
بسم الله الرحمن الرحيم

GIT Module

LGIS PHYSIOLOGY)

2nd Year MBBS (2025)

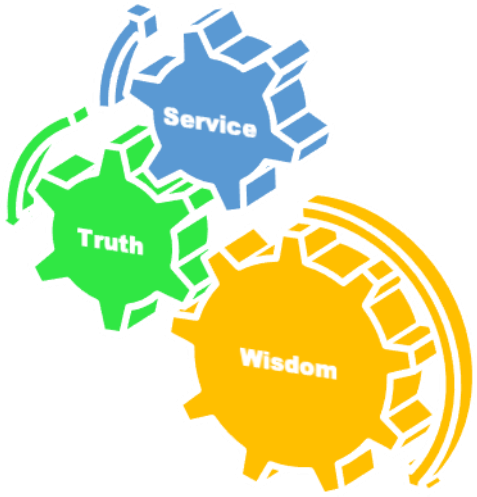
Pancreas & its role in digestion

Dr. Ali Zain
PGT physiology

Date: 00-00-0000

Table of contents

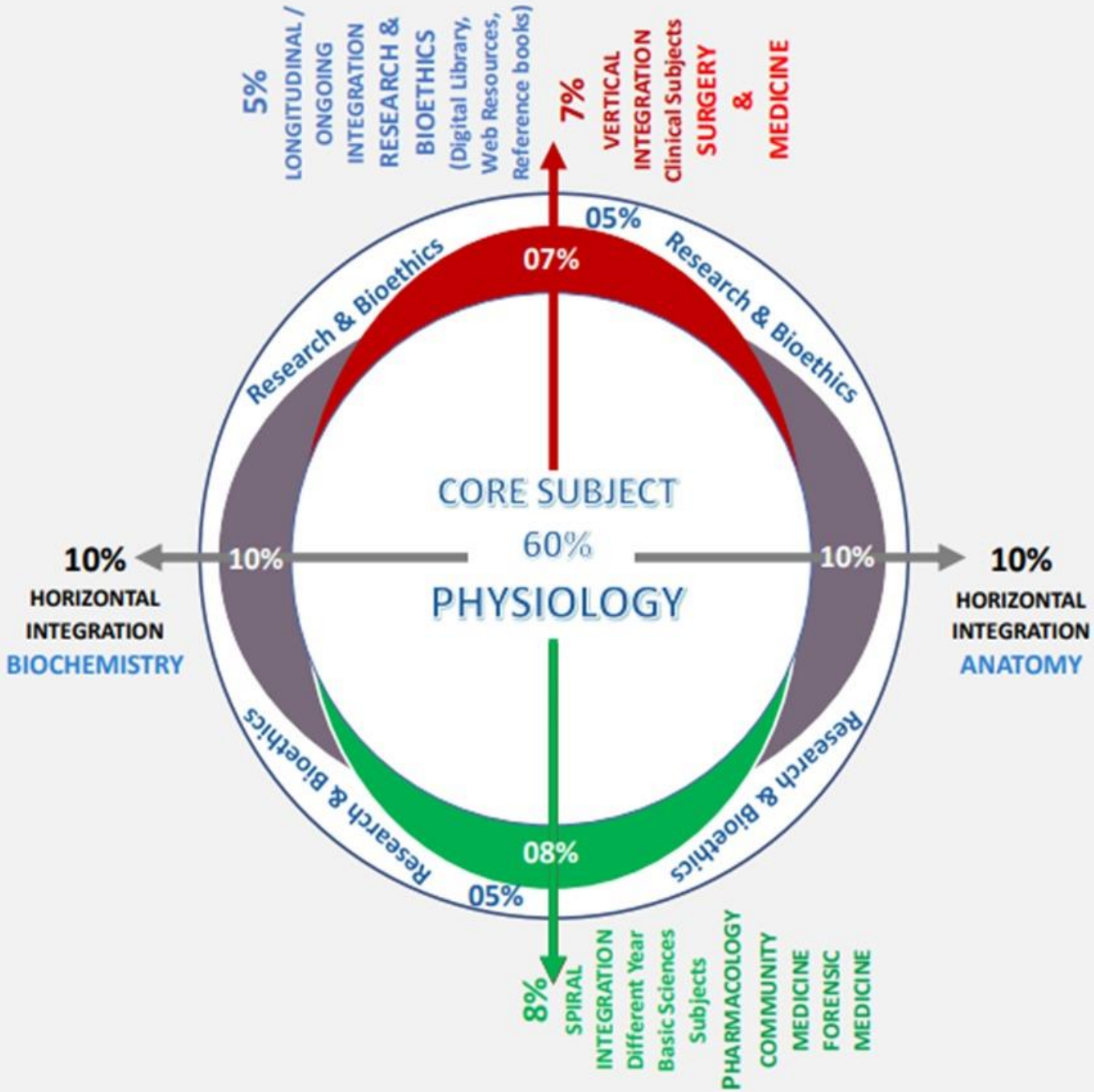
Motto



Vision; The Dream/Tomorrow

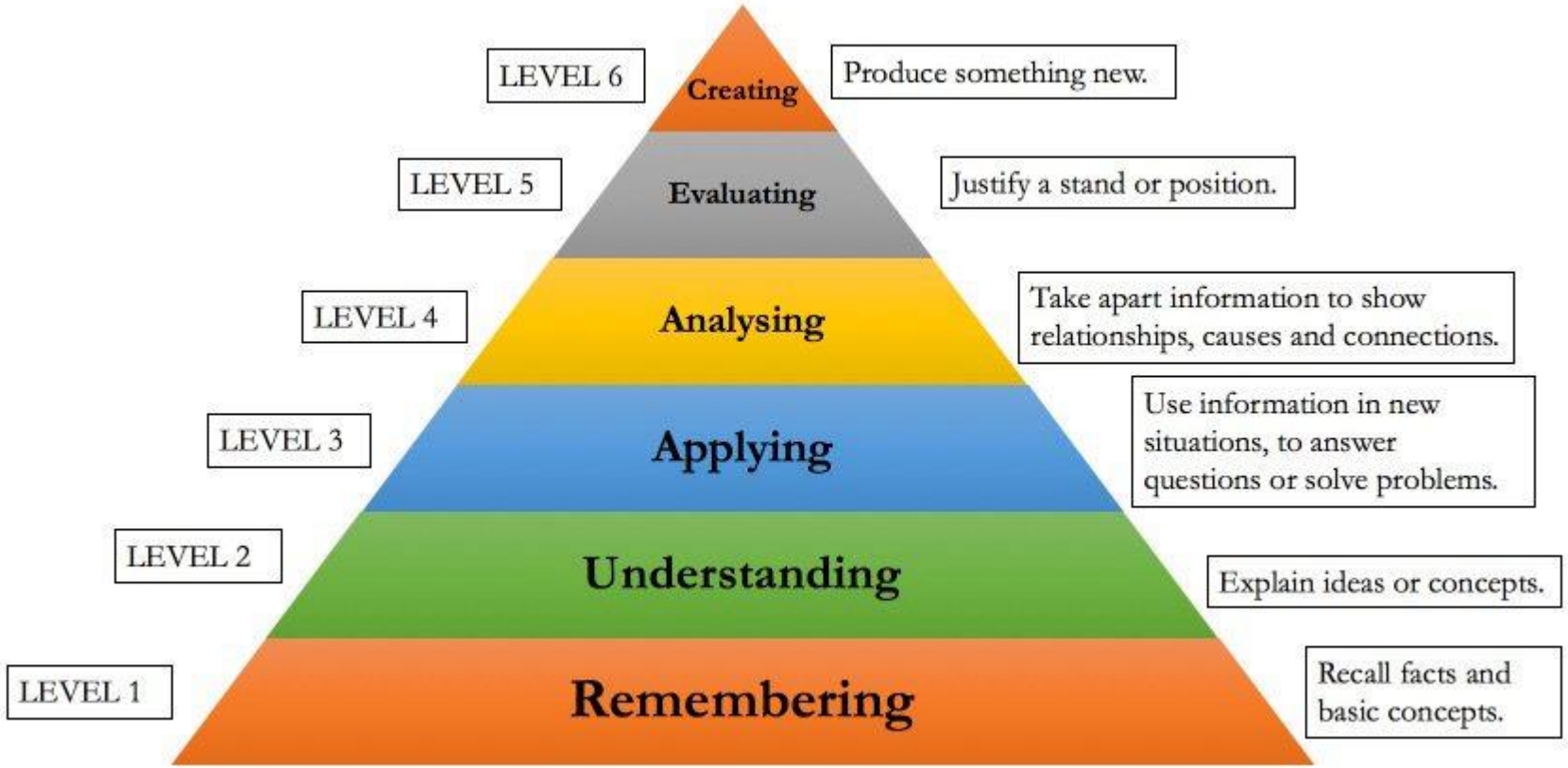
- To impart evidence based research oriented medical education
- To provide best possible patient care
- To inculcate the values of mutual respect and ethical practice of medicine

Prof. Umar's Clinically Oriented Integration Model For Basic Sciences Interactive Lectures



