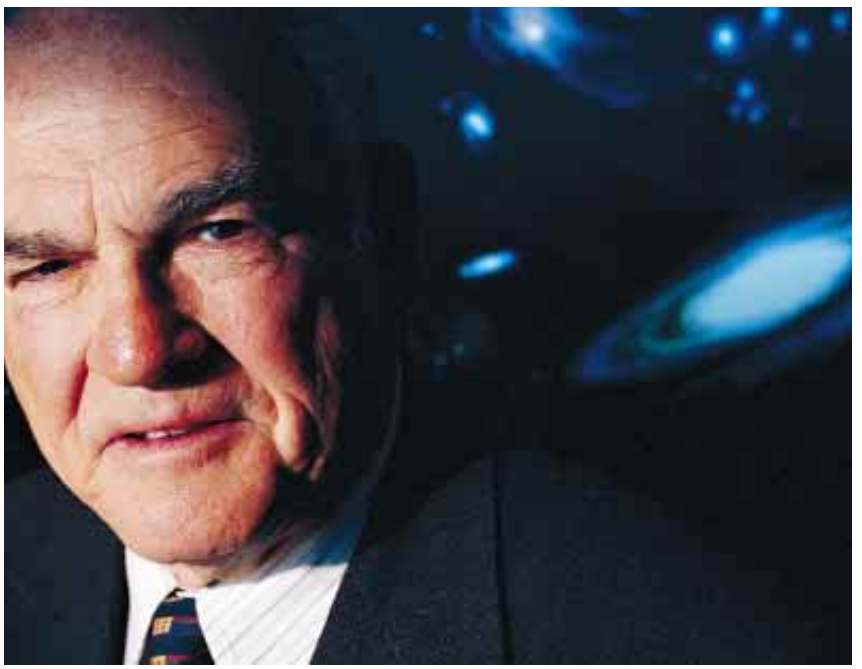
BIOCHEMIST_BARUCH S. BLUMBERG

The Search for Extreme Life

If microorganisms exist on other worlds, the head of NASA's fledgling Astrobiology Institute plans to find them

The relentless heat cooks the Badwater region of California's Death Valley so thoroughly that some expanses are textured like dry serpent skin. At some 284 feet below sea level—North America's lowest point—it is perhaps the hottest place on the surface of the earth: the temperature once peaked at a record 53.01 degrees Celsius (127.4 degrees Fahrenheit). Out here, blood-pumping mammals are scarce. It may seem unfitting to find a Nobel Prize winner, renowned for hepatitis B work, in this scorching pit. But Baruch S. Blumberg's latest challenge takes him beyond human subjects. As the first director of the National Aeronautics and Space Administration's Astrobiology Institute (NAI), he is searching for extreme life-forms, the kind the space agency aims to someday find on other worlds.

"I always liked the idea of doing fieldwork, exploring, going out and finding new things," Blumberg says back at NAI headquarters, which is nestled near Silicon Valley at the NASA Ames Research Center at Moffett Field. Out of his desert garb, the outdoors-loving Blumberg looks a good decade younger than his 75 years. At the job only since last September, Blumberg is trying to marshal gaggles of astronomers, chemists, ecologists, geologists, biologists, physicists and even zoologists. He is convinced that advances in molecular biology, space exploration and other endeavors make timely the reexamination of such age-old issues as the origins of life and its possible existence elsewhere.



MARTIN KLIMEK *Liaison Agency*

BARUCH S. BLUMBERG: NONEXTREMOPHILE

- **Born July 28, 1925: "A very optimistic time"**
- **Wife, Jean, a painter; daughters, Anne and Jane; sons, George and Noah**
- **Most Important Field Trip: The Philippines in 1967 to test hepatitis virus theory**
- **Best-Known Fact: Won 1976 Nobel Prize for Physiology or Medicine**
- **Least-Known Fact: His rustic western Maryland farm lacks indoor plumbing**
- **On Extraterrestrials in Our Solar System: "Highly evolved life is very unlikely, but we have to continue our search"**

"Technology is available to decipher the intricacies of this cause-and-effect chain" that wasn't available even five years ago, Blumberg notes, citing in particular advances achieved through the Human Genome Project. The 1996 announcement of potential fossilized life in a Martian meteorite known as ALH84001 boosted enthusiasm worldwide. Even Congress, which had quashed NASA's search for extraterrestrial intelligence (SETI) program in 1993, became receptive. On sabbatical at Stanford University in 1998, Blumberg, along with scores of others, helped to craft NASA's Astrobiology Roadmap during a series of workshops. It defined the role for the new institute.

"With NASA's Astrobiology Institute we are witnessing not just a shift in scientific paradigm but, more important, a shift in cultural acceptability among scientists," says extrasolar planet hunter Geoffrey W. Marcy of San Francisco State University. Already Blumberg's institute is becoming "the intellectual basis for a broad range of NASA missions," says NASA administrator Daniel S. Goldin. Goldin hopes to raise the NAI's budget from about $15 million to $100 million within five years. The NAI now comprises some 430 astrobiologists at 11 universities and research institutions.

