CHAPTER → 16 | DIGESTION AND ABSORPTION

① **Digestion** → Conversion of complex substances into simpler absorbable forms, through mechanical and biomechanical process.

② **Food** → Carbohydrate
→ Protein
→ Fats
→ Vitamins
→ Minerals
> Small quantities.

① energy
② Organic Materials (growth and repair of tissues).

③ **Water** → Metabolic processes.
→ prevents dehydration.

* Biomacromolecules → Broken Down → Simple absorbable Substances. (in digestive system)
(can't be utilised)

④ **Digestive System** → Alimentary Canal.
→ Associated Glands.

Alimentary Canal

Mouth
↓
Buccal Cavity or Oral Cavity
↙ ↘
Teeth — Muscular Tongue.

① Teeth

→ sequence (ICPM)

Thecodont
embedded in socket of jaw bone.

Diphodont
→ In mgjority of mammals.
→ Two sets of teeth
→ Temporary / Deciduous.
→ permanent = adult.

Heterodont
→ diff. teeth.
1. incisors
2. Canines
3. Molars
4. Pre Molars

adult = $\frac{2123}{2123}$

$\frac{2102}{2102}$ = child

* Hard chewing surface of teeth made up of enamel helps in mastication of food.

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② Muscular Tongue (Skeletal Muscle)

Freely Movable (muscular Organ)

attached to the floor by frenulum

upper surface have small projections → papillae. (Some papillae have taste buds)

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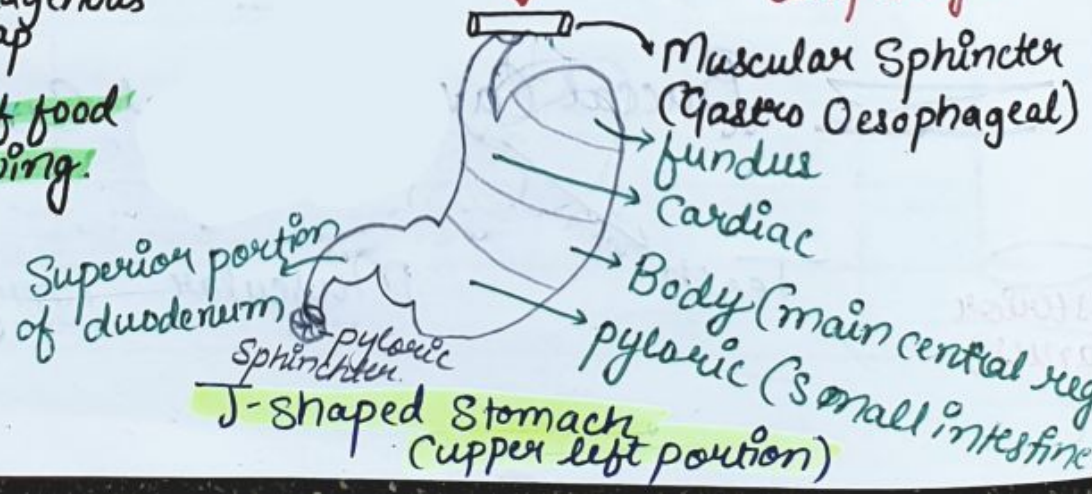
③ Short Pharynx → common passage for food and air.

Air (Trachea) (Wind pipe)
epiglottis → cartilagenous flap
glottis

prevents entry of food during swallowing.

Food (Oesophagus) (thin long tube)
post. passing through, neck, thorax, diaphragm



Pyloric
↓
Pyloric sphincter.
↓
Small intestine

Small Intestine. DJI

- Duodenum (C-shaped)
- Middle Jejunum (long coiled)
- Ileum (highly coiled) → Large Intestine.

