

HUMAN ANATOMY AND PHYSIOLOGY-II

DIGESTIVE SYSTEM

**(Anatomy and Physiology of Small and large Intestine,
Rectum, anal canal)**

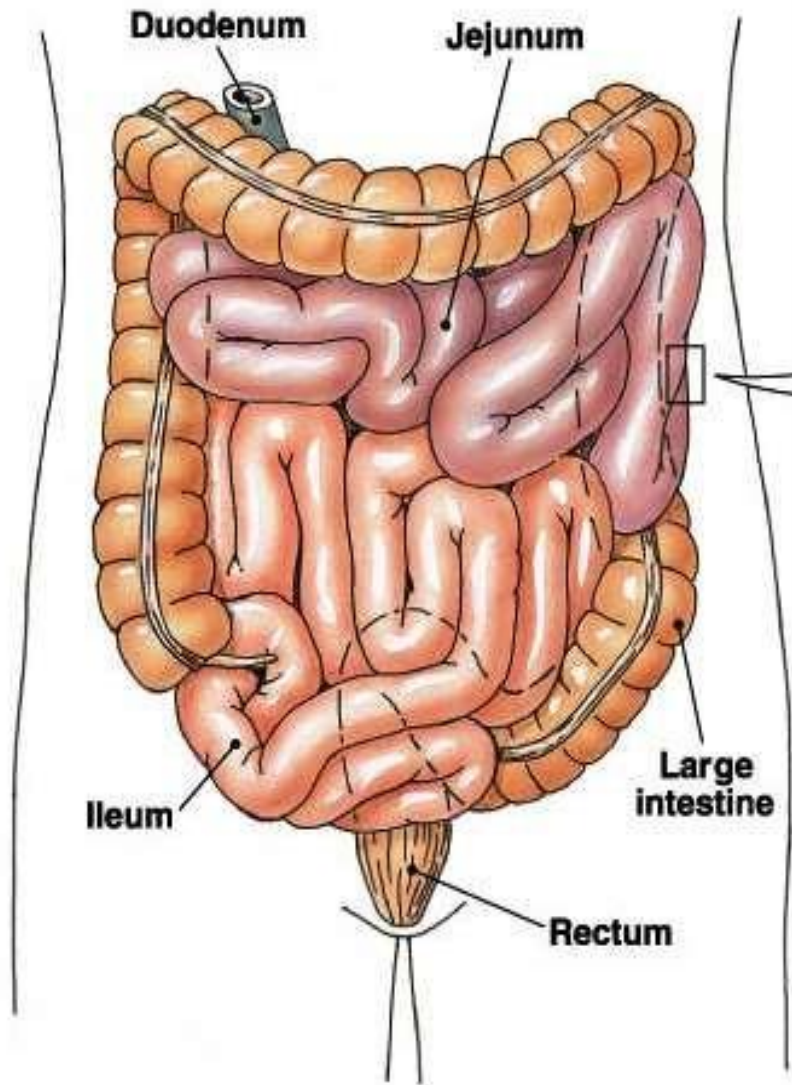


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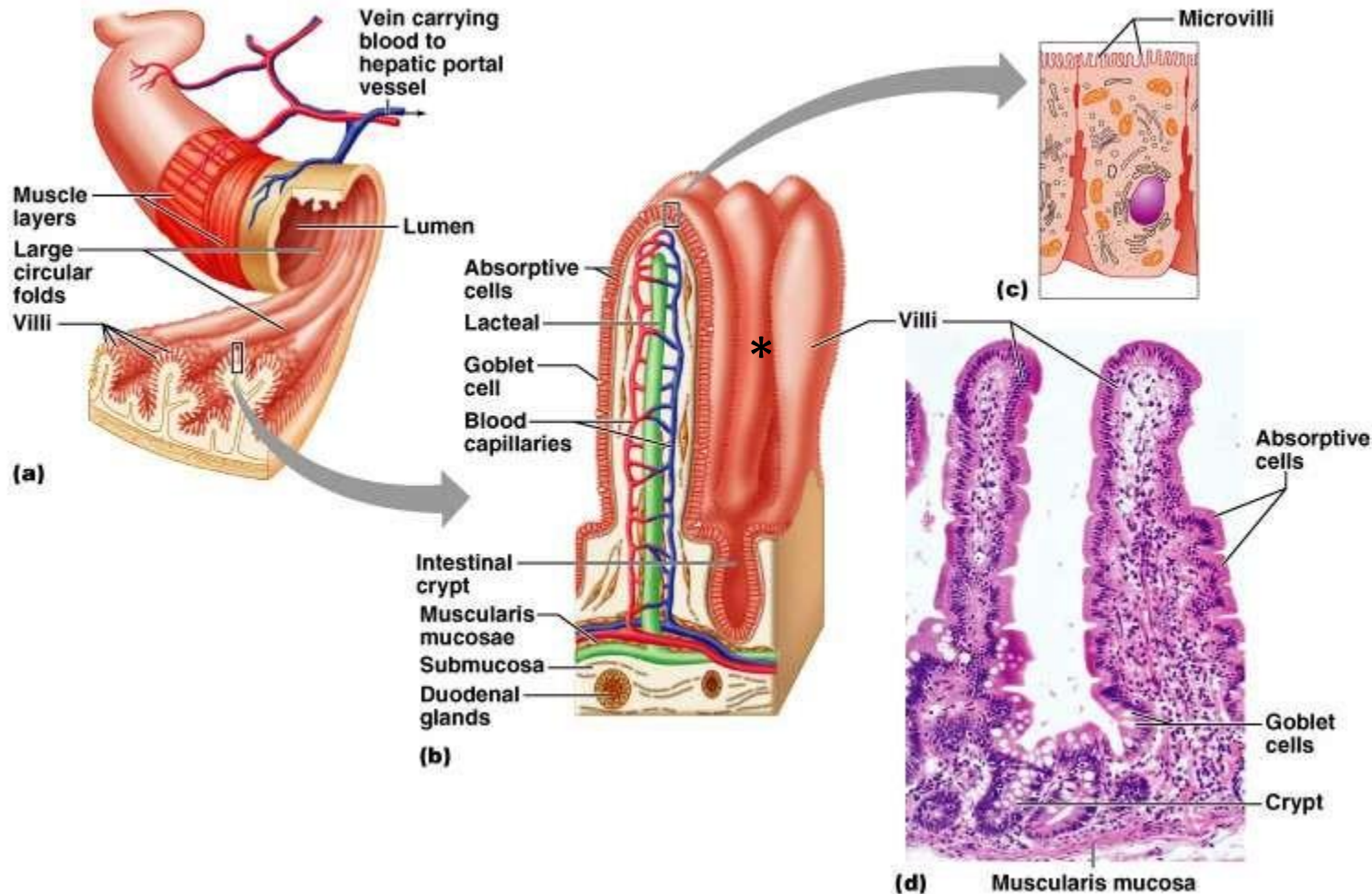
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Small intestine



- Longest part of alimentary canal (2.7-5 m)
- Site of greatest amount of digestion and absorption
- Small intestine has 3 subdivisions
 - Duodenum – 5% of length
 - Jejunum – almost 40%
 - Ileum – almost 60%
- **Modifications**
 - Circular folds or plicae circulares, villi, lacteal, microvilli
- **Cells of mucosa**
 - Absorptive, goblet, granular, endocrine

