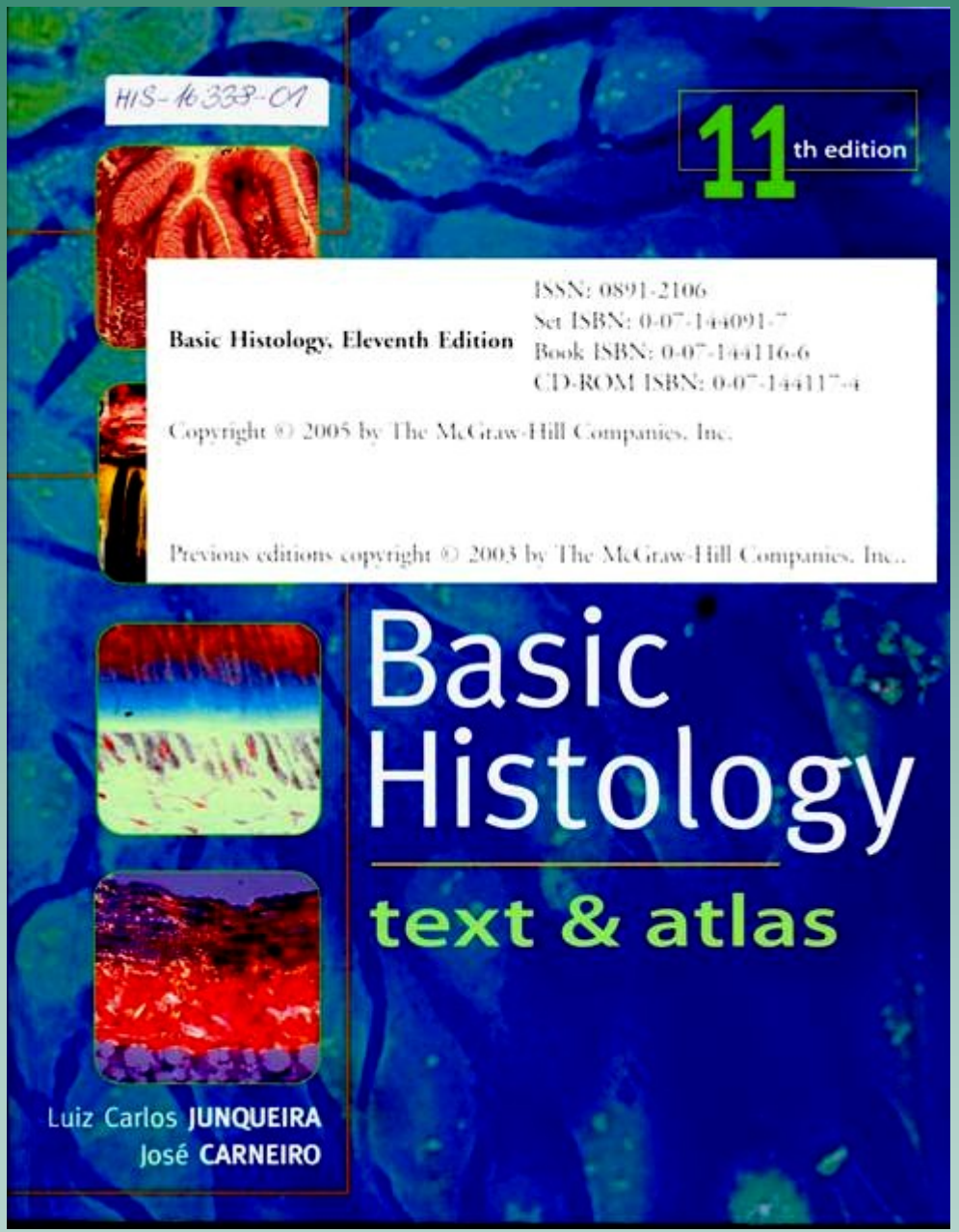
Lectures:
Po/Monday
9:00 – 10:40 A11 Room 234

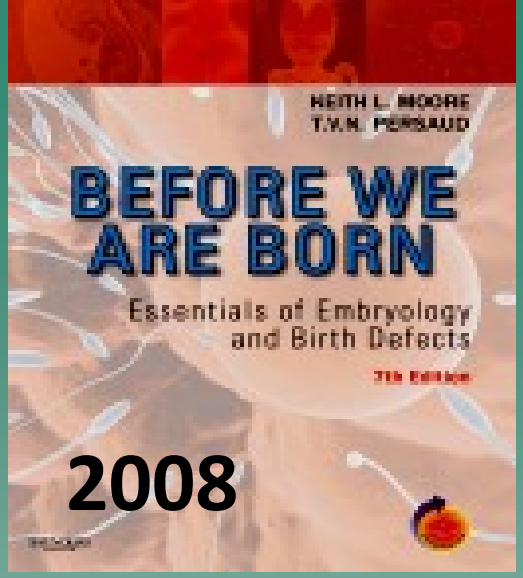
Practicals:
Út/Tuesday
10:30 – 13:00 Microscopic hall of the Dept.
30 31 32 33

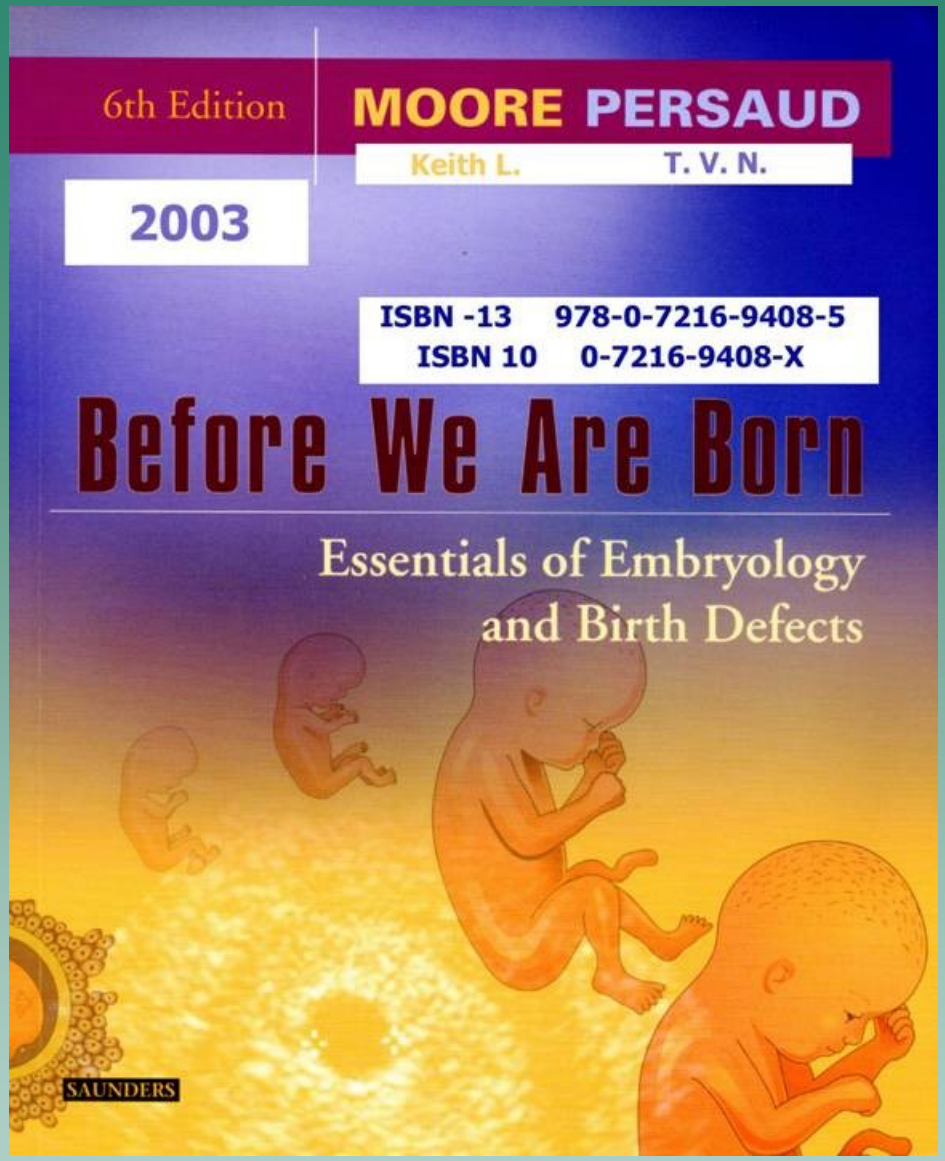
Recommended web-address:
http://www.med.muni.cz/histol/vyukac.htm

Literature for study:

Basic Histology
The Developing Human







ISBN: 978-1-4160-3705-7

Before We Are Born, 7th Edition - ***Essentials of Embryology and Birth Defects With STUDENT CONSULT Online Access***

By Keith L. Moore, BA, MSc, PhD, FIAC, FRSM and T. V. N. Persaud, MD, PhD, DSc, FRC Path(Lond)

368 pages 1308 ills

($54.95, Softcover)

Lecture 1 ESS_3rd semester

Outline of development of the digestive system – a revision

GENERAL STRUCTURE OF THE ALIMENTARY CANAL

(MICROSCOPIC STRUCTURE OF THE ORAL MUCOSA)

MICROSCOPIC STRUCTURE OF THE ESOPHAGUS, STOMACH, AND SMALL AND LARGE INTESTINE

HISTOPHYSIOLOGY OF THE INTESTINE AND BLOOD CIRCULATION

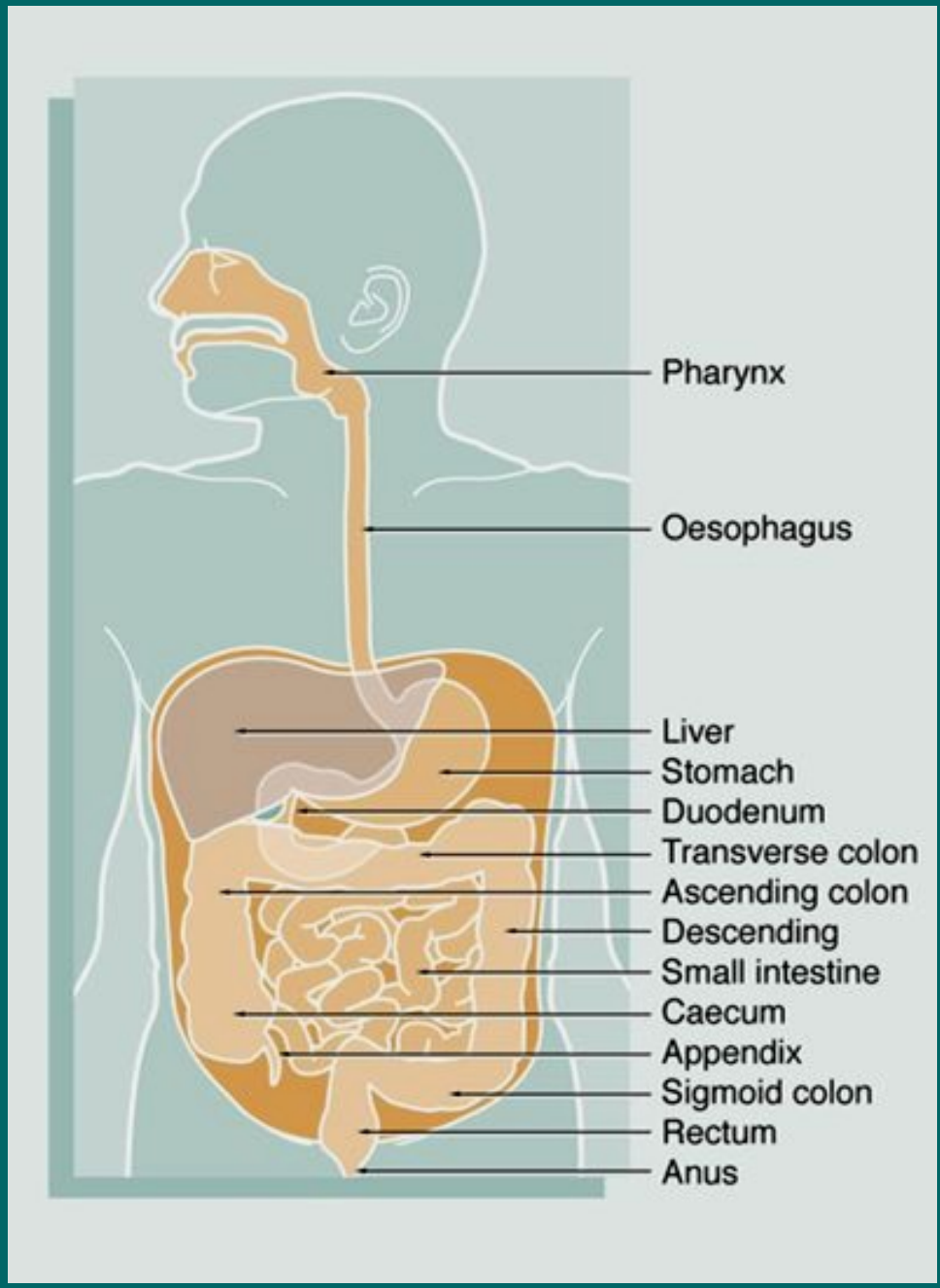
Digestive system consists of

- the **alimentary canal** - oral cavity, oropharynx, esophagus, stomach, small and large intestines, rectum and anus

- **associated glands** - salivary glands, liver and pancreas

function is to obtain from ingested food the metabolites necessary for the growth and energy needs of the body

food is digested and transformed into small molecules that can be easily absorbed through the lining of alimentary canal



Outline of development of the digestive system

Development of the alimentary canal:

it constitutes during the 4th week from 3 separate embryonic anlages (organs):

the stomodeum (primitive mouth) – develops on the cephalic end of the embryo, is limited by 5 frominences (frontonasal, 2 maxillary, 2 mandibular) - **ectoderm**

oropharyngeal membrane

the primitive gut – arises by incorporation of the dorsal part of the yolk sac into embryo during cephalocaudal and lateral folding of the embryo gut is connected to the yolk sac by means of the vitelline (omphalomesenteric) duct - **endoderm**

cloacal membrane

the proctodeum (anal pit) - develops on the caudal end of the embryo between future bases of lower limbs - **ectoderm**

stomodeum

oropharyngeal membrane

primitive gut

foregut

midgut

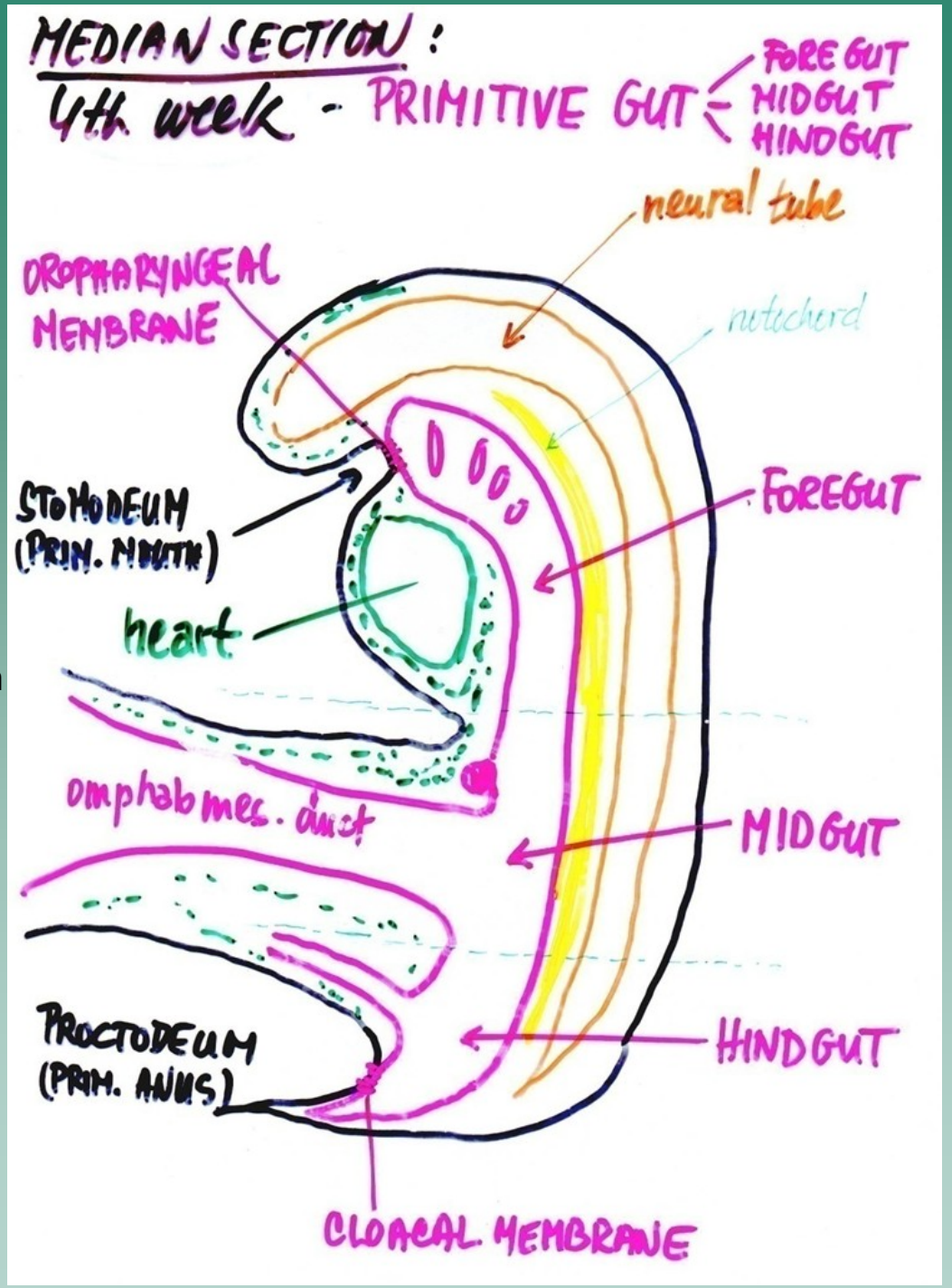
ventral mesenterium

dorsal mesenterium

hindgut

cloacal membrane

proctodeum



membranes are temporary structures and soon are ruptured – all three segments become continuos

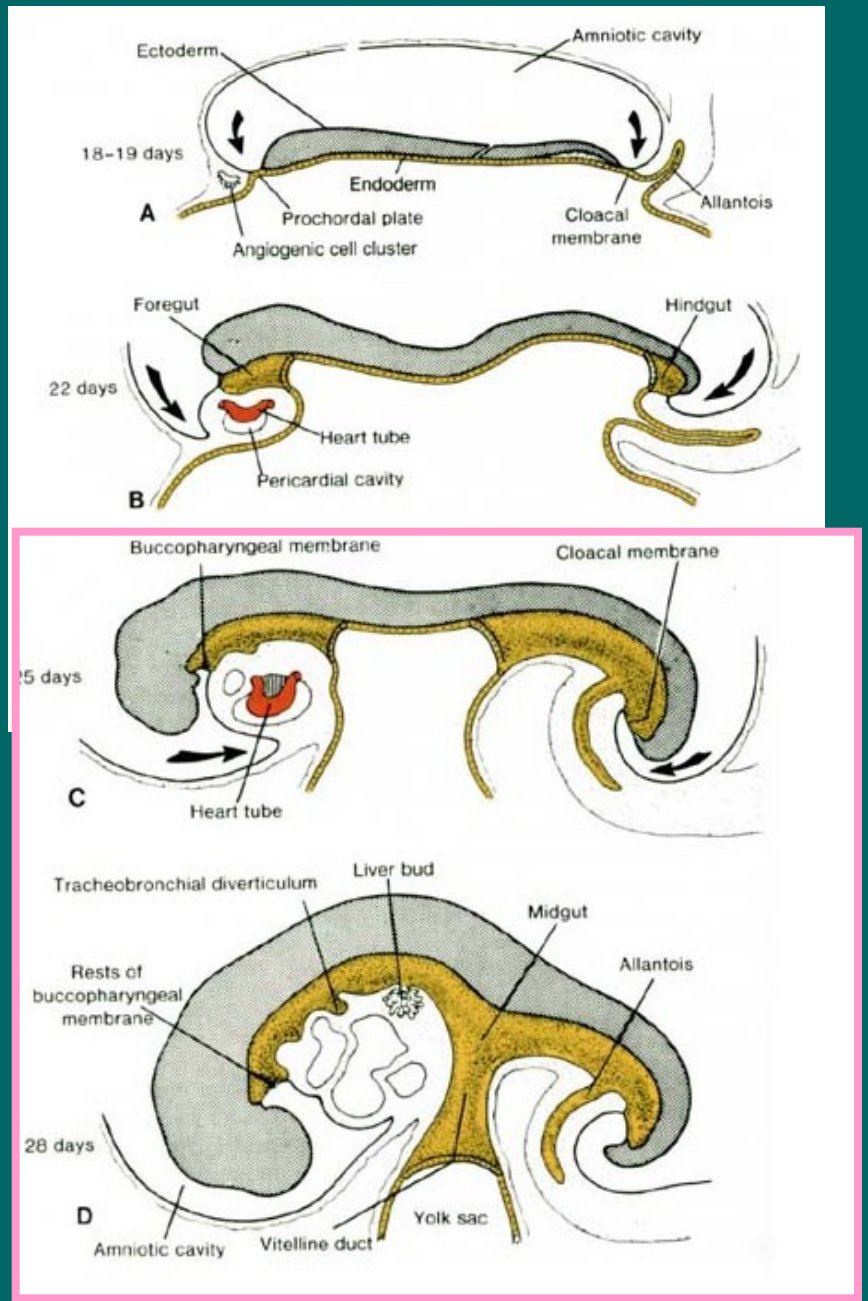
Segments of the primitive gut:

