What is astrobiology? (June 6, 2003 workshop)

Astrobiology is an interdisciplinary field combining concepts in:
Biology, Chemistry, Physics, Mathematics, Earth and space science.
For lesson plans
See the TERC website: http://astrobio.terc.edu/
JPL website: http://ares.jsc.nasa.gov/Education/astrobiology.htm

Astrobiology seeks to answer these questions:
What is the history of life on earth?
Is there anybody out there?
What is the future of life in universe?

See the NASA Astrobiology Website for an overview of sources
http://astrobiology.arc.nasa.gov/

What are the benefits of teaching astrobiology?

- Addresses science concepts in an absorbing story that is unfolding before student's eyes. New discoveries in astronomy and space science are becoming more frequent.

- Engages students in the science process including modeling, designing experiments, testing hypotheses, making systematic field observations, and image and data analysis.

- Concepts in astrobiology address standards in the new Tennessee State Curriculum Framework and the elementary and middle school "level one" Biology Gateway Standards.

NASA's Astrobiology Roadmap
Three Questions/Areas of Study
http://astrobiology.arc.nasa.gov/roadmap/index.html

1. How does life Begin and Develop?
(Relates well to the Biology Gateway Standards)

- Explore how life evolved at the molecular, organism, and ecosystem levels
- Examine the general principles governing the organization of matter into living systems

2. Does Life Exist Elsewhere in the universe?

- Look at extreme organisms as analogues for life on other planets
- Examine what makes a planet habitable

3. What is Life's Future on Earth and Beyond?

- Use space science to look at ecosystems on earth
- Examine how humans will adjust to life in space and on other planets

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Question One: How does life Begin and Develop?

What is the definition of life?
There is no single property that characterizes a living thing.

Activities: Students develop an operational definition of life. They make a list of properties that characterize all living things. Then students can devise methods for testing to be sure that different specimens fall into the following categories: living, non-living, once alive, or under certain conditions will be alive?

The areas of Earth Science that are critical to the field of astrobiology include paleontology and the study of change processes that are critical to supporting life. "Our Solar Neighborhood" workshop on June 12 called "Let the Earth Move Under Your Feet" will explore this question in depth.

See Nancy Stetten's website for information on Tennessee fossils:
www.nashvillefossils.com

Question two: Does Life Exist Elsewhere in the universe?

How do scientists look for life in the universe?

Zoom by Istvan Banyai Penguin Books 1995
A great book that provides a discussion point for how we perceive the world

Macro Investigations and Micro investigations of other planets and moons

- We study extreme organisms on Earth that provide us analogues to life on other planets.
- We look at fly-bys of planets
- We examine dirt and rock samples collected by landing craft or samples that are brought back

Comparative Planetology

Scientists use lessons from earth to draw conclusions about life on other planets and the moons of the solar system. NASA has sent out spacecraft that have gathered information in the following ways: Flybys (Voyager), Orbiting planets and moons (Galileo), Landers (Viking 1, 2), Landers with rovers (Pathfinder and Sojourner Rover on Mars)
Greg Henry at TSU: http://www.tnstate.edu/opr/planet.htm
NASA Solar System site: http://solarsystem.nasa.gov/features/planets/mars/mars.html
Mars pathfinder: http://mars.jpl.nasa.gov/MPF/index1.html
Mars exploration: http://mars.jpl.nasa.gov

Planet Quest: http://planetquest.jpl.nasa.gov/science/science_index.html

From the data and pictures sent back to Earth we know a lot about our solar system. We can make assumptions about which planets or moons in our solar system might have life or once may have had life. Astrobiology is the search for scientific information that supports these assumptions.

Organisms that love heat, cold, or toxic conditions: Extremophiles

Life in Extreme Environments

A recent discovery in the permafrost in the Kolyma Lowlands of northeastern Siberia found 40,000 year old bacteria that were still alive. In the black smokers of the hydrothermal deep sea vents we have found unusual life forms that defy our previous notions about how organisms should behave.