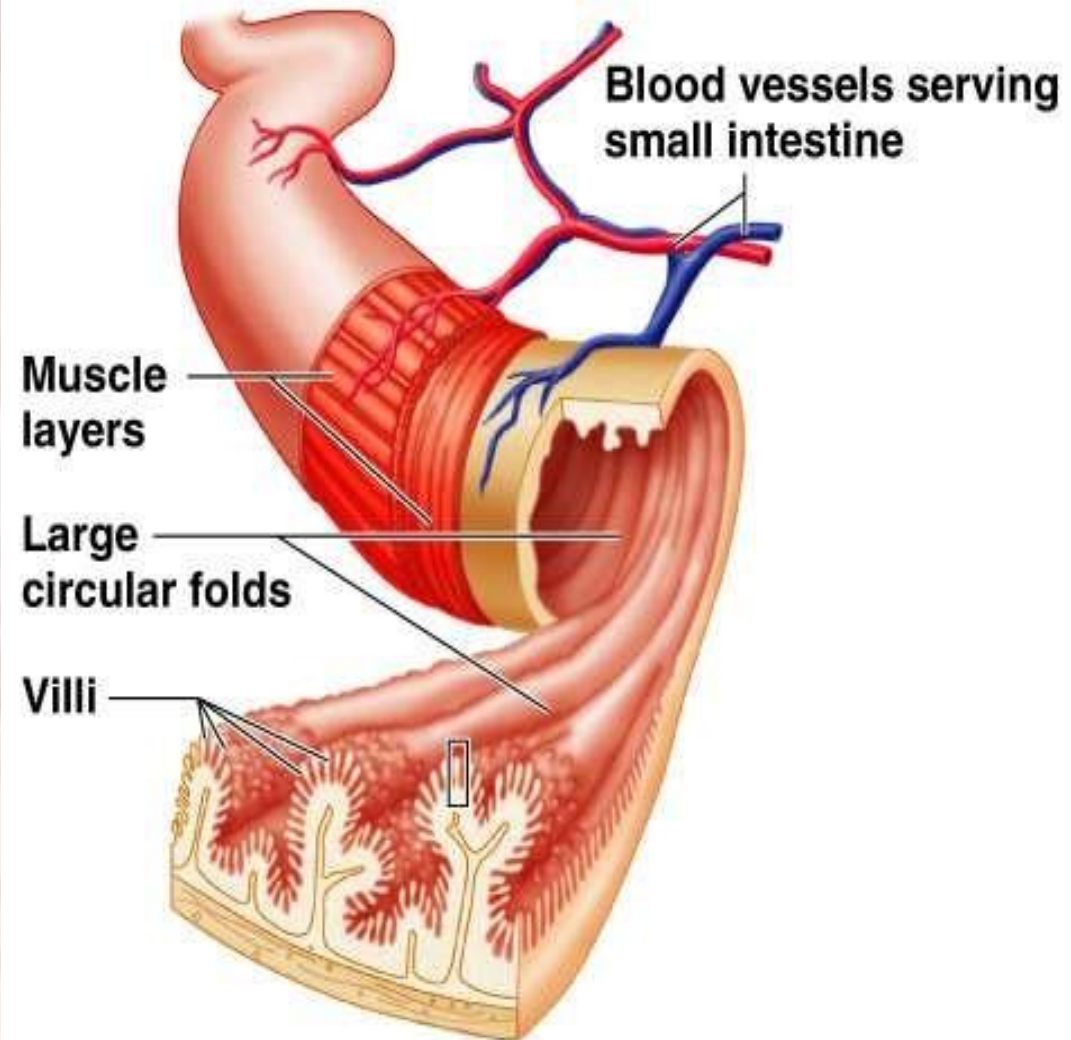
- **Small intestine designed for absorption**
 - Huge surface area because of great length
 - Structural modifications also increase absorptive area
 - Circular folds (plicae circulares)
 - Villi (fingerlike projections) 1 mm high – simple columnar epithelium: velvety
 - Microvilli



Absorptive cell with microvilli to increase surface area & many mitochondria: nutrient uptake is energy-demanding

