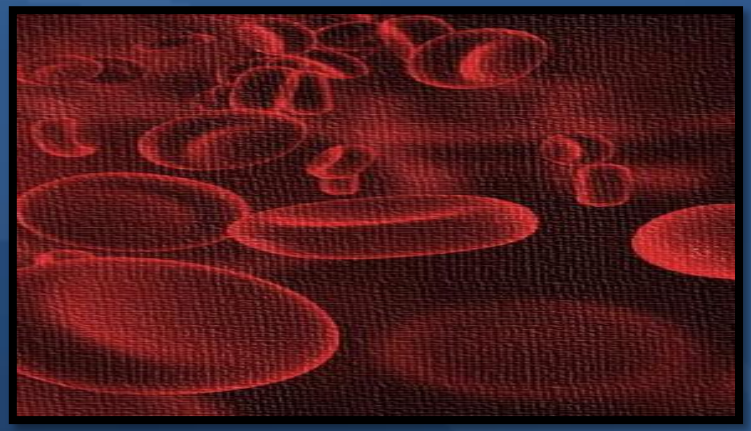
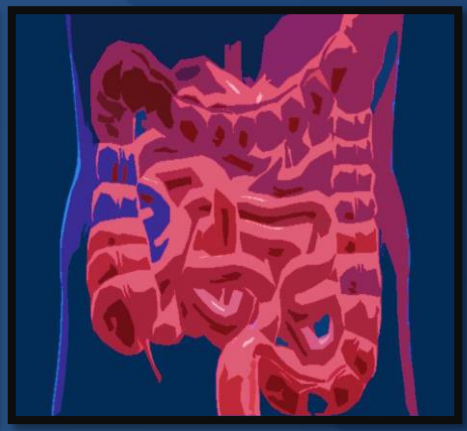
Physiology Team

