Mission Meals

Background

We may take for granted our daily intake of food. To many of us here in the United States, food is easy to come by, easy to transport, and easy to prepare. But what if a person is traveling to the Moon or to Mars. What is taken into consideration for a long car ride? Packing food that will not go bad, that will be nutritious, and will taste good is important. Providing food for astronauts on space travel offers some unique challenges. All of the food would need to be planned for in advance; there needs to be little or no preparation. Astronauts have an extremely limited amount of space, and weight must be taken into account as well; the food must be light-weight. The food for space travel is prepared to meet these demands. Dehydrating food is one way to meet these criteria. Another advantage is that most of the vitamins stay intact, which is imperative for the nutritional needs of an astronaut.

Each day the human body requires a balanced diet of a variety of foods to ensure health. This balanced diet includes a variety of nutrients: 6 to 11 servings of carbohydrates, 2 to 4 servings of fruit, 3 to 5 servings of vegetables, 2 to 3 servings of proteins, 2 to 3 servings of dairy products (or other source of calcium), and a minimal amount of fats, oils, and sweets. Meeting the daily needs of nutrition for the human body while keeping food light-weight and tasting good are all challenges in planning meals for astronauts who will spend a long period of time in space. To meet the challenge of planning mission meals, NASA prepares food in five different ways. They are:

1. Rehydratable (all water has been removed), for example, scrambled eggs.
2. Thermostabilized (heat processed or cooked at moderate temperature and sealed in cans), for example, peanut butter.
3. Irradiated (preserved by exposure to ionizing radiation), for example, breads, rolls, meat.
4. Intermediate moisture (process where part of the water has been removed), for example, dried fruit.
5. Natural food (packaged without any additional processing by NASA), for example, nuts and cookies.

Topics

Food preservation
Menu planning

Objectives

Students will:

- Calculate the percent of water found in a fruit/vegetable slice.
- Plan a well-balanced mission meal of space food using the Food Pyramid and the existing Shuttle Foods List.

Overview

Students will plan meals needed for a voyage to Mars. They will decide what types of foods are lightweight but nutritious and easy to prepare. Students will also determine how and why food is preserved. Using the Food Pyramid and the Shuttle Foods List, students will prepare a five-day mission menu for a balanced diet.

Key Question

Why is dehydration used to prepare some foods for space travel?

Key Concepts

- By removing water from some foods, they take up less room for space travel, and are preserved for longer missions.
- Each day humans need a variety of foods for a balanced diet.
- The suggested servings needed to make a balanced diet are supplied by the USDA's Food Pyramid.

Materials & Preparation

- Various fruits and vegetables (apples work best)
- Several .5 meter pieces of string and/or wax paper
- A paring knife
- Small paper clips
- Paper towels
- Balances
- Student Sheets
- Food Pyramid
- Shuttle Food List
- Space Shuttle menu

Part 1: Rehydratable Food

1. Begin the discussion by asking the class to describe the kinds of food they typically eat. Compare the kinds of food they eat for lunch with the kinds of food the astronauts eat. Astronauts generally eat foods such as trail mix, dehydrated potatoes, and dehydrated meats. Why does food that is eaten in space need to be different than the food we eat on Earth?
2. Explain that about one-third of the food eaten on the Space Shuttle is rehydratable. When food is dehydrated, the water is removed. Ask students why astronauts use food prepared in this way and other ways such as thermo-stabilized, irradiated, and intermediate moisture. Before rehydratable food is eaten, the water is replaced. Have students name some dehydrated foods that are rehydrated before they are eaten (beans, pasta, powdered drinks).
3. Peel and cut large slices of fruits and vegetables brought in by students.
4. Each group should have three slices of each fruit or vegetable for the experiment. Measure the weight of each slice and record.
5. Give students the Mission Meals Part 1 Student Data Table.
6. Students need to predict which food will lose the most weight over the period of one week and record their predictions on the student data table.
7. Food slices should be spread out on a piece of wax paper and placed under a lamp. Use a dehydrator if available, in which case it's all right to eat the food. Otherwise be sure not to eat the food.
8. Over the course of one week, measure the weight of each food slice and record.
9. Use the following formula to calculate the percent water content of each fruit/vegetable slice.

