Human Physiology

Digestion & Absorption

① Ingestion ② Digestion ③ Absorption ④ Assimilation ⑤ Egestion

② Digestion → Mechanical method, Biochemical methods

Conversion of Complex food subs. (Macromolecules) → simpler Absorbable forms.

Food → carboh., Fats, proteins → For energy & organic material for growth & tissue repair.
Food → Minerals & Vit
Food → Water → Metabolic rxns. & prevent dehydration.

Digestive System

- Alimentary canal
- Associated Glands.

Mouth (Ant. opening) → Buccal/oral cavity → Pharynx → Oesophagus → Stomach → S.I. → L.I → Anus (post. opening)

① Oral cavity → roof (Palate), side (Teeth), floor (tongue) (Muscular)

② Tooth (embedded in socket of jaw bone) → (Type of attach) Thecodont
→ (Milk/Deciduous & adult/permanent teeth) Majority of mammals → Diphyodont
→ Diff. types of teeth → Heterodont

Dental Formula: I C PM M (F)

Adult tooth (F): 2 1 2 3 / 2 1 2 3

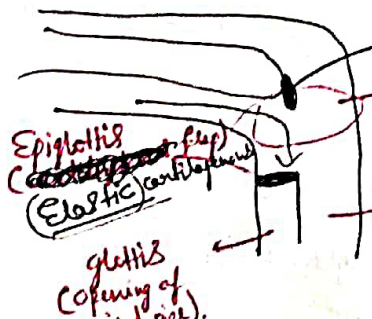
Child (milk teeth) (F): 2 1 0 2 / 2 1 0 2

③ Tooth → Hard Chewing surface → Enamel ($Ca_3(PO_4)_2$) (Hardest substance of body) → Mastification

(Molars) → 3 roots, PM → 2 roots

④ Tongue → Freely movable, Muscular
→ Attach by Frenulum to floor of Buccal cav.
→ Has small project^n → Papillae
Some Papillae → has taste buds.

Papillae
① Filliform (Most Abundant) → No taste bud
② Fungiform
③ Foliate
④ Circumvalate.



Oesophagus → go posteriorly & below diaphragm into Stomach.

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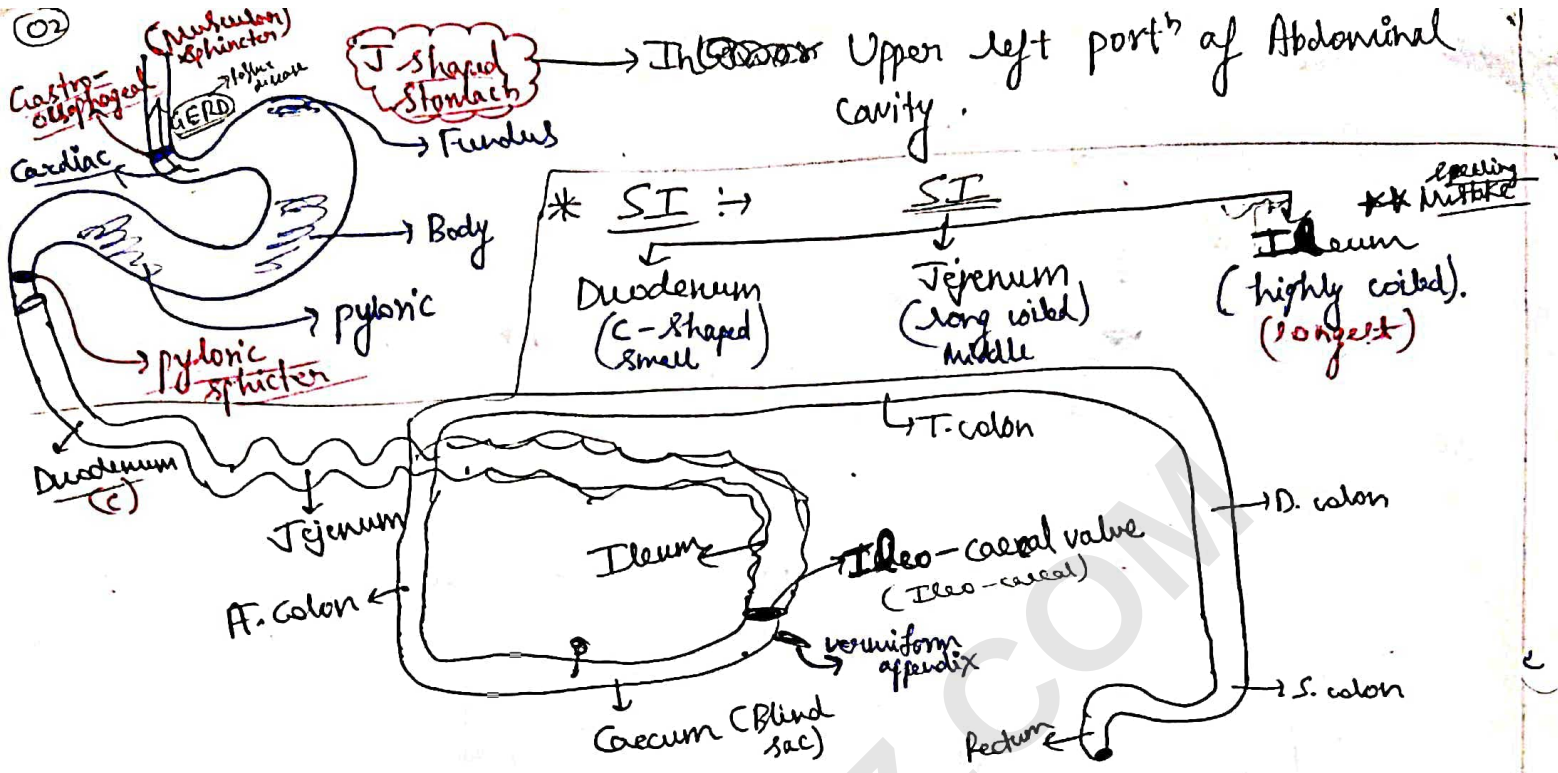


