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EXTRATERRESTRIAL LIFE A BIBLIOGRAPHY

PART I: REPORT LITERATURE

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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EXTRATERRESTRIAL LIFE A BIBLIOGRAPHY

PART I: REPORT LITERATURE

A selected listing of annotated references to unclassified scientific and technical reports.

1952 - 1964

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Scientific and Technical Information Division September, 1964
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Washington, D.C.

Introduction

Extraterrestrial Life is a comprehensive annotated bibliography that is being published in two parts. Part I contains selected references to domestic and foreign reports that were prepared during the period 1952 through July 1964, and are currently stored in the NASA information system. Part II will be comprised of a compilation of references to journal articles and books that have been published between 1900 and 1964. N65-16598

Although this bibliography is primarily concerned with the general subjects of extraterrestrial life and exobiology, its scope also makes provision for several particular topics that are directly pertinent to the search for extraterrestrial life. Included among these, in Part I, are the origin of life on earth, the suitability of other planets for the development of indigenous life, the possibility of intelligent extraterrestrial life forms, techniques and instrumentation for the detection of extraterrestrial life, the chemical basis of life including the synthesis of organic compounds from simple precursors, and terrestrial contamination of spacecraft. Several references, which describe the examination and analysis of meteorites and the relevance of such studies to the subject of extraterrestrial life, are also presented.

Each entry consists of a standard bibliographic citation and an annotation in the form of an abstract or a brief descriptive notation. Entries are listed in reverse chronological order, with the most recent references appearing first.

In addition to the abstract section, Part I contains a subject index, a personal author index, a corporate source index, and a contract number index.

author

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1964

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Marquardt Corp., Van Nuys, Calif.
STUDY OF MARBAC EXTRATERRESTRIAL LIFE DETECTION SYSTEM CONCEPT. Covering Period Apr. 1 through Apr. 30, 1964.
E. E. Sweeney, G. E. Ellis, J. G. Bitterly, and A. N. Thomas. May 7, 1964, 10 p., refs.
(NASA Contract NASw–810).
(N64–90106)

Progress in establishing the usefulness of oxidation-reduction potential change as the basis for extraterrestrial life detection is reported. The goal of this project, called the MARBAC program, is the production of significant (100-millivolt) redox changes within 24 hours by small initial numbers of microbes. It was found that the time required for a potential change was reduced 20% by allowing microbial metabolism to proceed until the potential began to change significantly, and then removing the organisms and using the modified solution in a test with a fresh inoculum. A new digital voltmeter and data aquisition system has greatly increased the accuracy and reproducibility of the results. M.P.G.

2

Space Technology Labs., Inc., Redondo Beach, Calif.
INTERPLANETARY MATTER: A BIBLIOGRAPHY, 1963 SUPPLEMENT.
L.R. Magnolia. comp. May 1964, 312 p., refs.
(Research Bibliography No. 50. Rept. 9990–6649–KU–000; N64–20475)

This bibliography consists of 662 annotated references on asteroids, comets, meteorites, meteors, micrometeorites, noctilucent clouds, nonterrestrial dust, the origin of the solar sysem, tektites, the zodiacal light, and related subjects. The majority of the items are those published in 1963 as well as those released in 1963 by DDC (formerly ASTIA) and NASA. I.v.L.

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California University, San Diego, Calif.
OPTICAL ACTIVITY IN SAPONIFIED ORGANIC MATTER ISOLATED FROM THE INTERIOR OF THE ORGUEIL METEORITE.
Bartholomew Nagy, Marty T. J. Murphy, V. E. Modzeleski (Calif. U., La Jolla), George Rouser (City of Hope Medical Center), George Claus (NYU), Umberto Colombo and Franco Gazzarrini (Inst. di Ricerche "G. Donegani," Italy). March 1964, 28 p., refs.
(NASA Grants NsG–341 and NsG–541)
(NASA–CR–53660; N64–22751) OTS: $2.60 ph.

Saponified extracts from the Orgueil carbonaceous meteorite have been shown to exhibit a small but well reproducible levo-rotation. All precautions were taken to exclude possible contaminants, and similar results were obtained on samples of three separate stones of this meteorite. In contrast, saponified fractions of museum dust, sealing wax, ragweed pollen, soil, recent alga, naphthenic acids in petroleum, and the Bruderheim noncarbonaceous meteorite were either dextro-rotatory or optically inactive. Thin layer chromatograms show that the composition of the Orgueil meteorite extracts is entirely different from saponified fractions of recent biological matter. These studies were undertaken because optical rotation in organic molecules is generally considered as evidence for biological origin. M.P.G.

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George Washington University, Washington, D.C.
EXOBIOLOGY. Annotated Bibliography. 1951–1964.
Joe W. Tyson and Ruby W. Moats. comp. March 1964, 77 p., refs.
(NASA Grant NsG–485)
(NASA–CR–53806; N64–23393) OTS: $7.60.

This annotated bibliography on exobiology is composed of selected references from 1951 to date. The topics covered include descriptions of planetary environments, speculations on the existence of extraterrestrial life and the forms that it may assume, life detection mechanisms, and considerations of chemical and biological evolution on earth. M.P.G

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Esso Research and Engineering Co., Linden, N.J.
DEVELOPMENT OF HYDROCARBON ANALYSES AS A MEANS OF DETECTING LIFE IN SPACE. Annual Report.
W. G. Meinschein. January 1, 1964, 10 p., refs.
(NASA Contract NASw–508)
(NASA–CR–53096; N64–23392) OTS: $1.10 ph.

Extensive data are being acquired on biological, sedimental, and abiotic alkanes. More than 300 GLC chromatographic "fiingerprints", 100 mass spectra, and many infrared and ultraviolet spectra of naturally occurring hydrocarbons have been catalogued. These data indicate that biotic hydrocarbons are readily distinguished from abiotic alkanes. Benzene extracts of elimination products and of recent sediments contain comparable percentages of alkanes. These percentages usually exceed greatly the concentrations of alkanes in biological lipids, but are significanly less than the concentrations of alkanes in ancient sediment extracts or crude oils. Paraffinic hydrocarbons from living things, fecal matter, and sediments have similar structures and optical properties. Analyses of alkanes of various geologic ages show that different types of biological alkanes can apparently keep their charactristics for more than a billion years in terrestrial environments. Data gathered strongly support the hypothesis that saturated hydro-

carbons are the best preserved and most widely distributed products of former organisms on earth. Alkanes may generally retain the most legible records of ancient life.

7

IIT Research Institute, Chicago, Ill.

LIFE IN EXTRATERRESTRIAL ENVIRONMENTS. Quarterly Status Report. November 15, 1963–February 15, 1964.

Charles A. Hagen and Regnel Jones. 1964, 16 p., refs.

(NASA Contract NASr–22, IITRI Proj. C 194)

(NASA CR–53106: IITRI C 194–12; N64–16745) OTS: $1.60 ph.; $0.80 mf.

Incorporation of 4.9% or 21.7% moisture into the dry simulated Martian soil modified by the addition of 1% organic medium increased the number of *B. subtilis* surviving the inoculating and flushing procedures. Lower moisture concentrations, 2.0% and 0.25%, did not have this effect. However, the death rate was greater in the tubes with 4.9 and 21.7% moisture. Thus, after 56 days of exposure there was no significant difference between the groups. Less than 0.02% of *Ps. aeruginosa* cells survived a 1-week exposure to Martian environment modified by 10% organic medium and 10% moisture. *B. cereus* spores survived the simulated Martian environment modified by 10% organic medium plus 20% moisture, but there was no apparent germination. Author

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Melpar, Inc., Falls Church, Va.

RESEARCH ON DETECTION OF EXTRATERRESTRIAL LIFE BY ULTRAVIOLET SPECTROPHOTOMETRY. Final Report. January 1964, 60 p., refs.

(NASA Contract NASw–571)

(NASA–CR–55655; N64–16109) OTS: $5.60 ph.; $2.00 mf.

A research program was carried out to determine the feasibility of applying absorption of far ultraviolet radiation by peptides to the detection of extraterrestrial life on Mars. Experiments were carried out on a variety of amino acids, dipeptides, tripeptides, polypeptides, and proteins. It was found that all substances containing peptide bonds showed an absorption maximum in the 185 mμ to 190 mμ region. A suspension of *Staphylococcus aureus* and extracts of local soil and sand also showed an absorption in this region. Experiments with substances that might give false positive absorptions showed that many nonpeptides similarly absorb in this region. However, it was observed that hydrolysis of the peptides resulted in a decrease in absorbancy, as did hydrolysis of the extracts of soil and sand. This effect allows for the distinction between peptides and nonpeptides. The effect of pH was studied, and it was found that the carboxyl ion absorbed in this same far ultraviolet region. Acidification to a pH well below the pH of a carboxylic acid resulted in the elimination of this absorption. Author

1963

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Union Carbide Research Inst., Tarrytown, N.Y.
THE GENERAL AND COMPARATIVE BIOLOGY OF TERRESTRIAL ORGANISMS UNDER EXPERIMENTAL STRESS CONDITIONS. Quarterly Report No. 2.
S. M. Siegel. December 31, 1963, 38 p.
(NASA Contract NASw–767)
(NASA–CR–52635; N64–15895) OTS: $3.60 ph.; $1.34 mf.

The topics discussed include: (1) anaerobiosis in seed germination—systematic and phylogenetic aspects; (2) germination in atmospheres containing nitrogen oxides; (3) effects of CO_2 and CO_2+O_2 combinations on seedling growth; (4) germination and growth in atmospheres containing volatile organic compounds; and (5) the low temperature-hydrogen interaction effect on seed germination. R.T.K.

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National Research Corp., Cambridge, Mass., Research Div.
EFFECTS OF SIMULATED SPACE ENVIRONMENTS ON THE VIABILITY OF MICROORGANISMS. Final Report. April 15, 1961–April 30, 1963.
Gerald J. Silverman (MIT), Rosario P. Giammanco, Norman S. Davis (MIT), Frank C. Benner, and Cecil G. Dunn (MIT). December 18, 1963, 34 p., refs.
(NASA Contract NASr–41)
(NASA–CR–55288; N64–15181) OTS: $3.60 ph.; $1.22 mf.

Spores of five test organisms, *Bacillus subtilis var. niger*, *Bacillus megaterium*, *Bacillus stearothermophilus*, *Clostridium sporogenes*, and *Aspergilus niger*, and soils were exposed while under ultrahigh vacuum to temperatures of from −190° to +170° C for 4 to 5 days. Up to a temperature of 25° C, no loss in viability of the test spores was noted when compared to original populations maintained at room temperature and atmospheric pressure over a desiccant. At elevated temperatures, differences in resistivity occurred so that at 88° C only *B. subtilis* var. *niger* and *A. niger* survived in appreciable numbers. At 107° C, only *A. niger* spores survived, but none were recoverable after exposure to 120° C. In comparison, *B. subtilis* var. *niger* survived at atmospheric pressure and 90° C for 5 days, but none of the other spores were viable after 24 hours. Author

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National Aeronautics and Space Administration.
Goddard Space Flight Center, Greenbelt, Md.
EXPERIMENTS FROM A SMALL PROBE WHICH ENTERS THE ATMOSPHERE OF MARS.
R. A. Hanel, L. E. Richtmyer, R. A. Stampfl, and W. G. Stroud. Washington, NASA, December 1963, 23 p., refs.
(NASA–TN–D–18991; N64–11234) OTS: $0.75.

This paper addresses itself to the design of a Mars capsule capable of a safe entry and landing on Mars. Quite simple sensors of pressure, temperature, density, molecular weight and gross composition of the atmosphere can yield significant physical and ecological data. The safe landing will permit the execution of significant biological experiments for the detection of life. Data transmitted at a rate of 1 bit/sec during the capsule descent and following the landing are best handled by a direct planet-to-Earth communication link. The significance of the experiments and the techniques required are discussed. Author

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IIT Research Institute, Chicago, Ill.
LIFE IN EXTRATERRESTRIAL ENVIRONMENTS. Quarterly Status Report. September 15–November 15, 1963
Charles A. Hagen and Regnal Jones. 1963, 20 p.
(NASA Contract NASr-22: IITRI Proj. C 194)
(NASA–CR–52841: IITRI–C 194–11; N64–11293) OTS: $1.60 ph.; $0.80 mf.

Bacterial counts are given for soil samples collected at Rocky Mountain National Park, Colorado and White Sands National Monument, New Mexico. Faculative, lecithinase positive microorganisms were isolated from a variety of desert and tundra soil samples. These bacteria were able to survive the simulated Martian environment of the experiment. Fungal components of lichen species were isolated and were able to survive the Martian atmosphere. Apothecia germination, with mycelial growth, also occurred in the simulated Martian environment. Some pigmentation of lichenized fungi grown in the Martian atmosphere was noticed. R.T.K.

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Naval Reserve Research Co., 12–5, Berkeley, Calif.
RESEARCH RESERVE SPACE SCIENCE SEMINAR. SUMMARY OF PRESENTATIONS, SAN FRANCISCO. October 20–November 2, 1963.
John T. Hayward, et al., 1963, 31 p., refs. (Summaries Only), (Sponsored by ONR).
(AD–429096; N64–14993) OTS: $3.60.

Topics discussed during this seminar include astronomy and astrophysics; space exploration; exobiology; spacecraft; propulsion and propellants; entry and landing; space physiology; closed ecological systems; unmanned deep space probes; and space telemetry, communications, and tracking. E.W.

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National Aeronautics and Space Administration.
Ames Research Center, Moffett Field, Calif.
STUDIES ON "MARTIAN" BIOLOGY.
Paul Deal. *In* Naval Reserve Research Co. 12–5, Berkeley, Calif. Research Reserve Space Science Seminar, Treasure Island, San Francisco, October 20–November 2, 1963, p. 13 (Summary Only). (N64–14993) OTS: $3.60.

According to best current knowledge, Martian atmosphere contains a high proportion of CO_2, very little water vapor, and no oxygen. The diurnal temperature in "summer" is from about −80° to 30° C. Liquid water would not exist on Mars except perhaps below the surface or bound by certain mineral structures. Such conditions are quite hostile to most forms of earth life. Certain bacteria have been tested for growth under simulated Martian conditions. Up till now these tests were mainly concerned with temperature cycling. Some, but not all, species tested showed ability to adapt to alternate freezing and thawing, with rather short periods at temperatures needed for growth. Nevertheless, growth did occur, which indicates that at least certain forms of earth life could survive and perhaps grow under Martian conditions. It is expected that life forms on Mars would be better adapted to its rigorous conditions. Author.

17

Stanford University, Palo Alto, Calif., School of Medicine.
THE SEARCH FOR EXTRATERRESTRIAL LIFE.
E. Shneour. *In* Naval Reserve Research Co. 12–5, Berkeley, Calif. Research Reserve Space Science Seminar, Treasure Island, San Francisco, October 20–November 2, 1963, p. 12 (Summary Only).
(N64–14993) OTS: $3.60.

The origin of life on earth indicates a high probability that life has evolved elsewhere in the universe. Such life would most likely be based upon carbon chemistry and would demand the presence of water at temperatures (0 to 100° C.) compatible with the liquid state. The abundant elements in living systems correspond to the cosmic abundance of the elements with a few exceptions: helium and silicon are abundant, but not important in living systems, while phosphorous is relatively rare, but important to life. On the prebiological earth, a reducing atmosphere containing CH_4, NH, and H_2O most likely existed. With ultraviolet light as an energy source, a large number of organic compounds were synthesized. The collection of such material into organized living material is less well understood. Of all planets, Mars shows highest possibility of existence of extraterrestrial life. If life doesn't exist, microbial forms should be found whether or not higher forms are present. A new device called Multivator will indicate such life processes. Contamination with earth organisms must be avoided. A.H.F.

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Jet Propulsion Laboratory, Calif. Inst. of Tech., Pasadena, Calif.
FLUOROMETRY AS AN APPROACH TO LIFE DETECTION.
Joon Rho. *In* Naval Reserve Research Co. 12–5, Berkeley, Calif. Research Reserve Space Science Seminar, San Francisco, October 20–November 2, 1963, (Summary Only).
(N64–14993) OTS: $3.60.

Fluorometry provides a very sensitive means of detecting microbiological life. Such microorganisms are more likely to be present on Mars than higher forms of life. Certain molecules characteristic of life absorb light at a longer wavelength. Some of these molecules fluoresce in their natural state, while others require chemical manipulation before they fluoresce. Proteins show characteristic fluorescence. Soil suspensions have been tested and found to show characteristic biological fluorescent spectra due to microbial organisms. Growth of the organisms produces an increase in the fluorescent signal. Incorporation of a fluorometer capable of scanning a number of wavelengths into an instrumented package for a Mars landing should enable us to detect biological molecules similar to, or perhaps different from, those known on earth. Growth of the organisms should be detected by an increase of the specific fluorescence. Author

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National Aeronautics and Space Administration, Washington, D.C.
PROBLEMS OF SPACE MICROBIOLOGY AND CYTOLOGY.
N. N. Zhukov-Verezhnikov, I. N. Mayskiy, V. I. Yazdovskiy, A. P. Pekhov, N. I. Rybakov, et al. *In* Problems of Space Biology, November 1963, p. 133–151, refs. Trans. into English from a book "Problemy Kosmicheskoy Biologii" Izd. Akad. Nauk., SSSR (Moscow), Vol.1, 1962.
(N64–11670; NASA–TT–F–174) OTS: $7.00.

Microbiological and cytological investigations carried out in the Soviet satellites Vostok-1 and Vostok-2 were intended for solving the following two problems of biology: (1) study of conditions of life in outer space (viability of microorganisms and somatic cells and reproduction after exposure); and, (2) study of the genetic effects caused by spaceflight. Biological material of different levels of organization was studied: bacteria, phages, cells in tissue culture (Hela cancer cells, fibroblasts, amnion cells), and skin flaps which were regrafted to their donors after flight. No essential changes were observed in comparison with controls in microbiological and cytological specimens used in the spaceflights. It is assumed, therefore, that spaceflight conditions have no unfavorable effect on highly organized, multicellular organisms of more highly developed animals or living cells. Only in one experiment in Vostok-2 was a slight increase observed in the induced phage production of lysogenic bacteria. The dissociative phenomena in the culture *E. coli* KK-12 increased somewhat. Author

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National Aeronautics and Space Administration, Washington, D.C.
THE POSSIBILITY OF EXISTENCE AND METHODS OF DETECTING EXTRATERRESTRIAL LIFE.
A. A. Imshenetskiy. *In* Problems of Space Biology, November 1963, p. 153–160. Trans. into English from a book "Problemy Kosmicheskoy Biologii" Izd. Akad. Nauk., SSSR (Moscow), Vol. 1, 1962.
(N64–11671; NASA–TT–F–174) OTS: $7.00.

The author briefly reviews past and present origin-of-life theories, and the possibility of interplanetary transport of life forms by means of radiation pressure. It is simpler in principle to suppose that life forms on other planets will resemble terrestrial uni-

cellular organisms, rather than to postulate the existence of types of metabolism not based on water and carbon. Such organisms can withstand liquid helium temperatures, but —10° C appears to be the lower limit at which reproduction has been observed. Some thermophilic bacteria can withstand boiling for 4 to 5 days, and the author postulates that organisms could have become adapted to temperatures up to 150° C on other planets. Many lower terrestrial forms are sufficiently radioresistant to withstand the effects of cosmic radiation, but resistance to ultraviolet radiation is much lower. The absence of oxygen is, in this respect, also immaterial as many terrestrial organisms can grow under anaerobic conditions. The author discusses various methods proposed for automatically recording the existence of life forms from a vehicle which has landed on a planet. Author

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Esso Research and Engineering Co., Linden, N.J.
DEVELOPMENT OF HYDROCARBON ANALYSES AS A MEANS OF DETECTING LIFE IN SPACE. Quarterly Report.
W. G. Meinschein, October 1, 1963, 21 p., refs.
(NASA Contract NASw–508)
(NASA–CR–52217; N64–20682) OTS: $2.60 ph.

Data have been collected which permit a testing of the hypotheses that the biochemically and chemically least active biological molecules may accumulate unaltered in the elimination products of living things and, in turn, in terrestrial sediments. The concentrations of alkanes in the benzene extracts of cow manure, bat guano, and terrestrial sediments are comparable. These concentrations exceed by more than two orders of magnitude the concentrations of alkanes in the benzene extracts of plants, animals, and a food, butter. Mass spectrometric analyses indicate that alkanes from living things, biological elimination products, and terrestrial sediments are composed of the same types of compounds. Optical activities of hydrocarbons in a crude oil obtained from a 1.1-billion-year-old sediment have been found to be of the same sign and magnitude as are the optical activities of some relatively young oils. Author

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California University, La Jolla, Calif.
REMARKS CONCERNING THE CHEMICAL COMPOSITION OF THE ATMOSPHERE OF VENUS.
Hans E. Suess. October 1963, 12 p., refs.
(NASA Grants NsG–322–63 and NsG–317–63)
(NASA–CR–55367; N64–14152) OTS: $1.60 ph.; $0.80 mf.

It is still impossible to decide, on the basis of observational data, whether the atmosphere of Venus is oxidizing, or reducing. Also, cosmochemical considerations do not lead to a conclusive answer to this important question. The atmosphere of Venus appears to be much more dense than that of the Earth. For several reasons, it seems probable that the main constituent of the dense atmosphere is neon. It might even be premature to exclude every possibility of finding an atmosphere on Venus that is, at some level of its profile, breathable by humans. Author

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Union Carbide Research Institute, Tarrytown, N.Y.
THE GENERAL AND COMPARATIVE BIOLOGY OF TERRESTRIAL ORGANISMS UNDER EXPERIMENTAL STRESS CONDITIONS. Quarterly Report One.
S. M. Siegel. September 30, 1963, 123 p., refs.
(NASA Contract NASw–767)
(NASA–CR–52082; N63–23616) OTS: $10.10 ph.; $3.89 mf.

