LIFE

SCIENCE
Nutrition in Space

Grade Level: 5

Time Required: 6 - 10 days
(using sun as energy source)
two 45 minute class periods
(using oven as energy source)

Countdown:
- Fruits (i.e. apples, bananas, grapes)
- Vegetables (i.e. celery, carrots, tomatoes)
- Knife
- Cheese Cloth
- Drying Trays (i.e. cookie sheet or aluminum foil pieces)
- Gram scale and masses

Ignition:
In 1959, NASA started planning for manned space travel and was challenged by the problem of how and what to feed astronauts. Two basic concerns arose: (1) preventing food crumbs from contaminating the spacecraft's atmosphere and (2) preventing the formation of potentially catastrophic disease-producing bacteria, viruses, and toxins.

To solve these problems, NASA hired the Pillsbury Company. The first solution was to coat bite-size food like sandwich cubes, thereby preventing crumbling. Also, as in Apollo, food like ham salad was packaged into toothpaste-type tubes and squeezed out. The second solution was more difficult. Pillsbury developed the HACCP (Hazard Analysis and Critical Control Point) concept. This procedure involves a systematic study of the food product to be produced and packaged, along with the processing conditions, handling, storage, packaging, distribution, and package directions for consumer use. The stages in the chain from raw materials to finished product are constantly monitored.

Due to lack of storage space and refrigerators on most manned spacecrafts, NASA has found that the method of dehydration and freeze-dried foods is an effective answer to feeding astronauts. The ancient method of dehydration serves two purposes: (1) to dry food, thereby reducing its moisture to between 5% and 25% and eliminating bacteria which cause decay and (2) to preserve food for future use without concern for an expiration date.
Liftoff:
According to time and resources available, choose between using sun energy (which could require 10 days) and using the oven.

1. Make sure that your fruit is fully ripe.
2. Have students weigh each fruit and vegetable before drying and record weights in the table provided.
3. To use the sun method:
   - Cut the food into medium chunks (except the grapes, which should be left whole, either in a bunch or separated).
   - Place fruits and vegetables on drying trays outside and cover with cheesecloth. Dry on one side, then turn and dry on the other side. This should take 6 - 10 days.
4. To use the oven method:
   - Slice the fruit and vegetables one-eighth inch thick; put in a single layer on the drying trays. (Do not try the grapes in the oven because of their skin.)
   - Place in a 120 F oven for 8 - 12 hours.
5. Ask the students to weigh the dried fruit and vegetables. Record new weights in the table, and determine the mass/water weight loss.

Conclusion:

1. Compare and contrast the process of dehydration with the processes of freezing and canning. Suggest that in other environments refrigerators may not be readily available. Ask for suggestions of other possible food storage.
2. Discuss the types of energy used. Predict energy sources that may be accessible in the future in different environments such as the moon and planets, most notably Mars.
More Ideas:

♦ Extend the measurements in the table to include the ratio of loss of mass to beginning mass and the percentage of water in a variety of different fruits and vegetables (pear, pineapple, potato, squash, mushroom).

♦ Preserve meats (i.e., ham, beef, chicken, lamb) by sun or oven drying. Use extra care when drying meats due to the possibility of spoilage. The drying time for meat is about 3 days if done outdoors (although this method is not recommended) and several hours in the oven.

♦ Make jerky, using the following recipe.

   **Jerky**
   1 1/2 lbs. Lean, boneless meat (beef flank, brisket, top round steed, venison, turkey)
   1/4 cup soy sauce
   1 T. pepper
   1/4 t. garlic powder
   1/2 t. onion powder
   1 t. liquid hickory smoke
   Flavored salt
   Hot sauce/Tabasco (optional)

   Partially freeze the meat to be used so that slicing will be easier. Trim and discard all fat from the meat. Cut the meat into 1/8 to 1/4-inch thick slices. In a bowl, combine sauces and seasonings until dissolved. Add the meat strips and coat thoroughly. Cover tightly; let stand overnight in the refrigerator. Shake off the excess liquid; sprinkle coarse black pepper on both sides. Arrange the meat strips close together, single layer, directly on the oven racks with shallow rimmed pans underneath. Dry the meat at 150 - 200 degrees F until it turns brown, feels hard, and is dry to the touch. Cooking time for chicken and turkey is about 5-6 hours, 4 - 7 hours for beef and venison. Pat off any beads of oil. Cook and store in airtight plastic bags or jars with tight fitting-lids.
The Effects of Dehydration on Fruits and Vegetables

<table>
<thead>
<tr>
<th>Food Sample</th>
<th>Mass (before drying) (g)</th>
<th>Mass (after drying) (g)</th>
<th>Loss of Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lunch Time

Grade Level: 5 - 6

Time Required: 30 - 45 minutes

Countdown:
- Food Word Search
- Menu Selection Sheet
- Pencils

Ignition:
Eating is essential to survival. Now that we have the International Space Station, astronauts are from many different countries. The food astronauts take into space must:

- be lightweight
- require little storage space
- be nutritious
- be convenient to use
- need no refrigeration
- be foods they like

Some foods are dehydrated to help meet weight and storage restrictions for the space shuttle liftoff. Dehydration means all the water is removed from the item. Can you think of a food you ate during the last week that was dehydrated? (Example: cup of soup, raisins, instant pudding, etc.)

The food is later rehydrated in orbit when it is ready to be eaten. Water used for rehydration comes from the space shuttle's fuel cells. The fuel cells produce electricity by combining hydrogen and oxygen, resulting in water. Since water is an available byproduct from the shuttle's fuel cells, it is possible to send food in a dried form for later rehydration.

What did each student eat for lunch? Write down all responses on the chalkboard or on a transparency on the overhead projector. Discuss whether each item could be taken on the space shuttle. Why or why not?

More than 100 different food items such as cereals, spaghetti, scrambled eggs, and strawberries, go through this dehydration/rehydration process.

Some 20 varieties of drinks, including tea and coffee, are also dehydrated for use in space travel. But pure orange juice or whole milk cannot be used for dehydration. Do you know why? If water is added to dehydrated orange crystals, the crystals just become orange rocks in water. During the 1960's, General Foods developed a synthetic orange juice product called Tang, which could be used in place of orange juice. If whole milk is rehydrated, the dried milk does not dissolve properly. Instead, it floats around in lumps and has a disagreeable taste. Instead, skim milk is used to avoid problems.
Liftoff:

Shuttle foods are brought aboard in several different forms.

- Divide students into four groups. Each group will be given one of the four ways that foods are brought aboard the space shuttle which are listed below. Each group will then come up with a list of examples of foods in each category. Have each group share with the class these examples.

**Natural Form** - examples are graham crackers, pecan cookies, peanut butter, hard candy and gum.

**Thermostabilized** - cooked at moderate temperatures and sealed in cans. Examples are tuna fish and 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, and pears.

Salt and pepper are packaged in liquid form because crystals would float around the cabin.

- The variety of food carried into orbit is so broad that crewmembers enjoy a several-day menu cycle. A typical dinner might consist of a shrimp cocktail, steak, broccoli, rice, fruit cocktail, chocolate pudding, and grape drink. Have each group plan a meal based on the example food list and then tell how it would prepare the meal. Each group will then share the results with the class.

To prepare the example typical meal, a crewmember takes a big plastic overwrap out of the food locker. The package is then attached to a worktable; inside the over-wrap are four smaller plastic overwraps, each holding a complete meal of separate containers. Using a hollow needle attached to the hot water outlet, the crewmember injects a prescribed amount of water into the plastic bowls of dehydrated broccoli and rice through a narrow passageway.

The crewmember then 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 can reach 82 degrees C (1880 degrees F), which does not harm the plastic containers. A fan circulates air so that the food is heated evenly.
While these items are heated in the oven, the crewmember takes four trays from the galley and attaches them by magnets or clamps to a portable dining table hooked to the lockers. The crewmember 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's dinnertime.

**English Students will:**
- Write a paper on mealtime in space.
- Learn new vocabulary words by unscrambling words in the *Shuttle Food Scramble*.
- How many space foods can you make from the words: *Shuttle Food Selection Menu?*

**More Ideas …**
- Complete “Foreign Bread” Word Search.
- Make a list of food items we use today that started because of the Space Program.
- Design a meal tray for the shuttle launch using a Styrofoam meat tray.
- Plan menus for a seven-day launch.
- Research foods that are eaten in each country. Identify foods that could be taken into space that would make this astronaut “feel at home.”
Foreign Breads

B I S C E Y R C R E P E K A E
I R H U T Z E L B R O T K U H E
A L D S D A E R B H C N E R F
P P R O C A Z Z I P B P L T O
K A P U S S P R E T L P I A T
A C N R C K T C R E I E M I L
I A R D O A U O R B N P P C A
S B S O B I R H L N I I A C L
E I P U I R A A E L B Z L A L
R S I G K S O S S S L E S O C I
R C Z H M P S T R A H N A O T
O U B A G U E A C Y U O F F R
L I Z P P I Z R N H E E P C O
L T P R E T Z E L T E B E F T
S S A E T T E U G A B N S R R

Kaiser Rolls          Hutzelbrot          Stollen          Kuhelhopf          Limpa Loaf
Sourdough             Pizza              Biscuits          Rye              Blini
Pretzel               Tortilla           Croissant         French Bread     Crepe
Baguette              Carasau            Brotchen          Focaccia          Pan

Bonus: The Japanese eat these more often than bread.
This crisp bread product is flat and crispy.
Which bread can you find more than once?
Name the countries that the breads and Astronauts represent.
Kulich, Crepe, Blini, Lefse, Tortilla, are names for what American breakfast product?
Foreign Breads Answer Sheet

Kaiser Rolls  Hutzelbrot  Stollen  Kuhelhopf  Limpa Loaf
Sourdough  Pizza  Biscuits  Rye  Blini
Pretzel  Tortilla  Croissant  French Bread  Crepe
Baguette  Carasau  Brotchen  Focaccia  Pan

Bonus: The Japanese eat these more often than bread. This crisp bread product is flat and crispy. What word is shown more than once? Countries of breads and astronauts: Canada, France, Germany, Italy, Japan, Spain, Sweden, Switzerland, and United States These are names for what popular American breakfast product? Pancake

