Name: Ginika Obiadi Department: Anatomy Matric No: 18/MHS03/009 Course Code: ANA 204 Course Title: Histology of the Systems 2<sup>nd</sup> Assignment

Describe the microanatomy of small and large intestine. Note: You are expected to state the functions, segment, layers, general features and epithelium of each of the small and large intestine.

#### THE SMALL INTESTINE

The small intestine also known as the small bowel lies between the stomach and the large intestine which is also known as the large bowel and includes the duodenum, jejunum, and ileum. The small is so called because its lumen diameter is smaller than that of the large intestine, although it is longer in length than the large intestine. The small intestine is the site where almost all of the digestion and absorption of nutrients and minerals from food take place. The average length of the small intestine in an adult human male is 6.9 m, and in the adult female 7.1 m. It can vary greatly, from as short as 4.6 m to as long as 9.8 m. The small intestine is approximately 2.5 to 3 cm in diameter, and is divided into three sections:

- 1. The duodenum is the first section of the small intestine and is the shortest part of the small intestine. It is where most chemical digestion using enzymes takes place.
- 2. The jejunum is the middle section of the small intestine. It has a lining which is designed to absorb carbohydrates and proteins. The inner surface of the jejunum, its mucous membrane, is covered in projections called villi, which increase the surface area of tissue available to absorb nutrients from the gut contents. The epithelial cells which line these villi possess even larger numbers of microvilli. The transport of nutrients across epithelial cells through the jejunum includes the passive transport of

some carbohydrates and the active transport of amino acids, small peptides, vitamins, and most glucose. The villi in the jejunum are much longer than in the duodenum or ileum.

3. The ileum is the final section of the small intestine. The function of the ileum is mainly to absorb vitamin B12, bile salts, and any products of digestion that were not absorbed by the jejunum. The wall itself is made up of folds, each of which has many tiny finger-like projections known as villi on its surface. The ileum has an extremely large surface area both for the adsorption of enzyme molecules and for the absorption of products of digestion.

## FUNCTIONS

• Digestion

The small intestine is where most chemical digestion takes place. Many of the digestive enzymes that act in the small intestine are secreted by the pancreas and liver and enter the small intestine via the pancreatic duct. Pancreatic enzymes and bile from the gallbladder enter the small intestine in response to the Hormone cholecystokinin, which is produced in the small intestine in response to the presence of nutrients. Secretin, another hormone produced in the small intestine, causes additional effects on the pancreas, where it promotes the release of bicarbonate into the duodenum in order to neutralize the potentially harmful acid coming from the stomach.

The three major classes of nutrients that undergo digestion are proteins, lipids (fats) and carbohydrate:

- Proteins are degraded into small peptides and amino acids before absorption. Chemical breakdown begins in the stomach and continues in the small intestine. Proteolytic enzymes, including trypsin and chymotrypsin, secreted are by the pancreas and cleave proteins into smaller peptides. Carboxypeptidase, which is a pancreatic brush border enzyme, splits one amino acid at a time. Aminopeptidase and dipeptidase free the end amino acid products.
- Lipids (fats) are degraded into fatty acids and glycerol. Pancreatic lipase breaks down triglycerides into free fatty acids and monoglycerides. Pancreatic lipase works with the help of the salts from the bile secreted by the liver and stored in the gall bladder. Bile salts attach to triglycerides to help emulsify them, which aids access by pancreatic lipase. This occurs because the lipase is water-soluble but the fatty triglycerides are hydrophobic and tend to orient towards each other and away from the watery intestinal surroundings.
- Some carbohydrates are degraded into simple sugars, or monosaccharides an example is glucose. Pancreatic amylase breaks down some carbohydrates (starch) into oligosaccharides. Other carbohydrates pass undigested into the large intestine and

further handling by intestinal bacteria. Brush border enzymes take over from there. The most important brush border enzymes are dextrinase and glucoamylase, which further break down oligosaccharides. Other brush border enzymes are maltase, sucrase and lactase. Lactase is absent in some adult humans and, for them, lactose (a disaccharide), as well as most polysaccharides, is not digested in the small intestine. Some carbohydrates, such as cellulose, are not digested at all, despite being made of multiple glucose units.

• Absorption

Digested food is now able to pass into the blood vessels in the wall of the intestine through either diffusion or active transport. The small intestine is the site where most of the nutrients from ingested food are absorbed. The inner wall, or mucosa, of the small intestine, is lined with simple columnar epithelial tissue. Structurally, the mucosa is covered in wrinkles or folds called plicae circulares, which are considered permanent features in the wall of the organ. They are distinct from rugae which are considered non-permanent or temporary allowing for distention and contraction. From the plicae circulares project microscopic fingerlike pieces of tissue called villi. The individual epithelial cells also have finger-like projections known as microvilli. The functions of the plicae circulares, the villi, and the microvilli are to increase the amount of surface area available for the absorption of nutrients, and to limit the loss of said nutrients to intestinal fauna.

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# Immunological

The small intestine supports the body's immune system. The presence of gut flora appears to contribute positively to the host's immune system. Peyer's patches, located within the ileum of the small intestine, are an important part of the digestive tracts local immune system. They are part of the lymphatic system, and provide a site for antigens from potentially harmful bacteria or other microorganisms in the digestive tract to be sampled, and subsequently presented to the immune system.

