Seminar

PD Dr. Anke Bernstein

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Materials for orthopedic applications

Bone is a dynamic and highly vascularised tissue that continues to remodel throughout the lifetime of an individual. Bone consists of cells, fibres and ground substance. Its extracellular components are calcified, making it hard and firm substance that ideally suited for its supportive and protective function in the skeleton.

In the individual bone, two types of bone tissue are distinguishable – compact bone, and spongy bone. At the microscopic level, bone can divided into two distinct types: woven and lamellar bone. Replacement of pre-existing connective tissue is always the basis for bone formation. Three basic mechanisms are involved in the development and turnover of bone: longitudinal growth, modelling, and remodelling. The process of bone formation and resorption are carried out by osteoblasts and osteoclasts. The functions of bone cells are regulated by actions of systemic, circulating hormones, by a variety of locally produced growth factors, by cytokines and by cellular connections between the bone cells themselves and other connective tissue cells in their vicinity such as must cells.

Bone repair is a fundamental part of the rapidly expanding medical care sector and has benefited from many recent technological developments. The market for biomaterials-based treatments in orthopedics is growing at a rapid rate.

Bone graft substitutes consist of several types and encompass various materials, material sources, and origins (natural vs synthetic). Many are formed from composites of one or more types of material. The use of porous material scaffolds from bioceramic and polymer components to support bone cell and tissue growth is a longstanding area of interest. Current challenges include the engineering of materials that can match both the mechanical and biological context of real bone tissue matrix and support the vascularization of large tissue constructs.

The development and modification of orthopaedic implants has taken place for many years. The goal of achieving an optimal bone-implant interface has been approached by the alteration of implant surface topography, chemistry, energy and charge as well as bulk material composition.

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An ideal bone implant material has a biocompatible chemical composition to avoid adverse tissue reaction, excellent corrosion resistance in the physiologic milieu, acceptable strength, a high resistance to wear and a modulus of elasticity similar to that of bone to minimise bone resorption around the implant.

In order to determine whether a newly developed implant material conforms to the requirements of biocompatibility, mechanical stability and safety, it must undergo rigorous testing both in vitro and in vivo. Results from in vitro studies can be difficult to extrapolate to the in vivo situation. For this reason the use of animal models is often an essential step in the testing of orthopaedic implants prior to clinical use in humans. For testing orthopaedic implants, it is necessary to use a model which is reproducible and in which implant dimensions are comparable to those used in humans.

Wednesday, January 11, 14h15

Hörsaal Makromolekulare Chemie, Stefan-Meier-Str. 31

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