



Physiology Of Pancreas

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- Important
 - Further explanation
- Important topic



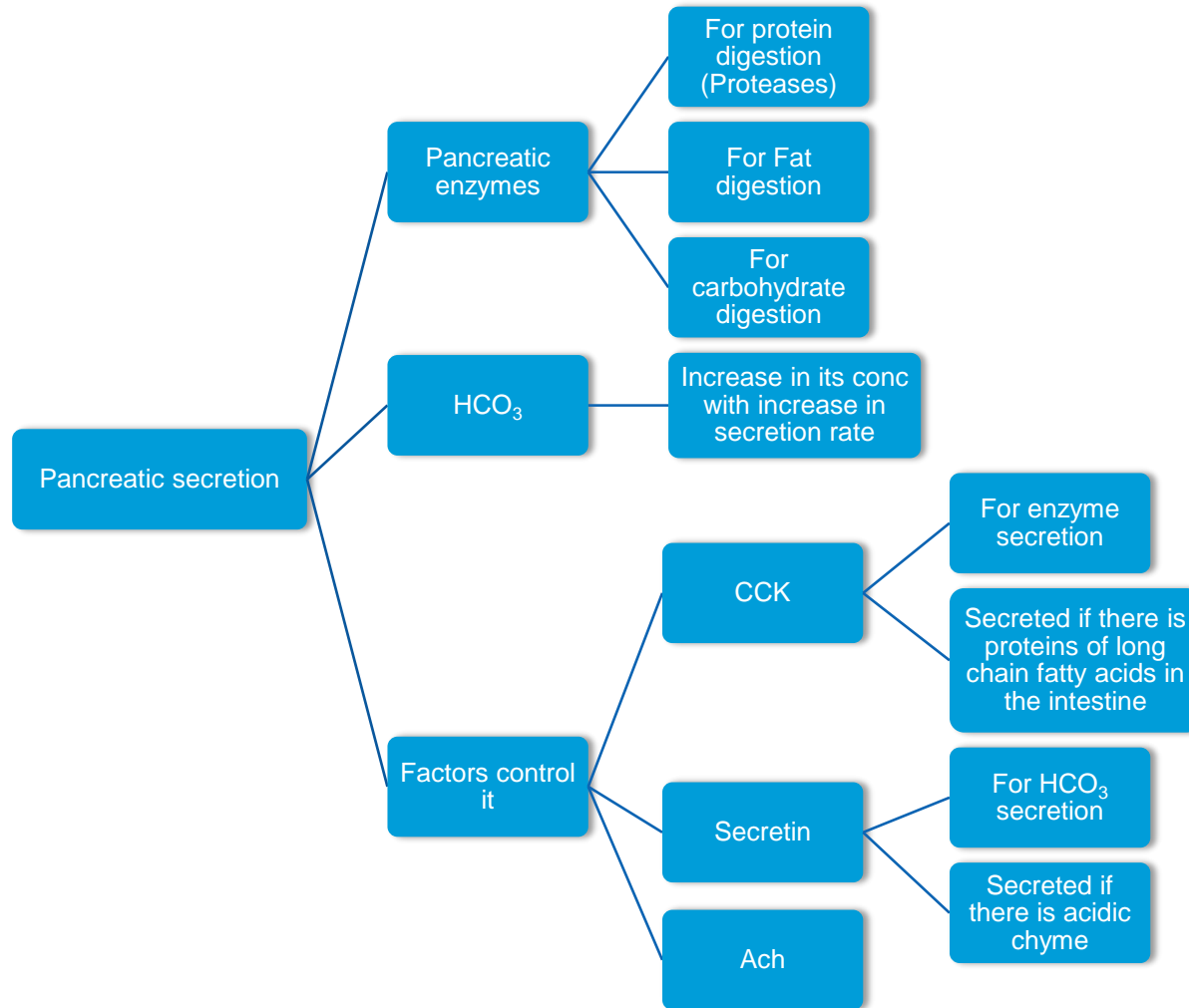
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Please check out this link before viewing the file to know if there are any additions/changes or corrections. The same link will be used for all of our work [Physiology Edit](#)

