Human nutrition lecture 2

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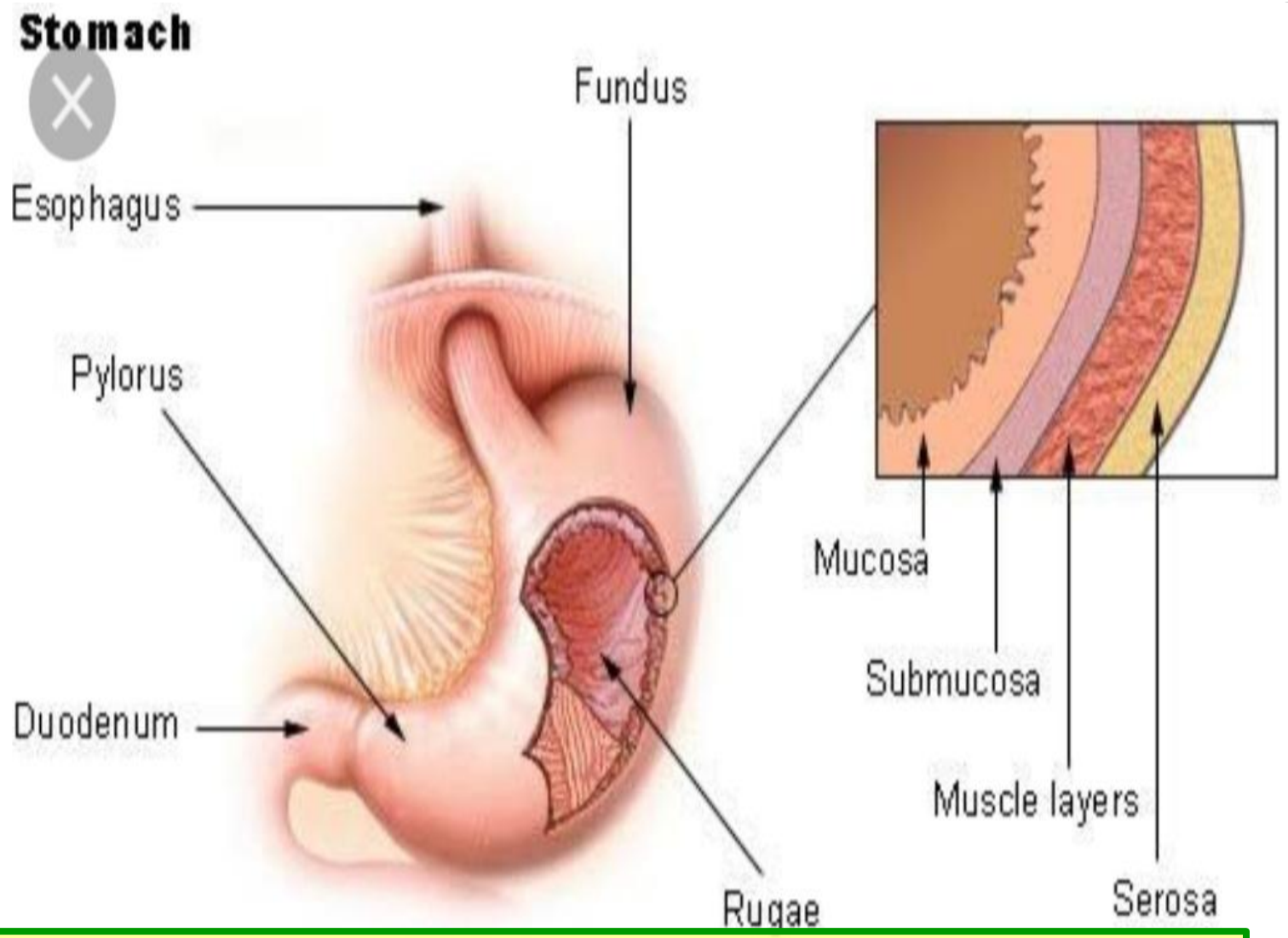
Histology of alimentary canal



wall of alimentary canal [from oesophagus to rectum]

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From outside to inside

serosa	Mesothelium/squamous epithelium
	Connective tissue
muscularis	Outer-longitudinal
	Middle-circular
	Inner –oblique (absent in intestine)
Sub mucosa	Loose connective tissue Blood vessel/lymph vessel/nerves Duodenum-Brunner's gland
mucosa	Goblet cells/mucus cells

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Mucosa –
modification in different region of alimentary canal

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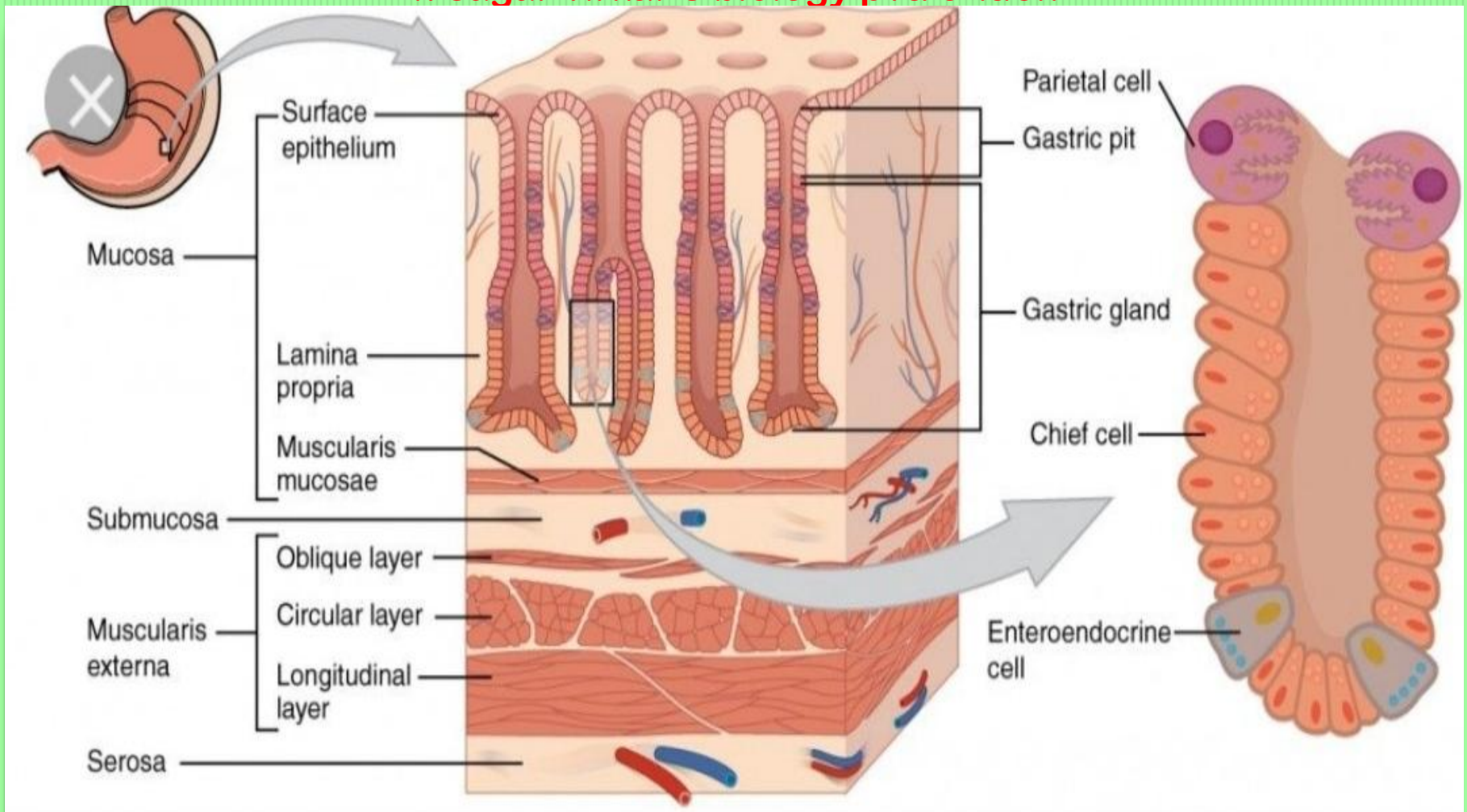
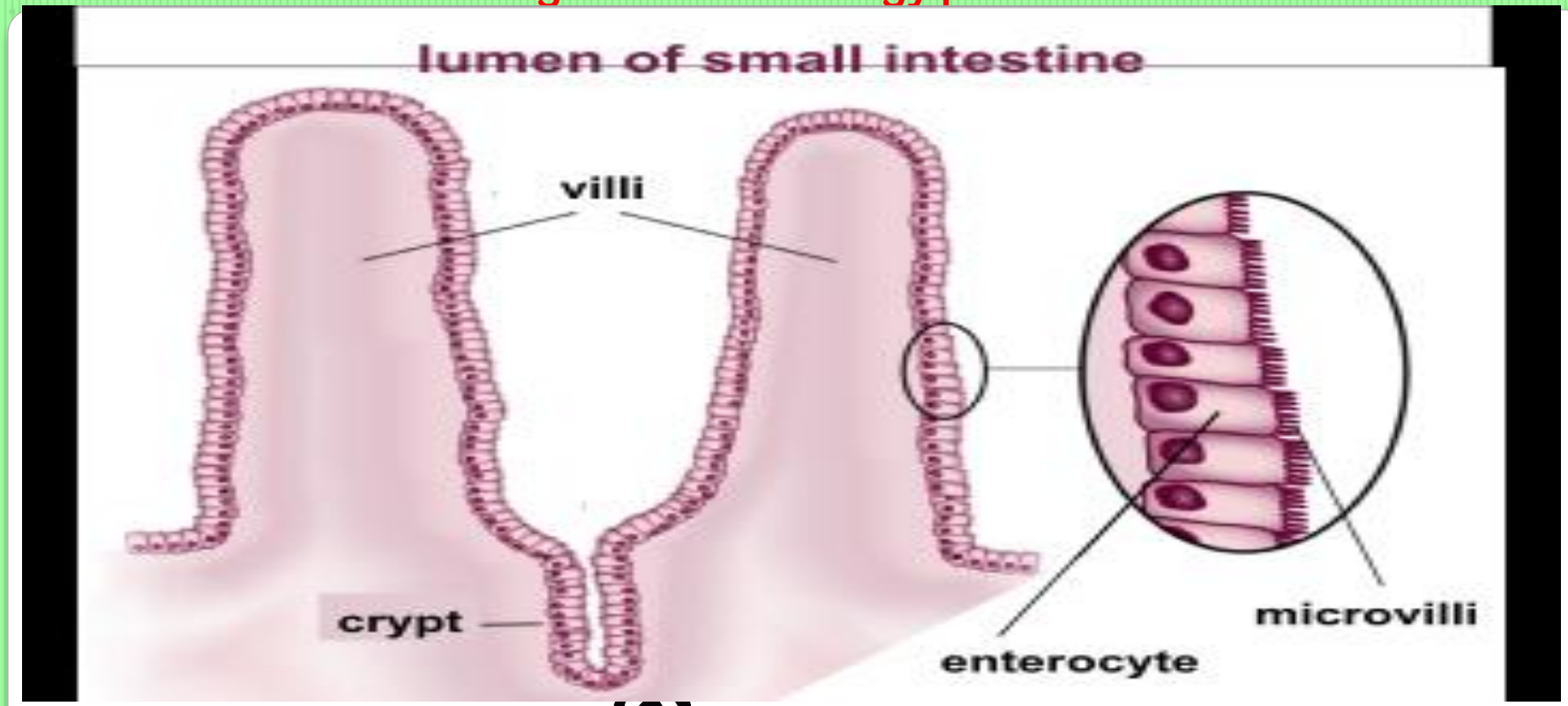


Stomach-mucosa is thrown into irregular folds called rugae./gastric gland-gastric juice



Mucosa of small intestine

-forms finger like folding called **villi.**

They are lined by brush border /epithelium cells having **microvilli** at free surface.

