EMBRYOLOGY

DEVELOPMENT OF PANCREAS AND SMALL INTESTINE

At the end of the lecture, the students should be able to :

-Describe the development of the duodenum.

-Describe the development of the pancreas.

-Describe the development of the small intestine.

-Identify the congenital anomalies of the small intestine :

Congenital omphalocele.

Umbilical hernia.

Meckel's diverticulum.

Embryology433@gmail.com

MIND MAP

Development of pancreas and small intestine

Pancreas	Duodenum	Small Intestine

The pancreas develops from 2 buds arising from the endoderm of the caudal part of foregut

:1-A ventral pancreatic bud : which develops from the proximal end of hepatic diverticulum (forms the liver & gall bladder).

2-A dorsal pancreatic bud : which develops from dorsal wall of duodenum slightly cranial to the ventral bud.

Most of pancreas is derived from the dorsal pancreatic bud.and when the duodenum rotates to the right and becomes C-shaped, the ventral pancreatic bud moves dorsally to lie below and behind the dorsal bud.Later the 2 buds fused together and lying in the dorsal mesentery

The ventral bud forms :

1-Uncinate process 2-Inferior part of head of pancreas.

The dorsal pancreatic bud forms :

1-Upper part of of head. 2-Neck. 3-Body 4-Tail of pancreas

The main pancreatic duct is formed from :

1-The duct of the ventral bud 2-The distal part of duct of dorsal bud.

The accessory pancreatic duct is derived from : Proximal part of duct of dorsal bud.

1-The parenchyma of pancreas is derived from the endoderm of pancreatic buds.

2-Pancreatic islets develops from parenchymatous pancreatic tissue.

3-Insuline secretion begins at 10th week of pregnancy

the small intestine is developed from :

1-Caudal part of foregut 2-All midgut.

Midgut is supplied by superior mesenteric artey

Derivatives of cranial part of the midgut loop :

1- Distal part of the duodenum 2-Jejunum3-Upper part of the ileum.

Derivatives of the caudal part of midgut loop :

1-Lower portion of ileum. 2-Cecum & appendix. 3-Ascending colon + proximal 2/3 of transverse colon

5 Stages of development::

1-Preherniation.2- physiological umbilical hernia.

3- rotation of midgut loop.4- reduction of umbilical hernia

.5- fixation of various parts of intestine

Early in the 4th week, the duodenum develops from the endoderm of primordial gut of :

1-Caudal part of foregut. 2-Cranial part of midgut & from: Splanchnic mesoderm.

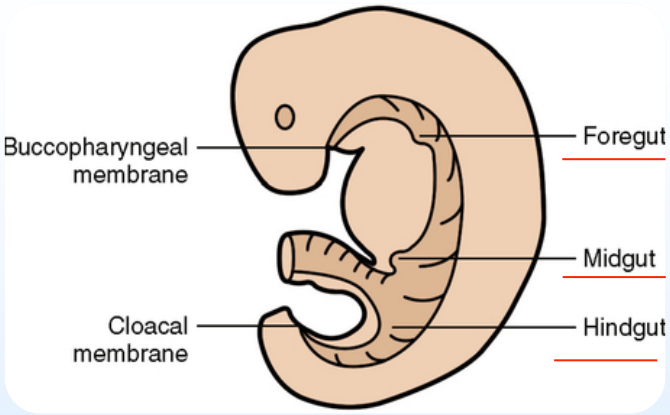
The junction of the 2 parts of the gut lies just below or distal to the origin of bile duct

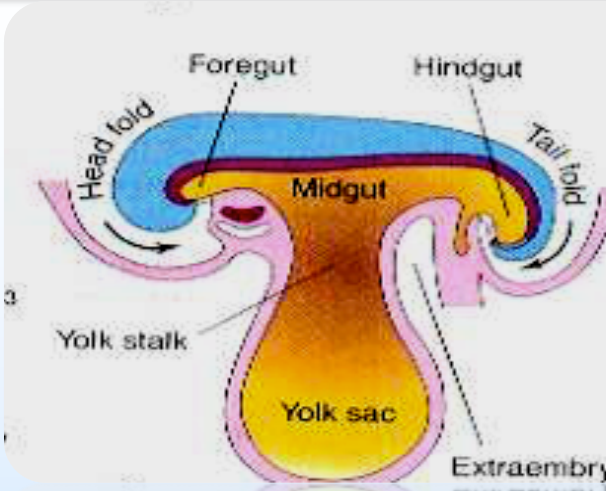
The duodenal loop is formed and projected ventrally, forming a C-shaped loop . The duodenal loop is rotated with the stomach to the right and comes to lie on the posterior abdominal wall retroperitoneally with the developing pancreas

During 5th & 6th weeks, the lumen of the duodenum is temporarily obliterated because of proliferation of its epithelial cells. And normally degeneration of epithelial cells occurs, so the duodenum normally becomes recanalized by the end of the embryonic period.