LECTURE 6

Physiology of Pancreas

GASTOINTISTINAL TRACT





DONE BY:
May H. Alorainy

REVISED BY:
Othman.T.AlMutairi

DESIGNED BY:
Khulood Al-Raddadi

OBJECTIVES

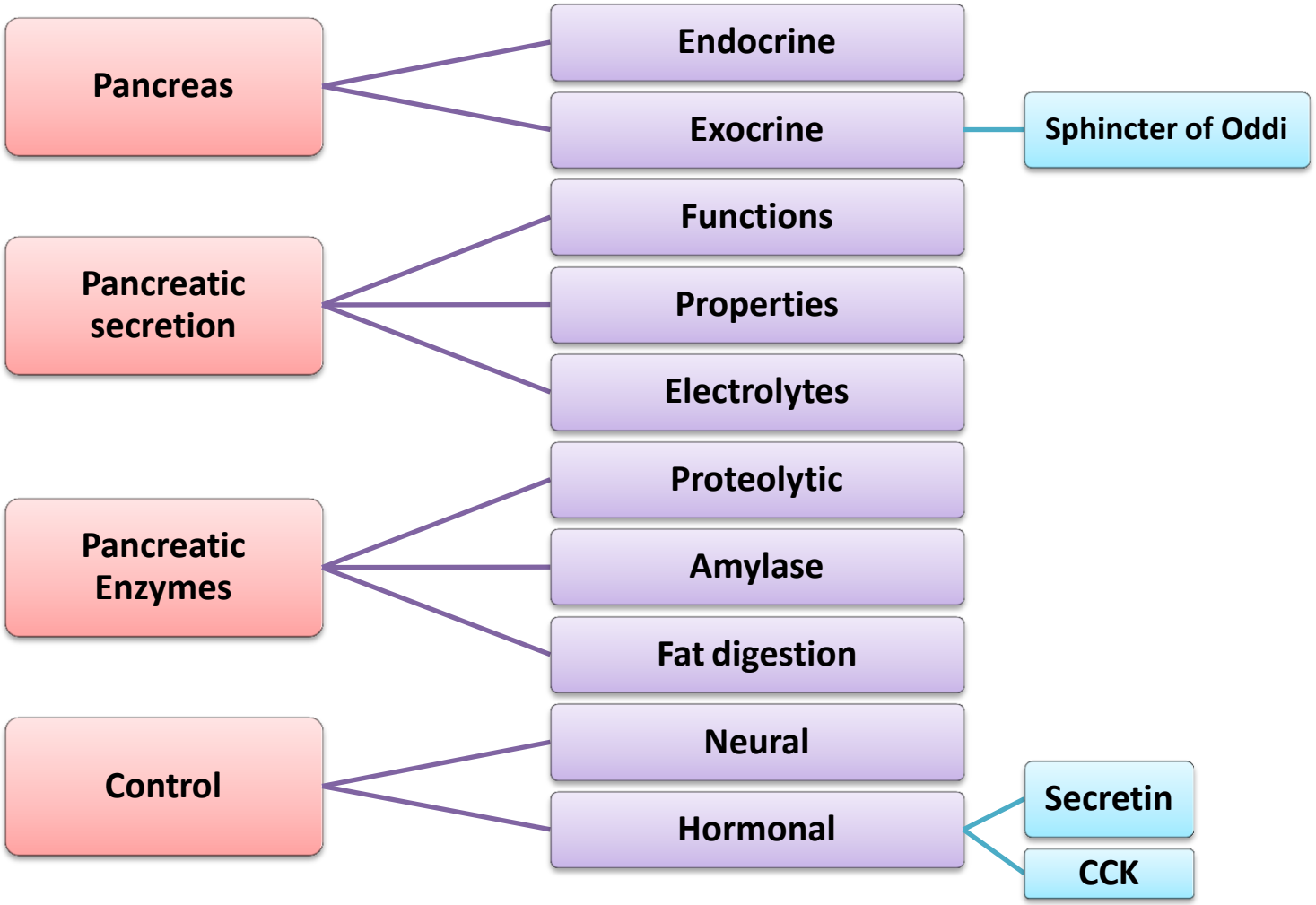
Physiology Team

At the end of this lecture, student should be able to describe:

- Functional anatomy.
- Pancreatic Acini.
- Cellular mechanism of bicarbonate secretion.
- Potentiation of secretory response.
- Pancreatic Secretion
- Pancreatic Enzymes
- Control of Pancreatic Secretion:
  - 1- Neural Control
  - 2- Hormonal Control:
    - Secretin
    - Choecystokinine

MIND MAP

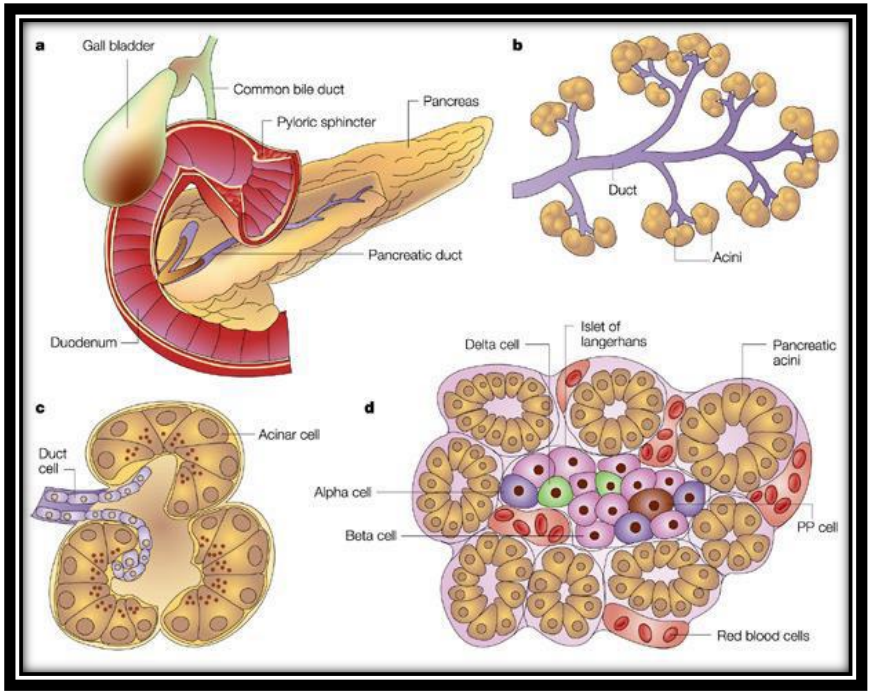
Physiology Team



Pancreas

Physiology Team

- The pancreas, which lies parallel to and beneath the stomach is composed of:
  1. The endocrine islets of Langerhans which secrete insulin (60% from beta cells), Glucagon (25% from alpha cells) and Somatostatin (10% from delta cells).
  2. Acinar gland tissues which produce pancreatic juice (the main source of digestive enzymes).
- The cells lining the acini are serous cells containing ZYMOGEN granules.
- Most of its structure are similar to that of Salivary glands.



