Summary of Minutes of the
Life Sciences Committee Meeting
June 1, 1977 - 8:30 a.m. - 5:30 p.m.
June 2, 1977 - 8:30 a.m. - 1:00 p.m.
NASA Headquarters, Room 5026, FOB6
Washington, DC 20546

I. Attendees

Chairman:	Whedon, G. Donald	
Members:	Berry, Charles A.	
	Hayes, J. M.	
	Holloway, H. C.	
	Horsfall, James G.	
	LaCelle, P. L.	
	Luetscher, John A.	
	Reals, William J.	
	Schopf, J. W.	
	Sheridan, T. B.	Presentation
	Spizizen, John	Presentation
	Sprugel, George	
	Spurlock, J. M.	
	Ward, C. H.	
Executive Secretary:	Vinograd, S. P.	
NASA Personnel & Invited Participants:	Barnwell, Lydia (Hq.)	
	Bejczy, A. K. (JPL)	
	Bold, Tom (Hq.)	
	Bradley, F. D. (Hq.)	
	Bredt, J. H. (Hq.)	Presentation
	Chambers, L. P. (Hq.)	
	Deutsch, S. (Hq.)	
	Dietlein, L. F. (JSC)	
	Disher, John H.	Presentation
	Dunning, R. W.	
	Farrell, R. (Hq.)	
	Fong, Louis B. (Hq.)	
	Halstead, Thora (Hq.)	
	Herman, Dan (Hq.)	Presentation
	Hessberg, R. (Hq.)	
	Hinners, Noel (Hq.)	
	LaRock, R. (Hq.)	Presentation
	Lauver, Anne (Hq.)	
	Laveson, Jack (Hq.)	
	Michel, E. L. (JSC)	
	Nicogossian, A. (Hq.)	
	Popma, Dan (Hq.)	Presentation
	O'Handley, D. (JPL)	

	Sharp, Joseph (ARC)	
	Shimel, W. H. (Hq.)	
	Swetnick, M. J. (Hq.)	
	Vitale, Joseph (Hq.)	Presentation
	Whitten, R. P. (Hq.)	Presentation
	Winter, D. L. (Hq.)	Presentation
	Young, A. T. (Hq.)	Presentation
	Young, R. S. (Hq.)	Presentation
Visitors:	Beem, Donald (AIBS)	
	Cassidy, Daniel E. (US House of Representatives)	
	Stabekis, P. D. (ExoTech)	

II. Agenda - Attachment I

III. Meeting Highlights

The meeting was fully open to the public. There were three visitors in attendance. They did not make an oral or written statement.

The meeting was convened by the Acting Chairman, Dr. John Spizizen, member of the Life Sciences Committee.

Item 1. Teleoperators. Mr. Dan Popma, Director, Biomedical Systems, and Operations, Office of Life Sciences, NASA Hqs., briefed the Committee on the Life Sciences teleoperator program. The current program consists of three tasks at ARC and three at JPL and has a total dollar value of about $500K. This research consists of studies to improve sensors, displays, manipulator range and flexibility, human control and integration, and performance evaluation techniques. Voice command and computer assisted operator controls are being developed. Proposed FY 78 activities include the definition of promising applications selected from those currently under study.

Dr. Tom Sheridan, Professor of Mechanical Engineering, MIT, and member of the Life Sciences Committee, presented an overview of the field of Teleoperator Technology. He discussed the purposes, characteristics, and major components of teleoperator systems. He indicated

that there are two primary levels of teleoperator control between entirely human activity and autonomous robot activity. These are master-slave manipulation and supervisory control of nearly automatic robot devices. In discussing the extent to which teleoperator research properly qualifies as an activity of the life sciences, Dr. Sheridan presented the rationale for the conclusion that so long as the technology involves an interface with man it is appropriate to the life sciences because teleoperator technology is a direct enhancement of man's functional capabilities, sensory, cognitive and motor. The life sciences issues are the relative roles of man and machine for each teleoperator task in space, how to make man and machine work better together to enhance and augment human function, and resolution of the discontinuities between man and machine.

He further pointed out that teleoperator research requires an untraditional interplay of academic disciplines between the physical sciences (computational science, control theory, mechanical and electrical engineering, etc.) and the biomedical sciences (psychology, neurology, musculoskeletal physiology, etc.). It, therefore, calls for collaboration between engineering and medical schools. Dr. Sheridan discussed both space and non-space applications of teleoperator technology and showed a movie illustrating representative investigative problems and approaches of teleoperator research.

The committee expressed its appreciation for these presentations and agreed unanimously that teleoperator research is appropriately a life sciences function. Dr. Winter stated that this work now receives

its sole NASA support from the Life Sciences and asked the LSC to consider whether we should continue supporting it in light of a diminishing budget and increasing costs. He stated that the NASA Life Sciences has now reached the point where it must drop whole segments of its SR&T program to prevent crippling of the remaining segments.

After an extensive discussion, the Committee stressed the importance of steady fundamental progress in this area regardless of currently known operational requirements, citing as an example the readiness of remote manipulator technology for Shuttle when Shuttle came along. Since NASA's teleoperator research is unique among federal agencies in recognizing man in the loop, NASA, in particular the NASA Life Sciences, must continue to support this SR&T effort. If financial constraints should force its discontinuation, the NASA Life Sciences should fully document the impact of its termination so that higher management is well apprised of the effects of this decision as well as the reasons for it. Recognizing the fact that the Mars Rover will require advanced teleoperator technology and that adequate funding for demonstration of new technology is not available in SR&T but requires user flight program support, the LSC recommended that the Life Sciences teleoperator SR&T group establish and maintain tighter communication with the NASA Rover group. The Committee regards the large problem of man's capacity to manipulate in space as a conceptual problem which must receive continuing research support and attention even if it is not yet applicable to an approved flight mission.

