NASA SBIR 2004 Phase I Solicitation

B2.01 Understanding and Utilizing Gravitational Effects on Plants and Animals

Lead Center: ARC

Participating Center(s): KSC

This subtopic area focuses on technologies that support the NASA Fundamental Biology Program in understanding the effects of gravity on plants and animals. The program supports investigations into the ways in which fundamental biological processes function in space, compared to their function on the ground. Given the Exploration Initiative newly assigned to NASA, this area of work and discovery is important to achieve the goals to explore the planets and allow plant, animal, and human habitation. To conduct these investigations, the program supports both ground and space flight research. The improved understanding of the role of gravity on plants requires innovative support equipment for observing, measuring, and manipulating the responses of plants to environmental variables. Areas of innovative technology development include:

- Measuring the atmospheric and radiation environment and optimizing the lighting and nutrient delivery systems for plants;
- Storage, transportation, maintenance, and in situ analyses of seeds and growing plants;
- Sensors with low power requirements and low mass to monitor the atmosphere and water (nutrient) environment, as well as automated control and data logging systems for the experiment containers to measure performance indicators, such as respiration (whole plant, shoot, root), evapotranspiration, photosynthesis, and other variables in plants;
- Data analysis and control;
- Modular seeding and/or planting units to minimize labor;
- Sensors for atmospheric, liquid, and solid analyses, including atmospheric and liquid contaminants, such as ethylene and other biogenic compounds, as well as analyses of hydroponic and solid media for N, P, K, Cu, Mg, and micronutrients;
- Remote sensors to identify biological stress; and
- Expert control systems for environmental chambers.
The improved understanding of the role of gravity on animals requires innovative instrumentation that tracks and analyzes from organism development, including gametogenesis through fertilization, embryonic development and maturation, through ecological system stability. Technologies may incorporate a variety of processes such as metabolism and metabolic control, through genetic expression and the control of development. Of particular interest are technologies that require minimal power and can noninvasively measure physical, chemical, metabolic, and developmental parameters. Such measurements will ultimately be made in environments at one or more of several gravity ranges, e.g., "microgravity" (.01 to .000001 g), "planetary" gravity (1 g ; 0.38 g or 0.12 g ) or hypergravity (up to 2 g). Refined and stable measurements, however, are as important as gravity independence. Of interest are sustained instrument sensitivity, accuracy and stability, and reductions in the need for frequent measurement standardization. Parameters requiring measurement include pH, temperature, pressure, ionic strength, gas concentration (O₂, CO₂, CO, etc.), and solute concentration (e.g., Na⁺, K⁺, etc.). In the case of new techniques and instruments, a clear path toward miniaturization, reduction in power demands and increased space worthiness should be identified. Technologies applicable to plant, microorganism, and animal study applications include the following areas:

- Live support and energy management;
- Expert data management systems;
- Capabilities for specimen storage, manipulation and dissection;
- Video-image analysis for specimen (cell, animal, plant) health and maintenance;
- Sensors for primary environmental parameters and microbial organisms; and
- Electrophysiology sensors, biotelemetry systems and biological monitors carried on spacecraft.