

## Topic 2: Biochemistry – 2c. Hair Chemistry (Give a Hair a Perm)

- Resources: Campbell, N., Reece, J. (2005). *Biology: Concepts and Connections*, 5th edition. Pearson/Benjamin Cummings.
- What Makes Curly Hair Curly? [Internet]. U.S. Department of Energy: Ask a Scientist. Available from: [www.newton.dep.anl.gov/askasci/chem99/chem99328.htm](http://www.newton.dep.anl.gov/askasci/chem99/chem99328.htm)
- Beam, J. What Makes Curly Hair Curly? [Internet]. Conjecture Corporation. Available from: [www.wisegeek.com/what-makes-curly-hair-curly.htm](http://www.wisegeek.com/what-makes-curly-hair-curly.htm)
- Building on: This lab deals with the structure of proteins. Specifically, it emphasizes the *bonds* that form to link amino acids together and the bonds that form between the *R groups of amino acids*. To get the most out of this lab, there will need to be discussion concerning the structural levels of proteins from the structure of an individual amino acid, the *primary structure of a polypeptide*, up to *tertiary structure* of complex proteins. It is necessary to discuss *hydrogen bonds* and *disulfide bonds* that can occur between R groups of different amino acids.
- On an anatomical level, this lab helps to explain how the *shape of the hair follicle* influences the texture of the hair.
- Links to Chemistry: Covalent bonds  
Hydrogen bonds  
Structure of an amino acid  
Interaction of amino acid R groups  
pH influence on bonds  
Denatured proteins
- Links to Physics: Molecules  
Compounds  
Chemical bonds  
pH
- Stories: Students will be curious to know why some people have curly hair and some have straight. They will probably know that it is a genetic trait, but have no idea the anatomy and physiology behind it. The real reason has to do with the shape of the hair follicle and the presence of disulfide bonds between R groups found on individual amino acids in the keratin protein. If the R groups are brought close together during protein formation (in the hair follicle), these strong disulfide bonds form causing a curve in the normally linear protein chain that makes up keratin. The more disulfide bonds between R groups, the curlier the hair. Therefore, people with

straight hair follicles have straight hair as the R groups never get close enough to each other to form the disulfide bonds. People with curly hair have hook-shaped hair follicles that allow R groups on amino acids that are pretty far apart to get close enough to form the disulfide bonds. The curlier the hair, the more curl in the hook of the hair follicle.

Students might also want to know how a perm is different from simply hot rolling hair. There is a weak attraction (hydrogen bonds) between keratin molecules that make up the hair shaft. Heat can break these hydrogen bond attractions and new ones will form as the hair cools. So, hot rollers put curl into straight hair and flat irons straighten out curly hair. These are only temporary because the hydrogen bonds are so weak that in the presence of moisture, the new hydrogen bonds break and the hair returns to its original state. That is why on a rainy day straight hair loses its curl and sags while curly hair that was straightened with a flat iron slowly curls back up. Now a perm chemically breaks any strong disulfide bonds when the protein is exposed to the alkaline solution of the ammonia and new disulfide bonds form when the hair is exposed to the acidic pH of the vinegar. The diameter of the curling rod the hair is on when the perm is given acts like a hair follicle and determines how many new disulfide bonds will form. If the curling rod is large, only a few disulfide bonds will form; but if the curling rod has a small diameter with the hair wound around it many times, lots of disulfide bonds will form. Because disulfide bonds are so strong, most of them will remain with that hair permanently, until the new hair grows out.

Two good websites for information on hair are:

[www.newton.dep.anl.gov/askasci/chem99/chem99328.htm](http://www.newton.dep.anl.gov/askasci/chem99/chem99328.htm)

[www.wisegeek.com/what-makes-curly-hair-curly.htm](http://www.wisegeek.com/what-makes-curly-hair-curly.htm)

Materials for the Lab:

- Glass stir rods
- Ammonia (grocery store bought)
- White vinegar (grocery store bought)
- A couple of blow dryers or a few small heaters
- Test tubes
- Small rubber bands kids get from the orthodontist (I ask the kids to bring them in and lots of them do.)

## **Hair Chemistry**

**Introduction:** Hair is composed of a protein called keratin. Acids, bases, and heat can affect keratin, like all proteins. Hair care professionals who give clients perms to curl their hair utilize this information.

**Purpose:** Read the procedure below and then write a purpose statement.

**Procedure:** **Draw a flowchart to outline the paragraph below.** You will need to get two strands of hair from the same person. The strands need to be at least 4" long. Each strand will be wrapped around a glass rod using small rubber bands to secure the ends of the hair to the glass. One glass rod will be placed into a test tube of ammonia for 15 minutes. The other glass rod will be placed in a test tube of water. After 15 minutes, the rod that was in the ammonia will be transferred to a test tube of vinegar for at least 5 minutes. The other rod should remain in the water for the same amount of time. Both rods should be blotted dry and the hair on them should then be dried with a blow dryer or small heater. Remove the hair from each rod. Draw and label each hair. Write a short observation comparing the two hairs. If each hair was slightly wetted and allowed to air dry, do you think they would behave differently? Your teacher may have you try this and observe the hairs in class tomorrow.

**Evidence:** There should be two drawings of the hairs, labeled "experimental" and "control." A short comparison statement should be entered below the drawings.

**Questions:**

1. What type of macromolecule makes up hair?
2. What are the monomers of that macromolecule?
3. What type of bond holds the monomers of the hair macromolecule together?
4. What specifically makes curly hair curly and straight hair straight?
5. How do you think the chemicals used in a perm cause straight hair to become curly, and what purpose does the curler (in this case the glass rod) serve in this process?
6. List and describe the four structural levels of proteins.
7. Define "denature." Was the hair used in the lab denatured? Explain.

**Conclusion:**

**NLQ:**