D.2 Digestion
**Understandings, Applications & Skills**

<table>
<thead>
<tr>
<th>Statement</th>
<th>Guidance</th>
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<tbody>
<tr>
<td><strong>D.2.U1</strong> Nervous and hormonal mechanisms control the secretion of digestive juices.</td>
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<td><strong>D.2.U2</strong> Exocrine glands secrete to the surface of the body or the lumen of the gut.</td>
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<td><strong>D.2 U3</strong> The volume and content of gastric secretions are controlled by nervous and hormonal mechanisms.</td>
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<td><strong>D.2 U4</strong> Acid conditions in the stomach favour some hydrolysis reactions and help to control pathogens in ingested food.</td>
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<tr>
<td><strong>D.2.U5</strong> The structure of cells of the epithelium of the villi is adapted to the absorption of food.</td>
<td>Adaptations of villus epithelial cells include microvilli and mitochondria.</td>
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<td><strong>D.2.U6</strong> The rate of transit of materials through the large intestine is positively correlated with their fibre content.</td>
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<td><strong>D.2.U7</strong> Materials not absorbed are egested.</td>
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# Understandings, Applications & Skills

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<td><strong>D.2.A1</strong> The reduction of stomach acid secretion by proton pump inhibitor drugs.</td>
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<td><strong>D.2.A2</strong> Dehydration due to cholera toxin.</td>
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<td><strong>D.2.A3</strong> Helicobacter pylori infection as a cause of stomach ulcers.</td>
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<tr>
<td><strong>D.2 S1</strong> Identification of exocrine gland cells that secrete digestive juices and villus epithelium cells that absorb digested foods from electron micrographs.</td>
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</table>
Dr. William Beaumont “Father of Gastric Physiology”

Nature of science: Serendipity and scientific discoveries—the role of gastric acid in digestion was established by William Beaumont while observing the process of digestion in an open wound caused by gunshot. (1.4)

https://www.youtube.com/watch?v=6YVE9PGzI_M
Nerves + Hormones control secretion of Digestive Juice

Fight or flight!

- If not necessary, digestion does not need to be occurring. Better to save energy in case “flight or fight” response is required.
- Conserve energy for muscle use creates the need to divert energy from the digestive process.

This is controlled by your autonomic nervous system
Divisions of the nervous system.
http://pharmacology-notes-free.blogspot.com/
Regulation of Gastric secretions

D.2 U3 The volume and content of gastric secretions are controlled by nervous and hormonal mechanisms

- Both nerves and hormones involved in controlling secretion of digestive juices.
  - Example: Gastric Juice
  - Starts with the sight or smell of food causes brain to send nerve impulses via the vagus nerve from the medulla ...
Digestive Juice! Who’s in Charge?

3 major types

1. Cephalic
2. Gastric
3. Intestinal

Read and take notes here

Gastric control

Video: https://www.youtube.com/watch?v=ifDp57pvK0g
<table>
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<tr>
<th>Hormone</th>
<th>Role</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gastrin</td>
<td>Stimulates secretion of acid and pepsinogen by two types of exocrine glands</td>
<td>Part of stomach nearest to duodenum (more detailed NR: released by G cells, endocrine cells that are located in the gastric epithelium)</td>
</tr>
<tr>
<td>Secretin</td>
<td>Inhibit gastrin secretion if pH in stomach too low</td>
<td>Duodenum</td>
</tr>
<tr>
<td>Somatostatin</td>
<td>Inhibit gastrin secretion if pH in stomach too low</td>
<td>pancreas and duodenum</td>
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D2. U2 Exocrine Glands secrete to the surface of the body or the lumen of the gut

- Passage of mouth to anus = ALIMENTARY CANAL
- Digestive juices added to food at several points
- Exocrine glands secrete the juices

