



Osteoporosis is a major public health threat for more than half of all Americans. An estimated 10 million already have the disease and another 34 million are at high risk of developing porous bones, shortening lives, and increasing health care costs.

Christopher Jacobs is working to unlock a stem cell mystery that could provide significant advances in the treatment for osteoporosis. He has received a \$1 million New York State grant to research stem cell behavior related to the condition.

Osteoporosis occurs when bone marrow stem cells fail to produce bone-forming osteoblasts in sufficient numbers. Very little is known, however, about the cellular mechanism by which bone marrow stem cells sense and respond to changes in their mechanical loading environment.

Jacobs' Cell and Molecular Biomechanics Laboratory will determine whether a novel cellular sensor, the primary cilium, is responsible for the stem cell's ability to sense mechanical loading. His lab was one of the first to show that primary cilia act as mechanical sensors in bone cells. The project will characterize the ability of transplanted stem cells to home in on sites of bone loading and form new bone and then determine whether the stem cells retain this ability if their primary cilia are first disrupted.

"If the hypothesis is proven to be true, it will be a breakthrough in skeletal mechanobiology and suggest approaches for new anti-osteoporosis drugs," Jacobs said. "It will also be a significant advance in relating primary cilia dysfunction to human disease."

Jacobs describes the overall focus of his lab is to understand how cells sense and respond to changes in their mechanical environment.

"Although a wide range of tissues are known to be regulated by physical signals, outside of sensory mechanisms, the cellular apparatus responsible for the initial 'mechanotransduction' event is poorly understood," he said. "Our group is primarily focused on mechanosensitivity of bone cells as it relates to osteoporosis, stress fractures, and disuse bone loss associated with spinal cord injury and space flight."

The group's active projects include Mechanotransduction in Bone via Oscillatory Fluid Flow; Mechanosensitive Primary Cilia in Osteogenic Differentiation of Stem Cells Due to Loading; Primary Cilia as Mechanosensors in Bone; and Primary Cilia Mechanics and Mechanobiology.

Jacobs was an assistant professor in the Department of Orthopaedic Surgery at Pennsylvania State University and an associate professor in the Department of Mechanical Engineering at Stanford University before coming to Columbia.

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Combating Bone Loss

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