Simulation of the Human Stomach WIP

Keywords: Biochemistry, Biology, Digestive System, Enzymes, stomach

Meta Description

Have you ever wondered what happens to the food you eat when it reaches the stomach? Try out this hands-on experiment to find out!

Learning Objectives

To understand the function of the stomach and how it operates. The effect of enzymes and acidity on food shall be investigated.

Key Terms

Enzymes
Biological molecules which act as catalysts to speed up reactions.

Digestion
The process of breaking down food into smaller parts which involves mechanical breakdown by chewing and churning action of the stomach and also chemical breakdown by the use of enzymes.

Esophagus
A tube that connects the mouth with the stomach.

Small intestine
A tube that connects the stomach with the large intestine. It is here where nutrients are absorbed into the bloodstream.

Catalyst
A chemical that helps to speed up a chemical reaction without itself being used up in the reaction process.

Peristalsis
Pulsating muscular action that pushes food along the gastrointestinal tract.

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Method

Step 1
Tear the slice of bread into very small pieces.

Step 2
Place the pieces of bread into the bag.

Step 3
Pour about half a cup of vinegar in the bag. (Just enough to cover the bread crumbs).

Step 4
Remove the extra air from the bag and then seal it.

Step 5
To simulate the churning action of the stomach squeeze the bag until all the contents in the bag become liquidized.

Step 6
Repeat experiment using water instead of vinegar (as a control).

Step 7
Steps 1-5, but this time, instead of vinegar, add half a cup of amylase solution together with 20 mL of dilute hydrochloric acid solution.

Step 8
Note any differences in the end result of the different chemicals used.

Alternative Method

In this experiment vinegar was used to simulate the acidity of the stomach since it is very similar to gastric acid, however, there are other acidic materials you can find in your kitchen such as orange juice, lemon juice, grapefruit juice, etc. These can be used as alternatives to vinegar.
https://www.teachengineering.org/lessons/view/cub_biomed_lesson05

Instead of using zip-up bags you can use balloons, this allows an element of surprise to the experiment. Basically, after the experiment is conducted with the balloon rather than the zip-up bag, the contents are squeezed out and the rather nasty dissolved bread oozing out can be seen.

There are other enzymes present in the stomach such as pepsin and lipases. Test the action of different enzymes on the bread and other food sources, then compare the differences between the end results.

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Precautions

1. This experiment can be rather messy, therefore it is advisable to wear an apron (or an old shirt), use gloves and also put down newspaper on the working bench.
2. In case you are allergic to bread, other food items can be used, for example a piece of chocolate (if you are willing to sacrifice chocolate). http://acaai.org/allergies/types/food-allergies/types-food-allergy/wheat-gluten-allergy
3. When handling hydrochloric acid make sure that you are wearing gloves, a lab coat, and lab goggles since it is corrosive. Following the experiment, discard of the zip bag containing hydrochloric acid solution in an appropriate waste bin. https://www.msdsonline.com/blog/health-safety/2014/09/10/hydrochloric-acid-hazards-safety-tips

Narrative

Imagine you have just been woken up by the smell of delicious food wafting into your bedrooms. You close your eyes, and sniff the air, “Are those……Pancakes!?” You race to the kitchen and devour those lovely pancakes, perhaps a little too quickly. As soon as you have finished that last mouthful, your stomach quickly jumps into action to digest the food. This experiment illustrates just what happens in the stomach and what happens to those pancakes, turns out you’re not done with them just yet.

Questions

Why is vinegar used?
To simulate the acidity in the stomach.

Why was the bag squashed?
To simulate the churning action occurring in the stomach, called peristalsis.
http://www.laparoscopic.md/digestion/stomach

Why is digestion needed?
To breakdown food so that it can be absorbed by the body.

What happens to the food following the stomach?
Passess to the small intestine where most of the absorption occurs.

Why was the bread crushed into tiny pieces?
To simulate what happens in the mouth using our teeth, cutting the food into smaller pieces.

Brief Explanation

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The digestive system consists of a number of organs which function to break down food and convert them into nutrients. These nutrients can then be utilized by the body to meet our high energy demand, as well as to growth and repair cells.

In the start of the experiment, the food was cut into tiny pieces. This simulated the action of the teeth in the mouth. Chewing allows large pieces of food to be broken down into smaller pieces which can then be digested. In the saliva there are enzymes which allows the chemical digestion of starch. These enzymes are known as amylase.
http://www.ducksters.com/science/digestive_system.php

After swallowing, the food passes through the esophagus into the stomach. Not much digestion actually occurs in the stomach, its main function is to protect the body from invaders. The stomach juices are very acidic, this kills off the majority of nasty bacteria which can make you sick. The acid in the stomach was represented by the vinegar since it has a similar pH to the gastric acid in the stomach.
https://www.teachengineering.org/lessons/view/cub_biomed_lesson05

The stomach also contains enzymes to breakdown the food. Enzymes speed up the chemical breakdown of food. They have a specific shape which only certain larger molecules can fit into, when the correct molecule slots into this “active site” chemical reactions can occur much quicker and break down these molecules into smaller compounds.

Amylase was used in this experiment. This enzyme allows the starch found abundantly in the bread pieces to be broken down into simple sugar molecules called glucose. Starch is a long chain of glucose molecules, the amylase breaks up the chain into single molecules which can be easily absorbed by the body. It must be noted that this enzyme is not found in the stomach but is secreted into the mouth and small intestine.

