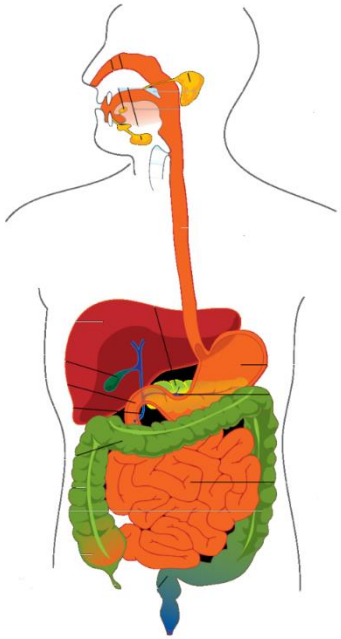
MUNI MED

Ústav histologie a embryologie



DIGESTIVE SYSTEM II

- Microscopic anatomy of pharynx, esophagus, stomach, small and large intestine, rectum
- Overview of embryonic development

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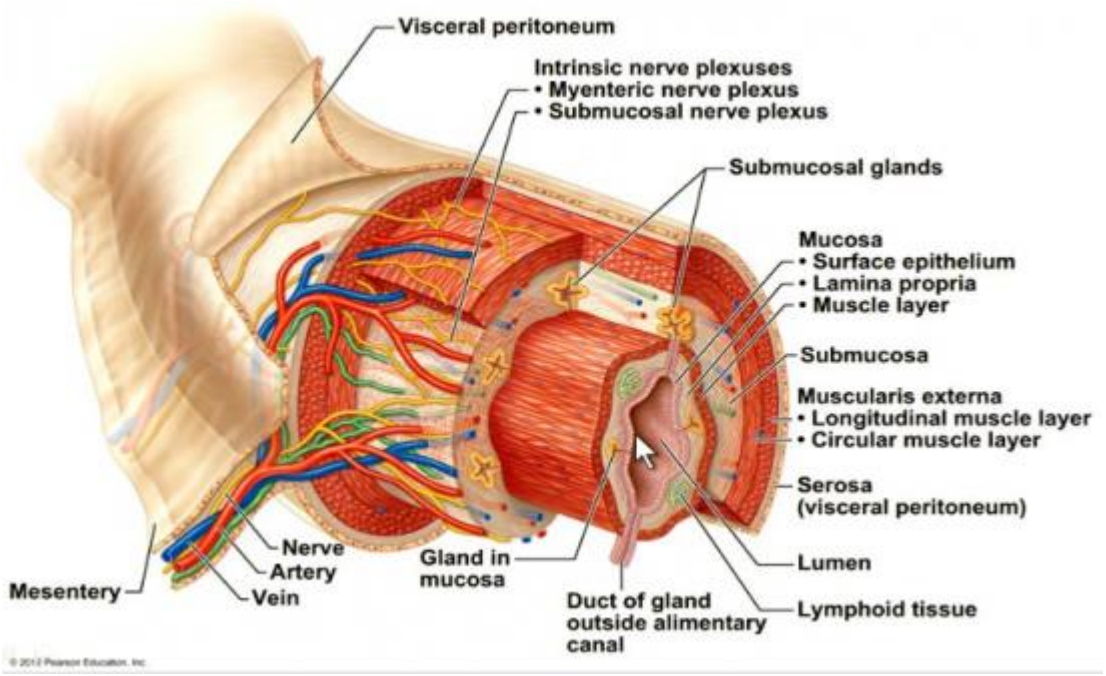
ALIMENTARY CANAL

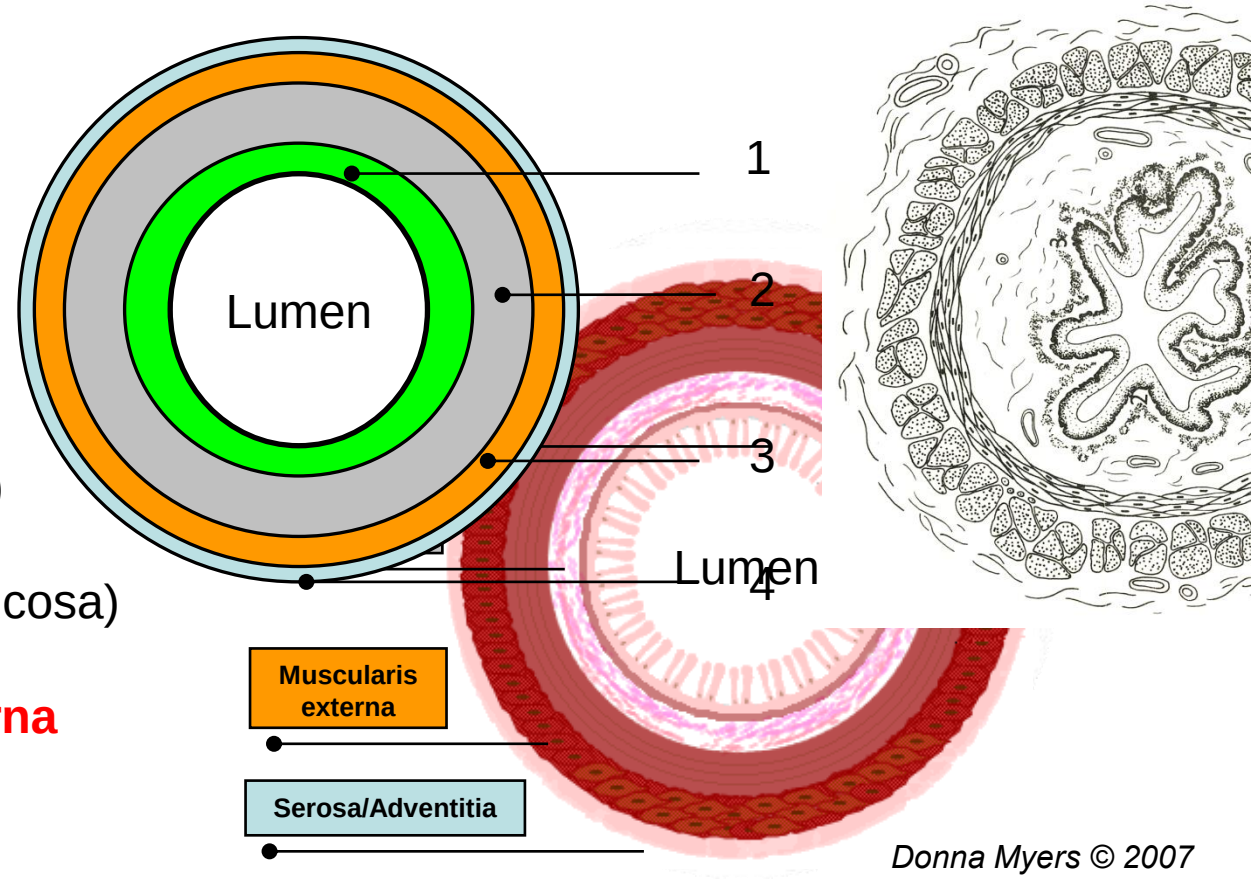


General architecture of hollow organs

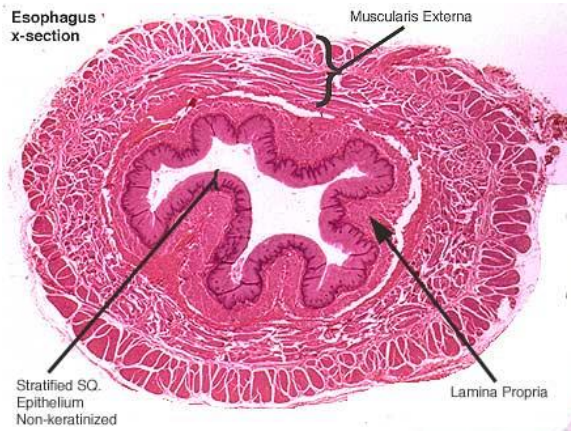
General architecture of hollow organs incl. gut tube

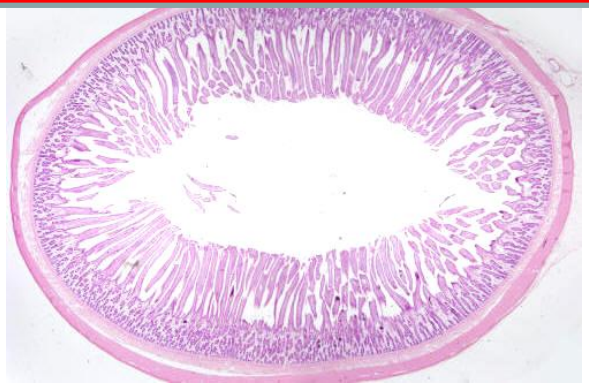
Four layers

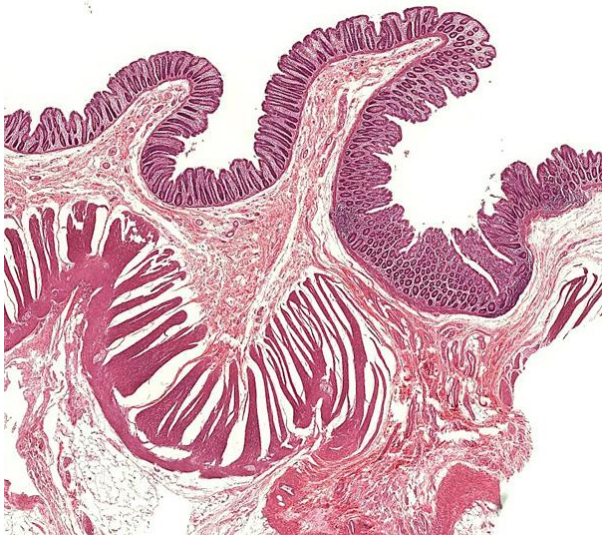
1. **Mucosa** (Tunica mucosa)
2. **Submucosa** (Tela submucosa)
3. **Tunica muscularis externa**
4. **Serosa/adventitia**

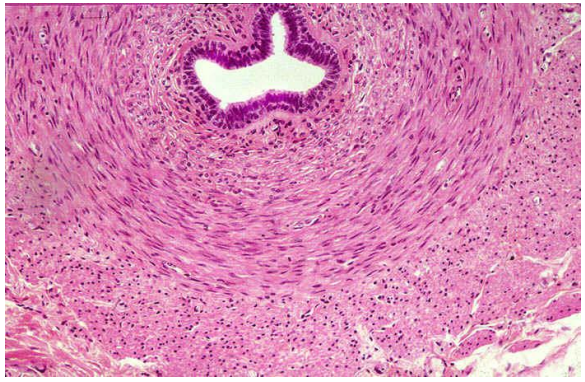


GENERAL ARCHITECTURE OF HOLLOW ORGANS

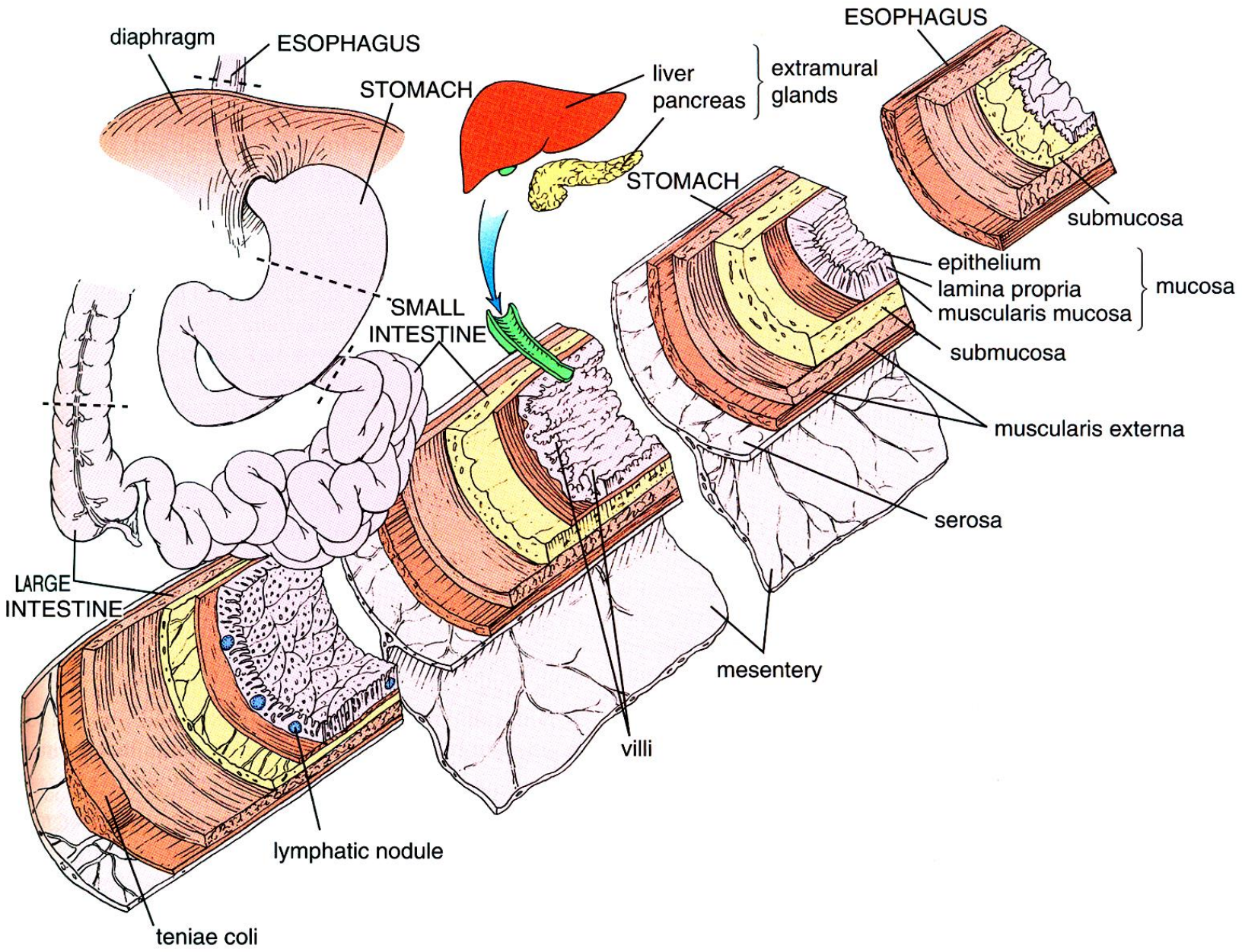








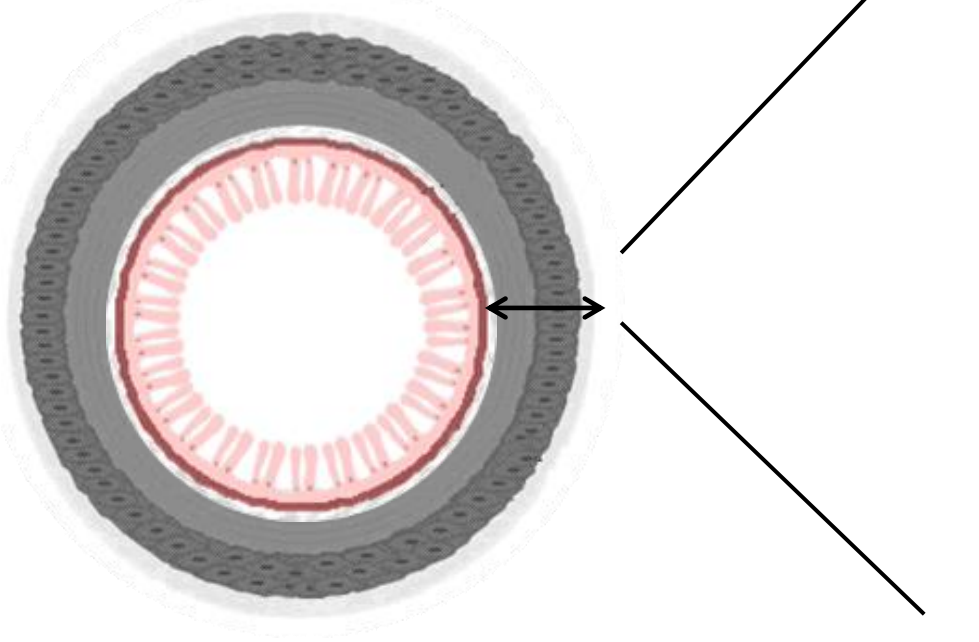
GENERAL ARCHITECTURE OF HOLLOW ORGANS

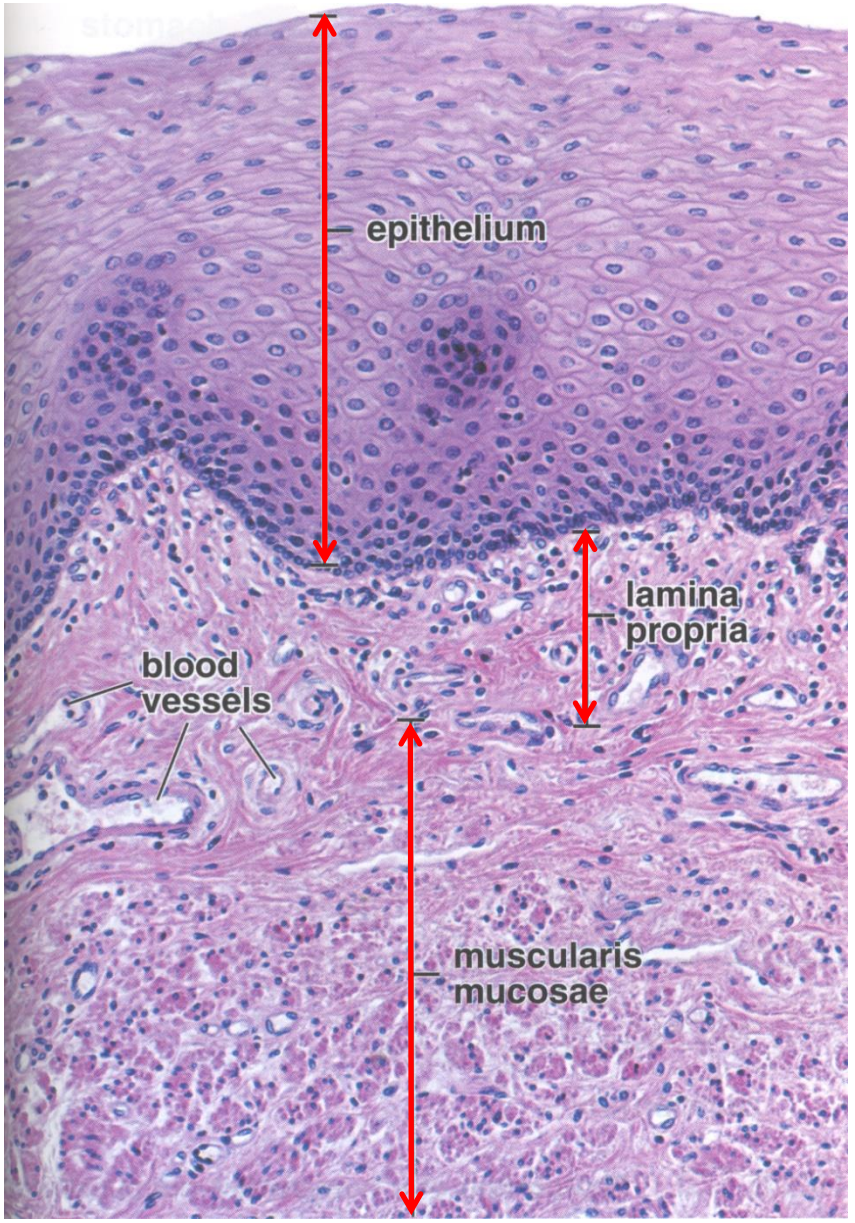


Mucosa (Tunica mucosa)

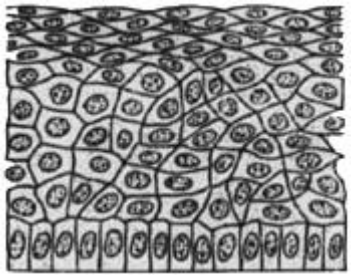
- inner layer of gut tube
- protective, absorption and resorption
- microscopic structure depending on localization

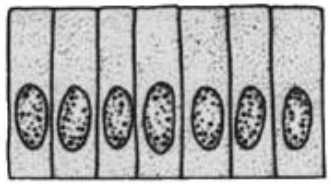
- **Lamina epithelialis** mucosae
- **Lamina propria** mucosae
- **Lamina muscularis** mucosae





Mucosa (Tunica mucosa)



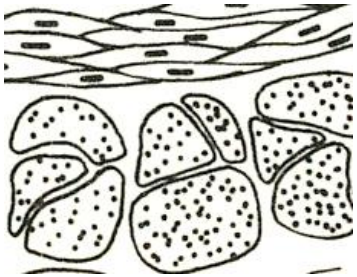


- **Lamina epithelialis** mucosae

- epithelium type corresponding to function of gut tube
- oral cavity, pharynx, esophagus, anus – **stratified squamous ep.**
- stomach, intestine – **simple columnar**
- **mucus** - secreted by mucosal or submucosal glands (oral cavity, esophagus), secretory epithelium (stomach) or goblet cells (intestine)

- **Lamina propria** mucosae

- Layer of mucosal connective tissue – loose collagen
- Fenestrated blood capillaries – transport of metabolite (intestine)
- mucosal glands in some regions /esophagus)
- innervations, immune system



- **Lamina muscularis** mucosae

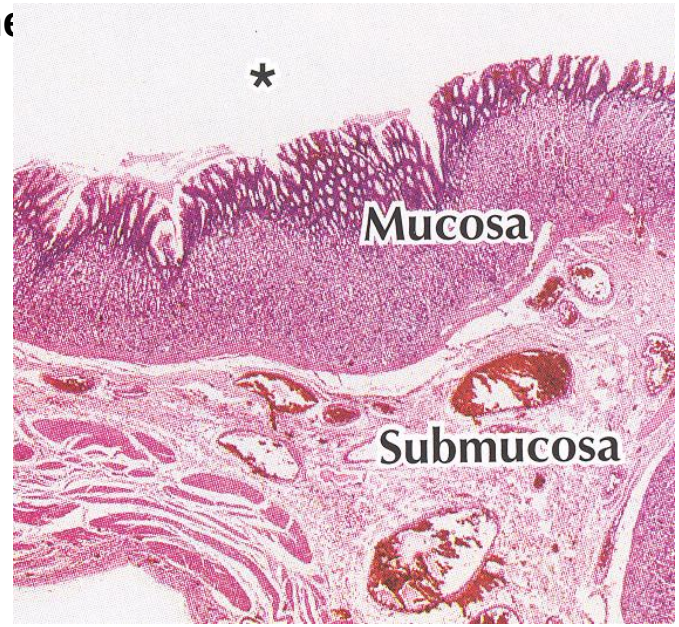
- smooth muscle cells in sevral layers with different orientation
- small mechanical movements of mucosa facilitating secretion and absorption independently on peristaltic movements.

Submucosa (Tela submucosa)

Submucosal connective tissue

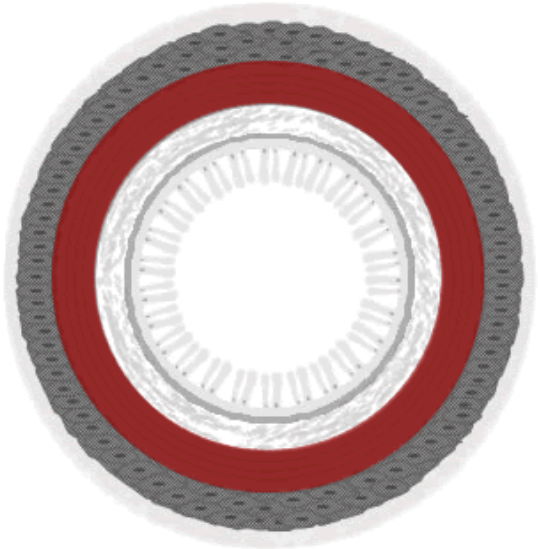
- distinct layer of loose connective tissue
- defines shape of mucosa (rugae, plicae)
- larger blood and lymph veins nourishing mucosa, muscularis externa and serosa
- **innervations** – nerve plexus - **plexus submucosus Meissne**
  = groups of multipolar neurons and small ganglions, visceral sensory fibers (sympaticus) and fibers and terminal ganglions of parasympaticus (enteric nerve system)

- glands – different in different regions
  - protective function

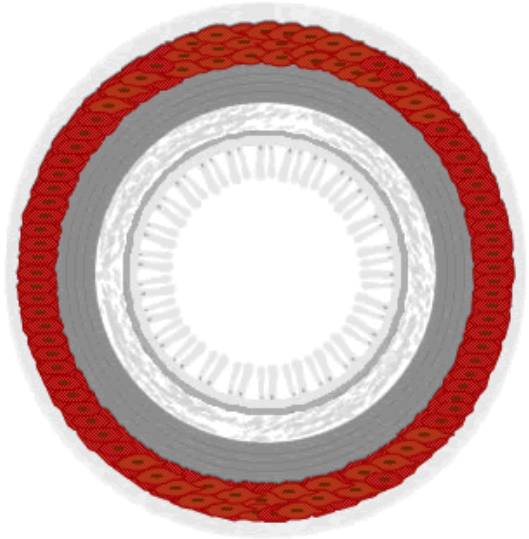


Outer muscular layers (Tunica muscularis externa)

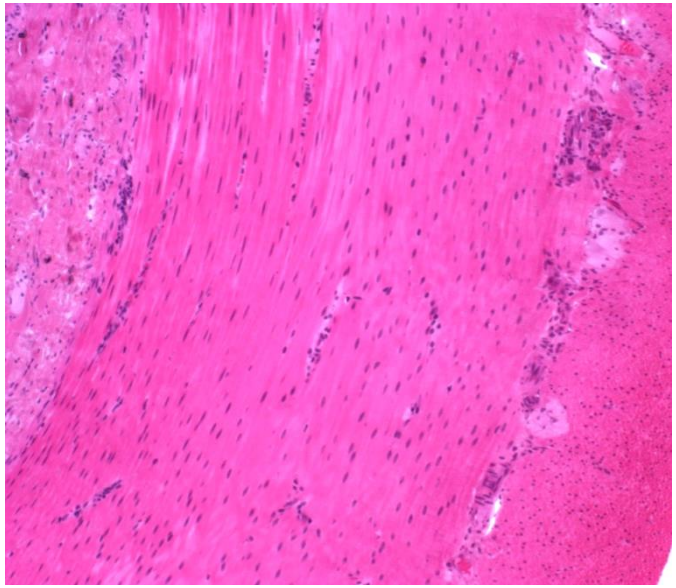
- Two concentric, thick layers of smooth muscle, separated by thin layer of connective tissue
- Inner – **circular**, outer – **longitudinal** (spiral)
- Myenteric (Auerbach) plexus
- Peristaltic – passage through the gut tube
- **Local modifications of m.e**.
    - pharyngoesophagal sphincter + external anal sphincter – skeletal muscles
    - stomach – third - oblique - layer
    - taenie coli – thickened part of longitudinal layer in colon



Circular



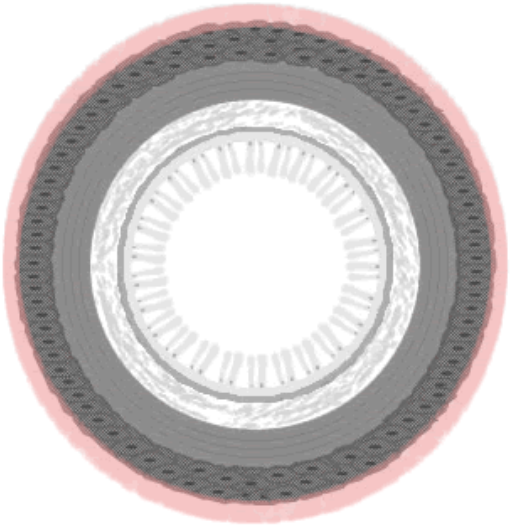
Longitudinal



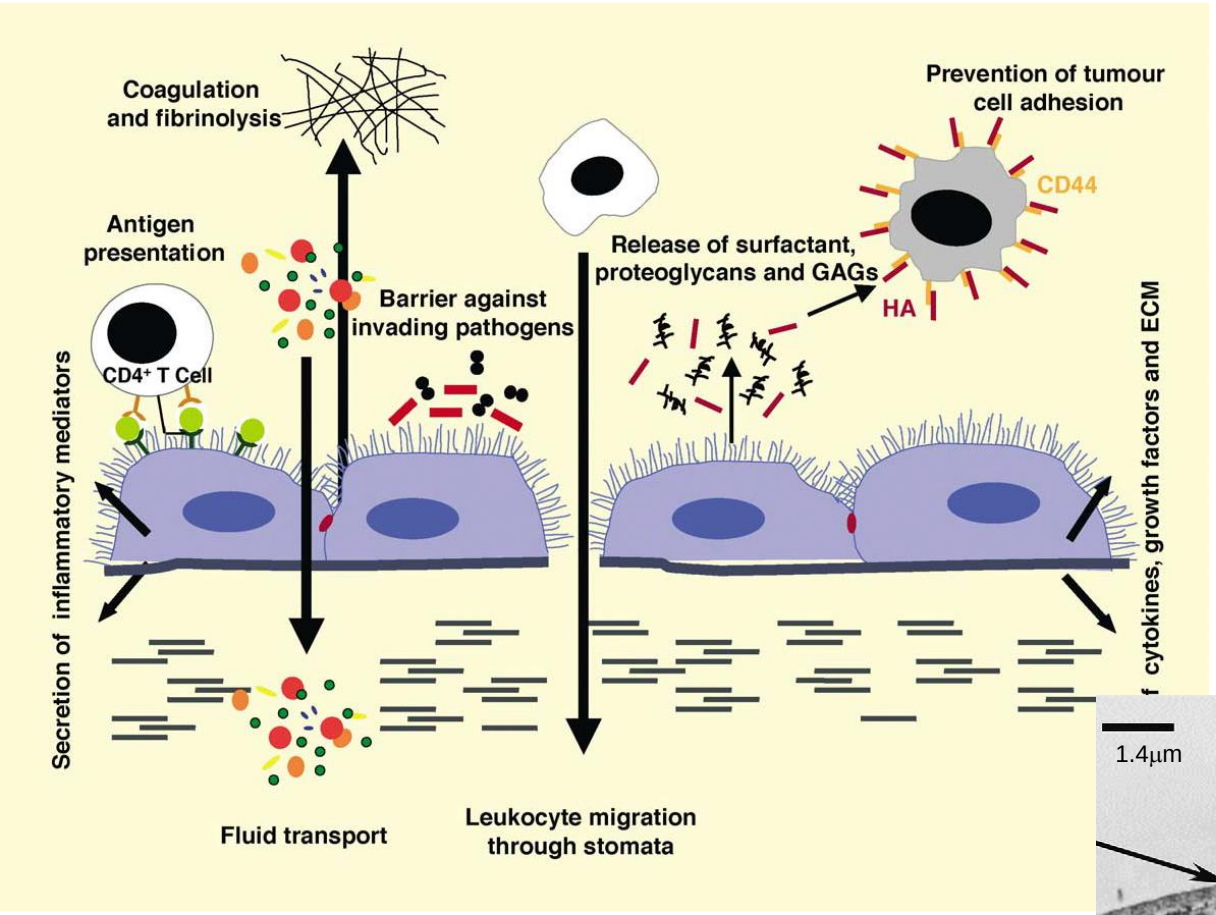
Serosa/Adventitia (Tunica serosa/adventitia)

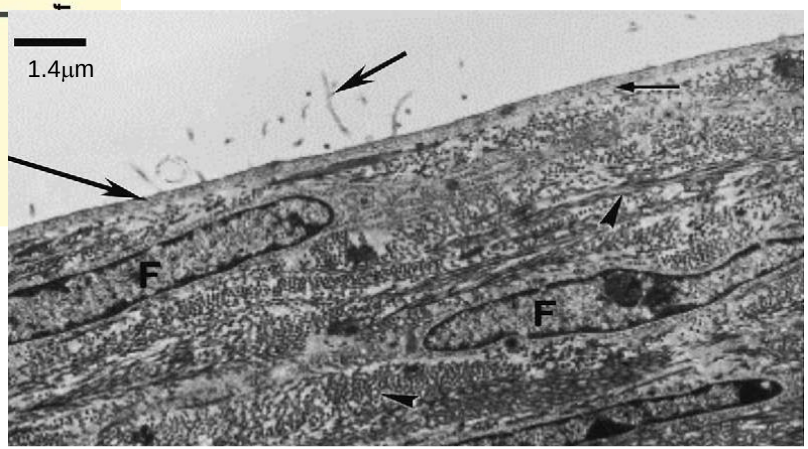
- outermost layer of gut tube
- **Serosa**
  - serous membrane of loose connective tissue (Lamina propria serosae) and single layer squamous epithelium (L. epithelialis serosae)
  - syn. mesothelium, visceral peritoneum
  - continuous with mesenterium
  - barrier against various pathogens , antiadhesive properties – intracoelomic movements, immune functions (Ag presentation), ECM production, etc.

