ARJUNA NEET BATCH

DIGESTION AND ABSORPTION- LECTURE -04

INTESTINAL GLANDS

Enterokinase

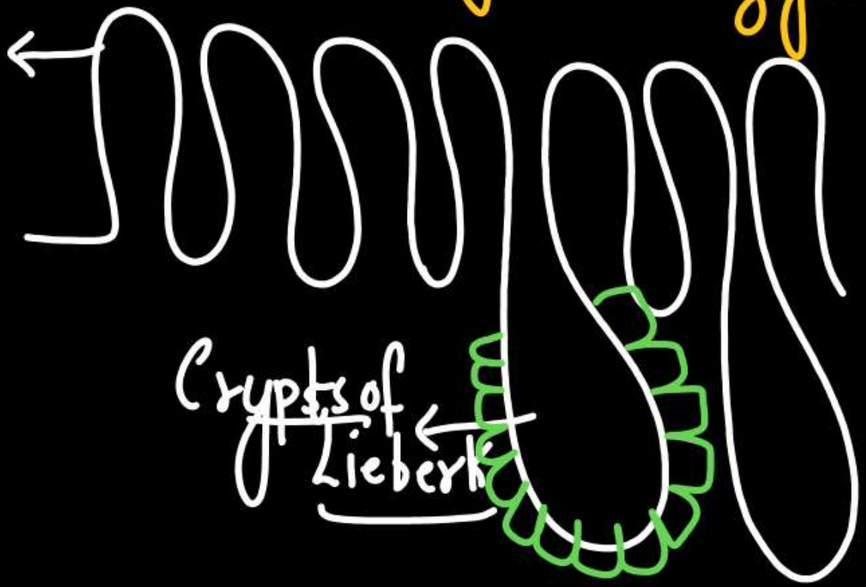
MUCOSAL GLANDS/CRYPTS OF LIBERKUHN

- ENTEROCYTES → Mav. enzymes
- GOBLET CELL → Mucus
- PANETH CELL → Lysozyme
- ARGENTAFFIN CELL → Produce Hormone

SUBMUCOSAL GLAND/BRUNNERS GLAND

→ Maximally produces Mucus, but also some enzyme.

villi



INTESTINAL GLANDS:

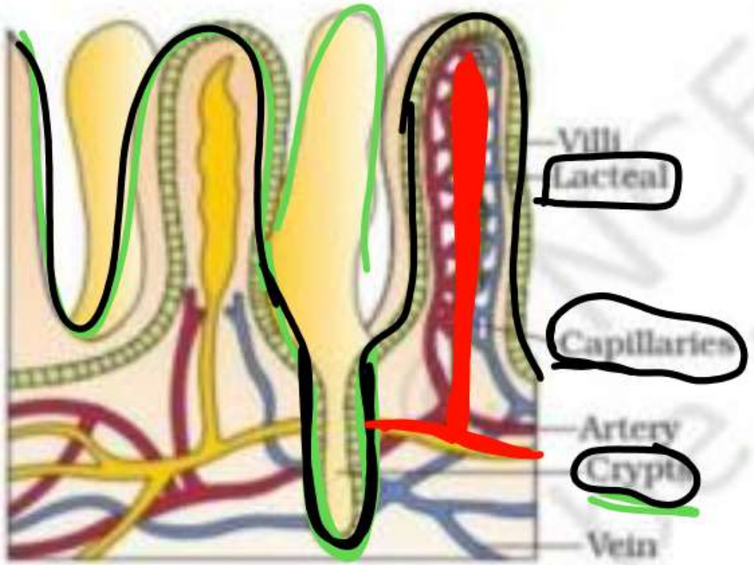


Figure 16.5 A section of small intestinal mucosa showing villi

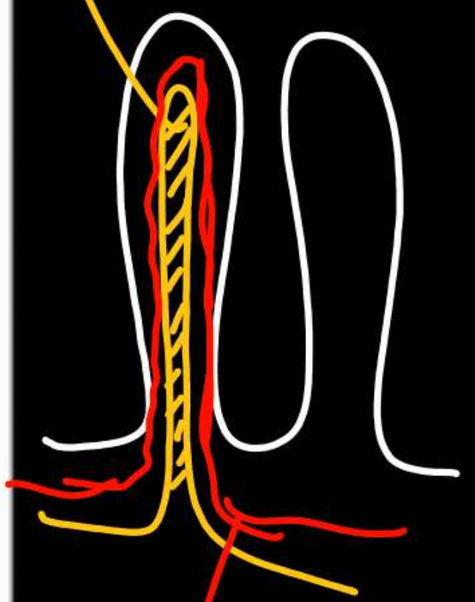
projections called microvilli giving a brush border appearance. These modifications increase the surface area enormously. Villi are supplied with a network of capillaries and a large lymph vessel called the lacteal. Mucosal epithelium has goblet cells which secrete mucus that help in lubrication. Mucosa also forms glands in the stomach (gastric glands) and crypts in between the bases of villi in the intestine (crypts of Lieberkuhn). All the four layers show modifications in different parts of the alimentary canal.

16.1.2 Digestive Glands

The digestive glands associated with the alimentary canal include the salivary glands, the liver and the pancreas.

Saliva is mainly produced by three pairs of

Lymphatic capillary → Lacteal



Blood capillary

INTESTINAL JUICE:

(produced by Crypts of Lieberkuhn & Brunner's gland)

↳ pH- Alkaline → also k/a SUCCUS ENTERICUS

ENZYMES PRESENT:

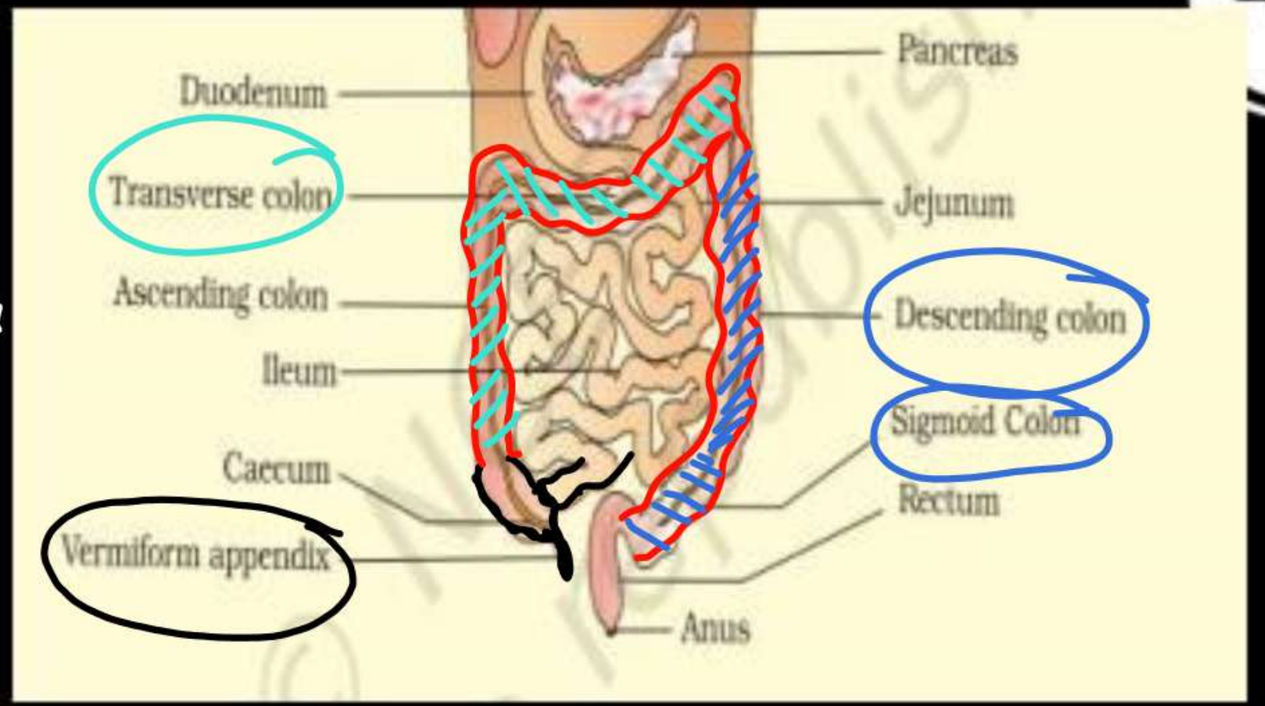
1. For Carbohydrates: MALTASE, SUCRASE, LACTASE — DISACCHARIDASE
2. For Proteins: Aminopeptidase, Dipeptidase → H.W → They belong to which Bigger Category of Enzyme
3. For Lipids: Intestinal Lipase.
4. For Nucleic Acid: Nucleotidase, Nucleosidase

