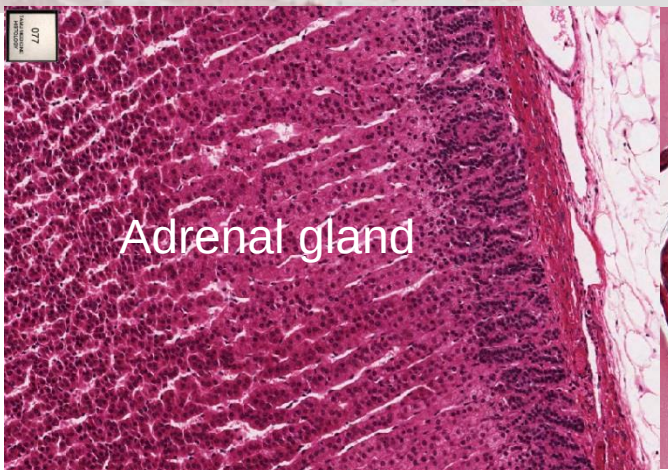
ENDOCRINE SYSTEM **Part 1**

Dr. Larry Johnson



Objectives

Part 1

- Distinguish between the neurohypophysis and the adenohypophysis and identify the cell types present in a slide or photomicrograph of the pituitary.
- Identify thyroid follicles, follicular cells, colloid, capillaries and parafollicular cells.
- Identify the capsule, chief cells, and oxyphil cells in the parathyroid gland.

Part 2

- Identify the capsule, cortex, zona glomerulosa, zona fasciculata, zona reticularis, medulla, and chromaffin cells in the adrenal gland.
- Identify the pinealocytes and corpora arenacea in the pineal gland.
- Identify the islets of Langerhans in the pancreas

From: Douglas P. Dohrman and TAMHSC Faculty 2012 Structure and Function of Human Organ Systems, Histology Laboratory Manual

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)

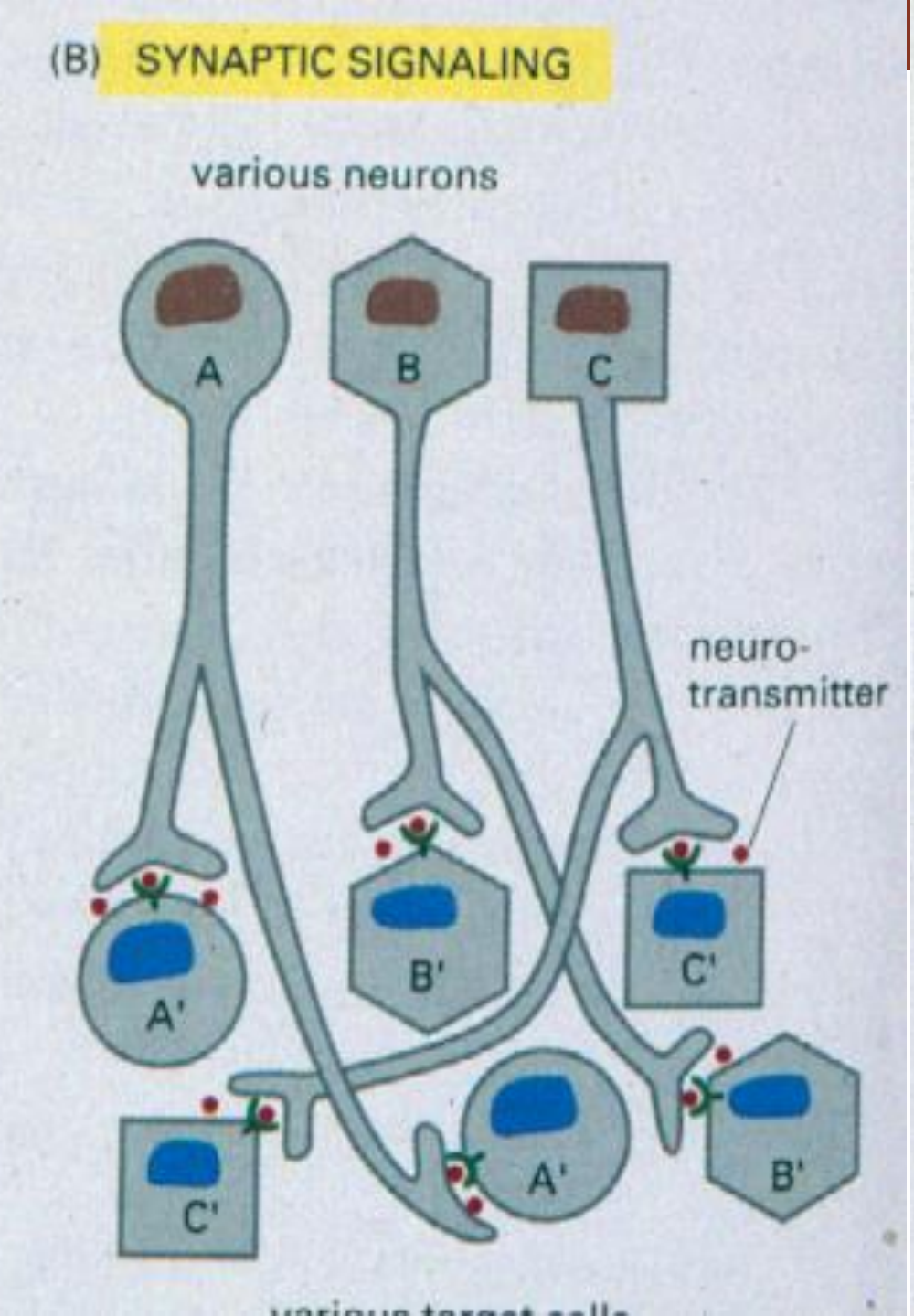
Pituitary gland	• Anterior pituitary = *pars distalis* or *adenohypophysis*
	  • Ectoderm
	• Posterior pituitary = *pars nervosa* or *neurohypophysis*
	  • Midbrain

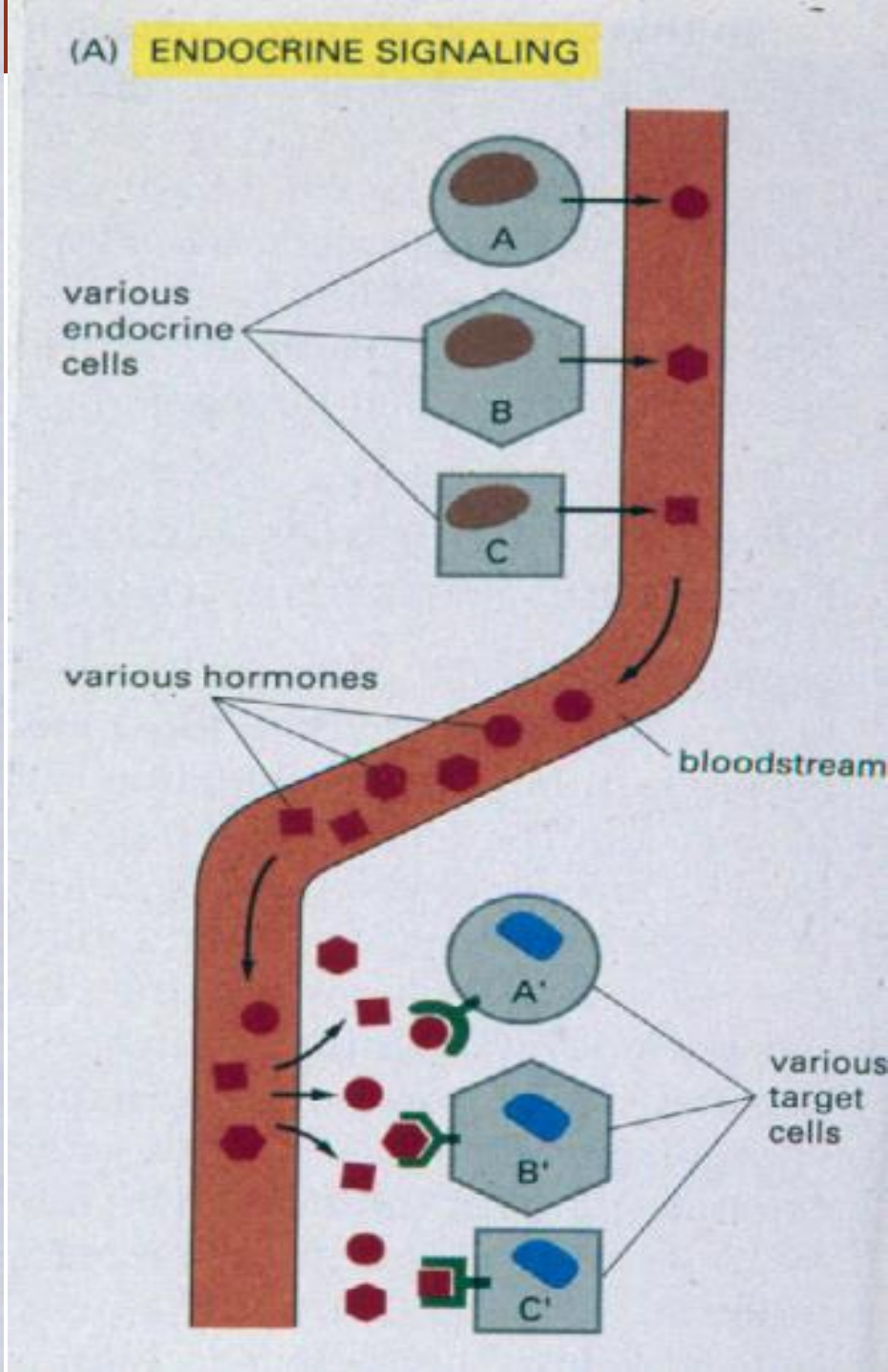
Thyroid gland	• Lobules and • Colloid filled follicles (extracellular storage)
Parathyroid gland	• Capsule with septa • Cords of epithelial cells supported by reticular fibers

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

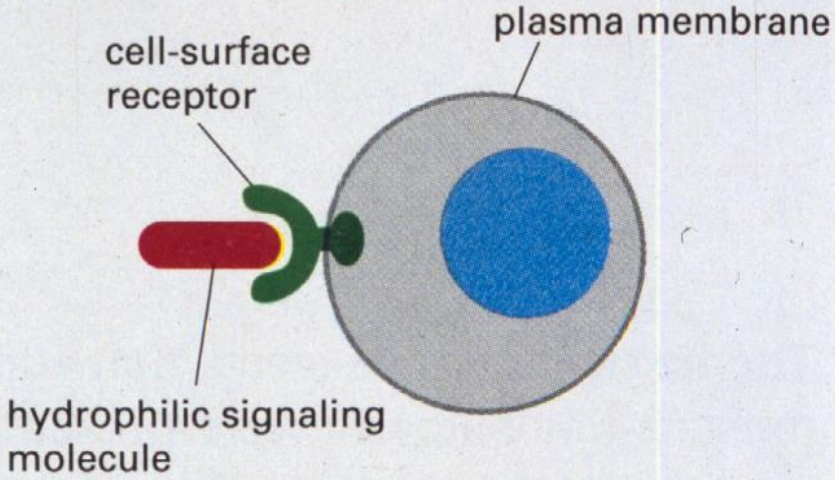
Pineal body	• *Epiphysis cerebri* • Capsule of pia mater • Lobules divided by capsule • Corpora arenacea = brain sand, pineal concretions that accumulate with age

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


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


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

CELL-SURFACE RECEPTORS



INTRACELLULAR RECEPTORS

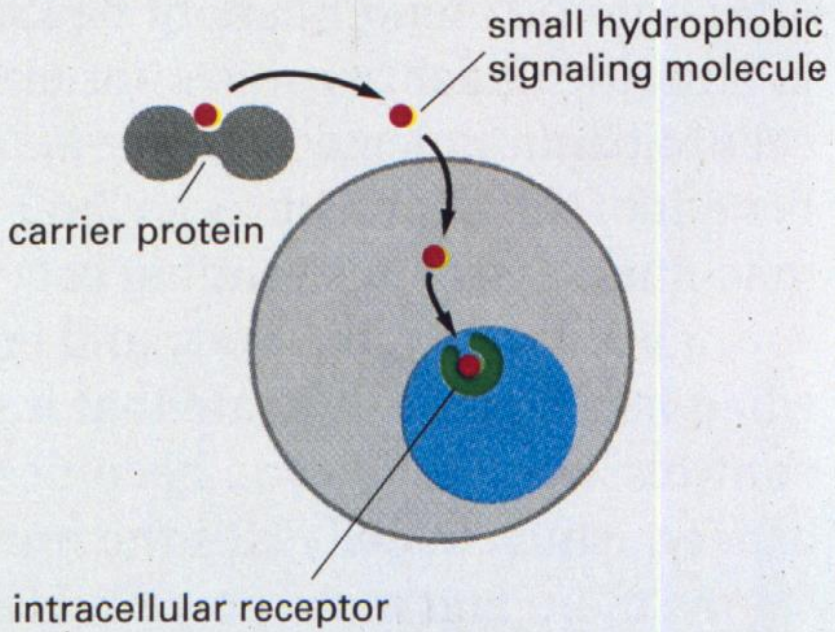
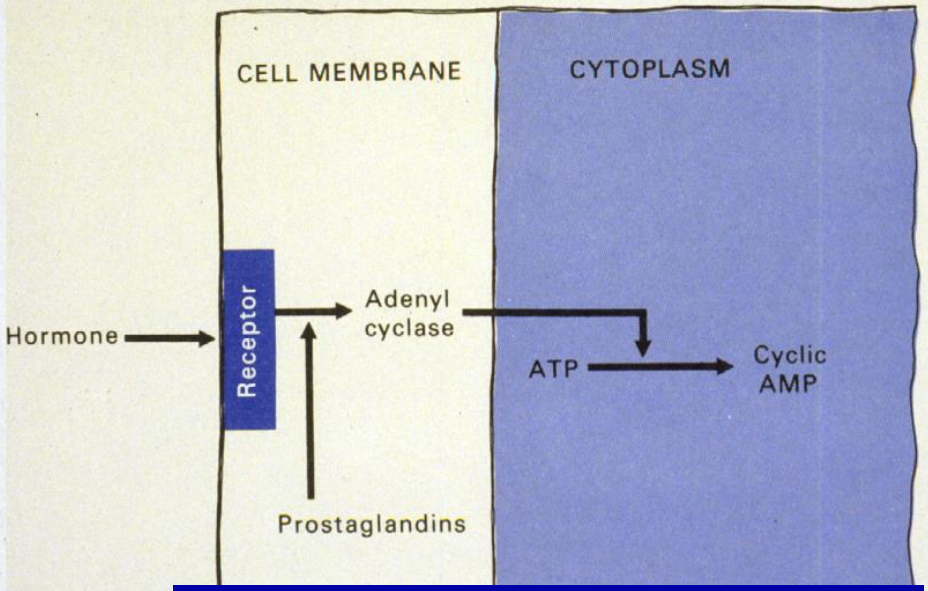


Figure 31-2. The cell membrane contains the enzyme adenyl cyclase essential for the conversion of ATP to cyclic AMP. The hormone initiating the sequence is the first messenger; cyclic AMP the second.

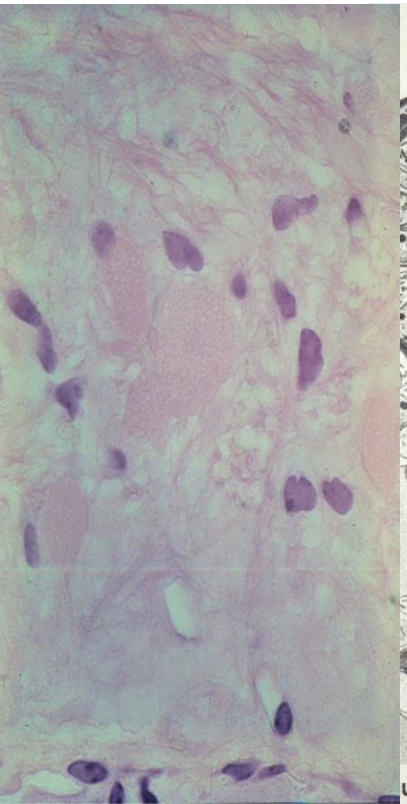


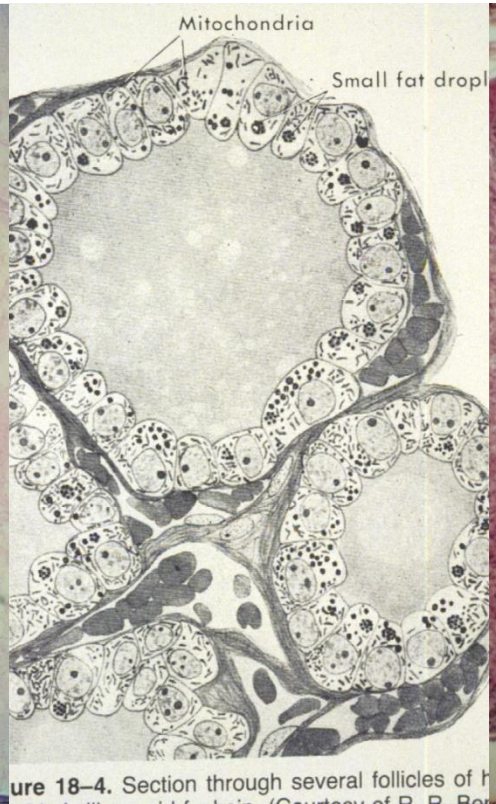
HORMONE
Thyroid-stimulating hormone (TSH)
Adrenocorticotropic hormone (ACTH)
Luteinizing hormone (LH)
Epinephrine
Parathyroid hormone
Epinephrine
Vasopressin
Epinephrine, ACTH, glucagon, TSH

ENDOCRINE = INTERNAL SECRETION (WITHOUT DUCTS)

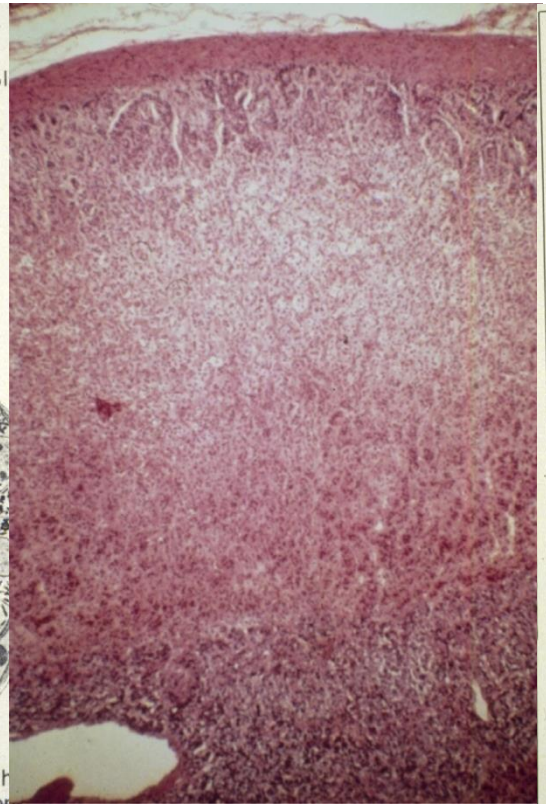
HORMONE = to AROUSE or SET in MOTION

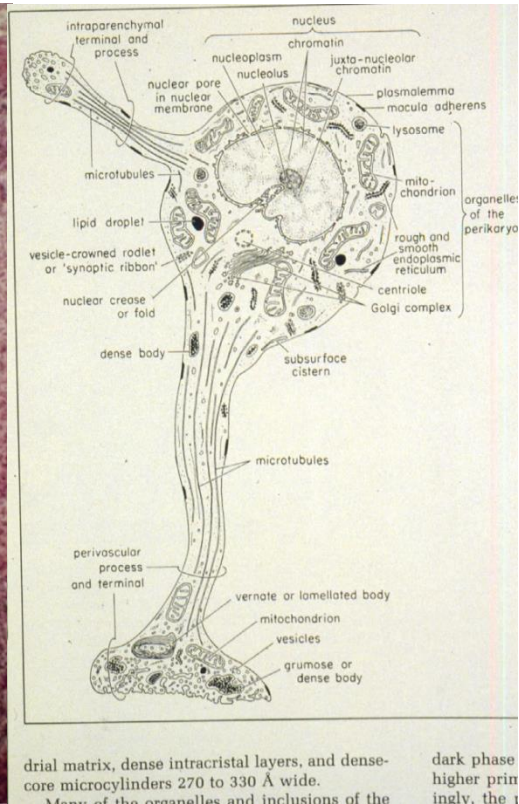
Endocrine glands are from endoderm





ure 18–4. Section through several follicles of h



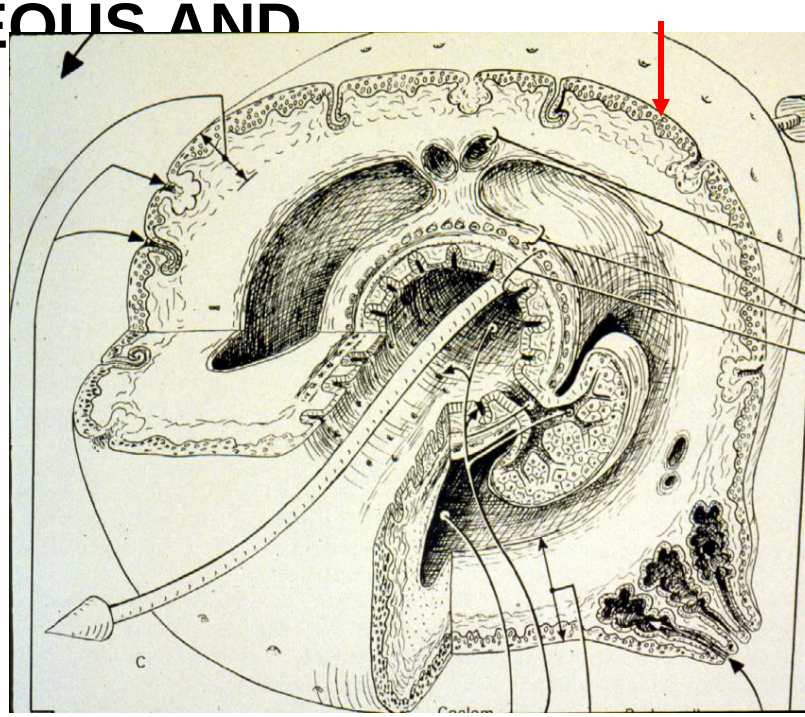


drial matrix, dense intracristal layers, and dense-core microcylinders 270 to 330 Å wide.

dark phase
higher prin
ingly, the

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

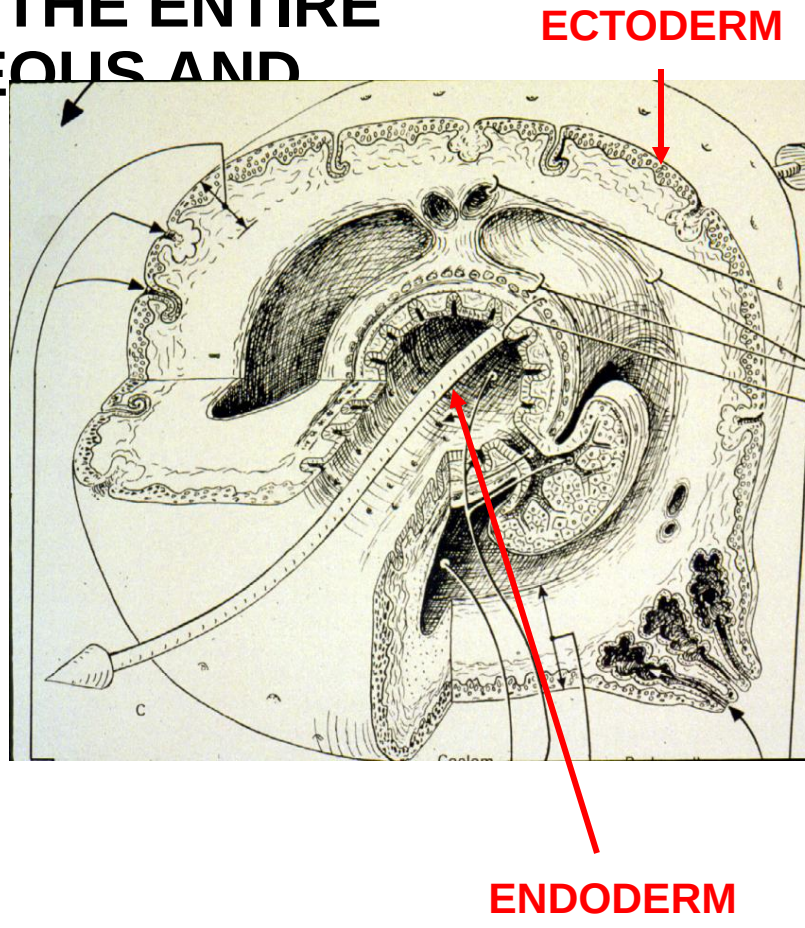


ORIGIN AND DISTRIBUTION OF EPITHELIUM

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



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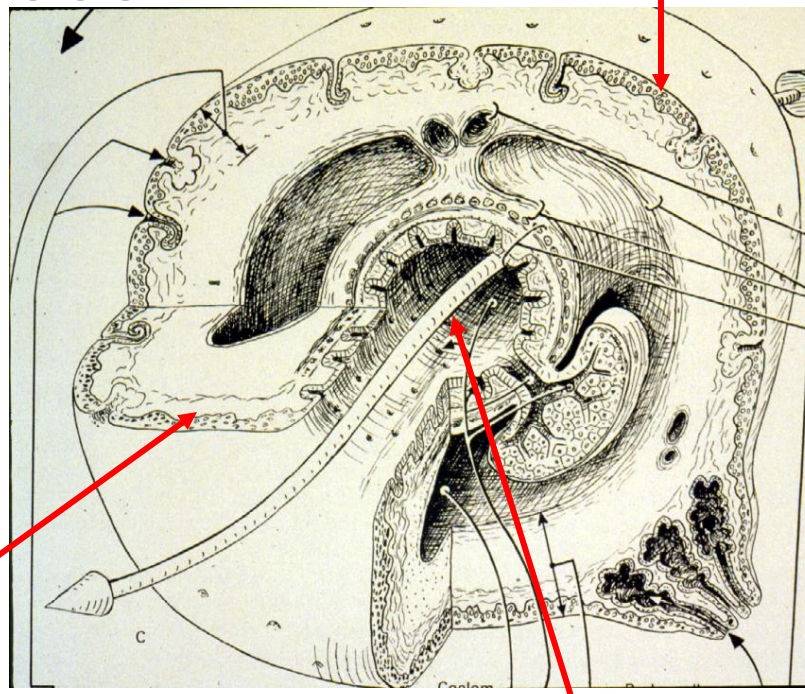
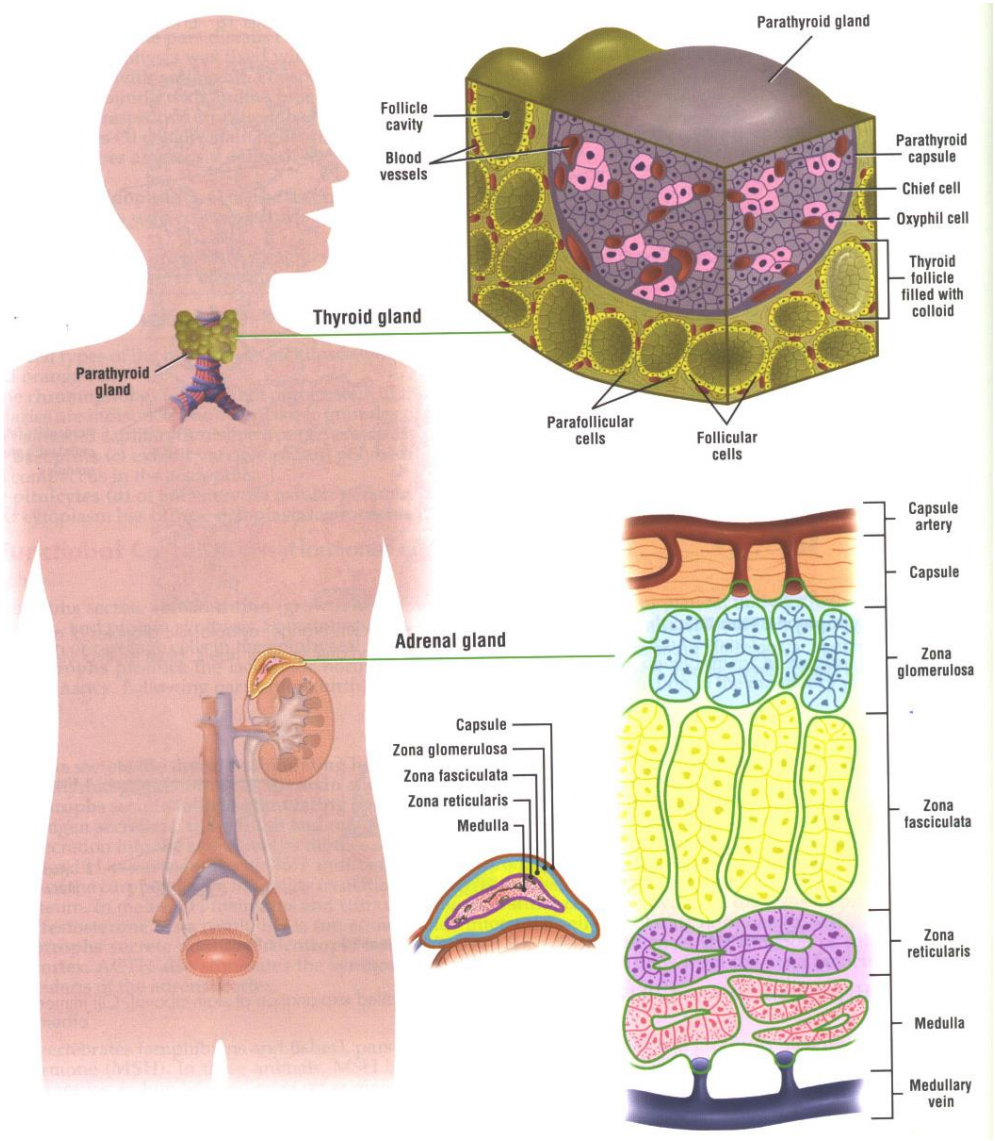


MESODERM

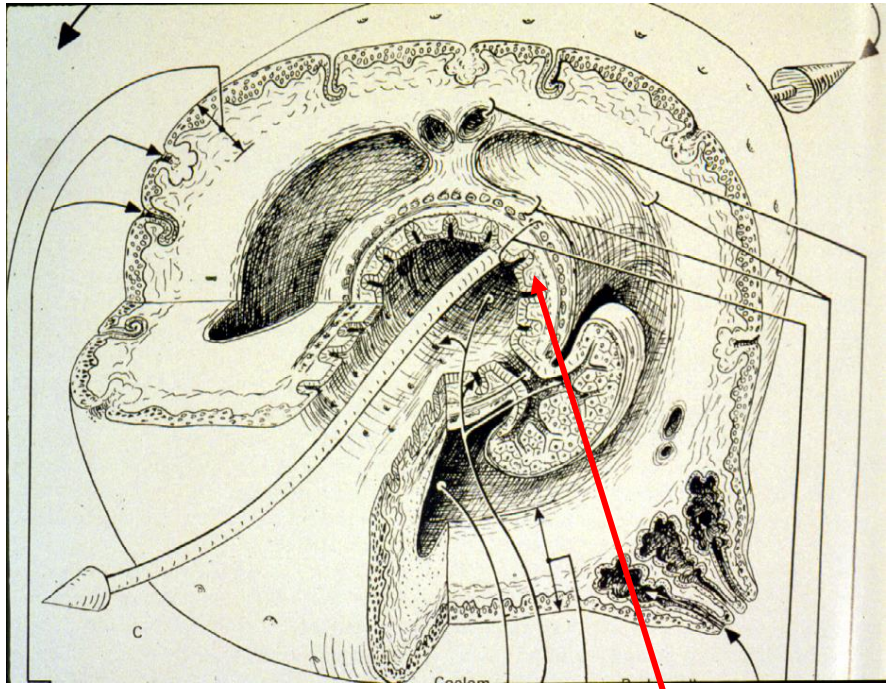
- ENDOTHELIUM - LINING OF BLOOD VESSELS
- MESOTHELIUM - LINING SEROUS CAVITIES

ORIGIN



ENDODERM –

ENDOCRINE GLANDS - LOSE CONNECTION WITH SURFACE



ENDODERM

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

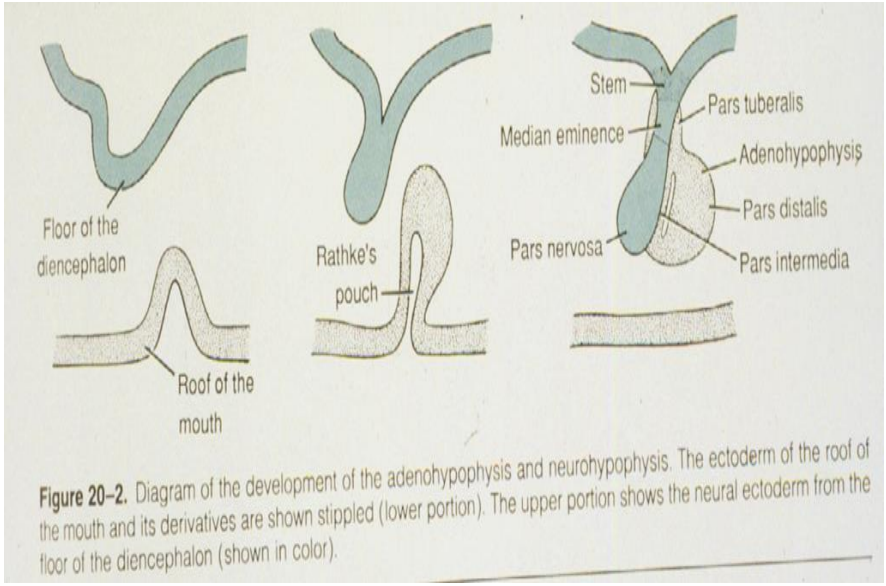
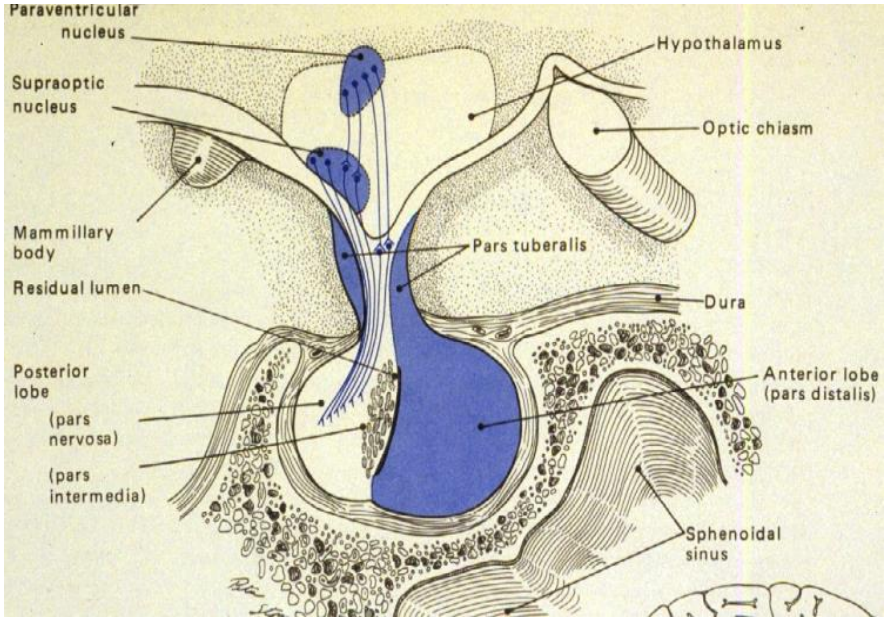
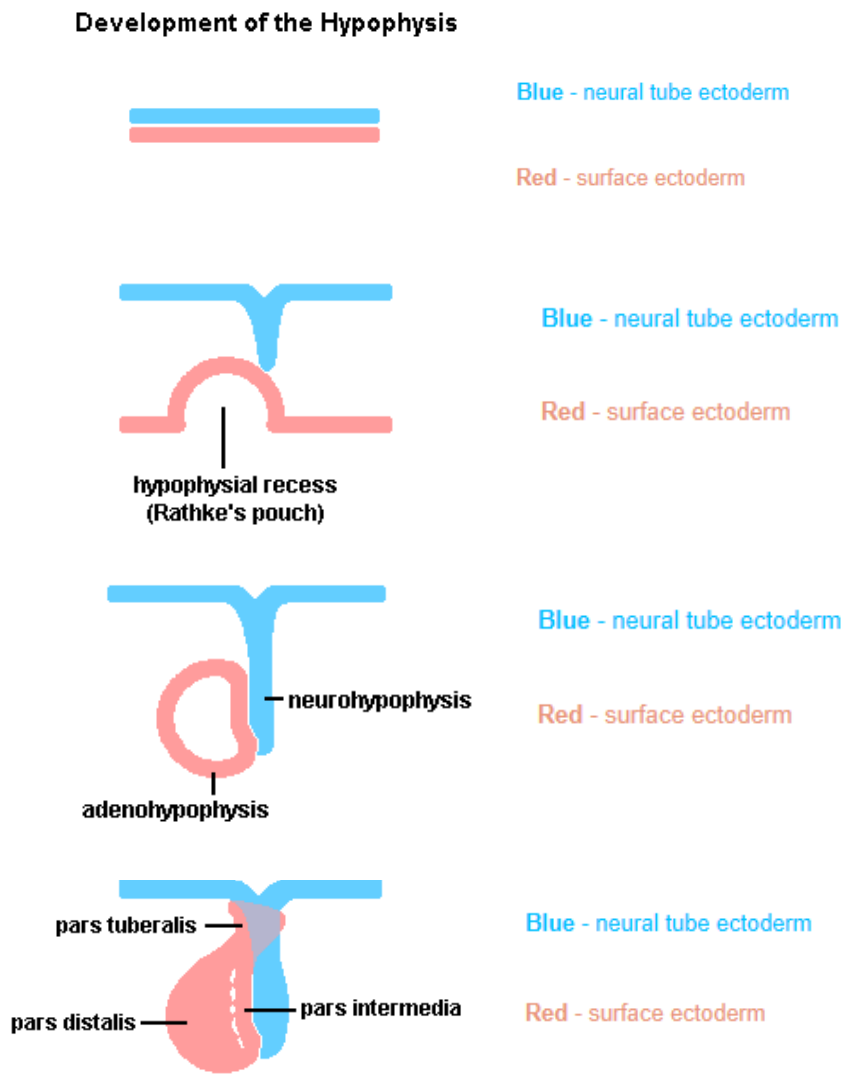


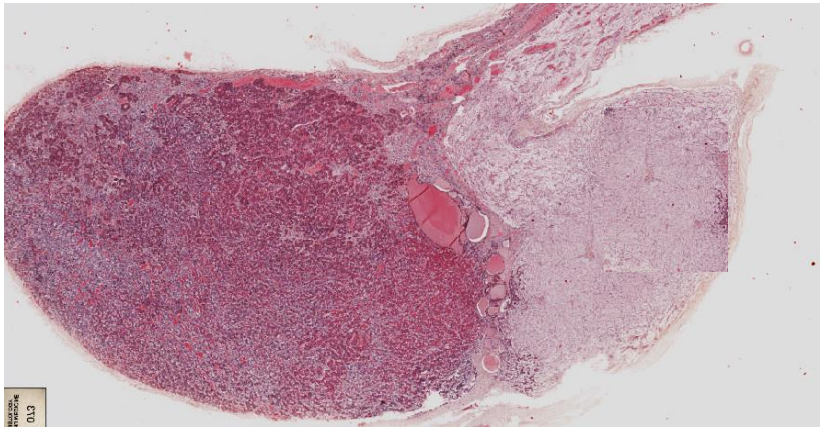
Figure 20–2. Diagram of the development of the adenohypophysis and neurohypophysis. The ectoderm of the roof of the mouth and its derivatives are shown stippled (lower portion). The upper portion shows the neural ectoderm from the floor of the diencephalon (shown in color).

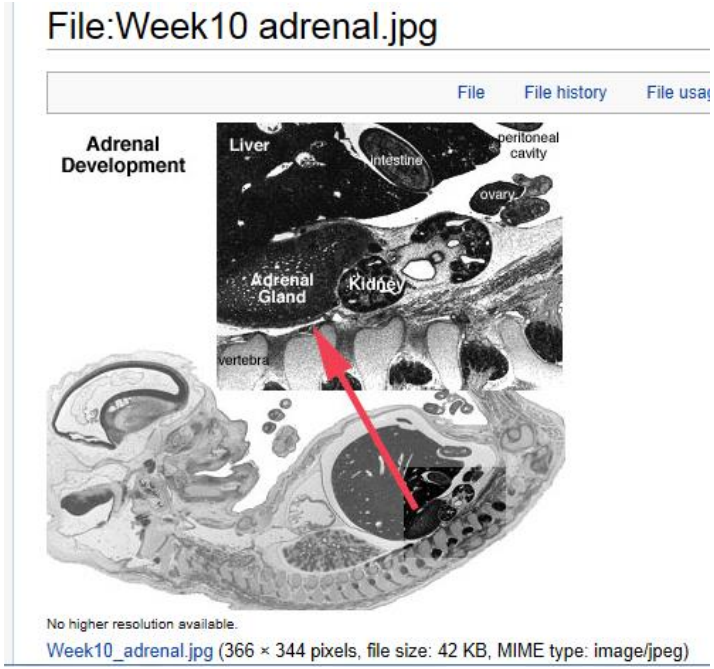


Pituitary development



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

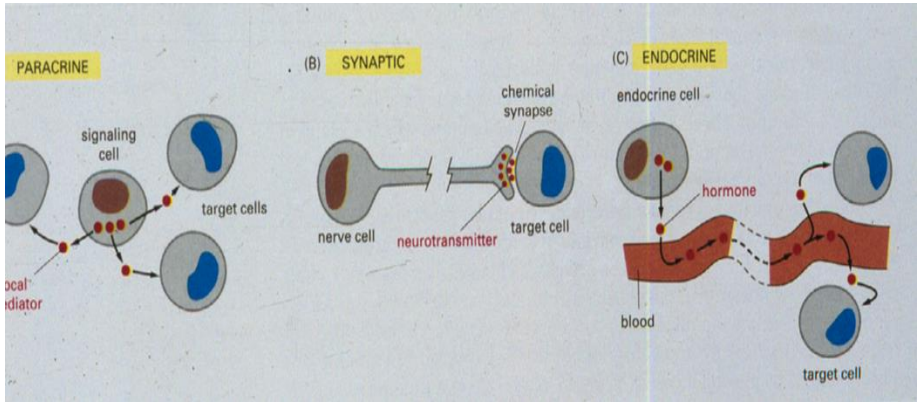


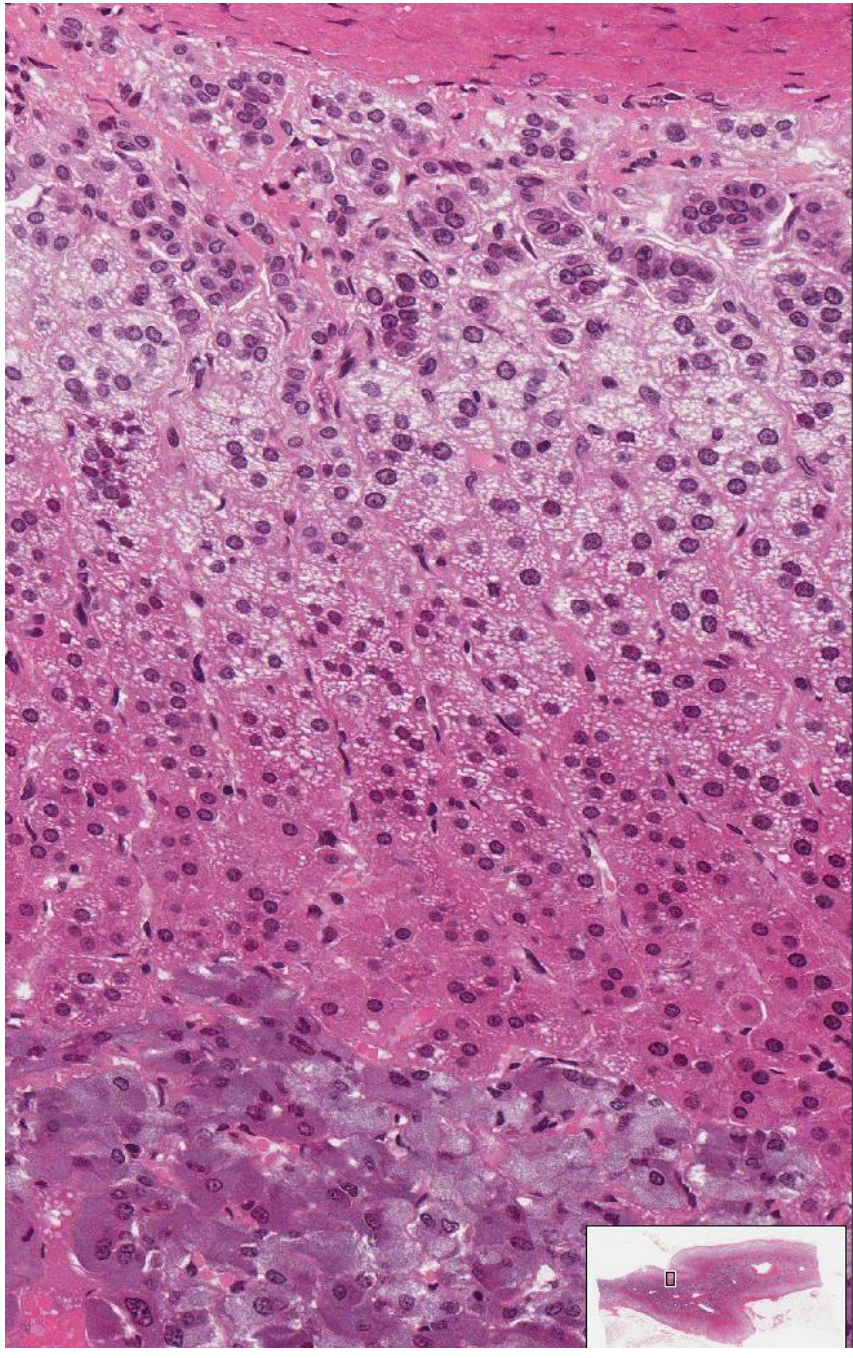


We need to

APPRECIATE THE DIVERSITY OF FUNCTIONS OF THE ENDOCRINE SYSTEM and to

RECOGNIZE DIFFERENT ORGANS, UNIQUE FEATURES OF ORGANS, AND CELLS THAT MAKE THE ENDOCRINE SYSTEM





HORMONE = to AROUSE or SET in MOTION

PHYSIOLOGICAL BLOOD LEVELS OF HORMONES compared to that for glucose

GLUCOSE 10^{-2} molar

STEROID 10^{-9} molar

PEPTIDE 10^{-12} molar

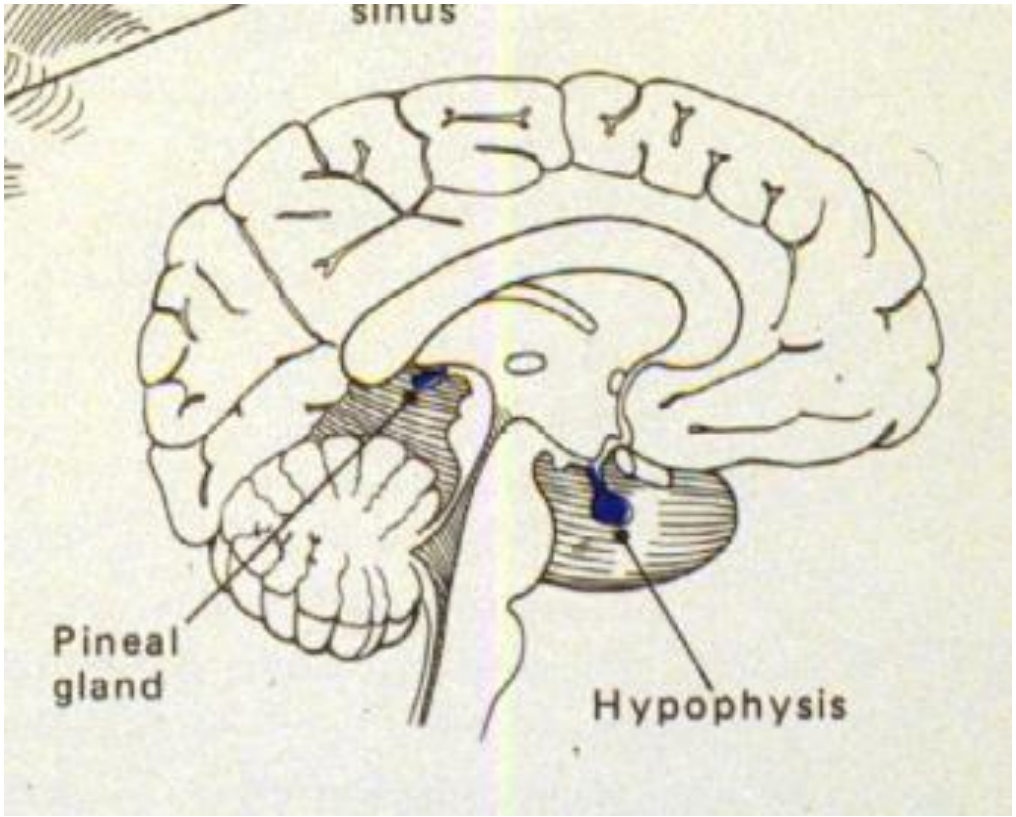
GROWTH HORMONE (BLOOD LEVELS)

