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DEPARTMENT: ANATOMY

COURSE: ANA 204

ASSIGNMENT

Describe the microanatomy of the small intestine

ANSWER

I. Large Intestine

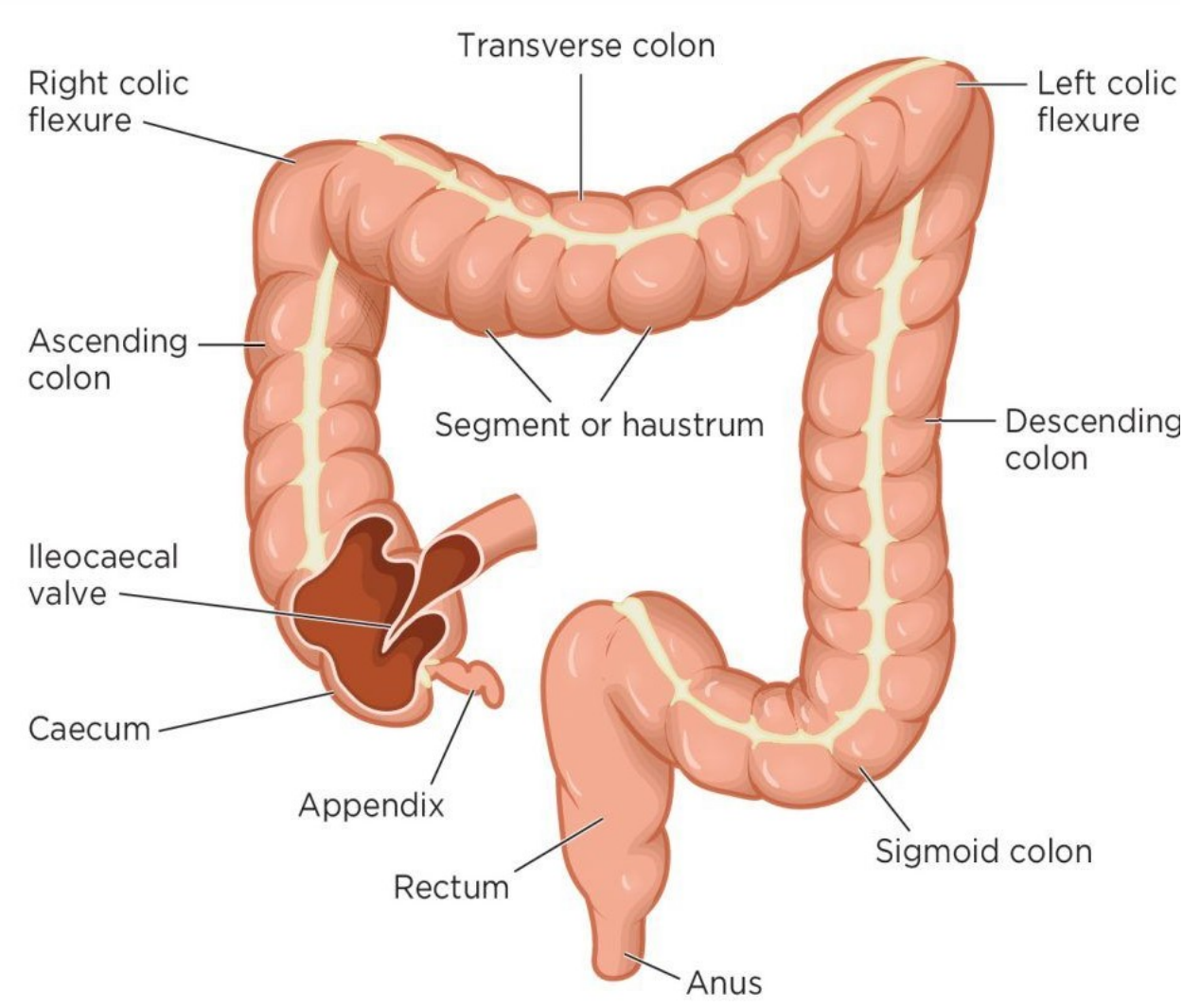

DIAGRAM OF THE LARGE INTESTINE

The large intestine is a long tubular structure that is not coiled like small intestine.

This tubular structure is sometimes known as large bowel or colon. The large intestine is wider in diameter and hence allows the lucid movement of the undigested food particles through it. The large intestine is divided into four parts that form the entire length of the intestine.

