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Chloroplast Structure and Function

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सत्यमेव जयते

Department of Plant Sciences, School of Life Sciences University of Hyderabad, Hyderabad 500 046, INDIA

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Overview

Photosynthesis - the complex biological process of converting light energy to chemical energy - is the energetic basis of life on Earth. The atmospheric oxygen, and thus the ozone shield, are also of photo-synthetic origin. The fossil energy carriers are 'solar-energy deposits' from photosynthesis of past millions of years, and the greenhouse gas CO_2 that is released during their excessive combustion is coun- terbalanced and recycled, to a large extent, by photosynthetic organisms, which thus have very strong impact not only on our everyday life but also on our long-term global environment. Taking into account the growing population of mankind, and the increased demand for food, feedstock, and raw material, as well as for clean, renewable energy, one of the biggest scientific and technological challenges of our society – aiming a sustainable development - is to exploit solar energy in a better and more efficient way. However, crop productivity and bioenergy production, at the present state of development of agriculture and biotechnology, is largely limited by the low efficiency of photosynthesis, especially under biotic and abiotic stress conditions. This is because photosynthesis has not evolved for maximum efficiency. The productivity of crop plants and algae should be improved via bridging the relatively large gap between the yield in nature and the theoretical capacity of photosynthesis; most experts agree that this, redesigning photosynthesis, is a realistic goal that can be reached gradually in the coming decades.

To achieve this goal, and to develop the bio-based economy sector, we need to explore all the basic structures of biological light-energy conversion, along with their astounding variations in nature at different levels of their structural complexity, and their variations under different environmental conditions; we also need to understand the underlying multilevel physical and molecular regulatory mechanisms.

The processes of photosynthesis are conventionally divided into light and dark reactions. The absorption of light and ultrafast (fs-ps) energy migration in the light-harvesting antenna system toward the photochemical reaction centers, driving the primary charge separations, are followed by a series of redox changes and ion movements along the so-called electron transport chain, resulting in evolution of molecular oxygen, the synthesis of the reducing agent NADPH and the formation, on the time-scale of milliseconds, of an electrochemical potential gradient consisting of transmembrane pH and electric potential gradients, which are utilized for the synthesis of the `energy carrier molecule', ATP. In the much slower dark reactions (sec-min), NADPH and ATP are consumed during the `fixation' of CO2, i.e. the synthesis of sugars. These steps and other consecutive metabolic processes in the photosynthetic organisms are coupled to each other and are under the control of complex regulatory mechanisms, with feedback effects on the primary photophysical and photochemical steps. Hence, research of photosynthesis requires a truly multidisciplinary approach and the use of a virtually full arsenal of biophysical, biochemical, molecular biology and plant physiology techniques. 'In return', the acquired knowledge, examples demonstrate, may be used in different areas of research, such as photochemistry and photobiology, bioenergetics, membrane biology, cellular and molecular biology as well as material sciences.

Objectives

The primary objectives of the course are as follows:

i) Explaining the participants the fundamental importance of photosynthesis in the evolution and sustaining life on Earth and showing the global figures in the energy fluxes, the atmospheric processes and other, key biogeochemical cycles.
ii) Providing an overview of the building blocks and basic structures of the hierarchically organized molecular devices of the photosynthetic apparatus and the basic processes of photosynthesis, from photophysical and photochemical events to physiology of plants.
iii) Exposing the common construction principles of photochemical reaction centers and photosynthetic membranes, along with the dazing variations of components in the peripheral units and in the regulatory mechanisms that developed to respond rapidly and slowly changing environmental conditions.
iv) Introducing the participants into the use of some key biophysical and biochemical/ analytical and molecular biology techniques and tools to monitor the operation of photosynthesis, tutorials focusing on basic principles, including hands-on demonstrations.
v) Establishing personal connections and providing the basis for future international collaborations in photosynthesis research.

