Anatomy, Functions and Pathology of the Large Intestine (Large Bowel)

The large intestine (lat. intestinum crassum) is distally adjacent to the small intestine, extending from the ileocecal valve to the anus. It is divided into the cecum with vermiform appendix, colon, and rectum. Thus, it forms the terminal portion of the human digestive tract. The relationship between distinct intestinal segments and the peritoneum, the differences between the large and the small intestine, and the general understanding of anatomy and physiology are important topics for examination. The overview below provides a basic insight into the large intestine.

Location of the Large Intestine

The large intestine originates at the ileocecal valve, which protects the small intestine against bacterial reflux. The adjacent cecum in the right lower abdomen is a blind pouch (cecum = blind gut). The vermiform appendix is attached to the cecum as an appendage. It is usually located retro-cecally. However, the location of the appendix is variable. The ascending colon is continuous with the cecum and travels upwards to the chest.
Approximately at the level of the 9th rib, a curvature of the colon bends abruptly inwards to the left, forming the hepatic flexure (flexura coli dextra). The transverse colon extends above the loops of the small intestine and ends in the splenic flexure (flexura coli sinistra) in the left half of the body, and continues as the descending colon to the left anterior iliac spine. The S-shaped sigmoid flexure and subsequently the rectum form the distal end of the large intestine.
Outer Appearance of the Large Intestine

The large intestine is **approximately 1.5 m long and measures about 5-8 cm in diameter**. It runs around segments of the small intestine like a framework.

One of the most important macroscopic features are haustra, which are sacculations or pouches in the wall of the large intestine. Haustre located in the internal wall of the intestinal lumen are known as **plicae semilunares coli**. The teniae are bands of longitudinal muscles, each measuring about 1 cm in width. The tenia libera, which is freely visible can be distinguished from tenia omentalis that lies close to the omentum majus and tenia mesocolica. The large intestine is also characterized by appendices epiploicae, appendages filled with adipose and connective tissue located at the teniae.
Segments of the large intestine at a glance:

- Cecum (blind gut) with the vermiformis appendix
- Hindgut
  - Colon: Colon ascendens, Colon transversum, Colon descendens, Colon sigmoideum
  - Rectum

Large Intestine in Relation to the Peritoneum

The large intestine in relation to the peritoneum is an important topic for examinations. Its complexity is rooted in the embryonic development and the associated intestinal rotation. In general, the sections of the large intestine alternate between intra- and retroperitoneal locations. Thus, the **cecum along with the vermiform appendix is located intraperitoneally**. Blood vessels of the appendix pass through the mesoappendix leading to the cecum and ileum.

Ascending and descending sections of the colon are located retroperitoneally. Colon
transversum and sigmoideum are in turn located intraperitoneally. The ligamentum gastrocolicum connects the curvature major of the stomach and the colon transversum. Surgical approach to the pancreas and other retroperitoneal organs requires resection of this ligament to locate the bursa omentalis underneath.

The Large Intestine in Relation to Adjacent Organs

- The colon ascends extends from the right lower abdomen to the chest. The small intestine is usually located on its left side.
- The flexura coli dextra borders on the liver and partially touches the right kidney.
- The colon transversum touches both the liver and the gall bladder.
- The flexura coli sinistra is slightly higher than the right side, approximately at the level of rib 10, bordering the spleen and touching the left kidney.
- The jejunum is often located on the right side of the colon descendens.

Vascularity of the Large Intestine

The large intestine is supplied by the colic branches of the superior mesenteric artery, namely A. ileocolica, A. colica dextra, and A. colica media. The arterial blood supply changes at the flexura coli sinistra. The blood supply as well as the innervation change at the so-called Cannon’s point. The remaining parts are supplied by A. colica sinistra, 2-3 Aa. sigmoideae, and A. rectalis superior, the main branches of the inferior mesenteric artery.

Nerve Supply of the Large Intestine

The movement of the large intestine is facilitated by its plexuses in the intestinal wall. Sympathetic fibers reduce intestinal motility whereas parasympathetic fibers increase it. They originate in the N. vagus and run to the flexura coli sinistra. At this point, the parasympathetic innervation is derived from the pelvic splanchnic nerves at segments S2-S4, which is known as the Cannon's point.
Differences Between Large and Small Intestine at a Glance

Macroscopically, the large intestine can be distinguished from the small intestine by its haustra, teniae, and appendices epiploicae. Also at the microscopic level, the wall of the large intestine differs significantly from the small intestine. The large intestine carries no villi but deep crypts (0.4–0.6 mm in length) containing multiple goblet cells exist.

Noduli lymphoidei solitarii occasionally exist in the wall. Most of the digestion and absorption of nutrients occurs in the small intestine. By contrast, the large intestine is predominantly the site of water extraction. Simultaneously, goblet cells secrete mucus that serves as a lubricant for the stool.

Functions of the Large Intestine

The vermiform appendix is rich in lymphatic tissue and is part of the immune system.

Feces pass the colon in 12-48 h via slow peristaltic movements and segmentation. Water is absorbed resulting in thickening of the stool. Every day, 0.5 to 2 L of fluid is absorbed. The capacity of large intestine for reabsorption of 5 to 6 L of water suggests potential mechanisms to compensate for missing uptake in the small intestine.

