'Plasticoma': A Bioengineered Platform to Study the Microplastic Pollution-Induced Cellular Pathologies and Discover Therapeutic Interventions

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Plastic pollution poses a global ‘One Health’ crisis, impacting humans, animals, and the environment. Microplastics have been detected in human blood and various tissues, with emerging evidence suggesting potential links to blood clots, artery plaques, and tumor development, though causal relationships remain unclear. This underscores the need for innovative model systems to investigate the health impacts of microplastics and explore potential interventions. I developed a novel ‘plasticoma’ platform using three-dimensional (3D) culture of human cells, fluorescent polystyrene microplastic particles, and an extracellular matrix. This model reproduces microplastic-induced cellular disorders in vitro. Using multiparametric flow cytometry, I demonstrated that blood myeloid cells, mainly intermediate (CD14+CD16+) and classical (CD14+CD16-) monocytes, actively phagocytose microplastics and become activated, leading to aggregation and the formation of plaque- or nodule-like lesions in the 3D cell culture. A scalable 3D model incorporating immortalized lung cells generated more prominent lesions, demonstrating the plaque- or tumor-like effects of polystyrene microplastics. The system enabled high-content screening of therapeutics, identifying FDA-approved and novel drugs with anti-adhesion and anti-inflammatory properties that can alleviate microplastic-induced lesions. The pliable model can be easily modified to include additional cell types. Importantly, this bioengineered platform offers an efficient tool for studying microplastic-related pathologies, identifying new treatments, and assessing toxicity. Finally, the versatile platform can stimulate new investigations, reduce animal use in microplastic research, and be modified to study other pollution-induced diseases.

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