10^{-13} molar = DWARF

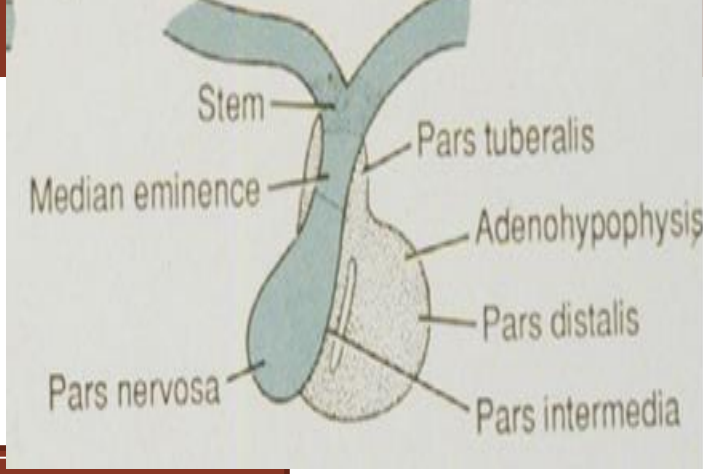
10^{-11} molar = GIANT

Pituitary gland (hypophysis) involvement in the neuroendocrine system

- Produces 9 hormones
- Reciprocal relations to other endocrine organs
- Neural and vascular connection to brain
- Location in key position for interplay between nervous and endocrine systems and establishment of neuroendocrine system



Pituitary gland

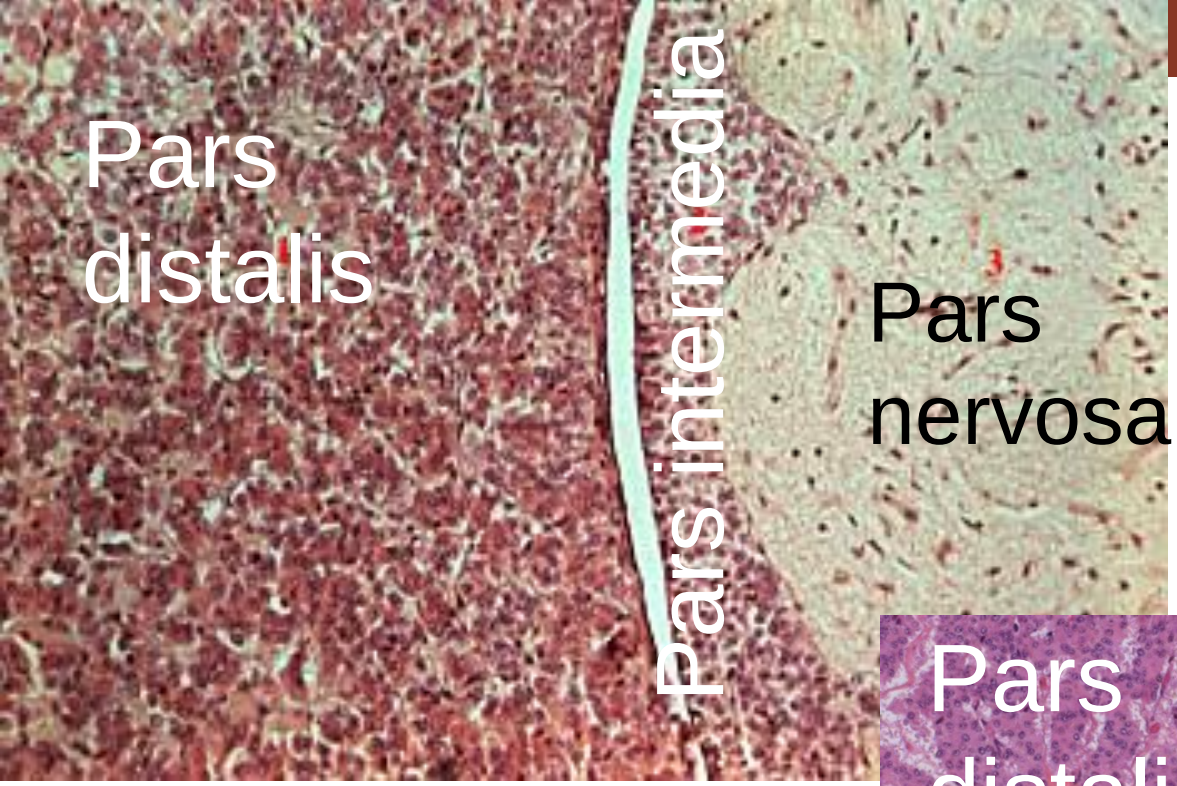


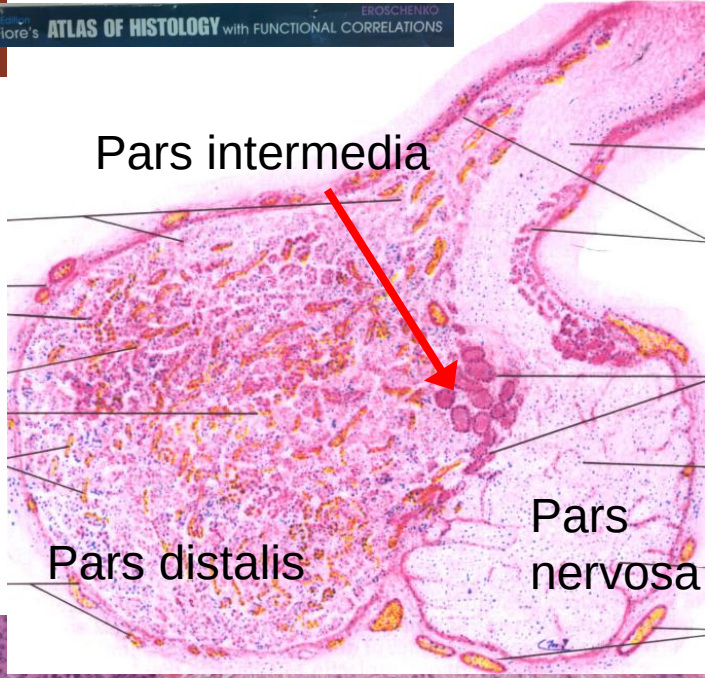
ADENOHYPOPHYSIS

- **PARS DISTALIS**
- **PARS TUBERALIS**
- **PARS INTERMEDIA**

NEUROHYPOPHYSIS

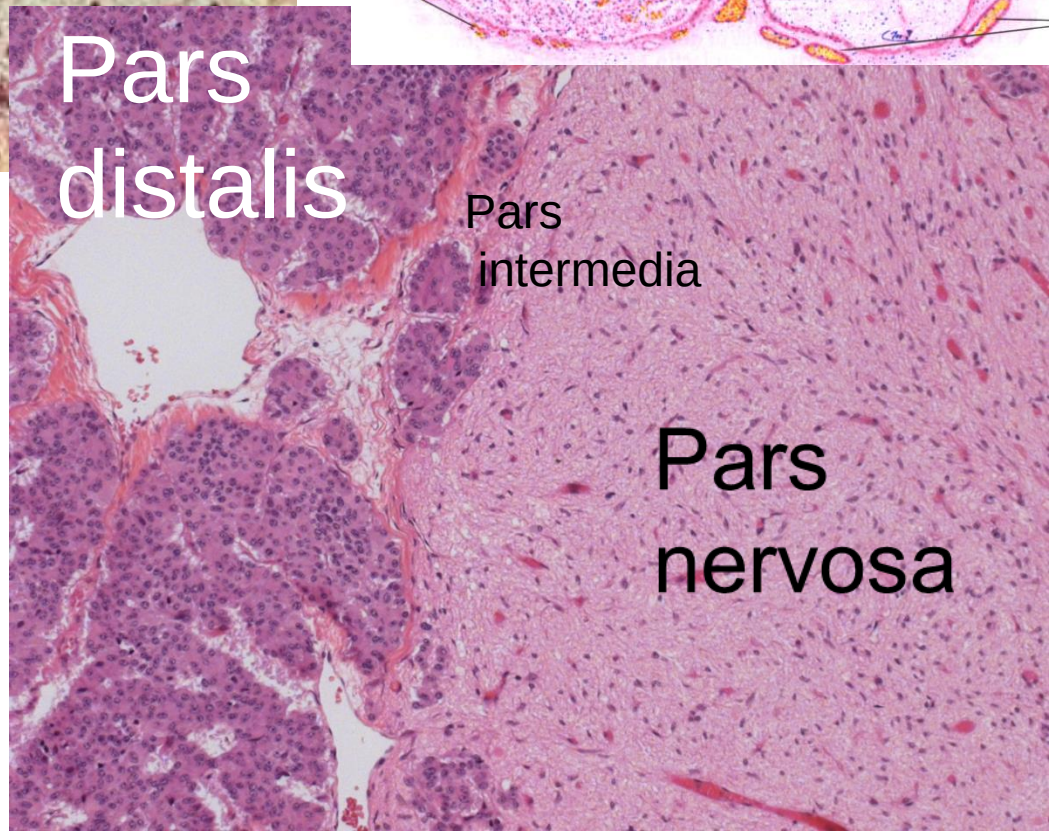
- **PARS NERVOSA**
  (PROCESSUS INFUNDIBULI)
- **INFUNDIBULUM**
  - **INFUNDIBULAR STEM**
  - **MEDIAN EMINENCE OF THE TUBER CINEREUM**

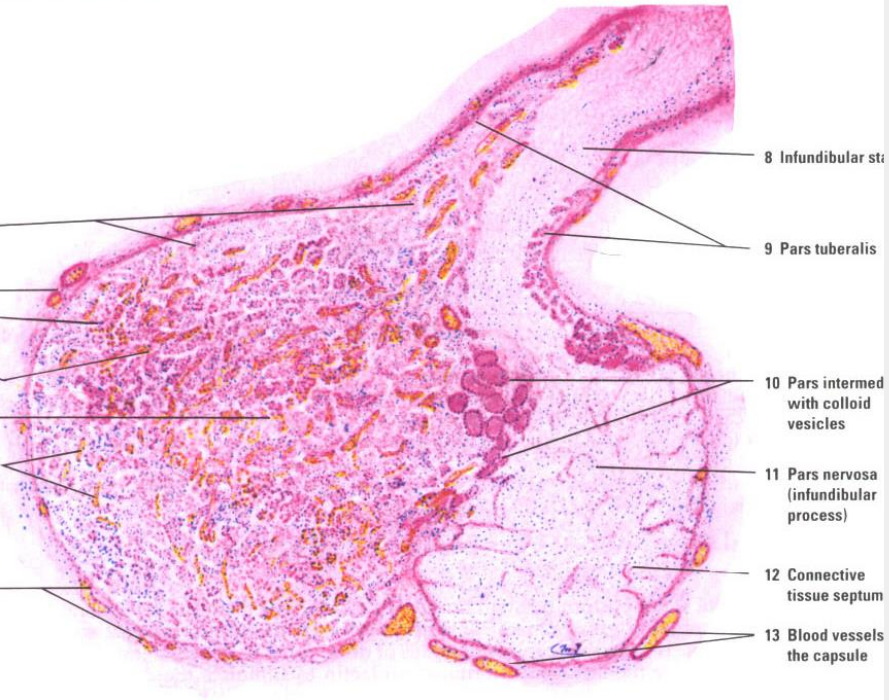




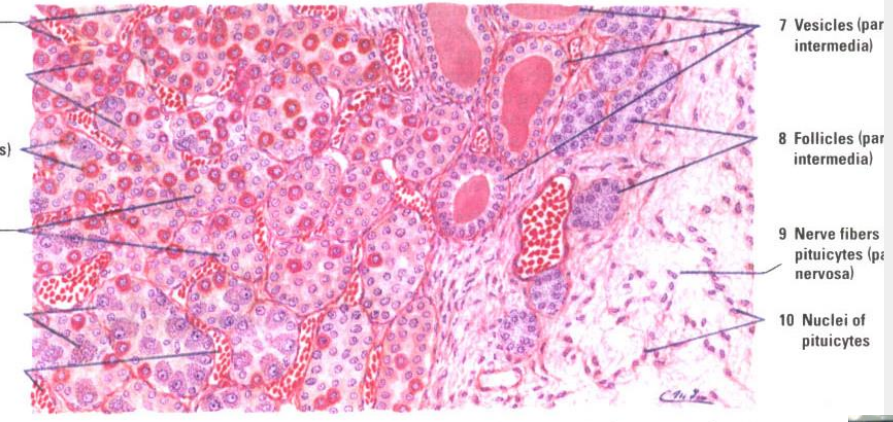
3 divisions of the pituitary gland:

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

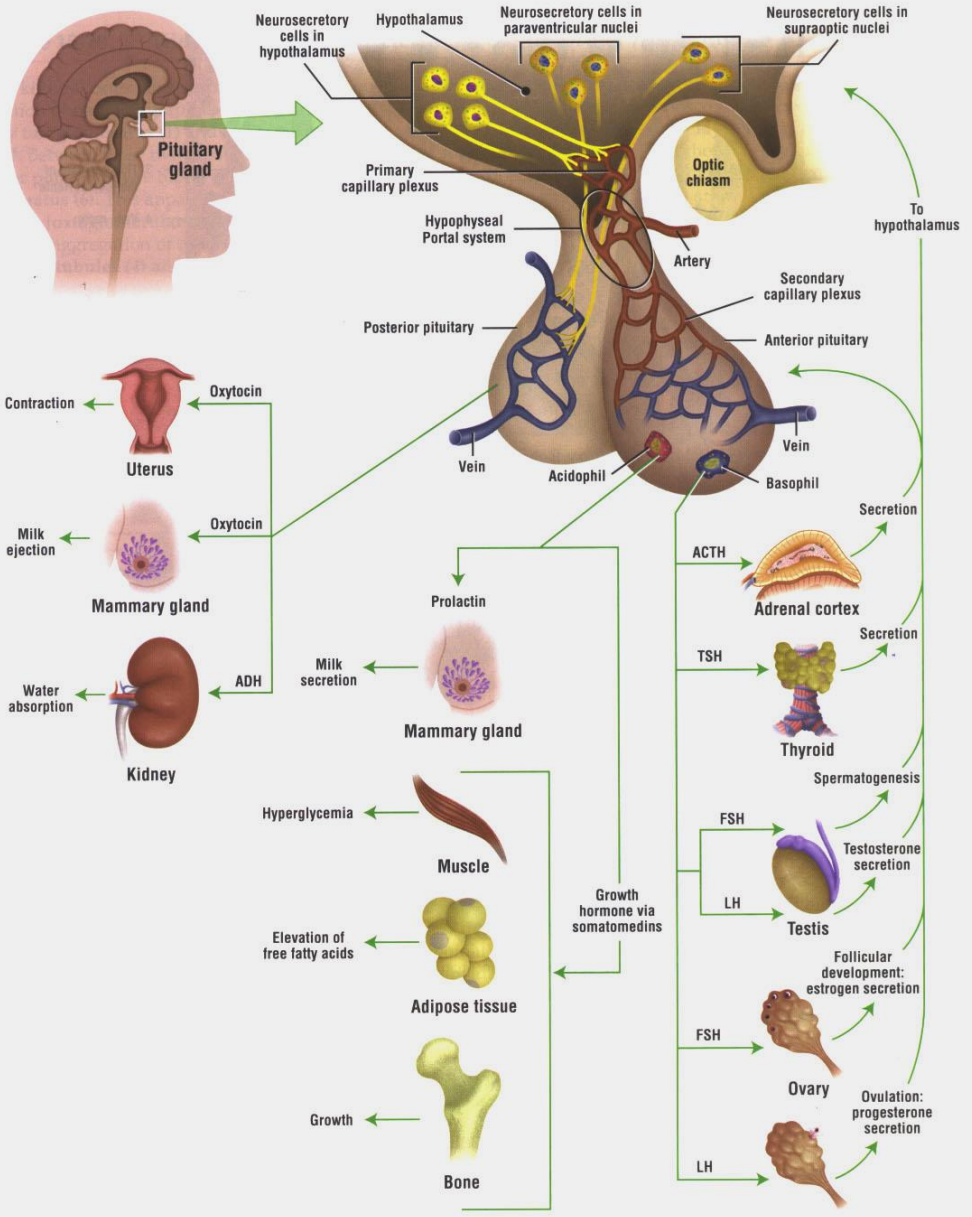




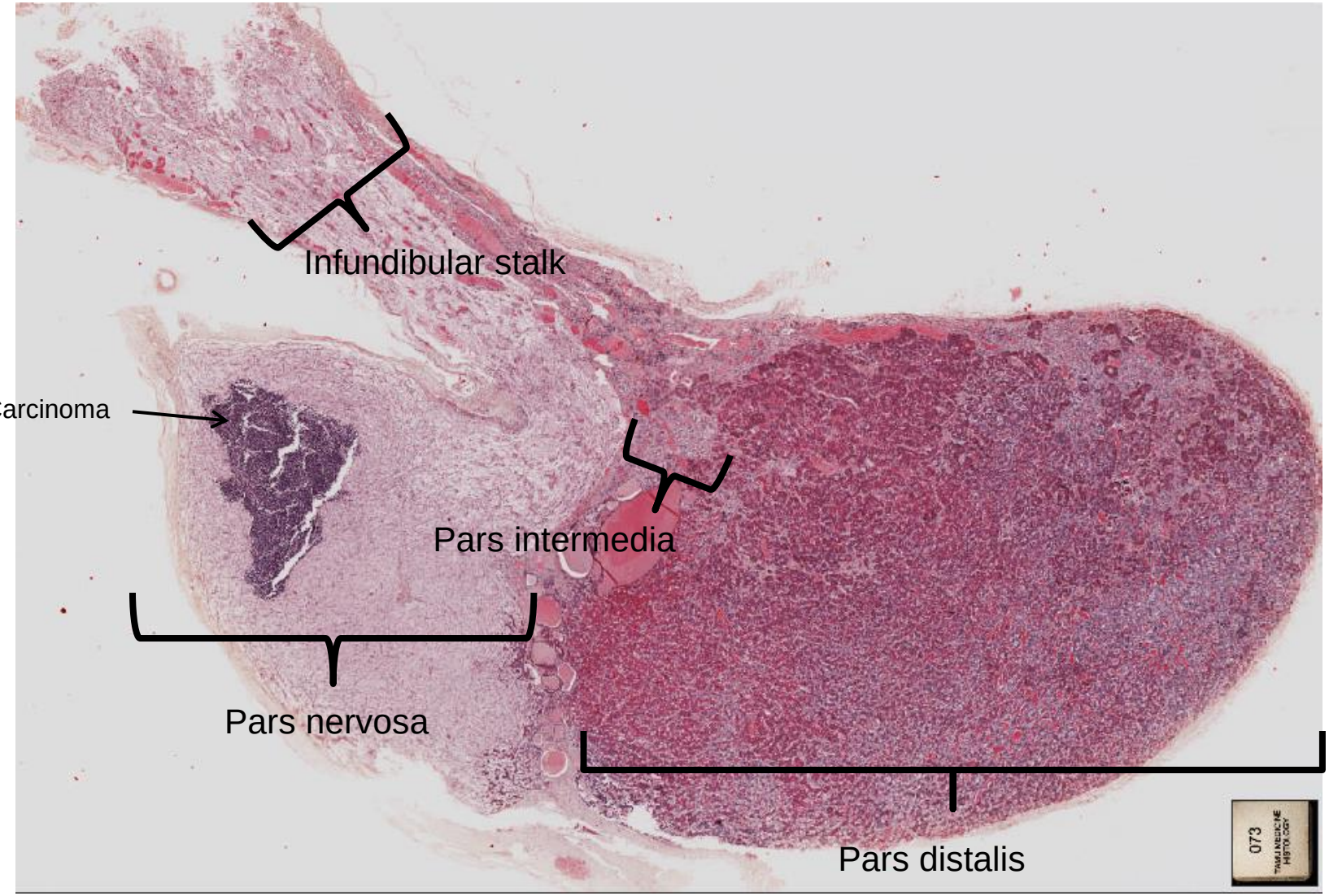
Hypophysis (panoramic view, sagittal section). Stain: hematoxylin-eosin. Low magnification.



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



Slide 73: Pituitary (early carcinoma in posterior lobe)



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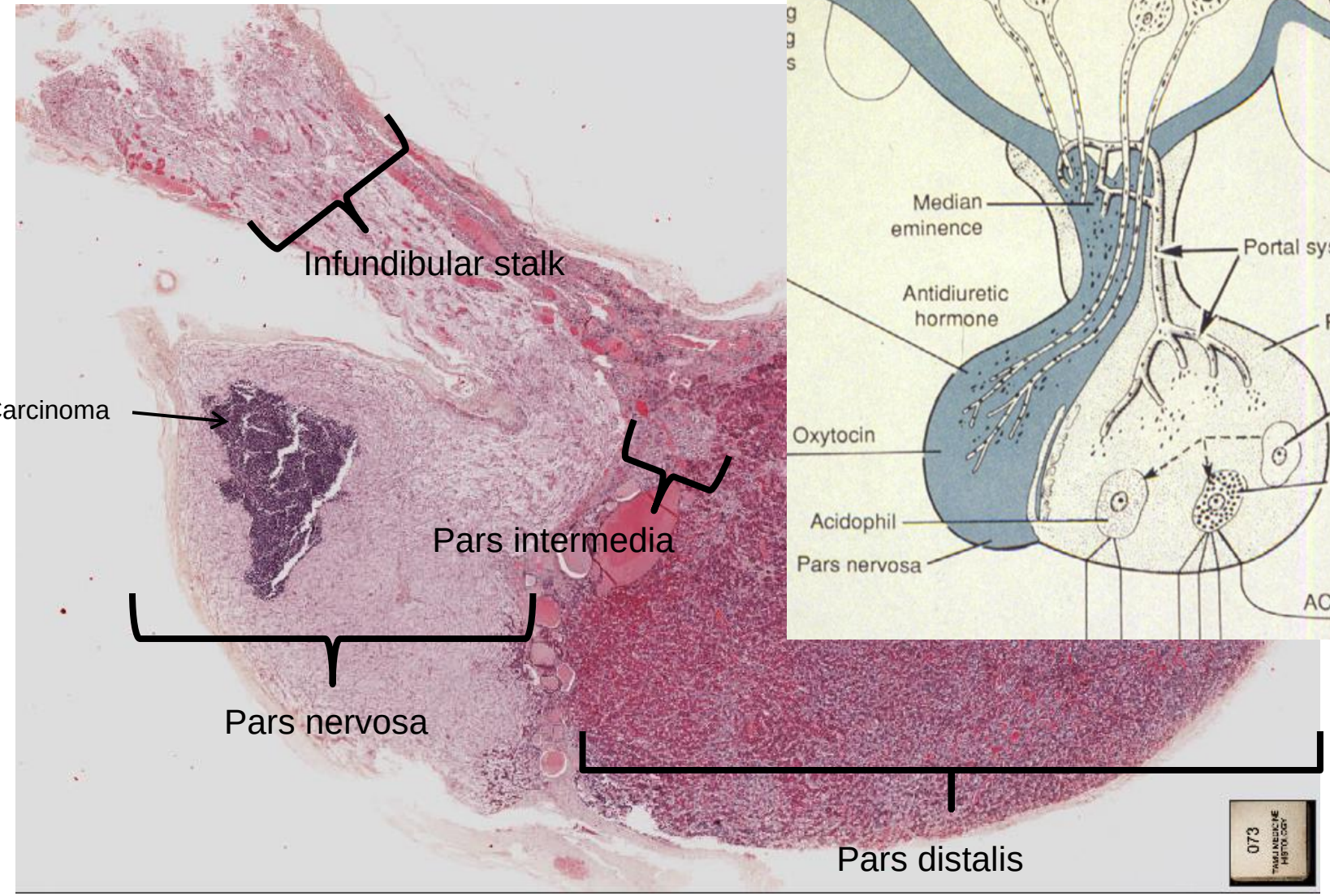
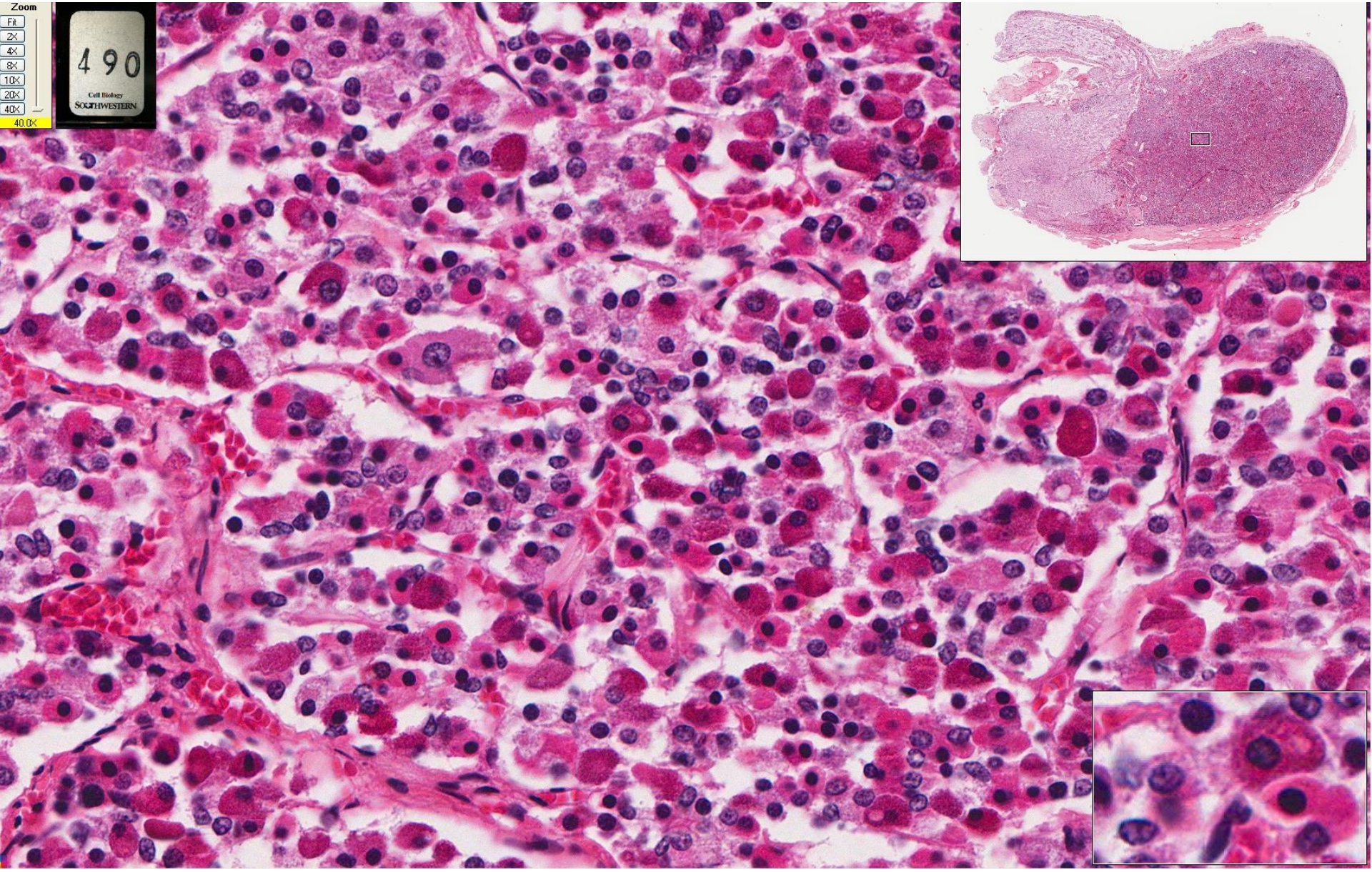
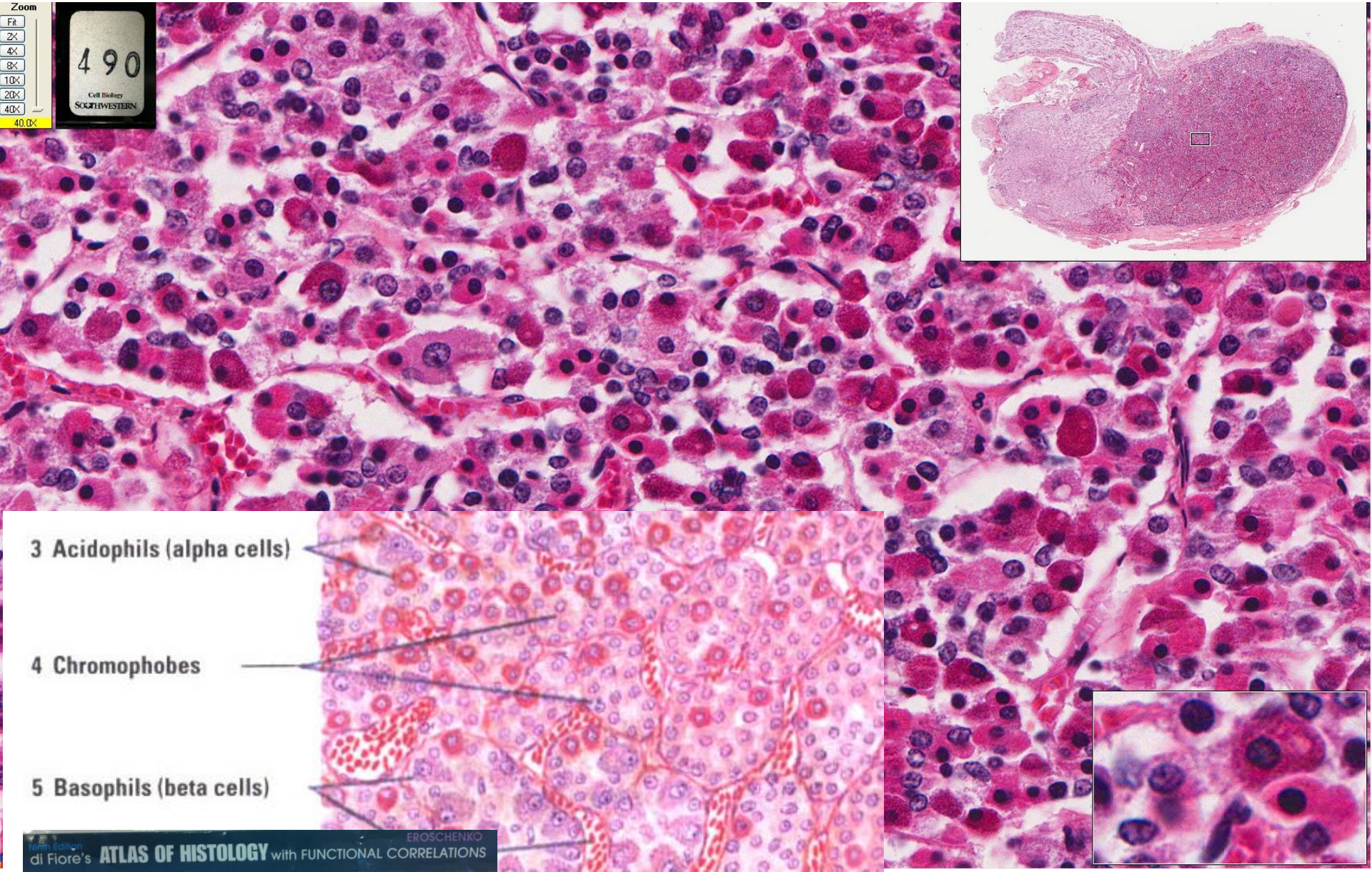


pars distalis of Hypophysis

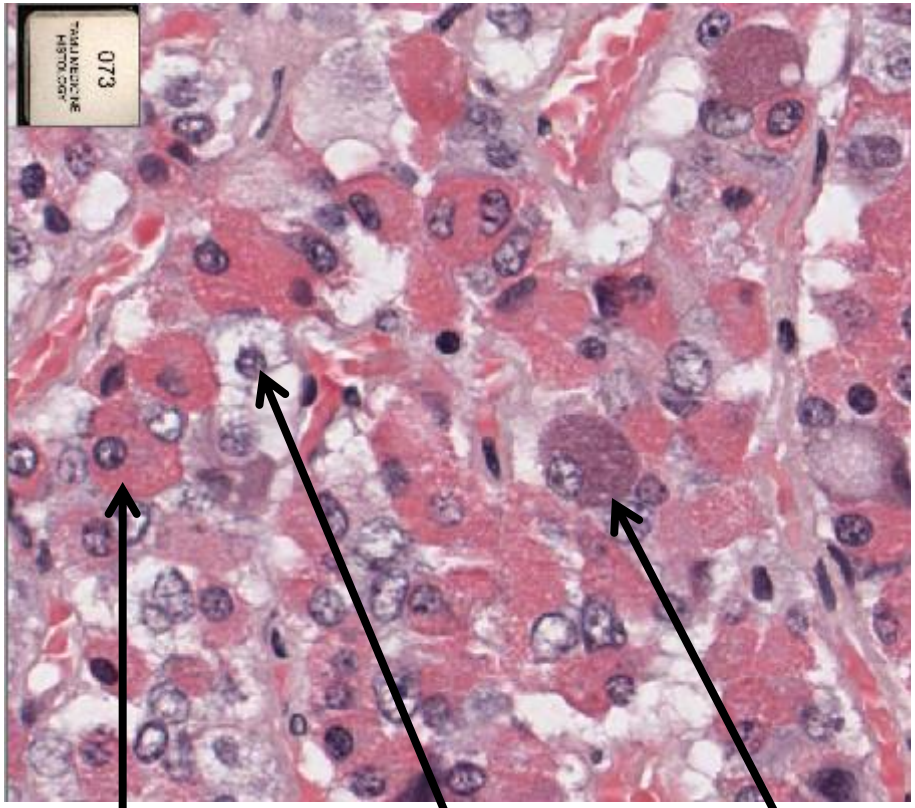


pars distalis of Hypophysis



Slide 73: Pituitary (early carcinoma in posterior lobe)

Pars distalis

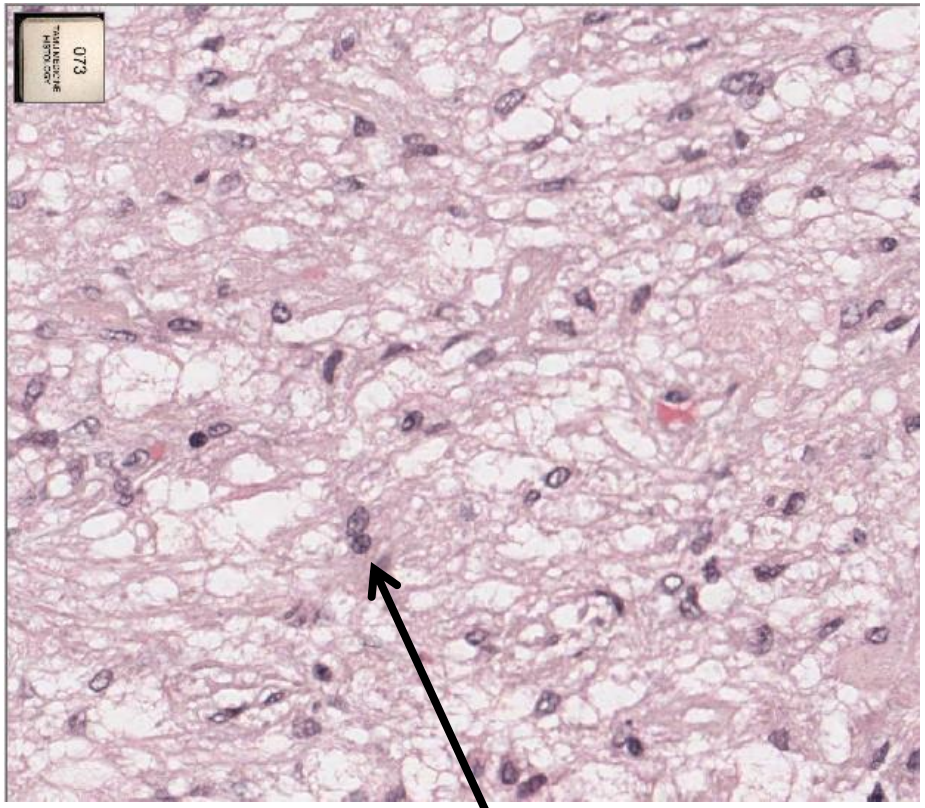


Acidophils

Chromophobes

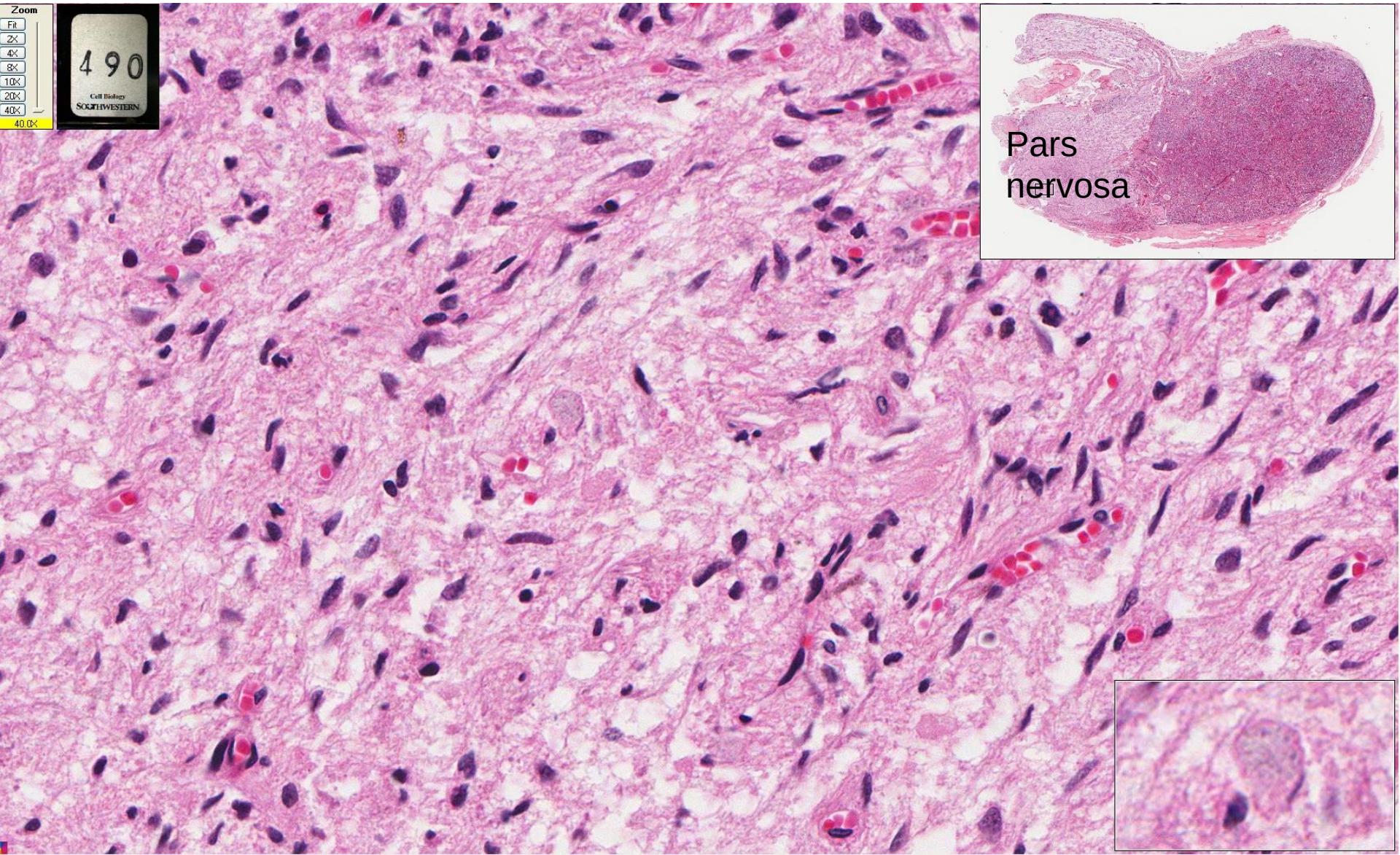
Basophils

Pars nervosa

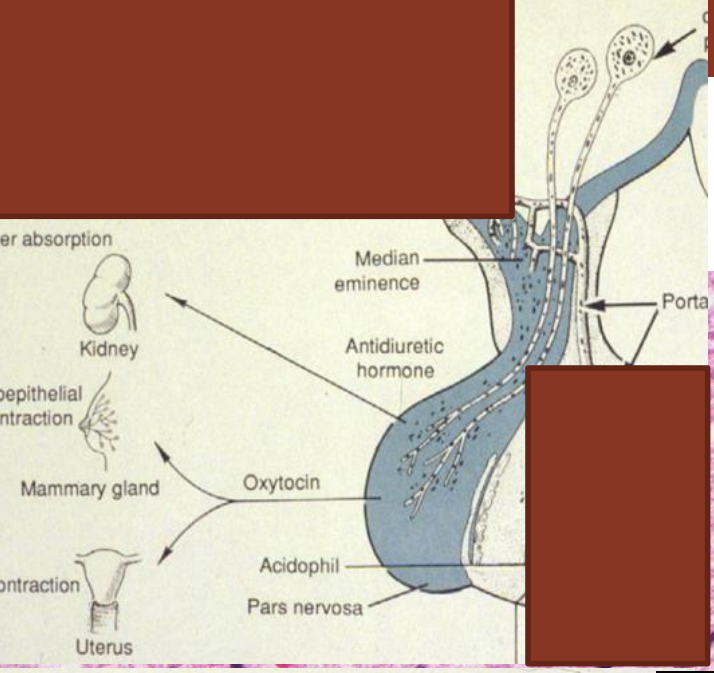


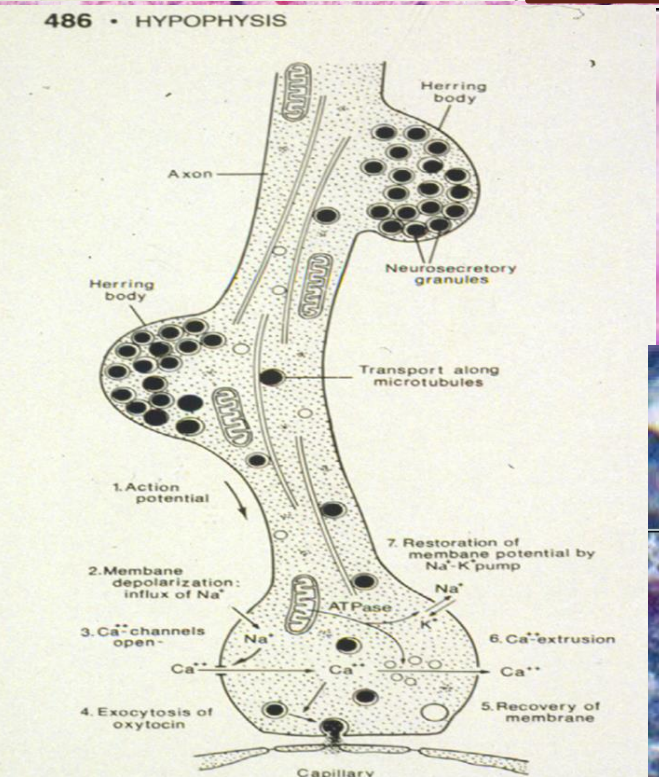
Pituicyte nuclei

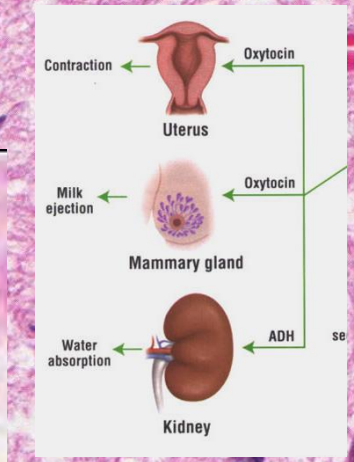
Herring bodies in pars nervosa of Hypophysis

