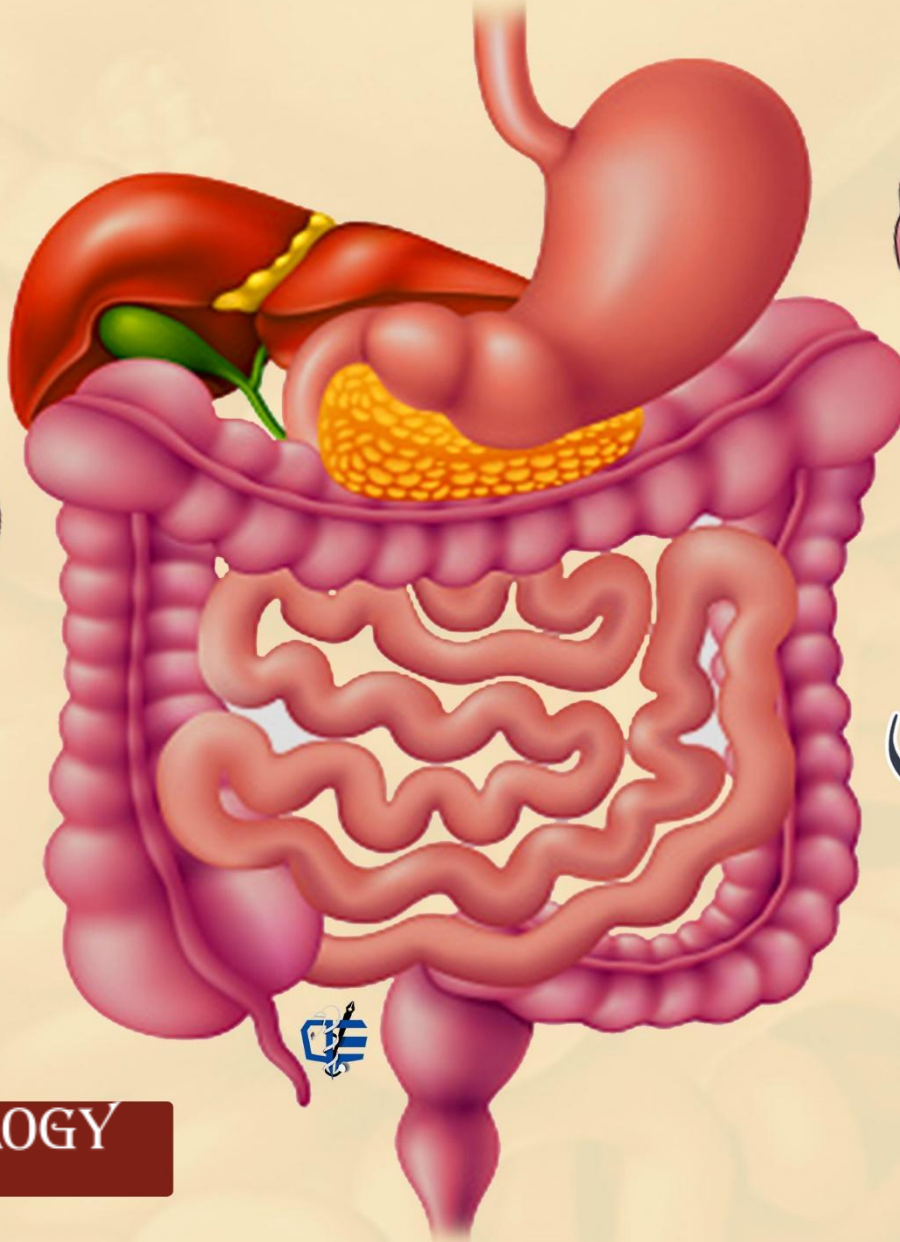


GastroIntestinal System



EMBRYOLOGY

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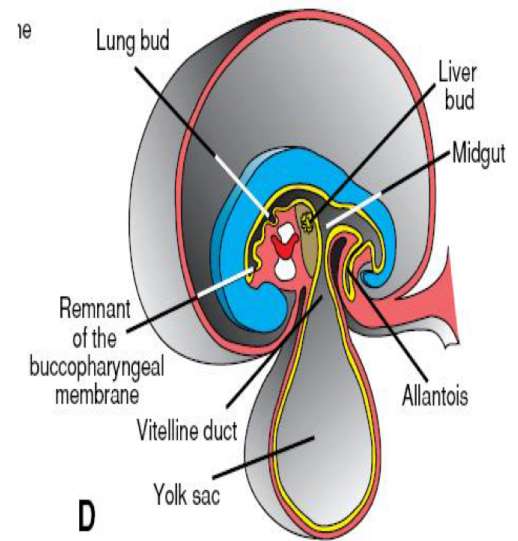
Midgut

We talked in the last lecture about the foregut (pharynx, esophagus, stomach, liver, pancreas and upper half of the duodenum) while the lower half of duodenum follows the Midgut.

