

Digestion and Absorption

Short Note for UG
NEET Examination

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- Reductionist approach: Increased use of physico-chemical concepts and techniques in studying life forms.
- Studies employed surviving tissue models or cell-free systems.
- Molecular biology emerged from the explosion of knowledge.
- Molecular physiology became synonymous with biochemistry and biophysics.
- Purely organismic or reductionistic molecular approaches are insufficient to reveal the truth about biological processes.
- Systems biology views living phenomena as emergent properties due to interactions among system components.
- Emergent properties arise from regulatory networks of molecules, supra molecular assemblies, cells, tissues, organisms, populations, and communities.
- Major human physiological processes described in cellular and molecular terms: digestion, gas exchange, blood circulation, locomotion, and movement.
- Coordination and regulation of body events at the organismic level.
- Alfonso Corti: Italian anatomist who studied the cardiovascular systems of reptiles and the mammalian auditory system.
- Published a paper in 1851 describing the organ of Corti, located on the basilar membrane of the cochlea.

- Food is a basic requirement for all living organisms.
- Major components of food: carbohydrates, proteins, and fats; vitamins and minerals required in small quantities.
- Food provides energy and organic materials for growth and tissue repair.
- Water plays a vital role in metabolic processes and prevents dehydration.
- Biomacromolecules in food need to be broken down and converted into simple absorbable forms through digestion.
- Digestion is carried out by the digestive system through mechanical and biochemical methods.
- Human digestive system consists of the alimentary canal and associated glands.
- Alimentary canal begins with the mouth and opens posteriorly through the anus.
- Mouth leads to the buccal cavity or oral cavity, containing teeth and a muscular tongue.
- Teeth are embedded in sockets of the jaw bone and classified as thecodont.
- Humans have two sets of teeth: temporary milk teeth and permanent adult teeth (diphyodont dentition).
- Adult human dentition includes incisors, canines, premolars, and molars (heterodont dentition).
- Dental formula for humans is $2123/2123$.
- Tongue is a movable muscular organ with papillae and taste buds on its upper surface.
- Pharynx serves as a common passage for food and air; it is connected to the esophagus and trachea.

- Epiglottis prevents food from entering the windpipe during swallowing.
- Esophagus is a thin, long tube that passes through the neck, thorax, and diaphragm, leading to the stomach.
- Gastro-esophageal sphincter regulates the opening of the esophagus into the stomach.
- Stomach has three major parts: cardiac portion, fundic region, and pyloric portion.
- Small intestine consists of duodenum, jejunum, and ileum.
- Pyloric sphincter guards the opening of the stomach into the duodenum.
- Large intestine includes the cecum, colon, and rectum.
- Vermiform appendix is a vestigial organ arising from the cecum.
- Alimentary canal wall has four layers: serosa, muscularis, sub-mucosa, and mucosa.
- Serosa is the outermost layer, muscularis consists of smooth muscle, sub-mucosa contains glands in the duodenum, and mucosa lines the lumen.
- Mucosa forms folds (rugae) in the stomach and finger-like projections (villi) in the small intestine.
- Villi increase the surface area and have a network of capillaries and a lacteal.
- Mucosal epithelium has goblet cells that secrete mucus, and glands are present in the stomach and crypts in the intestine.
- Digestive glands associated with the alimentary canal: salivary glands, liver, and pancreas.

- Saliva is produced by three pairs of salivary glands: parotids, sub-maxillary/sub-mandibular, and sub-linguals.
- Salivary glands secrete saliva into the buccal cavity.
- Liver is the largest gland, located below the diaphragm in the abdominal cavity.
- Liver has two lobes and hepatic lobules as structural and functional units.
- Hepatic cells in lobules secrete bile, which passes through hepatic ducts.
- Bile is stored and concentrated in the gall bladder, a thin muscular sac.
- Cystic duct from the gall bladder and hepatic duct from the liver form the common bile duct.
- Common bile duct and pancreatic duct open together into the duodenum as the common hepato-pancreatic duct.
- Common hepato-pancreatic duct is guarded by the sphincter of Oddi.
- Pancreas is a compound organ situated between the limbs of the duodenum.
- Pancreas has an exocrine portion that secretes alkaline pancreatic juice containing enzymes.
- Pancreas also has an endocrine portion that secretes hormones, insulin, and glucagon.
- Digestion is accomplished by mechanical and chemical processes.
- The buccal cavity performs mastication of food and facilitates swallowing.
- Teeth and tongue, aided by saliva, masticate and mix the food.

