

# Curriculum Vitae

## WILBUR H. CAMPBELL

**PRESENT POSITIONS:** Emeritus Professor of Biochemistry and Molecular Biology, Department of Biological Sciences, Michigan Technological University, Houghton, MI; and President and Chief Scientist, The Nitrate Elimination Company, Inc., Lake Linden, MI

**EDUCATION:** A.A., Santa Ana College, 1965, Santa Ana, California; B.A., Pomona College, 1967 (Chemistry), Claremont, California; Ph.D., University of Wisconsin-Madison, 1972, Prof. R.H. Burris (Biochemistry)

**POSTDOCTORAL RESEARCH:** Dept. of Biochemistry, University of Georgia-Athens, GA, Prof. C.C. Black, Jr., 1972-73; Molecular Biology Group, Mayo Clinic-Rochester, MN, Dr. Carl Bernofsky, 1973-74; Dept. of Biochemistry, Michigan State University, E. Lansing, MI, Prof. N.E. Tolbert, 1974-75

### PROFESSIONAL EXPERIENCE:

2003 Appointed Emeritus Professor, Michigan Tech Univ., Houghton MI  
2001→: Editorial Board – **Protein Expression and Purification (Academic Press)**  
2000→: Editorial Board – **Journal of Biological Chemistry**  
2000: Grants Review Panel USDA – Agriculture Plant Biochemistry Program  
1998: Visiting Professor, John Innes Centre, Norwich UK (Sabbatical Leave)  
1998: Underwood Fellowship, Biotechnology and Biological Sciences Research Council, United Kingdom  
1996: Fellow of Japan Society for Promotion of Science  
1994–2000: Monitoring Editor, **Plant Physiology**  
1993→: President and Chief Scientist, The Nitrate Elimination Company, Inc., Lake Linden, MI  
1992-3: Consultant, AGRECOL Corp., Enzyme Products Division, Madison, WI  
1991-92: Visiting Professor, Botany Dept., Univ. Stockholm, Stockholm, Sweden; and Dept. Mol. Biol., Uppsala Biomedical Center, Swedish Univ. of Agricultural Sciences, Uppsala, Sweden (Sabbatical Leave)  
1990→: Coordinator of the Phytotechnology Research Center, Michigan Tech. University  
1990→: Adjunct Professor, Dept. of Chemistry, Michigan Technological Univ.  
1989-93: Grants Review Panels, National Science Foundation, Cellular Biochemistry Program and Instruction and Laboratory Instrumentation Program  
1987: Visiting Scientist, Molecular Biology Computer Research Resource, Dana-Farber Cancer Institute, Harvard Medical School, Boston, MA  
1985→: Associate and Full Professor (from 1986), Department of Biological Sciences, Michigan Technological University, Houghton, MI  
1982: Guest Professor, Botanisches Institute, Universitat Bayreuth, West Germany (Sabbatical Leave)  
1975-85: Assistant and Associate Professor, Chemistry Department, State University of New York, College of Environmental Science and Forestry, Syracuse, NY

**AWARDS AND HONORS:** Sigma Xi, 1970-present; Editorial Board of Plant Physiology, 1982-1992; Excellence in Research Award, Michigan Technological University, 1988; Distinguished Faculty Award, Michigan Association of Governing Boards of State Universities, 1989; Japan Society for the Promotion of Science Fellowship, 1996

**LISTINGS:** Who's Who in the East, 1981-85; Who's Who in Frontiers of Science and Technology, 1992-2000; Who's Who in the World, 1986-2001; American Men and Women of Science, 16<sup>th</sup>, 17<sup>th</sup>, and 18<sup>th</sup> Editions.

