Understanding bacterial communities can help fight disease

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In nature bacteria rarely exist as lone cells. Most of the times they are found in communities known as biofilms. These biofilms forms on surfaces like rocks or wood or float on the surface of a liquid. Biofilms are a very good protection for bacteria against environmental threats, but also against antibiotics used to treat bacterial infections. When bacteria form biofilms within the human body they become very difficult to treat. Better knowledge about the components of biofilm can lead to new effective treatments of infections caused by biofilm forming bacteria. Using model organisms such as Escherichia coli and Bacillus subtilis to study the composition of biofilm helps to identify potential targets for treatment in other pathogenic bacteria that can cause disease in humans.

What is biofilm?

Biofilm is formed when bacteria come together and start to excrete sugars and proteins. This forms a coating which shields them from dangers in their environment such as dehydration and a lack of nutrients, but they also gain a good protection against antibiotics. Because of this bacterial biofilms are a problem for both the health care system as well as the industry. The bacteria excrete a wide variety of substances in their biofilm and between species these substances can vary greatly. The substances help give the biofilm a very complex structure which aids in the survival of the bacteria. The system for which the bacteria come together and excrete these substances are very complex and require careful regulation within the individual as well as communication within the population. One needs to understand these processes to be able to develop new treatments to be used in treating disease as well as help industry fight contamination.

Same same but different

The differences and similarities between biofilm formation in *Escherichia coli* and *Bacillus subtilis* has in the last 20 years become evident. What has been found is that although they excrete different substances into their biofilm, these substances have basically the same function within it. They both excrete sugars for protection and long, tough proteins for adhesion to surfaces and other cells. This is interesting since it shows that the bacteria uses different but still very similar substances to solve the same problem. The reason for why they need different substances is that the exterior of the two different species have a very different composition, namely their cell walls are very different. Proteins that are anchored to the outer surface of the cell therefor need to be different and other molecules that are excreted also needs to be different to pass through the different membranes.

All components matter

When looking at all of the different substances by themselves one thing becomes clear: they are all important for the structure of the biofilm. Biofilm has complex 3D-structure and works best when organized in that manner. It’s a maze of canals with a pillar formed exterior.

Bacteria lacking one compound can most often form biofilm but this biofilm will be flat, not have the complex pillar formed maze and will sometimes be very fragile. The bacteria in it will be protected, but not at all as well protected as they would have been if they had all their compounds. An interesting point is that bacteria lacking one compound can receive the compound from another bacteria and make the more complex biofilm. This is useful within the biofilm since the bacteria are living so close together. Missing one component doesn't mean that you can't be a part of the biofilm, you will just receive it from another cell. Example of biofilm on the surface of a liquid can be seen in Figure 1.

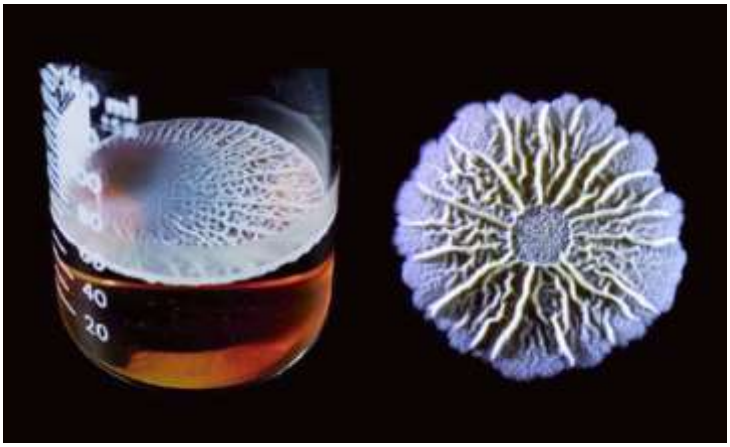

Figure 1. Bacteria that has formed biofilm on the surface of a liquid.

Regulation

The regulation between *E. coli* and *B. subtilis* differ. They both use a signaling system called quorum-sensing to communicate. They do this by excreting different molecules that other bacteria can sense and react to. When a bacteria senses the signal, it will swim to the source and start forming biofilm. *B. subtilis* has the ability form spores (inactive form of the bacteria which is much more protected) which *E. coli* don't, and *B. subtilis* has it's regulation of biofilm formation coupled with the regulation of forming spores. While *E. coli* has a different regulation system for every substance *B. subtilis* has a master regulator that controls much of the biofilm expression as well as spore forming.

The problem and the future

Bacteria more often than not form biofilms and in nature almost all bacteria live in biofilm. This because of the advantages biofilms give to the bacterial community, the most obvious advantage being protection. This protection is so good that bacteria that find their way into human environments, like hospitals and kitchens, can be very hard to get rid of. Bacteria in biofilm also show very high resilience against antibiotics. Therefor it is very important to understand the biofilm so new treatment that break down the biofilm can be developed, especially with the growing global problem of antibiotic resistant bacteria. Studies have come a long way of describing the different components in biofilm of several bacterial species, and also found ways how bacteria break down their own biofilm. This gives confidence to the struggle of finding ways to live along side of bacteria in the future.

For more reading see "Biofilmens sammansättning: En jämförelse mellan *Escherichia coli och Bacillus subtilis*".