1) Cecum: The first part of the large intestine is the cecum, a sac-like structure that is suspended inferior to the ileocecal valve. It is about 6 cm long, receives the contents of the ileum, and continues the absorption of water and salts. The appendix is a winding tube that attaches to the cecum. Although the 7.6-cm long appendix contains lymphoid tissue, suggesting an immunologic function, this organ is generally considered vestigial. However, at least one recent report postulates a survival advantage conferred by the appendix: In diarrheal illness, the appendix may serve as a bacterial reservoir to repopulate the enteric bacteria for those surviving the initial phases of the illness. Moreover, its twisted anatomy provides a haven for the accumulation and multiplication of enteric bacteria. The mesoappendix, the mesentery of the appendix, tethers it to the mesentery of the ileum.
2) Colon: The cecum blends seamlessly with the colon. Upon entering the colon, the food residue first travels up the ascending colon on the right side of the abdomen. At the inferior surface of the liver, the colon bends to form the right colic flexure (hepatic flexure) and becomes the transverse colon. The region defined as hindgut begins with the last third of the transverse colon and continues on. Food residue passing through the transverse colon travels across to the left side of the abdomen, where the colon angles sharply immediately inferior to the spleen, at the left colic flexure (splenic flexure). From there, food residue passes through the descending colon, which runs down the left side of the posterior abdominal wall. After entering the pelvis inferiorly, it becomes the s-shaped sigmoid colon, which extends medially to the midline. The ascending and descending colon, and the rectum (discussed next) are located in the retroperitoneum. The transverse and sigmoid colon are tethered to the posterior abdominal wall by the mesocolon.
3) Rectum: Food residue leaving the sigmoid colon enters the rectum in the pelvis, near the third sacral vertebra. The final 20.3 cm of the alimentary canal, the rectum extends anterior to the sacrum and coccyx. Even though rectum is Latin for “straight,” this structure follows the curved contour of the sacrum and has three lateral bends that create a trio of internal transverse folds called the rectal valves. These valves help separate the feces from gas to prevent the simultaneous passage of feces and gas.
4) Anus: Finally, food residue reaches the last part of the large intestine, the anal canal, which is located in the perineum, completely outside of the abdominopelvic cavity. This 3.8–5 cm long structure opens to the exterior of the body at the anus. The anal canal includes two sphincters. i) The internal anal

sphincter is made of smooth muscle, and its contractions are involuntary. ii) The external anal sphincter is made of skeletal muscle, which is under voluntary control. Except when defecating, both usually remain closed.

LOCATION

The large intestine as a single unit covers the abdominal cavity. It starts from where the ileum ends, ascends upwards and passes across the top of the stomach transversely. Then it again descends down along the left side of the body and forms the S-shaped structure. This S-shaped structure gives rise to the rectum and finally the anal opening.

STRUCTURE

- The large intestine starts from the ileocecal sphincter present at the end of the ileum.
- It then forms an inclined T which runs both superiorly and inferiorly.
- The superior part gives rise to the ascending colon while the inferior branch meets a dead-end. This small pouch-like structure is known as the vermiform appendix and is vestigial in nature.
- The vermiform appendix is attached with the ascending colon via the Gerlach's valve.
- The ascending colon rises upwards along the extreme right side of the abdominal cavity till it reaches just below the diaphragm.
- At that point which is the hepatic flexus, the ascending colon takes a sharp right angular turn and starts to run transversely across the stomach.
- The transverse colon is suspended from the stomach through the greater omentum, a peritoneal fold.
- On the back side, the colon is attached to the abdominal walls via transverse mesocolon.
- When it reaches the splenic flexus at the extreme left corner of the abdominal cavity, it turns around by ninety degrees and descends downwards.
- After descending down, the descending colon reaches the sigmoid flexus. At this point, the colon bends medially into an S-shaped structure called the sigmoid colon.
- It then enlarges into a bulb-like structure called the rectum which is the ending part of the alimentary canal.
- The tubular rectum finally terminates into an opening known as an anus.

Large Intestine Wall

The large intestinal wall is made up of four layers.

a) Mucosa is the innermost layer of the large intestine surrounding the lumen

b) Unlike small intestine, the mucosa here is free of villi and has a soft surface

c) It is made up of single-layered columnar epithelial cells.

d) The columnar epithelium has secretory cells that secrete mucus into the lumen of the intestine. The mucus ensures the lucid movement of the bowel.

e) Next to the mucosa lies the layer of blood vessels nerve fibers and connective tissue. This vascular layer is known as the submucosa. This layer acts as the anchor for the other layers of the large intestine.

f) The next layer in the outward direction is the visceral muscle layer known as muscular. This layer consists of radial and circular muscles that bring about the contraction and relaxation of the intestinal wall.

g) The external-most layer is made of a single layer of squamous epithelial tissue known as the serous layer. It secreted the serous fluid into the surface. The fluid acts as a lubricating medium and prevents the friction with other organs.

