Polymer Activity from the:

DNA – A Natural Polymer

Grades: 6-12 Life Science, Biology, or Chemistry

Science Standards: National Science Content Standards: 9-12 - B: Structure and properties of matter, C: The cell, molecular basis of heredity, G: The nature of scientific knowledge, 5-8 G: Science as a human endeavor. C: Structure and function in living systems, reproduction and heredity

Purpose: To illustrate the pairing of bases which determines structure and function of the DNA polymer using cornstarch (another polymer) Craft 'nuddles'.

Background: The nucleotides (mers) that chain together to make DNA molecules in humans number in the billions (actually about 2 meters long). That is one long, tiny polymer! This deoxyribonucleic acid is found in cells of all living organisms. This polymer contains the blueprint of life in all of us. To answer the riddle: What are little girls (boys) made of? The answer is… the same sugar-phosphate backbone and four bases we call A, T, C, and G. Comparing our DNA, humans are 99.9% identical and only one-tenth unique.

Materials: 6 different colors of 'nuddles' (like cornstarch packing peanuts from craft stores) separated by color
Sponges for moistening the ends of the nuddles
Water

Procedure: Teacher or students agree on a color key. Assigning a different color of nuddle to Sugar, Phosphate, Adenine, Thymine, Guanine, and Cytosine.
The rules for pairing (A-T and C-G) must be followed

1. Students work in pairs
2. Each person constructs one side of the DNA molecule using 4 sugars and 4 phosphates
3. Person 1 selects a base and connects it to their 'backbone'
4. Person 2 must select the corresponding base for their 'backbone', then the second choice of base.
5. They each continue to build a corresponding single strand of their DNA segment of four base pairs which are then to be connected together.
6. The entire class then connects each segment to make a long DNA model to be displayed at the front of the room.

OPTIONS

A. Teacher may construct ahead of time a couple of segments which contain a particular sequence, these may be imbedded into the class structure. Locating these sequences can be helpful to illustrate restriction enzyme 'cut' sites.
B. All students 'read' and write down the DNA sequence produced by the class while checking accuracy of the pairing rules.

C. Biology students can launch a discussion into genes, chemistry students can study the bonding of the polymer and chemical structure of the molecules

Conclusions: The material itself is a polymer, and the resulting model of DNA is a polymer. Measurement in SI and modeling always presents a challenge. The following model (using polymeric materials) is an example of microscopic size proportions.

This model illustrates the size of DNA in a bacterium.

The bacteria E. coli is estimated to be about 4.6 million nucleotides long. This molecule is 1,000 times longer than the cell in which it resides. Even more amazing, it only takes up 2-3% of the cell's weight and occupies only 10% of its volume! Our model will be 10,000 times larger than actual size. Imagine an ant magnified 10,000X. It would be the size of an eighteen wheeler truck!

Each student will use a 2-cm gelatin (natural polymer) capsule as an E.coli cell and 10-meter length of polyester (a manmade polymer) thread for the E.coli DNA. Students are instructed to devise a way to place the 10-meters of thread into the 2-cm capsule. As they are reminded of the structure and form of DNA, it helps imagine how amazing that DNA polymer truly is. The *length* of thread and capsule are proportional in size, the *thicknesses* are not accurate making it impossible to only use 10% of the volume of the capsule.

Contributed by: DeAnn Campbell, Oklahoma Polymer Ambassador 2009

Polymer Ambassador Web Site: *www.polymerambassadors.org*