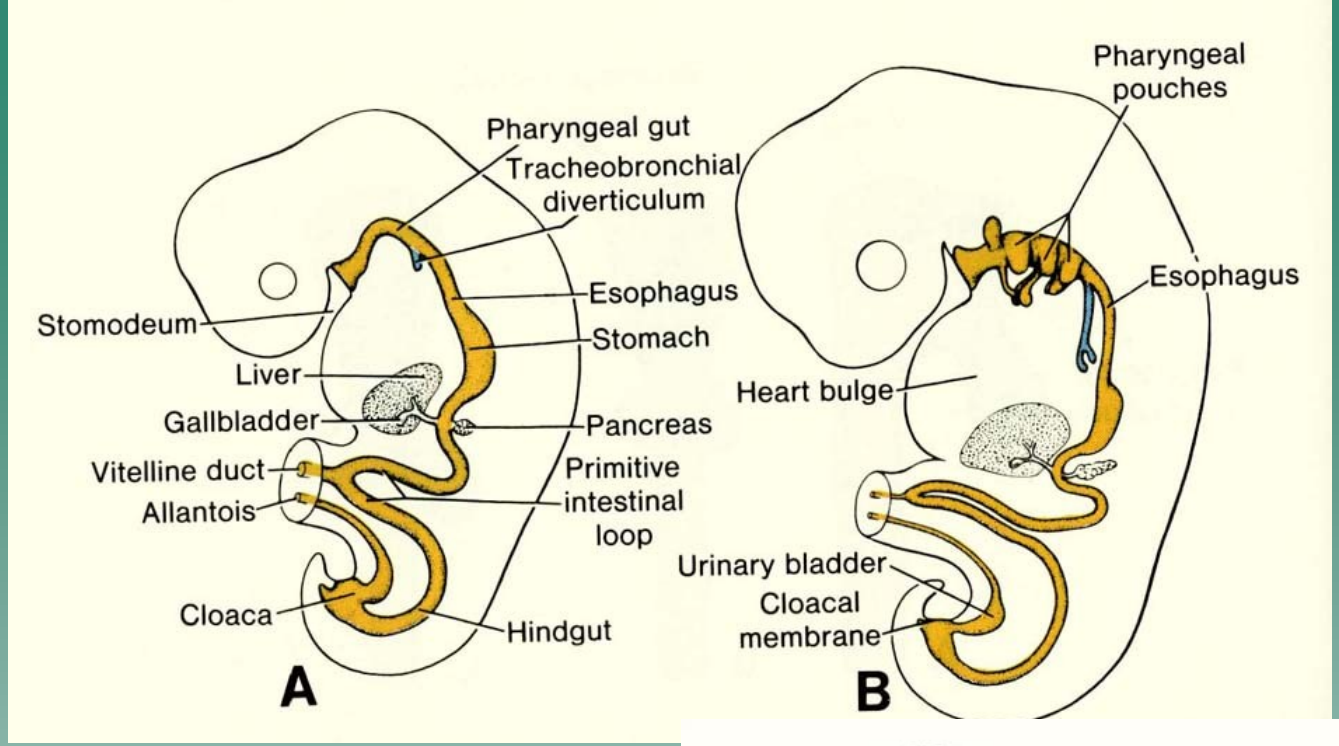
- **foregut**
  - **midgut**
  - **hindgut**

gut is suspended from the ventral and dorsal body wall by **mesenteries**

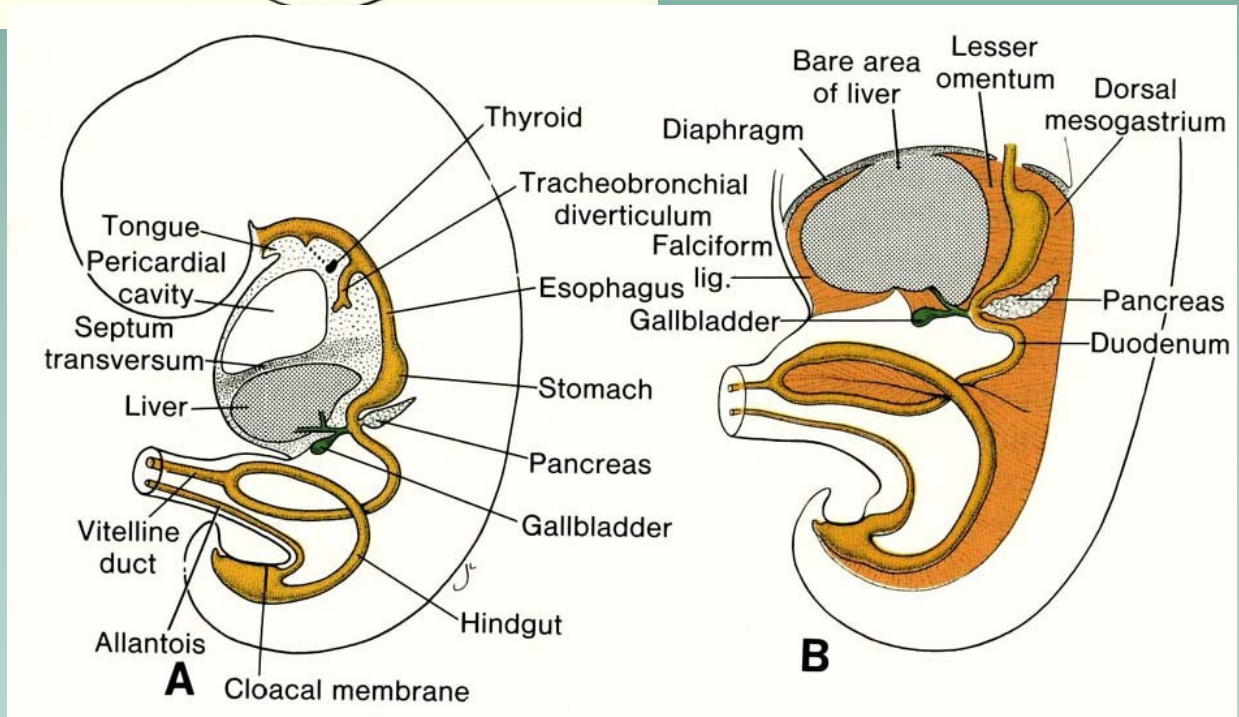
the dorsal mesentery – caudal end foregut – hindgut
the ventral mesentery – shorter

during further development midgut rapidly grows in length to form 2 loops (duodenal and umbilical), rotates and leaves even the abdominal cavity (physiological herniation)





after reposition of the herniation midgut occupies its defenitive position



while the ectoderm of the stomodeum and proctodeum as well as the endoderm of the gut differentiate into the epithelium of the alimentary canal,

the muscular and fibrous elements + visceral peritoneum derive from the splanchnic mesenchyma that surrounds the lining of the primitive gut

Development of associated glands:
(salivary glands, liver and pancreas)

develop from the endoderm (ectoderm) that gives rise to specific cells (hepatocytes, exo- and endocrine cells of the pancreas (**the parenchyma**)

DERIVATIVES OF THE PRIMITIVE GUT

The foregut:

- the pharynx and branchiogenic organs
- the lower respiratory tract
- the esophagus
- the stomach
- the duodenum proximal to the opening of the bile duct
- the liver and pancreas + the biliary apparatus

The midgut:

- the small intestines, including the part of the duodenum distal to the opening of the bile duct
- the caecum and appendix
- the ascending colon
- the transverse colon

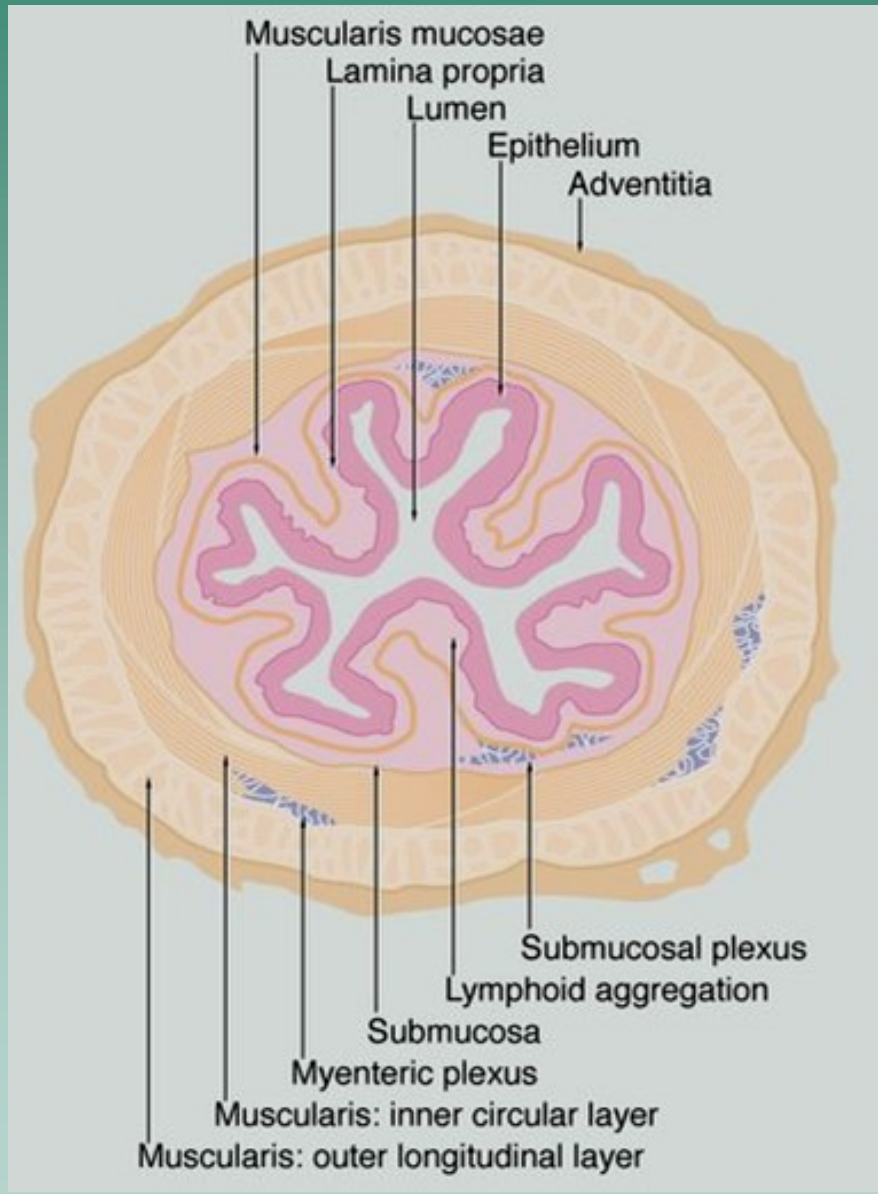
The hindgut:

- the descending colon
- the sigmoid colon
- the rectum
- the superior portion of the anal canal
- the epithelium of the urinary bladder and most of the urethra

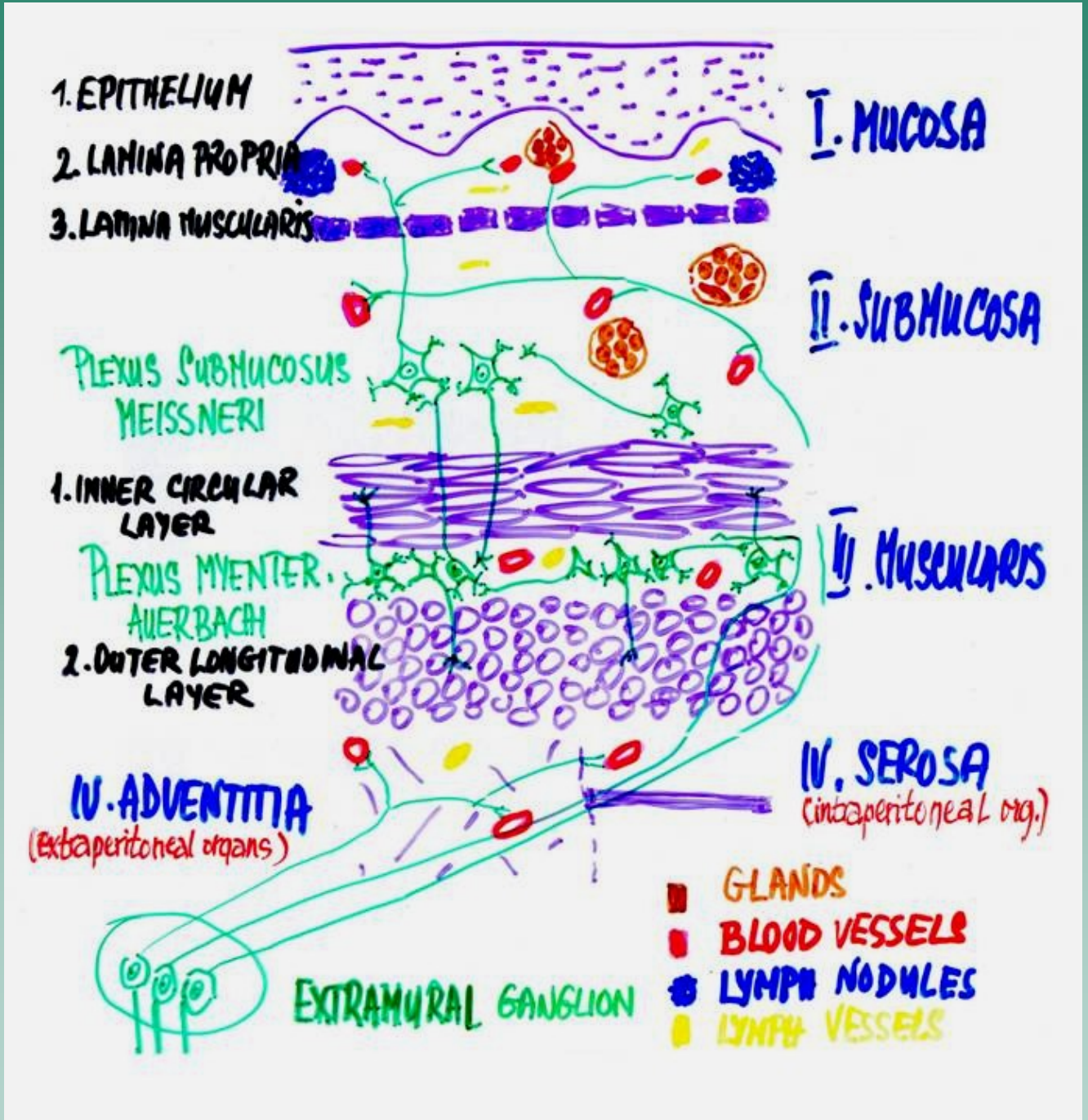
General structure of the definitive alimentary canal

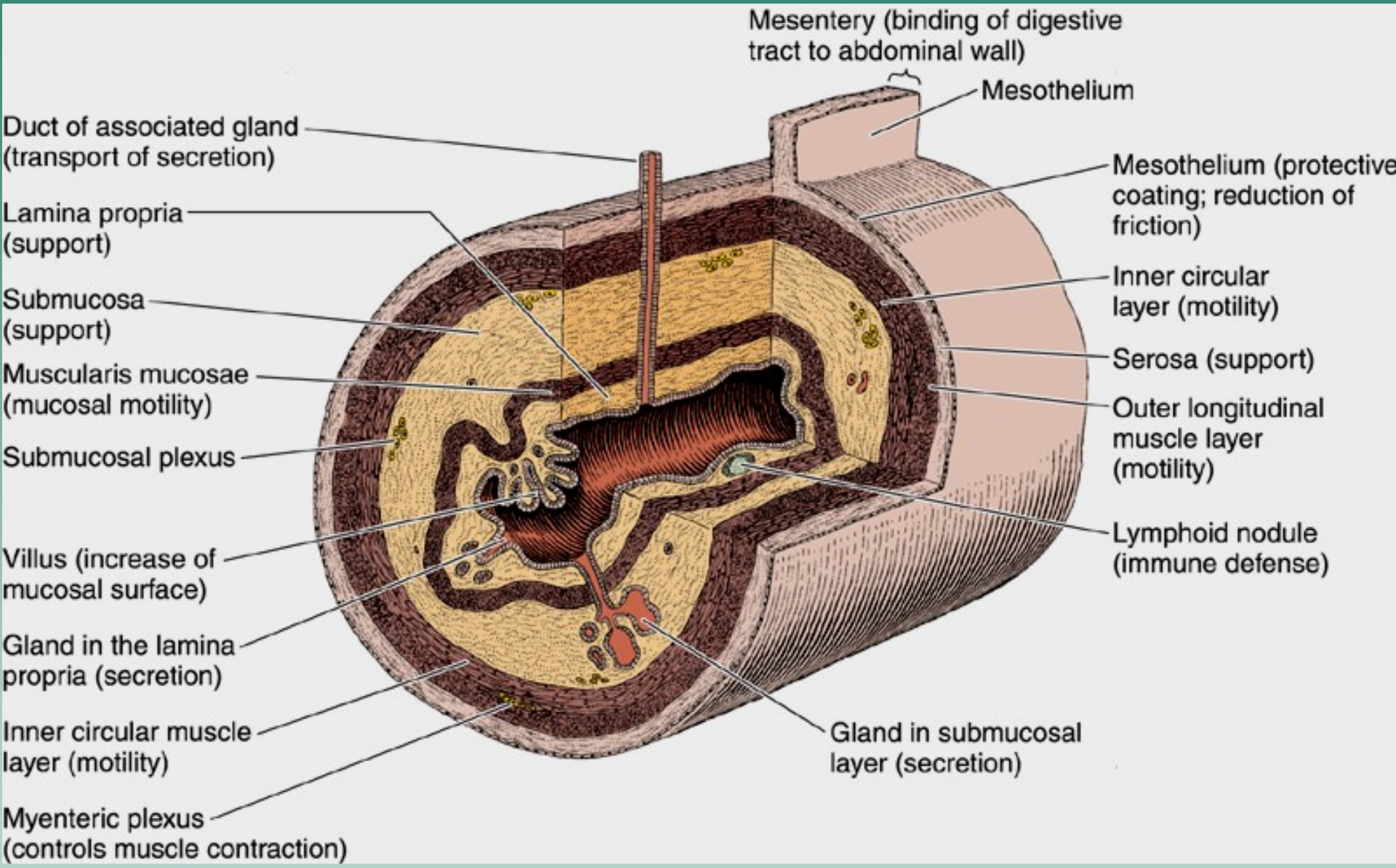
Layers of the wall of the alimentary canal:

- **mucous coat - tunica mucosa**
- **submucous coat - tela submucosa**
- **muscular coat - tunica muscularis**
- **serous coat (tunica serosa) or adventitia (tunica adventitia)**



Sublayers :


1. EPITHELIUM
2. LAMINA PROPRIA
3. LAMINA MUSCULARIS
I. MUCOSA
II. SUBMUCOSA
PLEXUS SUBMUCOSUS MEISSNERI
1. INNER CIRCULAR LAYER
PLEXUS MYENTER. AUERBACH
2. OUTER LONGITUDINAL LAYER
III. MUSCULARIS
IV. SEROSA
(intraperitoneal org.)
IV. ADVENTITIA
(extraperitoneal organs)
EXTRAMURAL GANGLION
GLANDS
BLOOD VESSELS
LYMPH NODULES
LYMPH VESSELS


Mesentery (binding of digestive tract to abdominal wall)
Mesothelium
Duct of associated gland (transport of secretion)
Mesothelium (protective coating; reduction of friction)
Lamina propria (support)
Inner circular layer (motility)
Submucosa (support)
Serosa (support)
Muscularis mucosae (mucosal motility)
Outer longitudinal muscle layer (motility)
Submucosal plexus
Lymphoid nodule (immune defense)
Villus (increase of mucosal surface)
Gland in the lamina propria (secretion)
Inner circular muscle layer (motility)
Gland in submucosal layer (secretion)
Myenteric plexus (controls muscle contraction)