Mind map

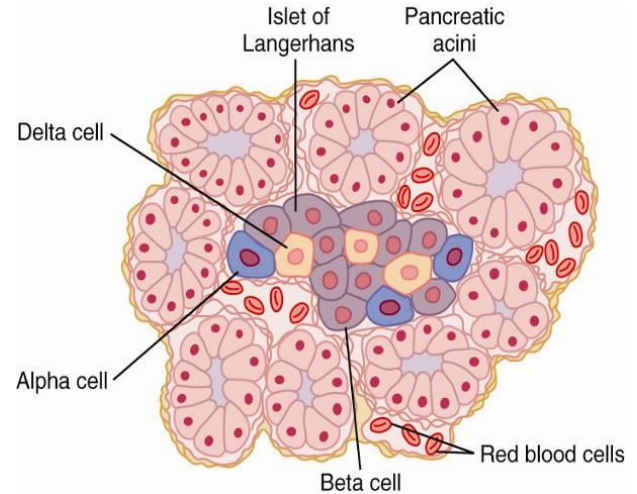


Functional Anatomy

Pancreas

Exocrine Part

Endocrine Part



✧ The Islet of Langerhans (Endocrine part) :

Secrete:

- Insulin (beta cells) --> regulation of glucose and fat and protein metabolism
- Glucagon (alpha cells) --> regulation of glucose and fat and protein metabolism.
- **Somatostatin** (Delta cells).

(Will discuss in details in endocrine Block)

✧ Pancreatic acini, the small ductules and large duct (Exocrine part)

Secrete :

- Pancreatic enzymes (NEXT SLIDE) (By the acini).
- Sodium bicarbonate (HCO_3) (by the duct cells).

These TWO are together called the **pancreatic juice** or **secretion**

Pancreatic Juices

Neutralize the acids

- By : HCO_3
- Functions: neutralize the acidity in duodenum to optimum PH for pancreatic enzymes. (PH = 7-8)

Prevent the damage to duodenal mucosa by acid

- By : HCO_3
- Pancreas secrete about 1 L/day of HCO_3 – rich fluid.

It has the pancreatic enzymes

- These pancreatic enzymes involve in digestion of
 - Carbohydrate
 - Fats
 - Proteins

- The osmolarity of pancreatic fluid is equal to that of plasma (Isotonic).

Pancreatic Enzymes

1. For the digestion of **proteins**:

The active enzyme	Trypsin	Chymotrypsin	Carboxypolypeptidase
Function	Split proteins into peptides of various size NOT single amino acids (Endopeptidase)*	Split proteins into peptides of various size NOT single amino acids (Endopeptidase)	Splits peptides into single amino acids (Exopeptidase)*
Inactive form	Trypsinogen	Chymotrypsinogen	Procarboxypeptidase
Activated by	1-Enteropeptidase (enterokinase) 2-Trypsin (Trypsin can automatically activate other trypsinogen and increase itself).	Trypsin	Trypsin
Types	-	-	A and B

IMPORTANT NOTE: The activation of Trypsinogen or other enzymes occur in the intestinal lumen.

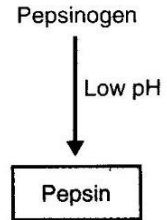
***Enteropeptidase** : This enzyme secreted by the intestinal mucosa when chyme comes in contact with the mucosa.

***Endopeptidases** : the trypsin and chymotrypsin can hydrolyze the middle amino acid bond only.

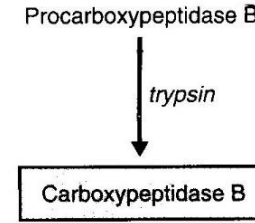
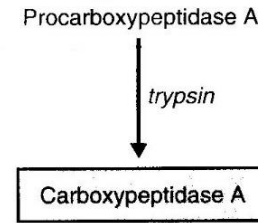
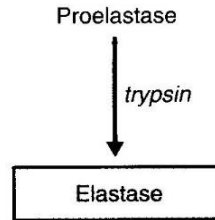
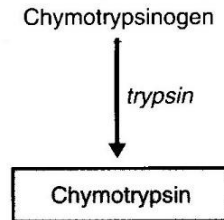
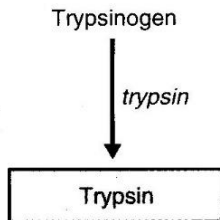
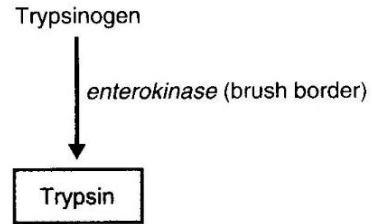
***Exopeptidase** : the Carboxypolypeptidase can hydrolyze the peripheral amino acid bond only..

