

REUBEN J. PETERS

Roy J. Carver Professor of Biochemistry, Biophysics & Molecular Biology
Roy J. Carver Department of Biochemistry, Biophysics & Molecular Biology
Iowa State University

Professional Preparation:

- 1987-1992 University of California at San Diego, John Muir College
B.S. in Molecular Biology (Minor in Computer Science-Theory)
- 1992-1998 University of California at San Francisco, Program in Biological Sciences
Ph.D. in Biochemistry & Biophysics with David A. Agard
- 1998-2002 Washington State University, Institute of Biological Chemistry
Jane Coffin Childs Postdoctoral fellow with Rodney B. Croteau

Appointments:

- 2011-present Professor, Roy J. Carver Dept. BBMB, ISU
- 2019-2024 Roy J. Carver Professor of Biochemistry, Biophysics & Molecular Biology
- 2009,11,13 Visiting Fellow, Max Planck Institute for Chemical Ecology (Jena, Germany)
- 2006-2014 Director of Graduate Education, BBMB, ISU
- 2007-2011 Associate Professor, Dept. BBMB, Iowa State Univ. (ISU)
- 2002-2007 Assistant Professor, Dept. Biochem., Biophys. & Mol. Biol. (BBMB), ISU

Research Interests:

- Natural products biosynthesis, particularly labdane-related diterpenoids (~7,000 known)
- Enzymatic mechanisms and engineering
 - Metabolic pathway elucidation and engineering
 - Investigation of physiological roles and biological activities

Teaching Interests:

- Biochemistry, metabolism, enzymology
- courses taught: General Biochemistry (undergraduate)
Enzymology & Plant Biochemistry (graduate)

Honors and Awards:

- 2019 ISU – Exemplary Faculty Mentor Award
- 2017 ISU – College of Liberal Arts and Sciences Graduate Mentoring Award
- 2015 Fellow of the American Association for the Advancement of Science
- 2009-2013 Alexander von Humboldt Research Fellowship
- 2008 ISU – College of Liberal Arts and Sciences Mid-Career Research Award
- 2008 ISU – College of Agriculture and Life Sciences Distance Education Award
- 2006 Neish Young Investigator Award – Phytochemical Society of North America
- 1999-2002 Fellow of the Jane Coffin Childs Memorial Fund for Medical Research

Membership in Professional Societies:

- 1994-present American Association for the Advancement of Science
- 1999-present American Chemical Society
- 2000-present American Society of Plant Biologists
- 2005-present Phytochemical Society of North America
- 2010-present American Society for Biochemistry and Molecular Biology

Professional Activities: reviewed >400 manuscripts & >300 grants

2017-present Associate Editor – Frontiers in Plant Metabolism and Chemodiversity
2012-present Editorial Board Member – Journal of Biological Chemistry
2014-present Scientific Advisory Board Member – Manus Bio, Inc.
2008-2018 Editorial Board Member – Phytochemistry
2015-2017 Scientific Advisory Board Member – TriForC (EU project)
2018 Grant Panel Member – National Science Foundation (Chem. Life Processes)
2015-2019 Ad hoc Study Section Member – National Inst. of Health (NIGMS-MIRA), 1/yr
2015 Ad hoc Study Section Member – National Inst. of Health (Glue grant)
2014 Ad hoc Study Section Member – National Inst. of Health (Syn. & Biol. Chem. B)
2009-2013 Regular Study Section Member – National Inst. of Health (Syn. & Biol. Chem. B)
2011 Grant Panel Member – National Science Foundation (Molecular Biochemistry)
2006-2010 Grant Panel Member – National Science Foundation (Metabolic Biochemistry)
2006,08 Ad hoc Study Section Member – National Inst. of Health (Syn. & Biol. Chem. B)
2004 Ad hoc Study Section Member – National Inst. of Health (Bioorg. Natural Prod.)

Service: selected from >40 (plus >30 thesis committees & mentoring 3 faculty members)

2015-present LAS Representative Assembly (Executive Council member 2017-2020)
2013-present Faculty founder/mentor – BBMB graduate learning community
2009-present Organizing committee – Terpenet International Symposium on Isoprenoids
2013,14,17-19 Mentor – ASBMB Minority Affairs Committee IMAGE New Faculty Workshop
2006-2014 BBMB Director of Graduate Education
2005-2008 LAS Honors committee

Research Mentoring: 12 postdoctoral scholars; 16 PhD, 5 MS and 38 undergraduate students.

