Digestive System

University of Jordan

Faculty of Medicine

Batch of 2013-2019

Medical Committee
The University of Jordan

◯ Slide ● Sheet ◯ Handout ◯ Other

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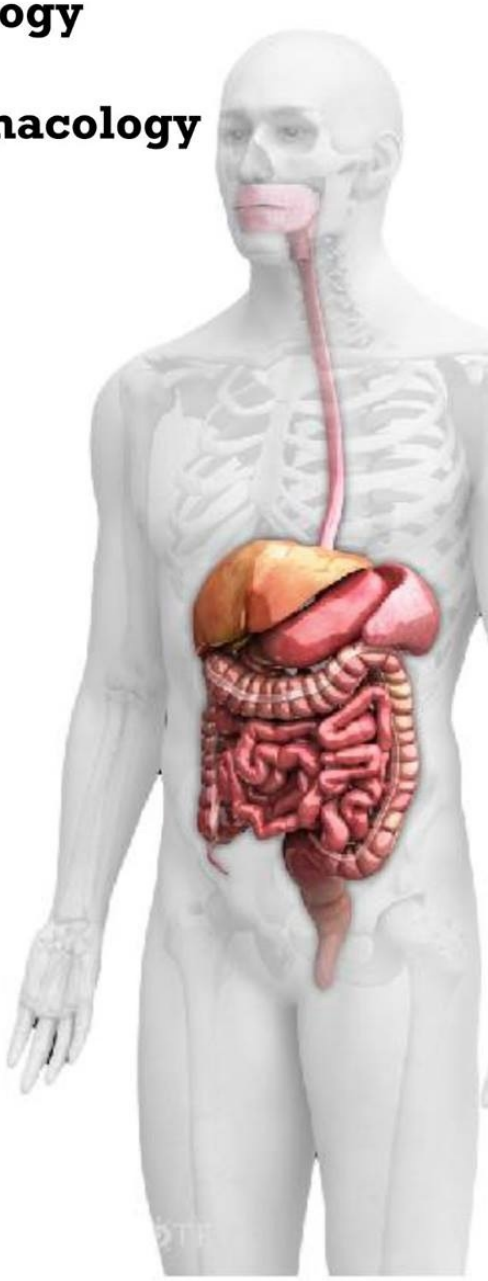

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Date:

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DESIGNED BY: TAMER ALTAMIMI "SMILE"

Development Of The Foregut, Midgut and hindgut

**I'm going to highlight the structures the doctor mentioned in the pictures shown in the lecture.

Development of the stomach:

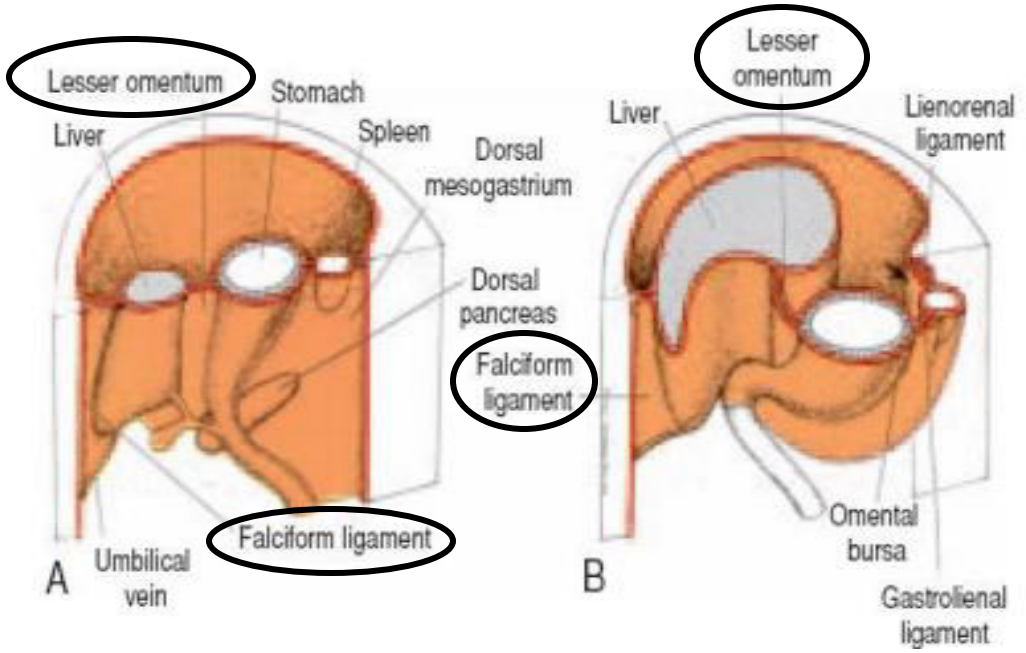
We finished the last lecture talking about the dorsal and ventral mesogastria (mesenteries).

