Emera Astronomy Center
and M. F. Jordan Planetarium

ASTRO.UMAINE.EDU FACEBOOK.COM/JORDANPLANTERARIUM 207-581-1341

Cosmic Classroom Guide

ORIGINS OF LIFE

COMPILED & EDITED BY
Leisa Preble

THE UNIVERSITY OF MAINE

A Member of the University of Maine System

Emera Astronomy Center
and M. F. Jordan Planetarium

Origins of Life
Edited by Leisa Preble

Mission Statement:
The mission of the Maynard F. Jordan Planetarium of the University of Maine is to provide the University and the public with educational multi-media programs and observational activities in astronomy and related subjects.

Cosmic Classroom

Looking for fun and interesting space activities? The planetarium staff has prepared a collection of materials we call the Cosmic Classroom for you to use before and/or after your visit. These materials are entirely for use at your own discretion and are not intended to be required curricula or a prerequisite to any planetarium visit. The Cosmic Classroom is one more way that the Jordan Planetarium extends its resources to help the front line teacher and support the teaching of astronomy and space science in Maine schools.

The lessons in this Cosmic Classroom have been edited and selected for the range of ages/grades that might attend a showing of this program at the Jordan Planetarium. Those activities that are not focused at your students may be adapted up or down in level. Our staff has invested the time to key these materials to the State of Maine Learning Results in order to save you time.

The State of Maine Learning Results performance indicators have been identified and listed for the program, the Cosmic Classroom as a package, and each individual activity within the package. The guide also includes related vocabulary and a list of other available resources including links to the virtual universe. We intend to support educators, so if there are additions or changes that you think would improve, PLEASE let us know.

Thank you, and may the stars light your way.

The Maynard F. Jordan Planetarium Staff

The Program – *Origins of Life*

Origins of Life deals with some of the most profound questions of life science: the origins of life and the human search for life beyond Earth. Starting with the Big Bang, in chronological order, the show deals with the prebiotic chemistry in the Universe, the formation of stars and solar systems, and the first life on Earth. *Origins of Life* also covers the great extinctions as well as our search for life beyond Earth. *Origins of Life* is an inspirational journey through time, and a celebration of life on Earth.

We are very glad that you have chosen to visit our planetarium with your group. We hope that this guide either will help you prepare your group or help you review their experience at the University of Maine's sky theater.

State of Maine Learning Results Guiding Principles

The lessons in this guide, in combination with *Origins of Life*, will help students to work towards some of the Guiding Principles set forth by the State of Maine Learning Results. By the simple act of visiting the planetarium, students of all ages open an avenue for self-directed lifelong learning. A field trip encourages students to think about learning from all environments including those beyond the schoolyard. A Jordan Planetarium visit also introduces visitors to the campus of the largest post-secondary school in Maine and encourages them to think of this as a place which holds opportunities for their future education, enjoyment and success.

Other sites on the University campus, including three museums, explore a variety of subjects, and the Visitors Center is always willing to arrange tours of the campus. A field trip can contribute to many different disciplines of the school curriculum and demonstrate that science is not separate from art, from mathematics, from history, etc. The world is not segregated into neat little boxes with labels such as social studies and science. A field trip is an opportunity for learning in an interdisciplinary setting, to bring it all together and to start the process of thinking. For a more complete discussion of field trips, please visit the Jordan Planetarium web site at http://www.galaxymaine.com.

If used in its entirety and accompanied by the Planetarium visit this guide will help students to:

Become **a clear and effective communicator** through

A. oral expression such as class discussions, and written presentations
B. listening to classmates while doing group work, cooperation, and record keeping.

Become **a self-directed and life long learner** by

A. introducing students to career and educational opportunities at the University of Maine and the Maynard F. Jordan Planetarium.
B. encouraging students to go further into the study of the subject at hand, and explore the question of "what if?"
C. giving students a chance to use a variety of resources for gathering information

Become **a creative and practical problem solver** by

A. asking students to observe phenomena and problems, and present solutions
B. urging students to ask extending questions and find answers to those questions
C. developing and applying problem solving techniques
D. encouraging alternative outcomes and solutions to presented problems

Become **a collaborative and quality worker** through

A. an understanding of the teamwork necessary to complete tasks
B. applying that understanding and working effectively in assigned groups
C. demonstrating a concern for the quality and accuracy needed to complete an activity

Become **an integrative and informed thinker** by

A. applying concepts learned in one subject area to solve problems and answer questions in another
B. participating in class discussion

State of Maine Learning Results Performance Indicators

In conjunction with the Maynard F. Jordan Planetarium show *Origins of Life,* this guide will help you meet the following State of Maine Learning Results Performance Indicators in your classroom.

Grades 3-5

Science and Technology –

D1. Universe and Solar System.

c. Recognize that the sun is a star and is similar to other stars in the universe.

D2. Earth

e. Recognize that the sun is the source of Earth's surface heat and light energy.

