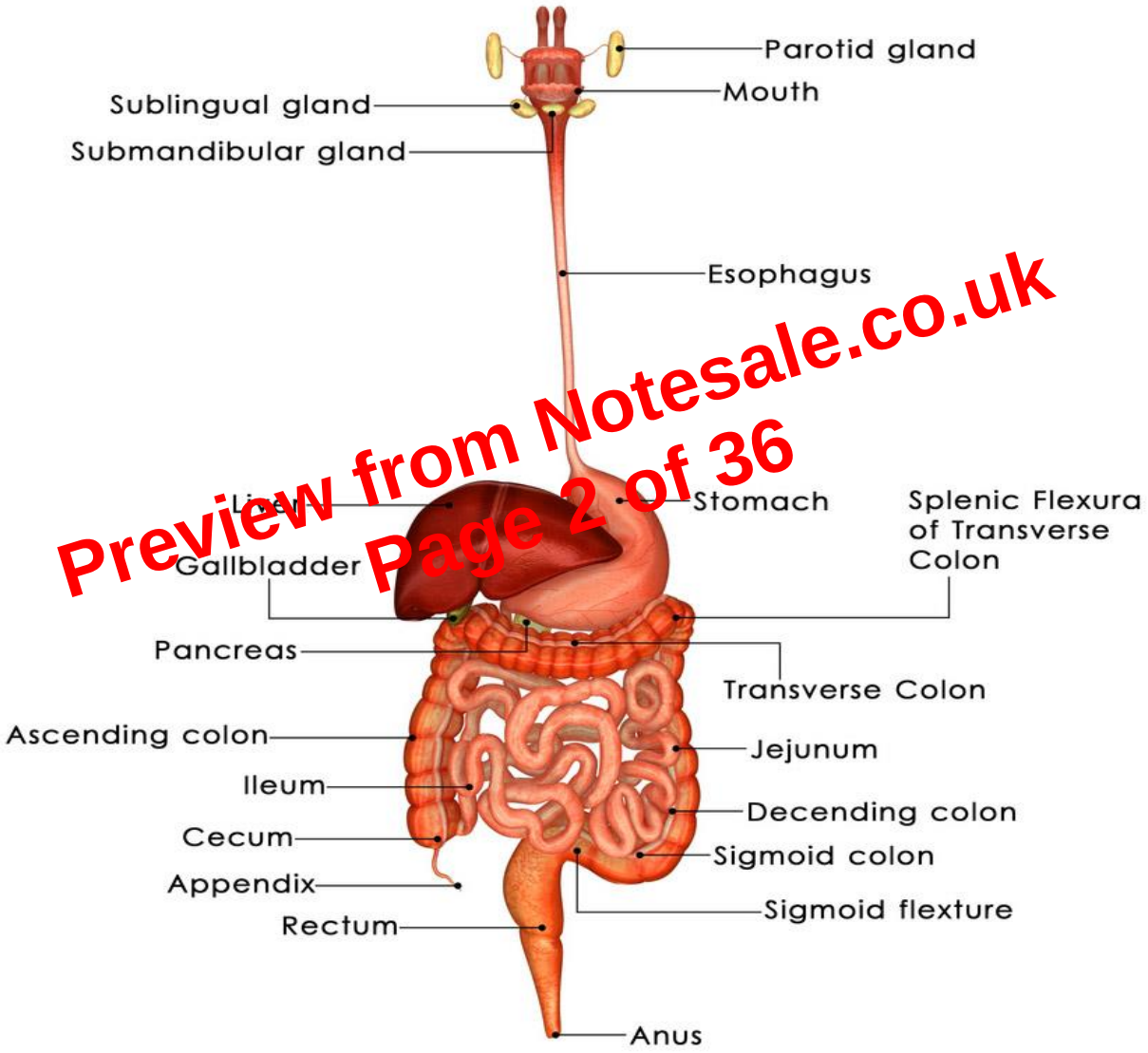
ALIMENTARY CANAL

The alimentary canal is a tubular structure (5-7 meters long) that extends from mouth to anus.