Item 2. The Gravitational Biology Program. Dr. Richard S. Young and Dr. Thora Halstead of the Biological Sciences Division, Office of Life Sciences, NASA Hqs., presented the Life Sciences Gravitational Biology Program. In his introductory remarks, Dr. Young, Biological Sciences Director, stated that it is a basic science program consisting of three primary areas of research: (1) Physiology and Biochemistry, (2) Embryology, Development and Morphology, and (3) Circadian Rhythm. He pointed out that the best flight experiments are those that evolve out of a solid SR&T base, and further stated that he feels that this program is under-funded by about $500K. The area most hampered by funding insufficiency is the second, Embryology, Development and Morphology.

Dr. Halstead then described the $1 million program in detail, task by task. All of these tasks have been evaluated for scientific merit by peer review within the past year, and all of those remaining in the program received favorable evaluations. Some principal investigators have been in the program for a long time, but all had resubmitted. Several longstanding tasks had been weeded out by peer review.

After several questions and comments by Committee members on specific tasks, the discussion turned to larger aspects of the program. The LSC strongly emphasized the need to correct deficiencies in the site monitoring of Life Sciences research, adding that reductions in the travel budget which restrict this function are cut-backs in the wrong place. The Committee also suggested that peer reviews for scientific merit should include site visits in many cases. This has not been done in the past.

In the discussion of the program content, the LSC noted that it is reasonable for this program to be scientifically oriented rather than problem oriented because problem orientation will tend to drive certain elements out. It is important, however, that the central scientific issues should be defined by the scientific community in order to enable NASA to give prospective new participants better guidance by informing them of prevailing opinion. In addition, the LSC wishes to be informed of what is being done world-wide, such as through COSPAR. Dr. R. S. Young agreed to attempt to derive a community consensus on the fundamental biological issues and to summarize world-wide activities in the field in time to brief the LSC of the next meeting.

Item 3. Administrative. Dr. Whedon assumed the Chair. The minutes of the prior meeting were approved as distributed. Meeting dates for the next two meetings were decided as follows:

The next meeting will be held Tuesday and Wednesday, November 1 and 2, 1977, at NASA Headquarters, Washington, DC.

The following meeting will be held Wednesday and Thursday, February 15 and 16, 1978, at either ARC or Cape Kennedy.

The Chairman noted that the Space Program Advisory Council (SPAC) did not convene in the interim since the last LSC meeting. He then called the Committee's attention to his letter to Dr. Naugle summarizing the salient features of the last meeting. He referred specifically to the "advocacy package" to be completed by the Committee and requested that the members direct their thoughts to the subject for discussion at the end of the meeting agenda.

With reference to the forthcoming National Academy of Sciences (NAS) summer study at Snow Mass, Colorado, Dr. Whedon stated that Dr. Neil Bricker, the Chairman of the study group, had invited him to attend. He feels, however, that additional LSC members should also be invited, a position that other members endorsed in view of the fact that the Bricker group report will be a permanent one. Dr. Winter stated that he would bring the matter to the attention of the NAS.

Dr. Whedon reported that the summer study plan is to divide the group into six disciplinary sub-groups which will meet daily and come together frequently. After the first week, most of the members will depart. Dr. Bricker and a few others will remain to write the report. The meeting dates are August 15 to 26, 1977.

The Chairman then referred to the Space Motion Sickness RTOP peer review scheduled to take place next month. At the last meeting the Committee proposed to assign representatives to attend because of the importance of this area of research. Dr. Holloway and Dr. Berry agreed to serve as liaison representatives at this peer review meeting. After a short discussion the Committee determined that similar LSC liaison arrangements should be made for all RTOP peer reviews. The Executive Secretary will take appropriate action.

Item 4. NASA Life Sciences Overview. Dr. Winter quickly reviewed the organization and disciplinary components of the NASA Life Sciences for the Committee. The newly revised NASA booklet called, "Space Life Sciences Program" was distributed to the members for later perusal. He

pointed out that SR&T is the backbone of the program. On the subject payloads, he stated that seven life sciences experiments are presently under study by the European Space Agency (ESA) as possible candidates for the second Spacelab. For the future, the Office of Life Sciences is now preparing specific mission requests for dedicated Life Sciences Laboratories. The intention is to establish these flights as OSS missions with the pallet half dedicated to the physical sciences. An Announcement of Opportunity is scheduled to be released in the fall to solicit experiments for four such dedicated laboratories to be flown over a two-year period. He concluded by requesting the comments of the LSC on a proposed new start for FY 79, the Closed Ecological Life Support System (CELSS), to be presented in the afternoon.

In reply to a question concerning NASA acceptance of the stated goals of the Life Sciences, Dr. Winter said that they had been presented to all levels of NASA top management, including the new NASA Administrator. Dr. Hinners stated that they were well understood and accepted throughout. During the ensuing discussion, the Committee again stressed the importance of site monitoring as essential to the direction of a sound and productive program and as a valuable exposure for NASA scientists. Although colloquia of principal investigators have been held at the NASA Centers, and the Committee agreed that this is a good technique, the LSC did not consider it an adequate substitute for site monitoring. Alternative site monitoring methods, such as the use of consultants for this purpose, were suggested and explored by the Committee, but no satisfactory techniques could be worked out which would decrease costs. It was concluded that the tightening of the

travel budget had been overdone to the extent that funds will not permit adequate program monitoring. Dr. Hinners agreed, stating that this is true across the entire program and that the matter has been discussed before the Congress.