Model 1st Year PHYSIOLOGY LGIS (≈30 slides)	
Core Subject – 60% (≈ 18-20 slides)	
Physiology(≈ 18-20 slides)	
Horizontal Integration – 20% (≈ 5-6 slides)	
Same Year Subjects	• Anatomy (10%) (≈ 2-3 slides) • Biochemistry (10%) (≈ 2-3 slides)
Vertical Integration – 07% (≈ 2-3 slides)	
Clinical Subjects	• Medicine (3-5%) (≈ 1-2 slides) • Surgery (3-5%) (≈ 1-2 slides)
Spiral Integration – 08% (≈ 2-3 slides)	
Different Year Basic Sciences Subjects	• Pharmacology(1-3%) (≈ 1-2 slides) • Community Medicine (1-3%) (≈ 1-2 slides) • Forensic Medicine (1-3%) (≈ 1-2 slides)
Longitudinal / Ongoing Integration – 05% (≈ 1-2 slides)	
Research, Bioethics & AI(≈ 1-2 slides)	

BLOOM'S TAXONOMY OF THE COGNITIVE DOMAIN



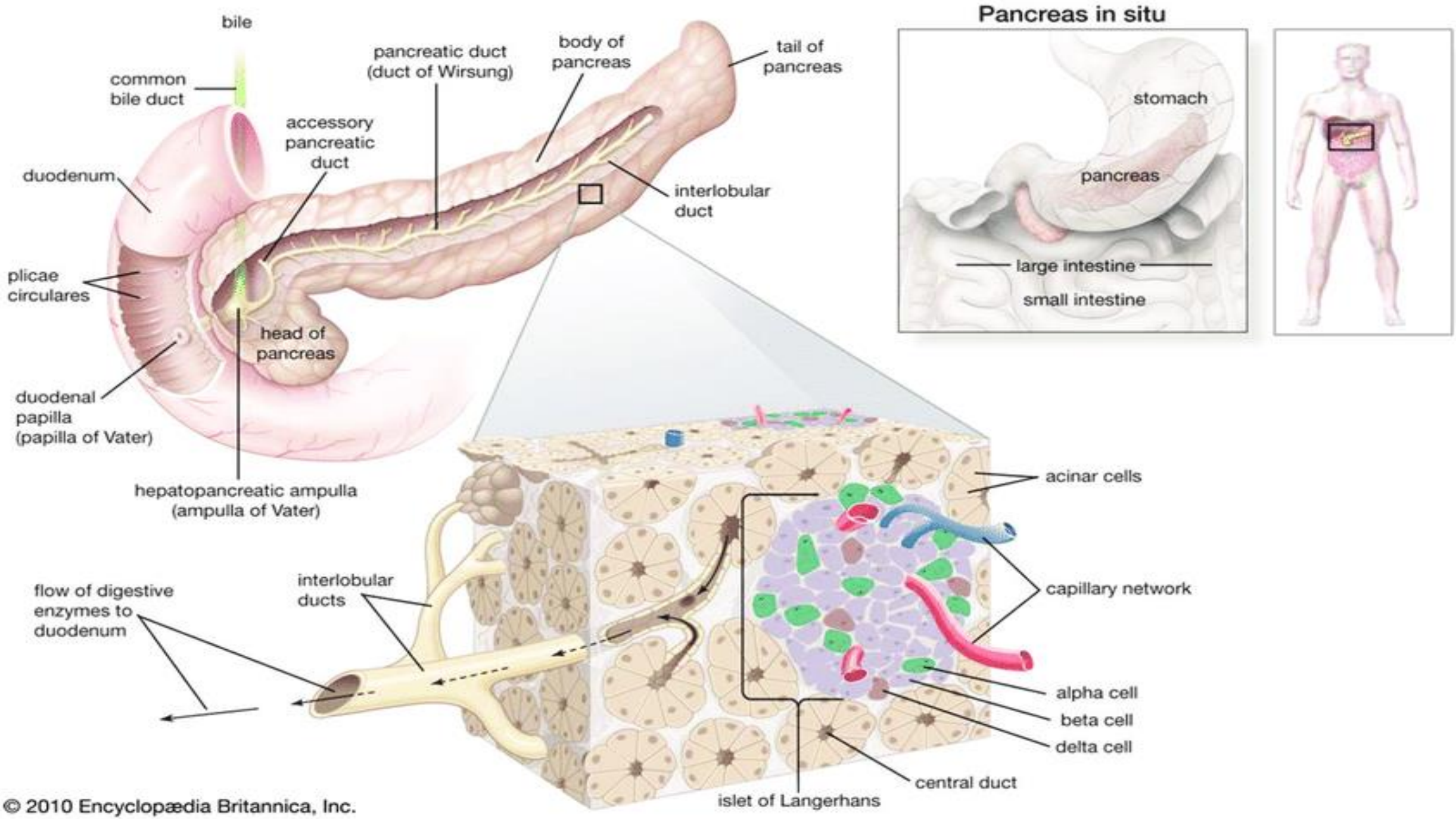
General Format for Large Group Interactive Session of Physiology:

S. No.	Headings	Domains/Type of Integration	Approximate %
1.	Title	• **Saliva & Mastication. Stages of Swallowing. Clinical Disorders of Swallowing & esophagus. Achalasia & Vomiting**	
2.	Learning Objectives	Mentioned on the separate slide	Mentioned on the separate slide
3.	Physiologic Anatomy (Histology)	• Brain Storming/ Horizontal Integration • Interactive	15%
4.	Core Concepts of the Topic	Core concepts of Physiology	60%
5.	Concept explained through Animations	Core Concepts of Physiology	10%
6.	Topic with key	• Interactive	5%
7.	Research article relevant to the topic with reference	• Promotion of research culture • Use of Digital Library • Critical Thinking • Self-directed Learning	5%
8.	PM&DC Code of Ethics/Professionalism/Communication Skills with reference	• Professional Ethics • Self-directed Learning • Interactive	5%

Learning objectives

1. Discuss composition of pancreatic secretions. ➢ Basic Mechanism of Secretion ➢ Secretion and activation of enzymes	C1
2. Describe mechanism of secretion of bicarbonate ions. ➢ Regulation of secretions	C1
3. Describe the regulation and phases of pancreatic secretion	C2
4. Sites, causes and physiological factors preventing Pancreatitis	C1

Horizontal integration
(Anatomy)



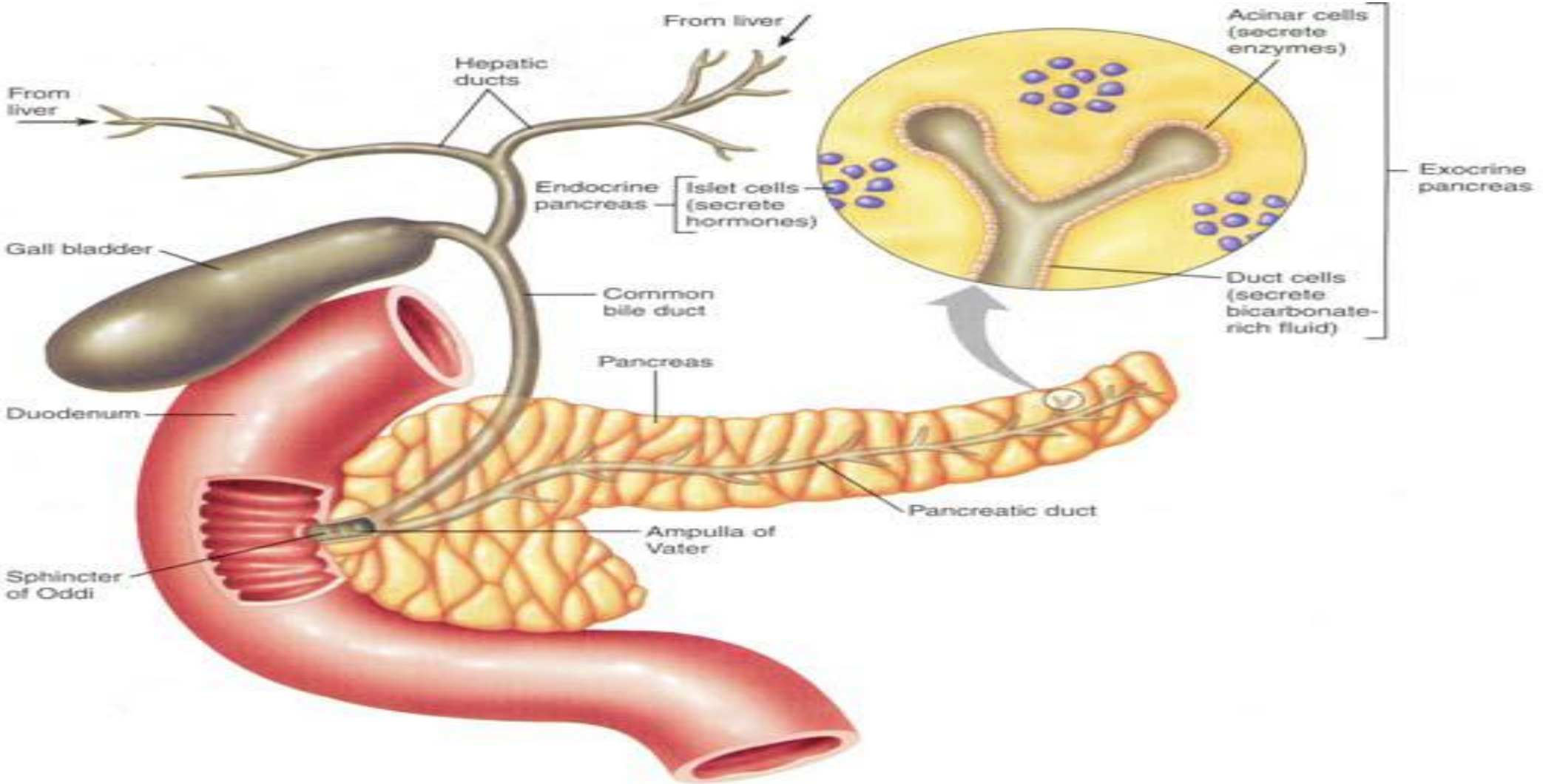


FIGURE 19.10 The pancreas and associated structures. *Enlarged view shows acini and ducts (exocrine pancreas) and islets (endocrine pancreas).*