Although the institute is lending new credibility to the search for extraterrestrial life, *X-Files* fans needn't hold their breath. Unlike the now privately funded SETI program, which focuses on radio transmissions and other hallmarks of presumably sentient beings [see "Where Are They?" by Ian Crawford, on page 38], the NAI is targeting microorganisms and other, even more primitive evidence of lifelike matter. Specifically, the NAI is looking for life in hostile environments—in deserts, volcanoes and ice caps; down thousands of meters below Earth's surface or into the ocean; and on Mars, Jupiter's moon Europa, Saturn's satellite Titan, even planets beyond the solar system.

For now at least, extremophiles on Earth offer the most probable model for testing the hypothesis that life exists elsewhere. NAI researchers hope to use genomic

databases of key microorganisms to link evolutionary sequences with geochemical and paleontological events. Another desire is to launch DNA microprobes on board miniature spacecraft to search for signs of life. Answers, if they ever come, may take many decades.

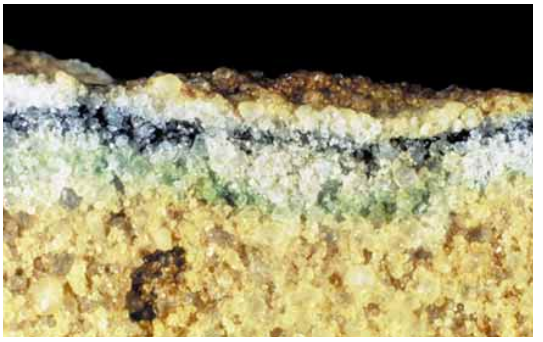
Blumberg believes his past biochemical work gives him intimate insights into lifeforms, whether of this world or not. "One of the things about doing medicine and medical research is that you really get a kind of feeling for the organism that you work with," he observes. Hence, profound questions of life "are coming directly and indirectly into your thinking."

As a child in a tight-knit immigrant community in Brooklyn, N.Y., Blumberg checked out book after library book on the reigning explorers. "Amundsen, Peary, Scott, Shackleton, Rae, Nansen were common names in my circle of friends," he recalls. "I believe this had an effect on my seeing science as discovery. My interest in fieldwork also fed into this." To this day he collects books on early travel and Arctic expeditions.

After graduating from Far Rockaway High School in 1943, he enlisted in the Naval Reserves and secured a physics degree at Union College in Schenectady, N.Y. At age 21 he made captain of a small U.S. Navy ship. "It is a great sensation to plot a course, take a few sights, do some dead reckoning, and end up more or less where you had predicted. It gives one confidence in the power of applied mathematics and the effectiveness of rational solutions." Captaining that crew 24 hours a day instilled an unshakable confidence in him. "I assumed that I would have leadership roles in whatever I did," he says.

In 1946, thanks to the G.I. Bill, Blumberg started graduate school in mathematics at Columbia University, only to transfer a year later to the medical school at the behest of his attorney father. For his medical internship and residency, Blumberg picked the crowded, understaffed wards of New York City's Bellevue Hospital, where the poor and chronically ill were typically sent. "And this was before health insurance," he emphasizes. Bellevue taught Blumberg a new definition of responsibility: "The fact that you've got to do it—if you don't do it, nobody else will."

Equipped with an M.D., he decided to pursue his own longing to be a scientist and went in 1955 to the University of Oxford, where he began his doctorate in biochemistry under Alexander G. Ogston. At the time, Oxbridge was buzzing with excitement over Watson and Crick's discovery of the DNA double helix. Blumberg himself had become intrigued with inherited genetic variations a few years earlier. In 1950 he had gone to a desolate mining-town hospital in Suriname in South America, where, besides witnessing the devastation caused by infectious diseases, he observed large differences in susceptibility to the elephantiasis parasite among diverse immigrant workers. A 1957 field trip to West Africa formally launched his study of such genetic variations, called polymorphisms, which he would continue at the National Institutes of Health.



CRYPTOENDOLITHS—microcolonies of fungi, algae and cyanobacteria (*colored layers*)—thrive inside this sandstone rock from cold and dry Antarctica, showing that life can exist in hostile conditions.

NASA ASTROBIOLOGY INSTITUTE

Blumberg collected data on the distribution of polymorphisms. Initially, he culled blood for clues to disease resistance. To find possible variants, he and his colleagues relied on the natural immune response to compare blood proteins from frequently transfused patients, mainly hemophiliacs. From antibodies in the patients' bloodstream, they could derive foreign antigens. In 1963 Blumberg's team isolated a peculiar variant and dubbed it "Australian antigen." Common among Australian Aborigines, Micronesians, Vietnamese and Taiwanese, the blood protein was rare among Westerners. The team, however, observed it in leukemia patients in the U.S., who also were receiving transfusions. The researchers set off exploring whether the unusual antigen played a role in susceptibility to leukemia.

