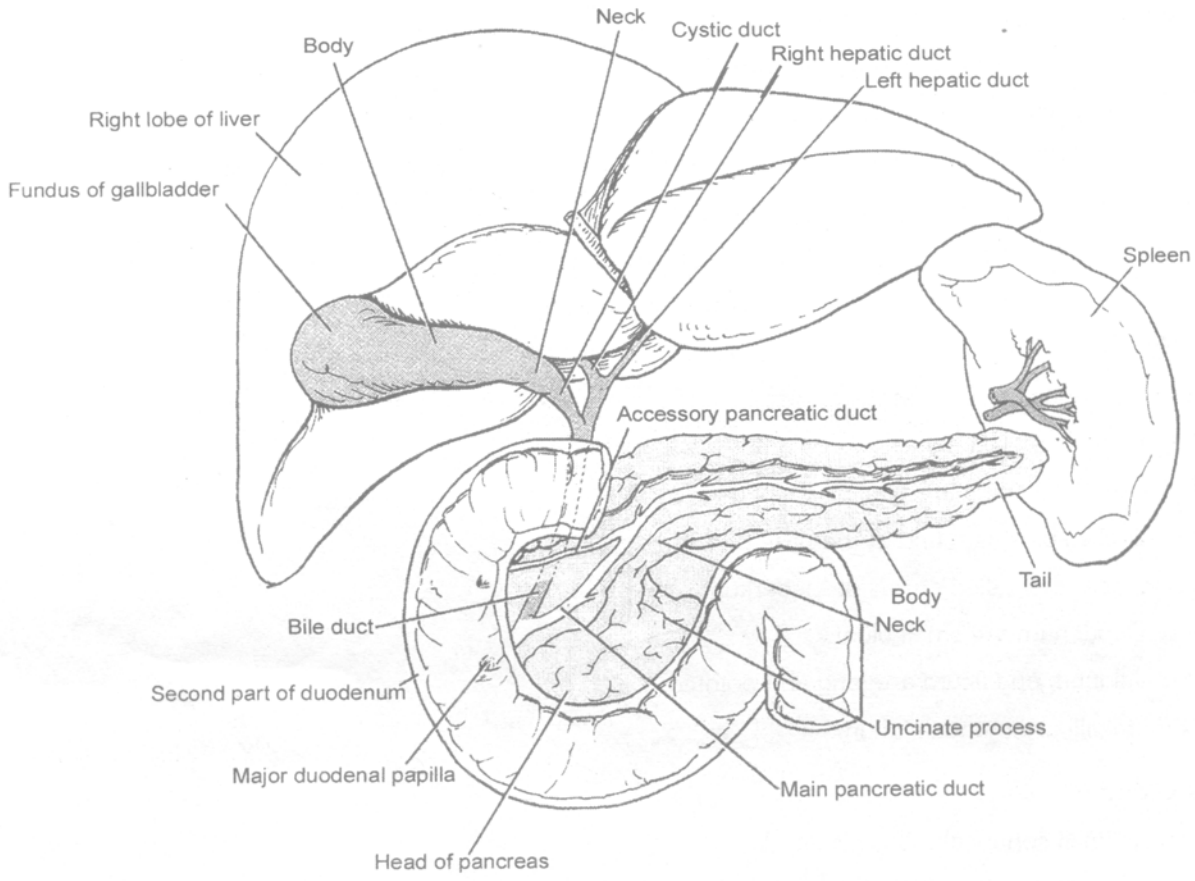
They are also called intestinal tonsils and provide immunity.

Nerve supply:

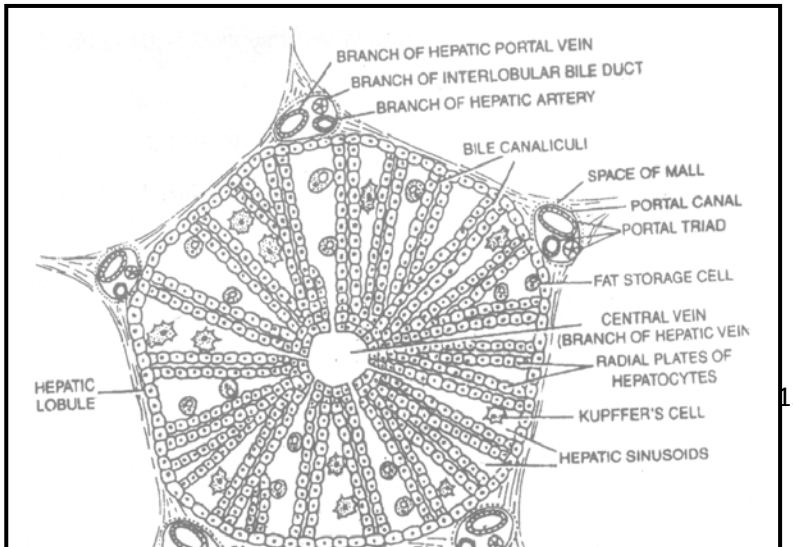
- Two types of Nerve plexus are found in muscle of alimentary canal. (These control muscle contraction)
  (1) Auerbach's N.P. this nerve plexus is found between longitudinal muscles and circular muscles.
  (2) Meissner's N.P. found between circular muscles and sub mucosa but in stomach it is found between oblique muscle & submucosa.

LIVER



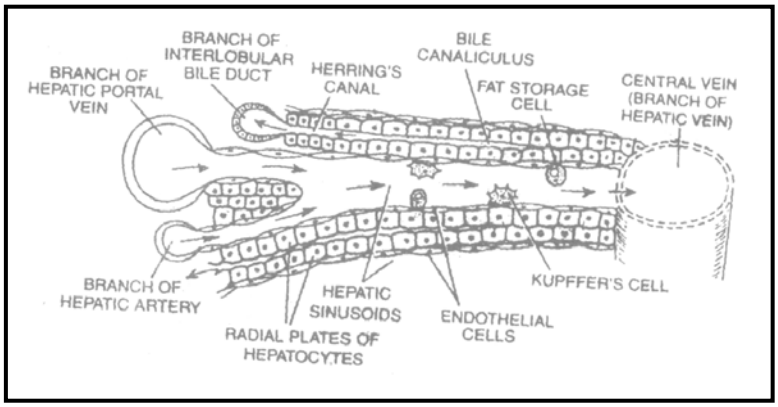
It develops from **endoderm**. (Weight 1.5 kg, both exocrine and endocrine)

- In human it is found in right side of abdominal cavity, below the diaphragm.
- The liver is the largest gland of body.
- It is made up of left and right lobe.
- Left lobe is smaller than right lobe. Right lobe forms 5/6 of the liver & left lobe forms 1/6 of liver.
- Right and left liver lobe are separate from each other by the falciform ligament, (Fibrous C.T.) which is made up of fold of peritoneum.



