

TEACHER'S GUIDE

SCIENCE KEY CONCEPTS SERIES:

HUMAN DIGESTIVE SYSTEM

19 minutes, Video

Chapters: 1. Testing Foods for Nutrients 6 min.
2. *Human Digestive System 5 min.ar* 3. *Digestive Enzymes and pH 7 min.*

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FOR USE IN: BIOLOGY

LEVEL: Grades 9-12

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EDUCATIONAL OBJECTIVES:

To help the student understand these key concepts:

- testing for fat, carbohydrate starch, carbohydrate reducing sugars, and protein in nutrients
- the structures and functions of the digestive system's parts
- the specific foods on which some important digestive enzymes and bile salts act
- the effect of pH on the speed at which various enzymes work.

CONTENT

Food and digestion is about the food we eat and how it is digested. Laboratory experiments show how food can be tested for the nutrients it contains. The digestive system and the process of digestion are investigated using diagrams and graphic animations. The effect of pH on the action of enzymes and the role of bile salts are investigated in the laboratory.

This program is divided into three parts:

1. Testing Foods for Nutrients 6 min.
2. Human Digestive System 5 min.

3. Digestive Enzymes and pH 7 min.

The foods available in a market are used to illustrate the nutrients that our bodies require: fats, carbohydrates, protein, plus small amounts of vitamins and minerals Bread, nuts and grape juice are tested in a laboratory to find out which contain fats, then carbohydrates, and finally protein.

Testing Foods for Nutrients 6 min.

As a demonstration test for fat, olive oil (100% oil) when smeared on a piece of filter paper remains translucent after drying for several minutes - the test for fat. When bread, nuts and grape juice are tested, only the solution of ground nuts leaves a translucent stain after the paper is dry. Only nuts contain fat.

Starch is a complex carbohydrate. In a demonstration test for starch, when iodine solution combines with starch in a potato, it turns a blue – black color. In the following tests for starch with the iodine indicator, only bread contains starch, nuts and grape juice do not.

Sugars are simple carbohydrates. Most sugars belong to a group called reducing sugars. In a demonstration test, when Benedict's Reagent indicator is added to a glucose, a common reducing sugar, and then when the mixture is heated, a color change is seen. The mixture turns green then orange then red, depending on how much sugar is present. Only grape juice tests positive for a reducing sugar.

In a demonstration test for protein, sodium hydroxide is added to egg white. Dilute copper sulphate is added to form a layer on top of this mixture. This is known as the Biuret test. A purple ring will appear after a few minutes if protein is present. Nuts and bread test positive for protein, grape juice does not.

The Digestive System

An egg sandwich contains starch in the bread, protein in the egg white and fat in egg yolk and buttery spread. These three nutrients consist of large molecules that must be broken down by enzymes during the digestive process into smaller molecules in order to be absorbed through the inner lining of small intestine and then transported throughout the body.

Animation illustrates the processes. Teeth begin the process by physically breaking up the food. Saliva moistens the food and contains the enzyme amylase which begins the breakdown of starch molecules.

The food is moved down the esophagus by a series of muscular contractions called peristalsis. This is illustrated using an x-ray of a person swallowing a barium solution.

In the stomach the food is churned by muscular contractions. Gastric pits secrete

hydrochloric acid and the enzyme pepsin, which is specific to breaking down (digesting) protein molecules.

The pancreas secretes the enzymes amylase, which finishes the digestion (break down) of starch molecules, protease completes the digestion of protein, and lipase digests fat. Bile salts secreted by the gall bladder into the small intestine, aids fat digestion by emulsifying fat into small droplets, so aiding lipase.

Most digestion takes place in the small intestine. The inner lining of the small intestine is has many folds and is covered with tiny projections called villi. The folding and villi enormously increase the surface area through which food can be absorbed through the intestinal wall and into blood capillaries.

Fiber makes up most of the indigestible component of food. The bulk it provides plays an important role in moving food through our digestive system and keeping it healthy.

Digestive Enzymes and pH 7 min

Most nutrients are made up of large molecules which must be broken down before they can be absorbed through the wall of the small intestine and into the blood system. Digestive enzymes greatly speed up the breakdown of larger molecules. The most important enzymes are amylase which breaks down starch, proteases which break down protein, and lipase which breaks down fats.

Enzymes work best at a particular pH known as the optimum pH.

In laboratory test, the speed at which amylase breaks down starch is measured at three different pH values, 3, 7, and 9. Amylase works best at pH 7 , neutral.

When pepsin is similarly tested, it worked best at pH3, which is why hydrochloric acid in the stomach maintains a pH3 acidity there.

Lipase breaks down fat but it is assisted by bile salts secreted from the gall bladder. In the laboratory tests, the action of lipase and bile salts is investigated using whole milk. When fat is digested fatty acids are formed. The fall in pH towards acidity then causes an indicator to change color from pink to colorless. This change occurs most quickly when lipase and bile work together. Bile causes larger fat droplets to break up into small pieces giving lipase a larger surface area to work on.

LINKS:

These are links to websites which provide additional information on the digestive system.

<http://www.worthington-biochem.com/introBiochem/> Worthington Biochemical Corporation: Beginning Biochemistry. This site has a graph showing optimum pH. There is information about the optimum pH of different digestive enzymes. The site has comprehensive information on all aspects of enzyme function.

http://academic.brooklyn.cuny.edu/biology/bio4fv/page/lect_o.htm Brooklyn College City University of New York: This site has detailed lecture notes on all aspects of enzymes.

http://www.accessexcellence.org/AE/AEC/AEF/1995/cave_digest.html Access Excellence: A lesson plan for a kinesthetic simulation of the digestive system involving students. The site has searchable indices of activities and resources for biology teachers.

<http://www.tvdsb.on.ca/westmin/science/sbi3a1/digest/digdiag.htm> Westminster Secondary School Science Department: The Digestive System. This site has a great section on enzymes with a diagram where parts are highlighted as you pass over the labels. The site also has a quiz.

<http://www.medtropolis.com/VBody.asp> Medtropolis Virtual Human Body: This site has a guided tour of the digestive system, detailed illustrations, and an activity which involves organising the organs.

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