Answers to Shuttle Food Scramble

Natural Form  Thermostabilized  Irradiated  Intermediate Moisture Process  Tang  Dehydrated  Rehydrated  Nutritious

SpaceExplorers http://www.tsgc.utexas.edu/spaceexplorers/
Life Sciences: Lunch Time
Texas Space Grant Consortium http://www.tsgc.utexas.edu/
Shuttle Food Scramble

AURTANL OMRF - ______________________________

OMREHDTSBAIIZE - ______________________________

ITERIDARAD - ______________________________

TNIMREIDEETA IOMUTSER ORPSECS - ______________________________

ANTG - ______________________________

HEDRDYETAD - ______________________________

ERHYTDARDE - ______________________________

IIUNTTSSUOR - ______________________________
## Example Shuttle Food Selection Menu

<table>
<thead>
<tr>
<th>Item</th>
<th>Brief Description</th>
<th>Item</th>
<th>Brief Description</th>
<th>Item</th>
<th>Brief Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Almonds (NF)</td>
<td></td>
<td>Fruit cocktail (T)</td>
<td></td>
<td>Sausage patty (R)</td>
<td></td>
</tr>
<tr>
<td>Applesauce (T)</td>
<td></td>
<td>Graham crackers (NF)</td>
<td></td>
<td>Shortbread patty (NF)</td>
<td></td>
</tr>
<tr>
<td>Apricots, dried (IM)</td>
<td></td>
<td>Granola cereal (R)</td>
<td></td>
<td>Shrimp cocktail (R)</td>
<td></td>
</tr>
<tr>
<td>Barbecue beef with sauce (R)</td>
<td></td>
<td>Granola cereal w/blueberries (R)</td>
<td></td>
<td>Shrimp creole (R)</td>
<td></td>
</tr>
<tr>
<td>Beef almondine (R)</td>
<td></td>
<td>Granola cereal w/raisins (R)</td>
<td></td>
<td>Soda crackers (NF)</td>
<td></td>
</tr>
<tr>
<td>Beef w/sauce (T)</td>
<td></td>
<td>Granola bar (NF)</td>
<td></td>
<td>Spaghetti, w/meat sauce (R)</td>
<td></td>
</tr>
<tr>
<td>Beef ground w/spice sauce (T)</td>
<td></td>
<td>Green beans and broccoli (R)</td>
<td></td>
<td>Spinach, creamed (R)</td>
<td></td>
</tr>
<tr>
<td>Beef patty (R)</td>
<td></td>
<td>Green beans w/mushrooms (R)</td>
<td></td>
<td>Strawberries (R)</td>
<td></td>
</tr>
<tr>
<td>Beef steak (T)</td>
<td></td>
<td>Ham (T)</td>
<td></td>
<td>Sweet 'n sour</td>
<td></td>
</tr>
<tr>
<td>Beef stroganoff w/noodles (R)</td>
<td></td>
<td>Ham salad sandwich spread (T)</td>
<td></td>
<td>Chicken (R)</td>
<td></td>
</tr>
<tr>
<td>Bran flakes (R)</td>
<td></td>
<td>Italian vegetables (R)</td>
<td></td>
<td>Teriyaki Chicken (R)</td>
<td></td>
</tr>
<tr>
<td>Bread (NF)</td>
<td></td>
<td>Jam/jelly (IM)</td>
<td></td>
<td>Trail mix (NF)</td>
<td></td>
</tr>
<tr>
<td>Breakfast roll (NF)</td>
<td></td>
<td>Lemon pudding (T)</td>
<td></td>
<td>Tuna (T)</td>
<td></td>
</tr>
<tr>
<td>Butter cookies (NF)</td>
<td></td>
<td>Life savers (NF)</td>
<td></td>
<td>Tuna salad spread (T)</td>
<td></td>
</tr>
<tr>
<td>Butterscotch pudding (T)</td>
<td></td>
<td></td>
<td></td>
<td>Turkey and gravy (T)</td>
<td></td>
</tr>
<tr>
<td>Candy coated chocolates (NF)</td>
<td></td>
<td></td>
<td></td>
<td>Turkey salad spread (T)</td>
<td></td>
</tr>
<tr>
<td>Candy coated peanuts (NF)</td>
<td></td>
<td></td>
<td></td>
<td>Turkey tetrazzini (R)</td>
<td></td>
</tr>
<tr>
<td>Cashews (NF)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cauliflower w/cheese (R)</td>
<td></td>
<td>Macadamia nuts (NF)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cheese spread (T)</td>
<td></td>
<td>Macaroni and cheese (R)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken a la king (T)</td>
<td></td>
<td>Meatballs w/BBQ sauce (T)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken consommé (R)</td>
<td></td>
<td>Mushroom soup (R)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken and rice (R)</td>
<td></td>
<td>Oatmeal w/raisins and spice (R)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chicken salad spread (T)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chili mac w/beef (R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chocolate mints (NF)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chocolate pudding (T)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn, green beans and paste (R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn flakes (R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dried beef (IM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eggs, scrambled (R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eggs, seasoned scrambled (R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eggs, Mexican scrambled (R)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frankfurters (T)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruit bars (IM)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruitcake (T)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salmon (T)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peach drink</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pineapple drink</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strawberry drink</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tea</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tea w/artificial sweetener</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tea w/cream</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tea, w/lemon</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tea w/lemon and sugar</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tropical punch</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tropical punch w/artificial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sauce</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condiments:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catsup</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mustard</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pepper</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hot pepper sauce</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mayonnaise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taco sauce</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beverages:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apple drink</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cherry drink</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>w/artificial sweetener</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citrus drink</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cocoa</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coffee, black</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coffee w/artificial sweetener</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condiments:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermostabilized</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intermediate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moisture</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rehydrated</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FD</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freeze Dried</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NF</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural Form</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Abbreviations:
- T: Thermostabilized
- IM: Intermediate
- FD: Freeze Dried
- NF: Natural Form
- FD: Freeze Dried
- R: Rehydrated
- NF: Natural Form
Is It Soup Yet?

Grade Level: 6

Time Required: 2 to 3 class periods

Countdown:
Baseline Shuttle Food List
Colored Paper
Paper for Menus
Colored Pens, Pencils and Markers
Food Guide Pyramid

Ignition:

Astronauts on shuttle missions have many of the same physical and social needs as we have here on Earth. It is essential for the healthy crewmember to eat and drink correctly -- according to space nutrition requirements -- to sleep, to exercise, and to relax. And, due to the size limitation of the spacecraft and the nature of the mission, it is vital that each of the crew functions well as a team member, showing leadership skills and following directions as dictated by the specific task and situation.

Liftoff:

A. Discussion
Tell students that a typical meal in space can be compared to an Earth meal, with some variations.
1. Foods are precooked or processed here on Earth and are individually packaged and stowed for easy handling in the microgravity environment. Weight allowed for food is 3.8 pounds per person daily.
2. Foods are either ready to eat or can easily be prepared by adding water or heating. Beverages are packaged in a foil laminate, similar to the Capri-Sun type juice bags. The drinks are usually dehydrated, so the crew adds water. A straw with a clip is inserted into the bag for easy drinking.
3. Fresh fruit and vegetables, i.e., apples, bananas, oranges, and carrot and celery sticks are stored in the fresh food locker along with tortillas, fresh bread, and breakfast rolls. The carrots and celery must be eaten within the first few days of flight to avoid spoilage. Refrigeration, except on Skylab, has not been available on space missions.
4. Astronauts use conventional eating utensils in space -- knives, forks, and spoons. In addition, they use scissors for cutting open the food and beverage packages.
5. A meal tray is used to hold the food and beverage containers. The tray can be attached to an astronaut's lap by a strap or attached to a wall. The meal tray becomes the astronaut's dinner plate and enables him/her to choose from several foods at once, just like a meal at

Suggested TEKS
Science - 6.4
Health - 6.11
Language Arts - 6.19
Art - 6.1
Computer - 123.13 (2)

Suggested SCANS
Interpersonal. Teaches others.

National Science and Math Standards
home. Without the tray, the contents of one container must be completely eaten before other containers are opened, so that they do not float away in the microgravity of space.

6. Meals are prepared in the galley located on the orbiter's mid deck. The galley contains a water dispenser for rehydrating foods and a forced air convection oven for warming foods to the proper serving temperature.

7. A supplementary food supply is stowed in the pantry on each flight. This provides about 2100 kilocalories per person for two extra days in case the flight is extended due to bad weather at the landing site or some other unforeseen reason. Also included are extra beverages and snacks.

B. Shuttle Menu Selection

1. Tell students that food evaluations are conducted about 8 to 9 months before the flight. At that time, the astronauts are given the opportunity to sample a variety of foods and beverages available for the flight. A pack of information is given to the astronauts to use in planning their personal preference menus. Included in the packet is a standard menu, training menu, past flight menu, and the baseline shuttle food and beverage list. Astronauts select their menus approximately five months before flight. The menus are analyzed by the shuttle dietitian, and recommendations are made to correct any nutrient deficiencies based on the Recommended Dietary Allowances. The menus are then finalized and sent to Houston three months before launch. The flight Equipment Processing Contractor (FEPC) processes, packages, and stows the food in the shuttle lockers.

2. Ask students to design and decorate a menu that includes breakfast, lunch, and supper for one day. They may use the Baseline Shuttle Food List that is given at the end of this activity. Remind them to include the necessary condiments for each meal. The astronauts' sense of taste and smell are reduced in-flight, so astronauts tend to enjoy more highly seasoned foods. Review the Food Pyramid and basic nutritional requirements.

3. Have the class select the winning student menu and, if possible, ask the school nutritionist to review it and make recommendations. You may also submit it to FSEF online.

4. Have students weigh all food eaten in one day. This may be done as a homework assignment. How does this compare to the 3.8 pounds of food astronaut’s are allowed? What percentage needs to be reduced?
Research

Possible reference:

1. Missions beyond ten days are called Extended Duration Orbiter (EDO) Missions. How do the astronauts handle the weight and volume of trash on EDO missions?
2. Dehydrated food on a space mission means that all of the water has been extracted from the foods to help meet the weight and storage restrictions for space shuttle liftoff. In order to rehydrate foods before eating, astronauts use water from the galley water dispenser. Where does the water come from?
3. Why are some foods completely dehydrated while others are only partially dehydrated with 15 to 30% moisture retained (Intermediate Moisture Foods)?
4. Foods flown on space missions are researched and developed at the Food Systems Engineering Facility (FSEF) at the NASA Johnson Space Center. How are foods analyzed? Also, how are foods tested to see how they will react in microgravity?

