EMBRYOLOGY
LEC 1 & 2

ORAL CAVITY &

→ endoderm (behind the stomodeum, separated by buccopharyngeal membrane)

→ ectoderm (outer surface of stomodeum)

- Stomodeum; junction between the endodermal and ectodermal of oral cavity.

the depression in the stomodeum gives origin to ant part of oral cavity. (ecto)

the cephalic pt of foregut (Post to stomodeum) gives the pharynx and post pt of oral cavity (endo)

BUCCOPHARYNGEAL MEMBRANE DISAPPEARS DURING THE 3rd WEEK.

we create an oblique imaginary line that starts from the body of sphenoid, passing thru soft palate and ending at the incisor teeth

above and ant
- hard palate (ecto)
- lips
- sides of mouth
- teeth enamel

below and post (endo)
- tongue + floor of the mouth
- soft palate
- palatoglossus + palatopharyngeal folds

SALIVARY GLANDS:

1) Sublingual (endo) 2) Submandibular (endo) 3) Parotid (ecto)

DEVELOPMENT @ 7th WEEK.

- proliferation of the epithelial cells into the mesenchyme, forming a bud in connective tissue.

Exocrine gland
1) canalization (duct)
2) the end of proliferation will form the secretory acini

Endocrine gland
1) proliferation, duct disappears
2) follicle cells + blood vessels

- the capsule is mesenchymal in origin.

TONGUE: ANTERIOR 2/3

1st arch
- 2 lateral lingual swellings
- the tuberculum impar
- nerve supply: mandibular of trigeminal
- sensory innervation: chorda tympani

POST 1/3
- median swelling copula/hypobranchial eminence (2nd + 3rd + pt of 4th arches)
- separated from ant by sulcus terminalis
- glossopharyngeal (mainly from 3rd arch)

epiglottis
- epiglottal swelling (4th arch)
- superior laryngeal

* the muscles of the tongue originate from occipital somites!
(innervation: hypoglossal nerve)

PHARYNX: highest point in foregut, endoderm of the pharyngeal pouches (he said cleft tho?)

ANT ABD WALL: segments from lateral plate of mesoderm
somatopleuric mesoderm gives off — ext oblique
— internal oblique
— trans abdominus

*the rectus abdominis also comes from the mesoderm, however it originates from MYOTOMES.
the right and left sides of mesenchyme fuse together @3months forming linea alba.

→ somatic (wall)

→ splanchnic (visceral)

UMBLICUS

*umblical cord is 45cm, starts from endoderm of mother's uterus and ends @ umblicus of fetus.

2 ARTERIES (deoxygenated blood from fetus to placenta)

2 VEINS (oxygenated blood from placenta to fetus)
[RV gets obliterated]

MUCOID CONNECTIVE TISSUE
wharton's jelly

* the umbilical cord is filled with stem cells (undifferentiated mesenchymal cells)

content of the umblical cord ① Vitelline duct (between umbilicus and ileum (midgut))
② remains of allantois
③ blood vessels

*the vitelline duct could cause meckle's diverticulum (2/2/2), contains pancreatic or gastric tissue and is prone to infection, could cause peritonitis.

*a vitelline cyst could also occur (instead of complete obliteration)

LUNG BUDS: ant surface of caudal part of foregut.
STARTS AT 4 WEEKS (determined by signals, FGF's)
lung bud (endodermal), bones cartilage muscle (mesoderm)

*in order to separate the lung bud from esophagus, a tracheoesophageal ridge is formed...
the ridge continues growing until it becomes a septum. (post: esophagus, ANT: trachea (lung bud)

foregut → dorsal (esophagus) } their only connection
→ ventral (lung bud) } is the epiglottis

*the splanchnic mesoderm makes up the muscular coat (upper ⅔ innervated by vagus + striated)
(lower part innervated by splanchnic plexus + smooth)

LEC 2 8

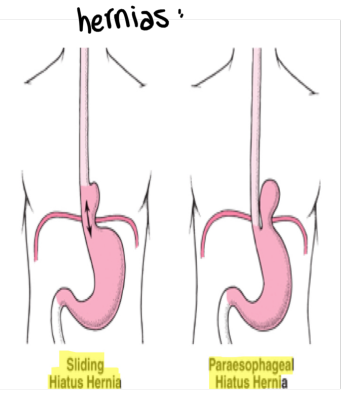
esophageal abnormalities
1) atresia (blind end) 2) fistula (a tract between 2 cavities) 3) stenosis 4) hernia
Tracheoesophageal fistula

the tracheoesophageal septum pushes the dorsal wall of foregut anteriorly and could cause fistulas.

