Final Technical Report

Plant Training Grant: DE-FG02-94ER20162

Period of Award: 9/15/94 through 9/14/01

The aim of this training grant was to educate students of Plant Science in the disciplines of Biochemistry and Chemistry, in additional to the more traditional courses in Plant Biology. Annual retreats were held which involved a day-long meeting and included lectures from Penn faculty as well as famous national and international scientists. The latter included:

Daniel Klessig, University of Rutgers
Pal Maliga, University of Rutgers
Clarence Ryan, Washington State University
Bill Cramer, Purdue University
Eran Pichersky, University of Michigan
Shinya Yoshikawa, Himeji Institute of Technology, Japan

Programs for two of these retreats are attached.

In addition to lecture courses, students performed research within the Departments of Biology, Chemistry, and Biochemistry and Biophysics. Publications resulting from this research include the following:

Caruthers, J.M., Kang, I., Rynkiewicz, M.J., Cane, D.E., Christianson, D.W. "Crystal Structure Determination of Aristolochene Synthase from the Blue Chees Mold, Penicillium roqueforti", J. Biol. Chem. 2000, 275, 25533-25539.

Drozdowicz, Y.M., Striepen, B., Roos, D.S., Rea, P.A. (2001) Molecular isolation, functional characterization and immunolocalization of vacuolar-type H+-pyrophosphatase from the parasitic protist *Toxoplasma gondii*. *Proc. Natl. Acad. Sci. USA*, in preparation.

Jiang, L., Phillips, T.E., Hamm, C.A., Drozdowicz, Y.M., Rea, P.A., Maeshima, M., Rogers, S.W., Rogers, J.C. (2001) The protein storage vacuole: a unique compound organelle. *J. Cell Sci.*, 155: 991-1002.

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Sánchez-Fernández, R., Davies, T.G.E., Coleman, J.O.D., Rea, P.A. (2001) Do plants have more genes than humans? Yes, when it comes to ABC proteins. *Trends Plant Sci.,* 6: 347-348.

Sánchez-Fernández, R., Davies, T.G.E., Coleman, J.O.D., Rea, P.A. (2001) The *Arabidopsis thaliana* ABC protein superfamily: a complete inventory. *J. Biol. Chem.,* 276: 30231-30244.

Drozdowicz, Y.M., Rea, P.A. (2001) Vacuolar H+-pyrophosphatases: from the evolutionary backwaters into the mainstream. *Trends Plant Sci.,* 6: 206-211.

McIntosh, M.T., Drozdowicz, Y.M., Laroiya, K., Rea, P.A., Vaidya, A.B. (2001) Two classes of plant-like vacuolar H+-pyrophosphatases in malaria parasites. *Mol. Biochem. Parasitol.* 114: 183-195.

Liu, G., Sánchez-Fernández, R., Rea, P.A. (2001) Enhanced multispecificity of *Arabidopsis* vacuolar multidrug resistance-associated protein-type ATP-binding cassette transporter, AtMRP2. *J. Biol. Chem.*, 276: 8648-8656.

Martinoia, E., Klein, M., Geisler, M., Sánchez-Fernández, R., Rea, P.A. (2000) Vacuolar transport of secondary metabolites and xenobiotics. In: *Vacuolar Compartments, Annual Plant Reviews*, Robinson, D.G, Rogers, J.C., Eds, 5: 221-253.

Drozdowicz, Y.M., Kissinger, J.C., Rea, P.A. (2000) AVP2, a sequence-divergent, monovalent cation-insensitive H+-translocating inorganic pyrophosphatase from *Arabidopsis thaliana. Plant Physiol.,* 123: 353-362.

Drozdowicz, Y.M., Lu, Y.-P., Patel, V., Fitz-Gibbon, S., Miller, J., Rea, P.A. (1999) PVP, a thermostable vacuolar-type pyrophosphate-dependent pump from the archaeon *Pyrobaculum aerophilum*: implications for the origins of pyrophosphate-energized pumps. *FEBS Lett.,* 460: 505-512.

Rea, P.A., Li, Z.-S., Lu, Y.-P., Drozdowicz, Y.M., Martinoia, E. (1998) From vacuolar GS-X pumps to multispecific ABC transporters. *Annu. Rev. Plant Physiol. Plant Mol. Biol.,* 49: 727-760.

