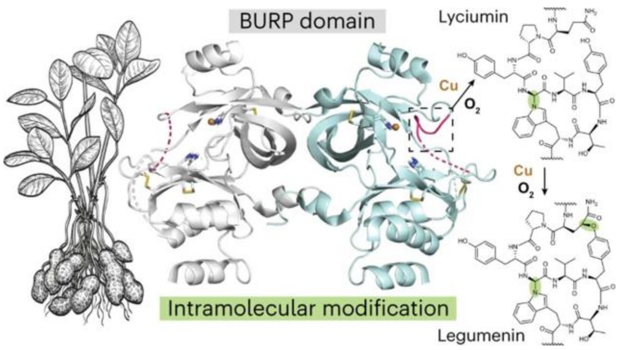
SCIENCE AT THE ADVANCED PHOTON SOURCE

NOVEL PLANT CYCLIC PEPTIDE BIOSYNTHESIS COULD LEAD TO NEW THERAPEUTICS

Scientists have identified a plant protein with an unexpected mechanism for producing a class of molecules that have therapeutic potential in various diseases, including cancer. The team of chemists used the Advanced Photon Source to probe the structure and workings of the protein, which has a unique protein fold. Researchers said that once the chemical process of the protein is better understood with further research, it might be possible to harness it to bioengineer new medicines.

Peptides are molecules that contain two or more amino acids. Mainly due to their size, they have several pharmaceutical advantages over small molecules when used as medical drugs, such as increased stability, more specificity and selectivity, greater potency and fewer side effects. Now a team of medicinal chemists at the University of Michigan and the University of Georgia have discovered a plant protein with a novel protein fold and an unusual way of forming cyclic peptides. The team identified a new protein called AhyBURP, which is found in the roots of the peanut plant.

When the scientists used X-ray crystallography to examine the protein, they discovered that it has a protein fold that has not been seen before. Usually, two proteins work together to take a linear peptide and transform it into a cyclic peptide. But with AhyBURP a single protein performs this process on its own. The protein also uses copper in the chemical process that creates the cyclic protein.. Uniquely, oxygen is required for the peptide cyclization to work, but the protein does not appear to add oxygen to the cyclic peptide structure.



The new protein, named AhyBURP, is found in the roots of the peanut plant and has a previously unseen protein fold.

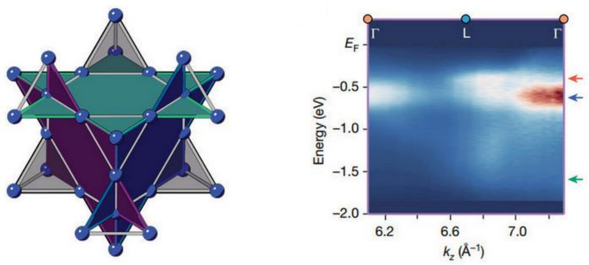
L.S. Mydy, et. al. "An intramolecular macrocyclase in plant ribosomal peptide biosynthesis," *Nat Chem Biol* 2024. https://doi.org/10.1038/s41589-024-01552-1

OBSERVING ELECTRONIC FLAT BANDS IN A 3D PYROCHLORE LATTICE

Quantum materials are increasingly being explored for their exotic properties. One fascinating phenomenon called an electronic flat band can occur in quantum materials with just the right geometric structure. These bands consist of many electrons with nearly the same kinetic energy, which enhances electron-electron interactions that produce unusual and technologically important behavior. Up until now, flat bands were only confirmed in graphene and other 2D structures. The extension of electronic flat bands into three dimensions would significantly aid further investigation of this quantum state, with many potential applications including high-temperature superconductivity and fractionalized topological states.

Scientists accomplished this by synthesizing calcium-nickel ($CaNi_2$) crystals featuring a star-shaped pattern called a pyrochlore lattice. This lattice is related to the 2D hexagonal shape that has previously been shown to produce two-dimensional flat bands. The researchers detected flat bands in a three-dimensional pyrochlore lattice using X-ray techniques performed at the Advanced Photon Source.

The researchers point out that the kagome structure can be realized in many types of pyrochlores besides the two examined here, as well as in non-pyrochlore compounds. This flexibility will allow scientists to synthesize custom crystals to investigate a wide range of quantum phenomena in 3D materials.



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J.P. Wakefield et. al., "Three-dimensional flat bands in pyrochlore metal $CaNi_2$," *Nature* **623** 301-306 (2023) https://doi.org/10.1038/s41586-023-06640-1

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