

# **Digestive system**

**Dr. Anna L. Kiss**

**Department of Anatomy, Histology and  
Embryology**

**Semmelweis University**

**Budapest**

**2019**

# The **gastrointestinal tract (GI tract)**: digestion and excretion

## Upper gastrointestinal tract

The upper GI tract consists of the

mouth, pharynx, esophagus, and stomach.

## The lower GI tract.

small intestine, which has three parts:

-duodenum

-jejunum

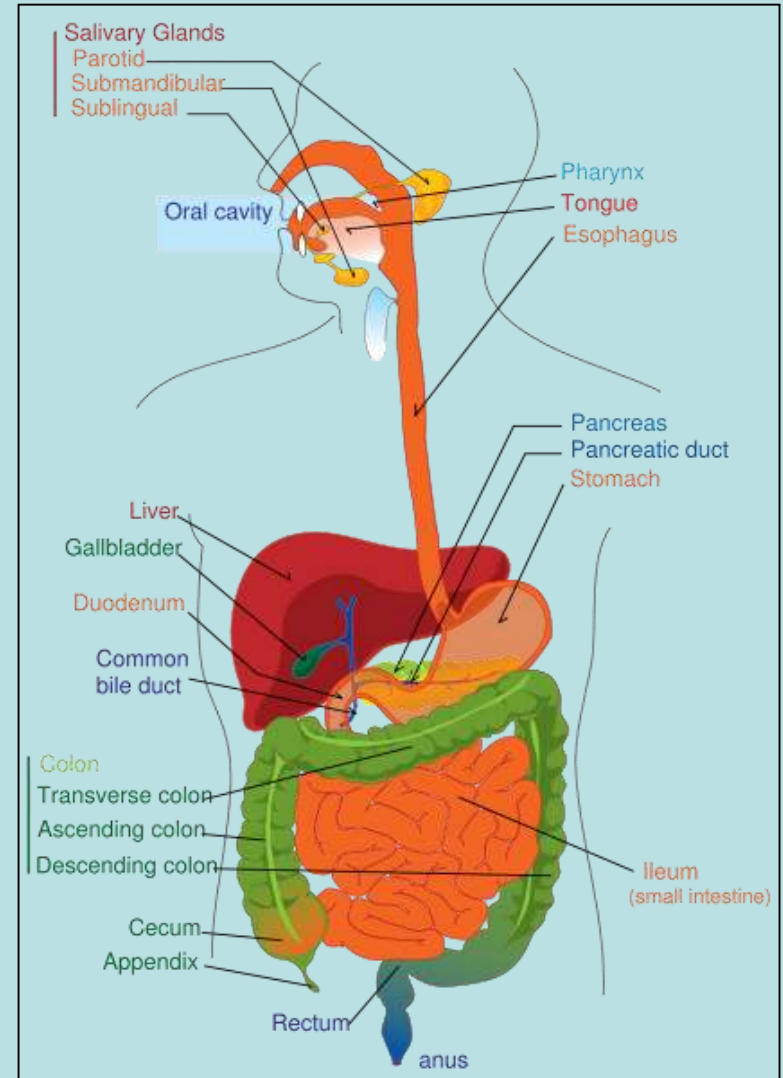
-ileum

large intestine, which has three parts:

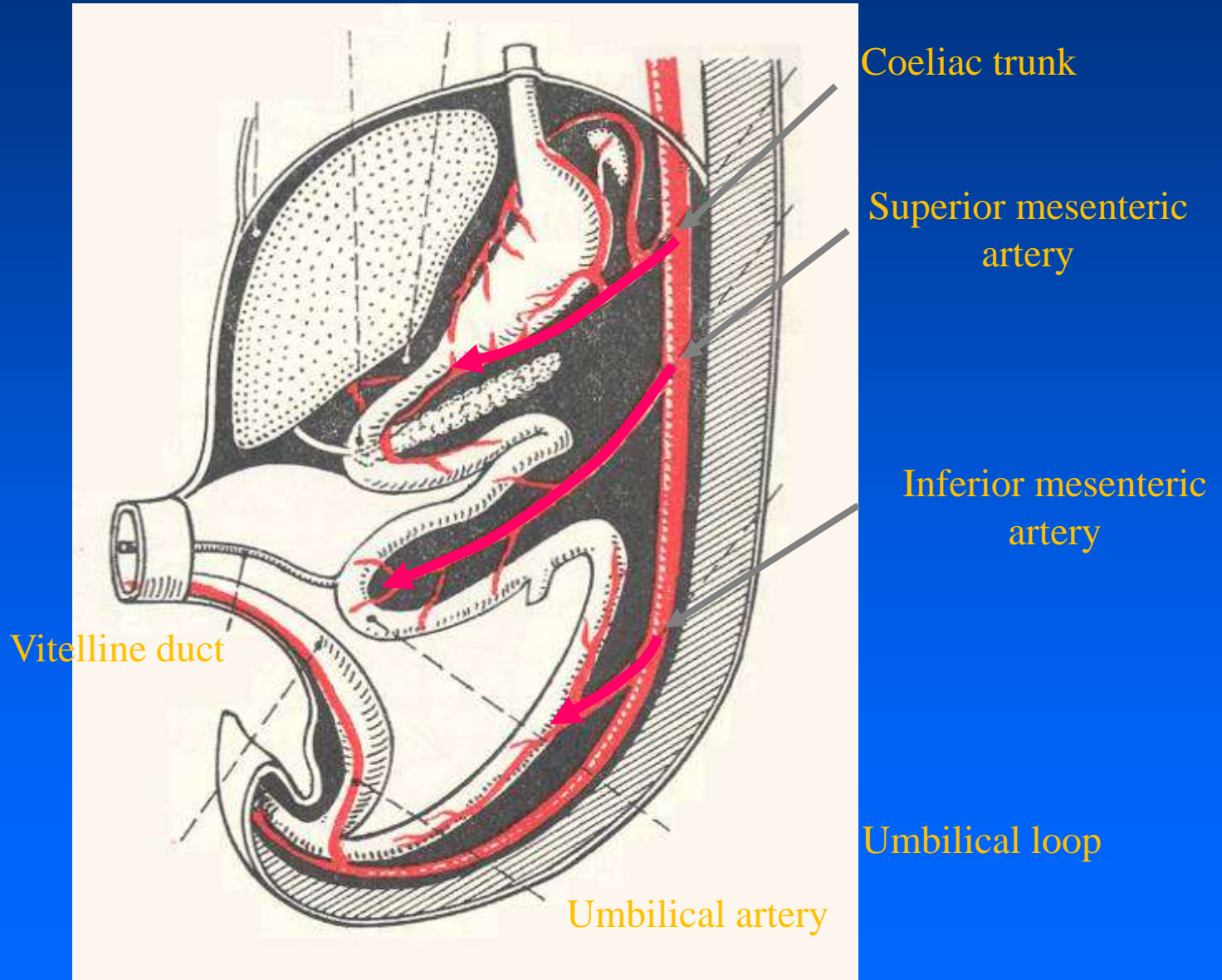
-cecum (the vermiform appendix is attached to the cecum).

-colon (ascending colon, transverse colon, descending colon and sigmoid flexure)

-rectum



# Primitive Gut Tube



# *Final Position of Parts of Gut Tube*

Abdominal  
esophagus

Thoracic  
esophagus

Liver

**Stomach**

Gall bladder  
& bile duct

Pancreas

**Duodenum**

**Jejunum & ileum**

2.) Transverse colon

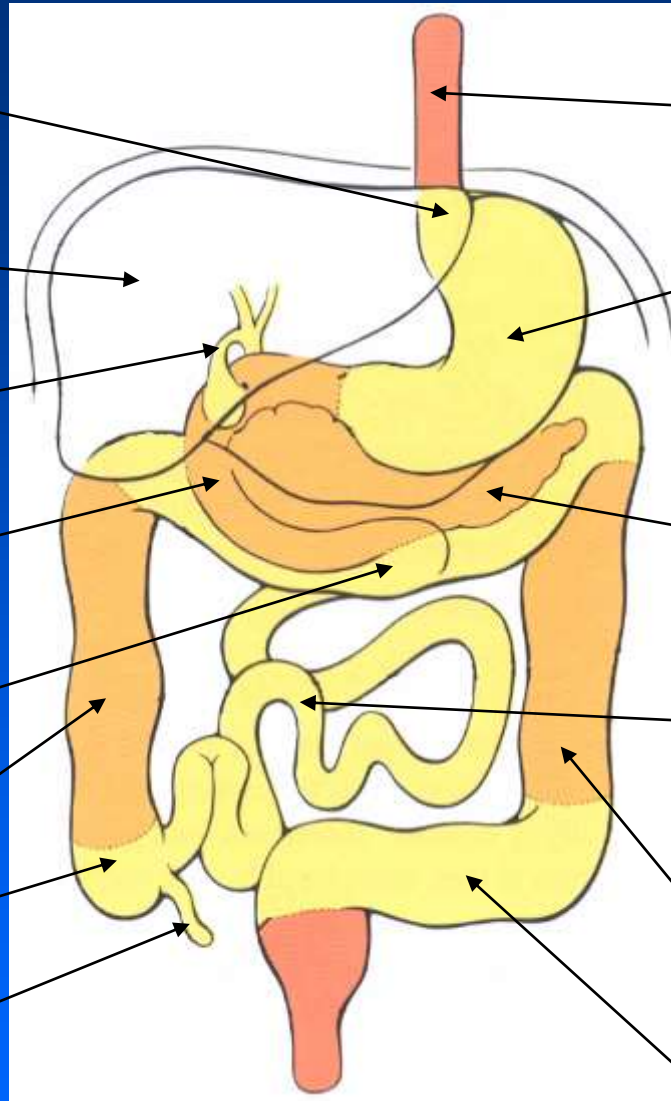
1.) Ascending colon

3.) Descending colon

Cecum

4.) Sigmoid colon

Appendix



# *Final Position of Parts of Gut Tube*

*Stomach:* left hypochondric region (intraperitoneal)

*Duodenum:* right side (partly retroperitoneal)

*Jejunum, ileum:* umbilical + iliac region  
(intraperitoneal)

*Appendix:* right side (Mc Burney point)  
(intraperitoneal)

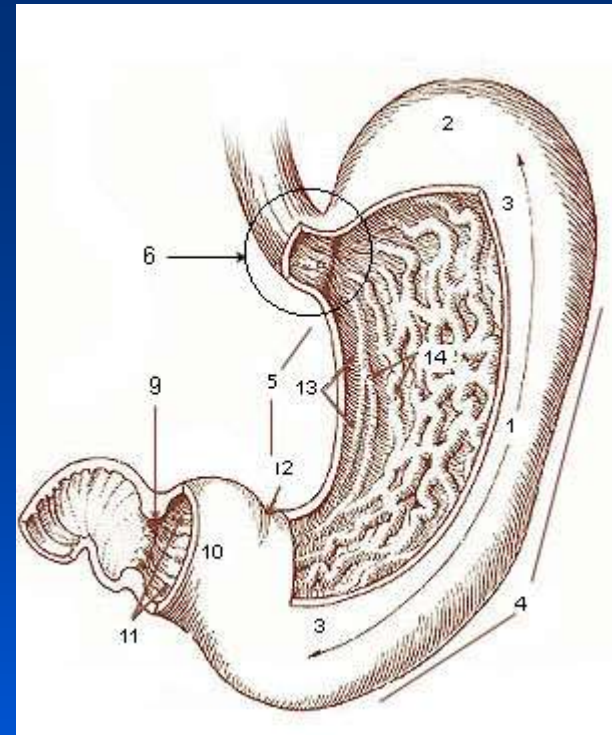
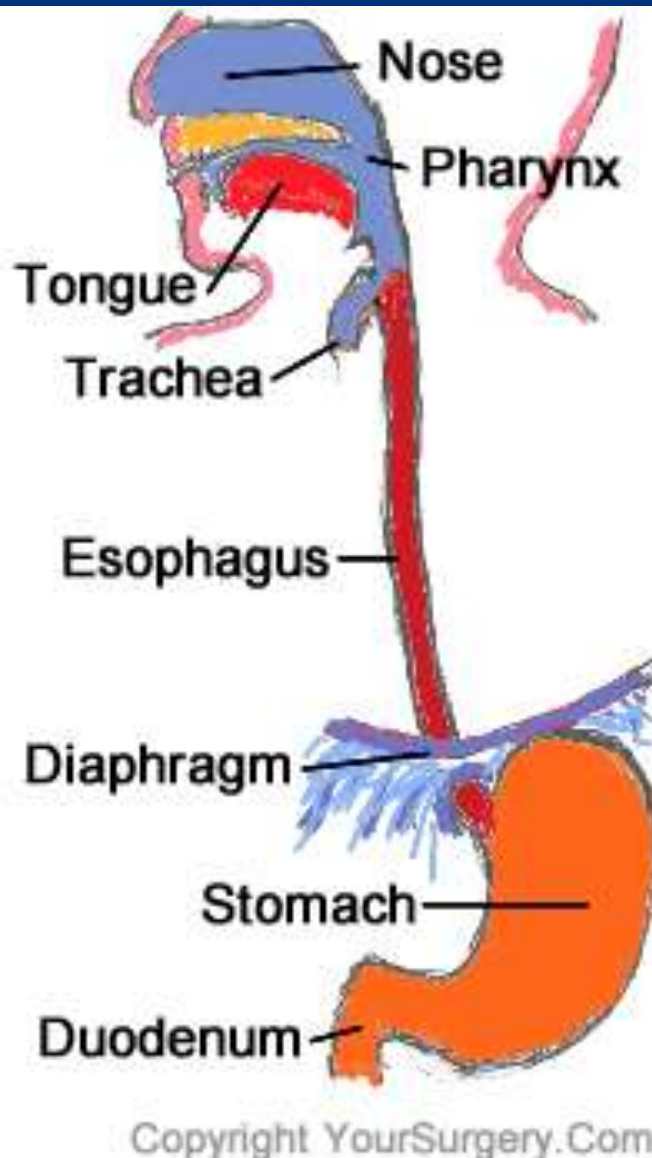
*Ascending colon:* right iliac region

*Transverse colon:* middle position (intraperitoneal)

*Descending colon:* left iliac region

*Sigmoid colon:* sacral and pelvic region (intraperitoneal)

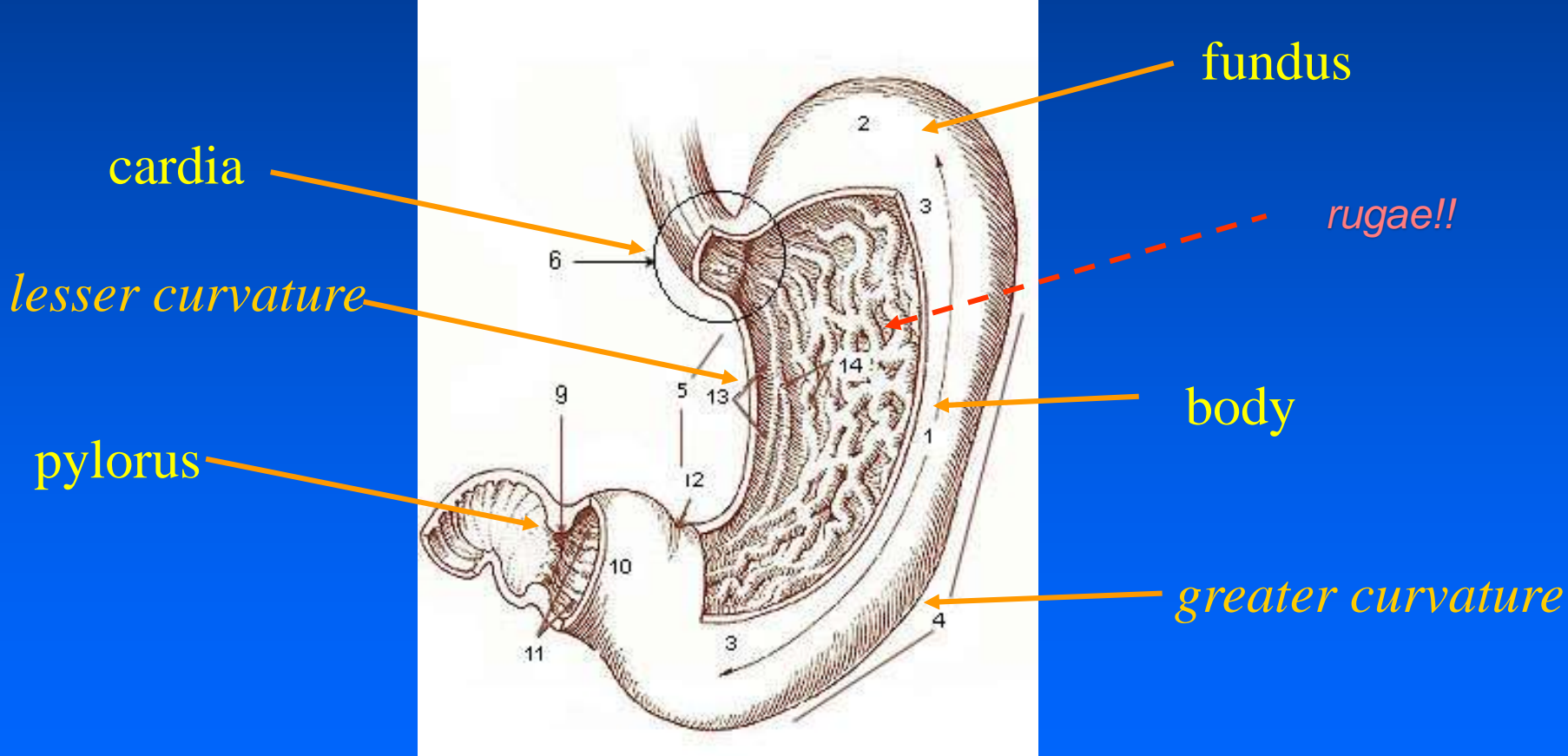


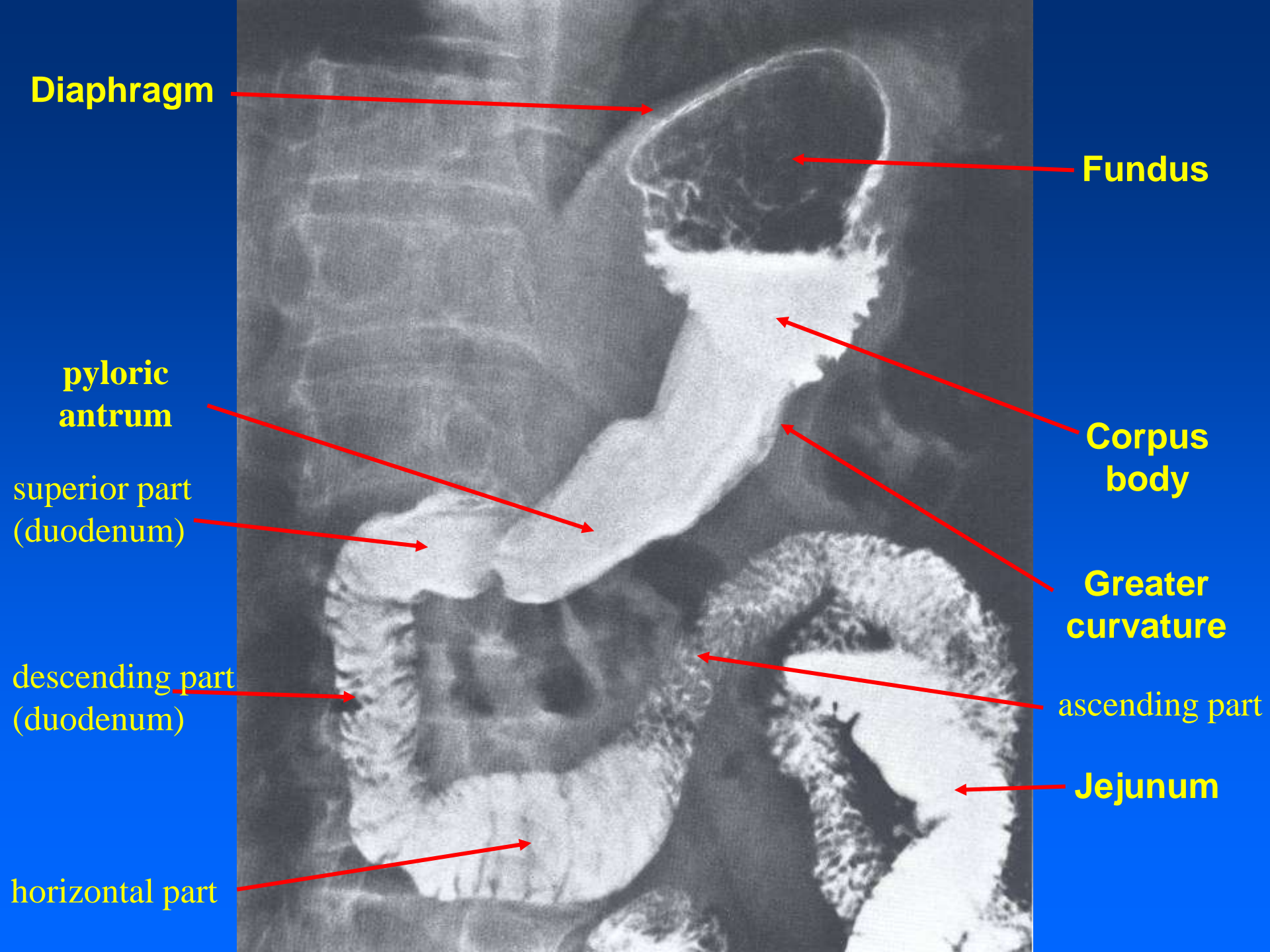


highly acidic environment due to [gastric acid](#) production

The stomach lies between the [esophagus](#) and the [duodenum](#)  
It is on the left side of the [abdominal cavity](#).

