Living and Working in Space

NGSS Standards (Core ideas related to this activity)

5-LS2.A – Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms and therefore operate as decomposers.

MS-LS1.C – Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules to support growth or to release energy.

Objectives:

The students will:

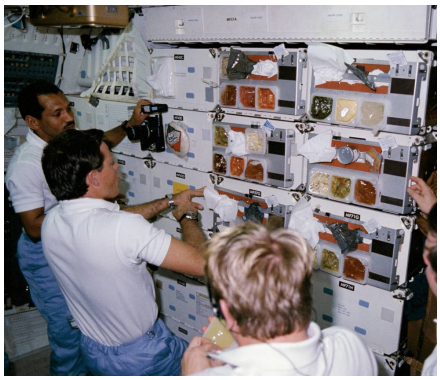
1. Investigate the properties of dehydration on foods and drinks.
2. Discuss the role of nutrition on astronaut health.
3. Investigate food spoilage and anti-microbials.

Background:

In the early days of the space program, NASA didn't have to worry about feeding the astronauts – Alan Shepard's first flight was only about 15 minutes long! As we stayed longer and worked harder however, we needed to make sure that the astronaut's needs were met. John Glenn was the first American to eat in space, and his snack consisted of applesauce in a tube and some xylitol tablets. Other Mercury astronauts had to deal with crumbly dehydrated cubes and mushy food in tubes. Needless to say, there were many complaints about space food.

As NASA began the Gemini program, one of the main goals was to stay in space for two weeks. NASA not only wanted the astronauts to be healthy, but also content. The squeeze tubes of food were gone, and rehydratable food was improved, adding convenience and variety. The addition of warm water during the Apollo program improved the rehydratable food even more. Astronauts could now enjoy foods such as shrimp cocktail (a favorite even today) and turkey with gravy for Christmas dinner.

Skylab, our first program where astronauts lived in space for an extended amount of time, brought homey comforts to meals, including a refrigerator and freezer (which means ice cream!) as well as a dinner table.



Shuttle era food brought even more improvements to the food, with the addition of many off the shelf commercially available items. Astronauts could now have a say in their own menus, working with a NASA nutritionist to ensure that the diet meets daily requirements. In addition to rehydrating foods, the orbiter had a warmer to bring foods up to proper serving temperature. Shuttle astronauts used meal trays, so that they could eat an entire meal with sides much like they do at home, rather than having to eat an entire dish before opening the next packet.

ISS astronauts enjoy more variety than ever before, not only with new recipes developed at Johnson Space Flight Center, but also because they share food with their international counterparts. Fresh fruits and vegetables are delivered when resupply spacecraft arrive and occasionally the astronauts' family will send treats from home to be included (with NASA's approval). All together there are more than 200 food and drink options on the International Space Station's standard menu.

Mold and bacteria are a huge concern in space, as we don't want the astronauts to get food poisoning and resupply is only every few months. NASA has several ways that they preserve the food sent on missions.

Irradiated – food is treated with radiation to kill any microorganisms that could make the astronauts sick.
Thermostabilized – food is sealed in a can or pouch and then heated to a temperature that kills any germs inside.
Rehydratable –most of the water has been removed to extend the shelf-life of the food. To eat, astronauts must add the moisture back.
Intermediate moisture – foods that have had some of the moisture removed, such as raisins and beef jerky.
Natural Form – foods that can be taken and eaten just as they are. Chocolates and tortillas are examples.
Fresh – foods like fruits and vegetables that are taken up on supply ships. These must be eaten within a few days of arrival to prevent spoilage.

Vocabulary:

- Nutrition - the study of nutrients in food, how the body uses them, and the relationship between diet, health, and disease.
- Calorie – unit used to measure the energy value of foods.
- Dietician -A registered dietitian nutritionist (RD or RDN) studies food, nutrition, and dietetics. To become a registered dietitian, a person needs to attend an accredited university, follow an approved curriculum, complete a rigorous internship, pass a licensure exam, and complete 75 or more continuing education hours every 5 years.
- Macronutrients - nutrients that people need in relatively large quantities, such as carbohydrates, proteins, and fats.

- Micronutrients – nutrients that are essential in small amounts. They include vitamins and minerals.
- Dehydrate – to remove the water from a substance.
- Rehydrate – to add water back into a substance.
- Anti-microbial – a substance that kills microorganisms or stops their growth.
- Control – in an experiment, the group that is not exposed to the experimental conditions; the group that remains 'normal'.

Procedures:

Calculating Daily Calorie Needs

NASA has a complex formula for calculating the daily **calorie** needs for the astronauts. This formula takes several things into consideration, including the astronaut's gender, size, and age. The result will give the **dietician** the goal for each astronaut. They can then sit down together and discuss food preferences. All of this information along with the recommended daily allowance for **macronutrients** and **micronutrients** allow the dietician to plan a menu that will keep the astronaut healthy and satisfied.

