Abstract
Chloroplast Control Mechanisms by Molecular Electronic Device †
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The aim of this research is to study the light phase of photosynthesis based on X-ray diffraction data from photosystems I and II (PS-I and PS-II), as well as the molecular structures of solar energy conversion and electron flow control systems.

The structural analysis of PS-II showed that the manganese cluster Mn₄O₅Ca(H₂O)₄ is an electron generator, where solar energy breaks the chemical bonds of water, accompanied by H₂O₂ formation. The electrochemical oxidation of H₂O₂ by Mn⁴⁺ ion leads to the formation of oxygen and two protons H₂O₂ → O₂↑ + 2H⁺ + 23.5 kcal, while Mn⁴⁺ is reduced to Mn²⁺. Mn⁴⁺ regeneration occurs by donating two electrons to PS-I to NADPH·H.

The uncontrolled generation of electrons in chloroplasts leads to the appearance of free radicals that destroy cellular structures. In this regard, chloroplasts have protective mechanisms to remove excess electrons. X-ray diffraction studies of PS-I and PS-II showed that the active centers P680 and P700 have formed photoelectrolysis systems in which chlorophyll molecules act as electrodes (cathode and anode). Electronic circuits P680 and P700 close iron–sulfur trigger clusters that control the flow of electrons. Triggers switch electron flows to reduce NADPH·H or send excess electrons to electrolyzers to oxidize water at the anode: 2H₂O → O₂↑ + 4H⁺ + 4e⁻ and reduce protons at the cathode: 2H⁺ + 2e⁻ → H₂.

Conclusions. Based on the results of X-ray diffraction studies of H₂O-plastoquinone oxidoreductase (PS-II), the mechanism of electron generation of Mn₄O₅Ca(H₂O)₄ is considered. Photoelectrolysis systems in the P680 PS-II and P700 PS-I structures have been identified, and the principle of their operation is described. A natural molecular electronic device that controls and monitors the processes occurring in the ETC of the light phase of photosynthesis is considered.

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