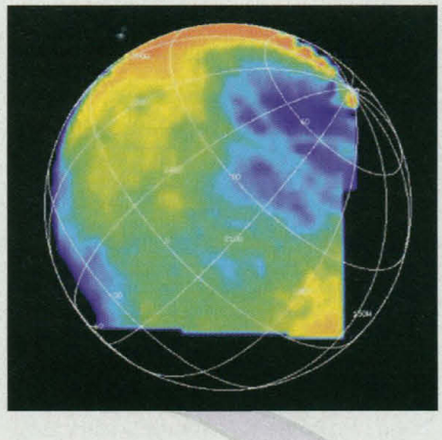
Ames Tackles the Riddle of Life

Researchers eagerly await the opening of the Astrobiology Institute at NASA's Ames Research Center next month. Its ambitious agenda includes creating a new field of science

MOUNTAIN VIEW, CALIFORNIA—Three years ago, NASA's Ames Research Center here was preparing to jettison large pieces of its scientific program after being ordered to narrow its mission and meet strict budget ceilings. A last-minute proposal from scientists won it a reprieve, however, and has led to the birth of a new scientific discipline: the study of how life might arise across the universe. Now NASA is betting that a series of startling discoveries in recent years will provide a rich payoff both for Ames and for humanity's understanding of its place in the cosmos.



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Europa. A 2003 mission will look for tidal changes on the jovian moon from a proposed ocean beneath a cracked ice sheet.

"There's been an explosion of discoveries ... that are really reinvigorating our quest for understanding life," NASA space science chief Wes Huntress told an audience last week at a conference at George Washington University in Washington, D.C. Adds Bruce Alberts, a biologist and president of the National Academy of Sciences, "This is a great adventure." Indeed, recent findings of ancient terrestrial fossils, possible fossils of martian microbes, an ocean on a moon of Jupiter, planets circling other stars, and evidence of life in solid rock 1 kilometer below Earth's surface have revitalized the once esoteric debate over how life adapts to extreme conditions and whether it could exist outside the atmosphere's protective blanket.

Next month, Ames will unveil its new Astrobiology Institute. NASA is on the verge of picking a director to run the institute, which will serve as the hub of a network of research teams tackling a range of topics. Although the institute's initial annual budget is a modest $4 million, NASA Administrator Dan Goldin predicts that it could eventually grow into a $100-million-a-year behemoth with astronomers, biologists, chemists, geologists, and researchers from an assortment of other specialties. "It seems to include everything from the big bang to elephant ecology," says Ken Nealson, a former University of Wisconsin microbiologist who was recently hired by NASA's Jet Propulsion Laboratory (JPL) in Pasadena, California. "It's up to us to define it." But skeptics worry about that fuzziness and fear that the institute could become mired in bureaucracy.

Cosmic imperative?

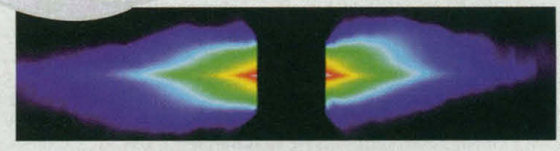
For years, NASA has funded research in exobiology—the study of potential life on other planets—and paid for missions like Viking, which sampled martian soil for signs of microbial life. Its work complemented the portfolio of agencies such as the National Science Foundation (NSF), which backed research on life in extreme environments on Earth and on evolutionary biology. But Huntress says astrobiology connotes a wider search for understanding the origin and development of life everywhere, from lichen in dry Antarctic valleys to complex organic compounds in interstellar clouds to the biological signatures of microbes on other planets. "It's imperative we broaden our thinking," he says.