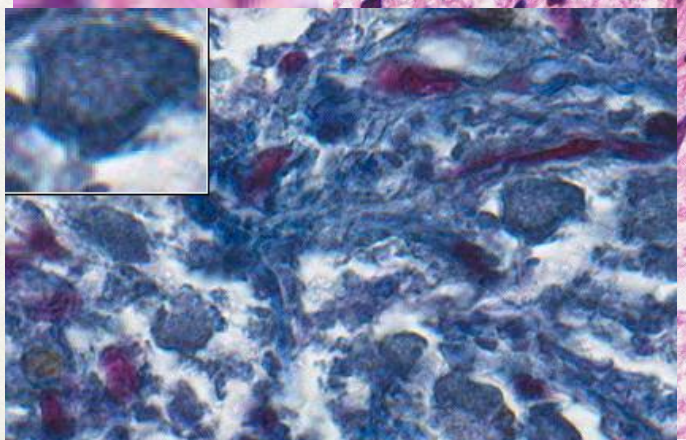


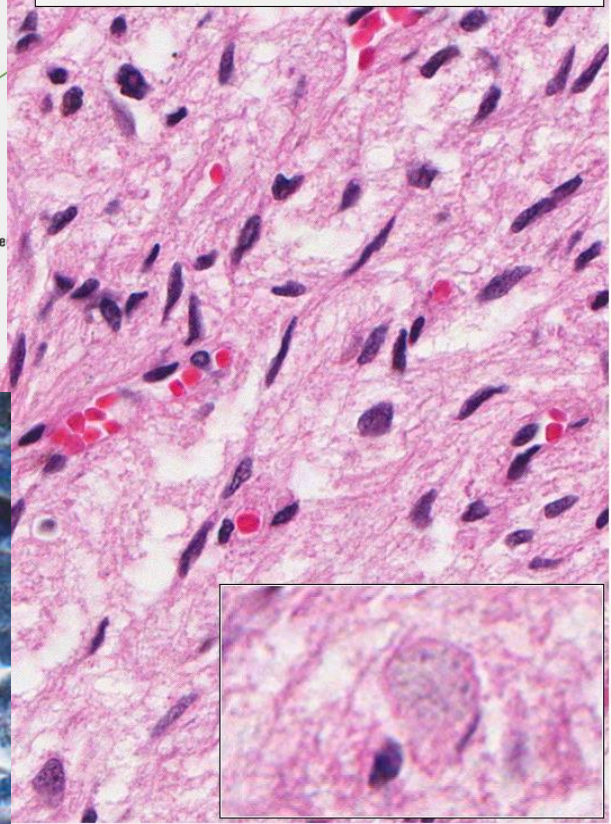
Herring bodies in pars nervosa of Hypophysis



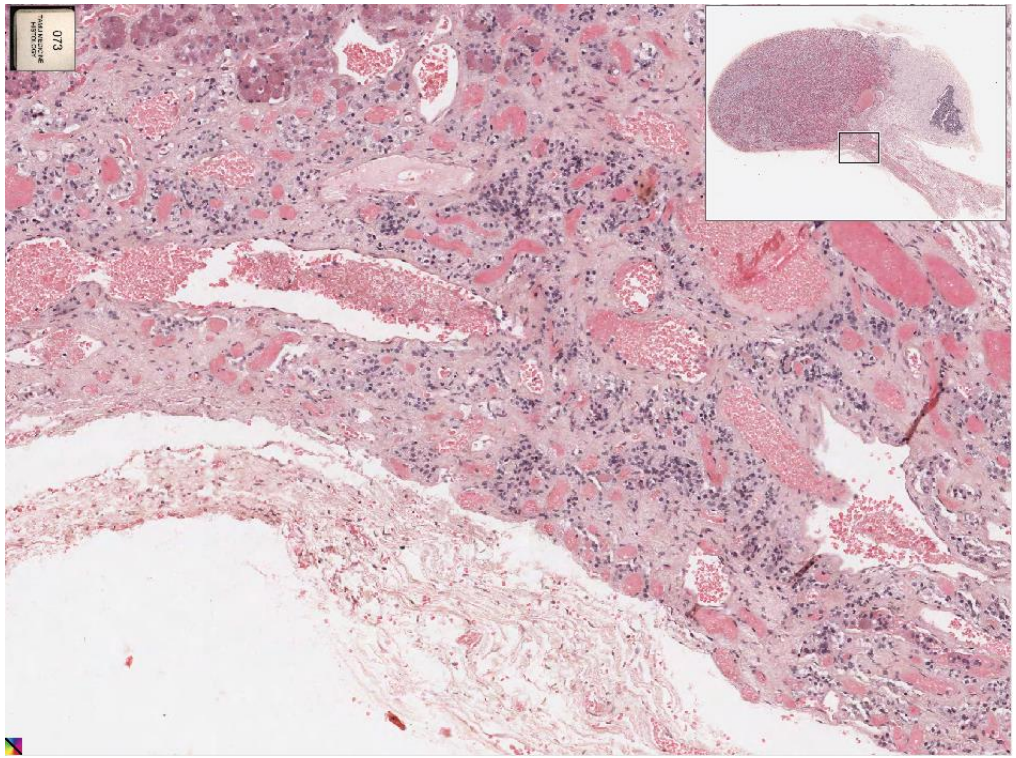




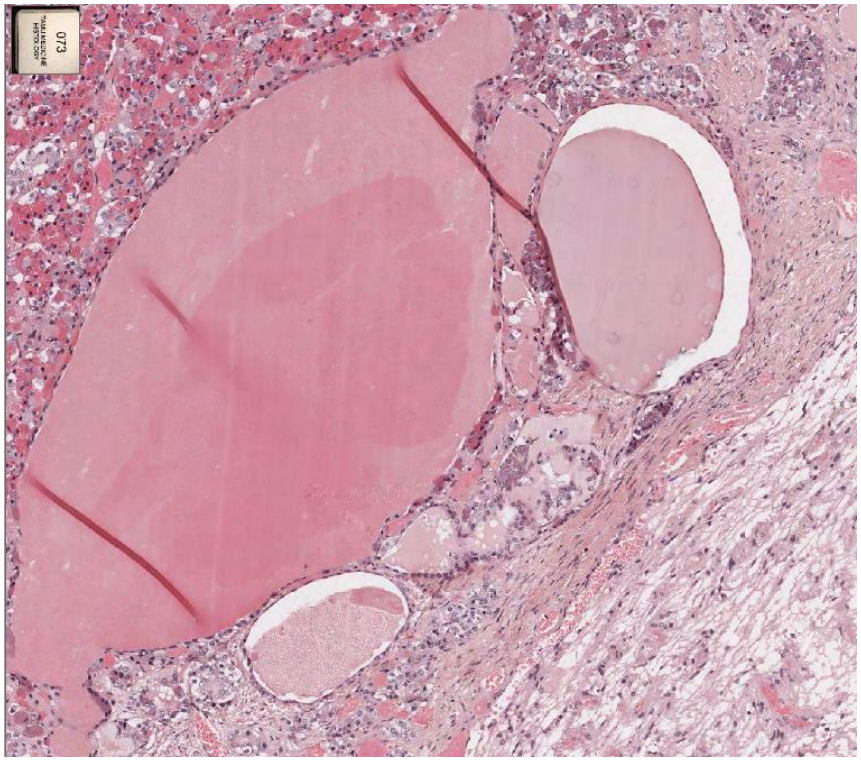




Slide 74: Pituitary (early carcinoma in posterior lobe)

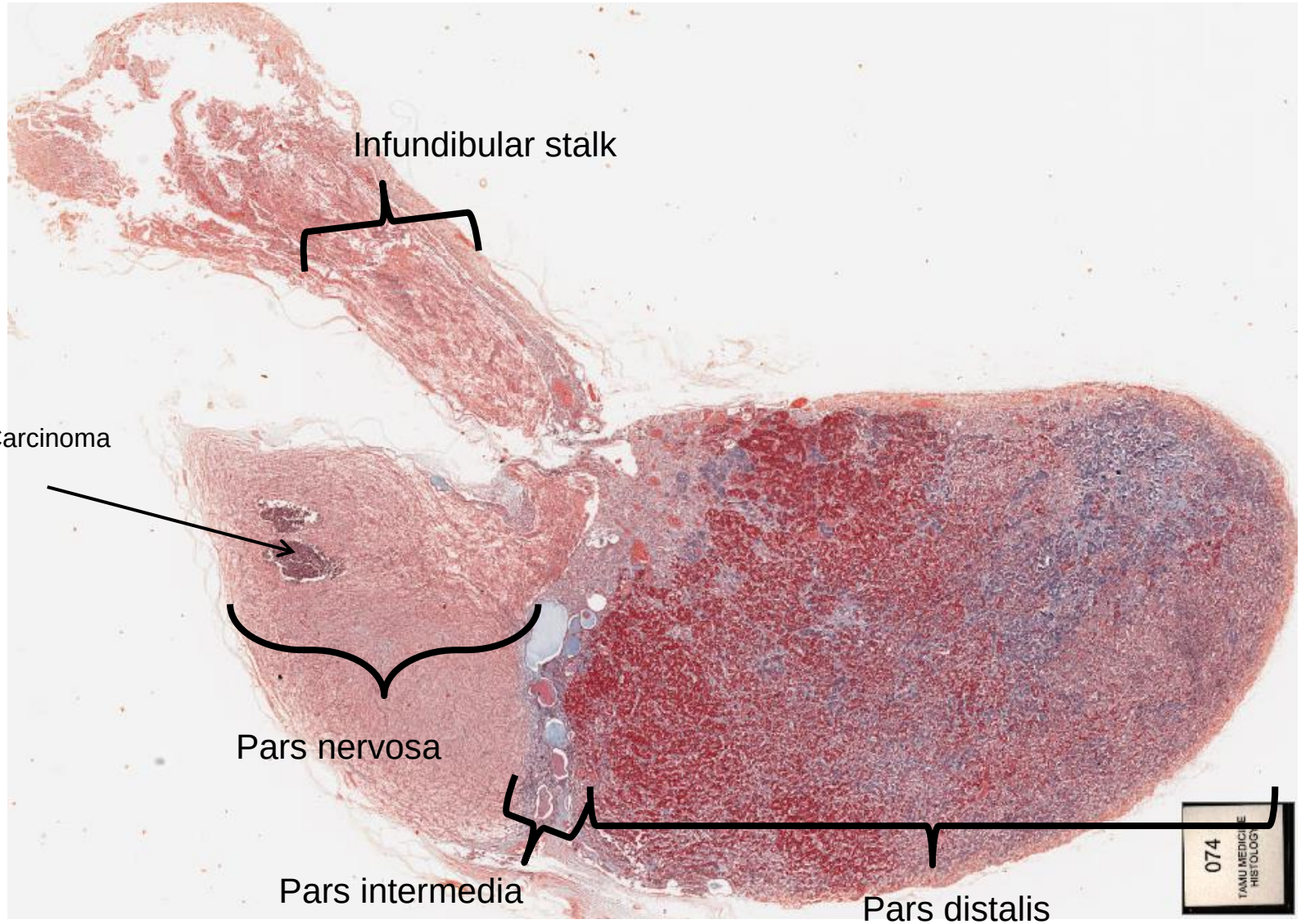


Pars tuberalis



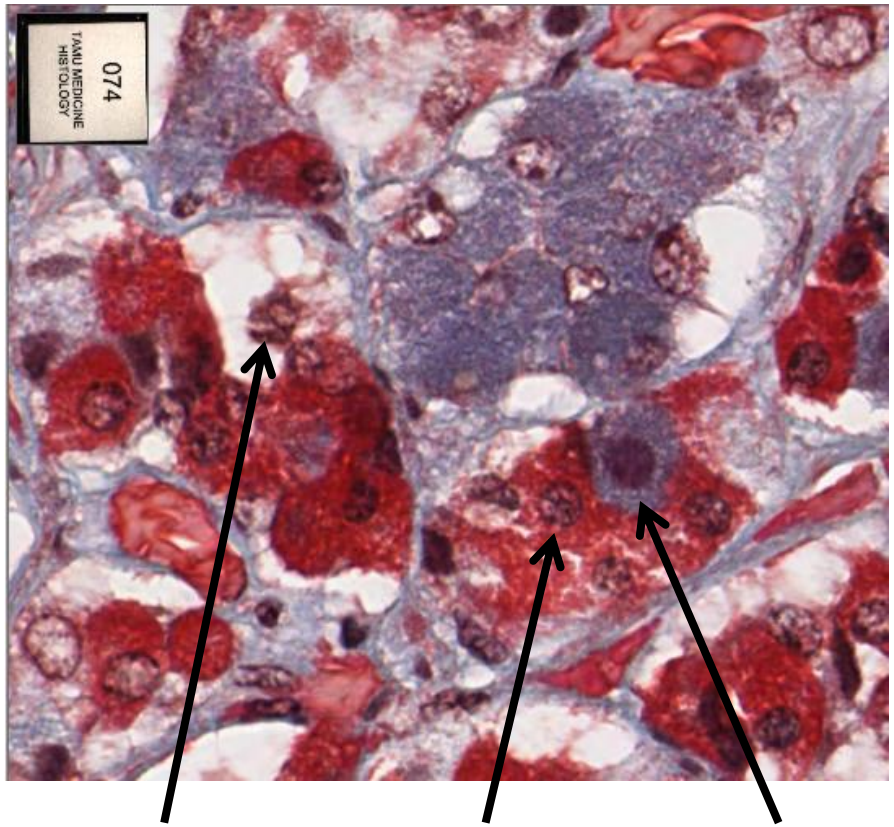
Pars intermedia with Rathke's cysts

Slide 74: Pituitary (Masson's trichrome)



Slide 74: Pituitary (early carcinoma in posterior lobe)

Pars distalis

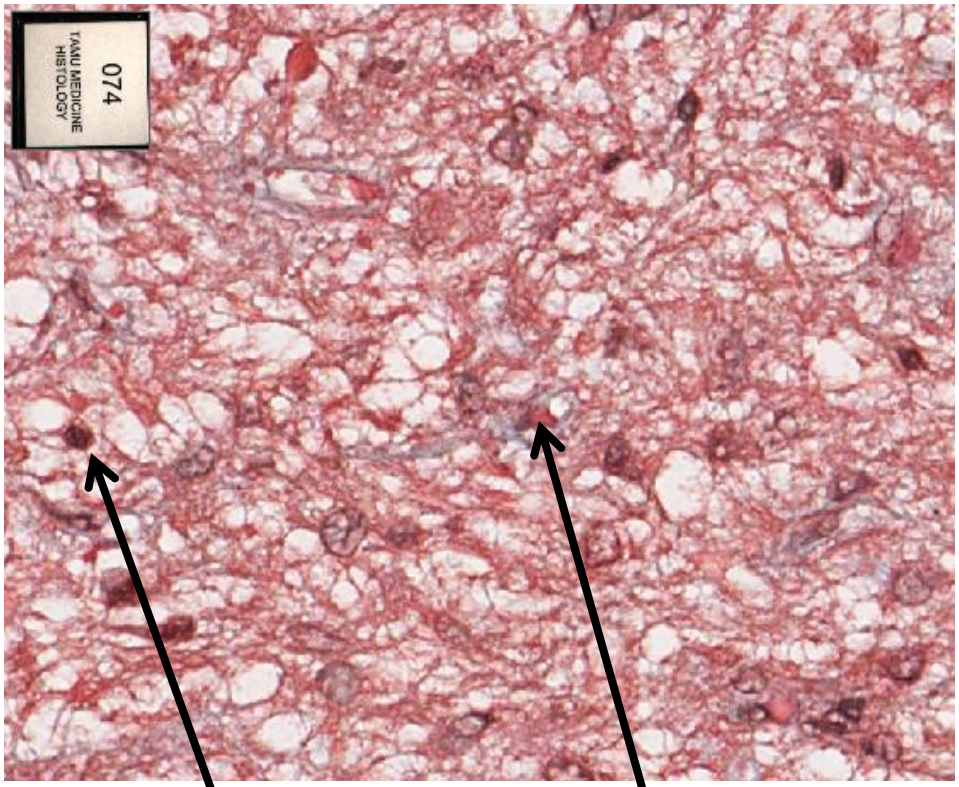


Chromophobes

Acidophils

Basophil

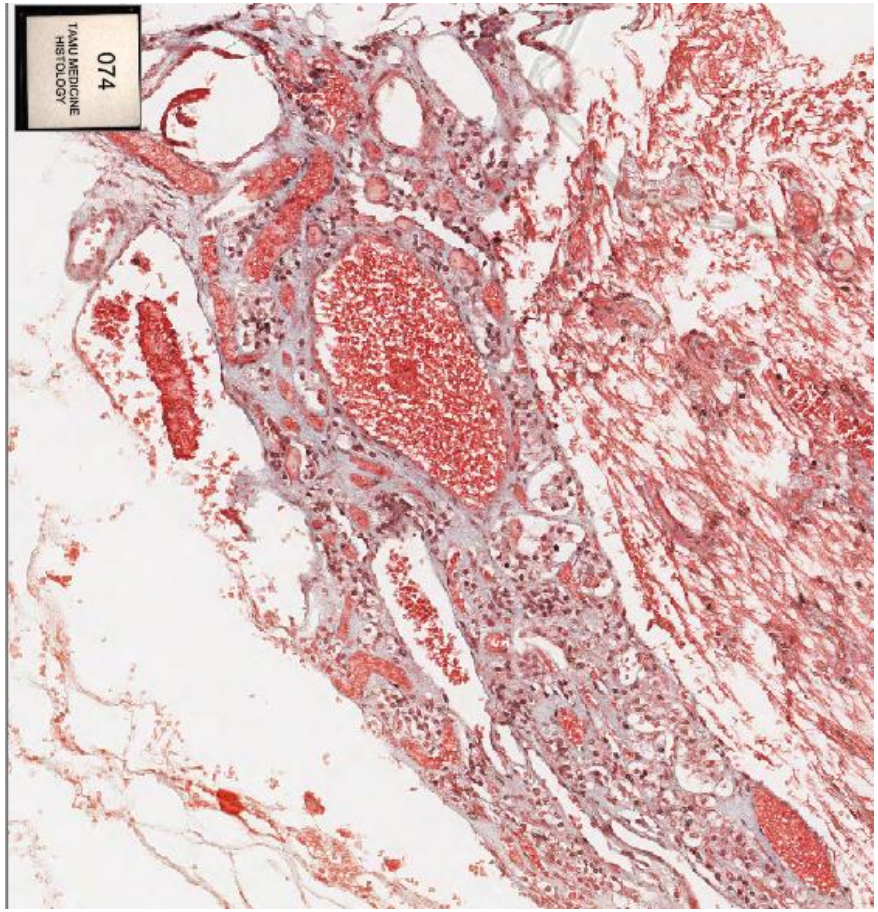
Pars nervosa



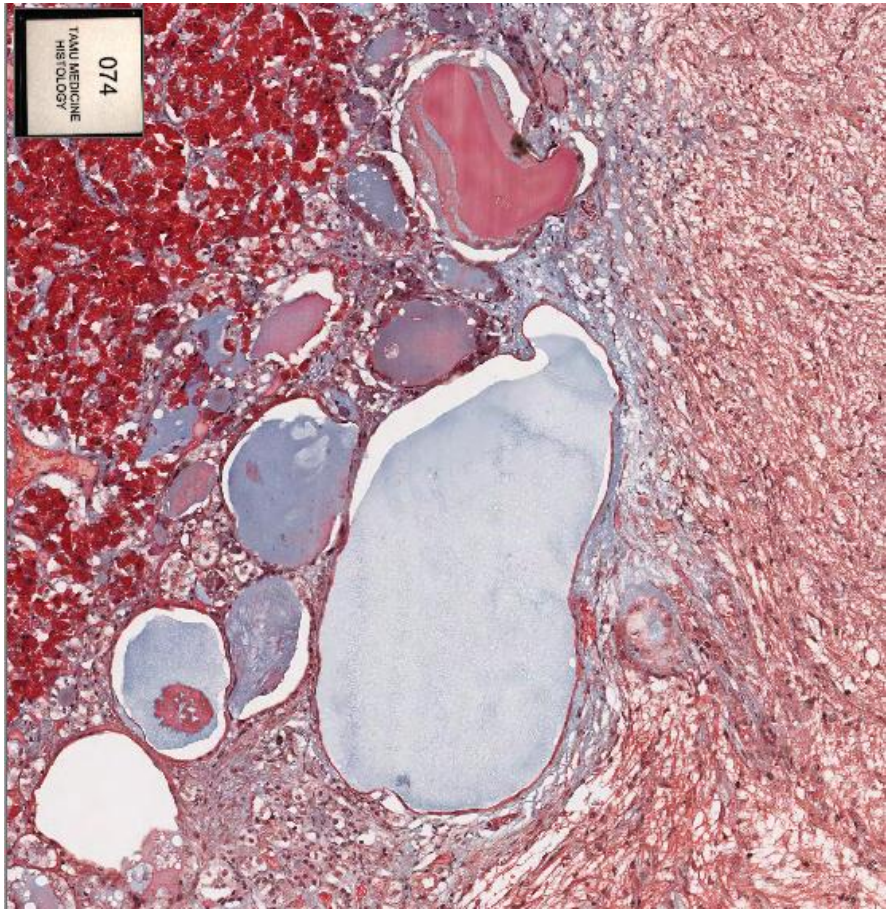
Pituicyte nuclei

Herring body

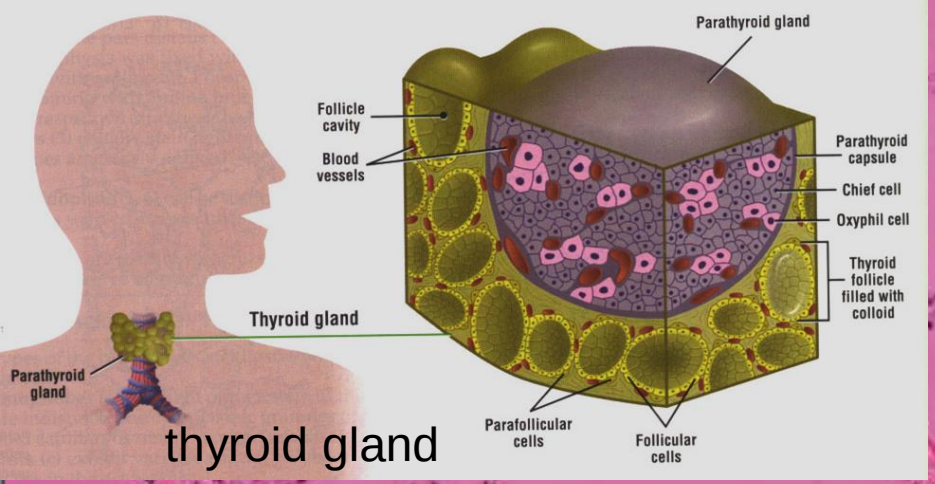
Slide 74: Pituitary (early carcinoma in posterior lobe)



Pars tuberalis



Pars intermedia with Rathke's cysts



thyroid gland

Thyroid gland

Follicle – no outlet

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

Colloid

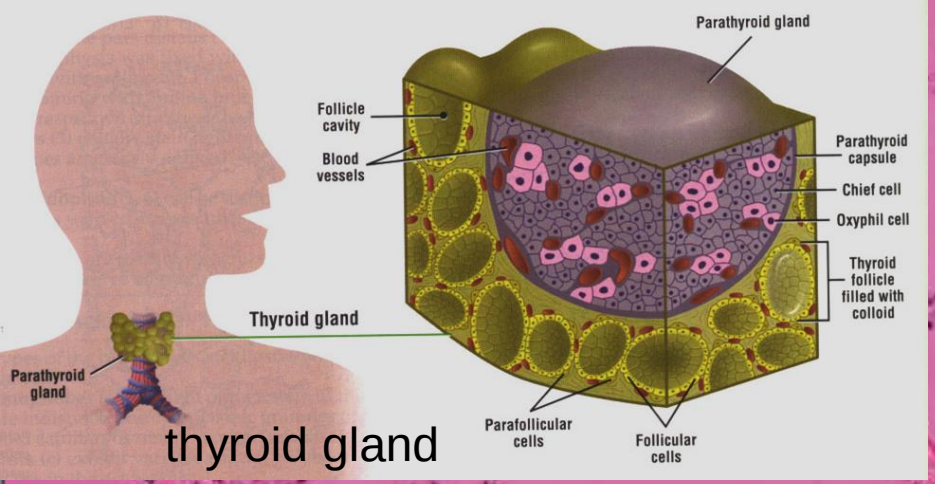
Capillary

Follicular cells

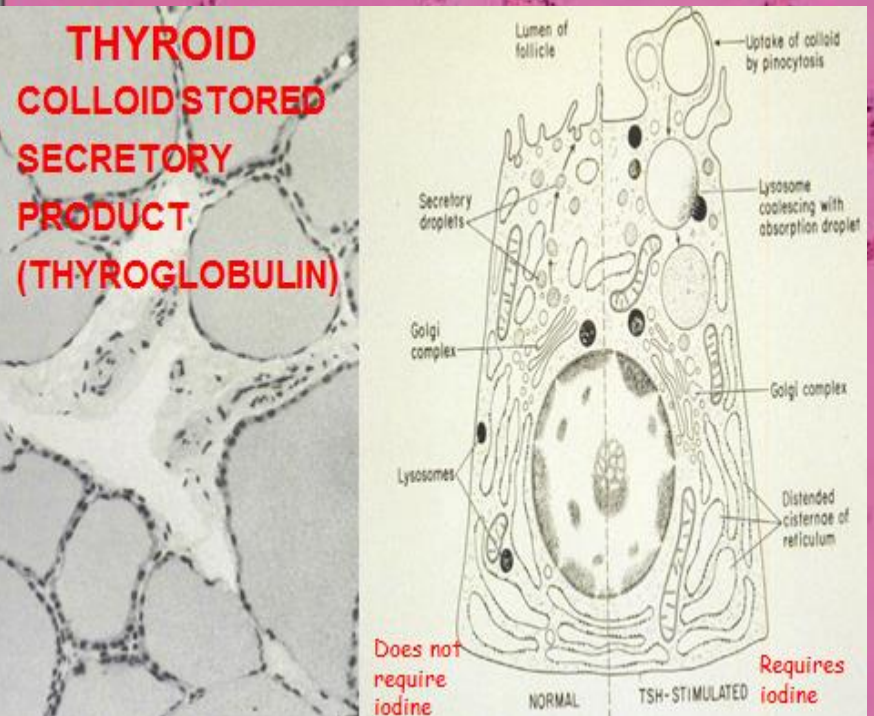
Thyroid gland

Follicle – no outlet

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



thyroid gland

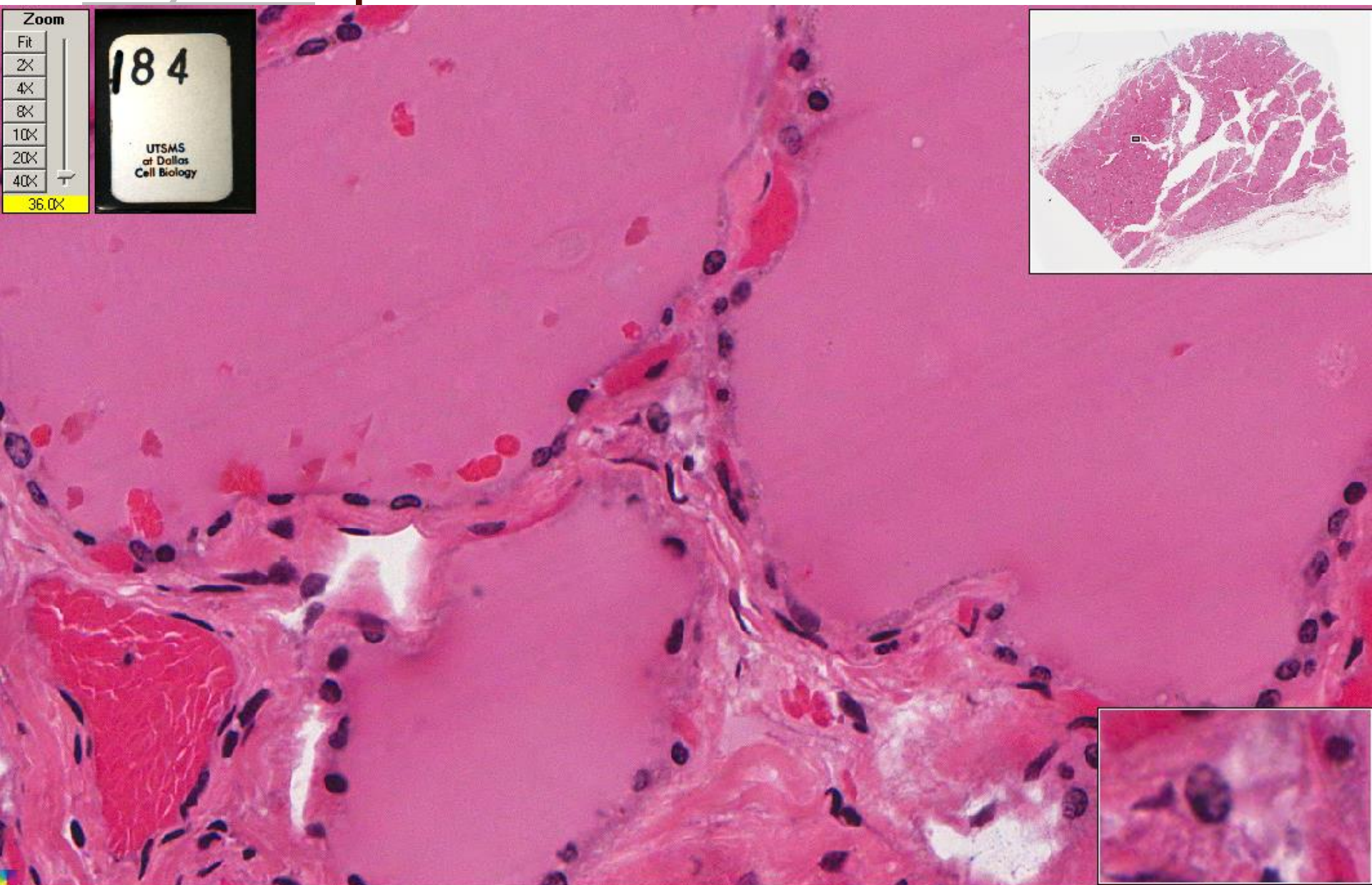


Colloid

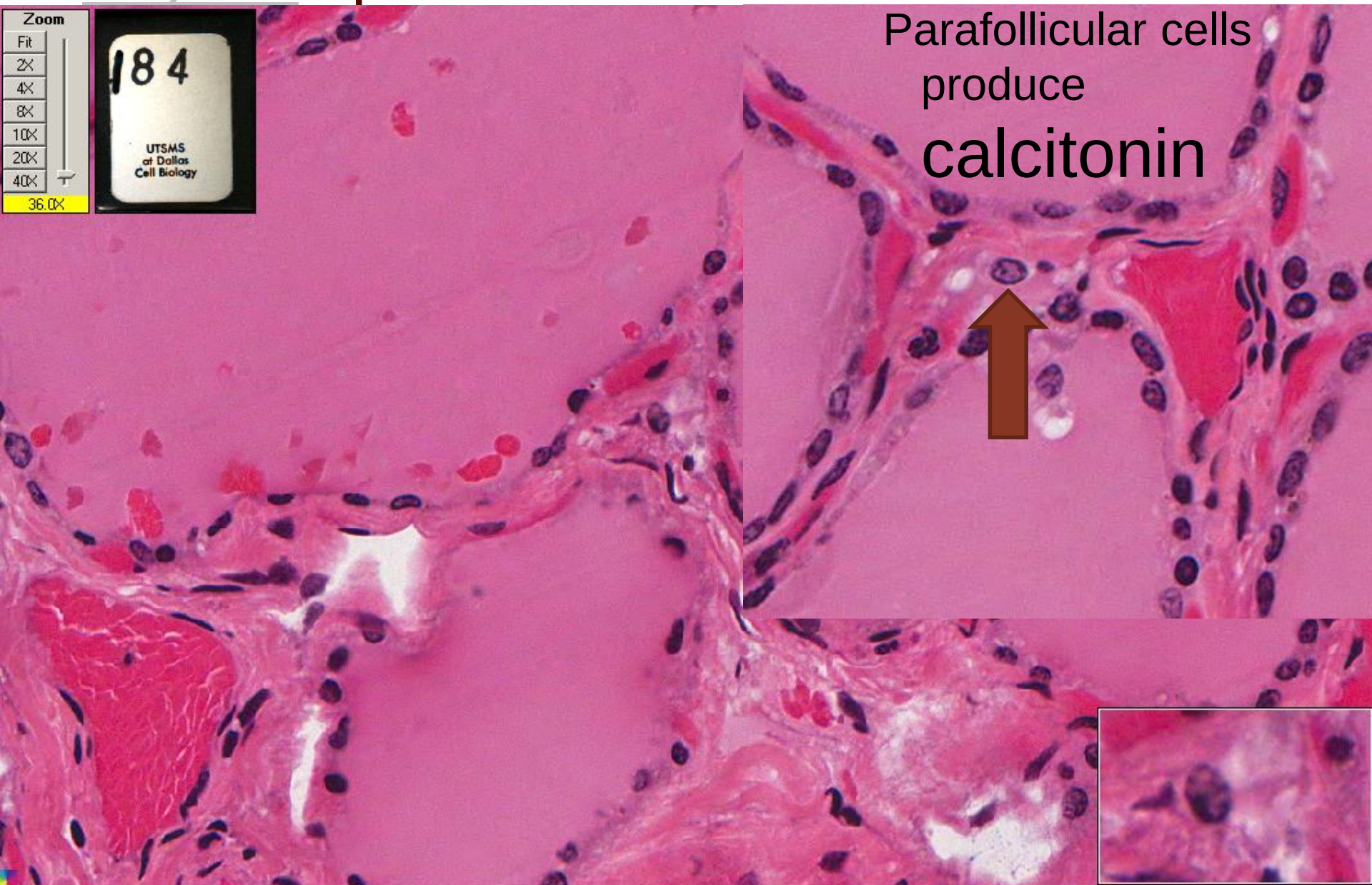
Capillary

Follicular cells

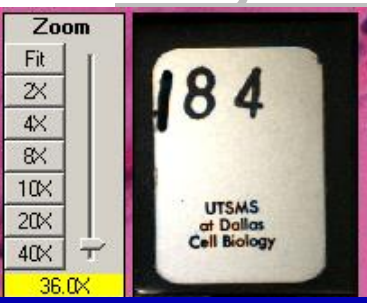
Thyroid –parafollicular cells



Thyroid –parafollicular cells



Thyroid –parafollicular cells



Parafollicular cells produce

calcitonin

FUNCTIONS OF BONE

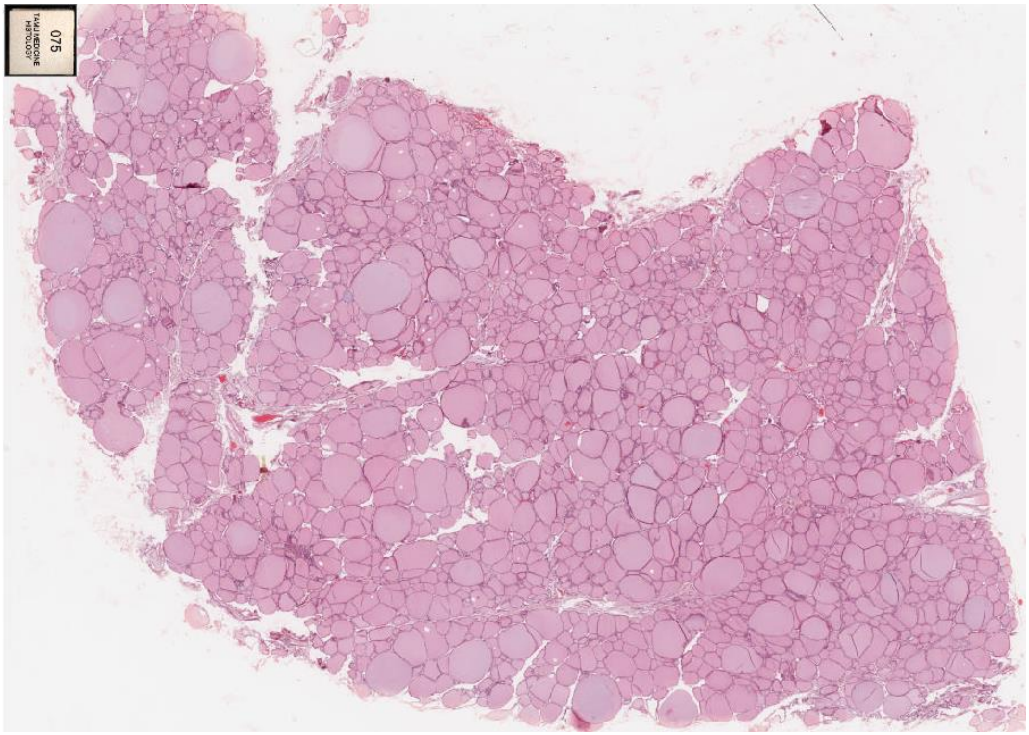
CALCIUM REGULATION

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.

Slide 75: Thyroid gland



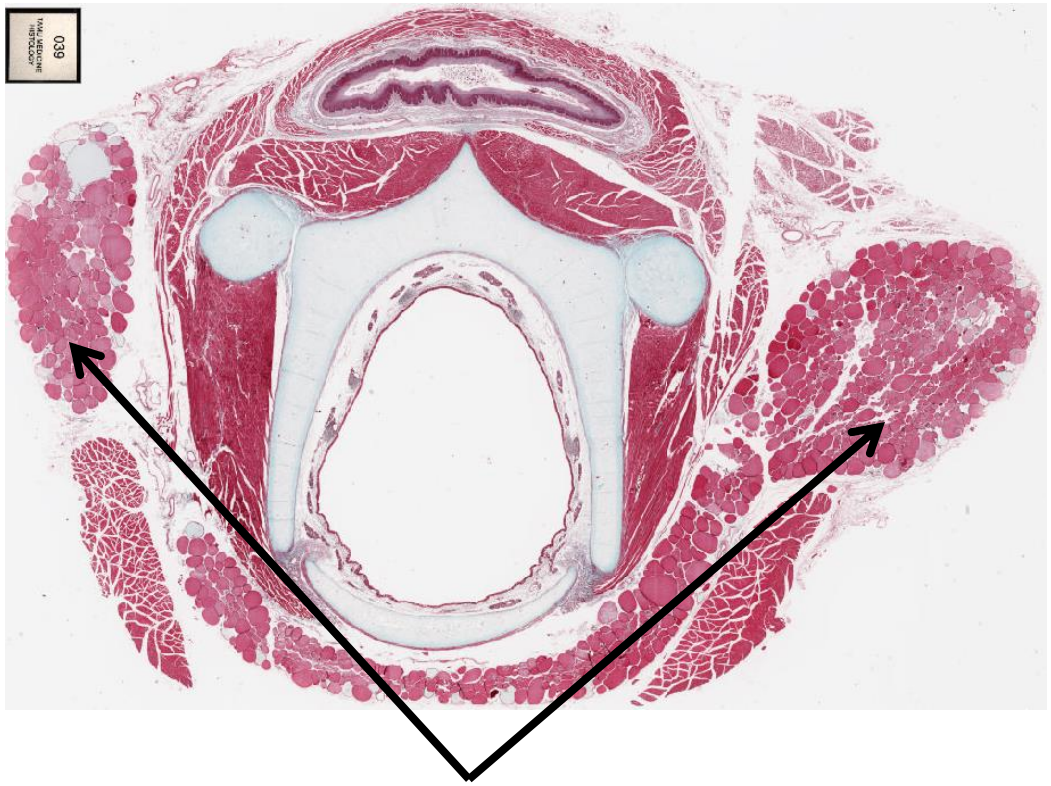
Thyroid gland has many colloid-filled follicles. Thyroid hormones increase the number and size of mitochondria and stimulate mitochondrial protein synthesis, helping to enhance carbohydrate metabolism in cells.

Follicular cells

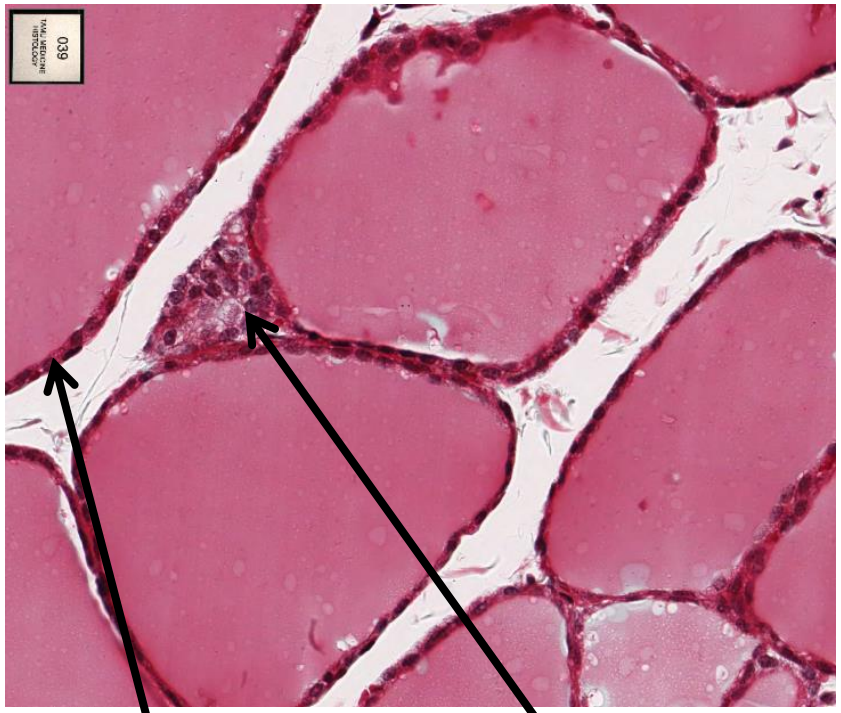
Parafollicular cells

Secrete calcitonin – reduced blood calcium concentrations

Slide 39: Thyroid gland

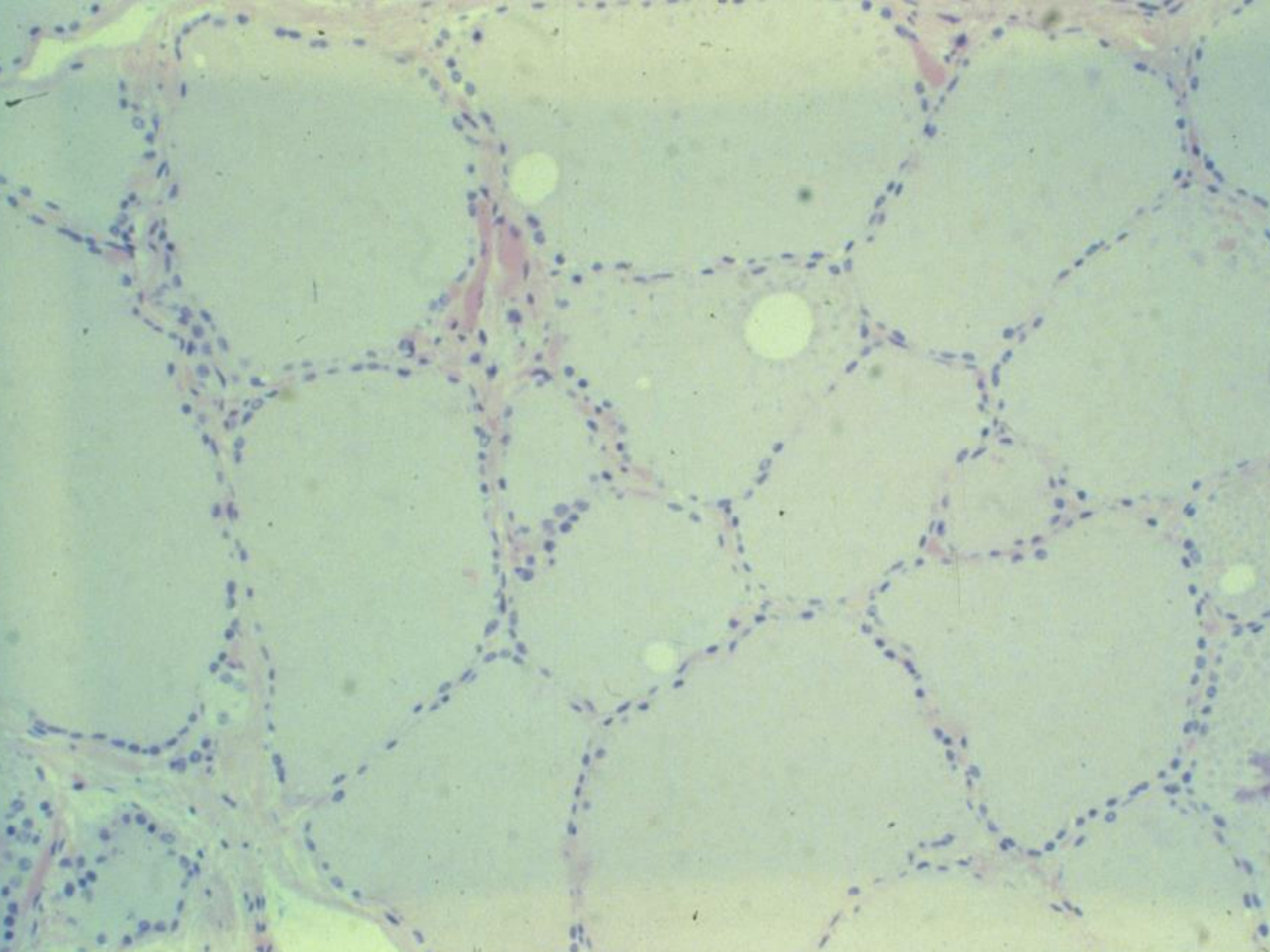


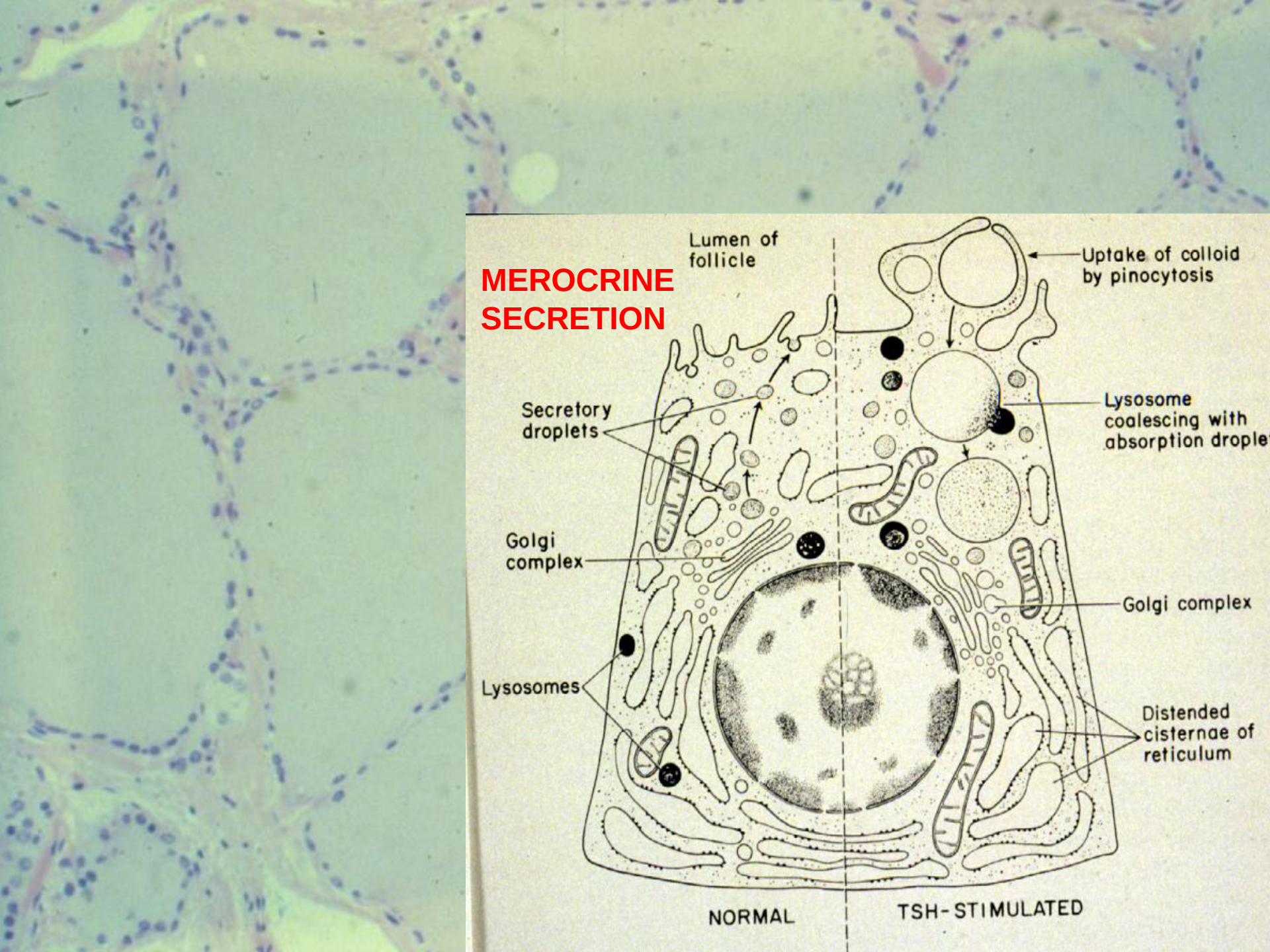
Thyroid gland with many colloid filled follicles



