

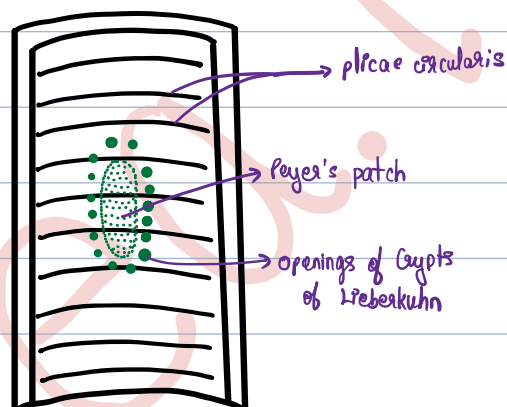
Small Intestine:

jejunum + ileum = small intestine proper $\Rightarrow$ from duodenojejunal flexure to ileocaecal junction

$\rightarrow$ upper $2/5$ = jejunum

lower $3/5$ = ileum

$\rightarrow$ jejunum & ileum are suspended from posterior abdominal wall by a large fold of peritoneum called mesentery of small intestine



Structure: 4 layers within outward

(i) mucosa

(ii) muscle layer

(iii) submucosa

(iv) serosa

Mucosa: 3 features -

Large Surface Area: for digestion, absorption of nutrients

$\rightarrow$ surface area is increased by plicae circulares, villi, microvilli

- Plicae circulares (Valves of Kerckring): permanent circular folds
- Villi: small finger-like projections from surface of circular folds
- Microvilli: surface epithelium covering villi presents microvilli.

Intestinal glands (Crypts of Lieberkuhn):

$\rightarrow$ in between the bases of villi

$\rightarrow$ they secrete digestive enzymes & mucus

Lymphatic follicles: lamina propria of mucous membrane contains -

- solitary lymph follicles $\Rightarrow$ distributed throughout the length of small intestine
- aggregated lymph follicles $\Rightarrow$ form circular/oval patches called Peyer's patches

$\Rightarrow$ each Peyer's patch has ≈ 260 solitary lymph follicles

$\Rightarrow$ Peyer's patches are few in distal part of jejunum & numerous in ileum

$\Rightarrow$ most numerous in distal part of ileum where they might extend into submucosa after breaking muscularis mucosa

Submucosa: loose areolar tissue with blood vessels

$\rightarrow$ contains nerve plexus $\Rightarrow$ Meissner's plexus.

Muscle Layer: - outer longitudinal & inner circular layers of smooth muscles

↳ Auerbach's nerve plexus is present between the 2 layers.

Serosa: formed by visceral peritoneum & is lined by simple squamous epithelium.

Arterial Supply: jejunal & ileal branches (10-15) of superior mesenteric artery.

Venous Drainage: veins correspond to branches of superior mesenteric artery & drain into portal vein.

Lymphatic Drainage: mesenteric nodes → superior mesenteric nodes

Nerve Supply:

Sympathetic: T10-T11 through splanchnic nerves & superior mesenteric plexus

↳ ∴ pain from jejunum & ileum is referred to umbilical region.

→ motor to gut sphincters

Parasympathetic: vagus nerves through coeliac & superior mesenteric plexuses

↳ stimulate peristalsis, inhibitory to sphincters.

Mesentery of Small Intestine: broad fan-shaped fold of peritoneum

→ root (attached margin) & free/intestinal margin.

→ root is attached to an oblique line across posterior abdominal wall from duodenojejunal flexure to ileocaecal junction.

→ root = 6 inches } ∴ there is formation

→ free margin = 6m. } of folds/pleats (bell-like arrangement of a skirt)

Development: jejunum & ileum develop from U-shaped midgut loop having cephalic & caudal limbs.

→ Cephalic limb gives jejunum & upper part of ileum.

→ caudal limb gives rise to lower part of ileum.

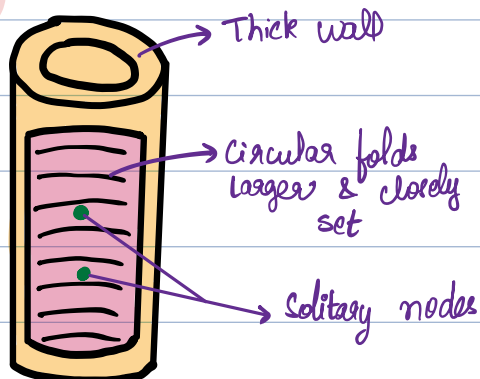
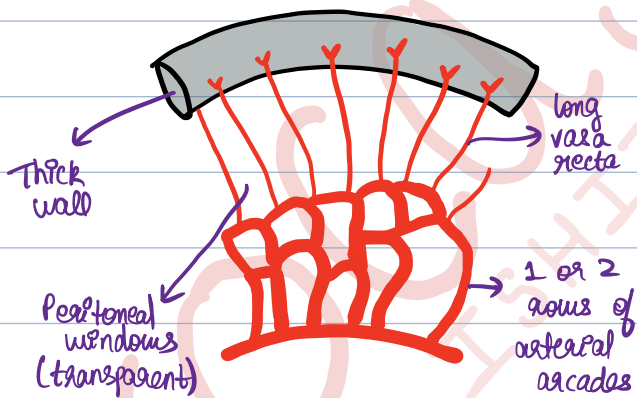
→ in embryonic life, apex of midgut loop communicates with yolk sac through vitello-intestinal duct

→ vitelline duct is generally obliterated by 6th week of IUL.

