Hydroxyapatite (HAp, Ca_{10}(PO_{4})_{6}(OH)_{2}) has a hexagonal crystalline system and is a mineral component of vertebrate hard tissues, an important raw biomaterials and an element of drug delivery systems. It is commonly used as a filler to replace amputated bone or as a coating to promote bone ingrowth into prosthetic implants. There are, therefore, two historical research approaches to develop bioconvertible materials for surgical implants, one is based on crystalline calcium phosphate materials related HAp, and the other is glassy calcium phosphate materials transformed into HAp.

Biomaterials related to crystalline HAp have been reported by many investigators, including Dr. Racquel Z. LeGeros (New York University), Dr. Lawrence C. Chow (American Dental Association Foundation) and Dr. Hideki Aoki (International Apatite Institute). They developed bone implant materials based on meta-stable calcium phosphates in 1970–80, such as carbonated HAp and tetracalcium phosphates. In contrast, Dr. Larry L. Hench (Imperial College of London) and others discovered that various kinds of glassy ceramics could bond to living bone. Dr. Tadashi Kokubo (Kyoto University) then investigated the relationships between the glassy materials and supersaturated solution, and developed a simulated body fluid forming a HAp layer on the surface of implantable materials. This work inspired a new field called Bioceramics, and the first International Symposium on Bioceramics was held in Kyoto, Japan in 1988. Research on this subject spread based on “Biomimicry” concept, and many novel intelligent organic and inorganic composite materials have been created as implantable materials and drug delivery systems.

Six world-known scientists were invited to contribute papers to this volume updating readers on Bioceramics related research contributing to improved bioactive implantable materials for use in orthotic therapy. The first review is “Syntheses of Single-Crystal Apatite Particles with Preferred Orientation to the c- and c-Axes as Models for Hard Tissue and Their Applications” by Dr. Mamoru Aizawa and co-workers (Meiji University). The HAp crystals have a c-axis orientation to a vertebrate long bone surface, but they have an a(b)-axis orientation to a tooth enamel surface, because the orientation to all their axes planes of these crystals is caused by specific protein adsorption to the crystal surface. They determined that porous apatite fiber scaffolds were fabricated using the fiber-shaped apatite particles and applied them to tissue engineering of bone.

The second review is “Coral Exoskeletons as a Precursor Material for the Development of a Calcium Phosphate Drug Delivery System for Bone Tissue Engineering” by Dr. Joshua Chou and co-workers (University of Technology Sydney, Australia). They developed novel calcium phosphate-based drug delivery systems containing zinc using coral exoskeletons as a precursor material. An in vitro zinc release test showed a significantly slow release from the devices. Furthermore, in vivo studies on osteoporotic mice using the biomimetic zinc delivery system showed significant cortical and cancellous bone increase.

The third review is “Hydroxyapatite/Collagen Bone-Like Nanocomposite” by Dr. Masanori Kikuchi (National Institute for Materials Science). He succeeded in synthesizing a hydroxyapatite/collagen (HAp/Col) bone-like nanocomposite which was completely incorporated into the bone remodeling process and there after substituted by new bone. He and his colleagues also developed a viscoelastic porous “HAp/ Col sponge” which was significantly better than that made of porous β-tricalcium phosphate when used in a clinical test as a bone filler.

The fourth review is “Organic–Inorganic Composites Designed for Biomedical Applications” by Dr. Toshiki Miyazaki (Kyushu Institute of Technology) and co-workers. They summarized their many results in combining inorganic glassy components with various organic polymer which led to the development of bioactive organic–inorganic composites. In addition, novel biomedical applications of the composites to a drug delivery system, scaffolds for tissue regeneration and injectable biomaterials are available by combining with drugs and appropriately controlling them in their microstructure.

The fifth review is “Application of Calcium Phosphate as a Controlled-Release Device” by Dr. Tomoko Ito and Dr. Makoto Otsuka (Musashino University). They developed an injectable self-setting apatite cement containing a plasmid DNA complex. Injection of the suspension into tumor-bearing mice had a high therapeutic effect on a solid tumor. They also developed an alginate gel/amorphous calcium phosphate injection system for drug delivery. A composite gel together with a drug for osteoporosis resulted in sustained release of the drug on in vitro osteoclast cell condition, and a strong therapeutic effect was achieved on the osteoporotic model rats.

The final review is “Sol–Gel Derived Silicate Nano-Hybrids for Biomedical Applications” by Dr. Kanji Tsuru and co-workers (Kyushu University). They created organic–inorganic hybrids of poly(dimethyl siloxane), gelatin, and chitosan with such silanes as tetraethoxysilane and 3-glycidoxytriethoxysilane by the sol–gel method. Their biomedical applications are discussed based on biomimetic deposition of bone-like apatite, cell culture, and in vivo behavior.

I believe that the papers in this Current Topics section will be helpful to pharmaceutical scientists in understanding the novel concept of “Bioceramics.” I sincerely thank all the authors for their contributions.

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