

Stem cells raise the prospect of regenerating failing body parts and treating a wide range of disorders that result from tissue loss or dysfunction. Over 16 million patients worldwide suffer from neurodegenerative disorders such as Parkinson's and Alzheimer's disease, over 200 million people suffer from diabetes, and millions more from cardiovascular disease, blindness, and other disorders that may one day be treatable using stem cell technology. With the advent of induced pluripotent stem (iPS) cells, we may even have a way to overcome the problem of immune rejection. In addition to being a promising—and potentially unlimited—source of cells for regenerative medicine and drug discovery, stem cells serve as an excellent model for studying both normal and abnormal vertebrate development.

The rapid progress and interest in stem cells has led to an avalanche of new knowledge and research tools that span multiple areas of scientific inquiry, ranging from cellular reprogramming to cloning to tissue engineering. Although books on various stem cell topics abound, *Stem Cell Anthology* combines in a single volume a collection of definitive

chapters and essential subject matter from five leading stem-cell related volumes, including *Essentials of Stem Cell Biology*, *Principles of Tissue Engineering*, *Principles of Regenerative Medicine*, *Human Stem Cell Manual*, and *Principles of Cloning*.

Stem Cell Anthology successfully integrates this exciting area of biology, combining the prerequisites for a general understanding of adult, embryonic, and induced pluripotent stem cells. No topic in the field of stem cells is left uncovered, including methods for preparing, maintaining, and genetically manipulating stem cells and progenitor populations; the types, properties, and characteristics of stem cells; application of stem cells to specific organ systems and diseases, including neural and pancreatic stem cells; cancer; burns and ulcers, and cardiovascular and musculoskeletal repair; as well as a section on ethical, religious, and FDA product and pre-clinical regulatory considerations. The result is a comprehensive, easy to follow reference by the world's experts that will be useful to students, scientists, and clinicians alike.

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Stem Cell Anthology: A Comprehensive Reference for the Field

WHAT IS A STEM CELL?

Stem cells are defined functionally as cells that have the capacity to self-renew as well as the ability to generate differentiated cells (Wientroub et al., 2004; Smith, 2001). More explicitly, stem cells, as generate daughter cells identical to their mother (self-renewal) as well as produce progeny with more restricted potential (differentiated cells). This simple and broad definition may be satisfactory for embryonic or fetal stem cells that do not perdure for the lifetime of an organism. But this definition breaks down in trying to discriminate between transient adult progenitor cells that have a reduced capacity for self-renewal and adult stem cells. It is therefore important when describing adult stem cells to further restrict this definition to cells that self-renew throughout the life span of the animal (see also Kiehl and Weiss, 2000). Another parameter that should be considered is potency: Does the stem cell generate all multiple differentiated cell types (multipotent) or is it only capable of producing one type of differentiated cell (unipotent)? Thus, a more complete discussion of a stem cell includes a consideration of regeneration capacity, clonality, and potency. Some theoretical as well as practical considerations surrounding these concepts are considered in this chapter.

Stem cells (SCs) (Smith, 2001; Wientroub et al., 2004) are a special type of cell that have the capacity to self-renewal as well as to generate adult stem cells (ASCs) (see below). A rigorous assessment of the capacity for self-renewal of certain adult stem cells can be obtained by single-cell or serial transfer into acceptable hosts, an excellent example of which is adult hematopoietic stem cells (HSCs) (Allsopp and Wientroub, 2000; Levey and Nave, 1997). Adult stem cells are probably still best defined as those which they must display sufficient proliferative capacity to last the lifetime of the animal. Terms such as "immortal" and "unlimited" are probably too broad (perhaps if a cell

Clonality

A second parameter, perhaps the more important, is the idea that stem cells are the original cell(s) that give rise to the capacity to create more stem cells. This idea has been extensively used in the literature and is essential for any definitive characterization of self-renewal, potency, and lineage. Methods for tracing the lineage of stem cells are described in subsequent chapters. Although the word "clone" is well understood, there remain several confusing practical issues. For instance, what constitutes a cell line? The lowest standard would include any population of cells