## **PUBLICATIONS OF WILBUR H. CAMPBELL**

1. Campbell, W.H. (1972) *Azotobacter vinelandii* cytochromes c. Ph.D. thesis. University of Wisconsin-Madison.
2. Campbell, W.H., W.H. Orme-Johnson, and R.H. Burris (1973) A comparison of the physical and chemical properties of four cytochromes c of *Azotobacter vinelandii*. *Biochem. J.* 135:617-630.
3. Chen, T.M., W.H. Campbell, P. Dittrich, and C.C. Black (1973) Distribution of carboxylation and decarboxylation enzymes in isolated mesophyll cells and bundle sheath strands. *Biochem. Biophys. Res. Comm.* 51:416-422.
4. Wynn, T., R.H. Brown, W.H. Campbell, and C.C. Black (1973) Dark release of  $^{14}\text{CO}_2$  from higher plant leaves. *Plant Physiol.* 52:288-291.
5. Dittrich, P., W.H. Campbell, and C.C. Black (1973) Phosphoenolpyruvate carboxykinase in plants exhibiting Crassulacean acid metabolism. *Plant Physiol.* 52:357-361.
6. Salin, M., W.H. Campbell, and C.C. Black (1973) Oxaloacetate as the Hill oxidant in mesophyll cells of plants possessing the  $\text{C}_4$ -dicarboxylic acid cycle of leaf photosynthesis. *Proc. Nat'l Academy of Sciences* 70:3730-3734.
7. Black, C.C., W.H. Campbell, T.M. Chen, and P. Dittrich (1973) The monocotyledons: Their evolution and comparative biology. III. Pathways of carbon dioxide metabolism related to net carbon assimilation by monocotyledons. *Quarterly Rev. Biol.* 48:299-313.
8. Chen, T.M., P. Dittrich, W.H. Campbell, and C.C. Black (1974) Metabolism of epidermal tissues, mesophyll cells and bundle sheath strands resolved from mature nutsedge leaves. *Arch. Biochem. Biophys.* 163:246-262.
9. Campbell, W.H., P. Robertie, R.H. Brown, and C.C. Black (1974) Adaptions at the cell and organelle level for utilizing light. *The Ohio J. Sci.* 74:339-348.
10. Jolly, S.O., W.H. Campbell, and N.E. Tolbert (1976) NADPH- and NADH-nitrate reductases from soybean leaves. *Arch. Biochem. Biophys.* 174:431-439.
11. Campbell, W.H. (1976) Separation of soybean leaf nitrate reductases by affinity chromatography. *Plant Sci. Lett.* 7:239-247.
12. Campbell, W.H., and C.C. Black (1978) The relationship of  $\text{CO}_2$  assimilation pathway and photorespiration to the physiological quantum requirement of green plant photosynthesis. *Biosystems* 10:253-264.
13. Campbell, W.H., and J. Smarrelli, Jr. (1978) Purification and kinetics of higher plant NADH:nitrate reductase. *Plant Physiol.* 61:611-616.
14. Campbell, W.H. (1978) Isolation of NADH: and NAD(P)H:nitrate reductase from scutellum of maize. *Z. Pflanzenphysiol.* 88:357-361.
15. Campbell, W.H. (1979) Affinity purification of squash cotyledon NADH: nitrate reductase. In: *Proc. Sixth Long Ashton Symp.*, C.V. Cutting and E.J. Hewitt, Eds, Academic Press, London, pp. 321-330.
16. Campbell, W.H., and C. Bernofsky (1979) Mitochondrial glucose-6-phosphate dehydrogenase from *Saccharomyces cerevisiae*. *Molecular and Cellular Biochemistry* 25:33-42.
17. Smarrelli, J., Jr., and W.H. Campbell (1979) NADH dehydrogenase activity of higher plant nitrate reductase (NADH). *Plant Sci. Lett.* 16:139-147.
18. Orihuel-Iranzo, B., and W.H. Campbell (1980) Development of NAD(P)H: and NADH:nitrate reductase activities of soybean cotyledons. *Plant Physiol.* 65:595-599.
19. Smarrelli, J., Jr., and W.H. Campbell (1980) Activation of *Thalassiosira pseudonana* NADH:nitrate reductase. *Phytochem.* 19:1601-1605.