The midgut is suspended from the dorsal abdominal wall by a short mesentery and communicates with the yolk sac by way of the vitelline duct or yolk stalk.

We said before that foregut blood supply is celiac trunk while the midgut is supplied by the superior mesenteric artery. And the hindgut is supplied by the inferior mesenteric artery.

Development of the midgut is characterized by rapid elongation of the gut and its mesentery (rapid elongation for the small intestine to reach 6 m length unlike the large intestine that is less rapidity), resulting in formation of the primary intestinal loop.



At its apex, the loop remains in open connection with the yolk sac by way of the narrow vitelline duct.

The midgut includes (lower half of the duodenum / jejunum / ileum / cecum / appendix / ascending colon / proximal 2/3 of the transverse colon) while the distal third follows the hindgut.

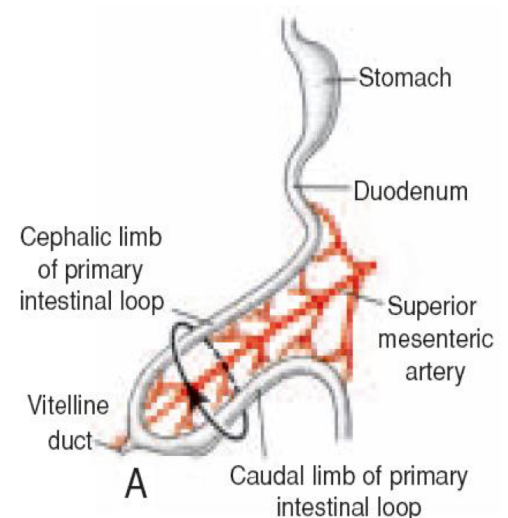
In the adult, the midgut begins immediately distal to the entrance of the bile duct into the duodenum and terminates at the junction of the proximal two-thirds of the transverse colon with the distal third.

The midgut is divided into a) cephalic limb b) caudal limb.

The cephalic limb of the loop develops into the distal part of the duodenum, the jejunum, and part of the ileum.

The caudal limb becomes the lower portion of the ileum, the cecum, the appendix, the ascending colon, and the proximal two-thirds of the transverse colon.

The apex of the cephalic and caudal limb is called the vitelline duct (that's connect the apex with umbilicus).



PHYSIOLOGICAL HERNIATION .

Development of the primary intestinal loop is characterized by rapid elongation, particularly of the cephalic limb.

As a result of the rapid growth and expansion and enlargement of the liver and heart the abdominal cavity temporarily becomes too small to contain all the intestinal loops, and they enter the extraembryonic cavity in the umbilical cord through the umbilical ring during the sixth week of development (physiological umbilical herniation)

ROTATION OF THE MIDGUT

Coincident with growth in length, the primary intestinal loop rotates around an axis formed by the superior mesenteric artery

When viewed from the front, this rotation is counterclockwise, and it amounts to approximately 270° when it is

complete(Rotation occurs during herniation (about 90°) as well as during return of the intestinal loops into the abdominal cavity (remaining 180°))

Even during rotation, elongation of the small intestinal loop continues, and the jejunum and ileum form a number of coiled loops (elongation to become 6 m)

The large intestine likewise lengthens considerably but does not participate in the coiling phenomenon.

