

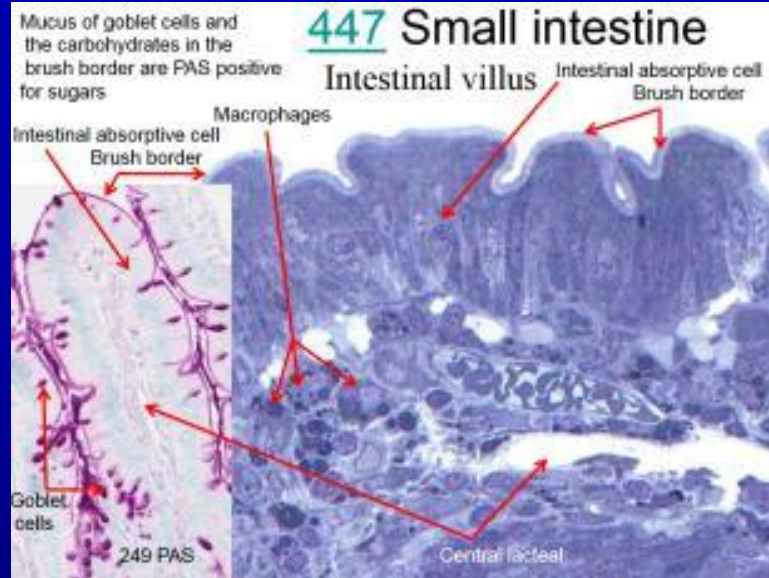
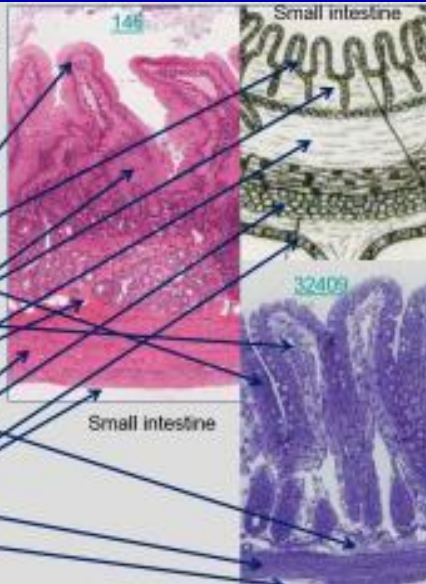
Digestive System

Undergraduate – Graduate
Histology Lecture Series

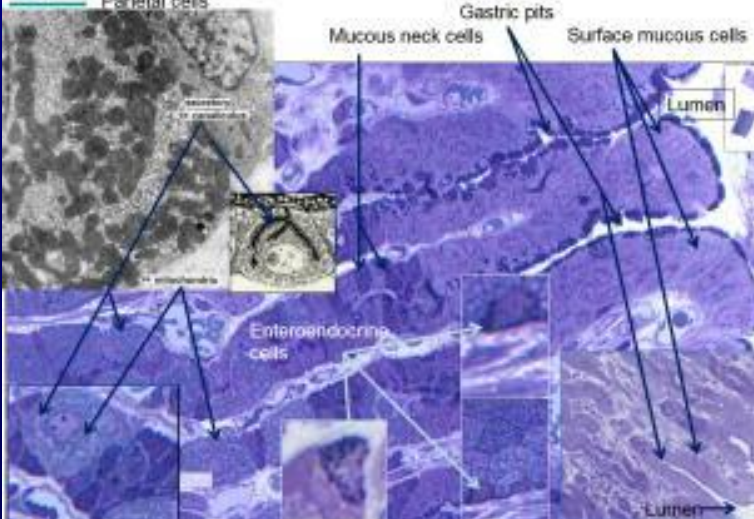
Larry Johnson, Professor
Veterinary Integrative Biosciences
Texas A&M University
College Station, TX 77843

General Structure of the Digestive Tract

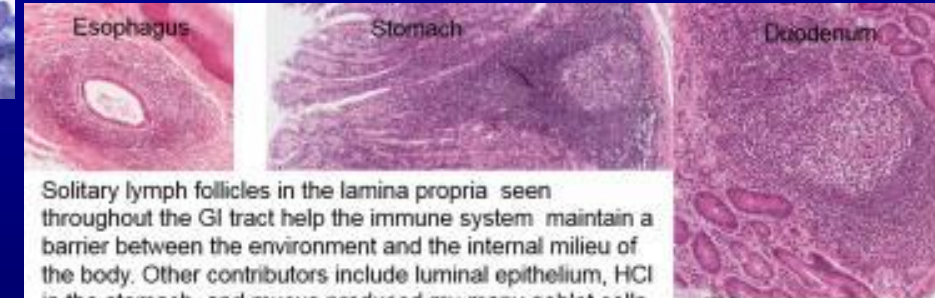
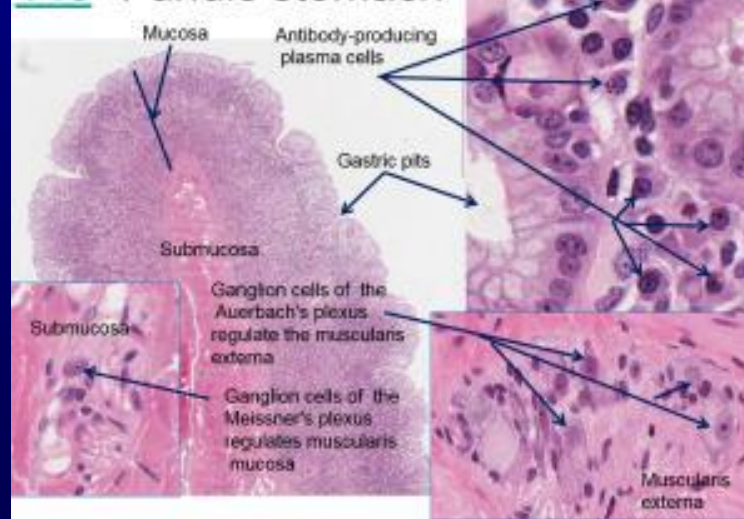
- Epithelium
- Lamina propria
- Submucosa
- Muscularis externa
- Serosa



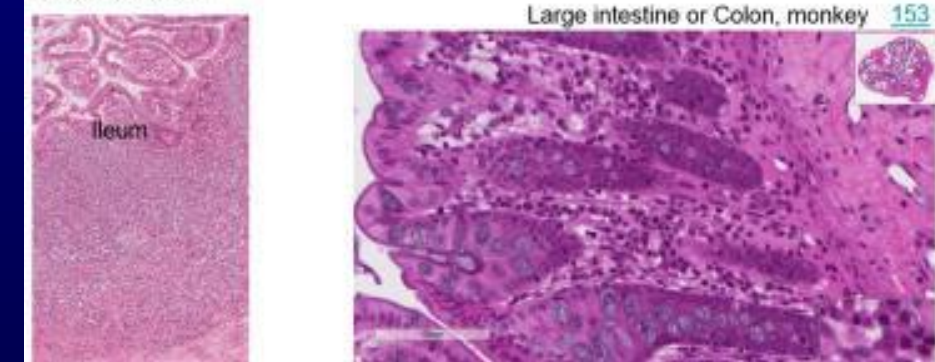
244 Fundic stomach, rabbit (toluidine blue)



145 Fundic stomach



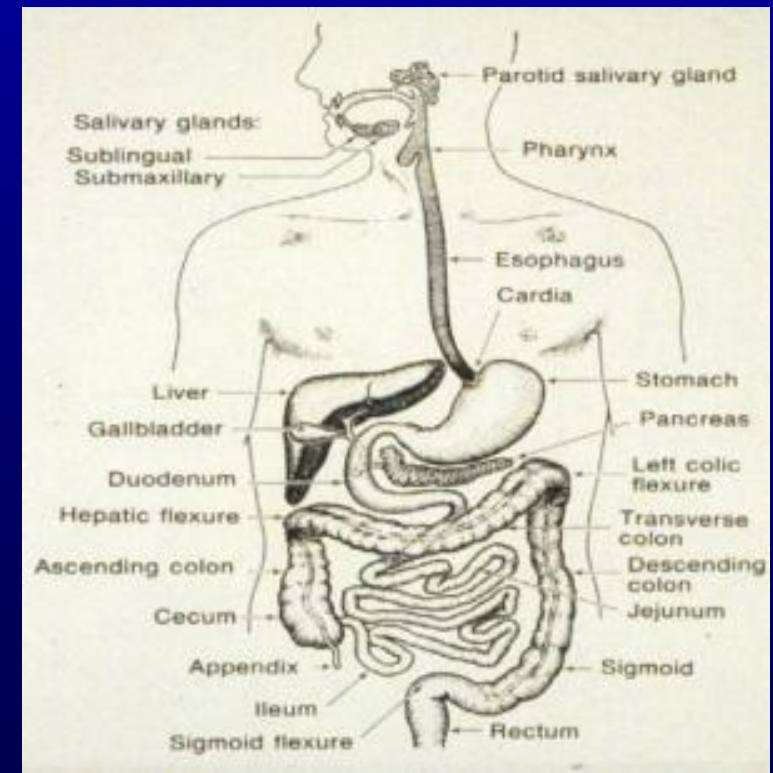
Solitary lymph follicles in the lamina propria seen throughout the GI tract help the immune system maintain a barrier between the environment and the internal milieu of the body. Other contributors include luminal epithelium, HCl in the stomach, and mucus produced by many goblet cells in the intestines.

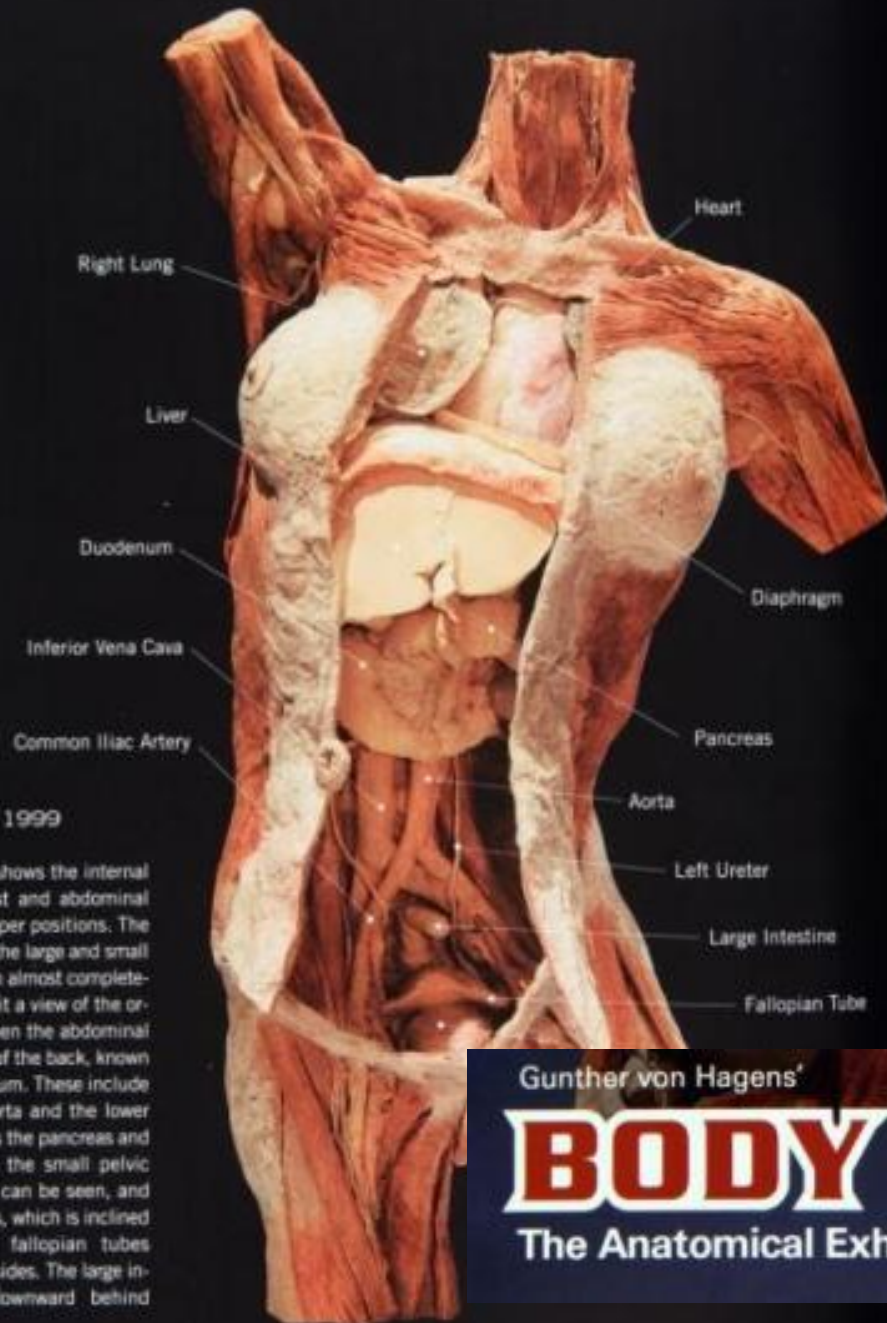


Objectives

To understand the general **organization** of organs of the digestive system and how they function to **obtain metabolites** necessary for **growth** and **energy** for the body, yet maintain a **barrier** between the environment and the internal milieu of the body

To identify and describe functions of **cellular structures, cells,** and groups of cells in the digestive system.

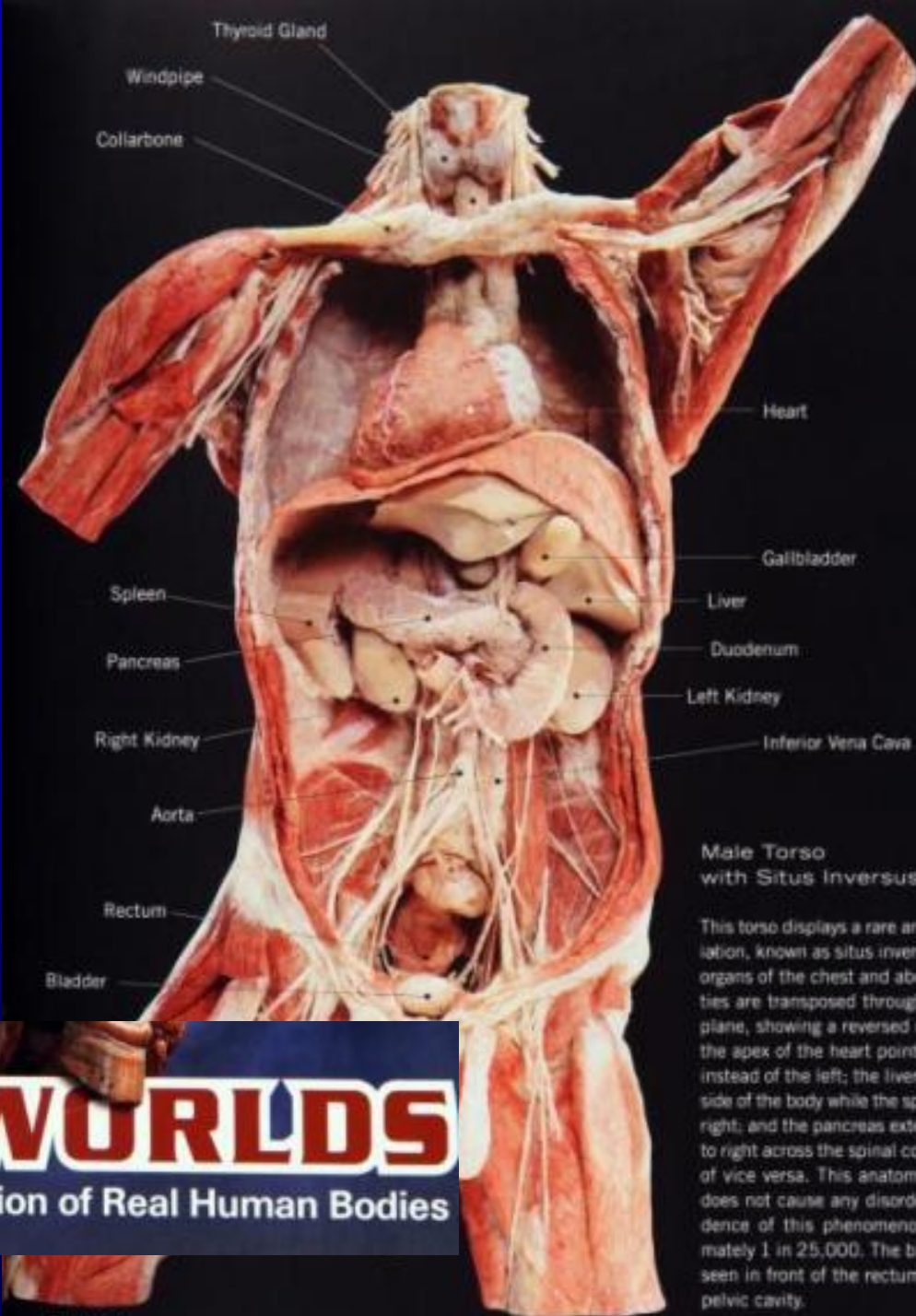




Female Torso, 1999

This opened torso shows the internal organs of the chest and abdominal cavities in their proper positions. The stomach as well as the large and small intestines have been almost completely removed to permit a view of the organs located between the abdominal cavity and the wall of the back, known as the retroperitoneum. These include the ureters, the aorta and the lower vena cava as well as the pancreas and the duodenum. In the small pelvic cavity, the bladder can be seen, and behind it, the uterus, which is inclined forward with the fallopian tubes emerging from the sides. The large intestine extends downward behind the uterus.

Abb. 9.43



Male Torso with Situs Inversus, 1999

This torso displays a rare anatomical variation, known as situs inversus. Here the organs of the chest and abdominal cavities are transposed through the sagittal plane, showing a reversed mirror-image: the apex of the heart points to the right instead of the left; the liver is on the left side of the body while the spleen is on the right; and the pancreas extends from left to right across the spinal column instead of vice versa. This anatomical variation does not cause any disorders. The incidence of this phenomenon is approximately 1 in 25,000. The bladder can be seen in front of the rectum in the small pelvic cavity.

Fig. 9.44

Gunther von Hagens' **BODY WORLDS**
The Anatomical Exhibition of Real Human Bodies

Three Key Steps of Combating Infections



Break the cycle of transmission



Kill the infectious agent



Increase host resistance

e.g., increase immunity
of host

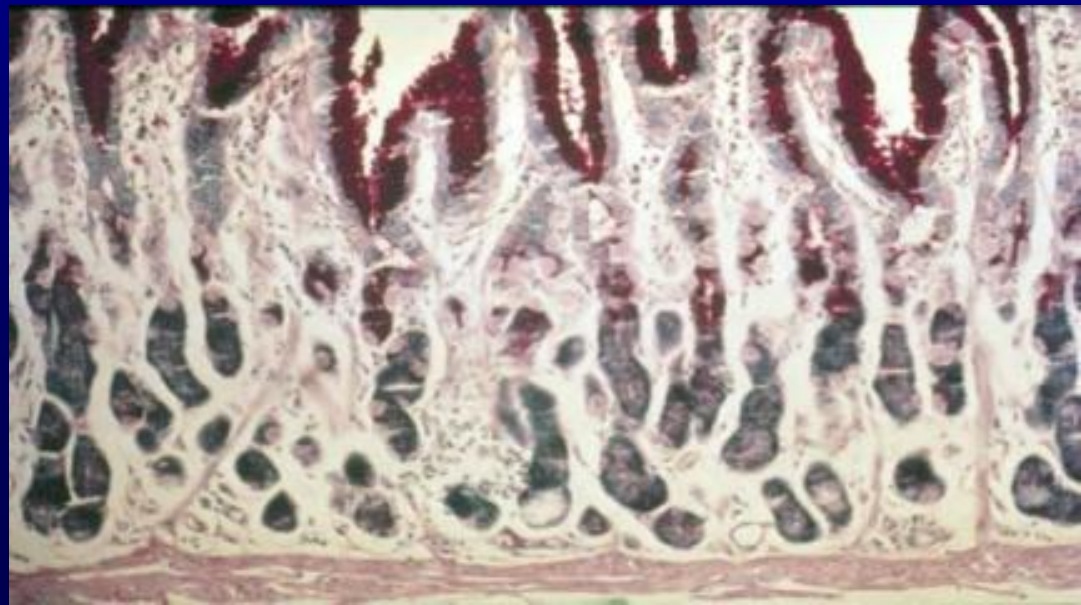
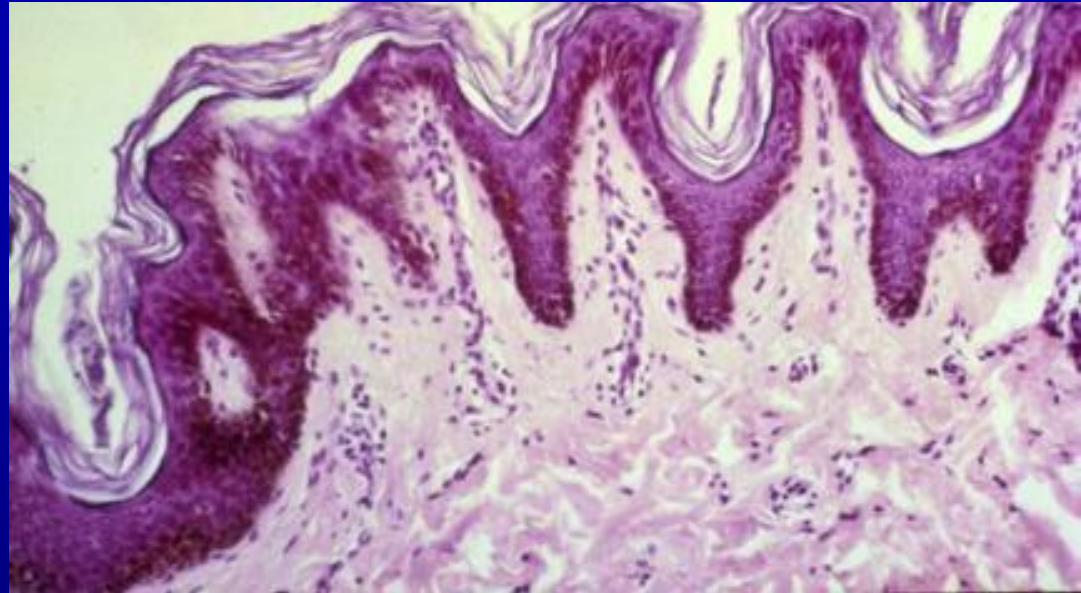


Lines of Defense

First Line: Physical Barrier

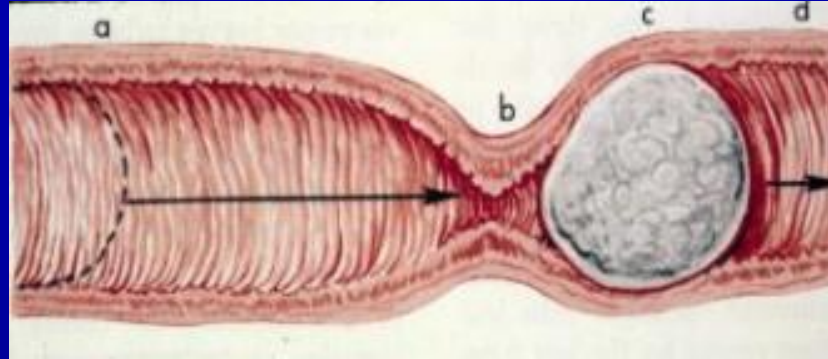
- Skin: Stratum Cornium
- **HCl in Stomach**
- **Mucus in Intestines**

Break the cycle
of transmission

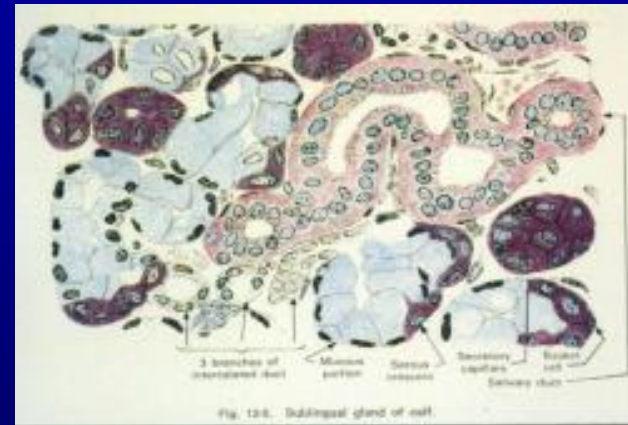


Three Basic Functions of the G.I. Tract

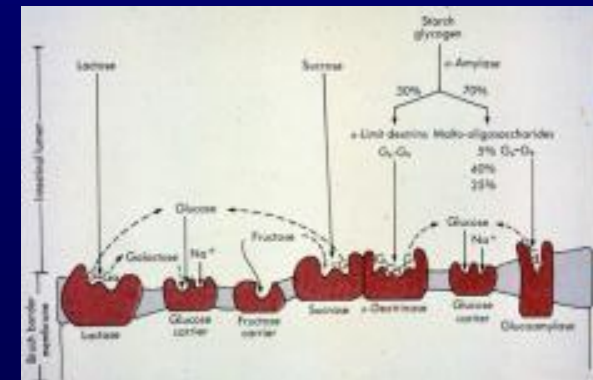
Movement of food



Secretion of digestive juices



Absorption of digested foods, water, and electrolytes



Adaptation of G.I. Tract for Specific Function

Function

Organ

Simple passage from one part to another

Esophagus

Storage of food or feces

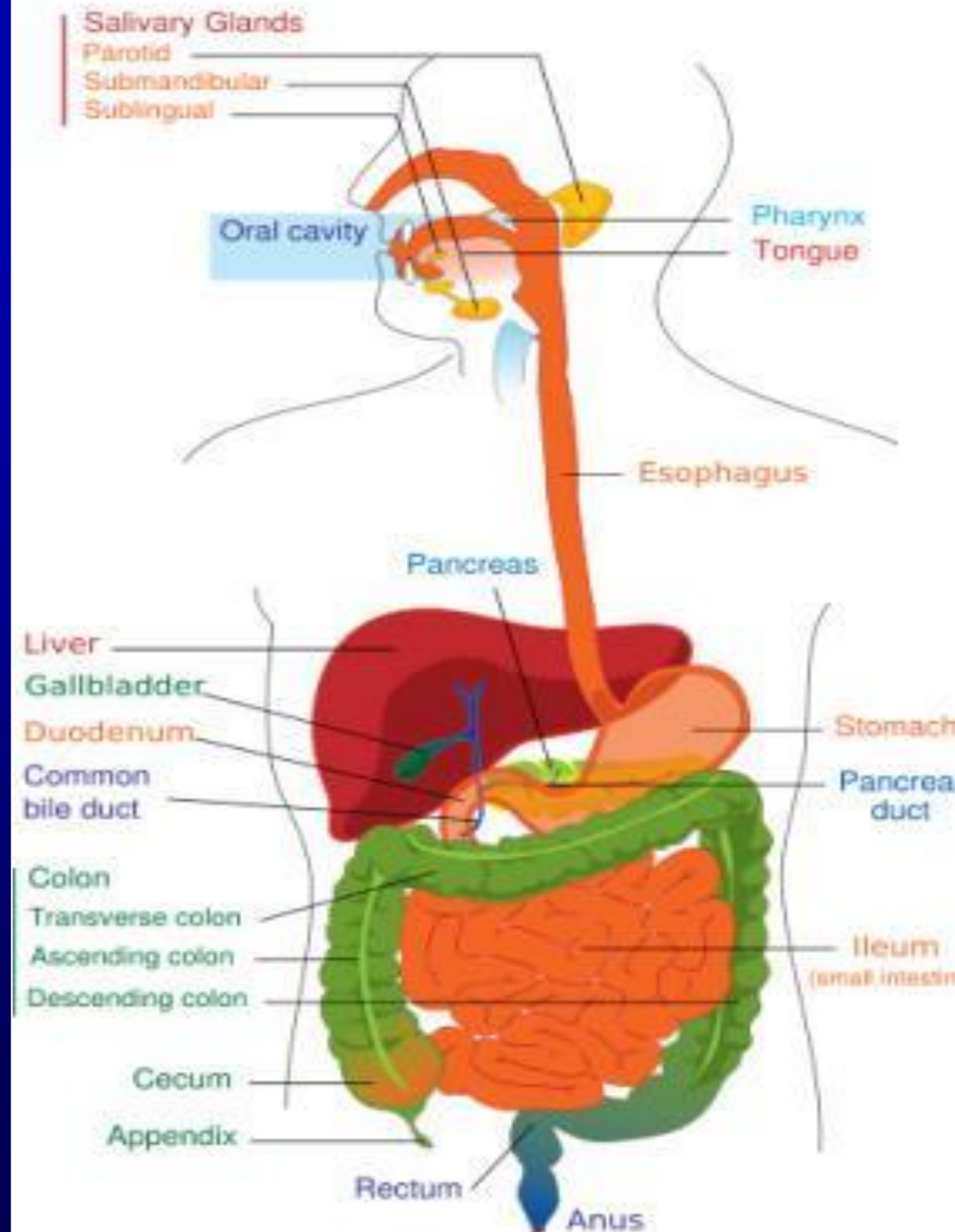
Stomach or distal colon

Digestion

Stomach, small intestine

Absorption of end products

Small intestine, proximal colon



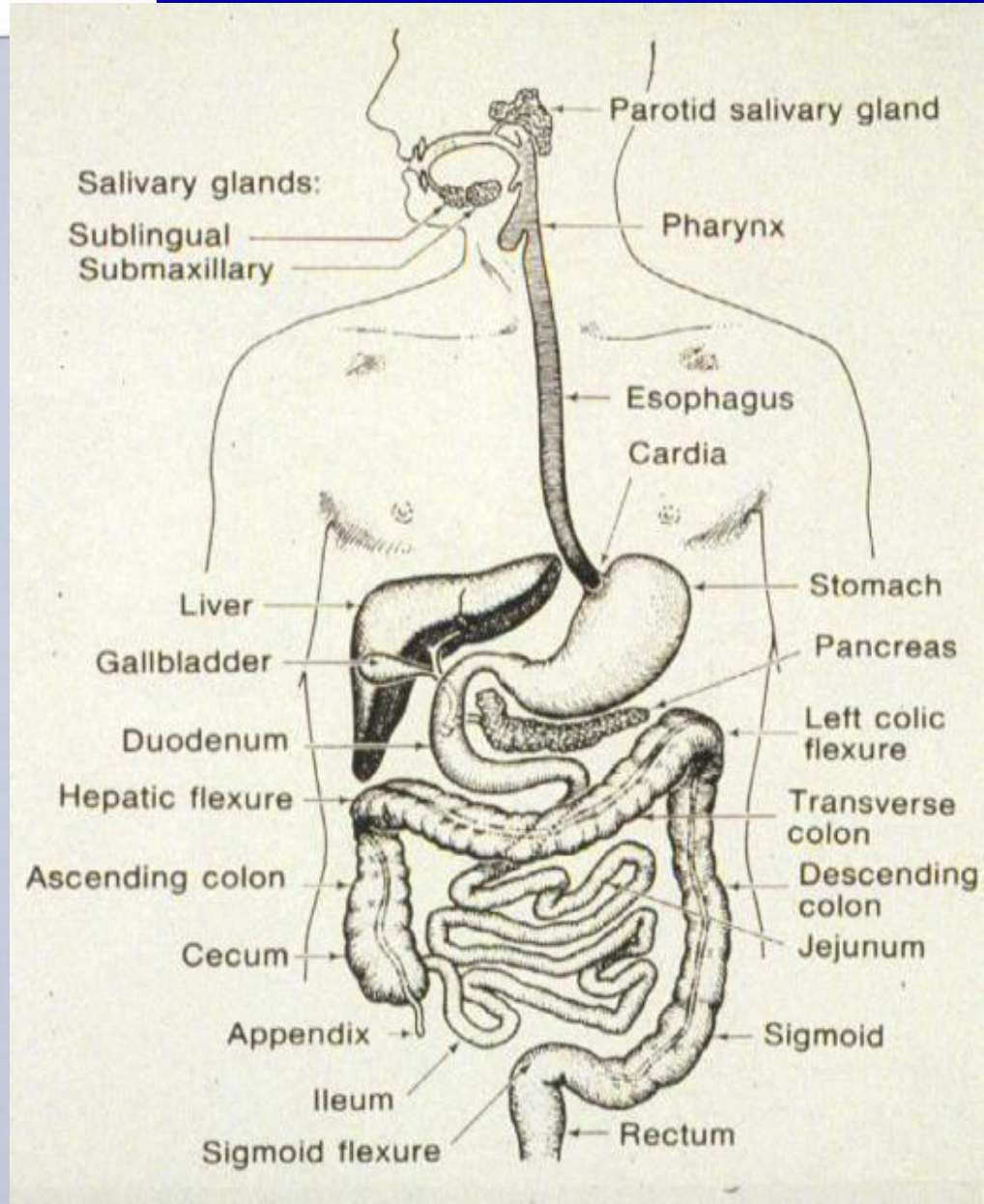
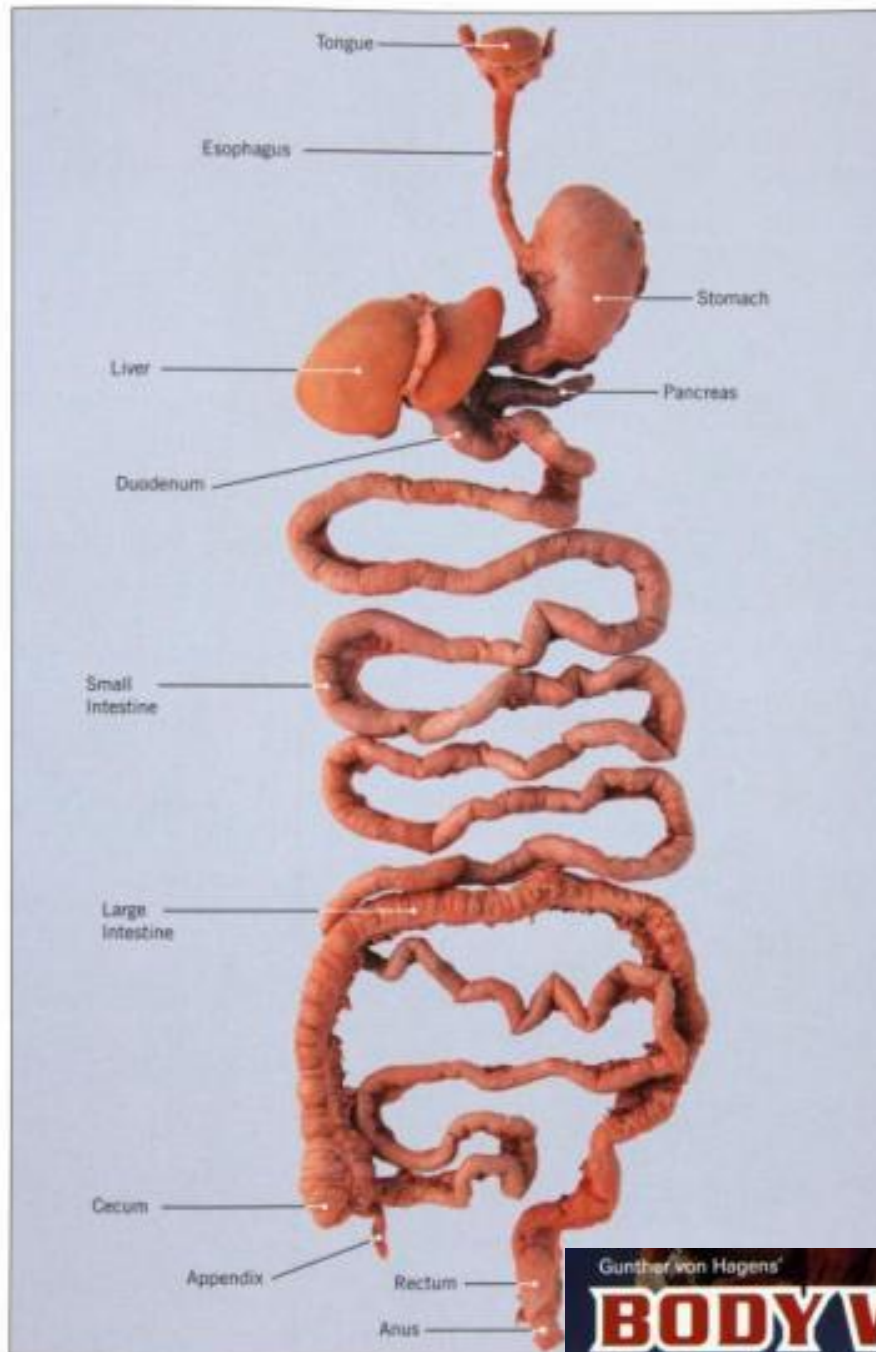


Fig. 5.1: The organs of the digestive system.

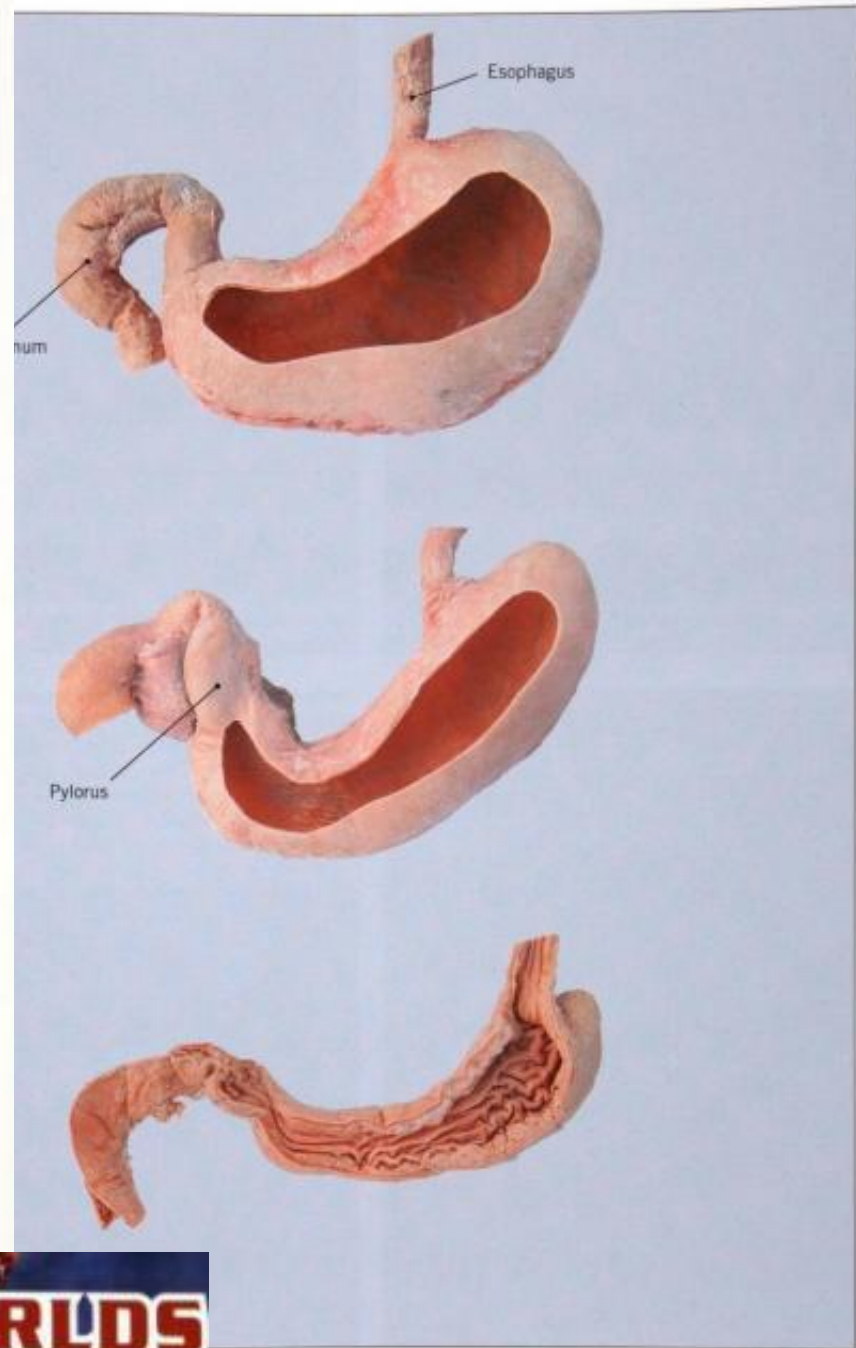
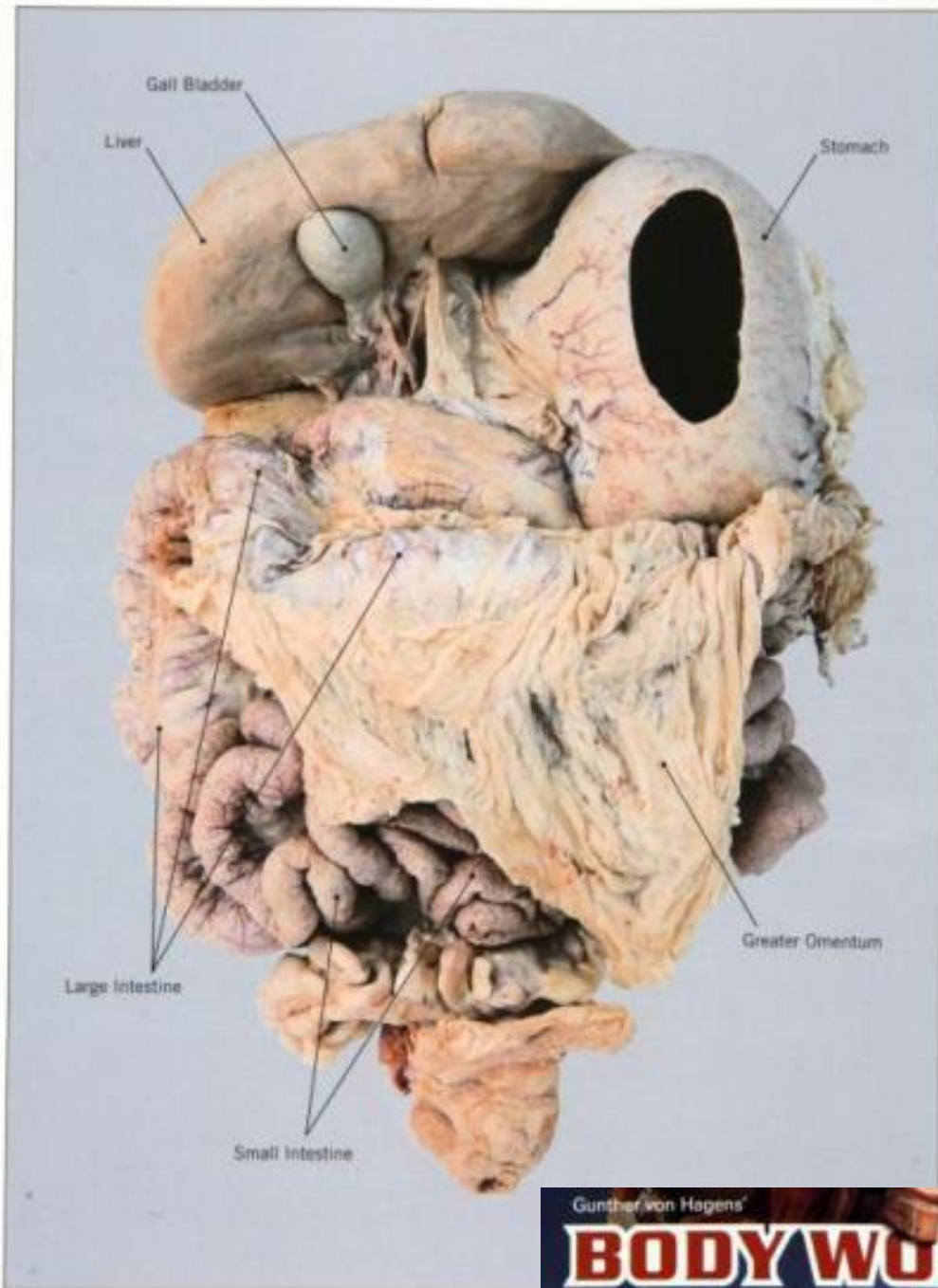
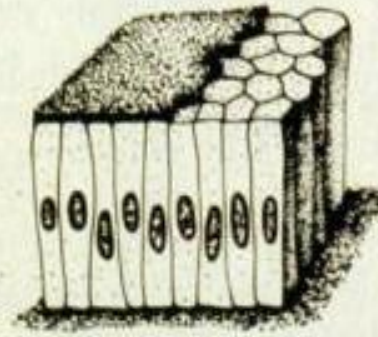
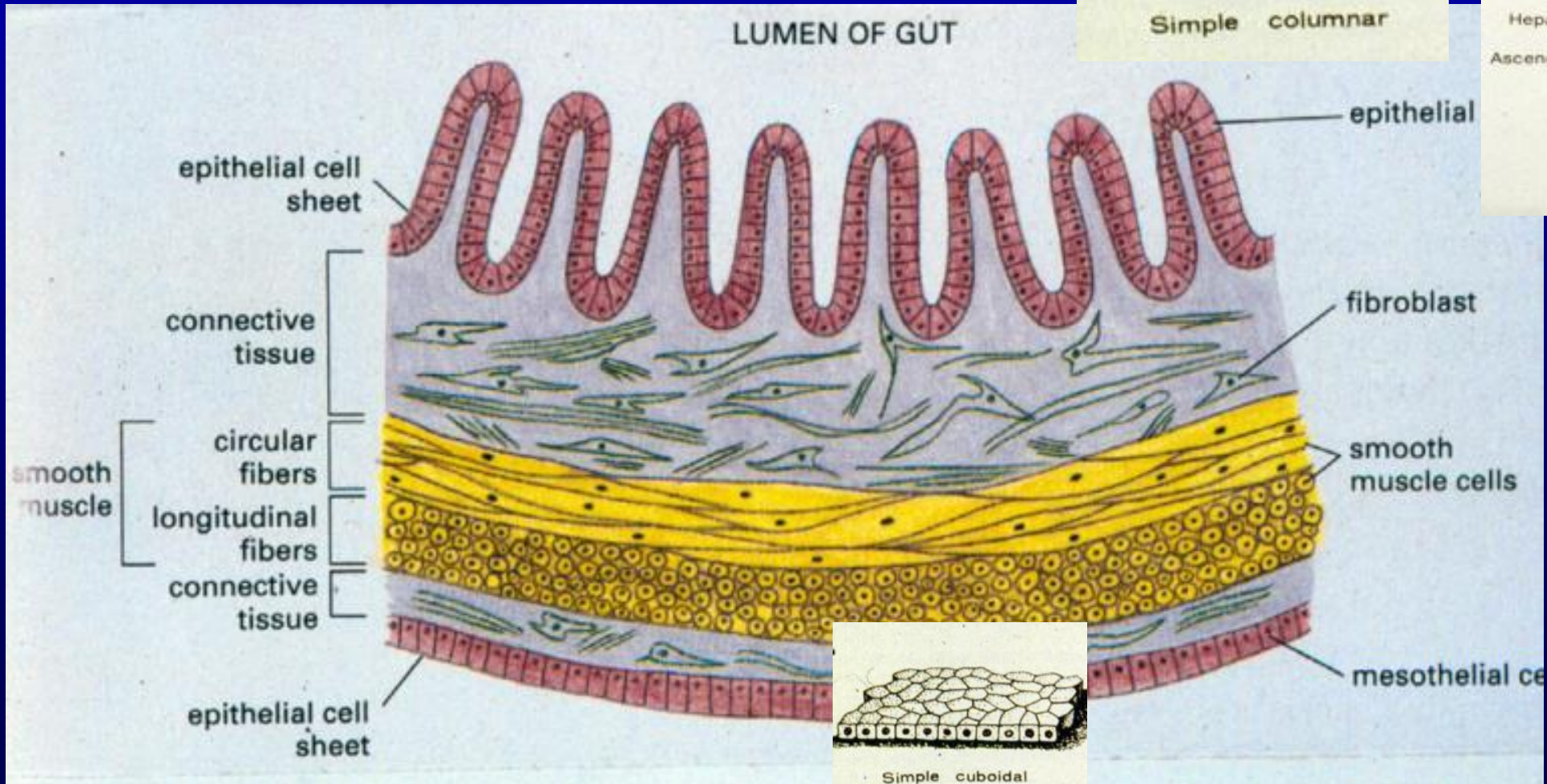
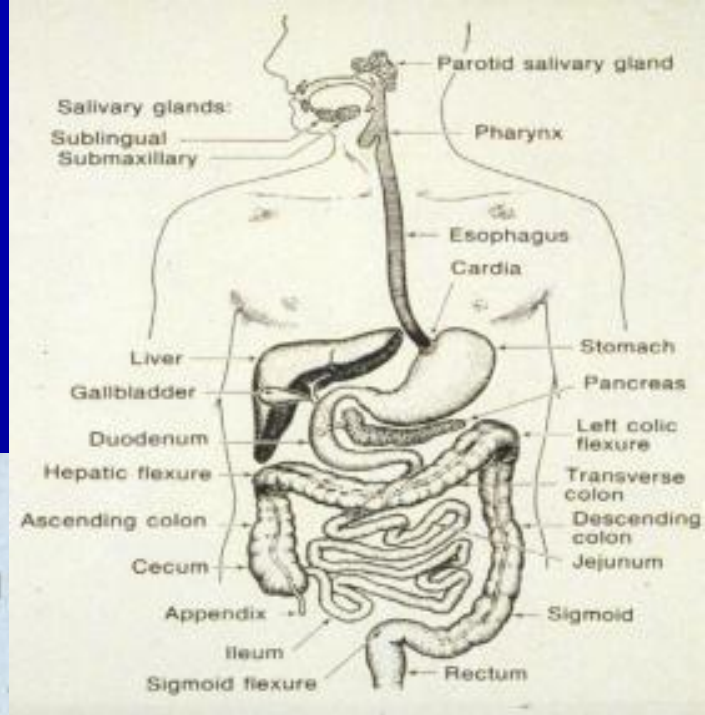


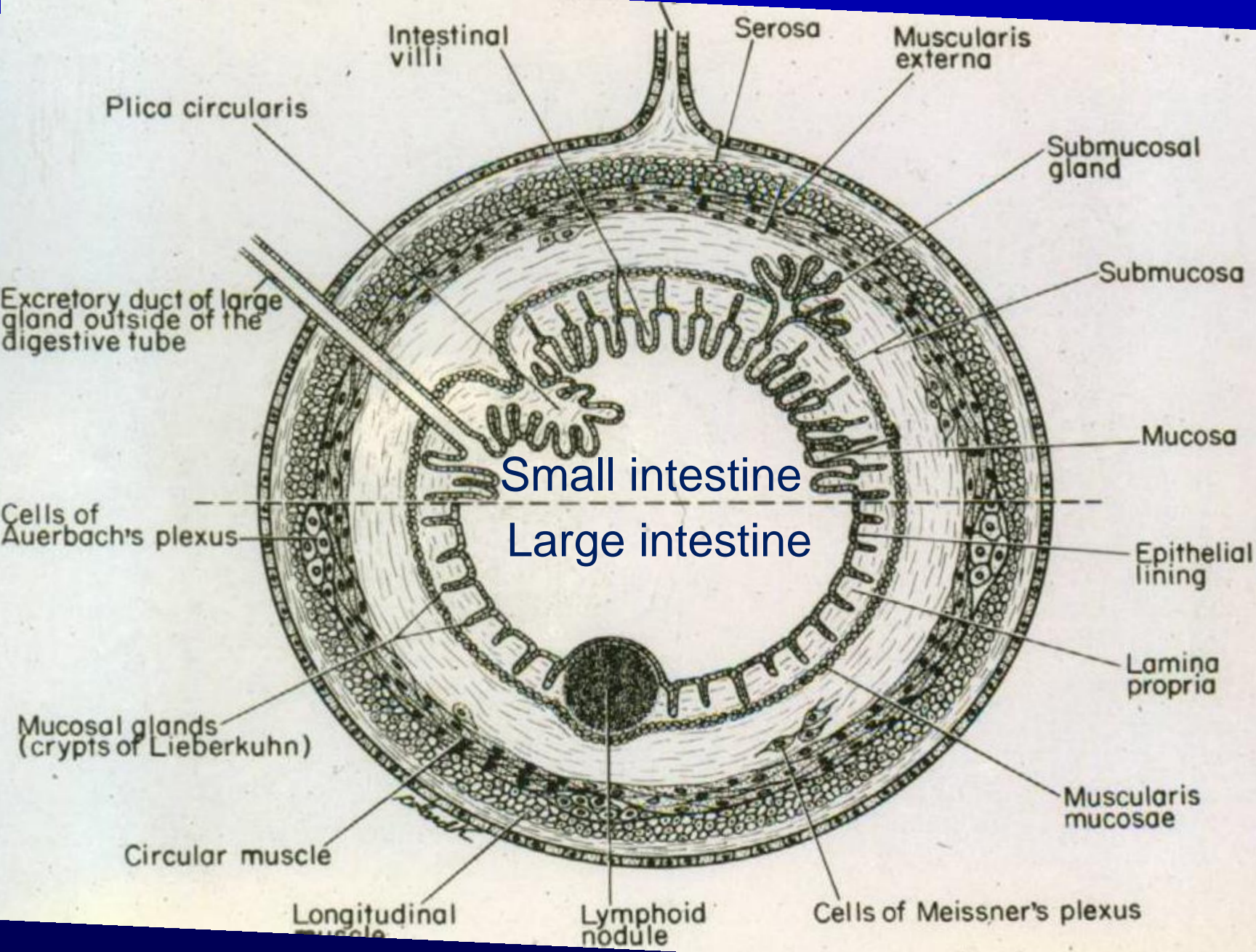
Fig. 5.2: The organs of the digestive system.

CELLS, CELLULAR STRUCTURES, AND GROUPS OF CELLS IN THE DIGESTIVE SYSTEM



Simple columnar





Small intestine
Large intestine

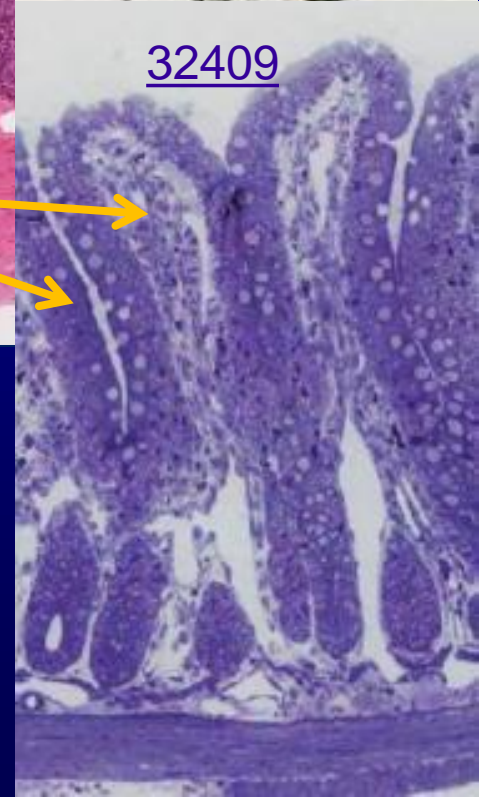
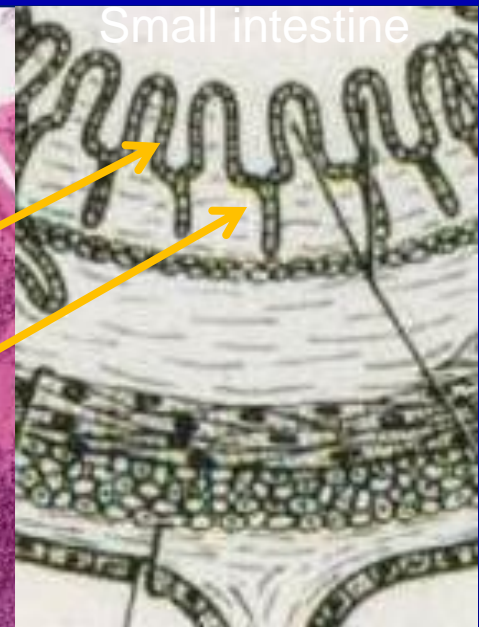
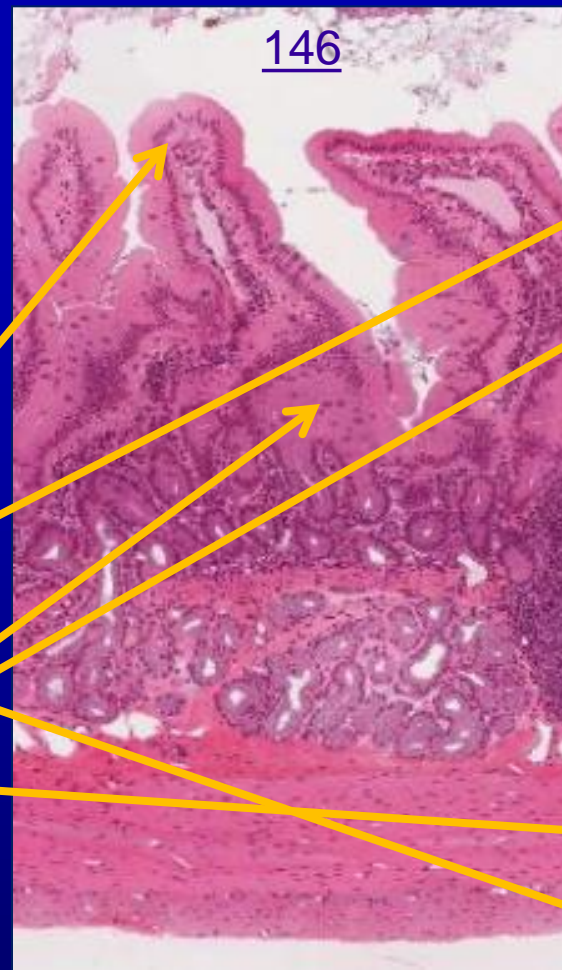
32409



Small intestine

General Structure of the Digestive Tract

Epithelium
Lamina propria
Submucosa
Muscularis externa
Serosa



General Structure of the Digestive Tract

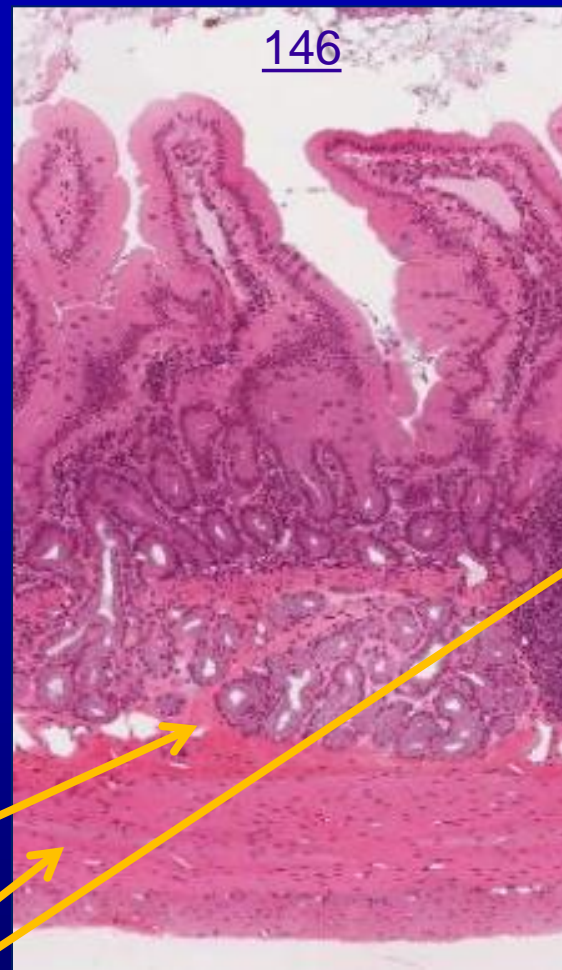
Epithelium

Lamina propria

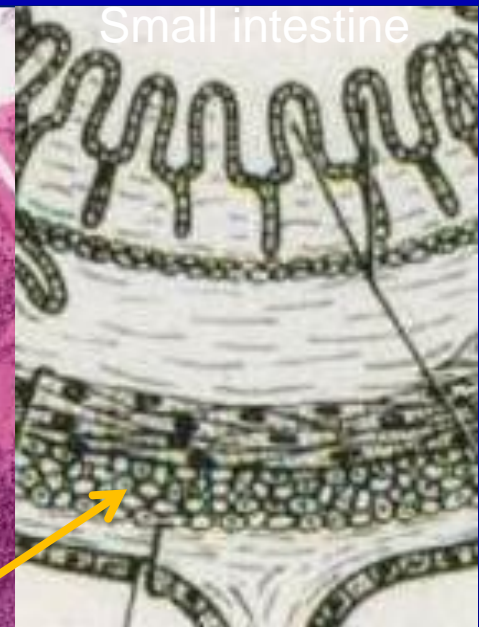
Submucosa

Muscularis externa

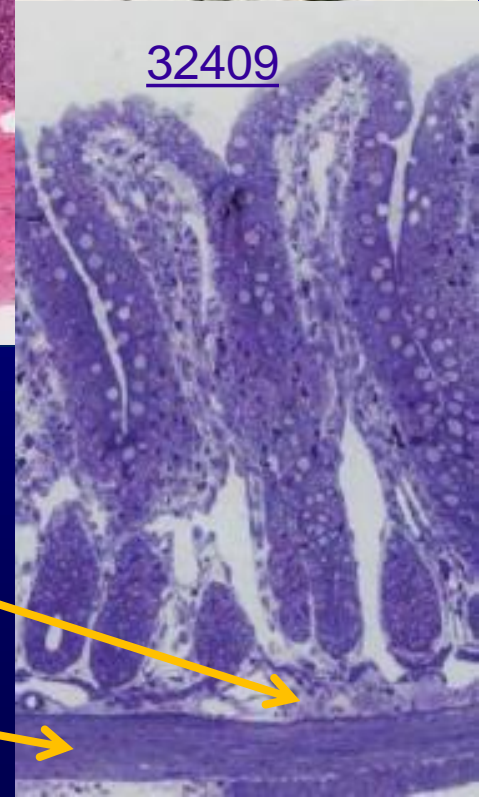
Serosa



146



Small intestine



32409

Small intestine

General Structure of the Digestive Tract

Epithelium

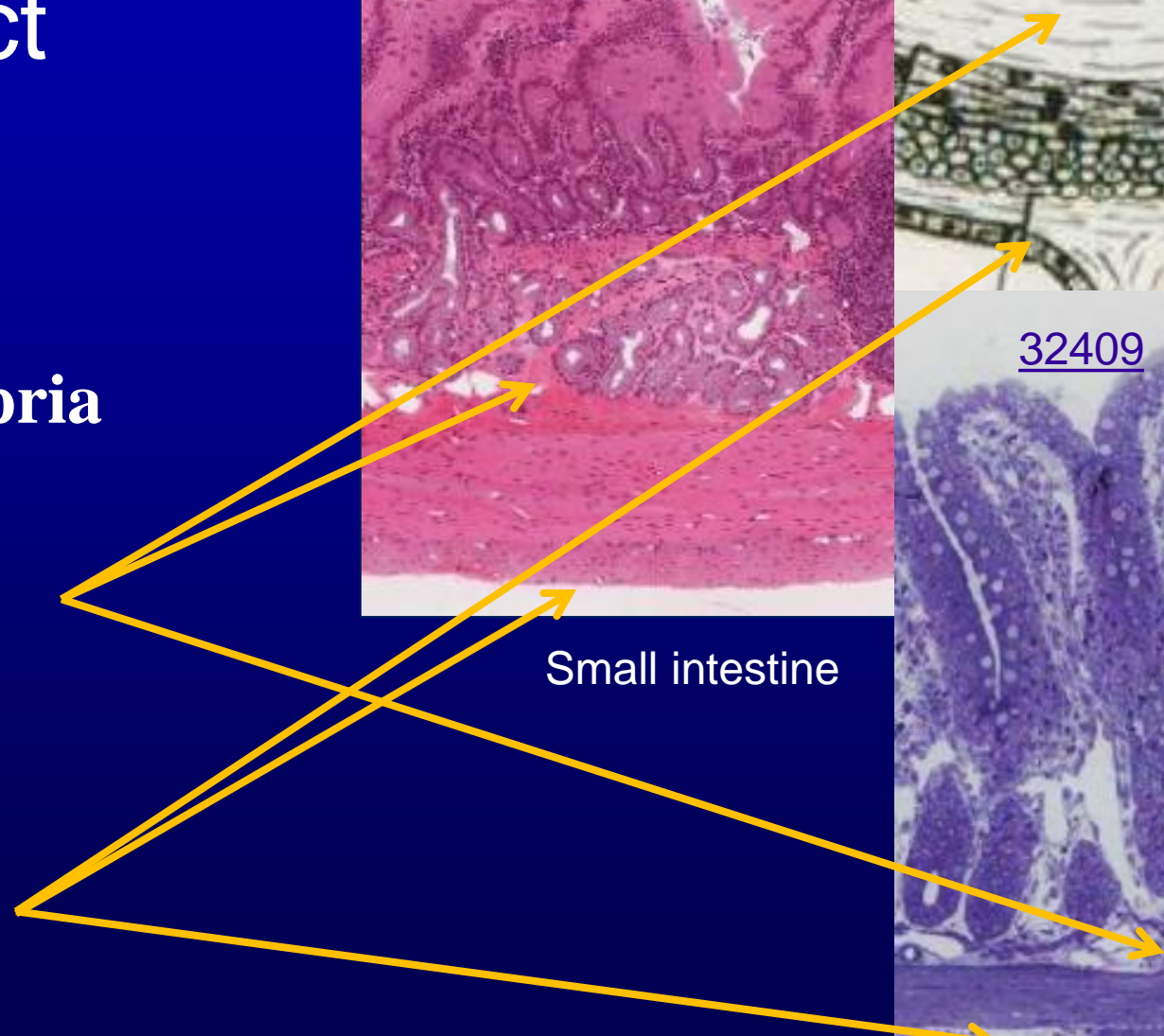
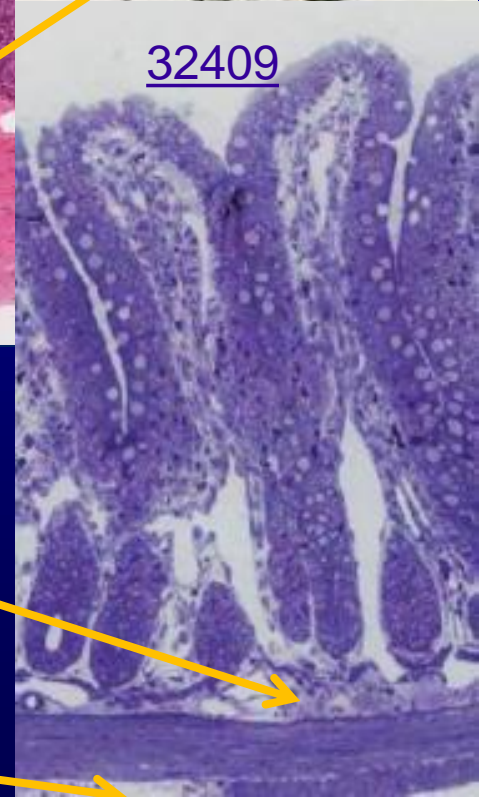
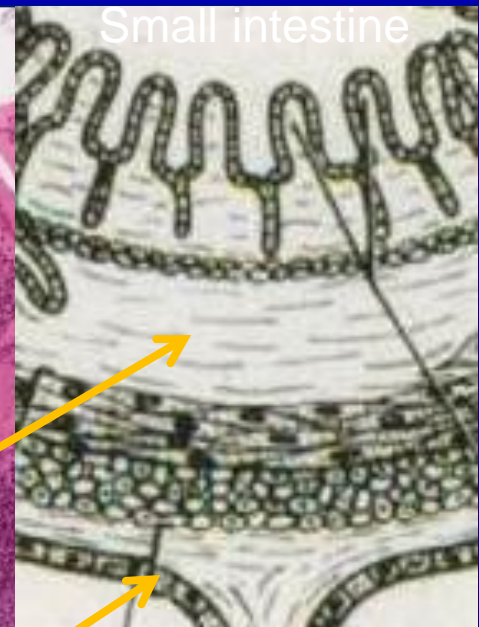
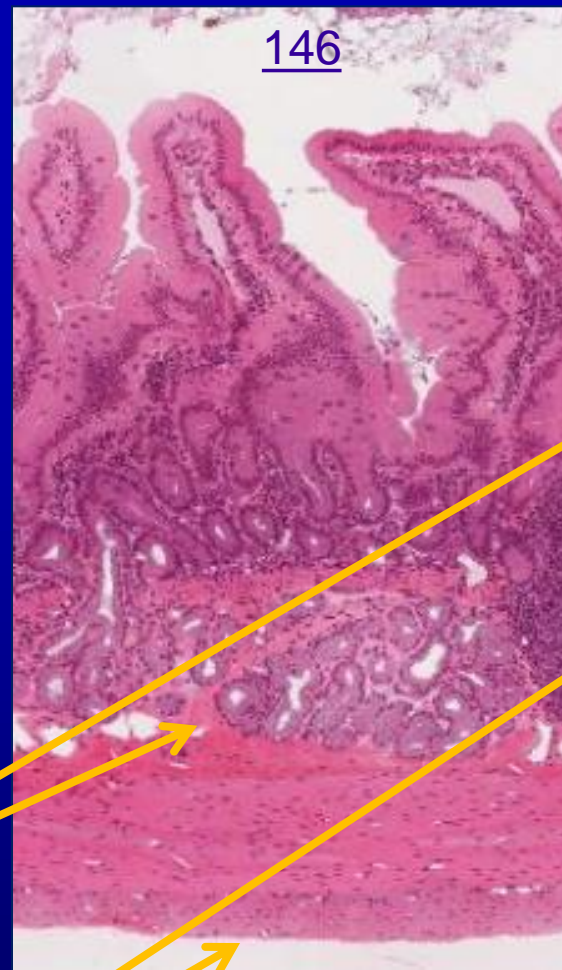
Lamina propria

Submucosa

Muscularis

externa

Serosa



General Structure of the Digestive Tract

Epithelium

Lamina propria

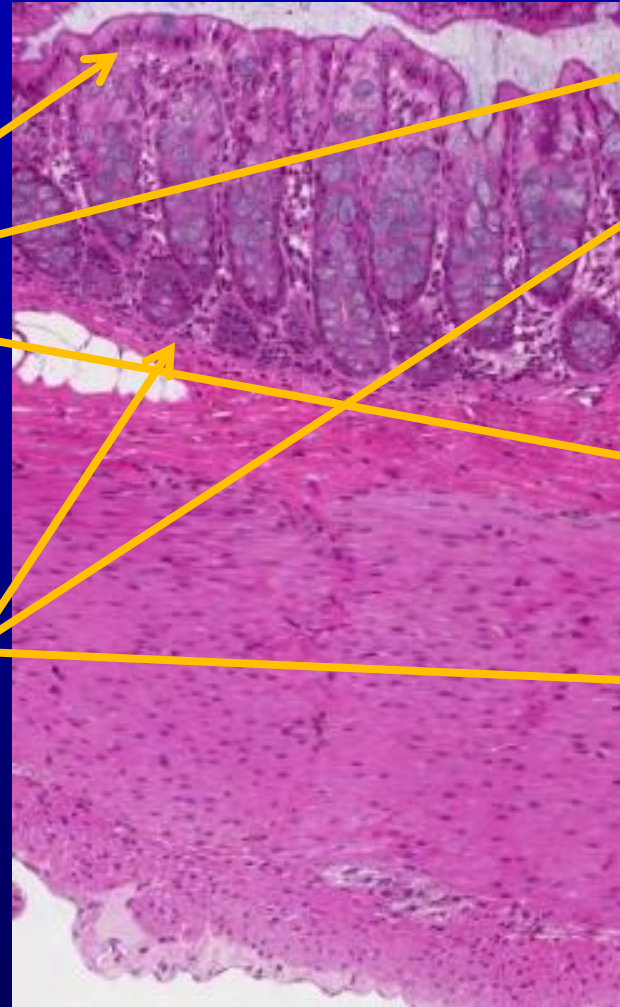
Muscularis mucosa

Submucosa

Muscularis externa

Large intestine

153



Stomach

145

Large intestine

General Structure of the Digestive Tract

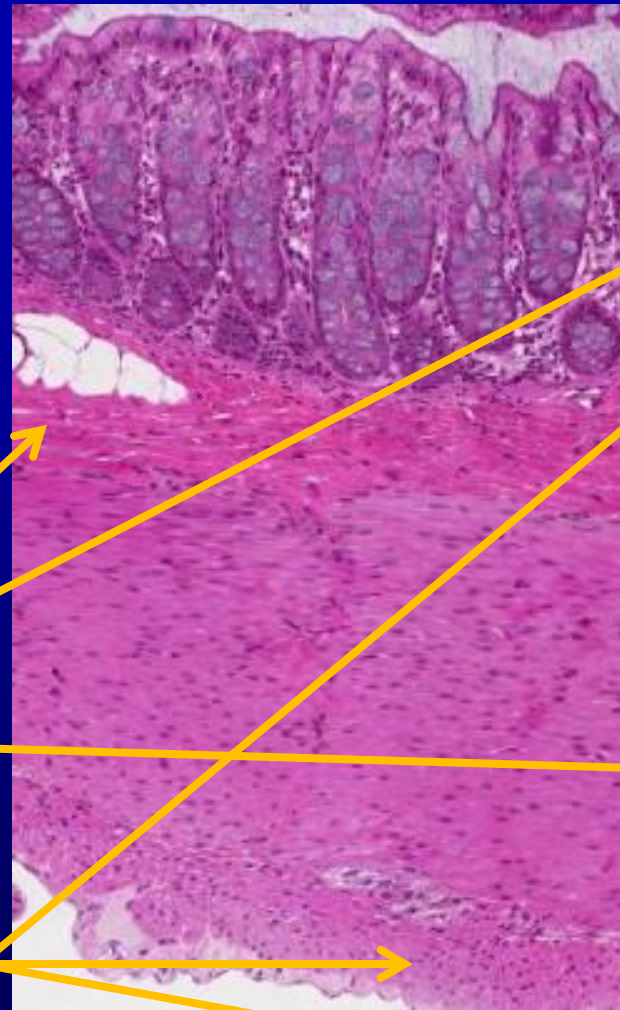
Epithelium

Lamina propria

Muscularis mucosa

Submucosa

Muscularis externa



153

Large intestine



Stomach

Large intestine

145

Large intestine

Muscularis externa

153

Mesothelium

153

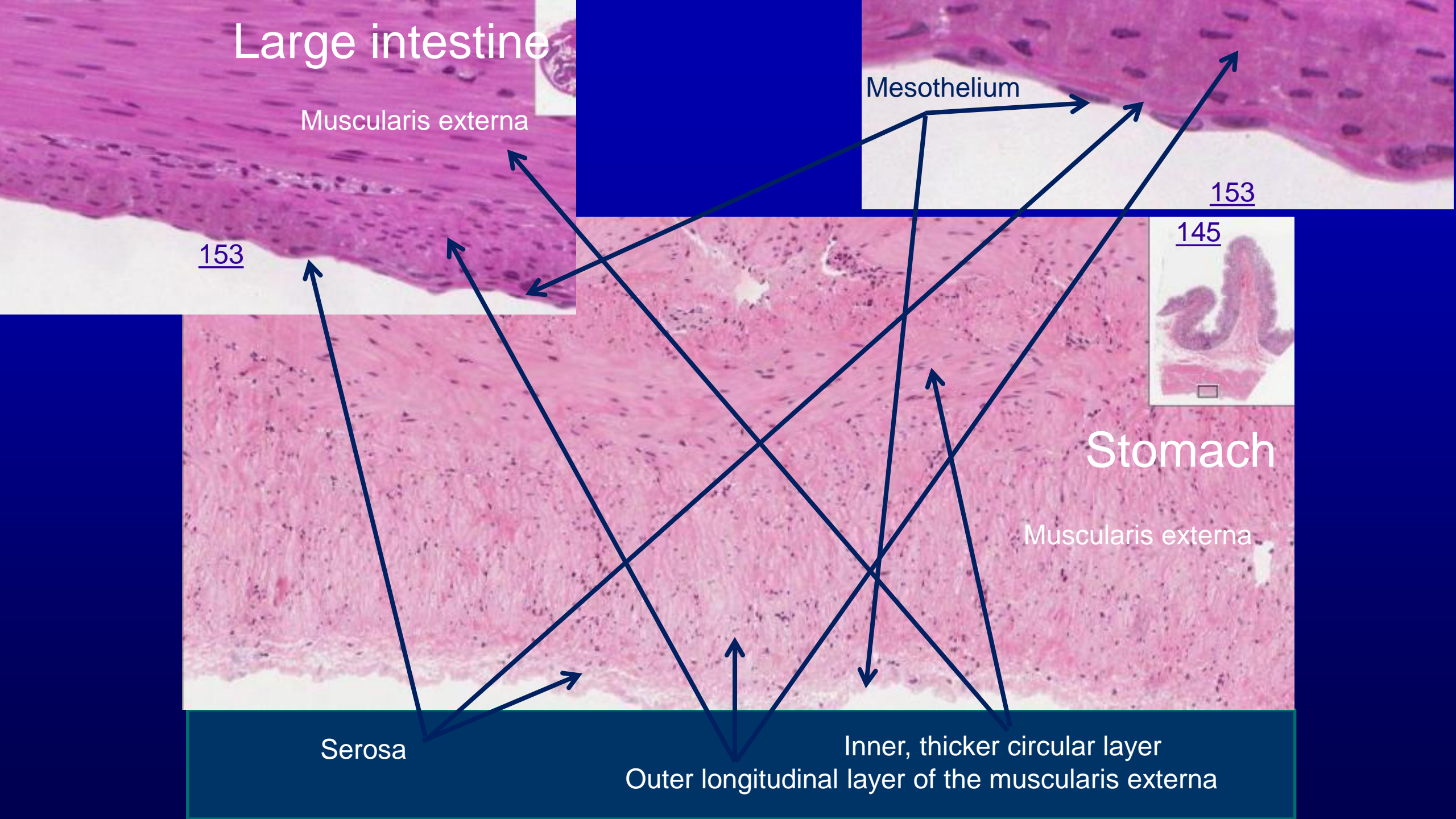
145

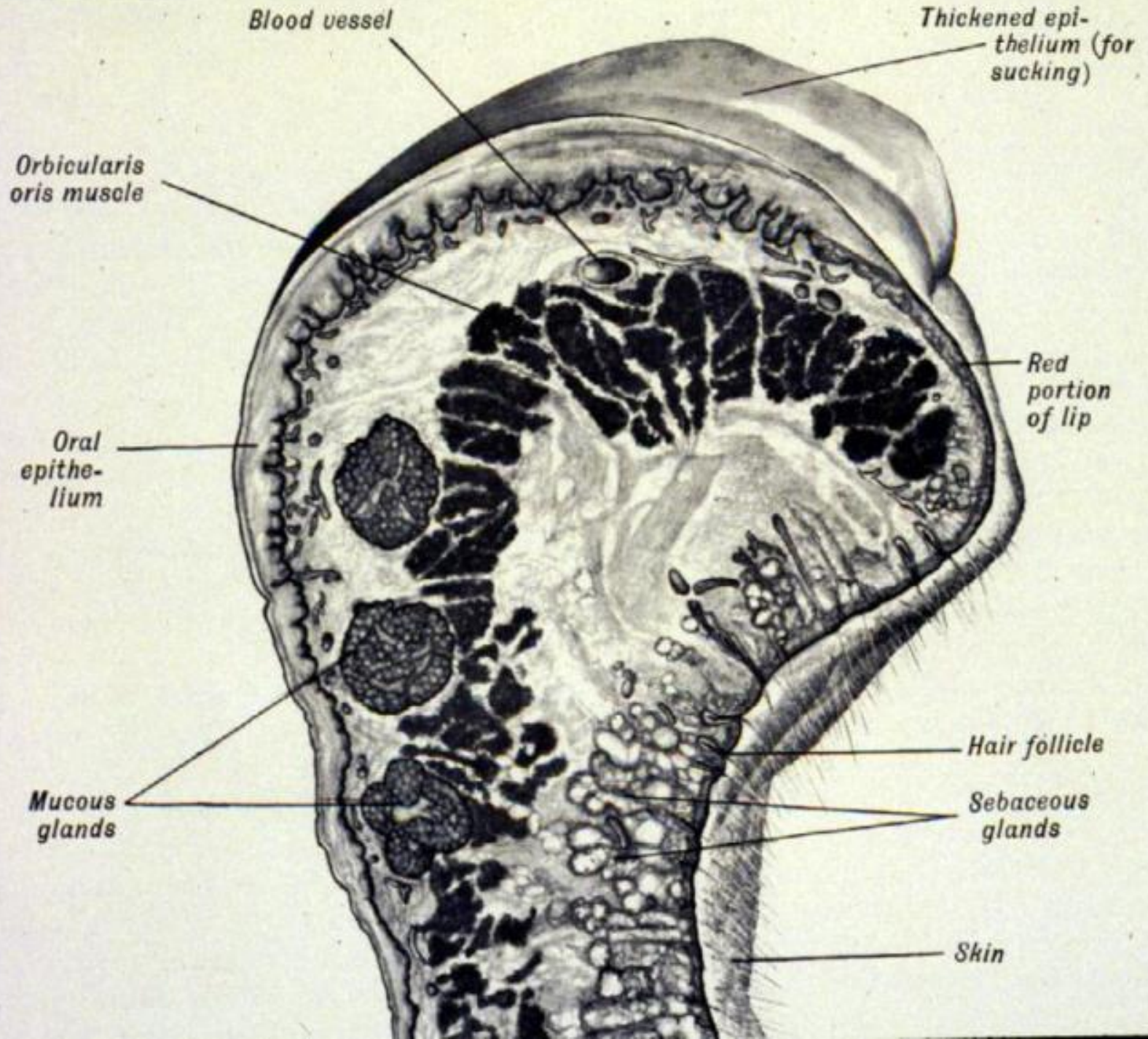
Stomach

Muscularis externa

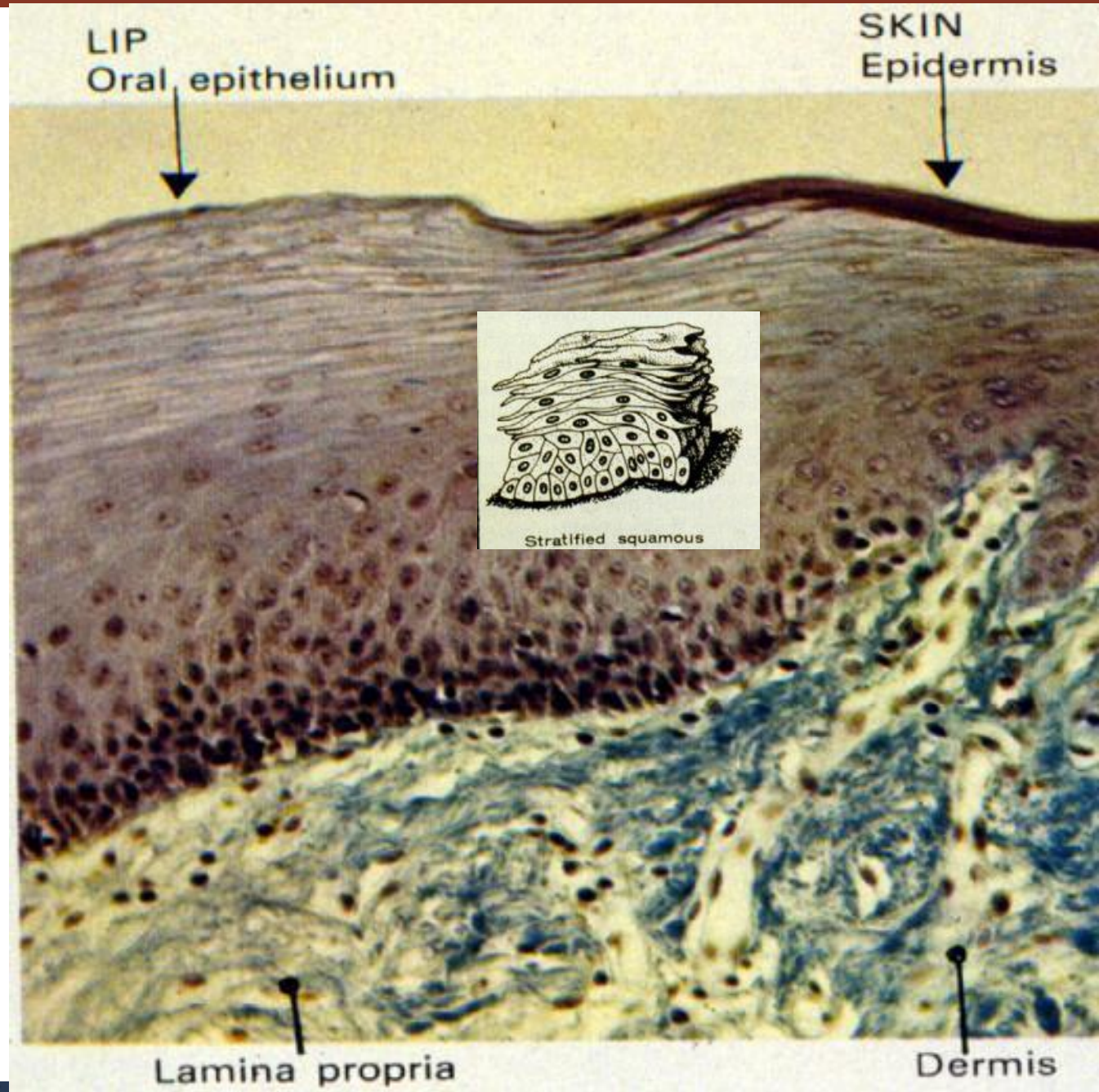
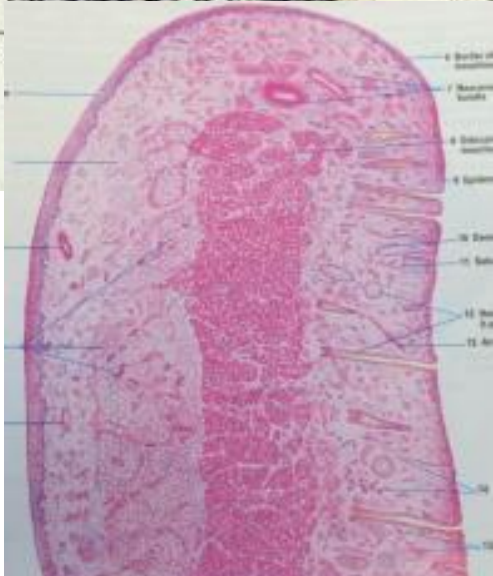
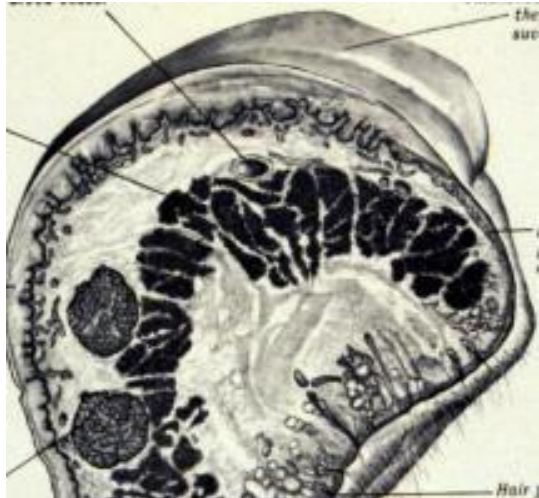
Serosa

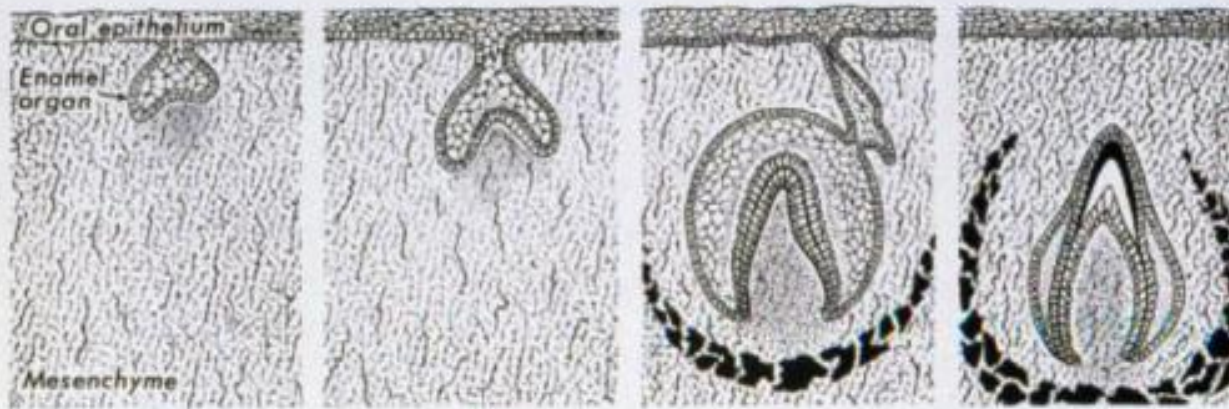
Inner, thicker circular layer
Outer longitudinal layer of the muscularis externa





MUCOCUTANEOUS JUNCTIONS





A
Bud stage

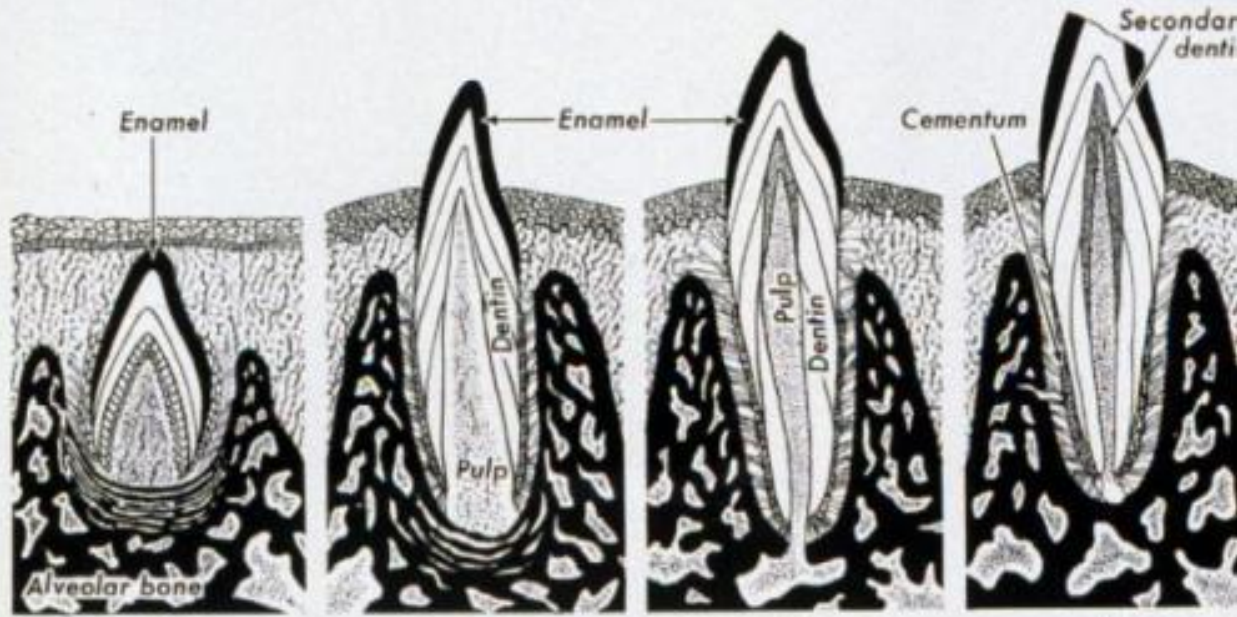
B
Cap stage

C
Bell stage
Calcification of bone

D
Apposition and
calcification of
enamel and dentin

GROWTH

CALCIFICATION



E
(Intra-osseous)

F
(Into oral cavity)

G

H

ERUPTION

ATTRITION

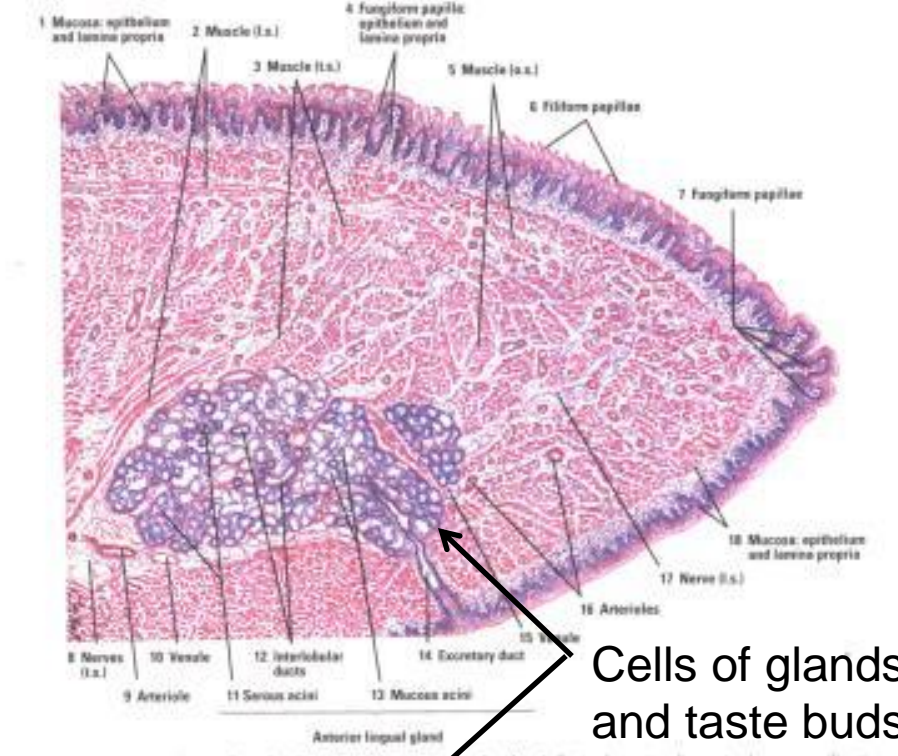
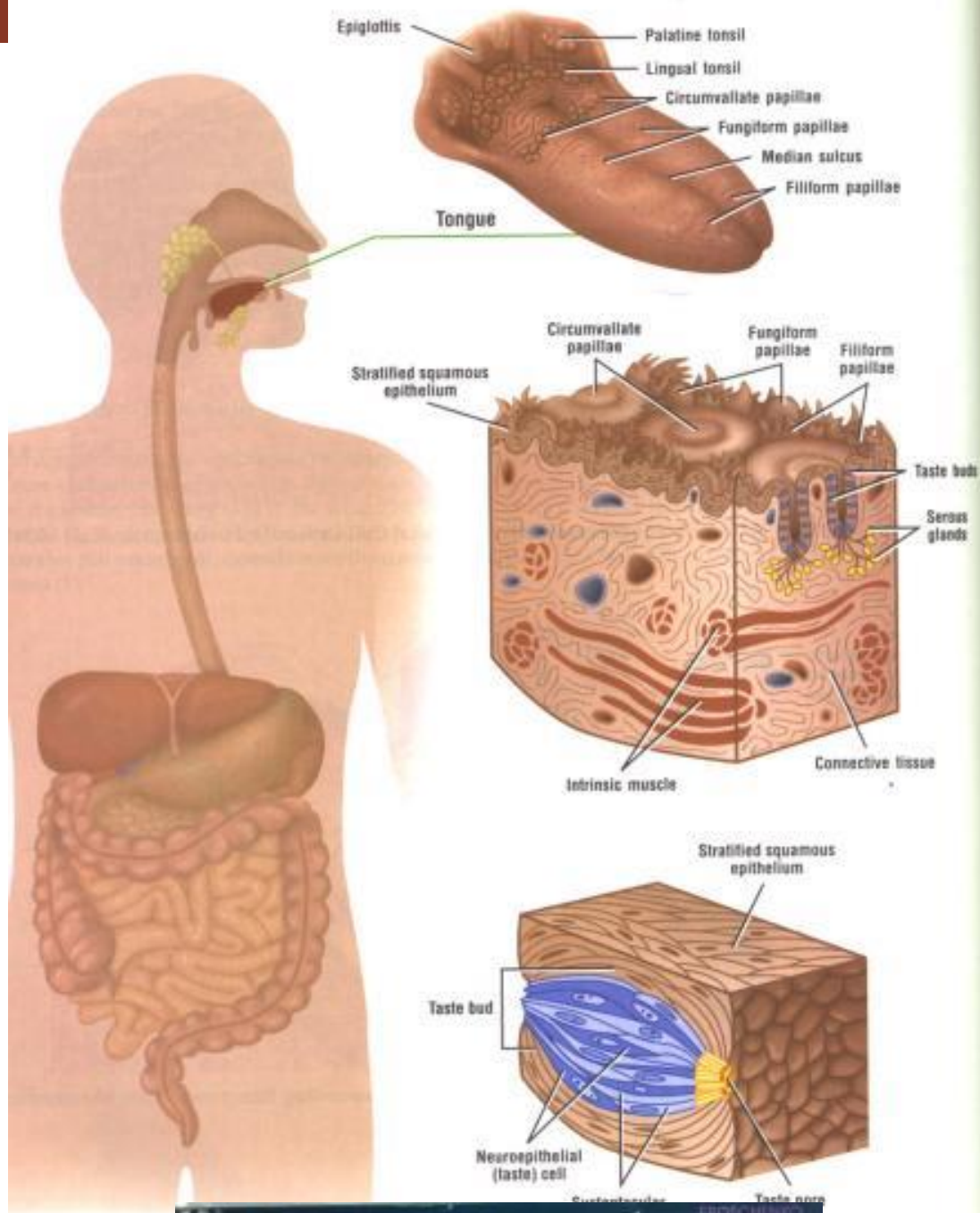
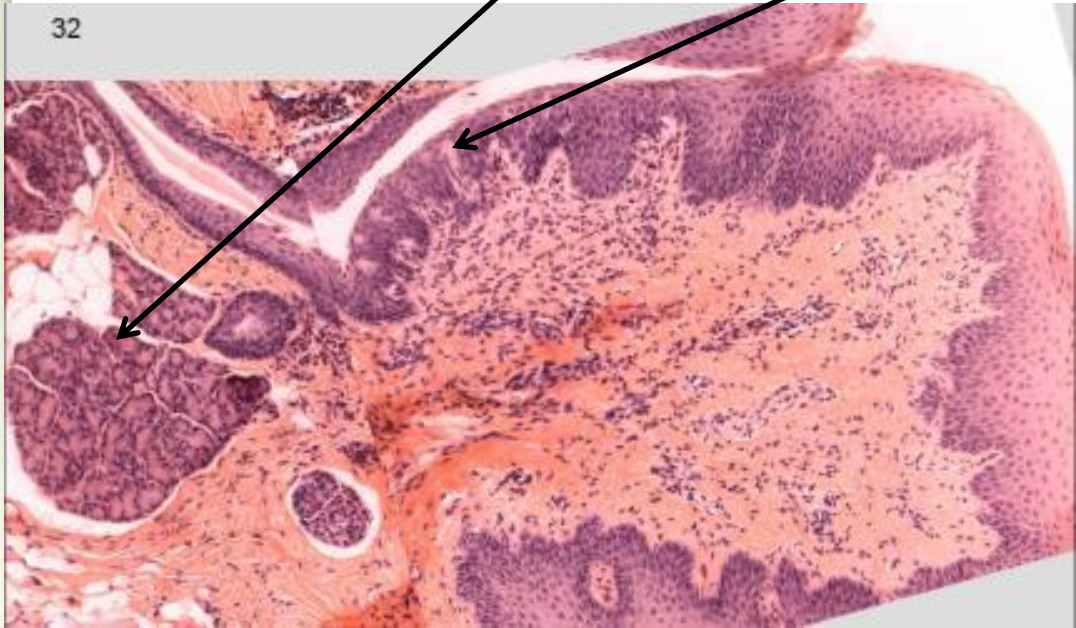


Fig. 10-2 Tongue: Apex (longitudinal section, panoramic view). Stain: hematoxylin-eosin. Low magnification.

