Digestion Pt. 2

**Regulation of GI Function**

Digestion is complicated. There are many control mechanisms (local & neural).

**Reflexes:**
- Long reflexes integrated in CNS
- Short reflexes integrated in ENS
- Reflexes involving GI peptides

**Integration of long and short reflexes in the digestive system**

**Long Reflexes**
- Cephalic reflexes (long-reflex that originates outside of digestive system)
- Emotions on GI tract (butterflies/travelers tummy)? ANS?

**Short Reflexes : Integration is in ENS not CNS**

- Digestion is complicated. There are many control mechanisms (local & neural).
- Hormones: released into blood can act on GI tract, accessories, brain
- Emotions on GI tract (butterflies/travelers tummy)? ANS?

**Regulation of GI Function**

Note: SNS and PNS have an effect – (long or short reflex?)

**Can work independently of CNS**

ENS Shares Features with CNS
- Intrinsic neurons (occur totally in gut – like interneurons in CNS)
- Neurotransmitters and neuromodulators (> 30 that are identical to those found in brain)
- Glial cells (similar to astrocytes)
- Diffusion barrier (caps that surround ganglia have barriers)
- Integrating center (does its own)
**Digestive Hormones**

<table>
<thead>
<tr>
<th>TABLE 21-1 The Digestive Hormones</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>STIMULUS FOR RELEASE</strong></td>
</tr>
<tr>
<td><strong>STOMACH</strong></td>
</tr>
<tr>
<td>Gastrin</td>
</tr>
<tr>
<td><strong>INTESTINE</strong></td>
</tr>
<tr>
<td>Cholecystokinin (CCK)</td>
</tr>
<tr>
<td>Secretin</td>
</tr>
<tr>
<td><strong>INTESTINE</strong></td>
</tr>
<tr>
<td>Gastric inhibitory peptide (GIP)</td>
</tr>
<tr>
<td>Glucagon-like peptide 1 (GLP-1)</td>
</tr>
</tbody>
</table>

**The Cephalic Phase**

Anticipatory stimuli and food in the mouth activates neurons in Medulla oblongata

- Chemical and mechanical digestion begins in the mouth
  - Chemical -
  - Salivary secretion is under autonomic control
    - Softens and lubricates food
    - Chemical digestion: Salivary amylase and some lipase
    - Lysozyme: antibacterial enzyme
    - Immunoglobulins: work on bacteria and viruses

**Mechanical -**
- Chewing: mastication

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**Swallowing Reflex**

Swallowing: Deglutition - a reflex

Food moves downward into the esophagus, propelled by peristaltic waves and aided by gravity.

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**The Gastric Phase**

Stomach has 3 main functions:

- Storage (upper stomach)
  - Digestion
    - Lower Stomach
    - Acid, enzymes, and signal molecules
- Protection
  - Bacteria & other Pathogens
  - From itself
The Gastric Phase

- Acid secretion: Parietal cells
- Enzyme secretion: Chief cells (pepsinogen to pepsin)
- Paracrine secretion: ECL secretes histamine promotes HCl release
- D Cells secrete Somatostatin inhibits gastric juice release
- Hormone release: G-cells secrete gastrin stimulate gastric juice release

Long and short reflexes of Cephalic and Gastric Phases

1. Food
2. Food or cephalic reflexes initiate gastric secretion.
3. Gastrin stimulates acid secretion by direct action on parietal cells or indirectly through histamine.
4. Acid stimulates short reflex secretion of pepsinogen.

Integration of cephalic and gastric phase secretion in the stomach

Figure 21-26, steps 1–3
**The Gastric Phase**

- **Input via vagus nerve**
- **Enteric sensory neuron**
- **ECL cell**
- **G cell**
- **D cell**
- **Histamine**
- **Pepsinogen**
- **Food**

Gastrin stimulates acid secretion by direct action on parietal cells or indirectly through histamine.

Acid stimulates short reflex secretion of pepsinogen.

Somatostatin release by \( H^+ \) is the negative feedback signal that modulates acid and pepsin release.

Figure 21-26, steps 1–4

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**How Mucus and Bicarbonate protect us**

- The mucus-bicarbonate barrier of the gastric mucosa
- Still NSAIDS, Helicobacter pylori, over production of HCl or Gastrin can be bad

Figure 21-27

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**The Intestinal Phase**

- Begins as chyme enters small intestine
  - Activates DND which slows gastric motility and secretion
  - CCK: secreted into blood if a fatty meal: stimulates Bile release and slows gastric release into intestine
  - GIP and GLP1 promote insulin release
  - Hyperosmotic chyme triggers receptors to inhibit gastric release

Figure 21-28

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**The Intestinal Phase**

- Bicarbonate neutralizes gastric acid
- Goblet cells secrete mucus for protection and lubrication
- Bile
  - Fat digestion
  - Brush border enzymes (peptidases, disaccharidases, proteases (enteropeptidase))

Figure 21-29

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**Zymogens: inactive enzymes**

- Trypsinogen
- Chymotrypsinogen
- Carboxypeptidase A
- Pancreatic secretions (include inactive zymogens)

Figure 21-30

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**Hepatic Portal System**

- Most fluid is absorbed in the small intestine (7.5 of 9 l)
- Most nutrients pass from SI to Liver via Hepatic Portal System

Figure 21-31
The Intestinal Phase

- Most digestion occurs in small intestine
- Large intestine concentrates waste for excretion
- Motility in large intestine
  - Mass movement triggers defecation
    - Occurs 3 – 4 times a day
    - Responsible for Defecation reflex
- Digestion and absorption in large intestine
  - Digestion: bacteria can break down some carbs and proteins
    - produces lactate, fatty acids, butyric acid (some of which is absorbed)
    - Bacteria produces Vit. K

The Intestinal Phase: Anatomy of the Large Intestine

- Rectum
- Rectum
- Internal anal sphincter
- Anus
- Cecum
- Appendix
- Ileum
- Ileocecal valve
- Ascending colon
- Transverse colon
- Descending colon
- Sigmoid colon
- Haustra
- Tenia coli
- Circular muscle
- Longitudinal layer
- Submucosa
- Muscularis mucosae
- Muscularis externa
- Intestinal glands
- Lymphoid nodule
- Muscularis mucosa
- Submucosa
- Muscularis externa

The Intestinal Phase: Defecation reflex

- Movement of feces into empty rectum triggers a spinal reflex
  1. Smooth muscle of internal anal sphincter relaxes
  2. Peristalsis in rectum moves “the package” towards anus
  3. External anal sphincter is consciously relaxed

- Valsalva maneuver

Immune Function

- Peyers patches – lymphatic tissue (GALT or MALT):
  - M cells on Peyers patches “sample” contents of the gut
    - Have antigen receptors
    - Move antigen by traneytosis to GALT
    - Macrophages and Lymphocytes do their thing
      - Cytokines trigger inflammatory response – or
      - Increase in Cl⁻, fluid, and mucus secretion
  - Vomiting (emesis) a protective reflex