18 Oct 1961

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TO: Exobiology Committee 14, Space Science Board, National Academy of Sciences

FROM: Joshua Lederberg, Chairman

Call for Meeting Saturday, October 28, 1961, 9:00 A.M.
Faculty Room, Dean's Office
Stanford Medical Center
Palo Alto, California

This is to remind you of the next meeting of the Exobiology Committee 14 of the Space Science Board. I hoped we might review the general status of the planetary program and the picture of the biological experimentation for it. We should get a more detailed briefing from the JPL representative. At the present time the tentative planetary program seems to be:

Launch Opportunities	Venus	Mars
1962	Mariner R flyby (Centaur not available)	--
1964	Mariner B flyby	flyby (the capsule dropsonde is at present suspended)
1966 - Jan. 1967	Voyager - ?	Voyager landing

The abandonment of the Mariner B Mars capsule has many implications for the time course of planetary biology that should be discussed.

I believe we should review old ground only briefly, e.g., microbiological experiments involving microscopy, enzymology, culture, particle analysis. A separate sheet will be distributed that summarizes some of the approaches already thought of. We should be starting to plan a package to see how different approaches match and complement one another.

We should stress new ideas, especially to be sure we are not overlooking some valuable opportunities outside microbiology. It would be particularly important to generate useful counsels on life detection at some distance - meters to kilometers - that might for example, influence the details of terrain photography. (If the Mariner B capsule is abandoned, what should be stressed to take its place in the bus to help define the Voyager program?)

Role of Universities

As always the most cogent problem is how these experiments will actually be accomplished. Our physical colleagues are often already accustomed to dealing with complex engineering projects in order to perform

their experiments, and in many universities, facilities are already available or could be readily developed to encompass experimentation for space research in the physical sciences. This is far less true in biology and is doubtless one of the main reasons for the limited number of proposals that have come from competent academic sources. This vacuum is bound to attract opportunistic interests, both from industry and from academic sources of less than highest competence, and some imaginative measures may be essential now to assure the highest level of university participation in exobiology. As you may know, NASA headquarters has been reorganized and space sciences are now administered as a single program under Homer Newell's directorship. This program will include the basic science activities of the former Office of Life Sciences which had previously operated independently and which included a very large part of applied biology which has now been transferred to the manned flight program. This reorganization, therefore, gives an opportunity for a fresh approach to the problem just mentioned, and for a closer coordination of basic research interests in the physical sciences and in biology. Should NASA seek to establish some central government laboratories for engineering development work which might then hope to collaborate with university scientists at several locations? Or do the pay standards and other inflexibilities of direct government employment preclude an effective program along these lines?

NASA has also gone a fair distance already in a program of direct grants to universities. To what extent should NASA be responsible for funding of basic research which may have only a remote or conceptual relationship with flight experiments? Should such research be funded more vigorously by NSF or NIH? These organizations have been, to some extent, reticent about supporting space related research - what measures might be taken to improve their sympathetic appreciation of these problems?

Are we sufficiently well informed concerning the activities of service laboratories in exobiology?

Role of the National Academy of Sciences

As we are all aware, there is a multiplicity of channels for technical advice on the space programs. NASA now has its own well organized advisory committees. There is also the National Space Council and at least two panels of the President's Scientific Advisory Committee. It has not, therefore, seemed urgent to keep the present committee too busy with frequent meetings. However, one set responsibility of the National Academy of Sciences is in the field of international relations since through COSPAR this is the main channel of scientific discussion with scientists from other countries, particularly the Soviet Union. Hopefully, Dr. Oyama will report on his experiences in Moscow last summer and we may use this as the starting point for further discussions of the possibilities for cooperative arrangements with other nations in exobiology.

Classification of Analytic Approaches

Draft Version - Drs. E. Levinthal and J. Lederberg are still working on a more definitive version which, hopefully, will be distributed at the meeting.

Premises - the detection of life is based either on the composition of the organism and its products or on the time change of composition or metabolism. This view allows the following systematic classification:

	Methods	Relevance to life
I. Atoms and nuclei H C O N P S	γ-ray spectra neutron activation electron-activation x-ray spectra X-ray absorption Mass spectra Conversion to molecules for (2) γ-ray back scattering	Particular (inference from high local concentration and variety): clues to higher complexity abundance: defines habitat.
II. Inorganic Molecules H_2O CO_2 CH_4 NH_3	Mass spectra Gas chromatography volatility and ionization, IR, UV detectors Special methods - hygrometry by conductivity; CO_2 by alkali absorption	Particular - as decomposition products of higher complexity abundance: defines habitat

		Methods	Relevance to Life
III.	Organic Molecules amino acids sugars nucleins lipids metabolites	Mass spectra IR absorption spectra UV absorption spectra ESR and NMR (Spectro) polarimetry Gas chromatography Special reagents,e.g., specific enzymes	Particular - as evidence of metabolism. Apart from specific identification net optical activity implies asymmetric catalysis.
IV.	Macromolecules Proteins Nucleic acids polysaccharides usually determined as agregates with high molecular weight, decomposable to the monomers	Diffusion: dialysis; molecular sieves, ultracentrifugation solubility end group analysis electron microscopy functional tests: enzymes and antigens Special reagents: enzymes and stains	May be reasonably decisive of some stage of life if the identification is adequate

	Methods	Relevance to Life
V. Organized Structures (cells, organelles)	Microscopy Decomposition to components analysable by destructive methods Non-destructive methods (spectroscopy) Separation by density	Form alone may or may not be persuasive; more so in combination with other analytical data, e.g, spectra - or with functional evidence: motility, catalysis, metabolism
VI. Artefacts (functional byproducts of life)	Microscopy Photography	Evidence of purposeful activity, e.g., bee hives, bomb shelters
VII. Information	Visual Acoustic Radio	Intelligent communication

"Particular" indicates the especial relevance of particles, that is, evidence of a concentration of a given component or the concurrence of different components in the same local space. On this basis, for example, one could infer the composition of molecules and macromolecules by methods of atomic analysis. Correspondingly the existence of an organism could be inferred from the local concentration of various metabolites and macromolecules. For these reasons, it is especially appropriate to consider those techniques which have not only a high sensitivity, but can be operated in a scanning or image-forming mode. This can also confer a higher degree of selectivity since the components of organisms are likely to be present in very high local concentrations, that is, in particles which are then widely dispersed in a large excess of inert or even interferring material. The list above is a tentative one and can be enlarged by further analysis and information; in constructing it only a little attention has or should be given to the feasibility of detailed methods of conducting the analyses along the indicated lines.

The time variation of a component or components indicating metabolism can be more persuasive than the static composition of a sample, and can also lend itself to higher sensitivity of detection than would otherwise be possible. An example of this is the possibility of detecting the conversion of C_{14}-labeled lactic acid to C^*O_2 as an index of bacterial metabolism (Levin - Research Resources). A measurement of static turbidity would be almost completely uninformative; measurements of increases in turbidity after inoculation of a medium would be at least provocative. Further, the metabolism of other added substrates, for example, nitrophenyl-phosphate can be used as indirect evidence of functioning macromolecules in the specimen, i.e., an enzyme phosphatase.