Pancreatic secretions

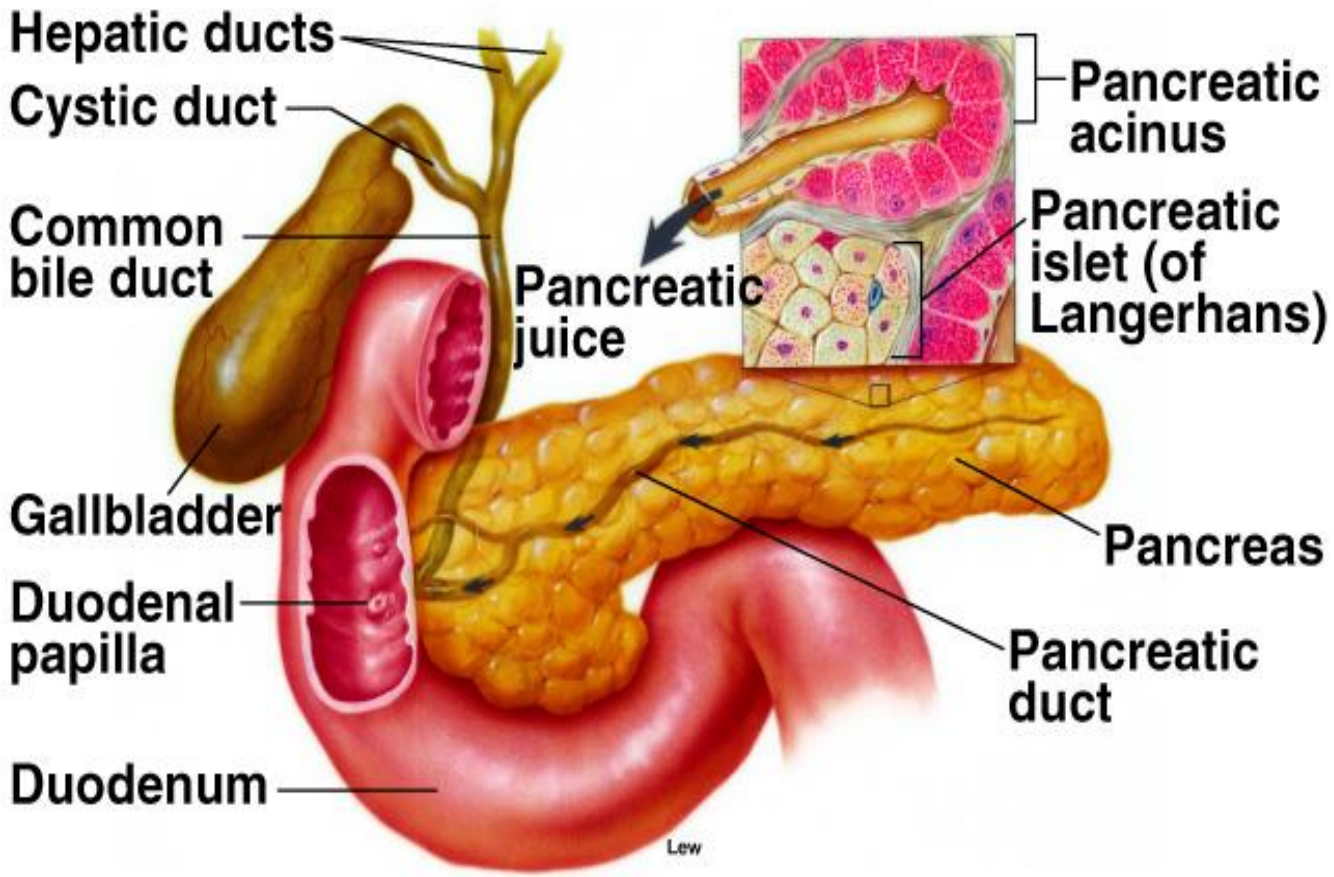
Core concept

- The pancreas acts as an exocrine gland by producing ***pancreatic juice*** which empties into the small intestine via a duct.
- The pancreas also acts as an endocrine gland to produce insulin.
- It plays an important role
  - in digestion of lipids proteins and carbohydrates,
  - in metabolism since it produces insulin.
  - in neutralizing the pH to become suitable for the action of the pancreatic digestive enzymes.

Core concept

Pancreas

- Exocrine:
  - Acini:
    - Secrete pancreatic juice.
- Endocrine:
  - Islets of Langerhans:
    - Secrete insulin and glucagon.



Pancreatic secretions

Core concept

Pancreatic secretions is an alkaline liquid secreted by the pancreas, which contains a variety of enzymes.

Composition of pancreatic secretion;

1- . The first component is a solution of bicarbonate, Na^+ , K^+ and water emitted by the epithelial cells that line the pancreatic ducts. This alkaline solution is designed to help neutralize stomach acid so that digestive enzymes can work more effectively.

2- The second component is the enzymatic component ;which include

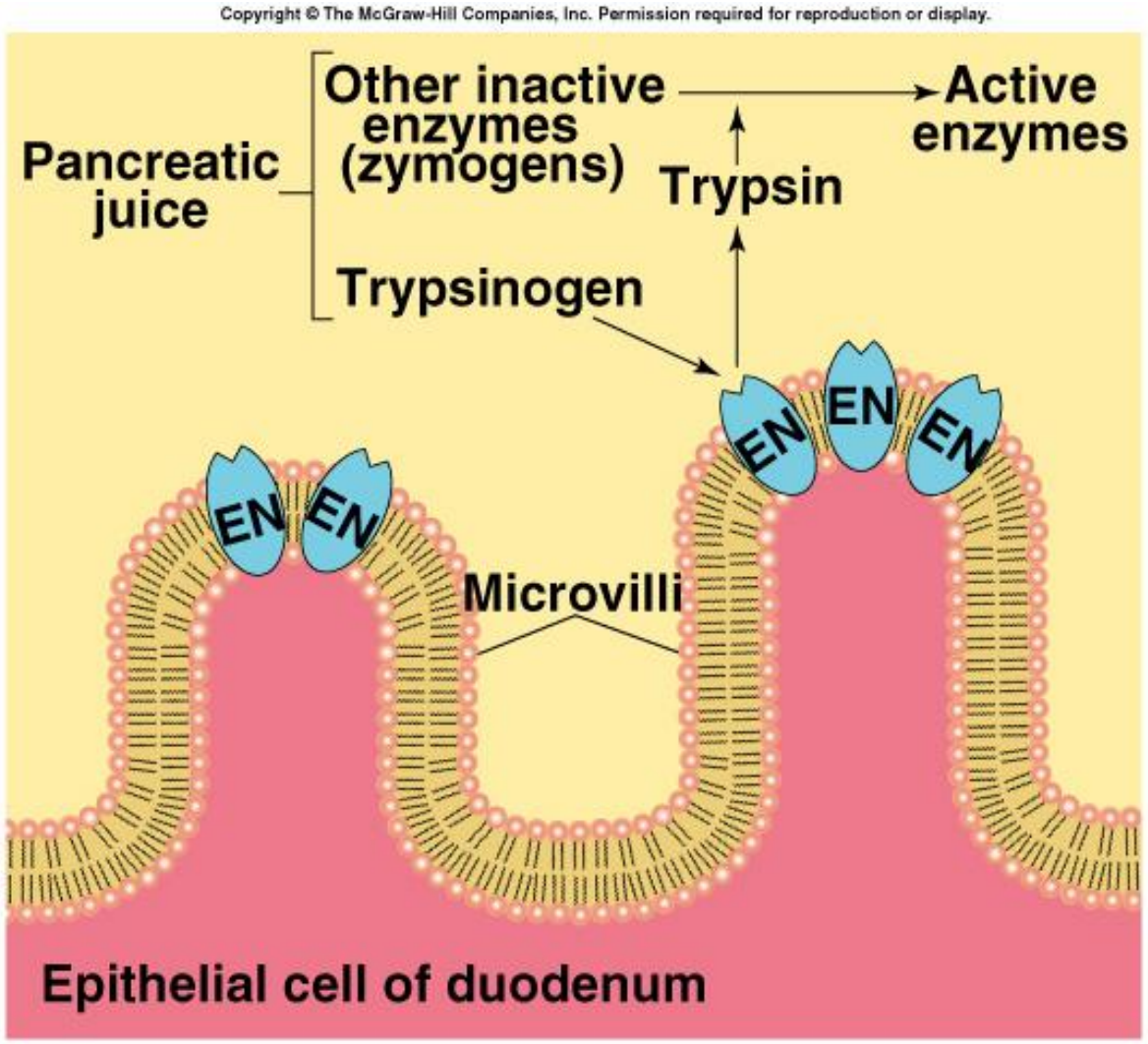
Pancreatic secretions

Core concept

- ribonucleases
- Trypsinogen
- Chymotrypsinogen
- Procarboxypeptidase
- Pancreatic amylase
- Pancreatic lipases
- Deoxyribonucleases

Pancreatic Juice

- Complete digestion of food requires action of both pancreatic and brush border enzymes.
  - Most pancreatic enzymes are produced as zymogens.
  - Trypsin (when activated by enterokinase) triggers the activation of other pancreatic enzymes.
- Pancreatic trypsin inhibitor attaches to trypsin.
  - Inhibits its activity in the pancreas.



