Medical Xpress

Biomaterial immune control discoveries could reduce implant rejection

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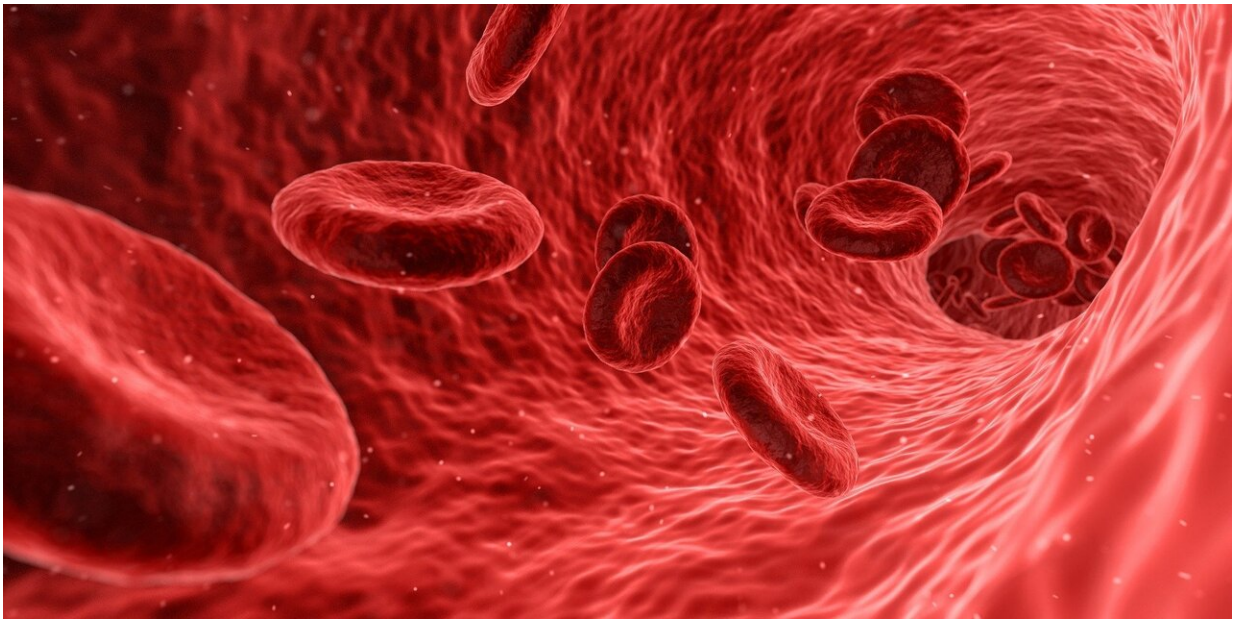

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The team from the University of Nottingham's Schools of Pharmacy and Life Sciences have found that the surface shape (topography) and chemical composition of polymer materials can be changed to create materials that control the body's immune response. This could have future applications in the fight against rejection of medical devices including artificial joints, dental implants and vascular implants. The results from two recent studies have been published in *Advanced Science*

and *Matter*.

Artificial joints, stents and dental implants are among the most common devices that use biomaterials to restore function or completely replace diseased or damaged tissues. However, following the implantation of biomaterials in the body, a host reaction is common, including responses such as inflammation, a foreign body reaction (FBR), and fibrous capsule development which can result in the implant failing.

These reactions are driven by the activation of immune cells called monocytes and macrophages attaching to the implant surface. The physical features on the surface of a material or implant known as 'topography' is known to influence macrophage attachment.

Professor Amir Ghaemmaghami has co-led the research, he explains: "We are looking at ways to create materials that can be safely put inside the body without the immune system attacking it and causing rejection. To do this we are exploring materials that can control the immune response. We have used high throughput screening technology to examine how the topography and chemical properties of a material can be used to design "immune-instructive" surfaces for potential use in implants, which influence macrophage function and consequently the foreign body responses to biomaterials."

Taking control of the immune response

A state-of-the-art high throughput screening approach was used to investigate the relationship between material topographies and immune cell attachment and behaviours for 2176 different micropatterns.

The results indicated that micron-scale pillars 5-10um in diameter were key in driving macrophage attachment, and that the density of the micropillars proved key in controlling inflammatory reactions.

The team also discovered immune instructive polymer chemistries that successfully controlled the immune response in a pre-clinical rodent model. This was achieved through screening libraries of diverse polymers and identifying materials that control the behaviour of macrophages.

An AI algorithm was used to model the relationships between the material chemistries and the cell responses they produced. These results suggest that different immune-instructive polymers attract different amounts of protein adsorption which was key to the macrophage responses.

Professor Morgan Alexander also co-led the research, he said: "These latest discoveries add to a wealth of materials research taking place at the University of Nottingham and it is exciting to have discovered these biomaterials that could be a real game-changer in the area of medical implants. Getting these materials used in a commercial product would be our ultimate aim for this research, there is still a way to go to get there but these discoveries are a significant step towards that."

This research was conducted in collaboration with Technical University Eindhoven, La Trobe University Australia and Maastricht University. It has been funded by an EPSRC Programme Grant in Next Generation Biomaterials Discovery that aims to find new biomaterials. The aim is to allow us to move beyond the existing limited range of polymeric drug and cell delivery agents and medical device polymers that are currently licensed for use in man, to bespoke materials identified to function optimally for specific applications.

More information: Hassan M. Rostam et al, Immune-Instructive Polymers Control Macrophage Phenotype and Modulate the Foreign Body Response In Vivo, *Matter* (2020). DOI: 10.1016/j.matt.2020.03.018

Matthew J. Vassey et al. Immune Modulation by Design: Using Topography to Control Human Monocyte Attachment and Macrophage Differentiation, *Advanced Science* (2020). DOI: 10.1002/advs.201903392