More Ideas …

- Record everything eaten the previous day. Beside each food item, the student will record if it can be taken on a space mission as is, or if changes need to occur. If so, what changes?
- Research how astronauts ate during the first space missions.
- Plan foods for one astronaut during a shuttle mission which will last five days.
- Interview a nutritionist about Why Food Variety is Important.
**Baseline Shuttle Food List**

<table>
<thead>
<tr>
<th>Category</th>
<th>Example Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef, Dried (IM)</td>
<td>Beef, Dried (IM)</td>
</tr>
<tr>
<td>Beef Goulash (T)</td>
<td>Beef Goulash (T)</td>
</tr>
<tr>
<td>Beef Pattie (R)</td>
<td>Beef Pattie (R)</td>
</tr>
<tr>
<td>Beef Steak (I)</td>
<td>Beef Steak (I)</td>
</tr>
<tr>
<td>Beef Stroganoff w/Noodles (R)</td>
<td>Beef Stroganoff w/Noodles (R)</td>
</tr>
<tr>
<td>Beef Tips w/Mushrooms (T)</td>
<td>Beef Tips w/Mushrooms (T)</td>
</tr>
<tr>
<td>Bread (FF)</td>
<td>Bread (FF)</td>
</tr>
<tr>
<td>Breakfast Roll (FF)</td>
<td>Breakfast Roll (FF)</td>
</tr>
<tr>
<td>Brownies (NF)</td>
<td>Brownies (NF)</td>
</tr>
<tr>
<td>Candy,</td>
<td>Candy,</td>
</tr>
<tr>
<td>Coated Chocolates (NF)</td>
<td>Coated Chocolates (NF)</td>
</tr>
<tr>
<td>Coated Peanuts (NF)</td>
<td>Coated Peanuts (NF)</td>
</tr>
<tr>
<td>Gum (NF)</td>
<td>Gum (NF)</td>
</tr>
<tr>
<td>Life Savers (NF)</td>
<td>Life Savers (NF)</td>
</tr>
<tr>
<td>Cereal</td>
<td>Cereal</td>
</tr>
<tr>
<td>Bran Chex (R)</td>
<td>Bran Chex (R)</td>
</tr>
<tr>
<td>Cornflakes (R)</td>
<td>Cornflakes (R)</td>
</tr>
<tr>
<td>Granola (R)</td>
<td>Granola (R)</td>
</tr>
<tr>
<td>Granola w/Blueberries (R)</td>
<td>Granola w/Blueberries (R)</td>
</tr>
<tr>
<td>Granola w/Raisins (R)</td>
<td>Granola w/Raisins (R)</td>
</tr>
<tr>
<td>Grits w/Butter (R)</td>
<td>Grits w/Butter (R)</td>
</tr>
<tr>
<td>Oatmeal w/Brown Sugar (R)</td>
<td>Oatmeal w/Brown Sugar (R)</td>
</tr>
<tr>
<td>Oatmeal w/Raisins (R)</td>
<td>Oatmeal w/Raisins (R)</td>
</tr>
<tr>
<td>Rice Krispies (R)</td>
<td>Rice Krispies (R)</td>
</tr>
<tr>
<td>Cheddar Cheese Spread (T)</td>
<td>Cheddar Cheese Spread (T)</td>
</tr>
<tr>
<td>Chicken</td>
<td>Chicken</td>
</tr>
<tr>
<td>Chicken ala King (T)</td>
<td>Chicken ala King (T)</td>
</tr>
<tr>
<td>Chicken Cacciatore (T)</td>
<td>Chicken Cacciatore (T)</td>
</tr>
<tr>
<td>Chicken Pattie (R)</td>
<td>Chicken Pattie (R)</td>
</tr>
<tr>
<td>Chicken Salad Spread (T)</td>
<td>Chicken Salad Spread (T)</td>
</tr>
<tr>
<td>Chicken, Sweet n Sour (T)</td>
<td>Chicken, Sweet n Sour (T)</td>
</tr>
<tr>
<td>Chicken, Sweet n Sour (R)</td>
<td>Chicken, Sweet n Sour (R)</td>
</tr>
<tr>
<td>Chicken Teriyaki (R)</td>
<td>Chicken Teriyaki (R)</td>
</tr>
<tr>
<td>Chunky Chicken Stew (T)</td>
<td>Chunky Chicken Stew (T)</td>
</tr>
<tr>
<td>Cookies</td>
<td>Cookies</td>
</tr>
<tr>
<td>Butter (NF)</td>
<td>Butter (NF)</td>
</tr>
<tr>
<td>Chocolate Covered (NF)</td>
<td>Chocolate Covered (NF)</td>
</tr>
<tr>
<td>Shortbread (NF)</td>
<td>Shortbread (NF)</td>
</tr>
<tr>
<td>Crackers</td>
<td>Crackers</td>
</tr>
<tr>
<td>Butter (NF)</td>
<td>Butter (NF)</td>
</tr>
<tr>
<td>Graham (NF)</td>
<td>Graham (NF)</td>
</tr>
<tr>
<td>Eggs</td>
<td>Eggs</td>
</tr>
<tr>
<td>Scrambled (R)</td>
<td>Scrambled (R)</td>
</tr>
<tr>
<td>Mexican Scrambled (R)</td>
<td>Mexican Scrambled (R)</td>
</tr>
<tr>
<td>Seasoned Scrambled (R)</td>
<td>Seasoned Scrambled (R)</td>
</tr>
<tr>
<td>Frankfurters (T)</td>
<td>Frankfurters (T)</td>
</tr>
<tr>
<td>Fruit</td>
<td>Fruit</td>
</tr>
<tr>
<td>Apple, Granny Smith (FF)</td>
<td>Apple, Granny Smith (FF)</td>
</tr>
<tr>
<td>Apple, Red Delicious (FF)</td>
<td>Apple, Red Delicious (FF)</td>
</tr>
<tr>
<td>Applesauce (T)</td>
<td>Applesauce (T)</td>
</tr>
<tr>
<td>Apricots, Dried (IM)</td>
<td>Apricots, Dried (IM)</td>
</tr>
<tr>
<td>Banana (FF)</td>
<td>Banana (FF)</td>
</tr>
<tr>
<td>Cocktail (T)</td>
<td>Cocktail (T)</td>
</tr>
<tr>
<td>Orange (FF)</td>
<td>Orange (FF)</td>
</tr>
<tr>
<td>Peach Ambrosia (R)</td>
<td>Peach Ambrosia (R)</td>
</tr>
<tr>
<td>Peaches, Diced (T)</td>
<td>Peaches, Diced (T)</td>
</tr>
<tr>
<td>Peaches, Dried (IM)</td>
<td>Peaches, Dried (IM)</td>
</tr>
<tr>
<td>Pears, Diced (T)</td>
<td>Pears, Diced (T)</td>
</tr>
<tr>
<td>Pears, Dried (IM)</td>
<td>Pears, Dried (IM)</td>
</tr>
<tr>
<td>Pineapple (T)</td>
<td>Pineapple (T)</td>
</tr>
<tr>
<td>Strawberries (R)</td>
<td>Strawberries (R)</td>
</tr>
<tr>
<td>Trail Mix (IM)</td>
<td>Trail Mix (IM)</td>
</tr>
<tr>
<td>Granola Bar (NF)</td>
<td>Granola Bar (NF)</td>
</tr>
<tr>
<td>Ham (T)</td>
<td>Ham (T)</td>
</tr>
<tr>
<td>Ham Salad Spread (T)</td>
<td>Ham Salad Spread (T)</td>
</tr>
<tr>
<td>Jelly</td>
<td>Jelly</td>
</tr>
<tr>
<td>Apple (T)</td>
<td>Apple (T)</td>
</tr>
<tr>
<td>Grade (T)</td>
<td>Grade (T)</td>
</tr>
<tr>
<td>Macaroni &amp; Cheese (R)</td>
<td>Macaroni &amp; Cheese (R)</td>
</tr>
<tr>
<td>Meatballs in Spicy Tomato (T)</td>
<td>Meatballs in Spicy Tomato (T)</td>
</tr>
<tr>
<td>Noodles and Chicken (R)</td>
<td>Noodles and Chicken (R)</td>
</tr>
<tr>
<td>Nuts</td>
<td>Nuts</td>
</tr>
<tr>
<td>Almonds (NF)</td>
<td>Almonds (NF)</td>
</tr>
<tr>
<td>Cashews (NF)</td>
<td>Cashews (NF)</td>
</tr>
<tr>
<td>Macadamia (NF)</td>
<td>Macadamia (NF)</td>
</tr>
<tr>
<td>Peanuts (NF)</td>
<td>Peanuts (NF)</td>
</tr>
<tr>
<td>Trail Mix (IM)</td>
<td>Trail Mix (IM)</td>
</tr>
<tr>
<td>Peanut Butter (T)</td>
<td>Peanut Butter (T)</td>
</tr>
<tr>
<td>Potatoes au Gratin (R)</td>
<td>Potatoes au Gratin (R)</td>
</tr>
<tr>
<td>Puddings</td>
<td>Puddings</td>
</tr>
<tr>
<td>Banana (T)</td>
<td>Banana (T)</td>
