Graduation in fluid mechanics : the flow fields generated by beating cilia

Masters graduation project

Experimental investigation of the flow fields generated by cilia

Problem:

Motile cilia are micron sized hair-like cell projections and are ubiquitous among eukaryotic living organisms (figure 1). These organelles are central to a variety of physical processes such as locomotion, fluid transport, mixing and mechanical signal transduction, which are in turn crucial to a wide range of vital biological processes such as reproduction, respiration or embryogenesis. The ability of cilia to generate micron-scale flow patterns well suited to a variety of biological processes is of tremendous interest in micro-system engineering and a source of inspiration for biomimetic microfluidic devices. The general fluid transport properties of cilia have been studied theoretically, but little experimental work has investigated the flow structures generated by cilia.

Project:

This project investigates transport properties of cilia experimentally by generating bio-inspired and controlled flow patterns and visualizing the flow experimentally. This exciting project will involve designing and building a simple 2D scaled-up model for cilia, and experimentally measure velocity fields with Particule Image Velocimetry. This scaled-up model will allow to easily control relevant parameters and to characterize fluid transport as a function of cilia density, wavelength, beating asymmetry…

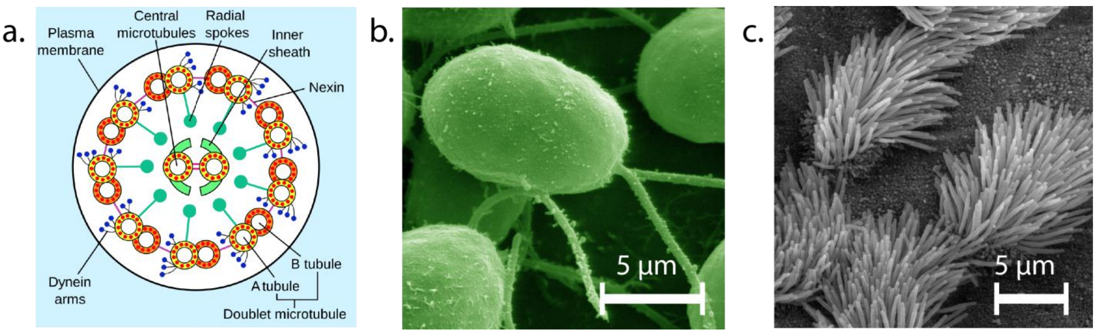

Figure 1. (a) Cross-sectional representation of the "9+2" biomolecular structure of the axoneme, the inner core cytoskeletal structure of the eukaryotic flagellum. Reproduced from *Molecular Cell Biology, 4th edition*, Lodish and Berk. (b) Scanning Electron Microscope (SEM) image of biflagellated green algae *Chlamydomonas Reinhardii*. (c) SEM image of the lung trachea epithelium, covered with motile cilia.

This project can be used to finish your M.Sc.-study Mech.Eng. in "SFM", "SPET" or "PME". For more information you can contact Daniel TAM.

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