ACTIVATION OF GASTROINTESTINAL PROTEASES

A Stomach



B Small intestine



Trypsin inhibitor

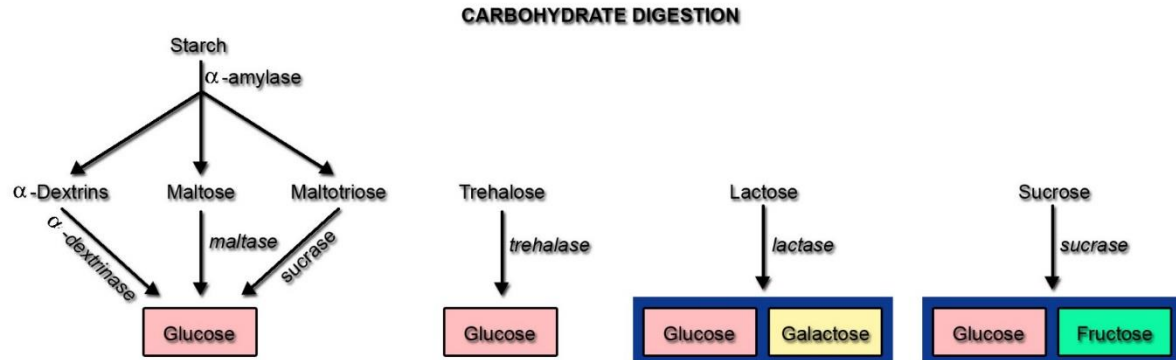
- As we said, the activation of Trypsinogen into trypsin occur in the intestinal lumen.
- The cells which secrete these pancreatic enzymes also secrete trypsin inhibitor (e.g alpha-antitrypsin) which inhibit the activation of trypsin in the pancreas.
- **So What if there is activation of trypsin in the pancreas!!?**
This will lead to digestion of the pancreas by this activated trypsin.

Pancreatic Enzymes

2. For the digestion of Carbohydrates:

- The pancreatic enzyme for digesting carbohydrates is **pancreatic amylase**, which hydrolyzes starches, glycogen, and most other carbohydrates (**except cellulose**) to form mostly disaccharides and a few tri-saccharides.

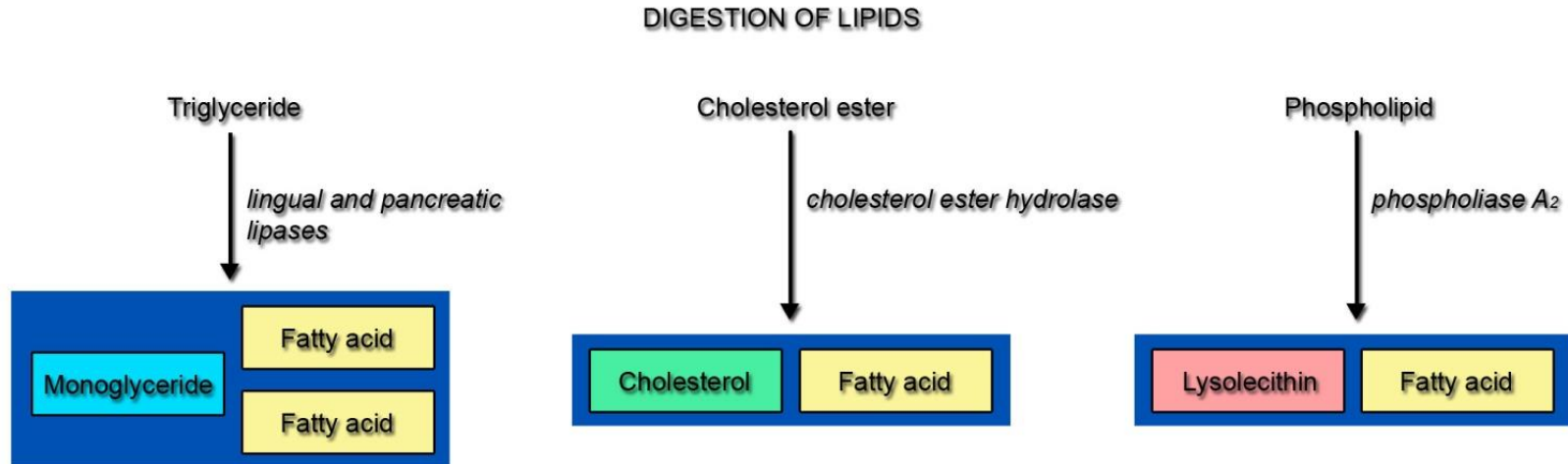
- Disaccharides are enzymes involved in digestion of disaccharides into monosaccharides such as Lactase ,Sucrase.
- There is no part of pancreatic enzymes (Found in brush border only).