The stress responses of 300 species and varieties of seed plants, 24 species of lower plants and protista, and over 20 species of animals to environmental conditions of a nearly simulated Mars Equatorial Summer and Anaerobic Desert conditions were studied. Seed germination was selected as a means for biological evaluation of atmosphere, temperature, and water availability. Winter rye withstood the environmental stress better than other seed plants, and fungi introduced accidentally as spores, grew well during simulator operation. Hydrogen production from sterilized seeds was observed. Winter rye shows a regular decline in germination as the osmotic pressure of sodium chloride is increased, and the presence of calcium enables rye to germinate without inhibition at the highest osmotic pressures tested. Most invertebrates tested, and the common turtle, were found to survive under variations in air and oxygen pressure. The Cephalous, metazoan, withstood centrifugation at 100,000 g. The response of seed germination to partial pressure of oxygen varies with the species and within the species. R.T.K.

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Melpar, Inc., Falls Church, Va.
DETECTION OF EXTRATERRESTRIAL LIFE. METHOD II: OPTICAL ROTATOR DISPERSION. Third Quarterly Report, June 19, 1963–September 1963. 1963, 43 p.
(NASA Contract NASw–557)
(NASA–CR–52073; N64–10169) OTS: $4.60 ph.; $1.49 mf.

A discussion is presented of the theoretical development preceding the use of an apparatus, designed and incorporated into a spectrophotometer, which permits premeasurement of optical rotation in media exhibiting absorption, scattering, and circular dichroism. Optical rotary dispersion measurements were obtained on pure water, 0.15N HCl, 0.15N NaOH, and 0.5N NaOH soluble extracts of soil. In the wavelength region from 230 to 280mμ, both the water and acid-soluble extracts of soil exhibit negative optical rotations. The 0.15N NaOH extract of soil shows a positive optical rotation, and the 1.5N NaOH extract indicates no measurable rotation in this wavelength region. Below 240 mμ the more basic extracts exhibit negative rotation. For the basic extracts, the use of the more basic solution apparently results in a rupture of the chemical bonds responsible for the optical activity in the less basic extract. The positive rotations obtained for the less basic extracts may be caused by the nucleic acids or their derivatives. P.V.E.

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School of Aerospace Medicine. Brooks AFB, Texas
STUDIES WITH A SIMULATED MARTIAN ENVIRONMENT. GERMINATION AND GROWTH OF BACTERIAL SPORES.
Thomas L. Roberts and Laurence A. Irvine. September 1963, 10 p., refs.
(SAM–TDR–63–75; AD–424189; N64–12340)

Simulated Martian microenvironment containing 8% moisture permitted germination and growth of endospores of Clostridium sporogenes. Author

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IIT Research Institute, Chicago Ill.
LIFE IN EXTRATERRESTRIAL ENVIRONMENTS. Quarterly Status Report. May 15–August 15, 1963.
Charles A. Hagen. 1963, 16 p., 6 refs.
(NASA Contract NASr–22)
(NASA–CR–50934; IITRI–C194–10; N64–22758) OTS: $1.60 ph.

Eighty-eight cultures of facultative anaerobic bacteria were obtained from 253 isolates from various California desert soils.

The cultures are screened for survival in a simulated Martian environment. A nonsporeforming organism identified as *S. aurantiaca* demonstrated a high resistance to the simulated Martian environment, after 112 days exposure. Initial screening tests indicated good survival of *Bacillus cereus var mucoides;* 37% of the cells were recovered as total count and the spore count increased 4.9 times after 28 days' exposure to the simulated Martian environment. J.R.C.

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National Aeronautics and Space Administration, Washington, D.C.
AFTER NOW, WHAT THEN IN SPACE? News Release. Presented at the Polytechnic Institute on Artificial Satellites, August 12, 1963; Blackburg, Va.
Homer E. Newell. Augus 12, 1963, 22 p.
(N63–19621)

NASA's possible choices of what to do next in space are discussed. Among the choices considered is the search for extraterrestrial life. The philosophical and biological significance that would attend the discovery of life in space is stressed. Mars is considered to be the most likely candidate, since balloon observations in the infrared have detected emission bands characteristic of the carbon-hydrogen bond. Should life be found on Mars, it may be sufficiently different from life on earth to provide, by comparison, extremely illuminating information about the nature of physical life. M.P.G.

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Douglas Aircraft Co., Inc., Santa Monica, Calif.
PHYSICAL PROPERTIES OF THE PLANET MARS.
August 1963, 98 p., 179 refs.
(SM–43634; N63–22371)

Topics of discussion include orbital elements, satellites, mass, diameter, shape, mean density, internal structure, surface gravity, the axis and period of rotation, temperature, climate, atmosphere, surface pressure, circulation, clouds, and electromagnetic and particle fields. The vegetation hypothesis as an explanation for Martian surface features is discussed in relation to observed changes in polar caps and canals. Theories on the existence of Martian life are reviewed along with the visual, spectroscopic, or experimental evidence upon which each is based. J.E.T.

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California University, Berkeley, Calif.
THE REFLECTION AND EMISSION OF ELECTROMAGNETIC RADIATION BY PLANETARY SURFACES AND CLOUDS.
D. G. Rea and W. J. Welch. July 26, 1963, 90 p., refs.
(NASA Grant NsG–101–61; NSF G–16741)
(NASA–CR–52222; N64–22770) OTS: $8.10.

A review of data dealing with the reflection and emission of electromagnetic radiation by planetary surfaces and clouds is presented. Only quantitative observations possessing a certain amount of spectral resolution are considered. Theoretical considerations are developed for reflection and emission by plane surfaces, layered surfaces, rough surfaces, and clouds. The radiometric determination of planetary temperatures is also discussed. Reflection and emission observations of the Moon, Mercury, Venus, Mars, Jupiter and Saturn are reviewed. The suggestion by Minnaert that the lichen *Cladonia rangeferina* best fits photometric observations of the lunar surface is discussed. The suggestion by Sinton and others that Martian infrared features may be due to surface organic material including carbohydrates is considered to be possible and of great significance to the possibility of a Martian biology. M.P.G.

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Army Chemical Corps, Ft. Detrick, Md. Physical Defense Division.
MICROBIAL CONTAMINATION OBTAINED ON SURFACES EXPOSED TO ROOM AIR OR TOUCHED BY THE HUMAN HAND.
Dorothy M. Portner, R. Hoffman, H. Decker, and C. Phillips. July 22, 1963, 10 p.
(NASA Order R–35)
(NASA–CR–50843; Rept. 1–64; N63–19962) OTS: $1.10 ph.; $0.80 mf.

A study to determine the level of microbial contamination that can be expected to accumulate on a surface was conducted in order to obtain an experimental basis for estimating microbial contamination on a spacecraft. In addition to the contamination acquired by the airborne route, the human hand, touching or handling the spacecraft, may also contribute microorganisms. In the present experiments, surfaces, used to simulate those of a spacecraft, were exposed to room air for various time periods; also other such surfaces were touched or handled by the human hand. The microbial recoveries obtained from surfaces exposed to these two routes are reported. Author

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Library of Congress, Washington, D.C. Aerospace information Division.
SOVIET BIOASTRONAUTICS AND BIOTECHNOLOGY FACILITIES, PROGRAMS, PERSONALITIES. Summary of Data.
July 9, 1963, 54 p., 211 refs.
(AID–P–63–95; N63–20253) OTS: $5.60 ph.; $1.82 mf.

Soviet bioastronautics and biotechnology facilities, programs, and personalities are summarized. Included are: (1) a list of leaders in Soviet bioastronautics, scientists associated with manned spaceflight, and organizations involved in the Soviet bioastronautics effort; and, (2) a list of spaceflight experiments and space-oriented research in closed ecological systems, biotelemetry, and exobiology. P.V.E.

33

Argonne National Laboratory, Lemont, Ill.
GROWTH AND DEVELOPMENT OF PLANTS IN COMPENSATED GRAVITATIONAL, MAGNETIC, AND ELECTRICAL FIELDS. Interim Report No. 2.
Solon A. Gordon, et al. July 1, 1963, 35 p., 25 refs.
(NASA Order R–46)
(NASA–CR–51180; N64–22776) OTS: $3.60 ph.

Biological response to continuous accelerations in magnitude on the order of a micro-g has been observed. To determine the threshold of such accelerations, a variable-velocity, two-dimentional compensator has been developed. A multiple one-dimensional apparatus was also constructed for pilot experiments with tissue cultures. A rigorous mathematical foundation was derived for design of a 3-dimensional compensator for field nullification. Author

34

Esso Research and Engineering Co., Linden, N.J.
DEVELOPMENT OF HYDROCARBON ANALYSES AS A MEANS OF DETECTING LIFE IN SPACE. Quarterly Report.
W. G. Meinschein. July 1, 1963, 10 p., 11 refs.
(NASA Contract NASw–508)
(NASA–CR–50703; N64–22761) OTS: $1.10 ph.

Gas chromatograms of alkanes obtained with Apiezon L-coated capillary columns apparently provide a means of "finger-

printing" mixtures of saturated hydrocarbons. Alkanes from bat guano and from a 60-million-year-old sediment both contain higher concentrations of even- than of odd-carbon number n-paraffins in the C_{11} to C_{20} range, and higher concentrations of odd- than of even-carbon number n-paraffins in the C_{23} to C_{31} range. Fischer-Tropsch saturated hydrocarbons, on the other hand, show a systematic increase followed by a systematic decrease in concentrations of homologous alkanes. These concentrational changes can be explained by the loss of volatile components from an abiotic product in which the reaction equilibria led to a decrease in concentration of homologous hydrocarbons with increasing carbon number. Nonsystematic fluctuations in the concentration versus carbon number plots of homologous alkanes appear to be characteristic of biological alkanes of low as well as of high molecular weights. Components of the benzene extract of the Orgueil meteorite vary nonsystematically in concentration with changing carbon number. Author

35

Stanford University, Palo Alto, Calif., Biophysics Laboratory.
MOLECULAR EVOLUTION IN PROTOBIOLOGICAL SYSTEMS, INCLUDING A SEARCH FOR CATALYSTS AND CATALYTIC ACTIVITY IN THE INTERMEDIATE SYSTEMS WHICH FORM DURING THE SYNTHESES OF LOW MOLECULAR WEIGHT ORGANIC COMPOUNDS. Semiannual Status Report No. 3. December 1, 1962–May 31, 1963.
M. S. Blois, Jr. and H. H. Pattee. July, 1963, 3 p.
(NASA Grant NsG–218–62)
(BL Rept. 86; N64–22781) OTS: $1.10 ph.

The ultraviolet photochemistry of amino acids, purines and pyrimidines, and the protection against uv photolysis afforded by clay surfaces when small molecules are adsorbed upon them are being studied. One result shows that the photochemistry of phenylalanine, subjected to long exposures of ultraviolet radiation (2537 A) is strongly affected by the presence or absence of oxygen, a result not unexpected from chemical considerations, but counter to the commonly expressed belief that (at least in a biological context) there is no "oxygen effect" in the case of ultraviolet radiation. A second series of experiments has been concerned with the production of polymeric and/or insoluble products by the irradiation of aromatic amino acids by ultraviolet. A third finding has been the confirmation of the predicted stabilizing effect of a clay (montmorillonite) surface upon which guanine was adsorbed. Under given irradiation conditions guanine in aqueous solution was photolyzed to $>$ 99% in an exposure of 30 hours. Under similar conditions, the guanine adsorbed on clay was, to a considerable extent, still unaffected after 183 hours. Author

36

Melpar, Inc., Falls Church, Va.
RESEARCH ON DETECTION OF EXTRATERRESTRIAL LIFE BY ULTRAVIOLET SPECTROPHOTOMETRY. Second Quarterly Progress Report. April 1–June 30, 1963.
Sol S. Nelson. 1963, 26 p., 3 refs.
(NASA Contract NASw–571)
(NASA–CR–50815; N64–22760) OTS: $2.60 ph.

Absorption maxima between 185 and 190 mμ were found in dipeptides, tripeptides, polylycine, polyglycine, and polyglutamic acid, bovine serium albumin, and extracts of soil samples. All the absorptivities were pH-dependent going through a maximum between pH3 and pH7. Present work includes an extension of these studies and a study of contributions to these absorptions by nonpeptide groups. Author

37

General Mills Electronics Group, Minneapolis, Minn.
RESEARCH TO DETERMINE THE EXISTENCE AND IDENTITY OF VIABLE MICROORGANISMS IN THE STRATOSPHERE. First Quarterly Status Report. March 18–June 18, 1963.
V. W. Greene. 1963, 3 p.
(NASA Contract NASw–648)
(NASA–CR–50698; N64–22769) OTS: $1.10 ph.

Arrangements for the first two spaceflights to determine the existence and identity of viable microorganisms in the stratosphere were completed. A launch and recovery of a four-stratosphere microorganism sampler payload, which reached an altitude of 90,000 feet were made. There were mechanical malfunctions of the anticontamination locks of the samplers, which limited the validity of the biological data. Results of the experiment suggest that: (1) the sterilizing and storage techniques prior to launch were satisfactory; (2) the concept of sampling during descent has been properly programed; and (3) the contamination controls designed for the program will serve their purpose if there are no mechanical malfunctions. The samplers and instrument packs were recovered intact and are being prepared for another flight. N.E.A.

38

National Aeronautics and Space Administration.
Ames Research Center, Moffett Field, Calif.
CHEMICAL EVOLUTION AND THE ORIGIN OF LIFE.
Cyril Ponnamperuma. 1963, 16 p., refs. Condensation of an address presented at the Annual Commencement Luncheon, Sigma Xi; and Phi Beta Kappa, Missouri U., Columbia, June 3, 1963.
(NASA–TM–X–54008; N64–22754) OTS: $1.60 ph.

The origin of life is discussed from the standpoint of the evolution of the inorganic, organic, and biological material necessary for the formation and support of living organisms. Taken into consideration is the chemical evolution of the elements of the periodic table from the primeval cloud of hydrogen gas by a series of reactions. These elements form the inorganic materials, which combine and progress to the organic compounds that compose living organisms. Because of the progressive series of change in this scheme, life is considered a special and very complicated form of the motion of matter. Life may then be considered as an inevitable process that must appear where conditions are favorable. Attention is directed toward the possibility of the existence of life elsewhere in the universe. Experiments are discussed in which several constituents of the nucleic acid molecule have been synthesized, beginning with the primitive atmospheres. C.L.W.

39

Air Force Systems Command, Kirtland AFB, N. Mex.
BIBLIOGRAPHY OF EXTRATERRESTRIAL RESEARCH.
Robert W. Henny. June 1963, 104 p., 1504 refs.
(AFWL–RTD–TDR–63–3025; N63–18778)

This bibliography on extraterrestrial research is subdivided into the following categories: Astrobiology; Astronomy and Cosmology; Cratering Phenomena; Extraterrestrial Matter; Materials; Meteoritic Cratering; Moon (Atlases and Photography, Configuration, Experimental Research, Exploration and Basing Concepts, Lunar-Earth Phenomena, Lunar Trajectories, Surface Materials, and Topographical Features); Planets; Power Systems; Space Vehicles and Probes; Tektites; and Vacuum Environmental Simulation. Author

40

Mass. Inst. of Tech., Cambridge, Mass.

THE DETECTION AND IDENTIFICATION OF ORGANIC MATTER BY MASS SPECTROMETRY.

Second and Third Semiannual Report. June 1, 1962-May 31, 1963.

K. Biemann. 1963, 2 p.

(NASA Grant NsG–211–62)

(NASA–CR–50678; N64–22762) OTS: $1.10 ph.

The investigation of the mass spectra of organic compounds of biological interest has been continued. Information has been obtained on the spectra of free amino acids, small peptides, carbohydrates, nucleosides, and purines and pyrimidines of the type occurring in nucleic acids. The spectra are being studied so as to identify compounds occurring in nature on earth. Also, methods are being developed to determine the structure of compounds not necessarily associated with terrestrial life. D.E.R.

41

Jet Propulsion Laboratory, Calif. Inst. of Tech., Pasadena, Calif.

SOIL ORGANIC MATTER.

R. E. Cameron and G. B. Blank. May 23, 1963, 17 p., 25 refs.

(NASA Contract NAS7–100)

(NASA–CR–50778; JPL–TR–32–443; N63–19786) OTS: $1.60 ph.

A determination of the amount, nature, and distribution of organic matter in desertic soils will be useful for extraterrestrial life detection and the biotic characterization of an extraterrestrial soil environment. Levels of organic matter in southern California desertic soils are given in terms of carbon and nitrogen and the total organic matter content. A direct determination of soil organic matter by the autoclave colorimetric method is presented for the first time, and it is compared with standard methods for the indirect estimation of soil organic matter from carbon and nitrogen values. The autoclave colorimetric method correlates with indirect methods and could secondarily provide information on soil texture. Author

42

IIT Research Institute, Chicago, Ill.

LIFE IN EXTRATERRESTRIAL ENVIRONMENTS. Quarterly Status Report. February 15–May 15, 1963.

Charles A. Hagen. 1963, 15 p., 3 refs.

(NASA Contract NASr–22)

(NASA–CR–50883; ARF 3194–9; N63–21997) OTS: $1.60 ph.; $0.80 mf.

A micrococcus, nonspore former, isolated from a California desert soil, was placed in a simulated Martian environment and survived with little change in total viable count for at least 28 days. Survival in the Martian environment of this microorganism was enhanced when the Martian soil was replaced with sterile desert soil from which it was isolated. The decrease in total viable count as a result of inoculation procedure and flushing with either Earth or Martian atmosphere was partially overcome by replacing the Martian soil with the desert soil. A partial listing of this microorganism's morphological and biochemical characteristics is given; the moisture, organic, and inorganic composition of the Martian soil and of 5 desert soils are reported, and the moisture uptake of Martian soil and of Martian soil with 1 and 10% dehydrated bacteriological medium is indicated. C.L.W.

43

National Research Corp., Cambridge, Mass.

EFFECTS OF SIMULATED SPACE ENVIRONMENTS ON THE VIABILITY OF MICROORGANISMS. Quarterly Status Report. January 16–April 15, 1963.

Norman S. Davis, Gerald J. Silverman (MIT), and Frank C. Benner. May 9, 1963, 6 p.

(NASA Contract NASr–41)

(NASA–CR–50333; N64–22752) OTS: $1.10 ph.

During this period of testing the viability of microorganisms in simulated space environments, the combined effects of thermal and ultrahigh vacuum exposure were studied in continuing experiments with organisms isolated from Mohave Desert soils. Studies of the combined effects of gamma radiation and ultrahigh vacuum on selected microorganisms were resumed in an improved vacuum system. The ultraviolet radiation system has been modified so that the intensity of the lamp output was reduced from 1,000 to 60 microwatts per square centimeter, thereby permitting studies at lower ultraviolet intensities. N.E.A.

44

Florida State University, Tallahassee, Fla., Institute for Space Biosciences.

RESEARCH IN SPACE BIOLOGY AND RELEVANT PHYSICAL ASPECTS OF PLANETARY AND SPACE ENVIRONMENTS. Semiannual Research Status Report.

S. Fox, S. Hess, and C. Metz. May 1, 1963, 11 p., 1 ref.

(NASA Grant NsG–173–62)

(NASA–CR–50483; N64–22775) OTS: $1.60 ph.

The following results were obtained from investigations in space biosciences: (1) studies on the thermal copolymerization of cystine with other amino acids reveal that cystine can form many other amino acids, aspartic acid being quantitatively prominent among these; (2) thermal proteinoids were further characterized through improvements of the Akabori hydrazinolysis methods; these studies show that proteinoids tend to have 2–4 C-termini per N-terminus which indicates a degree of branching comparable to that found in proteins; (3) the catalytic activity for *p*-nitrophenyl acetate of the proteinoids is found to a considerable degree in the thermal copolymers of a few amino acids, such as aspartic acid and histidine; (4) evidence was obtained spectrally for the binding of hemes by proteinoid; (5) the active site of hydrolytic enzymes was synthesized; (6) preparations of the thermal polymer of cytidylic acid are found to be attacked by ribonuclease; (7) the simultaneous polymerization of Leuchs anhydrides of the amino acids, common to protein, was accomplished and simplified; (8) a theoretical model of the general circulation of Venus in the deep layers of the atmosphere was formulated; (9) the first conception of a frost-point hygrometer to be dropped into the atmosphere of Mars was proved feasible; (10) two clones of callus cells from *Haplopappus gracilis* were grown on a simple mineral-sugar-vitamin-agar medium through 13 subcultures; (11) a study of the pachytene and metaphase in the corresponding allotetraploid of an F. intergeneric hybrid, *Lycopersicon esculentum* X *Solanum lycopersicoides*, indicated that synopsis is almost completely preferential in the tetraploid. I.v.L.

45

Jet Propulsion Laboratory, Calif. Inst. of Tech., Pasadena, Calif.
THE DETECTION OF WATER VAPOR ON MARS.
Hyron Spinrad, Guido Münch, and Lewis D. Kaplan. May 1963, 4 p.
(NASA Contract NAS7–100)
(JPL–TR–32–454; N63–23048) OTS: $1.10 ph.

Eleven weak lines of water vapor were found on a high-dispersion near-infrared spectrogram of Mars taken at the coudé focus of the Mount Wilson 100-inch reflector on April 12–13, 1963. The Martian H_2O lines in the λ 8200 water-vapor band were displaced 0.42 A longward of their telluric counterparts due to the relative velocities of the Earth and Mars: $\Delta V = +15$ km/sec on that date. The Martian lines were strongest over the poles of the planet. The spectrograph slit was set almost north-south to cover both polar regions. This apparent polar strengthening of the Martian H_2O lines is at least partially due to the increased air mass through the line-of-sight to high altitudes. The Martian H_2O lines have strengths of approximately 3 to 5 mA: but for such faint lines, east-west measurements are uncertain. Preliminary examination of the data indicates that the Martian H_2O abundance is probably near 5 to 10μ precipitable H_2O over the Martian poles. Also, the $5\nu_3$ band of CO_2 at λ 8689 was found in the Martian spectrum. The absorption lines in the R and P branches were well resolved, but they were extremely weak. The head of the 7820 ($\nu_1+5\nu_3$) CO_2 band was also visible. The detection of these lines implies a high CO_2 abundance on Mars. I.v.L.