INTESTINAL JUICE:

The intestinal mucosal epithelium has **goblet cells** which secrete mucus. The secretions of the brush border cells of the mucosa alongwith the secretions of the goblet cells constitute the intestinal juice or **succus entericus**. This juice contains a variety of enzymes like disaccharidases (e.g., maltase), dipeptidases, lipases, nucleosidases, etc. The mucus alongwith the bicarbonates from the pancreas protects the intestinal mucosa from acid as well as provide an alkaline medium (pH 7.8) for enzymatic activities. Sub-mucosal glands (Brunner's glands) also help in this.

LARGE INTESTINE

1. → CAECUM → Hosts some symbiotic Microorganisms.
   → Has VERMIFORM APPENDIX
   → BLIND SAC
2. → COLON → ASCENDING
   → TRANSVERSE
   → DESCENDING
   → SIGMOID
3. RECTUM
   → Last part that open outside via ANUS
   → Faecal Matter temporarily stored Here.



ARJUN

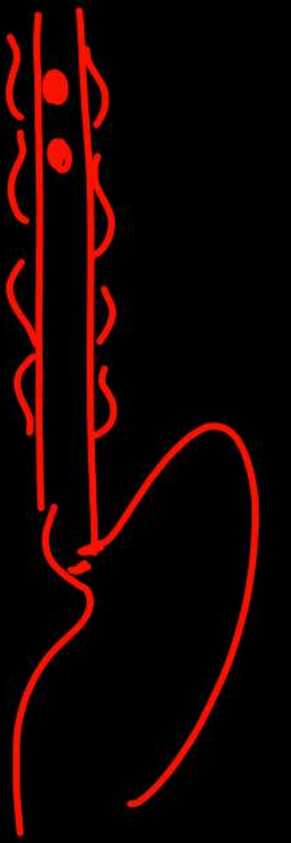
Stomach (CHYME → Bolus+HCl)

16.2 Digestion of Food

BOLUS → Saliva + Food

The process of digestion is accomplished by mechanical and chemical processes.

The buccal cavity performs two major functions, mastication of food and facilitation of swallowing. The teeth and the tongue with the help of saliva masticate and mix up the food thoroughly. Mucus in saliva helps in lubricating and adhering the masticated food particles into a **bolus**. The bolus is then conveyed into the pharynx and then into the oesophagus by swallowing or **deglutition**. The bolus further passes down through the oesophagus by successive waves of muscular contractions called peristalsis. The gastro-oesophageal sphincter controls the passage of food into the stomach.The saliva secreted into the oral cavity contains electrolytes (Na^+, K^+, Cl^-, HCO_3^-) and enzymes, salivary amylase and lysozyme. The chemical process of digestion is initiated in the oral cavity by the hydrolytic action of the carbohydrate splitting enzyme, the salivary



DIGESTION OF CARBOHYDRATES

→ In MOUTH:

30% Starch —Ptylin {6.8} ✓ / S. amylase→ MALTOSE

→ In Oesophagus: X

→ In STOMACH: X

→ In INTESTINE / DUODENUM:

Bile, Pancreatic Juice, intestinal Juice

Bile → X

Pancreatic Juice → Amylopsin ✓

70% STARCH → MALTOSE

Intestinal Juice → Maltase, Sucrase, Lactase

Disaccharidase ←

MALTOSE —Maltase→ Glucose + Glucose

LACTOSE —Lactase→ Glucose + Galact-ose

SUCROSE —Sucrase→ Glu + Fructose

DIGESTION OF PROTEINS

① In Mouth : ✗

② In oesophagus : ✗

③ In STOMACH : Pro-rennin, Pepsinogen — Inactive

HCl ✓

Rennin, Pepsin — Active

Note: In Infants

↓

Curding of Milk

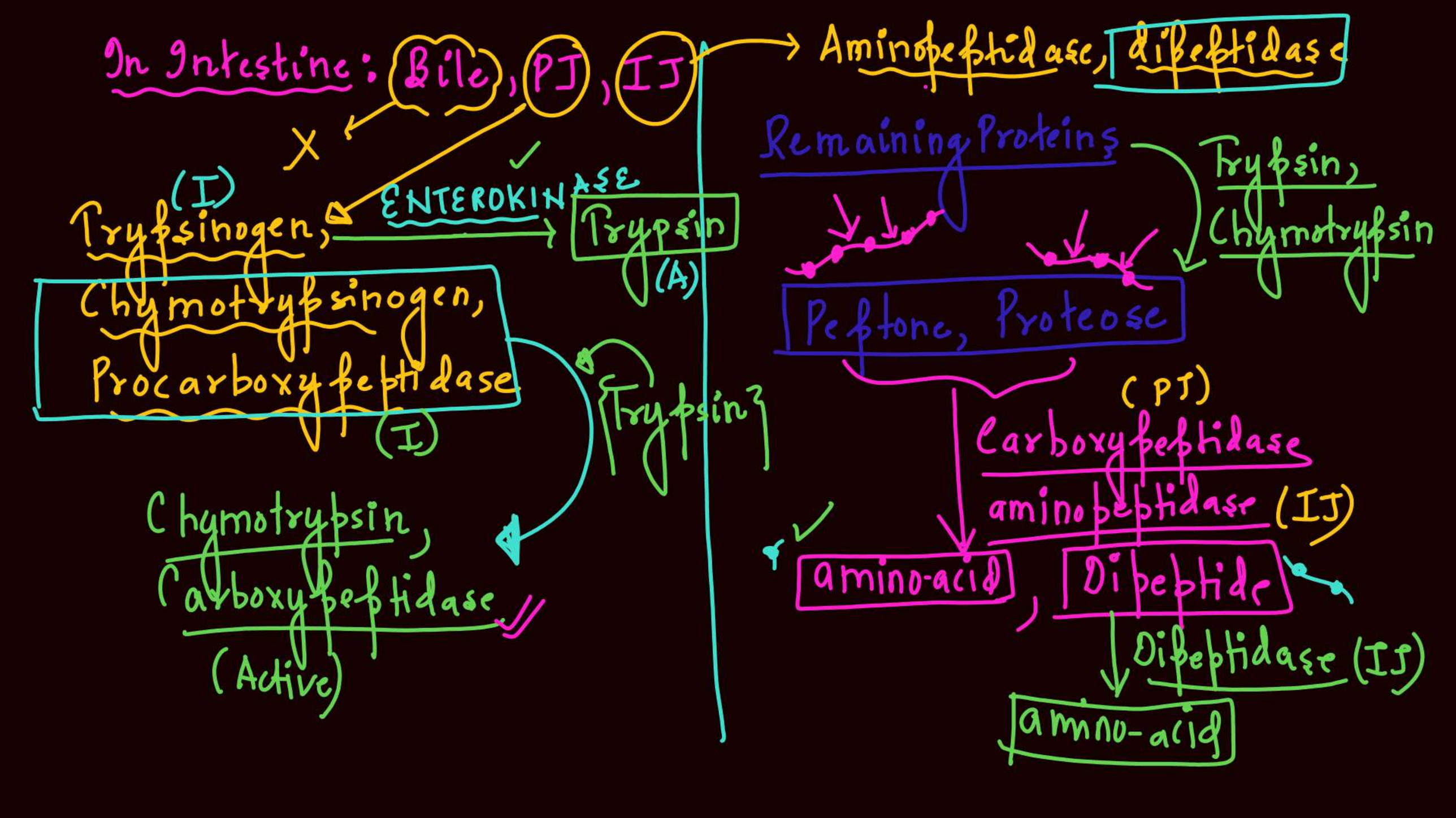
↓

Occurs with the Help of Rennin

Milk Protein (Casein) —Rennin→ Calcium paracaseinate (Curdling)

Some Proteins —Pepsin→ Peptones

Proteoses


In Intestine: Bile, PJ, IJ
Aminopeptidase, dipeptidase
X
✓
(I)
Trypsinogen,
ENTEROKINASE
Trypsin
(A)
Chymotrypsinogen,
Procarboxypeptidase
(I)
Trypsin?
Chymotrypsin,
Carboxypeptidase
(Active)
Remaining Proteins
Trypsin,
Chymotrypsin
Peptone, Proteose
(PJ)
Carboxypeptidase
aminopeptidase (IJ)
amino-acid
Dipeptide
Dipeptidase (IJ)
amino-acid

