Lesson 1: Biology Training Module

Canoeing on lake; Wyoming Travel & Tourism

Students review the basic requirements for human survival. Using an online, multimedia module, they make changes to the ecosystem and draw conclusions about the biologic conditions that are necessary for human survival.

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

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

Objectives	Standards
• Students make changes to Earth's ecosystem and write descriptive, objective observations of the effects of these changes on Earth. • Students will identify the characteristics of Earth's ecosystem that are required to allow for human survival.	**Meets:** NSES: A (5-8) #1 ISTE: 3, 5 **Partially meets:** 2061: 5A (6-8) #5 NSES C (5-8) #4.2, #4.3 **Addresses:** 2061: 4B (6-8) #2

Assessment	Abstract of Lesson
Write-up in Astro Journal.	Students review the basic requirements for human survival and predict how human survival requirements are met by characteristics of the Earth's ecosystem. They engage in an online Biology Training module in which they make changes to the Earth's ecosystem and observe the effects of these changes on Earth. They then draw conclusions about which biologic conditions are necessary to support human survival. Finally, students research plant and animal representatives of the two major global food webs and create a class mural that shows the interconnection of these two major webs.

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. (Astronomy Lesson 1) • Humans need a yellow star, a planet with a mass of one-quarter to four times Earth's mass orbiting in the Habitable Zone, and any Jupiter-size planet must be in a nearly circular orbit beyond 3AU. (Astronomy Lesson 2) • Systems consist of many parts that usually influence each other. Something may not work as well (or at all) if a part of the system is missing, broken, worn out, mismatched, or misconnected. (Astronomy Lesson 7) • Humans need the following atmospheric conditions (Atmosphere Lesson 1): – 0.000001 to 20% water vapor – 0.001 to 0.03% carbon dioxide – More than 80 Dobson Units of ozone in the stratosphere – 15 to 30% oxygen – More than 5% nitrogen • Humans need the following geologic conditions (Geology Lesson 1): – Liquid outer core (coupled with the planet's rotation and a thick atmosphere) – Viscous mantle (slow motion) – Slow motion of crust and upper mantle (lithosphere) of 3 to 5 centimeters per year • 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 cause is something that produces an effect or result. **Note to Teacher: The flow of energy, producers, consumers, decomposers, photosynthesis, and the cycle of matter 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 2 to 6 will give them the "whys" behind these needs.**	• The following biologic characteristics allow Earth to remain habitable to humans: – A medium energy source – Many producers – Some consumers – Some decomposers • All organisms, including humans, are part of and depend on two main interconnected global food webs. • One food web includes microscopic ocean plants, the animals that feed on them, and finally the animals that feed on those animals. • The other web includes land plants, the animals that feed on them, and so forth.

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:

- Human Survival Transparency
- Biologic Conditions Transparency
- 1 Biologist Career Fact Sheet for each group
- A class set of Astro Journals Lesson 1: Biology Training Module
- A large bulletin board
- Butcher paper
- Books, encyclopedias, biology textbooks, computer with Internet connection or other resources on plants and animals
- Plain paper, colored pencils, and markers for each student to create their animal or plant
- Yarn of three different colors
- Staples or punch pins
- 1 copy Biology Training Walkthrough (optional)
- Biology Training Screen Shots transparencies (optional)*
- 1 to 30 computers with Internet browser, Internet connection, and the Flash Player version 6 or later installed
- A printer connected to the computers
- Chart paper
- Overhead projector
- LCD projector or TV connected to a computer with video card (optional)

* Biology Training screen shots transparencies are in a separate PDF in the "Teachers/Parents" section of the Astro-Venture Web site.

Preparation:

- Prepare class sets of Astro Journals.
- Prepare overhead transparencies.
- Make copies of Astro Journal and Biologist Career Fact Sheet.
- On butcher paper, create Food Web Mural background with ocean on one side and land on the other side. Post on the bulletin board.
- Download and install Flash Players on computers. Test these at http://astroventure.arc.nasa.gov by clicking "Biology Training."
- Prepare chart paper with major concept of the lesson and human survival needs to post at the end of the lesson.

System Requirements to Run Biology 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
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.	

Differentiation

Accommodations

For students who may have special needs:

Pair advanced students with students that may 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 Biosphere II, in which an experiment was conducted to create a self-contained, balanced ecosystem. What were the results of this experiment? What living things affected humans' ability to survive in this environment?
- Research and report on scientific theories of how Earth acquired its water.

Engage

(approximately 10 minutes)

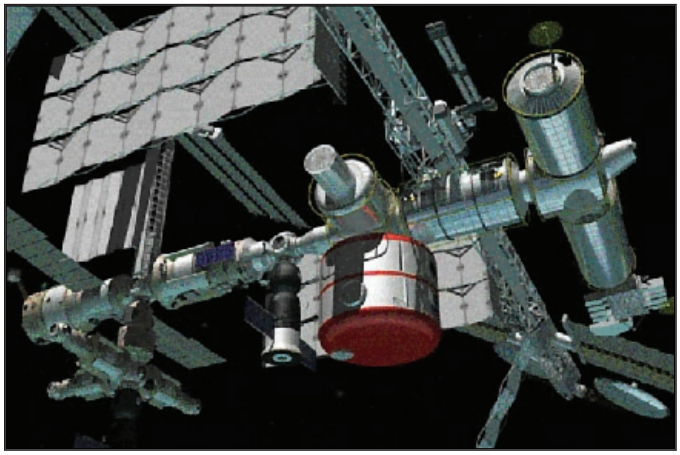

Illustration of Mars habitat docked at orbiting Space Station; John Frassanito and Associates, NASA

1. Review human survival needs (Astronomy Lesson 1), astronomical conditions that support human survival (Astronomy Lesson 2), atmospheric conditions that support human survival (Atmosphere Lesson 1), geologic conditions that support human survival (Geology Lesson 1), and systems (Astronomy Lesson 7).

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

- Put up the Human Survival Transparency.

- Question: In Astronomy, which of these necessary elements did we learn are influenced by astronomical conditions in our star system and planet?
- *Answer: We learned that star type, orbital distance, and planetary mass all determine the surface temperature of our planet, which in turn determines whether the planet can have liquid water. We learned that planetary mass determines the amount of gravity on a planet. We also learned that the orbit of any large objects, such as Jupiter, could disrupt this system.*

- Write these factors on the transparency for "Moderate temperature" under "What Factors Provide This" as seen in the diagram below.

Note to Teacher: You may have already filled out this chart in Atmosphere Lesson 1 or Geology Lesson 1, in which case you can just review what was already written.

- Question: In Atmosphere, which of these necessary elements did we learn are influenced by atmospheric conditions in our star system and planet?
- *Answer: We learned that greenhouse gases such as water vapor and carbon dioxide absorb and reradiate heat, playing a role in Earth's surface temperature. We learned that nitrogen is an important building block for proteins and, as an inert gas, greatly contributes to necessary air pressure. We also learned that oxygen is highly reactive, allowing us to get energy from sugars and that ozone absorbs harmful radiation preventing much from reaching Earth's surface.*

- Question: In Geology, which of these necessary elements did we learn are influenced by geologic conditions in our star system and planet?
- *Answer: We learned that the Earth's liquid outer core generates a magnetic field that, with our atmosphere, helps protect us from harmful solar wind and cosmic rays. We learned that the convection of the viscous mantle results in volcanoes and slow movement of the crust and upper mantle, The slow movement of the crust and upper mantle (lithosphere) plays an important role in circulating carbon in and out of our atmosphere. Since carbon dioxide is a greenhouse gas, the carbon cycle regulates the amount of carbon dioxide in our atmosphere, thus helping to maintain a moderate temperature on Earth's surface.*

Note to Teacher: Some students may also point out that a part of the carbon cycle involves the carbon that makes up the bodies of living things and the food they use for energy. Producers use carbon dioxide in the atmosphere for photosynthesis. The carbon is released into the atmophere during respiration and to the Earth during decomposition.

- Write these factors on the transparency for "Moderate temperature" and "Protection from high levels of radiation" under "What Factors Provide This" as seen in the diagram below. (Astronomy factors are in plain text. Atmosphere factors are italicized, and Geology factors are bolded.)