46

Stanford University, Palo Alto, Calif., School of Medicine.
AN INSTRUMENTATION CRISIS IN BIOLOGY.
Joshua Lederberg. May 1963, 9 p.
(NASA Grant NsG–81–60)
(NASA–CR–51095; N64–22774) OTS: $1.10 ph.

The inadequacy of the current art in biochemical instrumentation was brought to light by efforts to meet the requirements of exobiological studies. An immense amount of information is still locked up in spectra (optical absorption, magnetic resonance, rotary dispersion, mass spectra) and similar "fingerprints," which require the intensive development of the "man-computer symbiosis" for adequate resolution. Some of the more directly mission oriented projects which have been reasonably successful include: (1) the prototype model of the Multivator, a device for the acquisition of Martian surface dust samples and the determination of enzymatic activity or growth by various photometric measurements; (2) a videoscan spectrometer; (3) a colony counter; and, (4) a curve reader and analyzer. Suggestions are made for several more instruments which would be of significant value in both laboratory and exobiological applications. M.P.G.

47

Air Force Systems Command, Wright-Paterson AFB, Ohio. Foreign Technology Division.
THE TODAY AND TOMORROW OF COSMIC BIOLOGY.
N. Sisakyan. April 10, 1963, 14 p., translated into English from Aviats. i Kosmonavt. (Moscow), No. 1, p. 10–15, 1963.
(FTD–MT–63–18/1; N64–81191)

Human survival, experiments on animals in space, and the study of life in the universe are discussed. Two approaches to the question of extraterrestrial life are proposed: (1) study of the vital activity of terrestrial organisms under simulated space environments; and, (2) search for organic matter and organisms on planetary surfaces and substrata. Earth-based studies include astronomical observations of Mars and absorption spectroscopic analyses which have indicated spectra characteristic of organic matter of biologic origin. In addition, studies of the hydrocarbons found in meteorites and organic analyses of terrestrial organisms are relevant to cosmic biology. The discovery of extraterrestrial life will permit a comparison of the nature, appearance, and evolution of living matter in the universe and perhaps confirm the laws of the development of matter. A.H.F.

48

California University, Berkeley, Calif., Space Sciences Laboratory.
BIOCHEMICAL ACTIVITIES OF TERRESTRIAL MICROORGANISMS IN SIMULATED PLANETARY ENVIRONMENTS. Interim Report, August 1, 1962–January 31, 1963.
Carl Sagan and Samuel Silver. April 5, 1963, 6 p., 7 refs. (Its Ser. 4, issue 24).
(NASA Grant NsG–126–61)
(N64–22790) OTS: $1.10 ph.

Experiments concerned with extremes of temperature and other environmental factors, which might serve as possible restraints to the development of microorganisms on nearby planets, have been conducted. The results show that a variety of microbial types in their native soil environments, as in artificial media, can survive temperatures from ca. 200° to 300° K (Mars). Spore-forming bacteria capable of withstanding 10^{-3} mm Hg were recovered from soil samples maintained under anaerobic conditions at 373° K (Moon). A comparative study of photosynthetic bacteria and algae is being conducted at present. J.A.J.

49

California University, Berkeley, Calif., Space Sciences Laboratory.
DETECTION AND STUDY OF MICROORGANISMS IN THE UPPER ATMOSPHERE. Progress Report.
William J. Oswald, et al. April 3, 1963, 25 p., 4 refs.
(NASA Grant NsG–104–61)
(NASA–CR–50261; Its Ser. 4, Issue 26; N64–22763) OTS: $2.60 ph.

Research progress has been made in the following areas: (1) refinement and modification of electrostatic precipitator configuration; (2) generation of test aerosols; (3) study of electrical characteristics of the electrostatic precipitator under low air density conditions; (4) design of flight sampler; and, (5) development of bacteriological techniques. Author

50

National Aeronautics and Space Administration, Washington, D.C.
EVALUATION OF INFRARED SPECTROPHOTOMETRY FOR COMPOSITIONAL ANALYSIS OF LUNAR AND PLANETARY SOILS.
R. J. P. Lyon (Stanford Res. Inst.). April 1963, 136 p., 43 refs.
(NASA Contract NASr–49(04))
(NASA–TN–D–1871; N63–14406) OTS: $2.75.

A preliminary feasibility study of infrared analytical techniques for the study of the lunar surface has been made, including absorption studies of 370 rock and mineral samples, and reflection studies of 80 rocks. Spectral information was collected in the wavelength

range 2.5 to 25 mμ (4,000 to 400 cm^{-1}). Emittance spectra have been calculated from the reflectance data for several of the most important rock types. Author

51

Space Technology Laboratories, Inc., Redondo Beach, Calif.
INTERPLANETARY MATTER. A BIBLIOGRAPHY. 1962 Supplement.
L. R. Magnolia. comp. April 1963, 298 p., 567 refs.
(Research Bibliography 46: Rept. 9990–6380–KU–000; N63–22775) OTS: $1.60 ph.

This bibliography consists of 567 annotated references on asteroids, comets, meteorites, meteors, micrometeorites, noctilucent clouds, nonterrestrial dust, origin of the solar system, tektites, the zodiacal light, and related subjects. The majority of the references are those published in 1962 as well as those released in 1962 by ASTIA and NASA. This bibliography is a supplement to NASA N62–16764. J.E.T.

52

Melpar, Inc., Falls Church, Va.
RESEARCH ON DETECTION OF EXTRATERRESTRIAL LIFE BY ULTRAVIOLET SPECTROPHOTOMETRY. First Quarterly Progress Report. January 1–March 31, 1963.
Sol S. Nelson. 1963, 23 p., 3 refs.
(NASA Contract NASw–571)
(N63–15250) OTS: $2.60 ph.; $0.89 mf.

Absorption maxima between 185 and 190 mμ were found in bovine serum albumin and ribonuclease. The absorbencies at all maxima for these proteins vary with pH, go through a maximum at pH 7, and then fall off sharply. Absorption maxima between 185 and 190 mμ were found for phenylalanine, tryptophan, and tyrosine, but not for glycine, alanine, or glycyl glycine. Present work includes a systematic study of dipeptides, tripeptides, and polypeptides, and a study of the contribution of aromatic amino acids to the observed absorption. Author

53

Resources Research, Inc., Washington, D.C.
RADIOISOTOPIC BIOCHEMICAL PROBE FOR EXTRATERRESTRIAL LIFE. Second Annual Progress Report to NASA.
Gilbert V. Levin, Norman H. Horowitz, Allen H. Heim, and Mary-Frances Thompson. March 26, 1963, 152 p.
(NASA Contract NASr–10)
(N64–22756) OTS: $11.50 ph.

Tests of the radioisotopic biochemical probe for extraterrestrial life, Gulliver, are described. Advances in the two major lines of investigation, biology and instrumentation, are enumerated, and the Gulliver III instrument's design, applicability, and tests are reviewed. A program in which Gulliver is used in a photosynthetic experiment is described. D.E.R.

54

Melpar Inc., Falls Church, Va.
DETECTION OF EXTRATERRESTRIAL LIFE. METHOD II: OPTICAL ROTATORY DISPERSION. First Quarterly Report, December 20, 1962–March 19, 1963.
Sol S. Nelson. 1963, 24 p.
(NASA Contract NASw–557)
(N63–15039) OTS: $2.60 ph.; $0.92 mf.

Optical-rotation measurements performed on a water-soluble extract of soil have indicated a cotton effect at about 255 mμ. In addition, ultraviolet absorption measurements on this extract have shown that this approach is not as sensitive as rotatory dispersion for characterizing unknown mixtures. A new system, the ratio of a difference to a constant, has been developed which should permit measurement of optical rotations in the cotton region for both turbid and homogenous solutions. The theoretical development of this technique indicates that it may be possible to determine the difference in absorption coefficients associated with circular dichroism. The Cary spectrophotometer, model 15, is now being modified for this purpose. Author

55

Jet Propulsion Laboratory, Calif. Inst. of Tech., Pasadena, Calif.
A CATALOG OF MICROSTRUCTURES OBSERVED IN CARBONACEOUS CHONDRITES.
Gregg Mamikunian and Michael H. Briggs. March 15, 1963, 79 p. 20 refs.
(NASA Contract NAS7–100)
(JPL–TR–32–398; N63–13597) OTS: $7.60 ph.; $2.75 mf.

A catalog of microphotographs is presented that give the microstructures observed in carbonaceous chondrites. An examination of the microphotographs demonstrates that all meteorite preparations used in this study contain a variety of microstructures in the circa 20-μ size range that exhibit an unusual morphology and yet are not readily identifiable. Identification of certain microstructures as various mineral crystals or contaminating terrestrial debris is made. J.R.C.

56

National Research Corp., Cambridge, Mass.
EFFECTS OF SIMULATED SPACE ENVIRONMENTS ON THE VIABILITY OF MICROORGANISMS. Quarterly Status Report, October 16, 1962–January 15, 1963.
Norman S. Davis, Gerald Silverman, Samuel A. Goldblith (MIT, Cambridge), and Frank C. Benner. March 12, 1963, 9 p.
(NASA Contract NASr–41)
(N64–22786) OTS: $1.10 ph.

The study of microorganisms under vacuum simulated space environment is reported. Organisms have been isolated from samples of Mohave Desert soils. Only eight of the 50 cultures obtained were able to survive vacuum at 120° C. Seven of the cultures were colorless, punctiform, and sporeforming, while the other culture was amber and butyrous. Spores of microorganisms including *A. niger* and *B. subtilis* var. *niger* are being subjected to uv irradiation while under vacuum. In preliminary tests these spores showed 0.1 % and 0.5 % survival, respectively, after being subjected to a uv dose of 200,000 ergs. R.C.M.

57

Jet Propulsion Laboratory, Calif. Inst. of Tech., Pasadena, Calif.
SOME GEOLOGIC PROBLEMS OF MARS.
Alden A. Loomis. March 4, 1963, 22 p., 37 refs.
(NASA Contract NAS7–100)
(JPL–TR–32–400; N63–16444) OTS: $2.60 ph.; $0.80 mf.

Geological and geophysical knowledge and uncertainties concerning the surface and body of Mars are briefly discussed and evaluated. The large number of uncertainties in present data precludes an adequate model of Mars; reliable data are needed. Some geological inferences which can be drawn from available photographic and photometric data concerning topography, areas of water accumulation, and biological activity are discussed. The

priority of scientific geologic experiments is presented, and some present instrumentation capabilities and deficiencies are listed. Author

58

Aeronutronic, Newport Beach, Calif.
EXPERIMENTAL STUDIES FOR THE DETECTION OF PROTEIN IN TRACE AMOUNTS. Final Technical Report.
R. E. Kay. March 1963, 81 p., 26 refs.
(NASA Contract NASr–84)
(NASA–CR–50385; U–2062; N63–17219) OTS: $8.10 ph.; $2.63 mf.

A method of detecting biological macromolecules, based upon the observation of spectral changes due to aggregation of a dibenzo-thiacarbocyanine dye when it is adsorbed on the micromolecular structure, was investigated. The reactions of the dye with inorganic salts, microorganisms, pollen, polypeptides, simple proteins, conjugated proteins, synthetic polypeptides, polynucleotides, carbohydrates, amino acids, pyrimidine and purine bases, nucleosides and nucleotides were investigated. In trace amounts (less than 0.002 percent), only proteins, synthetic polypeptides, nucleic acids, microorganisms, pollen, and substituted polysaccharides cause changes in the absorption spectrum of the dye. The influence of such variables as pH, temperature, and dye-macromolecule stoichiometry on the stability and formation of the dye-macromolecule complexes and dye aggregates was also determined. The optimum conditions for dye-macromolecule formation and stability appear to be a pH of 7 to 9, dye concentration of 4×10^{-5}M, and a temperature of 20° to 40° C. The relationship of macromolecule structure to the absorption spectrum of the macromolecule-dye complex was examined; it was found, especially in the case of DNA, that the nature of the absorption spectrum of the dye-macromolecule complex could give significant information about the structure of the macromolecule. The macromolecule-dye reaction was investigated for its applicability to detection of macromolecules in heterogeneous materials by observing its behavior with soil extracts and suspensions of microorganisms. Author

59

RAND Corp., Santa Monica, Calif.
A SURVEY OF EXOBIOLOGY.
P. G. Seybold. March 1963, 48 p., 178 refs.
(Contract AF 49(638)–700; Proj. RAND)
(RM–3178–PR; N63–13946)

The term "exobiology" was coined by Joshua Lederberg to describe investigations into the possibility of life existing outside the earth. This paper comprises a referenced survey of current thought on this subject, with some attention being paid to the role of exobiology in the national space program. Specific topics considered are: (1) the origin of life on the earth; (2) chemical considerations for life; (3) the suitability of the planets of the solar system for indigenous life; (4) the contamination problem; (5) instrumentation for detecting extraterrestrial life; and, (6) the possibility of the existence of intelligent extraterrestrial life forms. A bibliography on these topics is appended. This survey indicates that in the entire field of exobiology speculations vastly outnumber scientific facts, the extreme case being the subarea dealing with the existence of intelligent forms of extraterrestrial life. The questions of most immediate interest, and areas where experimental progress appears most promising, are concerned with: (1) the existence of life forms, primitive or otherwise, on Mars; and (2) the origin of organic matter found in a small fraction of meteorites. Author

60

IIT Research Institute, Chicago, Ill.
LIFE IN EXTRATERRESTRIAL ENVIRONMENTS. Phase Report. February 16, 1962–February 28, 1963.
Charles A. Hagen and Ervin J. Hawrylewicz. February 28, 1963, 13 p.
(NASA Contract NASr–22)
(NASA–CR–50516; ARF–3194–8; N64–22759' OTS: $1.60 ph.

Two *Aerobacter* cultures, ATCC 1304· and butanediol-producing ATCC 8724, were subjected to simulated Martian environment for 28 days to determine their survival. At the end of 28 days, less than 1% of the cells survived in either of the cultures. A total of 235 representative microorganisms was isolated from five desert soil samples. The isolates were recovered from the samples before exposure to the Martian environment and after exposure for 28 and 84 days. Colonial morphology on agar, growth characteristics in nutrient broth, and the Gram's stain reaction of the isolates were recorded. Members of the genus *Bacillus* were most frequently present in the soil sample. *Actinomyces* organisms were present in fewer numbers, and occasionally *Micrococcus* and molds were present. With increased time in the Martian environment, there was a decrease in the number of *Actinomyces*. Studies were made with two pure *Coccus* and two pure *Bacillus* cultures isolated from the desert soil samples in contact with the Martian environment for 84 days. The *Coccus* cultures were more resistant to inoculation-flushing procedures and subsequently to the simulated Martian environment than the *Bacillus* cultures. Author

61

Jet Propulsion Laboratory, Calif. Inst. of Tech., Pasadena, Calif.
THE ROLE OF SOIL SCIENCE IN SPACE EXPLORATION.
Roy E. Cameron. February 16, 1963, 20 p., 57 refs. Presented before the Synapsis Club, Calif. U., Dec. 3, 1962.
(NASA Contract NAS7–100)
(JPL–TR–32–399; N63–13598) OTS: $1.60 ph.; $0.80 mf.

Current aspects of space science involving soil studies are presented, including a more detailed soil study program involving the microflora of desert soil ecosystems. Basic precepts are given for preparation, investigation, and use of extraterrestrial soil. Author

62

School of Aerospace Medicine, Brooks AFB, Texas.
THE ECOLOGICAL PROFILE OF MARS: BIOASTRONAUTICAL ASPECT.
Hubertus Strughold. *In* Lectures in Aerospace Medicine, February 4–8, 1963, p. 431–448, 30 refs.
(N63–20576)

The ecological profile of Mars shows: (1) atmosphere composition to be 93.8% nitrogen, 4% argon, 2.2% carbon dioxide, and traces of water vapor and oxygen; (2) a barometric pressure at ground level of about 65 mm. Hg; (3) the shield of the Martian atmosphere should offer adequate protection from meteorites and cosmic rays; (4) gravity on the Martian surface is about 38% of that on Earth; and, (5) there is no liquid hydrosphere on the Martian surface. P.V.E.

63

School of Aerospace Medicine, Brooks AFB, Texas.

THE BIO-COURIER: COMPARATIVE IMMUNOBIOLOGICAL SUPPORT FOR PLANETARY, SPACE, AND INTERPLANETARY EXPLORATIONS.

William G. Glenn. *In* Lectures in Aerospace Medicine, February 4–8, 1963, p. 411–428, 43 refs.
(N63–20575)

Bio-Courier techniques are applicable to three types of interdependent requirements: (1) scientific or nonscientific personnel in remote laboratories can initiate meaningful analyses of biological solutions and extracts which will: (a) detect the causative agents of infection and changes in such agents; (b) detect vectors and host of disease; (c) screen groups of people for immunity to disease; and (d) explore both endemic and exotic diseases; (2) biological analyses of body fluids for detecting changes in the immune status and homeostatic balance of teams of astronauts orbiting for extended periods and on interplanetary voyages; and, (3) in the biological exploration of satellites and planets the Bio-Courier will be one of several methods needed to identify extraterrestrial specimens. P.V.E.

64

Rochester University, Rochester, N.Y.

DEVELOPMENT OF A LIFE DETECTOR AND ANALYTICAL INSTRUMENTS FOR PLANETARY SOILS. Status Report, September 1961–February 1963.

W. Vishniac, 1963, 6 p.
(NASA Grant NsG–209–62)
(N64–22783) OTS: $1.10 ph.

A flight model of an extraterrestrial life detector, called the Wolf Trap is being constructed; and a laboratory model of a device to analyze major soluble constituents of planetary soils is described. The soil analyzer operates on paper chromatography principles, and the information is transmitted as the R_f of the individual spots. A pumping apparatus slowly transfers soil extracts to a continuous strip of chromatography paper. The apparatus selects on command from a bank of extracting liquids, spray reagents, and developers. The developed paper strip then moves past a phototube scanner, and the location of the spots is transmitted and recorded. M.P.G.

65

Yale University, New Haven, Conn., School of Medicine.

CONDUCT RESEARCH ON GAS CHROMATOGRAPHIC SYSTEMS TO ANALYZE CERTAIN CHEMICAL CONSTITUENTS OF THE SURFACE OF THE MOON. Progress Report, August 1, 1961–January 31, 1963.

S. R. Lipsky. 1963. 5 p., 3 refs.
(NASA Grant NsG–192–61)
(NASA–CR–50183; N64–22753) OTS: $1.10 ph.

The development of a suitable gas chromatographic detection system which will be capable of determining the presence of organic compounds on the surfaces of the Moon and Mars is discussed. A simple and highly sensitive system was developed for the analysis of both gases and organic vapors. The detector, containing a 200 mc tritium source, is an ionization chamber characterized by a low internal volume and concentric electrodes 1 mm apart. The limit of detection approached 10^{-12} moles per second per 25 ml of carrier gas. P.V.E.

66

California University, Berkeley, Calif., Lawrence Radiation Laboratory

ULTRAVIOLET-ABSORBING COMPOUND(S) REPORTED PRESENT IN THE MURRAY METEORITE.

John Oró. *In* Bio-Organic Chemistry. Quarterly Report, September–November, 1962, January 18, 1963, p. 114–121, 10 refs.
(N63–14636) OTS: $2.50.

It is concluded that the uv-absorbing compounds detected in water extracts of the Murray meteorite after treatment with Dowes 1 came from the resin and not from the meteorite. These findings are based on the identity of the maxima, identity of shifts caused by pH changes, and similarity of elution pattern. This conclusion is in line with observations made by Vaughn, but does not rule out the possibilities that some uv-absorbing compounds are present in the Murray meteorite because uv absorption was also found in extracts that had not come in contact with ion-exchange resins. D.E.R.

67

California University, Berkeley, Calif., Lawrence Radiation Laboratory

SYNTHESIS OF ORGANIC COMPOUNDS BY ELECTRIC DISCHARGES.

J. Oró. *In* Bio-Organic Chemistry, Quarterly Report, September–November, 1962. January 18, 1963, p. 84–101, 27 refs.
(Contract W–7405–ENG–48)
(N63–14636) OTS: $2.50.

The synthesis of organic compounds by electric discharge from ethane, methane, ammonia and water at reaction times of 7 hours or less is reported. The products obtained include isoleucine, asparagine, possible glycinamide, a yellowish oil, a highly insoluble polymer, and several ultraviolet-absorbing compounds. Ninhydrin and autoradiographic methods were used to identify amines, amino amides, and amino nitriles. The formation of asparagine and glycinamide in these experiments is signficant in two respects: (1) it confirms earlier observations that the amides of amino acids are the immediate precursors of the amino acids; and, (2) it supports the hypothesis that amino amides may have played a role in the synthesis of polypeptides under possible primitive earth conditions. M.P.G.

68

California University, Berkeley, Calif., Lawrence Radiation Laboratory.

SYNTHESIS OF ORGANIC COMPOUNDS BY HIGH-ENERGY ELECTRONS.

J. Oró. *In* Bio-Organic Chemistry, Quarterly Report, September–November, 1962. January 18, 1963, p. 114–121, 10 refs.
(Contract W–7405–ENG–48)
(N63–14636) OTS: $2.50.

The synthesis of organic compounds by the action of ionizing radiation on simple compounds containing C, N, O, and H under possible primitive earth conditions is reported. Experiments using C^{14}-methane and 5 Mev electrons were carried out with the irradiated mixture in both the gas phase and the solid phase. The pattern of compounds formed by the irradiation of the gas phase mixtures is similar to the pattern of compounds formed by the action of electrical discharges on analogous mixtures. Irradiation of methane-ammonia-water mixtures in the solid phase led to the formation of a reasonably large number of nonvolatile organic compounds. M.P.G.

69

Communication Research Institute, Miami, Fla.
A STUDY OF THE FEASIBILITY AND METHODOLOGY FOR ESTABLISHING COMMUNICATION BETWEEN MAN AND OTHER SPECIES.
Interim Report. July 1, 1962–January 1, 1963.
John C. Lilly. January 9, 1963, 9 p.
(NASA Grant NsG 278–62.)
(N64–22791) OTS: $1.10 ph.

