Lesson 1: Introduction

Spacewalking astronaut with Earth and Sun in background; NASA

Students are introduced to the basic requirements for human survival. Using an online, multimedia module, they change factors of our Solar System and draw conclusions about which factors are necessary for human survival.

Main Lesson Concept:

Humans need water, oxygen, food, gravity, a moderate temperature and protection from poisonous gases and high levels of radiation to survive.

Scientific Question:

What basic requirements do humans need to survive? Why?

Objectives	Standards
• Students will research and list the basic requirements for human survival in their Astro Journals. • They will write a survival story identifying these basic requirements, the consequences of not meeting them and how they are met. • After comparing characteristics of the Earth with other planets and moons, students will predict which features of the Earth they believe are crucial to human survival.	**Meets:** 2061: 6C (3-5) #1, 2 NSES: F (5-8), #1 **Addresses:** 2061: 4B (6-8) #2 NSES: A (5-8) #1 ISTE: 3, 5

Assessment	Abstract of Lesson
Write-up in Astro Journal.	Students are introduced to the overall goals and concepts of Astro-Venture and are given the background information for the Astronomy unit and final project. Students research the requirements for human survival and analyze the planets and moons in our solar system to assess the ability of each to support human survival.

Prerequisite Concepts	Major Concepts
• Energy is the capacity to do work (make an object move). • Information taken from a book, Web site or other resource is not always accurate. It is important to check the reputation of the source and to find several sources that agree.	• Humans need food, because it gives us energy so that we can move, grow and function. It also gives us nutrients to build and repair bones, teeth, nails, skin, hair, flesh and organs. • Humans need oxygen, because it helps us to obtain energy from sugars. • Humans need water, because it allows nutrients to circulate through the body. It also helps to regulate our body temperature, and our cells are made mainly of water. • Humans need a moderate temperature to prevent the body temperature from going above or below 98.6°F/37°C. • Humans need protection from high levels of radiation and poisonous gases to prevent cancer, disease and damage to the body. • Humans need gravity for normal development and function of our bodies, and for the Earth to hold onto an atmosphere. • Earth is the only planet that we know of that can meet our requirements for human survival.

Suggested Timeline (45-minute periods):

Day 1: Engage and Explore Part 1 Sections
Day 2: Explore Part 2 Section
Day 3: Explain Section
Day 4: Extend/Apply and Evaluate Sections

Materials and Equipment:

- An overhead transparency of the Astro-Venture Academy Letter of Acceptance
- A class set of the Astro-Venture Materials Packets
- A class set of Astro Journal Lesson 1: Unit Introduction*
- A class set of Survival Story
- 1 Planetary Comparison Chart for each group
- A class set of Human Requirements Reading
- Books, CD-ROMs or other resources on human survival needs, human health, biology or astrobiology.
- Chart Paper
- Overhead projector

Preparation:

- Gather resources (i.e., books, CD-ROMS etc.)
- Make overhead transparency of Astro-Venture Academy Letter of Acceptance.
- Duplicate a class sets of Astro-Venture Materials Packets, Astro Journals, Survival Story and Human Requirements Reading.
- Prepare copies of Planetary Comparison Charts for each group.
- Prepare chart paper with major concept of the lesson and human survival needs to post at the end of the lesson.

* A generic Astro Journal and Scientific Inquiry Rubric are included at the end of this lesson. If you prefer, you can have students use the generic Astro Journal instead of the ones designed to go with each lesson. This might be especially useful for older students who are already familiar with the inquiry material.

Differentiation
Accommodations For students who may have special needs, provide extra support for reading assignment (e.g., partner, read aloud, etc.).
Advanced Extensions • Research what a chosen microbe* needs to survive. • Create a Venn Diagram comparing and contrasting microbes' needs with human needs. * Suggested microbes: bacillus anthracis (anthrax) thermus aquaticus or pyrococcus furiosus.

Engage

(approximately 20 minutes)

Northern Mockingbird; National Park Service, USDI

1. Introduce Astro-Venture

- Project the overhead transparency of the Astro-Venture Academy Acceptance Letter (page 36).

- Read over the letter with students. Emphasize the overall concept, goal and purpose of Astro-Venture:

- Question: Why would we be interested in the study of life in the universe?
- *Answers may include: We are interested in the study of life in the universe in order to better understand life on Earth; to find out if life on Earth is unique; to better understand how life began and evolved; or to improve human ability to survive on other planets.*

- Question: Why would we want to study our own planet and star system's ability to support human life?
- *Answer: This will help us understand what kinds of places to look for in the universe that could also support human life.*

- Question: Why might we want to find other planets like Earth?
- *Answers may include: We may want to find other planets like Earth in order to find other forms of life and discover how this life might compare to life on Earth; to find out if we are alone in the universe; or to better understand how our planet, Solar System and life formed and evolved.*

- Say: Your goal as Astro-Venture scientists will be to determine what characteristics of Earth and our Solar System allow humans to survive and to find and design a planet and star system that meet these requirements.

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2. Hand out the of Astro-Venture Materials Packets.

Have students read through the materials individually or as a class. Go over the major goals and activities with students.
- Question: What is the major goal of the Astro-Venture Academy?
- *Answer: The major goal of the Astro-Venture Academy is to find, study, and design planets that would be habitable to humans.*

- Question: What kinds of activities will we participate in to achieve this goal?
- *Answer: We will participate in online training modules, off-line investigations, online mission modules and Design a Planet module to help with this goal.*

- Question: In this unit, we will focus on Astronomy. What are the goals of the Astronomy section of Astro-Venture?
- *Answer: The goals of the Astronomy section are to identify the astronomical features of our star system and planet that support human habitation, why we need these features and how we might go about finding a star system and planet like this.*

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3. Introduce the Scientific Question of the lesson.

- Scientific Question: What do humans need to survive? Why?

- Tell students that they will be conducting research to help answer this question.

Explore — Part 1

(approximately 25 minutes)

Wellness Program file photo; National Institutes of Health & National Cancer Institute, USDHHS

1. Ask students what they think are basic requirements for human survival.

- Record answers on the board or chart paper. Accept all answers.
- *Answers may include: Humans need food, water, shelter from cold or heat, air or oxygen, love to survive.*

- Question: Looking at this list, is there anything that we could live without?
- *Answers may vary.*

Note to Teacher: Students may have included things like cookies, TV, house, furniture, car or other luxuries that are nice but not necessary for survival. Allow them to decide which items they agree are really essential for survival. If students listed love or companionship, encourage a debate about whether we could survive without these things. Psychological needs are not a main focus of Astro-Venture; however, they are important to acknowledge.

2. Introduce students to their research assignment.

- Refer to the list of human needs the class has composed.

- Question: Why do we need food? What would happen to us, if we didn't have food?
- *Answers may vary and should be accepted without feedback on whether they are correct or incorrect.*

- Repeat this question for the other elements on the list, and accept all answers without feedback. At this point students are not expected to know why each element is needed.

- Tell students that they will be doing some research of health, biology, survival and astrobiology resources to see if there are any needs they left off their list and to see why we need each element.

3. Have students complete the Prediction section of their Astro Journal.

Explore — Part 2

(approximately 45 minutes)

Breakfast at 5400 meters elevation while glacier-monitoring in Ecuador; Laboratoire de Glaciologie et de Géophysique de l'Environment (LGGE)

1. Have students conduct research on the Internet, CD-ROMs and in books that have topics on health, survival and biology.

They should research human survival needs and the effects on the human body when these needs are not met, to see if their predictions were accurate. They should record their findings in the Data section of their Astro Journal and bibliographic information of the resources they used in the Materials section of their Astro Journal.

Web sites: Have students try key words such as anatomy, physiology, health, biology, human body and nutrition at the following search engines and directories for kids:

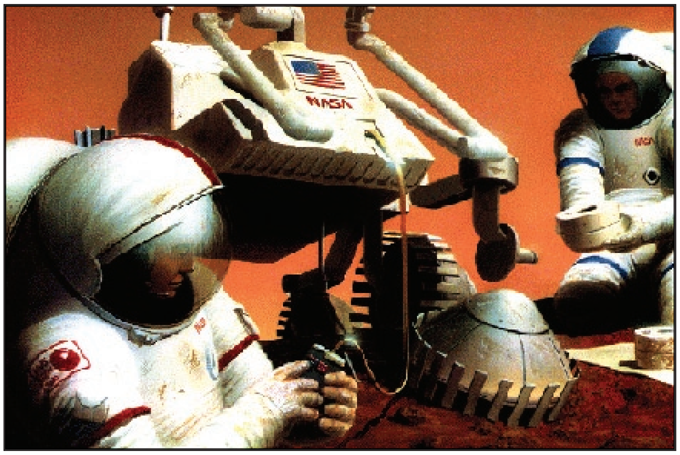
- Yahooligans! http://www.yahooligans.com
- Ask Jeeves for Kids: http://www.ajkids.com
- Ithaki for Kids: http://www.ithaki.net/kids
- Cyber Sleuth Kids: http://cybersleuth-kids.com
- Kids Click: http://sunsite.berkeley.edu/kidsclick

The following encyclopedia Web sites can also be useful:

- Columbia Encyclopedia: http://www.encyclopedia.com
- Microsoft Encarta: http://encarta.msn.com

Explain

(approximately 45 minutes)



"Human Touch" illustration: Two Mars astronauts working on a rover's wheel motors; Pat Rawlings, NASA

1. Students share and compare their results with a partner or small group.

They identify which elements and reasons they have in common and share these with the whole class.

