**Lec -2-**

**Physiology of digestion**

**Digestion:**

* Digestion is the process of gradual break down of foods that we  eat in a soluble form suitable for absorption. For example, meat, even when cooked, is chemically too complex to be absorbed from the alimentary canal.so, it first digested before absorption.
* Digestion releases its constituents: glucose,amino acids, mineral salts, fat and vitamins, which are ready for absorption.

The activities of the digestive system can be grouped under five main headings.  
**1. Ingestion:**This is the taking of food into the alimentary tract, i.e. eating and drinking.

**2. Propulsion:**This mixes and moves the contents along the alimentary tract.

**3. Digestion**. This consists of:  
• **mechanical digestion:**breakdown of food by, e.g. mastication (chewing)  
• **chemical**digestion: breakdown of food into small molecules by enzymes produced by digestive glands.

**4. Absorption:** This is the process by which digested food substances pass through the walls  
of alimentary canal into the blood and lymph capillaries to use by body cells.

**5. Elimination:** undigested and unabsorbed substances are excreted from the alimentary canal as faeces by the process of defaecation.

**Lec-3-**

**Mechanism of digestion**

**1. Mechanical digestion**

**i. Mastigation:**

* The teeth are admirably designed for chewing. The anterior teeth (incisors) provide a strong cutting action, and the posterior teeth (molars) provide a grinding action.
* Chewing is important for digestion of all foods, but it is especially important for most fruits  
  and raw vegetables because they have indigestible cellulose membranes around their  
  nutrient portions that must be broken before the food can be digested.
* Furthermore, chewing aids the digestion of food for another simple reason: Digestive enzymes act only on the surfaces of food particles; therefore, the rate of digestion is dependent on the total surface area exposed to the digestive secretions.
* In addition, grinding the food to a very fine particulate consistency prevents excoriation of the gastrointestinal tract and increases the ease with which food is emptied from the stomach into the small intestine, then into all succeeding segments of the gut.

**ii. Swallowing (deglutition):**

* Swallowing is a complicated mechanism, principally because the pharynx serves respiration and swallowing both.
* The pharynx is converted for only a few seconds at a time into a tract for swallowing of food.
* Tongue helps in mixing of saliva with the food.
* Saliva moistens and lubricates the food, which changes into semisolid form called bolus. The bolus is then swallowed through Oesophagus to the stomach.
* Peristalsis movement of alimentary canal also helps in swallowing.

**iii. Churning in stomach:**

* The wall of stomach undergoes periodic movement as well as contraction producing churning movement called peristalsis, which results in breakdown of complex food into simpler form.
* The bolus after mixing with gastric juice, turn into fine soluble form known as chime.

**2. Chemical digestion**

* It involves the breaking of covalent chemical bonds in organic molecules by digestive  
  enzymes.
* Carbohydrates are broken down into monosaccharides, proteins are broken down into amino acids, and fats are broken down into fatty acids and glycerol.

**i. Digestion of Carbohydrates**

* Ingested carbohydrates consist primarily of polysaccharides, such as starches (rice, bread), disaccharides, such as sucrose (table sugar) and lactose (milk sugar); and monosaccharides, such as glucose and fructose (found in many fruits).
* During the process of digestion, polysaccharides are broken down into smaller chains and finally into disaccharides and monosaccharides. Disaccharides are broken down into monosaccharides.

**a) digestion of carbohydrates in mouth;**

* Carbohydrate digestion begins in the oral cavity with the partial digestion of starches by  
  salivary amylase.
* About 30 percent of starch is hydrolysed here by this enzyme amylase (optimum pH 6.8) into a disaccharide – maltose.
* Lysozyme present in saliva acts as an antibacterialagent that prevents infections.

**b) digestion of carbohydrates in stomach and intestine;**

* A minor amount of digestion occurs in the stomach through the action of gastric amylase  
  and gelatinase.
* Carbohydrate digestion is continued in the intestine by pancreatic amylase.
* A series of disaccharidases enzymes that are released by intestinal epithelium digest disaccharides into monosaccharides.

**ii. Digestion of Proteins**

* Proteins are taken into the body from a number of dietary sources.
* Pepsin secreted by the stomach catalyzes the cleavage of covalent bonds in proteins to produce smaller polypeptide chains.

