Urease

The Enzymatic Conversion of Urea

Introduction

Demonstrate the enzymatic conversion of urea to ammonia and carbon dioxide by using the enzyme urease. Unmistakable visual and olfactory evidence leave no doubt as to the action of this molecular engineer!

Concepts

- Enzymes
- Acid–base indicators
- Biochemistry
- The nitrogen cycle
- Hydrolysis

Materials

Phenolphthalein indicator solution, 1% alcoholic, 1 mL
Urea solution, 1.0 M, $CO(NH_2)_2$, 150 mL
Urease powder (crude extract from jack bean meal), 2 g
Beaker or Erlenmeyer flask, 250-mL

Safety Precautions

The phenolphthalein solution is a flammable liquid and a fire risk. Keep from sources of heat and open flame. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Safety Data Sheets for additional safety, handling, and disposal information. Wash hands thoroughly with soap and water before leaving the laboratory.

Procedure

1. Pour 100 to 150 mL of the urea solution into a beaker or flask.
2. Add 10–20 drops of phenolphthalein indicator solution and swirl to mix. At this point the solution will be colorless with little or no odor of ammonia.
3. Sprinkle in approximately 2 grams (½ teaspoon) of urease and quickly stir to mix.
4. Within a few moments two things will be evident: (1) the solution turns pink, and (2) the distinctive odor of ammonia becomes very apparent. N*ote:* Use caution not to excessively inhale ammonia. If the odor becomes irritating, place the solution in a hood.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. All of the reactants and products of this laboratory exercise can be flushed down the drain with excess water according to Flinn Suggested Disposal Method #26b

Connecting to the National Standards

Unifying Concepts and Processes: Grades K–12
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standard F: Science in Personal and Social Perspectives; personal health
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure and properties of matter, chemical reactions
Content Standard C: Life Science, the cell
Content Standard F: Science in Personal and Social Perspectives; personal and community health; natural and human-induced hazards

Publication No. 841
032417

Tips

- This activity can either be done as a teacher demonstration or as a student lab. The advantage of individual students or student groups carrying out the procedure is that they will be able to smell the ammonia fumes that are produced. Exact measurements (concentrations, volume) are not critical.
- Prepare two controls. The first will contain everything but the urease to demonstrate that the reaction does not occur spontaneously, and the second will contain no urea to demonstrate that the urea is being decomposed.
- Slight heating of the urea solution prior to addition of the urease seems to speed the reaction. Test the activity of the enzyme at several temperatures—one beaker chilled, one at room temperature, and one heated to about 40 °C (too high a temperature will deactivate the enzyme).

Discussion

Urease catalyzes the hydrolysis of urea to produce CO_2 and NH_3 (ammonia).

$$H_2O + CO(NH_2)_2 \xrightarrow{\text{urease}} CO_2 + 2NH_3$$

Urease, with a molecular weight of 482,700, is naturally present in jack beans and soybeans. Urea is a common end product of protein metabolism and a principal excretory product of animals. To be utilized by plants the nitrogen present in urea must first be converted into ammonia/ammonium—one "step" in the nitrogen cycle. The role of urease in beans (seeds) may be to serve as an initial source of plant-usable nitrogen.

Reference

Morholt, E.; Brandwein, *P. F. A Sourcebook for the Biological Sciences*, 3rd Edition; Harcourt, Brace, Jovanovich: New York, 1986.

Materials for *Urease—The Enzymatic Conversion of Urea* are available from Flinn Scientific Inc.

Catalog No.	Description
P0017	Phenolphthalein, 25 g
P0019	Phenolphthalein Indicator Solution, 1%, 100 mL
U0003	Urea, 500 g
U0013	Urease, 10 g

Consult the Flinn Scientific website for current prices.