REMEMBER THIS: *1ST YEAR

AFTER FOLDING, PART OF YOLK SAC IS ENCLOSED WITHIN THE EMBRYO TO FORM THE GUT (FOREGUT, MIDGUT & HINDGUT).



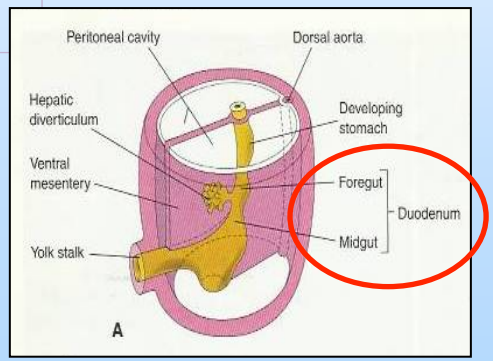


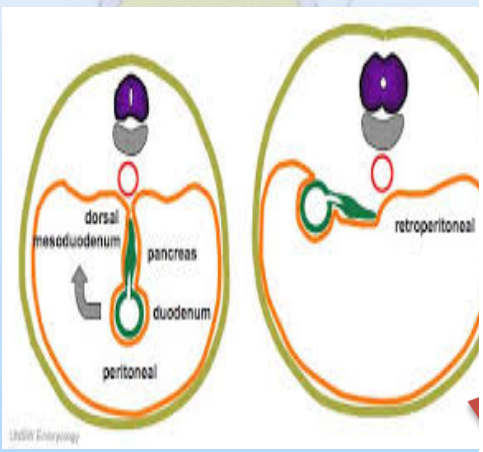
#DEVELOPMENT OF THE DUODENUM

*the development of duodenum and pancreas starts at the same time (early in 4th week).

*Each one of the guts have 2 parts caudal and cranial so the developed organ may arise from 2 guts. E.g; duodenum develop from the **endoderm of caudal part of foregut and cranial part of midgut + the splanchnic mesoderm.**

*The junction of the 2 parts of the gut lies just below or distal to the origin of bile duct.





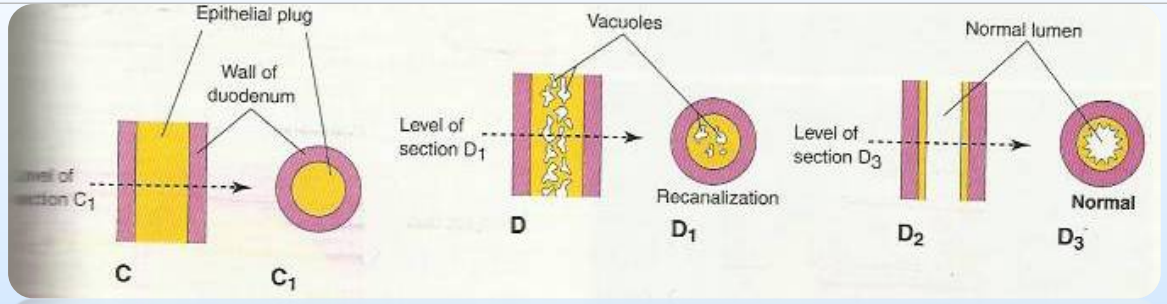
*The duodenal loop is formed and projected ventrally, forming a C-shaped loop (C).

*The duodenal loop is rotated with the stomach to the right and comes to lie on the posterior abdominal wall retroperitoneally with the developing pancreas. *it is secondary retroperitoneal because it wasn't retroperitoneal at the beginning*

Embryology433@gmail.com

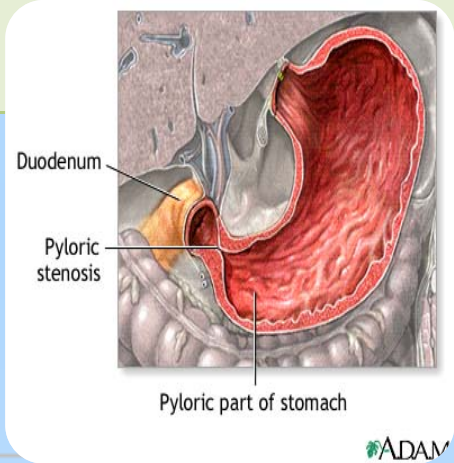
*During 5th & 6th weeks, the lumen of the duodenum is temporarily obliterated because of proliferation of its epithelial cells.