MICROSCOPIC STRUCTURE OF THE ESOPHAGUS, STOMACH, AND SMALL AND LARGE INTESTINE

HISTOPHYSIOLOGY OF THE INTESTINE AND BLOOD CIRCULATION

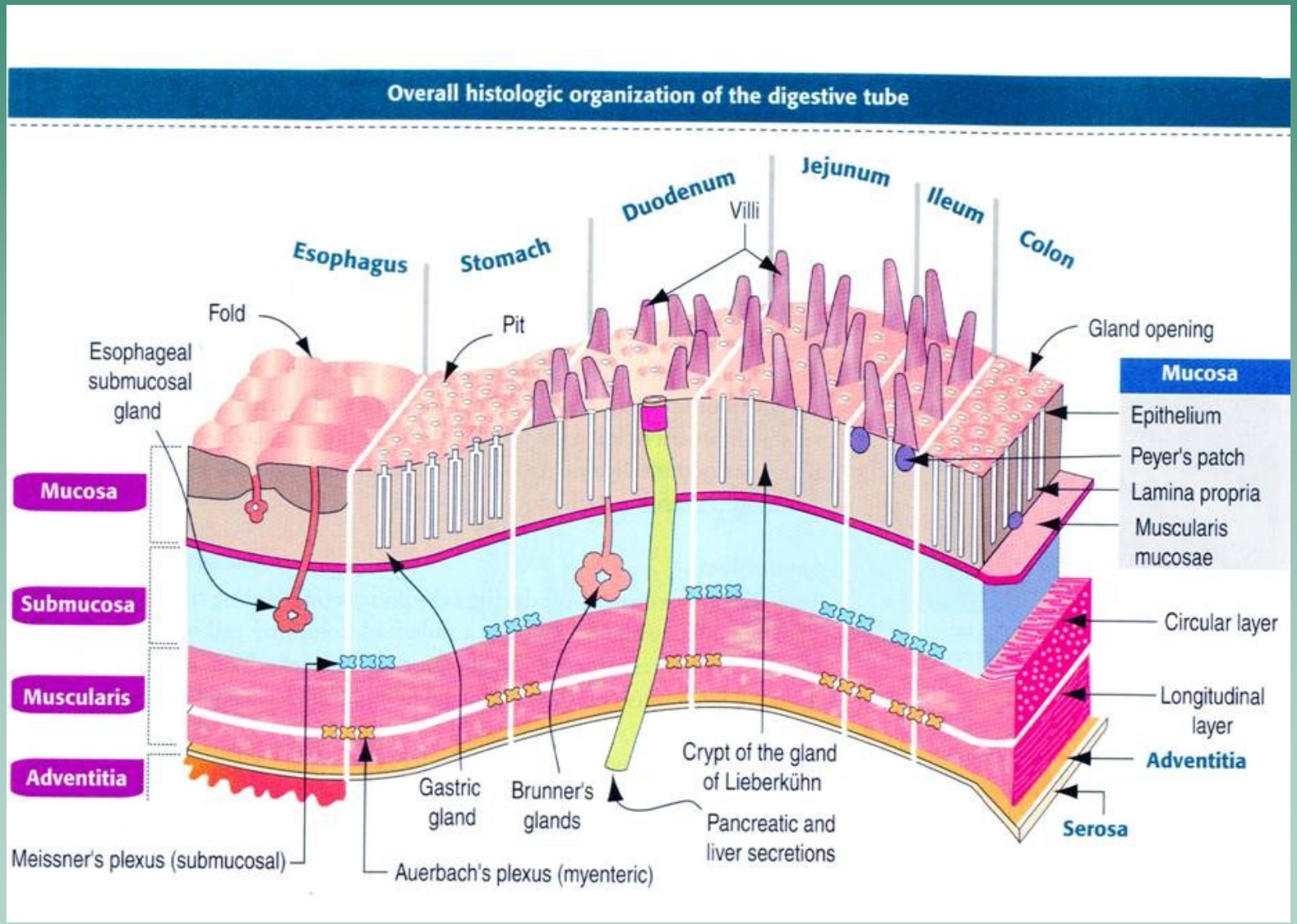
external appearance of the mucosa

shows close relation to function of the respective segment

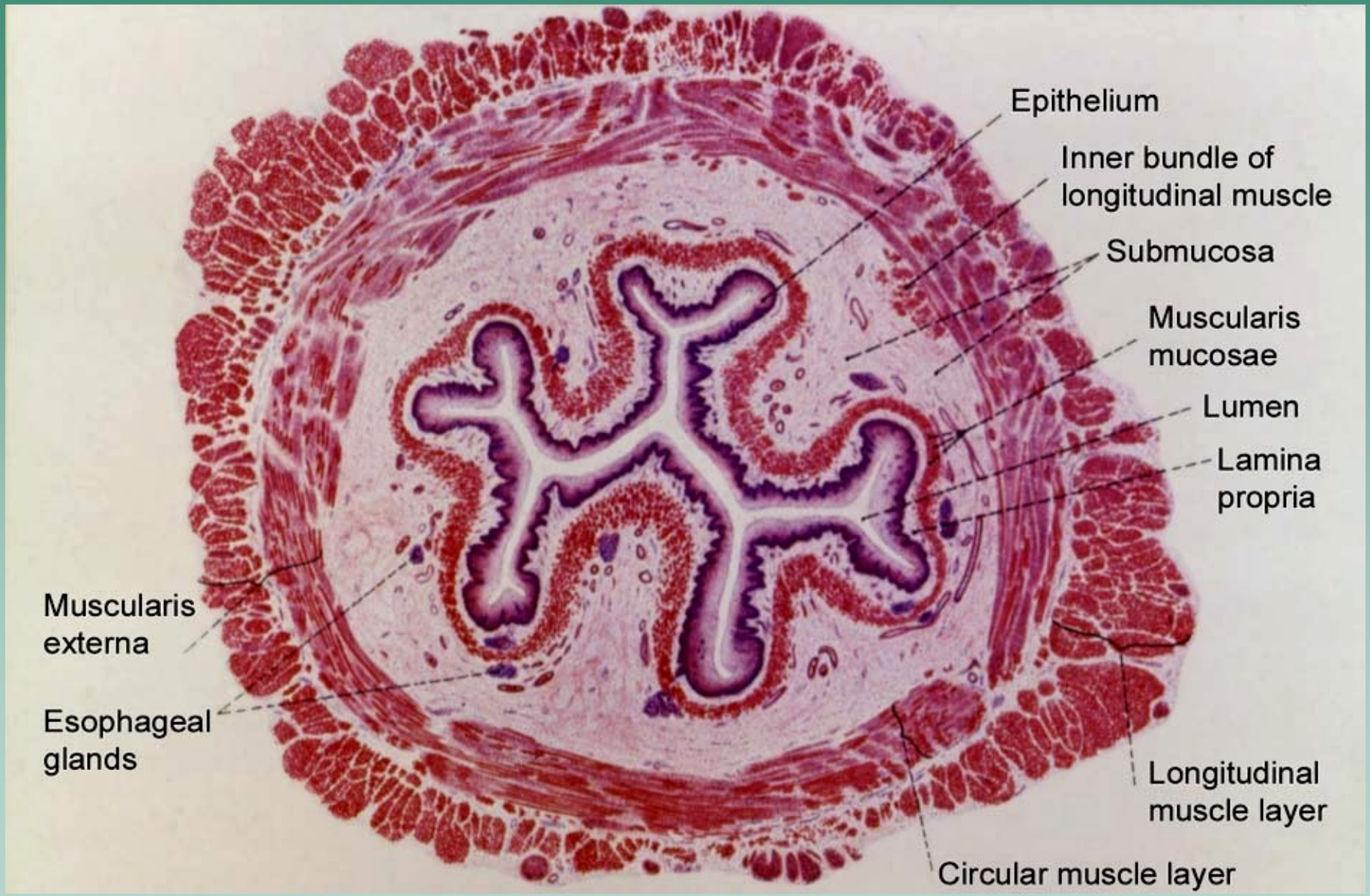
folds (transient or permanent)

pits – tubular invagination of the epithelium

villi – mucosal processes (epithelium and lamina propria)



Esophagus -20- 25 cm long muscular tube wall consists of 4 layers



Stomach (lat. ventriculus, gr. gaster, stomachus)

segment of alimentary canal that digests food and secretes hormones

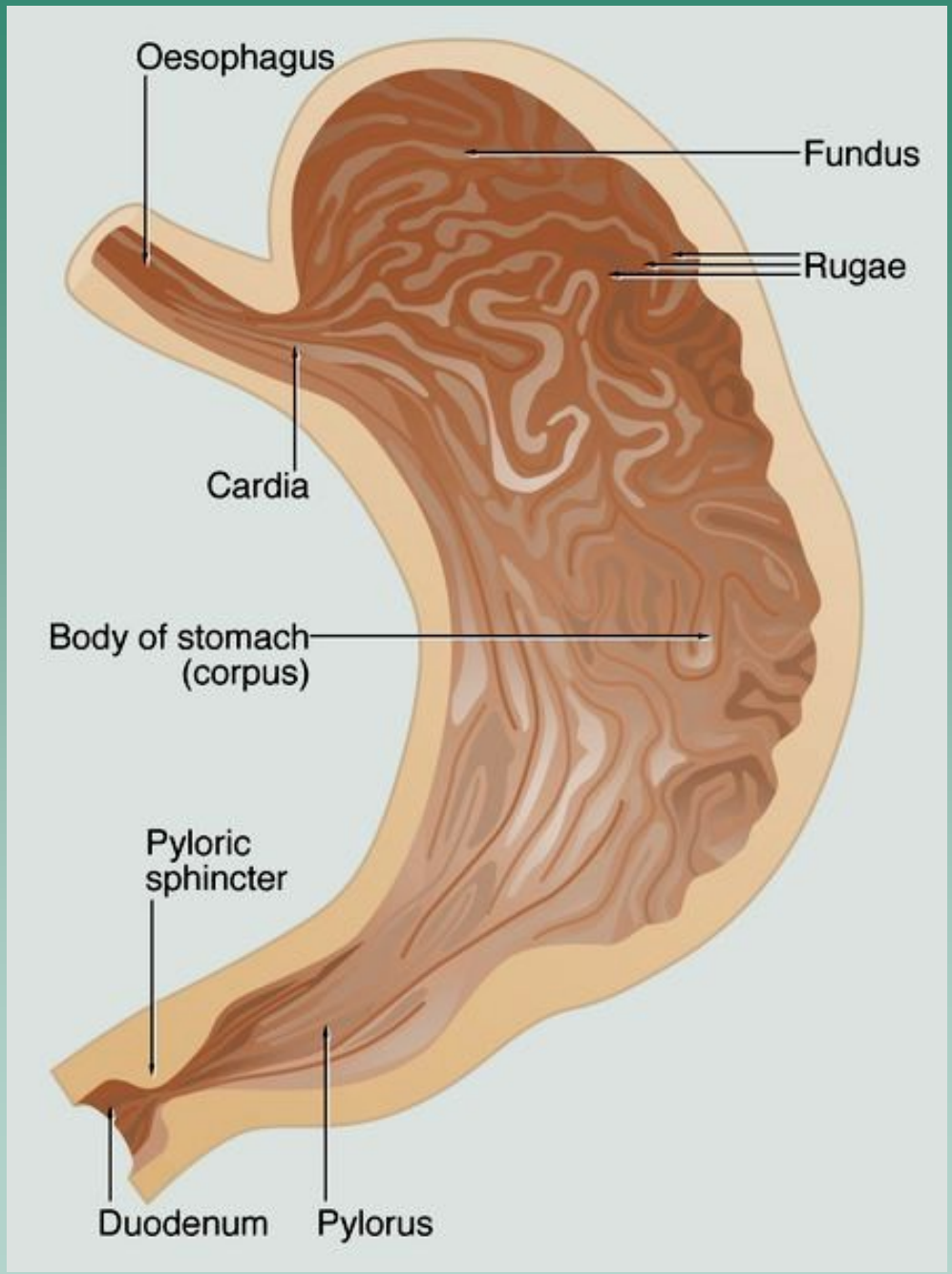
food mixed with gastric juice = chyme

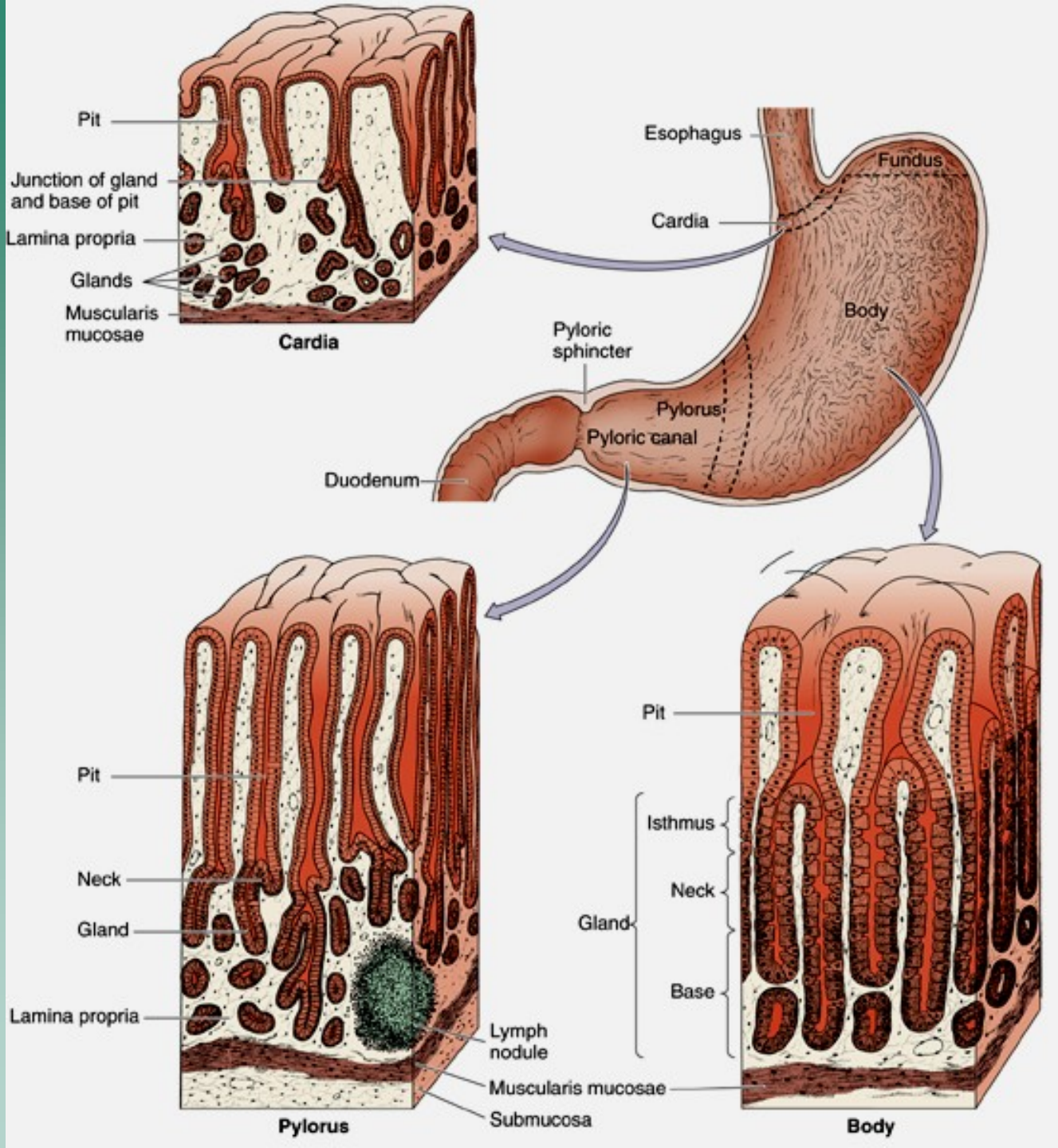
volume cca 2 l

cardia, fundus+body, pylorus

wall shows 4 layered organization:

1. **mucous coat** (pale, grayish pink)
   - **gastric areas** (2-6 mm in d.)
   - **gastric pits** (foveolae gastricae) - are tiny grooves
2. **submucous coat** - loose areolar tissue
3. **muscular coat** - inner oblique
   - middle circular
   - outer longitudunal
4. **serous coat** - peritoneal covering



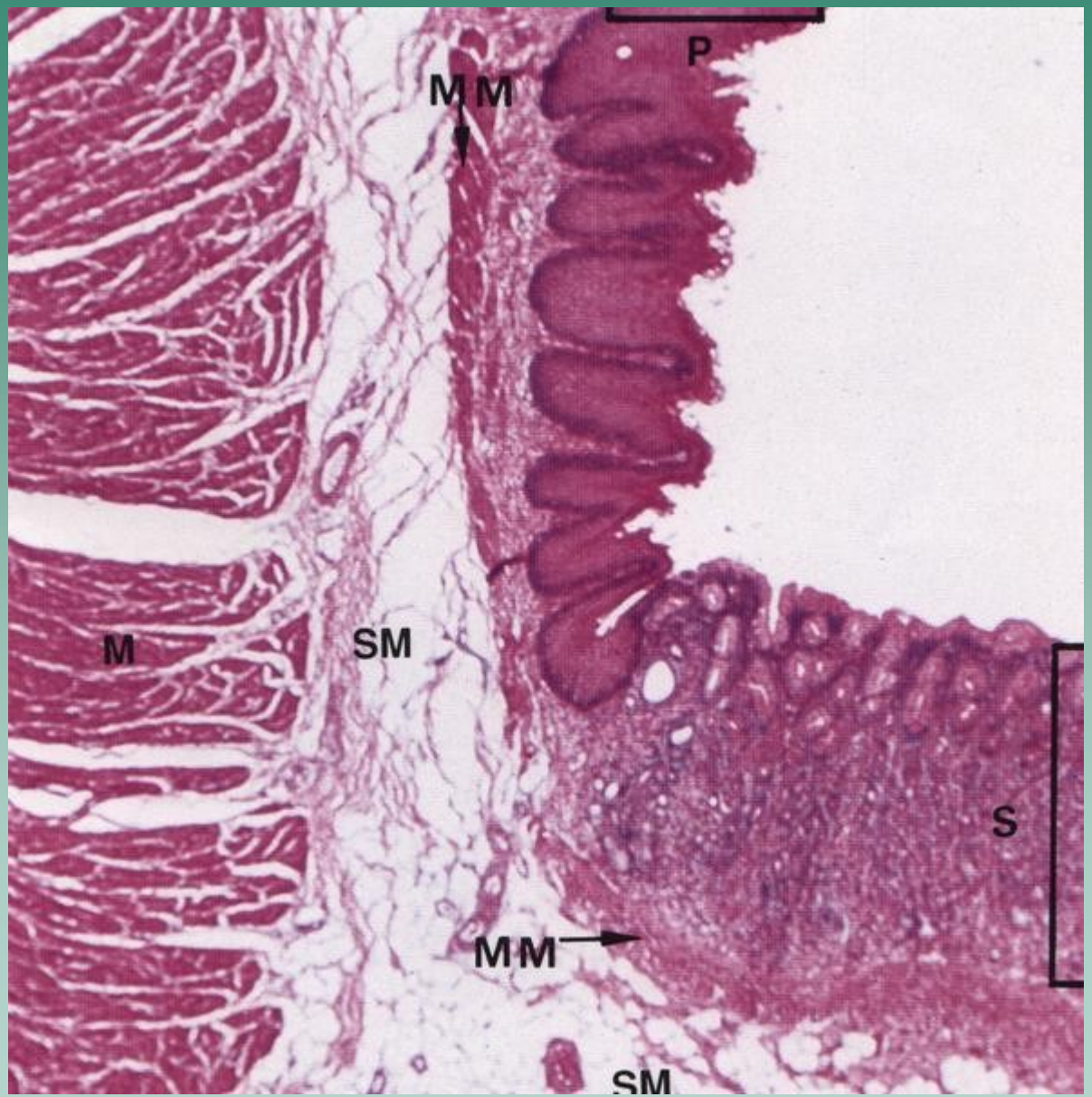

Pit
Junction of gland and base of pit
Lamina propria
Glands
Muscularis mucosae
Cardia
Esophagus
Fundus
Cardia
Body
Pyloric sphincter
Pylorus
Pyloric canal
Duodenum
Pit
Neck
Gland
Lamina propria
Lymph nodule
Muscularis mucosae
Submucosa
Pylorus
Pit
Isthmus
Neck
Gland
Base
Body

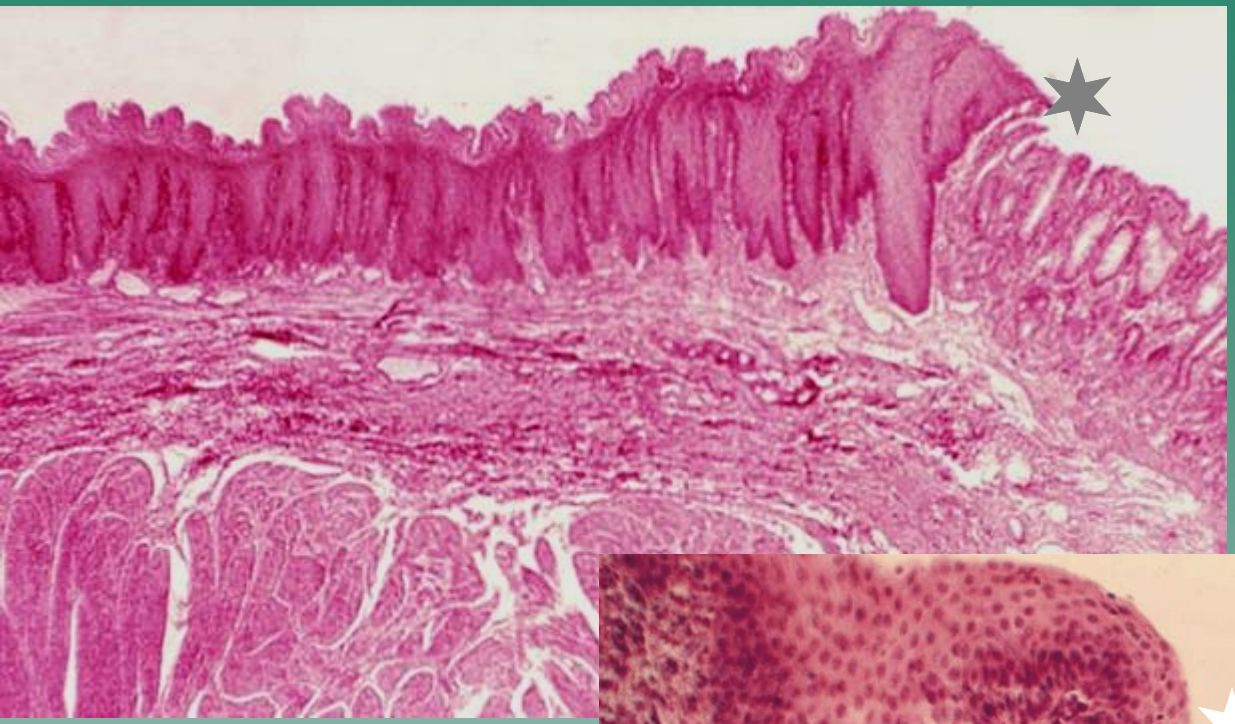
Cardia ventriculi:

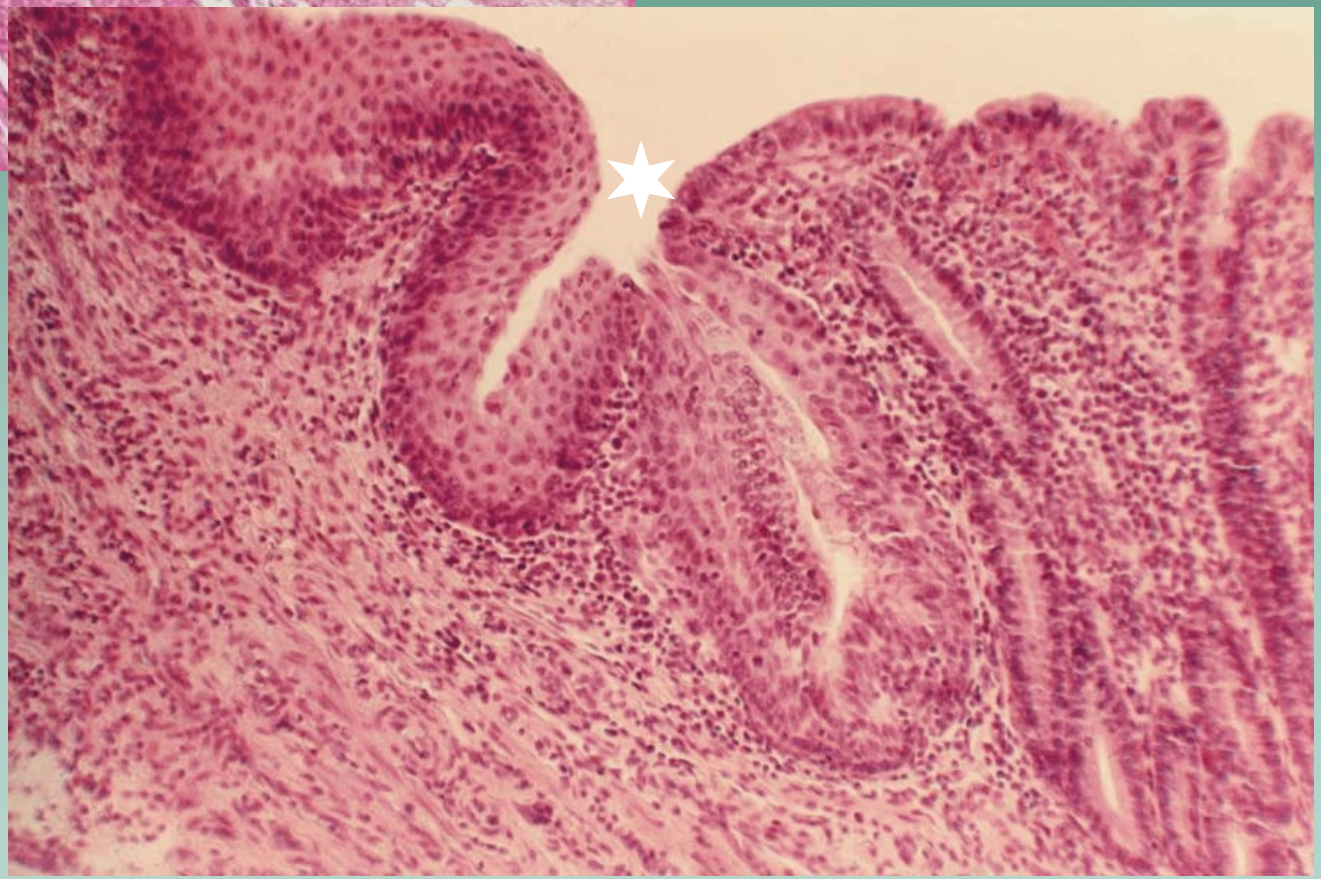
a narrow circular band (1,5 -3,0 cm in with) at the transition between esophagus and stomach

site of change of the epithelium

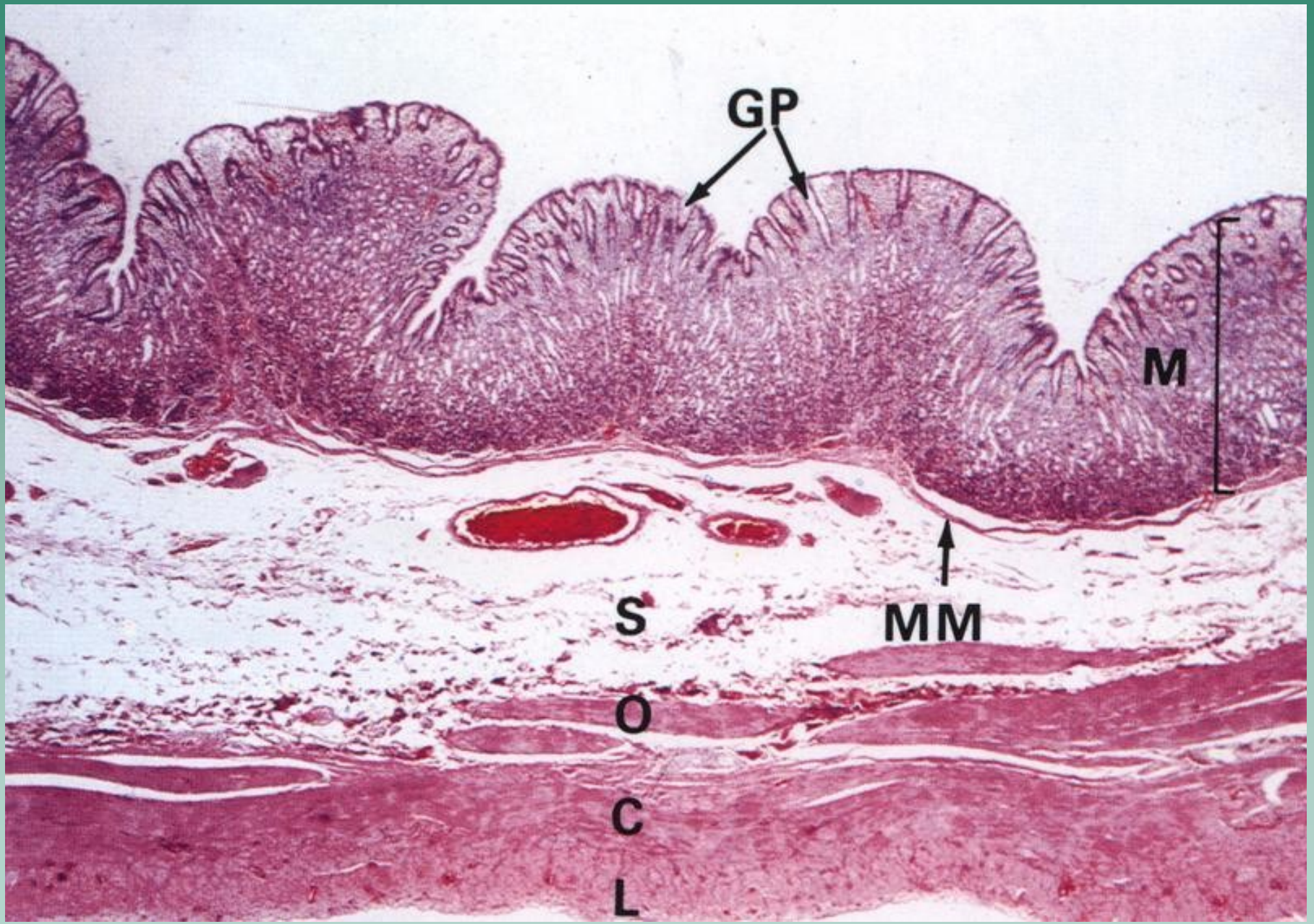
mucous cardiac glands in the lamina propria (mucus + lysozyme)



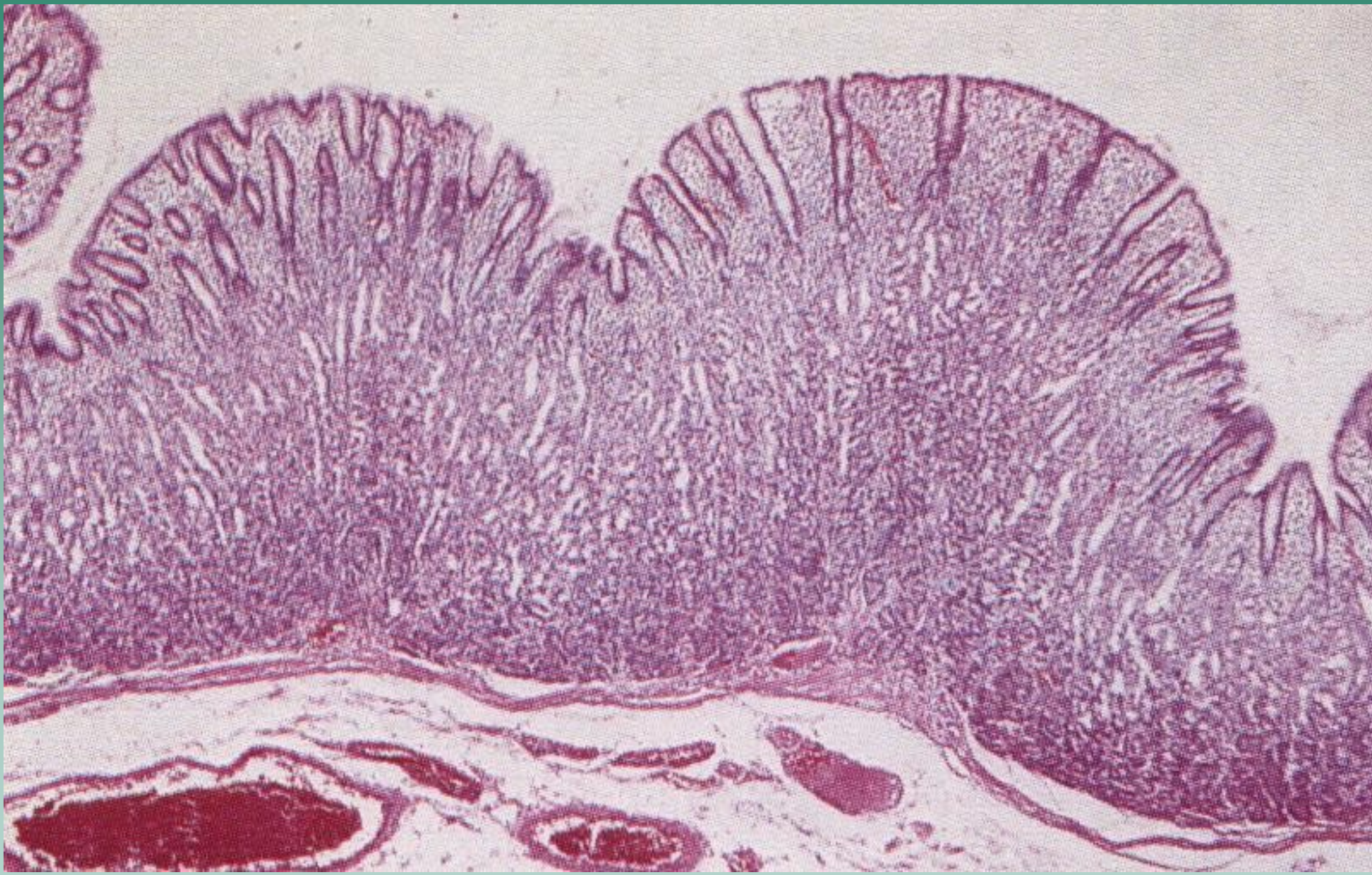


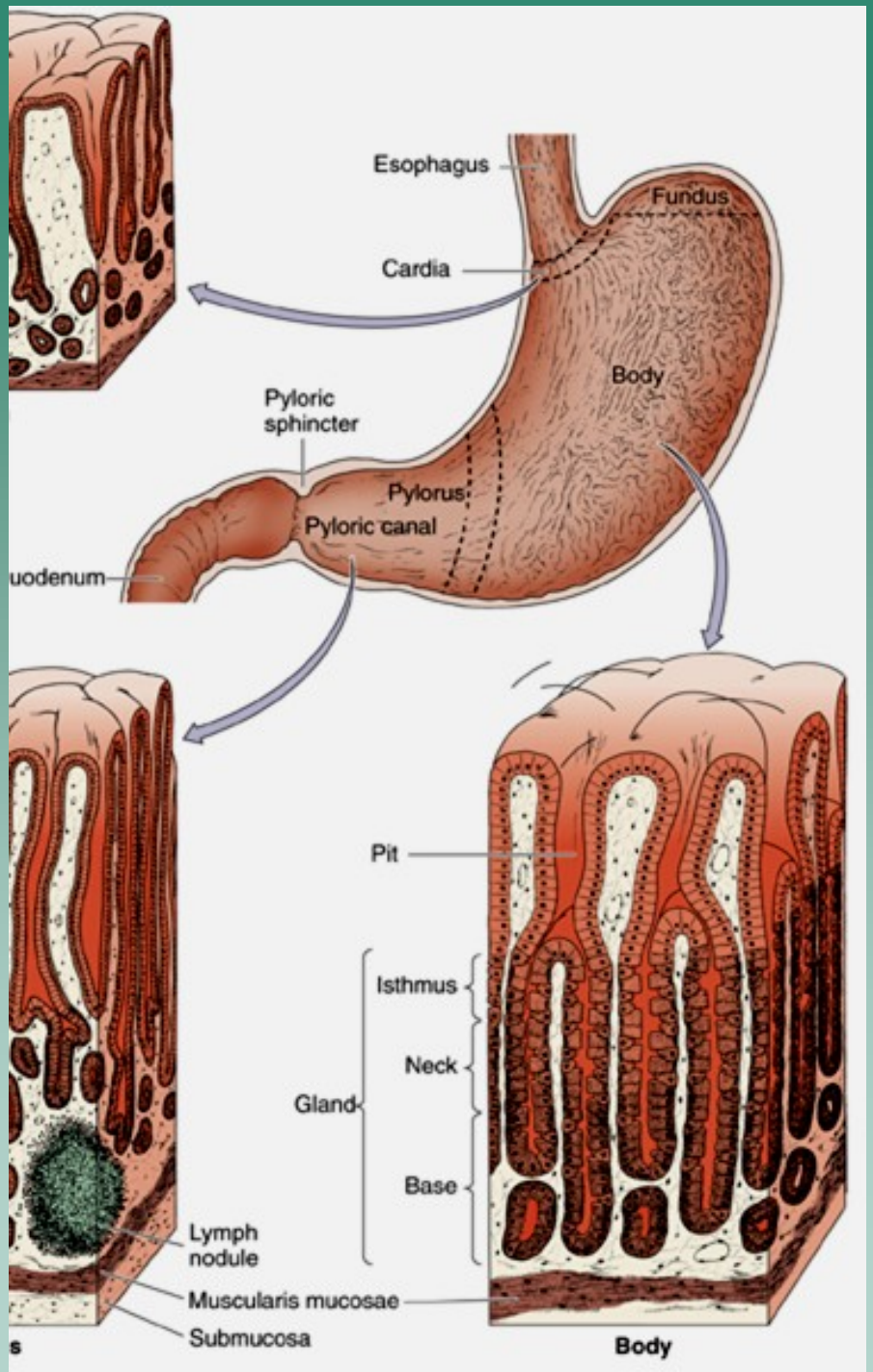


Fundus et corpus ventriculi:



Fundus et corpus ventricul – gastric areas:





Mucosa of the fundus and body:

- simple columnar epithelium

- lamina propria mucoae - loose areolar conn. tissue

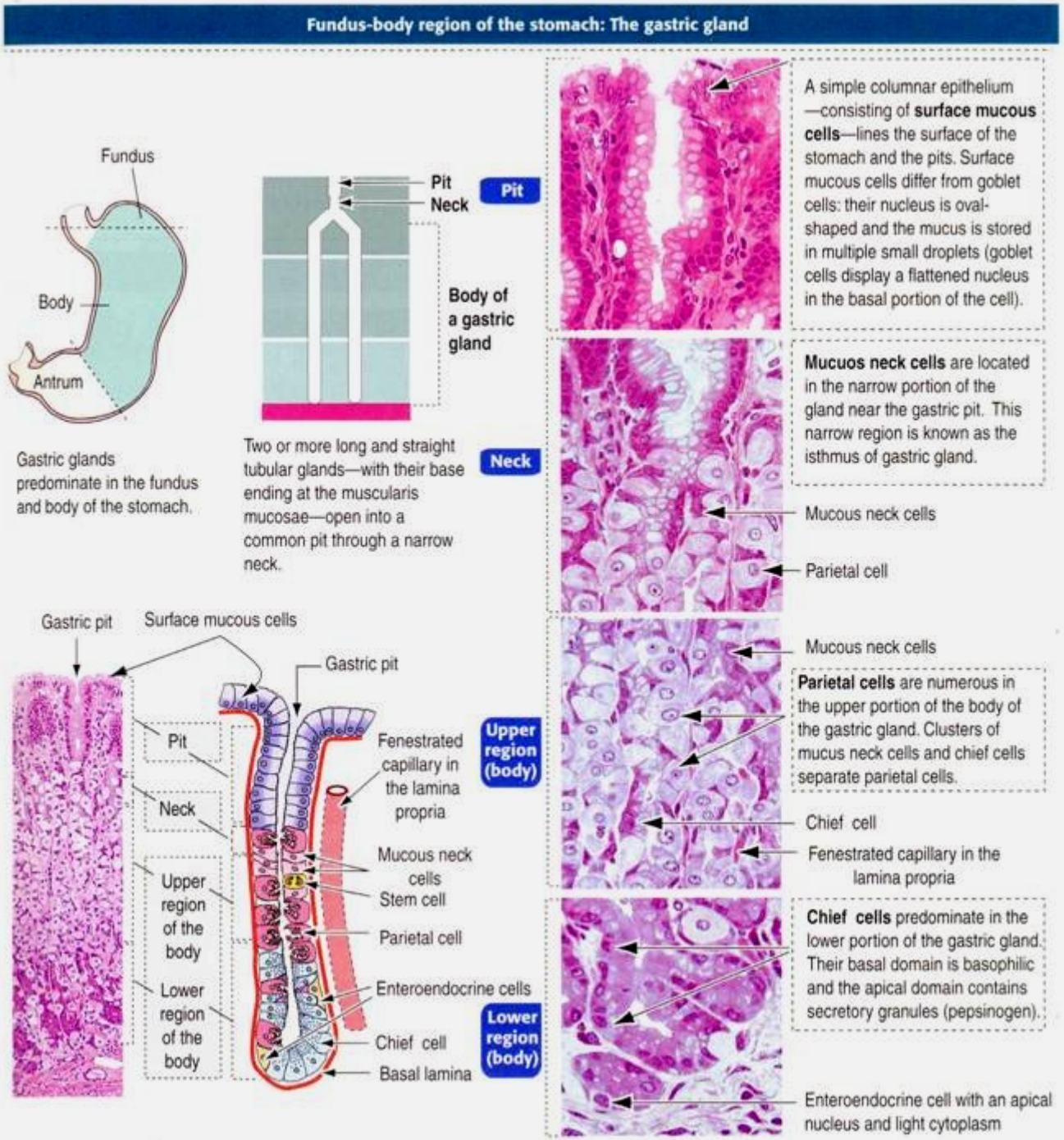
- lamina muscularis mucoae

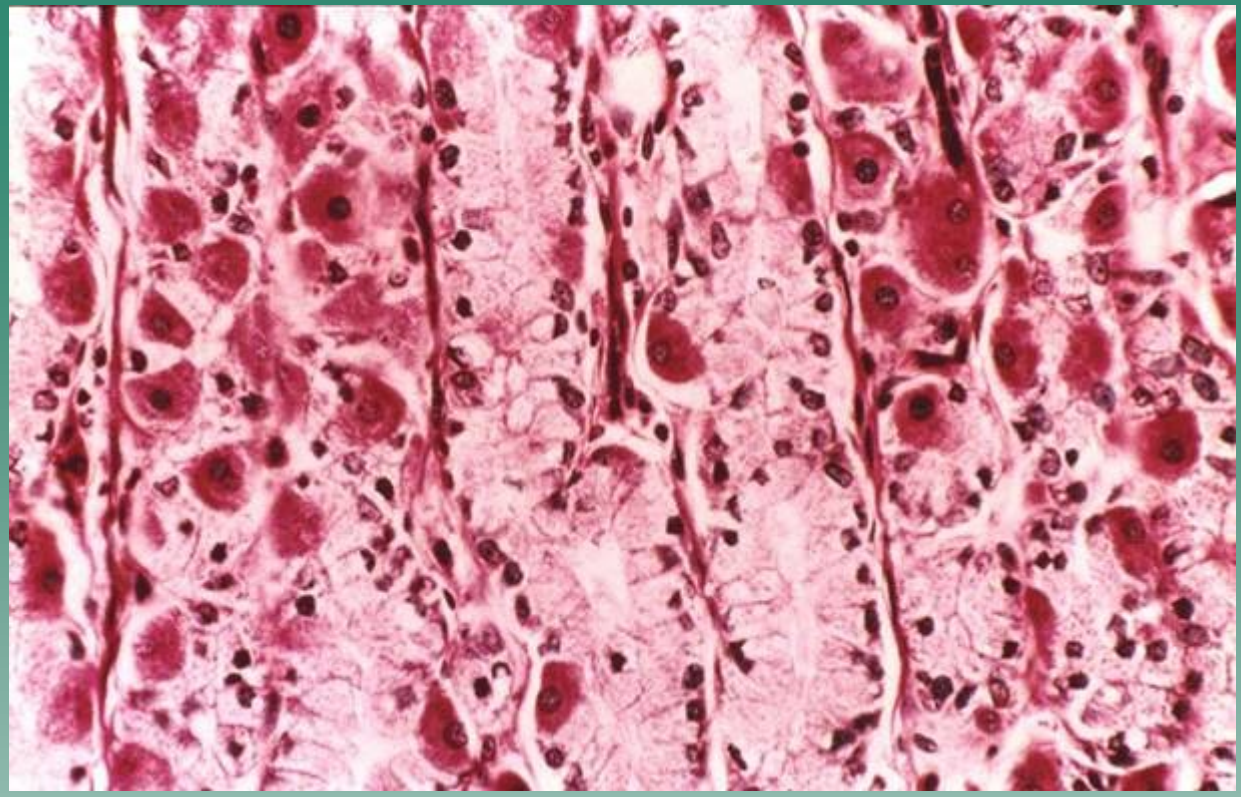
lamina propria is penetrated with branched tubular glands- gastric (fundic) glands

