C2 Carbohydrates as providers of energy for metabolism – Starch and sugar

Note: This answer sheet will go into the analyses for the individual subexperiments only if experience shows that there could be particular difficulties.

2 Hydrolysis of starch

2.5 Analysis

c) Formulate a reaction equation for the observed phenomenon.

Note: $(C_6H_{10}O_5)_n + (n/2 - 1)H_2O + (\text{amylase}) \rightarrow n/2\ C_{12}H_{22}O_{11}$
Starch + water + amylase (as a catalyst) → maltose

2.6 Questions

a) What is the name of the group of substances that includes the substance in the food you investigated in subexperiment 1?

Answer: The food contains three groups of substances that are nutrients: fats, proteins, and carbohydrates. Starch was dissolved in water in the last subexperiment, meaning that starch is a water-soluble substance. If you have ever tried to wash off cooking oil without using soap, you know that fats are not water-soluble. It is unlikely that starch is a protein, because plant-based foods are usually low in protein and high in carbohydrates. In subexperiment 1, the potato also turned blue in the presence of an iodine solution. Therefore potato starch obviously belongs to the group of carbohydrates.

b) What other foods contain similar substances?

Answer: Rice, corn, wheat, cassava, yams, bread, flour, noodles, etc.

c) What other nutrients are important for us?

Answer: Apart from the skeleton, our bodies are built from proteins and fats, meaning that our nutrition must also include proteins and fats.

d) What path does food take through the human body? Explain the path.

Answer: Food first enters the mouth, where it is coarsely ground. A portion of the nutrients (starch) is already broken down here. Then the food travels through the esophagus to the stomach, where another portion of the nutrients (fats and proteins) is partially degraded by strong acids. The degraded food continues to move through the small intestine, where the carbohydrates are split into glucose. The resulting degradation products of food – glucose, fatty acids, and amino acids – can now be absorbed by the body through the intestinal wall. The substances that cannot be broken down or absorbed by the body are then expelled through the colon as feces or filtered out by the kidneys and excreted from the bladder as urine.

e) Any nutritional guide will tell you that chewing your food well is important for digestion. How can this be explained from the biological and chemical perspectives?

Answer: Food first enters the mouth, where it is ground by the teeth during chewing. The chewed food is lubricated by saliva so that it is easy to swallow. The finer the degree of grinding, the greater the surface area of the bolus particles is and the faster the digestion processes take place in the stomach and colon. Moreover, the amylase in saliva breaks down the starch into maltose.

For further study:
Note: On the media portal of the Siemens Stiftung, you will find a link list in the media package for "Experimento | 10+: C2 Carbohydrates as providers of energy for metabolism" that refers to additional information.

f) Find out information about enzyme reactions. What are enzymes needed for in the body?

Answer: Most chemical reactions do not take place until the temperature is relatively high. This temperature can be lowered by catalysts (see the burning of sugar in experiment "C1 We burn sugar – Cellular respiration and respiratory chain"). The human body temperature is relatively low at 36°C, and so it needs special biocatalysts called enzymes (from the Greek for "leaven", in which the enzymes of yeast and bacteria are active).
For links for searching, see the link list for the experiment.

g) How are nutrients broken down in the human body?

Answer: See above and the teacher files for experiments "C1 We burn sugar – Cellular respiration and respiratory chain," "C2 Carbohydrates as providers of energy for metabolism – Starch and sugar" and "C3 How does human digestion break down fats? – Saponification of edible oil".

h) Reverse reaction: If you have too much glucose in the blood, the liver can combine the excess molecules to form the storage substance glycogen. This corresponds formally to the reverse reaction of those you learned about in this experiment. Find out information about glycogen and formulate a reaction equation for its synthesis.

Answer: $nC_6H_{12}O_6 \rightarrow \ldots \rightarrow \ldots \rightarrow \ldots \rightarrow (C_6H_{12}O_6)_n$
In reality, this process – presented here only in summary form – is an enzyme-controlled reaction chain with four intermediate stages, with other reactions taking place in parallel.
For links for searching, see the link list for the experiment.

