Electrochemical assessment of stem cell viability for application in regenerative medicine

Tamara Tomašević[1], Anabela Dragićević[1], Zorica Mojović[2], Dijana Mitić[3], Aleksandar Savić[4], Đura Nakarada[1], Miloš Mojović[1]
[1]*University of Belgrade - Faculty of Physical Chemistry, Serbia*
[2]*University of Belgrade - Institute of Chemistry, Technology and Metallurgy, Department of Catalysis and Chemical Engineering, Serbia*
[3]*University of Belgrade - Implant-Research Center - Faculty of Dental Medicine, Serbia*
[4]*Maecenium and Perun Biosciences - Houston, USA*

Stem cell research has emerged as a promising avenue for regenerative medicine, offering potential solutions for various medical conditions, particularly wound healing, such as burns, where conventional treatments often fall short. Central to this field is the exploration of stem cells and stem cell-conditioned media, which have shown remarkable therapeutic potential and contain a complex array of bioactive molecules, including growth factors, cytokines, and extracellular vesicles [1,2]. These factors play critical roles in modulating cellular behaviour, promoting tissue repair, and stimulating regeneration. One of the major concerns in the investigation and application of stem cells is the assessment of their viability. Usual methods for cell viability testing include morphological assessment, cell counting, viability staining, metabolic activity, apoptosis, and functional assays, which are time-consuming and expensive.
Electrochemical methods are fast and do not require special preparation of samples. This study focuses on the utilization of cyclic voltammetry and electrochemical impedance spectroscopy methods for rapid cell viability assessment. Dental pulp stem cells (DPSC) were grown in culture until they achieved appropriate confluence. To be able to compare the electrochemical response of viable cells to non-viable cells, DPSC were subjected to several cycles of freezing and heating. All electrochemical experiments were performed using aliquots of DPSC in its condition media as applied to a screen-printed electrode and immediately recorded.
Cyclic voltammograms did not show a predictable trend that could be used for the confirmation of cell viability. On the other hand, electrochemical impedance spectroscopy, which has the advantage of probing processes across a wide range of frequencies and resolving slow and fast processes, was more successful. The obtained Nyquist plots for viable and non-viable cells (Figure 1) shows a clear distinction.

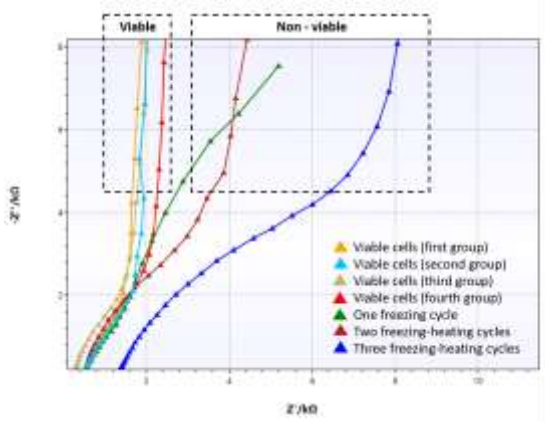

Figure 1. Nyquist plots of stem cell samples as received and conditioned by freezing-heating cycles

Viable cells show characteristic capacitive behaviour at lower frequencies, which can be attributed to the capacitive behaviour of the intact cell membrane. On the other hand, treated samples of cells showed deviations from this behaviour. The degree of deviation is in correlation with the number of freezing-heating cycles, i.e., the number of non-viable cells; a smaller number of viable cells results in a greater deviation from the capacitive behaviour.

Acknowledgement: This research has been financially supported by the Ministry of Science, Technological Development and Innovation of Republic of Serbia (Contract No. 451-03-65/2024-03/200146, 451-03-66/2024-03/200146 and 451-03-66/2024-03/200026).

References

1. P. Jayaraman, P. Nathan, P. Vasanthan, S. Musa, V. Govindasamy, *Cell Biology International* **37** (2013) 1122 https://doi.org/10.1002/cbin.10138
2. Y. An, S. Lin, X. Tan, S. Zhu, F. Nie, Y. Zhen, L. Gu, C. Zhang, B. Wang, W. Wei, D. Li, J. Wu, *Cell Proliferation* **54** (2021) 1 https://doi.org/10.1111/cpr.12993