Core component

Pancreatic secretions

Core concept

- Interaction of duodenal and pancreatic enzymes.
  - **Enterokinase** from the duodenal mucosa and attached to the brush border activates trypsinogen to **trypsin**.
  - Trypsin activates chymotrypsinogen to **chymotrypsin**
  - Trypsin activates **procarboxypeptidase** to carboxypeptidase.
- Trypsin, chymotrypsin and carboxypeptidase digest proteins: proteolytic.
- Pancreatic amylase continues digestion of starch
- Pancreatic lipase digests lipids
- Deoxyribonucleases and ribonucleases digest DNA and ribonucleic acid, respectively

Digestive Enzymes

Core concept

- **1. Proteases**
- Digestion of proteins is initiated by pepsin in the stomach, but the bulk of protein digestion is due to the pancreatic proteases. Several proteases are synthesized in the pancreas and secreted into the lumen of the small intestine. The two major pancreatic proteases are **trypsin** and**chymotrypsin**, which are synthesized and packaged into secretory vesicles as an the inactive proenzymes trypsinogen and chymotrypsinogen.

Pancreatic lipase

Core concept

- A major component of dietary fat is triglyceride, or neutral lipid. A triglyceride molecule cannot be directly absorbed across the intestinal mucosa. Rather, it must first be digested into a 2-monoglyceride and two free fatty acids. The enzyme that performs this hydrolysis is pancreatic lipase, which is delivered into the lumen of the gut as a constituent of pancreatic juice.

Core concept

- Sufficient quantities of bile salts must also be present in the lumen of the intestine in order for lipase to efficiently digest dietary triglyceride and for the resulting fatty acids and monoglyceride to be absorbed. This means that normal digestion and absorption of dietary fat is critically dependent on secretions from both the pancreas and liver

Core concept

- **3. Amylase**
- The major dietary carbohydrate for many species is starch, a storage form of glucose in plants. Amylase (technically alpha-amylase) is the enzyme that hydrolyses starch to maltose (a glucose-glucose disaccharide), as well as the trisaccharide maltotriose and small branchpoints fragments called limit dextrins. The major source of amylase in all species is pancreatic secretions, although amylase is also present in saliva of some animals, including humans.

Core concept

Table 18.4 Enzymes Contained in Pancreatic Juice

Enzyme	Zymogen	Activator	Action
Trypsin	Trypsinogen	Enterokinase	Cleaves internal peptide bonds
Chymotrypsin	Chymotrypsinogen	Trypsin	Cleaves internal peptide bonds
Elastase	Proelastase	Trypsin	Cleaves internal peptide bonds
Carboxypeptidase	Procarboxypeptidase	Trypsin	Cleaves last amino acid from carboxyl-terminal end of polypeptide
Phospholipase	Prophospholipase	Trypsin	Cleaves fatty acids from phospholipids such as lecithin
Lipase	None	None	Cleaves fatty acids from glycerol
Amylase	None	None	Digests starch to maltose and short chains of glucose molecules
Cholesterolesterase	None	None	Releases cholesterol from its bonds with other molecules
Ribonuclease	None	None	Cleaves RNA to form short chains
Deoxyribonuclease	None	None	Cleaves DNA to form short chains

Bicarbonate Ion Production in Pancreas

Core concept

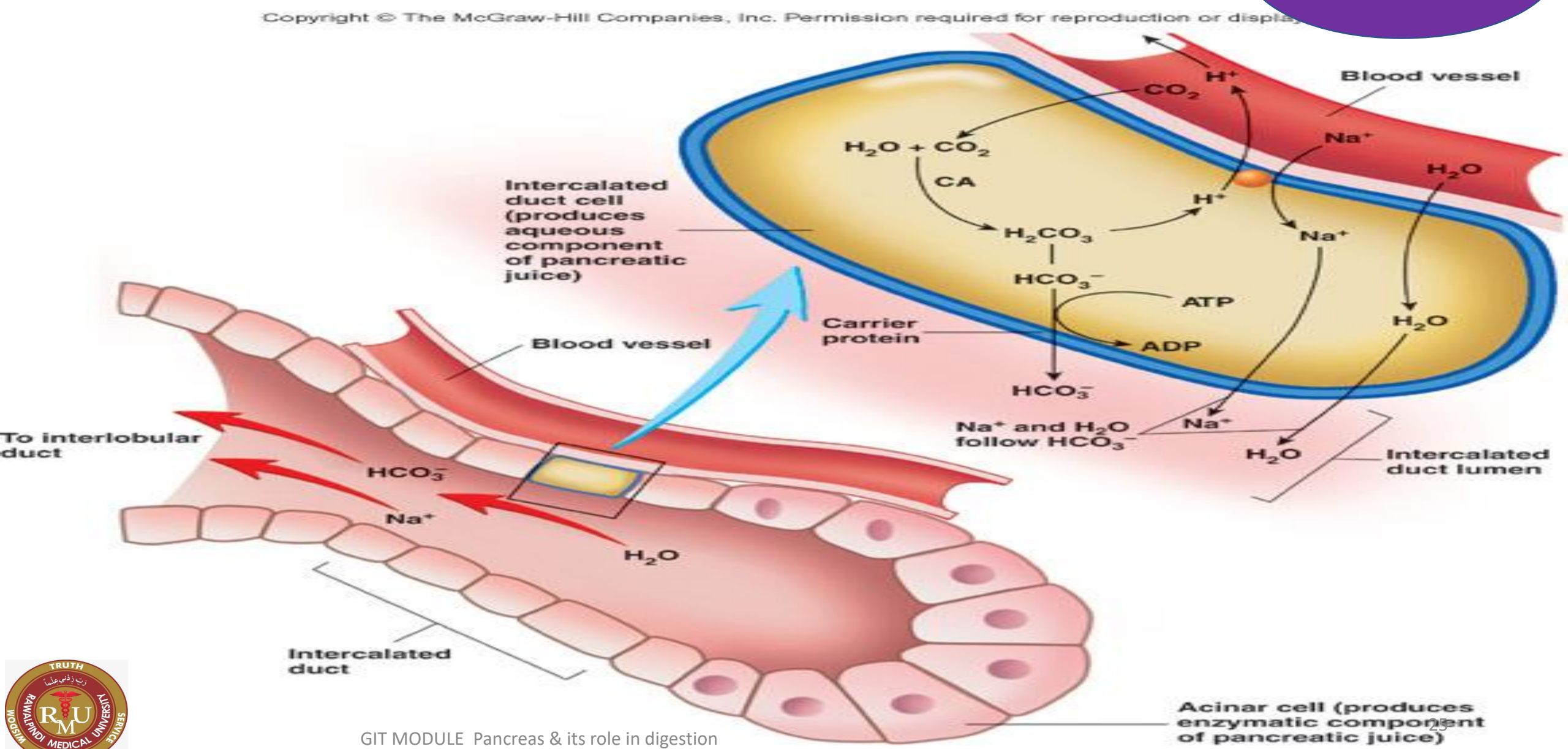
- 1-CO_2 diffuses to the interior of the ductule cells from blood and combines with H_2O by carbonic anhydrase to form H_2CO_3 which will dissociate into HCO_3^- and H^+ . The HCO_3^- is actively transported into the lumen.

- 2- The H^+ formed from the dissociated H_2CO_3 is exchanged for Na^+ ions by active transport through blood , which will diffuse or actively be transported to the lumen to neutralize the – ve charges of HCO_3^- .

- 3- The movement of HCO_3^- and Na^+ ions to the lumen causes an osmotic gradient causes water to move from blood to ductule cells of the pancreas producing eventually the HCO_3^- solution.

Bicarbonate Ion Production in Pancreas

Core concept



Secretion of Pancreatic Juice

Core concept

- Secretion of pancreatic juice and bile is stimulated by:
- Secretin:
  - Occurs in response to duodenal pH < 4.5.
  - Stimulates production of $HC0_3^-$ by pancreas.
  - Stimulates the liver to secrete $HC0_3^-$ into the bile.