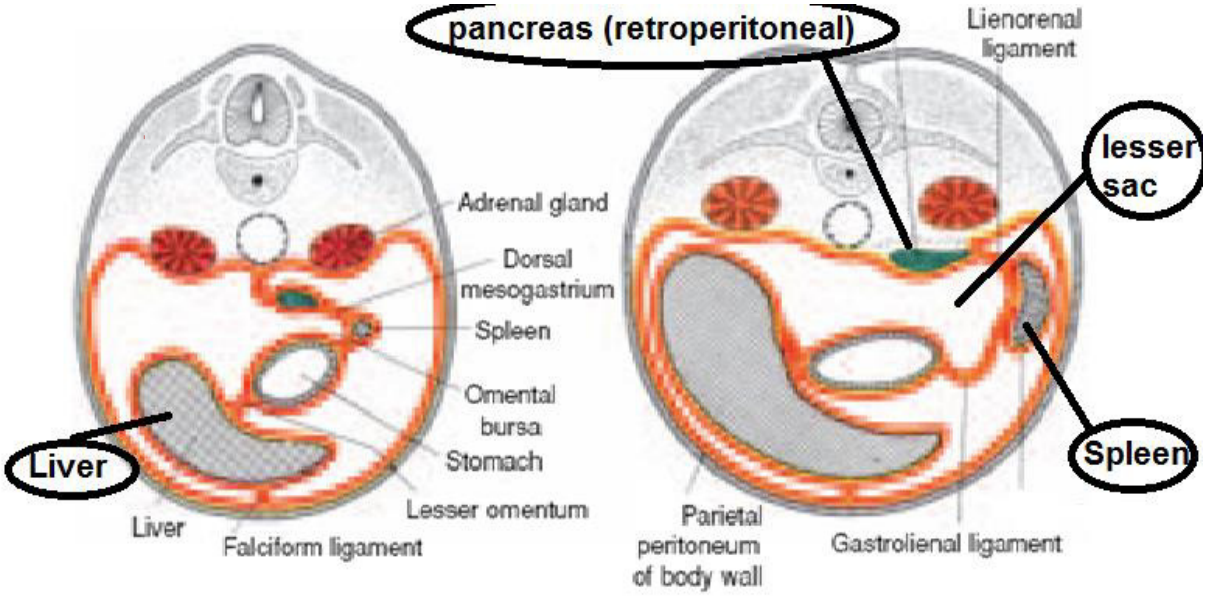
-When the stomach rotates, a space is formed behind the stomach called the Omental bursa (or lesser sac).

- The ventral mesentery is derived from the septum transversum which is found in the chest.

- The liver enlarges and moves to the right side dividing the ventral mesentery into:

1- lesser omentum 2- falciform ligament of the liver.





-The dorsal mesogastrium makes:

1-The lienorenal ligament 2-The gastrosplenic ligament 3-The greater omentum

-The greater curvature of the stomach gives off the greater omentum that is composed of two layers. The greater omentum descends then ascends as two layers and fuses with the mesentery of the transverse colon.

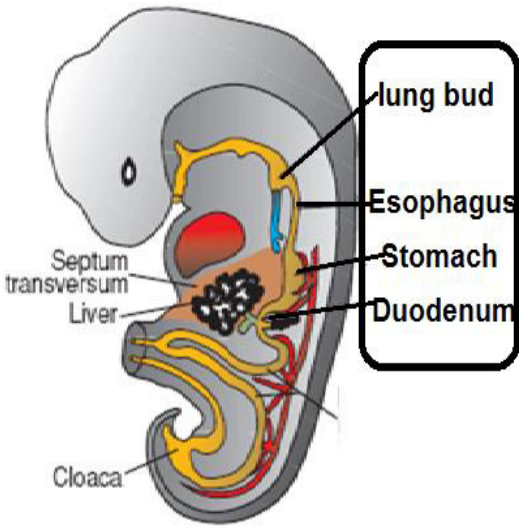
-Then the mesocolon (the mesentery of the transverse colon) terminates at the anterior border of the pancreas.