Cells of glands and taste buds



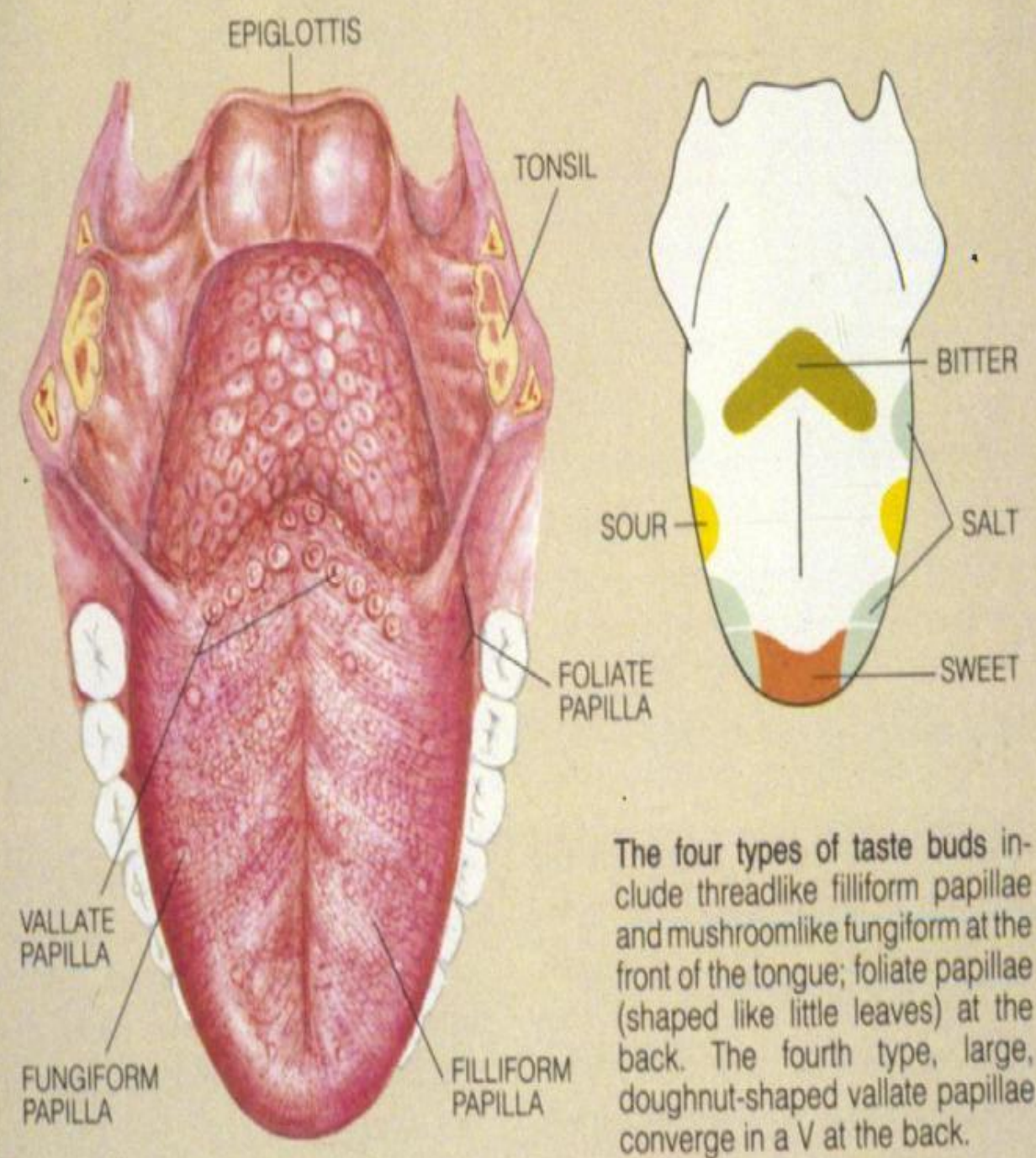
Mucocutaneous interactions

Oral cavity:

Epidermis-like epithelium

Tongue:

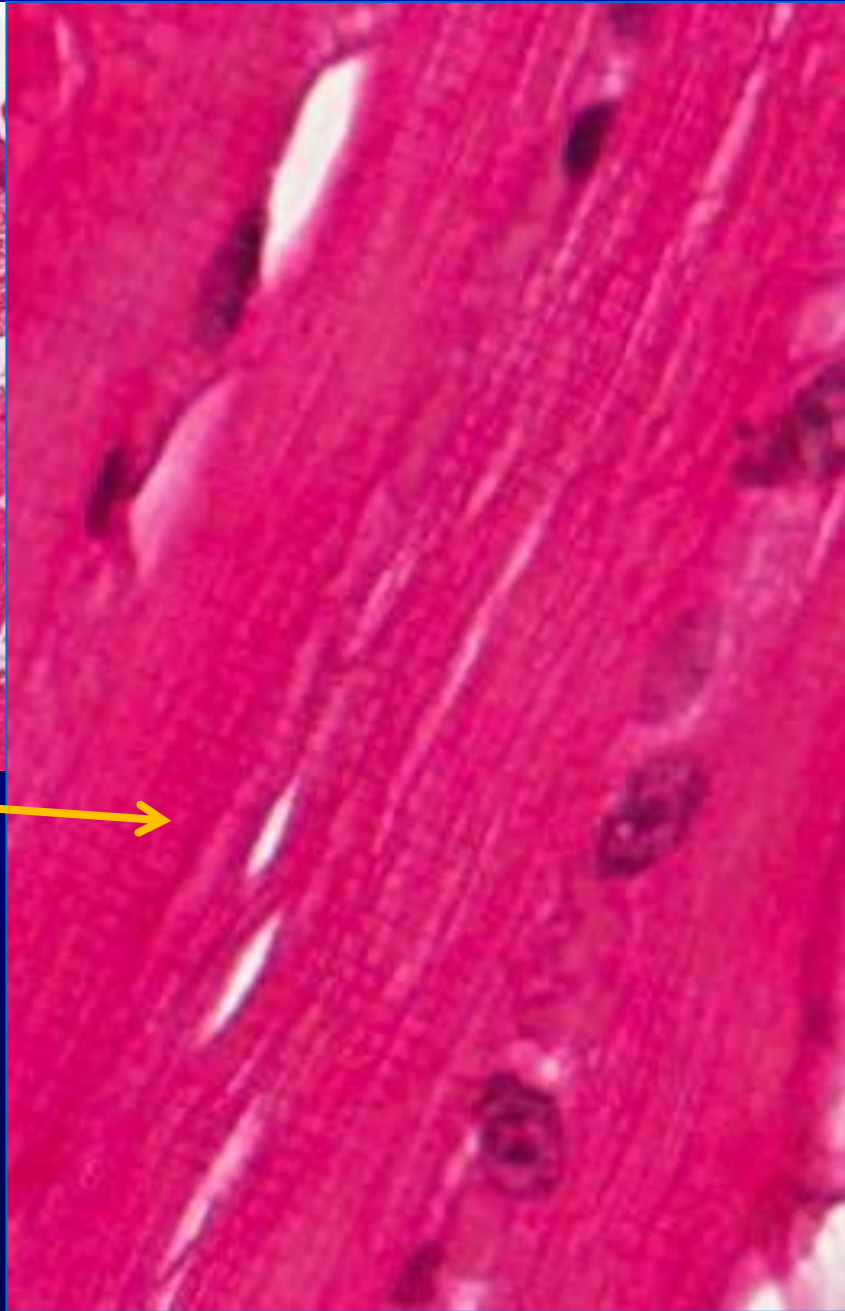
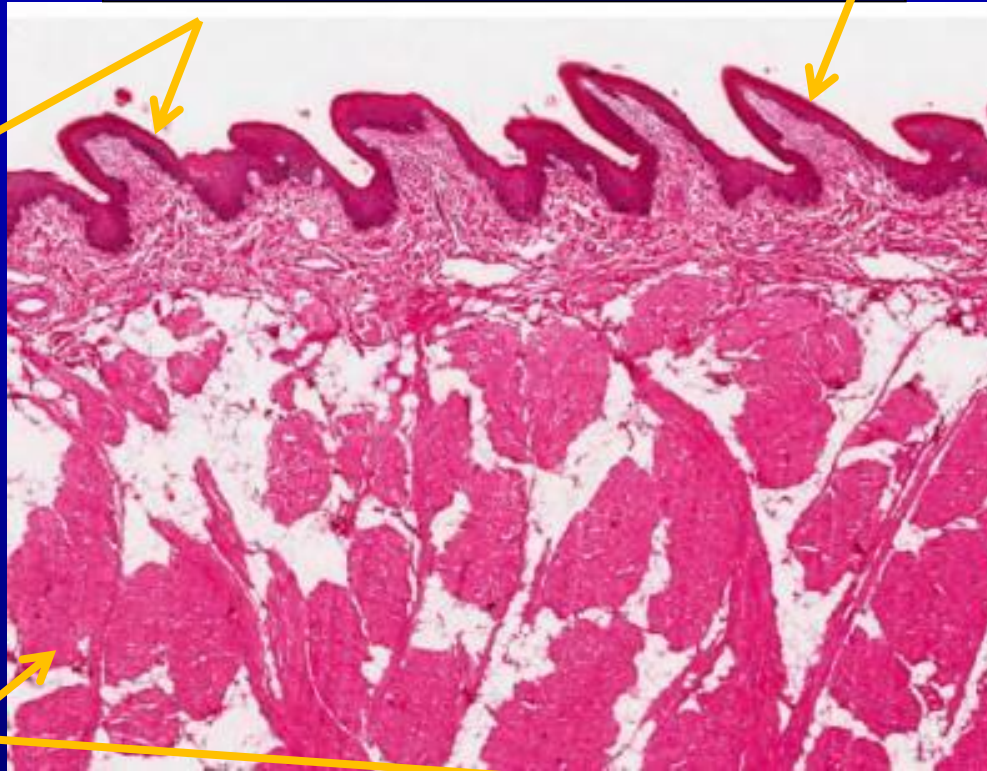
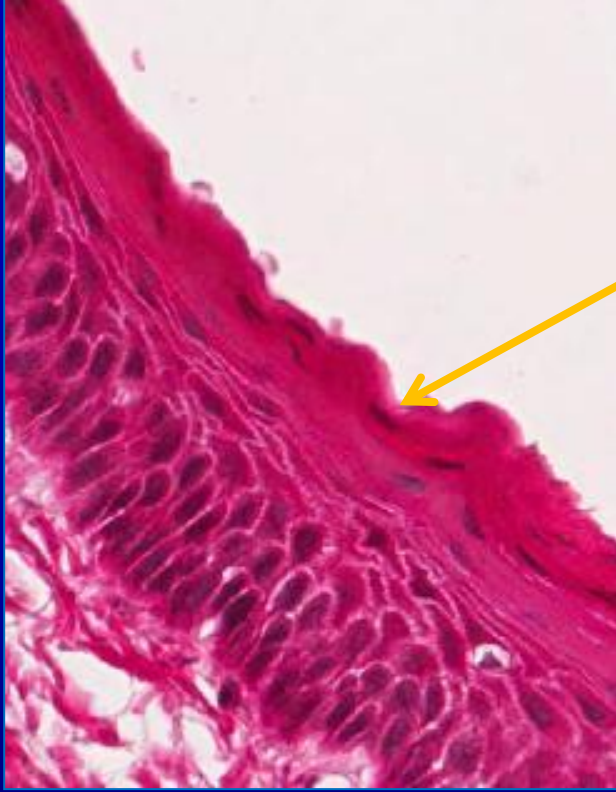
Filiform, fungiform, and circumvallate papillae



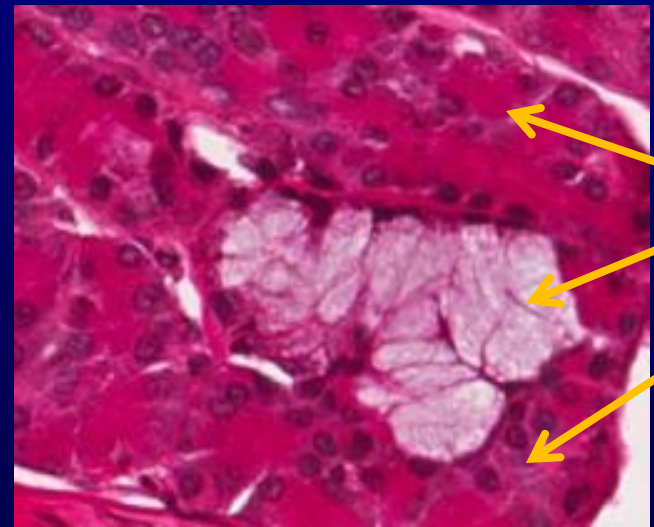
Non-keratinized stratified squamous epithelium.

Filiform Papillae

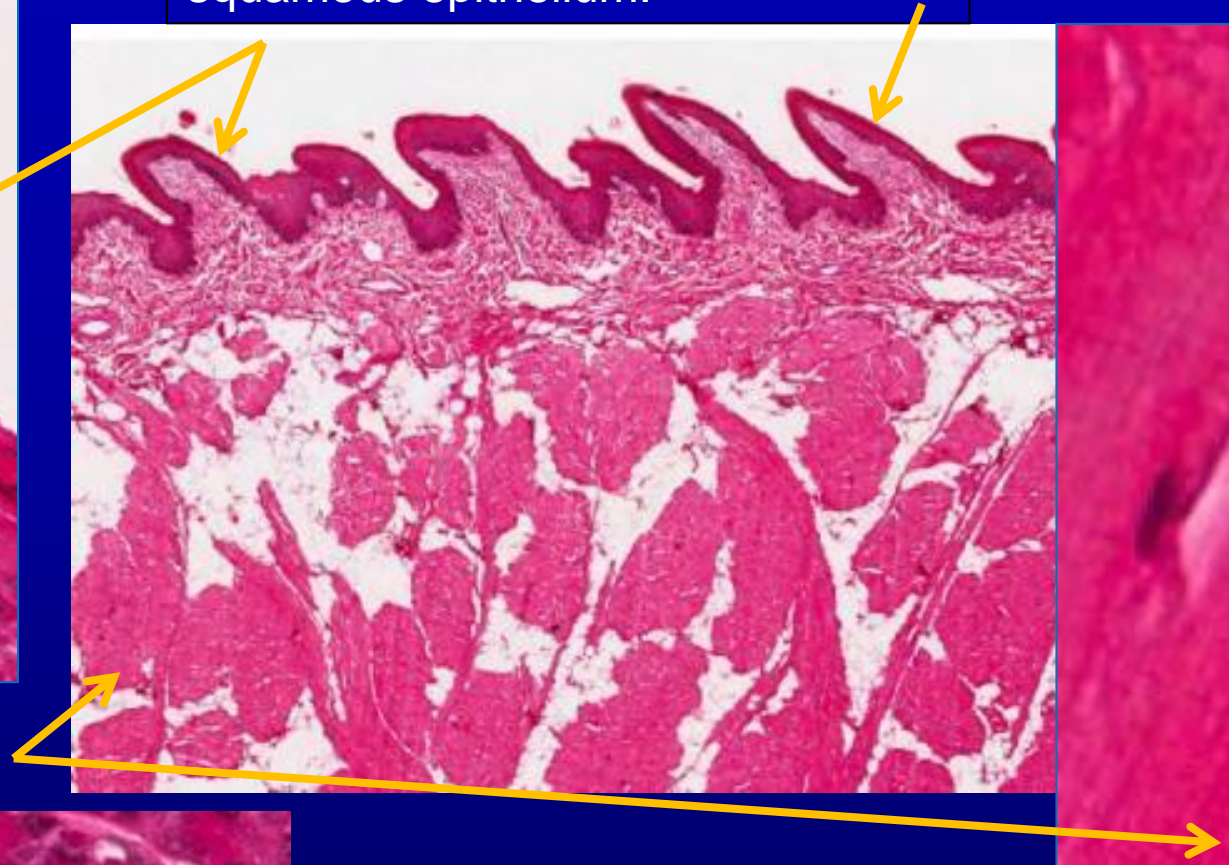
[Histo 51](#)



Skeletal muscle

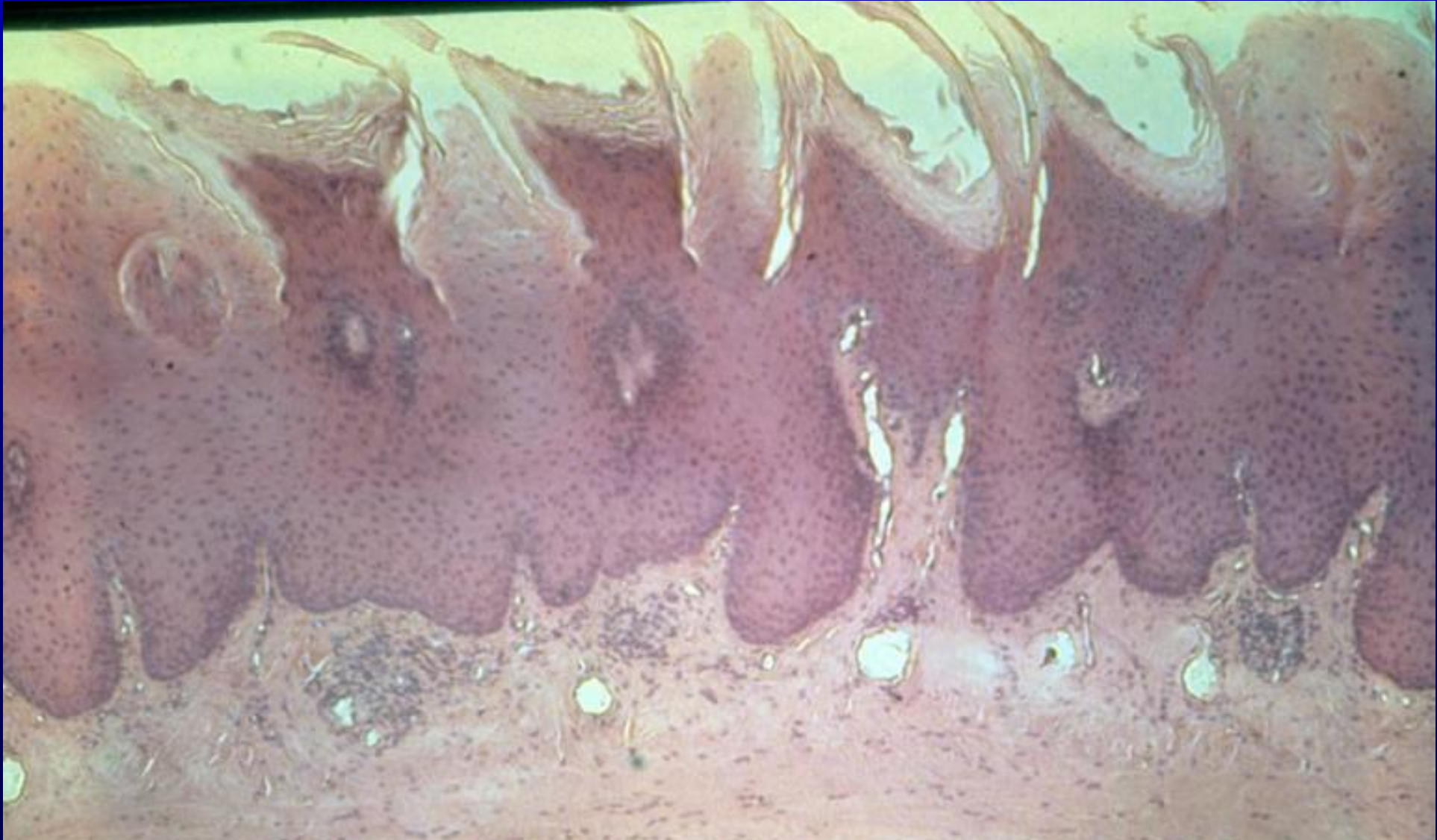


Mucus and Serous glands,



Filiform Papillae

Can be have keratinized stratified squamous epithelium



FILIFORM PAPILLAE

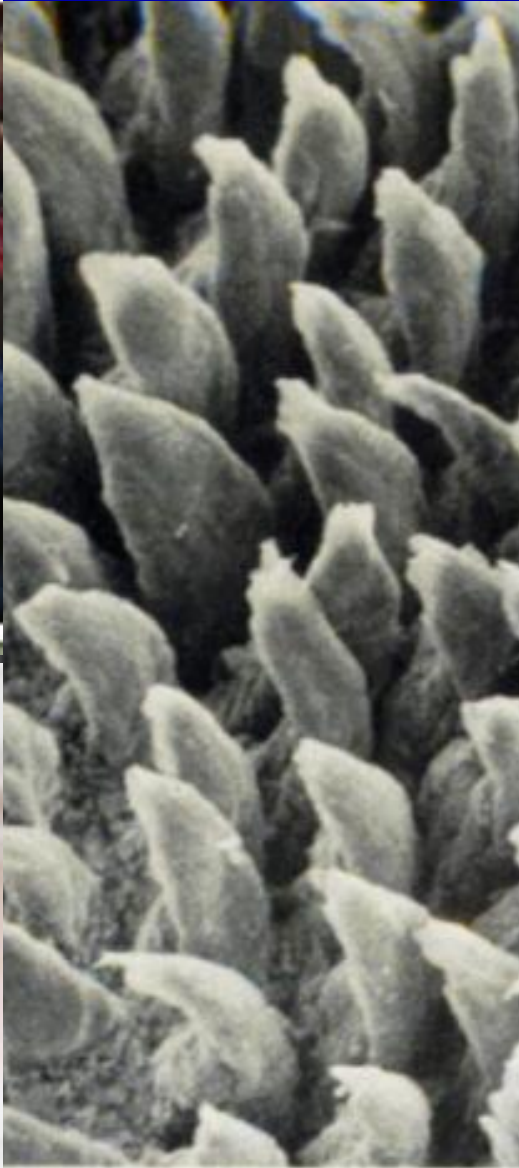
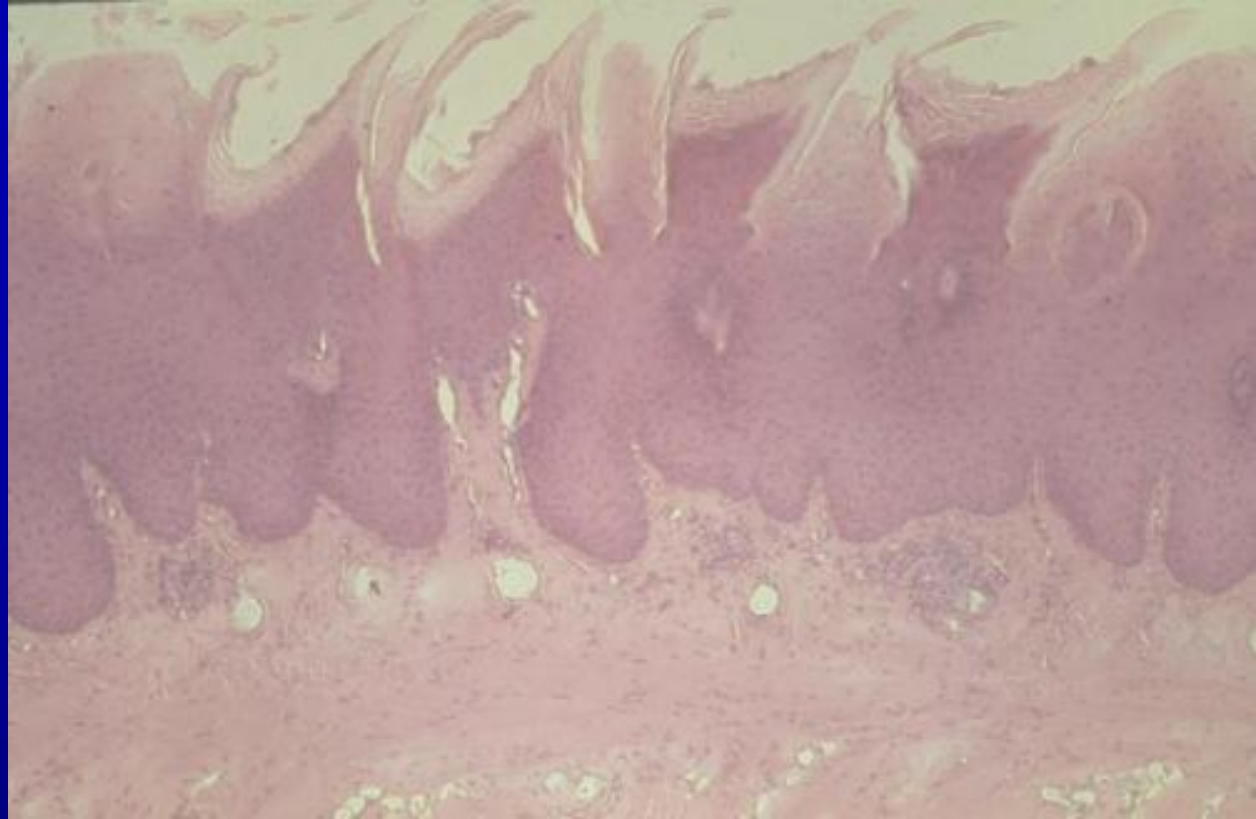
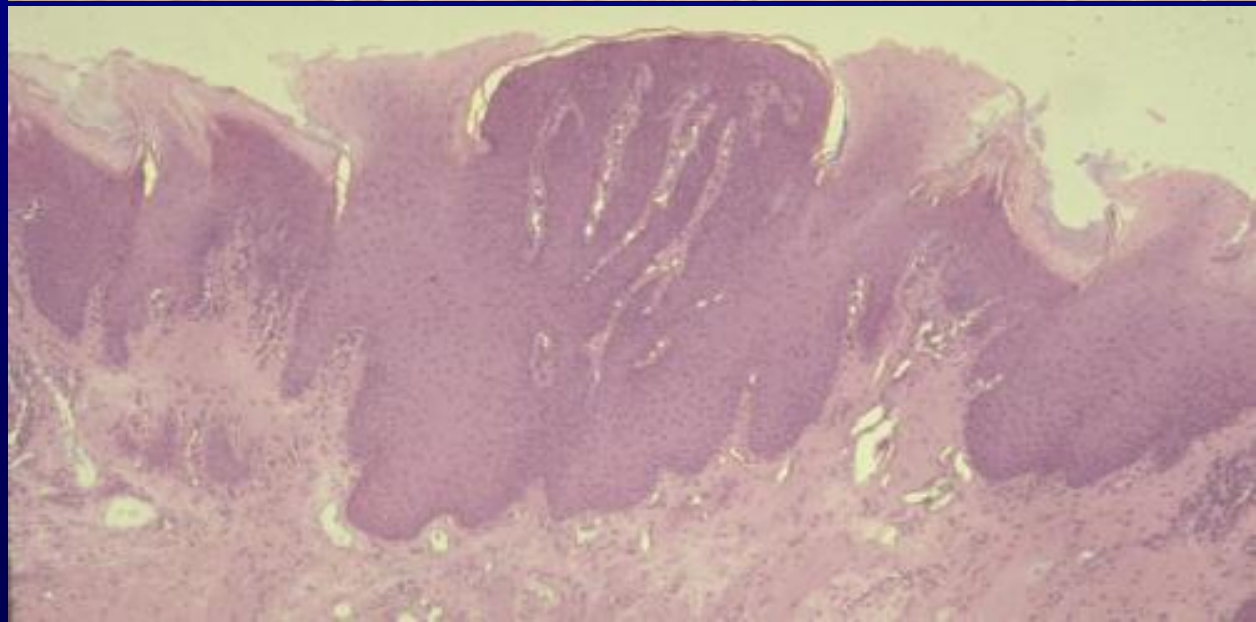


Figure 28-6. Scanning electron micrograph of the filiform papillae of rabbit tongue. (Micrograph courtesy of F. Fujita.)

Filiform
Papillae



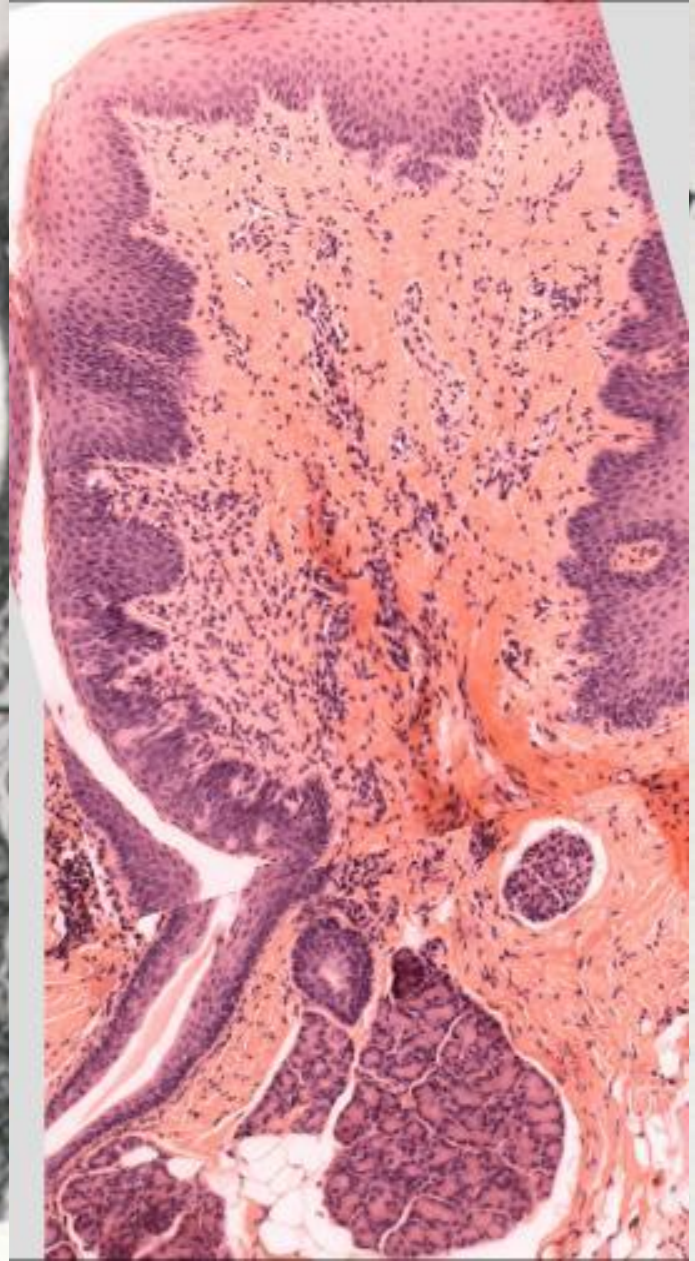
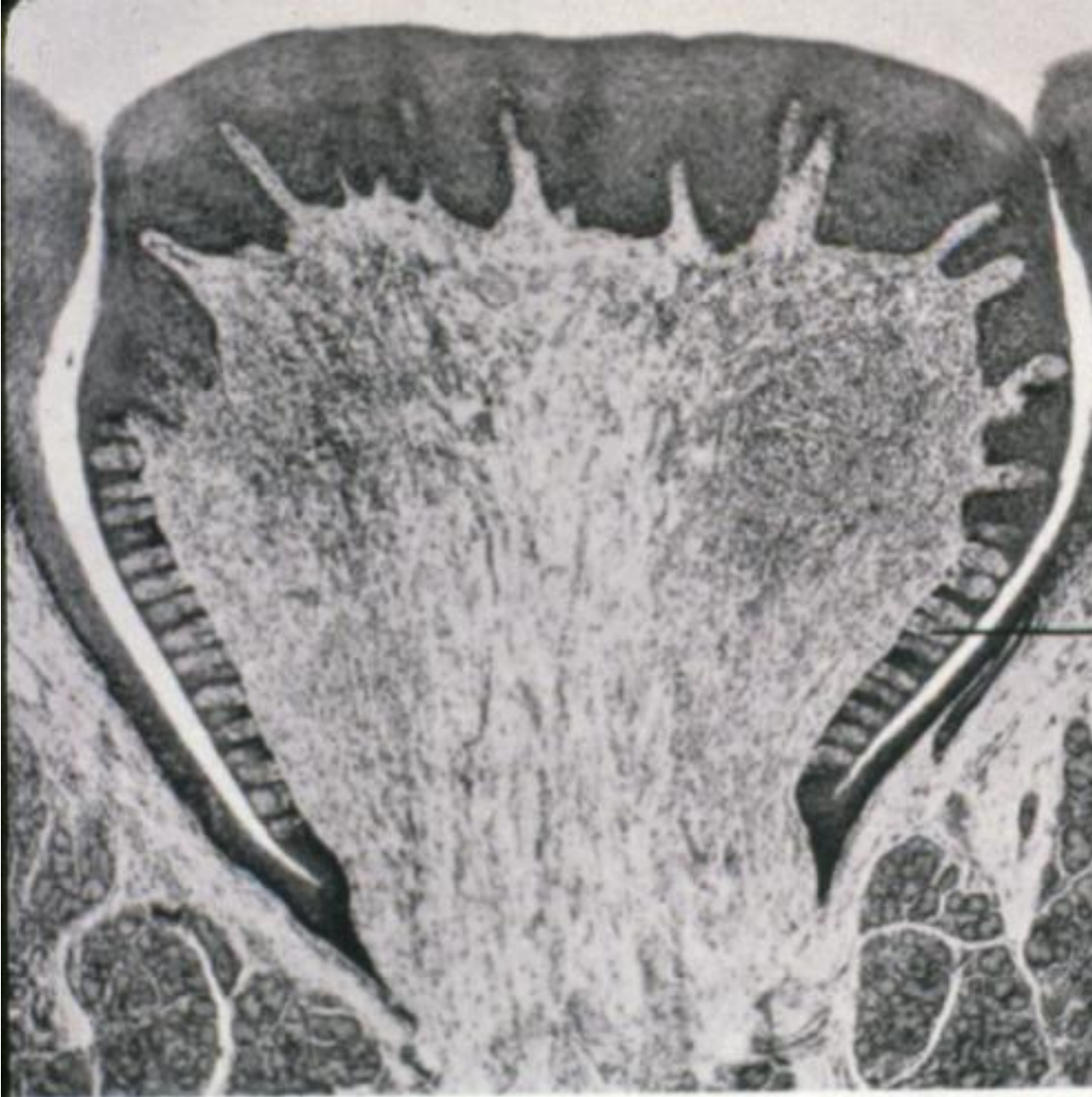
Fungiform
Papillae



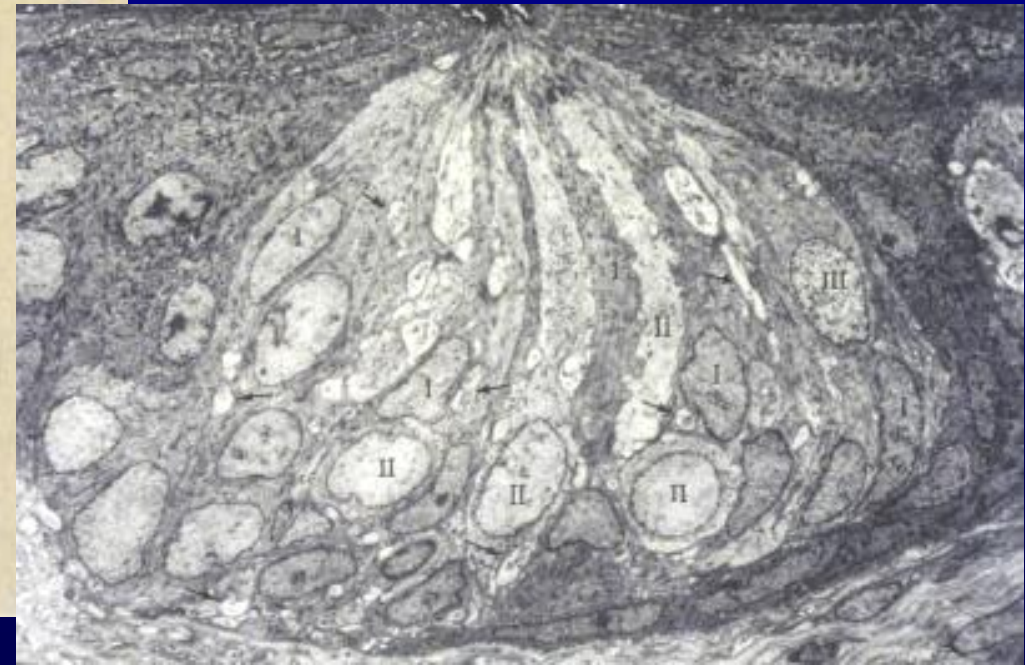
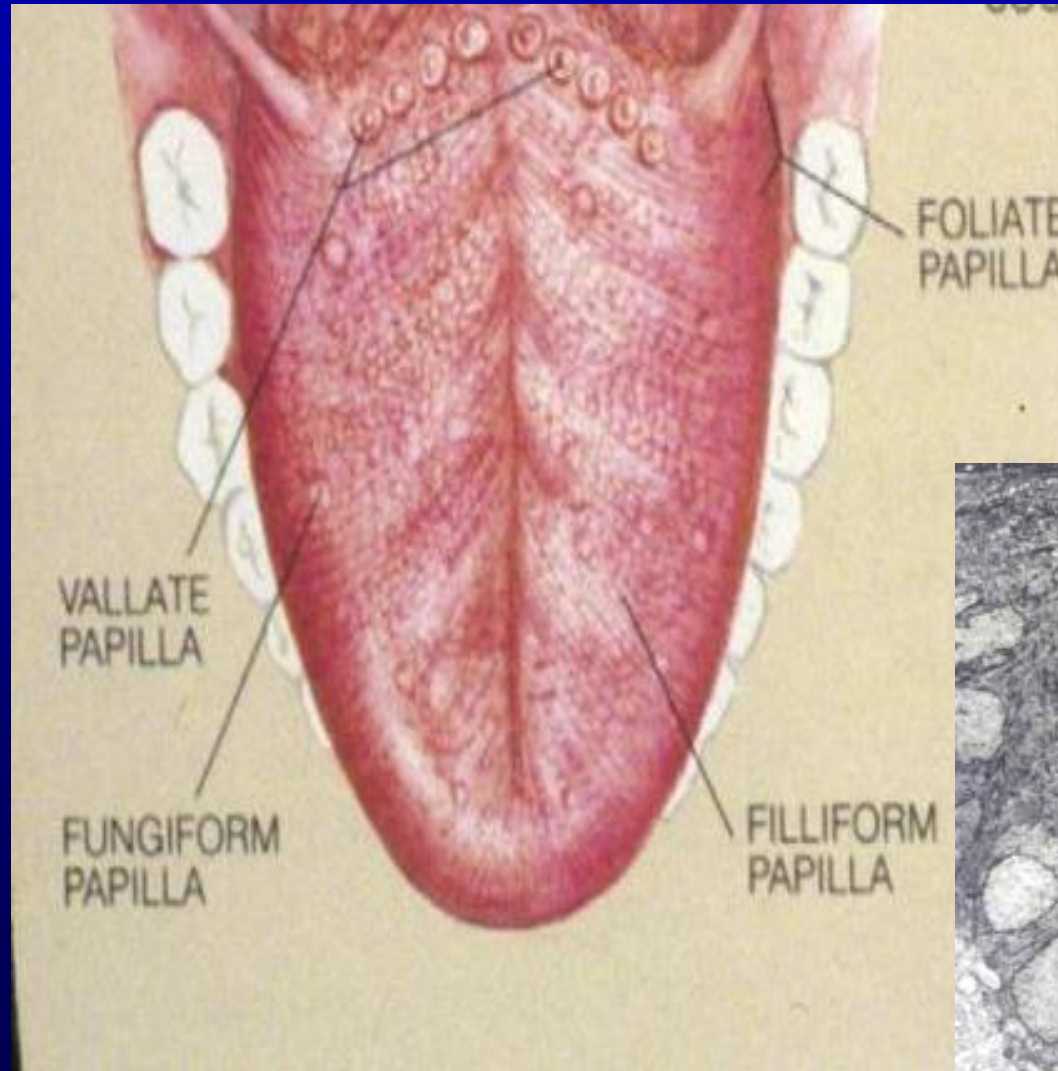
Fungiform Papillae



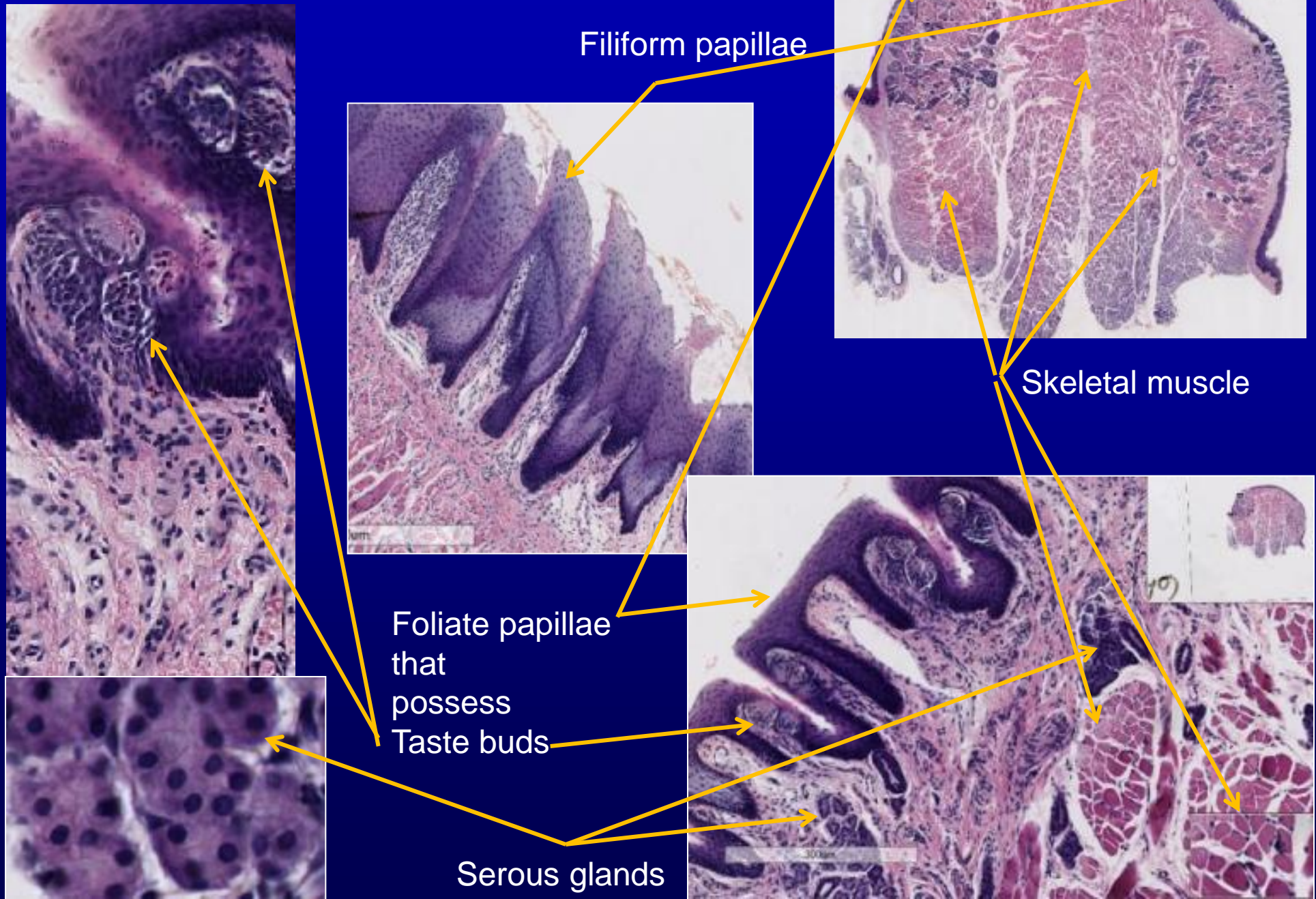
CIRCUMVALLATE PAPILLAE



Fungiform, foliate, and circumvallate Papillae have Taste buds



Slide #12 (1101). Tongue, rabbit.



ORAL CAVITY is lined by

OSA

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ia
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NCHED
LANDS.

purely
(e) or
co-serous

SALIVARY

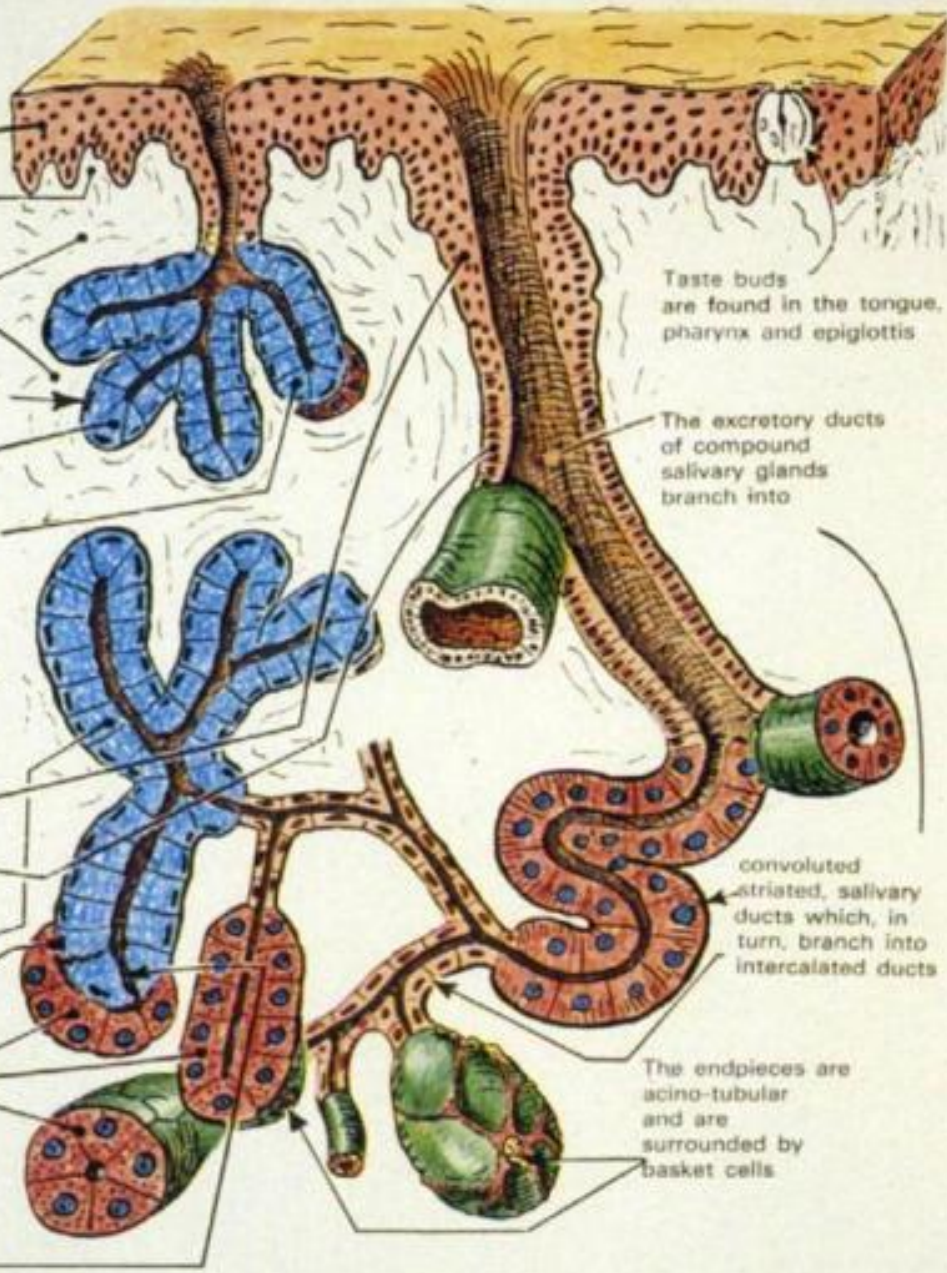
ry ducts
ally with
uamous

with simple
thelium

rs are
ia

rescents
ous

pillaries or
rmit
saliva
scents



Taste buds
are found in the tongue,
pharynx and epiglottis

The excretory ducts
of compound
salivary glands
branch into

convoluted,
striated, salivary
ducts which, in
turn, branch into
intercalated ducts

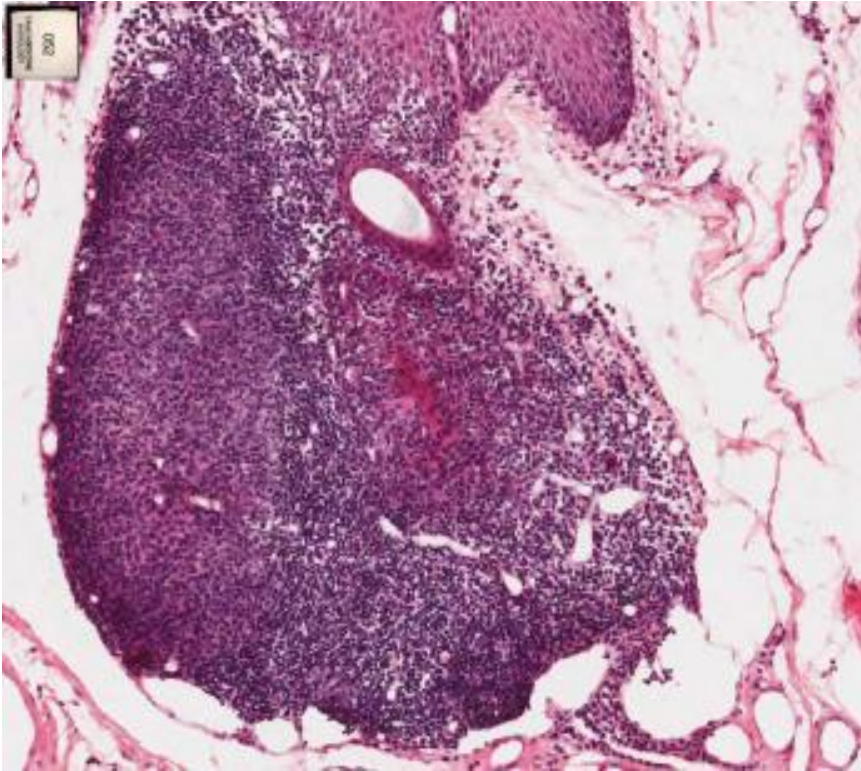
The endpieces are
acino-tubular
and are
surrounded by
basket cells

Fig. 12-4. Structures connected with the oral cavity.

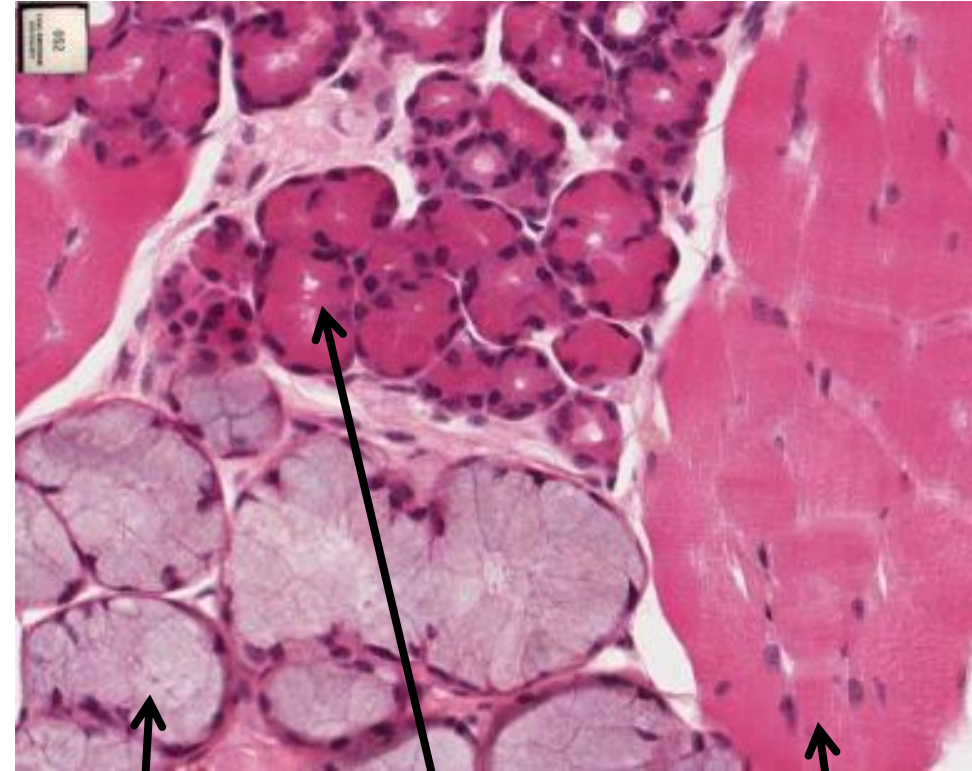


Fig. 12-5. Sublingual gland of calf.

Slide 52: Tongue (cross section, lingual tonsil)



Lymph tissue of lingual tonsil



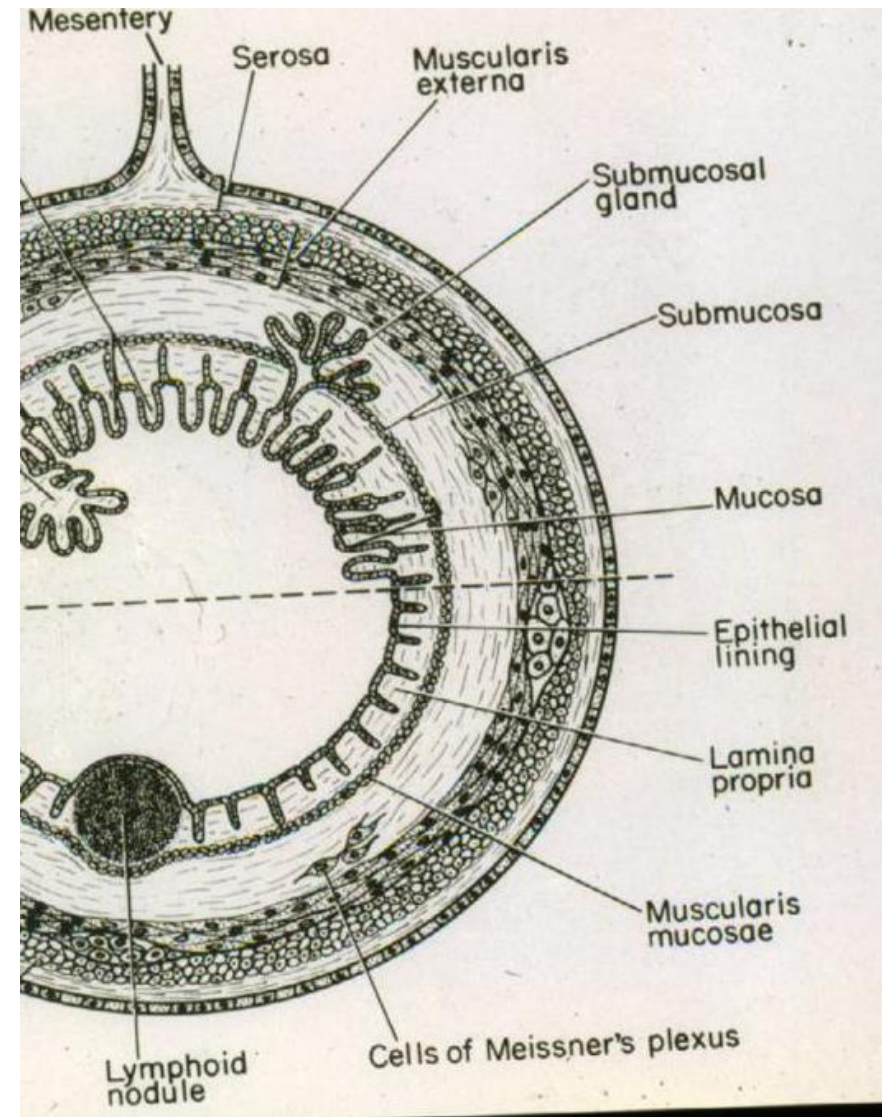
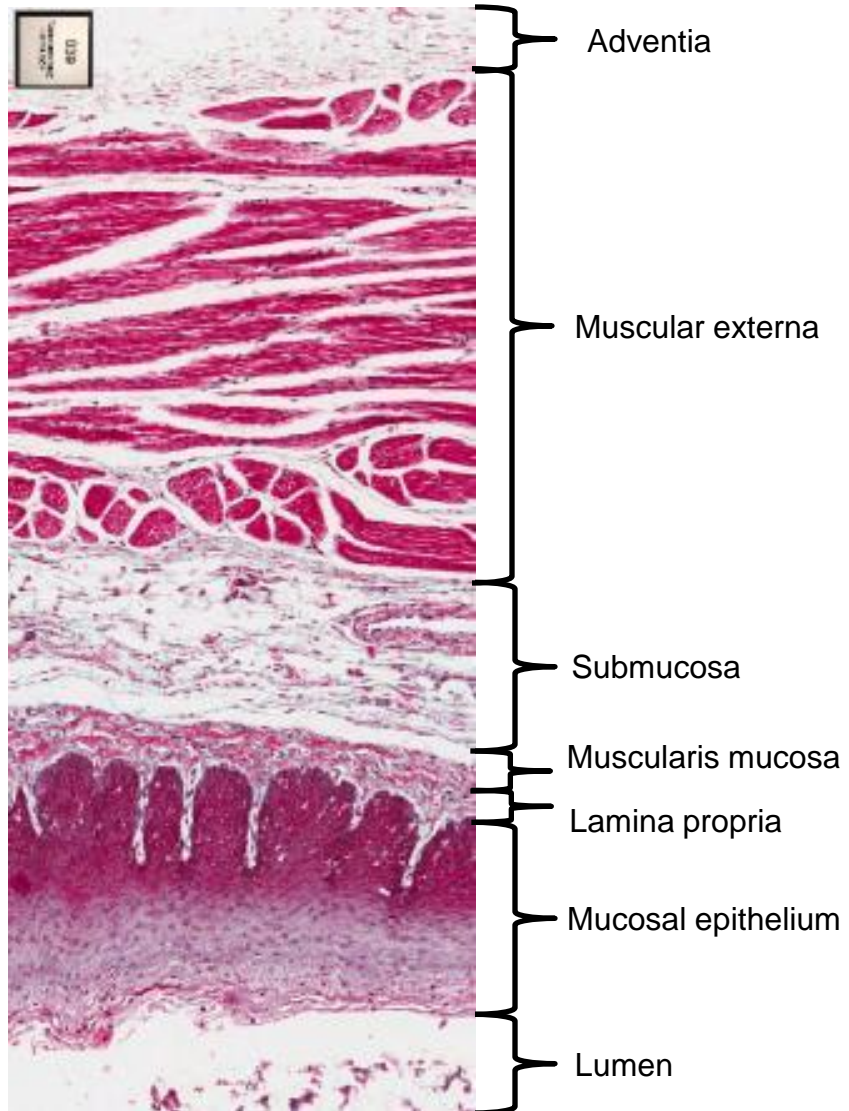
Mucous glands

Serous glands

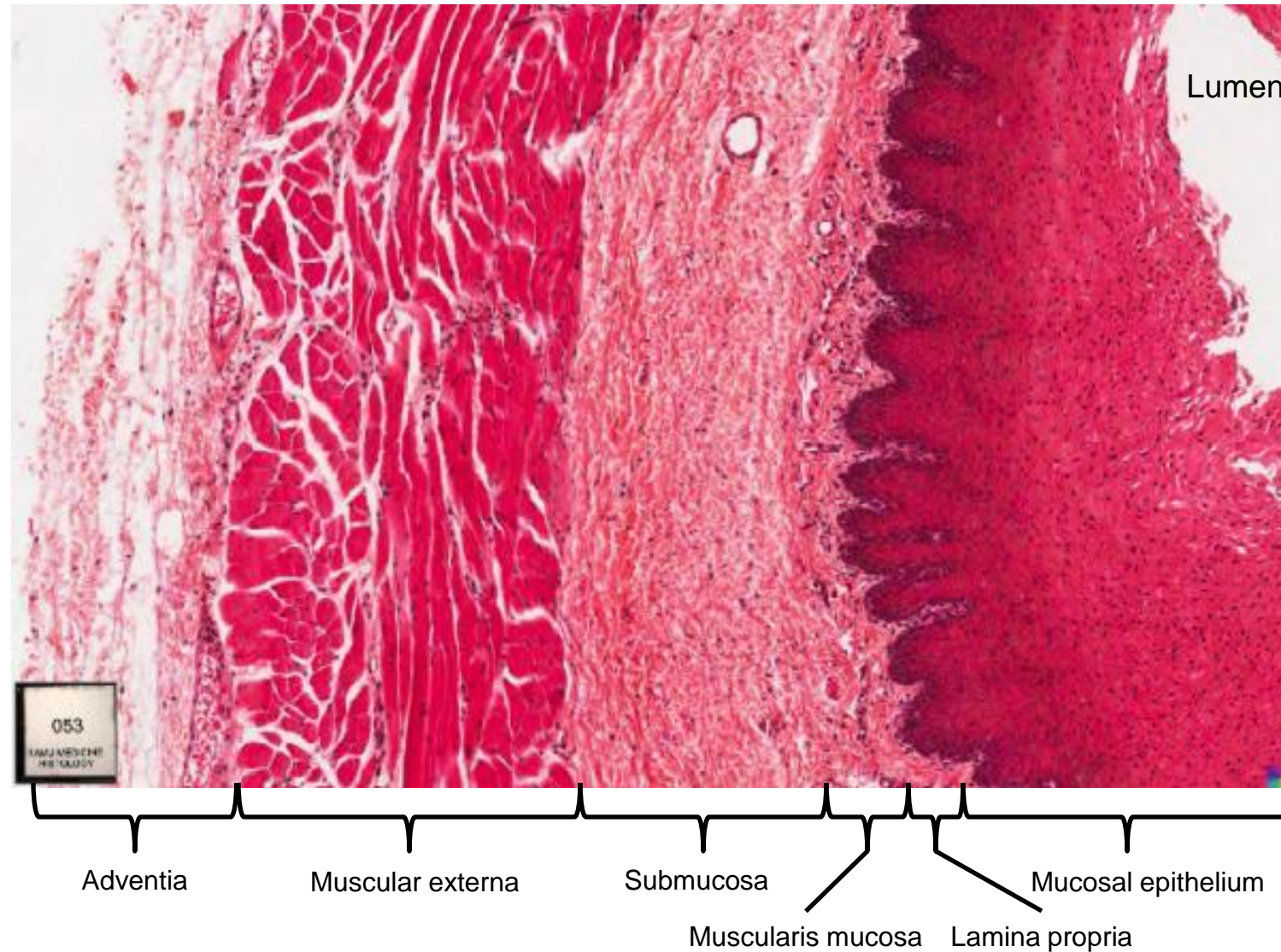
Skeletal muscle

Serous glands secretions contain a lipase that prevents the formation of a hydrophobic film on taste buds that would hinder gustation. Gustation is the act or sensation of tasting

Slide 39: Upper esophagus



Slide 53: Esophagus (upper portion)



Esophagus

Epithelium

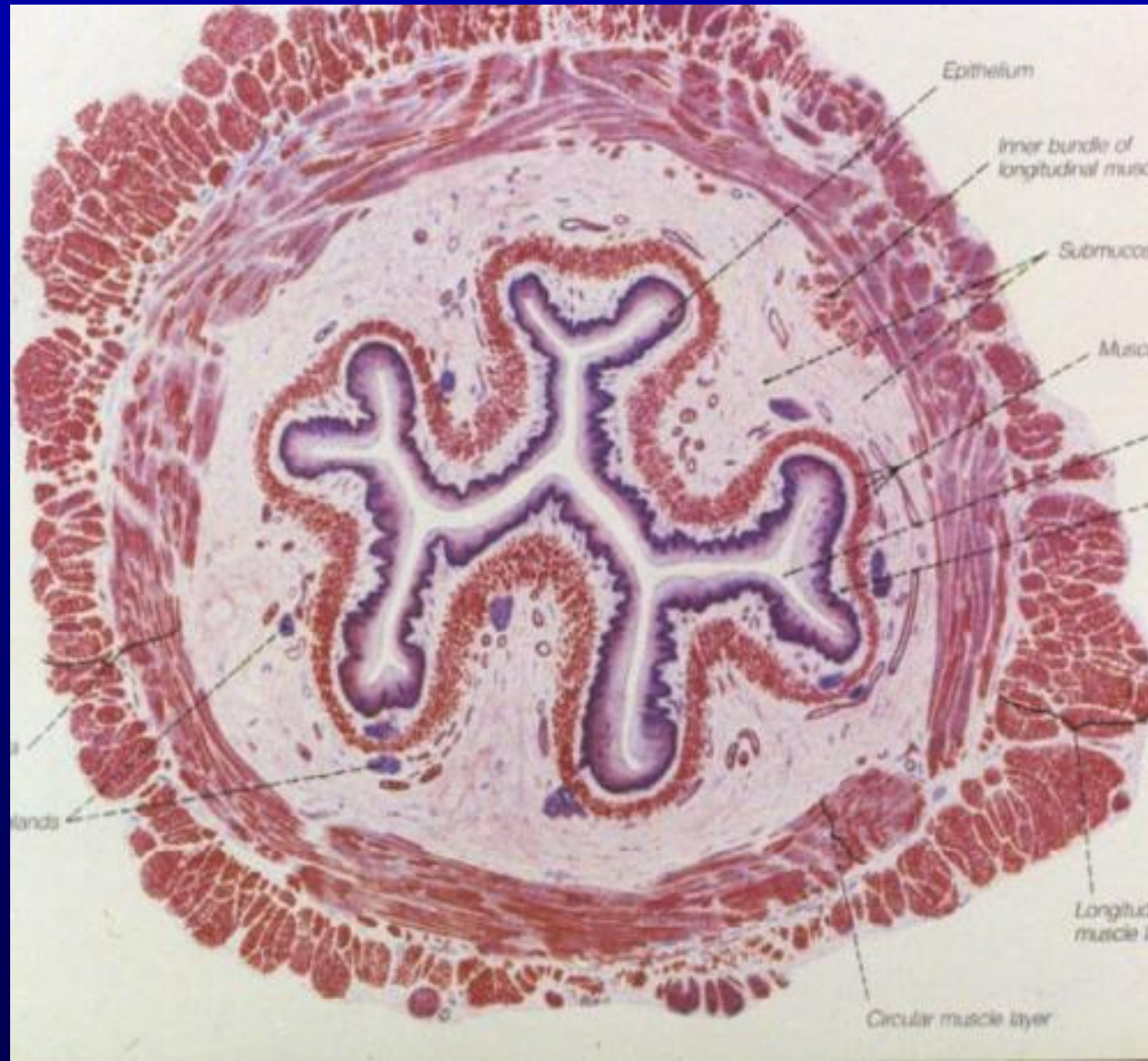
Glands

Esophageal glands,
proper

Esophageal glands,
cardiac

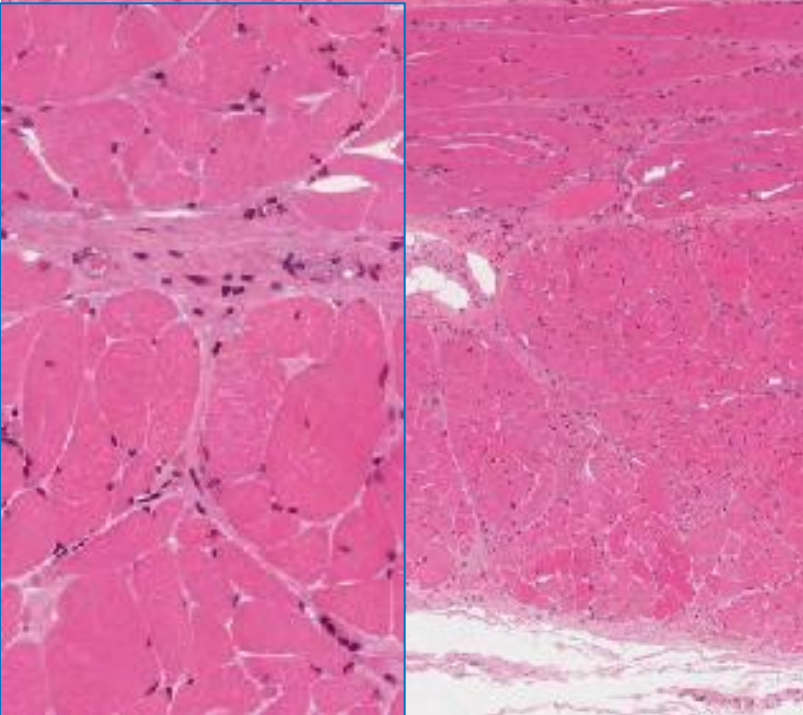
Muscularis

mucosa

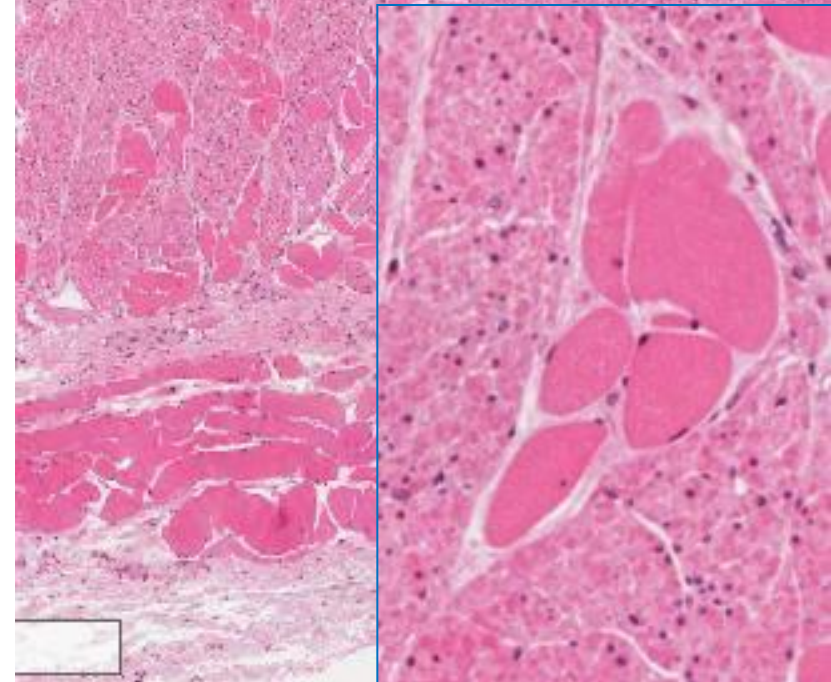


Esophagus

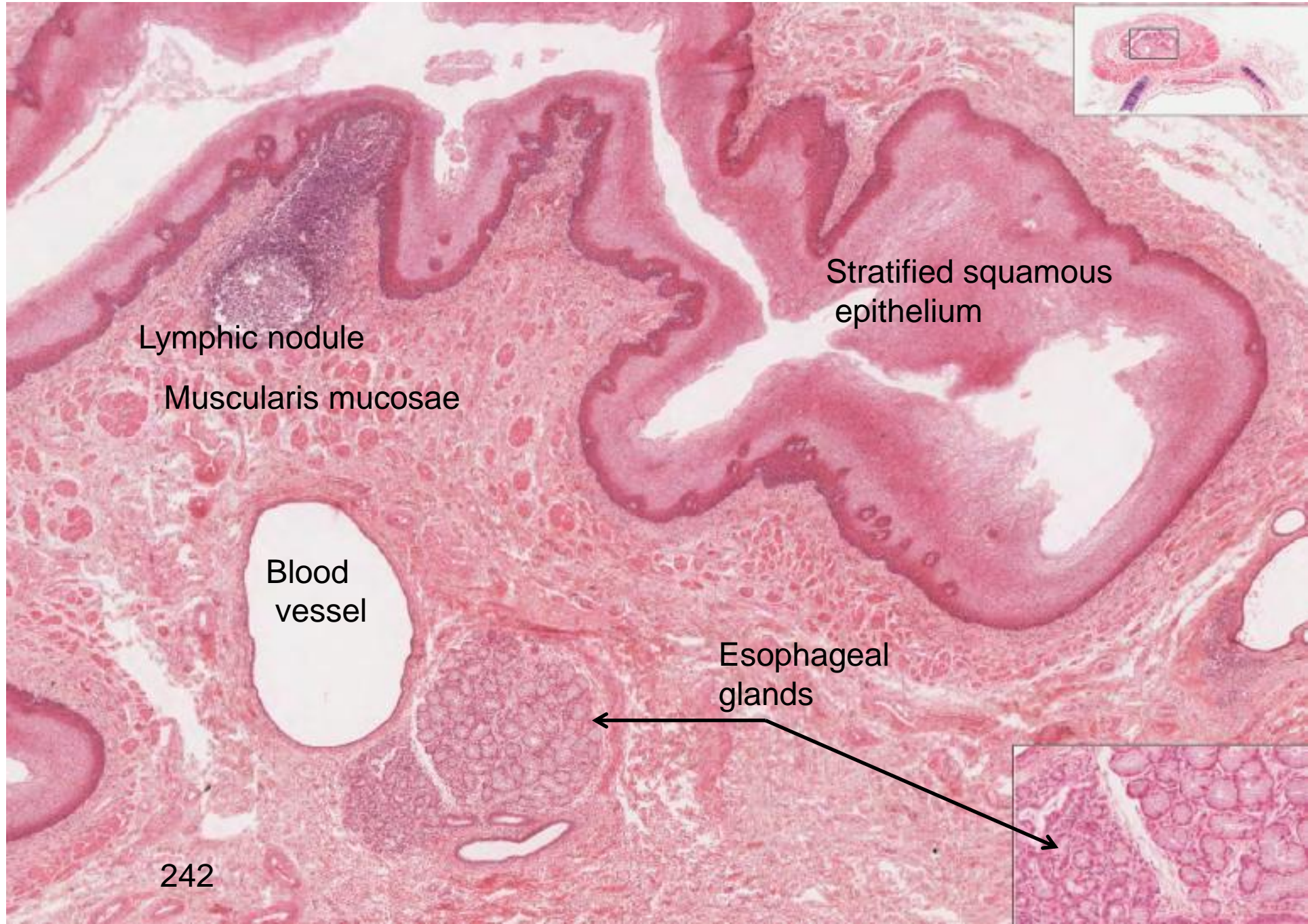
Muscularis externa of the upper esophagus is composed mostly of skeletal muscle

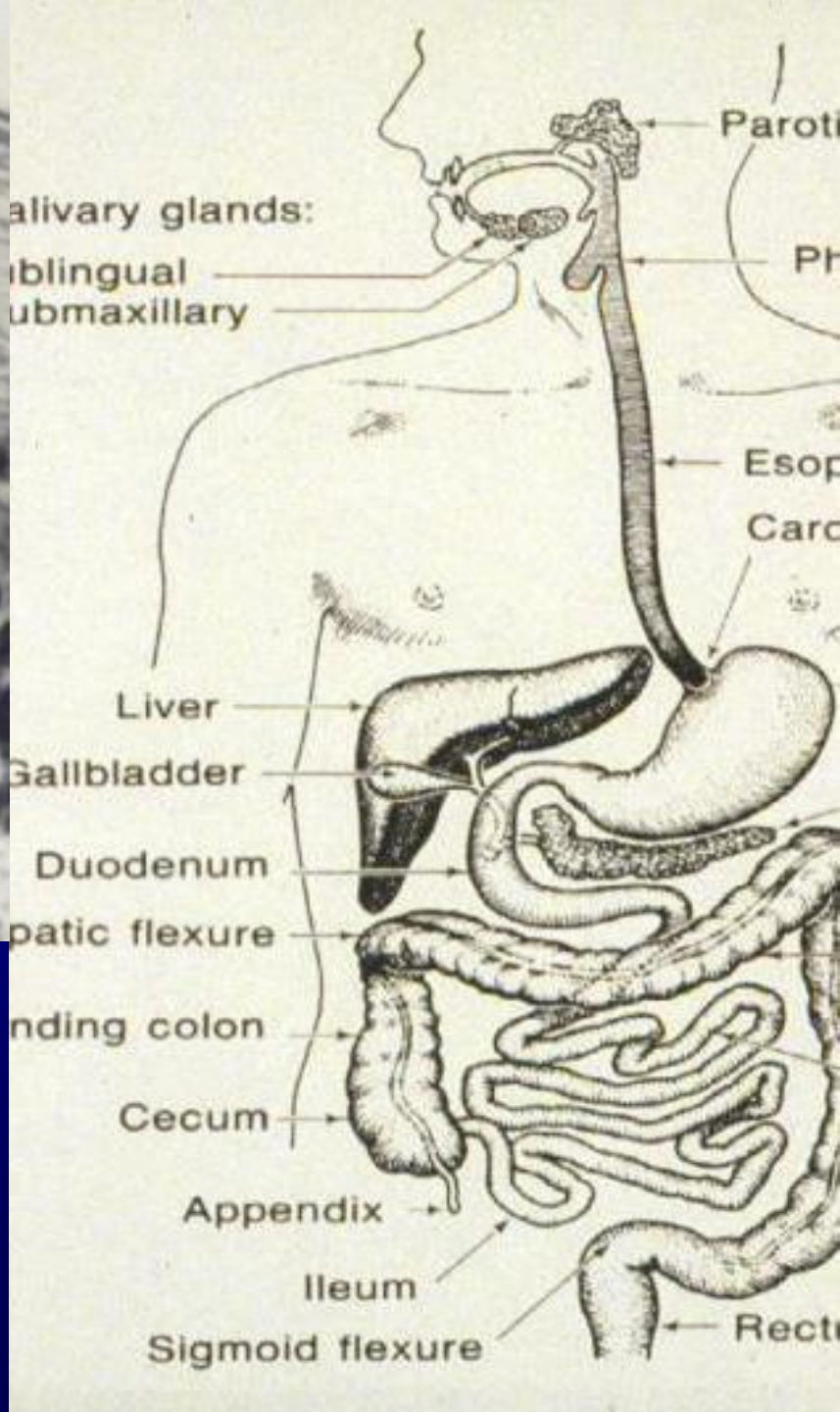
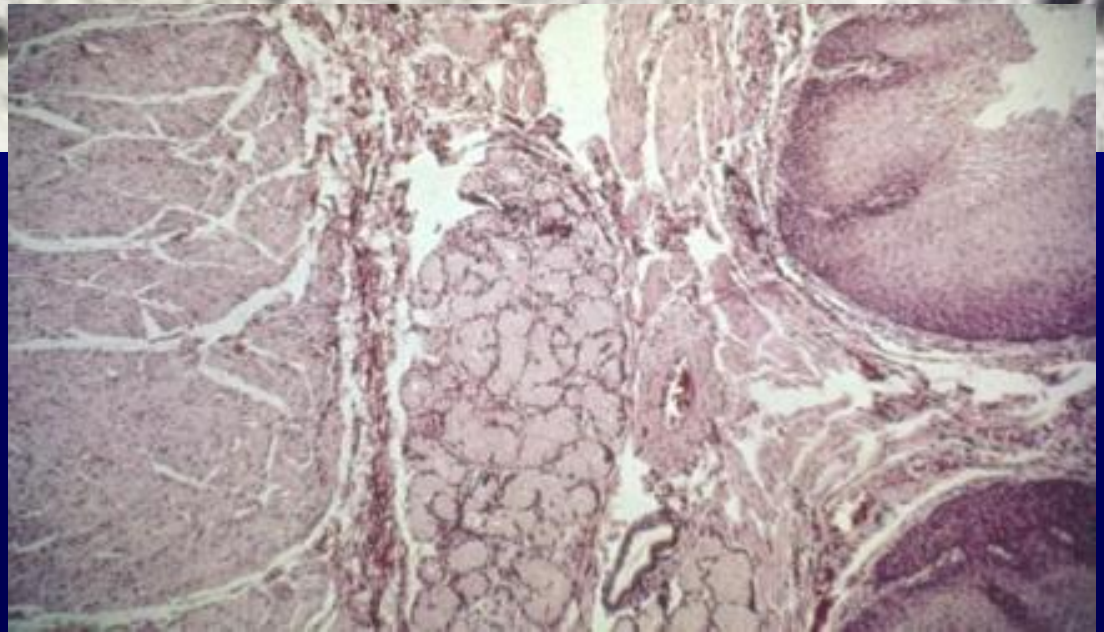
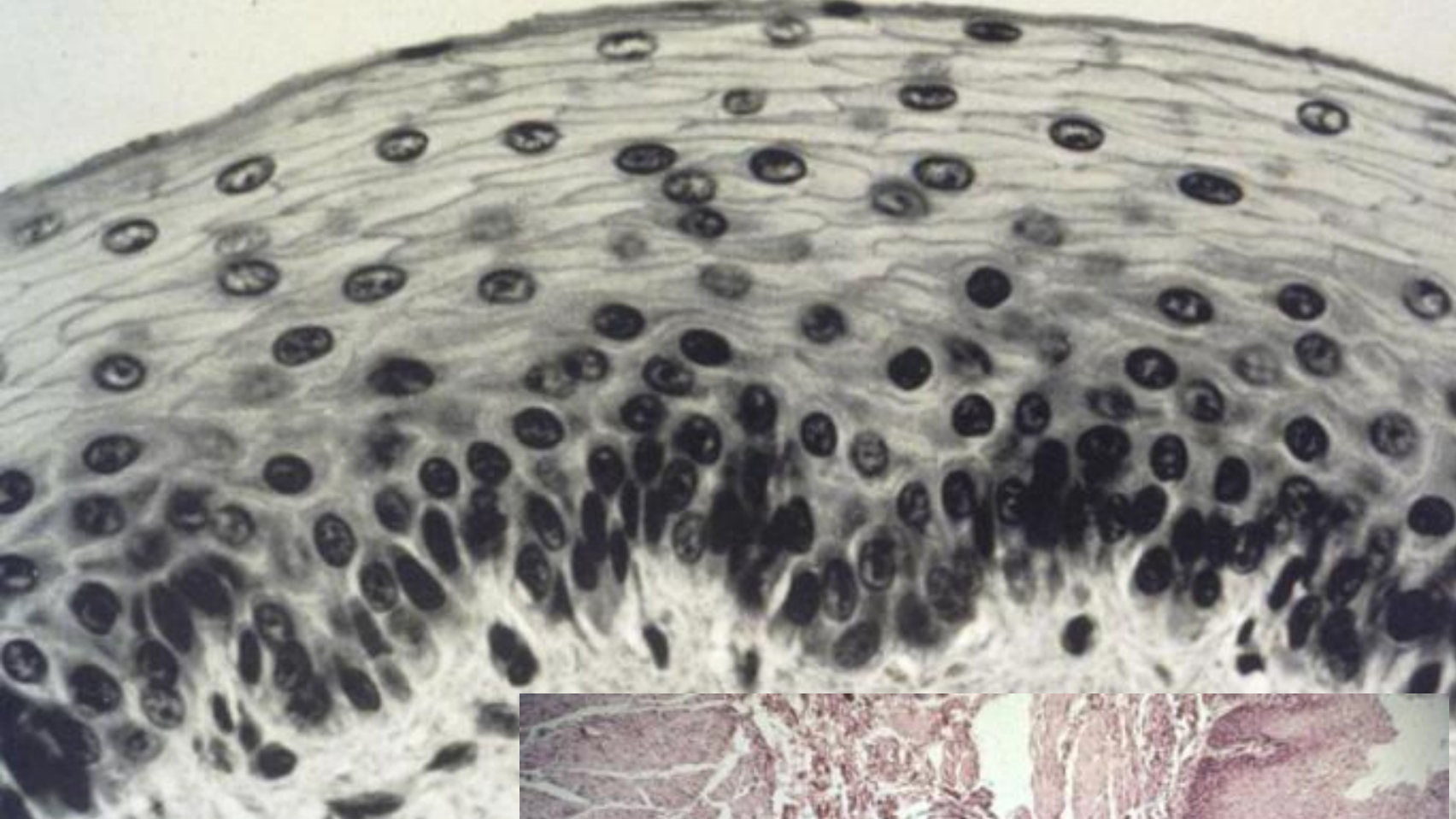


The muscularis externa in middle to lower esophagus is composed mostly of smooth muscle.