Until recently, however, the search for life beyond Earth was often derided by researchers, politicians, and the public alike. NASA's tiny SETI (Search for Extraterrestrial Intelligence) project—a systematic search for radio signals from outer space—was killed in 1993 by lawmakers who dismissed it as wasteful spending to find little green men. And there have been few obvious reasons to bring together chemists, geologists, biologists, and astronomers interested in the overarching question of life's emergence. "It's a term looking for a definition," sniffs one NASA biologist about the concept of astrobiology. Indeed, Ames researchers working on the topic in the 1970s rejected the word "because it sounded a bit too close to astrology," recalls the SETI Institute's John Billingham, a former chief of life sciences at Ames.

But a stream of apparently unrelated findings has earned the field new respect. Discoveries of life in extreme environments on Earth—such as in hot vents deep in the ocean and on basaltic rock hundreds of meters below the surface—are challenging traditional notions about life's adaptability. And geologists have uncovered fossils as old as 3.7 billion years, an unmistakable sign that life developed extremely rapidly after Earth cooled. At the same time, a NASA spacecraft has sent back convincing evidence that an ocean flows below the icy surface of Jupiter's moon Europa, perhaps providing an environment for life to begin, while the Hubble Space Telescope may have spotted planet-forming regions and ground-based instruments have fingered extrasolar planets.

Even the highly controversial claim that an ancient martian meteorite found in Antarctica contains evidence of fossilized microbes has served to legitimize the debate. "The Mars rock crystallized people's interest," says Gregory Wray, a biologist at the State University of New York, Stony Brook. "Suddenly [life beyond Earth] sounds like more of a reality." Popular culture also helped to alter public perceptions. Last year's Hollywood film *Contact*, for example, lionized scientists involved in the search for life beyond Earth.

It's a far cry from 1995, when Ames—saddled with an aging aeronautical research facility—was locked in a grim struggle for survival. "We were facing possible closure," says Harry MacDonald, the new center director. With an ultimatum from NASA headquarters to narrow its mission and cut costs, Ames managers reluctantly took steps to gut the science program. But scientists at the center made a last-ditch bid for the job of coordinating NASA's fledgling effort to understand life in the universe. Their arguments prevailed, transforming the center into a lab with the dual missions of information technology and astrobiology.



C. A. SCHULTZ/CSC/STSCI/NASA

Beta Pictoris. Earth-like bodies could arise from a protoplanetary disk like this one spotted by the Hubble telescope.

The new institute will focus attention on

this line of research and supplement efforts by other agencies, NASA officials say. Goldin has already spoken with Rita Colwell, the nominee to lead NSF, about greater research collaboration in the field, and NSF program managers, for example, are involved in the review of institute proposals. "It's the right time," says Mary Jane Osborn, a University of Connecticut microbiologist who serves on the National Research Council's space studies board. "Never mind the Mars rock, which triggered public interest; there's a growing realization that there is good science to be done." Adds Ursula Goodenough, a biologist at Washington University in St. Louis: "It's a real opportunity to fill a vacuum. The idea is very compelling, and the questions that need to be addressed are staggeringly underfunded."

NASA/JPL

Martian rocks. NASA rovers hope to arrive in 2001, returning samples to Earth by 2008.

That's been true historically at NASA, whose life sciences program is held in low esteem by the biological community. The National Institutes of Health prefer research with more direct medical applications, say researchers, while NSF has difficulty with proposals that touch on a variety of fields. Goldin, however, insists he can offer an attractive home to an array of life scientists despite an agency culture dominated by engineers and physicists. "How can we watch the explosion in biology with blinders on?" he asks. Bringing biologists into the fold, he says, will allow the agency to tailor its programs and instruments to the search for life elsewhere.

Two experiments

Goldin is not the only one excited by the new institute. When NASA officials announced last fall that they wanted help from a cadre of research teams, "I expected 20 to 25 proposals," says Gerald Soffen, director of NASA's university programs. Instead, the agency received twice that many. Soffen compares it to the California gold rush: "I was blown away—it was like Sutter's Creek." The proposals—ranging from ocean vent expeditions to studies of complexity theory and astropsychology—are now undergoing peer review, and the institute's new director is slated to meet in May with members of the seven or eight winning teams.