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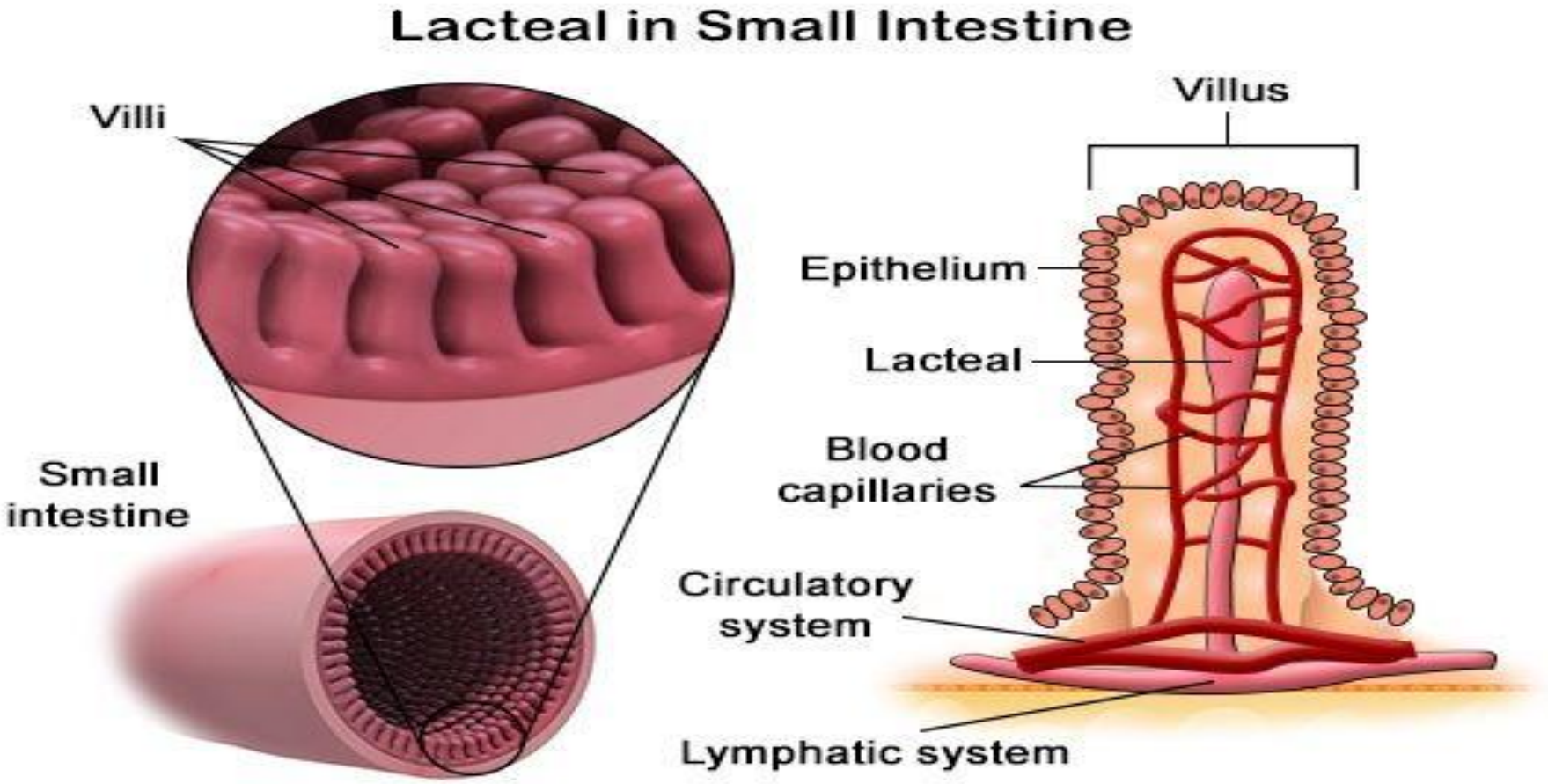
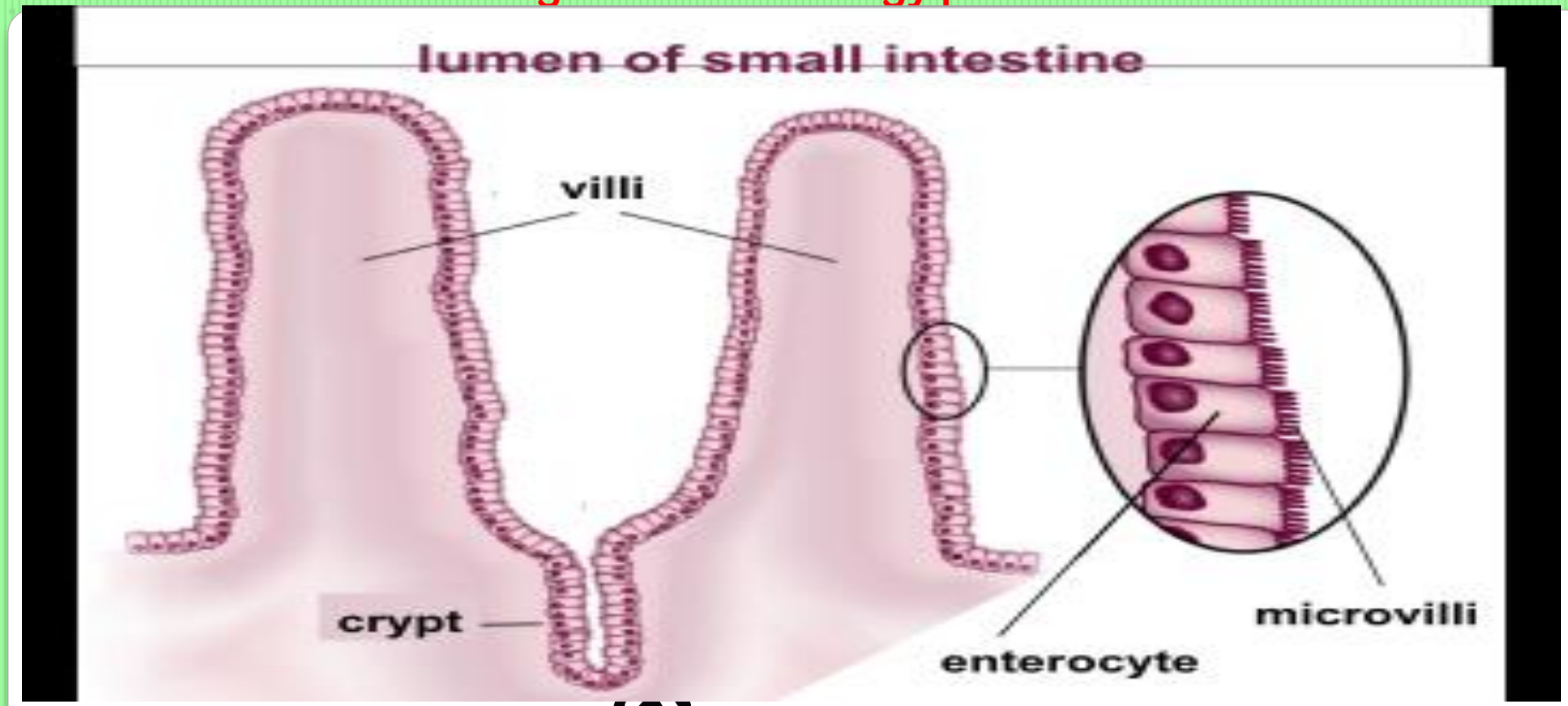


Villi are supplied with network of capillary and lymph vessel called-lacteal

Lymph= blood plasma + w.b.c



Mucosa forms crypts in between the bases of villi-crypts of lieberkuhn –intestinal gland

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Mucosa –

Ingestion-mucosa of it forms finger like folding called villi.

They are lined by brush border /epithelium cells having microvilli at free surface.

Villi are supplied with network of capillary/lymph -lacteal

Mucosa forms crypts in between the bases of villi-crypts of lieberkuhn –intestinal gland

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Digestive Gland

1. Salivary gland
2. Liver
3. Pancreas

4. Gastric gland
5. Intestinal gland

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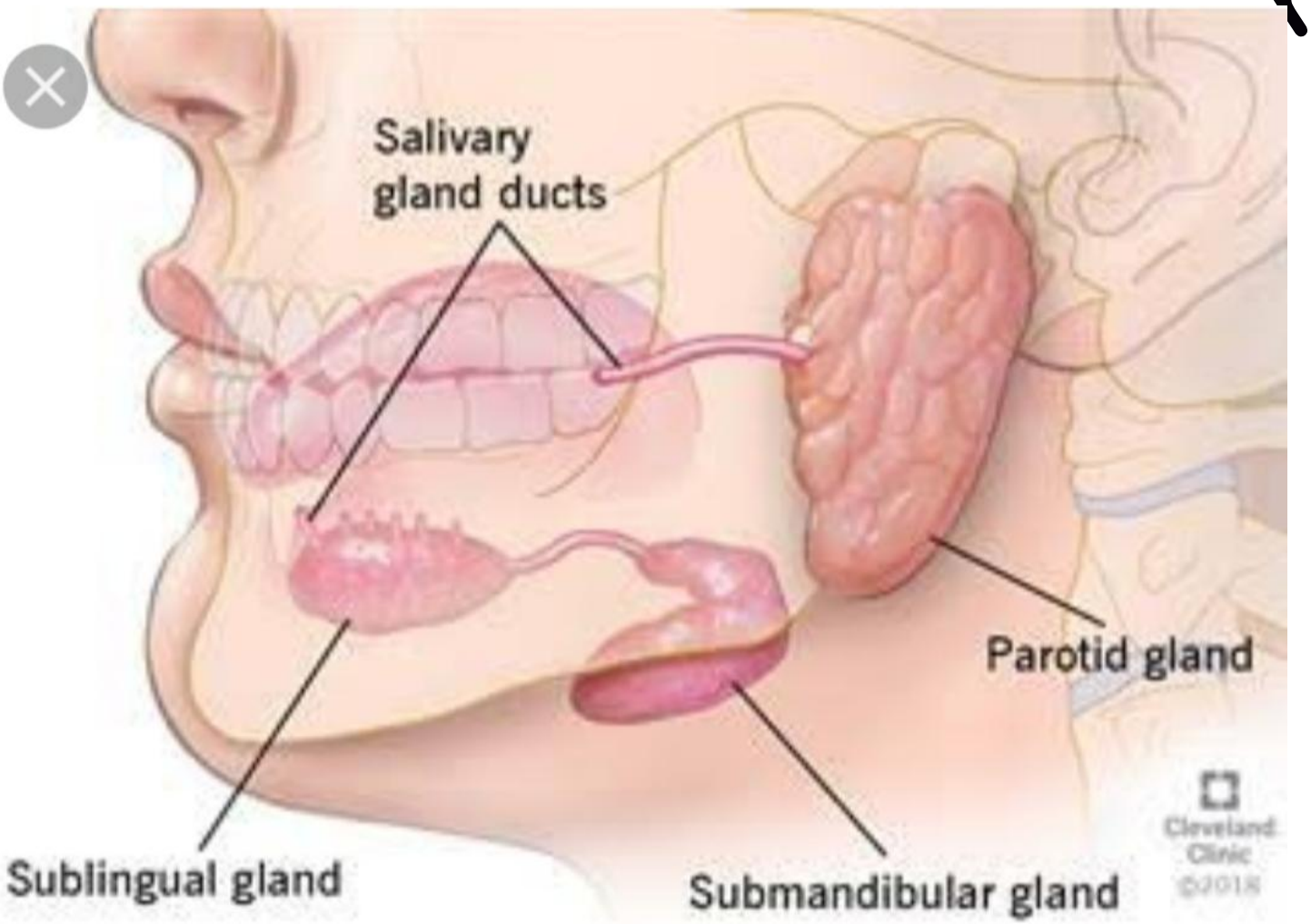
Salivary gland



Salivary gland

3 pairs Salivary gland

1. Parotid gland (in front of ear)
2. Sub-mandibular gland
   (below lower jaw/mandible)
3. Sublingual gland (below tongue)

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Salivary gland cells = 2 types

1.Serous cells-
salivary amylase/ptyalin
(digestive enzyme)

