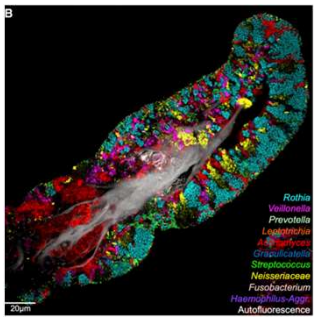
Morphologies for Bacteria

Shagufta Rehmat, Daniele Tammaro, Pier Luca Maffettone
1. Department of Chemical, Materials and Production Engineering of the University of Naples Federico II
Corresponding e-mail: shagufta.rehmat@unina.it

1. Background

- Microorganisms do not work alone.
- They make consortia and work together.
- Spatial distribution of microorganisms in the consortia is important for their functioning [1]



[4]

2. Challenges

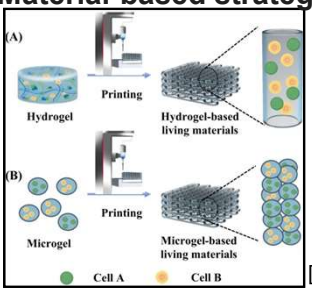
- The usual ways we grow microbes makes it hard to study how different spaces affect the way microbial communities interact.
- The production of spatially distributed bacterial populations with defined morphology is a challenge

[6]

3. State of the Art

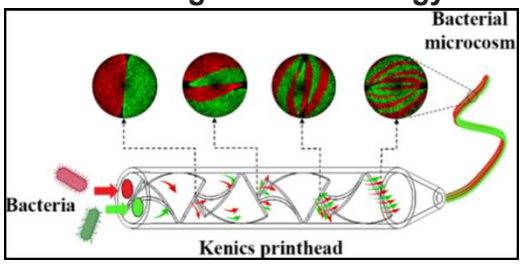
- To create these microbial consortia with spatial arrangements, 2 strategies are used so far

a. Material-based strategy



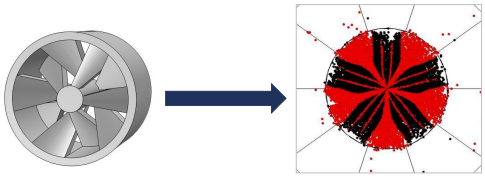
[2]

b. Design based Strategy



[1]

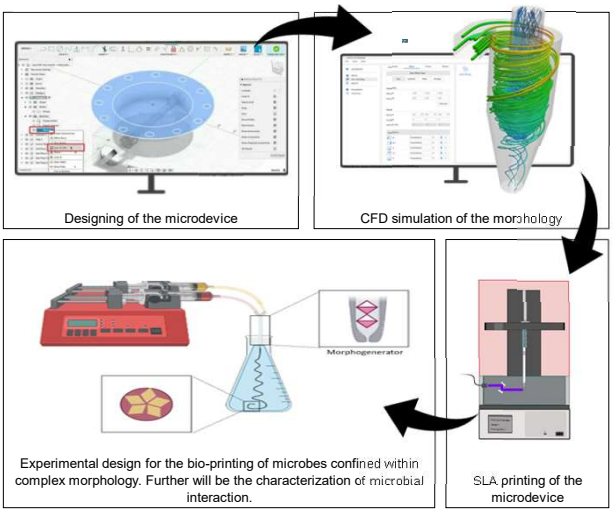
4. Objectives


[5]

The objective of this project is to:

- To produce a **structured material** with a desired complex morphology at the microscale.
- To overcome the challenges of **spatially distributed bacterial populations** with defined morphology
- To develop morphologies by **3D printing (spatially controlled) bacterial populations** using these microdevices.
- Development of a reverse engineering tool able to design the morphogenerator elements capable of inducing the desired final morphology to the product
- Machine learning techniques for building simulations

5. Proposed Methodology



6 Fundings

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7. References

1. Ceballos-González, Carlos Fernando, Edna Johana Bolívar-Monsalve, Diego Alonso Quevedo-Moreno, Li Lu Lam-Aguilar, Karen Ixchel Borrayo-Montaño, Juan F. Yee-De León, Yu Shrike Zhang, Mario Moisés Alvarez, and Grissel Trujillo-De Santiago. 2021. "High-Throughput and Continuous Chaotic Bioprinting of Spatially Controlled Bacterial Microcosms." *ACS Biomaterials Science and Engineering* 7 (6): 2408–19. https://doi.org/10.1021/acsbiomaterials.0c01646.
2. Gao, Hao, Wankui Jiang, Wenming Zhang, Min Jiang, and Fengxue Xin. 2023. "Customized Spatial Niches for Synthetic Microbial Consortia." *Trends in Biotechnology* xx (xx). https://doi.org/10.1016/j.tibtech.2023.05.003.
3. Bottura, B., Rooney, L. M., Hoskisson, P. A., & McConnell, G. (2022). Intra-colony channel morphology in Escherichia coli biofilms is governed by nutrient availability and substrate stiffness. *Biofilm*, *4*, 100084.
4. . Wilbert, Steven A., at al., "Spatial ecology of the human tongue dorsum microbiome." Cell reports 30.12 (2020): 4003-4015
5. Iodice Anna., *Morphogenerators: proof-of-concept through CFD simulations*, Università Degli Studi Di Napoli Federico II, 2020
6. Davidson, S. L., & Niepa, T. H. (2022). Micro-technologies for assessing microbial dynamics in controlled environments. *Frontiers in Microbiology*, *12*, 745835.

Shagufta Rehmat
PhD student
Engineering of Product and Industrial Process, Department of Chemical, Materials and Production Engineering of the University of Naples Federico II

CRESCENDO
Università degli Studi di Napoli Federico II
Task Force Microbiome
DICMaPI Dipartimento di Ingegneria Chimica, dei Materiali e della Produzione Industriale
Università degli Studi di Napoli Federico II