Highly tunable supramolecular peptide hydrogels for biomedical applications

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Abstract: Peptide self-assembly, a spontaneous process to form ordered structures using short amino acid sequences as building blocks, is a powerful bottom-up strategy for the synthesis of nanomaterials with complex, hierarchical architectures. This strategy is primarily inspired from the natural biological systems to design biomaterials that can be applied for combating the prominent problems related to healthcare area. Our aim is to develop diverse peptide hydrogels that can be applied as an efficient synthetic extracellular matrix, providing the structural support as well as bio/physicochemical cues to control the stem cell behavior. Control over peptide self-assembly to access diverse hydrogels is still a major challenge to the researchers. To this direction, we are exploring the non-conventional approach of using different self-assembly pathways to create diverse nanostructures instead of changing the molecular architecture of the building blocks.

Diverse hydrogels were accessed from identical gelator concentration self-assembled through different pathways. The diversity in the gel phase material was found to arise from differential intermolecular interactions that translated into variable nanostructure morphology, and thus resulting in variable mechanical properties. Different pathways lead to either kinetically trapped or thermodynamically favoured states giving rise to diverse hydrogels as evident from different spectroscopic and microscopic techniques. Interestingly, these diverse nanostructures showed differential interactions with cells, though they are derived from the single precursor. Our designer gels created by the minimalistic biomimetic approach of peptides self-assembly have immense potential in controlling cell behavior.

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