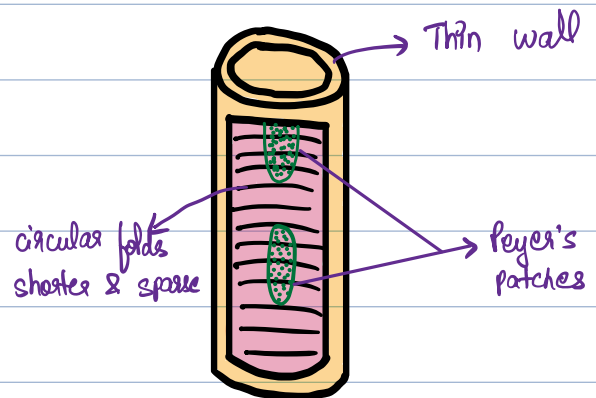
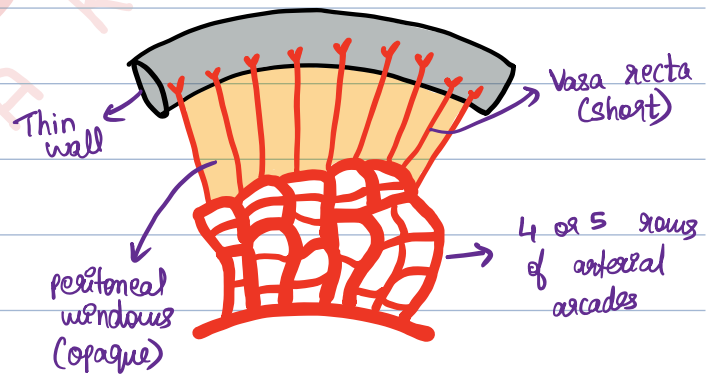
Differences between jejunum & ileum:

Features	Jejunum	Ileum
Walls	Thicker & more vascular	Thinner & less vascular
Lumen	Wider & often found empty	Narrower & often found full
Valves of Kerckring	longer & closely set	smaller & sparsely set
Villi	more, larger, thicker, leaf-like	less, shorter, thinner, finger-like
Peyer's patches	small, circular, few in number, found only in distal part	large, oval, more in number, found throughout ileum (maximum in distal part)
Mesentery	contains less fat & becomes semitranslucent b/w vasa recta called peritoneal windows	Contains more fat & no peritoneal windows
Arterial arcades	1-2 rows with long vasa recta	4-5 rows with short vasa recta

Jejunum



Ileum



Applied aspect:

Typhoid & tuberculous ulcers: Peyer's patches may be felt through anti-mesenteric border of ileum

→ they may ulcerate in typhoid fever forming oval ulcers which may perforate

∴ patients having typhoid fever are given non-spicy soft diet.

→ after healing, typhoid ulcers do not cause intestinal obstruction like tuberculous ulcers

→ great length of mesentery permits descent of loop of small intestine into sac of inguinal or femoral hernia

→ a group of lymph nodes when infected may become adherent to an adjoining loop of small intestine & may result in mechanical obstruction

→ an acute terminal mesenteric lymphadenitis is often indistinguishable from an acute appendicitis

Mesenteric cyst: mostly arise from mesenteric lymph nodes

→ clinical presentation - painless, cystic, fluctuant swelling in umbilical region

→ on examination, it is more mobile perpendicular to line of attachment of mesentery & less mobile along the line of attachment of mesentery.

→ failure of root of mesentery to fuse over its entire length with posterior abdominal wall allows a pocket of peritoneum to be formed which may form a sac of intra-peritoneal hernia called mesenteric parietal hernia of Waldeyer.

Meckel's / Ileal Diverticulum: persistent proximal part of embryonic vitello-intestinal duct

→ occurs in 2% of subjects

→ usually 2 inches long

→ situated 2 feet proximal to ileocaecal junction

→ 2 times more common in men

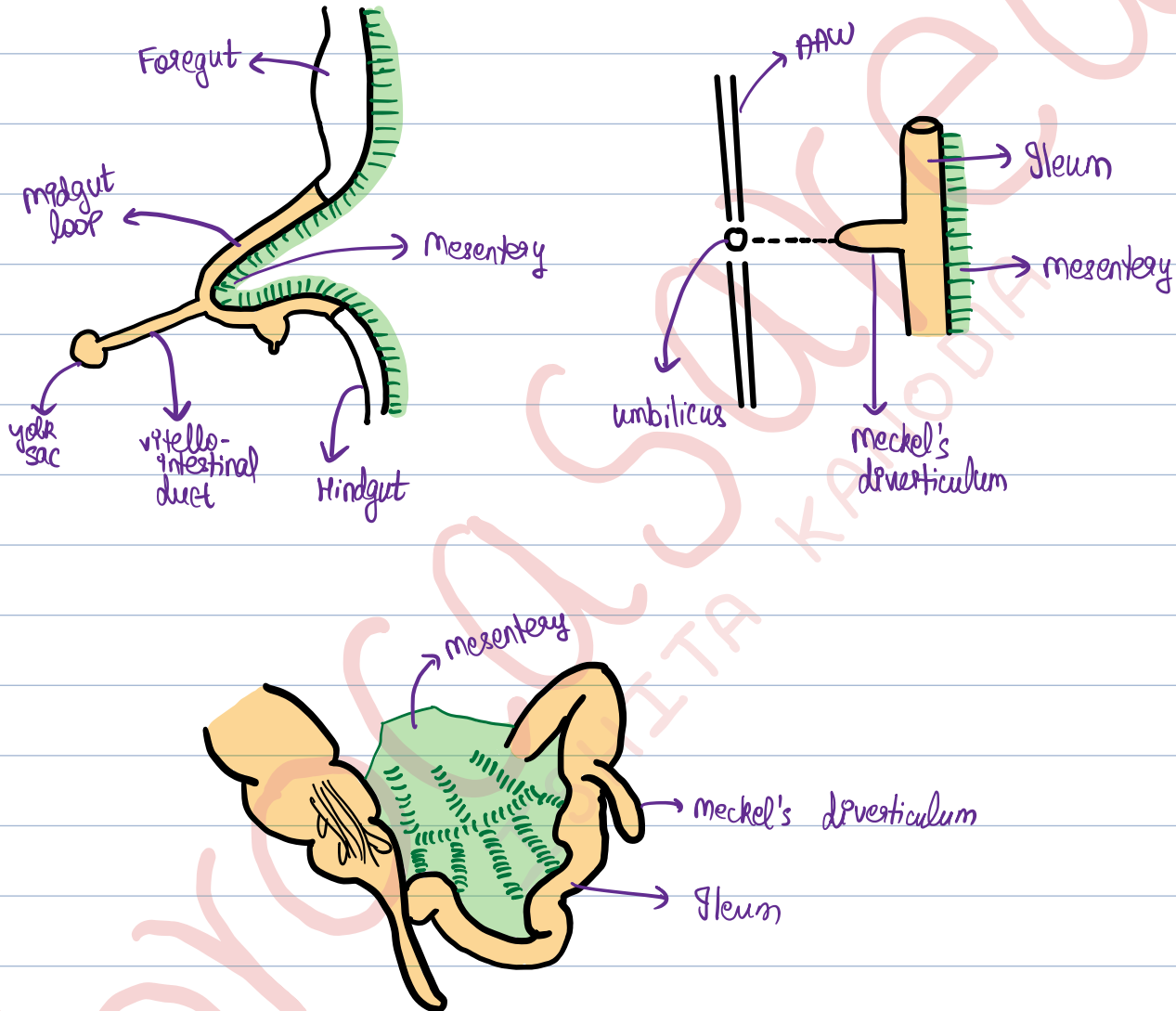
→ structure of its wall are similar to ileum

→ attached to anti-mesenteric border of ileum.