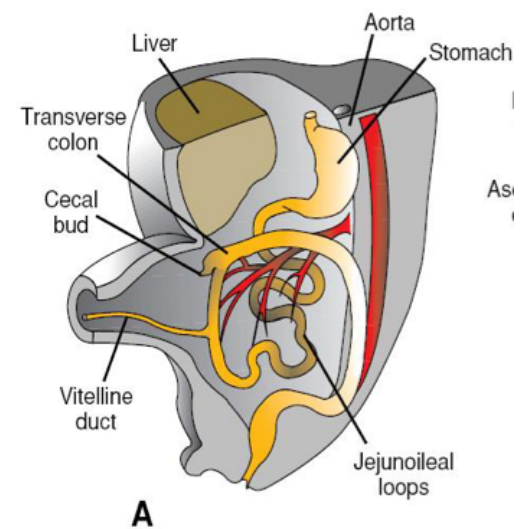
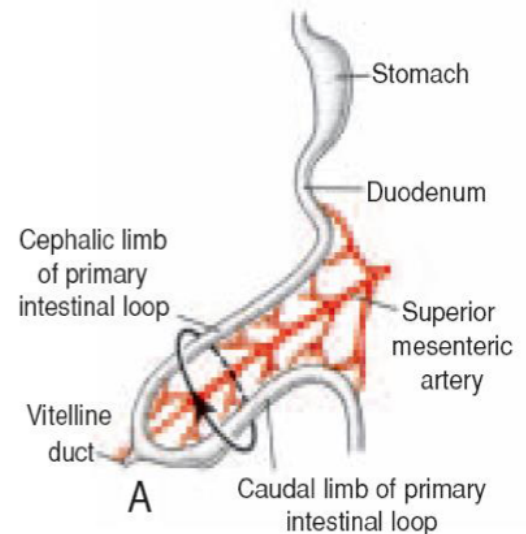
RETRACTION OF HERNIATED LOOPS:

During the 10th week, herniated intestinal loops begin to return to the abdominal cavity.

is thought that regression of the mesonephric kidney, reduced growth of the liver, and expansion of the abdominal cavity play important roles of retraction of the hernia .

During the retraction the proximal portion of the jejunum, the first part to reenter the abdominal cavity, comes to lie on the left side of the abdominal cavity .

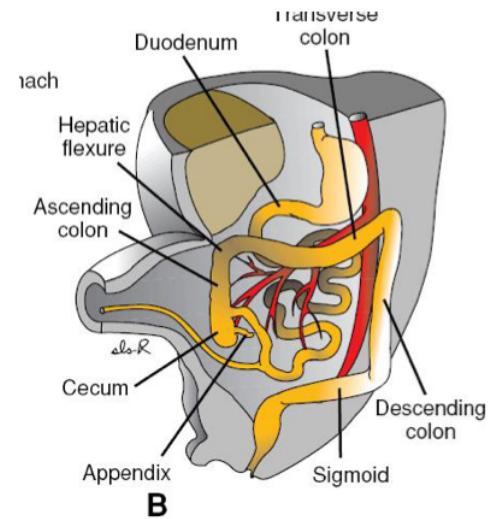
The later returning loops(like the cecum) gradually settle more and more to the right.



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.

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 give bud called appendicular bud forms the appendix) and hepatic flexure on the right side of the abdominal cavity



Notes about this figure:

A) cecal bud that's form below the liver and we see the vitelline duct

B) small intestine form a coiling and we see the cecal bud and appendicular diverticulum

C) then it descend downward in the right iliac fossa and form the appendix, cecum and ascending colon.

During this process the distal end of the cecal bud forms a narrow diverticulum, the appendix.

Since the appendix develops during descent of the colon, its final position frequently is posterior to the cecum or colon.

These positions of the appendix are called retrocecal or retrocolic, respectively.

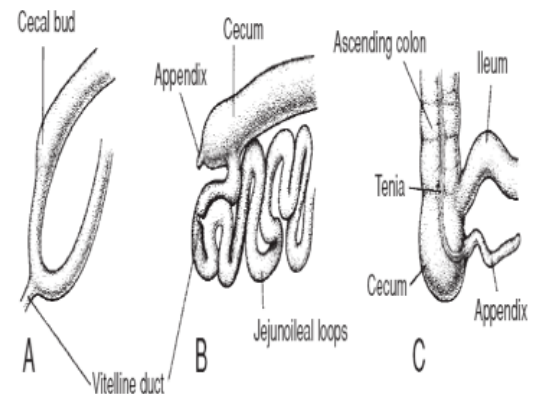


Figure 13.28 Successive stages in development of the cecum and appendix. **A.** 7 weeks. **B.** 8 weeks. **C.** Newborn.

MESENTERIES OF THE INTESTINAL LOOPS:

The transverse colon has mesocolon/ small intestine has mesentery (fan in shape) /sigmoid colon has mesentery

But the ascending and descending colon and duodenum fixed in the posterior abdominal wall.

The mesentery of the primary intestinal loop, the mesentery proper, undergoes profound changes with rotation and coiling of the bowel.

When the caudal limb of the loop moves to the right side of the abdominal cavity, the dorsal mesentery twists around the origin of the superior mesenteric artery.

