On the trail of bacteria: Infrared light allows characterization of pathogens

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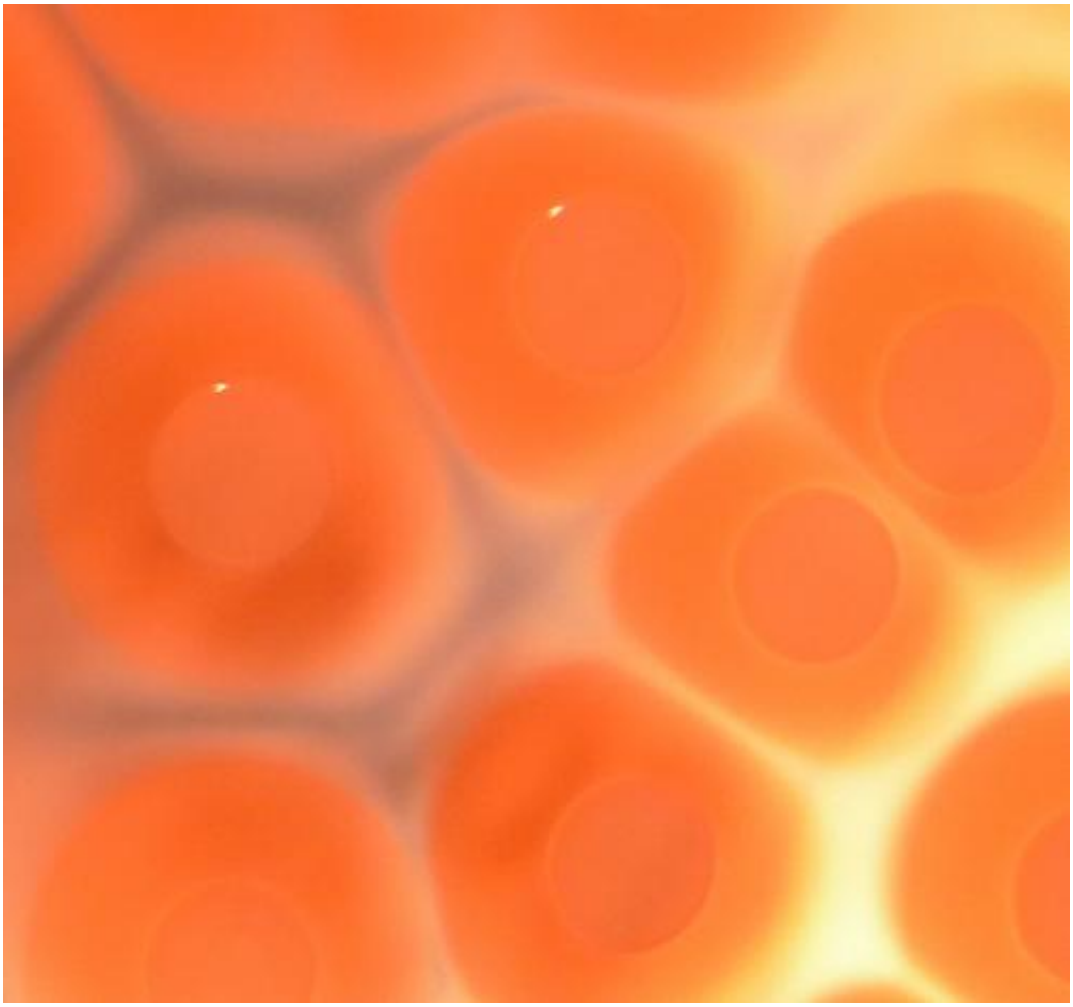

Staphylococcus aureus bacteria. Credit: Grunert/Vetmeduni Vienna

Scientists at the University of Veterinary Medicine, Vienna (Vetmeduni

Vienna) are hot on the trail of the bacterium Staphylococcus aureus. The researchers have developed a technique for the rapid and reliable distinction between strains that can cause chronic infections and those that cannot. Using infrared light and artificial intelligence, the scientists present a sophisticated method for the prediction of disease progression. Their results are now published in the *Journal of Clinical Microbiology*.

The bacterium Staphylococcus aureus (S. aureus) is commonly found in nature and frequently colonizes the skin and the upper respiratory tract of humans. A healthy immune system can fight the microorganism but once the immune system is weakened the pathogen can spread and lead to life-threatening diseases of the lungs, the heart and other organs. Moreover, S. aureus produces toxins in foods and can cause serious food poisoning. Its effects are not confined to humans: in cattle, S. aureus frequently causes inflammation of the udders, so the bacterium is also of great interest in veterinary medicine.

Bacterial microevolution and chronic infections

S. aureus comes in many different forms, which helps it evade the immune system. Aggressive types of S. aureus form capsules and multiply rapidly but are also quickly recognized by the immune system. Capsule-free forms are better able to survive within cells and are less well recognized by the immune system. In other words, they "hide and seek" before they attack and so are more likely to cause chronic infections that are harder to treat. Recent studies suggest that in the course of adapting to its host (human or animal) S. aureus undergoes a form of microevolution, during which it loses its capsule. The capsule-free form evades the host immune system and can even survive antibiotic treatment.

Infrared light distinguishes capsule types

S. aureus was previously detected – and the nature of its capsule checked – by means of specific antibodies that bind the capsule. The procedure is relatively complex, as the antibodies are not commercially available and thus have to be produced in animal experiments. Tom Grunert and colleagues have now developed a method by which the capsules can quickly and clearly be distinguished from one another without the use of antibodies. The technique relies on a physical procedure known as FTIR or Fourier Transform Infrared Spectroscopy. Infrared light is shone on the microorganisms to be tested and the resulting spectral data are input into a supervised self-learning system, a so called artificial neuronal network, which uses the data to work out the type of capsule. As Grunert says, "With the new method we can routinely test patient samples with a success rate of up to 99 per cent."

Bacteria at the crossroads

The head of Grunert's institute, Monika Ehling-Schulz, puts the work in a broader context. "In principle, germs have two choices when they infect a host: attack or hide – in technical terms virulence or persistence. If they attack, they risk destroying the host and consequently themselves, whereas if they hide, they may be outcompeted by others. A detailed knowledge of the mechanisms of virulence and persistence and the way bacteria switch between them will help us to develop novel and more effective therapies."

More information: Grunert, T. et al. Rabid and Reliable Identification of Staphylococcus aureus Capsular serotype by Means of Artificial Neural Network-Assisted Fourier Transform Infrared Spectroscopy, *Journal of Clinical Microbiology*.
www.ncbi.nlm.nih.gov/pubmed/23658268