   Total Mass Loss X 100/Original Mass

Part 2: Menu Planning

1. Give each group a copy of the Food Pyramid and a copy of the Shuttle Foods List.
2. Students are to use the Food Pyramid and the Shuttle Foods List to create a balanced menu for one week.

Management

Ask students to bring in various fruits and vegetables that can easily be dehydrated. Activity can be completed in two 30-minute periods, one week apart.

Reflection & Discussion

1. How do foods lose water when they are dried?
2. From our results, which food lost the most water?
3. Since the human body is more than 2/3 water, how do we replace water we lose through sweating, etc.? How will this affect our bodies during long flights in space?
4. What is the benefit of using rehydratable food?

Transfer/Extension

1. Design a balanced menu using the Shuttle Foods List for a long duration mission of one month.

STUDENT WORKSHEET

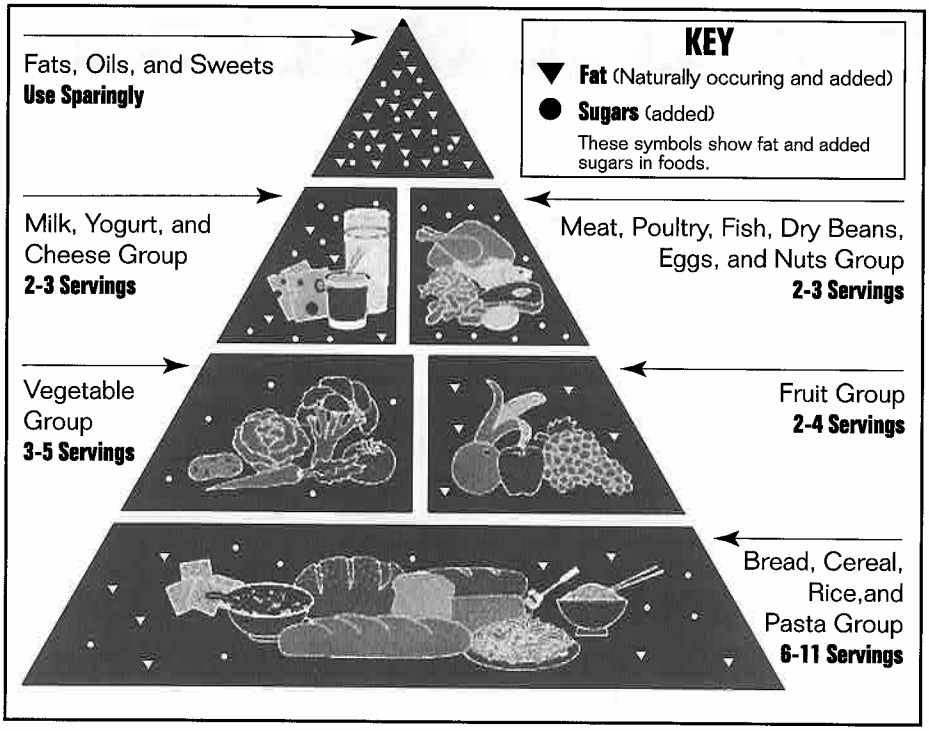
Mission Meals Part 1

Student Data Table

Fruit or Vegetable	Original Weight	Predicted End Weight	Weight After Day 2	Weight After Day 3	Weight After Day 4	Weight After Day 5	Total Weight Loss (Original Weight –Day 5 Weight)	Percent Water (Total Mass Loss x 100 / Original Mass)

Questions & Conclusion

1. How do foods lose water when they are dried?
2. From our results, which food lost the most water?
3. Since the human body is more than 2/3 water, how do we replace water we lose through sweating, etc.? How will this affect our bodies during long flights in space?



STUDENT WORKSHEET

Mission Meals Part 2

Design a week of mission meals for yourself using the Shuttle Foods List and Food Pyramid. Be sure that your meals meet the Recommended Daily Allowance for each day. Follow the steps listed below:

Student Procedures

1. Convert your weight into kilograms (your weight in pounds multiplied by .45 equals your weight in kilograms) and your height into centimeters (your height in inches multiplied by 2.54 equals your height in centimeters).
2. Figure your Basal Energy Expenditure (BEE). It is an estimate of your daily energy or calorie needs based on your height, weight, age, and sex:

   For men, the B.E.E. = [66.5 + (13.8 x W) + (5.0 x H) – (6.8 x A)]

   For women, the B.E.E. = [655.1 + (9.6 x W) + (1.9 x H) - (4.7 x A)]

   W = weight in kg, H = height in cm, A = age in years
3. Make a menu for 1 week so that the total daily caloric intake is 1.7 times the BEE for men and 1.6 times the BEE for women. Plan carefully so that you do not exceed the recommended number of servings for each food group.

