

EXPERIMENT

Starch Breakdown

Visitors use Benedict's solution and heat to test for the presence of simple sugars in glucose, sucrose, starch, and starch combined with amylase. They find simple sugars only in the glucose and in the starch with amylase solution.

OBJECTIVES:

Visitors learn the difference in structure between three different sugar molecules: glucose, sucrose, and starch. They observe that amylase, an enzyme in saliva, can break the bonded molecules in starch into separate glucose molecules. In the body, amylase breaks down starches to make them easier to digest.

SCIENCE TOPICS	PROCESS SKILLS	VOCABULARY
Indicators	Observing	Chemical Reaction
Enzymes (see also Proteins)	Measuring	Enzyme
Atomic Structure	Investigating	Molecule
Chemical Bonds	Controlling Variables	Sugar
Sugars (see also Carbohydrates)		
Biochemistry		



MATERIALS

*See Materials Prep
for more details*

(with amounts to have on hand)

- Benedict's solution (keep at least 100 ml on hand)
- Soluble starch (keep 50 g on hand)
- Dextrose (keep 25 g on hand)
- Sucrose (keep 25 g on hand)
- Dry fungal amylase (keep 10 g on hand)
- Four small test tubes
- One test-tube rack
- One 250-ml glass beaker
- One 100-ml beaker
- One thin test-tube brush
- Five 30-ml dropper bottles
- One hot plate
- One clock
- A Plexiglas shield for the hot plate
- Three plastic bottles, 250- to 500-ml size

Setup/Takedown Procedures

ORIGINAL SETUP

- Color code and label the small test tubes: "1 Glucose + Benedict's" (red); "2 Sucrose + Benedict's" (yellow); "3 Starch + Benedict's" (white); and "4 Starch, Amylase + Benedict's" (orange).
- Label the 250 ml beaker "Hot Water."
- Label the 100-ml beaker "Amylase in Ice Water."
- Label one 30-ml dropper bottle "1.5% Glucose" with red tape.
- Label one 30-ml dropper bottle "1.5% Sucrose" with yellow tape.
- Label one 30-ml dropper bottle "1.5% Starch" with white tape.
- Label one 30-ml dropper bottle "Benedict's Solution" with blue tape.
- Label one 30 ml dropper bottle "Amylase Solution" with white tape.

WEEKLY SETUP

- Place the hot plate near the back of the bench. Secure the loose cord to the bench with duct tape.



- Place a Plexiglas shield in front of the hot plate.
- Tape a warning "Caution: Hot!!" to the shield.
- Fill one labeled dropper bottle with 1.5% glucose solution. (See Materials Prep.) (Keep 50 ml on hand.)
- Fill one labeled dropper bottle with 1.5% sucrose solution. (See Materials Prep.) (Keep 50 ml on hand.)
- Fill one labeled dropper bottle with 1.5% starch solution. **KEEP THIS IN THE REFRIGERATOR** (See Materials Prep.) (Keep 100 ml on hand.)
- Fill one labeled dropper bottle with Benedict's solution.
- Fill the labeled glass dropper bottle with amylase solution. (See Materials Prep.) (Keep 50 ml on hand.) **KEEP THIS IN THE REFRIGERATOR.**
- Get the clock from general storage and place it in the tub.

DAILY SETUP

- Make sure the hot plate is behind the Plexiglas shield.
- Make sure the caution sign is attached to the Plexiglas shield.
- Put the large glass beaker, 2/3 full of water, on the hot plate.
- Plug in the hot plate.



- At least 15 minutes before opening, turn on the hot plate to about 150-200 degrees. Water should almost boil but should not be actively bubbling.
- Keep an eye on the water level throughout the day to make sure it stays at least 1/3 full.
- Set out the visitor instructions in the Plexiglas holder.
- On a tray lined with a white mat, set out the following:
 - The labeled dropper bottles of starch, $C_6H_{12}O_6$ (glucose), and Benedict's solution
 - The labeled dropper bottle of $C_{12}H_{22}O_{11}$ (sucrose) from the refrigerator
 - The four labeled test tubes in the test-tube rack, arranged in sequential order (1 to 4)
 - The test-tube brush
 - The clock with a second hand
 - The 100-ml labeled beaker

- The labeled amylase dropper bottle (from the refrigerator), placed in the small labeled beaker $\frac{1}{2}$ filled with ice
- Arrange the dropper bottles in sequential order (1, 2, 3, 4).
 - Refill the five labeled dropper bottles as necessary.
 - Remake stock glucose, sucrose, or starch solution if needed (see Materials Prep).

DAILY TAKEDOWN



- RETURN THE AMYLASE DROPPER BOTTLE, STARCH DROPPER BOTTLE, AND STARCH STOCK BOTTLE TO THE REFRIGERATOR.
- Clean all four test tubes.
- TURN OFF AND UNPLUG THE HOT PLATE.
- Take the beaker off the hot plate.
- Tightly cap all bottles and return them to the tub in an upright position.
- Return all supplies, except the hot plate and the Plexiglas shield, to the tub under the cabinet.

WEEKLY TAKEDOWN

- Return the hot plate, mat, clock, and Plexiglas shield to general storage.
- Sponge off the tub and bottles.
- Cap all bottles tightly and return them to the tub in an upright position.
- Return the sucrose dropper bottle, the sucrose storage bottle and the amylase dropper bottle to the refrigerator.
- Clean the tray and leave it at the station.



RUNNING SUGGESTIONS

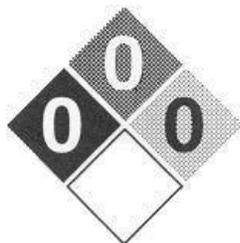
- ◇ The hot plate and water will be HOT; warn people of this and keep an eye on young children. (Test tubes should be significantly taller than the hot-water beaker, so visitors won't need to touch the hot beaker.)
- ◇ The amylase solution is finicky, test after each time to make the solution or refill the bottle, and at the beginning of each week.
- ◇ If the visitors check the sucrose with the amylase, they should see little color change. This is because the enzyme is designed to break glucose/glucose bonds, not glucose/fructose bonds.



EXTENSIONS

You can test sports drinks or other foods for the presence of glucose.

SAFETY & DISPOSAL



No special precautions are needed; follow standard lab safety procedures.

MATERIALS PREP

To prepare glucose solution:

- Weigh 1.5 g glucose (dextrose).
- Add 100 ml dH₂O (deionized water).
- Label and date the plastic storage bottle.

To prepare sucrose solution:

- Weigh 1.5 g sucrose.
- Add 100 ml dH₂O (deionized water).
- Label and date the plastic storage bottle. **STORE IT IN THE REFRIGERATOR.**

To prepare 1.5% starch solution:

- Boil 90 ml dH₂O (deionized water).
- Weigh 1.5 g soluble starch.
- Mix the starch with 10 ml of water to form a paste.
- Add the paste to the 90 ml of boiling water.
- Heat and stir the solution until it becomes clear.
- Cool the solution.
- Add dH₂O to bring the total to 100 ml.
- Label and date the plastic storage bottle.

To prepare amylase solution:

- Weigh 0.5 g dry amylase enzyme.

- Mix it with 100 ml dH₂O (deionized water).
- Label and date the plastic storage bottle. STORE IT IN THE REFRIGERATOR.

To prepare Benedict's Solution:

- Dissolve 10 grams Na₂CO₃·H₂O and 17.3 g Sodium Citrate·2H₂O in about 60 ml water
- dissolve 1.73 g CuSO₄·5H₂O in a separate beaker of 40 ml water
- combine the 2 solutions to make 100 ml solution