Supplies:

- Bathroom scale
- Measuring tape
- Calculators
- Pencils and paper

Procedure:

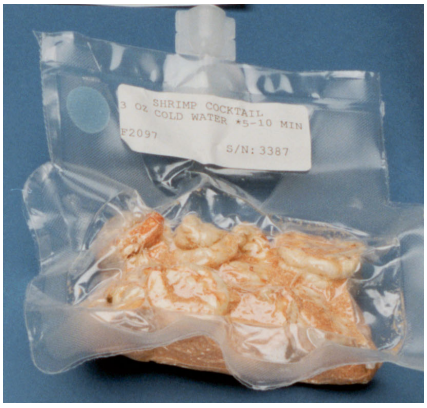
1. Place the bathroom scale in a corner of the room so that only the person weighing can see the number. Tape the measuring tape on a wall so that students can stand against it to record their height.
2. Using the bathroom scale, have the students weigh and write the number down on their paper. This can be a delicate issue, so each student should be able to do this without other students seeing and can keep their paper private. (NOTE: If you are not comfortable with this part of the activity you can create a fictional astronaut with age, height, and weight of your choosing.)
3. Have the students partner up to measure their height, one standing against the measuring tape while the other reads it. The student will then record their own height on their paper.
4. The student should also record their age on their paper.
5. Once the student has all three measurements, they are ready to calculate their Astronaut Calorie needs:

   For Women: Calories = 655 + (9.6 x Weight) + (1.7 x Height) – (4.7 x Age)
   For Men: Calories = 66 + (13.7 x Weight) + (5 x Height) – (6.8 x Age)

   Note: Use pounds and inches for your measurements

6. To extend the activity, students could plan a day's worth of meals and snacks based on their calorie needs. Nutritional information for most foods can be found online.

Making Astronaut Pudding and Beverage



One of the ways that NASA preserves food to send to the ISS is by **dehydrating** it. This means that almost all of the water is removed from the food or drink. This is good, not only to keep the food fresh and safe, but it also makes it much lighter to launch. When the astronaut is ready to eat a food that has been dehydrated, he or she must put the water back in to **rehydrate** it and make it eatable.

Supplies

- 1 package instant pudding mix
- 1 package instant drink crystals
- Sugar
- Artificial sweetener
- Nonfat dry milk
- Water
- Straws
- Plastic spoons
- Plastic zip-locking sandwich bags
- Sharpies
- Scissors

Procedures:

1. Give each student a ziptop bag.
2. Place 3 or 4 spoonfuls of dry pudding powder into the bag.
3. Place an equal amount of dry milk powder into the bag.
4. Seal the bag and have the students label the bag with a sharpie.
5. Give the students a second ziptop bag.
6. Place ½ spoonful drink powder into the bag.
7. Let the student decide if they would like sugar or artificial sweetener, and place a full spoonful into the bag.
8. Seal the bag and label it with a sharpie.
9. To rehydrate the pudding, add 3 or 4 spoonfuls of water to the bag, zip it back up, and let the students mush it from the outside with their fingers. Once the pudding is well mixed, they can snip the corner of the bag and squeeze the pudding out just like the astronauts! https://www.youtube.com/watch?v=eYV4gl558xc
10. To rehydrate the drink, add ¼ to ½ cup water to the bag, and zip it back up. The students can mush and shake it up to dissolve the drink and sweetener (you may discuss that the artificial sweetener dissolves more easily).
11. Give the students a straw. They can unzip one side of the bag, and insert the straw, then zip it back up to drink.
12. Possible follow up: Discuss any recipe changes the students may suggest. Discuss what happens with straws in space. (Astronauts must close the straws, or else liquid continues to flow because gravity doesn't pull it back down the straw.) Discuss the reasons pudding is a good space food (stickiness, tastiness, etc.)

Mold and Rot

During the early days of the space program, missions were not long enough to worry about spoilage and rot, but with the longer duration missions of Gemini, NASA became concerned about astronaut garbage. As a result, **anti-microbial** tablets were included with the meals. Once the astronaut had finished eating, they were to drop the tablet into the packaging and seal it up. The tablet reacted chemically with any leftovers to prevent mold and rot.

Supplies:

- Bread (3 pieces per group)
- Clean and sanitized serving tongs
- Ziplock bags (3 per group)
- Hand sanitizer
- Water spritzer
- Sharpies

Procedure:

1. Give each group of students 3 ziptop bags, and have them use a sharpie to label them as follows: (1) **Control** (2) Exposed with Sanitizer (3) Exposed without Sanitizer
2. Have the students open the first bag. Spritz a little water in it and using the tongs, place a slice of bread in the bag and seal it.
3. Have the students open the second bag and add a squirt of hand sanitizer. Have the students squish the bag to evenly distribute the sanitizer inside the bag.
4. Open the bag, spritz a little water in it. Have the students gently pass a piece of bread around, exposing it to their hands. Place it in the bag and seal it.
5. Open the third bag, spritz a little water in it. Have the students gently pass a piece of bread around, exposing it to their hands. Place it in the bag and seal it.
6. Place the three bags in a warm area. Have the students check it daily for any growth and record your results.
7. Discuss the results, including the role of the control bag, the role of the water, and the role of the sanitizer.

Resources:

https://www.nasa.gov/pdf/143163main_Space.Food.and.Nutrition.pdf

https://www.nasa.gov/content/european-space-agency-astronaut-luca-parmitano-0

https://www.nasa.gov/audience/forstudents/postsecondary/features/F_Food_for_Space_Flight.html

https://www.asc-csa.gc.ca/eng/astronauts/living-in-space/eating-in-space.asp

https://airandspace.si.edu/exhibitions/apollo-to-the-moon/online/astronaut-life/food-in-space.cfm

http://www.foodtimeline.org/spacefood.html

https://www.medicalnewstoday.com/articles/160774#:~:text=Nutrition%20is%20the%20study%20of,nutrients%20affect%20the%20human%20body.