Each successful team, made up of dozens of investigators from many institutions, will receive funding commitments for up to 5 years. The winners will communicate using NASA's new sophisticated high-speed computer network, reducing travel costs without impinging on the level of interaction. A small staff of civil servants at Ames will coordinate the effort. "We don't want to waste our money on bricks and mortar," says Goldin.

The institute will be a test both of a virtual institute and of the viability of the field. "We're trying to do two experiments: one to foster collaboration over great geographic distances, and the other to stimulate new ways to look at problems that are multidisciplinary in the academic community," says David Morrison, Ames's space science chief. For a model, he points to the growth of planetary science, a field that NASA helped to create 25 years ago. He predicts that within a decade astrobiologists will be enrolled in Ph.D. programs, publishing in their own journals, and conducting field expeditions to hydrothermal vents in the ocean or lakes in the Antarctic to set the stage for space missions.

SCHOPF *ET AL.*

The opportunity to get in on the ground floor of a new discipline is part of astrobiology's attraction, say researchers. "NASA managers are saying, 'Tell us what it is, we'll fund it, and that will define it,' " says JPL's Nealson. "Rather than being told what the problem is, we're being told to decide."

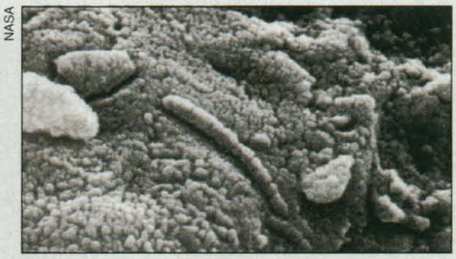
R. STONE

Antarctic dip. New forms of life may lurk in a lake under Russia's Vostok Station, which will also serve as a technology test-bed.

Nealson has taken NASA at its word, proposing a diverse team from California's Lawrence Berkeley National Laboratory, the Carnegie Institution in Washington, the University of Wisconsin at Madison, New York's University of Rochester, and NASA's Marshall Space Flight Center in Huntsville, Alabama, that would study ways to detect life in rocks. "Each represents a technology not available at JPL or [the California Institute of Technology, which operates JPL]," he notes.

That ambiguity is too much for some researchers. "I'm a little befuddled," says one evolutionary biologist whom NASA has consulted for advice. He's uncomfortable with NASA's lack of experience in biology, and he worries about shoring up a space life sciences program that "is not very credible." But although he may be cynical about the concept, he says the prospect of a stable funding source is certainly attractive.

NASA



Fossils. Evidence of cyanobacteria, left, from ancient Earth and elsewhere, like this martian meteorite, could illuminate how life developed.

The astrobiology effort also has made waves within NASA. Goldin assigned it to the office of space science rather than life sciences and microgravity research, a move that exacerbated tensions between the two bureaucracies. Life sciences managers so far have refused to contribute any funding. Joan Vernikos, a former Ames researcher who is now NASA's life sciences chief, says that having the organization run by civil servants rather than a fresh batch of outside scientists "could put the bureaucratic reins on the academic community" and make it harder for the institute to support top-notch science. She says she wants to see a string of achievements before she spends scarce funds. But Ames officials say the real issue is turf. "They are very concerned this could turn out to be a raid on their budget," explains MacDonald.

MacDonald, Morrison, and other proponents believe that keeping the institute closely tied to Ames will give biologists and others a greater voice in shaping future NASA missions at the same time that it strengthens the parent center. The agency already plans an ambitious set of space flights and is considering a joint effort with NSF to explore Antarctica's Lake Vostok. "The institute will serve as an intellectual center," says Huntress. "Its job is to make astrobiology credible."

That task seemed insurmountable 3 years ago. "The idea has succeeded beyond my wildest dreams," says one Ames researcher involved in the 1995 proposal. Morrison admits that a will to survive may have been the original force behind the institute, but he notes that the recent findings in so many disciplines suggest that astrobiology "has taken on a life of its own." Now the question for Ames researchers is whether the same is true for worlds beyond Earth.

–Andrew Lawler