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Directed Assembly of Biological Polymers

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The self-assembly of polypeptides into beta-sheet rich nanofibrils has attracted considerable attention in recent years to both understand amyloidgenesis and for their potential biomaterials applications. This self-assembly process is generic to all proteins where fibrillation is typically induced under harsh conditions of low pH and/or high temperature, which are of course not suitable for biomaterials applications. Here we will outline the method developed in our laboratory to create thermo-reversible fibrillar hydrogels from aqueous solutions of a series of proteins by adding a reductant. Proteins studied include beta-lactoglobulin, ovalbimum, lysozyme and bovine serum albimum; all contain an increasing number of disulfide bridges that are disrupted by the reductant. Such disruption destabilises the native state of the protein and this allows us to form transparent, self-supporting hydrogels under physiological conditions. The potential to control and manipulate the gel properties, including mechanical strength and structure (fibre diameter and mesh size of hydrogel) has been explored by varying the protein (consequently the number of disulfide bridges), protein concentration, reductant concentration and ionic strength of the matrix. Our results will be presented here and similarities and differences highlighted. Furthermore we will present both our 2- and 3-dimensional cell culture experiments that show the gel matrix promotes both fibroblast and chondrocyte cell spreading, attachment and proliferation; indicating our hydrogels gels are biocompatible and they can provide a viable support for different cell types.