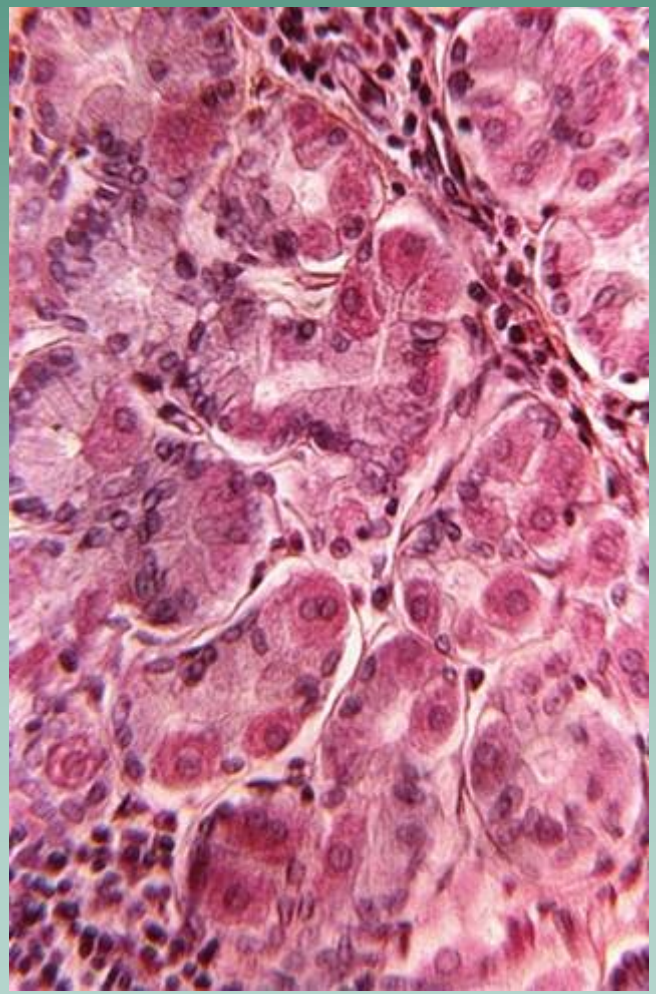
3 parts: base, body and neck

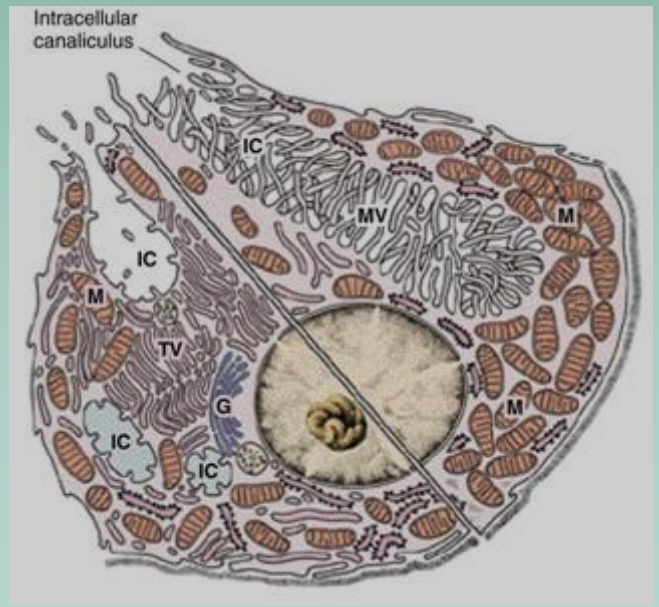
4 cell types:
- chief (pepsinogenic)
- parietal (oxyntic, HCl)
- mucous neck
- enteroendocrine

gastric juice



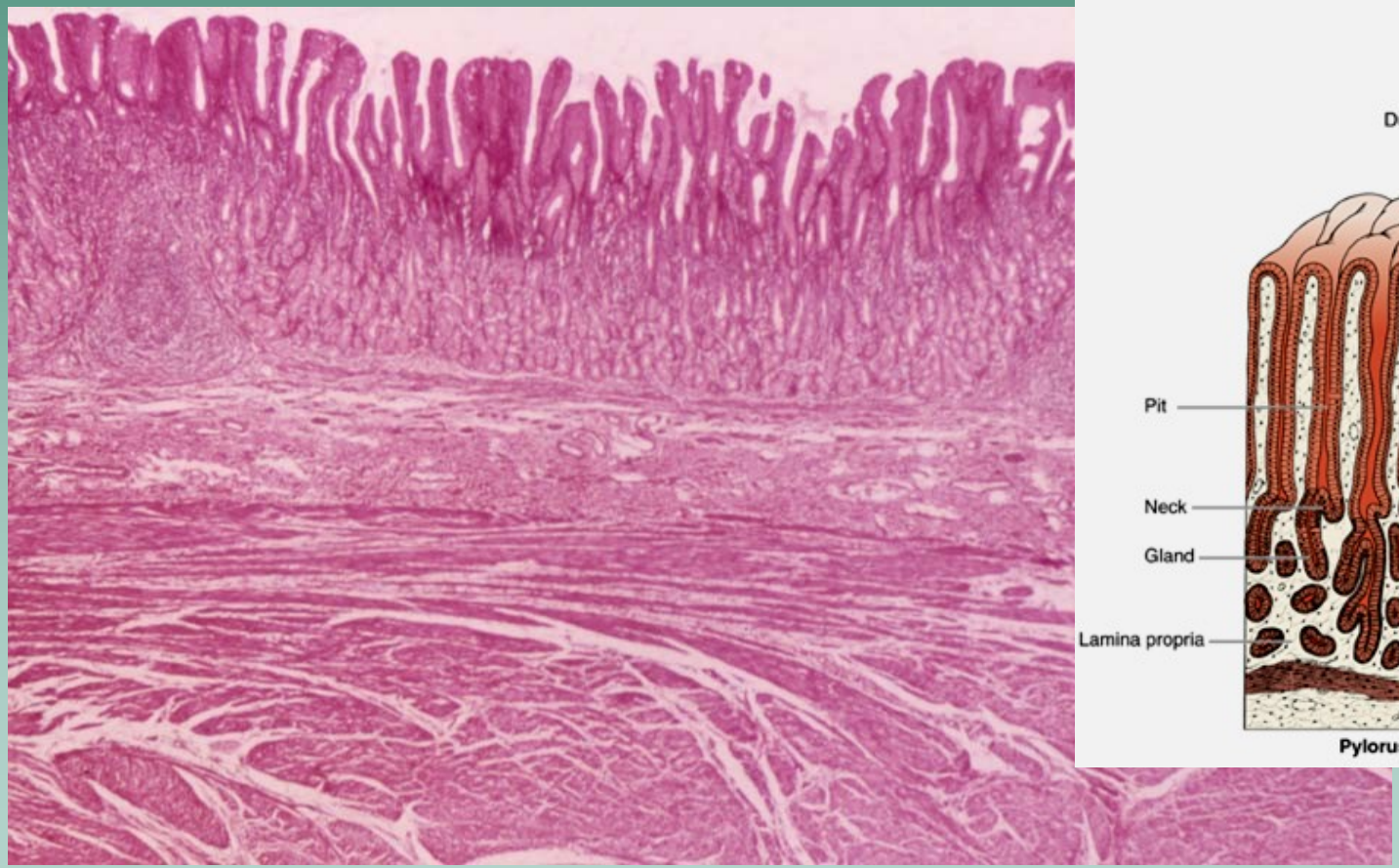


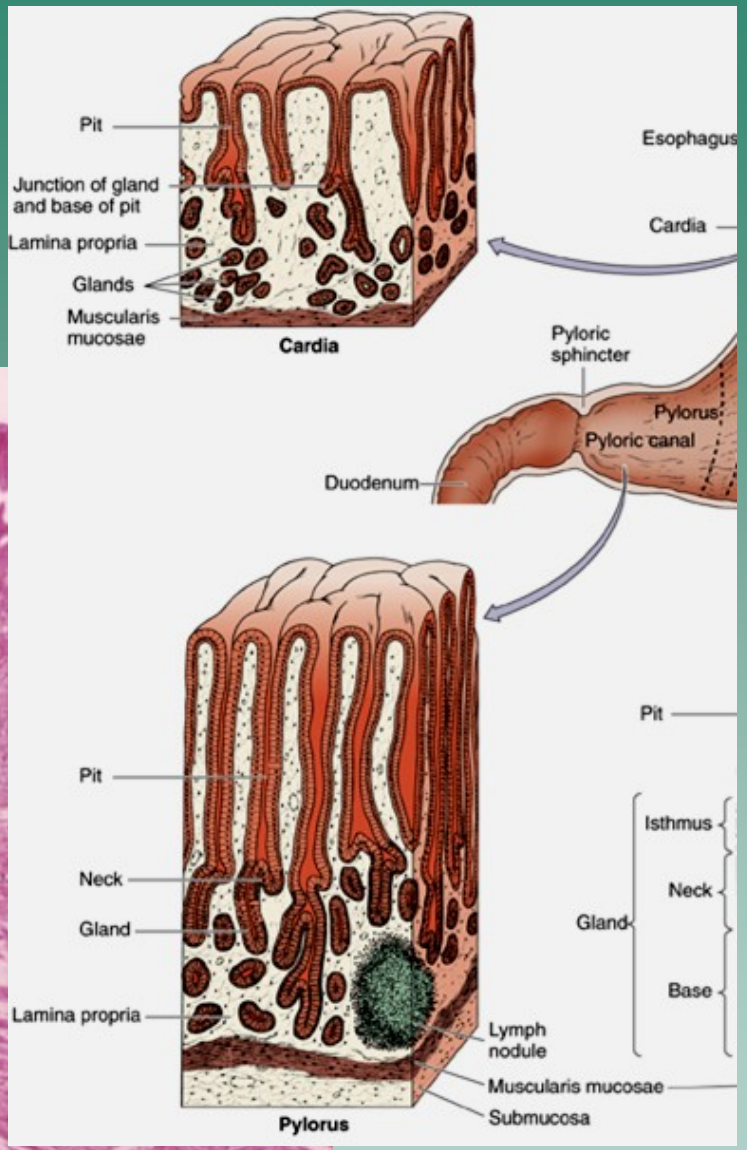




an enzyme typical of oxyntic cells is carbonic anhydrase

Pylorus ventriculi:
deeper gastric pits,
reticular conn. tissue, pyloric glands





Small intestine (intestinum tenue)

5–7 m in length

digestion, absorption

3 segments: **duodenum, jejunum and ileum**

wall consists of 4 layers: **mucous, submucous, muscular a serous coat**

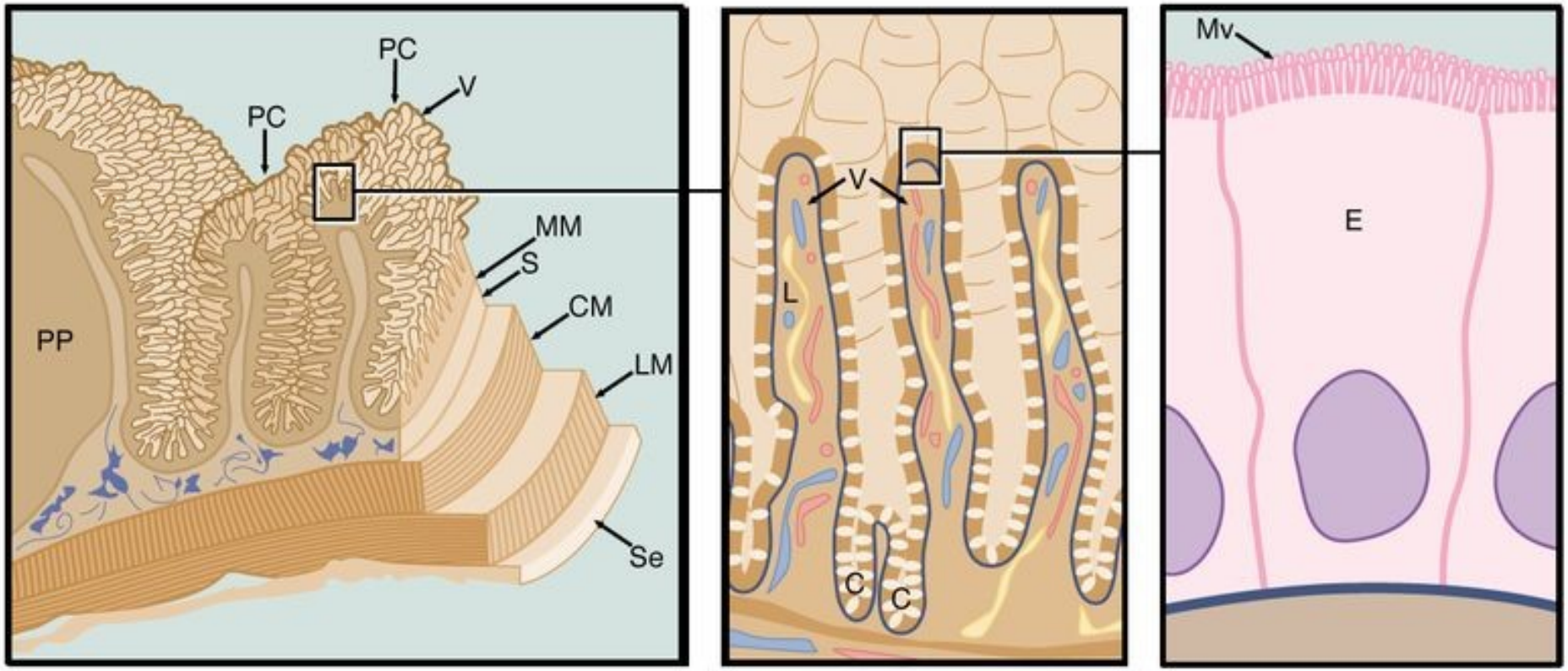
Surface specialization of the mucosa:

1. **plicae circulares (valves of Kerckring) - transverse and permanents folds with submucous core**
2. **intestinal villi and crypts - villi - finger-like or leaf-like projections 0.5 -1.5 mm in length**
   - crypts (of Lieberkühn) - tubular invaginations (0.5 mm in depth) between bases of villi
3. **microvilli - folds of the apical plasma membranes of enterocytes „brush border" in the LM**

circular plicae (valves of Kerckring, plicae circulares)

Intestinal villi (villi intestinales)

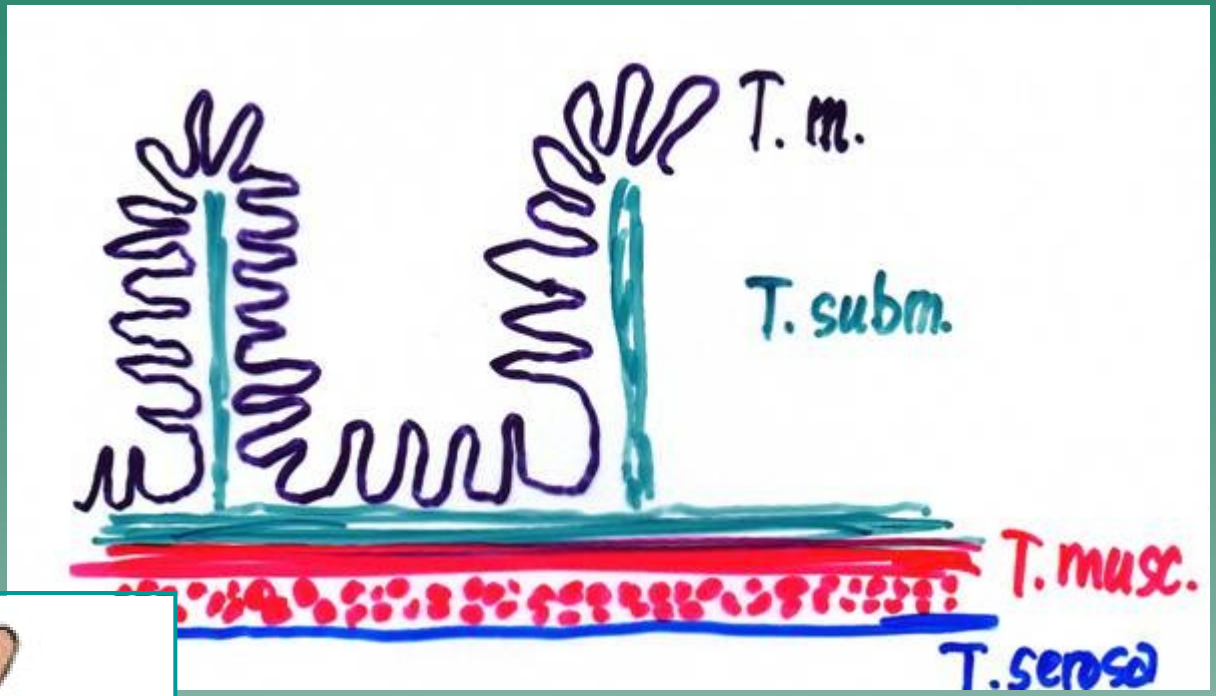
Microvilli

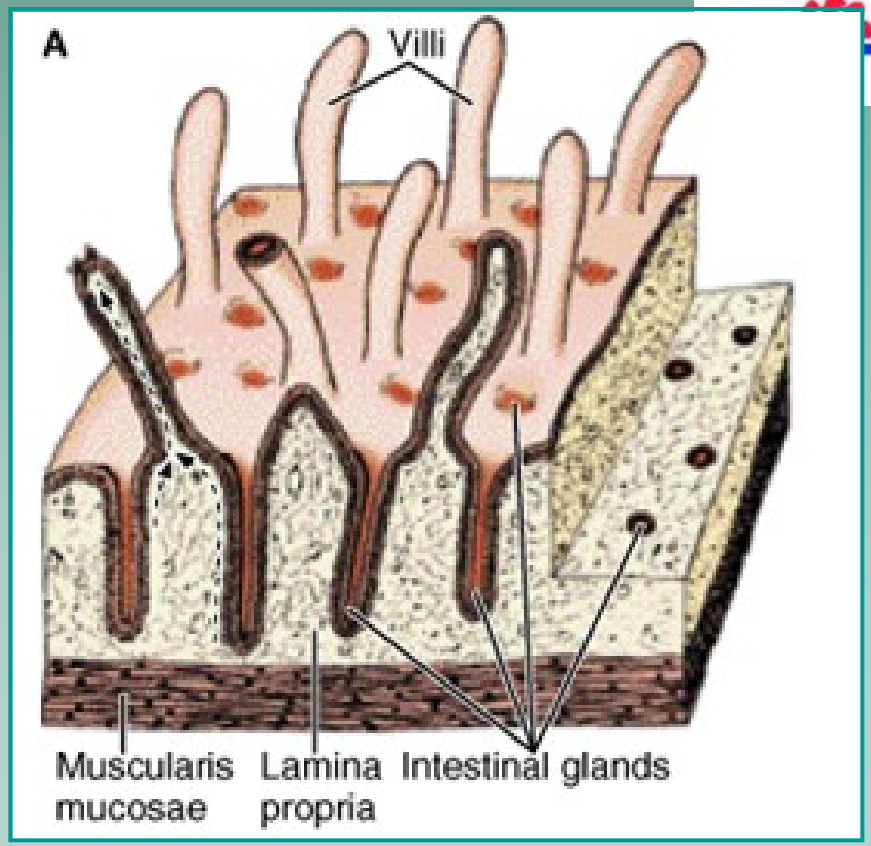


Small intestine -

surface

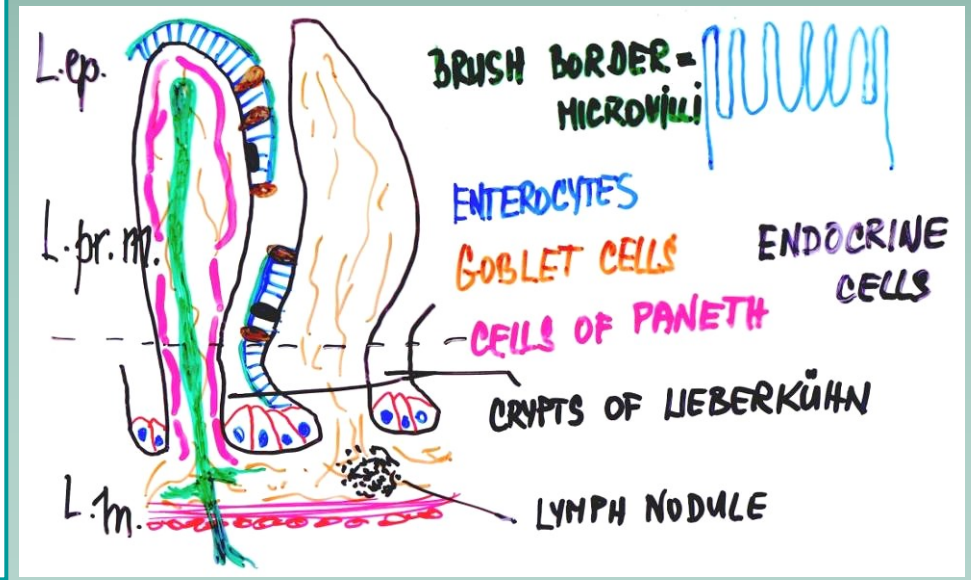
circular plicae (plicae of Kerckring, plicae circulares)



