

## Foreword

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## Regenerative medicine: the last 10 years

“The field of regenerative medicine has continued to grow and change rapidly in the past 10 years...these articles help highlight important advances that have occurred, and that are likely to impact the future success of the field.”

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It is an honor to serve as a guest editor for this special issue of *Regenerative Medicine*, which celebrates the journal's tenth anniversary. Much has happened in the last decade. Human induced pluripotent stem cells had not yet been generated. Indeed, progress in the field has been so rapid that the first clinical trials have now been carried out using both embryonic and induced pluripotent stem cells. During this time, scientists not only figured out how to reprogram differentiated human cells into induced pluripotent stem cells using a variety of methodologies, but a Nobel Prize was awarded in 2012 for this achievement. This special anniversary issue covers all of this progress as well as other advances in regenerative medicine, including reviews of research in the field, emerging opportunities and challenges, as well as forward-looking perspectives.

Significant progress has been made in the development of potential regenerative cell-based therapies, especially neurodegenerative diseases, such as Parkinson's disease, which are poised to enter the clinic in the next few years. This issue includes a special report by Roger Barker on how far we have come on this, covering the many challenges including ethical considerations, potential for immune-mediated rejection with allo- and xenogeneic tissue, as well as how dopaminergic neurons derived from stem cell sources could be used to develop cell-based therapies suitable for clinical use [1]. A second special report by Stephen Badylak focuses on lessons learned in regenerative medicine from 'Mother Nature'. Multidisciplinary approaches are

being investigated to restore functional tissue using evolutionarily conserved principles of stem cell biology, developmental biology, engineering and medicine. This evolution has the potential to capitalize upon the ability of cells to adapt, proliferate, self-organize and differentiate into functional tissue [2].

This special anniversary issue includes a variety of short editorials, commentaries and institutional profiles, as well as several perspectives. Paul Knoepfler discusses his perspective on CRISPR technology and beyond. He reviews the history of genome editing in stem cells (including via zinc finger nucleases, TALENs and CRISPR-Cas9), and discusses recent developments and the prospect for future advances in this exciting field [3]. Paul Kemp provides a perspective on regenerative medicine 'looking backward to move forward'. His review looks at the numerous changes that have occurred in the regenerative medicine industry during the past decade, and considers the direction that it may go in the future [4]. Paul Fairchild shares his perspective on the immunogenicity of cell types and tissues differentiated from pluripotent stem cells. He discusses contradictory claims about whether tissues derived from allogeneic sources can evade immune surveillance, as well as strategies for reducing the impact of immunogenicity on the future of regenerative medicine [5].

This special issue also includes several review articles, including one by Erin Kimbrel and myself that highlights key advancements in pluripotent stem cell research in the last 10 years, and how they will guide the direction of the field over the next decade [6].



**Robert Lanza**

Astellas Institute for Regenerative Medicine, 33 Locke Drive Marlborough, MA 01752 USA  
[robert.lanza@astellas.com](mailto:robert.lanza@astellas.com)



A review article by Paolo Madeddu focuses on the bone marrow pericyte as an orchestrator of vascular niche, the regenerative potential of these cells and the challenges related to their use in regenerative cell therapy [7]. Nanotechnology also offers significant potential in regenerative medicine. Ali Khademhosseini reviews potential nanotechnology-based regenerative medicine products, which may enable new applications for recreating composition, structure and functionalities of tissues at the nanoscale level in the near future [8]. Cato Laurencin discusses the past, present and future of ligament regenerative engineering, which may aid the enhancement of clinical reconstruction outcomes [9]. Last, Koudy Williams' review focuses on the current status of regenerative pharmacology, which promises to accelerate the development, maturation and function of bioengineered and regenerating tissues [10].

In his editorial, Dusko Ilic discusses the Japanese dominance over the development and commercialization of stem cell technologies [11]. And finally, Kevin McCormack and Stacey Johnson provide us with institutional profiles on the California Institute for Regenerative Medicine and the Centre for Commercializa-

tion of Regenerative Medicine respectively, giving us an insight into the institutions' history, achievements and upcoming projects [12,13].

The field of regenerative medicine has continued to grow and change rapidly in the past 10 years. We believe that these articles help highlight important advances that have occurred, and that are likely to impact the future success of the field. The publication of this special issue celebrates an exciting milestone for *Regenerative Medicine* – the tenth year anniversary of the journal. I hope you will join me in congratulating the journal for reaching this major milestone.

#### Financial & competing interests disclosure

Robert Lanza is an employee of the Astellas Institute for Regenerative Medicine, a company in the area of stem cells and regenerative medicine. The author has no other relevant affiliations or financial involvement with any organization or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript apart from those disclosed.

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