automated solid-phase synthesis methods and purified by standard reverse phase high performance liquid chromatography.

Preparing hydrogels by peptide self-assembly requires reliable design rules and excellent reviews have been published describing the chemistry and designs of various self-assembling peptides (Mendes et al. 2013a; Maude et al. 2013; Rubert Perez et al. 2015; Boekhoven and Stupp 2014; Fichman and Gazit 2014). Some self-assembling peptide gels have made the transition to *in vivo* studies, notably the ionic self-complementary peptides (KLD12, RADA16—PuraMatrix™) proposed by Zhang and co-workers at MIT (Gelain et al. 2007) and peptide amphiphiles (PAs) designed by the Stupp group at Northwestern University (Cui et al. 2010). Here, we focus on their application in regenerative medicine.

Neural regeneration

Self-assembling peptide gels are promising for central nervous system (CNS) regeneration as they can be easily injected into the injury site and functionalized to support regrowth of the nervous tissue (Liu et al. 2015b). A PA gel containing the IKVAV epitope (derived from laminin responsible for neurite growth) was used to encapsulate neural progenitor cells (Silva et al. 2004) and shown to induce their differentiation into neurons, while discouraging the development of astrocytes comparatively to laminin. A similar PA molecule containing the IKVAV epitope was tested *in vivo* in a mouse model of spinal cord injury (SCI) (Tysseling-Mattiace et al. 2008). The peptide solution was injected directly at the injury site and the PA treatment reduced astrogliosis and cell death, while increasing the number of oligodendroglia. Regeneration of injured motor and sensory axons was also promoted, while axons were unable to traverse the lesion in injured spinal cords treated with peptide gel without the IKVAV sequence. The injection of IKVAV PA on the animal functional recovery was also investigated using two SCI models (compression and contusion) and two different species (mice and rats) (Tysseling et al. 2010). This PA improved behavioural outcome by stimulating axon regeneration through the lesion. The same PA gel was applied, in combination with embryonic stem cells and neurotrophic factors, as replacement therapy for lesions of the auditory nerve (Palmgren et al. 2012). By promoting the localization and controlled release of neurotrophic factors, the PA gel increased cell survival and neuronal differentiation. Aligned monodomain PA gels containing IKVAV and RGDS epitopes enhanced the growth of neurites from neurons encapsulated in the gel with neurite aligned along the direction of the nanofibers (Berns et al. 2014). After two weeks of culture in the monodomain PA gels, neurons displayed spontaneous electrical activity and established synaptic connections. PA gels, encapsulating neural progenitor cells, were formed *in situ* within the spinal cord and resulted in the growth of oriented processes *in vivo* and extensive migration of dorsal root ganglion cells inside the gel with the direction of their movement guided by the nanofiber orientation.

RADA16 peptide gels have also performed successfully in neurorepair strategies (Holmes et al. 2000). They were able to support neuronal cell attachment, differentiation and extensive neurite outgrowth, being permissive substrates for functional synapse