Mathematical Modeling and Simulation of Plant Leaf Cell Photosynthesis

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Abstract: Photosynthesis is a very important process in plants which occurs in chloroplasts. Plants use photon energy to oxidize water molecule, release oxygen, and convert carbon dioxide to sugar molecule (sucrose). The process of photosynthesis contains two main parts: light dependent reactions and light independent reactions (called dark reactions).

A mathematical model, which describes the diffusion-transport and related chemical reactions in a multi-component flow in a single C_3 plant leaf cell, has been constructed. A subdomain of a leaf cell is considered containing multiple organelles: vacuole, chloroplast, mitochondria, and peroxisome. A typical distribution of a finite number of these organelles inside a cell is considered. The cell domain is decomposed in 5 subdomains, separated by fixed interfaces.The interacting chemical reactions induced by light, of the Calvin cycle, the starch synthesis, sugar synthesis, respiration and photorespiration are investigated. A system of partial differential equations, which describes the diffusion-transport and also related chemical reactions is formulated and simulated using the software Gascoigne. The resulting flow of substances is analysed.

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