→ apex may be free or attached to umbilicus by a fibrous band.

→ Normally symptomless but may cause the following clinical problems:

- Intestinal obstruction
- when it contains ectopic gastric mucosa or pancreatic tissue, its thin wall may ulcerate, perforate & bleed to mimic acute abdomen
- when inflamed, symptoms are similar to acute appendicitis



Large Intestine: (retroperitoneal except appendix, transverse colon & sigmoid colon $\Rightarrow$ intraperitoneal)

$\rightarrow$ 1.5m long

$\rightarrow$ from caecum in right iliac fossa to anus in perineum

$\rightarrow$ Functions - absorption of water from fluid contents helps in formation of faeces

- storage, lubrication, expulsion of faeces

- synthesis of vit. B by bacterial flora in lumen

- protection from invasion by microbes by its mucoid

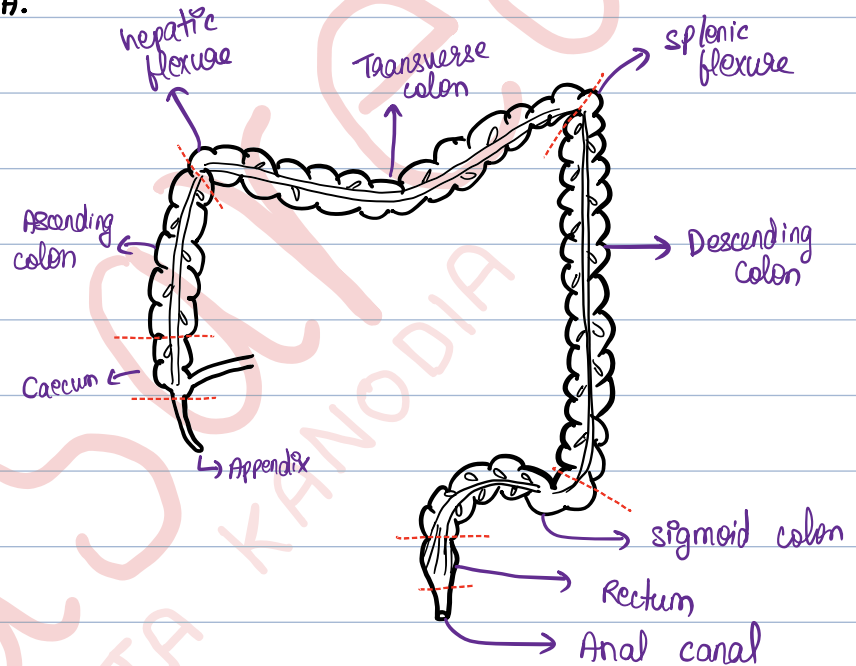
secretion which is rich in IgA.

Parts:- Caecum & appendix

- Colon $\rightarrow$ $\begin{cases} \text{ascending} \\ \text{transverse} \\ \text{descending} \\ \text{sigmoid} \end{cases}$

- Rectum

- Anal Canal



Structure of Colon:

$\rightarrow$ 4 layers from within outward - Mucosa

- Submucosa

- Muscle layer

- Serosa

Mucosa: $\rightarrow$ no plicae circulares or villi

$\rightarrow$ temporary folds present in undescended colon

$\rightarrow$ surface epithelium $\Rightarrow$ columnar cells with microvilli

$\rightarrow$ Intestinal glands (Crypts of Lieberkuhn) $\Rightarrow$ long & tubular & possess many goblet cells

$\rightarrow$ Lamina propria has no Peyer's patches.

Submucosa: loose areolar tissue

$\rightarrow$ contains Meissner's nerve plexus & blood & lymph vessels

Muscle layer: $\rightarrow$ outer longitudinal layer
(smooth muscles) $\rightarrow$ inner circular layer

$\rightarrow$ outer longitudinal layer $\Rightarrow$ arranged into 3 longitudinal bands (Teniae coli)

$\rightarrow$ inner circular Teniae coli is thinner.

Serosa: → covers transverse & sigmoid colon

→ ascending & descending colons are covered by tunica adventitia

Cardinal Features:

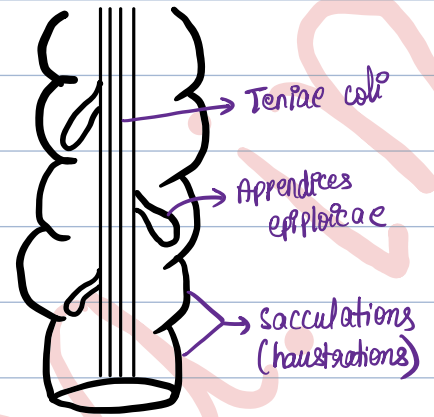
Teniae Coli: 3 bands of longitudinal muscle coat

→ bands converge proximally at base of appendix &
spread out distally to become continuous with rectum

→ Caecum
Ascending colon
Descending colon

positions of
Teniae coli ⇒

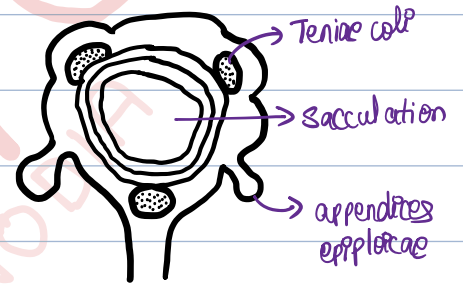
- anterior (Teniae libera)
- posteromedial (Teniae mesolica)
- posterolateral (Teniae mentalis)



→ Transverse colon ⇒ - inferior
- posterior
- superior

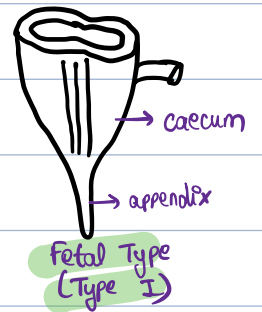
Appendices Epiploicae:

→ small bags of visceral peritoneum filled with fat attached to Teniae
→ absent in appendix, rectum & anal canal
→ most numerous on sides of sigmoid colon & posterior surface of transverse colon.



