Programming Multicellular Bacterial Patterns with Synthetic Adhesins

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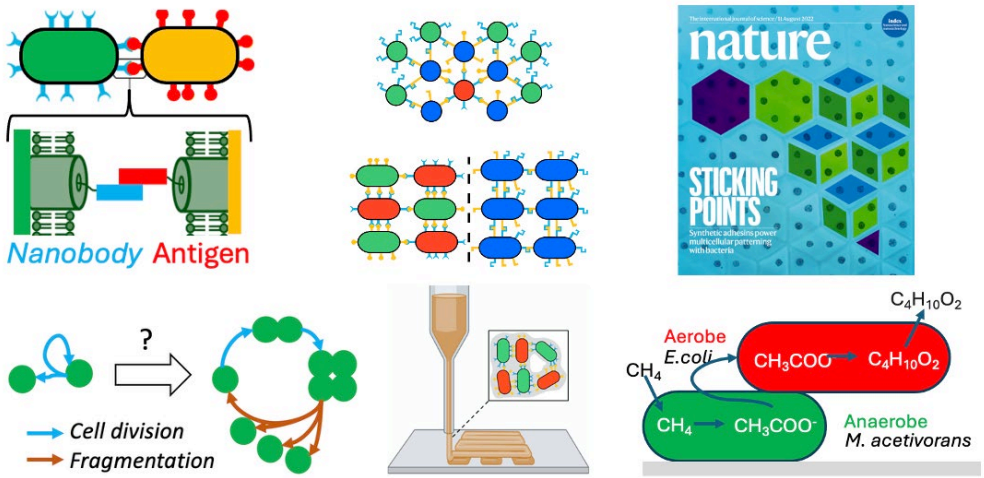
Multicellular systems, from bacterial biofilms to human organs, form spatial patterns and interfaces to achieve complex cooperative functionalities. Our understanding and ability to rationally engineer and control such active matter is still limited. To this end, my lab develops synthetic and optogenetic approaches that enable the versatile control of cell-cell and cell-surface adhesion for multicellular bacterial patterning. I will discuss the molecular engineering and biophysical characterization of such synthetic adhesins. I will then demonstrate their utility as a build-to-understand approach for basic scientific questions such as studying the physics and combinatorial self-assembly of active colloids, the programming of tissue-level interface and tiling patterns that mimic developmental programs, and the evolutionary origins of multicellular life. I will also demonstrate practical applications for health and sustainability, such as tunable biomaterials and microbial consortia for small molecule biosynthesis, e.g., converting greenhouse gases to value chemicals.



References

[1] Glass D, Riedel-Kruse IH
A genetically encoded adhesin toolbox for programming multicellular morphologies and patterns.
Cell; 2018. 174 (3) 649–658.

[2] Jin X, Riedel-Kruse IH
Optogenetic patterning generates multi-strain biofilms with spatially distributed antibiotic resistance.
Nature Communications; (2024) 15:9443.

[3] Kim H, Skinner DJ, Glass DS, Hamby AE, Stuart BAR, Dunkel J, Riedel-Kruse IH
4-bit adhesion logic enables universal multicellular interface patterning.
Nature; 2022. 608 324–329.

[4] Costan SA, Ryan PM, Kim H, Wolgemuth C, Riedel-Kruse IH
Biophysical characterization of synthetic adhesins for predicting and tuning engineered living material properties.
Matter; 2024. 7 1-9.

[5] Wood T, Gurgan I, Howley ET, Riedel-Kruse IH
Converting methane into electricity and value chemicals at scale via anaerobic microbial fuel cells.
Renewable and Sustainable Energy Reviews; 2023. 188 113749.

[6] Lee SA, Riedel-Kruse IH
Micro-HBI: Human-Biology Interaction with Living Cells, Viruses, and Molecules.
Frontiers Computer Science; (2022) 4, 849887.