Ileum → Large Intestine. CCR

- Caecum (small blind sac)
  - → hosts symbiotic micro-organisms.
  - → Vermiform appendix
    - Vesigial
    - Narrow finger like tubular projection.
- Colon
  1. ascending
  2. Transverse
  3. Descending
  4. Sigmoid
- Rectum → Anus → Inflammation of Rectal Veins → Piles

Walls of Alimentary Canal

(inside) Lumen → Mucosa ← Mucus ← Sub-Mucosa ← Muscularis ← Serosa

1. **Serosa** → Outermost layer.
   → Made of thin mesothelium with some connective tissue.
   → (epithelium of Viceral Organs)
2. **Muscularis** → Smooth Muscles
   - Inner Circular
   - Oblique (only in some region)
   - Outer-longitudinal
3. **Sub Mucosa** → loose connective tissues
   - Nerves
   - Blood
   - Lymph Vessels

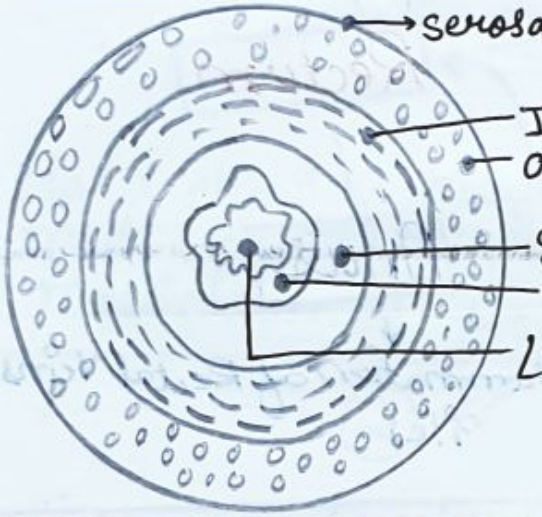
Brunner's gland.

In duodenum → glands are also present in sub-mucosa.

④ **Mucosa** → innermost layer.
→ lining the lumen of alimentary canal.

Irregular folds (rugae) in Stomach

Villi in Small intestine.
↓
Microvilli
(by cells lining Villi)
→ Brush border appearance
→ ↑↑ surface area.



– Transverse section of gut

Villi

Network of Capillaries — Large lymph Vessel = Lacteal

→ Mucosal epithelium has goblet cells which secreate mucus that helps in lubrication.
→ Mucosa forms glands in stomach = Gastric glands
→ and crypts in b/w bases of Villi (Intestine) [Crypts of Lieberkuhn]
→ In duodenum, glands are present in sub mucosa.
→ All 4 layers show modification in different parts of alimentary canal.

Digestive Glands.

Salivary Glands | Liver | Pancreas

(1) Salivary Glands :→ Three pairs of Salivary Glands.

- Parotids (cheek)
- Sub-Maxillary / Sub Mandibular (lower jaw)
- Sub linguals (below tongue)

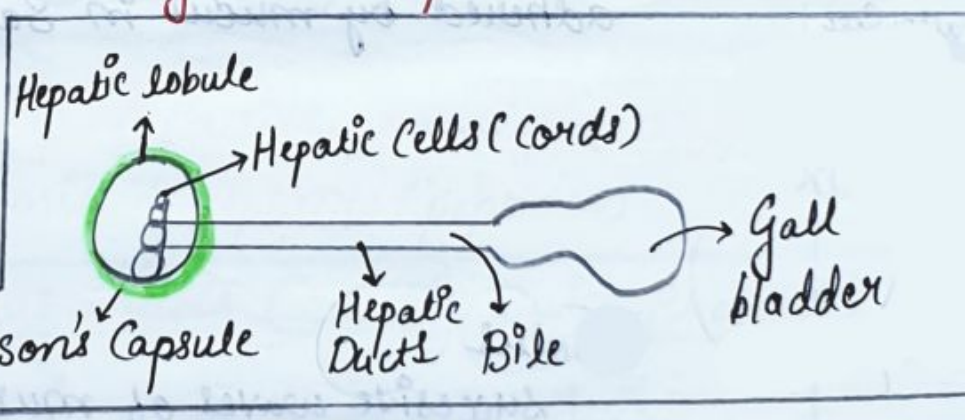
→ Situated just outside buccal cavity.
→ Secreates salivary juice into buccal cavity.

