Unpicking the Cellular Safety Belt

Structure-Mechanics Relations in Cytoskeletal Intermediate Filament Bundle Networks

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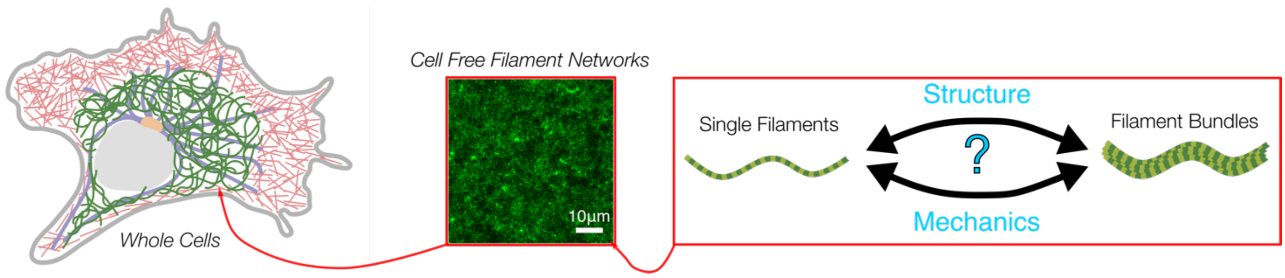
Seen from a Materials Sciences' perspective, living cells are remarkably versatile. They are highly resilient to large deformations but can also reshape, grow and reinforce themselves according to their surroundings. This remarkable adaptivity is made possible by the cytoskeleton, a multicomponent filamentous protein network that acts a supportive scaffold. One class of filament in the cytoskeleton, the intermediate filaments (IFs) play a unique role as the cell's `safety belt`, providing passive resistance to large and rapid deformations.[1] IFs form long lasting, resilient elastic networks through a variety of different structures from short filaments, close to the cell membrane, to dense bundles in the regions close to the cell nucleus. How these different structures contribute to cell mechanics remains largely unexplored and poorly understood. In this project, the student will use advanced biophysical techniques such as atomic force microscopy, shear rheology and confocal microscopy, to probe the biomechanical characteristics of cell-free filaments and filament networks of different morphologies.



The student will work in a highly cross-disciplinary environment, spanning soft matter physics and structural biology. Training will include recombinant protein expression, protein characterization and purification as well as mechanical and topographical measurement through atomic force microscopy and shear rheology. These will be complemented by training in image analysis and use of biopolymer models that relate single filament mechanics from bulk viscoelastic response. Aside from the core project objectives, the project is designed with scope for flexibility depending on the scientific interests of the student. This includes the possibility to contribute to development of new techniques to probe mechanics in changing chemical environments, the theoretical modelling of filament bundles or the recombinant modification of proteins to alter filament structure. This project will provide exceptional career development opportunities in the emerging area of cell-free biophysics that will be highly desirable for a future career in research or industry.

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[1] Guo, Ming, et al. "The role of vimentin intermediate filaments in cortical and cytoplasmic mechanics." Biophysical journal 105.7 (2013): 1562-1568.