Follicular cells

Parafollicular cells




MEROCRINE SECRETION
Lumen of follicle
Uptake of colloid by pinocytosis
Secretory droplets
Lysosome coalescing with absorption droplet
Golgi complex
Golgi complex
Lysosomes
Distended cisternae of reticulum
NORMAL
TSH-STIMULATED

Thyroid gland diseases

Goiter - accumulation of thyroglobulin with iodine deficiency

Graves disease – hyperthyroidism IgG immunoglobulin with long-acting thyroid

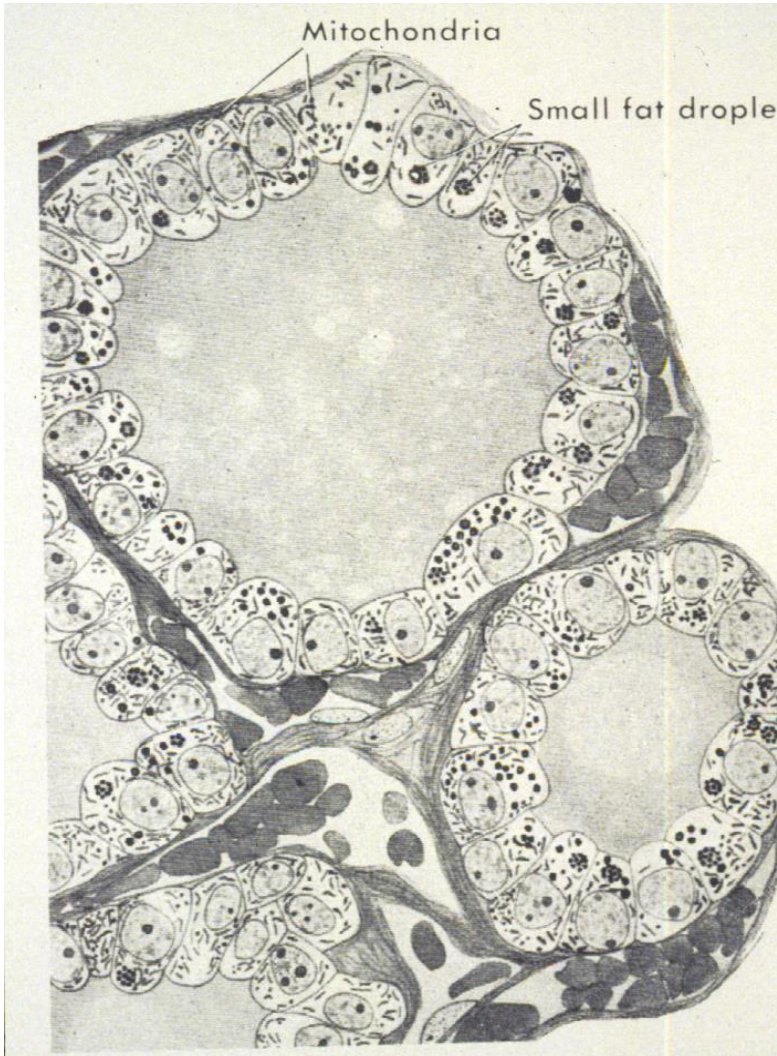


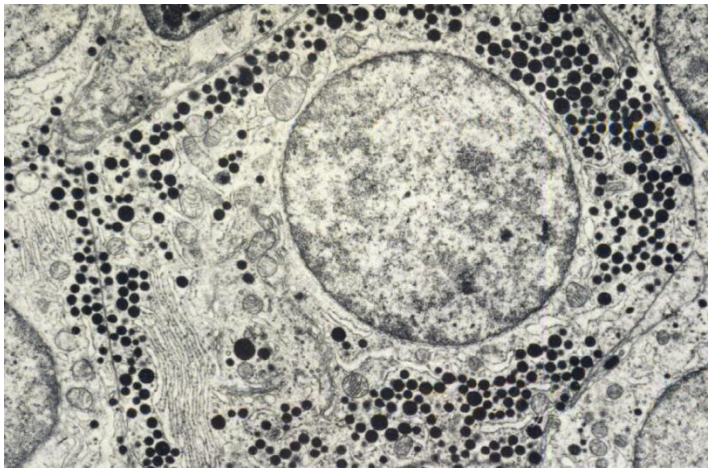
Figure 18–4. Section through several follicles of hu

Endocrine secretions

Stored in granules

Stored extracellularly

Immediate release with no storage



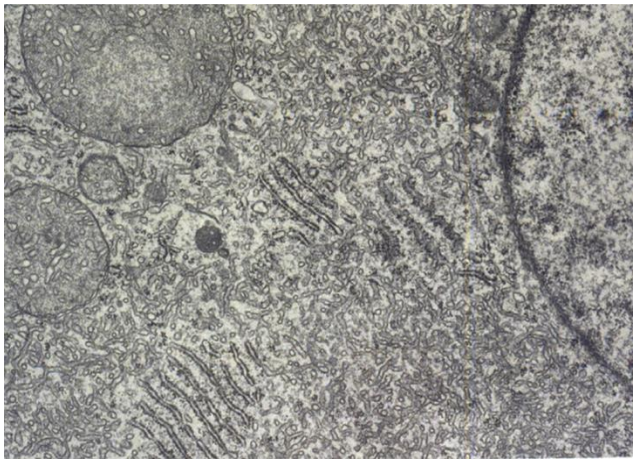
pituitary

Protein in cell

Figure 18–4. Section through several follicles of hu

thyroid

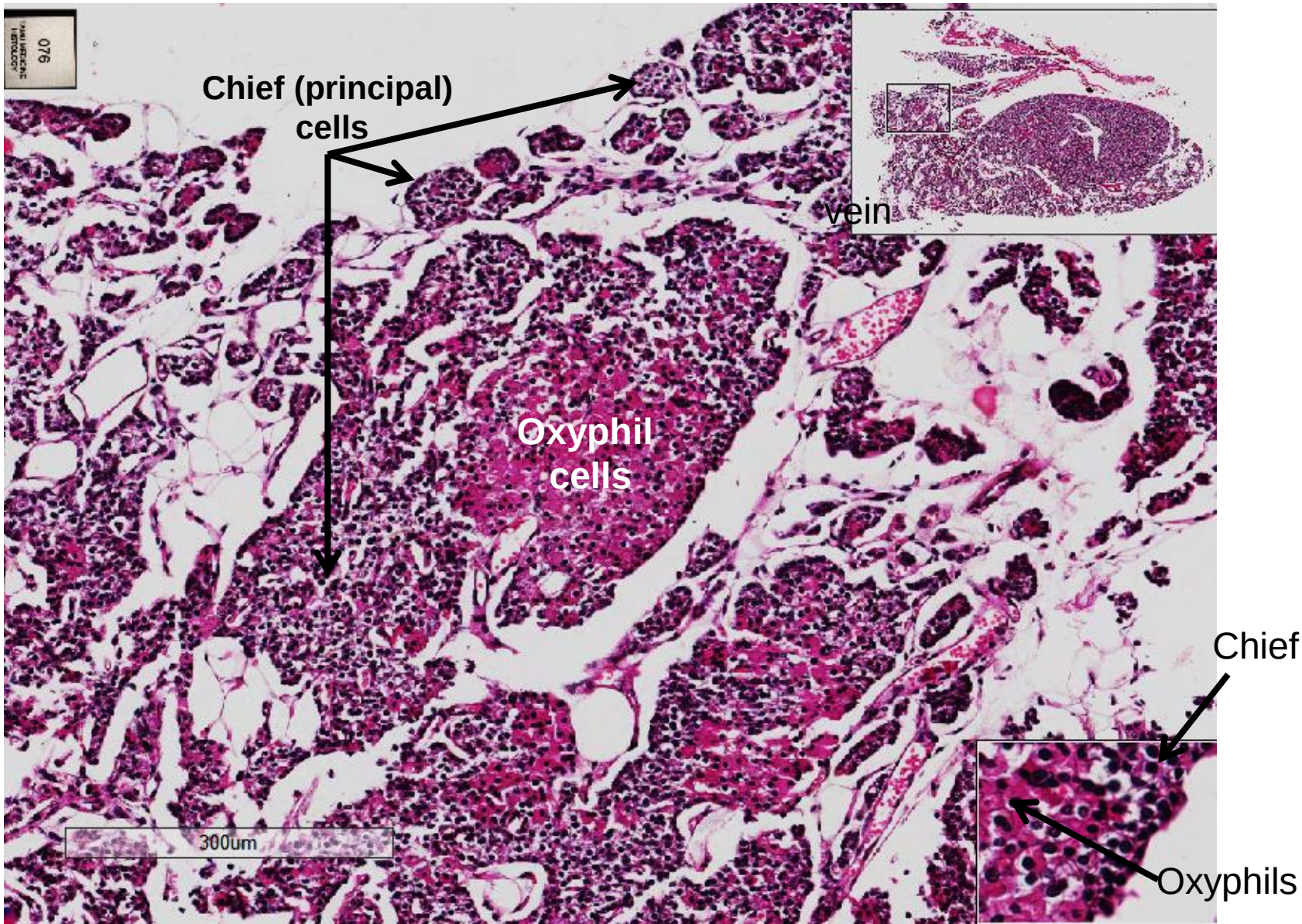
Thyroglobulin outside cell in colloid of follicle



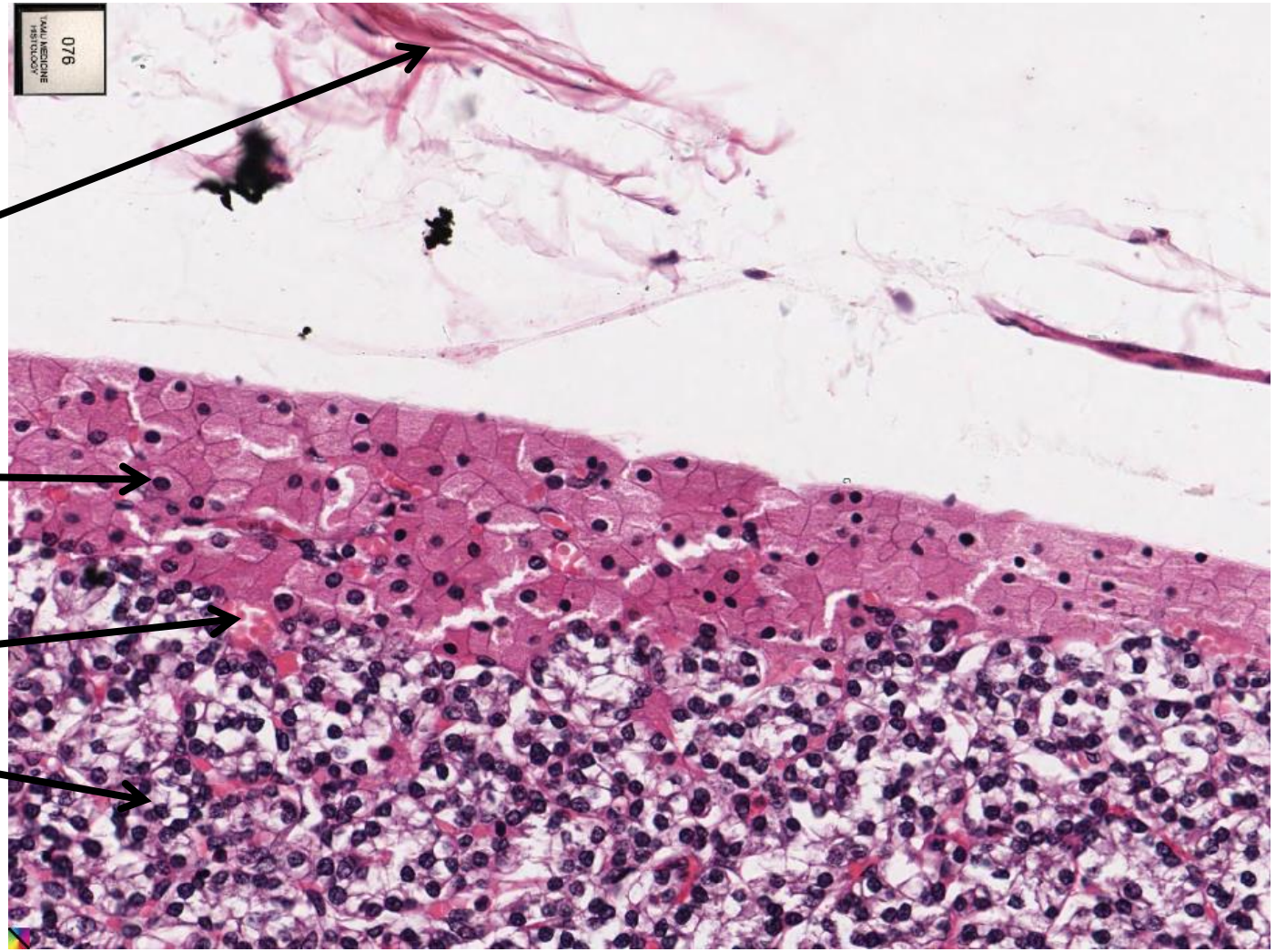
adrenal

Steroid pass through cell

Slide 76: Parathyroid gland



Slide 76: Parathyroid gland



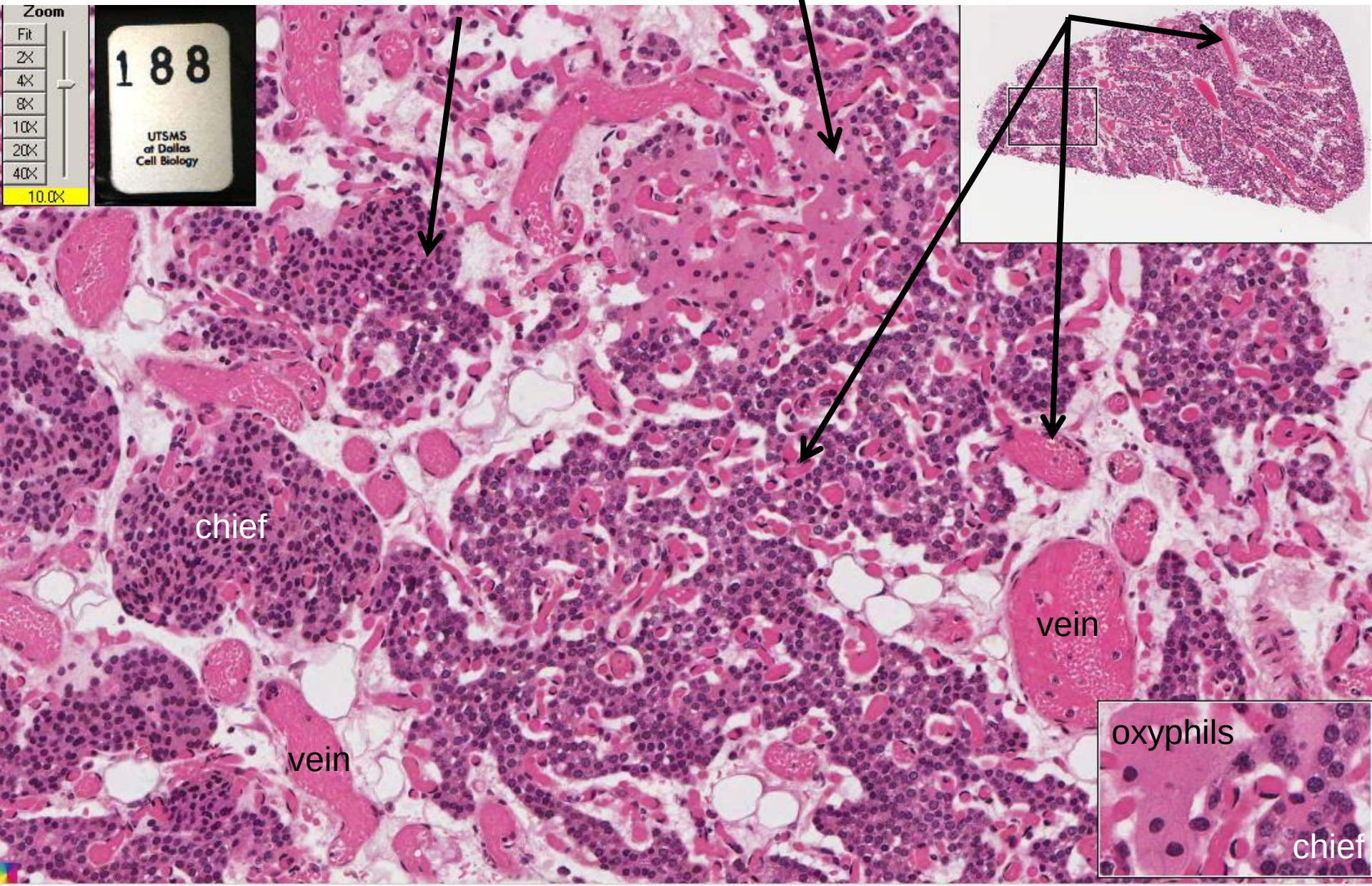
Detached (artifact) connective tissue capsule

Oxyphil cells

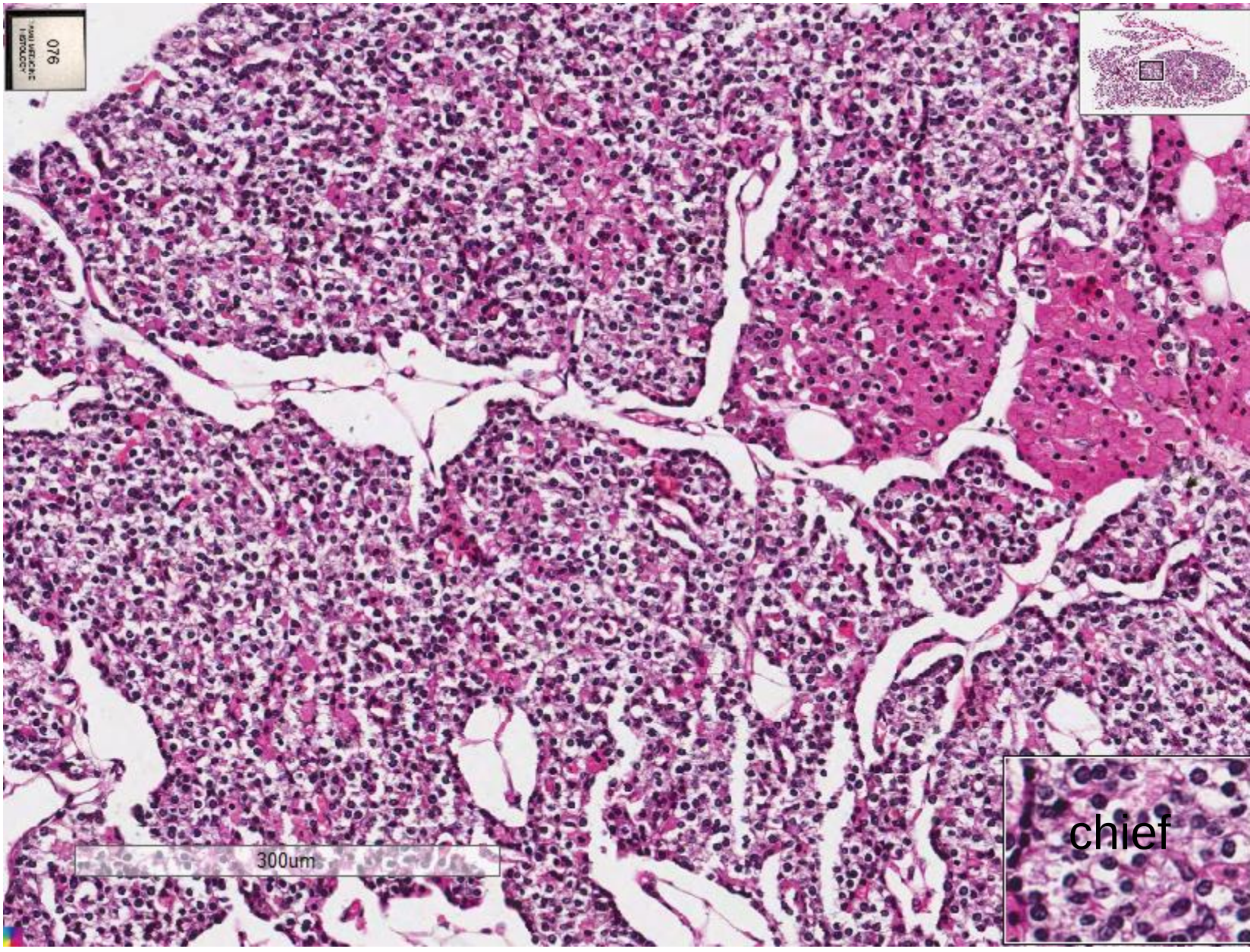
Blood vessel

Chief (principal) cells

Parathyroid – chief cells and oxyphils and rich vascular supply



Parathyroid – chief cells



Parathyroid – chief cells

FUNCTIONS OF BONE

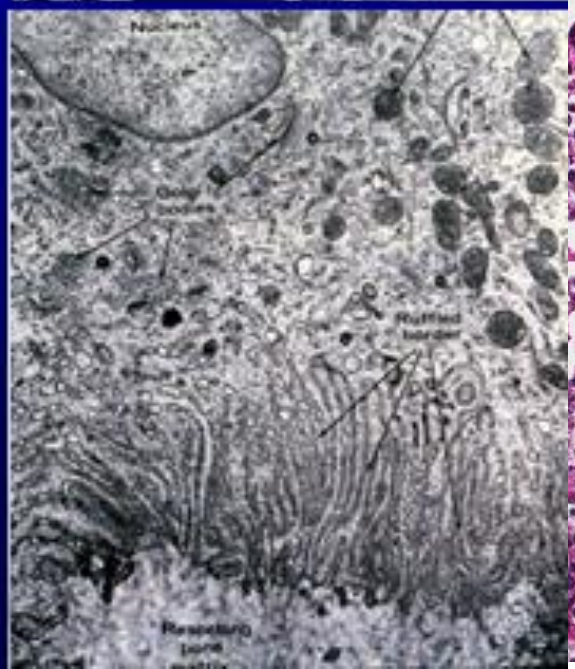
CALCIUM REGULATION

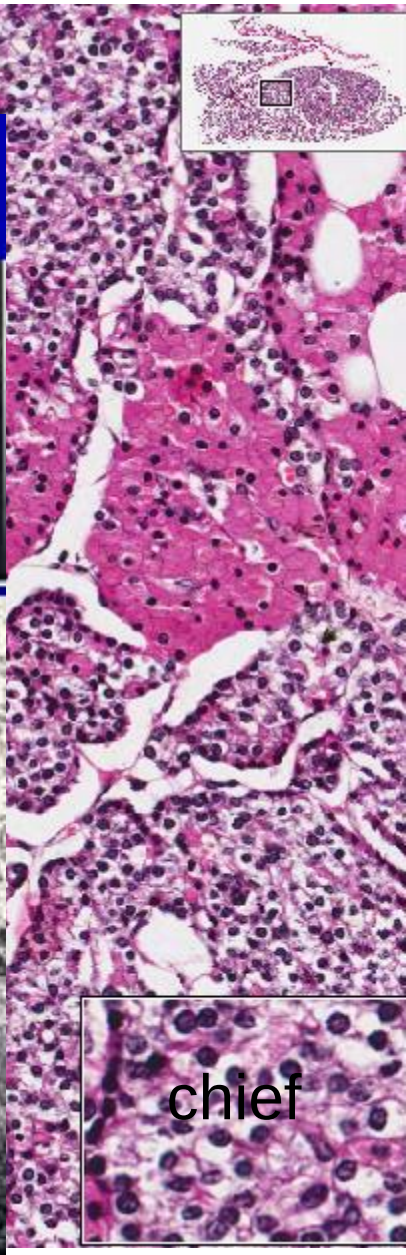
Parathroid hormone (stimulates osteoclast production)

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.

Osteoporosis due to hyperparathyroidism

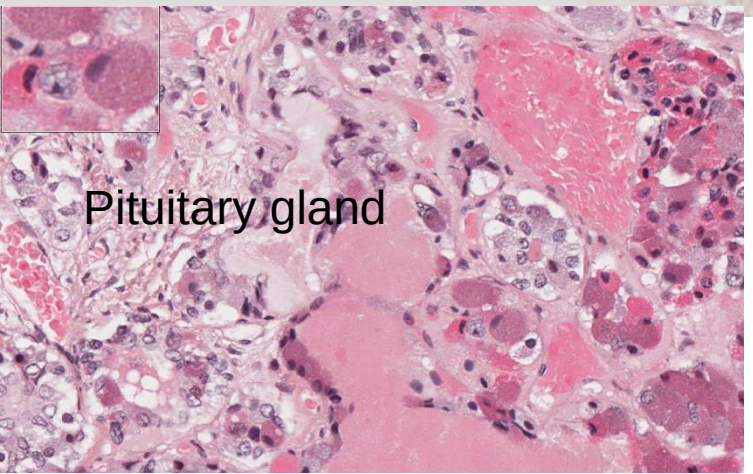


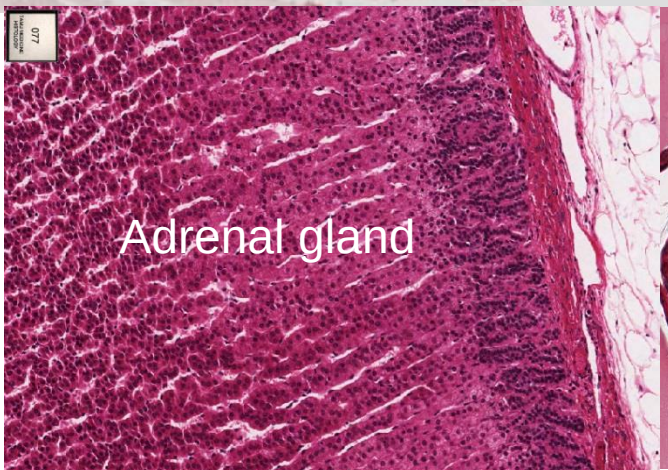


End of part 1

ENDOCRINE SYSTEM **Part 2**

Dr. Larry Johnson





Objectives

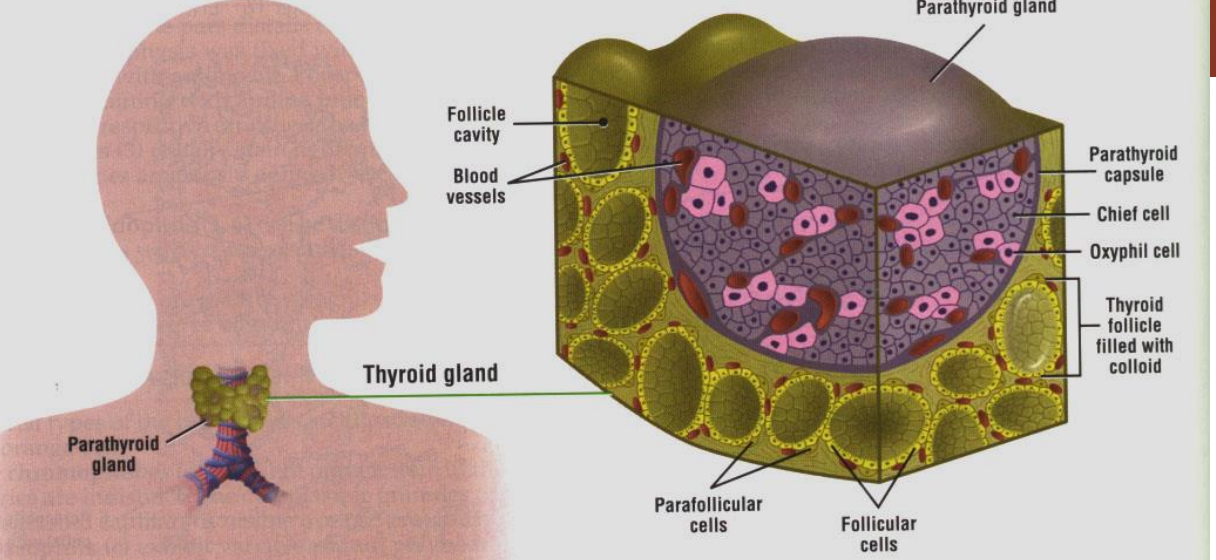
Part 1

- Distinguish between the neurohypophysis and the adenohypophysis and identify the cell types present in a slide or photomicrograph of the pituitary.
- Identify thyroid follicles, follicular cells, colloid, capillaries and parafollicular cells.
- Identify the capsule, chief cells, and oxyphil cells in the parathyroid gland.

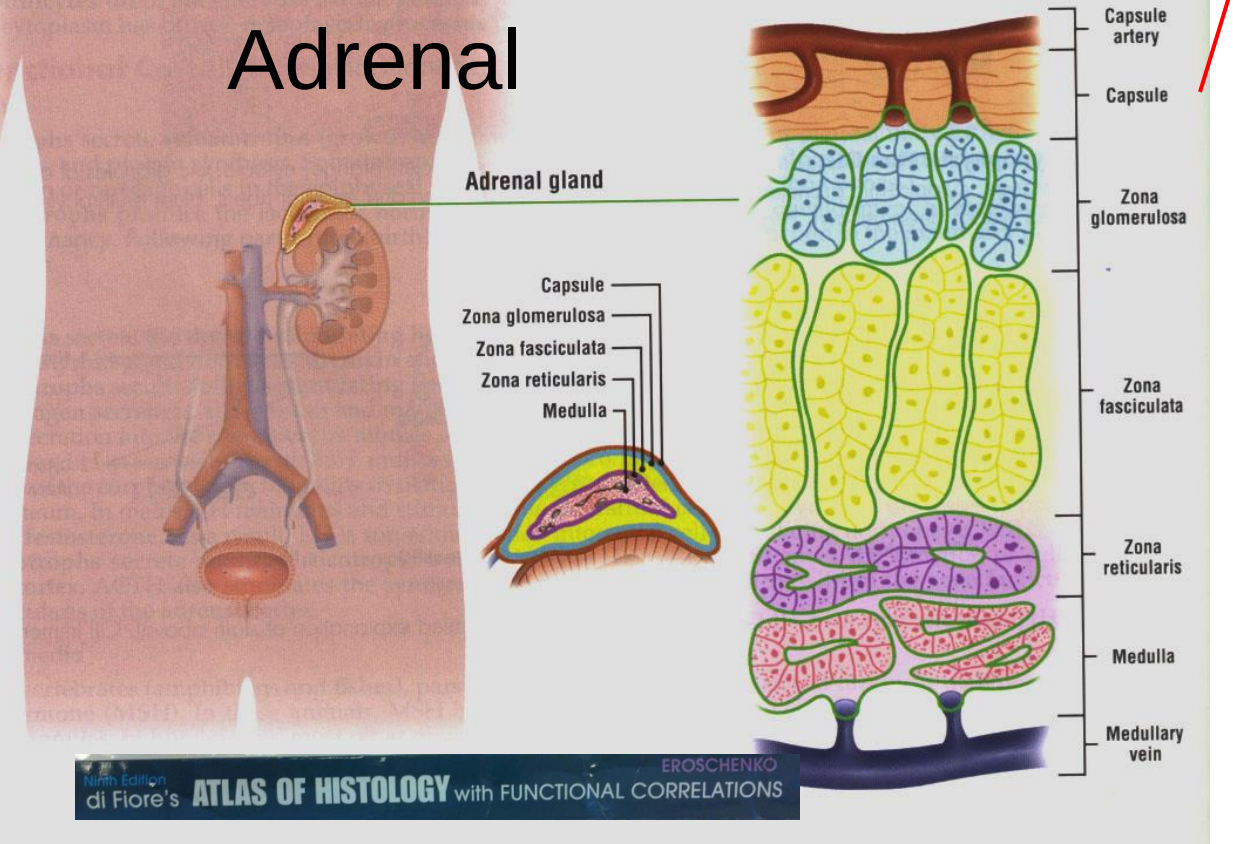
Part 2

- Identify the capsule, cortex, zona glomerulosa, zona fasciculata, zona reticularis, medulla, and chromaffin cells in the adrenal gland.
- Identify the pinealocytes and corpora arenacea in the pineal gland.
- Identify the islets of Langerhans in the pancreas

From: Douglas P. Dohrman and TAMHSC Faculty 2012 Structure and Function of Human Organ Systems, Histology Laboratory Manual


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
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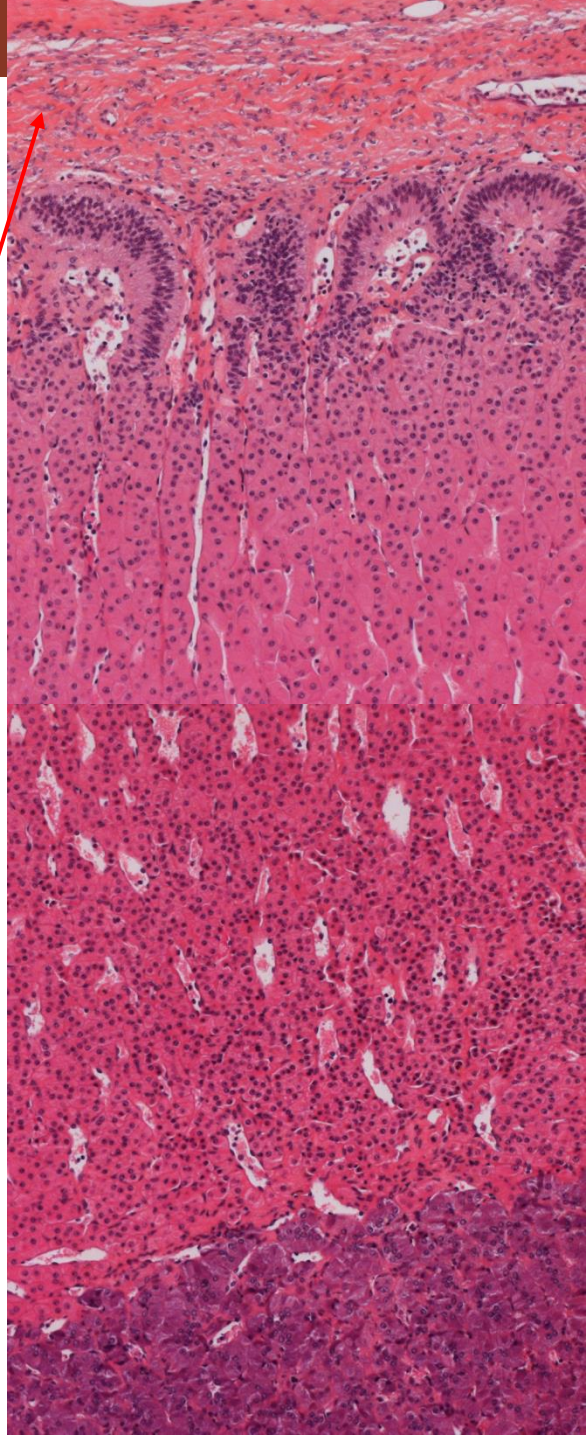
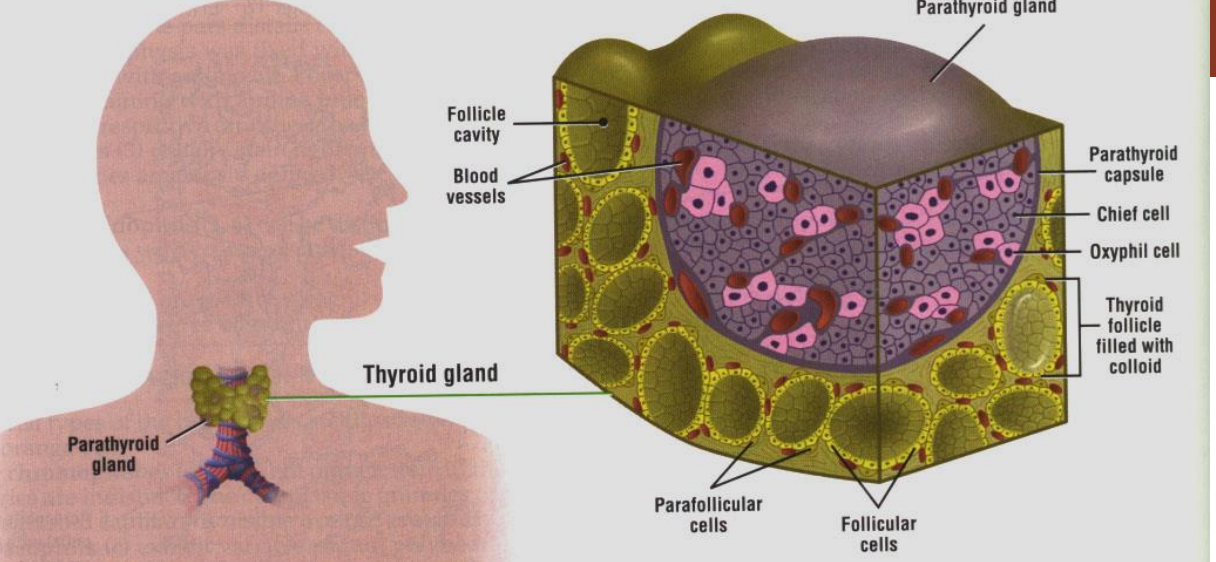
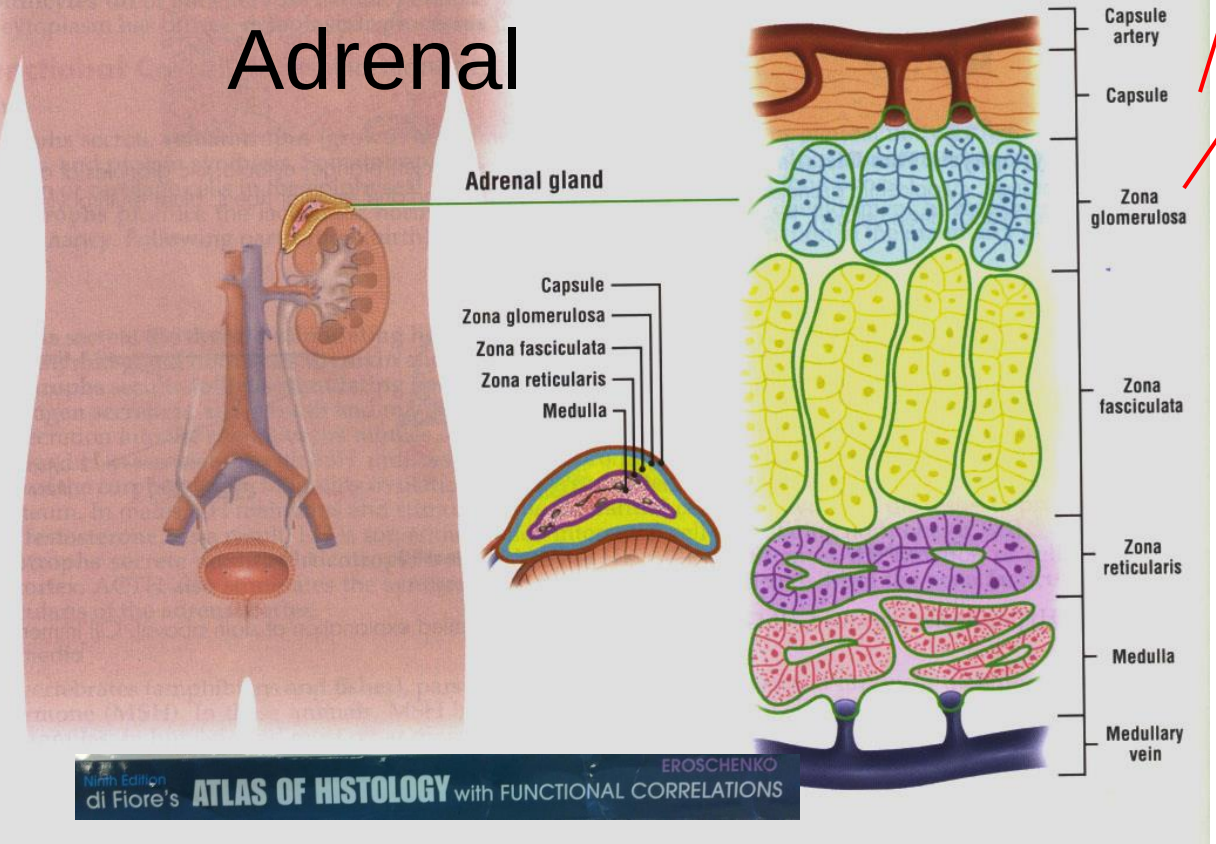
EROSCHENKO




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
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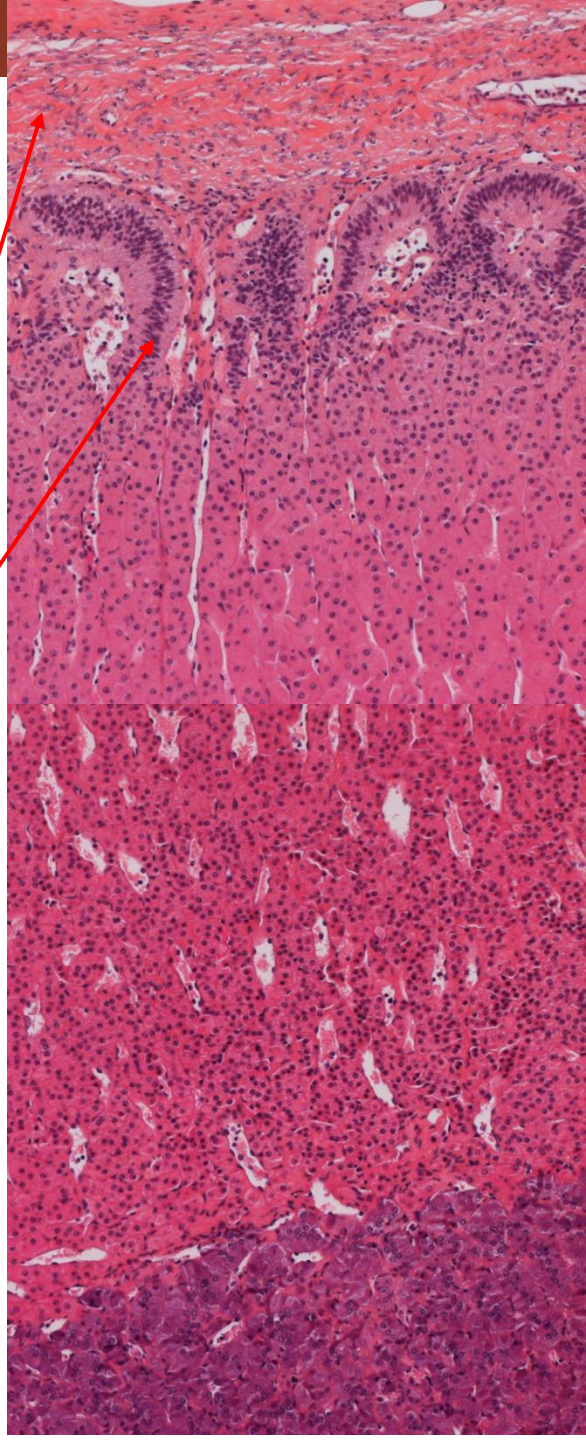

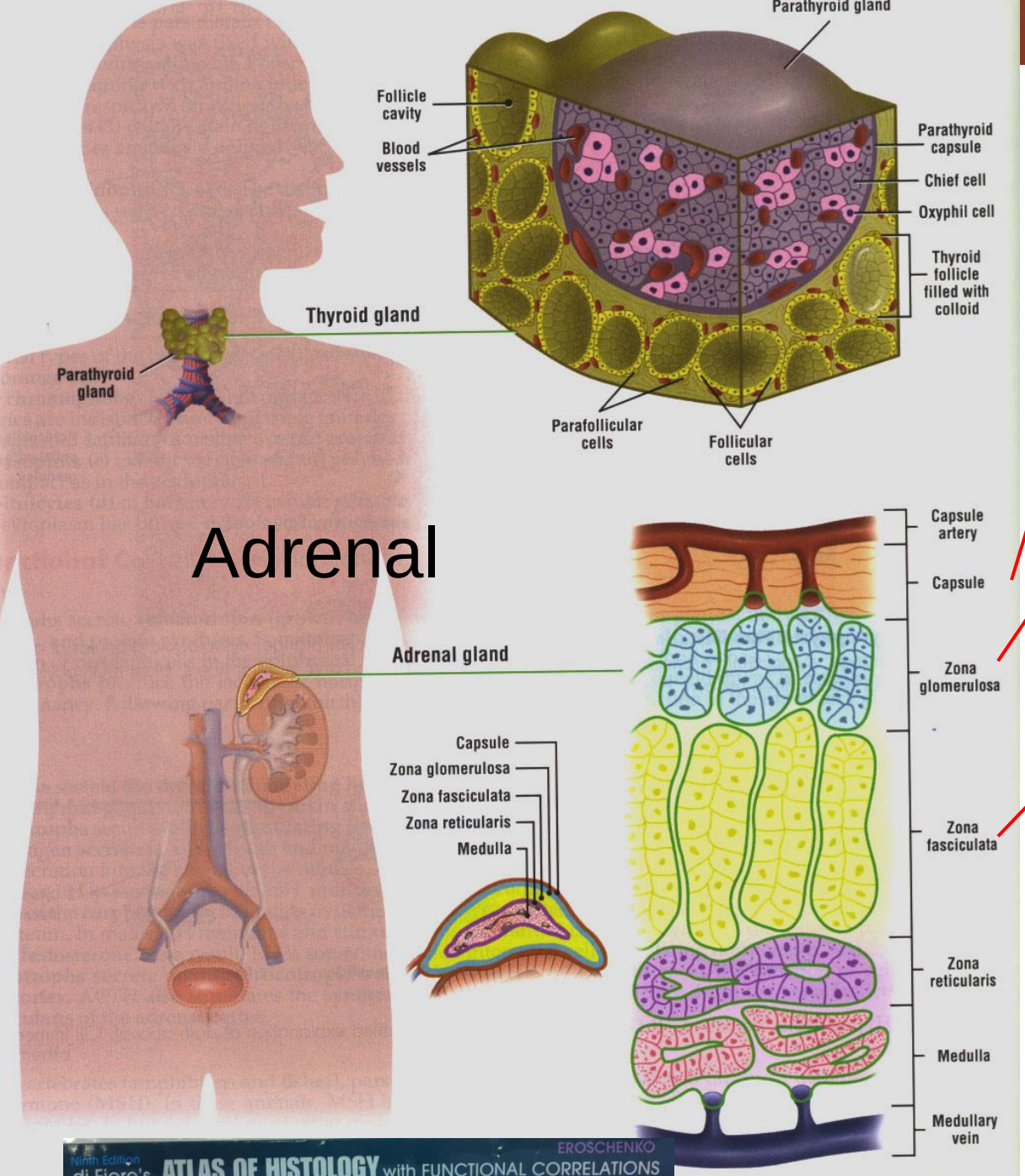
Parathyroid gland
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Parathyroid gland
Parafollicular cells
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Capsule
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Zona reticularis
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Zona fasciculata
Zona reticularis
Medulla
Medullary vein
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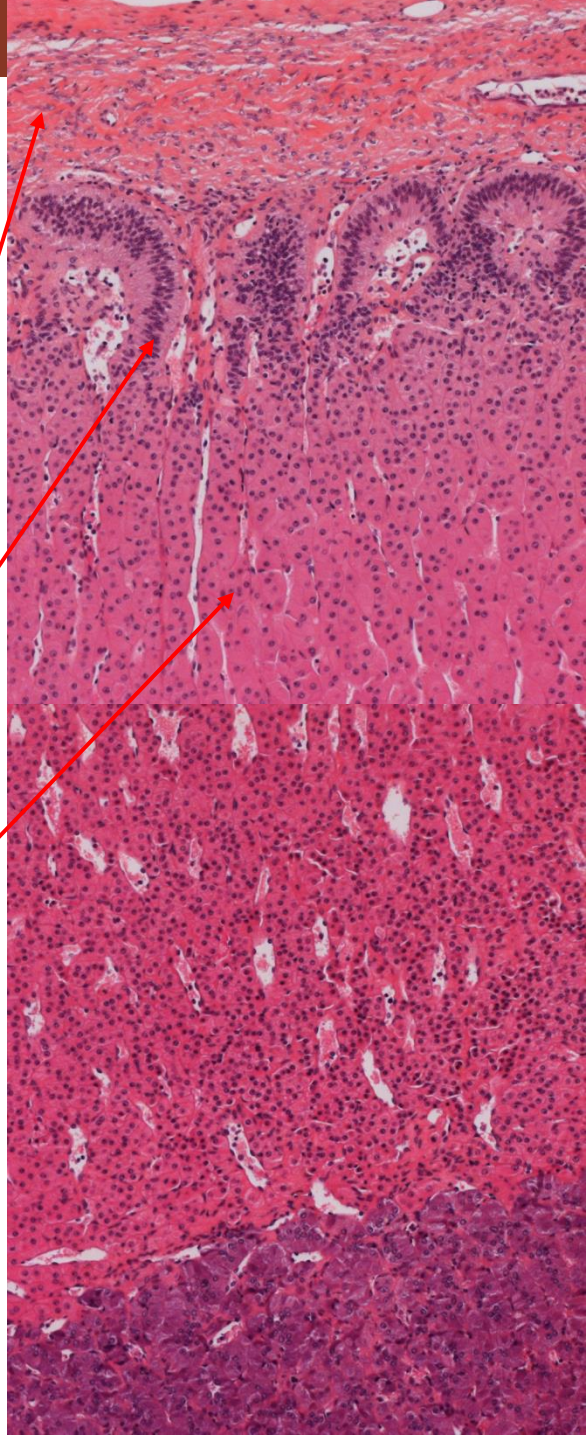

