University of Leicester

PhD Project Template

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Project Title	**When biomes meet: Interactions between the lung and aerosol bacterial and fungal microbiomes in airway disease**
Supervisors (2 Max) Include email addresses	Dr Catherine Pashley chp5@leicester.ac.uk
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Funding Status	Self-Funded Students Only
Application Deadline date	Ongoing
Project Description (max 700 words)	All human epithelial surfaces are in intimate contact with complex and diverse populations of microorganisms, including bacteria and fungi. These microbiomes differ in different locations and reflect both local growth conditions and colonisation from external sources; they may also cause host damage and dysfunction through a poorly specified biological imbalance referred to as dysbiosis[1]. With the advent of high throughput sequencing (HTS), the diversity and abundance of the microbiomes associated with clinical conditions are being explored to a greater depth than was possible with traditional culture-based approaches. In this project the overall aim will be to investigate interactions between bacterial and fungal populations in sputum samples from patients with chronic lung disease. To sustain themselves in a given environment microbes export molecules that inhibit or kill other microbes (antibiotics) and compete for common resources so that it is often possible to recognise antagonistic and cooperative relationships. Such relationships have been recognised within bacterial microbiomes [2] but relationships between fungi and bacteria are less well studied. This project will aim to detect and describe interactions between bacteria and fungi in the lung microbiome. The increased detail provided by combining fungal and bacterial microbiomes may yield clearer correlations with patients' clinical status than has been possible in earlier studies where only one group of microorganisms has been investigated. The respiratory tract is the main portal of entry for the microbes present in airborne particles. Fungal spore counts of the outdoor air can regularly reach >50,000 spores m^{-3} air day^{-1} during the summer months [3]. There is growing evidence to suggest exposure of the patients to the outdoor environment may influence the taxa detected in the lungs [4]. This project will analyse outdoor air samples taken on the same days as the clinical samples. Specific objectives include: 1. To describe and compare the relationship between the bacterial and fungal microbiomes in patients with chronic lung disease.

	2. To investigate the influence of the bacterial and fungal composition of the air on the lung microbiome and mycobiome. 3. To use *in vitro* model mixed cultures representing characteristic bacterial communities found in sputum to investigate the impact of fungal colonisation. This project will involve a broad training in aerobiology, medical mycology and microbiology including the morphological and molecular identification of fungal species, in addition to training in molecular techniques such as quantitative PCR, high-throughput sequencing (HTS) and bioinformatic analysis. The student will gain an insight into the differences between *in vivo* (human) and *in vitro* studies, learn to test association between lab results and clinical phenotypes, and be trained to collect relevant environmental samples.
References	1. Huffnagle GB, Noverr MC. The emerging world of the fungal microbiome. Trends Microbiol. 2013;21(7):334-41. 2. Wang Z, Bafadhel M, Haldar K, Spivak A, Mayhew D, Miller BE, et al. Lung microbiome dynamics in COPD exacerbations. The European respiratory journal. 2016;47(4):1082-92. 3. Pashley CH, Fairs A, Free RC, Wardlaw AJ. DNA analysis of outdoor air reveals a high degree of fungal diversity, temporal variability, and genera not seen by spore morphology. Fungal Biology. 2012;116(2):214-24. 4. Nguyen LD, Viscogliosi E, Delhaes L. The lung mycobiome: an emerging field of the human respiratory microbiome. Front Microbiol. 2015;6(89)
Funding Information	This is a self-funded project.
Link to online Application web page	https://www2.le.ac.uk/research-degrees/phd/applyphd
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