Molecularly Imprinted Sensors Targeting Extracellular Vesicles for Cancer Detection

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Abstract

Early and precise detection of breast cancer remains pivotal in expanding therapeutic windows, improving survival outcomes, and reducing disease burden. Conventional three-dimensional (3D) in vitro models often fall short in capturing the complex interplay of biophysical cues within the tumor microenvironment [1,2]. In this study, we focus on extracellular vesicles (EVs) as dynamic biomarkers and mediators of tumor progression, and we introduce an innovative platform for their early detection. We initially employ a microfluidic chip engineered to mimic the breast cancer microenvironment, enabling efficient isolation of EVs secreted by malignant MCF-7 cells. To overcome the inherent limitations of conventional antibody-based detection methods, we utilize molecular imprinting techniques to capture the nanoscale topography and surface chemistry of EVs onto functionalized nanoparticles. These EVs-imprinted nanoparticles are interfaced with optical biosensors to enable label-free, real-time, and highly specific detection. This strategy not only enhances analytical sensitivity and stability but also eliminates the dependence on complex reagents and multi-step protocols. Our integrative approach represents a transformative leap toward non-invasive, high-fidelity cancer diagnostics, offering deep insights into tumor biology and opening new avenues for precision medicine.

References

[1] Inci F., Langmuir, 38 (2022) 1897–1909.
[2] Altıntaş, O., Saylan, Y., Analytical Chemistry, 95 (2023) 16029-16048.

Figure

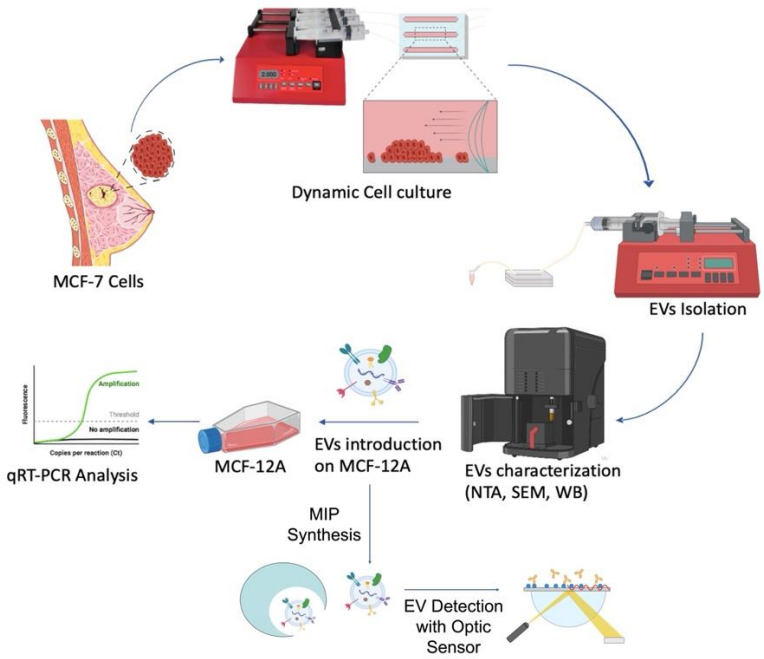

Figure 1: Experimental set up.

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