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Stem Cell Treatments May Reshape the Future of Medical Therapeutics

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Stem cells are biological cells that are capable of differentiation, division, renewal and tissue repair [1]. There are three types of stem cells: (1) totipotent; (2) multipotent such as mesenchymal stem cell (MSCs); and (3) pluripotent including embryonic stem cells (ESCs) and induced pluripotent stem cells (iPSCs) [1-5]. Stem cells can be derived from various sources including bone marrow, peripheral blood, umbilical cord, placenta, amniotic fluid, adipose tissue and dental pulp [1,2,6]. Each type of stem cells has its own distinguishing properties and flow cytometric findings [2,6].

The number of internationally registered clinical trials on MSCs has been increasing steadily since the year 2004 [7]. Their clinical applications include: (1) cardiovascular disorders such as coronary artery disease, myocardial infarction, dilated cardiomyopathy and critical limb ischemia; (2) type 1 diabetes mellitus; (3) autoimmune and collagen vascular disorders such as multiple sclerosis, systemic sclerosis, systemic lupus erythromatosis and Crohn's disease; (4) liver and spinal cord injuries, tissue repair, wound healing and regenerative medicine; (5) enhancement of engraftment as well as prevention and treatment of graft versus host disease in recipients of hematopoietic stem cell transplantation; and (6) sepsis, acute respiratory distress syndrome and various infections including multidrug resistant tuberculosis, viral hepatitis, Chagas disease and human immunodeficiency virus [5,6,8,9].

The use of iPSCs can avoid the obstacles and ethical issues that limit the use of ESCs [2,4]. Induction and programming of these stem cells employ DNA as well as non-DNA methods and require the presence of several factors including: species such as humans or mice; factors or chemicals such as proteins, genes or valproic acid; vectors such as lentivirus or retrovirus; cell type such as fibroblasts or blood cells and diseases with specific genetic mutations [2,4]. Their clinical applications include: (1) hemoglobinopathies such as β-thalassemia and sickle cell disease; (2) hereditary bone marrow failure syndromes such as Fanconi anemia and dyskeratosis congenita; (3) hemophilia A; (4) chronic myeloproliferative neoplasms such as myelofibrosis and polycythemia rubra vera; (5) synthesis of blood components; (6) disease modeling; (7) tissue engineering and regenerative medicine; (8) screening for drug toxicity, drug development and discovery; (9) metabolic disorders such as Hurler syndrome, Lysch-Nyhan syndrome and Wilson disease; and (10) various neurological and psychiatric disorders including Parkinson's disease, Alzheimer's disease, amyotrophic lateral sclerosis, Duchenne muscular dystrophy, Huntington's disease and schizophrenia [1,2,4,9].

MSCs & iPSCs may reshape the future of medical therapeutics and may eventually become curative for several chronic and intractable diseases [1,2,4-6,8,9]. However, the field is still in its infancy and plenty of research and clinical trials are needed to refine their future role [4,7]. Their complications particularly predisposition to cancer should not be underestimated. Also, the remaining challenges facing their clinical utilization need to be resolved [2,3]. Banking of stem cells is vital in order to make them readily available for clinical use [2]. Strict guidelines, standardization of techniques and quality control measures are essential for collection, culture, cryopreservation as well as clinical utilization of various types of stem cells [3,4,6,9].

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