(2) Liver. → Largest gland (1.2-1.5 Kg).

→ Just below diaphragm (abdominal cavity).
→ Two lobes
→ Hepatic lobules (Structural and functional unit)

have hepatic cells (in form of cords) → hepatic ducts (bile) → Stored in gall bladder (thin muscular sac)

covered by thin connective tissue. (Glisson's Capsule)



(1) Gall bladder (cystic duct) + Liver (Chepatic duct) → common bile duct

② Bile duct + Pancreatic Duct → Common Hepato-Pancreatic Duct → Duodenum

guarded by sphincter (Sphichter of Oddi)

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③ **Pancreas** (elongated Organ) (compound)

→ Situated b/w limbs of C-shaped duodenum.

exocrine endocrine

→ exocrine = alkaline pancreatic jucice containing enzyme.

→ endocrine = Hormones, Insulin, Glucagon.

Digestion of Food.

Mechanical | Biochemical

→ **Buccal Cavity**

- Mastication of food (Teeth and tongue)
- Facilitation of swallowing.

→ **Bolus** → (masticated food particles are lubricated and adhered by mucus in Saliva.)

Swallowing or degulation ↓

Pharynx ↓

Oesophagus ↓

gasto-Oesophageal sphincter (control passage of food into stomach)

Bolus ↓ succesive waves of muscular movements (Peristalsis).

Saliva

- electrolytes (Na^+, K^+, Cl^-, HCO_3^-) (नमक) ($CHCO_3$)
- Enzymes
  - Salivary Amylase
- lysozyme → anti-bacterial agent (prevents infection)

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* **Biochemical Digestion.** → Initiated in Oral Cavity.

Starch —(salivary amylase, pH = 6.8, 30%)→ Maltose (Di-Saccharide)

Hydrolytic action.
Carbohydrate splitting enzyme] Salivary amylase

Gastric Glands (Mucosa)

- **Mucus, Neck Cells** (Secreate mucus)
- **Peptic / Chief Cells** (Secreate proenzyme pepsinogen.)
- **Parietal / Oxyntic Cells** (Secreate HCl and intrinsic factor → absorption of Vitamin B12)

→ Stomach = 4-5 hrs → food.

→ Food + Acidic gastric juice → Chyme (Churning mov. of its muscular wall).

* Pepsinogen + HCl ⟶ Pepsin (active proteolytic enzyme)
* protein —(pepsin)→ proteosis + peptones (peptides)

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* **Mucus and Bicarbonates** (Gastric Juice Present)

Lubrication

protection of mucosal epithelium, from excoriation by HCl (pH 1.8) → for pepsins.

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* Rennin (Proteolytic enzyme)
  ↓
  gastric juice of Infants.
  (digestion of milk products)

* Small amount of lipase are also secreated by gastric glands.

* Small Intestine *

(various type of movements by muscularis) (through mixing)

• Bile Juice • Pancreatic Juice • Secreations of small intestine.
through hepato-pancreatic duct.

① Pancreatic Juice → Inactive enzymes.
Trypsinogen, Chymotrypsinogen, procarboxy-peptides,
amylase, lipase, nucleases.

* Trypsinogen —enterokinase (by intestinal mucosa)→ Trypsin (activates other enzyme)

② Bile Juice → into duodenum.
→ contains bile pigments (Billirubin and Billiverdin)
→ Bile salts, cholestrol, phospholipids.
↓
No Enzymes.

1). Fats —emulsification→ Small Micelles
2). Also activates lipases.

③ Intestinal → Mucosal epithelium has goblet cells.
↓
Secreate mucus.