Humans Need	Reason	Factors That Provide This
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.	*Nitrogen is a nutrient*
Oxygen	Helps us to obtain energy from sugars.	*Oxygen helps us get 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.	(related to temperature) *Water vapor is a greenhouse gas in our atmosphere*
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.	Star type Orbital distance Planetary mass (Orbits of large planets/objects could disrupt) *Greenhouse gases reradiate heat* **Crust and mantle motion cycle carbon in and out of atmosphere**

Humans Need	Reason	Factors That Provide This
Protection from poisonous gases and high levels of radiation	To prevent cancer, disease, and damage to the body.	*Ozone protects from UV* *Our atmosphere doesn't have high levels of poisonous gases* **Liquid outer core forms a magnetic field that helps to protect from solar wind and space radiation**
Gravity	Allows our biological systems to develop and function normally. Holds the atmosphere to the Earth so it doesn't escape into space.	Planetary mass *Nitrogen provides pressure*

- Question: So far, we've looked at many of the factors necessary for human survival. If a planet has all of these astronomical, atmospheric, and geologic conditions, is it habitable to humans? Explain.
- *Answer: It is not necessarily habitable to humans, because it may not have other conditions necessary for human habitation. The Earth is a system and requires many different factors to work together for the system to work.*

- Question: What could happen if a part of the system were missing or broken?
- *Answer: The system may not work as well (or at all).*

- Question: What other factors still need to be understood in order to make sure a planet is habitable to humans?
- *Answer: We need to understand what factors will allow our planet to have food, water, and oxygen.*

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2. Introduce the purpose of this lesson/unit.

- Say: We will now begin to explore the interaction between different living things on Earth to understand how these interactions support our survival needs. This will help us to determine what conditions to look for on other planets and what to include in the design of a habitable planet.

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3. Draw on students' prior knowledge of Earth's biology.

- Question: What other living things are on Earth besides humans?
- *Answer: (List students' ideas on the board. Encourage a wide range of answers representing different types of vertebrates, invertebrates, microbes, and plants.)*

- Question: How are these living things important to your survival?
- *Answer: (Allow students to discuss their ideas about this. They will probably mention that they eat some of them. They may also discuss that plants make oxygen and provide beauty and that pets provide love, companionship, and protection.)*

Note to Teacher: The idea that plants provide beauty and pets provide love and companionship may spark a debate on whether love is necessary for survival. Psychological needs are important consideration for survival, even though Astro-Venture focuses primarily on biological/physiological survival requirements.

4. Present the Scientific Question for this lesson.

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

Explore – Part 1 (approximately 35 minutes)

Desert test of the Extra-Vehicular Activity Robotic Assistant (ERA)

1. Put up the Biologic Conditions Transparency and help students identify possible biologic conditions for human survival.

- Say: In the Biology section of Astro-Venture, we will be focusing on life on Earth, and we will examine how this life helps to support the conditions we need to survive. We will call these conditions the "biologic conditions."
- Question: What do you think are some of the characteristics of life on Earth that allow Earth to be habitable to humans?
- *Answer: (Accept all answers. Record these ideas on the Biologic Conditions Transparency under Predicted Biologic Conditions.)*
- In the Prediction section of their Astro Journal, have students record their predictions of the biologic conditions that they think are necessary for human habitation on a planet.

2. Introduce Biology careers.

- Tell students that as they go through the Biology Training module, they will be role-playing biologists.
- Ask students what kinds of things they think a biologist might do and what kind of knowledge they might need to have.

- Pass out the Biologist Career Fact Sheet for students to read and then discuss this career.

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

- The Astro-Venture Biology Training module can be found on the Astro-Venture Web site at: http://astroventure.arc.nasa.gov. Click "Biology 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.) 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 biologic conditions of our planet and will observe the effects on Earth. They will then draw conclusions about the biologic conditions needed for human survival.

- Tell students that as they go through this module, they will be Astro-Venture Junior Biologists. They 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 Biology Training Screen Shots to walk the students through the following. (You will need to click through the introduction to get to this part.)
  – Click "Energy."
  – Click "low."

Note to Teacher: The terms "producer," "consumer," and "decomposer" are likely to be new to students. By making observations, they should be able to draw some general conclusions using the Biology Training Module about each of these groups. Encourage them to think about what types of living things make up each group, and tell them that these groups will be further explored in detail in subsequent lessons.

- 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: "Low energy causes the Earth to freeze and prevents plants from making food."

Note to Teacher: The sequence of events in this module is important. You may want to model this for students.

- Click "Enter" to see other scientists' observations. 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." Both their original answers and their new 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 complete an observation, that button turns purple. They must complete all observations in all four major sections before they can advance to the Astro Challenge section.

Note to Teacher: Some students may wonder why they can't just find the characteristics that allowed Earth to remain habitable and go on. Making good observations about the effects of life-threatening changes will help students understand why each condition is important to life.

- Click "Astro Facts" to read helpful background information about each main topic. This information can help students understand some of the effects they are observing and the overall importance of each part of the flow of energy to human life.
- Within the "Astro Facts," glossary words are in white. Click a white word and the definition will appear in a box. Click the "X" to close this box.
- Click the back arrows to return to the animations.
- Click "medium."
- Click "Play."
- Ask students to give a detailed observation such as: "The Earth has enough energy to stay warm and to provide energy for living things."

Explore – Part 2

(approximately 45 minutes)

The Moon as seen over Earth's atmosphere from the Space Shuttle; NASA

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

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

Note to Teacher: You will need the Flash Player plug-in, which can be downloaded and installed from http://www.macromedia.com/downloads. When tested with grades 5 to 8, the average completion time was 30 minutes with a range of completion times between 22 to 32 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. Students will also receive a certificate of achievement for completing the module. Make sure students are clear about the printing rules for both the Astro Journal and the certificate. After the Astro Challenge, they will have the option to print these items. This will be the only opportunity to print; students cannot go back later to print. If you want to take the whole class through the module using one computer, use the Biology Training Walkthrough at the end of this lesson as a guide.

Explain

(approximately 15 minutes)

Scientist taking ice samples from 32,000-year-old permafrost containing living organisms (extremophiles); NASA

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

2. Discuss students' conclusions and record them on the Biologic Conditions Transparency.

- Question: What biological conditions did you observe are necessary for human habitation of a planet?
- *Answer: (Record on the board.) We need a medium energy source, many producers, some consumers, and some decomposers.*

- Question: What kinds of living things make up the "producers" group?
- *Answer: Plants, algae, and some bacteria make up the producer group.*

- Question: What kinds of living things make up the "consumers" group?
- *Answer: Animals and some types of bacteria make up the consumer group.*

- Question: What kinds of living things make up the "decomposers" group?
- *Answer: Some types of fungi (like mushrooms) and bacteria make up the decomposer group.*

- Say: In the next few lessons, we'll be looking at each of these groups in more detail to better understand how each gets its energy for survival.

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

Observed Biologic Condition	Reason
A medium energy source	Provides energy to producers and keeps our planet warm.
Many producers	Provide food for some consumers and decomposers, produce oxygen, and remove carbon dioxide from the atmosphere.
Some consumers	Provide food for other consumers and decomposers and keep the energy flow in balance.
Some decomposers	Break down dead plants and animals, keeping the soil healthy and balancing life's energy flow.

- Question: Of all of our human survival needs, for which ones does biology have an important role?
- *Answer: Biology plays a role in providing food and oxygen, and removing carbon dioxide from the atmosphere.*

- Put up the Human Survival Transparency again and add this new information to it as follows: (Underlined text denotes biologic factors.)

