

**CURRICULUM VITAE**  
**Steven M. Theg**

Laboratory Address:           Sections of Plant Biology and of  
                                          Molecular & Cellular Biology  
                                          Division of Biological Sciences  
                                          2225 Life Science Addition  
                                          University of California-Davis  
                                          Davis, CA 95616

Laboratory Telephone:       (530) 752-0624  
FAX:                               (530) 752-5410  
Home Telephone:             (530) 753-7871  
Email:                         smtheg@ucdavis.edu  
Lab WWW page:              www-plb.ucdavis.edu/theg

**EDUCATION**

1977-1981    Molecular Biophysics Program at Florida State University, Tallahassee, FL.  
                  Ph.D. in Molecular Biophysics awarded in December 1981.

1974-1977    Boston College, Chestnut Hill, MA. Graduated cum laude with B.S. in Biological  
                  Science, May 1977.

**PROFESSIONAL EXPERIENCE**

August 2005 – present  
                  Interim Associate Dean for Undergraduate Academic Programs, College of Biological  
                  Sciences

July 1998 – present  
                  Professor, Section of Plant Biology (*primary affiliation*) and Section of Molecular &  
                  Cellular Biology (*secondary affiliation*), University of California, Davis, CA.

October 2001 – January 2003  
                  Interim Chair, Section of Plant Biology, University of California, Davis, CA.

July 1994-June 1998  
                  Associate Professor, Sections of Plant Biology and Molecular & Cellular Biology,  
                  University of California, Davis, CA.

## **PROFESSIONAL EXPERIENCE (cont.)**

Sept. 1988-June 1994

Assistant Professor, Department of Botany, University of California, Davis, CA.

Aug. 1986-Aug. 1988

Postdoctoral research associate with Professors B.R. Selman in the Department of Biochemistry, and K. Keegstra in the Department of Botany, University of Wisconsin.

Feb. 1983-Aug. 1986

Postdoctoral research associate with Professor R.A. Dilley in the Department of Biological Sciences, Purdue University. Projects involved investigations of the involvement of protons in a nonequilibrating pool in the thylakoid membrane with the backreactions in photosystem II and with ATP synthesis. Other projects were concerned with the location of the lesions in the electron transport chain produced by chloride depletion and photoinhibition.

Oct. 1981-Dec. 1982

Postdoctoral research associate with Professor W. Junge in the Department of Biophysics, Universitaet Osnabrueck, Osnabrueck, Federal Republic of Germany. Project involved investigation of flash-induced proton deposition into chloroplasts by photosystem II, and the influence of low concentrations of uncouplers thereon.

Sept. 1977-Oct. 1981

Graduate Research Assistant with Professor P.H. Homann in the Institute of Molecular Biophysics, Florida State University. Thesis, entitled "Studies on the composition and organization of the oxidizing side of photosystem II in chloroplasts", involved investigation of electron transport in and around photosystem II of green plants, including the requirements for chloride and manganese, and the arrangement of light harvesting pigments around the photosystem II reaction center.

## **EXTRAMURAL SUPPORT**

### **Past**

NSF: Assembly of a multimeric protein complex. April 1989 - March 1993, \$260,000.

NSF: Acquisition of a kinetic flash spectrophotometer/fluorimeter/luminometer. July 1990 - June 1992, \$43,200.

NSF: Plant Cell Biology Training Program (Theg is one of 13 Co-P.I.s.)  
July 1991 - June 1995, \$1,260,875.  
July 1995 - June 2003, \$938,530

USDA: A component of the chloroplast protein transport complex. September 1992 - August 1995, \$130,000.

USDA: 95-37304-2325: Components of the Thylakoid Protein Transport Machinery. September 1995 - September 1998, \$100,000.

USDA: 95-37304-2325: Components of the Thylakoid Protein Transport Machinery. September 1999 - September 2001, \$105,000.

DOE: DE-FG03-93ER20118: Protein transport and assembly in chloroplasts.  
July 1993 - June 1996, \$276,00.  
July 1996 – June 1999, \$294,000.  
July 1999 – June 2002, \$300,000.  
July 2002 – June 2003, \$100,000.

NSF: MCB-0080202: Development of an in vitro assay for chloroplast protein targeting in the moss *Physcomitrella patens*. August 2000 – July 2003, \$200,000.

#### **Current**

DOE: DE-FG02-03ER15405: Energetics of protein transport across chloroplast membranes. July 2003 - June 2006, \$330,000.

