Molecular microbiology: Enzymes and value-added chemicals via microbial catabolism of environmental molecules

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Introduction

Pseudomonas putida strains are among the microorganisms that have acquired the capability to use toxic and xenobiotic compounds, such as nicotine, for growth. Bacterial genomics helps us speed systematic unraveling of the unsolved pathway of nicotine degradation in *Pseudomonas*. Microbial degradation of *N*-heterocycles, such as nicotine, may produce numerous intermediates, and many of these intermediates are potential building blocks for the synthesis of agrochemicals and pharmaceuticals (Figure 1A).

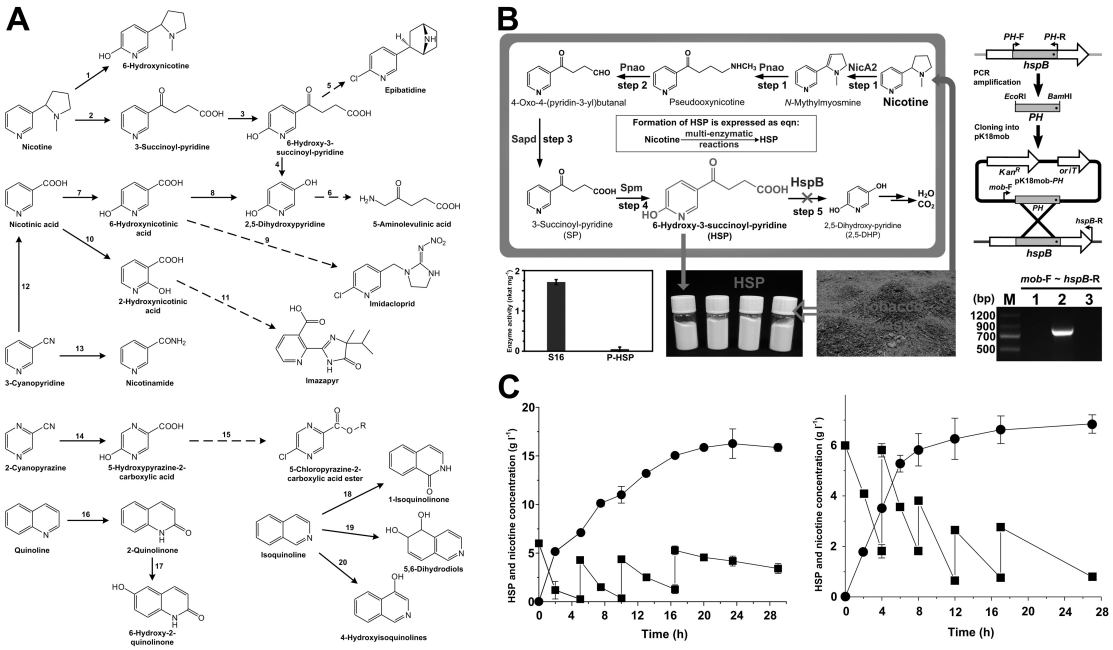

Figure 1A. Microbial transformation of some *N*-heterocycles, and the potential use in chemistry synthesis. Solid arrow line: biological processes. Arrow dash-line: chemical processes. **Figure 1B. Characteristics of engineered *P. putida* P-HSP.** (a) The metabolic pathway of nicotine in *P. putida* P-HSP was locally blocked (top). **Figure 1C. Time course of fed-batch whole-cell biotransformation by engineered strain *P. putida* P-HSP.**

Results

To comprehensively and accurately elucidate key processes of nicotine degradation in *Pseudomonas putida*, all the genes for the pathway have been characterized. The proteins and functional pathway identified in the current study represent attractive targets for degradation of environmental toxic compounds. A genetically engineered strain of *Pseudomonas putida* was constructed (Figure 1B), which realized the accumulation of a high-value-added chemical HSP from tobacco-waste, and the HSP production of engineered strain was 3.7-fold of the non-engineered strain (Figure 1C). This work demonstrates that a green strategy to block the catabolic pathway of *N*-heterocycles is a promising approach to achieve the mutasynthesis of valuable compounds.

Conclusion

Bacterial genomics is a powerful tool to systematic unraveling of the unsolved pathways of *N*-heterocycles degradation. In the heterocycles catabolism, there are many useful enzymes and reactions to be engineered for synthesis of value-added chemicals. The metabolic engineering or synthetic biology research based on microbial degradation highlights the potentials in biotechnology.

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Metabolic Engineering

Molecular Microbiology

Brief CV: Dr. Ping Xu is a distinguished professor of microbiology, biomolecular engineering and biochemical engineering as the deputy director of State Key Lab of Microbial Metabolism at Shanghai Jiao Tong University (SJTU). Dr. Xu has authored and co-authored over 220 research articles and over 80 issued and pending patent applications with several being licensed by industry. In addition, he has given over 100 of plenary, keynote or invited lectures in international meetings, universities, industries, and research institutes. Dr. Xu received numerous research and teaching awards and honors, such as Winner of Young Asian Biotechnologist Prize of the Society for Biotechnology Japan (2007), and a Fellow of the American Institute of Medical and Biological Engineering (AIMBE, 2014). He has been elected a member of the US National Academy of Inventors (NAI, 2015) and a Fellow of American Academy of Microbiology (AAM, 2019). Dr. Xu serves as the consultant for over 10 companies, and his primary research interests are in the seminal discovery of useful bacteria and using metabolic engineering for agricultural, biotechnological, clean-environmental engineering and waste treatment applications.

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