Humans Need	Reason	Factors That Provide This
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.	*Nitrogen is a nutrient* Carbon is another nutrient passed from organism to organism in the form of food. Sunlight provides energy for producers. Producers turn sunlight into food that consumers and decomposers consume. Decomposers break down dead things to provide nutrients for other living things.
Oxygen	Helps us to obtain energy from sugars.	*Oxygen helps us get energy from sugars* Producers release oxygen.
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.	(related to temperature) *Water vapor is a greenhouse gas in our atmosphere*
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.	Star type Orbital distance Planetary mass (Orbits of large planets/objects could disrupt) *Greenhouse gases reradiate heat* **Crust and mantle motion cycle carbon in and out of atmosphere.**
Protection from poisonous gases and high levels of radiation	To prevent cancer, disease, and damage to the body.	*Ozone protects from UV* *Our atmosphere doesn't have high levels of poisonous gases* **Liquid outer core forms a magnetic field that helps to protect from solar wind and space radiation.**
Gravity	Allows our biological systems to develop and function normally. Holds the atmosphere on the Earth so it doesn't escape into space.	Planetary mass *Nitrogen provides pressure*

- Question: So do we now have enough information about the factors on Earth that support all of our survival needs?
- *Answer: Yes, we now know all of the factors of Earth that support our survival needs.*

- Question: Did any one system support all of our needs?
- *Answer: No, many different systems interacting and working together support our survival needs.*

Note to Teacher: The one area that we did not address in Astro-Venture is how Earth obtained its water. This is a very interesting area of research and scientific debate. Some scientists speculate that most of Earth's water was present and/or created during the early stages of Earth's formation. Others think that most of the Earth's water was delivered by comets and other interplanetary objects. And still others think it is some combination of the two. This might be an interesting idea for students to research on astrobiology or exobiology Web sites.

Extend/Apply

(approximately 15 minutes)

Humpback whales migrating from near the poles to tropical waters; NOAA

1. Have students research and create a class mural of the two major, interconnected global food webs.

- Go over the Food Web Mural Activity directions in the Astro Journal.

- Divide the class into the following four groups:
  – Land plants
  – Land animals
  – Ocean plants
  – Ocean animals

- Have each group choose an animal or plant that is a member of their assigned group and research what they eat and/or what eats it. They may research these on the Internet, CD-ROMs, in encyclopedias, or other books on plants and animals.

- Web sites: Have students search the name of their plant or animal or search other key words such as "land plants," "aquatic life," "food web," "ecosystem," "what eats____," or "food chain" in the following search engines and directories for kids:
  – Yahooligans http://www.yahooligans.com
  – ithaki for Kids http://www.ithaki.net/kids
  – KidsClick http://sunsite.berkeley.edu/KidsClick!/
  – Ask Jeeves for Kids http://www.ajkids.com

- The following encyclopedia Web sites can also be useful:
  - Columbia Encyclopedia http://www.encyclopedia.com
  - Microsoft Encarta http://encarta.msn.com

Note to Teacher: The following are ideas for the types of plants and animals that might be researched to create the Sample Global Food Web seen below. Students will probably not include decomposers in their food web unless you guide them to do so. This is okay at this time, but is something that you may want to revisit and add to the mural when decomposers are explored in Biology Lesson 5.

- **Land plants: lettuce, berries, grass, trees**
- **Land animals: humans, bear, mountain lion, rabbit, deer, snake, grasshopper, hawk, small bird, cow**
- **Ocean plants: phytoplankton (plant plankton), algae**
- **Ocean animals: zooplankton (animal plankton), parrot fish, salmon, blue whale, killer whale, shark, seal, mussels, crab, gull**

- Have each student draw and label one or two living things they've researched.

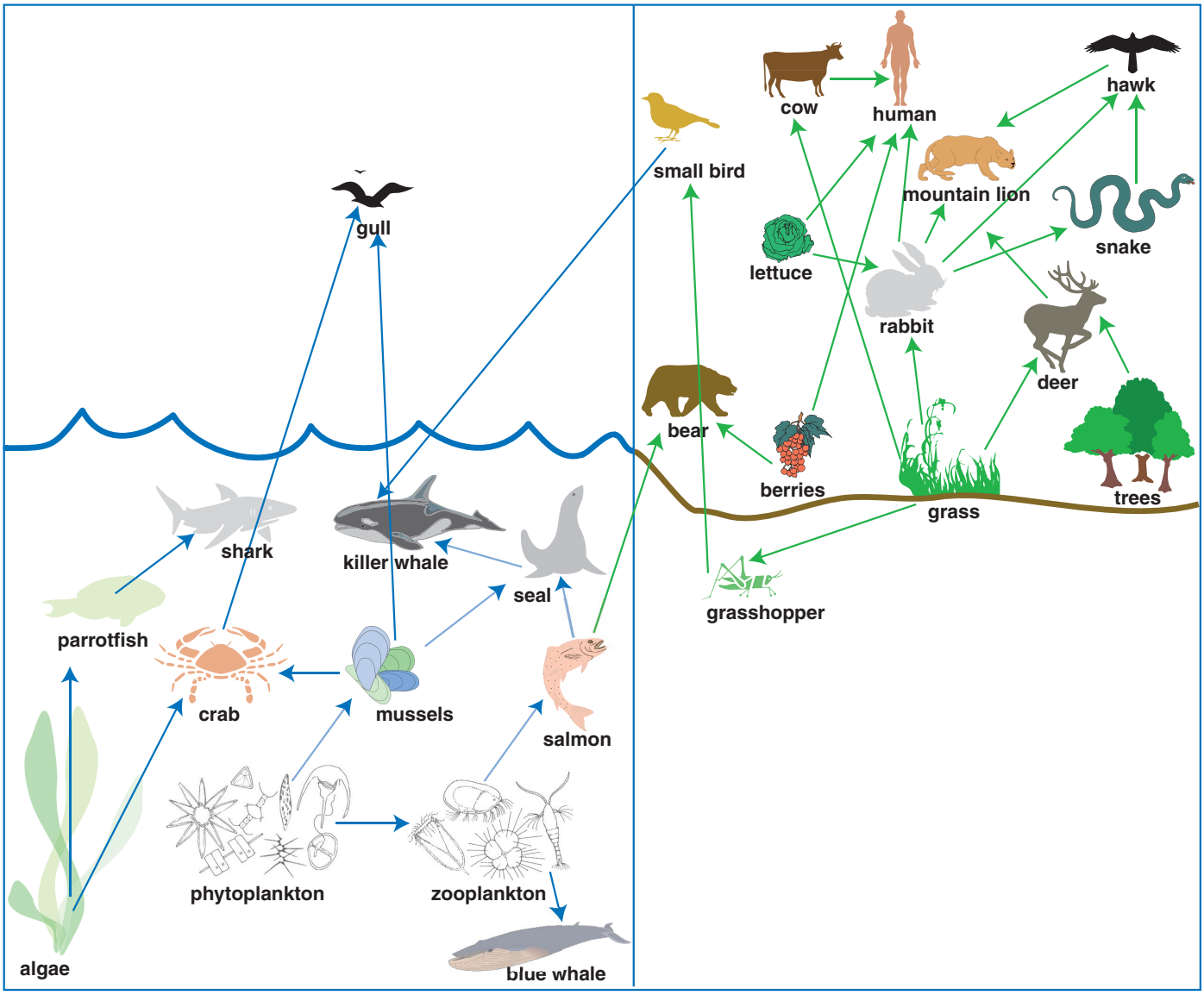
- Create a bulletin board that shows the ocean on one side and land on the other.

- Have students post their labeled plant or animal in its appropriate environment. Using yarn, have them connect it to where it gets its food and to the things that eat it for food.

Note to Teacher: You may want to use different color yarn to differentiate the ocean food web from the land food web. You may want to use a third color yarn where the ocean food web interconnects with the land food web.

- Have students complete the questions in the Food Web Mural Activity section of their Astro Journal.