2.Mucous cells-
mucus

Function=Mucus lubricates food and helps in swallowing

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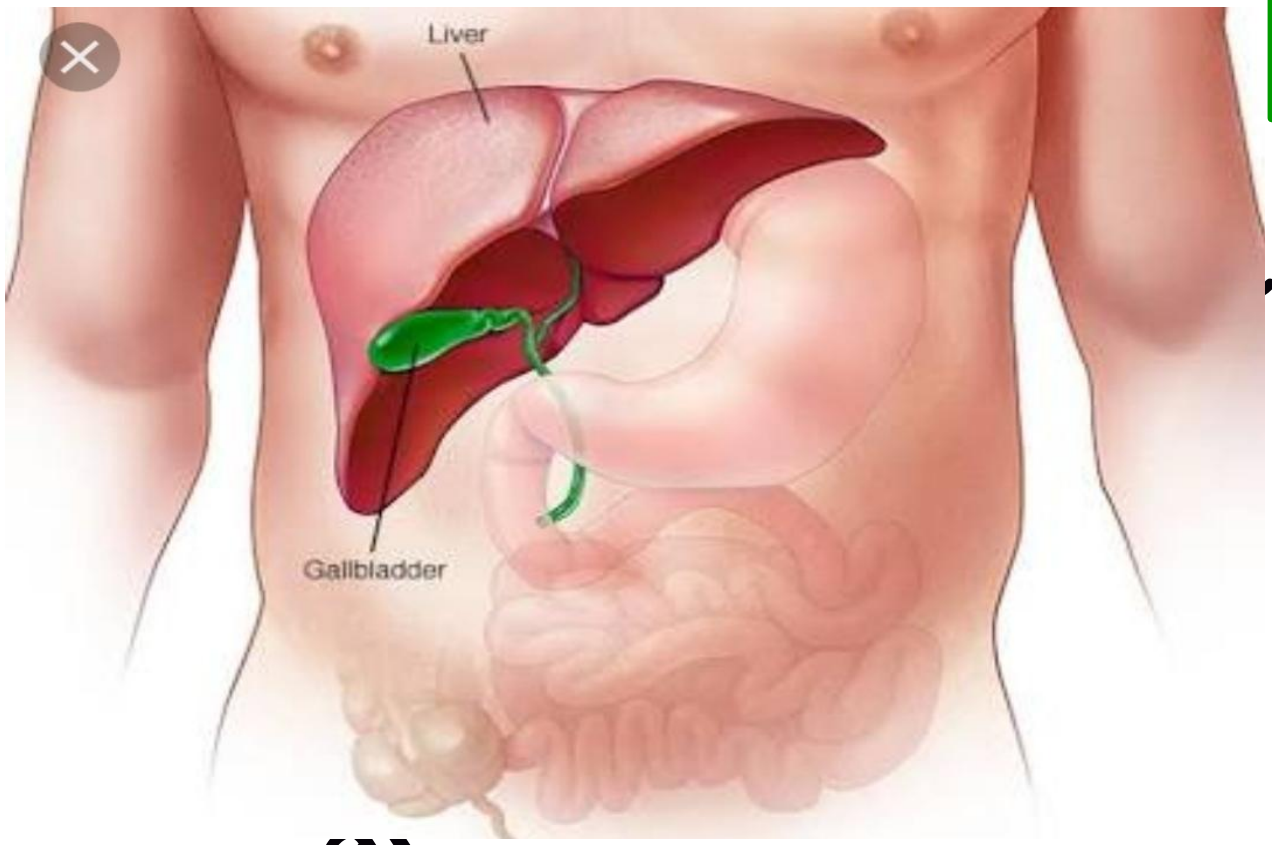

liver

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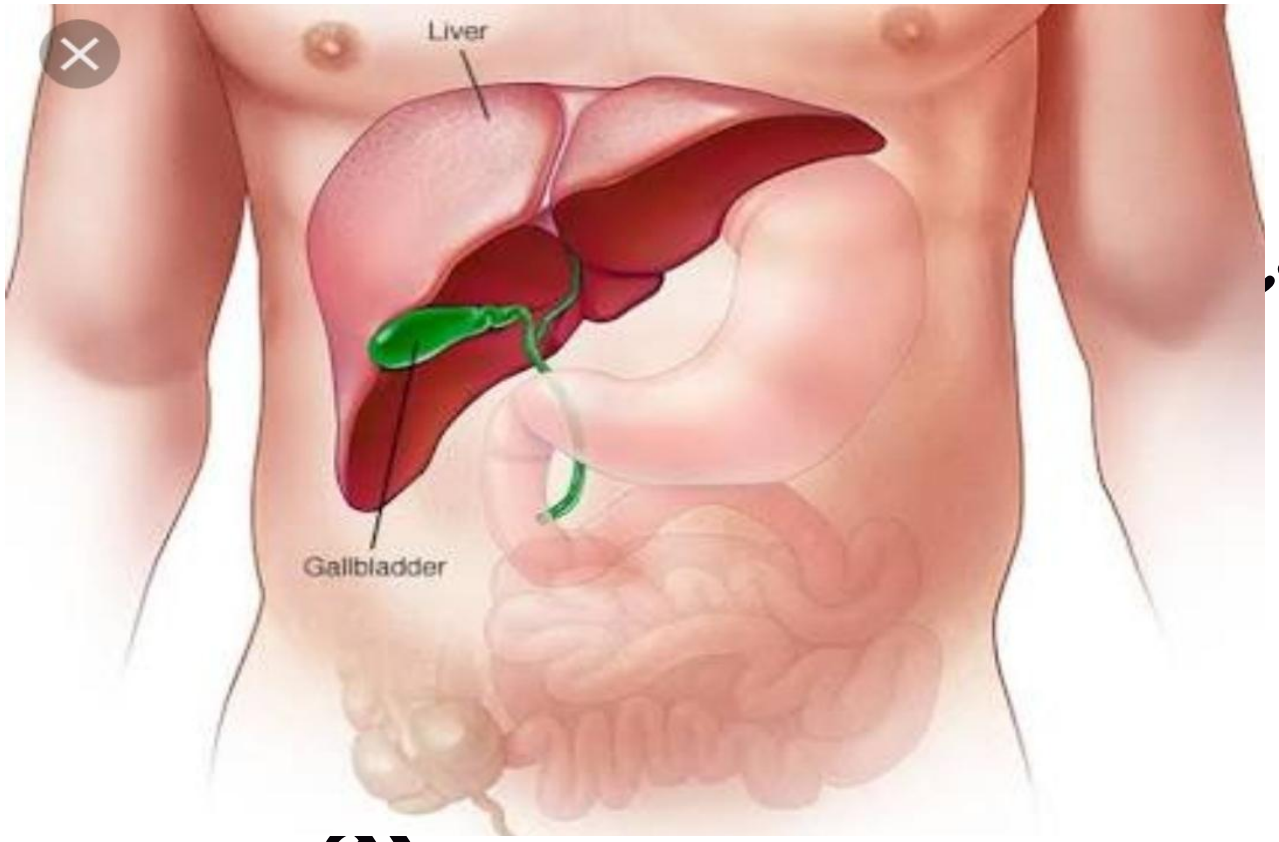
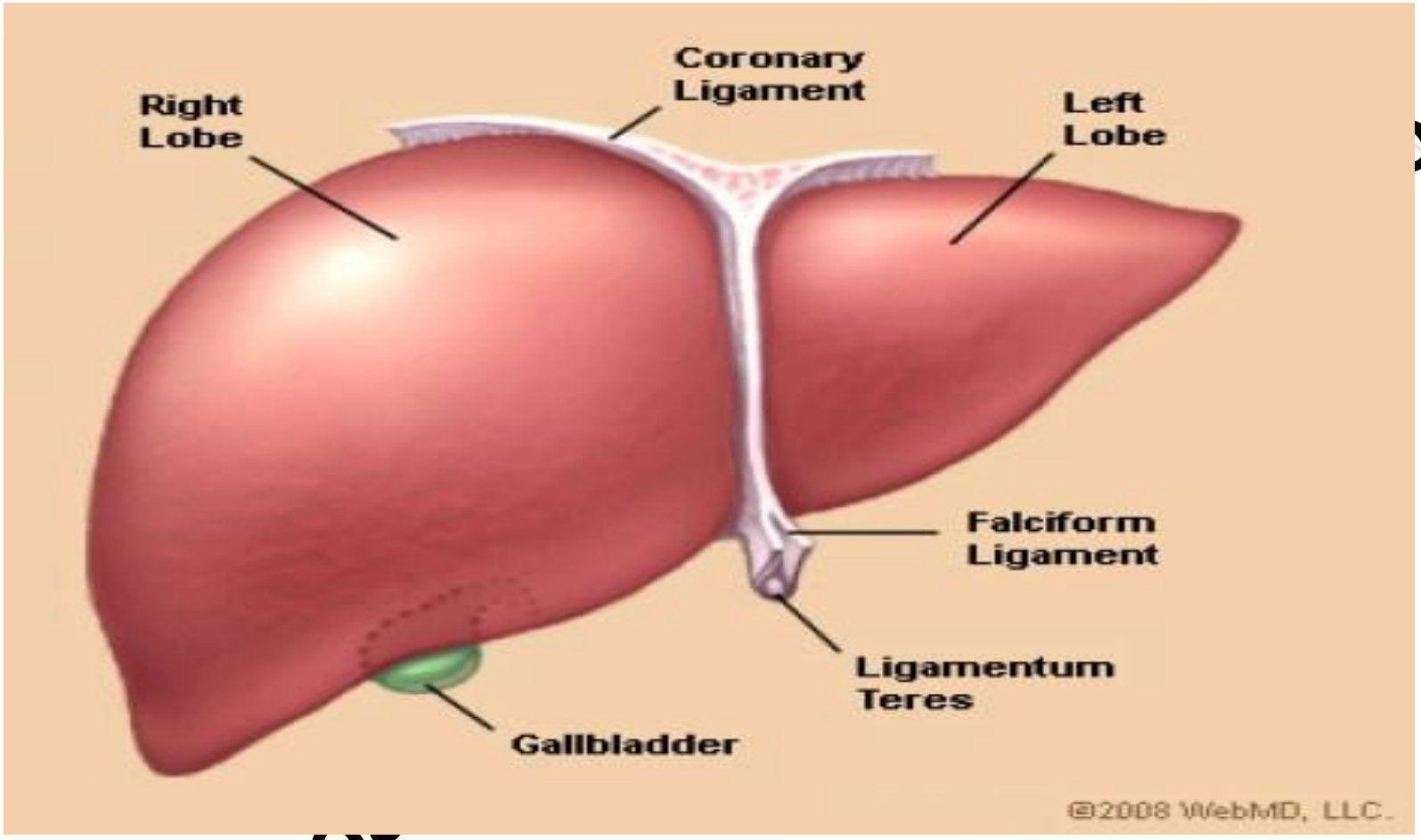


