The commercial development of space offers enabling benefits to space exploration for NASA. In accordance with the Space Act, as amended, to "seek and encourage to the maximum extent possible the fullest commercial use of space," NASA facilitates the use of space and microgravity for the development of commercial products and services. The products may use information from in-space activities to enhance an Earth-based effort, or may require in-space use. This subtopic has three goals. The first goal is the commercial demonstration of pivotal technologies or processes, for example, self-calibrating and self-repairing bio-MEMS devices for such uses as monitoring crew health in space along with dual applications on Earth for monitoring biological-physical interfaces. The second goal is the development of associated infrastructure equipment for commercial experimentation and operations in space, or the transfer of these technologies to industry in space or on Earth. An example of this is the automated processes and hardware (robotics), which will reduce crew exposure and time, and which are a priority. The third goal is the commercial research and technologies pursued and developed in the program often have direct applicability to NASA priority mission areas. This dual-use strategy for research and technology has the potential to greatly expand what the NASA scientific and engineering communities can do in advancing exploration mission requirements. All Agency activity in microgravity, including those in life science and microgravity sciences, which lead to commercial products and services as well as benefits to the mission requirements of exploration objectives, are of interest. Below are some specific areas for which proposals are sought.

### Biotechnology

This category comprises biotechnology, biomedical, and agricultural instrumentation or techniques that exploit space-derived capabilities or data to support the commercial development of space by the agricultural, medical, or pharmaceutical industry.

- **Portable biological sensors:** The need for sensing devices that can detect and identify biological pathogens (airborne or *in vivo*) is desired to support NASA's mission for a permanent presence of man in space.

- **Development of noninvasive health monitoring systems and models:** Application to NASA's crew health program for extended duration missions. For example, (1) novel *in vitro* cell-matrix models for studying the effects of microgravity on human tissue repair and wound healing, (2) novel organotypic skin models that simulate physiological changes found in humans under a microgravity environment, and (3) functional models for delineating the MG-inducible or MG-responsive pathways of human tissue angiogenesis (new...
blood vessel formation).

- Physiological measurement in microgravity of bone growth and the immune system in microgravity.
- Innovative research in plant-derived pharmaceuticals using microgravity.
- Agricultural research, i.e., genetic manipulation of plants using microgravity.
- Instrumentation or technology to explore the use of microgravity in genetic assay, analysis, and manipulation.
- Instrumentation to analyze cell reactor systems and characterize cell structure in microgravity in order to develop enhanced drug therapies that can also be applied to pharmaceutical development and commercialization.
- Innovative techniques for dynamic control and cryogenic preservation of protein crystals.
- Innovations in preparation of protein crystals for x-ray diffraction experiments without the use of frangible materials.
- Innovation of low-technology temperature control chambers requiring little or no power for bringing temperature sensitive experiments up to, or back from, the International Space Station.

**Materials Science**

Areas in which Materials Science innovations are sought include the following:

- Applications using space-grown semiconductor crystals, including epitaxially grown materials for commercial electronic devices. The applications will also attempt to use the knowledge of the space-grown material behavior to enhance ground processing of the materials to achieve equivalent performance of space-grown materials in electronic circuitry.
- Applications using space-grown optical electronic materials such as fluoride glasses and nonlinear optical compounds for commercial optical electronic devices and to achieve equivalent performance of space-grown materials in ground processing.
- Innovations using nonlinear optical material to be processed in space.
- Innovations for new space-processed glasses for optical electronic applications.