- Right and left hepatic duct develop from right and left liver lobe. Both these ducts combine to form a common Hepatic duct.
- Gall bladder is situated below right lobe of liver.
- Cystic duct of gall bladder is connected to common hepatic duct to form a common bile duct also called ductus **choledocus.**

- Internally liver is made up of numerous olygonal lobules. These lobules are covered called Glisson's Capsule.
- Each lobule consists of radial rows of hepatic cells which are called as hepatic cord Each row is one or two cell wide and two cell thick. In between the hepatic cord, a space is present called as hepatic sinusoid. These sinusoids are filled with blood.



Sinusoids are lined by the endothelial cells mostly but a few macrophages cells are also present. These are Called as Kupffer's cells. (Phagocytic cells)

The bile canaliculi run in between the two layers of cells in each cord. Hepatocytes (hepatic cells) pour bile into the canaliculi. Canaliculi open into branch of hepatic duct which is situated at the angular part of lobule in the Glisons capsule. All branches of Hepatic duct of right and left lobe are combined to form right and left Hepatic duct which come out from the liver and forms a common hepatic duct.

Hepatic artery and hepatic portal vein enter into liver and divide to form many branches. These branches are also found at the angular part. Its fine branches open into hepatic sinusoids. Branch of hepatic portal vein, branch of hepatic artery and branch of hepatic duct are collectively called as Portal triad. All hepatic sinusoids open into central vein or intralobular vein through fine aperture. All central vein combine to form hepatic vein which comes out from liver and opens into inferior vena cava.

FUNCTIONS OF LIVER :- (Liver is known as chemical factory of the body).

Most of the biochemical functions of the body are done by the liver.

1. **Secretion & synthesis of bile -** This is the main function of liver. Bile is yellowish – green, alkalin fluid. In bile juice, bile salts, sodium bicarbonate, glycocholate, taurocholate, bile pigments, cholesterol, Lecithin etc. are present.

   Bile salts help in emulsification of fats. Bile prevents the food from decomposition. It kills the harmful bacteria.

2. **Carbohydrate Metabolism -** The main centre of carbohydrate metabolism is liver.

   Following steps are related with carbohydrate metabolism -

   (I) Glycogenesis – The conversion and storage of extra amount of glucose into glycogen from the digested food is called glycogenesis. The main stored food in the liver is glycogen.

   (I) Glycogenolysis - The conversion of glycogen into glucose back when glucose level in blood falls down is called glycogenolysis.

   (III) Gluconeogenesis - At the time of need, liver converts non-carbohydrate compounds (e.g. Amino acids, fatty acids) into glucose. This conversion is called gluconeogenesis. This is neo-formative process of glucose.

   (Iv) Glyconeogenesis : Synthesis of glycogen from lactic acid (which comes from muscles) is called glyconeogenesis.

3. **Storage of fats -** Liver stores fats in a small amount. Hepatic cells play an important role in fat metabolism. The storage of fats is increases in the liver of alcohol addict person (Fatty liver). This storage of fats decreases the activity of liver. The damage of liver due to alcohol intake is called Alcoholic Liver cirrhosis.

4. **Deamination and Urea formation -** Deamination of amino acid is mainly done by liver (Amino acid NH_3) separation of urea from the amino acids is done by the liver.

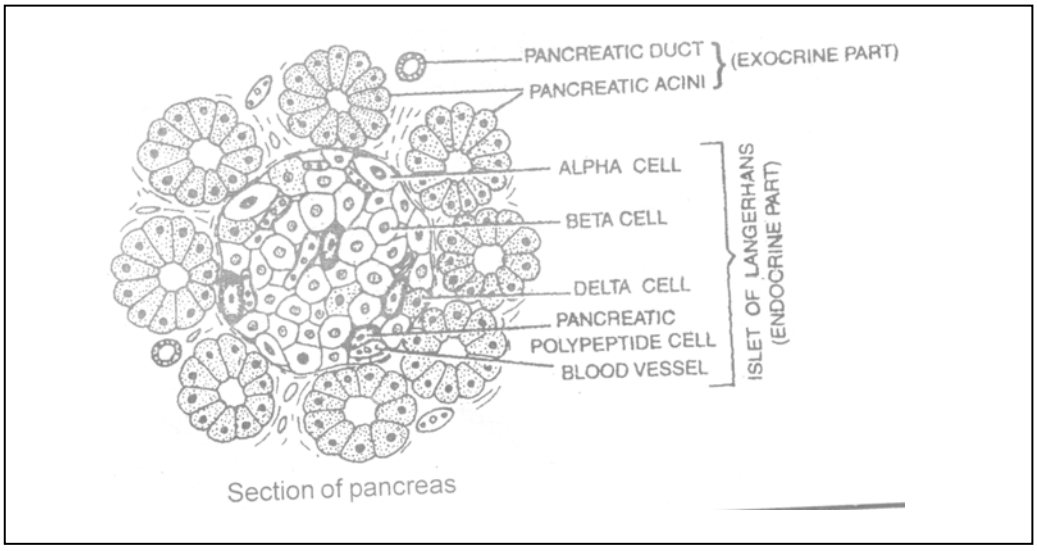
   Liver converts ammonia (obtained from deamination) Into urea through ornithine cycle. So after the spoilage of liver. The ammonia level in the animal body is increased and the animal dies.