20. Campbell, W.H., M.G. Redinbaugh, W.H. Mahony, and J. Smarrelli, Jr. (1981) New forms and new characteristics of higher plant nitrate reductases. In: Photosynthesis, Vol IV, G.A. Akoyunoglou, Ed., Balaban, Philadelphia, PA. pp. 707-714.
21. Orihuel-Iranzo, B., and W.H. Campbell (1981) Pyridine nucleotide specificity and kinetics of soybean leaf NAD(P)H:nitrate reductase. Photosynthesis, Vol IV, G.A. Akoyunoglou, Ed., Balaban, Philadelphia, PA. pp. 715-720.
22. Redinbaugh, M.G., and W.H. Campbell (1981) Purification and characteristics of NAD(P)H:nitrate reductase and NADH:nitrate reductase from corn roots. Plant Physiol. 68:115-120.
23. Smarrelli, J., Jr., and W.H. Campbell (1981) Immunological approach to structural comparisons of assimilatory nitrate reductases. Plant Physiol. 68:1226-1230.
24. Campbell, W.H., and C.C. Black (1982) Cellular aspects of C<sub>4</sub> Leaf Metabolism. In: Cellular and Subcellular Localization in Plant Metabolism, L. Creasy & G. Hrazdina, Eds., Plenum, New York, pp. 223-248.
25. Smarrelli, J., Jr., and W.H. Campbell (1983) Heavy metal inactivation and chelator stimulation of higher plant nitrate reductase. Biochem. Biophys. Acta 742:435-445.
26. Redinbaugh, M.G., and W.H. Campbell (1983) The Purification of Squash NADH:nitrate reductase by zinc chelate affinity chromatography, Plant Physiol. 71:205-207.
27. Redinbaugh, M.G., and W.H. Campbell (1983) Reduction of ferric citrate catalyzed by NADH:nitrate reductase. Biochem. Biophys. Research Comm. 114:1182-1188.
28. Campbell, W.H., and M.G. Redinbaugh (1984) Ferric citrate reductase activity of nitrate reductase and its role in iron assimilation by plant. J. Plant Nutrition 7:799-806.
29. Campbell, W.H., and K.G. Ripp (1984) An ELISA for higher plant nitrate reductase. Annuals of the New York Academy of Sciences 435:123-125.
30. Campbell, W.H., P. Ziegler, and E. Beck (1984) Development of nitrogen assimilation enzymes during photoautotrophic growth of *Chenopodium rubrum* suspension cultures. Plant Physiol. 74:947-950.
31. Campbell, W.H. (1984) The biochemistry of higher plant nitrate reductase. In: Nitrogen Fixation and CO<sub>2</sub> Metabolism, P. Ludden and J. Burris, Eds., Elsevier Sci Publishing, pp. 143-151.
32. Redinbaugh, M.G., and Wilbur H. Campbell (1985) Quaternary structure and composition of squash NADH:nitrate reductase. J. Biol. Chem. 260:3380-3385.
33. Redinbaugh, M.G., and W.H. Campbell (1985) Adaptation of the dye binding protein assay to microtiter plates. Anal. Biochem. 147:144-147.
34. Robin, R., L. Streit, W.H. Campbell, and J.E. Harper (1985) Immunochemical characterization of nitrate reductase forms from wild-type (cv. Williams) and nr<sub>1</sub> mutant soybean. Plant Physiol. 77:232-236.
35. Campbell, W.H., and J.L. Remmler (1986) Regulation of corn leaf nitrate reductase: I. Immunochemical methods for analysis of the enzyme's protein component. Plant Physiol. 80:435-441.
36. Remmler, J.L., and W.H. Campbell (1986) Regulation of corn leaf nitrate reductase: II. Synthesis and turnover of the enzyme's activity and protein. Plant Physiol. 80:442-447.
37. Campbell, W.H., and J. Smarrelli, Jr. (1986) Nitrate reductase: biochemistry and regulation. In: Biochemical Basis for Plant Breeding, C. Neyra, Ed., CRC Press, Uniscience Program, Chapter 1, pp. 1-39.
38. Miller, A., and W.H. Campbell (1986) Monoclonal antibodies for higher plant nitrate reductase. Current Topics in Plant Biochemistry and Physiology, 5:192.
39. Campbell, W.H. (1986) Properties of bromphenol blue as an electron donor for higher plant nitrate reductase. Plant Physiol. 82:729-732.

