Calcium Phosphates in Oral Biology and Medicine

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About the Author

Raquel Zapanta LeGeros was born in Manila, Philippines; received her BS from Adamson University (Manila) and her MS and PhD in chemistry from New York University. She is presently a professor in the Department of Dental Material Science as well as the Director of the Office of Research Program Coordination and Development at the New York University College of Dentistry, and a member of the National Advisory Council for the National Institute of Dental Research. She has served as a member of the Oral Biology and Medicine Study Section, National Institutes of Health (NIH); and as chairman of the Gordon Research Conference on Calcium Phosphates. Her research areas funded by NIH and industry, include: characterization of the mineral phase of calcified tissues and of commercial bone graft biomaterials; pioneering studies on substitutions of carbonate, magnesium, etc in apatites and on the formation and stability of calcium phosphates (relating to denta caries and calculus) in vitro; development of calcium phosphate-based bone substitute and coating materials for implants; and investigations on the physico-chemical events at the bone-biomaterial interfaces. She has published more than 80 articles and 120 abstracts on these subjects.

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Preface

Studies of synthetic and biological calcium phosphates are important for an improved understanding of dental calculus, dental caries, and of the biological fate of calcium phosphate biomaterials used as bone grafts.

Calcium phosphates (Ca-P) of biological significance are: amorphous calcium phosphate (ACP); brushite or dicalcium phosphate dihydrate (DCPD); monetite or dicalcium phosphate anhydrous (DCPA); octacalcium phosphate (OCP); whitlockite or tricalcium phosphate (β-TCP); calcium pyrophosphate dihydrate (CPPD), and apatite (AP). Several Ca-P phases coexist in the mineral phases of pathological calcifications (e.g., dental and urinary calculi, soft-tissue calcifications, etc.) while principally one Ca-P, apatite, is usually associated with those of normal calcifications (enamel, dentin, cementum, bone). This monograph describes simple methods of preparing synthetic calcium phosphates and points out some of the factors and conditions which favor or inhibit their formation in order to provide insights into the formation and stability of Ca-P in biological systems.

As early as 1926, using X-ray diffraction and chemical analyses, the mineral phases of enamel, dentin and bone have been identified as a calcium phosphate with an apatite structure, idealized as $Ca_{10}(PO_4)_6(OH)_2$, HA. However, the nonstoichiometry and the association of several minor and trace elements with biological apatites cause continued scientific inquiry and varied points of view. Some of the issues are: Does the mineral phases of enamel, dentin and bone consist only of apatite or apatite mixed with nonapatitic phase? What is the role of carbonate and fluoride on the formation and stability of dental apatite relating to caries? What is the role and distribution of magnesium in the organic/inorganic phase, in the apatitic/nonapatitic phase? What is the mechanism for the cariostatic effect of F and cariogenic/cariostatic effects of other elements (e.g., strontium, zinc)? What is the appropriate in vitro model for biological apatite-carbonate apatite? HA? Many competent researchers are diligently seeking answers to these and other important questions.

Calcium phosphate biomaterials, principally HA, now find wide clinical applications for repair of bony defects, bone augmentation, and coatings for metal implants. This monograph presents studies showing properties of commercial Ca-P biomaterials and studies on the in vitro and in vivo transformations of the Ca-P biomaterials.

This monograph attempts to show that results of studies of in vitro systems may, with great care, be extrapolated to answer to questions about in vivo systems relating to calcium phosphates in biological systems.

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Racquel Zapanta LeGeros, PhD

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