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Short Communication

Stem Cell Toxicology is a Useful Tool for Assessing the Impact of Environmental and Human Health

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ABSTRACT

Toxicology of humans and animals has had a significant impact on our historical and present understanding of pollution-related health impacts. Environmental contamination is a worldwide issue, and a lack of adequate toxicological evaluations may result in increased health hazards. To fully comprehend the health impacts of pollution, it is critical to undertake rapid, effective, and targeted toxicity testing that focuses on human models rather than time-consuming, expensive, and sometimes erroneous experiments utilizing live animals. Because of stem cells' potential to develop into many cell types and tissues of the human body, human stem cell toxicology offers a viable alternative to standard toxicity studies. Thus, *in vitro* assessment of cellular, embryonic, developmental, reproductive, and functional toxicity within a single system substantially relevant to human physiology is possible with this discipline of toxicology.

Keywords: Embryonic stem cells; Environmental contamination; Health effects; Stem cell biology

INTRODUCTION

Biological and chemical contaminants in the air, water, food, soil, and radiation, as well as radiation, can be toxic to humans. Environmental pollution is a worldwide problem that is not limited to a single country or city as a result of economic globalization, which enhances the interconnectedness of national economies across boundaries through the interchange of resources and production. For toxicity testing, we still rely extensively on live animals, which are time-consuming, resource-intensive, and ethically problematic. There are countless examples of medications that cleared animal testing but failed in human trials. As a result, the 3Rs (Replacement, Reduction, and Refinement), which are mostly based on *in vitro* research [1], may be more relevant now than ever before. *In vitro* toxicological tests with human models are generally based on cultured cells and have a number of drawbacks. Toxicologists' passion has been enlightened by the emergence and growth of stem cell biology. *In vitro* toxicology may be revolutionized if modern stem cell technologies are used to the examination of possible harmful implications of contaminants on human health.

History of Stem Cell Biology: A multipotent, clonal, self-renewing cell population that can create numerous differentiated cell types is defined as a stem cell line. We can broadly split stem cells into pluripotent stem cells (PSCs) and multipotent somatic stem cells (SSCs) based on their histology origin and differentiation capacity.

Pluripotent Stem Cells: Studying mouse embryonic carcinoma cells extracted from teratocarcinomas provided the first evidence that PSCs may differentiate into specialized cell types. The inner cell mass (ICM) of the pre-implantation blastocyst was found to be the source of mESCs [2]. Surprisingly, when ESCs were kept suspended, they produced minute aggregates known as embryoid bodies. Cell types from all three germ layers (ectoderm, mesoderm, and endoderm) developed and interacted at this stage, resulting in various tissue-like structures.The potential of PSCs to differentiate is likewise characterized by gametogenesis. PGCs (primordial germ cells) are another form of pluripotent cell capable of producing germ cells, eggs, and sperm. PGC-like cells may also be produced *in vitro* from mESCs or iPSCs using epiblast-like cells, which are close to but not identical to pre-gastrulating epiblasts but are not EpiSCs [3].

Multipotent SSCs: Pluripotent cells in the ICM are rearranged into the germ layers that eventually create all of the body's tissues during the gastrulation stage of embryogenesis, limiting their ability to differentiate into all lineages. These new cells are less malleable and can only form a narrow range of cells, typically within one or a few tissue types, making them multipotent; some of them survive until adulthood and are known as SSCs. Adult stem cells are also

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known as SSCs; however, they may also be present in fetal tissues including the umbilical cord and placenta, and are referred to as fetal stem cells. Furthermore, SSCs are divided into mesenchymal stem cells (MSCs), neural stem cells (NSCs), hematopoietic stem cells (HSCs), skin stem cells, and others based on their histological origin.

Toxicological Features of Stem Cells

Toxicology of pluripotent stem cells: Pluripotent embryonic stem cells and induced pluripotent stem cells (iPSCs) are capable of developing *in vitro* into practically all adult cell types, including germ cells. This feature is at the heart of stem cell toxicology, and it explains why, in comparison to other cell types employed *in vitro* and experimental animals, only stem cells have such enormous promise in toxicity research [4]. In circumstances when pollutants do not alter fetal development or lineage dedication, but rather impair the following functional performance of differentiated tissues, stem cell toxicology provides an integrated assessment of PSC-derived cells. In this regard, stem cell toxicology offers the benefit of evaluating specific cell types without resorting to complex and frequently invasive processes of tissue separation from actual tissues, which may be impractical.

Toxicology of somatic stem cells: SSCs, unlike ESCs, cannot be employed in teratogenic or embryo toxic studies. During the baby and teenage eras, however, SSCs may still self-renew and differentiate into somatic cells, and hence can be used to assess the impact of the environment on post-natal development into adulthood. SSCs are kept in a dormant condition in adult tissues until they are activated to restore damaged cells/tissues via self-renewal and differentiation cycles. Environmental toxins can cause irreversible tissue damage that cannot be healed by SSC differentiation or directly target SSCs, resulting in SSC depletion and/or pathological diseases, such as cancer. SSC-based toxicology can also include assays designed to assess the effects of pollutants on stem cell exhaustion and ageing during tissue regeneration after injury or degenerative diseases, as well as determine toxic effects of pollutants during tissue regeneration after injury or degenerative diseases [5].

CONCLUSION

Stem cell toxicology would reduce the necessity for whole-organism testing that isn't permitted in people while also giving a platform to assess a large range of untested compounds to which we are constantly exposed. Because of species-specific differences, experimental animal systems may not produce results that are fully applicable to human health, but cell therapy toxicology may cure the issue of conventional *in vitro* toxicology, which cannot reliably evaluate potential effects on the entire organism, bringing us one step closer to an ideal analysis system implemented entirely *in vitro*.

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