→ Brush border cells of Mucosa
+
Secreations of Goblet Cells
↓
Intestinal Juice or Succus entericus

→ enzymes → disaccharides (maltase), dipeptidases, lipases, nucleosidases.

→ Mucus + Bicarbonate → Pancreas
↓
protects intestinal mucosa + provide an alkaline medium (pH 7.8) for enzymatic activities.

→ Sub mucosal glands (Brunner's Gland) also help in this.

* Intestine *

① chyme [proteins, peptones, proteoses] —Trypsin/Chymotrypsin, Carboxypeptidase→ Dipeptides

② chyme (polysaccharides: starch) —Amylase→ Disaccharide

③ Fats —Lipase, Bile→ Diglycerides → Mono glycerides.

④ Nucleic acids —Nucleases in pancreatic juice→ Nucleotides → Nucleosides.

⑤ Final Steps in Digestion.

→ Very close to mucosal epithelial cells of intestine.

→ end products of above reactions. —Succus entericus→ simple absorbable forms

Dipeptides —Dipeptidases→ Amino acids

Maltose —Maltase→ glucose + glucose

Lactose —Lactase→ glucose + galactose

Sucrose —Sucrase→ glucose + fructose

Nucleotides —Nucleotidases→ Nucleosides —Nucleosidases→ Sugar + Base.

Di and Monoglycerides —lipases→ Fatty acid + Glycerol.

→ Duodenum region of small Intestine

- Absorbed
  - Jejunum
  - Ileum
- Undigested and Unabsorbed
  - ↓
  - large Intestine.

* Large Intestine *

(No significant digestive activity.) → Secreat mucus

- absorption of some water, minerals and certain drugs
- Adhere the waste
- lubricating undigested particles for easy passage.

Undigested, Unabsorbed Substances (Faeces)

↓ Ileo-Caecal Valve → prevent backflow.

Caecum

↓

Rectum (temporary stored, till defaecation)

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* Gastro - Intestinal Tract *

Neural Control | Hormonal Control

1. Sight / Smell / presence of food → stimulates secreation of Saliva.
2. Gastric / Intestinal tract → Neural Signals.
3. Muscular activities of different parts of alimentary canal.
   - ↓ Neural Mechanism → local / CNS
4. Digestive Juices (Hormonal Control)
   - ↓ Local Hormones → Gastric / Intestinal Mucosa

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* Absorption of Digested Products *

End products of digestion. —(Intestinal mucosa)→ Blood / lymph.

Absorption

* Max. absorption in small intestine.

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* Absorption *

Passive (simple diffusion)	Active (against conc. gradient)	Facillated
↓ conc. gradient	↓ requires energy	↓ carrier proteins
↓	↓	↓ glucose, amino acids.

monosaccharids: glucose, amino acids, some electrolyted like chloride ion — small amounts

Amino acids, monosaccharides like glucose, electrolytes (Na^+) → into blood

→ Transport of water depends upon osmotic gradient.
→ Fatty acids and glycerol (insoluable) → can't be absorbed into blood.
↳ • Incorporated into small droplets (Micelles)
↓
• Intestinal Mucosa
↓
• Reformed into chylomicrons (very small protein coated fat globules)
↓
• lymph Vessels (lacteals) in Villi
↓
Blood Stream

→ Absorption takes place in → Mouth, Stomach, Small-intestine, Large Intestine.
→ Max. absorption → Small Intestine.

Mouth	Stomach	Small Intestine	Large Intestine
Drugs → contact with (mucosa of mouth) (lower side of tongue) → absorbed into capillaries lining them.	Water, Simple Sugars, alcohol etc.	principal organ → absorption of nutrients. Digestion complete. glucose, fructose, fatty acids, glycerol, amino acids → mucosa into blood stream and lymph	Water, some minerals, drugs.

