BACKGROUND INFORMATION

Concepts
Eating is essential to survival. The food astronauts take into space must
- be lightweight
- require little storage space
- be nutritious
- be convenient to use
- need no refrigeration

Dehydrated Foods for Space Travel
Foods are dehydrated to meet weight restrictions for the Space Shuttle liftoff. They are later rehydrated in orbit when they are ready to be eaten. Water used for rehydration comes from the Shuttle's fuel cells. The fuel cells produce electricity by combining hydrogen and oxygen, resulting in water. Since water is an available by-product from the fuel cells, it is possible to send food in a dried form for later rehydration.

More than a hundred different food items, such as cereals, spaghetti, scrambled eggs, and strawberries, go through this dehydra- tion/rehydration process. When a strawberry is freeze-dried, it remains full-size in outline, with its color, texture, and quality intact. It can be rehydrated with saliva as it is chewed or by adding water to the package.

Twenty varieties of drinks, including tea and coffee, are also dehydrated for use in space travel. But pure orange juice or whole milk cannot be included. If water is added to dehydrated orange crystals, there is no rehydration mixture — just orange "rocks" in water. If whole milk is rehydrated, the dried milk does not dissolve properly. It floats around in lumps and has a disagreeable taste. So skim milk must be used. Back in the 1960s, General Foods developed a synthetic orange juice product called Tang, which could be used in place of orange juice.

Other Foods for Space Travel
Shuttle food items are brought aboard in several different forms:
Natural form
Examples are graham crackers, pecan cookies, peanut butter, hard candy, gum.
Thermostabilized
Cooked at moderate temperatures and sealed in cans. Examples are tuna fish, canned fruit in heavy syrup.
Irradiated
Preserved by exposure to ionizing radiation. Examples are meat and bread.
Intermediate moisture process
Removing part of the water. Examples are dried apricots, peaches, pears.
Salt and pepper are packaged in liquid form because crystals would float around the cabin. You may want to mention that tobacco and liquor are barred from the Shuttle.

Packaging Food for Space
All food in space must be packaged in individual serving portions that allow easy manipulation in the weightless environment of an orbiting spacecraft. Packages can be off-the-shelf thermostabilized cans, flexible pouches, or semirigid containers.

Food Preparation
The variety of food carried into orbit is so broad that crew members enjoy a six-day menu cycle. A typical dinner might consist of a shrimp cocktail, steak, broccoli, rice, fruit cocktail, chocolate pudding, and grape drink. To prepare the meal, the mission specialist chef takes a big plastic overwrap out of the food locker. The package is attached to a worktable. Inside the overwrap are four smaller plastic overwraps, each holding a complete meal of seven separate containers. Using a hollow needle attached to the hot water outlet, the chef injects a prescribed amount of water through a narrow passageway into the plastic bowls of dehydrated broccoli and rice.

The chef kneads the packages through their flexible plastic tops and secures them in the oven along with the four precooked steaks. The steaks are packaged in flexible aluminum-backed plastic bags, called flex-pouches. The heat in the oven is 82°C, which does not harm the plastic containers. A fan circulates air so that the food is heated evenly.

While these items warm in the oven, the mission specialist takes four trays from the galley and attaches them by magnets or clamps to a portable dining table hooked to the lockers. The mission specialist then adds cold water through the hollow needle to rehydrate the bowls of shrimp, chocolate pudding, and grape drink. A plastic straw with a clamp on it is inserted into the passageway of the grape drink. These cold items, along with the cans of fruit cocktail, the silverware, and a can opener, are assembled on the trays and held by magnets or Velcro tape. When the heated foods are ready, it is dinner time.
Objectives

Students will understand the following:

- Astronauts need food to survive.
- Astronauts must bring their food into space.
- Food is dehydrated because of limited space.

Motivation

1. Astronauts must eat balanced meals. If you were an astronaut, what foods would you take with you on a space flight?
   
   (Accept any answers that are food related. Possible answers: granola bars, Tang, powdered milk, beef jerky, apples, bread, or dehydrated vegetables, fish, and meat.)
   
2. To keep your body healthy, you need a variety of foods each day.
   What are the four food groups?
   
   (Meat, dairy, fruits and vegetables, bread and cereals.) Relate answers from question 1 to these four food groups.
   
3. Bring in pieces of dehydrated fruit, such as apples or banana chips for the students to taste. Explain the process of dehydration.
   
   Ask: What are some foods at home that are dehydrated?
   
   (Possible answers: Dehydrated pieces in packaged soups, such as mushrooms, chicken, parsley, green peppers, carrots. Dehydrated spices such as parsley and onions.)