Research Support: External total (Peters share only) > \$11,000,000

Current

Investigating (di)terpenoid biosynthesis

Agency: NIH-NIGMS (MIRA)

Amount: \$2,508,215 (total)

Period: June 1, 2019 – May 31, 2024

Role: PI (Co-I: Dean Tantillo & Justin Siegel)

Pending

Investigating the role of rice diterpenoid natural products in plant-microbe interactions

Agency: USDA-NIFA (PBI)

Amount: \$813,000 (total)

Period: June 1, 2020 – May 31, 2024

Role: PI (Co-PI: Bing Yang)

Publications: >7,600 citations; h=52; i10=108; rel. citation ratio – mean >2, weighted >240

128. Zhang, J., Peters, R.J. (2020) “Why are momilactones always associated with biosynthetic gene clusters in plants?”, *Proc. Natl. Acad. Sci. U.S.A.*, in press.
127. Nett, R.S., Nguyen, H., Nagel, R., Marcassa, A., Charles, T.C., Friedberg, I., Peters, R.J. (2020) “Unraveling a tangled skein: Evolutionary analysis of the bacterial gibberellin biosynthetic operon”, *mSphere*, in press.
126. Peters, R.J. (2020) “Doing the gene shuffle to close synteny: Dynamic assembly of biosynthetic gene clusters”, *New Phytol.*, in press.
125. Pu, X., Tian, Y., Gao, R., Hao, L., Hu, Y., He, C. Xu, M., Peters, R.J., Xu, Z. Song, J. (2020) “The honeysuckle genome provides insight into the molecular mechanisms of carotenoid metabolism underlying dynamic flower coloration”, *New Phytol.*, in press.

124. Tu, L.-C., Su, P., Zhang, Z.-H., Gao, L.-H., Wang, J.-D., Hu, T.-Y., Zhou, J.-W., Zhang, Y.-F., Zhao, Y.-J., Liu, Y., Xong, Y.-D., Tong, Y.-R., Lu, Y., Yang, J., Xu, C., Jia, M., Peters, R.J., Huang, L., Gao, W. (2020) “Multi-omics analysis of *Tripterygium wilfordii* provides a foundation for investigation of triptolide biosynthesis”, *Nat. Commun.*, 11(1):971.
123. Zhang, J., Zhang, Y., Xing, J., Yu, H., Zhang, R., Tian, X., Duan, L., Zhang, M., Peters, R.J., Li, Z. (2020) “Introducing Selective Agrochemical Manipulation of Gibberellin Metabolism into a Cereal Crop”, *Nat. Plants*, 6(2):67-72.
122. He, J., Chen, Q., Xin, P., Yuan, J., Ma, Y., Wang, X., Xu, M., Chu, J., Peters, R.J., Wang, G. (2019) “CYP72A Enzymes Catalyzing 13-Hydroxylation of Gibberellin are Indispensable for Primary Seed Dormancy in Brassicaceae Plants”, *Nat. Plants*, 5(10):1057-1065.
121. Lemke, C., Potter, K.C., Schulte, S., Peters, R.J. (2019) “Conserved bases for the initial cyclase in gibberellin phytohormone biosynthesis: from bacteria to plants”, *Biochem. J.*, 476(18):2607-2621.
120. Jia, M., Zhang, Y., Siegel, J.B., Tantillo, D.J., Peters, R.J. (2019) “Switching on a Nontraditional Enzymatic Base – Deprotonation by Serine in the *ent*-Kaurene Synthase from *Bradyrhizobium japonicum*”, *ACS Catal.*, 9(10):8867-8871.
119. Huang, J., Zha, W., An, T., Dong, H., Huang, Y., Wang, D., Yu, R., Duan, L., Zhang, X., Peters, R.J., Dai, Z., Zi, J. (2019) “Identification of RoCYP01 (CYP716A155) enables construction of engineered yeast for high-yield production of betulinic acid”, *Appl. Microbiol. Biotechnol.*, 103(17):7029-7039.
118. Jia, M., Mishra, S.K., Tufts, S., Jernigan, R.L., Peters, R.J. (2019) “Combinatorial biosynthesis and the basis for substrate promiscuity in class I diterpene synthases”, *Met. Eng.*, 55:44-58.
117. Sun, W., Leng, L., Yin, Q., Xu, M., Huang, M., Xu, Z., Zhang, Y., Wang, C., Xiong, C., Chen, S., Jiang, C., Xie, N., Song, C., Peters, R.J., Chen, S. (2019) “The medicinal plant *Andrographis paniculata* genome provides insight into biosynthesis of the bioactive diterpenoid neoandrographolide”, *Plant J.*, 97(5):841-857.
116. Nagel, R., Schmidt, A., Peters, R.J. (2019) “Isoprenyl diphosphate synthases, the chain length determining step in terpene biosynthesis”, *Planta*, 249(1):9-20.
115. Nagel, R., Bieber, J., Schmidt-Dannert, M.G., Nett, R.S., Peters, R.J. (2018) “A Third Class: Functional Gibberellin Biosynthetic Operon in Beta-Proteobacteria”, *Front. Microbiol.*, 9:2916.
114. Nagel, R., Thomas, J.A., Adekunle, F.A., Mann, F.M., Peters, R.J. (2018) “Arginine in the FARM & SARM: A role in chain-length determination for arginine in the aspartate-rich motifs of isoprenyl diphosphate synthases from *Mycobacterium tuberculosis*”, *Molecules*, 23(10):2546.
113. Nagel, R., Peters, R.J. (2018) “Probing the specificity of CYP112 in bacterial gibberellin biosynthesis”, *Biochem. J.*, 475(13):2167-2177.
112. Schulte, S., Potter, K.P., Lemke, C., Peters, R.J. (2018) “Catalytic bases and stereo-control in Lamiaceae class II diterpene cyclases”, *Biochemistry*, 57(25):3473-3479.
111. Lu, X., Zhang, J., Brown, B., Li, R., Rodríguez-Romero, J., Berasategui, A., Liu, B., Xu, M., Luo, D., Pan, Z., Baerson, S.R., Gershenzon, J., Li, Z., Sesma, A., Yang, B., Peters,