Grades 6-8

Science and Technology -

B2. Skills and Traits of Technological Design

c. Communicate a proposed design using drawings and simple models.

D1. Universe and Solar System

a. Describe the different kinds of objects in the solar system, including planets, sun, moons, asteroids, and comets.

b. Explain the motions that cause days, years, phases of the moon, and eclipses

D2. Earth

f. Give examples of abrupt changes and slow changes in Earth systems.

D3. Matter and Energy

e. Explain and apply the understanding that substances have characteristic properties, including density, boiling point, and solubility and these properties are not dependent on the amount of matter present.

9-Diploma

Science and Technology -

D2. Earth

a. Describe and analyze the effect of solar radiation, ocan currents, and atmospheric conditions on the earth's surface and the habitability of earth.

D3. Matter and Energy

g. Describe nuclear reactions, including fusion and fission, and the energy they release.

i. Explain the relationship between kinetic and potential energy and apply the knowledge to solve problems.

Performance Indicators Snapshot

	Grades 3-5.	9-Diploma
The Show	D1.c. D2.e.	D2.a D3.g. D3.i.
	Grades 6-8. B2.c. D1.a. D1.b. D2.f. D3.e.	
The Guide	**Grades 3-5.** D1.c. D2.e.	**9-Diploma** D2.a. D3.g. D3.i.
	Grades 6-8. B2.c. D1.a. D1.b. D2.f. D3.e.	

A Star Is Born

DiscoverySchool.com
http://www.discoveryschool.com

CREDIT:
Lee Ann Hennig, astronomy teacher, Thomas Jefferson High School for Science and Technology, Alexandria, Virginia.

Objectives and State of Maine Learning Results Performance Indicators:

1. Learners will be able to understand that the sun is the principle energy source for phenomena on the Earth's surface. (3-5. Science & Technology. D1.c.)
2. Learners will be able to understand characteristics and movement patterns of the nine planets in our solar system. (3-5. Science & Technology. D1.a.)
3. Learners will be able to understand characteristics and movement patterns of asteroids, comets, and meteors. (6-8. Science & Technology. D1.a.)
4. Learners will be able to understand common characteristics of stars in the universe (3-5. Science & Technology. D1.c.)
5. Learners will be able to understand that nuclear reactions convert a fraction of the mass of interacting particles into energy and release much greater amounts of energy than atomic interactions. (9-D. Science & Technology. D3.g.)
6. Learners will be able to access information at remote sites, using telecommunications. (6-8. Science & Technology. B2.c.)

The General Idea:

Since we cannot watch a star evolve through its entire lifetime, astronomers use their knowledge of a star's behavior at various stages of its life to piece together a picture of the star's entire life.

The most important factor in how a star evolves and eventually dies is its initial mass. (It is assumed that the students already possess background information concerning how stars of different masses evolve—solar mass stars, such as the sun; low-mass stars 0.8 or less than the sun's mass; and higher-mass stars.)

Getting Ready:

- Gather supplies listed below.
- Arrange all building materials on a large table and in boxes beside the table.

What You Need:

Only research materials are required for this activity. You might want to have a selection of sources on hand in the classroom, but students should go to the library or the Internet for additional research. Reference materials on stellar evolution, including, if possible, examples of images taken by the Hubble space telescope of stars in different stages of development. A computer with Internet access

What To Do:

1. Ask your students how they think astronomers can make inferences about the life of a particular star, from its birth to its death, taking into consideration that it is impossible to observe a star's evolution through its entire lifetime.
2. Make sure students understand that because a star's initial mass largely determines how the star will behave at various stages of its life, observing a star at any of those stages can give astronomers information about the star's initial mass and, therefore, about how the star was born, will evolve, and will die.

3. Tell the class that they will be dividing into teams to do research on a star's life. Each team will focus on one aspect of the stellar evolution of a particular star.
4. Assign each of seven teams a star at a particular stage of stellar evolution: protostar (example: the Eagle Nebula, a stellar nursery), protoplanetary disk and stellar system in formation (example: Orion Nebula), cluster of young stars (example: the Pleiades), middle-aged, normal star (example: the sun), cluster of older stars—red giant (example: Betelgeuse), dying stage—supernova, planetary nebula, white dwarf (example: Supernova 1987A), end state of a star—black dwarf, black hole, neutron star (example: Cygnus X-1).
5. Tell students to keep track of the sources for their facts so that they or other interested classmates can go back to those sources for further information.
6. Encourage students to include visuals in their reports.
7. Have teams report their findings to the class through a poster session, sharing of photographic or printed sources, PowerPoint presentation, or some other format of the students' own choosing.
8. After each team's report, have team members lead a whole-class discussion on what could be inferred about earlier and later stages of the star's development based on information about the star at the stage of stellar evolution the team has researched. What can they infer about the star's initial mass? (For example, our sun will never become a black hole because it has too little mass, and therefore too little gravity. Rather, it will expel a ring of gas rich in heavier elements as a planetary nebula and then contract to become a white dwarf.)