Villi of the Small Intestine

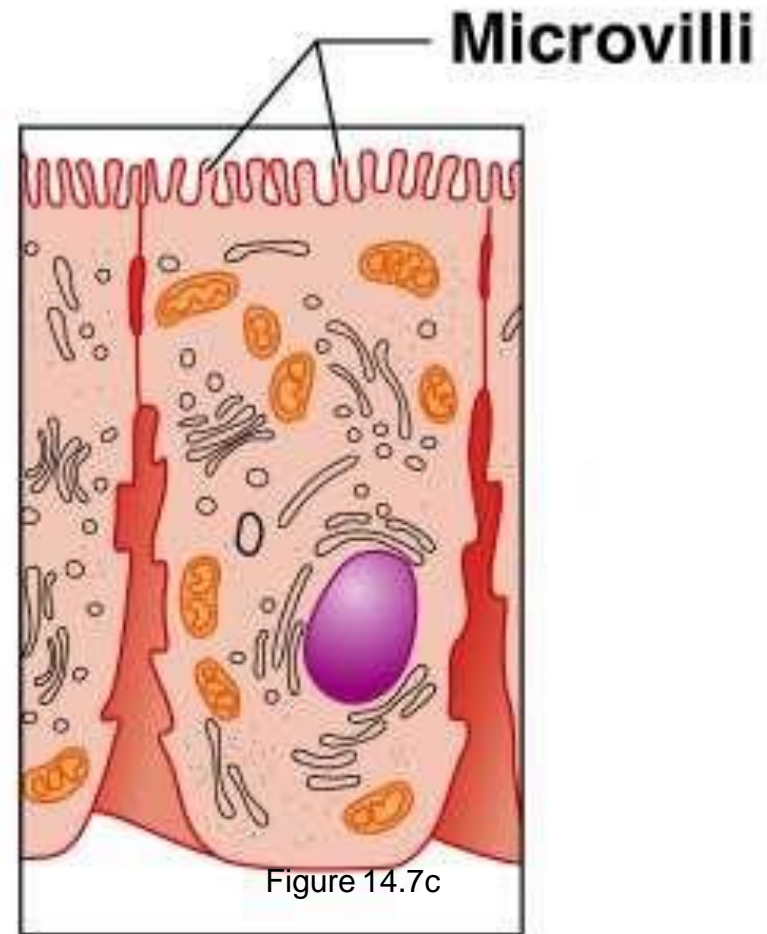
- Fingerlike structures formed by the mucosa
- Give the small intestine more surface area



