By Samuel Moffat and Elie A. Shneour

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Life Beyond the Earth

Epilogue by Joshua Lederberg

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A VISTAS OF SCIENCE® BOOK

Life Beyond the Earth

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Produced as a joint project of the NATIONAL SCIENCE TEACHERS ASSOCIATION and the NATIONAL AERONAUTICS and SPACE ADMINISTRATION. Published by SCHOLASTIC BOOK SERVICES, a division of Scholastic Magazines, Inc., New York, New York

Single copy price 50¢
Quantity prices available on request from Scholastic Book Services
904 Sylvan Avenue, Englewood Cliffs, N. J. 07632
Library of Congress Catalog Number: 64-24591

1st printing ..... September, 1965

Printed in U.S.A.

NATIONAL SCIENCE TEACHERS ASSOCIATION
1201 Sixteenth Street N.W., Washington, D.C. 20036

A Department of the National Education Association
An Affiliate of the American Association for the Advancement of Science

epilogue

what do we seek in space?

by joshua lederberg

BACTERIAL SPORES

WHAT do we seek in space?

Clearly, the journey will give us two unique rewards: a perspective on our own planet and a prospect on other worlds.

The first pioneering steps in space have already proved their value. Today orbiting satellites analyze the earth's atmosphere, reveal weather patterns, speed communications, and improve navigation. Tomorrow, more powerful craft will be developed, extending our reach and giving us new objectives.

Among these objectives, exobiology—the study of life beyond the earth—is the most subtle and demanding, for

it insists "Know thyself." It is for this reason that the opening chapters of this book deal with life on earth. When we have learned as much about life as earthbound science can teach us, then we will be ready to lift our gaze to the planets and the stars.

In the past century, biology has experienced a remarkable development as a scientific discipline, particularly in our understanding of the biochemical mechanisms of life. Once Darwin had set forth the concept of evolution, this understanding could come about. For it is this magnificent concept that helps to explain how structures as diverse as the microscopic amoeba and the giant Sequoia could have developed.

Our understanding of life on earth has now progressed to the level of cells and molecules. Evolution, we now know, has a chemical basis. Despite the outward differences of living organisms, their chemistry is the same. In all organisms the genetic material consists of nucleic acids. And in all organisms the cell structures are composed mainly of proteins. Indeed, on chemical inspection we find the composition of living cells so similar that it is difficult to tell the nucleus of a human nerve cell from the virus that might attack it.

In the world we know, nucleic acids and proteins come about only as copies of what has evolved before them. Their blueprints are handed down from parent to offspring. But how did these complex substances come about originally—without pre-existing cells or brains to guide their production?

Thirty years ago many people thought the answer to this question was beyond the reach of science. Today the

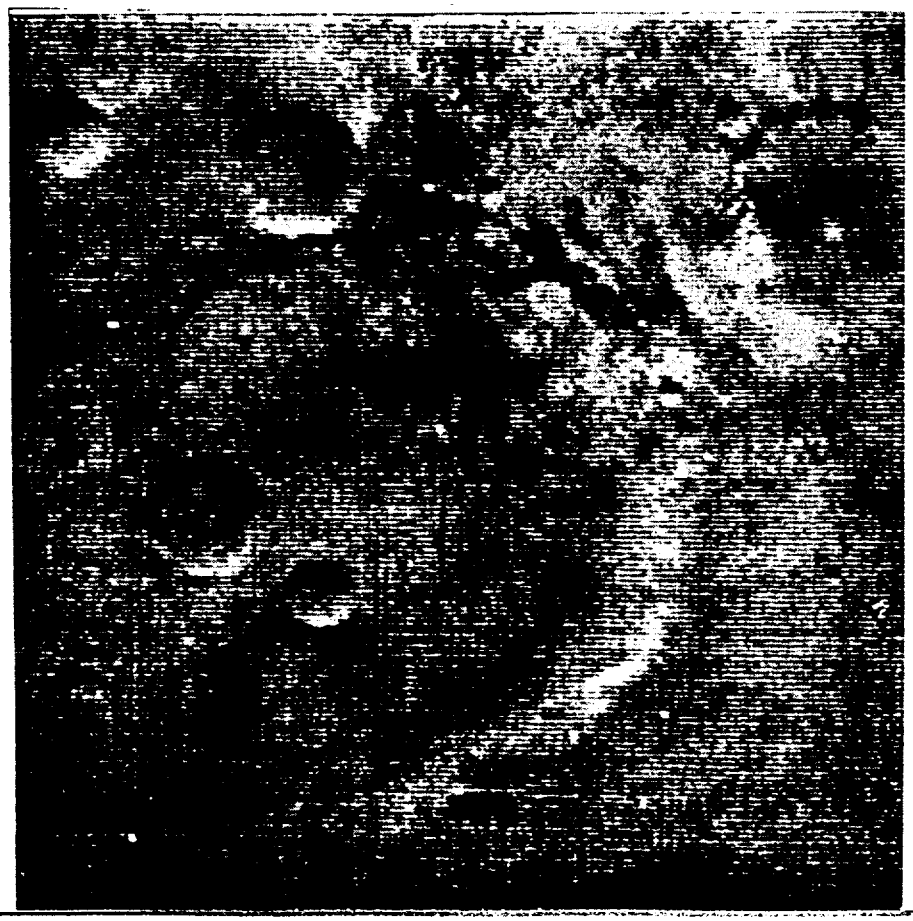
question leads us to fundamental problems of exobiology:

Are nucleic acids the only substances that can link the generations of living things that might exist anywhere in the universe? Or are they merely the only links that earthly life has encountered?

Are proteins the only means of building up cell structures? Or are they the accidental result of early chemical events on earth?

It is the purpose of exobiology to probe for the answers —and for a larger one as well.

The sensitive instruments of *Mariner 4* have brought *man's* vision to within 6,000 miles of Mars. Now the craters of the red planet beckon. Is there life beyond the earth? In the years to come, exobiologists will seek the answer.



In the past, biology's domain has been limited to the thin shell of the earth, to the way in which one spark of life has illuminated one speck in the cosmos. By contrast, the basic laws of physics are derived from the motions of the stars; and we know the scope of chemistry from studies of the light emitted by stars at the boundaries of the observable universe.

As yet, biology has no such grand universal system. But there is a principle which we confidently expect will prove to be universal—the principle of evolution. Until we have evidence from the planets themselves, however, we can only speculate about evolution elsewhere.

The ultimate goal of the exobiologist, then, is to answer questions about *all* life, about *all* evolution.

It would be difficult to point to any practical fruits of this research. Expeditions beyond the earth may be among the most costly experiments ever undertaken, but surely they count as one of the very aims of the human adventure. Is not the search for life beyond the earth the next stage of the great journey that has always led men into the unknown?

This *Epilogue* is adapted from an article in the Winter, 1963, issue of STANFORD TODAY, published by Stanford University.