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<tr>
<th>Digestive Fluid</th>
<th>Source</th>
<th>Composition</th>
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<tr>
<td>saliva</td>
<td>Salivary glands</td>
<td>Water, electrolytes, salivary amylase, mucus, lysosomes</td>
</tr>
<tr>
<td>Gastric juice</td>
<td>stomach</td>
<td>Water, mucus, enzymes including pepsin, rennin, HCl</td>
</tr>
<tr>
<td>Pancreatic juice</td>
<td>pancreas</td>
<td>Water, bicarbonate, enzymes including: amylase, lipase, carboxypeptidase, trypsinogen</td>
</tr>
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</table>
Exocrine vs. Endocrine Glands

Glands

Exocrine Glands: secrete to the surface of the body or the lumen of the gut

- Secrete into DUCTS

Endocrine Glands: secrete directly into the bloodstream
Identification of Exocrine Glands

Acinus: Groups of secretory cells that surround a duct branch
Adaptations of Villi

D2.U5 The structure of cells of the epithelium of the villi is adapted to the absorption of food.

- Folds of inner membrane of ileum make up villi
  - each epithelial cell adheres tightly to its neighbours assuring materials pass into the blood vessels lining the villi
  - microvilli make up the brush border on the lumen side to increase SA for absorption
  - large # of mitochondria, generate large amounts of ATP for active transport
  - many pinocytic vessels due to absorption by endocytosis
- Apical surface = surface facing lumen
- basal surface = surface facing blood vessels
  - BOTH contain different types of PROTEIN involved in material transport
Intestinal Villi

Figure 3 Longitudinal section through the ileum wall
ADDITIONAL NOTES: Adaptations of the Villus

- Each epithelial cell covering the villus adheres to its neighbours through TIGHT JUNCTIONS → which ensure that most materials pass through blood vessels lining the villi.
- The collection of microvilli on the intestinal side of the epithelial cells is termed BRUSH BORDER → function = to increase surface area.
Practice

Read and complete the DBQ on pg. 674 in textbook
Acid Conditions of the Stomach

- Acid secreted by the PARIELTAL CELL in the STOMACH
- strongly acidic fluid of the stomach kills many microbes found in found
- HCL partially denatures (and unfolds) proteins in fluid
- stimulates secretion of hormones that promote flow of bile and pancreatic juice
- Pepsinogen is activated to form Pepsin (active at pH 2) which breaks long polypeptides into shorter peptides
Inactive pepsinogen vs. Active Pepsin
- Surface mucus and mucus neck cells
- secrete mucus that is 1–3mm thick and forms a protective barrier that prevents active digestion of proteins in the stomach by pepsin
Ulcers

Crater like lesion in a membrane, peptic ulcers are a result in the GI tract.

Typically caused by…

1. H. Pylori (bacteria)
2. NSAID anti-inflammatory drugs such as aspirin
3. hypersecretion of HCl

How to cure?

1. Antibiotics
2. Proton pump inhibitor drugs
   a. omeprazole
Helicobacter pylori

Look up:
http://www.webmd.com/digestive-disorders/h-pylori-helicobacter-pylori

Type of bacteria:

Symptoms:

Outlook:

Cure:

Class of drugs used:

What does H. Pylori do?
Dietary Fibre

Indigestible plant carbohydrates

- cellulose
- lignin
- pectin

Insoluble fiber - woody + structural parts of plants, skin on fruit, coating of corn - speeds flow through the intestines

Soluble fiber- slows the passage and lowers cholesterol
**Cholera**

Research Cholera:

Who it affects:

What is the associated bacteria:

Are there any cures?

Why do people get so dehydrated
(Background info) Epithelial vs. Endothelial

• Both tissues are of epithelial origins, but the endothelial cells have vimentin, but epithelial cells have keratin filaments.

• By the sound of the terms, endothelium lines the innermost layer of the circulatory system while epithelium usually lines the outer surfaces of the body. Epithelium linings usually expose to the outside or exterior of the body (e.g. Skin, Intestine, Urinary bladder, Urethra, and many other organs). However, the endothelial layers are never exposed to the exterior as they line the innermost layer of the circulatory system, which is a closed system.

• Depending on the type of tissue, the number of layers varies for the epithelium, but endothelial cells always present as a single layered tissue.