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What if we could prevent bone loss and muscle atrophy in space?

Space Flex

Within Reach

Transitional

Visionary

Personalised bioengineered supplements prevent bone and muscle loss in space and on other planets, reducing limitations on humans' ability to spend extended periods beyond Earth while also offering a new solution for addressing bone and muscle mass decline on Earth.



UNCERTAINTIES

Systems, Technology

MEGATREND (Most significant)

Advanced Health and Nutrition

TRENDS

Future of Space Mobilising Innovation

TECHNOLOGIES

Biotechnology Genomics Nanomedicine

SECTORS IMPACTED

Automotive, Aerospace & Aviation Health & Healthcare Materials & Biotechnology

KEYWORDS

Bone Density Muscle Atrophy Nanotechnology Sarcopenia Space Exploration



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6,000

asteroids

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WHY IT MATTERS TODAY

Space exploration is entering a new era of ambition. Several national space agencies, including National Aeronautics and Space Administration's (NASA) Artemis programme, with private companies, are setting their sights on the Moon, Mars and beyond. In parallel, extraterrestrial resource mining holds opportunities.¹¹⁸³ NASA is currently tracking over 6,000 asteroids.¹¹⁸⁴ The top 10 most cost-effective asteroids alone could generate \$1.5 trillion profit, and a single asteroid, 16 Psyche, may contain \$700 quintillion worth of gold – enough to make every person on Earth a billionaire.¹¹⁸⁵

There are challenges to extended space exploration and residency. For example, microgravity significantly affects both muscle strength and bone density, severely impacting the prospect of long-duration missions to Mars and beyond.¹¹⁸⁶ Astronauts on a six-month International Space Station mission lose up to 20% of their muscle mass.¹¹⁸⁷ Interdisciplinary approaches are needed to address these and other challenges, such as team dynamics, conflict resolution, and ethical considerations in long-duration missions,¹¹⁸⁸ along with environmental conditions and mental health.¹¹⁸⁹

Muscle atrophy also severely impacts ageing adults and hospitalised patients on Earth. Among the elderly, the condition manifests as sarcopenia, which affects up to o13% of adults over 60 and up to 50% over 80,¹¹⁹⁰ increasing the risk of falls and reducing independence. For hospitalised patients, the deterioration is more rapid and severe, with muscle strength in the knee muscles declining up to 12% and thigh muscle strength, measured by the ability to climb stairs, declining by up to 18% in just 10 days of immobilisation.¹¹⁹¹ This accelerated loss not only extends hospital stays but also increases mortality rates and healthcare costs.¹¹⁹²

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The Global 50 (2025)

BENEFITS

RISKS

Longer space missions; better

muscle health longevity on Earth.

Unknown long-term effects; cost of research and development.

health in space settlements;

THE OPPORTUNITY

A bioengineered supplement prevents bone and muscle loss (atrophy) in astronauts during long space missions, extended space travel, and planetary settlement. It also offers another possible solution for musculoskeletal decline on Earth. The supplement combines essential nutrients, anti-inflammatory agents, and metabolic boosters, all delivered through biodegradable nanoparticles designed for precise absorption and effectiveness. The formulation is personalised based on factors such as the individual's starting condition and atrophy risk.

Using nanotechnology and bio-based computing, the supplement targets the bones and muscles most affected by microgravity. The nanoparticles release their compounds gradually, ensuring long-lasting effects while minimising side effects,¹¹⁹³ with release rates adapting to muscle changes over time. Use of the supplement reduces the reliance on intensive resistance training and exercise routines.



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