Editorial

Journal of PeptideScience

Received: 31 May 2014 Accepted: 3 June 2014 Published online in Wiley Online Library

(wileyonlinelibrary.com) DOI 10.1002/psc.2669

Peptide Materials for Biomedicine and Nanotechnology

In the last few years, research activity focused on peptide-based materials has been experiencing an explosion of interest and a remarkable advancement of knowledge both on the fundamental side, *i.e.* the molecular mechanisms and forces that determine the growth of nanometric and mesoscopic structures (nanowires, nanotubes, self-assembled monolayers, fibers, and fibrils) from basic peptide motifs, and the applicative side, *i.e.* peptide-based compounds for electronics, biosensing, peptide-assisted drug delivery, tissue engineering, and cell adhesion.

These objectives have been achieved by mimicking the strategies, essentially based on self-assembly and bottom-up procedures, that Nature peruses in the construction of complex supramolecular aggregates, capable of performing very specific operations with amazing efficiency. In particular, extremely fascinating is the interdisciplinary field that leads to the design of biohybrid materials, connecting the world of functional biomolecules to inorganic supports or polymeric compounds. In this connection, peptide adducts are prepared with quantum dots, carbon nanotubes, and nanoparticles, which generate biocompatible surfaces with predetermined hydrophobic/hydrophilic properties.

The First Conference on Peptide Materials for Biomedicine and Nanotechnology (PEPMAT2013), held in Sorrento (Italy) in October 2013 (http://www.peptidematerials2013.org) and aimed at rationalizing this rapidly growing field, represented a unique opportunity to assemble knowledge, experiences, and innovative ideas.

Significantly, the Journal of Peptide Science, the official journal of the European Peptide Society (EPS), decided to devote a Special Issue to the Conference by publishing selected contributions from PEPMAT2013.

This issue begins with a review article by I.W. Hamley and coworkers who describe the self-assembly properties of different classes of amphiphilic (namely lipo-, surfactant and amyloid) peptides. The influence of the environment on the morphology of the aggregates and the possibility to control the nanostructure of the peptide self-association motifs by photo- or enzymatic stimulation is thoroughly discussed.

On the biomedicine side, S. Galdiero *et al*. highlight the use of viruses as Trojan horse agents for intracellular delivery of peptide-based drugs. A detailed understanding of the virus structure and the mechanisms of cell permeabilization is preliminary to the development of targeted drug carriers.

Peptide self-assembly and the characterization of the morphology of peptide aggregates are within one of the most popular topics discussed at the Conference. In the third contribution of this issue, M. Reches and coworkers describe the self-assembly of aromatic dipeptides containing a photoactive, cross-linking azide moiety. Upon irradiation, the peptide assemblies undergo structural changes that affect both the morphology and the mechanical properties of the aggregates.

Next, G. Rosenman and coworkers report on the thermally-induced phase transformation of dipeptide aggregates from nanotubes to fibrils. Interestingly, the extended hydrogen-bonding network, which characterizes amyloid-like nanofibrils, gives rise to a blue photoluminescence that can be considered the optical signature of β-sheet structure formation.

In the fifth presentation G. Bocchinfuso *et al.* apply molecular dynamics (MD) techniques to study the aggregation propensity of helical Aib homo-peptides of different length. In agreement with the spectroscopic results and microscopy imaging data at nanometric resolution, the MD simulations reveal that only stable helices are able to induce formation of fibrils, triggered by the hydrophobic effect.

Interestingly, F. Gobeaux *et al.* show how to control the curvature of nanotubes formed by the cationic octapeptide lanreotide and how one can exploit this feature to promote crystallization of the peptide assembly and drive the crystal growth along a specific direction.

Great interest also raised the evergreen topic of peptide-membrane interactions. In their contribution, A.L. Maniero and coworkers discuss the use of bicelles, *i.e.* membrane model systems that can be macroscopically oriented in a magnetic field, for an EPR study of the behavior of antimicrobial peptides (AMPs) interacting with membranes. They demonstrate that spin-labeled bicelles are very sensitive to the membrane perturbation induced by the inclusion of AMPs, even at very low peptide concentrations.

Next, B. Bechinger *et al.* use CD- and solid-state NMR spectroscopies to analyze the interaction of hydrophobic peptides with model membranes by varying lipid composition, peptide-to-lipid ratio, and membrane topology.

Several contributions delivered at PEPMAT2013 deal with the conjugation of peptides with polymers or biomaterials. Hybrid polymer-peptide conjugates are synthesized by C. Aleman and coworkers and their electro-biocompatibility with cells investigated by electrochemical techniques. Interestingly, the electrochemical properties of these conjugates, in particular their capacity to exchange charge reversibly, strongly improve when coated with a cellular monolayer.

C. Peggion and colleagues present three new approaches for the synthesis of chemically linked peptide-cotton conjugates, with the idea to decorate natural textiles with peptides featuring antimicrobial activity.

The production and stability of reactive oxygen species by hypericin and the dipeptide L-Phe-L-Phe (FF)-nanotube (NT) conjugates are discussed by W.A. Alves and coworkers. More specifically, the structuration of hypericin/FF-NT hybrids in water-rich (hexagonal) and water-free (orthorhombic) phases is studied by MD simulations and photophysical experiments.

The possibility to retain the antimicrobial activity of AMPs in hybrid systems has also been intensively debated during the Conference. A. Lombana *et al.* report on the production of a bacteria-resistant biomaterial covalently linked to a broad-band antimicrobial peptide, *i.e.* thiolated temporin, on a gold surface. The peptide is shown to maintain its antimicrobial activity after covalent grafting on the surface, thus proving itself as an efficient antimicrobial coating agent.

A step ahead on the use of peptide materials for biomedicine is carried out by S. Kimura and collaborators who investigate the retention of peptide nanosheets composed of an amphiphilic polydepsipeptide, *i.e.* poly(Sar)$_{64}$-*block*-poly(L-Lac)$_{30}$, in which the L-Lac moiety is modified by substitution with the (L-Leu-Aib)$_6$ block. This peptide analog is shown to suppress the immune response and to abolish the blood clearance phenomenon.

Also on the side of the development of peptide materials for biomedicine, A. Saiani and coworkers investigate the possibility to use enzymatically triggered peptide hydrogels for the encapsulation and culture of cells. In particular, they are able to show that the cultured cells adopt a stretched morphology typical of fibroblasts.

The issue is closed by the important contribution reported by M. Dettin *et al.*, who use a novel bioactive titanium implant formed by ionic-complementary, self-assembling peptides for promoting osteoblast adhesion. An insulin-like growth factor-1 and/or a polypeptide containing four adhesive GRGDSP motifs are incorporated into the peptide hydrogel layer, which shows enhanced proliferation and/or increasing adhesion properties, respectively.

We are grateful to the Publisher (John Wiley & Sons, Chichester, UK) and the EPS, who gave us the opportunity to edit this Special Issue, and to all authors who contributed enthusiastically to its success. At the Conference, 33 lectures and 37 poster communications were delivered. In this Issue, the Editors were bound to limit the number of accepted articles to 15. However, the pdf abstracts related to all communications in the Conference booklet are freely available (address request to venanzi@uniroma2.it).

In Sorrento, we were fortunate to have three sunny days which helped all participants to enjoy scientific discussions and the warm hospitality. In a near future, we hope to share again all these opportunities with the readers of the Journal of Peptide Science and the EPS community.

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