YouTube

Endocrine vs. exocrine glands

http://www.youtube.com/watch?v=VBwCBdd0ru8

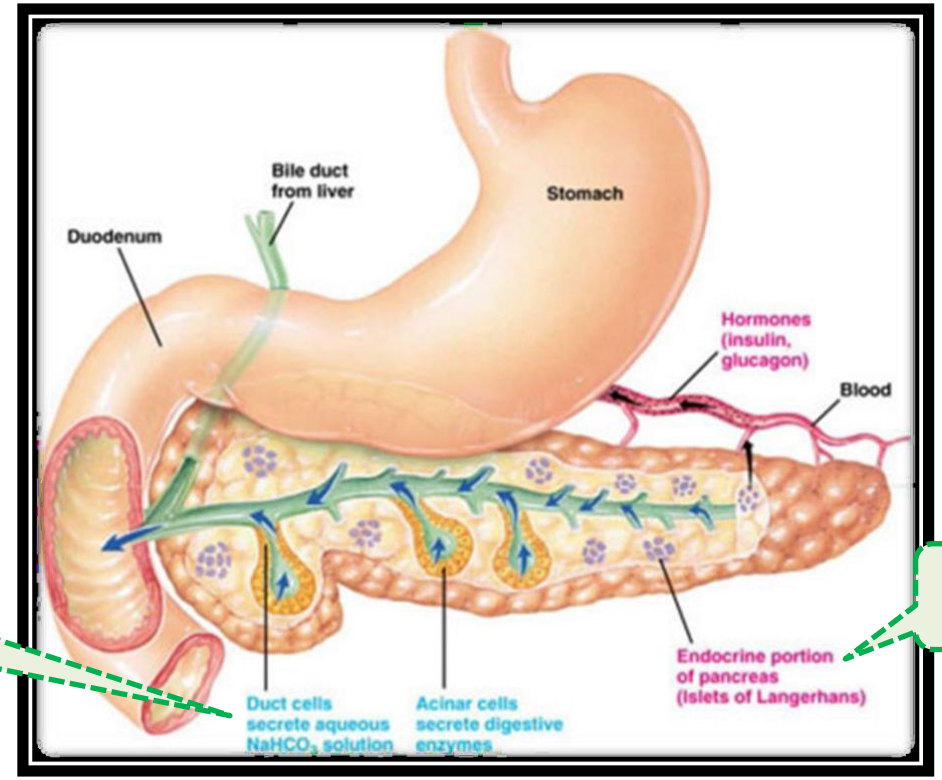
Pancreas

Physiology Team

- The main pancreatic duct joins into bile duct at ampulla of vater that is surrounded by sphincter of Oddi.
- Sphincter of Oddi controls the passage of pancreatic secretion and bile flow.
- Pancreatic duct and bile duct join each other and open by a single duct into duodenum.

Exocrine part

Secretions pass in pancreatic duct then to duodenum



Endocrine part

Secretions go directly to blood stream

Pancreatic Secretion

Physiology Team

- Pancreatic juice is secreted in response to the presence of CHYME in the upper portions of the small intestine.

- The major functions of pancreatic secretion:
  1. To neutralize the acids in the Duodenal chyme to optimum range for pancreatic enzyme activity (pH=7.0-8.0) . By alkaline secretion.
  2. To produce enzymes involved in the digestion of dietary carbohydrate, fat, and protein. It can even digest DNA & RNA.
  3. Mucosal protection against acid and pepsin.

- The Electrolytes:

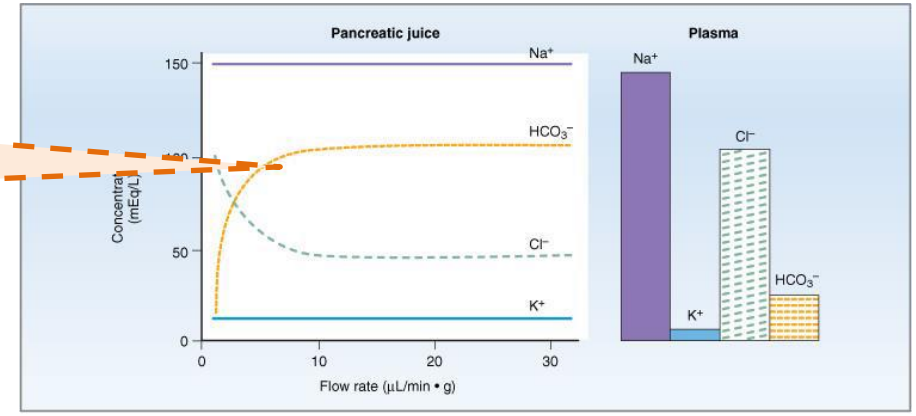
- They are produced from the epithelial cells of the ductules and ducts and include cations Na+, K+, Ca++ and anions HCO3- and Cl-.
- The greater bulk of electrolytes is in the form of NaHCO3. High concentration of NaHCO3 produces alkalinity.
- HCO3- concentration increases with increasing secretion rate.

Pancreatic Secretion

Properties	
Volume	1.2 – 1.51/day
Osmolarity	Isotonic
pH	8 (Alkaline) For acid neutralization + Providing optimum pH for the action of enzymes.
Composition	1% inorganic materials (electrolytes) + 1-2% organic materials mostly enzymes. The rest is water.

