

Exploration Activity: Plant Puzzle

Teacher Resource

This activity will assist in meeting the following Prescribed Learning Outcomes in the British Columbia Integrated Resource Package (2006) for Biology 11/12.

- A2 Design an experiment using the scientific method
- A3 Interpret data from a variety of text and visual sources
- B4 Analyse the structure and function of biological molecules in living systems (carbohydrates)
- B11 Analyse the roles of enzymes in biochemical reactions
- C1 Describe the components, pH, and digestive actions of salivary & pancreatic juices

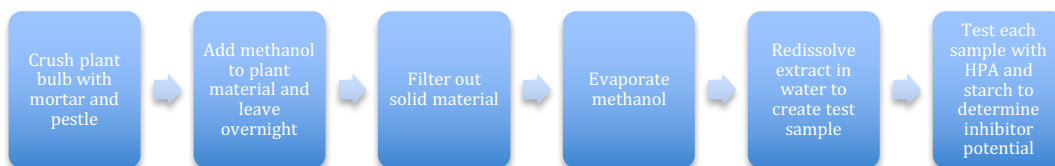
This lab attempts to replicate an extremely complicated procedure in a way that is accessible both for students and teachers. The first section of the activity gives background information into the research being done at UBC on Human Pancreatic Amylase inhibitors. Before beginning this activity, students should have already studied competitive inhibition, enzyme action, and be comfortable with designing simple labs.

As an introduction to the effects of amylase on starch, a teacher demonstration may be completed. The teacher may take a starch solution, add bacterial amylase, and test with iodine. In the presence of starch (at the beginning of the trial) the solution will be dark blue. As the amylase begins to degrade the starch, the iodine will turn yellow to show the absence of starch. Since iodine has a tendency to interfere with the actual amylase activity, it works best to test one sample with iodine and then run the amylase test on a separate sample and test that with iodine after about three minutes.

Procedure Notes

1. Students should refer to the background information notes to answer this question. Students should understand that starch is broken down to become glucose in several steps, the first of which is the action of α -amylase to form maltose. Glucosidases then work to form glucose.
2. The breakdown of starch begins in the human mouth, by salivary amylase. This process continues in the small intestine with pancreatic amylase.
3. Competitive inhibition occurs when a substance other than the substrate binds to the active site of an enzyme, preventing the reaction that would normally occur. In this case, the inhibitor from one of the plant materials would bind with the active site on HPA, preventing it from degrading starch into maltose. Students should also be aware of the induced fit model of enzyme activity and the slight change that allows for optimal enzyme activity.

4. This step requires students to create a flow chart and work through the steps necessary to create a workable experiment. Teachers may direct students to search for plant extraction steps on their own *via* the web, or guide students through the following points:
- The potential inhibitors for this reaction are stored in the tissue of the plant; to get them out, the tissue must be broken.
 - Alcohol, in particular methanol, will dissolve the chemicals of interest, but water extractions may be accomplished as well.
 - Solid plant material will need to be filtered out before students can use the extract.
 - If alcohol is used, it will need to be evaporated before use.
 - This may be done as a class, in partners, or individually depending on teacher preference. Students may use a variety of formats to complete this task, including comic strip-type sketches or written text boxes. At the end of this session, students should have something as follows:



5. The presence of starch may be indicated by using iodine drops. In the presence of starch, iodine will turn a dark blue-black colour. When starch is not present, iodine will turn a pale yellow colour.

Data & Results

Photocopy enough sheets for each student to have their own sheet. Answers to the questions are as follows:

- Starch was tested by itself as a control. If starch itself degrades without the presence of any enzyme, the results from this experiment would be invalid. The same is true for the starch and enzyme test. This provides a positive test result from which we can base the tests of samples A through C.
- The results of this experiment show that starch is present in the first sample, fourth sample, and possibly fifth sample. This is because the iodine drop is blue-black, which is a positive test for starch.
- The results of this experiment show that starch is not present in the second, third, and possibly fifth samples.
- Sample 5 is inconclusive. This could be from weak inhibitor action, or experimental error. Further tests are needed.
- The presence of starch may indicate the presence of an inhibitor. The absence of starch may indicate the absence of an inhibitor. It is important for students to understand that one result from one test does not conclusively prove that an

inhibitor is present or absent. Also, the concentrations of the amounts of possible inhibitors will influence the test results.

Analyze and Apply

1. From these results, the most promising sample would be sample B since there is a clear positive test for the presence of starch. Students may also suggest further study on sample C since it appears that there is still some starch left at the end of the test run, indicated by the blue-black material present.
2. High blood glucose levels are associated with a number of health concerns including:
 - a. heart disease
 - b. blurred vision and blindness
 - c. non-traumatic amputations
 - d. kidney failure
 - e. pregnancy complications

Traditional treatments for diabetes include monitoring blood glucose levels, insulin injections, diet modifications, exercise and weight control as well as diabetes pills.

Montbretin A holds promise for diabetics because it could mean preventing the breakdown of starch into maltose and then ultimately glucose, which could prevent blood glucose problems. Students may wonder if starch could possibly build up and cause problems for these patients, like glucose molecules do. Studies at UBC have shown that because starch is such a large molecule, it cannot be absorbed beyond the lumen of the small intestine and therefore has no indication of causing blood concentration problems.