

L'enseignement de l'anatomie des appareils digestif, urinaire et génital par l'utilisation de vidéos d'anatomie 3D en anglais, intérêts pédagogiques par rapport aux méthodes classiques d'enseignement

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***LARGE  
INTESTINE***

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## I. INTRODUCTION

The large intestine extends from the distal end of the ileum to the anus.

It absorbs fluids and salts from the gut contents and forms feces. Consequently, it constitutes a septic environment, and breaching it is very dangerous.

The large intestine represents the terminal portion of the gastrointestinal tract and consists of the caecum, appendix, ascending colon, right colic flexure, transverse colon, left colic flexure, descending colon, sigmoid colon, rectum, and anal canal. (Figure 1)

Although the rectum and the anal canal belongs to the large intestine, they will be treated in a separate course later.

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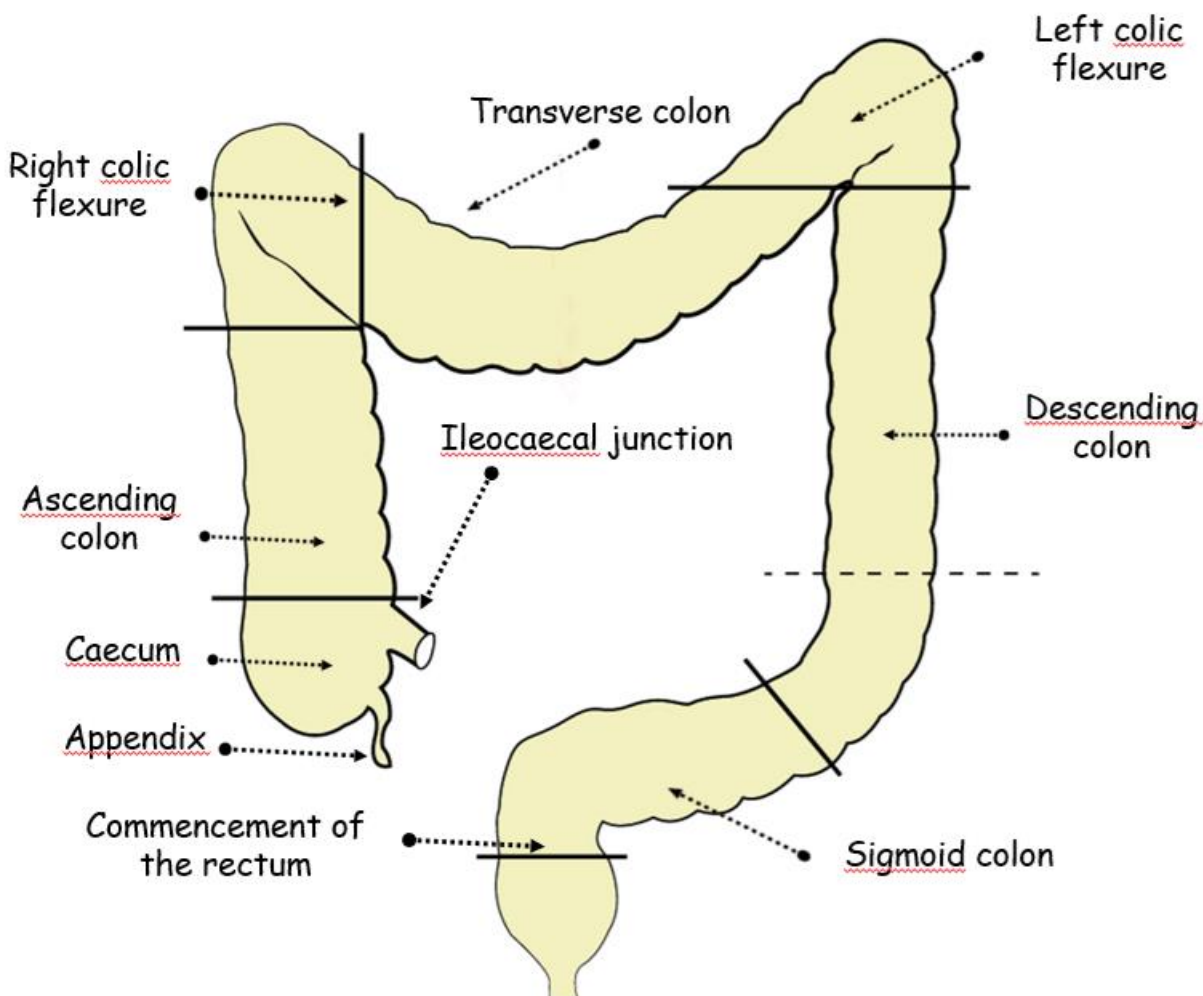