Discussion of the SR&T program brought out the following points: Future funding available for SR&T is forecasted as a flat curve with no provision for inflation. The SR&T program must be kept as strong as possible because it is the limiting factor of our future mission capabilities. A strong SR&T program is also essential to a productive flight experiment payloads program, which cannot benefit adequately from naive proposals. Because of low SR&T funding levels, it may become necessary to provide SR&T type growth of flight experiments in the payloads program.

A discussion of the most effective constructive action the LSC might take to help correct this problem followed. Dr. Hinners stated that the LSC could play an important role in maintaining high program quality by taking the position of a stiff devil's advocate. From the standpoint of LSC action to improve SR&T funding, no single pathway was clear. The Committee will continue to make recommendations as it feels they need to be made, even if only for the historical record. (It was pointed out that there may be no "receptor sites" in the OMB.) The Committee emphasized that it must continue to call for the correction of serious deficiencies. The LSC will consider phrasing a resolution concerning Life Sciences SR&T funding.

Item 5. Closed Environmental Life Support System (CELSS).

Mr. Dan Popma gave a presentation to the LSC on this proposed new start for FY 79. This effort consists of the research and development of a

closed system capability to support future long duration manned space flight. Past studies have shown that as mission durations are extended, launch weight (power) and cost efficiencies favor progressive closure of life support system loops. Closed loop physical-chemical subsystems require periodic resupply. Hence, they are optimal for long duration Earth orbital missions where resupply can be carried out efficiently. However, for long term space habitation, such as a space settlement or lunar habitat, the most efficient system will be an entirely closed, self-perpetuating and independent capability which provides the atmospheric, food, water, and waste management requirements to support man permanently. Such an ecological system would be similar to our natural system on Earth differing only in scale and complexity. The lead time needed to approach this objective will be extremely long (several decades). Therefore, now is an appropriate time to start if we are to be in a position to support such missions by the next century. The task of developing this technology is a complex one which will require the interaction of a diversity of academic disciplines. The state of the art in closed biological life support systems is at a low level in the United States. The USSR, however, has been supporting such research for several years and their scientists have published extensively on their work.

The approach to undertaking this work within the NASA Office of Life Sciences is presently taking form as a research plan which is being worked out by a selected group of consultants under a NASA Headquarters contract. These consultants represent the fields of plant physiology, aquaculture, animal husbandry, animal and human nutrition, microbiology, and the engineering sciences. Initial surveys

of applicable existing knowledge have identified several deficiencies, prominent among which are quantitative aspects of photosynthesis, human nutritional needs, and specific activities of soil microorganisms.

As presently envisioned, the initial effort in developing the overall research plan will be to identify critical areas of technology needs, determine the pacing items, and develop an understanding of of the technology interfaces which will be required. Elements contained within the anticipated approach at this time include the holding of national interdisciplinary colloquia, development of a basic life support network model, advancements in the state of the art through individual grants and contracts, development of ground-based system tests and, finally, flight tests. The tentative schedule cites the completion of the research plan this year, the start of ground-based closed system testing in 1985, the start of minimum scale flight test demonstrations in 1987, and the start of mini-biological system operational flight tests in 1990. Mr. Popma further discussed current conceptual guidelines for the system, and milestones by five-year periods through 1998 for the anticipated acquisition of specific information needs.

Discussion by the committee centered on several technical points, primarily on food, since physical-chemical systems cannot now effect closure of the food-waste loop. Opinion appears to be evenly divided on the human need for animal proteins. Some say animal purines are necessary, but how this might be so is not understood. Some primates, a species of bat, and bacteria require no animal proteins. Chicken is the most efficient food-producing animal and fish are also very efficient. Rice is a unique plant in that it can utilize nitrogen directly from the ground,

but it also burns off ammonia during the day. We have learned a good deal from the algae research supported by the Navy in the late 40's and 50's, such as the existence of a form of algae without cellulose cell walls that is probably edible. More current work has identified another form, Spurolina, that can serve as a good dietary supplement. The use of algae as a food for either land or aquatic animals was also mentioned. It was noted that one must bear in mind that man's nutritional requirements may change in space due to factors such as confinement and inactivity, as well as weightlessness.

LSC members stressed the importance of a thorough and discriminating literature review prior to establishing a firm research plan, stating that there is a great deal of literature pertaining to the subject, some good and some bad. It was further pointed out that recent work has now made it possible for us to make calculations which could not be done a few years ago. For example, we now know the photosynthetic efficiency of many plants. Similarly, other problems of the past are no longer mysteries. Mr. Popma stated that the literature review is continuing. To date, the NASA, USAF, and USSR literature has been reviewed.

Dr. Winter requested the advice of the LSC on this new line item. Is it worthwhile? Should we make the effort? The Committee was unanimous in its endorsement of this new program. Several members voiced the opinion that it is a very important effort, very much a NASA responsibility, and promises many beneficial public applications for the future. The LSC noted that it is very much a Life Sciences problem, not only because it is a life support system effort, but because biological recycling is really the system closure emphasized in the research required. The Committee suggested that a subsystem by subsystem approach

(water and gas first) would be the best way to proceed during the first years of the effort, and that program presentations should clearly reflect this approach. In addition, presentations to Congress should focus on future space flight. The LSC indicated its desire to observe closely the development of this project and requested a progress report at each meeting. Special interest was expressed in the current state of our knowledge of human nutritional requirements.

Item 6. Task Team Report on Planetary Quarantine and Containment.

