Development of Advanced Biomimetic Hybrid Liposomes via Microfluidics for Enhanced Targeted Delivery and Antitumor Activity in Glioblastoma Cells

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Abstract

The treatment of glioblastoma faces significant challenges primarily due to the blood-brain barrier (BBB) and the rapid immune clearance of drugs, underscoring the urgent need for advanced delivery systems. [1] This study aims to investigate an innovative drug delivery method using paclitaxel and carboplatin encapsulated in specially bioengineered liposomes. By incorporating cell membrane (CM) fragments extracted from a glioblastoma cell line into the liposomes, we aimed to endow them with stealth properties, improve their targeting efficiency, and enable them to evade immune detection. This modification allows the liposomes to accumulate in tumours through homotypic targeting preferentially.[2] Microfluidic technique was employed to produce these biohybrid liposomes (Figure 1), namely we developed a microfluidic sonication method that integrates active and passive mixing techniques to enhance nanoparticle production efficiency. [3] Specifically, we employed two approaches: 1) using a single device placed in a sonicator bath for cell membrane (CM) breakdown, and 2) using two devices in series, where device 1 was placed in a sonicator bath for CM breakdown and device 2 was used for nanoparticle (NP) formation. To assess hybridization and confirm successful membrane fusion, we performed Förster resonance energy transfer, colocalization studies by flow cytometry, and Western blotting techniques. In vitro studies confirmed that these biomimetic hybrid liposomes can effectively target tumors, cross the BBB, and maintain the efficacy of paclitaxel and carboplatin. This novel delivery system offers a promising non-invasive approach for glioblastoma treatment, potentially eliminating invasive procedures to achieve effective drug delivery across the BBB.

References

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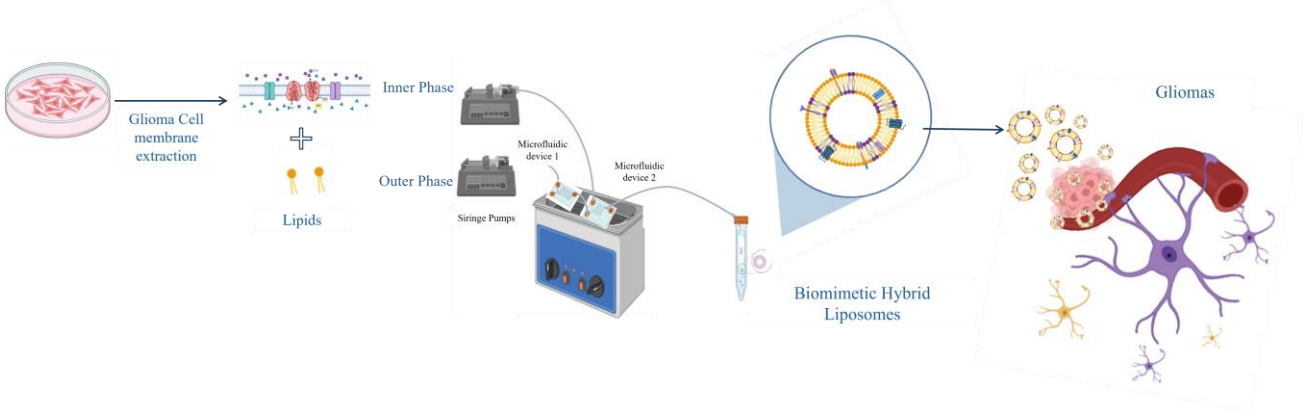

Figure 1: Scheme of the microfluidic production of biomimetic hybrid liposomes.