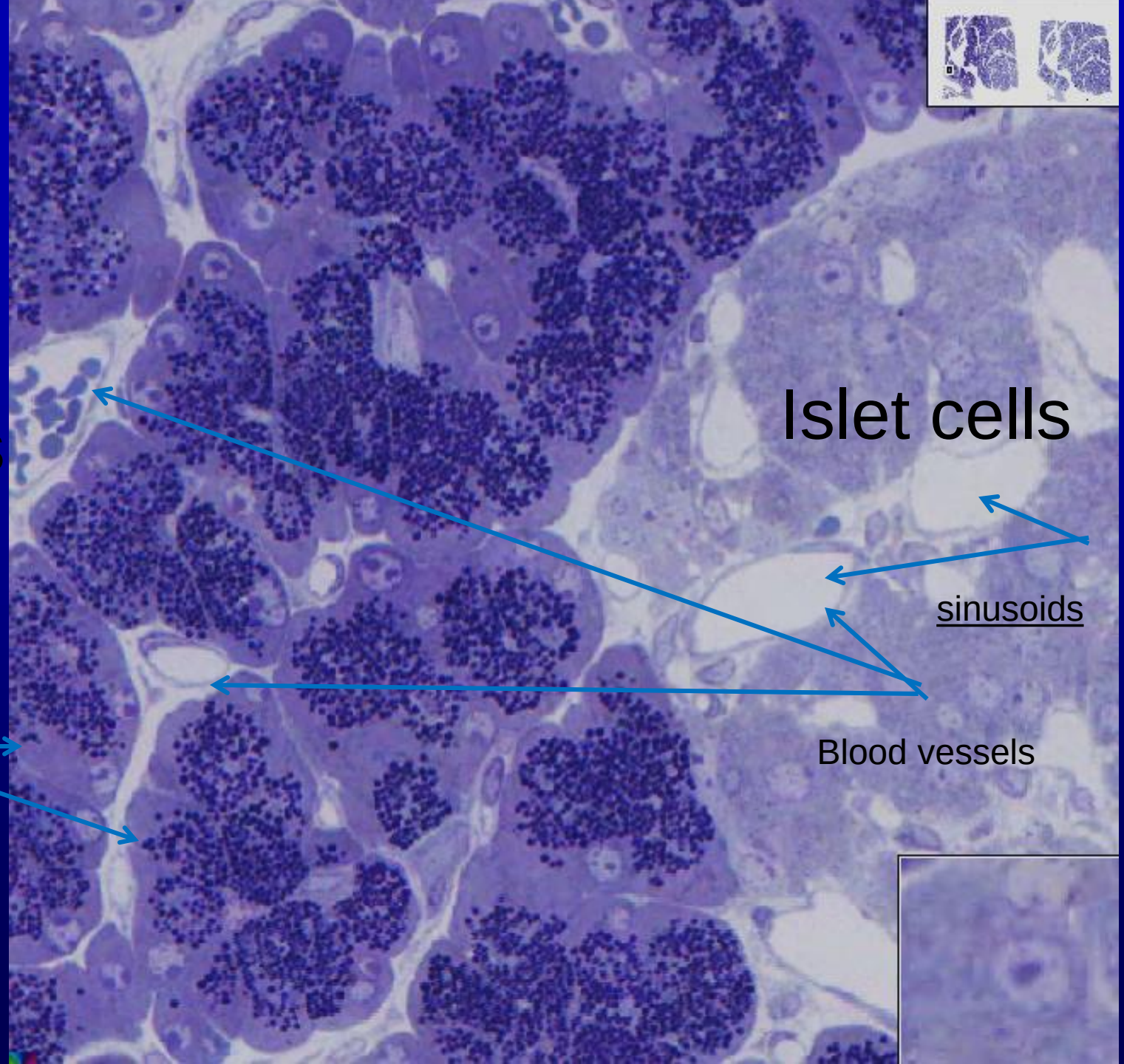
Pancreas

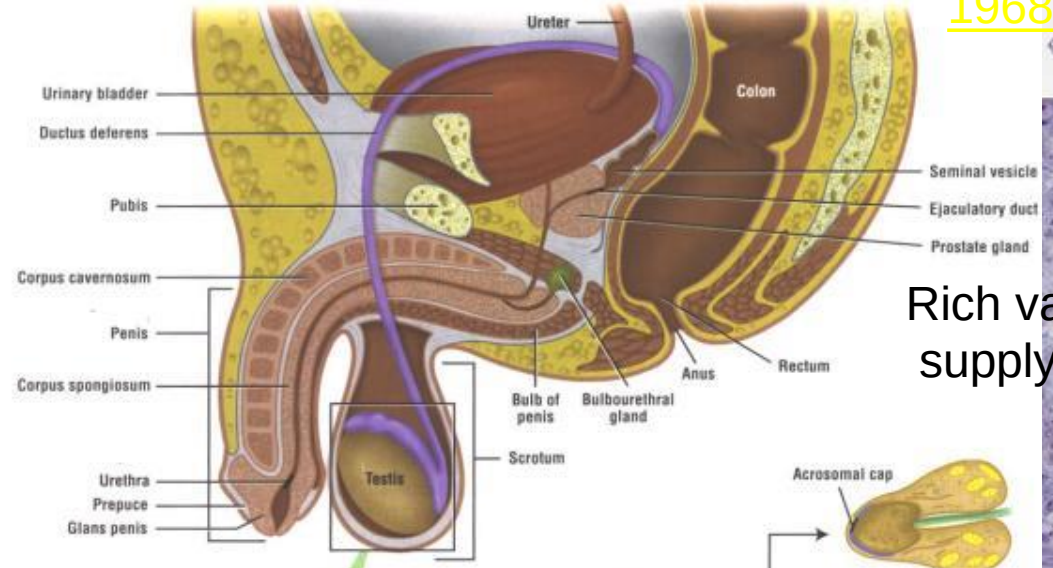
monkey

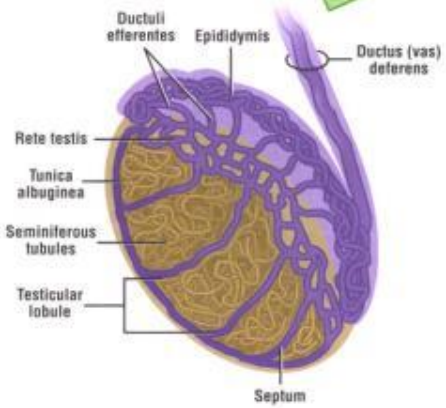


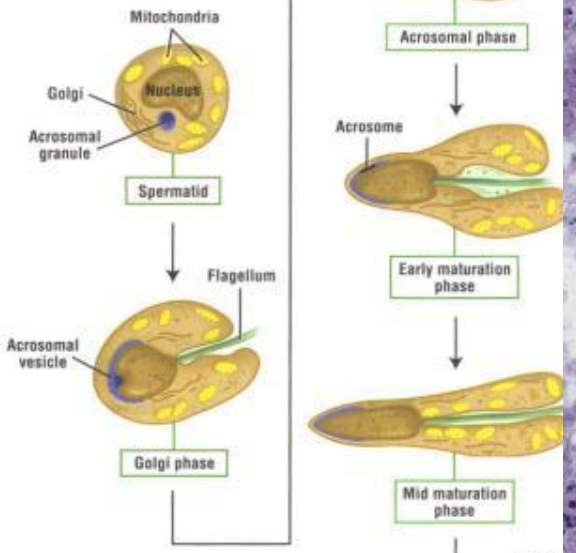
34218