Figure 1: Anterior view of the colon

## II. DESCRIPTIVE ANATOMY

### A- SITUATION

Beginning in the right groin as the cecum with its associated appendix, the colon continues upward as the ascending colon through the right flank and into the right hypochondrium.

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Just below the liver, it bends to the left, forming the right colic flexure and crosses the abdomen as the transverse colon to the left hypochondrium subdividing the peritoneal cavity to supracolic and infracolic compartments. Just below the spleen, the large intestine bends downward, forming the left colic flexure and continues as the descending colon through the left flank and into the left groin. Finally, it enters the upper part of the pelvic cavity as the sigmoid colon. Sagittally, the colon is deeper approaching the flexures and the descending colon is the deepest part. Vertically, the colon circles the jejunum and ileum.

### B- DIMENSIONS

The colon is one meter and half long. The cecum measures six centimetres long, the ascending colon ten, the transverse colon forty centimetres, the lumbar and iliac descending colons twelve centimetres each and the sigmoid colon measures forty centimetres long.

The internal diameter narrows from cecum to rectum. It measures thirteen centimetres in the caecum, five in the transverse colon and three centimetres in the descending colon.

### C- SHAPE

The external surface of the colon contains three stereotypical elements.

The taeniae coli are segregations of the longitudinal muscle of the colic wall into three narrow bands. The anterior band is inferior in transverse colon, the posteromedial is posterior in transverse colon and the posterolateral is superior in transverse colon. The taeniae coli are less visible in the rectum.

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The haustra of colon are sacculations of the colon between the taeniae coli separated by transverse sulci. They are constituted by the circular muscle of the colic wall and are, also, less visible in the rectum.

The omental appendices are peritoneal-covered accumulations of fat along the taeniae coli supplied by blood vessels from the mucosa that perforate the muscle wall. They are absent in caecum and appendix and are larger and more numerous in sigmoid colon.

### **III. STRUCTURE**

#### **A- LARGE INTESTINE WALL**

The large intestine wall is a four layers wall.

From the outer layer to the inner, the serous coat, made of mesothelium and subserous tissue, is rich of adipocytes in omental appendices. It covers the anterior face of fixed parts, whereas, it continues up behind and is reflected downwards to the floor of posterior abdominal wall in mobile parts.

The muscle of large intestine is made of two layers. The outer layer is longitudinal and the inner is circular.

The submucosa is a loose areolar connective tissue rich of vessels, lymphatics and nerves.

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The mucosa is secretory, absorptive and protective. It lacks villi and contains crypts.

The epithelium is simple and columnar rich of mucous cells. The lamina propria is rich of vessels and nerves. The muscularis mucosae is very thin and is made of smooth muscle cells.

## **B- LARGE INTESTINE LUMEN**

Macroscopically, the large intestine mucosa contains protrusions and depressions.

The longitudinal protrusions are formed by the taeniae coli.

The semilunar folds form the transverse sulci on the external surface.

The depressions between semilunar folds match with haustra of colon.

## **IV. PARTS OF COLON**

### **A- CECUM AND APPENDIX**

The cecum is a blind pouch of the large intestine that projects downwards from the commencement of the ascending colon below the ileocaecal junction.

Two muscular flaps project into the lumen of the large intestine and form the ileocecal fold surrounding the opening of ileum in caecum. Internally, the ileocaecal junction is guarded by the ileocaecal valve whose almost transverse lips may help to prevent some reflux into the ileum.

