

Objectives

The aim of this review is to explain the current situation of the stem cells (SC) and cancer stem cells (CSC). Regarding stem cells, I want to focus mainly on the stem cell types, their characteristics and their use in medicine, and regarding cancer stem cells I want to focus on their origin, characteristics, their role in treatment resistance and how to overcome it.

Stem cells

Stem cells are functionally defined as having the capacity to self-renew and the ability to generate differentiated cells. Also, they have unique properties:

- Extended life expectancy
- Capacity to modulate the immune system
- Resistance to cellular stress
- Regulated by several intrinsic and extrinsic factors from the microenvironment that surround them, known as stem cell niche.
- Heterogeneity
- Plasticity

Adult stem cells (such as hematopoietic or mesenchymal stem cells), are the ones that have given the best results for tissue regeneration therapies and for treatment of various diseases.

Figure 2. In many tissues, we find a stem cell with asymmetric cell division capacity that will give rise to another stem cell and one cell that will initiate differentiation, who is known as progenitor cell. This cell will have to go through a long succession of symmetrical cell divisions before its descendants become fully differentiated cells.

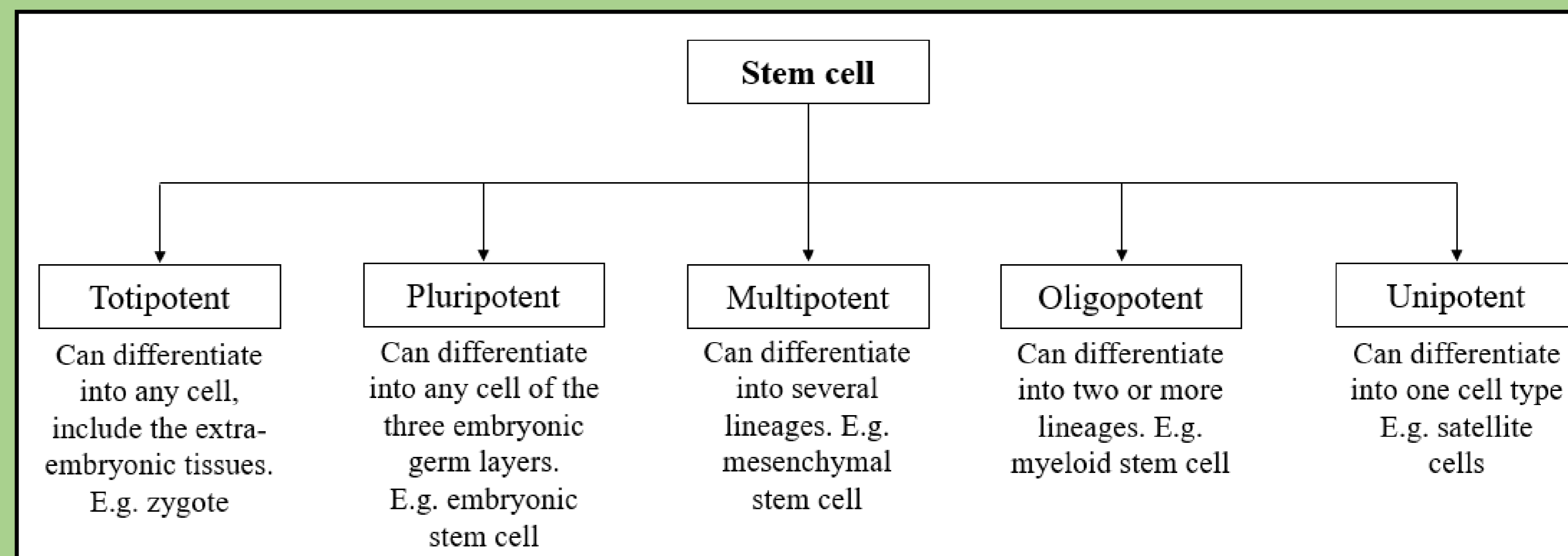


Figure 1. Classification of stem cells based on their potency.

