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 ileo-caecal valve to the anus. It is divided into the caecum with vermiform appendix, colon, and rectum. Thus, it is forming the terminal part of the human digestive tract. Particularly relevant for the exam are the relation of distinct intestinal sections with regard to the peritoneum, the differences between large and small intestine, and the general understanding of anatomy and physiology. The overview below provides all important basics about the large intestine.

Location of the Large Intestine

The large intestine begins at the ileo-caecal valve which protects the small intestine from bacteria reflux. The adjacent caecum in the right lower abdomen is a blind pouch (caecum = blind gut). Attached to it is the appendage of the caecum, also known as vermiform appendix. It is usually located retro-caecally, thus behind the caecum. Of clinical relevance, however, is the fact that the location of the appendix is variable. The ascending colon is continuous with the caecum and passes 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 passes transversely garland-like above the loops of the small intestine and ends in the splenic flexure (flexura coli sinistra) in the left half of the body. From that point, the descending colon runs 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 has a **length of approximately 1.5 m and a diameter of about 5-8 cm**. It runs around parts 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. If located in the internal wall of the intestinal lumen they are called **plicae semilunares coli**. The taeniae are bands of longitudinal muscles, each being about 1 cm in width. You may distinguish between taenia libera which is freely visible, taenia omentalis which lies in proximity to the omentum majus and taenia mesocolica. The appendices epiploicae, appendages filled with adipose and connective tissue located at the taeniae, are characteristic as well.
The segments of the large intestine at a glance:

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

The Large Intestine in Relation to the Peritoneum

The large intestine in relation to the peritoneum is a popular topic for exams. Its complexity is rooted in the embryonic development and the intestinal rotation that goes along with it. It can be noted in general, that the sections of the large intestine alternate between intra- and retro-peritoneal locations. Thus, the caecum with vermiform appendix is intra-peritoneal. Blood vessels of the appendix pass through the mesoappendix leading to the caecum and ileum.

Ascending and descending sections of the colon are secondarily retro-peritoneal. Colon
transversum and sigmoideum are in turn intra-peritoneal. The ligamentum gastrocolicum connects the curvature major of the stomach and the colon transversum. In order to surgically get to the pancreas and other retro-peritoneal organs, this ligament has to be severed. The **bursa omentalis** is located behind it.

**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. It borders the spleen and touches the **left kidney**.
- The **jejunum** is often located on the right side of the colon descendens.

**Vasculature 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**, main branches of the inferior mesenteric artery.

**Nerve Supply of the Large Intestine**

The movement of the large intestine is made possible by its plexuses in the intestinal wall. Sympathetic fibers reduce the intestinal motility. Parasympathetic fibers raise it. They originate from **N. vagus** and run to the flexura coli sinistra. At this point, parasympathetic innervation is derived from **pelvic splanchnic nerves** from segments S2-S4. This area is called **Cannon’s point**, just as it does regarding the blood supply.
Differences Between Large and Small Intestine at a Glance

Macroscopically, the large intestine can be distinguished from the small by its **haustra**, **taeniae**, and **appendices epliploicae**. Also at the microscopic level, the wall of the large intestine presents characteristics differing from the small intestine. The large intestine has no villi but deep crypts (0.4-0.6 mm in length) with many goblet cells.

**Noduli lymphoidei solitarii** occasionally exist in the wall. For the largest part, digestion takes place in the small intestine where many nutrients are absorbed. By contrast, the large intestine is mainly the site where water is extracted. Simultaneously, goblet cells secrete mucus that serves as a lubricant for the produced stool.

Functions of the Large Intestine

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

Feces pass the colon in **12-48h** by slow peristaltic movements and segmentation. Water is absorbed and the stool is thereby thickened. Every day, 0.5 to 2 L of fluid is absorbed. With an uptake capacity of 5 to 6 L of water in the large intestine, there is potential 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. Potassium is secreted, may, however, be reabsorbed in a state of deficiency.