Pancreatic Enzymes

3. For the digestion of **Fat**:

- Pancreatic lipase
- Cholesterol esterase
- Phospholipase

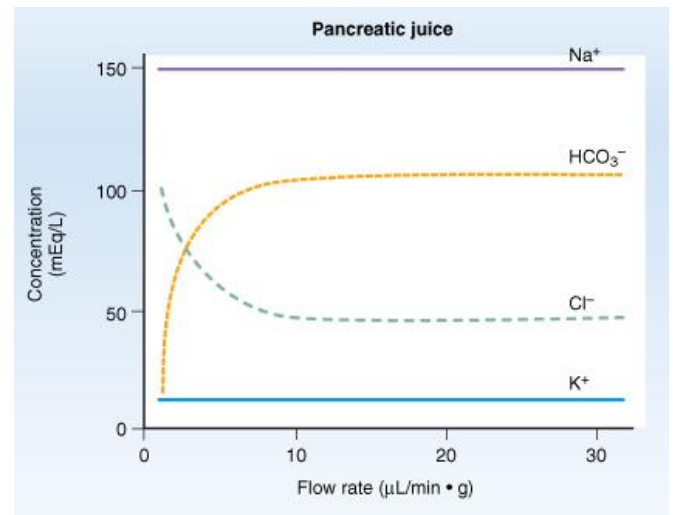
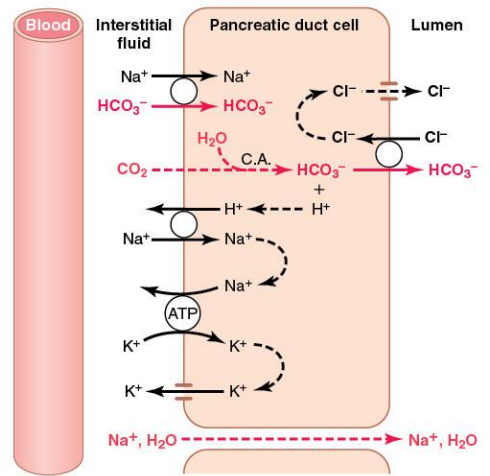




Secretion Of Bicarbonate Ions

- **HCO₃⁻ concentration increases with increasing secretion rate and chloride concentration decreases** (As you can see in the right figure and also can be explained by the left one), **and this is done by HCO₃⁻ Cl⁻ exchanger** (secondary active transport).
- **Blood around the pancreas is acidic (Opposite to that of stomach). WHY!!**

“As you can see in the left picture in the pancreatic duct cell there is the enzyme carbonic anhydrase which convert water and Co₂ into HCO₃⁻ and H⁺ , The HCO₃⁻ will be released into the lumen whereas the H⁺ will be released into the blood around the pancreas.



Factors Affect The Secretion Of Pancreatic Juices

- Pancreatic juices is under hormonal and neural control.

