<u>Title of the proposed research project:</u> Effect of biofilm formation on the removal of N and C in wastewater treatment plants

<u>Advisors:</u> Prof. Dr. Sara Kleindienst, Dr. Katharine Thompson

<u>Research group / department:</u> Department of Environmental Microbiology

<u>Keywords:</u> microorganisms, biofilms, microbial community structure, microcosms, dissolved organic carbon, denitrification, nitrification, microbial activities

<u>Introduction / Background:</u>

Municipal wastewater treatment plants in Germany treat upwards of 9 billion m^3 of wastewater annually [1] and up to 90% of the original organic waste is removed during the secondary treatment process [2, 3]. Secondary treatment can occur in many ways; the conventional process, however, occurs under fully aerated, oxic conditions (activated sludge treatment) where natural microbial communities break down organic carbon and excess nitrogen species [2, 3]. One method of aerated secondary treatment involves the use of rotating disk reactors (RDRs) where microbial biofilms form on a polymer that rotates through the wastewater, providing oxygen and time for the microbial communities to degrade organics and nutrients [4]. While this method has been shown to be very efficient, these systems are limited in size and cannot process the volume of waste often received at a treatment plant [5]. An alternative and more widely used method involves multiple aeration tanks where oxygen is pumped through the wastewater to facilitate the microbial growth [2]. These tanks, however, do not encourage biofilm formation due to the vigorous mixing. In specifically designed systems, the addition of biofilm formation in aeration tanks through the Integrated Fixed Film Activated Sludge System (IFAS) or Submerged Attached Growth Reactor (SAGR) has been shown to enhance organic carbon removal and increase microbial resistance to pollutants [6-9]. The exact role that biofilm formation plays in the enhanced removal of organic carbon and nitrogen species, however, remains unconstrained. Thus, it is imperative to investigate the specific role that biofilm formation plays in wastewater treatment and how current or new systems could be implemented to enhance wastewater treatment through the addition of biofilms.

<u>Research Environment:</u> The newly established Department of Environmental Microbiology at the Institute for Sanitary Engineering, Water Quality and Solid Waste Management (ISWA) at the University of Stuttgart consists of an interdisciplinary, international, and dynamic team of environmental microbiologists and microbial ecologists. The research group focusses on fundamental research with links to applied areas and studies topics related to microbial pollutant degradation. More information can be found on our webpage: https://www.iswa.uni-stuttgart.de/institute/em/. The PhD candidate will get the

opportunity to be creative and innovative, and to work on a challenging and interdisciplinary topic.

Research goals:

- To compare the active microbial community that form the biofilms on the RDRs to the microbial community that thrives in the aeration tanks.
- To compare the efficiency of the carbon and nitrogen removal in the RDRs and aeration tanks and relate these processes back to the active microbial community.
- To elucidate the role of biofilm formation in the efficiency of carbon and nitrogen removal during the secondary phase of wastewater treatment.
- To perform laboratory microcosm experiments where biofilm formation is stimulated and apply the findings, in collaboration with the engineering department, at the WWTP at our institute.

Methods to be used:

- 16S rRNA (gene) amplicon sequencing
- Quantification of C and N (e.g., HPLC, MS)
- DNA- and RNA-based qPCR for the 16S rRNA gene/transcript and genes/transcripts involved in key microbial C- and N-cycles
- Metagenomics and metatranscriptomics
- Statistical analysis of the obtained data sets
- Test current methods of biofilm formation in the WWTP

Prerequisites:

- Strong knowledge of environmental microbiology
- Experience with molecular biological techniques and data
- Independent researcher with the ability to work well in a team
- Motivated with excellent communication skills
- Very good in English and with a computer

References:

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