(a) Small intestine

Microvilli of the Small Intestine

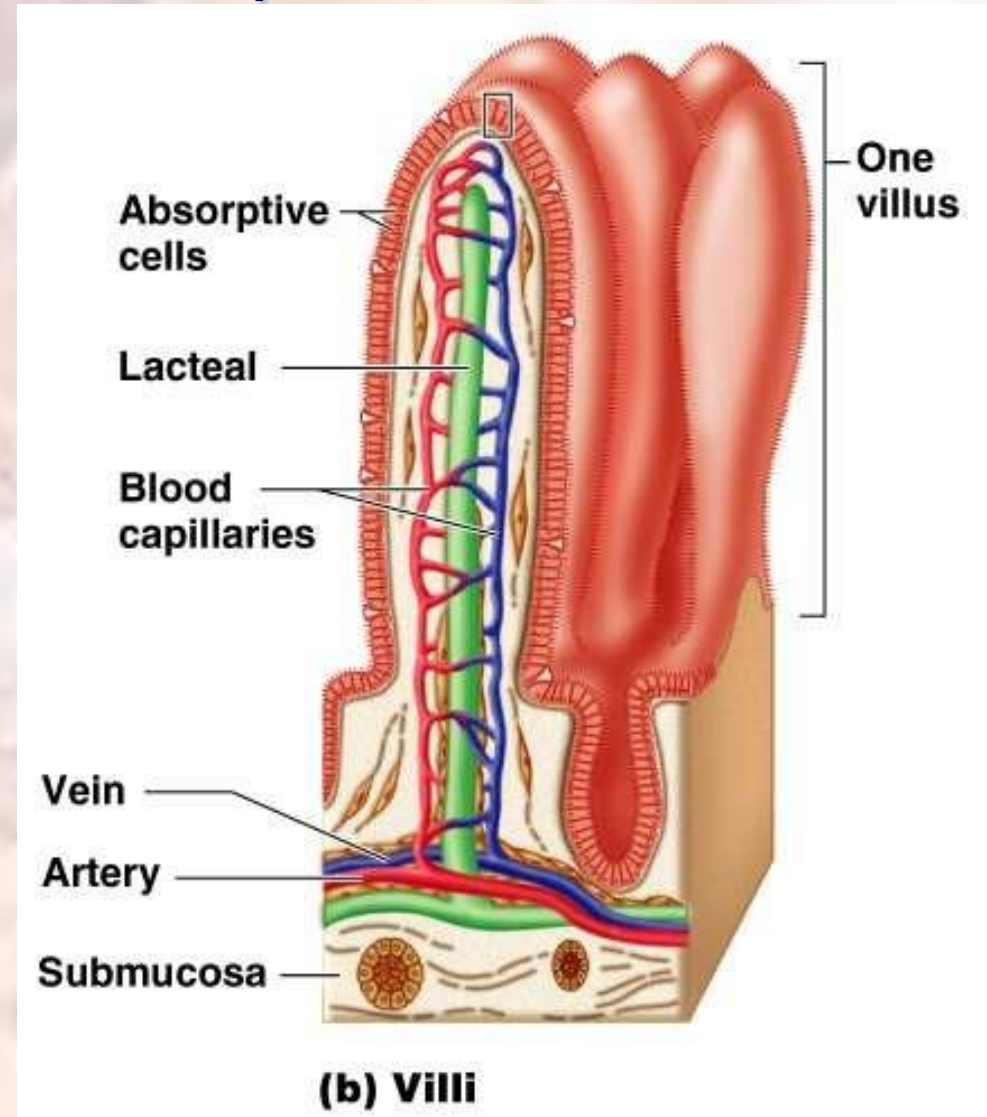
- Small projections of the plasma membrane
- Found on absorptive cells



(c) Absorptive cells

Structures Involved in Absorption of Nutrients

- Absorptive cells
- Blood capillaries
- Lacteals (specialized lymphatic capillaries)



Intestinal juice

About 1500 ml of intestinal juice are secreted daily by the glands of the small intestine.

It consists of:

- water
- mucus
- mineral salts.

The pH of intestinal juice is usually between 7.8 and 8.0.

Chemical digestion

- in the small intestine When acid chyme passes into the small intestine it is mixed with pancreatic juice, bile and intestinal juice, and is in contact with the enterocytes of the villi.
- In the small intestine digestion of all the nutrients is completed:
 - i. carbohydrates are broken down to monosaccharides
 - ii. proteins are broken down to amino acids
 - iii. fats are broken down to fatty acids and glycerol.