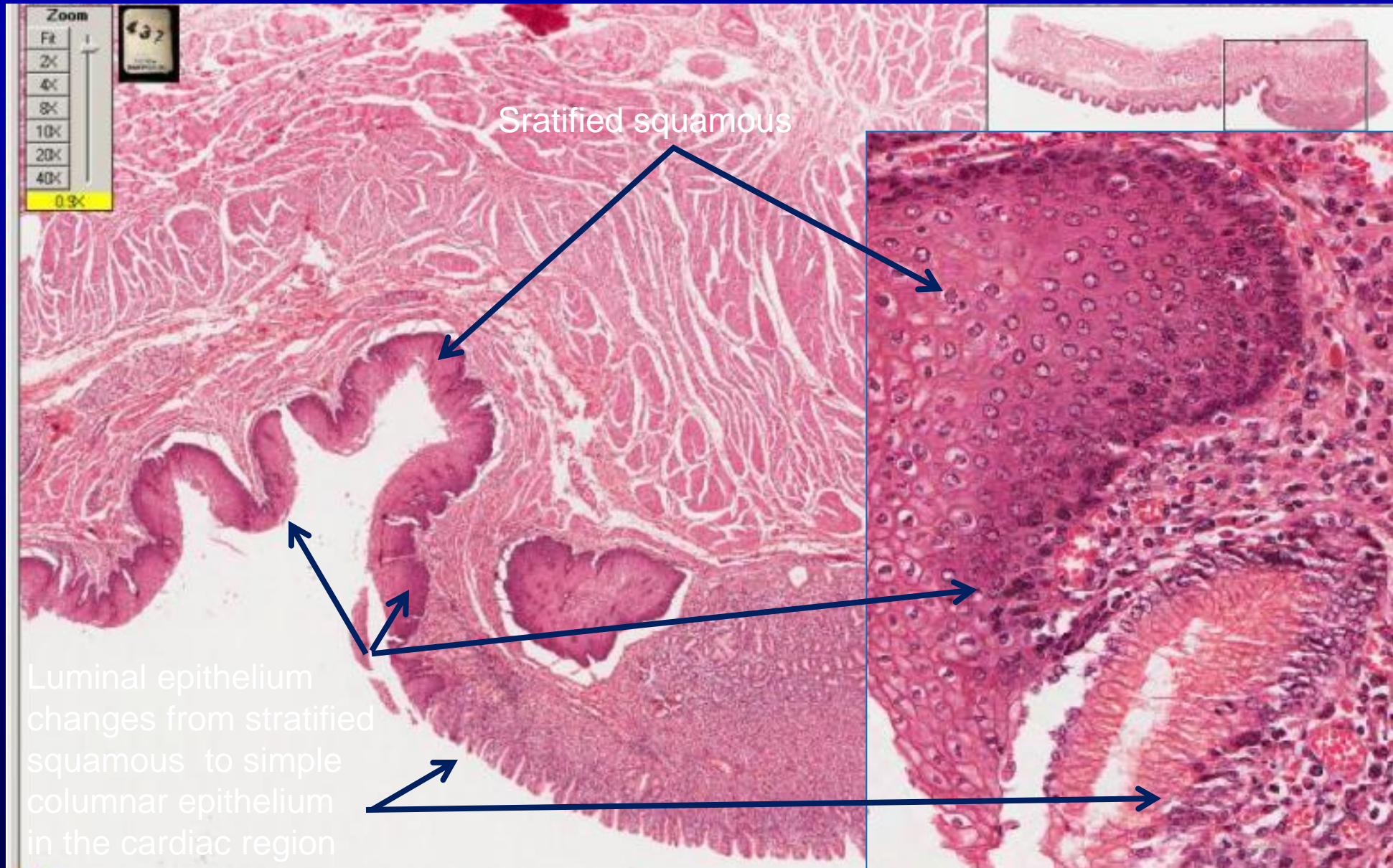


Monkey Esophagus



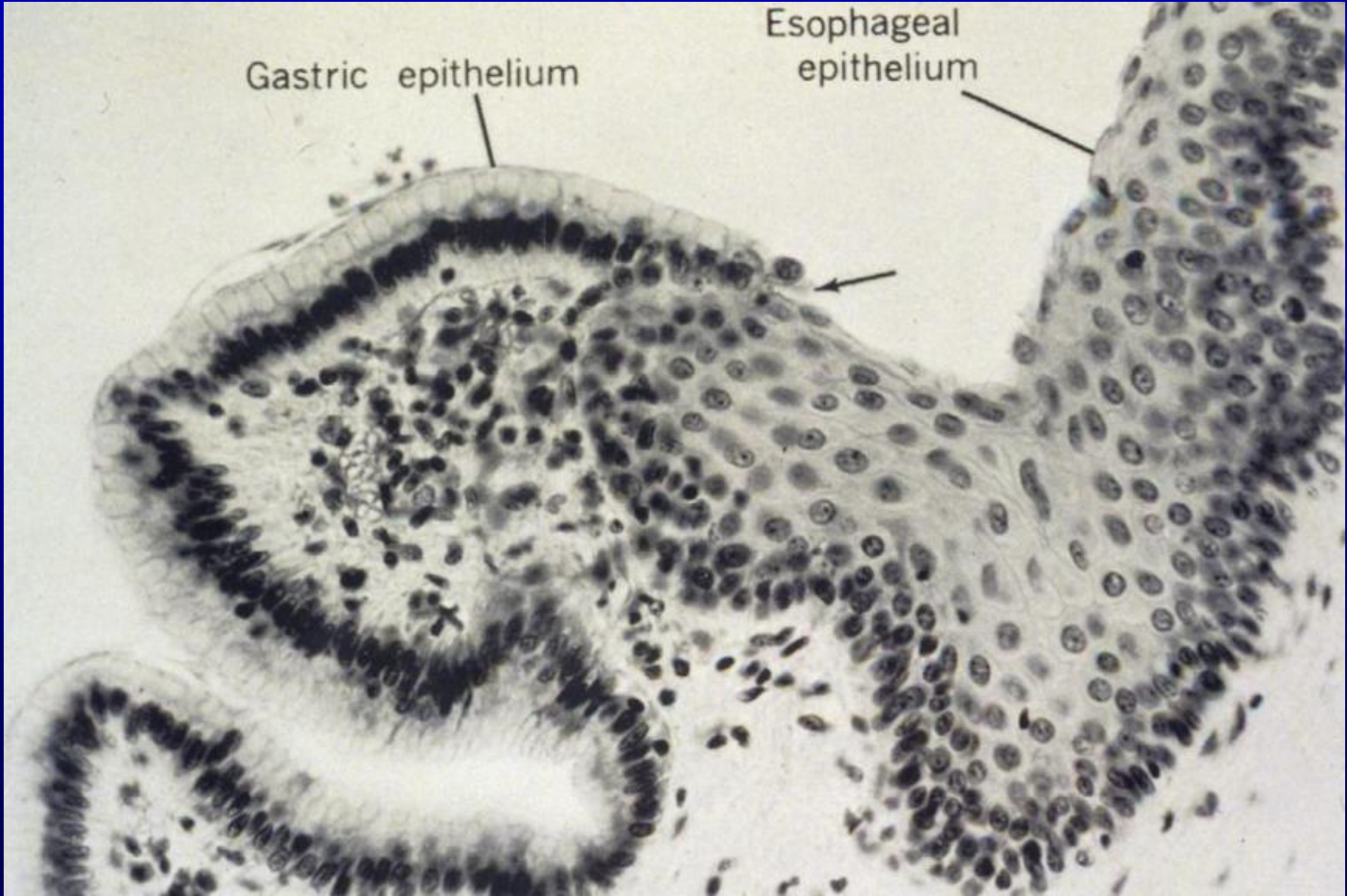


437 Cardio-esophageal junction



Gastric epithelium

Esophageal epithelium



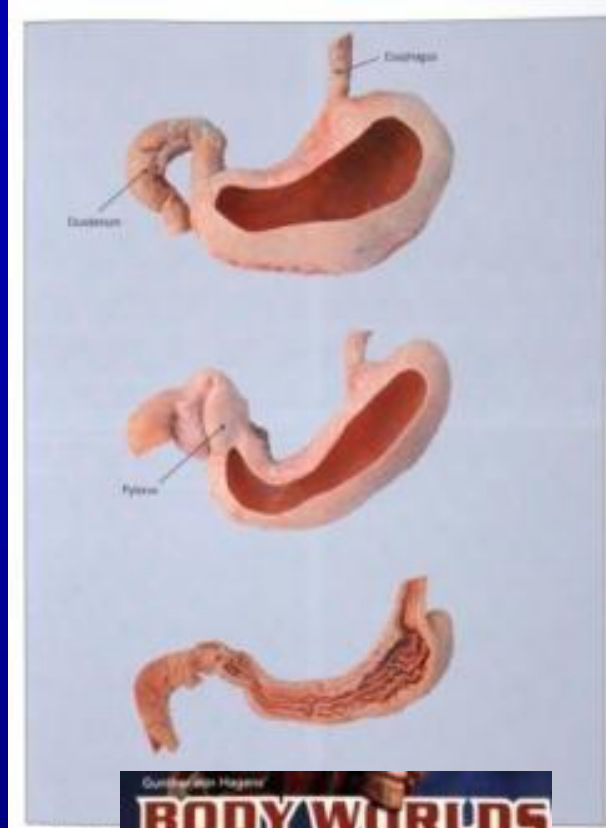


Fig. 25-6

Discovered by Hagena
BODY WORLDS
The Anatomical Exhibition of Real Human Bodies

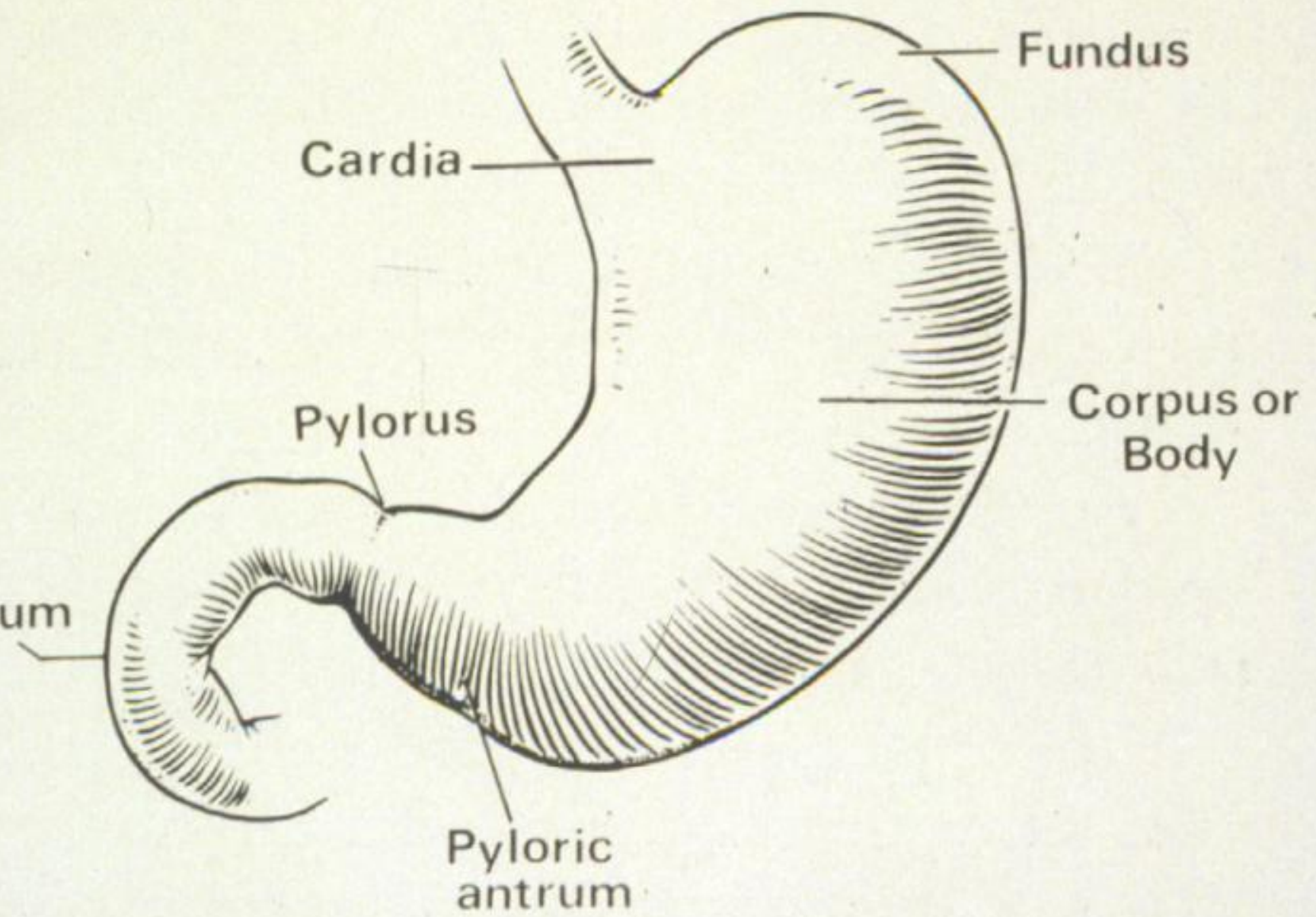
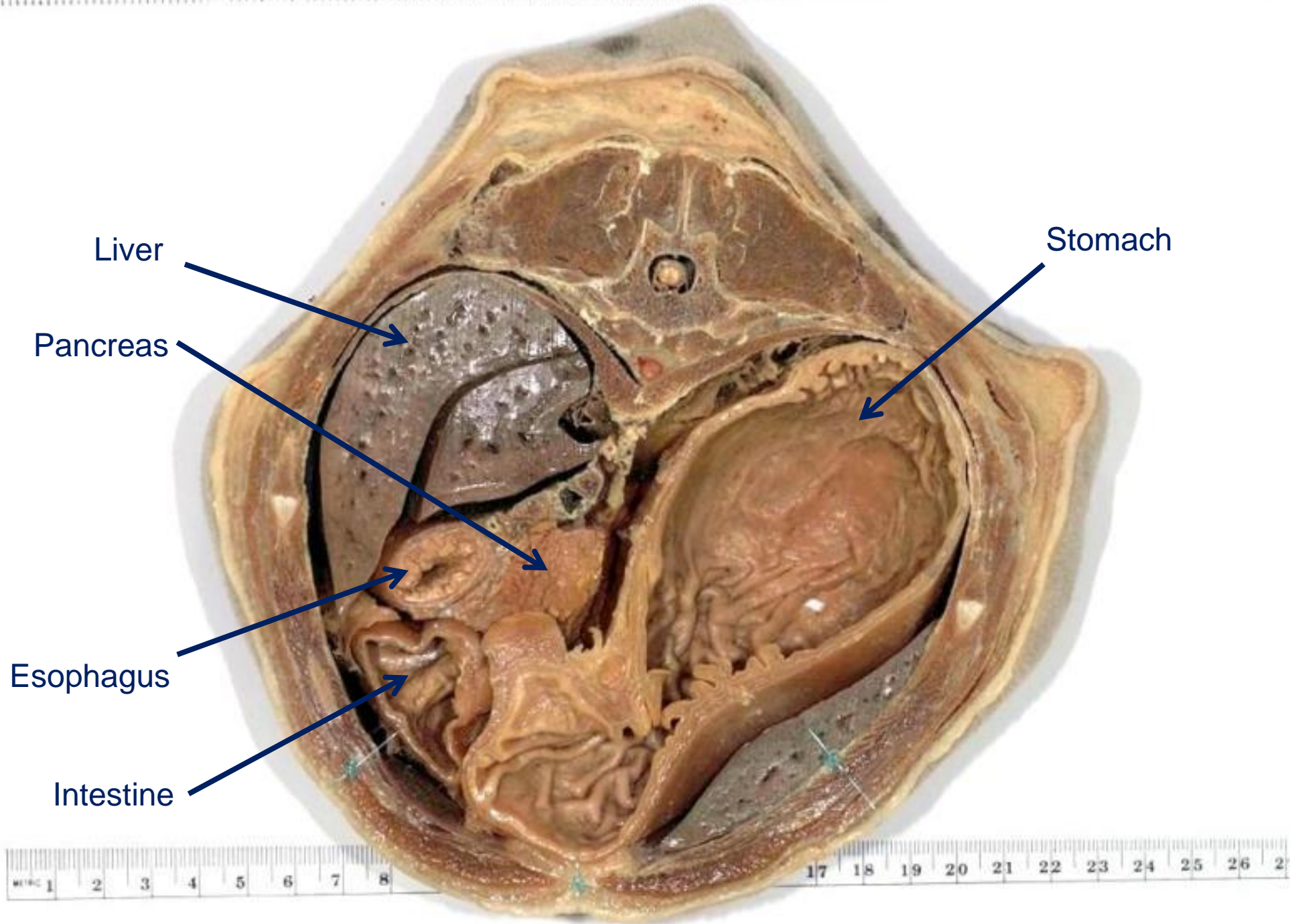


Figure 25–6. Drawing of the human stomach presenting



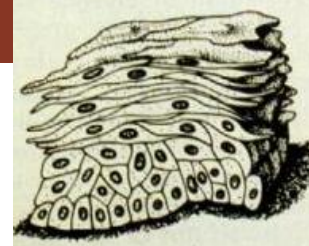
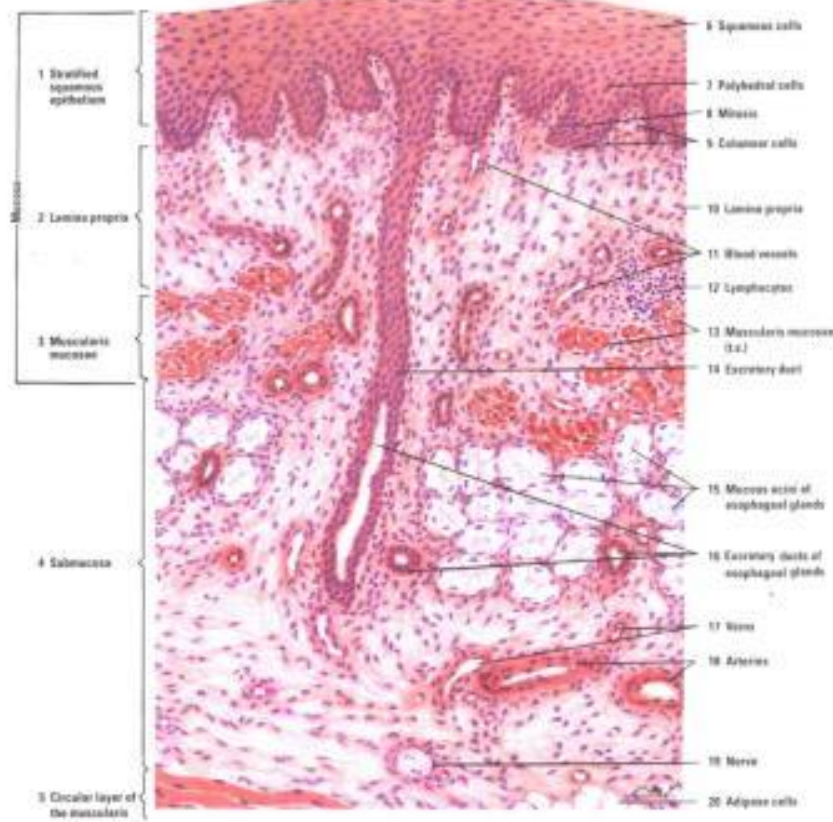
Liver

Pancreas

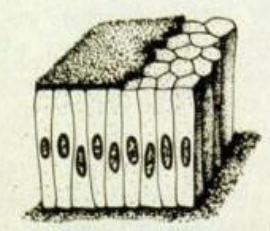
Esophagus

Intestine

Stomach



Stratified squamous



Simple columnar

di Fiore's **ATLAS OF HISTOLOGY** with FUNCTIONAL CORRELATIONS

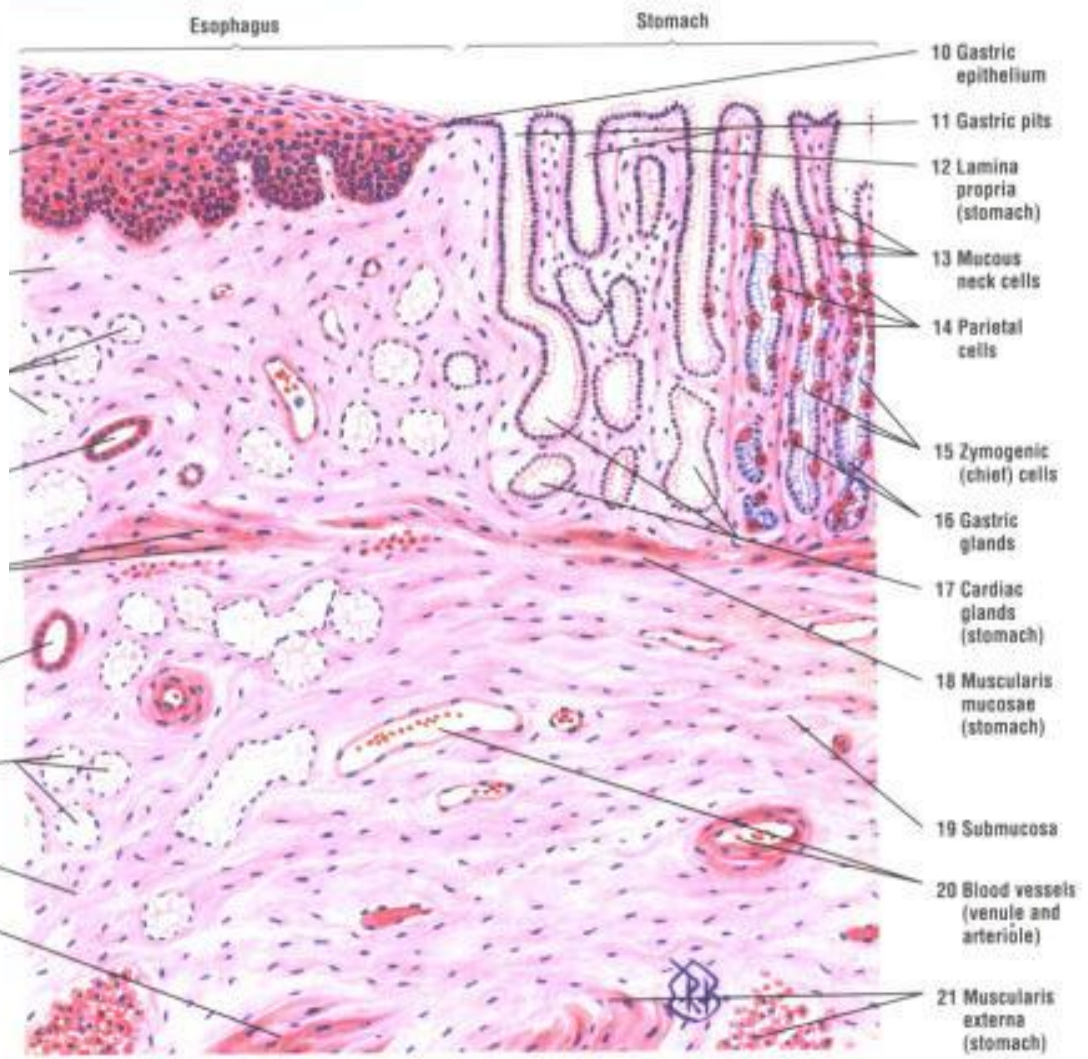
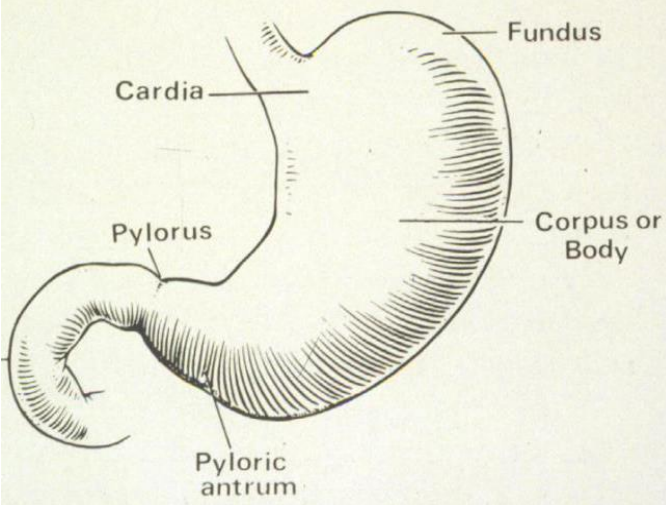
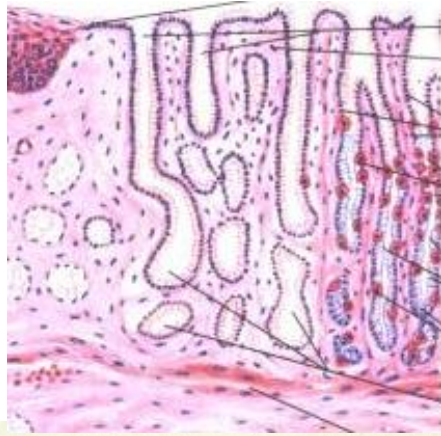


Fig. 11-5 Esophageal-Stomach Junction. Stain: hematoxylin-eosin. Low magnification.

CARDIAC GLANDS



© FINE'S **ATLAS OF HISTOLOGY** WITH FUNCTIONAL CORRELATIONS

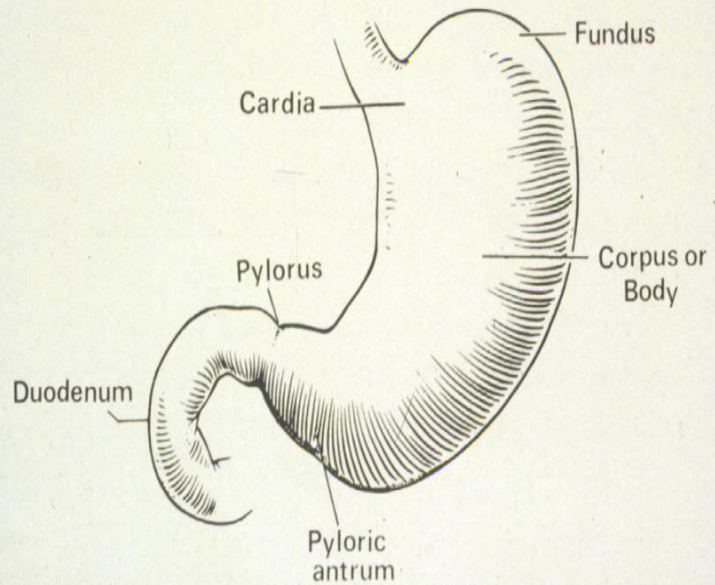
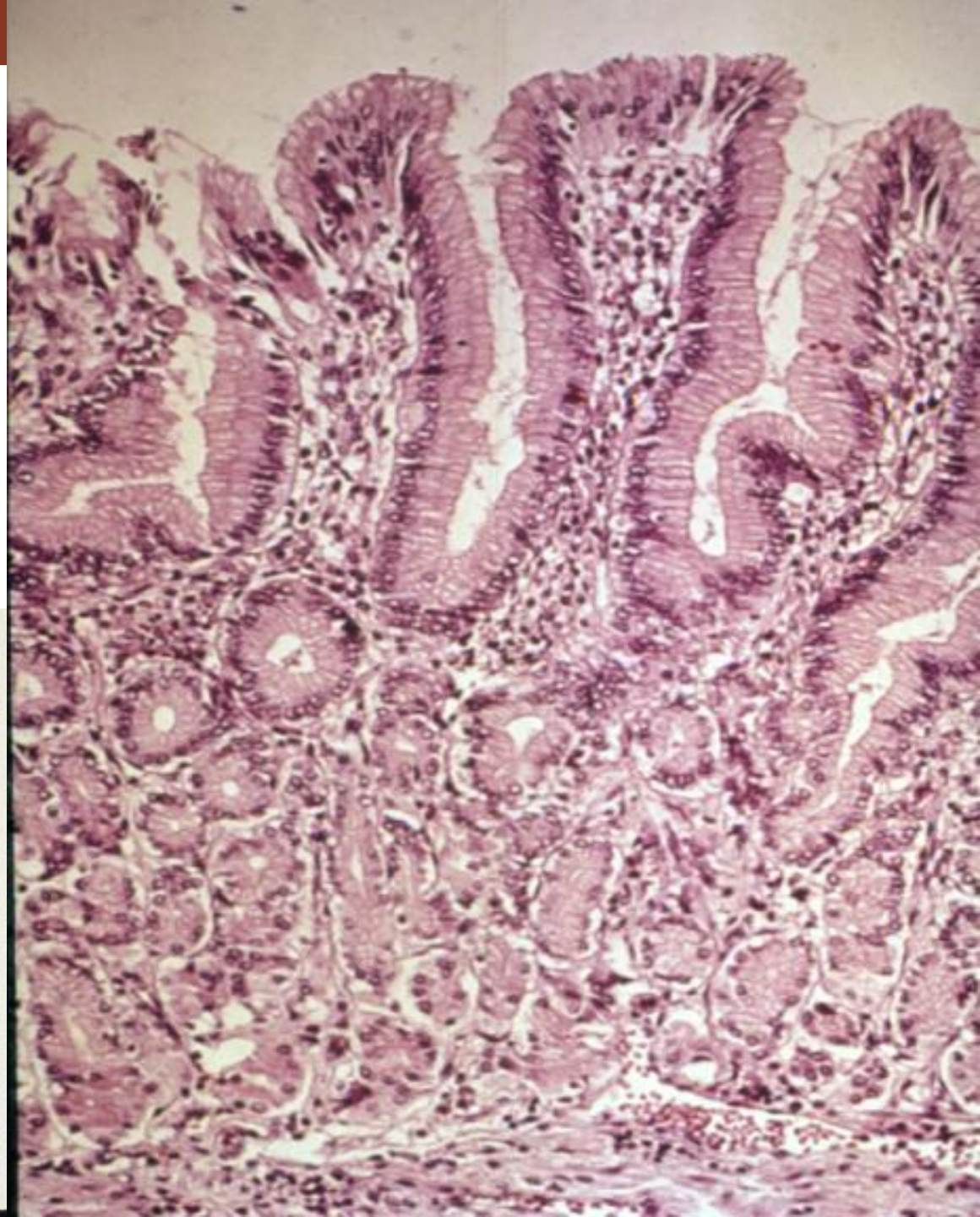


Figure 25-6. Drawing of the human stomach presenting



General organization of Stomach

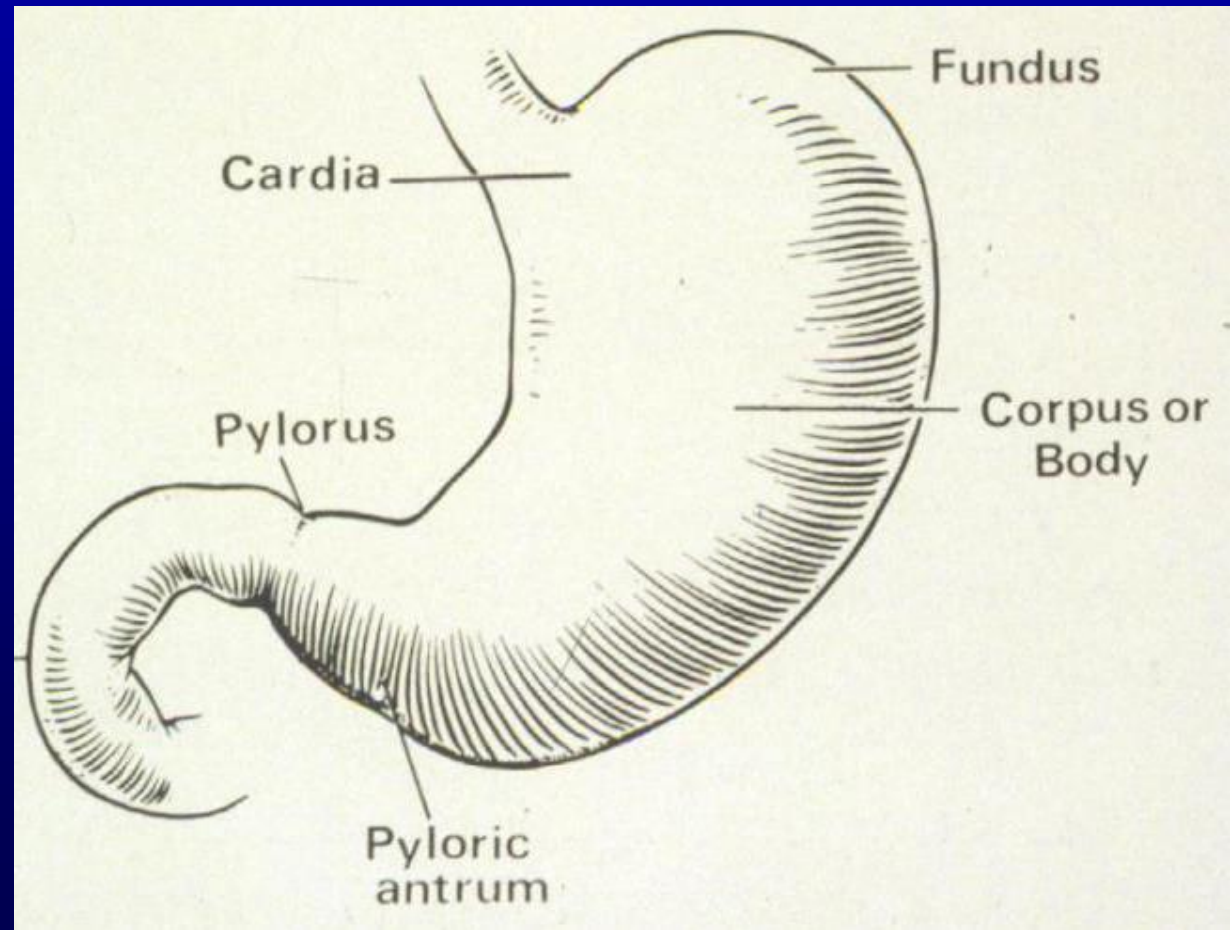
Gastric mucosa
epithelium

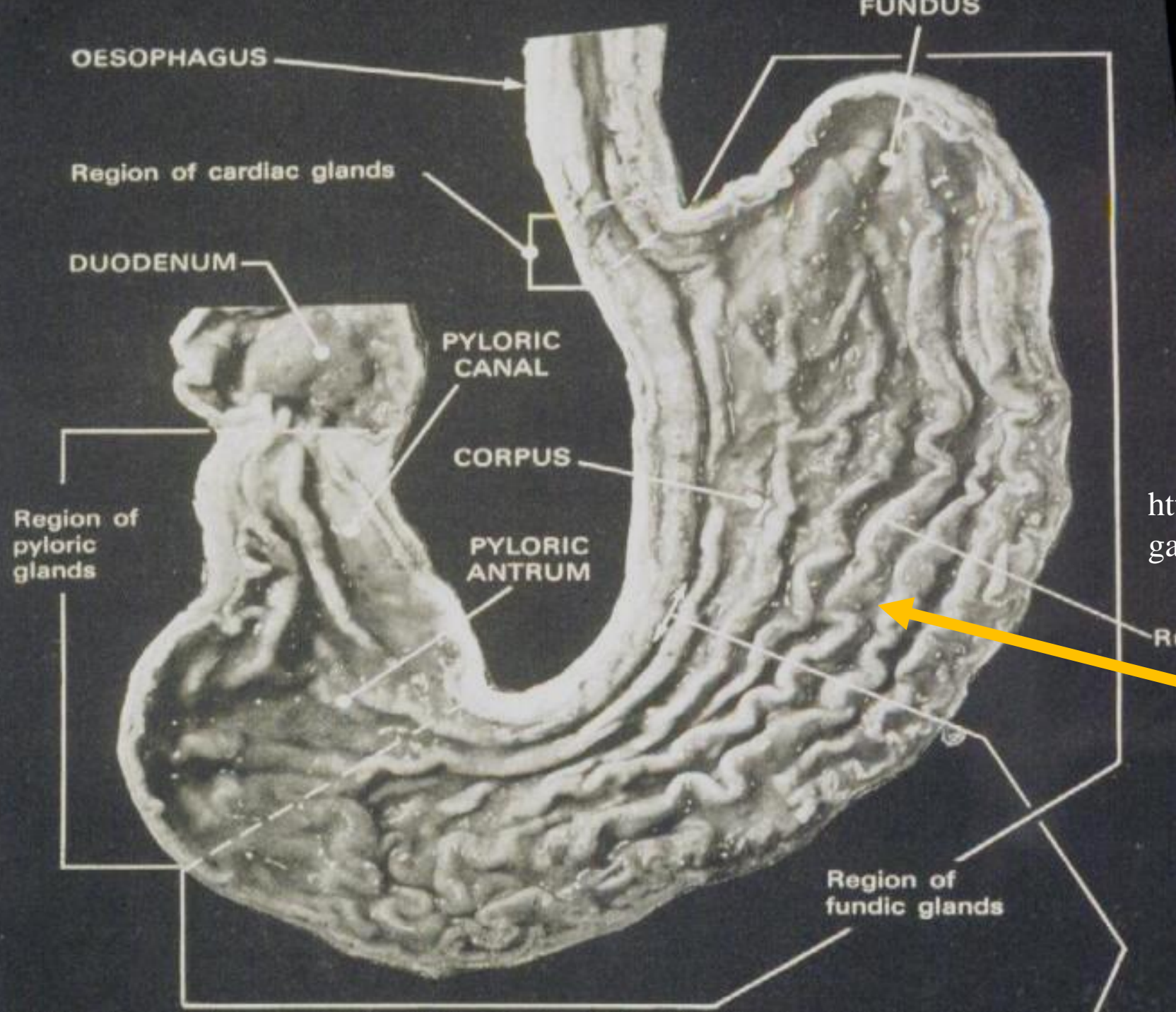
Surface epithelium

Cardiac glands

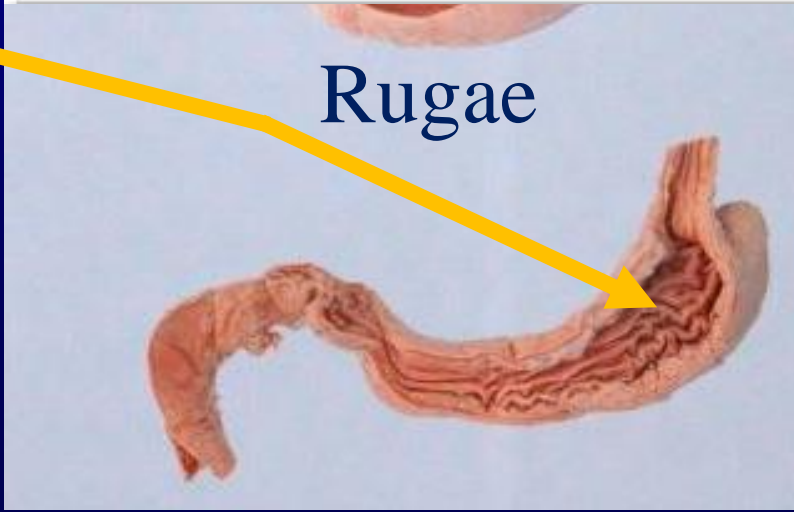
Gastric glands (oxyntic
Glands)

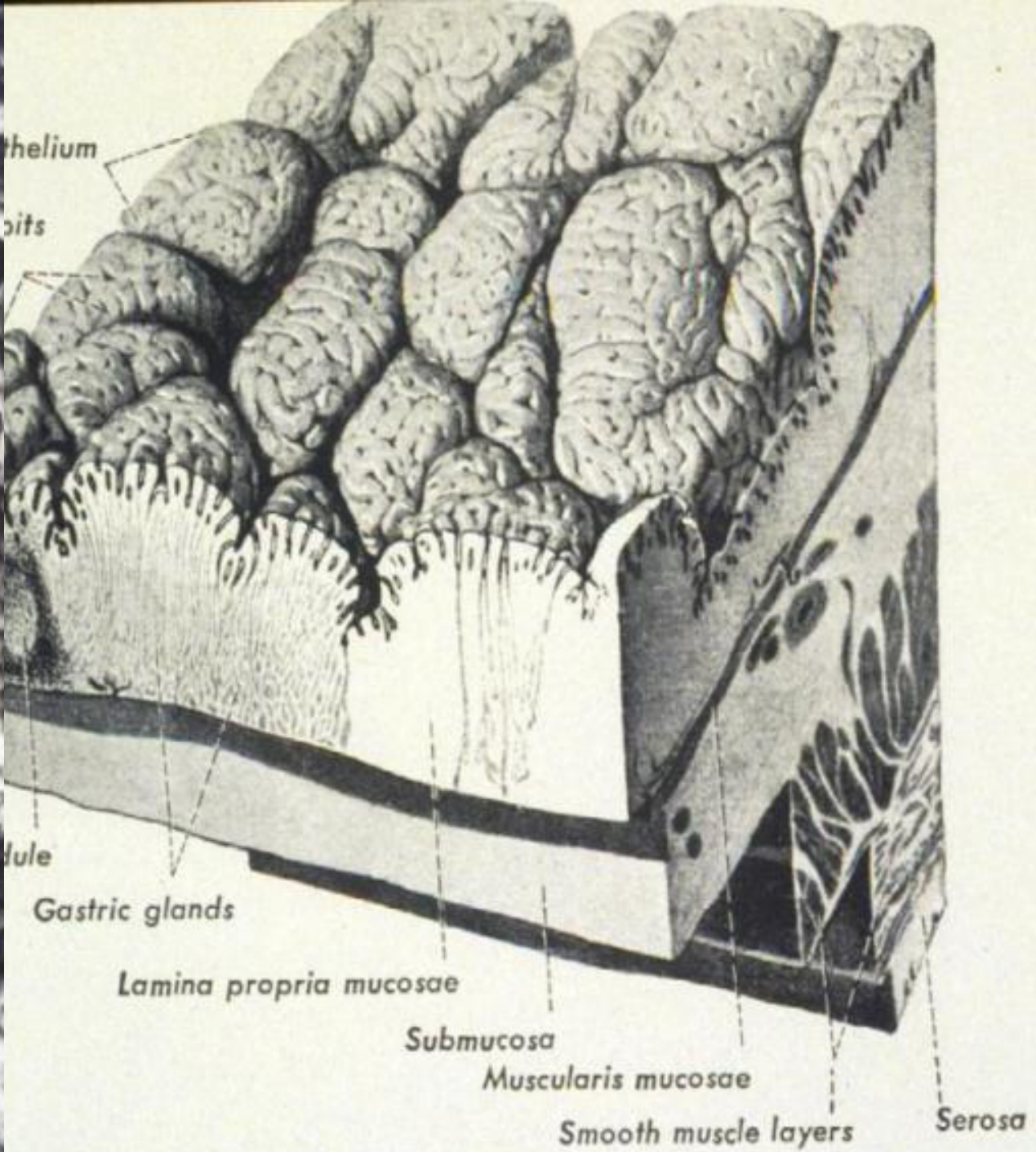
Pyloric glands



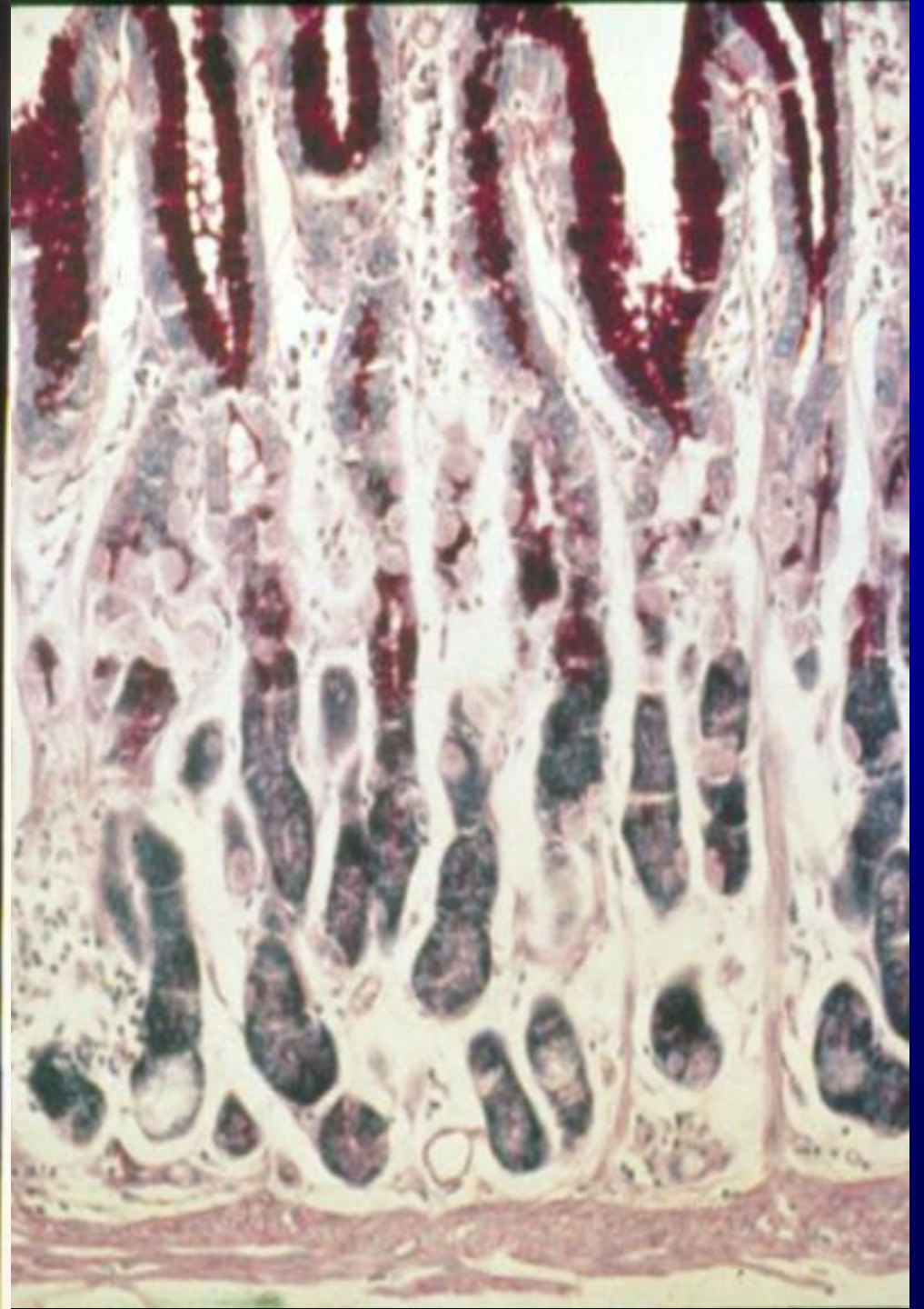
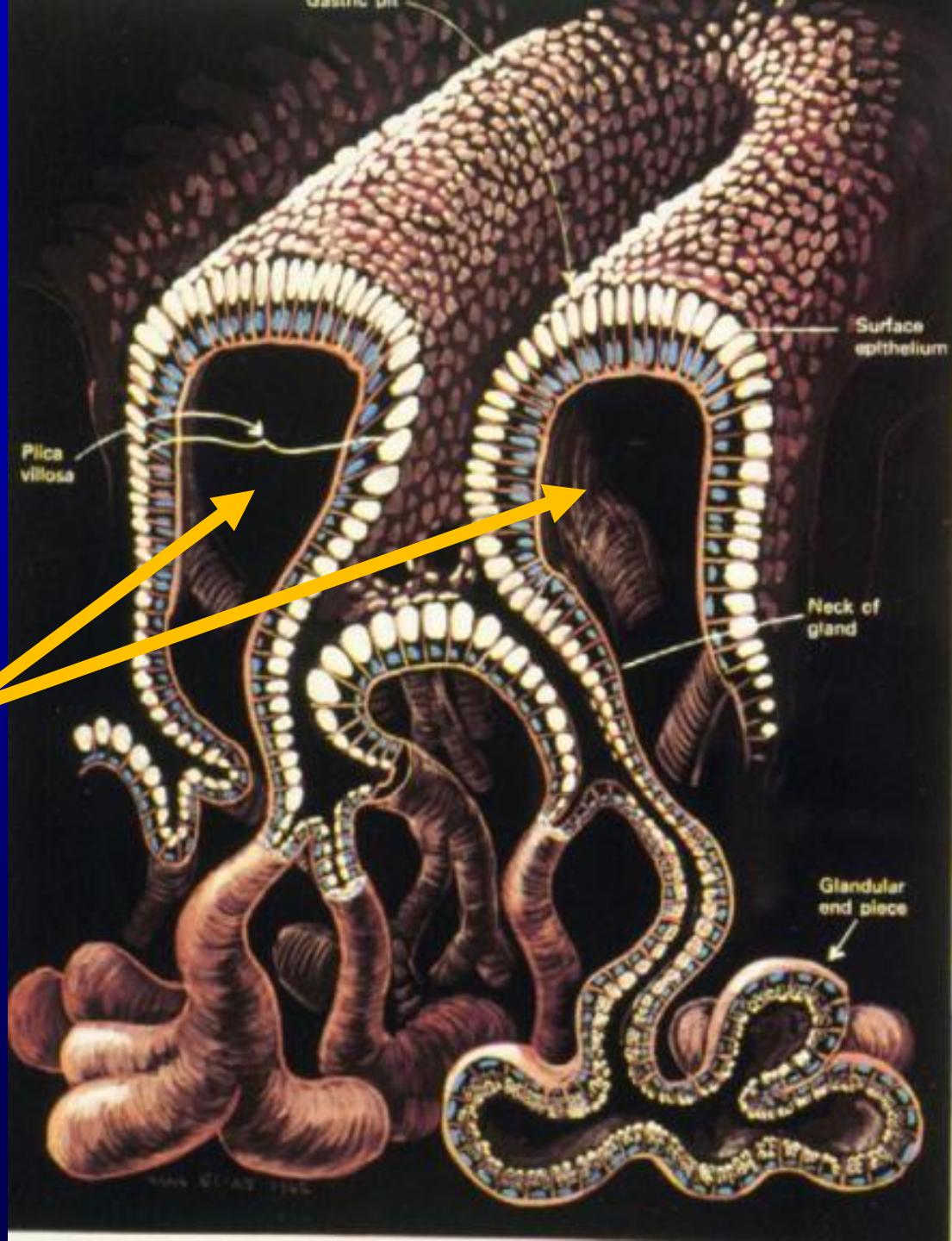


57. Picture of Stomach

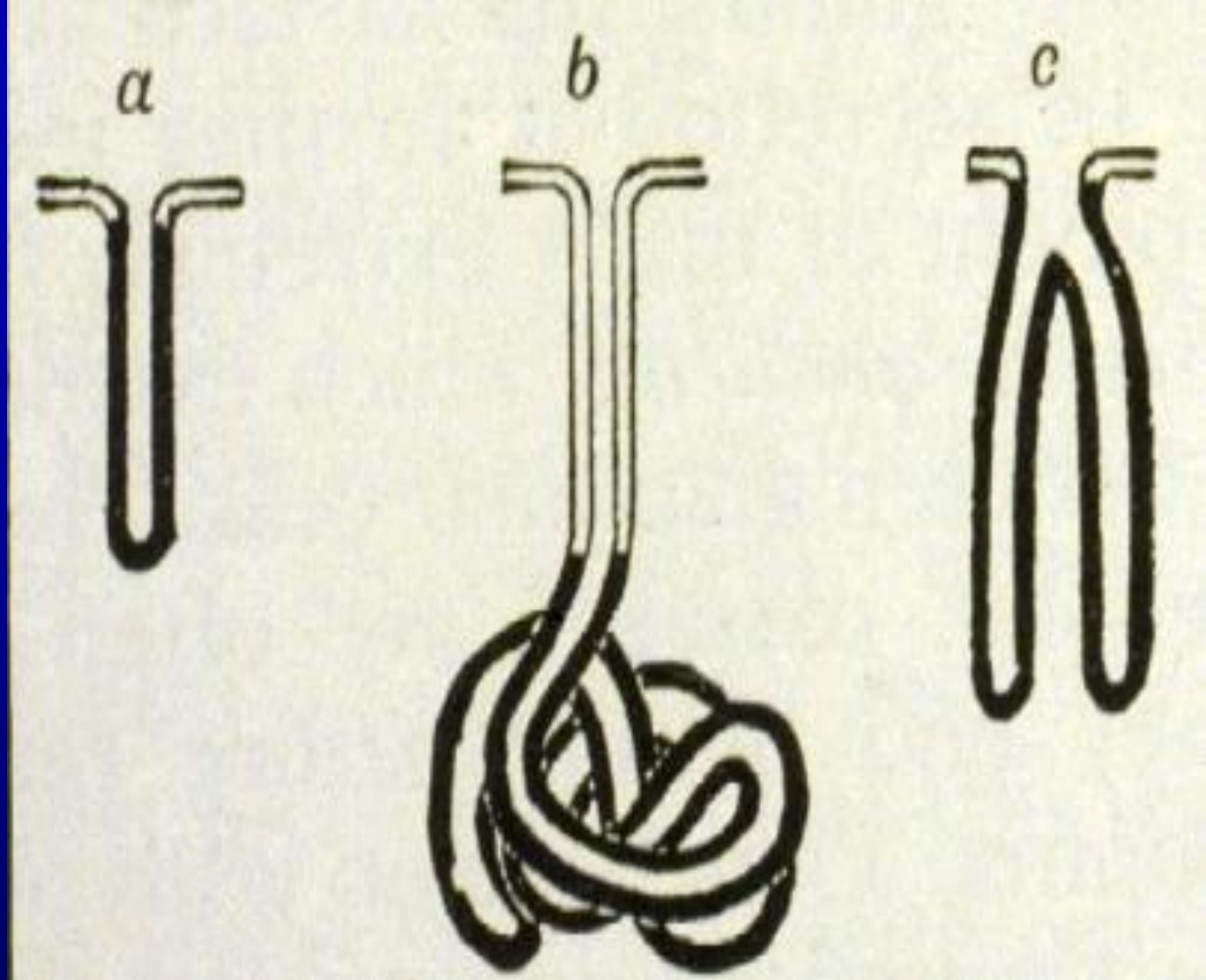




Rugae



Simple glands



Simple Tubular -- intestine

Simple Coiled tubular -- sweat gland

Simple Branched -- stomach glands

Glandular epithelial cells of stomach

Surface mucous cells

Mucous neck cell

Chief cell (zymogenic cell)

Parietal cell (oxyntic cell)

Endocrine cell (Argentaffin or enterochromaffin cell)

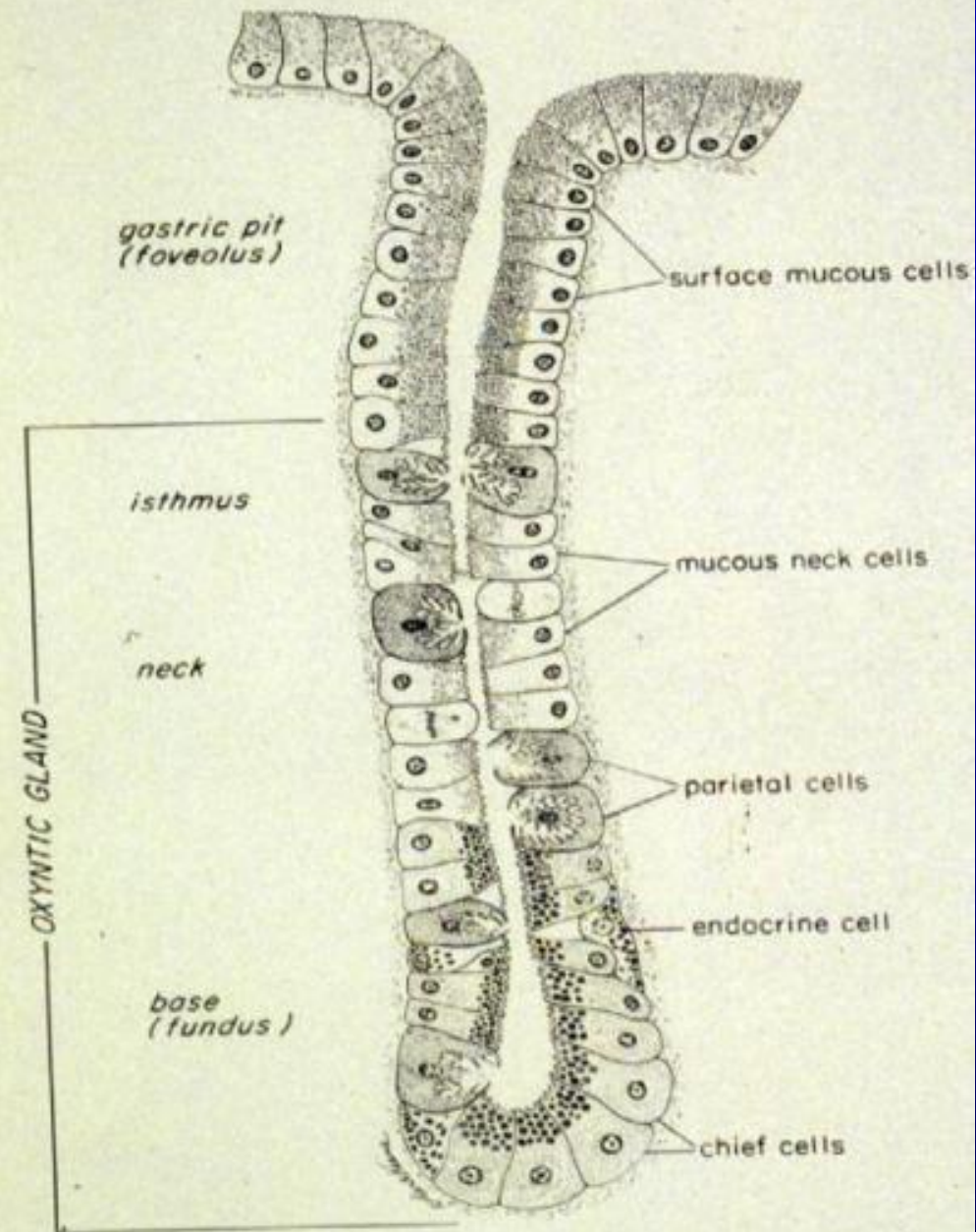


Figure 25-13. Diagram of an oxyntic gland from the corpus of a mammalian stomach. (From Ito, S. *In* Johnson L. R., ed.: *Physiology of the Gastrointestinal Tract*. New York, Raven Press, 1981.)

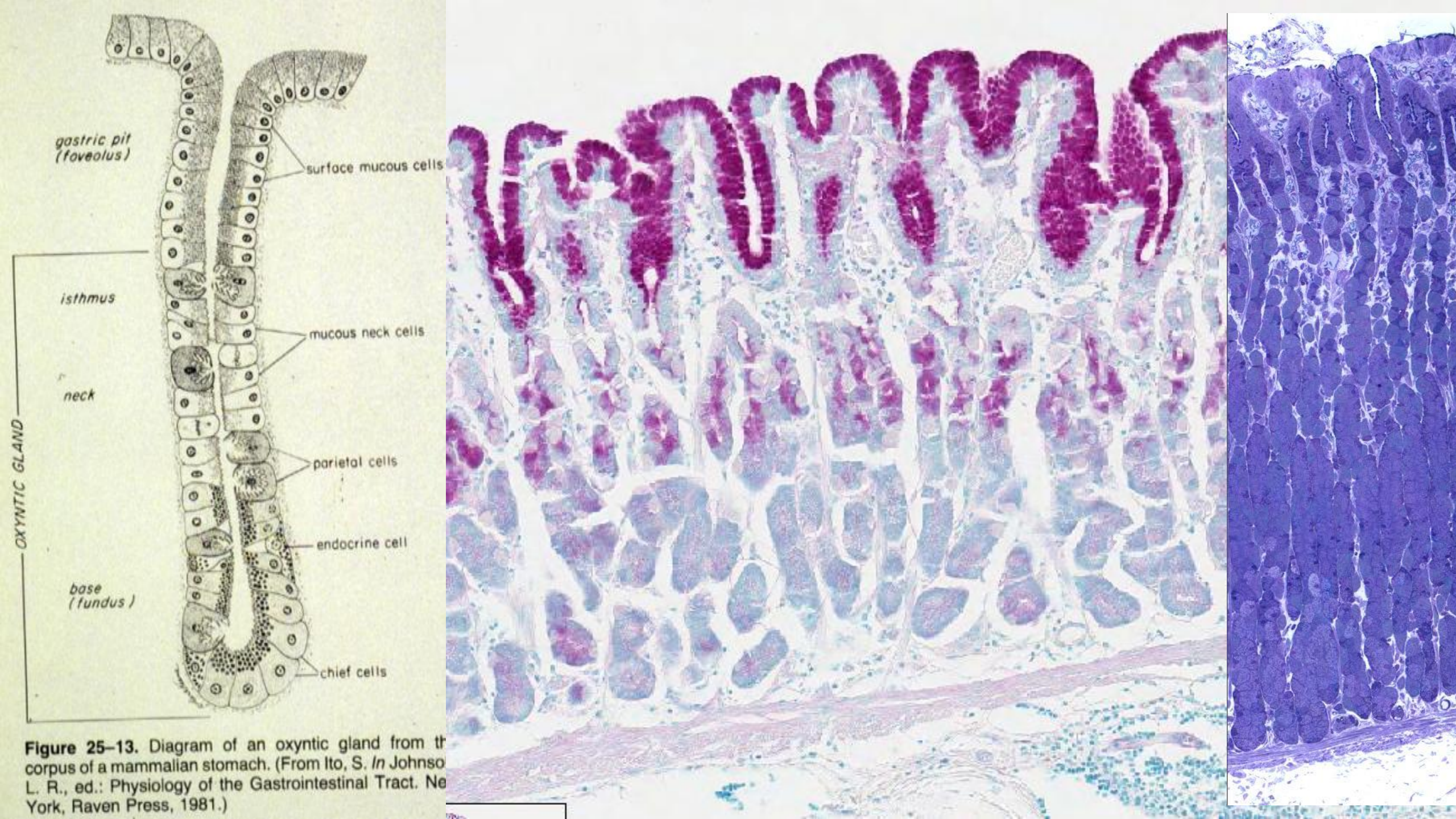
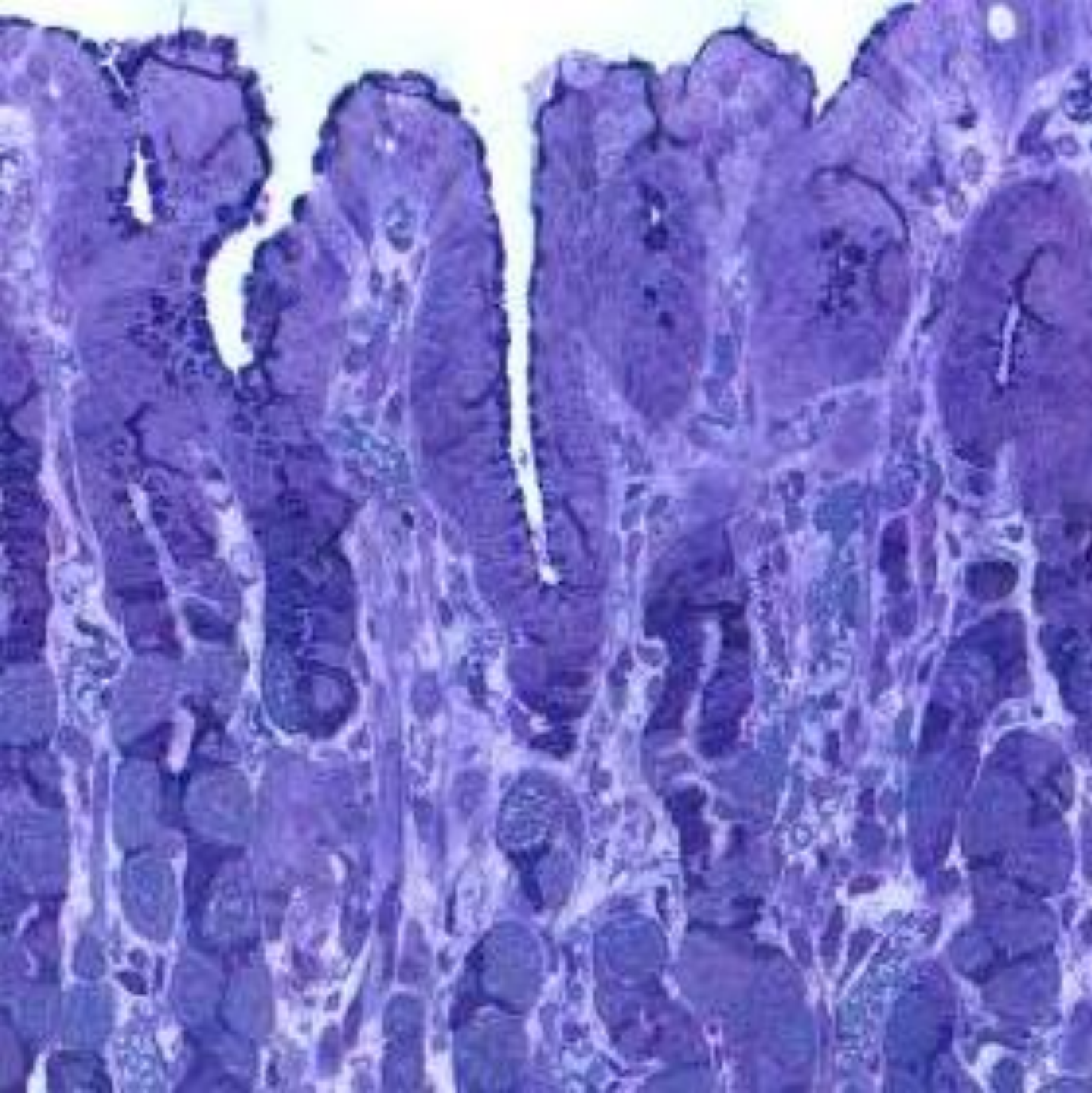
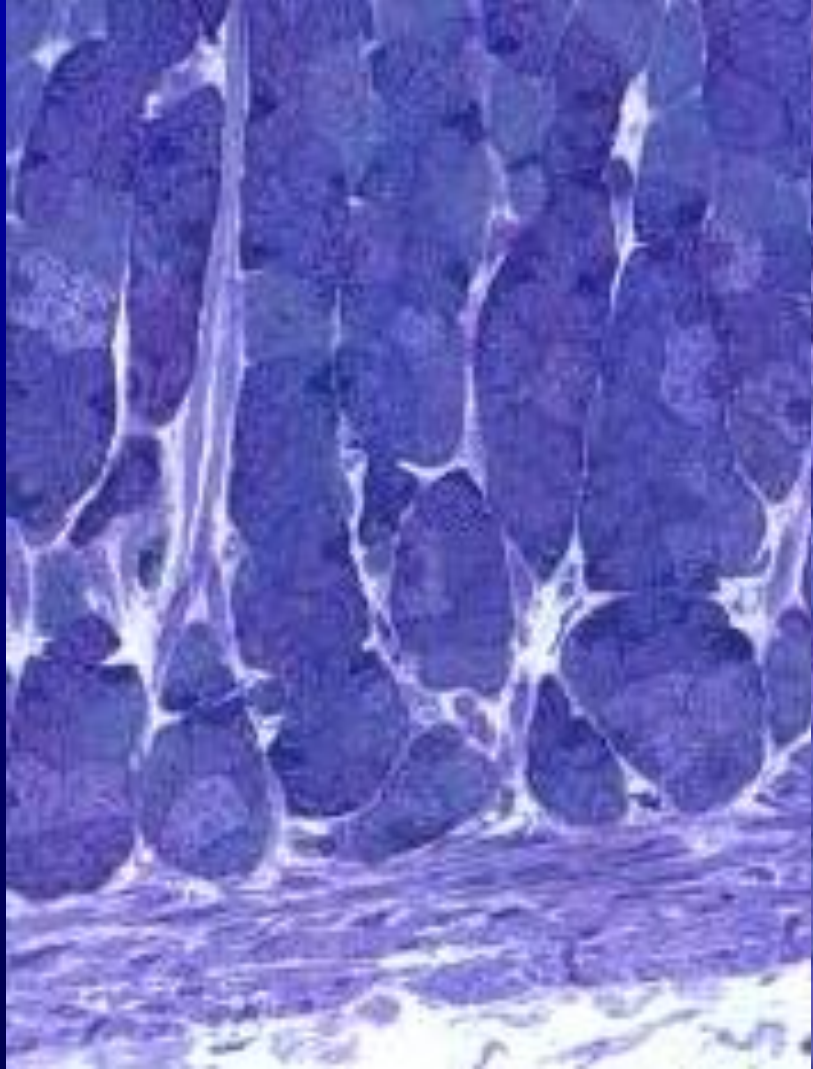


Figure 25-13. Diagram of an oxyntic gland from the corpus of a mammalian stomach. (From Ito, S. In Johnson L. R., ed.: *Physiology of the Gastrointestinal Tract*. New York, Raven Press, 1981.)

243 Fundic stomach, monkey (PAS)



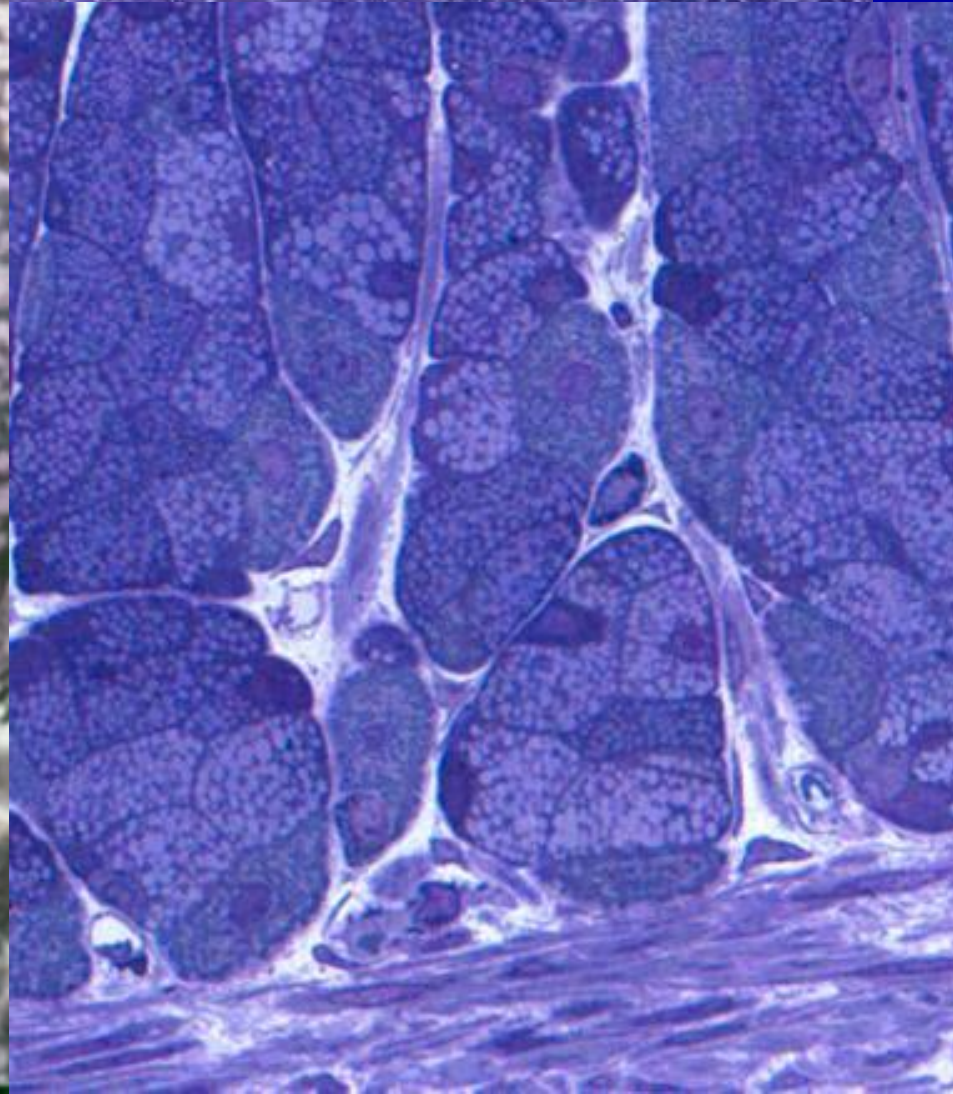
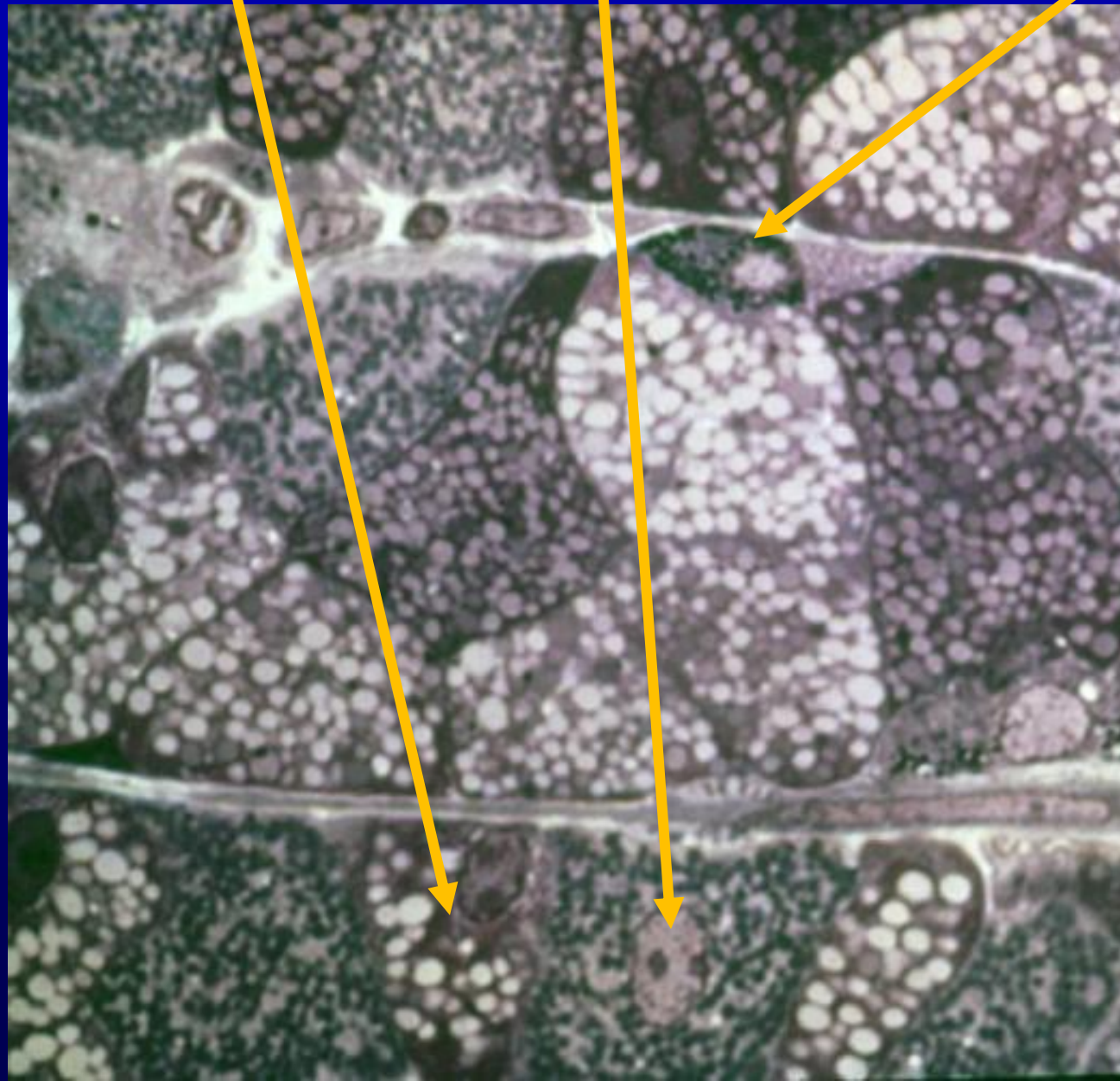
MUCOUS NECK CELL
CHIEF CELL
PARIETAL CELL
ENDOCRINE CELL
SURFACE MUCOUS CELLS

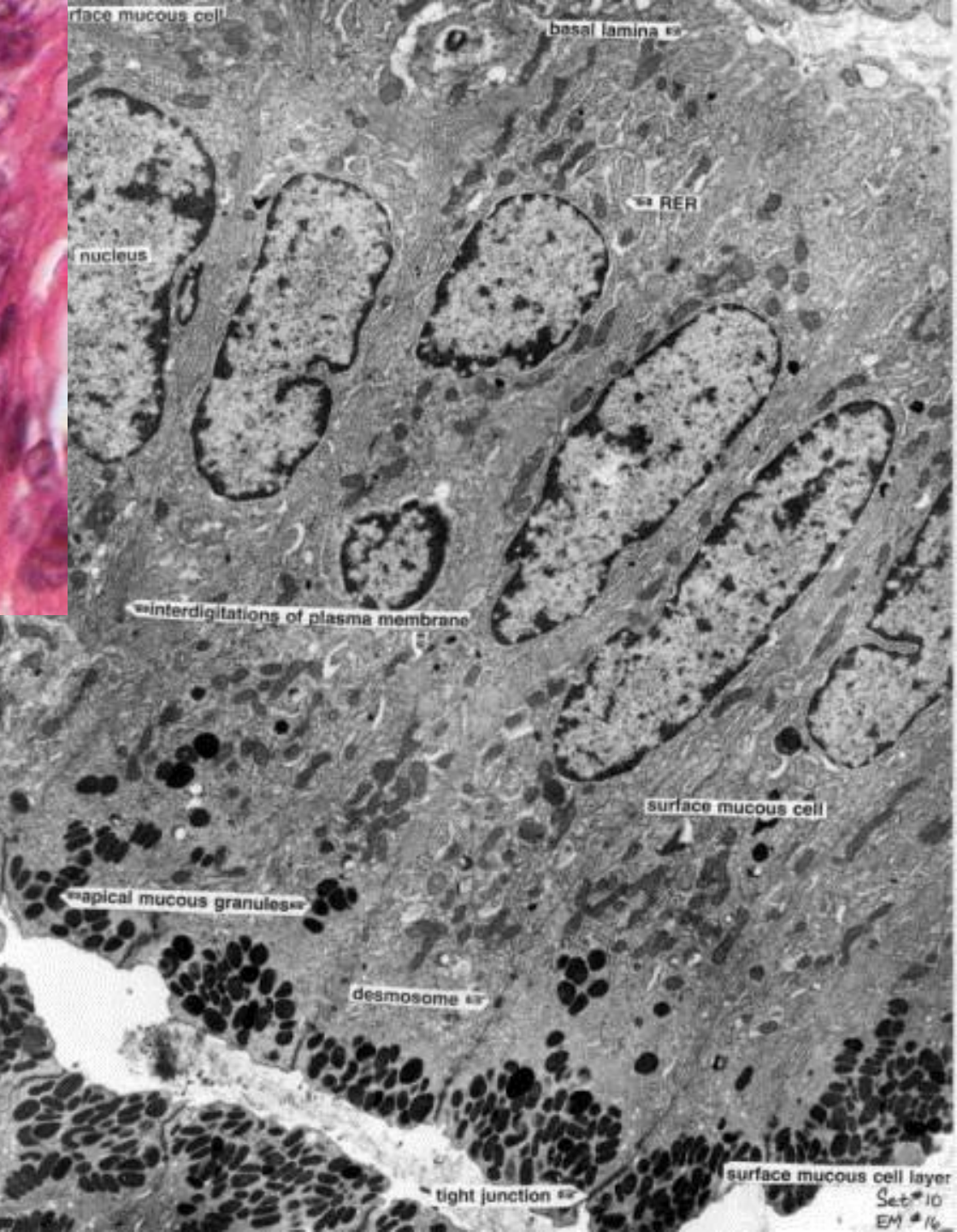
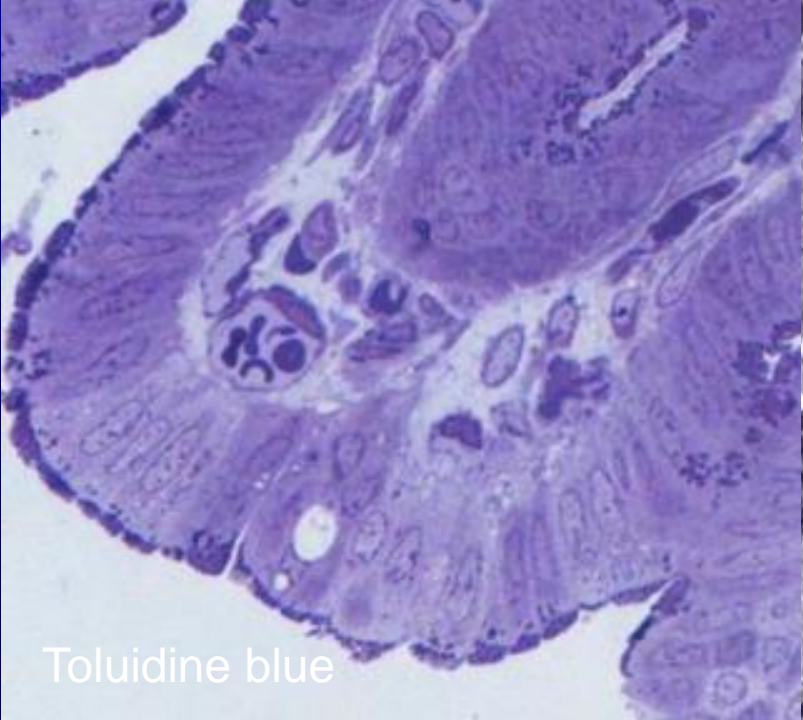
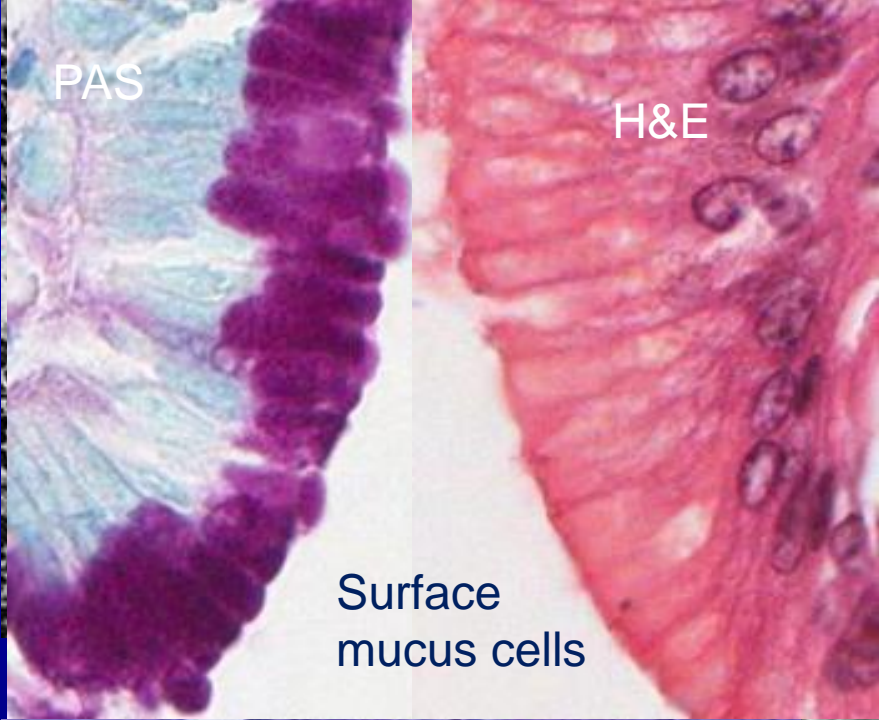


Chief cell

Parietal cell

Argentaffin cell





Chief cell

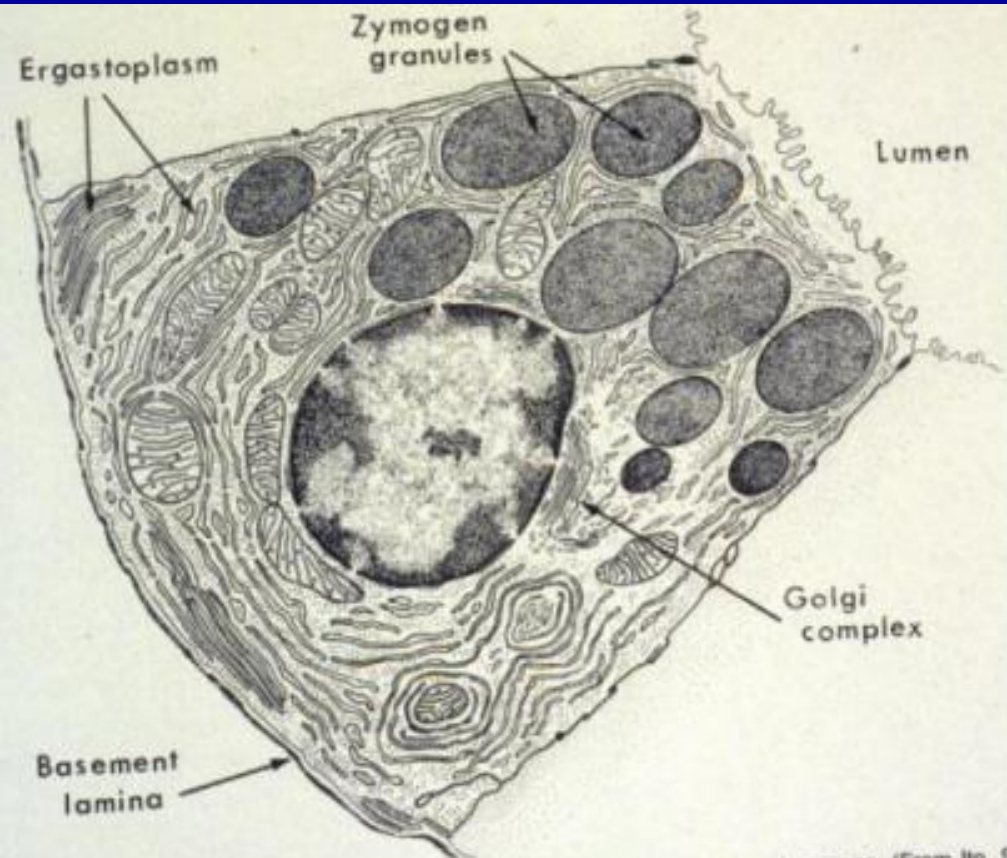
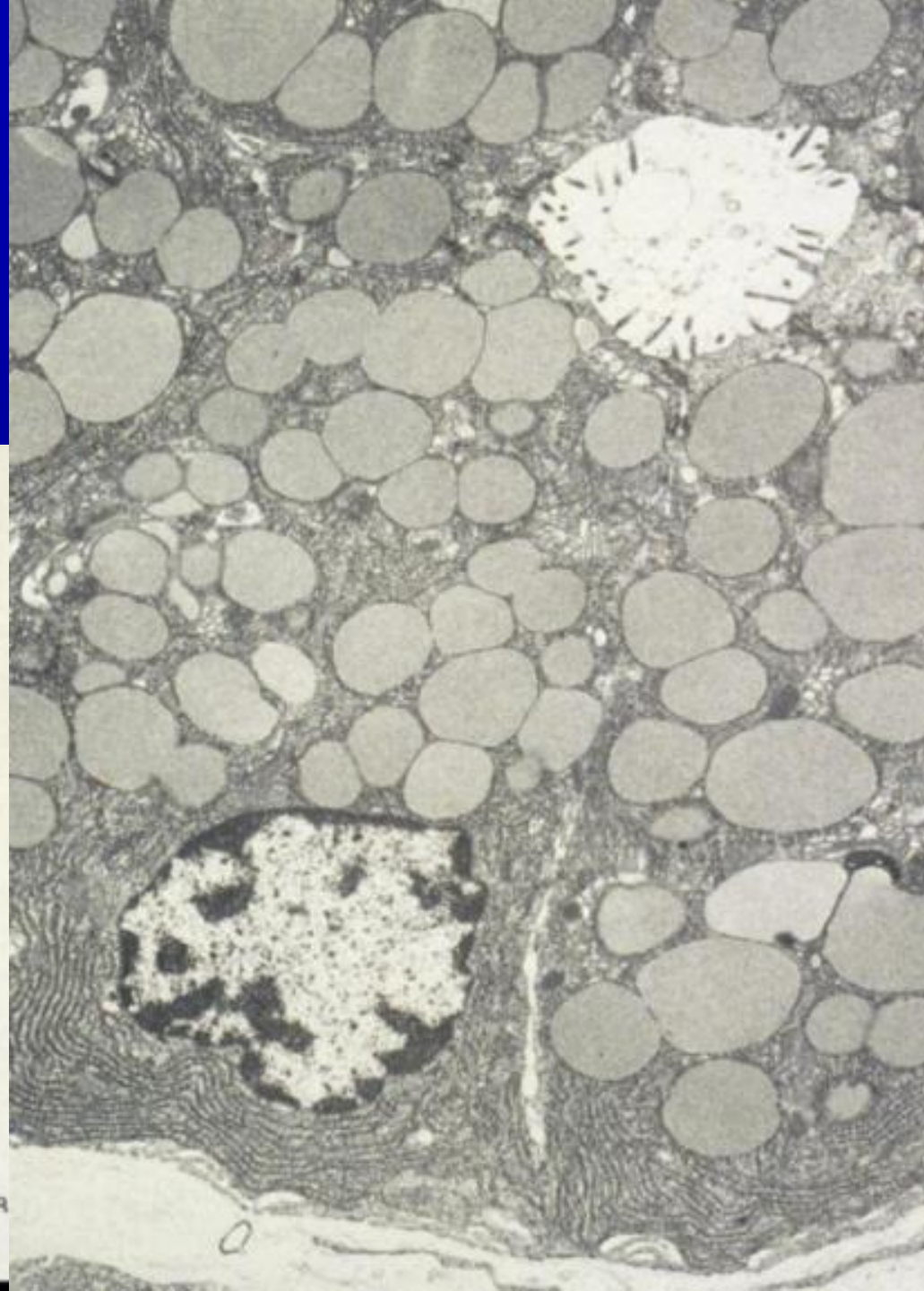
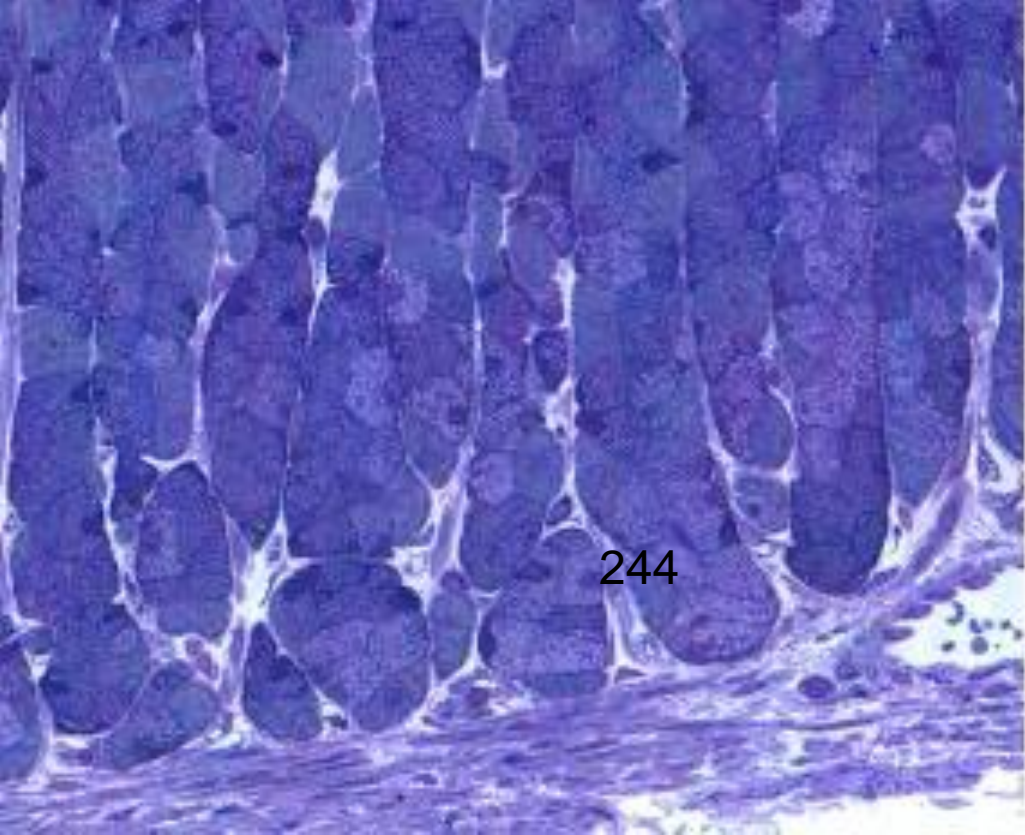
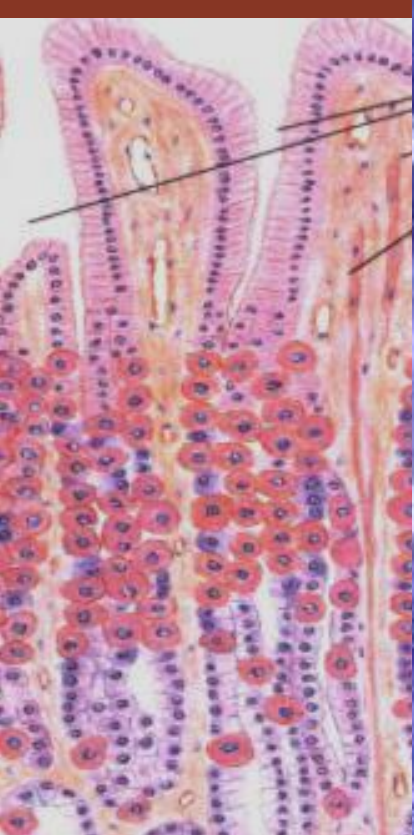
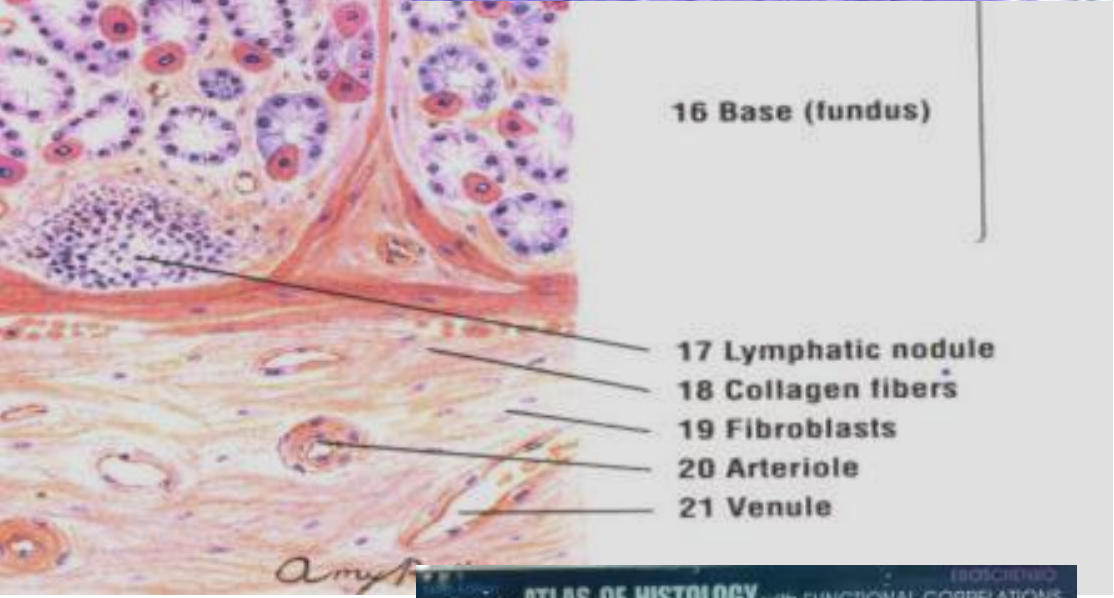


Figure 25-12. Drawing of the chief or zymogenic cell as seen with the electron microscope. (From Ito, S., and R. Winchester. *J. Cell Biol.* 16:541, 1963.)