Largest gland

Dark Reddish brown

1.2 -1.5 kg

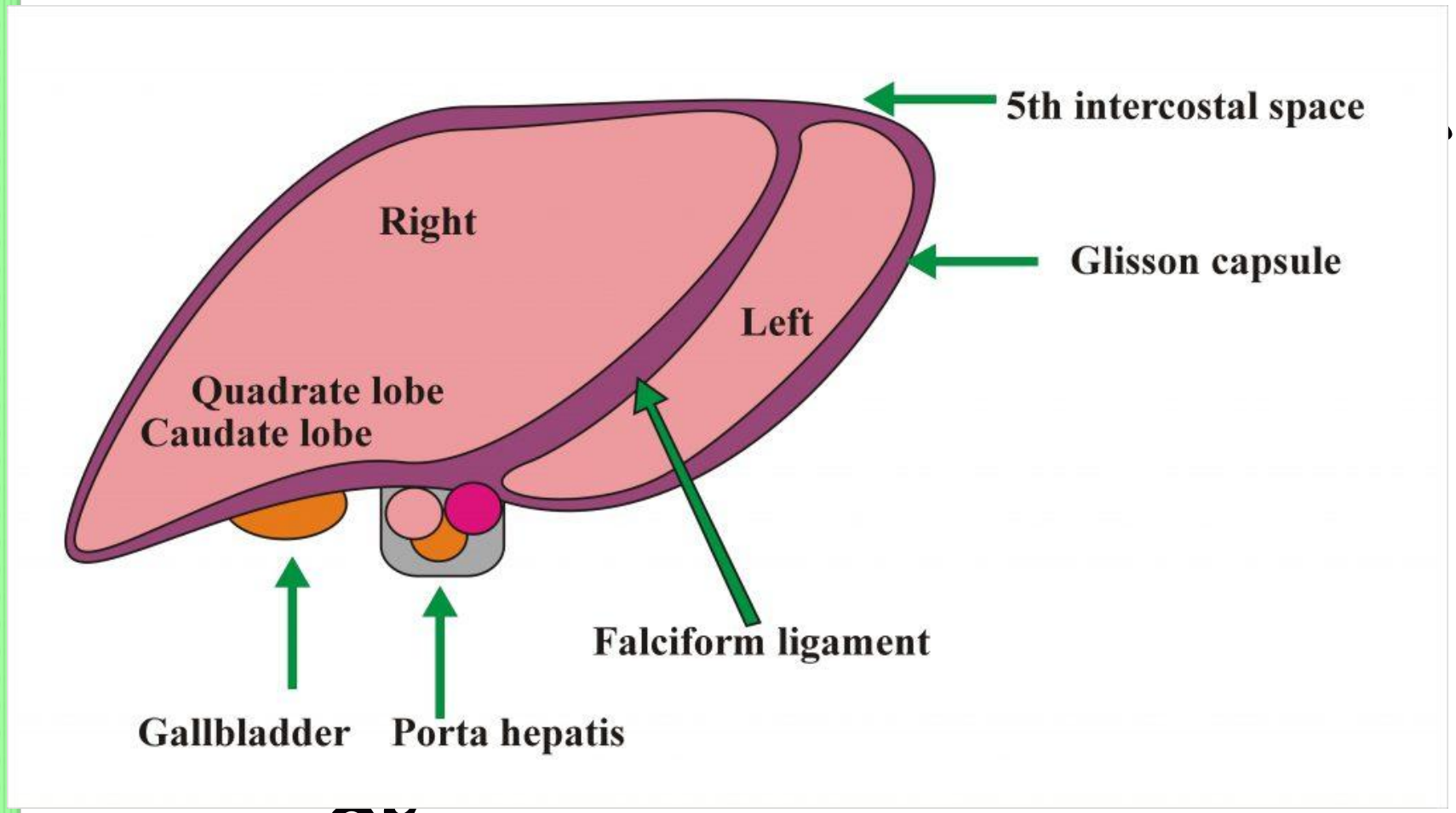
Location-right upper portion of abdominal cavity
Just below diaphragm



bilobed

Gall bladder store bile juice

Liver produces bile juice

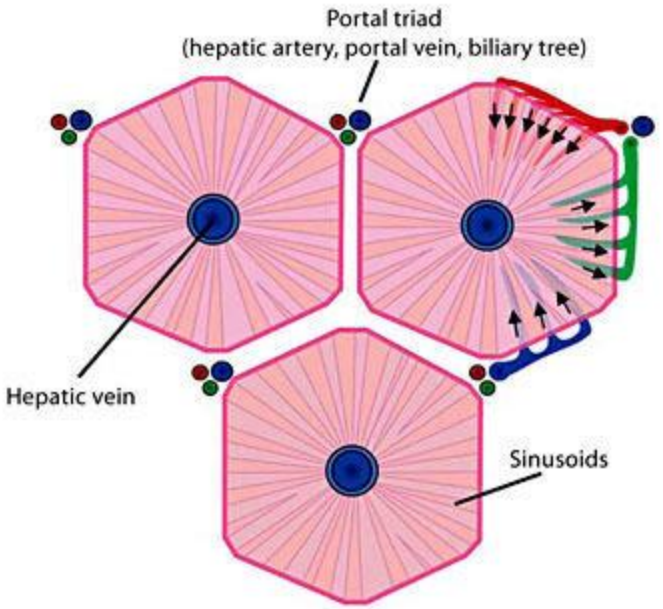


Liver is covered by thin covering of connective tissue called **Glisson's capsule**

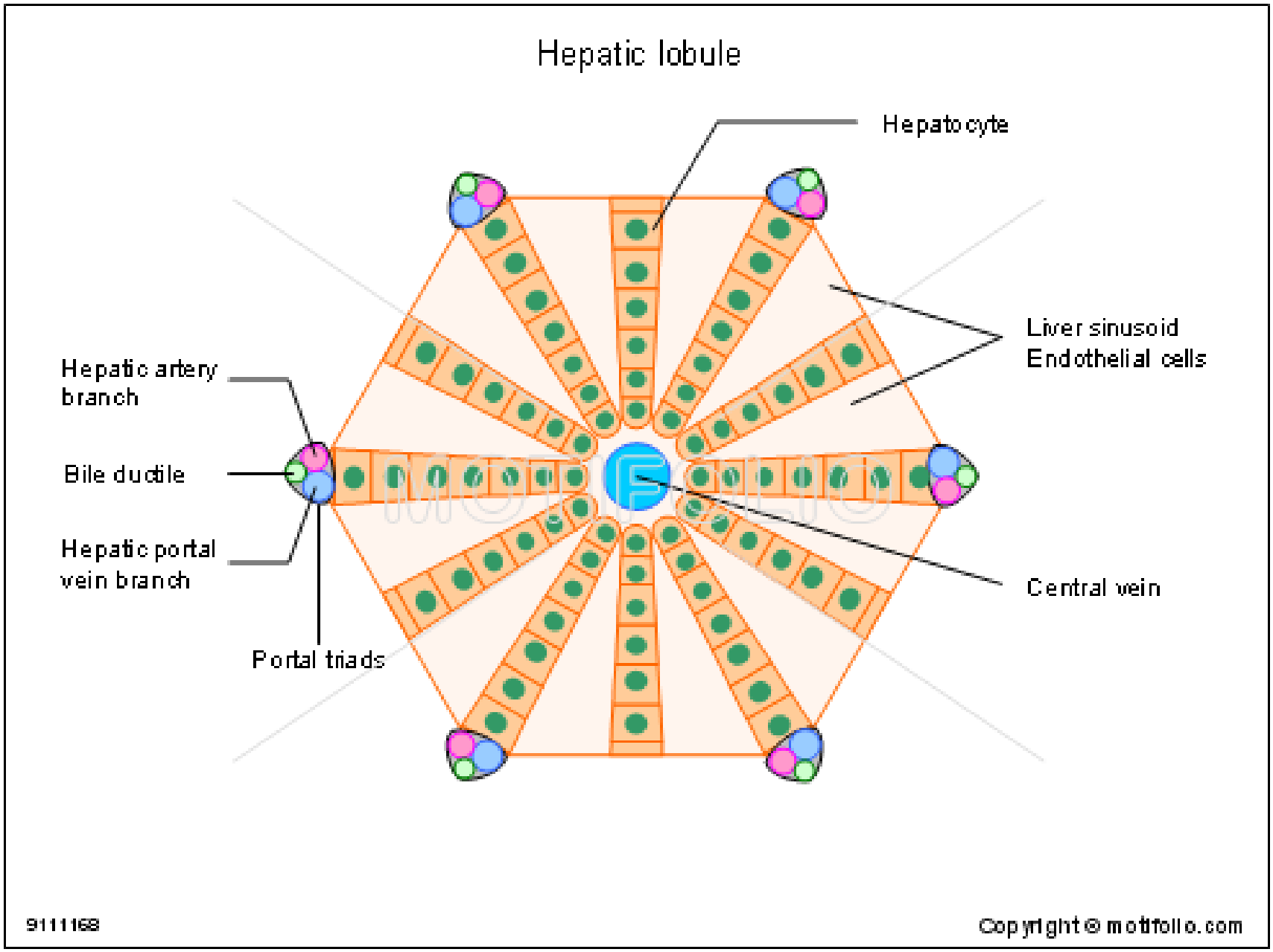
Liver -hepat

Liver – 2 lobe-
Each lobe is made up of several hepatic lobule

Hepatic lobule-
Structural and functional unit of liver
Polygonal in shape



Portal area –having branch of
1.Hepatic artery
2.Hepatic portal vein
3.Bile duct
It is located at junction of hepatic lobule


Hepatic lobule
Hepatocyte
Liver sinusoid
Endothelial cells
Hepatic artery
branch
Bile ductile
Hepatic portal
vein branch
Portal triads
Central vein
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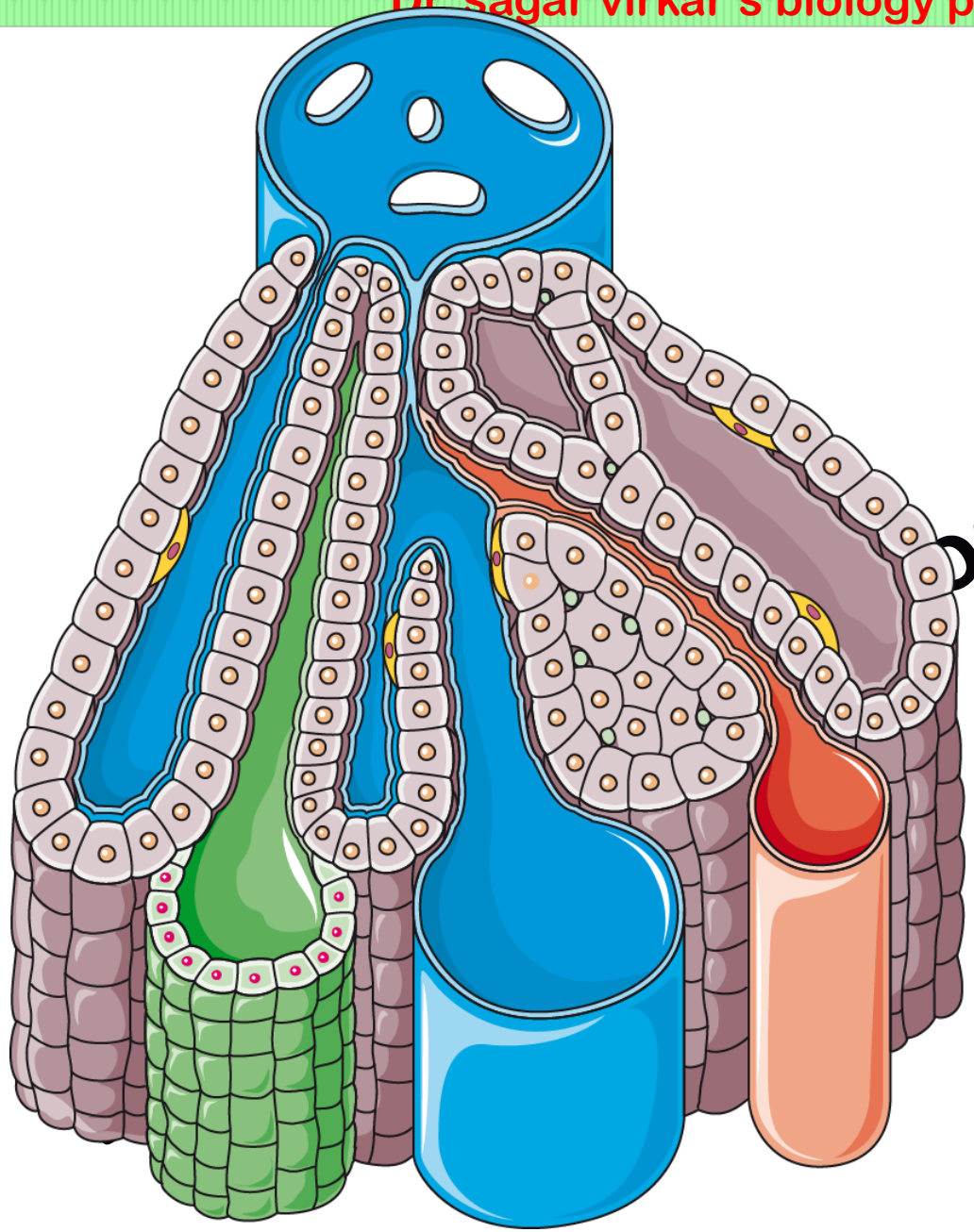

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pancreas

1.Leaf like
2.Heterocrine gland
Location- in the gap formed by bend of duodenum under stomach