The Food Web


gull
small bird
cow
human
hawk
mountain lion
snake
lettuce
rabbit
deer
bear
berries
grass
trees
grasshopper
shark
killer whale
seal
parrotfish
crab
mussels
salmon
phytoplankton
zooplankton
algae
blue whale

Evaluate

(approximately 15 minutes)

Bison cow and calf at Wind Cave National Park; U.S. Forest Service, USDA

1. Discuss the two major, interconnected global food webs.

- Question: What do the food webs show?
- *Answer: The food webs show how living things get their food and how living things are connected and dependent upon each other.*

- Question: You focused on one or two plants or animals. How does your plant or animal fit into the food webs? How are the food webs important to them?
- *Answers may include: My plant or animal provides food for other animals in the food web and/or it gets food from animals or plants in the food web.*

- Question: How many food webs are in the mural?
- *Answers may include: There are two major global food webs: land plants and animals, and ocean plants and animals. There are many smaller food webs that make up these larger food webs.*

- Question: What is the interaction between these food webs?
- *Answers may include: These two food webs are connected because some land animals eat some ocean animals.*

- Question: How do humans fit into these food webs?
- *Answers may include: Humans are a part of the interconnected food webs and depend on both webs for food.*

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2. Collect students' Astro Journals and evaluate them to ensure that they have each mastered the major concepts:

- The following biologic characteristics allow Earth to remain habitable to humans:
  - A medium energy source
  - Many producers
  - Some consumers
  - Some decomposers

3. Bridge to next lesson.

- Question: In the Biology Training Module, what were the different biological conditions that were important for human survival?
- *Answer: Sunlight, producers, consumers, and decomposers are all important to human survival.*

- Question: What is the main survival need that these biological conditions support?
- *Answer: They mainly provide food.*

- Question: Where do you see these in the food web mural we made?
- *Answer: Plants are producers. Animals are consumers. Some bacteria and fungi are decomposers.*

- Question: What conditions are we missing from our food web?
- *Answer: We are missing the Sun and decomposers.*

- Say: In the next lesson, we will begin to look at how energy flows from living thing to living thing and the importance of the Sun in all components of this process.

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.

Astro Journal Biology Lesson 1: Biology Training Module

Name _____ Date _____ Class/Period _____

Scientific Question:
What biologic conditions allow for human survival?

1. **Prediction:** What biologic conditions do you think humans need to survive? Why?

2. **Data:** 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
Low Energy	
Medium EnergyMedium Energy	
High Energy	
No Producers	
Many Producers	
No Consumers	
Some Consumers	
Many Consumers	
No Decomposers	
Some Decomposers	
Many Decomposers	

Astro Journal Biology Lesson 1: Biology Training Module

Name _____ Date _____ Class/Period _____

3. Results: What biologic conditions allow for human survival? Why? (Create a revised list below based on what you learned from the Biology Training Module.)

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

Astro Journal Biology Lesson 1: Biology Training Module

Name _____ Date _____ Class/Period _____

Food Web Mural Activity
Directions: 1. Choose one plant or animal that is a member of your assigned group. 2. Conduct research to find out what eats the plant or animal and how the plant/animal gets its food. 3. Draw and label your plant or animal. 4. Post your labeled plant or animal on the mural in the place where it would live. 5. Using yarn, connect your plant or animal to what eats it and to where it gets its food.
1. My assigned group is:_____
2. An animal or plant that is a member of this group is:_____
3. This plant or animal is eaten by:
4. This plant or animal eats:
5. What does a food web show?
6. How does your plant or animal fit into the food web?

Astro Journal Biology Lesson 1: Biology Training Module

Name _____ Date _____ Class/Period _____

Food Web Mural Activity
7. How are the food webs important to your plant or animal?
8. How many food webs are in the mural?
9. What is the interaction between these food webs?
10. How do humans fit into these food webs?

Biology Training Walkthrough

The following is an explanation of each section of Biology 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.

Introduction

1. Go through the introduction with students. This introduces Biology careers and explains the activity students will be going through to make changes to life on Earth, to observe the effects, and to see how these features work together to make a planet habitable to humans.

2. Enter a name for the class, and click "Enter."

3. When you first enter the main activity, a movie shows the flow of energy. All buttons are inactive during this short movie.

Activity

1. Astro Ferret directs you through the steps the first time. After that you are on your own, but you can click Astro for a reminder.

2. Click "Energy."

3. Click "low."

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

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

5. Ask students to describe what happened to Earth and why.

6. Have students record their observations in the Data section of their Astro Journal.

7. 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 "low energy" allows Earth to be habitable or not, and why or why not.

8. Record a good example of the kinds of observations you expect from students such as: "Low energy causes the Earth to freeze and prevents plants from making food."

Note to Teacher: The sequence of events in this module is important. You may want to model this for students.

9. Explain that a good scientific observation is detailed and describes what is observed.

10. Tell students that since they will be able to use their notes when they take the Astro Challenge, they should take thorough notes.

11. Click "Enter" to see other scientists' observations. 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." Both answers will be printed in their Astro Journal so that you can see if they are making good, initial observations.

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

13. Click "medium."

14. Click "Play."

15. Ask students to give a detailed observation such as: "The Earth has enough energy to stay warm and to provide energy for living things."

Completion of Activity

1. Continue through each level of "Energy," "Producer," "Consumer," and "Decomposer."

2. Have the class record their observations in their Astro Journals and then have individuals take turns typing in their observations in the computer.

3. In their Astro Journals, have students record the conditions they observed that resulted in a habitable Earth.

4. After all observations have been completed, click "Astro Challenge" on Astro Ferret and take the Astro Challenge as a class.

5. Encourage students to look at their notes in their Astro Journal to help answer the questions.

6. Have students vote on the answers.

Conclusion

1. Have students vote on the results that they found. Discuss how their results compare to their predictions.

2. Print the class certificate and the class Astro Journal, if you wish.

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 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?

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.

Additional Resources:

- 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
- Student Educational Employment Programs http://nasajobs.nasa.gov/stud_opps/employment/index.htm

Suggested School Subjects/Courses:

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

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
- ***Paleobotany***: study fossils to understand early plant life on Earth or other planets.

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. http://astroventure.arc.nasa.gov
- 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.

Biologist — Career Fact Sheet

Related Job Titles:

Life scientist, medical scientist, biomedical engineer, biological scientist, psychologist

Job Description:

Biologists study living things and their relationship to their environment. Most biologists work in research and development. Some work on basic research to learn more about living things such as bacteria and viruses. Some work on applied research which uses basic research to come up with new medicines, ways to make plants grow better or ways to protect the environment. At NASA, life scientists often research how space environments affect living things, how to support life in space and how life began and changed over time. Some biologists spend time writing proposals to ask for funding for their research. They usually work 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 science?
- Do you enjoy doing experiments?
- Are you interested in how animals and plants function?
- Do you work well on your own?
- Do you work well with a team?
- Do you enjoy solving mysteries or problems?

Education/Training Needed:

The minimum education required for this position is a bachelor's degree in biology or other appropriate field of life science 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.

Additional Resources:

- NASA Office of Life and Microgravity Sciences and Applications http://www.hq.nasa.gov/office/olmsa/
- 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
- American Society for Biochemistry and Molecular Biology http://www.biophysics.org/biophys/society/biohome.htm
- American Society for Microbiology http://www.asmusa.org
- Student Educational Employment Programs http://nasajobs.nasa.gov/stud_opps/employment/index.htm
- NASA Jobs http://nasajobs.nasa.gov/

Suggested School Subjects/Courses:

- Biology
- Chemistry
- Physics
- Biochemistry with laboratory research and fieldwork
- Math

Areas of Expertise:

- ***Chemical and Biological Evolution***: study what life is, where it's located, and how it began and changed over time
- ***Life Support***: research, develop and test life support equipment for aerospace flight
- ***Microbiology***: study animals or plants so small, they can only be seen through a microscope
- ***Biochemistry***: study the chemicals that living things are made of
- ***Physiology***: study how plants and animals function including growth, reproduction, photosynthesis, respiration, movement and how these are affected by space environments
- ***Neurobiology***: study the nervous system of living things and how it is affected by space environments

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. http://astroventure.arc.nasa.gov
- 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.

Ecologist — Career Fact Sheet

Related Job Titles:

Environmental biologist, biologist, environmental scientist

Job Description:

An ecologist studies the interactions between living things and their past, present and future environments. They often solve environmental problems such as habitat damage, global climate change, or species extinction. Ecologists are often responsible for addressing social issues such as the spread of disease and the effect of natural disturbances (fire, drought, flooding) on the surrounding environment. Ecologists often work in desolate and remote areas where field work can be strenuous and the extreme weather conditions demand a hardy and healthy individual. While in the field they collect plant, animal, soil, air and water samples to further analyze in the laboratory. Others work in more traditional environments such as laboratories, offices, work stations or universities where they conduct research, write and publish papers, advise government and environmental agencies, or teach.

