

# CURRICULUM VITAE

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**Nationality:** British

**Date of Birth:** 3 October 1952

**Current Position:** Professor of Plant Crop Science

**Citation Report:** H-Index = 59. The citation report in February, 2009 obtained from information on the Web of Knowledge for individual year counts for the last 5 years, reported 234 results with an average citation per article of 49.99. Last ranked number 7 in the top 10 list of world-wide most cited authors in Plant and Animal Sciences (<http://www.in-cites.com/top/2007/fourth07-pla.html>).

## **Education and Academic Qualifications:**

**1971-1974** University of Portsmouth, U.K.; B.Sc. 1974 with Class II division I Honours in Biology (CNAAs).

**1974-1977** Department of Biochemistry, Kings College, University of London, U.K.; Ph.D.

**1975-1976** Chelsea College, London, U.K. Part-time post-experience course in immunology. Certificate obtained.

**1998** Fellow of the Institute of Biology.

## **Professional Experience:**

**1977-1979** Postdoctoral research worker at the Department of Plant Sciences, Kings College, University of London, U.K.

**1979-1988** Senior Research Associate (AFRC) and independent research worker at the Research Institute for Photosynthesis, University of Sheffield, U.K.

**1988** Professeur invité at the Département de Structure et Métabolisme des Plantes, Université de Paris-Sud, 91405 Orsay, France.

**1988-1994** Directeur de Recherche, Laboratoire du Métabolisme et de la Nutrition des Plantes, INRA, Versailles, France.

**1994-1998** Head of the Environmental Biology Department, Institute of Grassland and Environmental Research, Aberystwyth, Ceredigion, U.K.

**1998-2001** Head of the Biochemistry and Physiology Department, Institute of Arable Crops Research, Rothamsted, Harpenden, Hertfordshire, U.K.

- 2001-2006** Band 3 Individual Merit Promotion Scientist, Crop Productivity and Improvement Division, Rothamsted Research, Harpenden, Hertfordshire, U.K.
- 2005** Professeur invité at the Departement de Structure et Métabolisme des Plantes, Université de Paris-Sud, 91405 Orsay, France.
- 2006-2009** Professor of Molecular Agriculture, School of Agriculture, Food and Rural Development, Agriculture Building, The University of Newcastle upon Tyne, Newcastle upon Tyne, NE1 7RU. UK.

### **Other Responsibilities: 2009**

- Visiting Professor at the University of Essex.
- Trustee, Annals of Botany Company.
- Member of the International Fellowship Panel and assessor for the Newton International Fellowships (Royal Society, U.K)
- Consultant for Pepsico.
- Chair of the Fellowship and Membership Committees of the Institute of Biology, U.K.
- Trustee, Member of Council, the Professional Affairs Board, the Finance Committee of the Institute of Biology, U.K.
- Associate Editor for Plant, Cell and Environment, Journal of Experimental Botany, Physiologia Plantarum and Functional Plant Biology.
- Chair of the grants & awards committee for the Federation of European Plant Biologists (FESPB).
- Member of the Scientific Advisory Board of the Universitaet Tuebingen (ZMBP – Verwaltung) Germany.
- Member of the visiting Review Committee on Plant Sciences, The Hebrew University of Jerusalem.
- Member of the the Scientific Advisory Board (SAB) of the Finnish Centre of Excellence (CoE) in Integrative Photosynthesis and Bioactive Compound Research at Systems Biology Level (2008-2013)
- Member of the the Evaluation Team for the Strategic Plans of the CSIC centers (Spain).
- Reader for the L'Oréal UK and Ireland Fellowships For Women In Science 2009

**Exterior Research Funding (from 1990):**

- 1991-1995** Eureka/Eurosilva No 18. Project co-ordinator: The biochemical, physiological and molecular basis of glutathione metabolism in poplar.  
130.000 FF per annum. Plus 1- year post-doc position
- 1993-1996** Biotechnology. B102 CT93-0400. Associated contractor: Molecular strategies to modify nitrogen-carbon partitioning in crop plants.  
168.000 ECU.
- 1993-1998** AIR 1-CT92-0205. Associated contractor: Engineering stress tolerance in maize (ESTIM).  
200.000 ECU.
- 1996-1999** Biotechnology. BIO4 CT96-0311. Contractor: Control of source-sink relations by carbohydrate regulation of gene expression.  
115,959 ECU.
- 1997-1999** FAIR CT 96-5055 RTD.  
91,424 ECU.
- 1998-2002** Unilever.  
£133,280.
- 2000** ISIS Travel Award for collaboration with University of Pisa.  
£965.
- 2000** Alliance: Rosine De Paepe (France) Redox regulation and signalling through respiration.  
£4,000.
- 2000-2004** RTN1-1999-00174. Contractor: Senescence and oxidative stress in plant systems.  
284,000 Euro.
- 2001** Alliance: Rosine De Paepe (France) Redox regulation and signalling through respiration.  
£4,000.
- 2001-2003** QLK5-2000-52102. Detoxification of reactive oxygen species: Molecular strategies.  
113, 972 Euros.
- 2001-2005** RT-2001-01461. Co-ordinator: Developing wheat with enhanced nitrogen use efficiency towards a sustainable system of production.
- 2003** ISIS Travel Award for collaboration for European Collaboration.  
£2,000.
- 2003-2004** ISIS Joint Project Award for collaboration with Rosine De Paepe, University of Orsay.  
£4,500.