ADAPTATIONS:

Instead of having team members act as discussion leaders, at the end of each report, ask the class specific questions they can answer by making inferences about earlier and later stages of the star's evolution based on information they have learned from the report.

<u>What To Discuss:</u>

1. Explain how the Hubble space telescope's discoveries have improved our understanding of stellar evolution.

2. Debate whether manned space missions should be scheduled during times of increased solar activity. Is space exploration worth the risk of exposing humans to harmful radiation?

3. Discuss what you would expect to see if you were observing a newly forming planetary system. How would the material be distributed? What events would you expect to see on the forming protoplanets?

4. Discuss the two possible explanations of why Venus rotates retrograde and hypothesize and debate alternative explanations.

5. Analyze how astronomers came to the conclusion that Neptune's great dark spot didn't just shift from the southern hemisphere to the northern hemisphere.

6. Our sun is like a giant thermonuclear reactor, generating an incredible amount of energy each second. Fortunately, this violent maelstrom is well contained. Explain how Einstein's famous equation, $E = mc^2$, relates to the sun's energy production. Describe what you think would happen if all the sun's mass were instantly converted to energy.

EVALUATION:

You can evaluate your students on their reports using the following three-point rubric:

- **Three points:** report well researched; information clearly and logically organized; presentation interesting and lively; discussion session well organized
- **Two points:** report adequately researched; information sufficiently organized; presentation dull; discussion session disorganized
- **One point:** report insufficiently researched; information inadequately organized; presentation poorly prepared; discussion session disorganized

You can ask your students to contribute to the assessment rubric by determining a minimum number of facts to be presented in a report and setting up criteria for an interesting and lively presentation.

Continuations/Extensions:

Inner Circle

The three largest terrestrial planets, Earth, Venus, and Mars, share a common heritage in terms of their location in the solar system, composition, and age; however, the path each of these planets took on its evolutionary track is very different. Divide the class into three teams with the assignment to research and present their findings on how their individual planet evolved to its current state. The teams' combined research should make it apparent that many factors played a role in the appearance of each of the three planets and the conditions surrounding each one. Be sure students address the following factors:

1. The planet's orbital characteristics
2. Development and composition of an atmosphere
3. Rotation rate
4. Surface conditions
5. Development of life

You might also initiate a discussion about terraforming, or altering an existing planet's conditions to allow it to become more Earth-like. How could terraforming be accomplished on a planet such as Mars or Venus? Should it be done at all? Would terraforming provide an option for survival when the sun becomes a red giant?

Stellar Scripts

Have students write an article on how life on Earth would change as the sun evolves from its present state to its red giant phase, and eventually to a white dwarf. Encourage them to include the effects on Earth's environment, society, and technology and on human evolution.

Life Cycle of Stars

Adler Planetarium & Astronomy Museum
Astronomy Connections: Gravity and Black Holes

OBJECTIVE:

1. Learners will understand how stars are formed and produce energy. (9-D. Science and Technology. D3.i.)
2. Learners will be able to demonstrate the motions of stars and other objects. (6-8. Science and Technology. D1.a.)

PURPOSE:

This activity enables students to enact the lifecycles of different types of stars, thereby illustrating the rarity of black hole-producing stars.

YOU WILL NEED:

- 12 Red, 12 Yellow, 4White, and 2 Blue Balloons (1 balloon/student for a class of 30)
- Wooden beads
- Marbles
- Ball bearings
- Pin (to pop balloons)
- Red, yellow, and black markers for writing on balloons

PREPARATION:

Place 1 wooden bead inside each red and yellow balloons.
Place 1 marble inside each white balloon.
Place 1 ball bearing inside each blue balloon.

PROCEDURE:

1. Begin by introducing the ways in which stars come into being and produce energy: through gravity's force and nuclear fusion. Nuclear fusion is the bringing together of atoms to form heavier atoms with a release of energy. This can best be done, perhaps, by asking students to state their ideas of what makes the stars shine.
2. Ask if all stars are the same, and ask students to help make a list of things that might vary between stars: mass, color, heat. Make sure to include "life cycle."
3. Ask if students know how black holes form (answer: they form when certain kinds of stars die). Ask how often students think that black holes form, and if they believe our Sun will form a black hole. Don't forget to ask them to explain the reasons behind their ideas! This information will be helpful to you in determining how best to structure your questions through the rest of the lesson.
4. State that the class will do an activity that illustrates how all of these differences in stars' characteristics are related, and will show when, and how often, black holes form.
5. Pass out balloons, distributing different colors, one balloon per student. You should have significantly more red and yellow balloons than blue and white, roughly 80% red and yellow, 15% white, and 5% blue. Explain that the property that causes the main differences between stars is mass. As you pass out balloons, tell students the approximate mass of their star.
6. Ask students which balloons they think represent the hottest stars. Point out that actually red stars are the coolest, and blue stars are the hottest. Ask what color our Sun is (yellow).

