Metamaterials as immunoengineering scaffolds

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Macrophages play an important part in our immune system. They are immune system white blood cells that are engaged in the detection, phagocytosis, anti-bacterial capabilities, and the countering of other hazardous pathogen organisms that infiltrate the human body. The goal of this research is to monitor and comprehend how macrophages respond to auxetic, ultra – stiff, and ultra – light scaffolds. Scaffolds are created using multiphoton lithography, which enables free – form 3D printing of high resolution structures such as micro – optical elements and 3D scaffolds for tissue engineering and regenerative medicine applications. The scaffolds are based on the well – known re – entrant hexagonal geometry (bowtie), a novel auxetic scaffold named "shuriken," and the ultra – light – ultra – stiff Kelvin foam of different dimensions (small structures: approximately 10μm unit size and large structures: approximately 40μm unit size). Murine macrophages (RAW 264.7) were seeded on the scaffolds, and cell morphology and/or differentiation into M1 or M2 phenotypes were studied in response to the various mechanical conditions. Mechanical stimuli and topography influence important cellular responses such as morphology, directionality, orientation, and differentiation according to our findings. [1], [2]

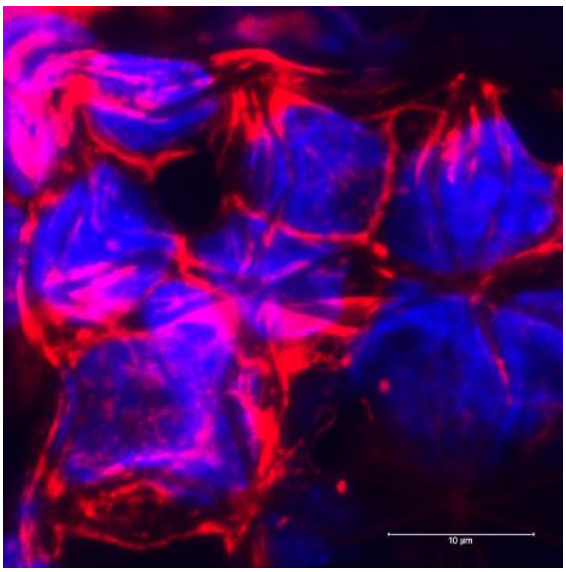

Figure 1: RAW 264.7 macrophages over structures with small pore size (~10μm) on Shuriken lattice. Red channel: actin fibers and blue channel: nuclei of the cells. The spread-out actin fibres gives us the information that the cell has spread out trying to take up as much space on the unit cell as it can.

References

[1] G. Flamourakis *et al.*, “Laser-made 3D Auxetic Metamaterial Scaffolds for Tissue Engineering Applications,” *Macromol. Mater. Eng.*, vol. 305, no. 7, pp. 1–9, 2020, doi: 10.1002/mame.202000238.

[2] R. Sridharan, A. R. Cameron, D. J. Kelly, C. J. Kearney, and F. J. O’Brien, “Biomaterial based modulation of macrophage polarization: A review and suggested design principles,” *Materials Today*, vol. 18, no. 6. pp. 313–325, 2015, doi: 10.1016/j.mattod.2015.01.019.