- Saliva contains electrolytes and enzymes (salivary amylase and lysozyme).
- Salivary amylase initiates the chemical digestion of carbohydrates.
- Swallowing or deglutition conveys the bolus from the buccal cavity to the pharynx and then to the esophagus.
- Peristalsis, muscular contractions, propels the bolus down the esophagus.
- Gastro-esophageal sphincter controls the passage of food into the stomach.
- Stomach contains gastric glands with three types of cells: mucus neck cells, peptic or chief cells, and parietal or oxyntic cells.
- Gastric juice mixes with food, forming chyme, through churning movements of the stomach wall.
- Pepsinogen is converted to pepsin by hydrochloric acid, and pepsin breaks down proteins into proteoses and peptones.
- Gastric juice provides lubrication and protection to the stomach's mucosal epithelium.
- Small amounts of lipases are also secreted by gastric glands.
- Muscularis layer of the small intestine generates various movements that aid in digestion.
- Secretions released into the small intestine include bile, pancreatic juice, and intestinal juice.
- Pancreatic juice contains inactive enzymes (trypsinogen, chymotrypsinogen, procarboxypeptidases, amylases, lipases, and nucleases).

- Trypsinogen is activated by enterokinase, an enzyme secreted by the intestinal mucosa.
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- Bile released into the duodenum contains bile pigments, bile salts, cholesterol, and phospholipids, aiding in the emulsification of fats and activating lipases.
- Goblet cells in the intestinal mucosal epithelium secrete mucus, while brush border cells secrete enzymes, forming the intestinal juice or succus entericus.
- Intestinal juice contains enzymes such as disaccharidases, dipeptidases, lipases, and nucleosidases.
- Mucus and bicarbonates protect the intestinal mucosa and provide an alkaline environment for enzymatic activities.
- Proteolytic enzymes in pancreatic juice break down proteins, proteoses, and peptones.
- Pancreatic amylase hydrolyzes carbohydrates into disaccharides.
- Lipases, along with bile, break down fats into di- and monoglycerides.
- Nucleases in pancreatic juice act on nucleic acids to form nucleotides and nucleosides.
- Enzymes in succus entericus further break down the end products of digestion into absorbable forms.

- Biomacromolecule breakdown occurs in the duodenum, while absorption takes place in the jejunum and ileum of the small intestine.
- Large intestine absorbs water, minerals, and certain drugs, and secretes mucus for waste adhesion and lubrication.
- Undigested, unabsorbed substances called feces enter the large intestine and are temporarily stored in the rectum until defecation.
- Gastrointestinal activities are controlled by neural and hormonal mechanisms, with saliva, gastric, and intestinal secretions stimulated by neural signals.
- Muscular activities in the alimentary canal can be modulated by neural mechanisms and hormonal control by local hormones produced by the gastric and intestinal mucosa.
- Absorption is the process of passing the end products of digestion through the intestinal mucosa into the blood or lymph.
- Absorption can occur through passive diffusion, active transport, or facilitated transport mechanisms.
- Monosaccharides, amino acids, and some electrolytes are generally absorbed by simple diffusion.
- Substances like fructose and certain amino acids are absorbed with the help of carrier ions like Na^+ through facilitated transport.
- Water absorption depends on osmotic gradients.
- Active transport requires energy and allows the absorption of various nutrients, including amino acids, glucose, and Na^+ .

- Insoluble fatty acids and glycerol are incorporated into micelles and then formed into chylomicrons, which are transported into lymph vessels (lacteals) in the villi and eventually released into the bloodstream.
- Absorption occurs in different parts of the alimentary canal, with the small intestine being the site of maximum absorption.
- The absorbed substances are utilized by tissues in a process called assimilation.
- Digestive wastes solidify into coherent feces in the rectum, triggering a neural reflex for their removal.
- Defecation, the elimination of feces through the anal opening, is a voluntary process and is facilitated by mass peristaltic movement.
- Inflammation of the intestinal tract: This is a common ailment caused by bacterial or viral infections, as well as parasites such as tapeworm, roundworm, threadworm, hookworm, and pinworm.
- Jaundice: It is a condition where the liver is affected, leading to the yellowing of the skin and eyes due to the deposition of bile pigments.
- Vomiting: The ejection of stomach contents through the mouth. It is controlled by the vomit center in the medulla, and nausea often precedes vomiting.
- Diarrhea: Abnormal frequency of bowel movements and increased liquidity of the fecal discharge. It can reduce the absorption of food.
- Constipation: The retention of feces within the rectum due to irregular bowel movements, resulting in difficulty in passing stools.

- Indigestion: The food is not properly digested, causing a feeling of fullness. Inadequate enzyme secretion, anxiety, food poisoning, overeating, and consumption of spicy food are some of the causes of indigestion.