7. Ask which color star students believe will live longest, and why. Write prediction on board. Record differing opinions, too.
8. Guide students through the following series of steps. For each age, tell students what to do for their color of balloon. To help students follow the progression, you might write different stages on a board or overhead as you move on, and note important events. Also, ask students to make predictions as you work.

EVALUATION**:**
Discuss as a class what they saw at different stages of each type of stars' life. Which stars became black holes? Why did only those stars become black holes? Which stars deflated and which exploded? What is the main difference between those stars?

CLOSURE**:**
Compare activity to predictions made at beginning of class. Record conclusions drawn from activity next to predictions, pointing out that changing your ideas is part of being a good scientist.

Life Cycle of Stars Information Chart

	Red Balloons	**Yellow Balloons**	**White Balloons**	**Blue Balloons**
Age of Star	0.4 Solar Mass (2/5 the mass of our Sun): Red stars	1 Solar Mass (the mass of our Sun): Yellow Stars	3 Solar Masses (3 times the mass of our Sun): White	9 Solar Masses (9 times the mass of our Sun): Blue
(start)	Blow up the star to about 3" diameter	Blow up the star to about 3" diameter	Blow up the star to about 3" diameter	Blow up the star to about 3" diameter
5 Million Years	Wait. Do not change diameter of balloon.	Wait. Do not change diameter of balloon.	Wait. Do not change diameter of balloon.	Blow slightly more air into balloon.
10 Million Years	Wait	Wait.	Blow up a little more	Blow up star as fast and as much as you can. When star is fully inflated, teacher pops balloon—a supernova.
500 Million Years	Wait.	Wait (note that planets are forming)	Continue to slowly inflate star. As it gets bigger, star cools, so color it yellow and red (make squiggles on surface with markers).	This popped star has become a black hole; all of the super nova remnants can be thrown out into space.
1 Billion Years	Wait	Blow up a little bit.	Quickly blow up star until fully inflated; pop balloon. Make sure to catch marble	Still black hole!

	Red Balloons	**Yellow Balloons**	**Blue Balloons**	**White Balloons**
8 Billion Years	Wait.	Blow up more. The star is getting cooler, so color it red with marker. It is now a supergiant.	This star has exploded. Holding on to neutron star (marble), throw supernova remnants into space.	Still black hole
10 Billion	Wait	Blow up a little more. Outer envelope dissolves, so cut up balloon. The inside ball becomes a white dwarf, and the bits of balloon represent the planetary nebula.	Neutron star	Black hole
50 billion years	Blow up a little more	Move "planetary nebula" farther away.	Neutron star	Black hole
200 Billion years.	Deflate; star has shrunk and died. Color black. Wooden bead inside is a white dwarf.	Nebula is gone. Discuss that the white wooden bead turns black to show that it has burned out.	Neutron star	Black hole.

Development of a Habitable Planet

http://www.teachersdomain.org/resource/ess05.sci.ess.eiu.lp_habitplanet/

Objectives and State of Maine Learning Results Performance Indicators:

1. Learners will be able to identify and sequence the major events that caused Earth to develop into the planet we know. (6-8. Science and Technology. E2.d.)
2. Learners will be able to understand where the ingredients for Earth originated, including the conditions necessary for life. (6-8. Science and Technology. D3.e.)
3. Learners will be able to consider the likelihood of other habitable worlds. (9-D. Science and Technology. E2. C.)

The General Idea:

Earth is just one of innumerable objects in the universe, but it is the only object known to be able to support life. How did the planet Earth develop into the life- bearing planet that it is today? Is it possible that other habitable worlds have also developed? In this lesson, students investigate the origin of the elements, the process of planet formation, the evolution of life on Earth, and the conditions necessary for life as we know it. Students research particular events in the history of Earth that have led to its present state, synthesize their findings with the class, and contemplate the rarity of habitable planets.

What You Need:

1. 10 index cards
2. Access to internet

What To Do:

Before the Lesson:

If possible, arrange computer access for all students to work individually or in pairs. Write each of the following events on an index card:

- Formation of the solar nebula
- Formation of a rocky planet circling the Sun
- Formation of the Moon
- Development of liquid water on the planet
- Appearance of anaerobic life
- Development of aerobic life
- Significant accumulation of oxygen in the atmosphere
- First ice age
- Cambrian Explosion
- Mass extinction of dinosaurs and other forms of life

What to Discuss:

Part I: Investigating the Formation of Earth

1. Ask students to think about the origin of Earth. Working alone or in pairs, have students explore the Infrared Search for Origins http://www.teachersdomain.org/resource/ ess05.sci.ess.eiu.irorigins/, focusing on the "Star Formation" and "Planetary Systems" sections.

