Hierarchical biomechanics: towards a cross lengthscale understanding of folded protein-based hydrogels

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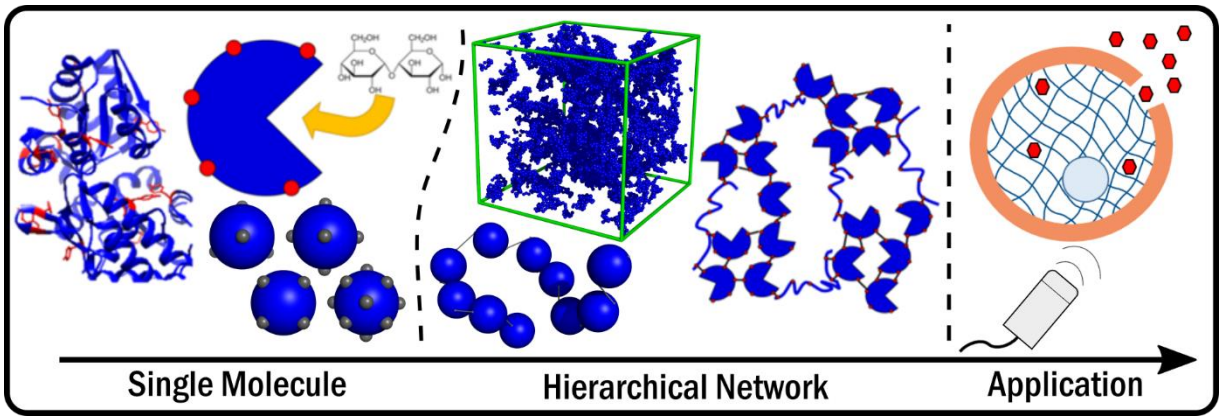
Engineered hydrogels that mimic the extracellular matrix are increasingly being used for applications including tissue engineering, wound repair, and triggered degradation. Hydrogels built from folded globular proteins are particularly appealing, as their well-defined response to mechanical forces can expose or conceal functional moieties. However, very little has been done to explore the soft matter physics of these systems, and connecting the mechanical properties of individual proteins to the collective response of the network represents a current challenge. In Leeds we are developing experimental and modelling approaches to examine the assembly of folded proteins into cross-linked hydrogel networks. This project will focus on establishing the design rules for creating novel, responsive hydrogels which exploit the specific biological functionality of globular proteins. This requires understanding of the evolution of network microstructure as the proteins crosslink prior to, and during, network percolation, and related questions such as the diffusion of drugs or growth factors through the gel.



A diverse range of experimental and modelling training and support will be provided to study proteins and their networks across length scales, including single molecule force spectroscopy, circular dichroism (CD), dynamic light scattering, differential scanning calorimetry (DSC); and small angle x-ray scattering (SAXS), rheology, and small angle neutron scattering (SANS). Training in computational modelling will be provided commensurate with the student's interests and experience, potentially including molecular dynamics/Monte Carlo simulations, and the use of Leeds' supercomputer (ARC). Training in equipment design and construction will be provided if of interest, supported by mechanical and electronic workshop technicians. The project will be based in the multidisciplinary Dougan group based in Physics, with strong links to the Bragg Centre for Materials Research.

For recent work see: Soft Matter, 16, 6389 (2020); Macromolecules, 53, 7335 (2020); Biomacromolecules, 21, 4254 (2020).