The need for a method of communication between man and other species may increase as new achievements occur in space. Current research is exemplified by a study of dolphins that is proceeding along two major lines, viz., an analysis of the spectrum of sonic frequencies employed in communications attempts by dolphins, and the relationship of such sound emissions to those which characterize a spoken language. F.W.K.

70

Jet Propulsion Laboratory, Calif. Inst. of Tech. Pasadena, Calif.
STERILIZATION OF UNMANNED PLANETARY AND LUNAR SPACE VEHICLES—AN ENGINEERING EXAMINATION.
L. D. Jaffe. January 7, 1963, 23 p., 40 refs.
(NASA Contract NAS7–100)
(JPL–TR–32–325; N63–13440) OTS: $2.60 ph.; $0.89 mf.

The probability of achieving and maintaining sterility of an unmanned spacecraft with various proposed procedures is examined in detail. The required degree of assurance against infection of a planet with Earth organisms is also considered. For Mars landers and orbiters, sterilization by dry heat, with no subsequent access to the spacecraft, is found to be desirable. Glove-box sterile assembly is not recommended for these missions; sterile assembly in a hood or in the open seem wholly unsatisfactory. For Venus landers and orbiters, sterilization standards can be somewhat relaxed; for the Moon, sterilization appears unnecessary, but microbial counts should be kept low. Sterilization lowers spacecraft and system reliability. It reduces the chance of launching within periods fixed by astronomical constraints, and increases costs. Author

71

Wisconsin University, Madison, Wisconsin. Geophysical and Polar Research Center.
A SURVEY OF DATA ON MICROSCOPIC EXTRATERRESTRIAL PARTICLES.
Richard A. Schmidt. January 1963, 86 p., refs.
(Res. Rept. 63–2; N64–18496)

A survey of data on the following particles is presented: cosmic dust, meteoritic dust, micrometeorites, meteoric dust, and interplanetary dust. The objective of this survey was to bring together as much available data as possible. Principal attention was devoted to the following information about these particles: description, size, physical properties, chemical composition, occurrence, location of samples, annual deposit, and theories of origin. I.v.L.

72

Brandeis University, Waltham, Mass.
EFFECTS OF EXTRATERRESTRIAL IRRADIATION ON NUCLEIC ACIDS AND A COMPARATIVE STUDY OF THE EVOLUTION OF NUCLEIC ACIDS.
Julius Marmur. 1963.
(AF–AFOSR–214–63)

The biological and physical chemical effects of nonionizing and ionizing radiation on nucleic acids will be studied; the findings will indicate possible effects of extraterrestrial exposure to such radiation. Also, DNA from as wide a variety of organisms as possible will be compared in base composition and base sequence homologies. These studies can indicate genetic, taxonomic, and evolutionary relationships between organisms. A fund of such knowledge will be important for comparing known forms of life with any extraterrestrial forms discovered in the future. Author

73

California University, La Jolla, Calif. Scripps Inst. of Oceanography.
ELECTRON MICROPROBE ANALYSIS OF SOME RARE MINERALS IN THE NORTON COUNTY ACHONDRITE.
Klaus Keil and Kurt Fredriksson. 1963, 28 p., 21 refs. Submitted for Publication.
(NASA Grant NsG–322–63)
(N63–15301) OTS: $2.60 ph.; $1.04 mf.

The composition of the minerals constituting the Norton County achondrite has been ascertained by measuring a large number of individual grains of each mineral, using electron-microprobe techniques. The following minerals were found: enstatite, forsterite, metallic nickel-iron, metallic copper, daubreelite, troilite, and two new species, titanoan troilite and ferromagnesian alabandite. The unusual association of minerals indicates that, when this meteorite was formed, the environment was strongly reducing, and any hypothesis on the origin of meteorites, based on comparison with terrestrial rock-forming mechanism, must take this into account. Author

74

California University, La Jolla, Calif.
ULTRAVIOLET SPECTRA OF ORGANIZED ELEMENTS IN THE ORGUEIL METEORITE DETERMINED WITH THE ULTRAMICROSPECTROGRAPH.
Bartholomew Nagy (Fordham U.), Kurt Fredriksson, Jan Kudynowski, and Leon Carlson (Karolinska Inst.). 1963, 6 p., refs.
(NASA Grant NsG–317–63; NASA Grant NsG–341; NASA Grant NsG–98–60)
(NASA–CR–55366; N64–22766) OTS: $1.10 ph.

An examination of the meteorite microstructures (organized elements) in petrographic thin sections and in powdered preparations of two stones of the Orgueil carbonaceous meteorite is discussed. The uv spectra of the acid-insoluble residues of individual organized elements showed absorption bands in the 2600 to 2800 A wavelength range. Chloroform extraction of the organized elements did not appear to change their spectra. The organized elements investigated in thin sections were 8μ to 11μ in diameter, brownish-yellow in color, and were opaque in the uv range before acid leaching was employed to remove their mineral content. P.V.E.

75

Florida State University, Tallahassee, Fla. Tallahassee Genetics Laboratories.
GENETIC STUDIES IN THE SPACE ENVIRONMENT. Final Summary Report.
A. Gib De Busk. 1963, 32 p., refs.
(NASA Grant NsG–103–61)
(NASA–CR–55359; N64–22767) OTS: $3.60 ph.

Studies to determine the genetic effects of the space environment on *Neurospora crassa* are reported. Because of the high mutation level and physiological injury noted in *Neurospora* flown on Nerv 1, laboratory studies are being conducted to develop experiments for the NASA Biosatellite program. This program to determine the possible interaction of radiation and the space

environment will include four basic experiments with *Neurospora:* (1) back mutation; (2) filtration concentration (Woodward technique); (3) recessive lethal; and, (4) inositol-less death. Descriptions of these and other genetic techniques are appended. M.P.G.

76

Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif.
VENUS: A SUMMARY OF PRESENT KNOWLEDGE.
Michael H. Briggs and Gregg Mamikunian. 1963, 39 p., 107 refs.
(NASA Contract NAS7–100)
(NASA–CR–50873); N63–19961) OTS: $3.60 ph.; $1.37 mf.

Various characteristics and phenomena of the planet Venus are discussed: orbital elements, inferior conjunctions of Venus to 1980, Venus transits, linear diameter, mass, color, depth of atmosphere from occultation, spectral features, gases in the atmosphere, clouds, temperature estimates, and rotation periods. There is no satisfactory evidence of life on Venus, although several authors have suggested their observations indicate the presence of organisms. If the surface temperature proves to be 600° K, the presence of organisms with a terrestrial type of biochemistry is precluded. A.H.F.

77

Library of Congress, Washington, D.C., Science and Technology Division.
AEROSPACE MEDICINE AND BIOLOGY. AN ANNOTATED BIBLIOGRAPHY, 1957 LITERATURE, VOLUME VI.
Arnold J. Jacobius, Roman Kenk, Leroy D. Davis, Elizabeth G. Koines, Kristallo Pappajohn, Ilga M. Terauds, and Paul E. Spiegler. 1963, 364 p., 1566 refs.
(Supported by NASA, AF, and FAA)
(N63–15258) OTS: $5.00.

This annotated bibliography on aerospace medicine and biology covers literature published in 1957. The abstracts are arranged by subject categories. A cumulative subject index is available for detailed information on a specific subject. There is also an author index that includes secondary authors, and a corporate author index. M.P.G.

78

Melpar, Inc., Falls Church, Va.
DETECTION OF EXTRATERRESTRIAL LIFE. METHOD II: OPTICAL ROTATORY DISPERSION. Final Report.
1963, 47 p.
(NASA Contract NASw–557)
(NSA–CR–55657; N64–15387) OTS: $4.60 ph.; $1.61 mf.

The object of this study was to develop polarimetric methods to determine the presence of optically active materials, particularly DNA or its cogeners, in soil suspension. Provided that such methods can be developed, the determination of the existence of life (as known terrestrially) on other planets may be accomplished by remote instrumentation. Two new experimental approaches for measuring optical activity were developed; they are the electronic ratio of the difference to a constant and a modified form, i.e., the simple ratio. Based upon these new developments, an instrument was designed to detect extraterrestrial life by measuring the optical activity in soils. Also, it has been found that it is possible to concentrate the organic components in soil. Based upon the above findings, an extraction procedure has been developed that will enable extraterrestrial polarimetric measurements to be made of these organic compounds. I.v.L.

79

National Aeronautics and Space Administration, Washington, D.C.
THE SEARCH FOR EXTRATERRESTRIAL LIFE.
1963, 23 p.
(NASA EP–10; N63–20935) GPO: $0.20.

The following are the techniques and instruments being used in the search for extraterrestrial life: (1) optical dispersion rotary profile for determining the presence of deoxyribonucleic acid (DNA); (2) a Multivator for detecting miscroscopic life in soil samples; (3) a vidicon miscroscope for examining Martian atmospheric dust; (4) J-band experiments for determining protein content of dust; (5) a radioisotope biochemical probe for detection of the presence of bacteria; (6) mass spectrometer for determination of amino acids; (7) a Wolf Trap for developing bacteria cultures; and (8) an ultraviolet spectrophotometer for identifying organic compounds by their absorption spectra. E.K.R.

80

National Aeronautics and Space Administration.
Ames Research Center, Moffet Field, Calif.
PRELIMINARY INVESTIGATIONS IN THE USAGE OF GAS CHROMATOGRAPHY FOR THE DETECTION OF LIFE ON MARS.
Vance I. Oyama. 1963, 11 p., 2 refs.
(NASA–TM–X–50806; N64–22773) OTS: $1.60 ph.

A 0.010" capillary column 300 feet long, coated with diethylene glycol succinate polyester, was temperature programed for the analyses of some microorganisms isolated from soils in order to ascertain as many of the products of protein thermal decomposition as is possible with a single system. Results indicate that, under these reproducible conditions during linear temperature programing, the chromatographic peaks descriptive of the retention products occur with a periodicity common to all of the organisms. There are differences in peak height relative to adjacent peaks, but the chromatograms indicate that thermal decomposition products of microorganisms can be displayed in a fashion to show equivalence. The relative peak heights in each separate chromatogram show differences and may indicate differences in the relative amounts of the precursor organic substance. Also, a pyrolyzate chromatogram of crystalline bovine albumin, under similar conditions, was made. Similar patterns, corresponding to early appearing chromatographic retention times of the microorganisms, were reproduced. Thus, similar patterns for proteins, whether they be of plant or animal origin, seem to exist. I.v.L.

81

School of Aerospace Medicine, Brooks AFB, Texas.
STUDIES WITH A SIMULATED MARTIAN ENVIRONMENT.
BACTERIAL SYNERGISM; PRELIMINARY SYSTEMS.
Thomas L. Roberts, Robert J. Ball, Jr., and E. Staten Wynne. January 1963, 8 p., 6 refs.
(SAM–TDR–62–151; N63–17555)

Simulated Martian environment permitted survival of endospores of *Bacillus cereus* but not the photosynthetic nitrogen-fixing soil bacterium, *Rhodospirillum rubrum.* There was no evidence of a synergistic relationship. Observed increases in colony counts of *B. cereus* appeared due to temperature cycling. Author

1962

82

General Mills Electronics Group, Minneapolis, Minn.
RESEARCH TO DETERMINE THE EXISTENCE AND IDENTITY OF VIABLE MICROORGANISMS IN THE STRATOSPHERE. *Final* Technical Report, January 1–December 31, 1962.
V. W. Greene. December 31, 1962, 58 p., 13 refs.
(NASA Contract NASr–81)
(Rept. 2363; N63–13268) OTS: $5.60 ph.; $1.94 mf.

During 1962, several autoclavable large-volume air samplers, suitable for collecting microbial contaminants from the stratosphere, were constructed. Two successful balloon-borne probes were carried to 65,000 and 90,000 feet, respectively, and large volumes of ambient air were taken from specific stratospheric profiles during controlled descents. During the first probe (August 1, 1962), 21,000 colonies were recovered from the 60,000- to 45,000-foot profile (0.3 per foot^3); 490 colonies from the 45,000- to 30,000-foot profile (0.06 per foot^3); and 112 colonies from the 30,000- to 10,000-foot profile (0.016 per foot^3). The high-altitude sample yielded several types of yeasts—*Cladosporium sp and Alternaria sp* molds; and members of three pigmented bacterial genera—*Flavobacterium sp, Brevibacterium sp* and *Corynebacterium sp*. The organisms isolated from the middle and low altitude profiles were predominantly *Penicillium sp*. During the second probe (October 19, 1962), 128 colonies were recovered from 90,000- to 60,000-foot profile (0.0009 per foot^3) and approximately 200 colonies from the 60,000- to 40,000-foot profile (0.01 per foot^3). This level of contamination was not significantly greater than that encountered on the "sterility" controls. The apparent discrepancy between the two flights may possibly be related to meteorological parameters. Author

84

Resources Research, Inc., Washington, D.C.
RADIOISOTOPIC BIOCHEMICAL PROBE FOR EXTRATERRESTRIAL LIFE. Quarterly Progress Report No. 7.
Gilbert V. Levin, Norman H. Horowitz, Allen H. Heim, and Mary-Frances Thompson. December 10, 1962, 31 p., refs.
(NASA Contract NASr-10)
(N64–22793) OTS: $3.60 ph.

Modifications of the medium have been made which decrease the quantities of complex constituents. This has been done by using yeast extract and peptone at concentrations of one-half those initially used and completely removing the amino-acid hydrolyzate from the medium. These changes do not affect the present test cultures adversely, and may be better for some of the facultative autotrophic organisms. The new medium will also lend itself better to an examination of the effects of radioactive amino acids planned for the near future. Studies of the effects of several antimetabolites have continued. Bard-Parker Germicide can be heated at 135° C for 26 hours and still inhibit the range of test organisms, without resulting in excessive sterile control levels. A working model of the instrument has been developed which is capable of functioning without attitude control. Mechanical aspects of the field tests with the new instrument have been satisfactory. The solid-state radiation detector used previously has been replaced with an anticoincident Geiger detection system. Author

85

North American Aviation, Inc., Downey, Calif., Space and Information Systems Division.
STERILIZATION FOR SPACE TRAVEL. A BIBLIOGRAPHY.
November 26, 1962, 24 p., 83 refs.
(SID–62–1418; N63–86094)

A literature survey on sterilization as applicable to travel between the earth and extraterrestrial bodies is presented. The scope of the documentation is limited to the life sciences; no attempt is made to cover fuel and materials contamination. The need for sterilization to protect the earth from contamination, to prevent transfer of earth microbes, and to further the science of exobiology is discussed. The various methods useful for sterilization of spacecraft are also noted. Author

86

IIT Research Institute, Chicago, Ill.
LIFE IN EXTRATERRESTRIAL ENVIRONMENTS. Quarterly Status Report, August 15–November 15, 1962.
Charles A. Hagen and E. J. Hawrylewicz. 1962, 28 p., 7 refs.
(NASA Contract NASr–22)
(ARF–3194–7; N63–11127) OTS: $2.60 ph.; $1.04 mf.

The objective of this phase of the program is to study the effect of a simulated Martian environment on the survival of terrestrial microorganisms. During the period covered by this report, the following studies were conducted on a strain of *Bacillus* under simulated Martian conditions: (1) survival; (2) adaptation; and, (3) effect of culture age on survival. Additional experiments initiated included (1) the effect of the Martian environment on the native flora of California desert soil samples; and, (2) the growth and survival of a strain of *Bacillus* in the Martian environment as a function of moisture and organic medium added to Martian soil. Author

87

Jet Propulsion Laboratory, Calif. Inst. of Tech., Pasadena, Calif.
THE SCIENTIFIC EXPLORATION OF DEEP SPACE.
Manfred Eimer. *In* NASA, Wash., D.C., Lunar and Planetary Sciences in Space Exploration p. 11–17, 3 refs. (Presented at the NASA-University Conference on the Science and Technology of Space Exploration, Chicago, November 1–3, 1962.)
(NASA SP–14) GPO: $0.55.

It is suggested that priorities be assigned to space exploration projects according to the significance of their relationship to the following crucial scientific questions: (1) stellar evolution and the synthesis of elements; (2) the formation of the planetary system; and, (3) the origin of life. The detection of life on Mars is one of the prime goals of the planetary exploration programs. M.P.G.

88

Florida State University, Institute for Space Biosciences, Tallahassee, Fla.
EMERGENT ORGANIC CHEMISTRY UNDER VARIOUS PLANETARY CONDITIONS AND EXTRATERRESTRIAL MATRICES AND ENVIRONMENTS. First Annual Report. October 1, 1961–September 30, 1962.
Sidney W. Fox, Seymour L. Hess, and Charles B. Metz. November 1, 1962, 52 p., 107 refs.
(NASA Grant NsG–173–62)
(N64–22787) OTS: $1.10 ph.

The organic chemistry which can emerge under a variety of planetary conditions is being investigated. Studies which are summarized and relate to this emergence are: abiogenesis, planetary atmospheres, the genetic mechanisms of plant tissue cultures and the evolutionary divergence of chromosomes, and fertilization physiology. A.R.B.

89

School of Aerospace Medicine, Brooks AFB, Texas.
STUDIES WITH A SIMULATED MARTIAN ENVIRONMENT: BACTERIAL SURVIVAL AND SOIL MOISTURE CONTENT.
Thomas L. Roberts and E. Staten Wynne. November 1962, 7 p., 9 refs.
(SAM–TDR–62–121; N63–10875)

In a simulated Martian environment based on the latest available data, colony counts of a sporeforming bacterium increased. There were no changes in soil moisture. Multiple entry into Mars jars did not affect counts or soil moisture. Author

90

Aeronutronic, Newport Beach, Calif.
EXPERIMENTAL STUDIES FOR THE DETECTION OF PROTEIN IN TRACE AMOUNTS (J-BANDS). Third Quarterly Status Report, August 1, 1962–October 31, 1962.
R. E. Kay. 1962, 5 p.
(NASA Contract NASr–84)
(QLR–62–20; N64–22795) OTS: $1.10 ph.

A dye method for detecting trace amounts of proteins, nucleic acids, and long chain polysaccharides in heterogeneous samples is presented. The method is based on the characteristic absorption spectra of the reactions of these macromolecules with an aqueous solution of the dye 3,3'-diethyl-9-methyl 4,5,4',5' dibenzothiacarbocyanine bromide. The characteristic spectra (J-bands) were termined for proteins, dipeptides and tripeptides, synthetic polypeptides, DNA, RNA, and carbohydrates. In addition, the sensitivity of the dye reaction to temperature in the presence of nucleic acids, proteins, and inorganic salts can be used to distinguish these compounds by simply determinig the optical density of the preparation at two temperatures. M.P.G.

91

RAND Corp., Santa Monica, Calif.
THE ENVIRONMENT OF THE PLANETS.
William W. Kellogg. October 1962, 13 p., 5 refs. Presented at the Space Exploration lecture series, Calif. U., October 1–4, 1962 and at Moffett Field, Anaheim, Los Angeles, and San Diego.
(P–2640; N63–19338)

This review discusses the solar system, the limitation of telescopic observations from the earth, radio telescopes, and space probes. Also included are studies of Mars and Venus atmospheres and surfaces and the possibilities of the existence of life forms on these planets. N.E.A.

92

National Research Corp., Cambridge, Mass.
EFFECTS OF SIMULATED SPACE ENVIRONMENTS ON THE VIABILITY OF MICROORGANISMS. Fifth Quarterly Status Report, April 16, 1962–July 15, 1962.
Norman S. Davis, Gerald Silverman, Samuel A. Goldblith (MIT), and Wayne H. Keller. September 19, 1962, 25 p., 10 refs.
(NASA Contract NASr–41; NRC Proj. 42–1–0113)
(N64–22785) OTS: $2.60 ph.

Microorganisms have been exposed to controlled environment to investigate their survival capabilities in space and provide data relevant to the transportation of organisms from one planet to another. The spores from pure cultures of *B. stearothermophilus, B. subtilis* var. *niger, B. megaterium, C. sporogenes,* and *A. niger* were exposed to high temperature (90° C) and gamma irradiation (200,000 rads) at both atmospheric and 1×10^{-8} torr pressures. At 90° C there were no survivors after exposure to vacuum, and only *B. subtilis* var. *niger* survived seven days' exposure to this temperature at atmospheric pressure. From the irradiation experiments, it was shown that *B. megaterium* is the most resistant to gamma rays. All of the spores were more resistant to irradiation under vacuum conditions than under atmospheric conditions. R.C.M.

93

California University, Berkeley, Calif., Space Sciences Laboratory.
BIOLOGICAL SYSTEMS IN INTERPLANETARY ENVIRONMENT. Final Status Report.
John V. Slater, ed., et al. September 1, 1962, 87 p., 50 refs.
(NASA Grants NTF–74 and NsG–94–60)
(Its Ser. 3, Issue 25; N63–12632) OTS: $8.10 ph.; $2.81 mf.

Included in this report are the results of experiments supporting the hypothesis that insects are the most likely form of animal life to be found coexisting with microbes and plants on Mars or Venus. The flour beetle *Tribolium* can exist at the range of Martian temperatures, is not affected by increased gravitational forces, survives an atmosphere of 100% CO_2, and has a low oxygen requirement and a very low water requirement. Its burrowing tendency and its black body would tend to shield it from ultraviolet radiation. The probable existence of micro-niches, where the environment would be even more favorable than the macroclimate determined by remote observations, is stressed. It is concluded that if a flourishing plant life exists on Mars, *Tribolium* may well be there also. Control experiments to determine the effects of localized radiation, pupae orientation, and temperature on the morphological development of insects are also reported. M.P.G.

94

Victoria University, Wellington, N. Zealand.
THE DISTRIBUTION OF LIFE IN THE SOLAR SYSTEM: AN EVALUATION OF THE PRESENT EVIDENCE.
Michael H. Briggs. September 1962, 25 p., 156 refs.
(N63–10771)

This paper assesses current information concerning the present distribution of life in the solar system before transfer of terrestrial forms has occurred. The paper discusses the possibility of life on meteorites, on the inner planets, on the outer planets, and on extrasolar planets. J.R.C.