5. **Purification of blood –** The spleen and liver separate dead blood cells and bacteria from the blood. Kupffer cells in liver and phagocytes in spleen perform this function.
6. **Synthesis of plasma proteins –** Many types of proteins are present in blood plasma. All the proteins except Gama-globulins are synthesized in the liver.
   Game globulins antibodies are formed by lymphocytes.
7. Most of the factors which are responsible for the clotting of blood are synthesized in the liver.

8. **Synthesis of heparin –** Herparin is an anticoagulant (muscopoysaccharide).
   *Some heparin is also formed by basophills, that are special type of white blood cell.

9. **Synthesis of Vitamin -** A The liver changes – carotene into vitamin – Ab carotene is a otosynthetic pigment which is obtain from plants. It is abundantly found in carrot.
10. Liver stores **Vitamins A,D,E,K, B12**
11. **Storage of minerals –** Liver stores iron, copper, zinc, cobalt, molybdenum etc. Liver is a good source of Iron .
12. **Detoxification -** The conversion of toxic substances into non-toxic substance is done by liver. The toxic substances are formed by metabolic activities of the body. E.g. Prussic acid is converted into Potassium sulfocynide (it is a non-toxic salt) by the liver.
13. **Haemopoiesis –** The formation of blood is called haemopoesis. In embryonic stage R.B.C and WBC are formed by liver
14. **Yolk synthesis -** Most of the yolk is synthesized in liver.
15. **Secretion of enzymes -** Some enzymes are secreted by liver. Participate in metabolism of proteins. Fats and carbohydrates e.g. Dehydrogenize, cytochrome oxidase etc.
16. Prothrobin and fibrinogen proteins are also formed in hepatic cells. These help in blood clotting.
17. Factors I,II, V, VII, IX and X are formed in liver, which are responsible for blood clotting.

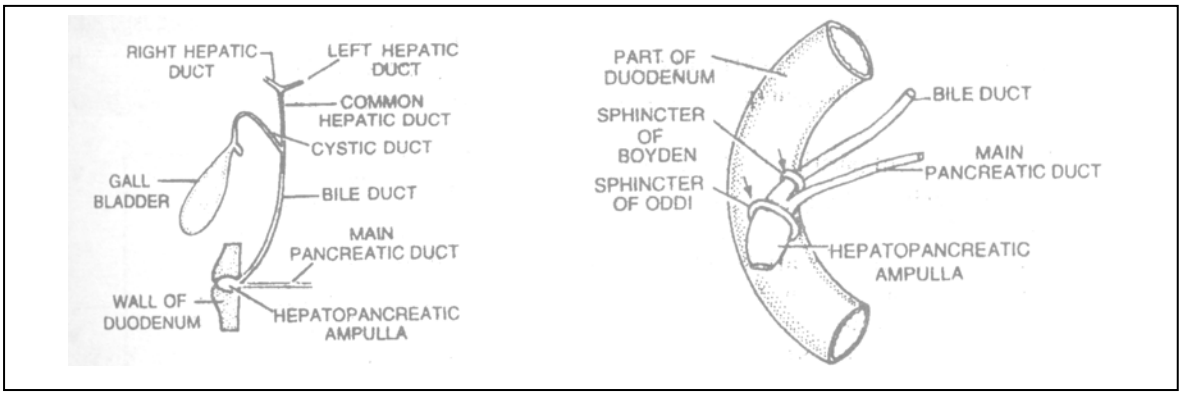
PANCREAS (Sweet bread)



- Develops from **endoderm.**
- It is soft, lobulated and elongated organ.
- It is made up of numerous acini. Acini is a group of secretory cells surrounding a cavity.
- Each acini is lined by pyramidal shaped cells. These acinar cells secrete the enzyme of pancreatic juice.
- Each acini opens into pancreatic ductile. Many pancreatic ductile combine to form main Pancreatic duct (Duct of wirsung.) The main pancreatic duct is join with the bile duct to form the hepatopancreatic ampulla

which opens into duodenum. The accessory Pancreatic duct (Duct of Santorini) opeins into duodenum with separate opening located above the opening of major Pancreatic duct.

- Some group of endocrine cells are also found in between groups of acini called islets of Langer han's These islets secrete insulin & glucagons hormone. So this gland is exocrine as well as endocrine. Its 99% part is exocrine while 1% part is endocrine (Heterocrine.)



- In rabbit, bile duct and Pancereatic duct both separately open into Duodenum.
- Bile duct opens into proximal limb of duodenum and is controlled by sphincter choledocus.
- Pancreatic duct opens into distal limb of duodenum called sphincter pancreaticus.
- In Humans both bile duct and pancreatic duct combine to form common duct called as Hepto-Pancreatic duct. The terminal end of common duct is swollen and is called as Ampulla of Vater or hepato pancreatic ampulla. Ampulla of Vater opens into middle part of Duodenum and is controlled by sphincter of Oddi while bile duct is controlled by sphincter of Boyden

PHYSIOLOBY OF DIGESTION

(I) DIGESTION IN ORAL CAVITY

Food enters through mouth food is tasted in oral cavity and mixed with saliva, tongue mixes the food with saliva. This food with saliva is called bolus. This saliva (pH 6.8-7.0) contains water (99.5%) and electrolytes (Na^+,K^+,Cl^-,HCO_3^-, Thiocynate).

Chemical Digestion:-

- ☛ In this type of digestion saliva act with food particles.
- ☛ Saliva contain 99.5% water & 0.5% salts.
- ☛ These salts are organic and inorganic type.
- ☛ The main salts are mucin, lysozyme, thiocynate and Ptyalin.

(A) Mucin :-

- ☛ It is a glycoprotein. It lubricates the food particles. It helps in the swallowing of food.

(B) Lysozyme :-

- ☛ It is an enzyme which kills the harmful bacteria. Due to this reason saliva is antiseptic lotion.

(C) Thiocynate:-

- ☛ It is a special salt which kills the harmful bacteria. So it is called bacteriocidal salt.