Secretion of Pancreatic Juice

Core concept

- CCK:
  - Occurs in response to fat and protein content of chyme in duodenum.
  - Stimulates the production of pancreatic enzymes.
  - Enhances secretin.
  - Stimulates relaxation of the sphincter of Oddi.

Core concept

- Acetylcholine released by parasympathetic nerve ending or other cholinergic nerve endings in enteric nerves.

Phases of pancreatic secretions

Core concept

- Cephalic phase account for 20 percent of secretions
- Stimulated by release of acetylcholine
- Little of these secretions flows immediately out of pancreatic duct
- Gastric phase accounts only 5 to 10 percent of enzymes secreted after meal
- Still only small amount reaches intestine

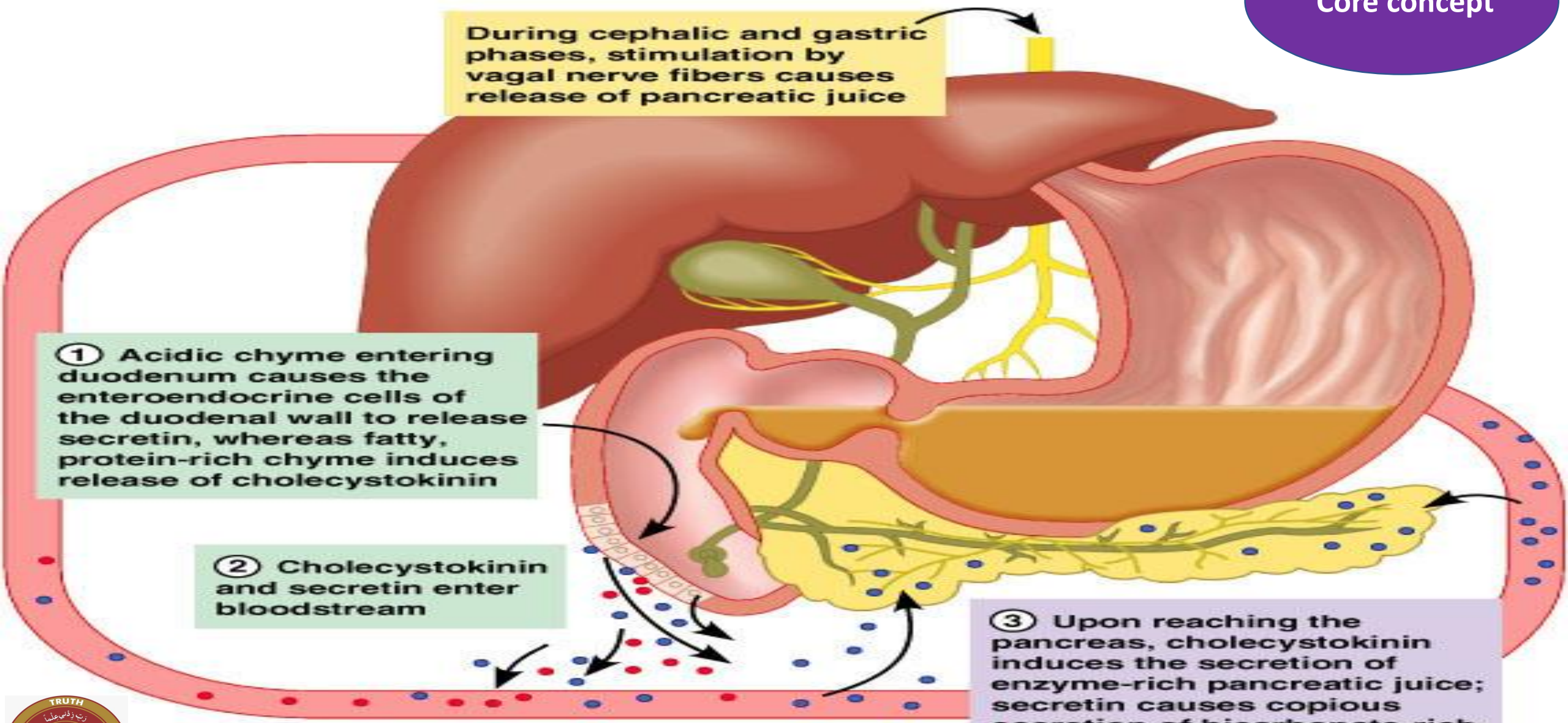
Intestinal phase

Core concept

- after chyme enters intestine ,pancreatic secretion becomes copious mainly in response to secretin and cholecystokinin