Later, when the ascending and descending portions of the colon obtain their definitive positions, their mesenteries press against the peritoneum of the posterior abdominal wall

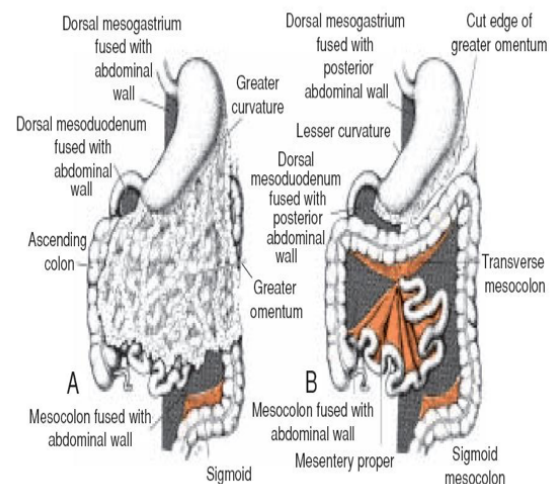
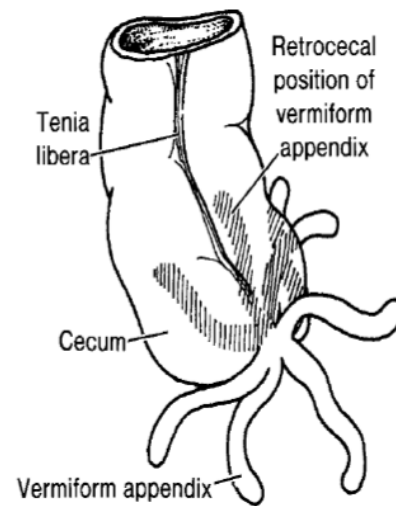


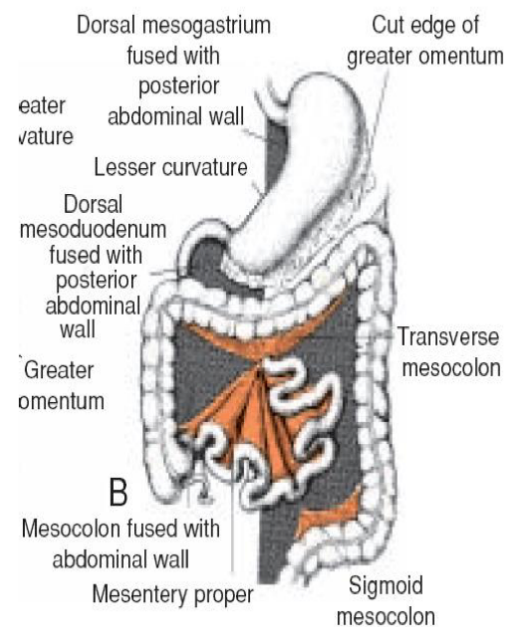
Figure 13.30 Frontal view of the intestinal loops with (A) and after removal of (B) the greater omentum. Gray areas, parts of the dorsal mesentery that fuse with the posterior abdominal wall. Note the line of attachment of the mesentery proper.

- After fusion of these layers, the ascending and descending colons are permanently anchored in a retroperitoneal position.
- The appendix, lower end of the cecum, and sigmoid colon, however, retain their free mesenteries
- The fate of the transverse mesocolon is different. It fuses with the posterior wall of the greater omentum but maintains its mobility.
- Its line of attachment finally extends from the hepatic flexure of the ascending colon to the splenic flexure of the descending colon



The mesentery of the jejunoileal loops is at first continuous with that of the ascending colon • When the mesentery of the ascending mesocolon fuses with the posterior abdominal wall, the mesentery of the jejunoileal loops obtains a new line of attachment that extends from the area where the duodenum becomes intraperitoneal to the ileocecal junction

The mesentery extends from the duodenojejunal junction on the left side at the level of the L2 and to the right side in front of sacroiliac joint in the right iliac fossa



Gut Rotation Defects: defects during rotation of the gut

Abnormal rotation of the intestinal loop may result in twisting of the intestine (volvulus) and a compromise of the blood supply. (Cause intestinal obstruction)

Normally the primary intestinal loop rotates 270° counterclockwise. Occasionally, however, rotation amounts to 90° only that's causing the volvulus when this occurs, the colon and cecum are the first portions of the gut to return from the umbilical cord, and they settle on the left side of the abdominal cavity, The later returning loops then move more and more to the right, resulting in left- sided colon.