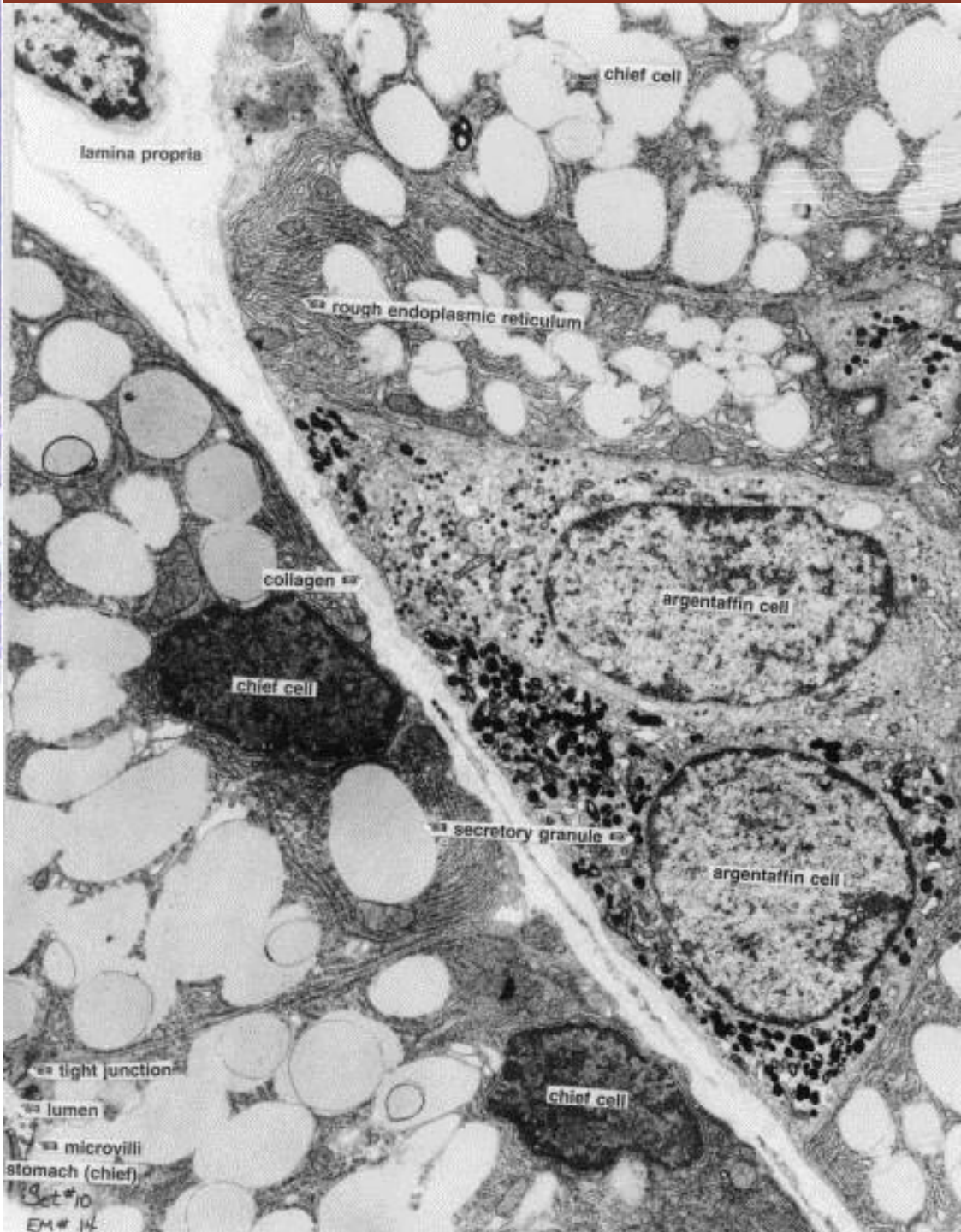
244



16 Base (fundus)

- 17 Lymphatic nodule
- 18 Collagen fibers
- 19 Fibroblasts
- 20 Arteriole
- 21 Venule

stomach



lamina propria

chief cell

rough endoplasmic reticulum

collagen

chief cell

argentaffin cell

secretory granule

argentaffin cell

tight junction

lumen

microvilli

chief cell

stomach (chief)

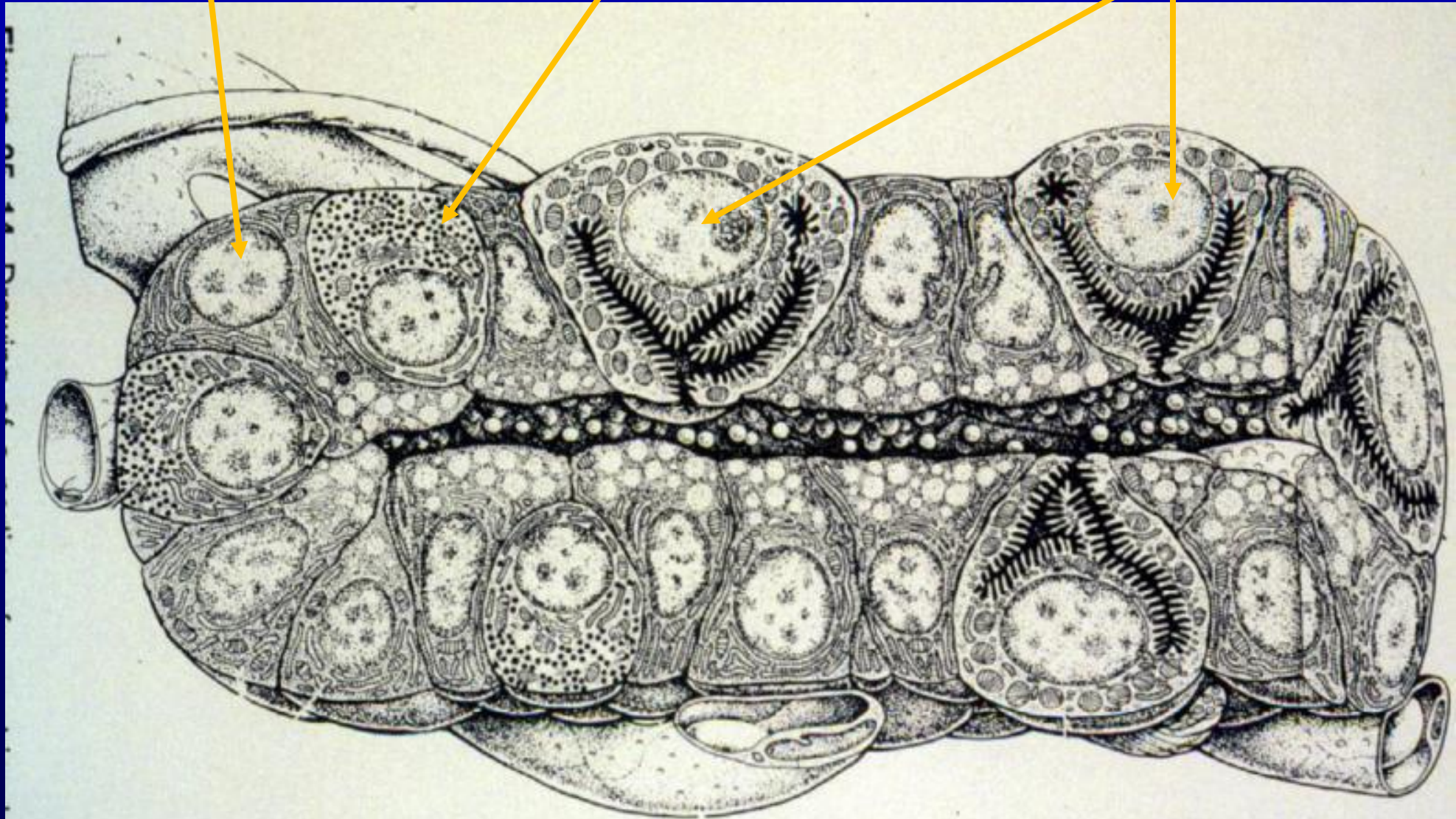
Set # 10

EM # 14

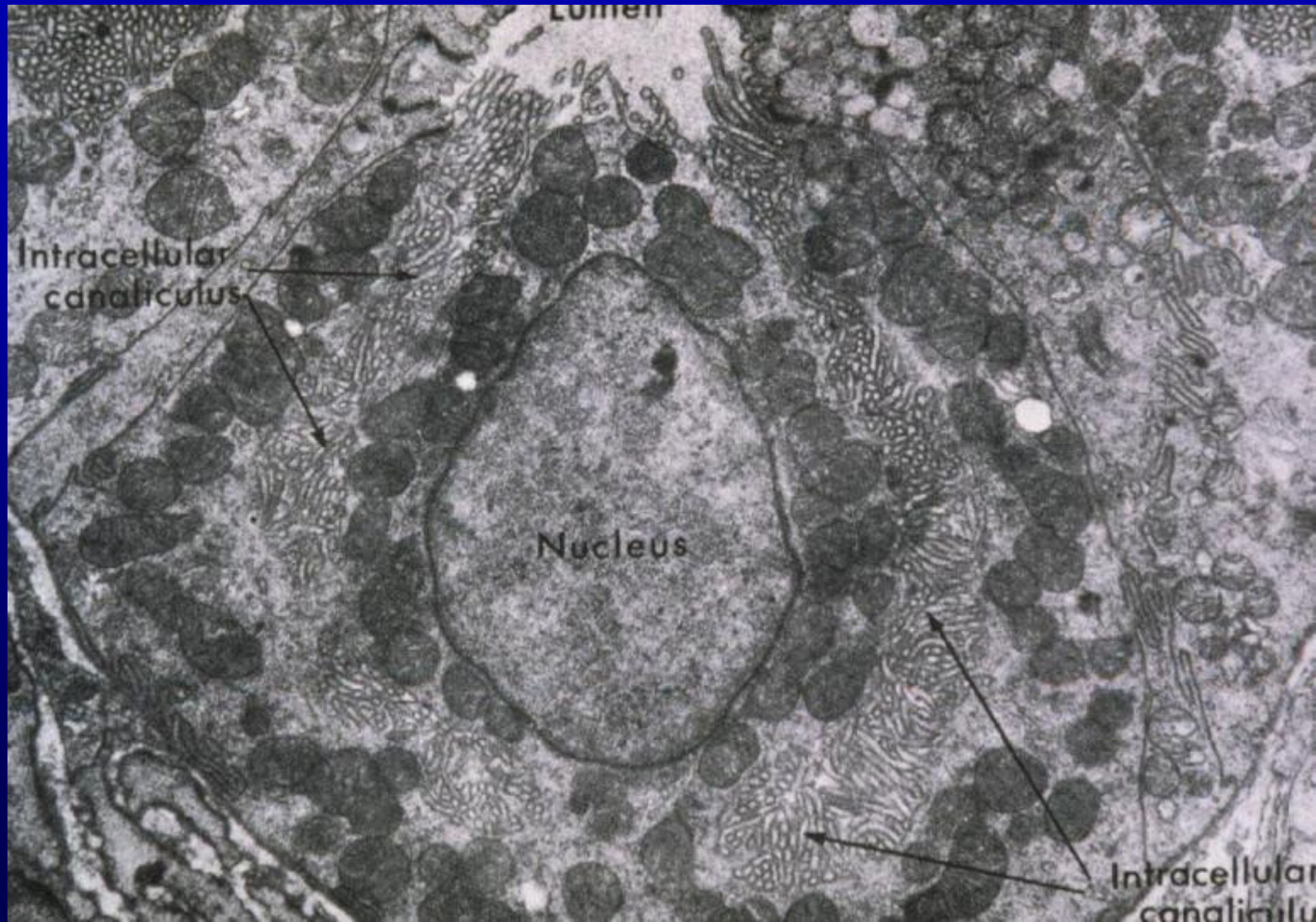
Chief cell

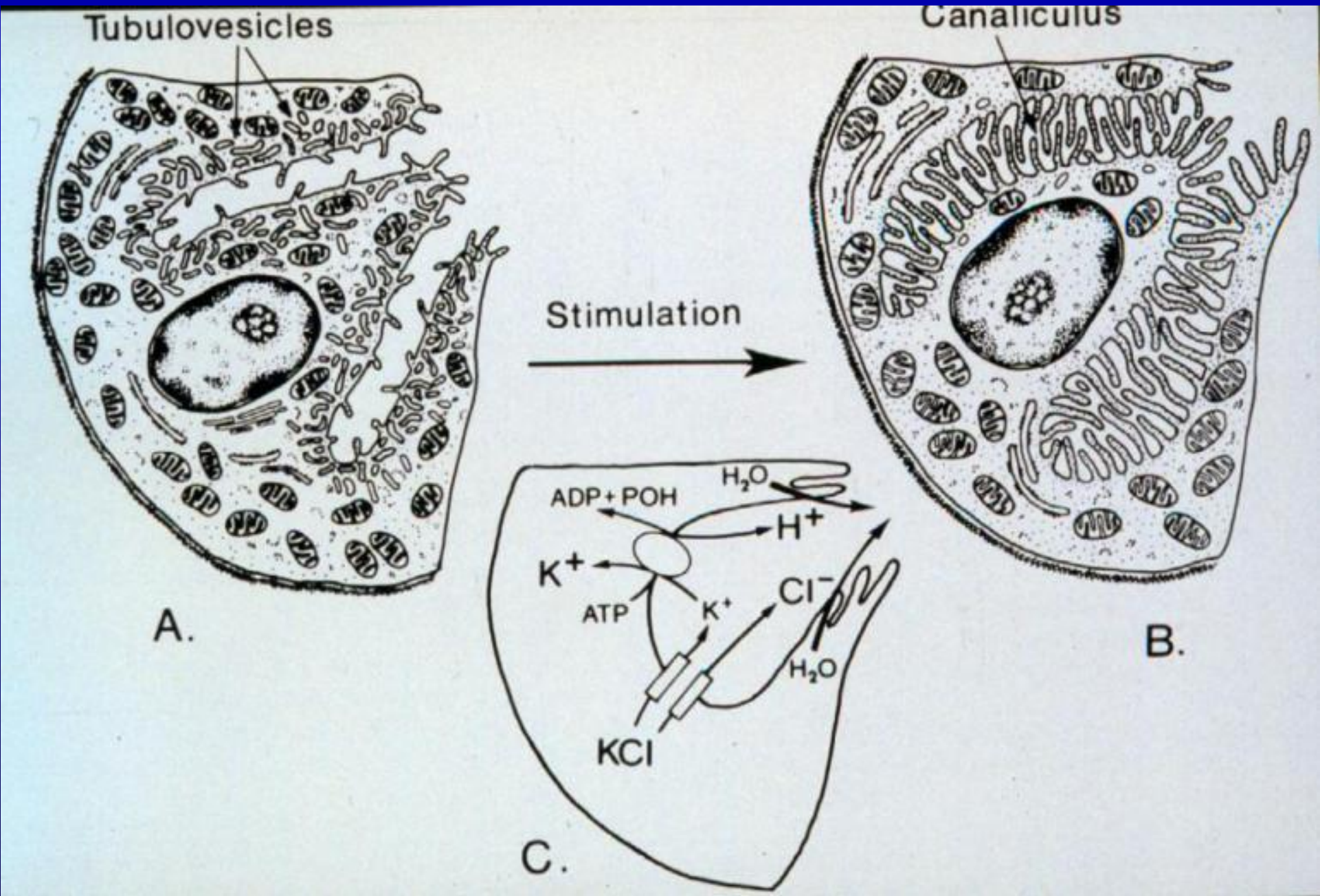
Argentaffin cell

Parietal cell

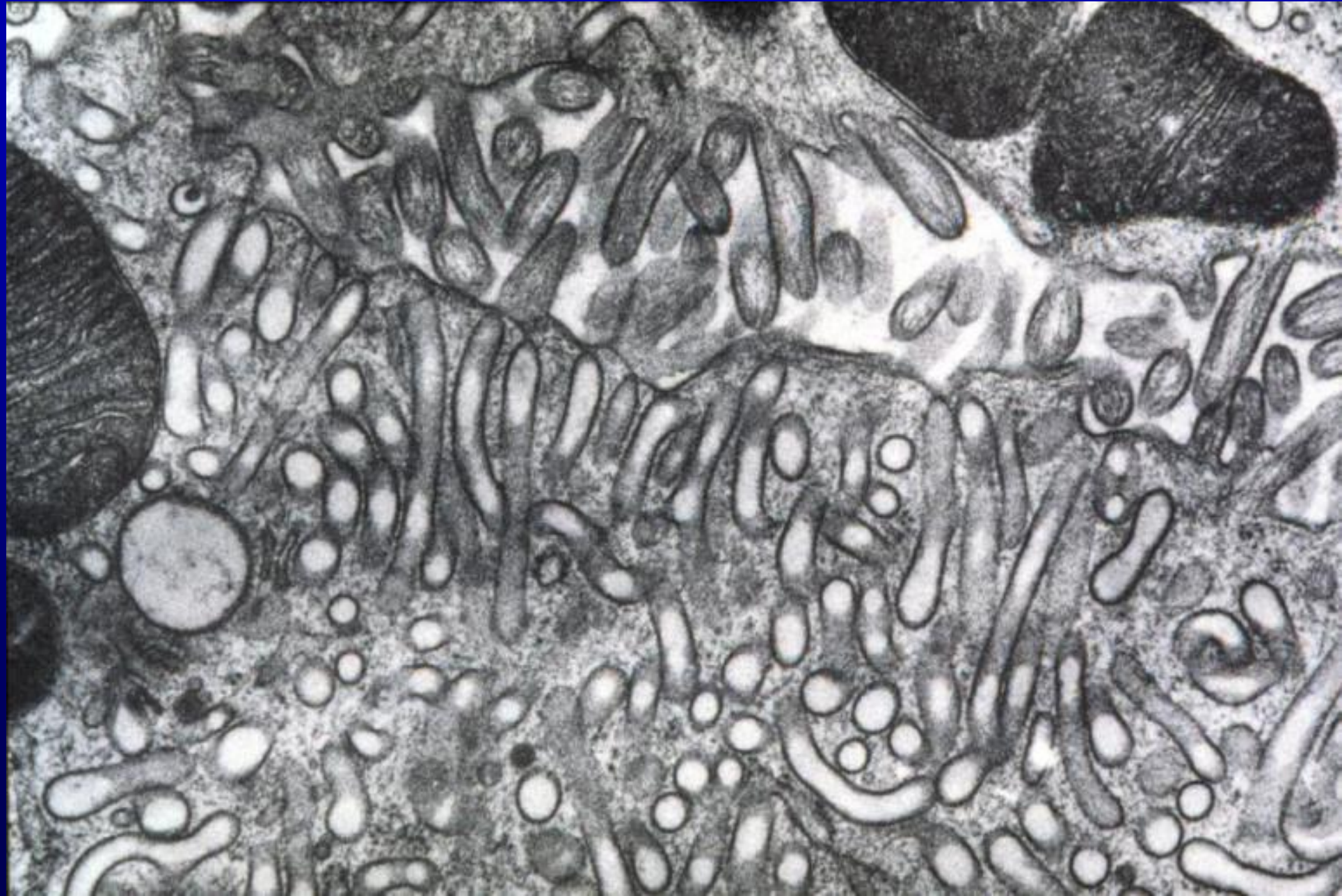


Parietal cell





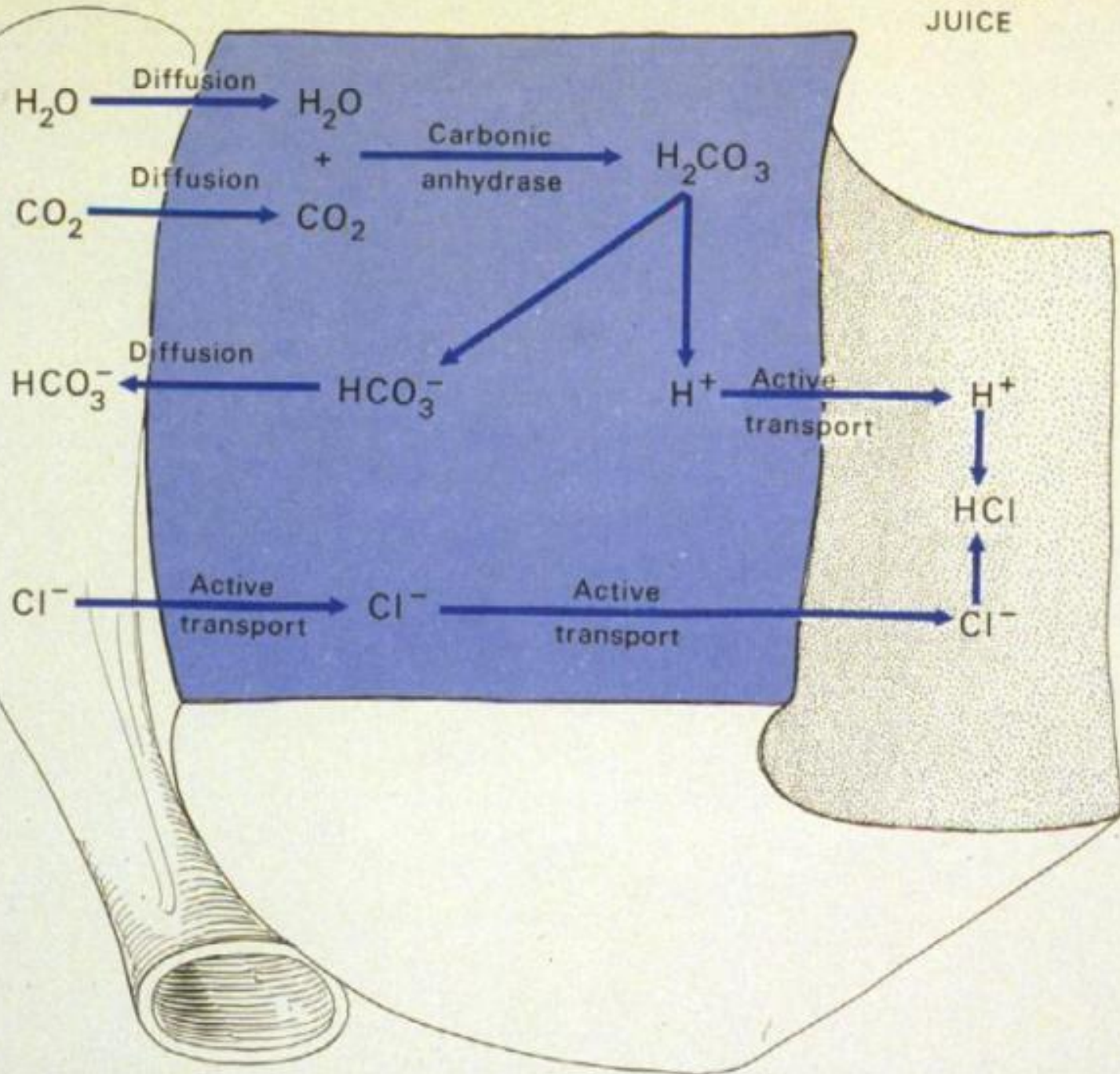
Parietal cell



BLOOD

PARIETAL CELL

GASTRIC JUICE



Protective bicarbonate flux

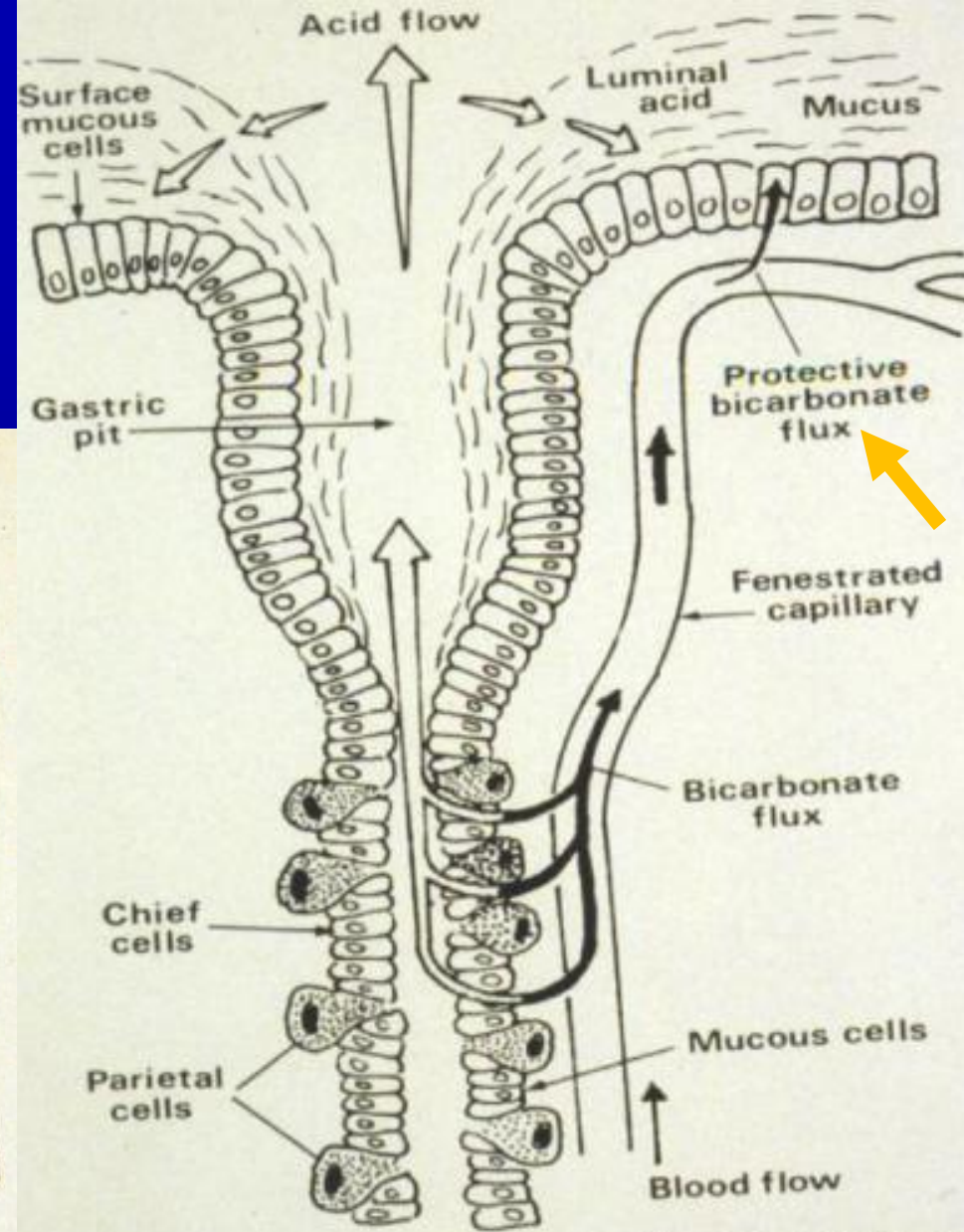
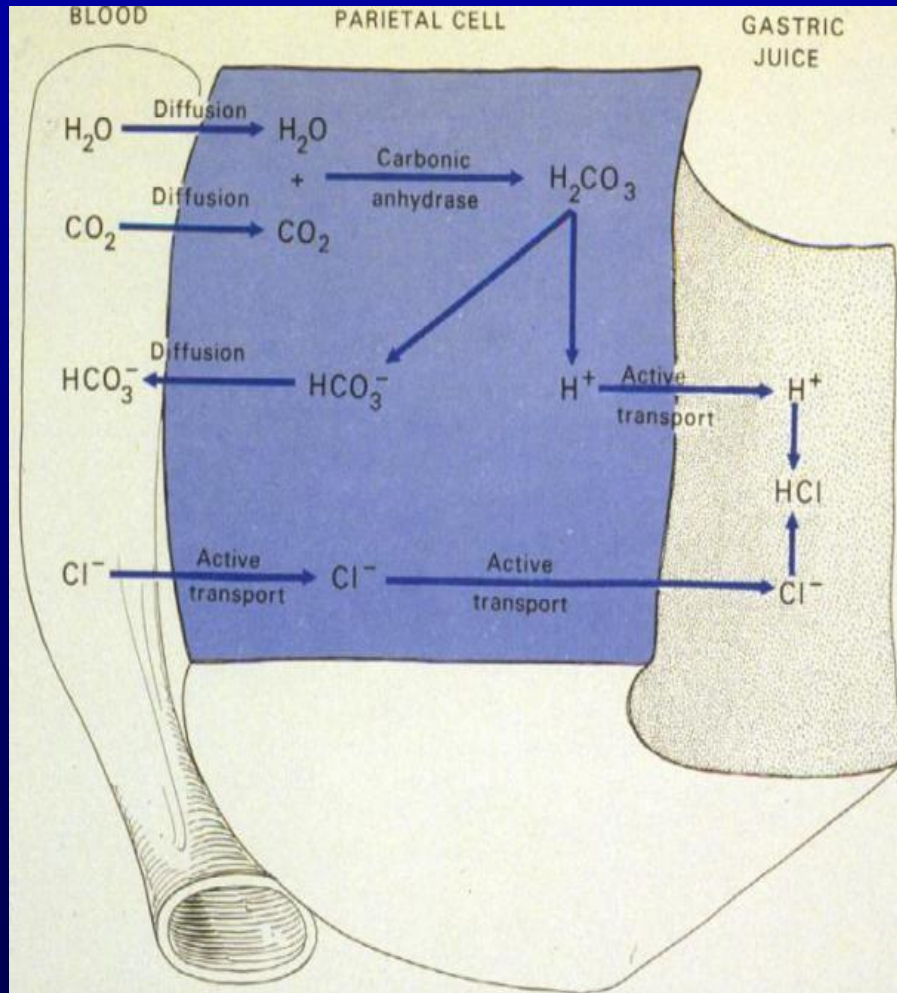
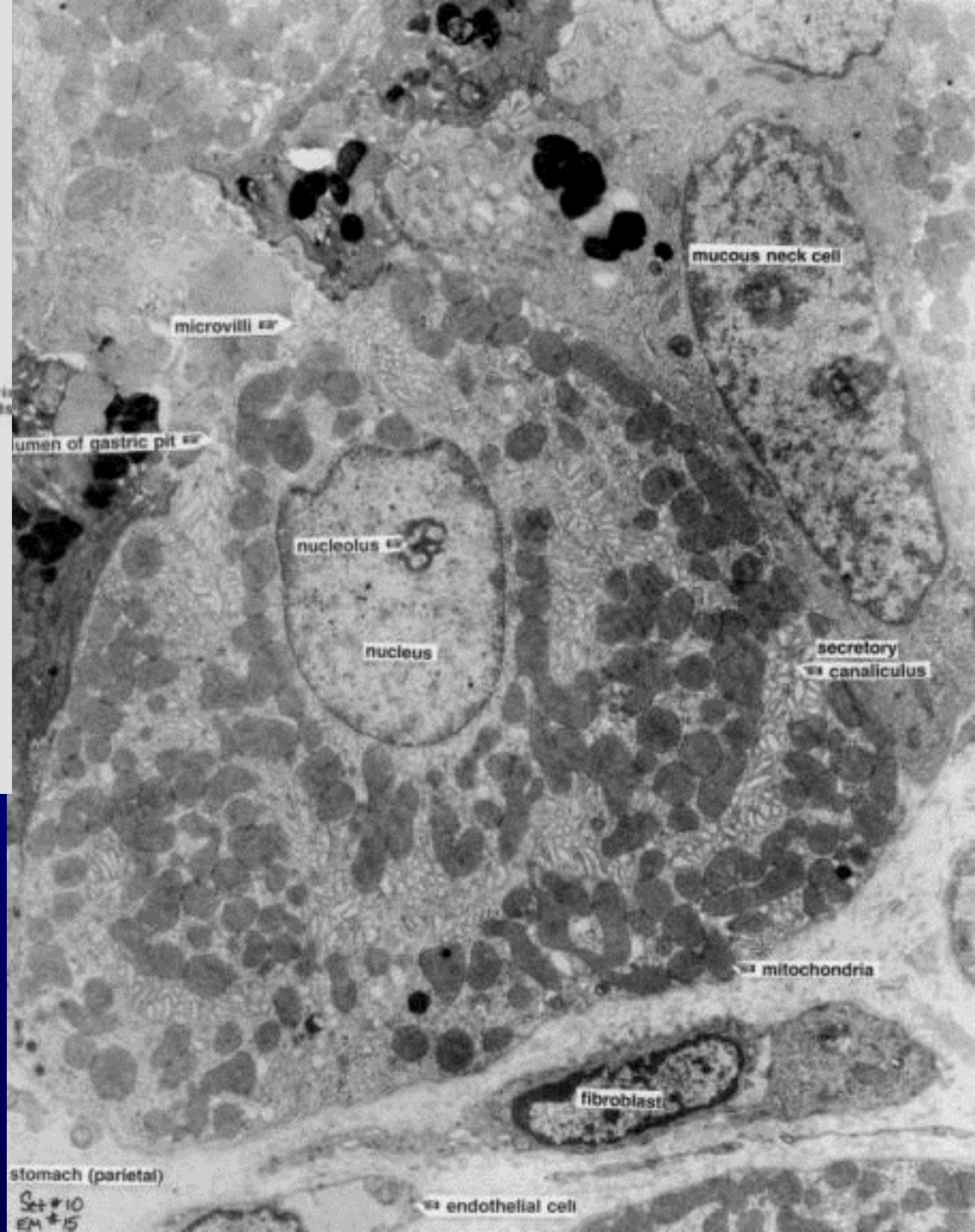
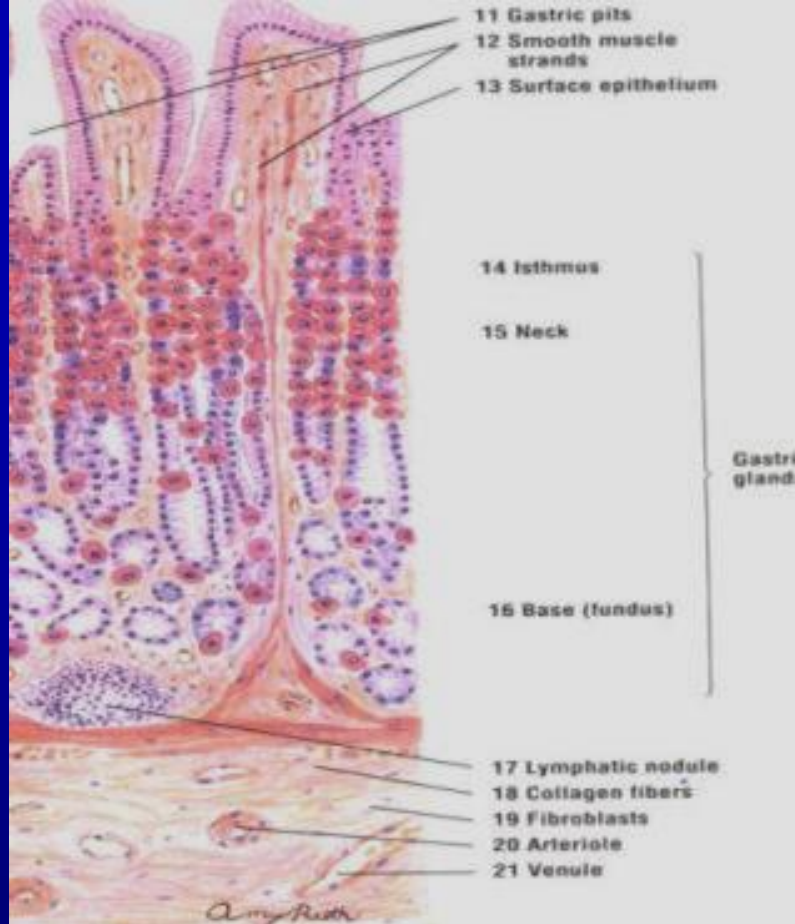


Figure 25-22. Diagram illustrating the postulated vascular transfer of bicarbonate ions, generated by active parietal cells, to the subsurface capillary network where it may protect the epithelium by neutralizing any back-diffusing hydrogen ions from the lumen. (Redrawn after Gannon



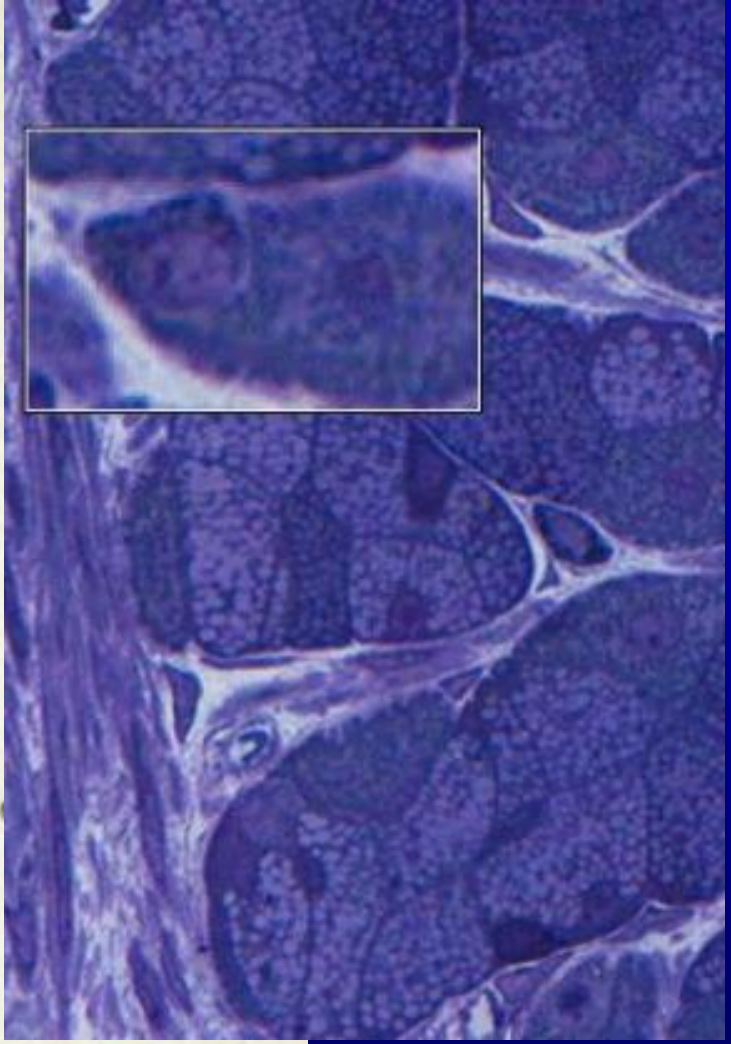
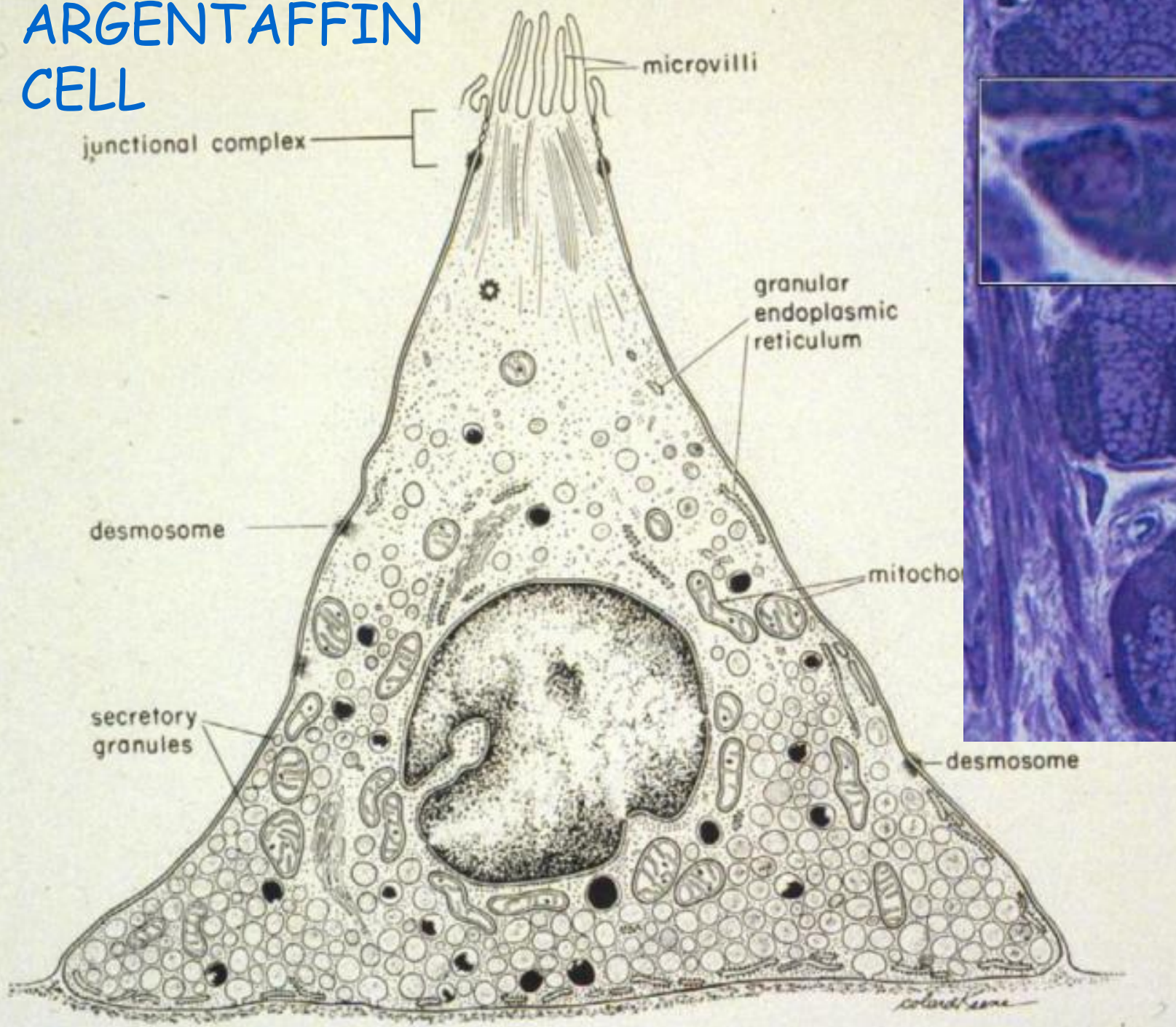
EM 15 Parietal cell produces

1. HCl
2. Bicarbonate
3. **Intrinsic factor** for vitamin B12 absorption by gut: needed in red blood cell formation

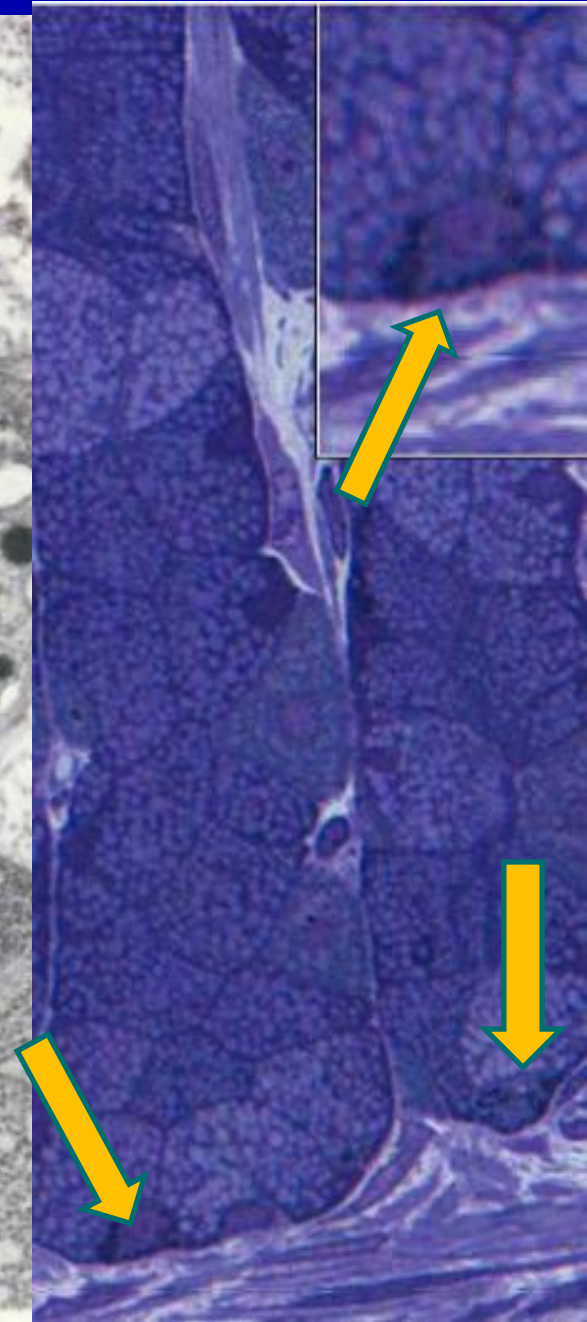
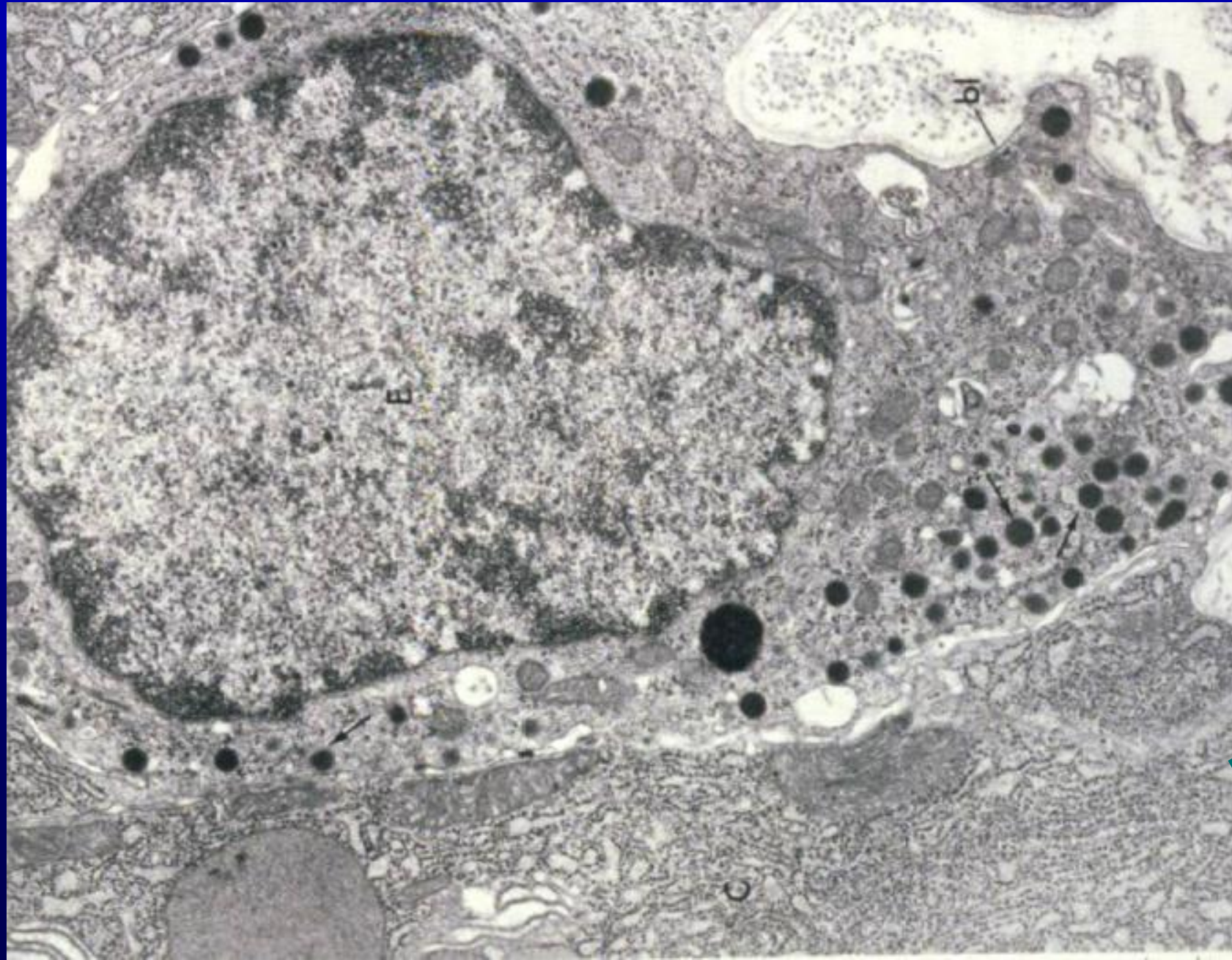
Gastric atrophy

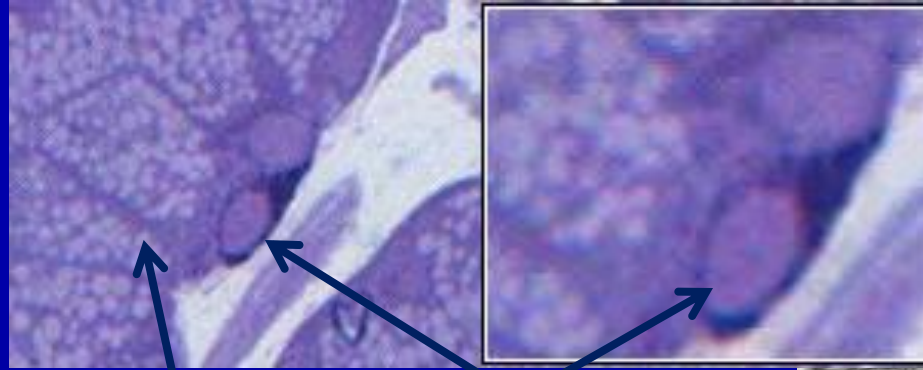
- Gastric atrophy is characterized by chronic inflammation of the gastric mucosa, resulting in loss of gastric glandular cells, and overall atrophy of the gastric mucosa.
- Gastric atrophy may result in extensive loss of parietal cells. This loss of parietal cells may result in decreased secretion of intrinsic factor, which is necessary for vitamin B12 absorption. Vitamin B12 is a necessary cofactor required for DNA synthesis; low levels of vitamin B12 can reduce proliferation of erythroblasts, producing pernicious anemia.

ARGENTAFFIN CELL



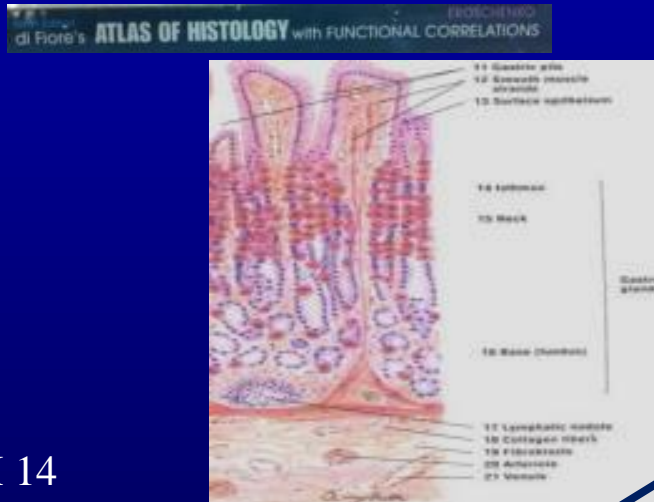
Argentaffin cell (Enteroendocrine cell)





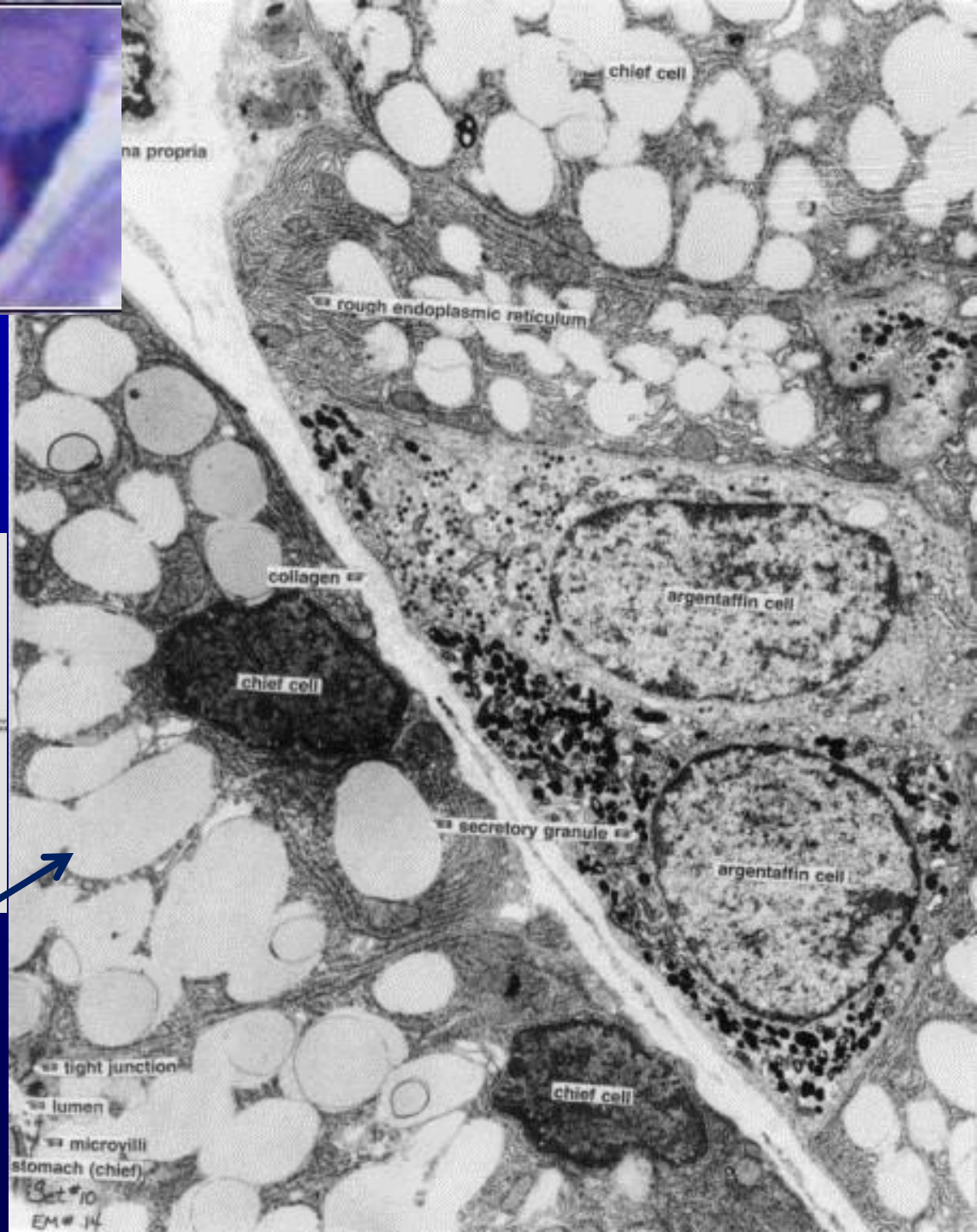
Large granules
of chief cell

Granules of an
argentaffin cell



EM 14

- Large granules of chief cell
- Granules of an argentaffin cell
- Lamina propria
- Nuclei



EM # 14

Stomach

Muscularis mucosa

Submucosa

Muscularis externa

Histophysiology

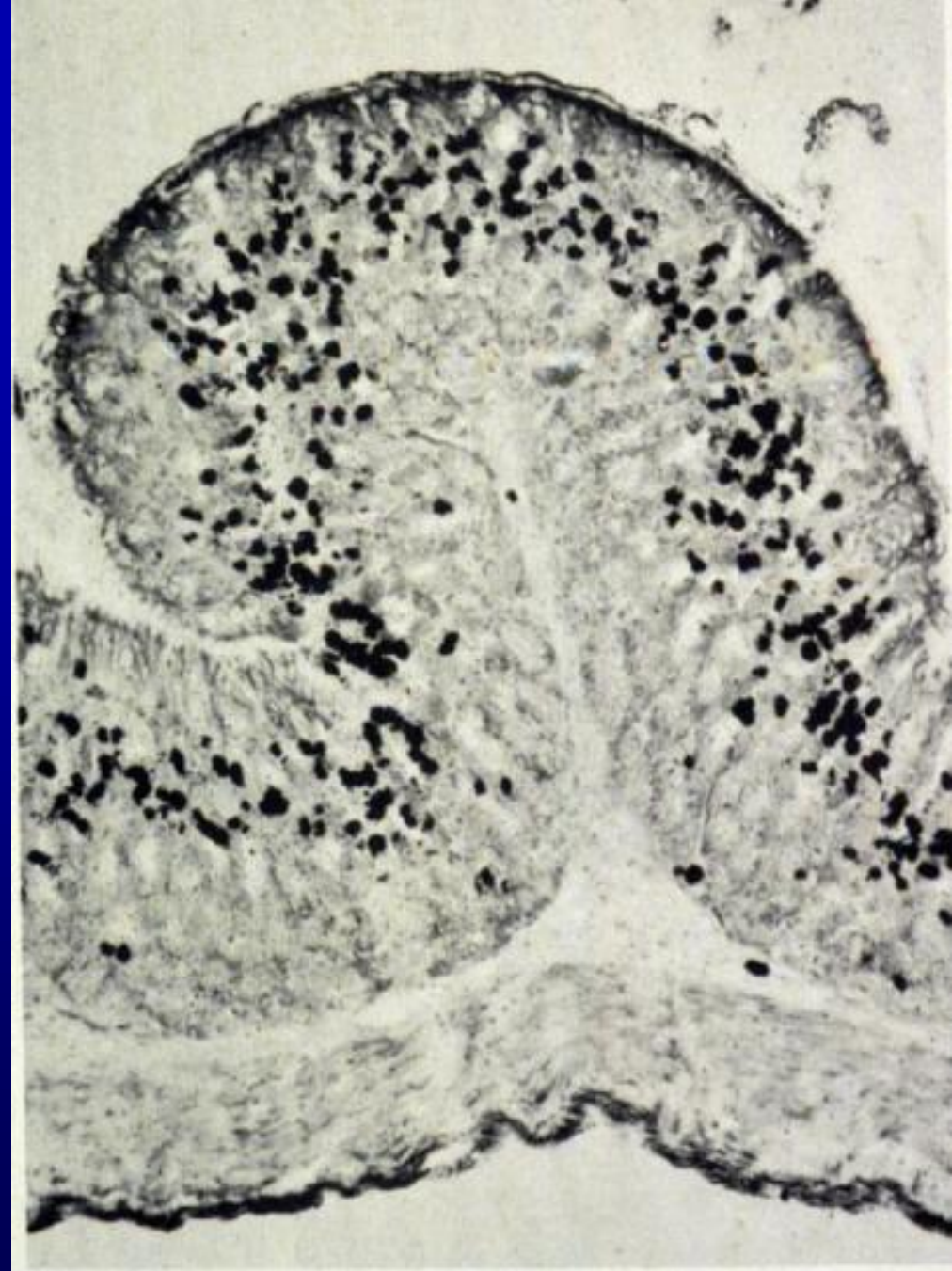
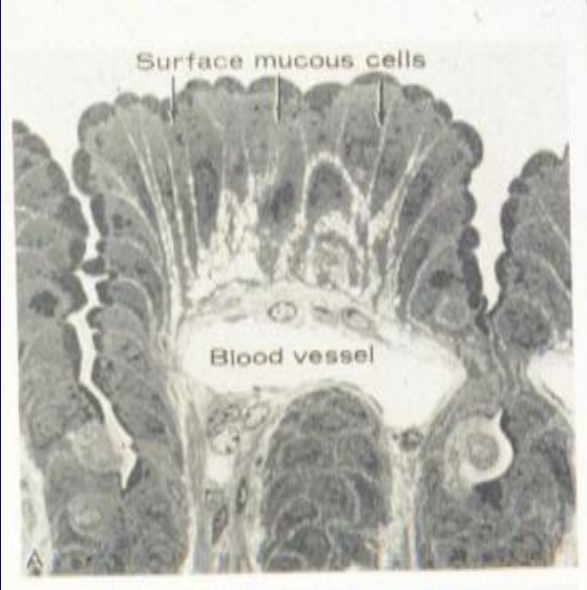


Figure 25-23. Autoradiograph of the gastric mucosa of



Acid treatment



Mucosa of stomach

Acid treatment with aspirin

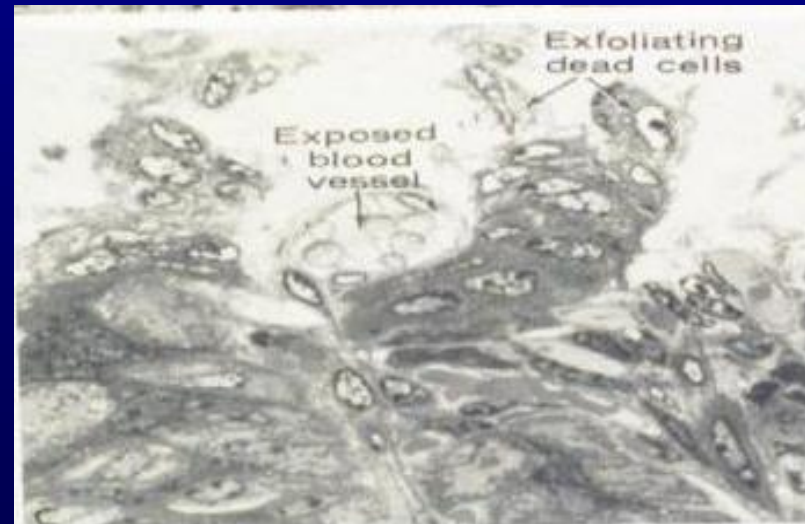
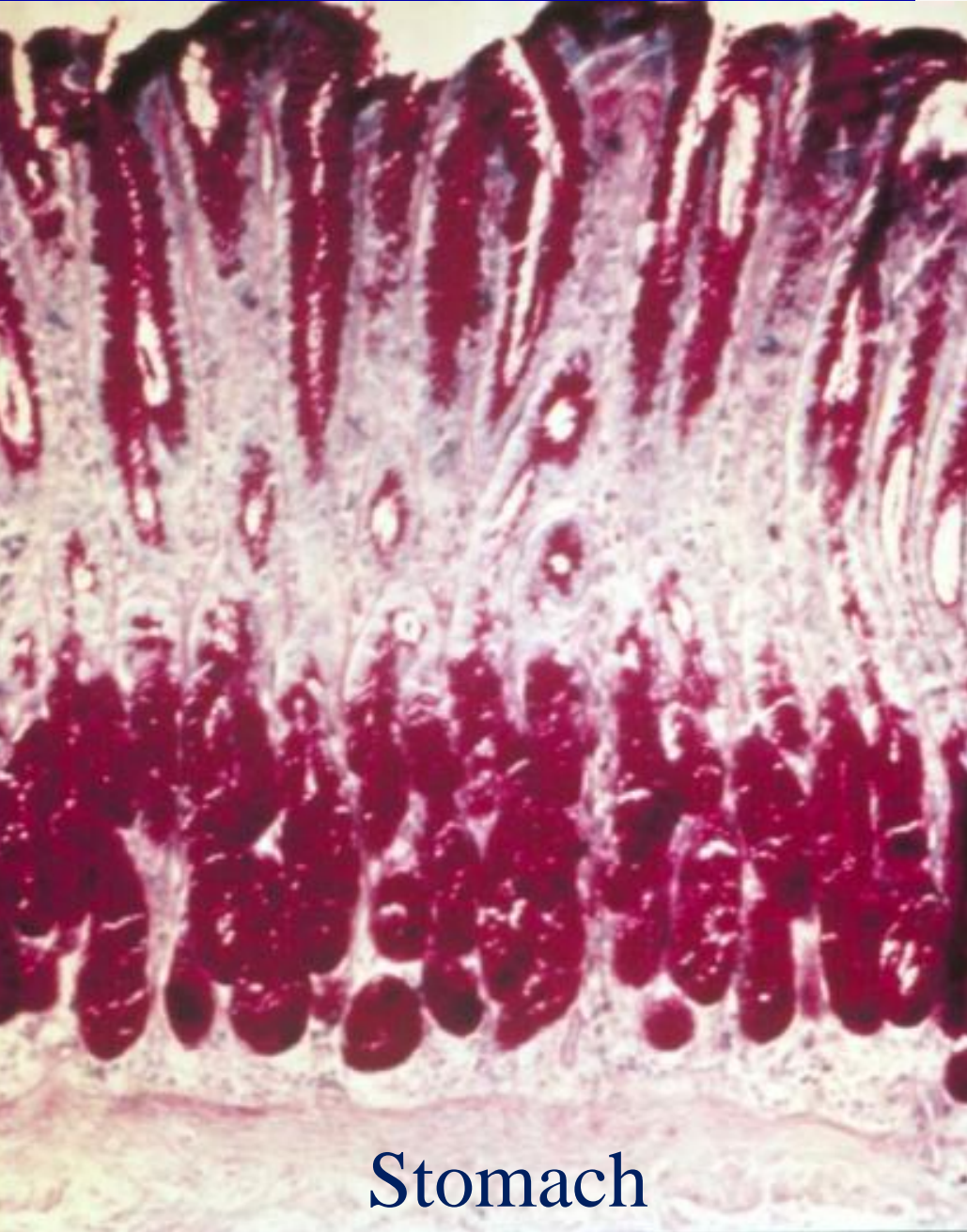
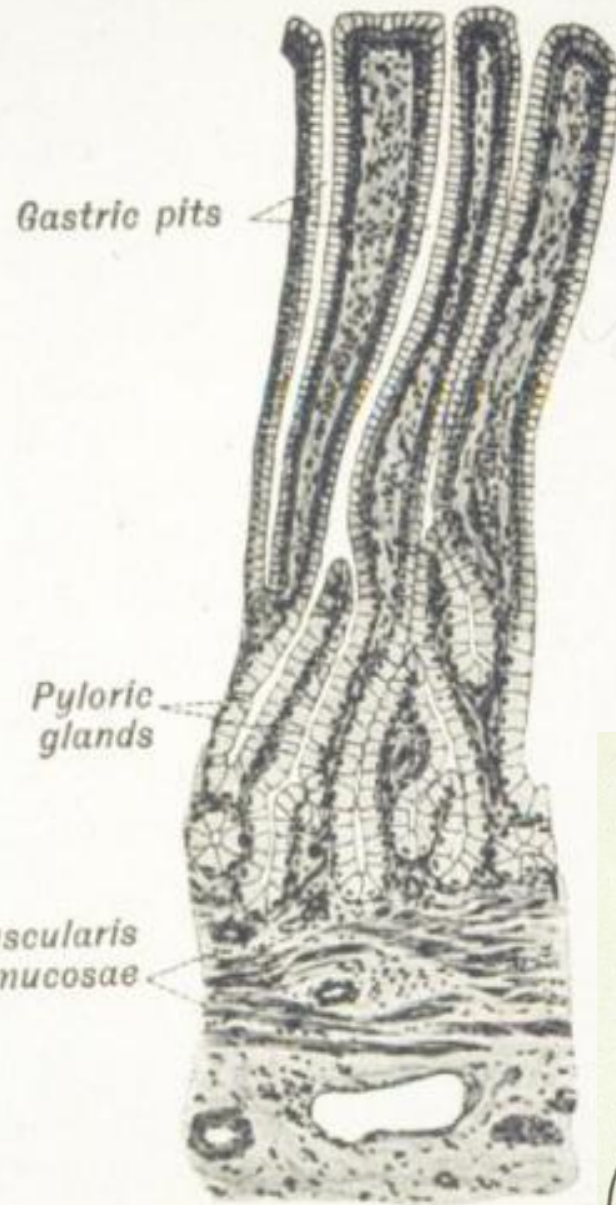


Figure 25-24. The protective permeability barrier that protects the stomach wall from damage by the acidity

Pyloric Glands

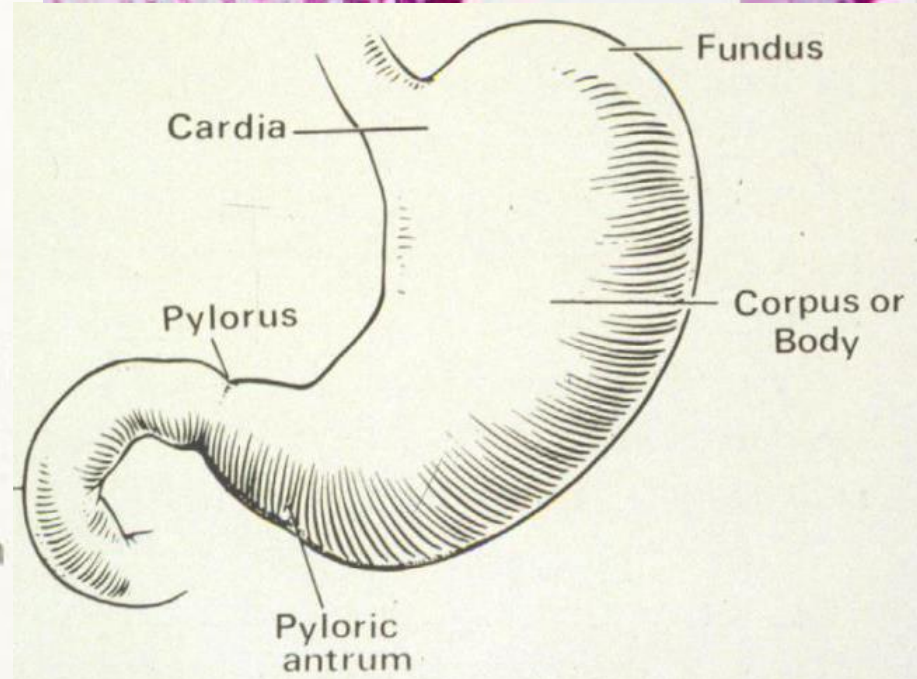
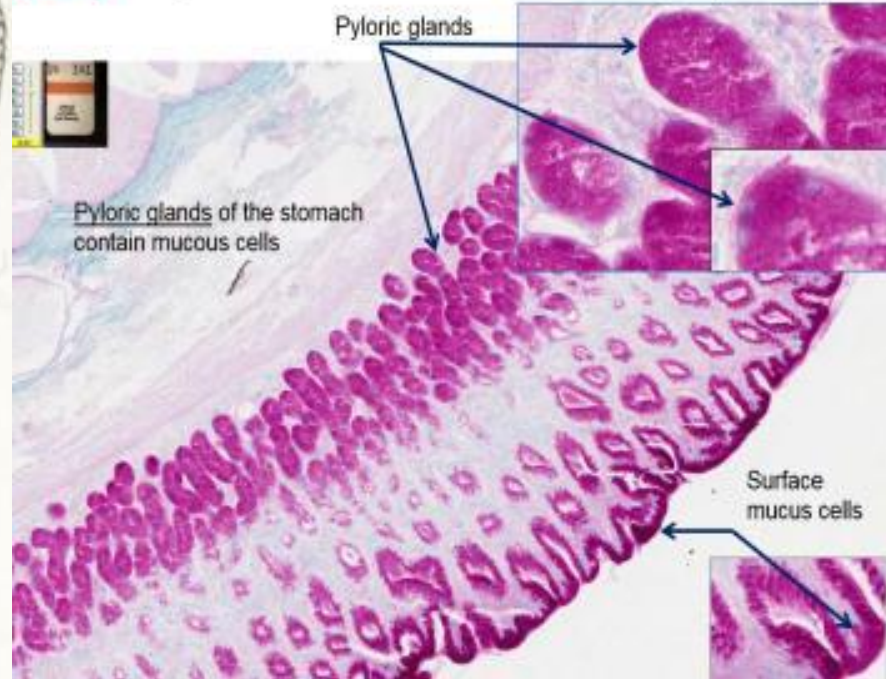


Stomach



20. Pyloric glands from human stomach. × 75. (After Braus.)

141 Pyloric stomach, monkey (PAS)



Small Intestine

General organization

Crypts of Lieberkuhn

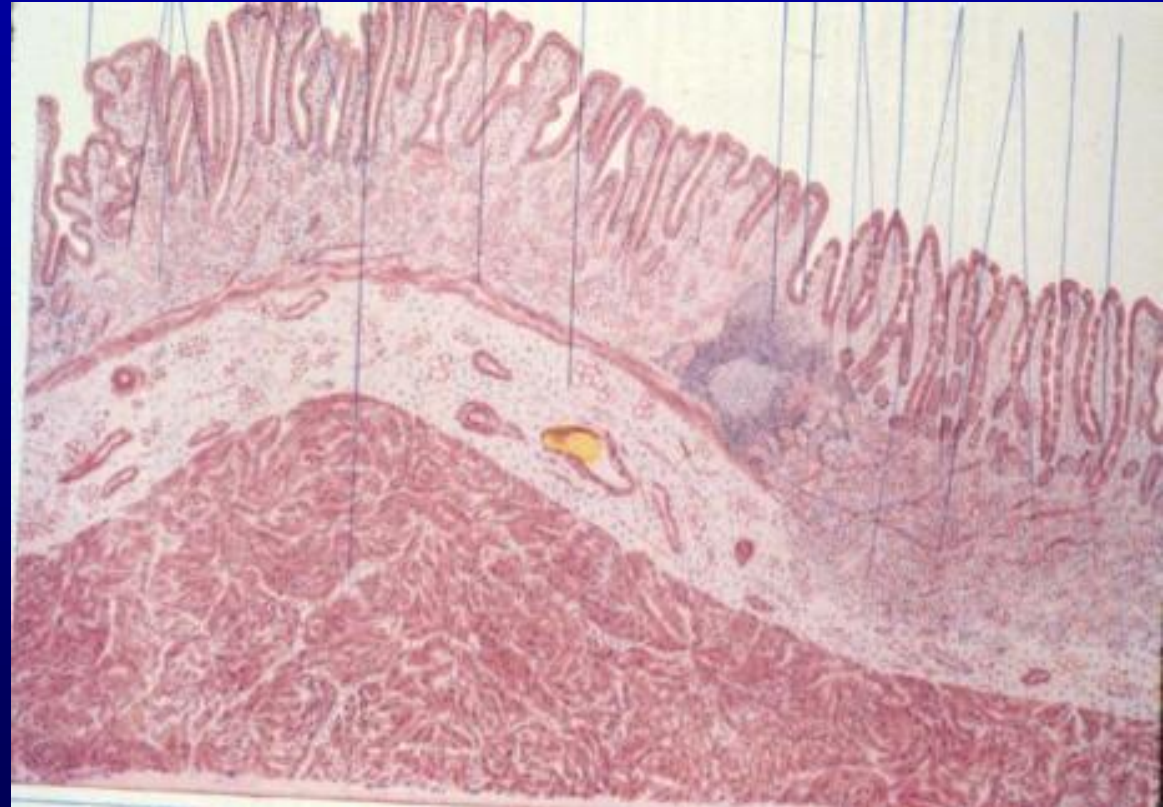
Intestinal epithelium

Absorptive cells

Enteroendocrine cells

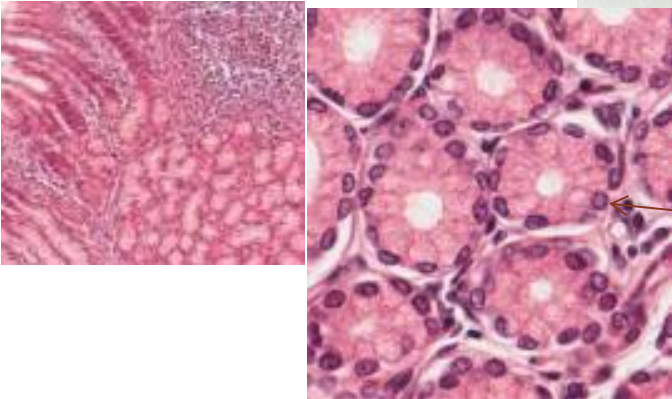
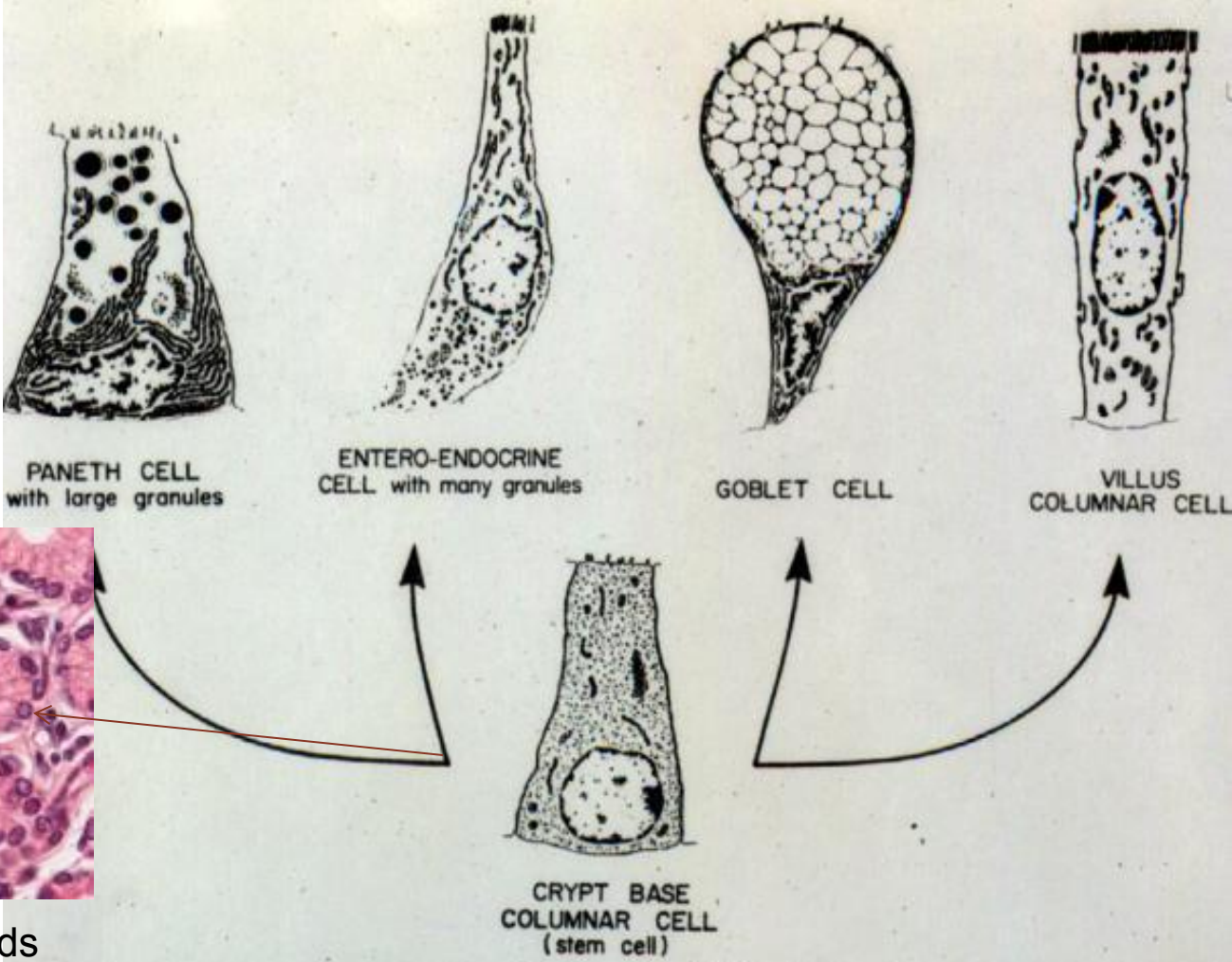
Paneth cells

Goblet cell



EPITHELIUM of the intestine - SIMPLE COLUMNAR

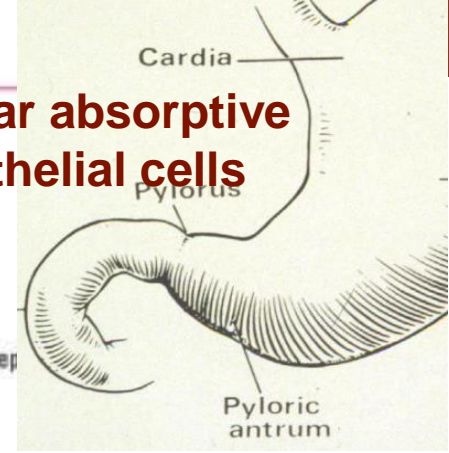
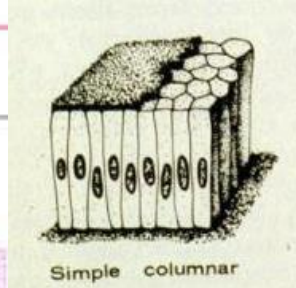
ABSORPTIVE CELLS
GOBLET CELLS
ARGENTAFFIN CELLS
PANETH CELLS
and cells of duodenal glands



Submucosal Brunner's glands

Simple columnar glandular epithelial cells

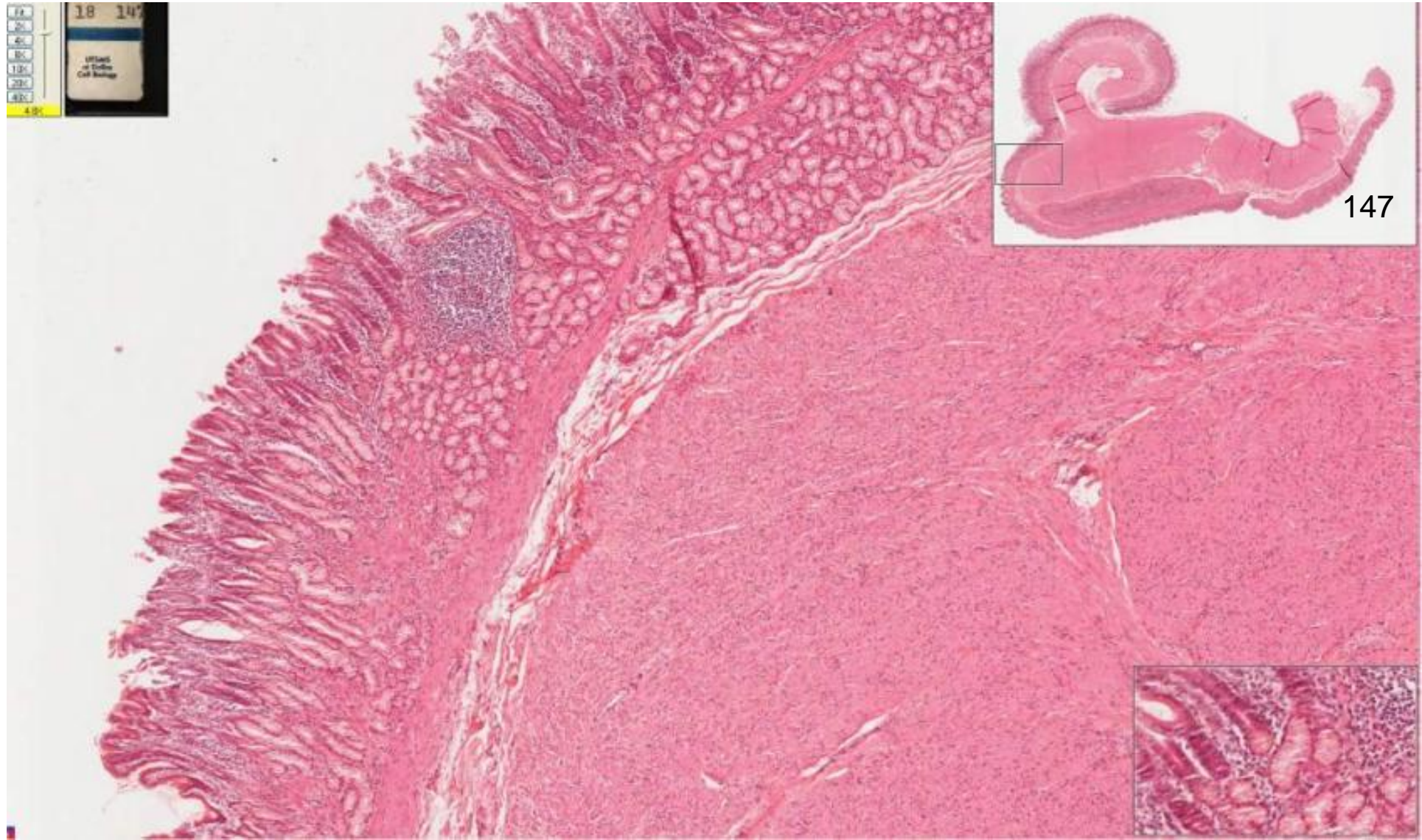
Simple columnar absorptive and goblet epithelial cells



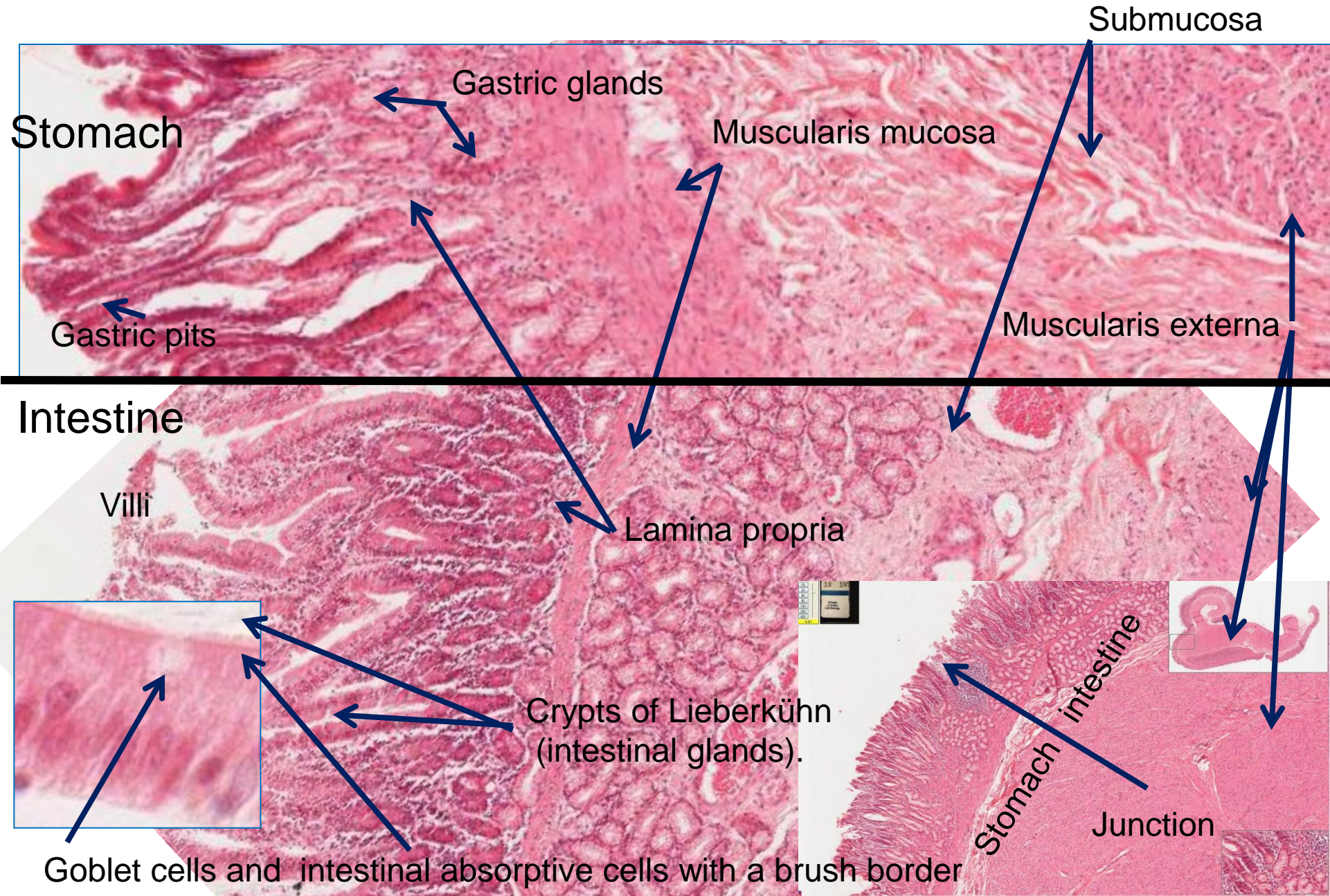
Pyloric glands

Fig. 11-11 Pyloric-Duodenal Junction (longitudinal section). Stain: hematoxylin-eosin. Low magnification.