Lu, Y.-P., Li, Z.-S., Drozdowicz, Y.M., Hörtensteiner, S., Martinoia, E., Rea, P.A. (1998) AtMRP2, an *Arabidopsis* ATP-binding cassette

transporter able to transport glutathione *S*-conjugates and chlorophyll catabolites: functional comparisons with AtMRP1. *Plant Cell*, 10: 1-18.

Retreat

Plant Science Institute

University of Pennsylvania

Friday June 7, 1996

SugarLoaf Conference Center
9230 Germantown Avenue
(215 242 9100)

8.30-9.00 Continental Breakfast

9.00-9.10 **Tony Cashmore**, Department of Biology (Opening remarks)

9.10-10.00 **Amita Sehgal**, Department of Neuroscience (Role of the *timeless* gene in the circadian clock)

10.00-10.30 **Andy Binns**, Biology Department (Interactions between *VirB* membrane proteins involved in the movement of DNA from *Agrobacterium tumefaciens* into plant cells)

10.30-11.00 Coffee Break

11.00-11.30 **Stan Opella**, Chemistry Department (NMR structural studies of the periplasmic and transport proteins of the bacterial mercury detoxification system)

11.30-12.00 **Fevzi Daldal**, Biology Department (Structure, function and biogenesis of bacterial cytochrome complexes)

12.00-12.30 **Scott Poethig**, Biology Department (A genetic analysis of shoot maturation)

12.30-2.00 Lunch

2.00-3.00 **Shinya Yoshikawa**; Department of Life Sciences, Himeji Institute of Technology, Japan (Crystal structure of bovine heart cytochrome c oxidase at 2.8 Å resolution)

3.00-3.30 **Bill Degrado**, Department of Biochemistry and Biophysics (De novo protein design)

3.30-4.00 Coffee Break

4.00-4.30 **Jeff Winkler**, Department of Chemistry (Chemical synthesis of taxol)

4.30-5.00 **Phil Rea**, Department of Biology (The vacuolar GS-X pump: A broad range xenobiotic detoxifier)

5.00-5.30 **Tony Cashmore**, Department of Biology (The cryptochrome family of blue light receptors)

5.30-5.35 **Andy Binns**, Department of Biology (Closing remarks)

5.45-8.45 Drinks and a Barbecue by the Pool (bring swimsuits)

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Retreat

Plant Science Institute

University of Pennsylvania

Monday May 12,1997

SugarLoaf Conference Center, 9230 Germantown Avenue (215 242-9100)

8.30-9.00 Continental Breakfast

9.00-9.10 Tony Cashmore; Penn, Department of Biology:" Opening remarks"

9.10-9.50 Eran Pichersky; University of Michigan, Department of Biology:"An investigation of of floral scent: from moths to molecules."

9.50-10.30 Joe Ecker; Penn, Department of Biology: "Signaling in plants via a simple hydrocarbon."

10.30-11.00 Coffee Break

11.00-11.40 Les Dutton; Penn, Department of Biochemistry and Biophysics: "Toward the synthesis of plant signaling and oxidoreductase proteins."

11.40-12.20 Robin Hochstrasser: Penn, Department of Chemistry: "Fundamental Aspects of Light Harvesting Using Ultrafast Spectroscopy and Properties of Single LH2 Units."

12.20-1.00 Dan Klessig; Waksman Institute, Rutgers University: "Studies on the Salicylic Acid-Mediated Signal Transduction Pathway(s) in Disease Resistance."

1.00-2.30 Lunch

2.30-3.30 Bill Cramer; Department of Biological Science, Purdue University: "Approaches to an understanding of structure-function in the cytochrome b6f electron transfer complex of oxygenic photosynthesis."

3.30-4.10 Fevzi Daldal; Penn, Department of Biology: "Structure, Function and Biogenesis of Cytochrome Complexes in Rhodobacter."

4.10-4.40 Coffee Break

4.40-5.20 Pal Maliga; Waksman Institute, Rutgers University; "The role of the two RNA polymerase in plastid function and development."

5.20-6.00 Mitch Lewis; Penn, Department of Biochemistry and Biophysics: " The lac repressor-structure and genetics."

6.00-6.05 Andy Binns; Penn, Department of Biology: "Closing remarks."

6.05-9.00 Drinks followed by a barbecue

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