Sacculon/Haustrations:

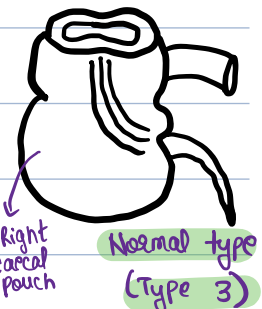
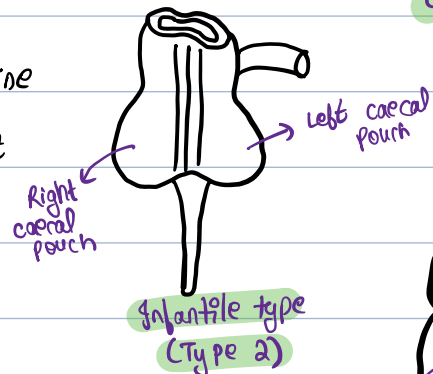
→ series of pouches/dilatations in wall of Caecum & colon between teniae
→ produced because muscle length of teniae falls short of length of circular muscle coat.



Caecum: large blind sac at proximal end of large intestine

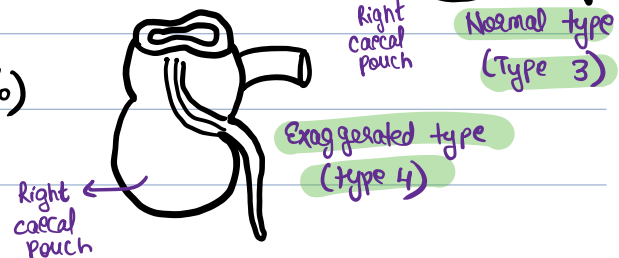
↳ right iliac fossa, above lateral half of inguinal ligament

→ communicates - superiorly with ascending colon
- medially (at ileocaecal junction) with ileum
- posteromedially with appendix



On the basis of Growth of Caecum, 4 types in adults:

- Conical/fetal type (2%)
- Infantile type (3%)
- Normal type (80-90%)
- Exaggerated type (4-5%)



Dimensions:

Length $\Rightarrow$ 2.5 inches

Width $\Rightarrow$ 3 inches

Relations:

Visceral Relations:

Anterior - coils of small intestine

- greater omentum

- AAW of right iliac fossa.

Posterior - right psoas major & iliacus

- femoral N., lateral cutaneous N. of thigh, genitofemoral N. of right side

- right gonadal vessels

- right external iliac artery

- retrocaecal recess

(90%) $\Rightarrow$

Peritoneal Relations: $\rightarrow$ almost completely surrounded by peritoneum with wide retrocaecal recess (often contains vermiform appendix)

$\rightarrow$ In 10% people, upper part of posterior surface of caecum is non-peritoneal & lies directly on fascia iliaca

Related Peritoneal Folds:

• Superior ileocaecal fold: between ileum & ascending colon (vascular fold of caecum)

• Inferior ileocaecal fold: from antero/inferior aspect of terminal part of ileum to caecum/appendix (bloodless fold of Treves)

• Caecal fold: lies on posterior surface of caecum.

Interior: Two orifices - ileocaecal & appendicular

Ileocaecal Orifice:

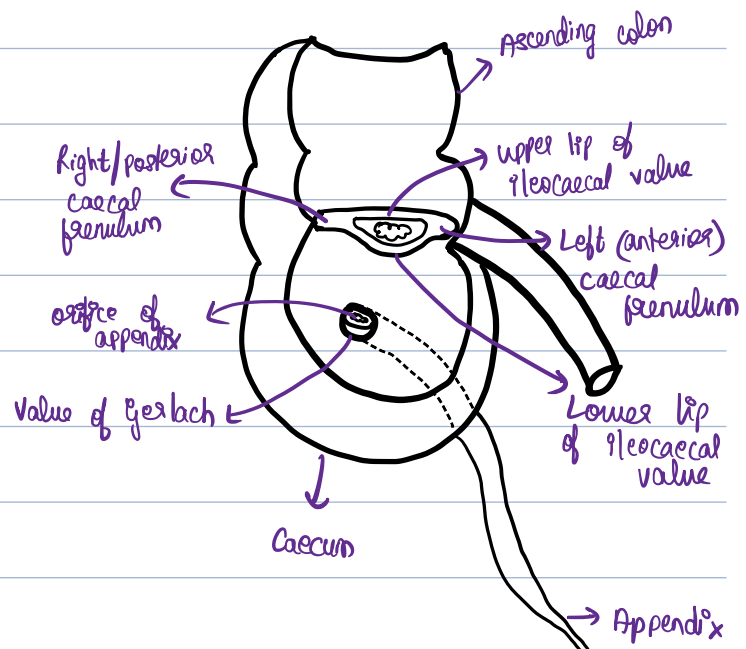
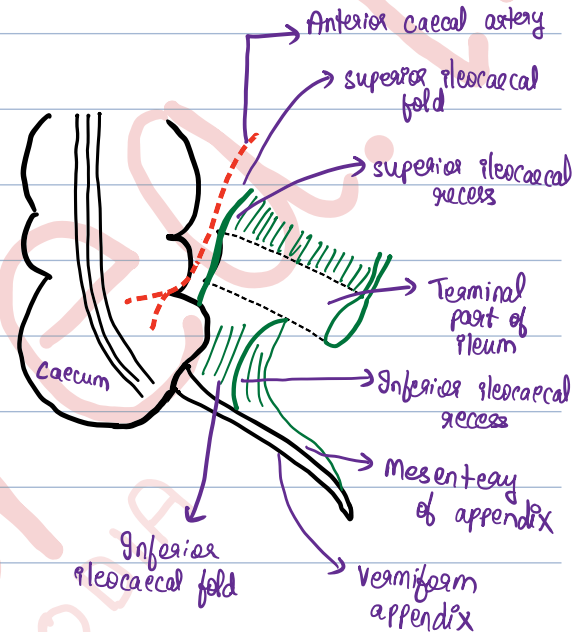
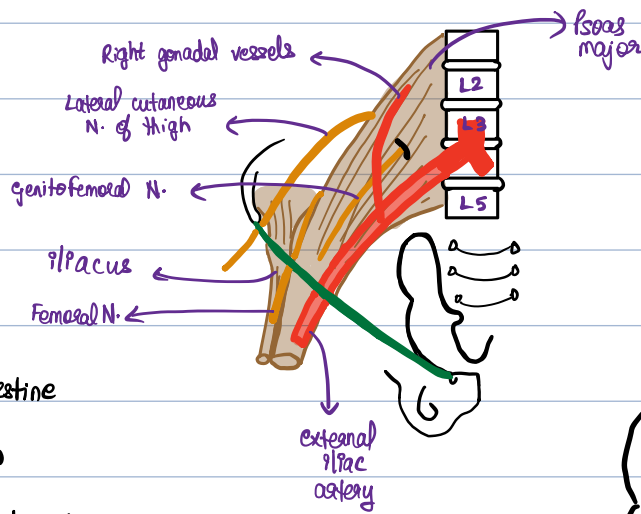
$\rightarrow$ present on posteromedial aspect of caecocolic junction