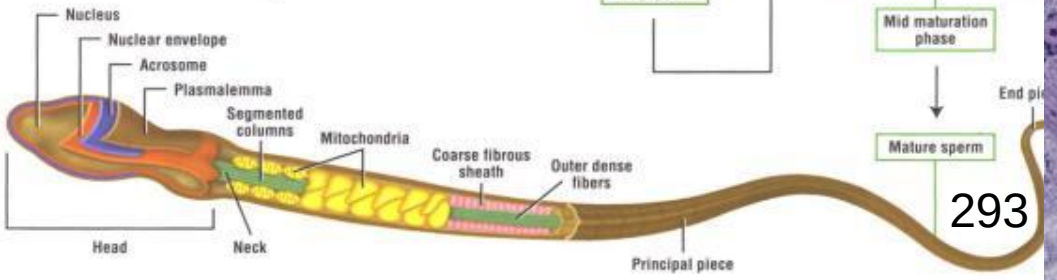
Rat pancreas







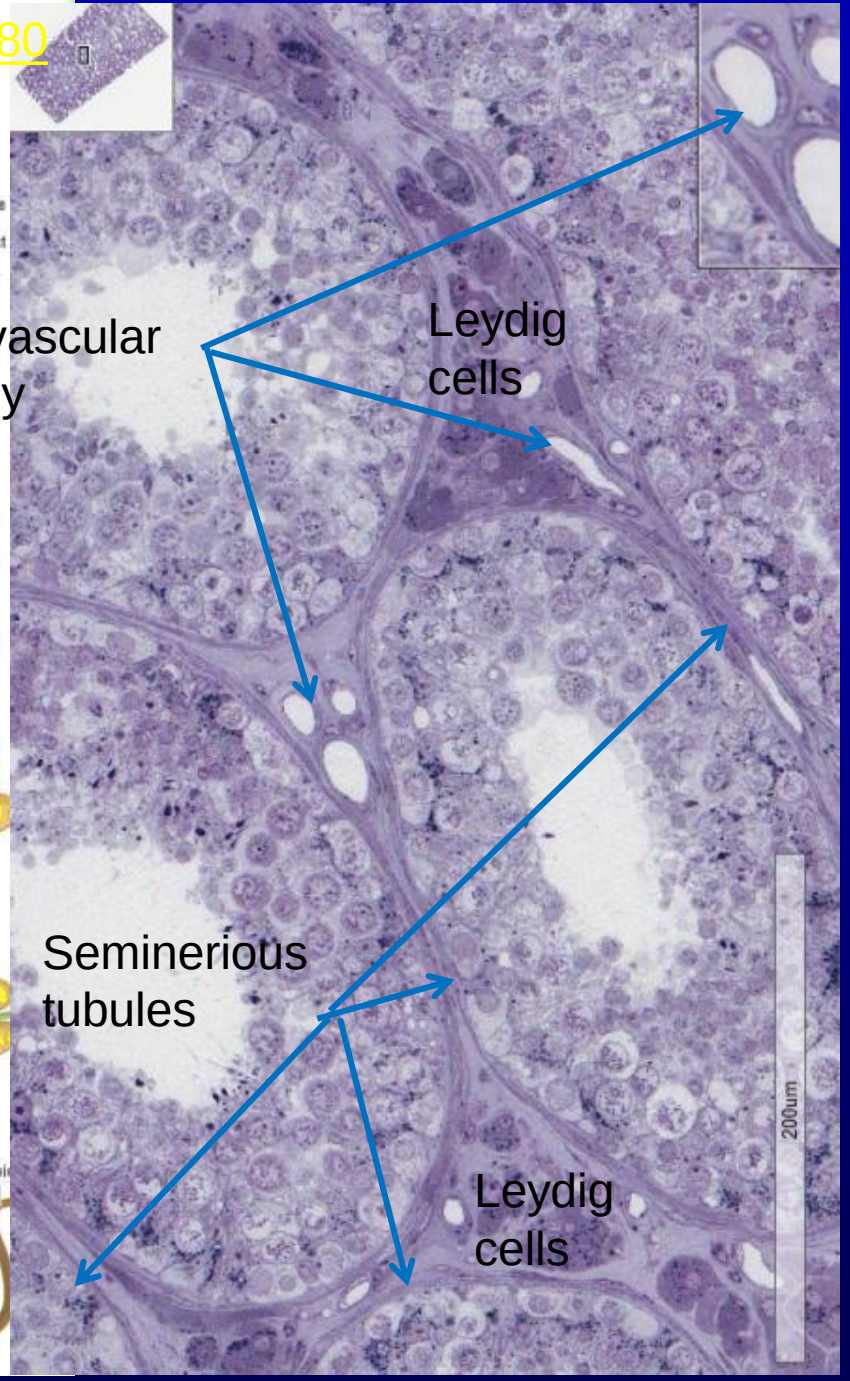


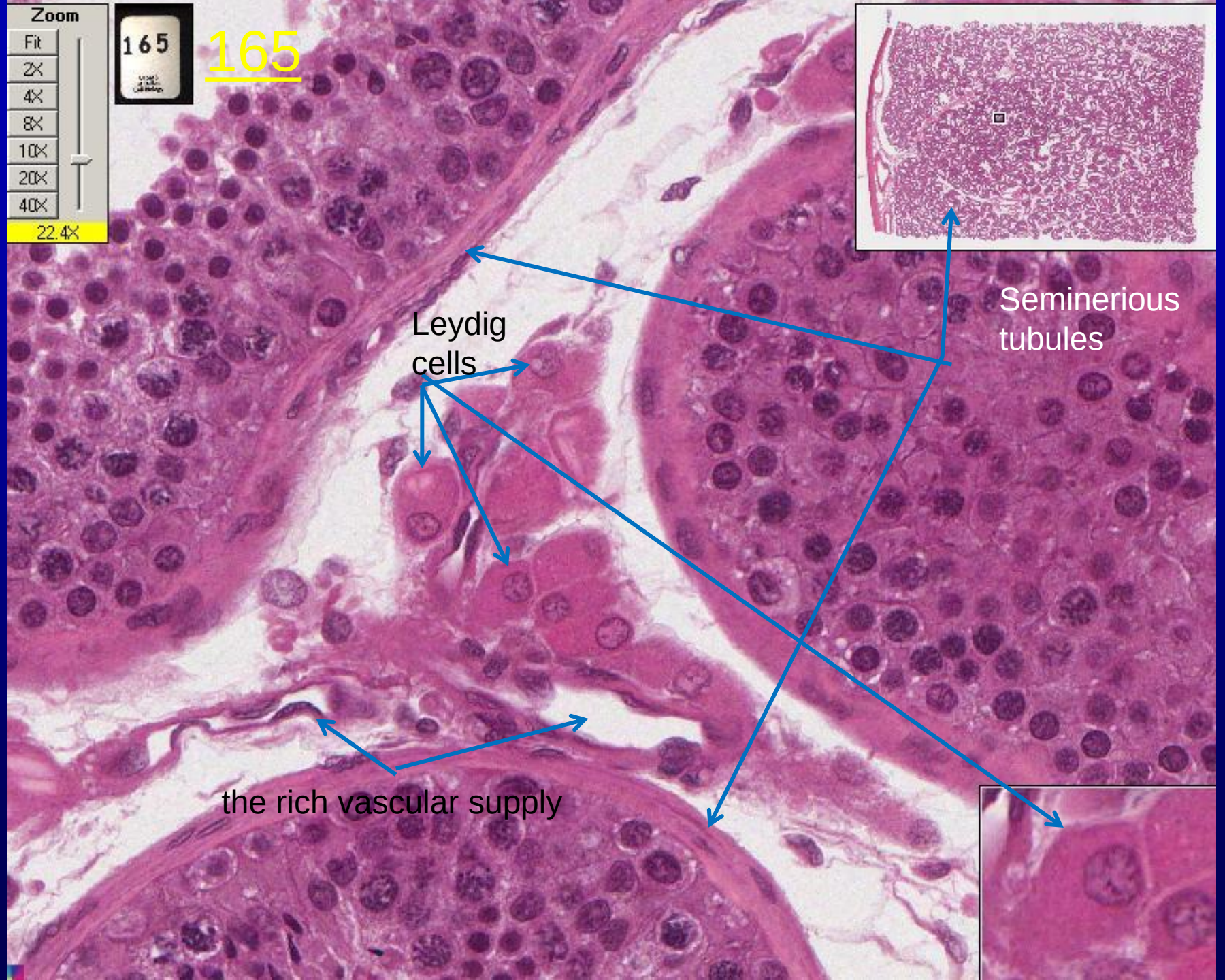


19680

293

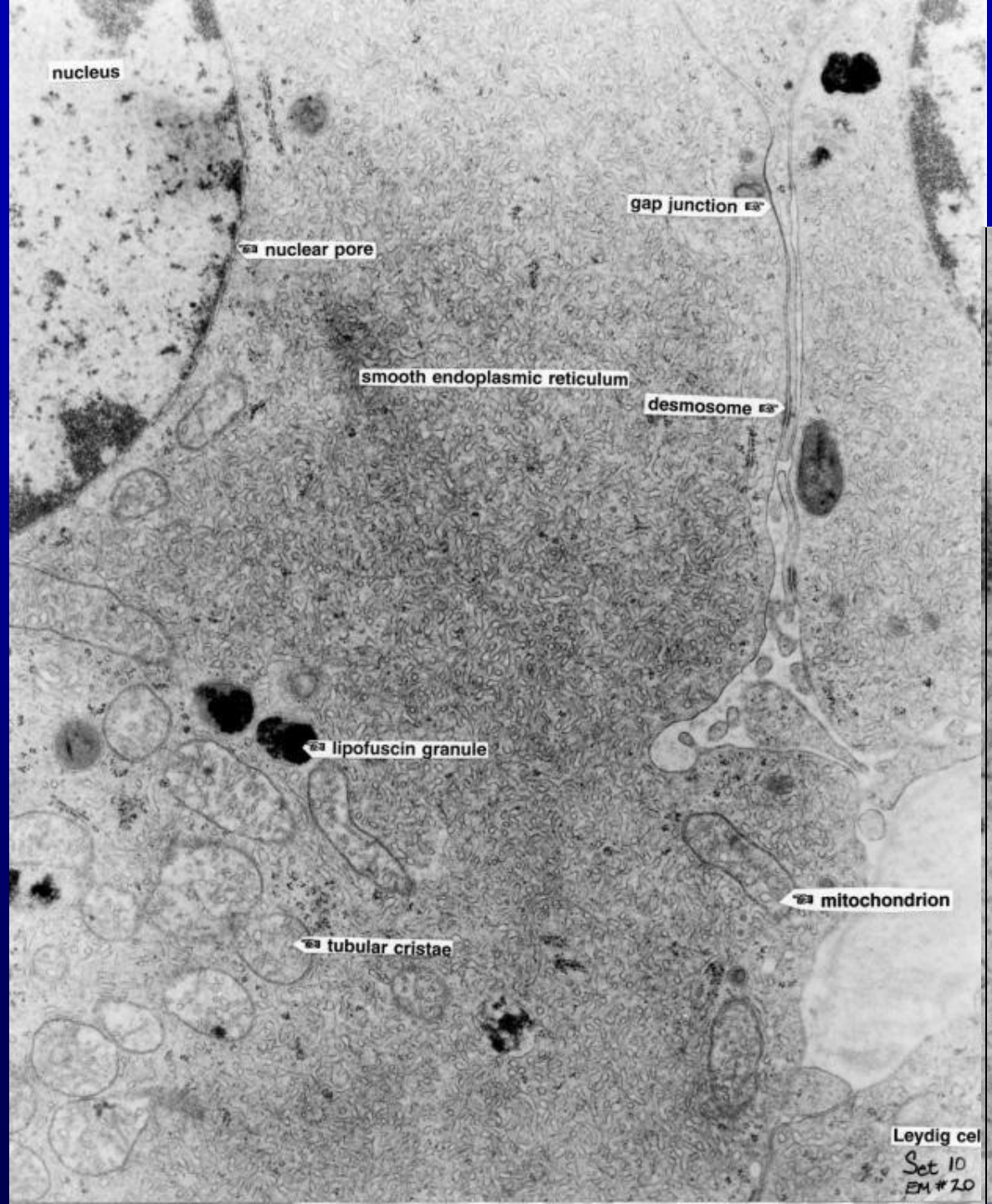