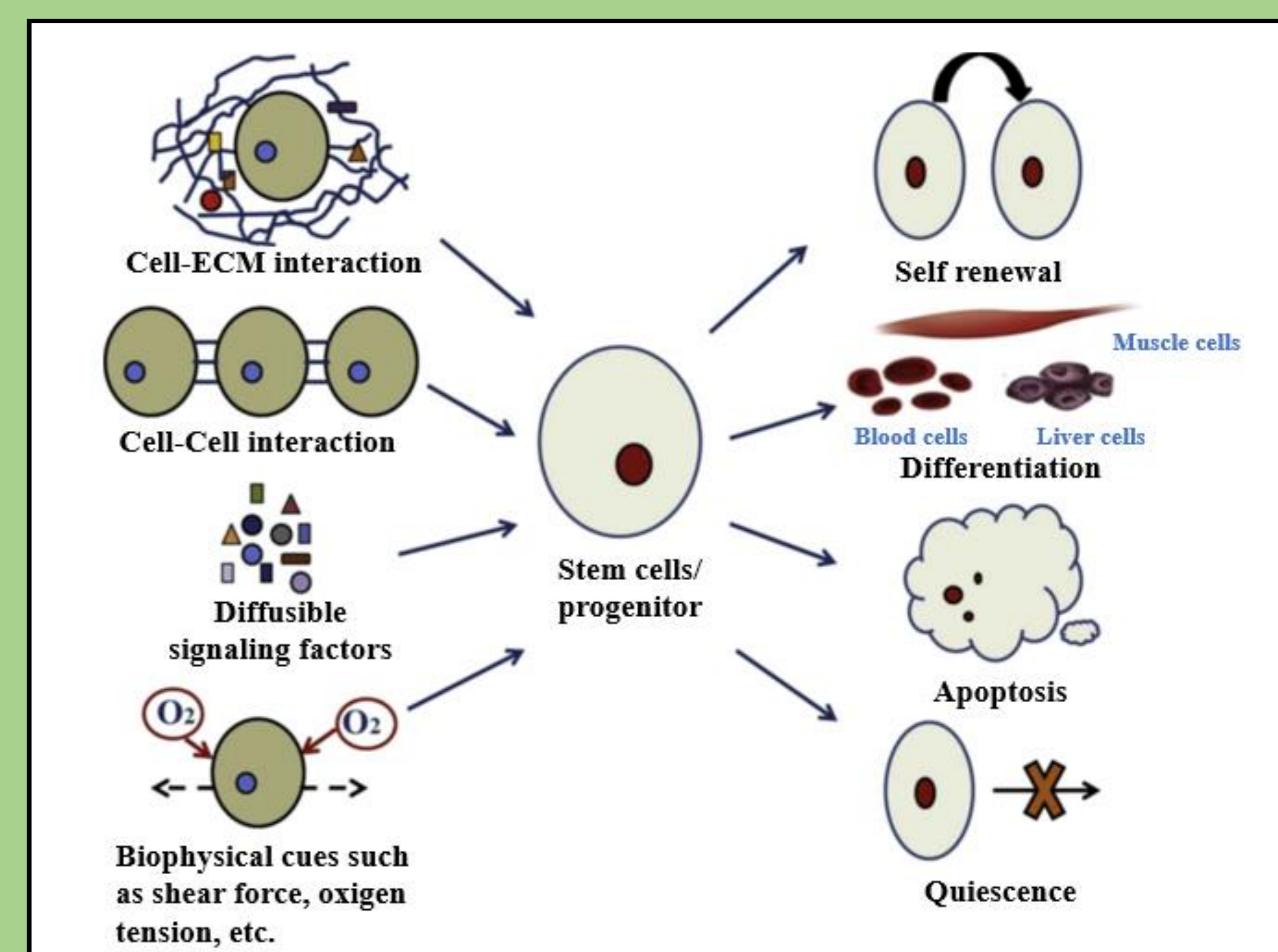