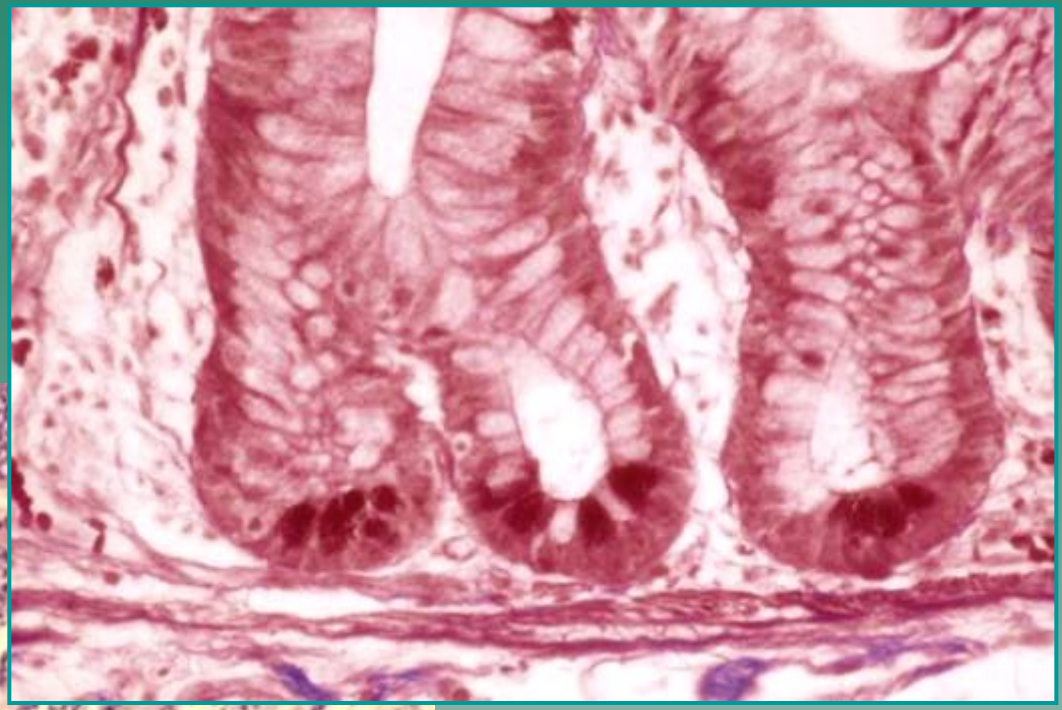


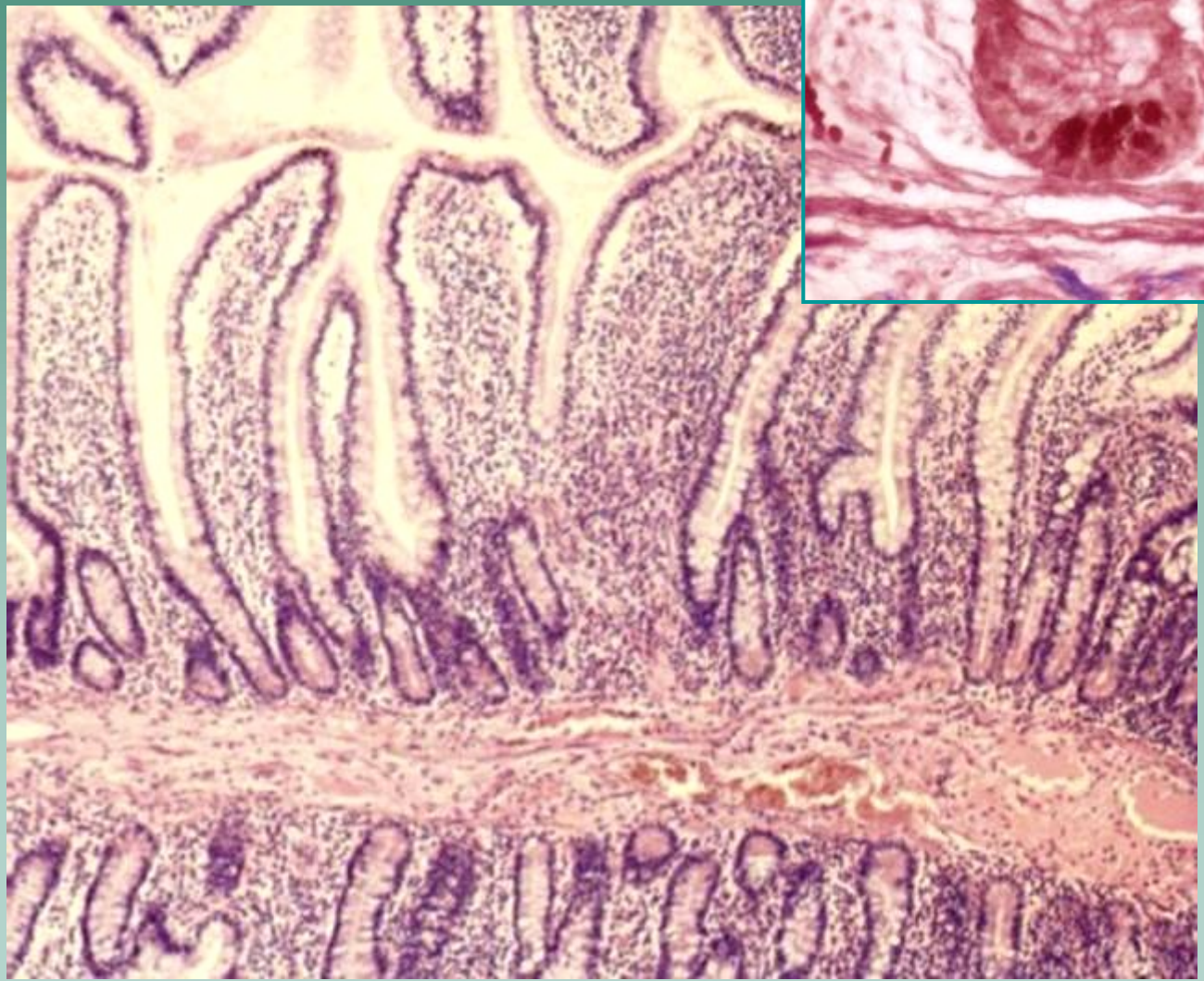
Intestinal villi (villi intestinales)

Microvilli



Intestinal villi (villi intestinales) and crypts of Lieberkühn



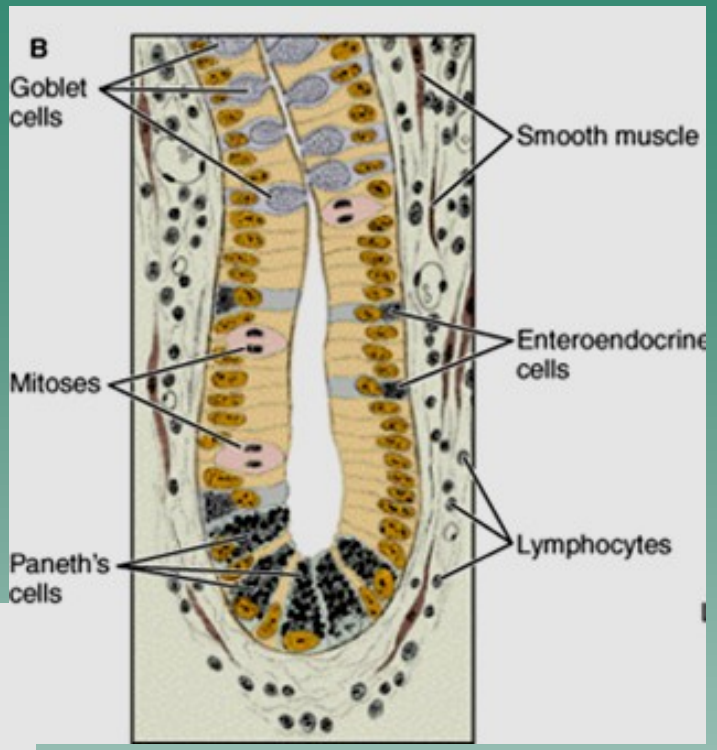


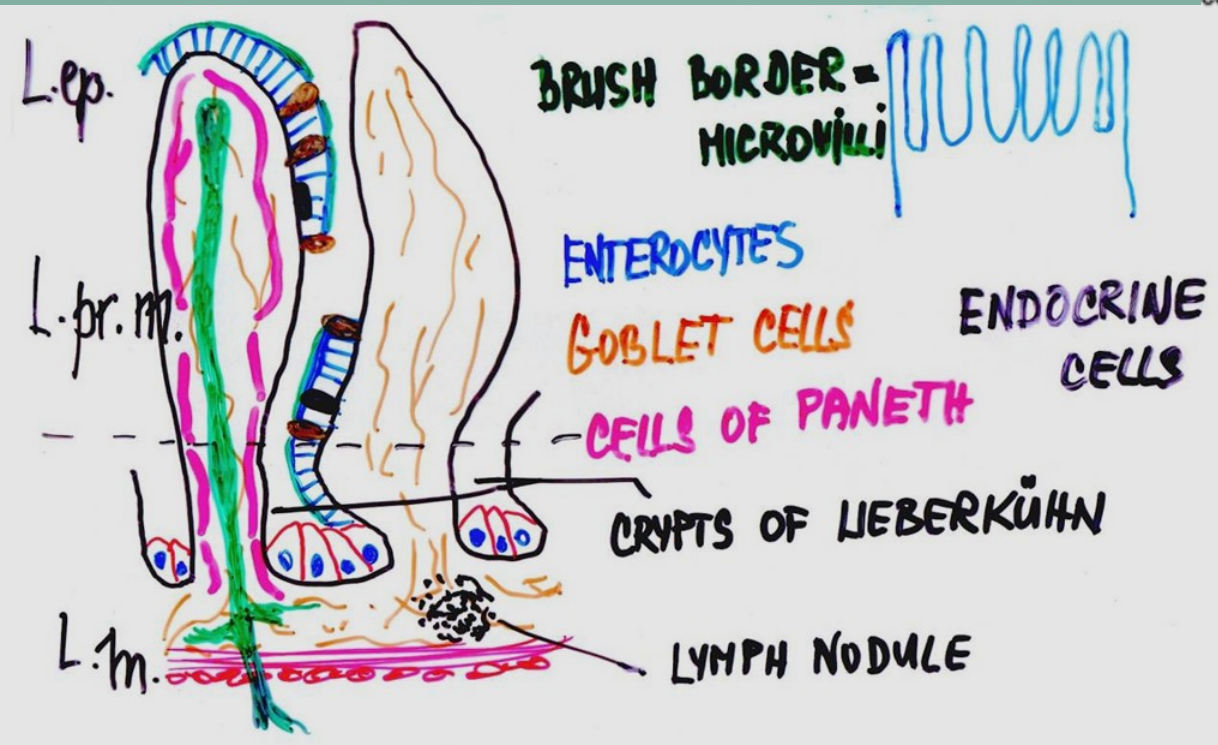
tunica mucosa

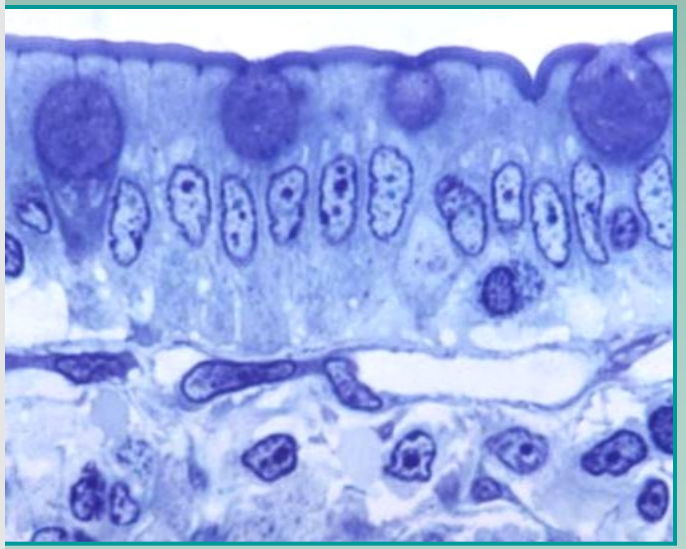
Epithelium - simple columnar
Lamina propria mucosae
Lamina muscularis mucoase

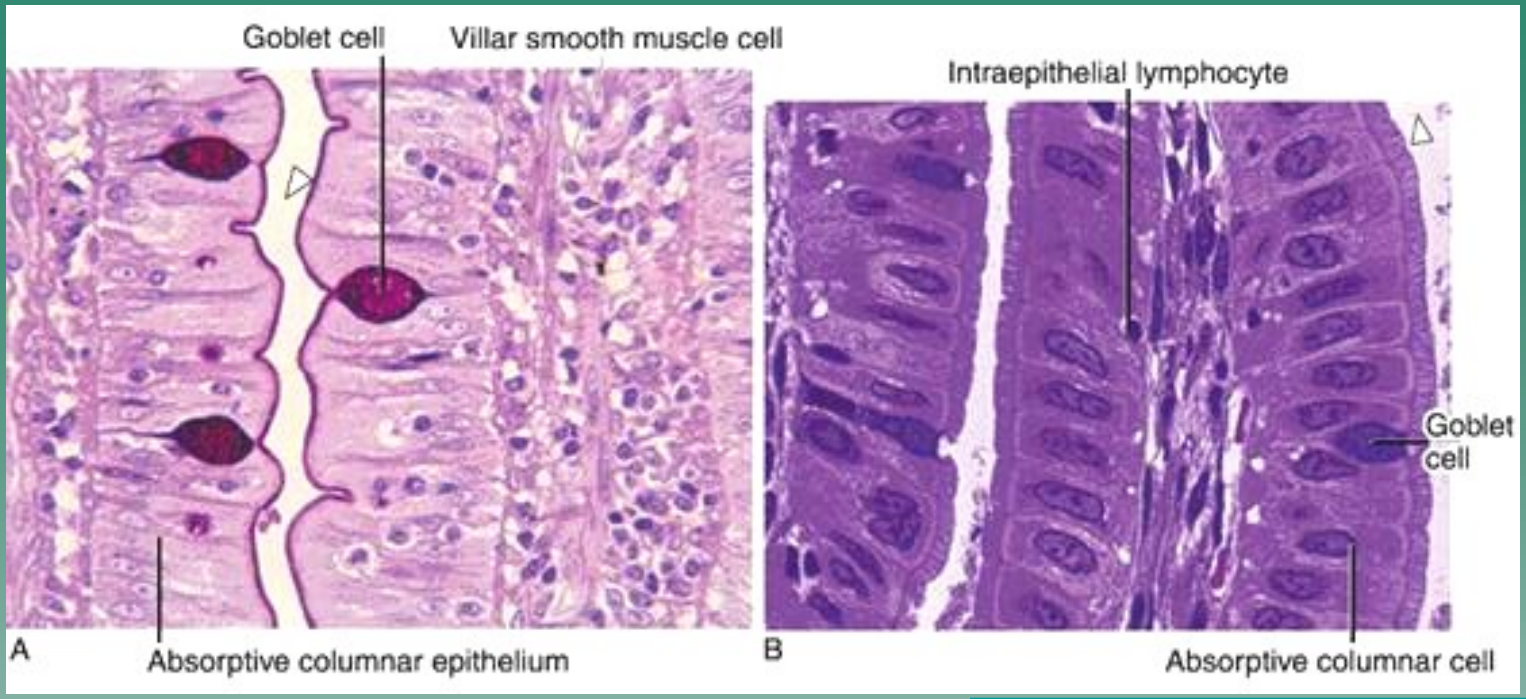
the epithelium:

absorptive cells: enterocytes
secretory cells: goblet cells, Paneth´s cells,
enteroendocrine cells