Rich vascular supply

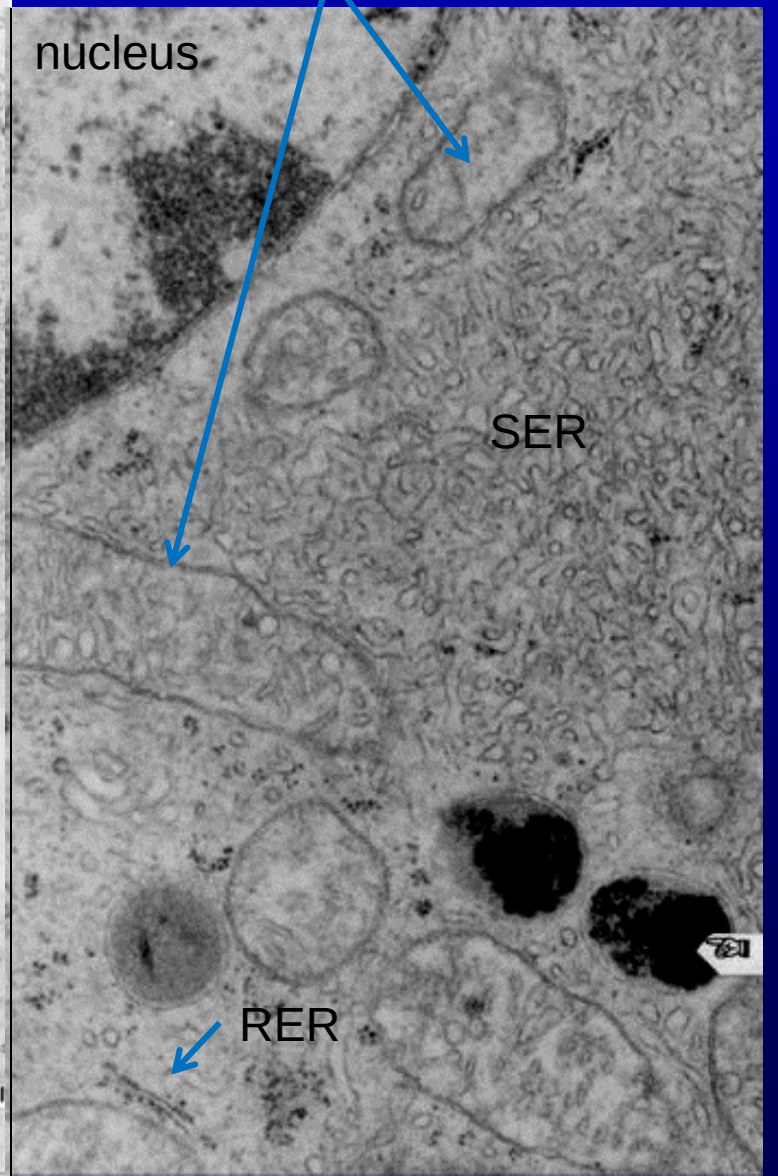


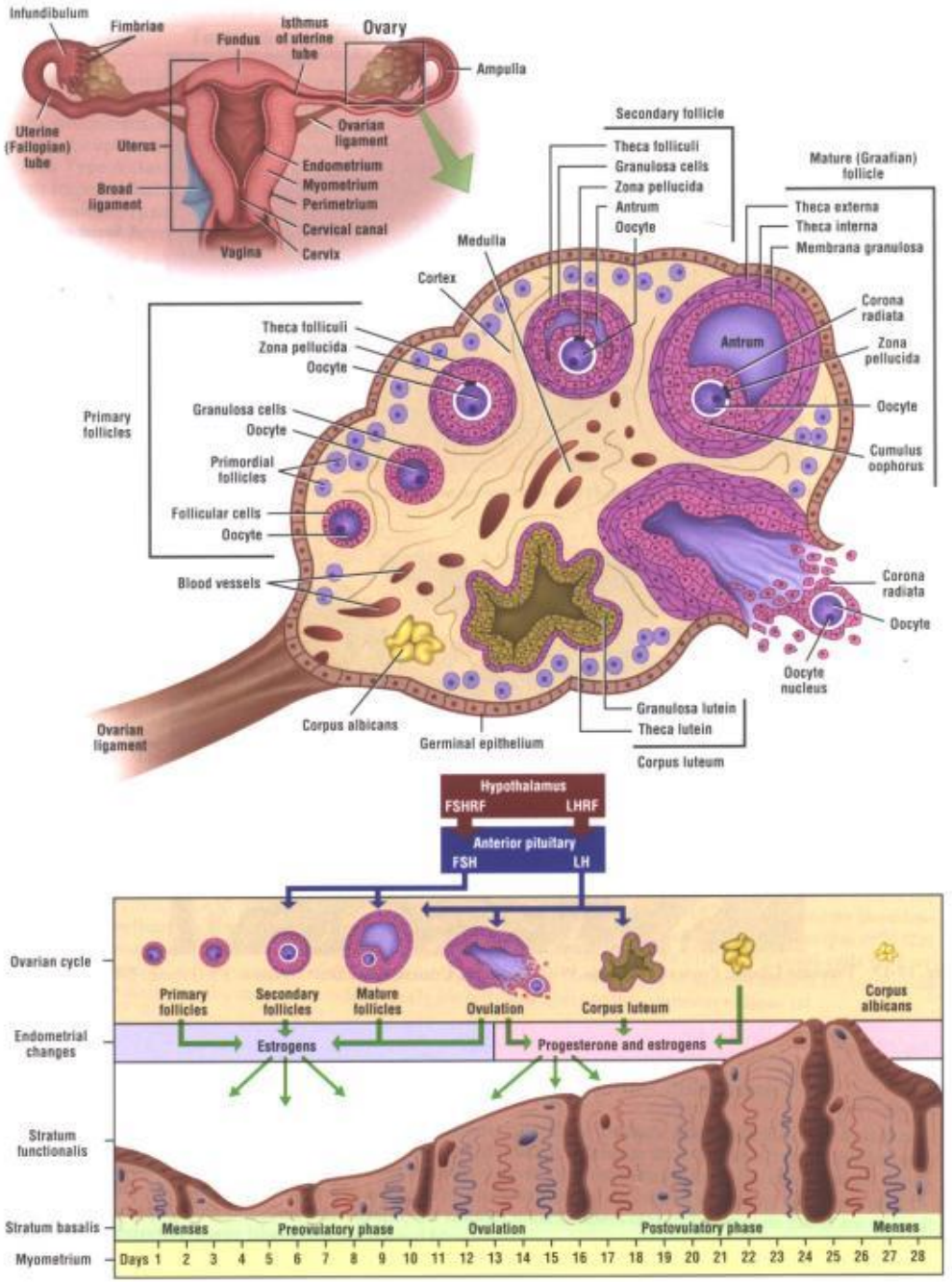

Zoom
Fit
2X
4X
8X
10X
20X
40X
22.4X
165
165
Leydig cells
Seminerious tubules
the rich vascular supply

