Cancer stem cells: Understanding tumor heterogeneity and therapeutic resistance.

Manousos Macc*

Department of Propaedeutic Surgery, National Kapodistrian University of Athens, Athens, Greece

Introduction

Cancer remains one of the most formidable challenges in modern medicine, with its complex and heterogeneous nature posing significant obstacles to effective treatment. Within the intricate landscape of tumors, a small subpopulation of cells known as cancer stem cells (CSCs) has emerged as a focal point of research, offering insights into the underlying mechanisms of tumor initiation, progression, and therapeutic resistance. In this article, we delve into the enigmatic world of cancer stem cells, exploring their characteristics, roles in tumorigenesis, and implications for cancer therapy [1].

Defining cancer stem cells

Cancer stem cells are a subset of cells within tumors that possess stem cell-like properties, including self-renewal, differentiation potential, and tumor-initiating capacity [2]. Similar to normal stem cells, CSCs can give rise to heterogeneous populations of cancer cells within tumors, contributing to intratumoral heterogeneity and therapeutic resistance. The identification and characterization of CSCs have transformed our understanding of cancer biology, highlighting the importance of targeting these cells in cancer therapy [3].

Characteristics of cancer stem cells: Cancer stem cells exhibit distinct phenotypic and functional characteristics that distinguish them from bulk tumor cells [4]. These include elevated expression of stem cell markers, such as CD44, CD133, and ALDH, as well as enhanced tumorigenic potential in xenograft models. CSCs also possess unique properties that contribute to their resistance to conventional therapies, such as enhanced DNA repair mechanisms, quiescence, and expression of drug efflux pumps [5].

Roles of cancer stem cells in tumorigenesis: Cancer stem cells play critical roles in tumor initiation, progression, metastasis, and recurrence [6]. As the driving force behind tumor growth and heterogeneity, CSCs contribute to the formation of primary tumors and the seeding of metastatic lesions in distant organs. Moreover, CSCs are implicated in therapeutic resistance, as their intrinsic properties confer resistance to chemotherapy, radiation therapy, and targeted therapies, leading to treatment failure and disease relapse [7].

The origin of cancer stem cells remains a topic of debate, with evidence suggesting that they may arise from normal tissue stem cells, progenitor cells, or dedifferentiated cancer cells through genetic and epigenetic alterations [8]. Furthermore, CSCs exhibit phenotypic and functional plasticity, transitioning between stem-like and differentiated states in response to microenvironmental cues and therapeutic pressures. This plasticity contributes to the dynamic nature of tumors and poses challenges for targeted therapies aimed at eradicating CSCs [9].

Therapeutic targeting of cancer stem cells: Targeting cancer stem cells represents a promising strategy for overcoming therapeutic resistance and improving patient outcomes. Approaches aimed at selectively targeting CSCs include inhibition of stem cell signaling pathways, disruption of stem cell niche interactions, induction of CSC differentiation, and eradication of quiescent CSCs. Combination therapies that target both CSCs and bulk tumor cells hold potential for achieving more durable responses and preventing disease recurrence [10].

Conclusion

Cancer stem cells represent a unique and elusive population within tumors, with profound implications for cancer biology and therapy. By elucidating the characteristics and roles of CSCs in tumorigenesis, researchers aim to develop innovative strategies for targeting these cells and overcoming therapeutic resistance. As our understanding of CSCs continues to evolve, the pursuit of effective therapies that eradicate CSCs while sparing normal tissues holds promise for transforming the landscape of cancer treatment and improving patient outcomes.

References

1. Yu Z, Pestell TG, Lisanti MP, et al. Cancer stem cells. The international journal of biochemistry & cell biology. 2012;44(12):2144-51.
2. Reya T, Morrison SJ, Clarke MF, et al. Stem cells, cancer, and cancer stem cells. nature. 2001;414(6859):105-11.
3. Batlle E, Clevers H. Cancer stem cells revisited. Nature medicine. 2017;23(10):1124-34.
4. Jordan CT, Guzman ML, Noble M. Cancer stem cells. New England Journal of Medicine. 2006;355(12):1253-61.
5. Nguyen LV, Vanner R, Dirks P, et al. Cancer stem cells: an evolving concept. Nature Reviews Cancer. 2012;12(2):133-43.

***Correspondence to:** Manousos Macc**,** Department of Propaedeutic Surgery, National Kapodistrian University of Athens, Athens, Greece, E-mail: Manousos@med.uoa.gr

***Received:** 04-Feb-2024, Manuscript No. AACBM-24-130186; **Editor assigned:** 06-Feb-2024, PreQC No. AACBM-24-1301865(PQ); **Reviewed:** 20-Feb-2024, QC No AACBM-24-1301865; **Revised:** 23-Feb-2024, Manuscript No. AACBM-24-1301865(R); **Published:** 28-Feb-2024, DOI:10.35841/aacbm-6.1.195*

***Citation:** Macc M. Cancer stem cells: Understanding tumor heterogeneity and therapeutic resistance. J Cell Biol Metab. 2024;6(1):195*

6. Iwasaki H, Suda T. Cancer stem cells and their niche. Cancer science. 2009;100(7):1166-72.

7. Kai K, Arima Y, Kamiya T, Saya H. Breast cancer stem cells. Breast Cancer. 2010;17:80-5.

8. Ischenko I, Seeliger H, Schaffer M, et al. Cancer stem cells: how can we target them?. Current medicinal chemistry. 2008;15(30):3171-84.

9. Tang C, Ang BT, Pervaiz S. Cancer stem cell: target for anti-cancer therapy. The FASEB Journal. 2007;21(14):3777-85.

10. Zhou J, Zhang Y. Cancer stem cells: Models, mechanisms and implications for improved treatment. Cell Cycle. 2008;7(10):1360-70.

Citation: *Macc M. Cancer stem cells: Understanding tumor heterogeneity and therapeutic resistance. J Cell Biol Metab. 2024;6(1):195*