- **Adventitia**
  - some parts of the tube are not covered with epithelium
  - esophagus in thorax, parts of digestive system in peritoneal cavity in walls (duodenum, part of colon, rectum, anal canal)
  - connective tissue only continuous with connective tissue of the walls



Serosa/Adventitia (Tunica serosa/adventitia)





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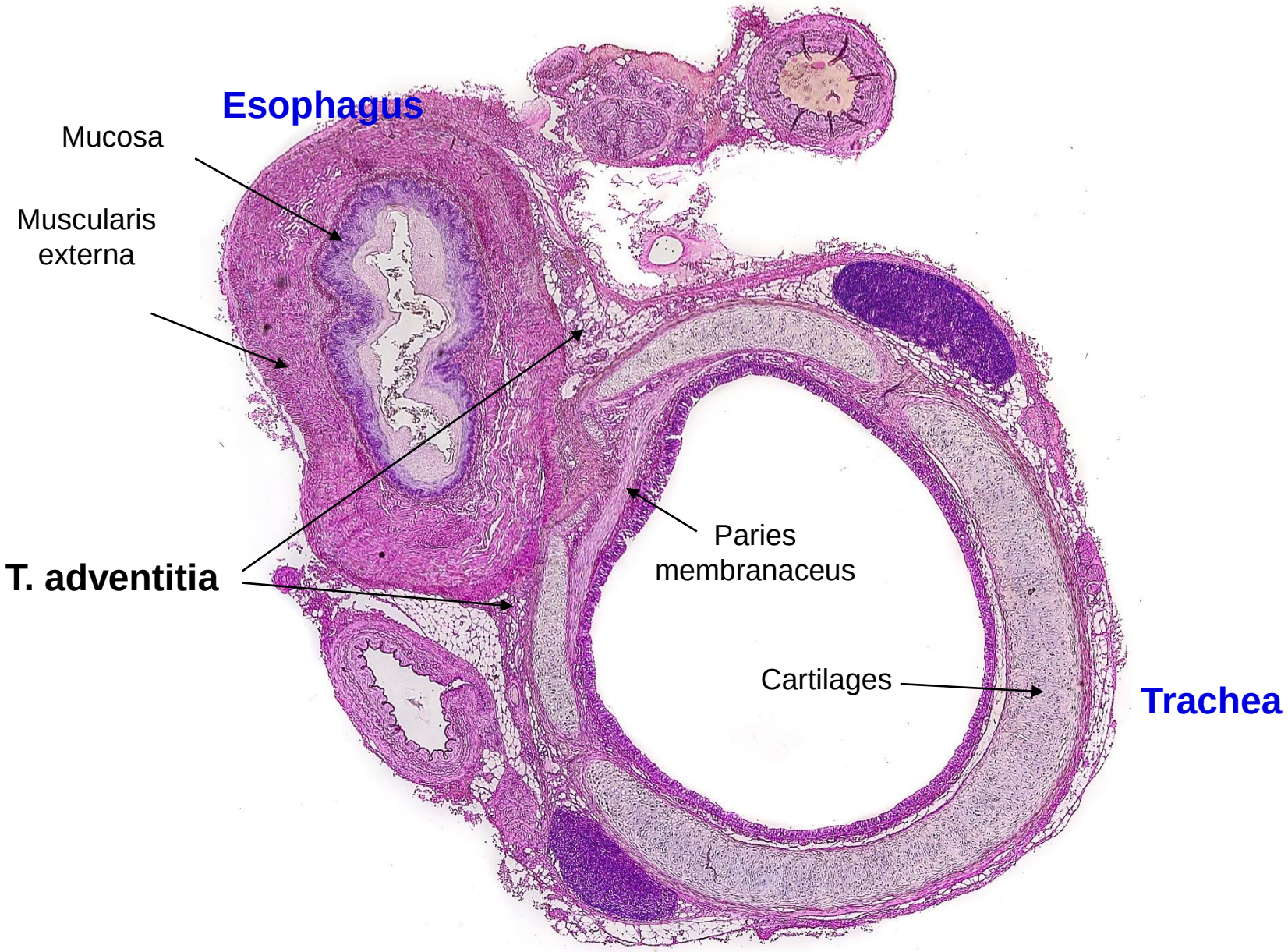
GENERAL ARCHITECTURE OF HOLLOW ORGANS

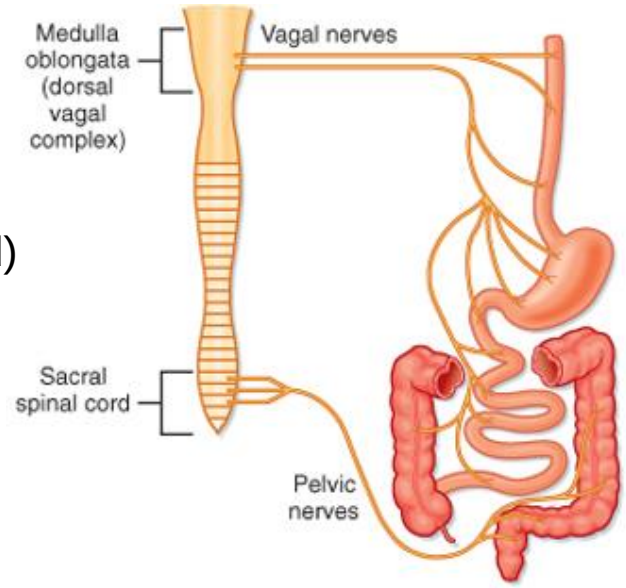


https://hmb302.ca/chapters/respiratory-system/

Innervation of the digestive tube

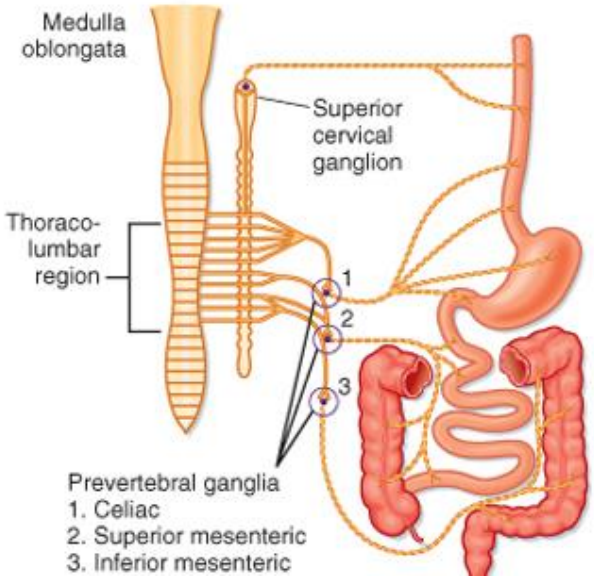
Enteric nervous system

- self-contained nervous system
- numerous ganglia, 100 x10^6 neurons (more than in spinal cord)
- Meissner submucosal plexus and Aurebach myenteric plexus
- peristaltic motility, secretory function, mucosal movements, regulation of blood flow
- sensory components



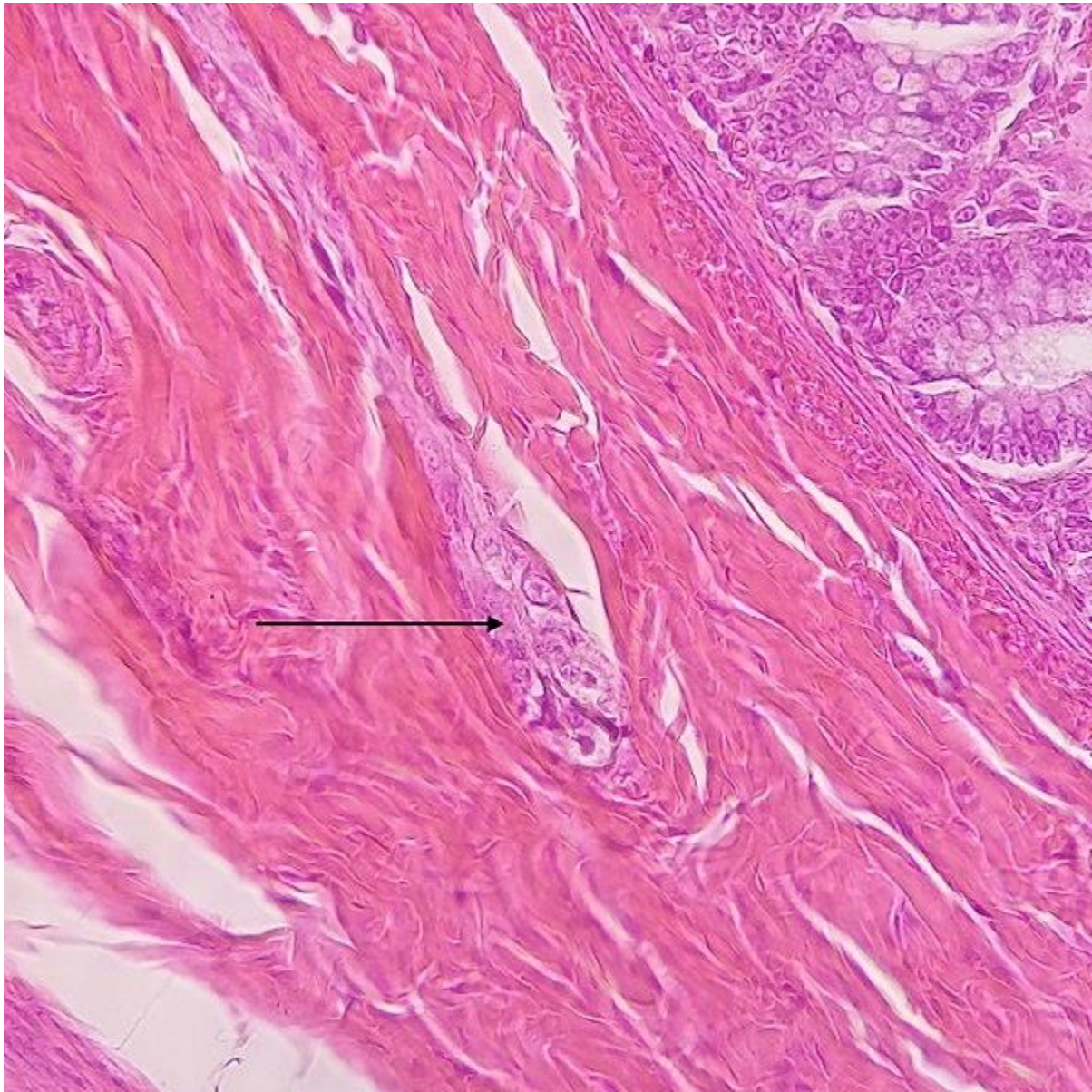
Parasympathetic and sympathetic supply

- **parasympathetic supply** mostly by vagus nerve (cranial X), colon and rectum by sacral spinal nerves
- vagus nerve – mostly sensory fibers (information from mucosa and back)
- secretion from glands, smooth muscle contractions
- *inhibits sphincters, stimulates peristaltics and secretion*
- **sympathetic supply** by splanchnic nerves
- vasomotor fibers – control of blood flow
- *activates sphincters, inhibits peristaltics and secretion*



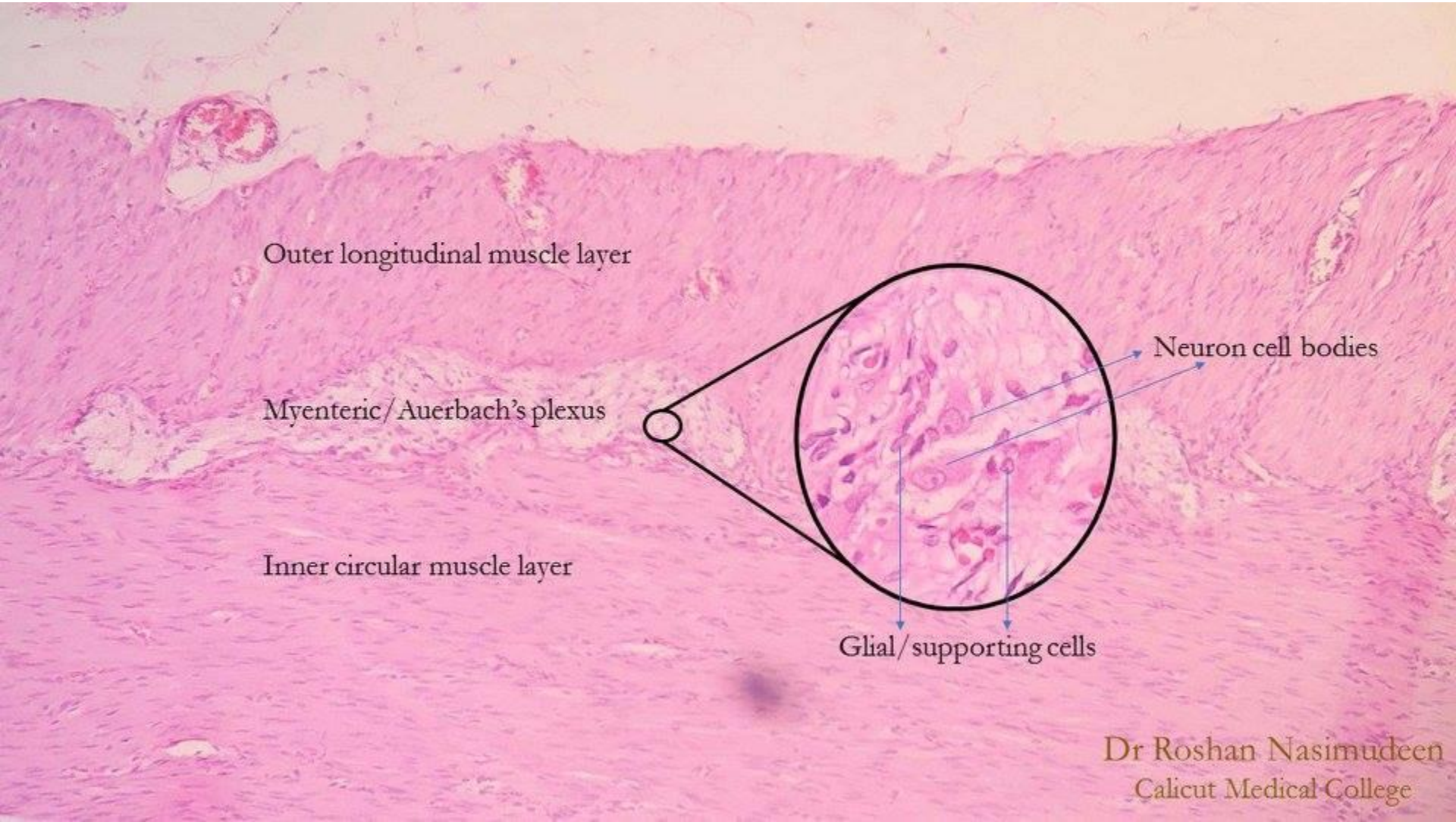
Enteric nervous system

Plexus submucosus (Meissneri)



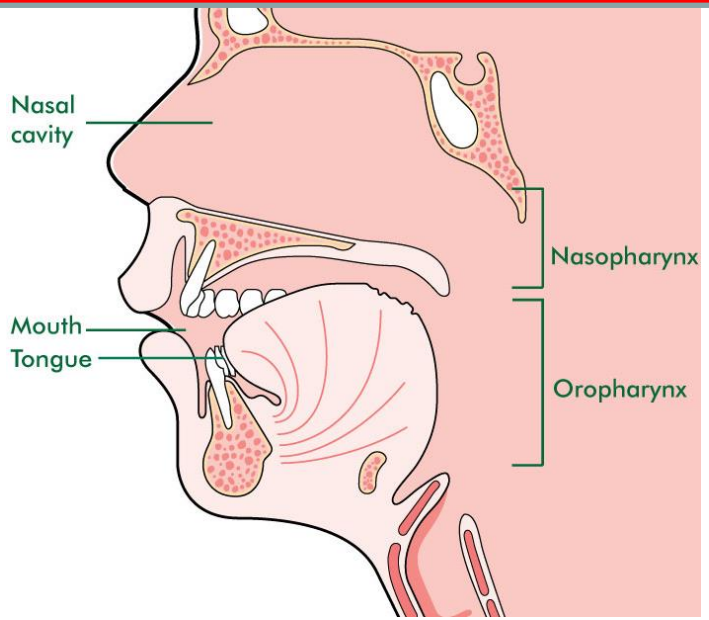
Enteric nervous system

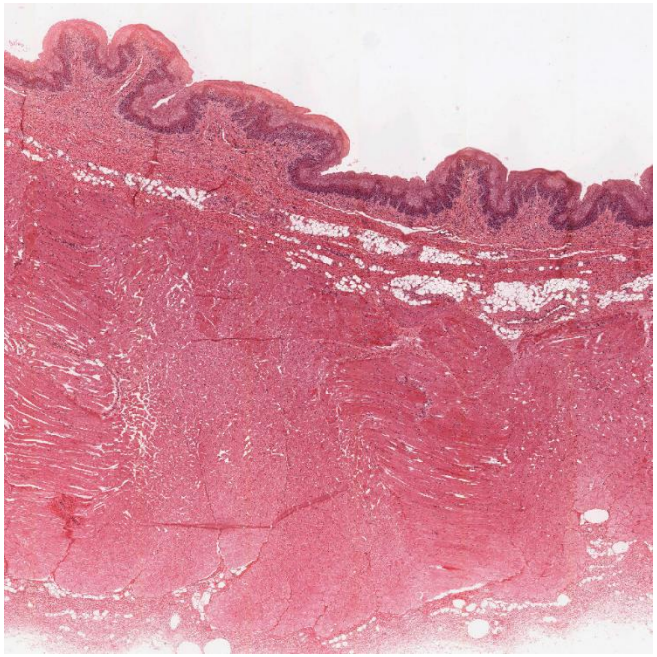
Plexus myentericus (Auerbachii)



PHARYNX

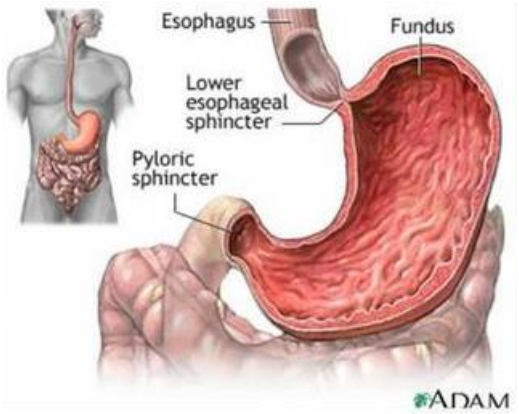
- **pars nasalis**
  - pseudostratified columnar ciliated epithelium
  - seromucous glands
- **pars oralis et laryngea**
  - nonkeratinized stratified squamous epithelium
  - mucous glands
- collagen c.t. (lamina propria), typical tela submucosa absent
- skeletal muscles

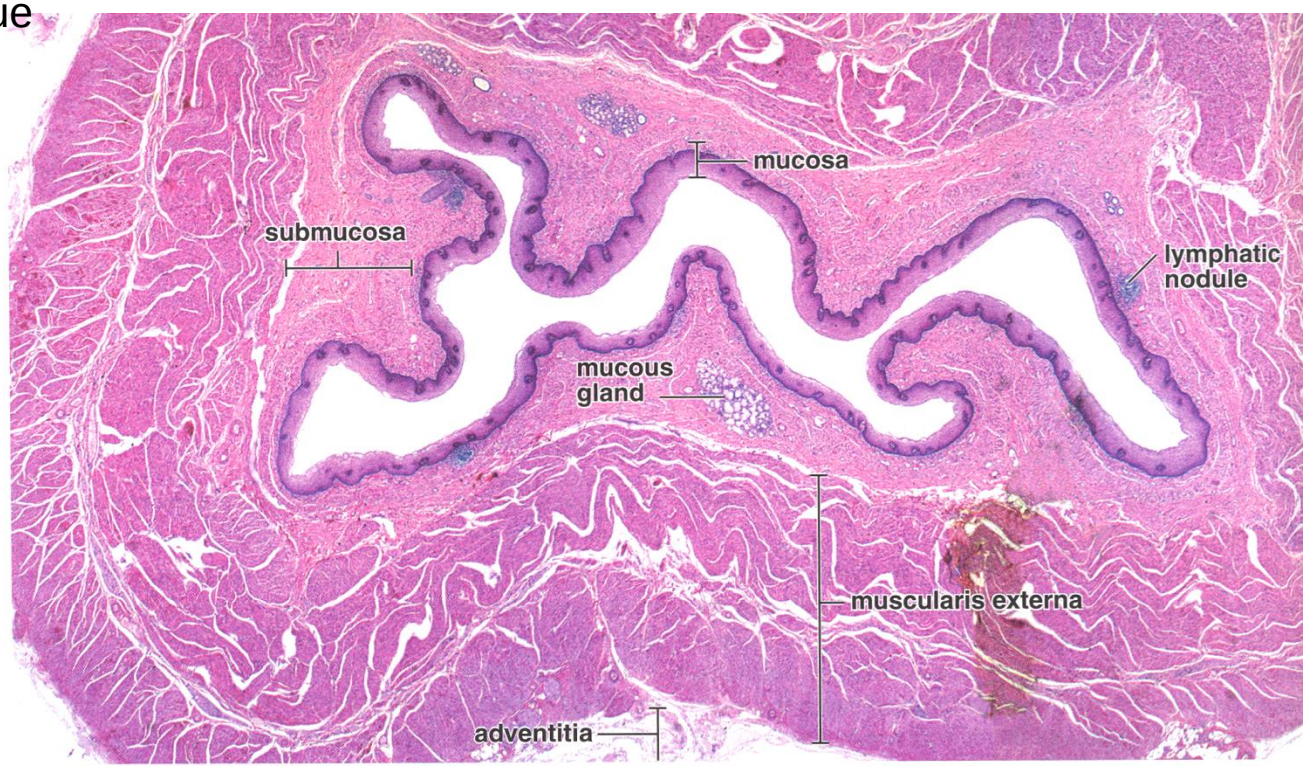




ESOPHAGUS (OESOPHAGUS)

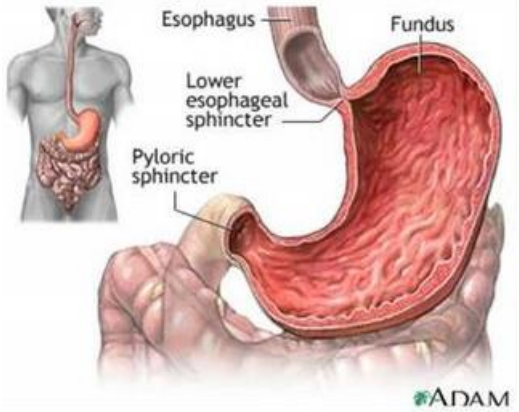
- **Mucosa**
  - nonkeratinized stratified squamous epithelium → mechanically protects esophagal tissue
  - l. propria contains cardial glands (tubular mucinous) and diffuse lymphatic tissue
- **Submucosa**
  - loose collagen connective tissue, defines shape of mucosa
  - blood and lymph veins, plexus submucosus Meissneri
  - submucosal glands (tubular mucinous)
  - diffuse lymphatic tissue

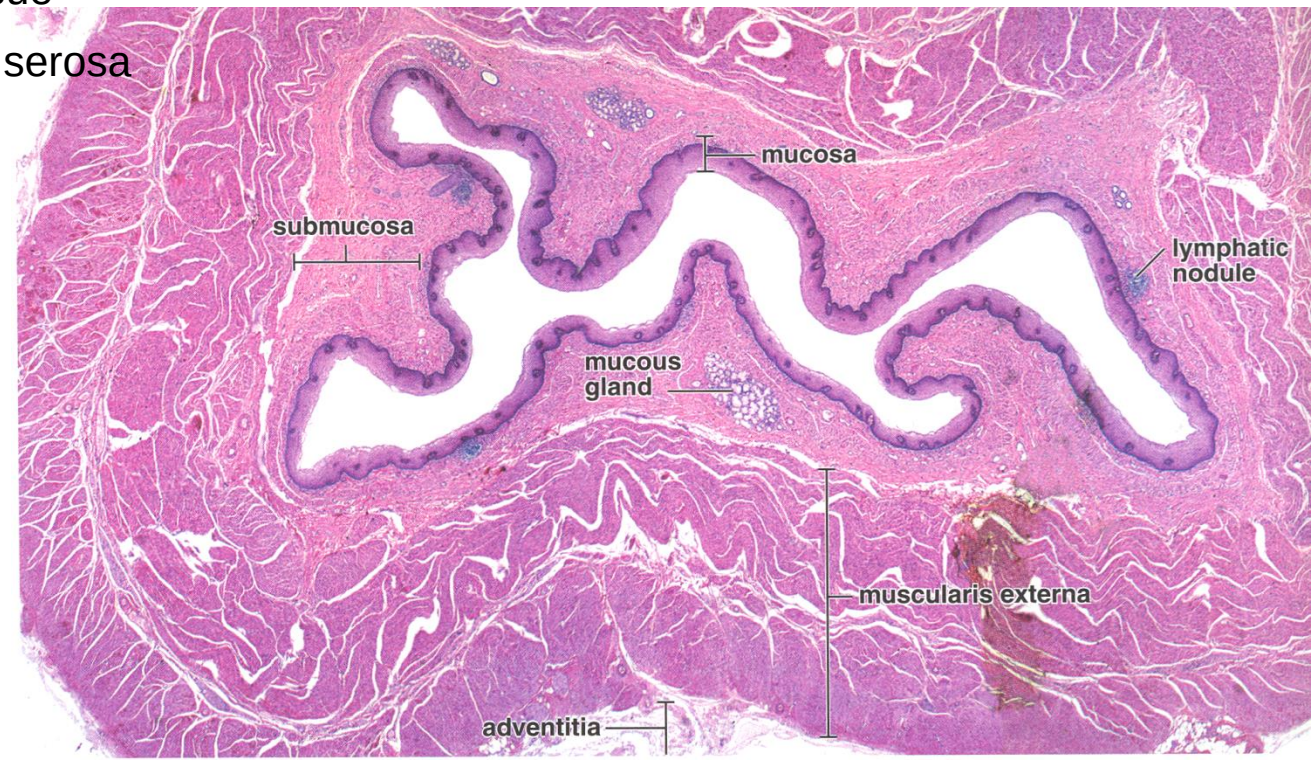




ESOPHAGUS (OESOPHAGUS)

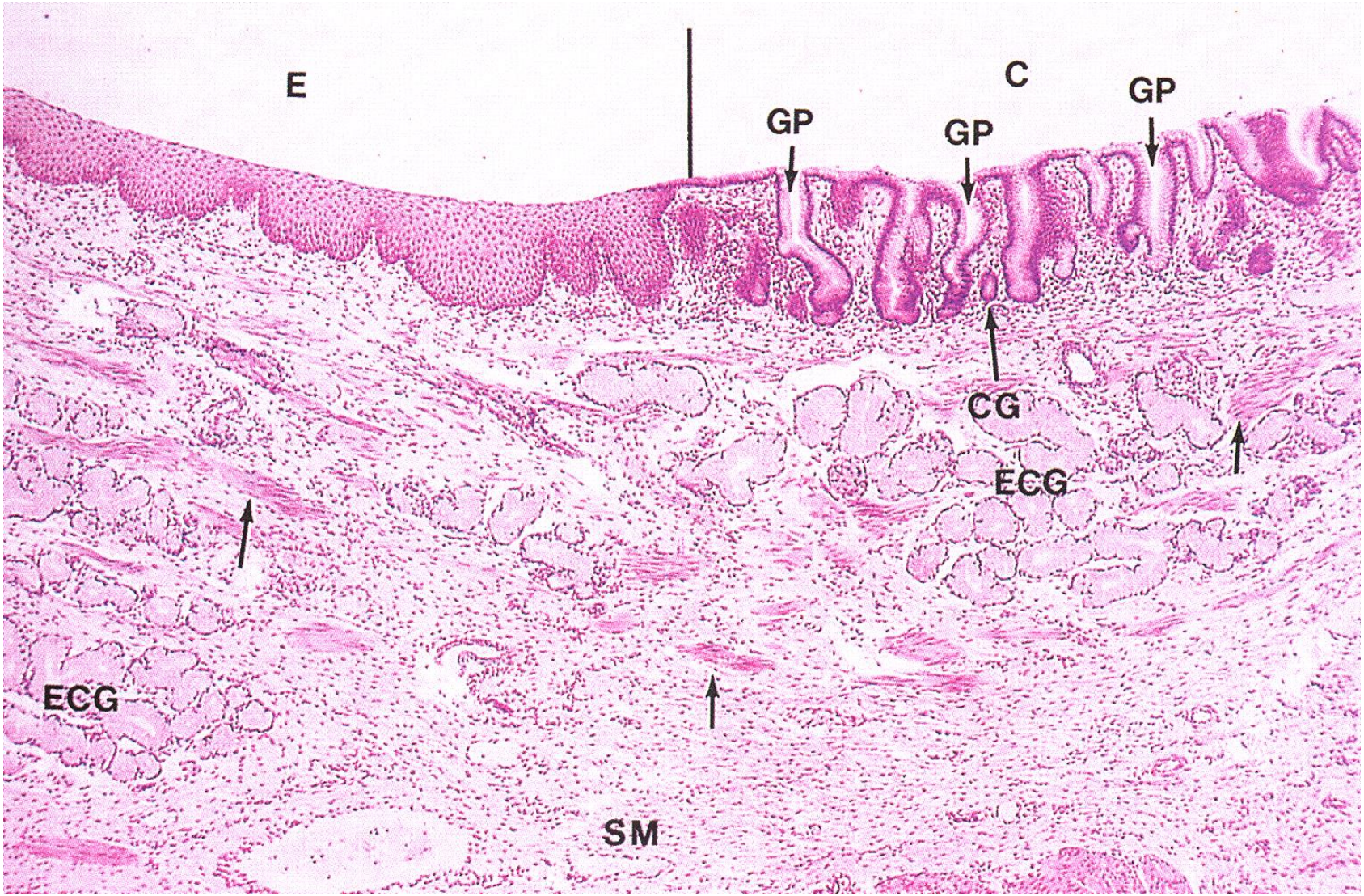
- **Muscularis externa**
  - inner circular and outer longitudinal layer
  - plexus myentericus Auerbachi
  - upper third – skeletal muscle, mid third – mixed smooth and skeletal, lower third – smooth muscles only
- **Adventitia**
  - neck and chest – connects esophagus with surrounding tissue
  - loose connective tissue
  - in peritoneal cavity - serosa





Cardia of stomach – connection with esophagus

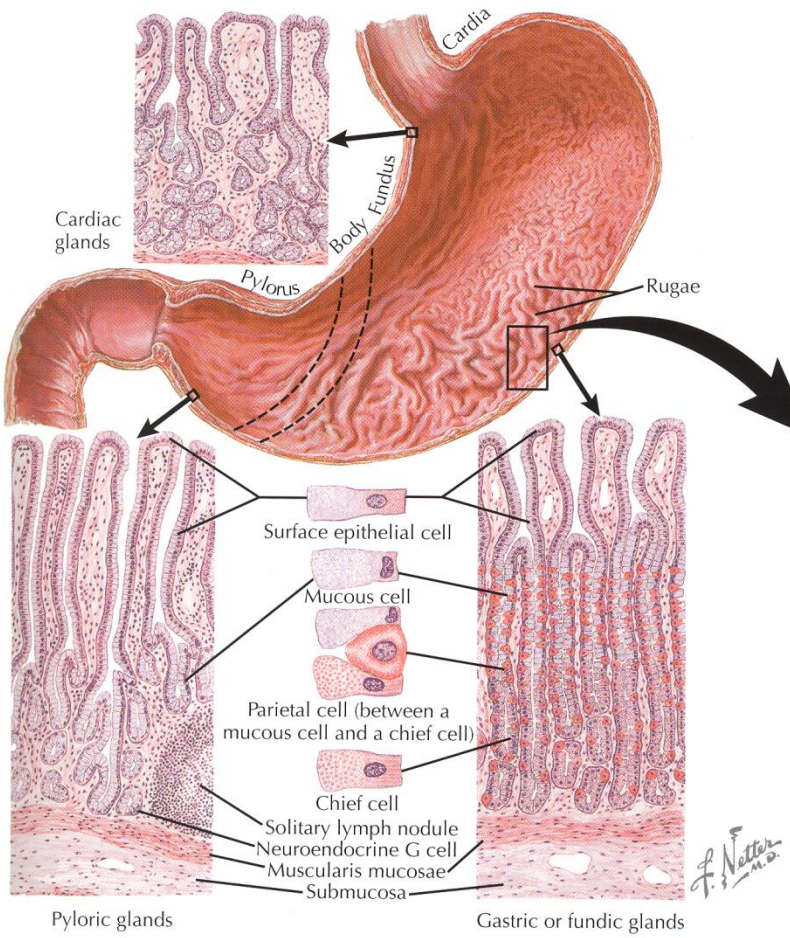
Nonkeratinized stratified squamous epithelium → simple columnar epithelium