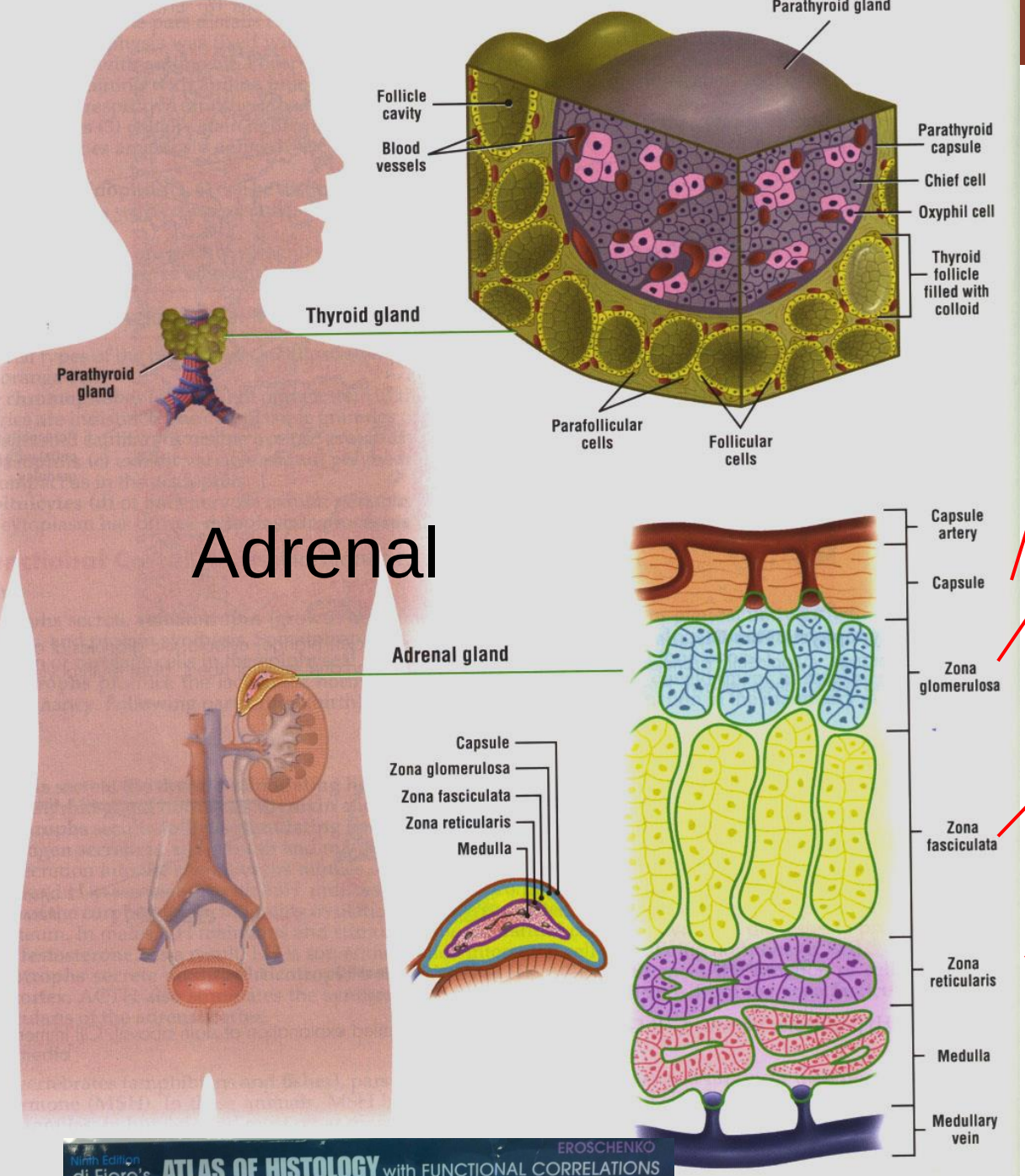
Parathyroid gland
Follicle cavity
Blood vessels
Parathyroid capsule
Chief cell
Oxyphil cell
Thyroid follicle filled with colloid
Thyroid gland
Parathyroid gland
Parafollicular cells
Follicular cells
Adrenal
Capsule artery
Capsule
Adrenal gland
Zona glomerulosa
Capsule
Zona glomerulosa
Zona fasciculata
Zona reticularis
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Zona reticularis
Medulla
Medullary vein
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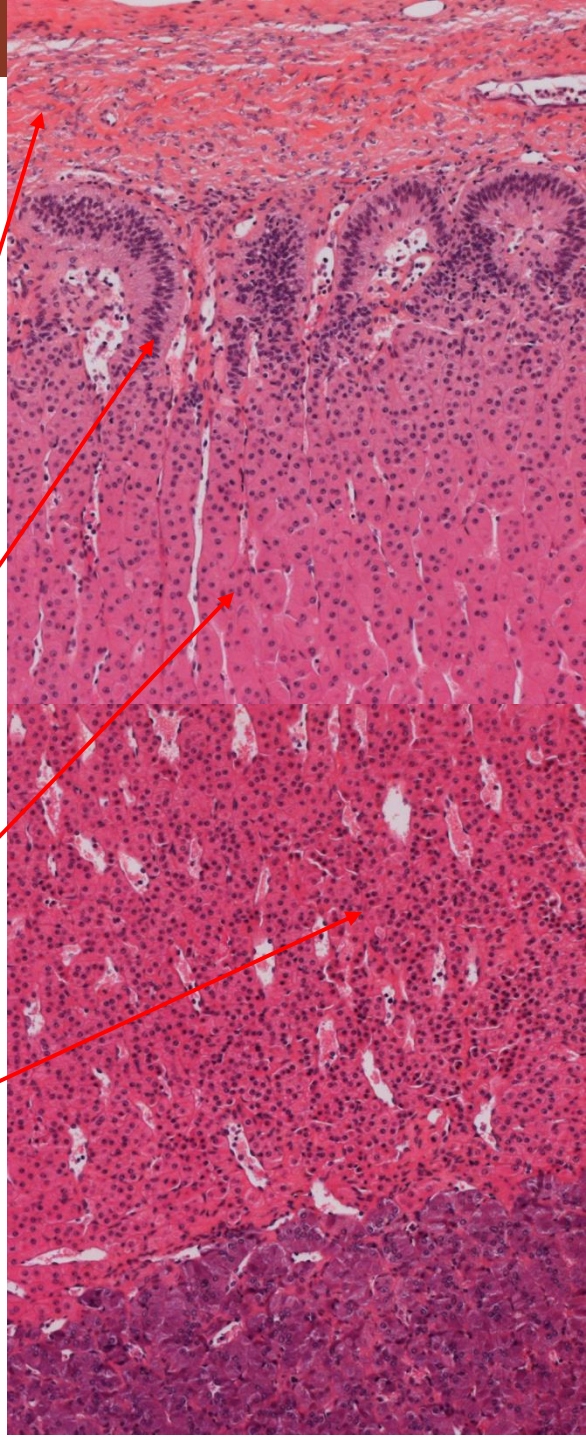

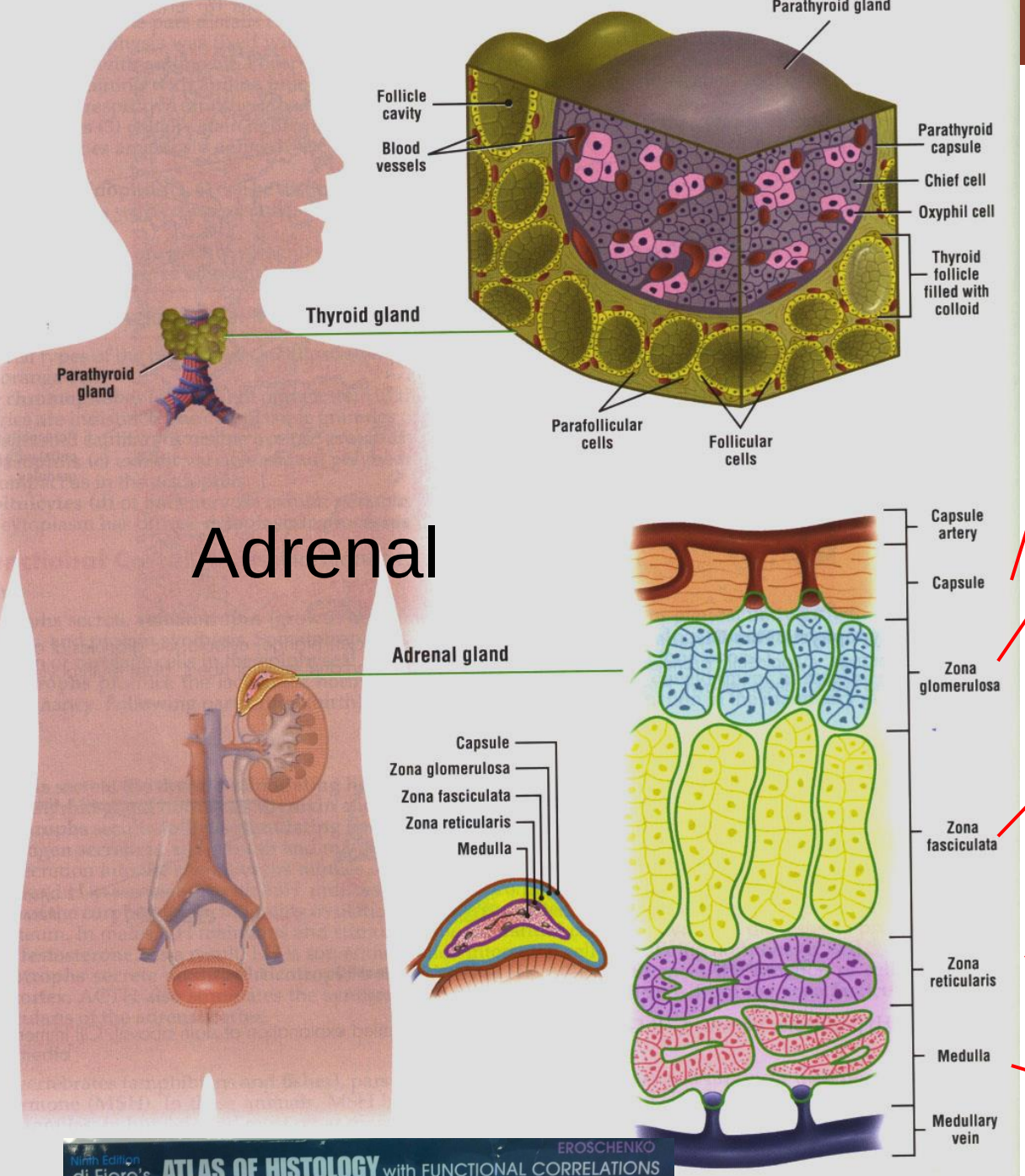

Adrenal

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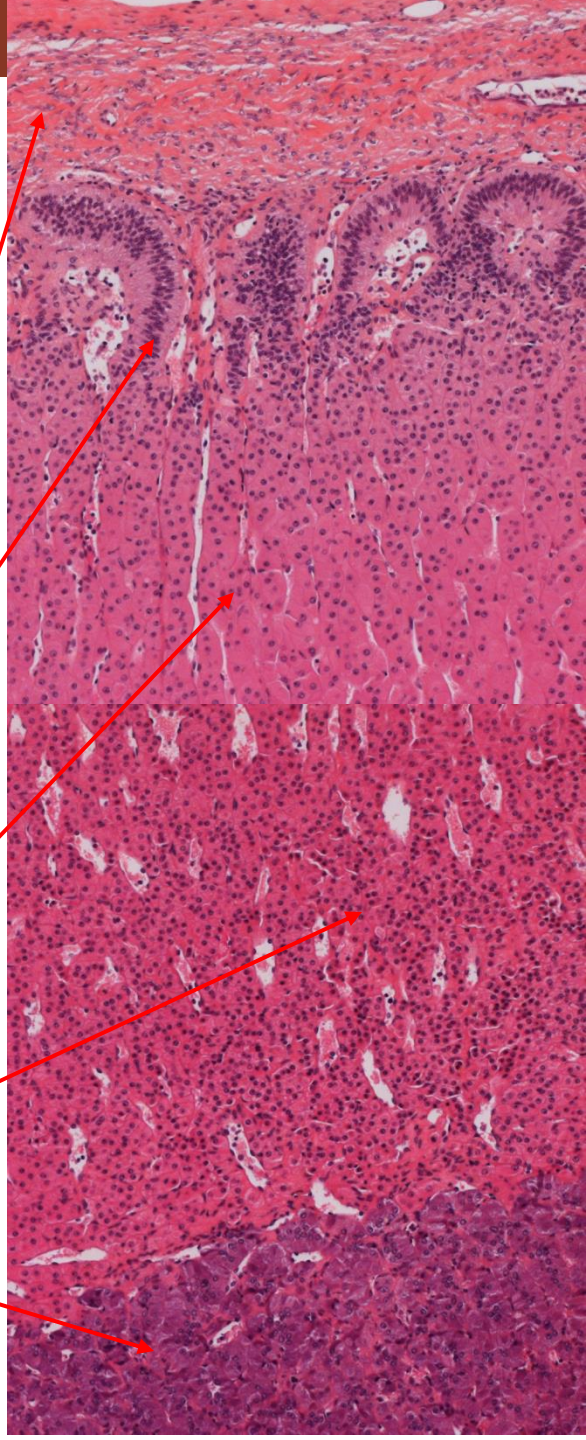
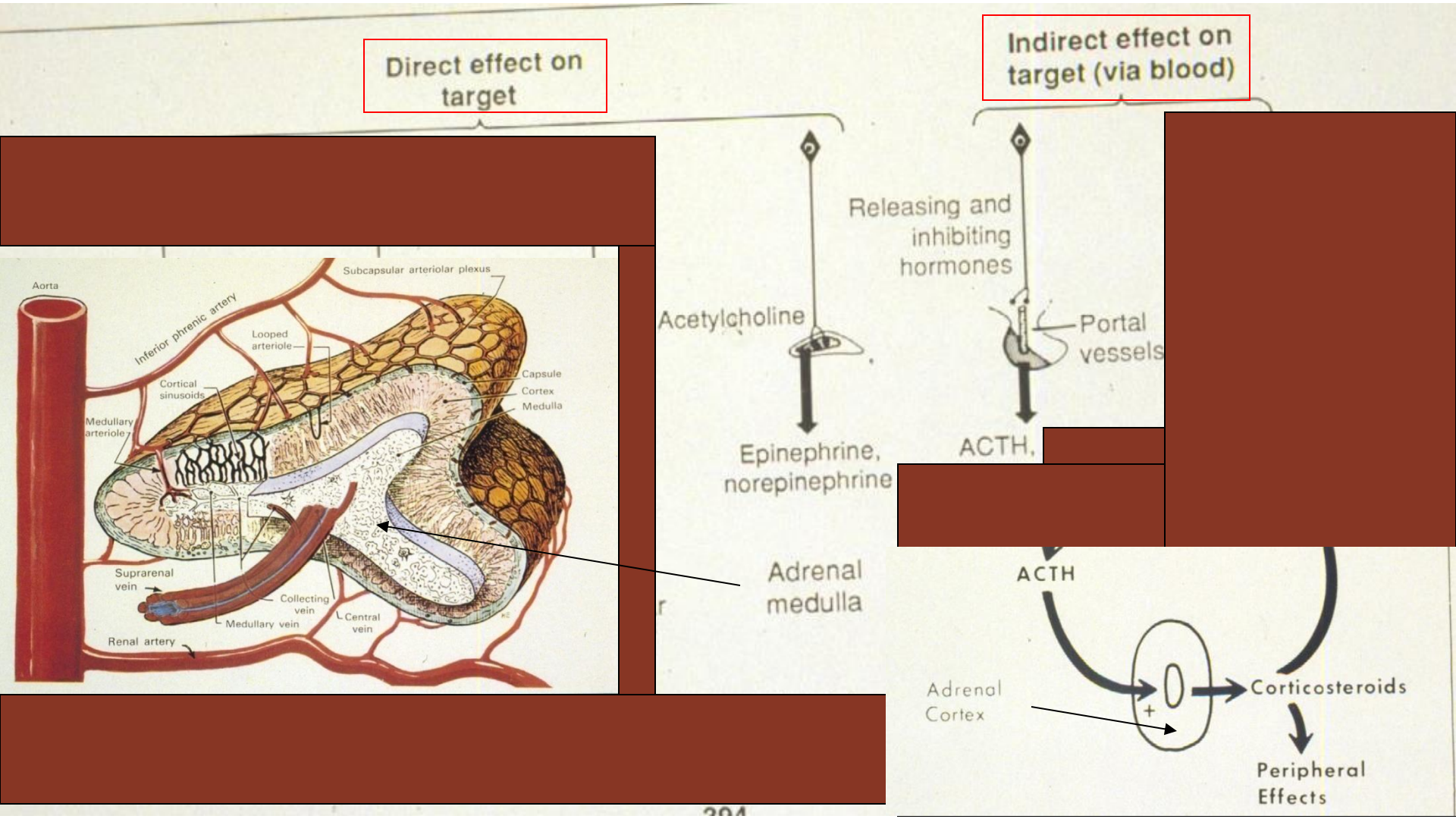
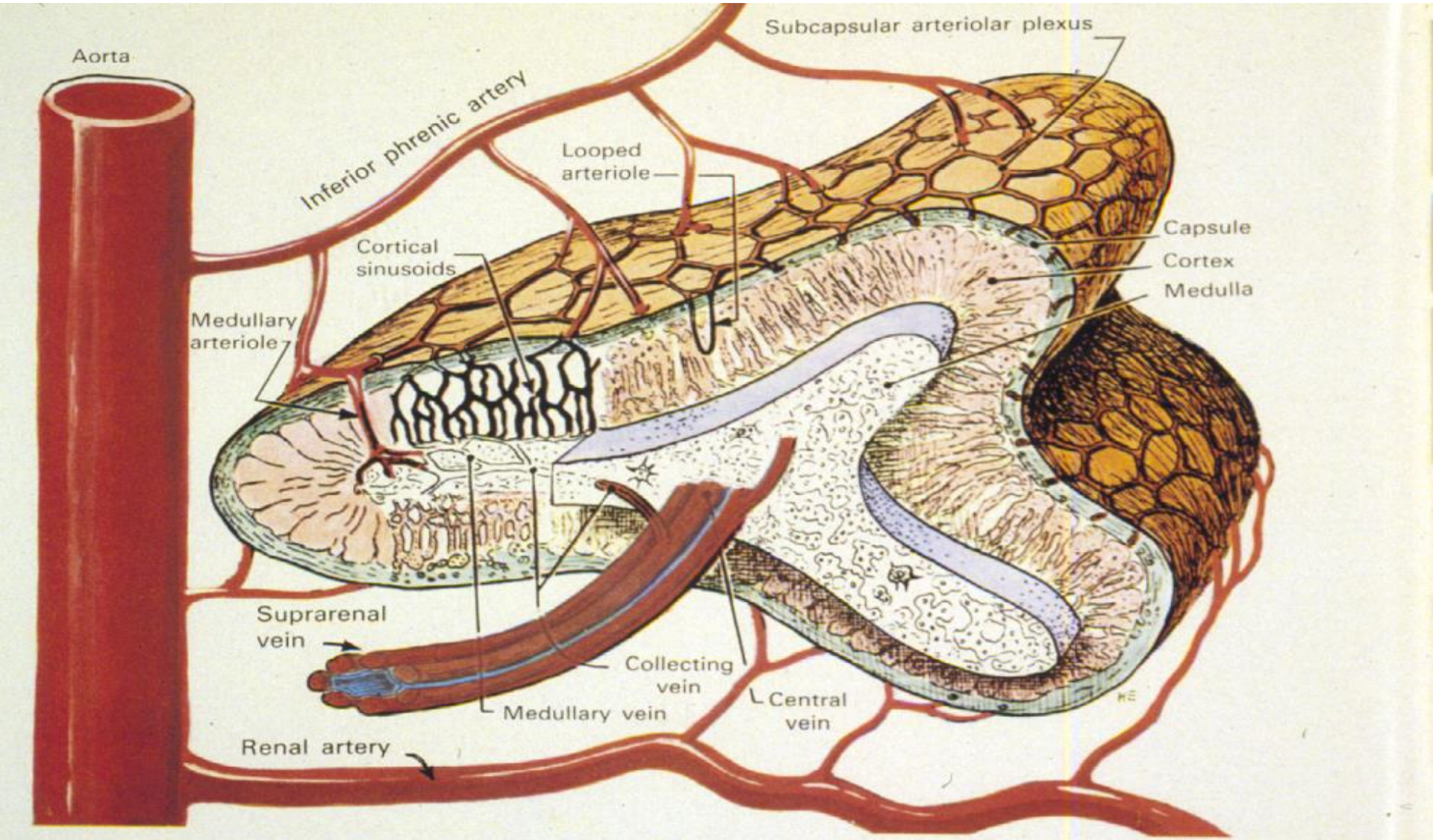


Releases of neurons associated with the adrenals (both direct and indirect)



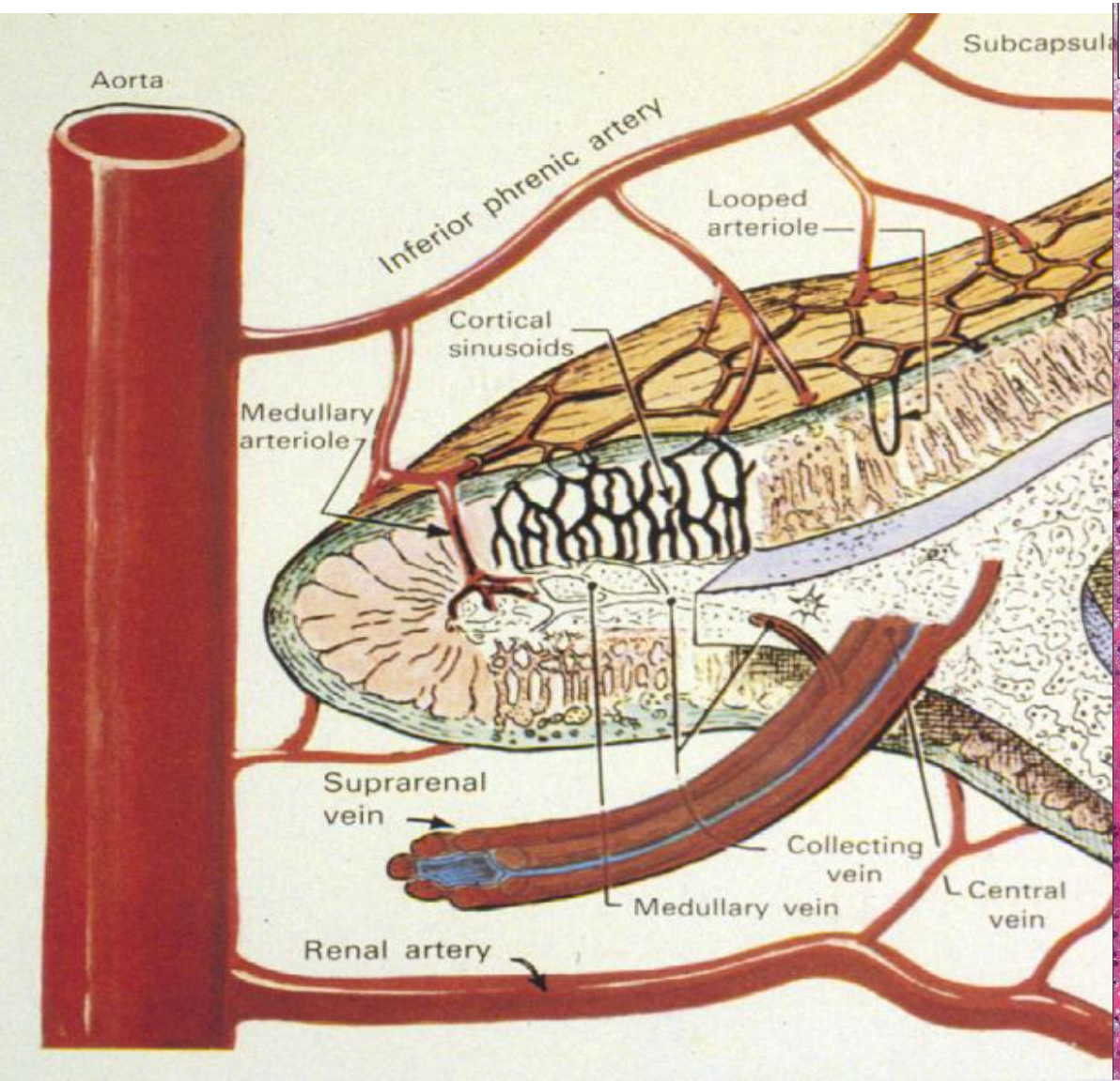
BLOOD SUPPLY

SINUSOIDS, MEDULLARY ARTERIES, ADRENAL VEIN



BLOOD SUPPLY

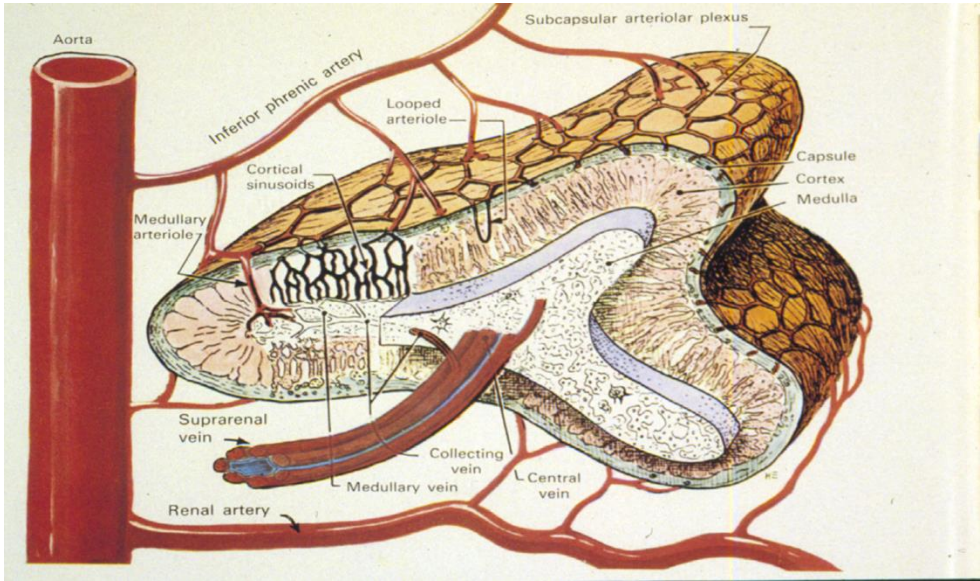
SINUSOIDS, MEDULLARY ARTERIES, ADRENAL VEIN



Adrenal

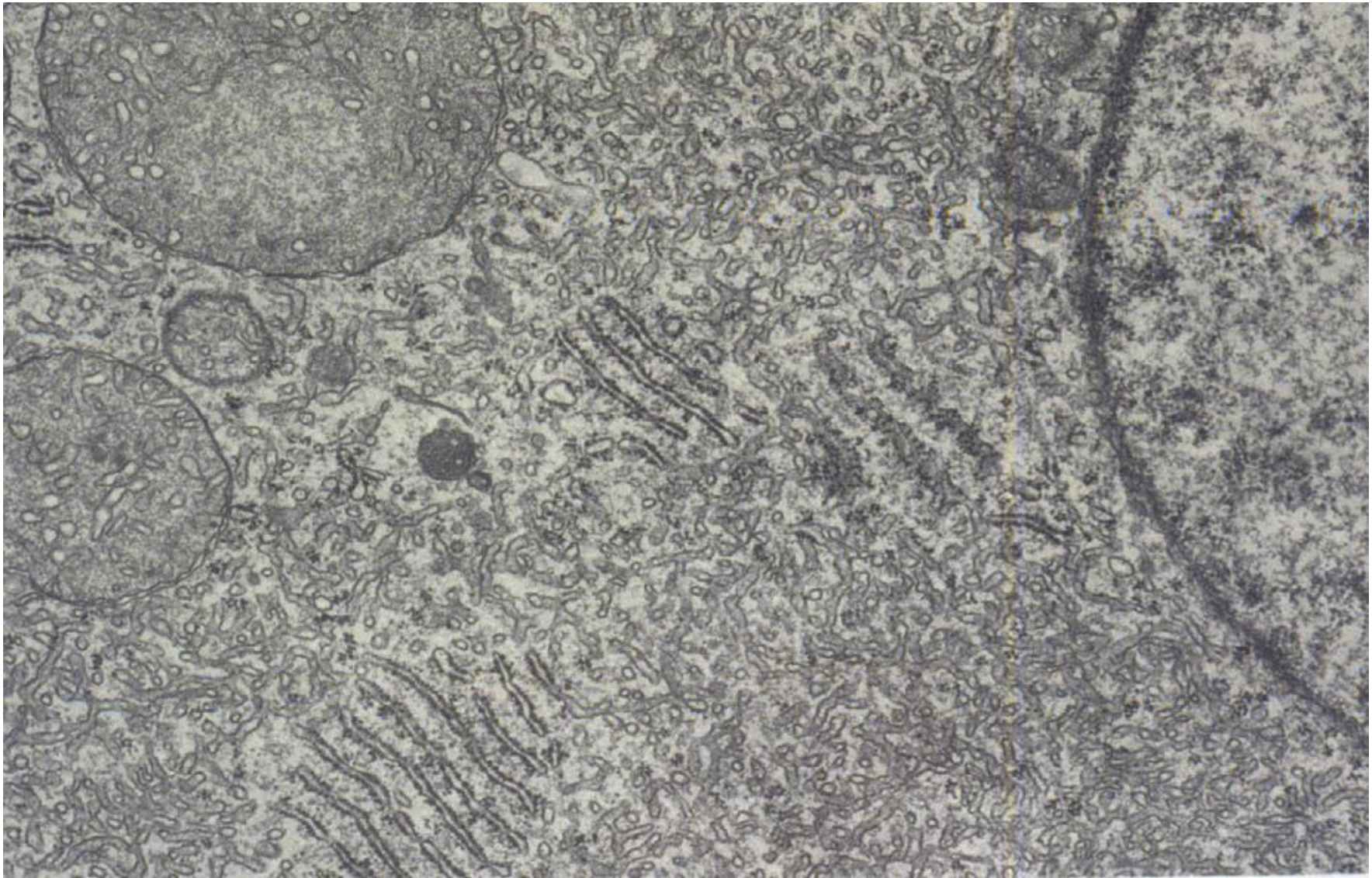
Arterial and venous blood flow to the adrenal gland.

- Peripheral arteries > cortical arteries > capillaries & sinusoids irrigating cortex > join medullary capillaries and arterioles > medullary fenestrated sinusoids with dual blood supply (arterial medullary blood and venous cortex blood) > medullary veins > suprarenal vein.

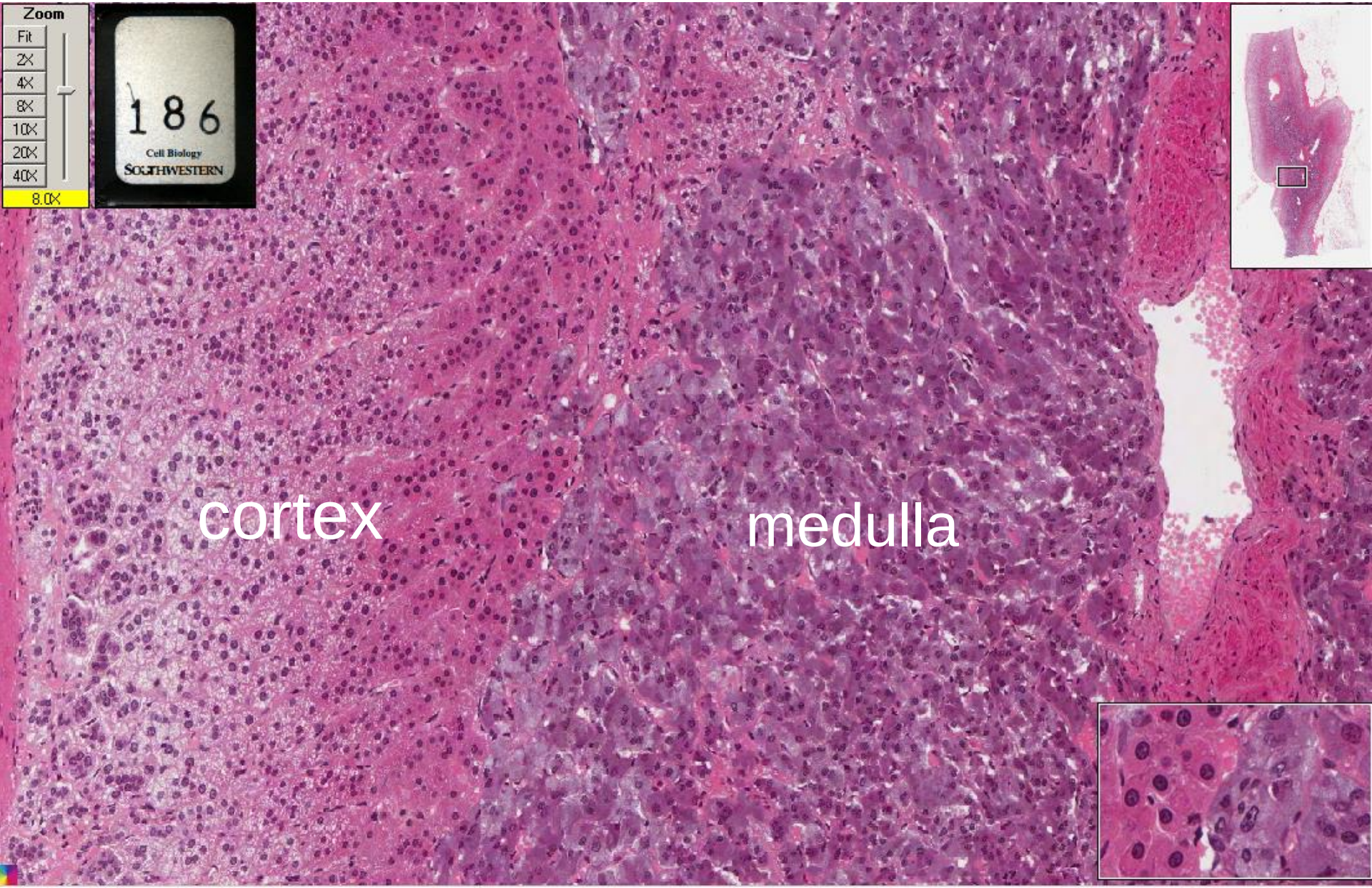


Human fetal adrenal cortical cell

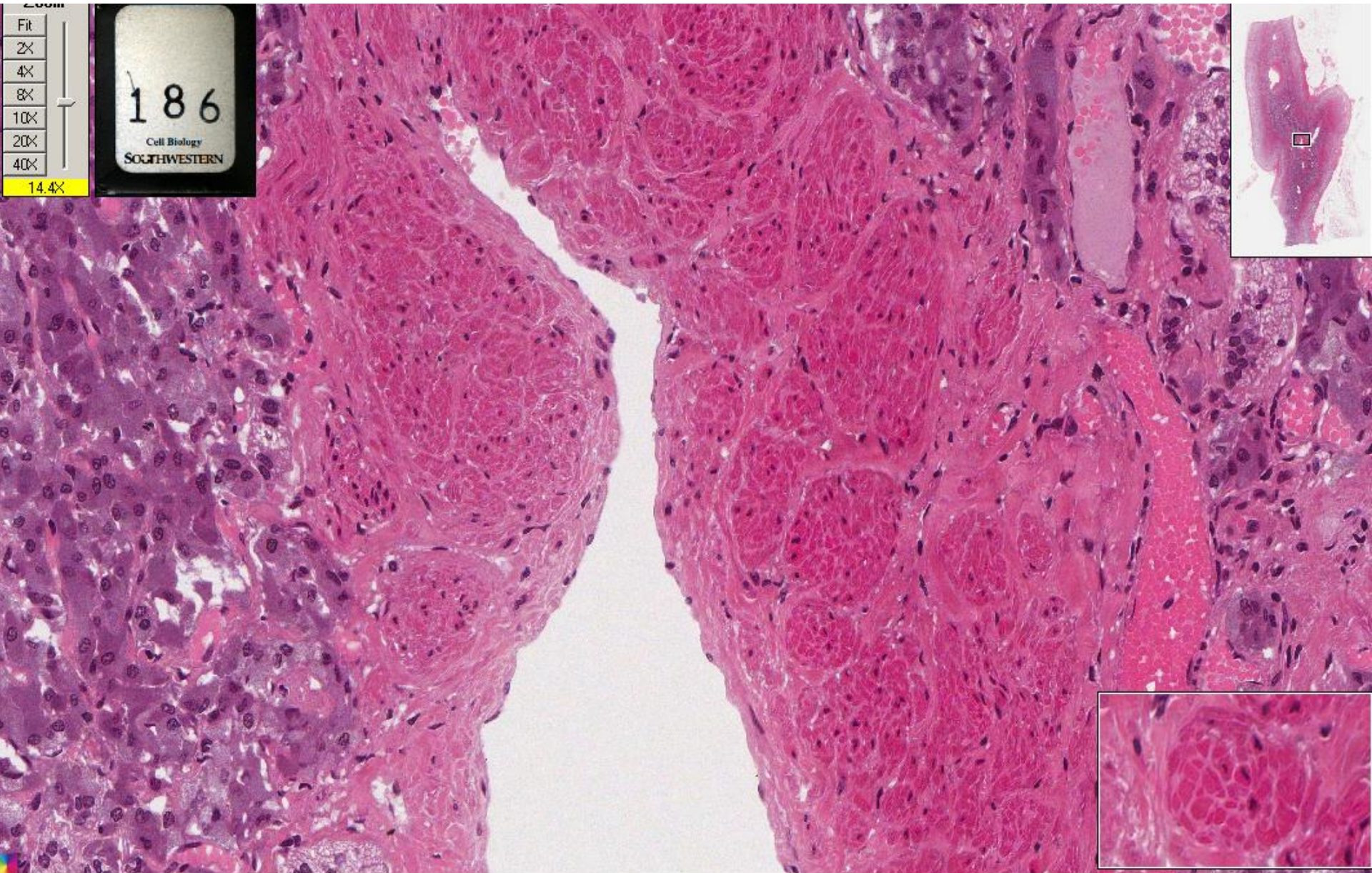
with lots of SER and large spherical mitochondria with tubular cristae