DIGESTION OF LIPIDS

1. In Mouth ✗
2. In Oesophagus ✗
3. In Stomach → Very little amount of Lipid digestion begins here with the help of Gastric Lipase.
4. In Intestine: BILE + PJ + IJ

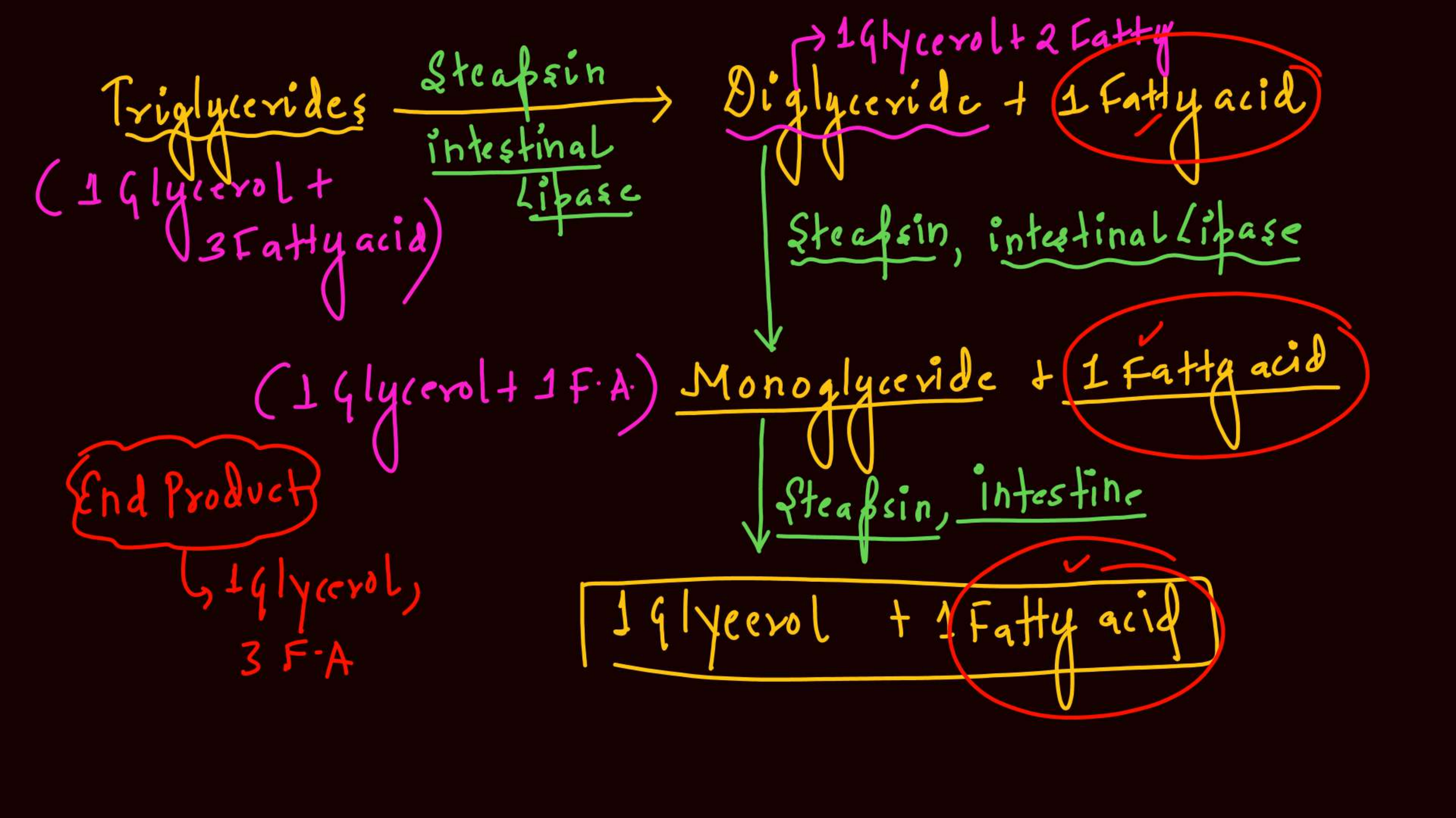
PJ → Steapsin

IJ → intestinal lipase

Triglyceride → 1 Glycerol + 3 Fatty acid

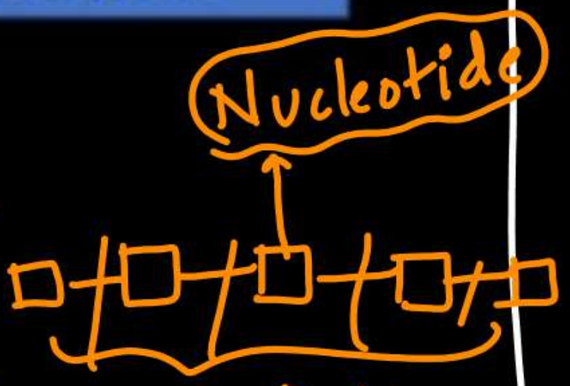
Large Fat globule → Emulsification of fat

EMULSIFICATION OF FATS


Triglycerides
(1 Glycerol + 3 Fatty acid)
Steapsin
intestinal Lipase
Diglyceride + 1 Fatty acid
1 Glycerol + 2 Fatty
Steapsin, intestinal Lipase
(1 Glycerol + 1 F.A)
Monoglyceride + 1 Fatty acid
Steapsin, intestine
1 Glycerol + 1 Fatty acid
End Product
1 Glycerol, 3 F.A

DIGESTION OF NUCLEIC ACID

1. In Mouth → X
2. In Oesophagus → X
3. In stomach → X
4. In Intestine : Bile + PJ + IJ



X

Nucleases

Nucleotidase

Nucleosidase

DNA, RNA / Nucleic Acid

↓ Nuclease (PJ)

NUCLEOTIDE

Nucleoside
Sugar, N₂ Base

↓ Nucleotidase (IJ)

Nucleoside + Phosphate

Phosphate

↑ Nucleosidase

Sugar + N₂ Base

amylase. About 30 per cent of starch is hydrolysed here by this enzyme (optimum pH 6.8) into a disaccharide – maltose. Lysozyme present in saliva acts as an antibacterial agent that prevents infections.

$$\text{Starch} \xrightarrow[\text{pH 6.8}]{\text{Salivary Amylase}} \text{Maltose}$$

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 the active enzyme pepsin, the proteolytic enzyme of the stomach. Pepsin 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. Small amounts of lipases are also secreted by gastric glands.

CHYME
↓
Food + acid

