

General Meeting
of the
NASA
Astrobiology
Institute

Education and Public Outreach

Building Community in Astrobiology Through Education and Public Outreach

Kindergarten through 12 th grade (Teachers and Students)	Undergraduate Education	Graduate Education	Science Organizations (and Science Advocacy Groups)
<ul style="list-style-type: none"> • Teacher Workshops • Student tours of Universities and Institutes • Lectures • Science mentoring • Career Fairs • Presentations and Workshops at education conferences • Websites and interactive web activities • JASON XI Project • Educational CD-ROMS • Curriculum development 	<ul style="list-style-type: none"> • Astrobiology courses and seminars • Departmental seminars • Virtual field trips • Invited talks, guest lectures • Websites and webcasts • Open houses 	<ul style="list-style-type: none"> • Departmental seminars • Lectures, invited talks and discussions • Astrobiology graduate courses • Support of graduate students • Posters at conferences • Postdoctoral research awards 	<ul style="list-style-type: none"> • Presentations at science societies and science organizations conferences and events • Articles in organizations news magazines and special publications • Poster presentations at meetings and conferences
Informal Education (Museums, Youth Groups, Community Groups etc.)	Media and Public Broadcasting	Business Community	Government Organizations
<ul style="list-style-type: none"> • Workshops and lectures at museums • Talks and presentations at Scout meetings, Rotary Clubs, Elderhostel groups, sport clubs etc. • Exhibits • Presentations at local festivals 	<ul style="list-style-type: none"> • Press conferences • Newspaper and magazine articles • Television and radio interviews • Television programs • Book publications • Presentations to media producers 	<ul style="list-style-type: none"> • Presentations and discussions at professional societies • Presentations and discussions at local businesses • Facility tours and talks 	<ul style="list-style-type: none"> • Lectures and presentations at other Government research organizations and laboratories • Science advisor to National Parks • Cross-training • Presentations to other NASA & non-NASA E&PO groups

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Astrobiology Education and Outreach at Penn State

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This poster presentation will outline several of the education and outreach activities being carried out by the Penn State Astrobiology Research Center (PSARC). Program activities target undergraduate students, K-12 educators and students, and the general public.

Higher Education

Astrobiology Minor: Undergraduate students at Penn State can now earn a Minor in Astrobiology. The program includes courses from the departments of Geosciences, Astronomy & Astrophysics, Biology, Microbiology, and Biochemistry & Molecular Biology.

WISER: Women In Science & Engineering Research. First-year undergraduate students gain invaluable experience and mentoring from PSARC scientists who participate in this research internship program which is designed to retain women students in the science and engineering fields.

K-12 Education

Teacher Workshop: an annual five-day residential workshop for in-service teachers in life science, chemistry or earth science, grades 7-12. The workshop is designed to provide teachers with astrobiology content knowledge as well as inquiry-based activities for use in the classroom. The teachers interact directly with several of the PSARC co-investigators through research presentations, laboratory tours, and field trips.

WISE Week: an annual one-week residential program for young women in the 11th grade. PSARC investigators participate by involving the students in two-hour hands-on workshops or week-long projects.

“What’s In The News?”: PSARC scientists work with Penn State Public Broadcasting to introduce the exciting field of astrobiology through this multimedia children’s current events program. Aimed primarily at grades 4-7, the weekly programs reach more than 5 million children in 32 states across the country. Along with the broadcasts, WITN provides printed support materials, a newspaper column, instructional kits, and web-based information and activities that offer a range of resources for both teachers and

students. The first astrobiology episode aired March 3, 2000. The on-line component of that program is archived at the WITN website (<http://witn.psu.edu/2223/>).

General Public

Lecture Series: Penn State hosted a series of Saturday public lectures on Astrobiology. The standing-room-only series featured NAI scientists from Penn State, Harvard, and the University of Colorado as well as scientists from the SETI Institute and Rice University. The lecture series was captured in an outstanding article by Research Penn State magazine. A special issue of the article is being disseminated through the NAI to high school science teachers for use in classrooms across the country (<http://www.research.psu.edu/rps/0101/Astrobiology.pdf>).

Space Day at Penn State: PSARC participates in this annual one-day event designed to showcase the exciting space-related research being carried out at Penn State.