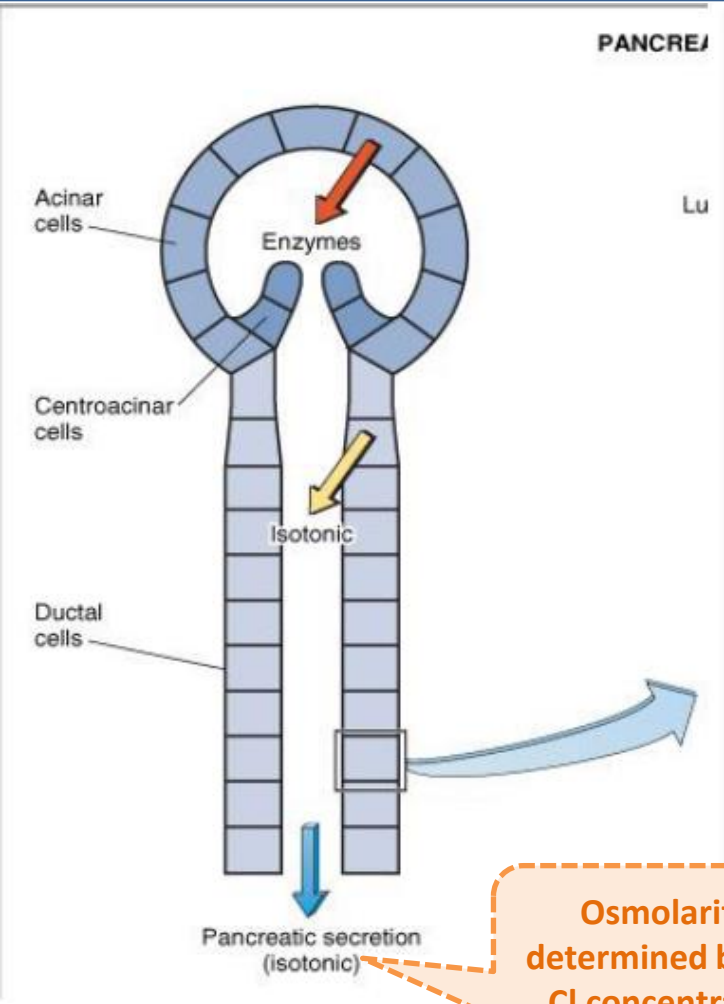
Flow Rate & Pancreatic Secretion

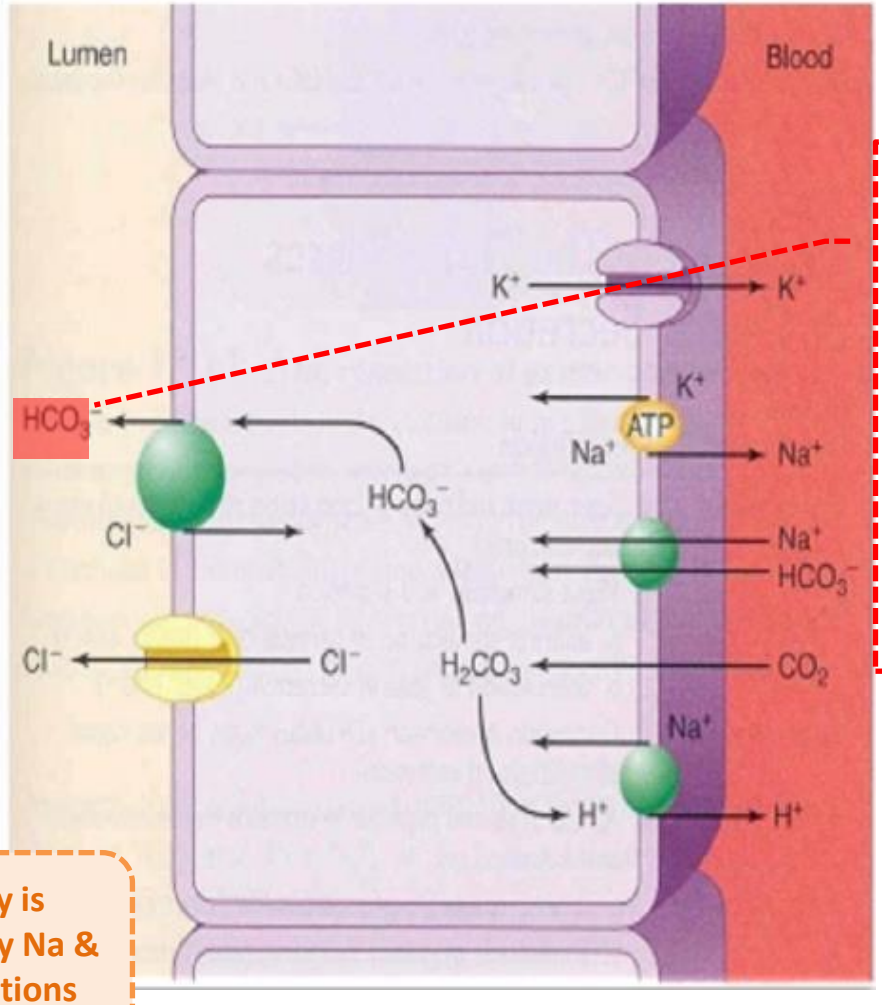
Bicarbonate secretion increases as the flow increases.



Secretion of Bicarbonate Ions

Physiology Team





HCO_3 is secreted into the lumen so it will be added to the pancreatic juice.

Osmolarity is determined by Na & Cl concentrations

Slides | Important | Females' Notes | Explanation | Males' Notes

Pancreatic Enzymes

Important

Physiology Team

The pancreas secrets enzymes that act on all major types of food stuffs.

