

## 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:

HIS-16333-01

11<sup>th</sup> edition

### Basic Histology, Eleventh Edition

ISSN: 0891-2106  
Set ISBN: 0-07-144091-7  
Book ISBN: 0-07-144116-6  
CD-ROM ISBN: 0-07-144117-4

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# Basic Histology

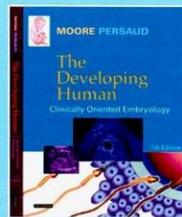
## text & atlas

Luiz Carlos JUNQUEIRA  
José CARNEIRO

# Basic Histology

## The Developing Human

### The Developing Human: Clinically Oriented Embryology, 7/e

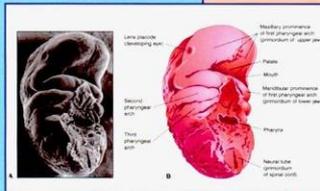


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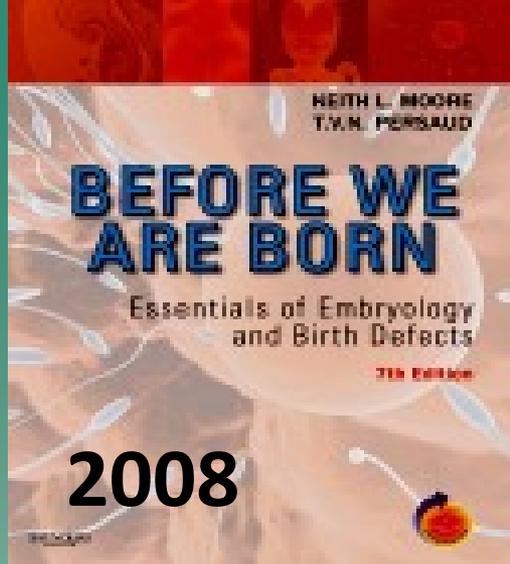
1. Introduction to the Developing Human
  2. The Beginning of Human Development: The First Week
  3. Formation of Bilaminar Embryonic Discs and Chorionic Sac: The Second Week
  4. Formation of Germ Layers and Early Tissue and Organ Differentiation: The Third Week
  5. Organogenetic Period: The Fourth to Eighth Weeks
  6. The Fetal Period: Ninth Week to Birth
  7. Placenta and Fetal Membranes
  8. Human Birth Defects
  9. Body Cavities, Mesenteries, and Diaphragm
  10. The Pharyngeal (Branchial) Apparatus
  11. The Respiratory System
  12. The Digestive System
  13. The Urogenital System
  14. The Cardiovascular System
  15. The Skeletal System
  16. The Muscular System
  17. The Limbs
  18. The Nervous System
  19. The Eye and Ear
  20. The Integumentary System
- Appendices: Timetable of Human Prenatal Development-1 to 6 weeks · Timetable of Human Prenatal Development-7 to 38 weeks · Critical Periods in Human Development



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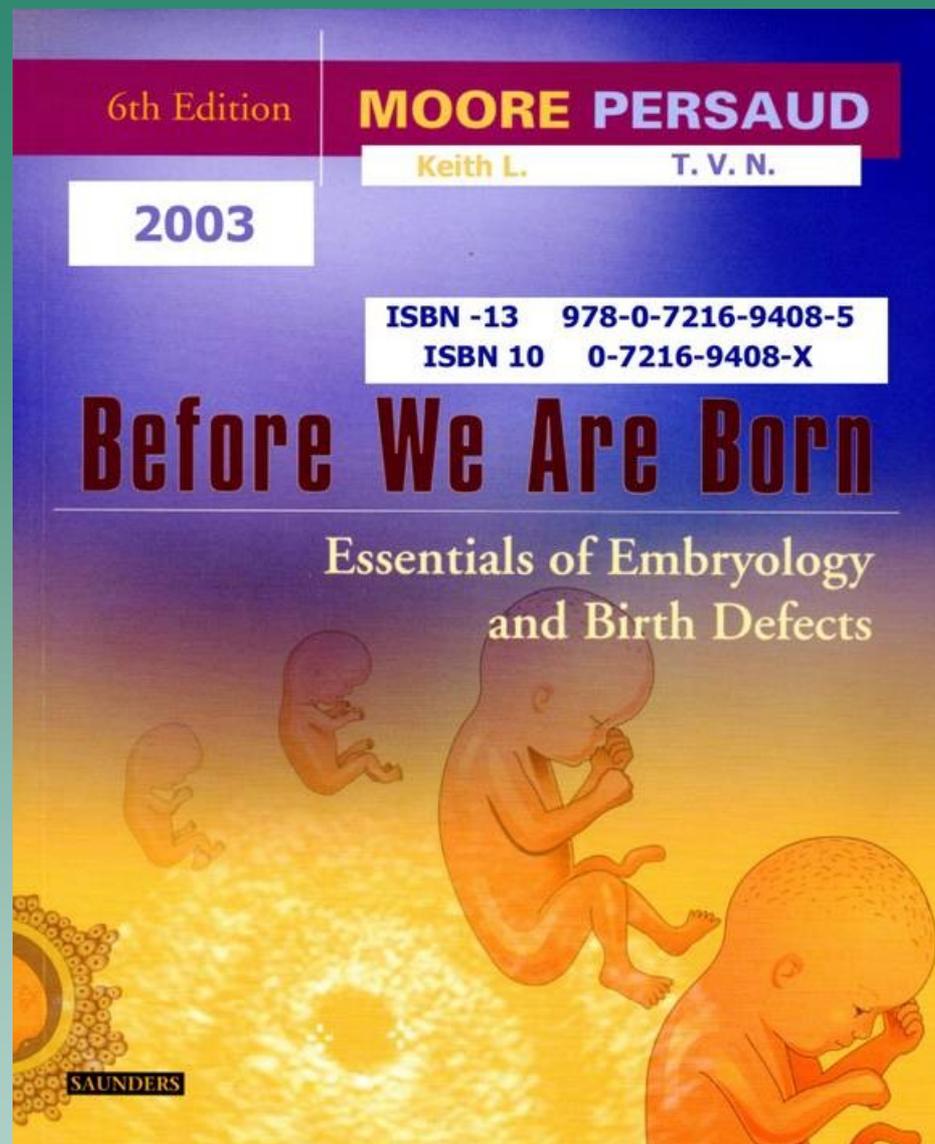
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# Lecture 1

# 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**

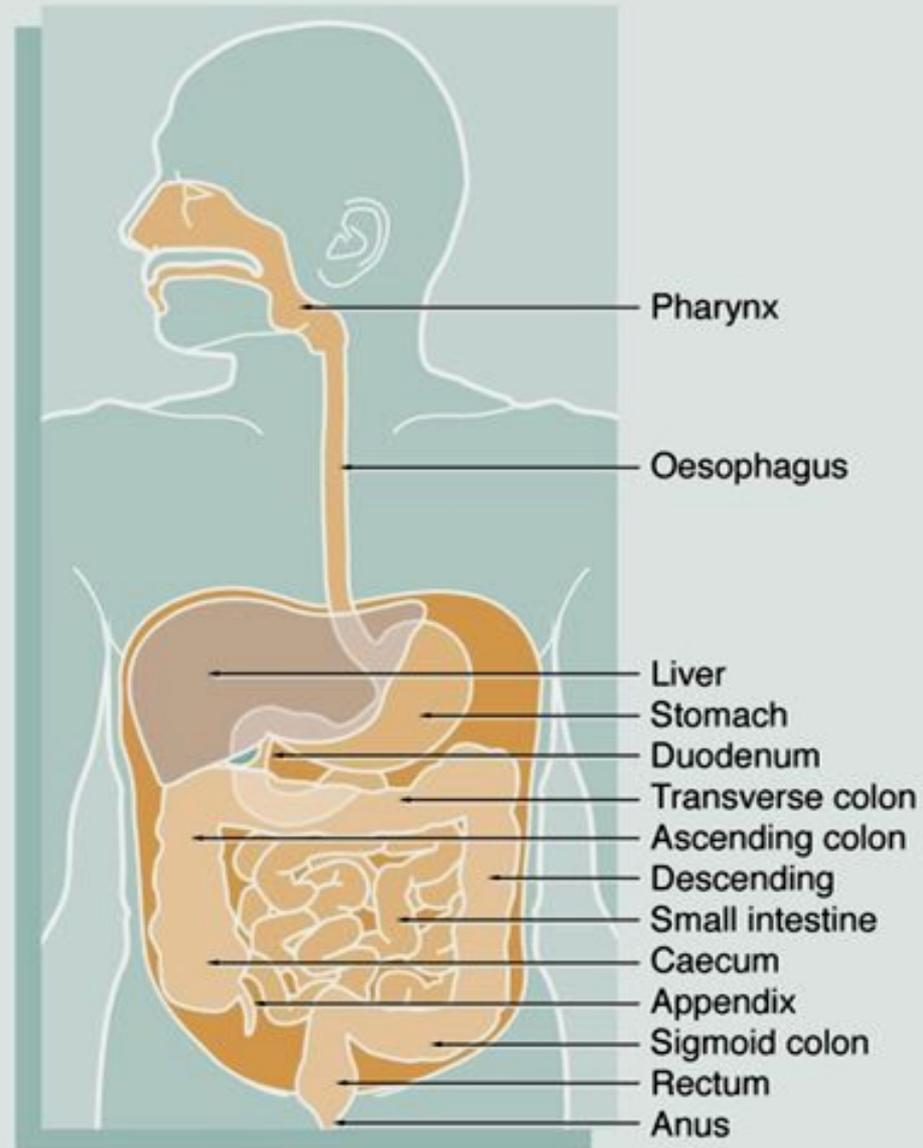
Digestive system consists of

■ 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 anlagen (organs):

**the stomodeum** (primitive mouth) – develops on the cephalic end of the embryo, is limited by 5 prominences (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**

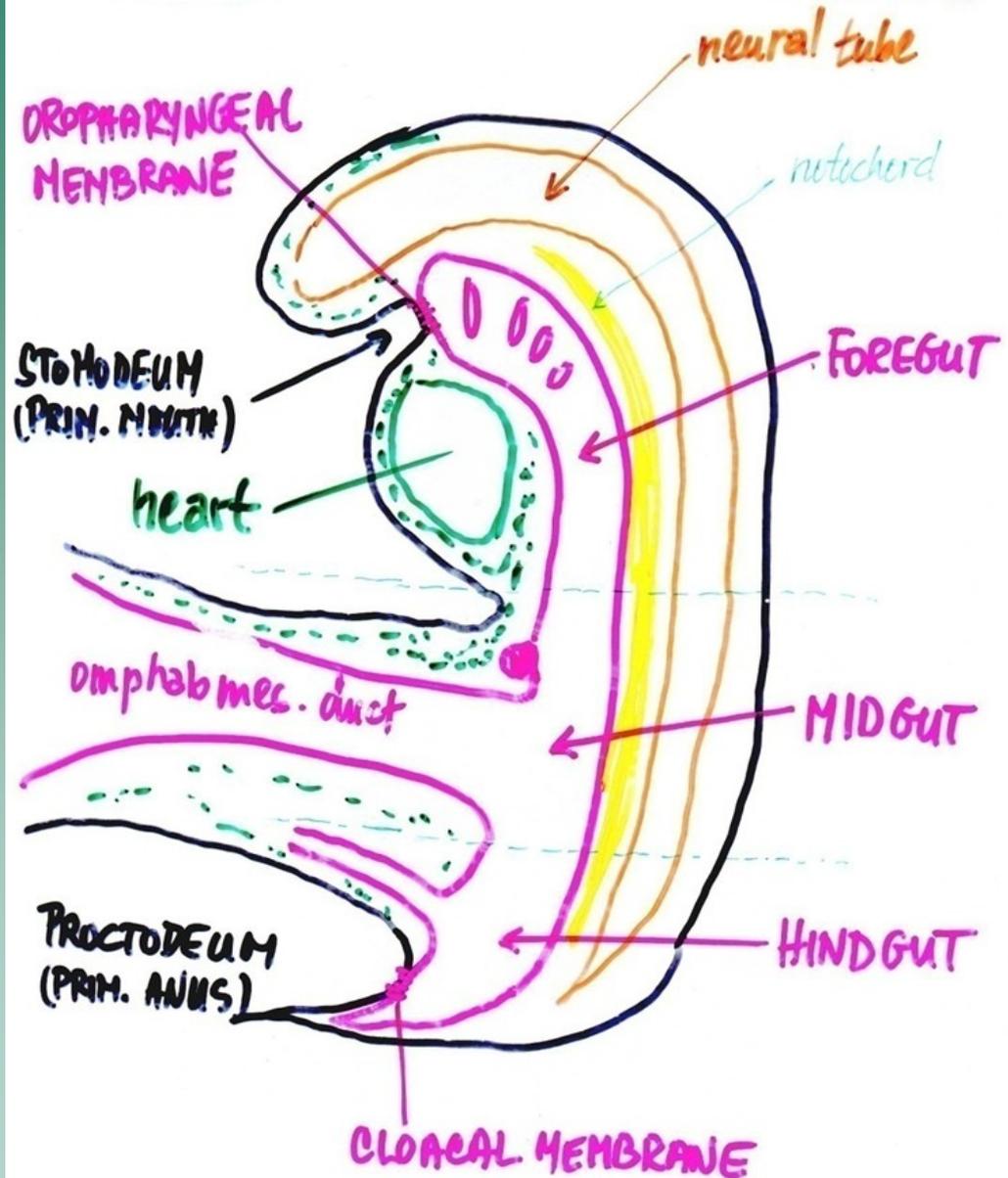
cloacal membrane

**proctodeum**

MEDIAN SECTION:

4th week - PRIMITIVE GUT

FOREGUT  
MIDGUT  
HINDGUT



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

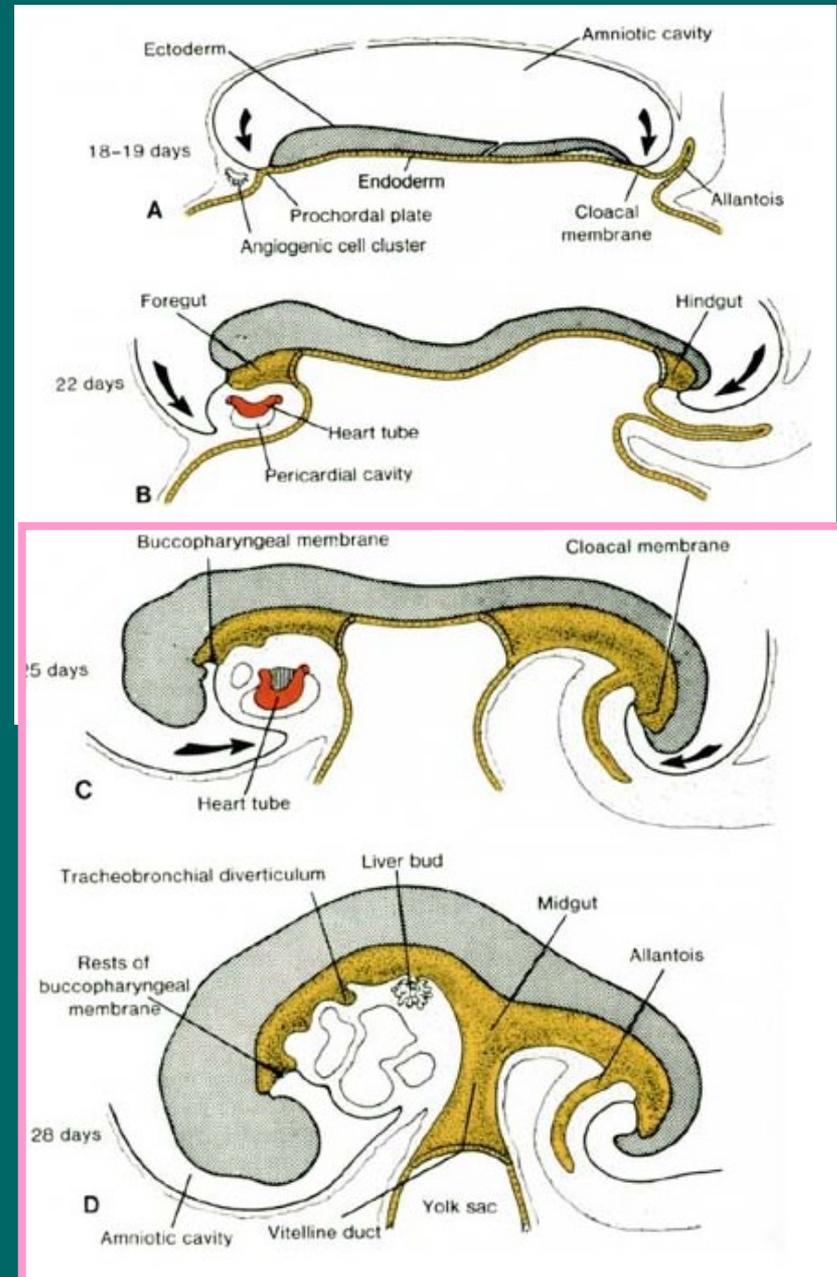
Segments of the primitive gut:

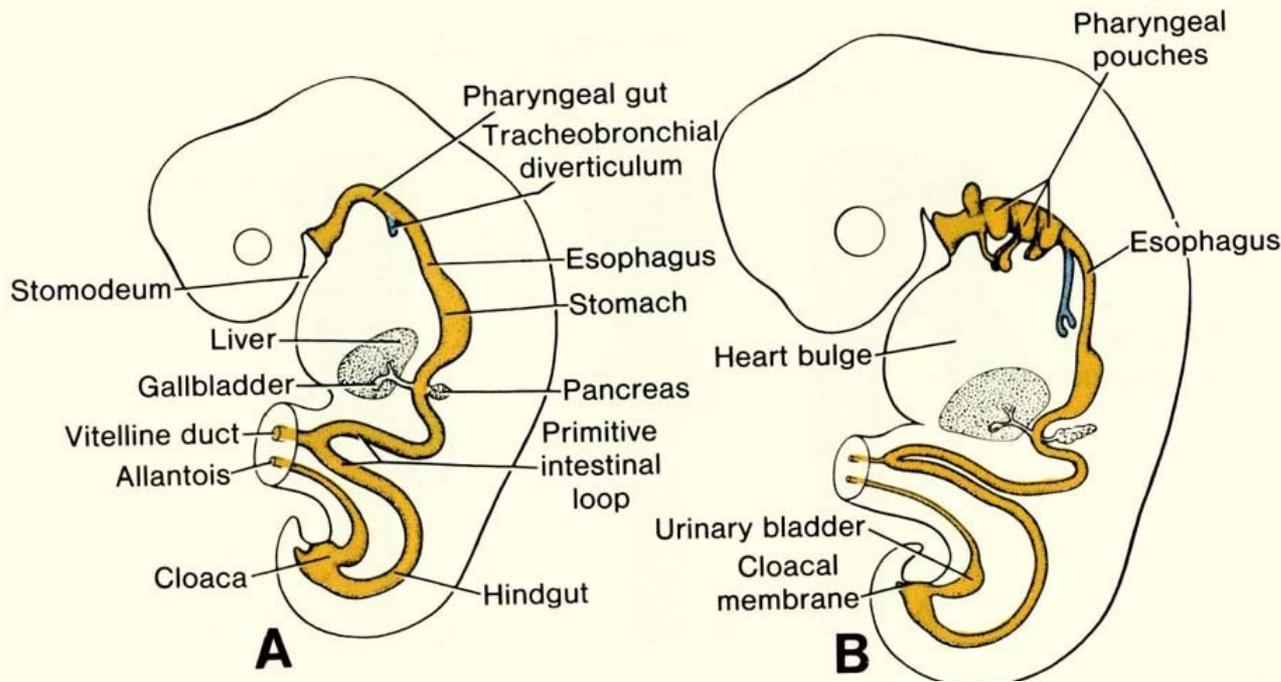
- foregut
- midgut
- hindgut

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

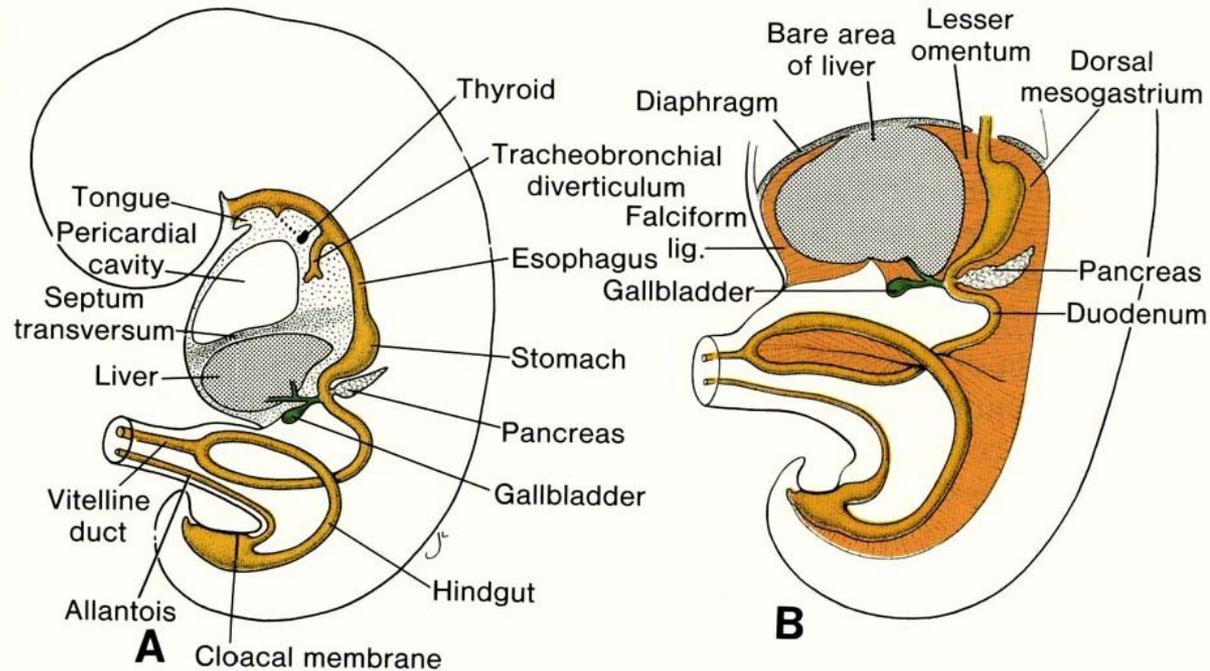
the dorsal mesentery – caudal end foregut – hindgut  
the ventral mesentery – shorter

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 definitive 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

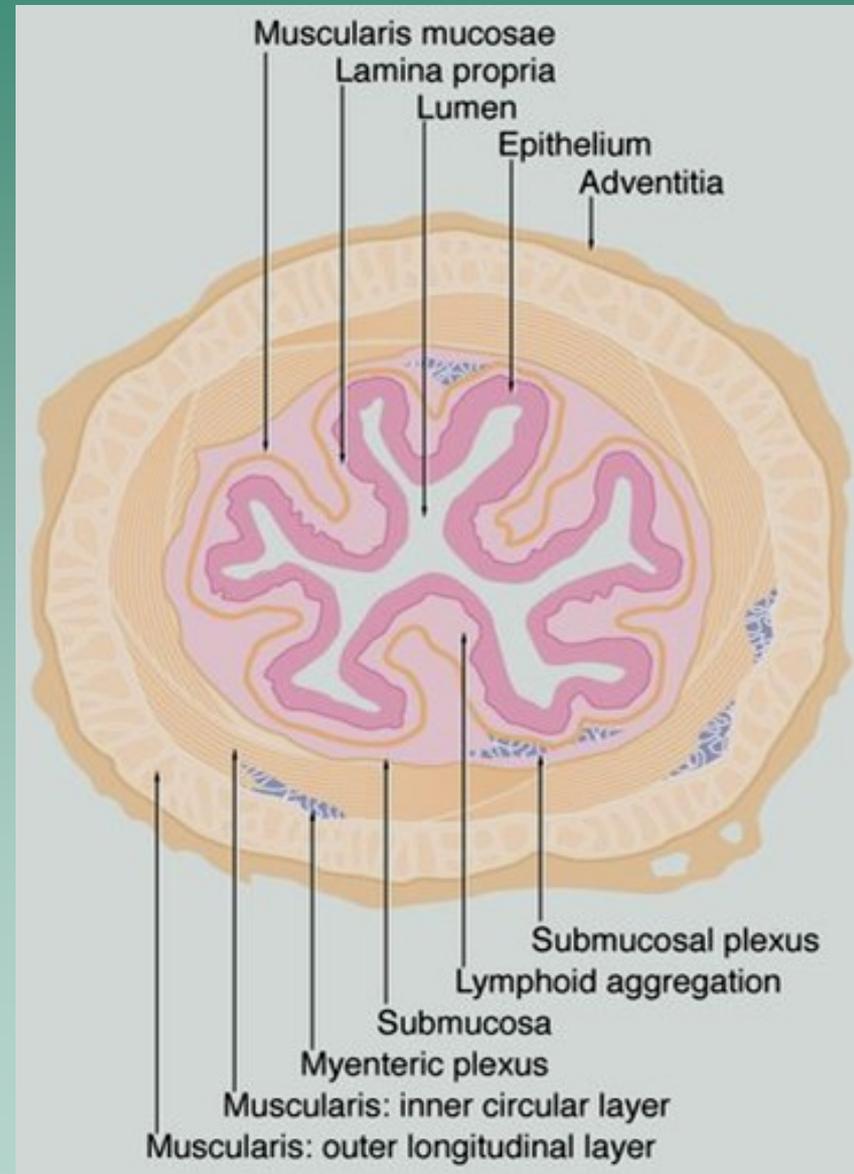
## **The hindgut:**

- 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

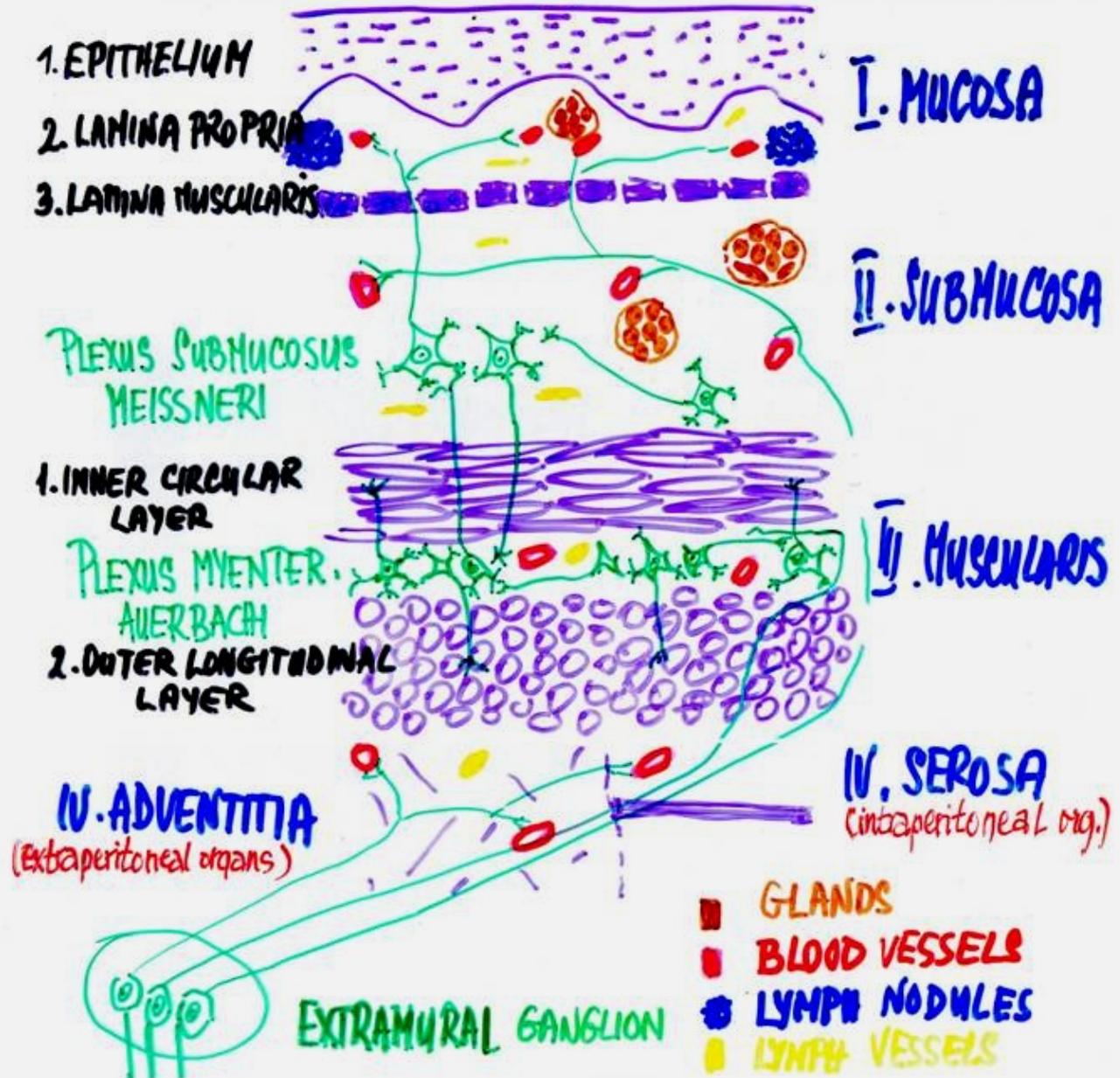
# General structure of the definitive alimentary canal

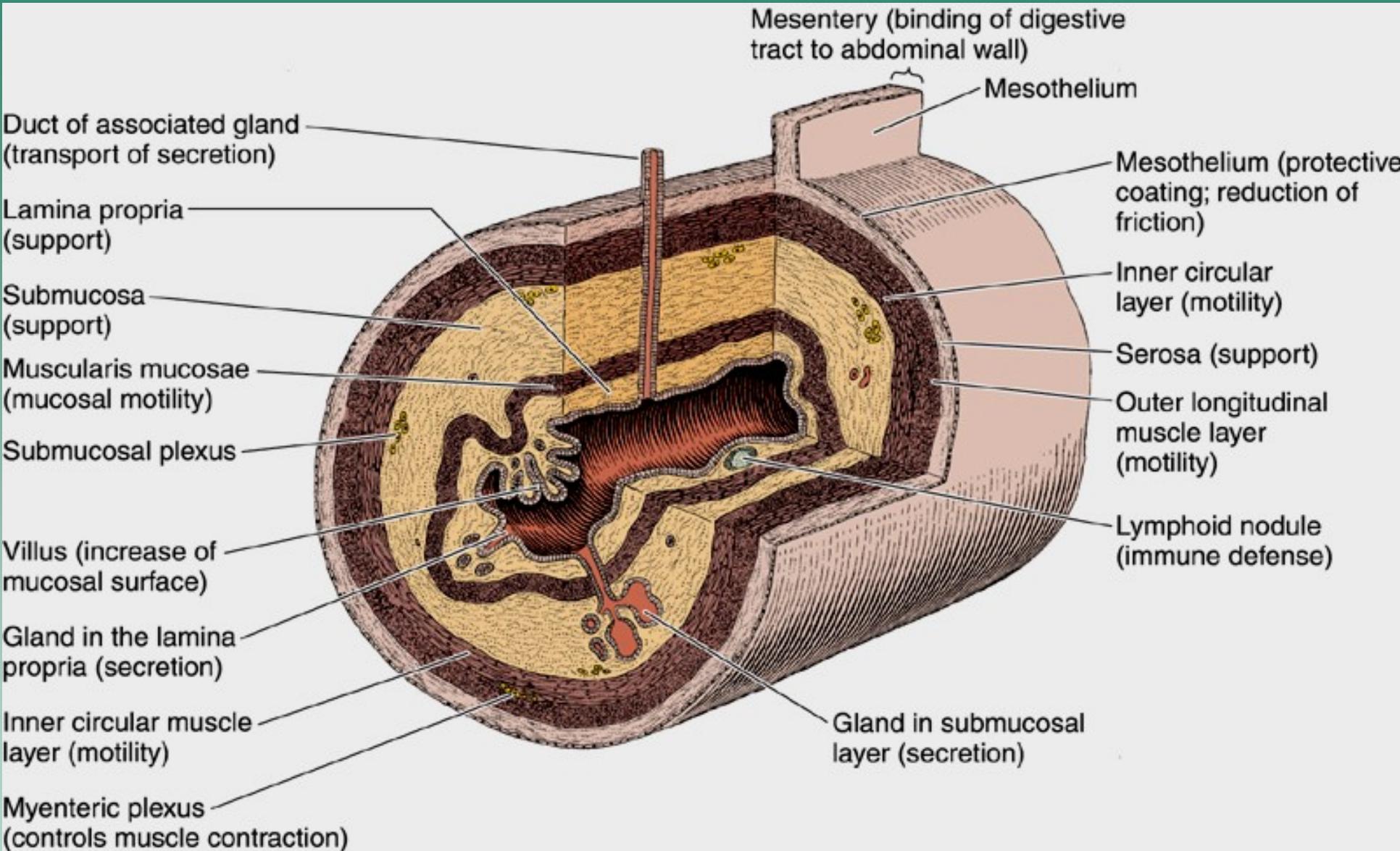
## Layers of the wall of the alimentary canal:

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



# Sublayers :





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

**HISTOPHYSIOLOGY OF THE INTESTINE AND  
BLOOD CIRCULATION**

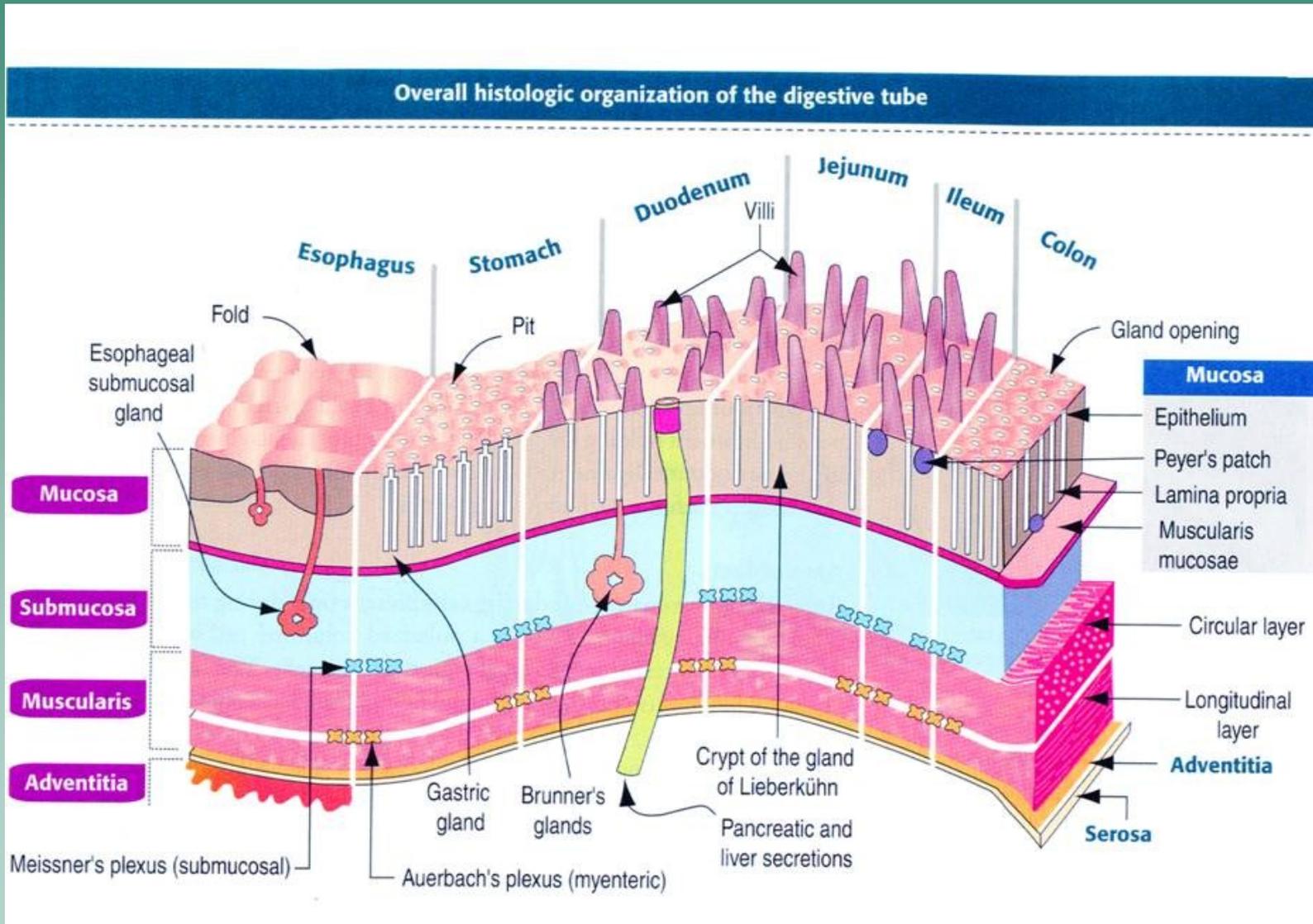
# external appearance of the mucosa

shows close relation to function of the respective segment

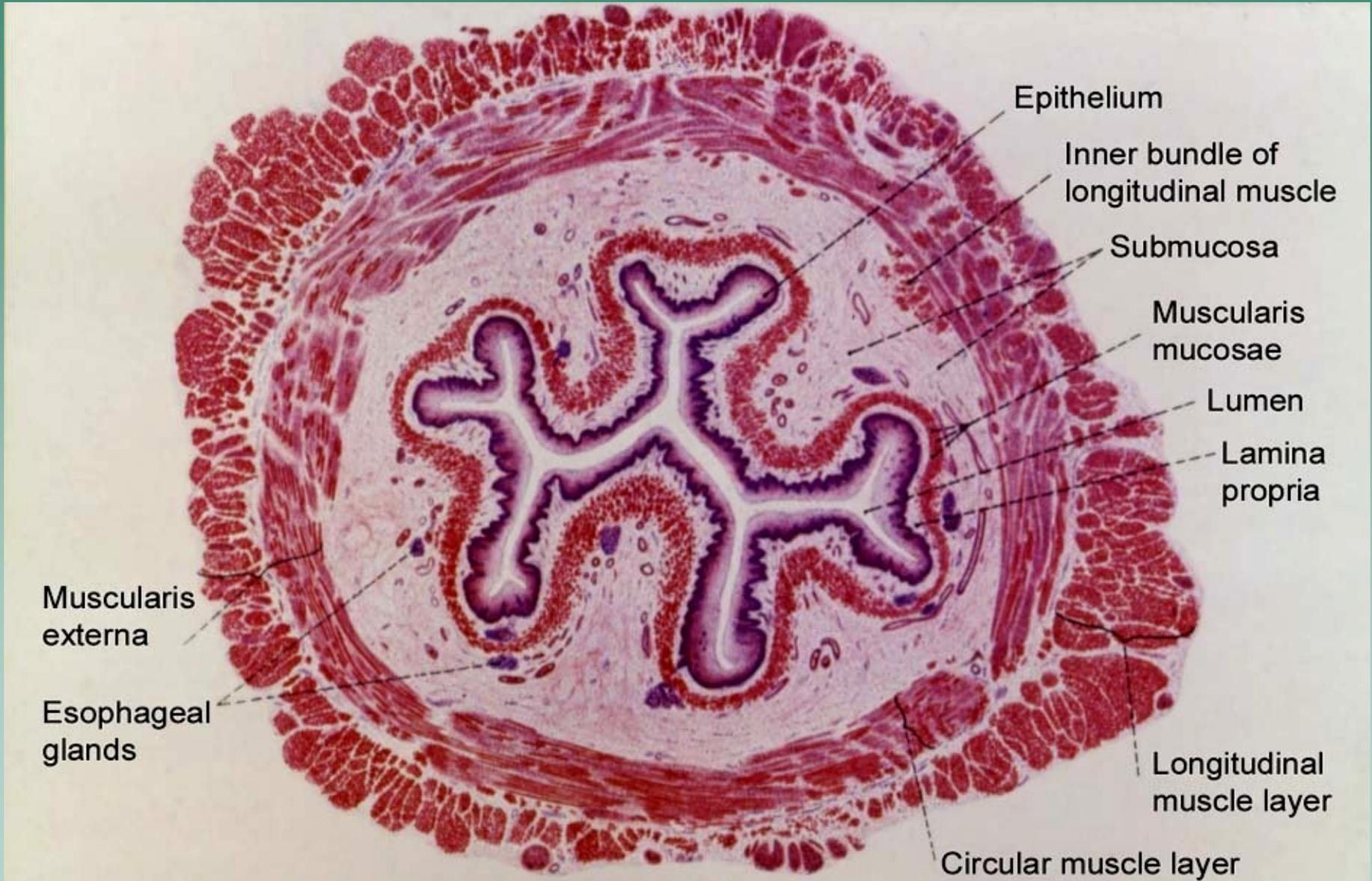
  folds (transient or permanent)