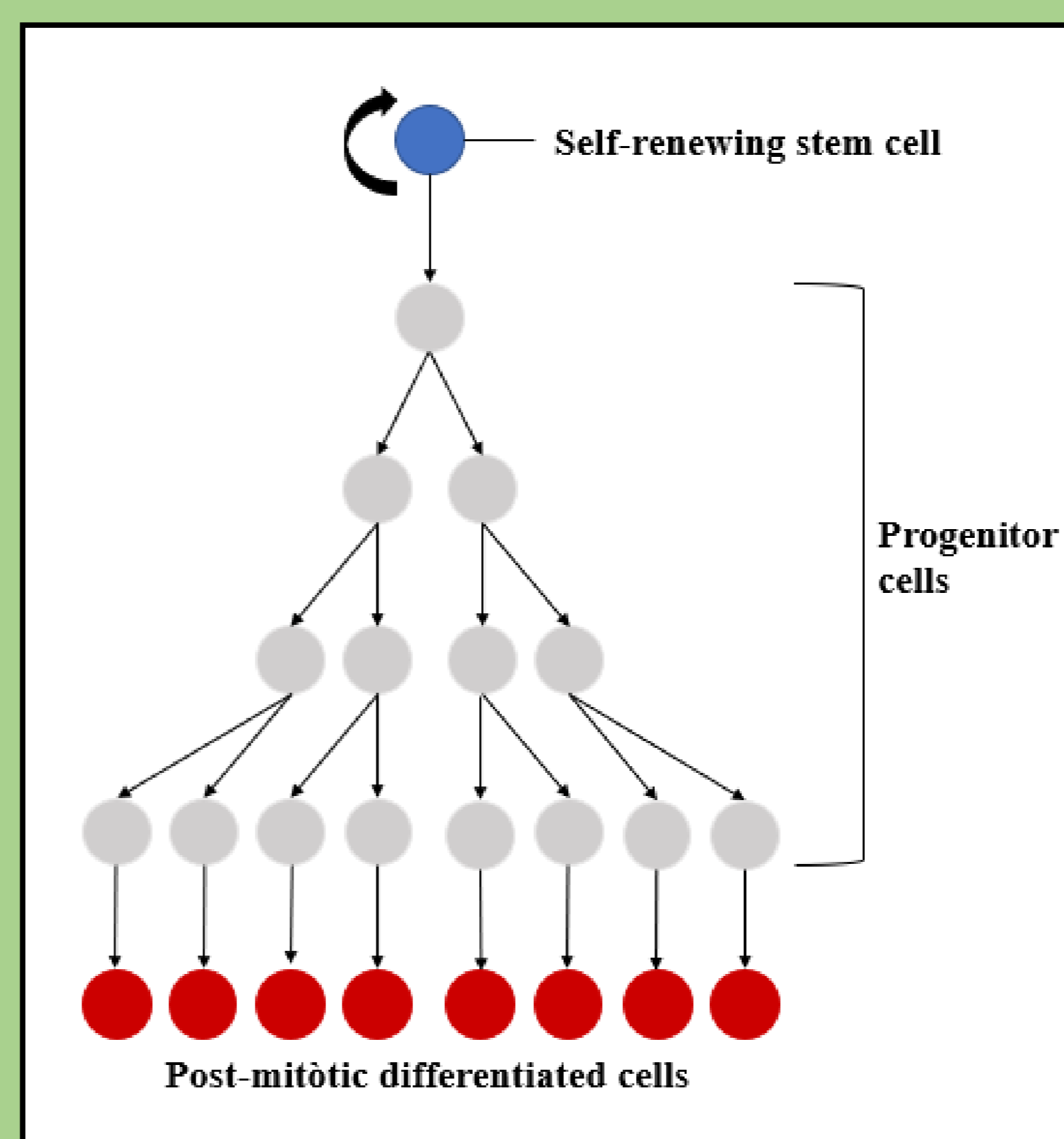