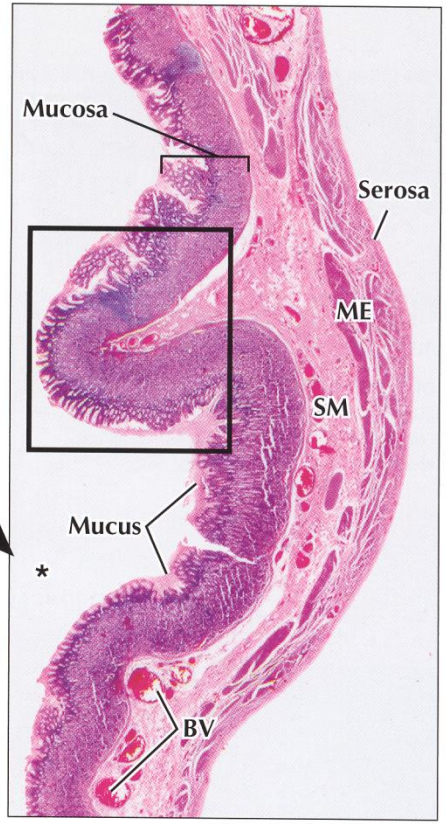


STOMACH (VENTRICULUS, GASTER)

- general anatomy of hollow tube
- anatomical regions differ also in histologic structure
- *rugae gastricae* (submucosa)

▼ **Mucous membrane of the stomach.**





▲ **Light micrograph (LM) of the stomach wall showing four concentric layers at low magnification.** A thick mucosa (formed mostly of tightly packed gastric glands) lines the lumen (*). The rectangle indicates a ruga consisting of a submucosal connective tissue core covered by mucosa. A thick layer of mucus secreted by surface cells forms a barrier over the mucosa for protection of tissues from acid and proteolytic enzymes in the lumen. The submucosa (**SM**) has prominent blood vessels (**BV**). Serosa covers the muscularis externa (**ME**) externally. 10×. *H&E.*

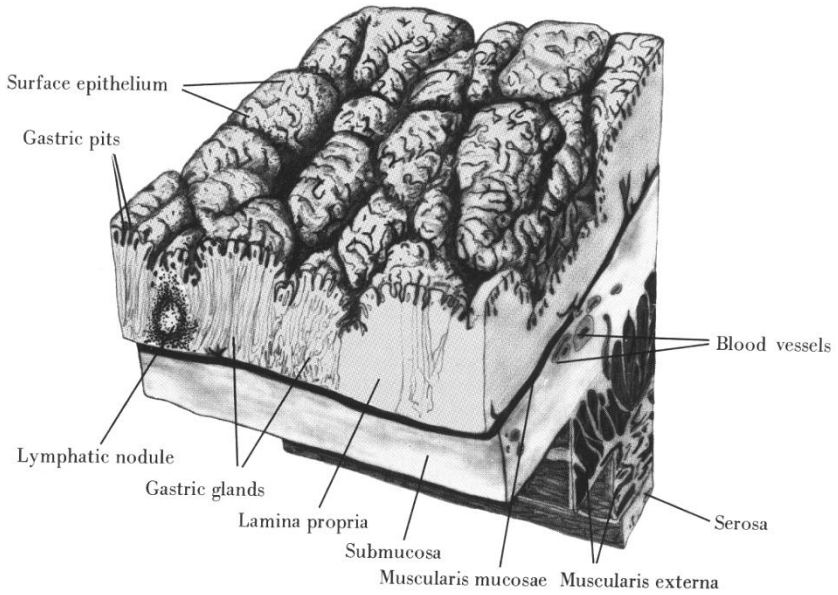
STOMACH (VENTRICULUS, GASTER)

- **Gastric mucosa**
- simple columnar epithelium
- surface epithelium produces mucus

(mucinogenic granules, high content of HCO_3^-, K^+)

<u>= protective function</u>

- areae gastricae, foveolae gastricae

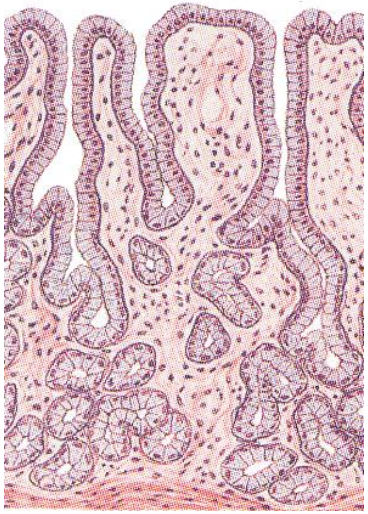


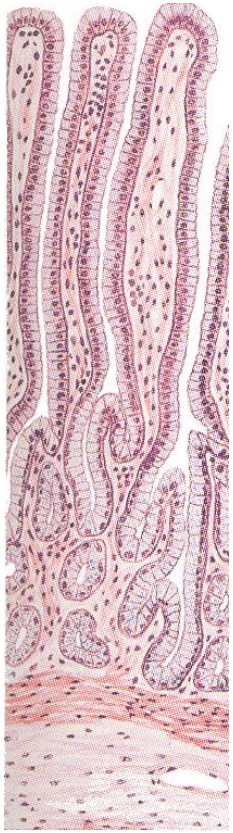
STOMACH (VENTRICULUS, GASTER)

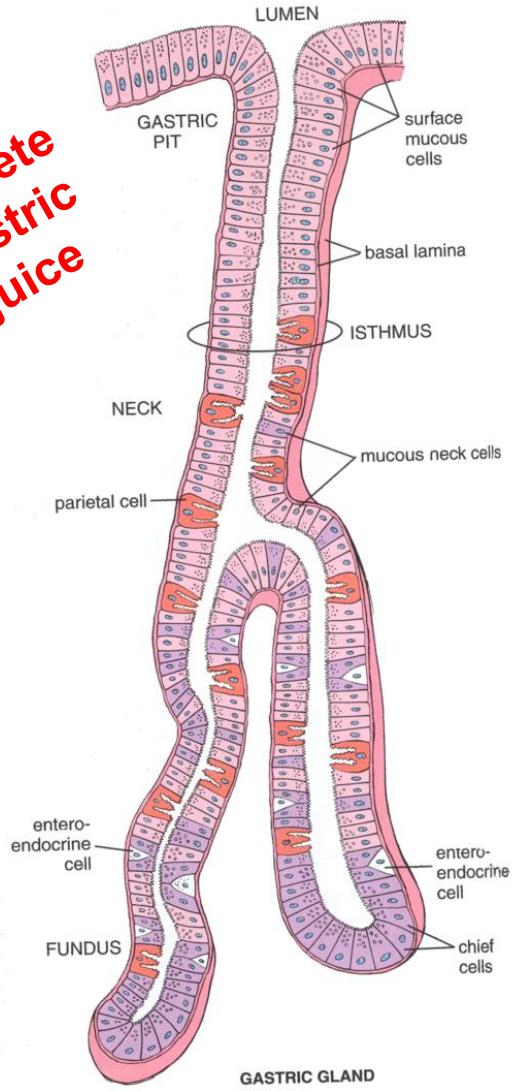
- **Gastric mucosa**
- L. propria contains large amount of glands
  - Gl. cardiacae
  - Gl. pyloricae
  - Gl. gastricae propriae

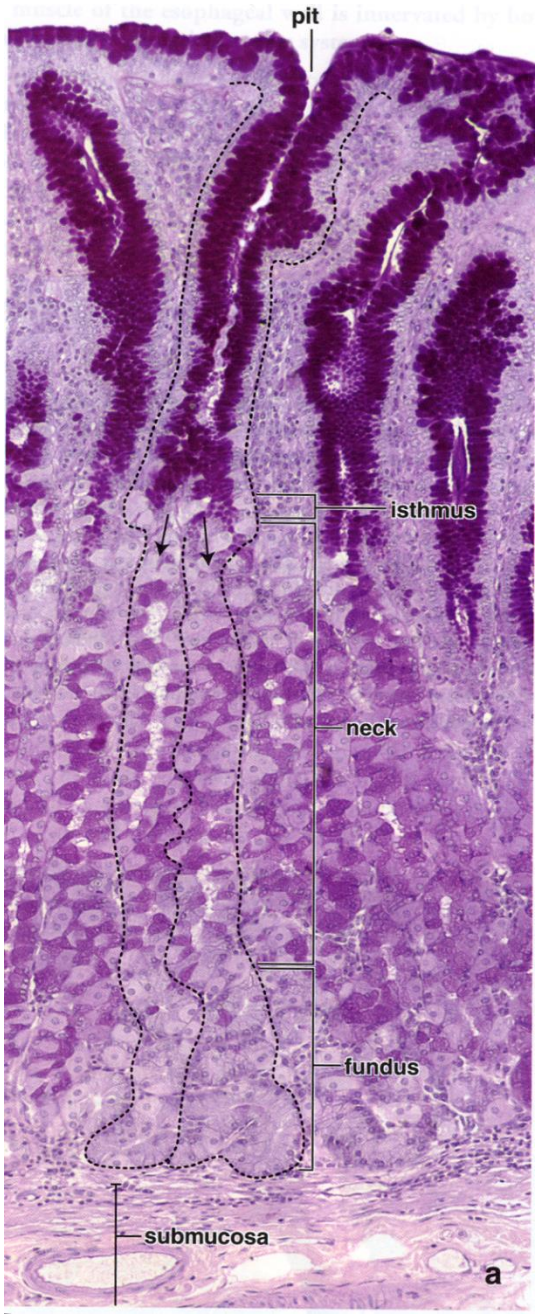
Mucous

Secrete gastric juice





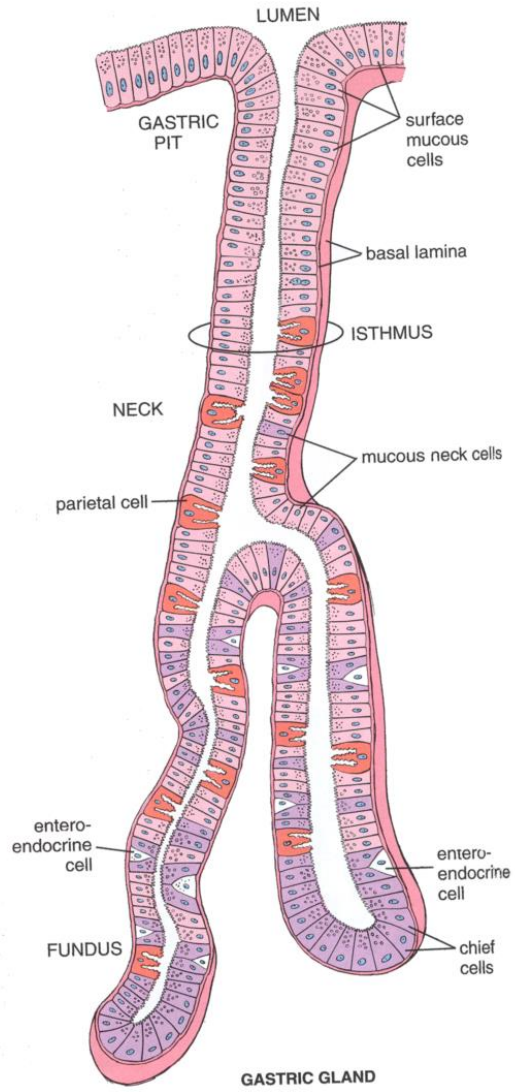


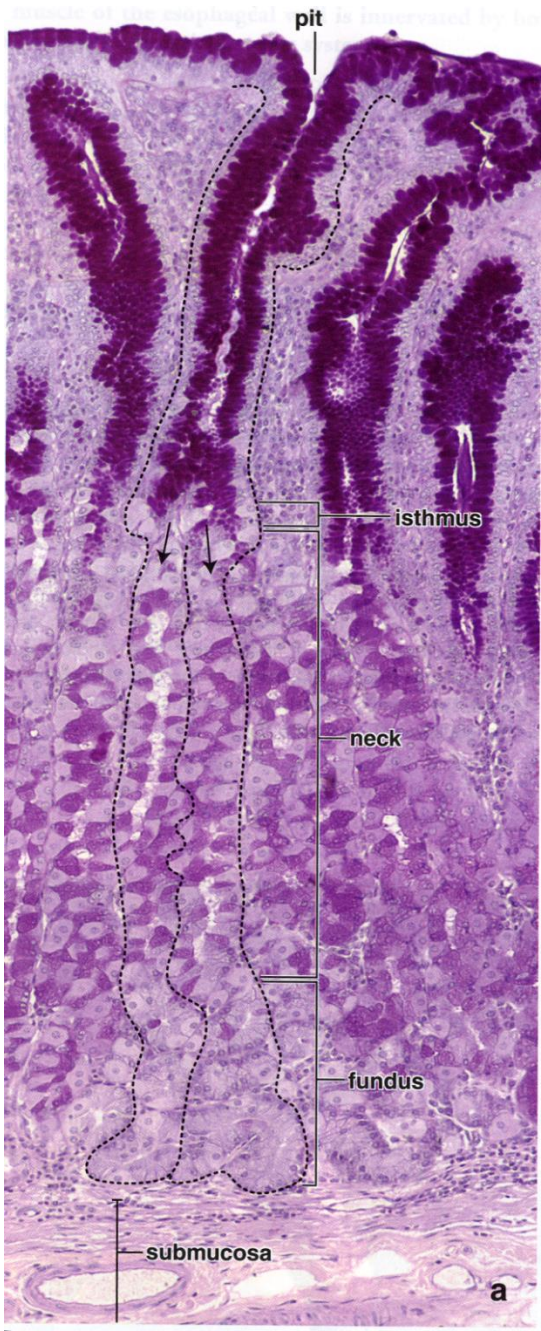


STOMACH (VENTRICULUS, GASTER)

- **Gl. gastricae propriae**
- glands of fundus and body
- simple tubular or branched
- 2-4 opens to the gastric pits

- **four cell types of gl. gastricae propriae**



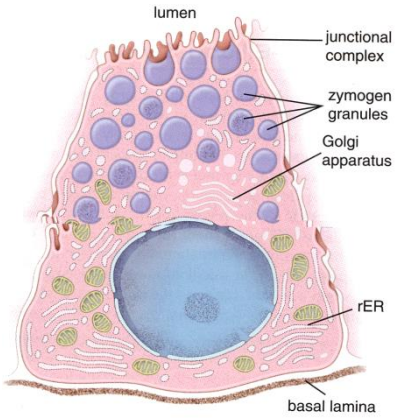


STOMACH (VENTRICULUS, GASTER)

Gl. gastricae propriae

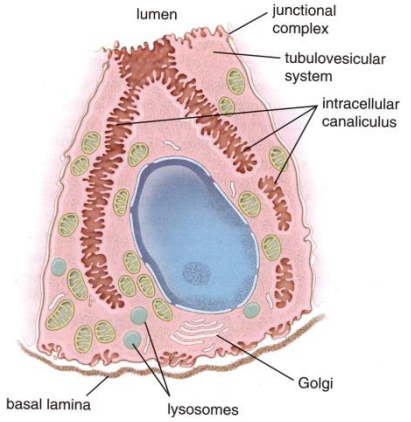
chief

- most abundant, lower part of body and fundus of the gland
- pyramidal shape, basophilic cytoplasm, RER, pepsinogenic granules



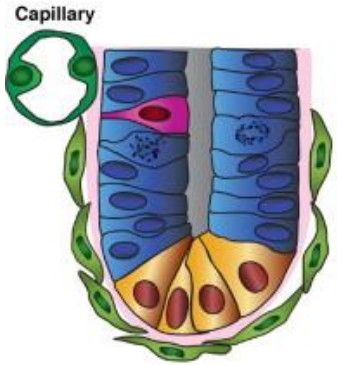
parietal

- neck-body junction
- eosinophilic cytoplasm, high numbers of mtch., SER
- complex and dynamic ultrastructure
- intracellular canals in apical part with microvilli – membrane bound enzyme complexes producing H^+ a Cl^- (<u>HCl originates extracelullarly</u>)



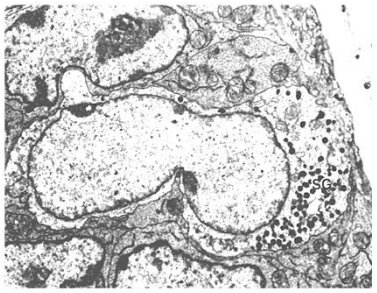
neck cells

- cubic, mucinous
- capable of regeneration of all cell types in gastric epithelium



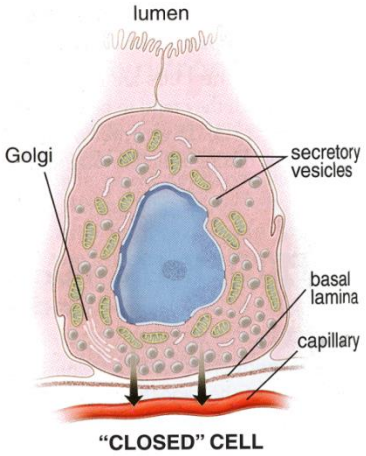
STOMACH (VENTRICULUS, GASTER)

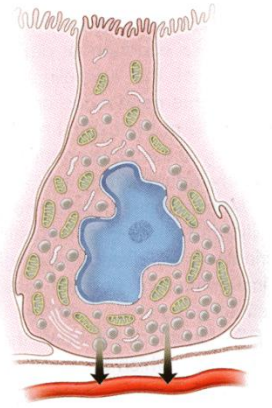
Gl. gastricae propriae



(entero)endocrine

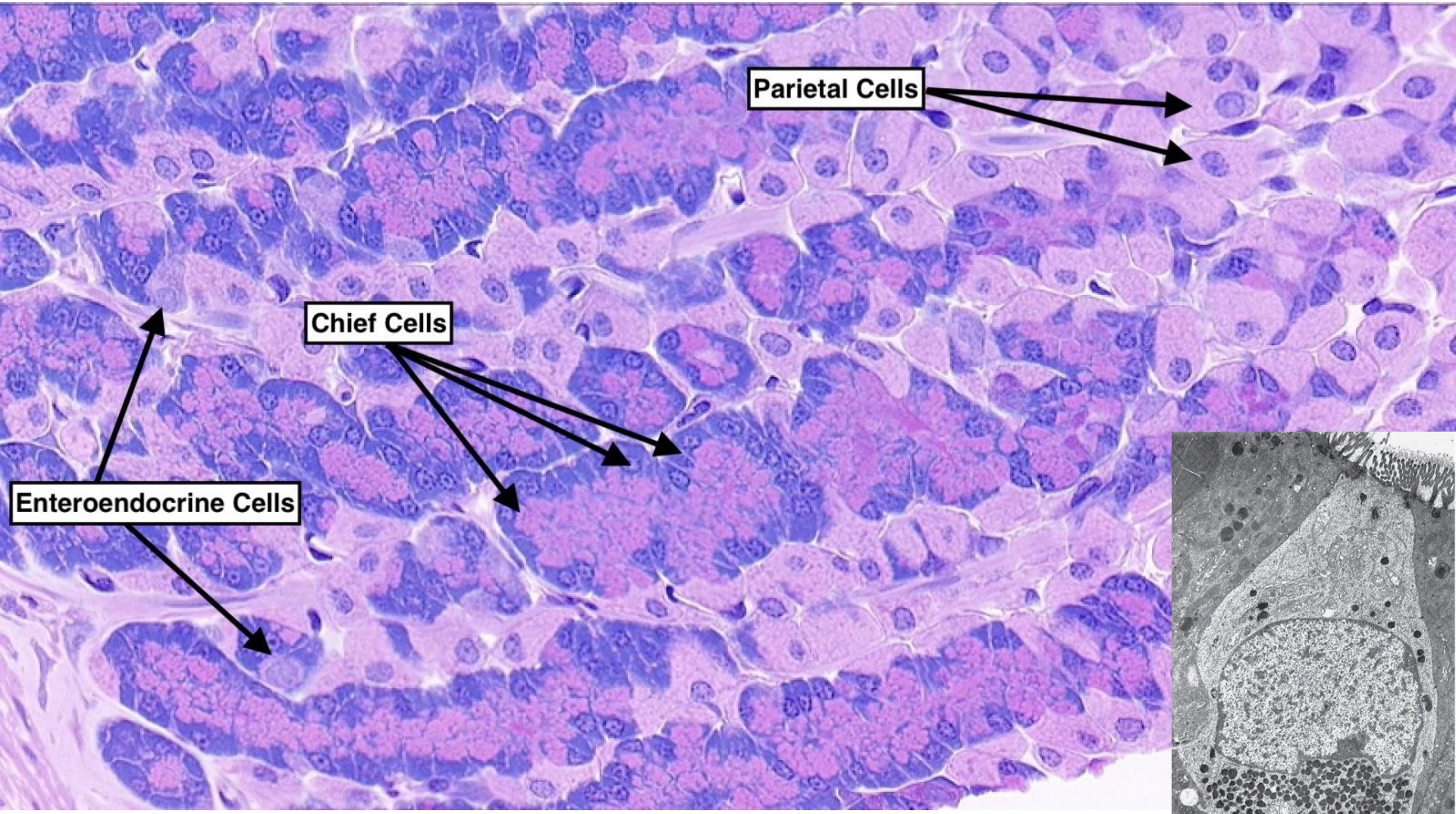
- minor, secretion
- granules
- different cell types with different sensitivity to various histological stainings
- secretion of various biologically active compounds
- DNES/APUD
- GIT chemosensing
- see lesson spring semester 2012 - Epithelial tissue





Type	Hormone	Localization/Function
D cells	Somatostatin	- Stomach, intestine, hepatic and pancreatic ducts
EC cells	Serotonin	- Stomach, gallbladder, intestine - Peristaltics
ECL cells	Histamin	- Stomach - HCl secretion
G cells	Gastrin	- Pars pylorica, duodenum - HCl, pepsin secretion
L (EG) cells	Enteroglucagon	- Stomach, intestine - attenuates secretion of pancreatic enzymes and peristaltics

Enteroendocrine system



Lumen

MV

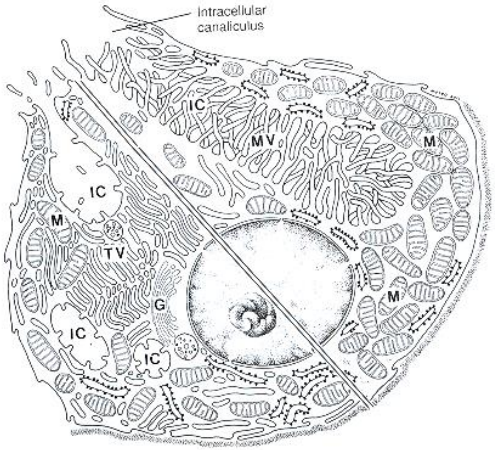
M

MV

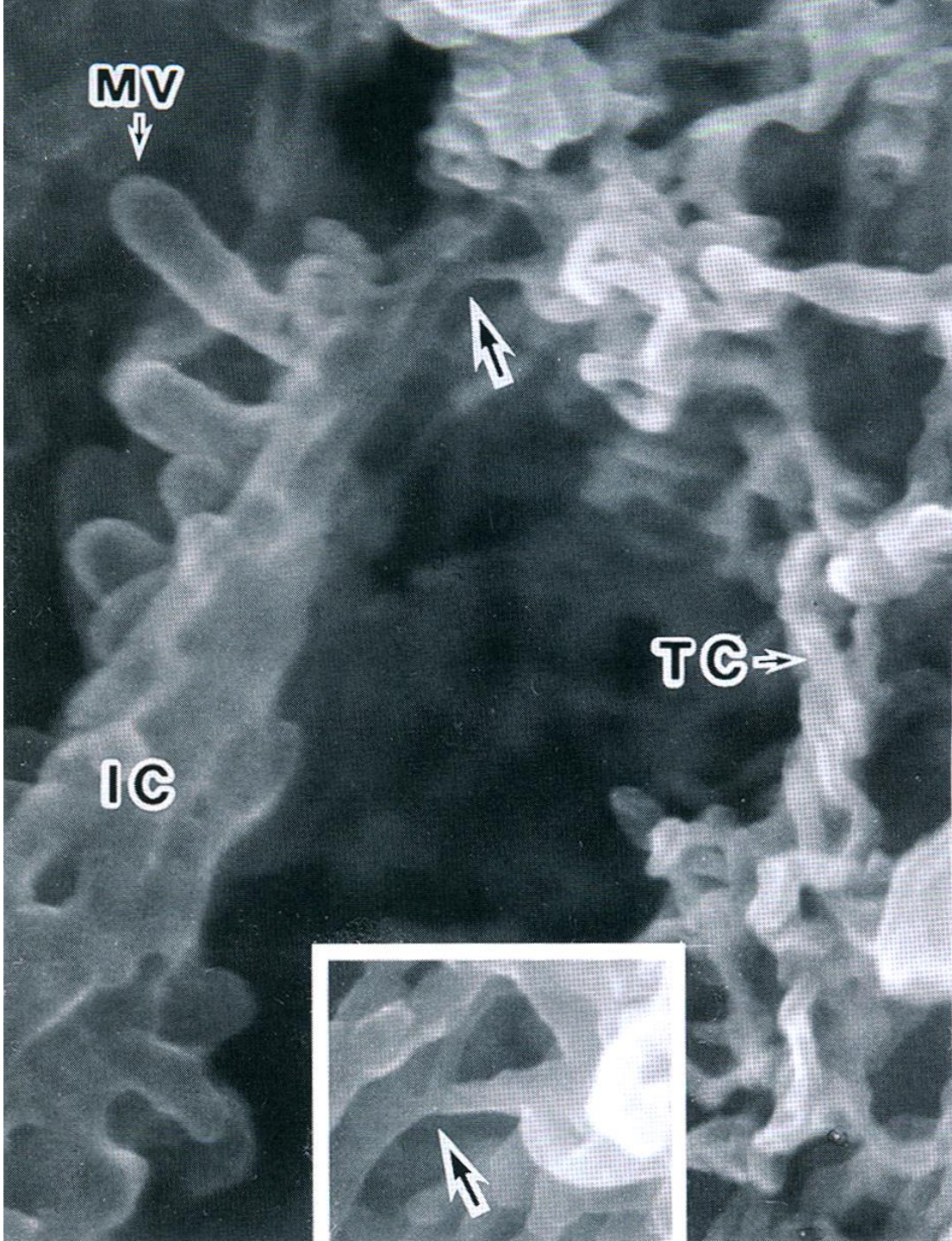
M

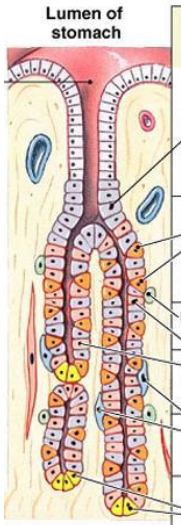
Parietal cell

×10200

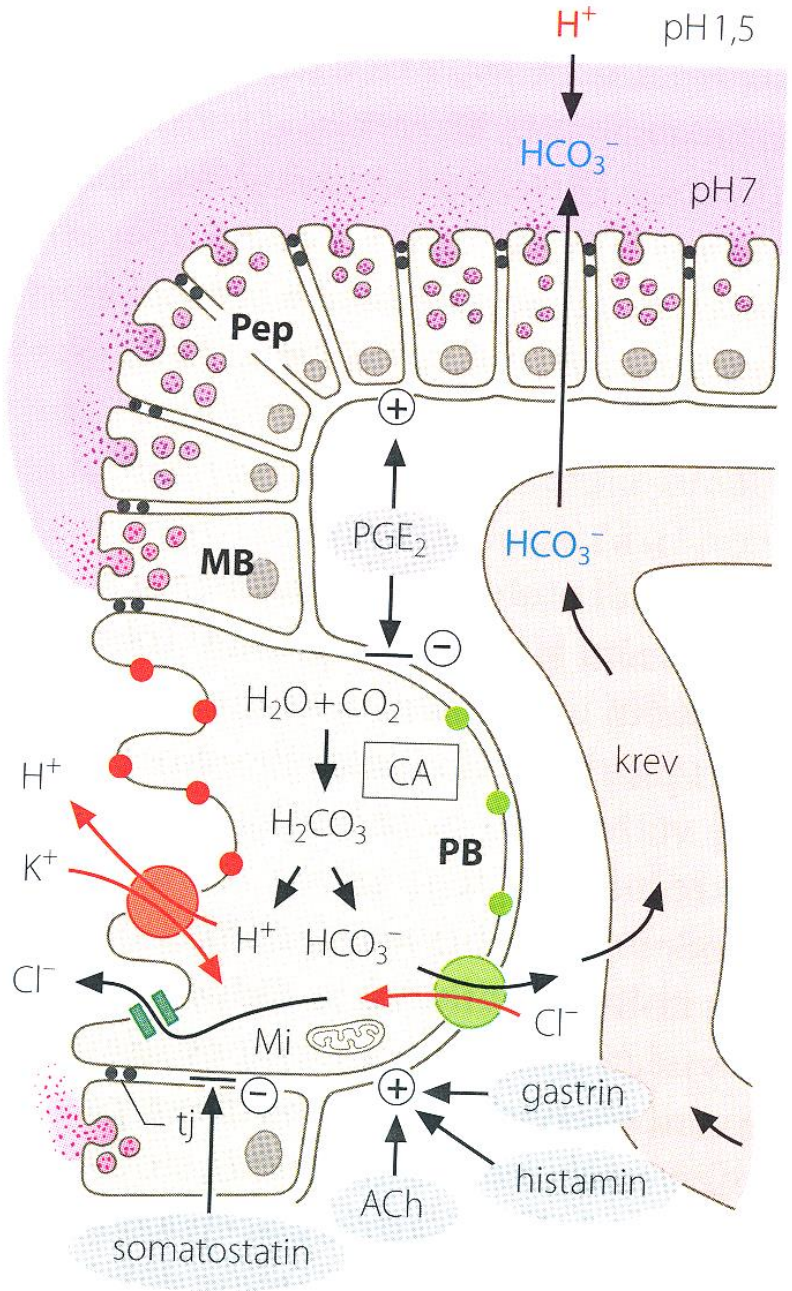


Parietal cell
×100 000

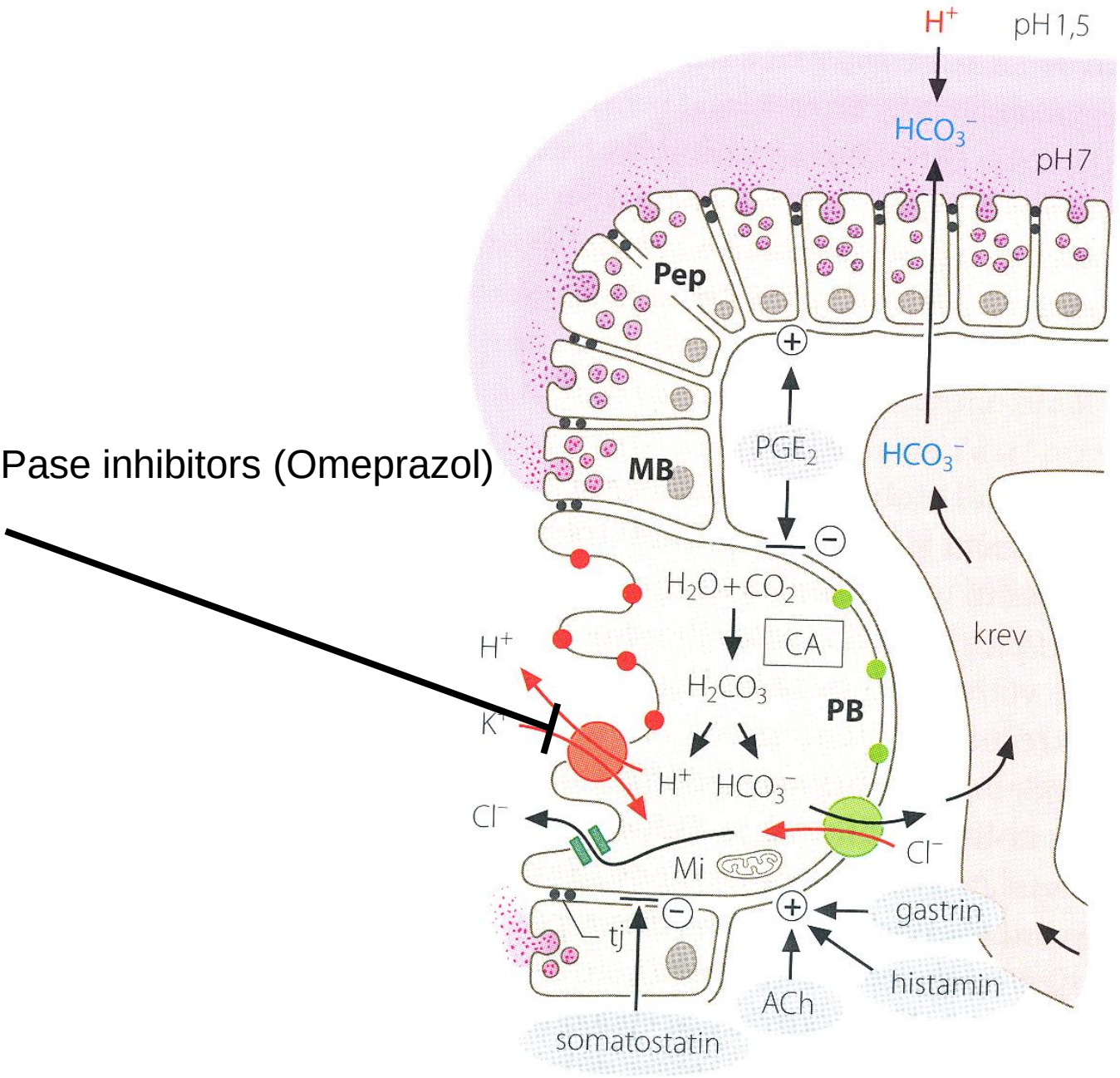




Cell Types	Substance Secreted
Mucous neck cell	Mucus (protects lining)
	Bicarbonate
Parietal cells	Gastric acid (HCl)
	Intrinsic factor (Ca++ absorption)
Enterochromaffin-like cell	Histamine (stimulates acid)
Chief cells	Pepsin(ogen)
	Gastric lipase
D cells	Somatostatin (inhibits acid)
G cells	Gastrin (stimulates acid)