40. Rufty, T.W., J.F. Thomas, J.L. Remmler, W.H. Campbell, and R. J. Volk (1986) Intercellular localization of nitrate reductase in roots. *Plant Physiol.* 82:675-680.
41. Crawford, N.M., W.H. Campbell, and R.W. Davis (1986) Nitrate reductase from squash: cDNA cloning and nitrate regulation. *Proc. Nat'l Acad. Sci.* 83:8073-8076.
42. Campbell, W.H. (1987) Regulation of nitrate reductase in maize: An immunochemical approach. In: *Inorganic Nitrogen Metabolism*, W.R. Ullich, P.J. Aparicio, P.J. Syrett & F. Castillo, Eds., Springer-Verlag, Berlin, pp. 99-103.
43. Campbell, W.H., D. J. DeGracia, and E.R. Campbell (1987) Regulation of molybdenum cofactor of maize leaf. *Phytochemistry*, 27:2149-2150.
44. Campbell, W.H., and G. Gowri (1987) Regulation of maize leaf NADH:nitrate reductase m-RNA by nitrate and light, *J. of Cellular Biochemistry*, 11B: 49.
45. Randall, D. D., D.G. Blevins and W.H. Campbell (Editors) (1988) *Current Topics in Plant Biochemistry and Physiology*, Vol 7, University of Missouri, Columbia.
46. Campbell, W.H. (1988) Higher plant nitrate reductase and its role in regulation of nitrate assimilation. *Physiologia Plantarum* 74:214-219.
47. Rajasekhar, V.K., G. Gowri, and W.H. Campbell (1988) Phytochrome-mediated light regulation of nitrate reductase expression in squash cotyledons. *Plant Physiol.* 88:242-244.
48. Campbell, W.H. (1988) Higher plant nitrate reductase: Arriving at a molecular view. *Current Topics in Plant Biochemistry and Physiology*, 7:1-15.
49. Campbell, W.H., and J.L. Remmler (1988) Application of immunochemistry to the synthesis and turnover of plant proteins. In: *Progress and Prospects in Forest and Crop Biotechnology*, F. Valentine, Ed., Springer-Verlag, New York, pp. 112-130.
50. Gowri, G., and W.H. Campbell (1988) Isolation of a cDNA clone for corn leaf NADH:nitrate reductase. *Current Topics in plant Biochemistry and Physiology*, 7:226.
51. Ho, G., W.H. Campbell, and E. Carlson (1988) Ovine-associated *Staphylococcus aureus* protein with immunochemical similarity to toxic shock syndrome toxin 1. *J. Clinical Microbiology*, 27:210-212.
52. Balch, W.M., C.M. Yentsch, B. Reguera, and W.H. Campbell (1988) Examining nitrate reduction by phytoplankton with an immunoassay. In: *Immunochemical Approaches to Coastal, Eustuarine and Oceanographic Questions*, C.M. Yentsch, F.C. Mangué and P.K. Horan, Eds., Springer-Verlag, New York, pp. 263-276.
53. Vaughn, K.C., and W.H. Campbell (1988) Immunogold localization of nitrate reductase in maize leaves. *Plant Physiol.* 88:1354-1357.
54. Bugos, R.C., V.L. Chiang and W.H. Campbell (1989) Isolation of O-methyltransferase associated with lignin biosynthesis. *Proceedings of the International Symposium on Wood and Pulping Chemistry*, Tappi Press, Atlanta, pp. 345-347.
55. Bugos, R.C., V.L. Chiang and W.H. Campbell (1989) Cloning of O-methyltransferase associated with lignin biosynthesis. *Proceedings of the 34th Japanese Lignin Symposium*, Nagoya University Press, Nagoya, Japan, pp. 25-29.
56. Kenis, J.D., and W.H. Campbell (1989) Oxygen inhibition of nitrate reductase biosynthesis in detached corn leaves via inhibition of total soluble protein synthesis. *Plant Physiol.* 91:883-888.
57. Ruoff, P., C. Lillo and W.H. Campbell (1989) NADH substrate inhibition and enhanced thermal stability of higher plant nitrate reductase immobilized via a monoclonal antibody. *Biochem. Biophys. Res. Comm.* 161:496-501.
58. Gowri, G., and W.H. Campbell (1989) cDNA clones for corn leaf NADH:nitrate reductase and chloroplast NAD(P)<sup>+</sup>:glyceraldehyde-3-phosphate dehydrogenase. Characterization of the clones and analysis of the expression of the genes in leaves as influenced by nitrate in the light and dark. *Plant Physiol.* 90:792-798.