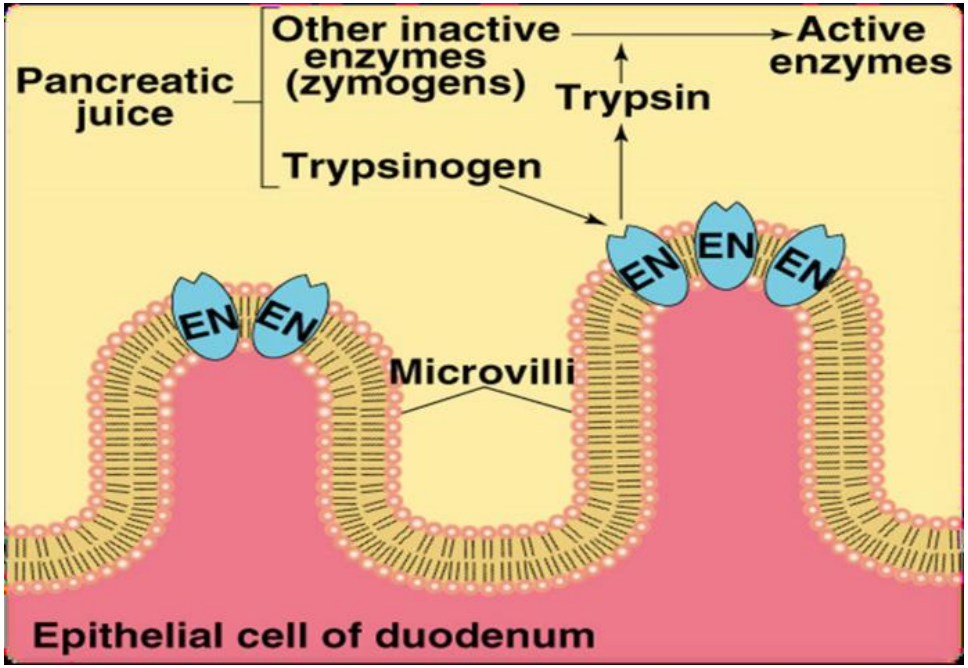
1- Pancreatic proteolytic enzymes (proteases):

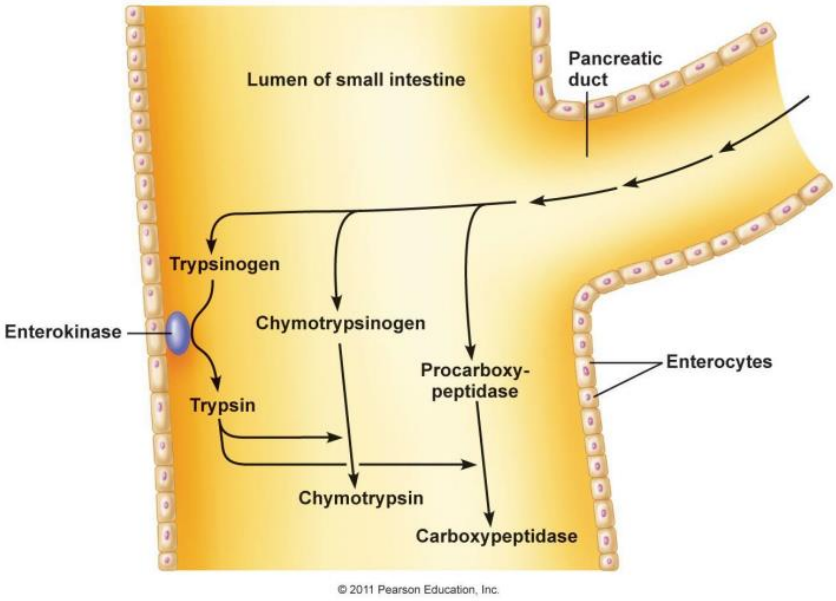
- Trypsin, chymotrypsin, elastase, carboxypeptidase (Carboxypolypeptidase).
- They are secreted in inactive form (so they don't digest pancreatic tissue) and activated in intestinal lumen.
- Trypsinogen is activated into trypsin by the enzyme enteropeptidase (enterokinase), secreted by duodenal mucosal cells. Enterokinase is not a proteolytic enzyme but it activates trypsin which in turn activates all pancreatic proteolytic enzymes.

Pancreatic Enzymes

Physiology Team

- Trypsinogen can be autocatalytically activated by trypsin formed from previously secreted trypsinogen
- **Trypsin activates chymotrypsinogen to chymotrypsin, proelastase to elastase and procarboxypeptidase into carboxypeptidase.**



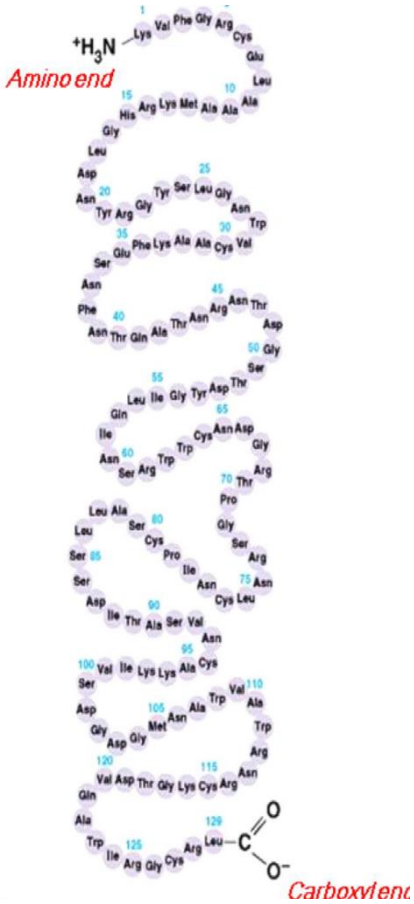


Slides | Important | Females' Notes | Explanation | Males' Notes

Pancreatic Enzymes

Physiology Team

- Trypsin, chymotrypsin and elastase are **endo**peptidases (working in the middle of the chain), splitting protein into shorter peptide chains.(don't cause a release of individual AA).
- Carboxypeptidase is an **exo**peptidase (working on terminal branches) which splits off amino acids at the carboxyl terminus of the peptide. (cause a release of AA).



