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Scientists discover secret plant 'glue' that could hold key to wooden skyscrapers

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Using *nanoscale imaging*, scientists at Cambridge and Warwick universities have discovered the secret behind the toughness of plant cell walls, and say it could pave the way toward the low-energy binding together of timber skyscrapers.

The study, led by a father-and-son team at the universities of Warwick and Cambridge, solves a long-standing mystery of how key sugars in cells bind to form strong, indigestible materials.

They believe the discovery will make it easier to break tough plant material down, but also to replicate the mechanism in order to bind things together in new, low-energy ways.

"We knew the answer must be elegant and simple. And in fact, it was"– Paul Dupree, University of Cambridge

Molecules 10,000 times narrower than the width of a human hair could hold the key to making possible wooden skyscrapers and more energy-efficient paper production, according to research published today (21 December) in the journal *Nature Communications*.

The two most common large molecules – or 'polymers' – found on Earth are cellulose and xylan, both of which are found in the cell walls of materials such as wood and straw. They play a key role in determining the strength of materials and how easily they can be broken down.

Scientists have known that these two polymers must somehow stick together to allow the formation of strong plant walls, but how it occurs has remained a mystery. Xylan is a long, winding polymer with so-called 'decorations' of other sugars and molecules attached, so how could this adhere to the thick, rod-like cellulose molecules?

"We knew the answer must be elegant and simple," explains Professor Paul Dupree from the Department of Biochemistry at the University of Cambridge, who led the research. "And in fact, it was. What we found was that cellulose induces xylan to untwist itself and straighten out, allowing it to attach itself to the cellulose molecule. It then acts as a kind of 'glue' that can protect cellulose or bind the molecules together, making very strong structures."

The Duprees used an imaging technique known as solid state nuclear magnetic resonance (ssNMR), which is based on the same physics as hospital MRI scanners, but can reveal structure at the nanoscale.

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Ray Dupree, Paul's father, supervised the work at the University of Warwick's ssNMR laboratory. "By studying these molecules, which are over 10,000 times narrower than the width of a human hair, we could see for the first time how cellulose and xylan slot together and why this makes for such strong cell walls."

Understanding how cellulose and xylan fit together could have a dramatic effect on industries as diverse as biofuels, paper production and construction, said Paul Dupree.

"One of the biggest barriers to 'digesting' plants – whether that's for use as biofuels or as animal feed, for example – has been breaking down the tough cellular walls," he said. "Take paper production – enormous amounts of energy are required for this process. A better understanding of the relationship between cellulose and xylan could help us vastly reduce the amount of energy required for such processes."

But just as this could improve how easily materials can be broken down, the discovery may also help them create stronger materials, he said. There are already plans to build houses in the UK more sustainably using wood, and Paul Dupree is involved in the Centre for Natural Material Innovation at the University of Cambridge, which is looking at whether buildings as tall as skyscrapers could be built using modified wood.

- *From The University of Cambridge*

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