National Center
for Earth and Space Science Education

Universities Space Research Association

Introduction to the *Journey through the Universe* Program and the *Are There Other Neighborhoods Like Our Own?* Module's Grade 9-12 Lessons

1. The Program

Journey through the Universe (http://journeythroughtheuniverse.org) is a national science education initiative that engages *entire* communities—students, teachers, families, and the public—using education programs in space exploration and the space sciences to inspire and captivate. The initiative embraces the notion that—*it takes a community to educate a child.*

Journey through the Universe programming is tailored to a community's strategic needs in science, technology, engineering, and mathematics (STEM) education, and is a framework for partnership between school districts, museums and science centers, colleges and universities, civic and business organizations, and the public. The cornerstone philosophy for all programming is—*inspire… then educate.*

2. The Grade K-12 *Are There Other Neighborhoods Like Our Own?* Education Module

Are There Other Neighborhoods Like Our Own? Searching for Abodes of Life in the Universe is one of several Education Modules developed for the *Journey through the Universe* program. The Module contains activities at three grade levels (K-4, 5-8, 9-12). Each grade level package is called an **Education Unit.** The Module also includes one Family and Home activity, and one activity on the Process of Science, both of which are suitable for use at all grade levels. Note that the Module currently uses an old lesson format.

The Module focuses on the search for abodes of life in the universe. Considering that life is found in just about every environment on Earth—from frozen Antarctica to sun-deprived hydrothermal vents at the bottom of the ocean to the interior of nuclear reactors—life flourishes over a wide range of environs. If it is conceivable for species to adapt to living conditions that are unthinkable for human survival, then similar adaptations might be possible for life on another world. Mars, with frozen water beneath its surface, and Jupiter's icy moon Europa, may seem like harsh environments to us, yet they may be abodes of life.

The storyline approach adopted for this Module is to address three questions at each grade level:

- *What* makes our neighborhood an abode of life, and might these conditions be present in other neighborhoods beyond our own?
- *Why* do we want to search for other neighborhoods like our own?
- *How* will we explore other neighborhoods beyond our own?

Each grade-level Education Unit has a lesson addressing each of these questions.

At the elementary level 'our neighborhood', a case study of a familiar life-bearing environment, is one's hometown and 'other neighborhoods' are other possible abodes of life within the Earth-Moon system. At the middle school level 'our neighborhood' is the Earth-Moon system and 'other neighborhoods' encompass those found across the Solar System. At high school 'our neighborhood' is the Solar System as an abode of life, and the search for 'other neighborhoods' spans the entire galaxy. The nature of a neighborhood at each grade level is based on the National Science Education Standards and Benchmarks for Science Literacy.

3. The *Are There Other Neighborhoods Like Our Own?* Grade 9-12 Lessons

This document provides a description of each lesson for the *Are There Other Neighborhoods Like Our Own?* **high school (grade 9-12)** Education Unit. Also provided are connections to grades 9-12 National Science Education Standards.

Are There Other Neighborhoods Like Our Own? The 9–12 Education Unit Progression	
Lesson Title	Lesson Description
Lesson 1: Habitable Zones	*Storyline question addressed: What makes our neighborhood an abode of life, and might these conditions be present in other neighborhoods beyond our own?* Students use bulbs of different wattage to serve as remarkably good analogs to different luminosity stars. Temperature-sensitive liquid crystal strips, positioned radially relative to the bulb, identify the Thermally Habitable Zone around the 'star', which is the annular region around the star where liquid water can exist. This physical analog very effectively demonstrates that the higher the luminosity of the star, the farther away, and *wider* is its Thermally Habitable Zone. The wider the Zone the higher is the probability that a planet potentially capable of supporting life formed in that zone. The lesson also includes discussion of the lifetime of stars, with the shortest lifetimes for the higher luminosity stars. Thus stars appropriate for astronomers to explore for Earth-like planets are those with reasonably wide Thermally Habitable Zones, but also lifetimes long enough for life to evolve—stars like our Sun.
Lesson 2: The Drake Equation	*Storyline question addressed: Why do we want to search for other neighborhoods like our own?* One motivation to explore beyond our neighborhood is to seek out a greater reality, and place our own existence in a larger context. If, for instance, we were to one day receive a 'hello' from beyond Earth, it would change us profoundly. In this lesson, students will study the Drake Equation, which provides an estimate of the number of potential technologically advanced civilizations in the galaxy. Students will consider the various probabilities embedded in the equation, which address whether: a star has planets, the planets are hospitable to life, life is emergent, life becomes intelligent, intelligent life develops technology, and the civilization survives for an appreciable amount of time. Students will investigate the current uncertainties in these probabilities, define defensible values for the probabilities, and draw their own conclusions about the possibility of intelligent, technically advanced life in the galaxy.
Lesson 3: Sending Messages to Space	*Storyline question addressed: How will we explore other neighborhoods beyond our own?* In 1974, the Arecibo Radio Observatory in Puerto Rico sent a message into space toward the Globular Cluster M13 in Hercules. The message included information about the human race and our planet, and used the physics and chemistry of the universe as the common language through which extraterrestrials could decipher the message. In this lesson students will be provided the message, attempt to interpret it, and gain a good understanding of the challenges of communicating with other intelligent life in the galaxy.

Connection to Standards

This Education Unit has been mapped to the National Science Education Standards (National Research Council, National Academy Press, Washington, DC, 1996). A complete explanation of the Standards can be found at: http://www.nap.edu/html/nses/html/. Core standards for each lesson are indicated by a "√."

	Education Standards In Are There Other Neighborhoods Like Our Own? 9-12 Education Unit							
	National Science Education Standards							
	Standard A: Science as Inquiry		Standard B: Physical Science	Standard C: Life Science	Standard D: Earth and Space Science	Standard E: Science and Technology	Standard G: History and Nature of Science	
	A1: Abilities necessary to do scientific inquiry	A2: Understandings about scientific inquiry	B6: Interactions of energy and matter	C5: Matter, energy, and organization in living systems	D3: Origin and evolution of the Earth system	E1: Abilities of technological design	G1: Science as a human endeavor	G2: Nature of scientific knowledge
Lesson 1: Habitable Zones	√	√	√	√	√		√	√
Lesson 2: The Drake Equation	√	√			√		√	√
Lesson 3: Sending Messages to Space	√	√				√	√	√