When the rotation instead of counterclockwise become clockwise we will find the left side organs become in the right and vice versa

Reversed rotation of the intestinal loop occurs when the primary loop rotates 90° clockwise In this

abnormality the transverse colon passes behind the duodenum and lies behind the superior mesenteric artery.(but if it rotates completely it become in the opposite side)

Duplications of intestinal loops and cysts may occur anywhere along the length of the gut tube

They are most frequently found in the region of the ileum, where they may vary from a long segment to a small diverticulum.

- Symptoms usually occur early in life, and 33% are associated with other defects, such as intestinal atresias, imperforate anus, gastroschisis, and omphalocele

Gut Atresias and Stenoses :

Atresias and stenoses may occur anywhere along the intestine

- Most occur in the duodenum, fewest occur in the colon, and equal numbers occur in the jejunum and ileum (1/1500 births).

- Atresias in the upper duodenum are probably due to a lack of recanalization

The duodenum early was solid filled with cells but after that recanalization take place .

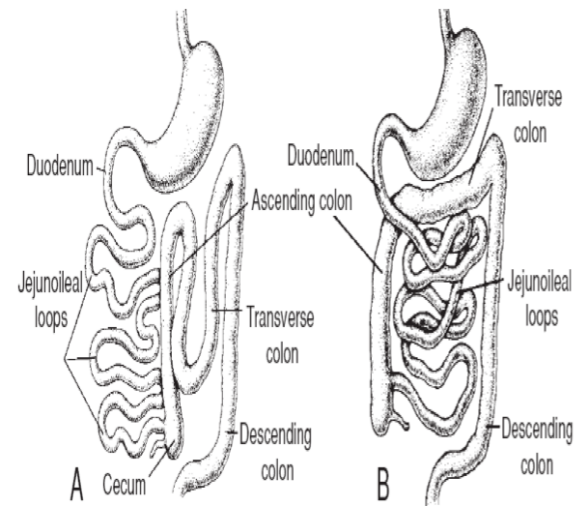


Figure 13.33 A. Abnormal rotation of the primary intestinal loop. The colon is on the left side of the abdomen, and the small intestinal loops are on the right. The ileum enters the cecum from the right. B. The primary intestinal loop is rotated 90° clockwise (reversed rotation). The transverse colon passes behind the duodenum.

Body Wall Defects:

Omphalocele involves herniation of abdominal viscera through an enlarged umbilical ring.

The origin of the defect is a failure of the bowel to return to the body cavity from its physiological herniation(remain in the umbilical cord outside the umbilical ring)

It characterized by the viscera are covered by amnion.

Omphalocele occurs in 2.5/10,000 births and is associated with a high rate of mortality (25%) and severe malformations, such as cardiac anomalies (50%) and neural tube defects (40%).

Approximately half of live-born infants with omphalocele have chromosomal abnormalities.



Gastroschisis is a herniation of abdominal contents through the body wall directly into the amniotic cavity.

- It occurs lateral to the umbilicus usually on the right not in the umbilical cord .



Hindgut

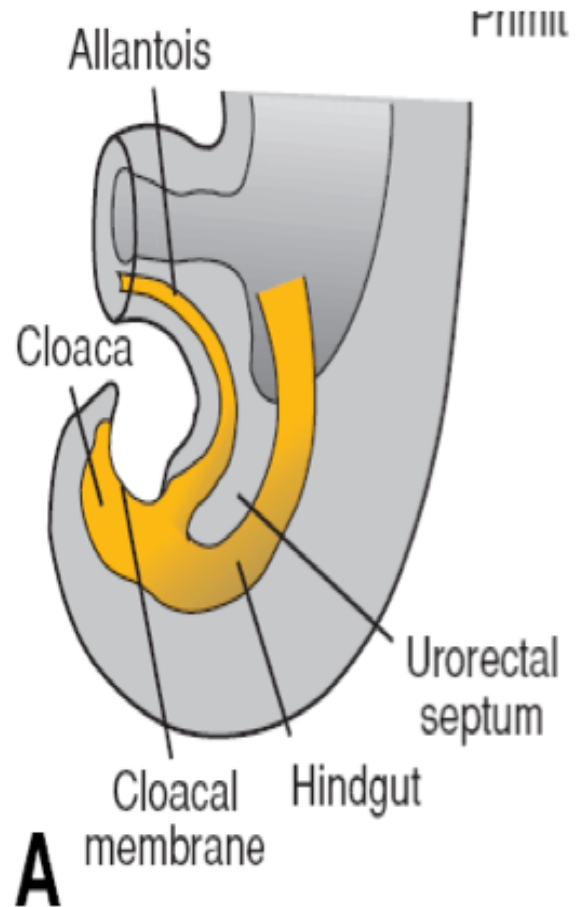
Notes about this figure:

We see hind gut that's connected with the cloaca(lower end of the GI tract it's endodermal sac connected anteriorly with the yolk sac and allantois) Allantois connected with the umbilicus and must obliterate to avoid the connection between urinary bladder and umbilicus and the urine get out through the umbilicus.

