Integrated Microfluidic Chip Development for the Quantification of Antibiotic Permeability Rates through Bacteria Cell Wall

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Abstract

Microfluidic chips have gained a lot of interest of researchers due to their ease of fabrication, cost-effectiveness, durability, and portability and these are highly preferable to handle micro and nano particles because of their micro-sized structure and rapid detecting properties (Casquillas et al., 2015). In this study, we are investigating an integrated chip comprising of titanium electrodes and microfluidic channel networks for rapid detection of permeability of antibiotics across the bacteria cell wall. This chip enables us to recognize the concentration of antibiotics inside and outside of the model cell over time. Model cells that have been used for the experiments are Gaint unilamellar vesicles, which are produced by one of the liposomes generation methods, Electroformation. Giant unilamellar vesicles (GUV) are widely used to study the properties of biological membranes as they have a cell-like diameter and contain the same phospholipids that constitute cell membranes (Breton et al., 2015). The whole chip size is approximately 38*26 mm which is quite easy to handle. The figure 1a shows the fabricated integrated chip and figure 1b displays the image of GUVs has taken by an optical microscope (scale bar: 50 um). Here in this platform, detection is label-free due to the fact that the electrochemical principles are used to monitor the antibiotic concentration, thus allows the study of both fluorescent and non-florescent antibiotics. Depending on the antibiotic type, charge, chemical structure, the permeability will be different, and we envision that the differences can be monitored using the integrated chip. In summary, we have developed integrated LOC biosensors serve as a platform to measure the antibiotic permeability into the bacterial cell. In return, it is envisioned that it would provide an alternative way to screen permeability rates and thus give an opportunity for health-care companies to design better antibiotics.

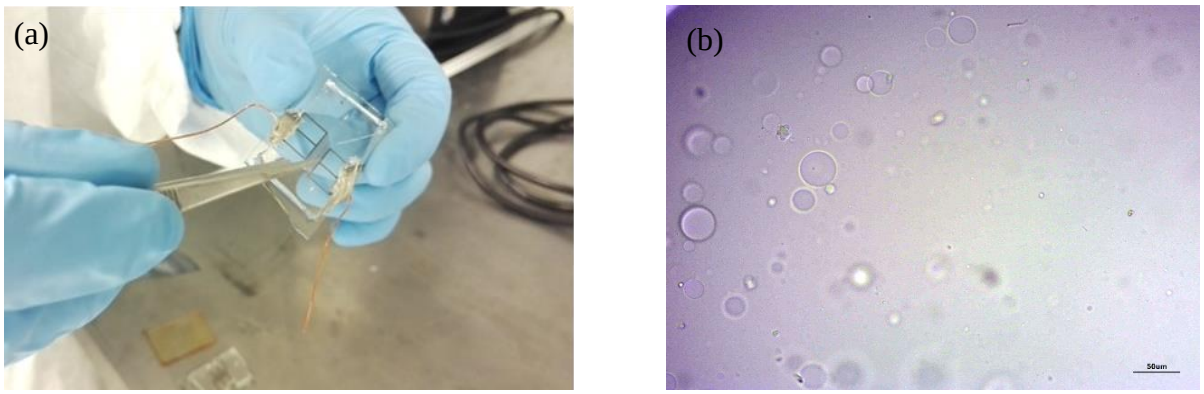

Figure 1: a) Fabricated LOC and b) Giant unilamellar vesicles.

Keywords: Microfluidics; Antibiotics; Impedance Measurement; Microfabrication; GUVs; Electroformation.

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References

Breton, Marie, et al. "Optimization of the Electroformation of Giant Unilamellar Vesicles (GUVs) with Unsaturated Phospholipids." Journal of Membrane Biology, 2015.

Casquillas, Velvé, et al. "Microfluidics and Microfluidic Devices: A Review." Elveflow, 2015, pp. 1–9.