* proximal atresia and a distal fistula is the most common type.
↳ 1) atresia is associated with Polyhydraminos (↑amniotic fluid around fetus)
2) bulging of the abdomen (air accumulation)
3) vomiting due to esophageal obstruction
4) if fistula is not detected, infection in trachea could occur → pneumonia.
5) other abnormalities might be found (ex: intraventricular septal defect, fallot tetralogy)

Stenosis (narrowing) bc of incomplete recanalization or vascular abnormalities

hernias:



STOMACH

*development 4th week (fusiform in shape and it develops around 1) longitudinal axis 2) anteroposterior axis)

1) stomach turns around the long axis 90° clockwise
↳ the dorsal surface grows faster (to the left side), ventral surface grows to the R side (slow)
* [greater curvature on left side, lesser curvature on R side]
* [left vagi ant, R vagi post]
* [the mesoderm gives off dorsal mesentry and ventral mesentry, the dorsal gives off the greater omentum and the ventral gives us the lesser omentum) +[pulls ventral mesogastrium to the R → hepatic ligaments]
ventral → ligament of the liver / dorsal → post abd wall.

2) development around the anteroposterior axis (+ cardia + pylorus)
↳ cardia moves to the left and downwards, pylorus goes upwards to the right
→ the epiploic foramen and the lesser sac are formed (IN THE SLIDES ITS BC OF LONG AXIS ROTATION)

*the dorsal mesogantrium also gives off the spleen + lienorenal ligament + gastrosplenic
↳ @ 5th week, mesodermal proliferation in dorsal mesogastrium → spleen.

pyloric stenosis thickening of the inner circular muscle of the sphincter
↳ PROJECTILE VOMITING!

the mesoderm consists of 3 layers: Paraxial, intermediate, lateral plate
lateral plate: somatopleuric → goes to the wall جداري
lateral plate: splanchnic → lining the abd cavity, pleura, Pericardia

★ the dorsal mesogastrium gives off:
1) greater omentum 2) gastrosplenic 3) leinorenal 4) mesentry for Trans colon, small intestine, mesocolon.

★ the ventral mesogastrium gives off:
1) lesser omentum 2) liver ligaments (falciform + coronary)
it goes to the direction of the septum transversum

⚠ ligamentum teres of the liver is an obliterated umbilical vein.

The septum transversum is between the thoracic cavity and abdominal cavity (makes the diaphragm), also it makes the sinusoids of the liver and the blood supply, and it has a role in the formation if the heart, diaphragm and liver) 21

LIVER AND GALLBLADDER

*the liver bud is an outgrowth above the sphincter of oddi (Proliferation of cells towards the septum transversum) the mesodermal plate in the septum transversum would give off the blood sinusoids.

→ hepatic cells will continue penetrating the septum forming the bile duct (canalization).

the gallbladder + cystic duct come from a small ventral outgrowth by bile duct.

- epithelial liver cords intermingle with the vitelline and umbilical veins → hepatic sinusoids (meso)

(the umbilical veins and vitelline veins are found in septum transversum)

- parenchyma of liver is endodermal.
- Kupffer cells, hematopoietic cells are from mesoderm.

ABNORMALITIES: 1) accessory hepatic duct 2) duplication of gallbladder 3) biliary atresia

↳ they lead to an obstruction → JAUNDICE.

DUODENUM:

- the rotation of the stomach causes the duodenum to rotate clockwise with a concavity directed backwards to the left.

the common bile duct was on the right side however the rotation of the duodenum causes it to become on the left side.

duodenum retroperitoneal except 1st 2nd last inches aka the dorsal mesogastrium disappears after pulling it to the post abd wall.

* duodenum must be recanalized, one of the abnormalities that could happen is Atresia.

