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A systems biology approach to investigate environmental influence on *Pseudomonas aeruginosa* biofilm formation

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Abstract

The investigation of biofilm formation is an urgent research theme in systems biology, as biofilms are heavily involved in bacterial chronic inflammatory and infectious diseases. Since the ability of pathogens to resist antibiotics is enhanced 10 to 1000 times once they form biofilms, a better understanding of the biofilm formation of pathogens can facilitate the prevention of biofilm-associated human diseases. In this work, we developed a systems biology approach to investigate the capability of *Pseudomonas aeruginosa* to form biofilms under different environmental conditions that are characterized by different accessible nutrition components. Specifically, gene expression data were used to pinpoint the reactions that are closely associated with biofilm formation. The flux changes through these biofilm-associated reactions, which were quantified via flux balance analysis and artificially-center-hit-and-run sampling method, were used as soft-sensors for quantifying the trend of biofilm formation upon the change of availability of a specific nutrient component. It was found from our study that limitation of the uptake of iron, phosphate, and sulfate strongly enhances *P. aeruginosa*'s biofilm formation, as evidenced by (a) the fluxes through certain biofilm-associated reactions surge, and (b) the biomass growth is significantly slowed down, which means that the enhanced fluxes through biofilm-associated reactions are not due to the increased bacterial growth. Addition of amino acids that include arginine, isoleucine, leucine, proline, ornithine, tyrosine and valine into the minimum medium was found to enhance the biofilm formation. The reactions encoded by genes *PA2007* and *PA4867* were identified to facilitate biofilm formation in amino acid rich environment.

Biography

Zuyi (Jacky) Huang completed his Ph.D. from Texas A&M University in 2010 and then worked as a Research Scientist in the Henry M. Jackson Foundation for the Advancement of Military Medicine. He joined the Department of Chemical Engineering at Villanova University as an Assistant Professor in 2011. He is now the Director of Computational Systems Biology Lab at Villanova University. He has published 18 papers in reputed journals. He is now serving as an editorial board member of Journal of Computer Science & Systems Biology. He is also serving on the International Federation of Automatic Control (IFAC) Policy Committee.