Research Reveals How Materials Direct Cell Response

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New Georgia Tech research indicates how cells “sense” differences in biomaterial surface chemistry. The findings explain how biomaterials influence cells and could be used to develop new classes of materials to improve device integration and function.

The body treats implanted medical devices – including everything from titanium hip replacements and blood vessel grafts – as invaders.

Cells surround and attack foreign material, resulting in an inflammatory response. This unfriendly reaction prevents implants from integrating into the body and functioning as well as they could.

While implanted biomaterials can be designed with different surface chemistries and roughness to influence inflammatory responses, the process is not well understood. Now, researchers from the Georgia Institute of Technology have discovered how cells “sense” differences in biomaterial surface chemistry. These differences in communication between the cell and the biomaterial result in changes in cell behavior, according to findings published in the Proceedings of the National Academy of Sciences (PNAS).

In addition to explaining how biomaterials influence cells, the findings could be used to develop new classes of materials to improve device integration and function. For example, these findings could be used to direct responses in stem cells, controlling their differentiation into mature, functional cell types.

The research was lead by Andrés García, an associate professor in the Woodruff School of Mechanical Engineering and the Petit Institute for Bioengineering and Bioscience at Georgia Tech. Benjamin Keselowsky, a post doctoral fellow in Mechanical Engineering, and David Collard, an associate professor in the School of Chemistry and Biochemistry at Georgia Tech, also collaborated on the project.

“From a molecular perspective, we now have a better idea of how cells interact with materials and how materials can direct cell responses,” García said. “And now that we understand that, it may be possible to engineer novel, rationally-designed biomaterials that can control those interactions.”

Cells interact with biomaterials using specialized adhesion proteins. These adhesion proteins on the cell bind to target proteins adsorbed on the biomaterial surface. In addition to anchoring cells, these adhesion proteins trigger signals that control many cell functions, including growth and protein production. An important feature of these adhesion proteins is that they only recognize a small number of target proteins.

“That’s how the cell makes sense of a very complicated environment like the body,” García said.

García and his group showed that the biomaterial surface chemistry altered the types of adhesion proteins that cells used to adhere to the biomaterial. As the surface chemistry of the material changed, so did the types of adhesion receptors that the cells used for binding. These differences in the binding of adhesion proteins changed the signals in the cell and resulted in very different cellular responses.

“The idea is that different adhesion proteins do different things by triggering different signals,” García said. “By controlling which adhesion proteins the cell is using to bind to a material, we can control what the

cell does and the quality of its interaction with the material."

These investigators are now focusing on directing stem cells into specific cell types and determining whether these engineered biomaterials integrate better into the body.

Source: Georgia Institute of Technology