Recent technology has allowed us to go into new frontiers of extreme temperatures and hostile locations. In the deep-sea vents a vast array of creatures ranging from crabs and worms to bacteria coexist in interdependent conditions. Dr. Ro Kinzler describes the conditions at the vents; "The tubeworms are special in the sense that they depend totally on the bacteria in a symbiotic way which means they don't have any digestive tract. They do not have any mouth, they have no anus. Instead they just host these bacteria inside their tissues and the bacteria are responsible for taking chemicals and thermal energy from the hot water and creating organic matter which the tubeworm just then lives on." http://science.nasa.gov/newhome/headlines/ast27jul99_1.htm

The recent discovery of extra solar planets spurs on our interest in asking the question, "Is anyone else out there?" Our research on deep ocean vents helps answer the question, "What else is down there?" It seems that the two questions are related.

For an account of the bacteria in the permafrost see Science at NASA
http://www.science.nasa.gov/newhome/headlines/ast27jul99_1.htm

Earth Microbes on the Moon

http://science.nasa.gov/newhome/headlines/ast01sep98_1.htm

Antarctica

Chris McKay is with the Space Science Division at NASA's Ames Research
http://www.pulseplanet.com/archive/Mar99/1835.html

NAI Site links to many other sites about extreme organisms

http://www.astrobiology.com/extreme.html

Yellowstone National Park: More than Geysers

"*Microbial research projects under way in Yellowstone involve basic studies on extremophiles that live in high temperature and extremes of pH.*

Dr. Thomas D. Brock at the University of Wisconsin, Madison, and other microbiologists have been studying extremophiles in Yellowstone National Park since the 1960's. That research laid a

solid foundation to our knowledge of the diversity, ecology, and physiology of thermophilic microorganisms." From an article by Dr. David M. Ward, a professor at the Department of Microbiology, Montana State University, Bozeman.

Microbiology in Yellowstone: http://www.wfed.org/resources/reports/article5.htm
Geology in Yellowstone: http://www.aqd.nps.gov/grd/parks/yell/
Workshop in Yellowstone: http://www.lpi.usra.edu/education/EPO/yellowstone/

Article by Dave Ward http://www.wfed.org/resources/reports/article5.htm

Almost all of Dr. Brock's book is on line at http://www.bact.wisc.edu/bact303/b1

Time Magazine published an article on extremophiles and the concept of "domains" to organize kingdoms. It is on line but you have to pay $2.95 to read it.
http://www.time.com/time/magazine/article/buylink/oldlink/0,11397,1101020729-322631,00.html

Or you can read the following for free:
The Domain Archaea http://www.ucmp.berkeley.edu/archaea/archaea.html

Searching for Life in the Universe
SETI Search for Extraterrestrial Intelligence
Let your computer be used by SETI when you are not using
http://setiathome.ssl.berkeley.edu/

Deep Sea Vents: Extreme Organisms
http://www.ocean.udel.edu/deepsea/level-2/chemistry/bacteria.html
http://www.womenoceanographers.org/doc/MSummit/Lesson/MelLesson.htm

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Question Three: What is Life's Future on Earth and Beyond?

Mars: 2020
Design a mission to Mars, join the NASA competitions.

NASA Competitions Challenge Students

"The NASA Student Involvement Program (NSIP) is a national program of six competitions linking students in grades K -12 directly with NASA's diverse and exciting mission of exploration, research, and discovery. Students may prepare entries as individuals, as teams of 2-4, or as a whole class, depending on the competition category and grade level. NSIP is a rewarding experience for students and for their teachers. It provides educators with instructional material and classroom-ready resources that support an inquiry-based approach to science, math, technology and geography education. In preparing their

investigations for submission to NSIP, students sharpen their inquiry, problem solving, and creative writing skills."

For more information on each of this year's competitions, entry checklists, application forms, judging rubric, and resource guides visit http://www.nsip.net/index.cfm

Join a teacher workshop to watch the launch of the Mars Rover http://msip.asu.edu/teacherevents.php

Mars Student Imaging Program

The Mars Student Imaging Program is using one of space exploration's most important inventions, satellite imaging. NASA and Arizona State University's Mars Education Program is offering students nationwide the opportunity to be involved in authentic Mars research by participating in the Mars Student Imaging Project (MSIP). Teams of students in the 5th through 12th grade will have the opportunity to work with scientists, mission planners and educators on the THEMIS team at ASU's Mars Space Flight Facility, to image a site on Mars using the THEMIS visible wavelength camera onboard the *Mars Odyssey* spacecraft, which is currently orbiting Mars every 2 hours.

