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A stem cell is a cell that has the ability to divide for indefinite periods, often throughout the life of the organism. Under the right conditions, or given the right signals, stem cells can give rise to the many different cell types that make up the organism. That is, stem cells have the potential to develop into mature cells that have characteristic shapes and specialized functions, such as heart cells, skin cells, or nerve cells ***(Chandross and Mezey, 2001).***

Adult stem cells, like all stem cells, share at least two characteristics. First, they can make identical copies of themselves for long periods of time; this ability to proliferate is referred to as long-term self-renewal. Second, they can give rise to mature cell types that have characteristic morphologies and specialized functions. ***(Robey, 2000).***

Adult stem cells are rare. Their primary functions are to maintain the steady state functioning of a cell and, with limitations, to replace cells that die because of injury or disease ***(Holtzer, 1978).***

For example, only an estimated 1 in 10,000 to 15,000 cells in the bone marrow is a hematopoietic stem cell (HSC) ***(Weissman et al., 2000).***

HSCs were first proven to be blood-forming stem cells in a series of experiments in mice; similar blood-forming stem cells occur in humans. HSCs are defined by their ability to self-renew and to give rise to all the kinds of blood cells in the body. This means that a single HSC is capable

of regenerating the entire hematopoietic system, although this has been demonstrated only a few times in mice ***(Osawa et al.,1996).***

Harrison et al. write that short-term blood-progenitor cells in a mouse may restore hematopoiesis for three to four months ***(Marshak, 2001).***

The notion that the bone marrow contains stem cells is not new. One population of bone marrow cells, HSCs is responsible for forming all of the types of blood cells in the body. HSCs were recognized as a stem cells more than 40 years ago ***(Becker et al., 1963).***

In the late 1980s, umbilical cord blood (UCB) was recognized as an important clinical source of HSCs. ***(Koh, 2004).***

Embryonic stem (ES) cells form a potential future source of HSCs. Both mouse and human ES cells have yielded hematopoietic cells in tissue culture, and they do so relatively readily. ***(Vodyanik, 2004).***

An ongoing set of investigations has led to claims that HSCs, as well as other stem cells, have the capacity to differentiate into a much wider range of tissues than previously thought possible. It has been claimed that, following reconstitution, bone marrow cells can differentiate not only into blood cells but also muscle cells ***(Jackson et al., 2001)***

The clinical use of stem cells holds great promise, although the application of most classes of adult stem cells is either currently untested or is in the earliest phases of clinical testing ***(Wakitani, 2002).***

HSCs, which have been used clinically since 1959 and are used increasingly routinely for transplantations, albeit almost exclusively in a non-pure form. By 1995,more than 40,000 transplants were performed annually world-wide ***(Horowitz, 1999).***

Currently the main indications for bone marrow transplantation are either hematopoietic cancers (leukemias and lymphomas), or the use of high-dose chemotherapy for nonhematopoietic malignancies (cancers in other organs). Other indications include diseases that involve genetic or acquired bone marrow failure, such as aplastic anemia, thalassemia sickle cell anemia, and increasingly, autoimmune diseases ***(Santos, 2000).***