$\rightarrow$ 2.5 cm transversely

$\rightarrow$ guarded by ileocaecal valve $\begin{cases} \text{upper lip} \\ \text{lower lip} \end{cases}$

$\rightarrow$ Upper lip is small & horizontal

$\rightarrow$ Lower lip is long & concave.



- 2 lips meet at ends & continue as caecal frenula which may act as caecocolic sphincter
- Lips ⇒ made of thickening of circular muscle coats covered by mucosa & submucosa
- ileocaecal valve regulates flow of contents from ileum to caecum & prevents regurgitation of contents of caecum into ileum.

Appendicular Orifice:

- ↳ 2cm below & slightly behind ileocaecal orifice
- guarded by insignificant semicircular fold of mucous membrane called valve of Gerlach

Blood Supply: anterior & posterior caecal branches of ileocolic artery (branch of SMA)

- veins follow arteries & drain into SMV which drains into portal vein

Lymphatic Drainage:

- ileocolic lymph nodes → superior mesenteric group of pre-aortic lymph nodes.

Nerve Supply:

Sympathetic - T11, L1 through superior mesenteric plexus

Parasympathetic - both vagus nerves.

Vermiform Appendix:

- narrow worm-like diverticulum
- arises from posteromedial wall of caecum, 2cm below ileocaecal junction

Dimensions:

Length ⇒ 2 - 20cm (longer in children)
width ⇒ 5mm

- Diameter of lumen varies with age - more in children than adults

Parts: base, body, tip - often obliterated after middle-age

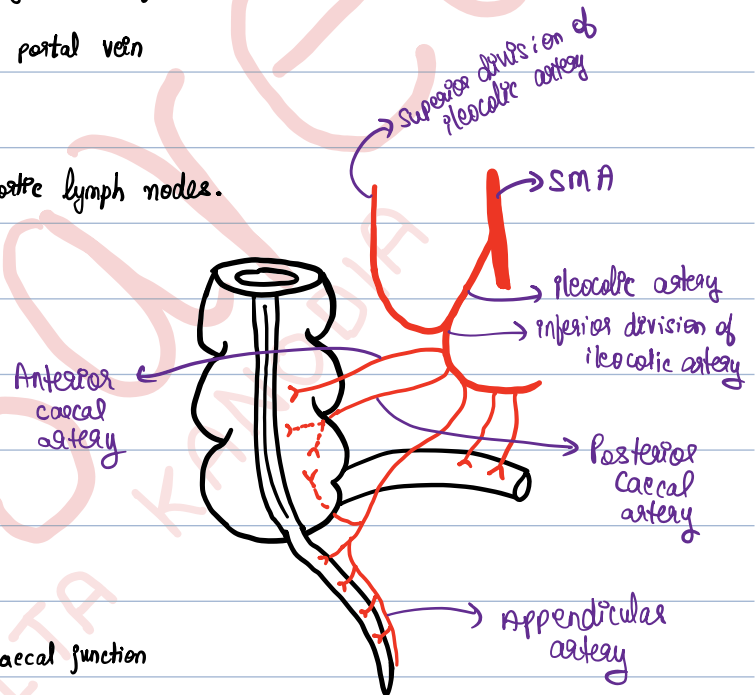
Base: attached to posteromedial wall of caecum about 2cm below ileocaecal junction.

- all 3 teniae converge here

- this serves as a guide to surgeons to search for appendix during appendectomy.

Body: narrow tubular part

Tip: least vascular distal blind end



Position: usually in right iliac fossa

ISHITA
KANODIA

↳ base is fixed; rest of it may occupy following positions:

Paracolic (11 o'clock): 2%

Retrocolic / Retrocaecal: 65.28%

Splenic: pre-ileal $\Rightarrow$ appendix passes upward & medially in front of terminal part of ileum $\Rightarrow$ 1%
(2 o'clock)
post-ileal $\Rightarrow$ " " " " " behind terminal part of ileum $\Rightarrow$ 0.4%

$\rightarrow$ pre-ileal position is most dangerous because inflammation from appendix spreads into general peritoneal cavity.

Promontoric: 3 o'clock

↳ appendix passes towards sacral promontory

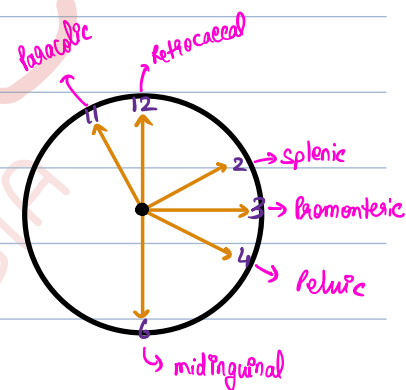
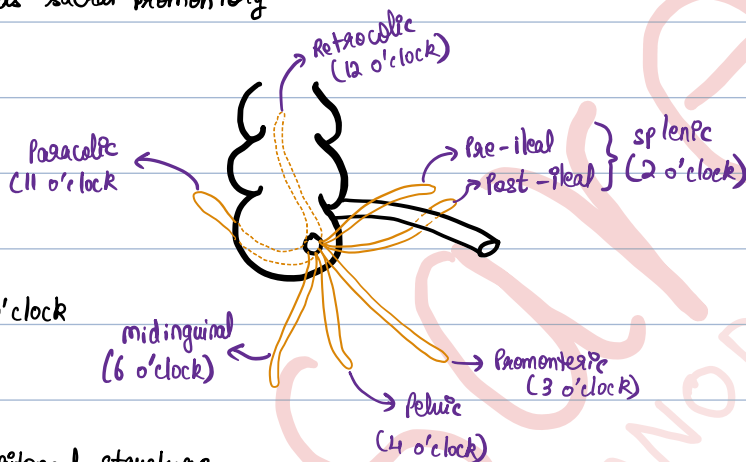
$\rightarrow$ < 1%