2. List any new elements on the class list that the class agrees is supported by evidence.

Have students share the reasons each element is needed.

3. Read with students the Human Requirements Reading.

Have students answer the reading comprehension questions.

4. Go over the human requirements described in the reading and compare them with the requirements the class listed.

Create a final chart like the one below and post this in the classroom for the duration of the unit.

- Question: What do humans need to survive and why?
- *Answer: Humans need food, water, oxygen, moderate temperature and protection from poisonous gases and high levels of radiation.*

Humans Need	Reason
Food	Gives us energy so that we can move, grow and function. It also gives us nutrients to build and mend bones, teeth, nails, skin, hair, flesh and organs.
Oxygen	Helps us to obtain energy from sugars.
Water	Allows nutrients to circulate through the body. Helps to regulate body temperature. The cells that make up our bodies are made mainly of water.
Moderate temperature (Average global temperature above 0°C and below 50°C)	Allows us to maintain an average body temperature of 98.6°F/37°C and to maintain water in a liquid state at all times.
Protection from poisonous gases and high levels of radiation	To prevent cancer, disease and damage to the body.
Gravity	Allows our biological systems to develop and function normally. Holds the atmosphere to the Earth so it doesn't escape into space.

5. Students record results and conclusions in the Results and Conclusion sections of their Astro Journal.

Extend/Apply

(approximately 20 minutes)

Astronauts and cosmonauts sharing a meal on the International Space Station (ISS); NASA

1. Discuss how human survival needs listed on the chart are met on Earth.

- Question: How is our requirement for food met on Earth?
- *Answer: (Accept all answers without feedback whether they are correct or incorrect.) We gain energy and nutrients from plants and animals that we eat. This energy first comes from the Sun.*

- Repeat this discussion for each of the elements on this list. At this point, students may not know all of the answers. They may not know how a moderate temperature is maintained or how we are protected from poisonous gases and radiation. These answers will be discussed throughout Astro-Venture.

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2. Introduce the planet comparison activity.

- Divide students into groups. Assign each group a different planet to compare with Earth.
- Have students look at the Planet Comparison Chart and determine whether the planet would be habitable or not. If they determine that the planet would not be habitable, have them explain which factors on the human requirements charts will not be met and why.

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3. Students share their assessments as a class.

Based on what students know so far, their assessments should include observations that these planets do not have oxygen, and most have no liquid water and have temperatures that are far too extreme for humans.

Evaluate

(approximately 25 minutes)

Cold water survival training; National Marine Fisheries Service, NOAA

1. Have students write a story using the Survival Story guidelines and Rubric.

In this story, students should describe a situation in which someone's survival is endangered and why their survival is endangered.

- Go over rubric for story.

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2. Students share stories with the class and provide feedback on the accuracy of the survival elements included.

Note to Teacher: After each lesson, consider posting the main concept of the lesson some place in your classroom. As you move through the unit, you and the students can refer to the 'conceptual flow' and reflect on the progression of the learning. This may be logistically difficult, but it is a powerful tool for building understanding. For this lesson, the chart of what is needed and why should also be posted.

National Aeronautics and Space Administration

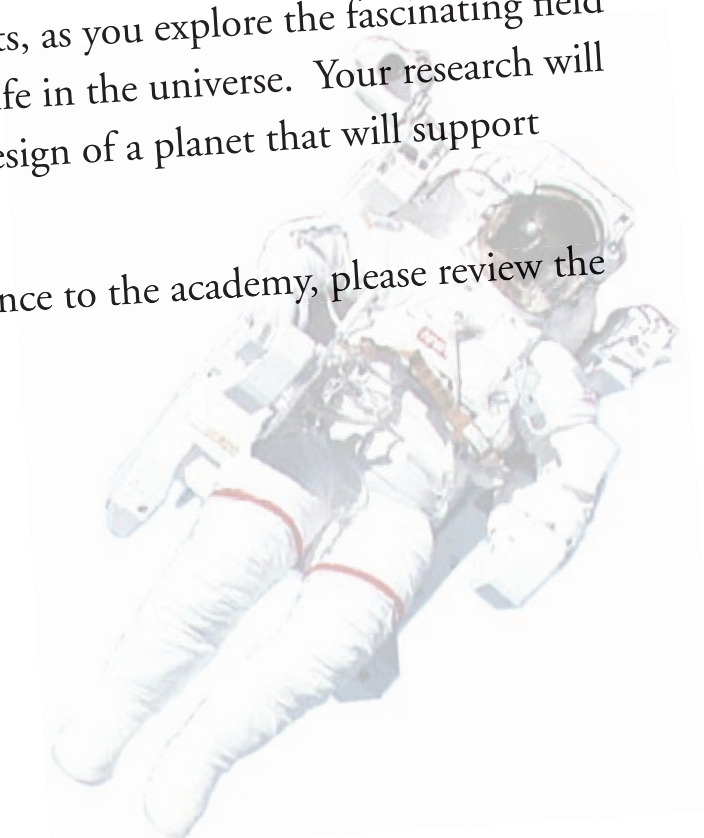
Astro-Venture Academy
World Headquarters
Admissions Department

Dear Applicant,

After extensive review of your application, the admissions committee is pleased to accept you to the Astro-Venture Academy.

At this prestigious academy, you will have the opportunity to train and work with NASA scientists, as you explore the fascinating field of astrobiology; the study of life in the universe. Your research will focus on the search for and design of a planet that will support human habitation.

In preparation for your entrance to the academy, please review the enclosed materials.



Sincerely yours,

Lorraine Wentz

Doctor Lorraine Wentz
Director of Admissions

Astro-Venture Academy Materials Packet

The Astro-Venture Academy

The Astro-Venture Academy is a virtual academy that you can attend using the Internet. Your school is one of a select group of schools and universities all over the world who are working together to study, find and design habitable planets. As a member school, you will be expected to complete the online training and mission modules as well as the off-line classroom explorations. This will be challenging, but the rewards will be great if you succeed in finding and designing a planet that can support human life! Good luck!

Academy Resources

During your studies and research, you will be able to use the academy's many instruments. These include:

- Telescopes that are orbiting the Earth above the atmosphere, where more information can be collected.
- Probes that can be sent out to other star systems and planets.

You will also have the opportunity to interact with many NASA scientists and specialists who will assist you along the way. You will be able to learn about many different jobs in astrobiology by reading these specialists' career facts sheets, collecting their trading cards and interacting with them in live webcasts and chats.

What is Astrobiology?

- How did life begin?
- Are we alone in the universe?
- What is the future of life?

These are the questions that astrobiologists are working to answer. Astrobiology is the study of life on Earth and in the universe. Astrobiologists want to have a better understanding of life on Earth and to find out if life on Earth is unique. They study all life forms on Earth. They are especially interested in microbial life, which can only be seen with a microscope. They are interested in studying microbes because they were the first life forms on Earth. Also, many microbes have the ability to live in extreme environments that are too hot or too cold for human survival or the environments have no oxygen. At the Astro-Venture Academy, we focus on human life, so that we can have a better understanding of ourselves and our own survival requirements.

Research Areas

At the Academy, you will explore four research areas:

1. Astronomy
2. Geology
3. Atmospheric sciences
4. Biology

Training

In each of these online modules, you will be trained on the requirements for human habitation that relate to that area of science. In these modules, you learn ***what*** humans need in a planet and star system to survive.

Investigations

Off-line, you will engage in many classroom investigations in which you will learn ***why*** humans need the requirements identified in the Training modules.

Missions

After your training, you will engage in online missions to search for a star system and planet that meet these qualifications. In these modules, you learn ***how*** to go about finding a planet that would support human survival.

Design a Planet

Once you've completed all four sections, you will engage in the online Design a Planet Module in which you will design a simulated star system and planet that meets all human survival requirements in all four areas: astronomy, geology, atmospheric sciences and biology.

Astronomy

As a Junior Astronomer, you will complete the online Astronomy Training module to discover the astronomical features of our Solar System that make Earth habitable for humans. When you have successfully completed your training, you will earn your badge and be promoted to Senior Astronomer. You will then engage in off-line Astronomy investigations, and you will discover why we need the features identified in Astronomy Training. Finally, you will proceed to your online Astronomy Mission where you will work with NASA scientists to find a star system and planet with the astronomy features that will support human life.

Final Astronomy Project

If you are successful in finding a planet and star system that meets the astronomical requirements for human life, write a proposal to the World Science Foundation to convince them that the star and planet you find is worthy of further study and exploration. Include evidence of why the star and planet needs further study, what we could learn from this study and what type of further exploration you would recommend.