A protrusive fold continues the ileocaecal valve laterally in both the anterior and posterior walls forming the frenulum of ileocaecal valve. (Figure 2)

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The external surface of the cecum has four faces. The anterior face touches the parietal peritoneum of the anterior abdominal wall. The posterior face lies on the iliac muscle. The base of the appendix lies in the posteromedial wall where the three taeniae coli converge. The lateral wall outgrows the medial and bulges down below the base of the appendix in the adult.

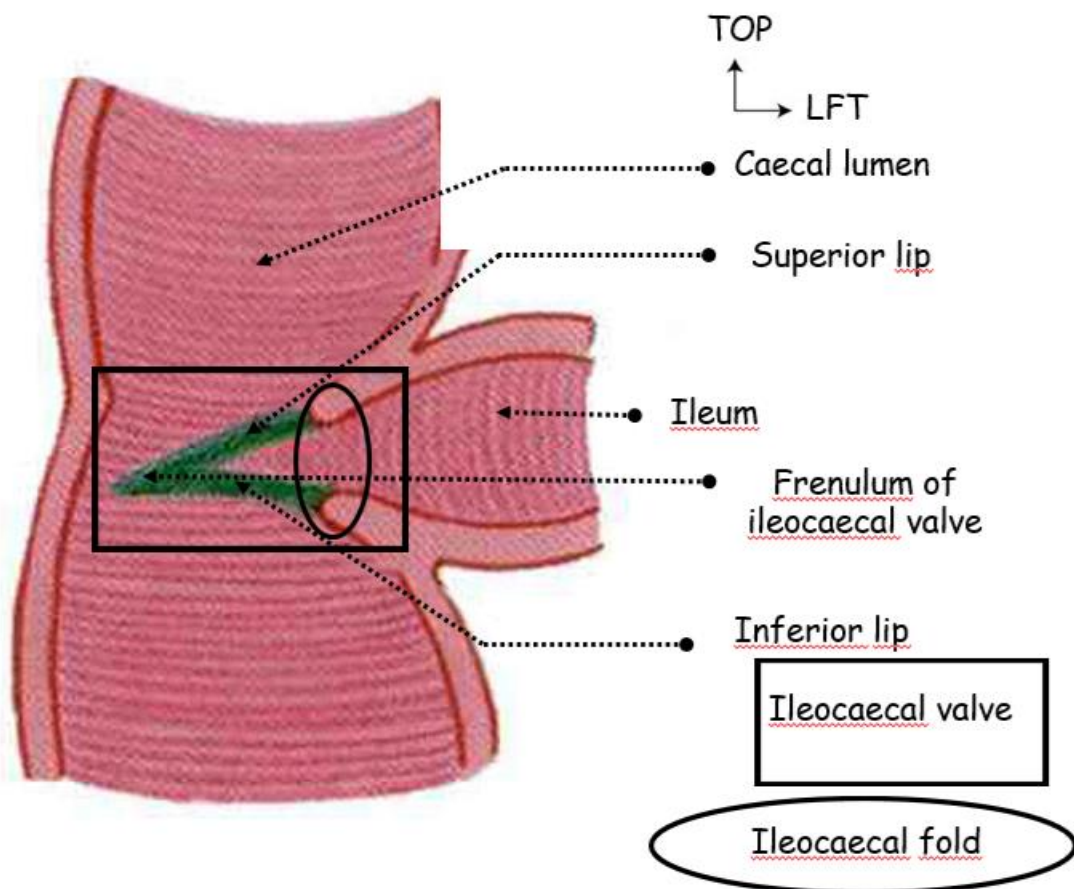


Figure 2: Coronal section of ileocecal junction

The appendix is a worm-shaped and blind-ending tube that opens into the posteromedial wall of the caecum two centimetres below the ileocaecal valve. Externally, the base of the appendix is at the point of convergence of the three taeniae coli on the posteromedial wall of the caecum.

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On the surface of the abdomen this point, McBurney's, lies one-third of the way up the oblique line that joins the right anterior superior iliac spine to the umbilicus. While the position of the base of the appendix is constant in relation to the caecum, the tip may lie in a variety of positions.