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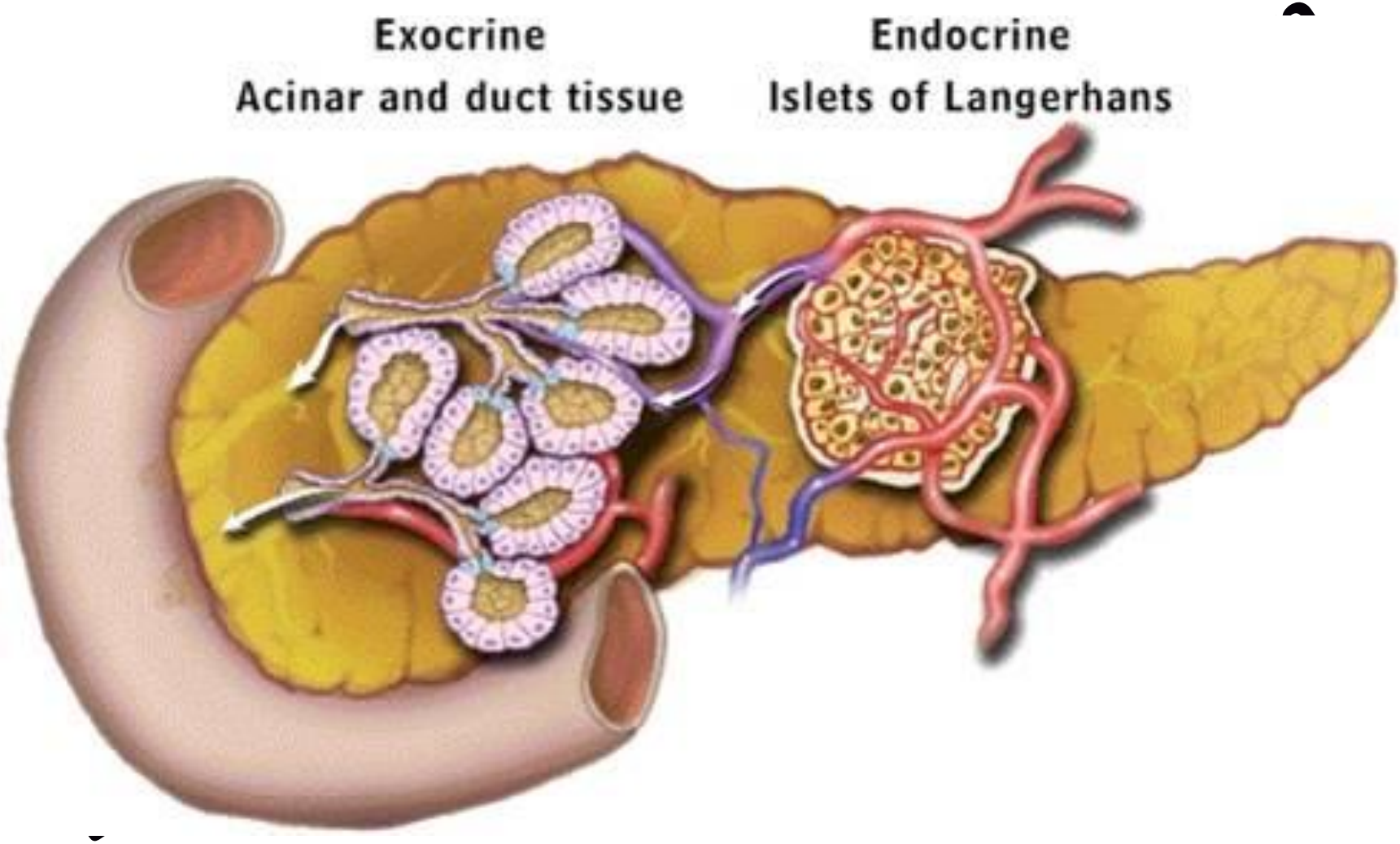
Exocrine
Acinar and duct tissue
Endocrine
Islets of Langerhans

Exocrine pancreas- acini-acinar cells
Alkaline pancreatic juice

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Endocrine –islet of langerhans

Type of cell	Secretion	Function
Alpha cell	Glucagon	Raises blood glucose levels
Beta cell	Insulin	Lowers blood glucose levels
Delta cell	Somatostatin	Inhibits growth hormone release from pituitary

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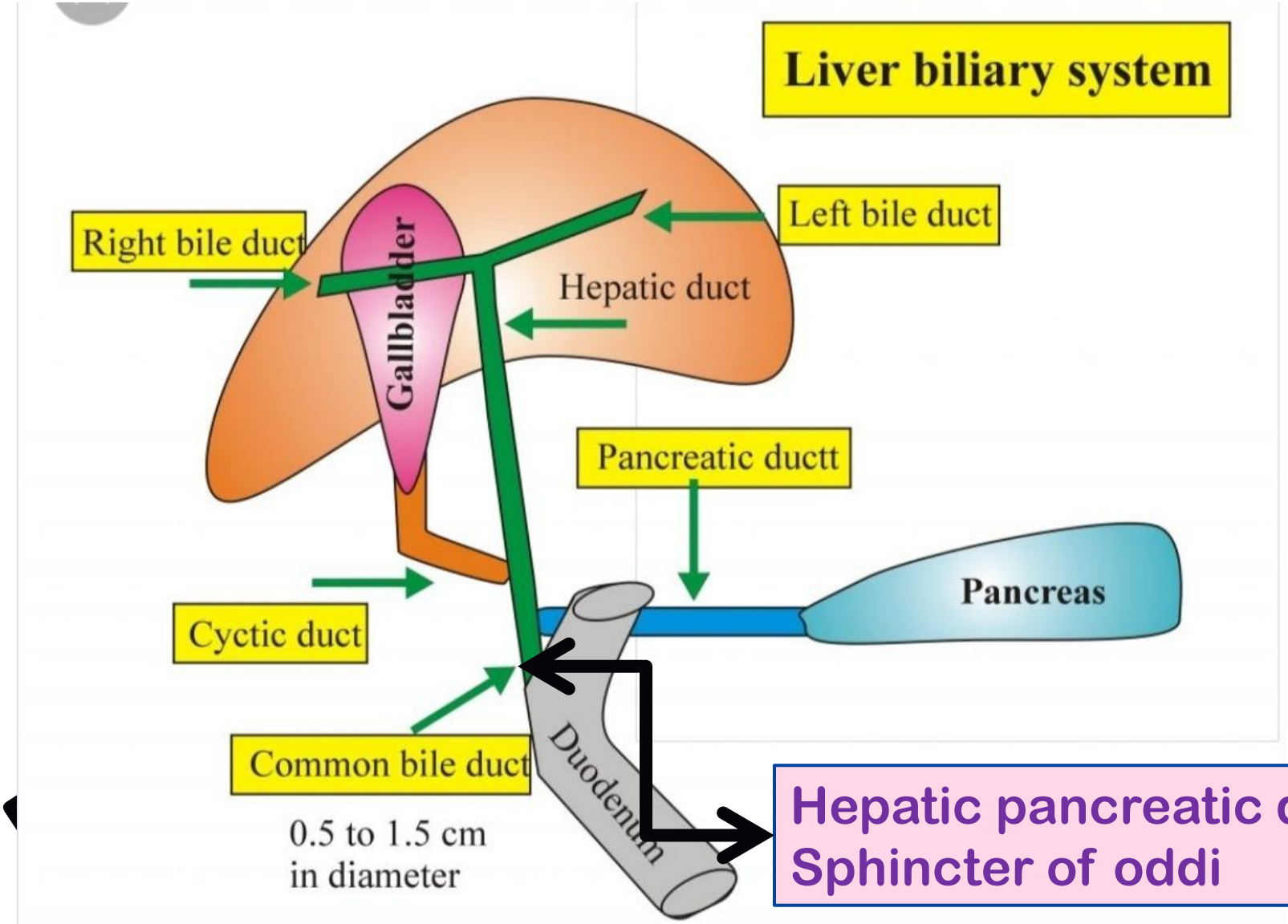
Liver biliary system
Right bile duct
Left bile duct
Gallbladder
Hepatic duct
Pancreatic ductt
Pancreas
Cyctic duct
Common bile duct
0.5 to 1.5 cm
in diameter
Duodenum
Hepatic pancreatic duct
Sphincter of oddi

Physiology of digestion

Various processes involved in simplification of food

- **DIGESTION=** conversion of
- complex ,non-diffusible ,non-absorbable food
- into simple,diffusible,absorbale food

- mechanical digestion
- chemical digestion

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Physiology of digestion

1. Mouth - Ingestion
2. Buccal cavity - m + c
3. Pharynx - m
4. Oesophagus-m
5. Stomach- m + c
6. Small intestine- m + c
7. Large intestine - Absorption
8. Anus - Egestion

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Physiology of digestion =MECHANICAL

1. Mouth - ingestion
2. Buccal cavity -mastication (bolus)
3. Pharynx – swallowing/deglutition
4. Oesophagus- peristalsis
5. Stomach- churning (chyme)
6. Small intestine- peristalsis (chyle)
7. Large intestine - absorption
8. Anus - egestion

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Physiology of digestion -CHEMICAL

1. Mouth - ingestion
2. Buccal cavity–YES – bolus (ball like)
3. Pharynx - ✘
4. Oesophagus- ✘
5. Stomach- YES –chyme (semi solid)
6. Small intestine- YES- chyle (liquid)
7. Large intestine - ✘ absorption
8. Anus - ✘ egestion)

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Chemical /enzyme involved in digestion

1. Salivary gland
2. Liver
3. Pancreas

4. Gastric gland
5. Intestinal gland

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Salivary gland -saliva

1. 98% water
2. 2% other constituents
   a) electrolyte- Na ,K , Ca ,Cl, HCO_3
   b) Salivary amylase
   c) Lysozyme (anti bacterial)

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Liver -gland – bile (dark green)

1. NO ENZYME
2. Phospholipids
3. Cholesterol
4. Bile salt
   a) Na –glycocholate
   b) Na taurocholate
5. Bile pigment
   a) Bilirubin (yellow)
   b) Biliverdin (green)

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Pancreas gland – pancreatic juice

1. Pancreatic amylase
2. Pancreatic lipase
3. Inactive enzyme- a) trypsinogen
   b) chymotrypsinogen
   c) procarboxypeptidase
4. Nucleases ,nucleotidases,nucleosidases

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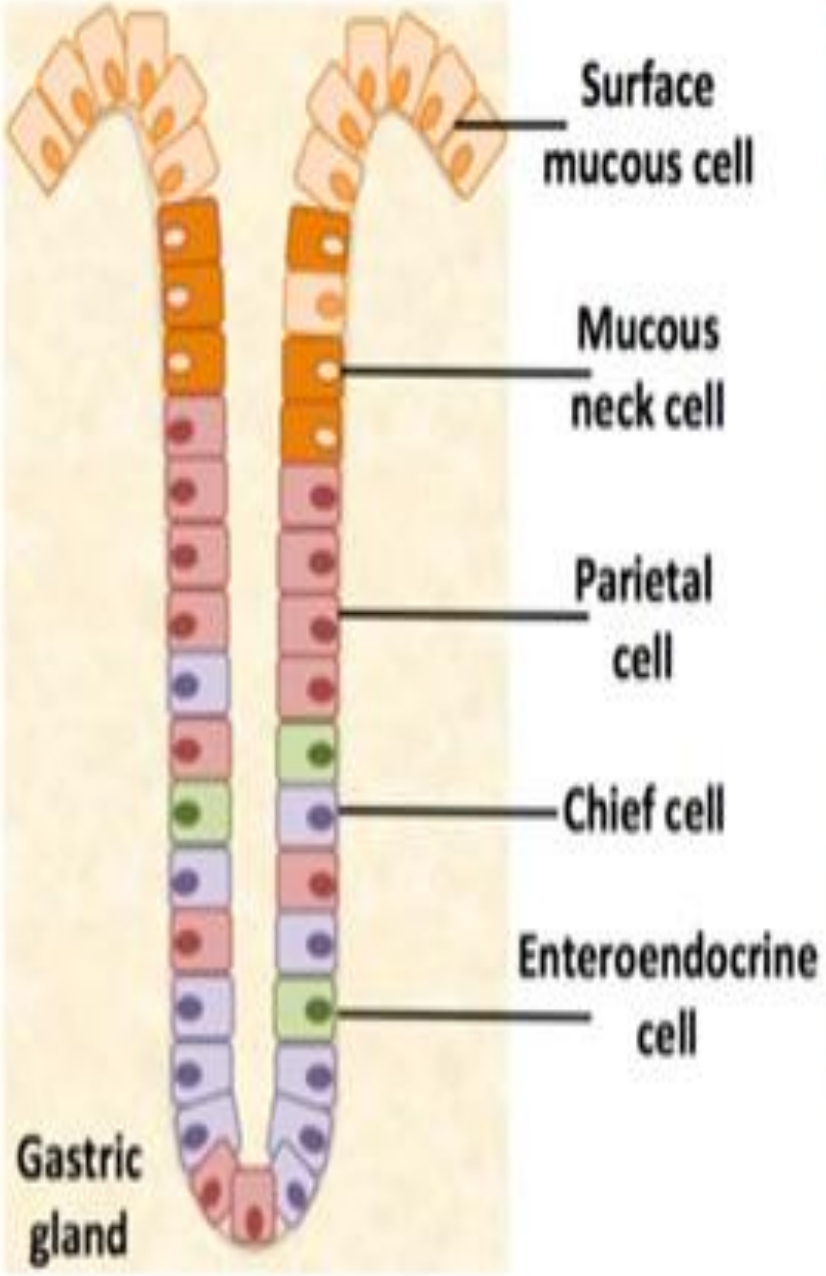