# Stomach





**Diaphragm**

**Fundus**

**pyloric  
antrum**

**Corpus  
body**

**superior part  
(duodenum)**

**Greater  
curvature**

**descending part  
(duodenum)**

**ascending part**

**horizontal part**

**Jejunum**



# Histology of the gut

## *Mucosa:*

- epithelium: simple columnar (goblet cells)
- propria (lymphoreticular connective tissue): glands (Lieberkhün crypts)
- muscularis mucosae (2 layered smooth muscle)

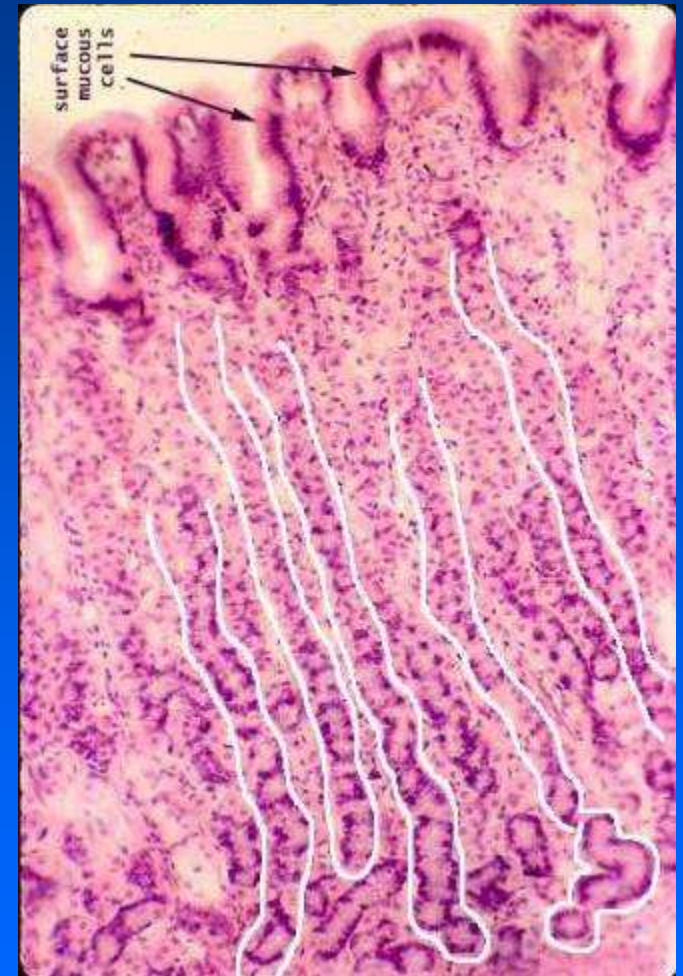
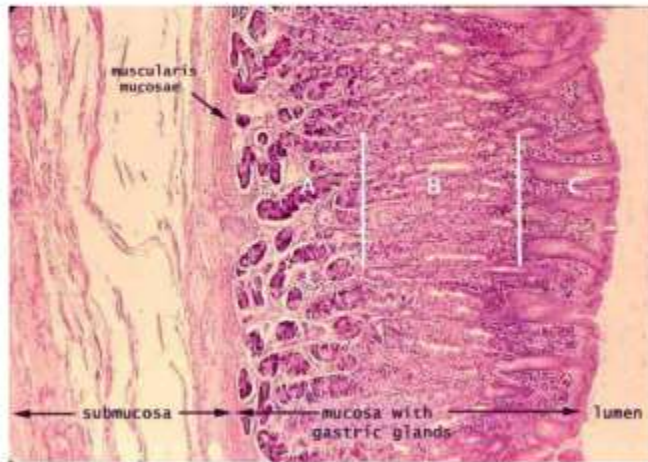
*Submucosa:* loose connective tissue (submucosus plexus; glands, lymphatic follicles)

*External muscle layer* (t. muscularis): smooth muscle  
(inner circular, outer longitudinal)

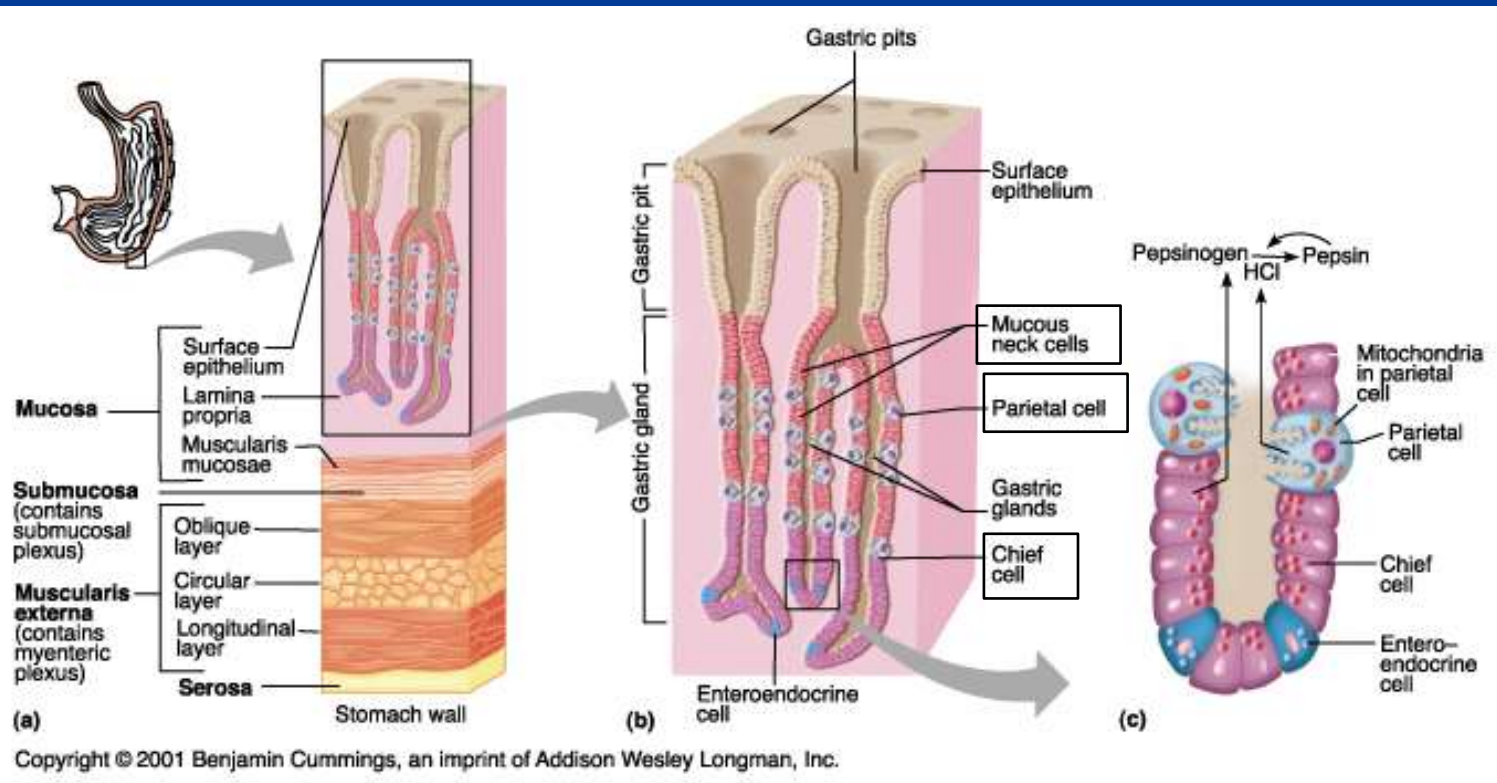
*Serosa or adventitia*

# Histology of the stomach

## Stomach Histology



# Histology of the stomach



# Histology of the stomach

To increase the surface: *rugae*

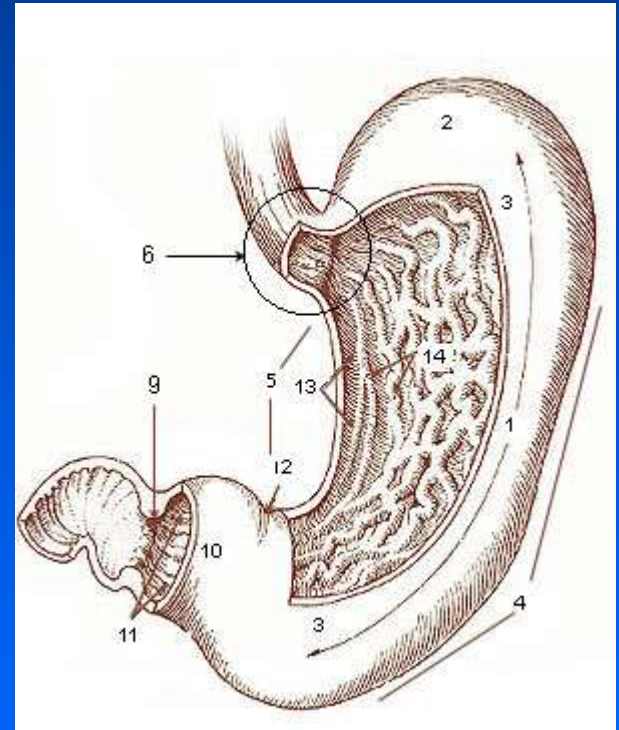
Gastric glands in the mucosa

Producing:

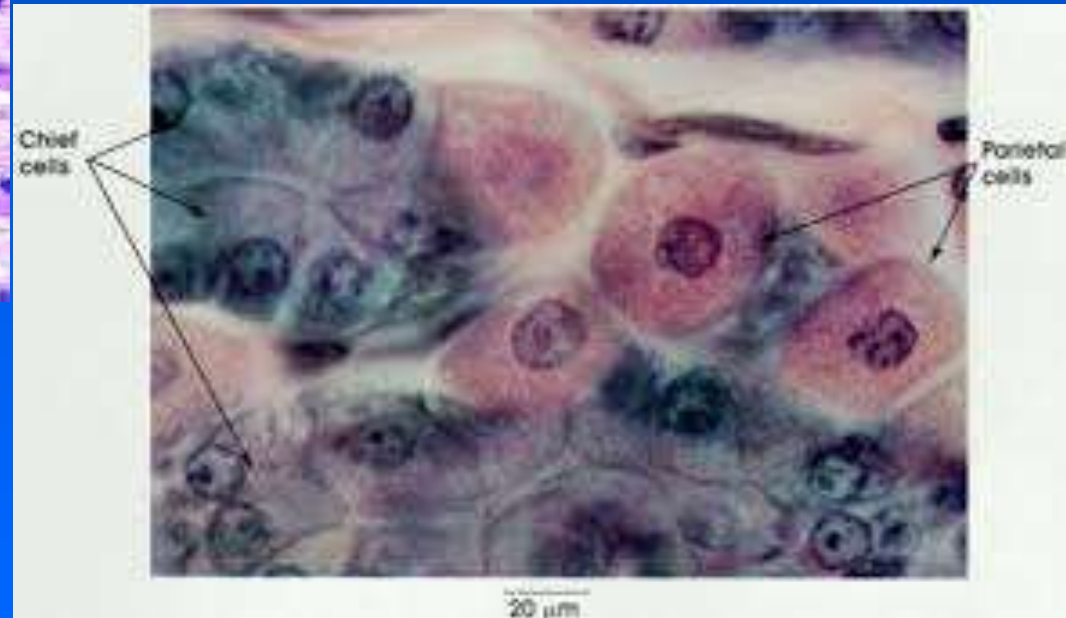
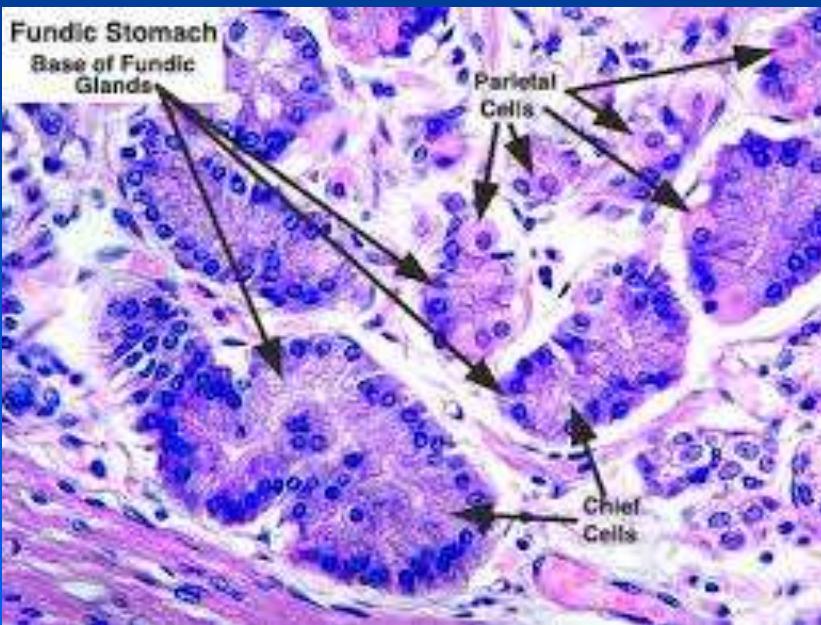
*pepsinogen*: **chief cells**

*HCl*+*intrinsic factor*: **parietal cells**

*mucus* (to protect the mucosa)