The appendix is six to nine centimetres long and has an internal diameter of seven millimetres.

The various positions of the cecum depend on the rotation angle of the primitive gut tube around the superior mesenteric axis. A normal rotation angle is about two hundred seventy degrees and corresponds to the suprailiac variety, the most frequent. The other positions of the cecum can be subhepatic, pelvic and ectopic.

The various positions of the appendix depend on the tip of the appendix and can be medial descending, the most frequent, medial ascending, ascending prececal, ascending retrocecal and subcecal.

The serous coat of the caecum covers the front and both sides and continues up behind it and is reflected downwards to the floor of the right iliac fossa. The retrocaecal peritoneal space may be shallow or deep according to the distance of the retrocaecal fold from the lower end of the caecum. Often there are two caecal folds, forming between them the retrocaecal recess in which the appendix may lie.

The serous coat of the ileocecal junction forms two folds, superior, above the terminal portion of the ileum containing the anterior cecal artery, limits with the terminal portion of the mesentery at the back the superior ileocecal recess; and inferior, below the terminal portion of the ileum, limits with the mesoappendix at the back the inferior ileocecal recess.

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The serous coat of the appendix, the mesoappendix, is a triangular fold of peritoneum representing the prolongation of the mesentery of the terminal ileum below. The appendicular artery runs first in the free margin of the mesoappendix.

## **B- ASCENDING COLON**

The ascending colon extends upwards from the ileocaecal junction to the right colic flexure. It lies vertically on the iliac fascia and the anterior layer of the lumbar fascia. Its sacculated surface contains seven to eight haustra.

The serous coat of the ascending colon covers the front face and stops at both sides when it runs laterally into the paracolic gutter and medially into the right infracolic compartment. It is fixed to the peritoneal floor of the iliac and lumbar fascia by extraperitoneal fibrous tissue, Toldt's fascia.

## **C- RIGHT COLIC FLEXURE**

The right colic flexure or hepatic flexure is a square angle and lies on the lateral surface of the inferior pole of the right kidney in contact with the inferior surface of the liver at the level of the anterior arch of the tenth rib. It is fixed, backwards, by Toldt's fascia, at the top, by the lesser omentum and, forwards, by the phrenicocolic ligament.

## **D- TRANSVERSE COLON**

The transverse colon extends from the hepatic to the splenic flexure in a loop which hangs down and front to a variable degree across the great curvature of the stomach.

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The serous coat of the transverse colon forms the transverse mesocolon. It subdivides the peritoneal cavity to supracolic and infracolic compartment.

The transverse mesocolon is attached from the inferior pole of the right kidney across the descending part of the duodenum and the pancreas to the inferior pole of the left kidney, double folded superior limits at the bottom the lesser sac and inferior, its root corresponds to the posterior parietal peritoneum and its ending to the posterior border of the transverse colon covering its anterior face, it contains the Riolan's arterial circle. The transverse mesocolon is connected to the gastrocolic omentum that fixes the great curvature of the stomach to the transverse mesocolon. It is connected, also, to the greater omentum which continues the transverse mesocolon below; the greater omentum is double folded, posterior pancreatic limits forwards the lesser sac and anterior connected to the gastrocolic omentum.

#### E- LEFT COLIC FLEXURE

The left colic flexure is a more acute bend at the junction of the transverse and descending colon that opens in front, bottom and inside, it is higher, more posterior and more fixed than the right colic flexure. It lies just inferior to the spleen at the level of the eighth rib and is attached to the diaphragm by the phrenicocolic ligament, to the posterior parietal peritoneum by the Toldt's fascia and to the anterior abdominal wall by the greater omentum.

#### F- DESCENDING COLON

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The lumbar colon extends vertically from the splenic flexure to the iliac crest. It is plastered to the posterior abdominal wall lying on the lumbar fascia and the iliac fascia like ascending colon by left Toldt's fascia, an extraperitoneal fibrous tissue.