2. Divide the class into 10 groups and hand each group an index card with the name of an event. Explain that each group will conduct their own research for their assigned event and that they should be prepared to discuss their findings with the class. You may want to remind them that the answers are not always clearly defined. They should be able to answer, to the best of their ability:
    a. The conditions prior to the event
    b. The event itself: What happened? What caused it? When and how did it happen?
    c. The conditions after the event and its impact on the future of Earth

3. Before having the students disperse to do their research, show the class the following video segments to introduce them to some history of the evolution of Earth and life. These videos do not directly relate to one another and do not have to be shown in order - use as time allows. As students watch the video segments, ask them to record one thing that they learned from each video and one thing that they would like to find out more about. If there is time, have students share their thoughts with the class.
    a. The Elements: Forged in Stars QuickTime Video explains the role of stars in creating the elements found on Earth and throughout the universe. *http://www.teachersdomain.org/resource/ess05.sci.ess.eiu.fusion/*
    b. The Origin of the Moon QuickTime Video shows how samples of rock from the Moon led scientists to theorize that the Moon was formed from Earth materials. *http://www.teachersdomain.org/resource/ess05.sci.ess.eiu.moon/*
    c. Jupiter: Earth's Shield QuickTime Video shows how Jupiter's gravity has protected Earth and why scientists are looking for a similar planetary setup for extrasolar planets. *http://www.teachersdomain.org/resource/ess05.sci.ess.eiu.jupitersrole/*
    d. Global Warming: The Physics of the Greenhouse Effect QuickTime Video explains how the greenhouse effect works on Earth and how humans are affecting it. *http://www.teachersdomain.org/resource/phy03.sci.phys.matter.greenhouse2/*
    e. Ingredients for Life: Water QuickTime Video demonstrates the importance of water to life and explores the possibilities for extreme forms of life. *http://www.teachersdomain.org/resource/ess05.sci.ess.eiu.water/*
    f. Life Before Oxygen QuickTime Video explains how our once oxygen-free atmosphere changed dramatically when primitive bacteria evolved the capacity to harness solar energy through photosynthesis, which produced oxygen as a by-product. Thought-provoking questions are included in the resource and should help students grasp the enormity of this development. *http://www.teachersdomain.org/resource/tdc02.sci.ess.earthsys.stetteroxy/*

Part II: Putting It into Perspective

4. Have students study the following interactive resources: Deep Time Flash Interactive (*www.teachersdomain.org/resource/tdc02.sci.ess.earthsys.deeptime/*) and The Wall of Time JPEG Image (*www.teachersdomain.org/resource/ess05.sci.ess.earthsys.walloftime/*). Both resources present a detailed, interactive timeline of events. They will help the students develop an understanding of their event and how it fits in with geologic time.

5. Have each group present its findings. Using the information they have gathered as a class, students should be able to piece together their own geologic timeline without help from the instructor. This can be done with students standing in front of the room and arranging themselves in the correct order, or by taping a representation of their event on a timeline wall in the classroom.

   Because of the complexity of these events and the interpretation of evidence, there may be several different "correct" versions of the timeline that the students create. Those who have collected the most evidence and have the most persuasive arguments may dictate the final result.

6. Ask students to consider the seemingly unique conditions on Earth. Allow time at the computers to look at the Life's Little Essential: Liquid Water HTML Document (*www.teachersdomain.org/resource/ess05.sci.ess.watcyc.lifeessential/*), the Mars Dead or Alive: Mars Up Close Flash Interactive (*www.teachersdomain.org/resource/ess05.sci.ess.eiu.upclose/*), the App Exception: (*ess05.sci.ess.eiu.planetsearch*), and the Caves: Extreme Conditions for Life QuickTime Video (*www.teachersdomain.org/resource/ess05.sci.ess.eiu.lifecondtn/*). Discuss the following:

   a. Why do most scientists think that water is necessary for life to exist?

   b. How did the discovery of extremophiles change views about life?

   c. Do you think that it is possible for life to exist on Mars?

   d. Do you think that there are other habitable planets in the universe? What about habitable moons?

   e. Did you find any answers to the questions that you had posed when watching the video segments earlier (in step 3)? Which of your questions did these resources answer?

7. Lead a debate about the search for extraterrestrial life. Now that we understand that there are billions of galaxies in the universe, with hundreds of billions of stars in each, it seems quite probable that there may be other life or other planets similar to Earth. And now that we have found extreme forms of life in places on Earth that were previously thought unlivable, it seems possible that life may be thriving in other non-Earthlike worlds.

   a. Divide the class into teams for and against further research to answer the question of whether or not humans are alone in the universe.

   b. Issues to address may include the following: the timescale for life to develop, the limitations of space exploration, the conditions necessary for life, methods to search for life as we know it, methods to look for life NOT as we know it, and the search for extraterrestrial intelligence.

