Biodesign of *Zymomonas mobilis* as a chassis for lignocellulosic bioproduct synthesis

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Abstract

Zymomonas mobilis, a native ethanologen, is widely recognized as a robust microbial catalyst for industrial lignocellulosic ethanol production but its development as a microbial chassis amenable to synthetic biology approaches and to metabolic engineering for production of desirable products other than ethanol remains a significant challenge. The US DOE Great Lakes Bioenergy Research Center (GLBRC) is optimizing *Zymomonas mobilis* as a component of its integrated strategy to convert dedicated bioenergy crops grown on lands not suitable for food production to economic and environmentally sustainable lignocellulosic biofuels and bioproducts. The GLBRC strategy relies on efficient catalytic deconstruction of biomass to lignin and sugar fractions and conversion of all available carbon including from process residues to useful biofuels or bioproducts. Center researchers have developed efficient systems to engineer the *Z. mobilis* genome, established gene expression control mechanisms for *Z. mobilis*, and defined its key metabolic bottlenecks for production of alternative fermentation products like isobutanol and for production of isoprenoids via its already robust methyl erythritol phosphate (MEP) pathway. By carefully regulating levels of pyruvate decarboxylase, the central node in the highly efficient Entner-Doudoroff glycolytic pathway in *Z. mobilis*, as well as the levels of enzymes needed for isobutanol synthesis, greater than 50% theoretical yields of isobutanol from glucose have been achieved. Current efforts focus on developing regulatory systems to balance microbial growth with maximal isobutanol production and on optimizing enzyme levels for MEP pathway overexpression.

Brief Biography

Prof. Robert Landick is Science Director for the US DOE Great Lakes Bioenergy Research Center and an expert on microbial gene regulation with particular emphasis on RNA polymerase structure, function, and regulation. He has served as a faculty member at the University of Wisconsin–Madison since 1996, most recently as the Charles Yanofsky Professor of Biochemistry and Bacteriology and the Laurens Anderson Professor of Biochemistry. He is a fellow of the American Academy of Microbiology, the American Association for the Advancement of Science, and the American Academy of Arts and Sciences. His decades of research into fundamental mechanisms of transcriptional regulation have defined the elemental mechanism and structural basis of transcriptional pausing, genome-scale mechanisms by which transcriptional factors and bacterial chromatin control gene expression, and the structure–function of RNA polymerase enzymes in diverse bacteria.

He has authored over 200 scientific publications and maintains active current efforts in teaching and training, science administration, and basic bioscience research.

Brief CV

Robert Landick, Ph.D.

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Education:

B.S Chemistry, University of Michigan, US, 1975

Ph.D. Biological Chemistry, University of Michigan, US, 1983

Professional Career:

1983-1986: Stanford University, US, Postdoctoral Fellow.

1986-1991: Washington University–St. Louis, US, Assistant Professor.

1991-1995: Washington University–St. Louis, US, Associate Professor.

1995-1996: Washington University–St. Louis, US, Professor.

1996-Present: University of Wisconsin–Madison, US, Professor.

Research Interests:

1. Microbial Gene Regulation
2. Microbial Systems and Synthetic Biology
3. RNA Polymerase Structure–Function

Selected publications

1. Shen, B. and Landick, R. ***J. Mol. Biol.***, 2019, ePub online.
2. Lui, Y. et al. ***ACS Synth Biol***, 2019, 8:264-273
3. Ghosh, I. et al. ***Metabolic Engineering***, 2018, 52:324-340.
4. Boudreau, B. et al. ***Nucleic Acids Res.***, 2018, 46:5525-5546.
5. Yang, S. et al. ***Biotechnol Biofuels***, 2018, 11:125.
6. Kohler, R. et al. ***Science***, 2017, 356:194-197.
7. Piotrowski, J. et al. ***Proc. Natl. Acad. Sci USA***, 2015, 112:e1490-1497.
8. Ghosh, I. et al. ***ACS Synth Biol***, 2016, 5:1519-1534.
9. Larson, M. et al. ***Science*** 2014, 344:1042-1047.
10. Haft, R. et al. ***Proc. Natl. Acad. Sci USA***, 2014, 111:e2576-2585.