Characterizing Electrical Properties of Glioblastoma Using Electrochemical Impedance Spectroscopy

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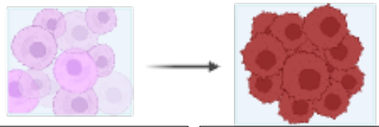
IMPACT STATEMENT: Using electrical signals to identify brain tumor types could enable faster, non-invasive diagnosis and improve treatment decisions.

1. Background

- Glioblastoma is highly aggressive brain cancer with severe heterogeneity.
- Current diagnostic methods are time consuming and invasive
- Biological tissues have unique electrical properties based on their structure and composition
- Electrical Impedance Spectroscopy provides a real time, label-free, non-invasive way to measure these properties

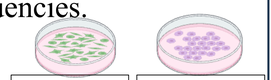


Healthy Brain Cells | Glioblastoma Cells

2. Research Objective

Determine whether EIS can distinguish glioblastoma subtypes: Glycolytic and Neuronal

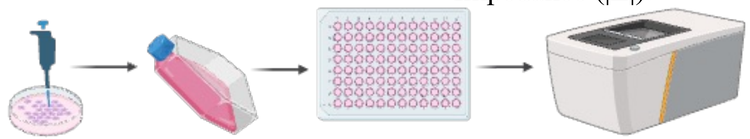
- Compare electrical behaviour of two human derived cell lines: GBM 22 (GPM subtype) and GBM 115 (NEU subtype)
- Identify subtype-specific signatures across different frequencies.



GBM 22 | GBM 115

3. Methods

1. **Experimental Setup**
   - Cells cultured under controlled conditions
   - Impedance measured across range of frequencies.
   - Multiple biological replicates to ensure reliability.
2. **Measurement System: Maestro Z**
   - High precision impedance analyzer
   - Frequency analyzer: 1 mHz – 10MHz
   - Measures Resistance (R), Reactance (X), and Impedance (|Z|).



Cells are cultured, plated, and analyzed using the Maestro Z system to measure impedance and assess cellular electrical properties.

4. Significance and Applications

1. Non-invasive Tumor Characterization	EIS can detect electrical differences without labelling or damaging cells.
2. Improved Diagnostics	Helps distinguish Glioblastoma subtypes based on electrical signatures.
3. Faster, Quantitative Assessment	Potential to support real-time analysis of clinical decisions.
4. Foundations for Advanced Diagnostics	Supports development of electricity-based tools for brain tumor detection.

5. Expected Results

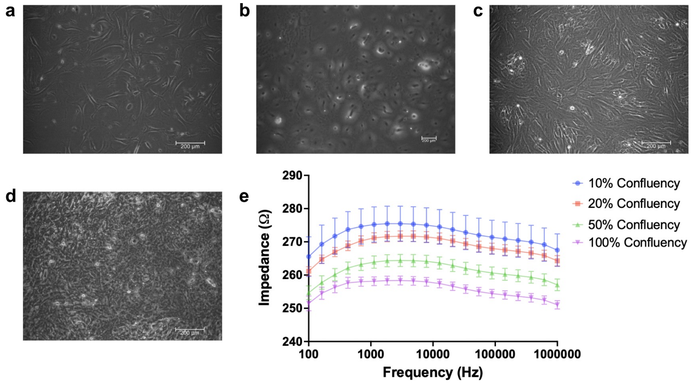


Figure 1: Light microscopy images of GBM 115 cells and data analysis. Percentage of viable cells cultured in a given area varied from (**a**) 10% confluency, (**b**) 20% confluency, (**c**) 50% confluency, and (**d**) 100% confluency. (**e**) Plot illustrating effect of GBM 115 cell confluency over a 20-step frequency sweep. n = 3 per cell confluency. Error bars represent standard error of the mean. Scale bars: 200 μM (**a, b, c, d**).

- Prior EIS findings validate that glioblastoma subtypes exhibit distinct electrical signatures, which the Maestro Z system aims to capture with improved scalability and biological integration.
- Increased confluency = decreased impedance (higher conductivity)
- Electrical differences likely arise from Extracellular Matrix (ECM) changes.

6. Future Work

- Validate findings with different cell lines and larger datasets.
- Compare Maestro Z results with other EIS systems (Eg: SpioSpec)
- Extend to in-vivo studies and patient derived samples.
- Improve models to identify key electrical features for classification.

7. Acknowledgements and References

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