HRN's: A possible future for orthopedics

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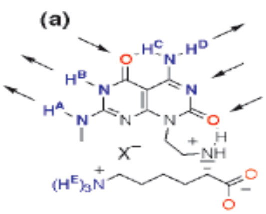
Nanotechnology is a field of bio-engineering that may hold the answer too many of modern medicines greatest problems. The ability to interact and construct on the molecular and cellular levels enables the manipulation of processes from protein production to the replacement of bone. Beyond all of the novel possibilities that present themselves there is also the ability to build on present day medicine such as implantable orthopedic devices and their interactions within the body.

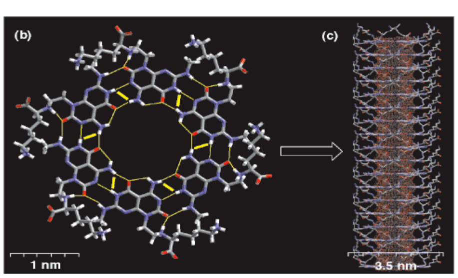
A major obstacle to orthopedic implants is the body ability to reject them. The rejection is derived from a biological response to the foreign material presented to the body and the objective is to mask these implants from this immune response. Several different methods have been tried, but one that holds a lot of promise is a coating made from helical rosette nano-tubes.

Helical Rosette nanotubes (HRN) are constructed using natural processes and can be further specialized to include specific surface properties. The basic development structure is the six membered supermacrocyle known as L-Module 1:



L-Module 1

The l-Module molecule is synthesized using the following combination: A hydrophobic base unit possessing the Watson-Crick donor-donor-acceptor, a Hydrogen-bond array of guanine, and an acceptor-acceptor-donor of cytosine from which the rosette molecules begin to naturally form. Through further introduction of hydrogen bonds, stacking interactions, and hydrophobic effects the rosettes form a hierarchical self assembled helix that we know as HRN, shown below.[i]



These helical nanotubes, due to their natural occurrence and properties which allow for selective manipulation make them attractive to many areas of science. Some highly financed areas of interest include orthopedic (cartilage repair) applications, vascular materials, and tissue sealants.[i]

Orthopedic implants have an inherent tendency for proteins, from cells and other biological fluid, to be deposited onto their respective surfaces. These proteins have the ability to hinder or support normal implant function and can be influenced by surface characteristics as well as the size, shape, stability and surface activity of the involved proteins. They have the ability to strongly influence cellular events such as signaling for matrix deposition, recruitment of other cells, or the proliferation of the layer.[ii] Specific cell adhesion and anchorage of the dependent cells is an important factor in the success and normal function of an implant.

HRN's can play a large role in the successful adhesion of osteoblast cells because of their chemical tenability. Due to applicable surface manipulation techniques of the HRN's and their relative ease of assembly they provide a promising path to improving osteoblast adhesion at the implant site.[ii]

HRN through drug delivery systems, size, and natural occurrence provide a great mechanism for the support of osteoblast production. It has been found that they do statistically increase the production at the treated site [ii] and that they also have low toxicity in other parts of the body which can be translated to this study.[iii]

Further research could be made into the potential for the HRN to be combined with an ardinine side chain, to form a scaffold that could aid in the formation of new bone. The deposition of collagen could lead to an enhanced cross linking technique that could provide a great platform for osteoarthritis and bone fractures.[ii]

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[i] Fenniri H, Mathivanan P, Vidale KL, Sherman DM, Hallenga K, Wood KV, Stowell JG. Helical rosette nanotubes: design, self-assembly and characterization. J Am Chem Soc 2001;123(16): 3854–5.

[ii] Chun AL, Moralez JG, Webster TJ, Fenniri H. Helical rosette nanotubes: A biomimetic coating for orthopedics? Biomaterials 26 (2005) 7304–7309

[iii] Journeay SW, Suri SS, Moralez JG, Fenniri H, Baljit S. Rosette nanotubes show low acute pulmonary toxicity in vivo. Int J Nanomedicine 2008;3(3):373-83.