# Histology of the stomach



# Duodenum

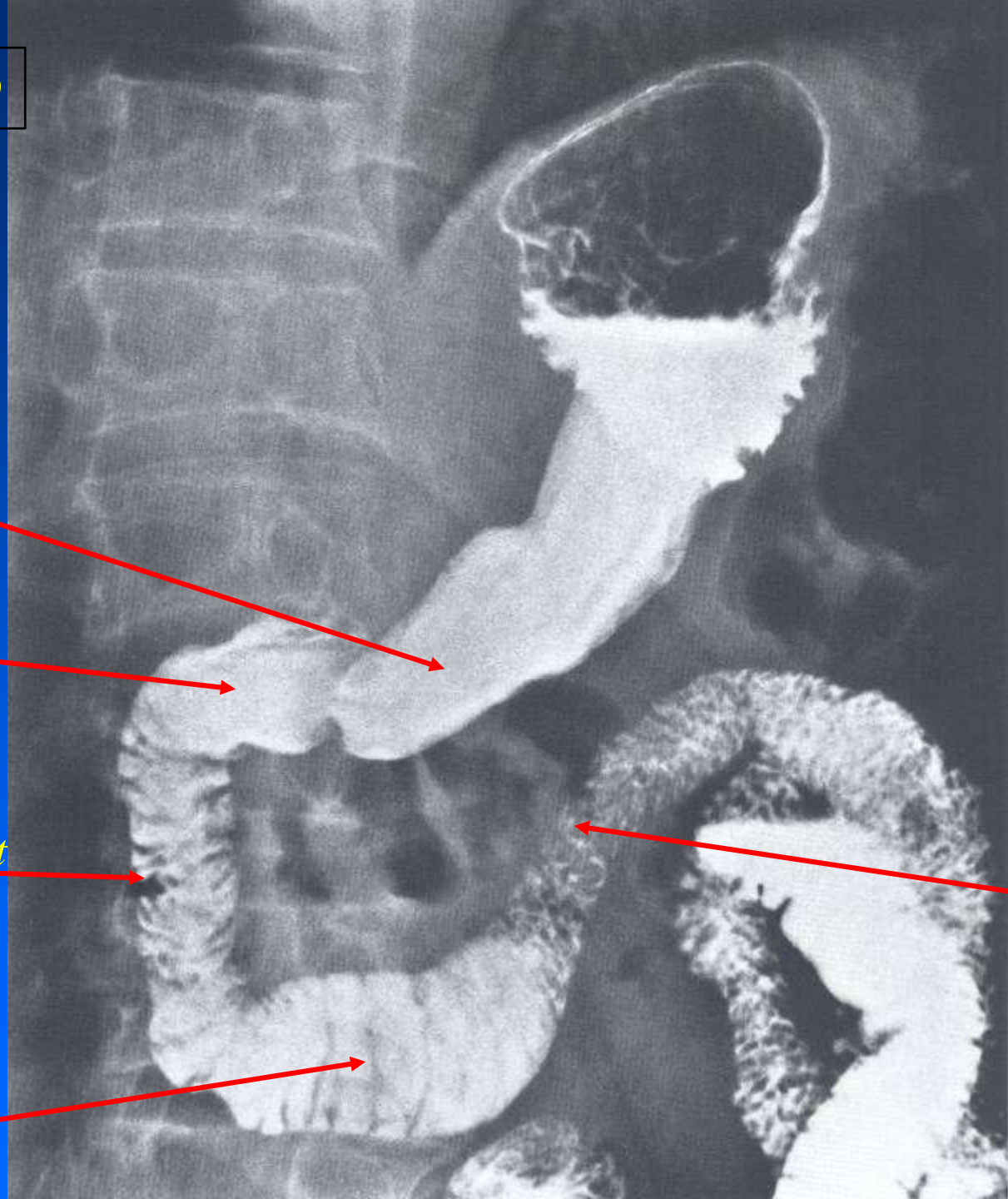
**pyloric  
antrum**

*superior part  
(duodenum)*

*descending part  
(duodenum)*

*horizontal  
part*

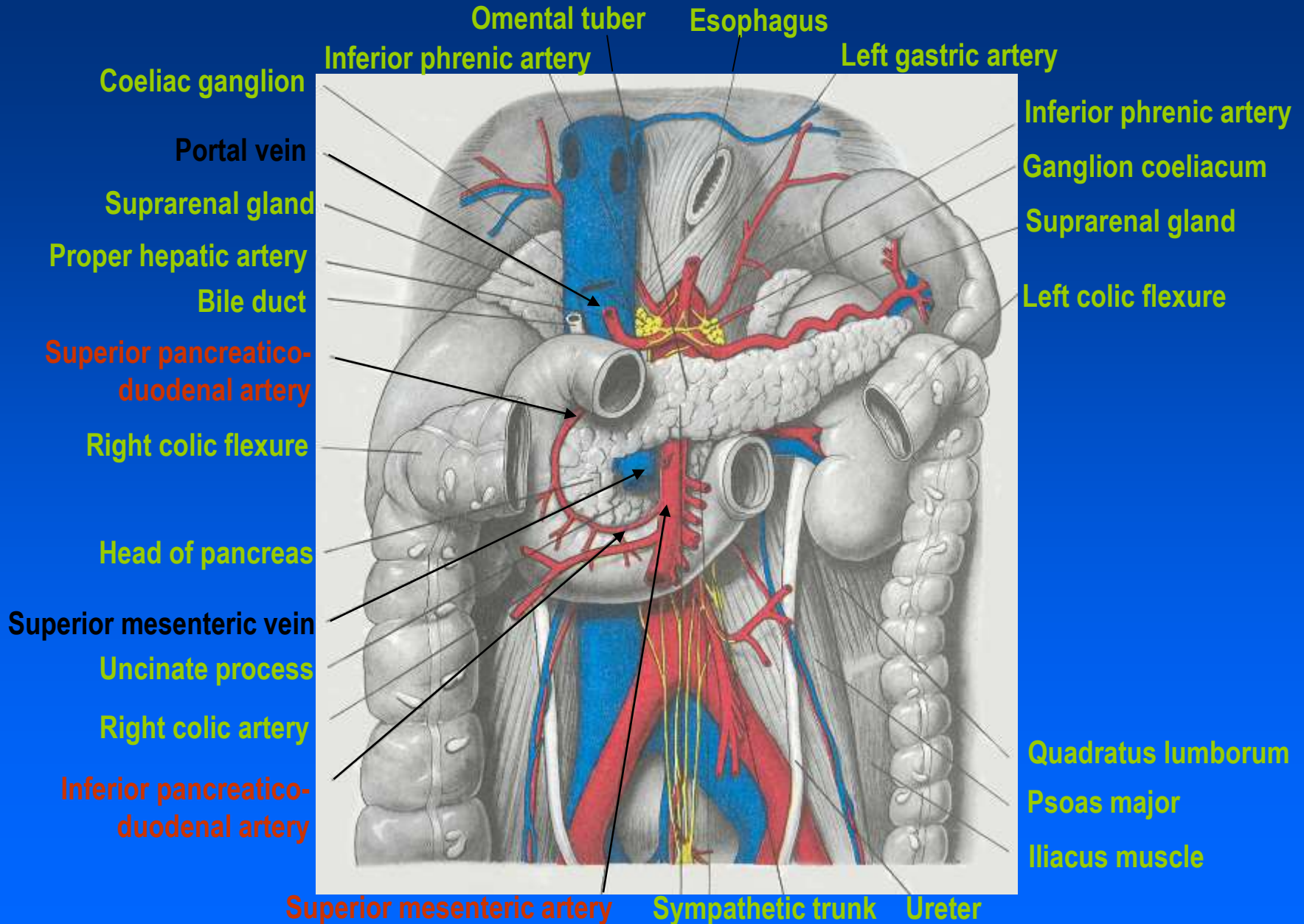
*ascending part*



# Duodenum

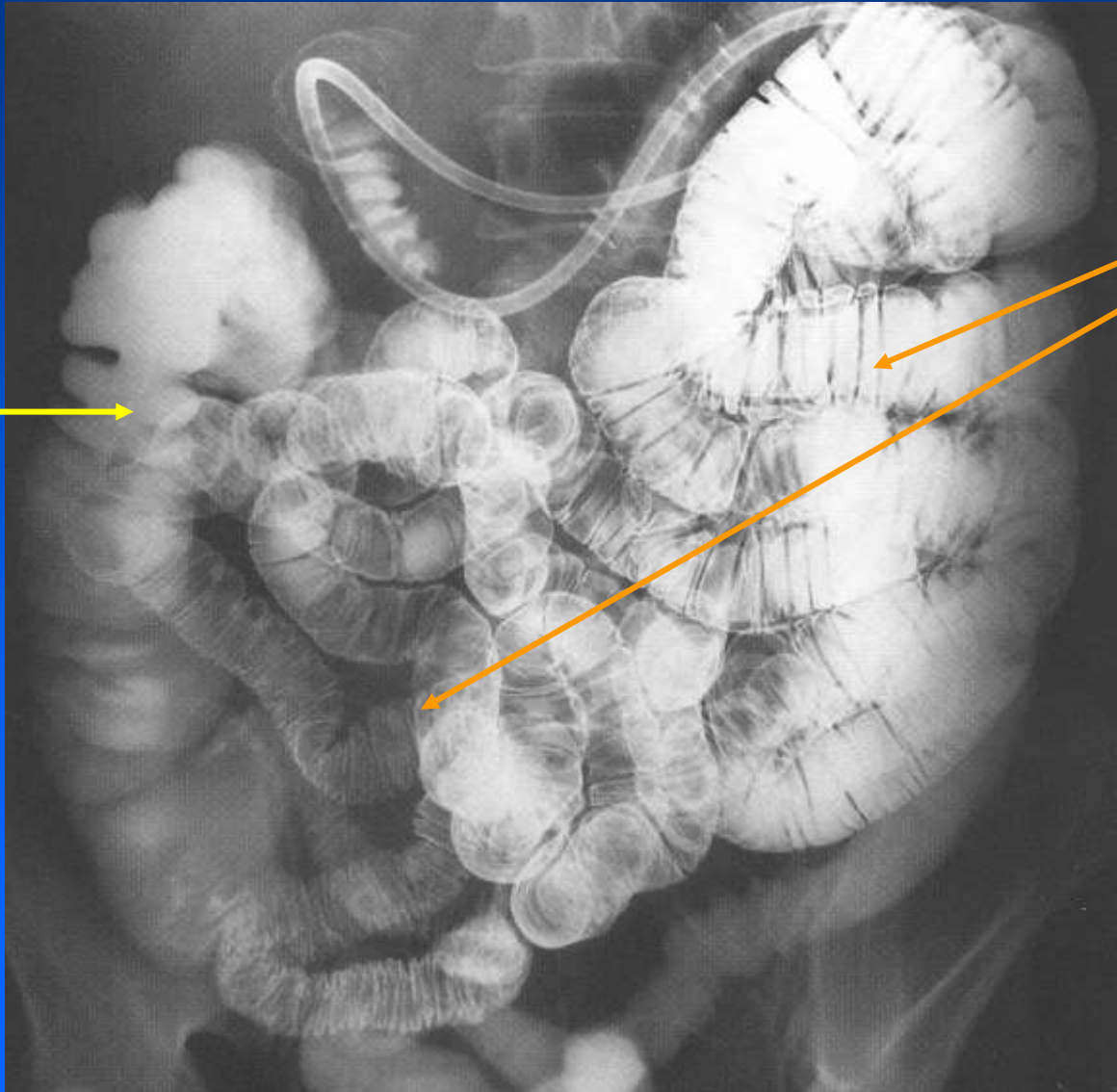
- main part of the digestion
- pancreas: empties to the descending part: all kind of digestive enzymes
- liver: bile
- Histologically: accomodation to the function: *increase the surface*:
  - Kerkring folds (submucosa)
  - villi: mucosa
  - microvilli: apical plasma membrane of the enterocytes

# Topography of Duodenum

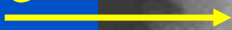




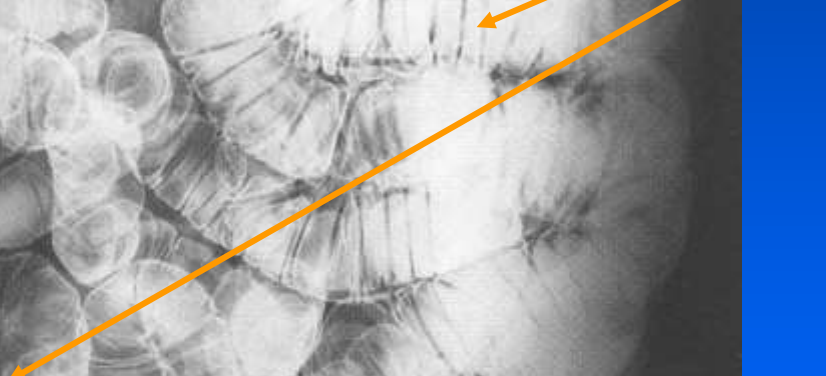
# Small intestine: jejunum and ileum



ascending  
colon



jejunum+ileum



# Jejunum and ileum

Main function:

- absorption (jejunum)
- digestion
- passing the non-digested material

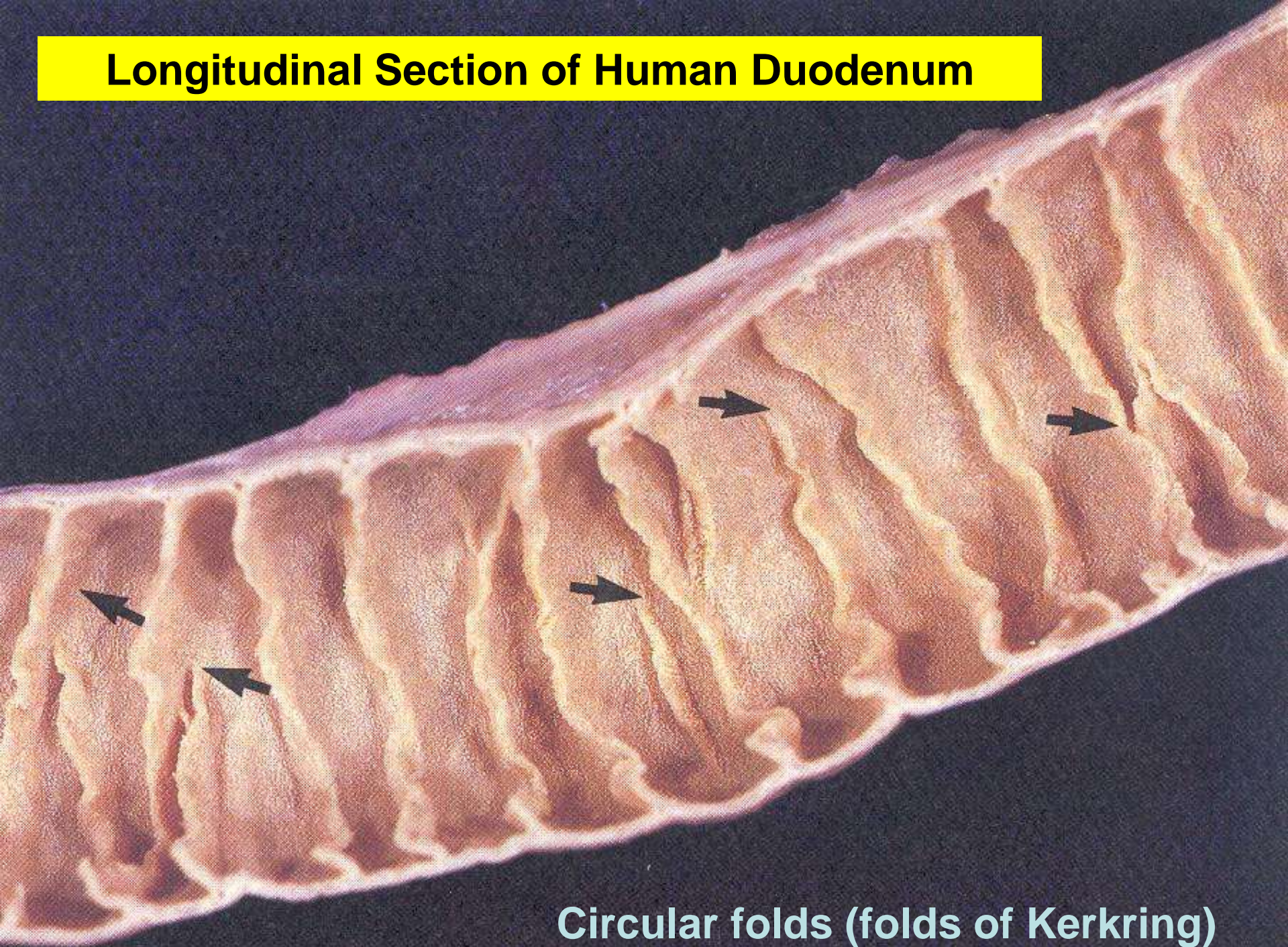
Histologically: surface increasing structures:

Kerkring folds: (submucosa)

villi: mucosa

microvilli: apical plasma membrane of the enterocytes

# Longitudinal Section of Human Duodenum



Circular folds (folds of Kerkring)

## *Folds of Kerkring*

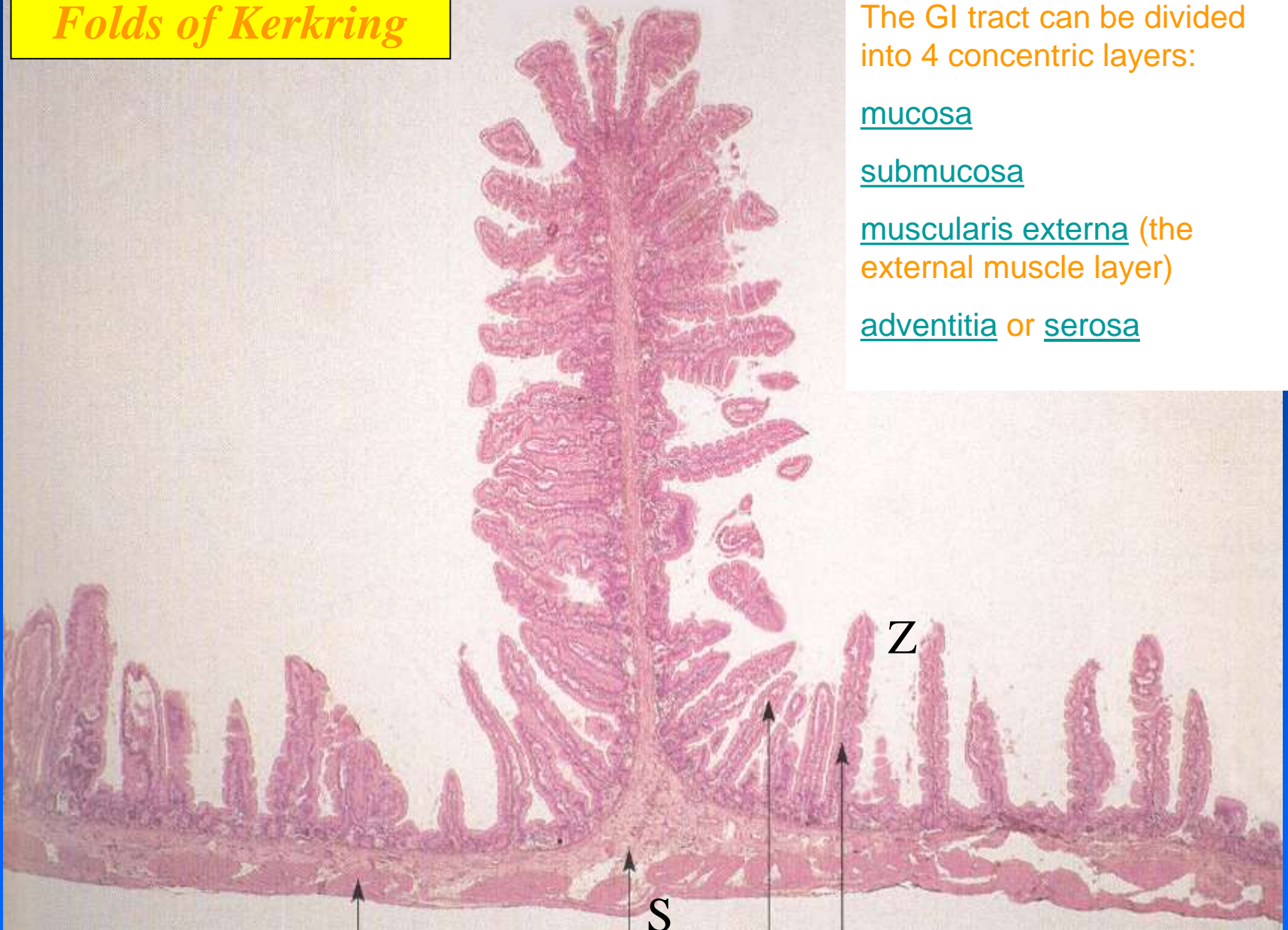
The GI tract can be divided into 4 concentric layers:

mucosa

submucosa

muscularis externa (the external muscle layer)

adventitia or serosa



M

P

# Structure of Wall of Small Intestines

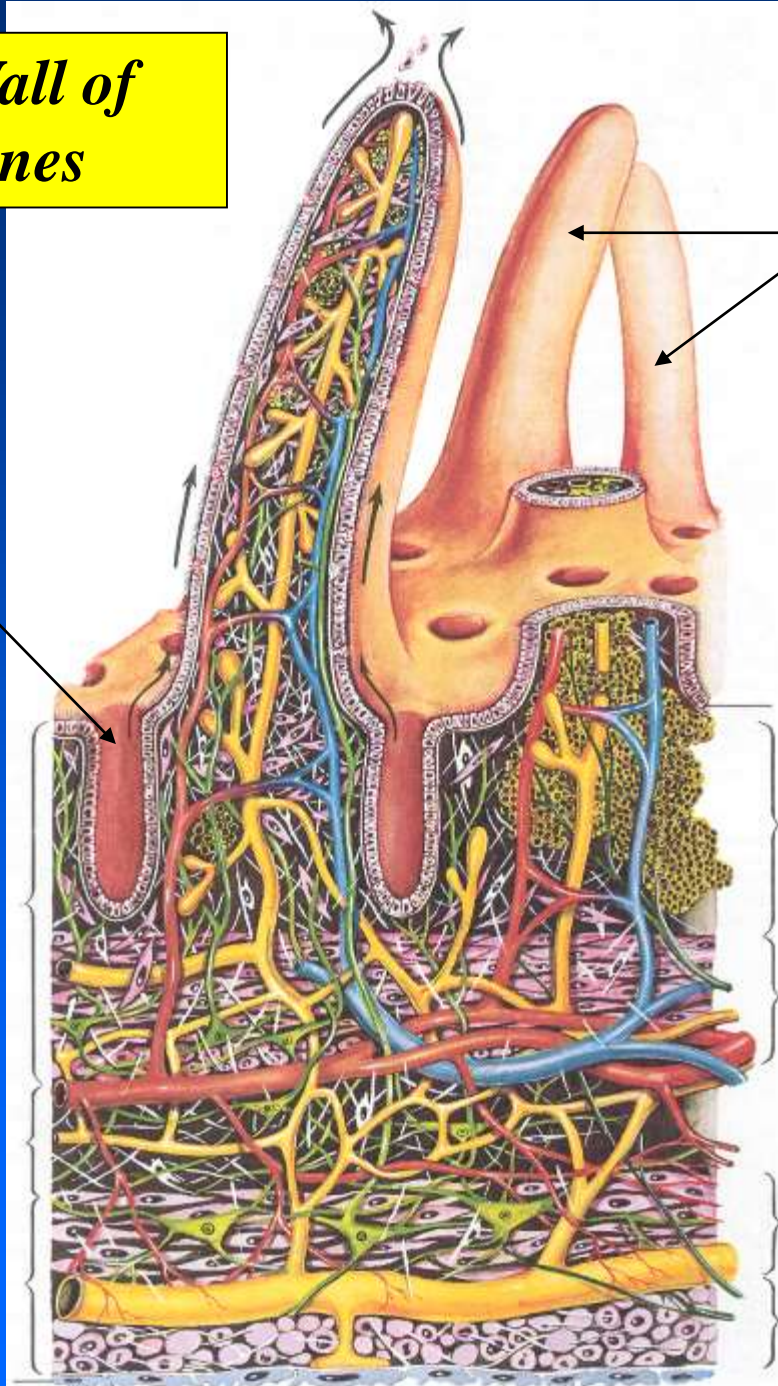
Crypts  
(intestinal  
glands)

Mucosa

Submucosa

Muscularis

Serosa



villi

epithelium

propria

muscularis mucosae

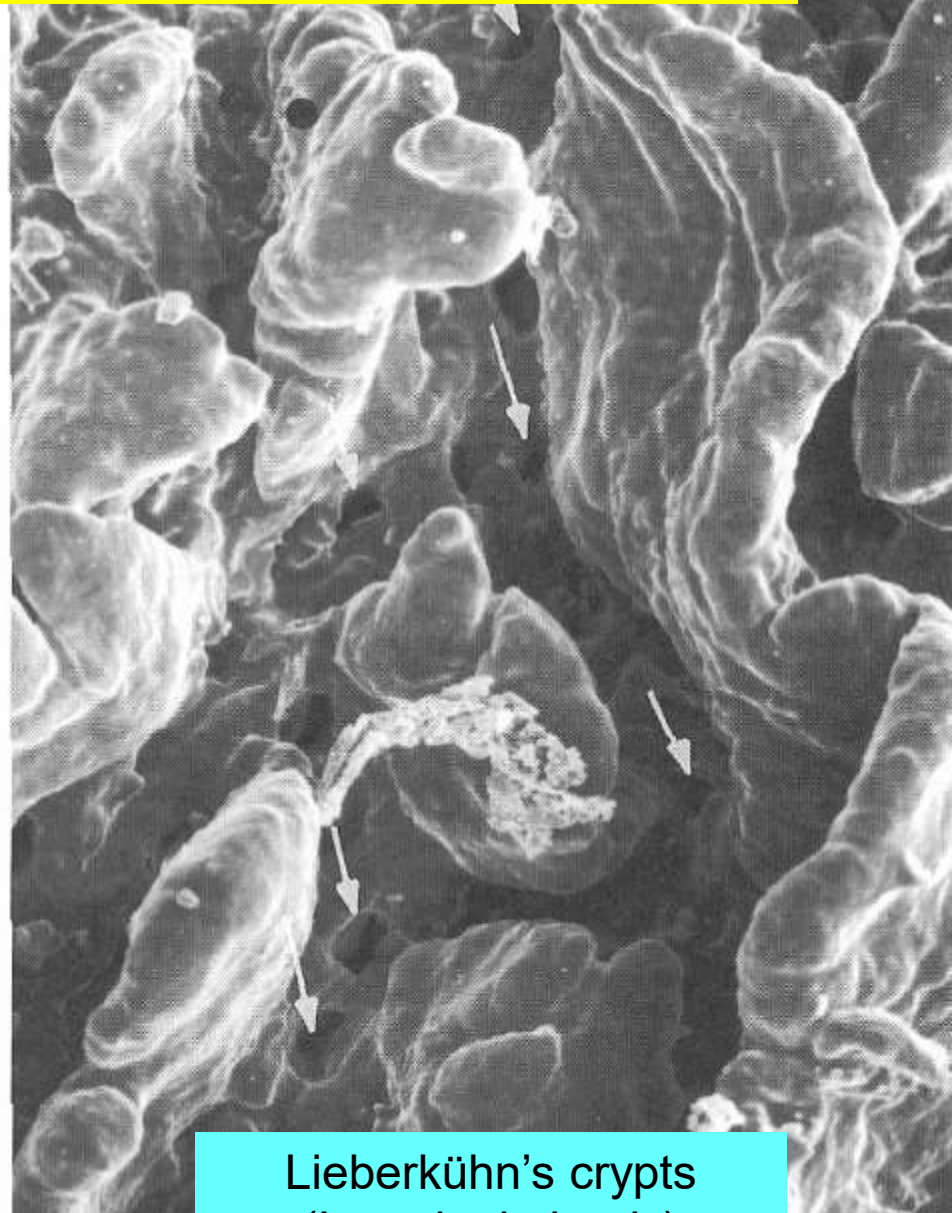
circular  
longitudinal

# Intestinal Villi (Scanning Electron Microscopy)



Intestinal villi

a



Lieberkühn's crypts  
(Intestinal glands)

b



LP

Ep

L

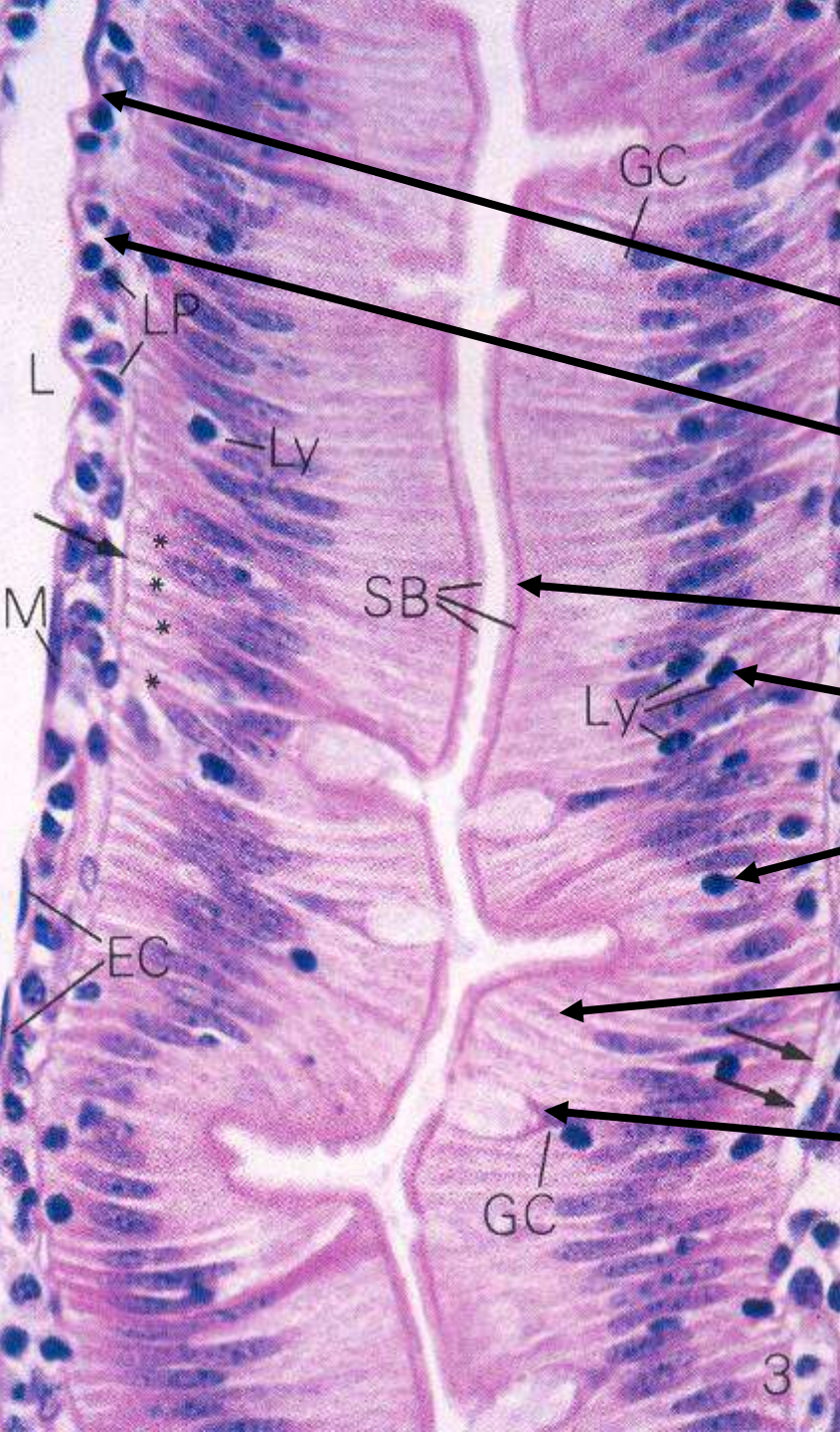
LP

L

GC

*Intestinal Villi*

# Two Neighboring Ileal Villi



Endothel cells (lymphatic vessel)

propria (lymphocytes)

