**Investigating crosslinker mediated regulation of structure and properties in biopolymer materials**

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Cells are made of active materials that adapt to, generate, and sustain mechanical forces. The cytoskeleton allows for these cell features and is composed of three main biopolymer filaments, actin, intermediate filaments, and microtubules. Actin supports cell structure, is a key component of intercellular transport, and is responsible for cell motility. The diverse assemblies that actin forms, such as networks, bundles, and liquid crystals are central to supporting such varied cellular functions. The formation of the different types of actin assemblies are mediated by protein crosslinkers, such as fascin, fimbrin, filamin, and alpha actinin. Abnormalities in the structures of crosslinkers can manifest in cellular malfunction and death, an example of which is a mutated form of alpha actinin-4 that causes familial focal segmental glomerulosclerosis. In this case, an overabundance of binding domains found on alpha actinin-4 causes an increased binding that leads to cell death through cell body rigidity[3]. We can study crosslinker effects in vitro by constructing model actin-based materials using purified proteins. To systematically investigate how crosslinker properties regulate biopolymer assembly formation and properties, we will develop synthetic crosslinkers using DNA with actin binding sites. DNA, while primarily used for storing genetic information, is a versatile polymer that can be designed into a variety of structures. Through the use of DNA Nanotechnology and Origami, we can program the order of DNA oligos and their final structure through folding[4]. We will use DNA rather than physiological crosslinkers in order to have the ability to change the specific characteristics of the crosslinker, such as length. We will use techniques such as TEM and gel electrophoresis to characterize crosslinker features such as spacing and geometry. We aim to investigate how the physical properties, such as length and geometry, of a crosslinker affects the formation and mechanics of different actin assemblies. We will investigate the resulting assembly formations and material properties through the use of confocal fluorescence microscopy. The findings of this research will contribute to our understanding of polymer soft material design, as well as provide insight into the principles and regulations of cell mechanics.

References:

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