Pluripotency of Stem Cells: An Overview

In cell biology, pluripotency refers to a stem cell's ability to differentiate into any of the three germ layers: endoderm (interior stomach lining, gastrointestinal tract, the lungs), mesoderm (muscle, bone, blood, urogenital), or ectoderm (epidermal tissues and nervous system). Pluripotent stem cells have the ability to transform into any fetal or adult cell type.

Established scientific research shows that during human development stem cells are released into umbilical cord blood and, as a recent study appearing in Nature Biotechnology (January 2007) reports, into amniotic fluid. While all scientific breakthroughs concerning stem cells are important, there are key distinctions that set cord blood stem cells apart from other non-embryonic stem cell sources.

Cord blood stem cells have vast medical potential. These stem cells are easily and painlessly acquired from a child's umbilical cord at birth and are not subject to the complex ethical issues that have embroiled embryonic stem cell research. Cord blood stem cells have been used in medical treatments for more than 20 years and are supported by a wealth of scientific research and by clinical evidence, with widely recognized safety and efficacy.

Amniotic fluid and placental cells have also been suggested as stem cell sources, but are complicated (and in the case of amniotic stem cells, potentially dangerous) to collect and have yet to be confirmed as safe or effective solutions for use in patients.

Embryonic-Like Stem Cells Found in Cord Blood

In 2005 Dr. Colin McGuckin isolated embryonic-like cells from human cord blood, suggesting that primitive pluripotent cells are present in cord blood. The study represented the culmination of years of research by many investigators, each of whom were able to isolate and expand different types of undifferentiated or immature cells from cord blood, including the building blocks of heart, nerve, bone, and liver tissue. Dr. McGuckin concluded that cord blood stem cells have the ability to differentiate into many different cell types. Cumulatively, the identification and isolation of pluripotent stem cells within cord blood represents a scientific breakthrough that could potentially impact every field of medicine.

Overview of Cord Blood Stem Cell Biology

Cord blood contains a diverse population of stem cells that are able to selectively migrate to and repair damaged tissues. Some of these cells are primitive and full of potential, while others have traveled further along their respective developmental pathways. This pool of cell types allows researchers to isolate a specific cell population and make use of its unique characteristics. As more cell types are identified and classified, researchers will be able to more fully harness the therapeutic potential of cord blood. Today, cord blood stem cells are used to treat about 70 chronic or life-threatening conditions including genetic disorders, blood diseases, immunodeficiencies and some cancers.

As medical research further advances and scientists learn how to selectively expand and isolate the most beneficial cell types for a given treatment, regenerative medicine can be expected to flourish. Regenerative medicine is an evolving field of research which involves the application of stem cells to rebuild damaged tissues, or grow living tissues in a laboratory for implantation into the patient. The industry currently is on the threshold of scientific breakthroughs that could revolutionize medicine.

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> Cord blood stem cells have nearly infinite medical potential. These stem cells are easily and painlessly acquired from a child's umbilical cord at birth and are not subject to the complex ethical issues that have brought embryonic stem cell research to a standstill. Cord blood stem cells are supported by a wealth of scientific research supported by clinical evidence, with widely recognized safety and efficacy.

The Future Potential of Regenerative Medicine

The ability to differentiate into a specific cell type is only the first step in creating a regenerative therapy. Once placed within a living body, stem cells must be able to safely and effectively work with existing cells and tissues to improve and repair function. Embryonic cells are able to differentiate into many different cell types, but once placed within an animal, begin to grow and proliferate in an uncontrolled manner, which can lead to tumor formation. The same is not true of cord blood stem cells, which appear to be far enough down the developmental path that their proliferation and behavior is easily and naturally controlled. They appear to be primitive enough to differentiate into multiple cell types, yet mature enough to work within the body's existing framework. Researchers are exploring the use of cord blood stem cells in a number of regenerative medicine applications. Here are just a few examples:

Type 1 Diabetes
Cord blood stem cells are being evaluated to treat several disease states, including type 1 diabetes. At the University of Florida, researchers are enrolling children with their own cord blood stem cells stored at a family bank and are using the cord blood to reseed the pancreas with insulin-producing islet cells. While the trial is not yet complete, the primary investigator reports that the first child treated has shown measurable improvement.

Heart
In animal studies, which are a precursor to clinical trials in human patients, cord blood stem cells have produced functional improvements in animal models of heart attack, as measured by improvements in ventricular ejection fraction and a decrease in the size of the damaged region. When infused into animals with an infarct, or blocked, region of the heart, the cord blood stem cells selectively migrated to the damaged areas and were not found in the non-damaged areas.

Central Nervous System
The same trend of selective migration was found in animal models of spinal cord injury, and following cord blood infusion, the transplanted cord blood cells differentiated into various neural cells—with positive effects on nerve regeneration and improved motor function. These findings are consistent with pre-clinical outcomes following neurological damage affecting the brain. In animal models of stroke and traumatic brain injury, cord blood stem cells crossed the blood-brain barrier, engrafted in the brain, and produced functional and physiological improvements.