
Preface

Degenerative cartilage and bone diseases have challenged physicians for many decades due to the inherent inability of the tissue to repair itself when ailing. Patients afflicted not only suffer from physical pain, but their quality of life is decreased as these diseases often progress, going hand in hand with physical disability. Although conventional treatment regimens can ameliorate the condition, full recovery is never achieved. Here, tissue engineering using stem cells has brought a promising new approach to the treatment of such diseases.

Whereas adult stem cells, such as mesenchymal stem cells, are already tested in clinical trials and have brought some success in spinal disc and cartilage regeneration, this particular stem cell source may have some disadvantages in the context of certain other diseases. Mesenchymal stem cells senesce in culture, which ultimately means that maximum cell number reached after in vitro expansion might not suffice to fill and repair larger defects.

Embryonic stem cells (ESCs) on the other hand are stem cells of embryonic origin with an unlimited self-renewing capacity. Therefore, these cells represent an almost bottomless source for regenerative medicine and tissue engineering approaches. ESCs have been first derived from mice and just celebrated their 29th birthday. We have an adequate understanding of the processes that control pluripotency and are now diving deeper into explaining epigenetics and reprogramming. Although many groups have been studying their in vitro differentiation potential into cardiomyocytes and neurons, pancreatic beta-cells, and hepatocytes, the study of osteogenesis and chondrogenesis using ESCs as a model is a relatively young field. With the derivation of human and primate ESCs, however, the potential of ESCs is more intriguing than ever and more and more researchers enter this rising field.

With this textbook, I would like to set the ground stone on which those entering the field – cell biologists, molecular biologists, bioengineers, and clinicians – can build their mission to understand the mechanisms involved in differentiation of ESCs into skeletal cell types. To bring ESCs to clinic, much of this is needed and will not be the single undertaking of one laboratory. *Embryonic Stem Cell Therapy for Osteo-Degenerative Diseases: Methods and Protocols* provides detailed descriptions on how to expand ESCs from the most commonly used species ex vivo – mouse and human – in static culture as well as in controllable bioreactor processes. It summarizes the methods that may be used to differentiate the cells along the desired lineage of choice – be it osteoblasts, osteoclasts, or chondrocytes – and consequentially also offers analysis tools for the characterization of resulting cells and evaluation of differentiation effectiveness. Each chapter gives special care to address possible pitfalls and provides a troubleshooting guide.

Embryonic Stem Cell Therapy for Osteo-Degenerative Diseases: Methods and Protocols contains only protocols that are specific to ESCs and stem cell differentiation, and I refer the reader to *Bone Research Protocols*, edited by Helfrich and Ralston (1), for a detailed description for DNA/RNA isolation from bone tissue, specific considerations for embedding and sectioning bone tissue, and other issues concerning characterization of bone tissue the reader might want to refer to after using ESCs for in vivo transplantation.

The contributors of this book were chosen because they represent the experts in the field of stem cell self-renewal and the pioneers in skeletogenesis from ESCs. All have published in reputable, peer-reviewed journals. I sincerely hope that the methodology described in this book will be successful in your hands and that it allows you to carry out critical research needed in order to publish your own peer-reviewed articles and bring the field closer to the clinic. Such protocols merit ongoing consideration to explore the potential of progenitor cells for skeletal tissue repair within practical clinical guidelines that would allow for the widespread application of a successful strategy. Ultimately, this will advance the field and bring new knowledge on ESCs and skeletal development in general.

Tremendous gratitude is owed to Prof. John Walker at Humana Press, who gave me the opportunity to learn a great deal from my fellow authors and guided me through the process of editing, for providing me with the opportunity to add a new volume focusing on my personal scientific interest – pluripotent stem cells in skeletal regeneration – to the series, *Methods in Molecular Biology*.

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Reference

1. Helfrich, M.H. and Ralston, S.H. (2003) Bone Research Protocols. Totowa, New Jersey, USA, p. 448

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