Goblet cells that are located in deep crypts secrete mucins. The resulting mucus facilitates the passage of stool through the intestines. The epithelial cells lining the crypt secrete and reabsorb electrolytes. The epithelial sodium channel (ENaC) regulates sodium reabsorption from the stool. This process is controlled by the steroid hormone aldosterone. However, the potassium may be reabsorbed under conditions of deficiency.

The acidic pH in the large intestine ranges between 5.5 and 6.8, with the pH increasing towards the more distal segments.

In the rectum, the stool is stored and is excretion only after accumulation of larger amounts. Otherwise, the stool would be excreted continuously.
Intestinal Flora

Another unique feature of the large intestine is the variety of colonizing bacteria. The presence of approx. 100 trillion mainly anaerobic bacteria ensures appropriate digestion of otherwise indigestible food components. Further, the intestinal bacteria secrete compounds that are essential for humans, such as vitamin K.

The sensitive intestinal flora may be disrupted as a result of repeated antibiotic therapies, which, in turn, may cause diarrheal disorders.

Pathology of Large Intestine

Appendicitis in the large intestine

Over the course of a lifetime, approximately 10% of the population suffers from appendicitis. The inflammation is generally caused by an obstruction of the lumen due to calcified feces, tumors, or foreign bodies.

Acute appendicitis may manifest within hours. Initially, pain typically arises in the umbilical area, later in the right lower abdomen. In addition, clinical manifestations include nausea, vomiting, and fever.

McBurney’s point

McBurney’s point exists in the right abdomen at a distance of one-third on the
connecting line between the right spina iliaca anterior superior and the umbilicus. Pressure applied to this area may trigger pain in patients with appendicitis.

Perforation into the peritoneal cavity is a potential complication associated with untreated appendicitis. The subsequent peritonitis can be a life-threatening complication. Generally, appendectomy is indicated for appendicitis.

**Irritable bowel syndrome**

Irritable bowel syndrome is a group of intestinal diseases with unclear etiology and absence of organic findings. The symptoms include pain, diarrhea, or constipation. Gluten sensitivity and psychological factors are associated with irritable bowel syndrome.

**Diverticulosis of the colon**

An intestinal diverticulum is a sac-like bulge of the intestinal wall or even of the intestinal mucosa. Diverticulosis is a civilization disorder associated with a diet low in fiber, resulting in a slow intestinal peristalsis. Forceful contraction of the large intestine increases the pressure on the walls resulting in protuberances, usually in the sigmoideum of the colon. Diverticulosis rarely occurs before the age of 30, but the probability increases by 6-8% annually. It is often detected incidentally because of the lack of symptoms. Possible complications may include diverticulitis, bleeding, perforation, fistula, and stenoses.

**Intestinal inflammation**

Inflammation in the large intestine is called colitis. Intestinal inflammation includes acute and chronic inflammatory bowel diseases.

Acute intestinal inflammation is also called enteritis. Colitis ulcerosa is one of the chronic inflammatory diseases characterized by recurrent inflammation of the intestinal tract over decades. Colitis ulcerosa is limited to colon and rectum.

**Polyps in the colon**

A polyp is an accumulation of tissue in the large intestine, either wide and flat, branched, or polypoid. They are usually smaller than 1 cm and do not cause any symptoms. Possible symptoms, however, are constipation, pain, or blood in the stool. Especially larger polyps may become malignant tumors, or colorectal carcinomas (adenoma-carcinoma sequence).

**Intestinal cancer**

A malignant tumor of the colon is known as colon carcinoma, which most often develops via stepwise progression starting with benign polyps and evolving sequentially as adenoma and carcinoma. Intestinal cancer most frequently occurs in the age group of 60 to 70 years.

A possibly undiagnosed chronic inflammatory bowel disease may exist in younger patients.

Risk factors include advanced age, intestinal polyposis, genetic factors, and colitis ulcerosa. Diet plays a particularly important role. A diet rich in fats increases the risk of
cancer, which is reduced by a high-fiber dietary intake. Therefore, intestinal cancer is more common in industrialized countries.

Symptoms such as occult bleeding typically develop late. The prognosis usually depends on the stage of cancer based on TNM classification. Lymphogenic metastasis occurs early, spreading to the regional lymphatic nodes. Hematogenously, the colon carcinoma metastasizes predominantly to the liver, lungs, and the skeleton.

Colon resection

Colon resection entails **partial removal of the colon**. Indications include diverticulosis, polyps of the colon, colon carcinoma, or chronic inflammatory bowel diseases, such as colitis ulcerosa.

Examination of the colon

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<tr>
<th>Procedure</th>
<th>Description</th>
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<tr>
<td>Percussion</td>
<td>You may hear a tympanic resonance.</td>
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<tr>
<td>X-ray</td>
<td>Contrast enema of the colon</td>
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<tr>
<td>Colonoscopy</td>
<td>Performed with a flexible endoscope. Prior to the procedure, the patient received laxatives and salt solution in order to cleanse the intestine.</td>
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References


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