59. Hyde G.E., J.A. Wilberding, A.L. Meyer, E.R. Campbell and W.H. Campbell (1989) Monoclonal antibody-based immunoaffinity chromatography for purifying corn and squash NADH:nitrate reductases. Evidence for an interchain disulfide bond in nitrate reductase. *Plant Mol. Biol.*, 13:233-246.
60. Ho, G., W.H. Campbell, M.S. Bergdoll and E. Carlson (1989) Production of a toxic shock syndrome toxin variant by *Staphylococcus aureus* strains associated with sheep, goats and cows. *J. Clinical Microbiol.* 27:1946-1948.
61. Campbell, W.H. (1989) Structure and regulation of nitrate reductase in higher plants. In: *Molecular and Genetic Aspects of Nitrate Assimilation*, J.L. Wray and J.R. Kinghorn, Eds., Oxford University Press, pp. 125-154.
62. Campbell, W.H. (1990) Applied Plant Molecular Biology. *BioScience*, 39:646-648. (A book review)
63. Campbell, W.H., and G. Gowri (1990) Codon usage in higher plants, green algae and cyanobacteria. *Plant Physiol.* 92:1-11.
64. Carlson, E., G. Ho, M.S. Bergdoll and W.H. Campbell (1990) Animal-associated *S. aureus* TSST variant: Prevalence and biological activity. *Proceedings of the International Symposium on the Molecular Biology of Staphylococcus aureus*, Amer. Society for Microbiology, Washington, D.C., in press.
65. Campbell, W.H. (1990) Purification, characterization and immunochemistry of higher plant nitrate reductase. In: *Nitrogen in Higher Plants - Recent Advances/Future Outlooks*, Y.P. Abrol, Ed., Wiley, New York, pp. 65-91.
66. Campbell, W.H. (1990) Higher plant nitrate reductase: Effects of light and nitrate on gene expression and enzyme activity. *Proceedings of 22nd Jornadas Argentinas de Botanica*, Cordoba, Argentina, Academic Nacional de Ciencias, Argentina, pp. 55-70.
67. Campbell, W.H. and J.R. Kinghorn (1990) Functional domains of assimilatory nitrate reductases and nitrite reductases. *Trends in Biochemical Sciences*, 15:315-319.
68. Hyde, G.E. and W.H. Campbell (1990) High-level expression in *Escherichia coli* of the catalytically active flavin domain of corn leaf NADH:nitrate reductase and its comparison to human NADH:cytochrome b<sub>5</sub> reductase. *Biochemical and Biophysical Research Communications*, 168:1285-1291.
69. Crawford, N.M. and W.H. Campbell (1990) Fertile Fields. *Plant Cell*, 2:829-835.
70. Campbell, W.H. (1990) Molecular characterization of maize NADH:nitrate reductase. In *WR Ullrich, C Rigano, A Fuggi, PJ Aparicio, eds, Inorganic Nitrogen in Plant and Microorganisms*, Springer-Verlag, Berlin, pp 266-272.
71. Campbell, W.H. (1991) Sequence motifs in the flavin domain of NADH:nitrate reductase. In: *Flavins and Flavoproteins 1990*, B. Curti, S. Ronchi & G. Zanetti, eds, de Gruyter, Berlin, pp. 761-764.
72. Redinbaugh, M.G., and W.H. Campbell (1991) Minireview: Higher plant responses to environmental nitrate. *Physiologia Plantarum*, 82: 640-650.
73. Gowri, G., R.C. Bugos, W.H. Campbell, C.A. Maxwell and R.A. Dixon (1991) Stress Response in Alfalfa (*Medicago sativa* L.) X. Molecular cloning and expression of S-Adenosyl-L-Methionine: caffeic acid 3-O-methyltransferase, a key enzyme of lignin biosynthesis. *Plant Physiology*, 97: 7-14.
74. Bugos, R.C., V.C. Chiang, and W.H. Campbell (1991) Seasonal expression of lignin specific caffeic acid/5-hydroxyferulic acid O-methyltransferase of aspen. *Proceedings of the International Symposium on Wood and Pulping Chemistry*, Melbourne, Australia, pp. 10-14.
75. Bugos, R.C., V.C. Chiang, and W.H. Campbell (1991) cDNA cloning, sequence analysis and seasonal expression of lignin bispecific caffeic acid/5-hydroxyferulic acid O-methyltransferase of aspen. *Plant Molecular Biology*, 17: 1203-1215.
76. Henne, L., W. H. Campbell, and E. Carlson (1991) Enhanced synthesis of endotoxin-induced tumor necrosis factor in mice by toxin shock syndrome toxin 1. *Infection and Immunity*, 59: 2929-33.
77. Hyde, G.E., N. Crawford, and W.H. Campbell (1991) The sequence of squash NADH:nitrate reductase and its relationship to the sequences of other flavoprotein oxidoreductases: A family of flavoprotein pyridine nucleotide cytochrome reductases. *Journal of Biological Chemistry* 266:23542-23547.
78. Gowri, G., J. Kenis, B. Ingemarsson, M.G. Redinbaugh, and W.H. Campbell (1992) Nitrate reductase transcript is expressed in the primary response of maize to environmental nitrate. *Plant Molecular Biology*, 18: 55-64.
79. Mellor, R.B., J. Ronnenberg, W.H. Campbell, and S. Diekmann (1992) Reduction of nitrate and nitrite in water by immobilized enzymes. *Nature* 355: 717-719.
80. Lu, G., W.H. Campbell, Y. Lindqvist, and G. Schneider (1992) Crystallization and preliminary crystallographic studies of the FAD domain of corn NADH:nitrate reductase. *Journal of Molecular Biology* 224: 277-279.