Interests/Abilities:

- Do you have a love of nature and being outdoors?
- Are you good at observing and then reporting what you see?
- Can you clearly communicate your ideas to others?
- Do you believe in trying to preserve the environment?
- Are you interested in how plants and animals interact with each other?

Education/Training Needed:

The minimum education required for this position is a bachelor's degree in biology, environmental science, or related field from an accredited college or university. This level general does not involve research and generally involves assisting others in testing and observation. A master's degree is required for applied research and managerial positions. A Ph.D. degree is usually necessary for independent research.

Additional Resources:

- NASA Office of Life and Microgravity Sciences and Applications http://www.hq.nasa.gov/office/olmsa/
- 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
- American Society for Biochemistry and Molecular Biology http://www.biophysics.org/biophys/society/biohome.htm
- American Society for Microbiology http://www.asmusa.org
- Student Educational Employment Programs http://nasajobs.nasa.gov/stud_opps/employment/index.htm
- NASA Jobs http://nasajobs.nasa.gov/

Suggested School Subjects/Courses:

- Biology
- Chemistry
- Physics
- Mathematics: Algebra, trigonometry and calculus
- Statistics
- Environmental studies
- Geography
- Laboratory research and fieldwork
- Writing and Speech

Areas of Expertise:

- ***Theoretical/Statistical***: mathematical modeling of the size, density, and distribution of a species
- ***Conservation***: scientists that help advocate preservation of ecosystems and natural resources through management and planning
- ***Plant***: study of plants in their environment
- ***Animal***: study of animals and the impact they have on their environment
- ***Freshwater/Marine***: study of aquatic plants and animals and their unique environment

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. http://astroventure.arc.nasa.gov
- 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.

Microbiologist — Career Fact Sheet

Related Job Titles:

Biologist, life scientist, medical scientist, molecular biologist, biochemist, physiologist, ecologist

Job Description:

Microbiologists study living things that are too small to be seen without a microscope such as bacteria, algae or fungi. They are interested in the effects micro-organisms have on plants, animals and humans; for example, how micro-organisms assist in the breakdown and decomposition of living things. Microbiologists are also interested in the uses micro-organisms may have in the environment and people's daily lives such as cures for human diseases. Microbiologists often work in traditional environments such as laboratories, offices, work stations or universities where they conduct research and a variety of experiments, write and publish papers, or teach.

Interests/Abilities:

- Do you like to examine things under a microscope?
- Are you good at observing and then reporting what you see?
- Can you clearly communicate your ideas to others?
- Do you like to help other people?
- Are you interested in what causes disease and how it is spread?

Education/Training Needed:

The minimum education required for this position is a bachelor's degree in biology, microbiology, or related field from an accredited college or university. This level general does not involve research and generally involves assisting others in testing and observation. A master's degree is required for applied research and managerial positions. A Ph.D. degree is usually necessary for independent research.

Additional Resources:

- American Society for Microbiology
  http://www.asm.org
- Magazine: ***Microbiology Today***
  http://www.sgm.ac.uk/pubs/micro_today/default.cfm
- Bioscience@Work (careers in microbiology)
  http://www.biocareers.org.uk/
- Exobiology at NASA Ames Research Center
  http://exobiology.arc.nasa.gov/
- NASA Astrobiology Institute
  http://nai.arc.nasa.gov/
- Student Educational Employment Programs
  http://nasajobs.nasa.gov/stud_opps/employment/index.htm
- NASA Jobs
  http://nasajobs.nasa.gov/
- NASA Summer High School Apprenticeship Research Program (SHARP)
  http://www.mtsibase.com/sharp/

Suggested School Subjects/Courses:

- Biology
- Chemistry
- Mathematics: Algebra, trigonometry and calculus
- Laboratory research and fieldwork
- Writing and Speech

Areas of Expertise:

- ***Bacteria***: study of bacteria and their relations to medicine, industry and agriculture
- ***Mycology***: a branch of biology dealing with fungi
- ***Viral***: a branch of science that deals with viruses
- ***Food/Industrial***: grow micro-organisms to be used in foods like yogurt and cheese
- ***Environmental***: identify micro-organisms that may pollute food, water and the environment,
- ***Medical***: identify micro-organisms that can be used in medicines or help identify or treat disease

What Can I Do Right Now?

- Take summer jobs or internships at parks, laboratories, museums or camps.
- Read books on nature and the environment.
- Borrow or buy a microscope and look at samples you have collected from soil or water.
- Visit a natural history museum.
- Join a local biology club or organization.
- Look in the phone book for biotech companies and see if you can arrange a tour or interview a scientist.
- Information on careers in biochemistry and biological sciences:
  Federation of American Societies
  for Experimental Biology
  9650 Rockville Pike
  Bethesda, MD 20814
  http://www.faseb.org

Molecular Biologist — Career Fact Sheet

Related Job Titles:

Biologist, life scientist, medical scientist, geneticist, biochemist, physiologist

Job Description:

Molecular biologists study how genes in cells cause biological characteristics and function in organisms. They study the detailed genetic make-up of plants, animals, humans, bacteria and fungi. They study nucleic acids (DNA and RNA) for medical testing for disease-causing organisms and to test for inherited human genetic disorders. Molecular biologists are also important in industry for developing new lines of plants, animals and micro-organisms, or aid in the development of new medicines. Molecular biologists often work long hours in traditional environments such as laboratories, offices, or universities where they conduct research and a variety of experiments, write and publish papers, or teach.

Interests/Abilities:

- Do you like to examine things under a microscope?
- Are you good at observing and then reporting what you see?
- Can you clearly communicate your ideas to others?
- Do you like to help other people?
- Do you pay attention to details and enjoy working accurately?
- Are you able to concentrate or work continuously for many hours?

Education/Training Needed:

The minimum education required for this position is a bachelor's degree in biology, microbiology, biochemistry, or related field from an accredited college or university. This level general does not involve research and generally involves assisting others in testing and observation. A master's degree is required for applied research and managerial positions. A Ph.D. degree is usually necessary for independent research and several years of research and post-doctoral work are generally required.

Additional Resources:

- American Society for Microbiology http://www.asm.org
- DNA Learning Center http://www.dnalc.org
- Genome Research Institute http://www.genome.gov
- NASA's Fundamental Space Biology Outreach Program http://weboflife.ksc.nasa.gov/index.htm
- NASA's Office of Biological and Physical Research http://spaceresearch.nasa.gov
- Student Educational Employment Programs http://nasajobs.nasa.gov/stud_opps/employment/index.htm
- NASA Jobs http://nasajobs.nasa.gov/
- NASA Summer High School Apprenticeship Research Program (SHARP) http://www.mtsibase.com/sharp/

Suggested School Subjects/Courses:

- Biology: biochemistry, genetics, microbiology, immunology
- Chemistry: organic, physical and inorganic
- Mathematics
- Laboratory research and fieldwork
- Writing and Speech

Areas of Expertise:

- ***Genetics***: understand the inheritance of genetic diseases and provide counseling to families
- ***Criminology***: provide law enforcement with evidence (such as DNA) to help solve crimes
- ***Agriculture***: manipulate genetic makeup to breed new crop plants or livestock
- ***Pharmaceutical***: study of molecular structure to design new medicines

What Can I Do Right Now?