</tr>
<tr>
<td>Butterscotch (T)</td>
<td>Butterscotch (T)</td>
</tr>
<tr>
<td>Chocolate (T)</td>
<td>Chocolate (T)</td>
</tr>
<tr>
<td>Tapioca (T)</td>
<td>Tapioca (T)</td>
</tr>
<tr>
<td>Vanilla (T)</td>
<td>Vanilla (T)</td>
</tr>
<tr>
<td>Rice and Chicken (R)</td>
<td>Rice and Chicken (R)</td>
</tr>
<tr>
<td>Rice Pilaf (R)</td>
<td>Rice Pilaf (R)</td>
</tr>
<tr>
<td>Salmon (T)</td>
<td>Salmon (T)</td>
</tr>
<tr>
<td>Sausage Pattie (R)</td>
<td>Sausage Pattie (R)</td>
</tr>
<tr>
<td>Shrimp Cocktail (R)</td>
<td>Shrimp Cocktail (R)</td>
</tr>
<tr>
<td>Soups</td>
<td>Soups</td>
</tr>
<tr>
<td>Chicken Consomme (R)</td>
<td>Chicken Consomme (R)</td>
</tr>
<tr>
<td>Mushroom (R)</td>
<td>Mushroom (R)</td>
</tr>
<tr>
<td>Rice &amp; Chicken (R)</td>
<td>Rice &amp; Chicken (R)</td>
</tr>
<tr>
<td>Spaghetti w/Meat (R)</td>
<td>Spaghetti w/Meat (R)</td>
</tr>
<tr>
<td>Tortillas (FF)</td>
<td>Tortillas (FF)</td>
</tr>
<tr>
<td>Tuna</td>
<td>Tuna</td>
</tr>
<tr>
<td>Tuna Creole (T)</td>
<td>Tuna Creole (T)</td>
</tr>
<tr>
<td>Tuna Salad Spread (T)</td>
<td>Tuna Salad Spread (T)</td>
</tr>
<tr>
<td>Turkey</td>
<td>Turkey</td>
</tr>
<tr>
<td>Turkey Salad Spread(T)</td>
<td>Turkey Salad Spread(T)</td>
</tr>
<tr>
<td>Turkey Tetrazini (R)</td>
<td>Turkey Tetrazini (R)</td>
</tr>
<tr>
<td>Vegetables</td>
<td>Vegetables</td>
</tr>
<tr>
<td>Asparagus (R)</td>
<td>Asparagus (R)</td>
</tr>
<tr>
<td>Broccoli au Gratin (R)</td>
<td>Broccoli au Gratin (R)</td>
</tr>
<tr>
<td>Carrot Sticks (FF)</td>
<td>Carrot Sticks (FF)</td>
</tr>
<tr>
<td>Cauliflower /cheese (R)</td>
<td>Cauliflower /cheese (R)</td>
</tr>
<tr>
<td>Celery Sticks (FF)</td>
<td>Celery Sticks (FF)</td>
</tr>
<tr>
<td>Gr. Beans/Broccoli (R)</td>
<td>Gr. Beans/Broccoli (R)</td>
</tr>
<tr>
<td>Gr.Beans/Mushroom(R)</td>
<td>Gr.Beans/Mushroom(R)</td>
</tr>
<tr>
<td>Italian (R)</td>
<td>Italian (R)</td>
</tr>
<tr>
<td>Spinach, Creamed (R)</td>
<td>Spinach, Creamed (R)</td>
</tr>
<tr>
<td>Tomatoes/Eggplant(T)</td>
<td>Tomatoes/Eggplant(T)</td>
</tr>
<tr>
<td>Yogurt</td>
<td>Yogurt</td>
</tr>
<tr>
<td>Blueberry (T)</td>
<td>Blueberry (T)</td>
</tr>
<tr>
<td>Peach (T)</td>
<td>Peach (T)</td>
</tr>
<tr>
<td>Raspberry (T)</td>
<td>Raspberry (T)</td>
</tr>
<tr>
<td>Strawberry (T)</td>
<td>Strawberry (T)</td>
</tr>
<tr>
<td>Condiments</td>
<td>Condiments</td>
</tr>
<tr>
<td>Catsup (T)</td>
<td>Catsup (T)</td>
</tr>
<tr>
<td>Mayonnaise (T)</td>
<td>Mayonnaise (T)</td>
</tr>
<tr>
<td>Mustard (T)</td>
<td>Mustard (T)</td>
</tr>
<tr>
<td>Pepper (Liquid)</td>
<td>Pepper (Liquid)</td>
</tr>
<tr>
<td>Salt (Liquid)</td>
<td>Salt (Liquid)</td>
</tr>
<tr>
<td>Tabasco Sauce (T)</td>
<td>Tabasco Sauce (T)</td>
</tr>
<tr>
<td>Taco Sauce (T)</td>
<td>Taco Sauce (T)</td>
</tr>
<tr>
<td>Abbreviations</td>
<td>Abbreviations</td>
</tr>
<tr>
<td>FF Fresh Food</td>
<td>FF Fresh Food</td>
</tr>
<tr>
<td>IM Intermediate Moisture</td>
<td>IM Intermediate Moisture</td>
</tr>
<tr>
<td>I Irradiated</td>
<td>I Irradiated</td>
</tr>
<tr>
<td>NF Natural Form</td>
<td>NF Natural Form</td>
</tr>
<tr>
<td>R Rehydrated</td>
<td>R Rehydrated</td>
</tr>
<tr>
<td>T Thermostabilized</td>
<td>T Thermostabilized</td>
</tr>
<tr>
<td>Beverages</td>
<td>Abbreviations</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Apple Cider</td>
<td>A/S - Artificial Sweetener</td>
</tr>
<tr>
<td>Cherry Drink w/A/S</td>
<td>R - Rehydratable</td>
</tr>
<tr>
<td>Cocoa</td>
<td>T - Thermostabilized</td>
</tr>
<tr>
<td>Coffee</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td></td>
</tr>
<tr>
<td>w/A/S</td>
<td></td>
</tr>
<tr>
<td>w/Cream</td>
<td></td>
</tr>
<tr>
<td>w/Cream &amp; A/S</td>
<td></td>
</tr>
<tr>
<td>w/Cream &amp; Sugar</td>
<td></td>
</tr>
<tr>
<td>w/Sugar</td>
<td></td>
</tr>
<tr>
<td>Coffee (Decaffeinated)</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td></td>
</tr>
<tr>
<td>w/A/S</td>
<td></td>
</tr>
<tr>
<td>w/Cream</td>
<td></td>
</tr>
<tr>
<td>w/Cream &amp; A/S</td>
<td></td>
</tr>
<tr>
<td>w/Cream &amp; Sugar</td>
<td></td>
</tr>
<tr>
<td>w/Sugar</td>
<td></td>
</tr>
<tr>
<td>Coffee (Kona)</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td></td>
</tr>
<tr>
<td>w/A/S</td>
<td></td>
</tr>
<tr>
<td>w/Cream</td>
<td></td>
</tr>
<tr>
<td>w/Cream &amp; A/S</td>
<td></td>
</tr>
<tr>
<td>w/Cream &amp; Sugar</td>
<td></td>
</tr>
<tr>
<td>w/Sugar</td>
<td></td>
</tr>
<tr>
<td>Grape Drink</td>
<td></td>
</tr>
<tr>
<td>Grape Drink w/A/S</td>
<td></td>
</tr>
<tr>
<td>Grapefruit Drink</td>
<td></td>
</tr>
<tr>
<td>Instant Breakfast</td>
<td></td>
</tr>
<tr>
<td>Chocolate</td>
<td></td>
</tr>
<tr>
<td>Strawberry</td>
<td></td>
</tr>
<tr>
<td>Vanilla</td>
<td></td>
</tr>
<tr>
<td>Lemonade</td>
<td></td>
</tr>
<tr>
<td>Lemonade w/A/S</td>
<td></td>
</tr>
<tr>
<td>Lemon-Lime Drink</td>
<td></td>
</tr>
<tr>
<td>Orange Drink</td>
<td></td>
</tr>
<tr>
<td>Orange Drink w/A/S</td>
<td></td>
</tr>
<tr>
<td>Orange Juice (Tang)</td>
<td></td>
</tr>
<tr>
<td>Orange-Grapefruit Drink</td>
<td></td>
</tr>
<tr>
<td>Orange-Mango Drink</td>
<td></td>
</tr>
<tr>
<td>Orange-Pineapple Drink</td>
<td></td>
</tr>
<tr>
<td>Peach-Apricot Drink</td>
<td></td>
</tr>
<tr>
<td>Pineapple Drink</td>
<td></td>
</tr>
<tr>
<td>Strawberry Drink</td>
<td></td>
</tr>
<tr>
<td>Tea</td>
<td></td>
</tr>
<tr>
<td>Plain</td>
<td></td>
</tr>
<tr>
<td>w/A/S</td>
<td></td>
</tr>
<tr>
<td>w/Cream</td>
<td></td>
</tr>
<tr>
<td>w/Lemon</td>
<td></td>
</tr>
<tr>
<td>w/Lemon &amp; A/S</td>
<td></td>
</tr>
<tr>
<td>w/Lemon &amp; Sugar</td>
<td></td>
</tr>
<tr>
<td>w/Sugar</td>
<td></td>
</tr>
<tr>
<td>Tropical Punch</td>
<td></td>
</tr>
</tbody>
</table>