NSF: MCB 0400365: Chloroplast protein transport in the moss *Physcomitrella patens*. August 2003 – July 2006, \$477,414

#### **Pending**

USDA: Role of Vipp1 in thylakoid protein transport. Proposed finding period and support: July 2006 – June 2009, \$402,195.

NSF: The mechanism of action of the stromal Hsp70 chaperones of *Physcomitrella patens*. Proposed funding period and support: September 2006 – August 2009. \$840,580.

#### **PROFESSIONAL SOCIETIES AND ACTIVITIES**

American Association for the Advancement of Science  
American Society of Plant Physiologists  
American Society of Cell Biologists

Contributing member, Faculty of 1000 – Cell Biology  
Editorial Board Member, Journal of Biological Chemistry, Jan. 2004 – present

**PUBLICATIONS****Research Articles**

1. Theg, S.M. and Sayre, R.T. (1979) Characterization of chloroplast manganese by electron paramagnetic resonance spectroscopy. *Plant Sci. Lett.* 16, 319-326.
2. Theg, S.M. and Homann, P.H. (1981) Studies on the organization of photosystem II. In: *Proc. 5th Intl. Congress on Photosynthesis* (Akoyunoglou, G., ed.) polypeptide. 309-318. Balaban Intl. Sci. Services, Philadelphia.
3. Theg, S.M. and Homann, P.H. (1982) Light-, pH- and uncoupler-dependent association of chloride with chloroplast thylakoids. *Biochim. Biophys. Acta* 679, 221-234.
4. Theg, S.M., Johnson, J.D. and Homann, P.H. (1982) Proton efflux from thylakoids induced in darkness and its effect on photosystem II. *FEBS Lett.* 145, 25-29.
5. Trissl, H.-W., Förster, V., Theg, S.M. and Junge, W. (1982) Investigations of energy conserving reactions in chromatophores and chloroplast thylakoids. In: *Photochemical, Photoelectrochemical and Photobiological Processes* (Hall, D.O., Palz, W. and Pirwitz, D., eds.) vol. 2, pp. 179-187. D. Reidel Publishing Co., Boston.
6. Theg, S.M. and Junge, W. (1983) The effect of low concentrations of uncouplers on the detectability of proton deposition in thylakoids: Evidence for subcompartmentation and preexisting pH differences in the dark. *Biochim. Biophys. Acta* 723, 294-307.
7. Junge, W., Theg, S.M., Qian, L.P., Hong, Y.Q. and Viale, A. (1983) Transient trapping of PS II-released protons: (a) by a site within PS II and (b) by CFO after mild extraction of CF1. In: *Proc. 6th Intl. Congress on Photosynthesis* (Sybesma, C., ed.) Vol. II, pp. 4.247-4.255. Martinus Nijhoff/Dr. W. Junk Publishers, The Hague.
8. Westerhoff, H.V., Helgerson, S.L., Theg, S.M., Van Kooten, O., Wikstrom, M., Skulachev, V.P. and Demoshazy, Zs. (1983) The present state of the chemiosmotic coupling theory. *Acta Biochem. Biophys. Sci. Hung.* 18, 125-149.
9. Theg, S.M., Jursinic, P. and Homann, P.H. (1984) Studies on the mechanism of chloride action on photosynthetic water oxidation. *Biochim. Biophys. Acta* 766, 636-646.
10. Theg, S.M., Filar, L.J. and Dilley, R.A. (1986) Photoinactivation of chloroplasts already inhibited on the oxidizing side of photosystem II. *Biochim. Biophys. Acta* 849, 104-111.
11. Cramer, W.A., Theg, S.M. and Widger, W.R. (1986) Recent progress on the structure, and a current hypothesis for the function, of cytochrome b-559. *Photosyn. Res.* 10, 247-258.
12. Theg, S.M., Belanger, K.M. and Dilley, R.A. (1986) Interaction of photosystem I-derived protons with the water-splitting enzyme complex- Evidence for localized domains. *J. Bioenerg. Biomembr.* 19, 53-68.