Vocabulary

Have the students use these words as part of your motivating discussion and in the follow-up Space Lab and Space Countdown activities.

- A-OK (Everything is fine!)
- milliliter (one thousandth of a liter)
- gram (one thousandth of a kilogram)
- astronaut
- spacecraft
- dehydrated
- graph

Activity Description

The Student Liftoff page for this lesson contains two activities: Space Lab and Space Countdown.

The Space Lab is a hands-on experiment in which students learn about rehydrating a food product. The students are asked: How is water put back into food? The experiment simulates rehydrating by reconstituting an orange drink. This activity may be done at school or at home.

The Space Countdown, a math activity, requires the student to count, read a graph, and compare quantities of most and least.

Additional Activities for School or Home

- Make instant pudding. Pour some pudding into a plastic Ziploc sandwich bag. Close the bag. Cut off the tip of the bag and have the students eat pudding by squeezing it out through the hole. This experiment shows how astronauts ate on early space flights.

- Create a class poem or story in which the students imagine being orange juice drink crystals (dehydrated form) and changing into a liquid orange drink (rehydrated form). This writing activity can be illustrated. Have each child list dehydrated foods found at home. Record the results as a class graph.

- Plan a tasting party with samples representing each of the different types of food taken on a Space Shuttle mission — rehydratable, thermostabilized, intermediate moisture, irradiated, and natural form.
Astronauts need food, even in space. But a spacecraft has little room to store food.

Scientists take water out of some foods. Then the food takes up less room.
The water is put back into the food at mealtime.
The food looks good and tastes good. Mealtime in space is A-OK.

Space Lab

How is water put back into food?

You need: 15 grams of orange drink crystals, 200 milliliters of cold water, 1 glass, 1 spoon, 1 straw.

Step 1. Measure 15 grams of orange drink crystals into a glass.
Step 2. Add 200 milliliters of cold water.
Step 3. Mix well with a spoon.
Step 4. Drink with a straw.

Look at the orange drink crystals. Look at the water.
How have the crystals changed? How has the water changed?

Space Countdown

Look at the graph. It shows how many glasses of orange drink each astronaut had.

Use the graph to answer the questions.

1. Which astronaut drank the most?
2. Which astronaut drank the least?
3. How many glasses of orange drink did they have altogether?
Objectives
Students will understand the following:
• Food must be lightweight to meet Shuttle liftoff restrictions.
• Food needs to be compactly packaged to meet storage limitations.
• Dehydrated food meets the special requirements for space flight.
• Dehydrated food is rehydrated before it is eaten.

Motivation
1. What’s in your lunch box today?
(Accept any food answers.)
2. If you had to fit food for seven days into your lunch box, what would you do?
(Accept any logical answers.)
3. Ask the students to predict what an astronaut might eat in space.
   Relate to question 2, explaining that food for several days must fit in a small space.
   (Accept any food answers, listing them on the board. After reading the text, have children decide which of the suggested foods could be dehydrated and taken aboard the Shuttle. Use background information to discuss other food forms.)

Vocabulary
Have the students use these words as part of your motivating discussion and in the follow-up Space Lab and Space Countdown activities.
• astronaut
• spacecraft
• lightweight
• dehydration
• balance scale

Activity Description
The Student Liftoff page for this lesson contains two activities: Space Lab and Space Countdown.

The Space Lab experiment with a dried apple gives students a hands-on experience with dehydrating a familiar food. The students are asked: Why does a dried apple take up less room than a fresh apple? The experiment compares a natural-form apple and dried apple slices. This activity may be done at school or at home. The dehydration of other locally available fruits, such as pears, peaches, or papayas could be an extension of this activity.

The Space Countdown, a math activity, requires the use of a scale to weigh a fresh apple and six dried apple slices. The activity requires subtraction and involves comparing the concepts of more and less.

Additional Activities for School or Home
• The teacher can make use of the background information provided here to discuss food preservation methods used on Space Shuttle flights. Then organize a trading party. Have students bring two samples of foods preserved in different ways — dried, dehydrated, salted, or smoked. Provide five minutes for students to trade foods. Compare and contrast different methods of preserving food. Complete this activity with a food-tasting party.
• Have students collect pictures illustrating foods that do not need refrigeration. Categorize according to method of preservation. Then use the pictures to create collages for display.
• This activity can be used to simulate the foods eaten by astronauts on early space flights. Have the students bring cooked vegetables to class. For example, steamed yams, carrots, white potatoes, squash, green beans. Puree foods individually in a blender, then seal in plastic Ziploc sandwich bags. Eat the food as astronauts did on early space flights. Clip a small hole in one corner of the bag. Squeeze the food into your mouth.
What is in an astronaut's lunch box? Food that is packaged to take up little room.
Food that is lightweight. Why? Because a spacecraft cannot carry extra weight.
Water is taken out of food. Then the food weighs less. This is called dehydration.
When it is time to eat, water is put back into the food. A long, thin tool is used to add water to the package.
Then the food tastes and looks like the food you eat.
Astronauts enjoy their meals in space.