- Trypsin inhibitor is present in cytoplasm of glandular cells. It inhibits activation of trypsin in acini and ducts of the pancreas.
- Absence of trypsin inhibitor can result in pancreatic auto-digestion which is a fatal condition.

2- Pancreatic Amylase :

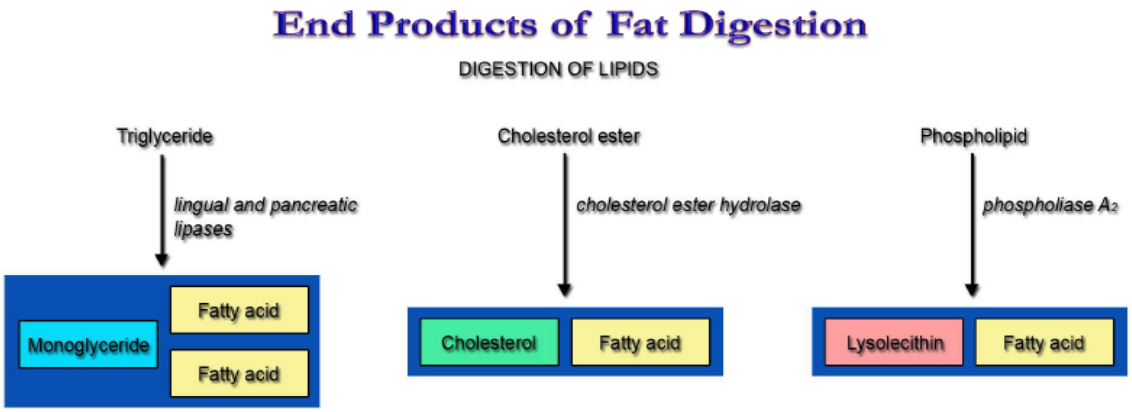
It splits starch to maltose, maltotriose and dextrins except cellulose. Pancreatic amylase is similar to salivary amylase however, food lasts for a longer period here thus, giving pancreatic amylase the chance to digest for a longer duration.

3- Enzymes for fat digestion :

a) Pancreatic lipase is the most important fat splitting enzyme. It breaks TG into MG and FA in the presence of bile salts and co-lipase (they are only facilitatory, they don't digest lipids.)

b) Cholesterol esterase which liberates cholesterol.

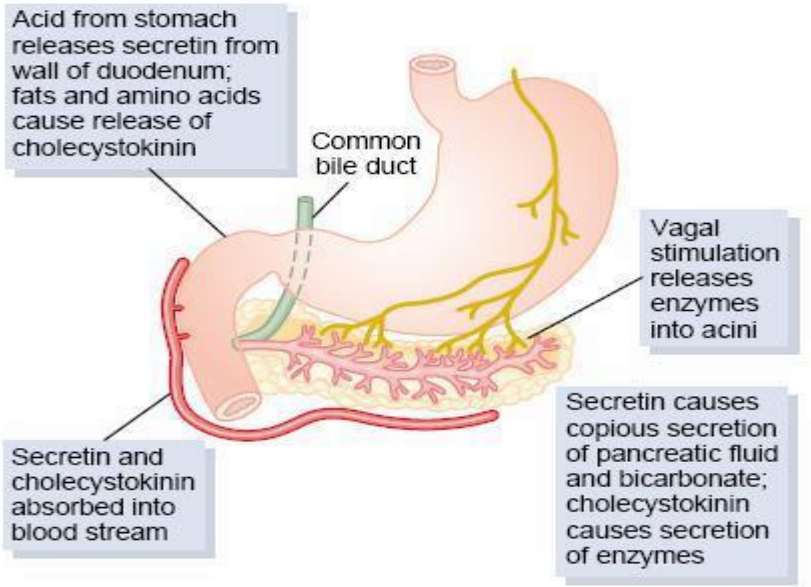
c) Phospholipase A2 which splits phospholipids into lysophospholipids & FA.



Pancreatic Secretion Control

Physiology Team

- Pancreatic secretion is under neural & hormonal control.
- Parasympathetic stimulation (through Ach on acinar cells) results in an increase in enzyme secretion-fluid and HCO3-.
- Secretin tends to stimulate a HCO3- rich secretion by activating ductal cells.
- Cholecystokinin (CCK) stimulates a marked increase in enzyme secretion by stimulating the acinar cells.
- Pancreatic secretion normally results from the combined effects of the multiple basic stimuli, not from one alone (potentiate each other).
- Secretin & CCK augment each other's effect.
- Ach and CCK stimulate acinar cells producing large quantity of Pancreatic enzyme and small quantity of water and electrolyte in contrast to Parasympathetic and secretin stimulation which will secrete large quantities of H_2O and $NaHCO_3$.
- Multiplication or potentiation effect occur when different pancreatic stimuli occur at once Then the total secretion is far greater than the sum of each and which is usually the setting.