Figure 3. Key components of stem cell niche and how they regulate the stem cell properties. ECM, extracellular matrix. Singh et al. 2019

Cancer stem cells

CSC have been identified in many common cancer types, including leukemia, breast cancer, colorectal cancer and brain cancer. These cells are highly resistant to current therapeutic approaches and are the main reason for cancer recurrence. Tumors are made up of heterogeneous populations of cells that express different degrees of differentiation and markers, two models were proposed to explain the origin of this tumor heterogeneity: the stochastic model and the hierarchical model.

To overcome therapy resistance of CSC, new therapies like immunotherapy, microRNA regulation and nanotechnology are being tested to target CSC or specific signal pathways of CSC niche.

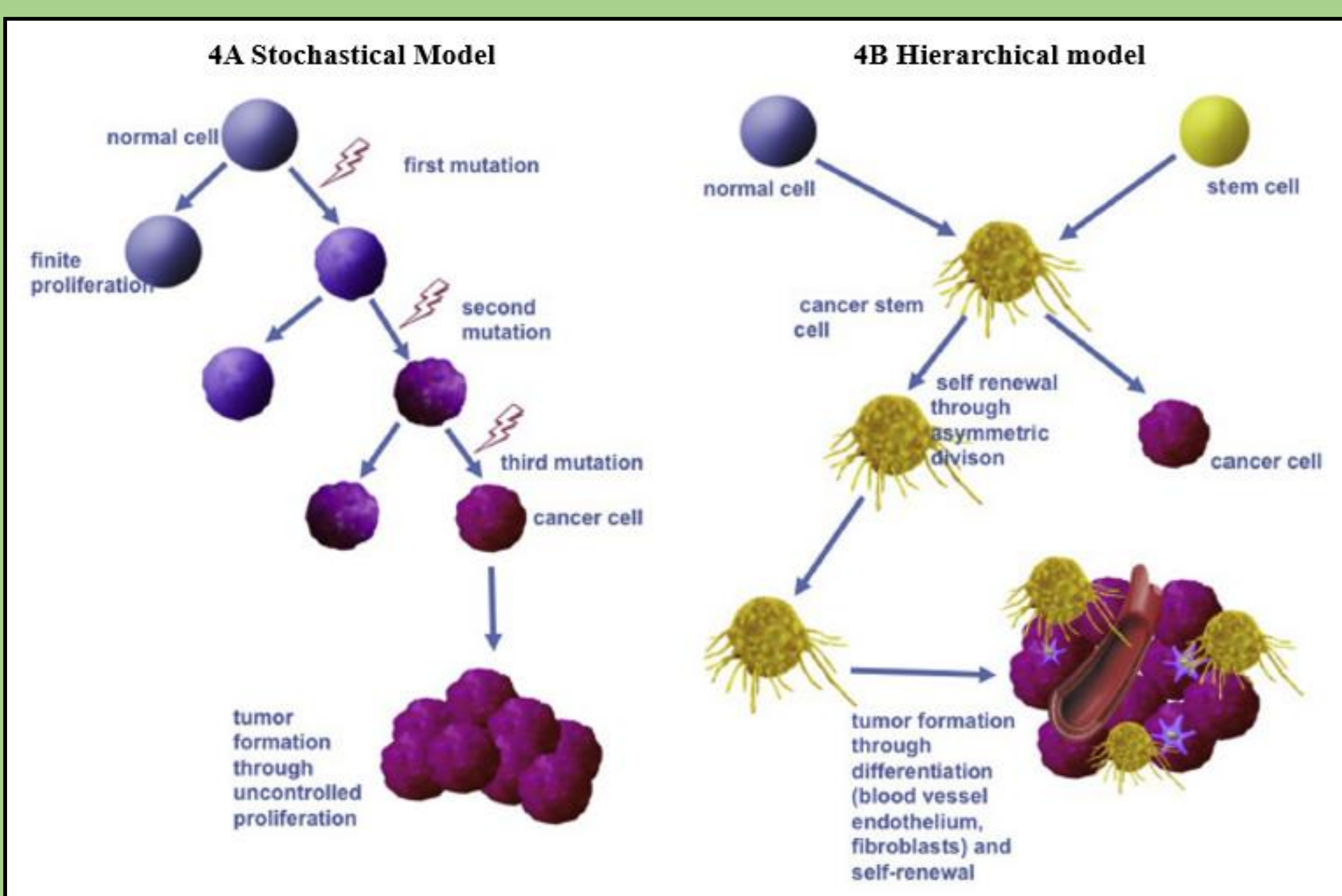


Figure 4. Stochastic (a) and hierarchical (b) model of tumor heterogeneity.

a: In the stochastic model all tumor cells have tumorigenic potential, which makes all tumor cells equipotent with the ability to self-renew or differentiate.

b: In the hierarchical model proposes that tumors are hierarchical organized tissues with CSC at the top. That will to progenitor cells that produce differentiated cells and cause heterogeneity tumors. Steinbichler et al. 2018.