*Normally degeneration of epithelial cells occurs, so the duodenum normally becomes recanalized by the end of the embryonic period (end of 8th week)

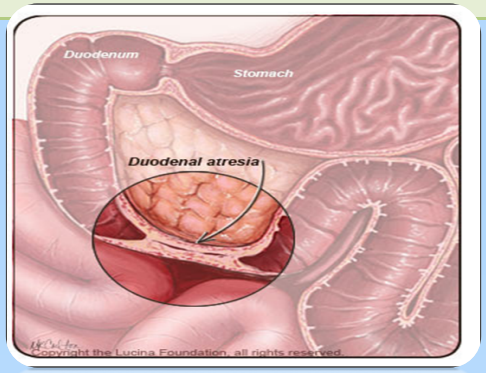


CONGENITAL ANOMALIES

Duodenal stenosis; results from incomplete recanalization of duodenum



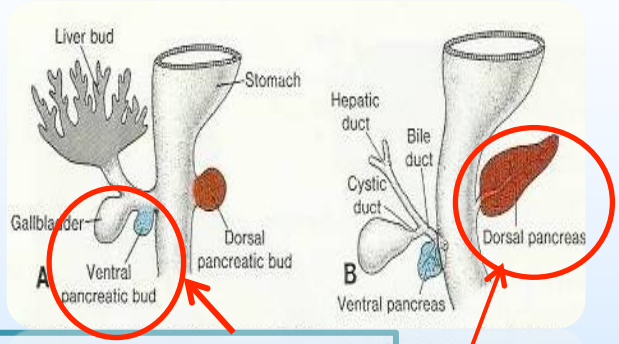
Duodenal atresia; results from failure of recanalization leading to complete occlusion of the duodenal lumen, (autosomal recessive inheritance)



Embryology433@gmail.com

DEVELOPMENT OF PANCREAS

The pancreas develops from **2 buds** arising from the endoderm of the caudal part of foregut:



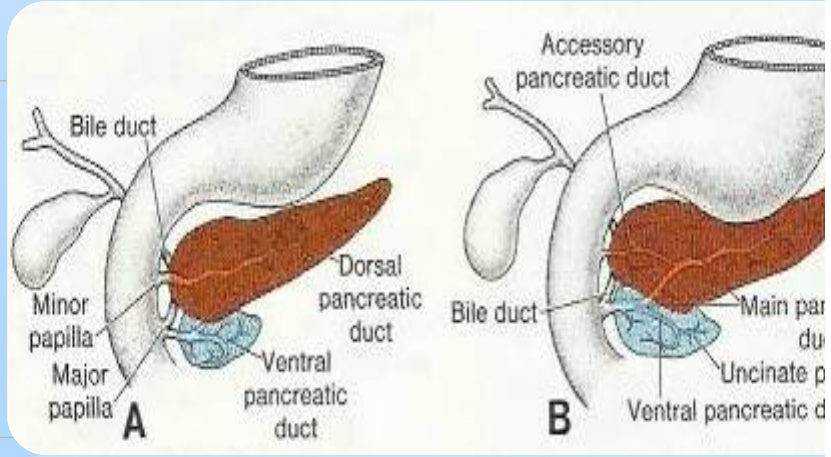
A ventral pancreatic bud : which develops from the proximal end of hepatic diverticulum (forms the liver & gall bladder).

A dorsal pancreatic bud : which develops from dorsal wall of duodenum slightly cranial to the ventral bud.

Most of pancreas is derived from the dorsal pancreatic bud.

*When the duodenum rotates to the right and becomes C-shaped, the ventral pancreatic bud moves dorsally to lie below and behind the dorsal bud.

*Later the 2 buds fused together and lying in the dorsal mesentery.

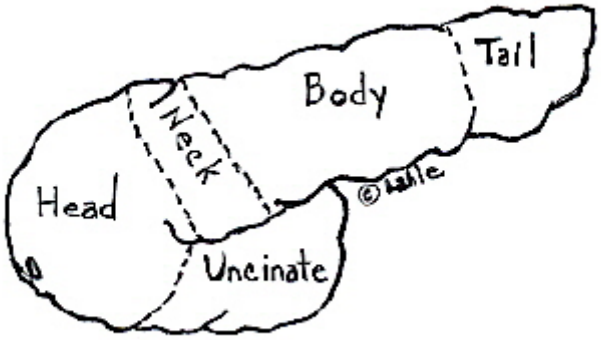


Embryology433@gmail.com

#parts of pancreas :

The ventral bud forms :
- Uncinate process.
- Inferior part of head of pancreas.