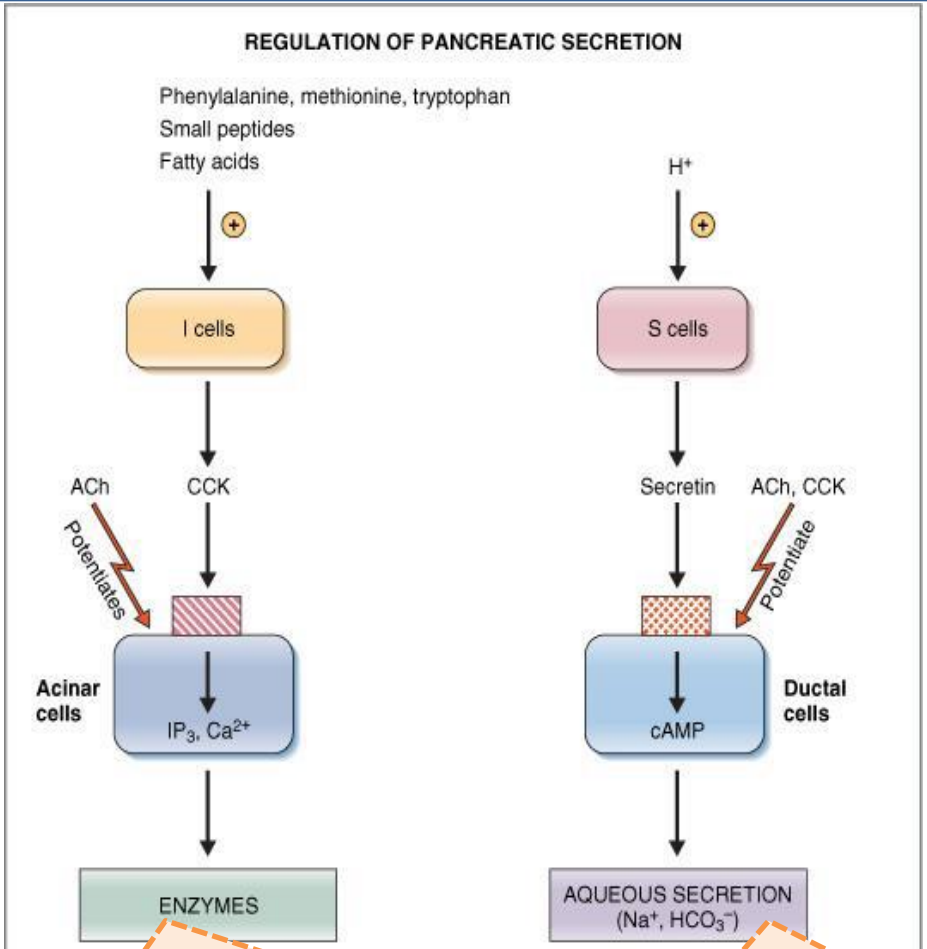
Phases of Pancreatic Secretion

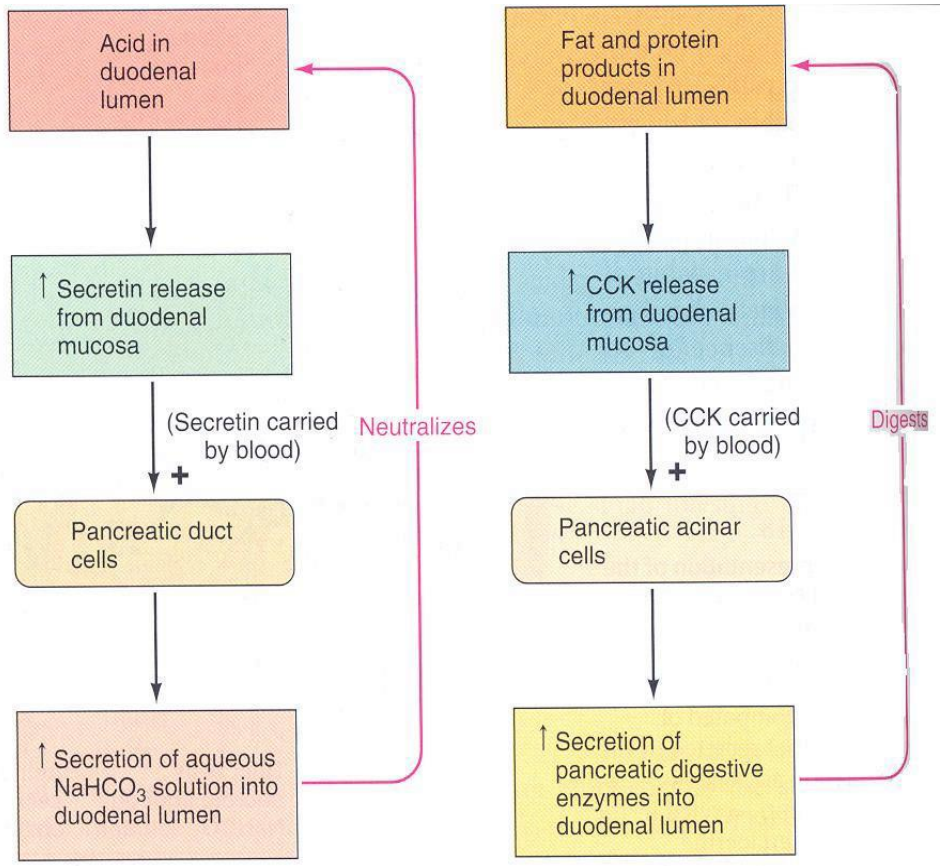
Physiology Team

Phase	Stimulus	Mediator
Cephalic phase	Smell, taste, chewing and swallowing	Release of Ach and gastrin
Gastric phase	Protein, gastric distention	Vago-vagal reflex
Intestinal phase	Acid in chyme, fatty acids	Secretin, CCK and vago-vagal reflex