Brushborder (microvilli)

Lymphocytes (infiltration)

Epithelial cells (enterocytes)

Goblet cells (GC)

L

LP

Ly

SB

Ly

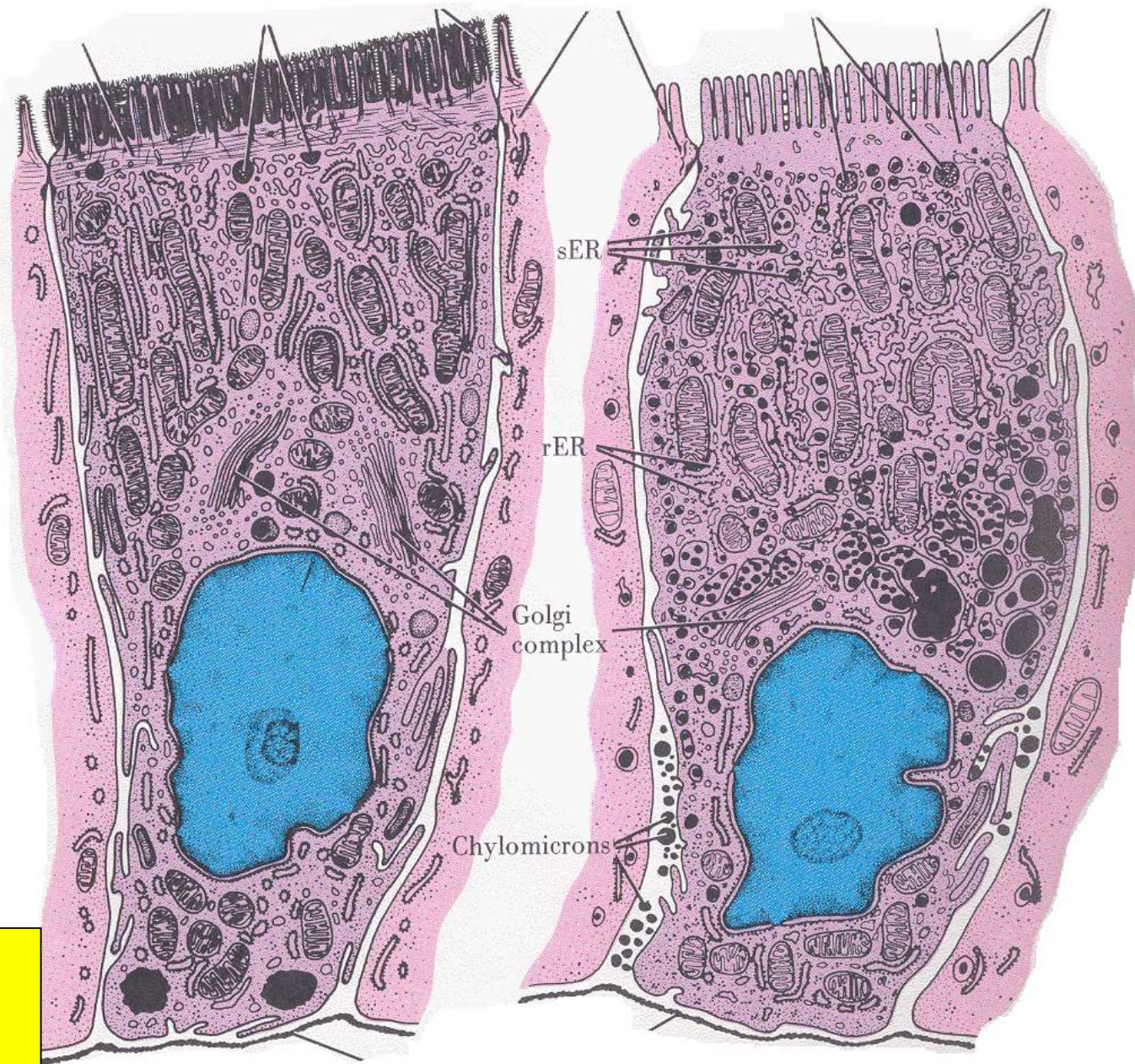
EC

GC

GC

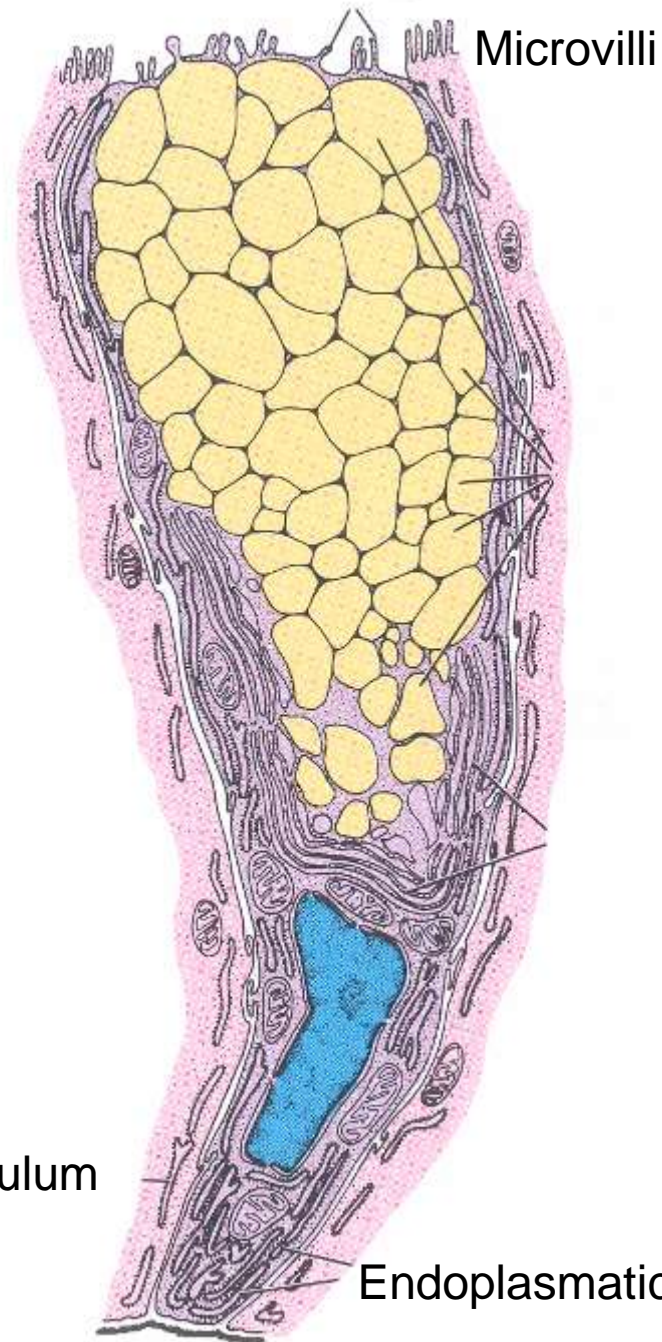
3





***Enterocytes with  
brushborder or  
microvilli***

# Goblet Cells



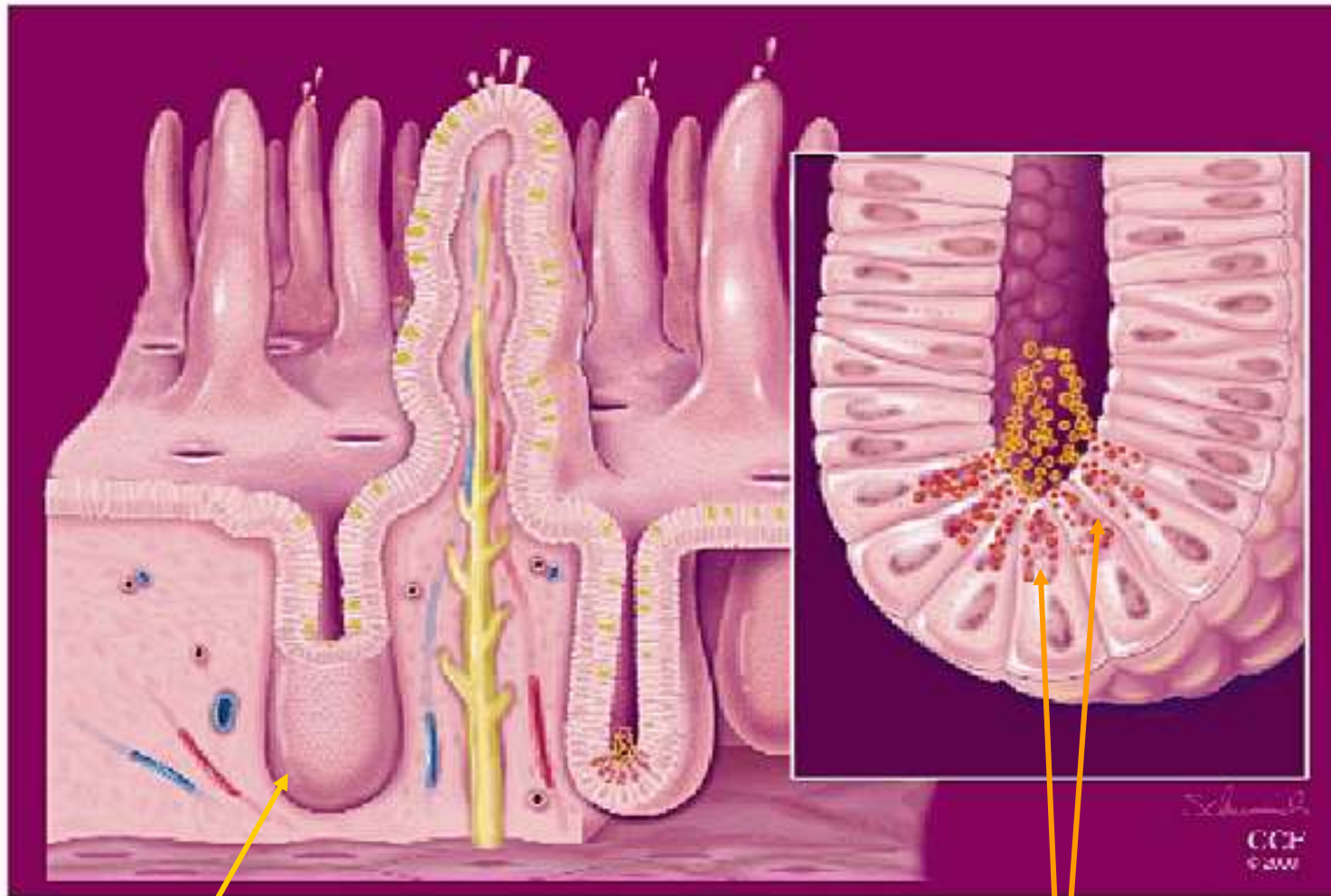
Microvilli

Mucinogenic granules

Golgi-apparatus

Endoplasmatic reticulum

Endoplasmatic reticulum



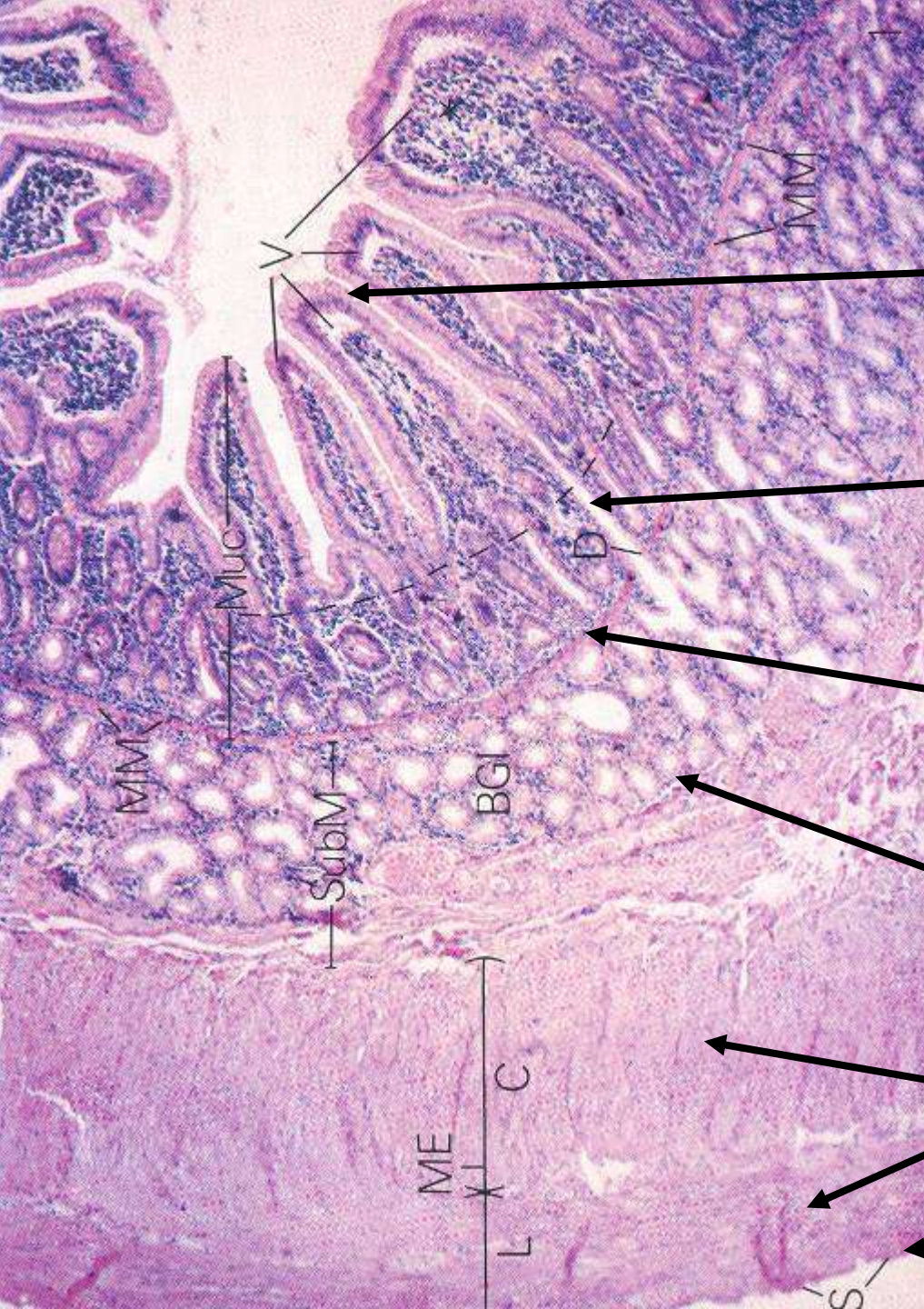
Cleveland Clinic Foundation

CCF  
© 2011

Lieberkühn crypt

Paneth cells: secrete antibacterial enzyme: lysozyme

# Duodenum



Mucosal epithelium

Lamina propria mucosae  
(+ Lieberkühn's crypts)

Tunica muscularis mucosae

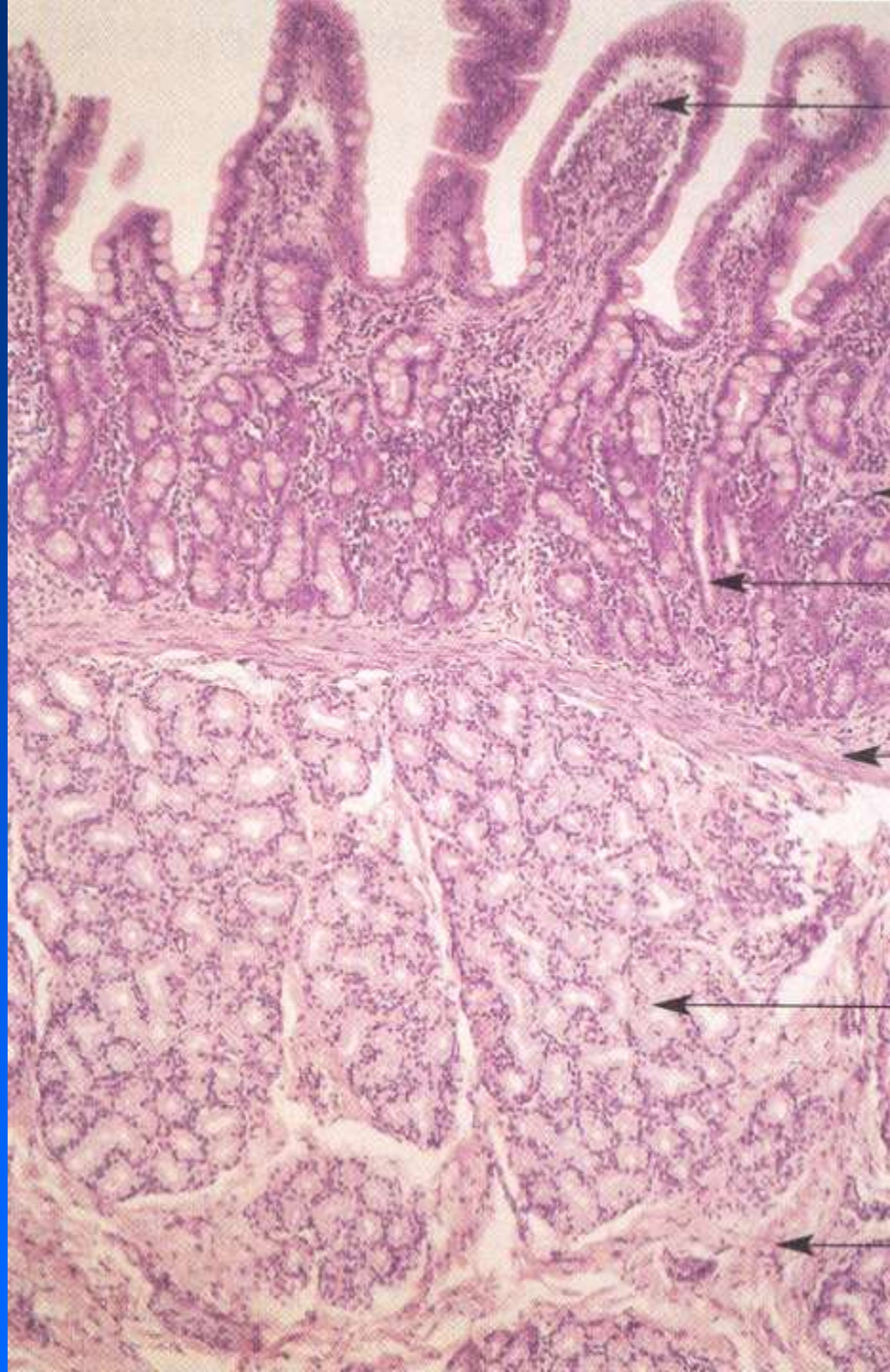
submucosa + Brunner's  
glands

Tunica muscularis (outer  
longitudinal and inner  
circular)

