

s.vandersteene@tue.nl

materials-driven regeneration

Topography affects macrophage-driven fibroblast physiology

Streggi Vandersteene[1], Els Alsema[1,2], Nicholas A. Kurniawan[1], Jan de Boer[1]

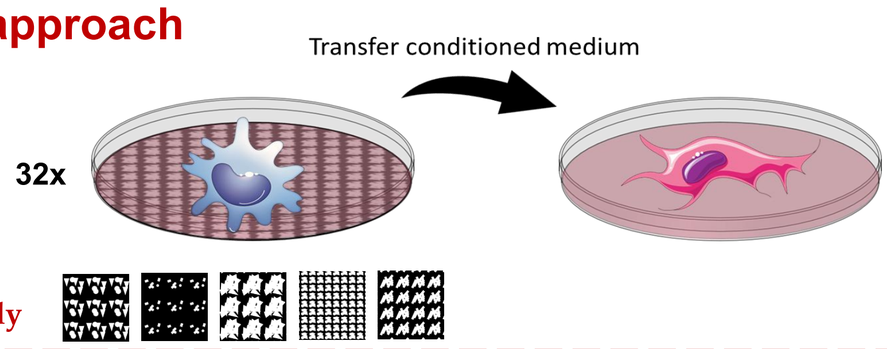
[1]Department of Biomedical Engineering, Eindhoven University of Technology, The Netherlands
[2]Center for Health Protection, RIVM National Institute for Public Health and the Environment, Bilthoven, The Netherlands

Do surface topographies modulate macrophage–fibroblast cross-talk via cytoskeletal reorganization?

We hypothesize that physical surface topographies influence macrophage cytoskeletal organization, which in turn shapes their cytokine secretion and downstream fibroblast responses through paracrine signaling.

Experimental approach

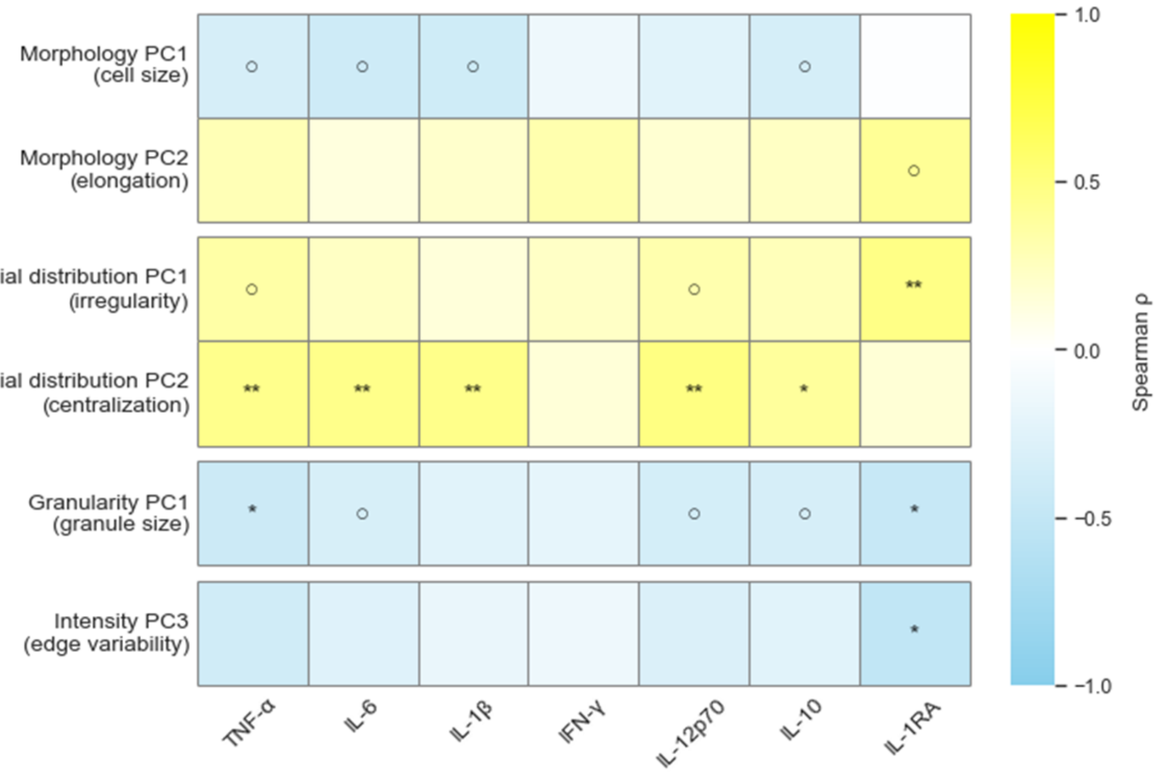
- Primary human macrophages cultured on engineered surface topographies
- Macrophage cytoskeletal organization and cytokine secretion quantified
- Conditioned medium transferred to human dermal fibroblasts
- Fibroblast morphology and activation assessed



Representative surface topographies used in this study

Macrophage response

Macrophage F-actin organization predicts cytokine secretion



Distinct descriptors of F-actin organization, capturing radial distribution, granularity, and intensity patterns, associate with macrophage cytokine output. ° $q < 0.10$, * $q < 0.05$, ** $q < 0.01$.