81. Bugos, R.C., V.L.C. Chiang, and W.H. Campbell (1992) Characterization of bispecific caffeic acid/5-hydroxyferulic acid O-methyltransferase from aspen. *Phytochemistry* 31: 1495-1498.
82. Campbell, W.H. (1992) Silicone spray as an aid for drying DNA sequencing gels. *Biotechniques* 13: 200-202.
83. Campbell, W.H. (1992) Expression in *Escherichia coli* of cytochrome c reductase activity from a maize NADH:nitrate reductase cDNA. *Plant Physiology* 99: 693-699.
84. Kenis, J. D., S. T. Silvente, C. M. Luna and W.H. Campbell (1992) Induction of nitrate reductase in detached corn leaves: the effect of the age of the leaves. *Physiologia Plantarum* 85: 49-56.
85. Huber, J.L., S.C. Huber, W.H. Campbell and M.G. Redinbaugh (1992) Reversible light/dark modulation of spinach leaf nitrate reductase activity involves protein phosphorylation. *Archives Biochem Biophysics* 296: 58-65.
86. Huber, S.C., J.L. Huber, W.H. Campbell and M.G. Redinbaugh (1992) Comparative studies of the light modulation of nitrate reductase and sucrose-phosphate synthase activities in spinach leaves. *Plant Physiol.* 100: 706-712.
87. Huber, S.C., J.L. Huber, W.H. Campbell and M.G. Redinbaugh (1992) Apparent dependence of the light activation of nitrate reductase and sucrose-phosphate synthase activities in spinach leaves on protein synthesis. *Plant Cell Physiol.* 33: 639-646.
88. Campbell, W.H., and B. Ingemarsson (1992) Autophosphorylation of maize leaf NADH: nitrate reductase. In: *Research in Photosynthesis*, N. Murata, ed., Kluwer Academic Press, Dordrecht, Vol IV, pp. 63-66.
89. Huber, S.C., J.L. Huber, R.W. McMichael, W.H. Campbell and M.G. Redinbaugh (1992) Regulation of cytoplasmic C- and N- metabolism by protein phosphorylation. In: *Research in Photosynthesis*, N. Murata, ed., Kluwer Academic Press, Dordrecht, Vol III, pp. 675-682.
90. Redinbaugh, M.G., and W.H. Campbell (1993) Glutamine synthetase and ferredoxin-dependent glutamate synthase expression in the maize (*Zea mays*) root primary response to nitrate: evidence for an organ-specific response. *Plant Physiol.* 101: 1249-1255.
91. Campbell, W. H., and U. N. Dwivedi (1993) Mutagenesis of the cysteine residues of the FAD domain of Nitrate reductase. In: *Flavins and Flavoproteins*, K. Yagi, ed., de Gruyter, Berlin, pp. 747-750.
92. Campbell, W. H. (1993) Commercial Potential of "Internal Redox Center" Enzymes: Applications of Nitrate Reductase. In: *Enzymes, A Billion Dollar Business by 2000: Fact or Fiction*, R. Heinneman and B. Wolnak, eds., Chicago, in press.
93. Dwivedi, U. N., N. Shiraishi, and W. H. Campbell (1994) Identification of an "essential" cysteine of nitrate reductase via mutagenesis of its recombinant cytochrome b reductase domain. *Journal of Biological Chemistry* 269: 13785-13791.
94. Caboche, M., W. H. Campbell, N. M. Crawford, E. Fernandez, A. Kleinhofs, S. Ida, R. Mendel, T. Omata, S. Rothstein, and J. Wray (1994) Genes Involved in Nitrate Assimilation. In: *Nomenclature of Sequenced Plant Genes*. *Plant Molecular Biology Reporter* 12: S45-S49.
95. Lu, G., W. H. Campbell, G. Schneider, and Y. Lindqvist (1994) Crystal structure of the FAD-containing fragment of corn nitrate reductase at 2.5 Å resolution: relationship to other flavoprotein reductases. *Structure*, 2: 809-821.
96. Ritchie, S. W., M. G. Redinbaugh, N. Shiraishi, J. M. Vrba and W. H. Campbell (1994) Identification of a maize root transcript expressed in the primary response to nitrate: Characterization of a cDNA with homology to ferredoxin NADP<sup>+</sup> oxidoreductase. *Plant Molecular Biology* 26: 679-690.
97. Dwivedi, U. N., N. Shiraishi, and W. H. Campbell (1994) Generation of multiple mutations in the same sequence via the polymerase chain reaction using a single selection primer. *Analytical Biochemistry*, 221: 425-428.
98. Ohlen, E., B. Ingemarsson, W. H. Campbell and C.-M. Larsson (1995) *Planta* in press.
99. Samuelson, M., W. H. Campbell and C.-M. Larsson (1995) The influence of cytokinins in nitrate regulation of nitrate reductase activity and expression in barley. *Physiologia Plantarum* 93: 533-539.
100. Dwivedi, U. N. and W. H. Campbell (1995) Antisense inhibition and co-suppression of lignin biosynthesis in transgenic *Arabidopsis* harboring O-methyltransferase gene constructs from aspen. *Life Science Advances - Plant Physiology* 14: 45-54.
101. Dwivedi, U. N., W. H. Campbell, J. Yu, R. S. S. Datla, R. C. Bugos, G. K. Podila and V. L. Chiang (1994) Modification of lignin biosynthesis in transgenic *Nicotiana* through expression of an antisense O-methyltransferase gene from *Populus*. *Plant Molecular Biology* 26: 61-71.
102. Dwivedi, U. N., J. Yu, R. S. S. Datla, W. H. Campbell, G. K. Podila and V. L. Chiang (1993) Expression of lignin-specific aspen O-methyltransferase antisense gene in tobacco and woody species to reduce lignin content. *CTAPI 7th International Symposium on Wood and Pulping Chemistry Proceedings*, 2: 633-639.

