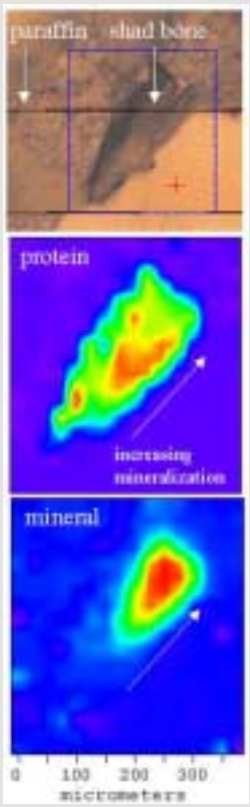
Space Travel



(Top) Picture of cut shad bone under a synchrotron infrared microscope showing the area that was imaged with IR light from the synchrotron (Bottom) Infrared data collected from a herring bone. There is protein (mostly collagen) in the whole bone section, but mineral only at one end.

Fast Facts

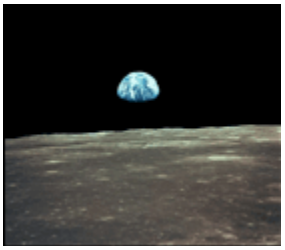
- In 1962, John Glenn became the first American to orbit in space. On October 29th 1998, at the age of 77, he flew into space for his second time. It's fitting that much of that flight was devoted to the study of aging.
- Bones, especially in the legs and feet, begin to lose significant density and strength when they are no longer used to support the body's weight for an extended period, such as during space flight.
- In zero gravity, astronauts also experience bone loss, but it occurs much faster than on Earth -- at a rate of 10% per month.

Introduction

There are many reasons why there is an interest in going into space. Many people want to step foot on Mars. They collect samples, and study the relationship between the material on Mars, and the Earth. Space stations are built with a dream that one-day people will be able to live in outer space.

What are the consequences of going into space?

One of the risks of living in space is bone deterioration. While in space, the amount of bone in an astronaut is reduced because there is a reduction in bone formation. It is suggested that the removal of osteoblastic cells (which make the bone grow) from the bone tissue results in a reduced ability to respond to weightlessness. However, in both cases, it is not known whether these changes in bone chemistry are caused by weightlessness. It is also known that weightlessness induces a reduction in the production of several hormones. One of these hormones is testosterone, which is a factor in bone growth.



What is being done at BNL?

In order to successfully live in space, researchers at BNL are studying how pressure, or "gravity," affects bone growth and mineralization. Bone is made up of collagen, which is a protein, and a calcium phosphate mineral that is similar to hydroxyapatite. When new bone is formed, the collagen is produced first. At this point, the bone is soft and flexible, like your nose and ears. Then the mineral attaches to the collagen and the bone becomes hard. If this process of mineralization does not occur properly, bones can be weak, lacking strength and flexibility. To date, the process of early bone mineralization is poorly understood.

The research is performed on the bones of herring and shad fish. These bones have a unique property: they are completely mineralized on one end and non-mineralized on the other end. Therefore, the process of mineralization can be studied by examining different regions of the fish bone. These bones, and calcium phosphate compounds similar to bone, are studied under different pressures to see how it affects the bone mineralization.

How is synchrotron light used?

The fish bones are embedded in wax, and cut into very thin slices using a microtome, which is like a deli meat slicer. The slices are then observed under a microscope that uses synchrotron infrared light. The synchrotron infrared light allows the scientists to determine the chemical composition of the bone, specifically the mineral in the bone. Where the bone is newly mineralized, pressure is applied using a diamond cell. Then the synchrotron infrared light will be used to see how the pressure affects the mineral in the bone. These results are compared to known calcium phosphate compounds under pressure.

How will this research benefit space travel in the future?

Scientists at BNL hope that understanding how gravity affects the process of bone mineralization will be helpful in treating and/or preventing bone loss in astronauts living in space.

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