Various types of movements are generated by the muscularis layer of the small intestine. These movements help in a thorough mixing up of the food with various secretions in the intestine and thereby facilitate digestion. 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, amylases, lipases and nucleases. 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. The bile released into the duodenum contains bile pigments (bilirubin and bili-verdin), bile salts, cholesterol and phospholipids but no enzymes. Bile helps in emulsification of fats, i.e., breaking down of the fats into very small micelles. Bile also activates lipases.

Proteins, proteoses and peptones (partially hydrolysed proteins) in the chyme reaching the intestine are acted upon by the proteolytic enzymes of pancreatic juice as given below:

Proteins, Peptones, Proteoses $\xrightarrow[\text{Carboxypeptidase}]{\text{Trypsin/Chymotrypsin}}$ Dipeptides

Carbohydrates in the chyme are hydrolysed by pancreatic amylase into disaccharides.

Polysaccharides (starch) $\xrightarrow{\text{Amylase}}$ Disaccharides

Maltose

Fats are broken down by lipases with the help of bile into di-and monoglycerides.

Fats $\xrightarrow{\text{Lipases}}$ Diglycerides $\longrightarrow$ Monoglycerides

Nucleases in the pancreatic juice acts on nucleic acids to form nucleotides and nucleosides

(PJ)

Nucleic acids $\xrightarrow{\text{Nucleases}}$ Nucleotides $\longrightarrow$ Nucleosides

Nucleotidase (IJ)

The enzymes in the succus entericus act on the end products of the above reactions to form the respective simple absorbable forms. These final steps in digestion occur very close to the mucosal epithelial cells of the intestine.