GRADES: 3 – 6

Chewing the Fat Plastic

OVERVIEW:

This lesson focuses on the structure of polymers and some of the characteristics which makes polymers so desirable and widely used. Common everyday substances which are made up of polymers will be stressed. Students will participate in several of the activities which Dr. Dirt uses on the show.

ITV SERIES:

DR. DIRT'S PH³: Polymers

LEARNING OBJECTIVES:

Students will be able to:

- ❖ explain the definition of "poly"
- ❖ identify common everyday substances which are made of polymers
- ❖ create a polymer from simple household substances
- ❖ list four ways in which polymers have made their life better
- ❖ identify "flexibility" and "strength" as characteristics which make polymers so useful to mankind.

MATERIALS:

Single items:

- dictionary
- map showing Polynesian Islands
- food label with the word "polyunsaturated" on it
- math book that illustrates a polygon
- plastic wrap & waxed paper
- plastic drinking cup & glass drinking cup
- plastic screw & metal screw
- cloth diaper & disposable diaper

For each student:

- Plastic Code Sheet
- bubble gum & regular gum (be sure to include sugar-free for any students whose sugar intake must be restricted)

For each group of 4 students:

- 100 gumdrops of 2 different colors (50 of each color A & B)
- 100 toothpicks
- crayons or markers to match the colors of the gumdrops
- paper
- 10 rubber bands (size 18 or larger)

BACKGROUND:

The word "polymer" usually conjures up the idea of plastics or space age products. Actually, synthetic plastics, a recent discovery, make up only a small portion of the world of polymers while natural polymers, such as cellulose, cotton fibers and rubber, have been used throughout history.

The word "polymer" comes from the Greek "poly" meaning many and "meros" meaning parts. The word refers to molecules that are composed of many repeating parts.

Known as macromolecules, polymers are often made up of thousands of repeating units. Cellulose, the natural fiber of plants, is an example of such a macromolecule.

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In the late 1800's John Wesley Hyatt created celluloid from the natural polymer cellulose. This synthetic polymer was quickly utilized to make billiard balls, stiff collars for shirts, photographic film and dentures. In 1909, L. H. Baekeland invented the substance, BAKELITE, a material which, because of its ability to be melted and molded, was ideal for a variety of materials, ranging from dinnerware to electrical moldings. In 1934, Wallace Carothers, working in the Dupont Laboratory, discovered NYLON, the first synthetic fabric.

Today, synthetic polymers are found in virtually every manufactured product from foods to medicines to clothing. Made primarily from oil, these products offer strength and versatility as no natural product can. However, the very characteristics which made plastics so desirable have led to their being the target of major environmental issues. Fortunately, the technology to recycle plastics is growing along with demand for recycled plastic products.

PRE-VIEWING ACTIVITIES:

Ask students if they can think of any words that have the prefix "poly" in them. Words most familiar to this age group may be limited to some of the more simple words such as **poly**gon, **poly**unsaturated, **poly**ester and **Poly**nesia. Show students a diagram of a polygon in a mathematics book and a map showing the group of islands referred to as Polynesia. Ask students to see if they can determine what the two words have in common. Have a student look the words up in a dictionary and direct them to the understanding that "poly" refers to "many." Meros means "parts;" consequently, the word polymer refers to "many-parts." Other "poly" words include **poly**graph, **poly**ester and per**-**haps, **poly**vinyl.

Share with students clothing labels that clearly have the fabric content marked "polyester."

Next, tell students that plastics are examples of polymers and are made from repeating units joined together. Ask students to look about the room and name as many items as they think are made of plastics. Have close by several items such as plastic wrap and wax paper; a plastic plate and a china plate; a plastic diaper and a cloth diaper, a plastic cup and a glass cup, etc. Ask students to discuss why the plastic item might be desirable over the non–plastic item. Ask students to name items that they use at home that are better made of plastic than of some other substance.

Divide students into groups of 4. Give each group a set of 100 gumdrops, 100 toothpicks, crayons and paper.

Direct students to make a model of their choice using toothpicks to connect the gumdrops using the following rules:

- each gumdrop of color A must be connected to 6 equally spaced gumdrops of color B;
- each gumdrop of color B must be connected to 6 equally spaced gumdrops of color A.
- no gumdrops of the same color can be connected.

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Give each group approximately 20 minutes to construct its models.

After completing their models, tell students that they have just constructed a model of a polymer. Compare different groups noting that even with just 2 colors, there are no models exactly alike! (rarely do students construct the same exact models unless they peek!) Remind students that in nature, the same basic atoms may be used to "build" molecules but because they can be attached in so many different ways, there are almost limitless types of molecules that can be constructed from the basic materials.†

FOCUS FOR VIEWING:

While it will be easy for students to pick out materials which are made of polymers, it will be more difficult for them to realize why polymers, such as plastics, are so desirable. Direct students to listen for the reasons Dr. Dirt gives for polymers being so useful.

