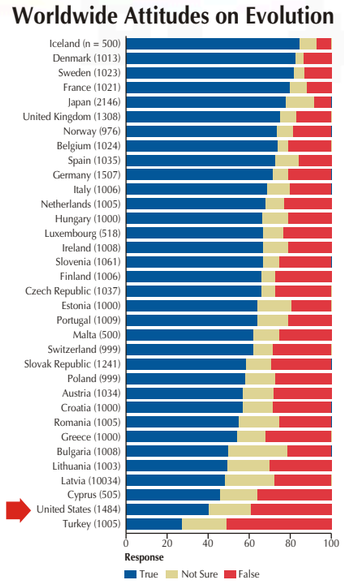
14th International Congress of Photosynthesis
Glasgow 22-27 July 2007

Education Programme, 25 July 2007
Organised by Sarah Blackford, Christine Foyer and Govindjee.
Chair: Don Ort

Sponsored by the Society for Experimental Biology, the American Society of Plant Biologists, *Annals of Botany*, *New Phytologist* and the *Journal of Experimental Botany*, the **Education session** ran for a lively two hours on the Wednesday morning of the Congress. With a turn out of over 150 delegates the Education session proved highly popular with some interesting questions and discussion.

Bob Blankenship (Washington University, St. Louis) was the first speaker and set the scene with his talk on the importance of considering evolution when teaching any biological subject, including photosynthesis: Here is an excerpt from the congress proceedings (Blankenship *et al*, 2007): "The teaching of evolution has historically been and continues to be a very emotionally charged and political topic, especially in the USA, where a third of people responding to a 2005 survey indicated that evolution is 'absolutely false' (Miller *et al*. 2006). Intelligent Design (ID) has been promoted as an alternative to the standard scientific explanation for the diversity of life. ID grew out of the older creationist movement that adopts a literal reading of the Bible, but has been updated to embrace some scientific findings. Creationists have made claims about aspects of the world that make them appear unscientific such as that the Earth is only a few thousand years old and that humans coexisted with dinosaurs. In contrast, ID has the patina of a scientific endeavour, accepting the age of the Earth and even that "microevolution" has taken place. However, ID proposes that certain biological structures or processes are "irreducibly complex" in that they are too complex to have evolved by the natural selection mechanism that underlies the scientific description of evolution.

Photosynthesis is an extremely complex biological process that has been studied extensively by a multitude of scientific disciplines. Its evolutionary origins and trajectory are still not well understood. Many aspects of photosynthesis that have been studied in detail show elegance and symmetry. Photosynthesis is thus a natural candidate to be included in some ID writings as an example of an irreducibly complex system on the one hand, and as part of the master plan on the other. Here we address why photosynthesis should not be considered as an irreducibly complex system or one that requires a master plan. While we certainly do not understand all the details of the extraordinary evolutionary history of the process of photosynthesis, there is nothing that suggests that it is beyond the reach of human understanding".



Miller et al. *Science* (2006) **313**:765-766

Hilary Evans (Liverpool John Moores) took on subject of Bioenergetics asking the question "Have we forgotten how and why to teach it?".

"Bioenergetics makes the world go round! The transduction of energy by biological systems is core to the existence of the Biosphere, and therefore core to all teaching of any Bioscience. The fundamental principles of electron transfer are universal so how is it that DNA is seen as exciting but Bioenergetics is not? The challenge in teaching Bioenergetics is to contextualise the content for the student class, whether medical students, ecologists or biochemists. The popular scientific press carries many stories which can aid in understanding and maintaining interest in Bioenergetics in student groups. Medical students can be taught by first discussing mitochondrial genetic disorders or DNA replication problems in aging, for example. Articles such as one I saw in the *Times* called 'How surge in plankton may be the saviour of mankind' can set the scene and grab the interest of particular cohorts of students which will provide meaning and importance of the need to underpin their field of interest with a knowledge of bioenergetics".

The session was completed by entertaining and colourful recollections from two of the conference's 'statesmen', Govindjee (University of Illinois, Urbana) and David Walker (Sheffield University, UK):

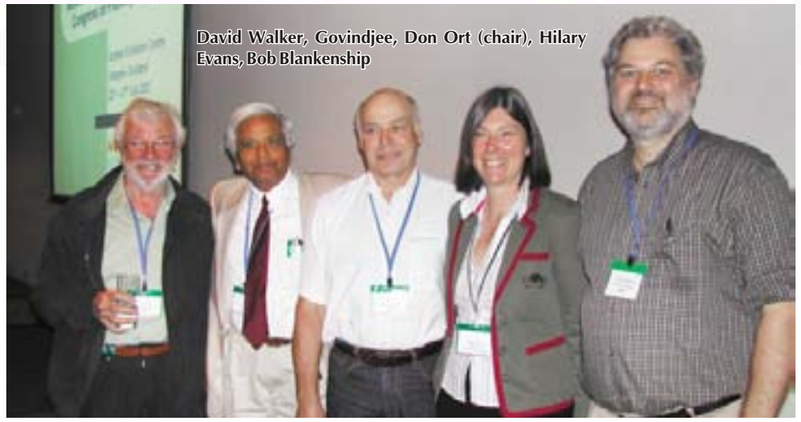
Govindjee: We don't need to be reminded of

