Name: ____ Period: _________ Date: ________

Cells of the Stomach Lining

In order for food to be used by our body cells, the macromolecules of which it is composed (carbohydrates, fats, and proteins) must first be broken down by our digestive system into their small molecular components (sugars, amino acids, fatty acids, and glycerol). This breakdown happens two ways: first, food is **physically** broken into smaller pieces; second, it is broken down **chemically**, by breaking the bonds that hold the macromolecules together. Both physical and chemical breakdown occur in the stomach, requiring the contributions of numerous different types of highly specialized cells.

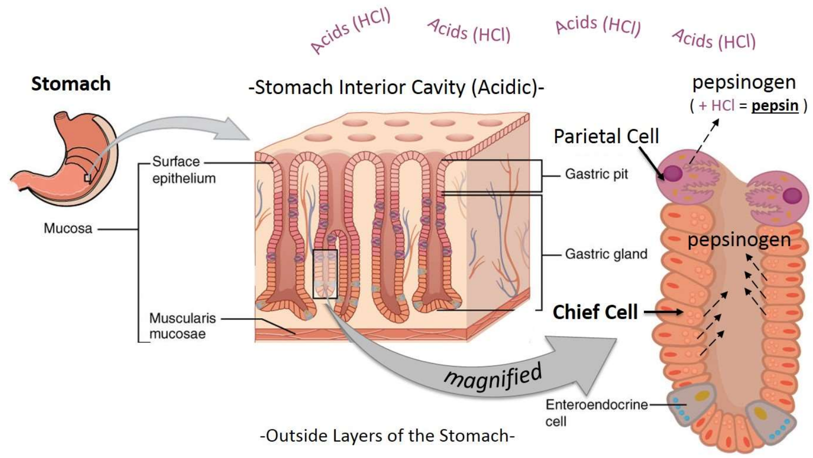

Fig. 1 Layers of the stomach, including tissues that produce pepsinogen. https://commons.wikimedia.org/wiki/File:2322_Fig_23.22-a.jpg

Smooth muscle cells lining the stomach walls have the special ability to contract, crushing and physically breaking food into smaller pieces. Chemical breakdown starts when food reaching the stomach triggers other special cells to produce **hydrochloric acid (HCL)**. HCl weakens the bonds within the macromolecules, particularly proteins, making it easier for **enzymes** (produced by yet another group of specialized cells) to begin breaking down large protein molecules into smaller chains of their building block components (amino acids). These smaller chains will eventually be fully broken down to individual amino acids in the small intestine where they will be absorbed into the bloodstream, then carried to the body cells by the circulatory system.

One of the most important enzymes responsible for chemical digestion in the stomach is **pepsin**. Pepsin catalyzes the breakdown of large protein molecules into short chains of amino acids. Since the stomach itself is made of protein, you might wonder why the pepsin doesn't break down the stomach walls themselves. To a large extent the walls are protected by a layer of mucous (produced by still other special cells!), but there is also an ingenious feedback mechanism that helps prevent self-digestion. The enzyme pepsin does not sit around in your empty stomach waiting for food to arrive. What IS always present is a protein called **pepsinogen**, produced by highly specialized cells of the stomach lining called **chief cells**. Pepsinogen is always present but does not threaten the stomach itself because it is inactive. When exposed to HCl however, pepsinogen converts into pepsin. Recall that HCl is only produced when food enters the stomach, thus the only time there is pepsin in the stomach is when food is also present. Since the active enzyme pepsin always has a readily available substance (your food!) on which to act, the stomach walls are safe.

Featured Protein: Pepsinogen

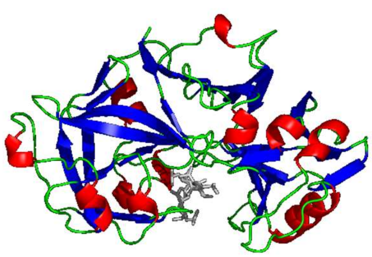

Fig. 2 Pepsin enzyme.

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Stomach cells contain 14,866 of the nearly 20,000 different proteins found in the human body. Almost all of those are also found in varying amounts in cells of other tissues in the body, but 17 of them are said to be **"enriched"** in stomach cells, meaning they are found in ***much*** higher amounts in the stomach than other cells of the body. One of the most important of the enriched stomach proteins is **pepsinogen**, discussed above. Two special properties of this particular protein make it possible for chemical digestion of proteins to occur in the stomach, namely: 1) the fact that pepsinogen itself is inactive, and 2) the fact that exposure to HCl converts it to the active enzyme pepsin. As explained above, both properties are essential for digestion of proteins to occur without the stomach wall itself being attacked. But what property of pepsinogen makes this possible? You may recall that enzymes are proteins necessary for all chemical reactions in the body, and that each is specific to one reaction, because of its unique shape. The shape of an enzyme must fit its target molecules like a lock and key. HCl changes the shape of the pepsinogen molecule. Pepsinogen itself does not "fit" with proteins in a way that affects their internal bonds, but once HCl changes it into pepsin, it does fit, and now it can break the bonds between amino acids in the proteins in our food.

PGA3, the gene that codes for pepsinogen, is found in humans on chromosome 11.