Pelvic: 4 o'clock

↳ 31.01%

Mitigunal / Subcaecal: 6 o'clock

$\rightarrow$ 2%



Peritoneal Relations: intraperitoneal structure

↳ appendix is suspended by a small triangular fold of peritoneum $\Rightarrow$ mesentery of appendix or mesoappendix.

$\rightarrow$ appendicular artery runs within free margin of mesoappendix

Arterial Supply: appendicular artery (branch of inferior division of ileocolic artery)

Venous Drainage: veins correspond to artery

↳ drain into superior mesenteric vein which drains into portal vein

Lymphatic Drainage:

$\rightarrow$ ileocolic lymph nodes directly or through appendicular nodes in mesoappendix

Nerve Supply:

Sympathetic $\Rightarrow$ carries pain sensation

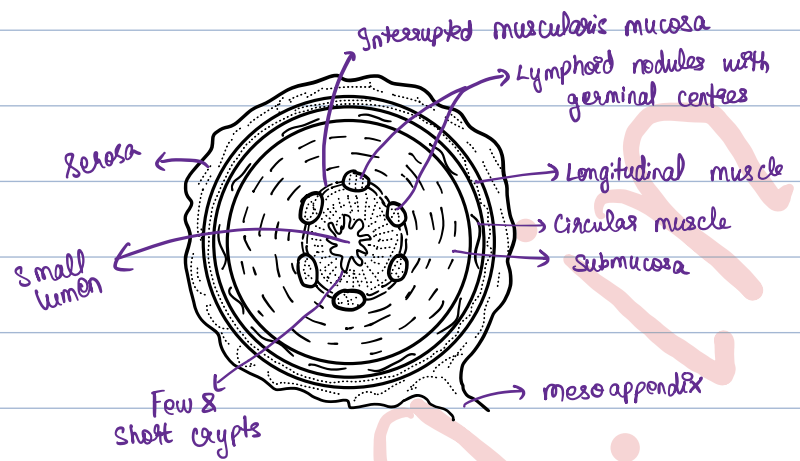
↳ T10 via lesser splanchnic N. & superior mesenteric plexus

$\therefore$ pain of appendicitis is referred to umbilicus

Parasympathetic $\Rightarrow$ both vagus nerves

Microscopic Structure:

- small angulated circular lumen
- thick wall $\Rightarrow$ 4 layers — Mucosa
 - Submucosa
 - Muscular layer
 - Serosa



Mucosa: lined by simple columnar cells & many goblet cells

↳ devoid of villi

→ intestinal glands (crypts of Lieberkuhn) $\Rightarrow$ few & short.

Submucosa: contains ring of large lymphoid follicles with germinal centers

$\therefore$ appendix is considered as abdominal tonsil

Muscular Layer: — outer longitudinal layer } smooth muscles
— inner circular layer }

Serosa: made of visceral peritoneum.

Applied Aspect:

Subhepatic appendix: → abnormal position of appendix

- lies underneath liver in right hypochondrium
- developmental anomaly
- occurs due to failure in descent of caecal bud that arises from post-arterial segment of midgut loop
- inflammation of subhepatic appendix causes pain & tenderness in right hypochondrium & may mimic acute cholecystitis

Appendicitis: inflammation of appendix

- ↳ commonly occurs due to obstruction of its lumen by faecaliths / oedema.
- initial pain is referred pain & felt in umbilical region (T10)
- gradually pain is localised in right iliac fossa
- Maximum tenderness elicited at Mc. Burney's point

Psoas test: when appendix is retrocaecal in position, it lies on & irritates right psoas major during appendicitis

↳ forced extension of thigh in such case increases pain in right iliac fossa.

Obturator Test: when appendix is in pelvic position

↳ may irritate obturator internus muscle

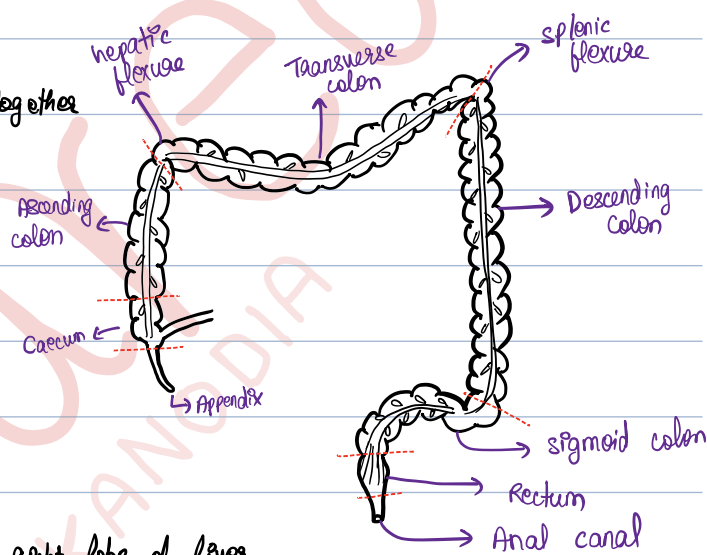
→ flexion & medial rotation of thigh causes pain in lower abdomen.

Appendectomy: gridiron incision in right iliac fossa

↳ 3 flat muscles are split

→ fascia transversalis & parietal peritoneum are incised together

→ appendix is cut at base & removed.



Colon:

Ascending colon: 5 inches

→ continuation of caecum

→ 1st right colic (hepatic) flexure at inferior surface of right lobe of liver

→ lies in right paracolic gutter

→ covered by peritoneum & front & sides which attaches it to posterior abdominal wall

→ posteriorly lies on 3 muscles — iliacus

— quadratus lumborum

— transversus abdominis

→ crosses 3 nerves from below upwards — lateral cutaneous N. of thigh

— ilioinguinal N.

