Fighting Bone Loss with Space Technology

Osteoporosis is a widespread disease that weakens bones and increases the risk of fractures, especially in older adults. Globally, it affects more than one in five women over the age of 50 and a smaller but still significant number of men. In Poland, over two million people are currently living with this condition. Despite its prevalence, osteoporosis remains difficult to study and treat because traditional lab models cannot fully mimic how bones behave in the human body.

Interestingly, researchers have found that astronauts lose bone mass in space at a much faster rate than people on Earth. This is because in microgravity, the bones are not “loaded” the same way as they are under Earth's gravity, which affects how bone cells function. While this may be problematic, it also presents a unique research opportunity. Studying how bones change in space could help us better understand diseases like osteoporosis and lead to new treatments.

By combining modern technologies like 3D tissue engineering and “organ-on-chip” systems with access to real spaceflight conditions, the project aims to discover more about how bones deteriorate—and how we might stop it. The first part of the project uses a polymeric scaffold material seeded with bone-like cells. This structure mimics the bone’s natural environment and will be sent to the International Space Station (ISS) in a miniature bioreactor called GraviTE, designed by students from the winning team of the Direction: Space competition. The cells will be exposed to space conditions and then frozen and returned to Earth for detailed molecular analysis.

At the same time, the second type of model will be developed: a bone-on-chip system. This tiny device simulates bone tissue using a microfluidic chip that pumps nutrients and applies gentle forces to mimic blood flow and mechanical stress. It will be used on Earth in a machine that simulates microgravity. This system allows researchers to run multiple tests quickly and safely.

Together, these two approaches will provide deeper insight into how bones respond to gravity changes and help identify drugs that could protect astronauts and osteoporosis patients alike. The project is not only advancing space medicine but also paving the way for better, more human-like lab models of bone diseases here on Earth.