  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)

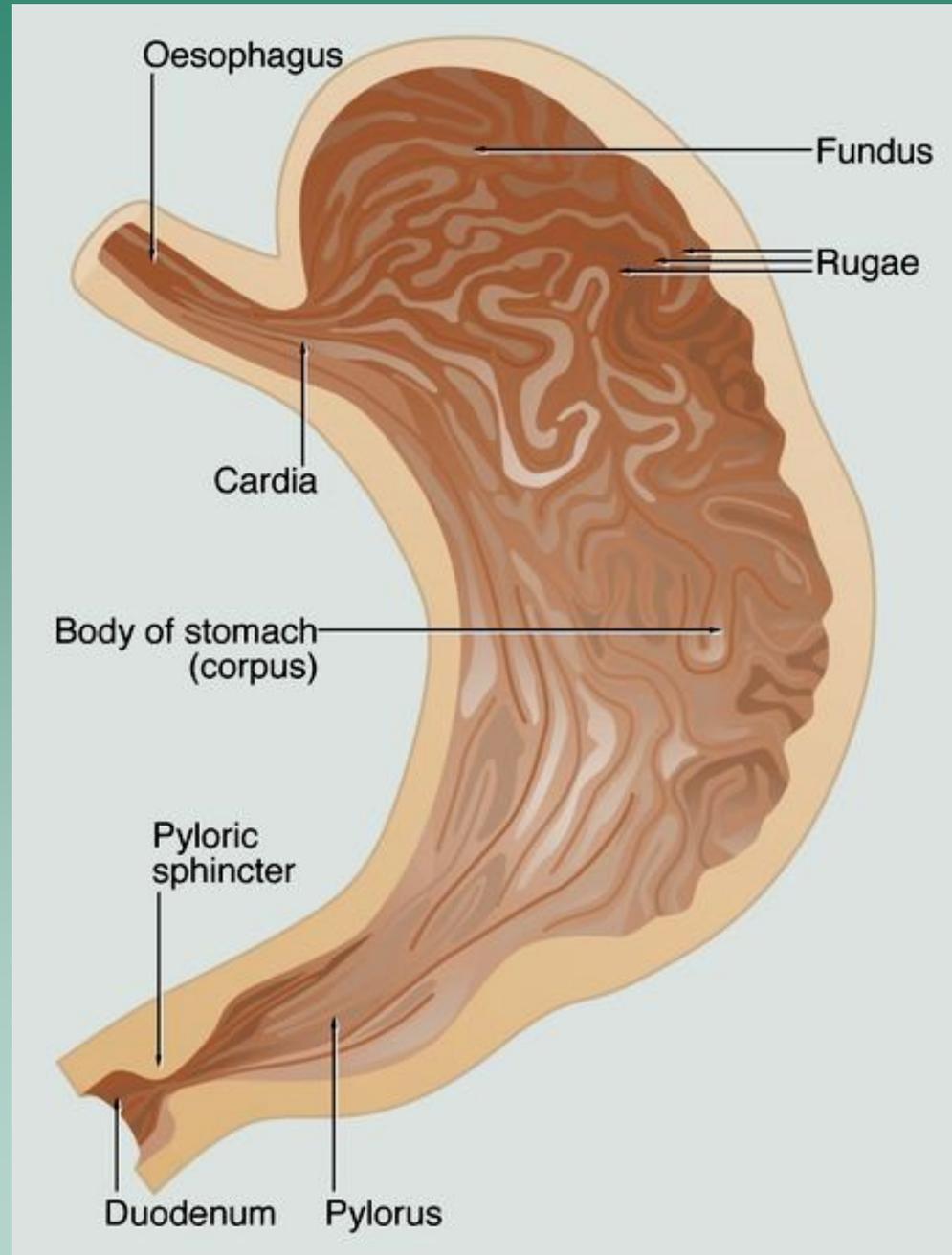
**gastric areas** (2-6 mm in d.)

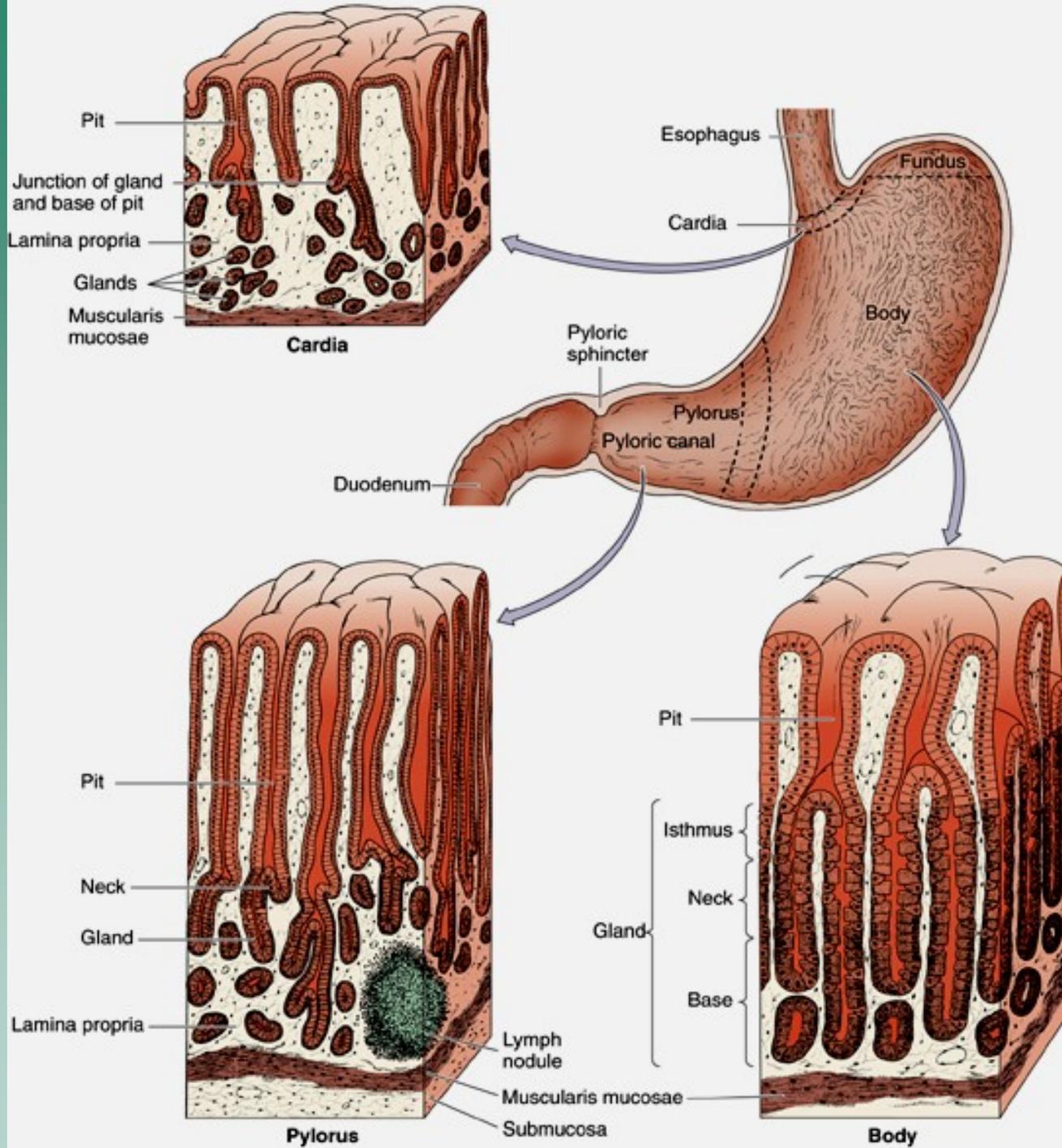
**gastric pits** (foveolae gastricae) - are tiny grooves

**2. submucous coat** - loose areolar tissue

**3. muscular coat** - inner oblique  
- middle circular  
- outer longitudinal

**4. serous coat** - peritoneal covering



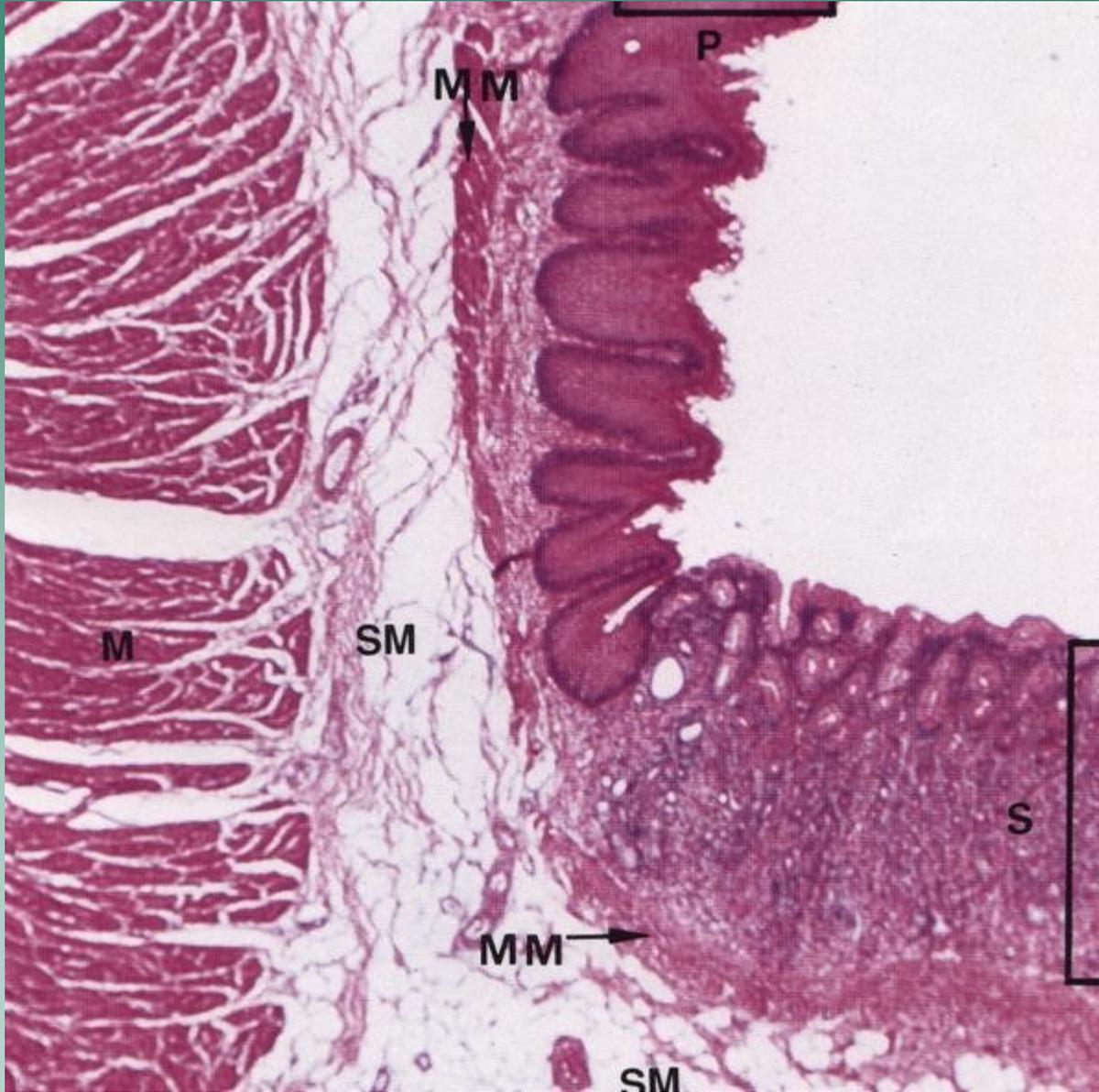


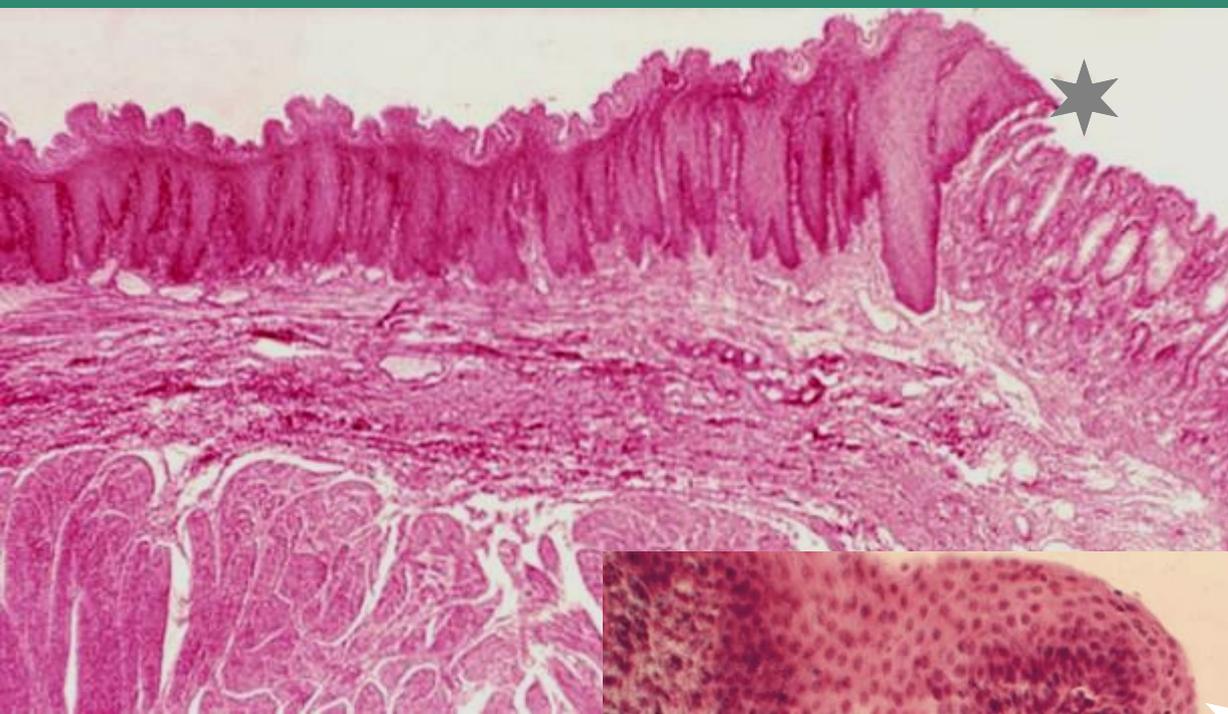
# Cardia ventriculi:

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

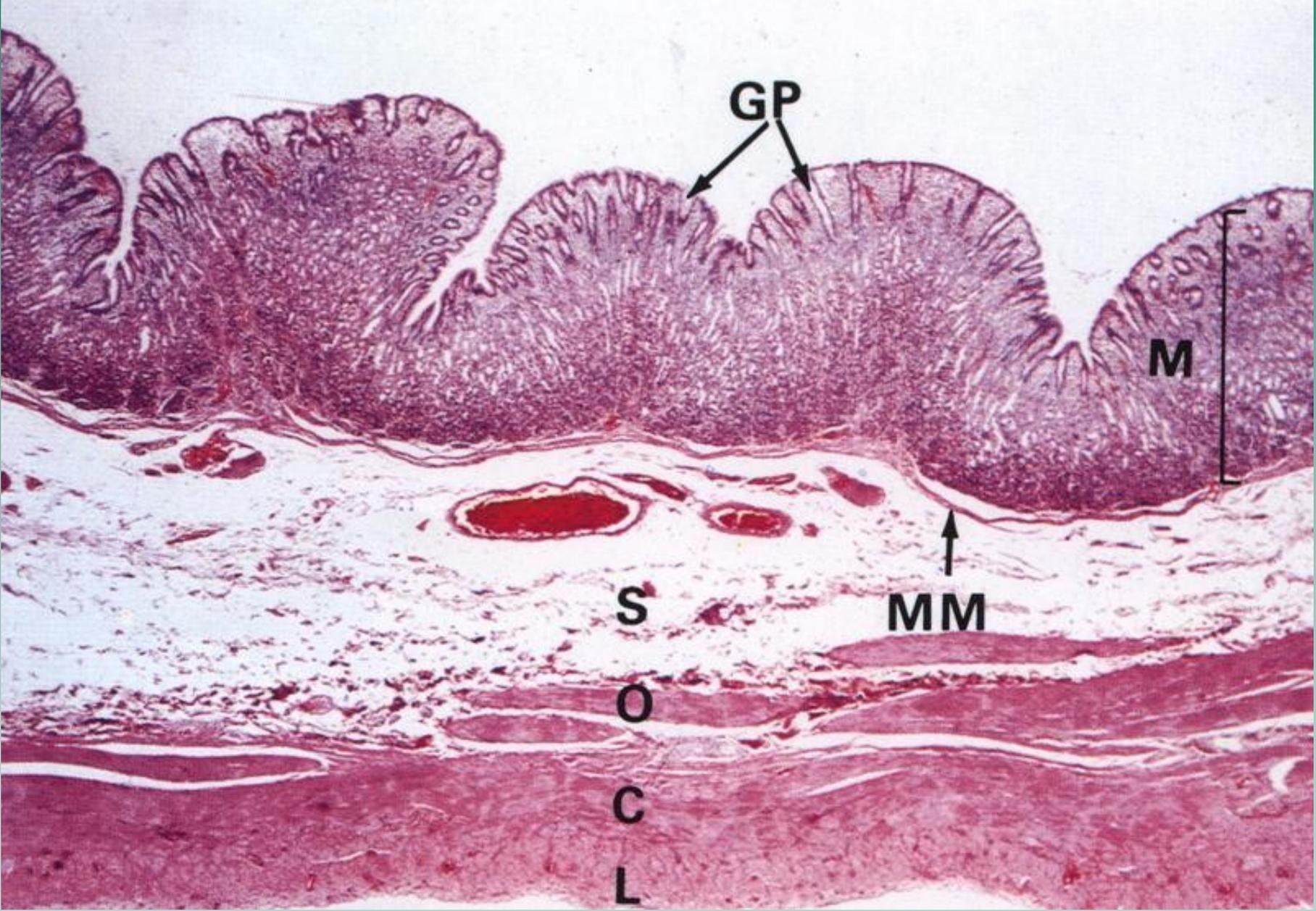
site of change of the epithelium

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

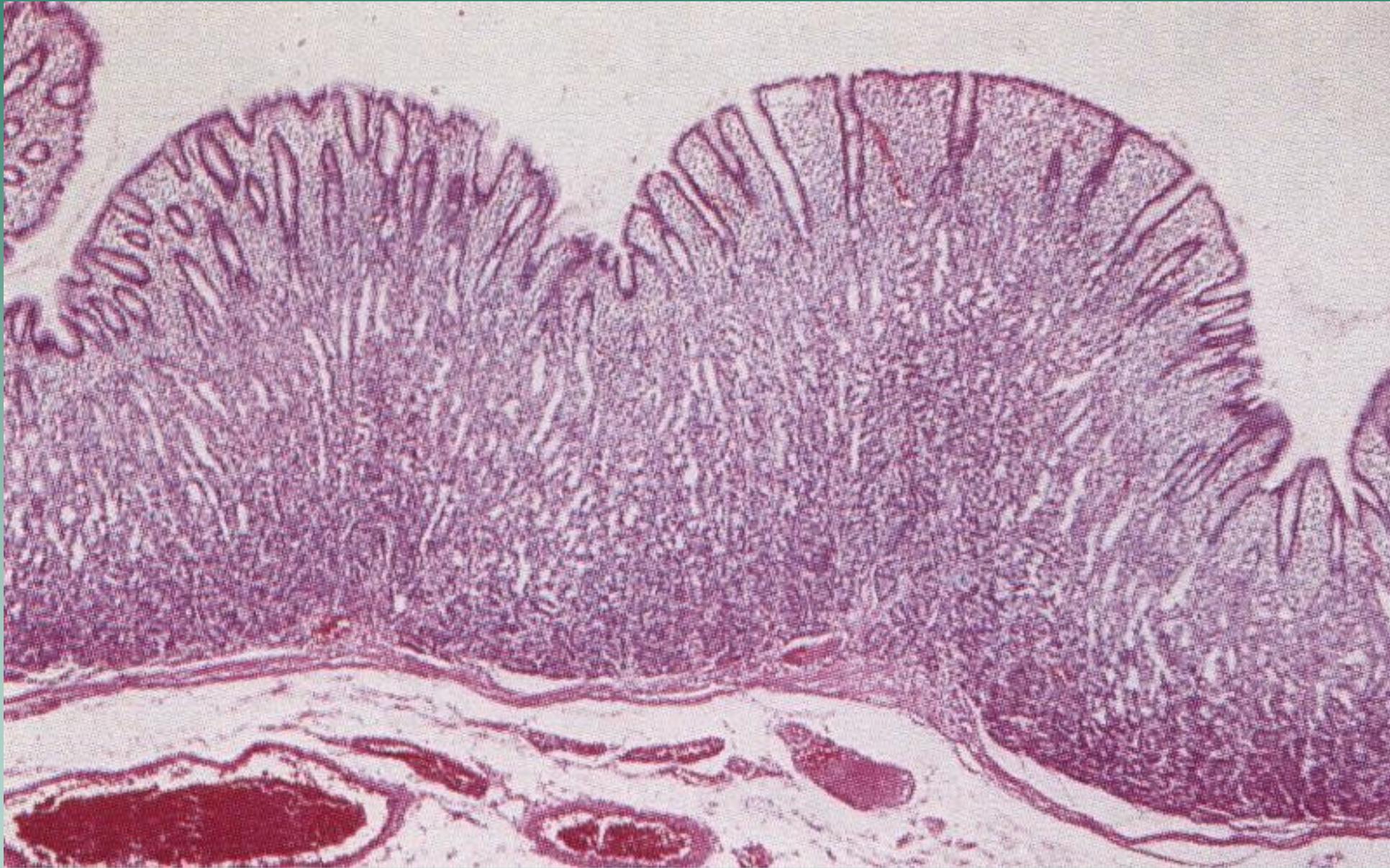




**Fundus et corpus ventriculi:**

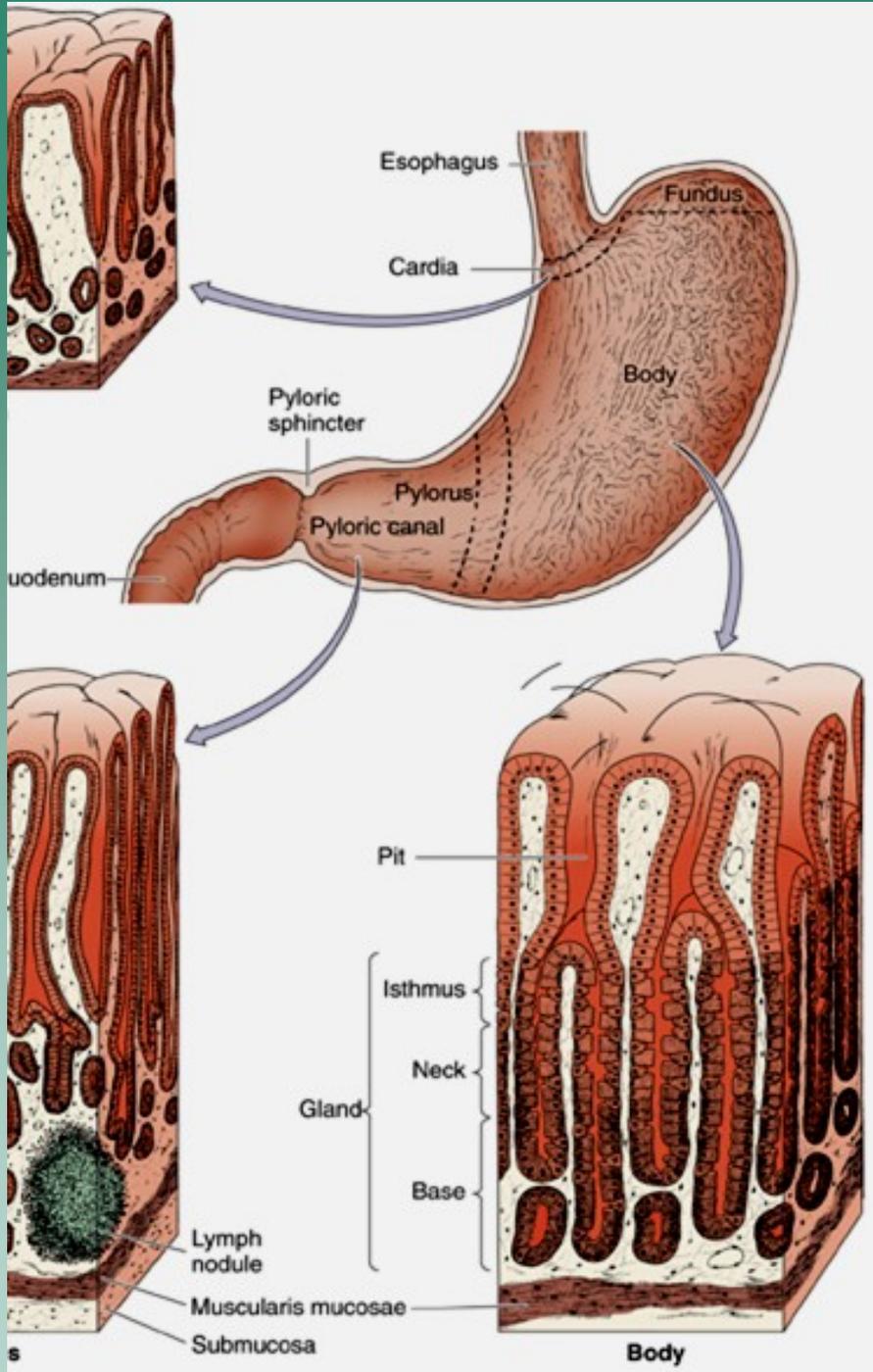


**Fundus et corpus ventricul – gastric areas:**



## 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**

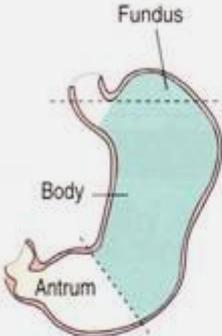
**3 parts: base, body and neck**

**4 cell types:**

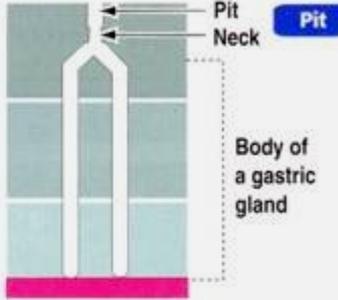
- chief (pepsinogenic)
- parietal (oxyntic, HCl)
- mucous neck
- enteroendocrine

**gastric juice**

**Fundus-body region of the stomach: The gastric gland**

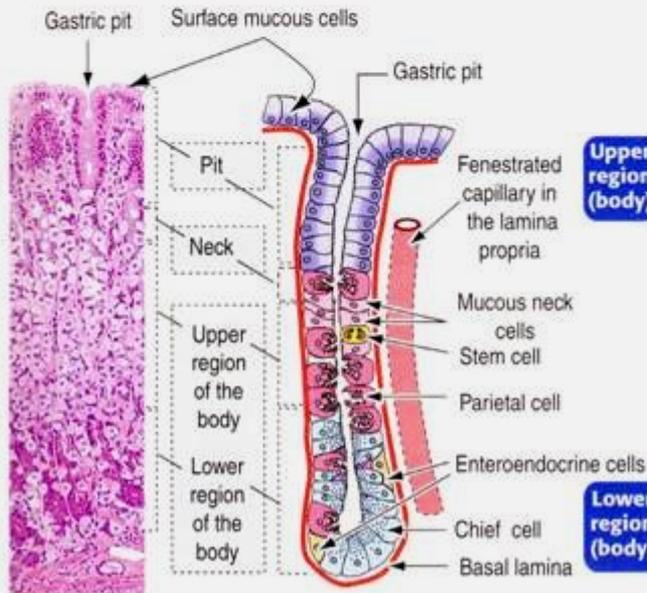


Fundus  
Body  
Antrum

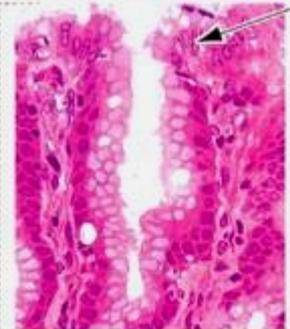


Pit  
Neck  
Body of a gastric gland

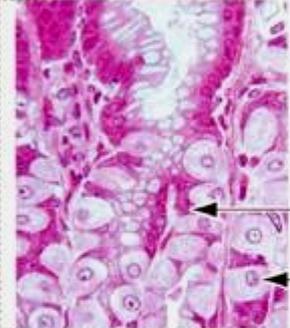
Gastric glands predominate in the fundus and body of the stomach. Two or more long and straight tubular glands—with their base ending at the muscularis mucosae—open into a common pit through a narrow neck.



Gastric pit  
Surface mucous cells  
Pit  
Neck  
Upper region of the body  
Lower region of the body  
Fenestrated capillary in the lamina propria  
Mucous neck cells  
Stem cell  
Parietal cell  
Enteroendocrine cells  
Chief cell  
Basal lamina

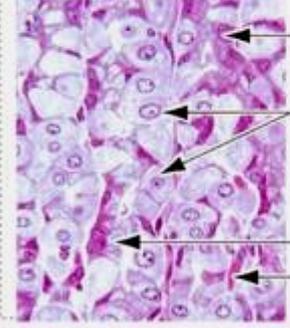


A simple columnar epithelium—consisting of **surface mucous cells**—lines the surface of the stomach and the pits. Surface mucous cells differ from goblet cells: their nucleus is oval-shaped and the mucus is stored in multiple small droplets (goblet cells display a flattened nucleus in the basal portion of the cell).



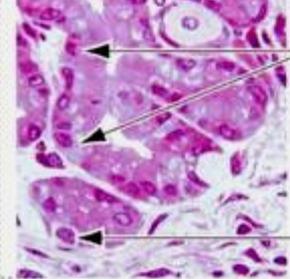
**Mucous neck cells** are located in the narrow portion of the gland near the gastric pit. This narrow region is known as the isthmus of gastric gland.

Mucous neck cells  
Parietal cell



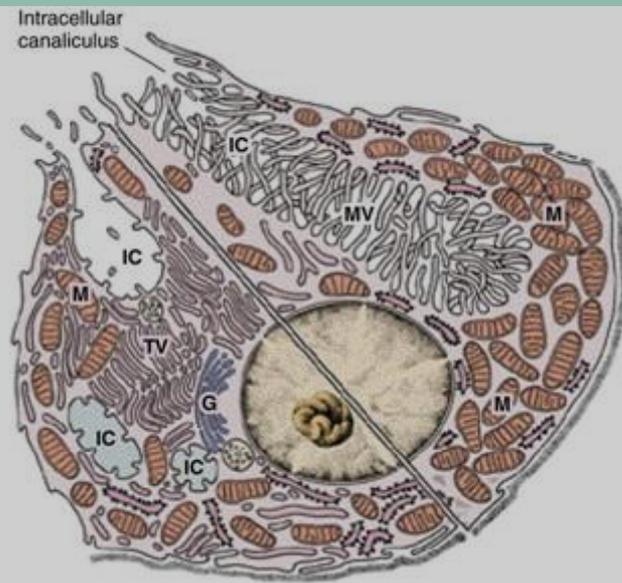
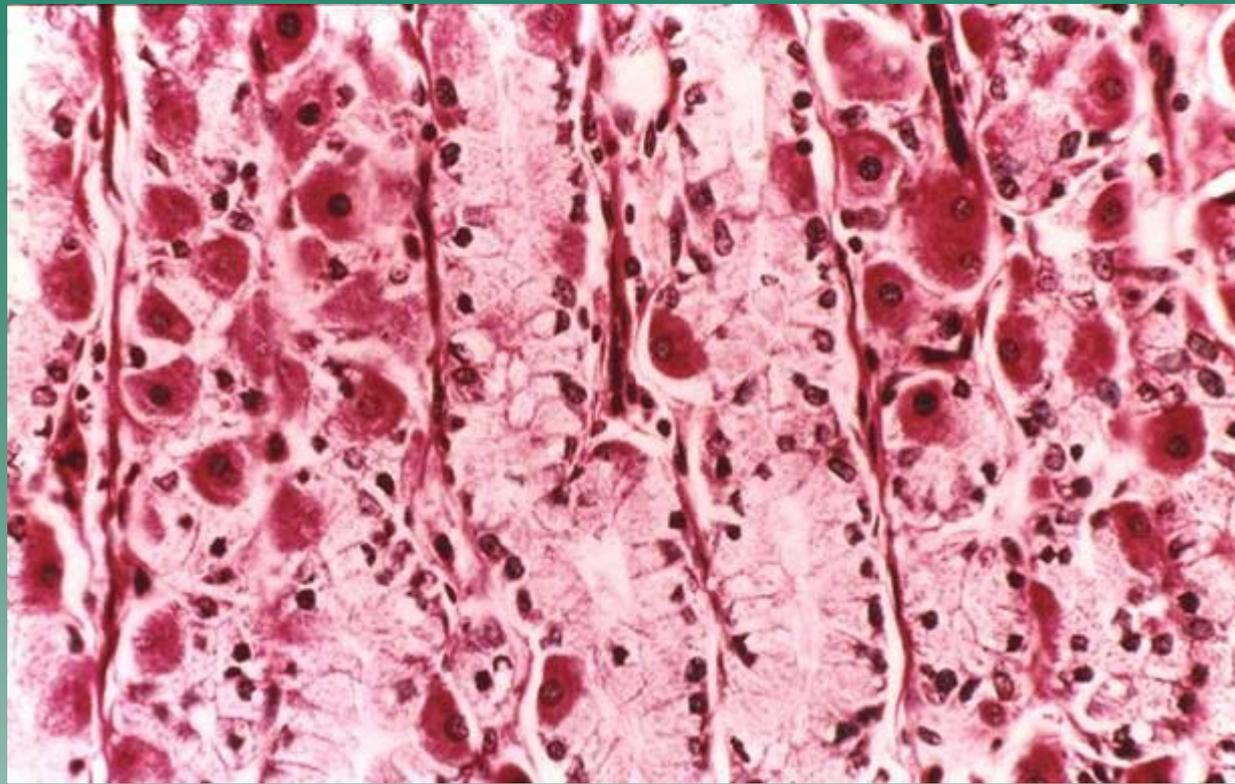
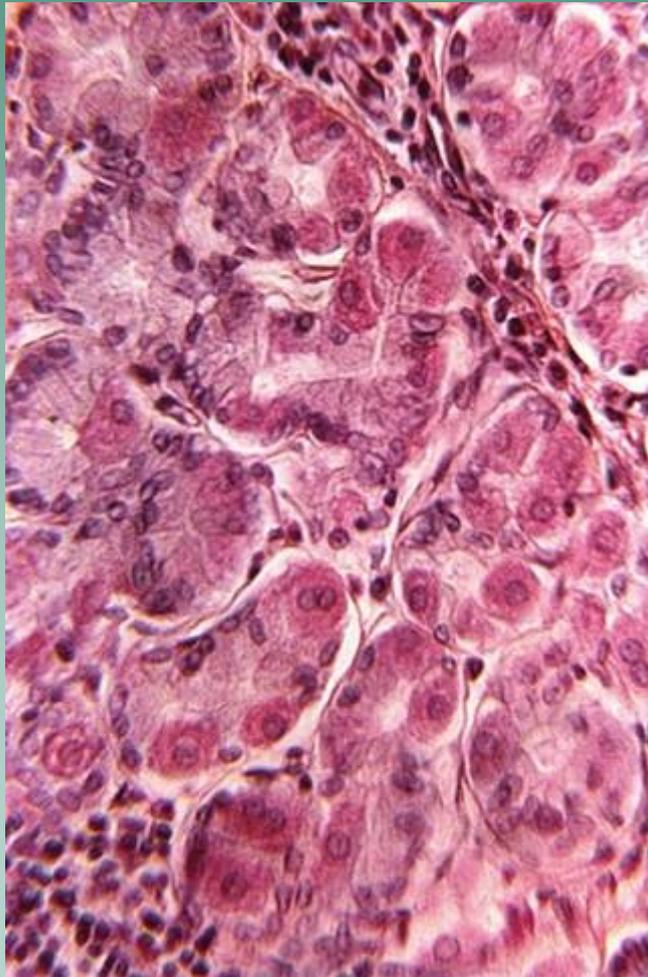
**Parietal cells** are numerous in the upper portion of the body of the gastric gland. Clusters of mucus neck cells and chief cells separate parietal cells.