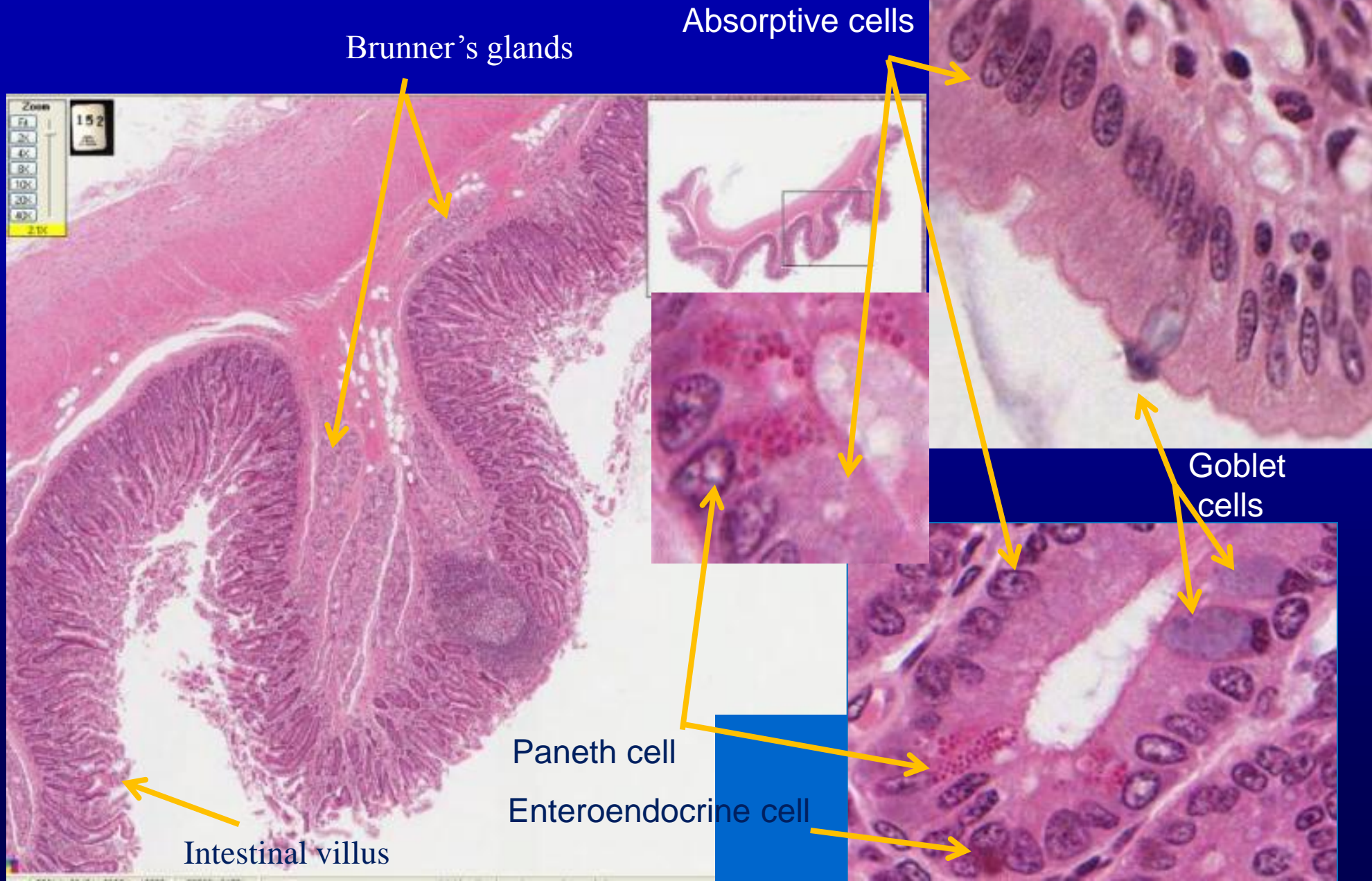
Pyloroduodenal junction, baboon



147 Pyloroduodenal junction, baboon



152 Duodenum

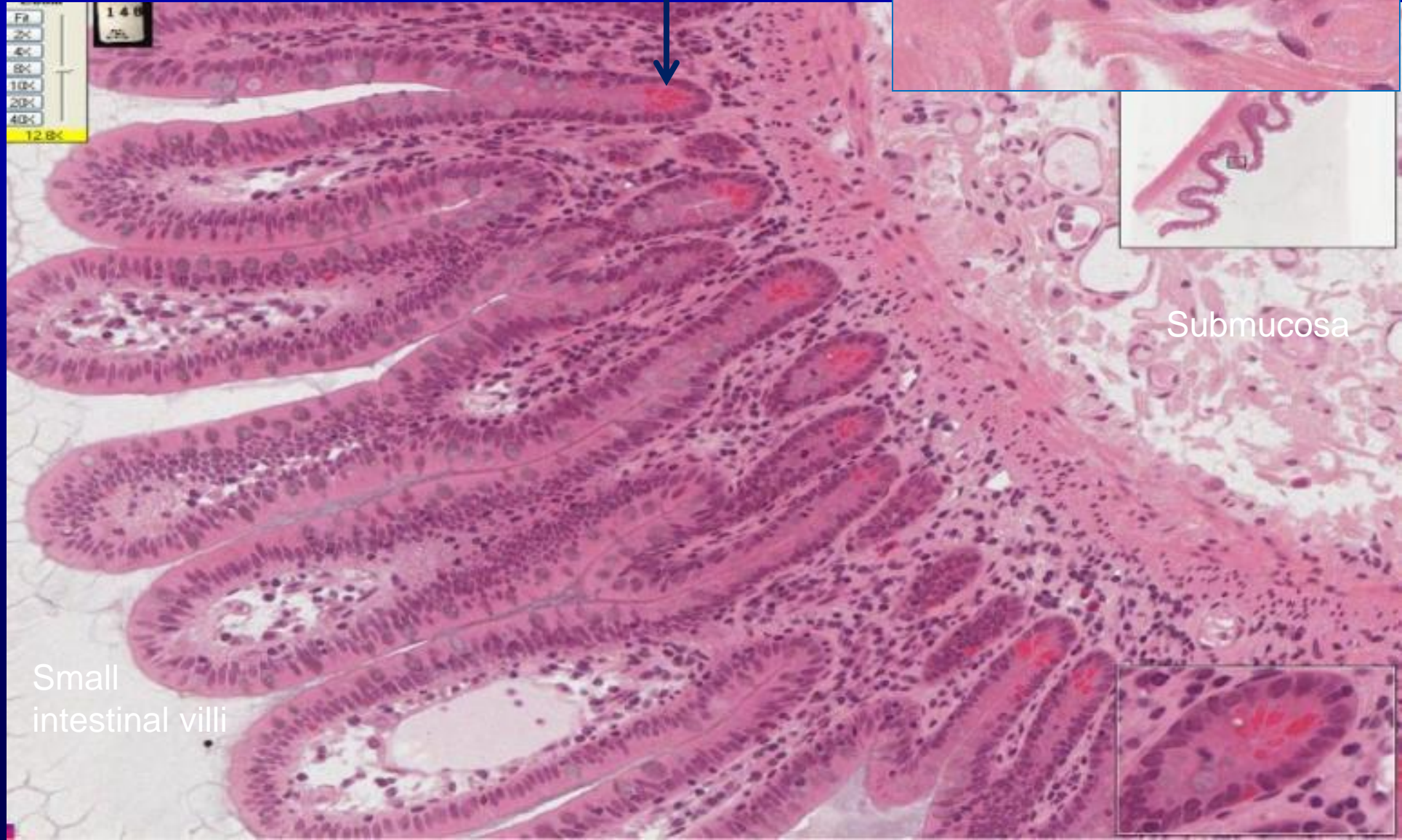




148 Ileum

Meissner's plexus cell bodies in submucosa

Paneth cell

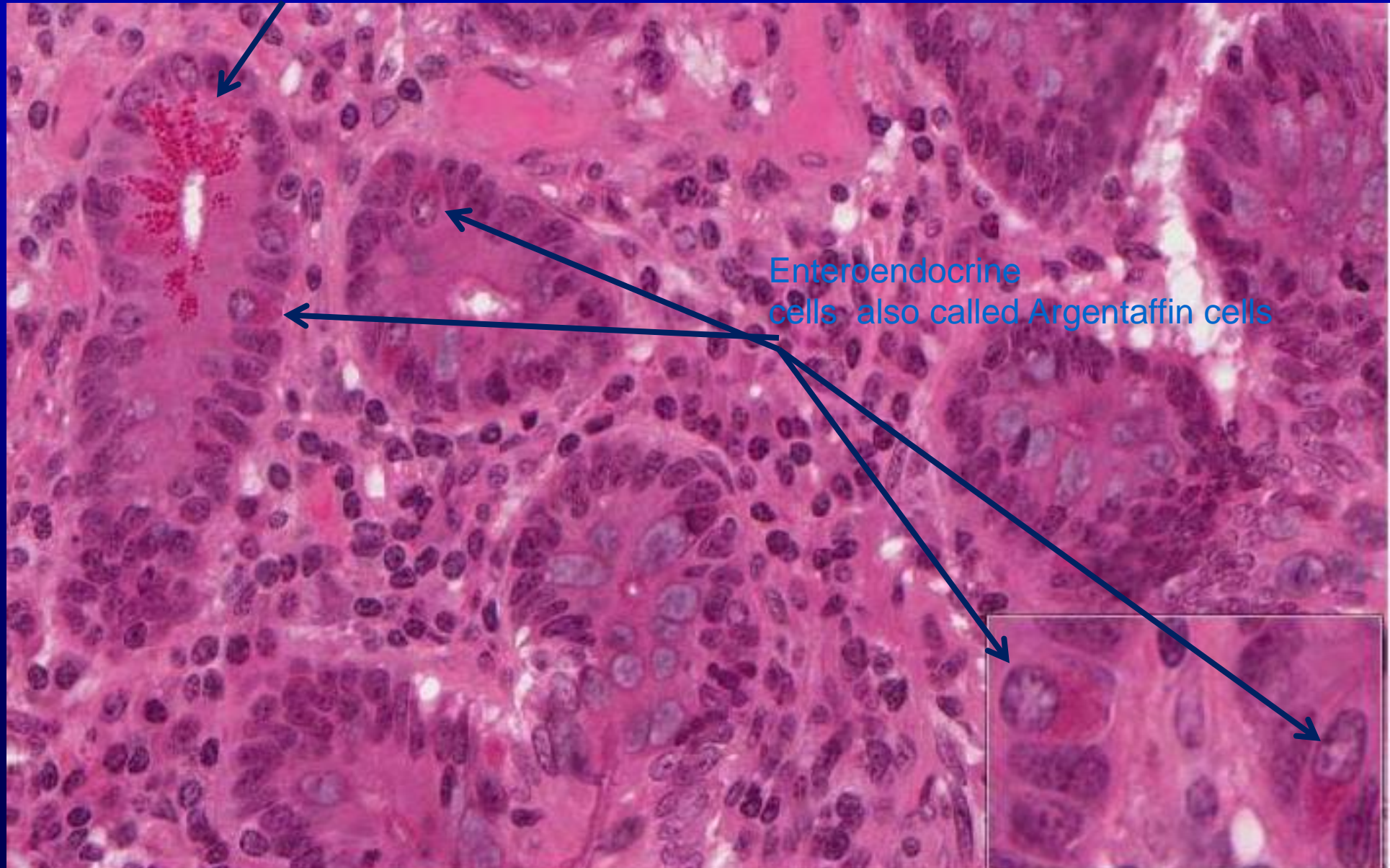


Small intestinal villi

Submucosa

250 Argentaffin cells of Ileum, monkey

Paneth cell



Small Intestine

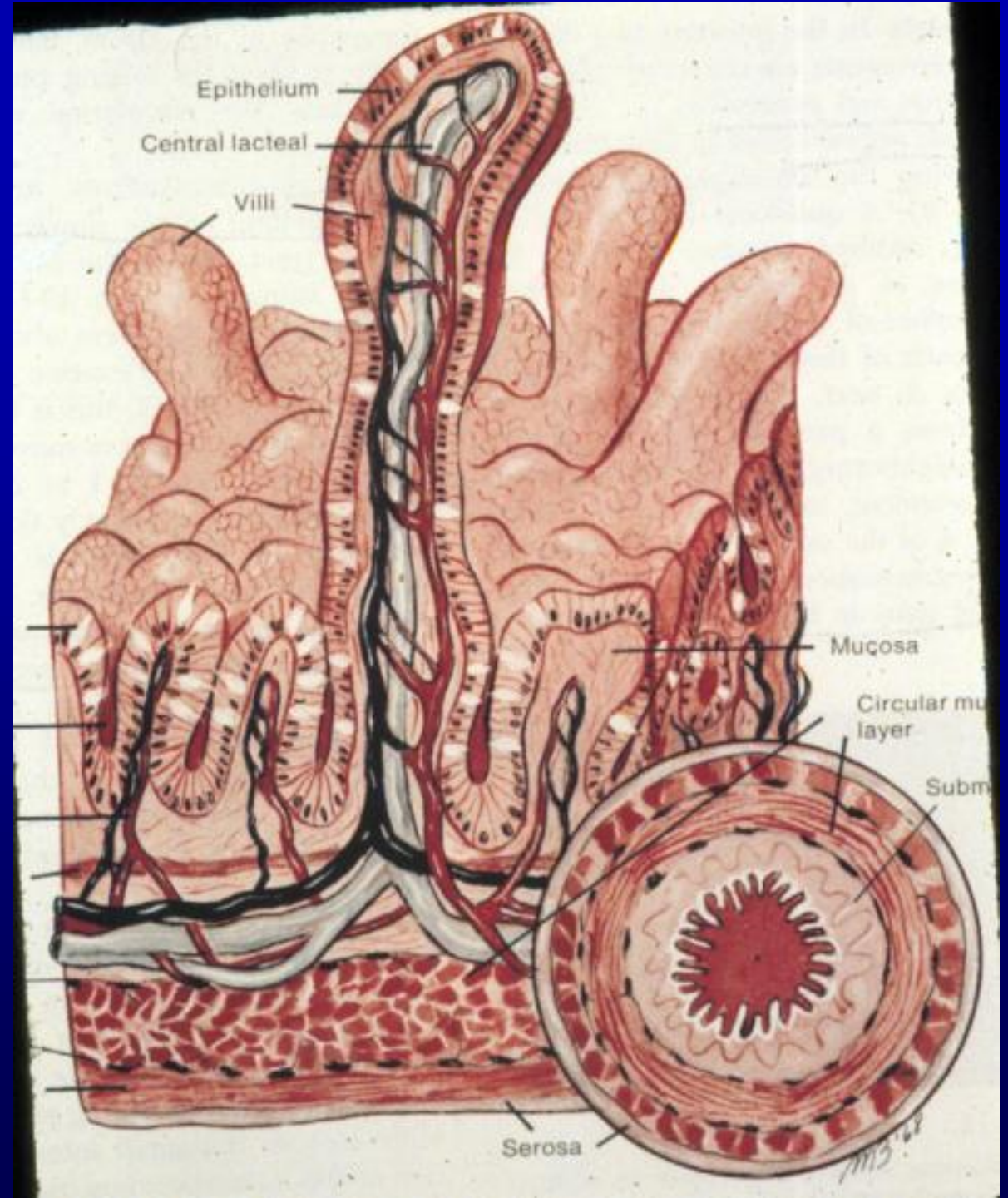
Lamina propria

Submucosa (glands of Brunner)

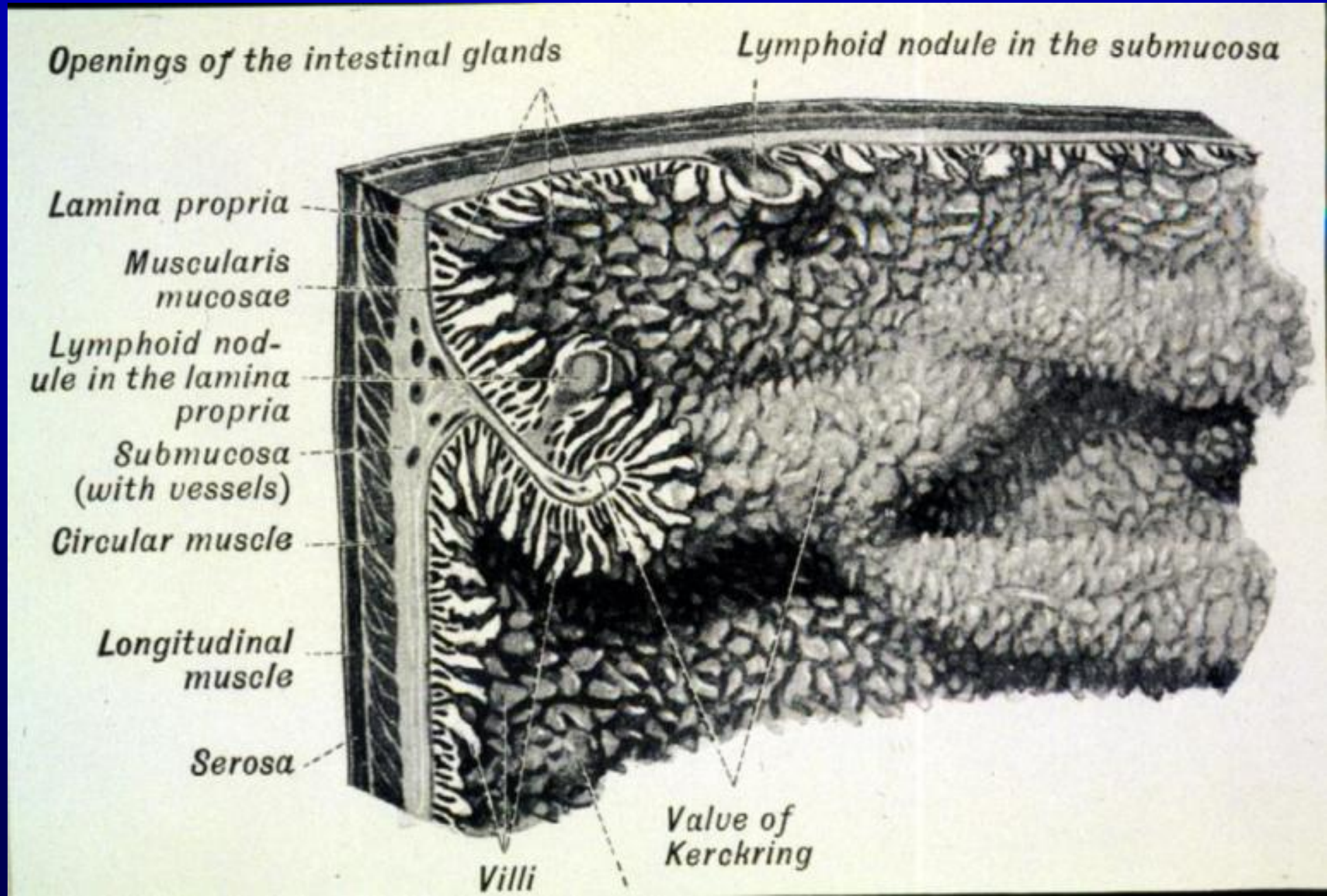
Muscularis externa

Histophysiology

- 1) Cell turnover and renewal
- 2) Secretory immune system of intestine

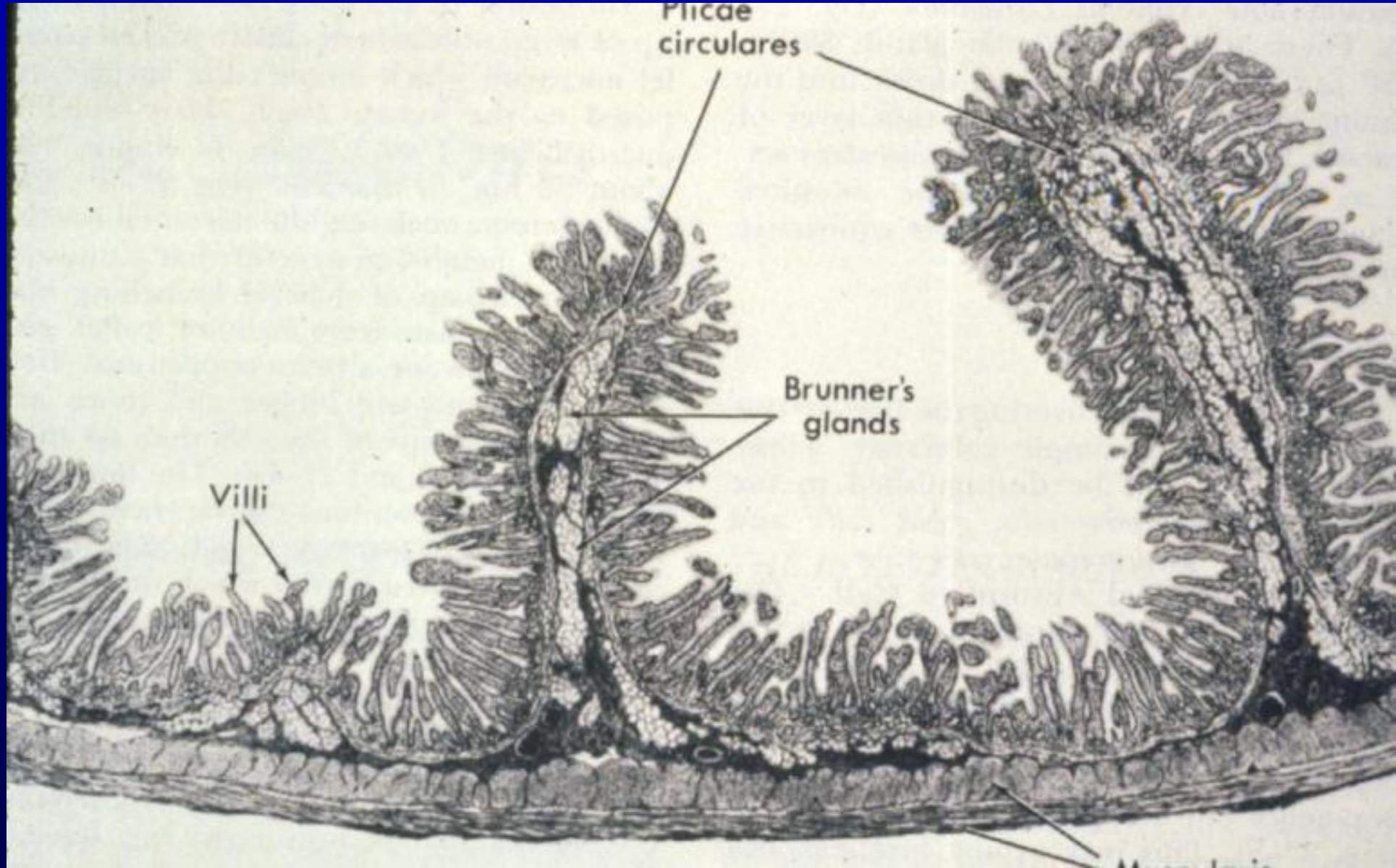


Small Intestine



Lamina propria

Submucosa (Glands of Brunner)



Surface Area Amplification

<u>Component</u>	<u>Size</u>	<u>Amplification</u>
Plicae circulares or valves of Kerkring	10 mm	3 fold
Intestinal villi	0.5 to 1 mm	10 fold
Microvilli (600/cell)	1 μm x 0.1 μm	20 fold

Total surface area 550 sq. meters

Intestinal villi

0.5 to 1 mm

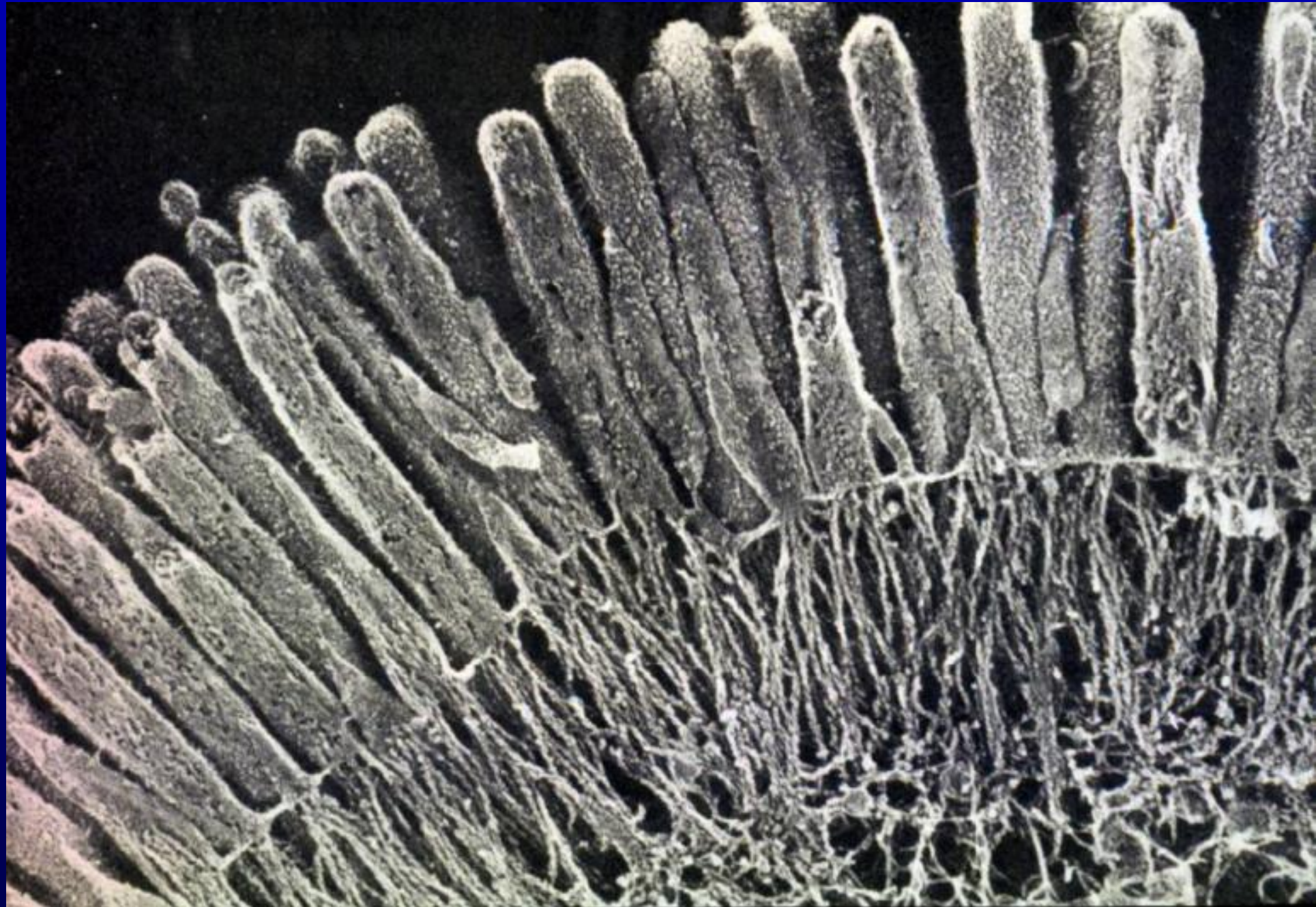
10 Fold



Microvilli (600/cell)

1 μ m x 0.1 μ m

20 fold



ABSORPTIVE CELL

BRUSH BORDER

GLYCOCALYX

- PROTECTION AGAINST ENZYMES
- ACTIVE IN DEIGESTION

TERMINAL WEB

ELONGATED MITOCHONDRIA

GOLGI COMPLEX LARGE

SER & RER

**LATERAL SURFACES -
INTERDIGITATION**

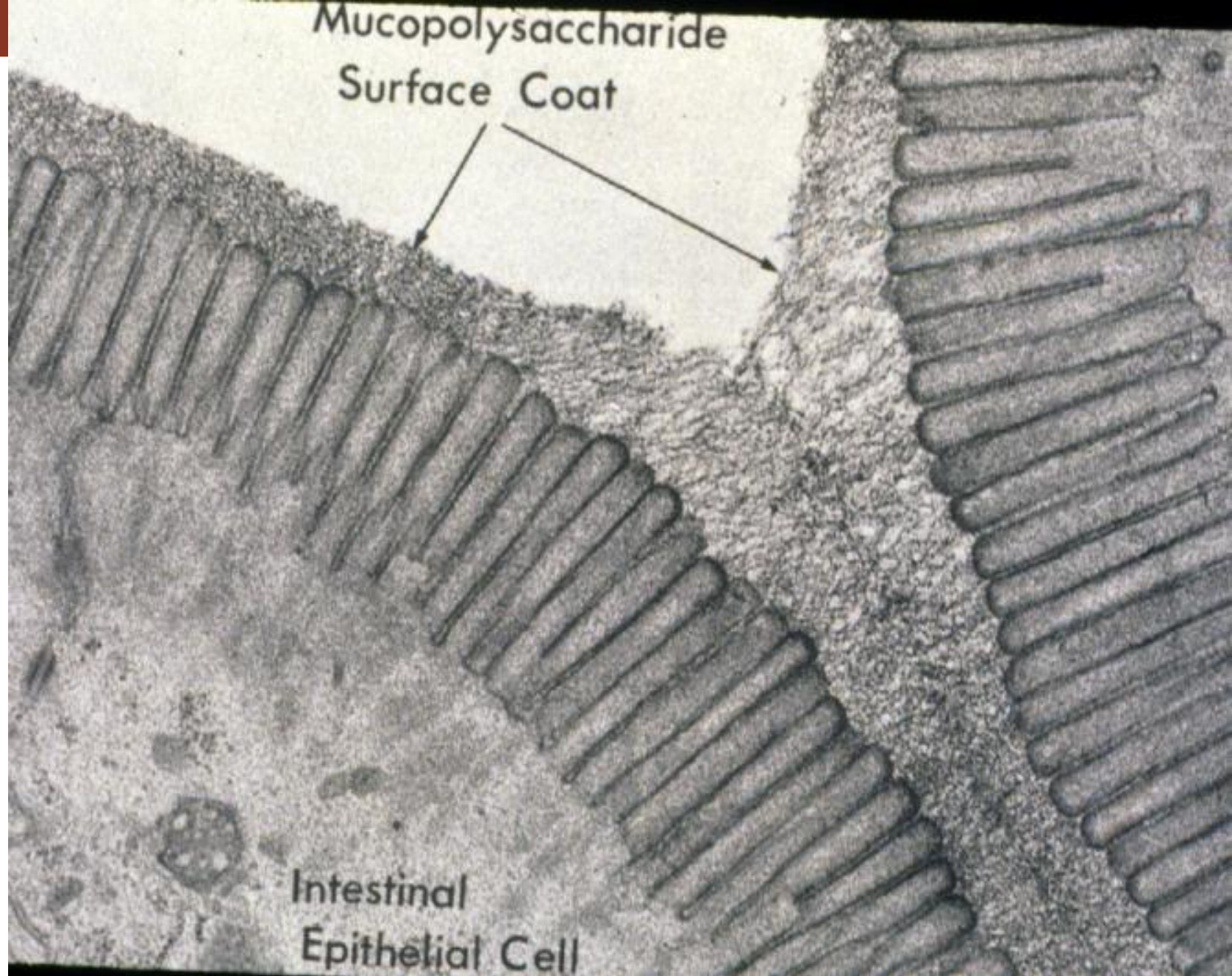


**BRUSH BORDER
GLYCOCALYX**

- PROTECTION AGAINST ENZYMES
- ACTIVE IN DEIGESTION



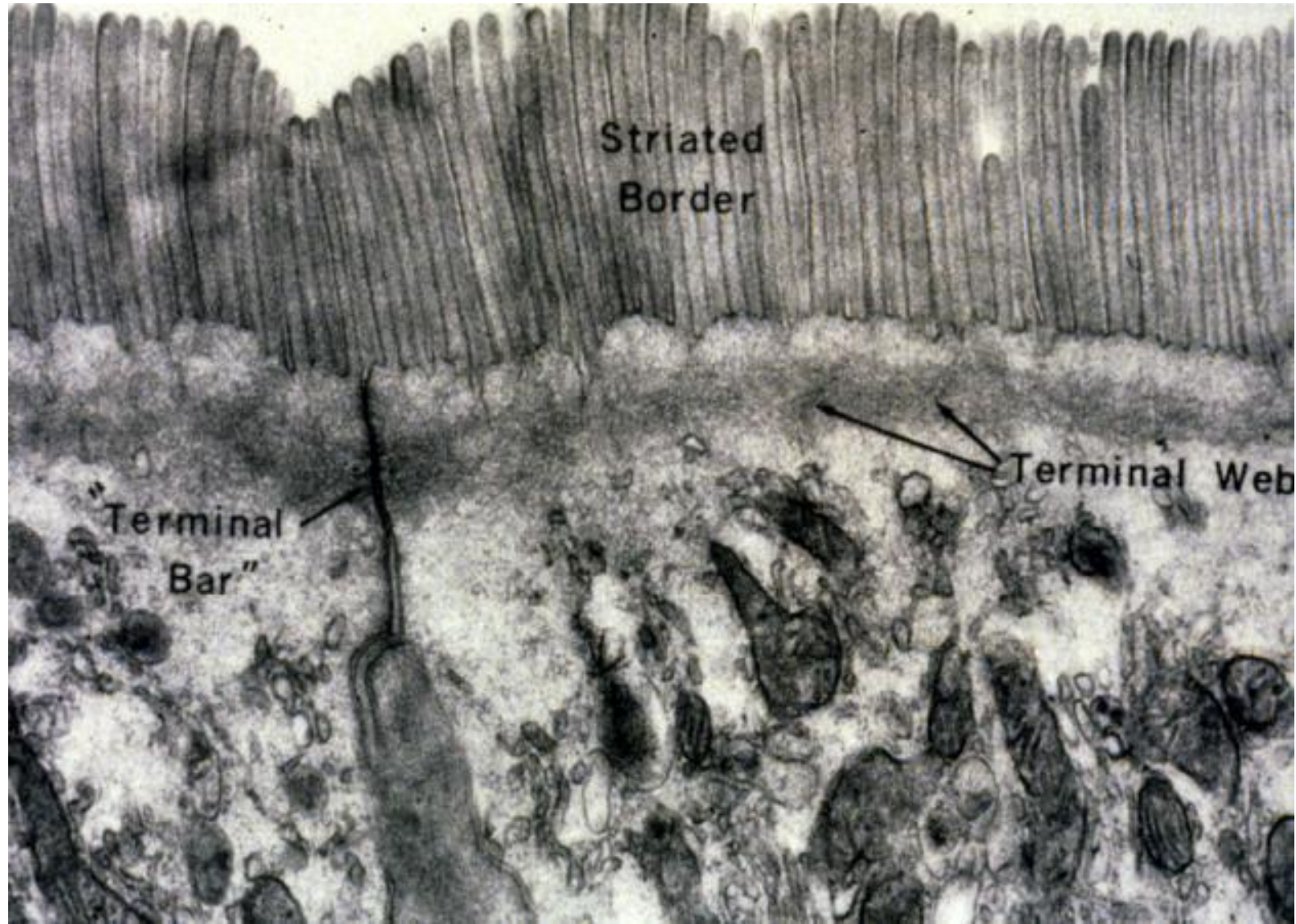
GLYCOCALYX



BRUSH BORDER

GLYCOCALYX

- PROTECTION AGAINST ENZYMES
- ACTIVE IN DEIGESTION



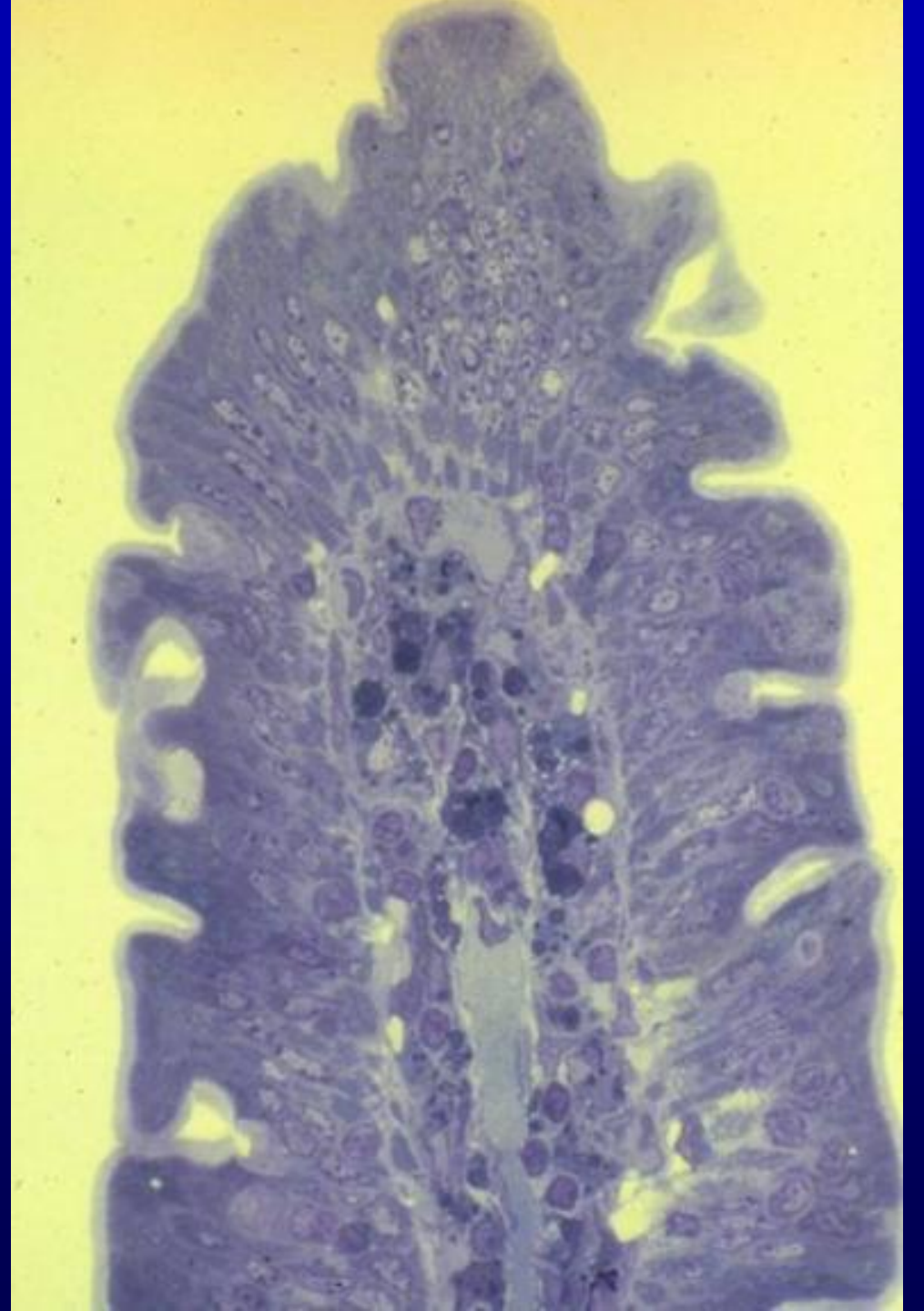
Lamina propria

**Connective tissue between
intestinal glands and forms cores
of intestinal villi**

Central lacteal

**Large numbers of lymphocytes,
plasma cells, eosinophils, mast
cells, and macrophages**

**Smooth muscle innervated by
Meissner's plexus**

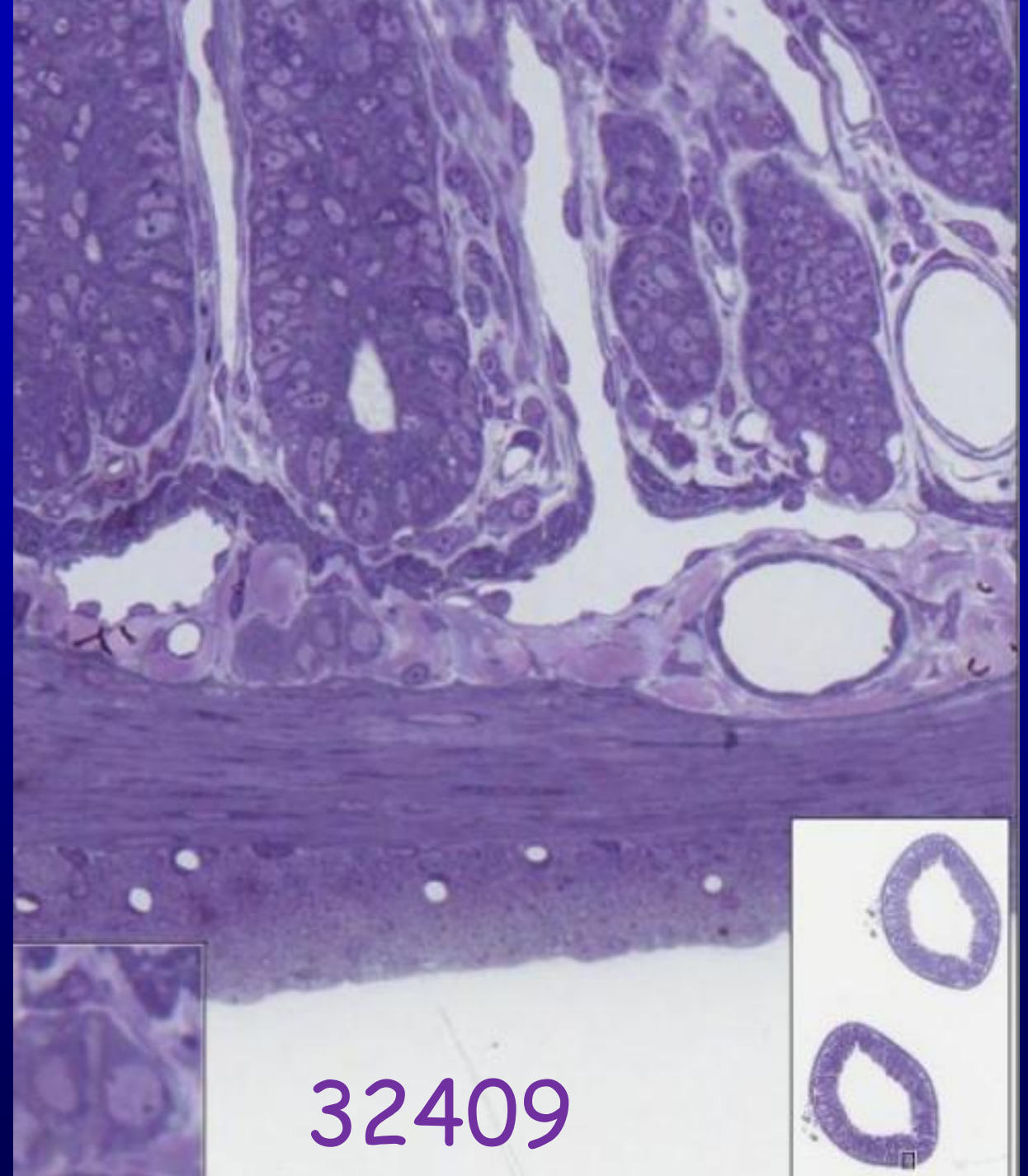


Lamina Propria

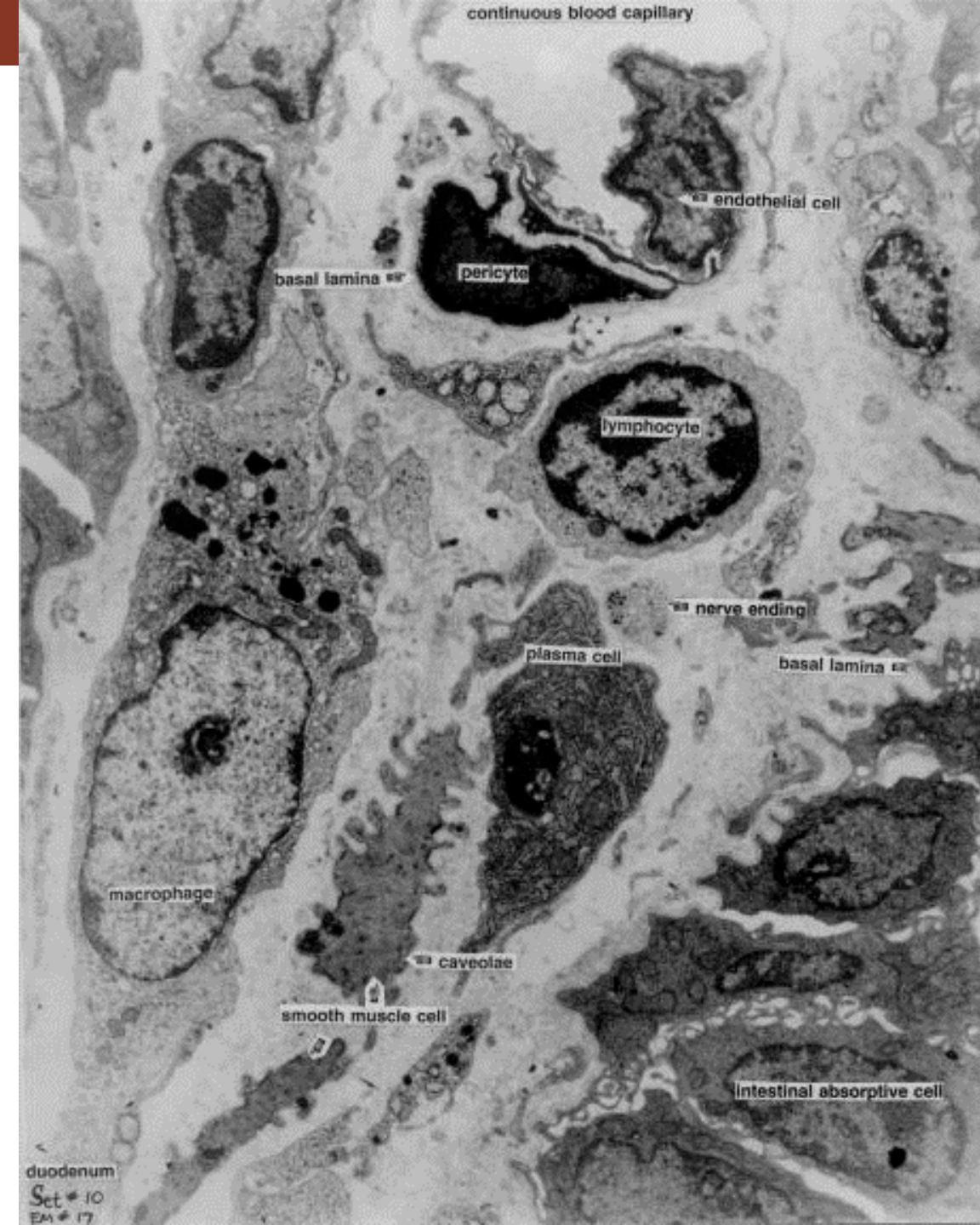
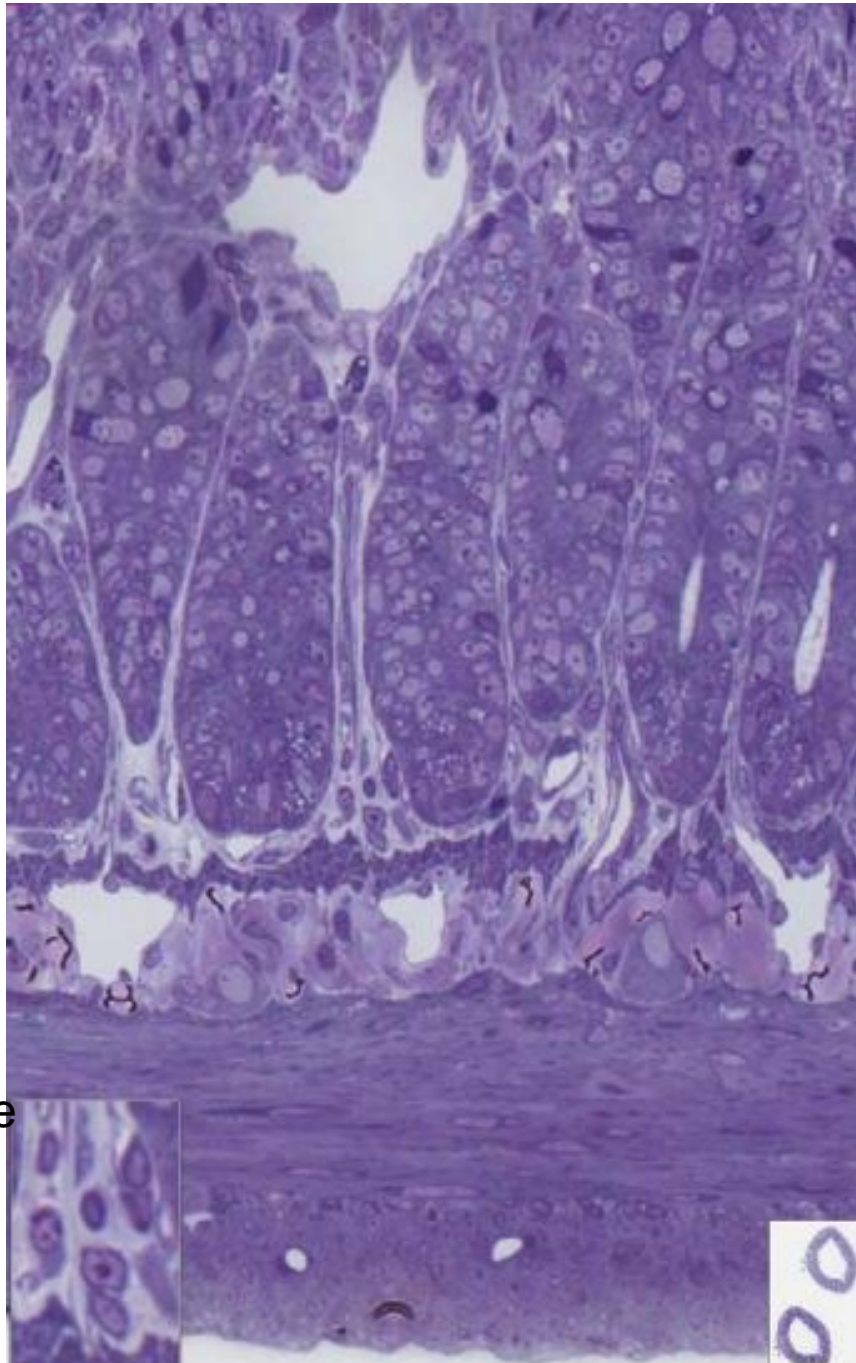
Connective tissue between intestinal glands and forms cores of intestinal villi

Central lacteal

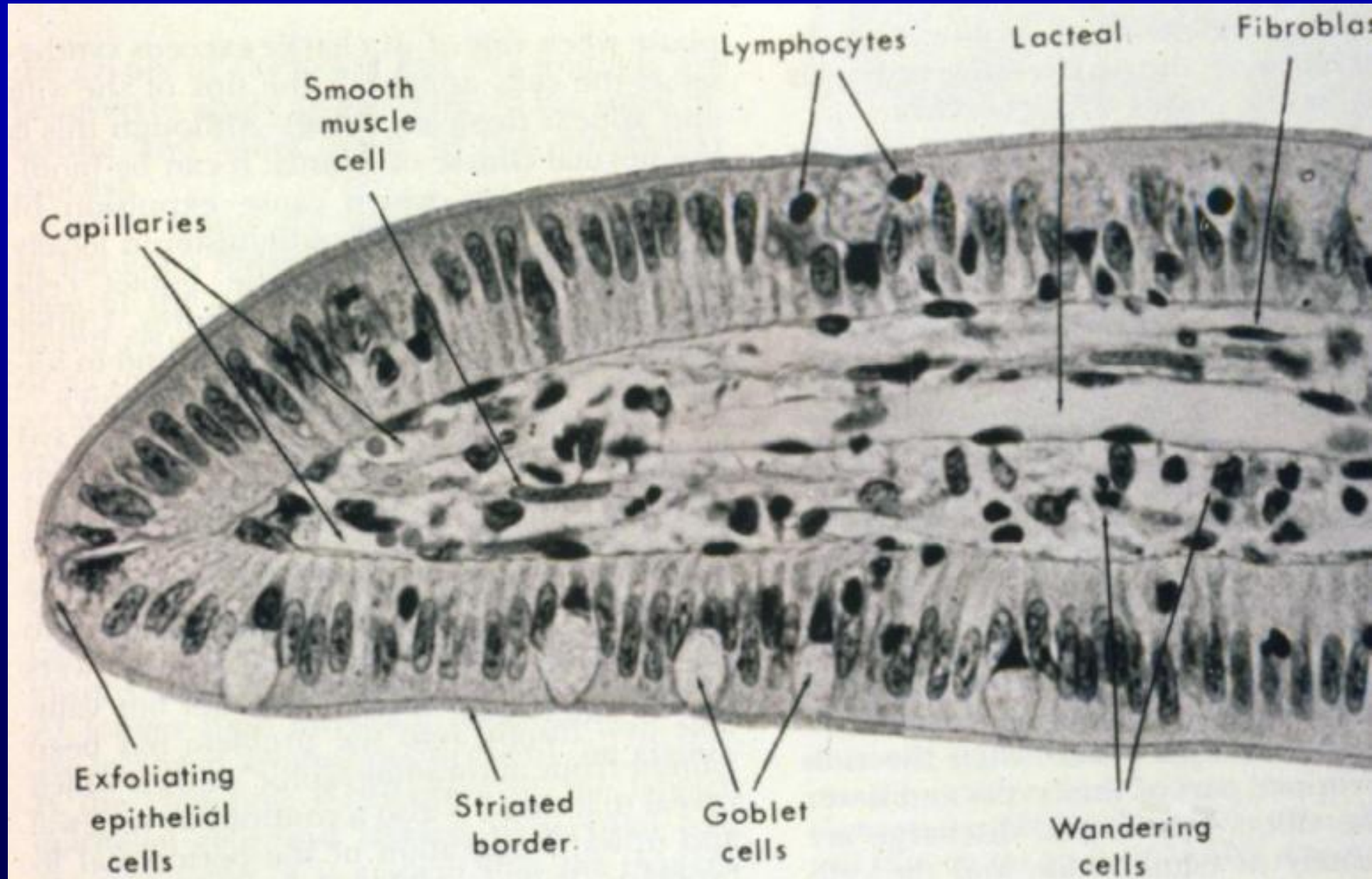
Smooth muscle innervated by Meissner's plexus in submucosa

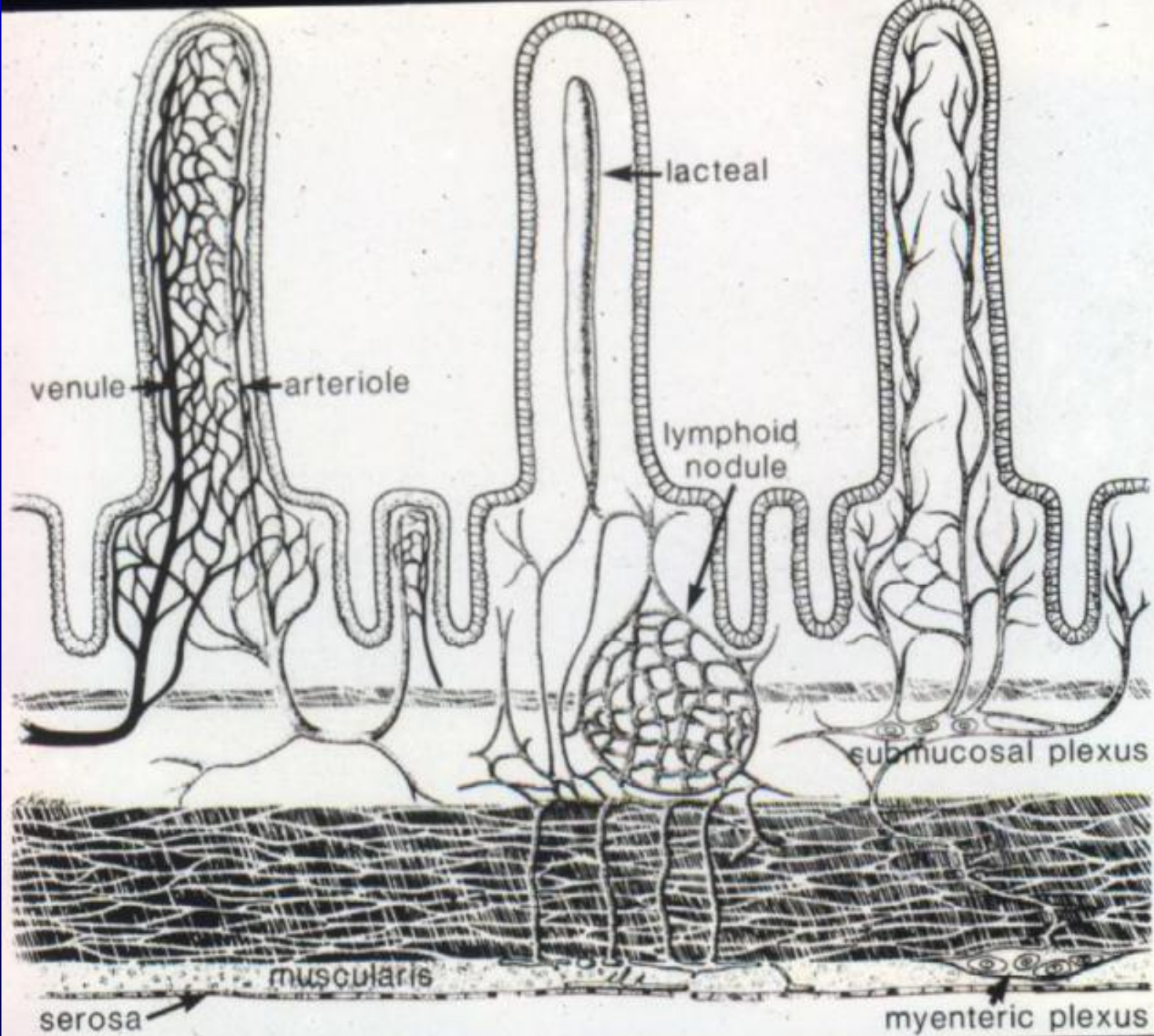


32409
rat intestine



Lamina Propria



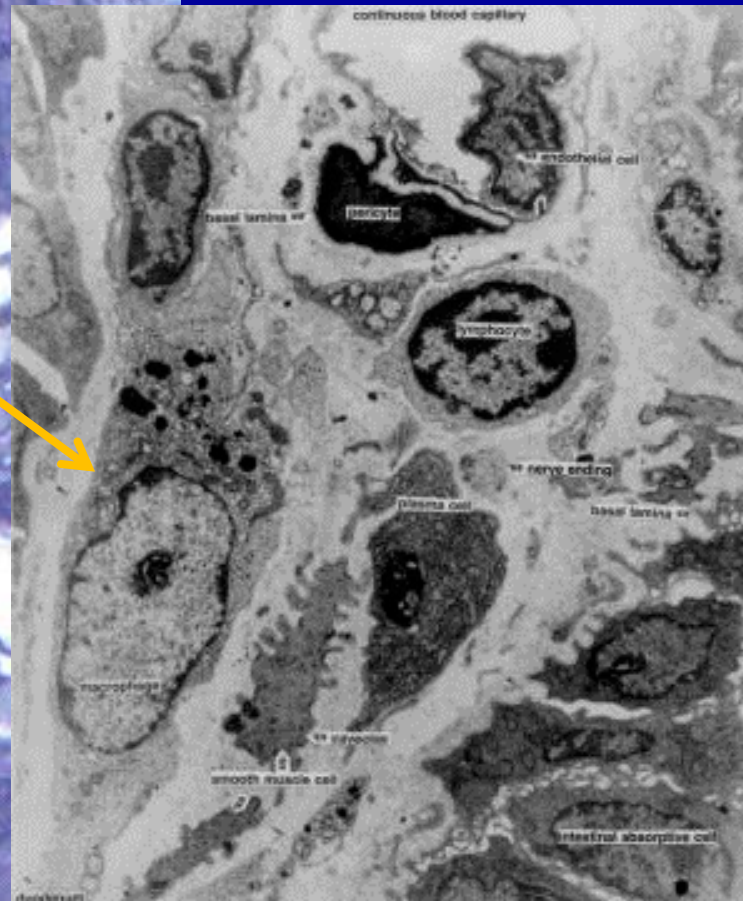
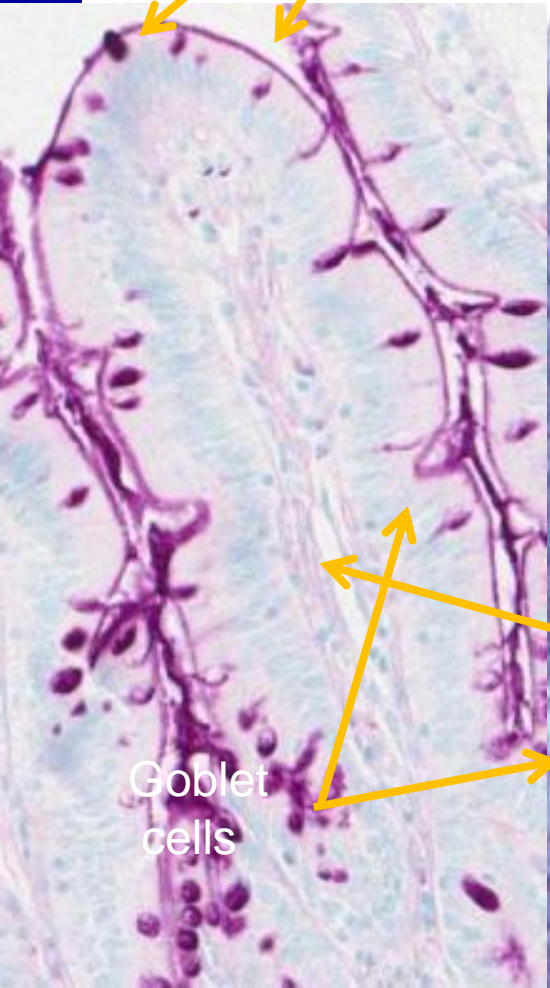
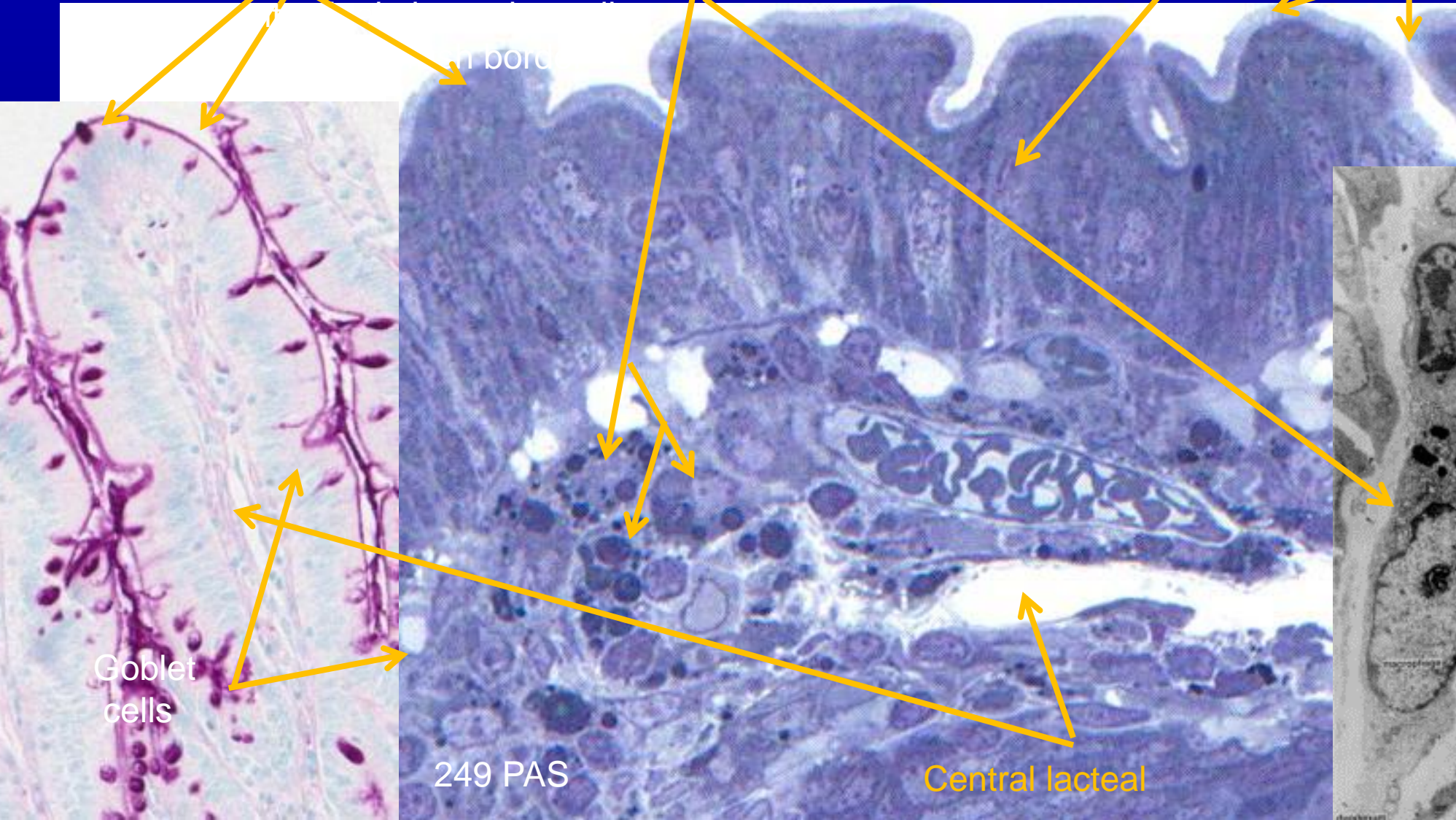


447 Small intestine

Mucus of goblet cells and the carbohydrates in the brush border are PAS positive for sugars

Intestinal villus
Intestinal absorptive cell
Brush border

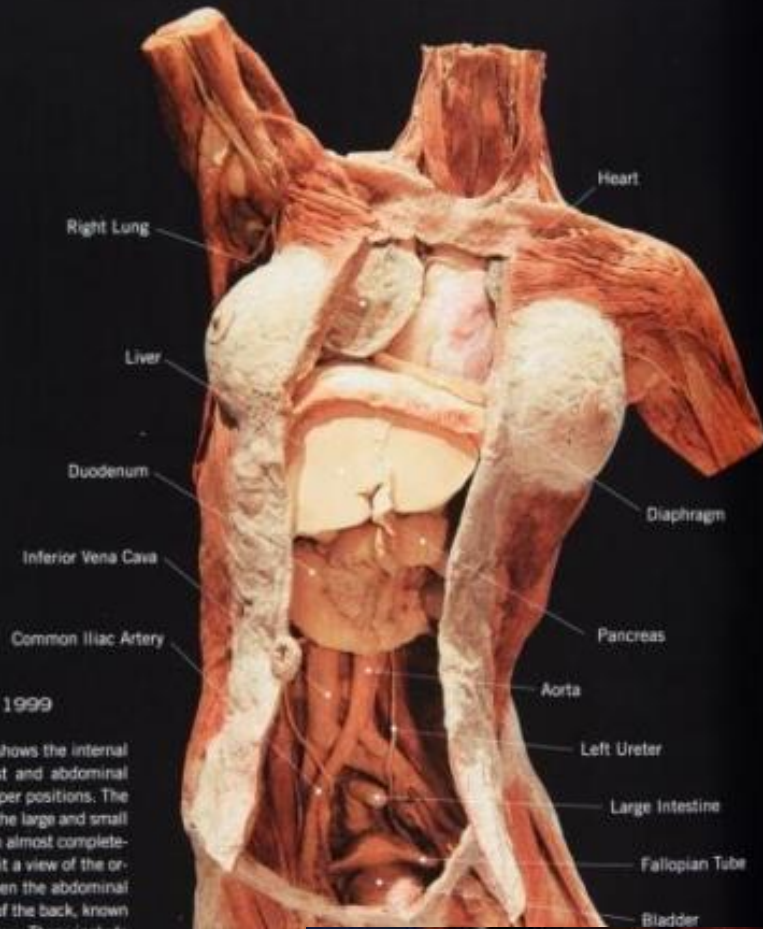
Macrophages



249 PAS

Central lacteal

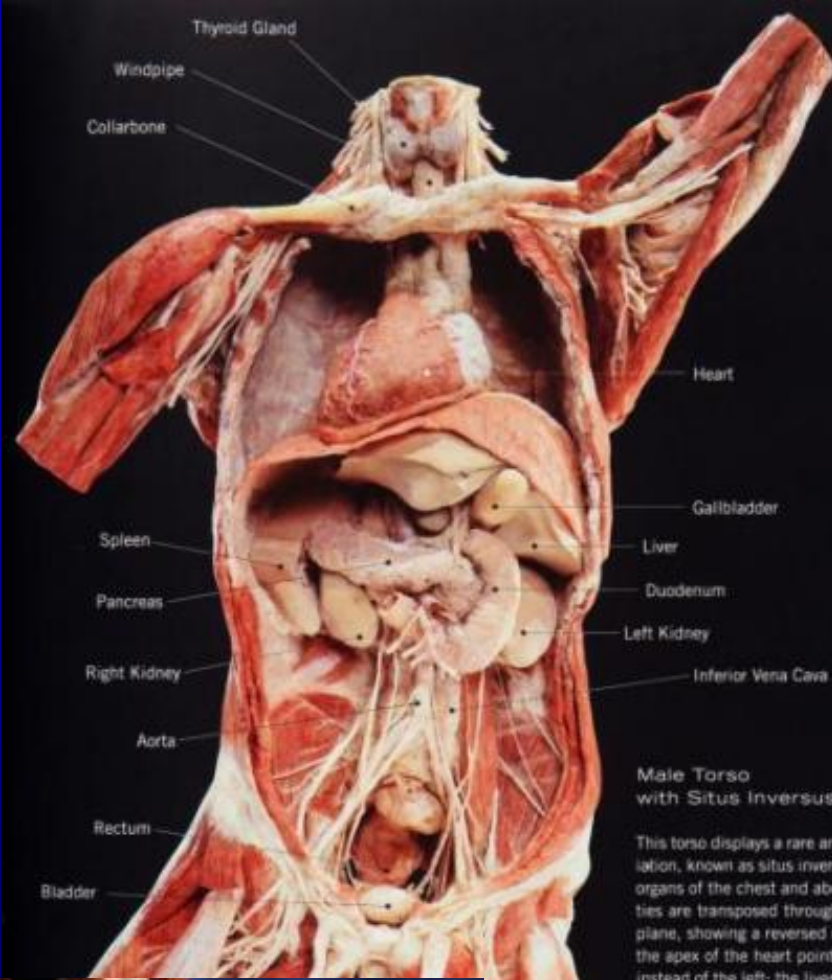
Goblet cells



Female Torso, 1999

This opened torso shows the internal organs of the chest and abdominal cavities in their proper positions. The stomach as well as the large and small intestines have been almost completely removed to permit a view of the organs located between the abdominal cavity and the wall of the back, known as the retroperitoneum. These include the ureters, the aorta and the lower vena cava as well as the pancreas and the duodenum. In the small pelvic cavity, the bladder can be seen, and behind it, the uterus, which is inclined forward with the fallopian tubes emerging from the sides. The large intestine extends downward behind the uterus.

Ab



Male Torso with Situs Inversus, 1999

This torso displays a rare anatomical variation, known as situs inversus. Here the organs of the chest and abdominal cavities are transposed through the sagittal plane, showing a reversed mirror-image: the apex of the heart points to the right instead of the left; the liver is on the left side of the body while the spleen is on the right; and the pancreas extends from left to right across the spinal column instead of vice versa. This anatomical variation does not cause any disorders. The incidence of this phenomenon is approximately 1 in 25,000. The bladder can be seen in front of the rectum in the small pelvic cavity.

Gunther von Hagens'

BODY WORLDS

The Anatomical Exhibition of Real Human Bodies

Digestive System continued

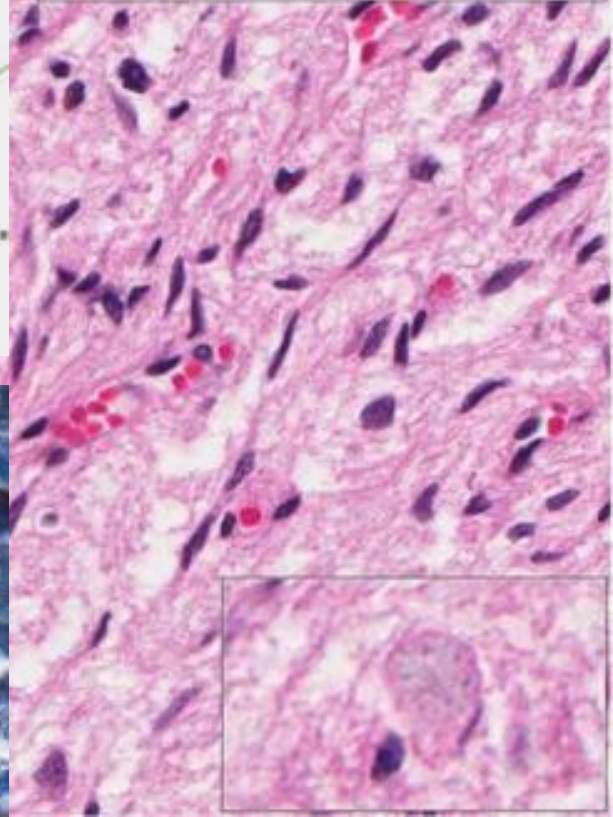
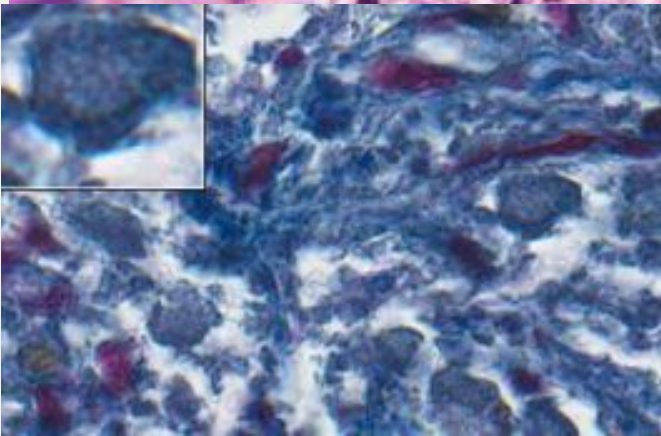
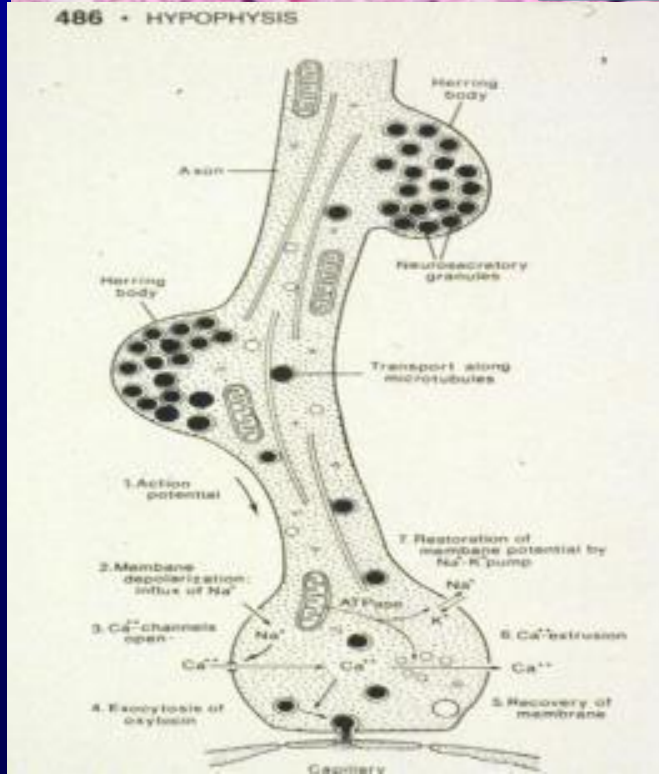
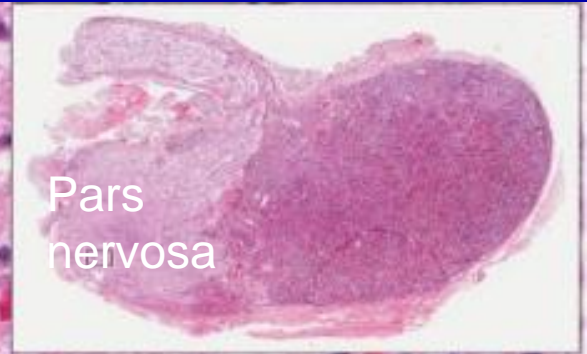
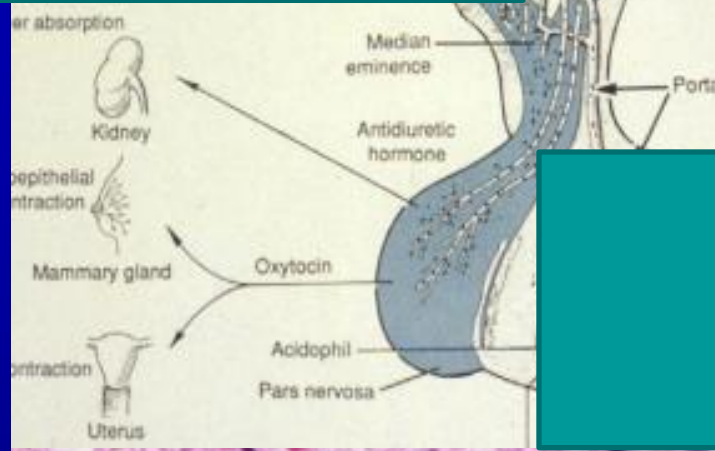






490

Herring bodies in pars nervosa of Hypophysis



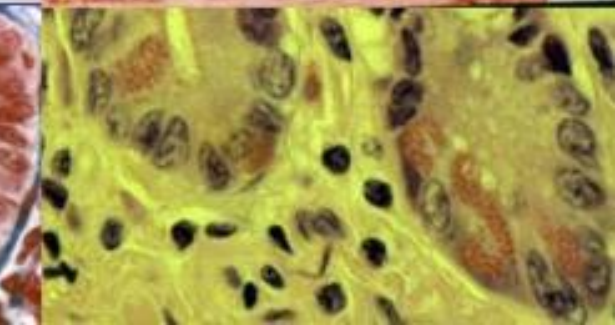
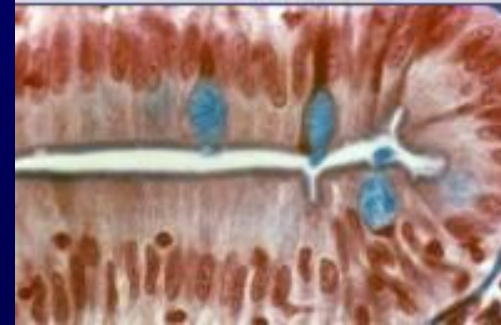
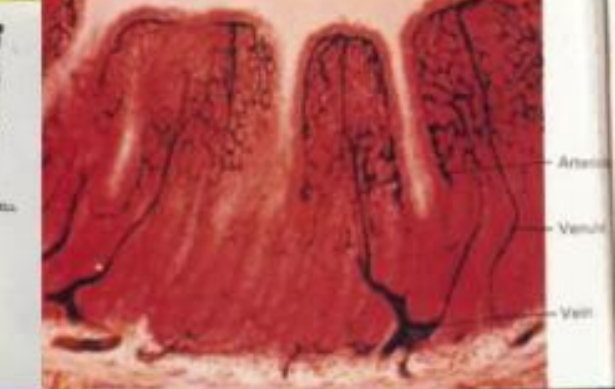
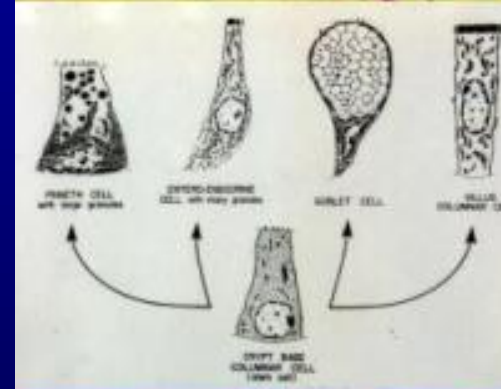
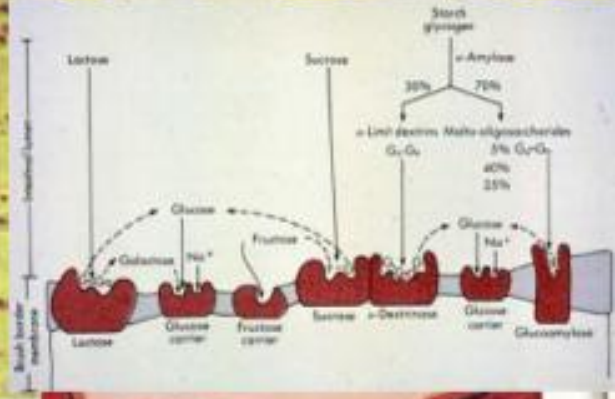
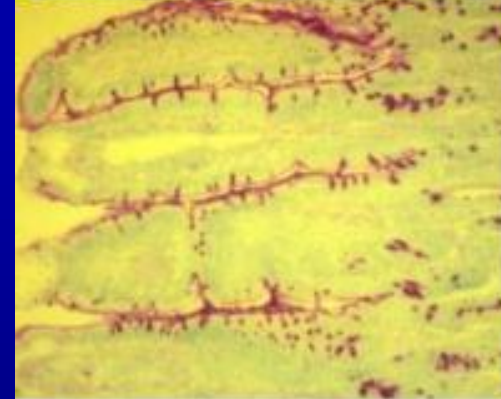
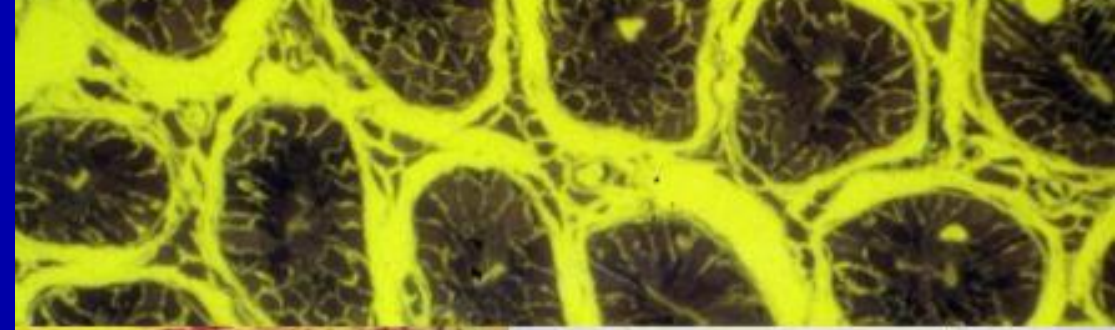
Digestive System continued



Objectives

To understand the general **organization** of organs of the digestive system and how they function to **obtain metabolites** necessary for **growth** and **energy** for the body, yet maintain a **barrier** between the environment and the internal milieu of the body

To identify and describe functions of **cellular structures, cells,** and groups of cells in the digestive system.





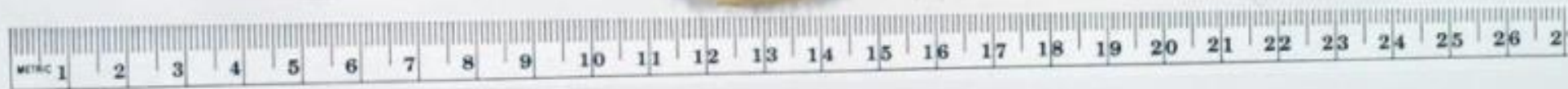
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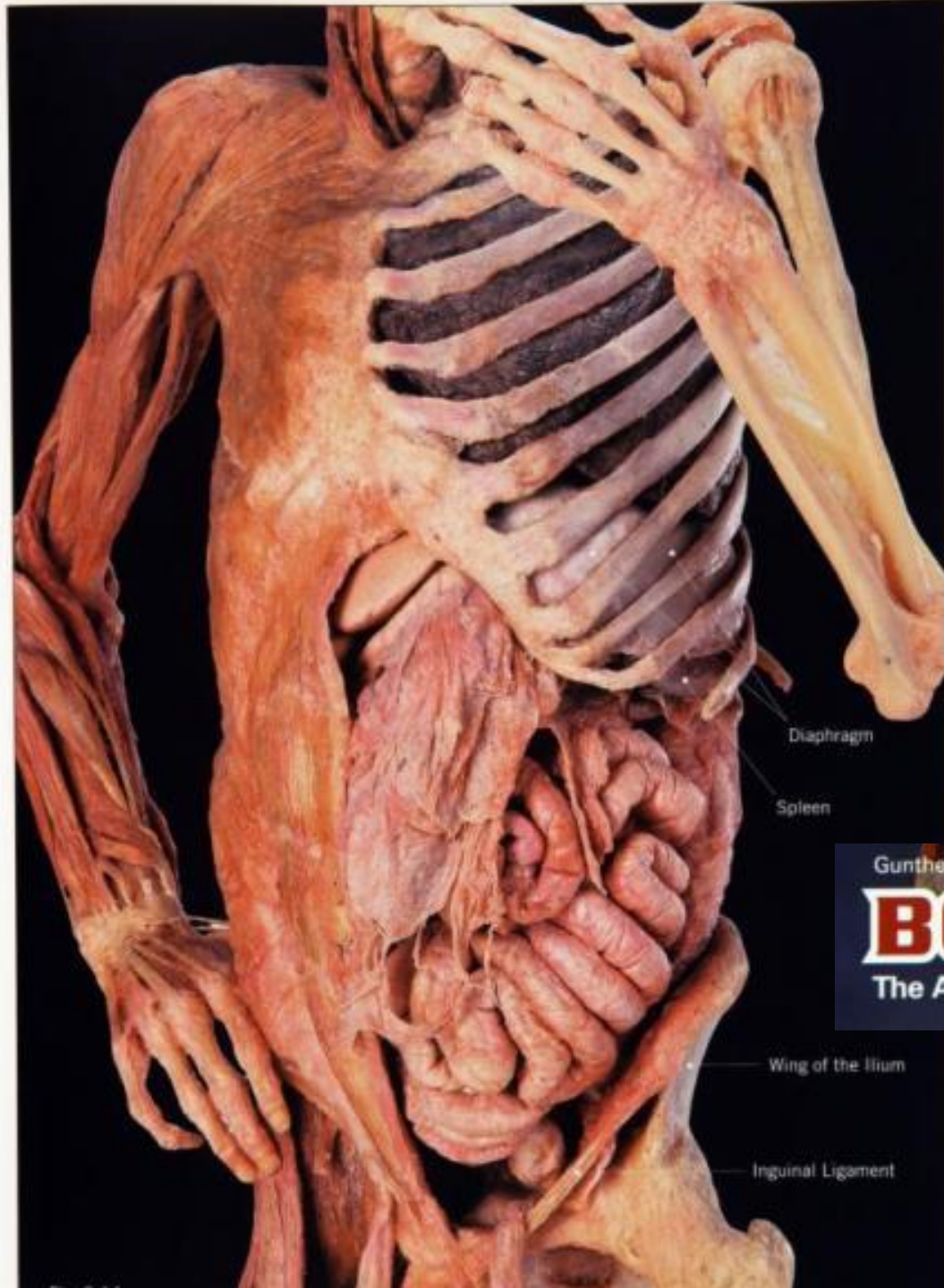
17 18 19 20 21 22 23 24 25 26 27











Diaphragm

Spleen

Gunther von Hagens'

BODY WORLDS

The Anatomical Exhibition of Real Human Bodies

Wing of the Ilium

Inguinal Ligament

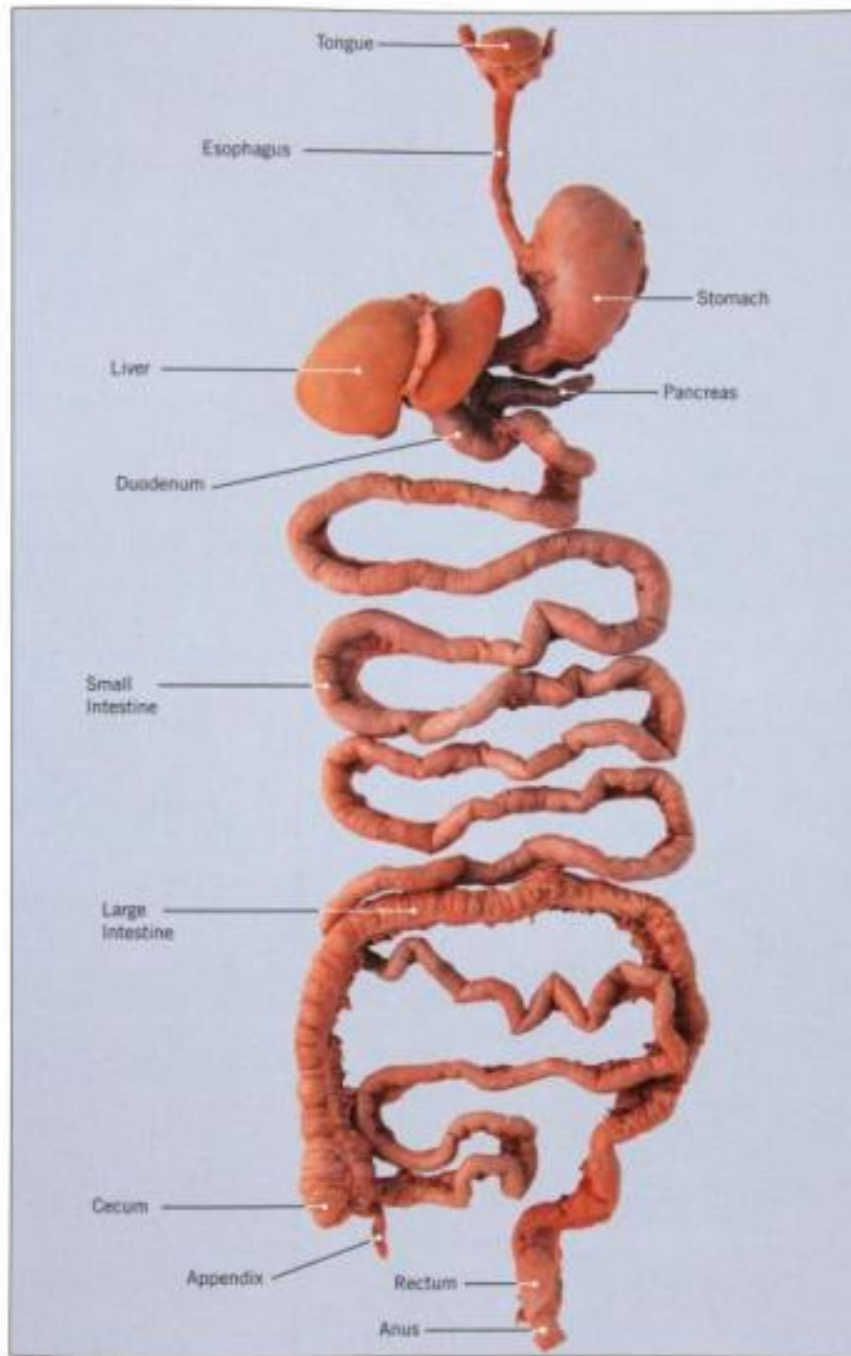


Fig. 5.1: The organs of the digestive system.

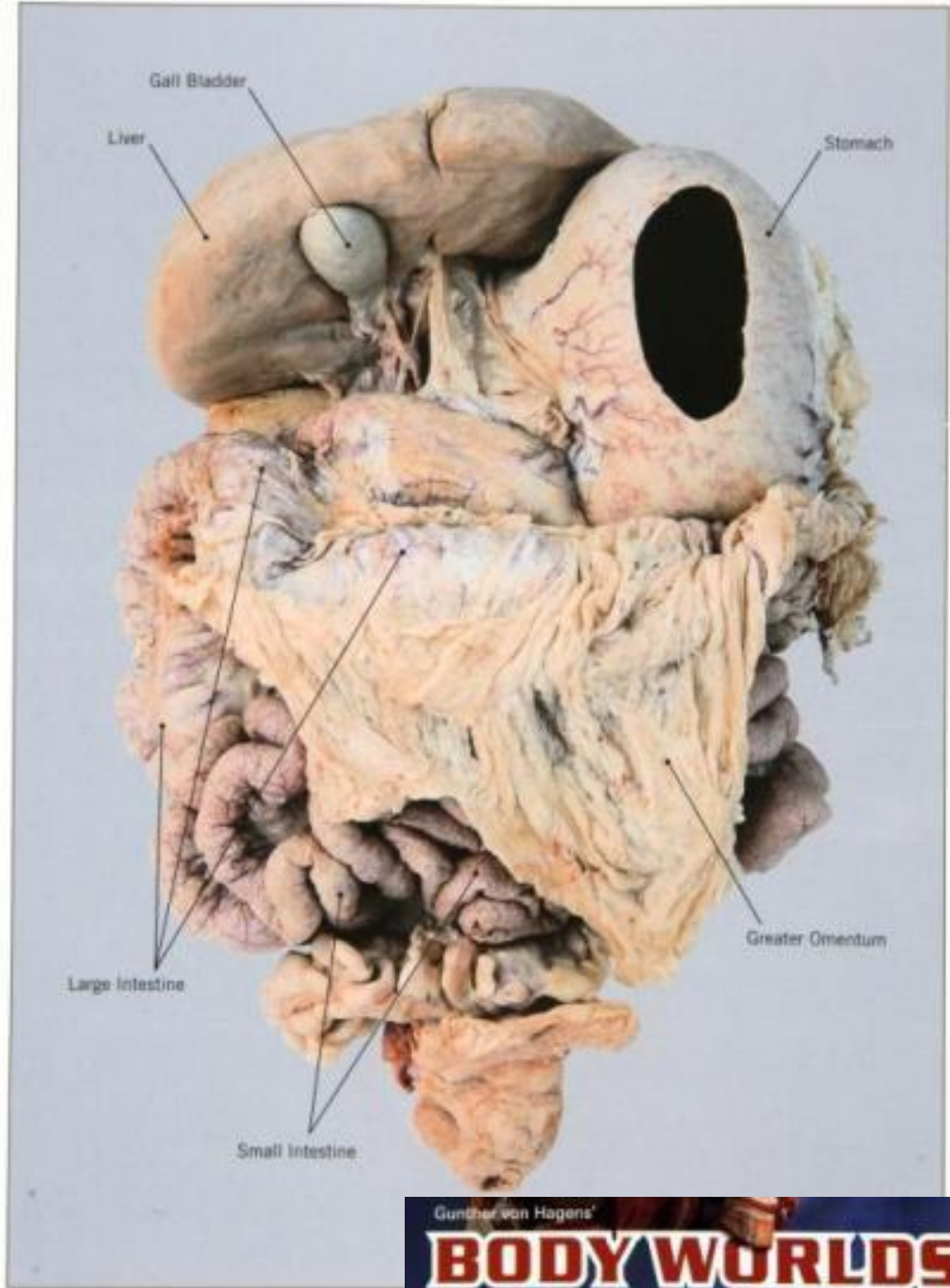
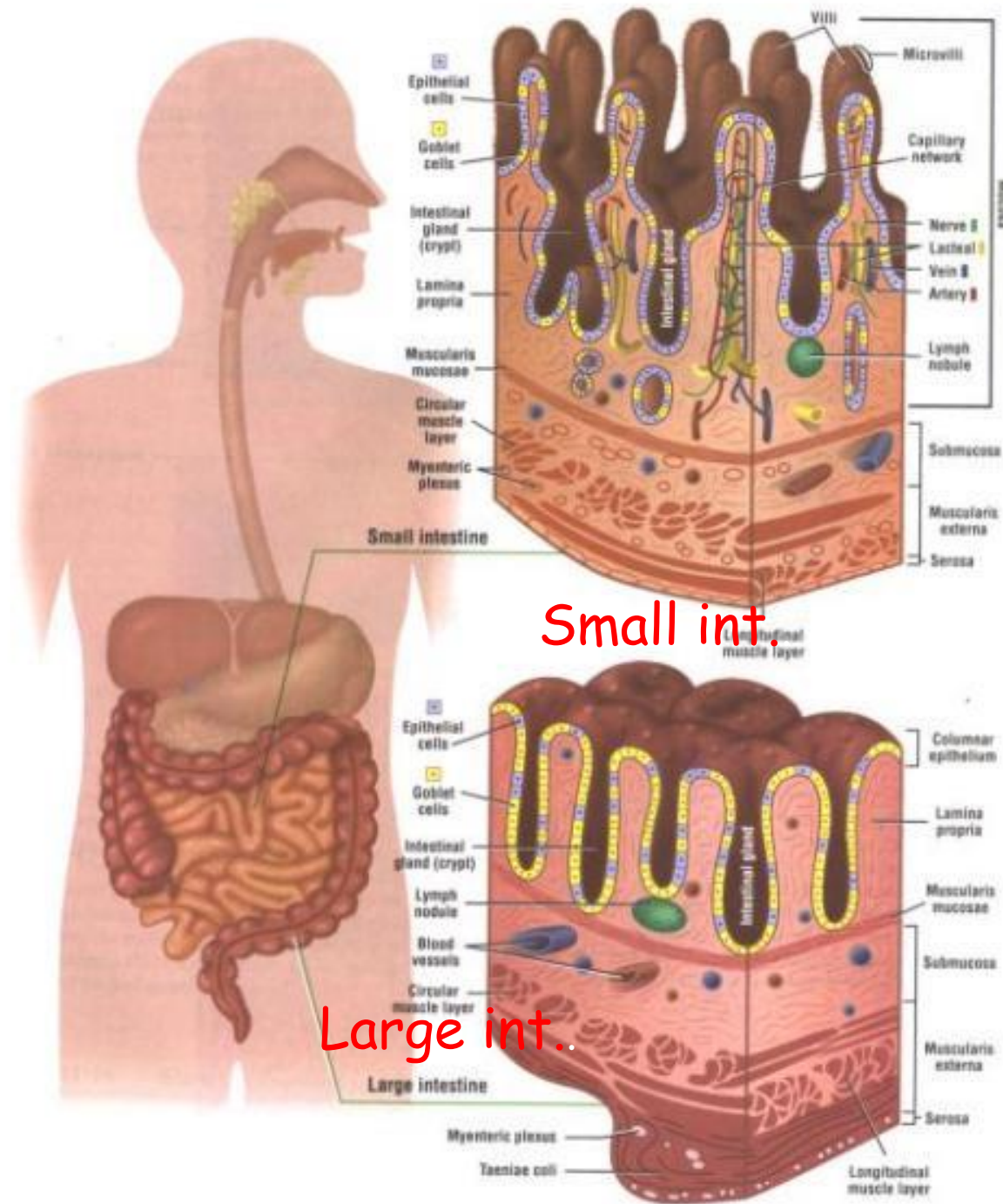


Fig. 5.2: The organs of the digestive system.