The iliac colon extends obliquely from the iliac crest to the pelvic brim about five centimetres above the inguinal ligament near the medial border of psoas muscle. Thus, it occupies the left iliac fossa. The iliac colon is concave inside and is fixed by left Toldt's fascia.

### G- SIGMOID COLON

The sigmoid colon is the terminal mobile S-shaped, concave outside, part of colon. It extends from the iliac colon to the commencement of the rectum in front of the third piece of the sacrum. It lies, usually, in the pelvic cavity, coiled in front of the rectum, lying on the peritoneal surface of the bladder in men and the uterus in women.

The serous coat of the sigmoid colon forms the sigmoid mesocolon that suspends it to the posterior wall. Its root is A-shaped, the limbs of the A diverge from the bifurcation of the left common iliac artery, over the sacroiliac joint at the pelvic brim.

The lateral limb is attached to the external iliac artery along the pelvic brim from this point halfway to the inguinal ligament.

The medial limb extends from the bifurcation of the common iliac artery to the midline of the posterior pelvic wall at the level of the third piece of the sacrum.

It measures about ten centimetres in its intestinal border and therefore the length of the sigmoid colon is four times as long showing its degree of coiling.

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The sigmoid vessels lie between the layers of the mesocolon.

## V. ANATOMICAL RELATIONS

### A- CECUM AND APPENDIX

The cecum lies on the posterior wall the right iliac fossa and, thus, is in contact with, from back to front, the iliac muscle, the genitofemoral nerve, the femoral nerve between the iliac and psoas muscle, the iliac fascia and the posterior parietal peritoneum. It is covered, forwards, by intestinal coils and anterior abdominal wall. Outside, it stands next to the lateral abdominal wall at the top and the right iliac fossa at the bottom. Inside, it circles the appendix, intestinal coils, iliac vessels and the right ureter.

The appendix, when medial descending, is in contact with the medial face of cecum, outside, the intestinal coils, inside and forwards, the anterior abdominal wall, forwards, the right iliac fossa and external iliac vessels, backwards, and pelvic organs at the bottom.

On the surface, the base of the appendix projects on the half of the line joining the anterior superior iliac spine to umbilicus, the Mac Burney's point. The tip projects on the junction of the right and middle thirds of the line joining the two anterior superior iliac spines, the Lanz' point. When the cecum is pelvic, the base projects on this point.

### B- ASCENDING COLON

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The ascending colon lies on the right iliac fossa and the right lumbar region and, thus, is in contact through Toldt's fascia and posterior parietal peritoneum with the lower pole of right kidney and prerenal fascia and lumbar fascia. Outside, it is surrounded by the lateral abdominal wall and the diaphragm. Forwards, it is covered by the intestinal coils and the anterior abdominal wall. Above, it is overhung by the inferior face of the liver. Inside, it circles the lower pole of the second portion of duodenum, intestinal coils, the right ureter and the right genital vessels.

### C- RIGHT COLIC FLEXURE

The hepatic flexure is limited by, at the top, the inferior face of the liver, inside, the second part of the duodenum, at the back, right Toldt's fascia of the duodenum and the lower half of right kidney and, outside, the diaphragm and the right phrenicocolic ligament.

### D- TRANSVERSE COLON

The transverse colon separates the supracolic and infracolic compartments and is in contact, through the mesocolon, with the retroperitoneal organs.

The supracolic compartment contains, from right to left, the liver, the great curvature of stomach, the colic impression of spleen and the inferior face of the body of pancreas.

The infracolic compartment contains intestinal coils.

The transverse colon is covered, from right to left, by the liver, the inferior recess of lesser sac, the greater omentum and the anterior abdominal wall.

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The retroperitoneal organs behind the root of transverse mesocolon include, from right to left, the right kidney, the second portion of duodenum, the head of pancreas, the third and fourth portions of duodenum and the left kidney. Under the transverse mesocolon, some intestinal coils stand behind the transverse colon.

#### E- LEFT COLIC FLEXURE

The splenic flexure is limited by, at the top, the phrenicocolic ligament, backwards, the left kidney and, forwards, the great curvature of stomach.