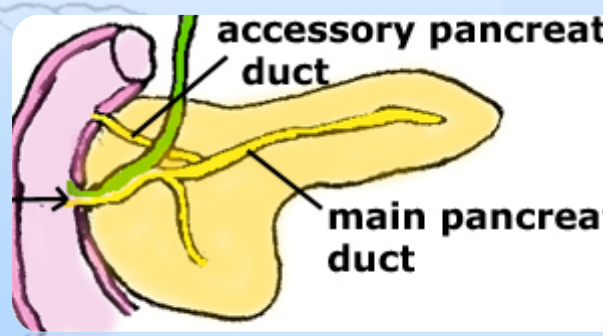
The dorsal bud forms :
- Upper part of of head.
- Neck.
- Body
- Tail of pancreas.



#pancreatic duct

main pancreatic duct is formed from
- *The duct of the ventral bud.
- *The distal part of duct of dorsal bud.

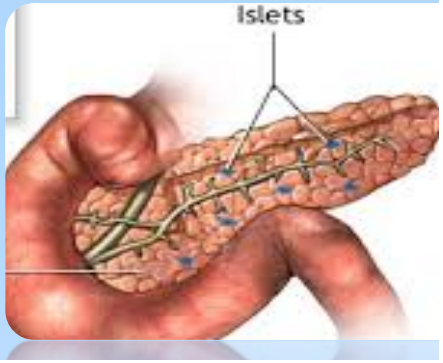
accessory pancreatic duct is derived from
- Proximal part of duct of dorsal bud.



Insuline secretion begins **at 10th week of pregnancy.*fetal life***

The parenchyma of pancreas is derived from the **endoderm** of pancreatic buds.

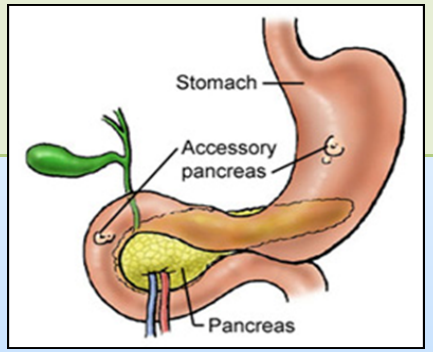
Pancreatic islets develops from parenchymatous pancreatic tissue.***endodermal in origin ***



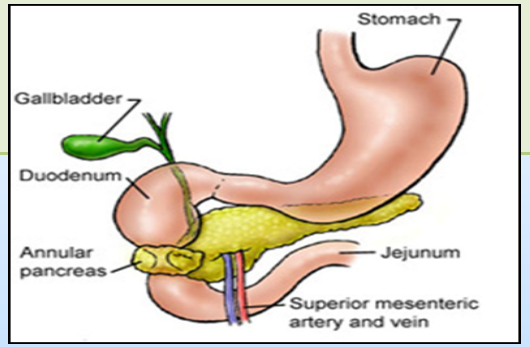
Embryology433@gmail.com

CONGENITAL ANOMALIES

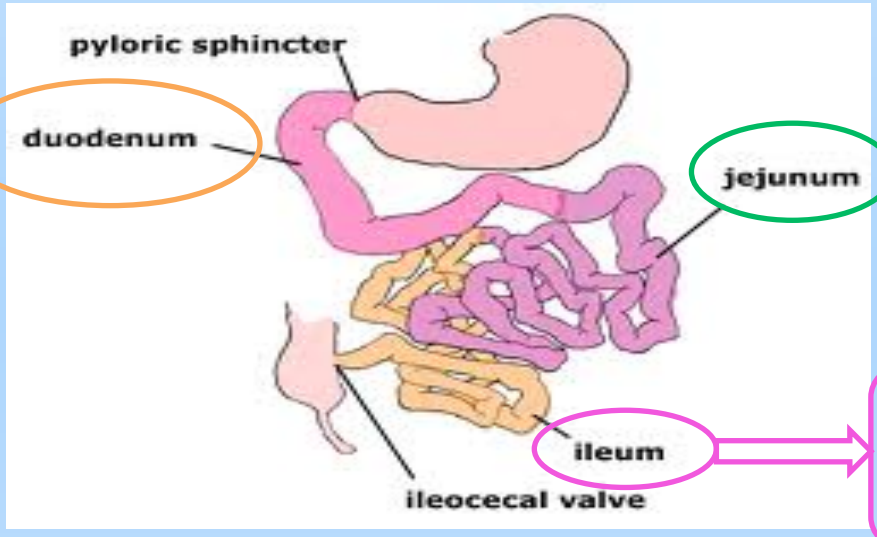
Accessory pancreatic tissue;*Ectobic* located in the wall of the stomach or duodenum.



Anular pancreas; a thin flat band of pancreatic tissue surrounding the second part of the duodenum, causing duodenal obstruction.



