Bioceramics Development and Applications

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# Ceramics that Up-regulate Cells Differentiation Process

**Kunio Ishikawa***

*Chairman and Professor, Department of Biomaterials, Faculty of Dental Science Kyushu University, Japan*

***Corresponding author:** Kunio Ishikawa , Chairman and Professor, Department of Biomaterials, Faculty of Dental Science Kyushu University 3-1-1, Maidashi, Higashi, Fukuoka 812-8582, Japan, Tel: 81-92-642-634; Fax: +81-92-642-6344; E-mail: ishikawa@dent.kyushu-u.ac.jp

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## Editorial

Ceramics is the only biomaterials that up-regulate cells' differentiation process. For example, apatite ceramics up-regulate differentiation of bone-related and connective tissue related cells. As a result, apatite and its related bioceramics hashave been used in clinics, especially for the regeneration and reconstruction of bone tissue defects. Despite the long history of apatite ceramics use, detailed mechanism of the up-regulation of osteoblasts by apatite ceramics has not been clarified up to date. This unfortunate current situation may arise, at least in part, to the usefulness of apatite ceramics for clinical use. Clinical application studies have been focused more attention rather than science of apatite. Although progress of apatite science is strongly awaited, application study of apatite seems to be accelerated due to the need of apatite ceramics in regenerative medicine.

Regenerative medicine requires three factors, i.e., cell, growth factor and scaffold. Cells, of course, play key roles for the regenerative medicine. However, growth factors and scaffold are required to maximize the potential of cells. Growth factors plays key role for the differentiation of cells. Scaffold, on the other hand, is expected to provide space to seed cells so that the desired three-dimensional tissue would be formed by cells. In other words, shape providing ability is expected to scaffold. Up to date, polymers have been evaluated more frequently when compared with bioceramics due to the easy shape providing ability and established biodegradability. Obviously, artificial polymers do not up-regulate differentiation unless they include bioceramics powder.

Bioceramics is the only biomaterials that up-regulate cells' differentiation process. Therefore, bioceramics has good potential value to supply better scaffold for tissue engineering. Progress of the regenerative medicine is accelerated by the stem cell research. As well knownwell-known, iSP, induced pluripotent stem cells, and STAP stem cells, stimulus-triggered acquisition of pluripotent stem cells, widen the further of stem cells research by elimination of ethical problems of embryonic cells (ES cells). In the case of regenerative medicine using stem cells, differentiation of the stem cells is one of the keys since stem cells can be differentiated into any cells.

Ability to up-regulate differentiation process of bioceramics can be improved by the combination with Ddrug delivery Delivery system System (DDS). In this area also, polymers have been used more frequently when compared to bioceramics since DDS can be established easily by just mixing biodegradable polymer with the drug. In contrast, ceramics is usually fabricated by sintering process, and thus thought not to be suitable for DDS. This is a serious misunderstanding, and bioceramics scientist should pay more attention so that DDS using bioceramics would be studied more extensively since bioceramics has higher affinity to many drugs. In addition, bioceramics is fabricated not only by sintering process but also by low-temperature setting reaction.

Bioceramics also has advantages for the inclusion of essential trace element that is also known to affect up-regulation of the cells' differentiation since introduction of essential trace element is easy for bioceramics.

Based on the current situation, bioceramics scientists are expected to reveal mystery of the materials, i.e., detailed mechanism of the cells' up-regulation of differentiation process, and fabricate new bioceramics that allows fruitful clinical results to the patients.