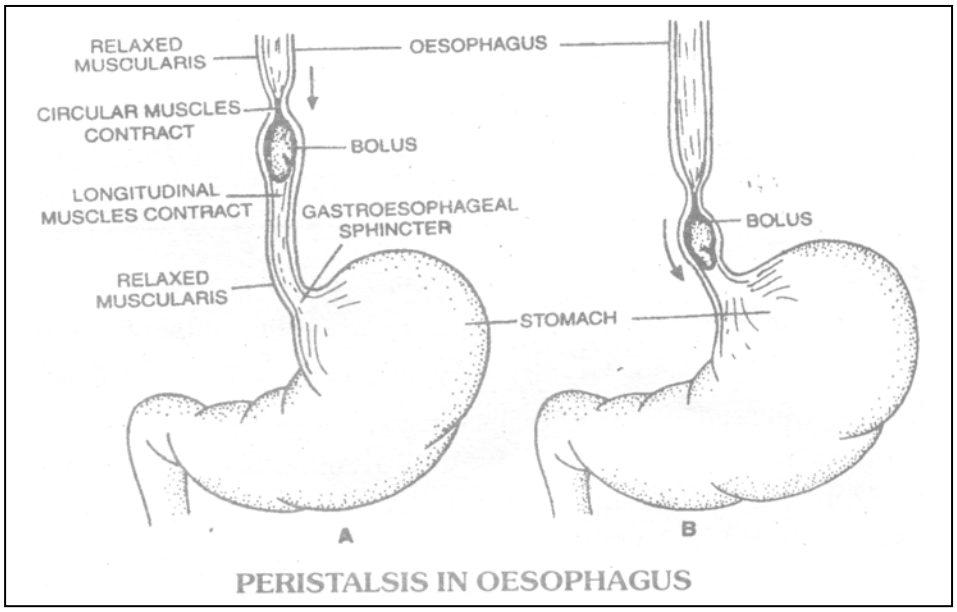
(D) Ptyalin :-

- ☛ Starch Maltose + Limit Dextrin

- ☛ Ptyalin is found in human saliva, because human food is mainly made up of starch. Ptyalin digest only ripe and cooked starch. It does not digest the starch.

Note :- Ptyalin is absent in saliva of rabbit and carnirous animal, because food of rabbit is mainly made up of celluse

Bolus is pushed invward through the pharynx into the oesophagus this process in called swallowing it is coordinated activity of tongue, soft palate, soft palate, pharynx and oesophagus. The tongue blocks the mouth. Soft palate close off the nose and larynx so that epiglottis closes off the trachea food move downward intothe oeswophagus A traveling wave of constriction called persistalsis pushes the Bolus (food) downward. Peristalsis is produced by involuntary contraction of circular muscles, which is preceded by a simultaneous contraction of the longitudinal muscle and relaxation of circular muscle lining the gut. When a peristaltic wave reaches the end of the oesophagus. (Digestion or digestive enzymes are absent in Oesophagus) The sphincter opens allowing the passage of bolus food to the stomach. Gastroesophageal sphincter of the oesophagus and stomach normally remains closed and does not allow contents of the stomach to move back.



PERISTALSIS IN OESOPHAGUS

(II) DIGESTION OF FOOD IN STOMACH:

When the food enters into stomach G-cells secrete gastrin hormones which stimulate the secretion of gastric juice by gastric glands.

Secretion of gastric juice is controlled by nerve, hormones and chemical substances.

Secretion of gastric juice is divided into 3 Phases-

1. **Cephalic Phase :-** This phase is mediated by parasympathetic. It is the first of step of secretion. When person see the food then due to optic reflex small amount of gastric juice secretes in the stomach due to sight.
2. **Gastric phase :-** When food enter into stomach then gastric phase is stared. When food particles strike to the fundic part of stomach the small amount of gastric juice is secreted due to like reflex action and distention. Gastric juice developes the peristalsis movement in the stomach. Due to peristalsis food particles are rubbed on mucosal layer of stomach.

   Due to rubbing process cells stimulates and secretes gastrin hormone powerfully stimulate the gastric glands for secretion of gastric juice.

   Some drinking substances also stimulates the secretion of gastric juice such a soup, alcohol, caffeince, histamine. These drinking substance and gastric juice stimulate the desire of appetite. So these substances are called Appetiser juice.

3. **Intestinal Phase :-** When food read at the Ileum mucosal layer of ileum secretes a chemical substance. Its nature in similar to the histamine or gastrin. This chemical substance goes into stomach through blood circulation where it stimulates the secretion of gastric juice.

Its actual cause is yet unknown. But it is believed that this phase starts after 8-10 hour of taking of meal.

Composition of Gastric Juice:

Water = 99.5%

HCL= 0.2 - 0 .3%

pH = 1.5 to 2.5 (very acidic)

rest = mucous water, HCL and gastric enzymes (Pepsinogen, prorennin, Gastric Lipase etc.).

Functions Of HCL-

1. The main function of HCL is to convert inactive enzymes (zymogens) into active enzymes.

   Pepsinogen → Pepsin.

   Prorennin → Rennin.

2. It destroys all the bacteria present in the food.
3. HCL stops the action of saliva on food. In stomach, the medium is highly acidic.
4. It dissolves the hard portions of the food and makes it soft.

* Pepisnogen and prorennin are inactive enzymes.

Digestion by Rennin (Chymosin) -

Rennin is active in the childhood stage of mammals only. It converts milk into curd like substance (clot the milk) and then digests it. In adult stages, it is inactive.

Rennin, acts on milk protein casein. Casein is a soluble protein.

In presence of Rennin casein gets converted into insoluble Ca- paracaseinat. This process is termed as Curdling of milk. After becoming insoluble, milk can remain in the stomach for a longer time. Rennin is absent in human (clotting of milk is done by HCL in human).

Digestion by Pepsin -

Inactive perpsinogen on getting proper pH converts into active pepsin. Peptidase:- The enzyme which breakes the peptided bond. These peptidase are of two types.

(a) Exopeptidase:- The peptidase enzyme which breaks the outer and marginal bond of polypeptide called exopeptidase. In this processs amino acid and polypeptides are formed.

(b) Endopeptidase:- The peptidase enzyme which breaks the inner peptide bond of large polypeptde and forms the small polypeptides such as peptone, proteoses and peptides.

Pepsin is a strongest Endopeptidase. It breaks proteins into smaller molecules.

Proteins → Peptones + Proteoses + peptides.

* In stomach, endopeptidases are found so only digestion of proteins can take place properly in the stomach.

