

What Role do Multifunctional Bioceramics Have in Tissue Engineering?

Jonathan C Knowles¹

Corresponding Author: j.knowles@ucl.ac.uk

¹Division of Biomaterials and Tissue Engineering, UCL Eastman Dental Institute,
256 Grays Inn Road, London WC1X 8LD

Introduction

Bioceramics play a significant role in the regeneration of a wide variety of tissues and in particular for the regeneration of hard tissue in both orthopaedic and dental applications. Originally, these materials may be viewed as having taken a relatively passive role, but the importance of the morphology of the materials and underlying chemistry is now being elucidated and understood. There are now a wide variety of ceramic-based materials available (notable is the expansion in use clinically) and these range from hydroxyapatite (HA) and tricalcium phosphates (TCP) through calcium orthophosphates through to an expanding field of calcium phosphate based cements which have recently undergone an expansion in research interest due to a more complete understanding and control of the setting chemistry.

Morphology

The morphology has been known for many years to affect the cellular and tissue response, but more recently the role of micropores coupled with the presence of nanoarchitecture is being unraveled (1) and utilized to control the tissue response (2). However a further layer of complexity may be added with the knowledge that the chemistry of the implant material can also control the tissue reaction seen (including repair and regeneration) may be as simple as the release of ions at appropriate levels and an excellent example of this is the development of biphasic materials (3). This is also critically important with bioactive glasses (4).

Biofunctionality

More recently, significant progress has been made to improve the biofunctionality of bioceramics by the incorporation of a secondary functionality via for example the inclusion of growth factors (5, 6) such as bone morphogenetic proteins (BMP) and related molecules.

Cell Seeding

Very recent work has focused on utilization of scaffolds and preseeding these with stem cells to further improve the bone regeneration (and presumably) with a view to further improvement of clinical success. This preseeding may be either cellular attachment to the scaffold or it may be via the inclusion of a hydrogel carrier.

Conclusions

The field of bioceramics is a buoyant research field with new developments coming on to the market. However one factor that should be borne in mind is the cost of these new developments and whether these costs make the device attractive to the procurer (healthcare insurers). This is particularly important for the newer combination products, where the cost:benefit ratio should be analysed.

References

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