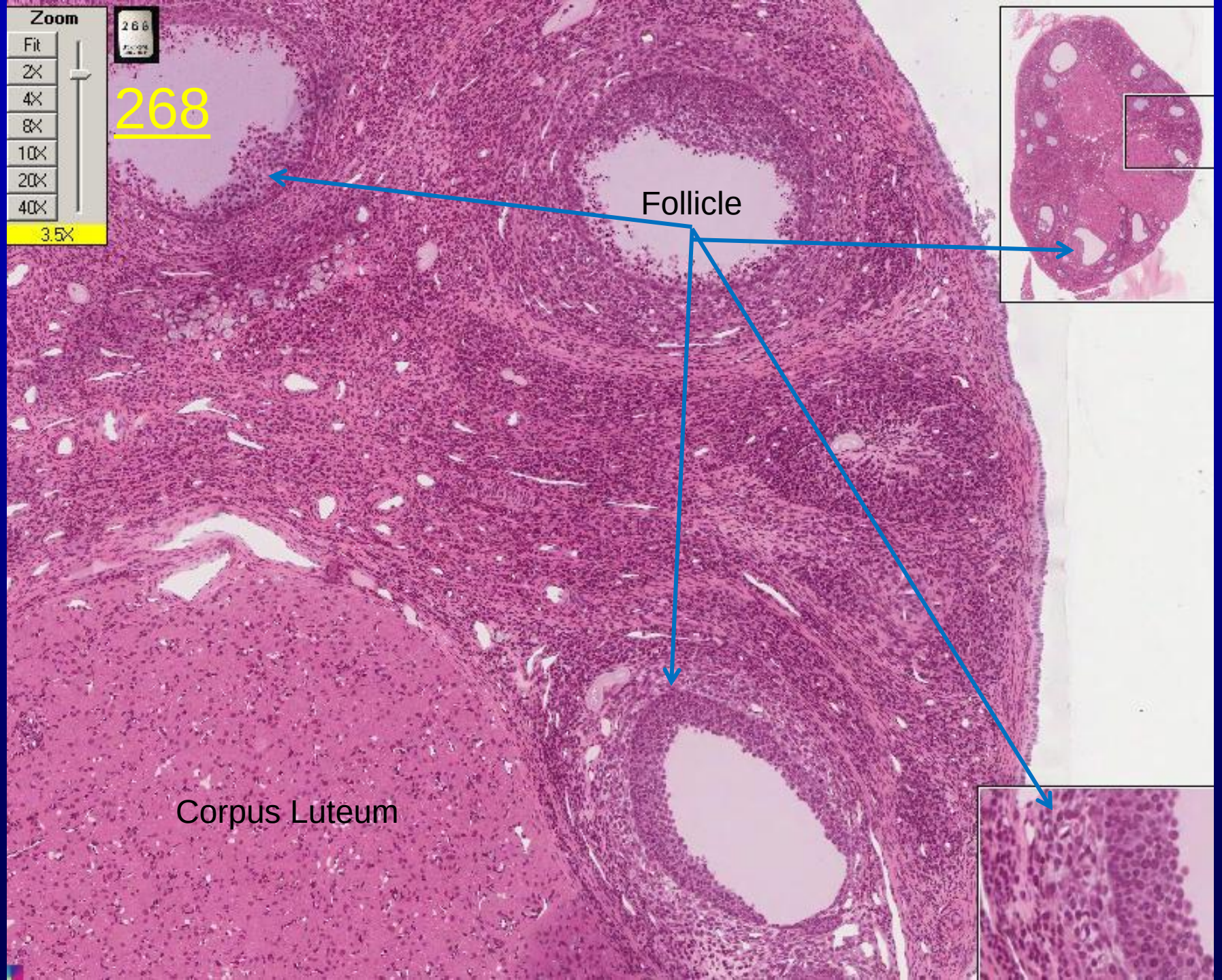
EM 20

tubular cristae in mitochondria

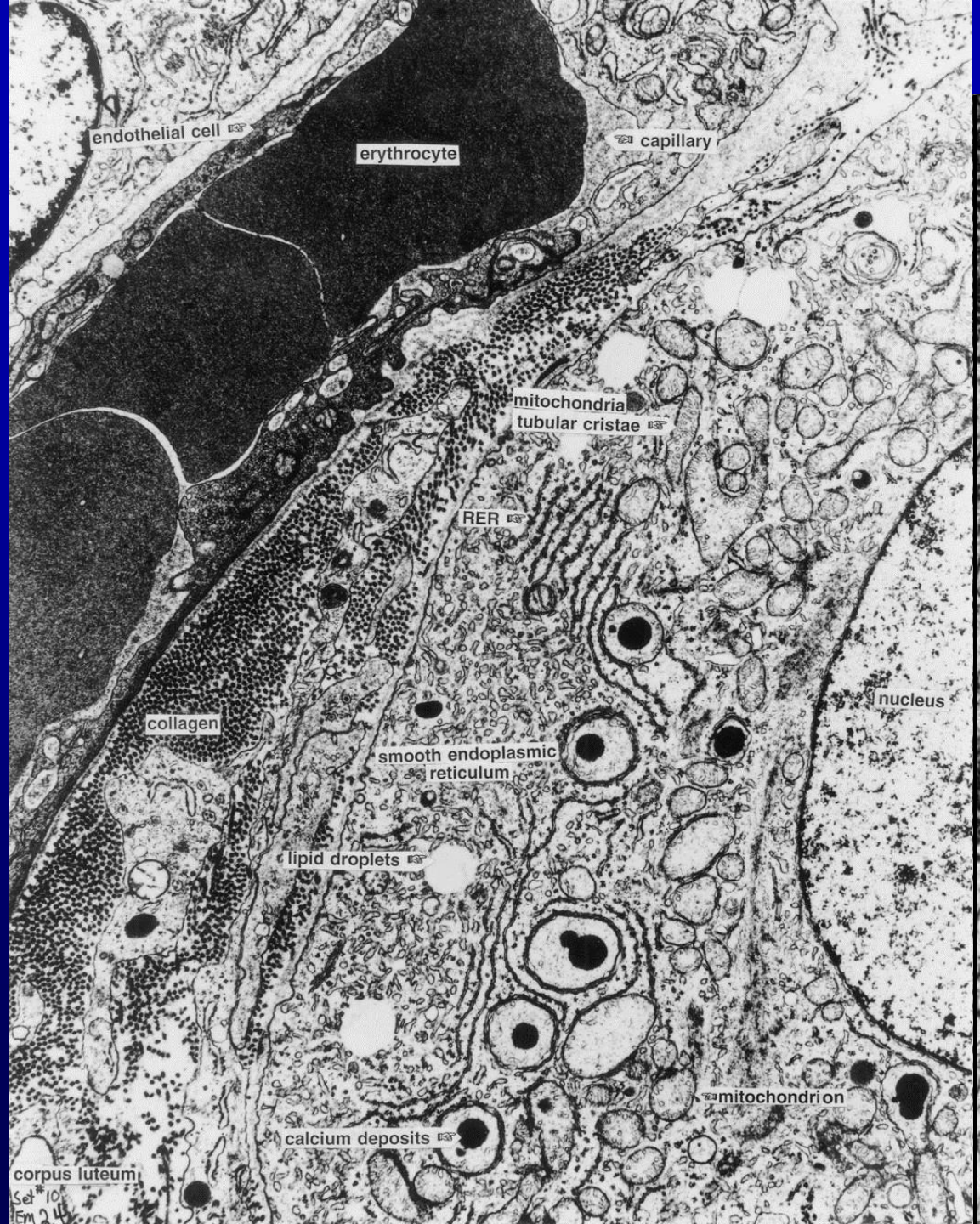


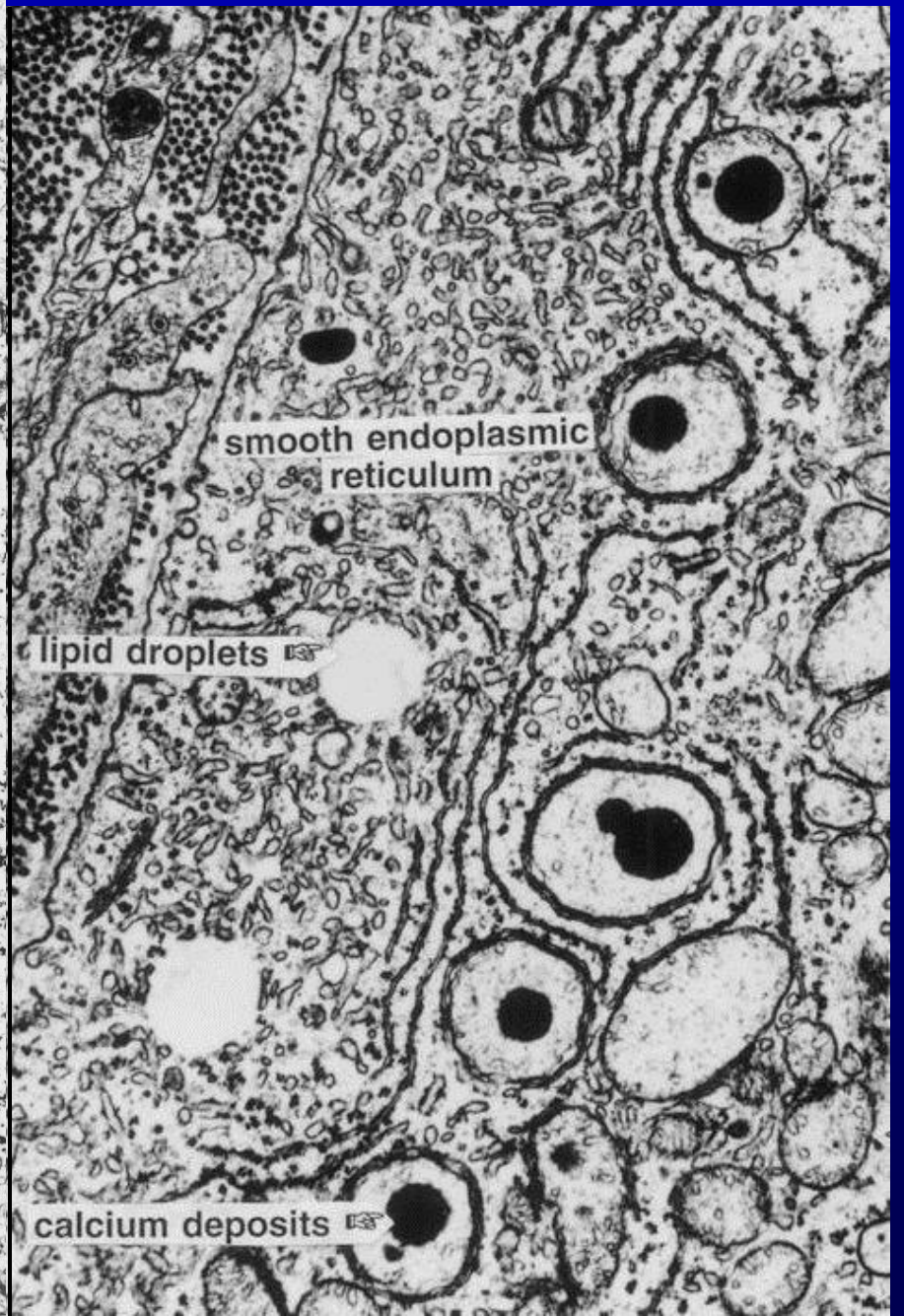




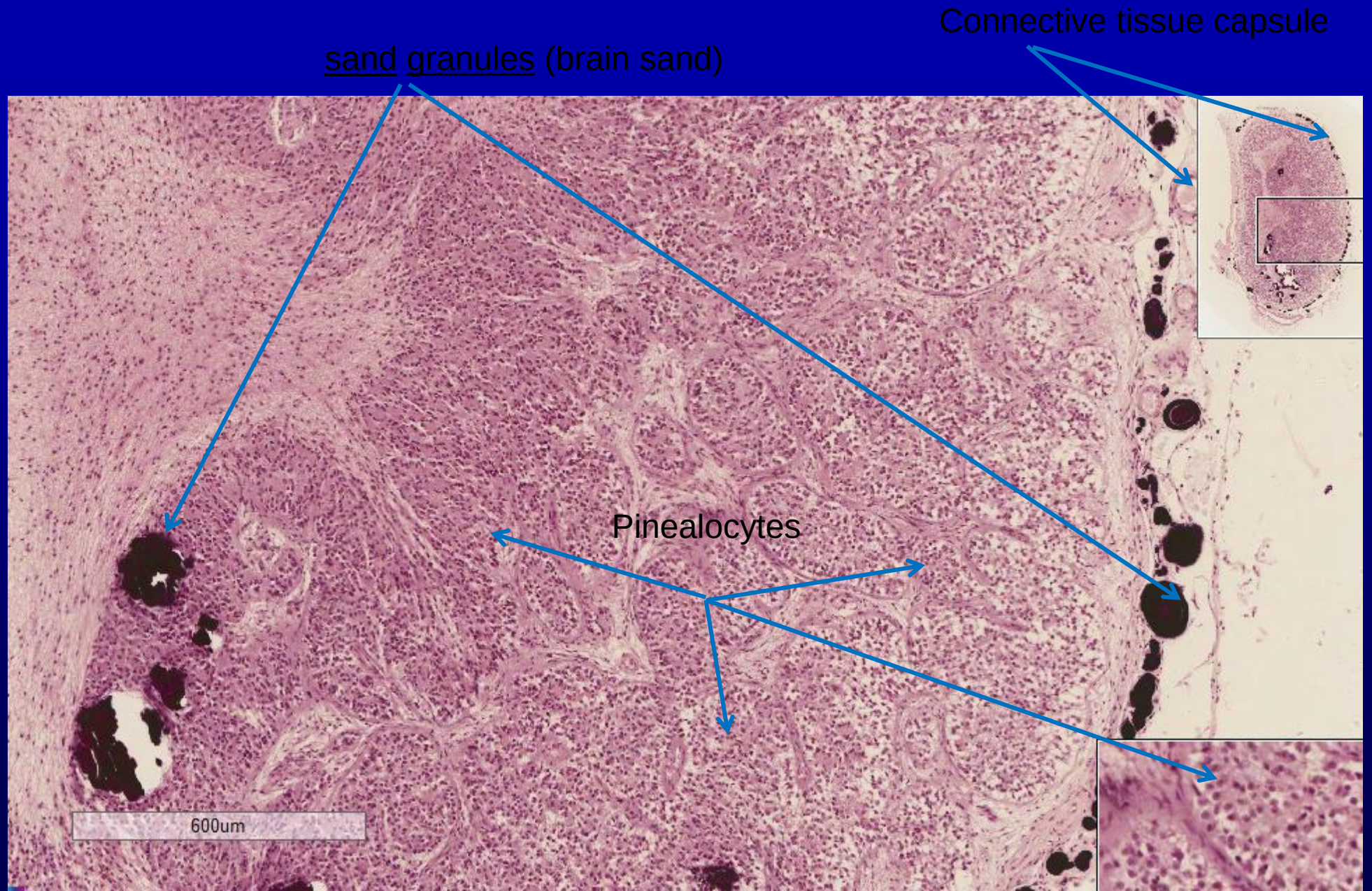

Zoom
Fit
2X
4X
8X
10X
20X
40X
3.5X
268
Follicle
Corpus Luteum

EM 24


endothelial cell
erythrocyte
capillary
mitochondria
tubular cristae
RER
collagen
smooth endoplasmic reticulum
nucleus
lipid droplets
mitochondrion
calcium deposits
corpus luteum
Set #10
Em 24