Digestion in the Small Intestine

Pancreatic enzymes play the major digestive function

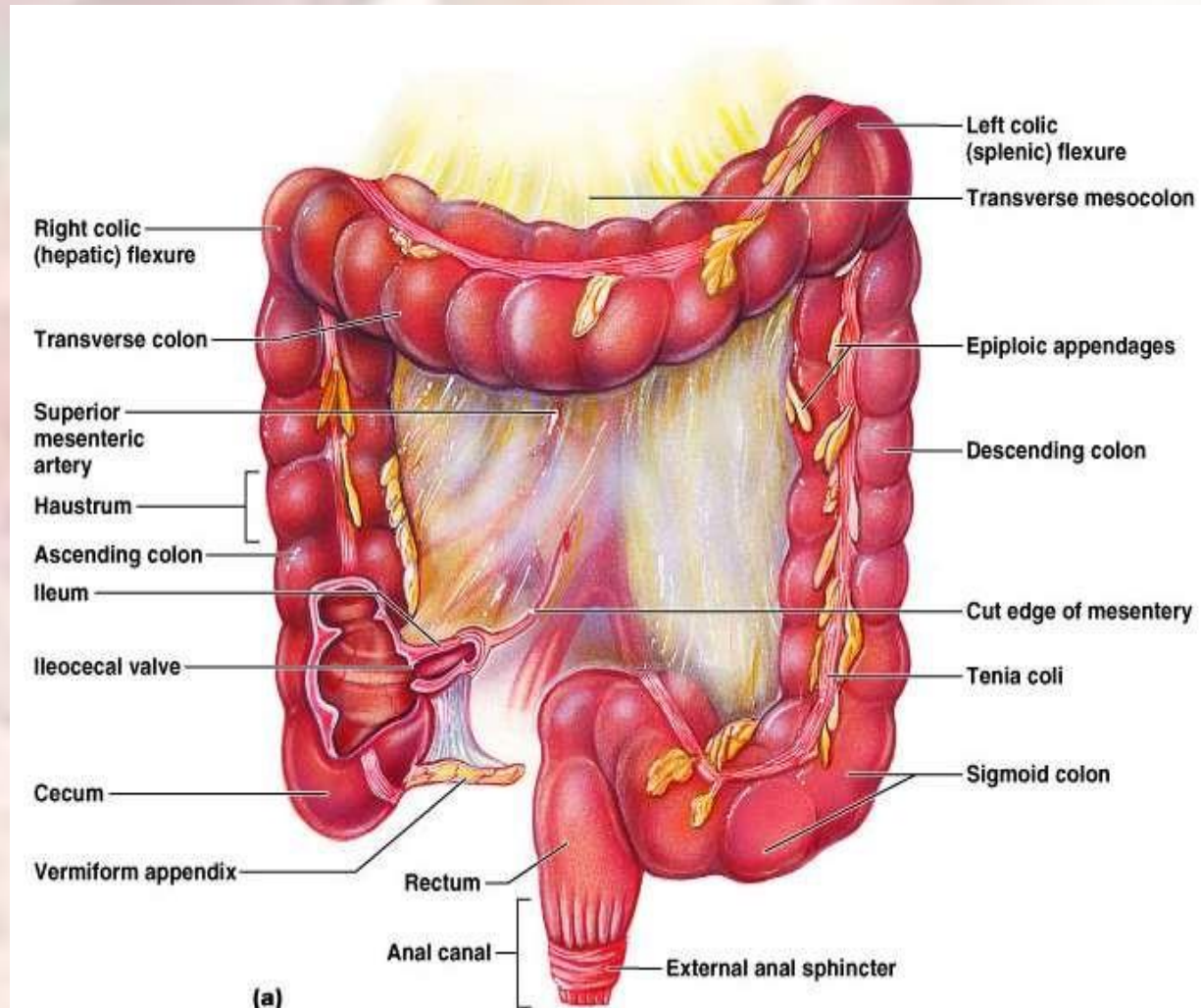
- Help complete digestion of starch (pancreatic amylase)
- Carry out about half of all protein digestion (trypsin, etc.)
- Responsible for fat digestion (lipase)
- Digest nucleic acids (nucleases)
- Alkaline content neutralizes acidic chyme

Absorption in the Small Intestine

- Water is absorbed along the length of the small intestine
- End products of digestion
 - Most substances are absorbed by active transport through cell membranes
 - Lipids are absorbed by diffusion
- Substances are transported to the liver by the hepatic portal vein or lymph

Large Intestine

- Larger in diameter, but shorter than the small intestine
- Frames the internal abdomen
- Digested residue reaches it
- Main function: to absorb water and electrolytes



Structures of the Large Intestine

- Cecum – saclike first part of the large intestine
 - Appendix
 - Accumulation of lymphatic tissue that sometimes becomes inflamed (appendicitis)
 - Hangs from the cecum
 - Colon
 - Ascending
 - Transverse
 - Descending
 - S-shaped sigmoidal
- ⊙ Rectum = Rectum is area for storage of feces
- ⊙ Leads to the anus, the external opening of the alimentary canal
- ⊙ Defecation

