

Preface

Throughout history, mankind has looked for the fountain of youth; the elixir for eternal life, keeping us forever young in body and mind. In the discovery of stem cells, has the modern biomedical scientist finally succeeded where wizards and alchemists failed? This book was written to address this and other questions on what stem cells can mean for health and society, now and in the near future. And because the field of stem cell research is moving so rapidly, just four years after its first edition, this book was in need of an update. This second edition includes new sections on biotechnology, "organs-on-chips," and the facts and fiction of stem cell therapies.

The organs of our body are built of a mixture of specialized cells that determine how each organ functions and what it does. These specialized cells have much shorter lives than our own: brain cells live for many years, but white blood cells, skin cells, and cells of the intestine survive sometimes for just a matter of days. This means that these cells continually need replacement. Stem cells hidden away in our body are the source of these new specialized cells. They have the lifelong task of waiting quietly until they are needed, and then they divide and replace a specialist cell that has in some way been destroyed.

Stem cells in bone marrow, which make all of our blood cells, have been used for decades to restore the blood and immune system after patients have been treated for leukemia, a cancer of the blood. These stem cells turned out to be remarkably simple to transplant from a healthy donor to a patient once their basic biology was understood. Following in these footsteps, many different types of stem cell have been discovered over the last 20 years, even in tissues where it was thought that none existed, such as the brain and the heart. By understanding their biology better, scientists hope to use them in the clinic one day, much like bone marrow stem cells now. The most amazing, yet controversial stem cells are undoubtedly those found in embryos just a few days old: embryonic stem cells. Until recently, these were the only stem cells able to make all of the 200 or so specialized cells of the body. Yet just when we thought this was an intractable problem, with ethical objections countering the potential benefit to very sick patients, stem cell research took a new and completely unexpected turn. This was the discovery of induced pluripotent stem cells, based on reprogramming of adult cells, for which Shinya Yamanaka and Sir John Gurdon were

jointly awarded the Nobel Prize in 2012. This discovery has in less than 10 years transformed the field and allowed scientists throughout the world to contribute to pluripotent stem cell research. We are just beginning to see the impact of this in biomedical research, and the new edition of this book anticipates what this will mean in the near future.

There is growing excitement surrounding stem cells as their power is harnessed and they make inroads into clinical and academic research. Scientists see an amazing technology emerging, the boundaries of which are unknown. Doctors see new opportunities to treat the diseases of old age. Entrepreneurs in biotechnology expect new marketing opportunities to develop for commercial products based on stem cells. Among political and religious leaders, questions are asked: do we want this technology, is it safe, and where will it lead? Where do we set limits for science and society?

As is often the case when science opens a new door, things can go wrong. In good faith, we may move forward too fast, and spectacular scientific claims may turn out not to be as robust as we thought. They might not even be true. Just as in many other professions, personal integrity and the attraction of fame and fortune can all influence individual behavior, and stem cell research has already been among those areas with serious cases of fraud. *Mala fide* stem cell practices continue to grow at epidemic rates and this growth of what has become known as "stem cell tourism" shows no signs of stopping, however much the experts warn patients of their lack of effect or even risks.

This book places the stormy developments in the stem cell field clearly in context. It provides an understandable and comprehensive overview of the history and state of the art, and distinguishes truth from fiction and empty promises from fact for nonexperts in the field. Whether you are a student or patient, politician or lawyer, entrepreneur or just plain interested, we hope you enjoy this book as much as we enjoyed researching and writing it!

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