Functions of Large Intestine

a) The large intestine helps in the formation of stool. The undigested food particles are passed through the entire four sections of the colon. The colon walls absorb the water and other fluids from the undigested food and facilitate the solidification of the liquid. As a result, feces are formed. The absorbed water is important for controlling metabolism in our body.

b) The undigested food should not stay for too little time or too long time within the colon. The former will cause less or minimal absorption of water and hence will lead to diarrhea. The later will cause excess water absorption and hence constipation.

c) The large intestine is the hub of many useful bacteria that help in the breakdown of the undigested food particles. During this breakdown, they release Vitamin K, vitamin B6, riboflavin and many other. Vitamin K is greatly absorbed into the bloodstream as the vitamin is an important clotting factor. Along with vitamins, many minerals and ions are too absorbed along with the water into the bloodstream. This maintains the ionic balance of the blood.

d) The anaerobic fermentation of the undigested carbohydrates and fatty acids produces lactic acid and other acids. These acids are strong enough to corrode the mucosa membrane due to the highly acidic medium in the colon. In order to

neutralize the acidic medium, large intestine secretes alkaline juices into the lumen, thereby maintaining the pH.

e) Large intestine helps in maintaining body's immune system greatly. It reduces antibodies that help in fighting the colon diseases. Also, the mucosa layer of the intestine prevents the absorption of the harmful bacteria into the bloodstream.

Innervations

- Like the small intestine and the rest of the gut, the sympathetic and parasympathetic nervous system triggers the neurogenic working of the large intestine.
- Vagus nerve from the tenth spinal nerve imparts parasympathetic impulses to the large intestine.
- The pelvic splanchnic nerves do another parasympathetic innervation of the large intestine.
- The thoracolumbar nerves from the tenth thoracic vertebrae to the second lumbar vertebrae (T10-L2) are responsible for the sympathetic inhibitory actions of the large intestine.
- These nerves form three synapses namely- superior mesenteric plexus, inferior mesenteric plexus and inferior hypogastric plexus.
- Cecum, appendix, ascending and transverse colon receives the sympathetic stimulations from the superior mesenteric plexus
- The inferior mesenteric plexus stimulates the colon from the point of left colic flexure and then to the rectum.
- The inferior hypogastric plexus also innervate rectum.

Clinical Significance

The colon diseases mainly affect large intestine. Other than that, there are certain specific disorders that affect a certain area of the entire column of the large intestine.

1. Appendicitis
2. Chronic functional abdominal pain
3. Colitis
4. Colorectal cancer
5. Colorectal polyp
6. Constipation
7. Crohn's disease

8. Diarrhea
9. Diverticulitis
10. Diverticulosis
11. Ileus
12. Intussusceptions
13. Irritable bowel syndrome
14. Ulcerative colitis

II. Small Intestine

Chyme released from the stomach enters the small intestine, which is the primary digestive organ in the body. Not only is this where most digestion occurs, it is also where practically all absorption occurs. The longest part of the alimentary canal, the small intestine is about 3.05 meters long in a living person (but about twice as long in a cadaver due to the loss of muscle tone). Its name derives from its relatively smaller diameter of only about 2.54 cm compared with 7.62 cm for the large intestine.

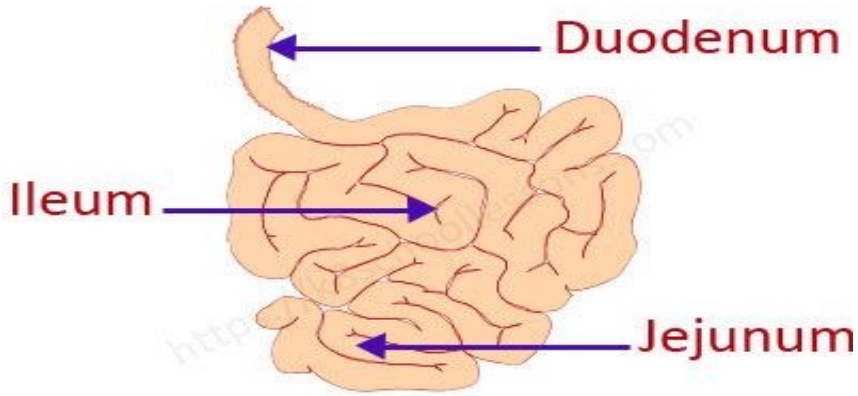

DIAGRAM OF THE SMALL INTESTINE

Structure

The coiled tube of the small intestine is subdivided into three regions. From proximal (at the stomach) to distal, these are the duodenum, jejunum, and ileum.

a) DUODENUM: The duodenum (25.4) is the shortest region which begins at the pyloric sphincter. Just past the pyloric sphincter, it bends posteriorly behind the peritoneum, becoming retroperitoneal, and then makes a C-shaped curve around the head of the pancreas before ascending anteriorly again to return to the peritoneal cavity and join the jejunum. The duodenum can therefore be subdivided into four segments: the superior, descending, horizontal, and ascending duodenum.

b) JEJUNUM: The jejunum is about 0.9 meters long and runs from the duodenum to the ileum. Jejunum means “empty” in Latin and supposedly was so named by the ancient Greeks who noticed it was always empty at death. No clear demarcation exists between the jejunum and the final segment of the small intestine, the ileum.

c) ILEUM: The ileum is the longest part of the small intestine, measuring about 1.8 meters in length. It is thicker, more vascular, and has more developed mucosal folds than the jejunum. The ileum joins the cecum, the first portion of the large intestine, at the ileocecal sphincter (or valve). The jejunum and ileum are tethered to the posterior abdominal wall by the mesentery. The large intestine frames these three parts of the small intestine.