Instead of an inherited immune factor, the curious surface antigen proved to be part of the then mysterious hepatitis B virus. "His discovery of Australian antigen was the Rosetta stone for unraveling the nature of the hepatitis viruses," comments Robert H. Purcell, head of the NIH's hepatitis lab.

This key finding enabled researchers to develop the first blood test to screen for the virus, thus protecting blood supplies. In 1969 Blumberg and microbiologist Irving Millman patented a strategy to develop a hepatitis B vaccine. Their novel approach relied on purifying from the virus those very same surface antigen particles—which by good fortune proved not only to produce protective antibodies but to be noninfectious. For advancing understanding of the mechanisms of infectious diseases, Blumberg shared the 1976 Nobel Prize for Physiology or Medicine.

A commercial vaccine based on Blumberg's method, now made using recombinant DNA techniques, has saved tens of millions of lives, according to World Health Organization estimates. Blumberg remains optimistic that hepatitis B can someday be eradicated, but today the virus continues to kill more than a million people a year, including 5,000 in the U.S.

When not working, the Nobelist prefers to birdwatch or kayak or even shovel manure on a cattle farm he owns with friends in western Maryland. "That kind of manual labor is an antidote to too much thinking," he says.

In Death Valley, Blumberg and other researchers, led by Christopher McKay of NASA Ames, used syringes to extract heat-loving microbes for DNA analysis back at the lab. Blumberg plans to accompany researchers on other field trips to collect extremophiles, perhaps in Mongolia's Gobi Desert or in Antarctica. Tests of new robots for planetary exploration might even send him to the Canadian Arctic.

Besides guiding and inspiring his researchers, Blumberg wants to take advantage of powerful computers to model how life might evolve elsewhere. "Astrobiology lends itself to iterated induction-deduction exercises, as well as theory and model construction," Blumberg explains. He notes wryly that in this field "there's a high probability you will reject the model." Just the same, he and his followers hope the conditions that allow life to flourish on Earth exist elsewhere in the Milky Way and beyond. "It could happen," Blumberg says. "In any case, you have to go and look." —*Julie Wakefield*

JULIE WAKEFIELD writes frequently on science and technology. She is based in Washington, D.C.

Advertisement. When it comes to survival, you have to grow beyond yourself, to prevent certain death. Mining accidents, falls from heights, shipwrecks and day-long odysseys through the desert â€“ these are all disasters that often involved the lives of those to an end in a most rapid manner. Some have survived by chance or by a fortunate twist of fate, Others fed on raw human flesh and even drank their own urine. When people fall into an extreme emergency situation, then they suddenly do things that they would have thought are possible never in normal life and so they finally secure their existe Extreme Life. Octopus Spring, an alkaline siliceous hot spring in Yellowstone National Park. (Image credit: David M. Ward). From bacteria that can survive inside rocks to microbes that can withstand tremendous heat, cold and radiation, life can take some extreme forms. These enterprising creatures reveal not just the resilience of life on Earth, but the possibilities for life elsewhere in the universe. Here are some especially amazing examples of so-called extremophiles. Not a drop to drink. The apparatus is calledâ€”brace yourselfâ€”the Subaru Coronagraphic Extreme Adaptive Optics (SCExAO, pronounced â€œskex-a-oâ€). Guyon wanted me to see it in action, but a power outage had shut down the Subaru. Instead he offers to give me a tour of the 141-foot dome enclosing the telescope.Â It would be grossly geocentric, however, to limit the search for extraterrestrial life to oxygen and methane. Life could take forms other than photosynthesizing plants, and indeed even here on Earth, anaerobic life existed for billions of years before oxygen began to accumulate in the atmosphere. As long as some basic requirements are metâ€”energy, nutrients, and a liquid mediumâ€”life could evolve in ways that would produce any number of different gases. Sign In. Search. The most extreme life-forms in the universe. Life 26 June 2008. By Anna Davison.Â Hydrothermal vents may have existed once on Mars and may still exist in an ocean under Europaâ€™s icy crust, some scientists say, making them prime targets in the search for extraterrestrial life. Cold comfort. The most frigid polar regions and the darkest depths of the ocean are home for a few organisms that like a good chill. Many are bacteria or similar single-celled organisms called Archaea, but some lichens called cryptoendoliths go to extremes by colonising pores in Antarctic rock. Thereâ€™s also an alga that creates reddish â€˜watermelon snowâ€™ â€“ a phenomenon first described by Aristotle. The Extreme Life. 305 likes. Page about 2 bros & their friends making vids & pics of extreme sports such as waterskiing, alpine skiing & trampolining...Â See more of The Extreme Life on Facebook. Log In. or. Create New Account. See more of The Extreme Life on Facebook. Log In. Forgot account?