

## Stem Cells and the Future of Regenerative Medicine

by the Board on Life Sciences, National Research Council, and Board on Neuroscience and Behavioral Health, Institute of Medicine

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Stem cells have emerged as one of the hottest topics of the new millennium, eliciting a confused mixture of scientific excitement, therapeutic promise, business opportunity and ethical debate. The confusion is fueled by rapid media coverage of unconfirmed scientific 'breakthroughs' compounded by a growing gap in public understanding of the biology and chemistry of living systems. Not surprisingly, there is also extensive heterogeneity of opinion, both within the United States and worldwide, about what constitute acceptable principles for developing a framework to guide future research on human stem cells. *Stem Cells and the Future of Regenerative Medicine* is one of the products of this ongoing discussion.

The recent successful culturing of early-stage human embryos to create stem-cell lines with demonstrable multi-tissue potentiality has clearly introduced a ready platform for rapid progress in many areas of human stem-cell biology. In addition, the establishment of mammalian reproductive cloning has introduced additional possibilities for extending this technology to human cells to create human embryonic stem cells by genome reprogramming mechanisms that were not even anticipated to exist a few years ago. Understandably, the assumed potential of all of these cells to generate complete human beings has also sparked divergent reactions about how the technology for their isolation and further use should be regulated.

Such a unique moment in the history of biomedical science has rightfully commanded attention from all sectors of society, including the senior members of the biomedical profession itself. *Stem Cells* is a recently published brief overview of issues considered relevant to this topic. It is authored by a Committee on the Biological and Biomedical Applications of Stem Cell Research that was formed by the National Research Council of the National Academy of Sciences and the National Academy of Engineering of the US. The members of this committee were deliberately chosen to be leading scholars not directly engaged in stem-cell research, and their contributions to this book were therefore developed with significant input from discussions held at a stem-cell workshop held in June, 2001. At this workshop, 17 senior stem-cell scientists, philosophers, ethicists and legal experts were invited to outline their views on what stem cells are, from where they can be obtained, how they may vary when isolated from different sources, what is known about their potential uses and what are the major challenges to their future clinical exploitation, both from a scientific and an ethical perspective.

*Stem Cells* summarizes what was thought to be understood about adult and embryonic stem cells in 2001. It also identifies key hurdles to rapid progress in the expansion and differentiation of stem cells for new medical indications, while recognizing that some applications are already well established; for example, hematopoietic stem-cell transplants in patients with hematological disorders and skin-cell transplants in burn patients. In addition, *Stem Cells* provides a thoughtful and balanced summary of the moral and ethical issues that surround the derivation of and experimentation with cells derived from human embryos. It also presents an insightful overview of the likely impact of public versus private research funding of human stem-cell research. Finally, it concludes with a series of recommendations. These include the creation by the National Institutes of Health of a national

multi-disciplinary advisory group of experts to oversee research on human embryonic stem cells.

Many, like myself, will find this book attractive and useful because of its combination of breadth and brevity. It thus serves as a handy resource for examples and arguments pertinent to the various specific areas covered. At the same time, it does not pretend to provide either a comprehensive or even a particularly critical assessment of these topics. Some may find the weight given to the verbal communications and published citations of the workshop participants an unnecessary departure from the more objective style of scientific communications, particularly where the views expounded may not be broadly accepted or may have caveats that would be difficult to cover adequately in such a book. As might be expected for a book about a rapidly evolving field, its scientific content is already out of date. Two notable omissions are the recent publication by the Verfaillie group in Minnesota of cells that can be isolated from adult tissues

that retain embryonic stem cell-like features and multi-potentiality (*Blood* 98, 2615-2625; 2001), and a possibly similar cell population in the dermis (*Nature Cell Biol.* 3, 778-784; 2001) identified by Miller and colleagues in Montreal. Other oversights are the lack of any discussions of ethical issues surrounding the creation of human/non-human chimeras or of the paucity of information available on most of the putative human embryonic stem-cell lines 'recognized' by the NIH.

Nevertheless, *Stem Cells* wins the day in my view by its careful formation of seven compelling recommendations that are summarized at the beginning and rationalized at the end of the text. Hopefully, the publication of these recommendations in association with a concise overview of the stem-cell field will prove to be a valuable tool in the development of policy guidelines for human stem-cell research that are both socially acceptable and beneficial to the ultimate goal of developing improved treatments for a wide spectrum of disabling human diseases.