smooth endoplasmic reticulum
lipid droplets
calcium deposits

PINEAL BODY (Slide 290 Human Pineal)



VARIATIONS IN THE MICROVASCULATURE

COMMON

ARTERIOLE ⇨ CAPILLARY ⇨ VENULE

VENOUS PORTAL SYSTEM

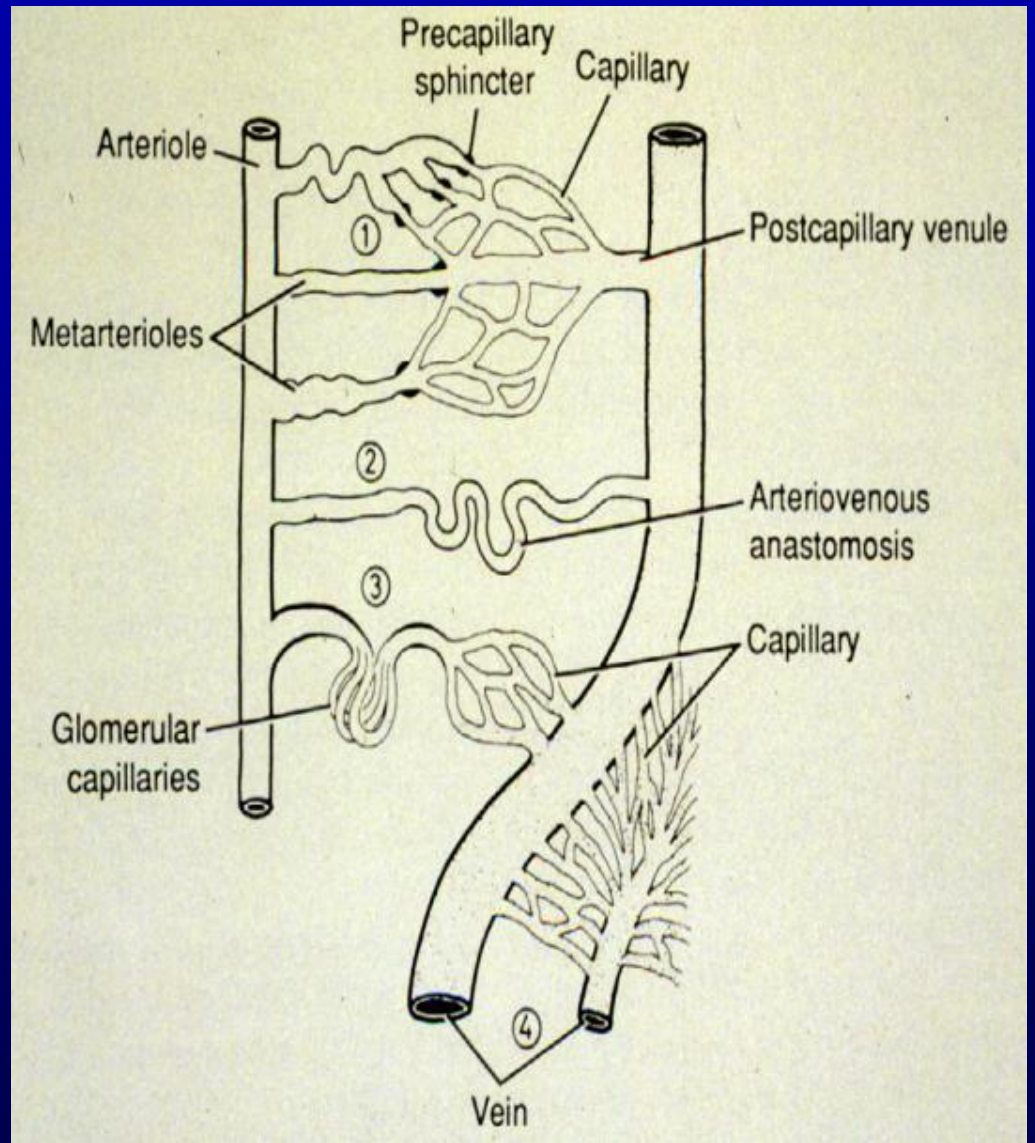
CAPILLARY ⇨ PORTAL VEIN ⇨ CAPILLARY

(ENDOCRINE EXAMPLE?)

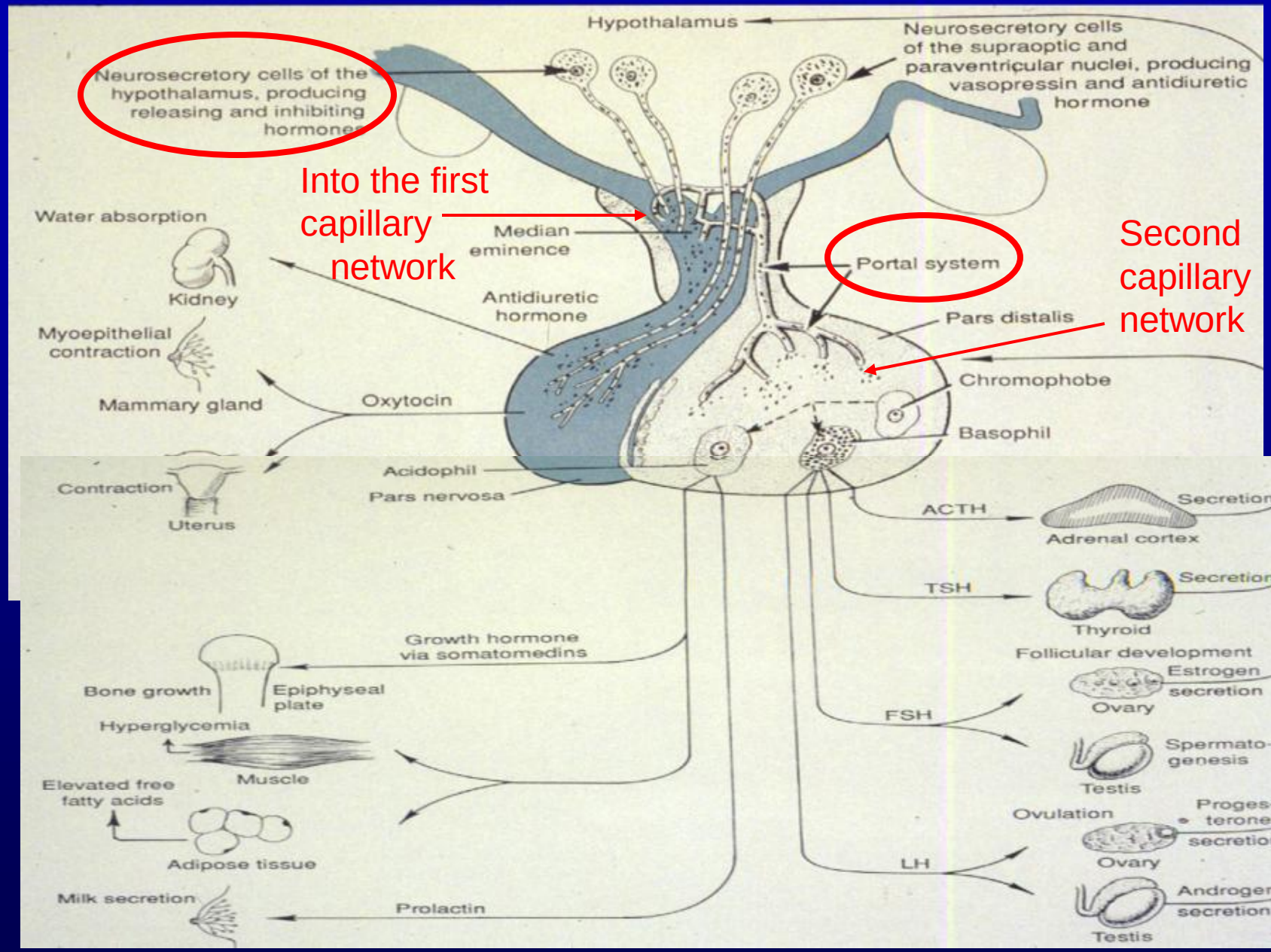
ARTERIAL PORTAL SYSTEM

CAPILLARY ⇨ PORTAL ARTERIOLE ⇨ CAPILLARY

(ENDOCRINE EXAMPLE?)