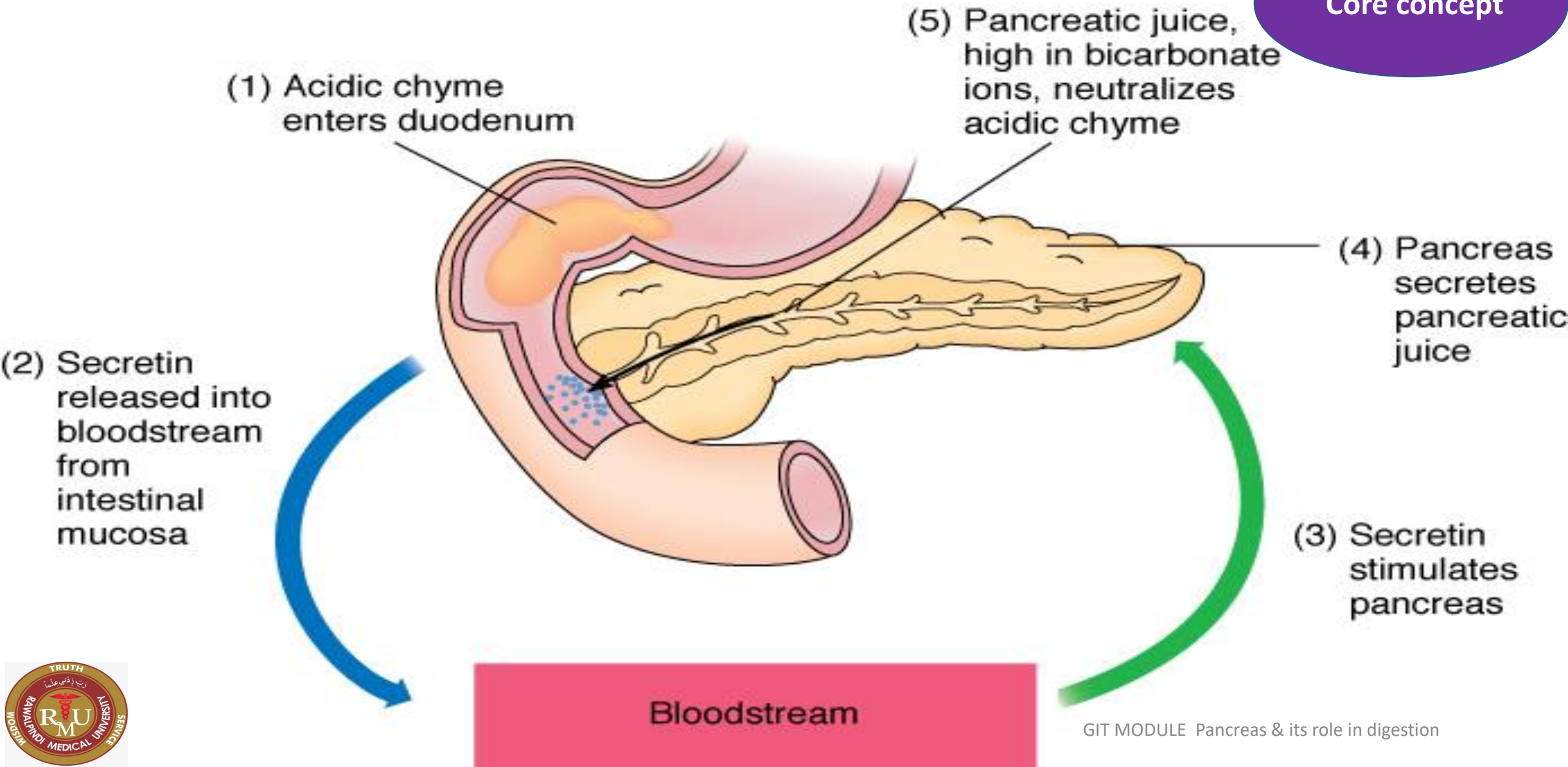
Regulation of Pancreatic Secretion

Core concept



CONTROL OF PANCREATIC SECRETIONS

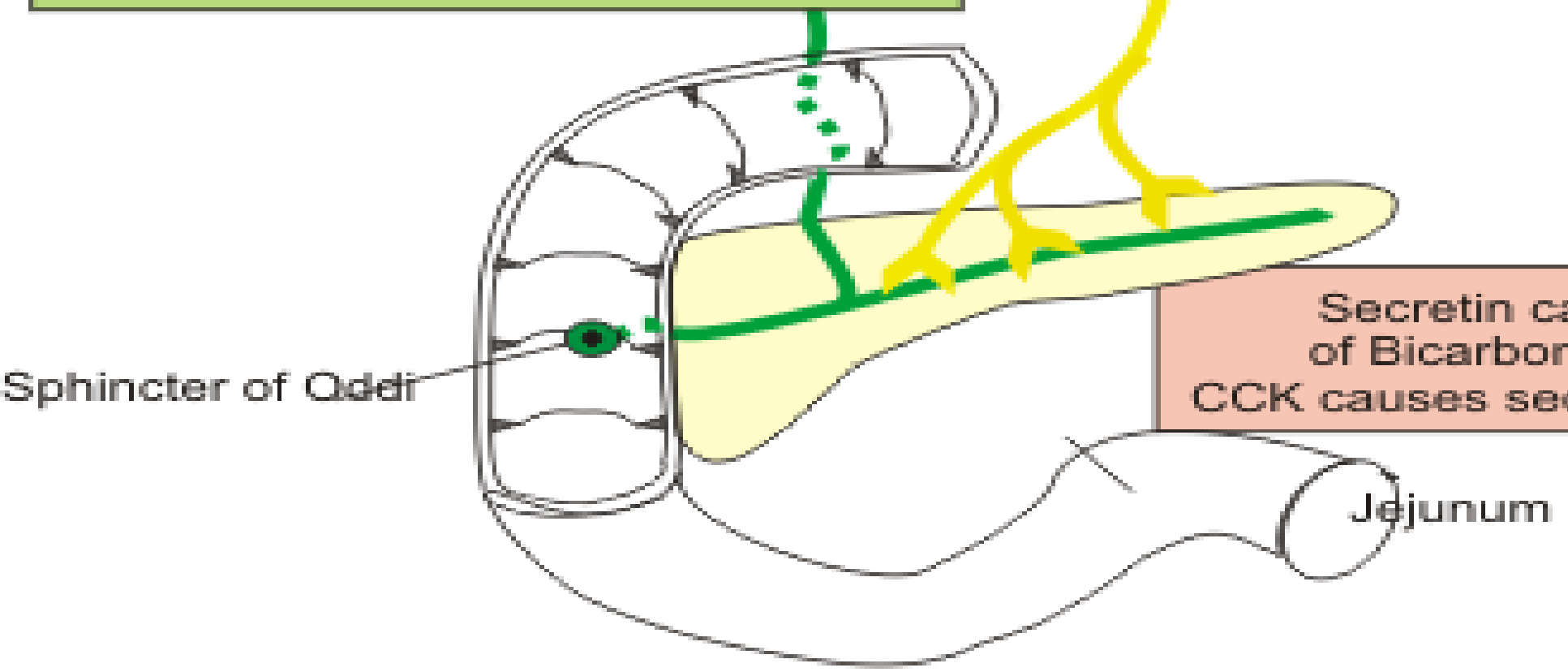
Core concept



Presence of acid in duodenum cause release of ***Secretin***

Presence of Fats in duodenum cause release of ***Cholecystokinin***

Vagal Stimulation cause release of pancreatic enzymes



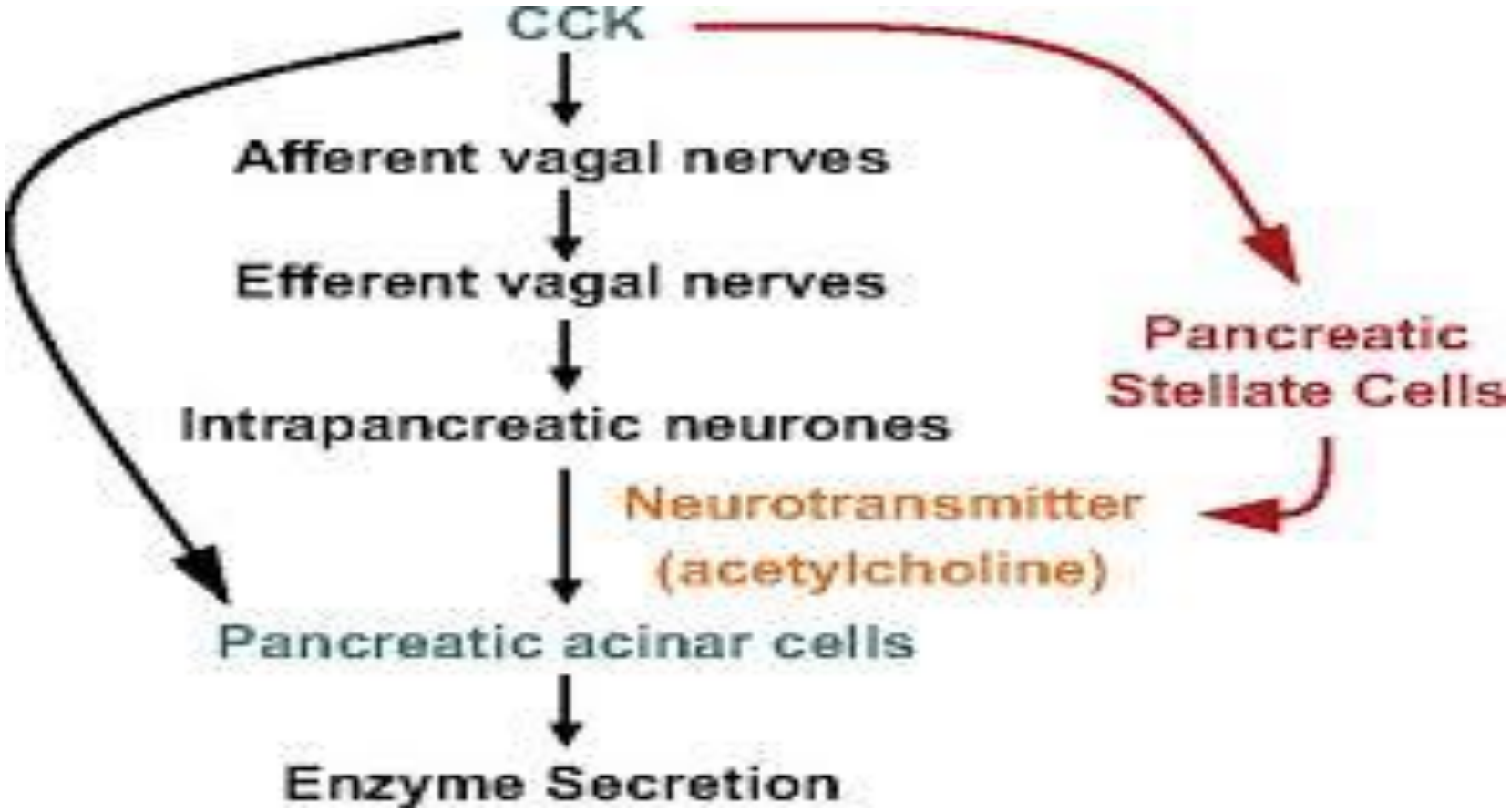
Secretin causes release of Bicarbonate secretions
CCK causes secretion of Enzymes