Mucous neck cells  
Chief cell  
Fenestrated capillary in the lamina propria



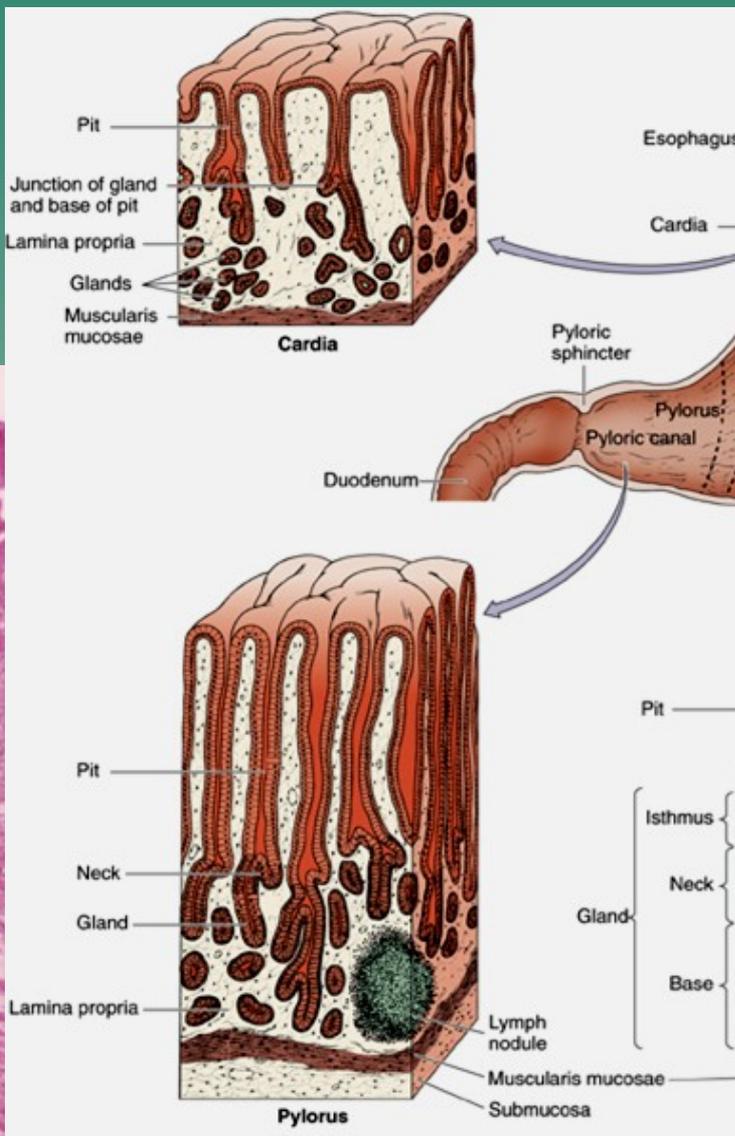
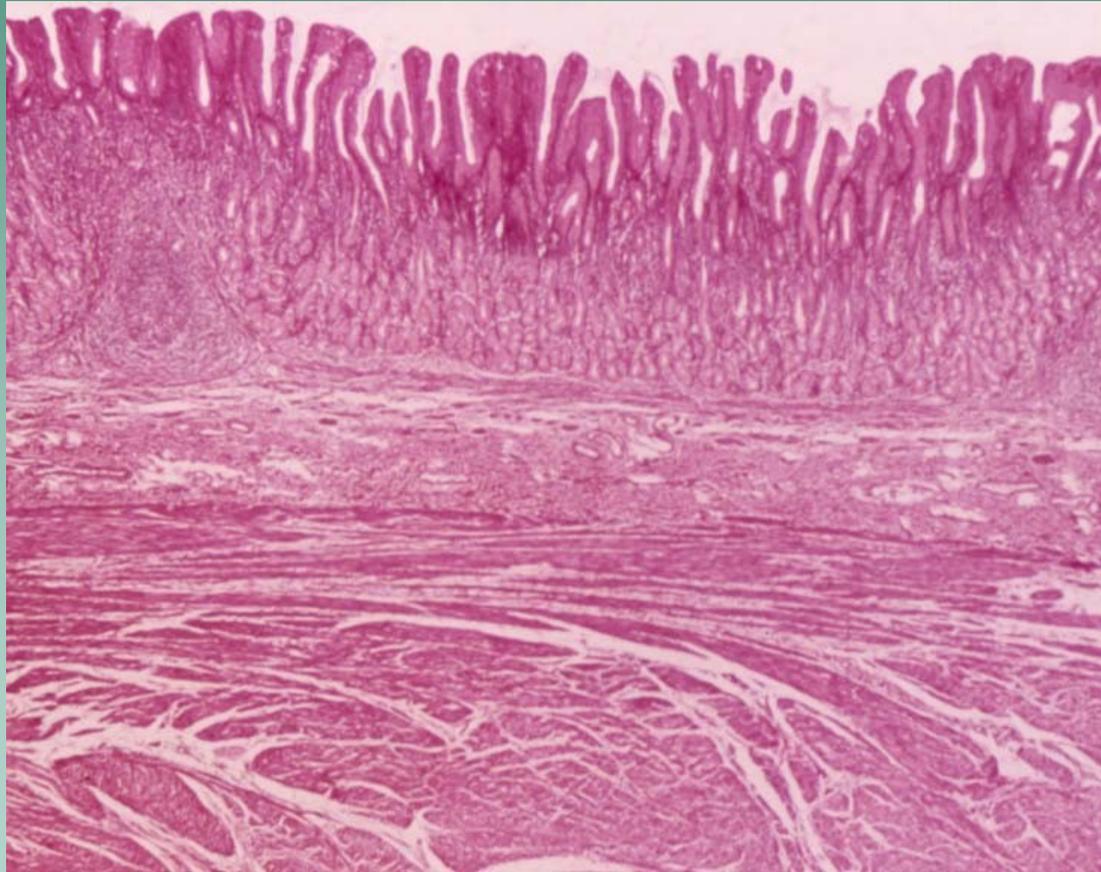
**Chief cells** predominate in the lower portion of the gastric gland. Their basal domain is basophilic and the apical domain contains secretory granules (pepsinogen).

Enteroendocrine cell with an apical nucleus and light cytoplasm



**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 and serous coat**

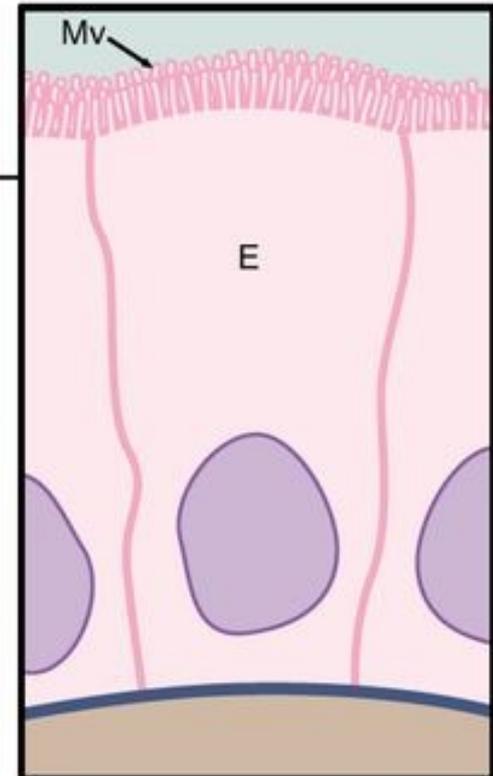
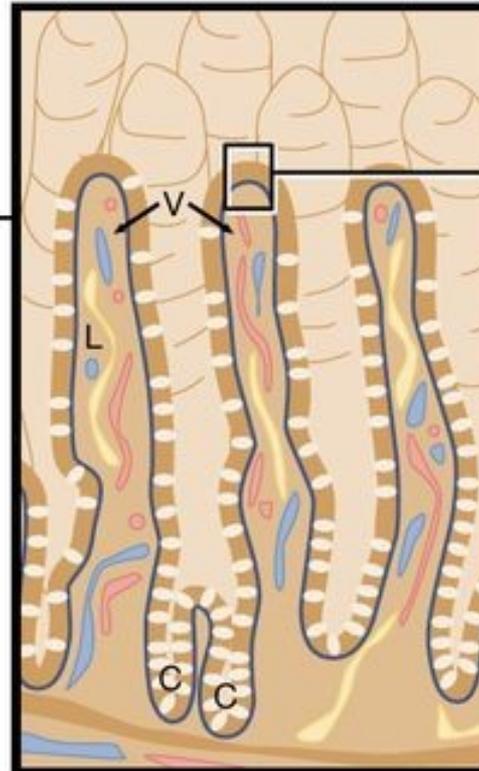
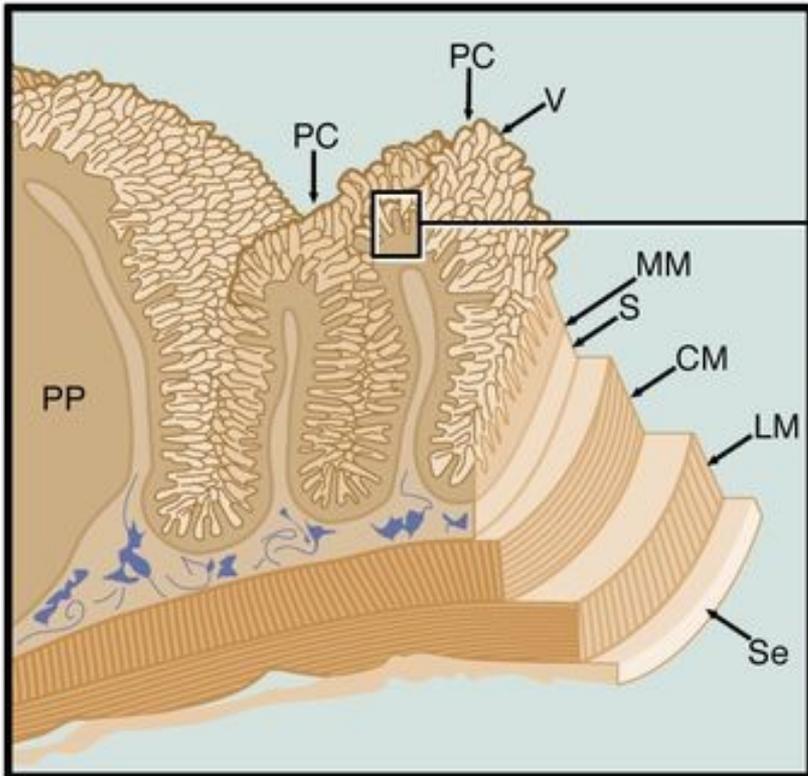
**Surface specialization of the mucosa:**

- 1. plicae circulares (valves of Kerckring)** - transverse and permanent 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)**

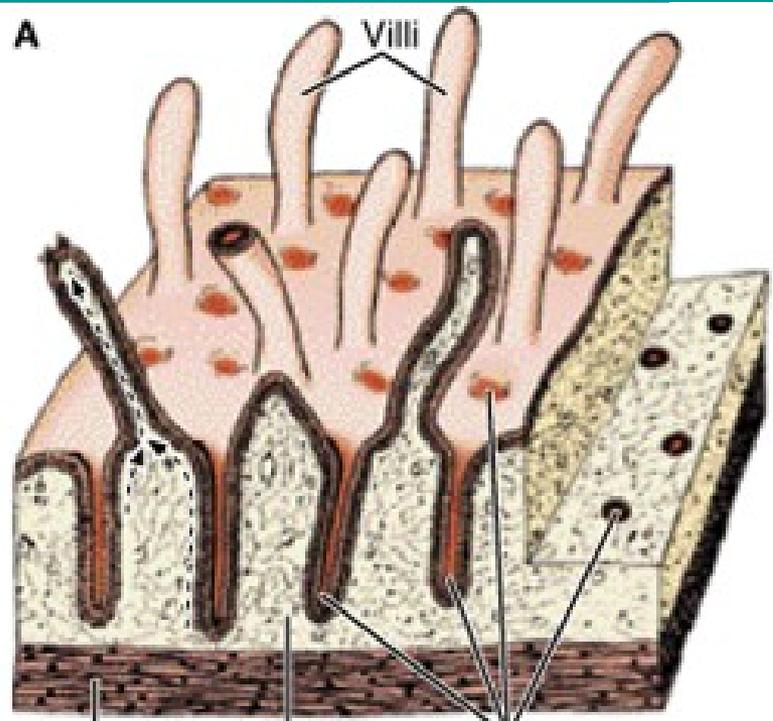
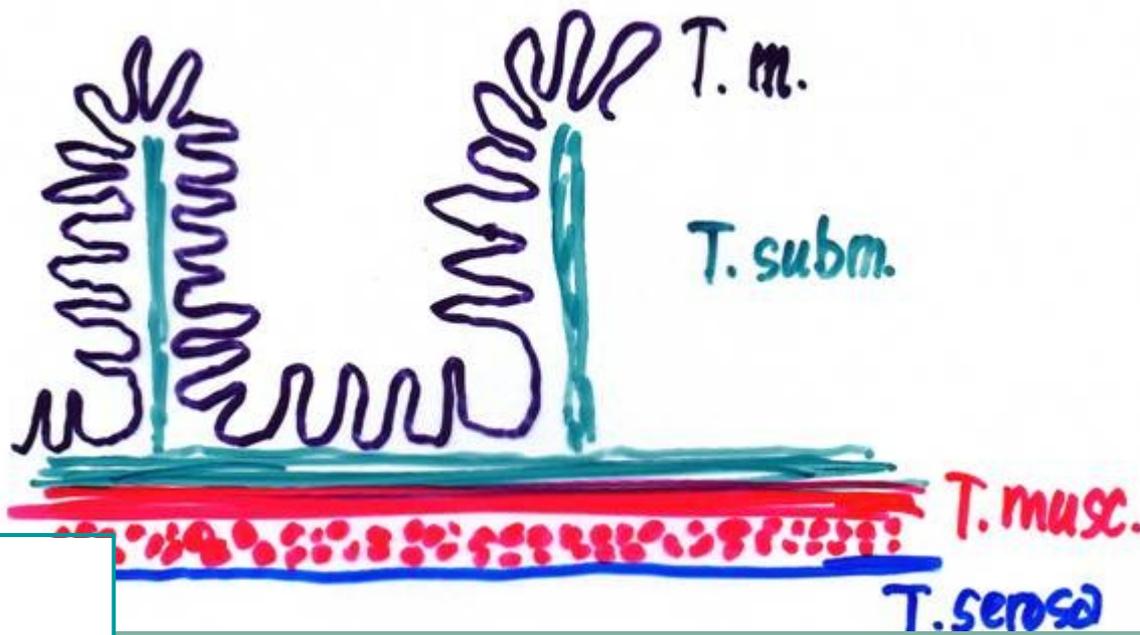
**Microvilli**



# Small intestine -

surface

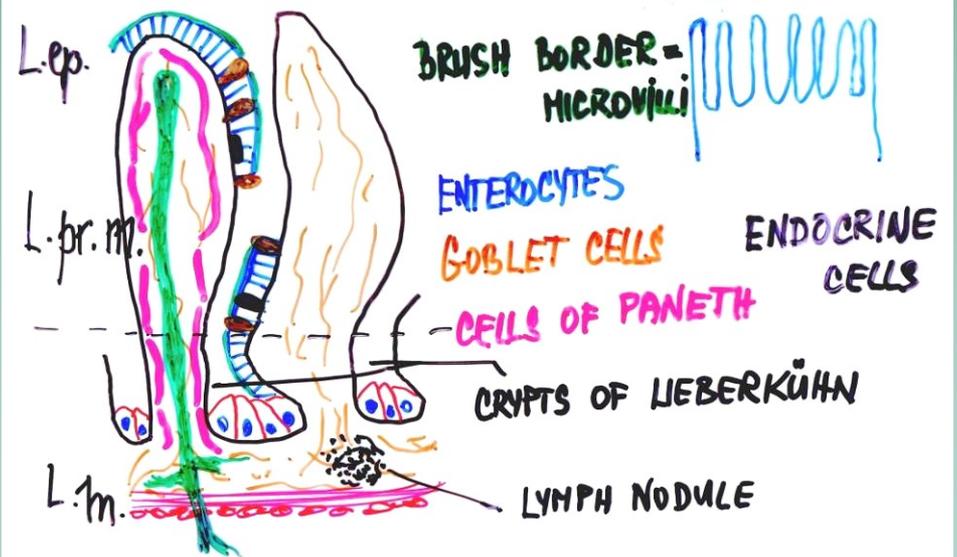
circular plicae (plicae of Kerckring, plicae circulares)



