Lesson Summary:

Students will learn about different types of food packaging, how they are designed, made and the three main functions. Then, in the activity, students act as if they are packaging engineers by designing and creating their own food packages for particular food types. Lastly, students will test and evaluate their package design.

Objectives:

Students will be able to:

- Identify three important functions of a food package.
- Identify four types of food packaging materials.
- Explain what a food packaging engineer does.
- Learn about teamwork and working in groups.
- Learn about food packaging design, planning and testing.

Time Required:

40 minutes

Background Information:

Food packages have four main functions besides providing food containers.

1. To keep the food clean.
2. To protect the food product from unwanted physical and chemical changes (such as oxidation and destruction from insects) and to facilitate desired physical changes (such as heating or cooling).
3. To identify the product and provide sales appeal.
4. To be inexpensive and economical, both in its materials and its transportation.

In this lesson, a focus on the first three functions of food packages provides a great introduction to how package materials are chosen. The first function is pretty simple to fulfill; packaging materials prevent dirt from getting into food. Fresh produce is an exception to this approach since a fruit or vegetable's skin protects its insides from contamination and consumers are expected to clean the produce before eating. Thus, natural fruit and vegetables are basically "self-packaged."

The second function of food packages is probably one of the hardest to understand. A number of physical changes can be considered for this function. The main physical change that can
occur is physical damage. Food can be crushed and damaged without the proper protection from its package.

Another physical change that children can relate to is soda going flat. The scientific word for this happening is effervescence, which is the escape of air bubbles from a liquid. This physical change occurs when a carbonated beverage is opened. The carbonation quickly escapes through the opening. Students should consider this physical change in the packaging of beverages. Bottles can be resealed to prevent the further escape of air bubbles while cans cannot.

Also many children are familiar with mixing. By mixing, we mean to disperse one substance throughout another, usually by swirling. A food example is dissolving a lemonade powder in water. This process is not a chemical change because the water and powder do not form a new chemical. The powder is solely dispersed evenly throughout the water to make a mixture of individual water and lemonade molecules.

One example of a major physical change is phase change. Phase changes occur if a food changes state between solid, liquid or gas. An example of a food whose package must consider phase change is ice cream. An ice cream carton is meant to hold an almost solid ice cream. However, the design must also anticipate liquid in case of melting. The design must also be capable of being put in the freezer and also taken out by the consumer. Thus, a good point to make is that a food package designer would not make an ice cream package of metal because it would be too cold to touch and remove from the freezer. Also, designs for packages for foods that are meant to be warmed up in microwaves must take into account the melting point (the temperature at which a material changes from solid to liquid) of the package materials. If a package is to be microwaved, a material with a low melting point would not be a good choice, since the package would melt into the food!

A major chemical change involved in the creation of food packages is organic growth in foods. Organic growth occurs by microorganisms, which feed on foods. As microorganisms feed, the food can rot and the microorganisms multiply. It is not eating the rotten food that makes a person sick, but eating the vast number of microorganisms on that food. Microorganism growth can include the growth of bacteria, molds and yeast. Microorganisms grow and affect different foods at different rates. The package in which a food is held affects a food's rate of organic change.

Such organic change affects how long a food can be stored before and after its opening. Plastics and cans do not allow moisture to seep into the food product that they hold. Thus, they keep microorganisms from outside away from the food. Vacuum sealing removes all of the oxygen from a food. Without oxygen, microorganisms cannot grow and so the food does not rot. If a
food's microorganisms are removed through processing, these packages prevent most organism growth in the food and enable its shelf life to be long. These non-perishable foods can last for two years or longer.

After opening a food package, however, microorganisms in the air can quickly get into the package to start an organic degradation of the food. This event is why food packages say, "Refrigerate after opening." Microorganisms can only grow in certain temperatures so refrigeration slows rotting and freezing usually stops degradation altogether. In spite of this, naturally non-perishable foods whose majority is not fruit, vegetable, nut oil or dairy are okay if not refrigerated for a reasonable amount of time since their rate of organic change is very slow.