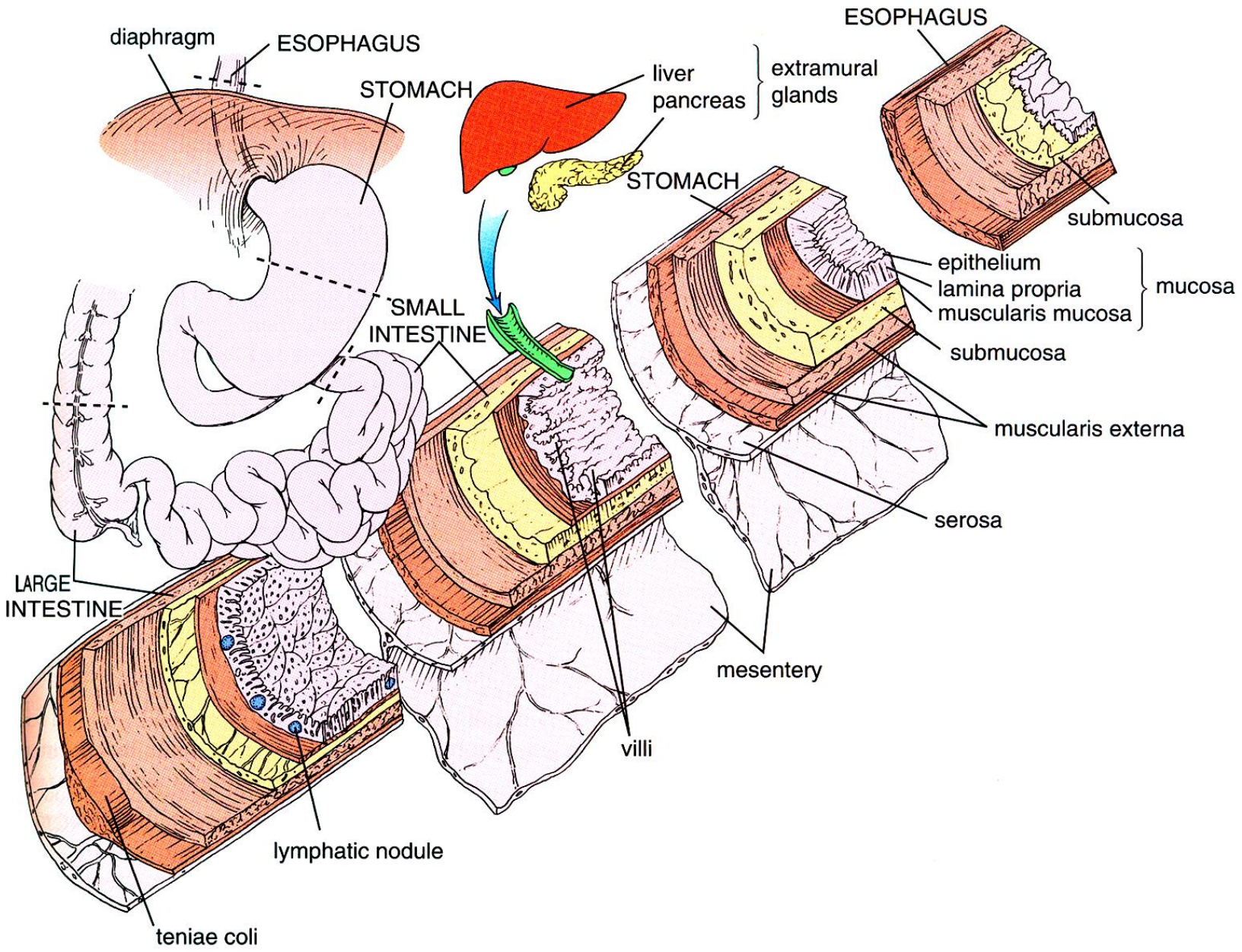


H+/K+ ATPase inhibitors (Omeprazol)

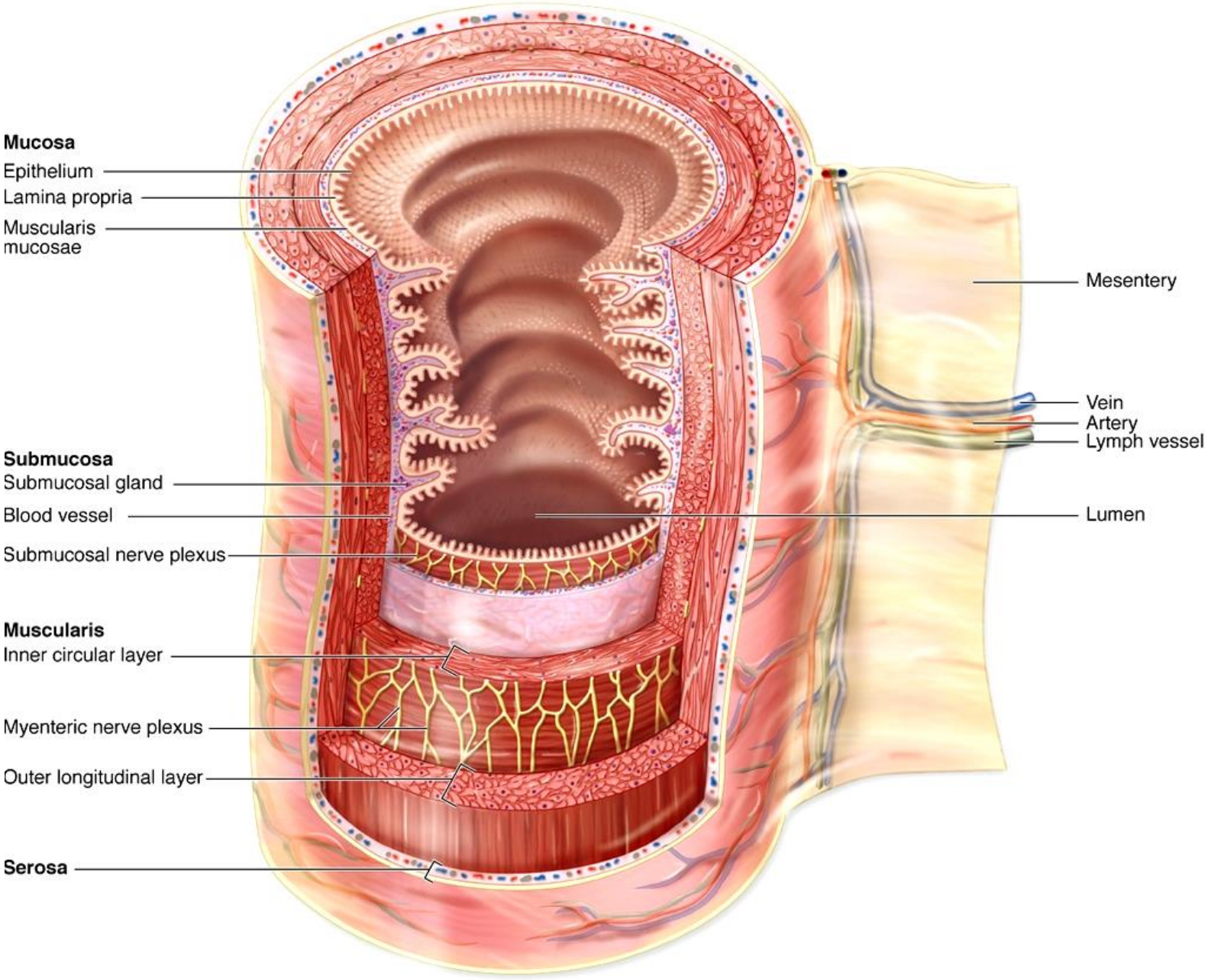


https://www.youtube.com/watch?v=XhB7WNJVg3U

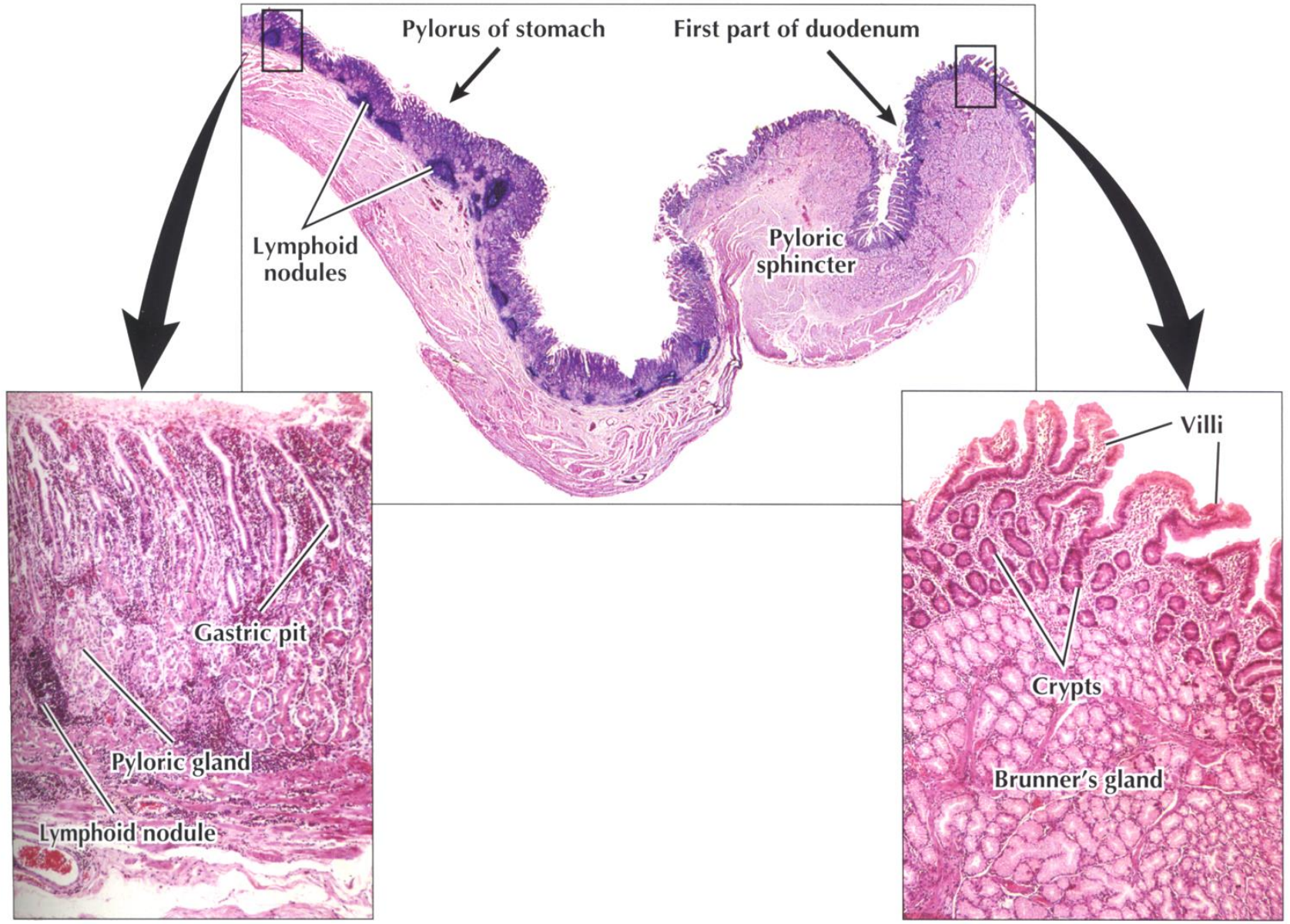
GENERAL ARCHITECTURE OF HOLLOW ORGANS



GENERAL ARCHITECTURE OF HOLLOW ORGANS



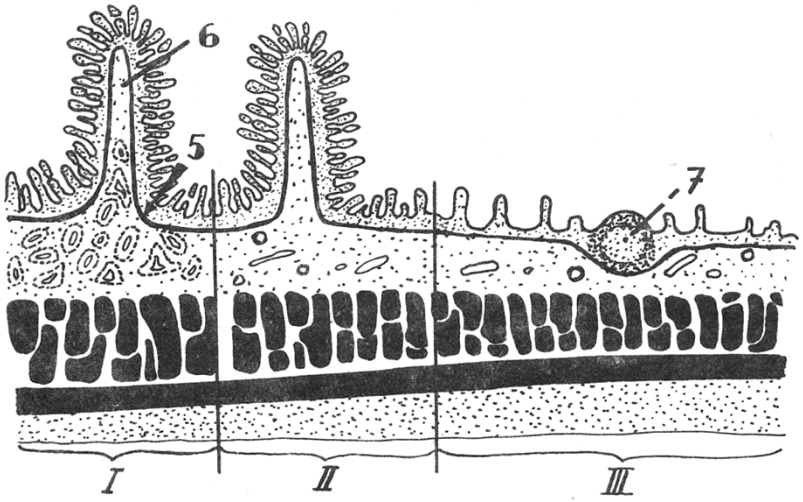
GASTRO-DUODENAL JUNCTION



SMALL INTESTINE – ADAPTATION TO EFFICIENT RESORPTION

Four basic layers: **mucosa, submucosa, muscularis externa, serosa**
mucosa and submucosa maximise the resorptive area

- **plicae circulares** (Kerckringi) – mucosa + submucosa, ca 800, increase **2-3x**, distal region of duodenum



- **villae** (villi intestinales) – mucosa (l. propria + epithelium) 0,5-1,5 mm long, 10-40/mm^2 , 4 000 000, increase **5-10x**

- **microvillae** – apical part of enterocytes – 1- 2 μm long, 0,1 μm wide, 100 mil./mm^2, increase **20x**

SMALL INTESTINE – ADAPTATION TO EFFICIENT RESORPTION

Intestinal mucosa

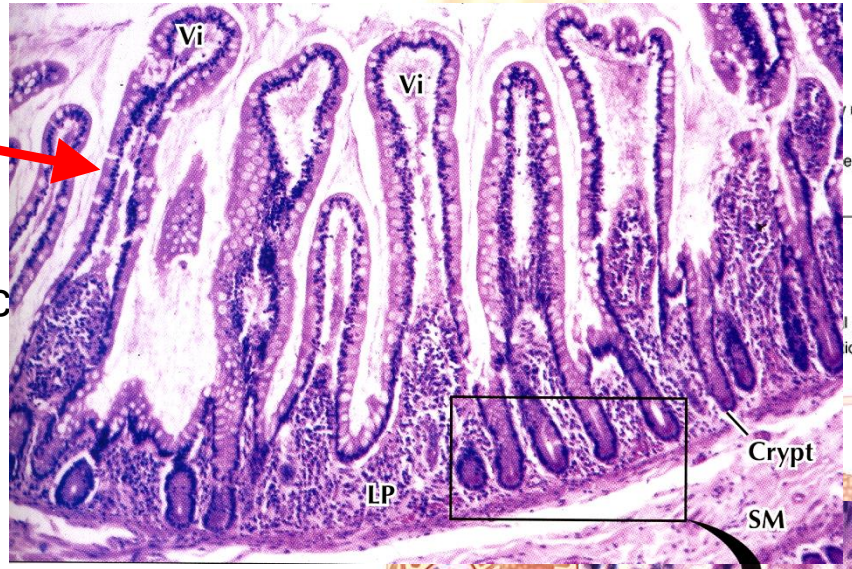
plicae circulares (Kerc
– **2-3x**

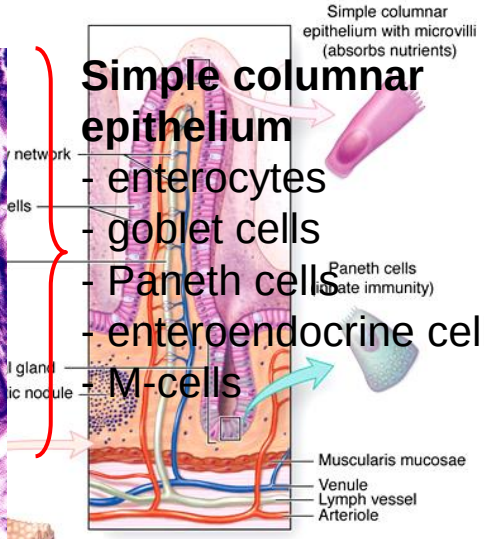
villi (villi intestinales)
– **5-10x**

microvilli (striated border)
– **20x**

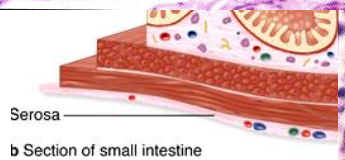
Crypts of Lieberkühn

200-600x



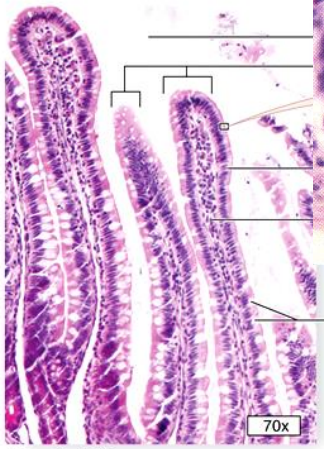


Simple columnar epithelium
- enterocytes
- goblet cells
- Paneth cells
- enteroendocrine cells
- M-cells



b Section of small intestine

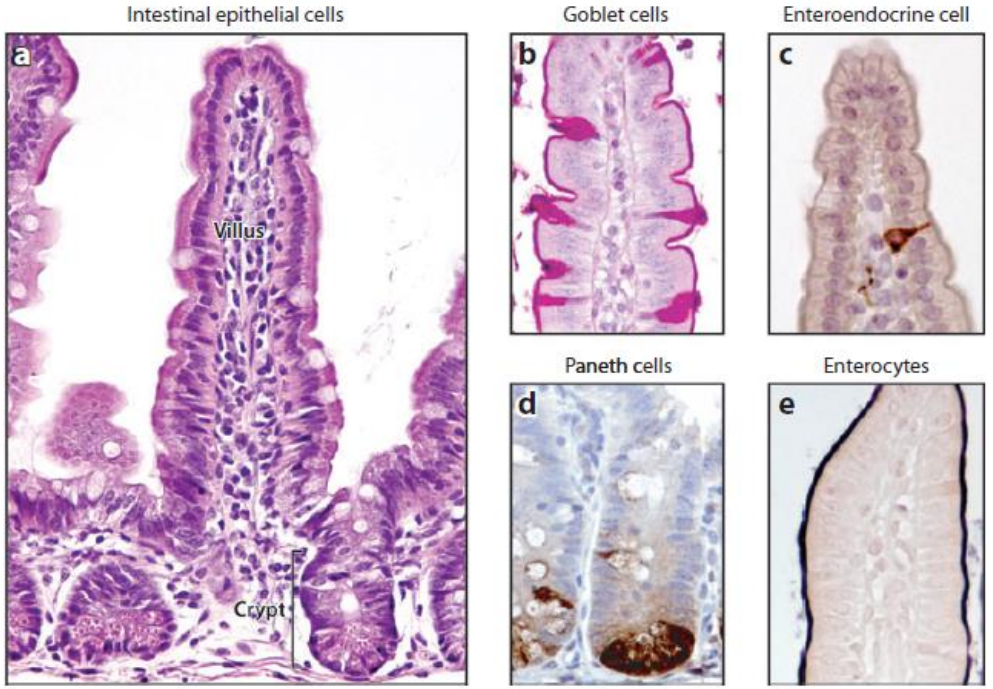
e Microvilli



d Intestinal villi

CRYPTS OF LIEBERKÜHN (GL. INTESTINALES)

- simple tubular structures of intestinal mucosa, depth 0,3-0,5 mm
- pass through l. propria and open to lumen
- different cell types
  - secretion of digestive enzymes
  - epithelial renewal
  - enteroendocrine cells
  - immune response



CELLS OF INTESTINAL MUCOSA

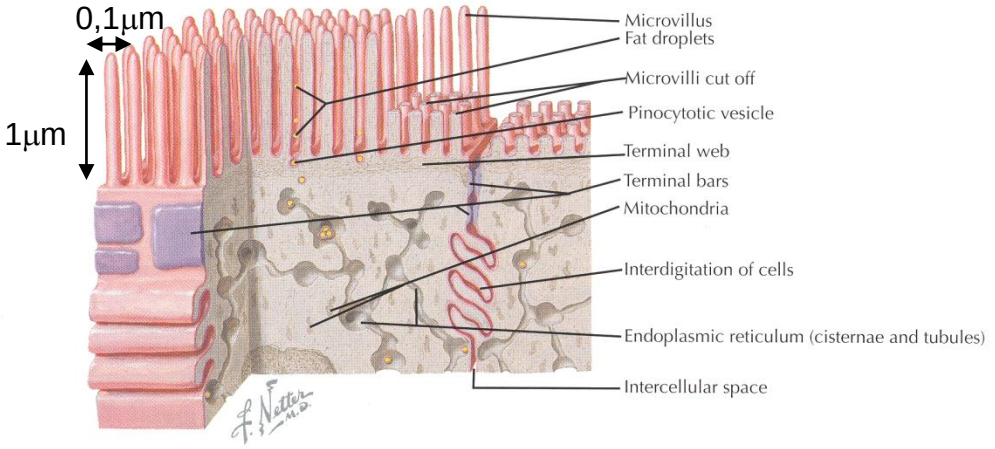
Enterocytes

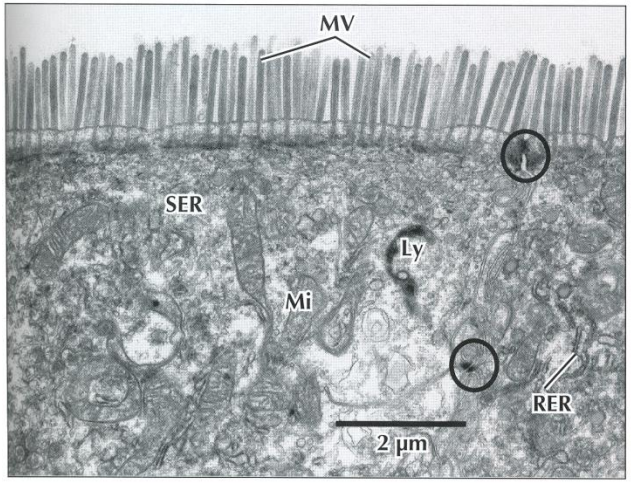
- tall, columnar cells
- nucleus located in basis of the cell
- apical surface modified- microvilli (3000) + glycocalyx (0,5μm) = *striated border (cuticle)*
- tight intercellular connections, interdigitations

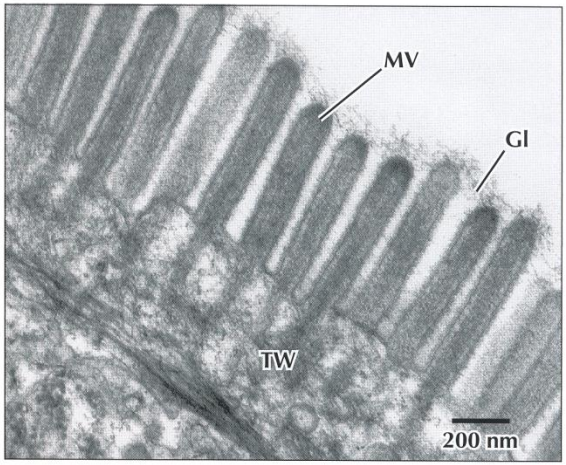
Function:

- digestion – enzymatic complexes on microvilli membrane
- absorption and transport – passive, facilitated i active
- lipid uptake - chylomicrons

▼ **Three-dimensional scheme of striated border of intestinal epithelial cells.**



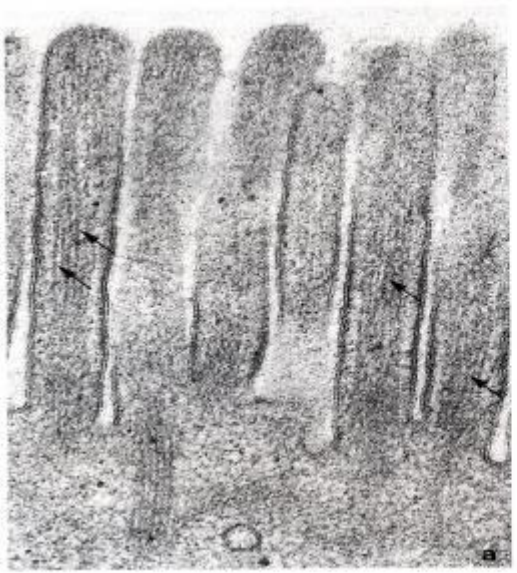


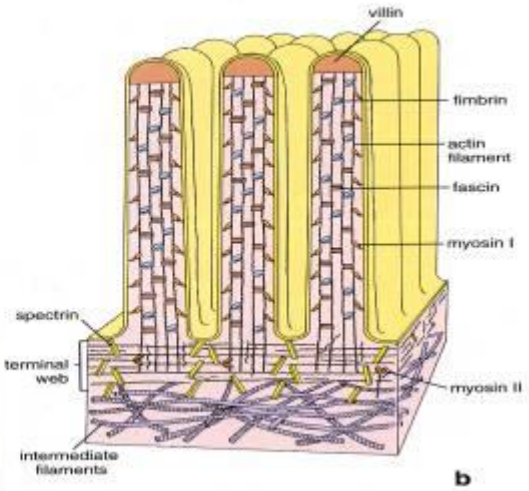


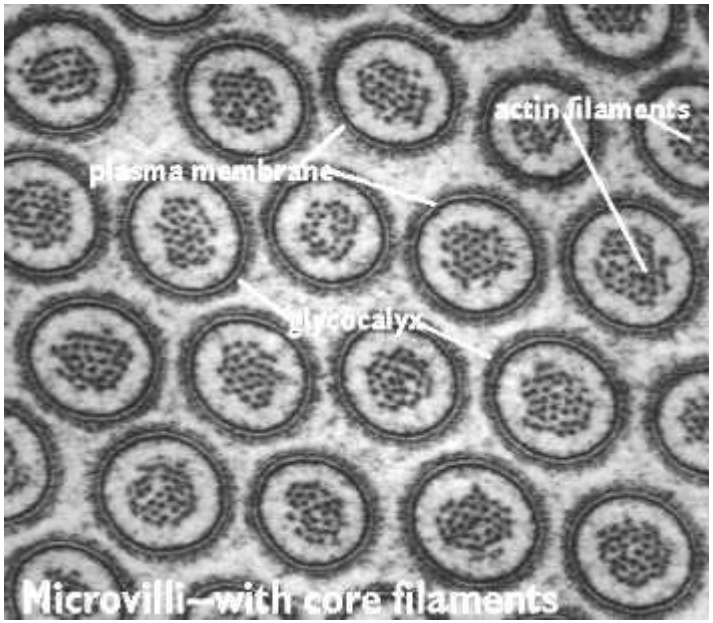
▲ **EMs of enterocytes at low (Left) and high (Right) magnification.** Apical microvilli (**MV**) make up a striated border and extend from free surfaces of the cells. A fuzzy glycocalyx (**Gl**) covers them. A terminal web (**TW**) of actin filaments in the apical cytoplasm reaches into microvilli. Intercellular junctions (**circles**) are between adjacent cells. The cytoplasm contains mitochondria (**Mi**), lysosomes (**Ly**), and smooth (**SER**) and rough (**RER**) endoplasmic reticulum. **Left:** 10,000×; **Right:** 50,000×.

CELLS OF INTESTINAL MUCOSA

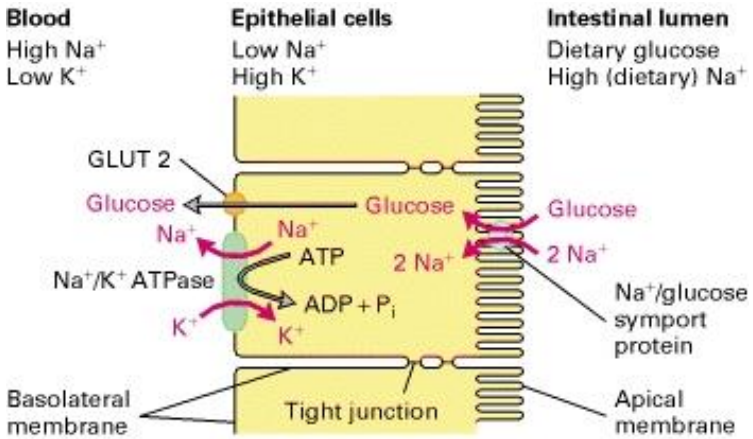
Microvilli

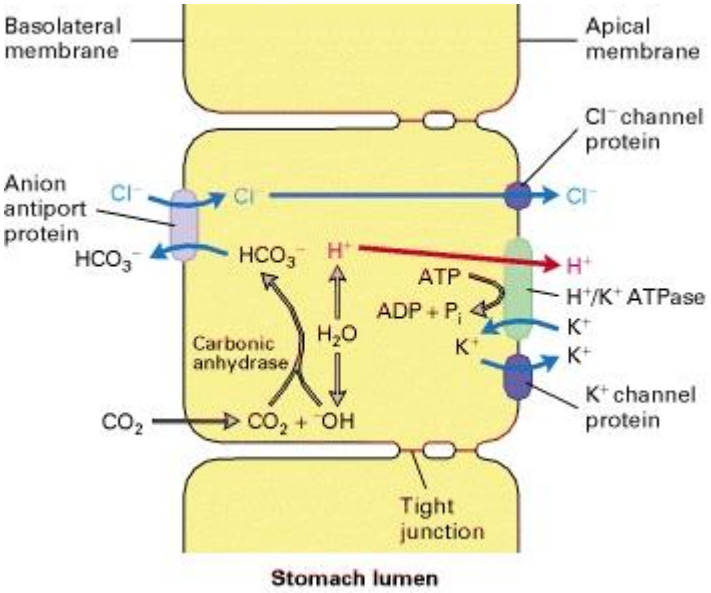






Transportion and resorption





Transport of glucose from intestinal lumen to blood stream

Na^+/K^+ ATPase - basolateral surface - concentration gradient Na^+ and K^+

K^+ gradient generates negative membrane potential

Na^+/glucose symport on apical surface

Facilitated diffusion by glucose uniporter (GLUT2) in basolateral membrane

Acidification of stomach fluid by parietal cells

Apical membrane - H^+/K^+ ATPase + Cl^- a K^+ canals

Basolateral membrane – anion antiporter HCO_3^- and Cl^- ions

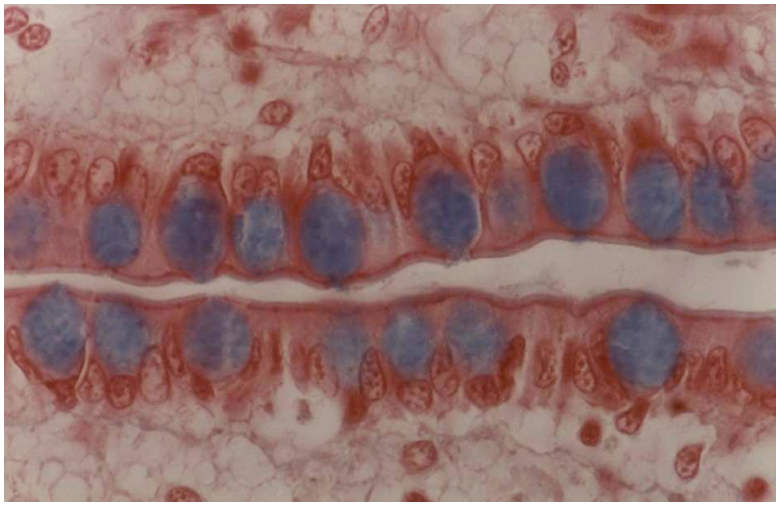
Combined activity of ion channels a cells keeps the electroneutrality and neutral cytoplasmic pH while reaching high extracellular concentration of H^+ and Cl^- in lumen of stomach

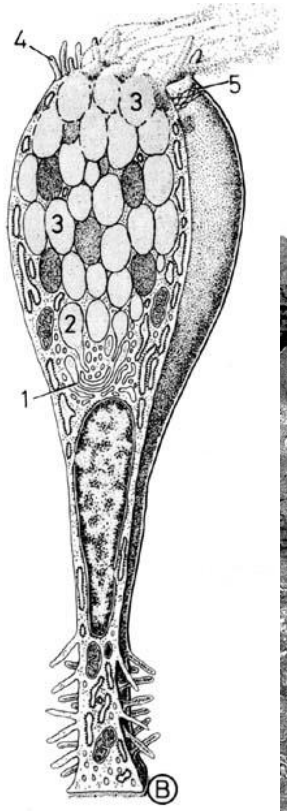
http://www.ncbi.nlm.nih.gov/books/NBK21502/