The report was given by Dr. John Spizizen, Chairman, Scripps Clinic and Research Foundation, and LSC member, and Dr. Richard S. Young. Dr. Allen G. Marr, the remaining team member, was not present. Dr. Spizizen stated that he and Dr. Marr reviewed the Planetary Quarantine and Containment Program with an AIBS review committee and and a National Academy of Sciences (NAS) group at JPL. It was decided that a retrenchment of the in-house program at JPL should be carried out, an action which has now been completed. For FY 78 and subsequent years the in-house JPL program will be reduced by about 50%. Headquarters will have only two grants remaining in its program, one at Hardin Simmons University and one with the FDA. The remaining funds are to be used for a newly emphasized area of study, Planetary Ecosystems. The task team recommended that the Planetary Quarantine and Containment Program continue at the reduced level of effort and that the Planetary Ecology Program be strengthened.

The problem of inadequacy of travel funds arose once again when Dr. Spizizen reported that the west coast (ARC) meeting of Dr. Marr and Dr. Spizizen with Dr. Young, an action issuing from the last LSC meeting, could not take place for this reason.

Dr. R. S. Young reviewed the PQ program content and funding of the last three years for the committee. He then described in detail the program plan for FY 78 showing the changes which will be made to reduce the program from its present $1500K level to approximately $765. The remaining $735K will be used to launch the new Planetary Ecosystems effort, as recommended.

In the brief discussion that followed, it was pointed out that the PQ program was originally undertaken in conformity with international agreements. The question was asked, will this program reduction sacrifice our ability to conform to these agreements? In reply, Dr. Young stated that the answer is, no. We have always worked on the advice of the NAS Space Science Board (SSB), who now advocate a program reduction. The NAS has recently reduced the probability of growth (Pg) on Mars from 10^{-6} to 10^{-10} or 10^{-12} based on Viking findings, and are in process of putting out a new report to that effect.

Item 7. Basic Ecology Program. Dr. R. S. Young briefed the Committee on the planning and current content of this program, also referred to as Planetary Environments. The program is seen as consisting of 2 segments, Planetary Characterization and Ecosystem Studies. Planetary Characterization, which consists of technique and instrumentation development for planetary mission studies of atmospheres, soils, and water, contains 3 on-going tasks. Environmental Studies, the new segment of the program, is a fundamental investigative effort into the dynamics of biological ecosystems. From the NASA standpoint, the need arises from the assumption of continued exploration in space. In the future, man will leave Earth for long periods of time, months to years,

to live in space habitats or on other planets. As pointed out earlier, closed ecological systems will be required when mission durations and characteristics are such that resupply and physical-chemical systems are beyond the cost-effective range. The purpose of this effort is to gather the fundamental biological and biochemical knowledge needed to make self-sustained habitation possible for man. It supports the CELSS program discussed by Mr. Popma.

Dr. Young outlined specific research questions to be addressed by the program and discussed 9 research tasks which are being considered. The general problem areas to be included in the Environmental Studies RTOP are: nitrogen cycles; farming models; planetary engineering; plant bacteria/soil interaction; multi-organism interactions; higher plant studies; and microbial food sources.

Dr. Young further pointed out during the discussion that the CELSS concept has already attracted a number of scientists who are stimulated to participate actively in biological investigations of basic ecosystems. The CELSS gives this work aim and direction.

The LSC expressed its appreciation to the Task Team for its work, voiced its support of the Task Team recommendations, and strongly endorsed the Planetary Ecosystem (Planetary Environments) program as an appropriate and important new emphasis which will provide fundamental biological support to the new CELSS effort.

Item 8. Future Studies of Mars. This briefing consisted of 3 presentations covering three aspects of the subject for the information of the Committee.

Mr. A. T. Young and Mr. Dan Herman, of the Lunar and Planetary Programs Division, OSS, NASA Hqs., discussed the status of NASA Plans

for Future Mars Exploration. Mr. Young first presented the current status of NASA's planetary programs as a background. NASA presently has two on-going planetary missions, both in the final stages of development. They are Voyager and Pioneer-Venus. Two Voyager spacecraft are scheduled to be launched, one in August (20th) and the other in September 1977, both from Cape Kennedy. The first will fly by Jupiter and Saturn. The second can be retargeted to Uranus (to arrive there in January 1986). The Pioneer Venus spacecraft, now being built by Hughes Aircraft Corporation under ARC's direction, is presently scheduled for launch July 15, 1978.

Congress has not yet approved any further flight programs beyond these two. The Jupiter Orbiter Probe (JOP) is being studied by Congress at this time. Future Mars missions are still under review.

The JOP mission flies an orbiter to Jupiter's magnetosphere where it remains in orbit for 20 months studying the magnetosphere, remote sensing the planet, and gathering data on its moons. Jupiter can be regarded as a miniature solar system in that it has 13 moons, 4 of which are the size of planets (about the size of Mercury). Mr. Young emphasized the importance of the JOP in terms of scientific gain and prestige value.

Mr. Dan Herman continued the presentation with his description of plans for future Mars exploration. These plans are the result of interactions between science advisory groups, engineers, and flight operations specialists. This has been found to be a most valuable approach to the development of planetary missions. Scientific groups have recommended that the bench mark for Martian missions should be sample return. Prior to such a mission, however, the best area to

sample from must first be determined. A Rover mission is considered to be the appropriate first step to provide this understanding of the environment.

The presently planned 1984 Mars mission includes an Orbiter, a Lander-Rover, and 3 Penetrators to be launched in one vehicle. The Orbiter will carry out geochemical mapping from its remote position. The Rover, with a traverse range of 100 km., will evaluate the minerology, chemistry, and topography of the surface, stopping to sample as it progresses slowly along. It will probably be directed along river channels, although other options are being considered. The Penetrators will hard land and impact in areas, such as craters, not suitable for Rover, to establish weather and seismic stations. Rover and Penetrators will be in communication with the Orbiter. The 1984 mission will not do biological studies, but will emphasize chemistry. Biological evaluations will await sample return.