- Take summer jobs or internships at parks, laboratories, museums or camps.
- Read books on biology and genetics.
- Borrow or buy a microscope and look at samples you have collected from soil or water.
- Construct a family tree and research your family medical history.
- Join a local biology club or organization.
- Read the book, ***The Cartoon Guide to Genetics*** by Larry Gonick (ISBN: 0062730991)
- Information on careers in biochemistry and biological sciences:
  Federation of American Societies for Experimental Biology
  9650 Rockville Pike
  Bethesda, MD 20814
  http://www.faseb.org

Botanist — Career Fact Sheet

Related Job Titles:

Biologist, life scientist, biochemist, ecologist, agricultural scientist, environmental scientist, paleontologist

Job Description:

Botanists study plants and their environment. Some study all aspects of plant life; others specialize in areas such as identification and classification of plants, the structure and function of plant parts, the biochemistry of plant processes, the causes and cures of plant diseases and the geological record of plants. Botanists work in a variety of environments both indoors and out. Good physical condition may be required to reach some remote areas where botanists collect plant samples to bring back to the laboratory for further testing. Others work solely in traditional, indoor environments such as laboratories, offices, museums, botanical gardens, or universities where they conduct research and a variety of experiments, write and publish papers, or teach. Many botanists strike a balance between indoor and outdoor environments.

Interests/Abilities:

- Do you like to examine things under a microscope?
- Are you good at observing and then reporting what you see?
- Do you like hiking or being out in nature?
- Can you clearly communicate your ideas to others?
- Are you good at organizing and classifying things?
- Are you curious about how living things function?

Education/Training Needed:

The minimum education required for this position is a bachelor's degree in biology, biochemistry, agriculture, horticulture or related field from an accredited college or university. A bachelor's degree in botany will generally qualify you for a laboratory technician or technical assistant. A master's degree is required for applied research and managerial positions. A Ph.D. degree is usually necessary for independent research.

Additional Resources:

- Botanical Society http://www.botany.org
- Encyclopedia of Plants and Flowers http://www.botany.com
- American Journal of Botany http://www.amjbot.org/
- NASA's Earth Observatory http://earthobservatory.nasa.gov/
- NASA's Office of Biological and Physical Research http://spaceresearch.nasa.gov
- Student Educational Employment Programs http://nasajobs.nasa.gov/stud_opps/employment/index.htm
- NASA Jobs http://nasajobs.nasa.gov/
- NASA Summer High School Apprenticeship Research Program (SHARP) http://www.mtsibase.com/sharp/

Suggested School Subjects/Courses:

- Biology
- Chemistry
- Mathematics
- Environmental studies
- Laboratory research and fieldwork
- Writing and Speech

Areas of Expertise:

- *Taxonomy*: identify and classify plants according to their presumed natural relationship
- *Agriculture*: manipulate genetic makeup to breed new crops or prevent disease
- *Pharmaceutical*: study of molecular structure and chemistry of plants and plant extracts to design new medicines
- *Paleobotany*: identify plant fossils or relics in rocks to help identify a geologic age or history of an area
- *Physiology*: study how plants function including growth, reproduction, photosynthesis, respiration, and movement

What Can I Do Right Now?

- Take summer jobs or internships at parks, laboratories, botanical gardens, nurseries, museums or camps.
- Read books on biology and the environment.
- Borrow or buy a microscope or magnifying glass and look at samples you have collected.
- Participate in science fairs.
- Go for a hike or a walk in your local park and sketch or journal about the things you see.
- Join a local science club or organization.
- Read the book, ***The Plant Hunters: Great Botanist-Explorers and the Plants They Sought*** by Tyler Whittle (ISBN: 1558215921)
- Information on careers in biochemistry and biological sciences:
  Federation of American Societies for Experimental Biology
  9650 Rockville Pike
  Bethesda, MD 20814
  http://www.faseb.org

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

Astrobiologist/Biogeochemist/Marine Microbial Ecologist — Career Fact Sheet

Dr. Brad Bebout

**Astrobiologist/
Biogeochemist/
Marine Microbial Ecologist**

NASA Ames Research Center

I am interested in all aspects of the ecology of microorganisms: how they survive in the sometimes harsh environments where they live, as well as how they affect our environment on Earth — and they do have a big effect. I maintain a research laboratory and do research both in the lab and in the field. One of the favorite parts of my work involves creating newer and better "gizmos" to measure biological and chemical processes in microbial communities. That means that I spend a fair amount of my time trying to make the gizmos work for our applications. I work in the exobiology branch at Ames. Scientists in the exobiology branch are interested in all sorts of questions about the origin and evolution of life on Earth, and possibly on other planets.

My areas of expertise:

- Microbial ecology
- Microbial mats
- Ecology of nitrogen fixation

How I first became interested in this profession:

I originally got interested in the Marine sciences as a direct result of diving. I started my undergraduate education at the University of Nevada, Reno, but got so involved with diving in the Monterey Bay that I transferred to the University of California at Santa Cruz so I could go diving more often. I took a lot of classes in marine biology, did a senior project in marine biology, and ended up going to graduate school to study marine sciences. My masters' thesis work was about the role marine fungi has in feeding salt marsh snails. My Ph.D. work was on microbial mats.

What helped prepare me for this job:

How did I end up as a NASA scientist? Sometimes I am not even sure myself. My real training is in the field of marine sciences, but I came to work at NASA because many of the areas that I had been studying were of great interest in NASA's efforts to understand the evolution of life on Earth.

My role models or inspirations:

When I was eight years old, my dad joined the United States Agency for International Development (USAID) and we traveled and lived all over the world. I think that my time abroad was very important to the way that I think about almost everything, and I really appreciate having had the opportunity
to see so many things.

My education and training:

- B.S., Marine Biology, University of California, Santa Cruz
- M.S., Marine Sciences, University of North Carolina, Chapel Hill
- Ph.D., Marine Sciences (Microbiology), University of North Carolina, Chapel Hill

My career path:

- Two years at the Max Planck Institute for Marine Microbiology, Germany
- Two years at the University of Maryland's Horn Point Lab, on the Chesapeake Bay, MD
- Research Scientist, Astrobiology Institute, NASA Ames Research Center

What I like about my job:

I get to spend my time trying to find out things that no one has ever found out before! I also enjoy making and using newer and better "gizmos" to measure processes in microbial communities. That means that I spend a fair amount of my time trying to make the gizmos work for our applications.

What I don't like about my job:

The thing I like least about my job is the paperwork that is required, including the process of producing papers about our research. This writing takes a lot of time, and that is time I can't use to find out new things. Of course, communicating our results is one of the most important parts of the scientific process, so I am most interested in improving upon it.

My advice to anyone interested in this occupation:

My advice to anyone interested in pursuing a career in science (or in anything else as far as I can tell) is the same advice that my parents gave me: "Do what you love, and everything will work out for the best." You know what, they were right! I am extremely fortunate to have a job doing what I love to do: finding out things that no one has ever found out before. If I can do it, I think that anyone can.

Payload Scientist — Career Fact Sheet

Lisa Dali

Payload Scientist

Contractor, Lockheed Martin Space Operations
NASA Ames Research Center

I help develop and manage biological experiments targeted for Space Shuttle and International Space Station (ISS) flights. I work with the Principle Investigators and NASA to define and advocate on-orbit experiment requirements, identify and monitor ground studies, and determine spaceflight equipment that will satisfy the experiment requirements. These steps help to advance the experiment through several phases of development so it will one day fly in space.

Areas of expertise:

- Cell and Molecular Biology
- Vertebrate Embryology
- Microbiology

How I first became interested in this profession:

My interest in Biology began during high school and became even stronger during college. I considered becoming a physician or a college professor, but during my Masters program, I realized I wanted a nontraditional science-related career. Although I did not know what I would end up doing, I was fortunate that NASA Ames offered me a terrific opportunity right at the end of my graduate work. My career "path" has never been defined, and I have learned that it does not have to be. You truly can make the career you desire.

What helped prepare me for this job:

Having a graduate degree is a definite advantage. The skills I learned in college provided me with a solid science foundation, but my graduate school experience was paramount in improving my analytical and scientific reasoning skills. I felt more at ease asking scientific questions after graduate school, and it was where I learned how to present and discuss science as a professional.

My role models or inspirations:

I am sort of a free-spirited scientist in that I did not have any people in the field that I aspired to be. I knew that I loved the field of Biology and I knew that somehow I would make a career for myself doing the things I enjoyed.

