Article: RT0363

Biotica Research Today

Vol 2:10 1016 / 1018

2020

How to cite this article?

Das and Saha, 2020. Implications of Stem Cell Therapy in Cancer Treatment. Biotica Research Today 2(10): 1016-1018.

# Implications of Stem Cell Therapy in Cancer Treatment

**Saswati Das* and Debanjana Saha**

Dept. of Biotechnology, Centurion University of Technology and Management, Jatni, Bhubaneswar, Odisha (752 050), India

Open Access

**Corresponding Author**

Saswati Das

*e-mail: saswatidas502@gmail.com*

**Keywords**

Cancer, Metastasis, Stem cells, Transplant

## Abstract

Cancer is a complex heterogeneous illness that posses particular barriers to its management. The survival of cancer patients increased dramatically, mostly due to multidisciplinary treatment and advanced chemotherapy. Despite recent advancements, many patients with solid tumors continue to undergo recurrence following adjuvant therapy, and their survival remains poor when their cancer is no longer limited to their lungs, as well as when advanced cancer is rarely cured. Over the years, the series of stem cell biology results has produced new possible methods through its unusual biological behaviour, including self-renewal, lateral migration, differentiation and modulatory effects on other cells, to cure cancer patients. In this article, we discuss the specific biological behaviour possessed by different types of stem cells along with the mechanisms associated with various stem cells for cancer care. We also emphasize on the obstacles encountered, along with the risk factors associated with them.

## Introduction

Cancer is one of the most feared diseases of the 20th century and continues to spread with rising frequency in the 21st century. And, the method of therapy depends on the form and severity of the disease. They become ineffective and unspecific target of therapeutics at tumor sites due to the drawbacks of the existing treatments, resulting in therapy resistance and eventual tumor recurrence. For the time being, the treatment of stem cells has given a promising choice in the battle against cancer by including both treatments using stem cells. Numerous stem cell therapies are currently under study in pre-clinical trials which demonstrate great promises and challenges for cancer care.

## Stem Cell Types for Cancer Therapy

Stem cells from diverse origins demonstrate distinct differentiation, proliferation and migration capacities that define their usage in anti-cancer therapy.

### *Pluripotent Stem Cells (PSCs)*

Human PSCs can be isolated from the blastocysts and preserved indefinitely in the culture to give birth to embryonic stem cells (ESCs). Embryonic stem cells, except for those in the placenta, have the ability to give birth to all cell types. However, due to legal concerns, demands for ESCs for clinical trials are limited. Since 2006, through the discovery of Yamanaka factors, which involve four transcription factors with the reprogramming technology invented by Yamanaka, a pluripotent ESCs like condition can be restored in an adult cell.

**Article History**

Received in 6th October 2020

Received in revised form 10th October 2020

Accepted in final form 11th October 2020

***E-mail:*** *bioticapublications@gmail.com*

***Adult Stem Cells (ASCs)***

ASCs have the ability to give birth to diverse tissues and organs with several specialized cell types. This includes hematopoietic stem cells (HSCs), mesenchymal stem cells (MSCs), and neural stem cells (NSCs) that assist in the treatment of cancer. HSCs are multipotent precursor cells that contain all kinds of blood cells in the body, including B cells, T cells, NK cells, macrophages, red blood cells, granulocytes, and monocytes, and are used for the treatment of multiple myeloma, leukemia, and diseases of the blood stream. In several tissues and organs, MSCs are present and perform major roles in tissue repair and regeneration. MSCs are able to migrate, called homing, directionally to particular tissues. The migrational property of MSCs into injuries and tumor sites makes them suitable for selective tumor therapy vehicles. NSCs found in the central nervous system can self-renew and produce new neurons and glial cells. They are tested for the treatment of breast, lung and prostate tumors, both primary and metastatic.

***Cancer Stem Cells (CSCs)***

Cancer stem cells in tumor tissues are present in a variety of solid cancers, including breast cancer, brain tumors, lung cancer, colon cancer, and melanoma. CSCs are capable of self-renewal, of producing progeny that are distinct from them, and of utilizing common signalling pathways that play important roles in the development, metastasis, and recurrence of cancer. Therefore, for a large spectrum of malignancies, targeting CSCs is a promising therapeutic target.

## Mechanisms Underlying the Function of Stem Cells in Cancer

***Homing to Bone Marrow***

In cases of active cancers, blood cells and leukocytes are totally or partly killed by extremely large doses of chemotherapy to kill cancer cells. In both cases, patients must undergo an intravenous injection of allogeneic or autologous HSCs. These HSCs conduct a homing mechanism that leads to their rapid migration to established stem cell niches in the bone marrow (BM) where the transplanted HSCs undergo a mechanism of grafting prior to the production of specialized blood cells. The molecular mechanism behind the HSC homing process relies primarily on the interaction of the stem cell CXCR4 receptor and the SDF-1 gradient with other molecular signals including extracellular ATP or UTP and $Ca^{2+}$ and $H^{+}$ ions.

