

	Question	Value
1,1	Proposal	
1,2	Name	Computational Modeling of Oral Microcosm Biofilm Project
1,3	Description	The oral microbiome represents one of the most complex microbial ecosystems in the human body, comprising hundreds of bacterial species and understanding ecological interactions is crucial for oral health research. Traditional in vitro experimental approaches face significant limitations when attempting to decipher the complex interactions occurring within oral microcosms derived from saliva samples. Recent studies have highlighted that while antimicrobial interventions can initially achieve significant bacterial load reductions of 2-3 log units, biofilm communities demonstrate remarkable resilience and can regrow to pre-treatment levels within 48 hours. More concerning is the observation that these regrown biofilms often exhibit altered species composition, with potential enrichment of more pathogenic or antimicrobial-resistant species, suggesting that current treatment strategies may inadvertently promote the development of more aggressive microbial communities. This project aims to develop a comprehensive computational modeling framework that integrates agent-based modeling with reaction-diffusion equations to simulate microbial dynamics in oral microcosms. Agent-based modeling will capture bacterial behaviours, species-specific growth characteristics, and inter-species interactions at the cellular level, while reaction-diffusion models will represent the spatial and temporal dynamics of nutrients, metabolic byproducts, pH gradients, and antimicrobial concentrations within the biofilm environment. The integrated approach will incorporate experimental data including 16S rDNA sequencing data, metabolic activity measurements, and viable cell count data to develop mechanistic insights into factors controlling microbial community stability and resilience. This computational framework will enable identification of key species interactions, predict how antimicrobial treatments affect long-term community composition, and serve as a tool for optimizing treatment strategies to minimize pathogenic regrowth while maintaining therapeutic efficacy, ultimately contributing to safer and more effective antimicrobial strategies in dentistry.
1,4	Work environment	The students will join a diverse team of researchers from the Informatics Institute (IVI) and ACTA. This group includes experts in modeling, experimental design, and validation. Students will have the opportunity to work closely with the researchers and contribute to the development of the computational model aimed at unravelling oral microbiome complexity.
1,5	Expectations	The student should have good programming skills (Python)
1,8	Research Tags	omics data, computational modelling & oral health
1,9	Programmes	Computational Science
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