Much of bone comprises shock-absorbing 'goo' that stops it shattering

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**A team of chemists from the UK has made a remarkable discovery about the structure of bone and shown that much of the mineral from which it is made comprises a viscous 'goo-like' fluid that is trapped between the crystals that form bone. They say their findings reveal new insights into bone diseases like osteoporosis.**

The goo-like fluid allows movement or slipperiness between the [calcium](http://www.medicalnewstoday.com/articles/248958.php) phosphate nano-crystals so they do not shatter under pressure. This newly discovered property is what gives bone its flexibility, say the researchers who write about their findings in the *Proceedings of the National Academy of Sciences*.

Lead investigator Dr. Melinda Duer of the Department of Chemistry at the University of Cambridge says "it's this layered structure that's been missing from our knowledge, and we can now see that without it you're stuffed."

The study shows that the goo-like viscous fluid is made of the chemical citrate - which is a natural by-product of cell metabolism - mixed with water.

New discovery will shift current thinking about bone diseases

The researchers suggest their discovery may explain how [osteoporosis](http://www.medicalnewstoday.com/articles/155646.php) arises and will shift current thinking about the causes of this and other bone diseases.

If the citrate goo leaks out, it fuses with the calcium phosphate crystals, creating big clumps that stick together, causing bone to lose its flexibility and become more brittle.

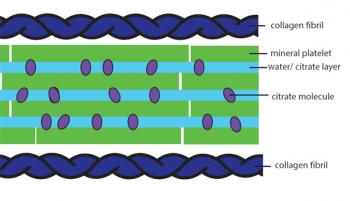
To arrive at their findings the team used nuclear magnetic resonance spectroscopy, X-ray diffraction, and the latest imaging techniques and high-level molecular modeling to reveal the citrate layers in bone.

Dr. Duer explains what they found:

"Bone mineral was thought to be closely related to this substance called hydroxyapatite. But what we've shown is that a large part of bone mineral - possibly as much as half of it in fact - is made up of this goo, where citrate is binding like a gel between mineral crystals."

The researchers found that the layering of citrate fluid and mineral crystals - which is visible only to the fine instruments they used - means the crystals stay in flat, plate-like shapes that can slip and slide around each other.

Without citrate goo, all crystals in bone mineral would fuse together and shatter

  
*The goo-like fluid allows movement between the calcium phosphate nano-crystals so they do not shatter under pressure.  
Image credit: University of Cambridge*

"Without citrate, all crystals in bone mineral would collapse together, become one big crystal and shatter," says Dr. Duer.

**Imagine two panes of glass with water in between, they stick together but can slide with respect to each other. The citrate is what keeps the plates together, without drying out and sticking to each other or flying apart.**

In terms of structure, the citrate molecule looks like a four-armed spider that bonds easily to calcium, the main element of bone mineral. The spidery citrate clings to the mineral crystals and stops the fusing, while at the same time trapping the water that allows the slipperiness that provides bone with its flexibility.

"Without citrate, water would just flow straight through these gaps," Dr. Duer explains.

The study is the first of several on bone chemistry that the team is working on - further findings are expected to be published later this year.

In November 2013, *Medical News Today* learned how a [bio patch regenerated missing or damaged bone](http://www.medicalnewstoday.com/articles/268526.php) when research led by the University of Iowa inserted DNA into nano-sized particles to deliver bone-making genetic instructions directly into cells. The method regrew enough bone to fully cover skull wounds in live rats.

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