#### F- DESCENDING COLON

The lumbar colon lies in front of the diaphragm and the two last left ribs, at the top, and the muscular wall of left lumbar fossa with the iliohypogastric, ilioinguinal, lateral femoral cutaneous, femoral and external iliac vessels, below, it is covered by intestinal coils, the greater omentum, the anterior lateral abdominal wall and the left paracolic gutter, forwards and outside, inside, it stands next to the left kidney, at the top, and the left ureter and genital vessels, below.

The iliac colon is limited, backwards, by the iliopsoas muscle and, forwards and outside, by intestinal coils.

#### G- SIGMOID COLON

The sigmoid colon separates pelvic organs from abdominal organs. At the top, it is in contact with intestinal coils and the greater omentum. At the bottom, it surrounds the rectum and bladder in men and the rectum and the uterus and adnexa in women. At the back, it stands in

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front of the left external iliac vessels, ureter and genital vessels. Forwards, it is hidden by the bladder in men and the uterus in women just behind the anterior abdominal wall.

## **VI. BLOOD SUPPLY; LYMPH DRAINAGE AND NERVE SUPPLY**

### **A- ARTERIES**

The large intestine is supplied by the superior and inferior mesenteric arteries.

The superior mesenteric artery supplies the cecum, ascending colon, hepatic flexure and the right two thirds of transverse colon through three branches, the ileocolic artery, the middle colic artery and the right colic artery. These arteries can be double or triple.

The ileocolic artery runs obliquely downwards and outwards along the root of mesentery and end at a certain distance from the ileocolic angle into the ascending colic artery, anterior and posterior cecal arteries, the appendicular artery and an ileal branch.

The right colic artery runs transversally along the right Toldt's fascia and end at the hepatic flexure into two branches, descending anastomosing with the ascending colic artery and ascending anastomosing with the middle colic artery.

The middle colic artery travels the transverse mesocolon and ends into two branches, right anastomosing with the right colic artery and left anastomosing with the left colic artery.

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The inferior mesenteric artery vascularises the left third of transverse colon, splenic flexure, descending colon and sigmoid colon through two branches, the left colic artery and the sigmoid arteries. It ends giving a terminal branch, the superior rectal artery.

The left colic artery runs transversally along the left Toldt's fascia, crosses the inferior mesenteric vein at the front and ends giving two terminal branches, descending anastomosing with the ascending branch of superior sigmoid artery and ascending anastomosing with the middle colic artery.

The sigmoid trunk divides into three branches, the superior, middle and inferior sigmoid arteries. Each of them divides in mesocolon into anastomotic branches between them and the left colic artery above and the superior rectal artery below.

The anastomotic branches near the medial margin of the whole colon form the arterial circle commonly called, unofficially, the marginal artery two centimetres and half from the mesocolic border of the sigmoid colon.

It is from this that short vessels and long vessels run into the gut wall; the short vessels enter the colic wall at the haustra and their territory is triangular with a mesocolic base; the long vessels enter the colic wall at the transverse sulci and their territory is triangular with a mesocolic summit; the epiploic vessels supply the epiploic appendices.