Featured Astronomy Careers

The careers featured in this unit are astrophysicists and astrobiologists. You will learn about the following areas of specialty in astrophysics:

- Spectroscopy
- Doppler Shift
- Photometry
- Habitable Zone

The following career fact sheets give more detail about these careers and people in these careers.

NASA Quest: Highlighting People and Professions related to NASA and its Exploration Mission

Astrobiologist — Career Fact Sheet

Related Job Titles:

Exobiologist, life scientist, space scientist

Job Description:

Astrobiologists study life in the **universe**: how it began, where it's located and how it has evolved or changed over time. Three main questions drive their research: How did life begin and evolve? Is there life elsewhere in the **universe**? What is the future for life on Earth and beyond? Astrobiologists need to understand how many different kinds of science work together. These kinds of science may include **biology (microbiology, botany, physiology, zoology), chemistry, physics, geology, paleontology** and **astronomy**. Some astrobiologists spend time writing proposals to ask for funding for their research. They usually work regular hours in laboratories and use **microscopes**, computers and other equipment. Some use plants and animals for experiments. Many do research outside, and many work with a team.

Interests/Abilities:

- Do you enjoy doing experiments?
- Are you interested in how animals and plants function?
- Are you curious about whether there is other life in the **universe**?
- Do you work well on your own?
- Do you work well with a team?
- Do you enjoy investigating mysteries or problems?

Suggested School Subjects/Courses:

- Science (**biology, chemistry, physics, astronomy, planetary science** with **laboratory** research and **fieldwork**)
- Math

Education/Training Needed:

The minimum education required for this position is a **bachelor's degree** in **biology, astronomy, space science, chemistry** or another appropriate subject from an accredited **college** or **university**. This course of study must include at least 20 semester hours of **physical science** or **engineering** or experience that leads to the understanding of the equipment used for manned aerospace flights. To do research, a **Ph.D.** is highly desired for this position.

Areas of Expertise:

- ***Chemical and biological evolution:*** study what life is, where it's located, how it began and changed over time
- ***Biogeochemistry:*** study rocks for evidence of life
- ***Microbiology:*** study microscopic organisms and the conditions of the environments where they can survive (especially very hot/cold environments)
- ***Solar system analysis:*** research and design new experiments and instruments to explore the **Solar System**

Additional Resources:

- NASA Office of Space Science
  http://www.hq.nasa.gov/office/oss
- NASA Office of Life and Microgravity Sciences and Applications
  http://www.hq.nasa.gov/office/olmsa
- Astrobiology at NASA
  http://astrobiology.arc.nasa.gov
- The Astrobiology Web
  http://www.astrobiology.com
- NASA Specialized Center of Research and Training (NSCORT)/Exobiology
  http://exobio.ucsd.edu
- American Institute of Biological Sciences
  http://www.aibs.org
- American Physiological Society
  http://www.faseb.org/aps
- Biotechnology Industry Organization
  http://www.bio.org/welcome.html
- Biophysical Society
  http://www.biophysics.org/biophys/society/biohome.htm

What Can I Do Right Now?

- Join a local environmental club or organization.
- Participate in Earth Day activities.
- Take summer jobs or internships at parks, farms, plant nurseries, laboratories, museums or camps.
- Visit Astro-Venture regularly to participate in chats and activities.
- Call the American Association of Science and Technology Centers for information on science museums in your area that you might visit. (202) 783-7200
- Participate in science fair projects.

NASA Quest: Highlighting People and Professions related to NASA and its Exploration Mission

Astrophysicist — Career Fact Sheet

Related Job Titles:

Space scientist, astronomer, research scientist, physicist, planetary scientist, space physicist, dynamicist, planetary spectroscopist, galactic astronomer, stellar spectroscopist

Job Description:

Astrophysicists study objects in the universe including galaxies and stars to understand what they are made of, their surface features, their histories and how they were formed. To study these bodies, astrophysicists often come up with new tools and ways to investigate them. Astrophysicists spend most of their time in laboratories and offices looking at a lot of information gathered by instruments such as telescopes, sensors and probes, deciding what the information means and writing papers and reports about what they find. Some also spend time discovering rules about how objects in space are formed or structured. A small portion of an astrophysicist's time is spent actually making observations with instruments. This may require travel to faraway locations and is done at night.

Interests/Abilities:

- Do you enjoy math and science?
- Do you have a good imagination?
- Do you work well on your own?
- Do you enjoy working with computers?
- Do you enjoy solving mysteries or problems?
- Do you enjoy learning about new things?
- Do you do well in math and science?

Education/Training Needed:

The minimum education required for this position is a **bachelor's degree** in **physics, mathematics, astrophysics, astronomy** or a related subject from an accredited **college** or **university**. This study must include one **physics**, or **engineering** lab in aerospace instrumentation. To do research, a **Ph.D**. is highly desired for this position.

Additional Resources:

- SETI Institute Online
  (Search for Extraterrestrial Intelligence)
  http://www.seti.org
- American Institute of Physics
  http://www.aip.org
- The American Physical Society
  http://www.aps.org
- American Astronomical Society
  (request a pamphlet with information on careers in astronomy)
  http://www.aas.org
- Yvonne Pendleton's Astronomy Web site for students
  (Yvonne is a NASA astrophysicist)
  http://web99.arc.nasa.gov/~yvonne
- The Planetary Society
  http://www.planetary.org
- Astronomical society of the Pacific
  http://www.aspsky.org

Suggested School Subjects/Courses:

- **physics**
- **chemisry**
- **astronomy**
- **electronics**
- **mathematics**

Areas of Expertise:

- ***Solar studies:*** study the Sun
- ***Stellar studies:*** study the Sun and other **stars**.
- ***Planetary studies:*** study **planets, moons, asteroids, meteoroids** and **comets**
- ***Optical physics:*** design and develop instruments that measure radiation
- ***Atmospheres and ionospheres:*** study atmospheres on Earth, other **planets** and **moons**.
- ***Fields and particles:*** study magnetic, gravitational and electric fields in space

What Can I Do Right Now?

- Visit Astro-Venture regularly to participate in chats and activities.
- Visit a planetarium or observatory near you.
- Call the American Association of Science and Technology Centers for information on science museums in your area that you might visit (202) 783-7200.
- Join an astronomy club.
- Buy an inexpensive telescope and study the stars from home.
- Read Astronomy and Sky and Telescope magazines.
- Ask your teacher to sign up for Astro, a program where astronomers visit your classroom.
- Attend U.S. Space Camp for a week-long program on astronomy and space sciences.

Astrophysicist

Dr. Ed Prather

Research Scientist with the Conceptual Astronomy and Physics Education Research (CAPER) Team

University of Arizona

The main focus of my work is on the topic of astrobiology—the search for life in the universe. Over the last two years, I worked at Montana State University as the NASA CERES Astrobiology Project Coordinator. This summer I moved to Tucson, Arizona, where I now work as a Research Scientist for the Conceptual Astronomy and Physics Education Research (CAPER) team in the Department of Astronomy at the University of Arizona. I spend the majority of my time teaching courses, conducting research into student beliefs and learning difficulties, and on developing new activities to help students learn about astronomy and physics.

My areas of expertise:

- Astronomy & Physics Education Research
- Physics, Earth & Space Science Curriculum and Course Development
- Faculty/Teacher Professional Enhancement Programs
- K–14 Public Outreach
- Online Course Development and Instruction

How I first became interested in this profession:

As a child and a teenager, I liked taking things apart to learn how they worked. In high school, I focused on auto-shop instead of science and math. I then worked as an auto mechanic, and started racing cars and motorcycles, but soon realized that I could not make a living as a professional racer. In my early twenties I decided to go back to school. I immediately fell in love with physics. I was amazed that there was a subject that described how the entire physical world around me worked. Studying physics helped me understand how my race cars and motorcycles operated. For me, the best part of learning physics was working in groups with other students. Along the way, I also discovered astronomy. My career was set, I was going to get a Ph.D. in Physics and teach.

What helped prepare me for this job:

The years I spent working on cars and motorcycles helped prepare me for a career in science. To be successful in repairing machines you must become an expert problem solver. You develop the ability to think of a system in terms of both its separate components and as group of interconnected processes. These skills are tremendously valuable when thinking about the physical relationships studied in physics and astronomy. My experience as a technical writer was also very valuable. Part of being successful in science involves your ability to communicate complex ideas clearly and effectively.

My role models or inspirations:

I am inspired by people that have a strong sense of commitment to their beliefs, and who have the passion and will to carry out their dreams. My first physics teacher has always served as my role model for teaching, he was the best. I also admire Leonardo da Vinci, Albert Einstein and Richard Feynman.

My education and training:

- AA degree, Bellevue Community College, Bellevue, WA
- B.S. in Physics and Astronomy, University of Washington
- Ph.D. in Physics, University of Maine

My career path:

- Three years as technical writer for Genie Industries, Redmond, WA
- Four years as research and lead graduate teaching assistant at the University of Maine, Orono, ME
- Two years as instructor in the Physics Department at Montana State University
- Two years as Project Coordinator for NASA CERES Astrobiology Project at Montana State University, Bozeman, MT

What I like about my job:

Personal Freedom!! Overall I like everything about my job. I feel lucky to be a scientist. My job provides me with the opportunity to work with a wide variety of intelligent, passionate, and very interesting people, while also having the chance to be creative, and think very deeply about cutting edge topics at the horizon of scientific discovery. For myself, the most exciting and rewarding part of my job is the opportunity to work with students – sometimes as their teacher, and other times as a researcher trying to uncover the difficulties they have when learning about physics and astronomy.