the importance of audio-visual tools for communicating scientific principles to the students. Govindjee summarized some of the methods he has used during his 40 years of teaching B.Sc. to Ph.D. level students. He has found that students learn some of the photosynthesis concepts faster and with ease when they are encouraged to imagine themselves (a) as molecules participating in exciton transfer from antenna to reaction center molecules, and in electron/ proton transfers from water to CO_2, or (b) as scientists of the past describing their own results. In his experience, the inclusion of analogies, photographs and personal aspects of the discoverers fascinates students while they absorb the scientific concepts. In addition, Govindjee showed simple and imagination-rich movie clips such as those showing, what he calls the *striptease* of water-oxidizing Photosystem II, exciton transfer, and rotating ATP Synthase; these, he said, imprint the dynamic nature of the processes in the minds of the students.

Among unique points, Govindjee emphasized, were (a) the process of photosynthesis on a time scale, from femtoseconds to a season (we specifically note that both photosystems I and II must begin their reactions almost simultaneously, not as electrons starting in Photosystem II and then going to Photosystem I) ; and (b) the concept of fates of excited states, as well as of downhill and uphill energy processes (see his photograph going up a ladder to throw balls of 3 different colours, representing the fates of the excited molecule as losing heat and as light (fluorescence) and its utilization to produce food. Finally, a great resource for teaching 'photosynthesis' at all levels was demonstrated from his web site http://www.life.uiuc.edu/govindjee/photoweb : L. Orr and Govindjee (2007): Photosynthesis and the Web: 2008.

Govindjee showed us how he teaches the "Z-Scheme" in "Photosynthesis" by having students take part as specific molecules, and balloons of different colour and sizes as electrons and protons. Workshop in Finland; featuring special students: Past President of the ISPR, International Society of Photosynthesis Research, Eva-Mari Aro acted as the reaction center P680 molecule, and Itzhak Ohad, of Israel, as the primary electron acceptor Pheophytin, both of Photosystem II.

David Walker completed the session highlighting his digital book, 'A New Leaf in Time', which is about photosynthesis and how green creatures have shaped the world: "It is aimed at readers of all ages who enjoy simplicity of presentation. As such it can be regarded as an exercise in 'vulgarisation' not, it is to be hoped, in the sense of "rendering something coarse and unrefined", but rather "the act of making something attractive to the general public". It was inspired by the works of Jean-Henri Fabre, famous (or infamous) for his colloquial style of writing.



As Fabre said, some "have reproached me with my style, which has not the solemnity, nay, better, the dryness of the schools. They fear lest a page that is read without fatigue should not always be the expression of the truth. *Were I to take their word for it, we are profound only on condition of being obscure.*"Fabre's books often had characters and a narrative. They were easy to understand, enjoyable to read. I have tried to emulate Fabre's approach believing that, if the language is simple and the subject engaging, there is very little in science that is too complex to be beyond comprehension if presented in this way.

Like Wikipedia, 'A New Leaf in Time' is full of hyperlinks, but it also has a narrative and characters. There is an ageing Professor, who doubles as grandfather to his nine year old grand-daughter Billie. There is her rather sharp friend Emily. Conscious of the lament of C.P Snow (i.e. the failure of the 'literate' to be familiar with the Laws of Thermodynamics) it also reaches out via the Internet to the works, for example, of such diverse authors as Kipling, Omar Khayyam, Oscar Wilde and W. S. Gilbert. Similarly, it celebrates the music, for example, of Enrico Caruso, Dusty Springfield and the Beatles. Its hyperlinks attempt to differentiate, by colour coding, between "general interest", "serious science" and "utterly frivolous"."

'A New Leaf in Time' is available to ISPR members for free download from http://www.dawalker.staff.shef.ac.uk/books/ANLIT1-7.pdf

Education Demonstrations

A programme of Demonstrations served to enhance the Education session with the input of our exhibitors at the congress. Steve Hunt (Qubit) demonstrated 'Novel approaches to practical classes in photosynthesis', whilst Lada Nedbal (Inst. Systems Biology and Ecology, Czech Republic) ran a competition for students, the winner of whom (Marja Hakala, Turku University, Finland) won one of their hand-held Fluorometric devices to teach photosynthesis.

Further demonstrations were made by Ulrich Schreiber with Heinz Walz on 'Energy conversion in PS I and PSII assessed by Imaging-PAM and Dual-PAM-100' and Reto Strasser's (University of Geneva) 'Experimental resolution and theoretical complexity determine the amount of information extractable from the chlorophyll fluorescence transient OJIP: A Demonstration with Instruments' proved highly popular. Meanwhile, David Walker and Govindjee, who had already spoken in the Education session gave a further demonstration of their innovative digital resources.

David Walker pictured with his son Richard Walker and grand-daughter Billie Rebecca Walker on the Hansatech stand.

Qubit

Reto Strasser

Marja Hakala with Martin Trtilek, director of PSI and Esa Tyystjarvi, her supervisor.

Ulrich Schreiber