Astrobiology at Arizona State University: Program Overview and Research/Outreach Highlights

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ASU's Astrobiology Program is an interdisciplinary program of study and research that offers exciting opportunities for both undergraduate and graduate students who seek a high-level academic experience at a Research One University. The current program includes faculty researchers and students at all levels from the Departments of Geological Sciences, Chemistry and Biochemistry, Biology, Plant Biology, and Microbiology. We also are supported by affiliated programs in Astronomy, Aerospace Engineering, and Biotechnology. The current program supports 15 funded ASU Co-Investigators across these disciplines with collaborative ties to the College of William & Mary, University of Alaska, University of Arizona, University of Connecticut, University of Puget Sound, University of Tennessee, Indiana University, and the National University of Mexico (UNAM), Mexico City. At last count, ongoing research projects are providing training opportunities for 19 graduate and 7 undergraduate students. Active research areas include the 1) cosmochemistry of carbonaceous meteorites, 2) organosynthesis in seafloor hydrothermal systems, 3) the origins and evolution of photosynthesis, 4) studies of the microbial fossil record, 5) environmental conditions on Archean Earth, 6) the structure, function and persistence of complex ecosystems in extreme environments, 7) the effects of impact processes on planetary habitability and evolution, and 8) the exploration for habitable environments and life on Mars and Europa. In this presentation we will review the present current research highlights and review recent Education and Public Outreach activities from the past year.

Some research highlights from the past year include the analysis of 1) a pristine carbonaceous meteorite which recently fell in Canada, 2) the synthesis of methanol under simulated seafloor hydrothermal conditions, 3) the discovery of novel photosynthetic organisms and molecular phylogenies which trace the origins of photosynthetic genes, 4) a robust model for the Archean oceans which suggests it was hypersaline, 5) discoveries of probable microbial biosignatures in subsurface hydrothermal deposits, and 6) the first detection of aqueous mineral deposits (specular hematite) on the surface of Mars by mid-infrared remote sensing methods. For more detailed information about these research projects and results, please see poster presentations by individual ASU investigators at this meeting.

Education and public outreach highlights for the year include a public lecture by Dr. Baruch Blumberg, Director of the NASA Astrobiology Institute and an NAI-supported workshop and poster session for local K-12 science teachers. High attendance at both of these events illustrates the high level of enthusiasm and excitement that Astrobiology generates within our local community. Other highlights include our participation in

ASU's Earth Sciences Day activities and SEE ASU, a day-long K-12 outreach program that provides students from Arizona schools with an opportunity to explore the many exciting degree programs offered at ASU.

We will also present highlights from the ASU Astrobiology Program website as an effective education and outreach tool and as a means to recruit top graduate students into the program. A list of the most recent publications from the ASU research team will be available.

SPACELINE, a Bibliographic Database for Astrobiology: Capabilities and Issues

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SPACELINE (<http://spaceline.usuhs.mil>) contains bibliographic references to publications in astrobiology and the space life sciences. It is a collaborative effort between NASA and the National Library of Medicine of the National Institutes of Health. The purposes of this poster are to demonstrate the database's capabilities, discuss some of the issues and challenges that accompany a bibliographic approach to astrobiology, and obtain feedback from the astrobiology community. SPACELINE is undergoing significant changes in its search interface and how it is searched during the first half of 2001, changes that will result in greater integration with National Library of Medicine databases. Online demonstrations will be given during the meeting.

A distinguishing characteristic of astrobiology is its interdisciplinary nature. It is a continuing challenge to balance the integration of different disciplines that a bibliographic database like SPACELINE can achieve against the effort necessary to provide comprehensive bibliographic coverage in individual disciplines. An interdisciplinary database best meets the needs of individuals in the field seeking interdisciplinary updates or scientists new to this field seeking to find out what is known, and in this way SPACELINE contributes to solving the interdisciplinary hurdles faced by astrobiology. To what extent such a database can, or should, also meet the more detailed needs of researchers within their own disciplines is an open question.

Other challenges include the evolving role of scientific publication and bibliographic databases in a web-linked world and SPACELINE/National Library of Medicine plans

for keeping up with these changes; and the possibility and value of creating a distinct astrobiology entity within SPACELINE.

An Astrobiology Microbes Exhibit and Education Module

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Introduction. Telling the story of NASA-sponsored scientific research to the public in exhibits is best done by partnerships of scientists and museum professionals. Likewise, preparing classroom activities and training teachers to use them should be done by teams of teachers and scientists. Here we describe how we used such partnerships to develop a new astrobiology augmentation to the *Microbes!* traveling exhibit and a companion education module.