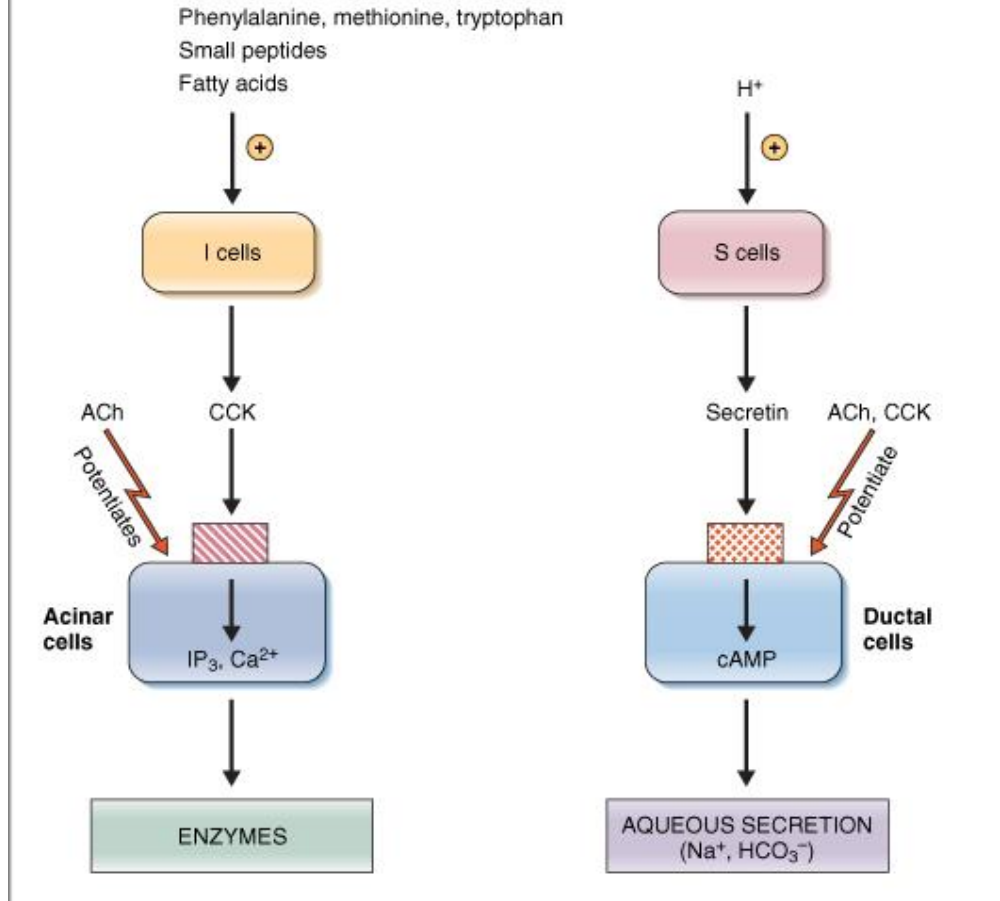
	Ach	Secretin	Cholecystokinin CCK
Function	increase in enzyme secretion-fluid and HCO ₃	Stimulate a HCO ₃ rich secretion (NaHCO ₃ solution) by activating ductal cells (Doesn't cause enzymes secretion) but a low concentration Cl ⁻ .	increase in enzyme secretion by stimulating the acinar cells
Secreted by	Nerve ending of PSNS	Present in an inactive form, prosecretin in the duodenal and jejunal mucosa (S cells)	Secreted by duodenal and upper jejunal mucosa (I cells)
Secreted if		When highly acidic chyme (PH between 4.5-5).	the presence of proteoses and peptones (products of partial protein digestion) and long-chain fatty acids in the chyme

Important note:

Pancreatic secretion normally results from the combined effects of the multiple basic stimuli, not from one alone (potentiate each other). --> The Potentiation Effect



REGULATION OF PANCREATIC SECRETION





Multiplicative Or Potentiation Effects Of Different Pancreatic Secretion Stimuli

- When all different stimuli of pancreatic secretion (acetylcholine, cholecystokinin, and secretin) occur at once, then **the total secretion is far greater than the sum of the secretions caused by each stimulus separately.** The stimuli are said to “multiply” or “potentiate” one another.