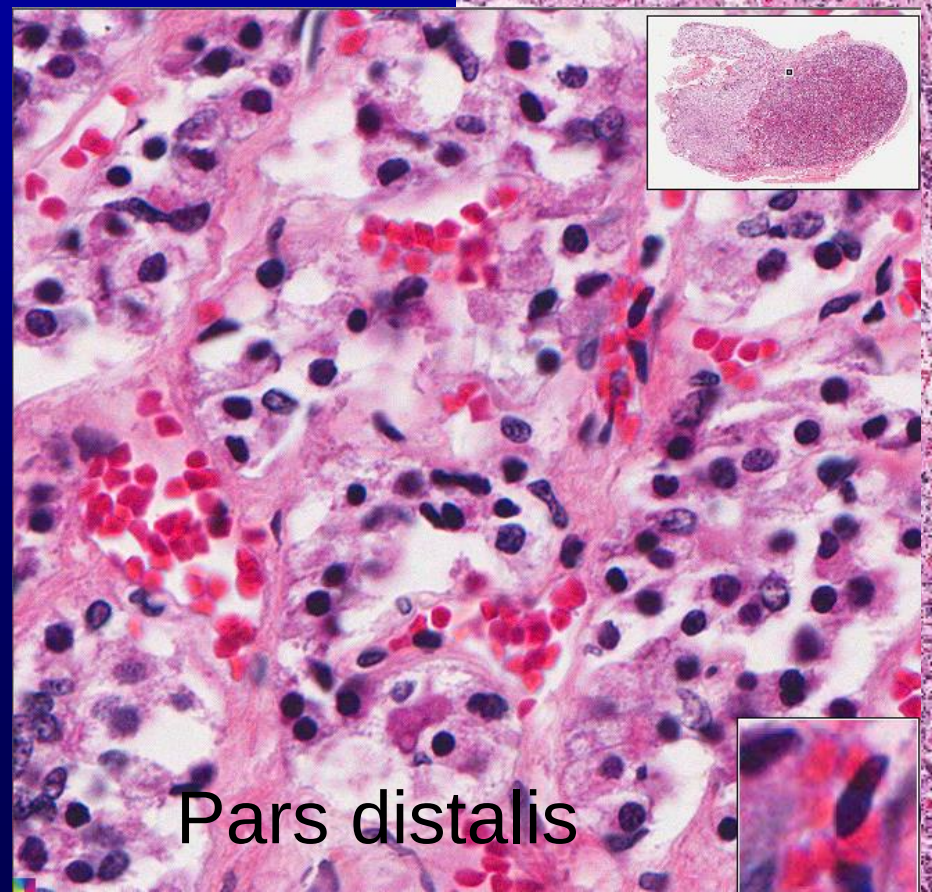


Releasing hormones are distributed in second capillary bed of venous portal system



490

490
Human pituitary



(1 st CAPILLARY in hypothalamus)

