

Scientists aim to improve photosynthesis to increase food and fuel production

April 12 2011



Stooks. Credit: me'nthedogs from Flickr

(PhysOrg.com) -- Two new initiatives at the University of Cambridge aim to address the growing demand on the Earth's resources for food and fuel by improving the process of photosynthesis.

As part of a new collaboration, the scientists have been awarded the major component of a \$4M initiative to improve the process of photosynthesis, which allows biological systems to convert sunlight into food and is also the source of fossil fuels.

Four transatlantic research teams – two of which include academics from Cambridge's Department of Plant Sciences – will explore ways to overcome limitations in photosynthesis which could then lead to ways of significantly increasing the yield of important crops for food production or sustainable bioenergy.

Professor Howard Griffiths from the Department of Plant Sciences said: “Plants really matter, and for the next generation, plant and microbial productivity will become the focus of key global issues: the basis for feeding an additional 2-3 billion mouths, to drive forward an economy currently trading on past sunlight, and maintain biodiversity in the face of climate change.”

The funding has been awarded by the UK Biotechnology and Biological Sciences Research Council (BBSRC) and the US National Science Foundation (NSF) in a pioneering undertaking for the best minds from the USA and UK to join forces to explore this important research.

Despite the fact that photosynthesis is the basis of energy capture from the sun in plants, algae and other organisms, it has some fundamental limitations. There are trade-offs in nature which mean that photosynthesis is not as efficient as it could be – for many important crops such as wheat, barley, potatoes and sugar beet, the theoretical maximum is only 5%, depending on how it is measured. There is scope to improve it for processes useful to us, for example increasing the amount of food crop or energy biomass a plant can produce from the same amount of sunlight.

Some of the research will focus on improving a reaction driven by an enzyme called Rubisco, which is a widely recognised bottleneck in the photosynthesis pathway. By attempting to transfer parts from algae and bacteria into plants, the researchers hope to make the environment in the plants’ cells around Rubisco richer in carbon dioxide which will allow photosynthesis to produce sugars more efficiently.

Professor Griffiths added: “The enzymatic powerhouse Rubisco takes carbon dioxide from the atmosphere and uses light energy to produce sugars and other building blocks of life. However, the enzyme is rather flawed and somewhat promiscuous: it engages with oxygen as well as

carbon dioxide, to the detriment of potential plant productivity.

“Some plants have evolved mechanisms, which act like biological turbochargers, to concentrate CO₂ around Rubisco and improve the enzyme’s operating efficiency. These carbon concentrating mechanisms have evolved in certain key crops, such as sugar cane and maize. Other plants, such as aquatic algae, have developed mechanism in parallel which actively concentrate bicarbonate as a source of CO₂ for Rubisco.”

The research projects have been funded by BBSRC and NSF following a multidisciplinary workshop held by the funders in California in September 2010. The workshop, called the Ideas Lab, enabled scientists from different disciplines and institutions in the UK and USA to explore ideas and potential projects before submitting them to BBSRC and NSF.

The Ideas Lab experience was likened by Professor Griffiths to be a combination of Big Brother, The Weakest Link and The Apprentice. Professor Griffiths is the consortium leader for one of the joint proposals funded, which will be exploring the operation of an algal carbon concentrating mechanism, and the possibility for introducing components into higher plant cells.

Dr. Julian Hibberd from the Department of Plant Sciences is part of one of the other initiatives which is seeking to increase the efficiency of light harvesting by broadening the wavelengths of light, as used by bacteria, to power biophysical transport processes in higher plants.

This research will consolidate a major Plant Sciences initiative at Cambridge, which is exploring the means to improve photosynthesis from the perspective of sustainable plant productivity and crop yields for the future. Additional work is also being undertaken by Dr. Hibberd to investigate the potential introduction of C₄ photosynthetic traits into crops such as rice. This programme is part of a broader sweep of

strategic research relevant to sustainable crop development, involving RNAi, pathogen suppression and epidemiological controls to maintain yields in a changing climate.

Provided by University of Cambridge

Citation: Scientists aim to improve photosynthesis to increase food and fuel production (2011, April 12) retrieved 19 May 2024 from <https://phys.org/news/2011-04-scientists-aim-photosynthesis-food-fuel.html>

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