Background. Space Center Houston (SCH), the visitor center for NASA Johnson Space Center (JSC), had contracted in advance to display the *Microbes! Invisible Invaders and Amazing Allies* exhibit during winter and spring 2001. The dynamic exhibit focused heavily on disease and cures due to major funding from Pfizer Pharmaceuticals. SCH and JSC planned to add a small component to the exhibit to highlight JSC microbiology and astrobiology research. Meanwhile, NASA Planetary Protection Officer John Rummel learned of the exhibit. He suggested that JSC expand the NASA section to have a strong astrobiology focus so that it could serve as a prototype for permanent augmentation into the *Microbes!* exhibit. Furthermore, he proposed that JSC add an education module consisting of a teacher guide and outline for a teacher workshop including both scientific presentations and hands-on activities.

Process. Planning for the NASA augmentation to the exhibit began with a visit to its Fall 2000 venue at the Discovery Museum in Ft. Lauderdale, FL. Rummel, Olendzenski, and the JSC-SCH team reviewed the exhibit and discussed topics to be incorporated. Then the JSC-SCH team prepared an outline for the exhibit augmentation. At this point Stocco and Tobola, two classroom teachers who have worked for several years with scientists from the JSC Astrobiology Institute, were brought on board to begin work on the education module. We thus divided into an exhibit team and an education team, with Lindstrom and Allen providing coordination between the two and also with various JSC scientists. The two teams worked in parallel to accomplish the tasks in the short three months remaining.

Exhibit. The NASA augmentations are incorporated mainly at the end of the exhibit because the existing *Microbes!* exhibit followed a time sequence from antiquity to the present. Some small displays are added earlier in the exhibit to correspond to the recent past. These include the quarantine of Apollo astronauts and samples upon return to Earth, the Viking search for life on Mars, finding possible fossil life in a martian meteorite, and microbiology aboard the space shuttle, Mir, and International Space Station.

The theme of the main NASA Astrobiology section is *Life in the Extremes- from the Deep Sea to Deep Space*. Artwork by Pat Rawlings serves to link various environments to the common theme. The environments depicted in the large vertical mural are: deep sea hydrothermal vents, volcanic hot springs, Antarctica, space station, Mars, Europa, and planets around other stars. A special section relates environments on Mars (lake beds or hot springs) and Europa (ocean under ice) to similar environments on Earth in order to consider the potential for extraterrestrial microbial life. Computers are used for some interactives, but an “acid cave” complete with touchable “microbial” snottites provides both visual and tactile stimulation for learning about these bizarre environments.

Education Module. The existing *Microbes!* exhibit provided a teachers’ guide containing commonly used activities for microbiology. In preparing the revised module, the education team carefully reviewed this guide, as well as the NASA Astrobiology teachers’ guide, activities developed by JSC and MBL member Astrobiology Institutes, and many materials from other sources. We considered the topics presented in the exhibit, especially the new Astrobiology augmentation, and chose existing classroom activities or developed appropriate new ones. We then prepared a workshop outline that includes scientist presentations and associated classroom activities, followed by a tour of the exhibit pointing out connections to the topics for classroom use. The activities are all keyed to the National Science Education Standards and the workshops are planned for two different age levels so that both science content and activities are grade-appropriate.

Conclusion. Our scientist-museum-educator partnership has developed a prototype astrobiology augmentation to the *Microbes!* exhibit and a companion education module. The exhibit opened at SCH February 1 and the teacher workshop was presented on February 14 to master teachers from the Houston area Region IV Science Collaborative. After a review of these products, it is hoped that they can be added as a permanent augmentation to the exhibit that is traveling nationwide.

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Fly Me to the Moon: A System for Technologically Enhanced Outreach.

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The NASA Astrobiology Institute is a “virtual organization”, and as such makes it possible to perform outreach in remote areas, which have until recently been excluded from such activities by preventive travel costs.

We show how new technology available for internal administration within NAI can be used for the creation of a simulated space mission, in which children in remote regions of the USA and elsewhere are sent on educational trips to other planets, under the supervision of a “mission base” in the form of one or two scientists located in a NAI center.

