

Chemistry of the Permanent Wave

Introduction

Hair is a fibrous protein made up of long strands of alpha-keratin molecules. Around 6 or 8 strands will twist around each other like a rope to form hair. Hair contains a specific amino acid called cystine. Cystine is unusual because it has a disulfide bridge that bonds protein chains together. Normal hair is composed of 10-14% cystine, which is what gives hair its shape.

In this lab, we will break the disulfide bonds in hair to reshape it from straight to curly by using a *permanent wave* lotion. We will then form new disulfide bridges by using a *neutralizer* so that the hair regains its strength. We will also test for the presence of the disulfide bonds (as a *sulfhydryl group*) found in hair using the chemical reaction of the lotion.



Materials

ammonium nitrate (NH_4NO_3)
hair
neutralizer solution

permanent wave lotion
sodium hydroxide (NaOH) solution, 6 M
sodium nitroferricyanide solution, 2%

Equipment

mannequin head
rollers

test tube rack
test tubes

Safety Considerations

- **Sodium hydroxide at this concentration is extremely dangerous and caustic to the skin and eyes! You must wear goggles and gloves while using it.**
- **Sodium nitroferricyanide solution is toxic; you must wear goggles and gloves while using it, and avoid putting your hands in or near your mouth and eyes.**
- Permanent wave lotion often has an unpleasant smell that remains on the hands after using it; you will want to wear gloves while working with it.
- Sometimes chemicals from previous labs still remain in glassware and on other lab equipment; wash all lab equipment before and after performing this lab.
- Wash your hands thoroughly after completing this lab.

Procedure A - Waving Hair

1. On the mannequin head, select a length of long, straight hair. Wet it and wind it around a plastic roller.
2. Apply the permanent wave lotion to the rolled hair.
3. Per the directions on the box, wait around 15-20 minutes for the lotion to work.
4. Per the directions on the box, rinse the lotion out of the hair and apply the neutralizer solution to the hair.
5. Remove the hair from the plastic roller. Record your observations in the Data Table.

Procedure B – Testing for the Sulfhydryl Group in Hair

1. Add a small amount of hair to three test tubes. Label the tubes 1, 2 and 3.
2. Prepare the test tubes as follows:
 - Tube #1: ½ tube of distilled water
 - Tubes #2 & 3: ½ tube of permanent wave lotion
3. Wait around 15 minutes for the lotion to work.
4. Using distilled water, wash the hair in test tubes #2 & #3 until the odor of the lotion is gone.
5. Add neutralizer solution to test tube #3. Wait around 15 minutes for the neutralizer to work. Rinse the hair using distilled water.
6. While wearing goggles, add the following to all three test tubes:
 - a. 5 mL of distilled water
 - b. 2 g of ammonium nitrate (cover & shake tube until dissolved)
 - c. 2 drops of sodium nitroferricyanide solution
 - d. 2 mL of concentrated NaOH
7. A purple color shows that a sulfhydryl group is present; in other words, the disulfide bonds in the hair were broken. Record your observations in the Data Table.

Clean-up

1. Dispose of any loose hair in the trash, NOT THE SINK.
2. Clean all used lab equipment with soap, water and a test tube brush.
3. Return all equipment to its proper location.
4. Wipe down your lab area and wash your hands before leaving the lab.

Data Table

Hair	Observations	Sulfhydryl?
before perm		
after perm		
<i>test tube #1:</i> hair + water		
<i>test tube #2:</i> hair + lotion		
<i>test tube #3:</i> hair + lotion + neutralizer		

Questions

1. How did your hair turn out on the mannequin head?

2. What effect did the neutralizer solution have on the hair in test tube #3?

3. Why do you think some people have naturally curly hair while other people's hair is straight?

4. What do you think would happen to a person's hair if they applied permanent wave lotion but forgot to apply the neutralizer solution? Why?

5. List one way you could change this lab and describe how your results might be different.