The sample return mission, itself, will follow this percursor mission with launch in about 1989 or 1990. It will carry a Rover capability and, if complemented by low thrust propulsion augmentation, will be able to return a sample of the order of tens of kilograms in size. This mission cannot fly earlier because of its dependence upon the knowledge gained from the 1984 mission. Considering traverse time to Mars, time in orbit before significant data begins to return (1 year), and time to reduce and interpret the data, sufficient information probably will not be available from the 1984 precursor mission to permit the sample return mission to be launched before 1989 or 1990. This schedule means that Phase B must be completed early in FY 83 and a Mars receiving laboratory must be available by 1993.

Dr. R. S. Young gave a brief presentation to the Committee on Science Payload Planning in NASA, the second of the three talks in this group. He distributed three documents encompassing the subject: (1) Viking Science Management Plan, (2) NASA Management Instruction on Announcements of Opportunity and the Acquisition and Administration of Space Science Investigations, and (3) Guidelines Used for Viking. He indicated that the first document is probably the most instructive but suggested that the Committee read all three. They describe the organization of science teams and give examples of pre-organized teams and individuals who served as one-man teams. The teams frequently designed and built their own instruments.

Dr. R. S. Young gave the final presentation of the three on Mars, Returned Sample Studies on Earth vs. Earth Orbit. He presented the decision train for both kinds of sample return missions and outlined and discussed the pro's, con's and requirements of each. Copies of this material were distributed. In closing, Dr. Young expressed his own opinion in favor of earth based analysis, giving several reasons, but stating that in the end the definitive analyses would have to be done in an earth based facility, anyway.

Dr. Ward took the opposite position saying that we would have space facilities, anyway, (Shuttle, Tug, perhaps a Space Station). He pointed out that this would be a very important role for man in space, in essence, carrying out screening analyses to protect man on Earth. Dr. Holloway countered this with three points. First, he felt that it will be a very long time before bacteriologists will agree on what constitutes an adequate bacterial challenge in the laboratory to guarantee the safety for Earth of a strange organism. He also

pointed to the problem of the contaminated man (orbiting scientist), stating that he would have to be returned to Earth, anyway. And, finally, he referred to the high cost of analysis in space vs. public opinion, saying that we can reach a point where we can be adversely affected by both. Dr. Spizizen commented that an earth based quarantine facility could have many additional uses, but he felt that the question really needs a lot of further examination.

Item 9. Potential Uses of Space. The LSC expressed a good deal of interest in this subject at its last meeting, especially with regard to potential life sciences flight experiments. Five briefings in the area were given by NASA personnel representing the organizational elements engaged in related activities. A sixth presentation on the Life Sciences Perspective, by Dr. Winter, became part of the discussion that followed.

A. Space Processing. Dr. James Bredt, Manager, Space Processing Applications, NASA Headquarters, discussed the goals, rationale, program plan, present status, and biological content of his program. He outlined in some detail the on-going and planned work in electrophoresis and its variants, reviewing the potential advantages of the space environment to this processing technology and the types of biological products that might be qualitatively or quantitatively enhanced.

Committee discussion brought out several points. The cost effectiveness of cell separation by electrophoresis in space is not yet worked out since NASA is still attempting to find out if it can be done. However, it cannot be done on the ground and the fact that a 10 cm. cell transfer has been done in space offers promise. At the

present time the driver of the program is not biology, but materials for electronics, especially crystal growth. Participation in the program by industry has not been large, but one company has been involved to some extent in exploring urokinase production. In response to a question, Dr. Bredt said that there is biomedical representation on his advisory committee, two people from NIH and two from NASA Life Sciences. In general, the biology community has not been very receptive to this effort. Dr. Hayes requested published reports or any other information that might be available on the biological experiments. Dr. Bredt agreed to forward them and stated that there are no scientific publications yet. He added that he would be most receptive to LSC advice in developing his R&D program.

B. Satellite Power Systems Program. Mr. Ralph LaRock, Director, Solar Energy Division, Office of Energy Programs, NASA Headquarters, presented an overview of this joint NASA-ERDA study program. He described the concept, gave its history, goals, objectives, milestones, and program organization. He discussed the studies of systems definitions, space related technologies, impact and benefits, comparative evaluations and environmental factors. The most pervasive issue is microwave power transmission, a major concern of which is the public health risk and effects on biota of long-term low-level microwave radiation. This is an area in need of further study. Current estimates are that approximately 120 ground stations up to 300 square miles, each, would be needed. Development cost estimates are extremely soft at this time, ranging from 5 to 500 million dollars per kilowatt hour. One ground station would supply all of the

needs of New York City. Twenty-five or thirty would accommodate 25 to 50% of new growth requirements in the USA. This system is potentially competitive with nuclear fusion. However, the concept will not provide all of our energy requirements. Alternative energy sources will still be needed.

Mr. LaRock alluded to the persistent thousand-fold disperity between permissible exposure limits in the USA and USSR to illustrate the point that a great deal remains to be learned about the biomedical effects of microwaves. Dr. Reals commented that this difference between US and USSR standards is really not based on science, adding that microwave radiation is S band radar, but continuous rather than pulsed. He stated that a major problem with all data is that we really don't know how to measure microwave energy very well. On the question of NASA's small budget allocation for this kind of research, Dr. Holloway pointed out that the Office of Telecommunications Policy (OTP) is the over-all coordinating group on microwave measurement and biological problems. He suggested that they should be consulted heavily as soon as their data system, which was temporarily disrupted, is back on line. He also stated that the Department of Microwave Research at Walter Reed developed a full USA and USSR published literature review which has recently been transferred to OTP.