-The falciform ligament, which is derived from the ventral mesogastrium, contains the umbilical vein which is obliterated after birth to form the **round ligament of the liver (aka ligamentum teres hepatis).**

-Ligament of trietz is found at the junction between duodenum & jejunum and attaches posteriorly to the right crus of the diaphragm. Its function is the fixation of the duodenum.

-The epiploic foramen is found deep to lesser omentum and connects the greater and lesser sac.

Liver & Gallbladder:



in the figure to the right we can see the lung bud, esophagus, and duodenum along with pancreas and liver.

-Actually, the duodenum, pancreas and liver all follow the development and rotation of the stomach (i.e. when the stomach rotates clockwise by 90 degrees, they all rotate in the same manner.) Also ventral (anterior) pancreatic bud (described later) will rotate and become under the posterior (dorsal) pancreatic bud.

-The liver appears in the middle of the **third week** as an outgrowth of the endodermal epithelium at the distal end of the foregut (i.e. at the junction between the upper and lower halves of the duodenum).
-this out growth is called the hepatic diverticulum or the liver bud, and below it there's the ventral pancreatic bud.
-**Liver bud,** consists of rapidly proliferating cells that penetrate the **septum transversum,** which is a mesenchyme (mesodermal plate) found in the lower part of chest between the pericardial cavity and the stalk of the yolk sac.
-this penetration of hepatic cells into the septum results in the formation of hepatic diverticulum which in turn forms the **Bile ducts**(right, left and common bile ducts).From the right bile duct there's a cystic bud that forms "later on" the cystic duct.

The formation of hepatic sinusoids:

The septum transversum (the mesenchyme) contains vitelline blood vessels and umbilical blood vessels that disintegrate and intermingle with epithelial liver cords to form hepatic sinusoids.

-So, hepatocytes are formed inside the mesenchyme. Kupffer cells and connective tissue cells are formed between hepatocytes.

-from slides: **Hematopoietic cells, Kupffer cells,** and **connective tissue cells** are derived from mesoderm of the septum transversum.

The formation of the Gallbladder:

From the right hepatic bud, the cystic bud appears then proliferates to form the gallbladder and cystic duct. After that, canalization happens in gallbladder and the cystic duct.

Liver & Gallbladder Abnormalities:

1- Duplication of the gallbladder along with one or two cystic ducts that open in the hepatic duct.
2- Stenosis or atresia in the biliary duct, occurs in 1/15,000 live births.
3- From slides: intrahepatic biliary duct atresia and hypoplasia.

Duodenum:

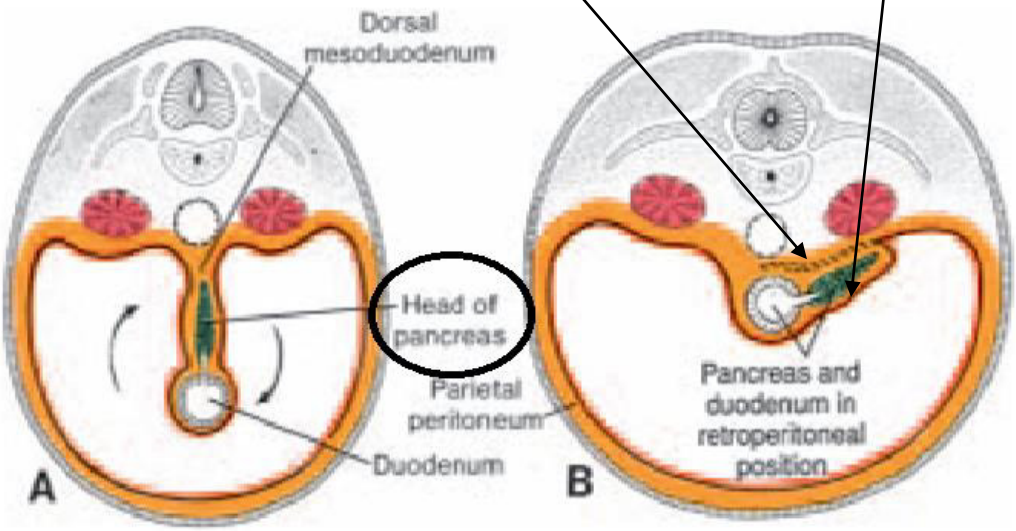
The duodenum is divided into upper and lower halves; the upper half belongs to the foregut, follows the rotation of the stomach and attached to the ventral mesogastrium (whereas the dorsal mesogastrium attaches to the dorsal part of **the whole duodenum (upper half and lower half, not only the upper half)**. However, the lower half follows the midgut.