Since the required equipment and personnel are already available within the NAI IT infrastructure the project cost can be held modest, while the result is still “slick” enough to excite teenagers with years of experience from highly advanced game and movie computer graphics.

micro*scope and *Biose-IT* – Web Based Resources for Promoting Awareness of Microbial Biodiversity

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Although Bacteria, Archaea, and protists are major players in all natural ecosystems, a lack of adequate traditional taxonomic resources hinders progress in many areas of microbial ecology. The resources that are currently available for microbiota do not compare favorably with those available for the macrobiota and there is a particular gap in availability of materials for educational purposes. **micro*scope** is a new internet initiative which aims to provide such resources. It will include five major areas:

1. Images: We will supply high quality images with associated explanatory text, downloadable as in a variety of formats including high-resolution TIF format. They will be free to educational users. The images are organized by group, alphabetically by name, or by habitat and can be accessed by asking questions such as - “What kinds of organisms am I likely to find in marine sediments?” or “What pictures are there of flagellates?”.
2. *Biose-IT* tools. These are software aids to promote the assembly, interrogation, and compilation of biodiversity information on the internet. They capitalize on the fact that all data are linked to the names of taxa and these names are placed in hierarchical structures. Such structures can be called upon to extend or narrow internet searches. The *Biose-IT* suite includes tools to search and compile data from external data sources. Biose-It software will be freely available.
3. Classification: Based on the rationale that classification can be used to enhance biodiversity search strategies, micro*scope will contain the first complete contemporary classification system of all protists. This has been assembled using Platypus © software. This structure is also used to associate formal descriptions,

drawings, and photographs of microbes with names. The compilation will also be available for downloading.

4. Identification guides. Identification keys using Lucid © v.2 will be included. Lucid © is identification and diagnostic software relying on a data matrix. The internet browser functions allow integration of the taxa covered by the key with all other biodiversity sites on the Internet. The keys will be downloadable.

5. Educational resources. We will include educational materials for secondary and tertiary educators. These resources include talks, reference material similar to that found in introductory university text books, and ideas and exercises that will guide teachers who wish to develop rewarding exercises using microbes.

We intend to foster collaborations with micro*scope to expand the site in a modular format. The site will be made accessible to the public in May 2001. Thereafter, expansion is planned to be modular. At this stage, we seek critical and constructive input and expressions of interest from potential collaborators.

Bacterial Paleontology as a Course of the Lectures for the Students – Geologist and Paleontologist of Moscow University

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The materials, obtained per last decade, on fossil bacteria and products of their vital function from Phanerozoic and Pre-Cambrian deposits of the Earth were a stimulus to isolation of a new branch – bacterial paleontology. The data of bacterial paleontology are extremely important for the studying of sedimentology, including elucidation of genesis of a series of important sedimentary mineral resources such as phosphorites, bauxites, manganese ores, oil, for discussion of problems of evolution of Biosphere, specially in a Pre-Cambrian and early Paleozoic, and for paleogeographic researches. At last, bacterial paleontology is one of key aspects for studying of astromaterials. For acquainting the paleontology and sedimentology students with achievements of bacterial paleontology A.Yu. Rozanov during two years was giving a course of lectures for geologists in Moscow State University. Colleagues – specialists on different parts of this discipline were involved in reading the lectures. On the basis of the read course the textbook "Bacterial paleontology" is compounded. The following parts are included in it: "Recent bacteria and bacterial assemblages. Procaryotic cell as a system" (G.A.Zavarzin); "Cyanobacteria, cyanobacterial assemblages, mats, biofilms" (L.M.Gerasimenko, G.T.Ushatinskaya); "Cyanobacterial mats is an analogue of fossil stromatoliths (laboratory modelling)" (V.K.Orleanskii); "Stromatoliths" (M.A.Raaben); "Experiments on laboratory fossilization" (L.M.Gerasimenko, G.T.Ushatinskaya); "Some fossil microbial assemblages. Silicified microfossils. Phosphorites. Bauxites" (V.Sergeev, E.A.Zhegallo, A.Yu.Rozanov, G.T.Ushatinskaya, E.L.Shkolnik); "Fossil bacteria sedimentation and ore genesis" (A.Yu.Rozanov); "Cyanobacterial mats is a source of parent matter of oil" (A.Yu.Rozanov); "Schungites is a model object for studying of globulization" (A.Yu.Rozanov, G.T.Ushatinskaya, E.A.Zhegallo); "Bacterial paleontology and astrobiology. Analyze of extraterrestrial matter" (A.Yu.Rozanov, R.Hoover, E.A.Zhegallo); "Viable ecosystems of cryolithosphere" (E.A.Vorobyova, V.S.Soina, D.G.Zvyagintsev, D.A.Gilichinskii); "Long anabiosis of microorganisms in a glacier of central Antarctic Continent" (S.S.Abyzov); "Development of life on the Earth" (G.A.Zavarzin). The photos, schemes, graphs and tables assisting to understand and to learn the expounded material are placed at the textbook. It is accompanied by the dictionary of the used scientific terms. The textbook will published on Russian and English.