Digestion by Gastric Lipase- It converts fats into fatty-acids and glycerols. It is secreted in a less amount so less digestion of fats takes place here.

This lipase acts on emulsified fat and convert it into fatty acid & glycerol. 1% emulsified fat is present in the food. Due to peristalsis the food is converted into a paste. This form of food which is thick. Acidic & semidigested in the stomach is called chyme.

After short intervals, the pyloric valves keeps on opening and closing so the chime is fed into the intestine in installments.

(III) DIGESTION OF FOOD IN DUODENUM -

When food leaves the stomach through its pyloric end and enter the duodenum it is called chime (acidic). The HCL of chyme stimulates theh wall of duodenum to secrete hormones. It secretes various homones-

1. **Secretin :-** It is the most important hormone of digestive tract and also first discovered hormone. This hormone stimulates pancreas for synthesis and secretion of non enzymatic par of pancreatic juice. It also stimulates liver for secretion of bile juice and inhibit the gastric juice secretion in stomach and reduce rate of contraction of stomach.
2. **Pancereozymin -** It stimulates the synthesis as well as seretion of pancreatic-juices.

   * Secretin promotes the secretion of the none enzymetic part of the pancreatic juice, while pancreozymin promotes the secretion of enzymatic part of the pancreatic juice.
3. **Hepatocrinin -** It promotes the synthesis and secretion of Bile juice in liver.
4. **Cholecystokinin -** It stimulates the liver and the Gall-bladder (mainly gall- bladder) to secrete Bile-juice.
5. **Duocrinin :-** It stimulates the Brunner's gland for synthesis and secretion and secretion of non enzymatic part of intestinal juice.
6. **Enterocrinin:-** This hormone stmulate Paneth cells for synthesis and secretion of enzymatic part of intestinal juice.
7. **Villikinin:-** It stimulates the activity of villi.
8. **Enterogaste4ron :-** It inhibts the seretion of of HCL in stomach.
9. **Gastric inhibitory peptide (GIP) :-** In inhibits the secretion of gastrin hormone.
10. **Vasoactive intestinal peptide and somatostation :-** They inhibits the movtivity of stomach.

BILE-JUICE

In the proximal-part of the duodenum bile-juice is secreted. The parenchyma cells of the liver produce bile-juice and it is stored in the Gall- bladder. Bile-juice does not contain any digestive enzyme. Therefore it is not a true digestive juice (Pseudodigestive juice.)

Compostion of Bile-juice :- Bile-juice is a greenish (Biliverdin) yellow (Bilirubin)coloured alkaline fluid.

Composition of liver bile.

	Liver bile
pH	8.0
H_2O	98%

Organic constituents are bile acid, bile pigment, cholesterol, Lecithin, inorganic constituents Na^+, K^+ etc.

Bile –pigments are the excretory-substances of the liver.

** Bile –salts are of two types-

(a) Inorganic- Salts – Bile-juice contains NaCl, Na_2CO_3, $NaHCO_3$ etc in it. Inorganic salts neutralize the acidity of the food and make the medium basic. It is necessary for the medium to become basic because the pancreatic-juice enzymes can act only in basic- medium.

(b) Organic- Salts - Organic salts like Na-glycocholae and N-taurocolate are fount in Bile Juice. The main function of these salts is the emulsification of fats. Because pancreatic Lipase can act only on emulsified fats.

** Bile salts also help in the absorption of fat-soluble vitamins (A,D,E,K) bile salts combine with fats and these vitamins to form compounds called Micelles. Which are absorbed rapidly.

** Bile-salts promote peristalsis in the small-intestine.

** Bile-pigments, cholesterol and Lecithin are the excretory substances found in Bile-juice.

Gall- Stone – Sometimes the passage insde theh bile-duct gets blocked or becomes narrow, so the cholesterol gets deposited or precipitated in the gall-bladder. This is termed as the gall-stone (cholelithiasis). Obstructive Jaundice- If the passage of bile is blocked then the amount of bilirubin increases in the blood. So the yellowish colouration of body skin, cornea and nails appear yellow. Urine also becomes yellow.

PANCREATIC JUICE

Pancreozymin stimulates the acini and glandular cells so pancreatic juice are secreted. The pancreatic-juice is secreted by the exocrine cells of the pancreas. Pancreatic juice is highly odouriferous, colourless basic fluid which contains enzymes and salts.

Composition of Pancreatic Juice-

Total amount in man = 500- 800 ml/day,

Water = 98%, pH = 7.5-8.3, Salts = 2%

* Pancreatic juice contains only inorganic – salts.

The action of enzymes present in the pancreatic juice is as follows-

(1) Pancreatic, α - Amylase : Amylase and Amylopsin dissociates starch into Maltose. Majority of starch breaks up into the duodenum.

(2) Trypsinogen and Chymotrypsinogen – The step by step action of these enzymes is as follows-

$$\text{Trypsinogen} \xrightarrow[\text{Enterokinase or Enteropeptidase}]{\text{Ca++}} \text{Trypsin}$$

$$\text{Chymotrypsinogen} \xrightarrow{\text{Trypsin}} \text{Chymotrypsin}$$

* Enterokinase is secreted by the Duodenal Mucosa.

* Trypsin and chymotripsin are Endopeptidase type of enzymes. They dissociate proteins into peptones and proteoses. Majority of proteins are broken into the stomach and the remaining are broken into the duodenum.

$$\text{Proteins} \xrightarrow[\text{Chymotryps sin}]{\text{Tryp sin and}} \text{Large peptide}$$

(3) Procarboxy Peptidase - These are also called zymogens. Trypsin convert in into active Carboxy-peptidase.

$$\text{Large peptide} \xrightarrow[\text{Peptidase}]{\text{Carboxy}} \text{Amino-acid}$$

(4) Large Peptides $\xrightarrow{\text{Amino peptidase}}$ Oligopeptides

(5) Fat digesting enzyme – In pancreatic-juices various Fat-digesting enzymes are found which are collectively called steapsin.

(I) Pancreatic Lipase - It converts triglycertide into monoglyceride, fatty acid, glycerol.