How to apply:

Interested candidates must login GIAN-MHRD website http://www.gian.iitkgp.ac.in/ to fill application. Please submit your detailed resume. For more details contact : thylakoidhcu@gmail.com or visit : http://www/slsuoh.org/thylakoid

Who can attend

- **University students of Life Science disciplines at advanced levels Faculty membres from all Life Science institutions**
- **Junior and senior scientists of industries**

Teaching Faculty

Prof. Győző Garab : Institute of Plant Biology, Biological Research Centre, Hungarian Academy of Sciences, Szeged, Hungary, area of research is on Chloroplast Structure and Function. Works of Győző Garab, with colleagues in his research group and with collaborating partners, by using a broad arsenal of biophysical, biochemical and molecular biology techniques, revealed physiologically important structure-function relationships in chloroplasts at different levels of structural complexity. Recently, their investigations–using circular dichroism spectroscopy as well as time-resolved fluorescence spectroscopy and the novel 2D and 3D femtosecond techniques have shown that the structure and function of the major plant LHA (LHCII depends on to a significant extent on its oligomerization state and the molecular environment, a remarkable structural flexibility that also appears to operate in vivo. LHCII, their investigations have shown, plays a key role in the macrodomain organization of Photosystem II (PSII) super complexes, and thus the lateral sorting of the protein complexes, which, together with stacking, govern the self-assembly and stabilization of granal thylakoid membranes. Using electron tomography, they established the quasi-helical model of the granum-stroma thylakoid membrane assembly, the most abundant, and possibly the most complex membrane system in the Biosphere. As revealed by small-angle neutron scattering techniques, grana, and multilamellar thylakoid membrane systems in algae and cyanobacteria, exhibit well defined periodic lamellar organizations, robust structures which nevertheless display well discernible ultrastructural reorganizations upon changes in the environmental conditions e.g. characteristic ultrastructural changes related to key photoprotection and chromatic adaptation mechanisms. They also discovered that lipid: LHCII lamellae are capable of undergoing light-induced reversible reorganizations proposed to be driven by the novel biological thermos-optic effect, a photophysical feedback mechanism based on the generation of ultrafast thermal transients in the close vicinity of the dissipation of excess excitation energy.

Prof. Rajagopal Subramanyam: University Hyderabad, made significant contributions to the area of photosynthesis related to the structure, bioenergetics and acclimation of chloroplasts. His group studied in detail the structural and organizational dynamics of photosystems (PS) and their light harvesting complexes (LHC) in *Chlamydomonas reinhardtii* as well as Arabidopsis thaliana under moderate stress. He discovered that under fluctuating light, the LHCB2 subunit undergoes dissociation of the entire LHCII from PSII and eventual migration to PSI which is called state transitions (balancing energy transfer between PSII and PSI). Under temperature stress too induced state transitions constituted an important protective strategy. His group studied the influence of high light and iron deficiency on the organization of photosynthetic apparatus and proposed a structural model of PSI from *C. reinhardtii*. Further, he showed *C.reinhardtii* cells acclimated through non-photochemical quenching dependent involvement of LHC stress related proteins in high light, Fe deficiency and drought stresses. In addition, his lab has used proteomics and metabolomics-based approaches to dissect the abiotic stress responsive signaling events in chloroplasts of higher plants, and algal systems

Guest Speakers

Prof. Nathan Nelson, Tel Aviv University , Israel
Prof. A.S. Raghavendra, University of Hyderabad, India Prof.
Prof. B.C. Tripathy, Jawaharlal Nehru University, New Delhi
Prof. A.R. Reddy, Yogivemana University, Kadapa
Prof. J.S.S. Prakash, University of Hyderabad, India

Registration Fees

Participants from abroad	US $ 500
P.G. Students	Rs. 1500/-
Postdocs/Ph. D scholars	Rs. 2500/-
Faculty/Scientist	Rs. 4500/-
Industry	Rs.10,000/-

For mode of payment please visit: http://www.slsuoh.org/thylakoid. The above fee includes all instructional materials, lunches, computer use for tutorials, 24 hr free internet facility. The participants will be provided with Guest house accommodation on payment basis.

Coordinator

Prof. S. Rajagopal, School of Life Sciences, UoH.

Please send your resume to: thylakoidhcu@gmail.com

on or before August 5th , 2019