DEVELOPMENT OF SMALL INTESTINE



Caudal Foregut & Cranial Midgut

Cranial Midgut

Cranial Midgut & Caudal Midgut

Embryology433@gmail.com

EXPLANATION FOR THE PREVIOUS PICTURE

the small intestine is developed from :

1. All midgut (Cranial & caudal midgut)

A. cranial part of the midgut gives rise to :

*Distal part of the duodenum.

*Jejunum.

*Upper part of the ileum.

B. caudal part of midgut gives rise to :

*Lower portion of ileum.

*Cecum & appendix.

*Ascending colon + proximal 2/3 of transverse colon

2.Caudal part of foregut **(proximal part of duodenum)**

STAGES OF DEVELOPMENT OF SMALL INTESTINE

*Preherniation stage.

*Stage of physiological umbilical hernia.

*stage of rotation of midgut

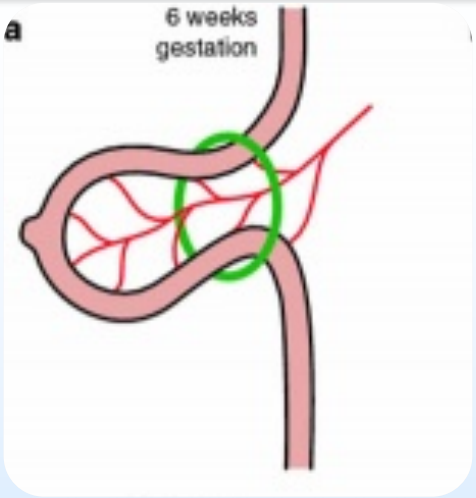
*Stage of reduction of umbilical hernia.

*Stage of fixation of various parts of intestine.

***Remember : Midgut is supplied by superior mesenteric artey (artery of midgut).**

Embryology433@gmail.com

DEVELOPMENT OF MIDGUT LOOP



1st stage

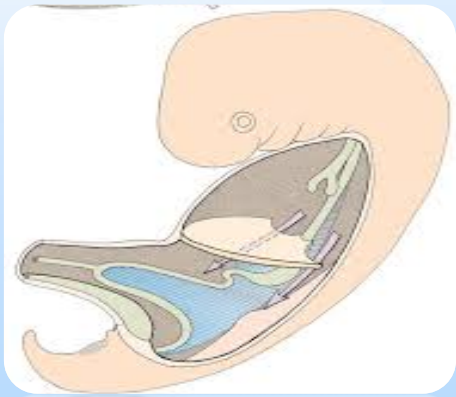
At the biginning of 6th week, the midgut elongates to form a venteral U-shaped midgut loop.

Midgut loop communicates with the yolk sac by vitelline duct or yolk stalk.

2nd stage

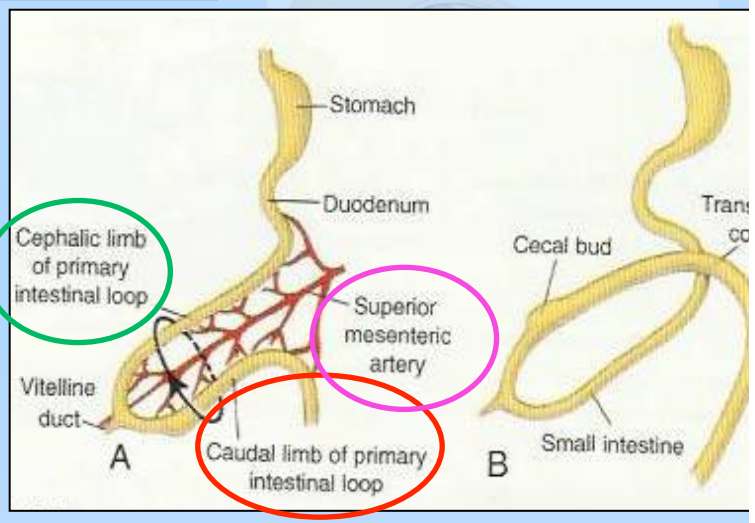
As a result of rapidly growing liver, kidneys & gut ,the abdominal cavity is **temporarily too small** to contain the developing rapidly growing intestinal loop.

So ,Midgut loop projects into **the umbilical cord** …this is called **physiological umbilical herniation (begins at 6th w.).**



DEVELOPMENT OF MIDGUT LOOP

3rd stage



***Midgut loop has a cranial limb & a caudal limb.**

Midgut loop rotates around the axis of the superior mesenteric

Embryology433@gmail.com

*Midgut loop rotates first 90 degrees to bring the cranial limb to the right and caudal limb to left during the physiological hernia.

*The cranial limb of midgut loop elongates to form the intestinal coiled loops (jejunum & ileum).

