Building blocks of all life gain new understanding

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New research on an enzyme that is essential for photosynthesis and all life on earth has uncovered a key finding in its structure which reveals how light can interact with matter to make an essential pigment for life.

The work gives a structural understanding of how a light activated enzyme involved in chlorophyll synthesis works. Light activated enzymes are rare in nature, with only three known. This enzyme in particular, called protochlorophyllide oxidoreductase or 'POR', is responsible for making the pigment vital for chlorophyll in plants. Without chlorophyll, there is no photosynthesis and no plant life.

Understanding the structure of the POR enzyme gives a rare glimpse of how a natural light-activated enzyme works. Chemists and bio-scientists alike have been fascinated by light activation of biological catalysis for many years and understanding how light can drive enzyme reactions has been a major challenge. The revealed structure shows how the architecture of the enzyme allows one of the reactants to capture light and channel it to drive a crucial biological reaction involved in chlorophyll synthesis. Understanding these fundamental concepts should have major implications for the design of new light-activated chemical and biochemical catalysts which are increasingly important in the use of enzymes in chemical manufacture.

The research led by The University of Manchester, together with colleagues in China (Chinese Academy of Agricultural Sciences, Shanghai Jiao Tong University, Zhejiang University of Technology and Qi Institute), is published today in the journal *Nature*. Professor Nigel Scrutton said of the new discovery: "These studies reveal how the POR enzyme brings about light-driven reduction of the pigment Pchlide. Our studies provide a structural basis for harnessing light energy to drive catalysis in this important chlorophyll biosynthetic enzyme, which is crucial for light-to-chemical energy conversion and energy flow in the biosphere."

Dr. Derren Heyes ran several of the experiments for the new research, he said: "The crystal structure of this important light-activated enzyme has proven to be elusive for many years. Our current work provides the crucial missing link between protein structure and reaction chemistry and paves the way for detailed computational studies of the reaction in the future."

Demonstrating such a fundamental aspect of biological life for the first time tells us how the process within the cells is carried out in order to allow photosynthesis to occur. The team discovered that light energy activates one of its substrates, protochlorophyllide, a precursor of chlorophyll, within the enzyme to drive 'downstream' bond breaking and making reactions.

This new discovery shows we are still unravelling the core building blocks of life which pre-date humans by billions of years. This major scientific breakthrough provides a unique structural and physical insight into a fundamental reaction in nature. This could open the door to the possibility of bioengineering artificial light-activated enzymes in the future.

More information: Structural basis for enzymatic photocatalysis in chlorophyll biosynthesis , *Nature* (2019). DOI: 10.1038/s41586-019-1685-2 , nature.com/articles/s41586-019-1685-2

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