# Are We

*An image of a nebula is displayed on a hyperwall at the California Institute for Telecommunications and Information Technology.*

*Photo Credit: Lockheed Martin/Estelle Dodson*

# Alone?

## Answering This Question Is Not a Lone Venture

BY WENDY DOLCI, ED GOOLISH, AND CARL PILCHER

How does life begin and evolve? Is there life elsewhere in the universe? What is the future of life on Earth and beyond? The NASA Astrobiology Institute (NAI) was founded in 1998 as part of NASA's long-term quest to explore these fundamental questions. The NAI is one of four elements of NASA's Astrobiology Program, which has its roots in the agency's Exobiology Program established in 1960.

*This artist's concept illustrates the connection between life and space exploration, both of which are key for astrobiology.*

Image Credit: NASA/Cheryse Triano

The field of astrobiology developed rapidly during the mid-1990s as several threads of scientific investigation came together. Scientists were recognizing the great diversity of life on Earth and life's ability to survive in extreme conditions. At the same time, the diversity of solar-system environments and their potential to harbor life were increasingly understood, and extrasolar planets were first detected. The NAI was born amid this convergence of discoveries and new ideas.

Capitalizing on advances in information technology that had begun to make remote collaboration practical, the NAI was designed as a nontraditional "institute without walls" with researchers distributed across the United States. Currently, fourteen interdisciplinary teams—encompassing about six hundred researchers at more than one hundred institutions—compose the core of the Institute. The teams work under competitively awarded cooperative agreements with five-year terms. A small management office at Ames Research Center administers the Institute and provides leadership to make the whole more than the sum of its parts.

Although basic and applied research in astrobiology is the Institute's first priority, NASA also envisioned that the NAI would test a new paradigm in science management, bringing scientists together across disciplinary, geographic, and organizational boundaries. The institute is further charged with playing a leading role in shaping space missions, making innovative use of information technologies, nourishing public interest in astrobiology through a strong education and outreach program, and training new generations of astrobiologists. This broad charter is a distinguishing characteristic of the NAI that puts the Institute and its science teams front and center in cultivating the field of astrobiology.

## Developing a Field, Creating a Community

Creating a community of scientists with diverse backgrounds is a multifaceted process. Astrobiology requires collaboration between researchers from the geo-, bio-, astro-, and other sciences. Of course, this expertise is not limited to one or even a few nations. With the founding of the NAI, NASA's long-term commitment to astrobiology catalyzed a global astrobiology community. Partnership with the NAI lent weight to the establishment of organizations abroad such as the Centro de Astrobiología in Spain and the Australian Centre for Astrobiology. The NAI maintains these early partnerships and today also has partnerships with astrobiology organizations in Britain, France, and Russia as well as with the European Astrobiology Network Association.

The NAI links national and global networks of astrobiologists through technology and a range of activities and funded programs. The Institute funds workshops and conference sessions, and it designed and operates the Astrobiology Program Web site for NASA Headquarters. It brings program news and activities together in one place online. Broad participation in NAI science is made possible through programs such as the Director's Discretionary Fund, which awards small grants each year for seeding new ideas; a Minority Institution Research Support program; and NAI focus groups that advance specific topics of community interest.

Addressing the questions of astrobiology will take a sustained effort over generations. Current scientific investigations and space missions will, in many cases, be brought to fruition by today's students. Recognizing that students need a stable environment to thrive, the NAI actively supports a growing network of early-career researchers in astrobiology. A key example is the NAI Postdoctoral Fellowship Program that has funded fifty-four postdoctoral fellows to date, with many of the earliest NAI fellows now in faculty positions and advising a new generation. An additional five hundred or so postdocs have been supported directly by NAI teams.

A critical aspect of training the next generation of astrobiologists is preserving continuity in the face of budget fluctuations and turnover in grants. When astrobiology budget

cuts occurred during the mid-2000s, student support remained a top priority for the NAI. And in 2008, NAI provided "continuity funding" for students who faced potential loss of funds when team grants ended their five-year terms.