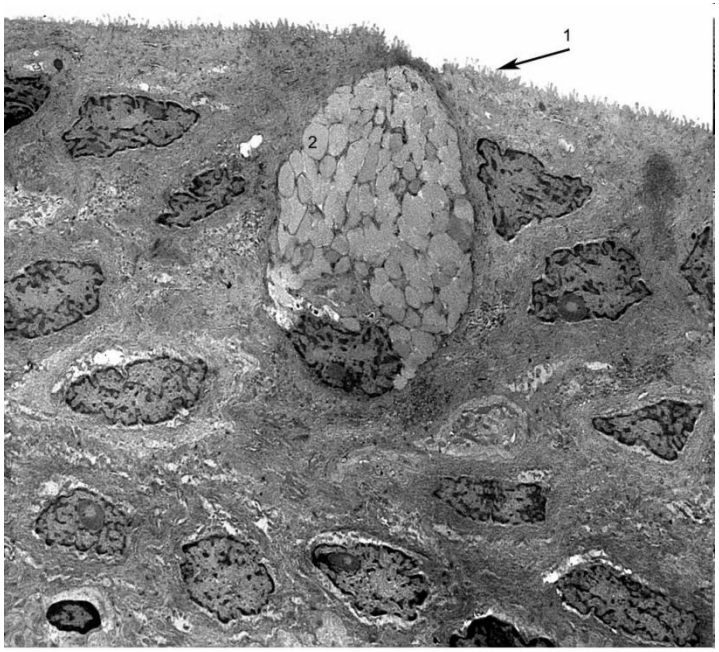
CELLS OF INTESTINAL MUCOSA

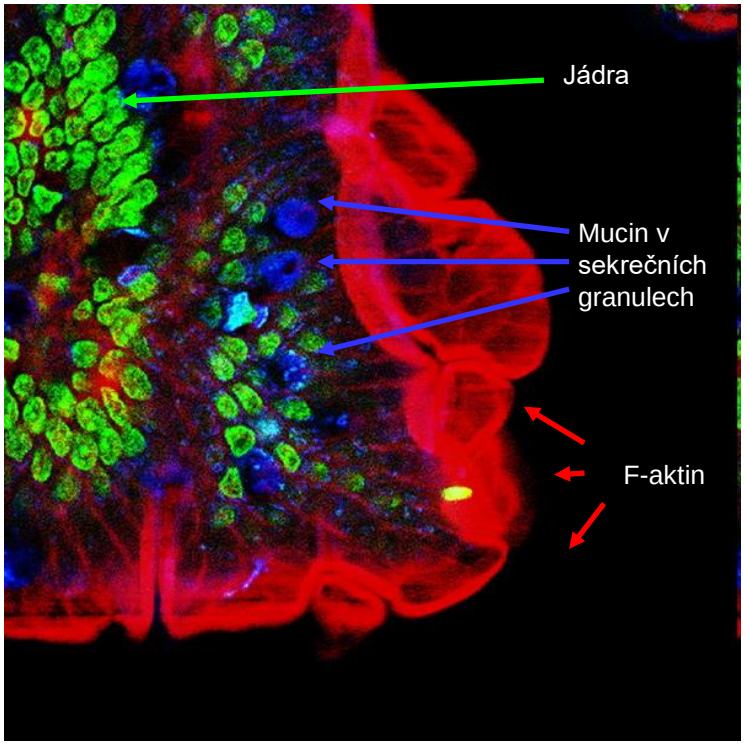
Goblet cells

- Cylindrical glandular epithelial cells
- Apical surface – apocrine/merocrine secretion of mucin
- Basal part – RER, GA, nucleus, mitochondria
- Mucinogenic granules
- see lesson spring semester 2015 - Epithelial tissue



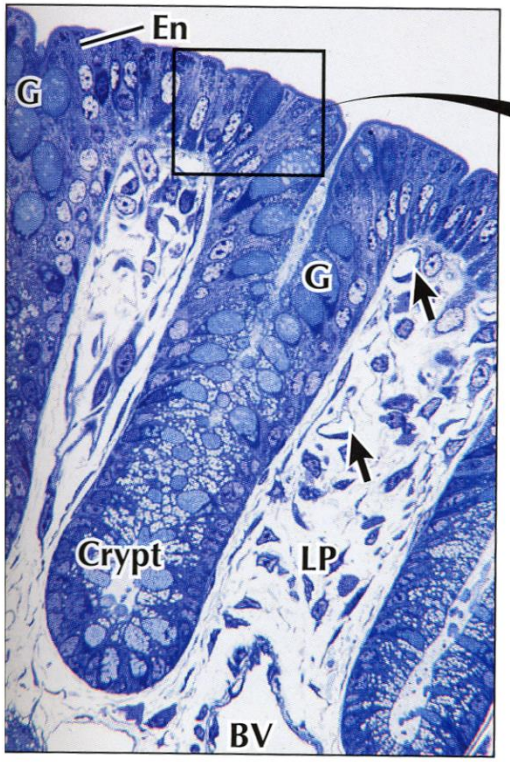




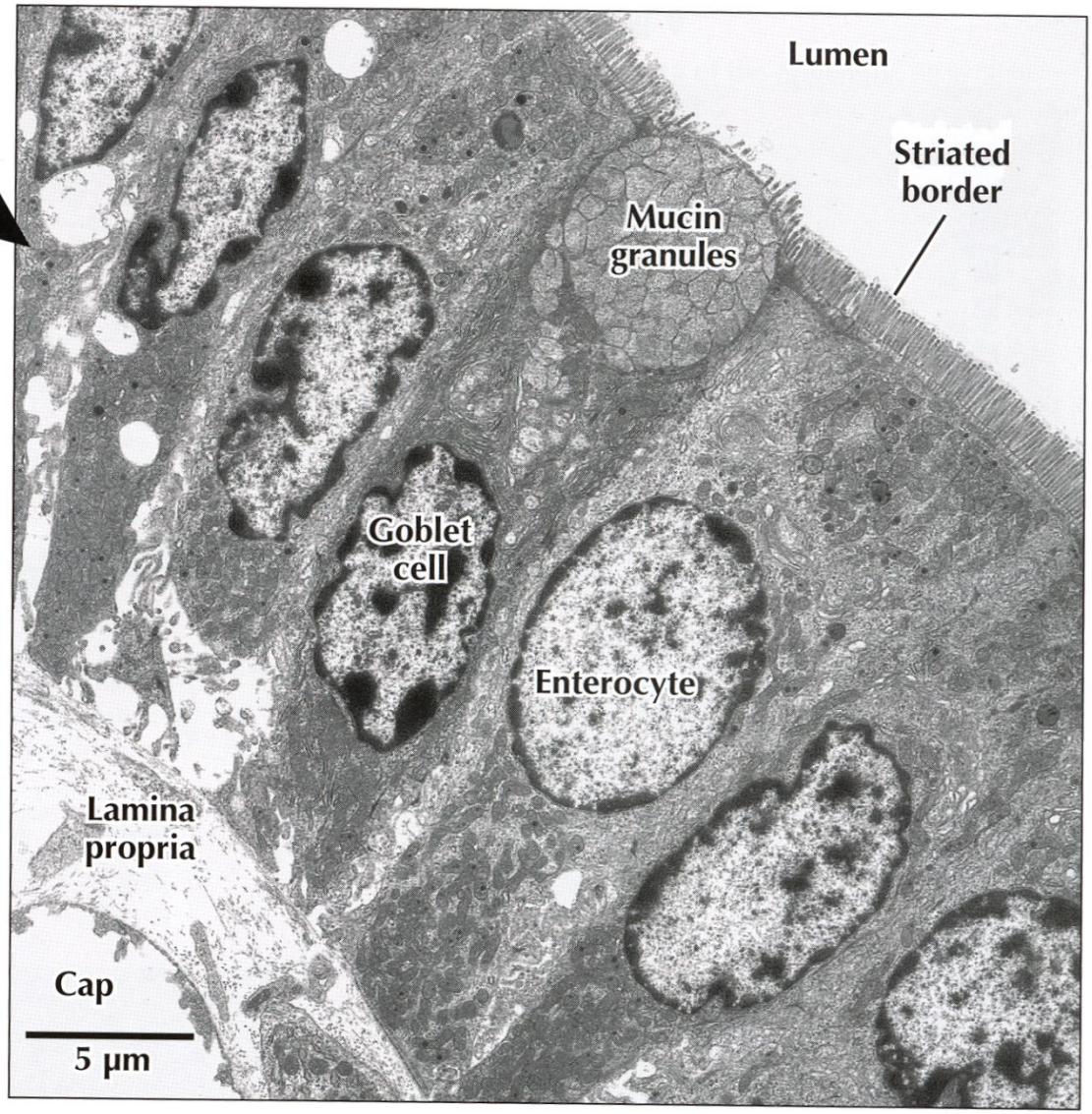


CELLS OF INTESTINAL MUCOSA

Goblet cells

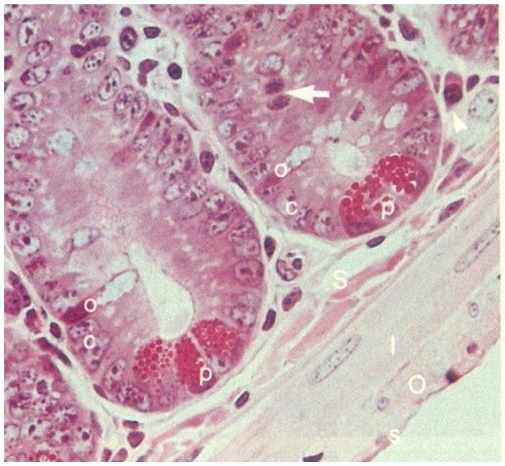


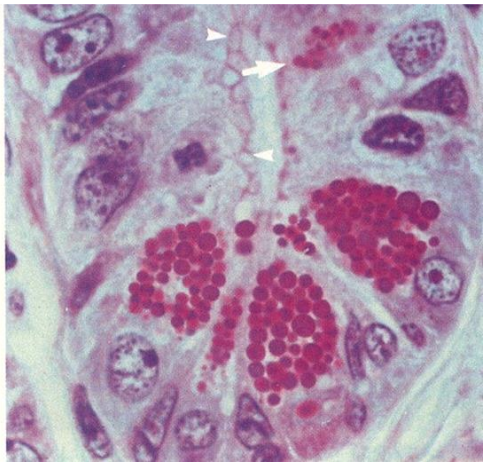
▲ **LM of the colonic mucosa.** Surface epithelium containing goblet cells (**G**) and enterocytes (**En**) invaginates to form an intestinal crypt. The lamina propria (**LP**), with capillaries (**arrows**) and larger blood vessels (**BV**), is richly cellular. 600×. *Toluidine blue.*



CELLS OF INTESTINAL MUCOSA

Paneth cells

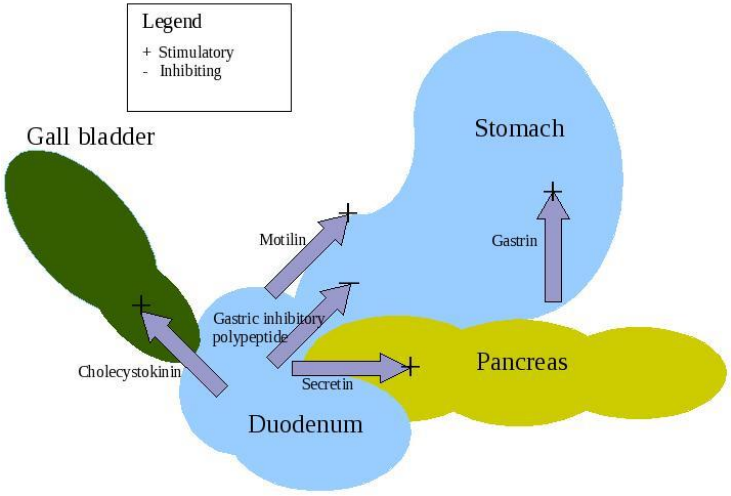




- basal part of crypts of Lieberkühn
- basophilic cytoplasm
- GA located above nucleus
- acidophilic (red) granules
- immune system
- secretion granules contain biologically active substances e.g. lysozym)
- influence intestinal microflora

Enteroendocrine cells

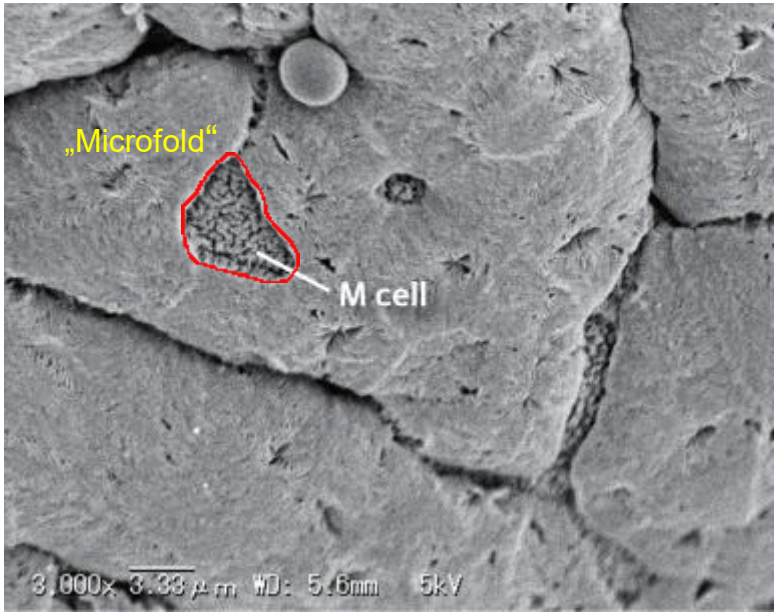
- similar to gastric enteroendocrine cells
- regulate pancreatic secretions
- homeostatic axis (brain-intestine-adipose tissue)
- cholecystokinin, secretin, GIP, motilin, neurocrine peptides etc.

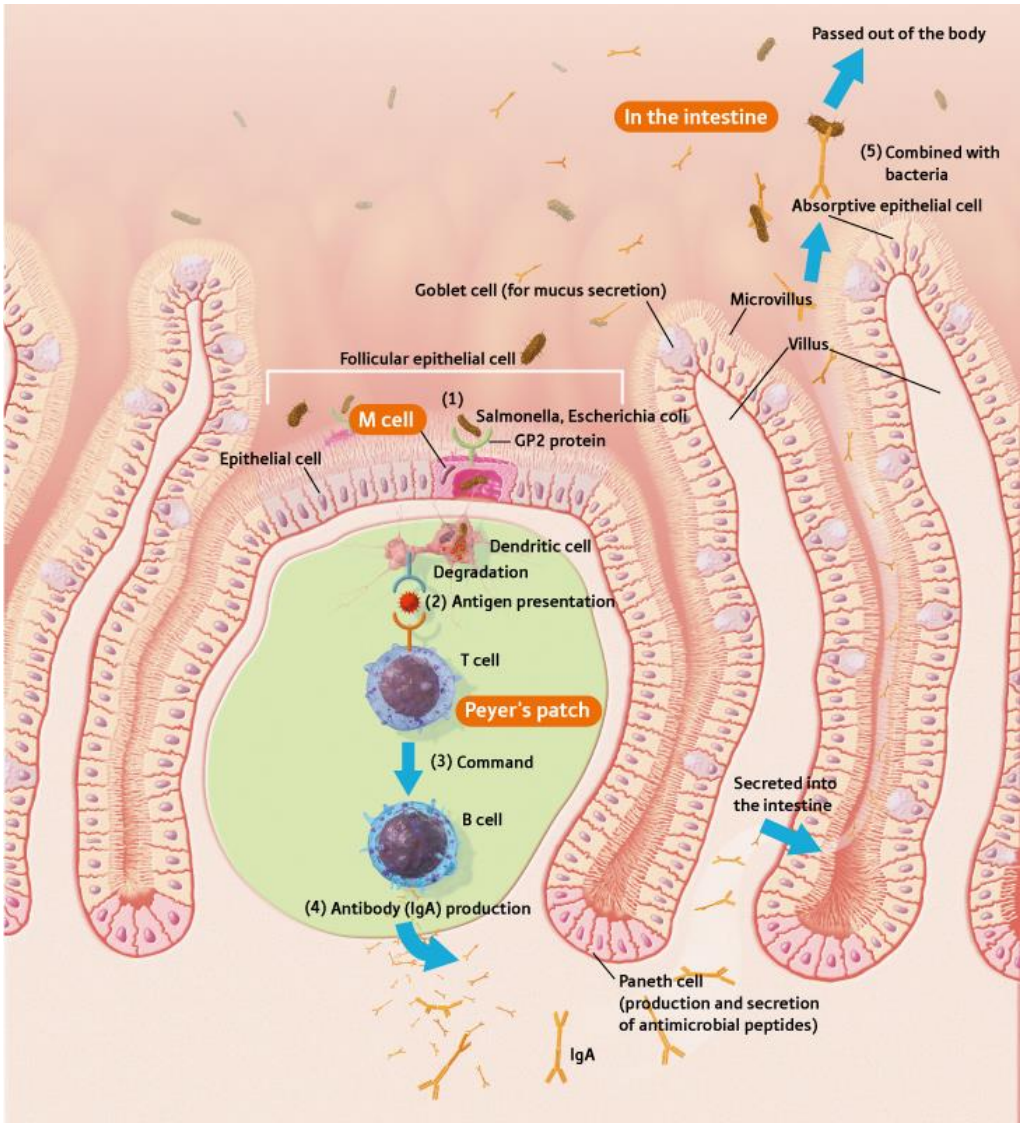


CELLS OF INTESTINAL MUCOSA

M cells (microfold)

- epithelial cells above Peyer's patches and lymphatic nodules
- no microvilli
- induces immune response
- MHCII
- antigen presentation to dendritic cells and lymphocytes

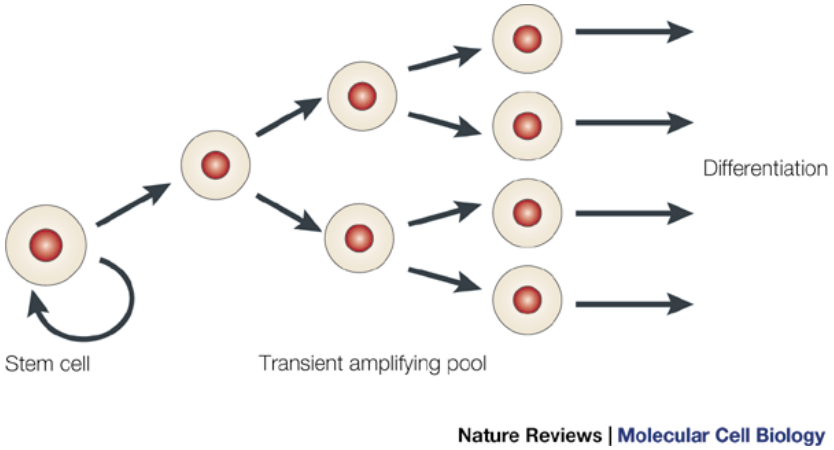


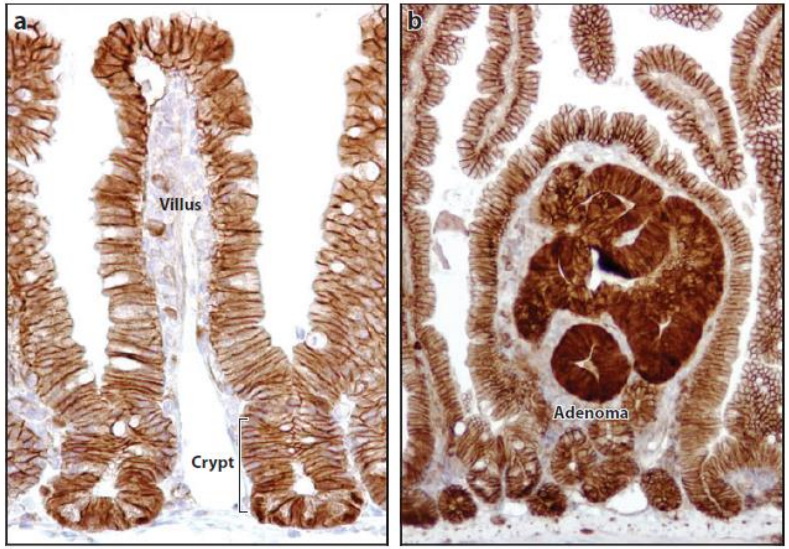


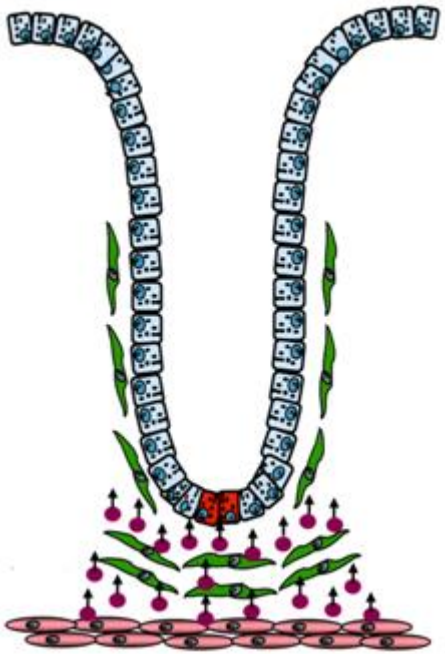
CELLS OF INTESTINAL MUCOSA

Intestinal stem cells

- bottom of crypts of Lieberkühn
- epithelial renewal (4-5 days)
- stem cell niche
- tumour transformation



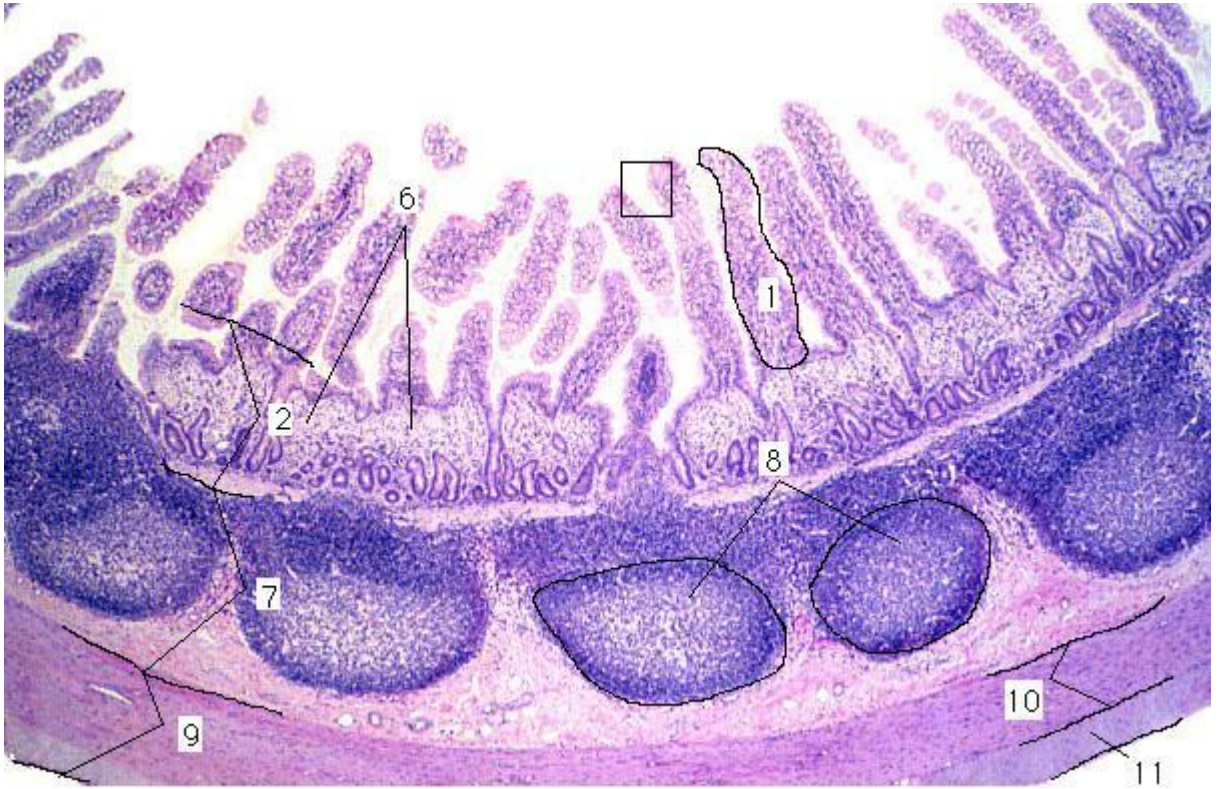




INTESTINAL MUCOSA

L. propria

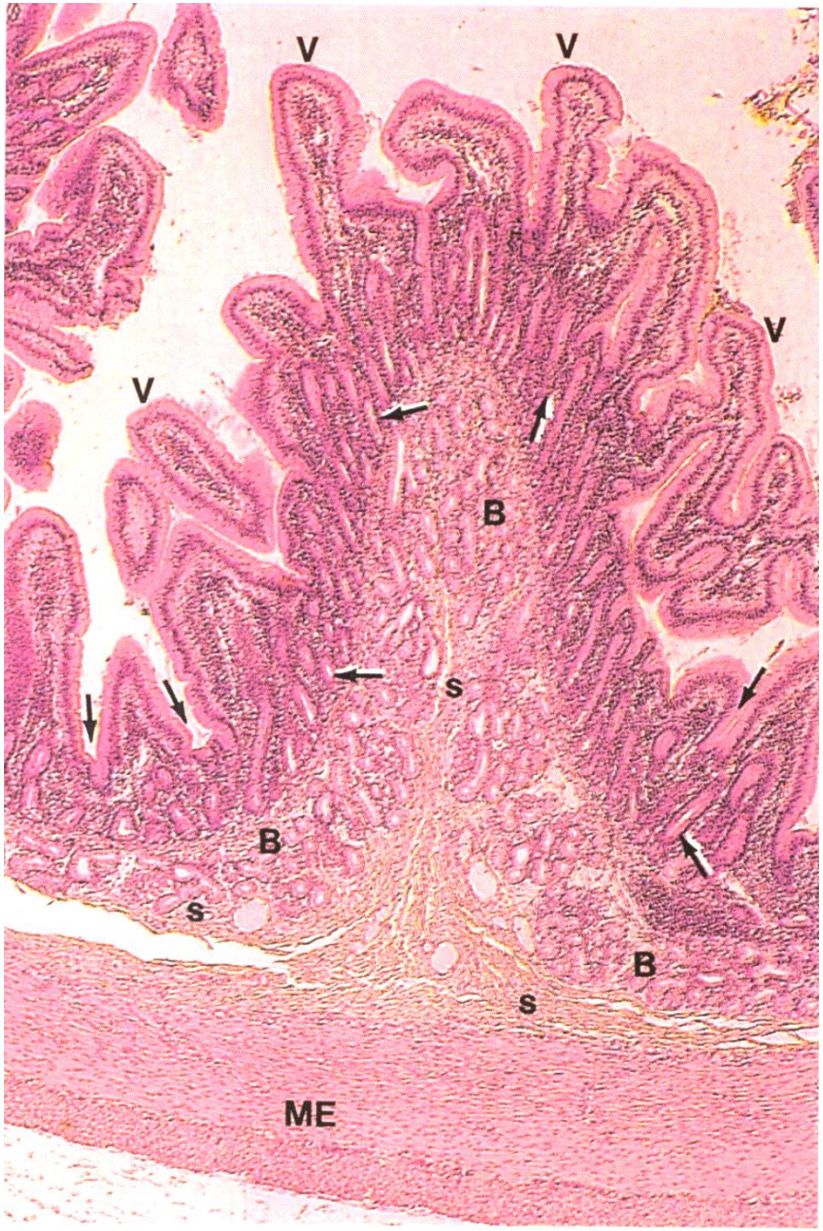
- immune system – GALT
- abundance of reticular fibers
- immunologic barrier
- Peyer's patches



INTESTINAL SUBMUCOSA

Brunner's glands

- gl. duodenale Brunneri
- branched tuboalveolar glands, columnar mucinous cells
- alkaline secretion
- connective tissue reduced to thin septa between glandular lobules
- open to crypts of Lieberkühn



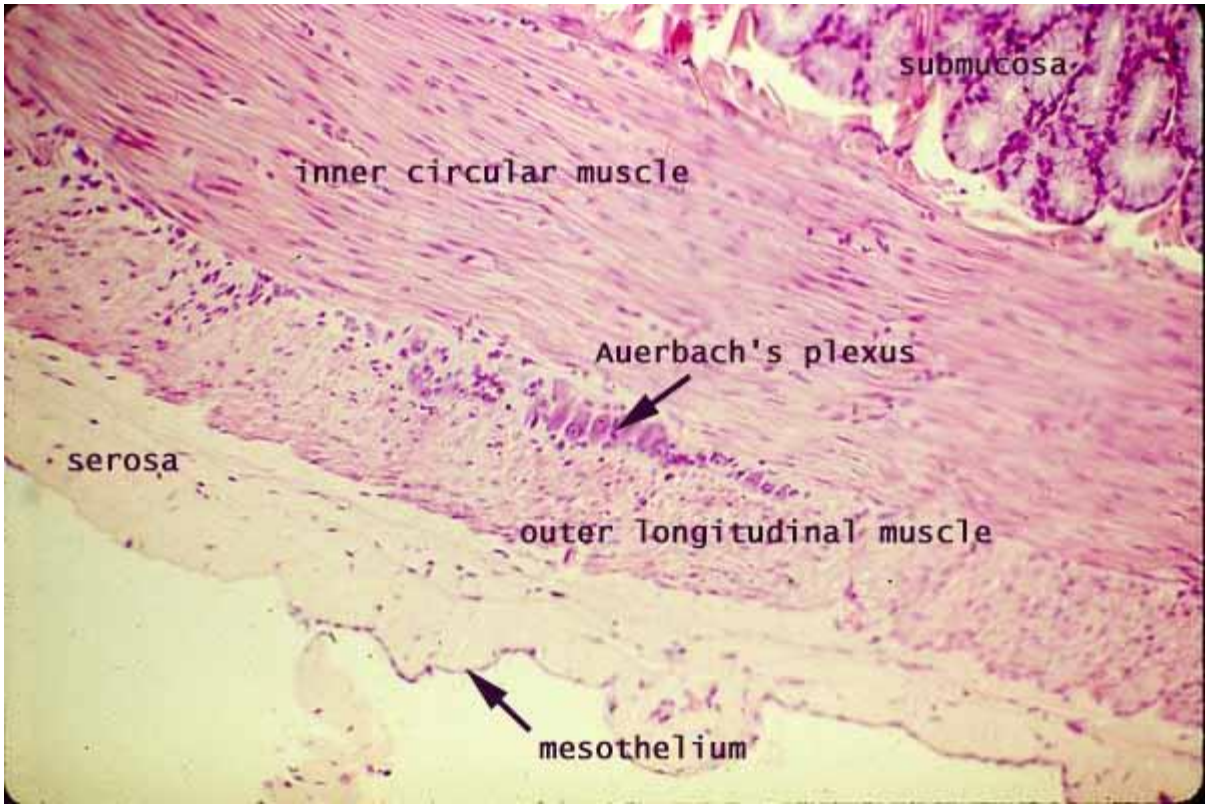
OUTER LAYERS OF INTESTINAL WALLS

Muscularis externa

- two layers of smooth muscle (inner circular, outer longitudinal)
- plexus myentericus Auerbachi

Serosa

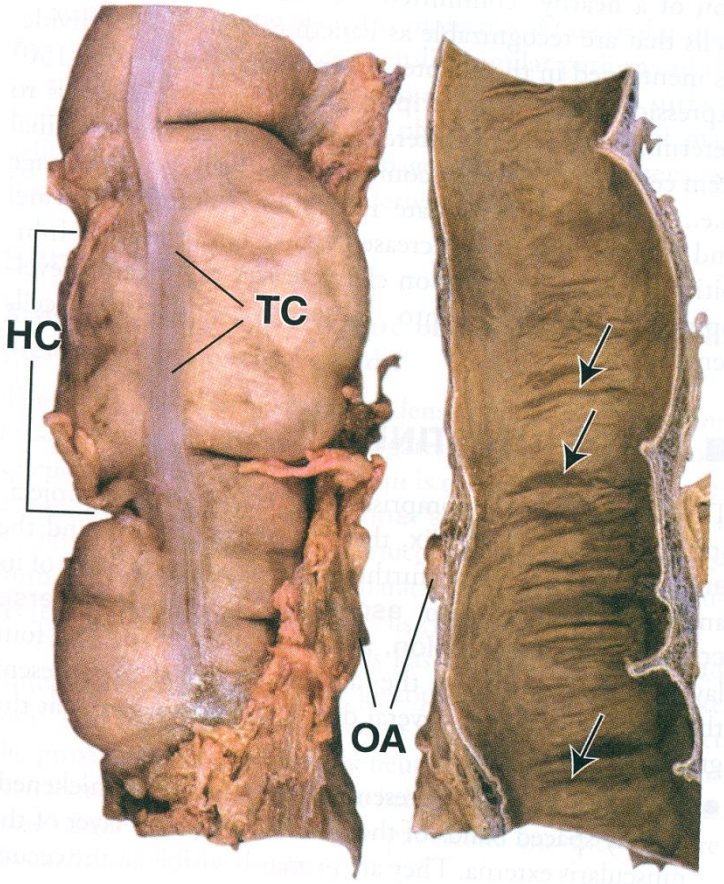
- loose collagen connective tissue + simple squamous epithelium (mesothelium)