Serosa

# *Duodenum*

**Brunner glands:** secrete alkalic substance to neutralise the acidic pH



villi

propria

Lieberkühn's crypts(glands)

muscularis mucosae

Brunner's glands (submucosa)

submucosa

# *Jejunum*

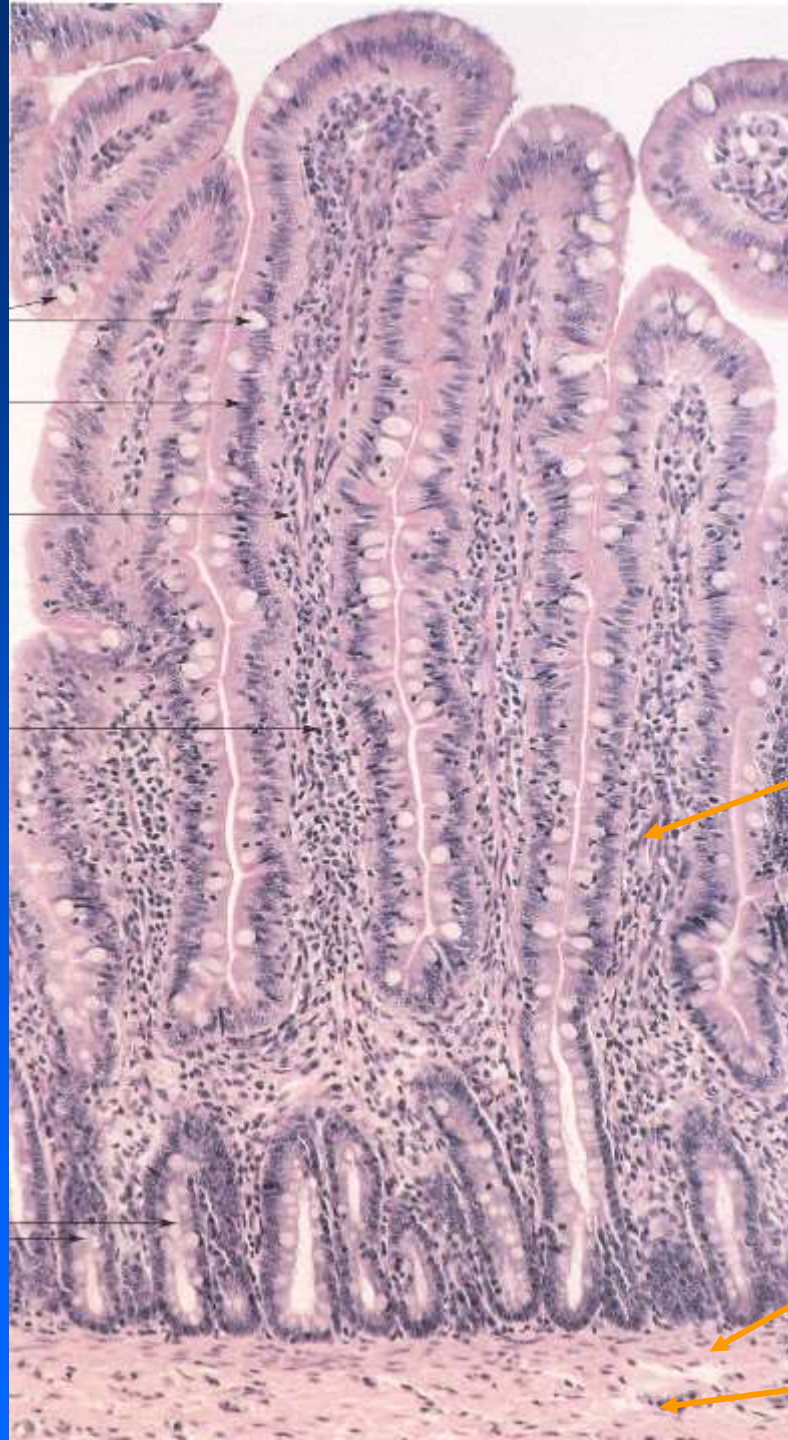
(longitudinal section  
of a villus)

Goblet cells

1.) *epithelium*

stroma of villus

Lieberkühn's crypts



**Mucosa layer**

2.) *propria*: wide,  
contains  
Lieberkühn  
crypts: glands

3.) *muscularis  
mucosae*

**Submucosa**

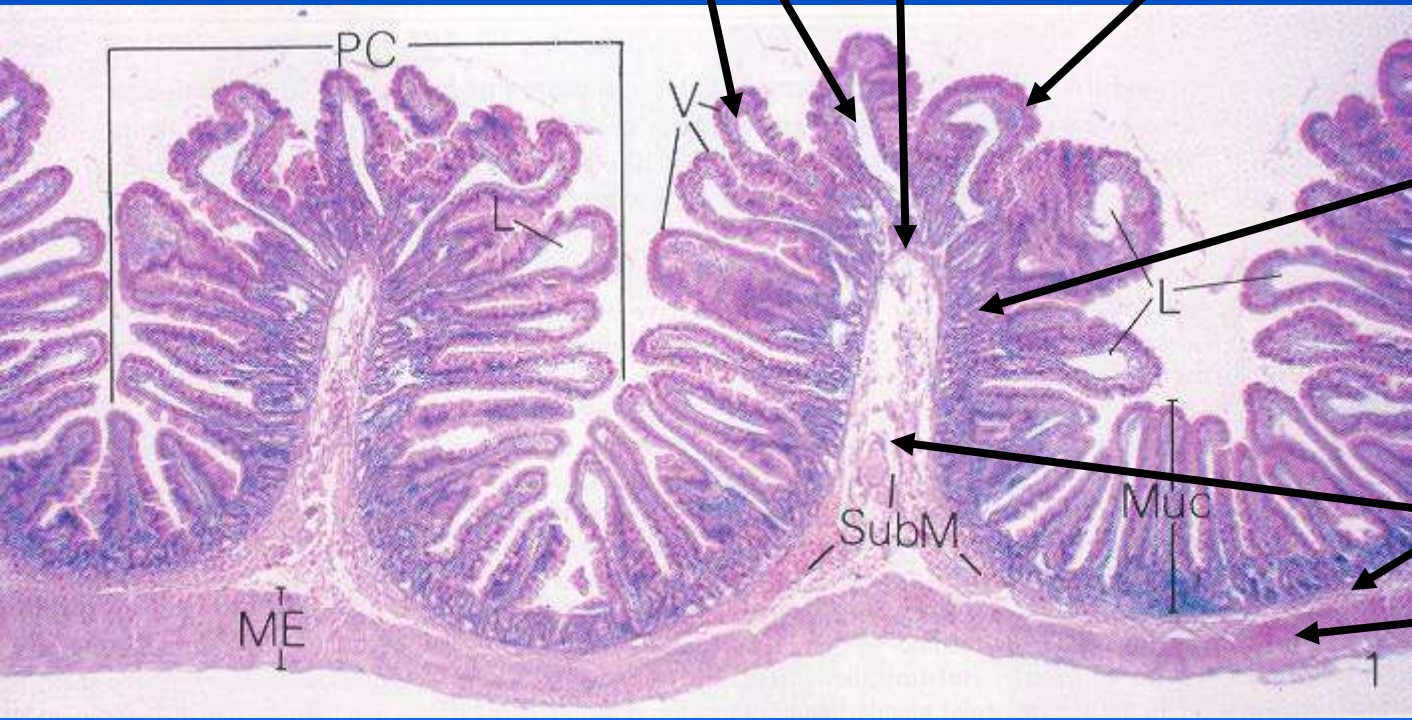
# Jejunum

muscularis  
mucosae

Intestinal villi

epithelium of mucosa

Kerkrings's folds

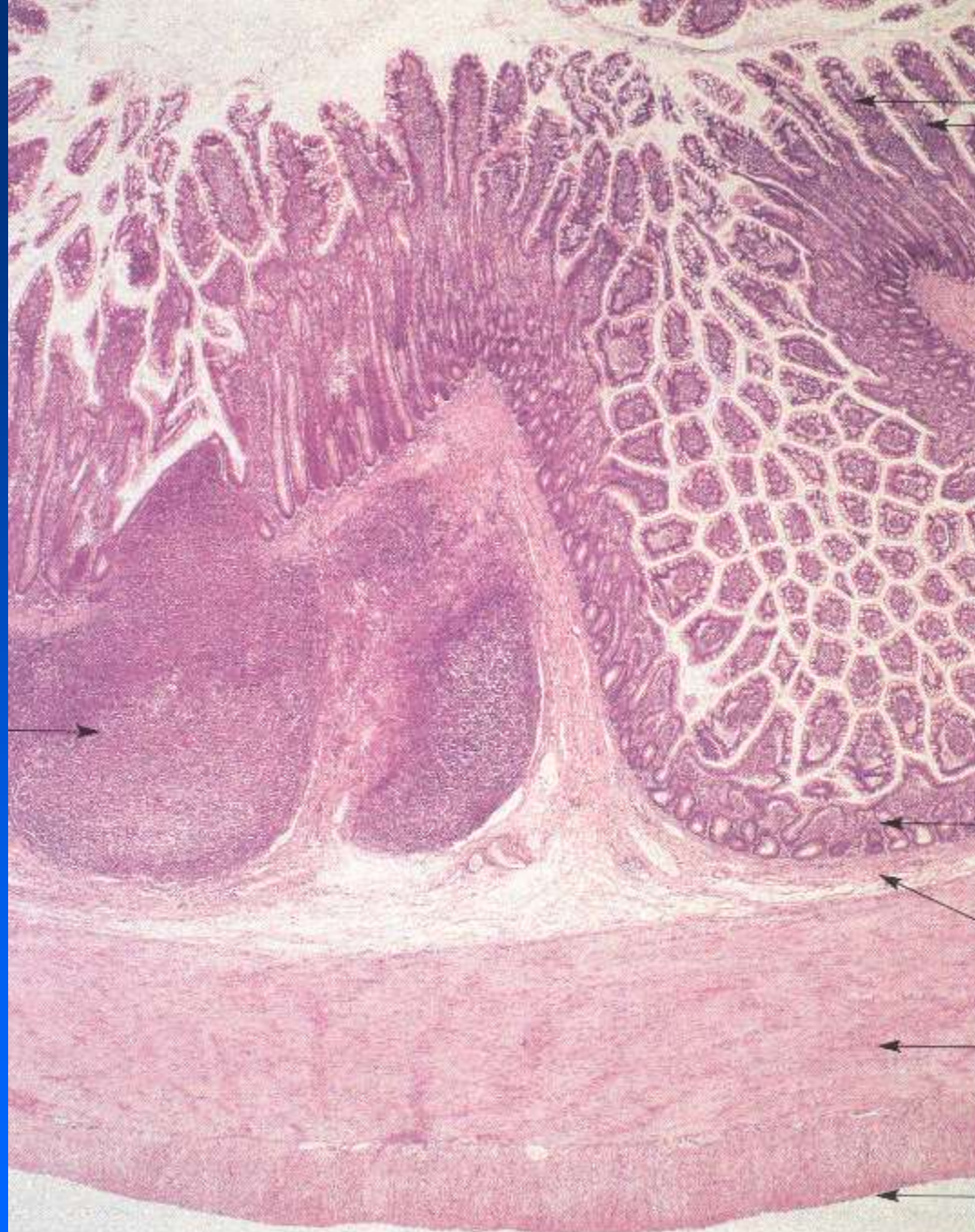


mucosa

submucosa

tunica muscularis  
+ serosa

# Ileum



villi

crypts

submucosa

muscle layer

serosa

Peyer's  
plaques

(Aggregated  
lymphatic  
follicles)



# GALT

About 70% of the body's immune system is found in the digestive tract.

The GALT is made up of several types of lymphoid tissue that produce and store immune cells that carry out attacks and defend against pathogens.

Lymphoid tissue in the gut is comprised of the following :

Tonsils and Adenoids (Waldeyer's ring)

Peyer's patches in the small intestine

Lymphoid aggregates in the appendix and large intestine

Lymphoid tissue accumulating with age in the stomach

Small lymphoid aggregates in the oesophagus

Diffusely distributed lymphoid cells and plasma cells in the lamina propria of the gut

# *Radiology of Large Intestines*

Right colic  
flexure

ascending  
colon

caecum

ileum

appendix

rectum

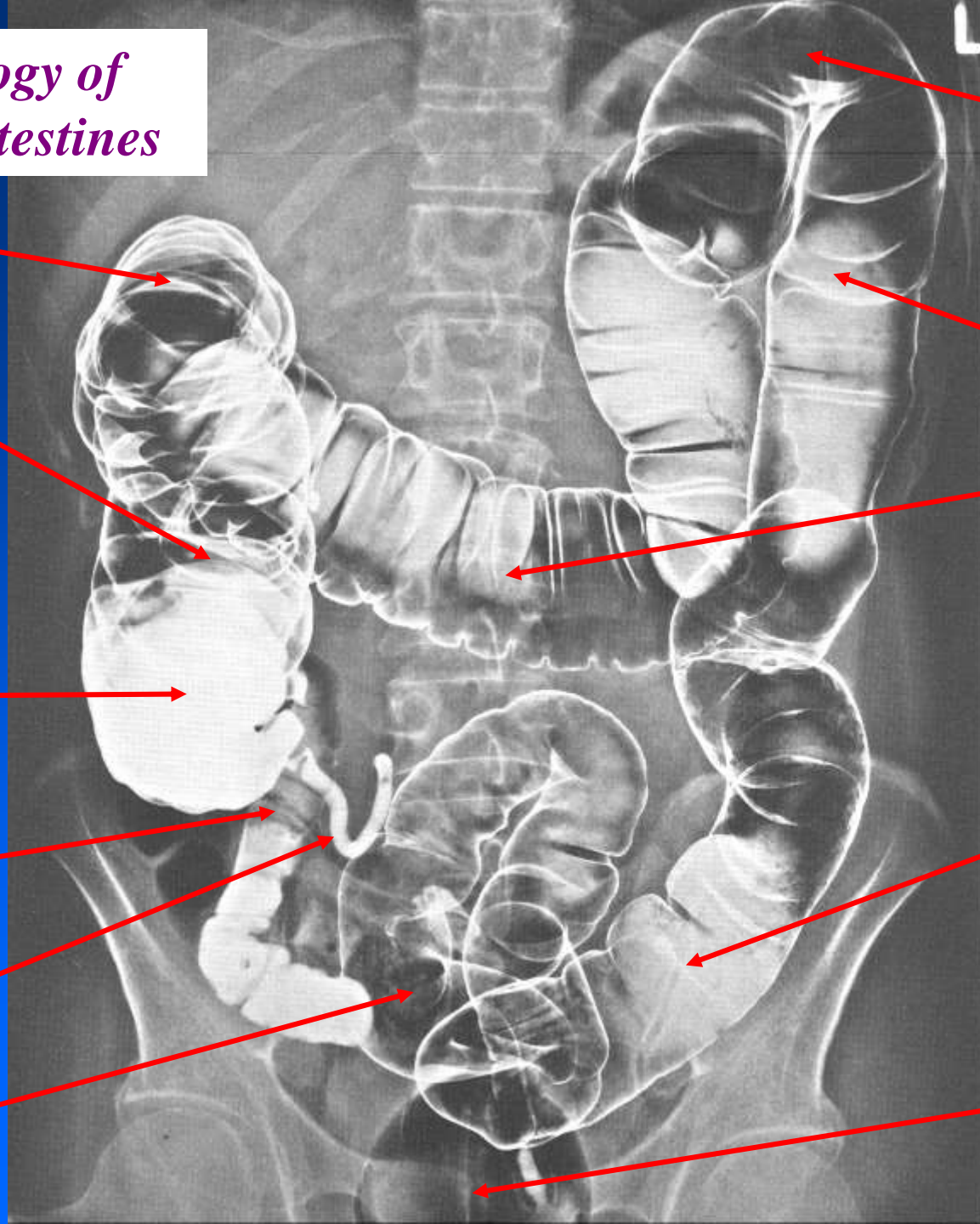
Left colic  
flexure

descending  
colon

transverse  
colon

sigmoid  
colon

symphysis



# Large Intestines

right colic flexure

tenia

ascending colon

epiploic appendices

Caecum

Vermiform appendix

Semilunar folds

Haustra

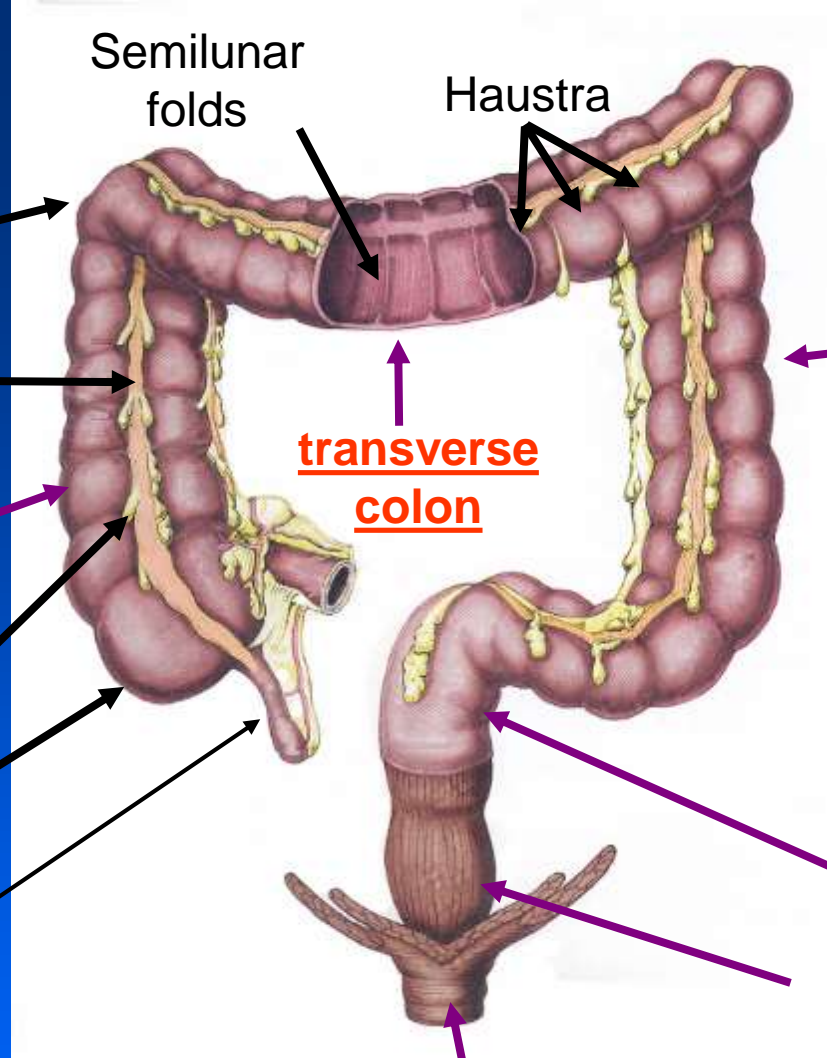
transverse colon

descending colon

sigmoid colon

Rectum

Anal canal



**Semilunar folds :**

(tela muscularis, inner, circular layer, ring fold)