The stomach is a muscular organ which allows it to squash and mix up the food, through a process known as peristalsis. This was simulated by squashing the contents of the bag throughout the experiment.

After the food has been sufficiently mixed, it is pushed into the small intestine where further digestion and absorption of food into the bloodstream occurs.

http://www.sciencekids.co.nz/sciencefacts/humanbody/digestivesystem.html

Detailed Explanation

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The digestive system consists of a group of organs that work in synchrony to allow the transform the chemical energy trapped in the food into a form which can be used throughout all of the cells in the body, through the process of respiration.
http://www.innerbody.com/image/digeov.html

The first part of the digestive system is the mouth. Chewing allows the mechanical breakdown of food into smaller pieces. Enzymes aid in the chemical digestion of these smaller pieces. Enzymes work more efficiently on smaller food particles since the smaller the food, the more exposed surface area for the enzymes to work on, this is known as having a larger surface area to volume ratio.

Enyzmes are a substance which greatly speed up the reactions of biochemical processes, but are not used up during the chemical reaction. Specific enzymes only work on certain types of molecules, this is because the proteins which make up these enzymes, are folded in a very specific way, which creates a cavity known as the enzymes “active site”. Only specific molecules can fit into these active sites, where chemical reactions can occur at a much faster rate.

Enzymes are released in the saliva by the 3 salivary glands located in the mouth. Saliva also helps to moisten the food to aid in the process of swallowing.

http://www.sciencekids.co.nz/sciencefacts/humanbody/digestivesystem.html

Some enzymes present in the mouth include:

1. Salivary amylase: acts on starch to produce maltose and glucose.
2. Lipase: breaks down fats into fatty acids and glycerol.

   From the mouth, the food is passed into the esophagus which pushes the food into the stomach, through a continuous muscle contraction, known as peristalsis.

   The stomach is a hollow, muscular organ which allows chemical digestion and mechanical digestion to occur. The hostile conditions of the stomach environment kills off any micro-organisms which were orally ingested.

   The acidity in the stomach is due to the presence of hydrochloric acid (HCl), although the main role of this acid is to kill microorganisms that could cause sickness, it does also slightly facilitate the breakdown of food. The hydrochloric acid is released by cells known as parietal cells. The low acidity also creates an ideal environment for the enzymes present in the stomach.
   https://www.teachengineering.org/lessons/view/cub_biomed_lesson05

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In this experiment, the enzyme amylase is used. Amylase breaks down the complex starch into maltose, through a hydrolysis reaction, which can then be converted into the monomer (single molecule) glucose by the enzyme maltase.
http://www.bbc.co.uk/education/guides/zwqycdm/revision/4

An important enzyme present in the stomach is the protease pepsin which is activated as a result of the acidic environment present in the stomach. Pepsin is responsible for the breakdown of proteins into their constituent amino acids.
http://www.indiana.edu/~nimsmsf/P215/p215notes/LabManual/Lab12.pdf

After the food is acted upon in the stomach it is passed into the small intestine where most of the food absorption into the bloodstream occurs.

Applications and Research

Applications

Enzymes have a variety of functions in the food industries such as for the production of sugars from starch or for yeast fermentation responsible for the rising of food.
Another important function of enzymes in the food industry is for the production of beer.

https://www.boundless.com/microbiology/textbooks/boundless-microbiology-textbook/industrial-microbiology-17/microbial-products-in-the-health-industry-199/enzymes-used-in-industry-1004-5469/

Research

The use of enzymes are crucial for life on this planet, chemical process which could take multiple years can occur in a tiny fraction of the time. It is not surprising that they have become a key component in our industry. Currently there are studies on the creation of photofuels in Germany, to reduce our reliance on fossil fuels. However, without these bio-catayst this research would not be possible. http://cordis.europa.eu/project/rcn/193744_en.html

Applications

Enzymes are also used for the biofuel industries such as for production of biodiesel in which the major enzymes used are lipase and phospholipase. Lipase is responsible for the production of fatty acid methyl esters which are main products of biodiesels.
http://www.biofuelsdigest.com/bdigest/2016/06/06/catalyst

Investigation

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1. It is important to be creative in science. Try being creative in this simple experiment. Go round the house and see what safe chemicals you can use to simulate the stomach, instead of using vinegar. Following this investigate which chemicals cause the bread to be broken down the most.
2. See if temperature has an effect on digestion. Repeat the experiment but this time place the zip bag in water baths having different temperatures and observe if an increase in temperature aids digestion.



Subject

Biology

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Education

Primary
Secondary

Time Required

~1 hour
Preparation: 15 mins
Conducting: 30 mins
Clean Up: 5 mins

Cost

0 – 10 €

Recommended Age

6 – 9
10 – 12

Number of People

1 participant

Supervision

Required

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Location

Indoors
Outdoors
Festivals
Laboratory

Materials

Slice of bread
Water
Vinegar
Plastic zip-up bag
Plastic cups
Hydrochloric acid
Amylase

Contributors

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Sources

Digestion Simulation

Biology for Kids- Human Digestive System

Your Digestive System

Digestive System

Digestive Physiology

The Digestive System: CrashCourse Biology #28

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How the Digestive System Works

How Does My Stomach Work?

Human Body for Kids/Stomach Song/Human Body Systems

Gastric acid simulation with minced meat

Additional Content

BBC News-Broadcasting live from inside a human stomach (Beginner)

Stomach: Facts, Functions & Diseases-LiveScience (Intermediate)

Digestive Physiology (Advanced)

Cite this Experiment

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