(II) Cholesterol esterase - It digests cholesterol esters. These esters are made up of cholesterol and fatte –acid Like – Lanolin, (cholesterol and Palmitic acid.)

(III) Phospholipase - These digest phospholipids.

(6) DNase and RNase - Digestion of DNA and RNA.

(IV) DIGESTION IN JEJUNUM AND ILEUM-

These hormones stimulate the crypts of Leiberkuhn to secrete Succus-entericus or intestinal juice. This succus entericus mainly contains water (99%) and digestive enzymes (<1%). Intestinal Juice act on food. Succus-entericus mainly contains the following enzymes-

1. **Peptidase or Erepsin -** This is a type of Exopeptidase. It converts oligo peptides into amino-acids.
2. **Disaccharidases**

Suscrase – It is also known as Invertase. It converts sucrose into glucose and fructose.

Maltase - It coverts maltose sugar into glucose molecules.

Lactase - This enzyme is found only in mammals. It converts milk sugar Lactose into glucose and galactose.

3. **Intesinal Lipase -** This fat –digesting enzyme converts fats into fatty-acids and glycerol.
4. **Nucleotidase and Nucleosidase -** These act in the following way:-

(i) Nucleotides $\xrightarrow{\text{Nucleotidase}}$ Nucleosides + Phosphate

(ii) Nucleosides $\xrightarrow{\text{Nucleotidase}}$ Pentose + Nitrogen base

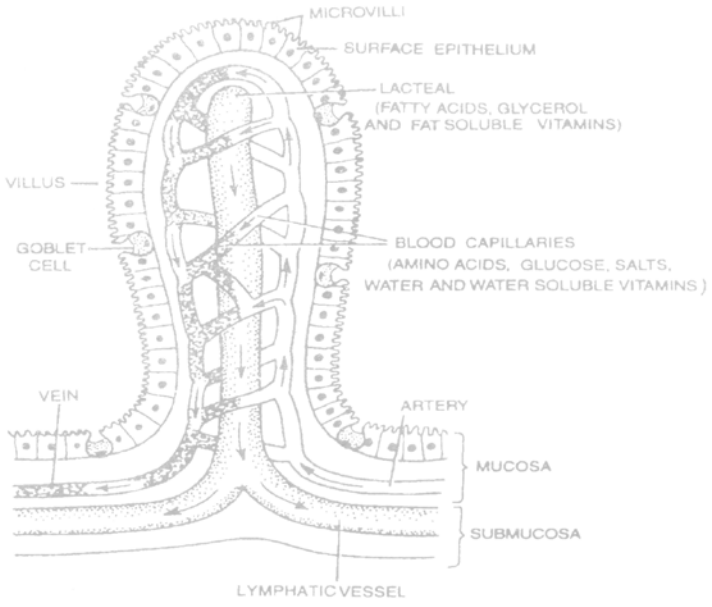
* Maximum digestion of carbohydrates is done in duodenum, but its digestion is completed in Jejunum.

(V) DIGESTION IN CAECUM:-

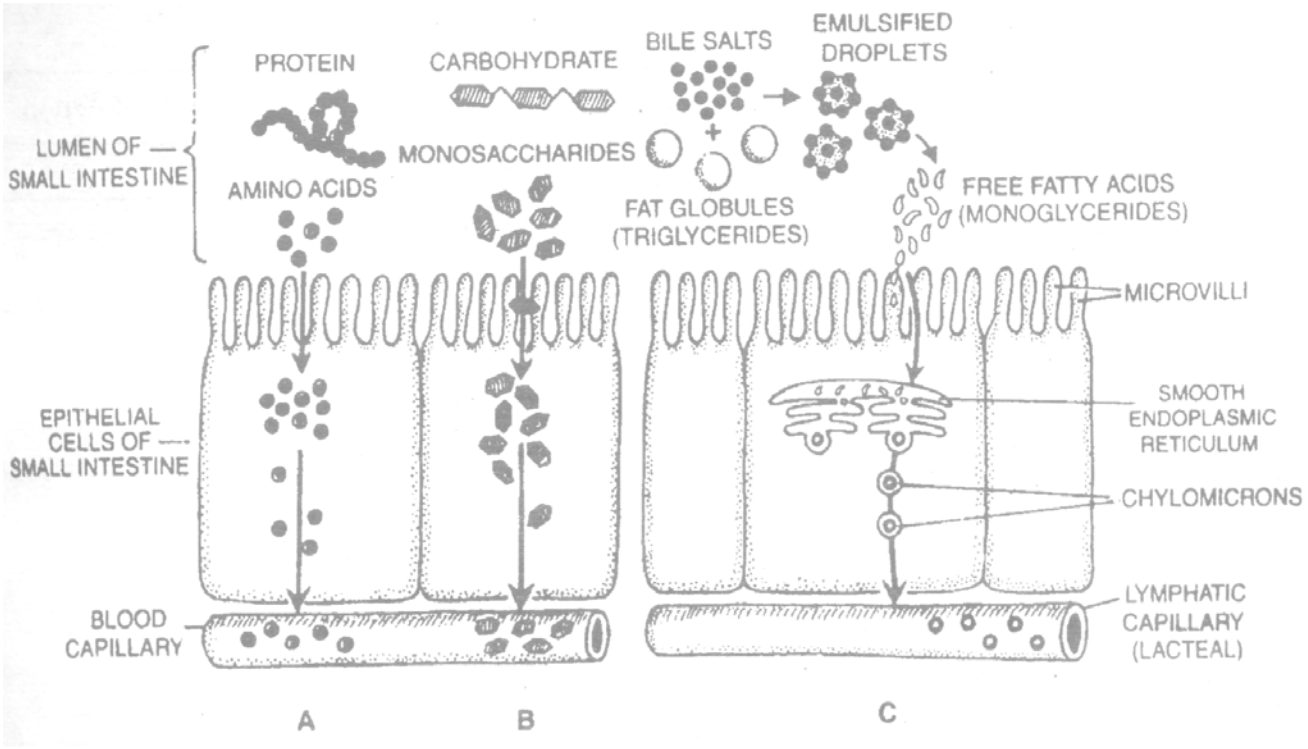
In herviores, the symbiotic bacteria and protozoans present in the caecum help in digestion of cellulose into glucose, So the digestion of cellulose takes place in caecum by the process of decomposition. This decomposition process is very slow, So very less amount of cellulose is digested at a time in caecum.
In the last part of the large intestine faeces is temporarily stored.