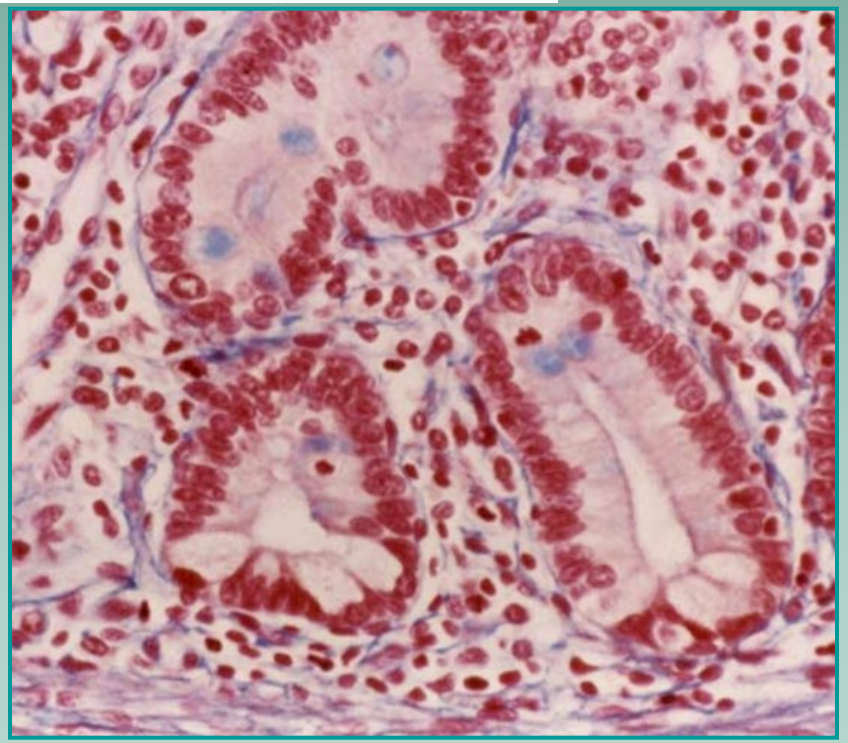




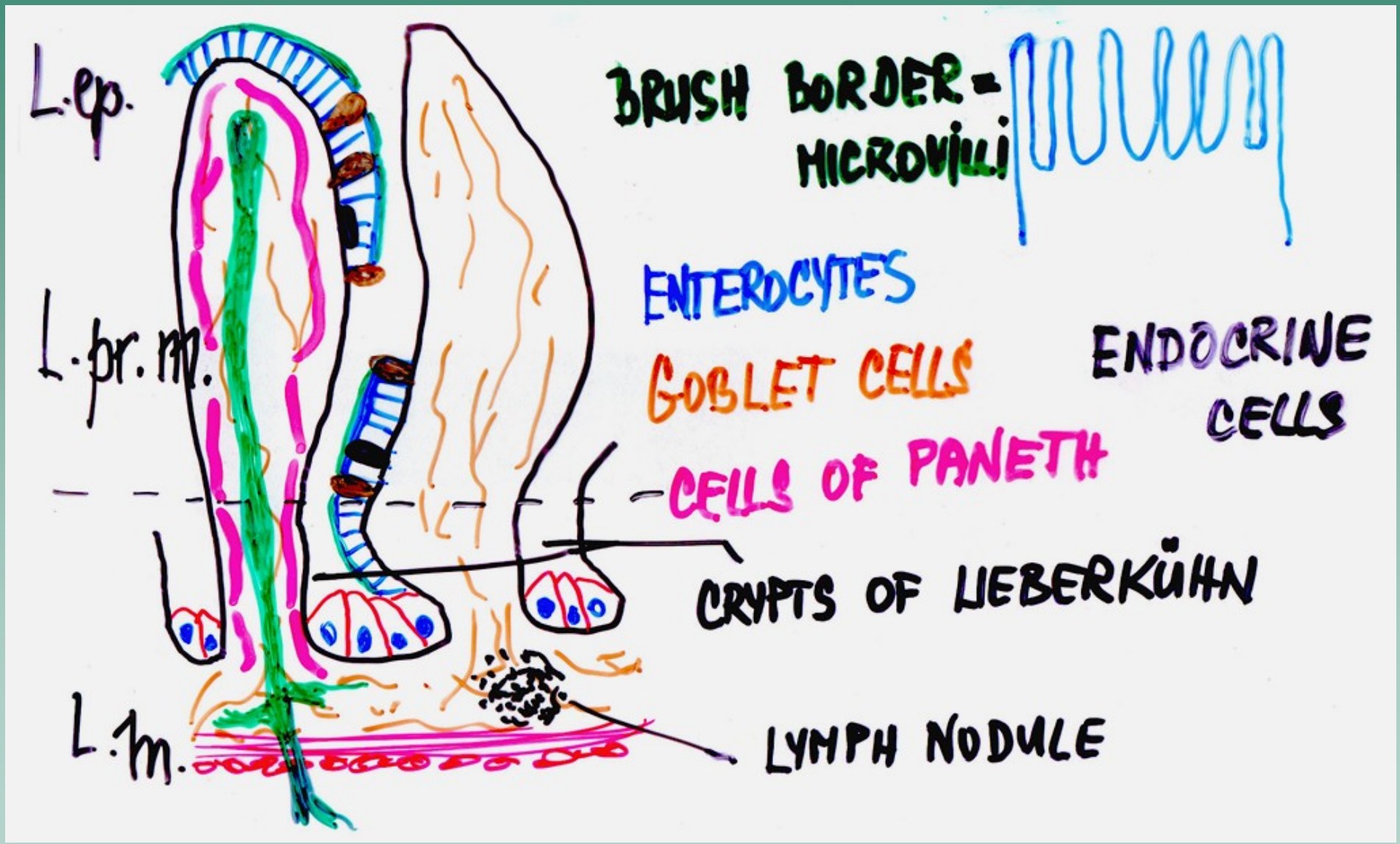




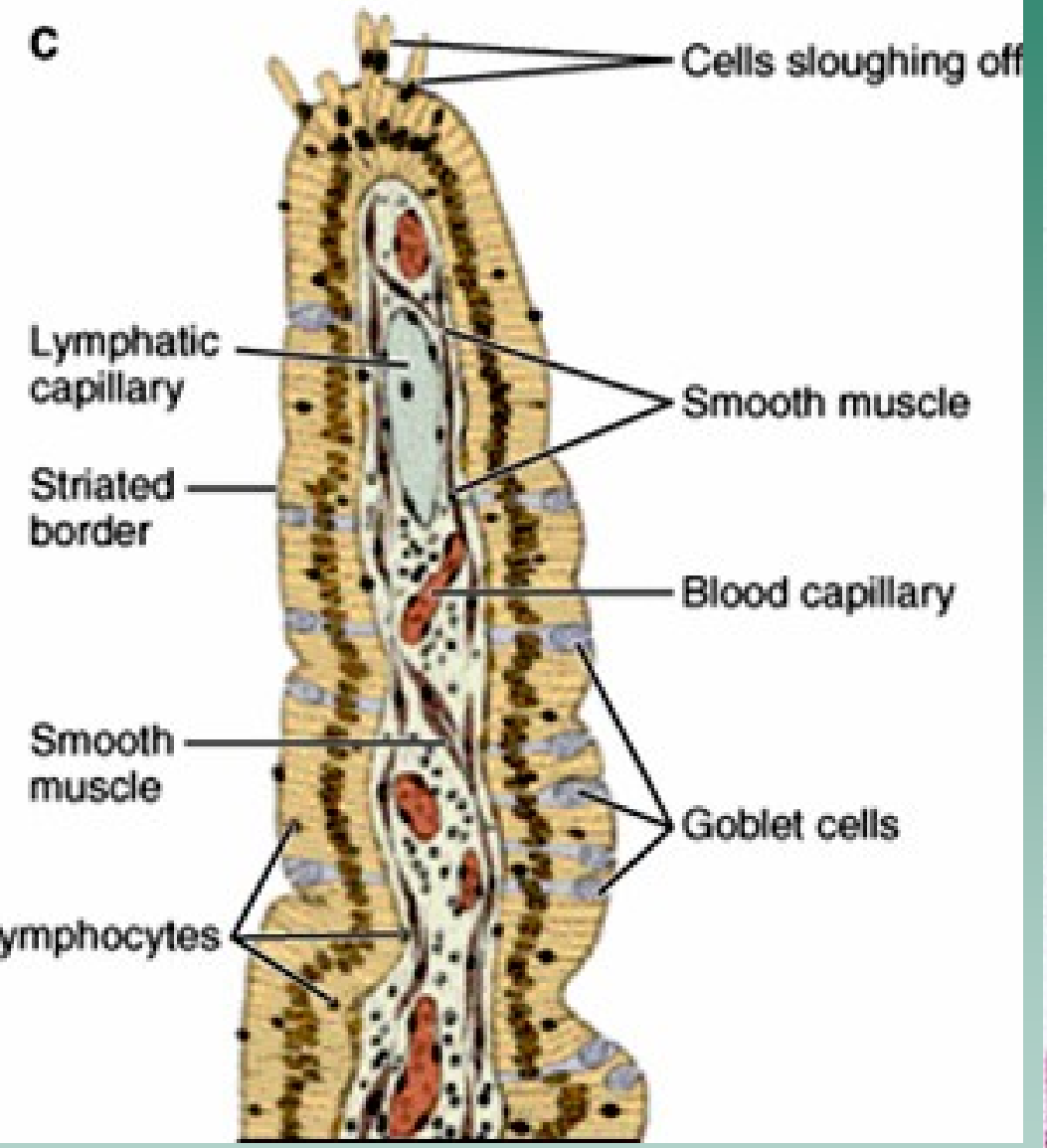
Paneth´s cells

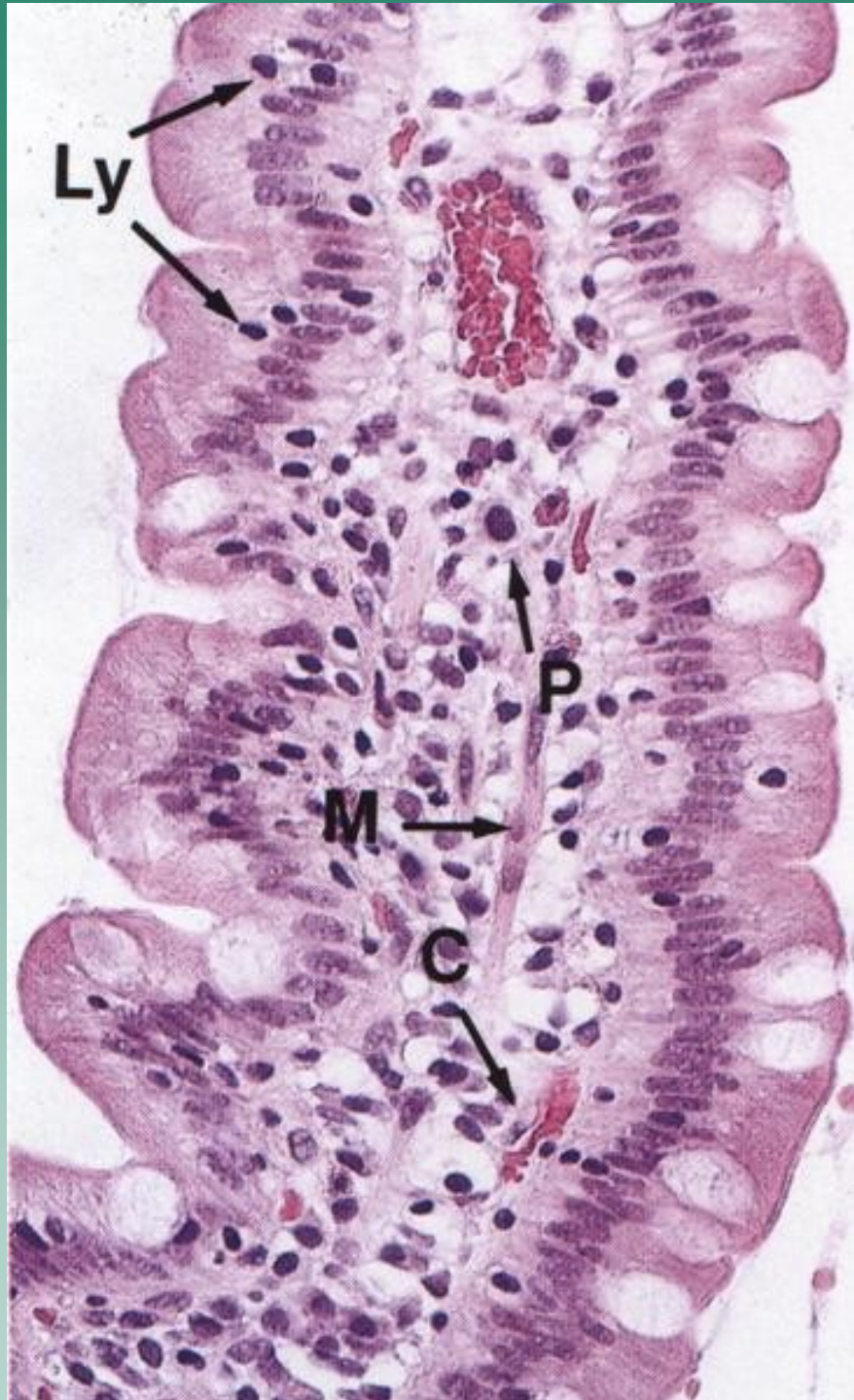


Intestinal villus (-i)- structure

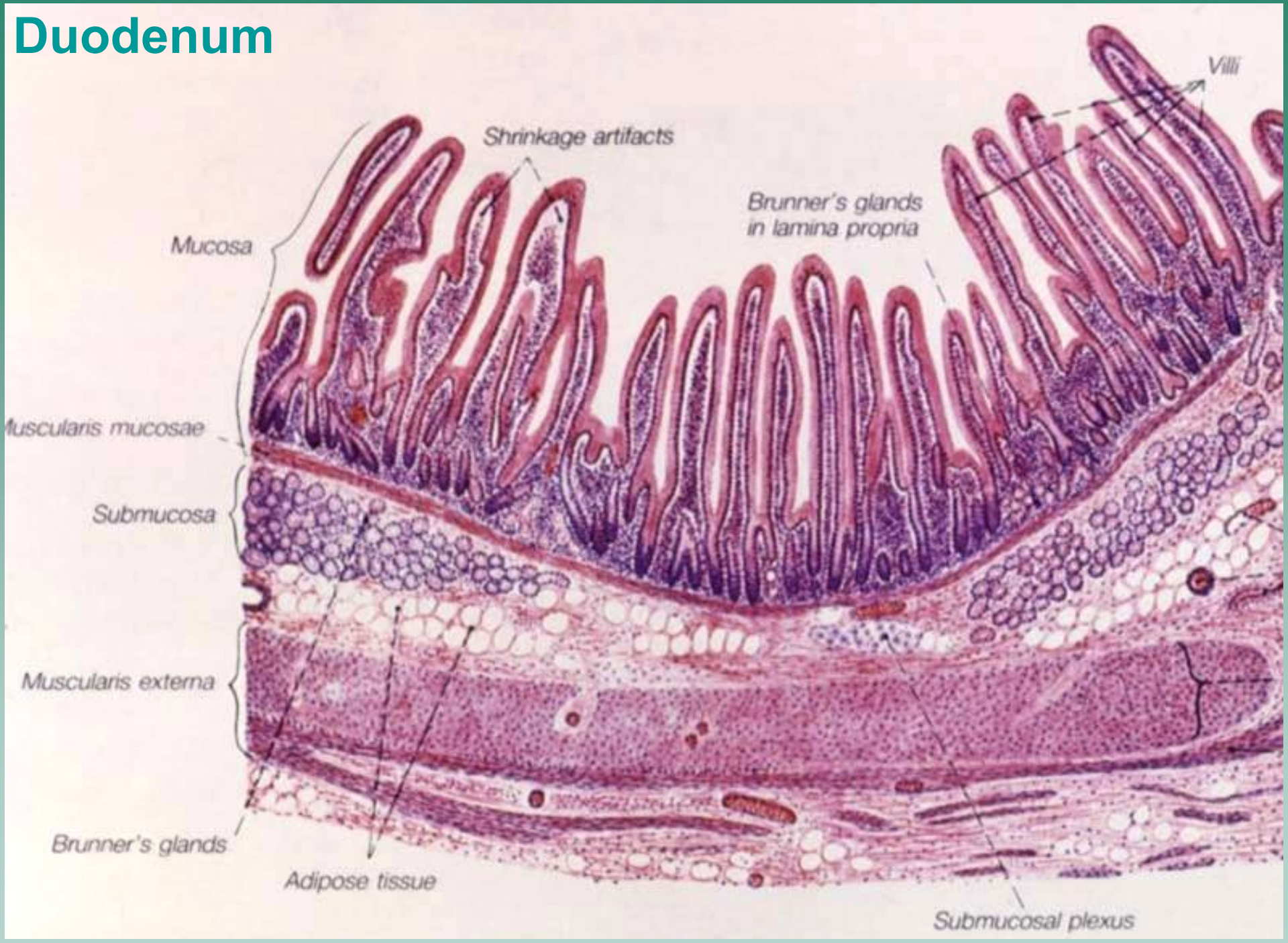


intestinal villus



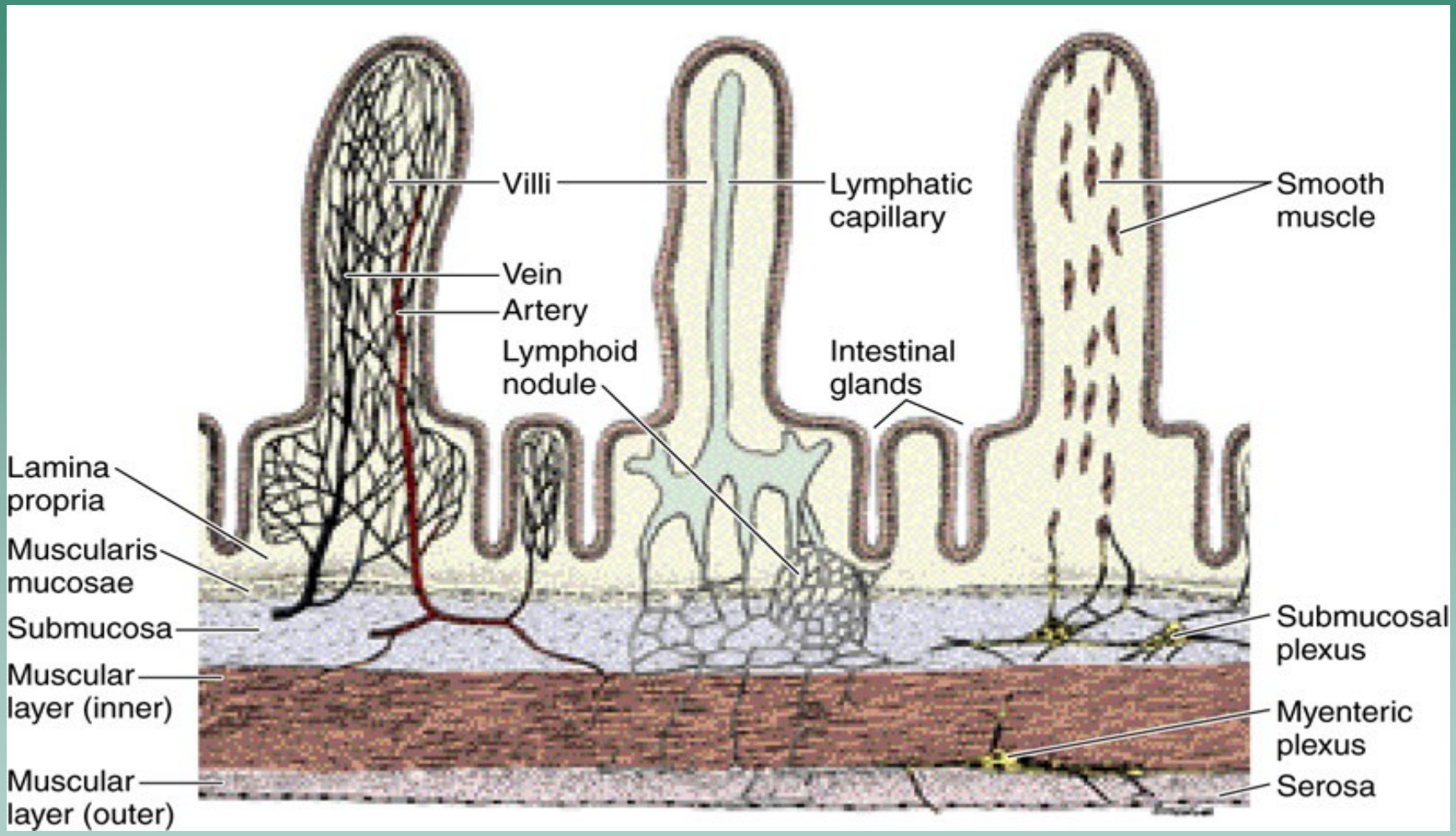


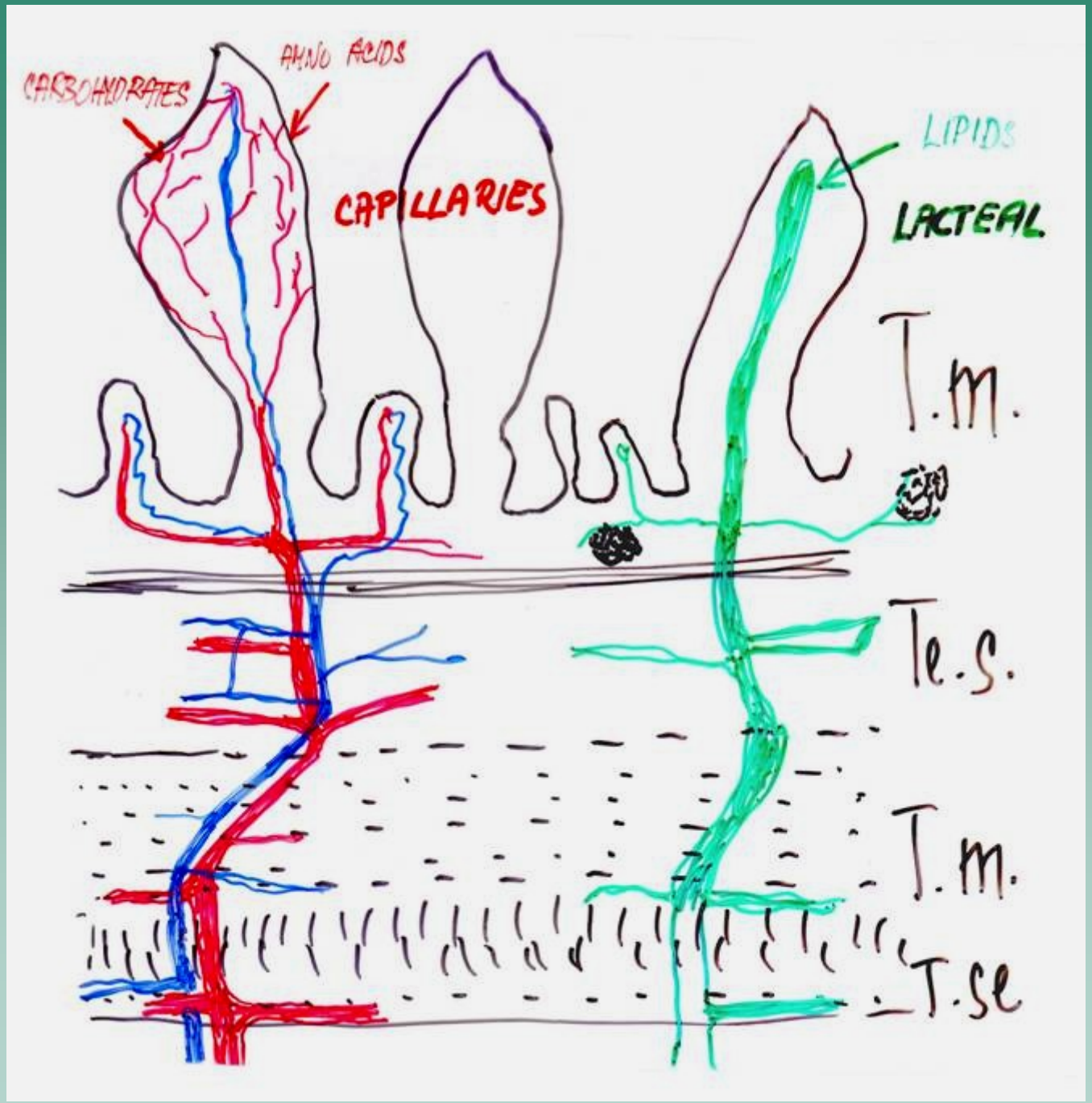
Duodenum

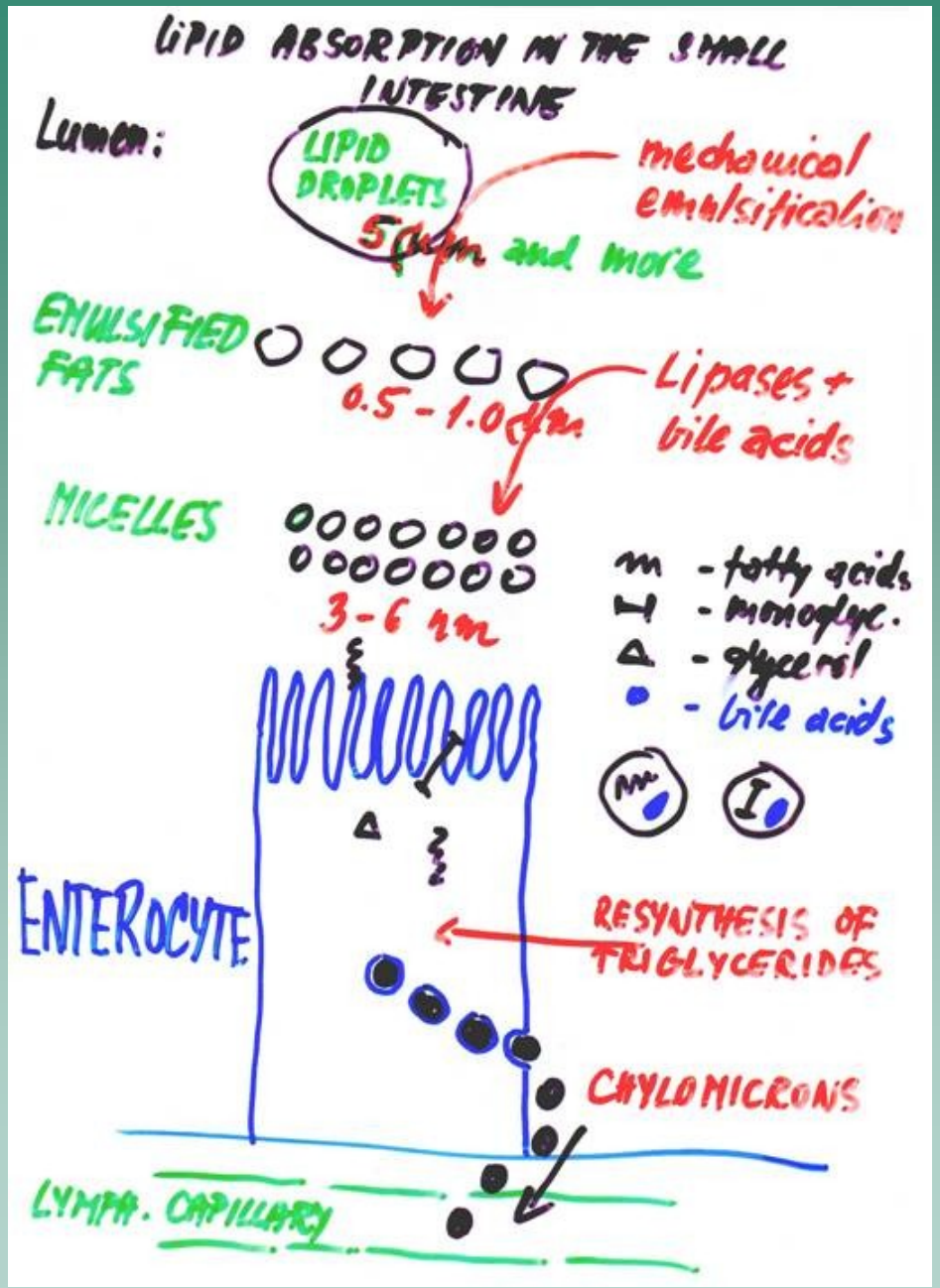

Villi
Shrinkage artifacts
Brunner's glands
in lamina propria
Mucosa
Muscularis mucosae
Submucosa
Muscularis externa
Brunner's glands
Adipose tissue
Submucosal plexus

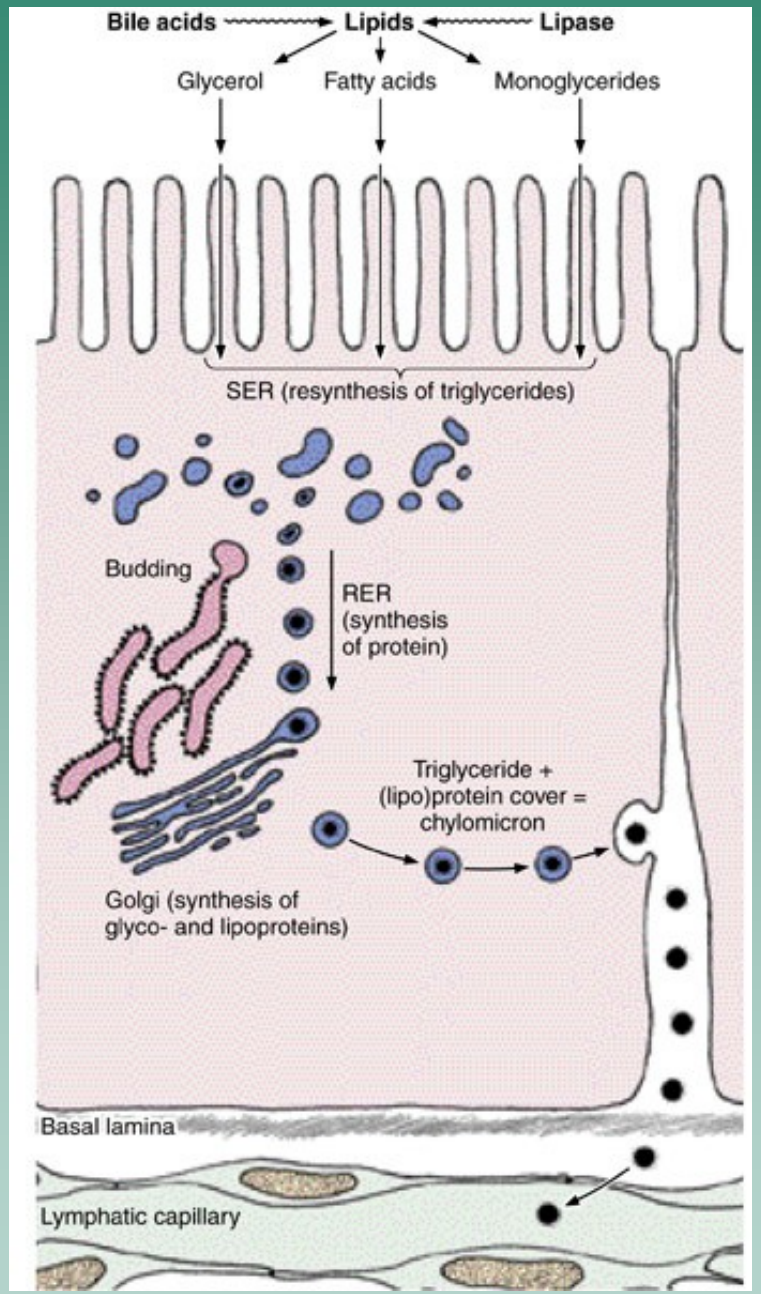
Jejunum

BLOOD AND LYMPH CIRCULATION




CARBOHYDRATES
AMINO ACIDS
CAPILLARIES
LIPIDS
LACTEAL
T.m.
Te.s.
T.m.
T.se


LIPID ABSORPTION IN THE SMALL INTESTINE
Lumen:
LIPID DROPLETS
5 µm and more
mechanical emulsification
EMULSIFIED FATS
0.5 - 1.0 µm
Lipases + bile acids
MICELLES
3 - 6 nm
- fatty acids
- monoglyc.
- glycerol
- bile acids
ENTEROCYTE
RESYNTHESIS OF TRIGLYCERIDES
CHYLOMICRONS
LYMPH. CAPILLARY


Bile acids
Lipids
Lipase
Glycerol
Fatty acids
Monoglycerides
SER (resynthesis of triglycerides)
Budding
RER (synthesis of protein)
Triglyceride + (lipo)protein cover = chylomicron
Golgi (synthesis of glyco- and lipoproteins)
Basal lamina
Lymphatic capillary

Large intestine (intestinum crassum)

1,5 m in length

intestinum caecum with vermiform appendix (appendix vermiformis), colon (colon ascendens, transversum, descendens, sigmoideum) and rectum (intestinum rectum)

faeces

4 layers: mucous, submucous, muscular a serous coats