103. Huber, J. L., M. G. Redinbaugh, S. C. Huber and W. H. Campbell (1994) Regulation of maize leaf nitrate reductase activity involves both gene expression and protein phosphorylation. *Plant Physiology* 106:1667-74.
104. Lu, G., Y. Lindqvist, G. Schneider, U. N. Dwivedi and Wilbur H. Campbell (1995) Structural studies on corn nitrate reductase. Refined structure of the cytochrome b reductase fragment at 2.5 Å, its ADP complex and an active site mutant and modeling of the cytochrome b domain. *Journal of Molecular Biology* 248: 931-48.
105. Ratnam K., N. Shiraishi, Wilbur H. Campbell and R. Hille (1995) Spectroscopic and kinetic characterization of the recombinant wild-type and C242S mutant of the cytochrome b reductase fragment of nitrate reductase. *Journal of Biological Chemistry* 270: 24067-72.
106. Bugos, R.C., V. L. Chiang, X.-H. Zhang, E. R. Campbell, G. K. Podila and W. H. Campbell (1995) RNA isolation from plant tissues recalcitrant to extraction in guanidine. *BioTechniques* 19: 734-737.
107. Meng, H., and W.H. Campbell (1995) Cloning of aspen (*Populus tremuloides*) xylem caffeoyl-CoA 3-O-methyltransferase (GenBank U27116). *Plant Physiology* 108: 1749; *Plant Gene Register* PGR95-040.
108. Bachmann M., N. Shiraishi, Wilbur H. Campbell, B.-C. Yoo, A. C. Harmon, S. C. Huber (1996) Identification of the major regulatory site as Ser-543 in spinach leaf nitrate reductase and its phosphorylation by a Ca<sup>2+</sup>-dependent protein kinase in vitro. *The Plant Cell*, 8: 505-517.
109. Redinbaugh, M. G., S. C. Huber, J. L. Huber, K. W. Hendrix and Wilbur H. Campbell (1996) Nitrate reductase expression in maize leaves (*Zea mays* L.) during light dark transitions. Complex effects of protein phosphatase inhibitors on enzyme activity, protein synthesis and transcript levels. *Physiologia Plantarum*, 98: 67-76.
110. Campbell, Wilbur H. (1996) Nitrate reductase biochemistry comes of age. *Plant Physiology*, 111: 355-361.
111. Meng, H. and Campbell, Wilbur H. (1996) Characterization and Site-directed Mutagenesis of Aspen Lignin-Specific O-Methyltransferase Expressed in *Escherichia coli*. *Archives of Biochemistry and Biophysics*, 330: 329-341.
112. Redinbaugh, M. G., S. W. Ritchie, K. W. Hendrix, C. T. MacKown and Wilbur H. Campbell (1996) Expression of enzyme activities and transcripts required for nitrate assimilation in maize (*Zea mays* L. A188 x BMS) suspension cell cultures. *Plant Science* 119: 169-181.
113. Ratnam, K., N. Shiraishi, Wilbur H. Campbell, and R. Hille (1997) Spectroscopic and kinetic characterization of the recombinant cytochrome c reductase fragment of nitrate reductase: identification of the rate limiting catalytic step. *Journal of Biological Chemistry*, 272: 2122-2128.
114. Shiraishi, N., and Wilbur H. Campbell (1997) Expression of Nitrate Reductase FAD-Containing Fragments in *Pichia*. In: *Flavins and Flavoproteins 1996*, K. J. Stevenson, V. Massey & C. H. Williams, eds., Univ. of Calgary Press, Calgary, pp. 931-934.
115. Lindqvist, Y., G. Lu, G. Schneider, and Wilbur H. Campbell (1997) Crystallographic studies of the FAD/NADH binding fragment of corn nitrate reductase. In: *Flavins and Flavoproteins 1996*, K. J. Stevenson, V. Massey & C. H. Williams, eds., Univ. of Calgary Press, Calgary, pp. 899-907.
116. Ratnam, K., N. Shiraishi, Wilbur H. Campbell, and R. Hille (1997) Kinetic Studies of the cytochrome c reductase fragment of nitrate reductase. In: *Flavins and Flavoproteins 1996*, K. J. Stevenson, V. Massey & C. H. Williams, eds., Univ. of Calgary Press, Calgary, pp. 921-925.
117. Meng, H., and Wilbur H. Campbell (1997) Facile Enzymatic Synthesis of Caffeoyl CoA. *Phytochemistry*, 44: 605-608.
118. Campbell, E. R., and Wilbur H. Campbell (1997) The Difficulties of Nitrate Removal – Efficient denitrification can pose problems for treatment dealers. *Water Technology* 20: 58-64.
119. Campbell, E. R., J. S. Corrigan, and Wilbur H. Campbell (1997) Field Determination of Nitrate using Nitrate Reductase. *Proceedings of the Symposium on Field Analytical Methods for Hazardous Wastes and Toxic Chemicals*, Ed. E. Koglin, Air & Waste Management Association, Pittsburgh PA, pp. 851-860.
120. Su W., J. A. Mertens, K. Kanamaru, Wilbur H. Campbell, and N. M. Crawford (1997) Analysis of wild-type and mutant plant nitrate reductase expressed in the methylotrophic yeast *Pichia pastoris*. *Plant Physiology*, 115: 1135-1143.
121. Glazier S. A., Campbell E. R., & Wilbur H. Campbell (1998) Construction and characterization of nitrate reductase-based amperometric electrode and nitrate assay of fertilizers and drinking water. *Anal. Chem.* 70:1511-15
122. Shiraishi, N., C. Croy, J. Kaur, Wilbur H. Campbell (1998) Engineering of pyridine nucleotide specificity of nitrate reductase: mutagenesis of recombinant cytochrome b reductase fragment of *Neurospora crassa* NADPH:nitrate reductase. *Arch. Biochem. Biophys.* 335: 104-115.
123. Meng, H., and Wilbur H. Campbell (1998) Substrate Profiles and Expression of Caffeoyl Coenzyme A and caffeic acid O-Methyltransferase in Secondary Xylem of Aspen during Seasonal Development. *Plant Molecular Biology*, 38: 513-520.