<u>Continuations/Extensions:</u>

1. What conditions are necessary for life as we know it?

2. How does solar system formation affect whether or not life will develop on a planet?

3. How does Earth's atmosphere impact life?

4. What do you think would happen if a giant asteroid hit Earth now?

The Digital Library for Earth System Education (www.dlese.org) offers access to additional resources on this topic: (*www.dlese.org/dds/query.do?q=%22origin%20of%20elements%22%20OR%20%22planet%20formation%22%20 OR%20%22life%20on%20Earth%22&gr=05&gr=02&s=0*).

Learning the Causes of Extinction

By Jacquylynn Brickman

http://www2.scholastic.com/browse/lessonplan.jsp?id=391

Objectives and State of Maine Learning Results Performance Indicators:

1. Sort various extinction scenarios into categories.(6-8. Science and Technology. E5.b.)
2. Develop a list of the five possible reasons why animals become extinct. (9-D. Science and Technology. E5.b.)
3. Learn the acronym HIPPO as a way of remembering causes of extinction.

The General Idea:

There are five major causes of extinction: habitat loss, an introduced species, pollution, population growth, and overconsumption. Through the activity, students will create a list of reasons why animals can become extinct.

What You Need:

1. Scenario Cards, prepared ahead of time by the teacher

SET UP AND PREPARE

1. Create scenario cards for each of the below causes of extinction. Multiple examples of each cause will be needed. An example: I lived in a forest until workers came and cut down all of the trees. (habitat loss) I lived near people until the smoke from their buildings made me sick. (pollution) (there are 16 cards included to get you started on this activity)

   H- Habitat loss
   I - Introduced species
   P- Pollution
   P- Population growth
   O- Overconsumption

2. Write this student-friendly objective on the board: "We will sort various scenarios into categories to discover the main reasons animals become extinct."

What To Do:

1. In small groups, students will sort scenarios into like categories. Teacher will guide the students with questions like, "What do the scenarios have in common?" or "Do you notice any scenarios that are similar?"
2. Students will label each category by completing the sentence, "These animals all became extinct because..." Groups will have one sentence for each category explaining their reasoning.
3. After the scenarios have been sorted, bring the whole group back together.
4. Ask students to explain why they sorted the scenarios into the categories that they did. "Tell me your thinking on that."
5. List student sentences on the board. Ask the group, "Do we see any of these sentences that could be combined?" Guide students into combining the sentences to match the following reasons: habitat loss, an introduced species, pollution, population growth, and overconsumption.

6. Teach the acronym H.I.P.P.O. as a way to remember the five main causes of extinction.

SUPPORTING ALL LEARNERS

Have students who receive Special Education services and English Language Learner services revisit the scenarios and review the vocabulary with their service providers.

What To Discuss:

Review the student-friendly objective. Ask students to reflect by asking them the following question, "How did you help your group meet this objective?"

Continuations/Extensions:

As a challenge, and as the unit progresses, ask students to expand on what they have learned by creating additional scenarios that fit into the categories, using specific animals. Can students use the scenario cards and the causes of extinction to create a board game?

ASSESS STUDENTS

More information can be found on the internet by looking up “Extinct animals”

Observe students at work and collect the sentence labels for the categories to assess group work. Ask yourself:

- Were the students able to sort the scenarios into like categories?
- Did their categories make sense?
- Were the students able to explain their thinking when asked about the sentences that labeled the categories?

ASSIGNMENTS

Students will sort scenarios into like categories.

HOME CONNECTION

Students can take copies of the scenarios home to cut out and sort with their families in a game-like situation.

EVALUATE THE LESSON

Ask yourself:

- What worked well?
- What would you do differently next time?
- What were the students able to do well?
- What did the students struggle with during the lesson?

Is Anyone Out There?

Objectives and State of Maine Learning Results Performance Indicators:

1. Learners will be able to determine the probability of the existence of extraterrestrial life.

The General Idea:

One of the most fascinating questions which could be asked is this: "What are the chances that life exists on another planet orbiting another star somewhere out there?" The attached worksheet will help students understand these chances by taking them step by step through the mathematics used to "guesstimate an answer.

Getting Ready:

- Photocopy the "Is Anyone Out There" worksheet

What You Need:

A copy of "Is Anyone Out There" for each student

What To Do:

1. Hand out the worksheet as homework, just for fun, or to complement another activity that you are doing. This worksheet is very good for a cross-curriculum activity combining the study of astronomy in science and the study of probability in mathematics.

Is Anyone Out There?

One of the most fascinating questions which could be asked is this: "What are the chances that life exists on another planet orbiting another star somewhere out there?" Perhaps it would be best to put some limits on the size of 'out there'. For purposes of this activity, "Out There" will be limited to our own island of stars, the Milky Way Galaxy. The Milky Way Galaxy probably looks like a huge turning pinwheel of stars. (The word 'probably' is used since no one has been outside the galaxy and no external photographs have ever been taken.)

