REGULATION OF PANCREATIC AND BILE SECRETION

OBJECTIVES
- Pancreatic juice
- Biliary system
- Liver bile
- Functions of gall bladder

THE PANCREAS
- The pancreas is both an endocrine and exocrine gland.

<table>
<thead>
<tr>
<th>ENDOCRINE PARTS</th>
<th>EXOCRINE PART</th>
</tr>
</thead>
<tbody>
<tr>
<td>islets of Langerhans</td>
<td>compound alveolar gland</td>
</tr>
<tr>
<td>secretes hormones</td>
<td>secretes the pancreatic juice</td>
</tr>
</tbody>
</table>

- The pancreatic secretion is conducted to the duodenum through a system of ducts. The small ducts drain into a single large duct which usually joins the common bile duct forming the ampulla of Vater.
- This opens through the duodenal papilla and its opening is encircled by the sphincter of Oddi.

NERVE SUPPLY OF THE PANCREAS
Like the stomach, the pancreas receives both:
1. Parasympathetic nerve fibers from the vagus
2. Sympathetic nerve fibers from the greater splanchnic nerve

THE PANCREATIC JUICE
- The most important digestive juice
- 1.5 liters/day
- Alkaline in reaction (pH is about 8) because it has a high bicarbonate content

Composition of the pancreatic juice

The pancreatic juice is formed of 2 main parts:

<table>
<thead>
<tr>
<th>AN AQUEOUS PART</th>
<th>AN ENZYMATIC PART</th>
</tr>
</thead>
<tbody>
<tr>
<td>watery juice rich in bicarbonate</td>
<td>viscid juice</td>
</tr>
<tr>
<td>secreted by the duct cells</td>
<td>secreted by the pancreatic alveoli</td>
</tr>
</tbody>
</table>

Function of bicarbonate solution

The bicarbonate solution in aqueous secretion
- Neutralized the acid chyme
- Protects the delicate duodenal mucosa from excess acidity
- Washes out the thick viscid enzymatic part secreted by the alveoli
The pancreatic enzymes

1. PROTEOLYTIC ENZYMES
   - Trypsinogen
   - Chymotrypsinogen
   - Proelastase
   - Procarboxypeptidase

2. PANCREATIC ALPHA-AMYLASE

3. LIPOLYTIC ENZYMES
   - Pancreatic lipase
   - Phospholipase A
   - Pancreatic esterase

4. PANCREATIC NUCLEASES

Control of pancreatic secretion

- The secretion of the pancreatic juice is controlled by both:
  1. nervous mechanism
  2. hormonal mechanism (more important)

NERVOUS CONTROL

<table>
<thead>
<tr>
<th>PARASYMPATHETIC</th>
<th>SYMPATHETIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulation of the vagus nerve.</td>
<td>Decreases the pancreatic secretion particularly bicarbonates.</td>
</tr>
<tr>
<td>Causes secretion of pancreatic juice little in amount but rich in enzymes.</td>
<td>Nicotine stimulates the sympathetic fibers and inhibits the release of secretin hormone.</td>
</tr>
<tr>
<td>Occurs by the conditioned &amp; unconditioned reflexes</td>
<td>Both effects reduce bicarbonate secretion from the pancreas and favors duodenal ulcers in cigarette smokers.</td>
</tr>
<tr>
<td>During the cephalic phase</td>
<td></td>
</tr>
</tbody>
</table>

HORMONAL CONTROL

Two gastrointestinal hormones affect pancreatic secretion:

<table>
<thead>
<tr>
<th>SECRETIN</th>
<th>CHOLECYSTOKININ (CCK)</th>
</tr>
</thead>
<tbody>
<tr>
<td>secreted by the duodenal mucosa on contact with the acid chyme delivered from the stomach</td>
<td>secreted by the duodenal mucosa on contact with the digestive products of proteins and fats.</td>
</tr>
<tr>
<td></td>
<td>stimulates the secretion of the enzymatic part of the pancreatic juice.</td>
</tr>
</tbody>
</table>

Physiological effects of secretin hormone

1. Stimulates the secretion of the aqueous part of the pancreatic juice.
2. Inhibits the secretion of gastric HCl.
3. Inhibits the gastrointestinal motility.
4. Stimulates the secretion of watery bile rich in inorganic constituents.
**Liver Bile**

**Composition of Liver Bile**
- The liver bile is a golden yellow alkaline fluid
- (pH 7.8-8.6)
- 500-800 ml/day
- Composed of
  1. Water
  2. Inorganic constituents: Na, HCO3, Cl
  3. Organic constituents: Bile salts, bile pigments, lipids

**Regulation of Bile Secretion and Flow**
(factors affecting bile secretion)
1. Hepatic blood flow
2. Vagal stimulation
3. Bile salts - it is choleretic
4. The hormone secretin (hydrocholeretic effect)

**Functions of the Gallbladder**
1. Storage of bile
2. Concentration of bile
3. Acidification of bile
4. Secretion of mucus
5. Evacuation
6. Decreasing the pressure in the bile ducts

**Control of Gallbladder Evacuation**

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<tr>
<th>Nervous Control</th>
<th>Hormonal Control</th>
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<tbody>
<tr>
<td>Stimulation of the vagus&lt;br&gt;Causes relaxation of sphincter of Oddi &amp; weak contraction of the gallbladder.&lt;br&gt;Is stimulated by meals through conditioned and unconditioned reflexes&lt;br&gt;During cephalic phase of gastric secretion</td>
<td>The hormone CCK&lt;br&gt;Causes contraction of the gallbladder wall &amp; evacuation of its contents into the duodenum.</td>
</tr>
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</table>

**Choleretics**
- Substances that increase bile secretion by the liver.

**Cholagogues**
- Substances that cause contraction of the gallbladder thus increasing the bile flow into the duodenum.

**Physiologic**
- Bile salts & secretin hormone.<br>CCK.

**Drugs**
- Vasodilator drugs that increase the hepatic secretion.<br>Magnesium sulphate and cholinergic drugs which cause weak contraction of the gallbladder.
FUNCTIONS OF BILE
1. contains bile salts that are essential for fat digestion and absorption & other important functions.
2. The alkali content of bile helps neutralization of gastric HCl.
3. The mucin in bile acts as lubricant in the small intestine.
4. An excretory route for many substances as bile pigment and drugs.

BILE SALTS
- These are Na+ and K+ salts of bile acids conjugated to glycine and taurine.
The Enterohepatic circulation of the bile salts:
- 90-95% of bile salts are actively reabsorbed from the terminal ileum and returns to the liver where they are resecreted.

FUNCTIONS OF THE BILE SALTS
1. Help digestion of fat by
   - Emulsification (decrease surface tension)
   - Dissolve FA
   - Activate pancreatic lipase enzyme
2. Help absorption of fat & fat soluble vit
3. Solvent action, keep cholesterol dissolved in bile.
4. Laxative effect
5. Choleretic effect
6. Anti putrification action
7. Help absorption of Ca,Mg,Fe

BILE PIGMENTS
- The bile pigments are the end-products of hemoglobin metabolism.
- The remaining part of the haem molecule (after removing the iron) is converted into a yellow pigment called bilirubin.
- This occurs in the RES cells.
- Bilirubin is secreted by the liver cells into the bile as bile pigments.

Effects of common bile duct obstruction
1. Obstructive jaundice
2. Impaired liver functions
3. Decreased flow of bile salts into the intestine
4. Pruritis (itching)
5. Bradycardia