95

General Mills, Inc., Minneapolis, Minn., Electronics Division.
MICROSCOPIC SYSTEM FOR MARS STUDY PROGRAM. Summary Report, Preliminary Experimental Design Study.
V. W. Greene, D. A. Lundgren, D. D. Mullin, and R. E. Peterson. August 30, 1962, 29 p.
(NASA Contract NAS7–100; JPL Contract 950123; Proj. 89268) (NASA–CR–51538; Rept. 2326; N63–23035) OTS: $2.60 ph.; $1.07 mf.

Preliminary results of experimental exploration into design concepts for the Mars microscope system have demonstrated the feasibility of pneumatic sampling techniques for collecting aerosolized surface particles. Mass sampling rates on the order of 100 mg/min have been achieved over representative soil substrates with an average power consumption, extrapolated to an equivalent Martian collecting condition, of 3 to 4 watts. Sample processing investigations were directed toward using density fractionation methods for segregating the microorganic constituents from the inert mineral background, and concentrating the biological fraction into a small volume of liquid to facilitate the further processing required for microscopic analysis. P.V.E.

96

California University, Berkeley, Calif., Space Sciences Laboratory.
REFLECTION SPECTRA AS A BASIS FOR STUDYING EXTRATERRESTRIAL LIFE. Interim Report, April 1–August 22, 1962.
Samuel Silver. August 22, 1962, 3 p.
(NASA Grant NsG–101–61)
(Its Ser. 3, Iss. 16; N64–83560)

Transmission spectra and polarized reflection spectra at angles of incidence from 5° to 70° are being assembled for a wide variety of samples. Measurements of the effects of particle size and layer thickness on the reflection coefficients are being analyzed. The spectral features of plants with a thick cuticle and of those forming rough surfaces, such as the lichens, are being studied. Sinton's assignment of the Martian 2710 cm^{-1} band to carbohydrates seems doubtful; Golthup's assignment of this band to acetaldehyde does not conflict with results to date, but other possibilities exist. A discussion is included of the possibility that the weak minimum, observed by Sinton and Strong at 11.2μ in the thermal emission of Venus, is associated with inorganic carbohydrates. M.P.G.

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California University, Berkeley, Calif., Space Sciences Laboratory.
DETECTION AND STUDY OF MICROORGANISMS IN THE UPPER ATMOSPHERE. Final Report.
Robert C. Spear, ed., *et al.* August 20, 1962, 19 p., 6 refs.
(NASA Grant NsG–104–61)
(N62–17032) OTS: $1.60 ph.; $0.80 mf.

Work has included: (1) feasibility studies of various air samplers with specific attention being given to the electrostatic precipitator; (2) the development of conceptual designs for a high-altitude electrostatic bacterial air sampler and the study of component feasibility for a sampler of this type; and, (3) the design and construction of an experiment to determine the performance of an electrostatic precipitator for high-altitude bacterial collection. Author

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ITT Research Institute, Chicago, Ill.
LIFE IN EXTRATERRESTRIAL ENVIRONMENTS. Quarterly Status Report No. 6, May 15–August 15, 1962.
Charles A. Hagen and Ervin J. Hawrylewicz. 1962, 14 p., 4 refs.
(NASA Contract NASr–22; ARF Proj. C–194)
(ARF–3194–6; N62–15892) OTS: $1.60 ph.; $0.80 mf.

The survival of a strain of *Bacillus* under simulated Martian environment is studied. Experiments run with the strain of *B. subtilis var. globigii* indicate that this strain can survive the simulated Martian environment. R.C.M.

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Resources Research, Inc., Washington, D.C.
RADIOISOTOPIC BIOCHEMICAL PROBE FOR EXTRATERRESTRIAL LIFE. Quarterly Progress Report No. 6.
Gilbert V. Levin. August 15, 1962, 95 p.
(Contract NASr–10)
(N62–15861) OTS: $8.60 ph.; $3.05 mf.

An automated $C^{14}O_2$ monitoring unit has been placed in full-time operation for laboratory studies. It permits time-response curves over any period desired and under conditions closely approximating those of Gulliver. Aluminum coated Mylar of 0.00015-inch thickness permits better detection of $C^{14}O_2$ than the 0.0007-inch thick Mylar previously used for supporting $Ba(OH)_2$ to collect the gas in the laboratory studies. Gulliver has been redesigned with the emphasis placed on eliminating the need for any attitude control. This is accomplished by carrying the radioactive medium inside the spool upon which the soil retrieval lines are wound, impregnating the lines with the medium to subsaturation levels and using them as a solid support for the liquid. Laboratory studies show that adequate metabolism and growth occur with this arrangement and the medium does not drip from the spool. Baffles are used as an added precaution against medium coming into contact with the detector. Author

100

National Academy of Sciences, Washington, D.C., Space Science Board.
BIOLOGY (CHAPTER 9). In Review of Space Research, 1962. Report of the Summer Study conducted at the State University of Iowa, Iowa City, June 17–August 10, 1962, 23 p.
(Supported by NASA Grant)
(NAS/NRC 1079; N63–11562) OTS: $26.00 ph.; $17.62 mf.

The biologist's task in space is defined with recommendations for future research. Detecting life on the Moon and Venus is considered as only remotely possible, but Mars is considered a prime target for exobiology investigations. The life potential of Mars should be studied first from a distance by: (1) ground-based astronomy and spectroscopy; (2) fly-by spectroscopy and photography of surface features; and, (3) optical studies using laser technology. Priority should be given to the acquisition of chemical information relating to the atmosphere and surface of Mars. Landing spacecraft could detect life by: (1) microscopic examination of samples; (2) detection of physiological activity, especially

CO_2 assimilation; (3) detection of enzymatic activity; and, (4) detection of motion. Electron microscopy of lunar and planetary samples could be used to investigate the panspermia hypothesis. Supporting research in environmental biology should include life response to gravity, periodism and biological time, radiation, electric and magnetic fields, and synergistic effects. Major advances in biological theory may be expected. A.H.F.

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California University, Berkeley, Calif., Space Sciences Laboratory.
BIOCHEMICAL ACTIVITIES OF TERRESTRIAL MICROORGANISMS IN SIMULATED PLANETARY ENVIRONMENT. *Semiannual Status Report.*
Carl Sagan and Stanley Scher. August 1, 1962, 15 p.
(NASA Grant NsG–126–61)
(*Its* Ser. 3, Issue 13; N63–11302; OTS: $1.60 ph.; $0.80 mf.

Studies of the biochemical activities of terrestrial microorganisms under simulated planetary conditions have continued, and results are reported in both defining the environmental conditions of Mars, Venus, and Jupiter and in determining the metabolic, ecologic, and genetic processes in microorganisms under these conditions. The denitrification and photosynthetic processes in *Rhodopseudomoncs* and *Rhodospirillum* were investigated under anaerobic conditions. The effect of environmental factors on the cytoplasmic DNA synthesis associated with chloroplast inheritance in *Euglena gracilis* was studied as well as the effect of simulated Martian environment on microorganisms in soil samples collected in the Sierras where extremes of temperature are normal. Reports on the physics of planets, on the structure of the lower atmosphere of Venus, and on observations of the Jovian Red Spot were presented. Abstracts of papers prepared during this period are appended. M.P.G.

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Melpar, Inc., Falls Church, Va.
DETECTION OF EXTRATERRESTRIAL LIFE. METHOD II: OPTICAL ROTATORY DISPERSION. *Final Report.*
Ira Blei. August 1962, 22 p.
(NASA Contract NASr–85)
(N62–16489) OTS: $2.60 ph.; $0.86 mf.

Apparatus has been designed and assembled into a unit that can measure optical rotation in systems which strongly attenuate incident polarized, monochromatic light. The optical rotatory dispersion spectra of nucleosides, a polynucleotide, and proteins have been determined. These were measured in solutions whose optical density at 260 mμ approached 1.0. The nucleosides were found to follow Biot's law at their rotatory maximum of 255 mμ. Yeast RNA exhibited the same rotatory maximum, but did not follow Biot's law. Its dispersion spectrum of 285 mμ indicated that a conformational change occurred upon changing concentrations, and that this change was the cause of its nonadherence to Biot's law. The specific rotations of the nucleosides and RNA are sufficiently different to permit an analytical scheme to be developed using this quantity as a basis. Author

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Wilmot Castle Co., Rochester, N.Y.
STERILIZATION OF SPACE PROBE COMPONENTS. Final Report, April 19, 1961–July 31, 1962.
Martin G. Koesterer. 1962, 83 p., 6 refs.
(NASA Contract NASr–31)
(N62–13482) OTS: $8.10 ph.; $2.69 mf.

The studies reported have attempted to define the various biological, chemical, and physical factors that could influence the effectiveness of dry-heat as a sterilizing process. A list of the areas of investigation follows: (1) the screening, isolation, and growth of organisms resistant to dry heat; (2) the effects of time, temperature, strain of microorganism, and concentration on the effectiveness of dry-heat sterilization; (3) the effect of the physical carrier (paper strip, glass tube, sand, and vermiculite) on the effectiveness of dry-heat sterilization; (4) the effects of air, vacuum, inert gases, entrapment of organisms in nonaqueous liquid and on solids; and, (5) methods for sterility testing of components after inoculation with spores of known resistance to dry heat and the subsequent application of adequate sterilization cycles. Findings to date are as follows: (1) mesophilic aerobic spore-formers are, in general, more resistant to dry heat than are the anaerobic and thermophilic spore-forming bacteria; (2) the type of carrier markedly affects the dose requirements for dry-heat sterilization; soil samples are the most resistant, with sand, vermiculite, glass, and paper following in that order; (3) the gaseous environment also markedly influences the time required for sterilization; samples in air are the most resistant with samples under helium and under low vacuum (10^{-1}–10^{-2} mm Hg) being less resistant, respectively; (4) entrapment of dry bacterial spores in solids definitely increases the dose of dry heat required for sterilization; (5) these data raise a question concerning the adequacy of the proposed 24-hour dry-heat cycle at a temperature of 125°C. Author

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National Research Corp., Cambridge, Mass.
EFFECTS OF SIMULATED SPACE ENVIRONMENTS ON THE VIABILITY OF MICRO-ORGANISMS. Interim Report, April 15, 1961–April 30, 1962.
Norman S. Davis, Gerald Silverman, Samuel A. Goldblith (MIT), and Wayne H. Keller. June 22, 1962, 33 p., 16 refs.
(Contract NASr–41; N.R.C. Project 42–1–0113)
(N62–14631) OTS: $3.60 ph.; $1.19 mf.

Observations of microorganisms after exposure to high vacuum were made to investigate their survival capabilities in simulated space environment so as to obtain data relevant to the transportation of organisms from one planet to another. The spores from pure cultures of *B. stearothermophilus, B. subtilis,* var. *niger, B. megaterium, C. sporogenes,* and *A. niger* were exposed to high vacuum (10^{-8} to 10^{-10} torr range) at temperatures from —190° to +120°C for five days. While all species survived at 25°C and below, only *A. niger* and *B. subtilis* var. *niger* survived at 107° C. Similar tests on soil containing a wide variety of organisms resulted in the survival of only the actinomycetes at 120°C. Tests are planned for pure cultures in soil to determine whether soil protects the organisms. R.C.M.

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Stanford University, Palo Alto, Calif., Biophysics Laboratory.
MOLECULAR EVOLUTION IN PROTOBIOLOGICAL SYSTEMS, INCLUDING A SEARCH FOR CATALYSTS AND CATALYTIC ACTIVITY IN THE INTERMEDIATE SYSTEMS WHICH FORM DURING THE SYNTHESES OF LOW MOLECULAR WEIGHT ORGANIC COMPOUNDS. Semiannual Status Report No. 1, December 1961–May, 1962.
M. S. Blois, Jr., and H. H. Pattee. July 1962, 5 p.
(NASA Grant NsG–218–62; Molecular Evolution Project)
(BL–71; N64–22792) OTS: $1.10 ph.

Molecular evolution and its relationship to the origin of life is under investigation. Several hypotheses concerning such a relationship have evolved, and three of these are considered in detail: the heterogeneous system, the homogenous system, and the imprint system. I.v.L.

106

Space Technology Laboratories, Inc., Redondo Beach, Calif.
INTERPLANETARY MATTER. A BIBLIOGRAPHY.
L. R. Magnolia. June 1962, 592 p., 1650 refs.
(Research Bibliography 42; Rept. 9990–6058–KU–000; AD–276–064; N62–16764)

This bibliography consists of 1650 references (mostly annotated) on asteroids, comets, meteorites, meteors, micrometeorites, noctilucent clouds, nonterrestrial dust, origin of the solar system, tektites, the zodiacal light, and related subjects. The majority of the references are those published between January 1950, and March 1962. Author, subject, agency, periodical, and ASTIA indices are also included. Author

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Stanford Research Institute, Menlo Park, Calif.
EVALUATION OF INFRARED SPECTROPHOTOMETRY FOR COMPOSITIONAL ANALYSIS OF LUNAR AND PLANETARY SOILS.
Interim Report No. 1, January 1–May 15, 1962.
R. J. P. Lyon. May 25, 1962, 31 p.
(NASA Contract NASr–49(04); SRI Project PSU–3943)
(N62–14641) OTS: $3.60 ph.; $1.13 mf.

Characteristic spectral absorption peaks for various minerals are being determined and analyzed, because of the possibility that the analyses can serve as the basis for instrumentation on lunar surface vehicles (Surveyor) or on orbiting spacecraft (Ranger). The instrumentation would use the reflected or emissive infrared radiation for compositional analyses of lunar soil. Qualitative analyses of purified single minerals (mainly silicates) have been performed spectrophotometrically in the region from 4000 cm^{-1} to 400 cm^{-1}, using both the NaCl and KBr prism optical regions. The spectra of mixtures of minerals were found to be additive, so characteristic absorbance peaks may be distinguished even when mineral percentages in the rock are small. Quantitation of specific mineral content is accomplished by placing reproducible quantities of the mineral in the infrared beam and plotting the absorbance values of the spectra obtained against concentrations of the mineral. Anion absorptions are indicative of chemical composition. Inorganic anions have strong simple absorption peaks; a strong absorption within one of these spectral bands implies that a given functional anion group is present. The wavelength of this strong peak or of smaller peaks will indicate to which metal cation the group is bonded. Intermediate values for the principal absorbances are diagnostic of solid solutions. Typical results for silicate mineral groups are presented. M.P.G.

108

California University, Berkeley, Calif.
LIFE BEYOND THE EARTH.
Carl Sagan. *In* USIA, Voice of America Forum Series on Space Science. January 8–May 21, 1962, p. 297–310.
(N63–23454; Lecture 20) Available from USIA.

The interrelated questions of extraterrestrial life and the origin of life on Earth are considered. A theory of the origin of life in the primitive oceans is reviewed, and the laboratory recreation of life is regarded as a likely possibility. The primitive environments of the other planets are expected to have been similar to the primitive environment of the Earth. Information on the present atmospheric and surface conditions of Venus, Mars, the Moon, and the Jovian planets is reviewed and related to the possibility of existence of life based on organic matter. The existence of life based on some other kind of chemistry is beyond comprehension at present. Speculation on extraterrestrial life has been popular over the years, but the prospect of actual experimentation to solve this question belongs to this generation. The importance of sterilizing the interiors of all space probes in order to prevent contamination of extraterrestrial areas with terrestrial microorganisms is stressed. M.P.G.

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Princeton University, Princeton, N.J.
SPACE AND THE LIFE SCIENCES.
Colin S. Pittendrigh. *In* USIA, Voice of America Forum Series on Space Science. January 8–May 21, 1962, p. 283–296.
(N63–23453; Lecture 19) Available from USIA.

The prospects for a major breakthrough in the life sciences due to the new space age technology are considered to depend upon such long-shots as the discovery of extraterrestrial life, whereas the real impact of the space program is seen to lie in the previously ignored fields of sensory and environmental physiology. The man-in-space programs, with their emphasis on providing the essentials of man's terrestrial environment within a space cabin, have already given great impetus to ground-based physiology. Optimum conditions of variables like temperature, moisture, oxygen, and carbon dioxide have been established with some precision; some second-order environmental variables which are still poorly understood are discussed. These include barometric pressure, magnetic fields, radiofrequency fields, low-voltage dc fields, navigation and homing instincts, periodic daily rhythms, and gravitational fields. Spacecraft can be considered as apparatus for studying these effects as well as the stimulus provoking renewed interest in such physiological studies. M.P.G.

110

Texas University, Austin, Texas
EXPLORATION OF THE NEARER PLANETS.
Gerard de Vaucouleurs. *In* USIA, Voice of America Forum Series on Space Science. January 8–May 21, 1962, p. 221–327.
(See N63–23436 24–01)
(N63–23449; Lecture 15) Available from USIA.

Reasons for exploring the nearer planets are discussed, and a rational program of unmanned experimentation of increasing sophistication leading eventually to manned planetary exploration is outlined. The reasons of special interest to individual scientific disciplines are considered to be incorporated into two transcendent goals: the discovery of clues to the origin, mode of formation, and prehistory of the solar system; and the scientific and philosophical significance of the possible discovery of extraterrestrial forms of life. Currently available information about Mercury, Venus, and Mars is reviewed. The orderly use of Earth-based observatories, stratospheric balloons, artificial earth satellites, fly-by space probes, and spacecraft which will go into controllable, closed orbits about the planets and serve as platforms for the launching of planetary atmospheric probes, hard-landing instrument packages, and eventually of soft-landing mobile equipment is considered to provide a solid foundation for a well-rounded program of exploration. M.P.G.

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Melpar, Inc., Falls Church, Va.

FEASIBILITY OF OPTICAL ROTATORY DISPERSION METHODS APPLIED TO THE DETECTION OF EXTRATERRESTRIAL LIFE. First Quarterly Report, February 18–May 18, 1962.

Ira Blei. 1962, 51 p.

(Contract NASr–85)

(N62–14019) OTS: $5.60 ph.; $1.73 mf.

The objective of this study is to develop polarimetric methods for detecting the presence of DNA or its congeners in soil suspensions and to employ these methods in determining the existence of life (as known terrestrially) on other planets. The ideal result of this study would involve the successful and meaningful measurement of rotatory signals from a turbid suspension of soil. Effort has been devoted to developing analytical approaches which will permit realistic interpretation of data and provide a groundwork for necessary instrumental modifications. Until now, instrumentation capable of detecting optical rotation in turbid systems has not been available. It is now possible to measure optical rotation in such systems, but the meaning of these signals is not yet clear. As a byproduct of exploring the general problem of scattering of electromagnetic radiation in turbid systems, a general mathematical treatment of Mie scattering has been produced. This study is apparently the first rigorous general treatment of the problem to appear in the English literature. An analytical approach is being developed which involves the derivation of an explicit function for the scattering in terms of the depolarization. V.D.S.

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IIT Research Institute, Chicago, Ill.

LIFE IN EXTRATERRESTRIAL ENVIRONMENTS. Quarterly Status Report. February 15–May 15, 1962.

Charles A. Hagen and Ervin J. Hawrylewicz. 1962, 20 p., refs.

(NASA Contract NASr–22; ARF Proj. C–194)

(ARF–3194–5; N62–14638) OTS: $1.60 ph.

A study is under way to investigate the effect of extraterrestrial environments on the survival of terrestrial microorganisms. Experiments have shown that some of the species of the genus *Bacillus* (*licheniformis, megatherium, brevis,* and *subtilis,* var. *globigii)* are capable of surviving the simulated Martian environment even though growth was not demonstrated; *B. cereus* did not survive the test conditions. In some of the experiments there appeared to be an increase in number of bacteria; this would seem to indicate that growth occurred, but the assumption of bacterial multiplication is a tenuous one, since the variance of the mean numbers of bacteria in these studies was so large. No lichens survived in the Martian environment after 2 months; lethal factors are considered to be the following: excessive moisture loss; diurnal temperature cycle; felsitelimonite soil; and lack of essential nutrients. Further experiments will be necessary to establish the cause of death. V.D.S.

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Resources Research, Inc., Washington, D.C.

RADIOISOTOPIC BIOCHEMICAL PROBE FOR EXTRATERRESTRIAL LIFE. Quarterly Progress Report No. 5; February 14, 1962–May 15, 1962.

Gilbert V. Levin. May 15, 1962, 63 p.

(Contract NASr–10)

(N62–13507) OTS: $6.60.

The radioactivity of the sodium formate-C^{14} has been increased to 5.0 μc/ml; and the activity of the glucose-C^{14} has been increased to the same level, which results in total activity of 10.0 μc/ml. Of nine new test organisms tested in M5, 7 responded within 3½ hours, 1 responded within 6 hours, and 1 responded between 6 and 24 hours. Of the total number of organisms tested, 22 have responded in M5 within 3½ hours, 3 within 6 hours, and 1 after 6 hours. Incubation of test organisms in soil extract containing C^{14} labeled carbon compounds offered no advantage over the use of M5 medium. Organisms (including psychrophiles) tested at temperatures of 4 to 8°C responded more slowly than they did at their optimum growth temperatures. Responses have been obtained using a number of soil samples from different sources. No soil sample tested has been negative. Most encouraging responses have been obtained from desert soils collected aseptically from areas believed to be relatively undisturbed by humans.

Several factors have been studied for the purpose of improving the sensitivity of the probe instrument. Increasing the size of the CO_2 collector area is under consideration. The ratio of culture to chamber volume is being changed to promote diffusion of CO_2. The presence of baffles in the throat of the chamber causes no apparent decrease in the amount of CO_2 detected. A series of time-response curves shows that fewer cells exhibit longer lag periods; that there is no essential diffrence in the amounts of CO_2 evolved by cells from soil samples inoculated on solid, semisolid, or liquid media; and that responses obtained from samples of soils from several desert locations rapidly and accurately reflect the metabolism of soil populations. Author

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General Mills Electronics Group, Minneapolis, Minn.

RESEARCH TO DETERMINE THE EXISTENCE AND IDENTITY OF VIABLE MICROORGANISMS IN THE STRATOSPHERE. Quarterly Status Report No. 1, January 1–March 31, 1962.