J shaped Stomach → In Upper left part of Abdominal cavity.

* SI :→ Duodenum (C-shaped small) | Jejunum (long coiled middle) | Ileum (highly coiled). (longest)

L.I. → Caecum | Colon | Rectum

Caecum: Small, Blind sac → Has symbiotic microorganisms

Colon: Asc. Trans Desen. Sigmoid → open into Rectum → Anus.

→ Has Narrow finger like project^{n} → Vermiform Appendix (vestigial organ).

* Walls of Alimentary Canal

Outer → Inner

* Serosa
  - Thin Mesothelium (epithelium of visceral organs) + some connective tissue

* Muscularis (Smooth muscle)
  - Outer (longitudinal) Pile like → for length
  - Inner (circular)
  - → An oblique muscle layer not in some region (eg in stomach)

* Sub-Mucosa
  - loose connective tissue + Blood/lymph vessel + nerve supply
  - Duodenum (Brunner's Gland)

* Mucosa
  - epithelium Mucosa
  - → Forms Gastric rugae (irregular folds) & gastric glands in Stomach
  - → Villi (small finger like foldings) having cells with numerous project^{n} c/a Microvilli → Brush Border appearance

* Villi → Supplied with → Lacteal (large lymph vessel) → Capillaries.

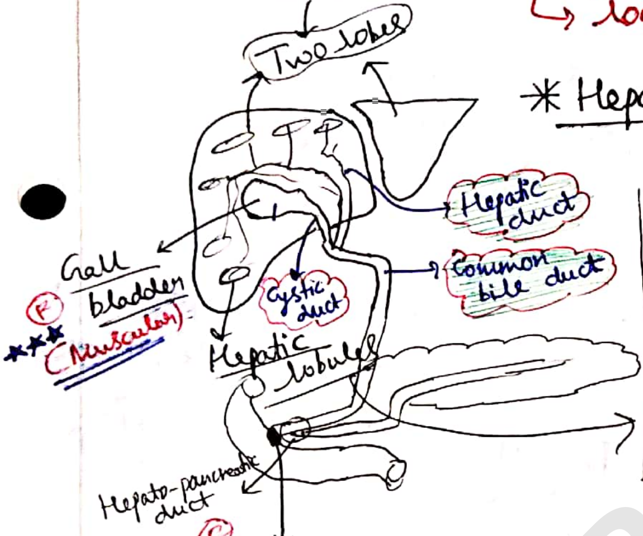
Mucosal epithelium → Goblet cells → mucus → lubricat^{n}.
Mucosa forms
→ crypts b/w bases of villi → Crypts of Lieberkuhn

Accessory Digestive Glands

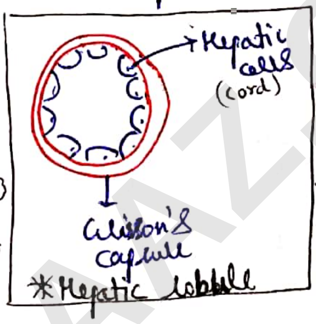
1. Salivary Gland : [3 pairs] → located just outside Bucc. cav. → Secrete salivary juice inside it.

