nature of periodic photonic nanostructure results in this enhancement, nonethe-
less, it will inevitably accompany with light capture efficiency reduction in the
photon trap spectrum range. Enhancement or reduction of light capture
efficiency depends on the coupling condition between the electric field spatial
variation and the lamellar structures. This work will provide insight about how
photonic band gap wavelength of the lamellae can be regulated and the possi-
Bility in correlation between this regulation and different strategies from nature
for environmental adaptation. Most of the plants with iridescent chloroplasts
dwell in understory environment, low light coherence condition might affect
the predicted efficiency enhancement, and some results will be presented. These
results will offer new perception about the formation of lamellar struc-
ture become a better tactic than accumulate more chlorophyll (or other light
absorbing materials) molecules together for obtaining better light harvesting
efficiency.

2578-Pos Board B594
Identification of Red Pigments in the Photosystem I Complex of Oxyge
Photosynthesis
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Oxygenic photosynthesis powers our biosphere using two large reaction cen-
ters, photosystem I and photosystem II (PSI and PSII). Both photosystems
are composed of hundreds of light harvesting pigments, mainly chlorophylls,
 coordinated by several transmembrane protein subunits. All chlorophylls are
not equivalent due to their interactions with their environment, either amino
acids side chains, lipids, or other chlorophylls. The absorption maxima of
some chlorophylls in the core antenna of PSI is tuned to very low levels, lower
than that of the final photochemical trap in the complex. Because of this low
excitation maximum, these red pigments play a crucial role in the path of exi-
tation energy through the core PSI antenna. The location of these red pigments
within the PSI antenna is unknown. Using chimeric PSI complexes in cyanob-
acteria we identified the first red pigment in the PSI antenna. We show that
a single added red pigment can greatly affect energy migration in the
core of PSI, which contain more than 90 other chlorophylls. We also deter-
mined the structure of chimeric PSI and observe the configuration of the added
red site.

2579-Pos Board B595
A Multiscale Model of Photosynthesis
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Photosynthetic light harvesting, the conversion of photons into chemical
energy, is responsible for all food and atmospheric oxygen on earth.
Understanding the design principles underpinning light harvesting from the
atomic to cellular length scales offers the potential of rationally engineering
the predicted efficiency enhancement, and some results will be presented. These
results will offer new perception about the formation of lamellar struc-
ture become a better tactic than accumulate more chlorophyll (or other light
absorbing materials) molecules together for obtaining better light harvesting
efficiency.

2581-Pos Board B597
Increase in Dynamical Collectivity and Directionality of Orange Carot-
ene Protein in the Photo-Protective State
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Photo-protection is crucial for photosynthesis efficiency. Cyanobacteria have
evolved a unique photo-protection mechanism mediated by Orange Carot-
enoid Protein (OCP). OCP binds a single ketocarotenoid as the chromophore,
esential to its photo-protective function. Under strong green-blue (or white)
illumination or high chaoptote concentration, OCP converts from the orange
state OCP to the activated or photo-protective red state OCP. The OCP facilitates
dissipation of excess energy via direct interaction with allophycocyanin (APC)
cores of the light-harvesting antenna Phyco(lobisome (PB). Pico-
second intramolecular vibrational dynamics are critical to the photo-protective
conformational switching, energy transfer between the APC and OCP, and
energy dissipation. In particular intramolecular vibrations at THz frequencies
can both provide efficient access to intermediate state conformations and
couple to embedded chromophore vibrations for energy dissipation. Here
we characterize global picosecond flexibility using temperature dependent ter-
ahertz spectroscopy on OCP solutions. The THz absorbance decreases and
structural resilience increases in the photoactive state. The dynamical turn
for temperature of picosecond dynamics shifts from 200K in OCP to
250K in OCP, signaling a substantial increase in vibrational collective
and structural stability. To characterize the nature of the intramolecular vibra-
tions in more detail, we employ our recently developed technique
Polarization-Varying Anisotropic Terahertz Microscopy (PV-ATM). The
technique isolates specific vibrational bands associated with long range collect-
ive motions of the protein structure. For the first time we demonstrate intra-
molecular vibrational changes with photoexcitation. In particular we find an
increase in vibrational directionality in the photo-activated OCP in the 60-
70 cm
-1 and 85-100 cm
-1 bands. In addition, the orientation of the vibra-
tional motions switches for the 38-48 cm
-1 band. We suggest that the
increased dynamical collectivity and directionality changes with photo-state
contribute to OCP efficiently binding and interacting with the APC complex
to optimize photo-protective function.

2582-Pos Board B598
Single-Molecule Measurements of Quenching and Photophysical Hetero-
genicity in Phyco(lobi)proteins
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Phycobilisomes, the membrane-associated light-harvesting antenna system of
cyanobacteria, dynamically adjust to changing irradiation by modulating en-
ergy capture and transfer over a few seconds or longer, for example by genetic
regulation, structural reorganization, or non-photochemical quenching by Or-
ange Carotenoid Protein (OCP). Recent observation of excitation-dependent
photodynamics in single intact surface-immobilized phycobilisomes, including
“blinking” to dark or dim states, suggests that the phycobilisome itself