- R.J. (2018) “Inferring roles in defense from metabolic allocation with rice diterpenoids”, *Plant Cell*, 30(5):1119-1131.
110. Liang, J., Liu, J., Jia, M., Brown, R., Zhou, K., Peters, R.J., Wang, Q. (2018) “Direct production of dihydroxylated sesquiterpenoids by a maize terpene synthase”, *Plant J.*, 94(5):847-856.
109. Nagel, R., Peters, R.J. (2018) “Diverging Mechanisms: Cytochrome-P450 Catalyzed Demethylation and γ -Lactone Formation in Bacterial Gibberellin Biosynthesis”, *Angew. Chem. Int. Ed.*, 57(21):6082-6085.
108. Jia, M., O’Brien, T.E., Zhang, Y., Siegel, J.B., Tantillo, D.J., Peters, R.J. (2018) “Changing face: A key residue for the addition of water by sclareol synthase”, *ACS Catal.*, 8(4):3133-3137.
107. Xu, M., Jia, M., Hong, Y.J., Yin, X., Tantillo, D.J., Proteau, P.J., Peters, R.J. (2018) “Premutilin synthase: Ring rearrangement by a class II diterpene cyclase”, *Org. Lett.*, 20:1200-1202.
106. Su, P., Guan, H., Zhao, Y., Tong, Y., Xu, M., Zhang, Y., Hu, T., Yang, J., Cheng, Q., Gao, L., Liu, Y., Zhou, J., Peters, R.J., Huang, L., Gao, W. (2018) “Identification and functional characterization of diterpene synthases for triptolide biosynthesis from *Tripterygium wilfordii*”, *Plant J.*, 93(1):50-63.
105. Nagel, R., Peters, R.J. (2017) “ $^{18}\text{O}_2$ labeling studies illuminate the oxidation of *ent*-kaurene in bacterial gibberellin biosynthesis”, *Org. Biomol. Chem.*, 15(36):7566-7571.
104. Inabuy, F.X., Fishedick, J.T., Lange, I., Hartmann, M., Srividya, N., Parrish, A.N., Xu, M., Peters, R.J., Lange, B.M. (2017) “Biosynthesis of diterpenoids in *Tripterygium* adventitious root cultures”, *Plant Physiol.*, 175(1):92-103.
103. Nagel, R., Peters, R.J. (2017) “Investigating the phylogenetic range of gibberellin biosynthesis in bacteria”, *Mol. Plant-Microbe Interact.*, 30(4):343-349.
102. Nett, R.S., Contreras, T., Peters, R.J. (2017) “Characterization of CYP115 as a gibberellin 3-oxidase indicates that certain rhizobia can produce bioactive gibberellin A₄”, *ACS Chem. Biol.*, 12(4):912-917.
101. Jia, M., Peters, R.J. (2017) “*cis* or *trans* with class II diterpene cyclases”, *Org. Biomol. Chem.*, 15(15):3158-3160.
100. Nagel, R., Turrini, P., Nett, R.S., Leach, J.E., Verdier, V., Van Sluys, M.-A., Peters, R.J. (2017) “An operon for production of bioactive gibberellin A₄ phytohormone with wide distribution in the bacterial rice leaf streak pathogen *Xanthomonas oryzae* pv. *oryzicola*”, *New Phytol.*, 214(3):1260-1266.
99. Jia, M., Zhou, K., Tufts, S., Schulte, S., Peters, R.J. (2017) “A pair of residues that interactively affect diterpene synthase product outcome”, *ACS Chem. Biol.*, 12(3):862-867.
98. Xu, M., Hillwig, M.L., Tiernan, M.S., Peters, R.J. (2017) “Probing labdane-related diterpenoid biosynthesis in the fungal genus *Aspergillus*”, *J. Nat. Prod.*, 80(2):328-333.
97. Nett, R.S., Montanares, M., Marcassa, A., Lu, X., Nagel, R., Charles, T.C., Hedden, P., Rojas, M.C., Peters, R.J. (2017) “Elucidation of gibberellin biosynthesis in bacteria reveals convergent evolution”, *Nat. Chem. Biol.*, 13(1):69-74.
96. Nett, R.S., Dickschat, J.S., Peters, R.J. (2016) “Labeling studies clarify the committed step in bacterial gibberellin biosynthesis”, *Org. Lett.*, 18(23):5974-5977.