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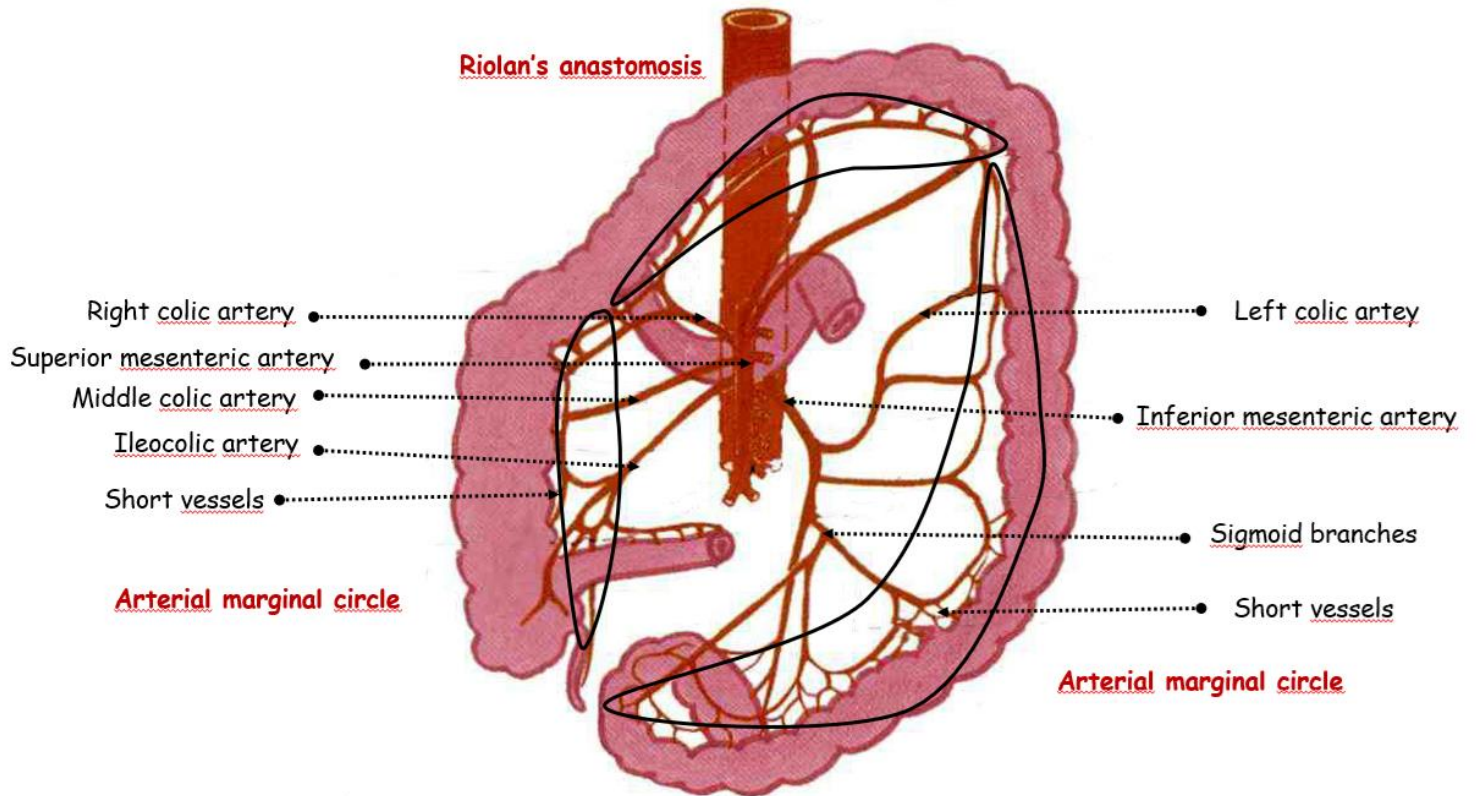


Figure 3: Anterior view showing arteries of the colon

Consequently, the subdivision of the colon according to the blood supply and lymph drainage, the surgical subdivision of colon, distinguishes the right colon, supplied by the superior mesenteric artery and the left colon supplied by the inferior mesenteric artery. (Figure 4)