**a) digestion of protein in stomach and intestine;**

* Gastric pepsin digests as much as 10%–20% of the total ingested protein.
* The mucosa of stomach has gastric glands.
* Gastric glands have three major types of cells namely –  
  (i) mucus cells:  which secrete mucus;  
  (ii) peptic or chief cells; which secrete the proenzyme pepsinogen; and  
  (iii) parietal or oxyntic cells; which secrete HCl and intrinsic factor (factor essential for  
  absorption of vitamin B12).
* The stomach stores the food for 4-5 hours.
* The food mixes thoroughly with the acidic gastric juice of the stomach by the churning movements of its muscular wall and is called the chyme.
* The proenzyme pepsinogen, on exposure to hydrochloric acid gets converted into pepsin.
* Pepsin then converts proteins into proteoses and peptones (peptides).
* The mucus and bicarbonates present in the gastric juice play an important role in lubrication and protection of the mucosal epithelium from excoriation by the highly concentrated hydrochloric acid.
* HCl provides the acidic pH (pH 1.8) optimal for pepsins.
* Rennin is a proteolytic enzyme found in gastric juice of infants which helps in the digestion of milk proteins.

**b) digestion of protein in intestine;**

* The bile, pancreatic juice and the intestinal juice are the secretions released into the small intestine.
* Pancreatic juice and bile are released through the hepato-pancreatic duct.
* The pancreatic juice contains inactive enzymes – trypsinogen, chymotrypsinogen, procarboxypeptidases.
* Trypsinogen is activated by an enzyme, enterokinase, secreted by the intestinal mucosa into active trypsin, which in turn activates the other enzymes in the pancreatic juice.
* Pancreatic proteinases (all secreted in their inactive forms) digest peptides into amino  
  acids:
* Trypsinogen is activated by enterokinase (secreted by duodenum) into trypsin, which in turn activates the other 3 enzymes –chymo-trypsinogen becomes chymotrypisn, proaminopeptidase becomes aminopeptidase, and procarboxypeptidase becomes  
  carboxypeptidase.

**iii. Digestion of Lipids**

* Lipids are molecules that are insoluble or only slightly soluble in water.
* Lipids include triglycerides, phospholipids, cholesterol, steroids, and fat-soluble vitamins.
* The first step in lipid digestion is emulsification, which is the transformation of large lipid droplets into much smaller droplets.
* The emulsification process increases the surface area of the lipid exposed to the digestive enzymes by decreasing the droplet size.
* Emulsification is accomplished by bile salts secreted by the liver and stored in the  
  gallbladder.
* Lipase digests lipid molecules .
* The vast majority of lipase is secreted by the pancreas. A minor amount of lingual lipase is secreted in the oral cavity, is swallowed with the food, and digests a small amount (<10%) of lipid in the stomach.
* The stomach also produces very small amounts of gastric lipase.
* The primary products of lipase digestion are free fatty acids and glycerol and few cholesterol and phospholipids.

**3. Absorption**

* Absorption is the process by which the end products of digestion pass through the intestinal  
  mucosa into the blood or lymph.
* It is carried out by passive, active or facilitated transport mechanisms.
* Water moves by osmosis; small fat soluble substances, e.g. fatty acids and glycerol, are able to diffuse through cell membranes; while others are generally transported inside the villi by other mechanisms.

**i. Passive transport:**

* Small amounts of monosaccharides like glucose, amino acids and some electrolytes like chloride ions are generally absorbed by simple diffusion.
* The passage of these substances into the blood depends upon the concentration gradients.

**ii. Active transport:**

* Active transport occurs against the concentration gradient and hence requires energy.
* Various nutrients like amino acids, monosaccharides like glucose, electrolytes like Na+ are absorbed into the blood by this mechanism.
* Some substances like glucose and amino acids are absorbed with the help of carrier proteins. This mechanism is called the facilitated transport.
* Fatty acids and glycerol being insoluble, cannot be absorbed into the blood. They are first  
  incorporated into small droplets called micelles which move into the intestinal mucosa. They are re-formed into very small protein coated fat globules called the chylomicrons  
  which are transported into the lymph vessels (lacteals) in the villi. These lymph vessels  
  ultimately release the absorbed substances into the blood stream. The absorbed substances  
  finally reach the tissues which utilise them for their activities. This process is called assimilation.

**4. Defaecation**

* The digestive wastes, solidified into coherent faeces in the rectum initiate a neural reflex  
  causing an urge or desire for its removal.
* The egestion of faeces to the outside through the anal opening (defaecation) is a voluntary process and is carried out by a mass peristaltic movement.