V. William Greene. April 1962, 7 p.

(NASA Contract NASr–81)

(N62–11127) OTS: $1.10 ph.; $0.80 mf.

Microbiological, engineering, meteorological and statistical problems related to a microbial assay of the atmosphere are defined. A plot, of altitude vs. approximate level of microbial contamination, was constructed for the troposphere. When this relationship was extrapolated to an altitude of 50,000 feet, an esti-

mate of microbial contamination of 10^{-3} organisms per cubic foot was obtained. This level of contamination necessitates the sampling of about 50,000 cubic feet of air in order to yield a level of about 50 organisms per sample; which, in turn, approaches the lower limit of statistical significance for detection and identification. The first balloon probe will consist of four direct flow sampling units in one package. Sampling will take place sequentially during controlled descent from 65–70,000 feet to less than 20,000 feet. The descent to 45,000 feet will be at the rate of about 250 feet/min, followed by faster rates below 45,000 feet. The sampling units will draw 600 cfm of atmospheric air through a one square-foot filter. On the basis of laboratory and simulated flight condition testing, polyurethane foam was chosen as the filter material. Bacteriological laboratory techniques have been developed and standardized to recover more than 90 percent of the organisms from the filter with a minimum of extraneous contamination. The techniques are applicable in the range of 10^1 to 10^4 organisms per square foot of filter. Design of automatic opening and sealing devices and streamlined cowlings for standard direct flow sampling units has begun. The first probe will probably be launched in July, 1962. M.P.G.

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National Aeronautics and Space Administration. Ames Research Center, Moffet Field, Calif.

EXPERIMENTAL BIOLOGY IN SPACE.

Richard S. Young. *In* NASA, Marshall Space Flight Center, Huntsville, Ala., From Peenemünde to Outer Space. [A volume of Papers] Commemorating the Fiftieth Birthday of Wernher Von Braun. March 23, 1962, p. 791–802.

(N63–16013)

The possibilities of space as a fundamental biologic research tool are discussed. Among the possibilities are an understanding of the origin of life on earth and elsewhere, studies of parameters such as zero-gravity and cosmic radiation which cannot be duplicated in the laboratory, and studies of the long- and short-term effects of the absence of any or all of the multiple factors (gravity, magnetic fields, radiation) comprising the total physical environment in which life on earth has evolved. Unfortunately, most of the space biology experiments have been unsuccessful due to improper vehicle performance, but much has been learned about packaging of experiments, experimental controls, launch and recovery operations, and experimental design and interpretation. The experience thus obtained is used to define the requirements which must be met if biological investigations in space are to be fruitful. M.P.G.

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Florida State University, Tallahassee, Fla. Institute for Space Biosciences.

STUDY OF ORGANISMS UNDER TERRESTRIAL AND EXTRATERRESTRIAL CONDITIONS. First Semi-annual Report.

S. W. Fox, S. L. Hess, and C. B. Metz. March 15, 1962, 12 p., refs.

(NASA Grant NsG–173–62)

(N64–22788) OTS: $1.60 ph.

An investigation is made of processes involved in the origin, evolution, and development of organisms under terrestrial and extraterrestrial conditions. The study includes work on the following: proteinoids, microspheres, the vertical structure of the atmosphere of Venus, immunochemical studies, research on antiradiation extracts, and observations of Jupiter. J.R.C.

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Stanford University, Palo Alto, Calif., School of Medicine.

CYTOCHEMICAL STUDIES OF PLANETARY MICROORGANISMS—EXPLORATIONS OF EXOBIOLOGY. Covering Period April 1, 1961–February 28, 1962.

Joshua Lederberg and Elliott Levinthal. February 28, 1962.

Experimental research in exobiology is reviewed from the period of April 1, 1961 to February 28, 1962. The proposed Mars Mariner B flight presents an opportunity for the detection and characterization of Martian life. Requirements for a Multivator are outlined including low-level fluorometry instrumentation, and biochemical assays and soil chemistry. Concentration of bacteria, fluorescent staining, and a high-speed scanning ultraviolet microspectrophotometer are discussed. J.P.L.

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Wilmot Castle Co., Rochester, N.Y.

STERILIZATION OF SPACE PROBE COMPONENTS. Progress Report No. 4, December 1, 1961–February 28, 1962.

Carl W. Bruch. February 28, 1962, 9 p., 2 refs.

(NASA Contract NASr–31)

(N62–11078) OTS: $1.10 ph.; $0.80 mf.

Screening studies on microbial resistance to dry heat sterilization have shown that the most resistant spores are produced by the aerobic mesophilic sporeformers. D values and F values for the destruction of one million spores on paper, glass, and sand are given for the various bacteria tested at 120° C. Spores on sand and vermiculite are more resistant to destruction than are spores dried on paper or glass. D values and F values for the sterilization of one million spores for two soils in the temperature range of 120–160° C are presented. The initial results from the sterilization of vacuum cleaner dust have shown that this material is easier to sterilize than are the soil samples. Preliminary results from the sterilization of spores entrapped in solids have given indications of slightly increased microbial resistance to destruction by dry heat. The extent of this increased resistance is now under investigation. Author

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IIT Research Institute, Chicago, Ill.

LIFE IN EXTRATERRESTRIAL ENVIRONMENTS.

Kenneth B. Basa and Ervin J. Hawrylewicz. February 1962, 29 p., 63 refs.

(NASA Contract NASr–22; ARF Proj. C 194)

(ARF–3194–4; N62–10045) OTS: $2.60 ph.

Martian environment was simulated to study the survival of terrestrial life. Types of organisms tested were: Bacteria, Algae, Lichen and Bryophytes. *Clostridium tetani* and *Escherichra coli* decreased rapidly in number, but tetanus toxin remained active during the 127-day experiment; *Bacillus subtilis* increased in number; *Trebouxia erici* survived for two weeks; Lichen survival results

were incomplete. Of the Bryophytes tested, only one unidentified moss survived. Color changes on the Martian surface are explained partially by color changes in surface vegetation resulting from moisture content.

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Resources Research Inc., Washington, D.C.
RADIOISOTOPIC BIOCHEMICAL PROBE FOR EXTRATERRESTRIAL LIFE. Annual Progress Report.
Gilbert V. Levin. February 1962, 50 p., 8 refs.
(NASA Contract NASr–10)
(N62–10069) OTS: $8.10 ph.; $2.84 mf.

Field tests have shown that a biochemical experiment using radioisotopic materials is feasible in the detection of extraterrestrial life. The medium developed supports the generation of detectable quantities of carbon dioxide by representative bacteria, streptomycetes, fungi, and algae within a period ranging from minutes to several hours. Test organisms which respond include aerobes, anaerobes, laculative anaerobes, thermophiles, mesophiles, heterotrophs, phototrophs, spore formers, and nonspore formers. Of the radioactive substances tested, singly and in combination, sodium formate-C^{14} and uniformly labeled glucose-C^{14} in combination gave the best results. A second model of the instrument, programmer, and associated electronics is confined to a weight of one and one quarter pounds. The instrumentation provides a means for collecting a sample of material from the surface of the ground by shooting out adhesive-covered strings and then reeling them in. Physiologically inert adhesives were selected. A tagged radioactive nutrient broth is inoculated with the collected sample; tagged gas, metabolically derived, is collected; and radioactivity is measured by a solid state radioactivity detector.

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California University, Space Sciences Laboratory, Berkeley, Calif.
REFLECTION SPECTRA AS A BASIS FOR STUDYING EXTRATERRESTRIAL LIFE. Quarterly Report.
Samuel Silver. January 22, 1962, 8 p.
(NASA Grant NsG–101–61)
(N64–83559)

Data are presented which show that the reflection spectrum is certainly not identical with the absorption spectrum for biological specimens. It is almost certain that the 2710 cm^{-1} band Sinton observes in his Mars spectrum is not due to carbohydrates as he proposes, because it is far too intense relative to the higher wave number bands. Colthup's suggestion that this band may be due to gaseous acetaldehyde is acceptable and is not invalidated by the relative band intensities. Work is continuing on measuring the infrared reflection spectra, together with band polarizations, of materials of potential interest to the surface of Mars.
M.P.G.

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National Research Corp., Cambridge, Mass.
EFFECTS OF SIMULATED SPACE ENVIRONMENT ON THE VIABILITY OF MICROORGANISMS. [Third] Quarterly Status Report, October 15, 1961 to January 15, 1962.
Gerald Silverman (MIT). January 8, 1962, 8 p.
(NASA Contract NASr–41; NRC Proj. 42–1–113)
(N62–13267) OTS: $1.10 ph.; $0.80 mf.

The objective of this project is to determine the capability of selected microorganisms to survive a combination of ultrahigh vacuum and certain stress conditions which may be encountered in outer space. Experiments performed during the second quarter period of this contract evaluated survival of spores of five organisms at several temperatures in a vacuum of 10^{-8} to 10^{-9} Torr (mm Hg). Although the spores were in the chamber for 5 days, 1 to 1.5 days were required to bring the chamber to the desired pressure and temperature. Recovery was based on the number of viable spores per exposed filter, determined from plate counts and the control filters plated at the initiation of the particular vacuum chamber experiment. It may be seen that survival values at −110°C and 25°C were of the same magnitude. Viability of *Bacillus megaterium* and *Clostridium sporogenes* was appreciably reduced at 53°C. *Bacillus stearothermophilus* is ordinarily grown at 55° to 60°C. The dry spores of this organism did not resist 53°C and 60°C for 4 days in vacuum. *Bacillus subtilis* var. *niger* spores were the most resistant of the organisms to the temperature-vacuum system. *Aspergillus niger* spores are not normally considered to be particularly heat resistant, yet they survived 60°C better than most of the bacterial spores. From the data, it may be inferred that heat survival is not correlated with optimum growth temperatures. Survival data at ambient temperature would suggest that, in general, vacuum alone does not tend to kill spores. The survival figures for *B. stearothermophilus* at −110°C and 25°C (ambient temperature) may also be a manifestation of the tendency of spores of this organism to either clump or to rehydrate slowly.
M.P.G.

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California University, La Jolla, Calif.
EXTRATERRESTRIAL LIFE.
Stanley L. Miller. *In* School of Aerospace Medicine, Lectures in Aerospace Medicine, January 8–12, 1962, p. 227–298.
(N62–14212)

Of the several theories on the origin of life, the idea that life arose in the oceans of the primitive earth under favorable conditions appears the most feasible. This hypothesis states that the earth had a reducing atmosphere in its early stages, that large quantities of organic compounds were produced by electrical discharges in this atmosphere, that these compounds accumulated in the primitive oceans and were polymerized to polypeptides and polynucleotides, and finally, that enzymes and a self-duplicating polynucleotide were formed, and this was the origin of life. While many of these steps have not been carried out in the laboratory, this scheme does not appear to be impossible. Outside the earth, there is some evidence of life on Mars. Since other stars are likely to have planetary systems, it is reasonable to think that life exists on many of these planets.
M.P.G.

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California University, La Jolla, Calif., School of Science and Engineering.
THERMODYNAMIC DATA ON THE FORMATION OF SOLID CARBON AND ORGANIC COMPOUNDS IN PRIMITIVE PLANETARY ATMOSPHERES.
Hans E. Suess. January 1962, 13 p., 21 refs.
(NASA Grants NsG–97–60 and NsG–98–60)
(N62–17885) OTS: $1.60 ph.; $0.80 mf.

Atmospheres of terrestrial planets lose the hydrogen originally present and produced by photolysis of CH_4, CH_3, and H_2O. Under conditions of increasing oxidation, the gases may pass through a phase during which elementary carbon and various organic compounds are thermodynamically stable. At low enough temperatures, especially in the presence of liquid water and ammonia such as existed on primitive earth, photochemical oxidation of methane

leads to a great variety of organic compounds. The gradual shift in the redoxy state of the system provides the free energy difference necessary for biological metabolism. Numerical calculation of the equilibrium concentrations of H_2, CH_4, CO, CO_2, and H_2O as a function of total H is difficult, but it has been carried out by Arnold Bainbridge at the La Jolla CDC–1604 computer for various temperatures, pressures, and carbon/oxygen ratios. The results show that at sufficiently low temperatures and sufficiently high carbon/oxygen ratios a range of total H will exist at which elementary carbon is thermodynamically stable. It seems possible that the surface rocks of Venus contain much more carbon than those of the earth. This would explain the presence of large amounts of CO_2 in the absence of oxygen on Venus. Author

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California University, Berkeley, Calif., Space Sciences Laboratory.
REFLECTION SPECTRA OF BIO-ORGANIC MATERIALS IN THE 2.5–4 μ REGION AND THE INTERPRETATION OF THE INFRARED SPECTRUM OF MARS.
D. G. Rea, T. Belsky, and M. Calvin. 1962, 23 p., 16 refs. Submitted for Publication.
(NASA Grant NsG–101–61)
(NASA CR–50208; N64–22764) OTS: $2.60 ph.

Infrared absorption bands have been observed on the Martian surface at 2710(3.69μ), 2793(3.58μ), and 2910 cm^{-1} (3.45μ); these bands fall in the region where organic molecules and some inorganic compounds absorb. Therefore, it so indicated that carbohydrates, especially aldehydes, are present in large quantities on Mars. To ascertain this theory, infrared spectrometers are included in spacecraft experimental packages destined for Mars. Also, the arguments, pro and con, for the existence of life on Mars are given, and an explanation of the infrared appearance of the planet, based on the existence of volcanic ash and suitable winds, is treated. D.E.R.

127

California University, La Jolla, Calif.
ELECTRON PROBE MICROANALYSIS OF ORGANIZED ELEMENTS IN THE ORGUEIL METEORITE.
Bartholomew Nagy, Kurt Fredriksson, George Claus, Christian A. Anderson, Harold C. Urey, and Joan Percy. 1962, 19 p., 21 refs.
(NASA Grants NsG–98–60 and NsG–341; Contract AT(11–1)–34)
(N63–13089) OTS: $1.60 ph.; $0.80 mf.

Electron probe X-ray microanalysis has shown that several of the organized elements contain major amounts of iron and, in addition, some chlorine and/or nickel. Morphologically less-well-developed microstructures are composed of hydrous iron-magnesium silicates. When powdered preparations of the Orgueil meteorite were boiled in 6N HCl for an hour, acid-resistant pellicles were obtained, which were found to be composed of carbonaceous matter. The presence of carbonaceous matter was deduced from measurements showing that the pellicles contained none of the elements detectable by the electron probe ($Z > 11$) and that their average atomic number agreed with that of the epoxy plastic in which they had been embedded for analysis. The finding of iron with some chlorine and nickel in organized elements in a petrographic thin section of the Orgueil meteorite shows that these particles are very probably not terrestrial contaminations. Electron microscopy of the HCl treated particles revealed organized structures, which suggests, but does not prove, biological origin. Author

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Florida State University, Tallahassee, Fla., Institute for Space Biosciences.
AMINO ACID COMPOSITIONS OF PROTEINOIDS.
Sidney W. Fox, Kaoru Harada, Kenneth R. Woods, and Charles Ray Windsor. 1962, 18 p., 30 refs. Submitted for Publication.
(NASA Grant NsG–173–62)
(NASA CR–50418: *Its* Contrib. 8; N63–18388) OTS: $1.60 ph.; $0.80 mf.

Proteinoids prepared by thermal copolymerization of eighteen common amino acids have been analyzed. The polycondensation reaction is accomplished by heating at 150 to 200° dry mixtures of amino acids containing a sufficient proportion of dicarboxylic amino acid or lysine. The polymers thus formed have the same qualitative amino acid composition as proteins, are within the same range of protein molecular weights, and are protein-like in many other properties. Conditions for quantitative recovery of the total amino acids following hydrolysis have been established. The effects of various amino acid reaction mixtures upon the composition of the polymers obtained have been studied. Author

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Florida State University, Tallahassee, Fla., Institute for Space Biosciences.
EXPERIMENTS SUGGESTING ORIGINS OF AMINO ACIDS AND PROTEINS.
Sidney W. Fox. 1962, 24 p., 36 refs.
(NASA Grant NsG–173–62 and NIH Grant C–3971)
(*Its* Contribution 6; N63–11402) OTS: $2.60 ph.; $0.92 mf.

The origin of proteinuceous life by simple spontaneous processes is reviewed; and Darwinian considerations (molecular evolution) are applied so as to understand protein heterogeneity. When compounds of carbon, hydrogen, oxygen, and nitrogen are present with a sufficient release of energy, amino acids inexorably result and aspartic acid is found to be a substantial component of the reaction products. When a sufficient quantity of aspartic acid is dry heated with all of the other amino acids, the products obtained contain all of the amino acids plus amide groups, have mean molecular weights as high as 8000, exhibit peptide bonding, and have many physical and chemical properties in common with proteins. Thus, methods simple enough to have been spontaneous yield polyamino acids as complex or more complex than proteins. Results with nucleotides also suggest that highly complex macromolecules can arise from relatively simple micromolecules by very simple processes. Research on thermal origins of micromolecules and macromolecules has led to a model of the origin of organized units. When water is introduced into the reaction mixture, microspheres having the size and shape of cocci are formed. These microspheres can be centrifuged without losing their integrity and exhibit gram-negative or gram-positive characteristics. M.P.G.

130

Jet Propulsion Laboratory, Calif. Inst. of Tech., Pasadena, Calif.
SOME MICROSTRUCTURES OF COMPLEX MORPHOLOGY OBSERVED IN PREPARATIONS OF CARBONACEOUS CHONDRITES MADE UNDER STERILE CONDITIONS.
Gregg Mamikunian and Michael H. Briggs. 1962, 18 p., 22 refs.
(N63–14203) OTS: $1.60 ph.; $0.80 mf.

A selection of photographs of some microstructures of complex morphology, observed in sterile preparations of various meteorites, is presented. Results of an examination of these microphotographs

indicate that the preparations contained a variety of rare microstructures in circa 20μ size range. Although the structures are not readily identifiable, it is indicated that they are either unusual mineral grains or terrestrial materials which have contaminated the meteorite during museum storage. I.v.L.

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Library of Congress, Washington D.C., Science and Tech. Division.
AEROSPACE MEDICINE AND BIOLOGY (FORMERLY AVIATION MEDICINE). AN ANNOTATED BIBLIOGRAPHY. 1956 LITERATURE. Vol. V. Arnold J. Jacobius, Roman Kenk, Leroy D. Davis, Elizabeth G. Koines, Kristallo Pappajohn, and Ilga M. Plavnieks. 1962, 378 p., 1493 refs.
(NASA Order R–34; RPO–805A, Project 7761; FAA Order 2–6776–1)
(N62–10854) OTS: $5.00.

This annotated bibliography on aerospace medicine and biology covers literature published in 1956. The abstracts are arranged by subject categories. A cumulative subject index is available for detailed information on a specific subject. There is also an author index that includes secondary authors, and a corporate author index. M.P.G.

132

Massachusetts Institute of Technology, Cambridge, Mass.
MASS SPECTRA OF ORGANIC MOLECULES, II. AMINO ACIDS. K. Biemann and James A. McCloskey. 1962, 5 p., 9 refs.
(NASA Grant NsG–211–62)
(N64–22794) OTS: $1.10 ph.

The mass spectra of amino acids, without prior conversion to more volatile derivatives, have been determined. Volatilization of the sample directly into the ion source and close to the ionizing electron beam gave excellent mass spectra of free amino acids and even their hydrochlorides. These spectra (determined with samples ranging from 0.25 μg to 10μg) were quite similar to those of the corresponding ethyl esters, indicating that free amino acids, though present in the solid state as zwitterions, exist in the gas phase as the undissociated amino carboxylic acids or possibly hydrogen-bonded forms thereof. The simplicity, speed, and sensitivity of the method described should make it a valuable tool for the identification and characterization of extremely small amounts of amino acids. I.v.L.

1961

133

Wilmot Castle Co., Rochester, N.Y.
DRY HEAT STERILIZATION OF COMPONENTS FOR SPACE PROBES. *Laboratory Progress Report No. 3, September 1—November 30, 1961.*
Carl W. Bruch. December 1, 1961, 9 p.
(NASA Contract NASr–31)
(N62–10899) OTS: $1.10 ph.; $0.80 mf.

Studies on the dry heat resistance of spore forming bacteria in various carriers were conducted to determine a given time temperature regimen that will destroy, within the limits of calculated probability, any known microbial population. Paper strips, glass tubes, sand and vermiculite were tested as spore carriers; the temperature time conditions for dry heat sterilization were determined in air and in vacuum. In all cases, vacuum shortened sterilization time. Since no combination of known microorganisms and carriers has been found to be more resistant than soil the sterilization times for soil sample in the temperature range of 130°–160°C are being determined to evaluate the interplay of biological sterilization. Future experiments will entrap spores in plastics or other materials before solidification. The solid materials will then be exposed to dry heat, and sterility assays will be made from drilled samples. The objective is to simulate modes of bacterial contamination that exist in electronic components of space probes. M.P.G.

134

National Research Corp., Cambridge, Mass.
EFFECTS OF SIMULATED SPACE ENVIRONMENTS ON THE VIABILITY OF MICROORGANISMS. *Quarterly Status Report, July 15, 1961–October 15, 1961.*
Gerald Silverman (M.I.T.). November 17, 1961, 3 p.
(Contract NASr–41; NRC Project 42–1–113)
(N62–10570) OTS: $1.10 ph.

The objective is to determine the capability of selected microorganisms to survive a combination of ultrahigh vacuum and certain stress conditions that might be encountered in outer space. Spore samples of *Bacillus subtilis* var. *niger*, *Bacillus megaterium*, *Clostridium sporogenes*, *Aspergillus niger*, and *Bacillus stearothermophilus* have been exposed to varying temperatures and pressures. These results are being analyzed and will be published shortly. A longer pumpdown was required at the elevated temperature exposures than at room temperatures. In raising the temperature of the specimens in the vacuum chamber to the desired level, increased outgassing of the system occurs which increases the pressure within the system. As soon as the desired temperature is reached and held constant, further increase in outgassing rate is stopped, outgassing then begins to decrease, and pressure drops again to the ultimate level. As a result of this temperature rise, and the concomitant increase in pressure, the total pumpdown time is increased. In the elevated temperature runs about 1½ days are required to reach the same vacuum as is achieved in one day at room temperature. J.S.