Phases of Pancreatic Secretion

Physiology Team





Hormonal control of pancreatic exocrine secretion

To digest food end products

To neutralize acidity

Slides | Important | Females' Notes | Explanation | Males' Notes

Pancreatic Secretion

Important

Physiology Team

	Secretin	Cholecystokinin (CCK)
Released from	S cells in upper intestinal mucosa	I cells in upper intestinal mucosa
Stimuli	Mainly acids (pH 4 or less) (PH<4.5-5)	Mainly by AA, FA, peptones and proteoses
Effect on pancreas	Acts on pancreatic duct cells to stimulate secretion of HCO3- and H2O.	1. Acts on pancreatic acinar cells to stimulate enzyme secretion. 2. Has trophic effect on pancreas.
Effect on stomach	Inhibits gastric motility, contracts pylorus and slows gastric emptying.	Stimulates gastric motility, contracts pylorus thus slows gastric emptying.
Effect on intestines	Inhibits intestinal motility & contracts ileocecal sphincter.	stimulates intestinal motility.
Effect on LES	Relaxation	Relaxation
Extra effects	1. Acts on biliary duct cells to stimulate hepatic bile flow and HCO3- secretion. 2. Inhibits gastric acid secretion and gastrin release. 3. Stimulates pepsin secretion.	1. Contracts gall bladder, relaxes sphincter of Oddi and causes bile discharge into intestine. 2. May be concerned with the mechanism of satiety.

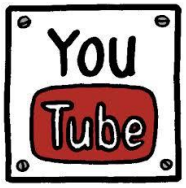
SUMMARY

Physiology Team

- Pancreatic acinar glands are the main source of digestive enzyme.
- Sphincter of Oddi surrounds ampulla of vater to control the passage of pancreatic juice.
- Pancreatic juice is secreted in response to the presence of chyme in the upper portions of the small intestine.
- HCO3- concentration increases with increasing secretion rate.
- Pancreatic enzymes are:

1. Protein digestion →Trypsin, chymotrypsin, elastase, carboxypeptidase.
2. Carbohydrate digestion →Pancreatic amylase.
3. Fat digestion → Pancreatic lipase, cholesterol esterase, phospholipase A2.

- Parasympathetic stimulation and CCK stimulate enzyme secretion from acinar cells.
- Secretin tends to stimulate a HCO3- rich secretion by activating ductal cells.
- Phases of pancreatic secretion are: Cephalic, gastric and intestinal.
- Secretin is mainly stimulate by HCl while CCK is mainly stimulated by AA & FA.
- This effect of CCK is similar to that caused by vagal stimulation but even more pronounced, accounting for 70-80% of the total secretion of the pancreatic digestive enzymes after a meal.



The Role and Anatomy of the Pancreas
http://www.youtube.com/watch?v=NZ4zcrTzUjA

QUESTIONS

Physiology Team

1) Pancreatic juice is released in response to:

A. Hypoglycemia.
B. Hyperglycemia.
C. Presence of chyme in small intestines.
D. Presence of chyme in stomach.

2) As the flow rate of pancreatic juice increases:

A. HCO_3 secretion increases.
B. HCO_3 secretion decreases.
C. HCO_3 secretion remains unchanged.

3) Which one of the following is an exopeptidase:

A. Trypsin
B. chymotrypsin
C. Elastase
D. Carboxypeptidase

4) Which of the following does not produce a direct effect on acinar cells:

A. Paraysmpathetic stimulation
B. Secretin
C. CCK

5) Which one of the following activates proelastase into elastase:

A. Enteropeptidase
B. Trypsin
C. Pepsin
D. Secretin

6) Which one of the following contracts gall bladder causing bile discharge into intestine:

A. Secretin
B. Cholecystokinin
C. Bile salts
D. Cholesterol ester

7) Which one of the following causes increased secretion of aqueous NaHCO3 solution into duodenal lumen?

A. Secretin
B. Cholecystokinin
C. Bile salts
D. Cholesterol ester

1 = C
2 = A
3 = D
4 = B
5 = B
6 = B
7 = A

THE END

Physiology Team

If there are any Problems or Suggestions,
Feel free to contact us:

Physiology Team Leaders

Mohammed Jameel & Shaimaa Al-Refaie

432Physiology@gmail.com

THANK YOU

IF YOU WANT TO SHARE ANY INFORMATION REGARDING PHYSIOLOGY OR ANY OTHER SUBJECT .. YOU CAN MENTION THIS ACCOUNT @MED432