- 2003-2004** Royal Society Joint Project Award for collaboration with Rosine De Paepe, University of Orsay. £6,000.
- 2004** Royal Society Fellowship.£1,600
- 2005-2010** Royal Society /NRF award.  
£250,000.
- 2005-2008** BBSRC grant BB/C51508X/1: £157,211
- 2005** Royal Society of New Zealand Fellowship. £2,000  
EMBO Small Grants Scheme for Initiatives in Science & Society £1,500
- 2006-2007** Royal Society 1 year Postdoctoral Fellowship (Christina Mathabe) £19,500
- 2007** Sir Frederick McMasters Fellowship (CSIRO, Australia) £18,000
- 2007-2010** British Council's Development Partnerships in Higher Education (DelPHE) Programme. £50,000
- 2008** University Research Office Professorship Fund on behalf of Professor Graham Noctor from the Institut de Biotechnologie des Plantes, Université de Paris XI, 91405 Orsay cedex, France (£4,500)
- 2008** Royal Society Ghana/Tanzania - UK science networking scheme (£9,727)
- 2008** Company Contract: R & D, Plant Physiology Division, BIOIBERICA, S.A. (Spain) (£40,000)
- 2008-2009** Fundación Séneca Postdoctoral fellowship (Regional Gouvernement of Murcia) for Pedro Diaz Vivancos.
- 2008-2010** EU: Initial Training (ITN): PITN-GA-2008-215174: Chloroplast Signals
- 2008-2010** FP7- PIRSES-GA-2008-230830 LEGIM
- 2009-2011** SCRI Joint PhD studentship £36,197

## **Teaching Experience:**

I am the Professor of Molecular Agriculture at Newcastle but I do not teach any courses at present. I also hold an honorary Professorship at the University of the West of England, U.K. I have given lectures, tutorials and practical classes for students of plant physiology, stress metabolism and general biochemistry. I have also taught advanced courses in metabolism and stress physiology.

I have successfully undertaken the direction of a large number of PhD students (17 to date). The PhD thesis work of all these students has been published in high citation index Journals. Many of these students have gone on to have successful careers in research or in science related posts. I have two new PhD students (Tonja Wolff and Pavel Kerchev) starting in my lab in September, 2008.

I examine a relatively large number of PhD theses. For example, to date I have examined 9 PhD theses from Universities in the UK and abroad between January, 2008 and January 2009.

I have published a book on photosynthesis for students (Foyer, CH 1984, "Photosynthesis", Bittar EE series ed., Cell Biology: A series of monographs, John Wiley and Sons, New York, 219 pp). I have also co-edited four books. These are (1) "Causes of photooxidative stress in plants and amelioration of defense systems", published in 1994, CRC Press, 416 pp. (2) "A Molecular Approach to Primary Metabolism in Plants" published by Taylor and Francis in 1998, London, U.K., 347 pp and (3). "Photosynthetic nitrogen assimilation and associated carbon and respiratory metabolism" for the Advances in Photosynthesis and Respiration series, published by Kluwer Academic Press in 2002, 284 pp. (4). "Redox Metabolism and Longevity Relationships in Animals and Plants", for the SEB Experimental Biology series, Volume 62, published by Taylor and Francis in 2009, 281 pp. I am currently co-editing a volume s titled: "Nitrogen Metabolism plants in the Post-Genomic Era", for publication in 2010.

I was the external assessor for the University of Nottingham, U.K., MSc. Courses in Plant Genetic Manipulation and Plant Biotechnology, from 2003-2006, and I was an invited Professor at the Université Paris XI, France in 2005.