Mr. LaRock stated that construction of the system in space will require 500,000 to 1 million pound payloads to be launched, for reasons of cost effectiveness. This will require precursor small scale launches to demonstrate this and associated new technology, but the system will not be operational before the year 2000, according to current planning.

C. Space Industrialization. Mr. John Disher, Director of Advanced Programs, Office of Space Flight, NASA Headquarters, prefaced his presentation by pointing out that this is not a program, per se, but an over-all effort on NASA's part to use the unique characteristics of space for economic and technical benefit. He discussed its goals, objectives, and general requirements. Tether operations in Shuttle are scheduled for 1981, inspection and retrieval capability in 1983, and flight of the 25 kilowatt solar power module aboard Shuttle in 1983. The effort embraces several additional concepts such as space construction with teleoperator systems, a space construction base, an advanced communications system, the Satellite Solar Power System, and several modules for a space base (life sciences, habitability, construction shack, space processing). A step-wise evolution of space transportation capabilities is envisioned to accommodate future requirements to achieve these goals and objectives with economy and flexibility. Many of these technological advancements can be achieved by 1987.

D. Technology Utilization Program. Mr. Raymond Whitten, Chief, Biomedical Applications Division, Technology Utilization Office, NASA Headquarters, presented the purposes, program elements, methods of operation, and content of the program. He discussed the program publications (and disseminated copies of "Spinoff 1977" to Committee members), the locations and functions of the industrial applications centers (IAC's), the applications teams, interagency cooperation in applications projects, and program evaluation and benefits assessment. He stressed the importance of thorough analysis before a project is

undertaken, traced the steps in project development, and reviewed the tasks in the current Biomedical Applications RTOP.

Committee discussion centered on the question, how is the information in this program and its successes disseminated? How does the taxpayer know? Mr. Whitten replied that the information is disseminated through the IAC's, BAT teams, publications such as "Spinoff," and Technical Briefs, and that even newspaper advertising has been tested. However, Technology Utilization does not do its own PIO. Information disseminated through the users often does not mention NASA. The LSC stressed the importance of the Public Information Office function in this regard and suggested that NASA strengthen this area.

E. University Space Applications Program. Mr. Joseph Vitale, Manager, Space Applications Programs, Office of University Affairs, NASA Headquarters, briefed the Committee on this NASA program. It provides grants to universities to encourage direct interaction between the university and state and local governments to demonstrate specific practical benefits from the use of remote sensing technology.
Mr. Vitale discussed three examples of this work, a platting problem in Arizona, location of a proper building site for apartment dwellings in Vale, Colorado (clear of avalanches), and the location of a well site for a Nebraska farmer, all involving LANDSAT imagery. As a result of these efforts, benefits are realized within the state, the NASA technology becomes accepted, and the university becomes an operational center of expertise in the use of this kind of technology for local problem solving. The program presently provides 22 grants to 22 universities in 22 states with a total budget of 2.7 million. Matching

funds are not required. All of the projects involve remote sensing but they do not all utilize LANDSAT.

Publicity received is usually local and occasionally national. The Committee again expressed its concern that the message on the public usefulness of NASA programs is not getting through to the taxpayers and voters at large.

Item 10. Discussion. The Chairman directed the attention of the Committee to the "advocacy package" to be written by the LSC. It should consist of comments and recommendations which will strengthen the Life Sciences program, demonstrate its value, and indicate why and how it should be a more active and vigorous part of the NASA program. It is expected that it will be utilized by the agency at several levels and in several ways to influence future planning, such as zero base budgeting and the 5 year plan. He emphasized the importance of including the rationale for any recommendations made. Drs. Hayes, Berry, and Winter brought out the point that in defining the scope of the NASA Life Sciences, both line and service functions must be included. All agreed that a document similar to the Physical Sciences Committee document is needed.

In discussing the organization of the document, Dr. Hayes commented that the first step is to establish its goal, and suggested that it should be the directions and priorities of the NASA Life Sciences for the next five years. Dr. Whedon appointed Drs. Hayes, Spizizen, and Holloway to form a task team to design the goals and outline of the project, suggesting that they work independently at first before exchanging ideas. He also recommended that all members

of the Committee give the matter some thought and note their ideas. LSC members discussed several possible approaches to the format. The Executive Secretary will distribute copies of the Physical Sciences Committee report to the members to use as a helpful reference. The Chairman directed that the agenda for the next meeting should allow sufficient time to work on this project.

Agenda items for the next two meetings were discussed and several requests were made. The Executive Secretary will contact Committee members for additional topics two months before the next meeting.

On programs outside of the Life Sciences purview which had been presented, Committee members expressed some question concerning the adequacy of review of the biomedical aspects of space processing. With respect to the microwave problem and the SSPS study, the suggestion was made that NASA administration should be made aware, as a potential problem, of the effect of past measurement inaccuracies on the validity of existing data.

V. Conclusions and Recommendations

As stated under respective items.

VI. Next Meetings

November 1-2, 1977, in Washington, DC.

February 15-16, 1978, at ARC or Cape Kennedy.