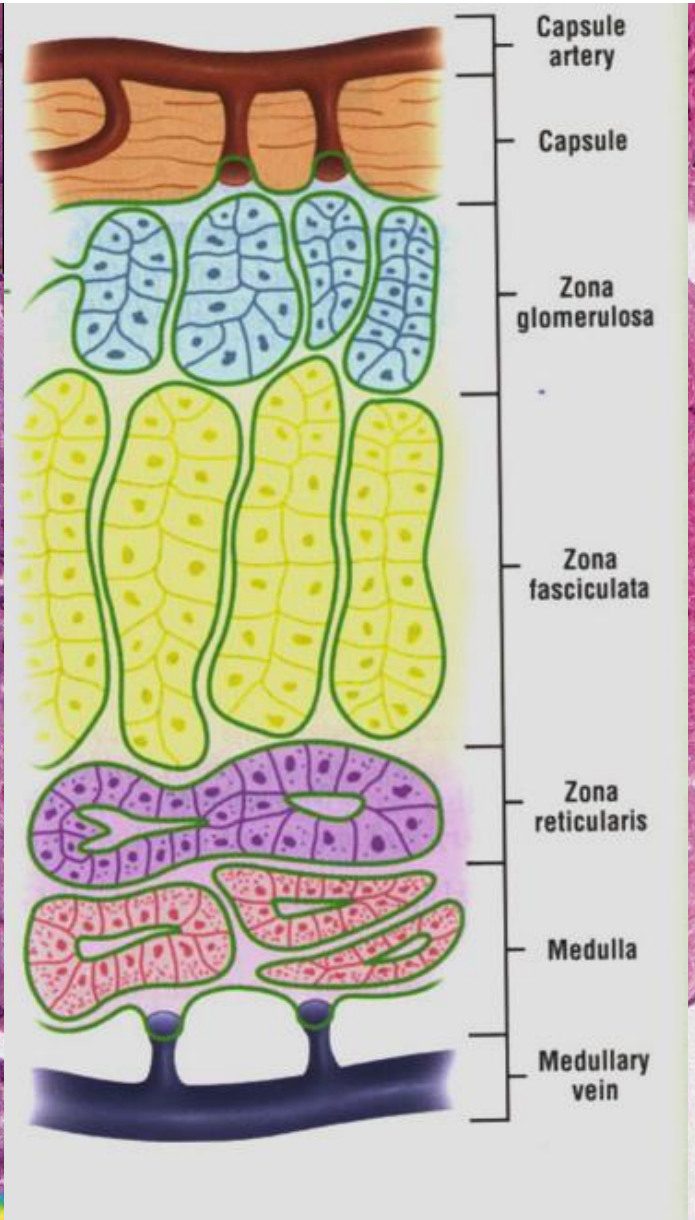
Adrenal -cortex and medulla

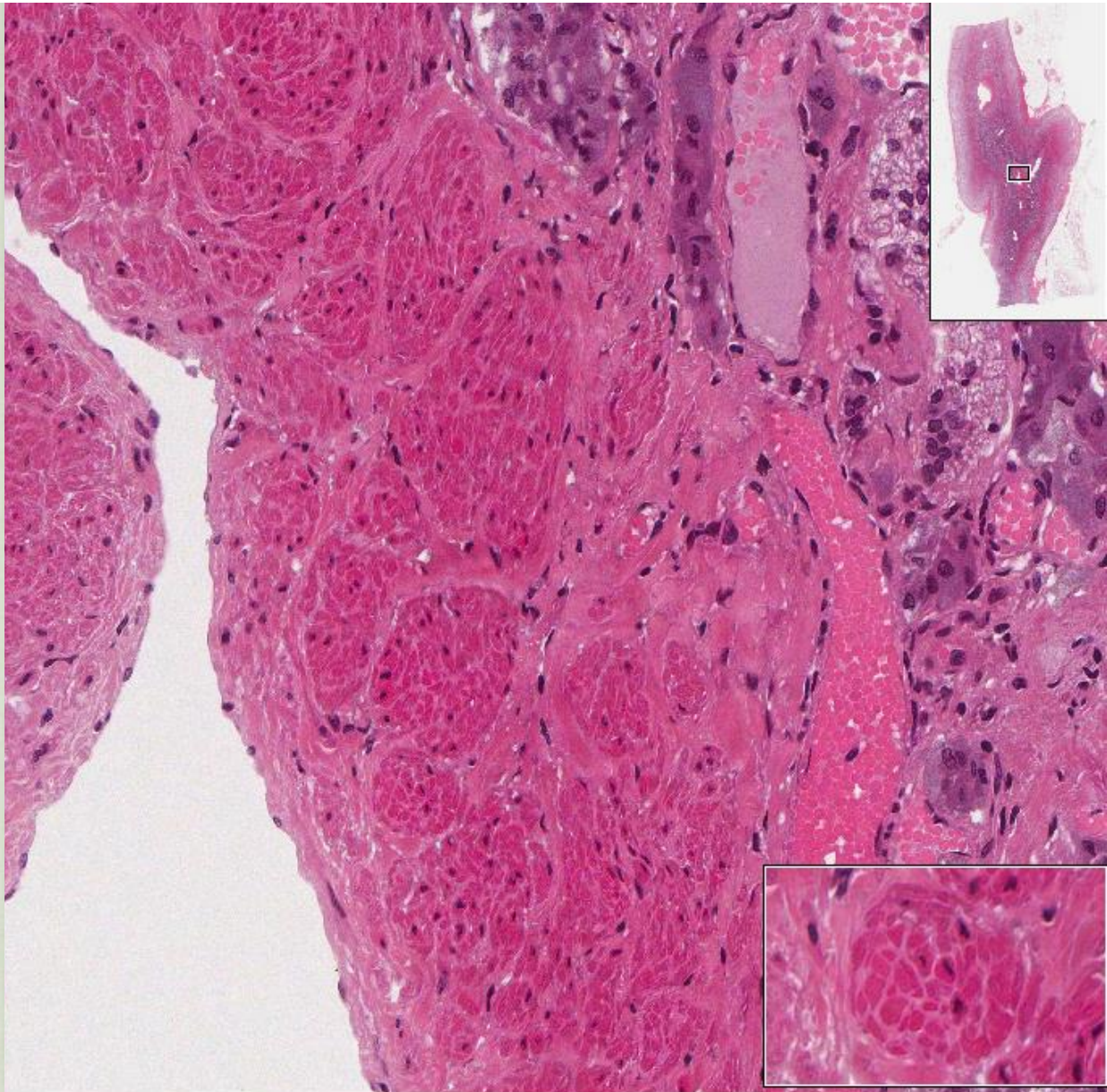


Adrenal - central vein



Adrenal - central vein

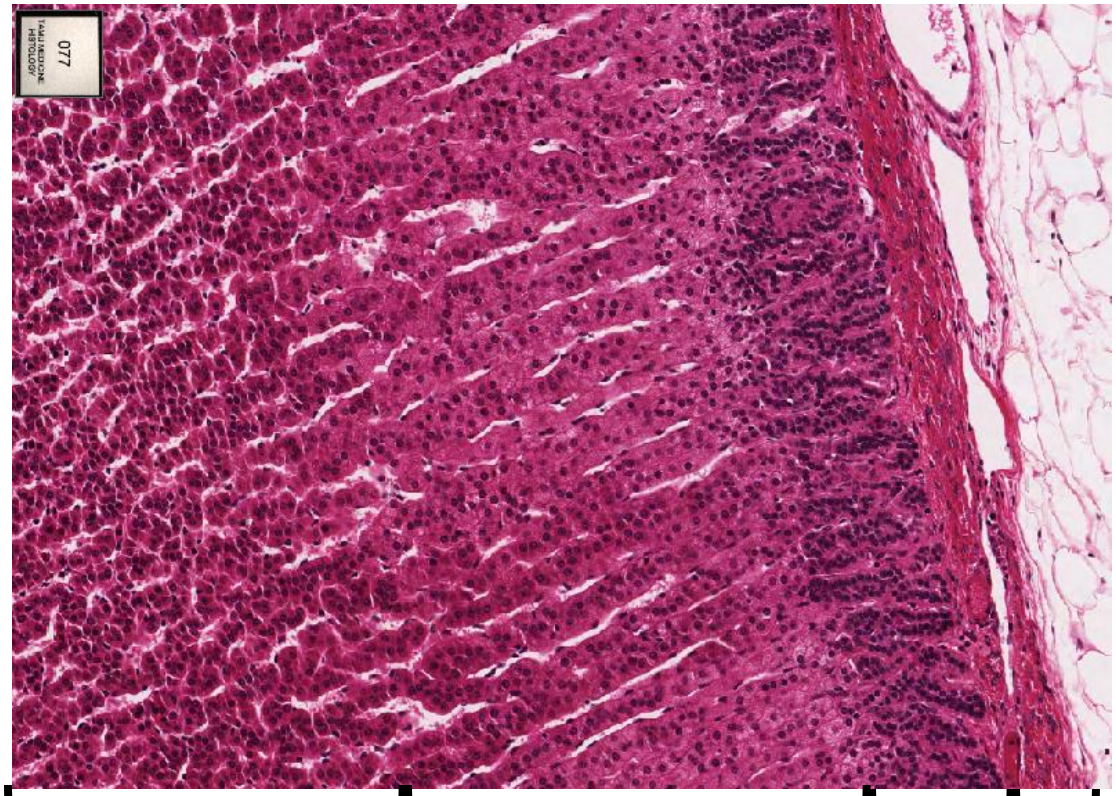




Slide 77: Adrenal gland

Cortex

Medulla



Zona reticularis

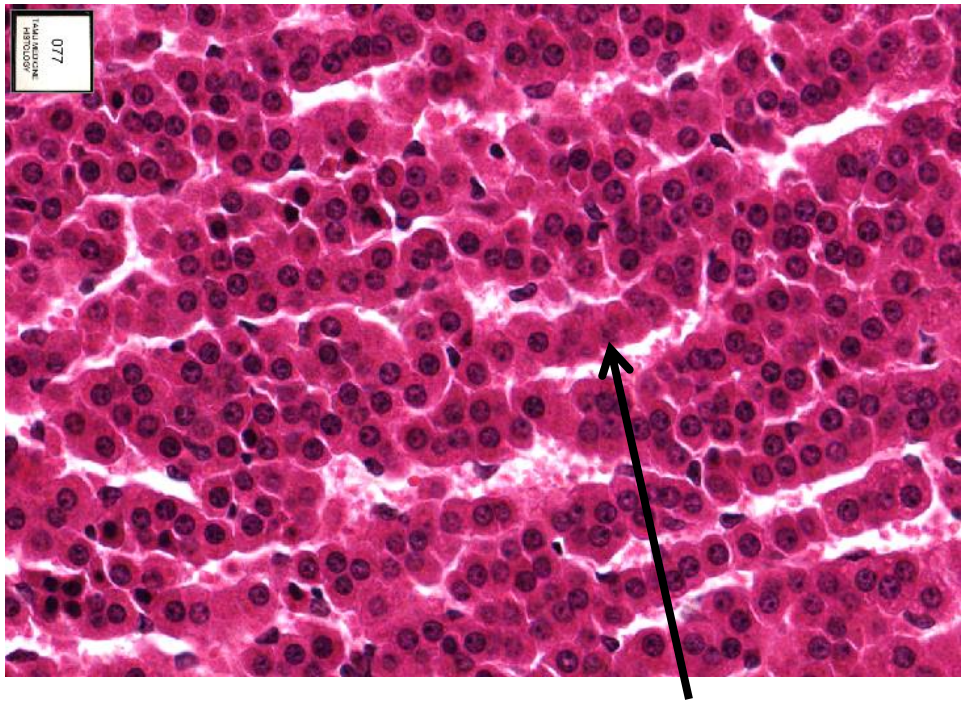
Zona fasciculata

Zona glomerulosa

Capsule

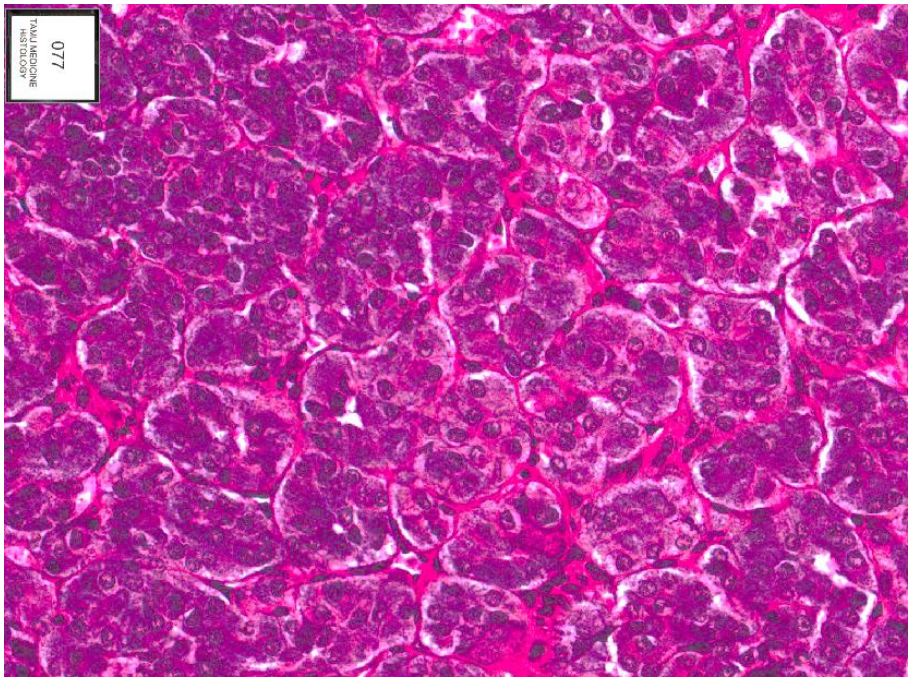
The zona glomerulosa layer is regulated by pituitary adrenocorticotrophin hormone (ACTH).

Slide 77: Adrenal gland



Trabeculae of cortex

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.

The zona reticularis has a rich vascularization with wide capillaries.

Adrenal function

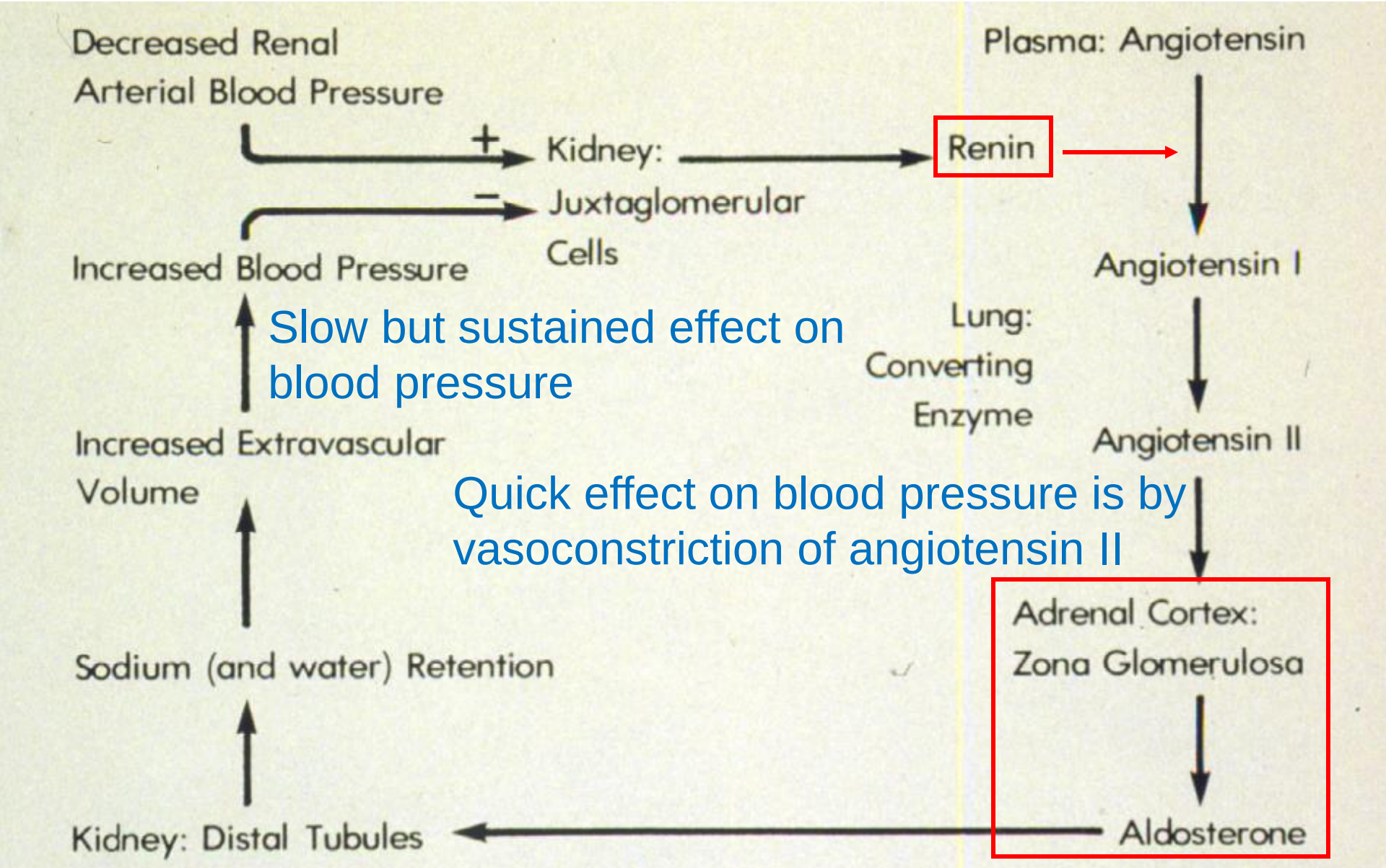
Aldosterone stimulates Na^+ resorption in:

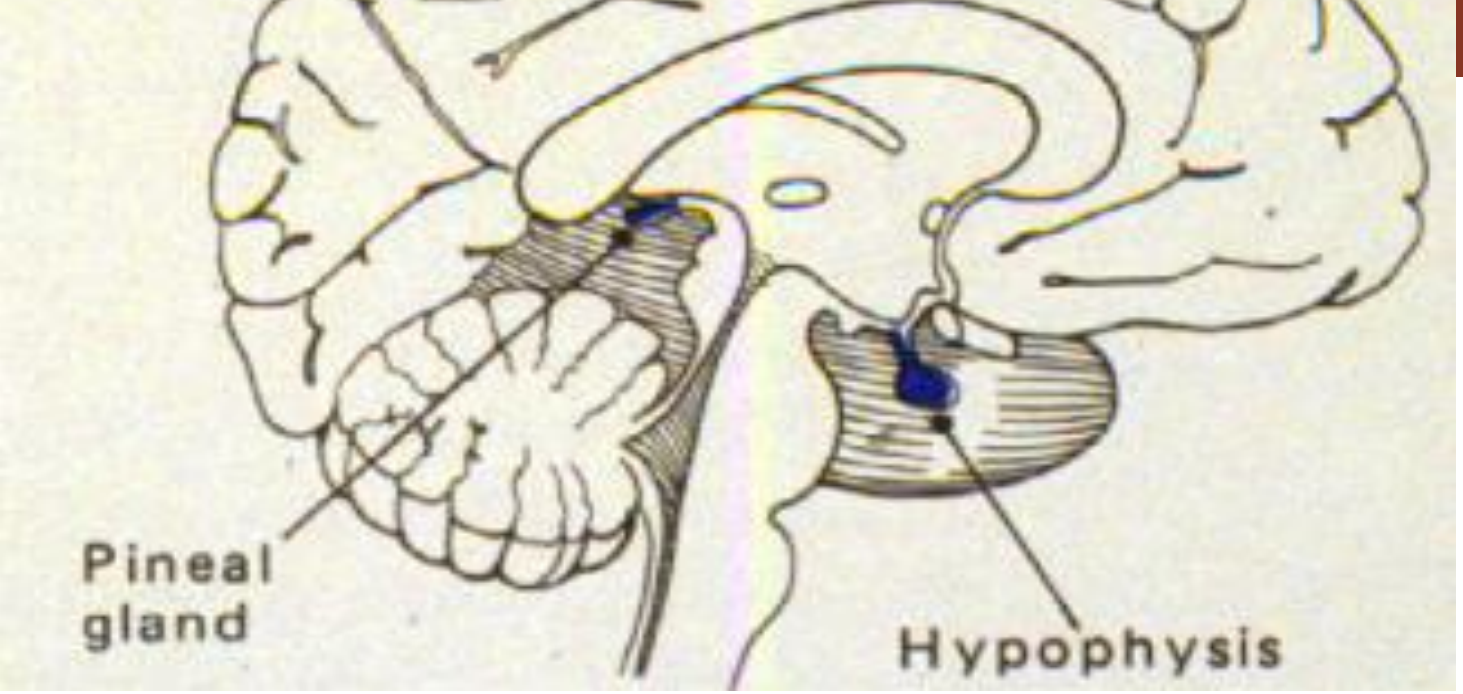
- distal tubule of kidney
- gastric mucosa
- salivary glands
- sweat glands

Cortisol - anti-inflammatory effects

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

Adrenal function: blood pressure





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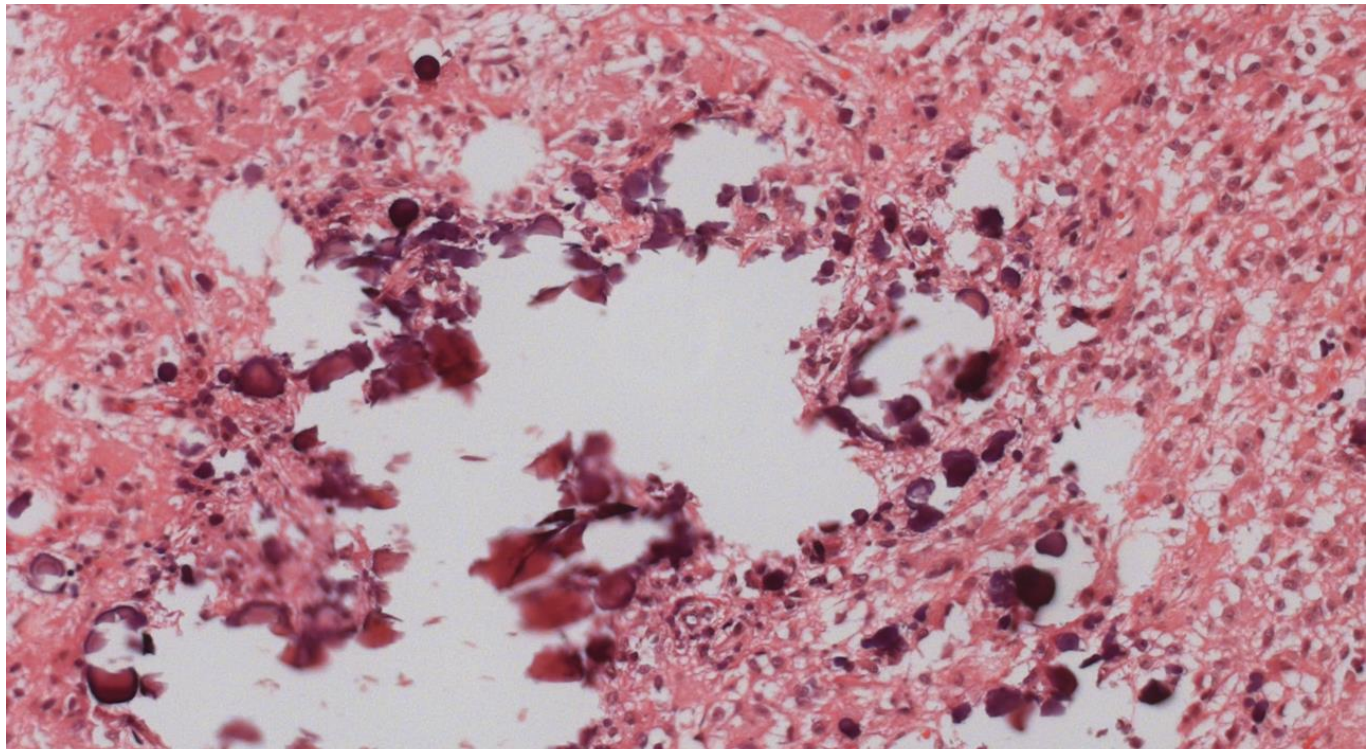
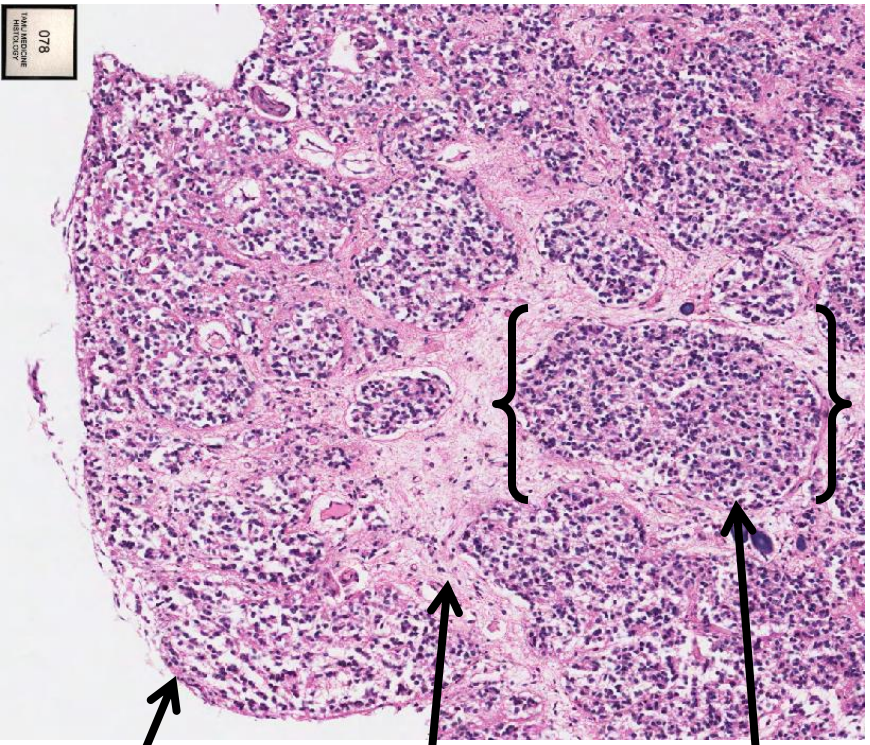
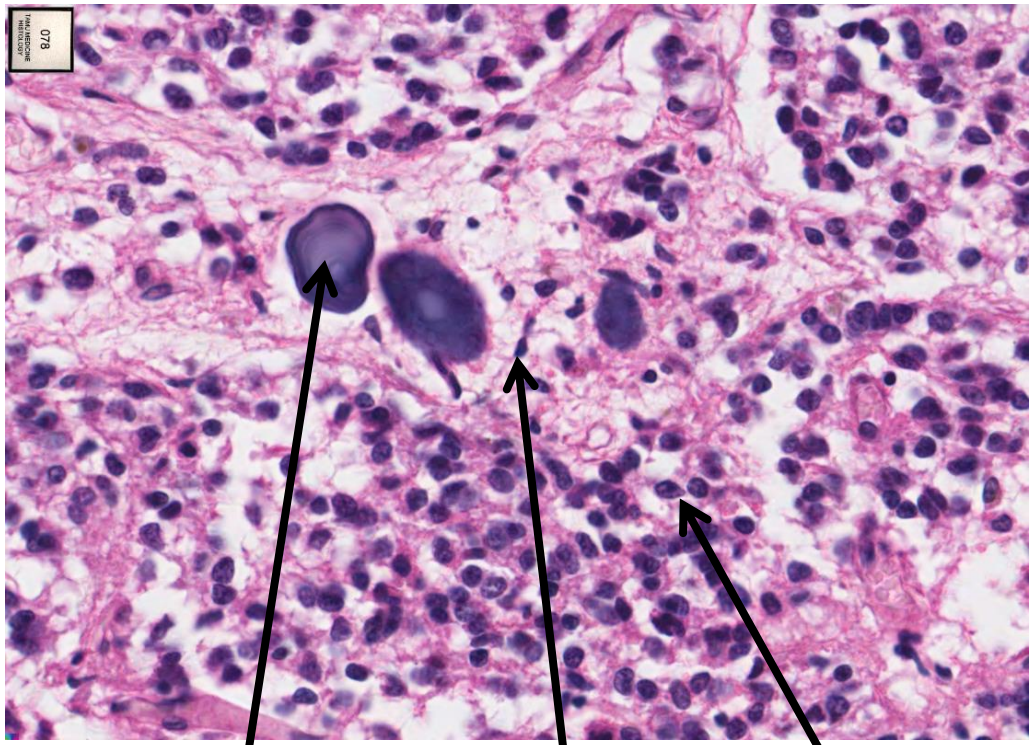


Slide 78: Pineal gland





Capsule

Trabeculae

Lobule

Corpora arenacea
(brain sand)

Neuroglia

Pinealocytes

. Melatonin release highest in the dark period.

Pineal gland: melatonin effect on hamster testis

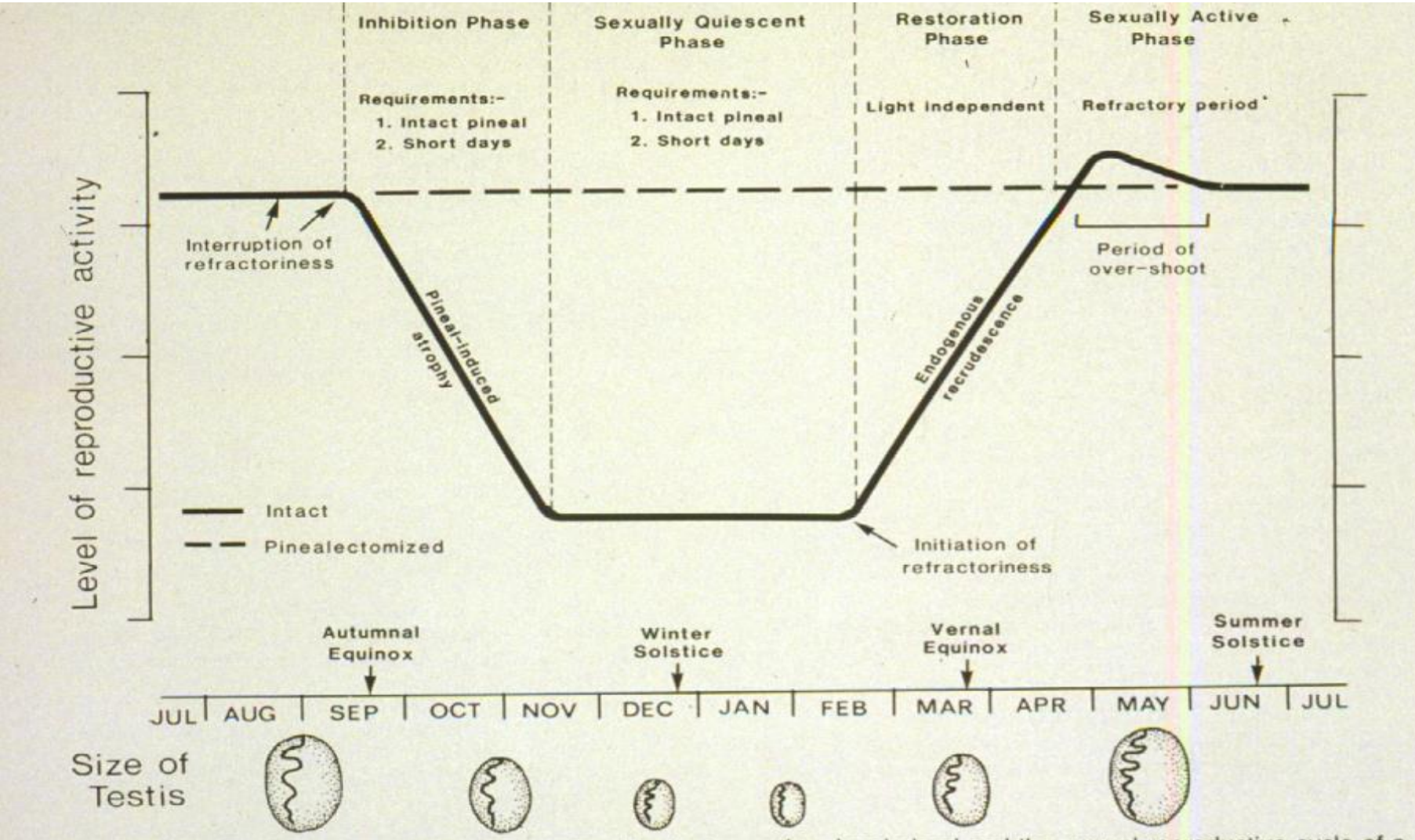


Figure 21–7. Schematic depiction of the relationships between the pineal gland and the annual reproductive cycle of a seasonal breeding species such as the hamster. (From Reiter, R. J. Endocr. Rev. *1*:109, 1980.)

Pineal gland

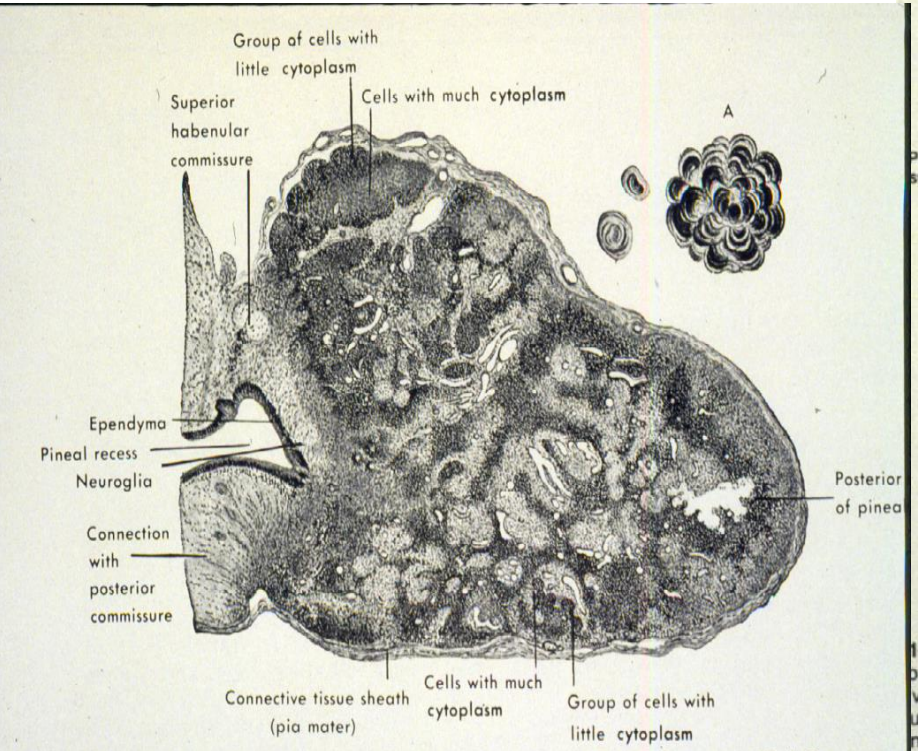
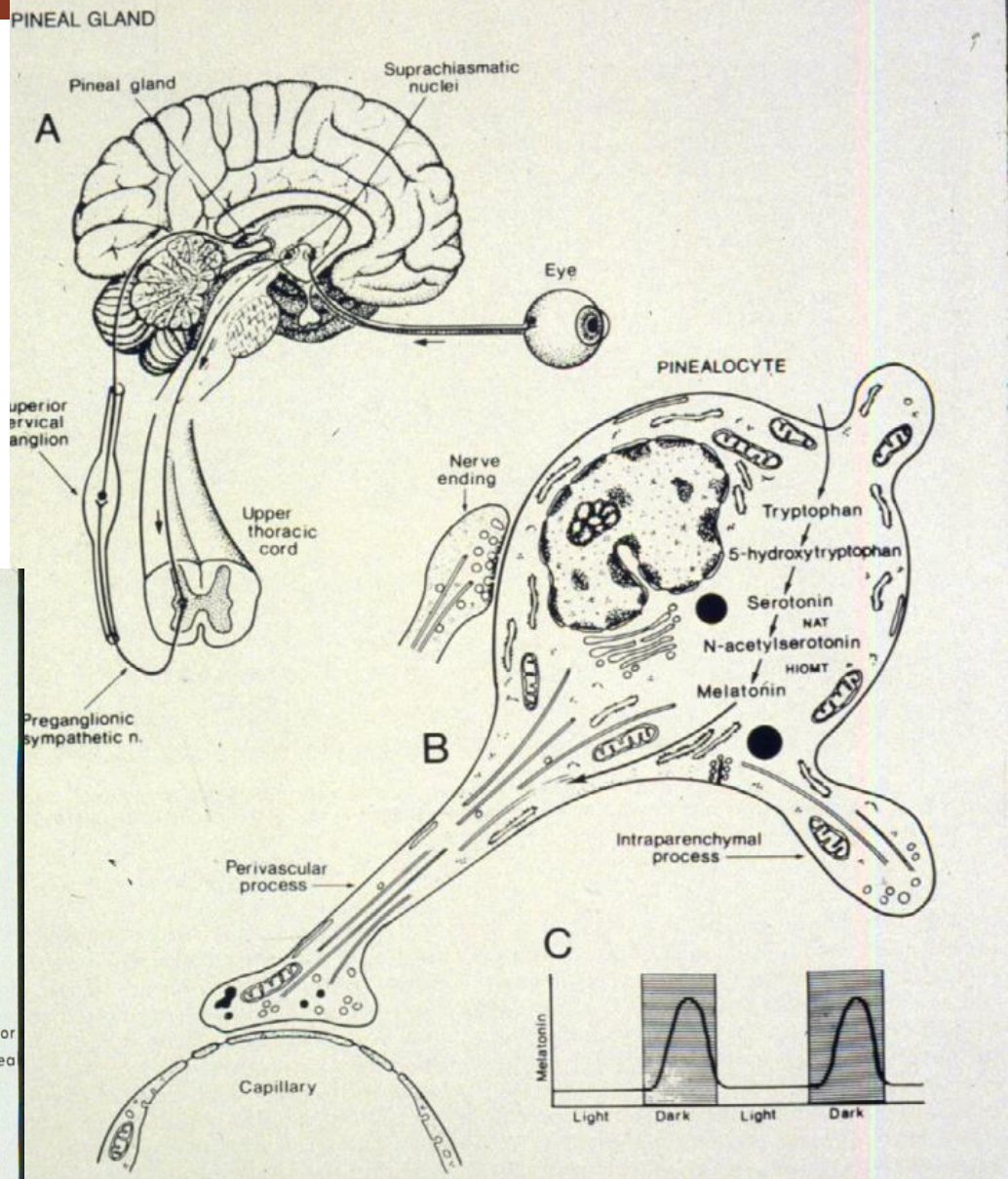
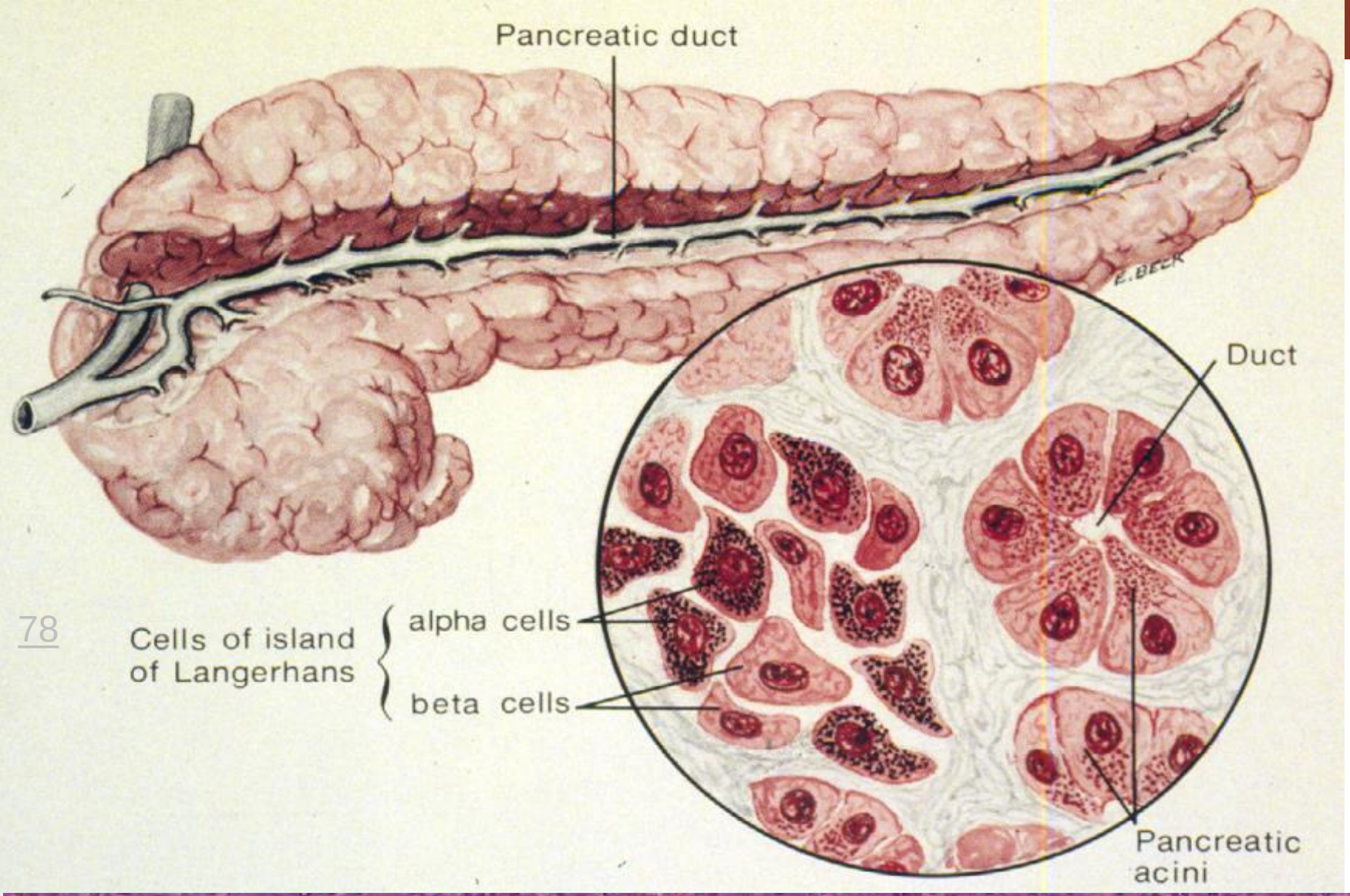
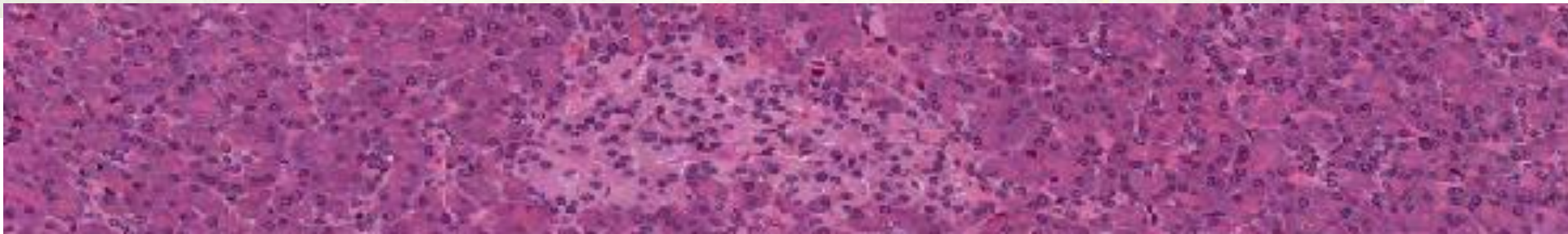


Figure 21–1. Median section through pineal body of a newborn child. Blood vessels empty. × 32. *A*, Corpora aren (sand granules) from the pineal body of a 69-year-old woman. × 160. (After Schaffer.)



1–6. (A) Path of information transfer from eyes to pineal: via retinohypothalamic tracts to suprachiasmatic nuclei; o 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.)

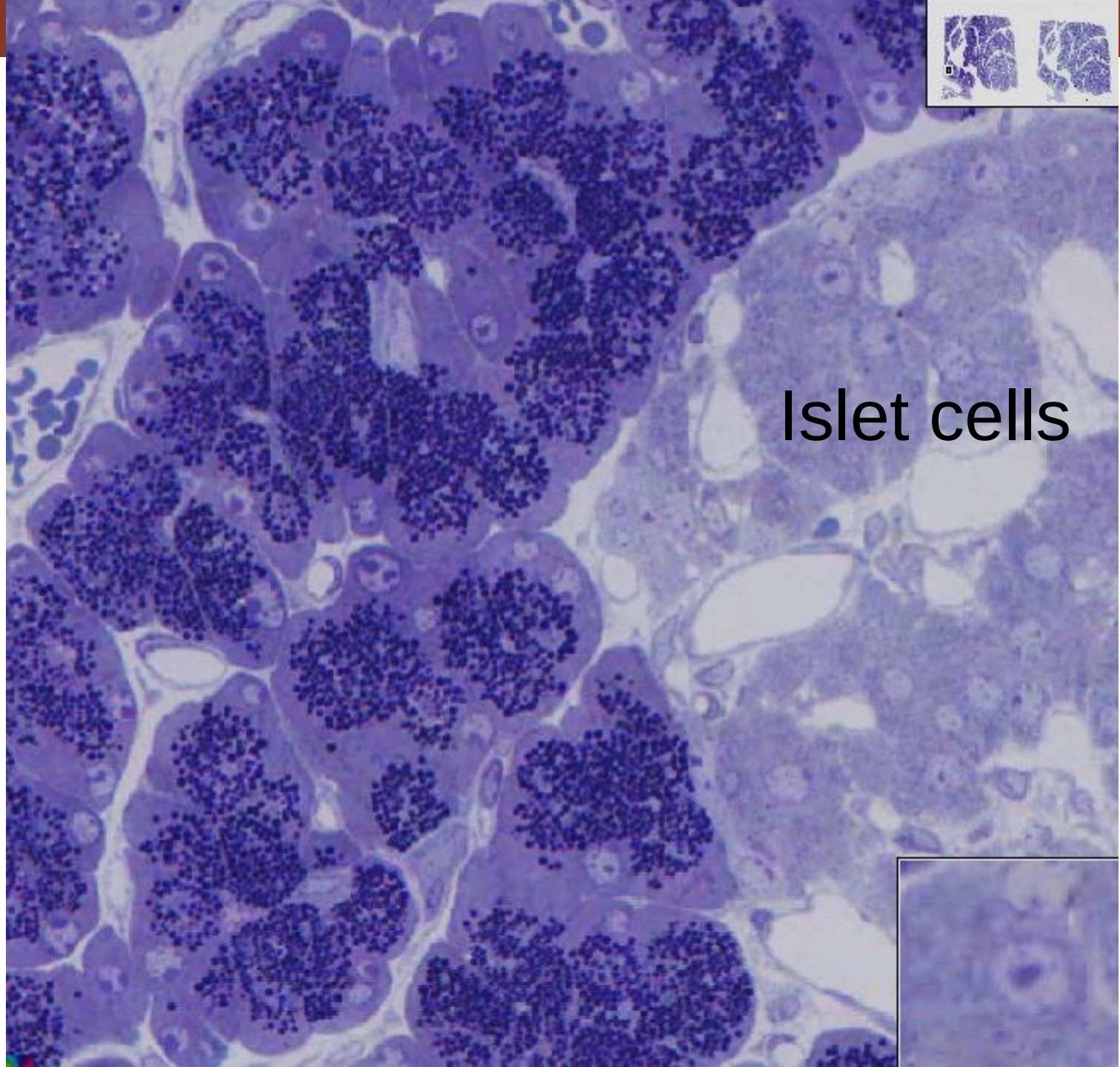

Pancreatic duct
Duct
Cells of island of Langerhans
alpha cells
beta cells
Pancreatic acini



34218

Rat pancreas

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

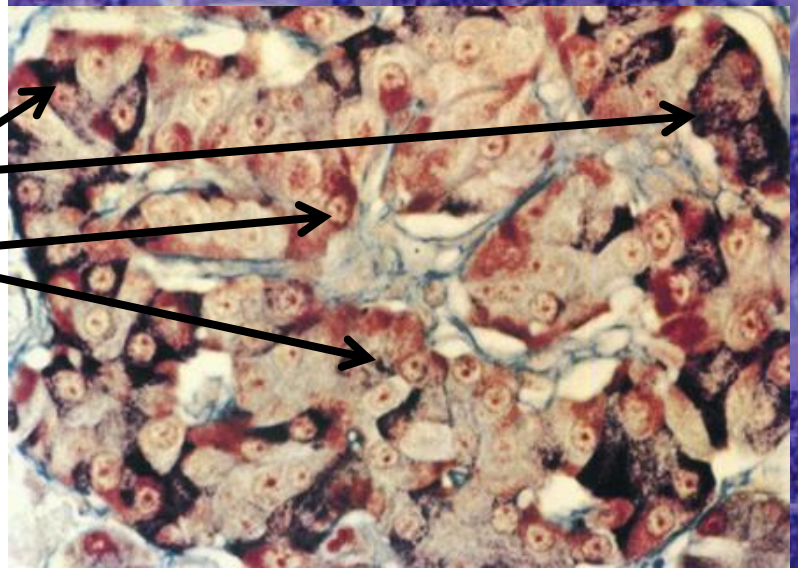


34218

Rat pancreas

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

Islet cells

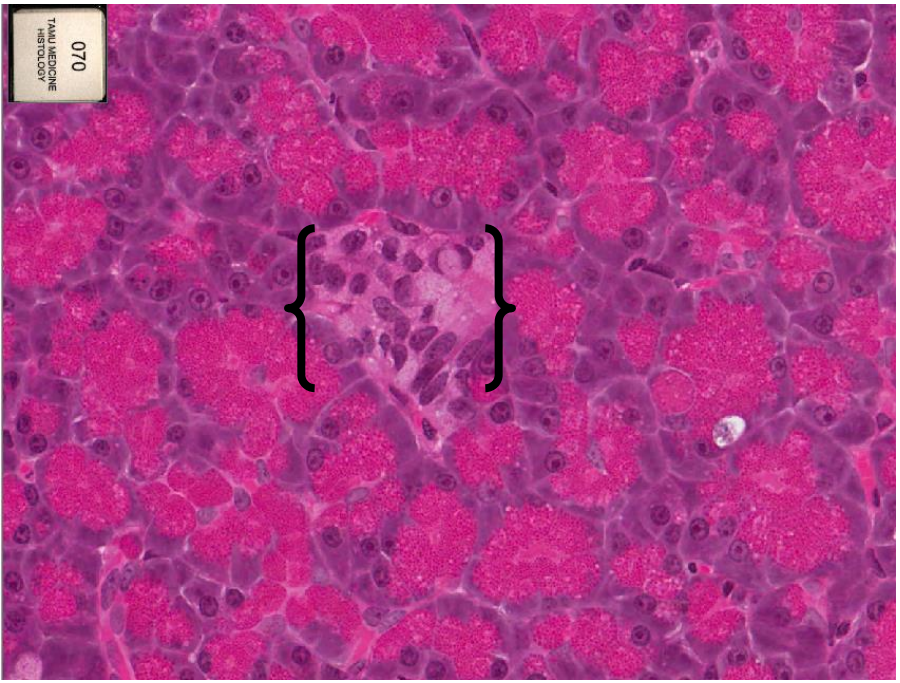


Alpha cells

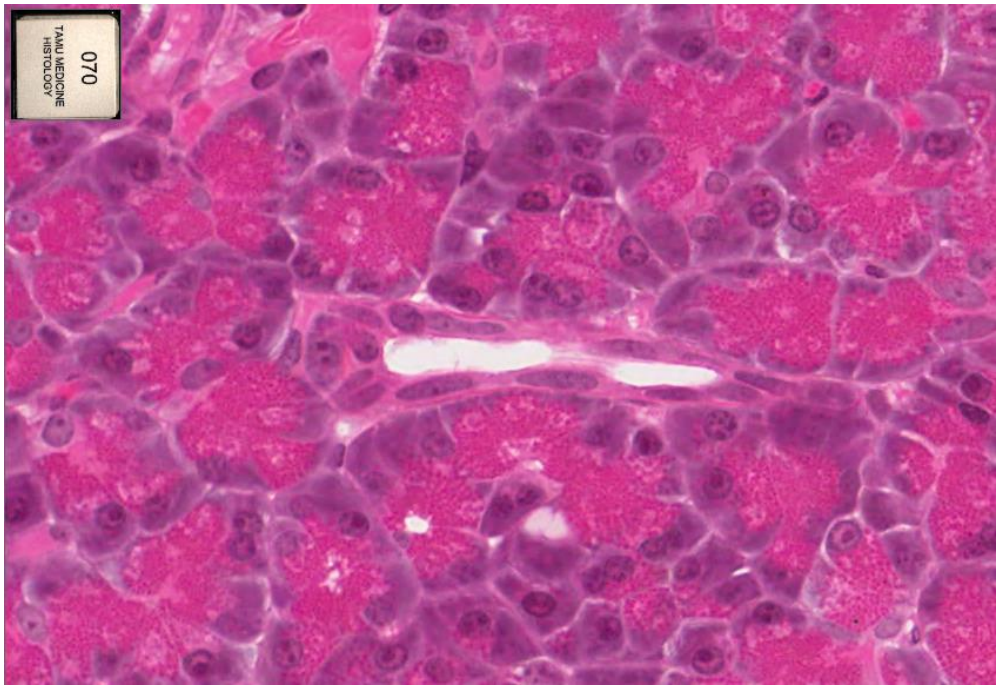
Beta cells

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

Slide 70: Pancreas (Islets of Langerhans)



Endocrine Islets of Langerhans



Exocrine pancreatic acini and exocrine duct

Clinical Correlation

There are numerous diseases that affect the endocrine system. For example, Hashimoto's thyroiditis is an auto-immune disease resulting in hypothyroidism while Grave's disease is the most common form of hyperthyroidism.

