Identification and Characterization of Direct Regulators of Secondary Wall Cellulose Synthases (CESAs)

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Project Goals: The overall goal of this project is to develop a knowledge base for biotechnological improvement of biomass feedstock. As a step toward achieving the goal, we pursue two specific objectives: (1) identification of transcriptional regulators that control the expression of the genes involved in secondary wall biosynthesis (*i.e.*, 'gene discovery') and (2) development of utility promoters that can drive transgene expression in a highly sink tissue-specific manner (i.e., 'biomass engineering').

Cellulose, the world's most abundant biopolymer, is a major feedstock for bioenergy. Therefore, genetic manipulation of cellulose synthesis in specific cells/tissues/organs of economically important crops is one of the top-priorities in current plant biotechnology research. Yet, biotechnological manipulation of cellulose biosynthesis has been one of the most challenging tasks, mainly because of the fact that cellulose biosynthesis is carried out by multi-member cellulose synthase complexes at the plasma membrane. In the secondary walls of *Arabidopsis* plants, three CESAs (CESA4, CESA7 and CESA8) are involved in cellulose biosynthesis. The most prudent approach to increase cellulose biosynthesis will be to simultaneously upregulate the genes encoding for all of the necessary cellulose synthases in the presence of increased substrate level. However, little is known about the transcription regulation of these CESA genes. In fact, no transcription factors that bind to the promoter of CESA gene has been reported yet. We have recently identified a direct regulator of CESAs, named Secondary wall Cellulose synthase Regulator 1 (SCR1), that can simultaneously upregulate the expression of all of the three secondary wall CESAs (US Patent, in filing). Several lines of evidence support our hypothesis that SCR1 may function as one of the direct transcriptional regulators of secondary wall cellulose synthase genes CESA4, CESA7, and CESA8. Building upon this preliminary success, we are developing a novel approach, termed 'targeted regulation of cellulose biosynthesis,' which combines our current understanding of cellulose biosynthesis with the state-of-the-art biotechnology to materialize the concept of '*in planta*' or better yet '*in crop*' manipulation of cellulose biosynthesis.

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