S. P. Vinograd, M. D.
Executive Secretary

G. Donald Whedon, M. D.
Chairman

August 4, 1977
Date

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
NATIONAL INSTITUTES OF HEALTH
BETHESDA, MARYLAND 20014

May 2, 1977

Dr. John E. Naugle
Associate Administrator
National Aeronautics and Space Administration
Washington, DC 20546

Dear Dr. Naugle:

The Life Sciences Committee had an informative and productive meeting at the Johnson Space Center on February 9 and 10, 1977. The preceding SPAC meeting of February 1 and 2, 1977, in Washington, DC, provided a valuable framework for this meeting by virtue of its discussion of the preliminary NASA five-year plan. The highlights and recommendations of our LSC meeting are summarized as follows:

1. On reviewing the elements of the preliminary NASA five-year plan, the LSC has several recommendations and observations to report to you. I will itemize these for the sake of clarity.

    a. We firmly endorse the CORE line item. The program to develop common operating research equipment as a Life Sciences facility should prove to be the most cost effective means of providing full use of the Shuttle for life sciences investigation by the scientific community.

    b. We similarly underscore the importance of ILLSE. Clearly, the support of principal investigators for approved experiments is essential for a successful Life Sciences program aboard Shuttle. This should be funded at a level adequate to support the many meaningful life sciences flight experiments to be done aboard Shuttle.

    c. In the life sciences perspective, Shuttle offers the opportunity to carry out at least three categories of experiments in space. Some will have as their fundamental objective the improved safety of man in flight, better protection of his health and expansion of his abilities in space. Others will seek to increase our fundamental knowledge of biological and physiological phenomena through the use of space. Still, others will be oriented to the improvement of man's life on Earth by exploiting potential medical and biological uses of space. The LSC feels that this third category is particularly important and in need of further amplification. We intend to explore this area in much greater detail during the next one or two meetings.

d. The LSC also intends to give more detailed attention to the five-year plan as a whole, beginning with its next meeting. At this point, it appears that little more than 1-1/2 pages of Life Sciences out of a total of 40, and a budget of six per cent of the Office of Space Science budget represent disportionately small attention and support of an important segment of NASA's activity. We have further reservations about the adequacy of a constant five-year level of funding for the SR&T program in that, among other drawbacks, this may not provide the needed seeding studies for future experiments. The absence of new projects above the base program is another cause of concern, as is the loss of the BESS capability for long term life sciences experiments without assurance of compensatory capability in another flight program, such as Space Station. We propose to formulate and submit to you a set of specific recommendations on future directions for the Life Sciences by the end of this year.

2. The Committee was informed that the National Academy of Sciences now has two committees concerned with the life sciences in space: The Committee on Space Biology and Medicine, and the Committee on Planetary Biology and Evolution. We were also notified of the forthcoming NAS summer study of potential Shuttle Life Sciences experiments. We strongly recommend close liaison between the LSC and each of these three National Academy of Sciences activities. Cross-staffing on a continuing basis would be particularly beneficial, especially inasmuch as past efforts toward communication and coordination have been sporadic and remote despite good intentions on both sides.

3. We were pleased to note the resourcefulness of the Viking life sciences investigators in dealing with the unexpected findings regarding the nature and reactivity of the Martian soil. Our Viking update briefing also gave us cause to cite the entire Viking team for the excellent manner in which they handled the equipment and operational problems that could easily have spoiled the outstanding success of the Viking program. We wish now to examine future options for follow-up Martian explorations. To that end, we have requested briefings on the results of relevant NASA studies for our next meeting agenda. These are to include considerations of possible returned sample missions and an analysis of trade-off risks vis-a-vis sample studies by man while quarantined in Earth orbit vs. studies on Earth in a contained environment.

4. The LSC task team (Drs. Marr and Spizizen) gave an interim report of their assessment of the Planetary Quarantine program. They had attended at AIBS and SSB review of this program at JPL a month earlier. As a preview of the nature of their impressions, they indicated that a shift now appears to be in order requiring new emphasis to be placed on fundamental studies of planetary ecology and less on planetary quarantine SR&T. The commensurate shifting of resources should be sufficient, at first, to get the new program started. The final task team report should be complete by the next LSC meeting, by which time a general program plan can be worked out. This will require a meeting of the task team at ARC with Dr. Richard Young (SBL) and key ARC scientists.

5. Discussion of the requirement for this meeting brought out the fact that there was considerable doubt that Dr. Young's trip to ARC could be worked into the Life Sciences travel budget. The LSC is most concerned that the Life Sciences travel budget was so severely reduced this year, and doubts seriously that this budget is sufficient to permit the NASA Office of Life Sciences to meet fully its responsibilities.

6. The ARC study on Human Factors and Aviation, presented by its Principal Investigator, Dr. Charles Billings, impressed the Committee very favorably. It is a well-planned, well-implemented, and productive study which is practically oriented to an area of need. We feel that this information will have genuine impact and that continuation of this research should be encouraged.

7. Dr. Ashton Graybiel reviewed for the LSC his pharmacological studies of space motion sickness control. He stressed the importance of this approach because of its promise as an effective countermeasure. The Committee agrees and reemphasizes the seriousness of this problem because of its possible adverse affect on Shuttle crew performance. For this reason, the LSC will assign one or more of its members to participate in the AIBS review of the Space Motion Sickness RTOP, which is scheduled to take place in July, 1977.

8. The Committee reviewed the status of NASA's bone and muscle research. Space flight and bed rest data were compared and progress in countermeasure research (sponsored by NASA-JSC at PHS Hospital, San Francisco, Research Unit) was presented. Because this problem may limit long-term manned space flight, and because satisfactory countermeasures have still not been developed, the LSC feels that this area continues to warrant vigorous study. The need for a capability aboard Shuttle to conduct further metabolic balance studies was stressed.

9. The LSC viewed and was briefed on (1) the Spacelab simulation equipment and test procedures, (2) the Shuttle space suit equipment and rescue ball, (3) biocidal water treatment equipment and research and, (4) current waste sampling technology development. All are essential aspects of Life Sciences preparations for Shuttle operations, and the Committee is grateful for the opportunity to gain this first-hand familiarity with them.