What I don't like about my job:

I find that having to continuously look for funding for my research, takes me away from my work. I would also like to see that more of our national budget is dedicated to educational efforts in science.

My advice to anyone interested in this occupation:

Find a topic that excites you, and then pursue your dreams with passion and dedication. Believe in yourself, don't worry about what other people think, and your dreams can come true.

NASA Quest: Highlighting People and Professions related to NASA and its Exploration Mission

Astrophysicist

Dr. Yvonne Pendleton

Astrophysicist
NASA Ames Research Center

I think of problems to solve, propose solutions, use the telescope to gather data, analyze the data and present the results in scientific journals and at conferences.

My areas of expertise:

- Infrared astronomy
- Star and planet formation
- Interstellar dust

How I first became interested in this profession:

I was inspired by the Apollo Program. I lived in Key West, Florida until I was thirteen, and I remember watching the Apollo rockets on clear days, as they arched overhead from their Cape Kennedy lift-off. I would stand there looking upward, promising myself that someday I would be a part of NASA, the great agency that could take us into space.

What helped prepare me for this job:

As a teenager, I spent every spare minute at the Fernbank Science Center in Atlanta, Georgia, where I was surrounded by scientists. In college, I was often the only woman in my aerospace engineering classes. I found out I was a very determined person, and that helped me overcome obstacles that being in a male-dominated environment presented. College life was demanding and there was little time off. I wish I would have known then what I know now -- that the long hours and hard work were well worth it.

My role models or inspirations:

My sister has always been a role model, because she got her Ph.D. in statistics and inspired me to stay in school. The scientists at the Fernbank Science Center were also a great source of inspiration to me.

My education and training:

- Ph.D. in Astrophysics
- M.S. in Aeronautics and Astronautics
- B.S. in Aerospace Engineering

My career path:

- Twenty years as an astrophysicist at NASA

What I like about my job:

I get the freedom to be as creative as I can be, scientifically. I get to choose the projects I want to investigate. The universe is a puzzle and I get to find some of the pieces.

What I don't like about my job:

I sometimes have to deal with government rules and responsibilities that take time away from my research.

My advice to anyone interested in this occupation:

Long hours and dedication to your studies now will put you in a good position later, so don't take the easy road. Follow your dreams and believe in yourself. Even when you think you aren't good enough for the task ahead of you, be confident. You'll surprise yourself!

NASA Quest: Highlighting People and Professions related to NASA and its Exploration Mission

Research Scientist

Dr. Michael Kaufman

Assistant Professor
San Jose State University

Research Scientist
NASA Ames Research Center

I make computer models of the chemical and physical makeup of the regions around new stars. Basically, I "teach" the computer how gases near the stars heat up, move, and change. I then compare the computer model to the observations of other scientists to see if they match up. I also teach classes on astronomy at San Jose State University.

My areas of expertise:

- The formation of stars

How I first became interested in this profession:

I liked the space program when I was in grade school. Looking at the stars always fascinated me.

What helped prepare me for this job:

Math and physics courses have been a big help for me. Also, good teachers helped prepare me by teaching me how to think and by showing me the kinds of jobs I can have once I got these skills.

My role models or inspirations:

I was greatly inspired by my teachers and professors. They had a passion for science, and they loved their jobs.

My education and training:

- M.S. and Ph.D. in Astrophysics, Johns Hopkins University
- B.A. in Physics, Middlebury College

My career path:

- Researcher at NASA on the National Research Council Fellowship for three years
- Assistant professor at San Jose State University for two years

What I like about my job:

I like being able to combine teaching with exploring things that nobody's ever seen before.

What I don't like about my job:

I don't like the business end of things like faculty meetings and/or anything that takes me away from teaching or research.

My advice to anyone interested in this occupation:

Do well in math and physics. It's easier to do well if it's something you love. You should also be pretty comfortable with computers.

Engineer

Dawn McIntosh

Engineer,
NASA Ames Research Center

I'm an Engineer. The group I work with does work with both the International Space Station and the Space Shuttle. I'm working on a 3D simulator of one of the labs on the ISS. Scientists will be able to prepare a science experiment, practice it with the simulator, and save it to be used by the astronauts for training. Then the astronauts can show up, watch the scientist's version of the experiment, and practice it themselves. There's also a 2D simulator that they can bring up to the ISS with them. They can use it for review before actually running the experiment. Others in my group are working to improve the docking between the ISS and the Space Shuttle.

My areas of expertise:

- 3D simulation
- Earth Atmosphere Studies
- Astrophysics
- Physics
- Astronomy

How I first became interested in this profession:

When I was in Junior College, I had no idea what to do for a career. I liked English, Shakespeare, Photography, Ceramics, and Math. Science was OK, but not my favorite. One of my friends talked me into taking a basic astronomy course, even though I didn't need it to graduate. I fell in love with the class (My friend dropped it). I knew after taking that class that I wanted to learn everything I could about Astronomy.

What helped prepare me for this job:

When I finished my Bachelor's Degree, I applied for a job at NASA Ames as a contractor. I was hired by the Earth Science department and worked with a group studying the Earth's atmosphere. After a couple of years, I applied for a civil servant position (means I work for the federal government rather than a company) as an Engineer at NASA Ames. That was only 6 months ago. I'm still figuring out how to do my new job, and it's been fun learning a whole new field.

My role models or inspirations:

I have lots of role models. My parents, who taught me the importance of family, and the value of hard work. My sister, because she is one of the most capable people I know. My husband, because he is so easygoing, loves science, and laughs all of the time. Dr. Adrienne Cool, an astrophysicist, has been one of my role models for years. She helped me learn how to do research, which is a lot different from studying books about science. It's also much more fun. Dr. Tim Castellano is an astronomer I know. He came back to college and became an astronomer after he'd already had a career in a different field. Dr. Yvonne Pendleton is an excellent astronomer at NASA Ames. She spends a lot of time teaching children about astronomy, which I believe is just as important as learning astronomy for yourself.

My education and training:

- B.S. in Astrophysics, San Francisco State University
- Engineering Studies at Stanford University

My career path:

- Contractor, working on Earth's Atmosphere Studies at the Earth Science Department, NASA Ames Research Center
- Aerospace Engineer at NASA Ames, working on a 3D experiment simulator for the International Space Station (ISS)

What I like about my job:

I like the challenge of discovering new things. It's both fun and frustrating, exciting and irritating to figure out how to make a computer program do what you want, and to analyze data and find out something you didn't know before. But the best feeling in the world is when you finally figure out a problem you were are working on. You feel relieved and thrilled all at once.

What I don't like about my job:

It takes a long time to learn something new, and that's hard for me, I like instant answers (those don't happen very often).

My advice to anyone interested in this occupation:

Adrienne Cool has a sign above her desk at San Francisco State University that says: "Think, think, read, think, read, think." This is what it takes to understand and do science. Also, choose a career that you love. Have you heard that before? Probably, but that's because many people don't follow the advice and then regret it. There are parts of science that I find really hard, but I always stuck with it. Mostly because I love it, and also because I'm super-stubborn.

Aerospace Engineer

Kelly Snook

Aerospace Engineer, Planetary Scientist, Project Manager

NASA Ames Research Center

I make computer models of Mars, and then compare them to the actual data that we get from the planet. I also do field work, which means I travel to different parts of the world to carry out my research. I recently traveled to the Canadian Arctic in order to test different ways to explore Mars, with which it shares some similarities. I tried on new space suit designs, and rode around on all-terrain vehicles to simulate being on Mars. Because I am a project manager, I also have to do a lot of organizing and paperwork!

My areas of expertise:

- Mars' atmosphere
- Manned Mars exploration

How I first became interested in this profession:

I really wanted to go into music, but I thought success might depend more on how lucky I was, than on how hard I worked. One day, I wrote all the professions I could think of on pieces of paper, and I drew engineering out of a hat. Aerospace Engineering sounded interesting. I decided to stick with it, and that became my job.

What helped prepare me for this job:

Working at NASA while doing my Ph.D. work gave me an idea of what working here would be like; I also met many of the people I'd be working with in the future. Hands-on, and project oriented courses have also been very useful in preparing me to build and design.

My role models or inspirations:

One of my role models was my Ph.D. advisor, who guided me through the process of starting to work here. Another major inspiration is Albert Einstein, who had a balanced approach to science and spirituality. I am also very inspired by my religion, the Baha'i Faith; its teachings of harmony between science and religion have motivated me to do well in my work, and through my work, to make the world a better place.