Cells of the gastric glands	Secretory products
Surface mucous cells	Mucin in an alkaline fluid
Mucous neck cells	Mucin in an acidic fluid
Parietal cells	HCl & intrinsic factor
Chief cells	Pepsinogen & lipase
G cells/enteroendocrine cells	Gastrin

Stomach-gastric gland –gastric juice

1. Gastric lipase
2. rennin (in infant)
3. Mucus
4. Pepsinogen (inactive)
5. HCL
6. Intrinsic factor for absorption of b12

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Intestinal gland – intestinal juice / succus entericus

1. Intestinal lipase
2. disaccharidases- a) maltase
   b)sucrase
   c) lactase
3. Dipeptidases
4. Enterokinase

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Constituent of food

1. Carbohydrate
2. Proteins
3. Lipids
4. Nucleic acid

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Carbohydrate

1. polysaccharide- a) starch –plant
   b) glycogen -animal

2. Disaccharide-
   a) maltose – glucose + glucose
   b) sucrose- glucose + fructose
   c) lactose- glucose + galactose

3. Monosaccharide-
   a) glucose
   b) fructose
   c) galactose

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protein

1. polypeptide
2. Dipeptide
3. amino acid

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lipids

1. fatty acid + glycerol

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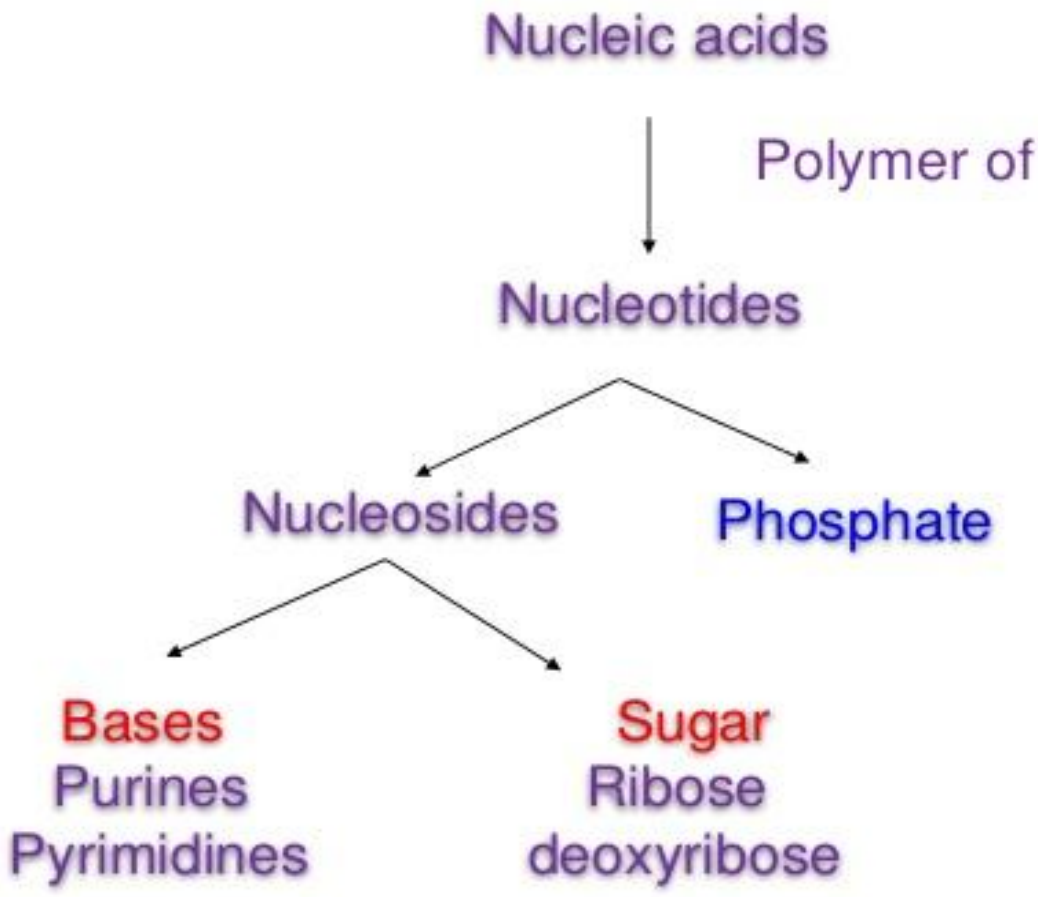
Composition of Nucleic acid



Digestion in the buccal cavity

mechanical and chemical digestion

Mastication or chewing of food takes place with the help of teeth and tongue. Teeth crush and grind the food. Tongue manipulates the food. Crushing of food becomes easier when it gets moistened by saliva. Mucus in the saliva lubricates the food as well as it helps in binding the food particles into a mass of food called bolus. The bolus is swallowed by deglutition. The tongue presses against the palate and pushes the bolus into pharynx. Bolus further passes to the oesophagus.

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About 30% starch gets converted to maltose in mouth.



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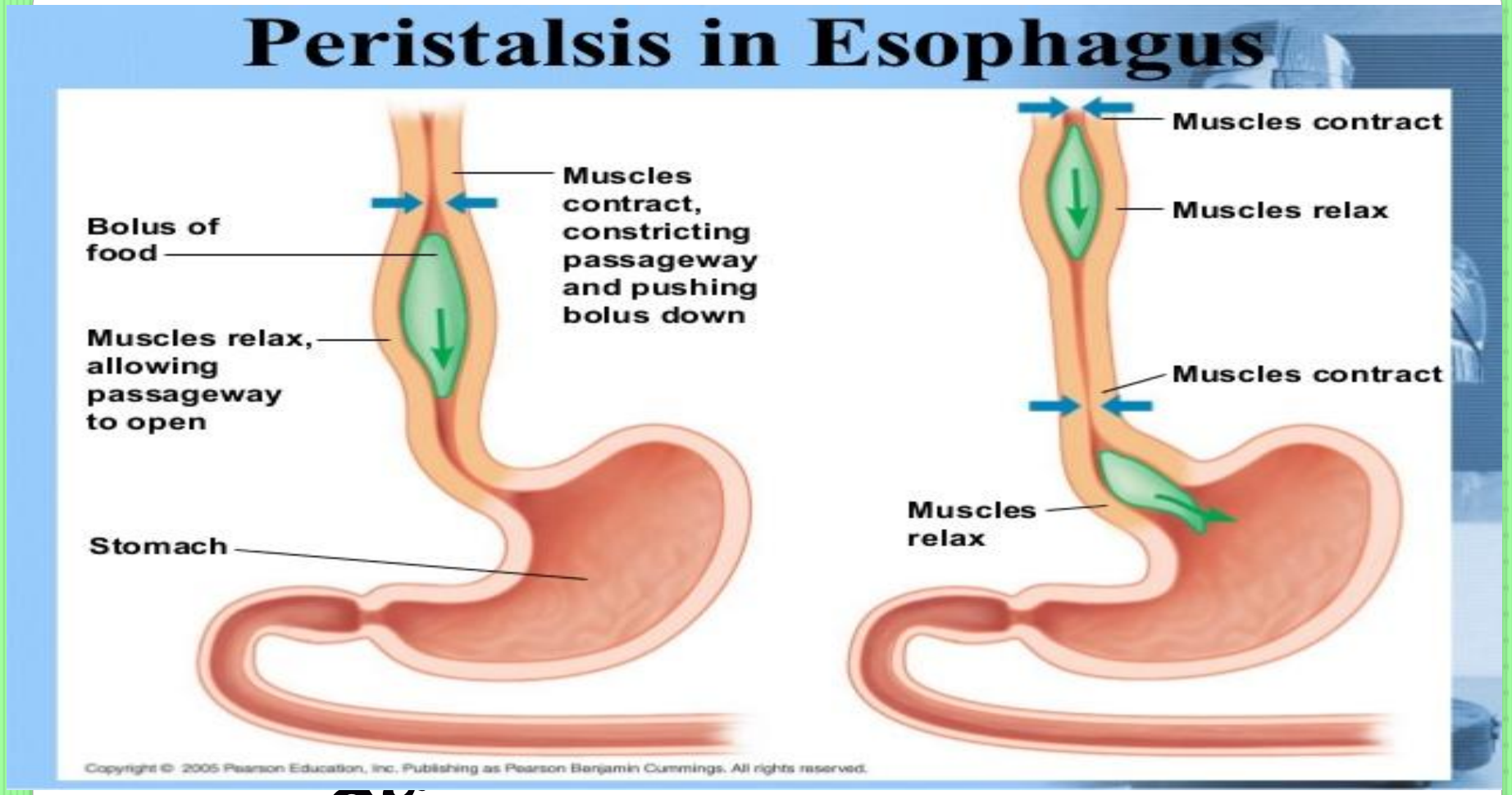

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The bolus further passes down through the oesophagus by peristalsis.

Digestion in the stomach :

mechanical and chemical digestion

. The stomach stores the food for 4-5 hours.
The physical digestion happens by churning of food. Thick muscular wall of stomach helps churning process. Churning further breaks down the food particles and also helps in thorough mixing of gastric juice with food.

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gastric juice contains
mucus,
inactive enzyme pepsinogen,
HCl and
intrinsic factor.
In infants, stomach also secretes rennin.

Function

1.Mucus protects the inner lining of stomach from HCl present in gastric juice.

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2.HCl in gastric juice makes the food acidic

3.stops the action of salivary amylase.

4.It kills the germs that might be present in the food.

5.Pepsinogen gets converted into active enzyme pepsin in the acidic medium provided by HCl.

6.In presence of pepsin, proteins in the food get converted into simpler forms like peptones and proteoses.