13. Theg, S.M. and Dilley, R.A. (1986) Protons contained in the thylakoid sequestered domains are utilized for energizing ATP formation. In: Prog. in Photosynth. Res. (Biggins, J., ed.) vol. 3, pp. 2.161-2.164. Martinus Nijhoff/Dr. W. Junk Publishers, The Hague.
14. Dilley, R.A., Theg, S.M. and Beard, W.A. (1987) Membrane-proton interactions in chloroplast bioenergetics: Localized proton domains. Ann. Rev. Plant Physiol. 38, 347-389.
15. Theg, S.M., Chiang, G. and Dilley, R.A. (1988) Protons in the thylakoid sequestered domains pass through the coupling factor during ATP synthesis in flashing light. J. Biol. Chem. 263, 673-681.
16. Yu, L.M., Merchant, S., Theg, S.M. and Selman, B.R. (1988) Isolation of a cDNA clone for the gamma subunit of the chloroplast ATP synthase of *Chlamydomonas reinhardtii*: Import and cleavage of the precursor protein. Proc. Natl. Acad. Sci. USA 85, 1369-1373.
17. Lubben, T.H., Theg, S.M. and Keegstra, K.G. (1988) Transport of proteins into chloroplasts. Photosyn. Res. 17, 173-194.
18. Olsen, L.J., Theg, S.M., Selman, B.R. and Keegstra, K. (1989) ATP is required for the binding of precursor proteins to chloroplasts. J. Biol. Chem. 264, 6724-6729.
19. Theg, S.M., Bauerle, C., Olsen, L.J., Selman, B.R. and Keegstra, K. (1989) Internal ATP is the only energy requirement for the translocation of precursor proteins across chloroplastic membranes. J. Biol. Chem. 264, 6730-6736.
20. Keegstra, K., Olsen, L.J. and Theg, S.M. (1989) Recent advances in the import of proteins into chloroplasts. Ann. Rev. Plant Physiol. & Molec. Biol. 40, 471-501.
21. Li, H., Theg, S.M., Bauerle, C.M. and Keegstra, K. (1990) Metal-ion-center assembly of ferredoxin and plastocyanin in isolated chloroplasts. Proc. Natl. Acad. Sci. USA 87, 6748-6752.
22. Yuan, J., Cline, K. and Theg, S.M. (1991) Cryopreservation of chloroplasts and thylakoids for studies of protein import and integration. Plant Physiol. 95, 1259-1264.
23. Renganathan, M., Pan, R.-S., Ewy, R.G., Theg, S.M., Allnut, F.T.C. and Dilley, R.A. (1991) Evidence that localized energy coupling in thylakoids can continue beyond the energetic threshold onset into steady illumination. Biochim. Biophys. Acta 1059, 16-27.
24. Ettinger, W.E. and Theg, S.M. (1991) Physiologically active chloroplasts contain pools of unassembled extrinsic proteins of the photosynthetic oxygen-evolving enzyme complex in the thylakoid lumen. J. Cell Biol. 115, 321-328.

25. Cline, K., Ettinger, W.F. and Theg, S.M. (1992) Protein-specific energy requirements for transport across or into thylakoid membranes: Two luminal proteins are transported in the absence of ATP. *J. Biol. Chem.* 267, 2688-2696.
26. Theg, S.M. and Geske, F.J. (1992) Biophysical characterization of a transit peptide directing chloroplast protein import. *Biochemistry* 31, 5053-5060.
27. Ettinger, W.F. and Theg, S.M. (1992) Sequence of the cDNA encoding the 17 kDa protein of the photosynthetic oxygen-evolving complex of pea. *Plant Physiol.* 99, 791-793.
28. Theg, S.M. and Scott, S.V. (1993) Protein import into chloroplasts. *Trends in Cell Biology* 3, 186-190.
29. Lippuner, V., Chou, I.T., Scott, S.V., Ettinger, W.F., Theg, S.M. and Gasser, C.S. (1994) Cloning and characterization of chloroplast and cytosolic forms of cyclophilin from *Arabidopsis thaliana*. *J. Biol. Chem.* 269, 7863-7868.
30. Leheny, E.A. and Theg, S.M. (1994) The apparent inhibition of chloroplast protein import by cold temperatures is due to energetic considerations, not membrane fluidity. *The Plant Cell* 6, 427-437.
31. Hashimoto, A., Yamamoto, Y. and Theg, S.M. (1995) Studies in the assembly of the oxygen-evolving complex from subunits newly imported into isolated intact chloroplasts. In *Photosynthesis: from Light to Biosphere* (Mathis, P., ed.) vol. III, pp. 857-860, Kulwer Academic Publishers, The Netherlands.
32. Teter, S.A. and Theg, S.M. (1995) Thylakoid protein translocation by the  $\Delta$ pH-dependent pathway is not accompanied by a large increase in membrane conductivity. In *Photosynthesis: from Light to Biosphere* (Mathis, P., ed.) vol. III, pp. 795-798, Kulwer Academic Publishers, The Netherlands.
33. Scott, S.V. and Theg, S.M. (1996) A new intermediate on the pathway for chloroplast protein import reveals distinct translocation machineries in the two envelope membranes: energetics and mechanistic implications. *J. Cell Biol.* 132, 63-75.
34. Hashimoto, A., Yamamoto, Y. and Theg, S.M. (1996) Unassembled subunits of the photosynthetic oxygen-evolving complex present in the thylakoid lumen are long-lived and assembly-competent. *FEBS Lett.* 391, 29-34.
35. Roffey, R.A. and Theg, S.M. (1996) Analysis of the import of carboxyl-terminal truncations of the 23 kDa subunit of the oxygen-evolving complex suggest thylakoid transport of the folded protein. *Plant Physiol.* 111:1329-1338.
36. Hashimoto, A., Ettinger, W.F., Yamamoto, Y. and Theg, S.M. (1997) *In organello* assembly of newly imported oxygen-evolving complex subunits in isolated chloroplasts: sites of assembly and mechanism of binding. *The Plant Cell* 9:441-452.