Frank Boumphrey M.D. 2009

Core concept

Control of Pancreatic Secretions

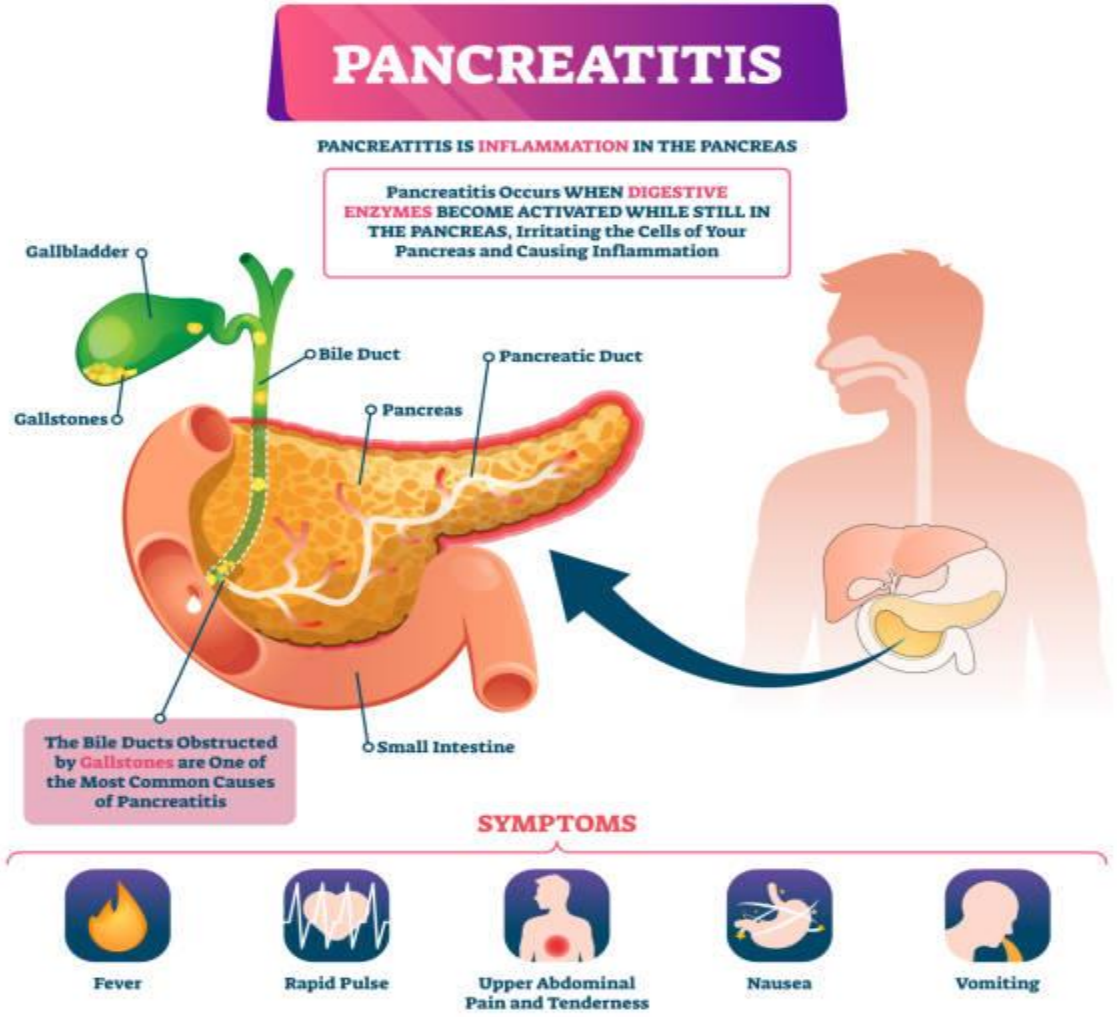
Core concept



Vertical integration

Core concept

- pancreatitis



Intestinal secretions

Core concept

Intestinal juice ; clear to pale yellow watery secretions from the glands lining the _small intestine walls.

The glands include;

1- Brunner's glands; They are located in the first few centimeters of the duodenum , where the pancreatic and bile juices empty into the duodenum .

Intestinal secretions

Core concept

These glands produce a slightly alkaline highly viscous fluid containing mucins ,the function of the mucus is to protect the duodenal wall from digestion by the gastric juices.

2- The Crypts of Lieberkühn ;

located on the entire surface of the small intestine are small pits called crypts of Lieberkühn ,they secret a fluid that is similar to the ECF but has a slightly alkaline pH 7.5 – 8.0 .

Intestinal secretions

Core concept

- Composition of the Intestinal secretions ;
- 1- mucin who's the function is to protect the duodenal wall from digestion by the gastric juices.
- 2- Water and electrolytes.
- 3- Enzymes ; a number of enzymes are present including , peptidase breaks down peptides into amino acids
- sucrase, maltase, lactase – break down disaccharides into monosaccharides
- lipase – breaks down fats into fatty acids and glycerol

Intestinal secretions

Core concept

- enterokinase – converts trypsinogen to trypsin
- somatostatin – hormone that inhibits acid secretion by stomach
- cholecystokinin – hormone that inhibits gastric glands, stimulates pancreas to release enzymes in pancreatic juice, stimulates gallbladder to release bile
- secretin – stimulates pancreas to release bicarbonate ions in pancreatic juice

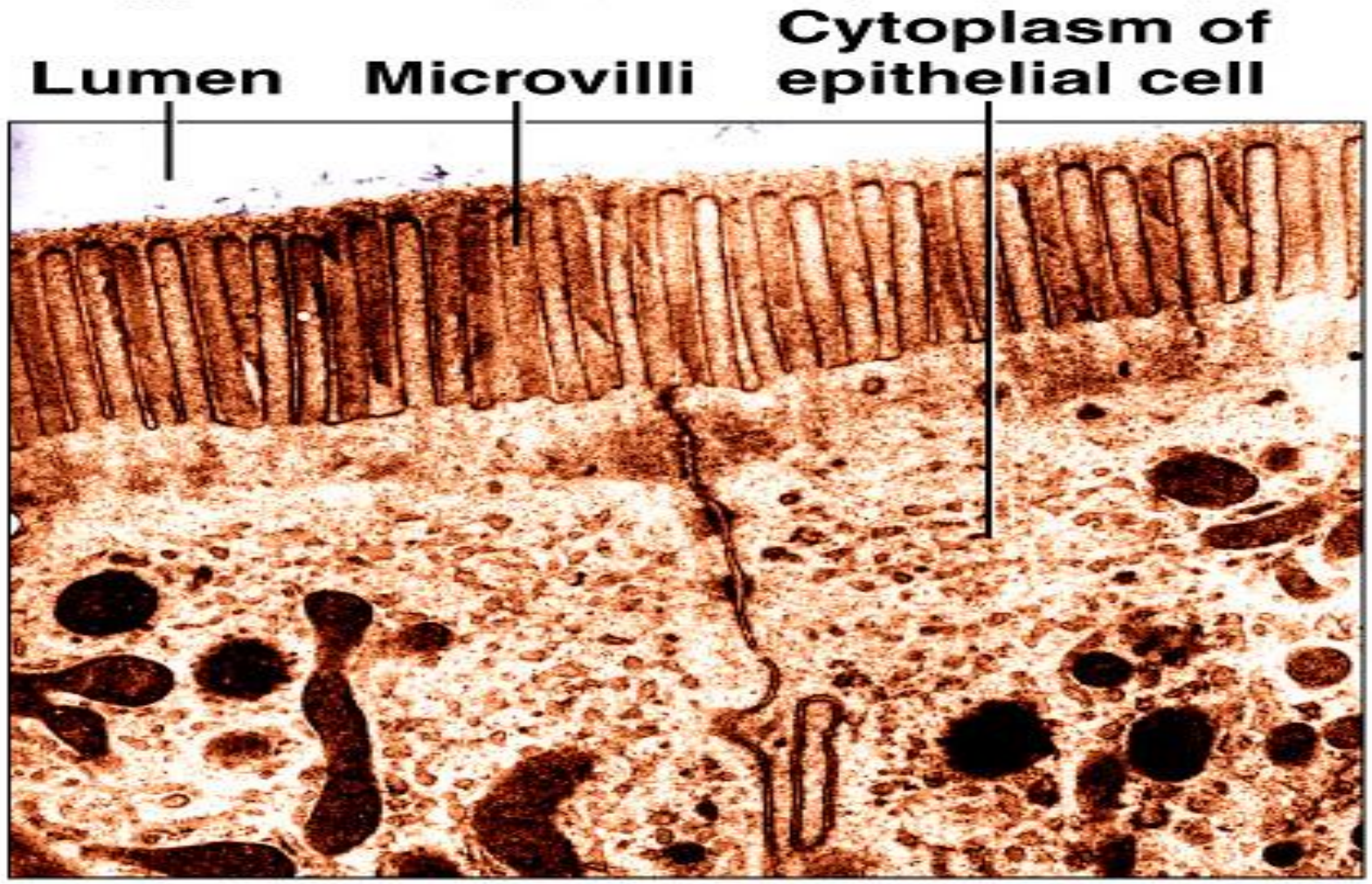
Regulation of Small Intestinal Secretions

Core concept

- mucus secretion stimulated by presence of chyme in small intestine
- distension of intestinal wall activates nerve plexuses in wall of small intestine
- parasympathetics trigger release of intestinal enzymes