The rotation of the duodenum with the stomach results in:
1- C-shaped concavity directed backwards.
2- The pancreas becomes directed from left to right and sits in the concavity of the duodenum.

The duodenum is originally a solid rod of growing and proliferating cells, and then canalization to this rod takes place so that it has a lumen.

Pancreas:

Originally found between the two layers of peritoneum, then the posterior layer of the peritoneum disappears (the dotted line in the figure), and the anterior layer persists as a parietal peritoneum, so the pancreas and duodenom are retroperitoneal organs that are attached to the posterior abdominal wall by connective tissue.

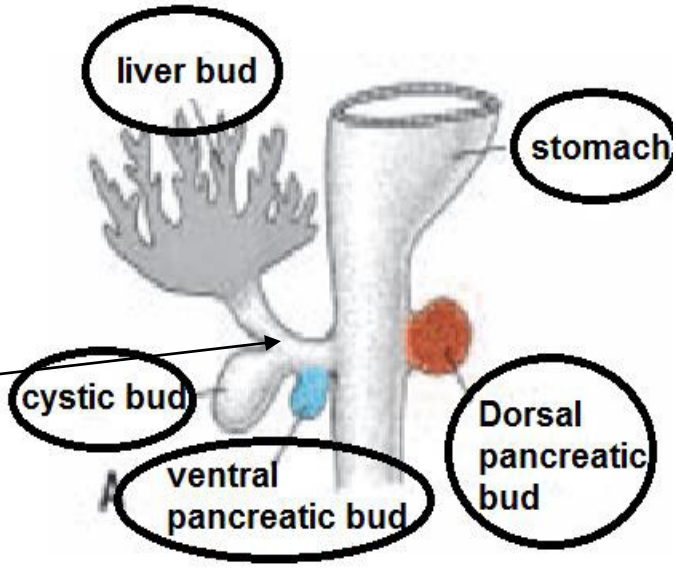


The pancreas is formed by two buds originating from the endodermal lining of the duodenum. ** The figure to the right represents the different buds:

-The dorsal pancreatic bud lies in the dorsal mesentery and the ventral bud lies in the ventral mesentery.

-When the stomach rotates clockwise by 90 degrees, the ventral pancreatic bud rotates also, so it becomes below the dorsal pancreatic bud.

-The duct of the liver bud will form the common bile duct which commonly opens with the pancreatic duct.



-The main pancreatic duct is mainly from the ventral bud and part of the dorsal. We could also have an accessory pancreatic duct.

At the third month of fetal life, the islets of langerhans develop from parenchyma of pancreatic tissue and are found scattered between pancreatic acini.

-Secretion of insulin, Glucagon and somatostatin begins approximately at the fifth month of fetal life.

Pancreatic Abnormalities:

1- **Annular pancreas:** failure of rotation of the ventral bud. Instead of being below the dorsal bud, it stays in the middle of duodenum and blocks or separates the duodenum causing stenosis or atresia in it. These cases are serious and need surgical intervention.

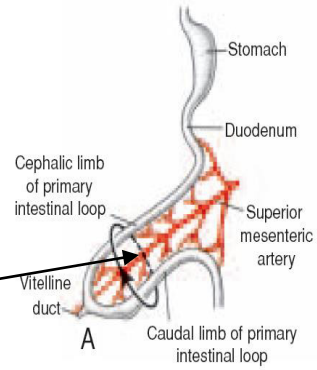
2- **Accessory pancreatic tissue** may be anywhere from the distal end of the esophagus to the tip of the primary intestinal loop, most frequently it lies in the mucosa of the stomach and in Meckel's diverticulum.

Midgut

-Extends from the lower half of the duodenum till the lateral third of transverse colon. So it involves the lower half of the duodenum, the small intestine (jejunum &illium), cecum, appendix, ascending colon and proximal two thirds of the transverse colon. While the hind gut involves the lateral third of transverse colon, descending colon, sigmoid colon, rectum and upper half of anal canal.

-The vitelline duct (also called vitellointestinal duct) connects midgut to the yolk sac or the umbilicus.

