Molecular chameleons reveal bacterial biofilms

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Molecules that change colour can be used to follow in real-time how bacteria form a protective biofilm around themselves. This new method, which has been developed in collaboration between researchers at Linköping University and Karolinska Institutet in Sweden, may in the future become significant both in medical care and the food industry, where bacterial biofilms are a problem.

Biofilms are formed when bacteria growing on a surface form three-dimensional colonies in which they survive better than when living alone.

"What characterises biofilms in particular is that the bacteria produce a special slime that binds the bacteria to each other. The biofilm helps the bacteria to withstand external stresses, such as antibiotics, the flow of fluid in a catheter and detergents in the form of dishwashing liquid and other cleaning agents," says Professor Agneta Richter-Dahlfors at Karolinska Institutet, who has led the study together with Professor Peter Nilsson at Linköping University.

The protective biofilm is a problem in, for example, medical care and the food industry. Until now, no specific method to detect biofilms has been available.

"This is the first method that specifically labels the biofilm components. This means that researchers who want to study the mechanisms behind how bacteria form biofilms now have access to a new tool in understanding the process," says Agneta Richter-Dahlfors.

In the present study, published in *Nature Journal Biofilms and Microbiomes*, the investigators have developed molecules that emit a sort of optical fingerprint that depends on what they bind to. One part of the molecule has the ability to emit light, while another part can bind specifically to a target molecule. In this case, this is a molecule present in the biofilm. When the tracer molecule has bound to the target molecule, the colour of the light emitted changes.

"The molecules that we have developed are unique in that they can emit different colours, depending on their conformation. We call them 'molecular chameleons', since they change colour according to the surroundings," says Peter Nilsson at Linköping University, whose research group has developed these tracer molecules.

The researchers have demonstrated in the project how the method can be used to study Salmonella bacteria, both in cell cultures and in infected tissue. The researchers hope that it will be possible eventually to use the method within medical care and the food industry, where biofilms are a problem. There are, however, also contexts in which the ability of bacteria to form biofilms is positive, for example when bacteria are used to produce biogas to be used as fuel.

"It is possible with the new method to follow in real-time how the bacteria form a biofilm. Now that we have a tool that we can use to see how biofilms are formed, we can also use it to evaluate methods that influence the process," says Peter Nilsson.

The research has been financed with support from the Swedish Research Council, the Swedish Foundation for Strategic Research, the Erling-Persson Family Foundation and Carl Bennet AB. Some of the researchers who work in the study are part-owners in a company that may commercialise the molecules for use within medical care and industry.

More information: Ferdinand X Choong et al, Real-time optotracing of curli and cellulose in live Salmonella biofilms using luminescent oligothiophenes, *npj Biofilms and Microbiomes* (2016). DOI: 10.1038/NPJBIOFILMS.2016.24

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