This rotation is counterclockwise and it is completed to **270** degrees, so after reduction of physiological hernia it rotates to about 180 degrees. **(90 degrees before the reduction + 180 degree after the reduction = 270 degrees)**

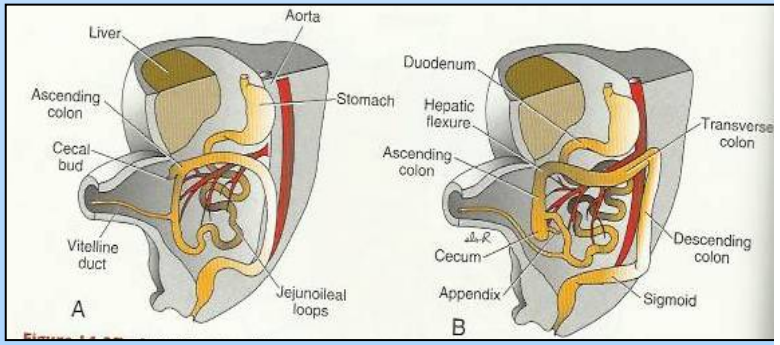
http://www.youtube.com/watch?v=AscKR_cQExY

Very helpful to understand the rotation

RETURN OF MIDGUT TO ABDOMEN*REDUCTION*

4th stage

During 10th week, the intestines return to the abdomen due to regression of liver & kidneys + expansion of abdominal cavity. It is **called reduction of physiological midgut hernia.**



*Rotation is completed and the coiled intestinal loops **lie in their final position in the left side.**

*The caecum at first lies below the liver, but **later it descends to lie in the right iliac fossa.**

FIXATION OF VARIOUS PARTS OF INTESTINE

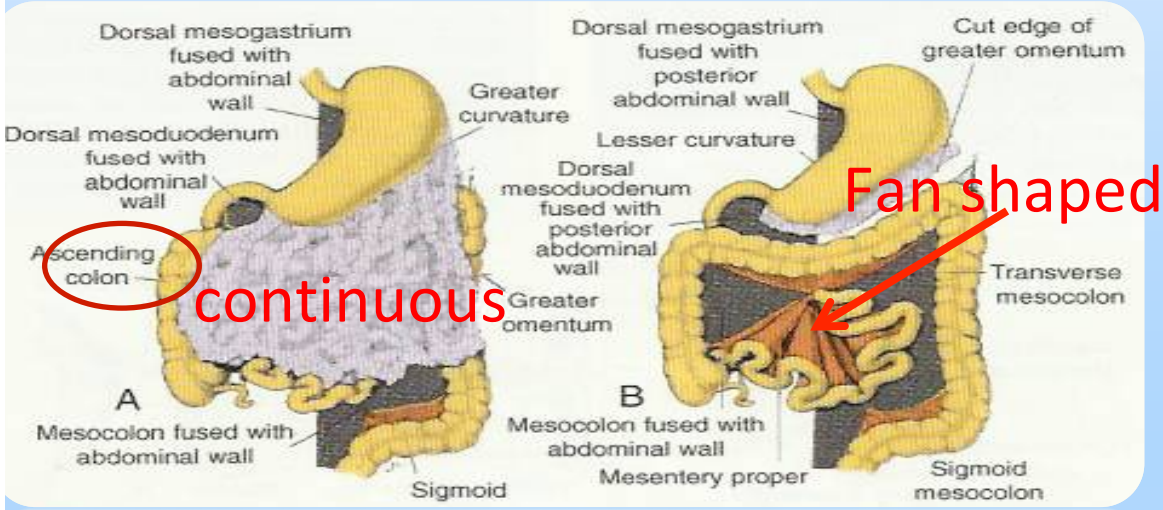
5th stage

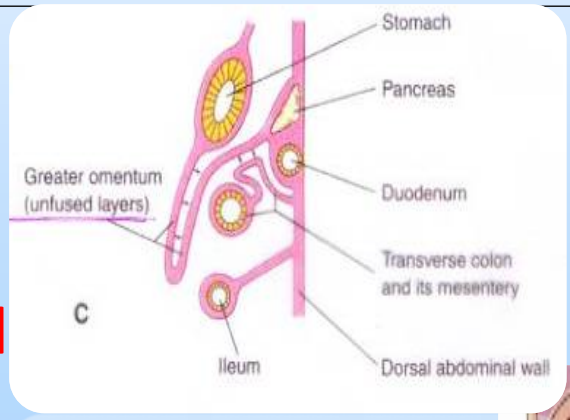
A*The mesentry of jejunoileal loops is at **first continuous with that** of the **ascending colon.**