### From Competitors to Collaborators

A central management challenge for the NAI is balancing healthy competition with collaboration. Selected teams must make the transition from the highly competitive proposal process to the collaborative environment of the NAI. Five years later they may again be competitors. Despite this, collaboration flourishes across the Institute.

In the Institute's early years, biennial general meetings drawing about five hundred scientists provided opportunities to meet, present research, and discuss potential collaboration. In recent years, strategic-planning workshops focused on particular goals, and topic-based "virtual meetings," have replaced large, general meetings. For example, addressing the issue of competition versus collaboration head-on, a workshop was held immediately following the selection of ten new teams in 2009 to identify common research threads. The premise was, "Okay, now the competition is over and we have fourteen NAI teams—let's see what we can accomplish together." Such an approach is unusual; research teams typically go their own way once grants are awarded. The result was a suite of cross-institute initiatives and a new network of connections among researchers.

One of these new initiatives became the subject of a "Workshop Without Walls" conducted in March 2010 using the NAI's advanced collaborative technologies. The workshop, on "The Organic Continuum from the Interstellar Medium to the Early Earth," was international, with more than 170 registrants from twenty-one U.S. states and sixteen other countries. Thirty-three scientific talks were presented over two days, with the vast majority of participants remaining at their home institutions—or in some cases, at home! The ease of joining the workshop

## THE VIRTUAL PLANETARY LAB

How do you get fifty-five scientists with diverse science backgrounds from five countries and twenty-three organizations to work together? By posing questions that are so big that they force interdisciplinary collaboration, says Vikki Meadows, head of the NAI's Virtual Planetary Lab (VPL) team at the University of Washington. The major question that drives Vikki and her team is this: Were we to find a rocky world orbiting another star, how would we know if that planet could or did support life? To help answer this question, the VPL team constructs models that simulate the planet's interaction with its parent star, and the resulting environments and spectral signatures of Earth-like planets. These models help us understand what "the fingerprints" of life look like—so that we might recognize life on distant planets when we see it.

The VPL team draws together scientists from more than fifteen disciplines, from biometeorologists to stellar spectroscopists—there is some truth to the inside joke that "it takes a planet to model a planet." Team members live across the United States and in a handful of other countries, including Australia, Mexico, and France. They use a mix of videoconferences, teleconferences, Web sites, and online meeting tools and workspaces for communication and remote interactions. In-person meetings also play an important role.

Developing a large team that works well together takes time. The five-year duration of NAI grants (and VPL's selection in two separate competitions) has provided time for the team to gel and produce truly interdisciplinary research, and to attract and support a cadre of young researchers launching their astrobiology careers. The distributed nature of the team has encouraged its members to stay involved over the long term. Colleagues who no longer have a formal role still connect from far-flung places for team meetings and contribute to VPL research.

*Former NAI Director Baruch Blumberg and members of the NAI Executive Council view an image of Mars on the NASA hyperwall at Ames Research Center.*


Photo Credit: NASA/Wendy Dolci

remotely made a great diversity of participants and increased interactions possible.

Bringing people from different disciplines together is not all that's required. Having a common language and a common understanding of multiple fields are key to working on interdisciplinary teams. The NAI has experimented with various ways to share knowledge across disciplinary boundaries. "Primer sessions"—an astronomy class for biologists, for example—have been held prior to astrobiology conferences to introduce multidisciplinary concepts and terminology.

Natural cross-training occurs when researchers from various disciplines work together, resulting in a new breed of individuals who are themselves interdisciplinary. Surveys conducted by NAI soon after its formation and again in 2007, asking scientists to identify their areas of expertise, show an increasing number of scientists calling themselves "astrobiologists." Furthermore, the 2007 survey, which asked for identification of primary, secondary, and tertiary disciplines, showed that many NAI scientists indicate expertise in multiple fields.