-superior mesenteric vessels supply midgut. The artery starts from the abdominal aorta then enter the yolk sac along with vitelline duct. The superior mesenteric artery forms the axis.



-During development, the following actions take place:
1- elongation and coiling of the small intestine (the large intestine also elongates but without coiling).

2- Rotation around the superior mesenteric artery. Here the rotation is different from the rotation of stomach; it's counter-clockwise by 270 degrees (90 then 180).

The enlargement of the liver and kidneys makes the space in the abdominal cavity smaller, so when the small intestine (mainly jejunum and ileum) elongates it passes through the umbilical cord towards the umbilicus, this process is called the **physiological herniation**, so physiological herniation is the passage of the midgut through the umbilical cord toward the umbilicus. During the physiological herniation a rotation by 90 degrees counter-clockwise takes place. This happens in the 6th(or 5th to 6th) week.

The hernia continues till the 10th week. Then in the 10th or 11th week the hernia (the midgut) returns back to the abdominal cavity. Other 180 degrees of rotation counter-clockwise are achieved during the process of returning back (90+180=270). The later returning loops gradually settle more and more to the right.

The cecum is a diverticulum in the large intestine, the appendix is a small bulge from the cecum. After the return of the hernia (before delivery), we will find the appendix below the liver as a result of the rotation. But after delivery it descends vertically downward to its position in the right iliac fossa.

The cecal bud appears at the 6th week as a small conical dilation (and the appendix emerges from it), temporarily it lays in the right upper quadrant directly below the right lobe of the liver. Later on it descends into the right iliac fossa, placing the **ascending colon and hepatic flexure on the right side of the abdominal** cavity. Appendix also develops and descends with the cecum to the final position in the right iliac fossa, and it mostly takes a retrocecal position.

MESENTERIES OF THE INTESTINAL LOOPS

They are derived from the dorsal mesentery which is attached to the posterior abdominal wall. It is composed of two layers. Between the two layers is the superior mesenteric artery.

The beginning of jejunum is attached via ligament of trietz to the right crus at the posterior abdominal wall. This ligament fixes the end of duodenum and the beginning of jejunum.

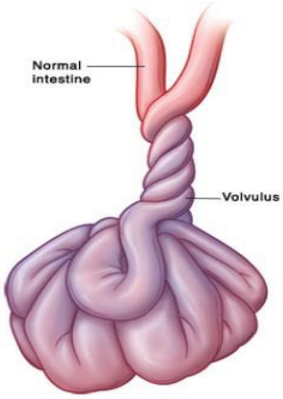
The mesentery of the transverse colon (the mesocolon), which is 2 layers peritoneum from greater omentum, goes toward the posterior abdominal wall and is attached to the anterior border of the pancreas.

So those mesenteries are important, derived from the dorsal mesentery, attached to the posterior abdominal wall and form the retroperitoneal position of some organs such as the duodenum.

Defects:

i.Gut Rotation Defects, like:

1- Volvulus: twisting of small intestine upon itself, like if you twist a long balloon on itself creating a kink, this is a very serious condition since it can cause cut off the blood supply. (See the figure).
2- Rotation of the intestinal loop clockwise instead of counterclockwise, so you can find the cecum and the appendix in the left iliac fossa instead of the right.
3- Duplication of the intestinal loop and cysts may also occur in the small intestine.



ii.Gut atresia or stenosis (closure)**:** results in difficulty in passage of the digestive material.

iii.Body Wall Defects, like:

1- Omphalocele:

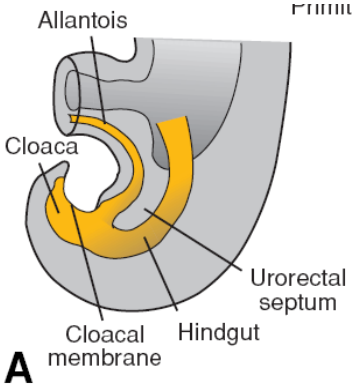
-a physiological herniation of the abdominal viscera through the umbilical ring.
-Usually covered by amnion.
-The origin of the defect is a failure of the bowel to return to the body cavity from its physiological herniation.
-occurs in 2.5/10,000 births and is associated with a high rate of mortality (25%) and (5%) severe malformations, such as cardiac anomalies (50%) and neural tube defects (40%).
-Infants with omphalocele have chromosomal abnormalities.

