Development of a novel biomaterial – a nanotechnological approach

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ABSTRACT

A primary focus area in development of new biomaterials is degradable materials capable of evoking a desired tissue response following implantation. Such materials could provide a large medical breakthrough as they can be used to reconstruct lost organs or tissue segments by evoking a tissue response that results in regeneration of tissue. A common strategy in the development of suitable material properties consists of integrating specific physiological effects in the material, e.g. by adding signaling proteins capable of influencing the tissue response in a desired direction. The work in this strategy comprises identification of potential signaling proteins and integrating them in a biomaterial while maintaining the protein functionality.

In this thesis it is attempted to develop and test a novel biomaterial suitable for templated regeneration of mineralized bone tissue. The biomaterial is designed with the aim of integrating a surface protein not previously used in a biomaterialscontext. It is known to play a key role in remodeling of mineralized bone tissue. The idea is that the protein will trick the cells in the body to include the biomaterial in the routine bone remodeling process – i.e. resorption of the material by osteoclasts and bone regeneration by the osteoclasts.

The development takes place in three steps: i) The adsorption on hydroxyapatite (HA) of the remodeling protein (OPN) and a previously well described protein is characterized, ii) The interaction of HA adsorbed OPN mesenchymal stem cells is analyzed and iii) The protein is incorporated in a composite consisting of a biodegradable polymer and HA particles in nanosize. Before mixing of polymer and particles the OPN is adsorbed on to the HA particles. The OPN containing polymer/HA composite was shown to be better at stimulating formation of mineralized tissue than pure polymer and a corresponding composite excluding OPN. Thus it is shown that OPN with advantage can be integrated in a biomaterial intended for guided formation of mineralized bone formation. It was furthermore found successful to approach development of a novel biomaterial from a molecular mechanism consisting of the spontaneous adsorption of OPN on HA.