## Working Together Across Distances

The basic NAI tools for remote communication include high-definition videoconferencing, teleconferences, Web sites, Web-meeting software, online recordings and podcasts, online workgroup software, social networking sites, and online office tools. In addition, the NAI experiments with hyperwall technology, high-speed networks, virtual worlds, and other leading-edge technologies to enhance research.

*Shadows of future astrobiologists.*

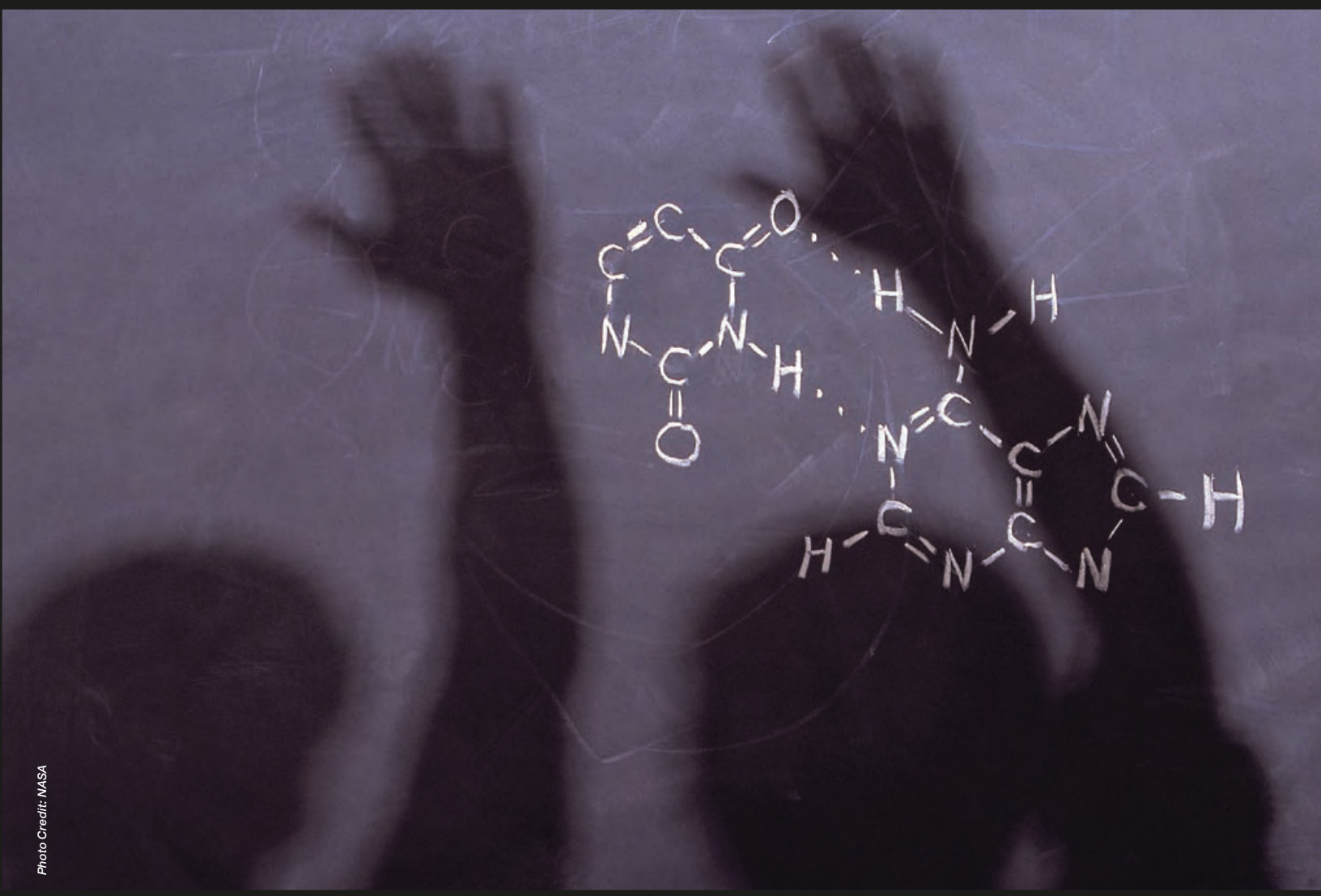

Photo Credit: NASA

Students in many cases are leaders in the use of information technology for science communication, reflecting their ease with social networking and other forms of remote communication. As part of the 2009 Astrobiology Graduate Student Conference, students held a mixed-reality event that took place simultaneously in person and in the virtual world Second Life. Students gathered in Seattle were able to interact with students from Portugal, Greece, Australia, Uruguay, and across the United States who otherwise would not have been able to participate.

A few management philosophies guide the NAI in its use of information technology. One is to offer a suite of tools and the expertise in how to use them, and support flexible solutions as teams create collaborative environments that suit their particular needs. Another is for the NAI's central office to be the first line of support for teams. Problems such as a forgotten password or a technical glitch can be barriers to success. Having a known and trusted point of contact for immediate resolution of problems is critical.

Videoconferencing in particular has seen much improvement since the late 1990s, when multipoint videoconferencing was fraught with problems and required racks of equipment. Today's videoconferencing solutions are reliable, much easier to use, and smaller; the NAI's high-definition multipoint controller (used for conferences that connect more than a handful of sites) is jokingly referred to as "the pizza box" because of its size and shape. Even more importantly, modern multipoint controllers come with a Web

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interface that allows users to schedule and manage their own conferences. High-definition videoconferencing improves the experience, as facial expressions and body language that are key to effective communication are much more discernable.

## Space, Slime, and Dinosaurs

Astrobiology has caught on as a way for science educators worldwide to engage their learners. Spanning many disciplines, it can be applied in many types of classrooms and facilitates teaming and problem solving. It is especially relevant to middle school–integrated science courses, positively affecting a critical age group at risk of turning away from science. Incorporating the natural affinity kids have for space, "slime," and dinosaurs, astrobiology has the added appeal of "aliens."

