Researchers describe protein previously unknown in biology

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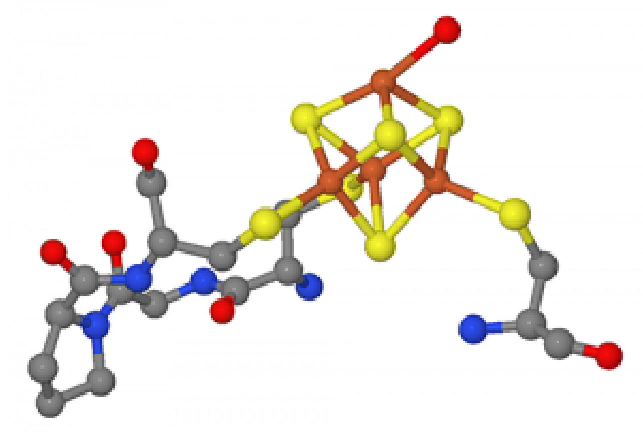

Ball-and-stick model of part of activated pig aconitase centered on (4Fe4S) cluster bound to cysteine-385, -448, -451, after PDB 7ACN. Credit: wikimedia commons

University of Georgia researchers have discovered a new way that iron is stored in microorganisms, a finding that provides new insights into the fundamental nature of how biological systems work. The research was recently published in the journal *Nature Communications*.

Iron, a metal that is required by all living organisms, is usually stored with oxygen inside a cell in a complex within a large protein known as ferritin. Researchers have now discovered a new type of protein, known as IssA, that stores iron with sulfur, instead of oxygen, in the form of an iron-sulrfur polymer known as thioferrate.

"This iron-sulfur polymer has been made previously in a test-tube but this is the first time thioferrate has been identified in a biological system," said Michael W. Adams, lead author and Distinguished Research Professor in the department of biochemistry and molecular biology. "In addition, this single type of protein, IssA, self-assembles into extremely large complexes or nanoparticles that can be more than 20-times the size of ferritin. The IssA nanoparticles are so large that they are visible inside whole cells using a microscope."

Researchers also discovered that this new protein plays a role not only in the storage of iron, but also in the assembly of proteins that contain iron-sulfur clusters.

"This work provides new insights into how microorganisms can store iron and also sulfur, and how single proteins can self-assemble into nanoparticles," said Adams. "It also gives a new perspective on how iron-sulfur clusters are synthesized in biological systems."

"Iron sulfur cluster-containing proteins are ubiquitous in biology where the clusters are used to catalyze chemical reactions or to transport electrons, for example, during respiration," he added. "In doing this research, we were interested in elucidating the function and biosynthesis of iron-sulfur clusters."

In the lab, the team grew microorganisms on a large scale, purified them and then were able to characterize a variety of iron-sulfur proteins and enzymes.

"From our genetic analyses of the organism we knew that IssA was a major protein in the cell, and during our biochemical analyses we noticed IssA due to its extremely large size. Its high abundance and large size made it quite easy to purify," he said. "With the purified protein we could apply various analytical, spectroscopic and microscopic techniques and that led us to conclude that IssA was a nanoparticle and contained thioferrate, a iron-sulfur polymer not previously seen in biology. With the pure IssA protein we could also generate antibodies, and this enabled us to visualize IssA in whole cells of the microorganism as a large complex within the cell."

While research of this nature provides fundamental knowledge about how biological systems work, the research could one day be used to engineer nanoparticles for medical or other applications.

"Nanoparticles are used in many medical and electronic applications, although they are typically made of inorganic components," he said. "Engineering protein nanoparticles might be possible if we could understand the properties of IssA that enable it to assemble into nanoparticle-like structures. It is also possible that nanoparticles built on the IssA protein but containing other inorganic materials could have applications."

More information: Brian J. Vaccaro et al. Biological iron-sulfur storage in a thioferrate-protein nanoparticle, *Nature Communications* (2017). DOI: 10.1038/ncomms16110

Provided by University of Georgia