My education and training:

- M.A. in Cell and Molecular Biology, San Francisco State University, 2000
- B.S. in Microbiology (minor in Chemistry), San Francisco State University, 1998

My career path:

- Graduate student at San Francisco State University for 2 years (1998-2000)
- Scientist/Biologist with Lockheed Martin at NASA Ames for 2 years (2000-current)

What I like about my job:

The fact that my efforts will help to launch several biological experiments into space is the best part of my job. I also really enjoy science writing, giving science presentations, and learning about different biological systems.

What I don't like about my job:

The launch delays! Many factors are involved in a shuttle launch, so things do not always happen on schedule. Sometimes it is challenging to work on a project that always seems far from completion.

My advice to anyone interested in this occupation:

Earn a good college education and an advanced degree. Be open-minded and do not be afraid to ask questions or make mistakes. That is how we learn. Be your own leader and build the career you want, even if it seems off the beaten path.

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

Research Scientist/ Biogeochemist/ Astrobiologist — Career Fact Sheet

Dr. David Des Marais

Research Scientist/ Biogeochemist/ Astrobiologist

NASA Ames Research Center

Astrobiology allows us to make predictions about life forms that future space missions might encounter on other planets. I study the evolution of micro-organisms over long periods of time, and then compare the findings with the corresponding changes in the Earth's evolution as a planet. To gather samples, our team goes to places with extreme environments, such as thermal springs, and parts of the sea where the salt content is high. In these extreme environments micro-organisms dominate, and scientists can study how they interact with each other. To learn about micro-organisms that lived billions of years ago, we gather and study fossil samples.

Areas of expertise:

- Geochemistry of carbon in lunar samples, meteorites, oceanic basalts, and ancient (Precambrian) carbonates and organic matter
- Biogeochemistry of microbial communities in hypersaline and hydrothermal environments
- Search for fossil evidence of life on Mars

How I first became interested in this profession:

Growing up, I enjoyed exploring caves. As graduate student in the 1970s, I studied earth science (geology), and I remember being fascinated by the lunar samples brought to Earth by earlier NASA lunar missions that we were able to study. This experience led to my interest in space science. Later on I became involved with biology, which added a new dimension to my research. This led to my later work on how the carbon cycle relates to Earth's history and to astrobiology.

What helped prepare me for this job:

In high school and college, I studied chemistry, physics, mathematics, and geology. Also, I learned that many of the questions we have about our biosphere and environment required the application of more than one of these disciplines. I learned about the scientific method, which provides a logical approach to finding answers to mysteries that intrigue me.

My role models or inspirations:

I had a great high school chemistry teacher, whose enthusiasm for chemistry and all of science was infectious. A college professor introduced me to the wonders of geology. My graduate school thesis advisor revealed how the power of modern analytical chemistry can unveil the early history of our biosphere.

My education and training:

- Ph.D., Geochemistry, Indiana University

My career path:

- One year as a research fellow at the Institute of Geophysics, University of California, Los Angeles (UCLA)
- Twenty-five years as research scientist in exobiology, NASA Ames Research Center

What I like about my job:

I find space exploration motivating and extremely exciting because it fulfills a natural desire—intrinsic to human nature—to go out and search for other forms of life. I believe that our type of work drives the pursuit of excellence in science and technology, and I enjoy contributing to the process.

What I don't like about my job:

Most of the time, I cannot be in the lab. I spend a lot of time making sure that others in my lab can have the resources and other support that they need to do the research. But my supporting role is still a vital part of the team research effort.

My advice to anyone interested in this occupation:

As an undergraduate, be sure that you get a good foundation in chemistry, physics, or mathematics, because they are the foundation of our efforts to learn the mysteries of life in the universe. Try to get some experience in a research laboratory.

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

Astrobiology and Space Research — Career Fact Sheet

Lynn Harper

Lead, Integrative Studies,

Astrobiology and Space Research Directorate

NASA Ames Research Center

A few years ago, I led the development of a NASA program which studies the origin, evolution, and distribution of life on many different scales. Now, it's my job to make connections between individual organisms (plants and animals), planets, and the universe, using various different technologies to explore them. I lead and manage spacecraft research related to life in the universe and try to come up with strategies to make new discoveries.

Areas of expertise:

- Astrobiology

How I first became interested in this profession:

When I was five years old, the first communication satellites, Telstar and Sputnik, were launched. My father and I would go and look for them. When we finally saw them, I was so excited! I remember asking, "What's that?" And my father said, "It's the world changing."

What helped prepare me for this job:

Being interested in a lot of things has helped me a lot. My original study in college was theater arts. This helped prepare me for astrobiology because many things have to come together in a theater production, just like many things have to come together in the study of life in the universe. Working on projects also helped me because they gave me experience.

My role models or inspirations:

I've been inspired by my family because they love learning. They've taught me not to be afraid to be bad at something, because success comes later. I've also had many good teachers and mentors as well as science fiction inspirations, like the cast of Star Trek.

My education and training:

- B.A., Biology, University of Bridgeport
- M.A., Cell Biology, University of Bridgeport

My career path:

- Program manager of Advanced Missions and Special Projects at NASA Ames for four years
- Chief of the Advanced Life Support Division at NASA Ames for four years
- Astrobiologist at NASA Ames for one year
- Lead, Integrative Studies, Astrobiology and Space Research Directorate at NASA Ames for one and a half years

What I like about my job:

I like the adventure of discovery and the sheer beauty of things in space, and of living things. I also love working with terrific people. It makes the job interesting when I get to work with great scientists and great human beings.

What I don't like about my job:

I'm not wild about the paperwork. I do more than I'd like.

My advice to anyone interested in this occupation:

Find three things that you really like to do and take the time to get as good at them as you can. Pursue those as your career. If you'd like to be an astrobiologist in particular, learn a science, a technology, and lots of computer skills. Also, develop a love of learning.

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Lab Specialist, Astrobiologist — Career Fact Sheet

Mary Hogan

Assistant Lab Specialist
Astrobiologist

NASA Ames Research Center

I study marine bacterial communities. Bacteria grow everywhere on Earth, including extreme environments (such as those with very cold or very hot temperatures, very low moisture, very high pressure, very high salinity, no sunlight, or no oxygen). I work with a variety of instruments and equipment to measure the chemicals that are both used and produced by bacteria during their growth processes: oxygen, carbon, nitrogen, and methane. I also participate in the operation of a simulated habitat. In this habitat we have samples of a marine bacterial community collected from a high salinity pond in Baja, Mexico. Since we can't stay at the field site indefinitely, we have brought samples back with us and are attempting to duplicate the microbial ecosystem in our habitat here. Since bacteria have been here the longest and have developed optimum strategies for living in the most diverse environments known, they may provide the best source or indication of what to look for as evidence of past or present life elsewhere.

Areas of expertise:

- Microbiology
- Marine science

How I first became interested in this profession:

I grew up in the mid–Hudson Valley of New York. What got me involved in science is that I'm just plain nosy. I wanted to know how things worked. The weirder the better—that's what grabbed me. In 4th grade we got to eat seaweed and in 10th grade we got to see how a cow's lungs worked. Of course some of it could be a little dull—just ask my high school physics teacher who threw chalk at me to keep me awake. But physics did explain some of the most inexplicable things, like how planes fly and boats float.

What helped prepare me for this job:

My education includes an A.A.S. in Medical Laboratory Technology from Orange County Community College of Middletown, NY, a B.S. in Biology from Ramapo College of Ramapo, NJ and an M.S. in Marine Science from the University of California, Santa Cruz. I have worked in a variety of laboratories that mostly had a connection to microbiology.

My role models or inspirations:

Because I love to read, I have a few literary heroes. After reading C.S. Lewis' The Narnia Tales and T.H. White's The Once and Future King, I was hooked on reading fantasy, which is a way to cultivate your imagination and ability to dream . My current favorite authors are Orson Scott Card, J. Gregory Keyes and George R. R. Martin. I like to read science fiction, fantasy and history. Books are great teachers.