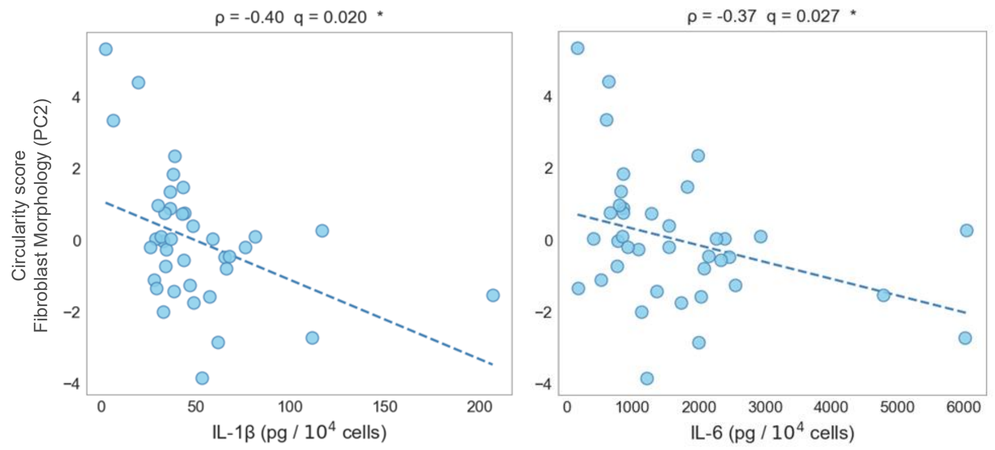
IL-1RA secretion consistently associates with heterogeneous actin organization

Feature class	Association with IL-1RA
Radial distribution (PC1)	↑ significant
Granularity (PC1)	↓ significant
Intensity (PC3)	↑ significant

IL-1RA correlates across multiple complementary feature representations, indicating a robust link to cytoskeletal remodeling rather than a single metric.

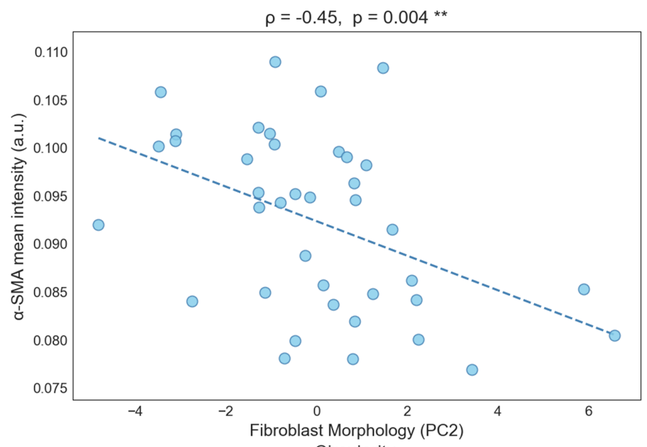
Fibroblast response

Macrophage-derived cytokines reshape fibroblast morphology

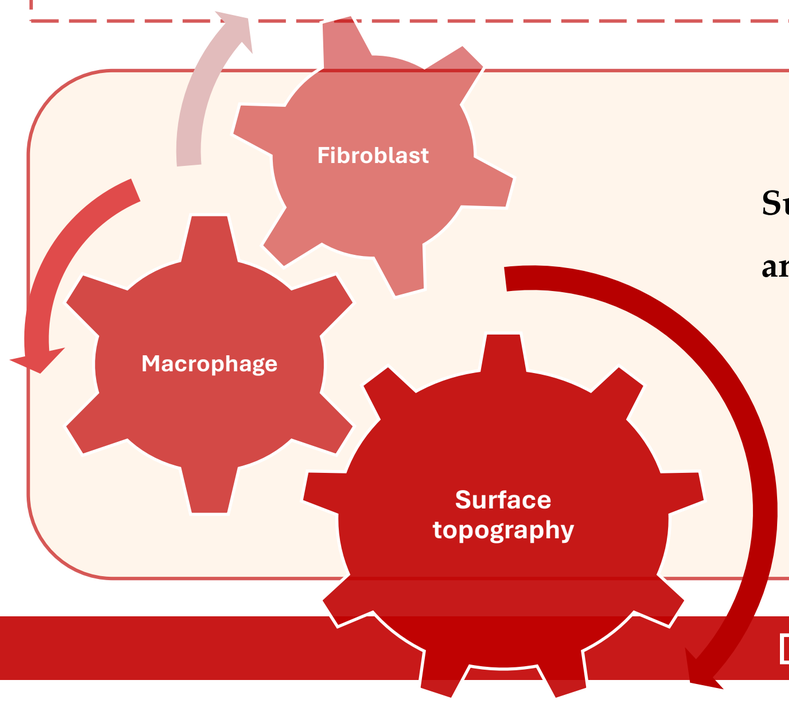


Fibroblast circularity decreases in response to macrophage-conditioned medium, consistent with a pro-remodeling phenotype. IL-1β and IL-6 are shown as representative cytokines with consistent associations across cytokines. * $q < 0.05$.

Morphological remodeling associates with partial fibroblast activation



Fibroblast circularity negatively associates with α-SMA intensity, consistent with partial myofibroblast-like activation. * $q < 0.05$, ** $q < 0.01$.



Take-home messages

Surface topography alters macrophage cytoskeletal organization, shaping cytokine secretion and downstream fibroblast physiology via macrophage-mediated paracrine signaling.

- Surface topography selectively remodels macrophage F-actin organization
- F-actin organization consistently predicts macrophage cytokine output
- IL-1RA is specifically linked to heterogeneous actin remodeling
- Fibroblast responses are mediated by macrophage-derived signals

DEPARTMENT OF BIOMEDICAL ENGINEERING

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