

# Preface

We are very pleased to present this *Atlas on Human Pluripotent Stem Cells—Derivation and Culturing*, summarizing 12 years of our team's experience, skill and knowledge in the derivation, culture and expansion of human embryonic stem cells, and more recently, of human induced pluripotent stem cells. The exploration and realization of the incredible potential of these pluripotent stem cells for studying the fundamentals of early human development and organogenesis, for cell-based therapy and for disease modeling in the dish are a key focus of current biomedical research. Although murine embryonic stem cells have been used in research for 4 decades, techniques established for their growth have proven less amenable for long-term culture, expansion and manipulation of human pluripotent stem cells.

The culmination of two events has enabled the production of human embryonic stem cells: the birth of the first IVF test-tube baby in 1978 (Steptoe and Edwards 1978) and the discovery in 1981 by Martin (1981) and Evans and Kaufman (1981) of mouse embryonic stem cells. Later, development of sequential media in the mid-1990s enabled the growth of fertilized oocytes to viable blastocysts, from which the inner cell mass was extracted and human embryonic stem cells derived. These breakthroughs paved the way to the derivation of the first five human embryonic stem cell lines by Thomson et al. in Madison, Wisconsin, 1998 (Thomson et al. 1998). More recently, Yamanaka and team enthused the scientific community with their publication on the reprogramming of adult skin fibroblasts into induced pluripotent stem cells (Takahashi and Yamanaka, 2006).

To realize the full potential of embryonic and induced pluripotent stem cells, technologies, and especially those related to stem cell-based therapies, must achieve controlled cell growth in defined conditions for prolonged time periods, while maintaining cell stability, i.e., minimal genetic abnormalities, pluripotency and differentiation potential. For stem cell-based therapies and screening, robust production of cells in controlled dynamic cultures (bioreactors) is required. To that end, methods for expansion of pluripotent stem cells in non-adherent conditions, i.e., in suspension, are emerging.

This atlas provides up-to-date techniques that will be useful to those currently active in basic as well as translational research in the field of embryonic and induced pluripotent stem cells. It commences with practical aspects of the derivation and growth of human embryonic stem cells from inner cell mass blastocyst stage embryos. Three chapters in this volume deal with cell culture techniques, presenting the protocols and morphology of cells cultured on mouse embryonic fibroblasts and on foreskin fibroblasts, and the culturing of cells in feeder-free conditions. Taken together, the information provided in these chapters will enable the culture of pluripotent stem cells in defined conditions that are animal product-free, serum-free and feeder-free. The subsequent chapter describes the transformation of cell growth from adhesion to non-adhesion cultures, laying the foundation for the development of a system for robust therapeutic and industrial modalities.

The pluripotency and differentiation potential of human pluripotent stem cells are examined and described in the two chapters that focus on the differentiation of the cells into embryoid bodies *in vitro* and teratoma formation *in vivo*. The differentiation by immunostaining of undifferentiated and early differentiated human pluripotent stem cells is demonstrated in the subsequent chapter. Karyotype stability of human pluripotent stem cells is sensitive to growth conditions and to the manner in which cells are handled. This important issue is discussed in another chapter describing the common principles of karyotyping and fluorescent *in situ* hybridization (FISH) methods as they apply to the field of pluripotent stem cells.

Induced pluripotent stem cells attract great interest for their potential in understanding the basics of cell reprogramming, personalized medicine and disease modeling—a topic that concludes this atlas. In this last chapter the method for the derivation of human induced pluripotent stem cells from hair follicle keratinocytes is described.

We hope that this concise yet comprehensive atlas becomes a reference and an encyclopedia for young as well as established researchers, students and other individuals, involved in the field of stem cells. It is also our hope that the methods, descriptions and images provided in this atlas facilitate the realization of the enormous potential of human pluripotent stem cells and shorten the path from the bench to the bedside.

We are grateful for the generous support of the Technion's Stem Cell Center by the Sohnis and Forman Families. We thank Ilana Laevsky and Atara Novak for their valuable contributions. The cooperation and enthusiasm shown by the staff members at Springer who were involved in the accomplishment of this project are greatly appreciated. Special thanks are extended to all the members of our laboratory who contributed during the past decade to the research presented in this book.

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<http://www.springer.com/978-1-61779-547-3>

Atlas of Human Pluripotent Stem Cells

Derivation and Culturing

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2012, XIV, 142 p. 105 illus., 88 illus. in color., Hardcover

ISBN: 978-1-61779-547-3

A product of Humana Press