My education and training:

- A.A.S., Medical Laboratory Technology, Orange County Community College
- B.S., Biology, Ramapo College
- M.S., Marine Science, University of California, Santa Cruz

My career path:

- I have worked in a variety of microbiology labs: twelve years at Avon, Inc.; six years at the University of California, Santa Cruz; and three years in the Stable Isotope lab at the University of California, Santa Cruz
- Astrobiology Institute, NASA Ames Research Center

What I like about my job:

When asked, "What would be your perfect job?" my answer always included working outside. My work in marine sciences has allowed me to be outside in some of the most wonderful places, including the California coast, the Pacific Ocean, and the Arabian Sea. This summer, I visited Yellowstone National Park to investigate thermal springs and the bacteria that live within them.

What I don't like about my job:

I get frustrated when I can't figure out why an instrument isn't performing as it should.

My advice to anyone interested in this occupation:

My advice to students is to try new things, find what interests you and have some fun. If you think science might be for you, try to get involved in activities with your school or town that have a scientific connection. And if you find out that it's not what you want to do, keep searching. Talk to people working at things you like. Read as much as you can about them, the things you like and also the things you don't—you never know what could be hiding there. Never stop learning!

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Space Biologist — Career Fact Sheet

Patricia Larenas

Space Biologist
International Space Station
Science Lead, Cell Culture Unit

Contractor, Lockheed Martin
NASA Ames Research Center

I provide input and science oversight for the development of a cell culture system destined for the International Space Station. Much of my activities center around reporting project progress, acting as a liaison on diverse issues, writing test plans, and insuring that NASA gets a quality product. In addition, I provide oversight of our labs at NASA Ames where I direct the testing done in-house. All of this work is done as part of a team, and the team takes part in all of the decision making.

Areas of expertise:

- Cell Biology
- Space Life-Science Hardware Development

How I first became interested in this profession:

I have been interested in living things and Space since childhood. I was always bringing "critters" home, much to my mother's distress! The study of Earth and the universe will always provide surprises and fascination for me.

What helped prepare me for this job:

My time spent in a research environment, and my ability to write and communicate clearly with others.

My role models or inspirations:

My family is inspiring; my parents immigrated from Chile when my brother and I were very young. All four children have done well in our careers and we all give back to the community through volunteer work or other involvement. Our professions include: a nurse, a bilingual teacher, a biochemist and a cell biologist. I credit our success to our dedicated parents and our cultural heritage.

My education and training:

- AS (Associate of Science) Animal Health Technology, Foothill College
- BA, San Jose State University
- MPA (Master of Public Administration), San Jose State University, currently in progress
- Additional advanced training in Immunology, U.C. Berkeley Extension.

My career path:

- Veterinary medicine for 2 years
- 3 years in biotechnology researching monoclonal antibodies and immunology.
- 12 years working on human immunology research projects at a research institute in Palo Alto, CA.
- Fall of 2000 to present, NASA Ames to participate in gravitational biology and space sciences.

What I like about my job:

I feel privileged to be a part of the space program and to contribute to space life sciences research. I also enjoy working as part of a team on a challenging project.

What I don't like about my job:

Sometimes the paperwork side of it can be overwhelming.

My advice to anyone interested in this occupation:

Get as much education as possible, hopefully at the graduate level. During your college years seek out internships at NASA centers (the Astrobiology Academy, too). Follow your heart, your passion, and things that interest you to pursue for a career.

Space Biologist — Career Fact Sheet

Jon Rask

Space Biologist
Space Station Biological Research Project (SSBRP)

Associate Scientist
Contractor, Lockheed Martin
NASA Ames Research Center

I help grow and study Drosophila (fruit flies), Arabidopsis (a small plant), yeast, and C. elegans (a worm). We use these organisms to determine if an incubator that is designed for the International Space Station can actually be used to support biological specimens. I also perform tissue culture for the cell culture unit, another habitat for SSBRP. In addition, I attend team meetings, order supplies, maintain inventories, and manage safety issues for the lab. Additionally, I volunteer and give talks about SSBRP and help train teachers for the Education Office at Ames. I even volunteer for the Mars Society and NASA JPL's Solar System Ambassador Program!

Areas of expertise:

- Biocompatibility of Space Mission Hardware
- Astrobiology Education

How I first became interested in this profession:

I've wanted to work for NASA as long as I can remember.

What helped prepare me for this job:

Persistence, consistency, and enthusiasm! Lab skills (molecular and non-molecular), communication and listening skills, knowledge of biology, microscopy, chemistry, mathematics, physics, and most importantly, a desire to learn.

My role models or inspirations:

My mother and father, former students, astronauts, pictures from Voyager 1 & 2, special relativity, winter in North Dakota, and Mars scientists.

My education and training:

- B.S. Education, North Dakota State University 1995
- M.S. Space Studies, University of North Dakota 2001

My career path:

- Farmer and Rancher, Mandan, ND; (1987-95)
- High School Science Teacher, Bismarck, ND (Biology, Physics, Applied Biology, Chemistry, Physical Science) (1995-1999)
- Graduate Research Assistant, Grand Forks, ND- Climate change, biodiversity, and agricultural stewardship using remote sensing imagery studies. (1999-2001)
- Biologist – Associate Scientist for SSBRP with LMSO at NASA ARC (2001- present)

What I like about my job:

Everything. I have the privilege of being on the United States' ISS science team for the Incubator and the Cell Culture Unit! I appreciate being able to listen and learn from world-class researchers, and I enjoy the flexibility of my schedule.

What I don't like about my job:

Sometimes lab work requires very intensive, long days of repetitive work, even on weekends. If we have organisms growing and experiments running, they need to be tended to all the time. But if I am consistent and persistent with this part of my job, good results make it all worth while.

My advice to anyone interested in this occupation:

Be ready to learn and have fun! Be VERY flexible and be sure to follow through on everything you say you will do.

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Experiment Support Scientist Career Fact Sheet

Delia L. Santiago

Experiment Support Scientist,
Life Sciences,
Flight Payload Operations

Contractor, Lockheed Martin
Space Operations
NASA Ames Research Center

My daily work consists of a lot of time on the computer, including writing technical documents, analyzing data on different computer programs, and working with a database. I also have contact with many people outside of my group, such as companies that support science work. The majority of my job involves arranging what needs to be done to support experiments being flown in space, and organizing data related to the experiments.

Areas of expertise:

- Life Science Payloads

How I first became interested in this profession:

While the Astrobiology course I took in college clarified my interest in space and the related space life sciences, space as a whole has always interested me, as have the sciences. Being part of the work NASA does is inspiring because I see NASA as an organization that pushes forward with humans doing the most amazing things.

What helped prepare me for this job:

The general science background I received in college, as well as being organized in the past. Also, having worked with computers a lot in school made me feel comfortable to handle that aspect of my job.

My role models or inspirations:

I don't have a specific set of names, but I guess people who pushed forward in the frontier they were working in. Pioneers in any field are an inspiration. Astronauts, of course, are inspiring, because they go where so few others get to go, really pushing the limits.

My education and training:

- B.S. in Biological Sciences, Stanford University

My career path:

- During my undergraduate work, I took an Astrobiology class, which focused on many areas of space-biology research and highlighted research being done nearby at Ames Research Center.
- After graduation, I investigated how to get involved at Ames and found a job in nutrition research.
- Next and currently, I serve on the Data Management Team for a Payload to be flown aboard Space Shuttle mission STS-107.

What I like about my job:

I am always learning new and exciting things about the space program and enjoy communicating with people from all parts of the science community. I enjoy being part of a big team with the common goal of putting science into space and the satisfaction that some new knowledge has been gained when a project is completed.

What I don't like about my job:

Sometimes the exciting science part of the job seems very distant because it feels like a long time before the rewards pay off. One can work on a payload for years before the experiment is launched. Also, the detailed documentation must be done in a very specific way.

My advice to anyone interested in this occupation:

A science background is a must, but managing experience may also be beneficial in managing payloads. In this occupation, you must balance communication with science people while keeping a managing and operations perspective. Remember to always tell people what interests you, and gain experience whenever you can, especially through internships.

Human Survival Transparency

Humans Need:	Reason:	What Factors Provide This?
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.**	

Biologic Conditions Transparency

Predicted Biologic Condition	Observed Biologic Condition	Reason