**Definitions**

- Irradiated (packaging is flexible, foil, laminated pouch)
- Natural Form (packaged in flexible pouches)
- Rehydratable (packaging in rehydratable containers)
- Thermostabilized (packaging is cans, plastic cups, flexible pouch)
Lung Model

Grade Level: 6

Time Required: 1 class period

Countdown:
Flexible Straws
Clear Plastic Cups (7, 8 or 9 oz.)
Small Balloons
Large Balloons

Ignition:
The respiratory system consists of lungs and air passages and is part of the cardiopulmonary system that supplies your body with oxygen and nutrients and removes carbon dioxide and other waste products produced within your cells.

Each breath begins with a contraction of the diaphragm, a dome-shaped sheet of muscle that lies just below the lungs. When you inhale, your diaphragm contracts, or flattens downward. This contraction creates a lower pressure in the chest cavity. Normal outside air pressure forces air through the nose and mouth, down the trachea and into the lungs. When you exhale, your diaphragm relaxes, increasing pressure on the lungs and forcing air, containing carbon dioxide, out of the body.

What causes your diaphragm to contract and relax? Your brain controls everything you do. The small area within the brain stem known as the medulla regulates your breathing. It senses the amount of carbon dioxide present, the faster you breathe.

Computer:

Scientists believe the condition of apparent weightlessness to which astronauts are subjected during spaceflight may affect the respiratory system. See if you can find tests that have been conducted during space flight on astronauts or when the astronaut returns to earth and the cardiopulmonary system must readjust to gravity. What did these tests show?
Liftoff:

1. Divide the students into pairs. Each team should have a cup, a straw, scissors, tape, two small balloons, one large balloon, and a rubber band.
2. Make a hole in the bottom of the plastic cup with scissors.
3. Cut a 5-cm, inflexible section of a straw.
4. Make a small slight in the elbow of another straw.
5. Insert the 5-cm piece of straw into the slit to form a “Y”. Tape this joint to make it airtight.
6. Tape the small balloons to each end of the diagonal segments of the “Y”. These connections must be airtight.
7. Thread the vertical leg of the “Y” through the hole in the cup and seal with tape.
8. Cut the neck off the large balloon and discard. Cover the open end of the cup with the remainder of the balloon.

Have each student describe the function of the respiratory system and identify its parts. This lung model demonstrates the movement of the diaphragm which regulates the pressure in the chest cavity and that air flows into the lungs when air pressure in the chest cavity is lowered.
More Ideas:
◊ Research the cause of lung disease.
◊ Identify ways to prevent lung disease.
◊ Make a list showing examples of lung disease.
◊ Give examples of how astronauts might keep their lungs in shape during space flight.
◊ Measure Lung Capacity of an Average Student with the experiment:  
  http://lifesci3.arc.nasa.gov/SpaceSettlement/teacher/course/lung_capacity.html
◊ Play Circulatory System Relay. Obtain directions from:  
Recycling on the Moon

Grade Level: 5 - 6

Time Required: 3 - 4 class periods

Countdown:
- Hot Plate
- 1 Candle
- Small Pot
- 3 Jars (different sizes) 1 Jar per student
- Cookie Sheet
- Ice Cubes
- Seeds (alfalfa, radish, soybeans, etc.)
- Masking Tape
- Plastic wrap/foil
- Strainers

Ignition:
The moon, according to our most recent information, is a “dead world”. There is no air to breathe, no vegetation, no life of any kind. The temperatures are extreme – 266 degrees F during the day and -200 degrees F during the two week lunar night. Nevertheless, human beings have already visited the moon briefly, NASA’s Lunar Prospector orbited the moon collecting data, and many scientists have begun making ambitious plans for possible permanent human bases on the moon.

At first, people who are traveling and planning to visit the moon will be required to bring all of their food, water, and air with them from Earth. Eventually, though, these necessities will need to be generated and recycled on the moon by means of life-support Systems designed for long-duration space missions.

Liftoff:

Experiments with Water
1. Emphasize that water in a life-support system needs to be reused or recycled.
2. Demonstrate the recycling of water as follows:
   - Fill the small pot with water, and heat the water until it boils.

Suggested TEKS
Science - 5.13 6.13
Computer - 5.15 6.15
Art - 5.2 6.2
Language Arts - 5.17 6.17
Math - 5.11 6.8

Suggested SCANS
Information. Acquires and evaluates information.

National Science and Math Standards
Science as Inquiry, Science in Personal and Social Perspectives, Earth and Space Science, Science and Technology, Physical Science, Observing, Communicating
• Put the ice cubes on the cookie sheet, and hold the sheet carefully over the pot of boiling water.
• Have the students describe what happens.
• Compare the results with the Earth water cycle. Define the terms condensation, precipitation, and evaporation.

3. Emphasize that water, when recycled continuously in a life-support system, needs to be cleaned. Elicit from the students different methods of purifying the water.

4. Ask the students to design their own water-purification devices. This could possibly be a home assignment or group classroom assignment. The experiments should meet the following criteria:
• The device will be designed to remove 10 grams of dirt from 250 ml of water in a time period of 5 minutes.
• At least half of the water will be returned to the collecting jar.
• A water clarity scale will be used to assess the device’s ability to cleanse the water.
  0 = no difference noted  
  1 = very dirty  
  2 = somewhat dirty  
  3 = slightly dirty  
  4 = mostly clear  
  5 = clear

• Student record keeping should include the following:
  • Written plan of design  
  • Sketch of design  
  • List of materials used (inexpensive materials – recycled, if possible)  
  • Step-by-step instructions for constructing the device  
  • Data observed and recorded in a table or chart  
  • After the students present and test their devices for the class, elicit ideas about which materials achieved the best results and why. Discuss also which designs were the most effective.

One example of a possible device is shown below:

Drawing of filtration system

Cotton
Sand
Coffee Filter
Jar

SpaceExplorers http://www.tsgc.utexas.edu/spaceexplorers/
Life Sciences: Recycling on the Moon
Texas Space Grant Consortium http://www.tsgc.utexas.edu/
More ideas:

♦ Visit a water purification plant.
♦ Invite a guest speaker. Possibilities include:
  - City Water Department on conservation
  - Health Department on water contamination and possible diseases
♦ Observe your home practices. What methods are used to reduce water consumption? How can this effect your family? Your environment? (Examples: low flow toilet and shower devices, take shower instead of bath, use bath water to wash cars, etc.)
♦ Design a media campaign (mailout, article, story, TV advertisement, radio PSA, etc.) on water conservation.

Computer:

Research and write a paper on where your city gets its water. Check city water rates. How can you reduce your home water bill?

Art:

⇒ Prepare a salt map on the route your water takes to get to your city.
⇒ Design a poster on the importance of water conservation.

Experiments With Air

1. Discuss that the air in a life-support system has to be recirculated. Ask why people in such a system don’t breathe up all the air.
2. Conduct the following experiment:
   • Carefully set the candle in a safe place, and light it.
• Set the smallest jar upside down over the candle.
• Record the time it takes the candle to go out.
• Predict what will happen with the other 2 jars. Follow the same procedure with both.
• Why did the candle go out? Ask the students to predict how long the candle would burn in a domed moon base.

**Experiments With Food**

Explain that in NASA’s Advanced Life Support System (ALSS), green plants will be used to convert carbon dioxide to oxygen through photosynthesis, provide potable water through evapotranspiration, recycle organic wastes, and produce food. Synthetic soil containing plant-growth nutrients plus water will be used to grow these plants.

1. Ask students if it is possible to grow food without soil.
2. Perform the following experiment:
   • Give each student a jar and several seeds (one type).
   • Have jars labeled with student names and seed type.
   • Put seeds in the jar and add 100 ml of water.
   • Cover with foil/plastic wrap. Leave overnight.
   • Discuss with students the data to be observed, i.e., water absorption, rate of growth, weight, and length.
   • On the second and succeeding days, drain the seeds, rinse them twice, and cover lightly. Store the jars in a dark place.
   • After the first leaves begin to appear on the sprouts, set the jars outside in the sun for a few hours daily to develop the chlorophyll.

Students will measure plant growth daily in cm.
Students will chart their findings.

**Computer**

Have students research the seed that they sprouted. What is the nutritive value of these sprouts as a food source? Determine if they are low in fat, high in minerals, vitamin content, etc. Find or create a recipe using this sprout.

• At the conclusion of the experiment, discuss the value of sprouts as a food source.
Discuss the life support systems in the diagram below. Write a paper that will compare and contrast these life support systems with our own way of living at the present time on Earth.
Exercise and Other Recreation

Grade Level: 7

Time Required: 2 class periods

Countdown:
Weekly Activity Chart/student
Pencils

Ignition:

On Earth, some people like to exercise more than others do. Aboard the space shuttle, however, astronauts have little choice. On earlier missions, scientists discovered that astronauts suffer some bone and muscle deterioration because their bodies were not getting the resistance they were accustomed to receiving in gravity.

Today, astronauts participate in a planned exercise program to counteract the effects of microgravity. Flight doctors recommend 15 minutes of exercise daily on 7 to 14-day missions and 30 minutes of exercise daily on 30-day missions.

As for other recreation, astronauts can do whatever they prefer. They take their own preference kits along on the missions. Examples of extra-time activities are: reading, e-mails home on laptops, listening to music, playing games, chatting with people on the ground via ham radio, hanging around the windows looking at Earth roll by underneath (during the first part of the flight).

Liftoff:

A. Discussion
Describe to students the types of shuttle exercises listed below:
1. Treadmill - astronauts exercise their arms by pushing upward on the bar while walking; moving air from a nearby duct dries off the perspiration.
2. Rowing machine
3. Exercise bicycle
B. Research
Ask students to research other types of exercise equipment, i.e., in school/gym weight rooms and make recommendations for additional shuttle exercise equipment. They should focus on resistance exercises.

C. Weekly Activity Chart
Tell students that they have been chosen to serve as Youth Representatives aboard a 7-day shuttle mission. What will they do during that time? Ask them to plan their week in space by completing the Weekly Activity Chart. Remind them to include time for “survival basics”: (eating, sleeping, exercising) as well as conducting experiments, observing the stars, and daily writing (shuttle jog, journal, letters home). Student compares their Weekly Activity Chart to a actual Astronaut schedule from a recent mission.

More Ideas …
1) Record an exercise video.
2) Plan a 30 minute exercise class.
3) Review and critique an exercise video.
4) Interview an athlete. Record their daily exercise and recreation regime.
### Weekly Activity Chart

<table>
<thead>
<tr>
<th>Time</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
</tr>
</thead>
<tbody>
<tr>
<td>6 am</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 am</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 am</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 am</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 am</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 am</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 am</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 pm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 pm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 pm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 pm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 pm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 pm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 pm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 pm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 pm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Sleeping In Space

Grade Level: 7
Time Required: 2 class periods

Countdown:
- Graph Paper
- Scale
- Pencils
- Paper

Ignition:
As can be expected, sleeping and sleeping accommodations on Earth vary greatly from those in microgravity. On Earth, our sleeping position is horizontal, whereas in microgravity where there is no "up", astronauts can sleep as comfortably in the vertical position as the horizontal.

In Earth's gravity, our bodies sink into a mattress. But, because of the near weightlessness of space, the hard bed board that is used in bunks feels soft.

Liftoff:
A. Discussion
Tell students that sleeping accommodations aboard the shuttle vary depending on the requirements of the particular mission. For single crew missions in which everyone in the crew shares the same sleep cycle or flight day, sleep compartments are not normally aboard the shuttle. However, on dual crew missions during which half the crew sleeps while the other half works, the sleep compartments are on-board to screen out the distractions of the working crew.

