Principles of Bone Regeneration

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Editors

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Preface

Bone healing is the process whereby deficiencies and discontinuities in bone tissue are repaired by a regeneration process that rescues the biomechanical properties of the skeleton. Inevitably, this process involves an ultimate net gain in the amount of mineralized matrix at the affected sites. This gain may progress slowly, as in the case of the positive shift of bone remodeling balance induced in the osteoporotic skeleton by bone anabolic agents, or, as an outburst of bone formation and remodeling characteristic of the bone tissue reaction to traumatic insults. The importance of bone healing to medicine and biomedical research is illustrated by the number of publications on the different aspects of the subject, which exceeded 2,000 in 2011 alone.

Either form of bone healing is affected by a multitude of genetic, environmental, mechanical, cellular, and endocrine variables which eventually lead to changes in gene expression that enhance the guided action of osteoblasts (and chondroblasts) to lay down bone that restores, or even improves, the skeletal load bearing capacity and body motion. Needless to say, osteoclasts are also involved in shaping the healed tissue. Recent breakthroughs in understanding the regulatory aspects of bone formation and resorption, at the basic, translational, and clinical arenas, offer new modalities to induce, enhance, and guide repair processes in bone for the benefit of millions of patients with conditions such as osteoporosis, nonunion fractures, critical size defects, orthodontic tooth movement, periodontal bone loss, intraosseous implants, and deformed bones.

An immense number of approaches to treating these conditions are currently under basic, preclinical, and clinical investigations. They range from the development of sophisticated biomaterials for implant surgery, identification of neurotransmitters active in bone and other molecular drug targets, new drugs engineered by cutting edge pharmacological and molecular approaches, and advanced methods for tissue engineering and gene and cell therapies.

Because of the multidisciplinary nature of these efforts, this book addresses the modern aspects of bone healing, with a special attempt to enhance the convergence of the different experimental and clinical approaches designed for the study and treatment of bone healing in its diverse forms and under varying conditions. The information and ideas provided should have value not only for the experimental skeletal biologist and clinician treating bone conditions but also for a general interpretation of healing and regenerative processes in mammals.

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About the Authors

Professor Jona J. Sela

Born 1939, Jerusalem; D.M.D. 1966, Hebrew University

Appointments at the Hebrew University: Lecturer 1970; Senior Lecturer 1974; Associate Professor 1977; Professor 1981

Director, Division of Oral Pathology, 1989–2002

Chairman, Institute of Dental Sciences, 2004–2008

External Academic Positions

Honorary Research Fellow, Hard Tissue Unit, Department of Anatomy, University College London, UK, 1977

Visiting Scientist, Department of Human Genetics, UCL, UK, 1983

Lady Davis Visiting Professor, Department of Morphological Sciences, Bruce Rappaport Faculty of Medicine, Technion-Israel Institute of Technology, Haifa, Israel, 1986–1987

Guest Professor Medical Center Steglitz, Free University of Berlin, 1987

Chief-Superintendent, Head, Forensic Odontology, Israel Nat. Police 1987–1996; Chairman, Terminology Committees on Biological Sciences and Dental Medicine, The Hebrew Language Academy 1985–date

Visiting Professor UKBF, Free University of Berlin, Germany, 1996

Membership, Fellowship and Chairman

Chairman, Israel Society of Electron Microscopy, 1988–1993

NY Acad. of Sciences; Amer. Acad. of Oral Path.; Royal Micros. Soc.

Chairman, Jerusalem Branch, Israel Dental Assoc., 1970–1975. Founder, Chairman, Unit for First Aid, Magen David Adom, Jerusalem; 1972–1975

Secretary, 1978–1979, President, 1979–1980, Isr. Div. Int. Assoc. Dent. Res.

Isr. Soc. of Oral Pathology and Oral Medicine; Isr. Soc. of Anatomy

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Research Interest and Projects

Gene-expression of bone cells around orthopedic implants. Automated image analysis supported by computerized quantitative morphometry for the study of observations obtained by electron and light microscopy in normal and pathological conditions. Development of novel computerized quantitative histomorphometric methodology to study oral and systemic pathological changes in cancer and wound healing.

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Appointments at the Hebrew University: Lecturer 1979; Senior Lecturer 1982; Associate Professor 1986; Professor 1994

Research Interests and Projects

The bone laboratory is engaged in multidisciplinary research studying the mechanisms involved in skeletal remodeling, metabolic bone diseases, and the integration of endosseous implants. The laboratory studies the effects of different hormone and growth factor derived drugs on bone remodeling, bone mass, and healing of bone injuries. Recently, the laboratory has been engaged in the development of a new scientific field, neuropsychoosteology, which explores the bidirectional interaction between the brain and the skeleton. The methodological approaches employed in the laboratory encompass micro-computed tomography and histomorphometry, cellular and molecular biology, genetics, biochemistry and medicinal chemistry.

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