VIEWING ACTIVITIES:

START the video. **PAUSE** immediately after the children begin to make the polymer and Dr. Dirt says, "When you get it really tight watch, stand back..." Ask children what they think will happen when Dr. Dirt drops the glue ball.

† Activity adapted from Steve Tomecek's lesson plans for the program *Dr. Dirt's Ph*^{3}

START the tape and see what happens to Dr. Dirt's glue ball! Run the tape and **PAUSE** immediately after he has put the needle through the balloon and says, "It goes right through the balloon without popping." Ask students why they think that the needle could go through the balloon without popping. Do not answer, only let them make a few suggestions. Complete the following activity:

Give each group of students a set of rubber bands. Have them loop each rubber band onto another one, making a chain. (See illustrationbelow)

Have students lay the chain out onto the desk top or table top. Instruct them to put their fingers into the inside of each rubber band and stretch. Tell students that the rubber bands represent the molecules making up the rubber balloon. Can they now come up with an hypothesis as to why the balloon did not break? Answers will vary but students should realize that the polymers making up the balloon materials will stretch (they are flexible) to accommodate the needle much like the rubber bands stretch to let the child's finger through. NOTE: The rubber in the rubber band is also a polymer!

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START the tape and see what explanation Dr. Dirt gives for the balloon not breaking. (You may want to do this balloon activity as a demonstration yourself. It's easy, but practice first! A drop of oil on the end of the needle sometimes makes it easier.)

Let the tape run until Dr. Dirt takes the students to the anvil and tells them, "Give it a tug and see what happens!" **PAUSE** the tape before the string breaks. Ask students what will happen and why. **START** the tape. **PAUSE** before the children pull on the nylon cord. Have students predict what will happen and why.

START the tape and see what happens to the string. View the remainder of the tape.

POST-VIEWING ACTIVITIES:

Bubble gum is made up of several polymers, one of which is used to give bubble gum the extra stretch not found in regular gum. Give half the class a piece of regular gum and the other half a piece of bubble gum. As they chew the gum, ask them to blow bubbles. Based upon what they have learned in the video, have students explain why they think that they cannot blow as big a bubble with the regular gum as with the bubble gum.

Use several different brands of bubble gum and have students devise an experiment to determine which brand blows the biggest bubble, which brand retains its blowing power the longest and which brand retains its flavor the longest. Students can graph their results. Students may also want to devise a survey form that they can use to poll the school during recess or lunchtime, as to other students' favorite bubble gum,etc.

Students should realize that plastics have made their lives better in many ways. Disposable syringes have lessened the chance of spreading infection and diseases; certain safety features in automobiles are made from plastics, and the bullet proof vests which police wear are made from an exceptionally strong synthetic fiber which is stronger than any natural fiber known. Yet, the characteristics which made these items so desirable also contribute to a potential environmental problem of disposal, i.e. they remain unchanged for so long. Many plastics can be recycled. Give students a copy of the plastics code sheet. Instruct them to take it home and find at least one item in each category. They should list the item in the proper square. Have the parent sign the sheet acknowledging that they have helped with the project.

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ACTION PLAN:

If there is not a recycling program at your school, have your students organize one.

Invite a municipal official to discuss the long range recycling program for your city. If there is no plan in place, organize students to discuss the issue at a future town meeting and to make the request to have such a program developed.

Schedule a trip to a local landfill and/or recycling industry.

Contact one of the petrochemical industries to get a guest scientist to come to your class and discuss how petroleum products are made into useful polymers. If possible, schedule a field trip to such an industrial site.

Have students separate their household garbage during a 3 day period and determine what percent of the total is plastic.

EXTENSIONS:

TECHNOLOGY: If students have modem capabilities with online networks, have them survey other schools, states, etc. to determine what recycling efforts are in place in their respective locations.

ART: Have students create collages and other items from recycled plastics. Have students create useful items to use in the classroom as well as gifts for birthdays, holidays, or other special occasions.

SOCIAL STUDIES/LANGUAGE ARTS: Students can write to pen pals in other countries and see what recycling efforts they have in place. Have students find out some of the natural polymers and on a map of the world, pinpoint the countries which supply these natural polymers. Many of the discoveries of polymers have had interesting, if not humorous beginnings. Have students find out how the SUPER BALL, SUPER GLUE, VELCRO and celluloid were discovered. (A good resource is the book, SERENDIPITY, Accidental Discoveries in Science by Royston M. Roberts.)

MATH: Have students separate their household garbage during a three day period and to determine what percent of the total is plastic. Compile a class data sheet of results.