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Microgravity Sciences on board of Space stations (6)

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BHARATIYA ANTARIKSHA STATION INDIA'S FUTURE IN MICROGRAVITY RESEARCH AND DEEP SPACE EXPLORATION

Abstract

As India advances its human spaceflight capabilities, the establishment of an indigenous space station Bharatiya Antariksha Station (BAS) will be a transformative milestone. Designed as a modular orbital platform, BAS will support long-duration human missions, foster cutting-edge microgravity research, and serve as a testing ground for deep-space exploration technologies. This initiative will strengthen India's self-reliance in space technology and contribute to global advancements in bioastronautics, in-space manufacturing, autonomous life support, and artificial gravity solutions. A primary focus of BAS will be the development of self-sustaining Environmental Control and Life Support Systems (ECLSS) to enable extended crewed missions. By integrating bioregenerative systems, AI-driven astronaut health monitoring, and in-situ food production, BAS will reduce dependency on Earth resupply, ensuring long-term sustainability. Biosensors, autonomous medical diagnostics, and radiation protection will enhance astronaut safety. BAS will facilitate microgravity research across various disciplines, including pharmaceuticals, biomedicine, materials science, and fluid dynamics. Studies on protein crystallization, space-grown biomaterials, and regenerative medicine will drive medical breakthroughs, while 3D bioprinting of tissues and organs could revolutionize healthcare. Additionally, space-based alloy production and nanomaterial development will unlock next-generation manufacturing capabilities. In-space manufacturing and resource utilization will be integral to BAS. Advanced 3D printing, robotic assembly, and closed-loop recycling systems will allow astronauts to produce essential tools, spare parts, and medical supplies on demand. To ensure crew safety, radiation shielding technologies, such as composite materials, regolith-based structures, and electrostatic plasma barriers, will be developed to counteract cosmic radiation. To mitigate the effects of prolonged weightlessness, BAS will explore artificial gravity solutions, including rotating habitat modules and hybrid centrifuge-based systems, ensuring astronaut health and performance on extended missions. Beyond Low Earth Orbit (LEO), BAS will serve as a staging point for deep-space missions, supporting lunar surface operations, Mars exploration, and asteroid mining initiatives. By fostering international collaborations with space agencies and private enterprises, BAS will position India as a global leader in human spaceflight and interplanetary exploration. By establishing Bharatiya Antariksha Station, India will solidify its position in the new era of space exploration, ensuring technological self-reliance, scientific advancements, and a sustainable pathway for future interplanetary missions. This paper presents a roadmap for BAS's development, research priorities, and its role in shaping India's future in space.