Intestinal Epithelium

Core concept

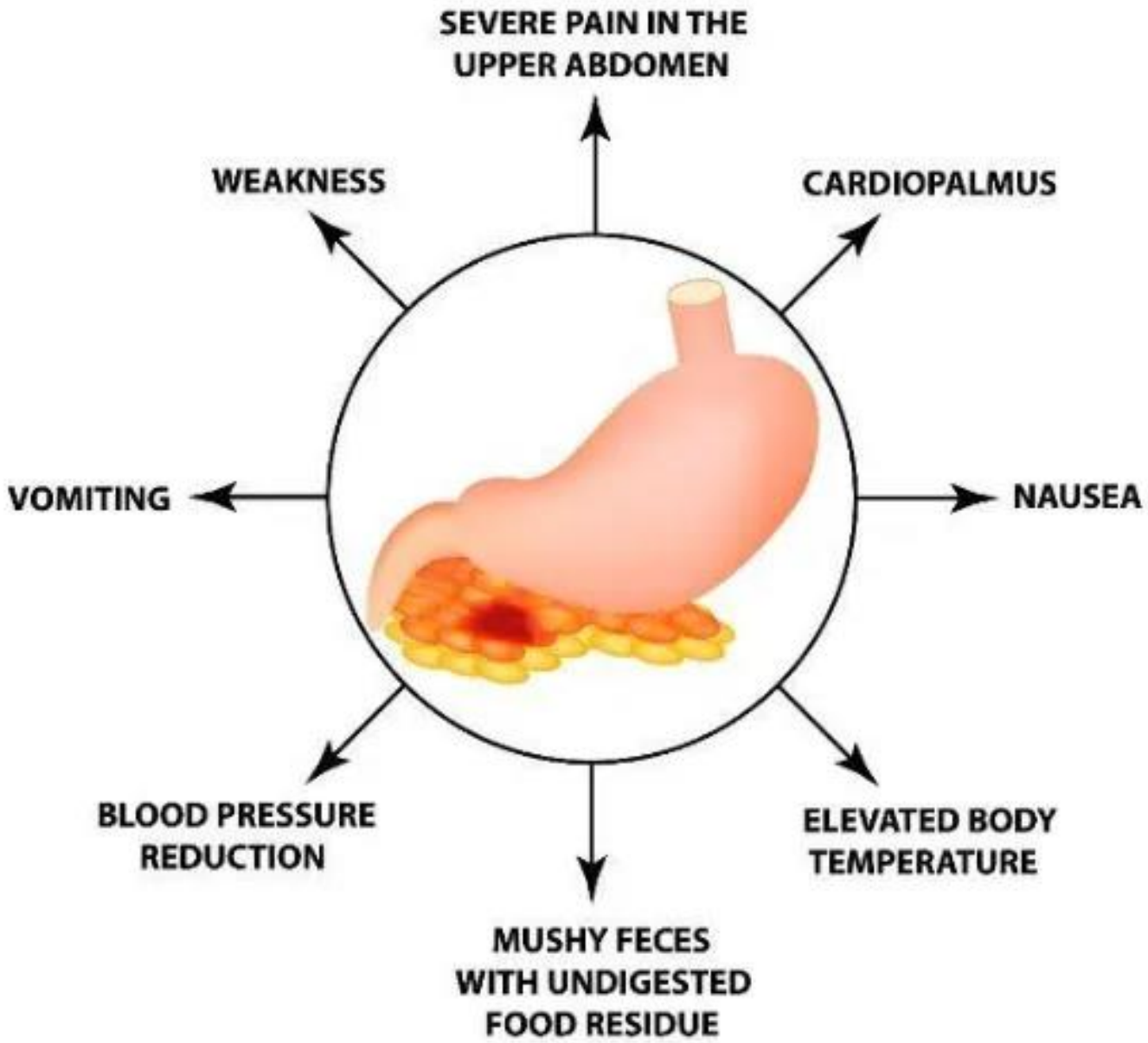


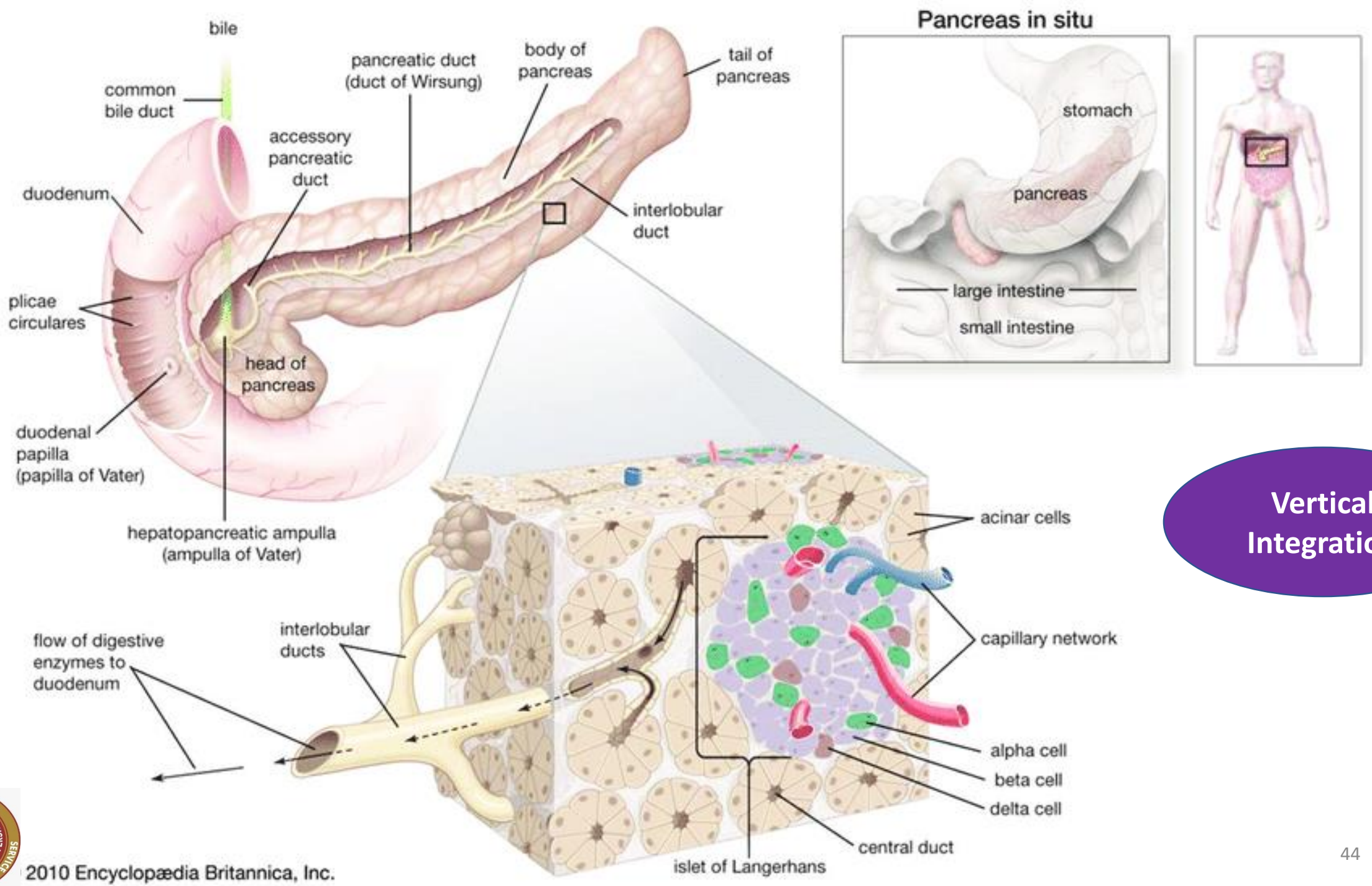
(b)

Vertical integration with Clinical & Paraclinical Sciences

SYMPTOMS OF PANCREATITIS

Vertical Integration





Vertical Integration

Brainstorming

Question & Answer

Brainstorming/Review

QUESTIONS

A patient is treated with cholestyramine, a bile-acid binding resin, for hypercholesterolemia. Absorption of which of the following is likely to be abnormal in this patient?

A. Long-chain triglyceride
B. Medium-chain triglyceride
C. Starch
D. Vitamin D
E. Vitamin B6

Brainstorming/Review

The correct answer is D.

Vitamin D is a fat-soluble vitamin whose uptake is entirely dependent on micelles. Cholestyramine will reduce the concentration of free bile acids in the intestinal lumen, likely below the critical micellar concentration such that micelles will not form. Absorption of the products of digestion of both long- and medium chain triglycerides is accelerated by the presence of micelles, but these products also have appreciable aqueous solubility.

Brainstorming/Review

QUESTIONS

A 20-year-old man with a history of mild cystic fibrosis notices that his stools are becoming bulky, pale-colored and oily. Laboratory tests confirm steatorrhea. Which of the following would not be involved in his apparent decrease in fat assimilation?

A. **Lipase inactivation**
B. **Decreased pancreatic lipase output**
C. **Reduced pancreatic bicarbonate secretion**
D. **Loss of the anatomic reserve**
E. **Decreased colipase synthesis**

Answer

The correct answer is D.

The intestinal surface area available for lipid absorption should not be altered in this patient. Cystic fibrosis, arising from mutations in CFTR, results in a decrease in the ability of the pancreatic ducts to secrete bicarbonate

Understanding Biomedical Ethics

Biomedical Ethics

Longitudinal bioethics Curriculum

Bioethics

- **Non-maleficence**

The principle of nonmaleficence holds that there is an obligation not to inflict harm on others. It is closely associated with the maxim primum non nocere (first do no harm).

Suggested Research Article

Research

StatPearls [Internet].

Show details

Search this book

Physiology, Pancreas

Suzan A. El Sayed; Sandeep Mukherjee.

Author Information and Affiliations

Last Update: May 1, 2023.

Introduction

Go to:

The pancreas is a composite organ, which has exocrine and endocrine functions. The endocrine portion is arranged as discrete islets of Langerhans, which are composed of five different endocrine cell types (alpha, beta, delta, epsilon, and upsilon) secreting at least five hormones including glucagon, insulin, somatostatin, ghrelin, and pancreatic polypeptide, respectively.

Function

Go to:

Pancreatic Hormones and Their Function[1][2][3]

Insulin

- https://www.ncbi.nlm.nih.gov/books/NBK459261

Research

Core concept

- Physiology, Pancreas - StatPearls
- https://www.ncbi.nlm.nih.gov/books/NBK459261

- Published: 2022/05/08
- Authors: Suzan A. El Sayed, Sandeep Mukherjee
- Affiliations: Oakland Un William Beaumont Sch of Med, Crei…
- The pancreas is a composite organ, which has exocrine and endocrine functions. The endocrine portion is arranged as discrete islets of Langerhans, which are composed of five different endocrine cell types (alpha, beta, delta, epsilon, and upsilon) secreting at least five hormones including glucagon,...

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References

- Guyton Text Book of Physiology
- Share Wood Text Book of Physiology
- Gagnon Text Book of Physiology
- Silverthorne Text Book of Physiology
- Person's Text Book of Physiology
- Essentials of Medical Physiology- by K Sembulingam *and* Prema Sembulingam 6th Edition.
- Physiology by Linda S. Costanzo 6th Edition.