- parotids (Largest) (Cheek) (F) → Stenson's duct.
- ** Sub-maxillary / Sub-mandibular (lower jaw) (F) → contribute most → Wharton's duct. (Mistake)
- Sub-linguals (F) (below tongue) → Duct of Rivinus

2. [Liver] :→ Largest gland → ** (F) (1.2 – 1.5) kg → adult
↳ located in (F) upper right part of abdominal cavity.



* Hepatic lobules :→ → Str. & funct. units of liver
→ Hepatic cells arr. in form of cords. (F)



→ Covered by thin Connective tissue sheath called as (F) Glisson's capsule.
→ Secrete Bile → pass by Hepatic duct
Store & concentr. in ← a (Muscular sac) Gall Bladder

* (F) Sphincter of Oddi :→ Guard opening of common Hepato-pancreatic duct in Duodenum.

[3] Pancreas → (F) Compound organ
↳ b/w C-shaped Duodenum's limbs.
- → Exocrine → (alkaline) pancreatic juices having enzymes. [pancreatic acini] 99%.
- → Endocrine [Islets of Langerhans] 1%
  - α-cells → Glucagon
  - β-cells → Insulin

Extra :→ [Liver]
- → Hepatic portal system → Nutrient from SI/LI to store
- → Hepatic vein → (deoxygenated blood) Max. urea
- Hepatic artery (oxygenated blood)

Digestⁿ of food

1. Buccal cavity → Mastificatⁿ (By teeth & tongue → mix properly with saliva).
↳ Facilitate swallowing (Deglutitⁿ)

(04)

Saliva → Mucus → Lubricat^{n} / adhering of food particles into Bolus.
→ Electrolytes (Cl^-, HCO_3^-, Na^+, K^+)
→ (F) Salivary amylase : Starch —(pH=6.8, F)→ Maltose + Isomaltose + Dextrose (equiv to carbohydrate)
→ 30% Starch break
→ (F) Lysozyme → Antibacterial agent.

Now: Bolus pass through oesophagus into stomach due to Peristaltic movement of muscles of oesophagus.

Stomach :→ Mucosa —(F)→ Gastric Glands (pylonic region)
↳ Store Food: 4-5 hrs. (F) 3 types of cells mainly

Mucus Neck cell → Secrete Mucus

(F) Peptic / Chief cells → Proenzyme: Pepsinogen & Prorennin (infants) (F)
(F) also (small amt) Gastric Lipase → Inactive

(F) Parietal / oxyntic cell → (F) HCl & CIF (for (vit B_{12} absorpt^{n}) → RBC$_{n}$ format^{n})

→ (F) Churning Movem. → Food mix thoroughly ⇒ Chyme

Proteins —(pH=1.8, Pepsin, F)→ proteases & peptones (peptides).

Mucus & HCO_3^- → Lubricat^{n} & protect^{n} of Mucosal epithelium.

Rennin → Proteolytic enzyme for milk protein (Casein) in infants stomach
↳ Do 1st step of casein digest^{n}.

Small amt of Lipases → By gastric glands

S.I. :→ Bile + Pancreatic ju. + Intestinal juice.
through Hepato-pancreatic duct
From Mucosa + some Brunner's Gland (sub mucosa)

(F) Pancreatic Juice :→ Inactive enzymes:
(1) Trypsinogen, Chymotrypsinogen, Procarboxypeptidases } → proteins (Zymogens)
(2) Amylases → Starch (3) Lipases (4) Nucleases

(F) Trypsinogen —(Enterokinase, ↑ Intestinal Mucosa)→ Trypsin → activates others enzymes.

(05)

Bile → Bile pigments :⇒ Bilirubin & Biliverdin.
→ Bile salts :⇒ Emulsificatⁿ of fats (micelle formatn) &
→ Cholesterol + Phospholipids

** (F) Lipases → Activated by Bile.

S.I :⇒ (Intestinal juice)
→ Succus Entericus → Mucus + Enzymes (F)

Mucus ← Goblet cells of Mucosal epithelium (Simple Columnar epithelial)

Enzymes ← From Brush Border Cells of Mucosa.

