

IN FOCUS

Stem Cell-Based Drug Therapies: A Discussion on Emerging Technologies and Future Developments

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Stem cell research has opened new experimental avenues for researching the mechanisms of debilitating diseases. Moreover, due to their ability to differentiate into highly specific cells with various functions, stem cells can provide a renewable source of replacement cells or tissue to treat disease. Because of their immense promise, pharmaceutical companies are rapidly initiating the development of stem-cell based therapeutics with the goal of revolutionizing disease treatment.

Stem cell technologies have begun to transform areas of drug discovery for pharmaceutical companies. Currently, these cells are used in high throughput screens (HTS[†]), which use extensive automation to test hundreds of thousands of compounds targeted toward the treatment of particular diseases. In such screens, stem cells would, ideally, provide limitless numbers of human cells for testing different characteristics of new therapeutics, including drug pharmacology, toxicology, and cytotoxicity [1].

During a panel entitled Translation to Clinic at the StemCONN 2009 conference in New Haven, Connecticut, in March, John D. McNeish, Ph.D., discussed the use of HTS at Pfizer Inc. in the last decade. Pfizer screens compounds with animal and adult stem cells to identify safer drugs. Pfizer also uses HTS to find drugs that may prompt the body to regenerate pancreas cells destroyed by the immune system in diabetes patients [2].

Although the use of embryonic stem (ES) cells has been quite controversial, the impact of ES cells on drug development is promising. ES cells can differentiate into any cell type and be directed to become diseased cells [3]. These newly generated cells then may be used as an advanced platform for testing pharmaceutical compounds *in vitro*. The use of stem cells in HTS is just one application for stem cells in healthcare and represents a novel technology in drug development.

Recent academic stem cell research has provided some groundwork for the de-

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[†]Abbreviations: HTS, high throughput screens; ES, embryonic stem; FDA, Food and Drug Administration.

velopment of future drug therapies. Haifan Lin, a leading stem cell researcher at Yale University, spoke at the conference about cancer stem cells. Like stem cells in general, cancer stem cells self renew and differentiate, although they form tumors as a result of this process [4]. *In vivo*, stem cells and cancer stem cells are found in an extremely complex environment or niche. The cells within the niche, or “niche cells,” transmit signals that control stem cell regulation and differentiation. The tumor cell niche, in particular, can reprogram surrounding stem cells, causing them to become diseased or tumorigenic by switching on or off particular genes [5]. Current drug therapies target tumors by killing cancer cells without affecting cancer stem cells [4]. To target the cancerous stem cells, researchers must first understand the signals, proteins, and properties of the environment involved in stem cell regulation. The generation of drugs targeting these mechanisms could treat cancer more specifically than current methods allow.

The applications of stem cell research are not limited to cancer treatment. Stem cells are already important participants in more than 182 clinical trials worldwide. Recently, Geron received U.S. Food and Drug Administration (FDA) approval to begin the world’s first human clinical trial of an embryonic stem cell-based therapy used for the regeneration of myelin, the protective cover of nerve cells [6]. Geron’s product, GRNOPC1, has been shown to help remyelination and nerve growth in animal models [7], and the ultimate goal is to

achieve the restoration of spinal cord function in patients with spinal injuries. Also, a British company, ReNeuron, received approval to start clinical trials with gene-modified neural stem cells for the treatment of stroke [8].

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