When the NAI was founded there were scant educational programs and materials to draw from; it had to bootstrap a program more or less from scratch. In the early years, the staff of the NAI central office took to the road, exhibiting at major education and scientific conferences to help educators understand the educational value of astrobiology. More recently, education and outreach activities have been conducted by the science teams, with coordination by the NAI central office. Having a close-knit community of science educators that work together as a team enables innovation and encourages individuals to draw on one another's expertise and experiences.

## On the Horizon

In the past ten years, tantalizing clues about the potential for life in the solar system have been uncovered. NASA missions to Mars have found extensive alteration of minerals by liquid water, indicating that one essential ingredient for life has been present on the red planet. Ground-based observations by NAI scientists and their colleagues have revealed that methane gas is being generated on Mars and may vary with the season. Since methane can be a byproduct of life or be produced by chemical means, scientists are hot on the trail of what accounts for it on Mars. Farther out in our solar system, liquid water exists under the icy crust of Jupiter's moon Europa and several other satellites. Looking beyond our solar system, the current count of extrasolar planets is well over four hundred. None of the known planets are Earth-like, but the Kepler mission is likely to change that. Launched in 2009, Kepler is designed to detect Earth-like planets around other stars. It is poised to tell us whether planets like ours are run-of-the-mill or rare. So, are we alone? Stay tuned. Astrobiologists are working hard to find out. ●

*Learn more at astrobiology.nasa.gov/nai.*

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**ED GOOLISH**, deputy director of NAI, has been with the NAI since 2000. Prior to that he conducted research at Ames on the biological effects of gravity, contributed to the design and development of biological research facilities for the International Space Station, and was involved in several life-science space missions.

**CARL PILCHER** has been director of NAI since 2006. He was a professor of astronomy and planetary science at the University of Hawaii before moving to NASA Headquarters in 1988, where he held a number of management positions in human and robotic solar-system exploration and astronomical research.