Succus Entericus → Disaccharidases, Dipeptidases, (F) Lipases, Nucleosidases

Mucus + HCO_3^- (Mainly from Pancreas) → (1) Makes pH alkaline (F) (7.8) for enzyme activities.
(2) protect Intes. Mucosa from acids.

Also helps in this ← Brunner's Gland (submucosal gland)

Chemical Actⁿ of :⇒

* a) Pancreatic Juice :⇒

Partially hydrolysed protein ← protein / peptones / proteases ← Trypsin, Chymotrypsin / Carboxypeptidases ← Dipeptides

Starch (polysac.) → (Amylase) → Disaccharides

(F) Fats → (Lipases) → Diglycerides → Monoglycerides.

Nucleic acid → (Nucleases) → Nucleotides → Nucleosides.

** b) Succus Entericus :⇒ (F) Forms absorbable forms (End pdts).

DO (F) Final steps → Very close to (F) Mucosal Epithelium cells of intestine.

* Dipeptides → (Dipeptidases) → [redacted] AA. ✓
* Disaccharides (Maltose, Lactose, Sucrose) → (Maltase / Lactase / Sucrase) → Glucose / Galactose / Fructose
* (F) Nucleotides → (Nucleotidases) → Nucleosides → (Nucleosidases) → Sugars + N-Bases

(66)

Di/Monoglycerides $\xrightarrow{\text{Lipases}}$ Fatty acids + Glycerol

(P) * Breakdown of macromolecules → Mainly in Duodenum..

(F) * Absorptⁿ → Jejenum & Ileum.

* Undigested / Unabsorbable subs → L.I.

L.I. functⁿs :- (E) No significant Digestⁿ.

(1) Absorptⁿ of water + Minerals + Drugs !!

(2) Secretⁿ of Mucus → Adhere waste material → Faecal Matter & lubricate them.

Faeces → Temporarily Store in Rectum (E) till Defaecatⁿ.

Control of activities of Gastro-Intestinal Tract :-

Neural Signals → for proper coordinatⁿ ← Hormonal control

→ Sight / Smell / think of food → Saliva secretⁿ in oral cavity

→ Gastric & Intestinal secretⁿs

→ Muscular activities (Peristalsis)

* Local Neural System

* CNS

→ By Local Hormones:

→ by gastric & intestinal mucosa.

⇓

Control of digestive juice secretⁿ.

** Absorptⁿ → passive, active, facilitated

* Small amt. of Glucose, AA, electrolyte Cl^- → By Simple diffusion

Subs. like, Gluc., AA (Galac. etc.) → Absorbed with help of carrier proteins (**) & carrier ions (Na^+).

⇓

Facilitated transport

Absorptⁿ of AA, monosaccharides (Glucose etc.), electrolytes (Na^+) → into blood (GIWL-2)

⇓

Active transport

Fatty ā, Glycerol → water insoluble → can't be absorbed in blood

FA, Gly. → incorporated into micelle → Move in Intes. Mucosa → Reformed into protein coated fat-globules (Chylomicrons) → Transported into Lacteals of villi → Released ultimately into blood.

(7)

Max- Absorpt^{n} → S.I.

Summary of Absorpt^{n}

Mouth	Stomach	S.I.	L.I.
→ Drugs (contact with mucosa (lower tongue side) → absorbed into capillaries	→ Water, simple sugars → Alcohol, → Medicines	→ Principal Absorpt^{n} organ → Final pdts → Glu, Gala, Fruc., AA, Glycerol, Fatty a., absorbed through mucosa into blood stream / Lacteal	→ Water → Minerals → Some drugs

Assimilat^{n} → Utilisat^{n} of absorbed pdts.

Defaecat^{n} → By Mass peristaltic Movem.
↳ (F) By Neural Reflex.

PEM (Protein- Energy Malnutrit^{n})
→ Underdeveloped countries South & South-East Asia.

Replacement of mother's milk by other diet

(F) Marasmus
→ (F) Protein + Calory deficiency
→ (F) < 1 year infants
→ Extreme Emaciation
→ Thining limbs, dry skin scaly
→ Body wt. ↓, growth rate ↓es
→ Mental health impaired

(F) Kwashiorkor
→ (F) Only protein defi
→ (F) Child > 1 year age
→ Extensive Oedema (F),
→ Swelling of body parts
→ Wasting of muscles (F)
→ (F) Thinning of limbs.
→ Mental develop. retarded.