Arizona State University has links to great Mars Websites
http://marsed.asu.edu/

NASA Spacelink resources on Mars:
http://spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/Space.Science/Our.Solar.System/Mars/.index.html

Is there now or was there ever life on Mars?
ALH84001 is one of only 12 meteorites worldwide identified as Martian, based on unique chemistry. At Johnson Space Center, painstaking examination of the mineral constituents of the globules at extremely high magnification using a transmission electron microscope reveal structures that look like fossils.
Martian meteorite: http://www-curator.jsc.nasa.gov/curator/antmet/marsmets/life.htm

Is it a fossil of a once living organism or the result of a non-life chemical process?

Decisions Based on Science
National Science Teachers Association
Campbell, Lofstrom, Jerome
Lesson: Meteors The Decision
"You are a member of the Union of Concerned Scientists (UCS). Your organization conducts research, issues position papers on science policy issues, and frequently testifies before Congress. Imagine that in 1994, and the collision of comet shoemaker-Levy 9 with Jupiter has created great scientific and public concern about large meteorites bombarding Earth. Congress has scheduled hearings on what can be done to prevent this situation from occurring on Earth. The president of the UCS has appointed you to head a committee to determine the organization's position so it can provide input to Congress."

Moon Journals: Writing, Art and Inquiry

By Joni Chancer and Gina Rester-Zodrow

"Observe the night sky every night for one month, from new moon to new moon. Be sure to record the date and time of your observations. Even though the moon is the star of your journal, pay attention to other nighttime wonders. Let your eyes adjust to the darkness and then—look up! What do you see? Are there clouds? Is it a foggy or misty night. Is the wind blowing? Is the sky dark or filled with moonlight? Do you see constellations or planets? Shooting stars? What do you hear? Crickets? Birds? Animals? Raindrops or wind? Cars or airplanes? Do you smell flowers, trees, or the smoky scent of a fire?"
Journaling is an excellent way to reflect on learning, synthesize thoughts, and keep track of plans for the future.

Drawn to Space:
Keeping a Discovery Journal of the Solar Neighborhood

Classroom Teachers and Art Teachers
Fall 2003
Elementary and Middle School All grades
Must be a team of at least two teachers including an Art Teacher
Tentative Dates for the First Round (Two evenings)
Tuesday September 9th Time 6 PM-9 PM (corrected time)
Tuesday October 14 Time 6 PM-9 PM
No stipend available Limit 15 teams/30 participants

You are invited to put together a team of two (or more) teachers from your school including:
A classroom teacher (may have more than one general education teacher and
An art teacher
Join us for a series of fall workshops on creating a "Discovery Journal" using the moon and stars as your inspiration. Dyer Observatory, a Nashville treasure, will be the site of this professional development that will allow teachers to work with some of the most renowned scientists and astronomers in Tennessee, while being mentored by armature astronomy volunteers, and instructed by experienced artists and educators. This project will be collaboration between Tennessee State University and Dyer Observatory of Vanderbilt University. The instructors for these workshops will be Judy Butler, Director of Education and Public Outreach for the Center of Excellence, Information Systems TSU and Rocky Alvey, Superintendent of Dyer Observatory of Vanderbilt. There is no stipend but each teacher will receive a book called *Moon Journals: Writing, Art, and Inquiry through Focused Nature Study* by Joni Chancer and Gina Rester-Zodrow and a large blank journal/sketchbook for multi-media projects along with NASA materials. Partial funding for this workshop comes from the Tennessee Space Grant Consortium

COMPUTER RESOURCES

Great Solar System Rescue Grades 5 – 8

Students become real-world scientists while exploring our solar system!
A Tom Snyder Product
http://www.tomsnyder.com

With this cooperative learning CD-ROM program, students must find and rescue probes lost in our solar system. Role-playing scientific experts, students use geology, planetary science, chemistry, and other subjects to guide their search. Students discover that teamwork and collaboration, as well as science, are key to success. In addition to four challenging rescue missions, the CD-ROM contains an extensive library of over 65 short movies and stills, each tied to a comprehensive lesson plan in the Teacher's Guide.
http://www.tomsnyder.com/products/ProductDetail.asp?PS=GREGSD
1-Computer License W-GSDA **$99.95**

Space Probe
Grades (4-8)
A math simulation in which students build and test fly scientific probes, and then compete to obtain contracts to conduct planetary exploration. Students form cooperative groups and develop flying probes to explore planets in different star systems.