124. Meng, H., and Wilbur H. Campbell (1998) Biochemistry and Molecular Biology of Lignin-Specific O-Methyltransferases from Woody Plant Species. In: Lignin and Lignan Biosynthesis, ACS Symposium Series 697, N. G. Lewis and S. Sarkanen, eds., American Chemical Society, Washington, DC, pp. 55-64.
125. Redinbaugh, M. G., and Wilbur H. Campbell (1998) Nitrate regulation of the oxidative pentose phosphate pathway in maize (*Zea mays* L.) root plastids: induction of 6-phosphogluconate dehydrogenase activity, protein and transcript levels. *Plant Science* 134: 129-140.
126. Campbell, E. R, and Wilbur H. Campbell (1998) Determination of Nitrate in Aqueous Matrices using Nitrate Reductase. In: Current Protocols in Field Analytical Chemistry, Supplement 1, Chapter 5 "Water Quality Parameters – Anions", John Wiley & Sons, Inc., New York, pp. 5A1.1-15.
127. Campbell, Wilbur H. (1999) Nitrate Reductase Structure, Function and Regulation: Bridging the Gap between Biochemistry and Physiology, *Annual Review of Plant Physiology and Plant Molecular Biology* 50:277-303.
128. George, G. N., Mertens, J. A., and Wilbur H. Campbell (1999) Structural Changes Induced by Catalytic Turnover at the Molybdenum Site of *Arabidopsis* Nitrate Reductase. *Journal of American Chemical Society*, 121: 9730-31.
129. Mertens, J. A., Wilbur H. Campbell, L. Skipper, and David J. Lowe (1999) Electron Transfer from FAD to Heme-Fe in Plant NADH:Nitrate Reductase. In: Flavins and Flavoproteins 1999, S. Ghisla, P. Kroneck, P. Macheroux, H. Sund, eds., Agency for Scientific Publications, Berlin, pp. 131-134. ISBN 3-00-005128-7.
130. Mertens, J. A., N. Shiraiishi, and Wilbur H. Campbell (2000) Recombinant Expression of Molybdenum Reductase Fragments of Plant Nitrate Reductase at High Levels in *Pichia pastoris*. *Plant Physiology* 123: 743-756.
131. Campbell, E. R., T. Kinnunen-Skidmore, L. A. Winowiecki, and W. H. Campbell (2001) A New Trend in Nitrate Analysis: An Enzyme-based Field Test for Nitrate. *American Laboratory (News Edition)* 33 (4): 90-92.
132. Campbell, W. H. (2001) Structure and Function of Eukaryotic NAD(P)H:Nitrate Reductase. *Cellular and Molecular Life Sciences*. 58: 194-204.
133. Mertens, J. A., R. Dubois-Dauphin, and Wilbur H. Campbell (2001) Domain-domain Interactions in Chimeric Corn-Arabidopsis NADH:Nitrate Reductase and Identification of Nitrate-Reducing Active Site Arginine Residues by Site-directed Mutagenesis in the Chimera. In preparation for submission.
134. Skipper L, WH Campbell, JA Mertens & DJ Lowe (2001) Pre-Steady-State Kinetic Analysis of Recombinant Arabidopsis NADH:Nitrate Reductase: Rate-Limiting Processes in Catalysis. *J. Biol. Chem.* 276: 26995-27002.
135. Campbell, W. H. (2002) Molecular Control of Nitrogen Metabolism and Its Relationship to Carbon Metabolism. In: *Advances in Photosynthesis and Respiration. Volume 12: Photosynthetic Nitrogen Assimilation and Associated Carbon and Respiratory Metabolism.* Foyer, C. H., and G. Noctor, eds., Kluwer Academic Press, Chapter 3, ISBN 0-7923-6336-1.
136. Patton CJ, AE Fischer, WH Campbell & ER Campbell (2002) Corn leaf nitrate reductase: A nontoxic alternative to cadmium for photometric nitrate determinations in water samples by air-segmented continuous-flow analysis. *Environmental Science and Technology*, 36: 729-35.
137. Campbell, WH (2002) Higher Plant Nitrate Reductase Biochemistry. *Physiology and Molecular Biology of Plants*, 8: 1-8.

## Patent Applications:

1. Polynucleotide coding for plant O-methyltransferase. Patent application filed by Michigan Technological University on behalf of Wilbur H. Campbell, Robert C. Bugos, and Vincent L. C. Chiang, September 27, 1991, Serial Number 767,138.
2. Nitrate detection, measurement and treatment system. Patent application filed by The Nitrate Elimination Co., Inc., on behalf of Wilbur H. Campbell and Ellen R. Campbell. November 25, 1996, Serial Number 08/758,147
3. Simplified eukaryotic nitrate reductase. Provisional patent application filed by The Nitrate Elimination Co., Inc., on behalf of Wilbur H. Campbell, Guillaume G. Barbier, and Ellen R. Campbell. December 14, 2001, Serial Number – 60/340,237.
4. Simplified eukaryotic nitrate reductase. International patent application filed by The Nitrate Elimination Co., Inc., on behalf of Wilbur H. Campbell, Guillaume G. Barbier, and Ellen R. Campbell, serial number PCT-US02-39341 (international patent publication WO 03/052063, June 26, 2003).