The acidic pH-milieu in the large intestine lies between **5.5-6.8**, whereby the pH increases towards the more distal segments.

In the rectum, the stool is stored so that there is an excretion only after the accumulation of larger amounts. Otherwise, stool would be excreted continuously.
The Intestinal Flora

Another special feature of the large intestine is the **variety of colonizing bacteria**. About **100 trillion mainly anaerobic bacteria** ensure that otherwise indigestible food components are made accessible. Moreover, the intestinal bacteria produce substances that are essential for humans, such as vitamin K.

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

Large Intestine Pathology

Appendicitis in the large intestine

Over the course of a lifetime, approximately **10% of the population** suffers from appendicitis. The inflammation commonly is 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, nausea, vomiting, and fever appear.

**McBurney’s point**

Point in the right abdomen, one-third of distance on the connecting line between right spina iliaca anterior superior and the umbilicus. Pressure applied to this area may trigger
pain in appendicitis patients. A potential complication of an untreated appendicitis is the perforation into the peritoneal cavity and, subsequently, a peritonitis that can even be life-threatening. In general, the treatment is an appendectomy.

Irritable bowel syndrome

An irritable bowel syndrome is a group of intestinal diseases that often lack any organic finding. Its etiology often is not clear. Symptoms are, among others, digestive problems with pain, diarrhea, or constipation. Gluten sensitivity and psychological factors are associated with the 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. Due to a diet low in fiber, the transport of intestinal content is slower. The large intestine has to contract more forcefully and therefore builds up more pressure.

As a result, these protuberances arise, usually in the sigmoideum of the colon. Diverticulosis rarely occurs before the age of 30, but afterward the probability of occurrence increases by 6-8% per year. It is often an incidental finding because of the lack of symptoms. Possible complications are, among others, diverticulitis, bleedings, perforation, fistula, and stenoses.

Intestinal inflammations

An inflammation in the large intestine is called colitis. A distinction is made between acute inflammatory and chronic inflammatory bowel diseases.

An acute intestinal inflammation is also called enteritis. Colitis ulcerosa is one of the chronic diseases with relevance for the exam. It is an inflammation of the intestinal tract running recurrently for 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 polyoid. 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, thus a colorectal carcinoma (Adenoma-carcinoma sequence).

Intestinal cancer

A malignant tumor of the colon is called colon carcinoma. Most of the time the carcinoma arises from still existing benign polyps by adenoma-carcinoma sequence. Intestinal cancer most frequently occurs in the age group of 60 to 70 years.

Please note: You may think of a possibly undiagnosed chronic inflammatory bowel disease in younger patients.
Risk factors are 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, whereas a high-fiber diet reduces it. Therefore, intestinal cancer is more common in industrialized countries.

Symptoms such as occult bleedings typically develop late. The prognosis usually depends on the stage of cancer at the discovery. It is determined by TNM classification. Lymphogenic metastases occur early, infecting the regional lymphatic nodes. Hematogenously, the colon carcinoma metastasizes predominantly in the liver, lungs, and the skeleton.

Colon resection

The colon resection is a 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>Percussion</th>
<th>You may hear a tympanic resonance</th>
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<tbody>
<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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Review Questions

The correct answers are below the references.

1. Which structure is to be found in the small as well as the large intestine?
   A. Haustra
   B. Taenia libera
   C. Taenia omentalis
   D. Appendices epiploicae
   E. Goblet cells

2. Which of the following statements about the colon is wrong?
   A. The large intestine has a length of up to 1.5m
   B. Cecum and colon transversum are intraperitoneal.
C. Colon ascendens and colon descendens are retroperitoneal.
D. In the large intestine, mainly nutrients are absorbed.
E. The rectum is part of the large intestine.

3. Which symptom is not typical of appendicitis?
   A. Hematemesis
   B. Fever
   C. Nausea
   D. Pain at McBurney’s point
   E. Vomiting

References


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Correct answers: 1E, 2D, 3A

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