Heat → ultimate form of all energies.

Gross calorific value (G.C.V.) → Energy liberated when 1g of food is completly combusted in a Bomb Calorimeter.

Actual amt. of energy → Physiological value of food.

	G.C.V.	P.V.
Carbohy.	4.1 Kcal/g	4 Kcal/g
Pro.	5.65 Kcal/g	4 Kcal/g
Fats	9.45 Kcal/g	9 Kcal/g

Disorders of Digestive System

1. **Jaundice** :→ Liver is affected. Yellow eyes, skin due to deposit^{n} of Bile pigments.

2. **Vomitting** :→ Eject^{n} of stoma. content from mouth → Reflex act^{n}
   ↳ Vomit centre → Medulla (preceded by Nausea feeling)

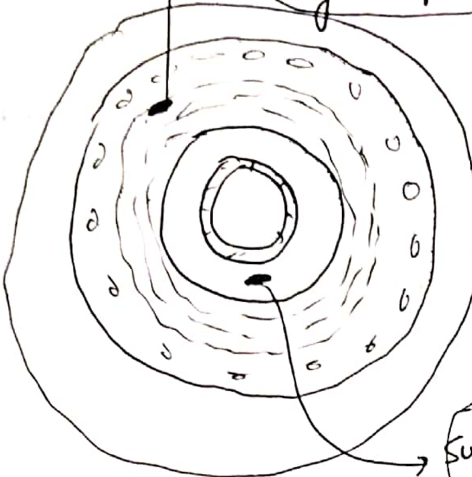
3. **Diarrhoea** :→ Abnormal freq. of Bowel movem. & Red liquidity of faecal discharge. → Reduce absorpt^{n} of food.

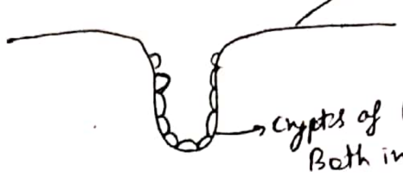
4. **Constipat^{n}** :→ Faces → Retained in Colon
   → Bowel movem. occur irregularly.

5. ~~Digest~~ **Indigest^{n}** :→ Not proper digest^{n} → Fullness Feeling
   ↳ Cause: Anxiety, inadequate enzyme secret^{n}, food poisoning, over eating, spicy food.

7

Masterclass

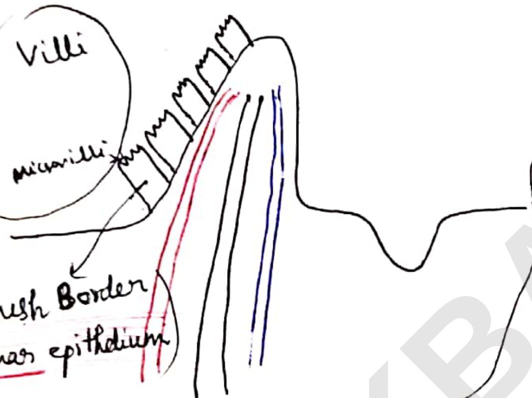




Both in SI & LI
- Secrete both Mucus & Enzymes
- Secrete Mucus

Deep tubular Gland (Stomach)

for ex → Brunner's Glan's Submucosa



★★ Brush Border
Columnar epithelium

Salivary Gland
- dsl Parotid → Stenson's duct
- Submandibular → Wharton's duct (Most secretⁿ/day)
- Sublingual → Duct of Rivinus

"Chole → Gall Bladder"

Cholecystitis → Inflammatⁿ of Gall bladder
Hepatitis → Inflammatⁿ of Liver (gland)
Angiotensinogen

Endocrine Control of GIT :→ Stomach

- Gastrin
- CCK
- Secretin
- GIP.