**Plenary lectures, Research Talks/Seminars, Institute Evaluations, PhD examinations Conferences, etc: 2005**

- February** Panel Member: Research Assessment Exercise, IBP, Universite de Paris Sud, Orsay, France.
- March** Invited speaker, Plant Frontier Meeting: Phenotype Plasticity and Changing Environment, Sheffield, U.K.
- April** Seminar Department of Botany, Stockholm University, Sweden  
PhD thesis examination: Christine Chang, Stockholm University, Sweden  
Plenary Lecture, Fourth International Symposium of the Collaborative Research Programme (SFB) 446, Mechanisms of Cell Behaviour, Tubingen, Germany.
- May** PhD thesis examination: Paul William Thomas, Sheffield University, U.K.  
PhD thesis examination: Stephen Dibley, Newcastle University, NSW, Australia.
- June:** PhD thesis examination: Thomas Lemaitre, Universite de Paris Sud-XI, France.  
Royal Society of New Zealand Fellowship.  
Seminar, National Centre for Advanced Bio-Protection Technologies, Lincoln University, New Zealand  
Seminar, Institute of Molecular BioSciences, Te Kura Putaiao Koiora-a-Ngota, Massey University, Palmeston North, New Zealand
- July:** Session Chair: Gordon Research Conference Session on “Redox, Environmental Control and State Transitions, Bryant University, Maryland, U.S.A.  
Annual SEB meeting, Barcelona, Spain (2 offered session talks by lab members)  
Invited speaker: 17<sup>th</sup> International Botanical Congress Symposium on “Antioxidants, Gene regulation, and Environmental Stress symposium”, Vienna, Austria.
- August:** PhD thesis examination: Stephen Dibley, University of New castle, Australia  
Masters of Science examination: Ms Nailah Conrad, University of Cape Town, South Africa.
- September** Seminar, University of Dundee  
Plenary lecturer at the 2nd Congress of the Polish Society for Experimental Plant Biology, Poznan, Poland.
- October** Panel Member: Research Assessment Exercise, VIB, Ghent, Belgium.
- November** Invited speaker at the China-UK (DFID) Symposium on Appropriate Science and Technology for Rural Sustainable Development-The Challenge and Opportunities, Yang Ling, China  
PhD thesis examination: Mathilde Clement, University of Sophia-Antipolis, France.
- December** Organiser, Session Chair and Invited speaker at the SFRR Plant Oxygen

Group Meeting on "Oxygen metabolism, ROs and redox signalling in Plants, Bristol, UK.

**Plenary lectures, Research Talks/Seminars, Institute Evaluations, PhD examinations Conferences, etc: 2006**

- January** Invited Speaker, ASE Annual conference, University of Reading UK.  
Seminar, University of the Witwatersrand, South Africa  
Seminar, FABI, University of Pretoria, South Africa  
PhD thesis examination: Rajesh Mehrotra, Banaras Hindu University, India
- February** PhD thesis examination: Ms Kershini Govender University of Cape Town, South Africa
- April** Keystone Symposium on Plant Responses to Abiotic Stress, Copper Mountain, Colorado, USA.  
Society for Experimental Biology Annual meeting, Canterbury.  
PhD thesis examination Getu Beyene, University of Pretoria, South Africa.
- May** Seminar in the CEBAS-CSIC, Plant Physiology Department, Murcia, Campus de Espinardo, Spain  
PhD thesis examination Guillaume Vidal, Universite de Paris Sud, Orsay, France.
- June** Seminar in the Science and Conservation Seminar Series, Kew Millennium Seed Bank Wakehurst Place, UK  
Plenary Speaker: PhD conference of the Scandinavian Plant Physiology Society, Lappland
- July** Society for Experimental Biology Cell Cycle Meeting, University of Southampton, UK  
Speaker and Session Chair at the XV Cogress of the Federation of European Societies of Plant Biology (FESPB), Lyons France
- August** Invited Speaker- Ameican Society of Plant Biologists meeting Boston, USA  
Invited Speaker-13<sup>th</sup> Biennial Cogress of the Society for Free Radical Research-International, Davos, Switzerland.  
Invited Speaker-1First International Congress of Respiratory Biology (ICRB) Bonn/Bad Honnef, Germany.
- October** Invited Speaker-African Academies meeting, Royal Society, UK  
PhD thesis examination, Marta Da Silva Sbino Lopes, Departamento de Biologia Vegetal University of Barcelona, Spain.
- November** PhD thesis examination, Ulrika Petersson, Stockholm University, Sweden.  
PhD thesis examination, Hasimah Alimon, Sheffield University, UK.
- December** Current Challenges in Plant Science' one day Ph.D. students seminar, Helsinki University

**Plenary lectures, Research Talks/Seminars, Institute Evaluations, PhD**

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**examinations Conferences, etc: 2007**