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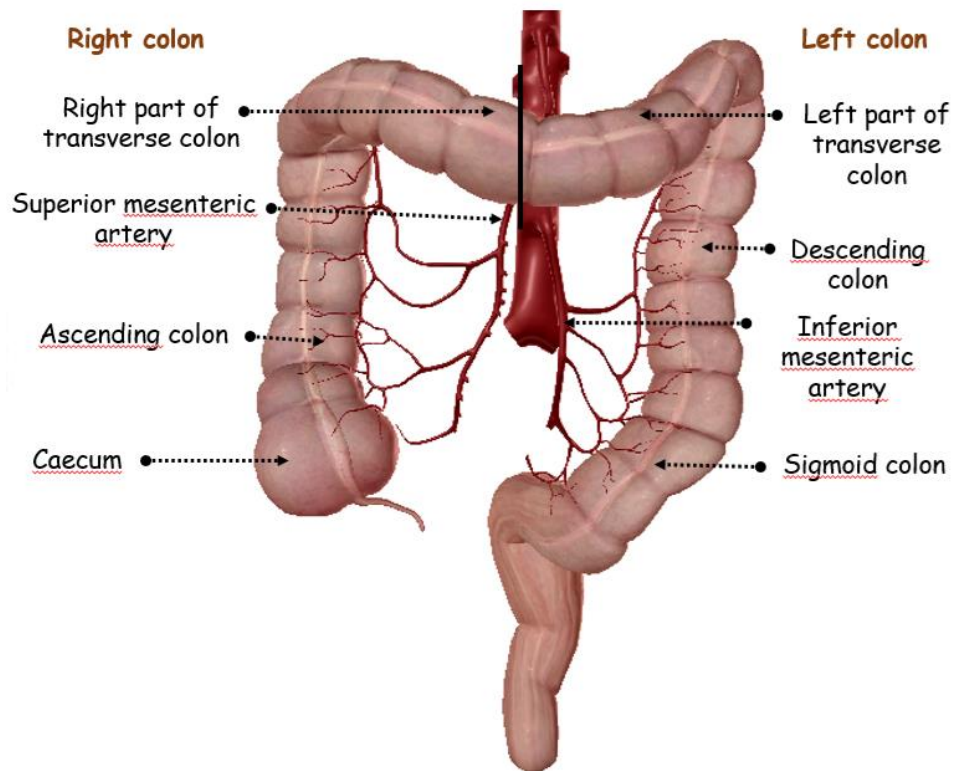


Figure 4: Anterior view showing the surgical parts of colon

## B- VEINS

The veins of large intestine correspond to the arteries. They drain to the portal vein through the superior and inferior mesenteric veins.

## C- LYMPH DRAINAGE

The lymphatics of colon pass back along the arteries to lymph nodes that lie in front of the aorta at the origins of the arteries through series of lymph node filters that lie between the mucous membrane of the gut and the cisterna chyli; the epicolic nodes, the paracolic nodes, the mesocolic nodes or the sigmoid nodes, the superior mesenteric nodes and the inferior mesenteric nodes.

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The cecum and the appendix drain into the ileocecal lymph nodes to the superior mesenteric nodes.

The right colon drains into the superior mesenteric nodes and the left colon drains into the inferior mesenteric nodes and the iliac nodes through sigmoid nodes.

#### D- NERVE SUPPLY

The parasympathetic supply is ensured by the vagi and partly by the pelvic splanchnic nerves and the sympathetic by the spinal cord segments T10-L2.

The superior and inferior mesenteric plexuses surrounding the corresponding arteries support the nerve supply of colon. This nerve supply constitutes the extrinsic nervous system of the gut and is connected to the intrinsic system.

### VII. SURGICAL APPROACH

The vessel pattern with the accompanying lymphatics determines the extent of partial resections of the colon for carcinoma.

For a right hemicolectomy the resection extends from the terminal ileum to the proximal part of the transverse colon, with ligation of the ileocolic and right colic vessels adjacent to superior mesenteric parent.

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In a transverse colectomy the transverse colon and the right and left colic flexures are removed together with the transverse mesocolon and greater omentum and the middle colic vessels.

For a left hemicolectomy the resection is from the left end of the transverse colon to part of the sigmoid colon, with ligation of left colic and sigmoid vessels, but the inferior mesenteric itself may have to be removed.

For sigmoid colectomy the removal extends from the lower descending colon to the rectum.

Resections for diverticular disease can of course be more localized.

## **VIII. CONCLUSION**

The large intestine is the terminal part of the gastrointestinal tract. It spreads over all areas of the abdomen and has a stereotyped architecture with particularities in each portion including its fixity; different from part to part. As a result, the large intestine has several peritoneal and visceral relations and a rich blood supply. On the other hand, the cecum, appendix and arteries of the colon are subject of multiple anatomical variations making its disease and surgery a bit challenging.

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