CHAPTER 12

GREAT PROMISE OF TISSUE-RESIDENT ADULT STEM/PROGENITOR CELLS IN TRANSPLANTATION AND CANCER THERAPIES

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Abstract: Recent progress in tissue-resident adult stem/progenitor cell research has inspired great interest because these immature cells from your own body can act as potential, easily accessible cell sources for cell transplantation in regenerative medicine and cancer therapies. The use of adult stem/progenitor cells endowed with a high self-renewal ability and multilineage differentiation potential, which are able to regenerate all the mature cells in the tissues from their origin, offers great promise in replacing non-functioning or lost cells and regenerating diseased and damaged tissues. The presence of a small subpopulation of adult stem/progenitor cells in most tissues and organs provides the possibility of stimulating their in vivo differentiation, or of using their ex vivo expanded progenies for cell-replacement and gene therapies with multiple applications in humans without a high-risk of graft rejection and major side effects. Among the diseases that could be treated by adult stem cell-based therapies are hematopoietic and immune disorders, multiple degenerative disorders such as Parkinson’s and Alzheimer’s diseases, Types 1 and 2 diabetes mellitus as well as skin, eye, liver, lung, tooth and cardiovascular disorders. In addition, a combination of the current cancer treatments with an adjuvant treatment consisting of an autologous or allogeneic adult stem/progenitor cell transplantation also represents a promising strategy for treating and even curing diverse aggressive, metastatic, recurrent and lethal cancers. In this chapter, we reviewed the most recent advancements on the characterization of phenotypic and functional properties of adult stem/progenitor cell types found in bone marrow, heart, brain and other tissues and discussed their therapeutic implications in the stem cell-based transplantation therapy.
INTRODUCTION

Recent advances in the field of the stem cell biology have led to the characterization of different tissue-resident adult stem/progenitor cells in most mammalian tissues and organs that constitute potential and easily accessible sources of immature cells with multiple promising therapeutic applications in stem cell-based transplantation therapies. Among the tissues harboring a small subpopulation of adult stem/progenitor cells, there are bone marrow (BM), vascular walls, heart, brain, tooth, skeletal muscles, adipose tissues as well as the epithelium of the skin, eye, lung, liver, digestive tract, pancreas, breast, ovary, uterus, prostate and testis (Fig. 1).\(^1\) Numerous studies have allowed researchers to define the unique features of each tissue-resident adult stem/progenitor cell type and their specialized local microenvironment designated as a niche (Fig. 1).\(^1\) The tissue-resident adult stem/progenitor cells and their early progenies endowed with a high self-renewal and multilineage differentiation potential generally provide critical physiological functions in the regenerative process for tissue homeostatic maintenance, and repair after intense injuries, such as chronic inflammatory atrophies and fibrosis.\(^1\) Multipotent adult stem/progenitor cells are able to give rise to different differentiated cell lineages in tissues from which they originate in physiological conditions, and thereby regenerate the tissues and organs throughout the lifespan of an individual. Importantly, it has also been shown that certain adult stem/progenitor cells, including BM-derived stem/progenitor cells, may be attracted at distant extramedullary peripheral sites after intense injuries, and thereby participate in the tissue repair through remodeling and regeneration of damaged areas.\(^1\) Of clinical interest, it has been shown that the small pools of endogenous adult stem/progenitor cells can be successfully used for cell replacement-based therapies in regenerative medicine and cancer therapy in humans.\(^3\) The use of autologous adult stem/progenitor cell transplant may reduce the high-risk of graft rejection and severe secondary effects observed with allogenic transplant or embryonic stem cell (ESC)-based transplantation therapies. Particularly, the in vivo stimulation of endogenous tissue-resident adult stem/progenitor cells or the replacement of nonfunctioning or lost adult stem/progenitor cells by new ex vivo expanded immature cells or their differentiated progenies have been recognized as promising therapeutic strategies.\(^3\) Among the human diseases that could be treated by stem cell-based transplantation therapies, there are hematopoietic and immune disorders, Type 1 or 2 diabetes mellitus, cardiovascular, neurodegenerative and musculoskeletal diseases and skin, eye, tooth, liver, and gastrointestinal disorders and aggressive and recurrent cancers (Figs. 1 and 2).\(^3\) In regard with this, we discussed the most recent progress in basic and clinical research in the adult stem/progenitor cell field in terms of their implications in the development of novel stem cell-based transplantation therapies. The emphasis is on the phenotypic and functional properties of adult stem/progenitor cells found in BM, heart and brain and their potential therapeutic applications to treat diverse severe disorders and aggressive cancers.