— iliohypogastric N.

→ anteriorly related to coils of small intestine

Transverse Colon: 20 inches

↳ most mobile part of large intestine

→ from right colic flexure (in right lumbar region) to left colic flexure (in left hypochondrium)

→ usually 'U'-shaped

→ Relations: Anterior $\Rightarrow$ PAW, greater omentum

Posterior $\Rightarrow$ 2nd part of duodenum, head of pancreas, coils of small intestine

Transverse Mesocolon: transverse colon & suspended from PAW by transverse mesocolon

→ divides peritoneal cavity into supra & infracolic compartments (forms a natural barrier against spread of infections)

→ on PAW, attached to 2nd part of duodenum, head & body of pancreas, anterior surface of left kidney

→ Contents (embedded in loose areolar tissue):

- middle colic vessels
- ascending branches of right & left colic vessels
- lymphatics
- nerve plexuses

Development: proximal $\frac{2}{3}$ from midgut

→ distal $\frac{1}{3}$ from hindgut

Descending Colon: 10 inches

↳ from left colic flexure to front of left external iliac artery at level of pelvic brim

→ covered by peritoneum on front & sides

→ Proximal part passes in front of 3 muscles, 3 Nerves

- quadratus lumborum	- iliohypogastric N.
- transversus abdominis	- ilioinguinal N.
- iliacus	- Lateral cutaneous N. of thigh

→ Distal part passes in front of

- psoas major	- genitofemoral N.
- femoral N.	- left external iliac vein
- testicular vessels	

Sigmoid/Pelvic Colon: 15 inches

↳ S-shaped

→ from lower end of descending colon at left pelvic inlet to pelvic surface of 3rd piece of sacrum

→ in pelvis, lies in front of bladder & uterus, below loops of ileum

→ 3 parts — 1st part ⇒ runs downward in contact with left pelvic wall

— 2nd part ⇒ traverses horizontally b/w bladder & rectum (in male) & uterus & rectum in female

— 3rd part ⇒ runs backwards to reach midline in front of 3rd sacral vertebra.

Sigmoid Mesocolon: inverted V-shaped attachment / root.

→ left limb ⇒ attached on external iliac artery

→ Right limb ⇒ attached on pelvic surface of sacrum

→ Apex ⇒ meeting point of two limbs ; apex of 'L'

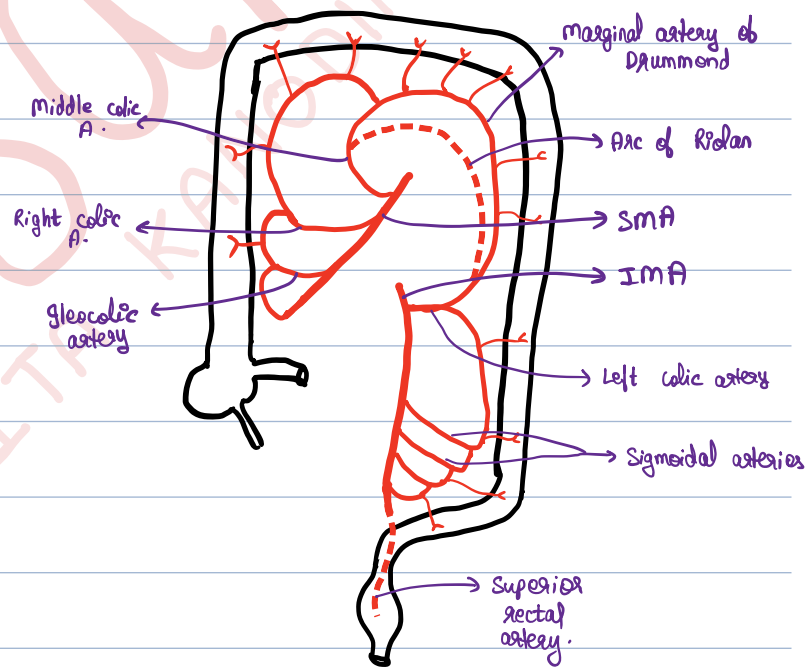
→ SMA divides near the apex of 'L'

→ Superior rectal artery enters right limb & sigmoidal arteries enter left limb

Arterial Supply of Colon:

- (i) Ileocolic A.
 - (ii) Right colic A.
 - (iii) Middle colic A.
- } branches of SMA

- (iv) Left colic A.
 - (v) Sigmoidal As.
 - (vi) Superior rectal A.
- } branches of IMA.



Marginal Artery of Drummond: extends from ileocolic junction to rectosigmoid junction

→ formed by anastomosis between colic branches of SMA & colic branches of IMA

Cervical Point of Colon: at level of splenic flexure

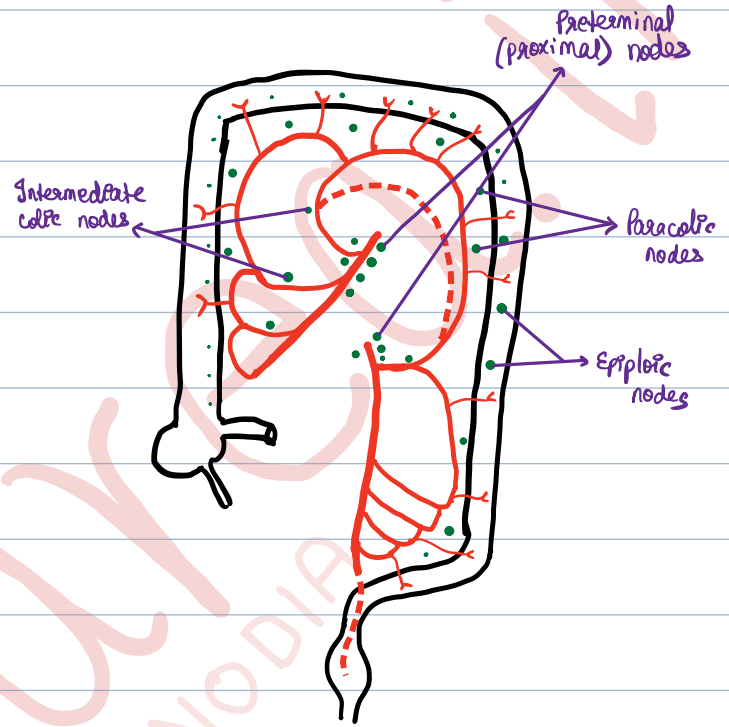
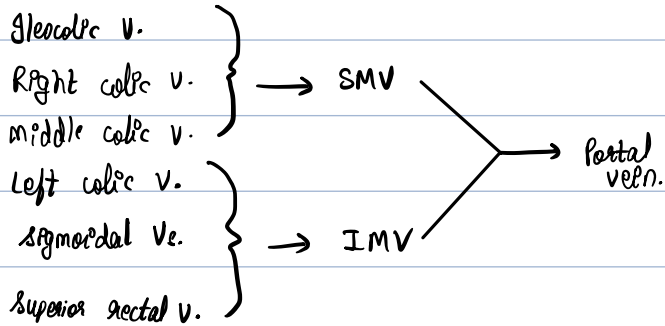
↳ here, ascending branch of left colic artery fails to anastomose with left branch of middle colic artery.