**Teniae of colon:** (tela muscularis, outer, longitudinal layer)

**Haustra:** outpouches between tenias and circular folds

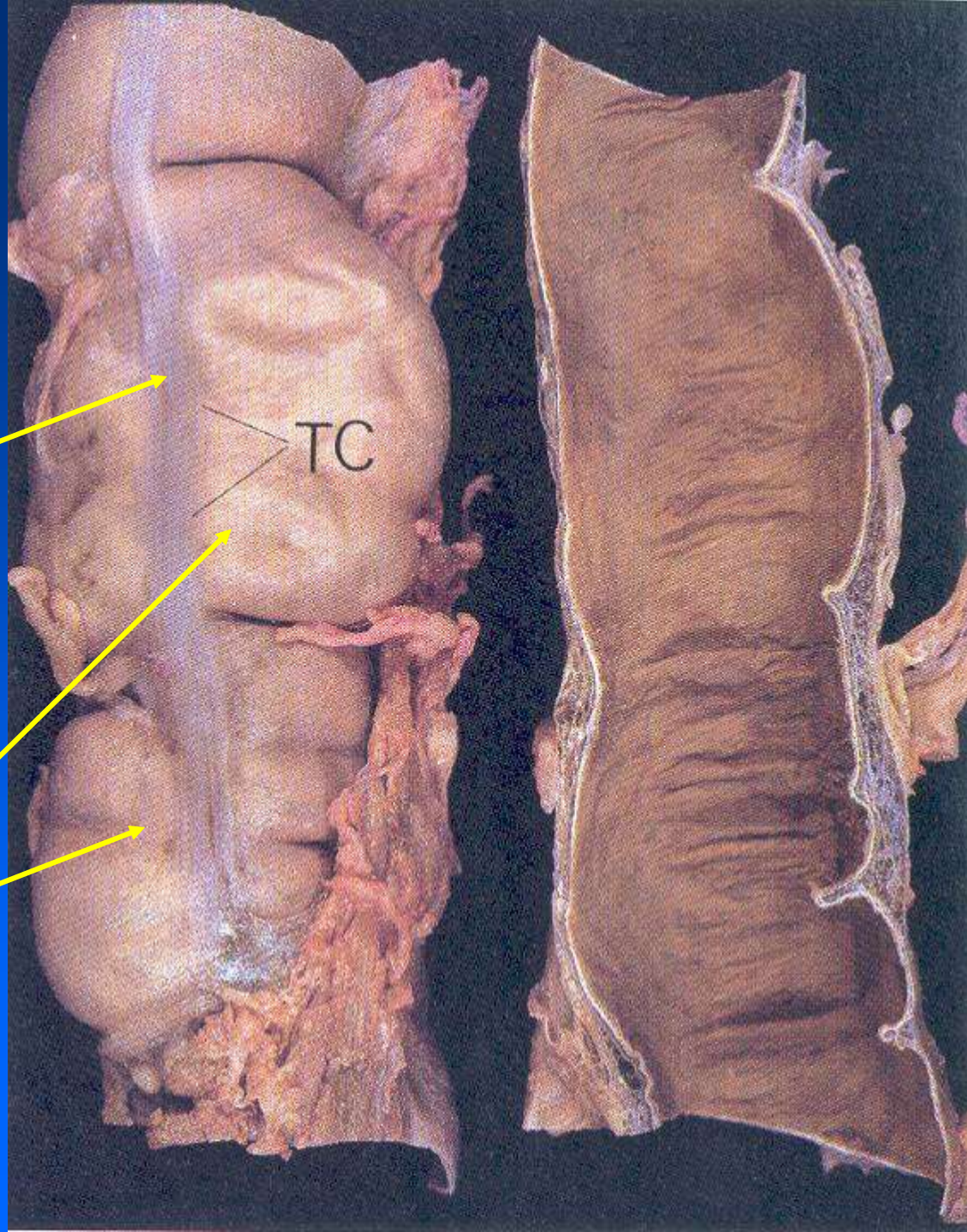
**Epiploic (omental) appendices:** fat bodies of the subserous connective tissue

Large Intestine  
from the outside  
and from the  
Inside

taenia

TC

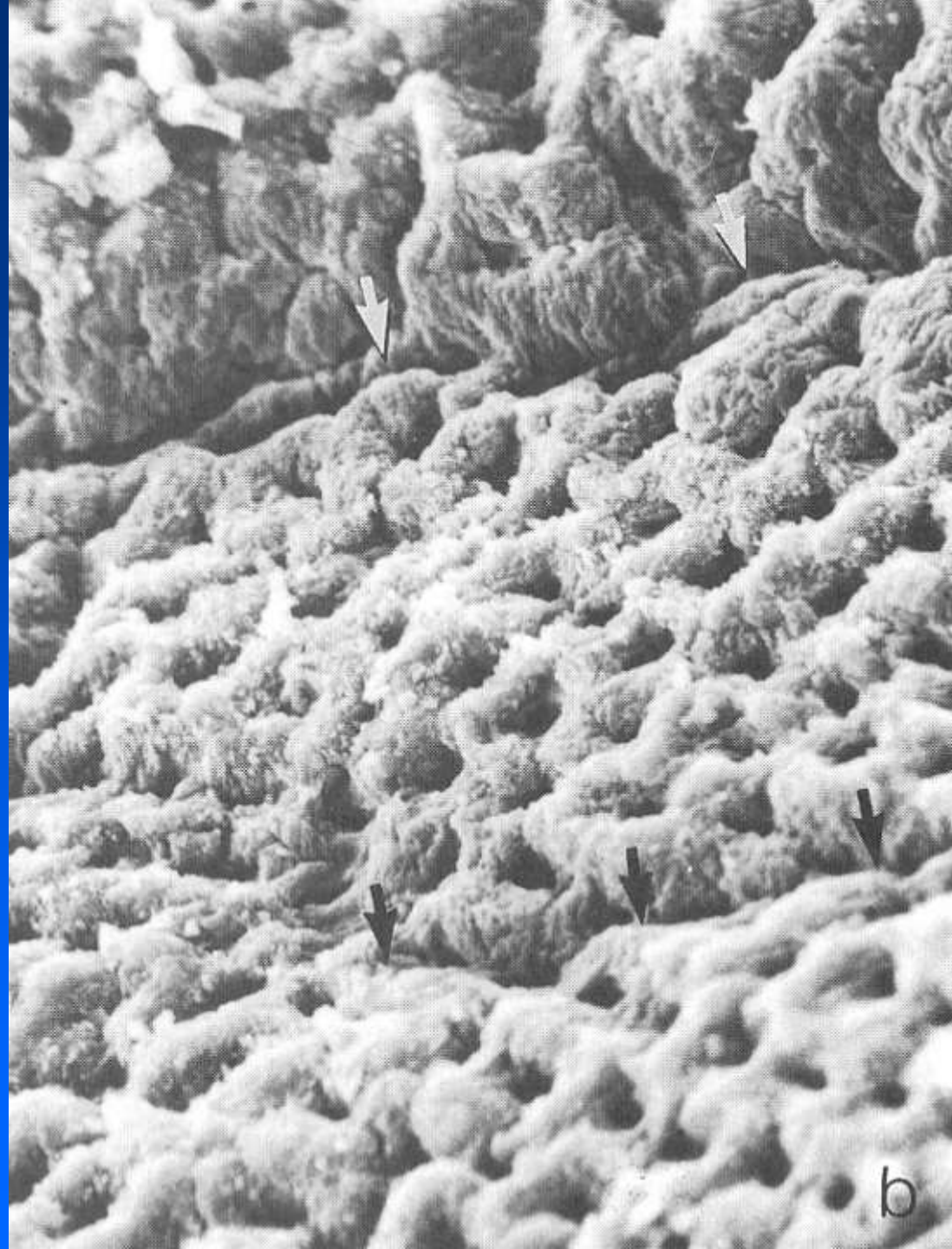
haustra



## Large Intestinal Mucosa

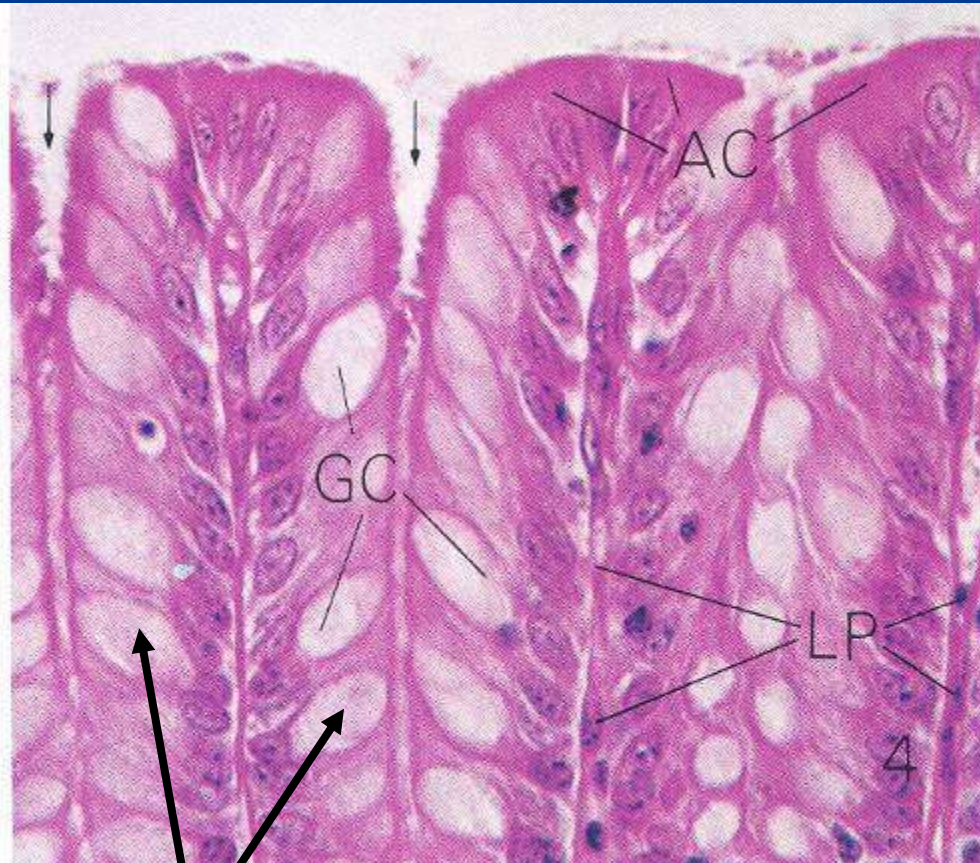
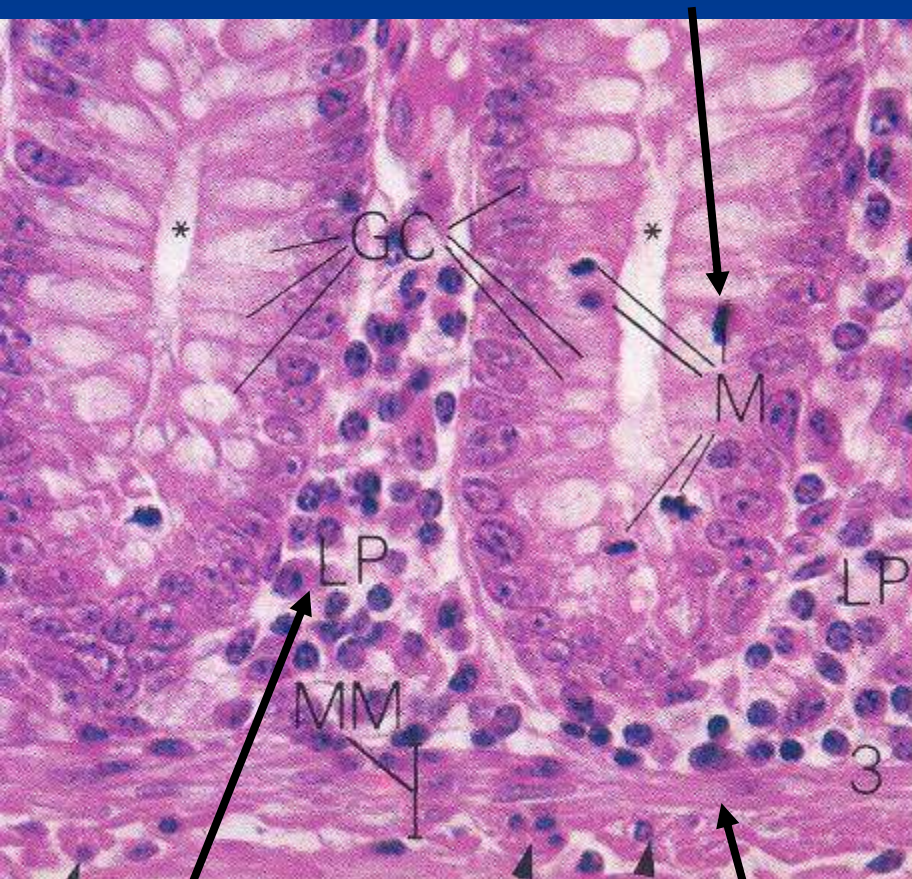
### Histologic Characteristics of Large Intestines as Compared to Small Intestines

- lack of villi
- deeper crypts
- rich in goblet cells
- absence of Paneth-cells
  
- adipose tissue in  
submucosa and subserosa
  
- only single lymph nodes  
(solitary lymphatic follicles)



# Wall of Large Intestines

Mitotic cells (M)

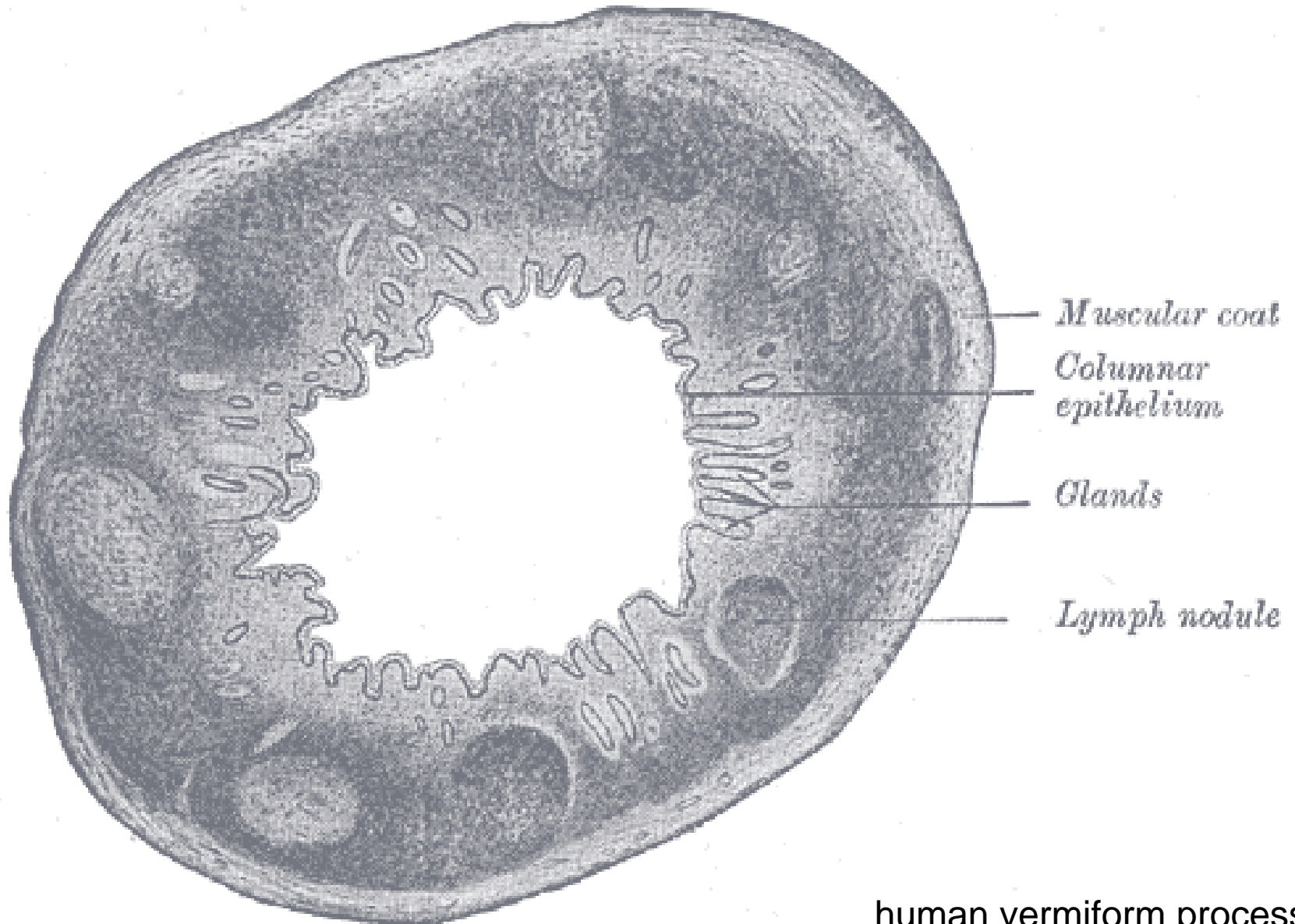


Lamina propria mucosae

Muscularis mucosae

Goblet cells

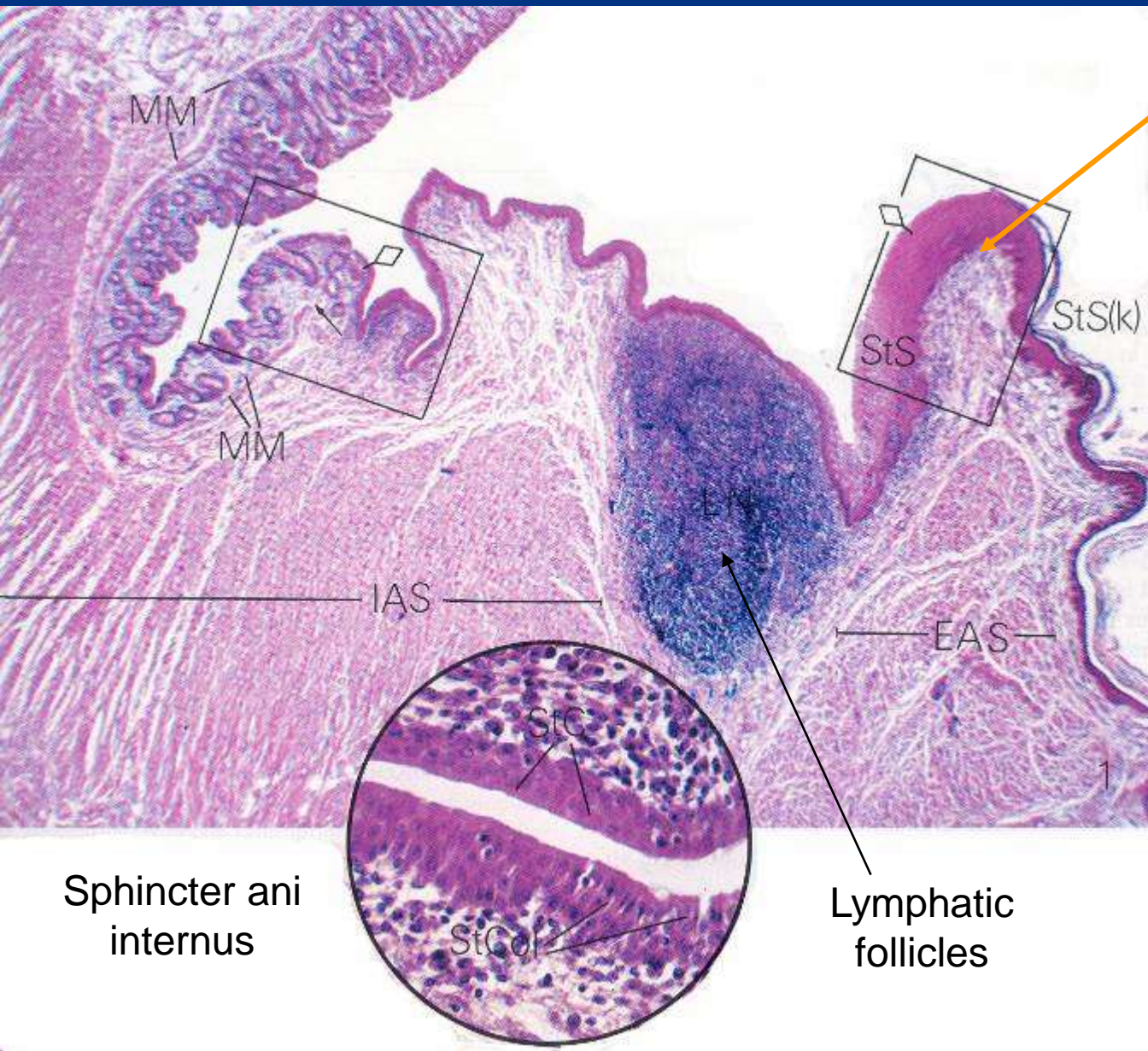
# Appendix Vermiformis



**Colon:** simple cylindrical epithelium

## Anorectal Junction

**Transition:** stratified columnar (cuboidal) epithelium



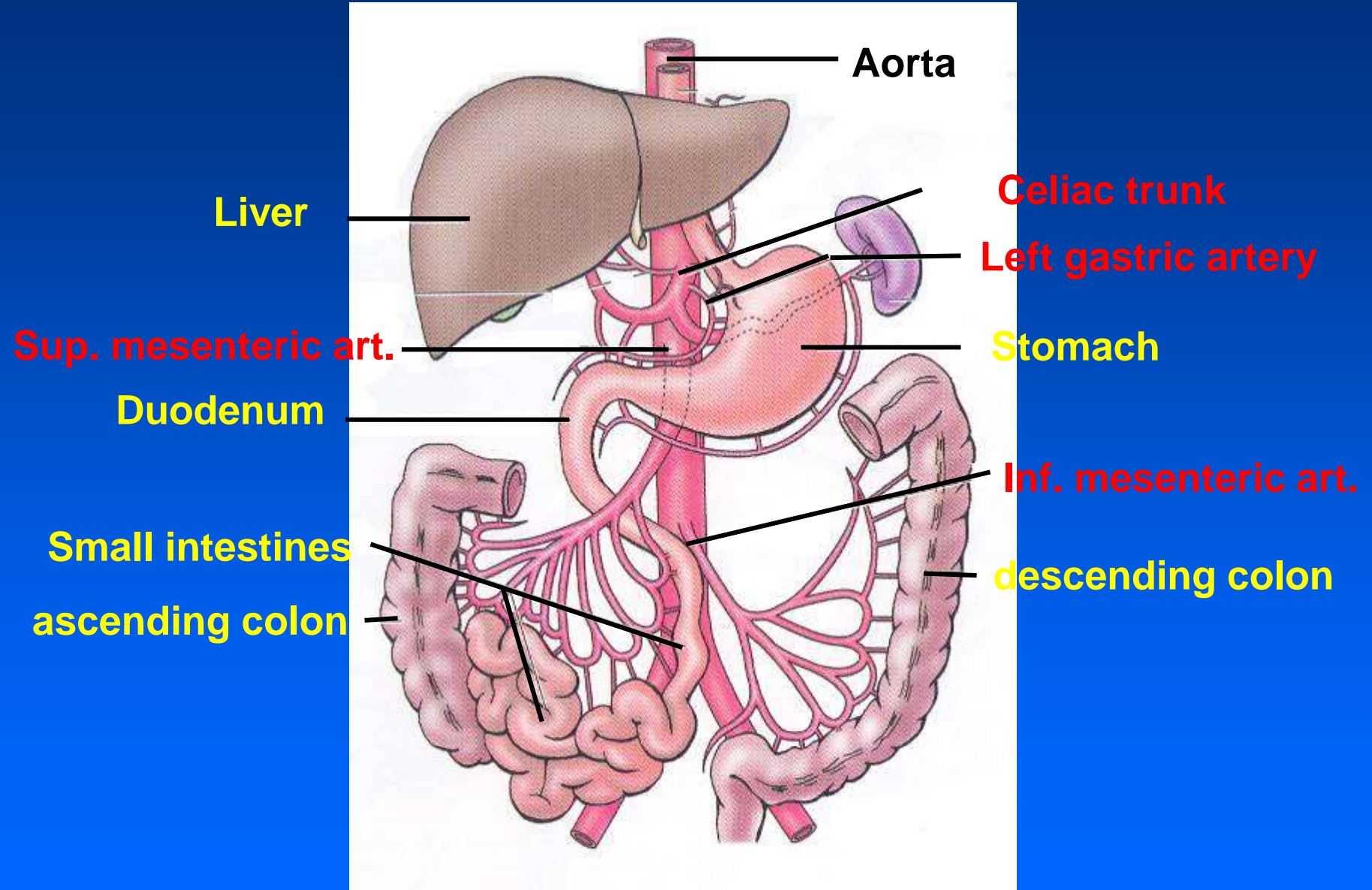
**Skin:** stratified squamous keratinized epithelium