- The colon The colon has four parts which have the same structure and functions.
- **The ascending colon** This passes upwards from the caecum to the level of the liver where it curves acutely to the left at the hepatic flexure to become the transverse colon.
- **The transverse colon** This is a loop of colon that extends across the abdominal cavity in front of the duodenum and the stomach to the area of the spleen where it forms the splenic flexure and curves acutely downwards to become the descending colon.
- **The descending colon** This passes down the left side of the abdominal cavity then curves towards the midline. After it enters the true pelvis it is known as the sigmoid colon.
- **The sigmoid colon** This part describes an S-shaped curve in the pelvis that continues downwards to become the rectum

- **The anal canal**
- This is a short passage about 3.8 cm long in the adult and leads from the rectum to the exterior.
- Two sphincter muscles control the anus; the internal sphincter, consisting of smooth muscle, is under the control of the autonomic nervous system and the external sphincter, formed by skeletal muscle, is under voluntary control

Functions of the Large Intestine

- Absorption of water
- Eliminates indigestible food from the body as feces
- Does not participate in digestion of food
- Goblet cells produce mucus to act as a lubricant

Food Breakdown and Absorption in the Large Intestine

- No digestive enzymes are produced
- Resident bacteria digest remaining nutrients
 - Produce some vitamin K and B
 - Release gases
- Water and vitamins K and B are absorbed
- Remaining materials are eliminated via feces

Functions of the large intestine, rectum and anal canal

- Absorption: absorption of water, by osmosis, continues until the familiar semisolid consistency of faeces is achieved. Mineral salts, vitamins and some drugs are also absorbed into the blood capillaries from the large intestine.
- Microbial activity: The large intestine is heavily colonised by certain types of bacteria, which synthesise vitamin K and folic acid. *Escherichia coli*, *Enterobacter aerogenes*, *Streptococcus faecalis* and *Clostridium perfringens*.
- These microbes are normally harmless, in humans.
- However, they may become pathogenic if transferred to another part of the body, e.g. *E. coli* may cause cystitis if it gains access to the urinary bladder

- Gases in the bowel consist of some of the constituents of air, mainly nitrogen, swallowed with food and drink and as a feature of some anxiety states.
- Hydrogen, carbon dioxide and methane are produced by bacterial fermentation of unabsorbed nutrients, especially carbohydrate. Gases pass out of the bowel as flatus (wind).

Mass movement

- The large intestine does not exhibit peristaltic movement as in other parts of the digestive tract.
- Only at fairly long intervals (about twice an hour) does a wave of strong peristalsis sweep along the transverse colon forcing its contents into the descending and sigmoid colons.
- This is known as mass movement and it is often precipitated by the entry of food into the stomach.
- This combination of stimulus and response is called the *gastrocolic reflex*.

Defaecation

- Usually the rectum is empty, but when a mass movement forces the contents of the sigmoid colon into the rectum the nerve endings in its walls are stimulated by stretch.
- In the infant, defaecation occurs by reflex (involuntary) action.
- defaecation involves involuntary contraction of the muscle of the rectum and relaxation of the internal anal sphincter.
- Contraction of the abdominal muscles and lowering of the diaphragm increase the intra-abdominal pressure (Valsalva's manoeuvre) and so assist the process of defaecation.
- When defaecation is voluntarily postponed the need to defaecate tends to fade until the next mass movement occurs and the reflex is initiated again.
- Repeated suppression of the reflex may lead to **constipation** (hard faeces) as more water is absorbed.
- **Constituents of faeces** *The faeces consist of a semisolid brown mass. The brown colour is due to the presence of stercobilin*
- *Even though absorption of water takes place in the small and large intestines, water still makes up about 60 to 70% of the weight of the faeces. The remainder consists of: fibre (indigestible cellular plant and animal material) dead and live microbes epithelial cells shed from the walls of the tract fatty acids mucus secreted by the epithelial lining of the large intestine*