- January** Seminar, CSIR, Petoria  
Royal Society Workshop, Dar es Salaam, Tanzania: 22-23 January 2007  
Invited speaker, ICNF & AABNF, Cape Town, South Africa,
- March** Seminar, Division Agricultural and Environmental Science, University of Nottingham, UK.
- April** Society for Experimental Biology session for the annual meeting in Glasgow  
31<sup>st</sup> March – 4<sup>th</sup> April 2007  
Invited speaker for “Redox Signals in Plants’ session.  
Invited speaker for “Nutritional Genomics’ session.  
Co-organiser, Invited speaker and Chair for “Antioxidants and Ageing”,  
session  
Sir Frederick McMasters Fellowship, CSIRO, Canberra, Australia,
- May** Seminars:  
School of Plant Biology, Faculty of Natural and Agricultural Sciences, The University of Western, Perth.  
Australian Centre for Plant Functional Genomics and the University of Adelaide.  
Department of Genetics, The University of Melbourne.  
Research School of Biological Sciences, Australian National University, Canberra  
Division of Plant Industry, CSIRO, Canberra
- June** Invited Speaker "Redox Signal Integration: from stimulus to networks and genes", Center for Interdisciplinary Research (ZiF), Bielefeld University.
- July** PhD thesis Olivier Van Aken, VIB Department of Plant Systems Biology, Ghent University, Belgium.  
Seminar VIB Department of Plant Systems Biology, Ghent University, Belgium.  
Organiser and Session Chair of the 14<sup>th</sup> International Photosynthesis Congress, Glasgow, UK.
- August** Invited lecture: Phd Summer School on "Environmental signalling, Arabidopsis as a model", Utrecht, The Netherlands.  
Plenary lecture: The 3<sup>rd</sup> Conference of the Polish Society of Experimental Plant Biology, Warsaw, Poland.  
Habilitation, Yves Gibon, University of Rennes, France.
- September** Keynote Lecture: ROS in Plants “Reactive oxygen and Nitrogen Species in Plants”, Ghent, Belgium.  
Keynote Lecture: Meeting of the Spanish Society for Plant Physiology, Madrid Spain.
- October** Keynote Lecture: Annual Meeting of the Society for Free Radical Research-Europe, Vilamoura, Portugal.  
Seminar, Botanisches Institut der CAU Kiel Biologie der Pflanzenzelle, University of Kiel, Germany.

- November** PhD thesis: Christophe Valtaud, Univeristy of Poitiers, France.  
Seminar, University of Durham
- December** PhD thesis: Renee Lee Bee Yong, Wolfson College, Univeristy of Oxford, UK

**Plenary lectures, Research Talks/Seminars, Institute Evaluations, PhD examinations Conferences, etc: 2008**

- January** Plenary lecture, The Jubilee Seminar of The Finnish Academy of Science and Letters, Helsinki, Finland  
PhD thesis: Maria Kaliff, Department of Plant Biology and Forest Genetics, Uppsala University, Sweden
- February** PhD thesis: Inmaculada Castro Marin, Max Planck Institute of Molecular Plant Physiology, Golm, Germany  
PhD thesis: Karen Smeets, University of Hasselt, Belgium
- May** PhD thesis: Mariana Jovanovic, Universite Paris 11, Orsay, France  
Evaluation of Plant Sciences at the Hebrew University of Jerusalem
- June** Evaluation of the Center of Excellence "Integrative Photosynthesis and Bioactive Compound Research", Turku, Finland.  
Evaluation of applications in Environmental sciences for the Research Council for Biosciences and Environment (RCBE) of the Academy of Finland, Helsinki, Finland  
Plenary lecture: 50th annual meeting of the Canadian Society of Plant Physiologists, Ottawa, Canada.
- July** PhD thesis: Ning Li, Nottingham University, UK
- August** Invited lecture at the symposium on "Glutathione and related thiols in microorganisms and plants" Nancy, France.
- September** Seminar, Scottish Crop Research Institute, UK
- October** PhD thesis: Gilles Innocenti, University of Nice-Sofia Antipolois, France  
Seminar: Department of Plant Sciences, University of Leeds, UK
- November** PhD thesis: Sofia Soares, University of Lisbon, Portugal  
PhD thesis: Hossein Fallahi, Australian National University, Canberra, Australia
- December** PhD thesis: Guillaume Queval University of Paris, France

**Plenary lectures, Research Talks/Seminars, Institute Evaluations, PhD examinations Conferences, etc: 2009**

- January** Panel Chair in the Evaluation Process of the Strategic Plans from CSIC centers, Seville, Spain.

- February** Invited lecture at the fourth European Workshop on Plant Senescence, Arvidsjar, Lapland, Sweden.
- May** Invited Speaker, International Conference for Plant Mitochondrial Biology, Lake Tahoe, USA.  
Chair and Speaker, Biotechnology Industry Organization (BIO) 2009 Convention, Atlanta, USA.  
Seminar, Department of Plant Sciences, University of California at Davis, USA.
- June** PhD thesis: Donna Maree Dond, Australian National University, Canberra, Australia  
PhD thesis: Vanessa Jane Melino, The University of Adelaide, Australia.  
Chair and Invited Speaker, International Congress on Photobiology (ICP 2009), Düsseldorf, Germany
- July** Plenary Speaker Gatsby, Plants Summer School, UK  
The First Strategic Summit of Plant Science Societies  
Invited Speaker, American Society of Plant Biologists and Phycological Society of America, Honolulu, Hawaii