Stomach Distention (AA)

Stomach → Pyloric gland → G-cells → Gastrin

Stomach → Oxyntic glands → Oxyntic/parietal cell, Chief/parietal cell

Gastrin → Stomach motility ↑es. → Pepsinogen ↑

Gastrin → Entero chromaffin like cells → Histamine

★★ parietal cells (oxyntic) → HCl ↑, CIF ↑

Chyme → Fat Rich, Acid Rich

Fat Rich → GIP, CCK

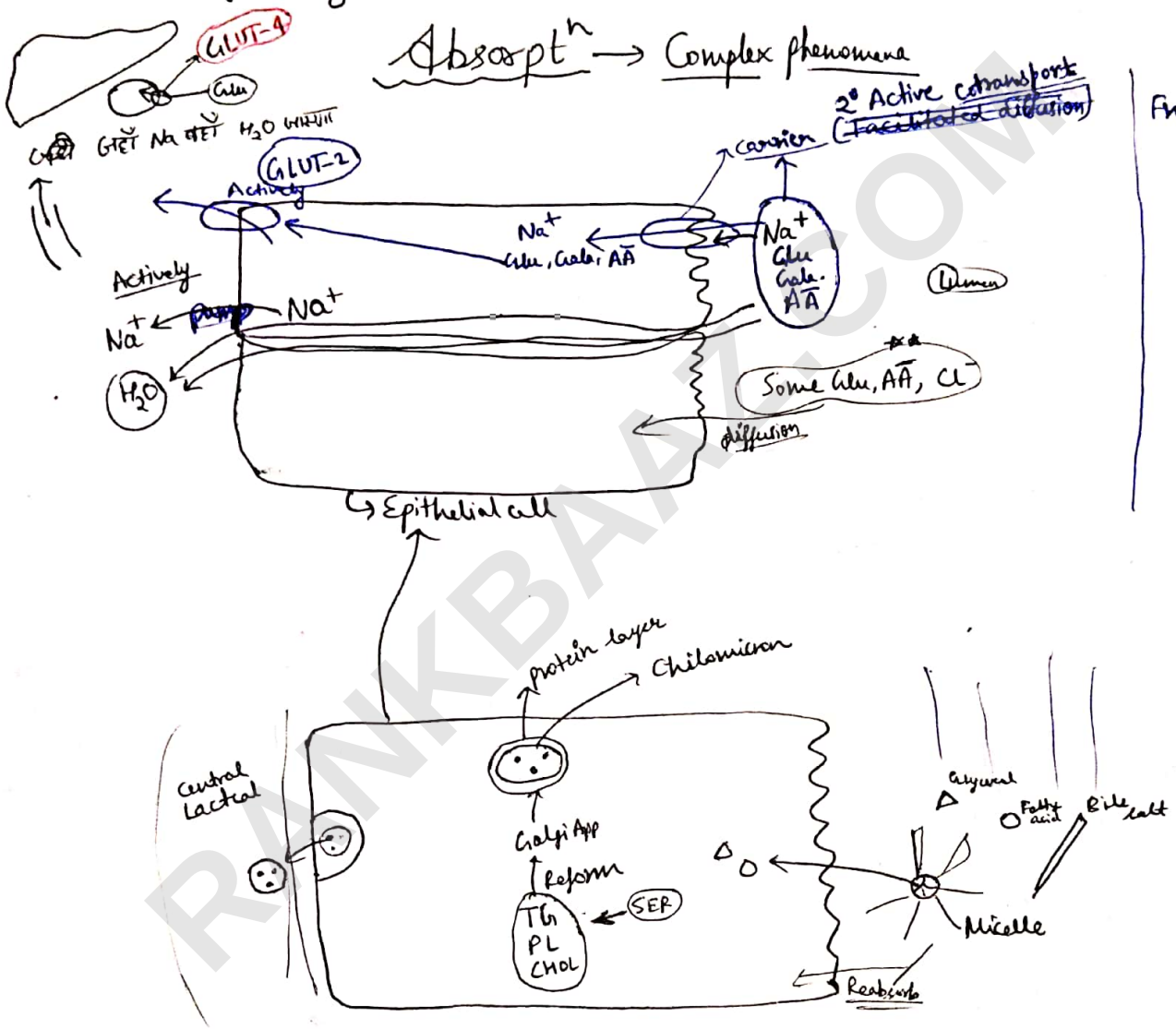
Enterogastrones → GIP → ↓es Stomach motility

CCK → Stomach motility ↓es; Contracts Gall Bladder → release Bile; Pancreas → Serous enzyme rich

Acid Rich → Secretin → Stomach motility ↓; Pancreas → Mucoid HCO_3^- + mucus

(5)

Zymogen → Activates only where is to act eg Trypsinogen, Pepsinogen, procarboxypeptidase
↳ very strong peptidases



Absorpt^{n} → Complex phenomena

Fructose (always Facilitated)

* Greatest Amt of water → Absorb by ~~Jejunum~~ SI
* " fract^{n}/% of water → LI " LI.