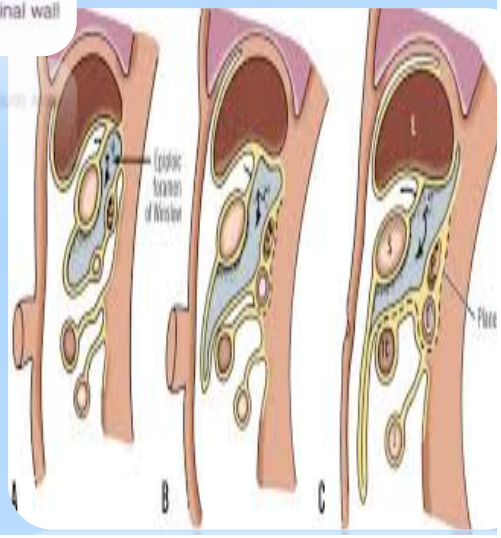
B*When the **mesentry of ascending** colon **fuses with** the **posterior abdominal wall**, **the mesentry of small intestine** becomes **fan-shaped** and acquires a new line of attachment that passes from duodenojejunal junction to the ileocecal junction.

***The enlarged colon presses the duodenum & pancreas against the posterior abdominal wall.**

***Most of duodenal mesentery is absorbed, so most of duodenum (except for about the first 2.5 cm derived from foregut) & pancreas become retroperitoneal.**







Embryology433@gmail.com

CONGENITAL ANOMALIES

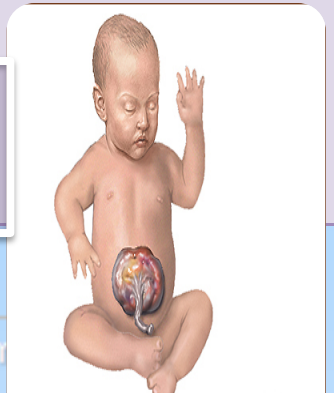
The covering layer in the first 2 anomalies are important

Congenital Anomalies of the Small Intestine		
Omphalocele	**Umbilical Hernia***	**Ileal (Meckel's) Diverticulum**
* It is a persistence of herniation of abdominal contents into proximal part of umbilical cord due to failure of reduction of physiological hernia to abdominal cavity at 10th week. *It is accompanied by small abdominal cavity. * The hernial sac is covered by the epithelium of the umbilical cord/ the amnion.	*The intestines return to abdominal cavity at 10th week, but herniate through an imperfectly closed umbilicus * It is a common type of hernia * The hernial sac is covered by skin & subcutaneous tissue. * It protrudes during crying,straining or coughing and can be easily reduced through fibrous ring at umbilicus	* most common anomalies *more common in male. * It is a small pouch from the ileum, and may contain small patches of gastric & pancreatic tissues causing ulceration, bleeding or even perforation *It is the remnant of proximal part nonobliterated part of yolk stalk (or vitelline duct). *It arises from antimesenteric border of ileum, 1/2 meter from ileocecal junction. * It is sometimes becomes inflammed and causes symptoms that mimic appendicitis.

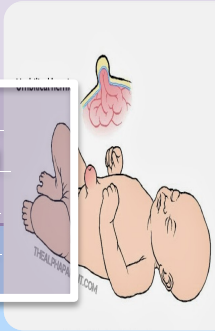
*The herniated contents are usually the greater omentum & small intestine.

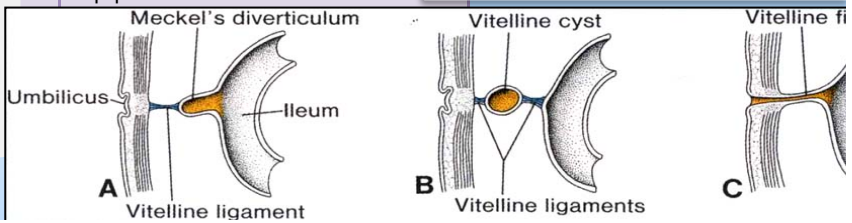
It may be connected to the umbilucus by a fibrous cord, or the middle portion forms a cyst or may remain patent forming the fistula so, faecal matter is carried through the duct into umbilicus.

Immediate surgical repair is required.



Surgery is performed at age of 3-5 years.





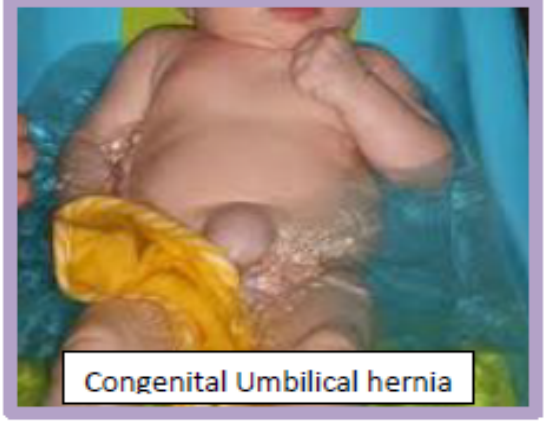
Embryology433@gmail.com

SUMMARY

Congenital anomalies

Pancreas	Duodenum	Small Intestine

Congenital omphalocele



Congenital Umbilical hernia

1-Congenital Omphalocele: It is a persistence of herniation of abdominal contents into proximal part of umbilical cord due to failure of reduction of physiological hernia to abdominal cavity at 10th week. Herniation of intestines more common than herniation of liver & intestines and It is accompanied by small abdominal cavity. The hernial sac is covered by the epithelium of the umbilical cord/ the amnion. **Immediate surgical repair is required**