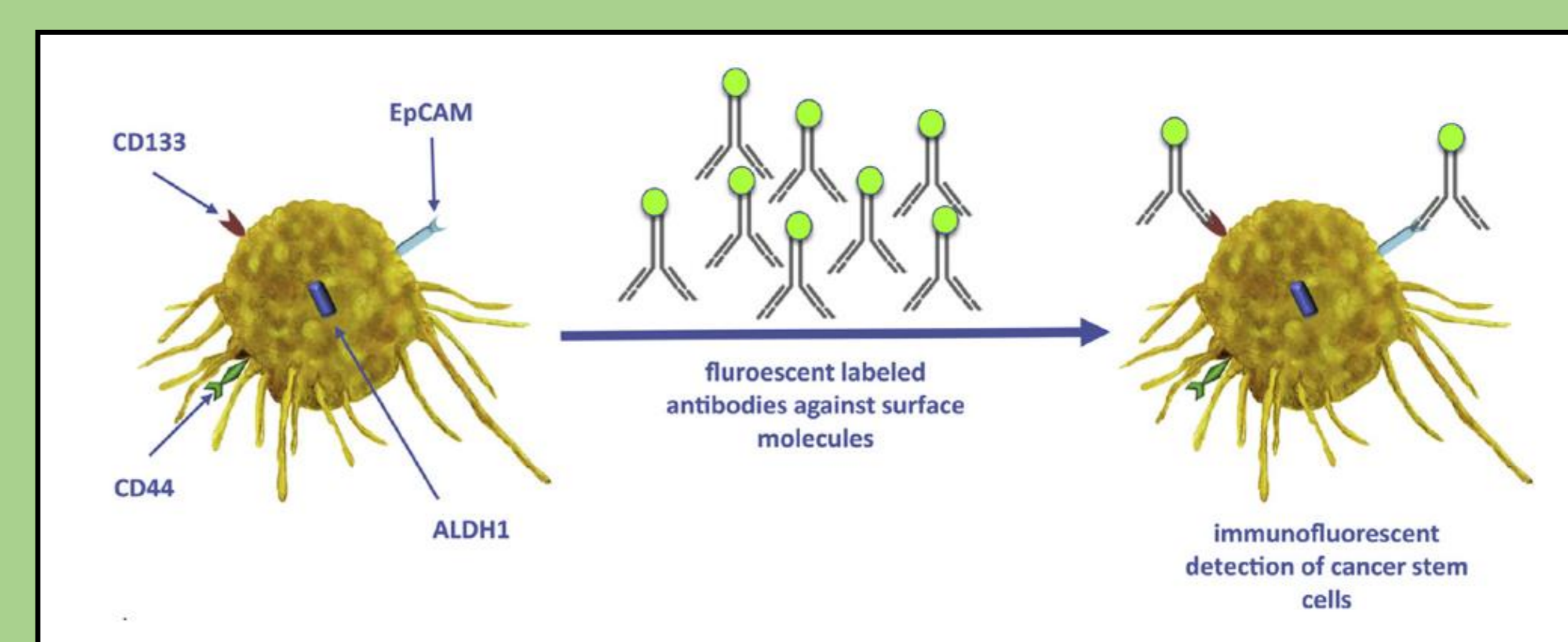


Figure 5. The main method of identifying CMTs is cell surface markers which combined with classification techniques such as fluorescence-activated cell sorting (FACS), have allowed the isolation of CMTs. Steinbichler et al. 2018.

Conclusions

Regenerative medicines market it's estimated to grow to over 50 billion dollars by 2025 and future researches should focus on:

- Improve the effectiveness and safety of stem cell treatments.
- Understand the physiology of cancer stem cells and everything around them in order to design effective therapies against cancer.