Marty Feldman in Young Frankenstein (1974) suffered from Grave's disease.

Cushing syndrome results from excessive production of glucocorticoids.

However, the most common cause of Cushing syndrome use of oral corticosteroid medication.

Left untreated, Cushing syndrome can result in exaggerated facial roundness, weight gain around the midsection and upper back, thinning of your arms and legs, and stretch marks

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

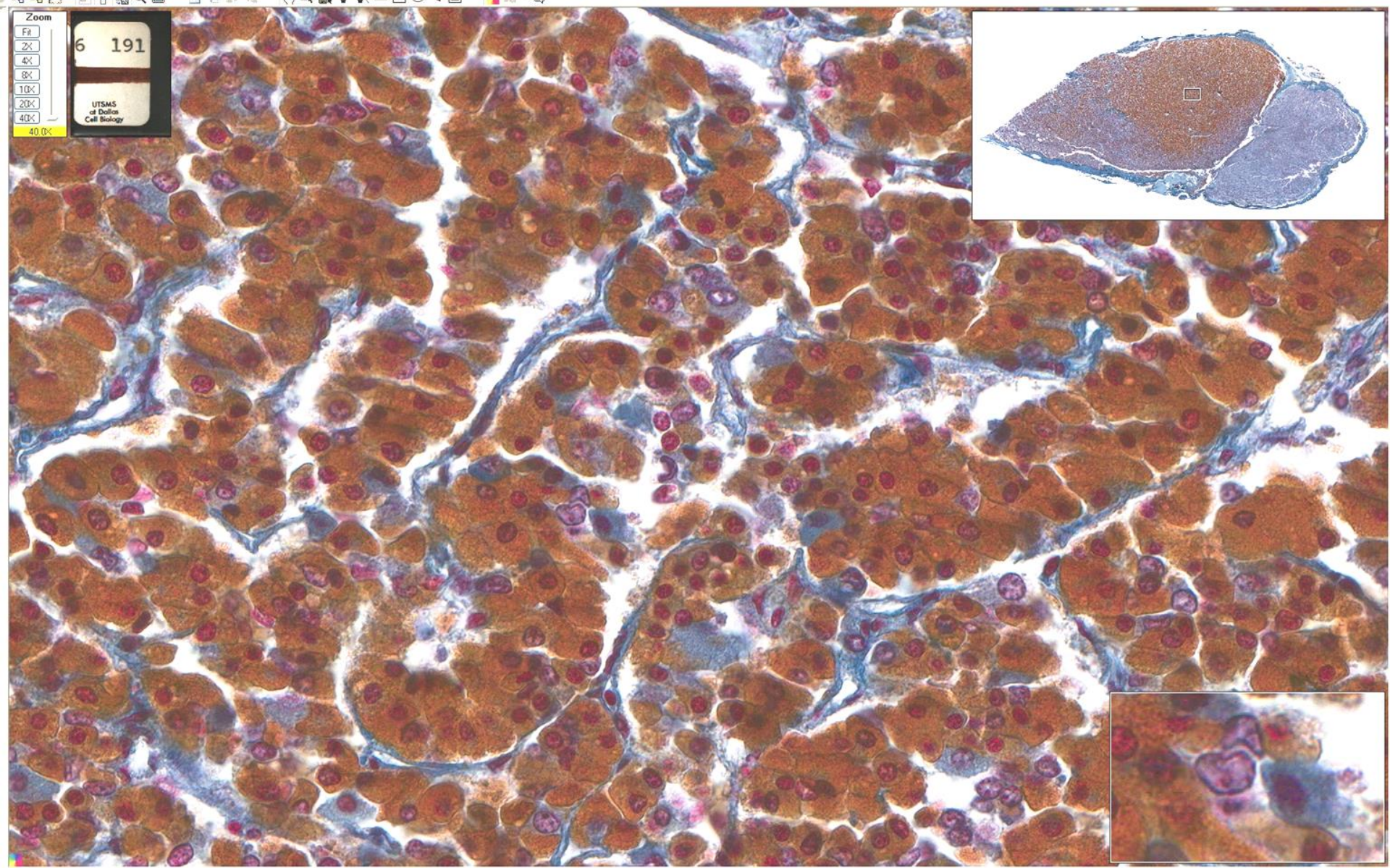
Endocrine System Worksheet

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

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

- Bruce Alberts, et al. 1983. Molecular Biology of the Cell. Garland Publishing, Inc., New York, NY.
- Bruce Alberts, et al. 1994. Molecular Biology of the Cell. Garland Publishing, Inc., New York, NY.
- William J. Banks, 1981. Applied Veterinary Histology. Williams and Wilkins, Los Angeles, CA.
- Hans Elias, et al. 1978. Histology and Human Microanatomy. John Wiley and Sons, New York, NY.
- Don W. Fawcett. 1986. Bloom and Fawcett. A textbook of histology. W. B. Saunders Company, Philadelphia, PA.
- Don W. Fawcett. 1994. Bloom and Fawcett. A textbook of histology. Chapman and Hall, New York, NY.
- Arthur W. Ham and David H. Cormack. 1979. Histology. J. S. Lippincott Company, Philadelphia, PA.
- Luis C. Junqueira, et al. 1983. Basic Histology. Lange Medical Publications, Los Altos, CA.
- L. Carlos Junqueira, et al. 1995. Basic Histology. Appleton and Lange, Norwalk, CT.
- L.L. Langley, et al. 1974. Dynamic Anatomy and Physiology. McGraw-Hill Book Company, New York, NY.
- W.W. Tuttle and Byron A. Schottelius. 1969. Textbook of Physiology. The C. V. Mosby Company, St. Louis, MO.
- Leon Weiss. 1977. Histology Cell and Tissue Biology. Elsevier Biomedical, New York, NY.
- Leon Weiss and Roy O. Greep. 1977. Histology. McGraw-Hill Book Company, New York, NY.
- Nature (http://www.nature.com), Vol. 414:88,2001.
- A.L. Mescher 2013 Junqueira's Basis Histology text and atlas, 13th ed. McGraw
- Douglas P. Dohrman and TAMHSC Faculty 2012 Structure and Function of Human Organ Systems, Histology Laboratory Manual - Slide selections were largely based on this manual for first year medical students at TAMHSC

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



VARIATIONS IN THE MICROVASCULATURE

COMMON

ARTERIOLE ⇨ CAPILLARY ⇨ VENULE

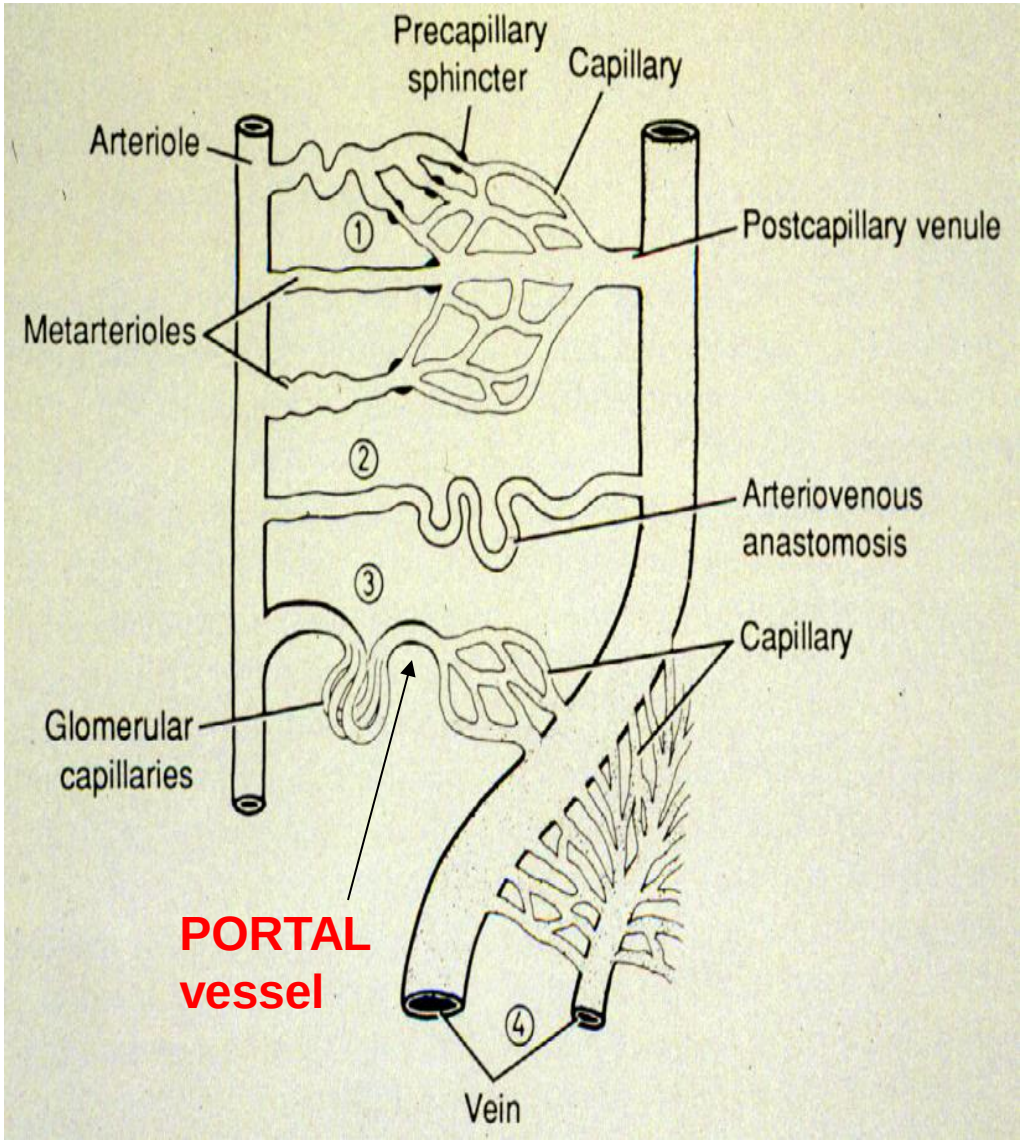
VENOUS PORTAL SYSTEM

CAPILLARY ⇨ PORTAL VEIN ⇨ CAPILLARY

ARTERIAL PORTAL SYSTEM

CAPILLARY ⇨ PORTAL ARTERIOLE ⇨ CAPILLARY

Portal system
create a local change in blood composition



VARIATIONS IN THE MICROVASCULATURE

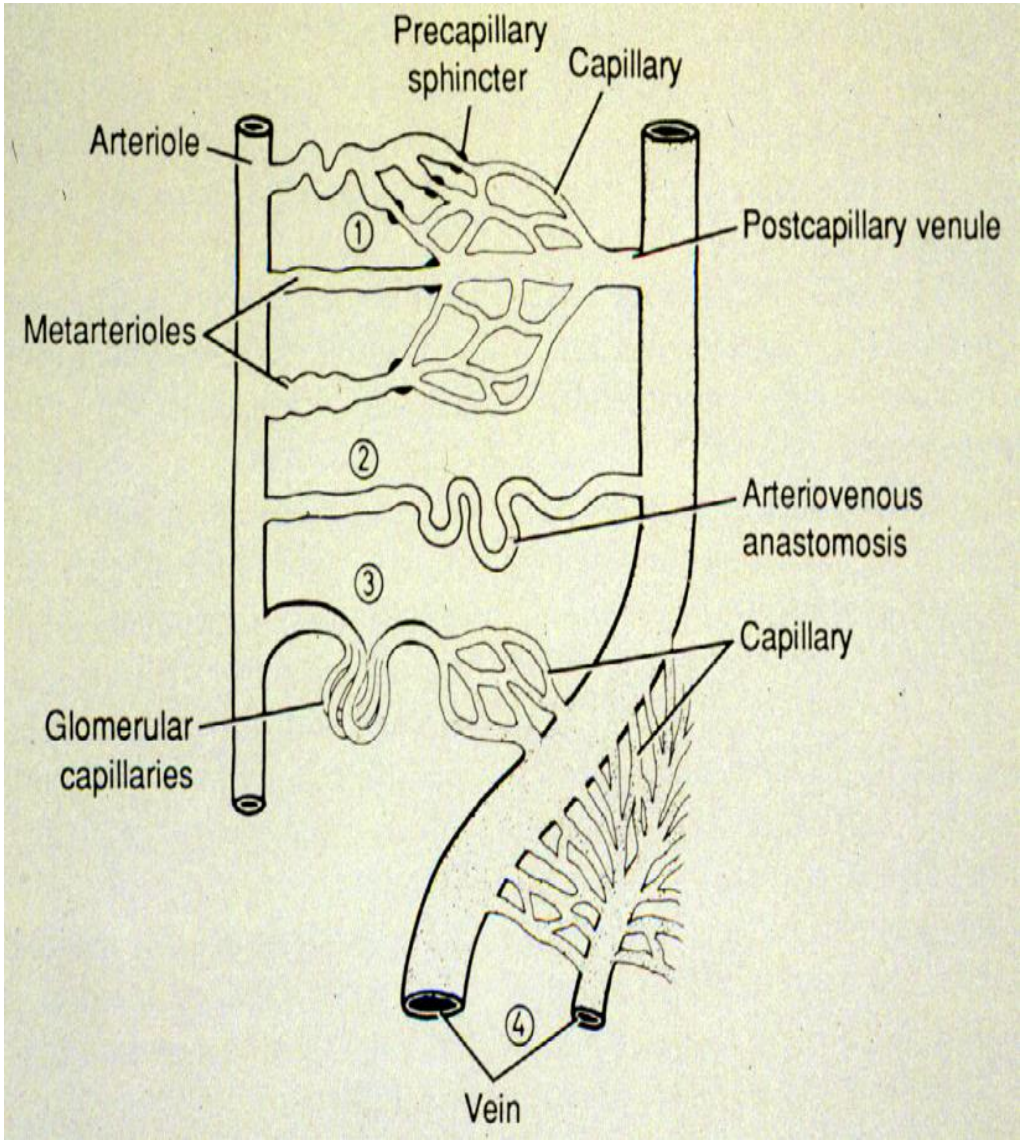
COMMON
ARTERIOLE ⇨ CAPILLARY ⇨ VENULE

VENOUS PORTAL SYSTEM
CAPILLARY ⇨ PORTAL VEIN ⇨ CAPILLARY

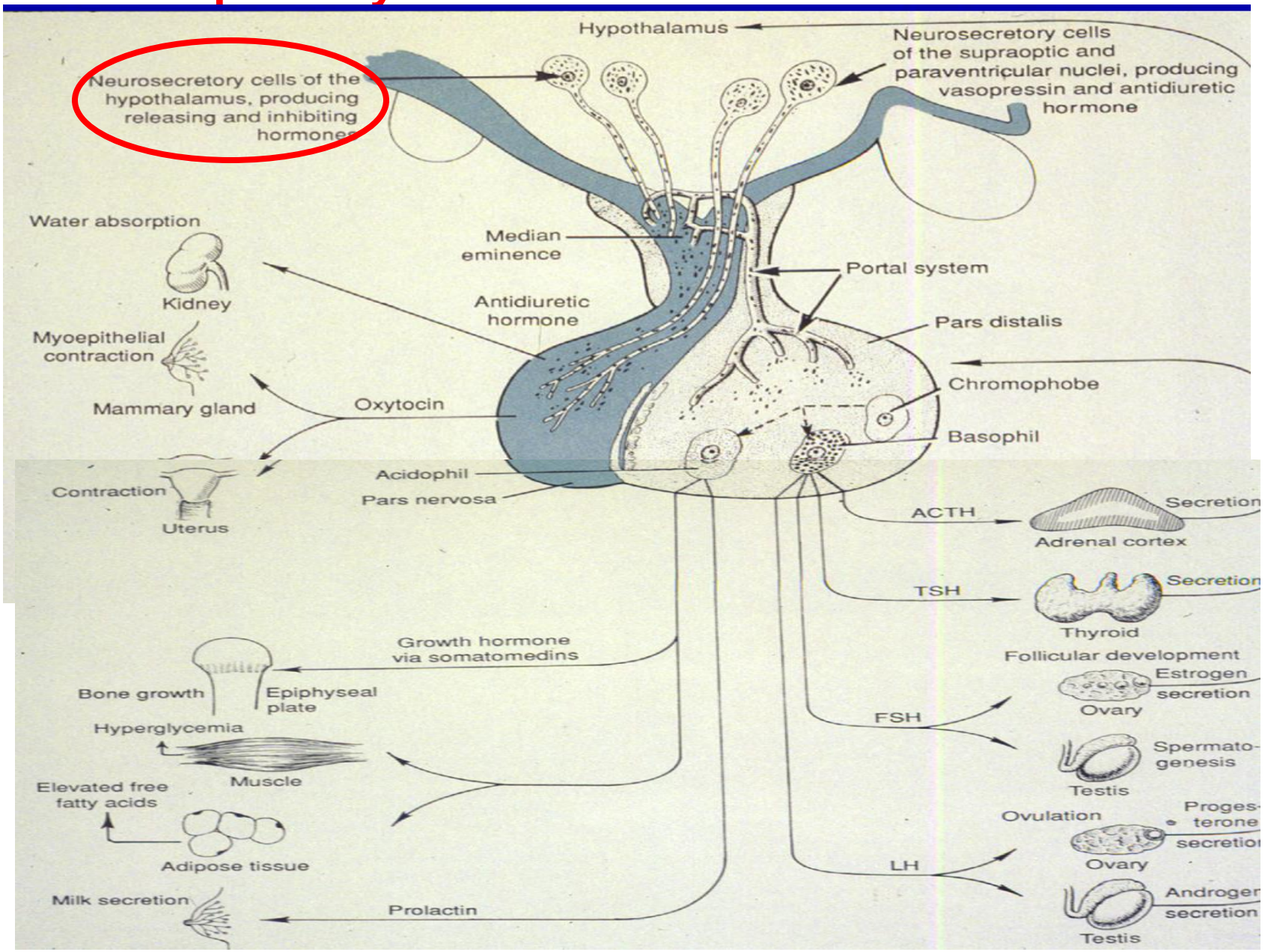
(ENDOCRINE EXAMPLE?)

ARTERIAL PORTAL SYSTEM
CAPILLARY ⇨ PORTAL ARTERIOLE ⇨ CAPILLARY

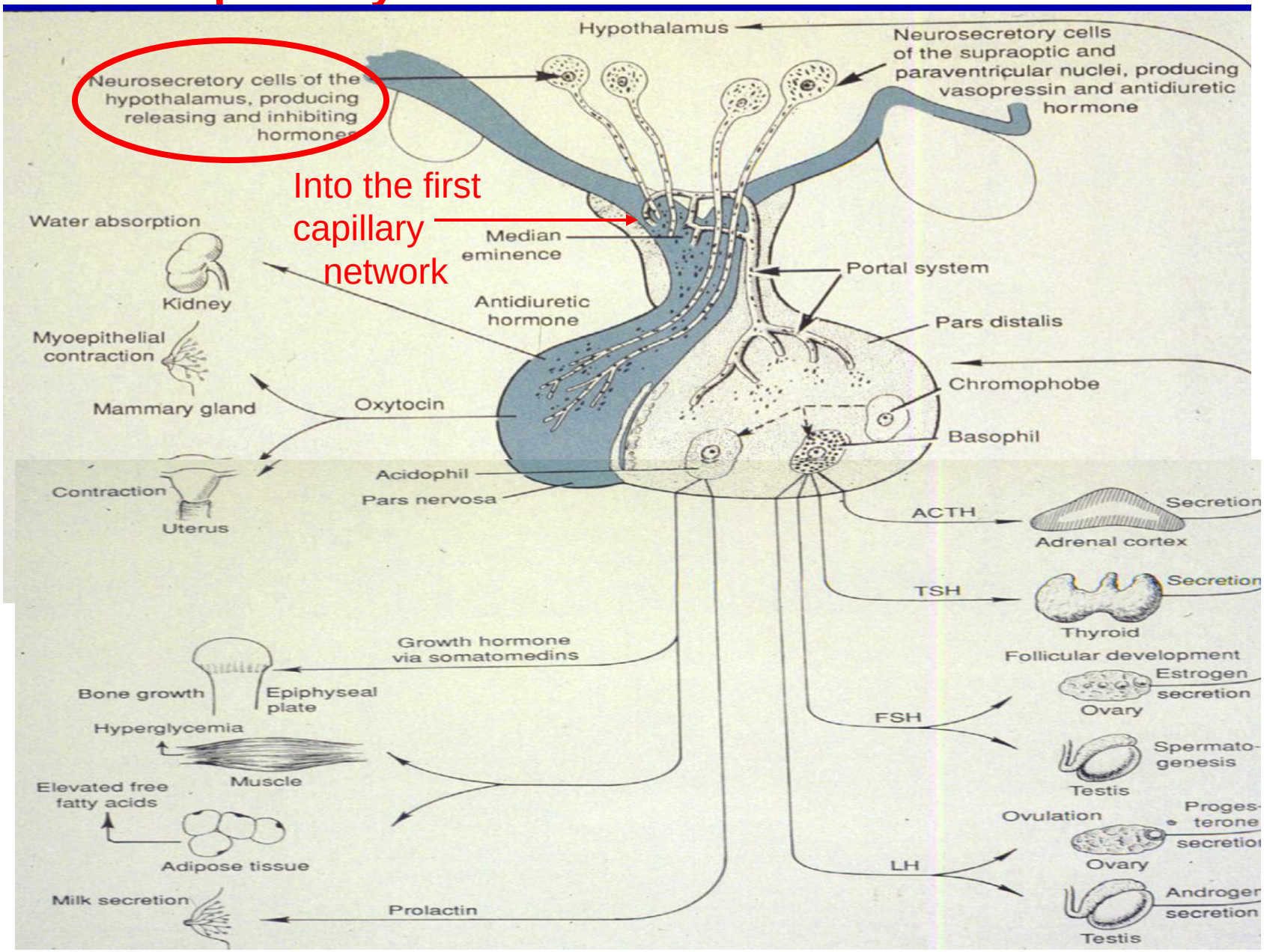
(ENDOCRINE EXAMPLE?)



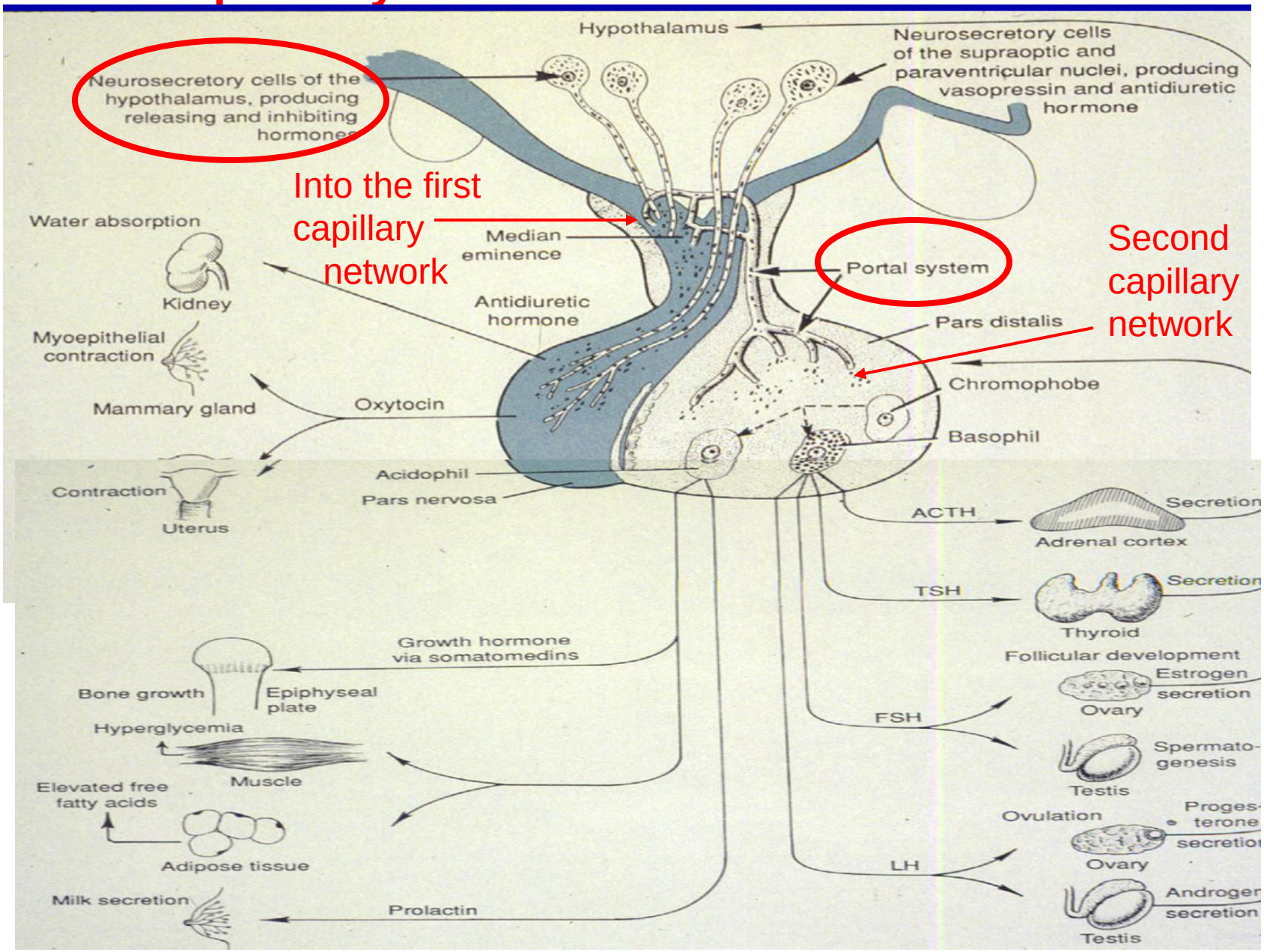
Releasing hormones are distributed in second capillary bed of venous portal system

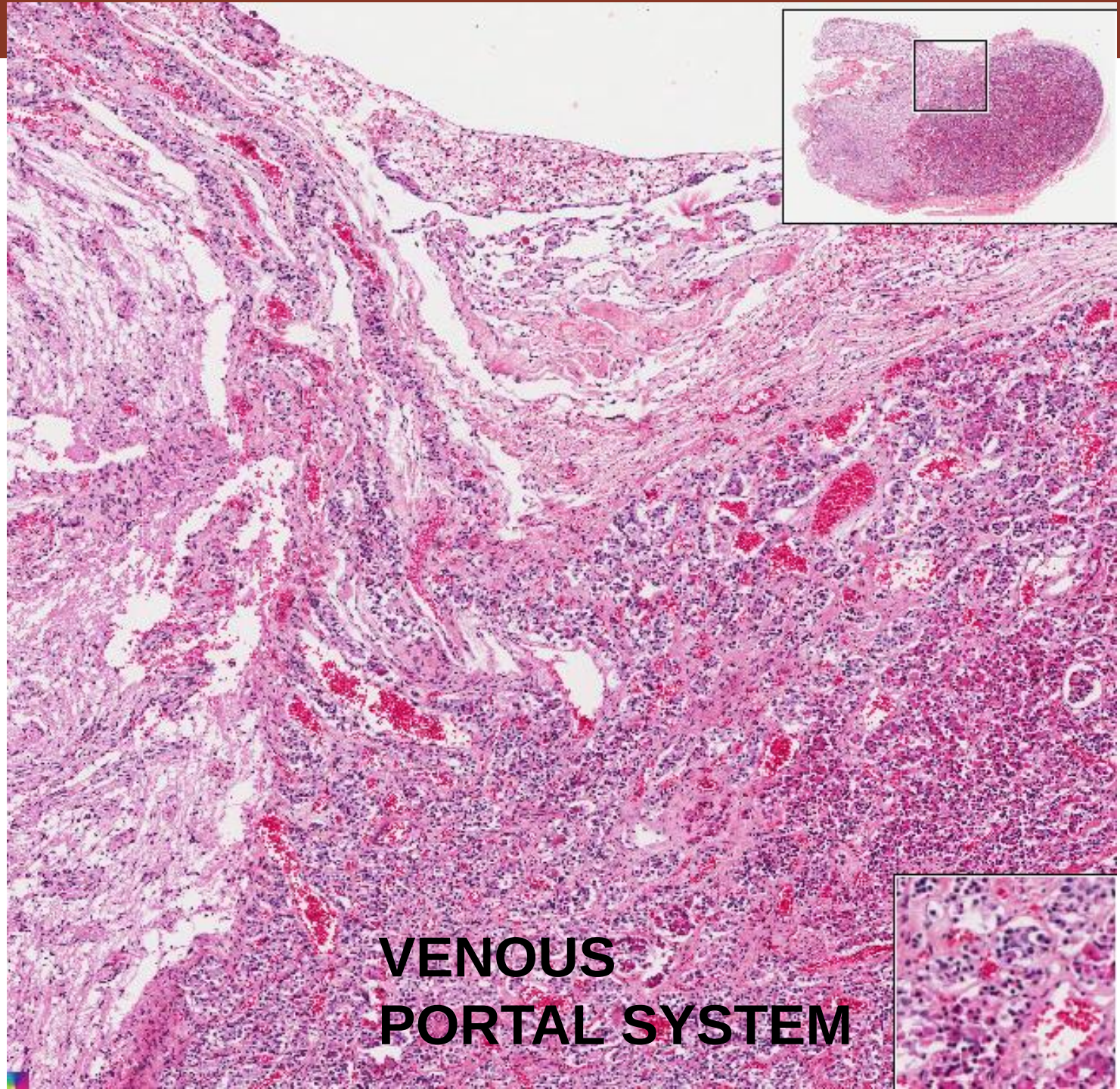


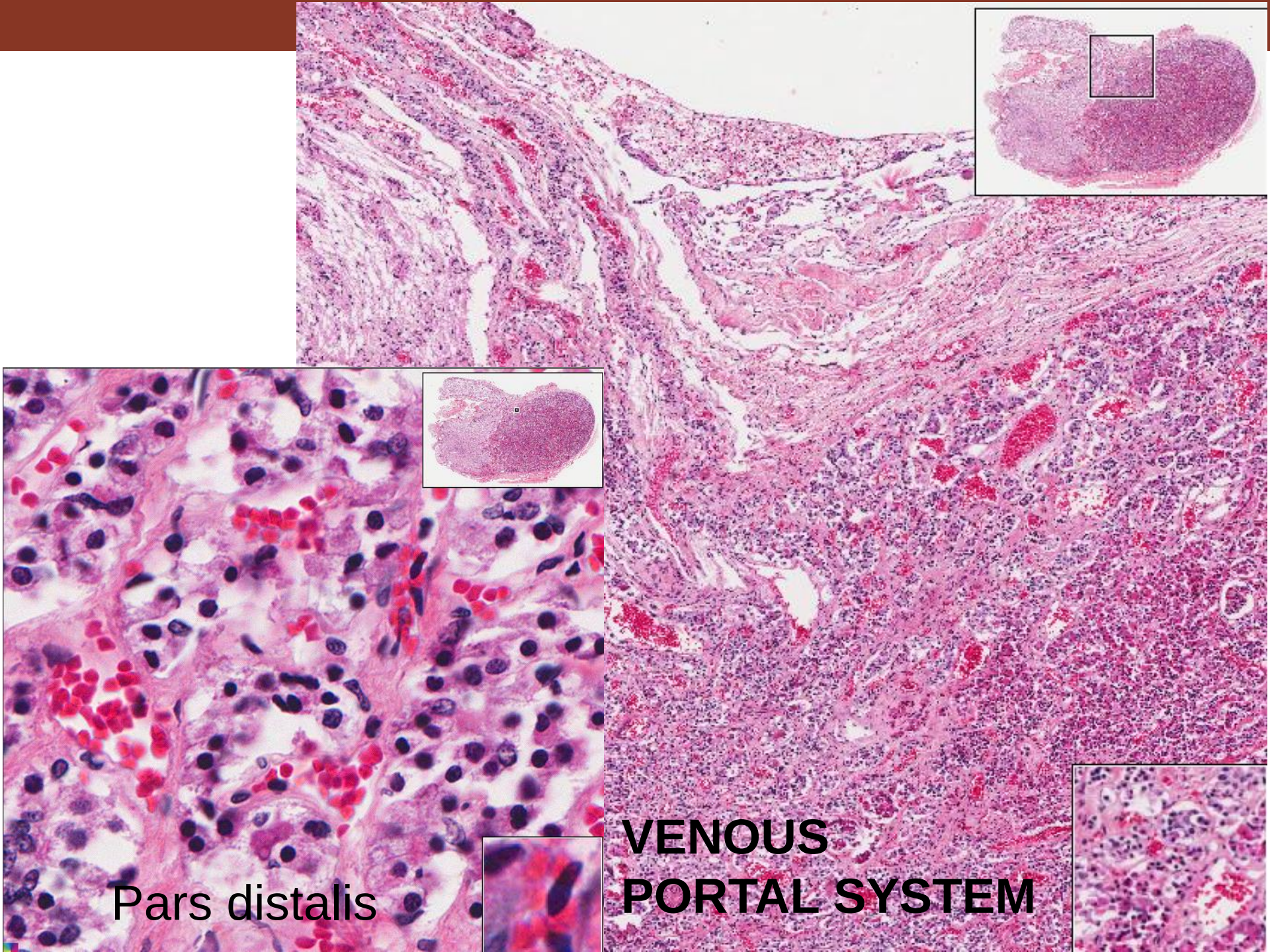
Releasing hormones are distributed in second capillary bed of venous portal system

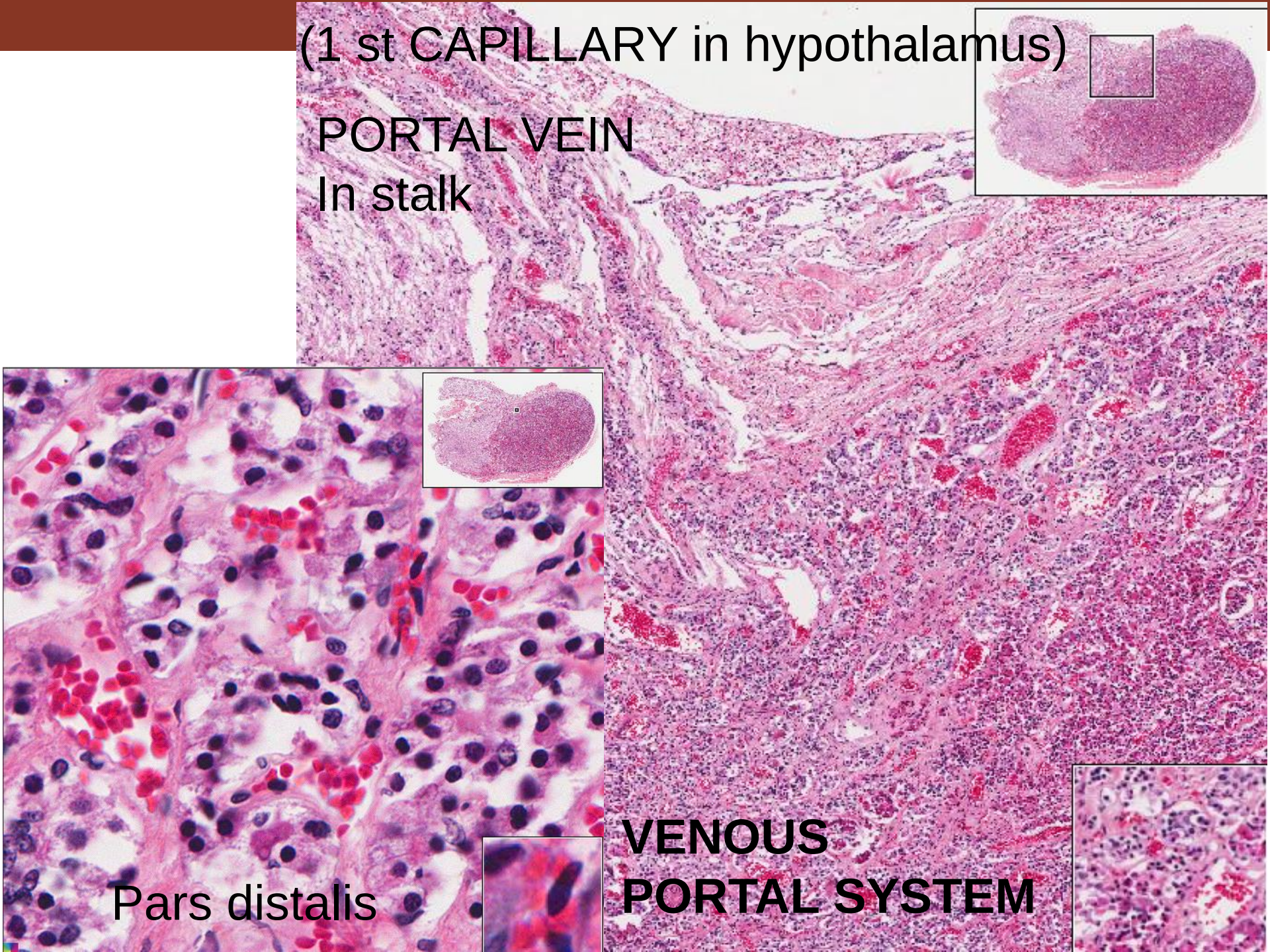


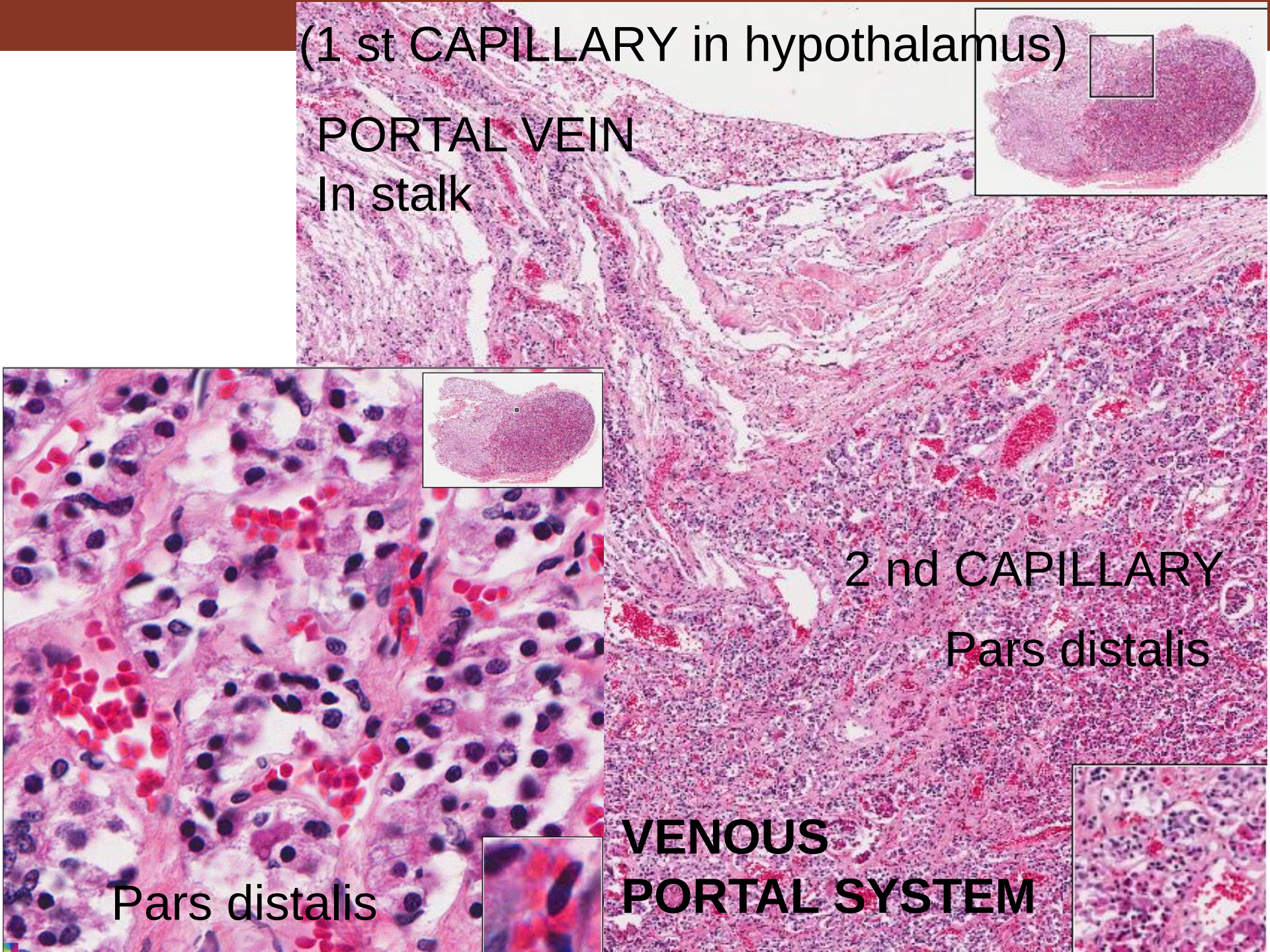
Releasing hormones are distributed in second capillary bed of venous portal system




VENOUS
PORTAL SYSTEM

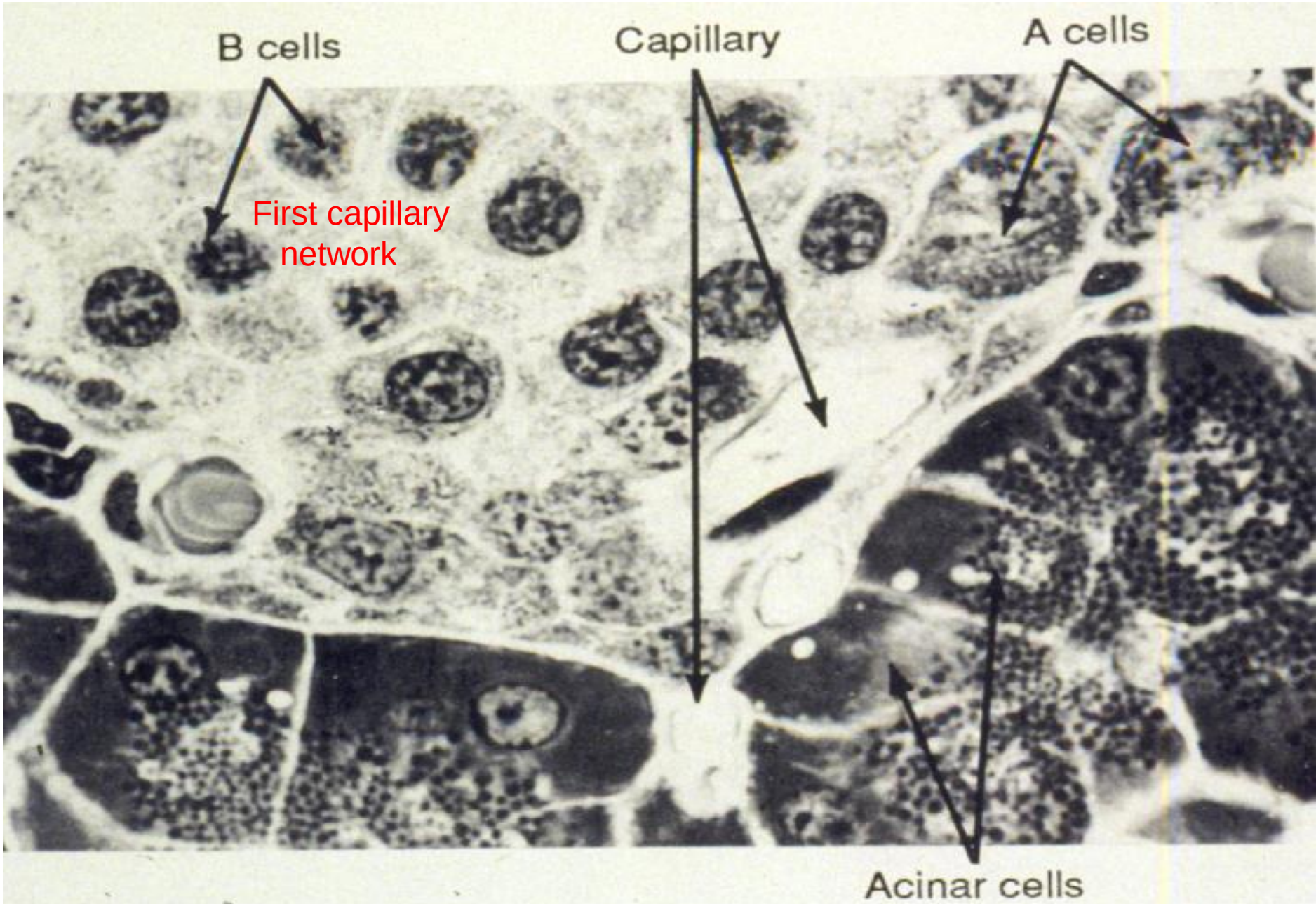

Pars distalis
VENOUS
PORTAL SYSTEM


(1 st CAPILLARY in hypothalamus)
PORTAL VEIN
In stalk
Pars distalis
VENOUS
PORTAL SYSTEM


(1 st CAPILLARY in hypothalamus)
PORTAL VEIN
In stalk
2 nd CAPILLARY
Pars distalis
Pars distalis
VENOUS
PORTAL SYSTEM