**List of Publications:**

1. Halliwell, B & Foyer, CH (1976). Ascorbic acid, metal ions and the superoxide radical. *Biochem. J.* **155**: 697-700.
2. Foyer, CH & Halliwell, B (1976). The presence of glutathione and glutathione reductase in chloroplasts: a proposed role in ascorbic acid metabolism. *Planta.* **133**: 21-25.
3. Foyer, CH & Halliwell, B (1977). Purification and properties of dehydroascorbate reductase from Spinach leaves. *Phytochemistry.* **16**: 1347-1350.
4. Halliwell, B & Foyer, CH (1978). Properties and physiological function of a glutathione reductase purified from Spinach leaves by affinity chromatography. *Planta.* **139**: 9-17.
5. Jackson, C, Dench, J, Moore, AL, Halliwell, B, Foyer, CH & Hall, DO (1978). Subcellular localisation and identification of superoxide dismutase in the leaves of higher plants. *Eur. J. Biochem.* **91**: 339-344.
6. Foyer, CH & Hall, DO (1979). A rapid procedure for the preparation of light harvesting chlorophyll *a/b* protein complex; an assessment of its manganese content. *FEBS Letts.* **101**: 324-328.
7. Foyer, CH & Hall, DO (1980). Oxygen metabolism in the active chloroplast. *Trends in Biochem. Sci.* **4**: 188-191.
8. Foyer, CH & Hall, DO (1980). Superoxide dismutase activity in the functioning chloroplast. *In Clinical and Biomedical Aspects of Superoxide and Superoxide Dismutase, Developments in Biochemistry IIa*, J.V. Bannister, H.A.O. Hill, eds, Elsevier/North Holland. 380-389.
9. Halliwell, B, Foyer, CH & Charles, SA (1981). The fate of hydrogen peroxide in illuminated chloroplasts. *In Photosynthesis II - Electron Transport and Photophosphorylation*, G. Akoyunoglou, ed., Balaban International Science Services, Philadelphia. 279-284.
10. McNeil, PH, Foyer, CH, Walker, DA, Bird, IF, Cornelius, MJ & Keys, AJ (1981). Similarity of RuBPCarboxylases of isogenic diploid and tetraploid ryegrass (*Lolium perenne* L) cultivars. *Plant Physiol.* **67**: 530-534.
11. Foyer, CH, Harbron, S & Walker, DA (1981). Regulation of sucrose phosphate synthetase and sucrose biosynthesis in spinach leaves. *In Photosynthesis IV - Regulation of carbon metabolism*, G. Akoyunoglou, ed., Balaban International Science Services, Philadelphia. 357-364.
12. Harbron, S, Foyer, CH & Walker, DA (1981). The purification and properties of sucrose-phosphate synthetase from Spinach leaves. The involvement of this enzyme and fructose bisphosphatase in the regulation of sucrose biosynthesis. *Arch. Biochem. Biophys.* **212**: 237-246.

13. Birkenhead, K, Walker, D & Latzko, E (1982). The intracellular distribution of adenylate kinase in the leaves of spinach, wheat and barley. *Planta*. **156**: 171-175.
14. Foyer, CH, Walker, DA & Latzko, E (1982). The regulation of cytoplasmic fructose 1,6-bisphosphate in relation to the control flow to sucrose in leaves. *Z. Pflanzenphysiol.* **107**: 457-465.
15. Foyer, CH, Walker, D, Spencer, C & Mann, B (1982). Observations on the phosphate status and intracellular pH of intact cells, protoplasts and chloroplasts from photosynthetic tissue using phosphorus-31 nuclear magnetic resonance. *Biochem. J.* **202**: 429-434.
16. Foyer, CH, Rowell, J & Walker, D (1983). The effect of sucrose on the rate of *de novo* sucrose biosynthesis in leaf protoplasts from spinach, wheat and barley. *Arch. Biochem. Biophys.* **220**: 232-238.
17. Horton, P & Foyer, CH (1983). Relationships between protein phosphorylation and electron transport in the reconstituted chloroplast system. *Biochem. J.* **210**: 517-521.
18. Fernyhough, P, Foyer, CH & Horton, P (1983). The influence of metabolic state on the level of phosphorylation of the light harvesting chlorophyll-protein complex in chloroplasts isolated from maize mesophyll. *Biochim. Biophys. Acta.* **725**: 155-161.
19. Foyer, CH, Rowell, J & Walker, DA (1983). Measurement of the ascorbate content of spinach leaf protoplasts and chloroplasts during illumination. *Planta*. **157**: 239-244.
20. Anderson, JW, Foyer, CH & Walker, DA (1983). Light-dependent reduction of dehydroascorbate and uptake of exogenous ascorbate by spinach chloroplasts. *Planta*. **158**: 442-450.
21. Anderson, JW, Foyer, CH & Walker, DA (1983). Light-dependent reduction of hydrogen peroxide by intact spinach chloroplasts. *Biochim. Biophys. Acta.* **724**: 69-74.
22. Foyer, CH, Anderson, J & Walker, DA (1984). Light-dependent reduction of hydrogen peroxide *via* the ascorbate-glutathione cycle in intact spinach chloroplasts. *In Advances in Photosynthesis Research III. 7.*, C. Sybesma, ed., Martinus Nijhoff/Dr W. Junk, The Hague, The Netherlands. 689-692.
23. Fernyhough, P, Horton, P & Foyer, CH (1984). Regulation of light harvesting chlorophyll a/b binding protein (LHCP) phosphorylation in intact maize mesophyll chloroplasts. *In Advances in Photosynthesis Research III. 4.*, C. Sybesma, ed, Martinus Nijhoff/Dr W. Junk, The Hague, The Netherlands. 299-302.
24. Black, M, Horton, P & Foyer, CH (1984). Effects of phosphorylation on the properties of thylakoid membranes. *In Advances in Photosynthesis Research III. 4.*, C. Sybesma, ed, Martinus Nijhoff/Dr W. Junk, The Hague, The Netherlands. 315-318.
25. Foyer, CH (1984). Phosphorylation of a stromal enzyme protein in maize (*Zea mays*) mesophyll chloroplasts. *Biochem. J.* **222**: 247-253.

