Establishment of C4 Photosynthesis in the Maize *(Zea mays)* Cotyledon Examined by Electron Tomography

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Chloroplasts are the organelles responsible for photosynthesis upon which survival of all life forms depends. The chloroplast belongs to the organelle family termed plastids of which members interconvert according to genetic programs or by environmental cues. Chloroplasts arise from proplastids or etioplasts. Proplastids in the seed that germinated on the ground develop directly into chloroplasts. If germinated underground, seeds will convert proplastids into etioplasts which will transform into chloroplast later induced by light.

Classification of C4 and C3 plant species is based on differences in their mechanisms of photosynthesis. In most C4 grasses, such as maize *(Zea mays),* the photosynthetic apparatus is partitioned over two cell types, the mesophyll cells (MCs) and bundle sheath cells (BSCs) surrounding the vascular bundle. MCs capture carbon dioxide (CO2) from the atmosphere to produce four carbon molecules while BSCs run the Calvin cycle to produce carbohydrate using the four carbon molecules. The differentiation of MCs and BSCs in maize called Kranz anatomy is critical for suppressing oxygenase activity of Rubisco.

Maize is an economically valuable and well-characterized crop plant. Its C4 photosynthesis is an NADP-dependent maleic enzyme (NADP-ME) type in which MCs synthesize maleic acid that is transported into BSCs where it releases CO2 and produces NADPH. Chloroplasts in the two cell types of the maize monocotyledon are structurally and functionally distinct. By contrast, immature chloroplasts at earlier cotyledon germination stage do not exhibit such differentiation. The bifurcated pathway of the chloroplasts development in the maize cotyledon is of interest in the field of plant cell biology as well as crop engineering.

Electron tomography (ET) captures high-resolution images of cells or macromolecular complexes in three-dimension. When combined with high-pressure freezing (HPF) and ET can reveal mechanisms of organelle remodeling such as Golgi differentiation and mitochondrial fusion/fission dynamics. I propose to elucidate the process of dimorphic chloroplast biogenesis in the MCs and BSCs and assembly of thylakoid membrane of maize monocotyledon during germination using the advanced electron microscopy.
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