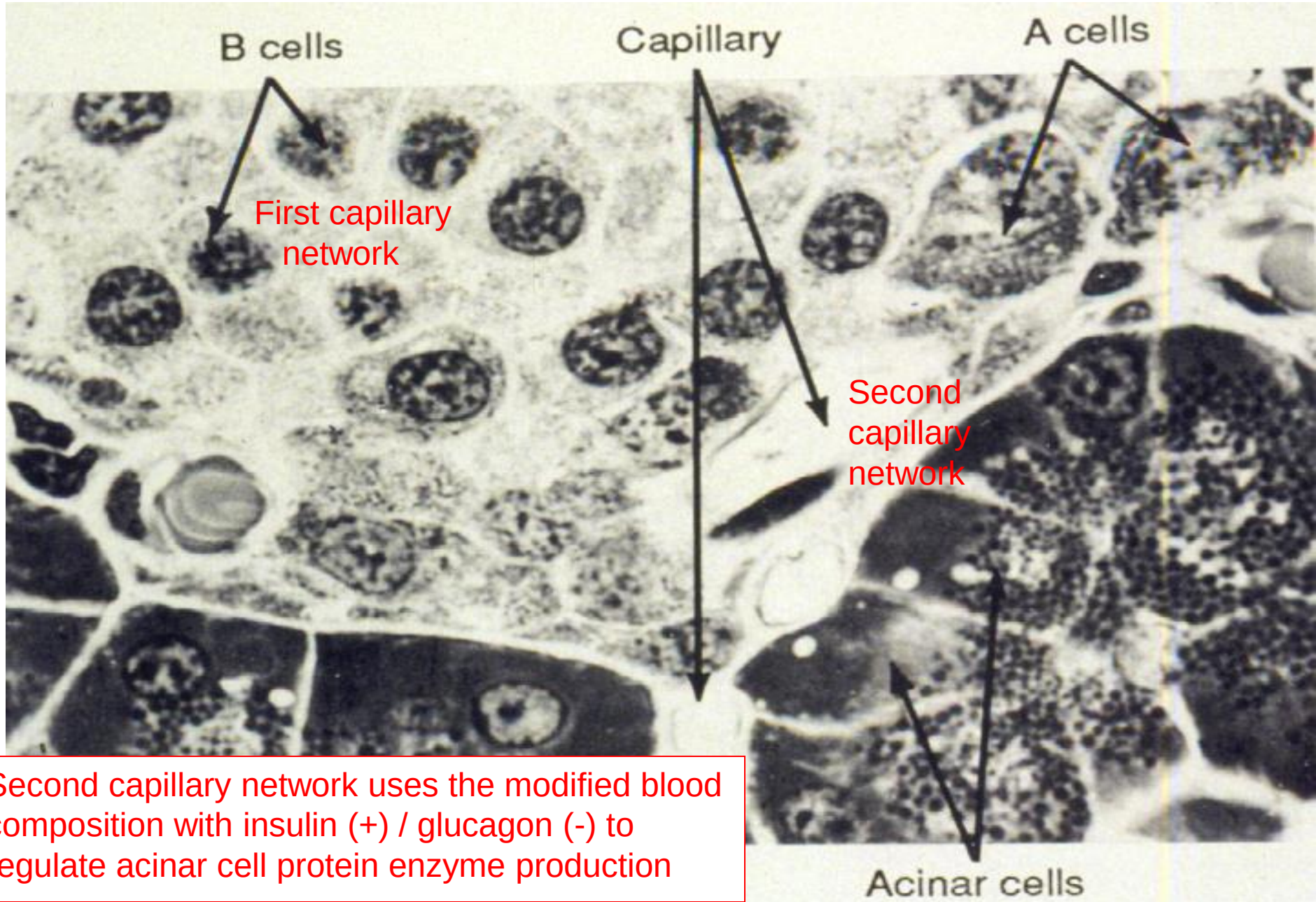
ISLETS Of

First capillary network of the **ARTERIAL PORTAL SYSTEM**

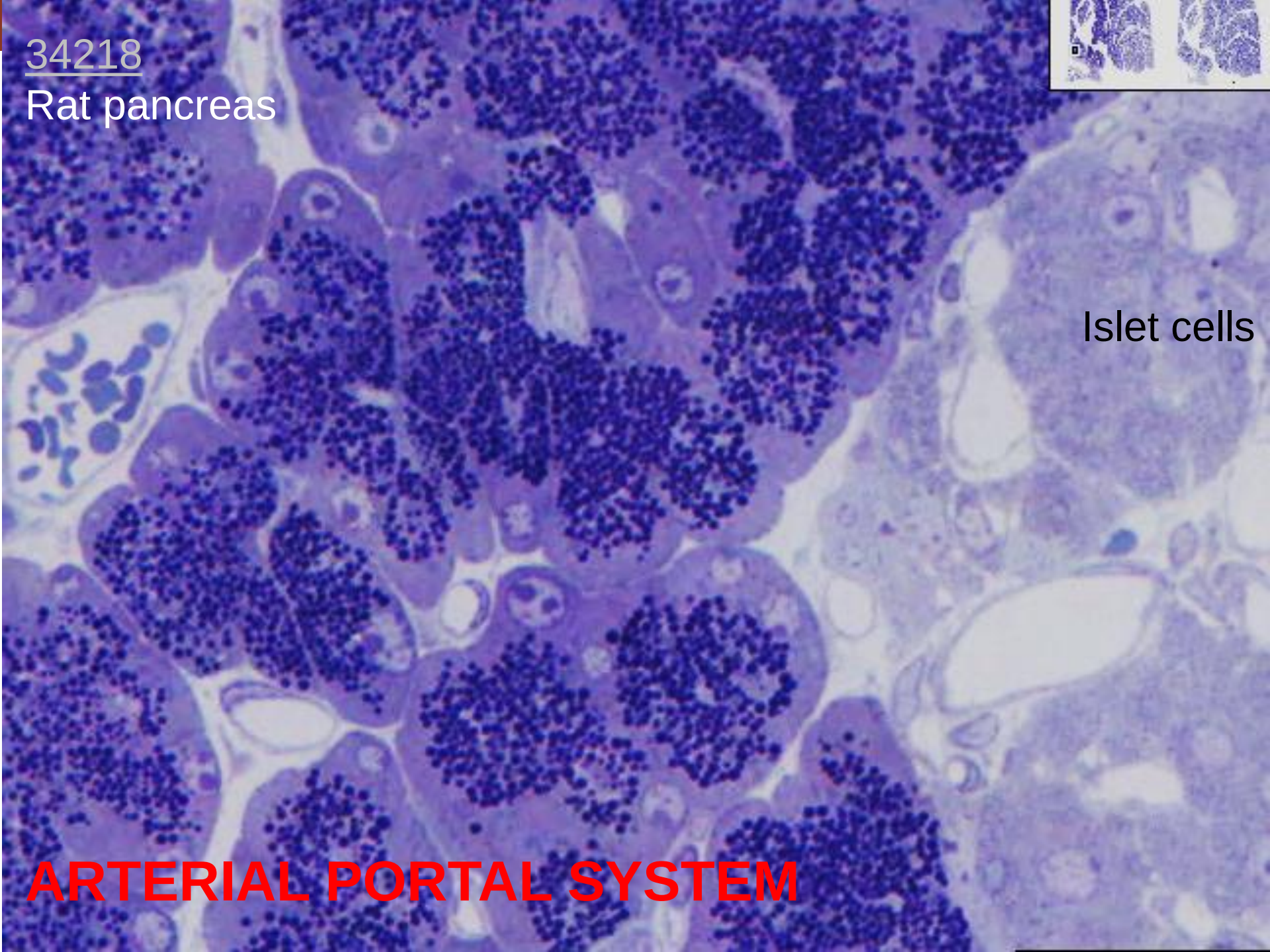


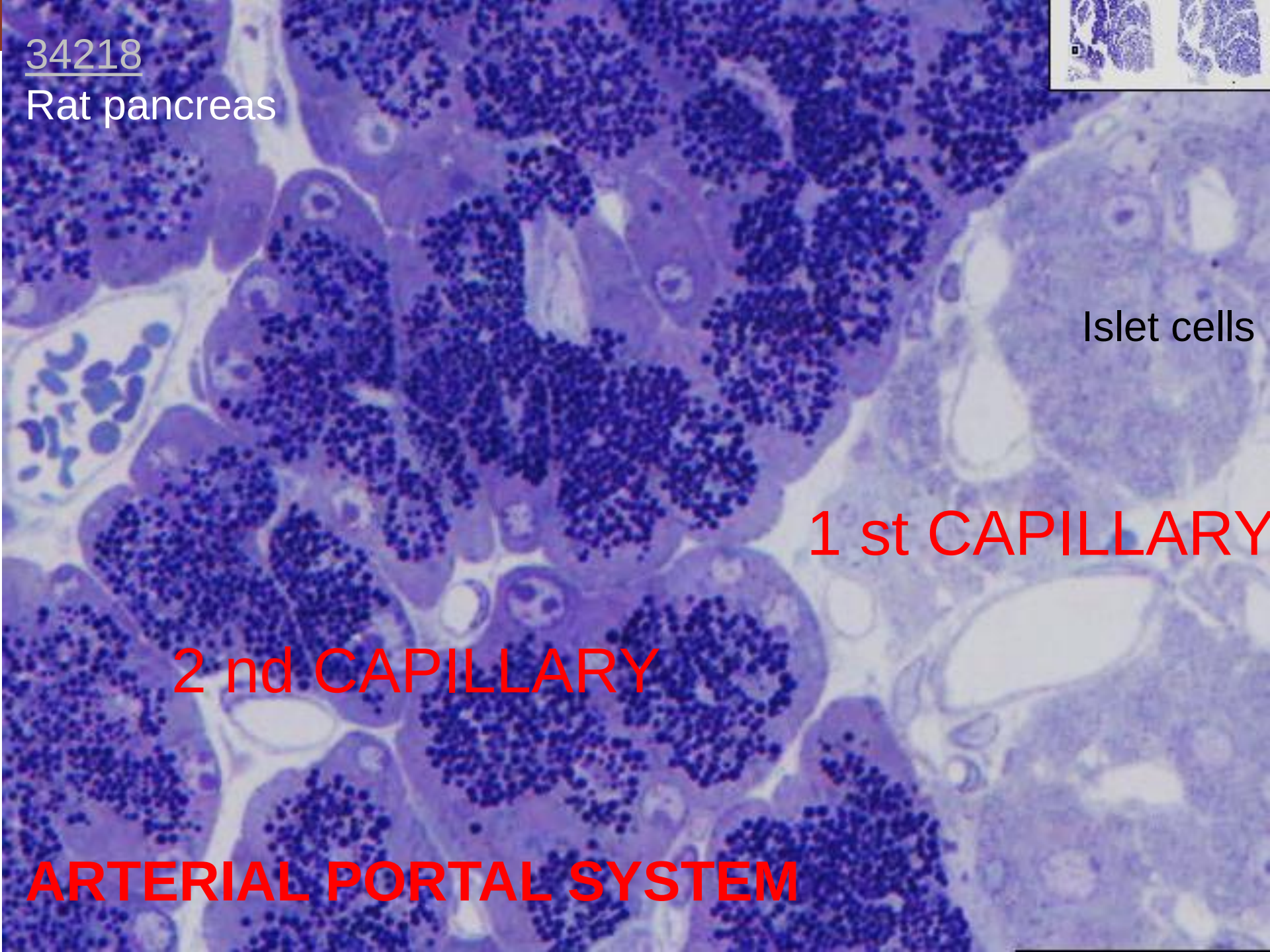
ISLETS Of

First capillary network of the **ARTERIAL PORTAL SYSTEM**

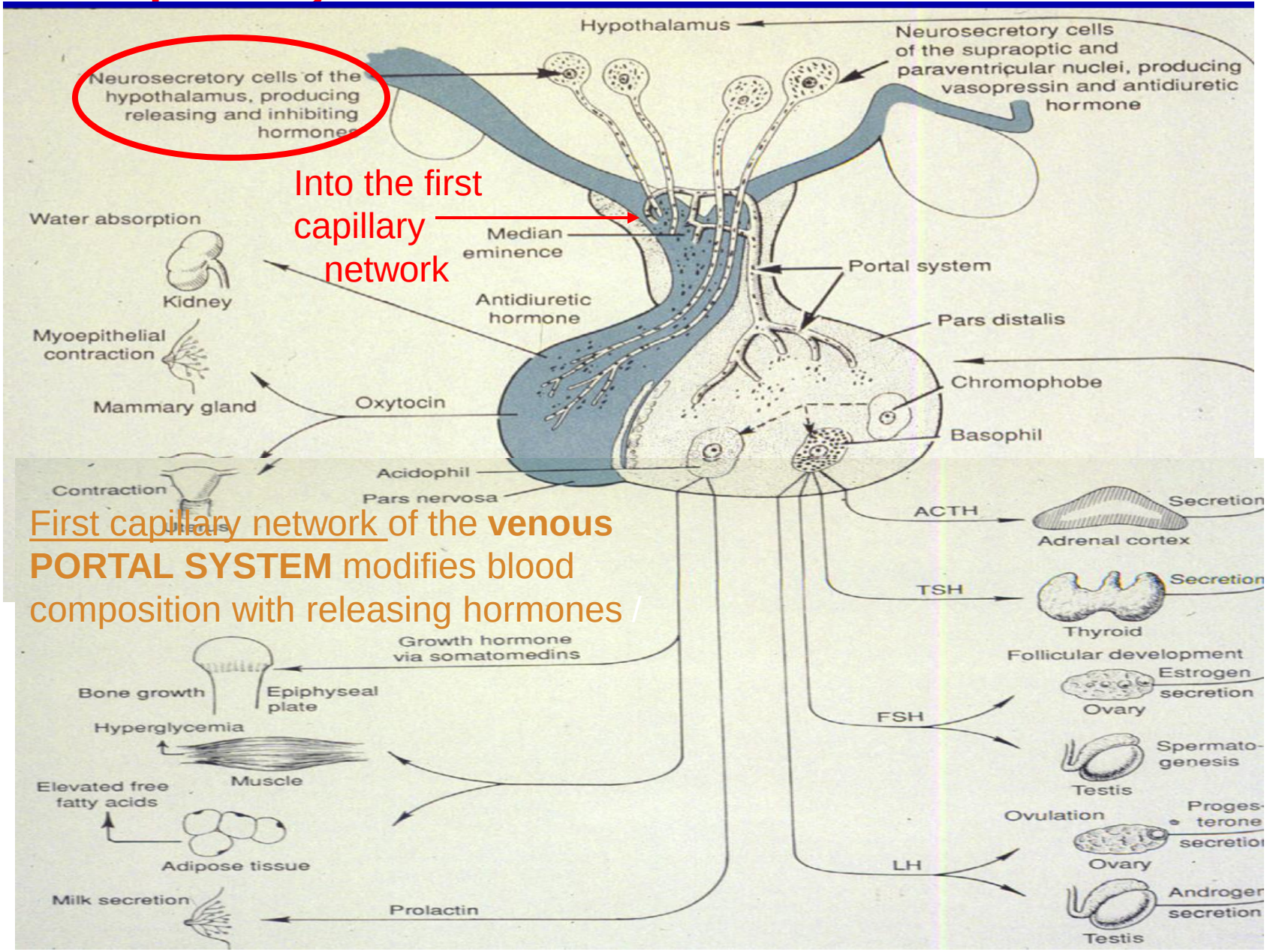


Second capillary network uses the modified blood composition with insulin (+) / glucagon (-) to regulate acinar cell protein enzyme production


34218
Rat pancreas
Islet cells
ARTERIAL PORTAL SYSTEM

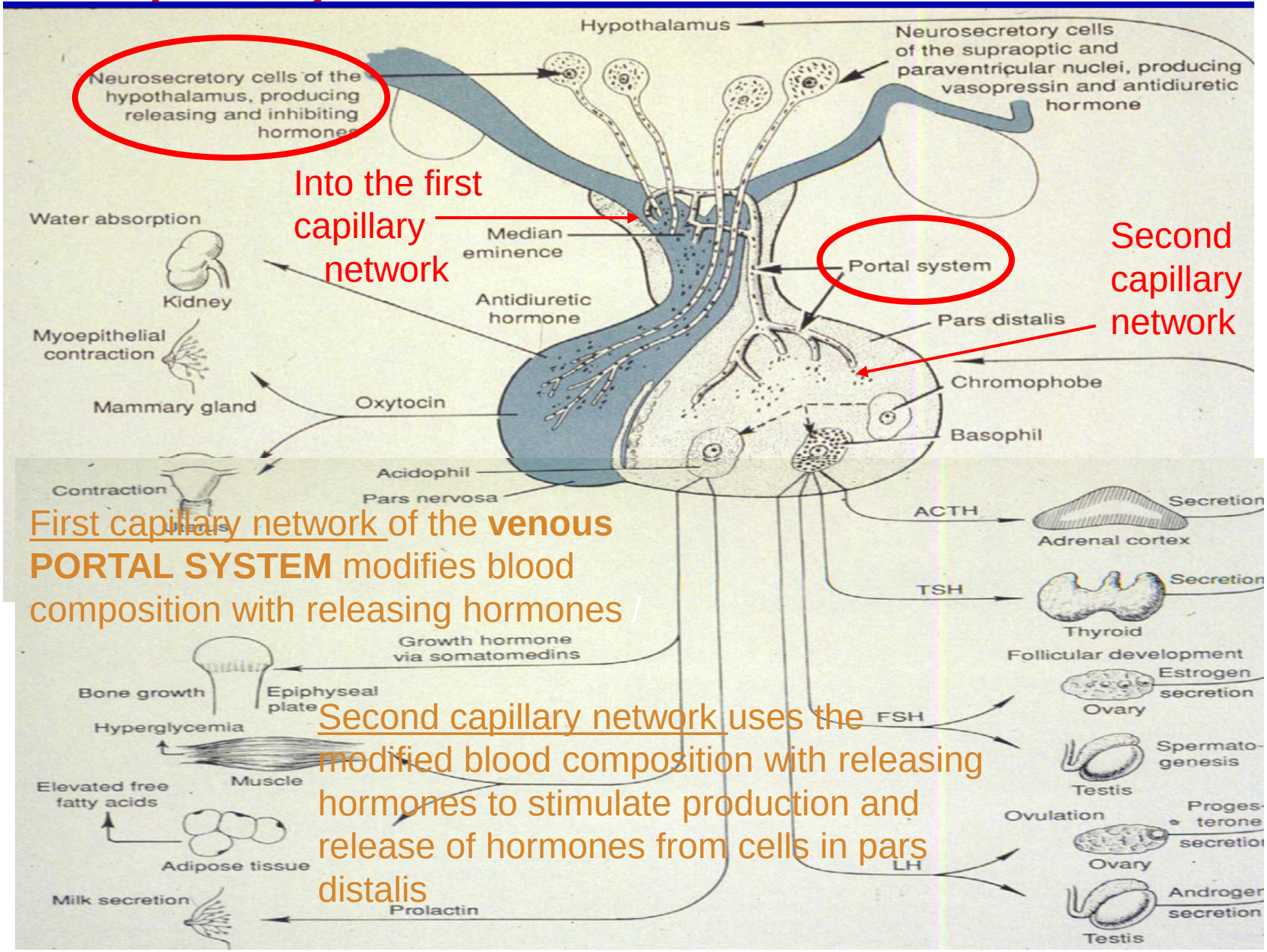

34218
Rat pancreas
Islet cells
1 st CAPILLARY
2 nd CAPILLARY
ARTERIAL PORTAL SYSTEM

venous portal system



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

venous portal system

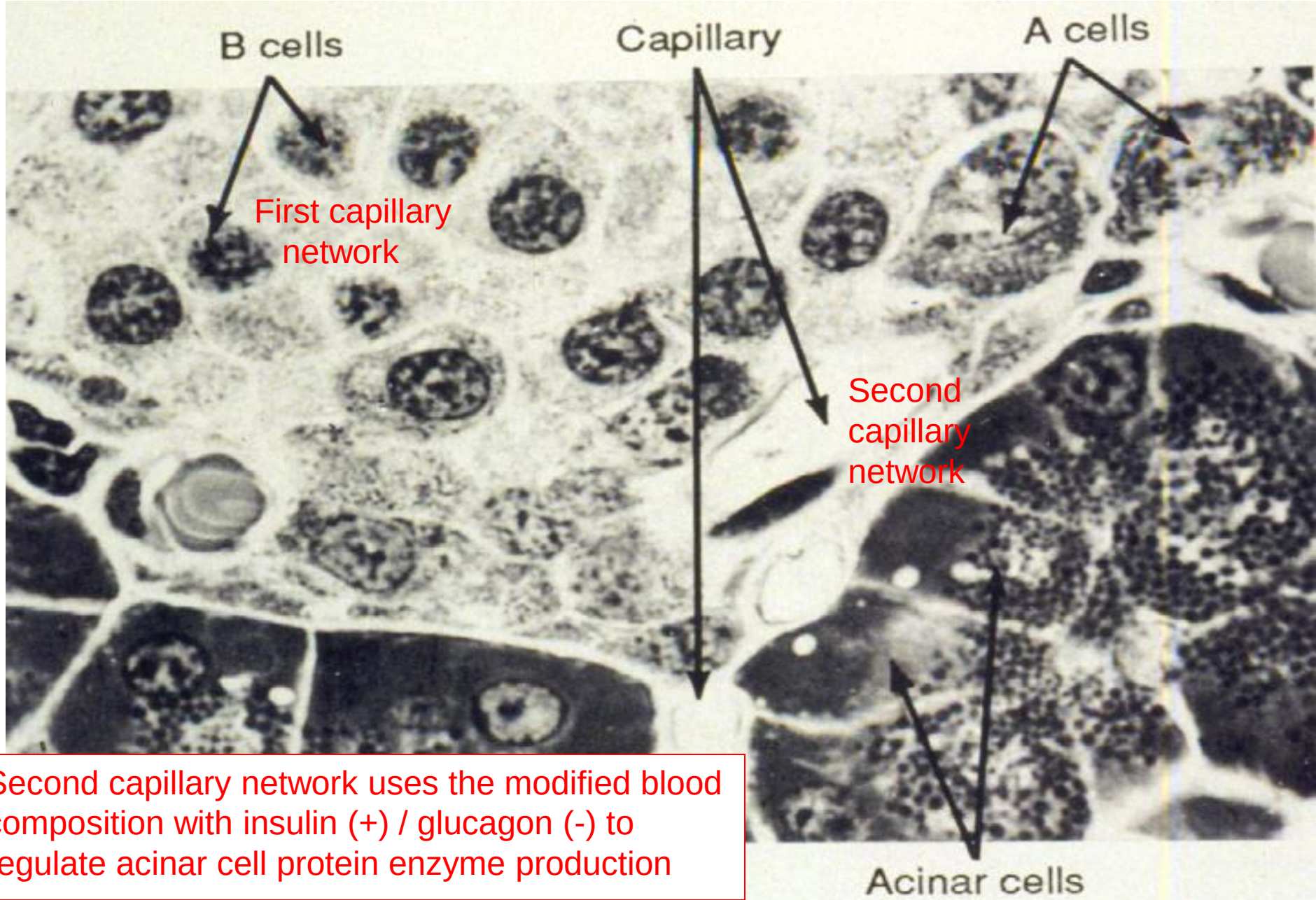


First capillary network of the **venous PORTAL SYSTEM** modifies blood composition with releasing hormones

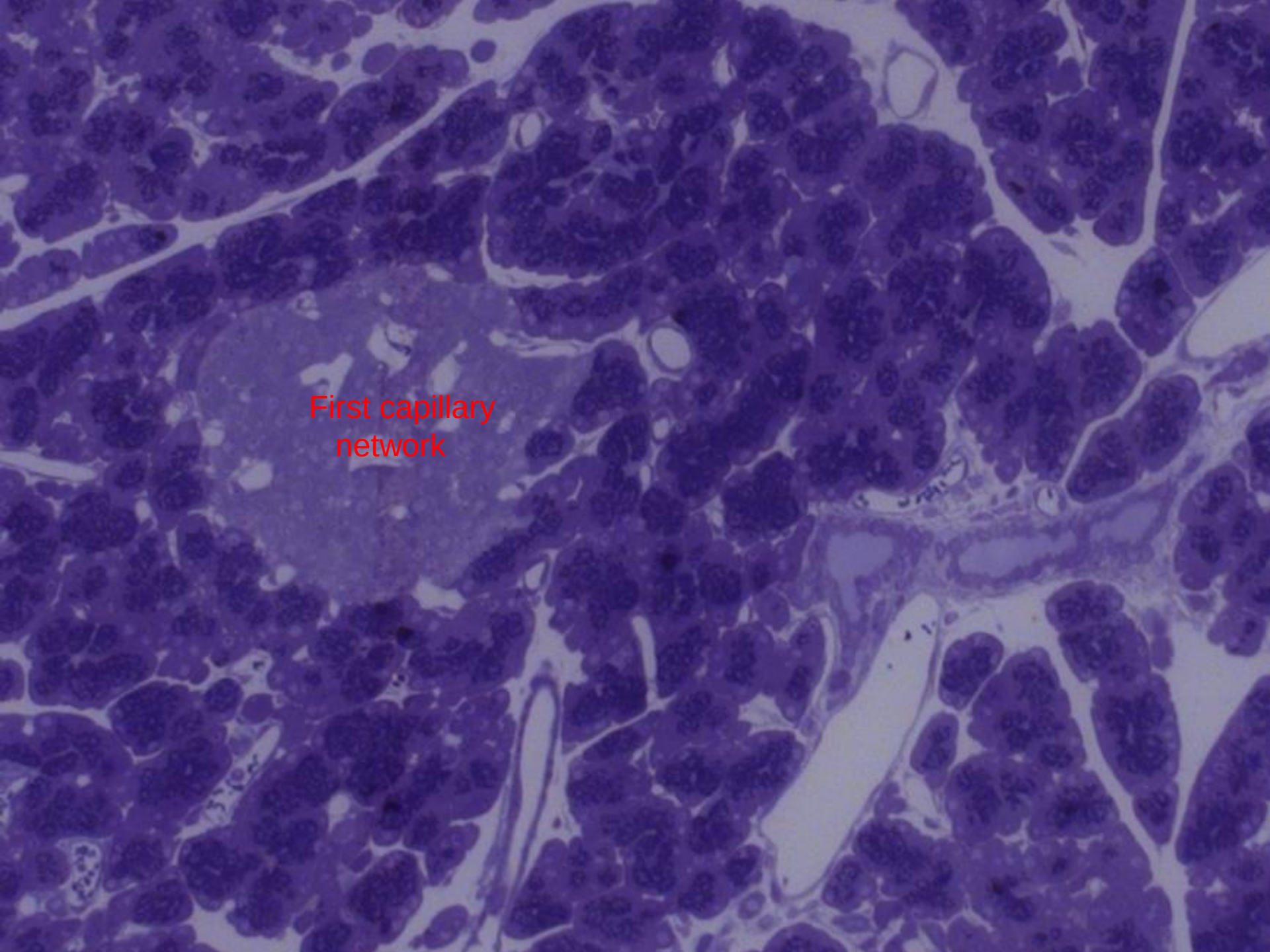
Second capillary network uses the modified blood composition with releasing hormones to stimulate production and release of hormones from cells in pars distalis

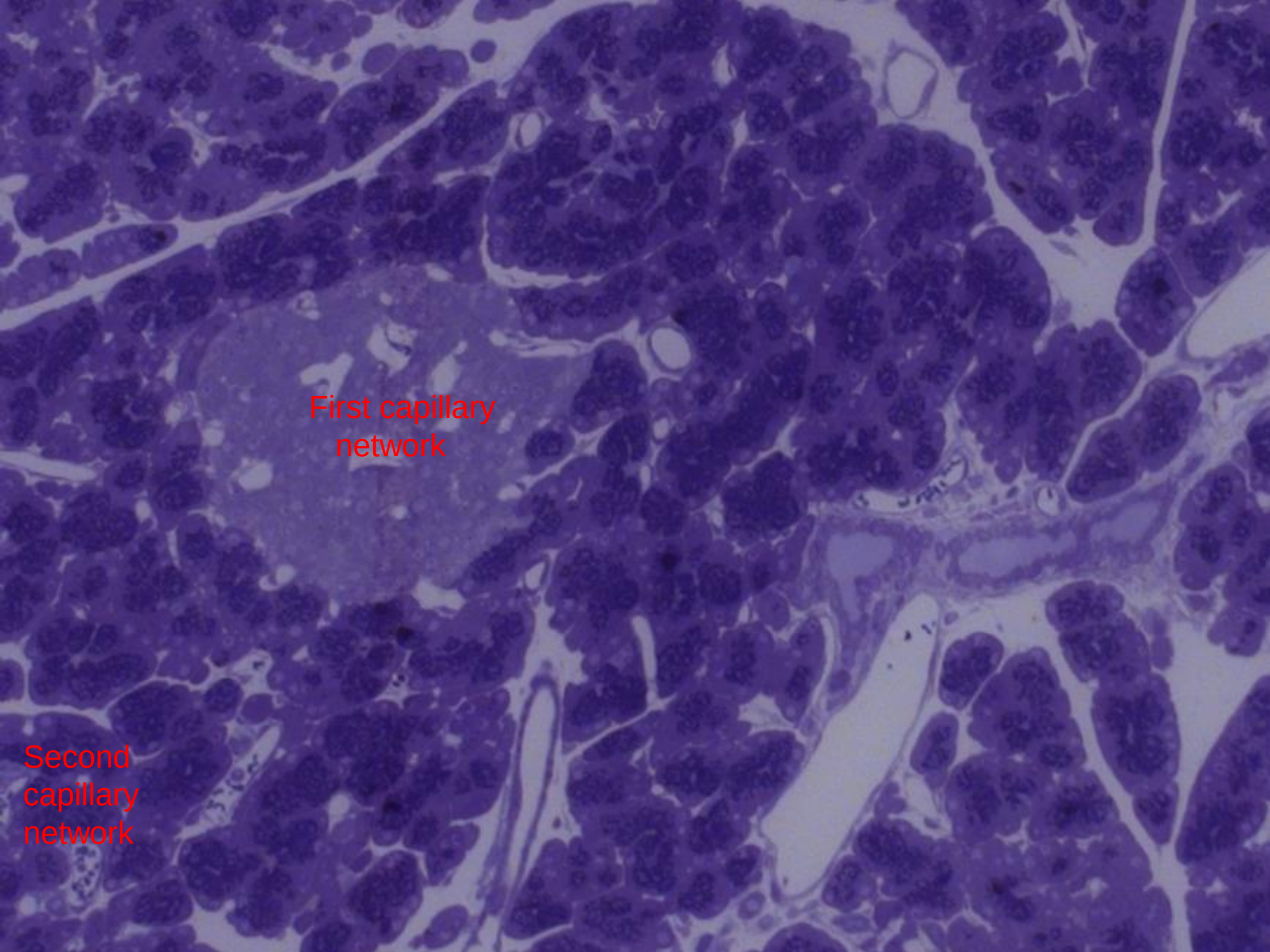
ISLETS Of LANGERHANS

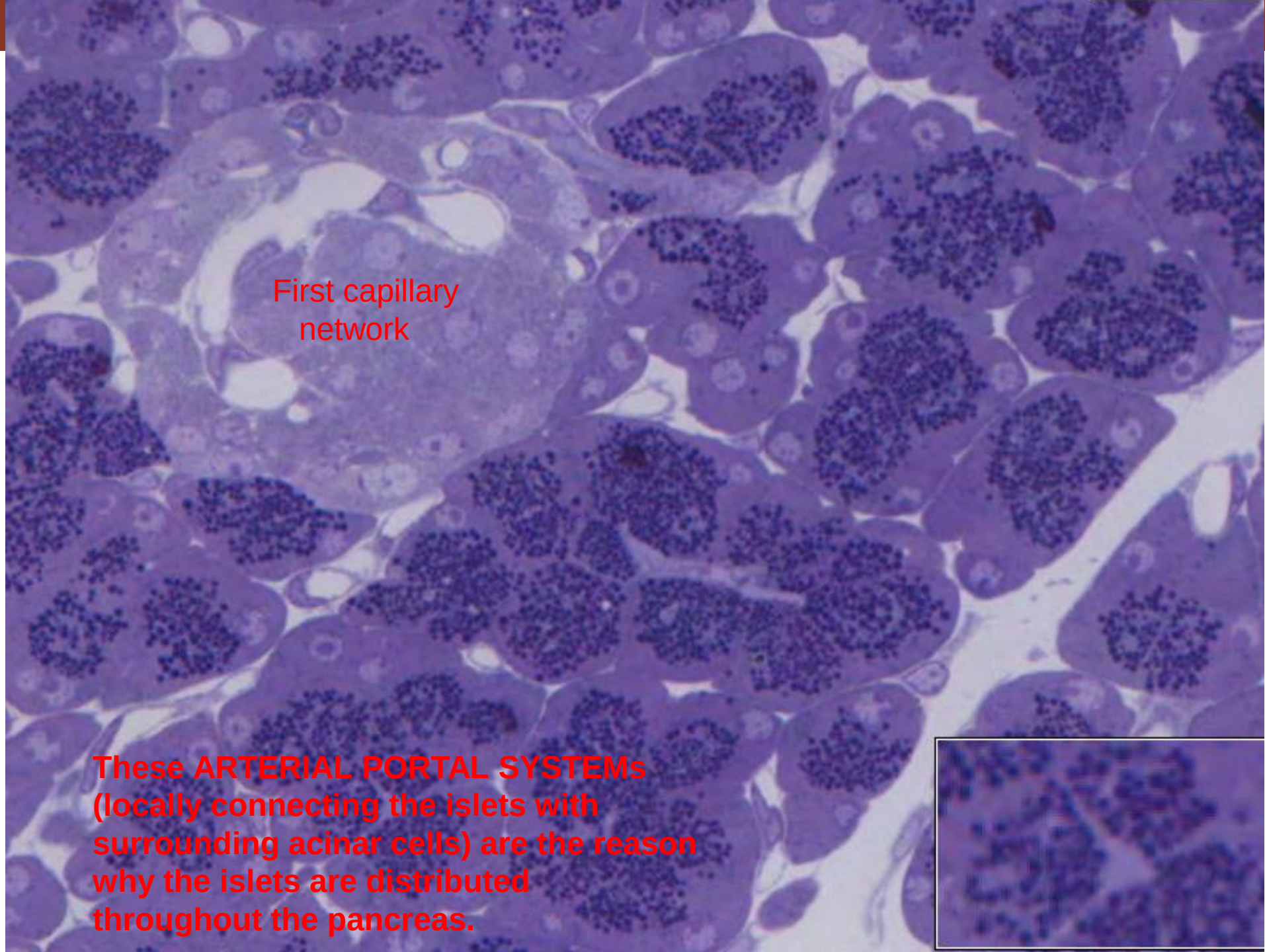
First capillary network of the **ARTERIAL PORTAL SYSTEM**

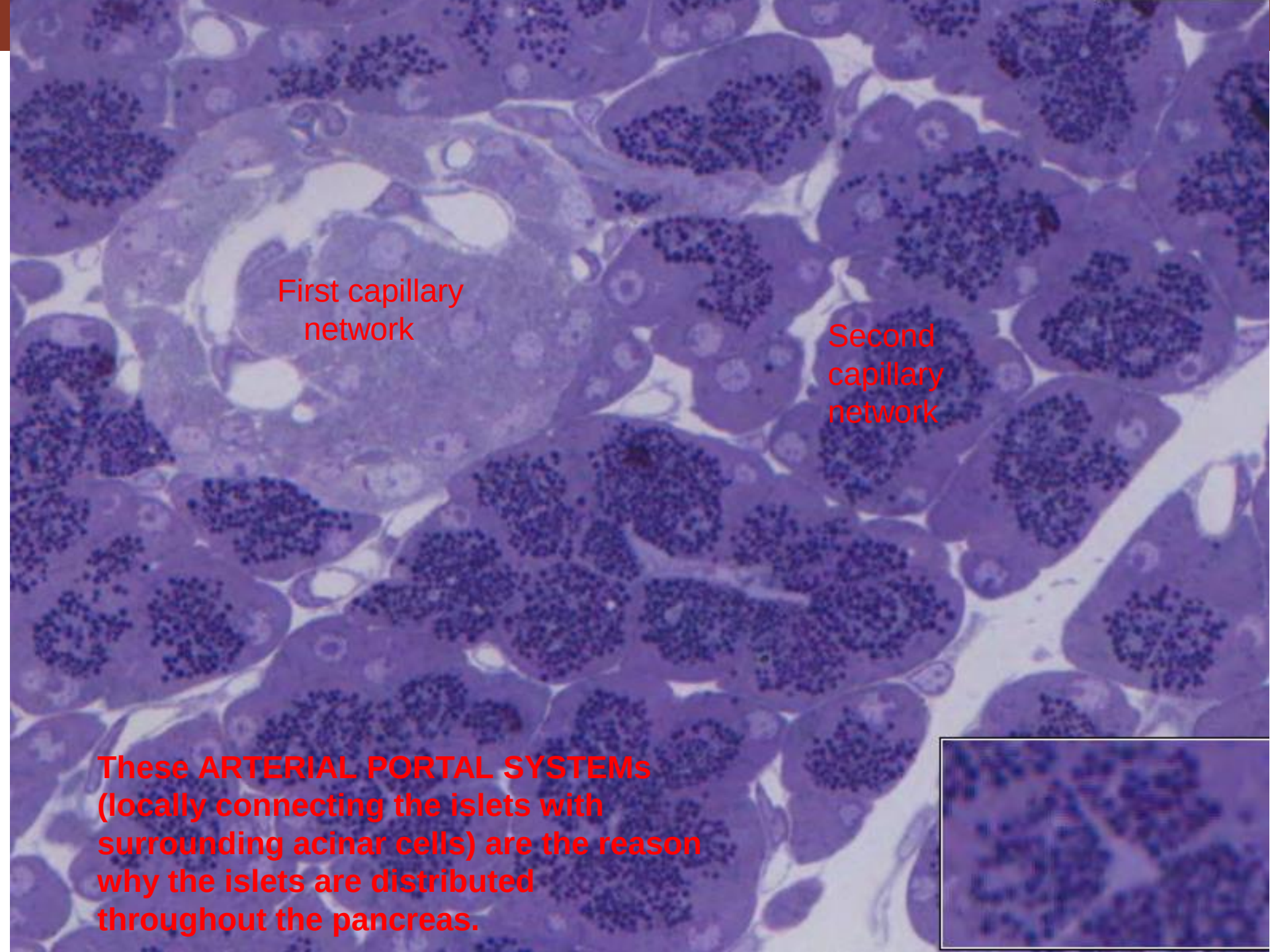


Second capillary network uses the modified blood composition with insulin (+) / glucagon (-) to regulate acinar cell protein enzyme production

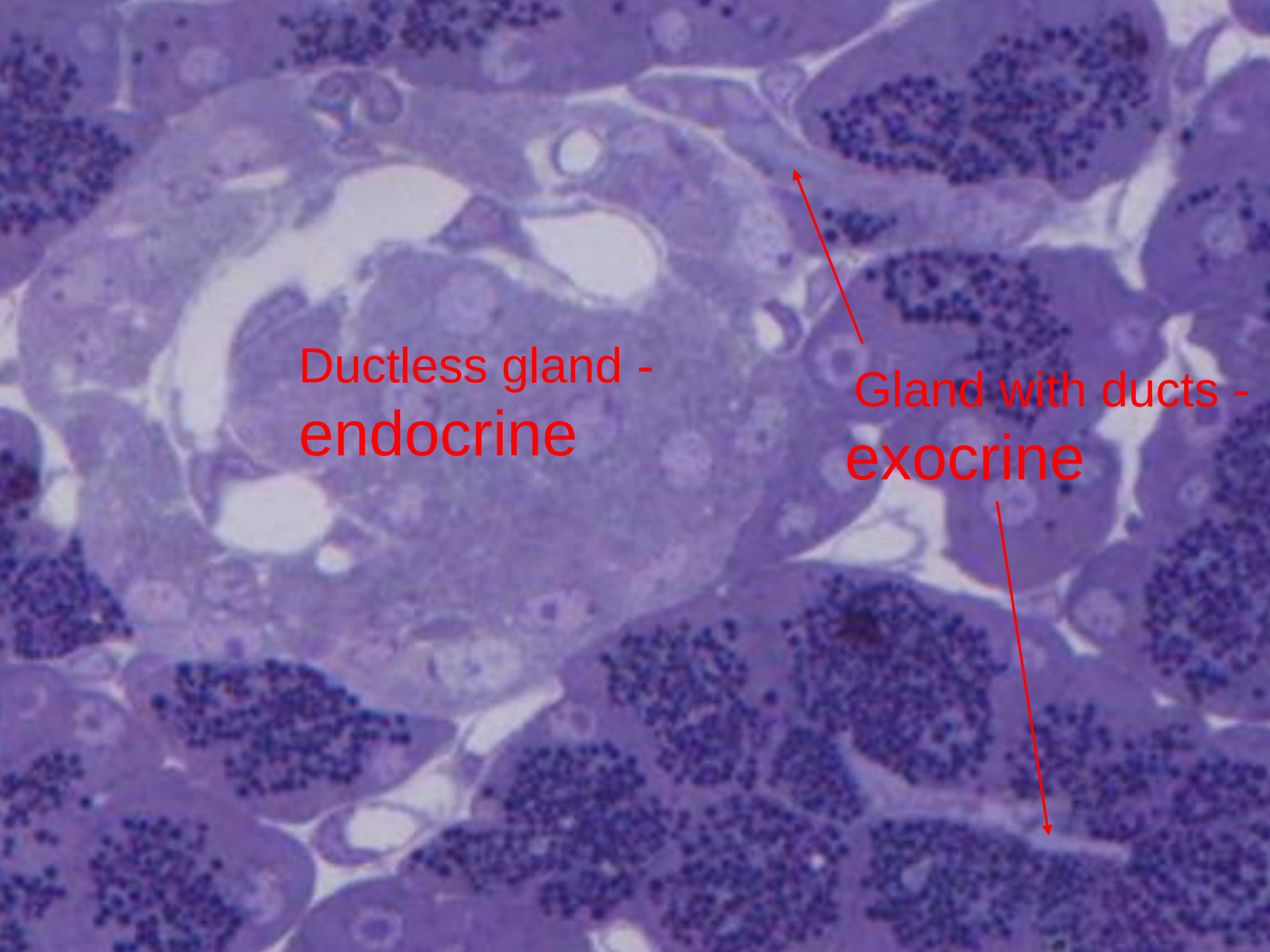

First capillary
network


First capillary network
Second capillary network

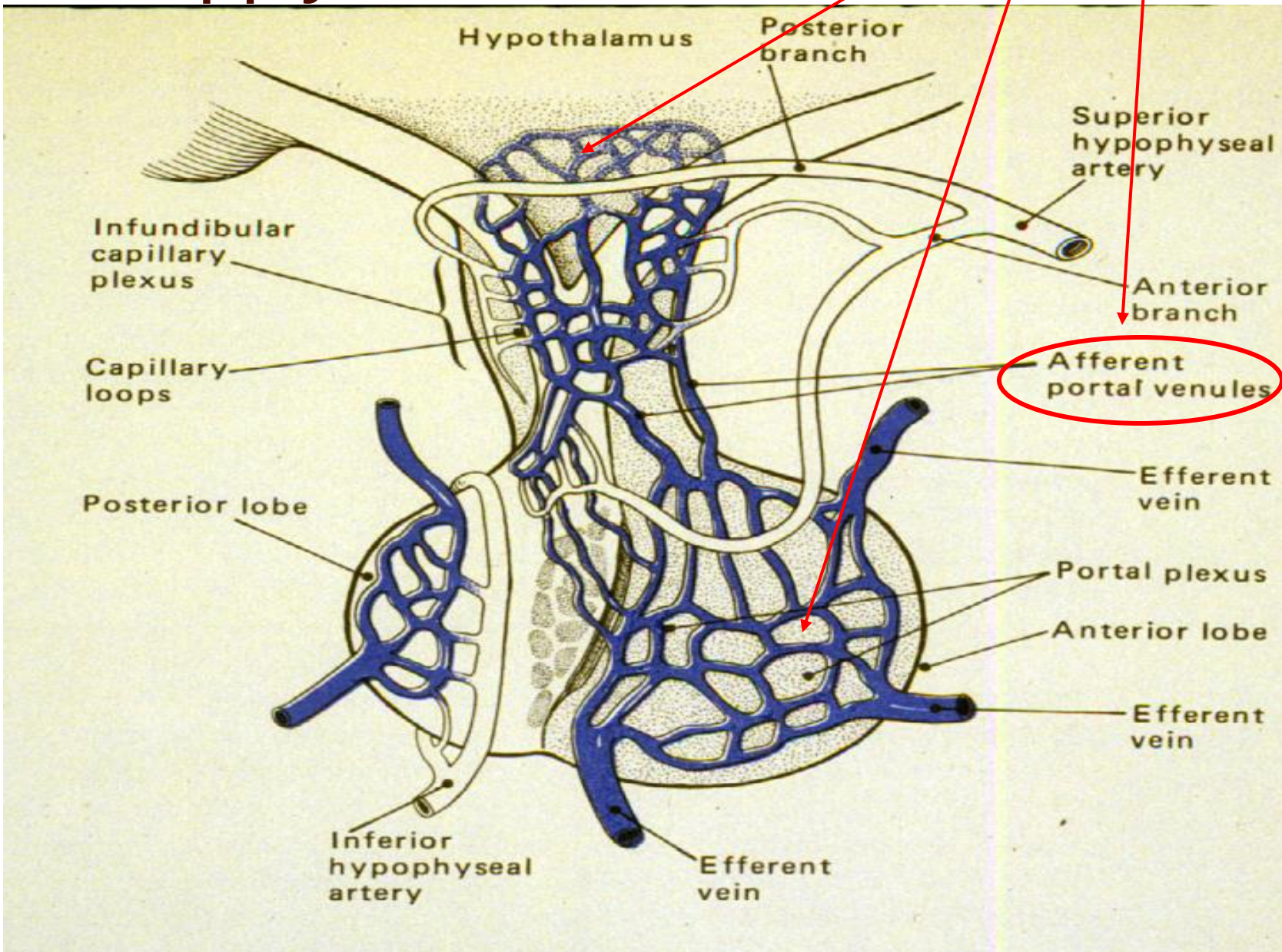

First capillary network
These ARTERIAL PORTAL SYSTEMs (locally connecting the islets with surrounding acinar cells) are the reason why the islets are distributed throughout the pancreas.



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

Blood supply



Answers to questions in lab manual

1. What hormones do acidophils and basophils produce and what is the action of these hormones?
   - Acidophils: secrete somatotrophin (GH, growth hormone [stimulates body growth]) and prolactin (PRL [stimulates synthesis of milk])
   - Basophils: secrete ACTH [stimulates adrenal cortex], FSH [in females: stimulates release of estrogens; in males: stimulates production of sperm], LH [in females: egg maturation and release; in males: stimulates testes to secrete testosterone], TSH [stimulates thyroid gland to secrete thyroxine] (& hCG only during pregnancy)=

2. Where are the cell bodies for the nerve fibers in the pars nervosa?
   - Hypothalamus

3. What is their (parafollicular cells, “C cells”) function?
   - Secrete calcitonin – reduced blood calcium levels

4. What is the effect of thyroid hormones on carbohydrate metabolism? Where are high affinity thyroid hormone receptors located in a cell?
   - Thyroid hormones increase the number and size of mitochondria and stimulate mitochondrial protein synthesis, helping to enhance metabolic activity

5. Is this layer (zona glomerulosa) regulated by pituitary adrenocorticotrophin hormone (ACTH)?
   - Yes

Answers to questions in lab manual

6. Why would these cells have abundant lipid droplets? What organelle would you expect to also be abundant?

- Cholesterol precursors for steroid hormones stored in lipid droplets; SER

7. Is vascularization rich or sparse in this zone?

- Rich vascularization by wide capillaries.

8. Describe the arterial and venous blood flow to the adrenal gland.

- Peripheral arteries > cortical arteries > capillaries & sinusoids irrigating cortex > join medullary capillaries and arterioles > medullary fenestrated sinusoids with dual blood supply (arterial medullary blood and venous cortex blood) > medullary veins > suprarenal vein.

9. Is melatonin release highest in the light or dark period?

- Dark period

10. Where in the islets are alpha cells and beta cells located?

- Alpha cells are generally on the border of islets of Langerhans and beta cells are located throughout the islets.

Answers to questions in lab manual

11. What is the effect of glucagon on glycogen breakdown and storage of triglycerides in the liver?

- Glucagon increases the blood glucose levels by stimulating glycogen breakdown and gluconeogenesis in the liver.

12. Describe the symptoms associated with Grave's disease.

- Weight loss, nervousness, sweating, heat intolerance, and other features.

13. What is the most common cause of Cushing syndrome?

- The most common cause of Cushing syndrome is exogenous administration of glucocorticoids prescribed by a health care practitioner to treat other diseases.

ENDOCRINE SYSTEM **Part 1**

Dr. Larry Johnson