My education and training:

- Ph.D. and M.S. in Aeronautics and Astronautics, Stanford University
- B.S. in Aerospace Engineering, University of Southern California

My career path:

- Eight years as a research/teaching assistant at Stanford University
- Five years as a consultant at NASA Ames
- Two years as an Aerospace Engineer at NASA Ames
- One year Co-Op at the Aerospace Corporation while an undergraduate

What I like about my job:

I like to think about how my work fits in the greater picture of human endeavor and progress. I also enjoy having a job that is exciting, and inspiring, and which allows me the freedom to do what interests me, and the flexibility to do it how and when I want to.

What I don't like about my job:

I don't like spending hours filling out forms, or doing other things that take me away from the task I'm here to do. Looking for the money to support my research, can also be time consuming and frustrating.

My advice to anyone interested in this occupation:

Be persistent. Get a good foundation in math, physics, biology, and geology. Don't lose sight of the things that inspire you, so you'll always be motivated to do your job well. Make sure to take public speaking, and technical writing courses, in order to get other people also interested in your work and ideas.

Astro Journal Lesson 1: Unit Introduction

Name ______________________ Date ____________ Class/Period ______________

Scientific Question:
What basic requirements do humans need to survive? Why?

1. Hypothesis/Prediction: What do humans need to survive? Why?

2. Materials: List the title, author, date and URL (if applicable) of each resource you used to find your data.

3. Data Collection: List elements that humans need to survive and explain why? (List only those elements that you can support with evidence from a reputable book, CD-ROM, Web site or other resource.)

Astro Journal Lesson 1: Unit Introduction

Name ______________________________ Date ______________ Class/Period __________________

Data Collection (continued):
4. Results: What do humans need to survive? Why? (Create a revised list below on what you learned from other members in the class and the Human Requirements Reading.)
5. Conclusions: Compare and contrast your predictions and results. How did conducting research change your original ideas?

Generic Astro Journal

Name ______________________________ Date ______________ Class/Period __________________

Scientific Question:
Hppothesis/Prediction: What do you predict and why?
Materials: What materials will you use to investigate?
Procedure: List the steps you will take to investigate.
Step 1.
Step 2.
Step 3.
Step 4.
Step 5.
Data Collection: Record and display your data in a chart, table, picture or graph.
Results: Summarize what your data mean.
Conclusions: Compare and contrast your hypothesis and results. How did testing your hypothesis/prediction change your original ideas?

Human Requirements Reading

Exercise physiology testing; New Jersey Health Care System, DOVA

Humans have a few basic needs for survival. These include energy sources (food, plants, the Sun), nutrients, water, oxygen and a moderate temperature. Humans also need protection from poisonous gases and high levels of radiation.

Food gives us energy. When we eat food, some components of food are broken down into sugar for energy. Our bodies use the sugar to make the energy we need to move and grow. Energy allows all of our organs to function, allows us to move, talk, run, think, breathe and do all of the things we do every moment. Food for humans is like electricity for a computer. Without electricity, a computer cannot do anything. Without energy, our bodies cannot do anything.

We cannot gain our energy directly from the Sun, so we have to eat plants that gather their energy from the Sun. Animals also gain their energy from plants, so we can also gather energy by eating animals. Therefore, humans need plants and the Sun's energy to survive.

Nutrients from food build and mend our bones, teeth, nails, skin, hair, flesh and organs and allow us to grow. We need to have a well-balanced diet in order to have all of the nutrients that our body needs.

We can't get energy from sugar without oxygen. When we breathe oxygen, it is carried throughout our body in the bloodstream to all parts of the body and into the cells where energy is made.

Humans need an average of two quarts of water a day. Our bodies are 60 to 70 percent water. Water is in our blood, our cells, our tissues and body fluids. In fact, our cells are mainly made up of water. Water allows nutrients to circulate throughout the body and allows the body to filter out waste and poisons. Water also allows the body to regulate its temperature. Without water our bodies become dehydrated. If you have ever run for a long time on a very hot day and became very thirsty, you might have been experiencing a little dehydration. Dehydration can become much worse. For example, sometimes when people have the flu, they can become dehydrated and have to go to the hospital. Humans can survive only about three days without water. In comparison, humans can last thirty days without food.

Humans cannot survive very cold or very hot temperatures. Humans must maintain an average body temperature of 98.6 degrees Fahrenheit/37 degrees Celsius. When our body temperature goes above this, we sweat to cool ourselves down. When our body temperature goes below this, we shiver to generate heat. However, our body cannot correct for very large temperature changes. If we are exposed to very cold temperatures, our bodies lose their heat, and we can die from hypothermia. If we are exposed to very hot temperatures, we can die from heat stroke.

Humans must also be protected from harmful gases and too much radiation. An atmosphere with poisonous gases would kill us. Likewise, we need protection from high levels of radiation that come from the Sun and from exploding stars. We especially need protection from solar flares, because they can be unpredictable and release a lot of radiation. High levels of radiation break down the tissues in plants and animals, causing cancer and eventually death.

Although humans can survive for as long as a year in microgravity, the effects of microgravity on our bodies have led scientists to conclude that gravity is important for normal development and function. Without gravity, our bones and muscles shrink and become weak. We lose bodily fluids and red blood cells needed to deliver oxygen and remove waste throughout the body. Fluids in our ears float, so that we become disoriented and confused, and we experience motion sickness. We do not know the range of gravity that is needed for our bodies to function normally, but too much gravity would also have negative effects on our bodies. Gravity is also important, because it holds on to Earth's atmosphere so it doesn't escape into space.

It is interesting to note that some living things can exist with different requirements than humans. There are microbes that can live in extremely cold or extremely hot environments, can obtain their energy from volcanic vents rather than from the Sun or other living things and are able to bear higher levels of ultraviolet radiation than humans.

If we have all of the essential things described in this reading, our bodies can function normally; however, some scientists would argue that this would not be enough. They point out that humans have psychological needs, too. Humans need interaction with other humans, for example. A big problem for astronauts who spent a lot of time on the Mir Space Station was that they missed their families a lot. There are scientists whose entire job is just to design the International Space Station so that it is a pleasant environment for scientists. They look at how to design the structure, select colors that are pleasing and to include plants to make the environment more comfortable for astronauts.

Astronauts aboard the Space Shuttle performing cardiovascular echocardiography experiments; NASA

Questions
(Answer on a separate sheet of paper)

1. What are three things humans need?
2. Where does our energy come from?
3. Why do we need oxygen?
4. What would happen to our bodies without water?
5. Why is the temperature of Earth important to human survival?
6. Do all living things need the same things as humans? Explain.

Survival Story

On a separate sheet of paper, write a story about a person whose survival is endangered. Stories must include references to human survival needs:

1. Describe all of the necessary elements for human survival and how each of these elements is threatened.
2. Describe the consequence of not having each element.
3. Describe how the hero faces and overcomes these challenges to find each element that he or she needs.

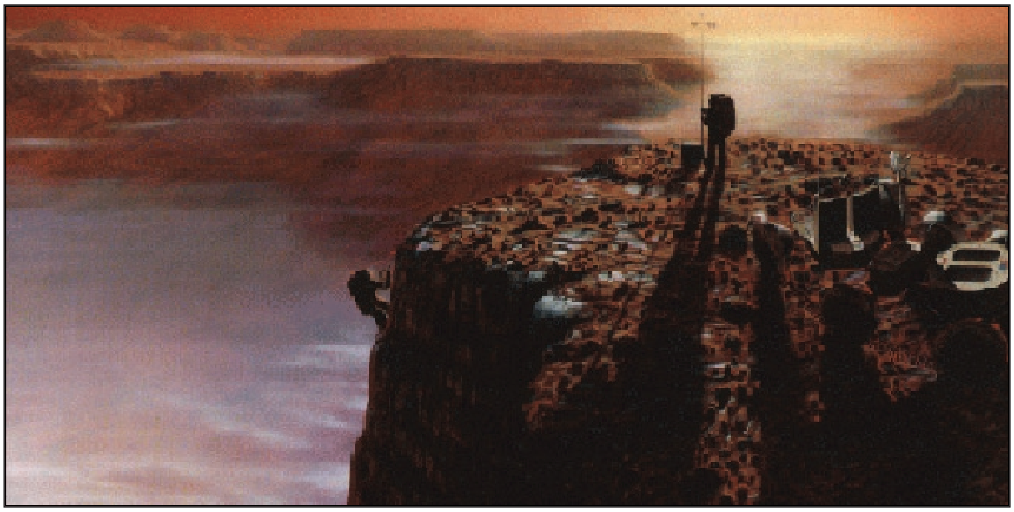
Your illustrations will be evaluated using the following rubric:

4 Expectations Exceeded	• Story clearly and accurately explains all human survival requirements. • Story has all required parts and uses examples and reasoning to create an exceptionally powerful and detailed explanation.
3 Expectations Met	• Story clearly and accurately explains all human survival requirements. • Story has all required parts, makes specific references to examples, and uses good reasoning in explanations.
2 Expectations Not Quite Met	• Story is not completely clear or accurate in explaining the human survival requirements. • Story has most required parts, makes some specific references to examples, and uses some good reasoning in explanations.
1 Expectations Not Met	• Story is not clear or accurate in explaining the human survival requirements. • Story is incomplete, makes few specific references to examples, and uses little or no good reasoning.

