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Publications of the NASA Controlled Ecological Life Support Systems (CELSS) Program 1989-1992

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Introduction

Food, water, and a breathable atmosphere are three elements fundamental to human survival. Expendable supplies of these elements may be carried onboard spacecraft for brief spaceflights. For permanent missions in low Earth orbit, however, they may be resupplied from Earth, though only at high cost. Missions to more distant places, such as the Moon, Mars and beyond, will require regeneration of food, air, and water. An autonomous bioregenerative life support system that is based upon the integration of biological and physical/chemical processes, and that will produce nutritious and palatable food, potable and hygienic water, and a breathable atmosphere by recycling metabolic and other wastes, is the goal of NASA's Controlled Ecological Life Support Systems (CELSS) Program.

NASA has conducted research in various aspects of closed regenerative life support systems since the 1960s. In 1978, the CELSS Program was initiated to encompass all of NASA's CELSS efforts into one program. CELSS research and technology development is currently being performed in a broad range of research areas, including biomass production and food processing, waste management, and systems management and control.

Biomass Production/Food Processing. This research area includes determining the optimal higher and lower plant species that will provide a large percentage of edible and palatable plant biomass, produce maximum yield and nutrient value, yet use a minimum of space and power. Another aspect of this research includes controlling the system's environment, i.e., examining and regulating such factors as temperature, airflow, humidity, CO_2 level, and illumination, to provide for optimal growth and production. Researchers also explore methods to convert inedible biomass to food.

Waste Management. Research in this subject area examines producing water of adequate quality to meet life support system requirements; maintaining a habitable atmosphere by regulating the concentrations of CO_2 and O_2; processing plant and human metabolic wastes for maximum recycling; and controlling the buildup of trace gas contaminants and other toxicological agents, such as pathogenic bacteria.

Systems Management and Control. This research area examines the integration, monitoring, control, and stability of whole CELSS systems. This includes modelling and design of systems within sealed chambers that provide for atmospheric regeneration, food production and processing, and waste management, thus testing the research results obtained in the other research areas. The purpose is to achieve and maintain stable, reliable operation of a CELSS to provide the crew with a predictable supply of life support consumables.

This bibliography has been compiled to provide the scientific community with a list of publications resulting from CELSS-related research during the period 1989 through mid-1992. It is anticipated that the bibliography will stimulate the exchange of information and ideas between scientists working in different areas of the program and in the field of bioregenerative life support in general.

The arrangement of citations in this bibliography follows the three research divisions outlined above. Publications are listed alphabetically by author within the research area with which they are most closely associated. Authors conducting research under the auspices of the CELSS Program have been identified with an asterisk, and a list of these investigators and their affiliations follows the bibliography.

The assistance of the CELSS Principal Investigators in providing lists of their publications and the technical assistance of Audrey Robin Brown are gratefully acknowledged.

Maurice M. Averner, Ph.D.
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BIOMASS PRODUCTION/ FOOD PROCESSING

Allen, E.R.; Hossner, L.R.; Henninger*, D.L.; Ming*, D.W.; Galindo, C.
Growth & nutrient uptake of wheat in a zeolite: Apatite substrate (Abstract).
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Physiologist 33(1, Suppl.): S100-S101, 1990. (GWU 11708)

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Comparative effects of selenite and selenate on nitrate assimilation in barley seedlings.
Plant, Cell and Environment 13(8): 773-782, 1990. (GWU 15954)

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Role of nitrate and nitrite in the induction of nitrite reductase in leaves of barley seedlings.
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Morphological responses of wheat to blue light.
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Publications of research sponsored by the NASA CELSS (Controlled Ecological Life Support System) Program are listed. The CELSS Program encompasses research and technology with the goal of developing an autonomous bioregenerative life support system, which is based upon the integration of biological and physical/chemical processes, and that will produce nutritious and palatable food, potable and hygienic water, and a breathable atmosphere by recycling metabolic and other wastes. This research and technology development is being performed in the areas of Biomass Production/Food Processing, Waste Management, and Systems Management and Control. The bibliography follows these divisions. Principal investigators whose research tasks resulted in publication are identified by an asterisk. Publications are identified by a record number corresponding with their entry in the Life Sciences Bibliographic Database, maintained at the George Washington University.

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