Embryology of the Midgut and Hind gut

Prof. Abdulameer Al-Nuaimi

E-mail: a.al-nuaimi@sheffield.ac.uk

E-mail: abdulameerh@yahoo.com
Development of Duodenum
The Proximal part of duodenum belongs to the foregut and the distal part is to Midgut. The junction between them is at the entrance of Common bile duct. During rotation of the Foregut, the duodenum changes to C-shaped Loop and rotates and swings to the right side of the body. The head of pancreas grows rapidly and fills in the concavity of the C-shaped duodenum.
In this process the right surface of dorsal mesoduodenum fuses with peritoneum lining the posterior abdominal wall, then both layers eventually disappear, and the duodenum and pancreas become fixed in a retroperitoneal position. Only the first inch of duodenum (duodenal cap, adjacent to the pylorus) retains its mesentery and remains intraperitoneal.

Since duodenum belongs partly to the Foregut and Midgut, it is supplied by Celiac and Superior mesenteric artery. These arteries anastomose with each other around the entrance of Com. bile duct.
Development of Duodenum

Liver
Com. Hepatic duct
Cystic duct
Com. Bile duct
Gall bladder
Ampulla of Vater
Sphincter of Oddi
Pancre
Pancreatic duct
Panc. head
Duodenum

www.google.co.uk/search?
Development of Duodenum

- Dorsal mesentery
- Dorsal pancreas
- Duodenum
- Ventral mesentery
- Ventral pancreas

Avascular plane of fusion (fascia of Treitz)

Pancreas

Duodenum
Development of midgut

In adult, the midgut begins immediately distal the entrance of the common bile duct into the duodenum and ends at the junction of the Rt. 2/3 of the transverse colon with its Lt. 1/3. It is suspended to the posterior abdominal wall by short dorsal mesentery. Midgut is connected to the yolk sac by the Vitelline duct. The midgut is supplied by the Superior Mesenteric Artery.

Development of midgut passes in many stages

1- Stage of Elongation: rapid elongation of the midgut takes place to form the Primary Intestinal loop

The cephalic limb (proximal part) of the primary Intestinal loop develops into

1- Distal part of the duodenum
2- Jejunum
3- Part of the ileum
The Caudal Limb (distal part) of the primary Intestinal loop develops into:

1. Lower portion of ileum
2. Caecum
3. Appendix
4. Ascending colon
5. Right 2/3 of the transverse colon

Midgut Midline section
Sagittal sections through embryos at various stages of development demonstrating the effect of cephalocaudal and lateral folding on the position of the endoderm-lined cavity. Note formation of the foregut, midgut, and hindgut. 

A. Presomite embryo. 
B. Embryo with seven somites. 
C. Embryo with 14 somites. 
D. At the end of the first month.
2- Stage of physiological Umbilical herniation

During the 6\textsuperscript{th} week of development, the loop of midgut elongates rapidly, particularly at its cephalic limb. This rapid growth with the enlargement of the liver and other abdominal viscera, makes the abdominal cavity too small to contain the primary intestinal loop, thus the midgut is pushed out into extraembryonic cavity in the umbilical cord.

www.google.co.uk/search?
Yolk Sac and Umbilical Cord

Figure 14.1 Sagittal sections through embryos at various stages of development demonstrating the effect of cephalocaudal and lateral folding on the position of the endoderm-lined cavity. Note formation of the foregut, midgut, and hindgut. A. Presomite embryo. B. Embryo with seven somites. C. Embryo with 14 somites. D. At the end of the first month.
3-Stage of Rotation
The elongated loop of midgut rotates 270° in an anticlockwise direction as it is viewed from the front, the rotation is around an axis formed by the superior mesenteric artery. The midgut loop rotates 90° during herniation, and 180° during the return of that loop into the abdominal cavity.

Elongation of the small intestine limb continues during the process of rotation, thus the jejunum and ileum form a number of coiled loops. The large intestine limb also elongates considerably, but it does not form coils.
Rotation of Midgut

Cecum

www.google.co.uk/search?
4-Stage of Retraction

During the 10\textsuperscript{th} week, the herniated midgut starts to return back into the abdominal cavity, the cause for this return could be due to the regression of the mesonephric kidney, reduced growth of the liver and expansion of the abdominal cavity.

**The Jejunum** is the first part that returns back to the abdomen and settles in its left side, the following returning intestinal coiled loops gradually located more and more to the right.
The caecal bud which appears as a small dilatation in the distal limb of the intestinal loop, is the last part of the midgut that returns back to the abdomen. It settles down at the right upper part of the abdomen below the Rt. Lobe of the liver.

Fixation of the hepatic flexure of the colon and elongation of the ascending colon, brings the caecum gradually to the Rt. Iliac fossa, and placement of the ascending colon and hepatic flexure in the Rt. Side of the abdomen.
During the descending process of the caecal bud, the **appendix** develops as a divertuculum at its distal end. The appendix has variable length and position. The final settlement of the appendix could be in one of the following positions.

1- Pelvic position 36.54%
2- Retrocaecal 32.69%
3- Post-ileal 11.53%
4- Pre-ileal 9.62%
5- Subcaecal 5.77%
6- Rt Paracolic 1.92%
7- Retrocolic 1.92%.
5-Stage of Fixation
During this stage, some regions of the gut lose their dorsal mesentery (their mesenteries press against the peritoneum of the posterior abdominal wall, fuse and degenerate). These parts are then fixed to the posterior abdominal wall by an anterior single layer of peritoneum, they are now in a retroperitoneal position (Extraperitoneal position).
The **Duodenum**, ascending colon and descending colon are permanently fixed in a **retroperitoneal position**.