The different sleeping accommodations are as follows:
1. Sleep compartments - are two level; the bunks measure more than 1.8 meters (6 ft.) long and .75 meters (30 in.) wide and are padded boards with fireproof sleeping bags attached. They can sleep four people.
   a. The first person sleeps on the top bunk, the second on the lower bunk.
   b. The third person sleeps on the underside of the bottom bunk facing the floor.
   c. The fourth person sleeps vertically in another bunk that stands against one end of the two level bed.
   d. Each astronaut has their own private compartment.
2. Seats -- crew can sleep in their seats, when necessary.
3. Walls - crewmembers can tether themselves to the orbiter walls with Velcro.
4. Sleeping bags - are cocoon-like restraints attached to the crew provision lockers; astronauts zip themselves inside the bags -- leaving their arms outside -- and snap together straps that circle the waist; other amenities include:
   - Lights that are provided for reading
   - Side panels that can be shut for privacy
   - Eye shades and earmuffs that are provided to reduce cabin light and noise.
   - Communications headgear that are provided for two of the crew, when all seven crewmembers are sleeping at the same time.

On the International Space Station, each crewmember has a private room, or “galley.” With no gravity, they’ll need to be anchored down in their beds so they don’t float away! That might sound like a strange way to catch some z’s, but astronauts from past space missions report that sleeping in space is actually pretty great!

B. Research
   Ask students to determine the specific inside dimensions of the basic shuttle.
   1. Using graph paper and a scale, students can then draw a cut-away view of the inside of the shuttle. Next, ask them to draw in the sleeping arrangements for all 7 astronauts, i.e., 2 could be sleeping in their chairs while 5 are tethered to the walls.
   2. Ask students to design and create new sleeping accommodations, keeping in mind the weight and space restrictions of the shuttle.
Weightlessness and the Human Body

Grade Level: 7

Time Required: 4 - 5 class periods

Countdown:
- Electronic Text
- Printed Resources
  (suggestions listed)

Ignition:
If we are ever to venture beyond Earth orbit and visit, perhaps even colonize planets and the moon, we must know the risk that our space explorers face.

As we leave the Earth's surface and escape its gravitational pull, our bodies rapidly adjust to the new weightless environment. Many of the changes seen are similar to the process of Earth-based diseases i.e. anemia, osteoporosis, muscular atrophy, and immune system dysfunction -- but in space these changes occur much faster than on Earth. Although we have observed and documented these changes, we have not yet answered these questions:

• How are they happening?
• Can we stop or prevent them?
• Do we need to?
• What risks are we asking our crews to accept?

Liftoff:
A. Discussion

Explain to the students that microgravity affects our bodies in many ways. Listed below are several that have been compiled from "Nutrition in Space", Vol. 21, #1, Nutrition Today (Jan./Feb/97).

1. **Loss of bone tissue** (in weight-bearing bones) - the lack of weight on the skeleton causes minerals to be released from the bones.
2. **Loss of muscle mass** - this is probably related to a stress-induced increase in protein turnover and changes in muscle nitrogen and pyridoxine metabolism.
3. **Loss of red blood cell mass** - the release and retention of new red cells seems to be halted upon entry into weightlessness; amnesia has, therefore, been observed for a short period of time after space flights.
4. **Decline in plasma volume** - fluids are shifted within the first 21 hours of flight from the extracellular to the intracellular space rather than being lost from the body.
5. **High iron intake** - when the red blood cells are destroyed, iron is released and processed for storage in the body; also, space foods tend to be high in iron.
6. **Endocrine influences on energy metabolism** - decreased sympathetic nervous system activity and increased cortisol secretion have been recorded.

Suggested TEKS
- Computer - 7.2
- Health - 7.2

Suggested SCANS
- Technology. Apply technology to task.

National Science and Math Standards
- Science as Inquiry, Life Science, Science in Personal and Social Perspectives, Physical Science, Computation, Measurement, Reasoning, Observing, Communicating

SpaceExplorers http://www.tsgc.utexas.edu/spaceexplorres/
Life Sciences: Weightlessness and the Human Body
Texas Space Grant Consortium http://www.tsgc.utexas.edu/
7. ** Calcium metabolism and Vitamin D** - calcium intake needs to be regulated daily (about 880 mg./day for each crewmember); Vitamin D also needs to be regulated to ensure calcium absorption.

8. **Space motion sickness** - about 70% of crewmembers experience some degree of motion sickness during the first few days of flight.

9. **Risk of forming kidney stones** - this is attributed to inadequate fluid intake and increases in urinary calcium.

.B. Research

1. Most of these consequences of space flight affect the nutrition requirements for the space crews. Ask students to research the nutrient requirements that act as countermeasures to the effects of microgravity on the body. Possible printed resources include:
   - Lane HW, Schulz LO. *Nutritional questions relevant to space flight*. Ann Rev Nutr 1992: 12: 257-78.

2. Nutritional intake has not been considered a high priority during the relatively brief programs of the Space Shuttle program (less than 21 days). However, on extended-duration missions of 30 days or more, nutrition becomes extremely critical. Ask students to research and analyze the differences between short duration and long duration mission nutrient requirements.

3. The Spacelab Life Sciences-1 mission (STS-40) in June 1991 was the first space mission dedicated to biomedical research, experiments in cardiovascular, cardiopulmonary, regulatory, neurovestibular, and muscle and bone physiology in both human and rodent subjects. Ask students to research this mission and its specific experiments and results.

4. More recently, on April 17, 1998, the shuttle Columbia undertook a two-week mission to study how the brain and nervous system adapt and develop in weightlessness. Other experiments included insomnia, vertigo, imbalance, reduced blood pressure, and weakened immunity. Have students research this mission.

.C. Activity

See Stellar link listed below for a Neutral Buoyancy and Simulated Weightlessness Activity - using a Cardiovascular module.

http://stellar.arc.nasa.gov/stellar/Activities/cardiovascular
History of International Cooperation

Grade Level: 7 - 8

Time Required: 3 to 4 class periods

Countdown:
Paper
Pencils

Ignition:
The concept of international cooperation in space was initiated more than 30 years ago. Three basic beliefs underlie this idea:

1) Space does not belong only to the mightiest.
2) No one country or people can realize its full potential without the cooperation of others.
3) Benefits derived from the exploration of space belong to all humankind.

Ironically, the Cold War between the United States and the former Soviet Union, characterized by unprecedented technological growth in the development of machines for mass destruction, brought about scientific advances that spilled over into the development of materials, processes, and a body of aeronautical knowledge that has made real the dream of long-term space habitation. The seeds of peaceful interdependence now inherent in space research around the world were sowed in strife.

On the grounds of the United Nations stands a bronze statue with the saying “Let Us Beat Swords in Plowshares”, a gift from the Soviet Union in 1959. It symbolizes the noble human desire to put an end to war and convert the means of destruction into creative tools for the welfare of all of human life.

Another significant landmark toward international cooperation was the Outer Space Treaty, the first international space treaty that was signed simultaneously in London, Moscow, and Washington, D.C. on January 27, 1967. The ultimate document governing space activities, it asserts the philosophy that space exploration should “contribute to broad international cooperation and the development of mutual understanding between States and peoples”.

Using the Outer Space Treaty and other agreements, the U. S., Russia, Japan, Canada, and the 14 member states of the European Space Agency (E.S.A.) began to develop the International Space Station (ISS). The first segment of ISS was launched from Russia in November 1998.
Liftoff:
A. Ask the students to envision that a moon colony has been recently established and that the inhabitants represent many different cultures. A vital part of colonization is to establish an International Space Treaty that will have a variety of purposes.

1. Define a “treaty” as an agreement between groups of people or nations. A treaty may be negotiated to:
   a. end wars
   b. settle boundary disputes
   c. form agreements on taxes, navigation, and fisheries
   d. set up international organizations, i.e. a Universal Postal Union
   e. deal with the extradition of criminals
   f. protect a country’s trademarks, copyrights, and patents
   g. deal with religious rights of individuals

2. Group students according to the countries or organizations that they wish to represent, i.e. United States, Canada, Japan, China, Russian, and E. S. A.

3. Ask each group to discuss general questions such as:
   a. Who will have the power to negotiate a treaty? (king, chief executive, etc.)
   b. How will the treaty be approved – by a majority vote or a unanimous vote?
   c. What will be the official language for negotiation?
   d. What might happen if a nation chooses not to sign the treaty? Will its people be banned from the moon colony?
   Discuss the answers to these questions as a class.

4. Then, tell each group that it will compose a bill for the treaty. The bill, once presented to all countries, will then be approved or dismissed by vote, majority or unanimous (whichever has been previously decided.)

5. The bill should specifically address the following questions:
   a. Who will make the laws, and how will they be enforced? Will poor nations have the same rights as rich nations?
   b. How will land rights be determined? On a first come, first-serve basis?
   c. Can a nation own the mineral and water rights on the moon?
   d. Should a nation be allowed to copyright its remote sensing imagery photographs and its space experiments?
   e. Should technological advances be shared by the international community? Or copyrighted and protected?
f. Should a system of public education be developed for all nations? Or should each nation develop its own education system?
g. Should an international religion and language be selected? Or should each nation retain its own language and religions?
h. How will trading rights be established, and what type of bartering or money system will be used?

6. When each “nation” has completed its discussion, pairs of nations may choose to work together in negotiation.

7. Then, using parliamentary procedure, the “floor” should be open for the discussion of each group’s bill. After each presentation, the entire class will vote on whether to accept or dismiss the bill. The vote should be unanimous for a bill to become part of the treaty. Additional negotiation among nations may be necessary.

8. Once the bill(s) have been accepted, the treaty will then be read aloud in its entirety and given a final vote. It will then be typed up and signed by each individual nation. All students should receive a copy.

B. The “Mission to Mir” Imax film is another resource that emphasizes international cooperation. According to Michael Kernan in The Smithsonian, it is “a magnificent, stirring tribute to Russian-American cooperation at space station Mir (peace), with cosmonauts and astronauts working together and signing “Moscow Nights” together to guitar accompaniment and all of the cheering for Shannon Lucid after her record 188 days in space.