26. Fernyhough, P, Foyer, CH & Horton, P (1984). Stimulation of protein kinase activity in maize mesophyll chloroplasts by decrease in the transthylakoid pH gradient. *FEBS Letts.* **176**: 133-138.
27. Woodrow, IE, Ellis, JR, Jellings, A & Foyer, CH (1984). Compartmentation and fluxes of inorganic phosphate in photosynthetic cells. *Planta.* **161**: 525-530.
28. Black, MT, Foyer, CH & Horton, P (1984). An investigation into the ATP requirement for phosphorylation of thylakoid proteins and for the ATP-induced decrease in the yield of chlorophyll fluorescence in chloroplasts at different stages of development. *Biochem. Biophys. Acta.* **767**: 557-562.
29. Foyer, CH (1984). Photosynthesis, E.E. Bittar series, ed., *Cell Biology: A series of monographs*, John Wiley and Sons, New York, 219 pp.
30. Furbank, RT, Stitt, M & Foyer, CH (1985). Intercellular compartmentation of sucrose synthesis in leaves of *Zea mays*. *Planta.* **163**: 172-178.
31. Leegood, RC, Walker, DA & Foyer, CH (1985). Regulation of the Benson-Calvin cycle. *In Photosynthetic mechanisms and the environment*, J. Barber, N.R. Baker, eds, vol. 6, Elsevier Biomedical Press, Amsterdam. 189-258.
32. Foyer, CH (1985). Stromal protein phosphorylation in spinach chloroplasts. *Biochem. J.* **222**: 97-103.
33. Stitt, M, Wirtz, W, Gerhardt, R, Heldt, HW, Spencer, C, Walker, D & Foyer, CH (1985). A comparative study of metabolite levels in plant leaf material in the dark. *Planta.* **166**: 354-364.
34. Dietz, KJ & Foyer, CH (1986). The relationship between phosphate status and photosynthesis in leaves. Reversibility of the effects of phosphate deficiency on photosynthesis. *Planta.* **167**: 376-381.
35. Foyer, CH & Spencer, C (1986). The relationship between phosphate status and photosynthesis in leaves. Effects on intracellular Pi, photosynthesis and assimilate partitioning. *Planta.* **167**: 369-375.
36. Furbank, RT & Foyer, CH (1986). Oscillations in Calvin cycle metabolite concentrations in spinach leaf discs generated by the transition from air to 5% CO<sub>2</sub>. *Arch. Biochem. Biophys.* **246**: 240-244.
37. Foyer, CH (1986). The regulation of carbon assimilation in photosynthesis. *Chemistry in Britain.* **22**: 723-726.
38. Furbank, RT, Foyer, CH & Walker, DA (1986). Inhibition of photophosphorylation by ribulose-1,5-bisphosphate carboxylase. *Biochim. Biophys. Acta.* **852**: 46-54.
39. Foyer, CH (1986). Discovery of the most abundant inhibitor in the world. *Nature.* **324**: 211.
40. Foyer, CH, Furbank, RT & Walker, DA (1987). Interactions of ribulose-1,5-bisphosphate carboxylase with thylakoid and stromal reactions. *In Progress in*