Small int.

Large int.

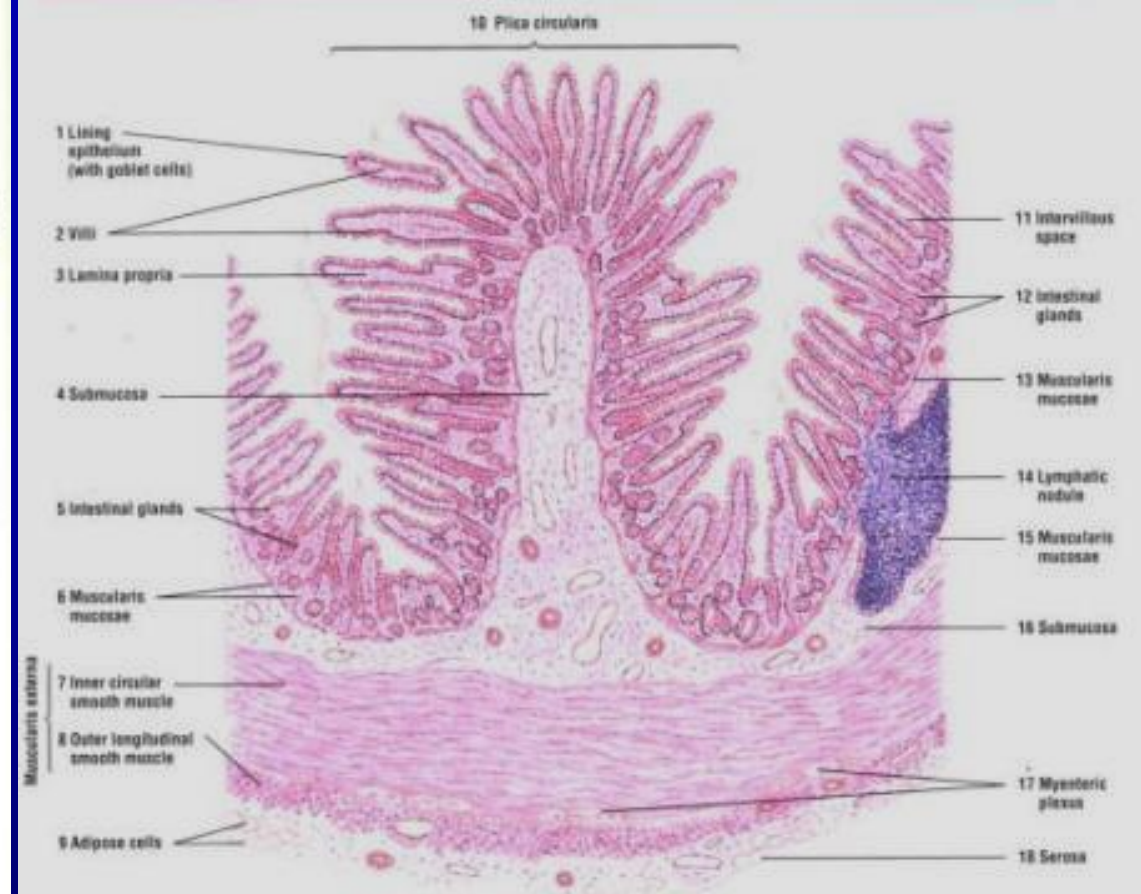


Fig. 12-2 Small Intestine: Jejunum-Ileum (transverse section). Stain: hematoxylin-eosin, low magnification.



Fig. 12-3 Intestinal Glands With Paneth Cells and Enteroendocrine Cells. Stain: hematoxylin-eosin, plastic section. High magnification.

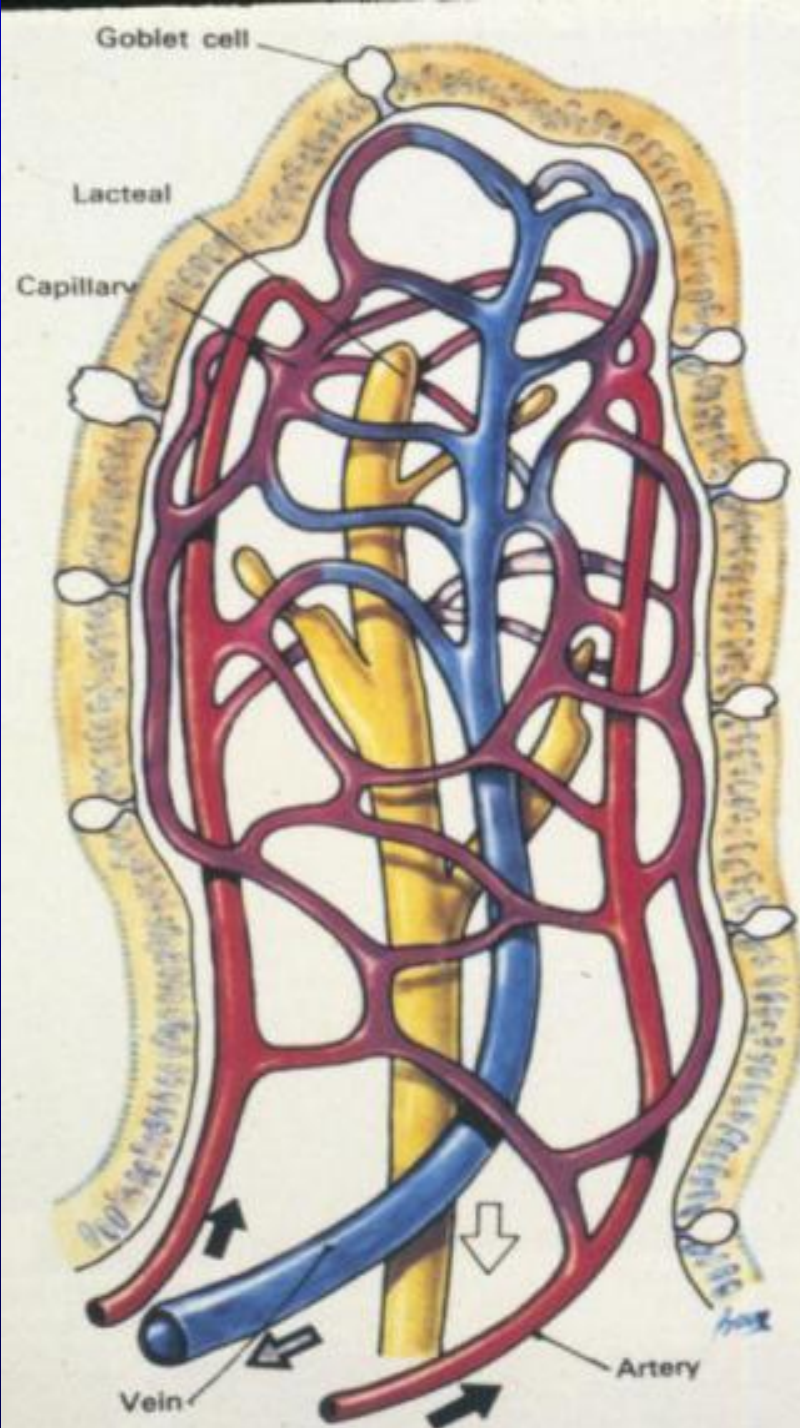


Figure 26-31. Scanning electron micrograph of a corrosion cast of the microcirculation of a rat intestinal villus showing a dense capillary network arising from an arteriole at the margin of the villus. (From Komuro, T. 1990. *Cell Tissue Res.* 239:183.)

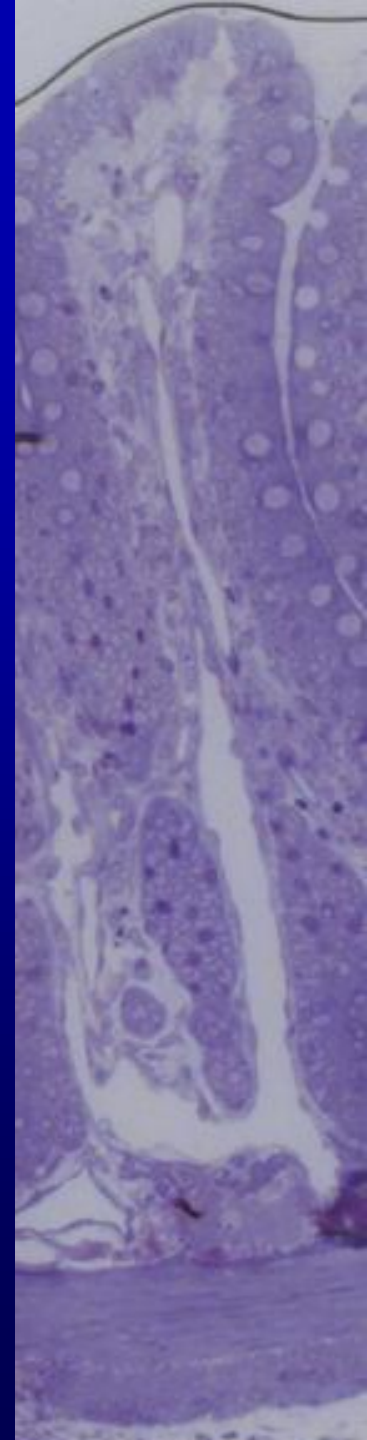
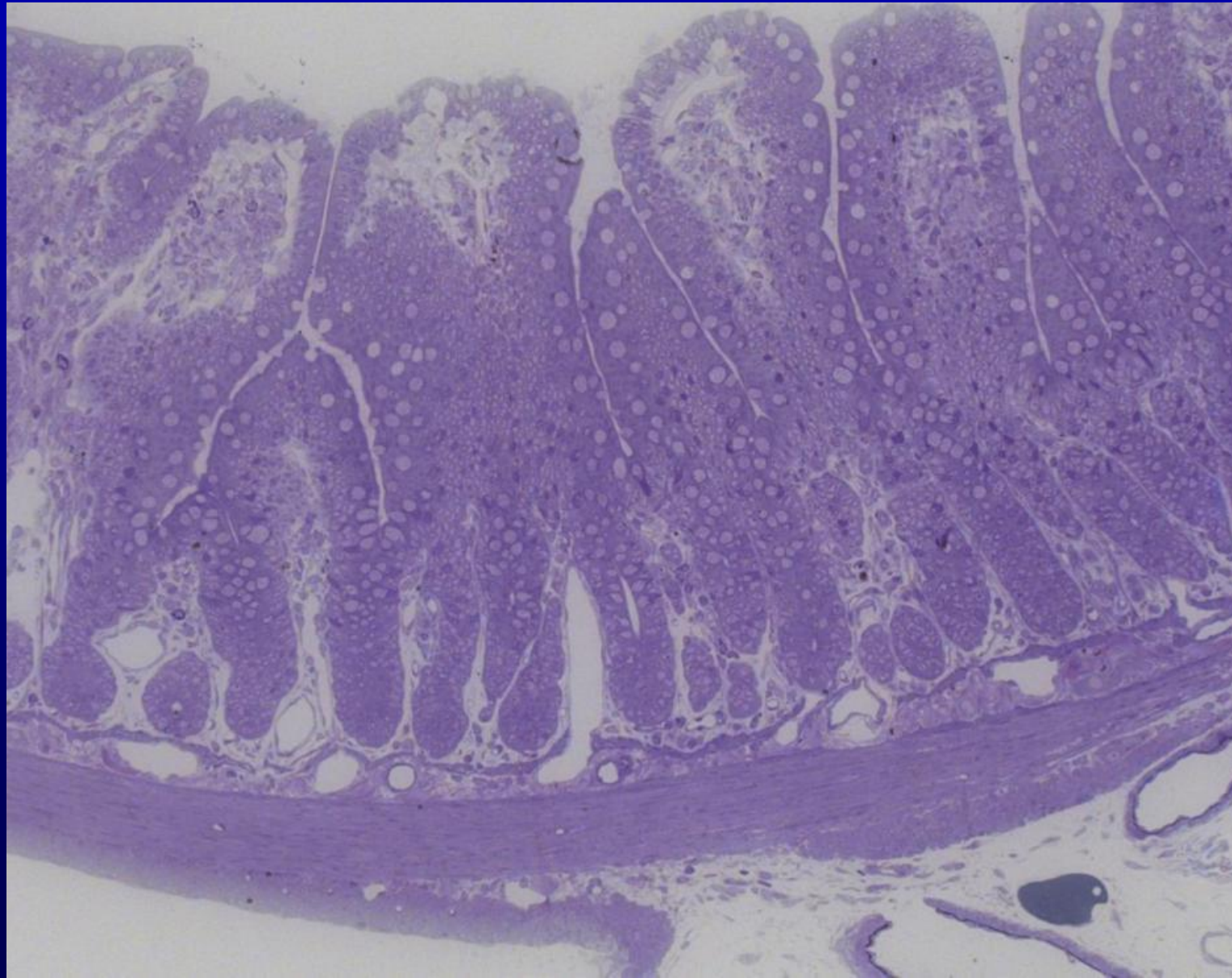


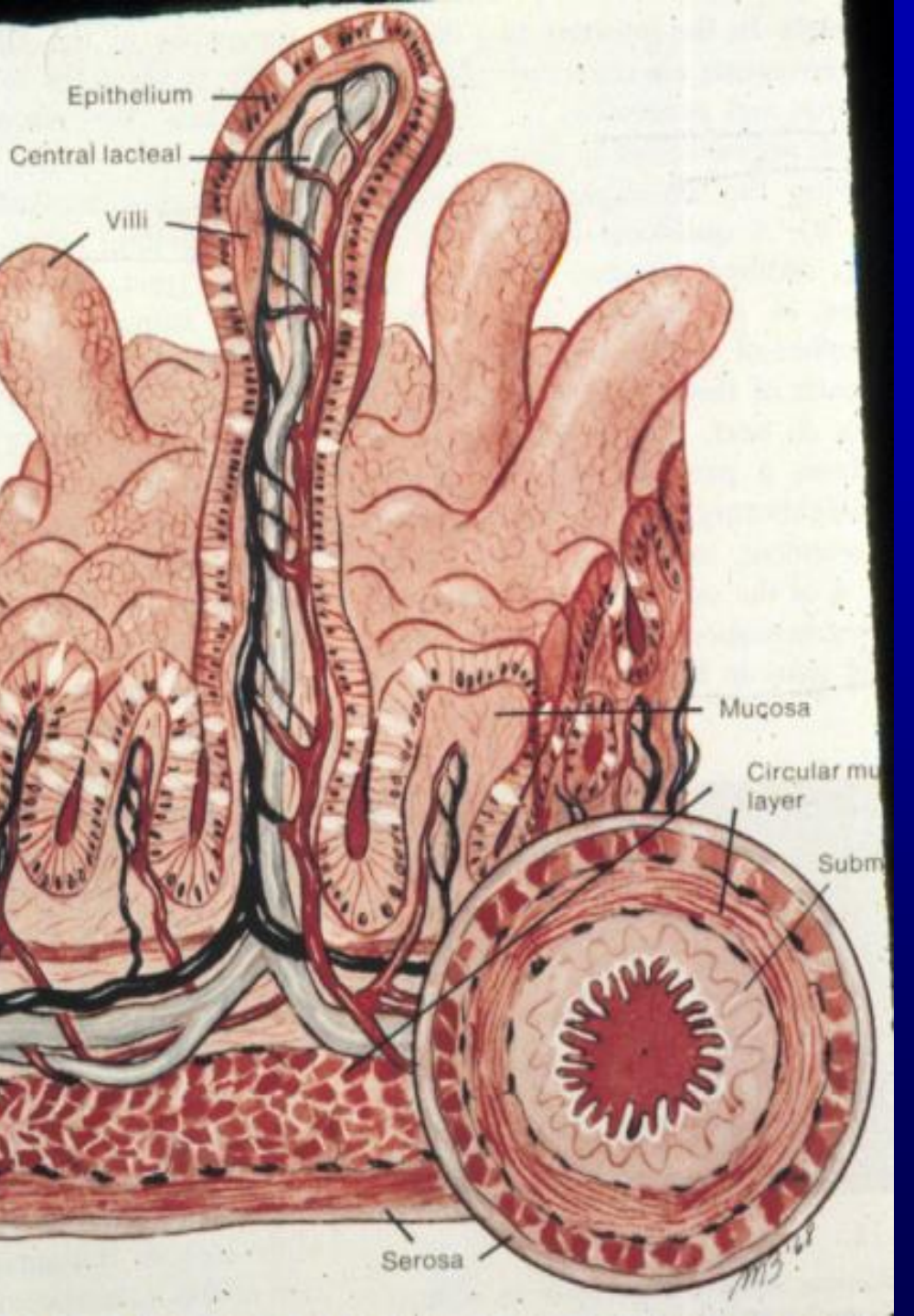
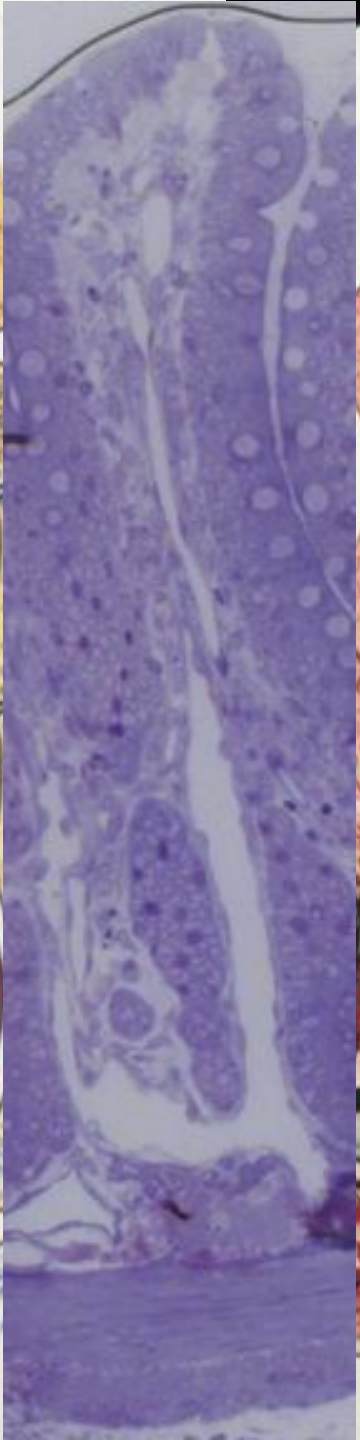
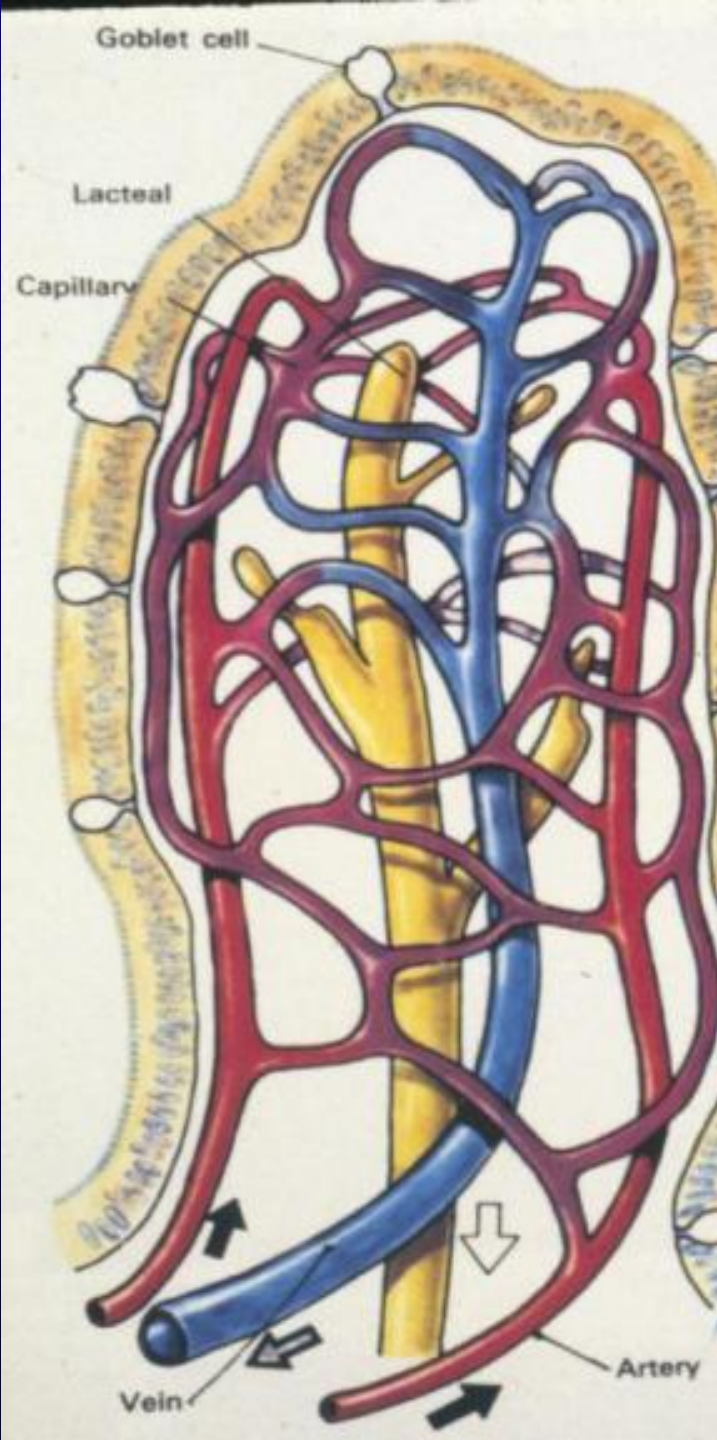
Arteriole

Venule

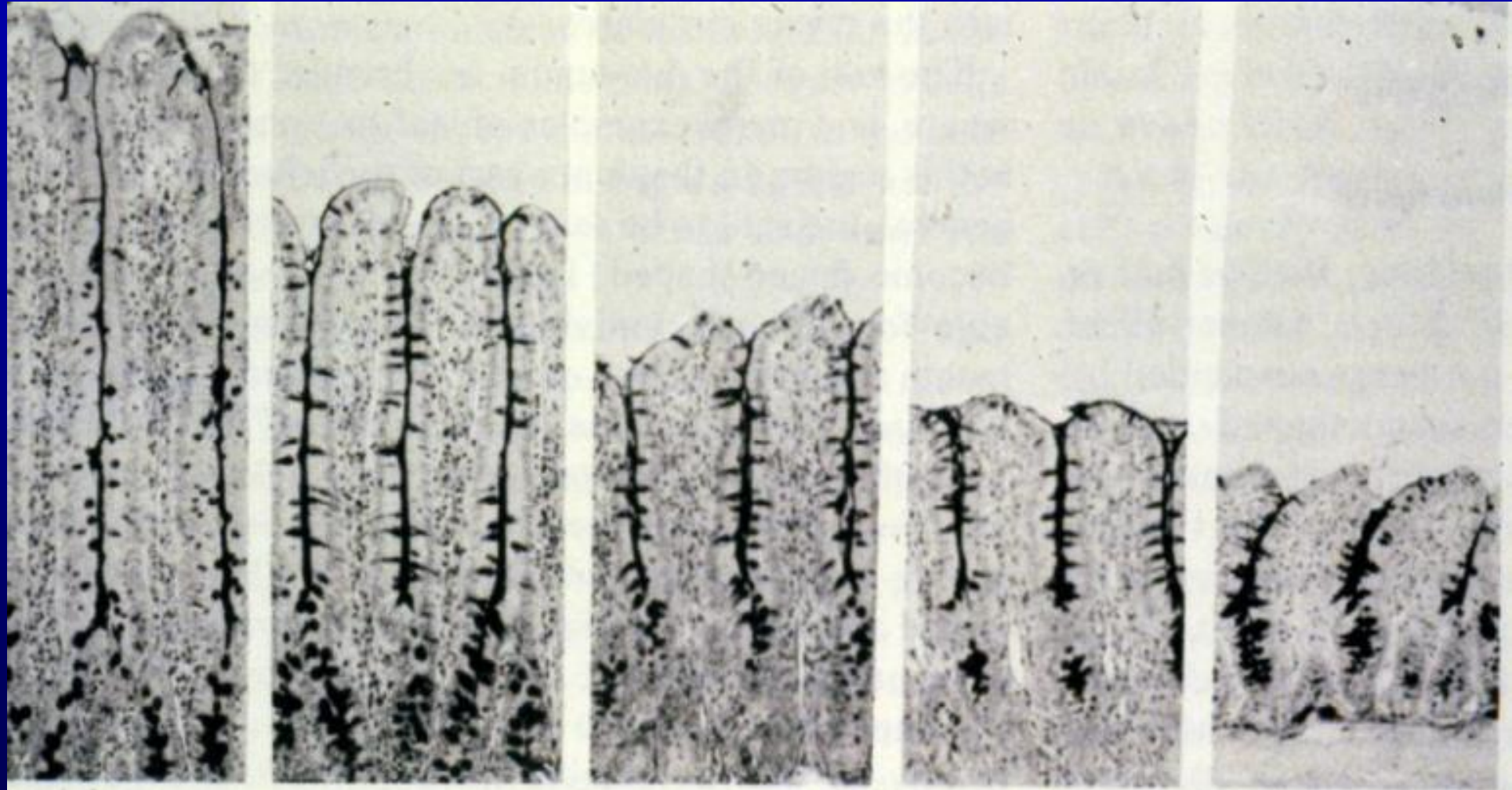
Vein

32409





Height of villi varies with location

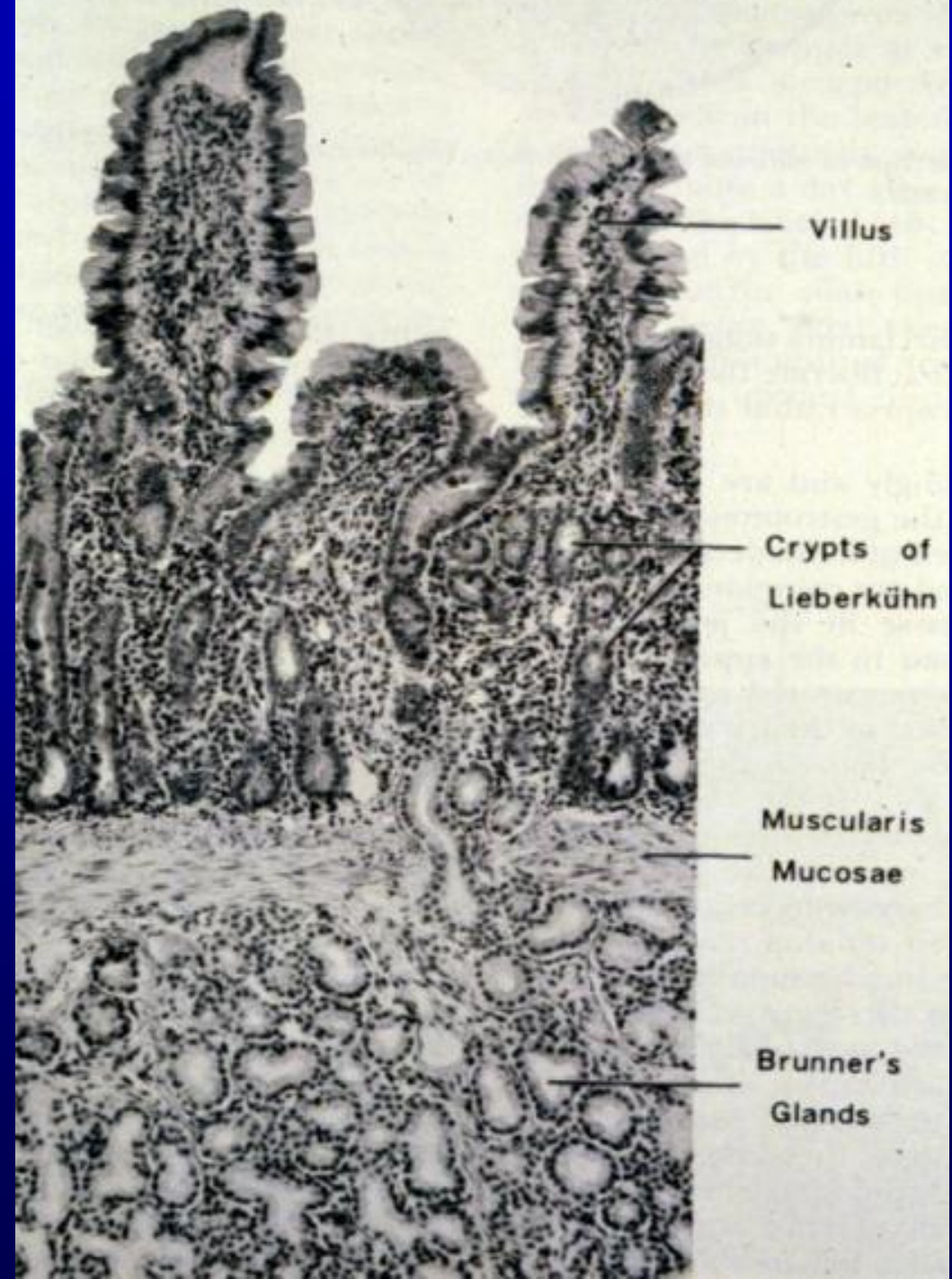
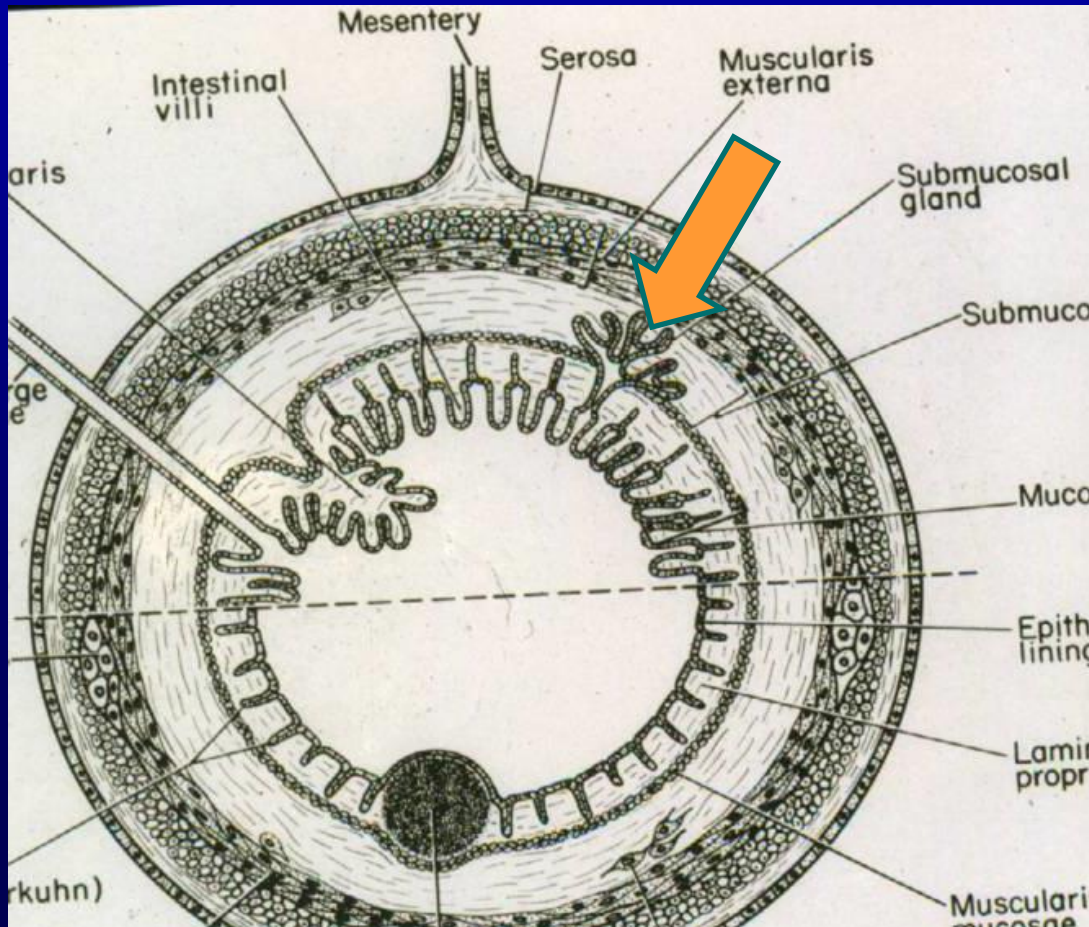


Duodenum

Lamina propria

Submucosa

(glands of Brunner)



Fi
2X
4X
8X
10X
20X
40X
3.2X

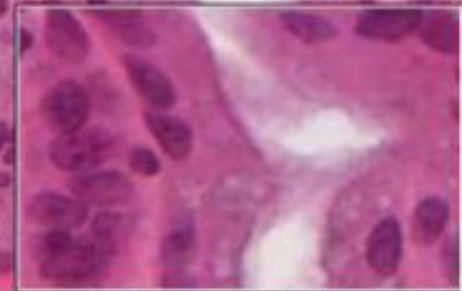
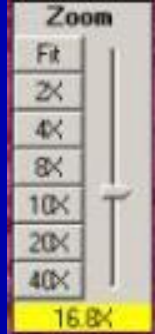
152

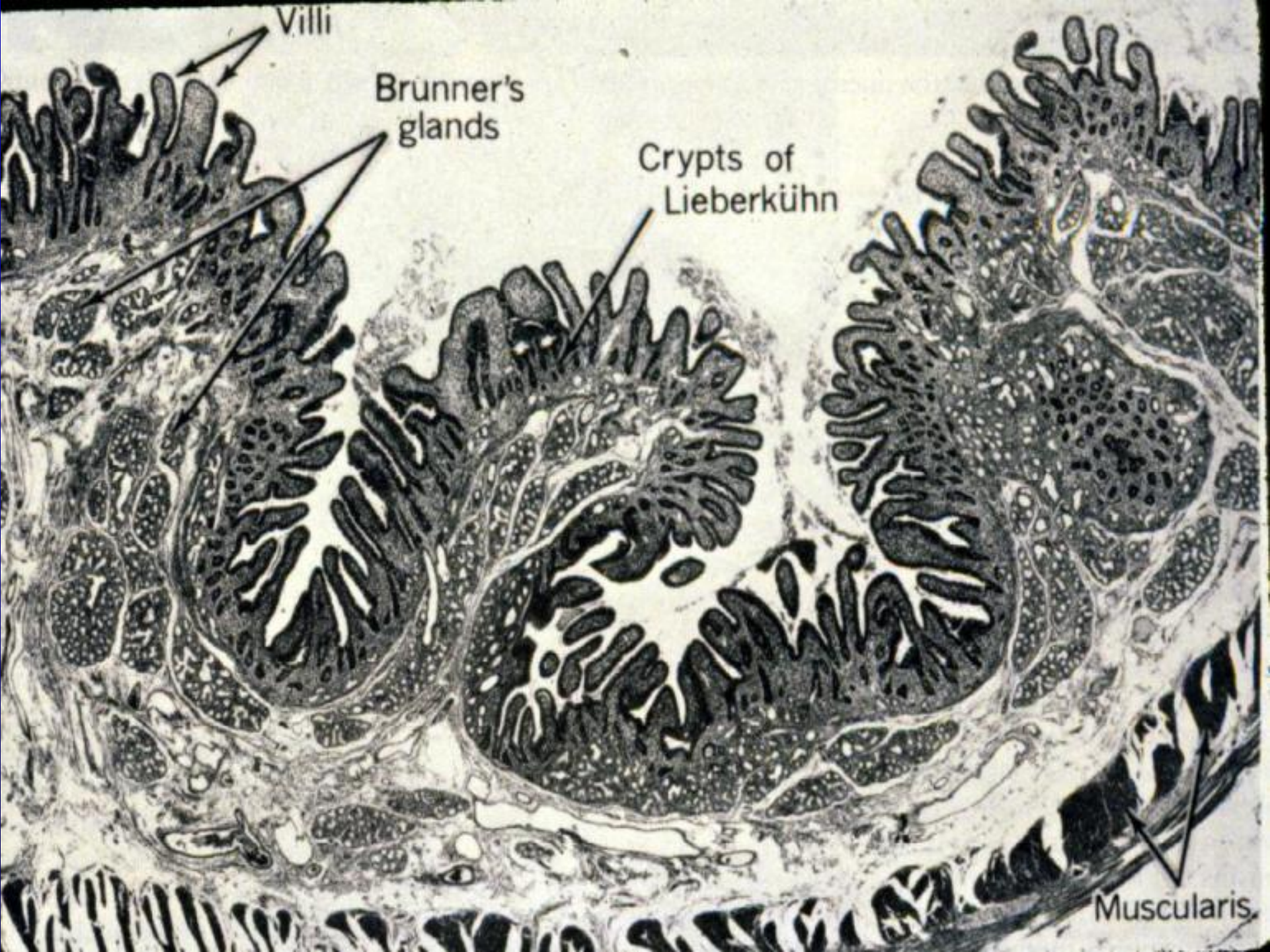
Duodenum

152



Duodenum, monkey





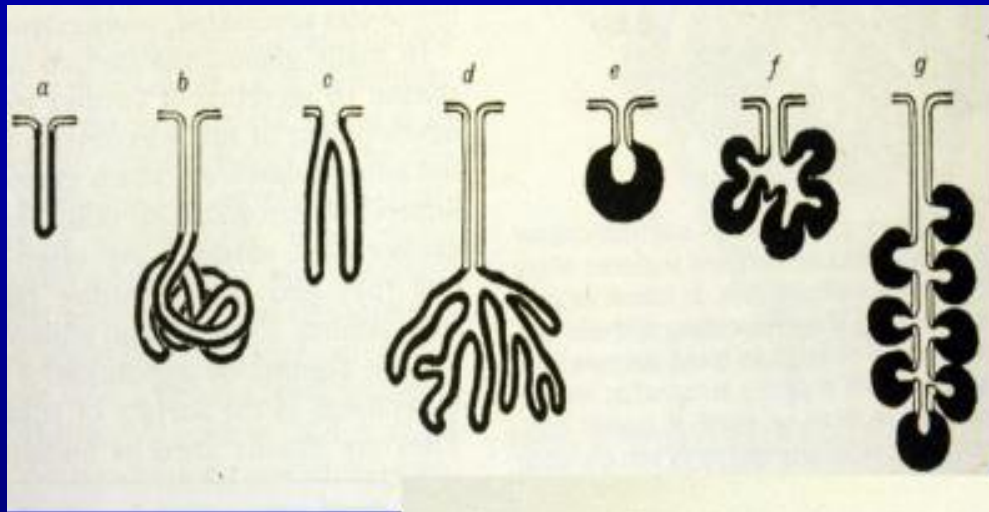
Villi

Brunner's
glands

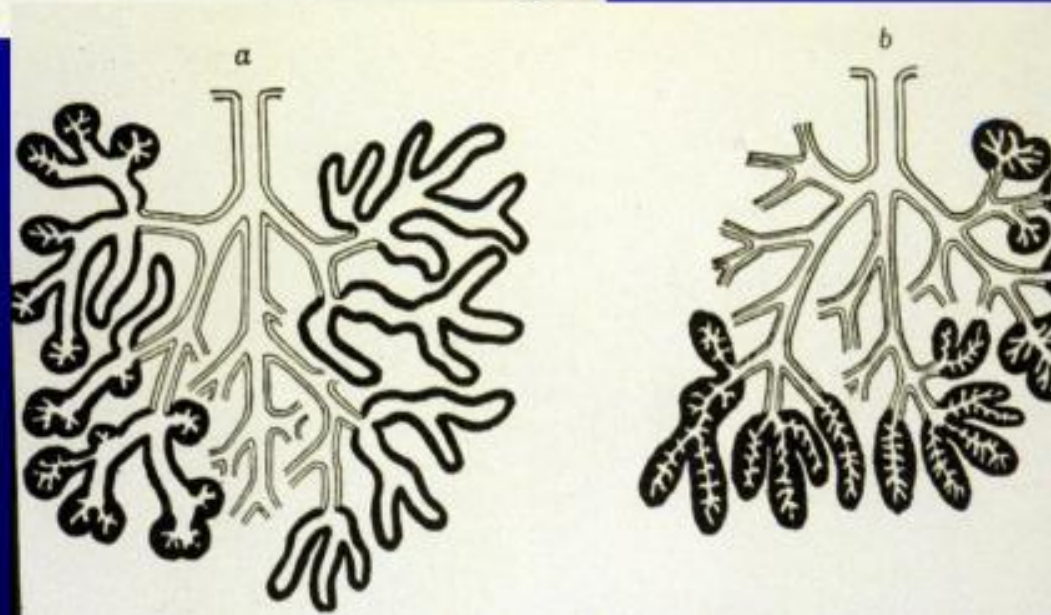
Crypts of
Lieberkühn

Muscularis

Submucosal intestinal glands of Brunner - simple branched tubuloacinar gland



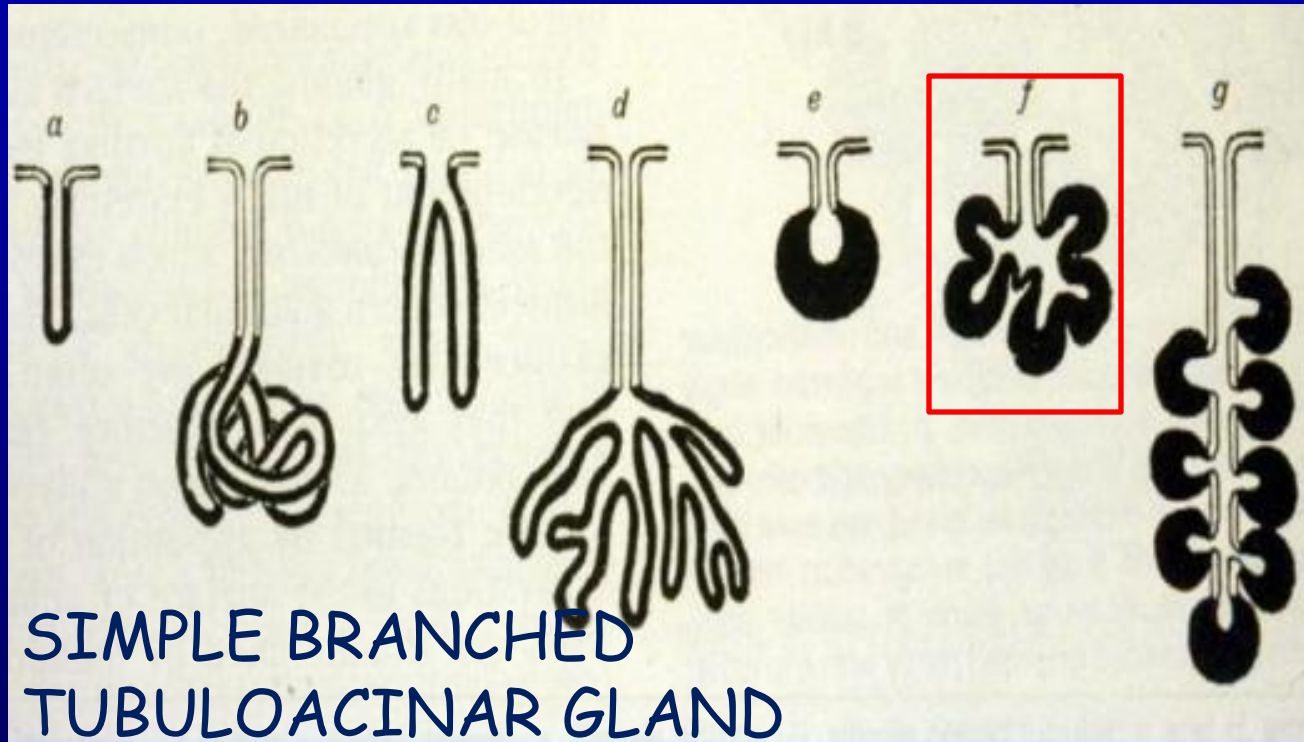
Simple duct



Compound duct



Submucosal intestinal glands of Brunner - simple branched tubuloacinar gland



SIMPLE BRANCHED
TUBULOACINAR GLAND

TUBULAR
COILED TUBULAR
BRANCHED TUBULAR
ALVEOLAR

BRANCHED ACINAR
TUBULOACINAR
TUBULOALVEOLAR

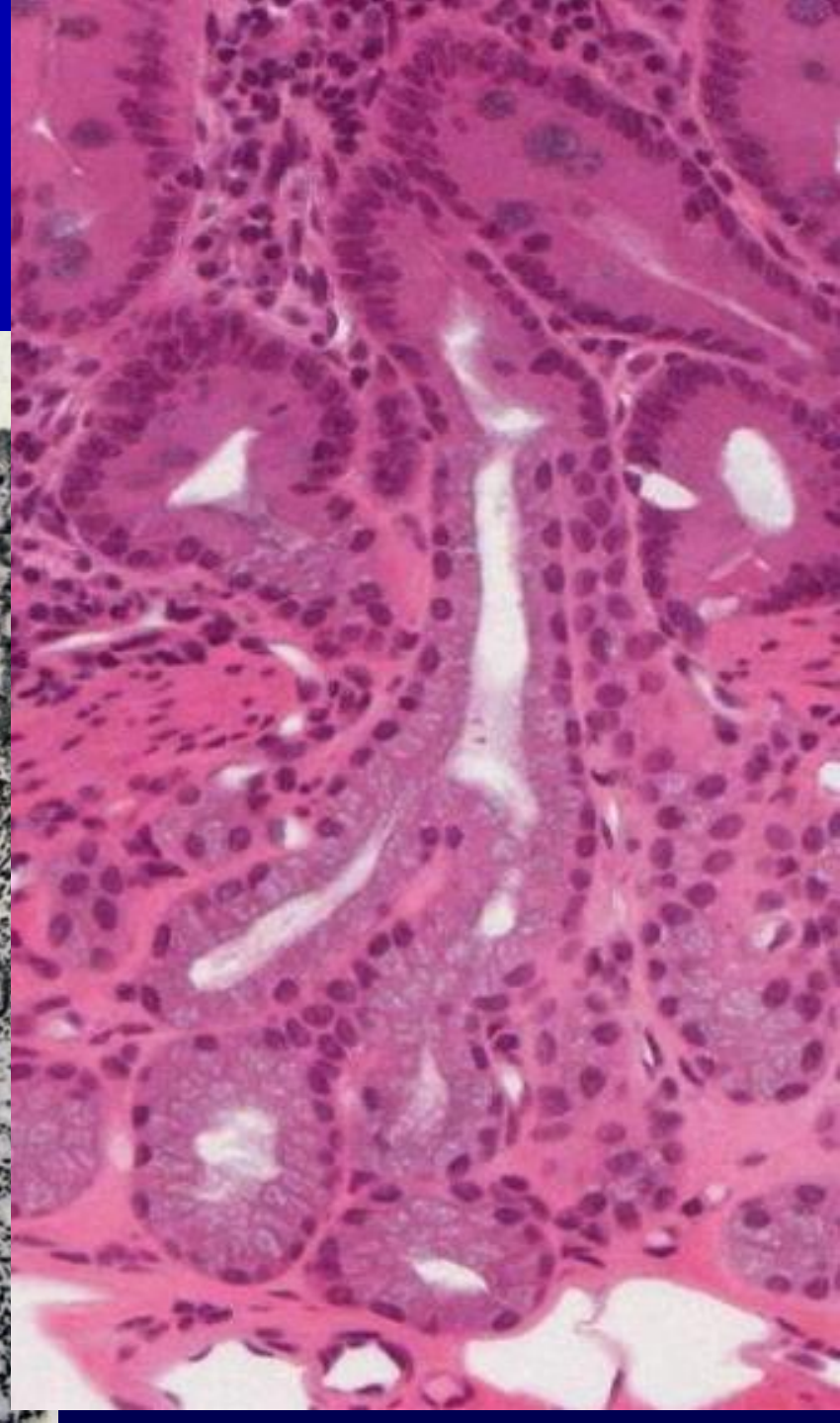


Submucosal intestinal glands of Brunner - simple branched tubuloacinar gland

Located at first few cm of duodenum
mainly between pylorus and papilla of
vater where pancreatic juices and bile
empty into duodenum. Also found in
proximal jejunum in horse, pig, and
large ruminants.

Secretion in response to

- A. direct tactile stimuli or irritation
- B. vagal stimulation
- C. intestinal hormones



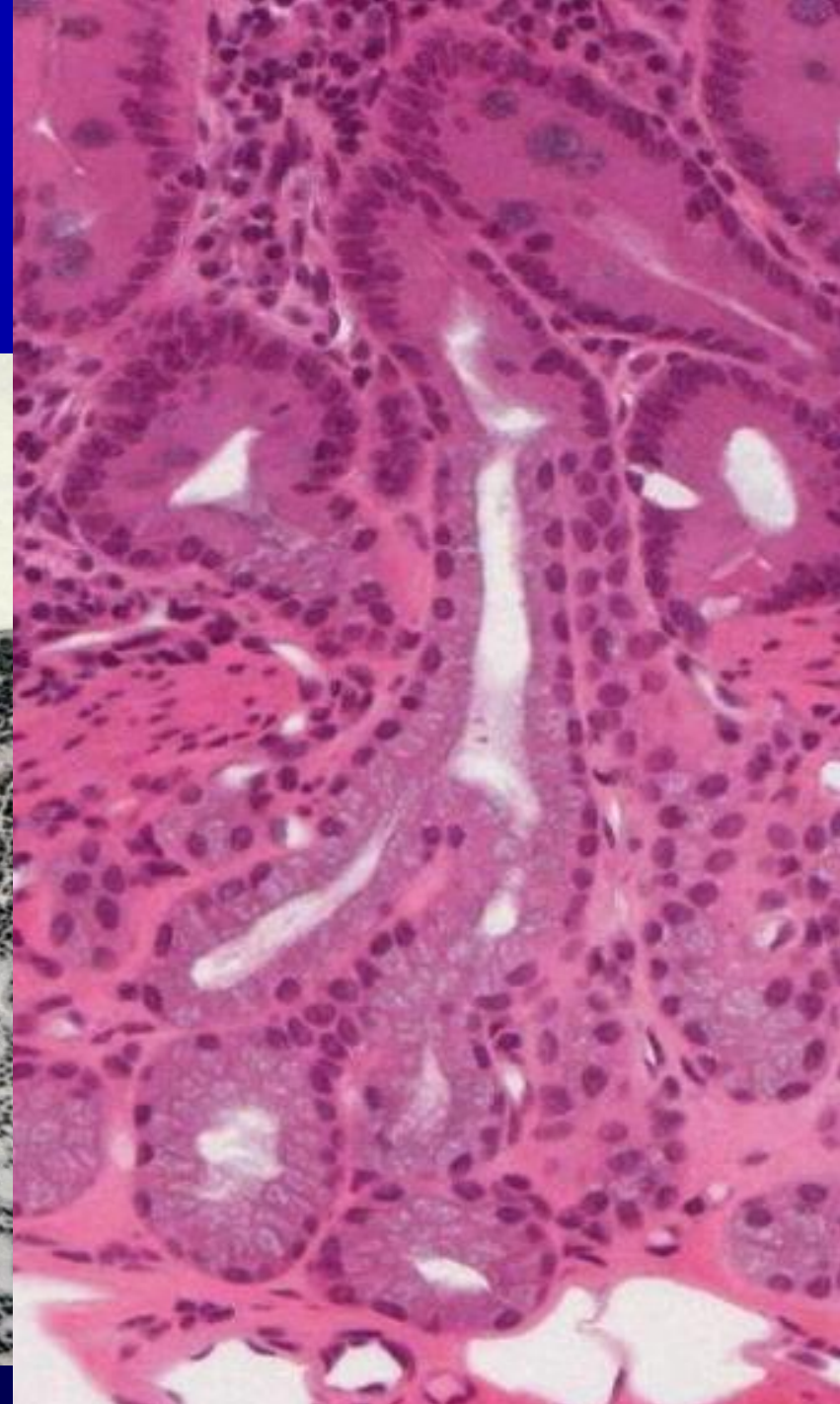
Submucosal intestinal glands of Brunner - simple branched tubuloacinar gland

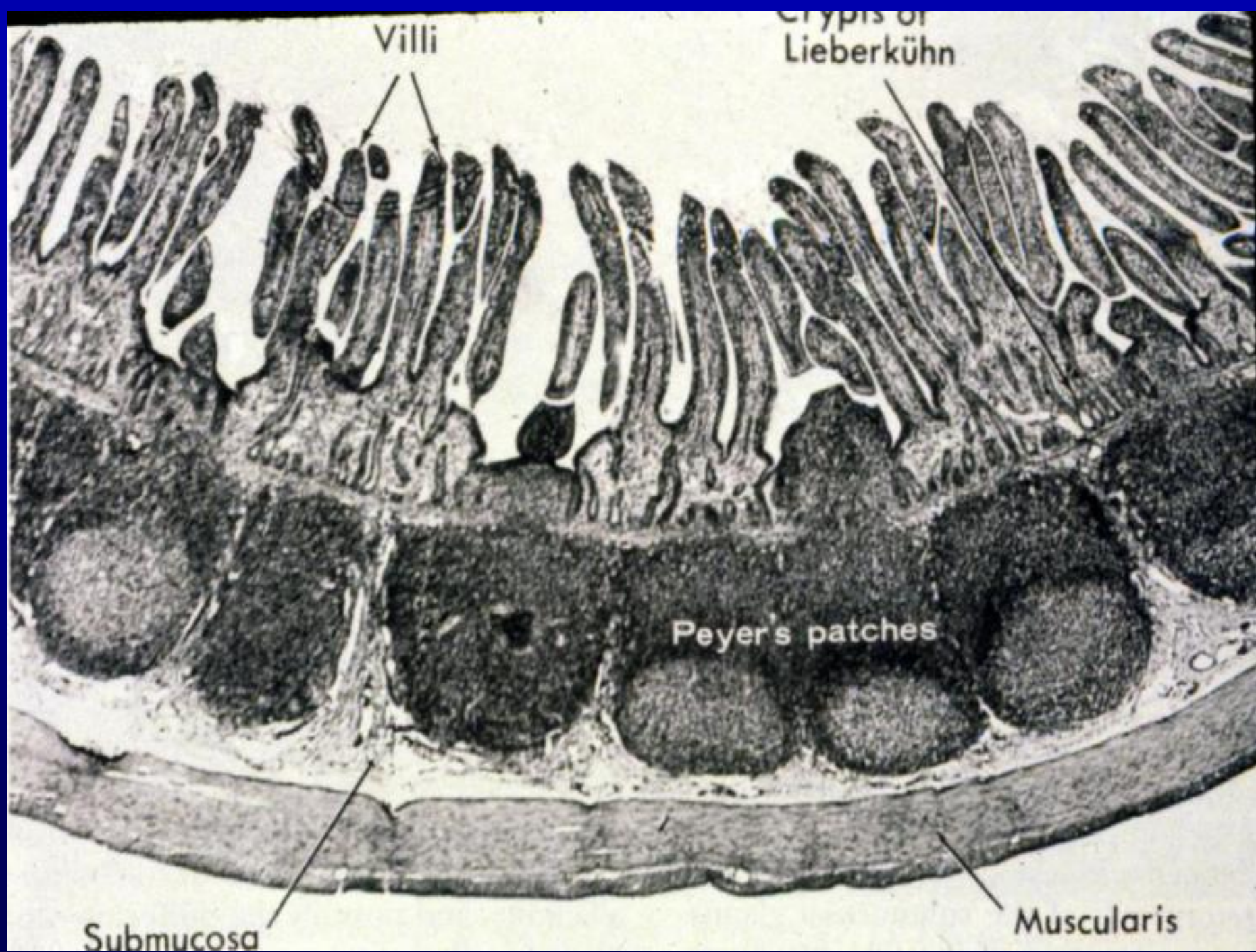
Function of secretions

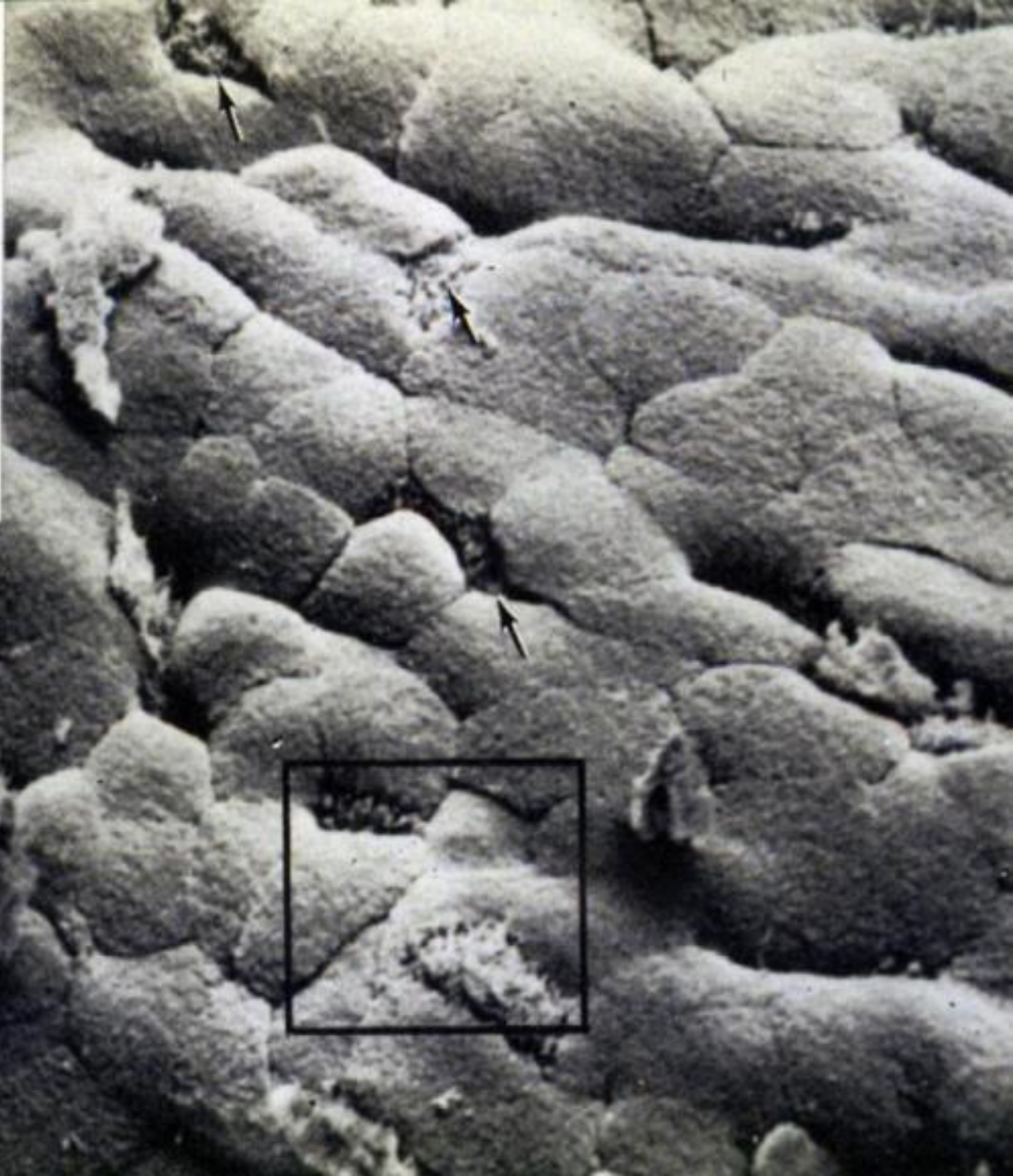
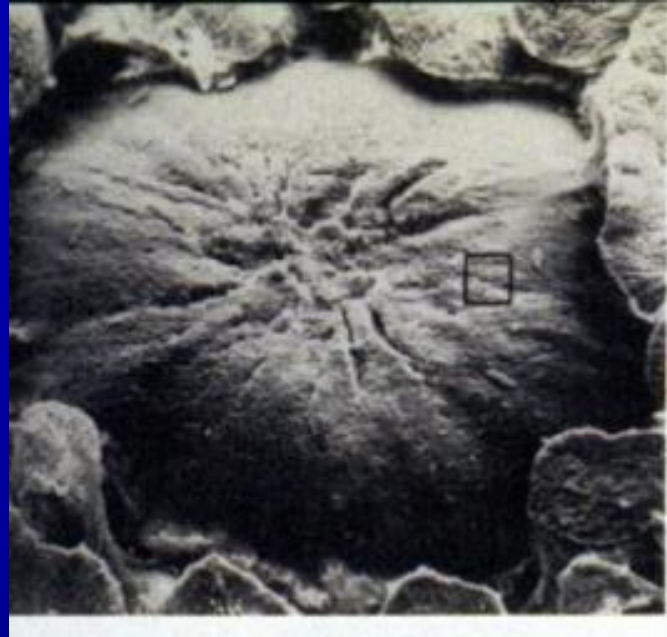
- Protect duodenum wall from digestion

Secretion strongly inhibited by sympathetic

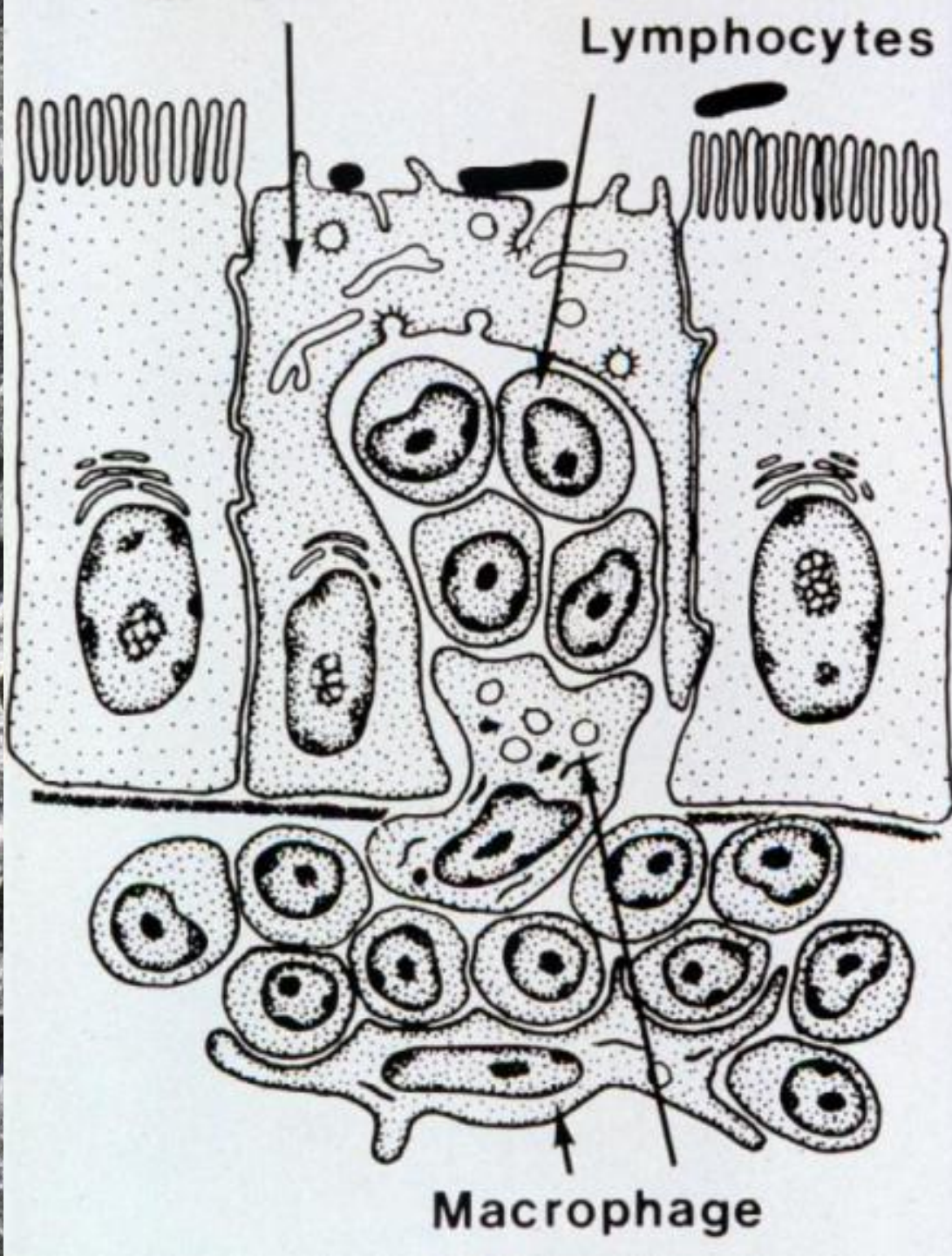
- 50% of ulcers occur in duodenum
- Mucous - ruminants & dog
- Mixed - mucous-serous in cats
- Serous - horse, pigs





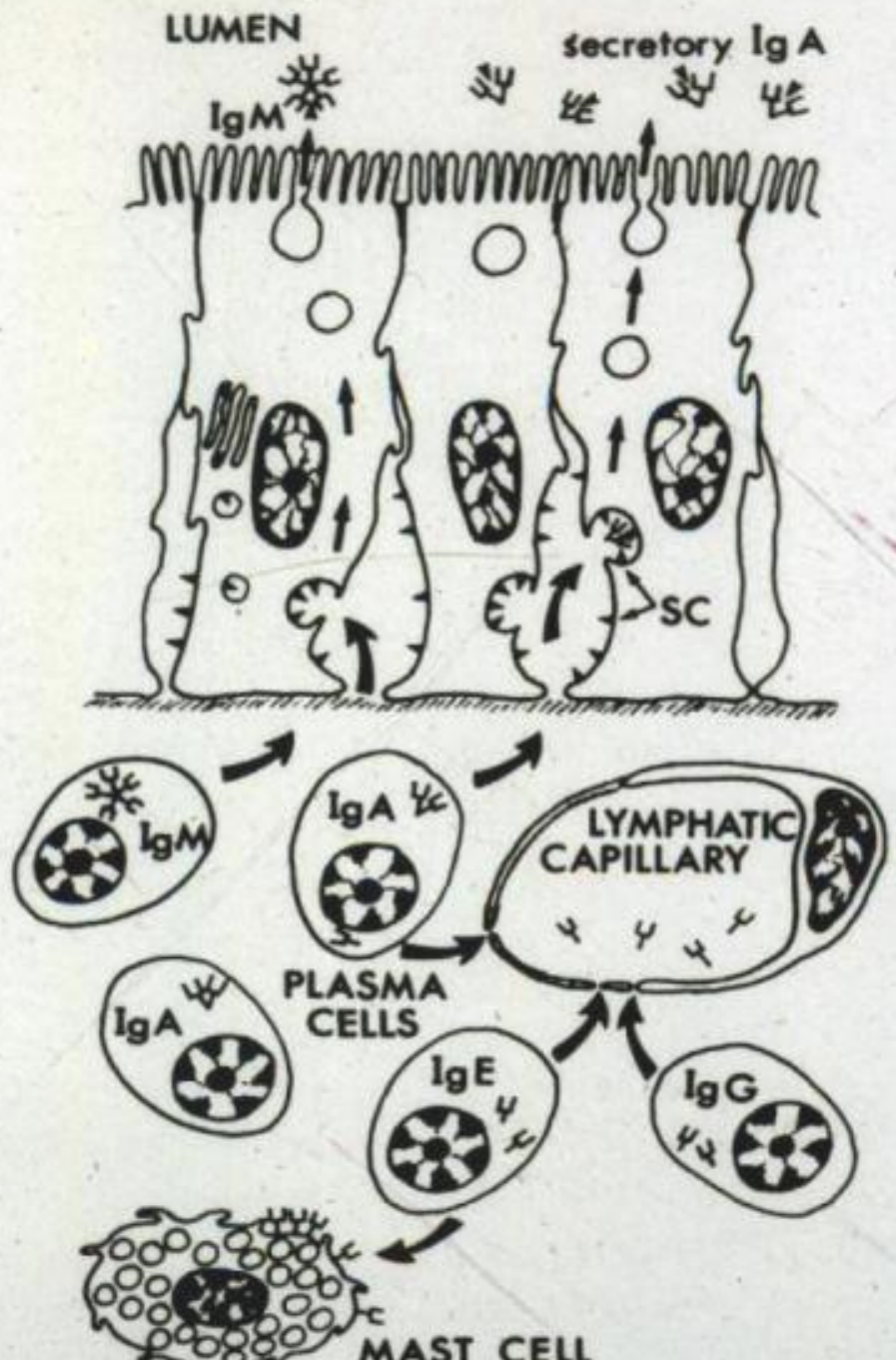
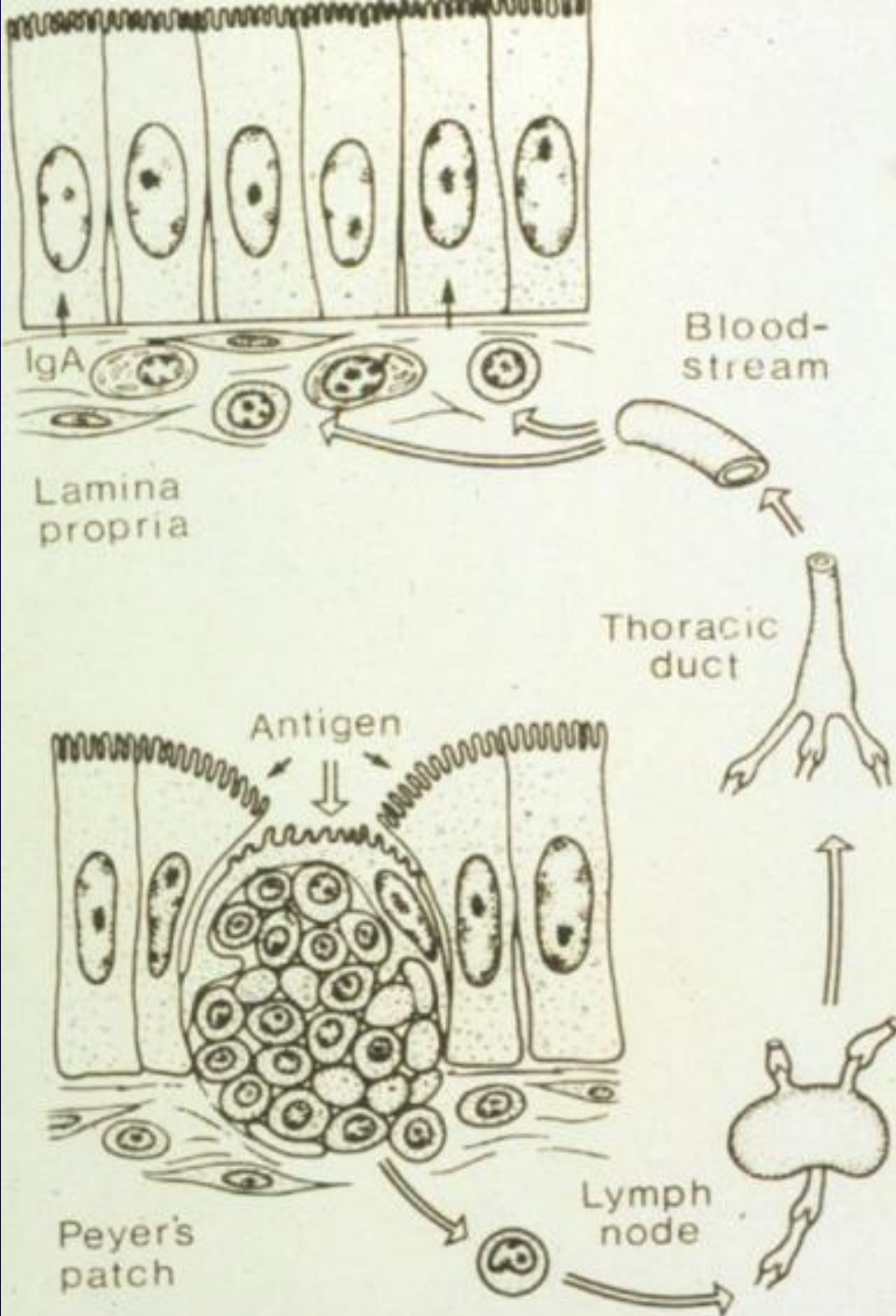






Lymphocytes

Macrophage



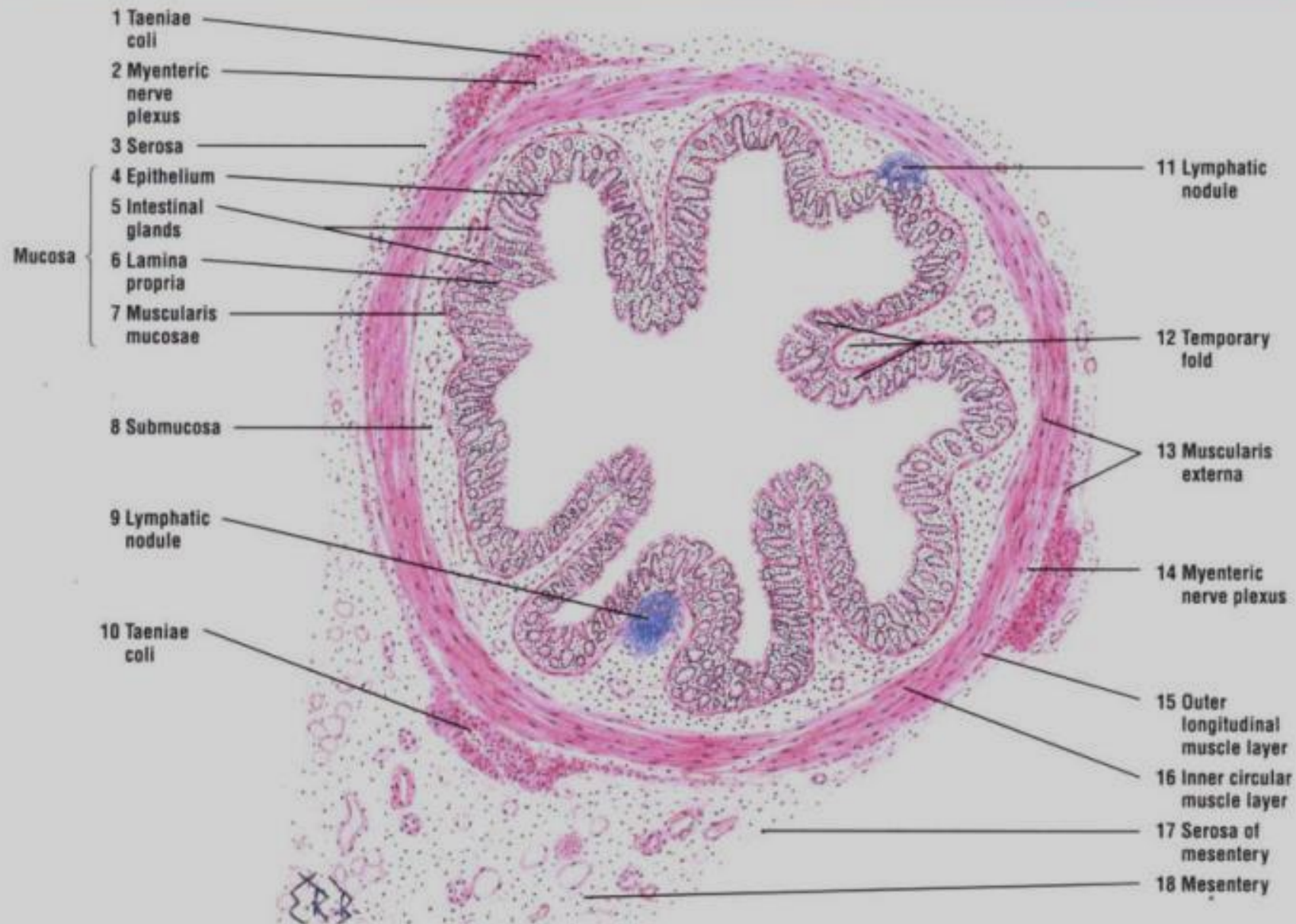


Fig. 12-6 Large Intestine: Colon and Mesentery (panoramic view, transverse section). Stain: hematoxylin-eosin. Low magnification.

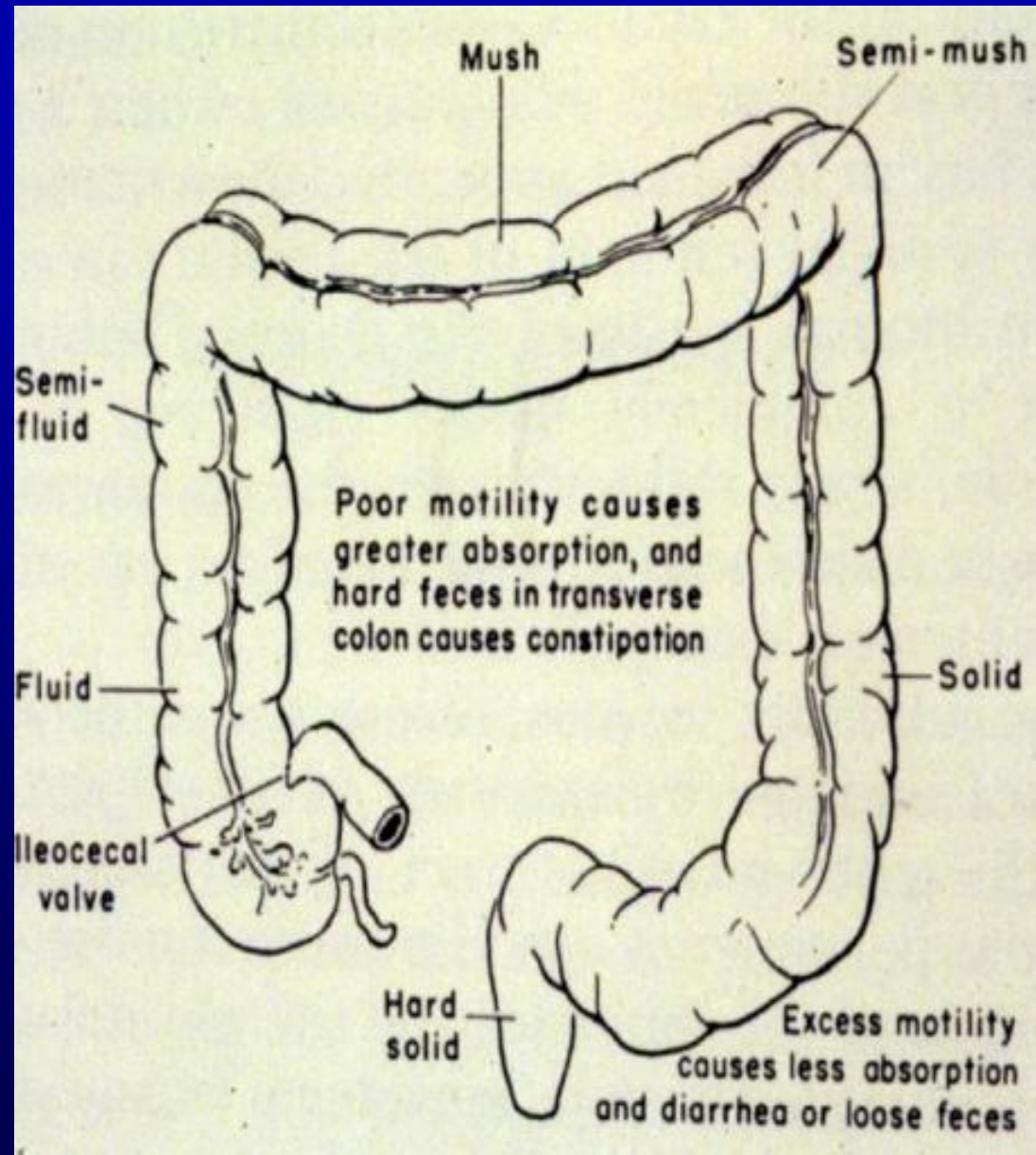
Large Intestine

Taeniae coli: longitudinal muscle in three flat bands in humans, 1-4 bands in horses, and none in some species

Haustrations: sack-like bulges

No villi yet, thick mucosa

Numerous goblet cells in intestinal crypts (of Lieberkuhn)



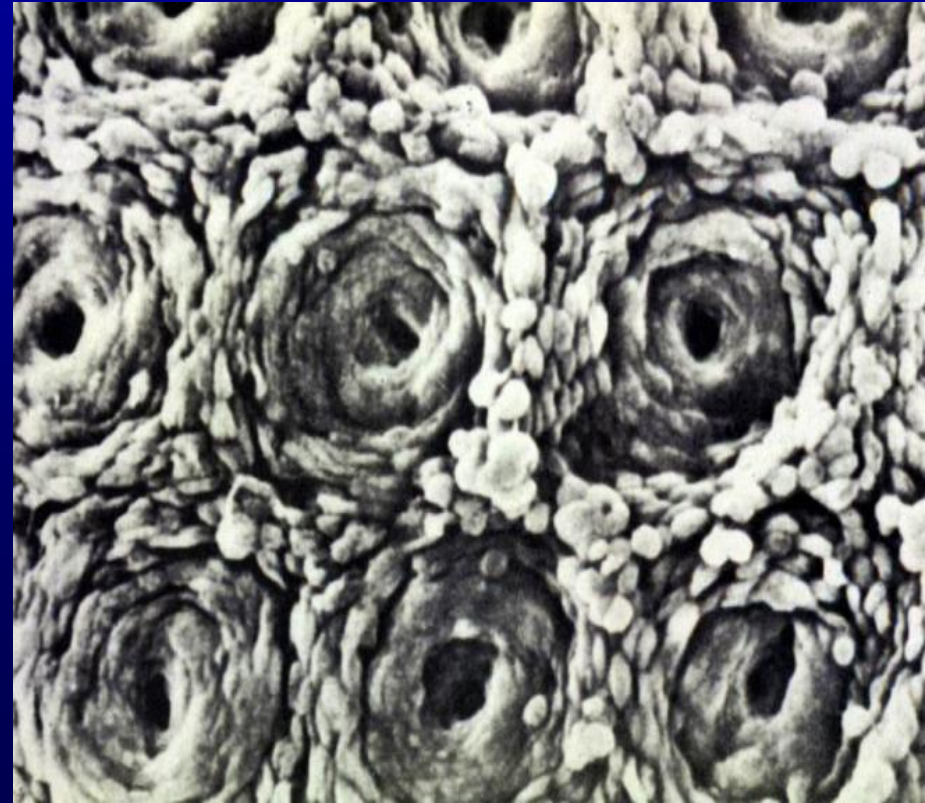
Compare luminal surfaces of the small and large intestines

small intestines

Villi

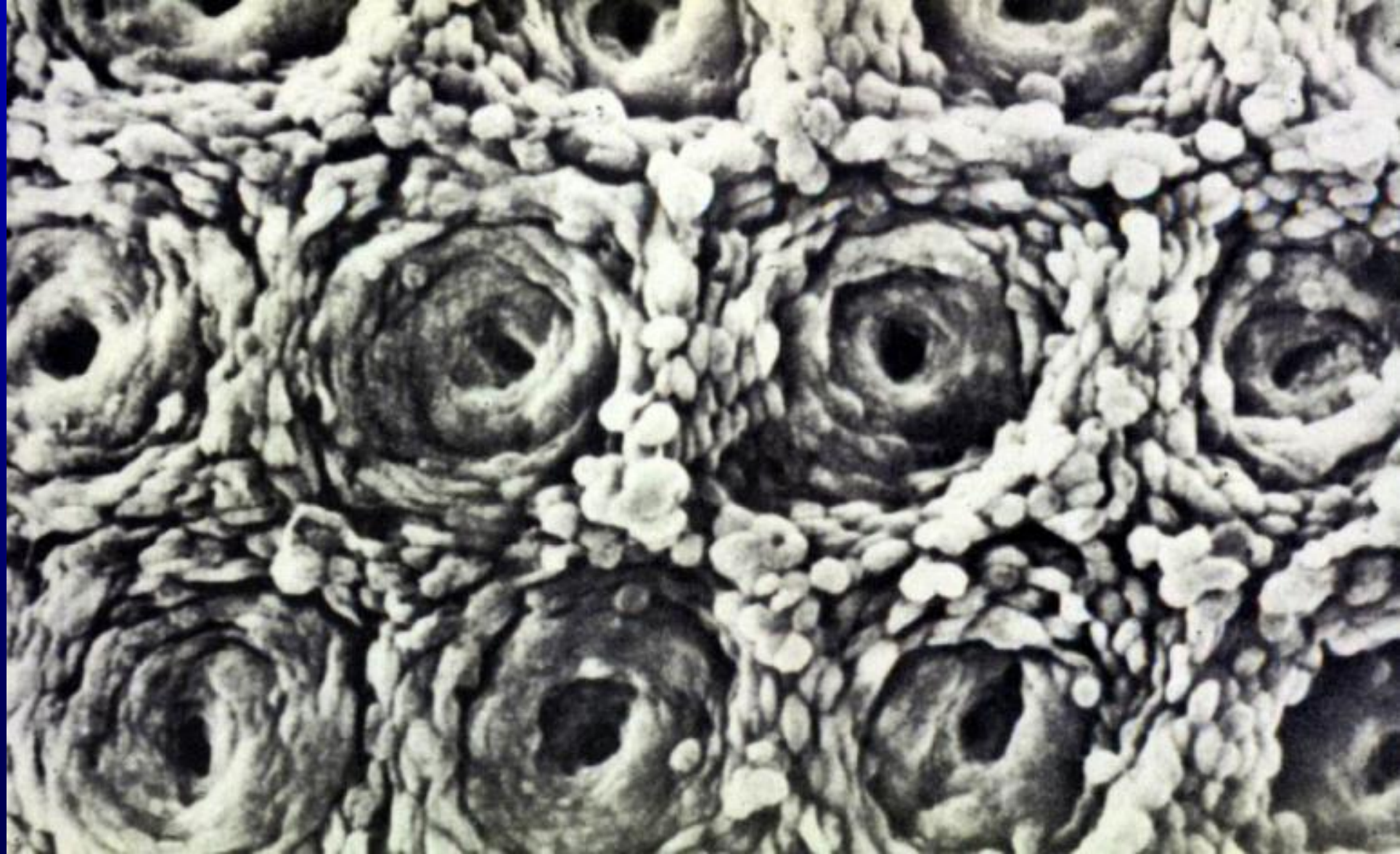
large intestines

NO Villi



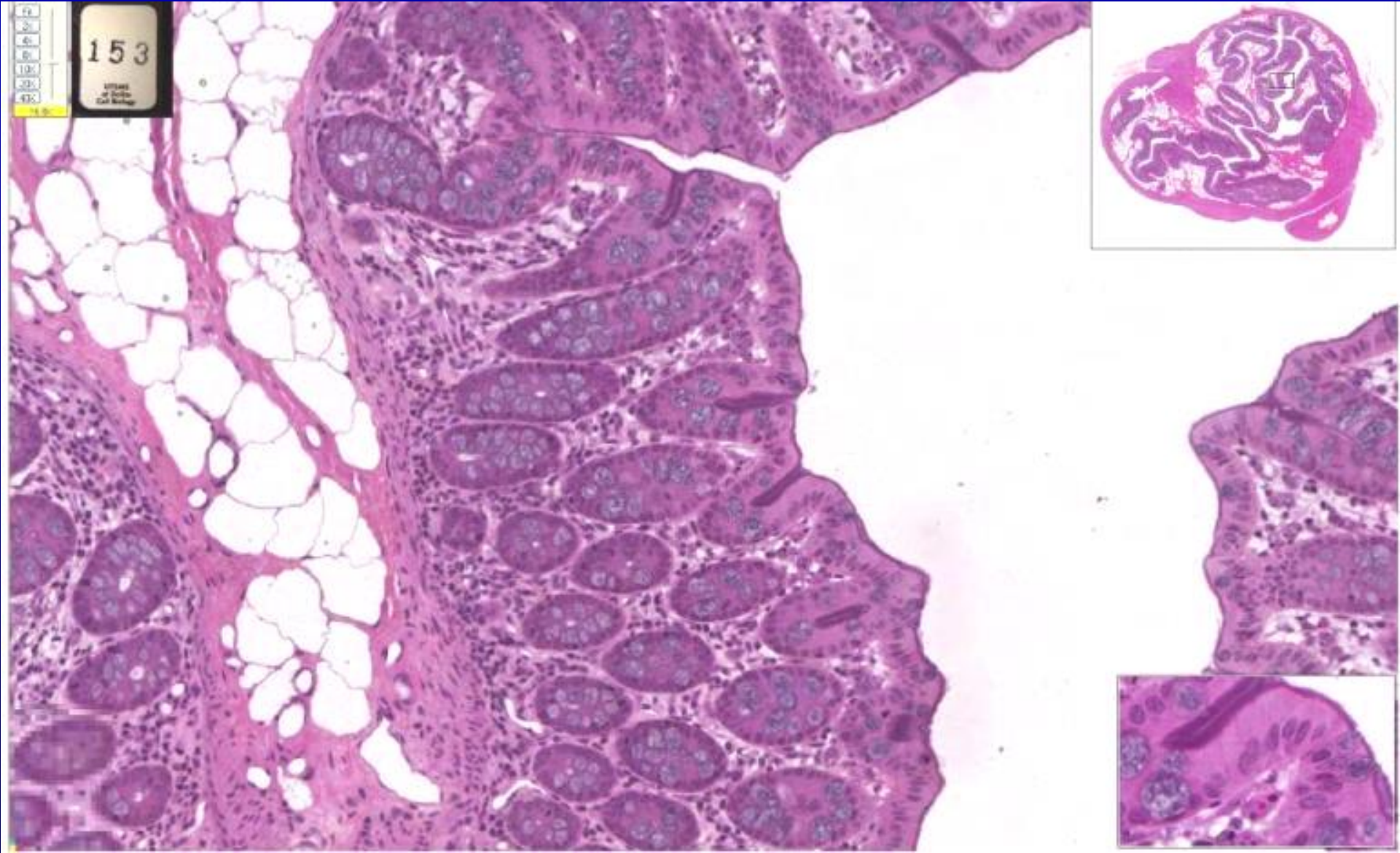
No villi yet, thick mucosa

Numerous goblet cells in intestinal glands (Crypts of Lieberkuhn)