COLON

- plicae of Kerckring, villi absent
- muscularis externa – longitudinal layer - **taenie coli**
- surface serosa - **appendices epiploicae** (adipose)

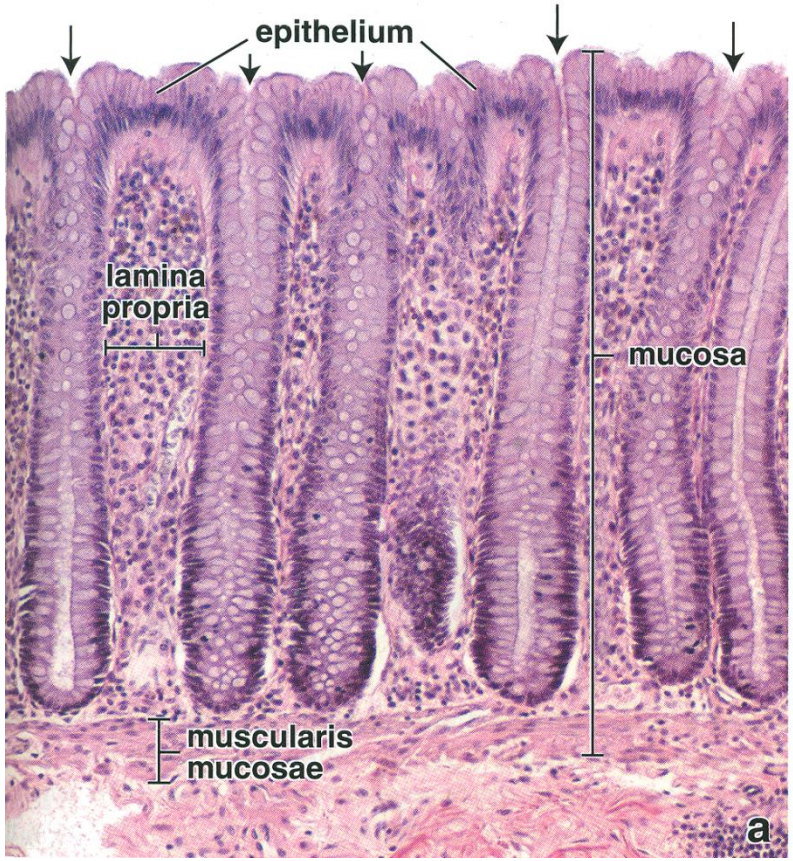
Small intestine

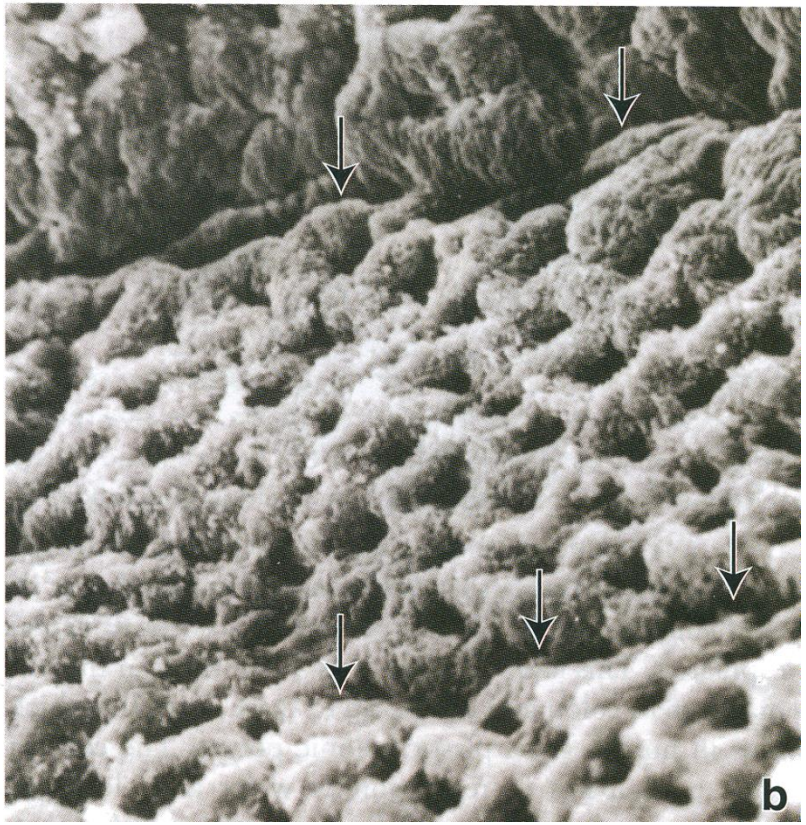


Colon

COLON

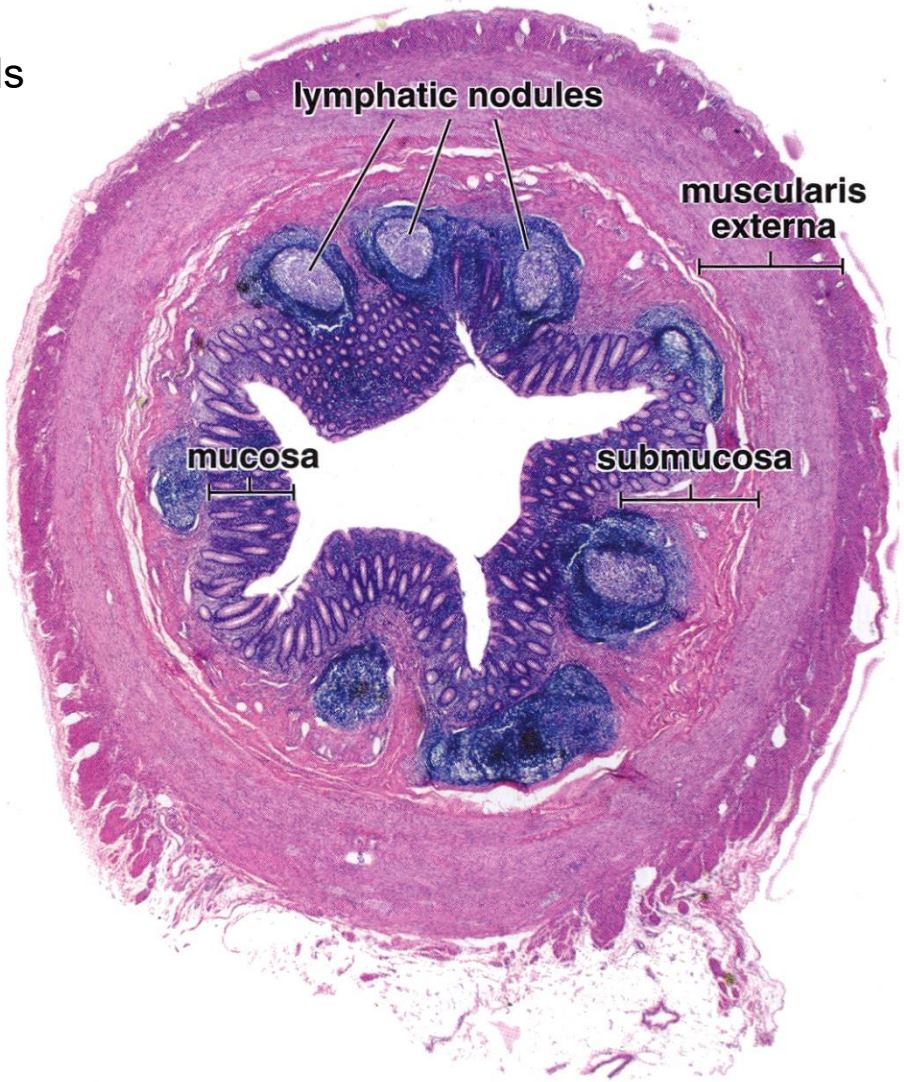
- absorption of water, electrolytes
- deeper crypts of Lieberkühn, no Paneth cells
- abundant goblet cells
- abundant lymphatic follicles in l. propria (GALT)





APPENDIX

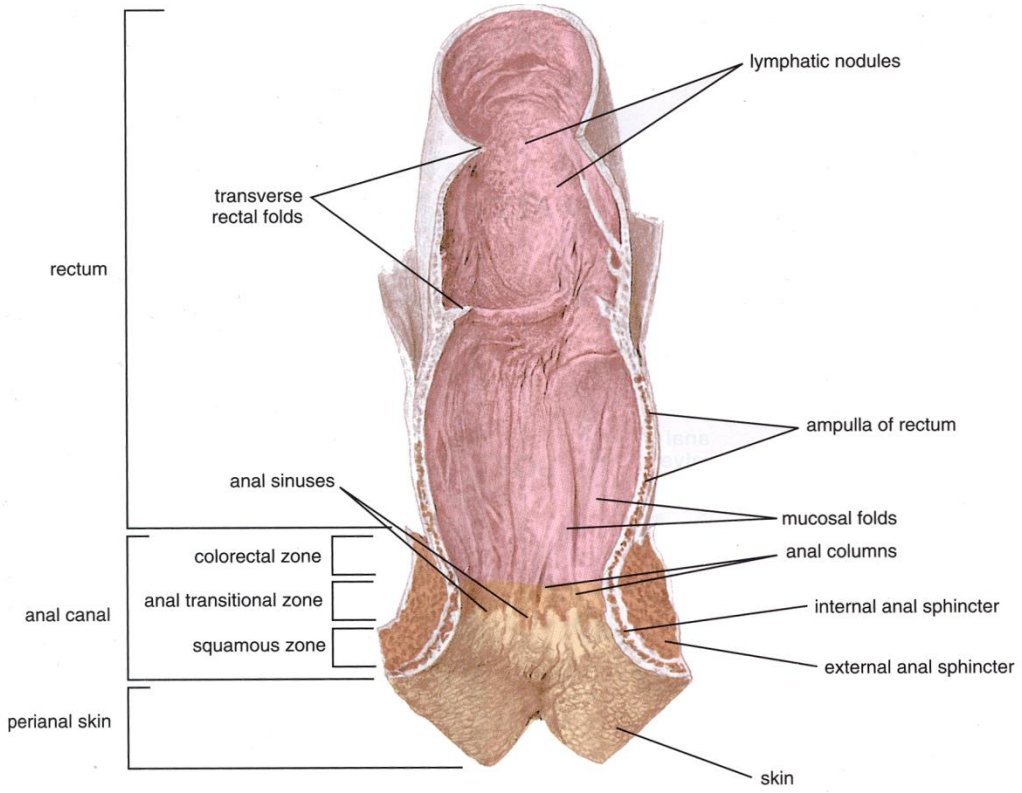
- develops from and is connected to caecum 8-10 cm (0,5-1cm)
- continuous longitudinal layer of m. externa
- lymphatic follicles reaching submucosa
- irregular crypts of Lieberkühn with Paneth cells



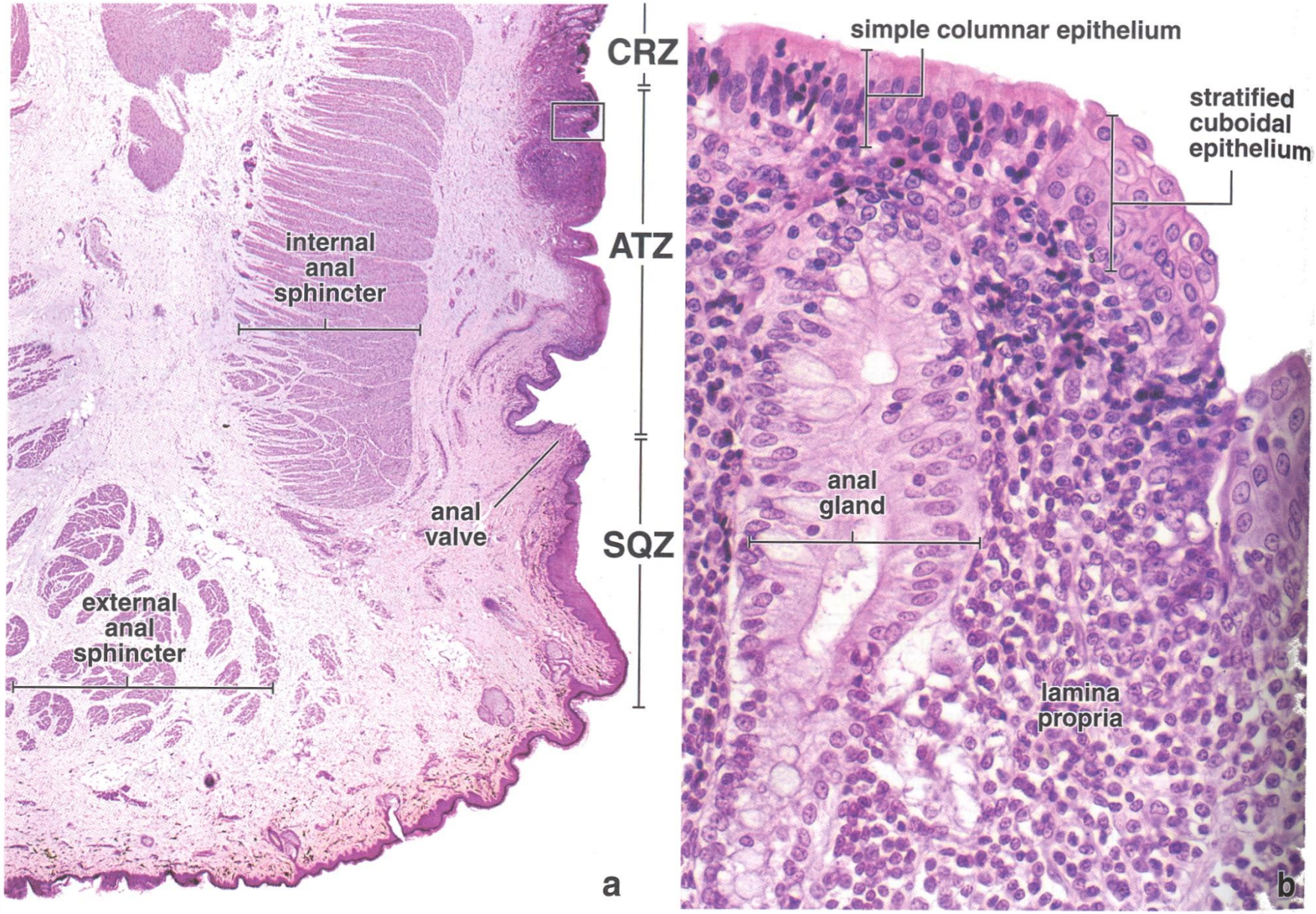
RECTUM AND ANAL CANAL

- Pars pelvina
  - *plicae transversae recti*
  - histological architecture identical to colon

- Canalis analis
  - anulus hemorhoidalis – no L. crypts, simple columnar epithelium replaced by stratified squamous epithelium
  - rich venous plexus
  - *columnae rectales*
  - *sinus rectales* and *valvulae rectales*
  - *zona cutanea* – typical skin



RECTUM AND ANAL CANAL



Organ	Region	Mucosa			Submucosa	Muscularis externa	Serosa/ Adventitia
		LEM	LPM	LMM			
Esophagus	1/3	stratified squamous e.		full	gll. oesophageales	skeletal	A
	2/3		glandulae oesophageae cardiacae			both	
	3/3					smooth	S
Stomach	cardia	simple columnar e.	gll. cardiacae	full		three layers oblique, circular, longitudinal	S
	fundus/ corpus		gll. gast. prop.				
	pylorus		gll. pyloricae				
Small intestine	duoenum	simple columnar e. brush border goblet cells	L. crypts villi	full	gll. duodenales Brunneri		A+S
	jejunum		Peyer's plaque		plicae circulares		S
	ileum						
Colon and rectum	apendix	simple columnar e. brush border goblet cells	lymph. follicles	partial	lymph. nodes	full	S
	caecum		villi absent	full		taeniae coli	A+S
	colon						A+S
	rektum	columnae rectales					A
Canalis analis	anorectal/ anocutaneous	stratified squamous e. non-keratinized	venous plexus	partial-absent	mucosal folds venous plexus	inner anal sphincter	A
	zona cutanea	stratified squamous e. keratinized	hair follicles, sweat glands				

Microscopic anatomy and development of the gut tube

see also the requirements for exam

- **General architecture of hollow organs and gut tube**: mucosa (l. epithelialis m ., l. propria, l. muscularis m.), submucosa, t. muscularis externa, serosa (l. propria s., l. epith. s.), adventitia

- **Pharynx** – structure and microscopic anatomy

- **Esophagus** - structure, epithelium, mucosal and submucosal glands, differences in t. muscularis ext.

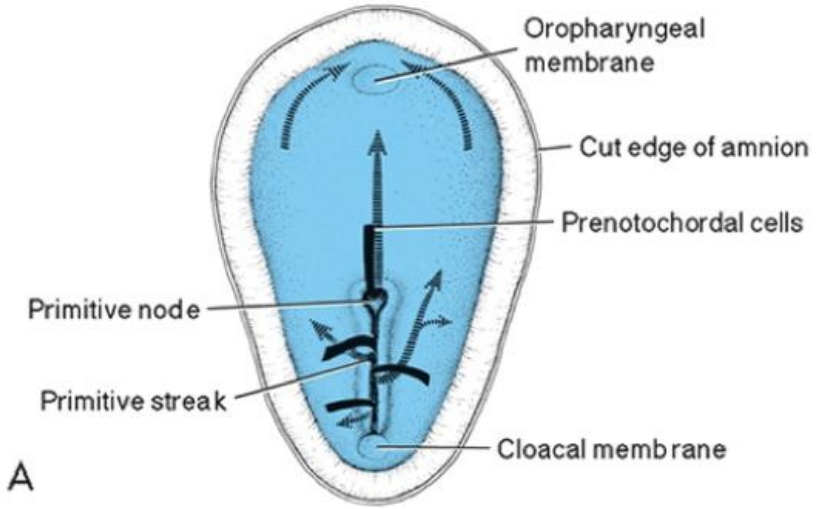
- **Stomach** – anatomical and histological structure, mucosa - areae gastricae, foveolae gastricae, gastric glands (pyloricae vs. propriae), localization, ultrastructure and function of gl. gastricae propriae and its cells (chief, parietal, neck, enteroendocrine

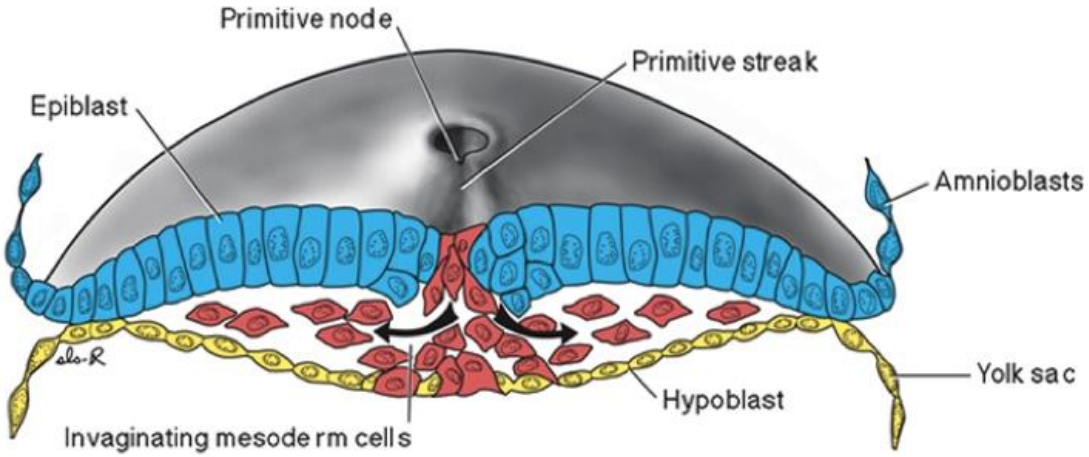
- **Small and large intestine, appendix** - anatomical and histological structure, mucosa, glands (crypts of Lieberkühn, Brunner's glands), cell types of intestinal mucosa, lymphatic system, modifications of intestinal wall

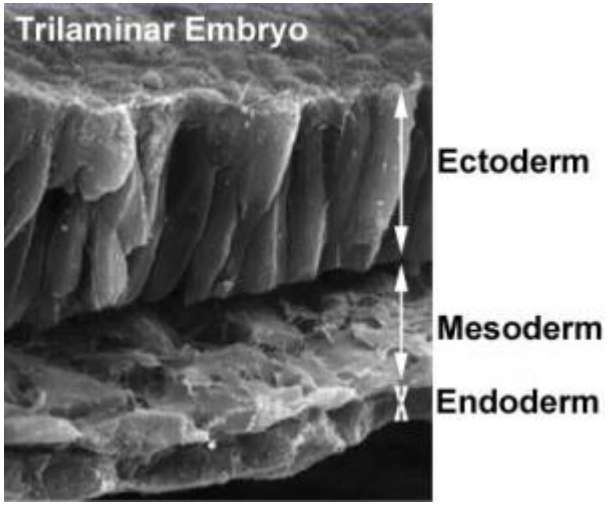
- **Rectum and anal canal** - anatomical and histological structure, mucosa, epithelium, description of associated structures

DEVELOPMENT OF GIT

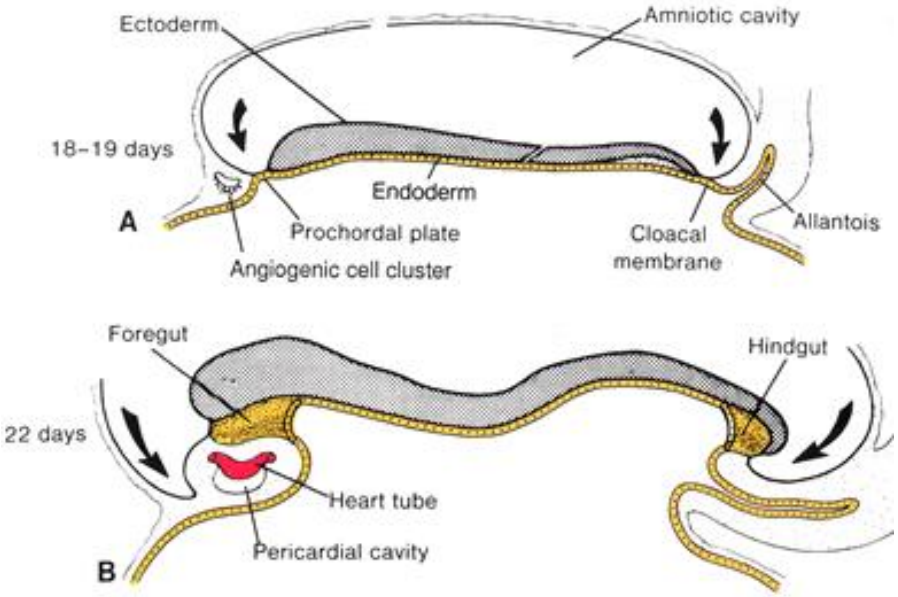
EARLY EVENTS – FROM 2TH TO 3RD WEEK

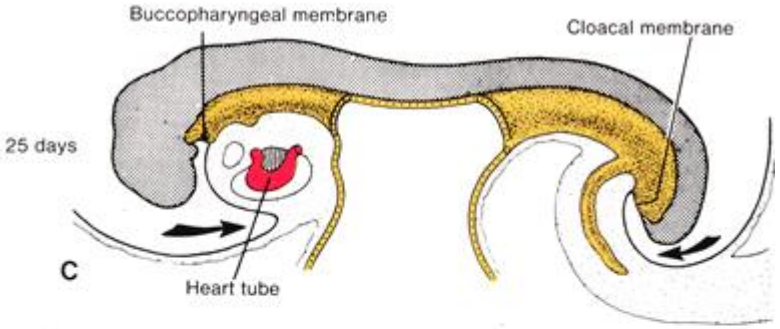


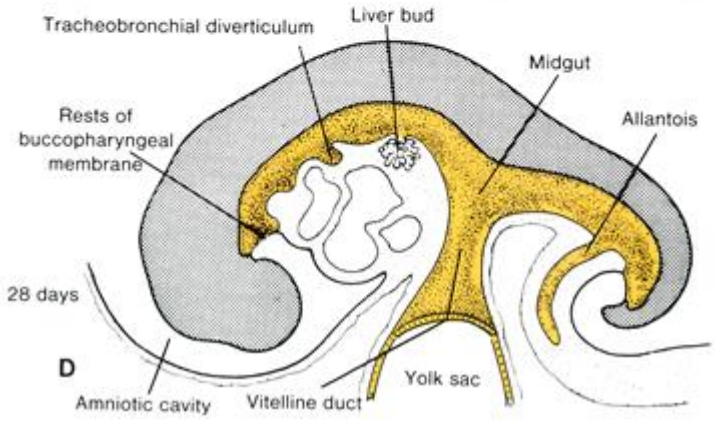




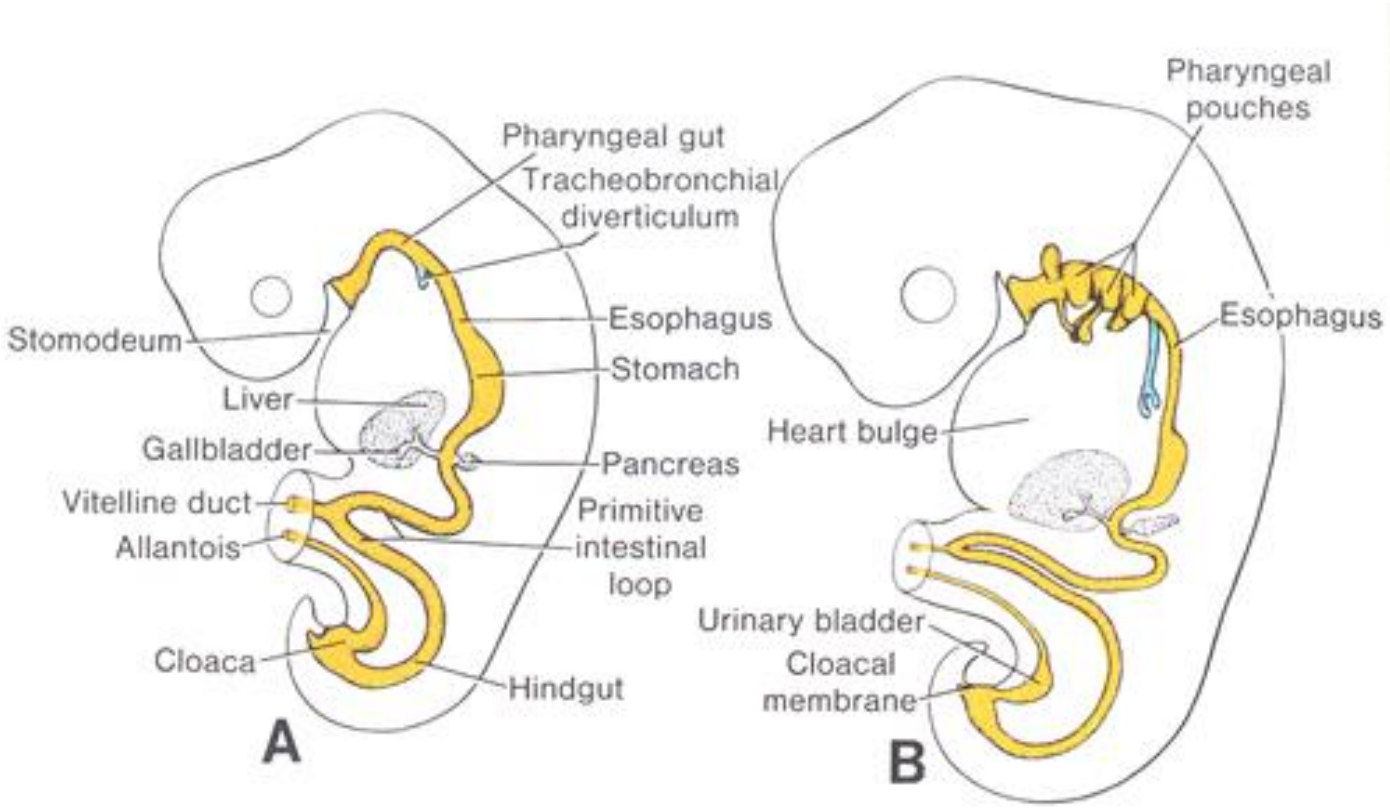
EARLY EVENTS – FROM 3RD TO 4THWEEK







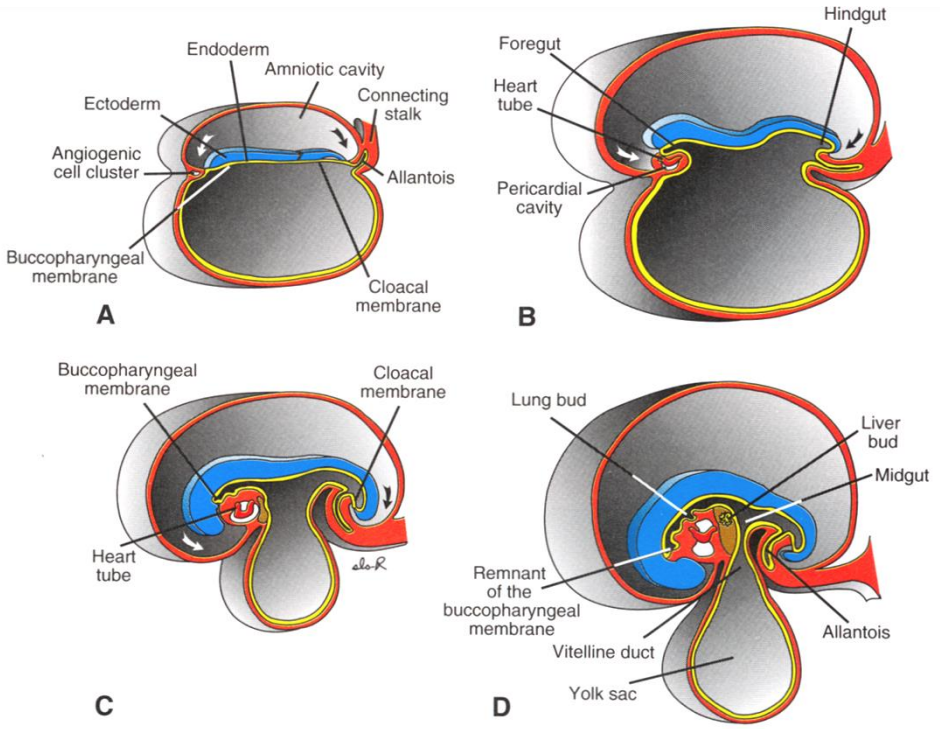
EARLY EVENTS – FROM 4TH TO 5THWEEK



EARLY EVENTS – PRIMITIVE GUT

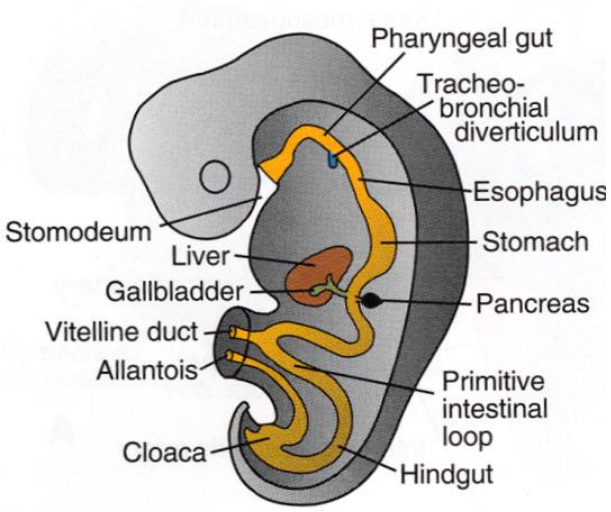
– cephalocaudal and lateral folding in 4th week

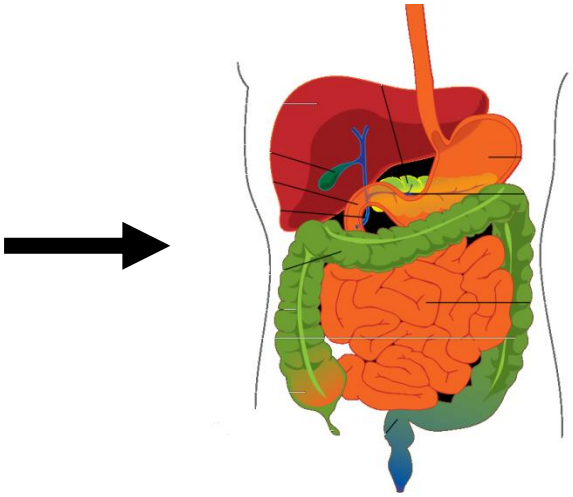
– primitive gut from buccopharyngeal membrane to cloacal membrane