Mouth

- Anterior opening or slit of the alimentary canal.
- Covered by the upper and lower lip.



Buccal cavity

It is subdivided into two parts.

- **Human Dentition**
  - **Milk teeth:** Teeth which appear during childhood are called milk teeth/temporary teeth/primary teeth.
  - **Permanent teeth:** Milk teeth are shed and replaced by permanent teeth which are not shed again in life.

- **Types of Teeth**

In mammals, four types of teeth are found:

- **Incisors:** These are the long, chisel-like teeth with sharp edges for gnawing the food.
- **Canines:** These are sharp-pointed, one cuspid teeth is meant for tearing and shearing the food.
- **Premolars**: These bicuspid teeth are used for chewing and crushing the food.
- **Molars (cheek teeth):** 4-5 cusps are present in the first and second molars while the third molars have 3 cusps. These are also meant for chewing and crushing the food.

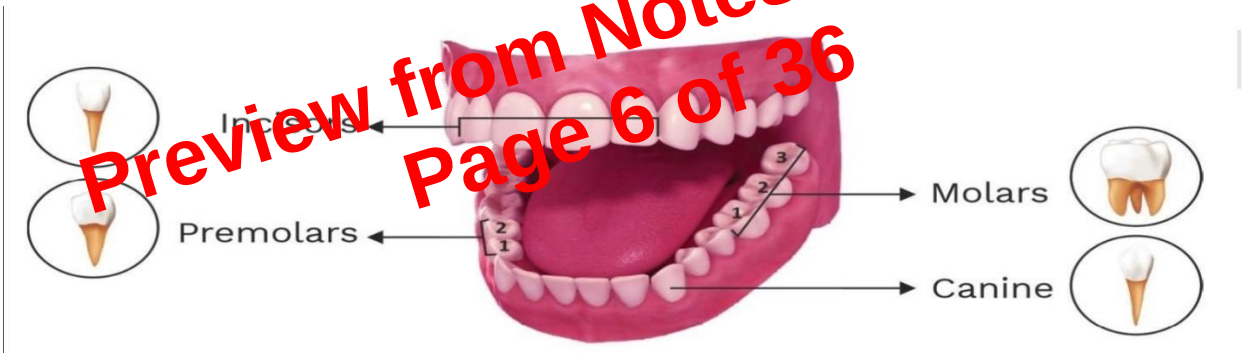


FIG. TYPES OF HUMAN TEETH

- **Dental Formula**

Child (2 – 4 years)

$$I\frac{2}{2}C\frac{1}{1}PM\frac{0}{0}M\frac{2}{2} = \frac{5}{5}\times 2 = \frac{10}{10} = 20$$

Adolescent (17 – 18 years)

$$I\frac{2}{2}C\frac{1}{1}PM\frac{2}{2}M\frac{2}{2} = \frac{7}{7}\times 2 = 28$$

Adult (23 – 25 years)

$$I\frac{2}{2}C\frac{1}{1}PM\frac{2}{2}M\frac{3}{3} = \frac{8}{8}\times 2 = \frac{16}{16} = 32$$

- Left curved surface of the stomach is covered by the greater omentum. Right curved surface of the stomach is covered by the lesser omentum.
- The stomach contains the following parts -
    - ❖ **Cardia:** The food from the stomach enters in cardia through gastroesophageal sphincter (cardiac sphincter).
    - ❖ **Fundus:** It is filled with air.
    - ❖ **Body:** It is main part of the stomach.
    - ❖ **Pylorus:** It is the posterior end part of the stomach through which food enters the duodenum through pyloric sphincter.
- The bolus which enters the stomach remains there for about 4-5 hours.
- The longitudinal, circular and oblique muscular layers present in the gastric wall thoroughly mix the bolus with acidic gastric juice of the stomach.
- The inner lining of the stomach (mucosa) has many folds called gastric rugae for its timely expansion to accommodate more food.

Do You Know ?