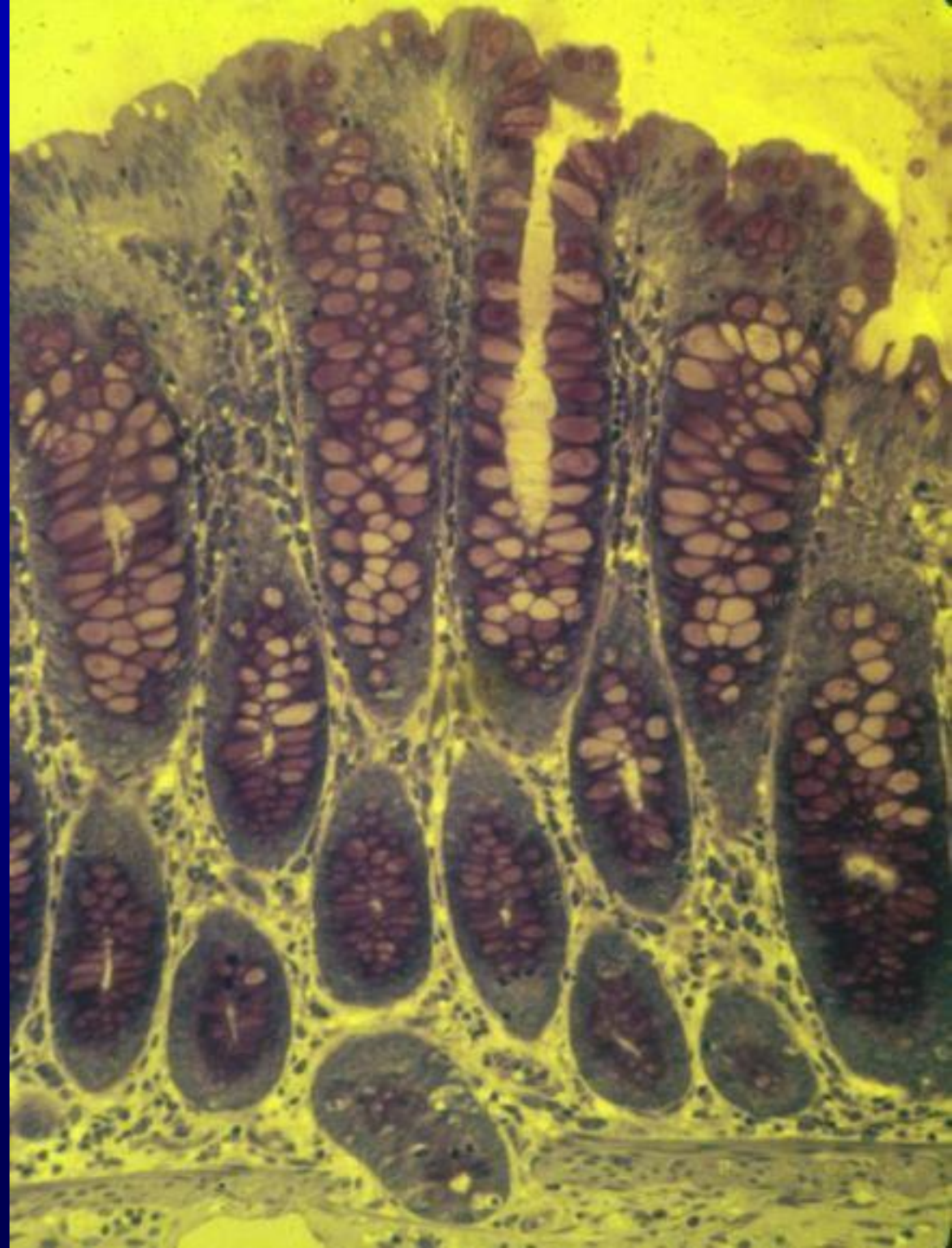


153

Large intestine or Colon, monkey

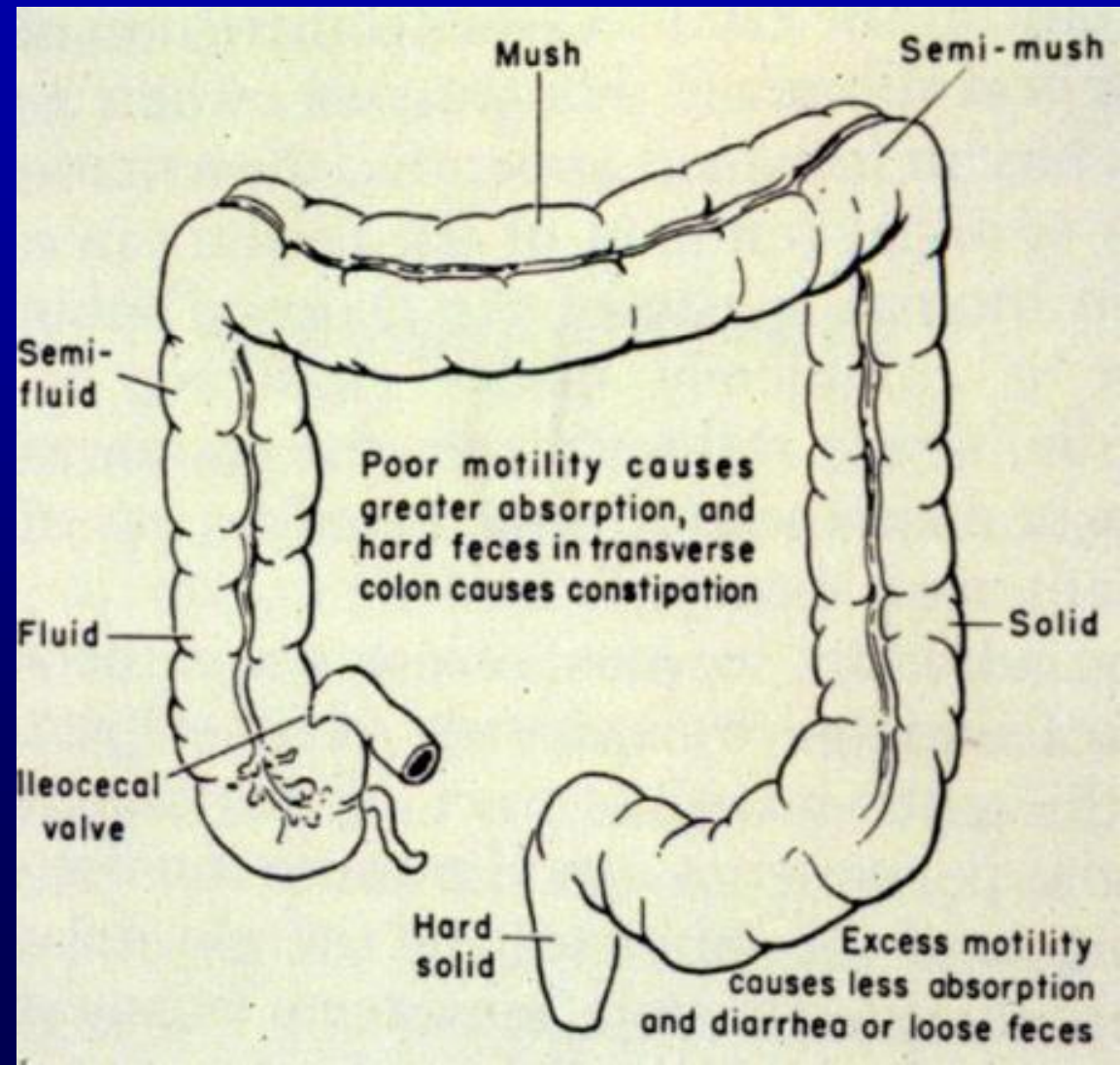


No villi yet, thick mucosa
Numerous goblet cells in
intestinal glands (Crypts of
Lieberkuhn)

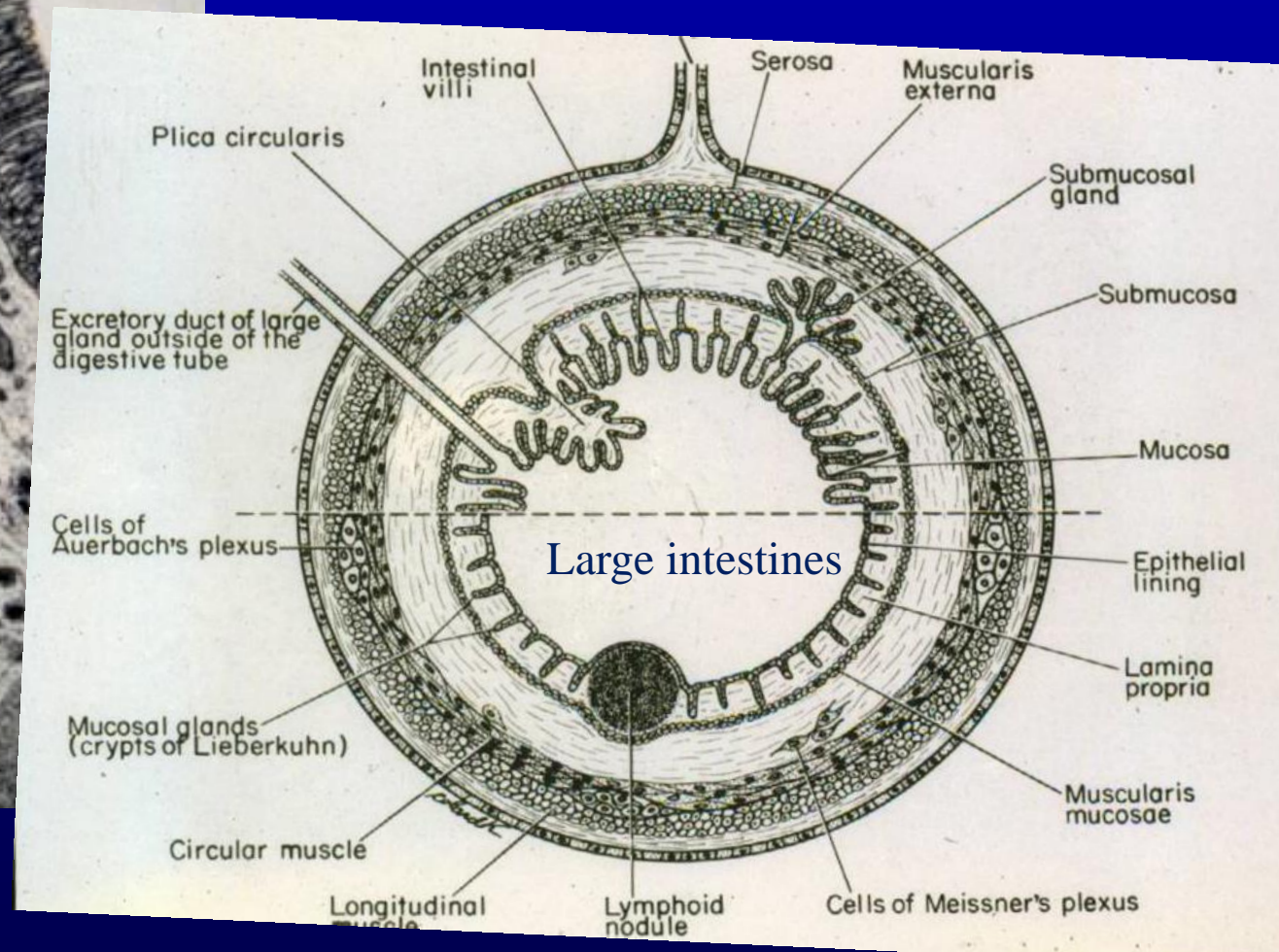
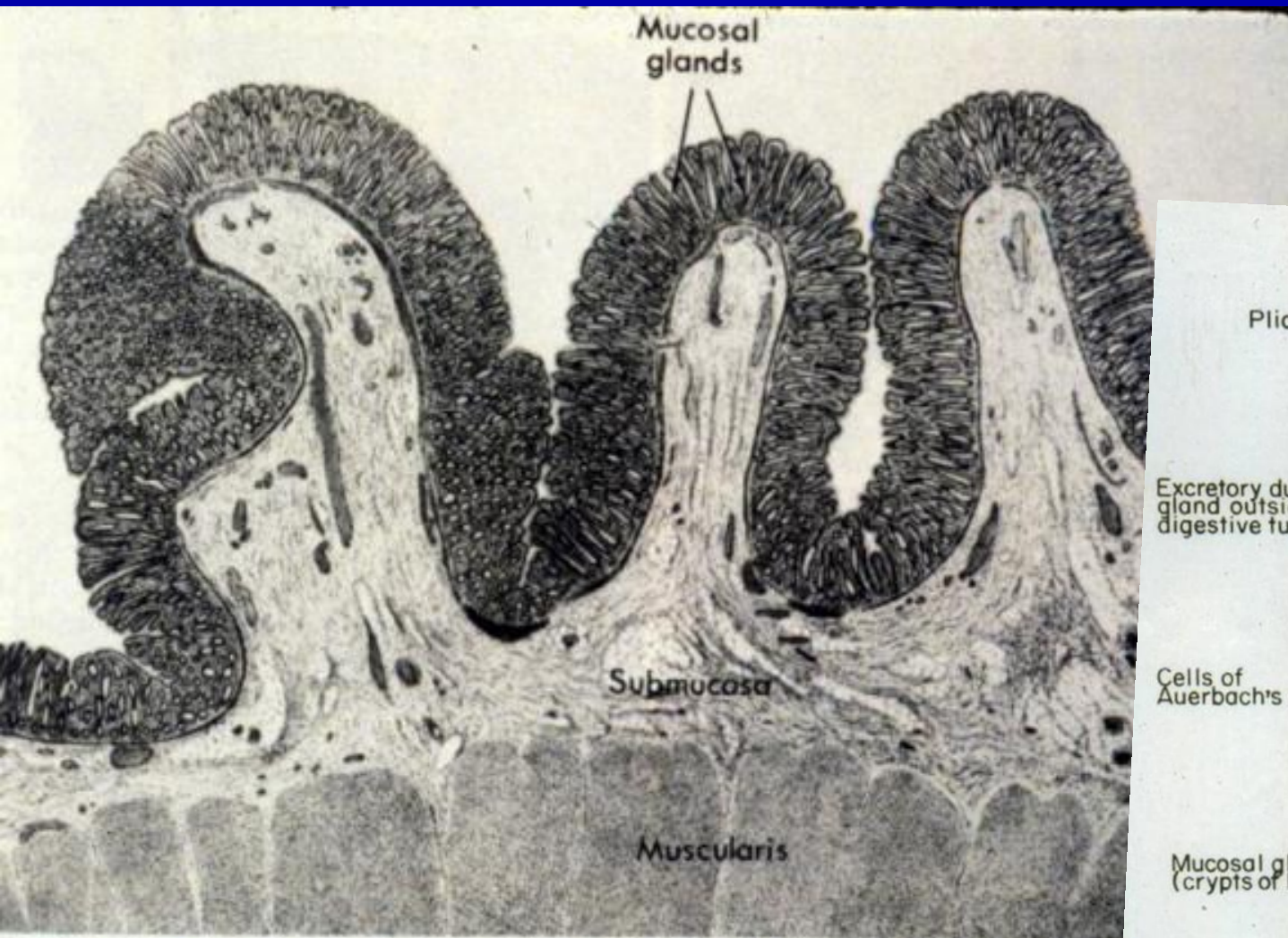


Large Intestine

- General organization
- The appendix
- The cecum and colon
- The rectum and anus
- Histophysiology of the intestine



Epithelium, lamina propria, muscularis mucosa, submucosa, muscularis externa, and serosa



The Appendix

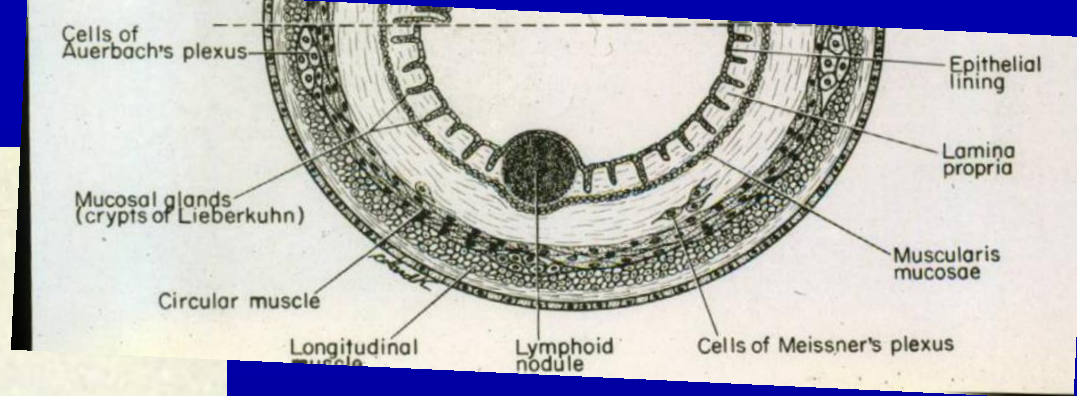
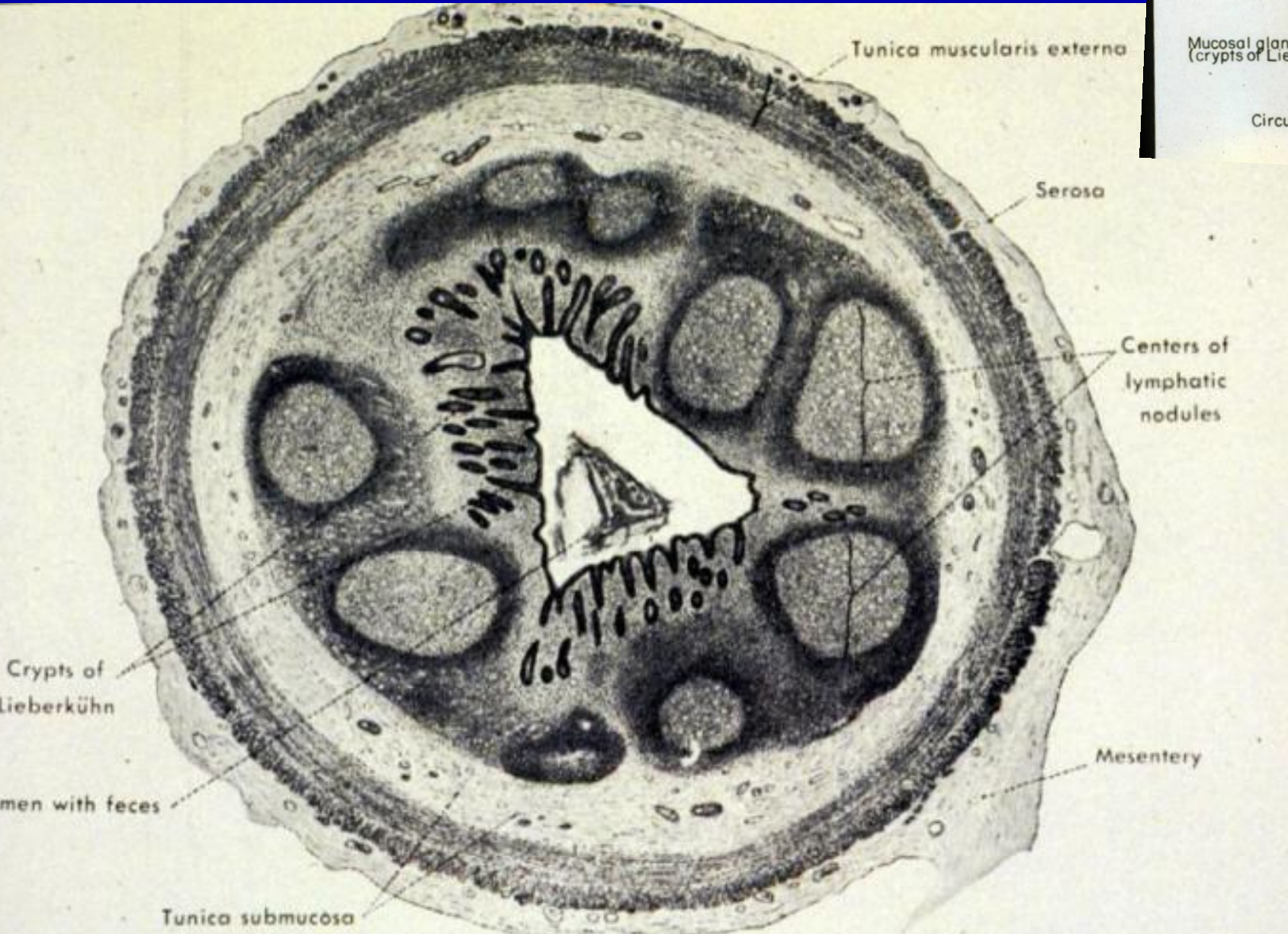


Figure 26-20. Cross section of appendix from a 23-year-old man. $\times 22$. (After Sobotta.)

Intestinal Glands (Crypts of Lieberkuhn)

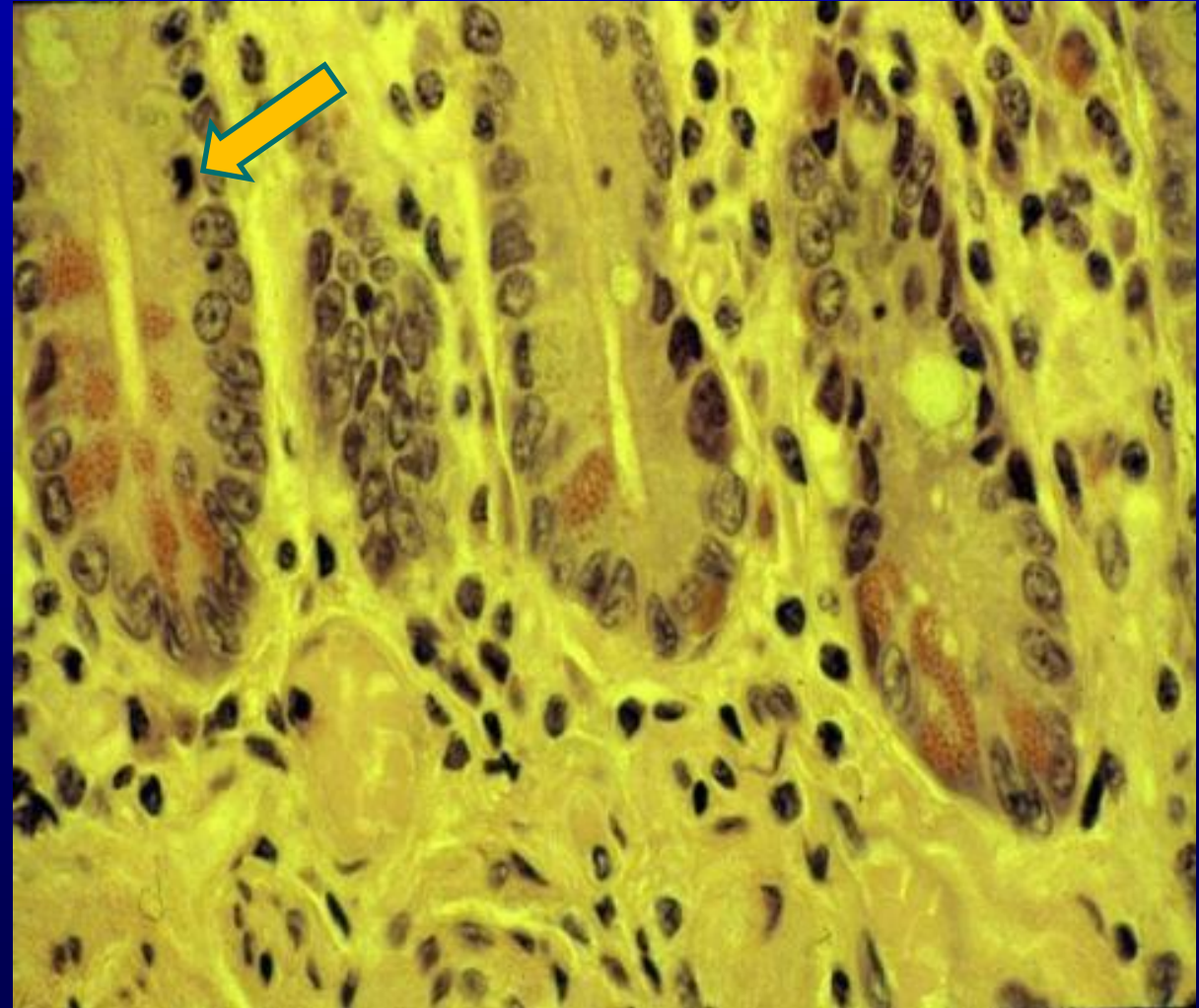
Secretion - 3000 ml
per day

Neutral pH (6.5 to 7.5)

Secretions provide
vehicle for
absorption

Mitosis to replace
epithelium

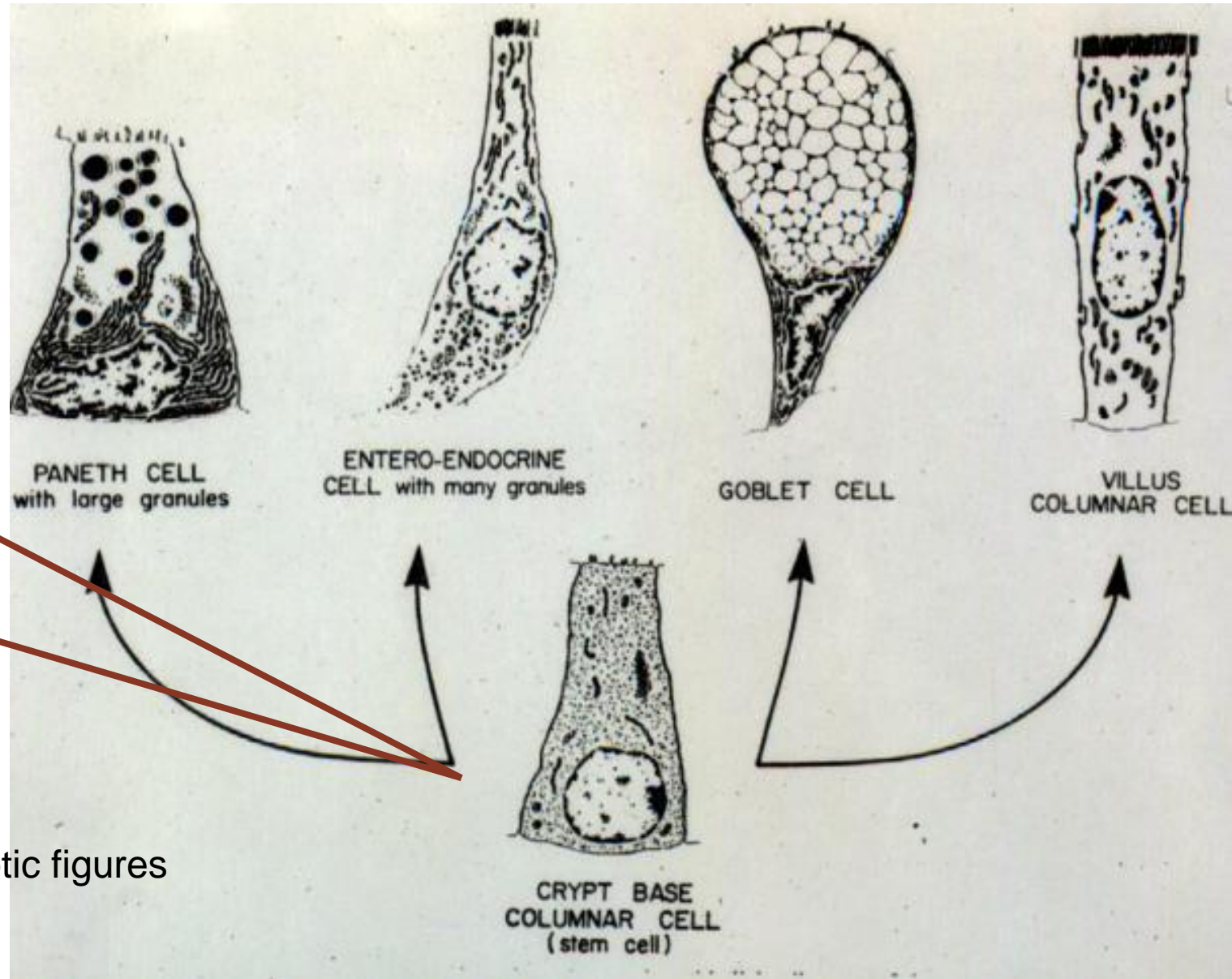
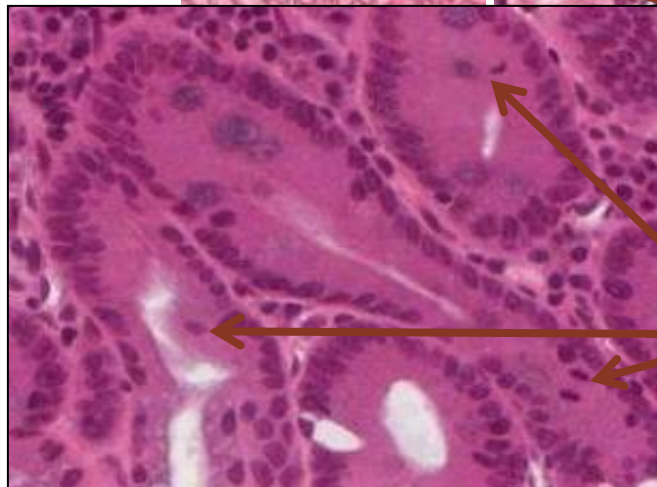
Paneth cells at base



EPITHELIUM of the intestine - SIMPLE COLUMNAR

ABSORPTIVE CELLS
GOBLET CELLS
ARGENTAFFIN CELLS
PANETH CELLS
and cells of duodenal
glands

Submucosal
Brunner's glands



Absorptive cell

Brush border

Glycocalyx

- Protection against enzymes
- Active in digestion

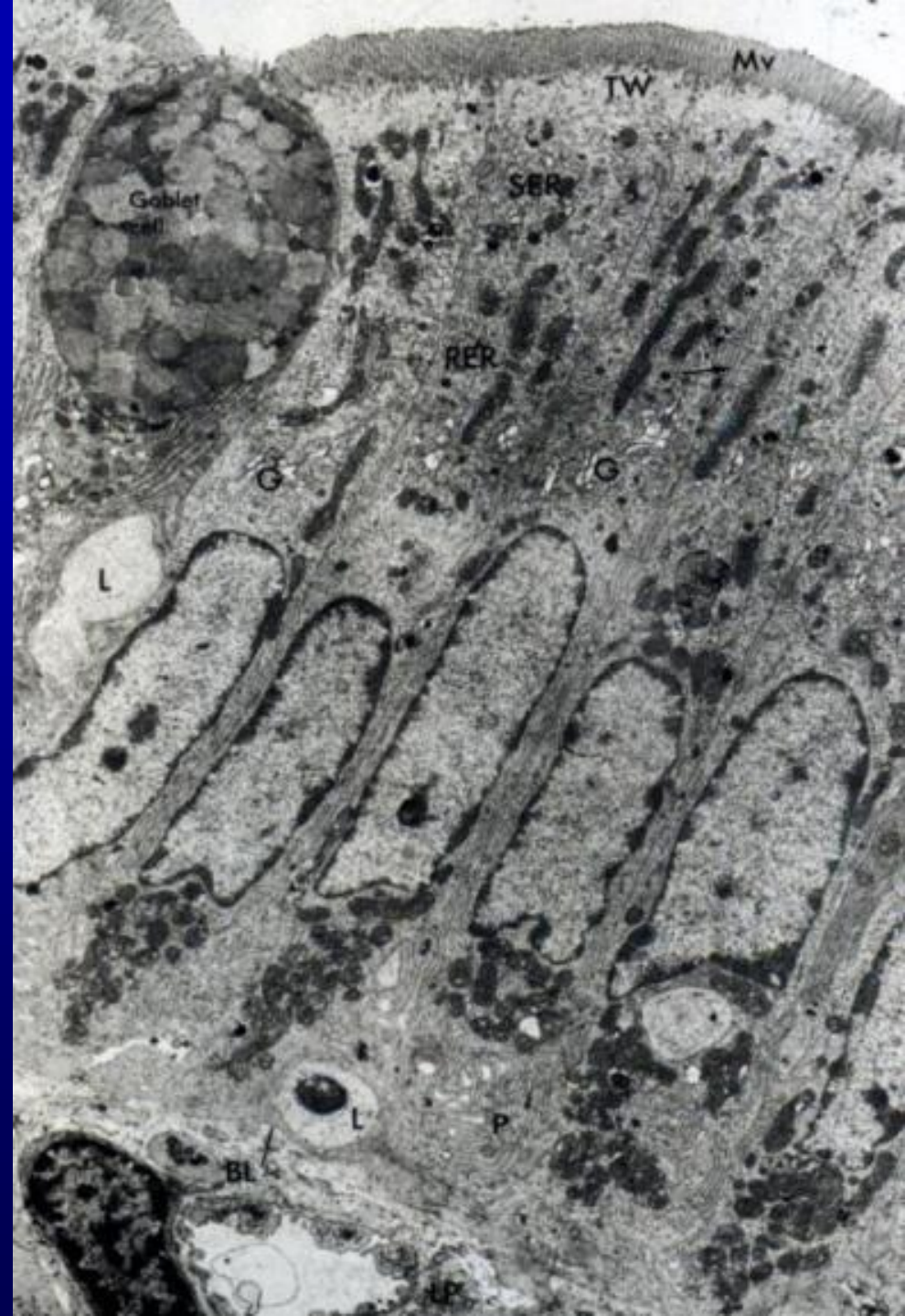
Terminal web

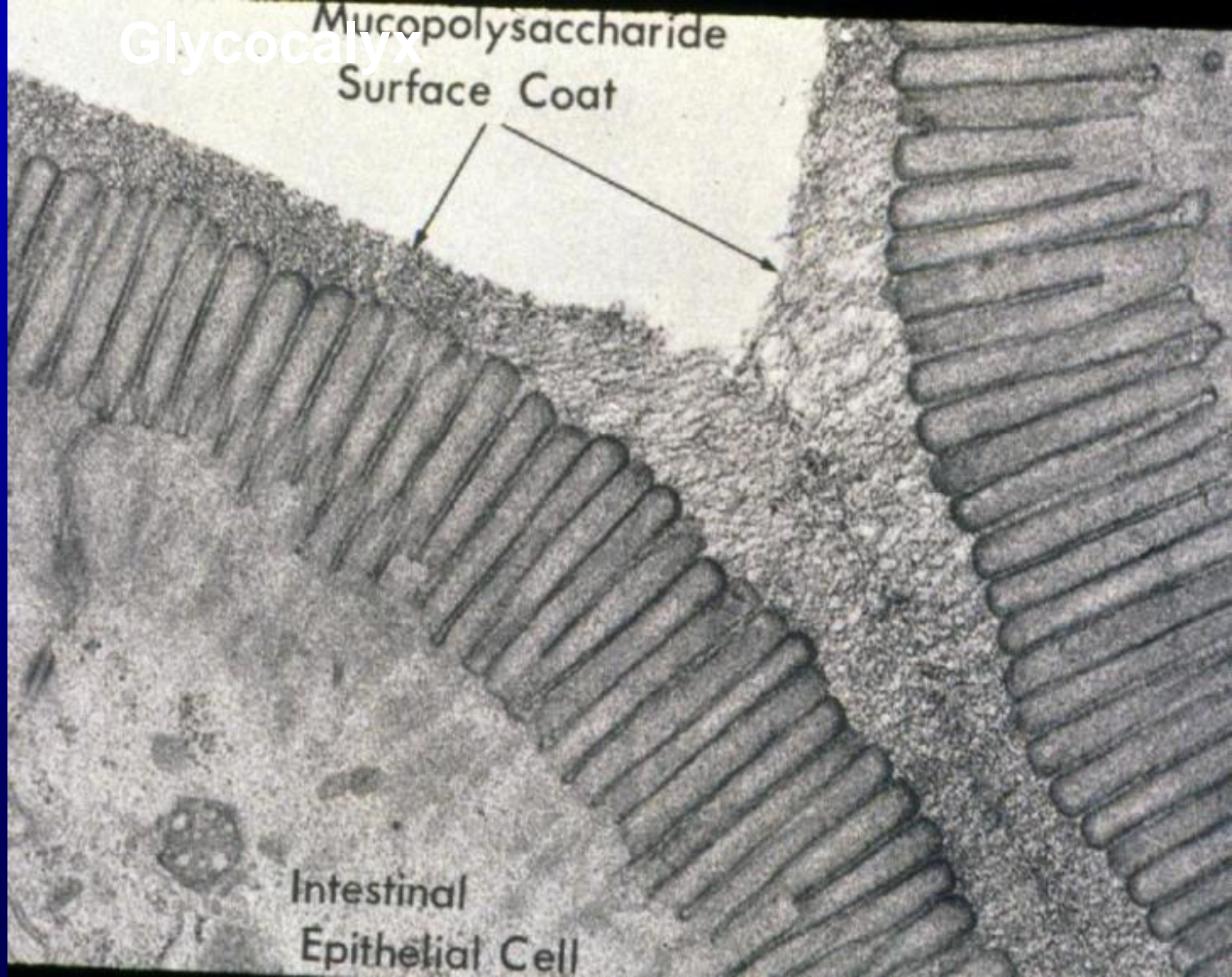
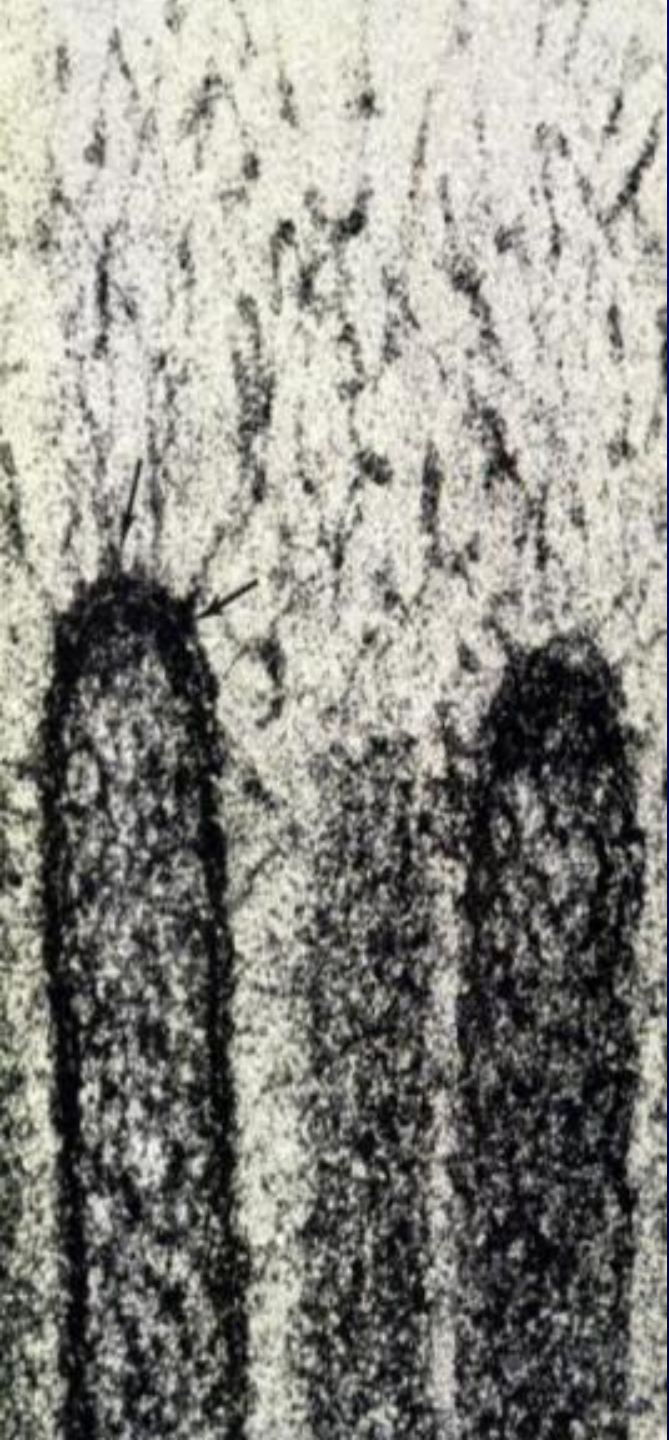
Elongated mitochondria

Golgi complex large

SER & RER

**Lateral surfaces -
interdigitation**

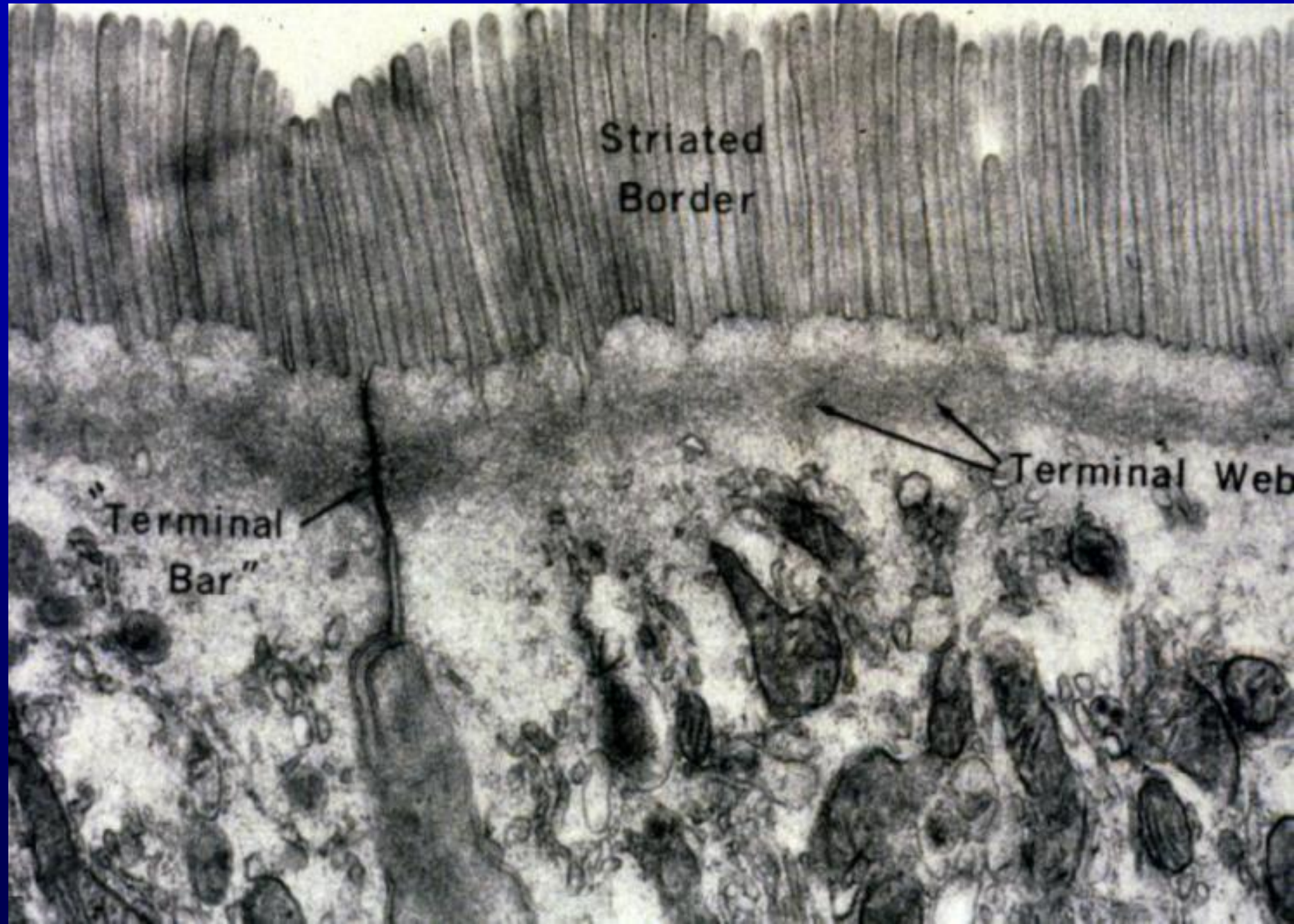




Brush border

Glycocalyx

- Protection against enzymes
- Active in digestion



Enzymes of Intestinal Absorptive Cell

Several peptidases

polypeptides to amino acids

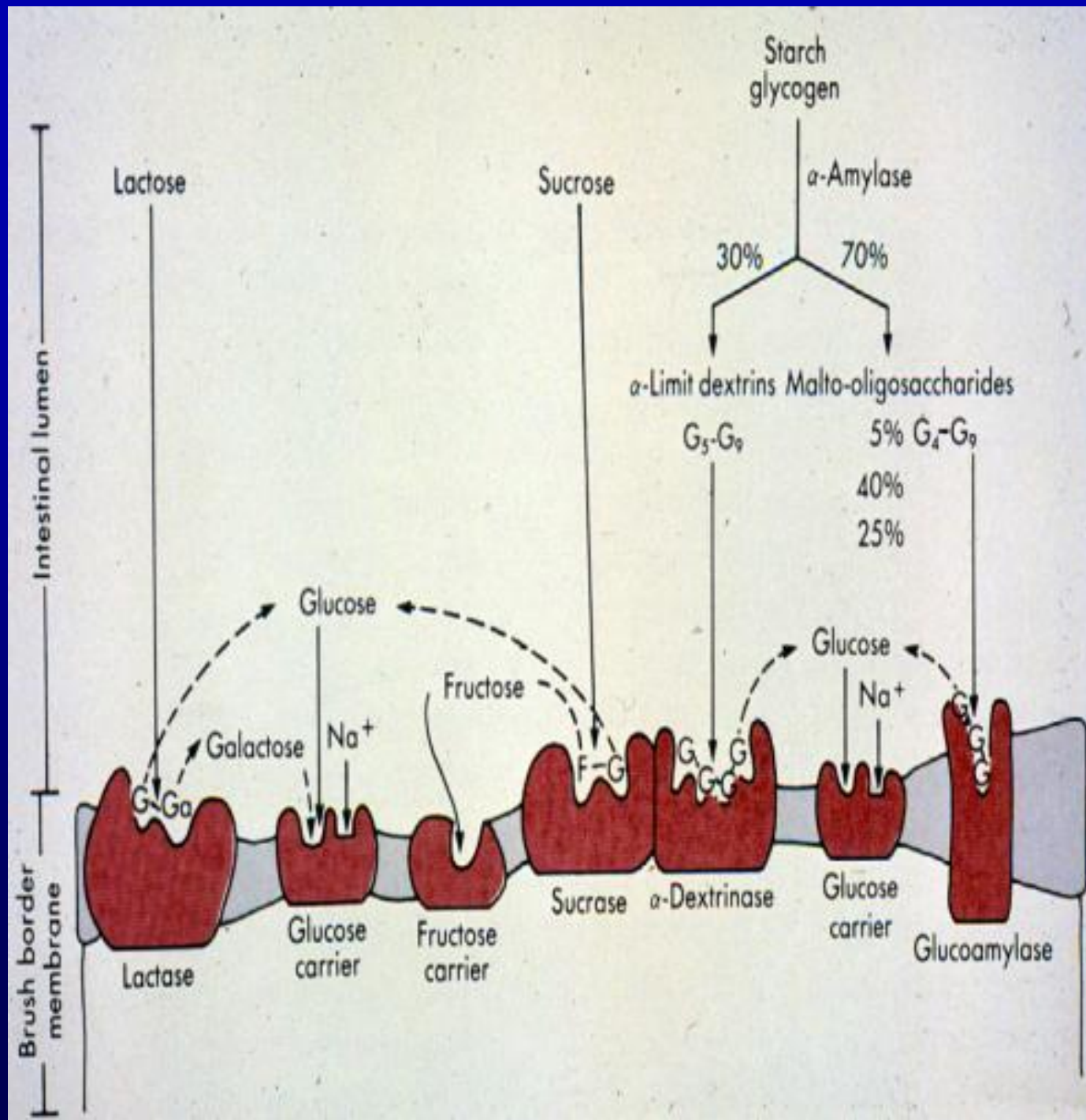
Four disaccharidases

disaccharides to monosaccharide

Lipase

neutral fats to glycerol and fatty acid

Carbohydratases small amount of amylase



Basic Mechanism of Absorption

Active transport

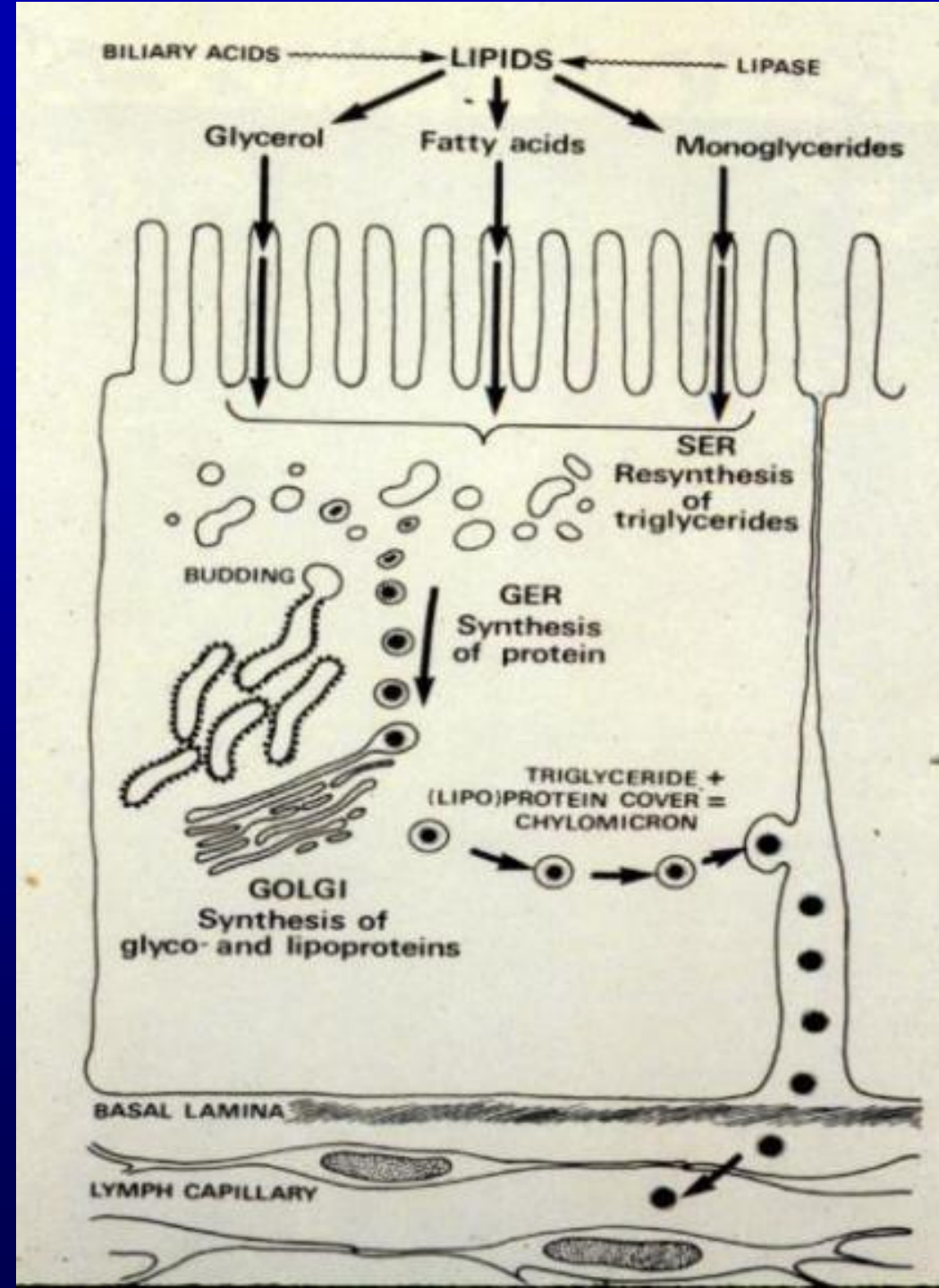
Monosaccharides

Amino acids

Passive diffusion fatty acids

Monoglycerides

Resynthesis of triglycerides in SER



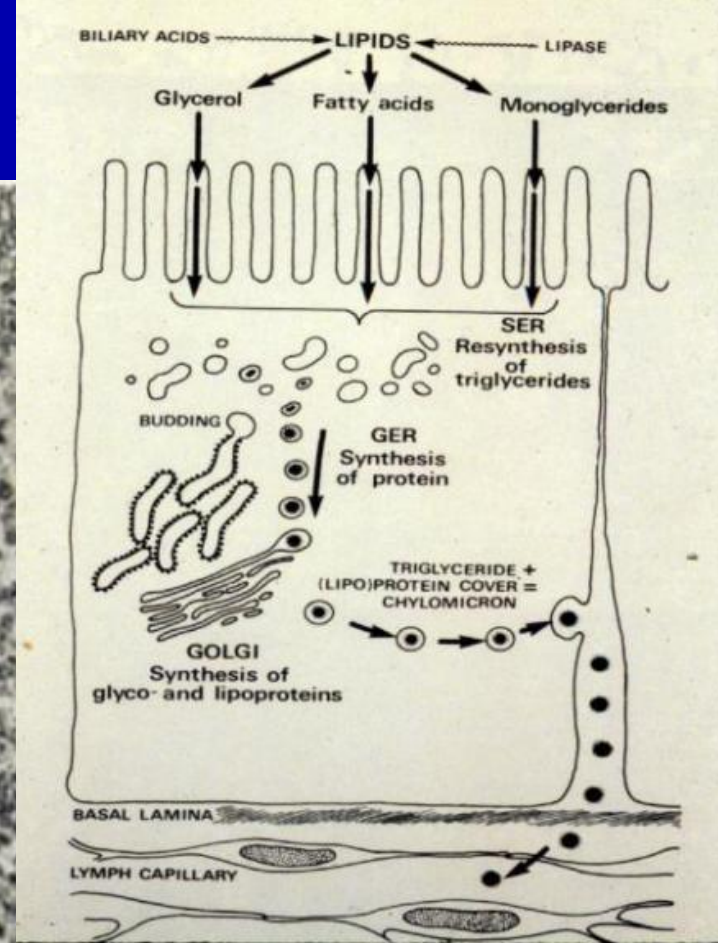
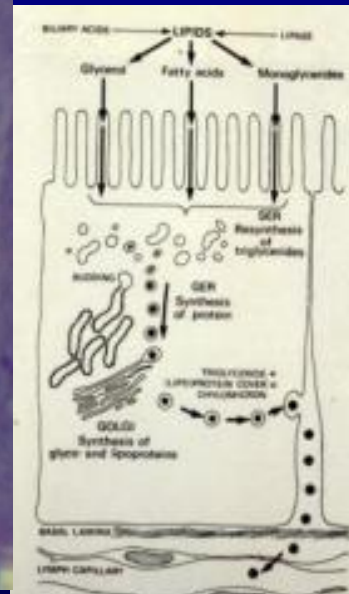
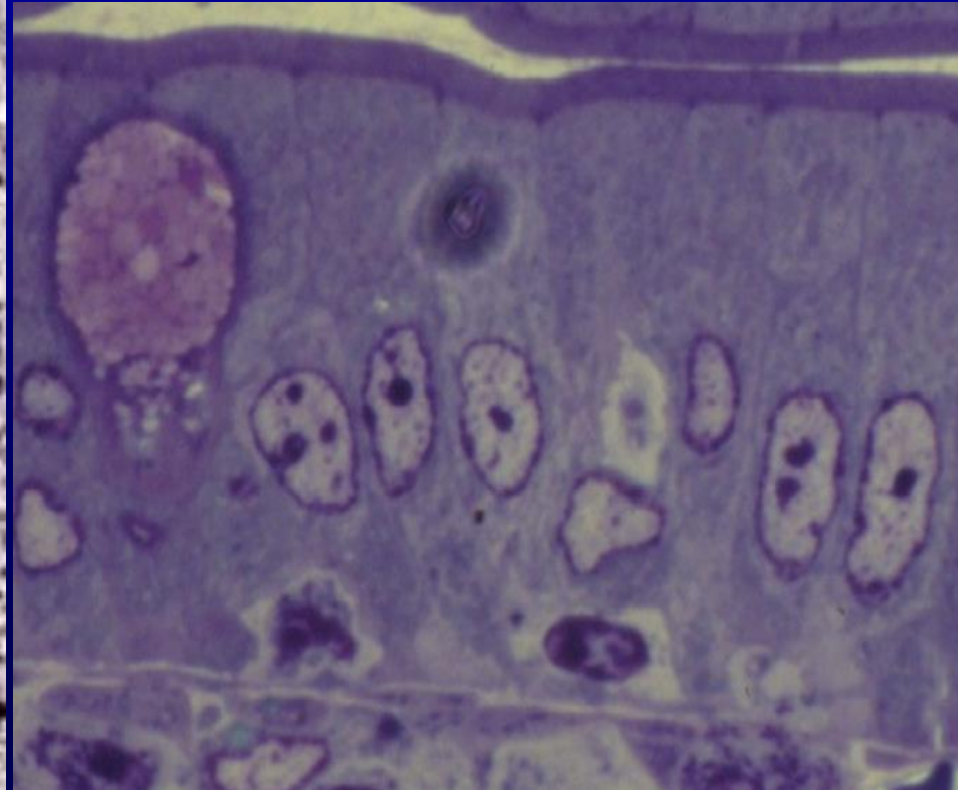
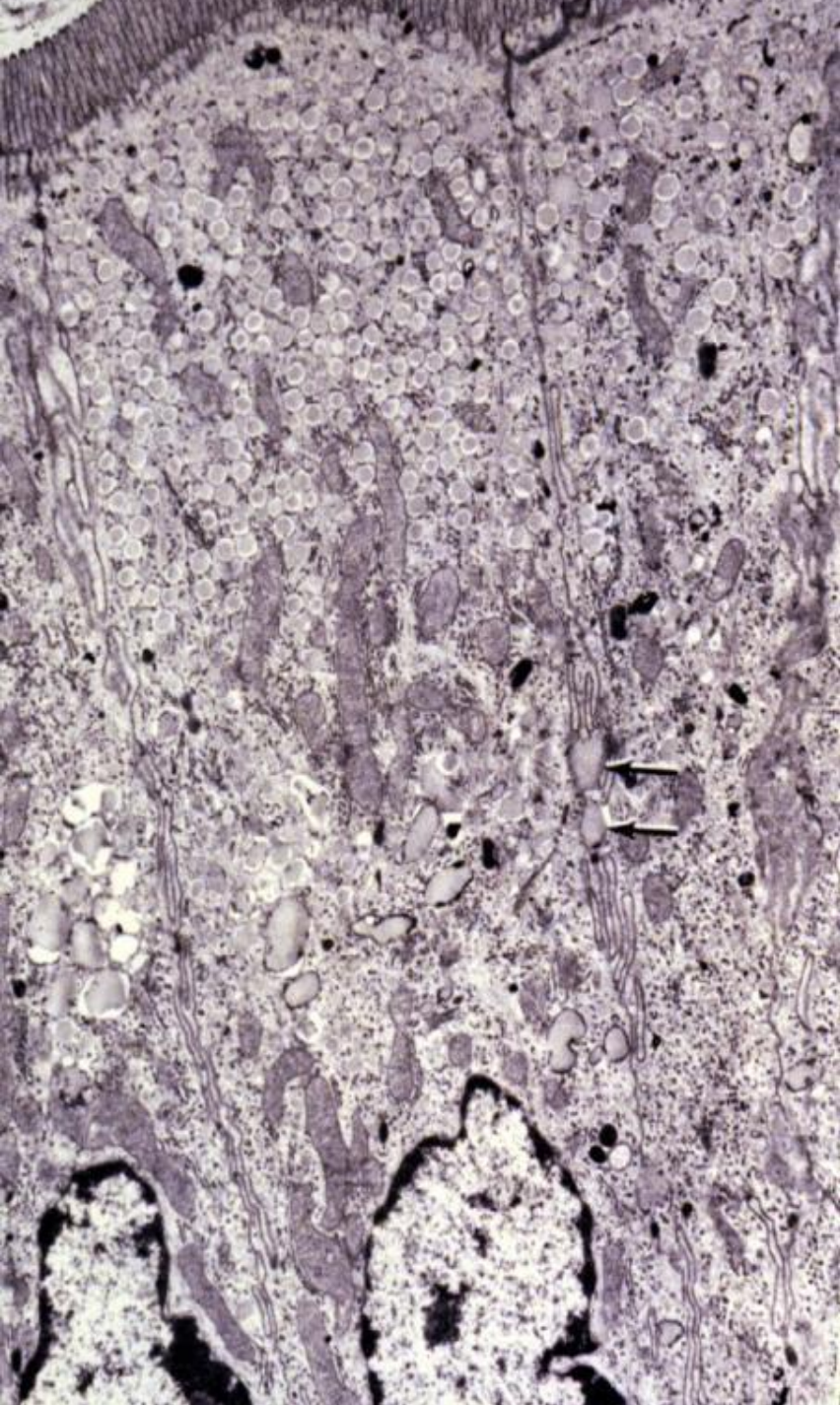


Figure 26-29. Electron micrograph of the boundary between two rat intestinal epithelial cells during lipid absorp

Smooth endoplasmic reticulum

- **Function:**
 - **Synthesis & Transport of lipids in the intestines**



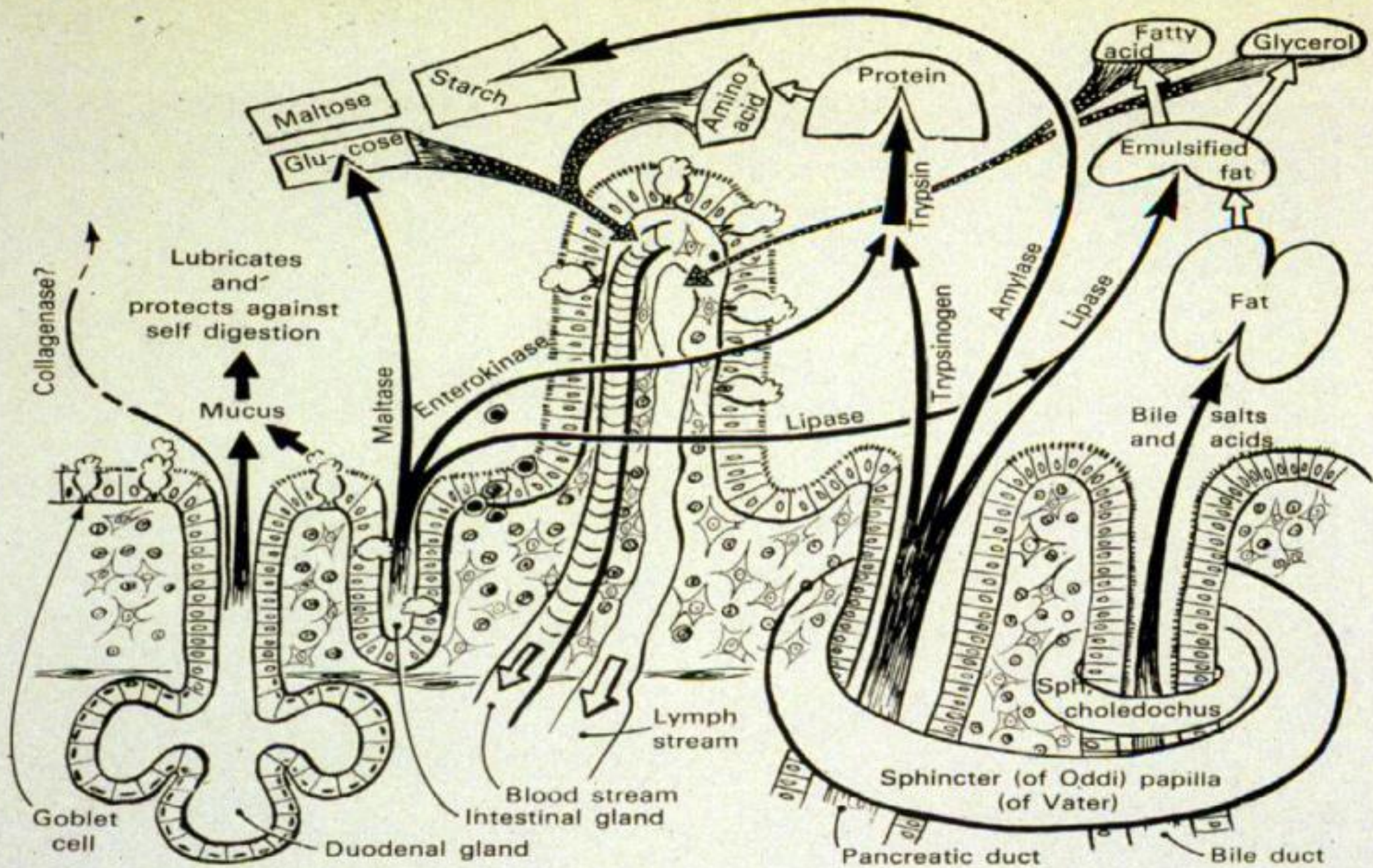


Fig. 12-49. Diagram of intestinal functions.

Paneth Cells

Depths of crypts of Lieberkuhn

Stable population

Abundant in humans, horse, & ruminants

– (Absent in other domestic species)

Organelles indicative of protein synthesis

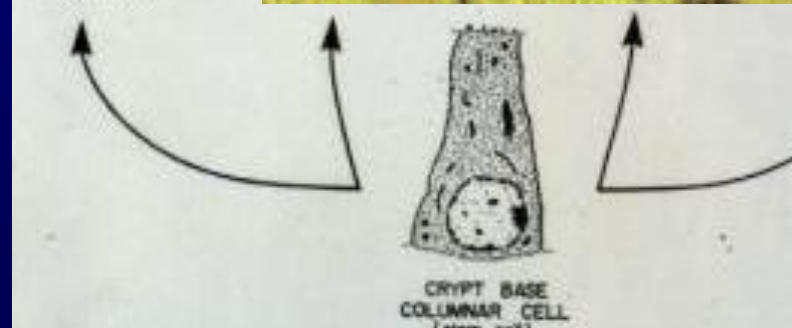
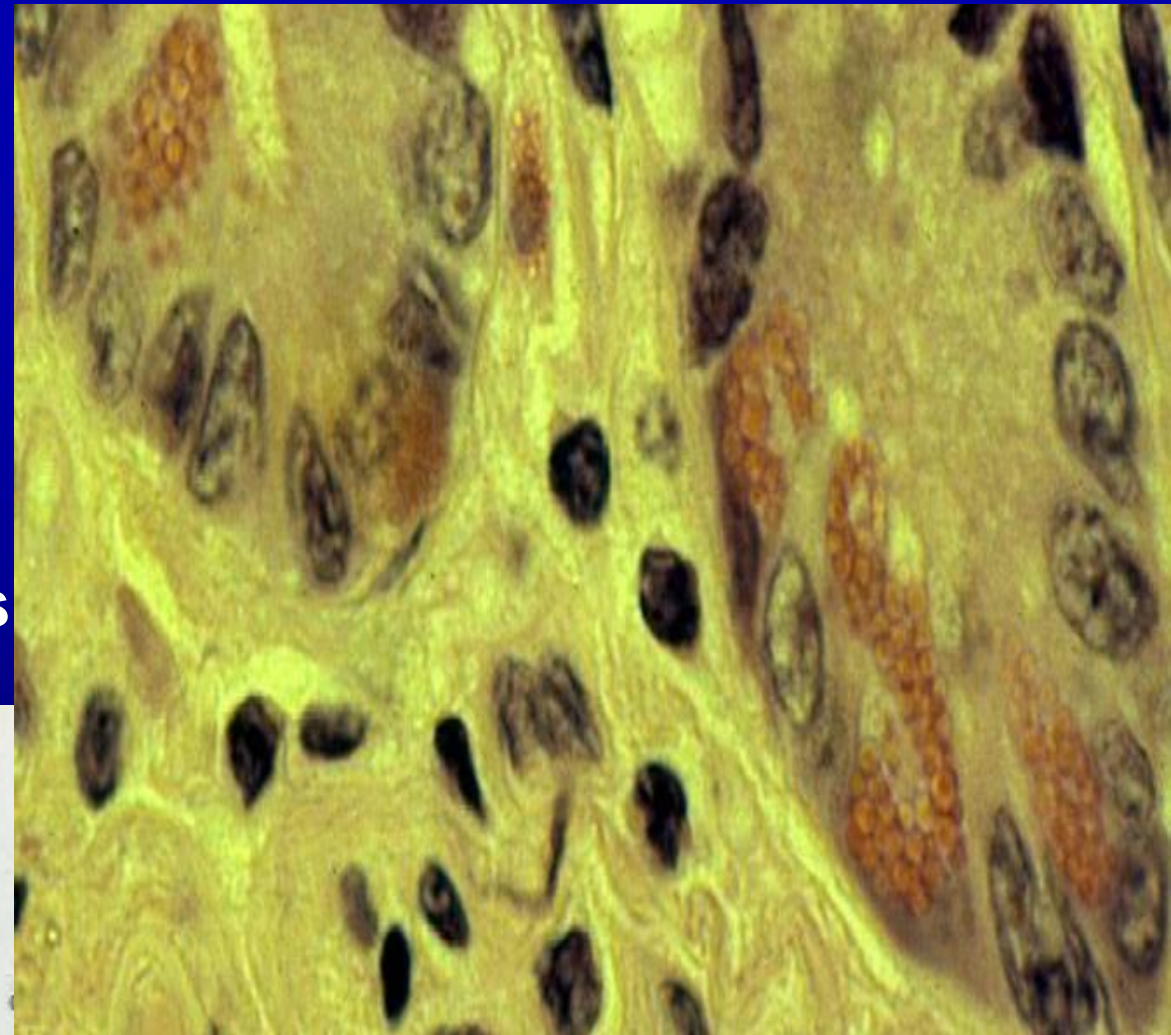
Large secretory granules

Granules

– Acidophilic (Eosin)

– Lysozyme capable of
lysing bacteria

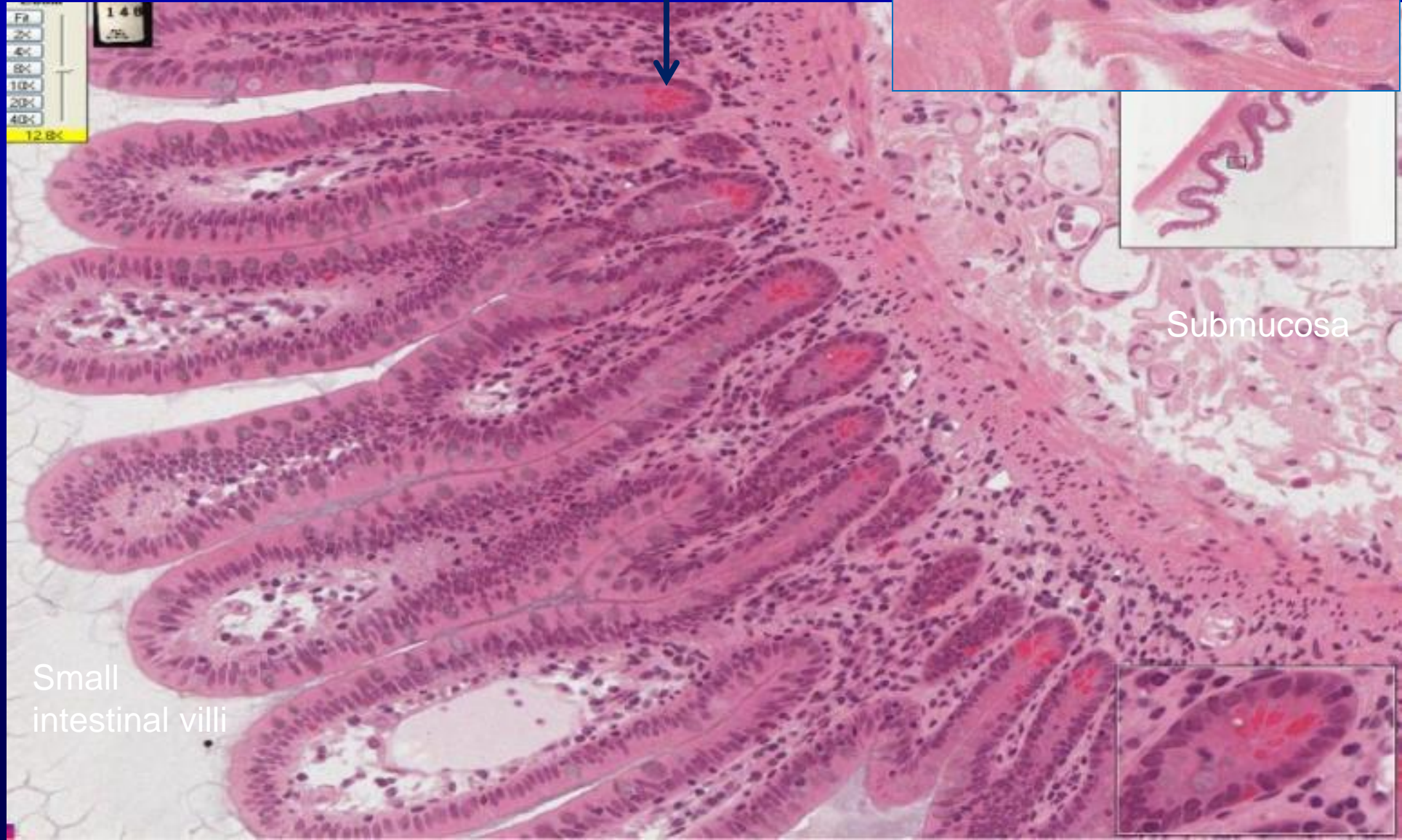
Concentration of
radioactive zinc



148 Ileum

Meissner's plexus cell bodies in submucosa

Paneth cell

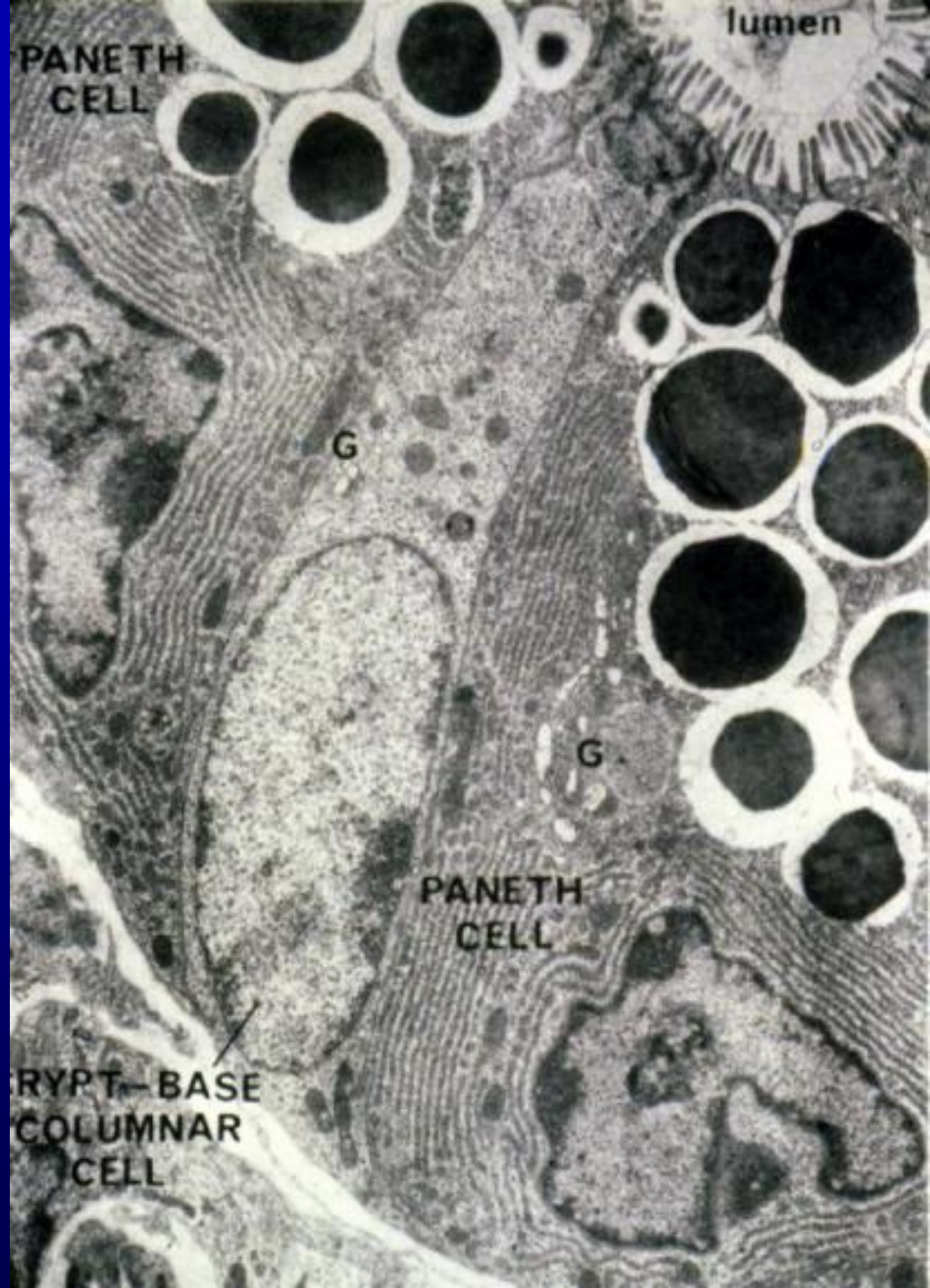
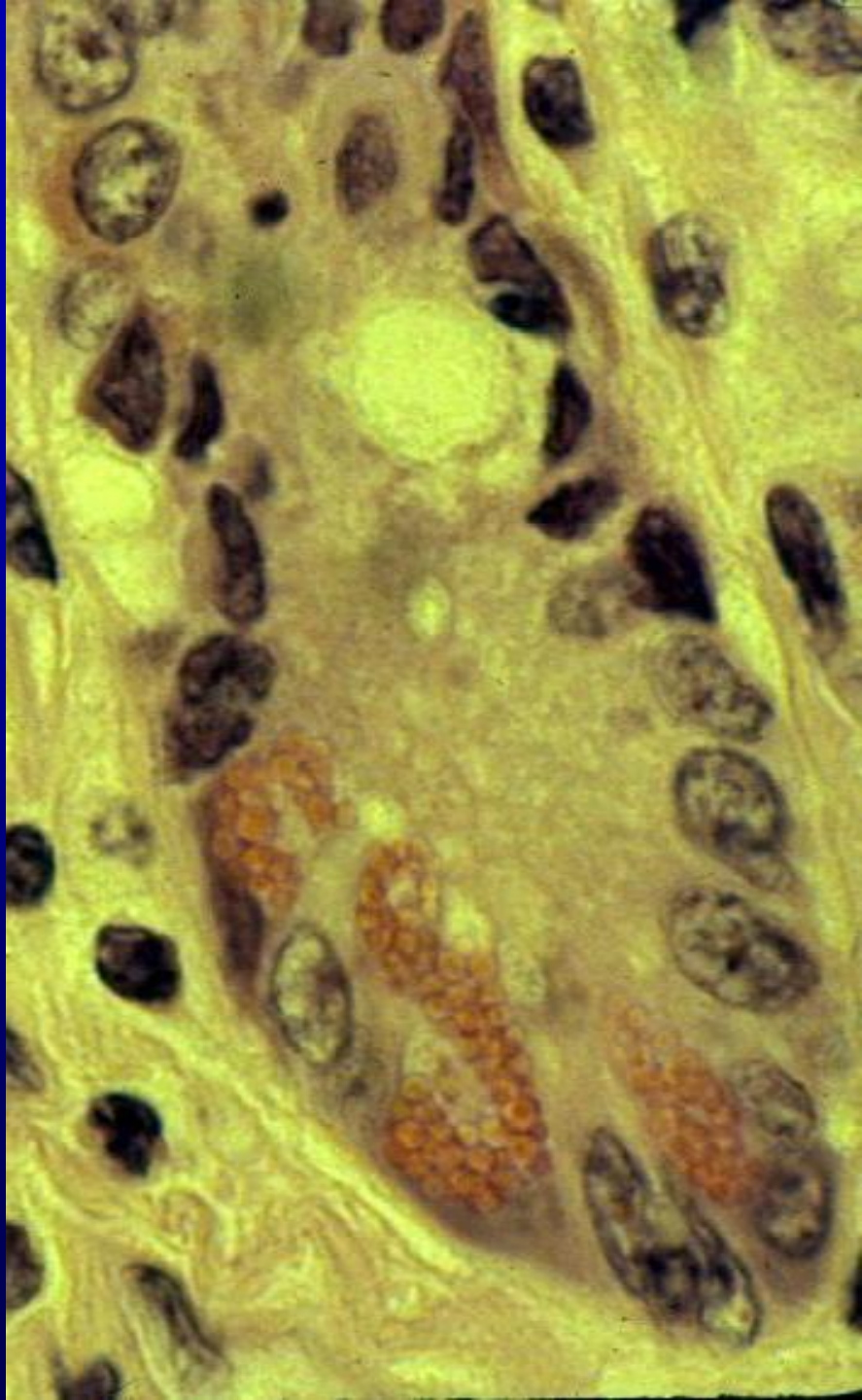


Small intestinal villi

Submucosa

Fr
20x
40x
80x
100x
200x
400x
12.8x

148



Goblet cell

Unicellular gland

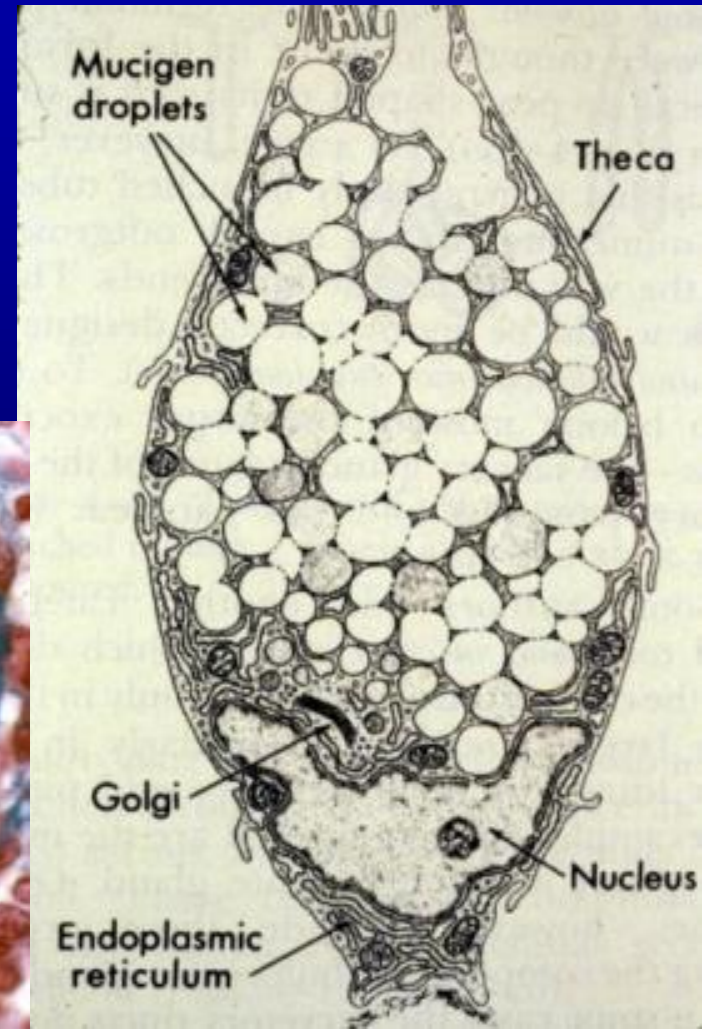
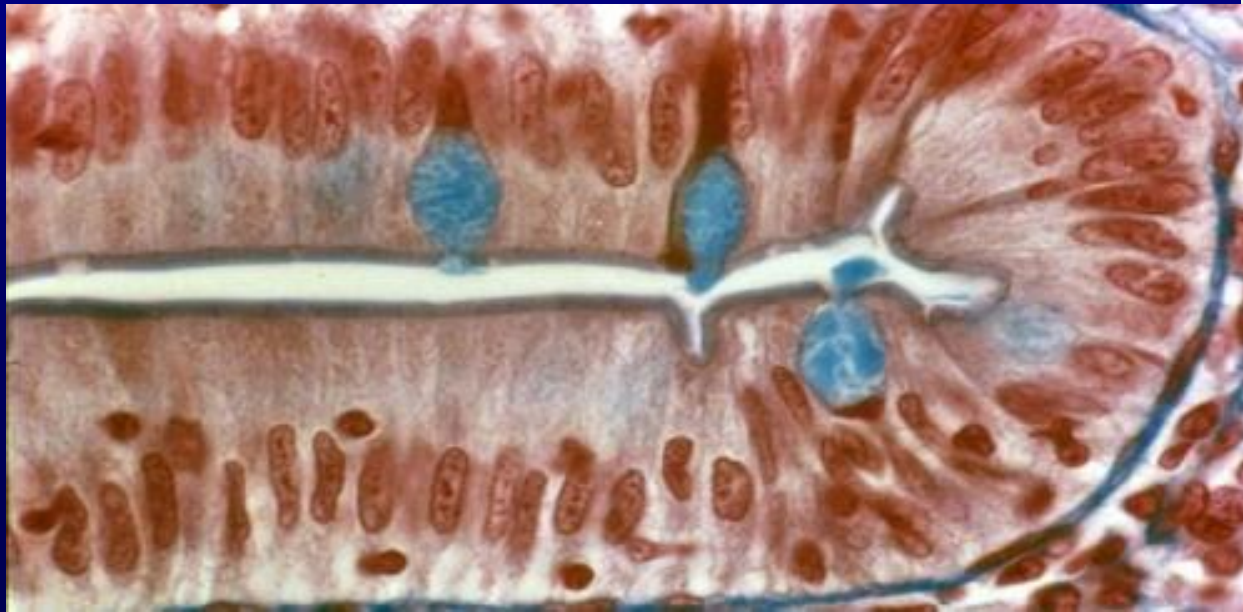
Theca

Flattened nucleus

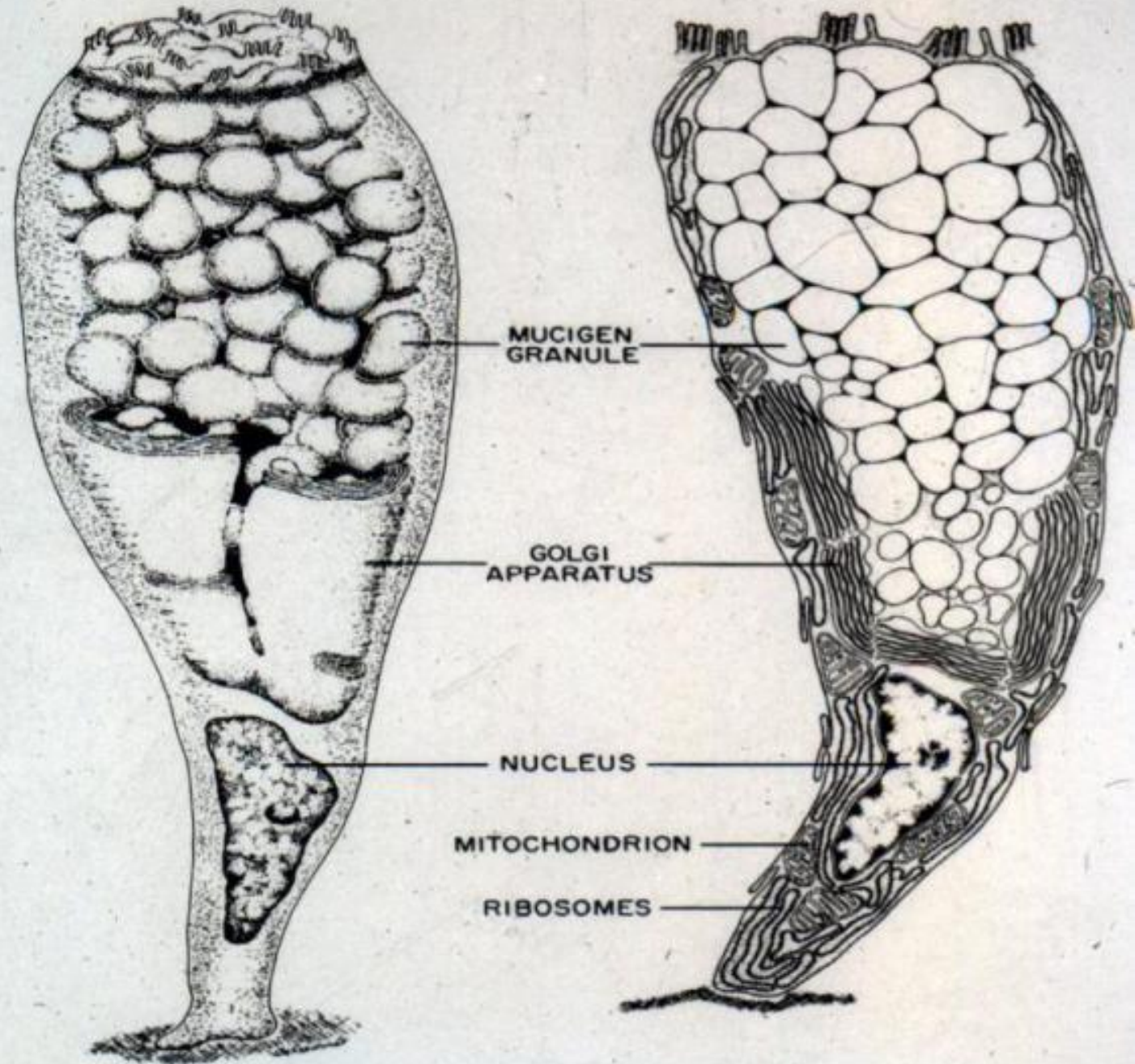
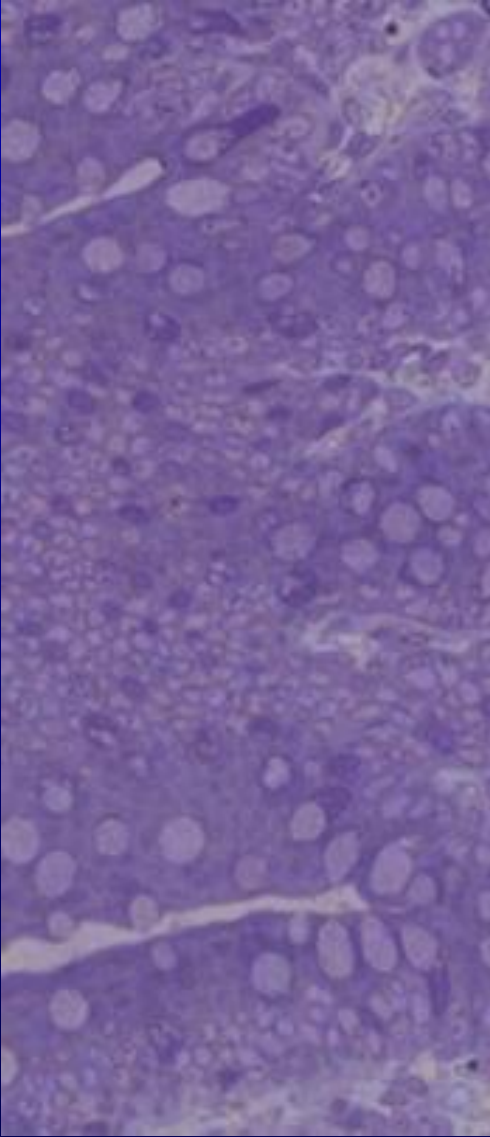
Short lived - one