While the exact number of stars in the Milky Way is not known, most astronomers will agree that there are probably several hundred billion stars. For purposes of this activity, the estimate to be used is two hundred billion. (That's the number 2 with 11 zeros behind it.) Most of these stars are congregated in a central bulge with the remaining strewn out in great spiral arms.

STEP ONE:

We mentioned before that our galaxy may contain as many as 200 billion stars. However, not all of these stars are good candidates. Easily half of all the stars in the galaxy are double stars (two stars going around each other) or triple stars. If life were to develop on planets going around stars, it would have a better chance if that star were a single star like our Sun. Thus, to find out how many total single stars there are in our galaxy, do the math step below.

1. 200,000,000,000 X 1/2= _______________single stars

STEP TWO:

If life as we know it exists elsewhere, it probably is on a planet which goes around a sun like our own. Since not all the remaining single stars are like the Sun, some are hotter and blue in color (to hot for life) and others are cooler and red colored (too cold for life.), we will assume that only one star in ten is a star like our own. Thus, your next calculation is as follows:

2. (insert answer from step 1)_______________X 1/10___________single stars

STEP THREE

Not all of the remaining stars have the more complex elements from which life could develop. Some of these stars are what we call early stars, and they contain only hydrogen. Let us suppose that only one star is five has the elements required for life to develop. Perform the calculation below.

3. (insert answer from step 2) ________________X 1/5___________single stars

STEP FOUR:

These remaining stars might not have planets going around them which would be the right size for life. If the planet were too large, like Jupiter, it would hold in all the poison gases. If it were too small, like Mercury, there would not be enough gravity to hold onto an atmosphere. The next calculation is used if we assume that that only one in ten stars have an Earth-sized planet.

4. (insert answer from step 3) _______________ X 1/10 _____________Planets

STEP FIVE:

Next, the Earth-sized planets would have to be at the exact distance from their stars. If it were too close, there would be too much heat for life; too far away - too cold. Suppose that only one planet in ten is at the right distance. Do the calculation below.

5. (insert answer from step 4) _______________ X 1/10 _____________Planets

STEP SIX:

Of these remaining planets, not all of them may have developed an atmosphere which could sustain life. Let us assume that only one in ten has the proper blanket of air. Calculate the number of remaining planets below.

6. (insert answer from step 5) _______________ X 1/10 _____________Planets

STEP SEVEN:

Even though we have narrowed things down considerably, we still are not finished. The odds are fairly thin that life might actually develop on any of these planets. To be conservative, let us reduce the chances to one in a thousand.

7. (insert answer from step 6) _____________ X 1/1000 _____________Planets

STEP EIGHT:

One last reduction is necessary. The life which mathematically might exist on these planets may only be simple life (microscopic organisms, for example.) The chances that there might be planets with <u>INTELLIGENT</u> life are slim. To be on the safe side, reduce the number of remaining planets by a factor of 1000.

8. (insert answer from step 7) _____________ X 1/1000 _____________Planets

Vocabulary List

Aerobic	An organism or tissue requiring the presence of air or free oxygen for life.
Anaerobic	An organism or tissue living in the absence of air or free oxygen.
Black dwarf	The remains of a white dwarf star after it has expended all of its energy and is no longer emitting detectable radiation.
Black hole	A theoretical massive object, formed at the beginning of the universe or by the gravitational collapse of a star exploding as a supernova, whose gravitational field is so intense that no electromagnetic radiation can escape.
Cambrian Explosion	The rapid diversification of multicellular animal life around the beginning of the Cambrian Period, resulting in the appearance of almost all modern animal phyla.
corona	The tenuous outermost part of the atmosphere of a star (like the sun).
cosmic rays	Extremely high-energy, short wavelength particles such as protons, neutrons, and atomic nuclei which originate outside the solar system.
equilibrium	A state of balance between opposing forces or actions. In the sun, this refers to the balancing of inward-pulling gravitational forces with outward-pushing pressure.
Endemic	Specific to a certain area
Extinction	The act or process of becoming extinct; a coming to an end or dying out: the extinction of a species.
Extremophile	An organism adapted to living in conditions of extreme temperature, pressure, or chemical concentration, as in highly acidic or salty environments.
gas giant	One of the outer planets of the solar system (Jupiter, Saturn, Uranus, and Neptune), which are composed of various amounts of hydrogen, helium, methane, and other gases.
greenhouse gas	Any of the gases whose absorption of solar radiation is responsible for the greenhouse effect, including carbon dioxide, methane, ozone, and the fluorocarbons.
nebulae	Clouds of gas or dust in interstellar space.
Neutron star	An extremely dense, compact star composed primarily of neutrons, esp. the collapsed core of a supernova.
Planetary nebula	An expanding shell of thin ionized gas that is ejected from and surrounds a hot, dying star of about the same mass as the sun; the gas absorbs ultraviolet radiation from the central star and reemits it as visible light by the process of fluorescence.
prograde	A direction of rotation or revolution that is counterclockwise as viewed from the north pole of a planet.
Protoplanetary disk	A rotating disk of dust and gas that surrounds the core of a developing solar system. It may eventually develop into orbiting celestial bodies such as planets and asteroids.