→ Absorbed substances reach tissues which utilises them → Assimilation.
→ Digestive Waste → Solidified into coherent faeces.
↓
Rectum
↓
Neural Reflex
↓
Removal / ejestion of faeces through anal opening (defaecation)

Voluntary process — Carried out by mass peristaltic movement.

* Disorders of Digestive System *

→ Inflammation of intestinal tract (Most common ailment) due to bacterial / Viral Infections.
→ also caused by parasites of intestine. → Tapeworm, Round Worm, Pinworm, Hookworm.

① Jaundice. → liver affected.
↓
• Skin, Eyes → Yellow → deposition of bile pigments.

② Vomiting. → ejection of stomach content through mouth.
↓
• This reflex action controlled by vomit centre in Medulla.
• Nausea feeling preceeds Vomiting.

③ Diarrhoea. → abnormal feeling of bowel movement.
↓
• Increased liquidity of faecal discharge.
• Reduces absorption of food.

④ Constipation. → Faeces are retained within colon as bowel movements occur irregularly.

⑤ Indigestion. → Food not properly digested → feeling of fullness
• Causes → Inadequate enzyme secretion, anxiety, food poisoning, over eating and spicy food.

PEM (protin energy malnutrition)

→ dietry deficiency.
proteins ↙ ↘ total food Calories

→ Under developed countries of South, South east asia, South America, West and Central Africa.
→ affect large sections during drought, political turmoil.
→ Bangladesh → Liberation War
→ Ethopia → during severe drought in mid-eighties.

PEM

Marasmus	Kwashiorkar
① protein and Caloric deficiency	① Only protein deficiency
② In infant (<1yr)	② Child (>1yr)
③ Mother's milk replaced → other foods having ↓↓ protein and calorific value.	③ Mother's milk replaced → high caloric low protein diet
④ Normally during second child birth when older infant is still, too young.	④ Shows wasting of muscles, thinning of limbs, failure of growth and brain development
⑤ Impairs growth replacement of tissues, proteins, extreme emaciation of body, thinning of limbs.	⑤ Fat is still left under skin.
⑥ Skin becomes dry, thin and wrinkled.	⑥ extensive edema and swelling of body parts.
⑦ Growth rate and body weight decline.	
⑧ Growth of brain and mental faculties are impaired.	

Imp MCQ's :→

① Digestion is carried out by → both mechanical and biochemical methods

② When tooth is embedded in socket of jaw bone → Thecodont

③ Dental formula → $\frac{2123}{2123}$.

④ Tongue is attached to floor of Oral Cavity by frenulum.

⑤ Symbiotic micro-organisms are found in Caecum.

⑥ Outermost layer of gut → Serosa.

⑦ Structural and functional unit of liver → Hepatic Lobule.

⑧ Hepato-Pancreatic duct is guarded by → Sphincter of Oddi

⑨ Food after mixing with gastric juice of stomach by

churning movements → Chyme

(10) PH of HCl is → 1.8

(11) Trypsinogen activated by an enzyme → enterokinase.

(12) Sub mucosal glands of duodenum → Brunner's Gland.

(13) proteoses and peptones are → partially hydrolysed proteins.

(14) Nucleases (enzyme) present in → pancreatic juice.

(15) protein coated fat globules in intestine → Chylomicrons

(16) Vomit centre present in → Medulla.

(17) Absorption of fructose occurs through → faciliated Transport

(18) pepsinogen secreated by → peptic / chief cells

(19) HCl secreated by → parietal / Oxyntic cells.

(20) pH of salivary amylase → 6.8

(21) Function of lysosomes in Saliva → Antibacterial agent

(22) Cells of Gastric Glands → Mucus neck cells, peptic / chief cells, parietal / Oxyntic Cells.

(23) Starch digested in Mouth → 30% by Salivary Amylase.

(24) Nutrients absorbed actively → Amino acids, Monosacharide (Glucose), Na^+.

(25) Absorbed substances finally reach tissues which utilize them → Assimilation