Maximum digestion of food- Duodenum.
While digestion of food complete in – Jejunum.
Maximum absorption of food in – Jejunum.

Millions of microscopic folds or finger like projections are present in the lumen of gut which are called villi. These villi are supplided with a network of blood capillaries and Lymphatic vessels. Largest of which is central Lacteal. The cells that line the surface of villi numerous microscopic bristle like projections are called micro villi or brush border. These further increase the surface area for the absorption of the nutrients/digested food. On the surface of the mucous epithelium are billions of single cell cucous glands called mucous or goblet cells. These cells mainly secrete mucus that acts as a lubricant and protects the epithelial surface from damage and digestion.



VILLUS AND ABSORPTION OF DIGESTED NUTRIENTS IN IT



Ephithelial cells of small interstine showing absorption of nutrients. A, Absorption of a aminozcids. B, Absorption of monosasccharides. C, Absorption of fatty acids.

Role of Some Major Gastrointestinal Peptide Hormones in Digestion

Hormone	Source Secretion	Stimulus to	Target/Action
Gastrin	Pyloric stomach and duolenum/G-cells	Vagus nerve activity; peptides and proteins in stomach.	Secretory cells and muscles of stomach; secretion of HCL and stimulation of gastric mobility.
Cholecystokinin (CCK)	Upper small intestine (Duodenum)	Food (Fatty chyme and amino acids) in duodenum.	Gall bladder; contraction of gall bladder (bile release)
Secretin	Intestinal wall (Duodenum)	Food and strong acid in stomach and intestine.	Pancreas, secretory cells. And muscles of stomach; secretion of water and bicarbonate ($NaHCO_3$); inhibition of gastric motility.
Gastric Inhibitory Peptide (GIP)	Upper small intestine (Duodenum)	Monosaccharides and fats (fatty chyme) in duodenum.	Gastric mucosa and muscles; inhibition of gastric inhibition of gastric secretion and mobility/motlity (slowing food passage).

An overview of the Action of Major Enzymes in Human

Enzyme	Site of Action	Substrate	Products of Action

Salivary juice (Salivary Gland)

Salviary amylase or Ptyalin	Mouth and Stomach Buccal cavity	Starch	Disaccharides (few)

Gastric Juice (Stomach)

(a) Pepsinogen: pepsin	Stomach	Proteins	Large peptides

Pancreatic Juice (Pancreas)

(a) Pancreatic - amylase	Small intestine	Starch	Disaccharides
(b) Trypsinogen: trypsin	Small intestine	Proteins	Large peptides
(c) Chymotrypsin	Small intestine	Proteins	Large peptides
(d) Elastase	Small intestine	Elastin	Oligopeptides
(e) Carboxypeptidases	Small intestine	Large peptides	Amino-acid
(f) Aminopeptidase	Small intestine	Large peptides	Oligopeptides
(g) Lipase	Small intestine	Triglycerides fatty acids, glycerol	Monoglycerides
(h) Nucleases	Small intestine	Nucleic acids	Nucleotides

Intestinal Juice (Small Intestine)

(a) Enteropeptidase or enterokinase	Duodenum	Trypsinogen	Trypsin
(b) Peptidase	Duodenum	Oligopeptides	Amino acids
(c) Disaccharidases	Duodenum	Disaccharides	Monosaccharides
(d) Nucleotidase	Duodenum	Nucleotides Phosphoric acid	Nucleosidases
(e) Nucleosidases	Duodenum	Nucleosides Pyrimidines	Sugars, purnies

The lining cells of the villi are columnar epithelial cells called enterocytes. On the surface of enterocytes, numerous microvilli are found, they increase the surface area of mucous membrane.

ABSORPTION OF DIGESTIED FOOD

The process through which the food stuff diffuses through the intestinal mucous membrane and reaches the blood, is termed as absorption. The process of absorption in different parts of the alimentary canal takes place in the following manner.

(1) Absorption in Buccal- Cavity:-

No absorption of food takes place in the oral and the oespharygeal cavity. Only some chemical/medicines and alcohol are absorbed in oro pharyngeal cavity.

(2) Absorption in stomach:-

In the stomach, absorption of water, some salts, alcohol and glucose takes place, complete absorption of alcohol takes place in the stomach.

(3) Absorption in duodenum – Iron & calcium ion are absorbed in the duodenum.

(4) Absorption in jejunum - Maximum absorption take place in jejunum.

Carbohydrate-

The principal carbohydrate of our food is usually starch (from rice or wheat) which is broken down by the pancreatic amylase. Disaccharides are broken down to their monosaccharide by enzymes of the succus-entericus. Monosaccharides are absorbed via the capillary blood with in the finally reach into portal vein. Absorption of glucose molecules occurs along with Na+ by active symport, Fructose is absorbed passively.

Digestion and absorption of amino acid-

All these proteins are exposed to pepsin, trysin, chymotrypsin, Carboxypeptidases etc and as a result they are converted into tri and dipeptides or free amino acids. Amino acid are of two types L-amino acid & D-amino acid.

The L-amino acids are naturally occurring 7 are absorbed by active process against the concentration gradient while D-amino acid are absorbed passively by diffusion.

Di-and tripeptide enter the entercytes where they are hydrolyzed to amino acids by dipeptidases and then absorbed via portal blood.

Digestion and absorption of Fat -

One molecule of triglyceride is hydrolyzed into one molecule of monoglyceride and two molecule of fatty acids by pancreatic lipase.

After hydrolysis, the bile salt, monoglyceride and the fatty acid together produce a complex called a mixed micelle. These are water soluble & enter in the enterocytes. Monoglyceride and fatty acid are resynthesized with in enterocyte to form a molecule of triglyceride (T_G). T_G combines with a small amount of protein and resultant complex is called chylomicron (150 m, white). Chylomicron enters the lacteal

Fat soluble vitamins are absorbed along with dietary fat whereas water soluble vitamins are absorbed by passive diffusion. Vit. B_{12} is absorbed with intrinsic factor by forming a complex.