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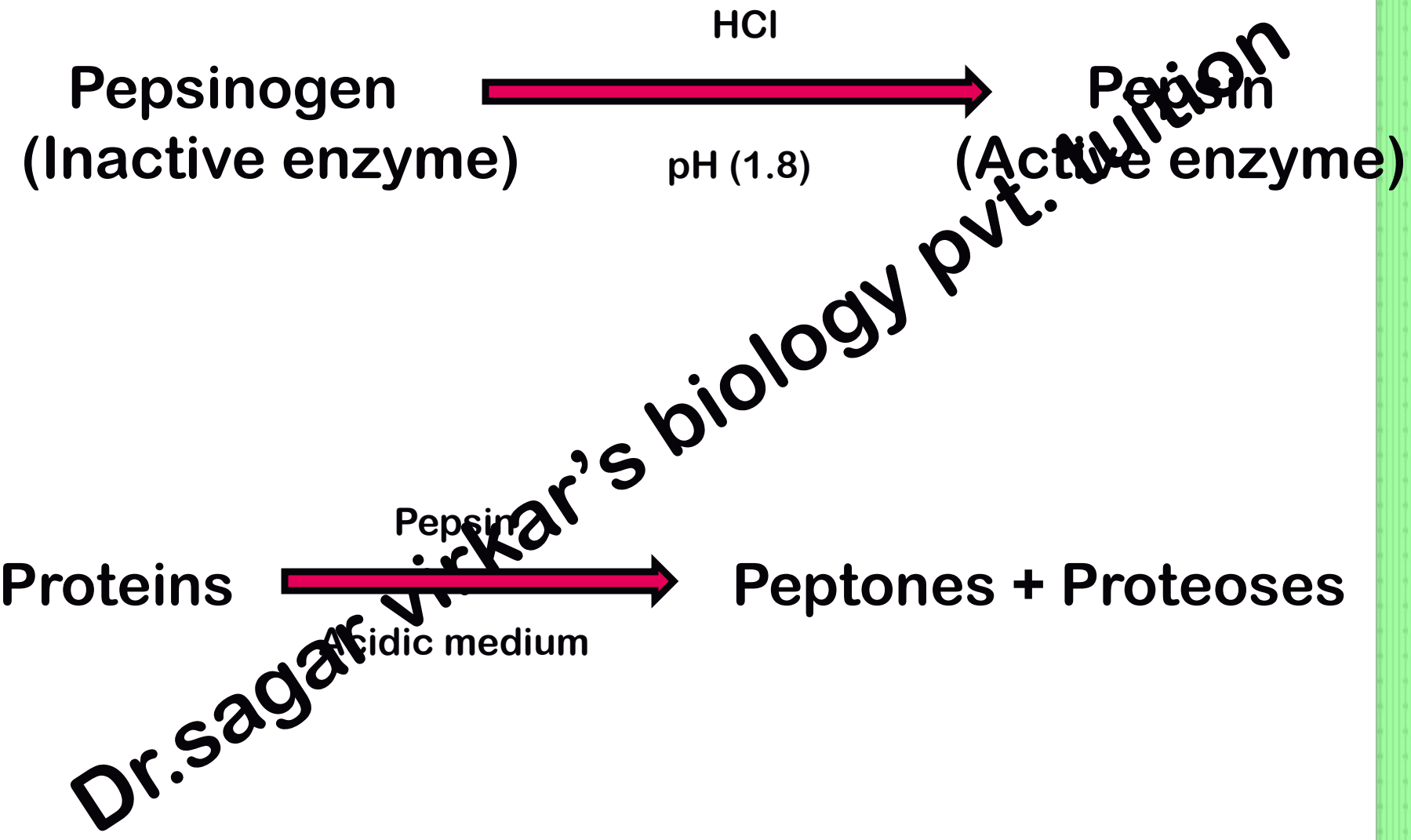

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At the end of gastric digestion, food is converted to a semifluid acidic mass of partially digested food is called **chyme.** The chyme from stomach is pushed in the small intestine through pyloric sphincter for further digestion.

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Rennin found in gastric juice of infants acts on casein, a protein present in milk. It brings about curdling of milk protein with the help of calcium. The coagulated milk protein is further digested with the help of pepsin. Rennin is absent in adults.

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Digestion in the small intestine :

In the small intestine,
bile juice and
pancreatic juice
intestinal juice,
are mixed with food.

Peristaltic movements of muscularis layer help in proper mixing of digestive juices with chyme. Bile juice and pancreatic juice are poured in duodenum through hepato-pancreatic duct.

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Function of bile

Bile does not contain any digestive enzyme

1. Bile salts neutralise the acidity of chyme and make it alkaline.
2. It brings about emulsification of fats.
3. It also activates lipid digesting enzymes or lipases.
4. Bile pigments impart colour to faecal matter..

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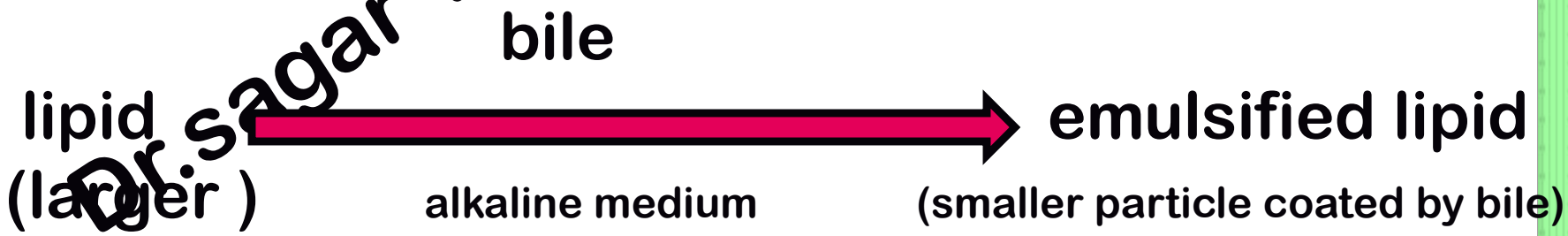

Function of Pancreatic juice

Mucus plus intestinal enzymes together constitute **intestinal juice or succus entericus**.

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Action of pancreatic juice :

1.Pancreatic amylase acts on glycogen and starch (70%) and convert those to disaccharides.



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Action of pancreatic juice :

2. Lipases hydrolyse fat molecules into fatty acids and monoglycerides.



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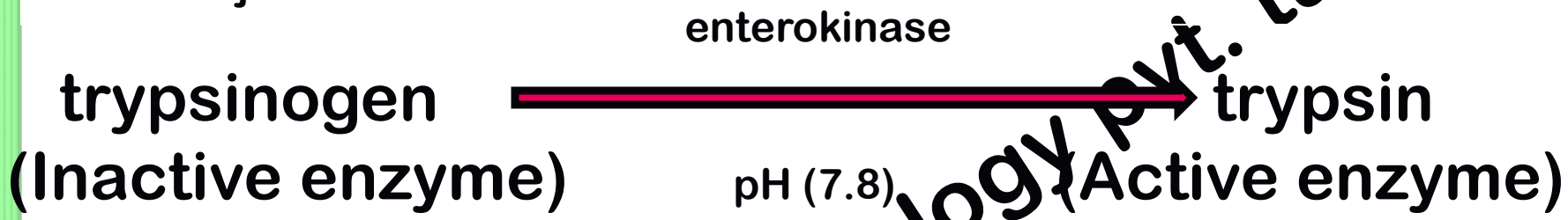
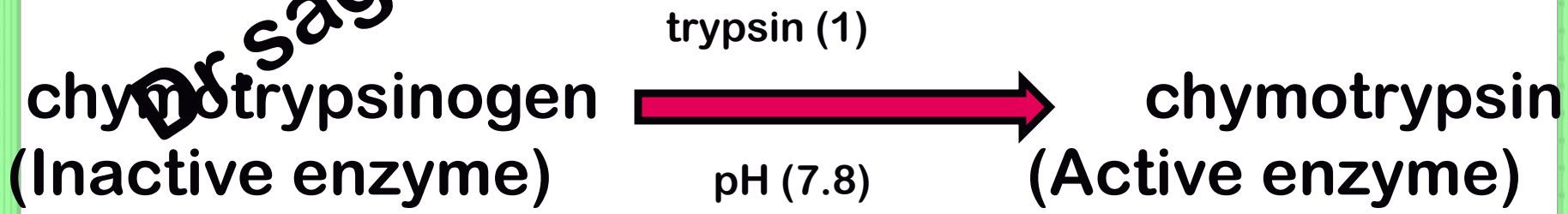
Action of pancreatic juice

3.Inactive trypsinogen present in pancreatic juice is converted to its active form, trypsin. This conversion is brought about by enterokinase present in intestinal juice.



4.Trypsin converts chymotrypsinogen to active chymotrypsin.



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5. Trypsin converts proteins as well as proteoses and peptones to polypeptides.

protein,peptones,proteoses Polysaccharide) —trypsin (2), pH 7.8 /alkaline medium→ polypeptide

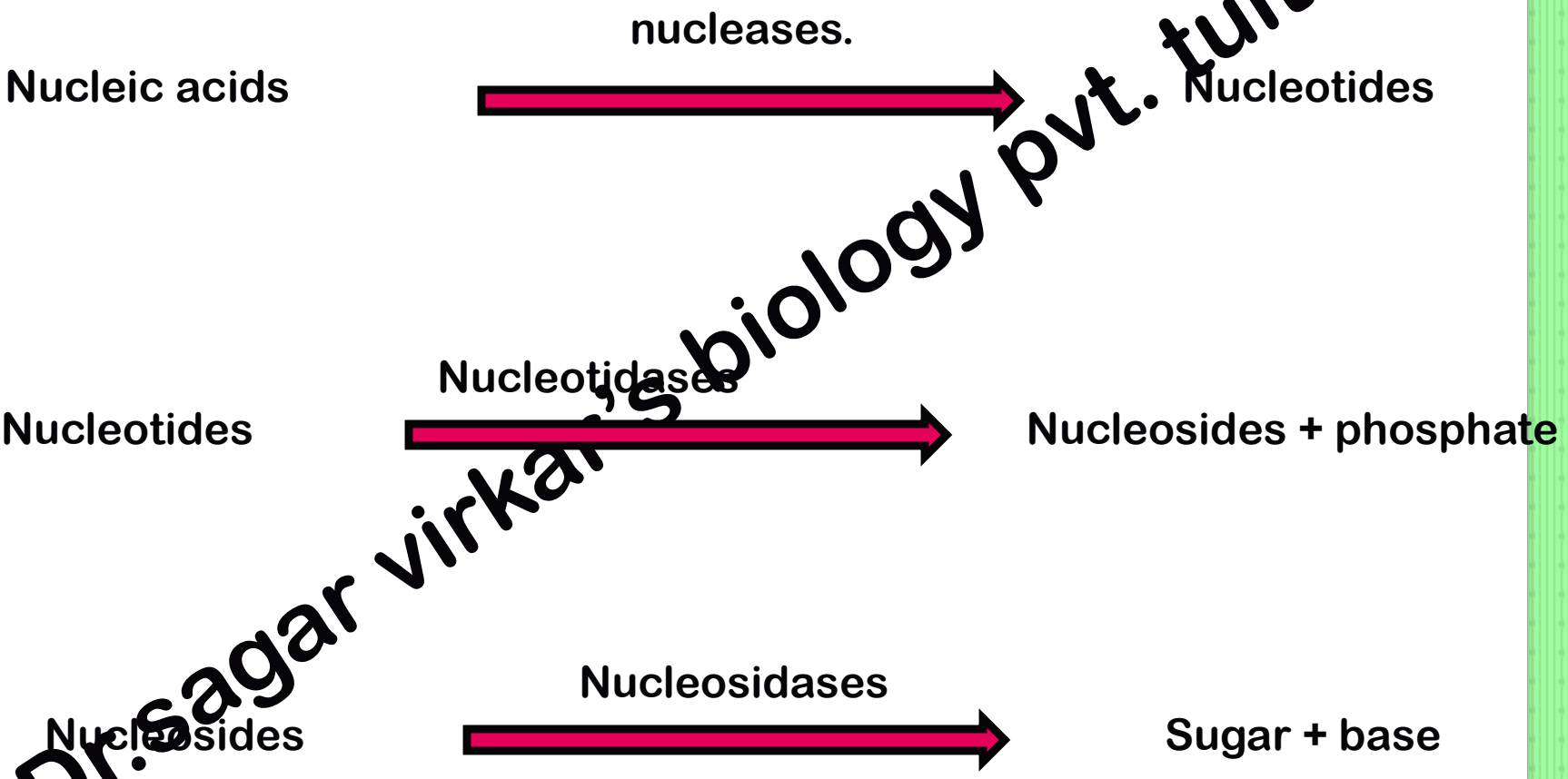
6.Chymotrypsin converts polypeptides to dipeptides.

polypeptide —chymotrypsin, pH (7.8)→ dipeptide

7..Dipeptidase converts dipeptides. Into amino acid

dipeptide —dipeptidase, pH (7.8)→ amino acid

Nucleases present in pancreatic juice help in digestion of nucleic acids to pentose sugar and nitrogenous base.



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Action of intestinal juice

1.dipeptidases

Maltose —(Maltase)→ glucose +glucose

Sucrose —(Sucrase)→ glucose + fructose

Lactose —(Lactase)→ glucose + galactose

2.intestinal lipase

emulsified lipid —(intestinal lipase; pH 7.8 /alkaline medium)→ fatty acid + glycerol (monoglyceride)

(Polysaccharide)

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Both pancreatic and intestinal lipases initially convert fats into fatty acid and diglycerides. Diglycerides are further converted to monoglycerides by removal of fatty acid from glycerol. The mucus and bicarbonates present in pancreatic juice protect the intestinal mucosa and provide alkaline medium for enzymatic action. Sub-mucosal Brunner's glands help in the action of goblet cells. Most of the digestion gets over in small intestine.