Planetary Comparison Chart

Planet	Atmosphere	Mass Earth = 1	Diameter *(Radius)* (km)	Density (gm/m^3)	Liquid Water	Average Temperature	Force of Gravity Earth = 1	Atmospheric Mass (kg)
Mercury	very little: argon, neon and helium	0.06	4,878 *(2,439)*	5,430	too hot for surface water	day: 350°C/662°F night: -170°C/-274°F	0.38	2.03×10^{8}
Venus	carbon dioxide	0.82	12,104 *(6,052)*	5,250	too hot for surface water	465°C/869°F	0.90	1.41×10^{21}
Earth	nitrogen, oxygen	1.00	12,755 *(6,378)*	5,520	liquid water on the surface	15°C/59°F	1.00	5.33×10^{18}
Moon	none	0.01	3,476 *(1738)*	3,300	no liquid water	sunlit side: 134°C/273°F dark side: -153°C/-243°F	0.17	0
Mars	carbon dioxide	0.11	6,790 *(3,395)*	3,940	Mars may have once had surface water, but doesn't now. Ice has been detected at the North Pole.	-23°C/-9.4°F	0.39	3.09×10^{16}
Jupiter	hydrogen, helium	318	142,796 *(71,398)*	1,314	some water vapor and ice crystals in the atmosphere	-150°C/-238°F	2.53	2.6×10^{22}
Saturn	hydrogen, helium	95	120,660 *(60,330)*	690	some water vapor and ice crystals in the atmosphere	-180°C/-292°F	1.06	4.4×10^{22}
Uranus	hydrogen, helium	15	51,118 *(25,559)*	1,290	some water vapor and ice crystals in the atmosphere	-221°C/-391°F	0.93	7.8×10^{21}
Neptune	hydrogen, helium	17	49,528 *(24,764)*	1,640	some water vapor and ice crystals in the atmosphere	-235°C/-391°F	1.18	7.4×10^{21}
Pluto	methane	0.002	approx. 2,300 *(1,150)*	2,030	any water is frozen as ice	-220°C/-364°F	0.07	variable

Lesson 2: Astronomy Training Module



“First Light” illustration: Mars astronauts exploring the Noctis Labyrinthus canyon just after sunrise; Pat Rawlings, NASA

Students are introduced to the basic requirements for human survival. Using an online, multimedia module, they change factors of our Solar System and draw conclusions about which factors are necessary for human survival.

Main Lesson Concept:
Certain astronomical conditions help to support human survival.

Scientific Question:
What astronomical conditions are required for human survival?

Objectives	Standards
• Students make changes to our solar system and write descriptive, unbiased observations of the effects of these changes on Earth. • Students will identify the characteristics of our solar system that are required to allow for human survival.	**Meets:** NSES: A (5-8) #1 ISTE: 3, 5 **Addresses:** 2061: 4B (6-8) #2 2061: 4A (6-8) #1 NSES: D (5-8) #3

Assessment	Abstract of Lesson
Write-up in Astro Journal.	Students predict how human survival requirements are met by characteristics of our solar system and planet. They engage in an online Astronomy Training module in which they make changes to the astronomical conditions of our solar system and observe the effects of these changes on Earth. They then draw conclusions about which astronomical conditions are necessary to support human survival.

Prerequisite Concepts	Major Concepts
• Humans need water, oxygen, food, gravity, a moderate temperature and protection from poisonous gases and high levels of radiation to survive. (Lesson 1) • The Earth is one of several planets that orbit the Sun. Jupiter is a very large planet approximately ten times the diameter of Earth. • Scientific observations are detailed descriptions of what can be learned using the senses and scientific instruments. These scientific observations do not include ideas, opinions or speculations about what is being observed. • A star is a large, hot ball of gases, which gives off its own light. • A planet is a body that does not give off its own light and is orbiting a star. A planet is generally much smaller than a star and can be made of solid, liquid and/or gas. • A cause is something that produces an effect or result. • An astronomical unit (AU) is the average distance from Earth to the Sun, which is equal to 149,598,770 kilometers or 93,000,000 miles.	• The following characteristics allow Earth to remain habitable to humans: – A yellow star – Jupiter in a circular orbit beyond three astronomical units (AU). – An Earth-size planet of a mass that is between one-fourth and four times Earth's mass – The orbit of the Earth-size planet is in the Habitable Zone. • Maintaining liquid water on Earth at all times is essential to support human life.

Misconception:

A common misconception that students have is that the Sun is not a star but is a planet or other object. To help to address this misconception, ask students what the Sun would look like if it were very far away. Ask them what the North Star or other stars would look like, if we were very close to them. Ask students what the differences are between a planet and star. Ask them what kind of object the Sun is. Help them to see that because the Sun is a ball of gases, it is in fact a star, but it doesn't look like other stars, because it is very close to us, while other stars are very far away. In fact, the closest star would take us thousands of years to reach if we were travelling in the fastest rocket.

Note to Teacher: Star types, orbits, planet mass and the Habitable Zone are concepts that are all explored and defined in later lessons. In this lesson, students simply need to make good observations about "what" is needed for human survival. Lessons 3 thru 12 will give them the "whys" behind these needs.

Suggested Timeline (45-minute periods):

Day 1: Engage and Explore – Part 1 sections
Day 2: Explore – Part 2 section
Day 3: Explain, Extend/Apply, and Evaluate sections

Materials and Equipment:

- A class set of Astro Journals Lesson 2: Astronomy Training Module *
- 1 Planetary Comparison Chart for each group
- Astronomy Training Walkthrough (Optional)
- Overhead transparencies of Astronomy Training Screen Shots (Optional) **
- 1 to 30 computers with Internet browser, Internet connection and the Shockwave Player version 8.5 or later installed
- A printer connected to the computers
- Chart Paper
- Overhead projector
- Headphones for the computers (Optional)

* A generic Astro Journal and Scientific Rubric are included at the end of Lesson 1. If you prefer, you can have students use the generic Astro Journal instead of the ones designed to go with each lesson. This might be especially useful for older students who are already familiar with the inquiry method.

** Astronomy Training Screen Shots are available as a separate PDF on the Astro-Venture Web site in the "Teachers/Parents" section. These can be used if you don't have the ability to project a computer screen to the class.

System Requirements to Run Astronomy Training Module	
Operating System	**Browser**
Windows 95 Windows 98 Windows Me Windows NT Windows 2000 Windows XP or later	Internet Explorer 4.0 or later, Netscape Navigator 4 or later, Netscape 6.2 or later with standard install defaults, Firefox
Macintosh: System 8.6 System 9.0 System 9.1 System 9.2	Netscape 4.5 or later, Netscape 6.2 or later, Microsoft Internet Explorer 5.0 or later
Macintosh OS X	Microsoft Internet Explorer 5.1 or later, Netscape 6.2 or later, Firefox
Macintosh OS X 10.1 or later	Netscape 7.0 or later (Netscape 6 is not recommended), Microsoft Internet Explorer 5.1 or later
RAM Memory requirements vary depending on your operating system, browser and plug-in version combination. We recommend a minimum of 128 MB.	
Sound Astro-Venture uses narration and some sound effects. Computers will require a sound card and either headphones or speakers. Pairs of students using the same computer can use a y-cable to connect two pairs of headphones to one computer.	

Preparation:
- Prepare class sets of Astro Journals.
- Prepare overhead transparencies of Astronomy Training Screen Shots.
- Make copies of Planetary Comparison Charts for each group.
- Download and install Shockwave Players on computers from: http://www.macromedia.com/downloads. Test these at: http://astroventure.arc.nasa.gov by clicking "Astronomy Training."
- Prepare chart paper with major concept of the lesson to post at the end of the lesson.

Differentiation
Accommodations For students who may have special needs: • Pair advanced students with students that need more guidance • Encourage students to talk about what they are learning.
Advanced Extensions For students who have mastered this concept: • Research and report on whether the moon is a necessary astronomical condition for life and why or why not.

Engage

(approximately 10 minutes)

Pond providing water for farm; Natural Resources Conservation Service, USDA

1. Review Lesson 1.

- Question: As members of the Astro-Venture Academy, what is our goal?
- *Answer: Our goal is to find, study and design planets that would be habitable to humans.*

- Question: In the first lesson, what elements did you learn are necessary for human survival?
- *Answer: The elements humans need for survival are: food, gravity, oxygen, water, a moderate temperature and protection from poisonous gases and high levels of radiation.*

2. Introduce the purpose of the lesson.

- Say: Since we know that these elements are necessary for our survival, and our goal is to find and design a habitable planet, then we need to determine which conditions of our star system and planet are most likely to have the elements needed for human survival.

3. Bridge to this lesson.

- Question: When you look at the other planets in our Solar System, which of the necessary elements are most planets missing?
- *Answer: Most planets do not have oxygen or liquid water, and most have temperatures that are far too extreme for humans.*

- Question: Why do you think the other planets do not have these elements?
- *Answer: (Accept all answers)*

4. Present the Scientific Question for this lesson.

- What astronomical conditions allow for human survival?
- Tell students that they will be role-playing scientists and using a computer activity to find out which astronomical conditions humans need to survive and why.

