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境外生研究獎學金

Research Scholarship for International Graduate Students



Assessment of T-cell Function in Lung Cancer on a Microfluidic Chip Device

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Abstract

Interleukin-6 (IL-6) has a dual role in immune modulation, directing T-cells to sites of infection and inflammation while impacting diverse biological pathways. We introduce the Flow-Based Microfluidic Gradient Generator Lung-TME-Lab-Chip, a 3D microsystem engineered to explore IL-6's effects on immune cells in a controlled tumor microenvironment (TME) model. This innovative platform enables precise, time- and dose-dependent analysis of IL-6 gradients on T-cell phenotypes and lung cancer cell behaviors. Our findings underscore the complex influence of IL-6 gradients on immune responses within the TME, offering valuable insights for developing targeted therapeutic strategies.

Lung-TME-Lab-Chip Fabrication

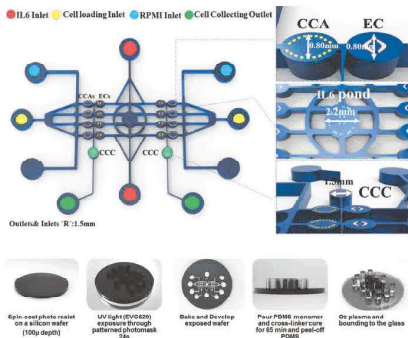


Fig.1 Flow-based Microfluidic Gradient Generator Lung-TME-Lab-Chip Fabrication Process

Lung-TME-Lab-Chip Principles

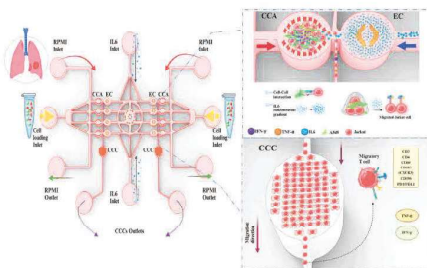


Fig.2 The Illustration of Flow-based Microfluidic Gradient Generator Lung-TME-Lab-Chip Design

Lung-TME-Lab-Chip

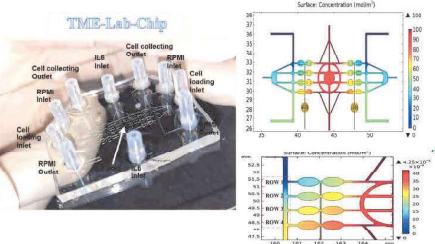


Fig.3 COMSOL Simulation of Gradient Generator Lung-TME-Lab-Chip

Hydrogel Structure

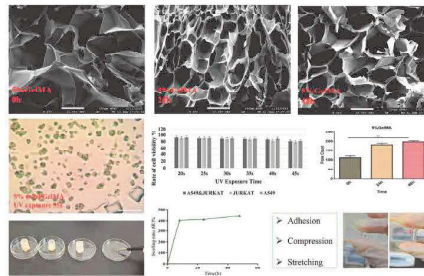


Fig.4 5% Gelatin Methacrylate (GelMA) Variation as a 3D Culture Structure Analysis

Immune T-cell Response

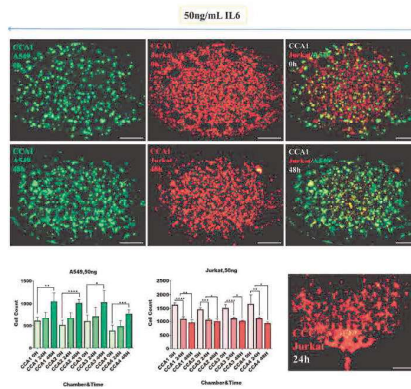


Fig.5 Effects of 50 ng/mL IL-6 Dilution on Co-Cultured A549 & Jurkat Cells

100ng/mL IL-6

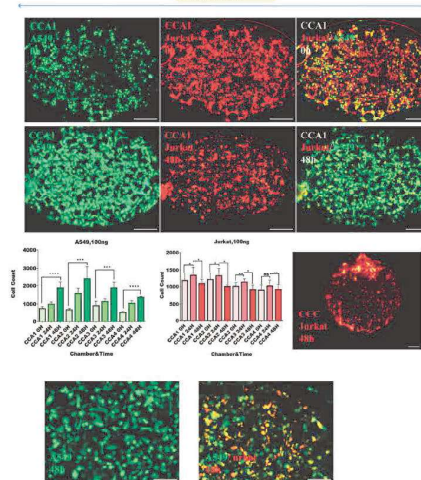


Fig.6 Effects of 100 ng/mL IL-6 Dilution on Co-Cultured A549 & Jurkat Cells

Flow Cytometry Results

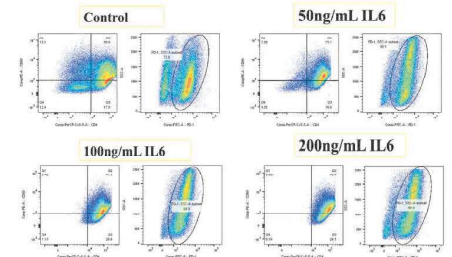


Fig.6 Expression of CD49 and PDI Markers on Migratory CD4+ T-cells

ELISA

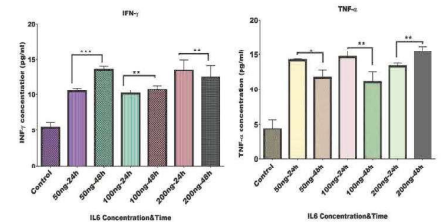


Fig.7 Analysis of TNFα & IFNγ in A549 & Jurkat Cells Co-Cultured in Lab-Chip

Research Results

Our results demonstrate that the IL-6 gradient within the Lung-TME-Lab-Chip plays a pivotal role in shaping immune cell behavior and interactions with cancer cells. The Lung-TME-Lab-Chip enabled precise control of IL-6 concentrations across chambers, revealing that IL-6 gradients significantly influence T-cell activation and migration, as evidenced by the upregulation of CD markers in Jurkat T-cells co-cultured with A549 lung cancer cells. Additionally, the dynamic IL-6 gradient affected TNFα and IFNγ levels, suggesting that IL-6 not only directs T-cell phenotype but also modulates inflammatory cytokine production, contributing to a complex immune environment around the tumor. These insights into the IL-6-mediated interplay between immune and cancer cells underscore the potential for targeting IL-6 pathways in therapeutic strategies aimed at modulating immune responses within the TME.

Selected Journal Publications

- P. Sardarabadi, K.-Y. Lee, W.-L. Sun, A. A. Kojabad, and C.-H. Liu, "Investigating T Cell Immune Dynamics and IL-6's Duality in a Microfluidic Lung Tumor Model," *ACS Applied Materials & Interfaces*, 2024/10/29 2024, doi: 10.1021/acami.4c09065.
- P. Sardarabadi, K.-Y. Lee, W.-L. Sun, and C.-H. Liu, "Immune response to IL6 gradient in a diffusion-based microfluidic labchip," *Sensors and Actuators B: Chemical*, vol. 417, p. 136141, 2024.
- P. Sardarabadi, A. A. Kojabad, D. Jafari, and C.-H. Liu, "Liquid biopsy-based biosensors for MRD detection and treatment monitoring in Non-Small Cell Lung Cancer (NSCLC)," *Biosensors*, vol. 11, no. 10, p. 394, 2021.