Usually, **Pancreatic secretion normally results from the combined effects of the multiple basic stimuli, not from one alone (potentiate each other).** --> **The Potentiation Effect**

The Phases Of Pancreatic Secretion

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

1-What is the final effect on HCO_3 as the secretion rate increases?

- A. Decrease
- B. Increase
- C. NO Effect
- D. Constant

2-Acidic chyme in the duodenum, What is the effect on pancreatic secretion?

- A. The secretion of enzyme will increase
- B. The secretion of HCO_3 will increase
- C. Decrease in both HCO_3 and enzymes
- D.A+B

3-Which of the following is true about the secretion from exocrine pancreas?

- A. It has higher Cl^- concentration than does plasma.
- B. It is stimulated by the presence of HCO_3 in the duodenum.
- C. Pancreatic HCO_3 secretion is decreased by gastrin
- D. Pancreatic enzyme secretion is increased by cholecystokinin

4- Which of the following enzymes activate the other inactive enzymes involve in protein digestion?

- A. Trypsinogen
- B. Trypsin
- C. Chymotrypsin
- D. Carboxypolypeptidase

5-Which of the following pancreatic enzymes involve in carbohydrate digestion?

- A. Lactase
- B. Fructose
- C. Sucrase
- D. Amylase

6- Measuring the PH of the blood around the pancreas, What do you think the result might be

- A. < 7
- B. > 7
- C. $=7$ neutral

7-Certain disease is associated with decrease activity of trypsin inhibitors, What do you think the manifestation of the this disease?

- A. Liver dysfunction
- B. Pancreas insufficiency
- C. CNS manifestation
- D. Kidney problem

Q1: Which hormone is activated by the presence of protein in the intestine?

Ans: CCK

Q2: What is the effect of CCK in the pancreas secretion?

Ans: increase the enzymes secretion

Q3: What are the pancreatic enzymes involve in protein digestion?

Ans:

Trypsin

Chymotrypsin

Carboxypeptidase

Q4: What is the type of transporter is found in the pancreatic ductal cells?

Ans: HCO₃ Cl⁻ exchanger (secondary active transport)

Q5: What is the mediators involve in the the increase the secretion of pancreas by gastric distention?

Ans: vago-vagal reflex

Q6: As the flow rate of pancreatic juice increases, what will happen to Chloride secretion?

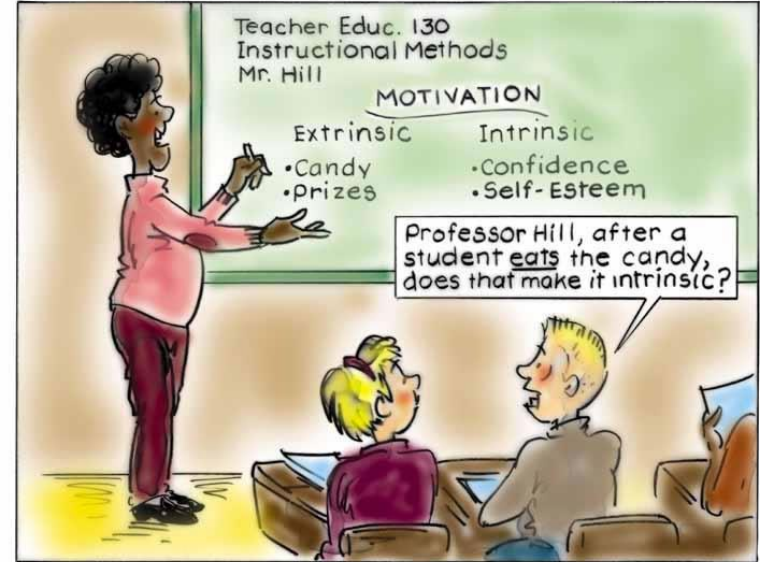
Ans: Decrease

Thanks for checking our work

Good Luck

Done by:

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- Omar AlRahbeeni



You may not be there yet, but you're closer than you were yesterday.