We see urorectal septum (that's mesenchyme (CT surrounding the end of the hindgut , allantois and yolk sac.

The hindgut gives rise to the distal third of the transverse colon, the descending colon, the sigmoid, the rectum, and the upper part of the anal canal.

- The endoderm of the hindgut also forms the internal lining of the bladder and urethra (that are anteriorly)
- The terminal portion of the hindgut enters into the posterior region of the cloaca, the primitive anorectal canal; the allantois enters into the anterior portion, the primitive urogenital sinus.



So the cloaca is attached anteriorly by yolk sac / allantois/urogenital sinus (that's form the urinary bladder and urethra)

And posteriorly the hindgut

The cloaca itself is an endoderm- lined cavity covered at its ventral boundary by surface ectoderm. (called proctodeum that's important because it forms the lower half of anal canal

- This boundary between the endoderm and the ectoderm forms the cloacal membrane
- A layer of mesoderm, the urorectal septum, separates the region between the allantois and hindgut.
- This septum is derived from the merging of mesoderm covering the yolk sac and surrounding the allantois.

At the end of the seventh week, the cloacal membrane ruptures, creating the anal opening for the hindgut and a ventral opening for the urogenital sinus.

- Between the two, the tip of the urorectal septum forms the perineal body
- proliferation of ectoderm closes the caudal most region of the anal canal.(after rupture of the anal membrane the ectoderm make closure of the septum and separation between the ectodermal part and the endodermal parts)
- During the ninth week, this region recanalizes •

Thus, the caudal part(lower half)of the anal canal originates in the ectoderm (proctodeum) and it is supplied by the inferior rectal arteries, branches of the internal pudendal arteries while the upper half supplied by the superior rectal artery)

The junction between the endodermal andectodermal regions of the anal canal is delineated by the pectinate line, just below the anal columns

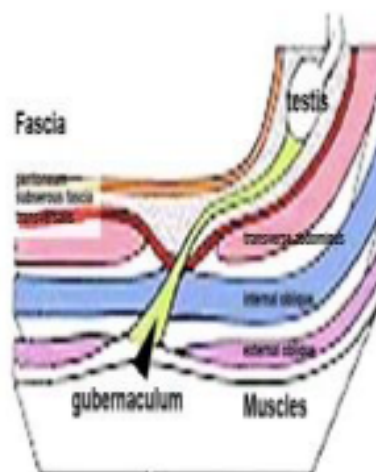
- At this line, the epithelium changes from columnar to stratified squamous epithelium.

Abnormalities in the hindgut

- 1)Urorectal fistula (connection between the lower end of the rectum and urinary bladder)**
- 2)rectovaginal in female (rectum opening into the vagina)**
- 3)rectoperineal fistula (opening into perineum)**
- 4)imperforated anus (resulting from failure of the anal membrane to breakdown)**

Testis

- Toward the end of the second month, the **urogenital mesentery attaches the testis** and mesonephros to the posterior abdominal wall
- Prior to descent of the testis, this band of mesenchyme terminates in the inguinal region between the differentiating internal and external abdominal oblique muscles.
- Later, as the testis begins to descend toward the inguinal ring, an extra-abdominal portion of the gubernaculum forms and grows from the inguinal region toward the scrotal swellings.
- When the testis passes through the inguinal canal, this extra-abdominal portion contacts the scrotal floor



- Normally, the testes reach the inguinal region by approximately 12 weeks gestation, migrate through the inguinal canal by 28 weeks, and reach the scrotum by 33 weeks
- The process is influenced by hormones, including androgens and MIS
- Independently from descent of the testis, the peritoneum of the abdominal cavity forms an evagination on each side of the midline into the ventral abdominal wall.
- This evagination, the **processus vaginalis**, follows the course of the gubernaculum testis into the scrotal swellings
- Hence the processus vaginalis, accompanied by the muscular and fascial layers of the body wall, evaginates into the scrotal swelling, forming the **inguinal canal**

