
Preface

Stem Cells are nature's indispensable gift to multicellular organisms, including humans.

In human history, immortality has been one of the most cherished, but unrealistic, wishes of human beings. Indeed, we are still hoping to cure serious diseases to achieve immortality, but medical treatments have been proven to result in less than impressive success. An excessive emphasis on medical therapies has diverted attention from nontherapeutical efforts to prolong life, i.e., to slow down the inevitable aging process. In fact, unfortunately some treatments may shorten life instead of prolonging it.

This is volume 13 of the multivolume series *Stem Cells and Cancer Stem Cells: Therapeutic Applications in Disease and Tissue Injury*. The discovery that stem cells possess unique capability of self-renewal and indefinite growth and differentiation into almost every cell type in the human body has allowed us to explore the possibility of cell therapy applications. Various types of stem cells, including cancer stems cells, are available for specific applications. By expressing four transcription factors in somatic cells, these cells can give rise to almost any other type of cell in the human body. The ethical limitations of embryonic stem cells have been overcome by producing induced pluripotent stem cells which like the former cells can give rise to almost every cell type. In other words, induced pluripotent stem cells have similar properties to those possessed by embryonic stem cells. The current understanding of molecular mechanisms underlying human somatic cell reprogramming to generate induced pluripotent stem cells is explained. Experts have discussed the advantages and limitations of the applications (e.g., transplantation) of some of the stem cell types (pluripotent stem cells, neural stem cells) in this volume.

It is well-established that stem cells have the unique capabilities of self-renewal, grow indefinitely, and differentiate into multiple types of cells. Many different types of stem cells exist, but they are found in very small populations in the human body; for example, in circulating blood there is one stem cell in 100,000 cells. Stem cell markers can be used for distinguishing stem cells from other types of cells. Specific stem cell markers are also available for identifying and isolating embryonic mesenchymal, hematopoietic, neural, skin, muscle, fat, endothelial, pancreatic, and tumor stem cells.

A stem cell is defined as a cell that can self-renew and differentiate into one or more specialized cell types. A stem cell may be pluripotent, which is able to give rise to the endodermal, ectodermal, and mesodermal lineages; an

example is embryonic stem cells. A stem cell may be multipotent, which is able to give rise to all cells in a particular lineage; examples are hematopoietic stem cells and neural stem cells. A stem cell may be unipotent, which is able to give rise to only one cell type; an example is keratinocytes.

A cancer stem cell is a cell type within a tumor that possesses the capacity of self-renewal and can give rise to the heterogeneous lineages of cancer cells that comprise the tumor. In other words, a cancer stem cell is a tumor-initiating cell. A unique feature of cancer stem cell is that although conventional chemotherapy will kill most cells in a tumor, cancer stem cells remain intact, resulting in the development of resistance to therapy. These types of stem cells are discussed in this series. Different sources of cancer stem cells are discussed. Potential clinical importance of cancer stem cells in the normal lung and lung cancer is also explained.

A detailed overview of the progress from embryonic stem cells to transduced pluripotent stem cells is presented. The importance of cancer stem cells in clinical application and their dynamics and regulation are explained. Characteristics of glioblastoma multiforme stem cells are presented. The importance of stem cell markers in diagnosis is included. Also, included is the role of stem cells in angiogenesis.

The adipose tissue functions as a critical organ for energy regulation, inflammation, and immune response through intricate signals. Mature adipocytes can be reprogrammed through their gene expression profile into different cytotypes. Human adipose-derived stem cells can be isolated in a greater number than those from the blood or bone marrow. Because adipose-derived stem cells are of autologous tissue origin, they are non-immunogenic. Although these cells are of mesodermal origin, their regenerative capacity extends to both ectodermal and endodermal tissues and organs. These cells are suitable for clinical applications in cell therapy and regenerative medicine. It is known that endothelial progenitor cells are capable of self-renewal and participate in vasculogenesis, angiogenesis, and arteriogenesis. Adipose-derived stem cells are ideal for practical regenerative medicine because, as mentioned above, they can be produced in large quantities. The authors describe their proliferation and differentiation capacities in a variety of regenerative medicine, including neurodegenerative diseases. A method for isolating multipotent endothelial-like cells from human adipose tissue is presented.

The most serious late complication of allogeneic stem cell transplantation is the graft versus host disease (GVHD). Up to a minimum of 100 days following stem cell transplantation, ~50 % of patients will experience some degree of GVHD. The most efficient preventive strategy for GVHD consists of an immunosuppressive regimen although this treatment is immunologically nonspecific and thus is only partially effective. However, with the possibility that transplantation of stem cells might cure HIV infection and multiple sclerosis, this technology is described in detail in this volume. The transplantation technology using oligodendrocytes and motoneuron progenitors from human embryonic stem cells to achieve locomotor recovery after spinal cord transaction is also explained here.

As the field of stem cell research advances, there will be an ongoing and increasing need for mathematical and other quantitative tools to facilitate research and discovery. One author has discussed several mathematical models related to the cancer stem cell hypothesis and their use in studying stem cell differentiation.

By bringing together a large number of experts (oncologists, neurosurgeons, physicians, research scientists, and pathologists) in various aspects of this medical field, it is my hope that substantial progress will be made against terrible human disease and injury. It is difficult for a single author to discuss effectively the complexity of diagnosis, and therapy, including tissue regeneration. Another advantage of involving more than one author is to present different points of view on a specific controversial aspect of cancer cure and tissue regeneration. I hope these goals will be fulfilled in this and other volumes of the series. This volume was written by 22 contributors representing 6 countries. I am grateful to them for their promptness in accepting my suggestions. Their practical experience highlights their writings, which should build and further the endeavors of the readers in these important areas of disease and injury. I respect and appreciate the hard work and exceptional insight into the nature of cancer and other diseases provided by these contributors. The contents of the volume are divided into two subheadings: Treatments and General Applications for the convenience of the readers.

It is my hope that subsequent volumes of the series will join this volume in assisting in the more complete understanding of the causes, diagnosis, and cell-based treatment of major human diseases and debilitating tissue/organ injuries. There exists a tremendous, urgent demand by the public and the scientific community to address to disease diagnosis, treatment, cure, and hopefully prevention. In the light of existing cancer calamity, government funding must give priority to eradicating deadly malignancies over military superiority. I am thankful to Dr. Dawood Farahi and Philip Connelly for their encouragement to me to continue the endeavor to publish these volumes. I am also thankful to my students for their help in many ways in completing this project.

Union, NJ, USA
February, 2015

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Stem Cells and Cancer Stem Cells, Volume 13
Therapeutic Applications in Disease and Injury

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2015, XL, 123 p. 11 illus., 8 illus. in color., Hardcover

ISBN: 978-94-017-7232-7