- Photosynthesis Research, J. Biggins, ed, Vol. 3, Martinus Nijhoff Publishers, Dordrecht, Boston, Lancaster. 309-312.
41. Foyer, CH, Furbank, RT & Walker, DA (1987). Interactions between ribulose-1,5-bisphosphate carboxylase and stromal metabolites. I. Modulation by Calvin cycle intermediates. *Biochim. Biophys. Acta.* **894**: 157-164.
  42. Furbank, RT, Foyer, CH & Walker, DA (1987). Interactions between ribulose-1,5-bisphosphate carboxylase and stromal metabolites. II. Corroboration of the role of this enzyme as a metabolite buffer. *Biochim. Biophys. Acta.* **894**: 165-173.
  43. Foyer, CH (1987). Evidence for different kinases in thylakoid protein phosphorylation. *Biochem J.* **248**: 103-108.
  44. Furbank, RT, Foyer, CH & Walker, DA (1987). Regulation of photosynthesis in isolated spinach chloroplasts during orthophosphate limitation. *Biochim. Biophys. Acta.* **894**: 552-561.
  45. Foyer, CH (1987). The basis for source-sink interaction in leaves. *Plant Physiol. Biochem.* **25**: 649-657.
  46. Furbank, RT & Foyer, CH (1988). C<sub>4</sub> plants as model experimental systems for the study of photosynthesis. *New Phytol.* **109**: 265-277.
  47. Parry, M, Keys, A, Foyer, CH, Furbank, RT & Walker, DA (1988). The mechanism of regulation of ribulose-1,5-bisphosphate carboxylase activity by the activase system in lysed spinach chloroplasts. *Plant Physiol.* **87**: 558-561.
  48. Foyer, CH (1988). Feedback inhibition of photosynthesis by modulation of source-sink interactions in leaves. *Plant Physiol. Biochem.* **26**: 483-492.
  49. Foyer, CH, Furbank, RT & Walker, DA (1989). Co-regulation of electron transport and Benson-Calvin cycle activity in isolated spinach chloroplasts. Studies on glycerate 3-phosphate reduction. *Arch. Biochem. Biophys.* **268**: 687-697.
  50. Foyer, CH, Dujardyn, M & Lemoine, Y (1989). Responses of photosynthesis and the xanthophyll and ascorbate-glutathione cycles to changes in irradiance, photoinhibition and recovery. *Plant Physiol. Biochem.* **27**: 751-760.
  51. Foyer, CH, Dujardyn, M & Lemoine, Y (1989). Turnover of the xanthophyll cycle during photoinhibition and recovery. *In Current Research in Photosynthesis*, vol. II 6, M. Baltscheffsky, ed., Kluwer Academic Publishers, The Netherlands. 491-494.
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## **Research Plan 2009-2012**

### **Redox metabolism as a central integrator of plant growth and defence responses**

My lab is interested in the regulation of cellular redox homeostasis in plants and the associated mechanisms that co-ordinate to plant growth and defence. We study how the electron transport processes in the chloroplasts and mitochondria contribute to cellular redox homeostasis and signalling. We are particularly interested in how these redox processes influence plant growth and regulate enzymes such as poly(ADP-ribose) polymerase in the nucleus. We analyse the respective roles of the major plant antioxidants ascorbate and glutathione, and also pyridine nucleotides, in cellular redox homeostasis and signalling. We are very interested in how the distribution of these redox metabolites between the chloroplasts, mitochondria and nucleus is controlled. For example, we are studying the processes associated with glutathione recruitment into the nucleus during the plant cell cycle. Much of this work is undertaken on model plant species such as *Arabidopsis* and tobacco, but we also apply these studies to important crop plants such as maize and soybean. We have several collaborative projects with laboratories in Africa. A major aim of this work is to gain a better understanding of the factors that limit legume nodule sustainability particularly in stressful environmental conditions. For example, we study the effects of environmental stress on nodule development and the breakdown of symbiosis in different African soybean genotypes, with the aim of identifying the genes and processes that confer enhanced stress tolerance. We are particularly interested in the roles of redox processes and cysteine proteases and cysteine protease inhibitors. Finally, we also study the effects of CO<sub>2</sub> enrichment on the capacity of maize plants to withstand temperature and drought stress.

#### **1. Environmental controls of redox-signalling in plant development and development**

Plant growth is controlled by a network of phytohormone and nutritional/metabolic/environmental signalling pathways. Mechanisms of perception and adaptation to changing growth conditions such as light or stress will be investigated in *Arabidopsis thaliana*. Several approaches will be used to uncover mechanisms connecting growth and cellular redox homeostasis to the activities of chloroplast and mitochondrial electron transport chains, and elucidate the mechanism that adapt primary metabolism and growth to environmental changes. First, the impact of redox factors i.e. reactive oxygen species (ROS) ascorbate, glutathione and thioredoxins on the cell cycle and extension growth will be studied in *Arabidopsis* cells in culture and in various mutants deficient in either low molecular weight antioxidants or antioxidant enzymes such as catalase. We will determine how the distribution of cellular glutathione between the organelles, nucleus and cytosol varies throughout the cell cycle. The growth of the shoots and roots will be studied as a function of redox state manipulated by chemical ROS generators, high light stress or nitrate deficiency. The effects of light quantity and quality will be analysed with the specific aim of determining the relationship between photoperiod, cellular redox state and growth. Mutants with controlled perturbation of thiol status and photoperiod signalling will be used for this purpose. Secondly, inhibitors and modulators of electron transport chains will be used to search for specific signals (i.e. redox or calcium) arising from chloroplasts or mitochondria, which link organellar electron transport process to the activities of cytosolic kinases and other enzymes such as poly(ADP-ribose) polymerase (PARP). Redox processes that modulate endogenous chloroplast/ mitochondrial kinases and phosphatases will be compared to identify common signal transduction pathways and also to explore the role of energy exchange between organelles on redox regulation and signal transduction. Thirdly, we will

identify specific markers in the leaf and root proteome that accompany redox-regulated growth limitations and monitor metabolic changes in mutants by targeted profiling of specific metabolite classes (i.e. sugars, amino acids, thiols, soluble redox couples) by HPLC or enzyme assays in the laboratory. The relationships between cellular redox state, growth and defence processes (particularly the induction of senescence and programmed cell death) will also be analysed in an array of Arabidopsis mutants such as *lsd 1*, *fmo1-2* and *eds 1-2* that show altered pathogen responses.

