Amyloid Designable Peptide Materials and Their Use as Scaffolds for Biomedical and Environmental Applications

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Abstract:

Amyloid self-assembly refers to the conversion of specific proteins and peptides from their native functional states into long unbranched fibers that are characterized by a cross-beta sheet quaternary structure. Amyloid formation has been associated with a range of human disorders, including Alzheimer's disease, prion and Parkinson's disease. Fibrous amyloid structured aggregates are not only involved in misfolding and disease, but can also be exploited for the formation of novel functional amyloid biomaterials. Amyloid biomaterials have significantly advantageous properties, which among others include their easy fabrication, and the capacity to tune their properties by changes at their sequence level. Naturally occurring peptide sequences extracted from amyloid proteins or beta-sheet protein regions can self- assemble outside the context of the entire sequence into amyloid fibrils and can serve as scaffolds for novel biomaterials. Peptide sequences GAIIG and GAITIG are part of the amyloid-beta (Aβ) peptide, linked to Alzheimer's disease, and the adenovirus fiber shaft, respectively.
In this study we took advantage of their unique self-assembling properties and with the aid of computational methods we applied suitably selected modifications at flexible positions, to tune the properties of amyloid forming peptides in order to discover novel functional biomaterials in two different applications. In the first application, our computational and experimental results suggest interaction of a designed beta-breaker peptide GAIPIG with Alzheimer's Aβ peptide, delaying the aggregation of the peptide $A\beta_{1\text{-}40}$ *in vitro* and considering it as a potential inhibitor of amyloid formation. In the second application, we present novel amyloid biomaterials that are capable of binding and capturing cesium ions at neutral and low pH conditions, enabling their use as scaffolds for the removal of cesium ions from nuclear waste or blood.

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