→ But, there is an anastomotic venous channel b/w main trunk of middle colic & ascending branch of left colic ⇒ Arc of Riolan

→ If anastomosis is insufficient $\Rightarrow$ splenic flexure undergoes ischaemic changes

$\therefore$ called critical point of Sudeck.

Venous Drainage: veins accompany arteries



Lymphatic Drainage: clinically important because carcinoma of colon spreads via this route

- Epiploic nodes
- Para-colic nodes
- Intermediate colic nodes
- Preterminal nodes

Applied Aspect:

Examination of Interior of Colon: Barium enema used

→ nowadays endoscopic examination is routinely followed.

Congenital Megacolon/Hirschsprung Disease: occurs when neural crest cells fail to migrate & form myenteric plexus

plexus in sigmoid colon & rectum

→ absence of peristalsis

→ Normal proximal colon becomes grossly dilated due to faecal retention causing abdominal distension

Carcinoma of Colon: slow growing tumour that constricts the colon

→ growth is restricted to wall of colon before it spreads to lymphatics

→ In advanced cases $\Rightarrow$ spreads to liver via portal circulation

→ if diagnosed early, hemicolectomy (partial resection of colon is done)

Surgical Resection of Cancer:

→ lymph from gut may miss epiploic & para-colic nodes & directly enter intermediate & preterminal nodes

→ territory of lymphatic drainage is divided fairly into areas corresponding to areas supplied by main arteries

→ Removal of lymph nodes is possible only after ligating main arteries

∴ whole segment of colon being supplied by ligated artery should be removed to avoid gangrene.

Diverticulae: involves herniation of lining mucosa through circular muscle between Teniae coli.

↳ herniation occurs where circular muscle coat is weakest (where it is pierced by blood vessels)

→ inflammation of diverticulata = diverticulitis

Volvulus: portion of gut rotates on axis of its mesentery

→ may correct itself spontaneously or rotation may continue until blood supply of gut is cut off leading to ischemia

→ sigmoid colon is vulnerable to volvulus due to extreme mobility of its mesentery.

Intussusception: proximal segment of bowel invaginates into lumen of adjoining distal segment

↳ may cut off blood supply to bowel & cause gangrene

→ different types - ileocolic, ileocolic, colocolic.

Superior Mesenteric Artery (SMA):

Origin: from abdominal aorta at level of L1 (behind body of pancreas)

↳ 1/2 inch below coeliac trunk

Course:

↓
passes in front of uncinate process

↓
in front of 3rd part of duodenum to enter
root of mesentery

Termination:

↓
terminates in right iliac fossa by
anastomosing with a branch
of ileocolic artery (its own branch)

→ SMV on right side of SMA

Relations:

Anteriorly ⇒ from above downward - body of pancreas & splenic vein

Posteriorly ⇒ from above downward - left renal vein

- uncinate process
- 3rd part of duodenum
- IVC
- right ureter
- right psoas major

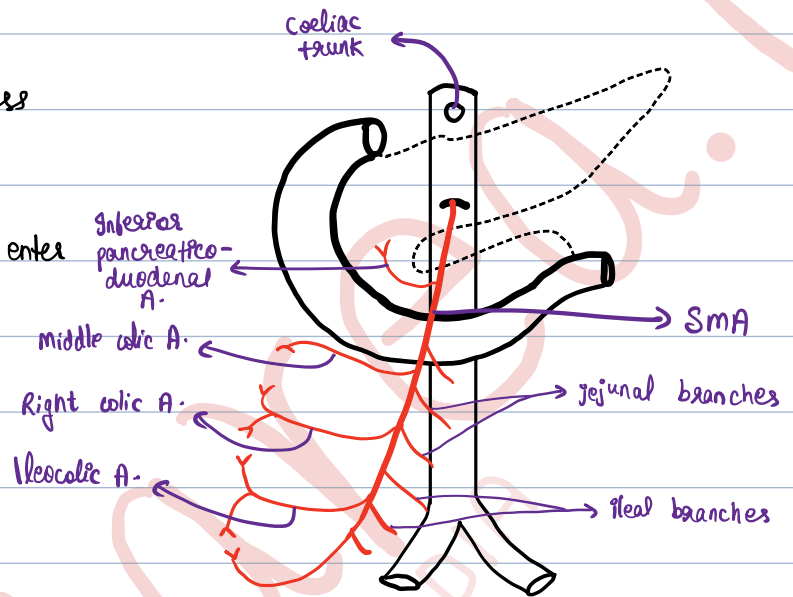
Branches: - Inferior pancreaticoduodenal A.

- middle colic A.
- right colic A.
- ileocolic A.
- jejunal & ileal branches

Distribution: SMA ⇒ artery of midgut

→ Supplies - lower half of duodenum (below opening of hepatopancreatic duct)

- jejunum & ileum
- caecum, appendix, ascending colon
- right 2/3 of transverse colon.



Inferior Mesenteric Artery:

Origin: from abdominal aorta at level of L3 (behind 3rd part of duodenum)



runs behind peritoneum to cause termination of
left common iliac artery



becomes superior rectal artery here

- Branches:
- Left colic A.
 - sigmoidal As.
 - Superior rectal A. (continuation)

Distribution: IMA $\Rightarrow$ artery of hindgut

- $\rightarrow$ supplies -
- left $\frac{1}{3}$ of transverse colon
 - descending, sigmoid colon
 - rectum
 - upper part of anal canal.

