Medical Xpress

Multifunctional biomaterial prevents bacterial infection

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Credit: Eindhoven University of Technology

Moniek Schmitz developed a fast and feasible way to test new, multifunctional biomaterials that prevent bacterial growth and reduce the use of antibiotics.

A major problem with the use of biomaterials is that infections can occur. Biomedical engineer Moniek Schmitz developed various coatings to stimulate better interaction between the biomaterial and the body's own tissue, but also to prevent bacterial growth. To accelerate the search for the ideal multifunctional biomaterial, she set up a screening method to test as many as hundreds of material combinations simultaneously. Schmitz defended her doctoral thesis at the department of Biomedical Engineering on February 15.

Dental implants, wound dressings, artificial hips, stents, contact lenses; the use of biomaterials in healthcare is extensive. These materials are often implanted to replace or repair damaged tissue. But while a biomaterial should primarily provide reinforcement, it is also becoming increasingly important that the material does not induce an inflammatory reaction in the human body, explains Ph.D. student Moniek Schmitz.

Alarming numbers

"Such a biomaterial-associated infection could occur immediately after implantation because the material or the environment is not completely sterile. But a relatively harmless infection somewhere else in the body can also cause problems years later. Via the bloodstream, pathogens can still trigger an infection in the tissue surrounding the biomaterial or on its surface."

Biomaterial-associated infections are currently treated with antibiotics to kill the bacteria and cure the infection. Often, antibiotics are also given preventively during implantation to prevent infection. According to Schmitz, this needs to change. "There are more and more multi-resistant bacteria. According to recent United Nations estimates, the number of deaths due to antibiotic resistance will reach about ten million a year by 2050, alarming numbers."

To reduce antibiotic use, Schmitz and her colleagues have been looking for innovative ways to combat these infections. With new, multifunctional biomaterials. "These materials must not only perform the function for which they were specifically developed, but also stimulate integration with the body and kill pathogens on and around the biomaterial."

Chain of cubes

To do this, Schmitz used supramolecular biomaterials, constructed as a kind of chain of different cubes linked together. The different cubes provide different properties of the material and thus both mechanical and biological properties can be adjusted.

Schmitz's biomaterials are all based on the supramolecular molecule ureido-pyrimidinone. In several studies, she developed a coating that causes body cells to adhere better to the material, and a coating that proved successful in killing bacteria on the implant surface.

Molecule library

A good first step, Schmitz believes, but as her Ph.D. research progressed she saw that her step-by-step approach was not the most appropriate method to efficiently reduce complex biomaterial-associated infections.

"We are dealing with different time scales, different materials and cells from humans and bacteria. That's much more complex than a coating that targets one aspect. We have certainly gained fundamental knowledge from this, but ultimately, we want to develop a multifunctional biomaterial as soon as possible.

The screening method that Schmitz then set up allows hundreds of

combinations of materials to be tested simultaneously, which she hopes will give biomaterial research a boost. To do so, she printed on a microscope slide a molecule library, all with different properties.

"These high throughput screenings enable fast progress—feasible and necessary—in the developing and testing of new, multifunctional biomaterials.

Moniek Schmitz defended her Ph.D.-thesis, titled "Supramolecular Antimicrobial Biomaterials—From Molecular Design to Screening" on February 15th.

More information: Antimicrobial Supramolecular Biomaterials: From Molecular Design to Screening: research.tue.nl/files/19516588 … 20215_Schmitz_hf.pdf

Provided by Eindhoven University of Technology