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Conversion of proteins into amino acids, fats to fatty acids and monoglycerides, nucleic acids to sugar and nitrogenous base and carbohydrates to monosaccharides marks the end of digestion of food. Food is now called **chyle**. Chyle is an alkaline slurry which contains various nutrients ready for absorption. The nutrients are absorbed and undigested remains are transported to large intestine. Remember, mucosa of large intestine

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Digestion of Carbohydrate

1. buccal cavity - yes

Starch (30%) (Polysaccharide) —Salivary amylase, pH 6.8→ Maltose (Disaccharide)

2. Stomach - no

3. Small intestine- yes

Starch (70%) (Polysaccharide) —pancreatic amylase, pH 7.8 /alkaline medium→ Maltose (Disaccharide)

dipeptidases

Maltose —Maltase→ glucose +glucose

Sucrose —Sucrase→ glucose + fructose

Lactose —Lactase→ glucose + galactose

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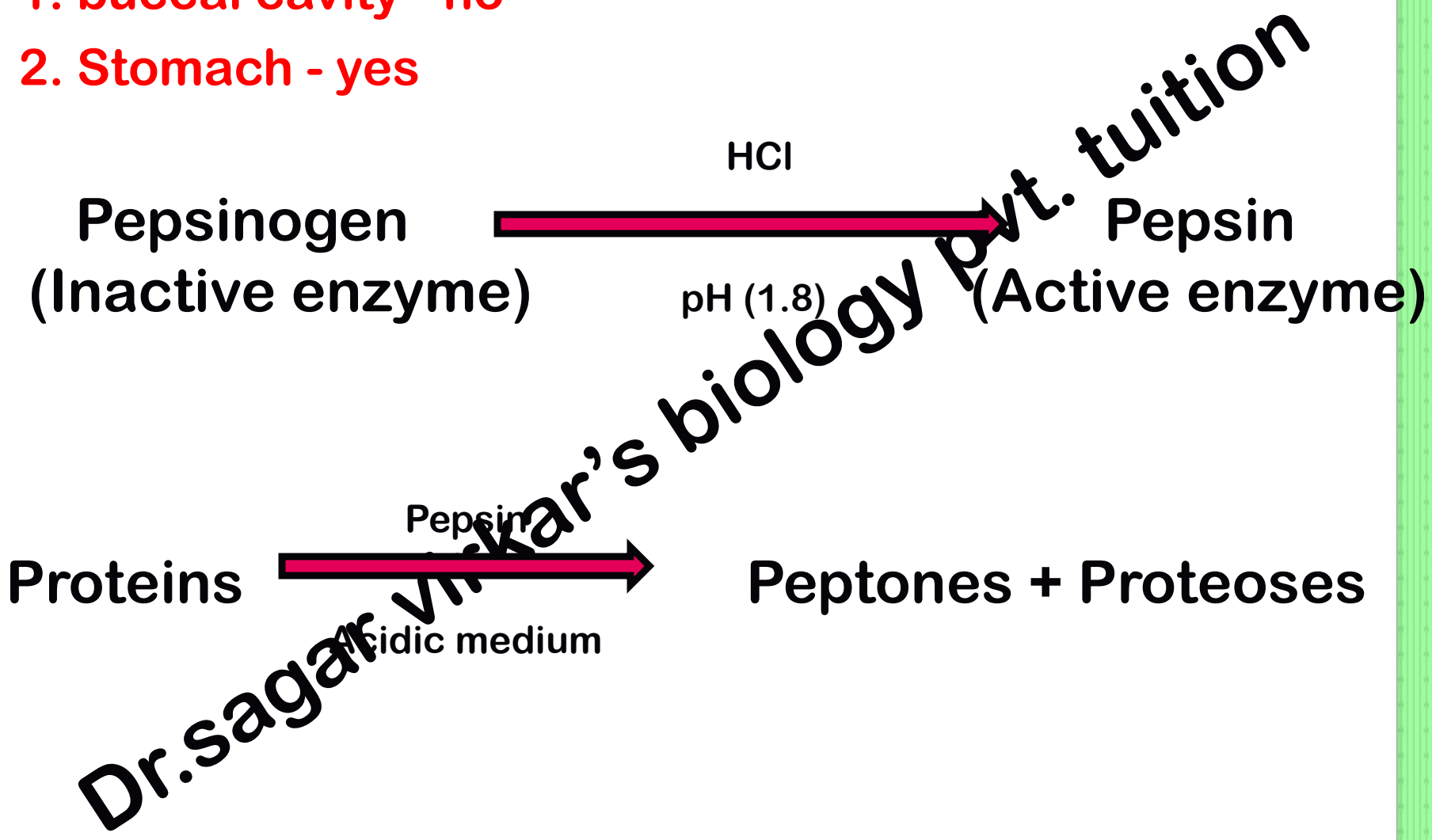
Digestion of protein

1. buccal cavity - no
2. Stomach - yes



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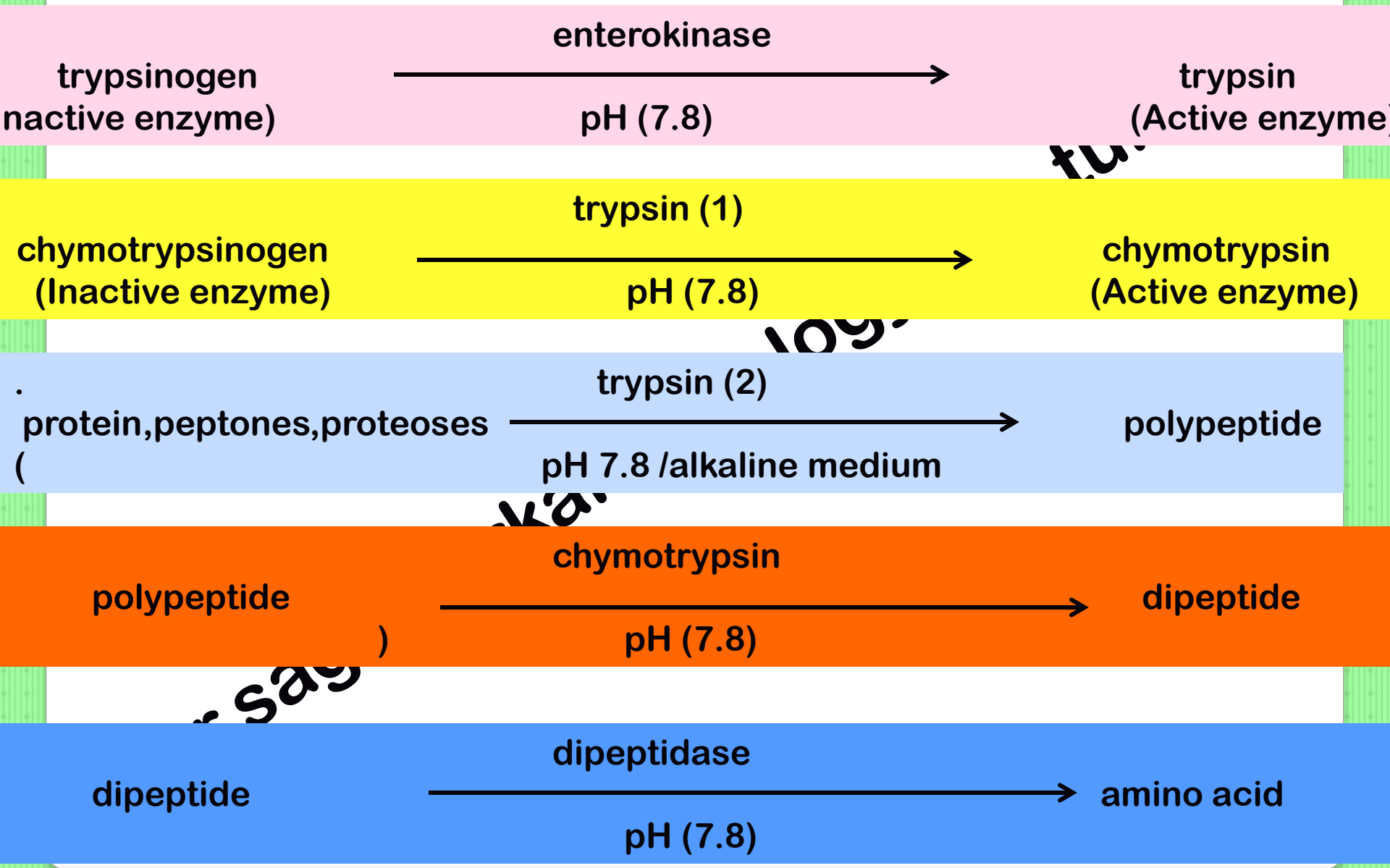
3. Small intestine- yes



Digestion of lipids

1. buccal cavity - no
2. stomach - no
3. Small intestine - yes

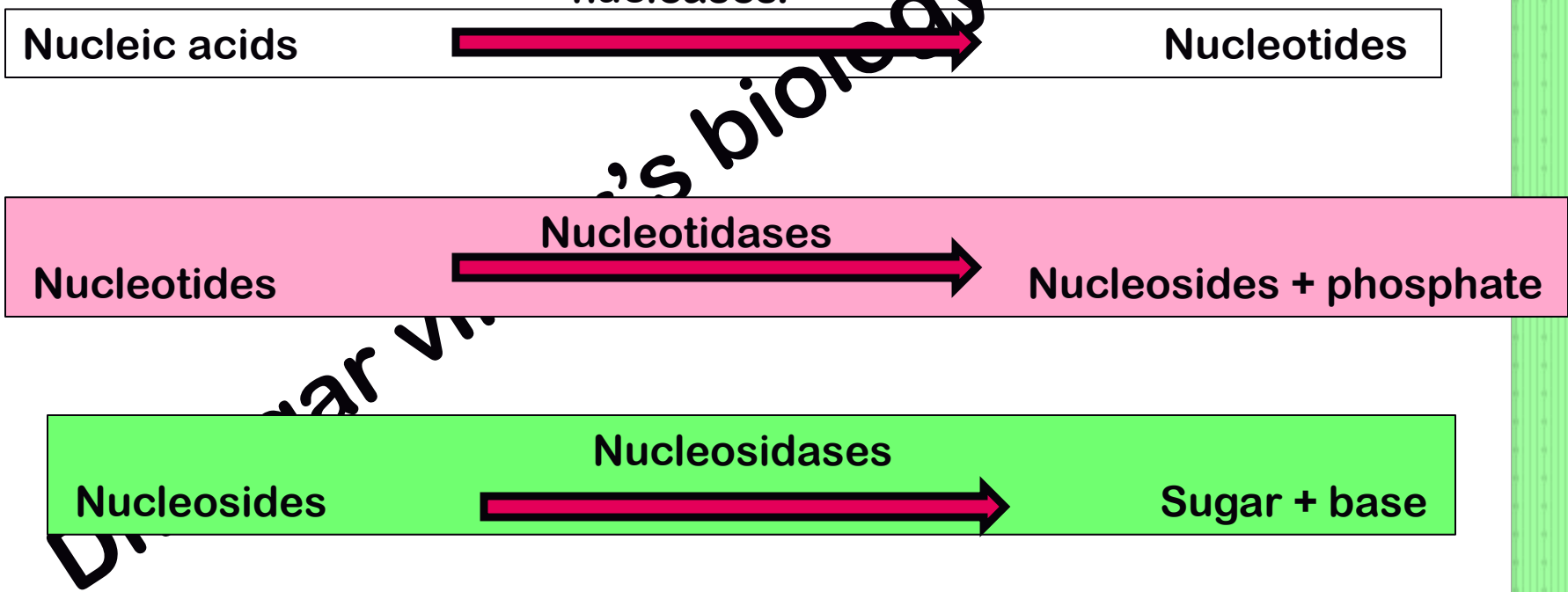
lipid (larger) —bile, alkaline medium→ emulsified lipid (smaller particle coated by bile)

emulsified lipid —pancreatic lipase, pH 7.8 /alkaline medium→ fatty acid + glycerol (monoglyceride)

emulsified lipid (Polysaccharide) —intestinal lipase, pH 7.8 /alkaline medium→ fatty acid + glycerol (monoglyceride)

Digestion of Nucleic acid

1. buccal cavity - no
2. stomach - no
3. Small intestine - yes



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