2-Congenital Umbilical Hernia.: The intestines return to abdominal cavity at 10th week, but herniate through an imperfectly closed umbilicus. **It is a common type of hernia.** The herniated contents are usually the greater omentum & small intestine. The hernial sac is covered by skin & subcutaneous tissue It protrudes during crying, straining or coughing and can be easily reduced through fibrous ring at umbilicus. **Surgery is performed at age of 3-5 years.**

3-Ileal (Meckel's) Diverticulum: It is one of the most common anomalies, more common in males. It is a small pouch from the ileum, and may contain small patches of gastric & pancreatic tissues causing ulceration, bleeding or even perforation. It is the remnant of proximal part nonobliterated part of yolk stalk (or vitelline duct). It arises from antimesenteric border of ileum It is sometimes becomes inflammed and causes symptoms that mimic appendicitis and It may be connected to the umbilucus by a fibrous cord, or the middle portion forms a cyst or may remain patent forming the fistula so, faecal matter is carried through the duct into umbilicus.

1-Duodenal stenosis; results from incomplete recanalization of duodenum.

2-Duodenal atresia; results from failure of recanalization leading to complete occlusion of the duodenal lumen, (autosomal recessive inheritance).

1-Accessory pancreatic tissue; located in the wall of the stomach or duodenum.

2-Anular pancreas; a thin flat band of pancreatic tissue surrounding the second part of the duodenum, causing duodenal obstruction.

1- duodenum have distal and proximal part , each one develop differently :
-proximal from caudal part of foregut
-distal from cranial part of mid gut
then it will project ventrally forming C shaped loop (it will obstruct in 5th week and then recanalize)

2- Pancreas : develops from 2 buds arising from] caudal part of foregut (like duodenum)
-ventral pancreatic duct : from proximal end of hepatic diverticulum
-dorsal pancreatic duct : from dorsal wall of duodenum

3- small intestine: is develop from midgut and caudal part of foregut.
- The midgut loop elongate to form U shape (have communication with yolk stalk) it will project in the umbilicus(due to small cavity) then return back to the cavity with rotation 270 degree (90 degree before returning and 180 after returning)

4th week	The development of duodenum
5th +6th week	Obliteration of the lumen of duodenum
10th week	Start of insulin secretion
6th week	Stage of physiological umbilical hernia
10th week	Stage of reduction of umbilical hernia

QUIZ YOURSELF

1.Which part of the pancreas the dorsal pancreatic bud forms :

A.Upper part of the head
B.Lower part of the head
C. Body.
D. A&C .

2.The cranial limb of midgut loop gives rise to :

A.The liver.
B.The pancreas.
C.The stomach.
D.The jejunum & ileum

3. During 10th week :

A.duodenal obstruction.
B.duodenum develops from the endoderm
C.reduction of physiological midgut hernia.
D.the lumen of the duodenum is temporarily obliterated

4- Early in the 4th week:

A.duodenal obstruction.
B.The duodenum develops from the endoderm
C.reduction of physiological midgut hernia.
D.the lumen of the duodenum is temporarily obliterated

5.Derived from the caudal part of midgut loop : Lower portion of ileum.

A.True
B.False

6- IN the Congenital anomalies Accessory pancreatic tissue located in the wall of the

A.stomach
B.liver
C.duodenum
D.A &C

7-Distal part of duodenum is developed from caudal part of foregut).

A.True
B.False

8-The Midgut loop rotates around the axis of the Superior mesenteric artery

A.True
B.False

9.The Congenital Umbilical Hernia is covered with :

A.skin & subcutaneous tissue
B.It is a small pouch from the ileum,
C.It is the remnant of proximal part nonobliterated part of yolk stalk (or vitelline duct).
D.epithelium of the umbilical cord/ the amnion.

Answers: 1.D 2.D 3.C 4.B 5.A 6.D 7.B 8.A 9.A

Embryology433@gmail.com

GOOD LUCK

DONE BY

Rawan Alotaibi

Amani Alotaibi

Sarah Alseneidi

Awatif Alenezi

Noura Alnajashi

Baraah Alqarni