Many different processes exist to make a food non-perishable, as discussed earlier. A common process is thermal processing, in which foods are treated with heat to destroy all microorganisms. Thermal processing takes less energy for plastic-packaged foods than metal packaged foods. Thus, taste is preserved more in plastic-packaged food than canned food. This is a major advantage to use plastic in packaging rather than metal.

Since paper packages permit the entrance of oxygen and moisture, they usually hold foods whose rate of organic change is very slow or foods whose consumption is assumed to happen within days of production.

Despite the physical and chemical changes that some materials may prevent or encourage, all materials have advantages and disadvantages.

Engineering Connection

An entire industry is devoted to packaging engineering and this industry is expanding as more and more products are created. Packaging engineers focus on the same components as students in this design challenge, which includes research, design, production, marketing and analysis. Engineers often work with marketing, sales and perhaps a creative department when recommending packaging requirement for a product. Good packaging must protect the product, eliminate any damage while moving, shipping, or storing the products, and also make the product attractive if it is to be displayed in a consumer environment such as a grocery store, hardware store, or department store. For this reason, packaging is a critical part of a products design and engineering process, and engineers must take many factors into consideration including appearance, function and costs.

Materials:
- One set of materials for each group of students:
- One chip (or a few chips depending on how many you have)
- Paper
Ship the Chip

- Glue
- Tape
- String
- Cotton balls
- Plastic wrap
- Toothpicks
- Popsicle sticks
- Foil
- Any other materials you have on hand.
- Examples of food packaging ideas (boxes, bags, cans, jugs, etc.)
- Scale

**Procedures:**

1. Explain to the students that today they are going to practice being a food packaging engineer, but first they must learn a few things about food packaging.
2. Hold up different packaging and talk about the four main functions of packaging.
   a. To keep the food clean.
   b. To protect the food product from unwanted physical and chemical changes (such as oxidation and destruction from insects) and to facilitate desired physical changes (such as heating or cooling).
   c. To identify the product and provide sales appeal.
   d. To be inexpensive and economical, both in its materials and its transportation.
3. Show students different examples of food packaging. Examples may include: canned food, boxed foods, plastic bags, glass and plastic bottles, candy wrappers and paper packaging.
   a. Cartons are rigid and provide support for fluid foods.
   b. Boxes are usually used as a secondary package to store foods that are sold in quantities larger than one, but are individually wrapped and give structure and support.
   c. Bags are flexible so they can be stored easily.
   d. Cans hold liquids and carbonation well and can be stacked well.
   e. Bottles hold liquids and carbonation well and are re-sealable.
   f. Wrappers are light and do not take up too much space.
4. Now explain to the students that you are hiring them as food packaging engineers. Explain what a food packaging engineer does from the information given above. The students are going to work in teams to design, plan and then test their package design.
5. Divide the students into groups of 2-3. Provide a set of materials for each group.

6. Explain to the students that they must work in teams of engineers who have been given the challenge of designing the smallest lightest package of all the engineering teams in your classroom that will protect a single potato chip that will be put through a test to see if it would make it unharmed if sent through the mail. The chip must arrive edible after its test through the postal system.

7. Students will first meet, plan and draw their planned package (give them 5 minutes to do this part). Have each group make a list of which supplies they will use in their package.

8. Next, students will construct their packages and prepare them for testing. See if they can come up with a way to protect the food, keep it clean, identify what kind of food it is and the last one you may have to help them – inexpensive and environmentally friendly.

9. When students have completed packages they are weighed then tested. You can set up any kind of simple test such as having students drop the package from a marked height into a box.

10. After testing, open the packages one by one to see if the chip survived. When opening the packaging you can discuss with students the pros and cons of their package design (too many materials, environmentally friendly, etc.)

Assessment:

Ask students:

- Identify three important functions of a food package.
- Identify four types of food packaging materials.
- Explain what a food packaging engineer does.

References/Resources:

www.tryengineering.org