In ileum Vit B_{12} & Bile salt are absorbed. In colon only water is absorbed.

All lymph- capillaries comig out of the alimentary canal unite to form Lymph-vessels. All lymph – vessels coming from the alimentary canal into the Left Thoracic Lymph Duct. This duct now opens into the Left Subclavian vein. Through the blood. Fats reaches the heart and from here it is distributed throughout the body.

** Besides fats, other substances of the digested food like- sugars, amino-acids, vitamins, minerals- salts after being absorbed, enter the blood capillaries. All blood- capillaries coming out of the alimentary canal. Join together to form the Hepatic portal vein. This vein takes the digested food material into the liver. From the liver, the Hepatic vein and the superior post – caval vein takes to the heart. Heart distributes them throughout the body. Liver performs some necessary and important actions on the digested food.

Maximum water absorption occurs from upper part of small intestine passively.

(**4**) **Absorption in colon :-** colon absorbs water from the undigested food. Due to Haustra the water-absorbing surface of colon increases and it efficiently increases absorption of water.]

** The excreta of rabbit is given out of the body in the form of small pellets. The process of removal of undigested food from the body is termed as the Defaecation. The process of defaecation is involuntary in rabbit, though it is voluntary in most animals.

Symbiotic bacteria found in colon. Bacterias synthesise vitamin – K, B_1, B_2 etc.

Undigested food goes into rectum where it gets converted into faeces contains – water and solid matter. Solid Matter contains dead bacteria 30%, fat 10-12%, Proteis 2-4% and ohers.

These faeces ejected outside through anus.

In the morning the excreta of rabbit is in the form of semi-solid pellets. It has more amount of undigested cellulose in it. Cellulose is a colloid substance, Colloids have the capacity to bind water on their surface, so complete absorption of water is not possible in intestine. To completely digest the cellulose rabbit again ingests the semi-solid excreta so again digestion of cellulose takes place in the caecum.

In the evening the excreta of rabbit is in the form of solid, dry pellets. These have less amount of undigested cellulose in them. This nature of rabbit to eat is own excreta is termed as Coprophagy or Caecotrophy or also Pseudorumination. Double circulation of food through the alimentary-canal is termed as Caecotrophy. Food of rabbit mainly consists of cellulose so this activity is necessary for rabbit.

Brown colour of the excreta is due to 2 pigments – Stercobilin and Urobilin. Both of them are formed due to the degradation of Bilirubin. Foul smell of the excreta is due to Indole, Scatole and Tryptophan. CH_4, NH_3,H_2S. These are found in the colon due to he decomposition of amino-acids by bacteria. Pellets of rabbit don't have a foul smell because it has a minimum amount of proteins in its diet. Carnivores have excess protein- rich diet so their excreta is highly foul-smelling.

Compound stomach:-

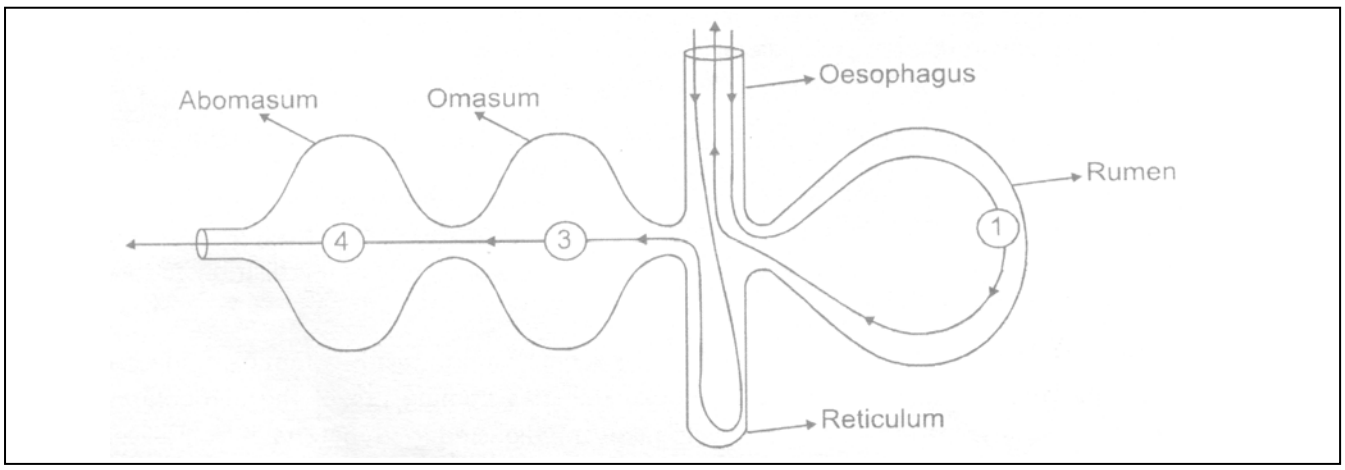
Stomach of Runinant animals made of 4 chambers:

Rumen → largest

Reticulum → Smallest

Omasum

Abomasum → true stomach



Gastric juice- secreted by Abomasum. So it is called true stomach. Inner surface of Rumen and Reticulum lined by Keratinised epitheliu. Symbiotic bacteria found in Rumen and Reticulum. Voluntary muscles found in Rumen and Oewophagus. Hence reverse peristalsis are found in Rumen and oesophagus which is controlled by will power of animal. Of animal. Omasum is absent in Camel and deer.

Caloric value :

The amount of heat liberated from complete combustion of 1 gm food in a bomb calorimeter (a closed metal chamber filled with O_2) is its gross calorific value or gross energy value (G.C.V.).

The actual amount of energy liberated in the human body due to combustion of 1 gm of food is the physiologic value (P.V.) of food.

Food substance	G.C.V. (in K.cal/gm)	P.V. In K.cal/gm)
Carbohydrate	4.1	4.0
Protein	5.65	4.0
Fats	9.45	9.0

Assimilation

The use of absorbed digested food by the body is termed as assimilation. Amino-acids synthesise proteins, which in turn synthesis enzymes and new protoplasm. Glucose fatty-acids and glycerol on oxidation provide energy.