PORTAL VEIN
In stalk

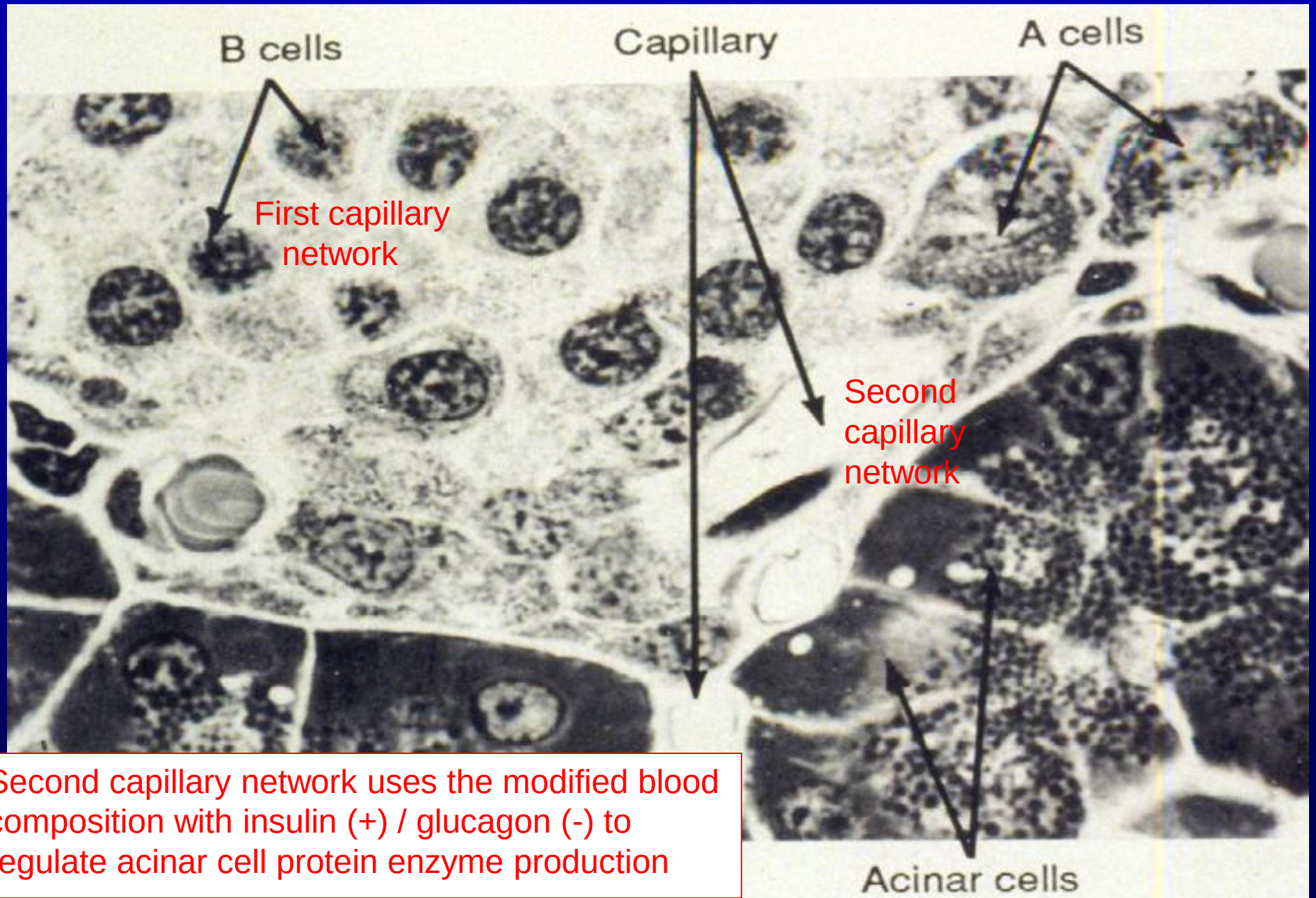
2 nd CAPILLARY

Pars distalis

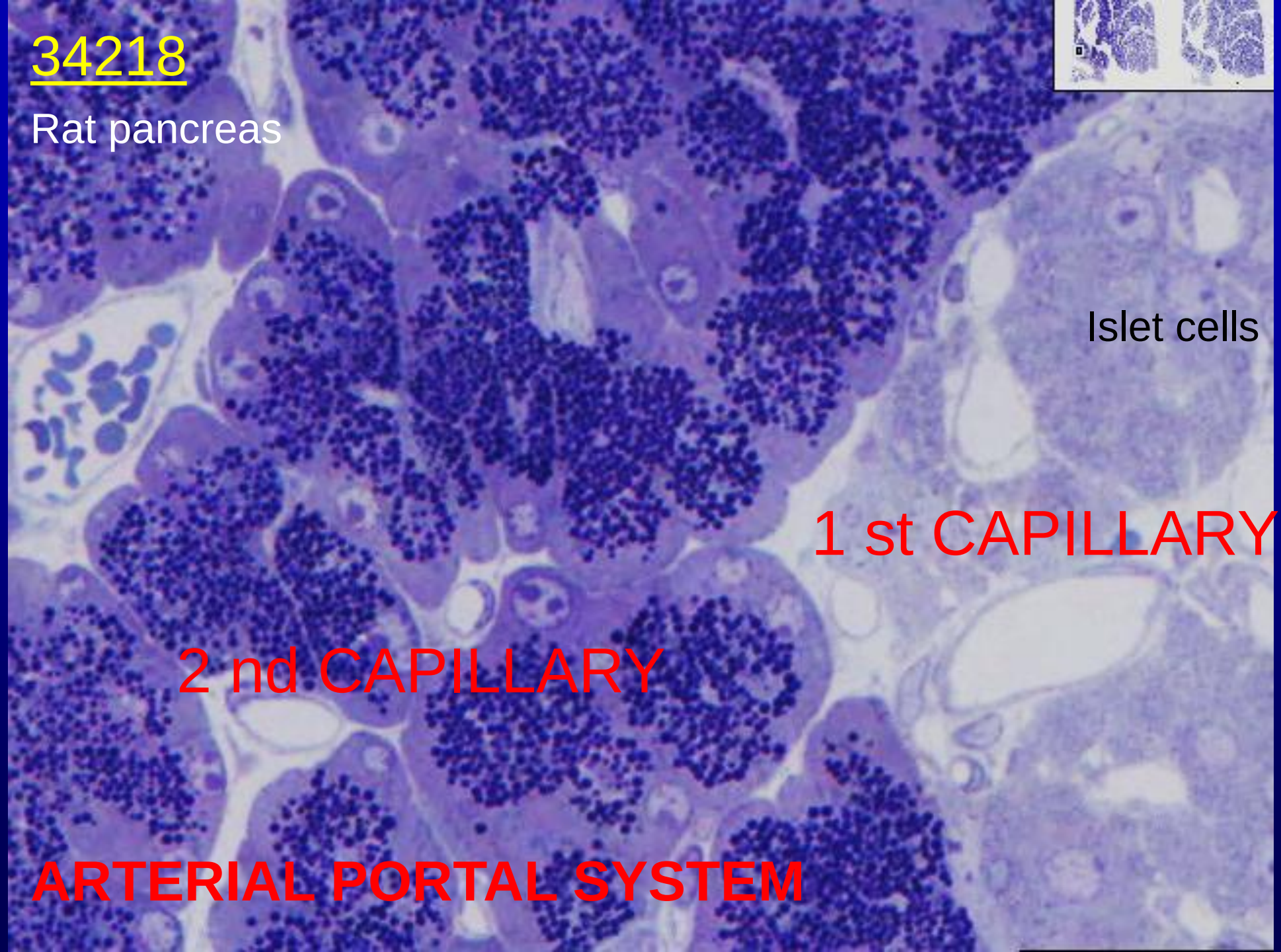
VENOUS PORTAL SYSTEM

ISLETS Of LANGERHANS

First capillary network of the **ARTERIAL PORTAL SYSTEM** modifies blood composition with insulin / glucagon



Second capillary network uses the modified blood composition with insulin (+) / glucagon (-) to regulate acinar cell protein enzyme production

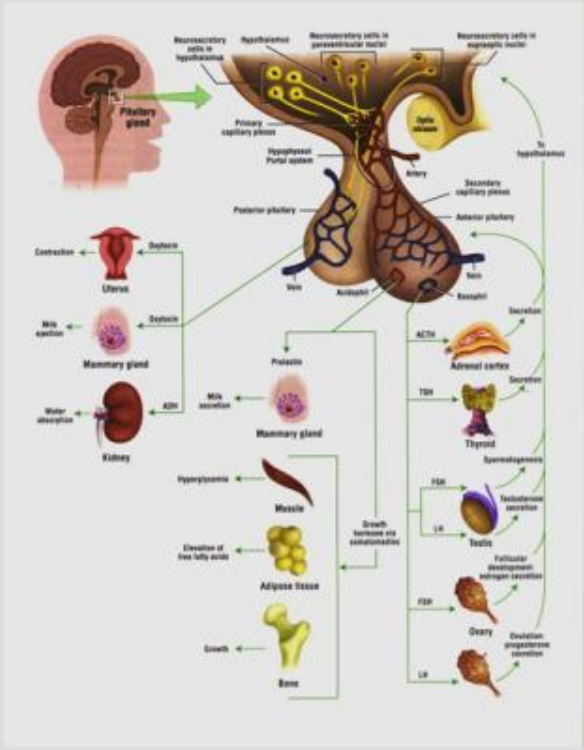

34218
Rat pancreas
Islet cells
1 st CAPILLARY
2 nd CAPILLARY
ARTERIAL PORTAL SYSTEM

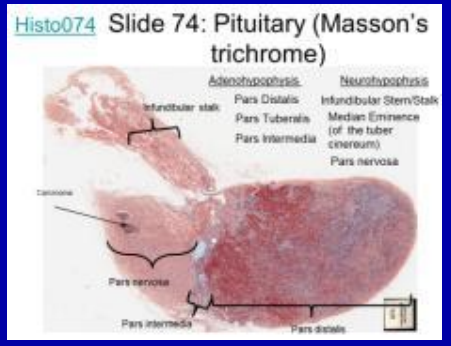
In summary

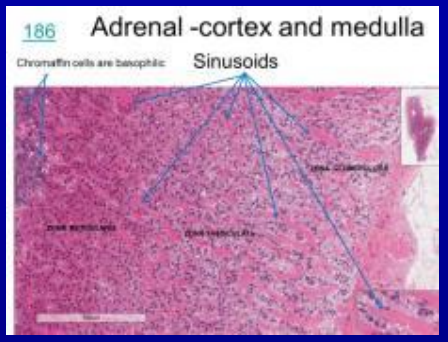
Function of endocrine system

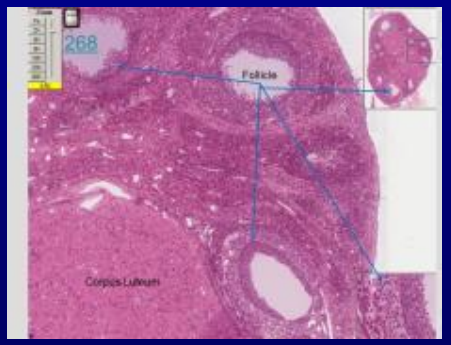
"The endocrine system is the collection of glands that produce hormones that regulate metabolism, growth and development, tissue function, sexual function, reproduction, sleep, and mood, among other things."

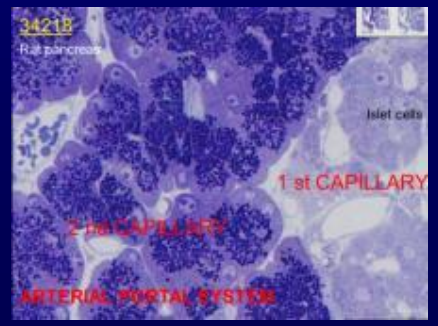
http://www.livescience.com/26496-endocrine-system.html











Questions on the endocrine system

1.The pituitary has little effect on regulation of hormone secretions in which of the following?

a. ovary
b. adrenal cortex
c. adrenal medulla
d. a and b
e. a, b, and c

2. Calcium concentrations in the blood are affected by:

a. calcitonin from the thyroid
b. resorption of bone by osteocytes
c. parathyroid hormone from the parafollicular cells
d. a and b
e. a, b, and c

3. Which region of the adrenal - hormone produced match?

a. zona glomerulosa - aldosterone
b. zona fasciculata - cortisol
c. zona reticularis - androgens
d. a and b
e. a, b, and c