37. Clark, S.A. and Theg, S.M. (1997) A folded protein can be transported across chloroplast envelope and thylakoid membranes. *Mol Biol Cell* 8:923-93.
38. Theg, S.M. (1998) Protein targeting into and within chloroplasts. In: *Lipid and Protein Traffic: Pathways and Molecular Mechanisms*, J.A.F. Op den Kamp, ed., pp. 17 – 39. Springer-Verlag, Berlin Heidelberg.
39. Leheny, E.A., Teter, S.A. and Theg, S.M. (1998) Identification of a role for an azide-sensitive factor in the thylakoid transport of the 17-kda subunit of the photosynthetic oxygen-evolving complex. *Plant Physiol.* 166:805-814
40. Teter, S.A. and Theg, S.M. (1998) Energy-transducing thylakoid membranes maintain a high ion permeability barrier during protein translocation. *Proc. Natl. Acad. Sci. USA* 95:1590-1594.
41. Tamura, N., Tsuda, T., Tanaka, I. and Theg, S.M. (1998) Reassembly of the photosynthetic water-oxidizing complex on the thylakoid membranes. *In: Photosynthesis: Mechanisms and Effects* (Garab, G, ed.) Vol. II, pp. 1443-1446. Kluwer Academic Publishers, The Netherlands.
42. Havrilla, M.E., Alder, N.N. and Theg, S.M. (1998) Protein transport and assembly in thylakoids. *In: Photosynthesis: Mechanisms and Effects* (Garab, G, ed.) Vol. IV, pp. 3063-3068. Kluwer Academic Publishers, The Netherlands.
43. Musser, S.M. and Theg, S.M. (2000) Characterization of the early steps of OE17 precursor transport by the thylakoid  $\Delta$ pH/Tat machinery. *Eur. J. Biochem.* 267:2588-2598.
44. Musser, S.M. and Theg, S.M. (2000) Proton transfer limits protein translocation rate by the thylakoid Tat machinery. *Biochemistry* 39:8228-8233.
45. Ishikawa, Y., Yamamoto, Y., Otsubo, M., Theg, S.M. and Tamura, N. (2001) Chemical modification of the amino groups on PSII proteins retards photoassembly of the photosynthetic water-oxidizing complex. *Biochemistry* 41:1972-80.
46. Moseley, J.L., Page, M.D., Alder, N.P., Eriksson, M., Quinn, J., Soto, F., Theg, S.M., Hippler, M. and Merchant, S. (2001) Reciprocal expression of two di-iron enzymes affecting photosystem I and light-harvesting complex accumulation. *The Plant Cell* 14: 673-688.
47. Alder, N.N. and Theg, S.M. (2003) Energetics of protein transport across biological membranes: A study of the thylakoid  $\Delta$ pH-dependent/cpTat pathway. *Cell* 112:231-242.
48. Alder, N.N. and Theg, S.M. (2003) Kinetics and cooperativity of protein transport via the thylakoid  $\Delta$ pH-dependent / cpTat pathway. *FEBS Lett* 540:96-100.

