BIO-TALK: Nanoscale Mapping of Cell Adhesion Receptors: A Super-Resolution Approach to Mechanobiology

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13:00 to 14:00
Blue Lecture Room

Within every tissue, cells are embedded in and supported by a complex network of proteins and polysaccharides known as the extracellular matrix (ECM). Far more than just a structural scaffold, the ECM is an active signalling platform that provides cells with essential instructions for maintaining tissue integrity and function, instructions that are profoundly altered in pathological conditions such as cancer and fibrosis. Cells decode these cues through integrin-based focal adhesions (FAs): specialized protein complexes that anchor cells to the ECM and convert mechanical forces into biochemical signals.

FAs were classically depicted as homogeneous micron-sized assemblies, but are now recognised as highly dynamic and modular structures. Inside a single FA, more than 60 core proteins must organise with nanoscale precision in space and time. Yet diffraction-limited microscopy cannot resolve this organisation. In this seminar, I will show how super-resolution microscopy (STED, STORM, and DNA-PAINT) allows us to map FA proteins with nanometre precision.

Our recent findings reveal that FA organisation is far more complex and spatially regulated than the classical textbook view: adhesion proteins assemble into discrete, non-overlapping nanoclusters that serve as universal adhesion units, whose localisation and organisation are tightly coupled to their mechanical and signalling state. I will also discuss how we are coupling biomaterial engineering, including polyacrylamide gels and supported lipid bilayers, with super-resolution imaging to interrogate how cells reorganise their adhesion machinery in response to defined microenvironments, intending to establish a nanoscale framework linking integrin organisation to mechanobiological function.

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