The **Jejunum, Ileum, Caecum, Appendix, Transverse colon** and **Sigmoid colon** retain their mesenteries and are **intraperitoneal organs**.

The **Transverse mesocolon** fuses with the posterior wall of the Greater Omentum. Its line of attachment to the posterior abdominal wall, extends **transversely** from the hepatic Flexure to the Splenic Flexure.

**Mesentery of the Jejunum** and **Ileum** is attached to the posterior abdominal wall along an **oblique line** that extends from the Duodenojejunal flexure to the Ileo-caecal junction.
Transverse Mesocolon
Sigmoid Mesocolon
Greater Omentum
Lesser Sac
Mesentery of Jej. & Ileum
Transverse Mesocolon
Sigmoid Mesocolon
Greater Sac

Mesenteries
Fate of the Yolk Sac
At age of 4 weeks and earlier, the yolk sac is large. By age of 10 weeks, the yolk sac has decreased in size to a pear-shaped remnant, it is about 5 mm in diameter and is connected to the Midgut by a narrow yolk stalk (Vitelline duct). By age of 20 weeks, the yolk sac is very small and disappear with the Vitelline duct.
Development of the Hindgut

The hind gut is the caudal part of the primitive gut, it develops into: the left third of the transverse colon, descending colon, sigmoid colon, rectum and anal canal.

In early embryonic life, the hindgut has dorsal mesentery. During development, the Transverse colon retains its dorsal mesentery and remains intraperitoneal.

Descending colon swings to the left side, loses its mesentery and is fixed in a retroperitoneal position. Sigmoid colon retains its mesentery and remains in an intraperitoneal position.
Rectum and anal canal have got no mesentery, they develop below the intraperitoneal space; they are infraperitoneal organs.

Sagittal section shows the Peritoneal cavity and infraperitoneal organs.
Formation of Rectum and Anal canal

Caudal end of the hindgut dilates to form the cloaca which is situated below the peritoneal cavity.

The cloaca is connected to the allantois (Primitive Urogenital Sinus) anteriorly.

Cloaca is a common opening through which the digestive, urinary and reproductive system that exit.

During development, the cloaca is divided, so that the digestive system ends separately from the urinary and reproductive system. The urinary and reproductive system separate as well.
Cloaca is endodermal in origin, it is covered by ectoderm (Proctodeum) at its ventral surface. The ectoderm in this region develops during the folding of the outer body wall.

The ventral boundary of the cloaca is called the Cloacal membrane, it represents the opposed layers of ectoderm and endoderm.
Sagittal sections through embryos at various stages of development demonstrating the effect of cephalocaudal and lateral folding on the position of the endoderm-lined cavity. Note formation of the foregut, midgut, and hindgut. A. Presomite embryo. B. Embryo with seven somites. C. Embryo with 14 somites. D. At the end of the first month.
The mesoderm at the angle between the allantois and the hindgut proliferates and forming a septum called **urorectal septum**.

The septum extends caudally to divide the cloaca into:

1. **Primitive urogenital sinus** ventrally.
2. **Anorectal canal** dorsally.
As the embryo grows, further downwards extension of the urorectal septum takes place, it reaches the cloacal membrane and divides it into 2 parts:

1- anterior part called **urogenital membrane**.
2- posterior part called **anal membrane**.

The Urorectal septum raises the ectoderm between the urogenital membrane and the anal membrane, forming the **perineal body**.
Stages of development of anal canal

- Urogenital sinus
- Urorectal septum
- Perineal body
- Anal canal

Opening of Urogenital sinus

Anal Pit and Anal membrane

Cloacal memb
Development of Anal canal
Anorectal canal (endodermal in origin), forms the mucosa of rectum and the upper 2/3 of Anal canal.

The lower 1/3 of anal canal is derived from the Ectoderm (proctodeum). It develops through proliferation of the mesenchyme around the anal membrane. This creates an ectodermal depression called the Anal Pit.

The anal pit depression is roofed by anal membrane.

At the 7th week of development, the anal membrane ruptures and establishes continuity between the upper 2/3 and lower 1/3 of the Anal Canal. Mesoderm surrounding the anorectal canal forms the muscles of rectum and anal canal.
Development of anal canal

A

B

C

D

Anal pit

Anal membrane

Lower 1/3 anal canal

Upper 2/3 anal canal

Anorectal canal

Ectoderm

Columns of Morgagni

Dentate (pectinate) line

Lever ani muscle

Deep Subcutaneous

Superficial

Skin

Squamous mucosa

www.google.co.uk/search?A

www.google.co.uk/search?B

www.google.co.uk/search?C

www.google.co.uk/search?D
The junction between the upper 2/3 (Endodermal in origin) and lower third (Ectodermal in origin) of Anal Canal is delineated by the **Pectinate line** (a remnant of the proctodeum). At this line the Endothelial lining changes from Simple columnar to a Stratified Squamous Epithelium. On top of this line are the **Anal Columns** (Endodermal in origin).
Lower 1/3 of anal canal is lined superiorly by a stratified squamous non-keratinized epithelium (zona hemorrhagica).

It is lined inferiorly by a stratified squamous keratinized epithelium (zona cutanea). The junction between them is **Hilton's white line**.
Blood supply and Nerve supply of the anal canal

The **upper 2/3** of anal canal is Endodermal in origin, thus it is supplied by the **Superior rectal artery**, branch of the inferior mesenteric artery (the artery of the hindgut). The nerve supply is by Autonomic nervous system.

The **lower third** of anal canal is ectodermal in origin (skin), thus it is supplied by the **Inferior Rectal arteries** which are branch of internal pudendal arteries.

The nerve supply is by the inferior rectal nerve, a branch of the pudendal nerve (Somatic system).
Thank You