Your students will:

* Select appropriate units and tools to measure the accuracy of scientific space probes
* Record and graph data to determine the quality of the probes
* Draw conclusions about the best probe for each space mission
* Earn points based upon the accuracy of their estimates in comparison to actual trials
* Participate in contests that test probe quality
* Draw blueprints and write directions so that their probes can be reconstructed

Teacher Guide and 35 Student Guides
http://www.interact-simulations.com/Home.asp
Interact Company
Unit Price
$56.00
5937 Darwin Court, Suite 106, Carlsbad, CA 92008
Phone: (800) 359-0961 Fax: (800) 700-5093 Email: sales@interact-simulations.com

Astrobiology University Programs

University of Washington Astrobiology web site developed by Dr. Woody Sullivan in the Department of Astronomy
http://www.astro.washington.edu/woody/

NAI Lead Teams
http://nai.arc.nasa.gov/institute/lead_teams.cfm

UCLA The IGPP Center for Astrobiology
http://www.astrobiology.ucla.edu/

Penn State University Astrobiology Research Center
http://psarc.geosc.psu.edu
http://psarc.geosc.psu.edu/new_homepage/outreach.htm

Education and Outreach Sites for Astrobiology
NASA Astrobiology Institute web site for teachers
http://nai.arc.nasa.gov/teachers/

Astro-Ventureuses astrobiology content, the scientific inquiry process and critical thinking skills to increase awareness of NASA careers and to educate students in grades 5-8 on the requirements of a habitable planet.
http://quest.arc.nasa.gov/projects/astrobiology/astroventure/avhome.html

Sign up for the
Tennessean's **Newspaper In Education** for the fall issue
"Astrobiology: Our Solar Neighborhood"
This will be a 16 page insert on Astrobiology for Teachers/Students
http://www.tennessean.com/nie/index.shtml
Or call to sign up: 615-259-8032

EXTREMOPHILE CHART

Extremophiles are organisms that require extreme environments for growth. The term "extreme" is relative, with the point of relativity being what is normal for humans. As humans define extremophiles they are organisms that "love" (phile) environments including high temperature, pH, pressure, and salt concentration. These extreme conditions exist at both ends of the continuum for high or low temperatures, high or low acidity or high or low pressure.

	Description	**Environmental Habitat**	**Example**	**What Planet Might Have Similar Organisms?**
Alkaliphile	Organisms with optimal growth at pH values above 10.	They thrive in soda lakes and carbonate-rich soils like those in Egypt and the Rift Valley of Africa	Alkalphilic bacteria	
Barophile	Organisms that lives optimally at high hydrostatic pressure	They thrive at depths where the pressure is at least 700 atm and will not grow at all at 1 atm.	Barotolerant microbes	
Acidophile	Organisms with a pH optimum for growth at or below pH 3.	They thrive in acidic environments such as sulfuric pools also in the debris left over from coal mining	Unclassified organisms growing on gypsum in caves	
Halophile	Organisms requiring at least 2.0M salt for growth.	They thrive in extremely salty lakes including the Great Salt Lakes and The Dead Sea	Halobacterium	
Psychrophile	Organisms having a growth temperature no higher than 15C	They thrive in Artic & Antarctic Ocean	Polaromonas vacuolata	
Hyperthermophile	Organisms having a growth temperature optimum of >80C	Vulcano Island, Italy	Pyrococcus furiosus	
Thermophile	Organisms having a growth temperature>45C	They brighten hot springs in Yellowstone's National Park	Thermus aquaticus	

Chart developed by Tenisha Taylor