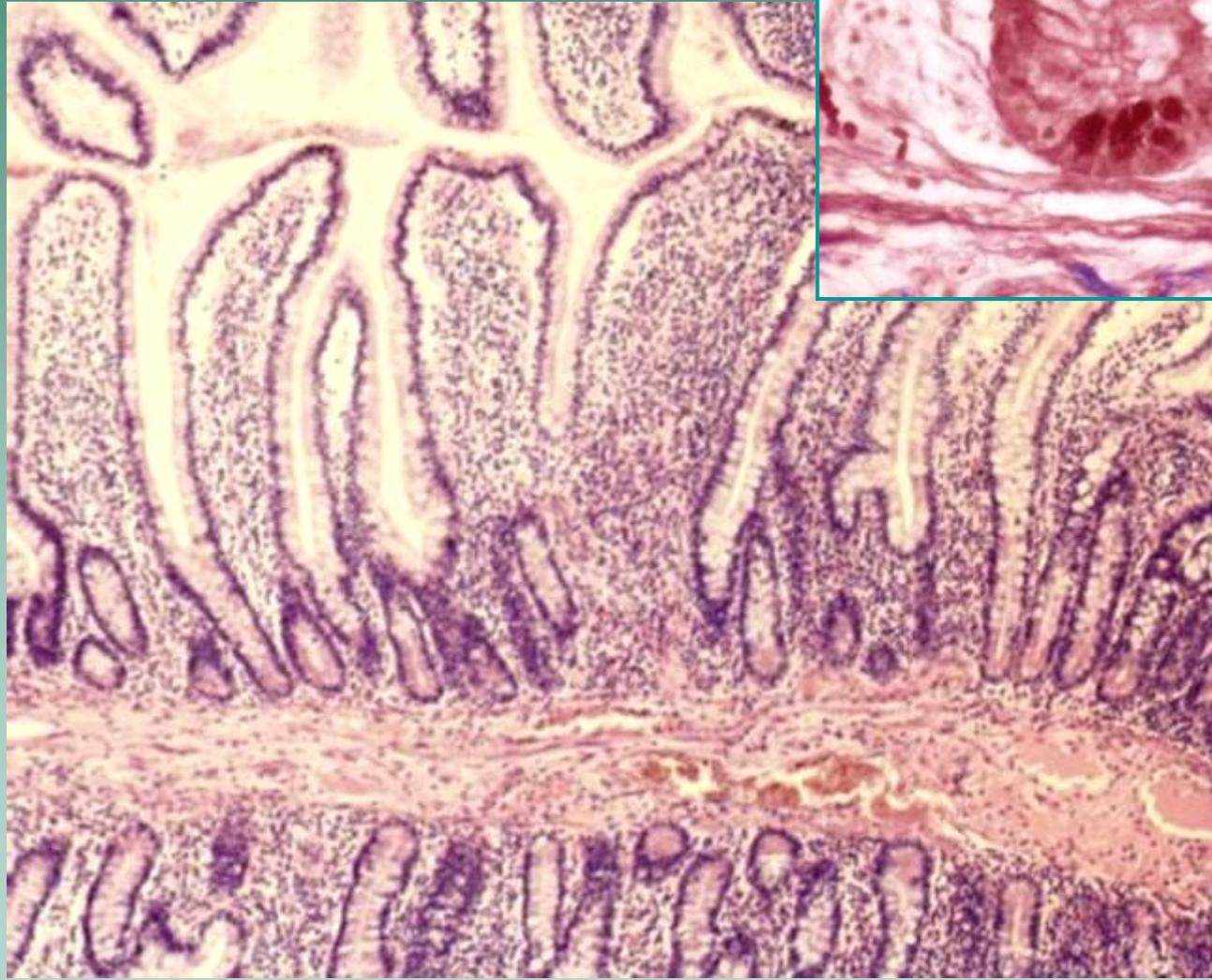
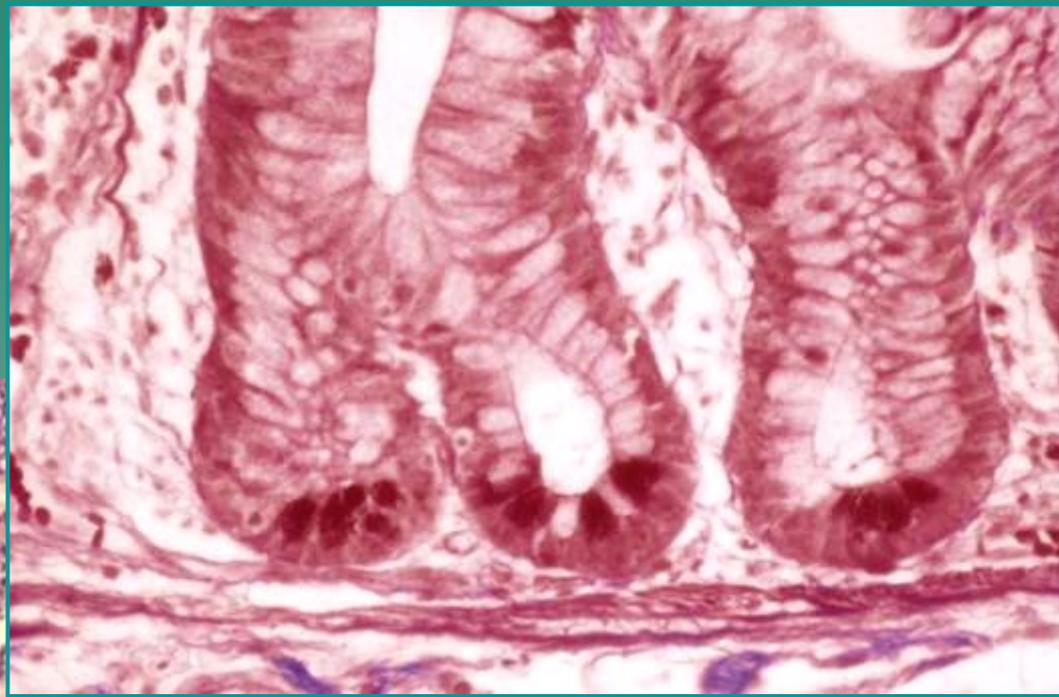
Muscularis mucosae  
Lamina propria  
Intestinal glands

## Intestinal villi (villi intestinales)

### Microvilli



# Intestinal villi (villi intestinales) and crypts of Lieberkühn

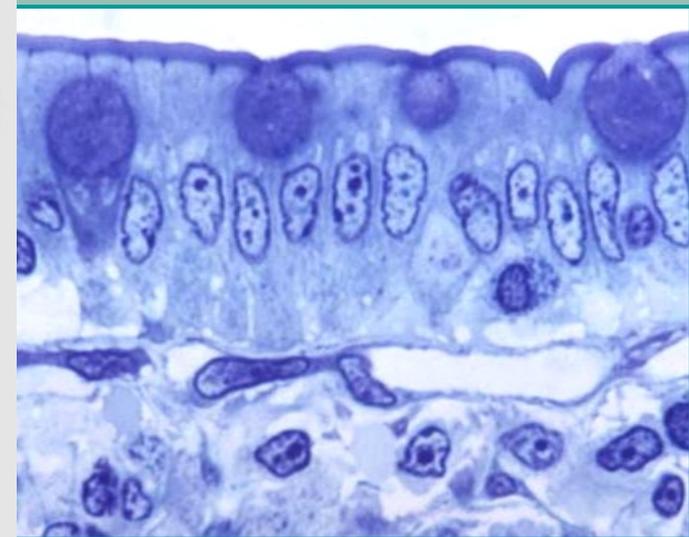
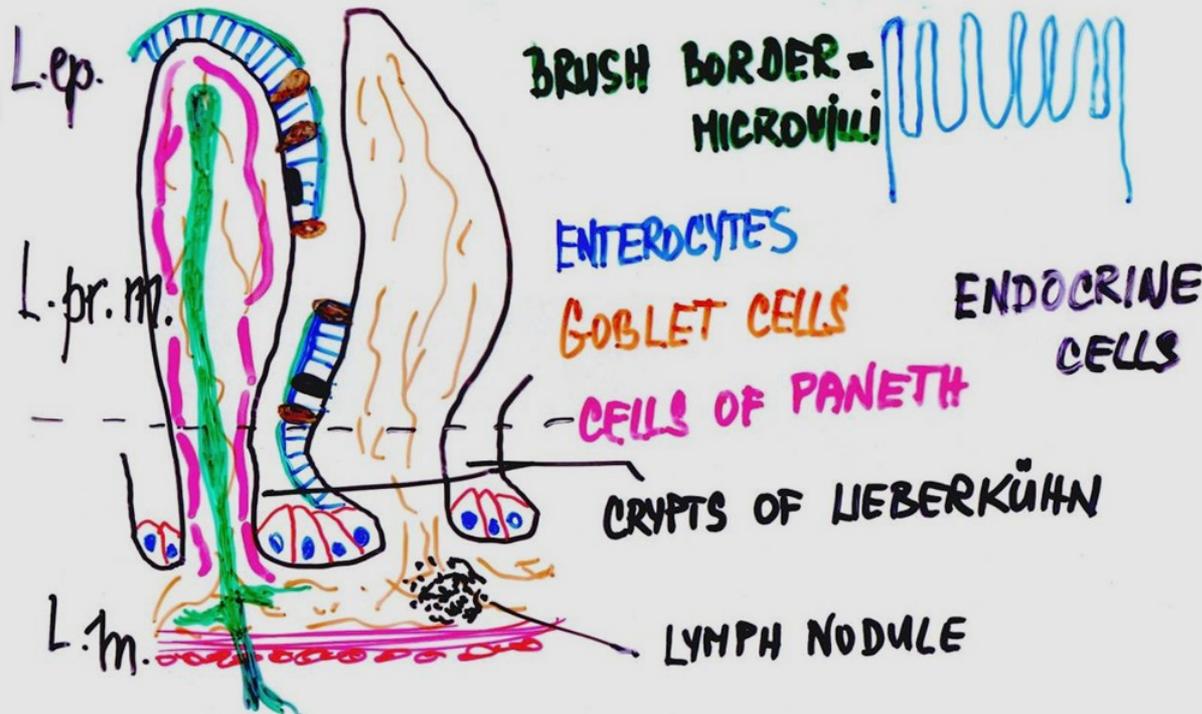
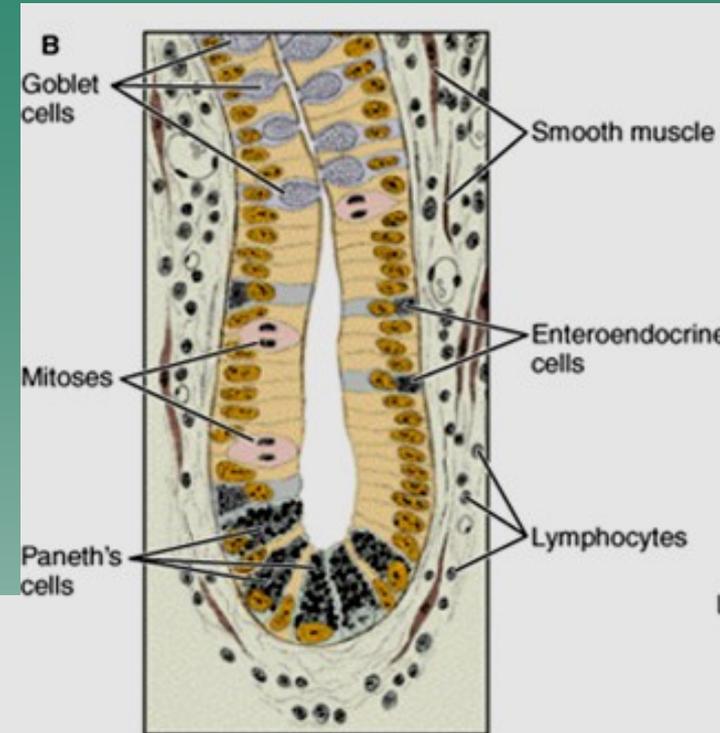


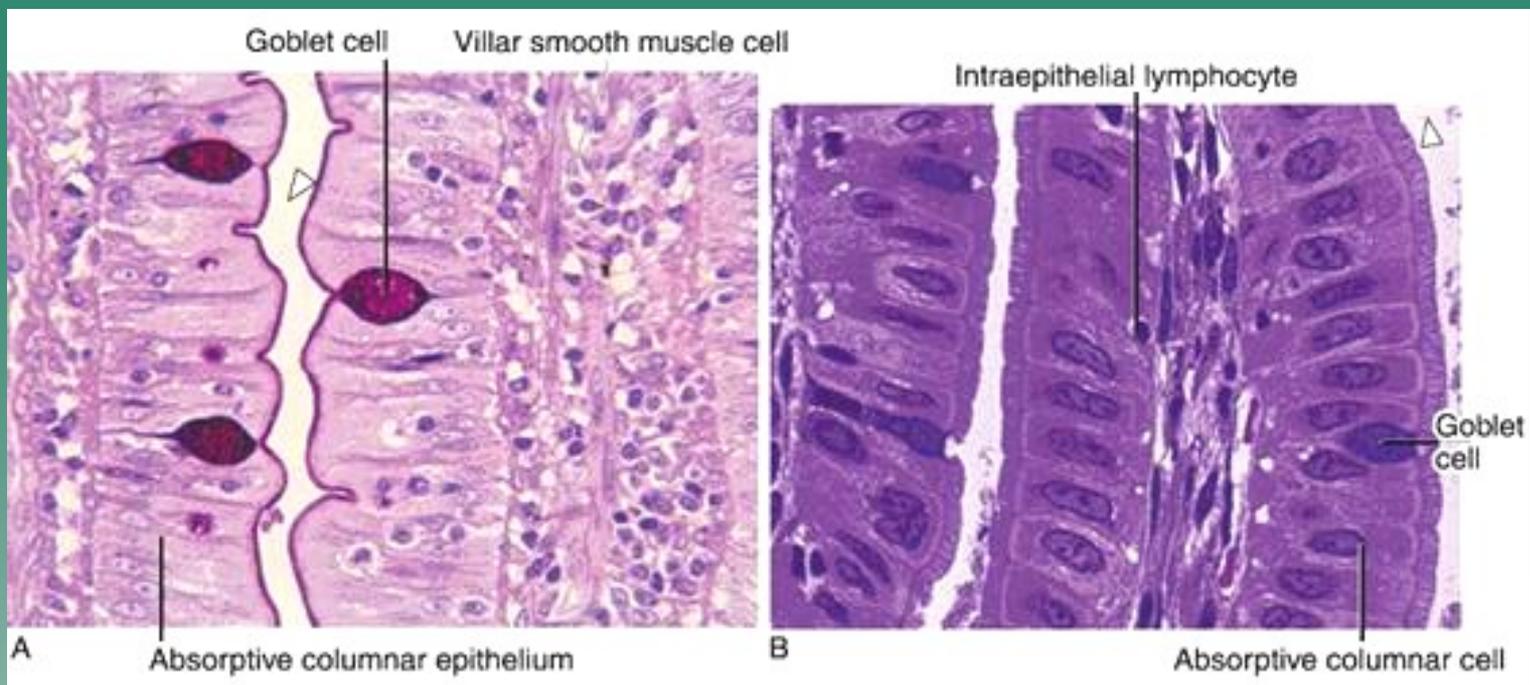
# tunica mucosa

- Epithelium - simple columnar
- Lamina propria mucosae
- Lamina muscularis mucoase

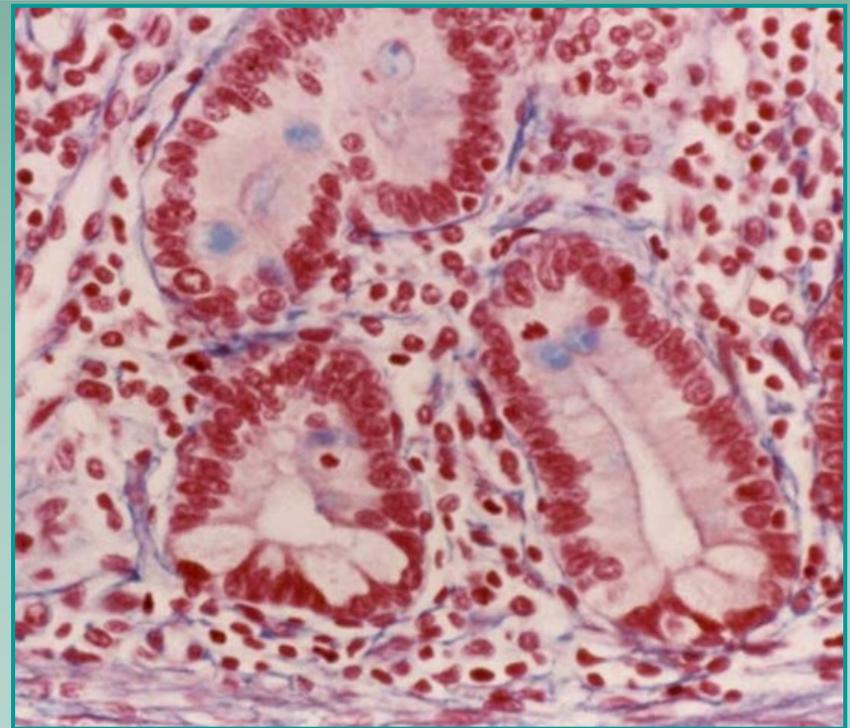
the epithelium:

- absorptive cells:** enterocytes
- secretory cells:** goblet cells, Paneth's cells, enteroendocrine cells