Parasympathetic nerve fibers from the vagus nerve and sympathetic nerve fibers from the thoracic splanchnic nerve provide extrinsic innervation to the small intestine. The superior mesenteric artery is its main arterial supply. Veins run parallel to the arteries and drain into the superior mesenteric vein. Nutrient-rich blood from the small intestine is then carried to the liver via the hepatic portal vein.

Small Intestinal Wall

The wall of the small intestine is composed of the same four layers typically present in the alimentary system. However, three features of the mucosa and submucosa are unique. These features, which increase the absorptive surface area of the small intestine more than 600-fold, include circular folds, villi, and microvilli. These adaptations are most abundant in the proximal two-thirds of the small intestine, where the majority of absorption occurs.

- Circular folds

Also called a plica circulare, a circular fold is a deep ridge in the mucosa and submucosa. Beginning near the proximal part of the duodenum and ending near the middle of the ileum, these folds facilitate absorption. Their shape causes the chyme to spiral, rather than move in a straight line, through the small intestine. Spiraling slows the movement of chyme and provides the time needed for nutrients to be fully absorbed.

- Villi

Within the circular folds are small (0.5–1 mm long) hairlike vascularized projections called villi that give the mucosa a furry texture. There are about 20 to 40 villi per square millimeter, increasing the surface area of the epithelium tremendously. The mucosal epithelium, primarily composed of absorptive cells, covers the villi. In addition to muscle and connective tissue to support its structure, each villus contains a capillary bed composed of one arteriole and one venule, as well as a lymphatic capillary called a lacteal. The breakdown products of carbohydrates and proteins (sugars and amino acids) can enter the bloodstream directly, but lipid breakdown products are absorbed by the lacteals and transported to the bloodstream via the lymphatic system.

- Microvilli

Microvilli are much smaller (1 μm) than villi. They are cylindrical apical surface extensions of the plasma membrane of the mucosa's epithelial cells, and are supported by microfilaments within those cells. Although their small size makes it difficult to see each microvillus, their combined microscopic appearance suggests a mass of bristles, which is termed the brush border. Fixed to the surface of the microvilli membranes are enzymes that finish digesting carbohydrates and proteins. There are an estimated 200 million microvilli per square millimeter of small intestine, greatly expanding the surface area of the plasma membrane and thus greatly enhancing absorption.

Intestinal Glands

In addition to the three specialized absorptive features just discussed, the mucosa between the villi is dotted with deep crevices that each lead into a tubular intestinal gland (crypt of Lieberkühn), which is formed by cells that line the crevices. These produce intestinal juice, a slightly alkaline (pH 7.4 to 7.8) mixture of water and mucus. Each day, about 0.95 to 1.9 liters (1 to 2 quarts) are secreted in response to the distention of the small intestine or the irritating effects of chyme on the intestinal mucosa.The submucosa of the duodenum is the only site of the complex mucus-secreting duodenal glands (Brunner's glands), which produce a bicarbonate-rich alkaline mucus that buffers the acidic chyme as it enters from the stomach.

Clinical Significance

A number of clinical conditions harm the small intestine. Starting from physical obstruction of the lumen to bacterial or viral symptoms, there are many complex disorders.

A. Physical obstructive disorders

- Hernia
- Adhesions
- Paralytic ileus
- Volvulus

B. Infectious diseases

- Ascariasis
- Tropical sprue
- Hookworm
- Nematodes
- Protozoan infection
- Giardiasis

C. Bacterial infections

- Cholera
- Dysentery
- Diarrhea
- Infections caused by Mycobacterium, Campylobacter, Shigella, etc
- Typhoid and paratyphoid fever
- Botulism

D. Viral infections

- Adenoviral infection
- Rotaviral infection
- Astroviral infection

E. Neoplastic disorders

- Adenocarcinoma
- Carcinoid
- Gastro-intestinal stromal tumor
- Sarcoma
- Melanoma

F. Genetic disorders

- Meckel’s diverticulum
- Pyloric stenosis

- Pancreas divisum
- Situs Inversus
- Cystic fibrosis
- Primary bile acid malabsorption
- Gardner syndrome