Three regions of primitive gut

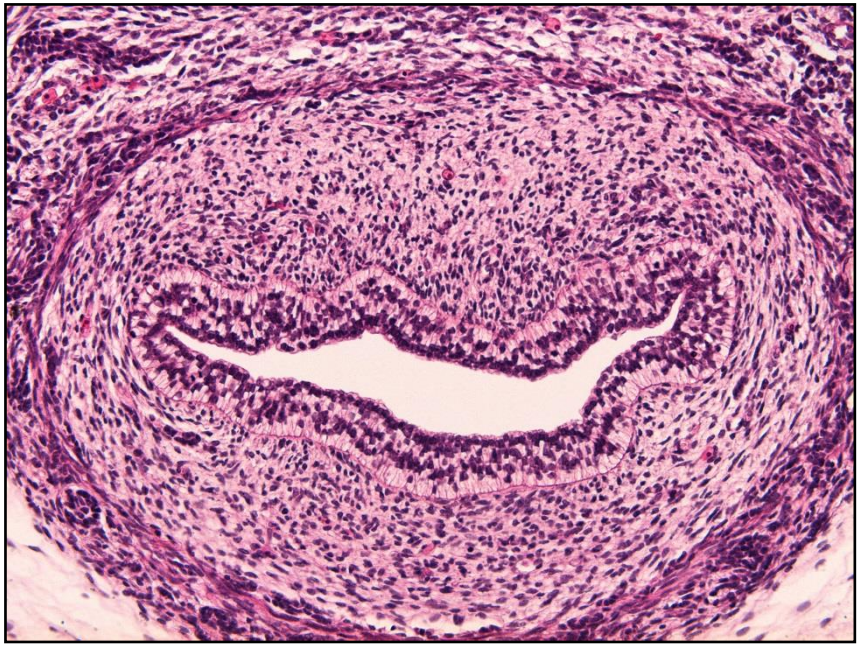
- foregut
- midgut
- hindgut



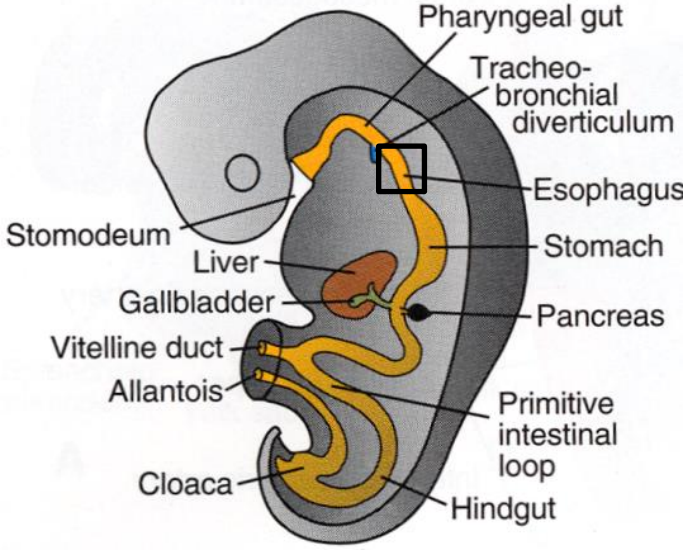


DEVELOPMENT OF ESOPHAGUS

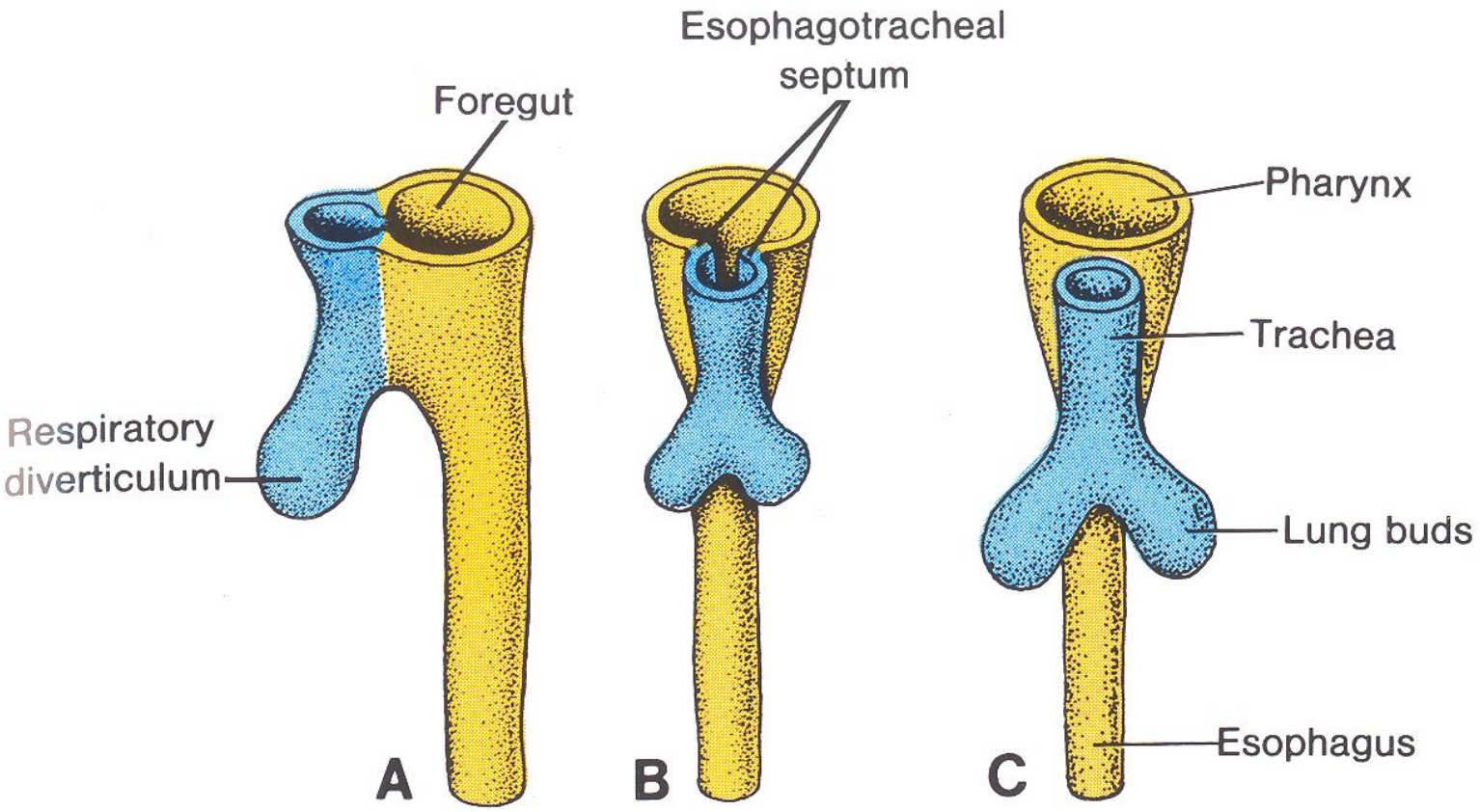
- region of foregut caudal of respiratory diverticulum
- esophagotracheal septum
- rapid elongation: 7th week - final relative length
- rapid proliferation of endoderm (epithelium and glands) that obliterates lumen – recanalization about 8th week
- connective tissue and muscle tissue – mesenchyme of caudal pharyngeal arches and splanchnic mesenchyme
- innervation by branches of *n. vagus* (caudal pharyngeal arches)



8th week

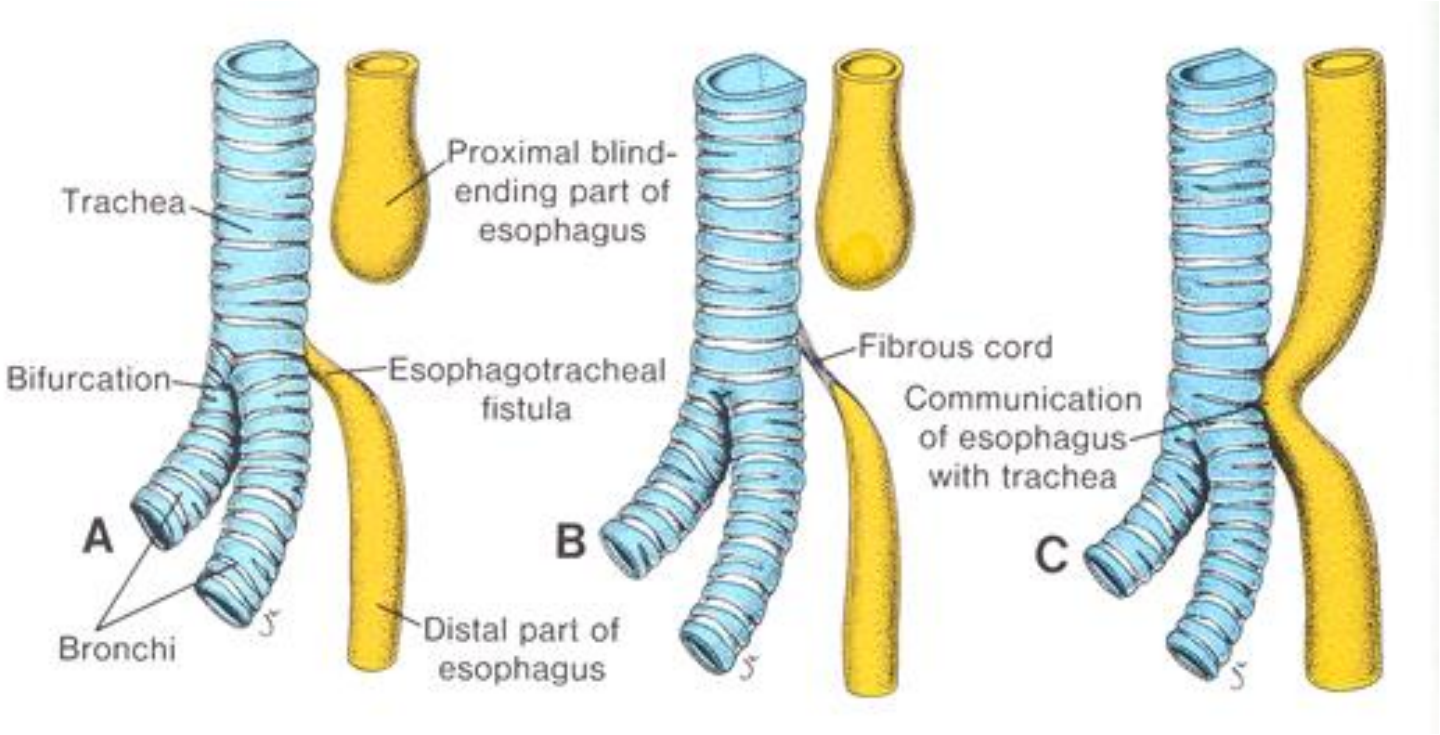


DEVELOPMENT OF ESOPHAGUS

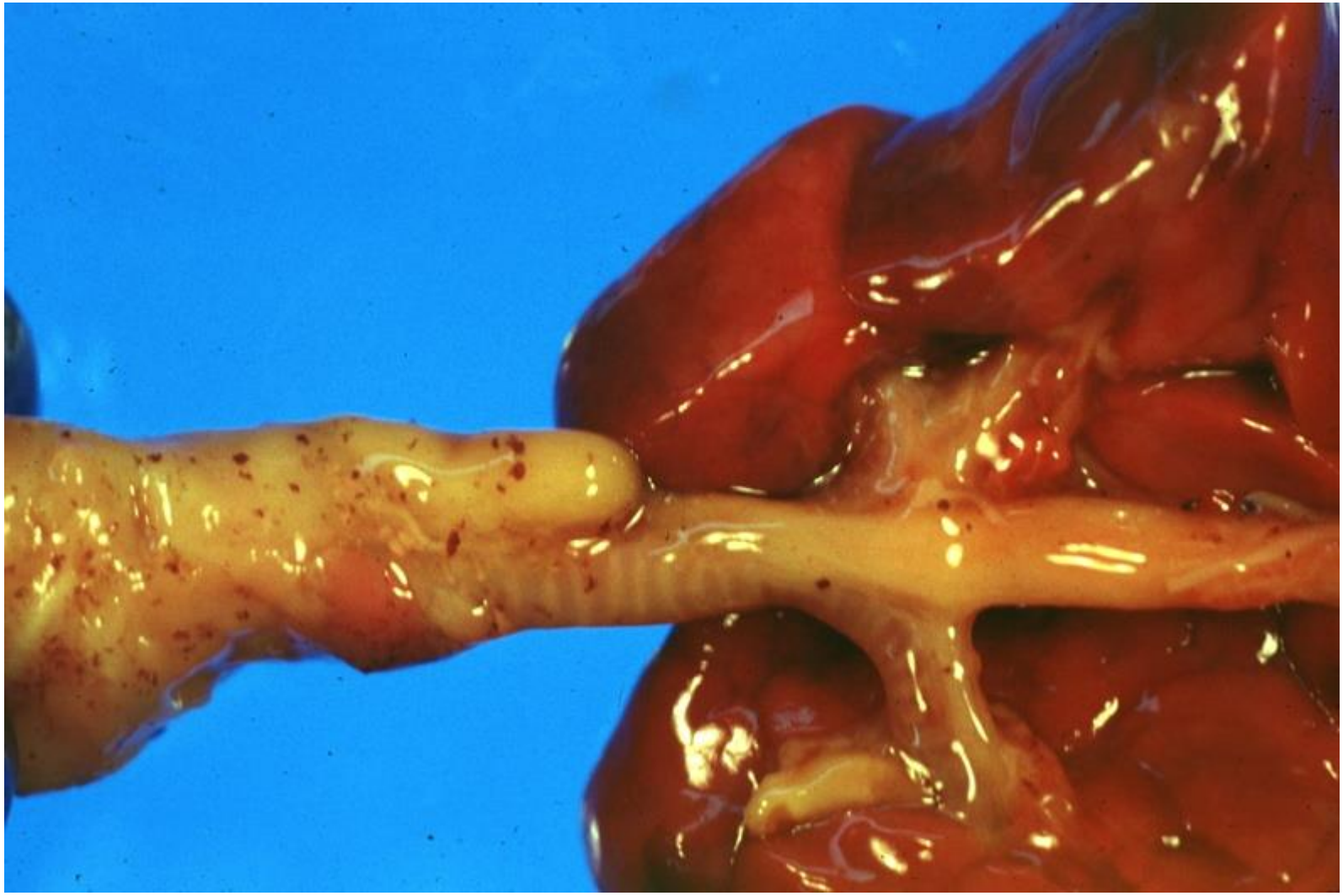


DEVELOPMENT OF ESOPHAGUS

ABNORMALITIES



DEVELOPMENT OF ESOPHAGUS - FISTULA



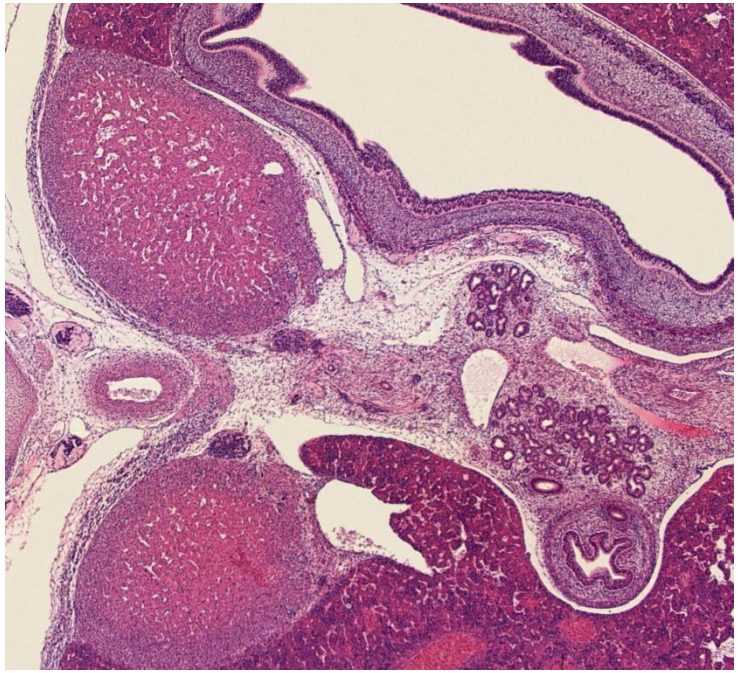
GROSS: GASTROINTESTINAL: Esophagus: Tracheoesophageal Fistula: Gross posterior view of chest contents showing blind sac of esophagus above and continuation of esophagus from carina inferiorly good example

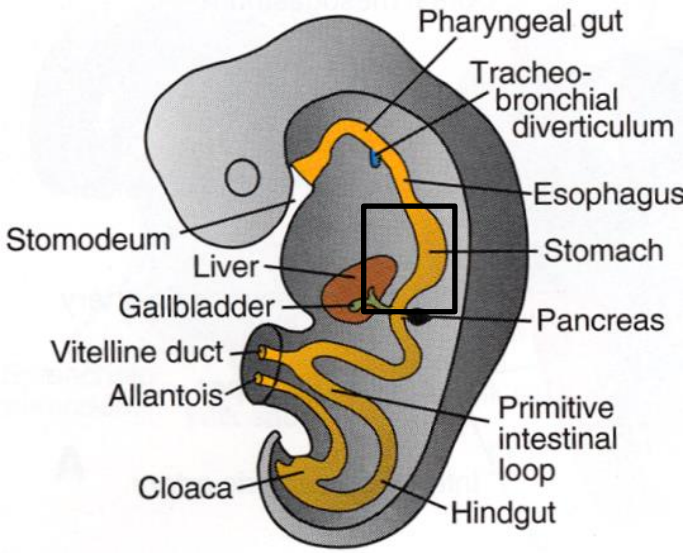
Autor
Peter Anderson

DEVELOPMENT OF STOMACH

- fusiform dilatation of the foregut
- different growth rates in various regions → greater and lesser curvature
- rotation 90°C clockwise around longitudinal and anteroposterior axis
- definitive location and shape - 2nd month i.u.

8th week



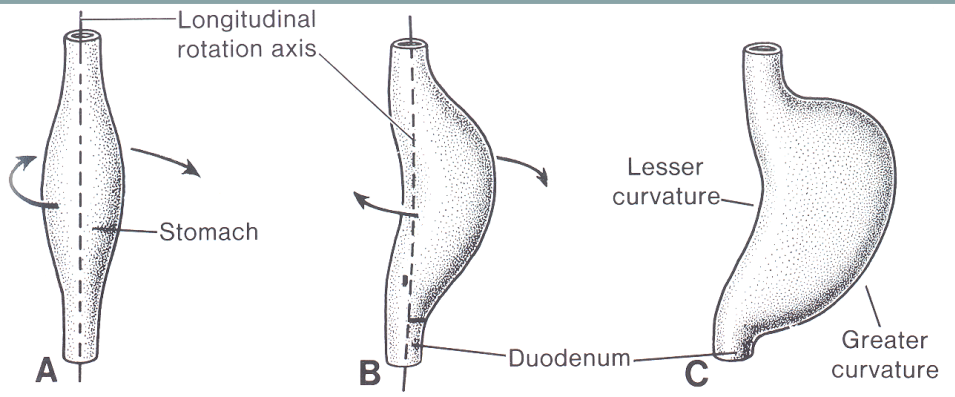


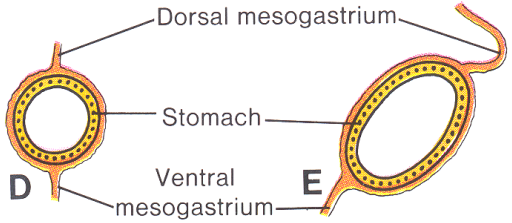
STOMACH - ROTATION

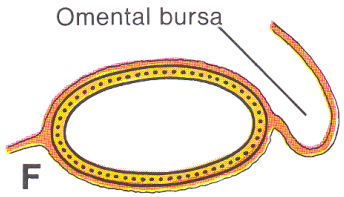
- 90°

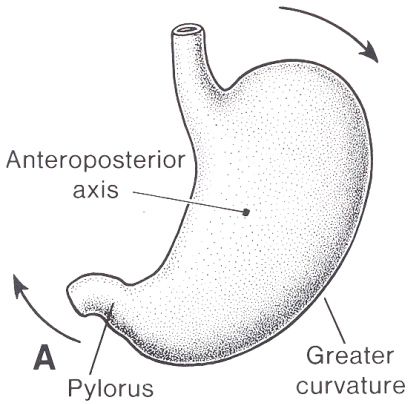
ventral lesser curvature → right
dorsal greater curvature → left
left side → ventrally
right side → dorsally
cranial part → left caudally
caudal part → right cranially

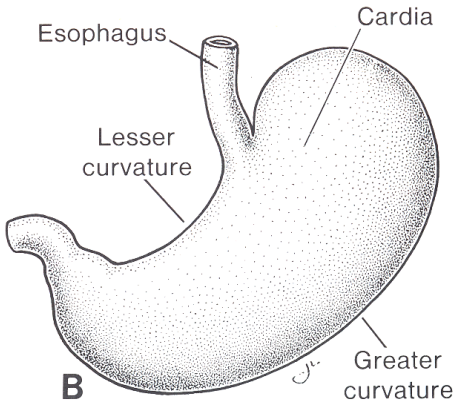
→ definitive anatomical position of left and right *nervus vagus*







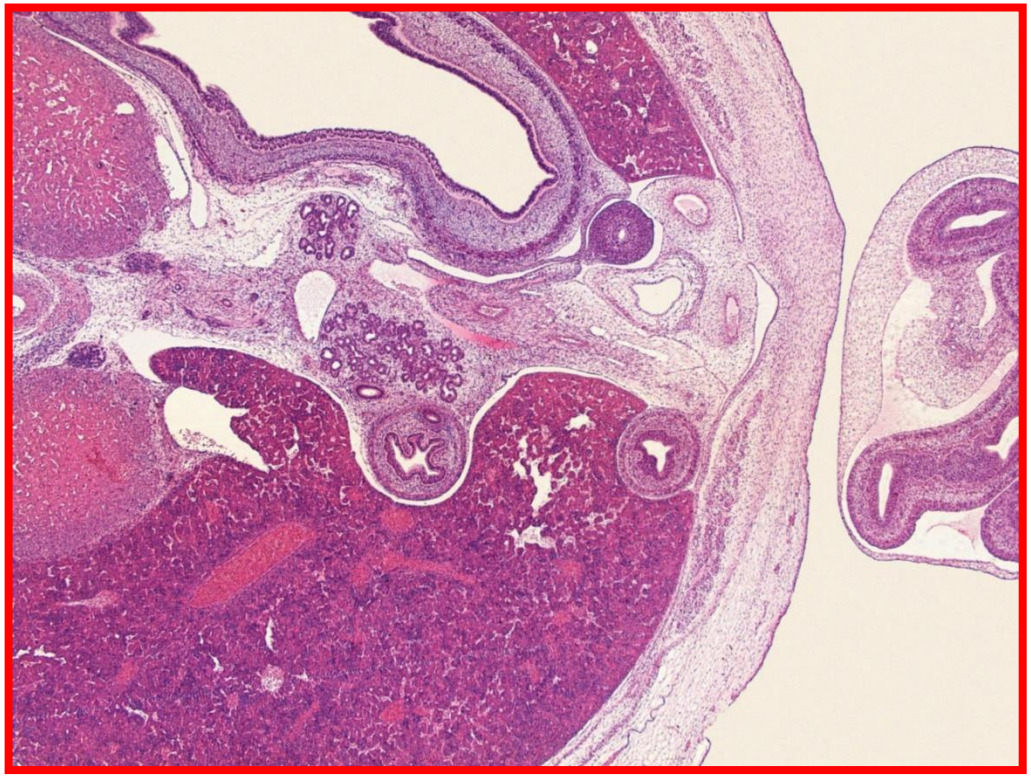


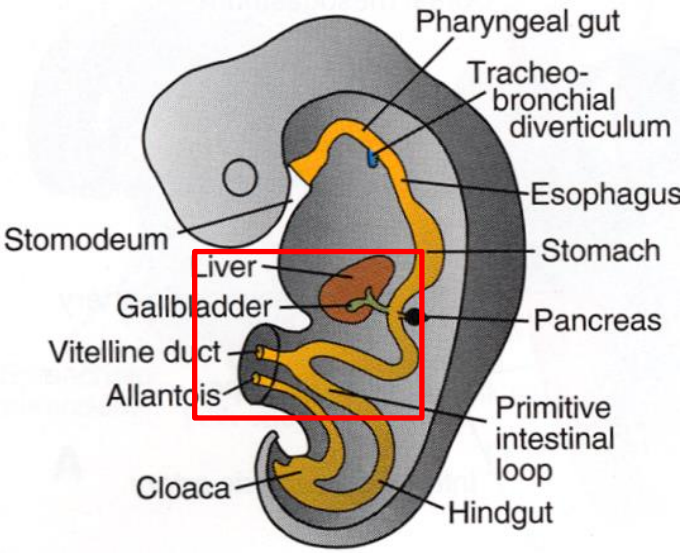


DEVELOPMENT OF INTESTINE

- midgut – primary intestinal loop
- rotation during development
- physiological umbilical herniation