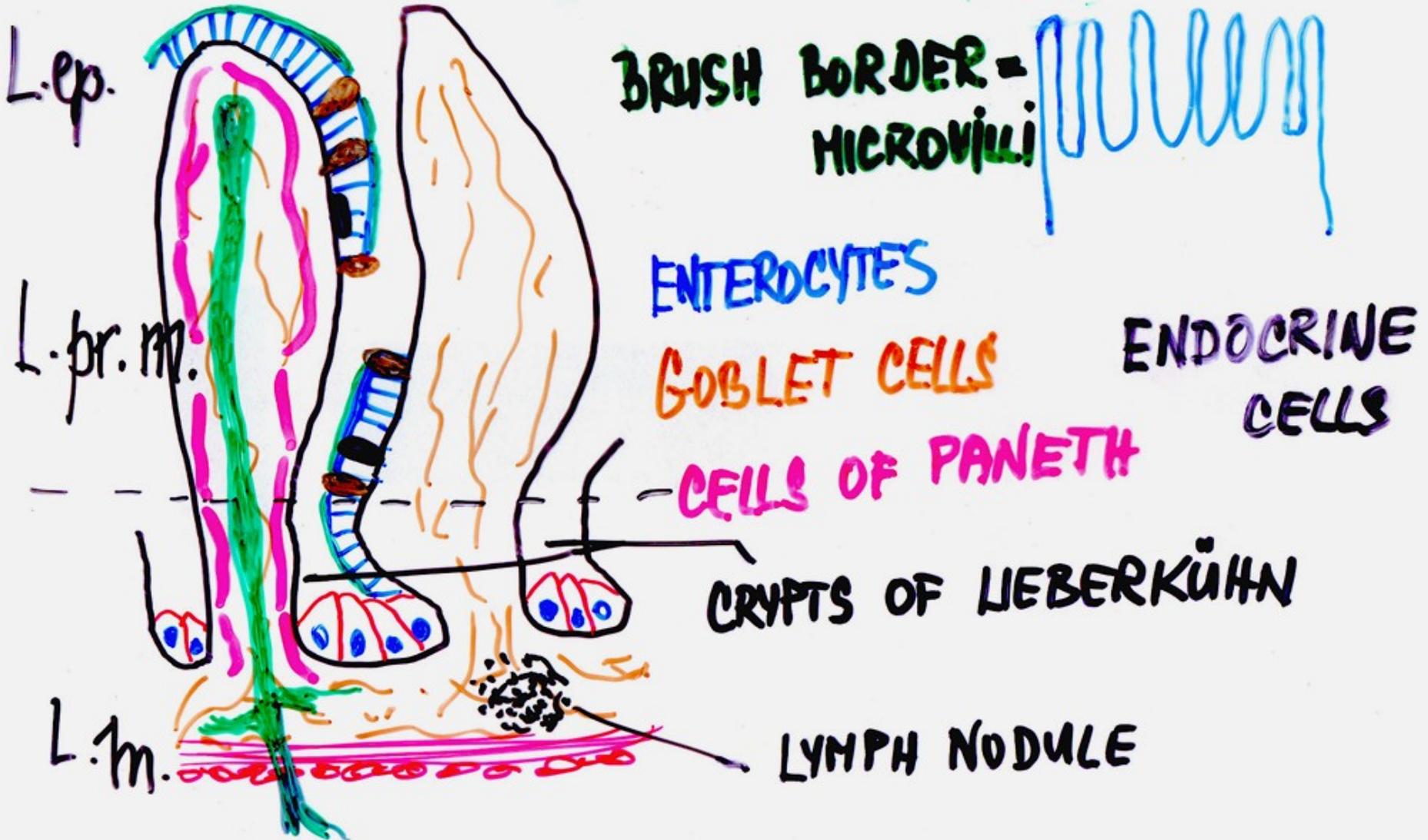




**Paneth's cells**

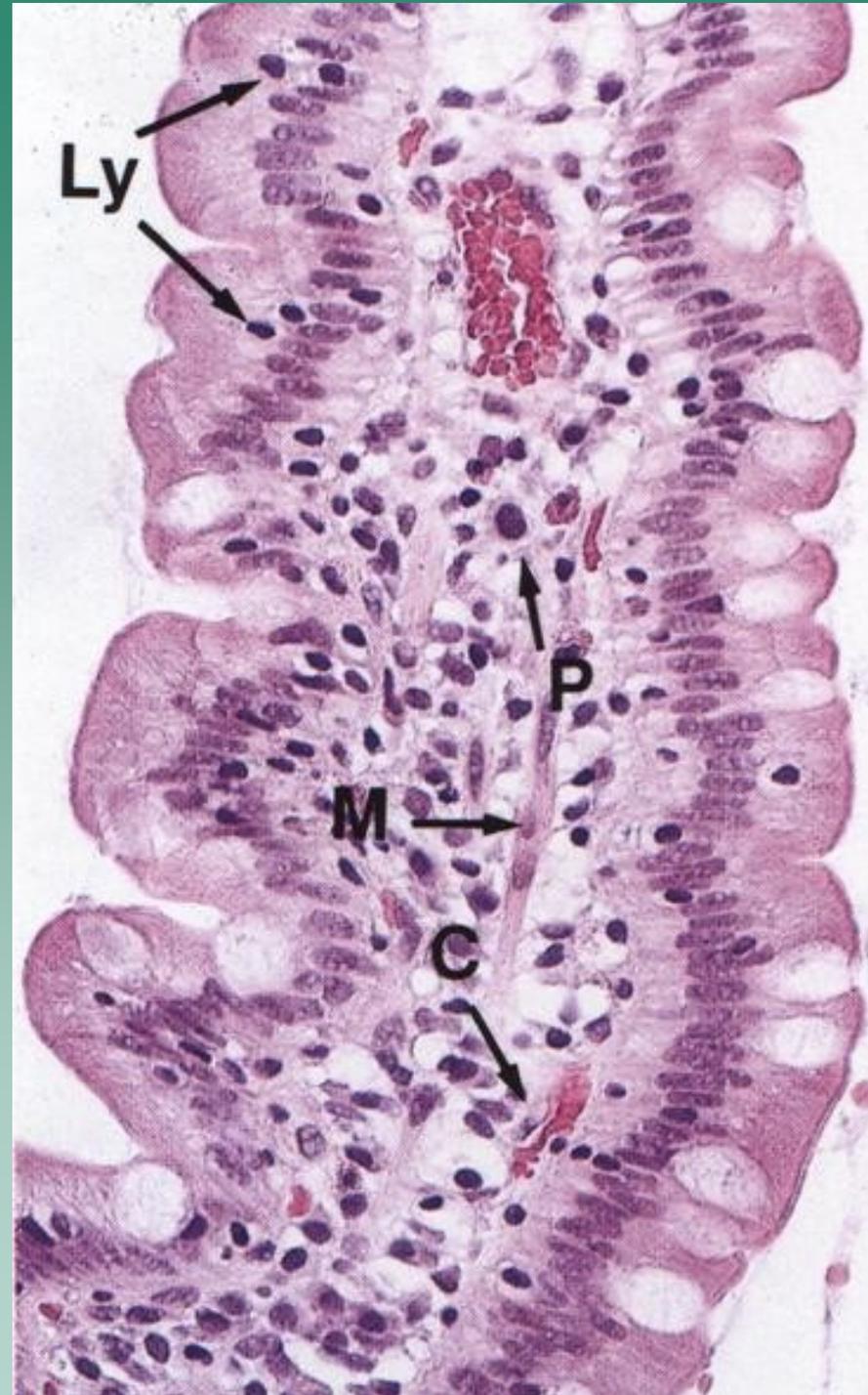
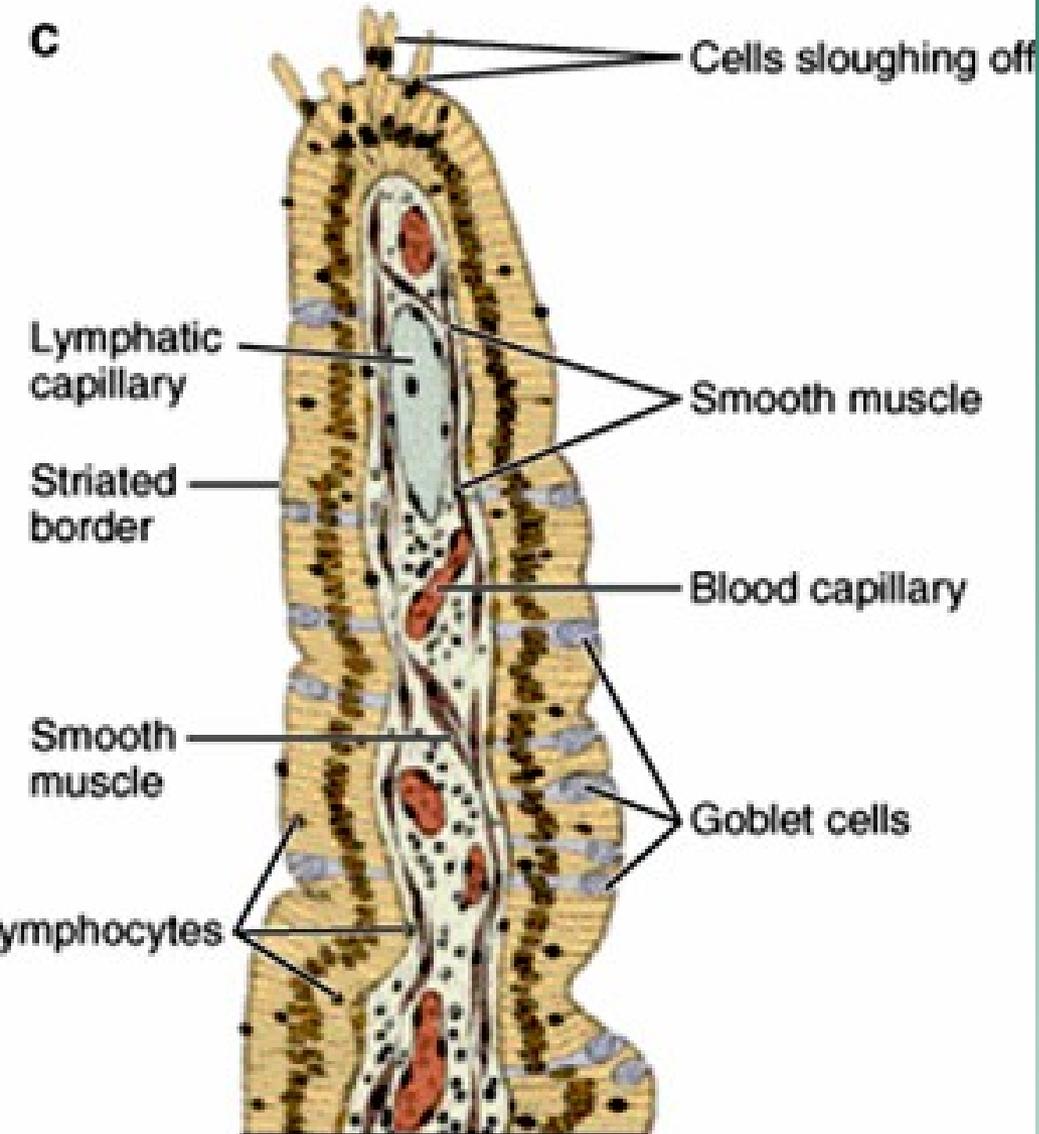


# Intestinal villus (-i)- structure

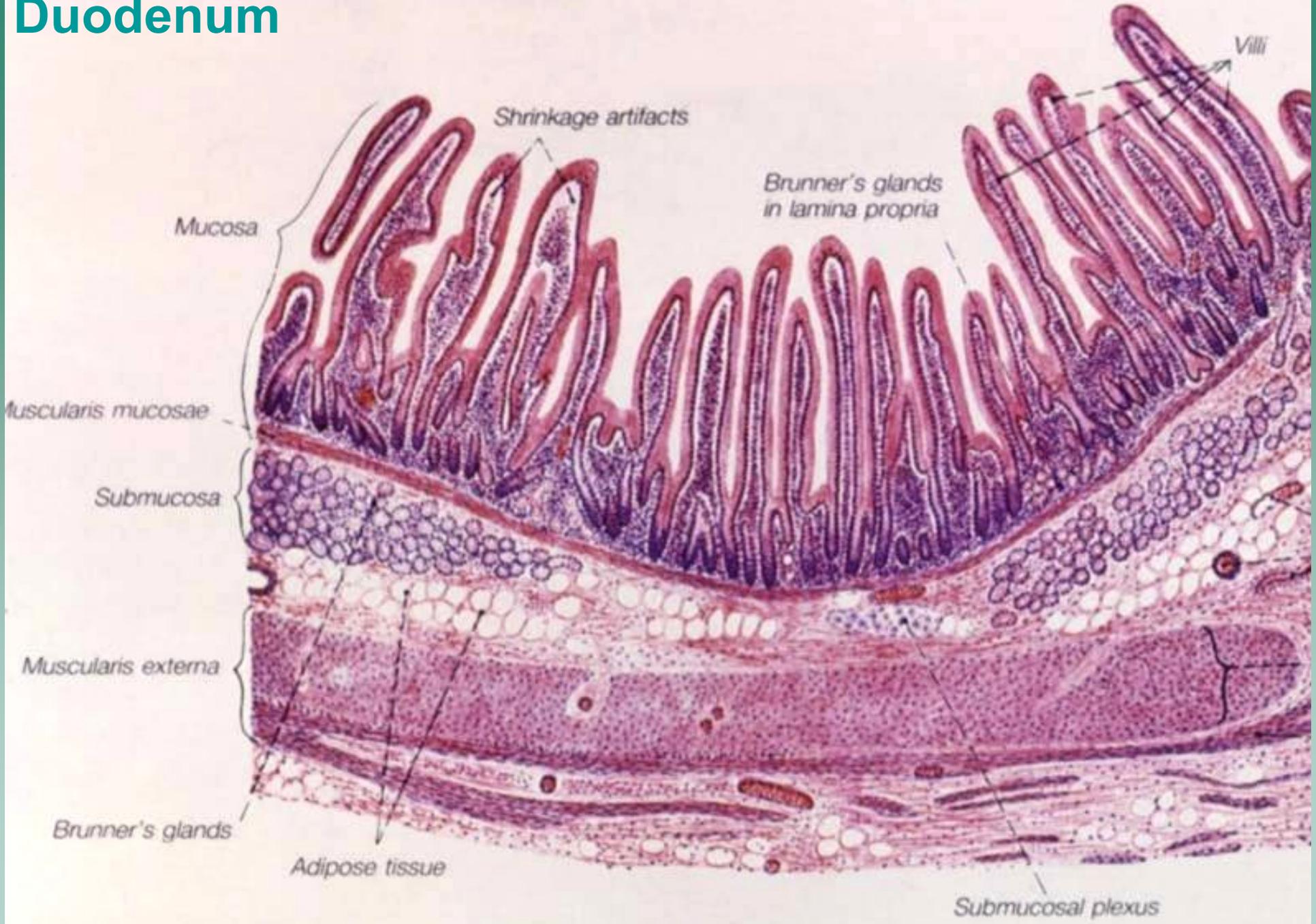


# intestinal villus

C



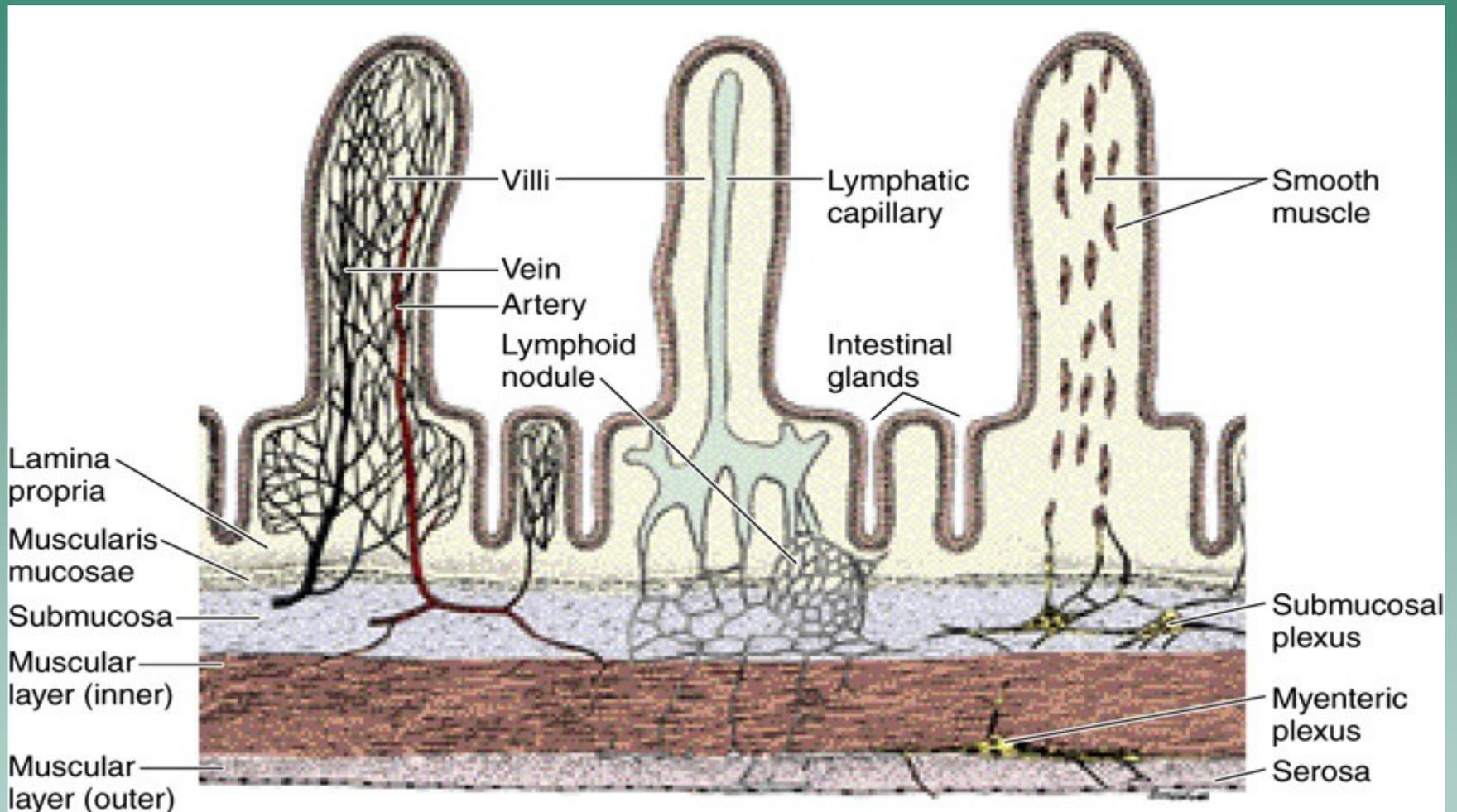
# Duodenum

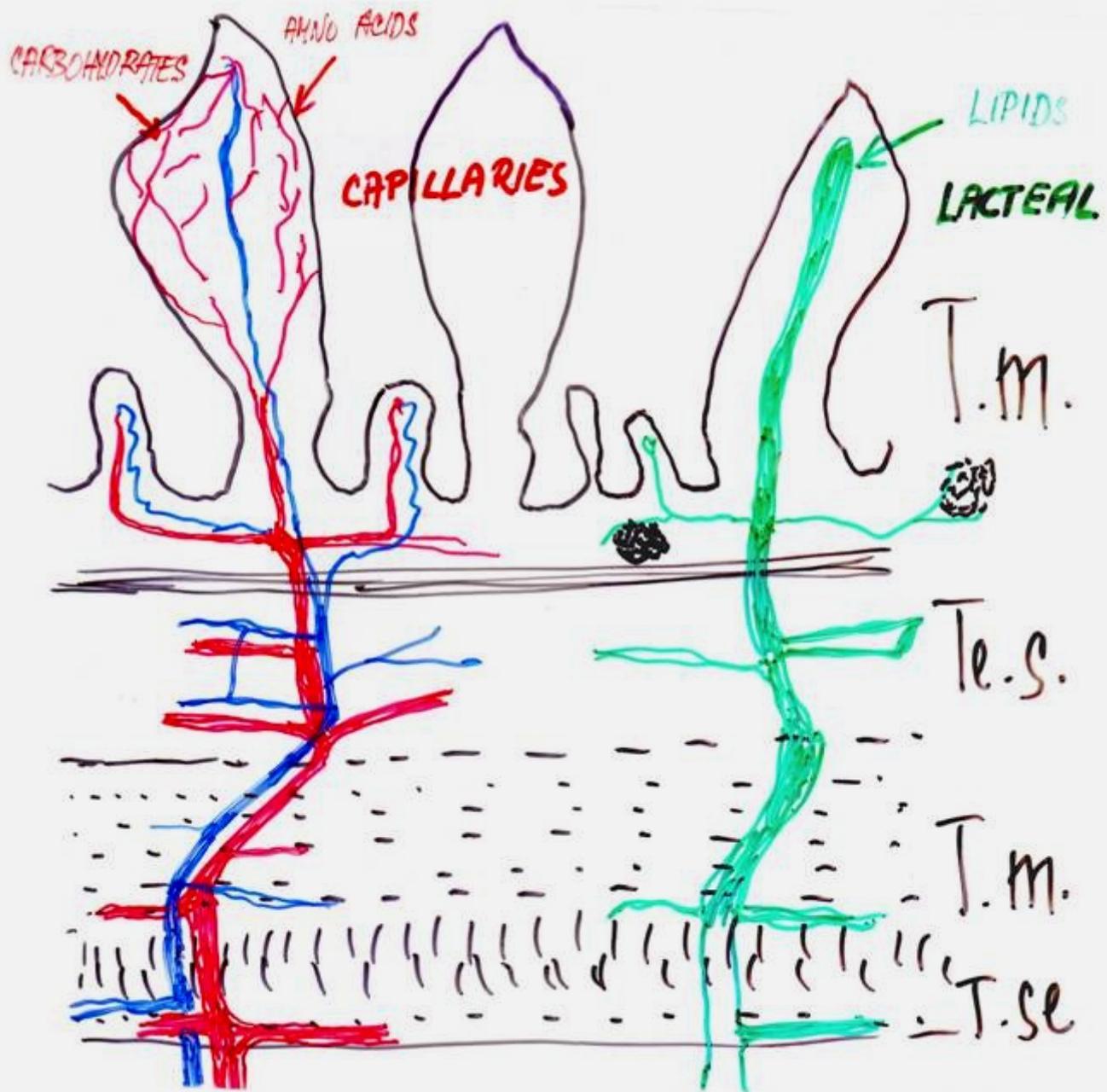


# Jejunum



# BLOOD AND LYMPH CIRCULATION





# LIPID ABSORPTION IN THE SMALL INTESTINE

Lumen:

**LIPID DROPLETS**

5  $\mu$ m and more

mechanical emulsification

**EMULSIFIED FATS**



0.5 - 1.0  $\mu$ m

Lipases + bile acids

**MICELLES**

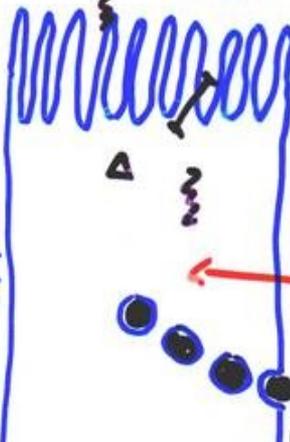


3 - 6 nm

- m - fatty acids
- I - monoglyc.
- $\Delta$  - glycerol
- - bile acids



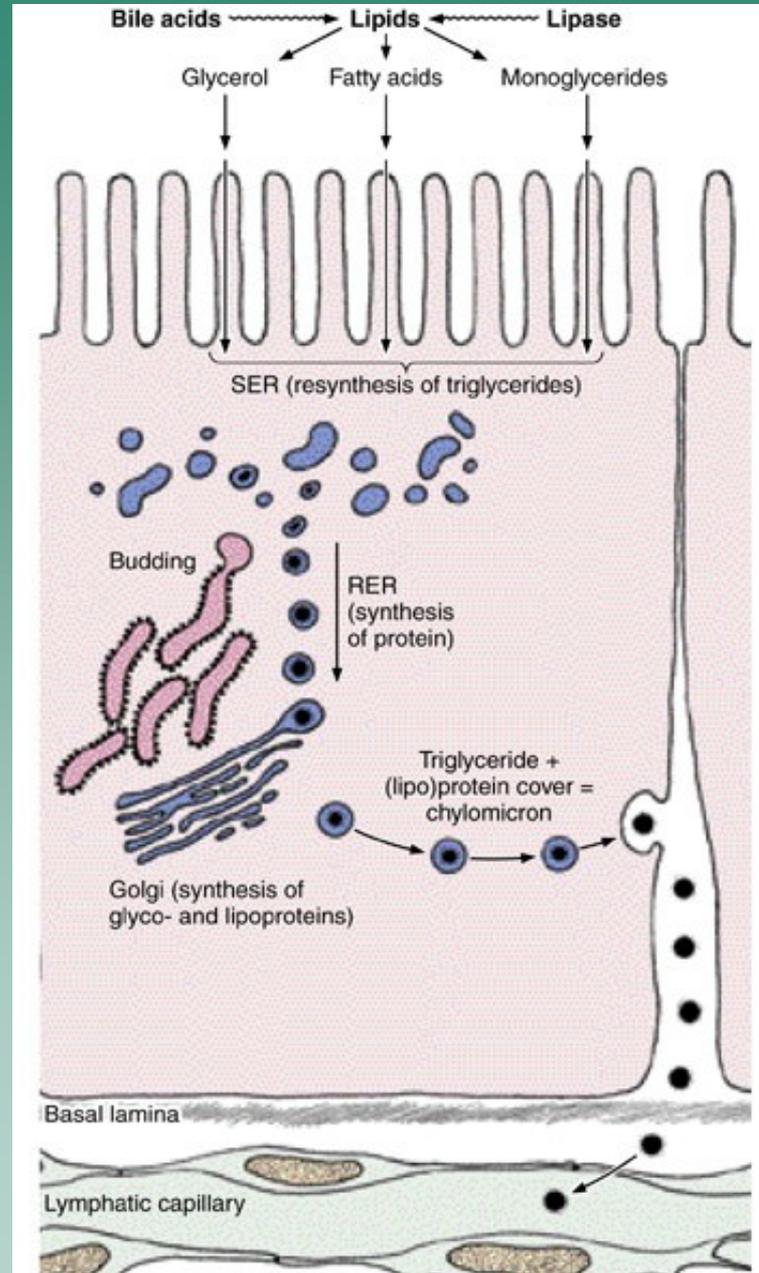
**ENTEROCYTE**



RESYNTHESIS OF TRIGLYCERIDES

**CHYLOMICRONS**

**LYMPH. 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**

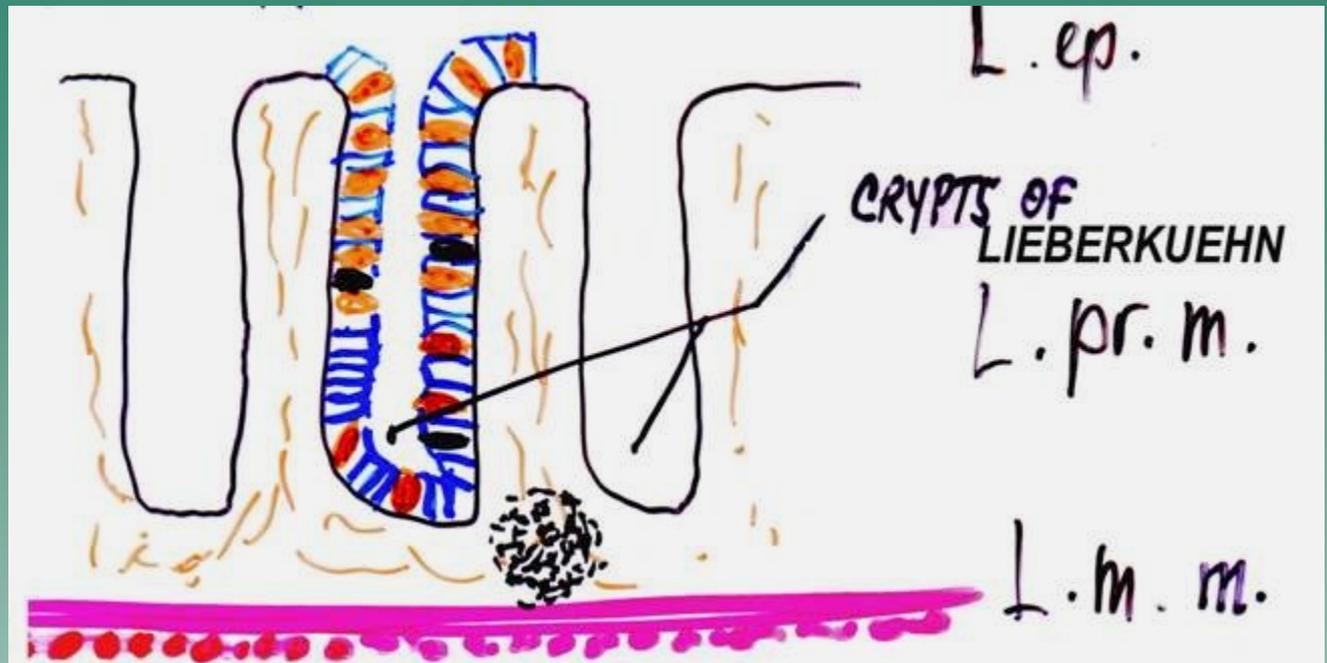
**2. the submucous coat - wide, made up of areolar connective tissue**

**3. the muscular coat - inner circular and outer longitudinal (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:



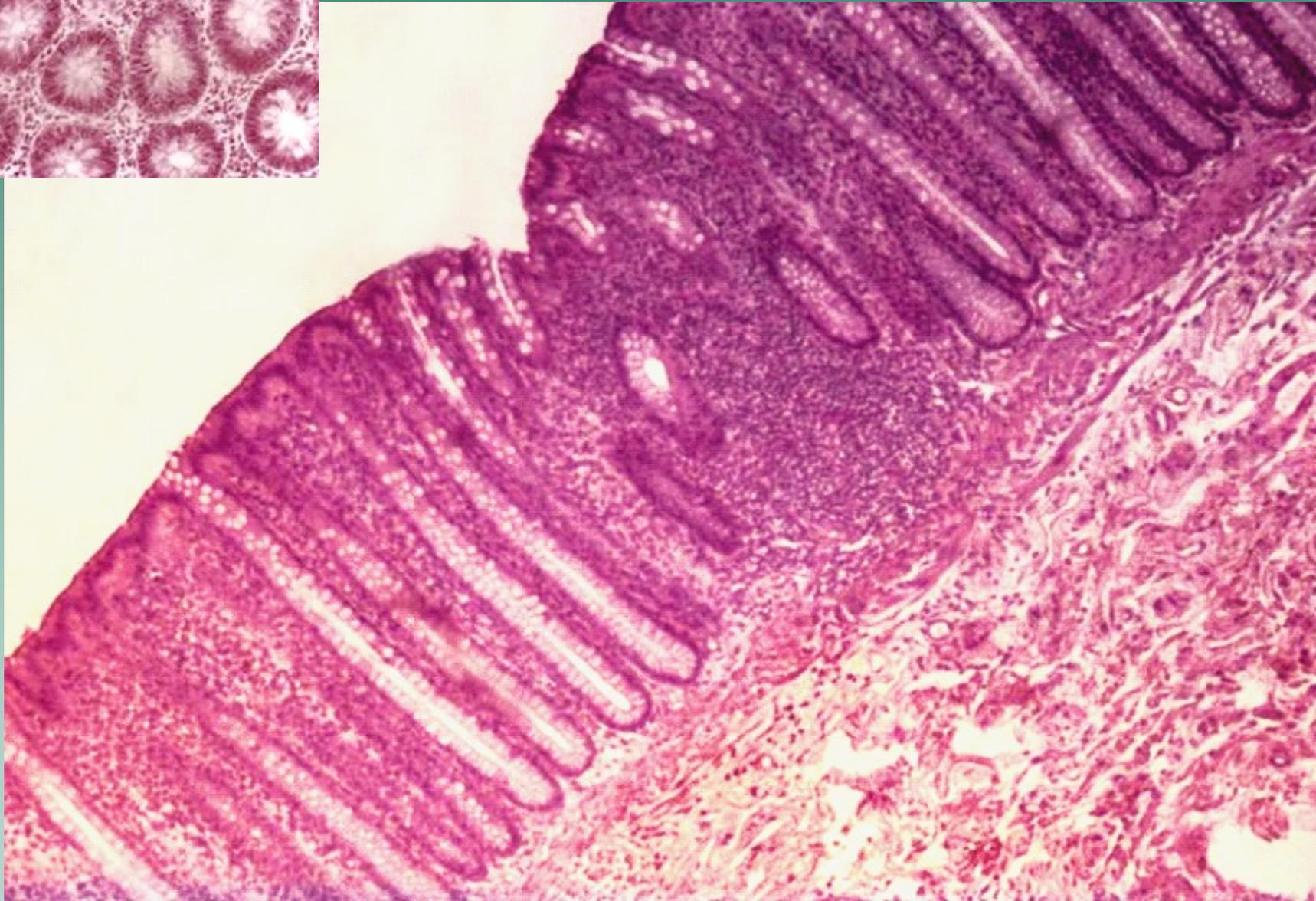
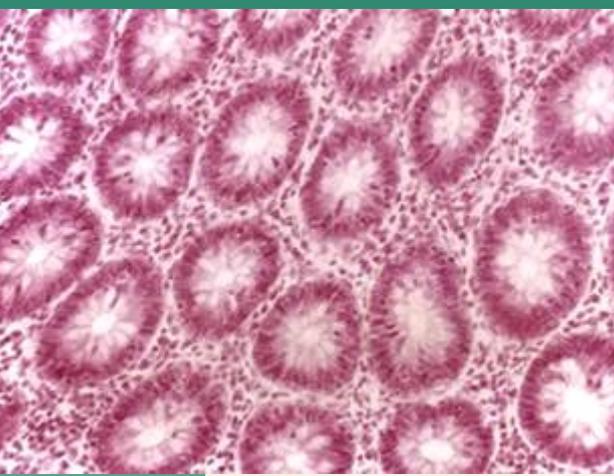
ENTEROCYTES

GOBLET CELLS

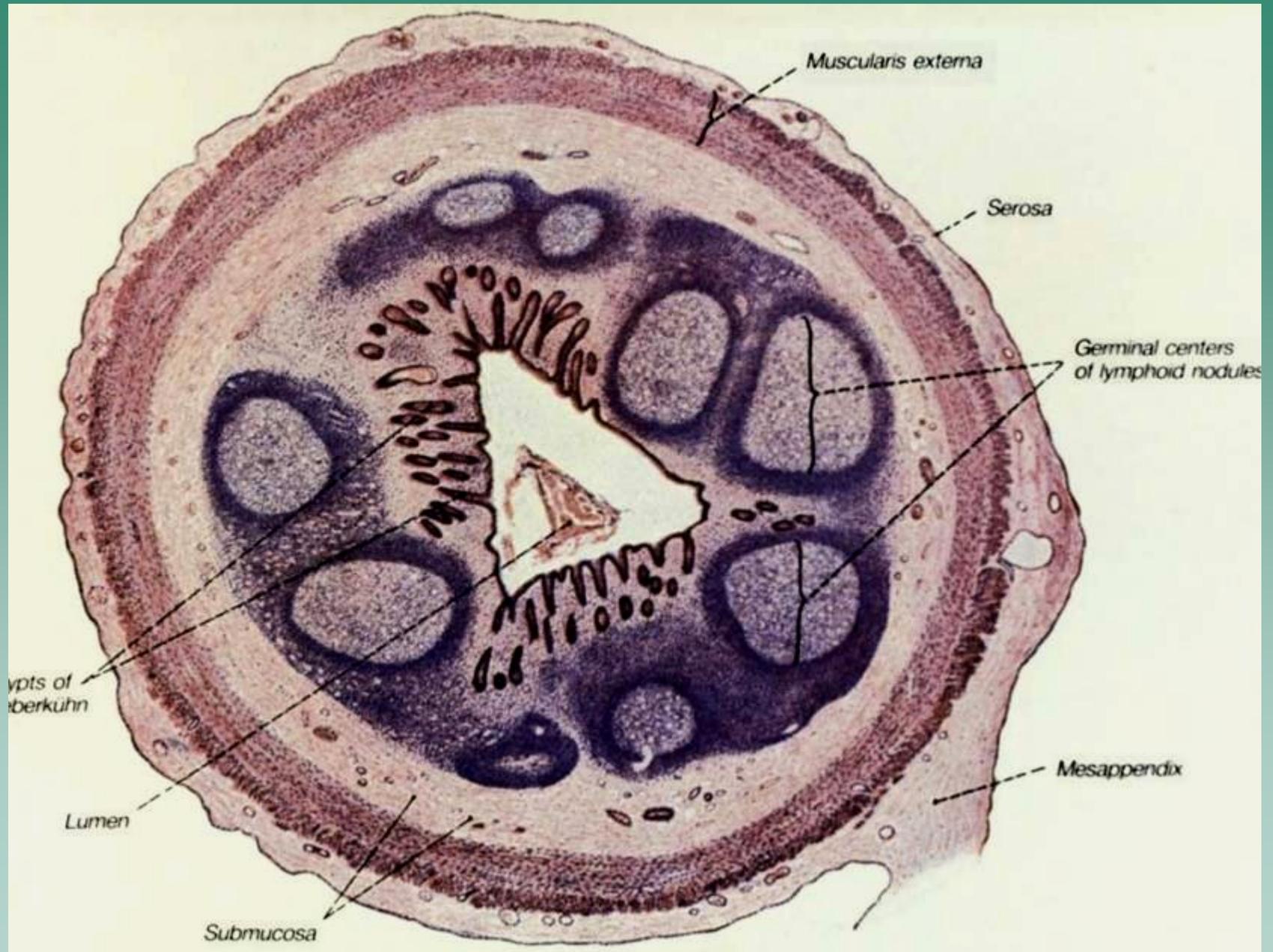
ENDOCRINE CELLS (ARGENTAFFIN)

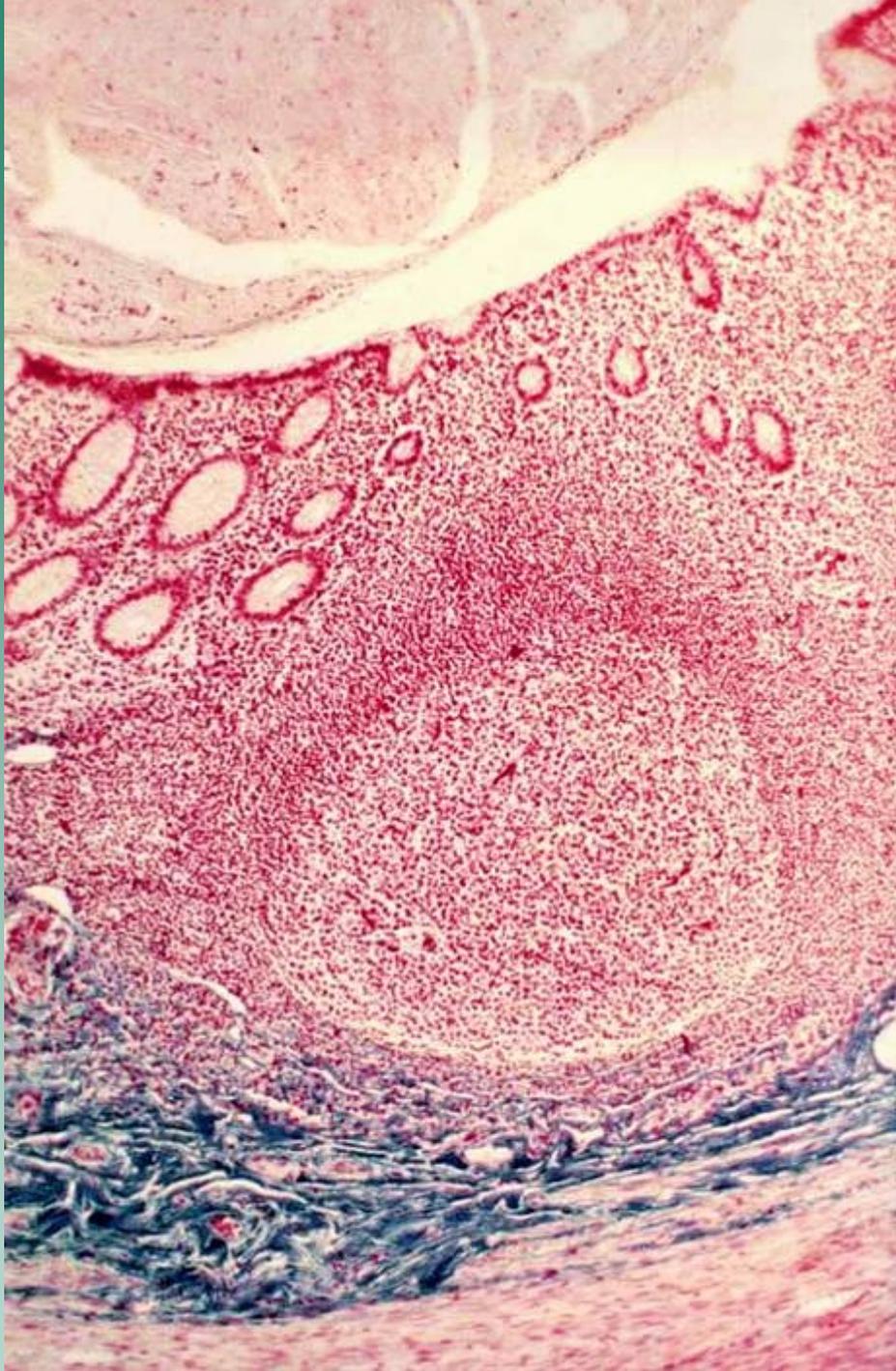
[CELLS OF PANETH - VERMIFORM APPENDIX ONLY!]

**the mucous tunic**



# Vermiform appendix





# The rectum

upper p. - pars ampullaris recti - S<sub>3</sub> - 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 (HORBOW)

transition of a simple columnar ep. into noncornified stratified squamous ep.

l. musc. mac. - is missing

Submucosa - rich venous plexuses

## 2. the intermediate z.

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

## 3. the cutaneous z.

covers the anal orifice, keratinized stratified squamous ep., l. propria and submucosa are found (circum-anal glands - gl. circumanales)