10. Dr. Winter reviewed for us the status of Life Sciences experiments planning for early Shuttle flights. The LSC agrees with the proposed change from flight-by-flight announcements of Opportunity to longer term grouping. Dr. Winter was commended for implementing the present system of scientific peer review for both in-house and out-of-house proposals.

11. The LSC feels very strongly that the keys to a successful Life Sciences program in space are, (1) leadership and direction to the life sciences community, (2) maintenance of a high quality scientific peer review system, (3) adequate support for flight principal investigators and, (4) a strong and adequately funded SR&T program. These measures are essential to the effective recruitment of the life sciences community to support NASA's activities, in particular the role and responsibilities of the NASA Life Sciences in them.

The meeting was stimulating and provocative. You should be aware that the LSC, as now constituted, is intensely interested in the space program and most anxious to be helpful. I feel that several constructive recommendations and observations were made during the meeting. I hope that you will find them to be helpful.

Sincerely yours,

Don Whedon

G. Donald Whedon, M.D.
Chairman
Life Sciences Committee

National Aeronautics and
Space Administration

Washington, D.C.
20546

Office of the Administrator

JUN 14 1977

G. Donald Whedon, M. D.
Chairman
Life Sciences Committee
Public Health Service
National Institutes of Health
Department of Health, Education, and Welfare
Bethesda, MD 20014

Dear Dr. Whedon:

Thank you for your May 2 letter summary of the SPAC Life Sciences Committee Meeting of February 9 and 10, 1977. As always, your observations and recommendations on our behalf are very much appreciated. In reply, I offer our comments in the same order as the items appear in your letter:

1. The endorsements of CORE and ILLSE do much to strengthen our position on these line items and our intention to provide adequate support for them. With respect to your comments on the NASA Five-Year Plan, there is no a priori allocation of space in the plan to any program. I should point out, however, that there is more discussion or rationale devoted to those parts of our programs which have the prospects of becoming significantly increased budget items in the future. We look forward to receiving your specific recommendations on the future directions for the life sciences and their appropriate consideration in the next version of the five-year plan when you have completed your evaluations. In the meantime, as part of our budget process, Dr. Hinners will review with Dr. Winter the adequacy of SR&T funding for the Life Sciences. Along those lines, you might consider a LSC review of the SR&T similar to that conducted by the PSC for the physical sciences (copy enclosed). A good time to do that would be after we have the results of the SSB summer study on "Life Sciences in Space."

2. I am in full agreement with your comments on the desirability of cross-staffing between your committee and the two life sciences committees of the National Academy of Sciences. Drs. Hinners and Rasool will be happy to assist you in that effort.

3. Your laudatory comments on the Viking life sciences investigators and Viking team are sincerely appreciated. I, too, feel that they have carried out their, at times, very difficult tasks extremely well. The question of follow-up Martian exploration is of more than passing interest to our future, and I will look forward to your comments on the subject after you have completed your deliberations.

4. Your suggestions for changes in the Planetary Quarantine and Containment Program will, I am sure, be reflected in your recommendations concerning the five-year plan. The shift of emphasis to studies of fundamental ecology is an interesting concept. The final report of the task team should prove to be a stimulating one.

5. With respect to the Life Sciences travel budget, as you know, overall budget austerity has necessitated marked travel restrictions, not only in NASA but government wide. OSS receives an allocation and must make suballocations to its Divisions. Each of them has been severely constrained to the point of it being a genuine management concern. We are trying to take corrective action in our next budget.

6. Although I am not closely familiar with Dr. Billings' study, I am pleased with the favorable comments of the Life Sciences Committee and with the fact that aviation research is not being overlooked by the NASA Life Sciences. Aviation remains an important segment of NASA's function. The fact that this research is of such high quality in the opinion of the Life Sciences Committee clearly argues strongly in favor ot its continuation.

7. The emphasis of the Life Sciences Committee on the importance of space motion sickness research has not been overlooked by NASA management. The Life Sciences Program has made presentations on this subject to Dr. Fletcher, Dr. Lovelace, myself, and, very recently, Dr. Frosch. I am very pleased that the LSC will assign a representation of its members to participate in the forthcoming AIBS review of the Space Motion Sickness RTOP. Any constructive comments that the LSC might make will be viewed with keen interest.

8. Similarly, in accordance with your recommendations concerning the importance of bone and muscle research, we plan to continue a strong SR&T program in this area. Here, too, Dr. Frosch and other members of NASA top management have been fully briefed by the Life Sciences Program on the problem, its background, its

significance, and the status and future plans of our bone and muscle research. The capability to conduct further balance studies is being planned for inclusion aboard Shuttle.

9. Your report on the LSC briefing and tour of the JSC facilities and preparations for Shuttle and Spacelab is appreciated. I agree that first-hand familiarity with the preparations and equipment involved is essential for the LSC.

10. Your endorsement of our scientific peer review system and with our shift away from flight-by-flight Announcements of Opportunity is welcome. We, too, feel that these are important steps toward realizing the elements of a successful Life Sciences program as you itemize in your Item 11. I might note that these four "keys" are equally applicable to other areas of academic disciplines. We are continuing to do the best we can to support and achieve all four of these elements.

The work of the Life Sciences Committee and its specific recommendations are much appreciated. We look forward to your future comments, particularly those concerning the five-year plan.

Sincerely,

Original signed by
John E. Naugle

John E. Naugle
Associate Administrator

Enclosure

cc: Dr. Noel W. Hinners
David L. Winter, M. D.

SBR/S.P.Vinograd:hpc:6/6/77:53723

A-33004 (6/8/77)
SB77-212 (6/6/77)

bcc: A, ADA, AA, AC, AEM-3, M, O, W, S