Space Garden: An Introduction

Providing astronauts in space a diet with adequate calories and nutritional value that is also palatable and appealing is an ongoing challenge. Although there are more than 200 items, including some fresh fruits and vegetables, to select from on the current ISS menu, astronauts on extended missions miss the taste, texture, and aroma of fresh food. Many have even asked to be able to grow some food on board the spacecraft. Astronauts have also found through experiments involving plant growth in space that they derive positive psychological benefit from nurturing and observing plants.

On the ISS, growing plants for food can improve the nutrition and variety of the astronauts' diets as well as provide them with entertainment and mental stimulation. Since the ISS can only be re-supplied from Earth every 90 days, growing plants in space can be a much appreciated addition to the daily fare and routine. On a mission to Mars, it will be an absolute necessity.

The following four related activities will help students to understand and explore some of the similarities and differences between growing plants on earth and in space, and to consider how NASA might choose which plants will be grown for food on the ISS and/or on other extended missions. All of these activities will use the Space Garden, a made-for schools version of the Astronaut Plant Bag developed by Orbital Technologies Corporation of Madison, Wisconsin.

The first activity, "Food and Nutrition in Space," engages students in research and creative discussion to ascertain some of the criteria that might be used by NASA to choose among the countless possibilities to determine which plants astronauts will grow in space. They will examine and manipulate the Space Garden and discuss why and how it is a suitable vessel for growing plants in space.

In the second activity, "How Does My Garden Grow," students will choose a plant to grow in their Space Garden based on the criteria they established in Food and Nutrition in Space. They will gain a basic understanding of plant growth and

development as they plant, tend, harvest, measure, and taste their chosen crop. They will also grow a control crop (seed provided) known to have been successfully grown. Students will evaluate their crop's suitability for space gardening by comparing their results with the established criteria and with the control crop.

In Activities 3 (Gravitropism) and 4 (Phototropism) students will extend their understanding of plant growth and physiology through Space Garden experiments that control variation of factors such as available water and nutrition, gravitational direction, and the amount and quality of light.

Standards Matrix

Lesson	Food in Space	Space Garden	Root Zone	Tropisms
Unifying Concepts and Processes[1]				
Systems, order and organization	X	X	X	X
Evidence, models and explanation		X	X	X
Change, constancy and measurement		X	X	X
Form and function	X	X	X	X
Science as Inquiry[1]				
Abilities necessary to do scientific inquiry		X	X	X
Understandings about scientific inquiry	X	X	X	X
Physical Science[1]				
Properties of matter	X		X	
Motion and forces				X
Life Science[1]				
Structure and function in living systems		X	X	X
Regulation and behavior			X	X
Ecosystems		X		
Diversity of organisms		X		
Science and Technology[1]				
Understanding about science and technology	X	X	X	
Technological design	X	X	X	X
Science in Personal and Social Perspectives[1]				
Personal health	X			
Science and technology in society	X	X		
History and Nature of Science[1]	X		X	X
History of Science				
Science as a human endeavor	X	X		
Mathematics[2]				
Understand systems and tools of measurement		X	X	X
Collect, organize and present data		X	X	X
Interpret data		X	X	X
Language Arts[3]				
Generate ideas and pose questions	X	X	X	X
Use a variety of information resources to conduct research	X			
Comprehend, interpret and evaluate information	X	X	X	X
Use spoken and written language to communicate ideas	X	X	X	X

1. *National Science Education Standards*, National Academy Press, Washington, D.C., 1996
2. National Council of Teachers of Mathematics Standards
3. *Standards for the English Language* Arts, The National Council of Teachers of English

Space Garden: References

1. http://spaceflight.nasa.gov/shuttle/reference/factsheets/food.html
NASA's Food for Space Flight site

2. http://www.ag.iastate.edu/centers/ftcsc/pages/educate.htm
NASA Food Technology Commercial Space Center, Iowa State University with college-level educational activities

3. http://www.mypyramid.gov/index.html
USDA home page for food pyramid activities

4. http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/T/Tropisms.html
Tropisms (Darwin's experiment)

5. http://www.biologie.uni-hamburg.de/b-online/e32/32b.htm
Tropisms (A. de Candolle's phototropism experiment)

6. http://www.biologie.uni-hamburg.de/b-online/e32/32c.htm
Gravitropism, early experiments

7. http://lsda.jsc.nasa.gov/scripts/experiment/exper.cfm?exp_index=234
Bandurski, early corn experiment in space

8. http://www.sciam.com/article.cfm?articleID=000790A5-749C-1C70-84A9809EC588EF21
Scientific American gravity experiment. Shawn Carlson

9. http://www.nutritionexplorations.org/
Nutrition lesson plans; free registration required

10. http://www.ncte.org/about/over/standards/110846.htm
National Council of Teachers of English site for their book,
Standards for the English Language Arts.
(Note - these standards are apparently somewhat controversial.) Reference originally found at: http://www.educationworld.com/standards/national/lang_arts/index.shtml.