***Tumor Tropic Effect***

Tumor development and invasion is determined by the tumor microenvironment where extracellular matrix (ECM) and secreted paracrine factors are deposited. It attracts the directional migration of different cell types, such as endothelial cells, immune cell infiltrators and MSCs. MSCs are capable of migrating directionally to particular tissues such as the tumor microenvironment referred to as the homing phase. Both tumor cells and tumor-associated immune cells are involved in this homing phase of MSC by secreting numerous chemo-attractive factors such as CXCL16, SDF-1, IL-6, etc. from prostate cancer, osteosarcoma and breast cancer cells. MSCs may divide into endothelial cells or myofibroblasts that lead to the growth of the tumor stromal.

***Secretion and Differentiation Capability of Paracrine Factor***

Stem cells have been shown to work by releasing some paracrine factors, including extracellular vesicles and soluble materials, which may influence tumour growth, proliferation and metastases. For cancer therapy, the differentiation ability of stem cells is also highly significant. For example, all other blood cells in the body may result from transplanted HSCs. As a result, the number and quality of engrafted HSCs will have an effect on health conditions and the regeneration of blood systems. NSCs, on the other hand, may replace injured neurons and glial cells in brain cancer. Likewise, ESCs and iPSCs act as a cell source for the development of immune cells for tumor targeting.

***Signaling in CSCs***

Regular stem cells and CSCs have been well known to share their key signalling pathways. CSCs are present in a number of tumor forms including leukemia, breast, brain, lung and gastrointestinal cancers. CSCs have a high potential for self-renewal and differentiation to aid in tumor formation, recurrence and metastases. CSCs are also responsible for conventional tumor resistance therapy, which is why CSC development is so critical in improving successful cancer care. CSCs are usually isolated and classified using different techniques such as cell surface markers and metabolic or functional properties. To classify CSCs from heterogeneous cell types present in tumors such as brain, lung, colorectal, liver, breast, gastric, etc., surface markers such as CD133, CD44 and CD24 are used. High glycolic activity, slow cell division, increased therapy resistance and increased immune resistance are found in CSCs.

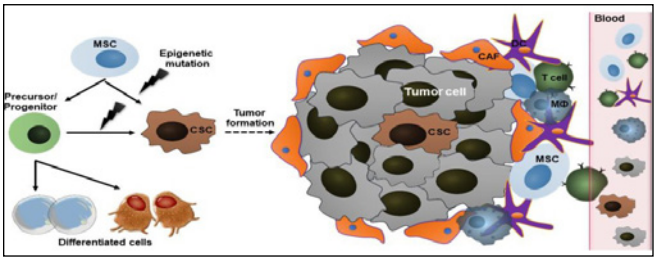


Figure 1: Tumor formation and its complex microenvironment

## Challenges and Risks Associated with Stem Cell Therapy

Studies suggest that detailed in vivo and in vitro evidence promoting stem cell therapy suggest that cancer stem cells are a possible therapeutic target for

a wide variety of malignancies. However, the applicability of this strategy is restricted for several important reasons. As the microenvironment of normal stem cells is modified, normal stem cells will gradually become CSCs, leading to the development of whole tumor tissue. Man's endogenous stem cells are exclusively regulated by other surrounding cells, so they are able to function in the right manner. However, on the other hand, when in culture, the transplanted stem cells are exposed to the external environment. The longer the culture duration, the more likely it is that natural stem cells are able to turn into malignant tumors. The main issue is the post-transplantation immune rejection of donor cells by the host immune system, and recent findings have shown that the bulk of donor cell death happens in the first hours to days following transplantation, limiting the effectiveness of therapies dependent on stem cells. There are several safety and toxicity issues with respect to transplantation, engraftment and long-term survival of stem cells. Donor stem cells that manage to resist immune rejection can later become oncogenic due to their limitless ability to replicate. The use of ES cells could also give rise to social and ethical issues in the future.

## Conclusion

A special therapy for cancer patients is stem cell research, as it has both diagnostic and therapeutic potential. The ability of these cells to rebuild healthy tissues and repair weakened ones has tremendous potential and thus stem cell therapy for cancer treatment is possible in the immediate future. With progress in both clinical and pre-clinical applications, stem cell therapy faces numerous obstacles that need to be addressed in the immediate future. In brief, recent advances from stem cell biology are strongly promising for tumor therapy and fundamental research developments in the standardization of stem cell derivation, culture and differentiation techniques, along with advanced methods for transplantation, engraftment and survival, will aid in the future to establish safer and more productive stem cell-based therapies.

## References

Chu, C.T., Nguyen, T.T., Tien, N.L.B., Tran, D.K., Jeong, J.H., Anh, P.G., Thanh, V.V., Truong, D.T., Dinh, T.C., 2020. Recent progress of stem cell therapy in cancer treatment: Molecular Mechanisms and Potential Applications. Cells 9(3), 563.

Dawood, S., Austin, L., Cristofanilli, M., 2014. Cancer stem cells: implications for cancer therapy. Oncology (Williston Park) 28(12), 1101-7, 1110.

Lin, W., Huang, L., Li, Y., Fang, B., Li, G., Chen, L., Xu, L., 2019. Mesenchymal stem cells and cancer: Clinical challenges and opportunities. Biomed Res Int.