Explore — Part 1

(approximately 30 minutes)

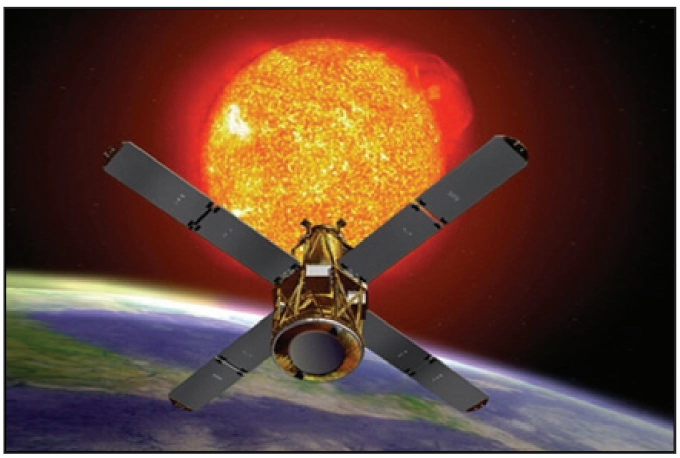


Illustration of High Energy Solar Spectroscopic Imager (HESSI) studying secrets of solar flares; NASA

1. Help students identify possible astronomical conditions for human survival.

- Say: In the Astronomy section of Astro-Venture, we will be focusing on the star (like our Sun) and the planets and how these parts of our Solar System interact to give us the conditions we need to survive. We will call these conditions the astronomical conditions.

- Question: What do you think are some of the characteristics of our Solar System that allow Earth to be habitable to humans?
- *Answer: (Accept all answers. Record these ideas on the board.)*

- Have students place a star by the appropriate answers that are astronomical conditions as opposed to conditions related to geology, atmospheric sciences or biology. (These might include orbital shape and distance, star type, the mass of planetary bodies, location of a star in its galaxy, types of objects in the Solar System, the presence of moons.)
- Tell students that we will focus on conditions that have to do with planetary and atmospheric composition and the flow of matter and energy in other sections of Astro-Venture.

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2. Have students record their predictions in the Prediction section of their Astro Journal of the astronomical conditions that they predict are necessary for human habitation on a planet.

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3. Introduce students to the Astro-Venture Astronomy Training Module.

- The Astro-Venture Astronomy Training Module can be found on the Astro-Venture Web site at: http://astroventure.arc.nasa.gov. Click "Astronomy Training" to load the module.

Note to Teacher: If the text in the multimedia module is small and thus difficult to read, you can increase the screen resolution of the computers so that the module fills more of the screen, and the text is larger. To do this, follow the directions below:

For PC
1. **Locate the lower left-hand "Start" button and select it.**
2. **Choose "Settings."**
3. **Select "Control Panel."**
4. **Locate the "Display" icon and click it.**
5. **From the tab choices select "settings."**
6. **Adjust "Screen Resolution" from the drop down or slider bar. (Select "800X600" for best results.)**
7. **Click ok when finished.**
8. **Click "apply changes" if necessary. (A computer restart may or may not be required on some machines.)**

For Mac
1. **Locate the Apple icon in the top left-hand corner and select it.**
2. **Choose "System Preferences."**
3. **Locate the "Display" icon and click it.**
4. **Adjust "Resolution" from the menu of choices. (Select "800X600" for best results.)**
5. **Resolution will change immediately. Close the "Display" window.**

- Tell students that they will be engaging in an online activity where they will change aspects of the astronomical conditions of our Solar System and will observe the effects on Earth. They will then draw conclusions about the astronomical conditions needed for human survival.

- Tell students that as they go through this module, they will be Astro-Venture Junior Astronomers, and will be evaluated on how detailed their observations are, and whether they give reasons for the effects they observe. They will be able to use their notes on the Astro Challenge, so they should take thorough notes.

- You may want to model for students an example of a "good observation." Either project from a computer for the class to see or project the Astronomy Training Screen Shots to walk the students through the following. (You will need to click through the introduction to get to this part.)

- Click "Star Type."

- Click "Yellow Star."

- Click "Play" to see the effect on Earth.

- Ask students to describe what happened to Earth and why. Record a good example of the kinds of observations you expect from students such as: "The Earth remained habitable."

- Click "Enter" to see another scientist's observation. Stress to students that they do not need to type the exact same thing, but should have the same general idea.

Note to Teacher: Students can change their answer after they click "Enter." However, their original answers will be printed in their Astro Journal so that you can see if they are making good, initial observations.

- Point out to students that when they have completed an observation, the factor which they have chosen turns purple. They must complete all observations in all four major sections before they can advance to the Astro Challenge section.

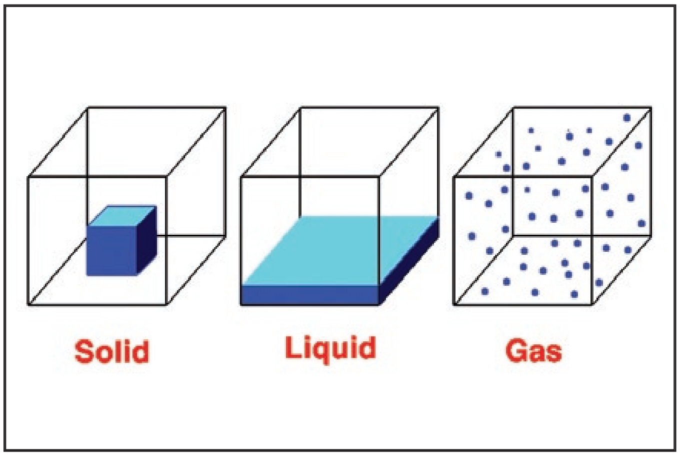
- Click "Red Star."

- Click "Play."

- Ask students to give a detailed observation such as: "The Earth would grow cold and would be covered with ice and snow, because the Red Star is too cold."

Explore — Part 2

(approximately 45 minutes)



Three states of matter: solid, liquid, and gas; NASA

1. Have students engage in the Astronomy Training Module individually, in pairs, small groups or as a class.

- Students should visit: http://astroventure.arc.nasa.gov and click "Astronomy Training."

Note to Teacher: You will need the Shockwave/Flash Player plug-in, which can be downloaded and installed from http://sdc.shockwave.com/shockwave/download/. When tested with grades 5 to 8, the average completion time for 5th graders was 45 minutes. For 8th graders it was 30 minutes. Also, you will want to have accessibility to a printer, so students can print their Astro Journals at the end of the module. These can be used for evaluation purposes. If you want to take the whole class through the module using one computer, use the Walkthrough as a guide.

Explain

(approximately 15 minutes)

Illustration of Pluto landscape with Pluto Express spacecraft, Moon Charon and Sun in background; NASA

1. Have students fill out the Results and Conclusion section of their Astro Journals.

2. Discuss Students' Conclusions.

- Question: What astronomical conditions did you observe are necessary for human habitation of a planet?
- *Answer: (Record on the board.) We need: a yellow star, any Jupiter-size planets in a circular orbit beyond 3 AU, a planet with a mass that is $^1/_4$ to 4 times the mass of Earth that is orbiting in the Habitable Zone.*

- Question: Why do we need each of these? What happens to the planet otherwise?
- *Answer: (Record the reasons next to each factor.)*

Astronomical Condition	Reason
A yellow star	To maintain a temperature that is neither too hot nor too cold for liquid water.
Jupiter-size planet in a circular orbit beyond 3 AU	To prevent any Earth-size planets from being thrown out of their orbit to freeze.
A planet with a mass between $^1/_4$ and 4 times Earth's mass	To maintain a temperature that is neither too hot nor too cold for liquid water.
The Earth-size planet must orbit in a Habitable Zone	To maintain a temperature that is neither too hot nor too cold for liquid water.

- Question: What is the common theme of all of these conditions?
- *Answer: They allow for liquid water to be present on a planet.*

Extend/Apply

(approximately 15 minutes)

Sunset over Bering Sea; Russian-American Long-term Census of the Arctic (RUSALCA), NOAA

1. Have students apply these astronomical conditions to another planet in our Solar System.

Have students choose another planet in our Solar System, and use the Planetary Comparison Chart to describe what astronomical conditions would need to change in order for the selected planet to be habitable. They should record this information in the Creating Habitable Conditions for Other Planets section of their Astro Journals.

