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Defining novel targets in microalgae to improve starch yield and structure in cereals

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Transient or long-term storage of photosynthate in starch granules is the last step of eukaryote photosynthesis. The storage of glucose into structures larger than an individual bacterial cell is a complex mechanism that distinguishes the chloroplast from its ancestor prochloron or cyanobacterial-like cell. Starch biosynthesis has evolved from a pre-existing simpler bacterial glycogen synthesis pathway. However the number of enzymes involved in plant starch synthesis appears considerably higher.

Chlamydomonas reinhardtii is a powerful model system to select for mutants defective in various aspects of granule biogenesis, degradation or overproduction. A description of the 11 loci involved is presented and the involvement of the 3-PGA/Pi ratio in controlling the rates of polysaccharide synthesis is demonstrated genetically. The evidence for the respective functions of the starch synthases in the building of specific sub-structures of the granule is detailed. The selection of starchless *C. reinhardtii* mutants, in which macrogranular starch is replaced with disorganized glycogen-like structures has paved the way for a deeper understanding of plant amylopectin synthesis. A model is thus presented proposing the existence of pre-amylopectin, a branched precursor that is subsequently trimmed into an ordered structure. In addition, two enzymes have unexpected important roles in starch biosynthesis in *Chlamydomonas reinhardtii*. These biochemical steps define novel targets for improving the structure of starch in cereals.