In plant photosynthesis, scientists see clues for improving solar energy cells

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Solar cells optimized to suit local light conditions, or made more efficient by using a broader part of the solar spectrum, are among the imaginative applications foreseen from ground-breaking new insights into plant photosynthesis pioneered in Canada.

Indeed new, more fully detailed knowledge of how plants and other living organisms convert sunlight into energy and carbon dioxide into biomass may offer clues to addressing both the global energy crisis and global warming, says Dr. Gregory Scholes, among the world's most renowned scientists in plant photosynthesis.

Dr. Scholes, distinguished professor of Chemistry at the University of Toronto and 2012 recipient of the John C. Polanyi Award from Canada's

Natural Sciences and Engineering Research Council (NSERC), will describe his work in a special public lecture Nov. 26 supported by the Royal Canadian Institute (RCI) for the Advancement of Science, NSERC, and Toronto's Ryerson University.

"This new bio-inspired understanding will help scientists devise artificial light gathering systems that can far exceed existing solar cells in functionality, and so pave the way to new, environmentally-friendly energy technologies," says Dr. Scholes.

"We can imagine, for example, solar cells that optimize themselves to suit the local light conditions or that make better use of the solar spectrum by efficiently capturing and processing light of different colors."

Studies of nature's "photosynthetic machines" have involved such organisms as fronds in kelp forests (which can grow 15 cm - 6 inches - in a single day), algae growing 20 meters - 60 feet - underwater even in winter when over 1 meter of ice covers the water - and bacteria from the South Andros Black Hole, Bahamas, which have evolved to short circuit photosynthetic light harvesting and thereby warm their local environment.

All have helped science identify some fascinating chemical physics and determine that a chain of reactions involved in photosynthesis starts with hundreds of light-absorbing molecules that harvest sunlight and 'concentrate' the fleetingly stored energy at a biological solar cell called a "reaction center."

And that happens with incredible speed. After sunlight is absorbed, the energy is trapped at reaction centers in about one billionth of a second.

New understanding of the photosynthetic process can also help alleviate the biggest looming threat to humanity—climate change—since photosynthesis makes use of the sun's energy to convert the greenhouse gas carbon dioxide (CO_2) into useful biomass.

More than 10 quadrillion photons of light strike a leaf each second. Incredibly, almost every visible photon (those with wavelengths between 400 and 700 nanometers—1 nm equalling 1 billionth of a meter) is captured by pigments and initiates the steps of plant growth.

Says Dr. Scholes: "Photosynthetic solar energy conversion occurs on an immense scale across the Earth, influencing our biosphere from climate to oceanic food webs. Energy from sunlight is absorbed by brightly colored molecules, like chlorophyll, embedded in proteins comprising the photosynthetic unit."

"While photosynthesis does not generate electricity from light, like a solar cell, it produces energy - a "solar fuel" - stored in molecules," he adds. "Solar powered production of complex molecules is foreseen as an important contribution to energy management in the future."

Concludes Dr. Scholes: "Nature has worked out with astonishing efficiency some the riddles of fundamental importance that vex our species today," he adds. "If we are hunting for inspiration, we should keep our eyes open for the unexpected and learn from the natural sciences."

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