# **Clinical Significance**

- Diarrhea: Is a frequent passage of unformed stool.
- Obstructive disorder: Infectious diseases such as tape worm
- Neoplastic growths may include gastrointestinal stromal tumors (GIST), lymphomas and sarcomas.

#### EPITHELIUM OF SMALL INTESTINE

- 1. Mucosa of the small intestine is lined by a SIMPLE COLUMNAR EPITHELIUM. The mucosa of the small intestine is characterized by evagination into plicae and villi.
- 2. Submucosa of small intestine is relatively unspecialized
- 3. Muscularis Externa of the small intestine has standard layers of inner circular and outer longitudinal smooth muscle.
- 4. Lamina propria also has thin strands of smooth muscle.
- 5. Muscularis mucosa of the small intestine forms a thin layer beneath the deep end.

#### LARGE INTESTINE

The large intestine, also known as the large bowel, is the last part of the gastrointestinal tract and of the digestive system in vertebrates. Water is absorbed here and the remaining waste material is stored as feces before being removed by defecation. The colon is the largest portion of the large intestine, so many mentions of the large intestine and colon overlap in meaning whenever precision is not the focus. Most sources define the large intestine as the combination of the cecum, colon, rectum, and anal canal. Some other sources exclude the anal canal.

In humans, the large intestine begins in the right iliac region of the pelvis, just at or below the waist, where it is joined to the end of the small intestine at the cecum, via the ileocecal valve. It then continues as the colon ascending the abdomen, across the width of the abdominal cavity as the transverse colon, and then descending to the rectum and its endpoint at the anal canal. Overall, in humans, the large intestine is about 1.5 meters long, which is about one-fifth of the whole length of the gastrointestinal tract.

The colon consists of six sections which are:

## • Cecum and appendix

The cecum is the first section of the colon and involved in the digestion, while the appendix which develops embryologically from it, is a structure of the colon, not involved in digestion and considered to be part of the gut-associated lymphoid tissue. The function of the appendix is uncertain, but some sources believe that the appendix has a role in housing a sample of the colon's microflora, and is able to help to repopulate the colon with bacteria if the microflora has been damaged during the course of an immune reaction. The appendix has also been shown to have a high concentration of lymphatic cells.

• Ascending colon

The ascending colon is the first of four main sections of the large intestine. It is connected to the small intestine by a section of bowel called the cecum. The ascending colon runs upwards through the abdominal cavity toward the transverse colon for approximately eight inches (20 cm).

One of the main functions of the colon is to remove the water and other key nutrients from waste material and recycle it. As the waste material exits the small intestine through the ileocecal valve, it will move into the cecum and then to the ascending colon where this process of extraction starts. The unwanted waste material is moved upwards toward the transverse colon by the action of peristalsis.

• Transverse colon

The transverse colon is the part of the colon from the hepatic flexure, also known as the right colic, to the splenin flexure also known as the left colic. The transverse colon hangs off the stomach, attached to it by a large fold of peritoneum called the greater omentum. On the posterior side, the transverse colon is connected to the posterior abdominal wall by a mesentery known as the transverse mesocolon

• Descending colon

The descending colon is the part of the colon from the splenic flexure to the beginning of the sigmoid colon. One function of the descending colon in the digestive system is to store feces that will be emptied into the rectum. It is retroperitoneal in two-thirds of humans. In the other third, it has a (usually short) mesentery. The arterial supply comes via the left colic artery. The descending colon is also called the distal gut, as it is further along the gastrointestinal tract than the proximal gut.

## • Sigmoid colon

The sigmoid colon is the part of the large intestine after the descending colon and before the rectum. The walls of the sigmoid colon are muscular, and contract to increase the pressure inside the colon, causing the stool to move into the rectum

• Rectum

The rectum is the last section of the large intestine. It holds the formed feces awaiting elimination via defecation

## FUNCTIONS

• Standing gradient osmosis

Water absorption at the colon typically proceeds against a transmucosal osmotic pressure gradient. The standing gradient osmosis is the reabsorption of water against the osmotic gradient in the intestines. Cells occupying the intestinal lining pump sodium ions into the intercellular space, raising the osmolarity of the intercellular fluid. This hypertonic fluid creates an osmotic pressure that drives water into the lateral intercellular spaces by osmosis true tight junctions and adjacent cells, which then in turn moves across the basement membrane and into the capillaries, while more sodium ions are pumped again into the intercellular fluid. Although water travels down an osmotic gradient in each individual step, overall, water usually travels against the osmotic gradient due to the pumping of sodium ions into the intercellular fluid. This allows the large intestine to absorb water despite the blood in capillaries being hypotonic compared to the fluid within the intestinal lumen.

• Gut flora

The large intestine houses over 700 species of bacteria that perform a variety of functions, as well as fungi, protozoa, and archaea, Species diversity varies by geography and diet. The microbes in a human distal gut often number in the vicinity of 100 trillion, and can weigh around 200 grams.

The large intestine absorbs some of the products formed by the bacteria inhabiting this region. Undigested polysaccharide (fiber) are metabolized to short-chain fatty acids by bacteria in the large intestine and absorbed by passive diffusion. The bicarbonate that the large intestine secretes helps to neutralize the increased acidity resulting from the formation of these fatty acids.

#### EPITHELIUM OF LARGE INTESTINE

The wall of the large intestine is line with SIMPLE COLUMNAR EPITHELIUM.