1. the mucous tunic

is smooth without intestinal villi, but crypts of Lieberkühn are retained, absence of Paneth cells

- simple columnar epithelium (enterocytes, goblet cells, endocrine cells)

- lamina propria - reticular tissue (lymph nodules)

- muscularis mucosae

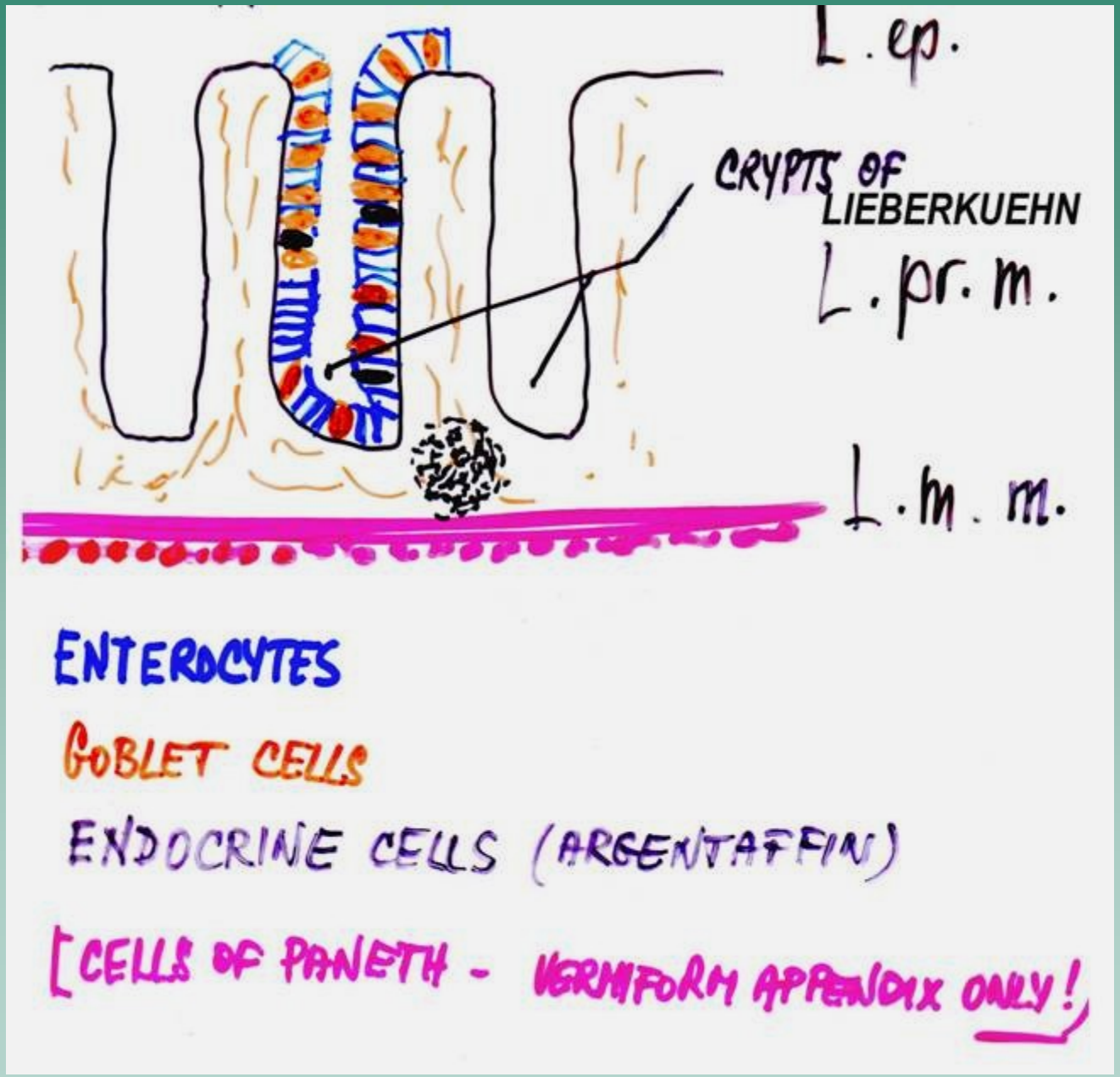
2. the submucous coat - wide, made up of areolar connective tissue

3. the muscular coat - inner circular and outer longitudina (3 taeniae coli)

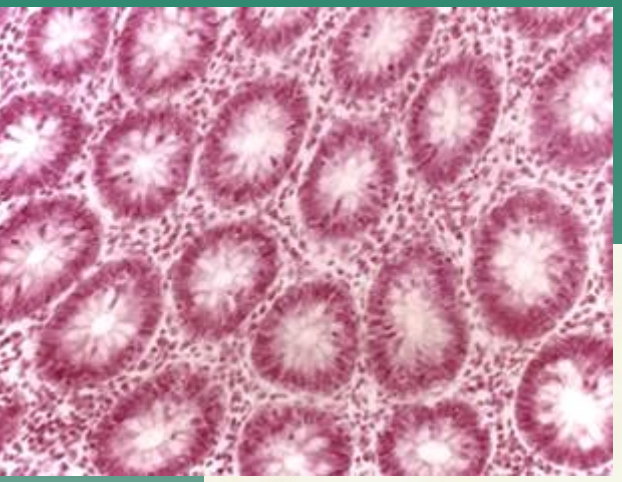
4. the serous coat or adventitia (deposits of adipose tissue in the serosa - appendices epiploicae)

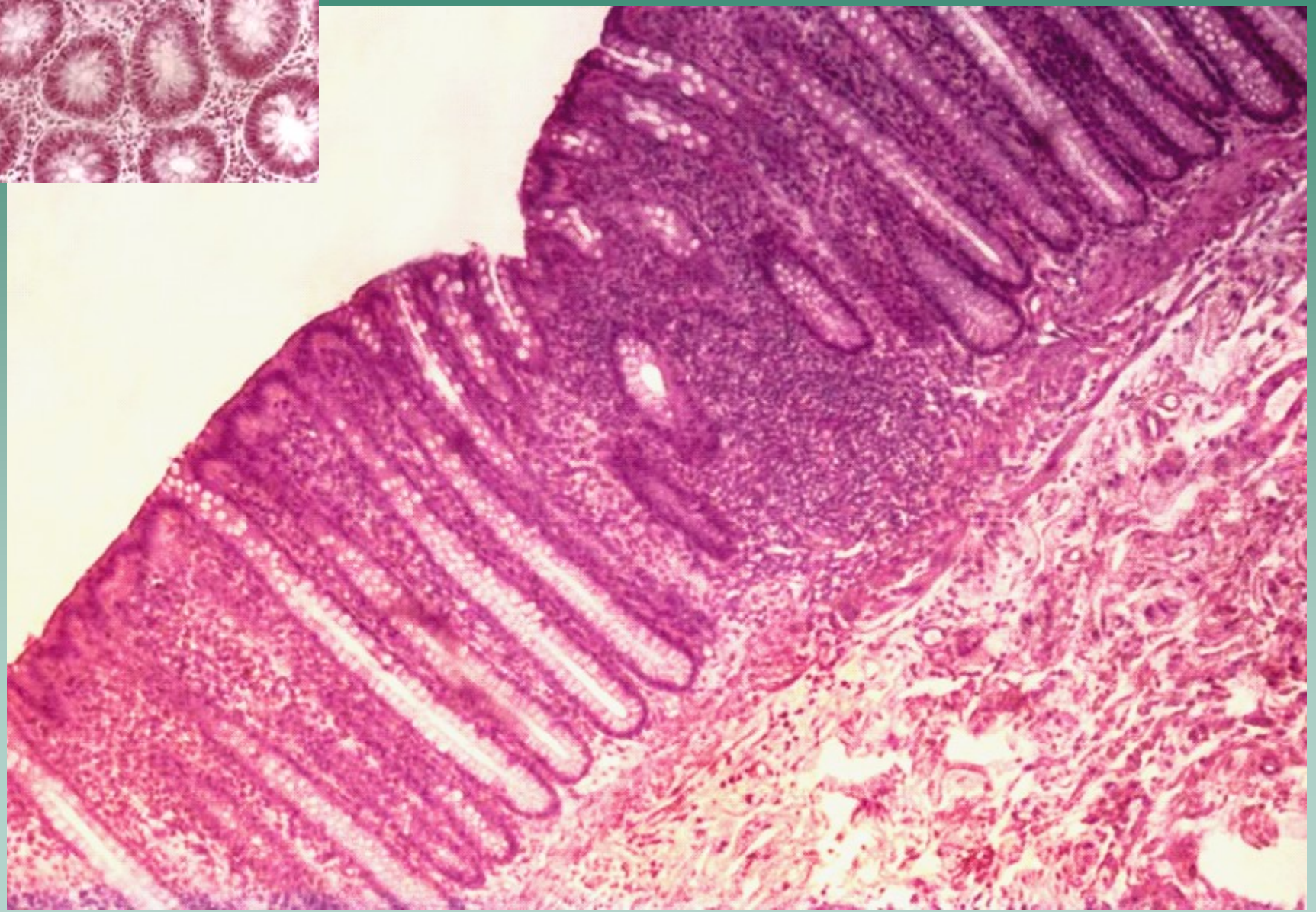
plicae semilunares : permanent plicae made up of t. mucosa, submucous coat and t. muscularis

the large intestine mucosa:

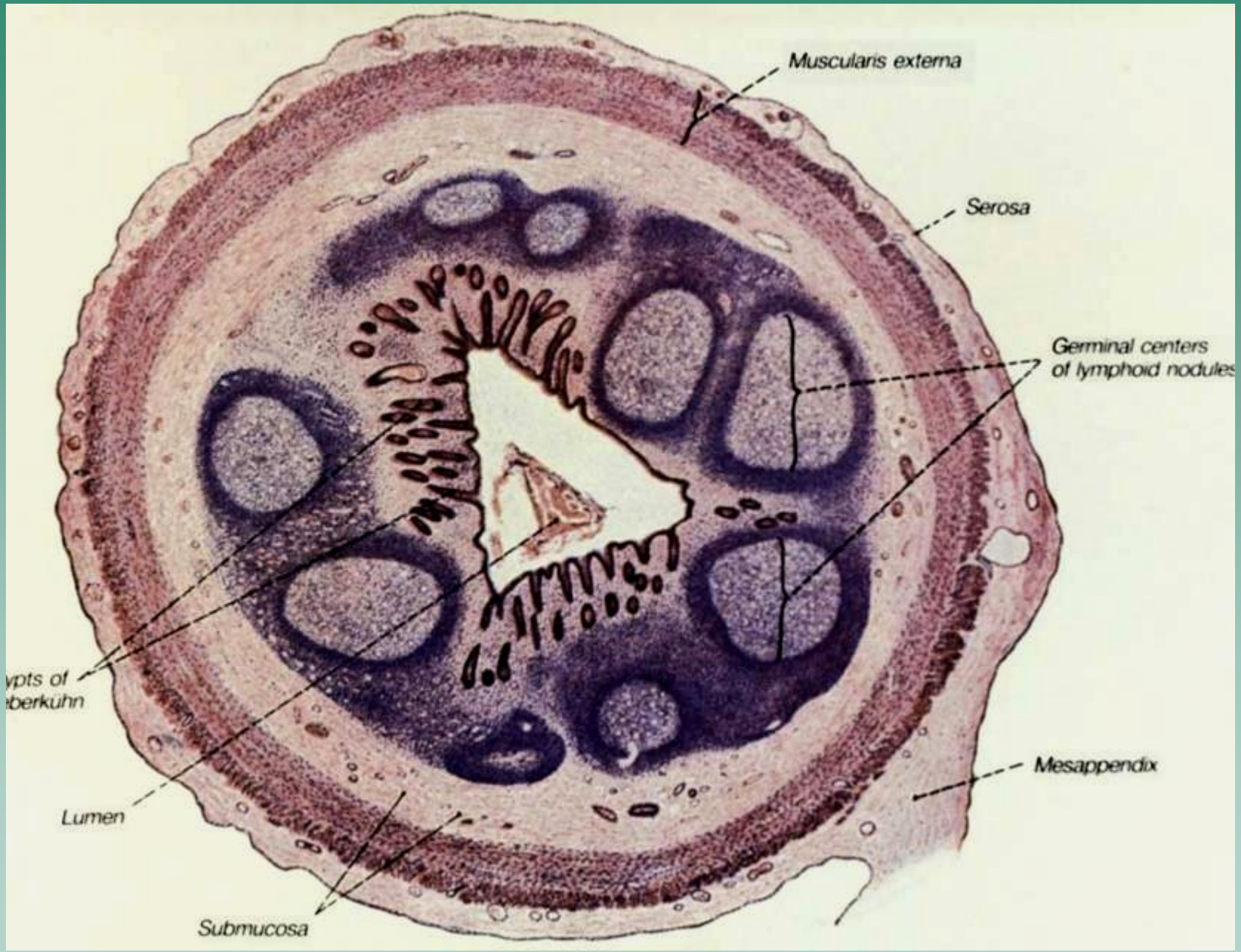


the mucous tunic





Vermiform appendix



The rectum

upper p. – pars ampullaris recti – S_3 – diaphragm pelvis; composed of the same layers as the colon

Lower p. – canalis analis – 3 zones
the hemorrhoidal, intermediate, cutaneous.

1. the hemorrhoidal z.
longitudinal folds – rectal columns (Morgagni)
transition of a simple columnar ep. into noncornified stratified squamous ep.
L. musc. muc. – is missing
Submucosa – rich venous plexuses

2. the intermediate z.
site of the internal anal sphincter
2 stratified squamous ep.
numerous Vater-Pacini corpuscles in the submucosa coat

3. the cutaneous z.
covers the anal orifice, keratinized stratified squamous ep., L. muscularis and submucosa are fused, (circumanal glands – gll. circumanales)