CHEMICALLY DRIVEN SURFACE MODIFICATION OF POROUS POLYCARBONATE MEMBRANES IN DUAL-CHANNEL MICROFLUIDIC SYSTEMS TO ENHANCE CELL ADHESION

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Microfluidic and organ-on-chip technologies provide advanced platforms for in vitro modeling, however, insufficient cell adhesion on synthetic membranes remains a major technical challenge, particularly under dynamic flow conditions [1]. This study investigates multiple chemically driven surface modification strategies for porous synthetic polycarbonate (PC) membranes to enhance cell attachment, spreading uniformity, and long-term stability in dual-channel microfluidic systems [2]. PC membranes were functionalized using several chemical agents, including polyethyleneimine (PEI), dopamine hydrochloride, and other surface-active compounds, either alone or in combination with biological coatings such as collagen and fibronectin. Surface topography and physicochemical changes were characterized by atomic force microscopy (AFM) and Fourier-transform infrared spectroscopy (FTIR). Cell adhesion, morphology, and spatial distribution were evaluated using optical microscopy. Results demonstrate that chemically modified membranes exhibit significantly improved initial cell adhesion compared to untreated membranes, indicating the critical role of surface chemistry in regulating cell–material interactions. Different chemical functionalization strategies produced distinct adhesion profiles, reflected in variations in cell attachment efficiency, spreading behavior, and spatial distribution. Certain surface treatments promoted more homogeneous cell coverage and enhanced cellular spreading, suggesting improved surface compatibility. In several cases, combining chemical modification with additional surface coatings further increased attachment uniformity. Overall, this work highlights chemically driven surface functionalization as an effective strategy to overcome adhesion limitations of synthetic porous polycarbonate membranes, supporting the development of robust and reproducible dual-channel microfluidic and organ-on-chip platforms for long-term in vitro applications.

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