

APR 1 1969

SPACE BIOLOGY

GOALS

- To contribute ^{to some fundamental issues in the general} ~~substantially to the development of a fundamental~~ unifying theory of biology, by increasing our understanding of the influence of gravity and ^{periodicity} ~~time~~ on life processes and structures.

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To utilize this biological theory in combination with the unique capabilities of space flight for the advancement of such fields as medicine, public health, and agriculture.

FUTURE POSITION OF VALUE

The significant position of achievement, to which our space biology program will contribute substantially during the next fifteen years is the development of coherent and unifying theory of biology.

The possession of such ^{the} theory will make it possible to increase by several-fold the contribution of biological research to the solution of contemporary social problems.

Although biological knowledge to date has resulted in some of the most useful applications in the whole of human existence, such as a phenomenal increase in longevity and in food production, the knowledge has come from empirical research approaches which are very slow and which are low in predictive value. In other fields of science, such as physics and chemistry, unifying theories have greatly increased the ability to predict events. Therefore, we can logically expect ~~a~~ new theory in biology to result in a much improved ability to produce useful benefits for man. Since many of our major problems are biological in origin (population, food, health, pollution), it follows that many of the solutions will be biological in nature. ^{But more particular than general in the sense of possibility, amenability to general theory.}

- ✓ Two missing links in our development of biological theory are the operation of gravity and time (Earth-induced periodic influences) on living processes.
- ✓ Space flight frees experiments from the regulating influences found in laboratories on Earth, allowing us to accurately study the mechanisms involved. Thus, space flight can provide a unique environment for

I cannot agree that physical studies have such a potentiality compared to chemical ones (e.g. DNA synthesis).

in areas where earth-based studies
have reached an impasse.

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obtaining these missing links in our knowledge, speeding our theory-building and ~~vastly improving our ability to place biological research at the service of pressing human needs.~~ It is in support of this area of research that the Space Biology Program is dedicated.

Exobiology, a related area of research, is expected to provide the third key ingredient from the space program to the building of a general theory of biology. This activity is supported under the Lunar and Planetary Exploration programs. The discovery of life elsewhere in the Universe would allow us to compare its chemistry, structure, and function, with that of life on Earth. It would allow us to derive universal concepts of biology and broaden our understanding of the laws governing the science of life. It would provide us with a much better understanding of the relationship of life and life processes to the laws governing the related sciences of physics and chemistry. Much can be learned from an independent set of molecules and molecular systems, whether they are, or have been, alive. In particular, extraterrestrial genetic codes or morphologies could provide, through comparisons, opportunities to understand the origin and evolution of life on Earth.

BROAD AND SPECIFIC OBJECTIVES

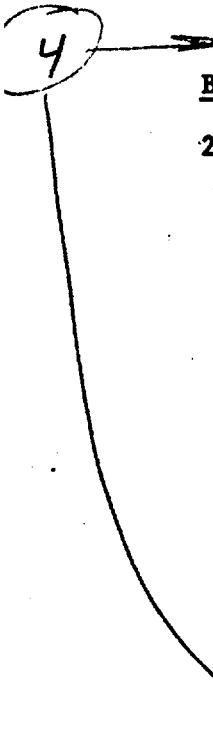
Broad Objective

1. Understand the biological roles of the universal force of gravity on life and the capability of life to adapt to gravitational changes.

Supporting Specific Objectives

- a. To determine the effects of gravity on maintaining normal organization in living cells.
- b. To determine the gravity sensors and the effects of gravity on plant growth, development, physiology, and morphogenesis.
- c. To determine gravity sensing thresholds and gravity selection preference for animals.
- d. To determine the effects of gravity on the development, growth, metabolism, physiology, and behavior of animals.

- e. To determine the effects of weightlessness in producing and correcting abnormalities and to modify or alter mechanisms in organisms.



Broad Objective

- 2. Understand the roles of time expressed in oscillations, rhythms, and life spans on living organisms.

Supporting Specific Objectives

- a. To determine the influence of Earth and lunar environmental periodicities in inducing and maintaining oscillations and biorhythms in living organisms using Earth orbital, lunar, and heliocentric missions.
- b. To determine the role of oscillations and biorhythms in maintaining normal organization and life, and determine whether they are innate or environmentally induced.
- c. To determine the interaction of time phenomena with gravity and organism volume (space).

Broad Objective

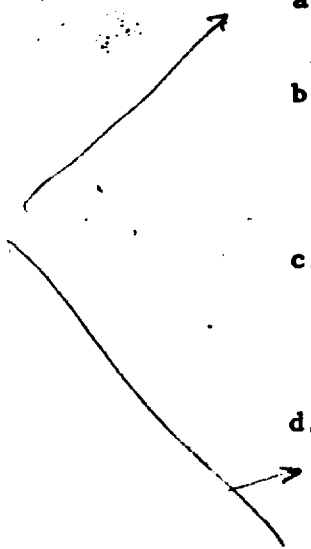
- 3. Determine the potential applications and develop techniques to modify or alter living systems to produce changes or correct abnormalities to advance medicine, public health, agriculture, and space exploration, including modification of planetary atmospheres or surfaces.

Supporting Specific Objectives

- a. To determine the capabilities of life to change and adapt to environmental factors. *them.*
- b. To develop techniques to use time and weightlessness in producing and correcting abnormalities and to modify or alter mechanisms in organisms.
- c. To utilize the experimentation techniques and capabilities developed in the program, for short-leadtime problem-solving in biology and medicine.
- d. To explore the potential use of Earth organisms to modify or alter environments on planetary or lunar surfaces.

[= USDA]

Use no forward thinking for advanced missions!



To understand how extreme environ-
mentality and...

Bring current into top of

PROGRAM THRUST

~~Pursue a program to make a broad survey, and~~ carry out selected intensive studies on the biological effects of space environmental factors on a variety of types of Earth life. Studies will be carried out initially in Earth orbit and then in interplanetary space, and on lunar and planetary surfaces. The program will be balanced, including: ~~studies on Earth;~~ automated recoverable biological satellites; non-recoverable Earth orbital and heliocentric missions; and manned flight experiment programs, both manual and automated.

strong emphasis on preliminary studies as Earth
to validate those which will show ~~apparent~~
economically justifiable
~~cost~~ benefit from spaceborne experiments.

- G 1. To focus attention and support earth-based studies on effects of physical environment on organisms, stimulated by adaptive challenges of space. These parameters include extreme gravitational fields, vibration and noise, radiation, sensory monotony, acute temperature shifts, chronic hypothermia (hibernation)....

To lay the groundwork of experimental studies involving spaceflight (1) to exploit unique capabilities for weightlessness and isolation from terrestrial rhythms, (2) evaluate the use of infra-human organisms in space exploration, e.g., as cabin monitors or as visual sensors, and (3) to assess the long range problems of manned space flight with experiments and assays that could not properly be done with man at this stage.

2. Chronicity is important but we have hardly begun to exploit avenues of earth-based study. Very few problems here are at the point where it is vital to uncouple from earth. (There are a few.)
- 3A. If extraterrestrial forms of life are found, great caution will be needed before introducing them into our ecology. Our quarantine and sterilization programs can also be helpful in learning how to contain potentially dangerous microbes already indigenous on earth.
- 3B. Even if planetary targets are now uninhabited, their chemical study will illuminate the aboriginal status of the earth, whence life originated. We can also begin to think of the re-engineering of the planets to make them available for human occupation and exploration.
4. To study the effects of drugs and other means of ameliorating the harmful effects of disturbances in these parameters.