특강4 Molecular Mechanisms to Maintain Photosystem II Activity in Higher Plants

Minkyun Kim

Department of Agricultural Chemistry
Seoul National University

The chloroplast *psbD-psbC* genes encode D2 and CP43, a reaction center protein and chlorophyll-binding antenna protein of photosystem II, respectively. Differential accumulation of light-induced *psbD-psbC* mRNAs in chloroplasts was due to transcription from a blue light-responsive promoter (*psbD* LRP). The light-induced mRNAs help to maintain levels of the D2 polypeptide, which is photodamaged and degraded in illuminated plants. The accumulation of light-induced *psbD-psbC* mRNAs was conserved in various plant species, despite differences in the structure and expression of the *psbD-psbC* operons. In addition, sequences within 130 base pairs (bp) of the *psbD* LRP are highly conserved in higher plants. Therefore, physiological and gene regulatory demands of the chloroplast are likely to act as constraints that preserve the linkage of the *psbD* LRP with *psbD*. The structure of the *psbD* LRP was analyzed using deletion and site-directed mutagenesis, *in vitro* transcription, gel shift assays, and DNAse I footprinting experiments. Deletion analysis showed that a 53-bp DNA region of the *psbD* LRP, from -57 to -5, was sufficient for transcription *in vitro*. Mutation of a putative prokaryotic -10 element located from -7 to -12 inhibited transcription from the *psbD* LRP. In contrast, mutation of a putative prokaryotic -35 element had no influence on transcription. Site-directed mutation of sequences located betwen -35 and -10 had no effect on transcription from the *psbD* LRP. Transcription from the *psbD* LRP required a 22-bp sequence, termed the AAG-box, located between -36 and -57. The AAG-box specifically bound the activating complex, termed AGF. Transcription from the *psbD* LRP is thus similar to type II bacterial promoters that use activating proteins to stimulate transcription. Transcription of the *psbD* LRP was ~6.5-fold greater in plastid extracts from illuminated *versus* dark-grown plants. This suggests that light-induced activation *in vivo* involves factors interacting with the 53-bp *psbD* LRP *in vitro*.