Meal	Food	Fat (g)	Weight (g)	Protein (g)	Carbohydrate (g)	Calories
Breakfast						
Lunch						
Dinner						
Snacks						
Total						

STUDENT WORKSHEET

Shuttle Foods List

Food (single serving)	Fat (g)	Protein (g)	Carbohydrate (g)	Weight (g)	Calories
Almonds	24.70	11.70	1.830	45.00	276.0
Apple cider	0.000	0.000	31.40	28.70	113.0
Apple jelly	0.000	0.000	18.10	14.20	37.60
Asparagus	0.120	2.810	2.640	8.400	22.90
Banana pudding	4.370	2.670	30.70	142.0	173.0
Beef goulash	5.660	29.60	19.30	255.0	247.0
Beef patties	12.30	17.20	2.350	34.00	189.0
Beef stroganoff	11.70	8.120	13.90	34.00	186.0
Beef tips w/mushrooms	4.230	36.10	7.220	255.0	212.0
Beef w/ spicy sauce	12.50	22.00	15.60	227.0	263.0
Blueberry yogurt	1.720	4.300	31.00	135.0	156.0
Bran flakes	0.465	6.670	28.20	43.50	144.0
Breakfast roll	16.60	5.620	50.90	100.0	375.0
Broccoli au gratin	8.010	6.950	8.710	30.00	135.0
Brownie	10.90	2.620	37.80	57.00	260.0
Butter cookies	7.780	2.290	25.80	37.00	182.0
Candy-coated chocolate	5.950	1.940	21.20	30.00	146.0
Cashews	22.10	9.850	8.800	45.00	273.0
Cheese spread	13.90	4.370	1.080	36.00	147.0
Cherry drink w/a/s	0.000	0.000	0.960	1.200	4.430
Chicken cacciatore	1.890	36.50	.600	255.0	194.0
Chicken consume	0.306	0.435	1.760	5.000	11.60
Chicken salad spread	28.30	22.90	17.00	212.0	416.0
Chicken a là king	15.60	28.70	11.40	227.0	300.0
Chocolate pudding	4.300	3.860	31.70	142.0	181.0
Cocoa	0.960	2.800	44.60	50.50	198.0
Cornflakes	0.024	4.460	32.90	40.00	150.00
Creamed spinach	3.140	3.290	7.500	18.00	71.50
Diced peaches	0.000	0.770	23.50	128.0	97.30
Diced pears	0.000	0.240	26.40	128.0	106.0
Dried apricots	0.000	2.470	29.90	62.00	130.0
Dried beef	0.620	10.50	1.340	30.00	53.10
Dried peaches	0.000	2.690	35.00	62.00	151.00
Dried pears	0.000	1.020	38.50	62.00	158.0
Frankfurter	25.60	15.80	1.810	122.0	300.0
Fruit cocktail	0.000	0.435	25.20	128.0	102.0
Graham crackers	3.220	2.370	22.50	32.00	128.0
Granola	9.610	12.40	50.90	80.00	339.0
Granola bar	5.790	2.010	22.90	35.00	152.0
Granola w/raisins	9.030	11.50	52.30	80.00	336.0
Grape drink	0.000	0.000	29.90	30.00	119.0
Grape jelly	0.000	0.026	10.00	14.20	40.20
Grapefruit drink	0.000	0.020	31.70	32.20	127.0
Grits	0.267	2.530	26.20	34.50	117.0
Ham	8.280	27.80	3.860	142.0	202.0
Ham salad spread	11.90	19.40	20.90	212.0	269.0
In-suit fruit bar	0.000	0.576	38.40	50.00	156.0
Italian vegetables	5.700	3.140	13.00	30.00	116.0
Ketchup	0.000	0.234	2.320	9.000	10.20
Lemonade	0.000	0.000	20.90	21.00	83.40
Lemonade w/a/s	0.000	0.000	1.690	1.900	7.110
Lemon-lime drink	0.000	0.000	20.60	21.50	82.30