95. Jia, M., Peters, R.J. (2016) "Extending a single residue switch for abbreviating catalysis in plant *ent*-kaurene synthases", *Front. Plant Sci.*, 7:1765.
94. Wang, Q., Jia, M., Huh, J.-H., Peters, R.J., Tholl, D. (2016) "Identification of a Dolabellane Type Diterpene Synthase and other Root-Expressed Diterpene Synthases in *Arabidopsis*", *Front. Plant Sci.*, 7:1761.
93. Kumar, S., Kempinski, C., Zhuang, X., Norris, A., Mafu, S., Zi, J., Bell, S., Nybo, S., Kinison, S., Jiang, Z., Goklany, S., Linscott, K., Chen, X., Jia, Q., Brown, S., Bowman, J. Babbitt, P. Peters, R.J., Chen, F., Chappell, J. (2016) "Molecular Diversity of Terpene Synthases in the Liverwort *Marchantia polymorpha*", *Plant Cell*, 28(10):2632-2650.
92. Kitaoka, N., Wu, Y., Wang, Q., Zi, J., Peters, R.J. (2016) "Investigating inducible short-chain alcohol dehydrogenases/reductases clarifies rice oryzalexin biosynthesis", *Plant J.*, 88(2):271-279.
91. Xu, H., Song, J., Luo, H., Li, Q., Zhu, Y., Xu, J., Li, Y., Song, C., Wang, B., Sun, W., Shen, G., Zhang, X., Qian, J., Zhang, Y., Ji, A., Xu, Z., Luo, X., He, L., Li, C., Sun, C., Yan, H., Cui, G., Li, X., Wei, J., Li, X., Liu, J., Wang, Y., Hayward, A., Nelson, D., Ning, Z., Peters, R.J., Qi, X., Chen, S. (2016) "Analysis of the genome sequence of the medicinal plant *Salvia miltiorrhiza*", *Mol. Plant*, 9(6):949-952.
90. Jia, M., Potter, K.C., Peters, R.J. (2016) "Extreme promiscuity of a bacterial and a plant diterpene synthase enables combinatorial biosynthesis", *Met. Eng.*, 37:24-34.
89. Guo, J., Ma, X., Cai, Y., Ma, Y., Zhan, Z., Zhou, Y.J., Liu, W., Guan, M., Yang, J., Cui, G. Kang, L., Yang, L., Shen, Y., Tang, J., Lin, H., Ma, X., Liu, Z., Peters, R.J., Zhao, Z.K., Huang, L. (2016) "Cytochrome P450 promiscuity leads to a bifurcating biosynthetic pathway for tanshinones", *New Phytol.*, 210(2):525-534.
88. Potter, K.C., Jia, M., Young, Y.J., Tantillo, D.J., Peters, R.J. (2016) "Product rearrangement from altering a single residue in the rice *syn*-copalyl diphosphate synthase", *Org. Lett.*, 18(5):1060-1063.
87. Mafu, S., Jia, M., Zi, J., Morrone, D., Wu, Y., Xu, M., Hillwig, M.L., Peters, R.J. (2016) "Probing the promiscuity of *ent*-kaurene oxidase via combinatorial biosynthesis", *Proc. Natl. Acad. Sci. U.S.A.*, 113(9):2526-2531.
86. Fu, J., Ren, F., Lu, X., Mao, H., Xu, M., Degenhardt, J., Peters, R.J., Wang, Q. (2016) "A tandem array of *ent*-kaurene synthases in maize with roles in gibberellin and more specialized metabolism", *Plant Physiol.*, 170(2):742-751.
85. Potter, K.C., Zi, J., Young, Y.J., Schulte, S., Malchow, B.K., Tantillo, D.J., Peters, R.J. (2016) "Blocking deprotonation with retention of aromaticity in a plant *ent*-copalyl diphosphate synthase leads to product rearrangement", *Angew. Chem. Int. Ed.*, 55(2):634-638.
84. Mao, H., Liu, J., Ren, F., Peters, R.J., Wang, Q. (2016) "Characterization of CYP71Z18 indicates a role in maize zealexin biosynthesis", *Phytochemistry*, 121(1):4-10.
83. Cui, G., Duan, L., Jin, B., Qian, J., Xue, Z., Shen, G., Snyder, J.H., Song, J., Chen, S., Huang, L., Peters, R.J., Qi, X. (2015) "Functional divergence of diterpene synthases in the medicinal plant *Salvia miltiorrhiza* Bunge", *Plant Physiol.*, 169(3):1607-1618.
82. Kitaoka, N., Wu, Y., Xu, M., Peters, R.J. (2015) "Optimization of recombinant expression enables discovery of novel cytochrome P450 activity in rice diterpenoid biosynthesis", *Appl. Microbiol. Biotechnol.*, 99(18):7549-7558.

