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RESEARCH & COLLABORATION PROFILE

KEY WORDS : Synthetic Biology, Systems Biology, Microbial Cell Factory, Metabolic Engineering, Diagnostics

Research Snapshot. Prof. Han develops synthetic biology tools and evolutionary engineering strategies to build efficient, predictable microbial cell factories. His work integrates synthetic transcriptional/translational control systems, adaptive laboratory evolution, and multi-omics analysis to enable precise and scalable production of chemicals, biofuels, and pharmaceuticals in bacteria, and he is expanding into cell-free prototyping and molecular diagnostics.

RESEARCH EXPERTISE

- **Synthetic gene expression control:** engineering synthetic translational coupling systems and RNA/protein-based bioparts for accurate, predictable control of polycistronic gene expression in bacteria.
- **Evolutionary & genome engineering:** adaptive laboratory evolution and genome-scale mutagenesis (Tn-seq/MAGE) to improve microbial phenotypes and uncover genotype–phenotype relationships.
- **Microbial cell factory design:** metabolic pathway redesign in *E. coli*, *Vibrio*, and methanotrophic bacteria for improved substrate utilization and biochemical production.
- **Cell-free systems & diagnostics:** prototyping synthetic biology tools and molecular diagnostic kits on cell-free expression platforms.

RECENT RESEARCH HIGHLIGHTS

- **Rapid genome engineering (Trends in Biotechnology, 2026):** co-developed an integrated Tn-seq and MAGE-assisted platform for rapid, targeted genome engineering in *E. coli*.
- **Synthetic translational coupling (Metabolic Engineering, 2025):** developed a synthetic translational coupling system enabling accurate, predictable control of polycistronic gene expression in bacteria.
- **Elucidation of molecular mechanism (Nucleic Acids Research, 2025):** discovered promoter-proximal transcription control mechanism in *E. coli*.

POTENTIAL COLLABORATION RESEARCH

Best-fit collaborator areas: synthetic biology & metabolic engineering | microbial genome/evolutionary engineering | multi-omics & systems biology | cell-free synthetic biology & diagnostics

- **1. Microbial strain engineering:** joint construction of microbial cell factories for producing biochemicals, biofuels, and pharmaceuticals.
- **2. Evolutionary engineering:** adaptive laboratory evolution campaigns coupled with multi-omics analysis to identify beneficial mutations.
- **3. Cell-free prototyping & diagnostics:** collaborative development of cell-free expression systems and molecular diagnostic kits.
- **4. Bioremediation:** microbial cell engineering for pollution, heavy metals, and waste treatment.

SELECTED RECENT PUBLICATIONS

- ***Trends Biotechnol.* 44, 836–861 (2026) —** Rapid genome engineering platform in *E. coli* based on transposon, biosensor, NGS, and MAGE.
- ***Metab. Eng.* 88, 148–159 (2025) —** Synthetic genetic parts based on the translational coupling mechanism for accurate and predictable polycistronic gene expression control.
- ***Nucleic Acids Res.* 53, (2025) —** Control mechanism of early transcription in *E. coli*.
- ***iScience* 29, 114322 (2026) —** Genetic regulation under nitrogen limitation in a methanotroph.

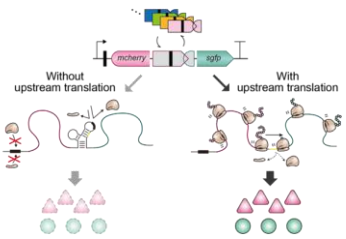
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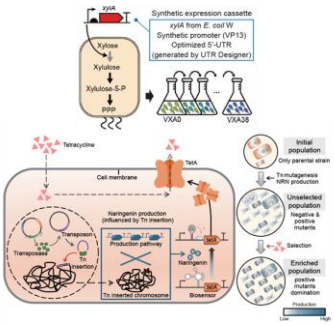
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REPRESENTATIVE RESEARCH FIGURES / SCHEMES

Synthetic genetic tools & systems



Cell engineering / evolution



Multiomics analysis