2- Gastroschisis:

-is also a herniation of abdominal contents through the abdominal wall **directly into the amniotic cavity.**
-occurs lateral to the umbilicus usually on the right side.

Hindgut

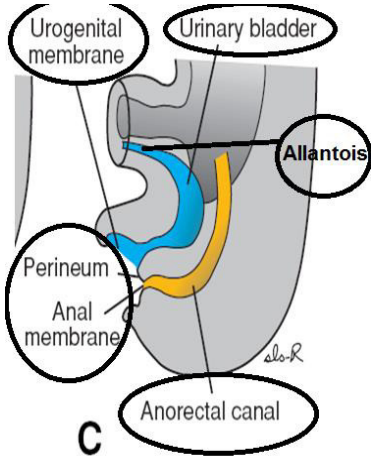
Involves the lateral third of the transverse colon, descending colon, sigmoid colon, rectum and anal canal.



-The **allantois** is a duct between the urinary bladder and the umbilicus, if it is abnormally not obliterated, urine may pass from the urinary bladder to the umbilicus.
-in the figure, you can notice the **urogenital sinus** which will develop into the urinary system and genital organs.
-**Cloaca** is what will develop into urinary bladder.
-at the stage represented by the first figure, there is a *connection* between the cloaca and the hindgut. Also you

can see between them the cloacal membrane found at the surface.

- During development, there should be separation of them and each of them should open into a special opening. The **urorectal septum** (a connective tissue septum separates the region between the allantois and the hindgut) is going to do this job by growing downward.



-The cloacal membrane, anal membrane and the urogenital membrane rupture.
-The perineum is formed between the urinary and anal triangle.
-So we end up with two parts (anal part and urogenital part) that take blood supply from *inferior mesenteric artery* which gives off branches especially to the lower part (inferior rectal & internal pudendal branches).
-The region that ruptures is closed at the beginning then canalization process takes place so that it becomes opened.

-in the anal canal, there is a line called the **pectinate line**, which is a junction (separates) between the upper (endodermal)& lower (ectodermal) halves.
-the upper half is endodermal in origin and represents the end of the hindgut.
-the lower half is ectodermal in origin and comes from the **proctodeum** which comes from the surface. That's why the lower half is lined by stratified squamous epithelium.

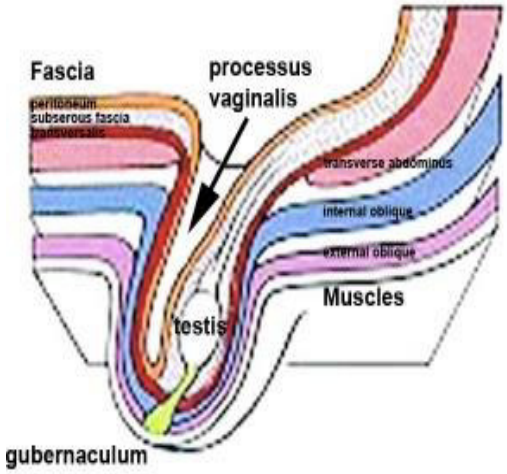
Abnormalities in the development of the anal canal:

1- Imperforated anus: the proctodium did not rupture thus there is no opening.
2- Fistula between the rectum and urinary bladder (urorectal fistula "opening"), there is no formation of the lower half of the anal canal and that results in the formation of a fistula.
3- In female, a fistula between the rectum and vagina (rectovaginal fistula) may form, also because there is no formation of the lower half of the anal canal.

Testes

They are formed at the level of L1 in the posterior abdominal wall, then the gubernaculum (comes from the embryo) and the processus vaginalis (from the peritoneum) pull them down to the scrotum.

-The gubernaculum (in the yellow color) is considered as a guideline; it pulls the testis downward and the processus vaginalis follows.
-The peocessus vaginalis runs with (follows) the gubernaculum and forms the inguinal canal between the deep and superficial inguinal ring, then the testis reaches the scrotum in the 8th month (could be 7th). If it does not reach the scrotum, then there is a maldescending and we should look for its position and treat it as soon as possible because its cells can transform into cancerous cells. Also the descending of the testis into the scrotum is important for the formation of sperms before the puberty age.



يعيش النادي الأهلي العريق
dedications to Mamoun عشان نفسه تنكتب اسمه بشيت
& Qusai Masad عشان أكل راسي وهو بطلب مني أعمله ديديكيشن بده يبين مشهور وهيك
& abo alMahafzah تحية خاصة هو بعرف ليش