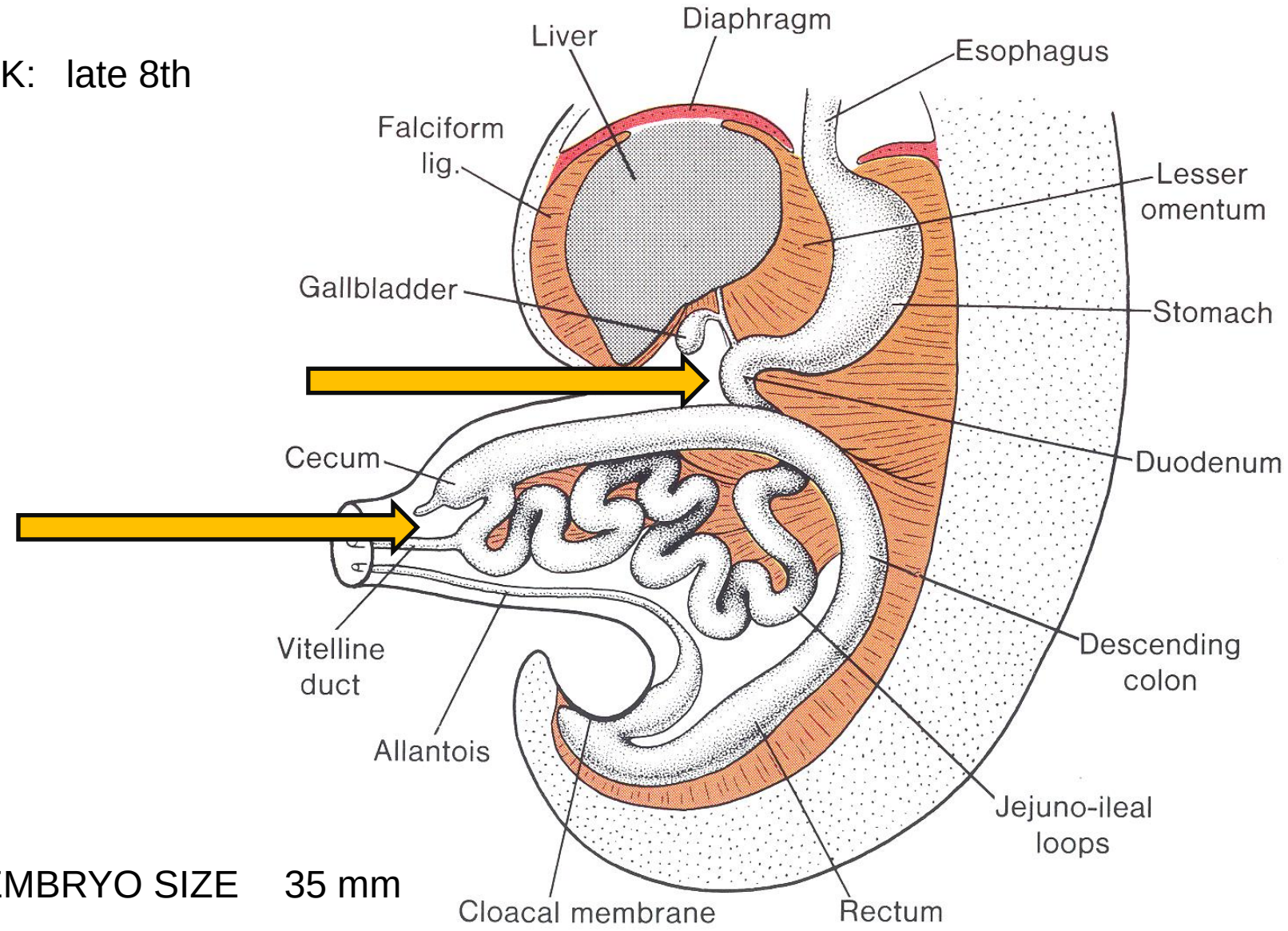
8th week





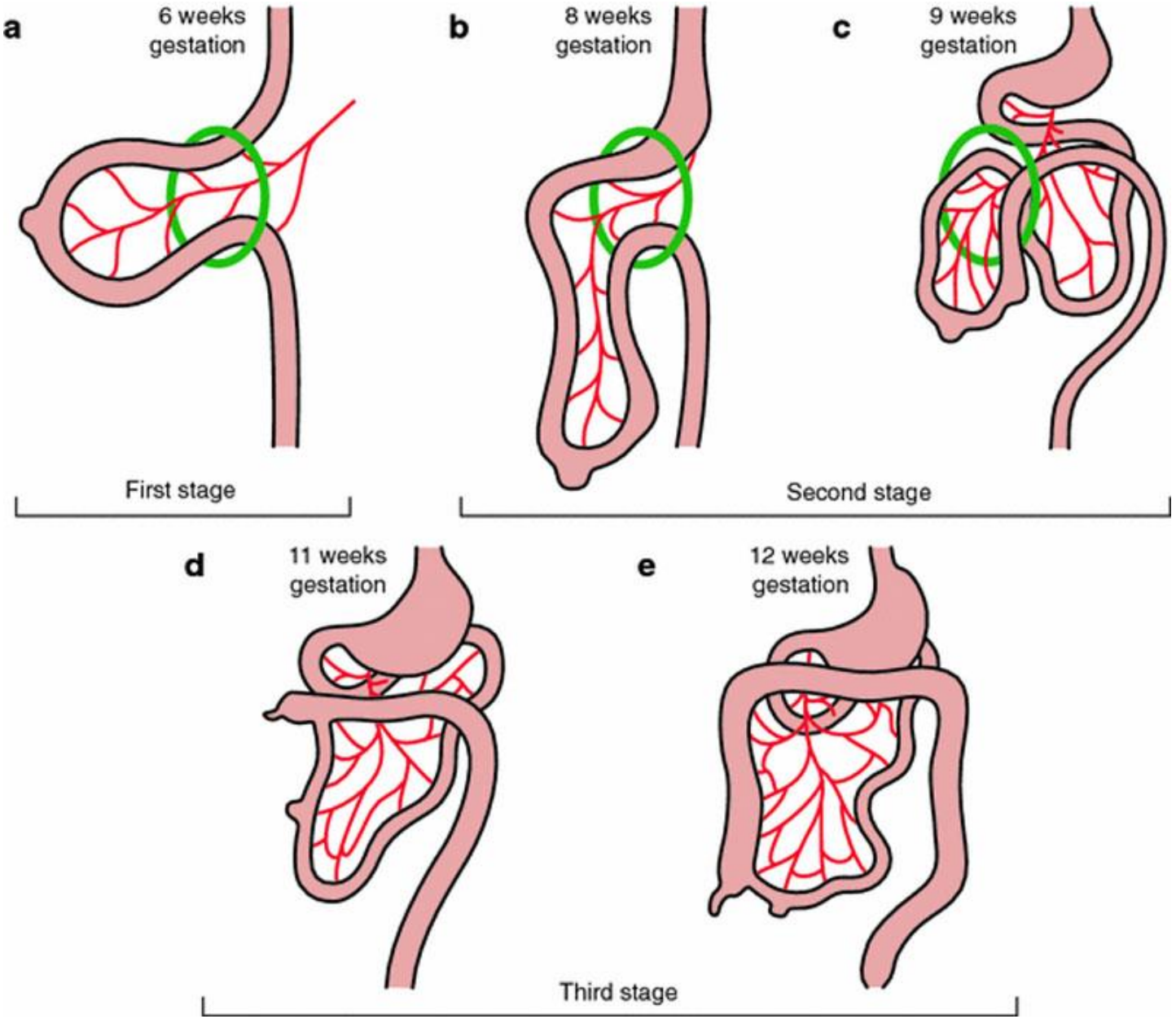
DEVELOPMENT OF INTESTINE

WEEK: late 8th

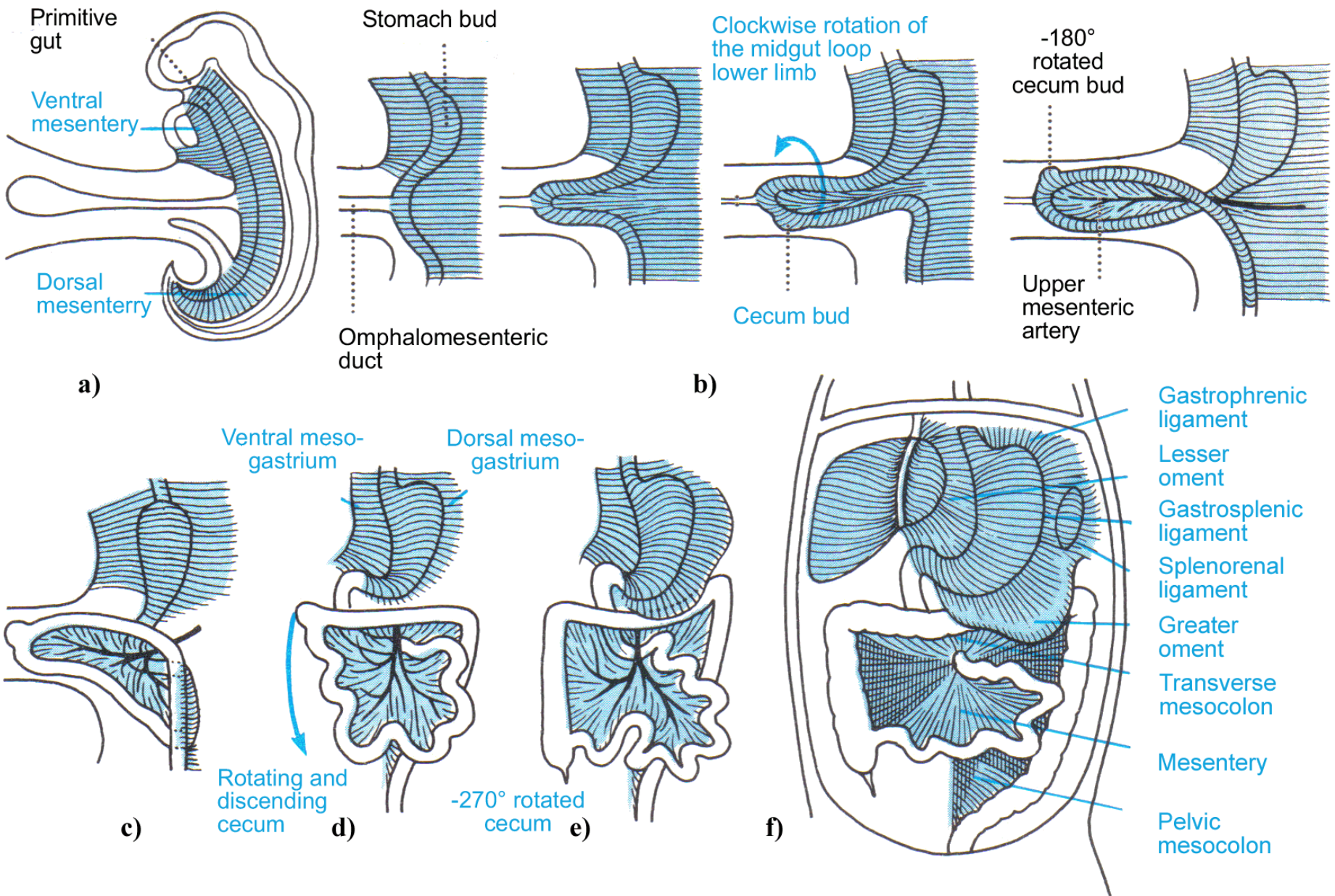


EMBRYO SIZE 35 mm

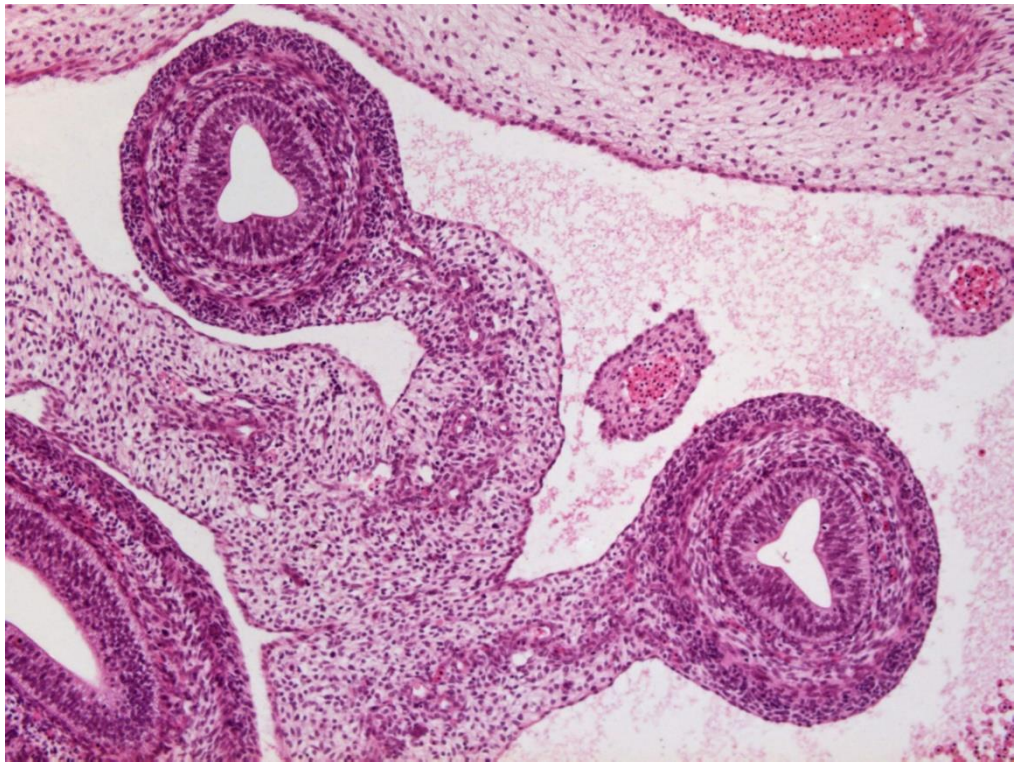
INTESTINAL ROTATION

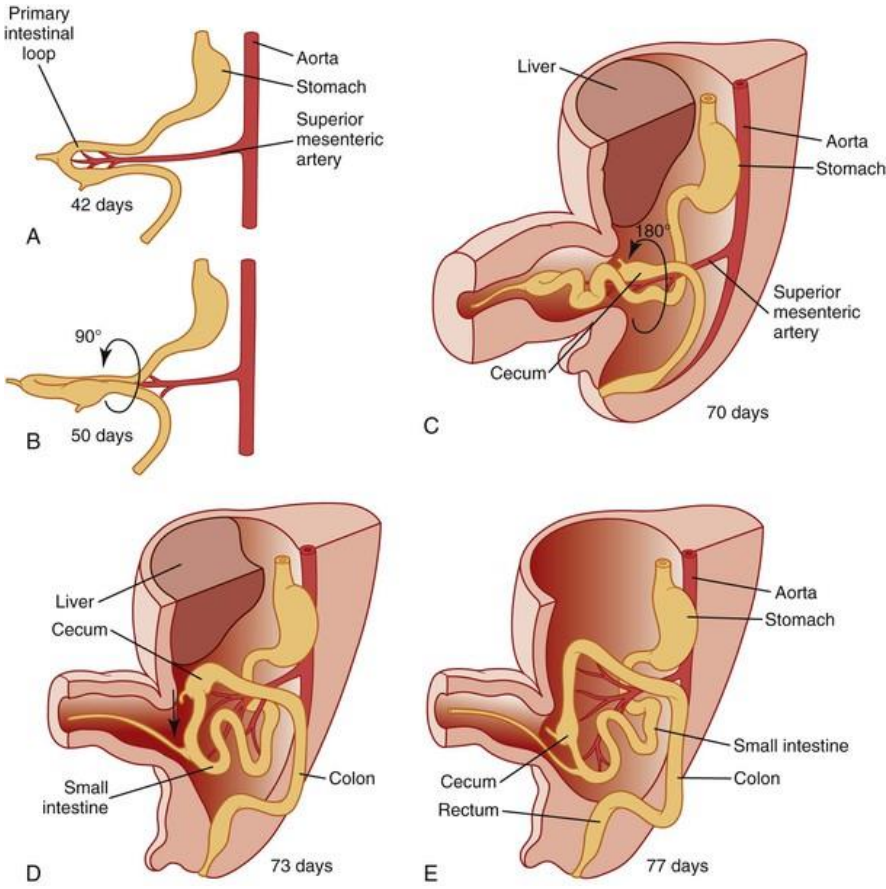


INTESTINAL ROTATION - MESENTERIES



INTESTINAL ROTATION – UMBILICAL HERNIA





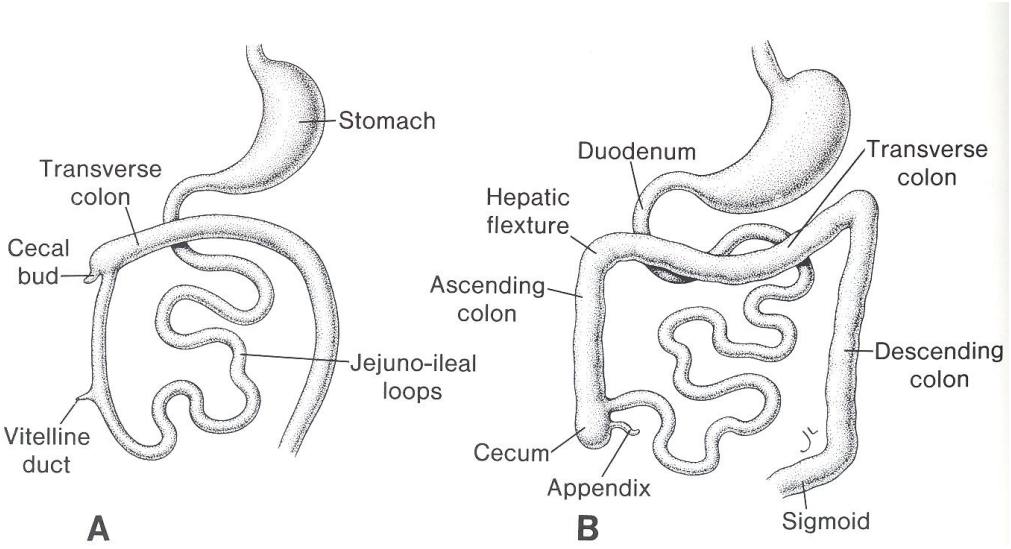
- (6-) 8th week
- Normal reposition in 10th week

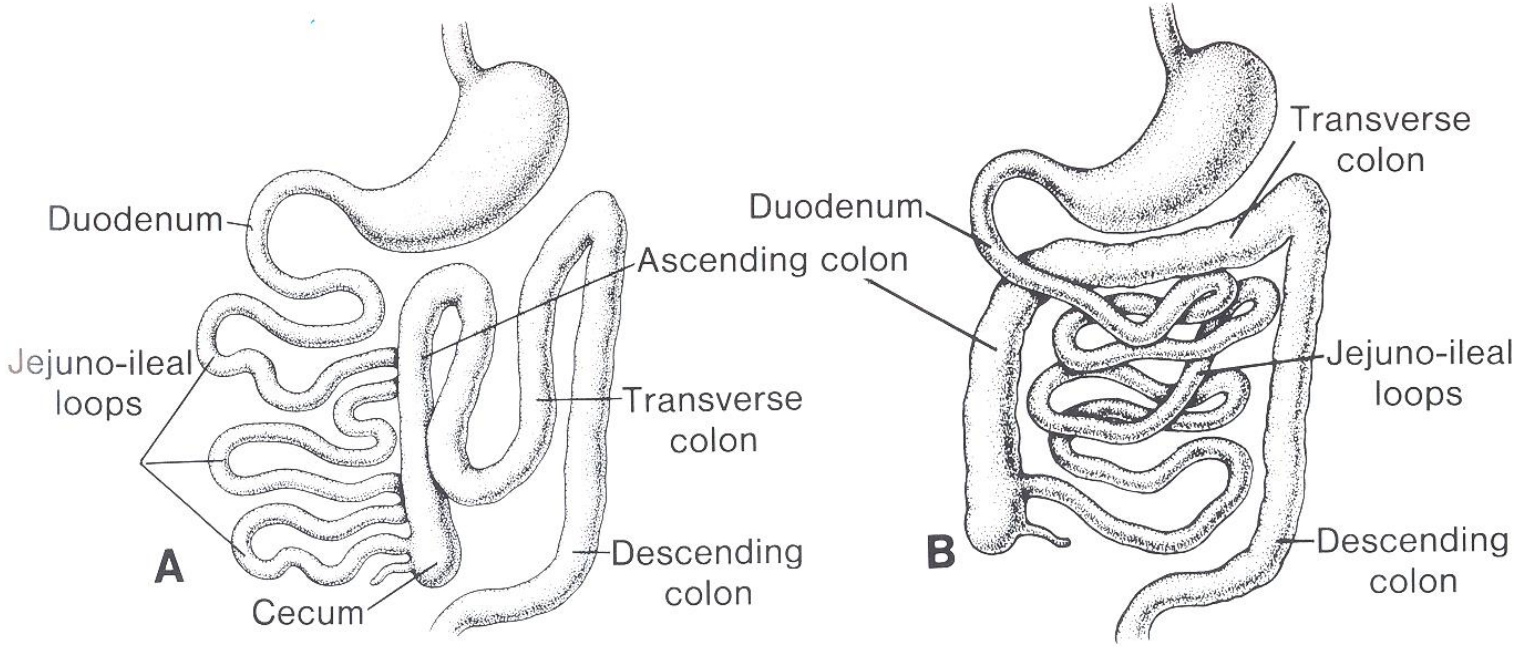
Abnormalities:

- Hernia may develop postantaly, evisceration or spontaneous reposition possible (X gastroschisis)
- Inomplete closure of umbilicus, may include omentum majus and small intestine, skin and connective tissue

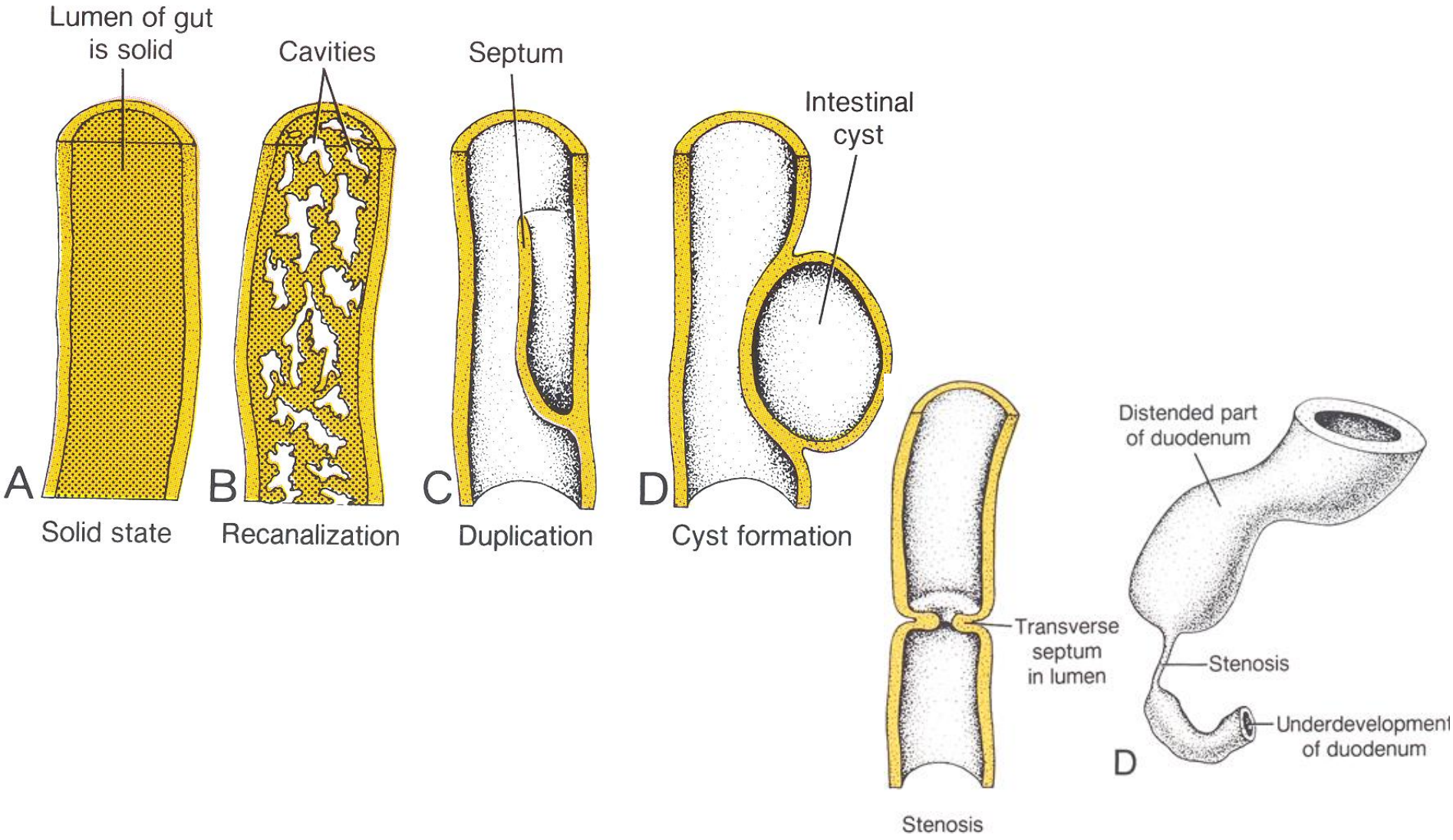
INTESTINAL ROTATION – UMBILICAL HERNIA

ABNORMALITIES



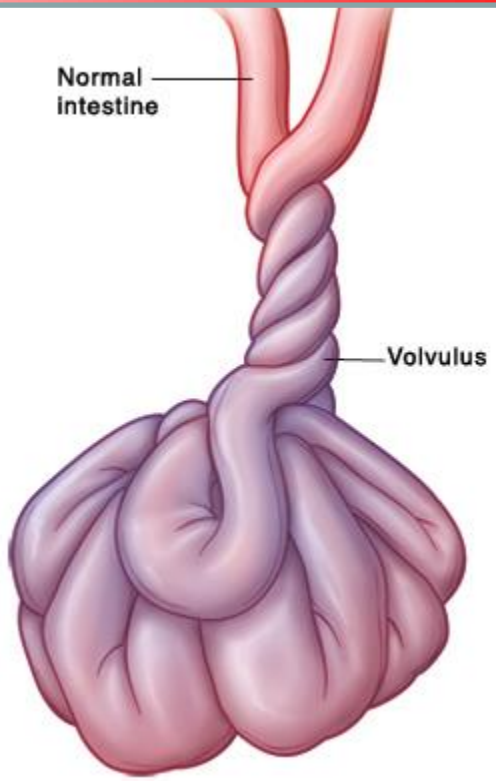


ILEUM DEVELOPMENT AND ABNORMALITIES



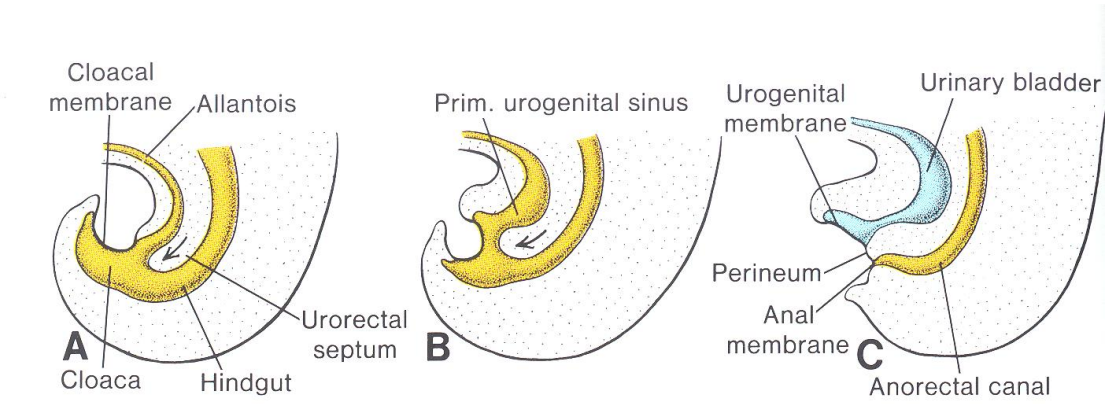
ILEUM DEVELOPMENT AND ABNORMALITIES

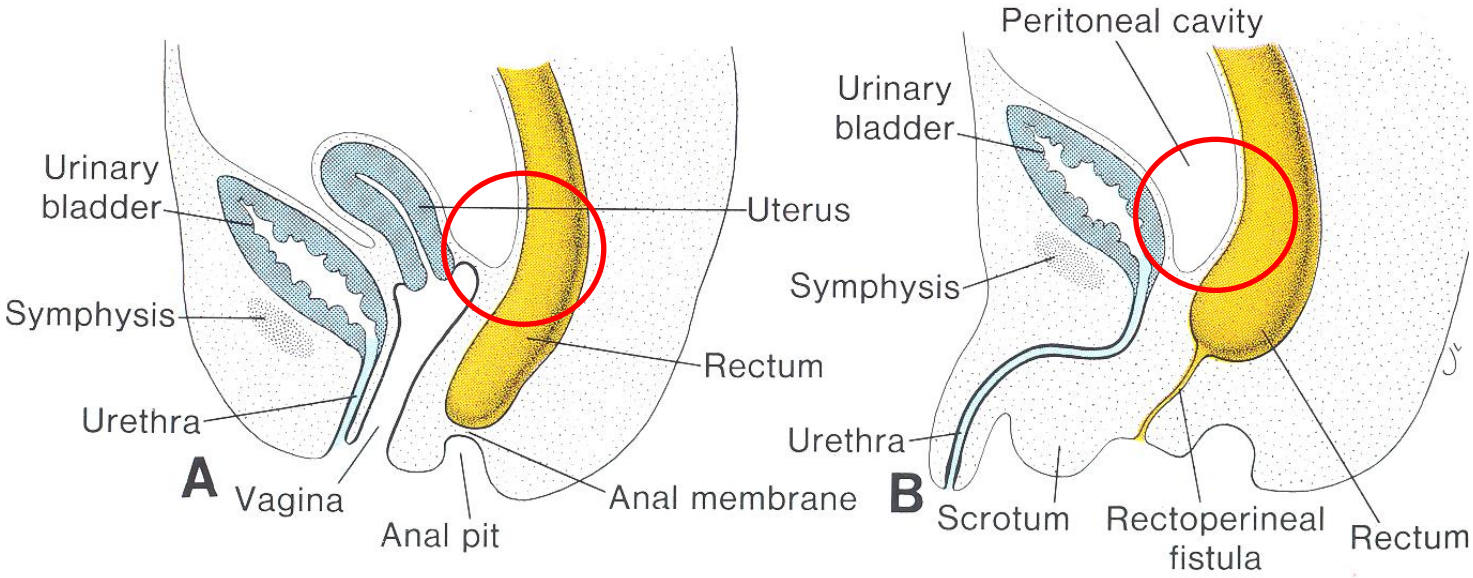
VOLVULUS



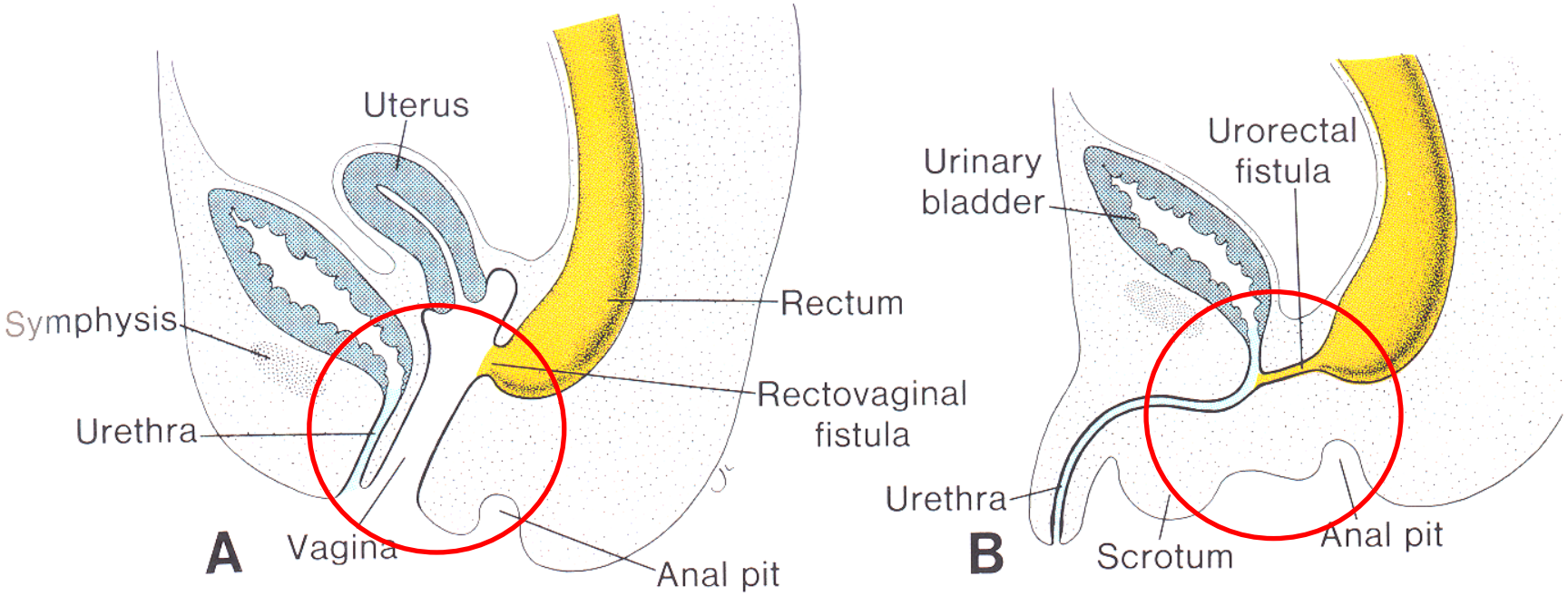
- malrotation of midgut and left colon (obstruction of a. mesenterica sup. and duodenum)
- reversed rotation (obstruction of colon)
- abnormal ahesion of caecum to liver (subhepatic caecum) - abnormal position of appendix
- caecum mobile

ANUS DEVELOPMENT AND ABNORMALITIES



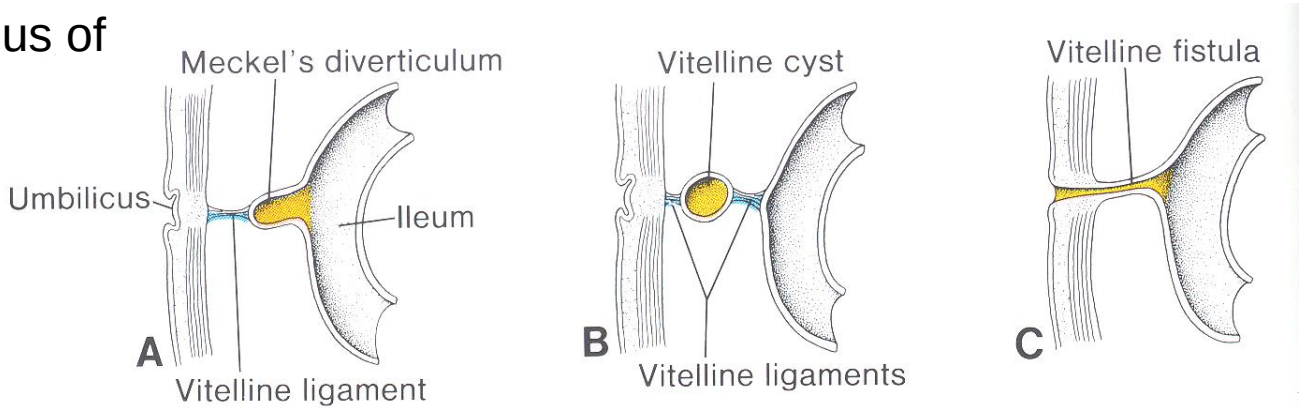


ANUS DEVELOPMENT AND ABNORMALITIES



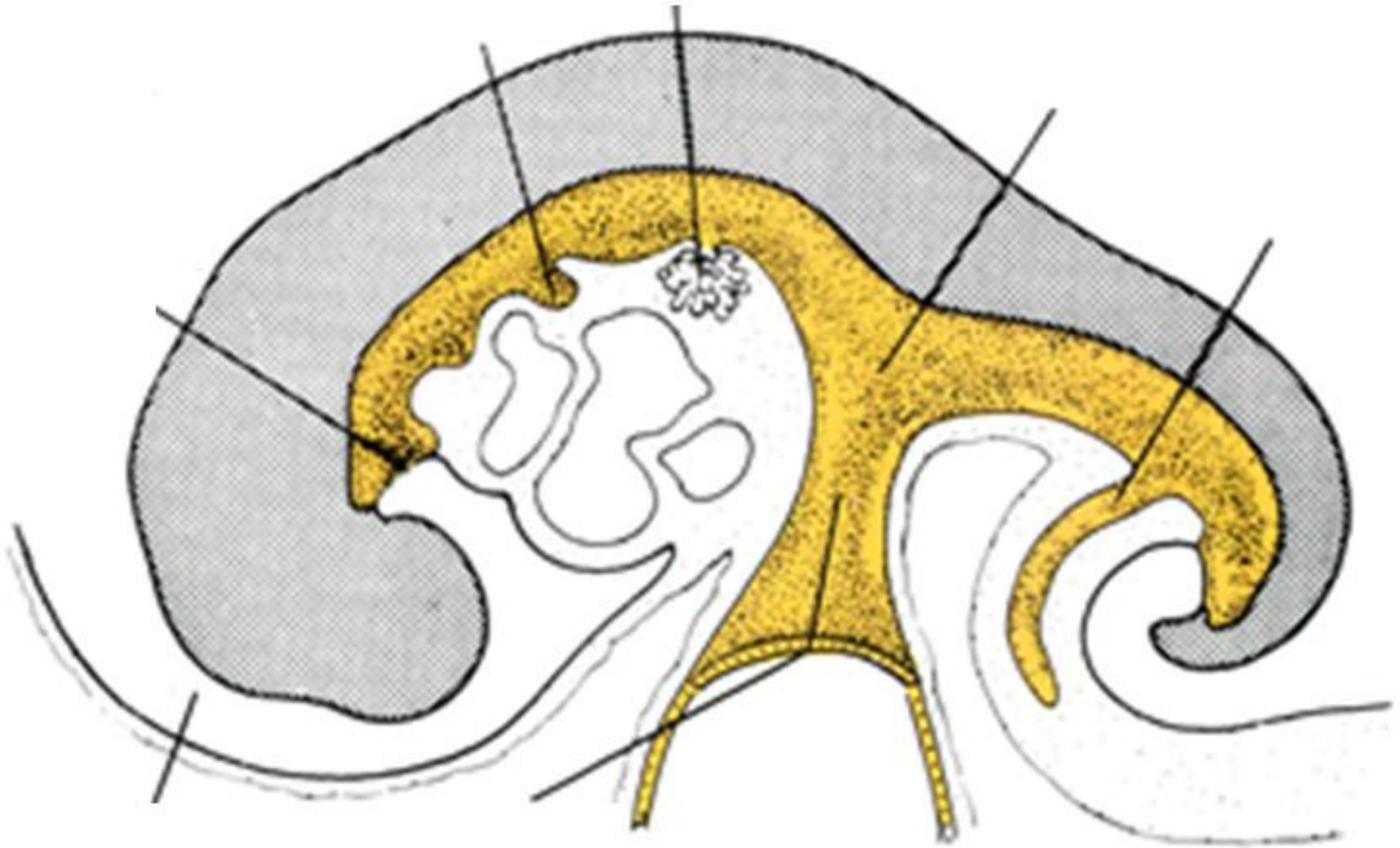
DIVERTICULUM MECKELI

- often phenomenon (2-4%)
- clinically relevant
- vitelline cysts, volvulus of diverticle



Primitive gut		
	Foregut	**vascularization**: truncus coeliacus
		derivatives: pharynx (also pharyngeal arches contribute), esophagus, stomach, proximal duodenum, liver, bile ducts and gall bladder, pancreas
		developmental events: stomach and duodenal rotation, obliteration and recanalization of esophageal and duodenal lumen
	Midgut	**vascularization**: a. mesenterica superior
		derivatives: distal duodenum, jejunum, ileum, colon ascendens, 1/3-2/3 of colon transversum
		developmental events: intestinal rotation, physiological umbilical hernitation and reposition. Diverticulum Meckeli
	Hindgut	**vascularization**: a. mesenterica inferior
		derivatives: 1/3-2/3 of colon transversum, rectum, part of analis canalis, part of urinary bladder, part of urethra
		developmental events: septation of cloaca by septum urorectale, development of perineum, rectum, anus and sinus urogenitalis

SUMMARY



With the chest cavity open and the heart fully exposed, Dr. Robbyn suddenly regretted cutting class to go pub crawling that crisp fall day four years ago.

Thank you for attention

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http://www.med.muni.cz/histology/education/