Mucus

- Raw egg white
- Lubricate and protect



Goblet Cell

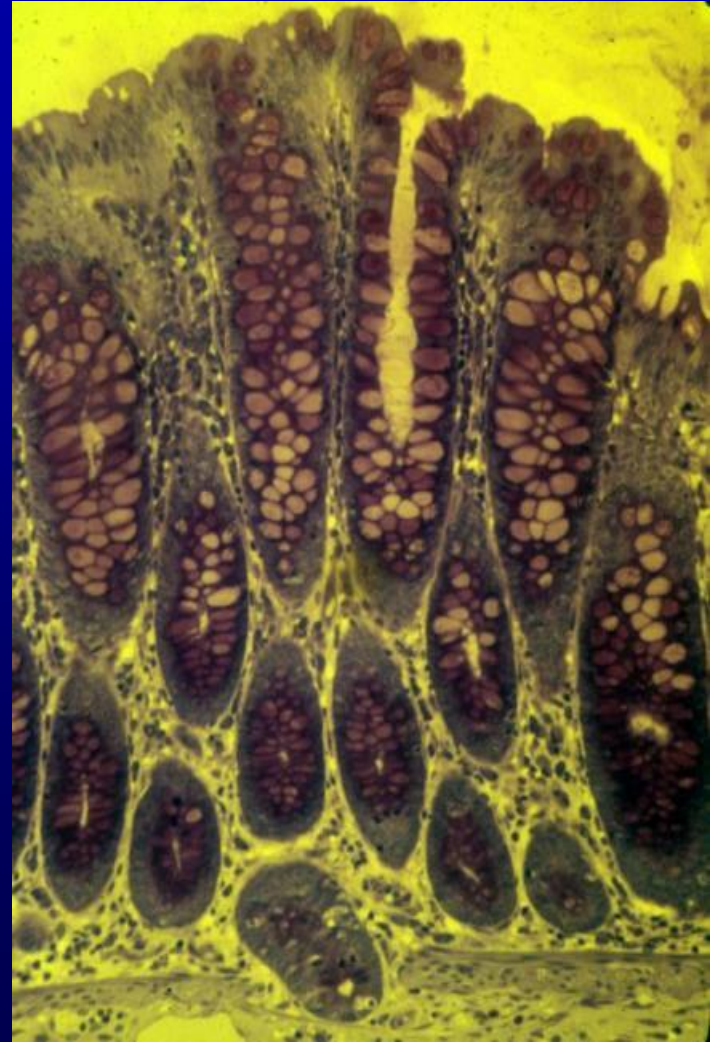


Function of Mucus in Large Intestines

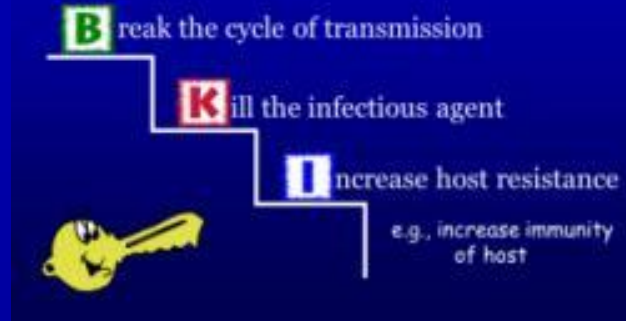
Protects wall against excoriation

Provides adherent qualities to
feces

Protects wall against bacterial
activity



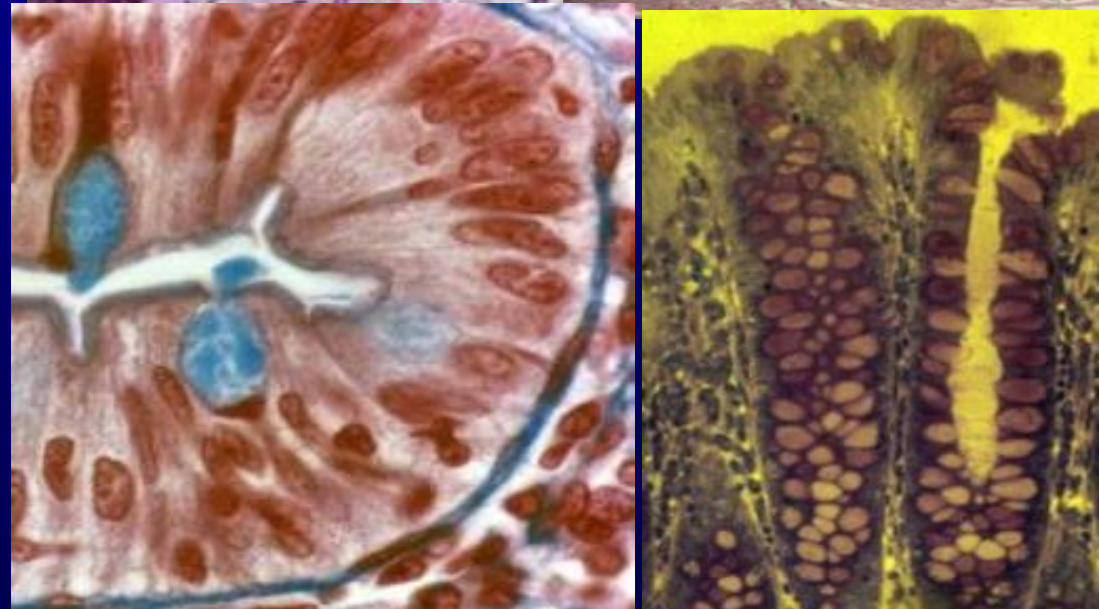
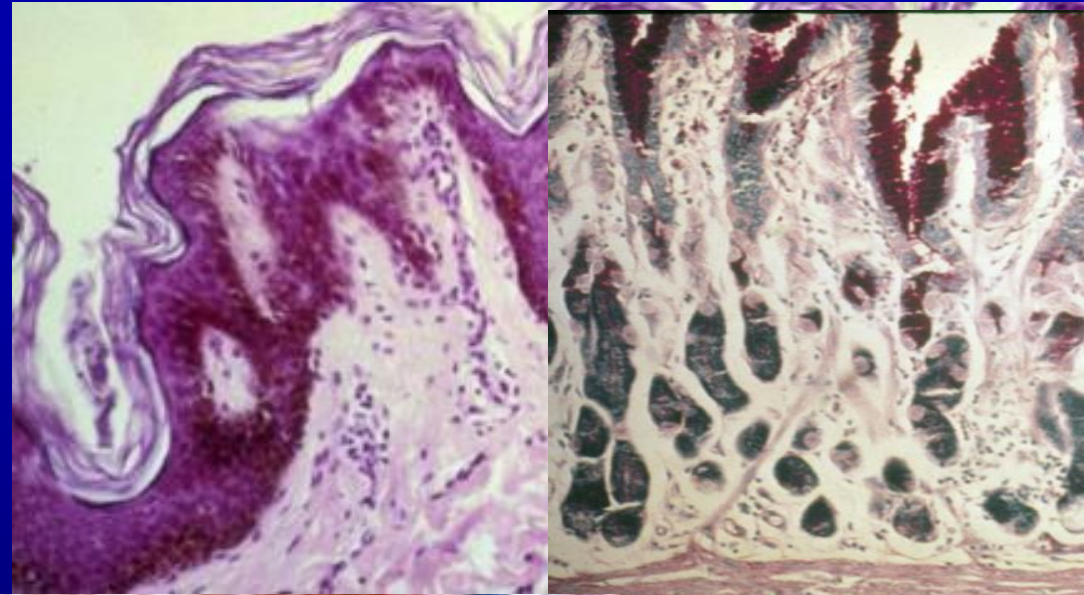
Three Key Steps of Combating Infections



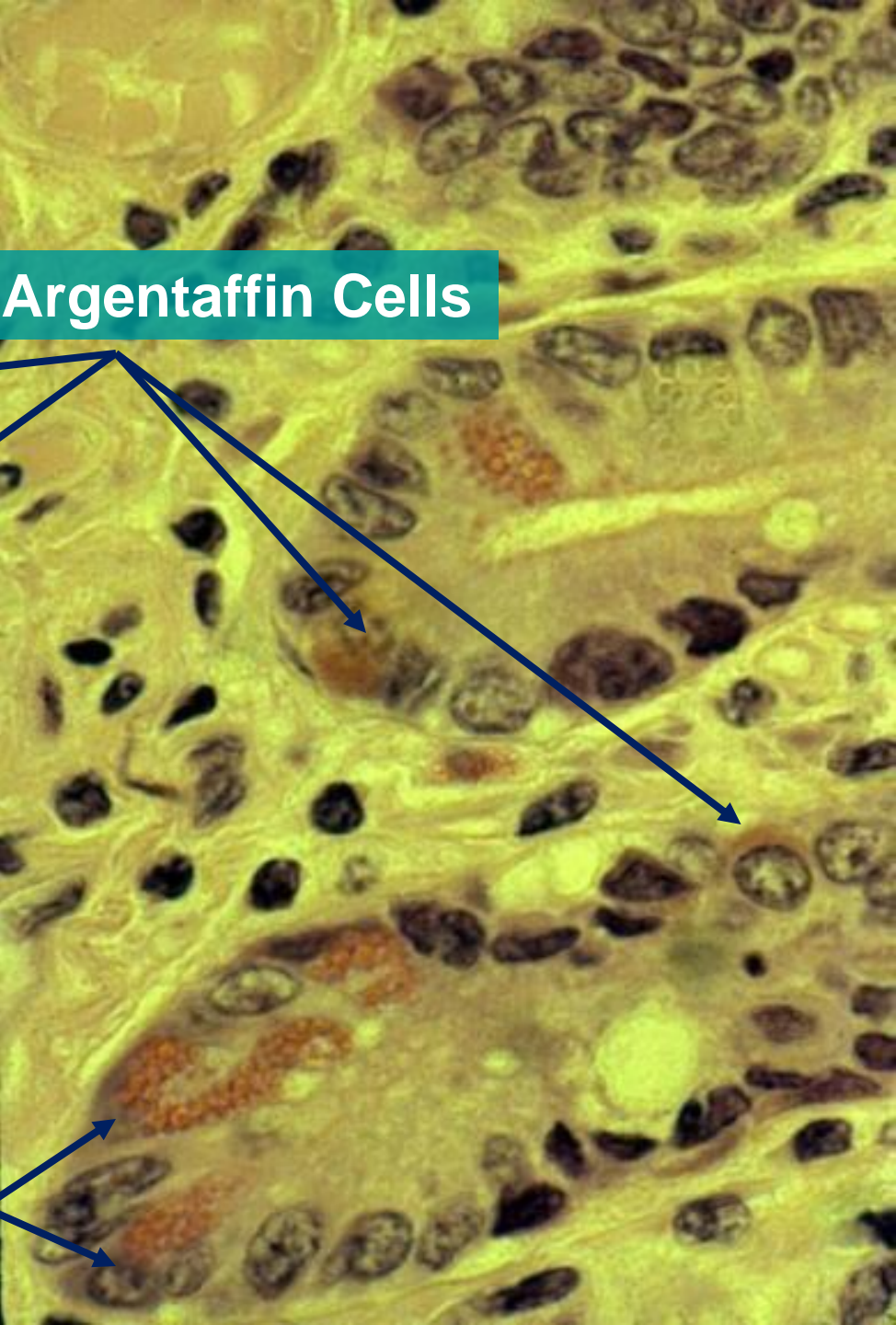
Skin and GI tract function as part of the First of Defense against infections

First line - physical barrier

- Skin - stratum corium
- HCl in stomach
- **Mucus in intestines**



Break the cycle of transmission



Argentaffin Cells

Paneth cells



Argentaffin (basal granular cells)

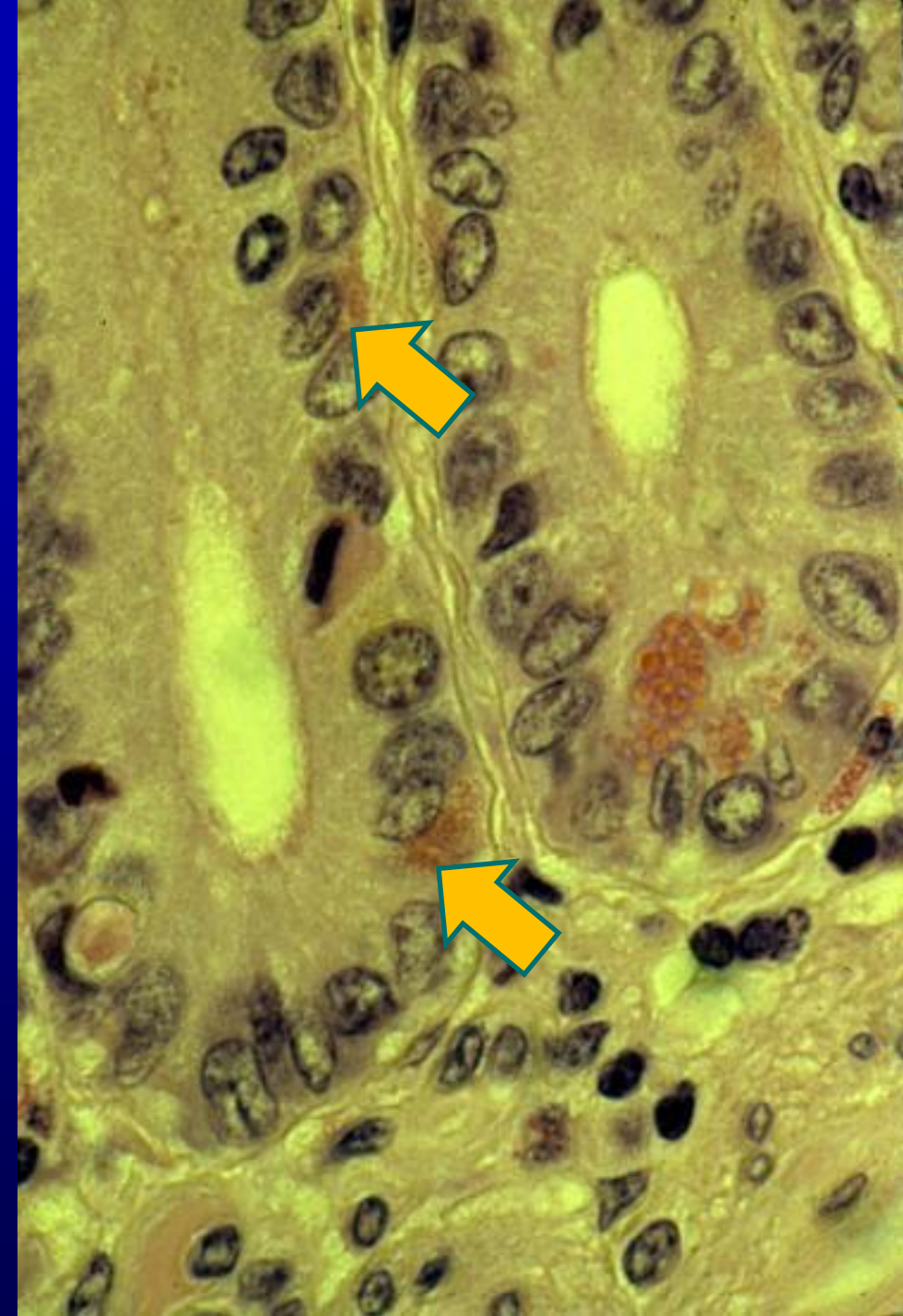
In crypts and villi

Granules at base

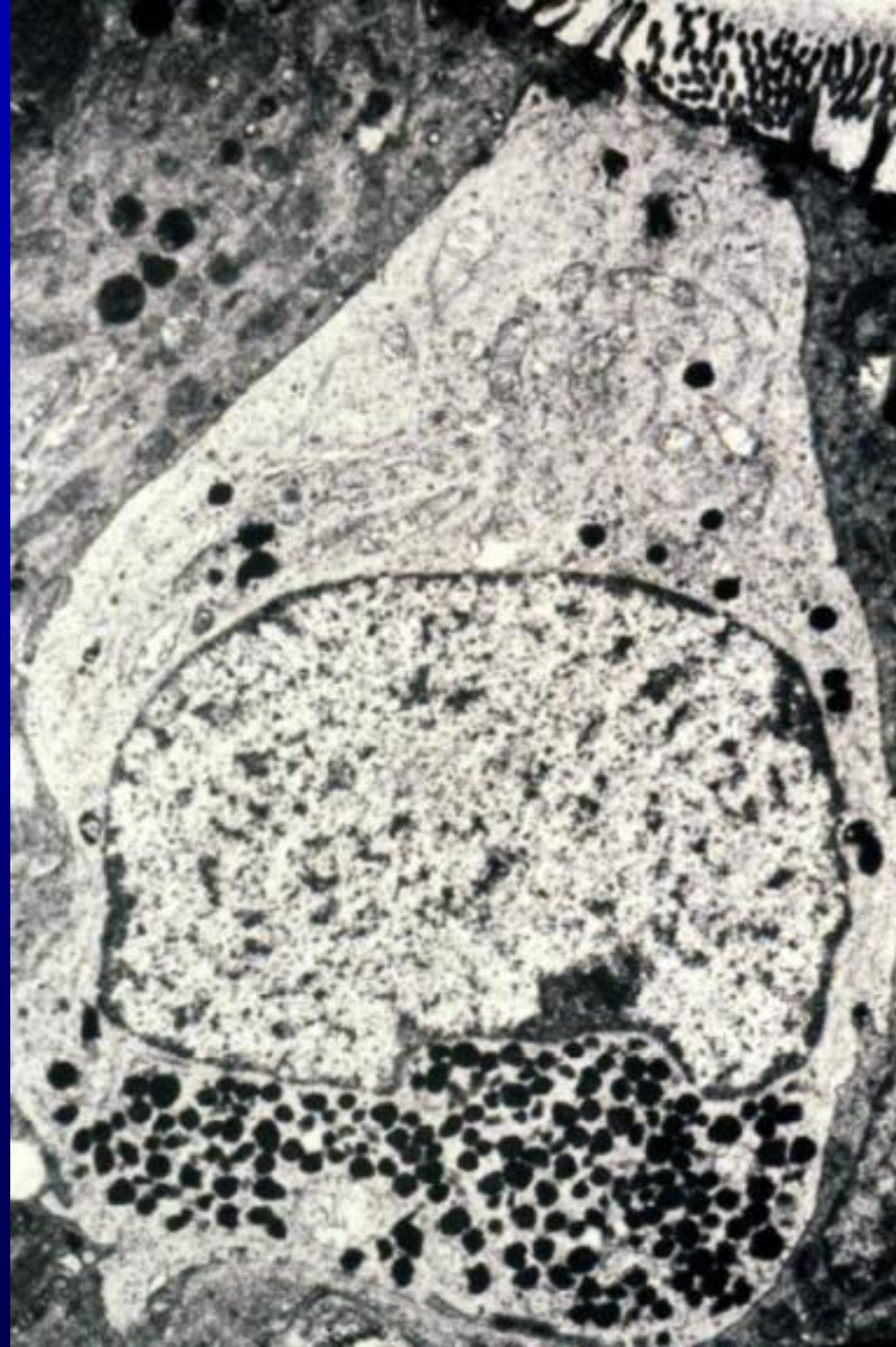
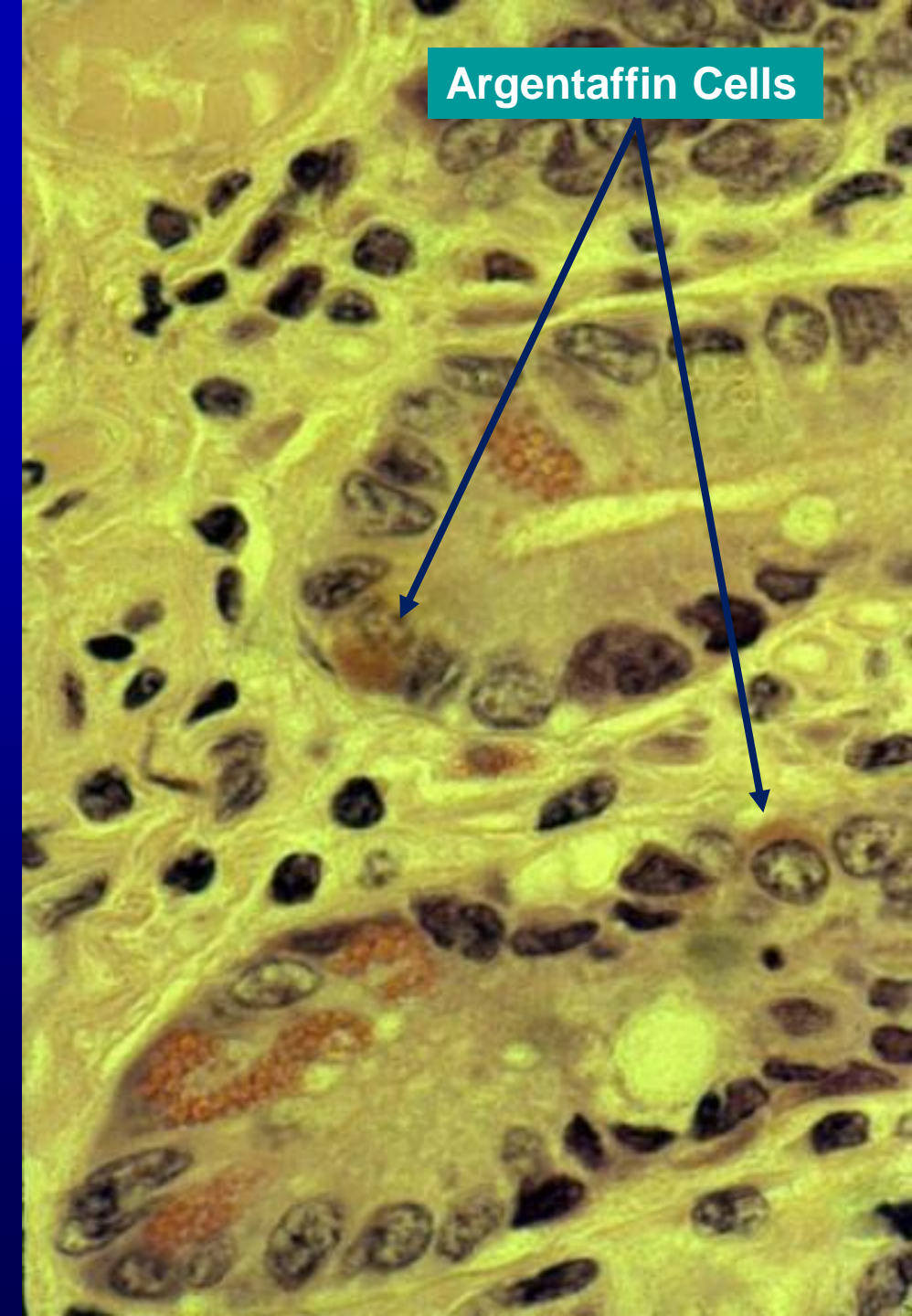
Widely scattered throughout GI tract

Secretions - serotonin

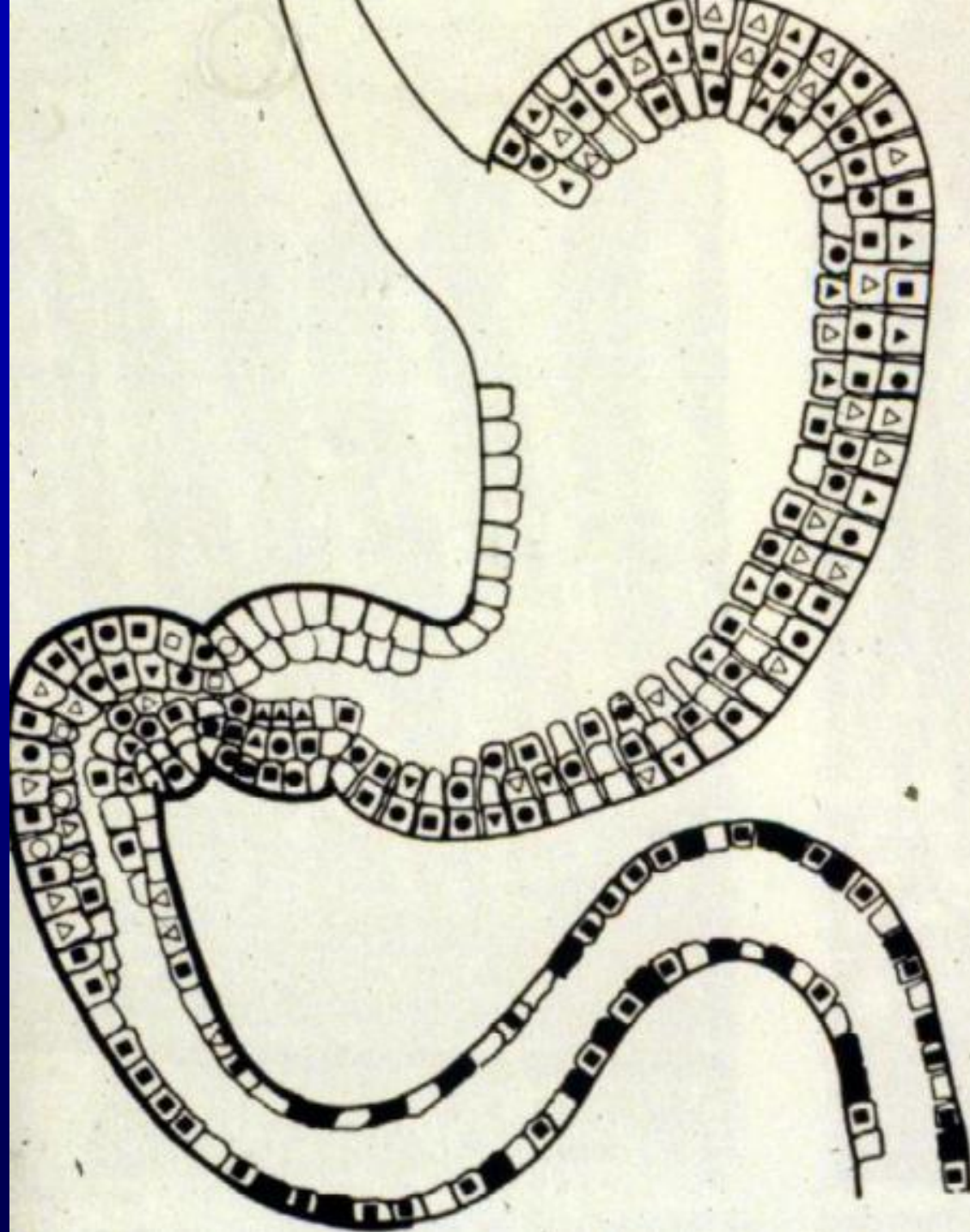
vigorous contraction of smooth muscle nervous system



Argentaffin Cells



They extend into the lumen to detect luminal contents



Name
of
Cells

Product

D₁



Gastric inhibitory polypeptide (GIP)

ECL



Similar to EC

A



Glucagonlike substance

EC



5-Hydroxytryptamine

G



Gastrin

D



Unknown

S



Secretin

I



Unknown

Basal Granular Cells (Argentaffin)

Organ

Stomach

Duodenum

Jejunum and Ileum

Appendix

Abundance

Moderate

Common

Sparse

Abundant

Secretions of Gut Argentaffin Cells

Cell Name	Location	Product	Major Action
A	Stomach	Pancreatic glucagon	Hepatic glycogenolysis
B	Pylorus, duodenum	Somatostatin	Local inhibition of endocrine cells (?)
D	Stomach, intestines	Vasoactive intestinal peptide (VIP)	Ion/water secretion, gut motility
EC	Stomach, intestine, submucosal glands, appendix, etc.	Serotonin (5-HT), motilin, substance P	Gut motility

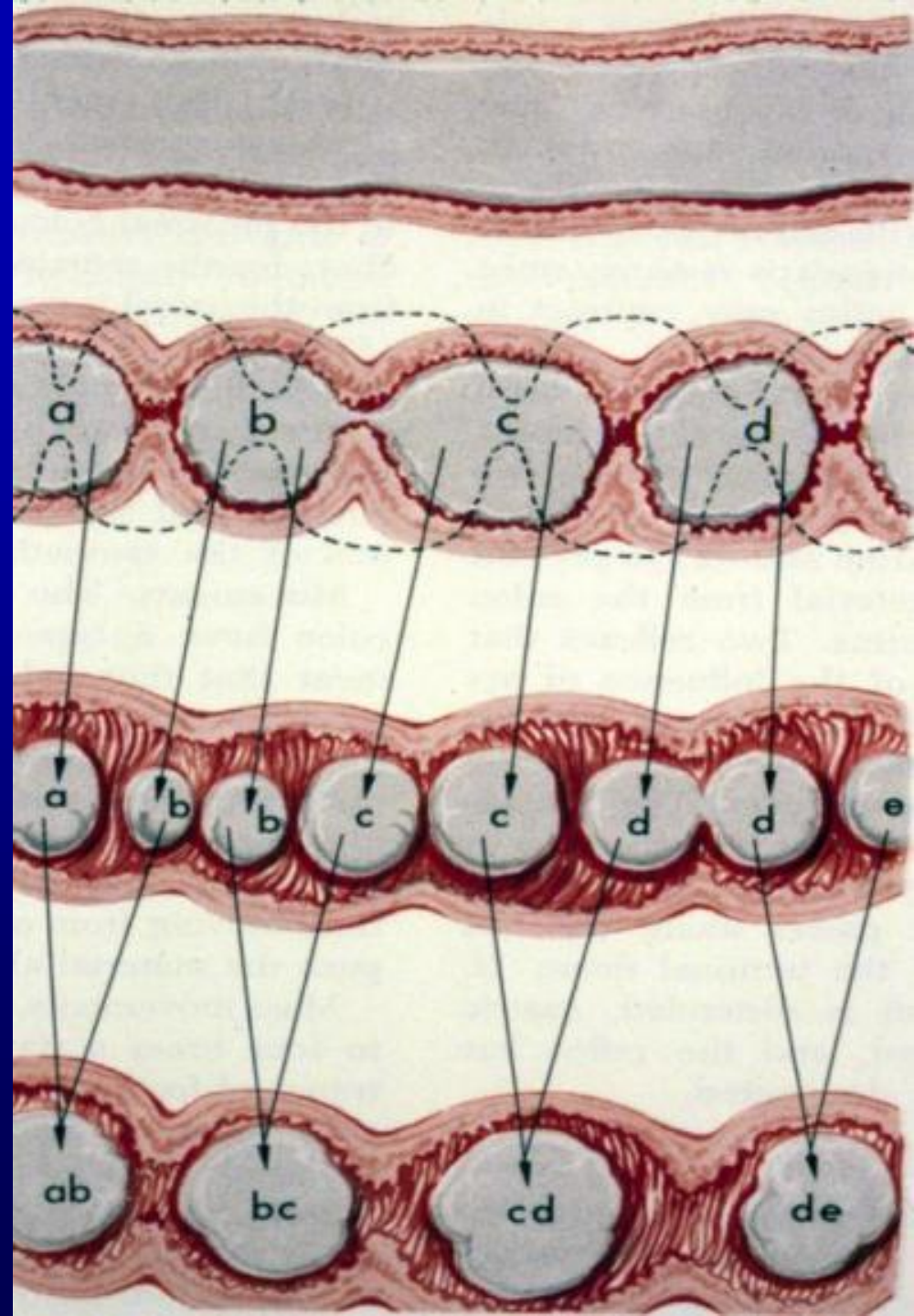
Secretions of Gut Argentaffin Cells

Cell Name	Location	Product	Major Action
G	Pylorus, duodenum	Gastrin	Gastric acid secretion
I	Small intestine	Cholecystokinin	Pancreatic enzyme secretion, gallbladder emptying
K	Small intestine	Gastric inhibitory peptide (GIP)	Inhibition of gastric acid secretion
L	Small intestine, colon	Gut-type glucagon, pancreatic glucagon	Hepatic glycogenolysis
N	Small intestine	Neurotensin	
S	Small intestine	Secretin	Pancreatic and biliary ion/water secretion

Types of Movements

Rhythmic Segmentation

- **Mixing**

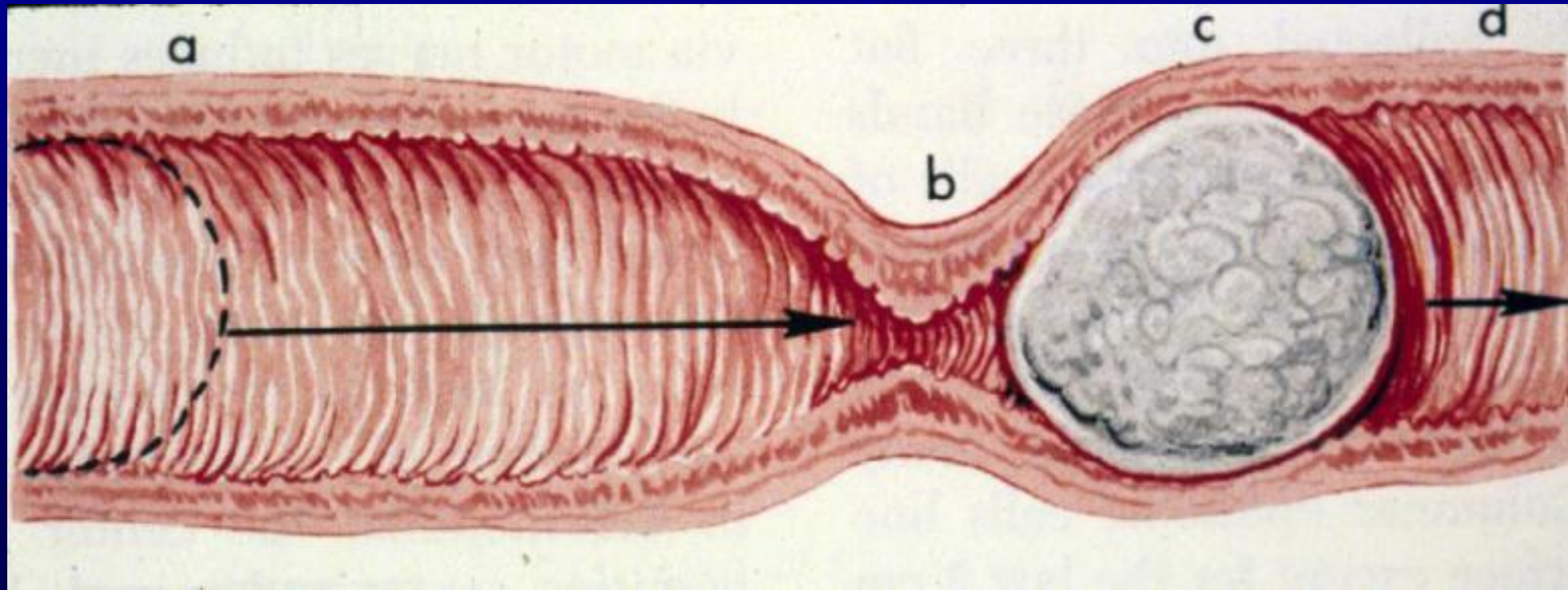


Types of Movements

Peristalsis

- Progressive Forward
- Rotation

<http://www.youtube.com/watch?v=LeVAeNM3Kd4&NR=1>



Nervous Stimulation

Parasympathetic - Activates Auerbach's Plexus

Sympathetic - inhibitory to GI tract movements

- **Excites Ileocecal Sphincter**
- **Internal Anal Sphincter**

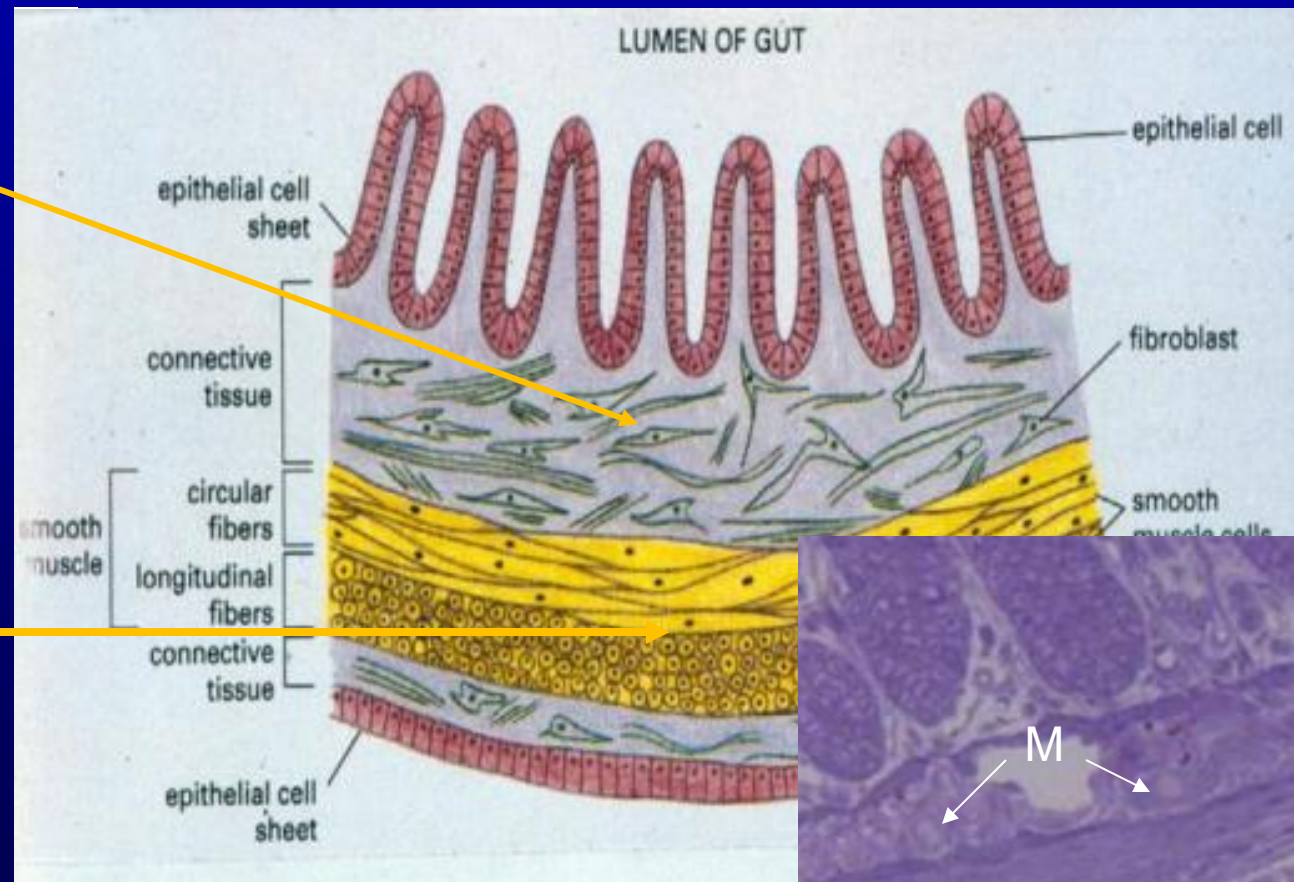
Intramural nerve plexus extends from esophagus to anus

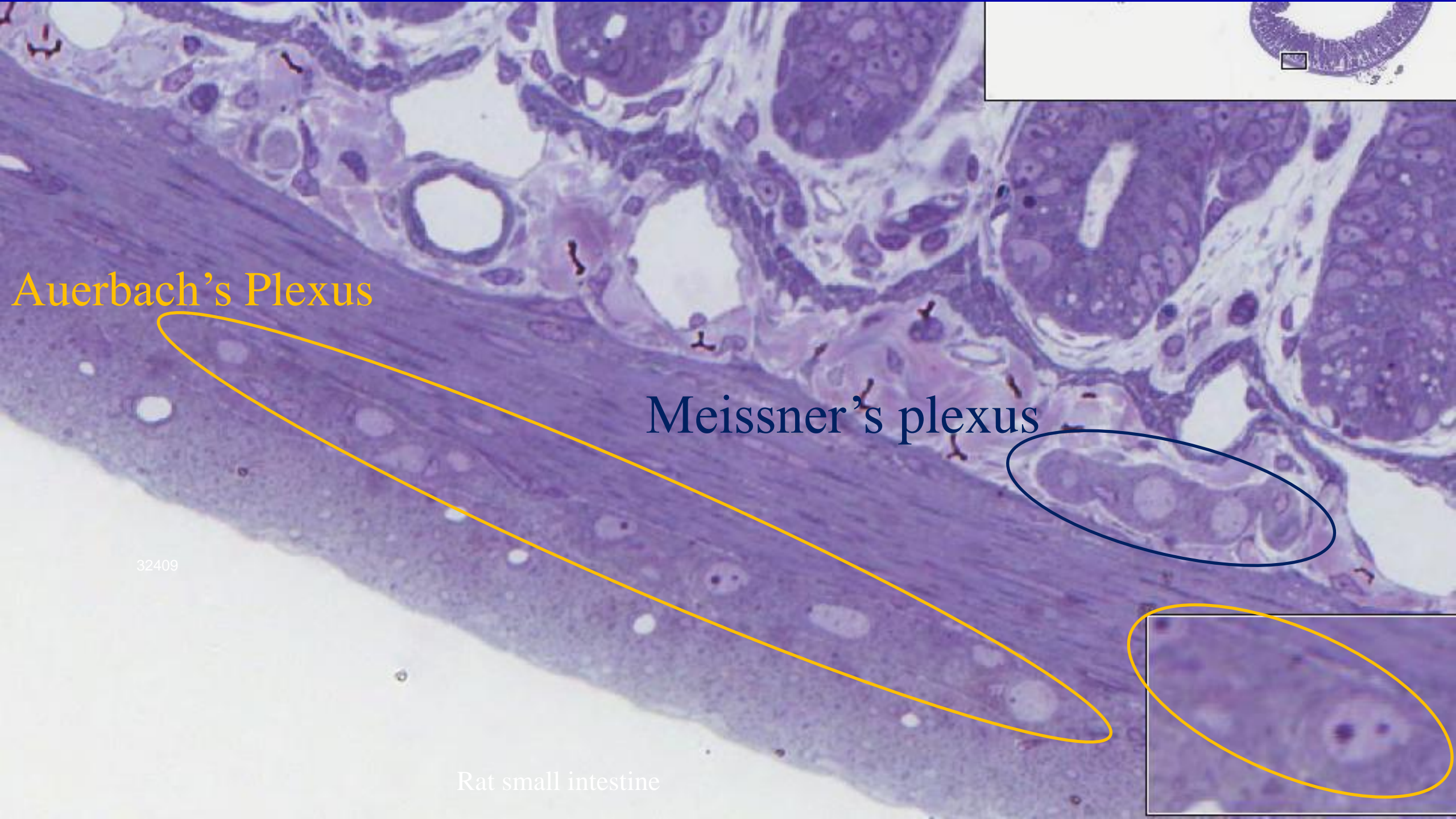
Meissner's Plexus

in submucosa
muscularis
mucosa

Auerbach's Plexus

Muscularis
Externa





Auerbach's Plexus

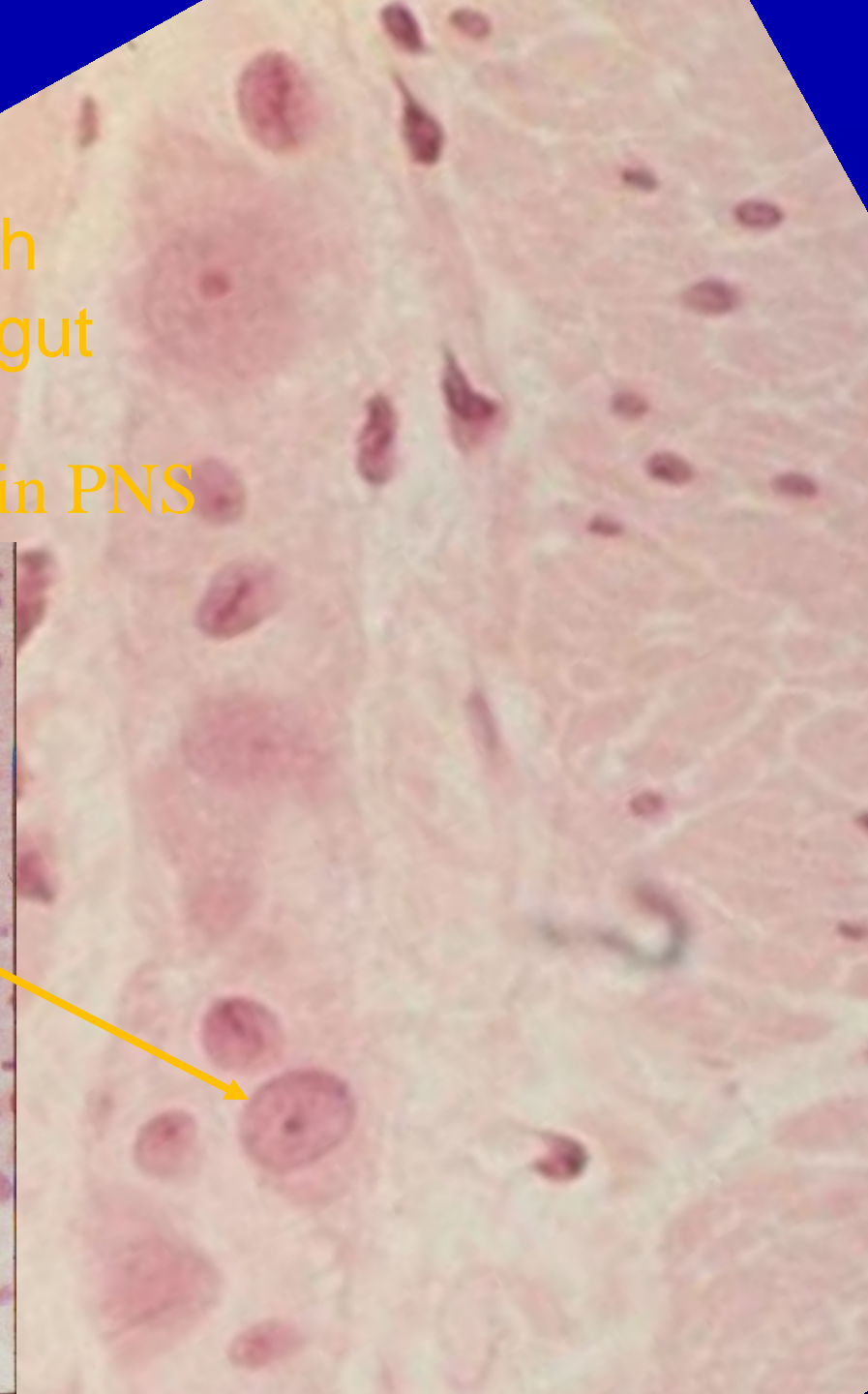
Meissner's plexus

32409

Rat small intestine

Auerbach's Plexus ("Myenteric Plexus") is sandwiched between the two layers of smooth muscle in the muscularis externa that controls gut peristalsis

Ganglia - collections of nerve cell bodies in PNS



Auerbach's plexus over smooth muscle cells



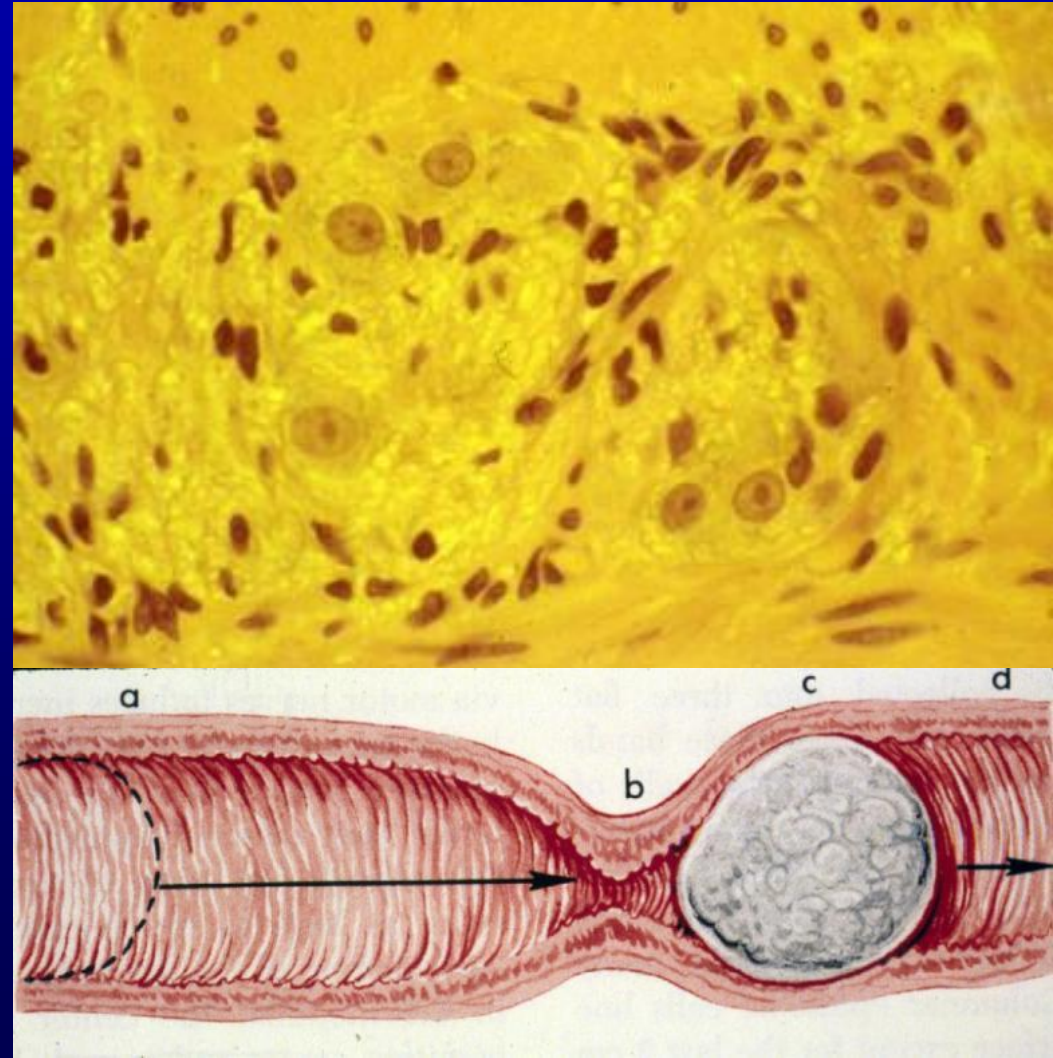
Auerbach's plexus: control of contraction

**Tonic contraction
(tone)**

**Intensity of rhythmic
contraction**

**Rate of rhythmic
contraction**

**Velocity of
conduction of
excitatory waves
along the gut wall**

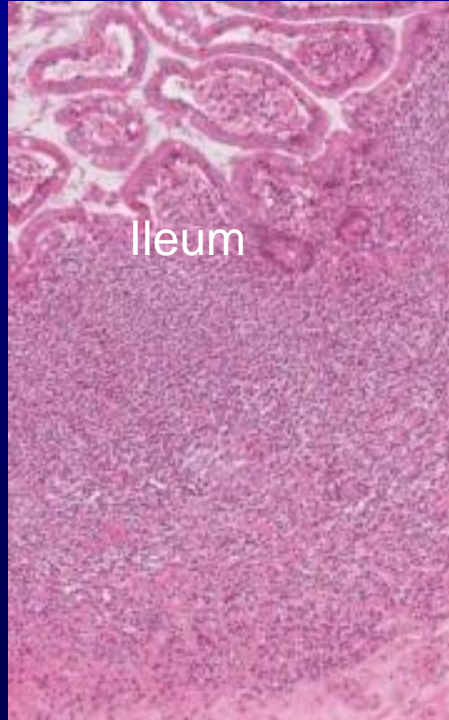


Large intestines

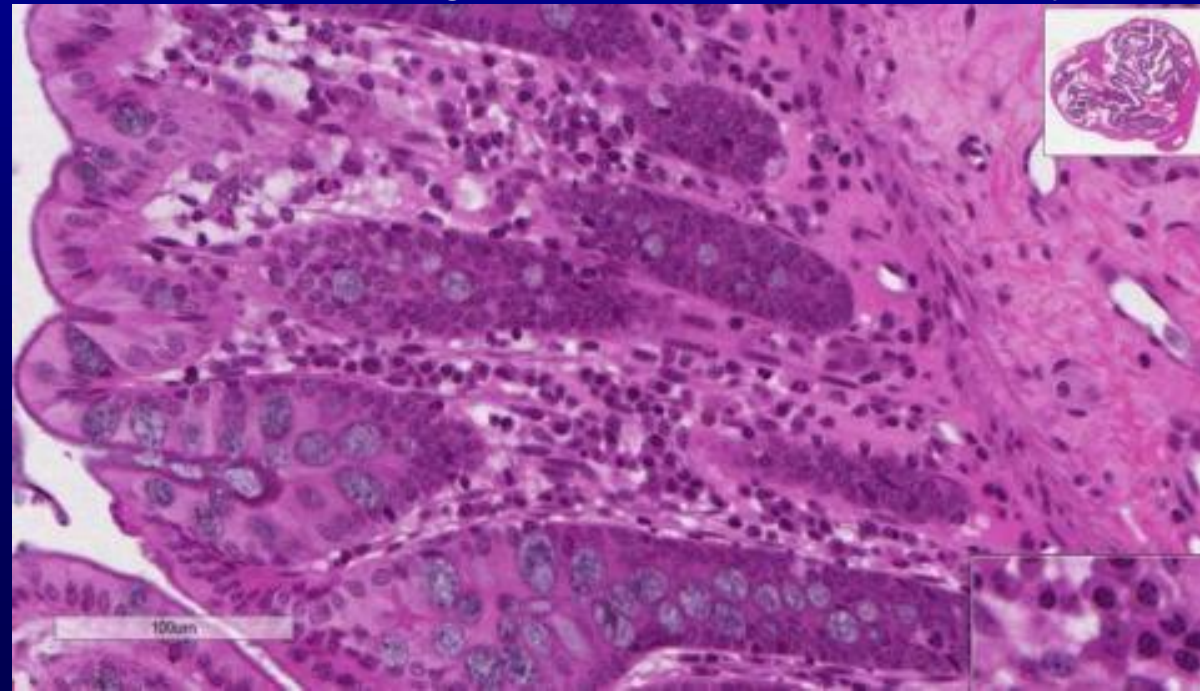


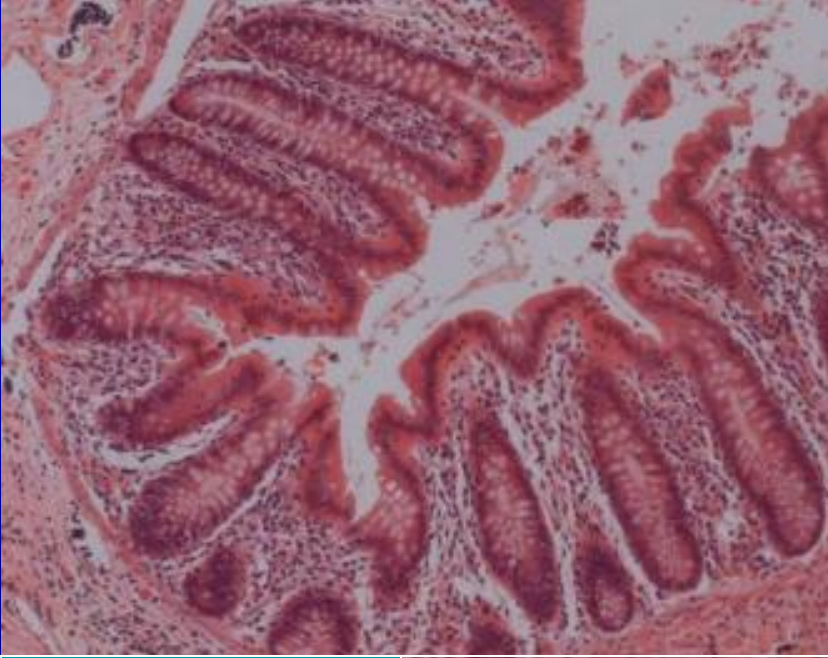


Solitary lymph follicles in the lamina propria seen throughout the GI tract help the immune system maintain a barrier between the environment and the internal milieu of the body. Other contributors include luminal epithelium, HCl in the stomach, and mucus produced by many goblet cells in the intestines.

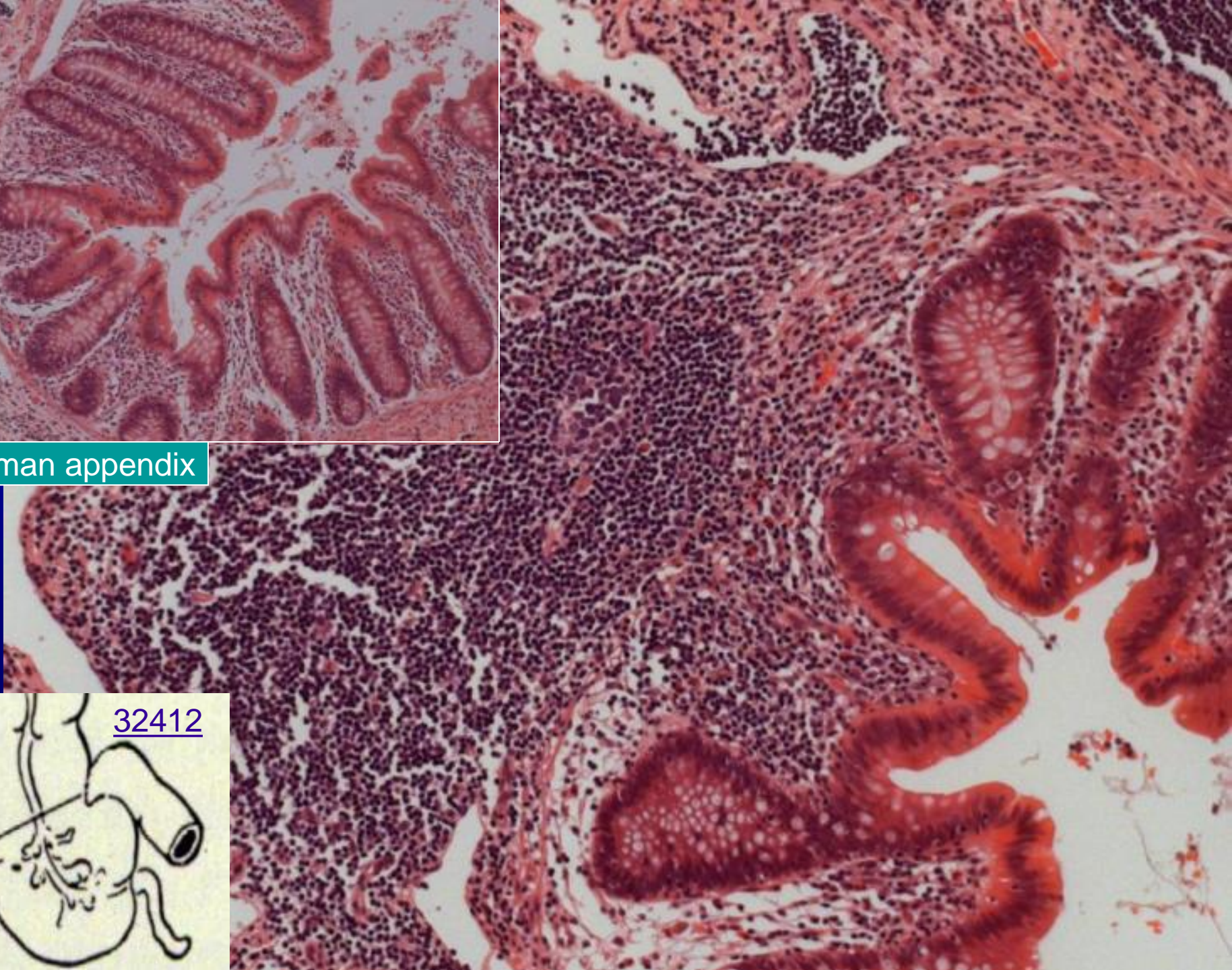


Large intestine or Colon, monkey [153](#)





Human appendix



32412

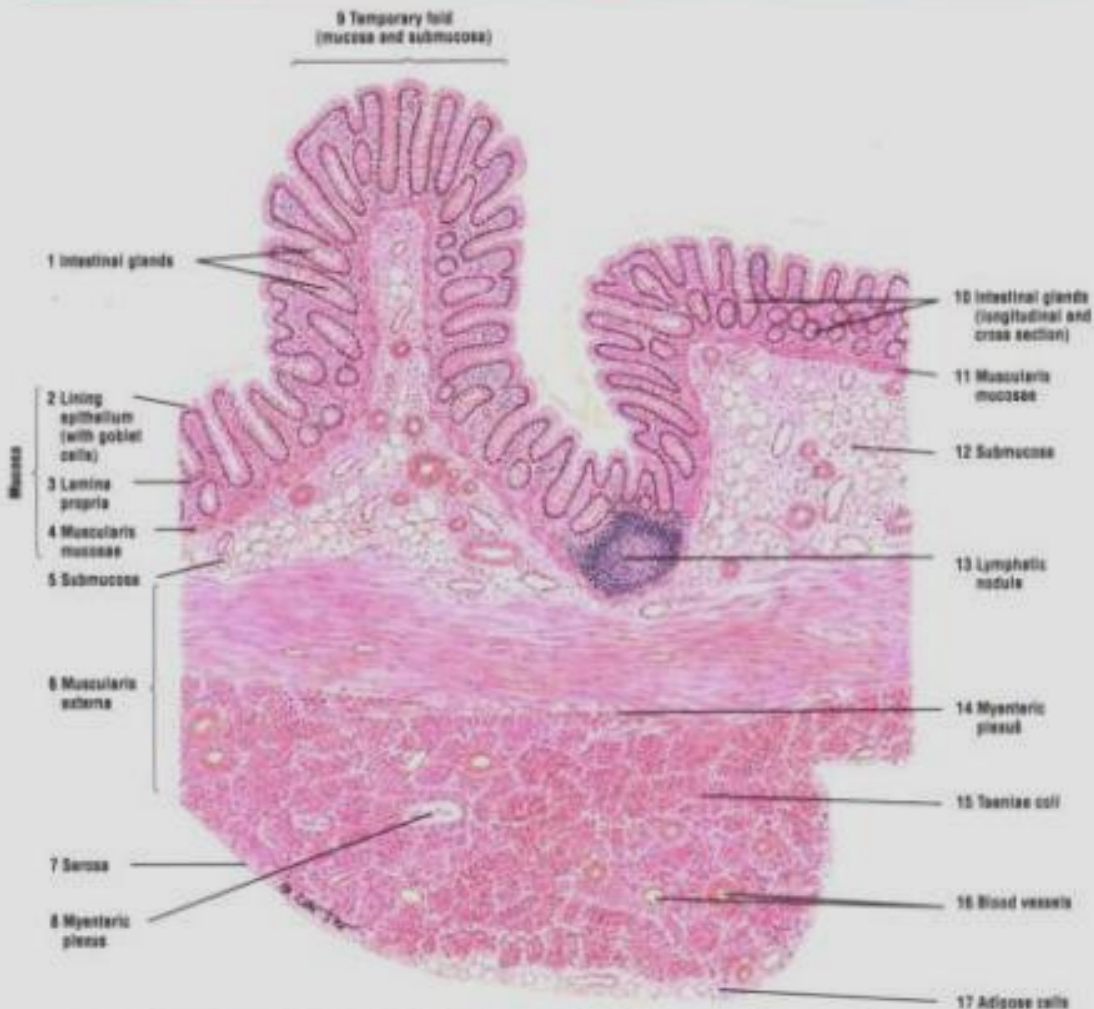


Fig. 12-7 Large Intestine: Colon Wall (transverse section). Stain: hematoxylin-eosin. Medium magnification.

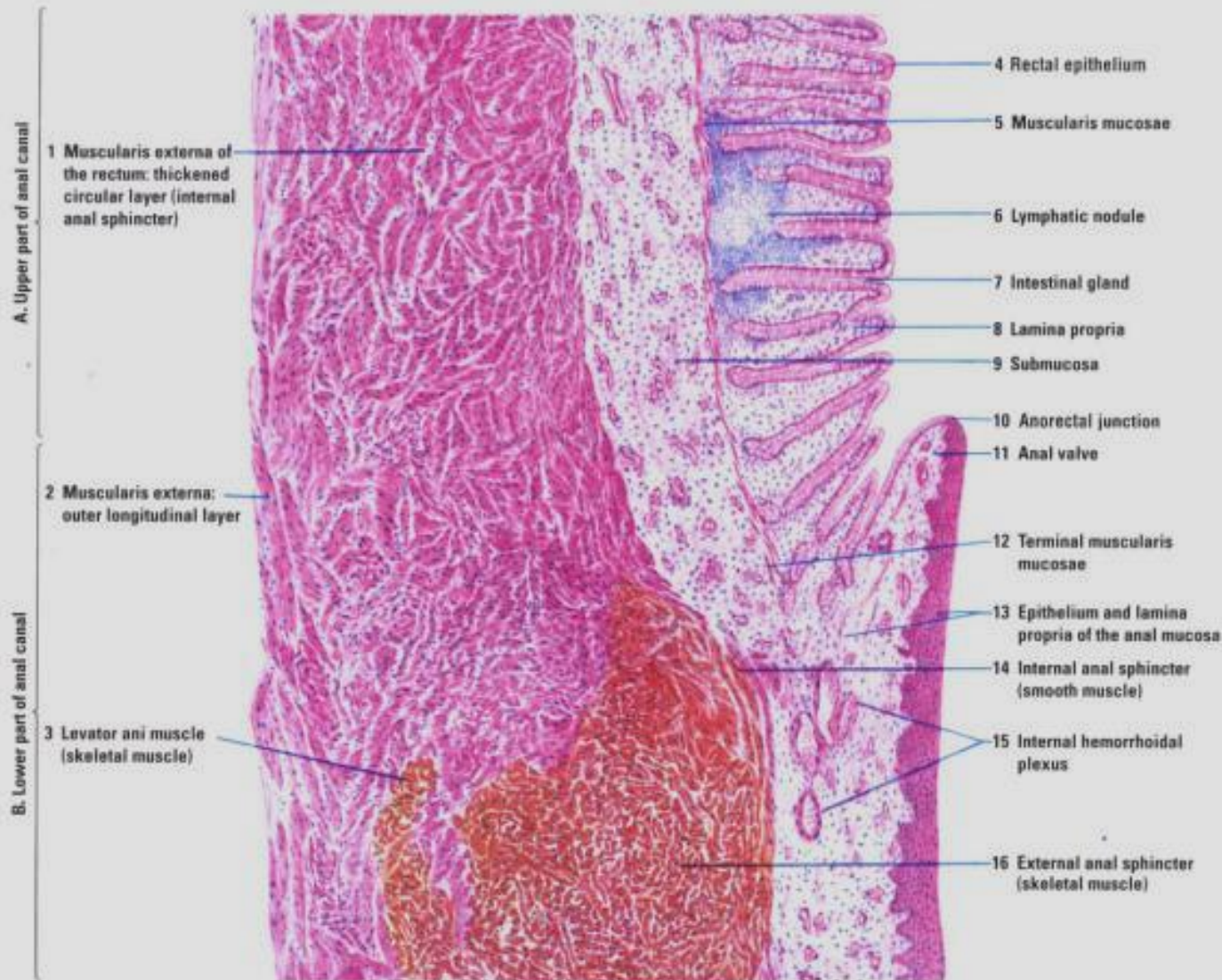
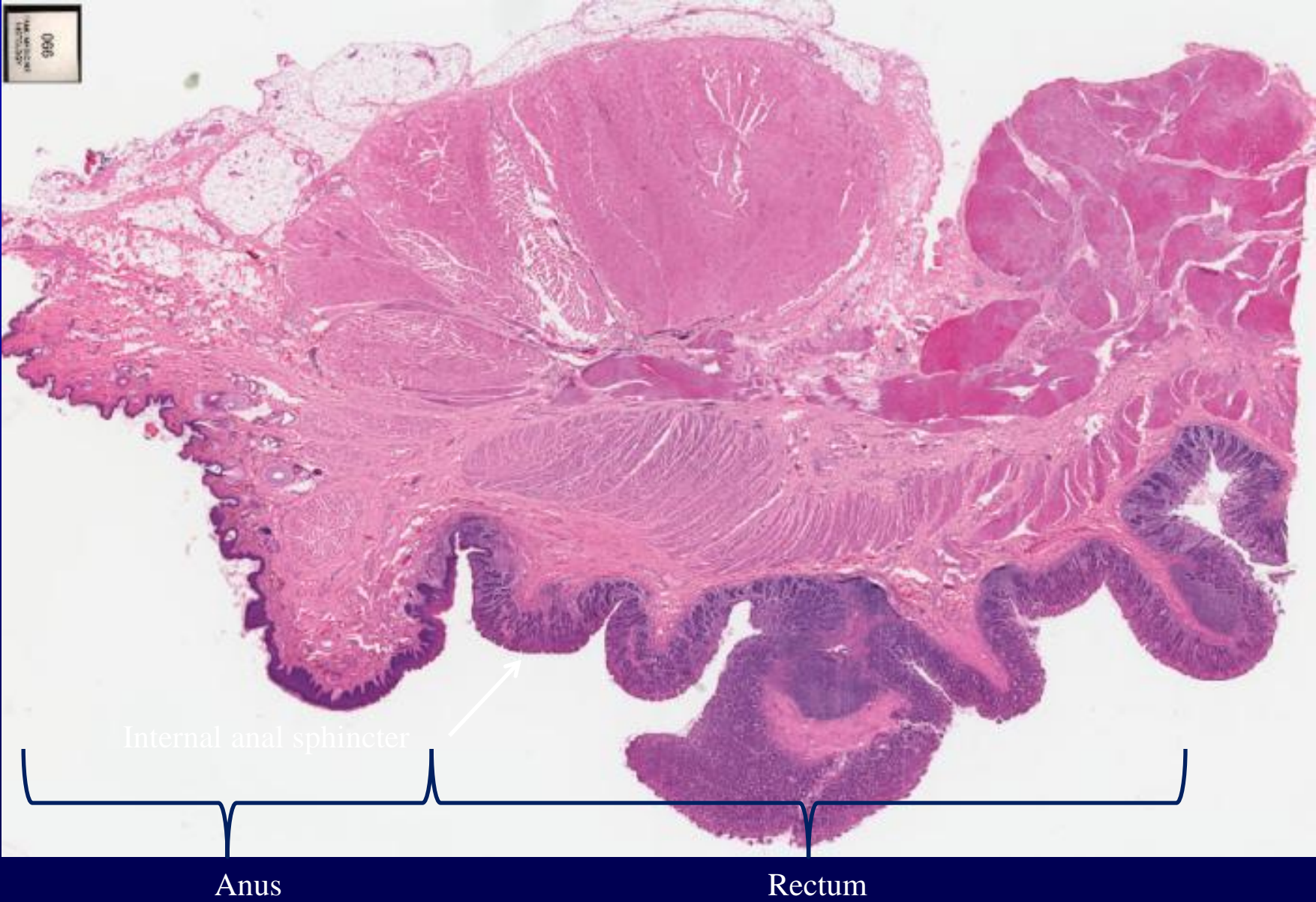
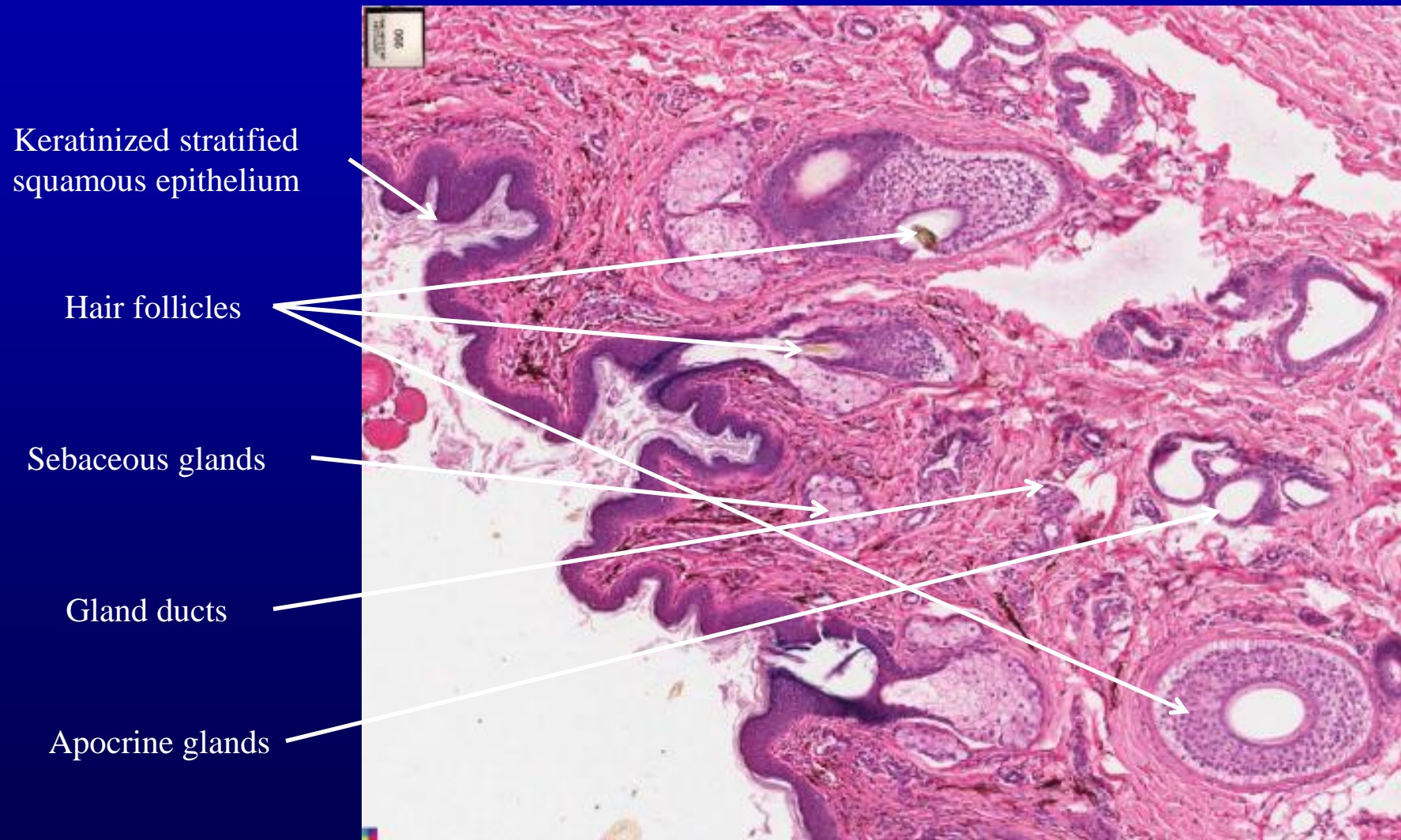


Fig. 12-10 Anal Canal (longitudinal section). Stain: hematoxylin-eosin. Low magnification.

Slide 66: Recto-anal junction



Slide 66: Recto-anal junction



Anus

Large intestines

Anal skin



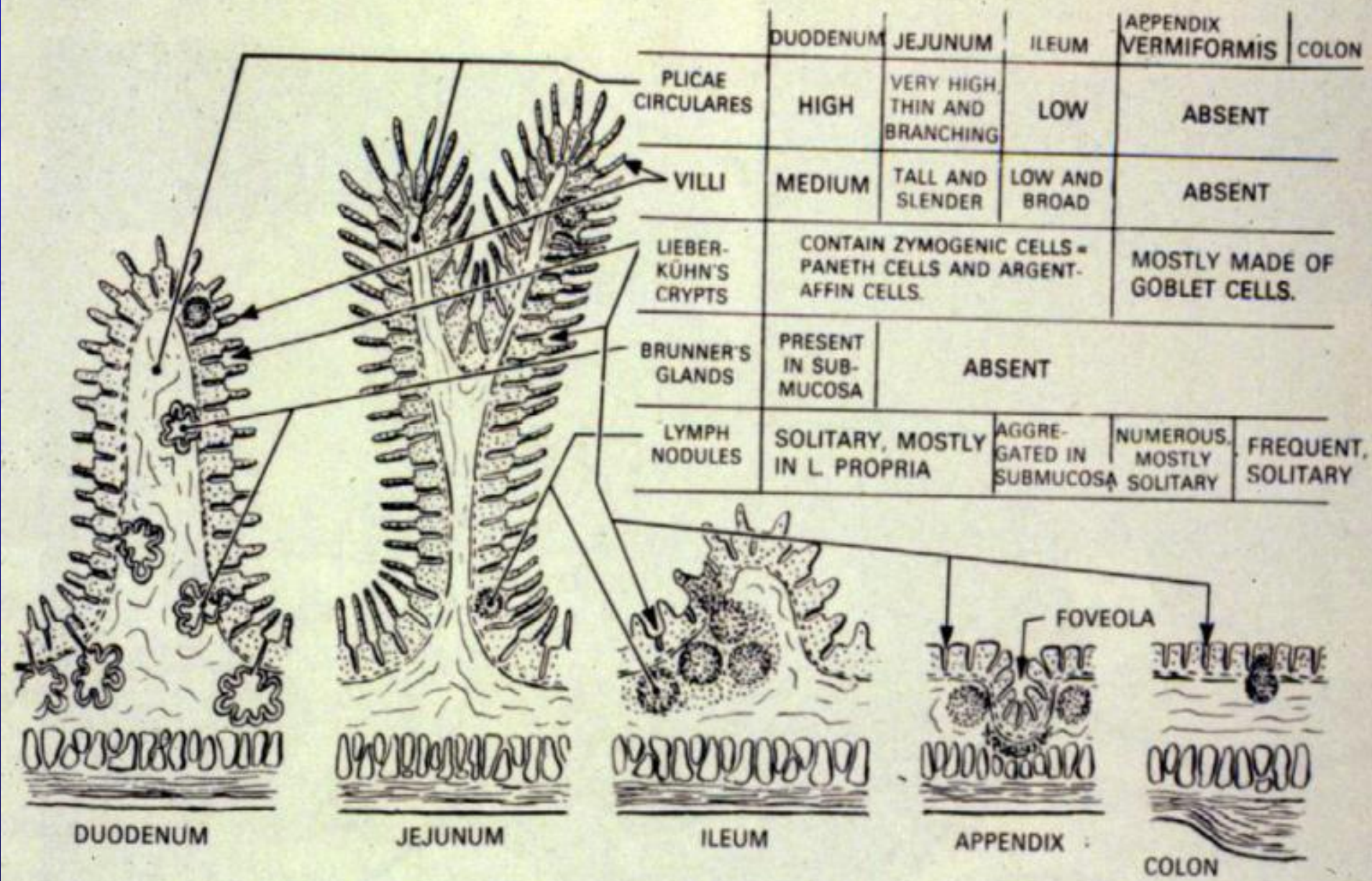


Fig. 12-70. Synopsis of the intestine.

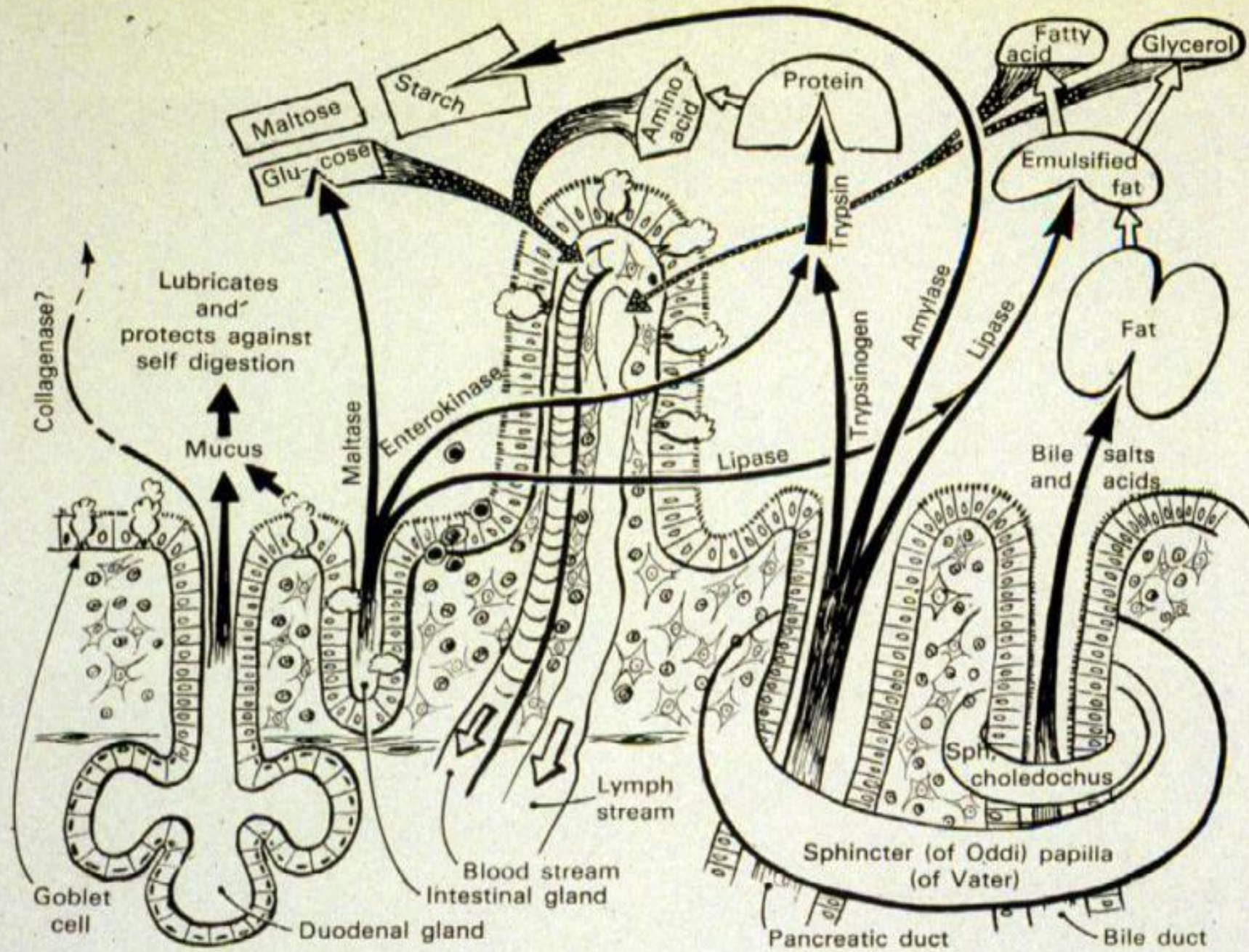


Fig 12-49. Diagram of intestinal functions.

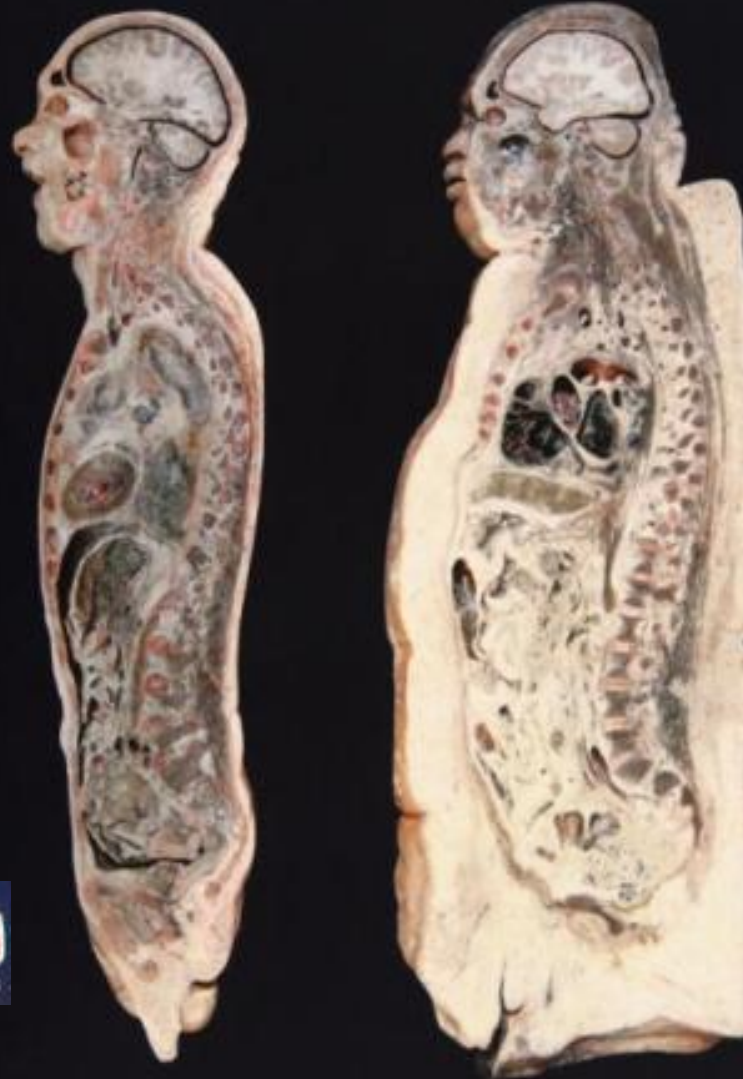
Many illustrations in these VIBS Histology YouTube videos were modified from the following books and sources: Many thanks to original sources!

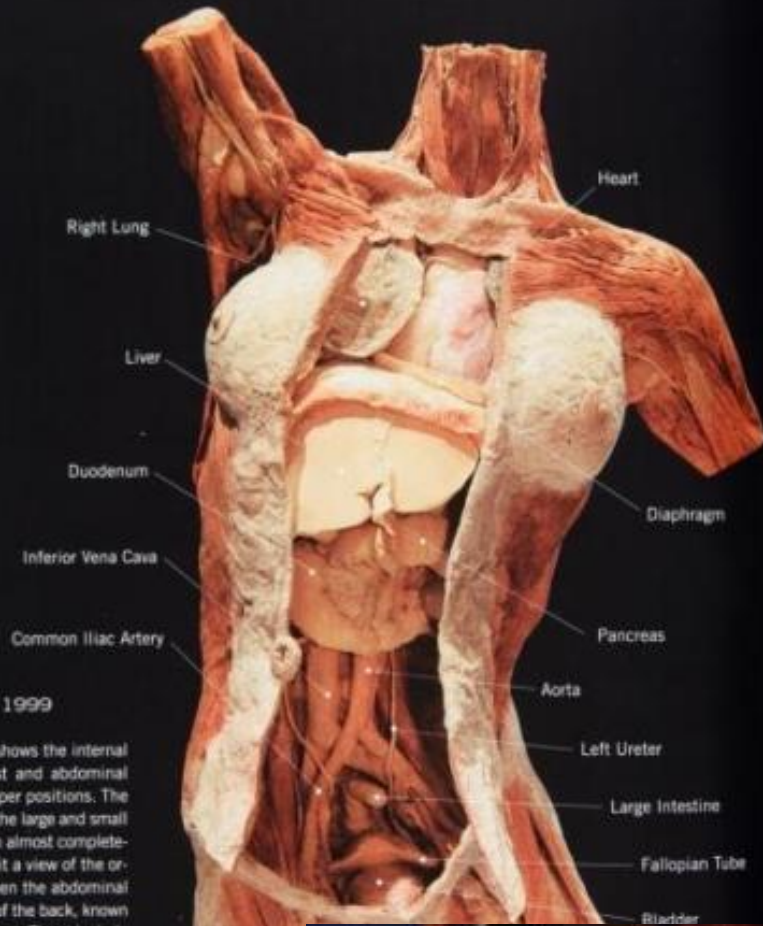
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- Leon Weiss and Roy O. Greep. 1977. Histology. McGraw-Hill Book Company, New York, NY.
- Nature (<http://www.nature.com>), Vol. 414:88,2001.
- A.L. Mescher 2013 Junqueira's Basis Histology text and atlas, 13th ed. McGraw
- Internet images and videos on biological presentations



Obesity Revealed, 2005

These specimens are the first of their kind. Due to a breakthrough in polymer technology for plastination, it is now possible to preserve fat tissue in its natural white color. Comparing the sagittally cut slices of an obese person (300 pounds) to those of a slim one (120 pounds) shockingly reveals the burden that the inner organs endured during this person's shortened life. As obvious from the enlarged heart and supported by his clinical data, the heart was finally not able to supply the body with uninterrupted blood flow. The person died of a malfunction in his heart at the age of about 50.

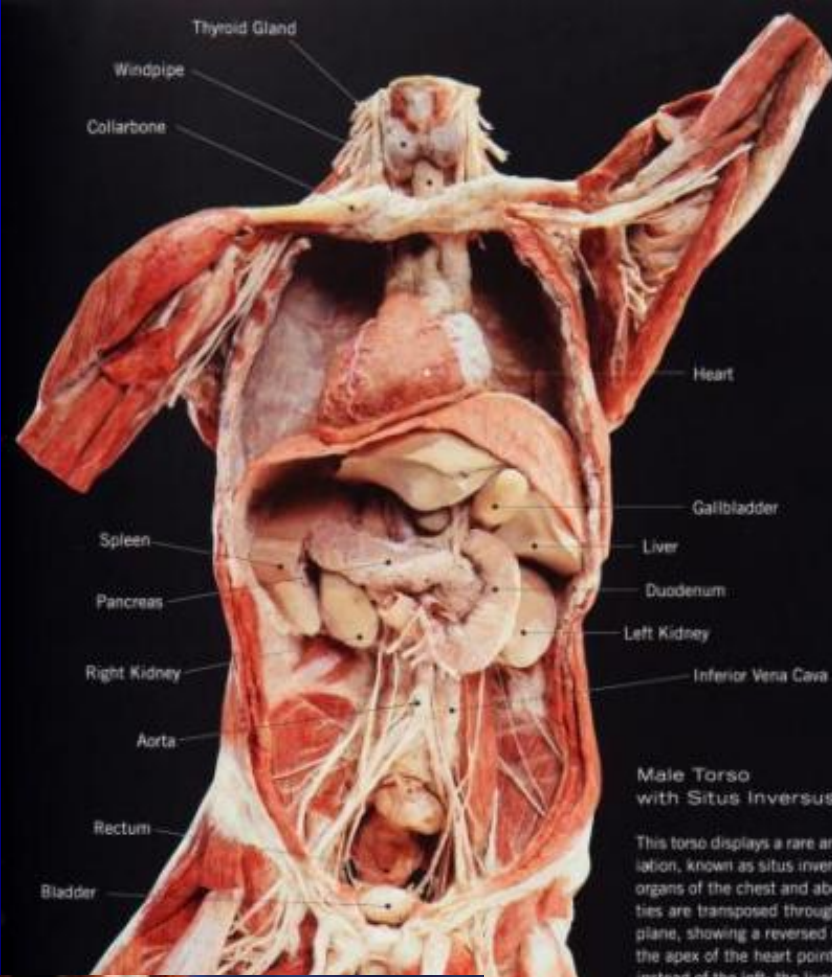




Female Torso, 1999

This opened torso shows the internal organs of the chest and abdominal cavities in their proper positions. The stomach as well as the large and small intestines have been almost completely removed to permit a view of the organs located between the abdominal cavity and the wall of the back, known as the retroperitoneum. These include the ureters, the aorta and the lower vena cava as well as the pancreas and the duodenum. In the small pelvic cavity, the bladder can be seen, and behind it, the uterus, which is inclined forward with the fallopian tubes emerging from the sides. The large intestine extends downward behind the uterus.

Ab



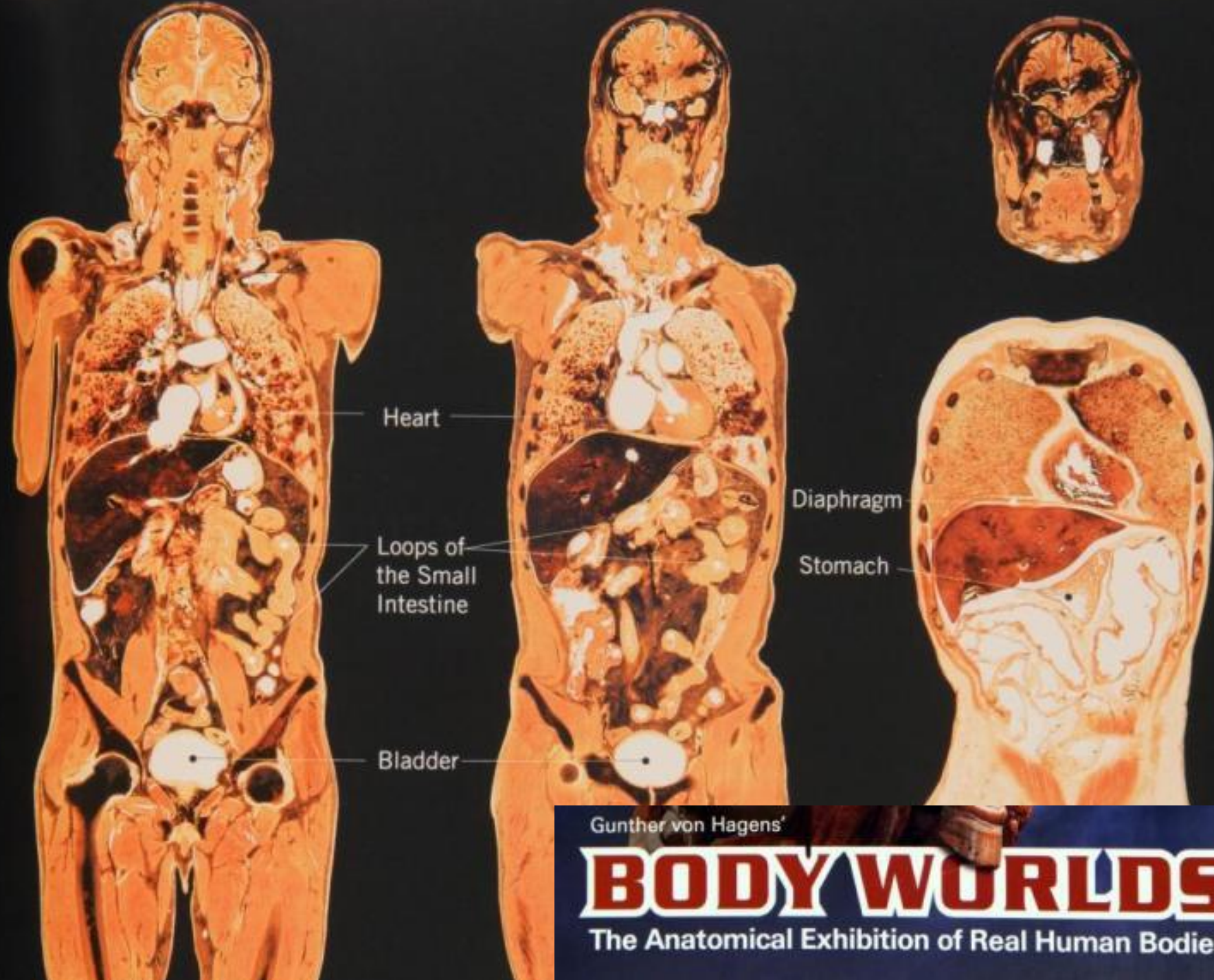
Male Torso with Situs Inversus, 1999

This torso displays a rare anatomical variation, known as situs inversus. Here the organs of the chest and abdominal cavities are transposed through the sagittal plane, showing a reversed mirror-image: the apex of the heart points to the right instead of the left; the liver is on the left side of the body while the spleen is on the right; and the pancreas extends from left to right across the spinal column instead of vice versa. This anatomical variation does not cause any disorders. The incidence of this phenomenon is approximately 1 in 25,000. The bladder can be seen in front of the rectum in the small pelvic cavity.

Gunther von Hagens'

BODY WORLDS

The Anatomical Exhibition of Real Human Bodies



Gunther von Hagens'

BODY WORLDS

The Anatomical Exhibition of Real Human Bodies

Next time

Liver, Gallbladder, Pancreas, and Salivary Glands