Protostar	Any early stage in the formation of a star when an interstellar cloud of gas and dust starts to collapse but before nuclear synthesis has begun at its core.
retrograde	A direction of rotation or revolution that is clockwise as viewed from the north pole of a planet.
Solar nebula	A cloud of interstellar gas and/or dust is disturbed and collapses under its own gravity. The disturbance could be, for example, the shock wave from a nearby supernova.
supernova	The explosion of a very large star in which the star may reach a maximum intrinsic luminosity one billion times that of the sun.
White dwarf	A star, approximately the size of the earth, that has undergone gravitational collapse and is in the final stage of evolution for low-mass stars, beginning hot and white and ending cold and dark (black dwarf).

Some good books to use with *Origins of Life*

Stars and Atoms: From the Big Bang to the Solar System

Stuart Clark. Oxford University Press, 1995.

The concepts and ideas of modern astronomy and cosmology are presented in this clearly worded book, which is supplemented with illustrations, charts, and tables. Read and learn about the universe and its fate, the big bang, galaxies and quasars, stars, and planets.

The Story of Astronomy

Lloyd Motz and Jefferson Hane Weaver. Plenum Press, 1995.

Trace the evolution of the great astronomical ideas from their birth as pure speculations in the minds of the great ancient Greek astronomers to the reality of present-day astronomy. Read about Kepler, Tycho Brahe, Galileo, Newton, Gauss, and Einstein, and the relationship between astronomy and physics.

Life's Matrix: A Biography of Water.

Ball, Phillip. New York: Farrar, Straus and Giroux, 1999.

Tells of the possible origins of water— its history, pervasiveness and potential presence on other planets.

Asteroids, Comets, and Meteors

Marsh, Carole. New York: Twenty-First Century Books, 1996.

Compares asteroids, comets, and meteors and provides a range of general information on the solar system, the galaxy, and the universe.

Some good web sites to use with *Origins of Life*

world.smv.mus.va.us/~jims/student2.htm

Starlight brings us the secrets of the distant stars—their masses, ages and even their temperatures. Explore our nearest star with this interactive website, and learn how to use the tools of spectroscopy.

zebu.uoregon.edu/~js/ast122/lectures/lec14.html

Simple explanations of star formation, enriched with colorful diagrams and related internet links, make this website an excellent primer on stellar evolution.

www.astro.uva.nl/~michielb/sun/kaft.htm

What better place to start a study of stars than our very own Sun. In a "Trip through the Sun" you'll see flames larger than ten earths, winds going 1000 mph, and you'll witness the eventual fate of the earth when the sun dies.

imagine.gsfc.nasa.gov/docs/teachers/lifecycles/SC_title2.html

This is a NASA sponsored website of teacher made activities relating to "The Life Cycles of Stars."

seds.lpl.arizona.edu

Created by Students for the Exploration and Development of Space (SEDS) at University of Arizona.

en.wikipedia.org/wiki/Extinction

Explanations for different types of extinction, as well as many other links regarding extinction.

Lessons From The World Wide Web

Also, a wide variety of lesson plans and activities can be found on the World Wide Web. These sites are dedicated to lesson planning in a variety of subjects.

multiverse.ssl.berkeley.edu/

The Center for Science Education at U. C. Berkeley Space Science Laboratory home page with a link to the Science Education Gateway, Lesson Plans

btc.montana.edu/ceres

Maintained by the Burns Telecommunications Center, this page links to educational activities and classroom resources.

spaceplace.jpl.nasa.gov/spacepl.htm

This California Institute of Technology and NASA Jet Propulsion Laboratory site for kids offers information and activities.

http://www.pbslearningmedia.org/

Digital Media for the Classroom and Professional Development - an online library of more than 1,000 free media resources from the best in public television.

Astronomy Web Sites Worth a Visit

Astro.umaine.edu

The Emera Astronomy Center and the Maynard F. Jordan Planetarium & Observatory home page.

space.jpl.nasa.gov

NASA's Jet Propulsion Laboratory web site

ssd.jpl.nasa.gov

A site about our solar system maintained by the Solar System Dynamics Group of the Jet Propulsion Laboratory.

www.clearsail.net/students.htm

School/Student links from the ClearSail student fun and research site

www.dustbunny.com/afk

A web site about astronomy, designed for kids, with tons of information

hawastsoc.org

The Hawaiian Astronomical Society's home page

www.nss.org/

The National Space Society webpage

stardate.org

Learn what's going on TODAY in astronomy on the "Star Date" web page, maintained by the University of Texas' McDonald Observatory

The Maynard F. Jordan Planetarium does not guarantee that the information given on the above web sites to be accurate, accessible, or appropriate for students.

Activities/Worksheets

Extinction cards
Background: Threatened or extinct species