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How can we study tuberculosis using microfluidic chip?

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Tuberculosis (TB) is a highly infectious disease that continues to affect 10 million people worldwide, resulting in over a million deaths each year. This is despite the high availability of the BCG vaccine and various antibiotics and largely due to rising antibiotic resistance. Traditional methods of TB research are complicated by the need for biosafety level 3 (BSL-3) facilities for handling *Mycobacterium Tuberculosis* (MTB). Using the non-pathogenic *Mycobacterium smegmatis* (MSMG) as a model organism leverages its physiological and metabolic similarities to MTB while providing a safer and more accessible alternative for studies in BSL-1 laboratories.
A key approach in advancing TB research involves the use of microfluidic chips, which enables precise control over experimental conditions at a microscale, leading to reduced sample consumption while improving experimental reproducibility. These devices enable monitoring of bacterial morphology, growth patterns, and responses to environmental stressors, such as oxygen depletion and antibiotic exposure by mimicking the conditions mycobacteria encounter in the human body.
The design and fabrication of microfluidic devices involve soft lithography techniques, where PDMS is moulded onto a master wafer. The PDMS structure is then bonded to a glass slide using oxygen plasma treatment, creating a sealed microchannel network. The fabrication process ensures reliable bacterial trapping, nutrient supply, and optimal conditions for live-cell imaging. The aim of this work is to integrate MSMG with optimized microfluidic chips to contribute to more efficient TB studies by mimicking *in vivo* conditions and through improved visualization and real-time monitoring of bacterial behaviour. This approach has the potential to lead to better diagnostics and therapeutic interventions.