81. Mafu, S., Potter, K.C., Hillwig, M.L., Schulte, S., Criswell, J., Peters, R.J. (2015) "Efficient heterocyclisation by (di)terpene synthases", *Chem. Commun.*, 51(70):13485-13487.
80. Xu, Z., Peters, R.J., Weirather, J., Luo, H., Liao, B., Zhang, X., Zhu, Y., Ji, A., Zhang, B., Hu, S., Au, K.I., Song, J., Chen, S., (2015) "Full-length transcriptome sequences and splice variants obtained by a combination of sequencing platforms applied to different root tissues of *Salvia miltiorrhiza* and tanshinone biosynthesis", *Plant J.*, 82(6):951-961.
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78. Matsuba, Y., Zi, J., Jones, A.D., Peters, R.J., Pichersky, E. (2015) "Biosynthesis of the diterpenoid lycosantalol via nerylneryl diphosphate in *Solanum lycopersicum*", *PLOS One*, 10(3):e0119302.
77. Lu, X., Hershey, D.M., Wang, L., Bogdanove, A.J., Peters, R.J. (2015) "An *ent*-kaurene derived diterpenoid virulence factor from *Xanthomonas oryzae* pv. *oryzicola*", *New Phytol.*, 206(1):295-302.
76. Boutanaev, A., Moses, T., Zi, J., Nelson, D., Mugford, S., Peters, R.J., Osbourn, A. (2015) "Investigation of terpene diversification across multiple sequenced plant genomes", *Proc. Natl. Acad. Sci. U.S.A.*, 112(1):E81-E88.
75. Kitaoka, N., Lu, X., Yang, B., Peters, R.J. (2015) "The application of synthetic biology to elucidation of plant mono-, sesqui-, and diterpenoid metabolism", *Mol. Plant*, 8(1):6-16.
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66. Köksal, M., Potter, K., Peters, R.J., Christianson, D.W. (2014) "1.55 Å-Resolution Structure of *ent*-Copalyl Diphosphate Synthase and Exploration of General Acid Function by Site-Directed Mutagenesis", *BBA-Proteins Proteom.*, 1840(1):184-190.
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63. Guo, J., Zhou, Y.J., Hillwig, M.L., Shen, Y., Yang, L., Wang, Y., Zhang, X., Liu, W., Peters, R.J., Chen, X., Zhao, Z.K., Huang, L. (2013) "CYP76AH1 catalyzes turnover of miltiradiene in tanshinones biosynthesis and enables heterologous production of ferruginol in yeasts", *Proc. Natl. Acad. Sci. U.S.A.*, 110(29):12108-12113.
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59. Wu, Y., Zhou, K., Toyomasu, T., Sugawara, C., Oku, M., Abe, S., Usui, M., Mitsuhashi, W., Chono, M., Chandler, P.M., Peters, R.J. (2012) "Functional characterization of wheat copalyl diphosphate synthases sheds light on the early evolution of labdane-related diterpenoid metabolism in the cereals", *Phytochemistry*, 84:40-46.
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2. Peters, R.J.; Xu, M. "Identification of *syn*-stemodene synthase" U.S. Patent No. 7,833,748.
3. Peters, R.J.; Russell, D.G.; Mann, F.M. "A diterpene modulator of macrophage phagosomal maturation" U.S. Patent No. 8,309,322.
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