## **2. Integration of metabolic and environmental signals in the control of plant growth**

We will test the hypothesis that N and redox status can influence plant growth, root/shoot partitioning and stress tolerance through modification of GA biosynthesis and inactivation. We will identify possible primary gene targets within the GA pathway for these factors. Experiments will be performed with Arabidopsis, in order to utilise the genetic, mutant and gene reporter resources available for this species. We will determine the effects of low N availability and altered redox status on GA composition, expression levels of GA-biosynthetic and signal transduction genes and the abundance of DELLA proteins. Gene reporter lines will be used to investigate changes in the spatial distribution of GA-biosynthetic/signalling gene expression in response to low N. The response of GA-biosynthetic/signalling mutants to N-depletion and altered redox status will be compared with that of the wild-type. Transcription factors, whose expression is sensitive to both N availability and GA treatment, will be investigated as potential mediators of the cross-talk between N and GA signalling. The performance of plants over-expressing or lacking expression of these genes will be determined in terms of growth in high and low N, response to GA, effects on GA biosynthesis/signalling and their response to abiotic stresses: drought, salt and temperature. We have shown previously that the mitochondrial Complex I-deficient mutant of *N. sylvestris* has enhanced stress tolerance. We will determine whether Complex I mutants of Arabidopsis behave similarly and whether this is related to a low GA/high DELLA status, known to be associated with high stress tolerance.

## **3. Effects of climate change on maize with specific emphasis on atmospheric CO<sub>2</sub> enrichment and drought (a collaborative project with partners in South Africa and France)**

We chose to study the effects of CO<sub>2</sub> enrichment and drought in maize because it is a major C<sub>4</sub> food and forage crop that has been forecast to become even more important in the future. Moreover, CO<sub>2</sub> enrichment does not significantly alter the rates of photosynthesis and yet substantial acclimatory changes in leaf structure such as epidermal/stomatal patterning are observed. We are currently analysing the effects of growth with CO<sub>2</sub> enrichment on the drought responses of maize. We are currently undertaking comparisons of maize leaf transcriptome, proteome and metabolome in order to understand the mechanisms involved in CO<sub>2</sub>-signalling, particularly those involving cellular redox status and protein turnover, together with an appraisal of their effects on the responses to drought. Our first leaf transcriptome analyses have identified two novel two serine protease inhibitors, whose expression is regulated by the redox and carbohydrate status of the leaves. We will also use sense and anti-sense expression of the serine protease inhibitors in transformed Arabidopsis plants to study functions in the control of plant growth and development.

## **4. Legume Improvement (a collaborative project with partners in South Africa and Belgium)**

Legume nodule development and sustainability is a key determinant of the predictability of legume crop yields and income to the farmer and it also has a major impact on the quality of the crop and hence the reliability of grain legumes for food and agro-industries. This project is focussed on nodule development from the point where the bacteria are taken up by the plant cells, develop into bacteroids within symbiosomes and start to fix atmospheric nitrogen to the point where symbiosis ends and the nodules lose the ability to fix atmospheric nitrogen. Although the initial steps of nodule development, mediated by the bacterial Nod factors have been intensively studied, relatively few traits that have the potential to contribute or enhance nitrogen fixation in agricultural practices have been characterised in terms of molecular and protein biology. This project will address this issue directly and contribute to current knowledge and concepts of nodule development and sustainability. Current research in my lab focuses on the mechanisms that cause the breakdown of symbiosis particularly during chilling and drought stress. In this work we use two South Africa soybean genotypes that differ in chilling sensitivity (PAN809, which is denoted as chilling-sensitive and Highveld Top, which is a more chilling-resistant genotype). The research program consists of two major interacting approaches. These are (i) gene discovery and (2) characterization of the function and regulation of the nodule cysteine protease (CP)/cysteine protease inhibitor (CPI) system. The first approach will involve a combined microarray and proteome analysis to identify components involved in natural and stress-induced senescence. The second approach, which is targeted to the CP/CPI system, involves determination of the protease and protease inhibitor profiles during nodule development and natural senescence as well as during premature stress-induced senescence (drought; chilling) in controlled environment experiments. We will also use sense and anti-sense expression of the new cysteine protease identified in the soybean micro-array experiments to test for function, firstly in *Arabidopsis* and then also in *Medicago truncatula* and soybean, in collaboration with our partners in South Africa.