ASU School of Molecular Sciences
Arizona State University

SMS Fall 2022 Seminar P&T

Friday Aug 26 | 2:30pm | Biodesign Auditorium

Heterogeneity in Photosystem I and its Antenna Systems

Oxygenic photosynthesis powers our biosphere using the suns energy, but we still cannot control the way light is harvested and utilized in this process. Two large membrane complexes or photosystems catalyze light driven charge separation, the primary reaction of photosynthesis, in cellular membranes. Photosystem I provide the energy cells use, while photosystem II uses light to oxidize water. In cells photosystems are often found as photosynthetic units, a photosystem core surrounded by multiple antenna proteins that harvest light collectively. A single photosynthetic unit can maintain near unity quantum efficiency while containing hundreds or thousands of light harvesting chlorophylls.

In response to iron deprivation cyanobacteria induce the IsiA antenna which quickly becomes the most abundant chlorophyll binding protein in the cell. In the photosynthetic membrane, IsiA forms many oligomeric assemblies with and without photosystem I. We used cryo-EM to solve the structure of PSI_3-$IsiA_{18}$, one of the largest photosynthetic units in nature. Surprisingly, large levels of structural heterogeneity are observed at the IsiA PSI interface. We show that some IsiA specific chlorophylls are responsible for preserving the efficiency of energy transfer in PSI_3-$IsiA_{18}$ at these high levels of heterogeneity. We suggest that these features are important to maintain efficient light harvesting in flexible cellular membranes.

The cores of both photosystems are the destination for most of the photons absorbed by photosynthetic organisms. The core antenna of photosystem I contains 90 chlorophylls arranged in a highly conserved structure. The optical properties of each chlorophyll are tuned by the protein environment and neighboring chlorophylls to support the function of photosystem I. Our understanding of the role of individual chlorophylls in the PSI antenna is limited due to technical and theoretical challenges. We used natural variation in PSI genes to generate a series of PSI chimera’s which led to the association of several molecular structures with the lowest energy states in PSI. This collection is being used to explore the functional significance of these low energy, or red, states in light harvesting and photoprotection. Cryo-EM structures of several PSI trimers also showed considerable structural heterogeneity, suggesting that heterogeneity is common in photosynthetic complexes.

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Prof. Yuval Mazor received his Ph.D. and M.Sc. from the department of microbiology and biotechnology in Tel Aviv University doing research on the genetic basis of telomere maintenance and epigenetic gene silencing. He then joined the lab of Professor Nathan Nelson, also in Tel Aviv University, where he studied the structure of large photosynthetic complexes in cyanobacteria and plants.

Mazor is currently assistant professor at Arizona State University's School of Molecular Sciences and The Biodesign Institute.

**ZOOM option available: https://asu.zoom.us/j/87081218152*