Blood supply: Celiac + SM

PANCREAS

(origin of cells of pancreas is also endodermal)

2 Buds → dorsal (left side of duodenum)
→ ventral (right side of duodenum)

when the duodenum rotates, the ventral part of the pancreas will lie below and behind the dorsal bud.

ventral: lower part of the head + uncinate process ★

dorsal: rest of the pancreas ★

the main pancreatic duct (Wirsung) is formed by the distal part of dorsal bud and the entire ventral bud.

if the proximal part of the dorsal bud persisted → ACCESSORY DUCT

at 3rd MONTH PANCREATIC ISLETS DEVELOP, INSULIN SECRETION at 5th MONTH

pancreatic abnormalities, 1) annular pancreas ★

↓

pancreatic tissue encircling the duodenum (results in bilious vomitting)

(could cause obstruction)

2) accessory pancreatic tissue [normal position: pancreas, retroperitoneal, in umbilical region

↓

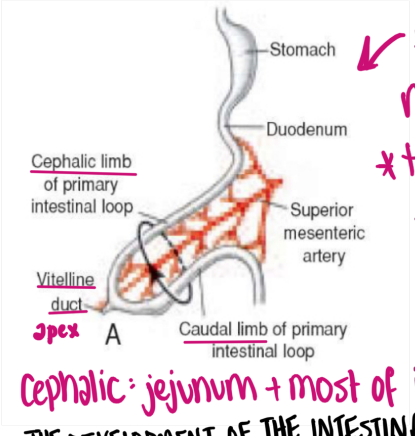
found at abnormal spaces (around esophagus, stomach, etc)

LEC 3
MIDGUT

(starts after the liver bud and contains pt of duodenum, jejunum, ileum, proximal ⅔ of trans colon)

the vitelline duct connects the yolk sac to the ileum.

*the midgut is characterized by rapid elongation of jejunum + ileum (primary intestinal loop) and the apex of this loop remains open with the vitelline duct.



the axis is the superior mesentric artery.

*the cephalic part elongates faster than the caudal part.

Cephalic: jejunum + most of ileum | Caudal: cecum, appendix, ascending colon, ⅔ of trans colon, lower pt of ileum.

THE DEVELOPMENT OF THE INTESTINAL LOOP CONSISTS OF 2 PROCESSES

1) physiological herniation

*rapid elongation of the cephalic limb in the intestinal loop so it descends thru umbilical cord.

*it enters the umbilical cord bc of 1) Liver enlargement 2) Diaphragm descending downwards [↓size of abd cavity]

*this occurs during the 6th week and ends during 10th week.

* midgut returns to abd cavity in 10th week (bc the abd cavity got enlarged; regression of Kidney + liver goes upward)

2) rotation around the superior mesentric artery (270°)

90° anticlockwise rotation during physiological herniation.

180° rotation @ 10th week during the return of the intestinal loop to the abdominal cavity. (counterclockwise too)

*the 1st part to return to abdominal cavity is the jejenum (upwards to the left)
the last to return are the cecum and appendix (right below liver)

- The **cecal bud, which appears** at about the sixth week as a small conical dilation of the caudal limb of the primary intestinal loop, is the last part of the gut to reenter the abdominal cavity at 10th week.
- Temporarily it lies in the right upper quadrant directly below the right lobe of the liver
- From here it descends into the right iliac fossa, placing the **ascending colon and hepatic flexure on the right side of the abdominal** cavity

] during this process the cecal bud forms a narrow diverticulum (appendix) [Retrocecal]

MESENTRIES OF INTESTINE

↗ intraperitoneal: jejenum, ileum, trans colon, sigmoid. (mesentry attaches them to post abd wall).

↘ retroperitoneal: ascending colon, descending, appendix (mesentry disappears post, fixes organs on post abd wall).

GUT ROTATION DEFECTS

1) VOLVULUS
(abnormal rotation, causing cut of blood supply)
twisting of intestine mainly in jejenum and ileum.

2) Partial rotation
90° rotation instead of 270°
(you'd find the cecum + appendix on left side)

3) Reversed Rotation
90° rotation clockwise
(duplication of intestinal loops + cysts occuring anywhere esp in jejenum + ileum)

4) Atresia + stenosis
mostly in duodenum
1/5000 births
due to failed recanalization.