C. The National Air and Space Museum has an excellent exhibit entitled “Space Race”. On display are the following:

1. a Russian spacesuit with a small dagger for fighting off bears and wolves since the cosmonauts had decided on U.S.S.R. rural landings, not ocean landings

2. a mannequin named Ivan Ivanovich (or John Doe) sent up to test the resistance of Vostok life-support systems to the 10-G impact of landing

3. Yuri Gagarin’s ID card as Cosmonaut No. 01 and his training suit—beside John Glenn’s actual spacesuit

4. the training air lock and spacesuit that Aleksei Leonov used in preparation for the first space walk in 1965

5. a Soviet moon suit with a built-in life support backpack

6. a doll autographed by an early cosmonaut—dated the day he expected to return from space; however, his capsule accidentally depressurized and he was killed
7. our Corona satellite – a secret space camera that was declassified recently

8. a video depicting Oklahoman Thomas Stafford and Leonov reminiscing about the first joint American-Soviet spaceflight, Apollo-Suyuz, in 1975.

More Ideas …

- Research Apollo-Suyuz.
- Record ways we are presently cooperating internationally in the space program.
- Draw a picture or layout of the proposed space station.
Shuttle Spacesuits

Grade Level: 8

Time Required: 45 - 60 minutes

Countdown:
Several metric measuring tapes
Metric rulers
Cardboard calipers
Brass paper fasteners
Pencil and paper
Field-of-view measuring device: (plywood board 60 x 30 cm), white poster board, thumbtacks, marking pen, protractor

Ignition:
Like the shuttle itself, the new shuttle spacesuit Extravehicular Mobility Unit (EMU) is reusable. Spacesuits used in previous manned space flight programs were not; they were custom made to each astronaut’s body size. For example, in the Apollo program, each astronaut had three suits – one for flight, one for training, and one for flight backup. Shuttle suits, however are tailored from a stock of standard-size parts to fit male and female astronauts with a wide range of measurements.

Earlier suits had to serve multiple functions. In the Gemini mission, they had to provide backup pressure in case of cabin pressure failure and protection if ejection became necessary during launch. In the Apollo missions, they had to provide an environment for EVA in microgravity and walking on the moon. Suits were worn during liftoff and reentry and had to be comfortable under the high-g forces experienced during acceleration and deceleration.

Shuttle suits are designed to serve one function – going EVA (spacewalking). They are worn in their entirety only when it is time to venture outside the orbiter cabin. Otherwise, the crew wears comfortable shirts and slacks, or coveralls.

The suit is a pressure retention structure that, coupled with a life support system, provides a life-sustaining environment that protects the astronauts against the hazards of space. These hazards include the following:

1) temperature extremes of -300 degrees F
2) a vacuum environment, where low pressure would allow blood to boil
3) the impact of micrometeoroids, which could rip through the spacesuit.

Twelve garment layers serve to protect astronauts from these hazards. The two inner layers, made of spandex fabric and plastic tubing, comprise the liquid-cooling and ventilation
garment. Next comes the pressure bladder layer of urethane-coated nylon and a fabric layer of pressure-restraining Dacron. This is followed by a seven-layer micrometeoroid garment of aluminized Mylar, laminated with Dacron scrim topped with a single-layer fabric combination of Gortex, Kevlar, and Nomex materials.

Computer or Library Research

- Students will look up the characteristics of the following fabrics and their uses.
  - Dacron, Mylar, Gortex, Kevlar, Nomex
- Visit the following web site for additional information

Liftoff:

Spacesuit Parts

A. Discuss with students the 19 separate parts of an EVA shuttle spacesuit.

1. Primary Life-Support System (PLSS) - a self-contained backpack unit with an oxygen supply, carbon-dioxide removal equipment, caution and warning system, electrical power, water cooling equipment, ventilating fan, machinery, and radio

2. Displays and Control Module (DCM) - a chest-mounted control module with all controls, a digital display, and the external liquid, gas, and electrical interfaces; has the primary purge valve for use with the SOO

3. EMU Electrical Harness (EEH) - a harness worn inside the suit to provide bioinstrumentation and communications connections to the PLSS

4. Secondary Oxygen Pack (SOP) - 2 oxygen tanks with a 30-minute emergency supply, valve, and regulators; it is attached to the base of the PLSS
5. Service and Cooling Umbilical (SCU) - connects the orbiter airlock support system to the EMU to support the astronaut before EVA and to provide in-orbit recharge capability for the PLSS; contains lines for power, communications, oxygen and water recharge, and water drainage

6. Battery - supplies electrical power for the EMU during EVA; is rechargeable in orbit

7. Contaminant Control Cartridge (CCC) - cleanses suit atmosphere of contaminants; is replaceable in orbit

8. Hard Upper Torso (HUT) - composed of a hard fiberglass shell; provides a structural support for mounting the PLSS, DCM, arms In-Suit Drink Bag, EEH and the upper half of the waist closure; can mount a mini-workstation tool carrier

9. Lower Torso - spacesuit pants, boots, and the lower half of the closure at the waist; has a waist bearing for body rotation and mobility, and brackets for attaching a tether

10. Arms (left and right) - shoulder joint and armscye (shoulder) joint and armscye (shoulder) bearing, upper arm bearings, elbow joint, and glove-attaching closure

11. EVA Gloves (left and right) - wrist bearing and disconnect, wrist joint, and fingers; one glove has a wrist-watch sewn onto the outer layer; both have tethers for restraining small tools and equipment; thin fabric comfort gloves with knitted wristlets are also worn underneath

12. Helmet - plastic pressure bubble with neck disconnected ring and ventilation pad; has a backup purge valve for use with the secondary oxygen pack to remove expired carbon dioxide
13. Liquid Cooling and Ventilation Garment (LCVG) - long underwear-like garment worn inside the pressure layer; has liquid cooling tubes, gas ventilation ducting, and multiple water and gas connectors for attachment to the PLSS through the HUT.

14. Urine Collection Device (UCD) - for male crewmembers consisting of a roll-on cuff and storage bag; discarded after use.

15. Disposable Absorption and Containment Trunk (DACT) - for female crewmembers consisting of a pair of shorts made from 5 layers of chemically treated absorbent nonwoven fibrous materials; discarded after use.

16. Extravehicular Visor Assembly (EVA) - contains a metallic-gold covered sun-filtering visor, a clear-thermal impact-protective visor, a clear thermal impact-protective visor, and adjustable blinders that attach over the helmet; also, 4 small “head lamps” are used and a TV camera-transmitter may be added.

17. In-Suit Drink Bag (IDB) - plastic water-filled pouch mounted inside the HUT; a tube projecting into the helmet works like a straw.

18. Communications Carrier Assembly (CCA) - fabric cap with built-in earphones and a microphone for use with the EMU radio.

19. Airlock Adapter Plate (AAP) - fixture for mounting and storing the EMU inside the airlock; also used to help put on the suit.

When fully assembled, the shuttle EMU is a nearly complete short-term spacecraft for one person. It provides pressure, thermal and micrometeoroid protection, oxygen, cooling water, drinking water, food, waste collection (including carbon dioxide removal), electrical power, and communications. The only thing that the EMU lacks is maneuvering capability, but this can be added by fitting a gas jet propelled Manned Maneuvering Unit (MMU) over the EMU’s primary life-support system.

On Earth, the suit fully assembled with all its parts (except the MMU) weighs about 113 kilograms. Orbiting above Earth, it has no weight at all. It does, however, keep its mass in space, which is felt as resistance to a change in motion.
Getting the Right Fit

1. Working in teams of 3 to 5, ask the students to design and build space helmets that can be used by anyone in the class.
2. Working in teams, the students should take four separate measurements of each member’s head in centimeters, and record the data. Measure the following:

   - Head Circumference
   - Head Breadth
   - Head Depth
   - Chin to Top of Head

Use calipers and a cloth tape measure for the actual measuring. Be sure the students check their work and record all data.

3. After the measurements are taken, the teams should calculate the average measurements for all members of the team.
4. Each group will report the average for each measurement to the class. The class will then calculate the classroom average for each measurement.

Field of View Measure

1. Construct a field-of-view measurement device out of wood and poster board. Cut a partial circle (220 degrees) with a radius of at least 30-cm out of plywood. Refer to the pattern on the next page for details. Tack or glue a strip of white poster board to the arc. Using a protractor and a marking pen, measure and mark the degrees around the arc as shown in the illustration.
2. Place the device on the edge of a table so that it extends over the edge slightly. Begin measuring the field of view by having a student touch his or her nose to the center of the arc and look straight ahead. Have a second student slide a marker, such as a small strip of folded paper around the arc. Begin on the right side of the 110-degree mark. The student being tested should say, “Now”, when he or she sees the marker out of the corner of the eye. Record the angle of the marker on a data table for the right eye. Repeat for the left eye.

3. Take the same measurements for the other students. When all the data have been collected, calculate the average field of view for all students.

---

**Designing A Space Helmet**

1. Working in the same team as before, have the students draw sketches on graph paper of their ideas for a space helmet that could be worn by anyone in class. The students should determine a scale on the graph paper that will translate into a full-size helmet. In designing the helmet, three considerations must be met. First, it must fit anyone in the class. Second, it must provide adequate visibility. Finally, it must be made as small as possible to reduce its launch weight and make it as comfortable to wear as possible.

2. Students may wish to add special features to their helmet designs such as mounting points for helmet lights and radios.

---

**Building a Space Helmet**

1. Have each team inflate a large round balloon to serve as a form for making a space helmet. Tie the balloon with a string.
2. Using strips of newspaper and paper maché paste, cover the balloon except for the nozzle. Put on a thin layer of newspaper and hang the balloon by the string to dry.
3. After the first layer of paper maché is dry, add more layers until a rigid shell is formed around the balloon. Lights, antennas, and other appendages can be attached to the helmet as the layers are built up.
4. Using a pin, pop the balloon inside the paper maché shell. According to the design prepared in the earlier activity, cut out a hole for slipping the helmet over the head and a second hole for the eyes.
5. Paint the helmet, and add any designs desired.
6. When all helmets are completed, evaluate each one for comfort and utility. Have students try on the helmets and rate them on a scale that the students design. (Example: on a scale of 1 to 5, with 1 being the best, how easy is it to put the helmet on?)
Mission Design - Personnel

Grade Level: 8
Time Required: 2 class periods

Suggested TEKS:
Language Arts - 8.13 8.21
Science - 8.3

SCANS
Information. Interprets and Communicates

National Science and Math Standards
Science as Inquiry Life Science Observing Communicating

Countdown:
Items for teacher:
Basic Form for a Resumé (sample attached)
Basic form/questions for conducting an interview (sample attached)

Ignition:
One of the most important aspects in planning for a NASA shuttle mission is the team selected – both on the shuttle and on the ground. The shuttle team, with a minimum crew of 5, consists of the following crew positions.