Heartburn: Sometimes the lower esophageal sphincter fails to close adequately. This causes reflux of acidic stomach contents into the esophagus. This is called gastroesophageal reflux disease (GERD) or heartburn.

Functions of Stomach

- HCL present in the gastric juice provides an acidic pH (PH1.8) which gives an optimum functioning condition for gastric enzymes and kills microorganisms coming along with the swallowed materials.
- Gastric digestive enzymes are secreted on stimulation by Gastrin hormone which partially digests the food components.
- Mucus and bicarbonates present in the gastric juice lubricate and protect the mucosal epithelium from highly concentrated HCL.

Small intestine

- It is about 6.25 m long. Proteins, carbohydrates, fats and nucleic acids are completely digested in the small intestine.
- Absorption of digested food also happens in the small intestine.
- Hormones like cholecystokinin, secretin, enterogastrone, duocrinin, enterocrinin and villikinin are produced here.
- It also secretes intestinal digestive enzymes.
- The small intestine is differentiated into three parts- duodenum, jejunum, and ileum,
    - ❖ **Duodenum (25cm long):** Duodenum is the shortest, widest, C-shaped part of small intestine. Maximum digestion takes place in duodenum.

    - **Glycogenolysis:** The conversion of glycogen into glucose, when glucose level in blood falls, is called glycogenolysis.
    - **Gluconeogenesis:** Liver converts non carbohydrate compounds (e.g.; amino acids, fatty acids) into glucose.
    - **Glyconeogenesis:** Synthesis of glycogen from lactic acid.
  - **Storage of fats:** Liver stores fats in a small amount.
  - **Deamination and Urea formation:** Deamination of amino acids is mainly done by liver (Amino acid → NH_2).
  - Liver converts ammonia (more toxic) into urea (less toxic) through ornithine cycle.
  - **Purification of blood:** Kupffer cells of liver are the phagocytic cells, help in phagocytosis of dead blood cells and bacteria from the blood.
  - **Synthesis of plasma proteins:** All plasma proteins (except Gamma-globulins) synthesized in the liver. are
  - Prothrombin and fibrinogen proteins are also formed in hepatic cells. These help in clotting of blood. Factors II, VII, IX and X are formed in liver, which are responsible for blood clotting.
  - **Synthesis of heparin:** Heparin is a natural anticoagulant (mucopolysaccharide). Some heparin is also formed by basophils (granulated WBC) and mast cells.
  - **Synthesis of vitamin A:** The liver changes β-carotene into vitamin A.
  - **Storage of vitamins:** Vitamins are stored in liver like vitamin A, D, E, K and B
  - **Storage of minerals:** Iron, copper, zinc, cobalt, molybdenum etc. are stored in liver.
  - **Detoxification:** The liver converts toxic substances into non-toxic substances.
  - **Hemopoiesis:** The formation of blood cells is called hemopoiesis. In embryonic stage, RBCs and WBCs are formed by liver.
  - Formation of Lymph
  - Formation of Angiotensinogen: Angiotensinogen formed in the liver is changed to angiotensin which helps in regulation of kidney.
- **Functions of Bile Juice**
  - Neutralization of HCl.
  - **Emulsification:** Sodium glycocholate and sodium taurocholate are bile salts which break large fat droplets into the smaller ones thereby increasing the surface area for lipase action.
  - **Absorption of fat and fat-soluble vitamins:** Salts of bile juice help in the absorption of fat (fatty acids and glycerol) and fat-soluble vitamins (Vitamin D, A, E and K).

- **Digestion of Fats (in Stomach)**
  - A very small amount of fats is digested in the stomach by gastric lipase and lingual lipase (swallowed with saliva) because of the absence. of any emulsifying agent.
- **Digestion of Fats in the Small Intestine Emulsification of fats**
  - Lipases can act only in the region of water-fat interface as they are soluble in water whereas fats are insoluble in water. To increase the interface, fats must be broken down to fine droplets through a process called emulsification by bile salts.
  - Bile released in the duodenum consists of a large amount of bile salts and phospholipid lecithin.