Sphincter ani internus

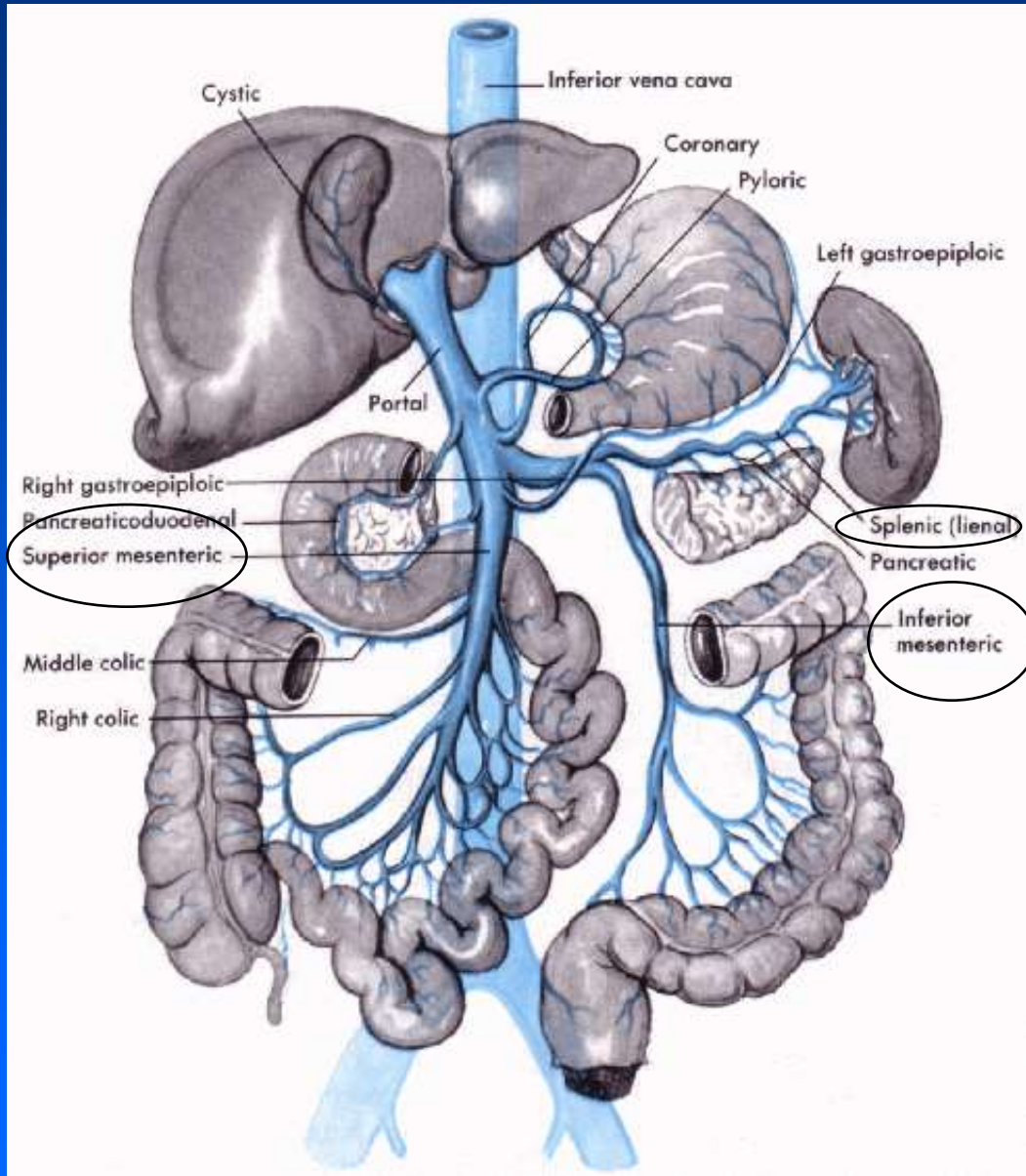
Lymphatic follicles



# Blood Supply

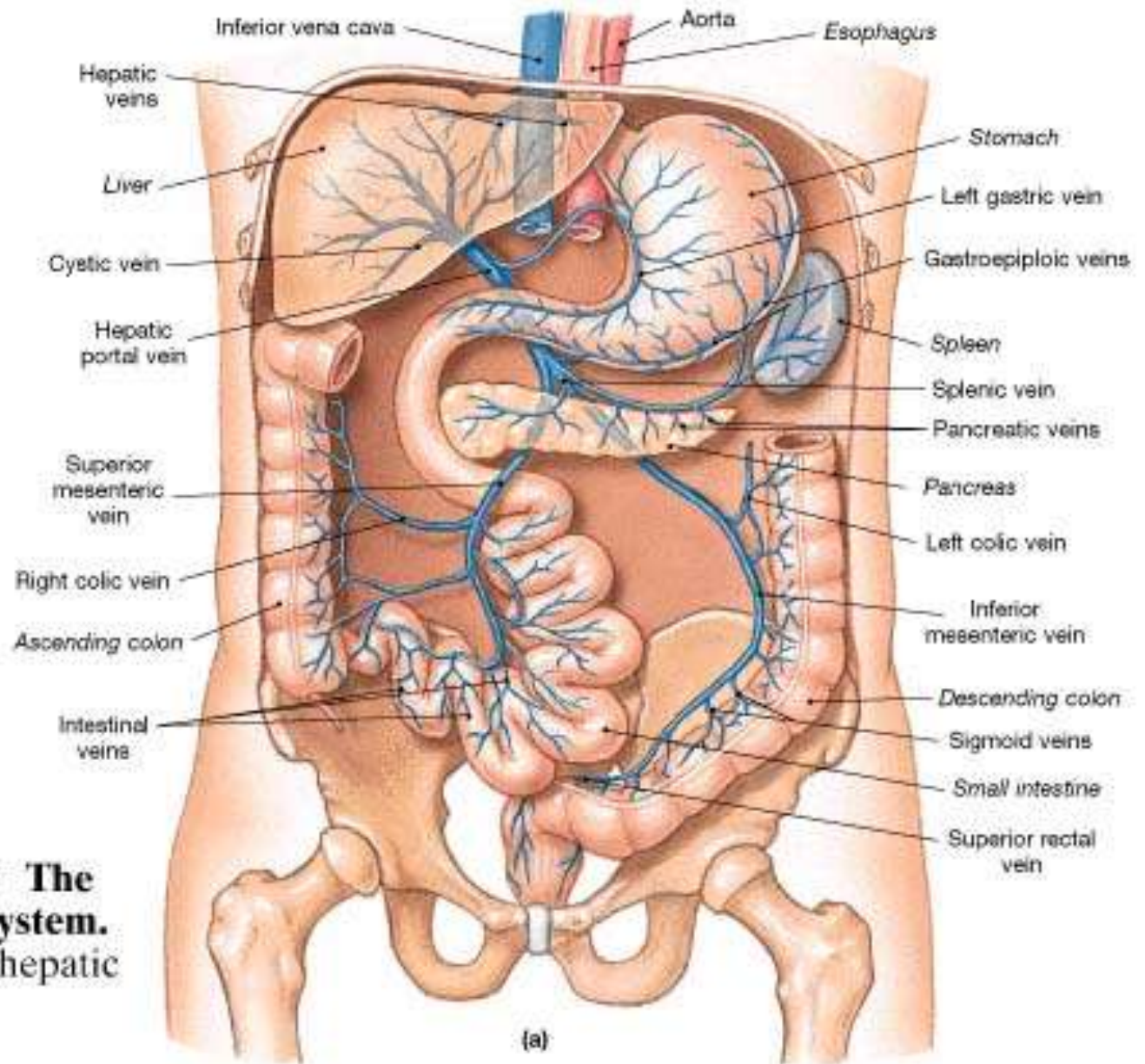


# Vena portae system



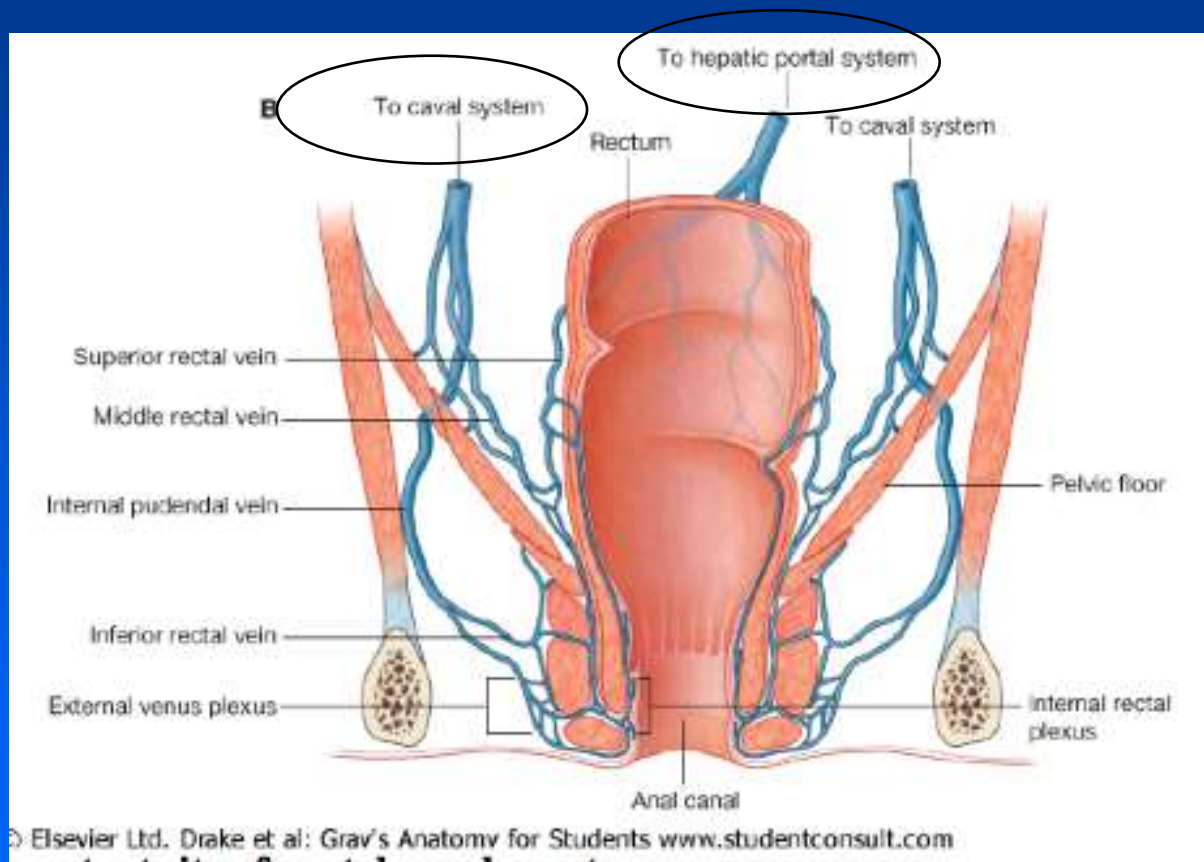
3 main veins:

- splenic vein
- sup. mesenteric
- inf. mesenteric



**• FIGURE 21-35 The Hepatic Portal System.**  
**(a)** Vessels of the hepatic portal system.

# Venous drainage of the rectum



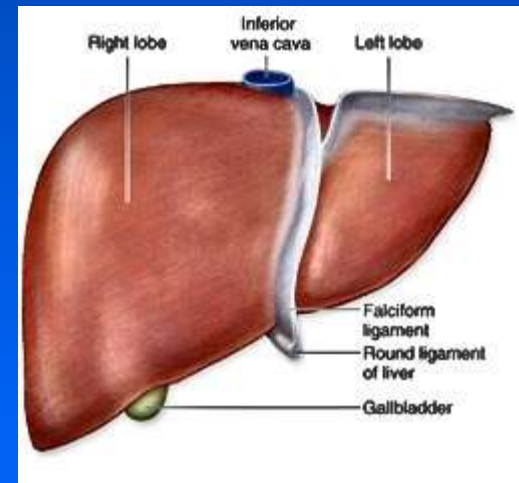
upper 1/3: portal system

lower 2/3: inf. v. cava

# Liver

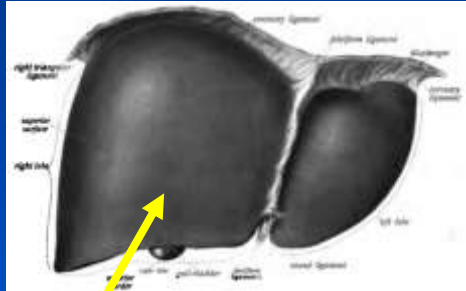


Right hypochondric region

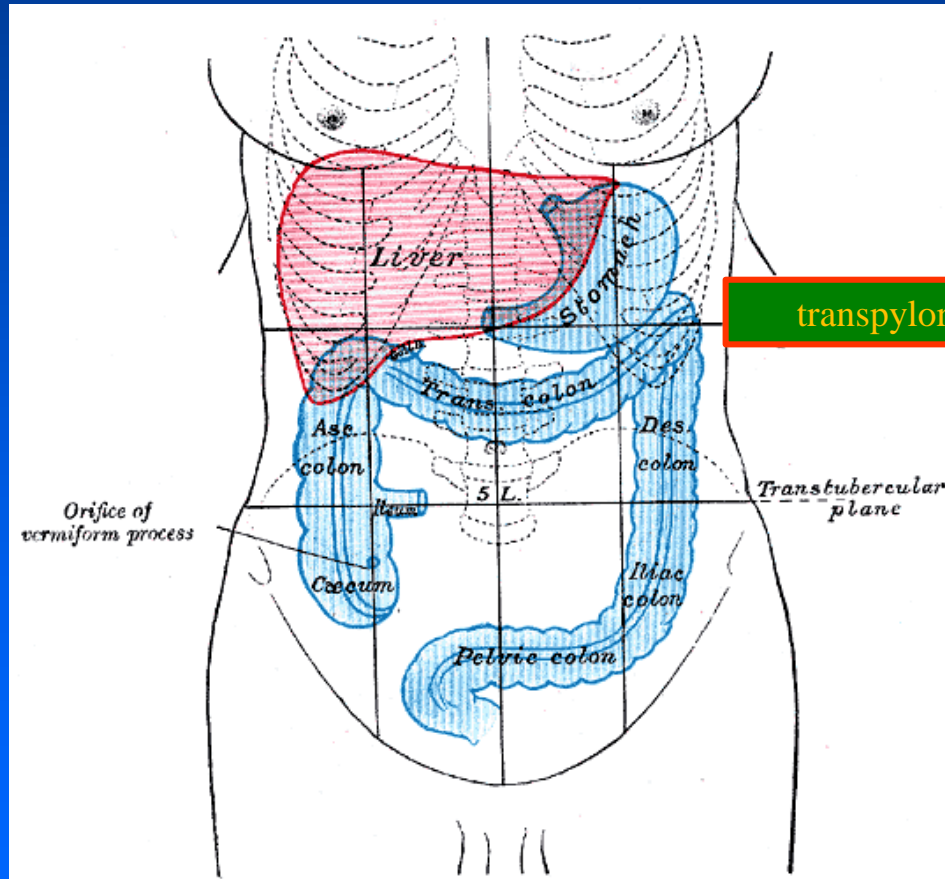


diaphragmatic surface

# Topography of the liver

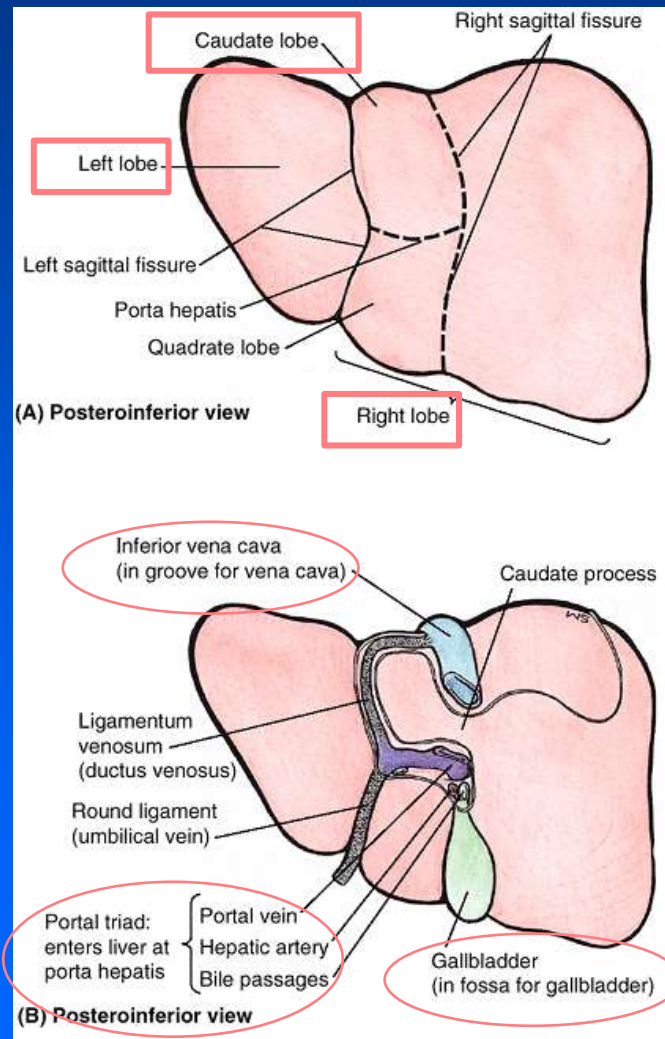


Diaphragmatic surface



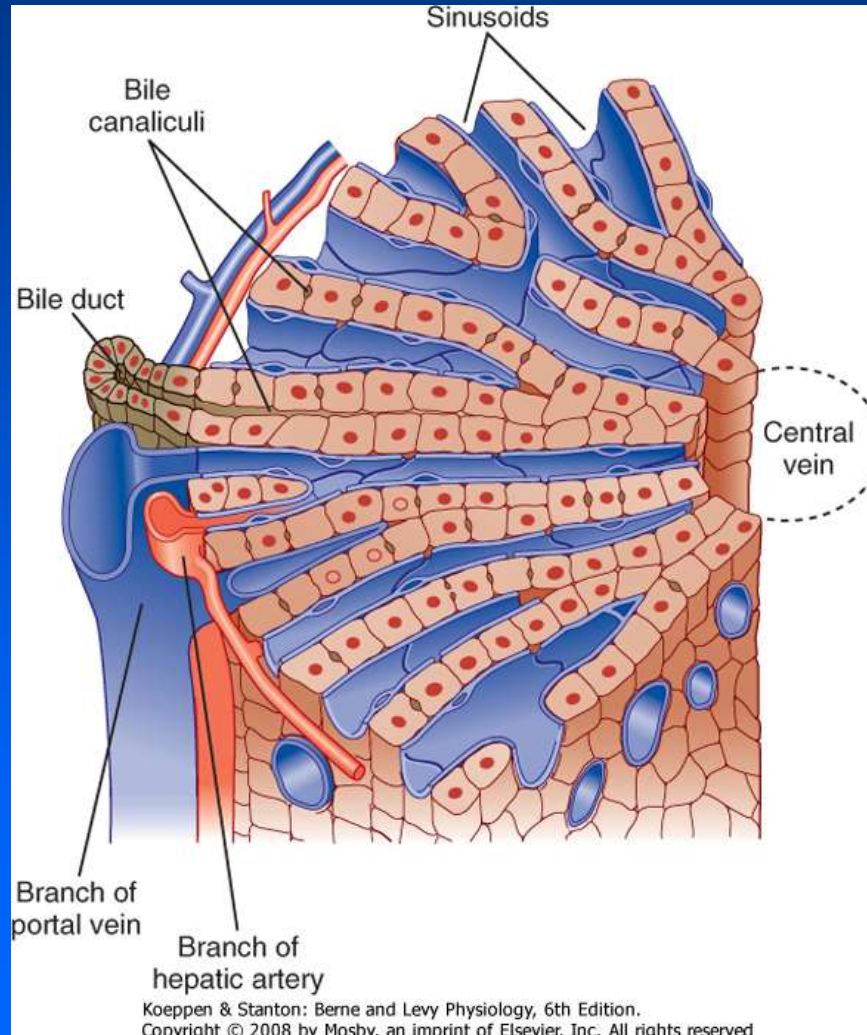
transpyloric plane

# Gross anatomy of the liver



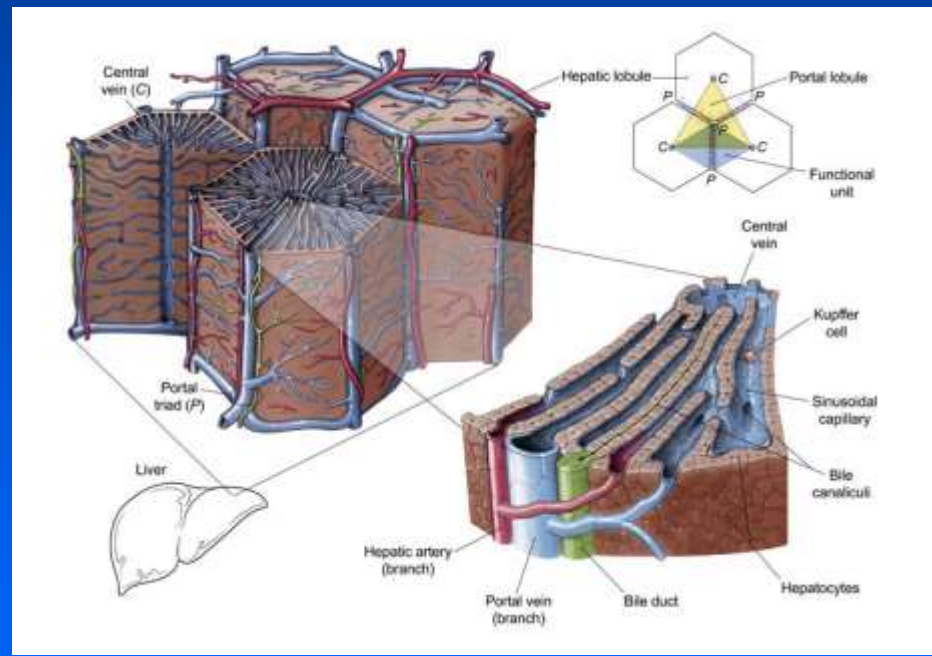
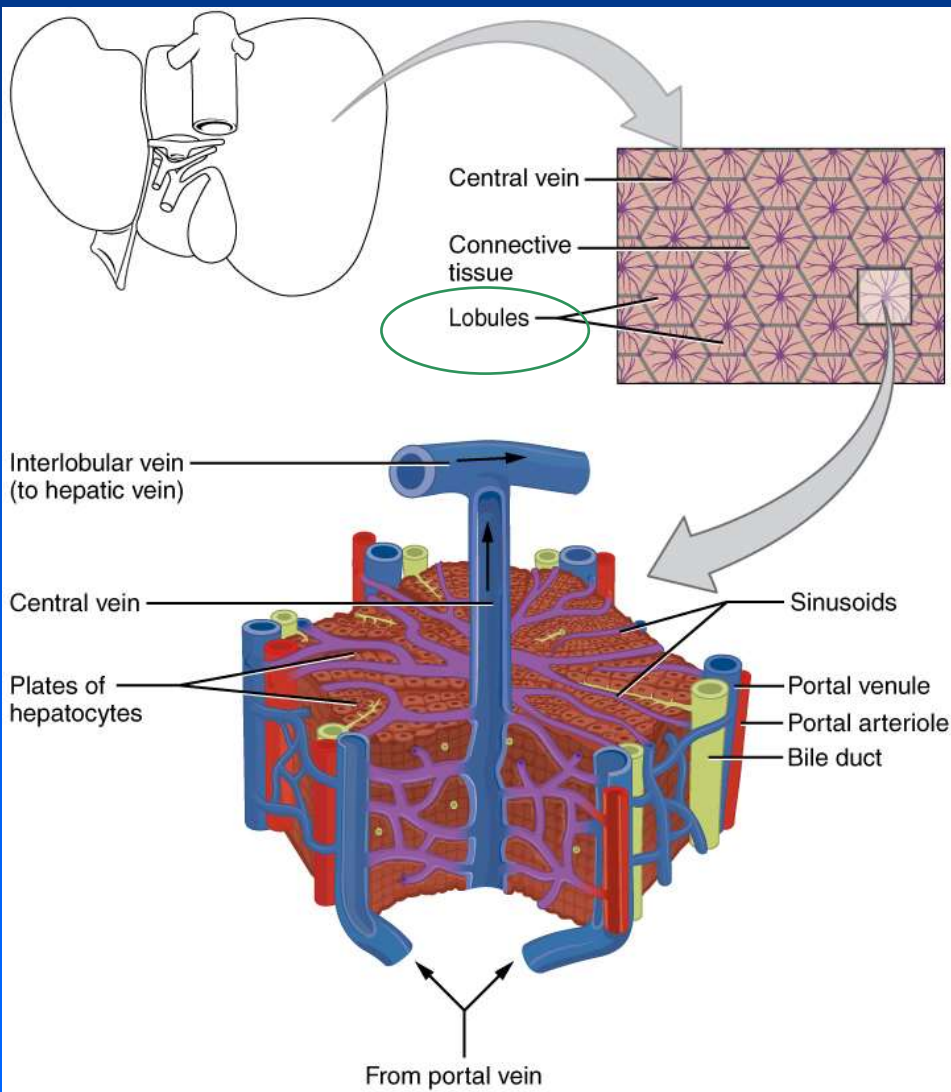
visceral surface

# Hepatic lobule

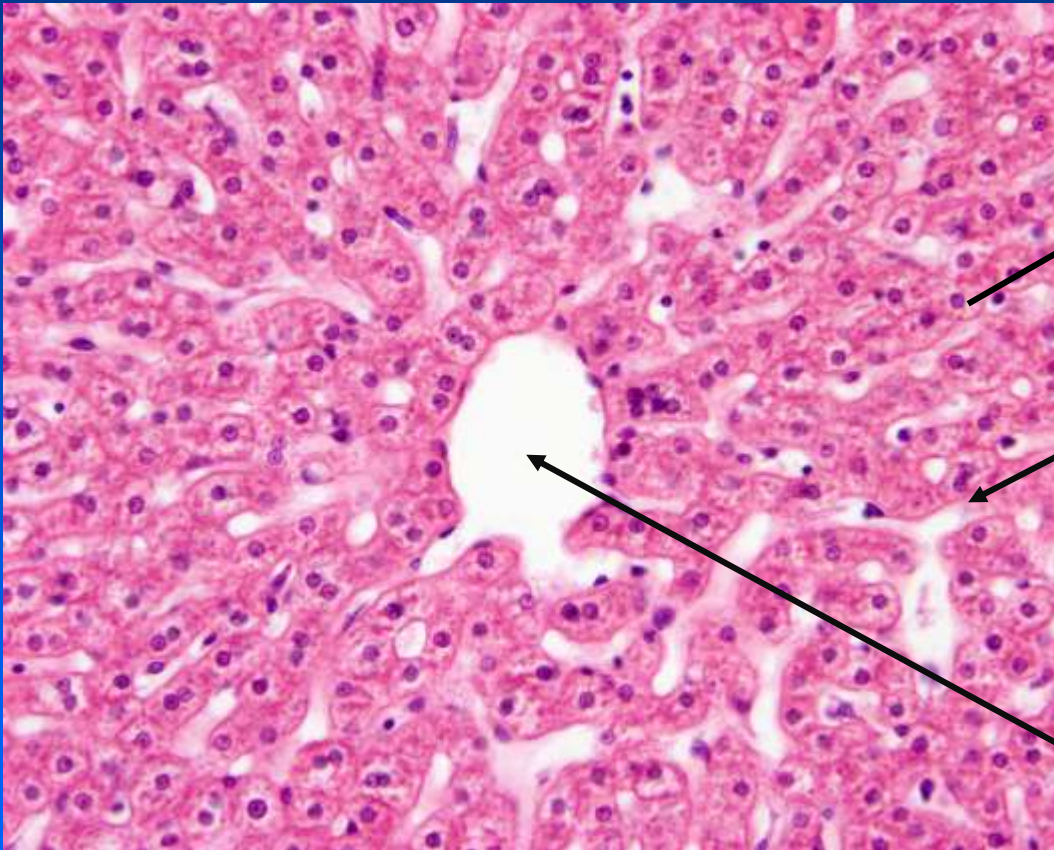




# Portal circulation



# Histology of the liver



hepatocytes

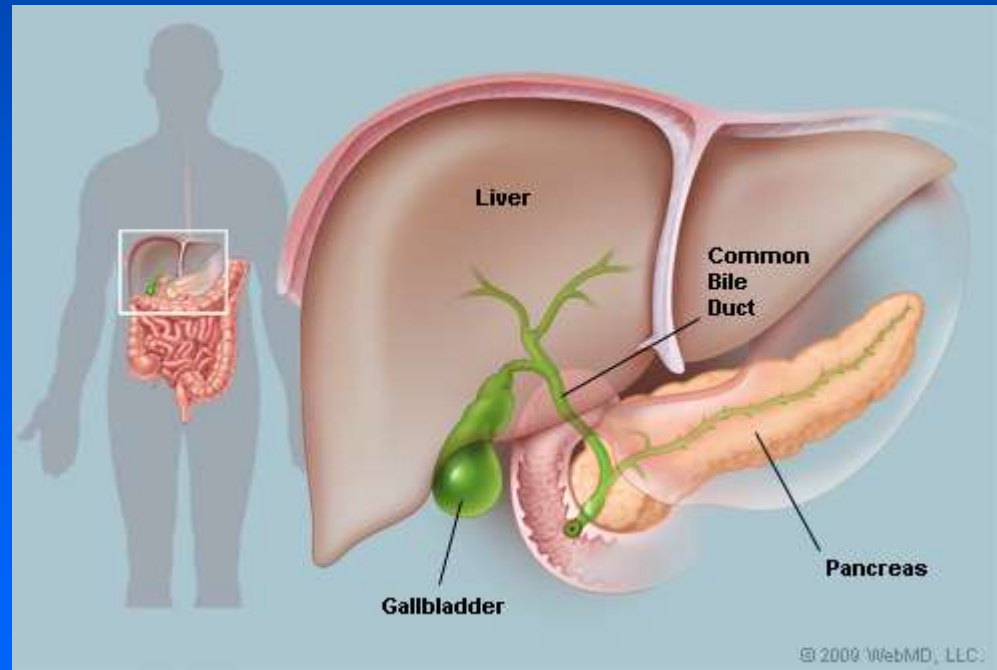
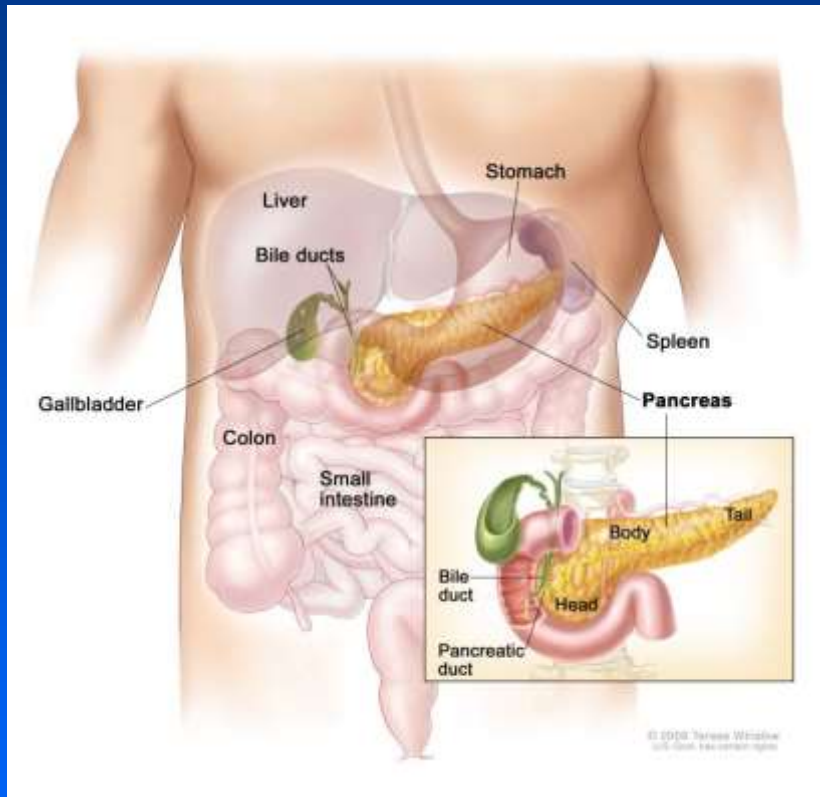
sinusoids

central vein

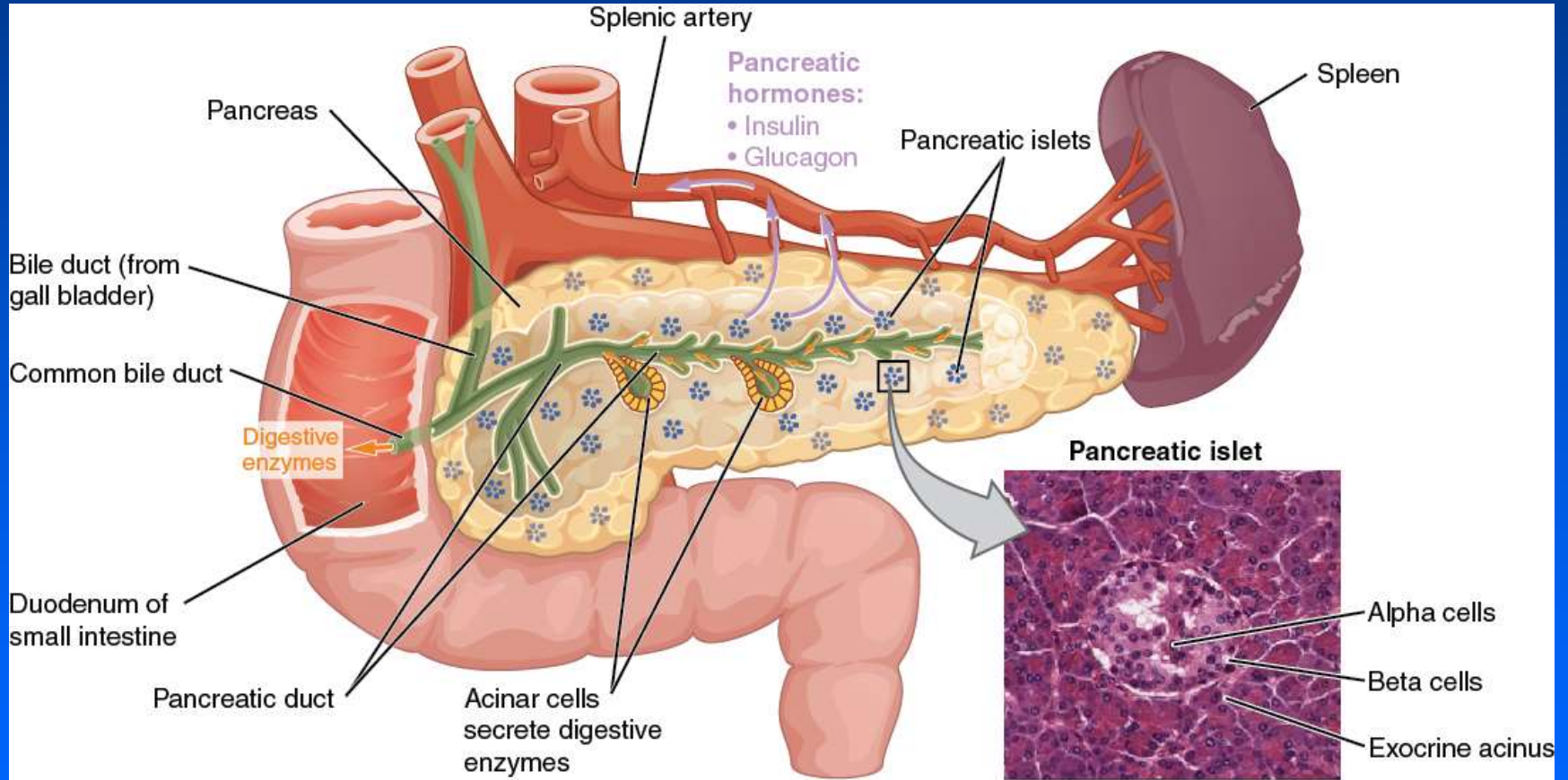
# Pancreas

Exocrine and endocrine gland  
Serous exocrine acini:

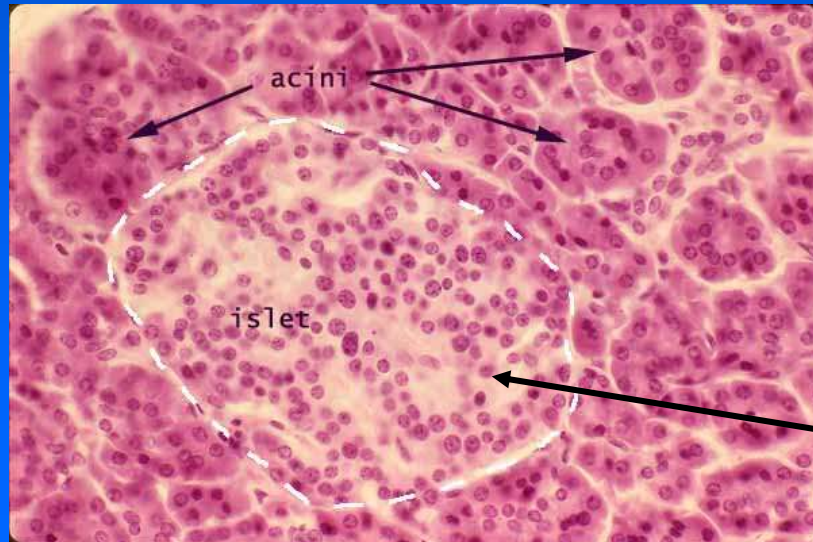
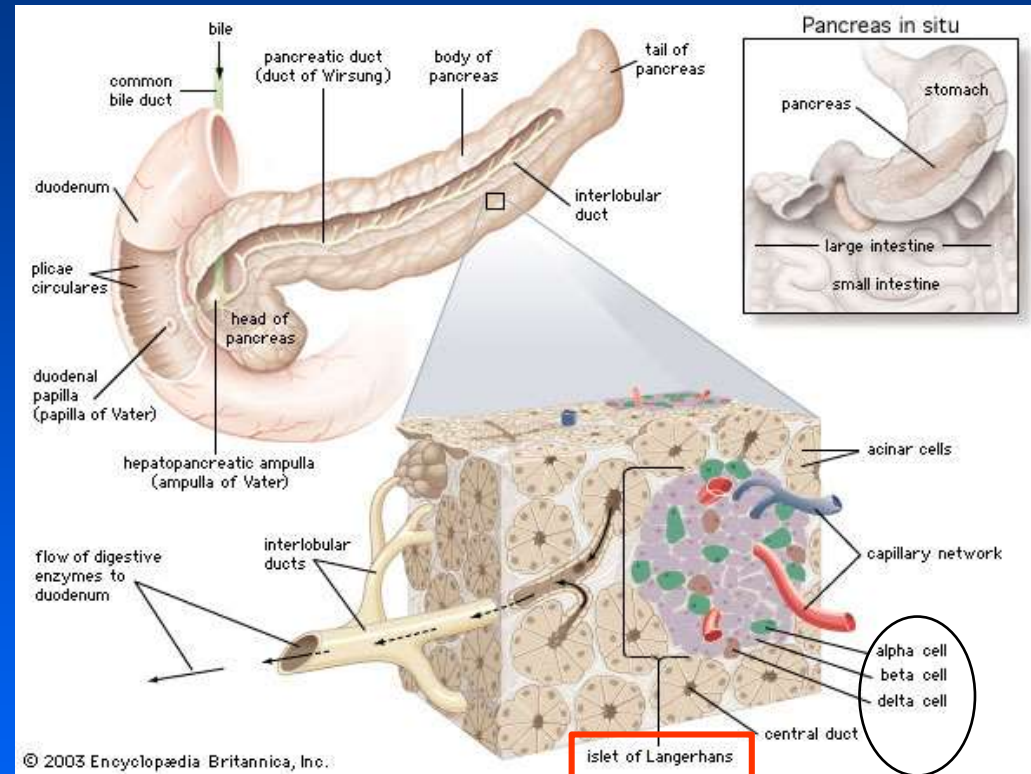
- produce digestive enzymes
- ducts open to the duodenum



# Pancreas



# Pancreas



Endocrine pancreas: insulin , glucagon  
Langerhans islet

## References

Bruce M. Carlson (2004).

*Human Embryology and Developmental Biology,*

3rd edition, Saint Louis: Mosby.

Richard Coico, Geoffrey Sunshine, Eli Benjamini (2003).

*Immunology: a short course.*

New York: Wiley-Liss.

Abraham L. Kierszenbaum (2002).

*Histology and cell biology: an introduction to pathology.*

St. Louis: Mosby.