Evaluate

(approximately 15 minutes)

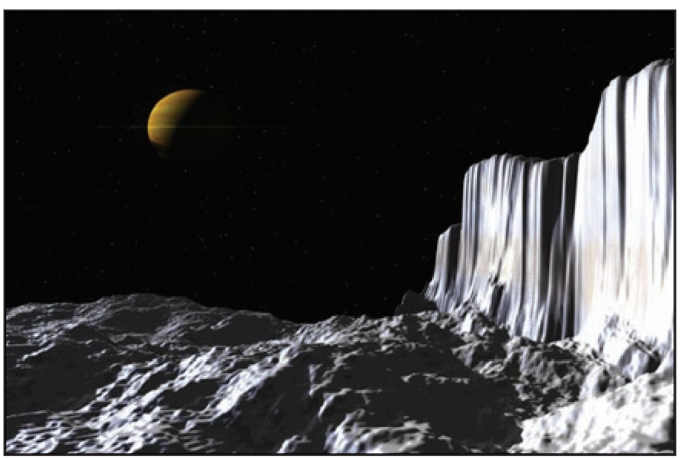


Illustration of rugged landscape of Hyperion, one of Saturn's smaller moons; NASA

1. As a class, have students share their planet and discuss what astronomical changes would be necessary to make it habitable to humans.

Based on what students know so far, their assessments should include observations that most planets are not in the Habitable Zone or have a mass that is too large or small.

2. Tell students that in the next section they will begin to explore the conditions required for water to be a liquid and to clarify how these conditions help us to maintain this essential element for human survival.

3. Collect Astro Journals and evaluate using the Scientific Inquiry Evaluation Rubric to make sure students are ready for the next lesson.

In particular, assess students' scientific observations for detail, accuracy and inclusion of a reason and absence of bias.

Note to Teacher: After each lesson, consider posting the main concept of the lesson some place in your classroom. As you move through the unit, you and the students can refer to the 'conceptual flow' and reflect on the progression of the learning. This may be logistically difficult, but it is a powerful tool for building understanding. For this lesson, the chart of astronomical conditions needed for human survival on a planet and why these conditions are necessary should also be posted.

Astro Journal Lesson 2: Astronomy Training Module

Name_______________________ Date ____________ Class/Period _____________

Scientific Question:
What astronomical conditions are required for human survival?

1. Hypothesis/Prediction: What astronomical conditions do you think humans need to survive? Why?

2. Materials: What source will you use to gather data that will help answer this question?

3. Data Collection: The following may be recorded and printed online. However, if you are unable to print from the computer, you may use the following chart to record your observations.

Cause	Effect on Earth
Blue Star	
Yellow Star	
Red Giant	
Red Dwarf	
Jupiter in a circular orbit beyond 3 AU	
Jupiter in an elliptical orbit at 1 AU	
Small Earth (less than $^1/_4$ mass)	
Average Earth ($^1/_4$ to 4 times mass)	
Large Earth (more than 4 times mass)	
Short of the Habitable Zone	
In the Habitable Zone	
Beyond the Habitable Zone	
Earth in an elliptical orbit	

Astro Journal Lesson 2: Astronomy Training Module

Name______________________________ Date _______________ Class/Period __________________

4. Results: What astronomical conditions allow for human survival? Why? (Create a revised list below based on what you learned from Astronomy Training Module.

5. Conclusions: Compare and contrast your predictions and results. How did conducting research change your original ideas?

Creating Habitable Conditions for Other Planets. Choose another planet in our solar system. Write a paragraph explaining what astronomical conditions would need to change in order for this planet to be habitable and why.

Astronomy Training Walkthrough

The following is an explanation of each section of Astronomy Training. It offers suggestions for how you might take a whole class through the module, if you only have one computer with the ability to project.

Welcome

- Read the introduction with students. This explains the activity students will be going through to make changes to different features of the Solar System, to observe the effects and to record these effects.

Choose Your Character

- Tell students that they will be role-playing scientists. Read with students about each character and have them choose a scientist they wish to be. Discuss why they chose that character. (Students who are in the same group can role-play the same character so all students in the class can print out badges with their names at the end.)
  - Choose your characters, entering the first name of each student.
  - Variation: If you don't want to take the time for each student to choose a character, you could have the class vote on a character to represent the whole class.

Note to Teacher: The names collected are used only so that they can be printed on the badge and Astro Journal at the end. NASA does not collect this information.

What do Humans Need to Survive?

- Have students vote on their predictions, and enter these. Emphasize that in science, scientists begin with a good scientific guess. Students are not expected to know the information at this point, but are just predicting.

Note to Teacher: At the end, students will be able to enter their conclusions and see a comparison of their predictions with other scientists' findings to receive feedback on what they have learned.

Demo

- Read over the training directions with the class and go through the tutorial. Ask students if they think the "Yellow Star" allows Earth to remain habitable or not and why or why not.

Activity

- Click "Star Type."
- Click "Yellow Star."
- Ask students what they predict will happen to Earth.
- Click "Play" to see the effect on Earth.

Note to Teacher: "Play" can be clicked multiple times to see the effect again.

- Ask students to describe what happened to Earth and why.
- Have students record their observations in their copy of the Astro Journal under Data.
- Call on individuals to share what they wrote and have them type their observations in the Astro Journal on the computer. Ask students if they think a "Yellow Star" allows Earth to be habitable or not and why or why not.

- Record a good example of the kinds of observations you expect from students such as: "The Earth remained habitable."
- Click "Enter" to see another scientist's observation. Stress to students that they don't need to type the exact same thing, but should have the same general idea.

Note to Teacher: Students can change their answer after they click "Enter." However, their original answers will be printed in their Astro Journal so that you can see if they are making good, initial observations.

- Point out to students that when they have completed an observation, that factor turns purple. They must complete all observations in all four major sections before they can advance to the Astro Challenge section.
- Click "Red Star."
- Click "Play."
- Ask students to give a detailed observation such as: "The Earth would grow cold and would be covered with ice and snow, because the Red Star is too cold."
- Explain that a good scientific observation is detailed and describes what is observed.
- Tell students that since they will be able to use their notes when they take the Astro Challenge, they should take thorough notes.

Completion of Activity

- Continue through each "Star Type," "Jupiter's Orbit," "Earth's Mass" and "Earth's Orbit."
- Have the class record their observations in their Astro Journals and then have individuals take turns typing in their observations in the computer.
- Have students record in Astro Journals the results of the changes they observed which resulted in a habitable Earth.
- After all observations have been completed, click "Submit" and take the Astro Challenge as a class.
- Encourage students to go back to the relevant sections and look at their notes in the Data collection chart (located in the Astro Journal section) to help answer the questions.
- Have students vote on the answers.

Conclusion

- Have students vote on the results that they found. Discuss how their results compare to their predictions.
- Print student badges, the class Astro Journal and trading cards, if you wish.

Planetary Comparison Chart

Planet	Atmosphere	Mass Earth = 1	Diameter *(Radius)* (km)	Density (gm/m^3)	Liquid Water	Average Temperature	Force of Gravity Earth = 1	Atmospheric Mass (kg)
Mercury	very little: argon, neon and helium	0.06	4,878 *(2,439)*	5,430	too hot for surface water	day: 350°C/662°F night: -170°C/-274°F	0.38	2.03×10^{8}
Venus	carbon dioxide	0.82	12,104 *(6,052)*	5,250	too hot for surface water	465°C/869°F	0.90	1.41×10^{21}
Earth	nitrogen, oxygen	1.00	12,755 *(6,378)*	5,520	liquid water on the surface	15°C/59°F	1.00	5.33×10^{18}
Moon	none	0.01	3,476 *(1738)*	3,300	no liquid water	sunlit side: 134°C/273°F dark side: -153°C/-243°F	0.17	0
Mars	carbon dioxide	0.11	6,790 *(3,395)*	3,940	Mars may have once had surface water, but doesn't now. Ice has been detected at the North Pole.	-23°C/-9.4°F	0.39	3.09×10^{16}
Jupiter	hydrogen, helium	318	142,796 *(71,398)*	1,314	some water vapor and ice crystals in the atmosphere	-150°C/-238°F	2.53	2.6×10^{22}
Saturn	hydrogen, helium	95	120,660 *(60,330)*	690	some water vapor and ice crystals in the atmosphere	-180°C/-292°F	1.06	4.4×10^{22}
Uranus	hydrogen, helium	15	51,118 *(25,559)*	1,290	some water vapor and ice crystals in the atmosphere	-221°C/-391°F	0.93	7.8×10^{21}
Neptune	hydrogen, helium	17	49,528 *(24,764)*	1,640	some water vapor and ice crystals in the atmosphere	-235°C/-391°F	1.18	7.4×10^{21}
Pluto	methane	0.002	approx. 2,300 *(1,150)*	2,030	any water is frozen as ice	-220°C/-364°F	0.07	variable

Scientific Inquiry Evaluation Rubric for Evaluating Astro Journal Entries

Component	Expectations
Hypothesis/Prediction	• Clearly stated • Specific enough to be testable/observable and give a meaningful result • Has basis in solid information or observations and a logical reasoning process
Materials, Procedures, and Data	• Clearly stated • Complete • Accurate and tied directly to hypothesis and Scientific Question
Results	• Clearly stated • Refers directly to Scientific Question and data • Draws a reasonable conclusion from that data
Conclusions	• Clearly stated • States how hypothesis/prediction was confirmed and/or altered • Refers directly to findings, observations, and/or data to explain why thoughts were changed

Scoring Metrics

4	Expectations Exceeded
3	Expectations Met
2	Expectations Not Quite Met
1	Expectations Not Met