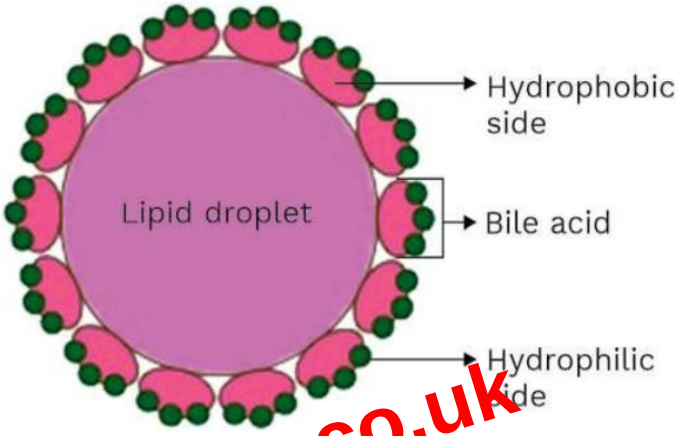


Fig: Emulsified Lipid Droplet

  - Bile salts and lecithin are amphipathic compounds (having both water-loving, hydrophilic or polar part and water-repelling, hydrophobic or non-polar part) and behave as biological detergents.
  - The polar parts of bile salts and lecithin project out of the surface of fat lobules while the fat-soluble, non-polar part dissolves in the surface layer of fat lobules.
  - On agitation in the lumen of duodenum, the big fat lobules with reduced interfacial tension (because of the water-soluble polar projections) are broken up into several minute particles very easily, and thus increase the total surface area of the fats manyfold.
  - All this is important as the fat-digesting lipase enzymes are water-soluble and thus it can hydrolyze the fat globules only on their surfaces.
- **Action of Lipases:**
  - In the small intestine both pancreatic lipase (main fat-digesting enzyme) and intestinal. lipase become active after bile salts produce a stable fine emulsion of fats (emulsified fat).
  - Lipases hydrolyze triglycerides to fatty acids and diglycerides. The diglycerides are further broken down into fatty acid molecules and monoglycerides and finally monoglycerides are hydrolyzed to glycerol and fatty acids.

and gastrin-releasing peptide, which is released by vagus nerve stimulation.
    - ❖ Its main function is to stimulate the secretion of gastric acid and to stimulate the growth of gastric mucosa.
- **Motilin**
    - ❖ It is secreted by upper duodenum during fasting. It increases gastrointestinal motility.
- **Cholecystokinin (CCK)**
    - ❖ It is secreted by 'I' cells present in the inner lining of duodenum and jejunum as a result of response to digestive products of fatty acids, monoglycerides and fats in the contents of intestinal lumen.
    - ❖ Its main function is to contract the gall bladder strongly to release bile into the intestine.
- **Secretin**
    - ❖ It is secreted by the 'S' cells of duodenal mucosa because of acidic gastric juice entering in the duodenum.
    - ❖ It mildly inhibits the gastrointestinal motility and promotes bicarbonate secretion from. pancreas to neutralize the acid of the chyme. Also promotes secretion of Brunner's glands.
- **Vasoactive Intestinal Peptide**
    - ❖ Secreted by the small intestine and help in inhibition of gastric acid secretion and dilation of peripheral blood vessels of the gut.
- **Duocrinin**
    - ❖ It is also secreted by the duodenal mucosa because of chyme. Its function is to activate Brunner's glands.
- **Enterocrinin**
    - ❖ The mucosa of duodenum and jejunum secretes enterocrinin in response to the chyme. It activates crypts of Lieberkuhn.
- **Villikinin**
    - ❖ Secreted by the Small intestine, villikinin increases motility of villi.
- **Gastric inhibitory peptide (GIP) or Enterogastrone**
    - ❖ It is secreted by the mucosa of Duodenum in response to majorly fatty acid and amino acids and minorly carbohydrates.
    - ❖ It causes slow gastric emptying and stimulates insulin secretion