49. Alder, N.N. and Theg, S.M. (2003) Energy Utilization by Biological Protein Transport Systems. *Trends in Biochemical Sciences* 28:442-451.
50. Hofmann, N.R. and Theg, S.M. (2003) Chloroplast protein transport in the moss, *Physcomitrella patens*: Conserved machineries between vascular and non-vascular plants. *Plant Molecular Biology* (with cover photo) 53:643-654.
51. Page M.L., Hamel P.P, Gabilly S.T., Zegzouti H., Perea J.V., Alonso J.M., Ecker J.R., Theg S.M., Christensen S.K. and Merchant S. (2004) A homolog of prokaryotic thiol disulfide transporter CcdA is required for the assembly of the cytochrome b6f complex in *Arabidopsis* chloroplasts. *J. Biol. Chem* 279: 32474-32482.
52. Theg, S.M., Cline, K., Finazzi, G. and Wollman, F.-A. (2005) The energetics of the chloroplast Tat protein transport pathway revisited – CORRESPONDENCE. *Trends in Plant Science* 10: 153-154.
53. Hofmann, N. R. and Theg, S.M. (2005) Toc64 is not required for protein import into chloroplasts. *The Plant Journal* 43: 675-87.
54. Hofmann, N.R. and Theg, S.M. Theg (2005) Integration of proteins into the chloroplast outer envelope membrane. *Trends in Plant Science* 10: 450-457.
55. Inoue, K., Potter, D., Shipman, R.L., Perea, J.V. and Theg. S.M. (2005) Involvement of a type I signal peptidase in biogenesis of chloroplasts – Towards identification of the enzyme for maturation of the chloroplast protein translocation channel. In *Photosynthesis: Fundamental Aspects to Global Perspectives*, eds. van der Est A and Bruce D. (Allen Press, Lawrence), pp. 933-935.
56. Inoue K, Baldwin AJ, Shipman RL, Matsui K, Theg SM and Ohme-Takagi M. (2005) Complete maturation of the plastid protein translocation channel requires a type I signal peptidase. *J Cell Biol.* 2005 Nov 7;171(3):425-30.
57. Theg, S.M. and Shi, L.-X. (2005) Protein transport and post-translational processing in Photosystem II biosynthesis and homeostasis. In *Photosystem II: The Light-Driven Water:Plastoquinone Oxidoreductase*, eds. Wydrzynski, T.J. and Satoh, K. (Springer, Berlin), pp. 669-682.
58. Hofmann, N.R. and Theg. S.M. (2005) Protein- and energy-mediated targeting of proteins to the chloroplast outer envelope membrane. *The Plant Journal* 44:917-927.
59. Lu, Y-K., Theg, S.M. and Stemler, A.J. (2005) Carbonic Anhydrase activity of the Photosystem II OEC-33 protein from pea. *Plant Cell Physiol.* 46:1944-53.
60. Chehab, E.W., Perea, J.W., Gopalan, B., Theg, S.M. and Dehesh, K. (2006) Oxylinin pathway in rice and *Arabidopsis* . *J. Int. Plant Biol.* 49: 43-51.

61. Armstrong, M.T., Theg, S.M., Braun, N., Wainwright, N., Pardy, R.L. and Armstrong, P.B. (2006) Histochemical evidence for lipid A (endotoxin) in eukaryote chloroplasts. *FASEB J.*20:2145-6.
62. Radhamony, R.N. and Theg, S.M. (2006) Evidence for an ER to Golgi to chloroplast protein transport pathway. *Trends Cell Biol.*16:385-387.
63. Braun, N.A., Davis, A.W. and Theg, S.M. (2007) The chloroplast Tat pathway utilizes the transmembrane electric potential as an energy source. *Biophys J.*93:1993-1998.
64. Braun, N.A. and Theg, S.M. (2008) The cpTat pathway transports substrates in the dark. *J. Biol. Chem.* *In press.*

### **Books**

1. Jemiolo, D.K. and Theg, S.M. (1999) Student Solutions Manual, Study Guide and Problems Book to accompany Garrett & Grisham *BIOCHEMISTRY*, Second Edition, Saunders College Publishing, Philadelphia.
2. Jemiolo, D.K. and Theg, S.M. (2001) Student Study Guide and Problems Book for *PRINCIPLES OF BIOCHEMISTRY WITH A HUMAN FOCUS*, Garrett & Grisham, Saunders College Publishing, Philadelphia.
3. Jemiolo, D.K. and Theg, S.M. (2004) Student Solutions Manual, Study Guide and Problems Book for Garrett & Grisham's *BIOCHEMISTRY*, Third Edition, Thompson Brooks/Cole, Belmont.