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Organ Regeneration

3D Stem Cell Culture & Manipulation

Edited by

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Dedication

This book is dedicated to the memory of Yoshiki Sasai, a scientist who made a great contribution to the advancement of developmental biology.

Preface

Organogenesis is a complex process that involves tissue self-organization, cell-cell interactions, regulations of cell signaling molecules, and cell movements. During embryonic development, organ-forming fields are organized in a process depending on the body plan. Various lineages of stem cells are produced and play central roles in organ development. In recent years, stem cell researchers have made advances in various aspects of three-dimensional organogenesis including cell growth, differentiation, and morphogenesis. Studies using multipotent stem cells have provided knowledge of the complex pattern formation and tissue self-organization during embryogenesis.

Stem cell research not only promotes basic biology but also can aid the development of regenerative medicine as a potential future clinical application. The current approaches to developing future regenerative therapies are influenced by our understanding of embryonic development, stem cell biology, and tissue engineering technology. To restore the partial loss of organ function, stem cell transplantation therapies were developed for several diseases such as hematopoietic malignancies, Parkinson's disease, myocardial infarction, and hepatic insufficiency. The next generation of regenerative therapy will be the development of fully functioning bioengineered organs that can replace lost or damaged organs following disease, injury, or aging. It is expected that bioengineering technology will be developed to reconstruct fully functional organs in vitro through the precise arrangement of several different cell types.

In recent years, significant advances in techniques for organ regeneration have been made using three-dimensional stem cell culture in vitro. Several groups recently reported the generation of neuroectodermal and endodermal organs via the regulation of complex patterning signals during embryogenesis and self-formation of pluripotent stem cells in three-dimensional (3D) stem cell culture. Other groups attempted to generate functional organs that develop by reciprocal epithelial and mesenchymal interactions using embryonic organ inductive stem cells. Several groups reported the generation of three-dimensional mini-organs/tissues by the reproduction of stem cells and their niches. These studies provide a better understanding of organogenesis in developmental biology and open possibilities for methodologies to be used in next-generation organ regenerative therapy.

Here, we focus on recent studies of organ regeneration from stem cells using in vitro three-dimensional cell culture and manipulation. These protocols have led both basic and clinical researchers to face new challenges in the investigation of organogenesis in developmental biology in order to develop applications for next-generation regenerative therapies.

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Kobe, Hyogo, Japan *Takashi Tsuji*

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