Living and functioning efficiently and safely in space and in the hypogravity of the Moon (1/6g) or Mars (3/8g), requires an understanding of the effects of micro- and hypogravity and other space-environment related factors on human physiology responses and adaptations to a unique set of imposed demands. As a result, a variety of countermeasures are needed to mitigate the deleterious changes that occur during space flight and upon subsequent exposure to reduced-gravitational environments. The ability to monitor the effectiveness of countermeasures and alterations in human physiology during space exploration missions, particularly when several countermeasures are used concurrently, is equally important. This subtopic seeks innovative technologies in several very specific key areas. As launch costs relate directly to mass and volume, instruments and sensors must be small and lightweight with an emphasis on multi-functional capabilities. Low power consumption is a major factor, as are design enhancements to improve the operation, design reliability, and maintainability of these instruments in the environment of space and on planetary surfaces. As the efficient use of time is extremely important, innovative instrumentation setup, ease of usage, improved astronaut (patient) comfort, noninvasive sensors, and easy-to-read information displays are also very important considerations. Extended shelf-life and ambient storage conditions of consumables are also key necessities. Ability to operate in 0g, 1/6g, and 3/8g become more important as we march towards human Moon and Mars missions.

**Non-invasive Pharmacotherapy and Monitoring**

Development of innovative technologies resulting in non-invasive methods for diagnosis, treatment, and therapeutic drug monitoring is needed to facilitate effective pharmacotherapy of humans in space. Many questions remain about the effectiveness of pharmaceuticals in micro- and hypogravity environments, which may interfere with their activity by sensitizing or desensitizing the crew member or interfering in other ways with the desired physiological effect. Micro-encapsulation of drugs and development of novel drug delivery systems under micro- and hypogravity conditions. Devices for continual monitoring of physiology during pharmacotherapy would also be advantageous to ensure that on-orbit expression of therapies relates to on-Earth histories.

**Non-invasive Technology to Assess Bone Micro- and Macroarchitecture**

A complete assessment of bone strength will better monitor life-time skeletal integrity and will generate data critical for developing probability fracture risk models in younger-aged crew. Novel technology for non-invasive assessments of “bone quality” indices such as microarchitecture, macroarchitecture and trabecular Bone mineral density (BMD).
Technologies to Detect Biomarkers

Develop technologies to detect products of bone demineralization in urine during Flight and the biomarkers of bone degradation include N-telopeptide (NTX), C-telopeptide (CTX), pyridinoline and deoxypyridinoline collagen cross-links, and calcium ion. Develop technologies to monitor bone specific alkaline phosphatase and osteocalcin in serum samples.

Portable Motion Simulator

Develop a portable research platform to investigate the influence of spatial disorientation on manual control tasks during lunar-type landings. A 6-DOF motion simulator with full visual motion display will be developed to simulate landing tasks with and without visual motion (brownout) conditions. The simulator should be portable, and fit within standard (8 ft) room heights. The power requirements should be limited to 240VAC 30A. The subject restraint should accommodate both standing and seated positions. The control system should allow the user to import motion profiles, and provide the capability to evaluate various pilot-induced filter (PIO) options from a hand-held controller.