BODY WALL DEFECTS

1) Omphalocele

- unreturned physiological hernia, the hernia stays in the umbilical cord.
- the viscera covered by aminotic fluid
- rare (2.9/10000), high rate of mortality
+ 50% cardiac anomalies + neural tube defects.
- chromosomal abnormalities

2) Gastroschisis

- herniation of abd content thru body wall directly into amniotic cavity
- usually on right side of umbilicus (not in umbilical cord)

HINDGUT

(distal ⅓ of trans colon, sigmoid, rectum, upper ½ of anal canal, descending colon)

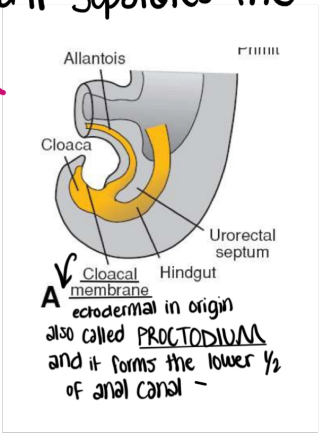
* the hindgut is attached to the cloaca (pelvic structure attached to the hindgut and allantois)

* the cloaca posteriorly forms the terminal portion of hindgut + anteriorly it participates in the formation of the urogenital sinus.

*the allantois is endodermal in origin, it gives rise to the urinary bladder. [the urorectal septum lies post to it]: the urorectal septum separates the area between allantois and hindgut

the cloaca itself is endodermal in origin, the urorectal septum is from mesoderm and it separates the hindgut from the urogenital tract. This septum ends as the PERINEAL BODY.

perineal body separates the anal canal from urinary bladder and urethra.



A ectodermal in origin also called PROCTODIUM and it forms the lower ½ of anal canal

ANORECTAL MALFORMATIONS

(birth defects between anus and rectum)

1) the membrane present over the anal opening
(anorectal membrane does not rupture)

2) rectum not connected to anus (imperforate anus)
(according to o2o lecs, it results from failure of anal membrane to break down)

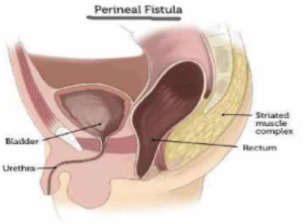
3) rectum connecting to urinary tract (fistula)

4) narrow anal canal

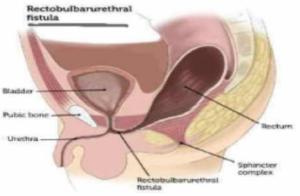
- **Types of anorectal malformations:**
- Anorectal malformations, including imperforate anus, can affect male and female babies in different ways.
- In boys, the main anorectal malformations are perineal fistula, rectobulbarurethral fistula, rectoprostatic fistula and rectobladderneck fistula.
- In girls, the main anorectal malformations are rectoperineal fistula, rectovestibular fistula and cloaca.
- A type of anorectal malformation called imperforate anus can occur in both boys and girls.

* rectovaginal fistula results from incomplete separation of hindgut from urogenital sinus by the septum.

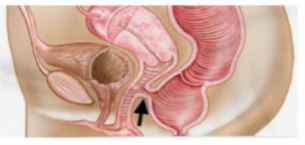
Types of anorectal malformations



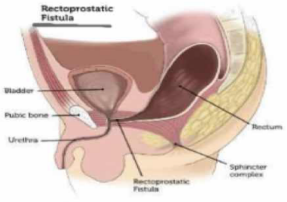
1-Rectum is opened to perinum.



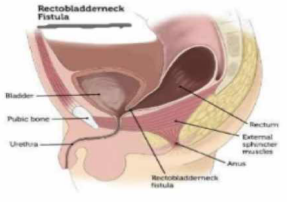
2-Rectum is opened to urethra and bulbar membrane.



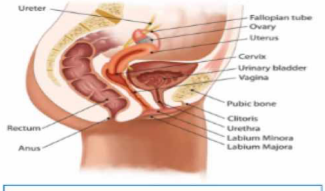
5-Rectovaginal opening also may occur.



3-Rectoprostatic, rectum is open to prostate.



4-Rectobladderneck fistula. On the neck of the bladder.



This is the normal rectal opening for reference