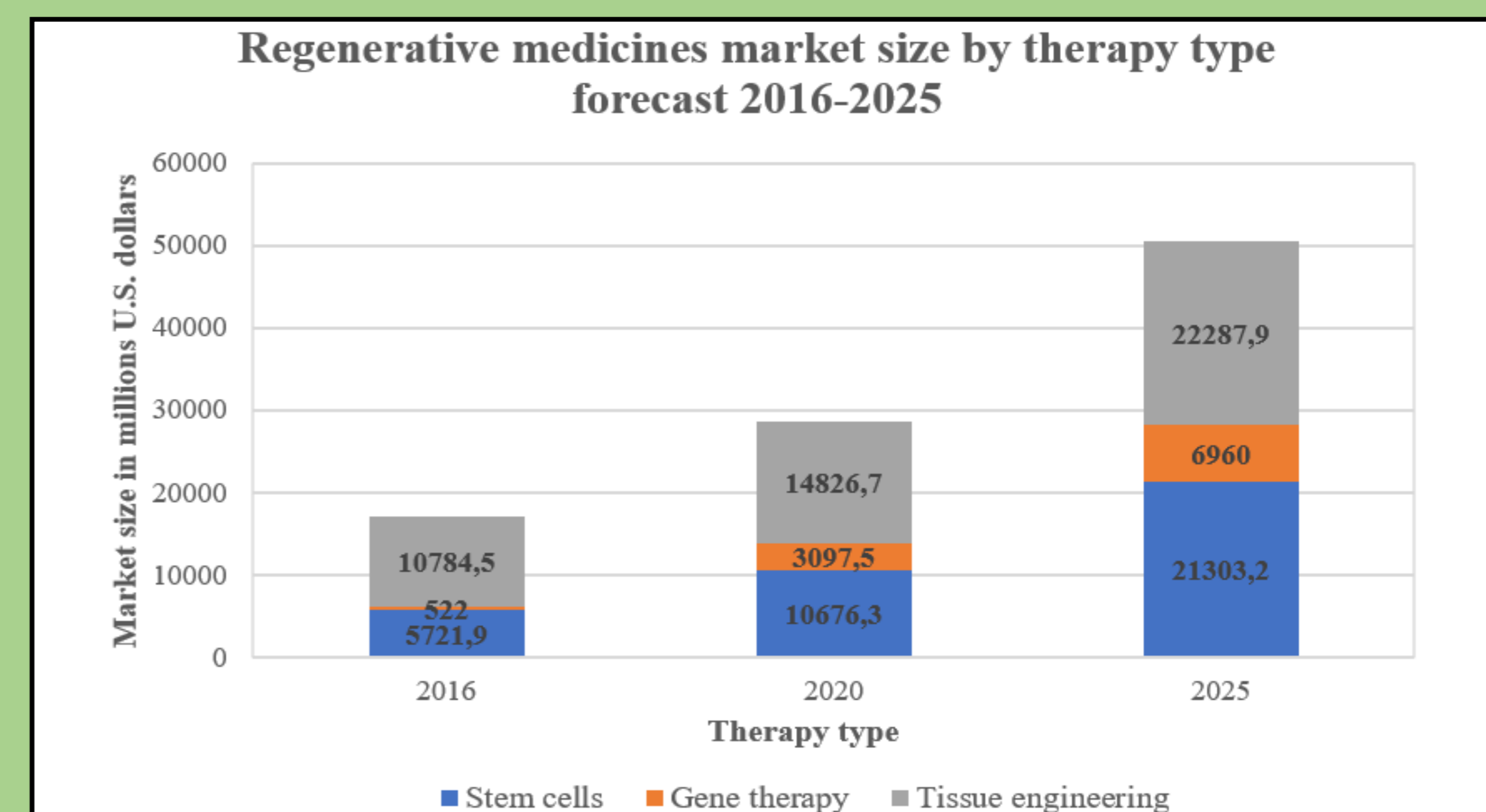


Figure 6. Global regenerative medicines market by therapy type in 2016 and a forecast for 2020 and 2025 (in million U.S dollars). Based on Mikulic 2022.

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