135

Resources Research, Inc., Washington, D.C.
RADIOISOTOPIC BIOCHEMICAL PROBE FOR EXTRATERRESTRIAL LIFE. Quarterly Progress Report No. 3.
Gilbert V. Levin, Allen H. Heim, John R. Clendenning, and Mary F. Thompson. November 15, 1961, 42 p., 5 refs.
(NASA Contract NASr–10)
(N62–13299) OTS: $4.60 ph.; $1.46 mf.

Two test media (Medium III and AC Medium) containing Na formate-C^{14}, uniformly labeled glucose-C^{14}, Na acetate-1-C^{14}, Na pyruvate-1-C^{14}, or cysteine-S^{35}, have been evaluated with 16 test organisms. The labeled substrates were incorporated into the media individually in some experiments and in various combinations in other experiments. The highest percentage of significant responses (94%) was obtained with AC Medium containing Na formate-C^{14} and glucose-C^{14}. Included in this group are three species of anaerobes. In a preliminary experiment indigenous flora of a soil sample responded significantly, when incubated with an aqueous solution of Na formate-C^{14} and glucose-C^{14} with no additional nutrients supplied. Investigations of the sensitivity of the radioisotope technique indicate very high sensitivity for the method, probably greater than that of any process in current use. Sterilization of one test medium with dry heat at 130° C for 24 hours did not alter the nutritive quality of the medium or increase spurious CO_2 evolution. Silicone stopcock grease was found to be suitable for the string sample collector. It is adhesive, biologically inert and retains a constant viscosity over a wide temperature range. A literature survey of the self-degradation of labeled compounds indicates that this effect is negligible in the case of the compounds and specific activities currently used. Author

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IIT Research Institute, Chicago, Ill.
LIFE IN EXTRATERRESTRIAL ENVIRONMENTS. Quarterly Status Report, August 15—November 15, 1961.
Kenneth B. Basa and Ervin J. Hawrylewicz. 1961, 14 p.
(NASA Contract NASr–22; ARF Proj. C–194)
(ARF–3194–3; N62–11318) OTS: $1.60 ph.; $0.80 mf.

The effect of extraterrestrial environment on the survival of terrestrial organisms was studied. Environmental chambers were

the Mars bottle and the "marsarium." Felsite soil was used as a simulant for Martian soil. Survival tests were run on the algae *Trebouxia erici* and the anaerobic pathogen *Clostridium tetani* with the following results. *Trebouxia erici* showed only a slight resistance to the Martian environment. *Clostridium tetani* vegetative cells died rapidly. During the bioassay, mortality was observed during the first two sampling periods (0 to 3 days), but morbidity was present in samples held for the 72-day observation period. The appearance of symptoms of the disease in inoculated mice may be due to the presence of toxin in the original inoculum; thus the toxin probably withstands the simulated environment. After reincubation of the inocula from the Martian environment there was a positive response in the mice inoculated with this material. This response suggests the presence in the original inocula of extremely small numbers of viable organisms capable of producing toxic material. Mosses of the order Bryales were found to survive though they did not thrive. Protonemata were observed in all samples except those withdrawn from the environment after 20 days. Mosses of the genus *Pogonatum* died after 16 days. Studies are being conducted on various lichens, the liverwort *Marchantia polymorpha* and the mosses *Minium sp.* and *Polytrichum sp.* Results are incomplete but survival of the mosses and liverwort will be confirmed by determining new growth after exposure to the experimental conditions. The survival of lichens will be evaluated by the Ahmadjian technique. Studies of the survival of the blue-green algae *Nostoc commune* and *Anabaena variabilis* and the bacterium *Escherchia coli* were initiated I.v.L.

137

School of Aerospace Medicine, Brooks AFB, Texas.
STUDIES ON THE PREVENTION OF CONTAMINATION OF EXTRATERRESTRIAL BODIES BY THE BACTERIOLOGIC EXAMINATION OF HERMETICALLY SEALED ELECTRONIC COMPONENTS.
Joseph T. Cordaro. November 1961, 7 p., 8 refs.
(N63–83863)

Bacteriological techniques to determine the existence of contamination in hermetically sealed electronic components were examined as well as components considered typical of being included in the electronic systems of spacecraft. Of the 166 components examined, 11 were contaminated. Paper and mylar-type capacitors were found more likely to be contaminated during fabrication than other types of capacitors examined. An approach to the development of procedures for the sterilization of electronic components is presented. Author

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Resources Research, Inc., Washington, D.C.
RADIOISOTOPIC BIOCHEMICAL PROBE FOR EXTRATERRESTRIAL LIFE. Quarterly Progress Report No. 2.
Gilbert V. Levin, John R. Clendenning, and Mary F. Thompson. August 15, 1961, 38 p.
(NASA Contract NASr–10)
(N62–13298) OTS: $3.60 ph.; $1.34 mf.

Two individual media, which evoke a significant response with over one-half of the number of test organisms to yield a total response from 10 of the 14 test organisms, have been developed. These organisms were selected in order to impose the most stringent requirements on the test media. The two media have not yet been tried in combination. The feasibility of a glycerol-impregnated string collection system has been investigated by dragging such strings over the following surfaces: soil, asphalt, plate glass, sand and gravel, and measuring the resulting activity of gas evolved in a laboratory system containing nutrient broth labled with Na formate-C^{14}. A significant response was produced in each case; and, of critical importance to this investigation, exponential growth was demonstrated. The effects of three intensities of gamma radiation on Medium II labeled with Na formate-C^{14} were examined, and results to date indicate that this particular type of radiation poses no serious problems. Author

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Yale University, New Haven, Conn.
DEVELOPMENT OF A LIFE DETECTOR FOR PLANETARY SOILS. Final Report. June 1960–August 1961.
Wolf Vishniac. 1961, 7 p.
(NASA Grant NsG–19–59)
(N64–22789) OTS: $1.10 ph.

This report deals with the final laboratory version of a device which is capable of detecting living organisms when placed on soil or on the laboratory floor. This device operates on the principle of introducing dust samples into one or more selected media in which the growth of the microorganisms is detected by optical and chemical changes in the medium, i.e., the change in light transmission and the change in pH, respectively. I.v.L.

140

Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.
SPACE MEDICINE.
W. Randolph Lovelace II. *In* Advisory Group for Aeronautical Research and Development, Paris, France, Proc. of the Eleventh AGARD Gen. Assembly, July 27–28, 1961. 1961, p. 53–64.
(N63–17050)

The requirements for a manned space mission are discussed and recent advances in aerospace medicine due to manned orbital flight are listed. Effects of environmental stress, acceleration, space radiation, nuclear propulsion, and changes in ambient time cycles on biological systems are discussed, and the objectives of the search for extraterrestrial life are given. D.E.R.

141

Air Force Cambridge Research Laboratories, Bedford, Mass.
BIBLIOGRAPHY OF LUNAR AND PLANETARY RESEARCH—1960 (WITH ANNOTATIONS).
John W. Salisbury and Lynne T. Salisbury. July 1961, 61 p.
(GRD Res. Notes No. 62; AFCRL–684; N–102856)

A checklist of lunar and planetary research articles published in 1960 is provided plus a convenient starting place for a literature search on astrobiology, meteors and meteorites, the moon, the origin of the solar system, the planets, and tektites. In some cases, articles published in 1959 have been included to present a more well-rounded reference list. Author

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Resources Research, Inc., Washington, D.C.
RADIOISOTOPIC BIOCHEMICAL PROBE FOR EXTRATERRESTRIAL LIFE. Quarterly Progress Report No. 1.
Gilbert V. Levin, Harold G. Hedrick, John R. Clendenning, and Mary F. Thompson. May 15, 1961, 28 p., 1 ref.
(NASA Contract NASr–10)
(N62–11554) OTS: $3.60 ph.; $1.22 mf.

The biological phase of the work was concerned with literature reviews and laboratory activities, and information necessary to the

development of a basic nonspecific microbiological medium was obtained. In the laboratory, the radioisotope techniques were established and preliminary experiments were performed. Various labeled compounds were incorporated into media. A number of species of bacteria were inoculated into portions of labeled medium, and the evolved gas was detected by its radioactivity. The design phase was concerned with instrumentation development. The device for obtaining soil samples from the target planet has been refined. Experiments were carried out to select the radioactive gas fixing system and to study liquid and solid absorbers. The Geiger counter circuit was designed and components obtained.
Author

143

IIT Research Institute, Chicago, Ill.
LIFE IN EXTRATERRESTRIAL ENVIRONMENTS. Quarterly Status Report, February 15—May 15, 1961.
Kenneth B. Basa and Ervin J. Hawrylewicz. 1961, 8 p., 48 refs.
(NASA Contract NASr—22; ARF Proj. C—194)
(ARF—3194—1; N62—11063) *OTS: $1.10 ph.; $0.80 mf.*

The ability of various terrestrial organisms to survive in simulated extraterrestrial environments is investigated. A literature search was made to obtain data on conditions existing upon the planets Venus, Earth, and Mars, plus their natural satellites which orbit within the solar ecosphere. It was decided to make initial laboratory studies on lichens and their symbiotic algae under simulated Martian conditions. A Martian environment is being simulated; and algae of the genus Trebouxia are being cultured.
M.P.G.

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Jet Propulsion Laboratory, California Institute of Technology, Pasadena, Calif.
APPLICATIONS OF GAS CHROMATOGRAPHY TO THE ANALYSES OF ORGANICS, WATER, AND ADSORBED GASES IN THE LUNAR CRUST.
V. I. Oyama, S. P. Vango, and E. M. Wilson. April 25, 1961, 15 p., 15 refs.
(NASA Contract NASw—6)
(JPL TR 32—107; NASA—CR—51588; N63—85226)

The possibility of finding clues to the origin of life in the material of the lunar crust is discussed and a gas chromatograph apparatus that is being developed to detect organic material on the moon is described. The absence of a hydrosphere and atmosphere on the moon would tend to preserve any abiogenic organic residues formed in an originally reducing atmosphere. Most theories of the origin of life are based on the availability of these preformed organic materials, and studies have shown that organic materials can be detected by gas chromatography. Therefore, data obtained from the controlled heating of biogenic materials with mineral mixtures are being used in designing a gas chromatograph apparatus to determine organics, water, and adsorbed gases in the lunar crust.
M.P.G.

145

Library of Congress, Washington, D.C. Air Information Division.
ATMOSPHERE OF VENUS. REVIEW OF SOVIET LITERATURE.
March 31, 1961, 16 p., refs.
(AID—61—30; AD—254403; N64—81444)

Efforts to describe the physical nature of Venus are critically examined. Barabashov's theory on light absorption and scattering in the region of the Venus terminator and rim seems questionable. Several weak points are noted in Sharonov's model; although the A and O layers he proposes are reasonable, the layer of transparent gas between the O layer and the clouds or surface could not possibly be in a stationary state, and his concept of the illumination of the O layer from within is hardly acceptable. Martynov has speculated the existence of great oceans on the Venusian surface based on the observation of mirror-like reflections. The presence and optical properties of gases in the Venusian atmosphere has lead Shklovskiy to hypothesize a greenhouse temperature effect. Neither Martynov's nor Shklovskiy's hypothesis has been proven, and each negates the other. Venus remains one of the least investigated and understood of the planets.
A.H.F.

146

School of Aviation Medicine, Brooks AFB, Texas.
STERILIZATION OF SPACE VEHICLES: THE PROBLEM OF MUTUAL CONTAMINATION.
E. S. Wynne. *In* Lectures in Aerospace Medicine, January 16—20, 1961, 29 p., 17 refs., (Article No. 16).

The author reviews the problems of spreading earth microorganisms to other planets and the moon. The adverse effects this would have on the study of extraterrestrial life, the possible use of extraterrestrial organisms for the benefit of man, and the study of the origin of life on earth are pointed out. Possible contamination of the earth by extraterrestrial forms is also discussed. Methods of sterilization of various space vehicle components by heat, radiation, or chemicals are debated. For studying the bacterial content of hermetically sealed components, the author presents an ethylene oxide and heat sterilization technique. Using *Pseudomonas aeruginosa* as the test organism, small electric components were subjected to heat and ethylene oxide.. Ethylene oxide proved sufficient for sterilizing the exteriors of the components, while the interiors of most types could be sterilized by heat treatment at 121° C for 16 hours. Components that failed to function after heat treatment can probably be treated by radiation.
Aerosp. M.A.

147

California University, Berkeley, Calif. Space Sciences Laboratory.
INTERSTELLAR PANSPERMIA.
Carl Sagan. *In* Biochemical Activities of Terrestrial Microorganisms in Simulated Environments. 1961, 15 p.
(NASA Grant NsG—126—61)
(Its Series No. 3, Issue 1; Project 109)

The panspermia hypothesis proposes that terrestrial life originated beyond the Earth, and that living forms have drifted from world to world propelled by radiation pressure through interstellar space. A model bug is proposed that is approximately the size of bacterial and fungal spores and viruses. Such a bug could transverse the distance from the Earth to Mars in weeks, Jupiter in months and Neptune in years. Transit time across the galaxy is 2×10^8 years. However ultraviolet radiation would kill all organisms traveling between Earth and Mars. X-rays and protons of stellar origin would give an integrated dose over interstellar transit of 10^7 rep. Radiation doses are so high for stars of the solar type that panspermia is untenable for a planet in a position comparable to that of Earth. Panspermia is only tenable for main sequence stars between spectral types A0 and G5. Possible are accepter planets of cool G and K stars and all planets of M dwarfs. Panspermia may originate in the moons of outer Jovian planets, especially Triton.
A.H.F.

148

Florida State University, Tallahassee, Fla. Institute for Space Biosciences.
EXPERIMENTS RELATED TO THE CHEMICAL ORIGINS OF PROTEIN.
Sidney W. Fox and Kaoru Harada. [1961?,] 11 [4] p., 53 refs.
(NASA Grant NsG–105–61)
(N62–10408) OTS: $1.60 ph.; $0.80 mf.

A likely mode for the primordial synthesis of protein molecules may be polymerization of amino acids. However, this experimental program revealed that the heart of a process for obtaining protein-like materials is not simply polymerization, but controlled thermal copolymerization within moderately wide limits. The polymers that result from thermal reaction mixtures are referred to as proteinoids owing to their similarity to proteins. Through an experimental model, it was shown how such primitive protein could have been organized to yield precellular forms. Microscopic spherical units suggesting precellular morphology resulted from treatment of proteinoids with hot water. These thermal experiments suggest a sequence consisting of a spontaneous origin of protein and therefrom a simple modulation to the first cells rather than the origin of cells and the synthesis of ordered protein only by such organized units.

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Florida State University, Tallahassee, Fla. Institute for Space Biosciences.
THE THERMAL COPOLYMERIZATION OF AMINO ACIDS.
Sidney W. Fox, Kaoru Harada, and Duane L. Rohlfing. 1961?, 23 p., 28 refs.
(NASA Grant NsG–105–61; NIH Grant C–3971; NSF Grant G–4566)
(N62–10407) OTS: $2.60 ph.; $0.89 mf.

A method for the copolymerization of α-aminoacids into synthetic protein-like polymers (proteinoids), without coagulation or decomposition, is described. The necessary conditions for copolymerization are the dry heating of the thermolabile neutral aminoacids with minimum sufficient proportions of the nonneutral aminoacids. All of the aminoacids commonly found in protein have been bound in peptide linkage by this dry heating process. The resulting proteinoids, as tested by standard protein determinations, have many of the qualitative properties of proteins, including chromatographic similarity, proportional composition similarity, and nutritional assimilation by *Factobacillus arabinosus*. By quantitative methods, however, none of the proteinoids were 100 percent hydrolyzable into aminoacids. Although panpolymers, incorporating all of the aminoacids in one molecule, have been formed by this method, more information on this sequence has been derived from the study of simple copolymers. A detailed description of the thermal polymers obtained with lysine as the dominant monomer is presented, and the catalytic activity for p-nitrophenol acetate in several series of aminoacid copolymers is given.

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Library of Congress, Washington, D.C. Science and Technology Division.
AEROSPACE MEDICINE AND BIOLOGY. AN ANNOTATED BIBLIOGRAPHY, 1955 LITERATURE, VOLUME IV.
Arnold J. Jacobius, Roman Kenk, Leroy D. Davis, Elizabeth G. Kolnes, Ilga M. Plavnieks, and Kristallo Voulgaris. 1961, 344 p., 1515 refs.
(Supported by NASA; Advanced Res. Projects Agency; Defense Res. Board of Canada)
(N63–90055)

This annotated bibliography on aerospace medicine and biology covers literature published in 1955. The abstracts are arranged by subject categories. A cumulative subject index is available for detailed information on a specific subject. There is also an author index that includes secondary authors, and a corporate author index. M.P.G.

151

London Institute of Biology, Great Britain.
BIOLOGY OF SPACE TRAVEL.
N. W. Pirie. 1961, 120 p.

The danger of contamination of planets and the earth is considered, and the probable environment on other planets and their suitability for some forms of life are discussed.

152

National Academy of Sciences, Washington, D.C. Space Science Board.
THE ATMOSPHERES OF MARS AND VENUS. A Report by the Ad Hoc Panel of Planetary Atmospheres.
William Kellogg (Rand Corp.) and Carl Sagan (Calif. U.) 1961, 151 p., refs.
(NAS–NRC–944; N62–10421)

This report presents a comprehensive summary of man's knowledge of the atmospheres of Mars and Venus, the controversies over them, and experimental approaches most likely to lead to resolution of these controversies. The body of the report consists of five chapters: Observational methods; General circulation of planetary atmospheres; Mars; Venus; and, Future planetary atmospheres research. In addition, nine appendices present authoritative reviews of key topics by leading experts in the field of planetary studies. The point is made that this knowledge of the physical factors will facilitate biological experiments.

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National Academy of Sciences, Washington, D.C. Space Science Board.
THE QUESTION OF LIFE ON MARS.
William Kellogg (Rand Corp.) and Carl Sagan (Calif. U.). *In* The Atmospheres of Mars and Venus, 1961, p. 33–45.
(NAS–NRC–944; N62–10421)

Recent studies of the origin of the solar system elucidate processes which underlay the origin of life. Mars may have life, based on the Darwinian theory extended to the natural selection of molecular systems. Early forms of life on Earth and Mars were possibly quite similar but divergent physical conditions led to dissimilar evolutionary developments. Direct evidences suggestive of Martian life are: (1) receding polar caps and seasonal color changes in the dark areas of Mars indicate vegetation; (2) polarization data lead to a theory of seasonal proliferation of microorganisms; and, (3) absorption features in the 3.4 to 3.7 μ range which occur in the reflection spectrum of the dark areas are interpreted as vibrational transitions in hydrocarbon and carbohydrate or aldehyde bonds. The localization of organic matter in the dark areas, where visual polarimetric evidence suggests the presence of life, is most naturally explained by a biological origin. Experiments to test the hypothesis that life exists on Mars, which would use ultraviolet light, infrared spectroscopy, vidicon cameras, and microorganism cultures, may answer the question of the existence of life on Mars in the next decade.

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National Academy of Sciences–National Research Council, Washington, D.C.

ORGANIC MATTER AND THE MOON.

Carl Sagan. Washington, D.C. 1961, 55 p., refs.
(NRC–757; N64–82521)

This monograph is concerned with the possibility of finding indigenous lunar organisms or organic matter, and with the possibility of lunar contamination by deposited terrestrial organisms or organic matter. The rate of synthesis of organic molecules by solar ultraviolet radiation in the primitive lunar atmosphere is estimated. Reports of gas clouds on the lunar surface are discussed and shown to be probably unreliable. However, the observations of Kozyrev, if verified, would be evidence for the existence of lunar subsurface organic matter. Fremlin's theory of heat localization by hydrostatic pressure in dust indicates that constant, biologically optimum temperatures exist at just the level where surviving primitive organic matter is probably localized. Therefore, the possibilities of multiplication of terrestrial microorganisms on the Moon and of survival of indigenous lunar organisms from the early history of the Moon are not as remote as have sometimes been thought. The probability of survival of a terrestrial microorganism accidentally deposited on the Moon by an impacting lunar probe is computed. The possible kinds of lunar biological contamination are then discussed. It is recommended that all lunar probes be thoroughly decontaminated, and that the first soft-landing probes be equipped for chemical analysis and biological plating of subsurface samples. J.P.L.

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New Mexico State University, Las Cruces, N. Mex.

VISUAL AND PHOTOGRAPHIC OBSERVATIONS OF MARS AND VENUS. APPENDIX 2.

C. W. Tombaugh. *In* National Academy of Sciences, Space Science Board, Wash., D.C. *Atmospheres of Mars and Venus.* 1961, p. 72–75.
(NAS–NRC–944; N62–10421)

Detailed evaluations of color changes observed when viewing Venus, and especially Mars, are presented, and the technical problems involved in recording observations are noted. Much of the disagreement among observers is due to the lack of sensing spatial proportions on the disk; the shapes, intensities and positions of the markings. Seasonal changes are, in general, repeated each Martian year. Then there are recorded cases where a conspicuous development occurred to a particular dark marking which was never witnessed before in the lifetime of a veteran observer. Dark patches have appeared and lightenings have also occurred. It is suggested that there are areas on Mars of an intermediate altitude where the supposed vegetation flourishes at certain times and not at others. As a rule, the various maria have their characteristic colors which undergo regular changes with the seasons. Specific features and their colors are described. A.H.F.

1960

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Georgetown College Observatory, Washington, D.C.
RECENT STUDIES OF THE KNOWN PHYSICAL CHARACTERISTICS OF THE MOON AND THE PLANETS.
C. C. Kiess and D. S. Birney. December 1960, 18 p., refs.
(AFCRL–TN–60–666; Monograph 15)

Recent studies of the known physical characteristics of the moon and planets are reviewed. Lack of spectroscopic evidence for water or oxygen on Mars does not deter scientists from the belief that life exists on Mars in forms analogous to terrestrial forms. Recent investigations of the infrared spectra analysis lead some investigators to believe that: (1) Polar caps and cloud areas contain frozen water; and, (2) C–H bond of organic molecules is present. The authors believe their powerful grating spectrographs of high dispersion show that the atmosphere contains a substance with absorbing characteristics similar to hydrogen peroxide which is toxic to life. Thus, life on Mars is very doubtful. A.H.F.