⇒ Commander - pilot astronaut has on-board responsibility for the vehicle, crew, mission success, and safety of flight.
⇒ Pilot - assists the commander in controlling and operating the vehicle; keeps track of the shuttle location by plotting the longitude and latitude on a world map; maintains communication with mission control.
⇒ Mission Specialist - is responsible for crew activity planning, consumables usage, and experiment/payload operations; performs extravehicular activities (EVAs) or spacewalks; gives information to the crew about specific experiment operations
⇒ Video Specialist - records all shuttle experiments and special events on a video
⇒ Medical Technician - takes blood pressure and pulse readings before and after liftoff and during exercise and at rest; times reactions for certain activities; gives basic first aid; conducts medical experiments.
⇒ Payload Specialist - person other than a NASA astronaut who has specialized on-board duties; monitors equipment, i.e., the remote manipulator arm

The ground team consists of many trained specialists working in mission control. These people keep continuous contact with the shuttle crew throughout the mission, by using voice contact, computers, and security cameras with monitors.

The United States, in cooperation with Japan, Canada, and the European Space Agency, is presently developing the International Space Station. Future spacecraft missions to the Moon and Mars are additionally being planned, so the need for qualified space flight professionals is vital.
Liftoff:

A. Discussion of Qualifications

Discuss with students that NASA accepts applications for the Astronaut Candidate Program on a continuous basis. Candidates are selected as needed, normally every two years, for pilot and mission specialist positions. Both civilians and military personnel may apply. Civilians may apply at any time; military personnel must be nominated through their particular branch in the service.

Mission specialist and pilot astronaut candidates must have at least a bachelor’s degree from an accredited institution in engineering, biological science, physical science, or mathematics. An advanced degree is desirable; this may be substituted for part of the specific educational requirement (Master’s = 1 year of work experience, Doctoral = 3 years of work experience).

Specific requirements for pilot astronaut applicants are:
* at least 1,000 hours pilot-in-command time in jet aircraft; flight test experience highly desirable
* ability to pass NASA Class I space physical (similar to military or civilian class I physical)
* height between 64 and 75 inches

Specific requirements for mission specialist applicants are similar to those listed for the pilot astronaut, with one major exception: the qualifying physical is a NASA Class II space physical (similar to military or civilian Class II flight physical). *Have students research actual qualifications before writing job description and resume.*

B. Writing a Resumé

1. Divide the class into the following groups:

   one panel of 6 interviewers
   one group of student interviewees, interested in the shuttle crew positions
   one group of student interviewees interested in the mission control positions

2. Announce that all 6 shuttle crew positions are open and the 5 mission specialist positions are available.
3. Specify the tasks for each group. The interview panel should cooperatively write specific job descriptions for each positions. Special emphasis should be placed on the job skills for effective teamwork, leadership, communication, and the ability to follow directions. This team should develop a set of questions to ask at the interview. The two groups of job seekers should collectively decide on a brief format for a resumé. Then, individually, each person will write his/her resumé and prepare to be interviewed.

C. Interviews

Discuss the interview procedure with the entire class. Suggest to the panel that each interviewer should make notes regarding applicants’ particular strengths and possible weaknesses. Set a time limit for each interview. Have interviews conducted individually, in a separate space in the classroom.

When the interview process has been completed, give the panel an opportunity to confer and make final decisions. Interviewers should then thank all of the applicants for their interest, and offer the available positions to the persons most qualified. They should, additionally, make one or two positive comments on what impressed them most in each interview.
Sample Resumé

John G. Jobhunter
777 Forest Road
Apartment AA-1
Some Town, XX 55555
Phone: (999) 999-9999
Fax: (999) 999-9991
Email: csmart@please.com

Overview
A high-energy and peak-performing Senior Media Buyer with 7 years of progressively responsible experience. Recognized for:
> Commitment and reliability
> Strong communication and negotiation skills
> Exceptional organizational and analytical skills
> Client relations and account maintenance abilities
> Willingness to go the "extra mile"
> Friendly and outgoing personality
> Creative problem solving abilities
> Proven leadership aptitude

HIGHLIGHTS OF EXPERIENCE

Media Buying: Negotiate and maintain media buys from network, cable, and syndication channels. Expertise in prime-time and sports programming. Prescreen programs, maintain familiarity with Nielson Ratings, allocate inventory, analyze proposals, conduct post-analyses of buys, and negotiate for additional units.

Management and Supervision: Interview and hire job candidates. Supervise assistant media buyer and interns; assure quality performance on projects. Maintain detailed records and track purchasing budgets. Involved in up-front budget planning and negotiations.

Relationship Building: Develop rapport and cooperation, maintain excellent relations with networks. Successfully serve as an intermediary between networks and clients; conduct negotiations assertively and effectively. Design customized proposals and deliver presentations; skilled at listening to client needs and developing effective solutions.

Strategy and Planning: Successfully launched 3 new brands. Designed and implemented launch strategies; developed unique sponsorships and innovative techniques for marketing products, researched target audience, hand-picked media buys, and coordinated strategically timed product launched.

PROFESSIONAL HISTORY

Some Advertising Agency, Somewhere, TX 1990 - Present
Senior Media Buyer (1996 - Present)
Media Buyer (1993 - 1996)
Assistant Media Buyer (1990-1993)

EDUCATION

Bachelor of Science The University of Texas, Austin, Texas (1990)
Major: Business Administration - concentration in Marketing

Computer Literate - Proficient with Lotus, WordPerfect, Word, Excel, JDS Netline, Internet

References furnished upon request.

Sample Interview Questions
QUESTIONS DESIGNED TO DISCOVER CANDIDATE’S TRAITS

Considering your current employment status, what attracts you to this position?
If I were to contact your current (previous supervisor), what would s/he tell me about your dependability and reliability?
Did you ever have a disagreement with your present (or previous) supervisor?
If yes, briefly explain the issue, its relative importance and the pro or con consequences.
Give me two reasons why I should not hire you? Why I should hire you?
What do you consider to be the best characteristic a supervisor could have? The worst?
Tell me a bit of what you know about our company (organization, department, etc.), in terms of our mission, goals, objects; or products and services?
If selected for this position, where do you see yourself two, four or six years from now?
What are your career goals, both short- and long-term?
What are you doing to achieve your goals?
What are your strengths/weaknesses?
How would you describe yourself?
Why did you choose this career?
What does success mean to you?
How can you contribute to this organization?
What achievements have given you the most satisfaction? Why?
Do you work well under pressure?
Aging: Space Pioneer John Glenn

Grade Level: 8

Time Required: 2 - 4 class periods

Countdown:

Electronic Text
http://www.senate.gov/~glenn/main.html
http://www.senate.gov/~glenn/17.html
http://www.senate.gov/~glenn/discovery.html

Ignition:

The recent revolution in our ideas about aging has been remarkable. Many Americans are enjoying tremendous vitality at a time of life that would have been unimaginable to their grandparents.

In Prevention's March 1998 issue, "Super Immunity" states that scientists have also learned that age is not just measured by the calendar. Rather, it depends more on biology than on chronology. And two things shape biology: our genetic makeup (over which we have no control) and our lifestyle (which we can control).

The overall message that we are currently receiving is that exercise and a healthy diet can empower our old age profoundly. Numerous studies have been conducted during this decade at the USDA Human Nutrition Research Center on Aging (HNRCA) at Tufts University in Boston that validate and emphasize this message.

Liftoff:
A. Discussion
1. Give background information about John Glenn. Tell students that on January 16, 1998, 76 year-old Glenn persuaded NASA of the importance of studying the effects of aging and space. Part of his "argument" was that perhaps space can explain some of the aging processes on the human body because weightlessness often induces similar, if temporary, conditions in younger astronauts. He also emphasized that "the study of aging becomes even more critical as we enter the 21st century. By 2030, the number of Americans over the age of 65 is estimated to exceed 69 million, more than double the current figure. This increase will have a profound effect on our economy, culture, and healthcare". (John Glenn's Flight on STS interview)

2. Talk about Glenn's personal comments about the October 29, 1998, flight. Also, go over the facts about STS, its crew and its mission.
3. Discuss Friendship 7 statistics and Glenn's comments on this 1962 mission.

**Research**

Ask students to contact the National Institute on Aging (NIA) and/or USDA Human Nutrition Research Center on Aging (HNRCA) and request information about specific experiments on aging. Have them list and discuss the findings about the aging process. This research can be done on the computer or letters written.

**B. Mission Update**

Suggest to students that they retrieve current information on the Discovery through the NASA Homepage or NASA's Spacelinks. They may also refer to local newspapers and newsmagazines.

**C. Analysis**

1. Ask students to compare and contrast the two missions.

<table>
<thead>
<tr>
<th>Friendship 7</th>
<th>STS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2. John Glenn has been referred to as a Space Pioneer. Ask students to explain why he was
considered a pioneer on the Friendship 7 flight and why he is considered a pioneer on
STS.

D. Research
1. Ask students to research the different types of experiments conducted on past NASA
missions.
2. Students define the difference between a Payload Specialist and a Mission Specialist.
   Which was Glenn categorized as?
   - Have students design and complete an application to NASA to be a payload specialist
     in a future shuttle mission.
   - Ask students to design an experiment to be conducted in space.

E. Documentary
Explain to students that a documentary is a program that presents facts in an interesting
manner. Ask them to determine what viewers would like to know about John Glenn's
background, education and training, and experiences as an astronaut. Have them write their
ideas in documentary form, and then present the documentary to the class.

F. Tasks
1. Have student's design and complete an application to NASA for the Payload Specialist
   position opening on a future shuttle mission.
2. Ask students to design an experiment to be conducted in space.

G. Vertical Verse
In his Friendship Seven interview, John Glenn describes the sensations he felt during lift-off
and in flight (weightlessness). Ask students to write a poem whose lines begin with the
letters liftoff and weightless. Remind them to include vivid descriptive words and
onomatopoeia (sound words). They may wish to display their poem in the shape of a
spacecraft ready for launch.
Vertical Verse

L
I
F
T
O
F
F
W
E
I
G
H
T
L
E
S
S