Food (single serving)	**Fat** (g)	**Protein** (g)	**Carbohydrate** (g)	**Weight** (g)	**Calories**
Macadamia nuts	29.50	4.230	2.790	45.00	294.0
Macaroni & cheese	7.520	9.700	18.20	40.00	179.0
Mayonnaise	10.20	0.138	0.000	12.10	92.30
Meatballs (spicy)	17.30	22.40	34.40	227.0	384.0
Mexican scrambled eggs	14.20	12.90	5.780	36.00	202.0
Mushroom soup	10.50	3.330	9.340	27.00	145.0
Mustard	0.094	0.113	0.133	2.400	1.820
Noodles & chicken	5.150	5.190	15.45	28.00	129.0
Oatmeal w/ brown sugar	1.390	5.710	32.50	46.10	166.0
Oatmeal w/ raisins	1.370	6.340	32.60	47.20	168.0
Orange juice	0.000	1.310	21.60	24.00	91.70
Orange mango drink	0.000	0.000	33.30	33.60	133.0
Orange/grapefruit drink	0.000	0.026	30.20	30.60	121.0
Orange drink	0.000	0.030	27.80	28.10	111.0
Peach drink	0.000	0.084	33.20	33.60	133.0
Peach yogurt	1.910	4.860	28.30	135.0	150.0
Peaches lite	0.000	0.560	16.50	128.0	67.80
Peanuts	21.80	12.90	8.190	45.00	280.0
Pineapple drink	0.000	0.000	33.20	33.60	133.0
Pineapples	0.000	0.380	17.30	128.0	70.90
Potato pattie	5.980	1.760	16.20	27.00	126.0
Potatoes au gratin	5.250	4.410	16.30	30.00	130.0
Raspberry yogurt	1.670	4.510	29.90	135.0	152.0
Rice and chicken	5.290	3.650	22.80	34.00	154.0
Rice crispies	0.040	4.670	32.70	40.00	150.0
Rice pilaf	2.420	2.120	18.70	25.00	105.0
Salmon	10.10	22.30	0.000	112.0	180.0
Sausage pattie	14.40	14.30	2.860	34.00	198.0
Scrambled eggs	14.10	12.60	5.160	34.50	198.0
Seasoned scrambled eggs	12.50	13.10	6.240	35.00	190.0
Shortbread cookies	7.010	2.100	19.10	30.00	148.0
Shrimp cocktail	0.986	14.50	15.80	35.00	130.0
Spaghetti w/meat sauce	2.900	7.130	17.10	30.00	115.0
Strawberries	0.026	0.785	19.80	23.80	82.60
Strawberry yogurt	1.740	4.630	29.80	135.0	154.0
Sweet 'n' sour chicken	3.100	21.20	10.20	36.00	153.0
Tabasco sauce	0.000	0.019	0.043	2.600	0.260
Taco sauce	0.000	0.150	1.320	10.60	5.940
Tapioca pudding	4.360	3.440	33.30	142.0	186.0
Tea	0.000	0.000	0.743	1.000	3.100
Tea w/sugar	0.000	0.000	13.30	13.50	53.10
Teriyaki chicken	3.080	22.70	6.780	36.00	145.0
Tortilla flour	2.330	2.420	15.40	30.00	92.10
Trail mix	14.10	4.140	24.20	50.00	240.0
Tropical punch	0.000	0.000	24.90	25.00	99.80
Tuna	0.770	23.00	0.000	96.00	98.90
Tuna salad spread	27.10	21.20	18.80	212.0	403.0
Turkey & gravy	15.50	31.40	8.510	227.0	300.0
Turkey tetrazzini	4.190	7.070	13.10	27.00	119.0
Vanilla instant breakfast	1.700	9.360	41.10	56.00	219.0
Vanilla pudding	3.820	2.800	34.10	142.0	182.0
Whole wheat bread	1.220	2.690	12.70	28.00	68.60

Source: Shuttle Food Lab, Johnson Space Center