158

Jet Propulsion Laboratory, Calif. Inst. of Tech. Pasadena, California.
THE RADIATION BALANCE OF VENUS.
Carl Sagan. September 15, 1960, 31 p., 75 refs.
(NASA Contract NASw–6)
(JPL–TR–32–34; N63–82537)

Recent microwave observations of Venus give brightness temperatures near 600°K, and the properties of the atmosphere are deduced. The radio spectrum and the possibility of non-thermal emission are discussed, the resulting model atmosphere for CO_2 is given and the requirements for atmospheric absorption in the far infrared are described. A model of the Venus Cloud layer and the origin of the derived Venus atmosphere are described. No known terrestrial microorganisms can survive more than a few minutes exposure to 600°K.; proteins are immediately denatured, DNA is depolymerized, and even small organic molecules are dissociated in short periods of time. Consequently there seems to be little danger of biological contamination of Venus. At these elevated temperatures, and in the absence of liquid water, it appears extremely unlikely that there are indigenous organisms on the surface. In the light of present evidence, Venus is a hot, dry, sandy, windy, cloudy, and probably lifeless planet. A.H.F.

159

National Aeronautics and Space Administration, Washington, D.C.
THE LIMITING SIZES OF THE HABITABLE PLANETS.
Su-Shu Huang. September 1960, 6 p.
(NASA–TN–D–499; N62–71073) OTS: $0.50.

The astrobiological problem of the occurrence of life in the universe is discussed from the standpoint of the size and nature of planets upon which living organisms might arise. The conclusion is tentatively drawn that the most likely radius of a habitable planet lies between 10^8 and 2×10^9 cm. Conditions of temperature and density also bear upon the occurrence of life; thus the Moon and Mercury, although both fall within the range of favorable radii, are nevertheless believed uninhabited by indigenous life.

160

School of Aerospace Medicine, Brooks AFB, Texas.
BIOPHYSICS OF THE SPACE ENVIRONMENT.
Hubertus Strughold. In Lectures in Aerospace Medicine, Conducted at the School of Aviation Medicine, USAF Aerospace Medical Center (ATC), Brooks AFB, Tex. January 11–15, 1960. Lecture 2, p. 1–33.
(N63–81653)

A biophysical spatiography of the areas between the celestial bodies is given. The basic structure of the environment of space within the solar system is a vacuum but is not empty. The contents of matter and energy in space are discussed: (1) meteorites; (2) dust particles; (3) molecules and atoms; (4) atomic particles; (5) electromagnetic radiation; (6) magnetic field forces; and, (7) gravitational field forces. Ecologically, solar space contains a belt within the realm of the inner planets which is not too hostile to space operations and relatively favorable to life on the planets. This zone is called the ecosphere in the solar system and extends from Venus to beyond Mars.

161

School of Aerospace Medicine, Brooks AFB, Texas.
CELESTIAL BODIES. II. PLANETARY ECOLOGY (ASTROBIOLOGY).
Hubertus Strughold. *In* Lectures in Aerospace Medicine, Conducted at the School of Aviation Medicine, USAF Aerospace Medical Center (ATC), Brooks AFB, Tex. January 11–15, 1960, Lecture 5, p. 1–28.
(N63–81656)

Possible life forces and conditions on the planets are discussed. The sun is responsible for ecological conditions on the planets: temperature, light, chemical composition of atmosphere,

and gravitation control. In the solar system of today, there are two basic types of atmospheres, viz., reducing and oxidizing. They correspond to historical phases of the earth's atmosphere. The biotemperate belt contains Venus (hot), Mars (cold), and earth (moderate). Liquid water may be in same belt, and also light conditions suitable for life. This ecosphere comprises 5% of the range from the Sun to Pluto. Theories on indigenous life on Mars, as indicated by seasonal green changes, are expressed. Organic theory must be based on knowledge of life existing under severe physical conditions on earth and on known capacity of life adaptation processes. Recent findings of scientists in this field are discussed. A.H.F.

162

New Mexico State University, University Park, N. Mex. Research Center.

CELESTIAL BODIES. III. MOON, MARS, VENUS.

Clyde W. Tombaugh. *In* Aerospace Medical Division, School of Aerospace Medicine, Brooks AFB, Tex. Lectures in Aerospace Medicine Conducted at the School of Aviation Medicine, USAF Aerospace Medical Center (ATC), Brooks AFB, Tex. January 11–15, 1960, Lecture 6, p. 1–51, refs.

(N63–81657)

Physical characteristics of the Moon, Mars, and Venus, as discerned by telescope, are identified, and the theories of their origin are discussed. Mars exhibits some canals over 1,000 miles in length. They appear to be interconnected and radiating from oases which, in contrast to the bright rays of the moon, are dark, and are visible most frequently during summer seasons. Photographs show an intense greenish darkening, perhaps vegetation, following the decline of the polar ice caps. Mars is endowed with an atmosphere with a surface density of one twelfth our own. The transfer of Mars water to the polar regions each half Martian year requires an atmosphere. Nineteenth century astronomers thought the dark areas on Mars were seas and called them maria. Vegetation now appears a better answer, and even the former presence of seas on Mars seems questionable. Since Mars is in the asteroid belt, oasis-canal patterns may be attributable to collision patterns. The dark oasis on the Margritifer Sinus tip may be caused by an asteroid impact. Its enlarged penumbral fringe may represent temporary vegetation on the broken rock outside of the crater. A.H.F.

163

Library of Congress, Washington, D.C., Science and Technology Division.

AEROSPACE MEDICINE AND BIOLOGY. AN ANNOTATED BIBLIOGRAPHY, 1954 LITERATURE, VOL. III.

Arnold J. Jacobius, Roman Kenk, Eugene Marrow, Ilga M. Plavnieks, Kristallo Voulgaris, et al. 1960, 545 p., refs.

(Supported by NASA; Advanced Res. Proj. Agency Defense Res. Board of Canada)

This annotated bibliography on areospace medicine and biology covers literature published in 1954. The abstracts are arranged by subject categories. A cumulative subject index is available for detailed information on a specific subject. There is also an author index that includes secondary authors, and a corporate author index. M.P.G.

164

National Academy of Sciences—National Research Council, Washington, D.C.

SCIENCE IN SPACE. THE MOON. Chapter IV

Harold C. Urey. 1960, 16 p., 6 refs.

(N63–84286)

The surface features and interior of the Moon, as well as its chemical composition and physical characteristics, are discussed. Life would not be supported on the surface of the Moon in any important way, although terrestrial organisms might support themselves temporarily in subsurface regions where inorganic carbon compounds exist. It is doubtful that indigenous life exists on the Moon. However, geologic samples of lunar dust from the Moon should be collected under sterile conditions for the use of biologists in making cultures. A.H.F.

165

National Academy of Sciences—National Research Council, Washington, D.C.

SCIENCE IN SPACE. THE PLANETS. Chapter V

Harold C. Urey. 1960, 19 p., 6 refs.

(N63–84287)

The possibility of preexistent life or the survival of terrestrial organisms on Mars or Venus is discussed, and several life detection experiments are proposed. These include: (1) measurement of the physical and chemical characteristics of the environment; (2) detection of spectra characteristic of known organic matter, e.g., chlorophyll; (3) detection by pulsed radar returns similar to those of terrestrial vegetation; (4) detection of metabolic byproducts by a suitably instrumented container designed to enclose a sample of the environment after a soft landing; (5) photography; and (6) in the case of soft landings, auditory observations. Resumes of atmospheres, surfaces, structures and magnetic fields of the various planets are given. A.H.F.

166

Yale University, New Haven, Conn.

DEVELOPMENT OF LIFE DETECTOR FOR PLANETARY SOILS. Semiannual Status Report.

R. Davies. 1960.

(NASA Grant NsG–19–59)

The construction of a device called a Wolftrap for the detection of microorganisms on other planets has been undertaken. It is comprised of two compartments, one serving as a vacuum reservoir and one as an instrument compartment. Dust and other surface material will be sucked through a gas inlet and a culture tube, and then into the vacuum reservoir. Changes in acidity or turbidity will close relays which will, in turn, activate telemetering devices. A.H.F.

1952–1959

167

California University, Berkeley, Calif. Lawrence Radiation Laboratory.
ORIGIN OF LIFE ON EARTH AND ELSEWHERE.
Melvin Calvin. December 1959, 46 p., refs.
(Contract W–7405–eng–48)
(UCRL–9005; N63–85428)

An analysis of the probabilities of life in the universe, based on chemical and biological information, is presented. A path is traced from primitive molecules to the information-transmitting DNA molecule which is capable of self-reproduction and variation. On the molecular level, the number of changes occurring per second is high and predictable with certainty. On the biological level, segregation and recombination of genes is an undetermined or random process. An estimated 100 million planets can support life. Therefore, the existence of cellular life elsewhere in the universe can be considered a mathematical and scientific certainty. Further, the possibility of the existence of other forms of matter which might be called living cannot be denied. A.H.F.

168

School of Aviation Medicine, Brooks AFB, Texas.
MICROBIOLOGIC STUDIES ON ECOLOGIC CONSIDERATION OF THE MARTIAN ENVIRONMENT.
Irving Davis and John D. Fulton. October 1959, 10 p., 18 refs.
(Aeromedical Review 2–60; N–90744)

Studies are made on bacteria in various ecological environments. Conditions considered include soil, water, atmosphere, temperature and radiation. Simulated environments were produced in modified Brewer anaerobic jars containing microbial specimens. The jars are held at room temperature during the day and are then placed in a freezer at night. Soil types are simulated by employing red sandstone high in iron oxide and red and black lava soil. Moisture level is controlled, but no radiation is used. Results regarding the survival and multiplication of terrestrial microorganisms exposed to simulated Martian environments may be generalized: (1) certain soil bacteria, capable of physiologic adaptation to a simulated Martian environment, survive and multiply; (2) spore forming bacteria appear to have a higher rate of cell multiplication than strictly vegetative cells; (3) a simulated Martian environment appears to yield greater numbers of viable cells than a similar environment maintained at room temperature; (4) recoverable moisture from specimens in a simulated Martian environment, including temperature cycling, appears consistently less than that found in specimens maintained in a similar environment held at room temperature. A.H.F.

169

Ohio State University, Columbus, Ohio. Research Foundation.
NATURAL ENVIRONMENT OF THE PLANET MARS. Technical Note No. 1.
J. H. Shaw. February 1959, 60 p., refs.
(Contract AF 33(616)–5914)
(AD–242175; N63–82036)

Present knowledge and speculations concerning the planet Mars are summarized with extensive references. The section on surface conditions states that the present observational data neither rule out nor confirm the existence of living matter on the planet. If it does exist, and if water is an essential component, the small amount of water vapor available will probably lead to a very stunted growth. M.P.G.

170

Illinois Institution of Technology, Chicago, Ill.
A STUDY OF LUNAR RESEARCH FLIGHTS. Vol. I
L. Reiffel. 1959?
(Contract AF 29(601)–1164)
(AFSWC–TR–59–39)

A study was conducted of various theories of the moon's structure and origin, and a description of the probable nature of the lunar surface is given. The areas discussed in some detail are optical lunar studies, seismic observations, lunar surface and magnetic fields, plasma and magnetic field effects, and organic matter on the moon. Author

171

School of Aviation Medicine, Randolph AFB, Texas.
THE REACTIONS OF TERRESTRIAL MICROORGANISMS TO SIMULATED MARTIAN CONDITIONS.
Irving Davis and John D. Fulton. 1959, 9 p.

The nature of possible Martian life has been suggested to be similar to certain simple forms of terrestrial life. The first known attempt to test the validity of this assumption by means of laboratory experimentation was reported from our laboratory. These continuing studies on the survival and multiplication of certain terrestrial forms of life under a simulated Martian environment are elaborated upon in this communication. Author

172

School of Aviation Medicine, Randolph AFB, Texas. Medical Sciences Division.

SURVIVAL OF TERRESTRIAL MICROORGANISMS UNDER SIMULATED MARTIAN CONDITIONS.

John D. Fulton. 1959, 10 p.

(N64–81534)

Studies with bacterial varieties of terrestrial microorganisms in simulated Martian environments are described. Results show a loss of obligate aerobic forms (both bacteria and fungi) with a proportional increase in the anaerobic and facultative anaerobic forms. Martian life my or may not be different from terrestrial life. A.H.F.

173

Georgetown College Observatory, Washington, D.C.

THE KNOWN PHYSICAL CHARACTERISTICS OF THE MOON AND THE PLANETS.

Carl C. Kiess and K. Lassovzsky. July 1958, 43 p., refs.

(Contract AF 18(600)–1770)

(ARDC–TR–58–41; AD–115617; N63–83268)

The physical characteristics of the Moon, Mercury, Venus, and Mars are discussed in terms of orbits, dimensions, atmospheres, temperatures, surface features, magnetic fields and life conditions. The extreme temperatures and the absence of water vapor and oxygen make it quite improbable that any life exists on Mercury. Since the physical conditions are perhaps more severe than those on the Moon, the survival of terrestrial life forms is also extremely unlikely. Although the size mass and surface gravity of Venus differ only slightly from those of Earth, the lack of oxygen and water vapor and the high surface temperature argue against the development of life on Venus. The question of life on Mars lies entirely in the realm of speculation—there is no positive evidence for its existence or nonexistence in either vegetable or animal form. The Martian green color and its seasonal changes can be attributed to the composition of volcanic ash and its weathering in the Martian atmosphere. A.H.F.

174

RAND Corp., Santa Monica, Calif.

EXPERIMENTS IN INTERPLANETARY BIOMIGRATION AND SPACE CONTAMINATION.

I. Cooper and A. G. Wilson. June 16, 1958, 13 p., refs.

(P–1406; N63–85665)

Specific questions which may be examined as a result of space flight are: (1) biogenesis; (2) parabiology; (3) generalized ecology; and, (4) interplanetary biomigration. A study of the contamination problem is divided into the following phases: (1) the probability of an organism from the earth's surface reaching the exosphere by convection, impact transfer, etc.; (2) the probability of an organism in the exosphere acquiring a hyperbolic orbit by radiation pressure, impact, or some other accelerating mechanism; (3) the probability of a hyperbolic orbit leading to positions in space favorable to the organisms being swept by another planet; (4) the probability of capture and descent to another planet; and, (5) the probability of survival at each stage. Experiments to investigate these points are placed in three categories: (1) experiments designed to ascertain the survival of microorganisms under various atmospheric space conditions; (2) experiments to determine the astrophysical properties of microorganisms; and, (3) actual samples taken at various levels of the atmosphere and exosphere to determine the presence (if any) of microorganisms, soils, and atmospheres of other celestial bodies. A.H.F.

175

Brazilian Interplanetary Society.

A THEORY OF NIGHTLY AND HIBERNAL ANABIOSIS OF THE ULTRA-XEROPHYTIC FLORA AND POSSIBLE SYMBIONTIC FAUNA ON MARS.

F. A. Pereira. 1958, 30 p.

The views obtained from a survey of the literature concerning vegetable or animal life on Mars are discussed. The possibility of anabiosis (a reduction of metabolical intensity to the threshold of biochemical processes) during evening and in winter climates is raised. Large daily and seasonal changes in Martian temperature and humidity make anabiosis in the afternoons and at the end of fall likely. J.P.L.

176

School of Aviation Medicine, Randolph AFB, Texas.

COMPARATIVE ECOLOGICAL STUDY OF THE CHEMISTRY OF THE PLANETARY ATMOSPHERES.

H. Strughold. *In* Epitome of Space Medicine, 1958, 6 p., 34 refs., (Article No. 8).

(Previously published as Special Report, dated December 1963)

The earth's atmosphere is used as a reference in this discussion. Historically, the development of the earth's atmosphere has passed through a reducing and reduced phase with no oxidizing power, through a transitional stage capable of partial oxidation and partial reduction, and then to the highly oxidized atmosphere of today. The first type of atmosphere, mentioned above, includes as similar types the atmospheres of Pluto, Neptune, Uranus, Saturn, and Jupiter. The Martian atmosphere is an oxidized one, with a slight potential for further oxidation; vegetation of lower order may exist there. Venus has a completely oxidized atmosphere with no potential oxidizing power. No description is given of an atmosphere for Mercury. Aviation M. B.

177

School of Aviation Medicine, Randolph AFB, Texas.

ECOLOGICAL ASPECTS OF PLANETARY ATMOSPHERES WITH SPECIAL REFERENCE TO MARS.

H. Strughold. *In* Epitome of Space Medicine, 1958, 11 p., 50 refs.

Of the planets, only Mars and possibly Venus have atmospheres capable of supporting life as we know it on the earth. On Mercury the surface temperature is above the range of active life and the surface temperatures on the larger planets are below it. The temperature of Venus is more than 100° C in the lower atmospheric layers, and about —25° C in the upper atmosphere; on Mars, the atmospheric temperature ranges from 30° to —60° C. The Martian atmosphere has an extremely low oxygen tension, if any, which precludes the existence of all higher animals and plants. There are, however, lower plants (lichens and mosses) which may be able to store the oxygen produced by photosynthesis in their intercellular air spaces and use it for their life processes. Heinz Haber has also advanced the hypothesis that life might exist as a "biological aerosol" in certain strata of the Venusian atmosphere. Aviation M. B.

178

School of Aviation Medicine, Randolph AFB, Texas.

THE ECOSPHERE OF THE SUN.

H. Strughold. *In* Epitome of Space Medicine, 1958, p. 323–328, (Article No. 27).

The ecosphere of the sun, or the helioecosphere, is a biologically defined concept. It indicates a zone surrounding the sun in

which the radiation on the one hand does not exceed the ecological maximum, and on the other hand does not fall below the ecological minimum. Considering the various ecological factors, we may speak of a biotemperature belt, a liquid water belt, and an oxygen belt in the planetary system. They all lie in about the same area around the sun. Thus, the designation ecosphere of the sun may be an appropriate and general concept to cover all of them. The decisive factor is the distance from the sun. In our planetary system the ecosphere evidently extends from the area of Venus to beyond Mars, roughly from about 50 to 150 million miles distance away from the sun. Author

179

School of Aviation Medicine, Randolph AFB, Texas.
LIFE ON MARS IN VIEW OF PHYSIOLOGICAL PRINCIPLES.
H. Strughold. *In* Epitome of Space Medicine, 1958, 8 p., 25 refs., (Article No. 3).

The problem of extraterrestrial life is discussed on the basis of present physiological experience. Particular attention is given to environmental factors of temperature and oxygen because of their close interrelation in biological processes. It is assumed that the laws of biological processes are the same in the entire universe and that the structure of living matter is based on the carbon atom and its unique chemical properties. A.H.F.

180

School of Aviation Medicine, Randolph AFB, Texas.
THE OXYGEN BELT IN THE PLANETARY SYSTEM.
H. Strughold. *In* Epitome of Space Medicine, 1958, p. 27–29, 13 refs., (Article No. 30).

The realm of oxidized atmospheres includes only Mars, earth, and Venus. Among these, the earth is outstanding with its additional rich supply of oxygen—the "oxygen belt". Only in this belt was the photochemical transformation of the original planetary atmosphere possible. Only in this belt, therefore, are organisms conceivable that depend upon oxygen or more generally on oxidation processes. Only biological oxidation has made possible the development of living creatures to higher stages. A.H.F.

181

School of Aerospace Medicine, Randolph AFB, Texas.
THE POSSIBILITIES OF AN INHABITABLE EXTRATERRESTRIAL ENVIRONMENT REACHABLE FROM THE EARTH.
H. Strughold. *In* Epitome of Space Medicine, 1958, p. 507–512, 9 refs., (Article No. 38).

When considering life based on carbon and oxygen, Venus and Mars are thought to be the only planets with the possibility of supporting life similar to that on earth. Ecological factors indispensable for life such as water, oxygen, carbon dioxide, temperature and light are considered. A discussion is given of the atmospheric condition on Mars and the protection a man will need when landing there. The surface air pressure on Mars will be equivalent to an altitude of 55,000 feet in our atmosphere, and pressure suits or pressure breathing will be necessary. Subzero temperatures at night will necessitate adequate heating apparatus. Cosmic rays and light intensity will not impose great hazards. Various requirements for indigenous life point out that organisms if present will probably take the form of cold-hardy vegetation. The total environment on Mars is likened to a combination of the microclimate of Tibet or the Pamir Plateau and the macroclimate of the stratosphere of the earth. Aerosp. M.B.

182

Smithsonian Institution, Washington, D.C.
THE MYSTERY OF MARS.
H. P. Wilkins. *In* Annual Report for 1956, 1957, p. 229–244.

Evidence is given of the presence of water on Mars. Indications are that the amount is small. Also, the seasonal changes in the dark markings and their altered colors, the way in which the canals begin to make their appearance as the polar caps melt, the certain, if occasional, presence of clouds or at least mists on Mars, and the general appearance of this planet, all combine to suggest that Mars is a waterless desert and that the dark areas are really tracks of vegetation owing life to what water can be conveyed along the natural waterways and canals. The possibility that intelligent beings may exist on Mars is discussed. No evidence supports this conclusion. A.H.F.

183

Lowell Observatory, Flagstaff, Ariz.
COLOR CHANGES ON MARS.
Seymour L. Hess. *In* The Study of Planetary Atmospheres, September 30, 1952, p. 42–46, 2 refs.
(N63–84183)

If the dark markings on Mars are vegetation, then they must be protected from ultraviolet radiation. This function can be performed on Mars by the "blue haze" layer. If this is the case, damaging ultraviolet should reach the surface during periods of clearing of the blue haze and its effect should become apparent through a change in color. Photographs taken in 1941 and 1939 have been measured to test this, with a confirmatory result in 1941 and an inconclusive result in 1939. If this can be substantiated during other years, it will strongly support the vegetative hypothesis and thus imply the existence of N_2 in the atmosphere and possibly H_2S. Author

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