Space Lab

Why does a dried apple take up less room than a fresh apple?

You need: 2 apples, a knife, a large-eyed needle, a 30-centimeter piece of yarn.

Step 1. Put an apple in a cool place. Peel and cut the other apple into 6 round slices.

Step 2. Push the threaded needle through each apple piece.

Step 3. Hang the pieces to dry. Check them each day.

Step 4. Place the whole apple next to the pile of dried apple slices.
Compare the whole apple with the dried apple slices.
Which takes up less room? Why?

Space Countdown

Use the scale in your classroom.
Weigh a whole apple. Write its weight here. _______
Weigh the six dried apple slices from the Space Lab experiment. Write their weight here. _______
Which weighs more? Why? Subtract the weight of the dried slices from the weight of the whole apple.
What is the difference?
Objectives
Students will understand the following:
- Mission specialists prepare food for the entire crew.
- Food requires special preparation according to form.
- Food eaten during a mission is similar to food eaten on Earth.

Motivation
1. What kinds of food might your family take on a camping trip if no cooler was available?
(Foods that do not need refrigeration, such as canned foods, dried foods, cereals, crackers, bread.)
2. Who would prepare the food?
(Any member of the family who likes to cook.)
3. In what ways would camping foods and space flight foods be similar?
(Both would be lightweight, compact for limited storage space, and have no need for refrigeration.)
4. Who would prepare the food?
(A cook or each astronaut.)

Vocabulary
Have the students use these words as part of your motivating discussion and in the follow-up Space Lab and Space Count-
down activities.
- food locker (place to store food aboard the Space Shuttle)
- Velcro (self-gripping fastener with meshing plastic ridges)
- milliliter (one thousandth of a liter)
- mission specialist
- rehydrated
- magnet
- liquified

Activity Description
The Student Liftoff page for this lesson contains two activities: Space Lab and Space Countdown.
The Space Lab is a hands-on experiment comparing the weight of dehydrated with rehydrated foods. The student are asked: How does rehydrating food make it weigh more? The students then rehydrate oatmeal. This experiment shows how rehydrated food has more weight and volume than dehydrated food. This activity may be done at school or at home.
The Space Countdown, a math activity, requires the student to read a clock, add time, and subtract time. Students will also need to know the difference between a.m. and p.m.

Additional Activities for School or Home
- Have students bring to class some of the fruit from commercial cereals that contain freeze-dried fruit. Weigh the fruit before placing it in a small bowl with a small measured amount of water. Wait a few minutes and measure the water again. Weigh the fruit after rehydration. Observe what happens to the water and to the fruit. Is the fruit still as hard as when it was first placed into the bowl of water? Explain what happened.
- Have each student imagine he or she is a mission specialist chef aboard the Space Shuttle. Have each student write a letter to someone back on Earth detailing the job. Include some unusual event or problem that occurs. How do these mission specialists meet the challenge?
Would you like to be the chef on a space mission? Today's menu is shrimp cocktail, steak, broccoli, rice, grape drink, chocolate pudding, and fruit cocktail.

A mission specialist chef prepares this meal in about thirty minutes. The chef removes a complete meal package from the food locker. Food that needs water is rehydrated. Other foods are heated in the oven.

When everything is ready, the food is arranged on trays held in place by Velcro or magnets. The crew season their food with mustard, catsup, or liquified salt and pepper. It's time to dig in!

**Space Lab**

*You will need an adult to help you with this experiment. How does rehydrating food make it weigh more?*

*You need:* 2 packages of instant oatmeal, 150 milliliters of boiling water, 2 bowls, a spoon.

*Step 1.* Put 1 package of instant oatmeal into each bowl.

*Step 2.* Pour boiling water into 1 bowl of oatmeal. Mix well with a spoon.

*Step 3.* Lift the bowl with dry cereal. Lift the bowl with mixed cereal.

Which weighs more? Why?

How does adding water to food change the weight of the food?

**Space Countdown**

A mission specialist prepares a meal in thirty minutes.

**Answer the following questions:**

1. Breakfast is at 7:30 a.m. When will the mission specialist start the preparations?
2. If lunch is started at 11:45 a.m., when will the crew eat?
3. Dinner is taken out of storage at 5:15 p.m. When will the astronauts eat?
4. How many hours are there between breakfast and lunch?
   Between lunch and dinner?