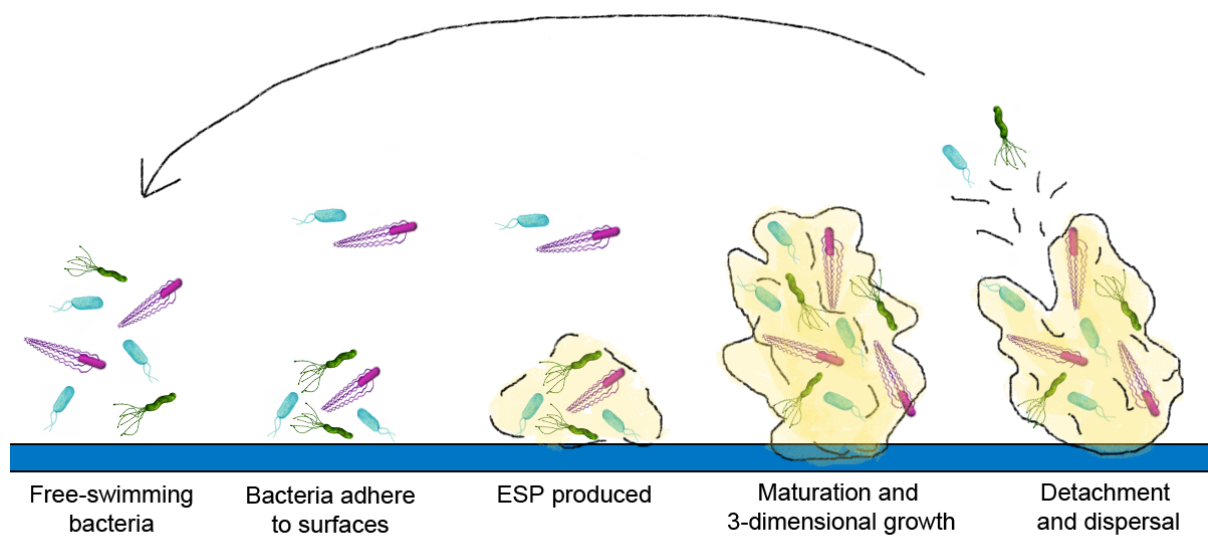


## Biofilms

Biofilms are communities of microbes that live on a variety of both natural and manmade surfaces. You have probably encountered biofilms before – the dental plaque that forms on your teeth and causes cavities is an example of one. So is the film that you scrub off your toilet bowl!

We have called biofilms ‘bacterial cities’ because it’s a good illustration of what a biofilm is – lots of different types of bacteria and other microbes growing together on a surface, cooperating and even communicating with one another in order to maximise their chances of survival.



## Why are biofilms important?

Biofilms give bacteria protection from outside elements; a biofilm forms when bacteria attach to a surface and then produce a sticky, sugary matrix known as "extracellular polymeric substances" (EPS). The EPS surrounds the bacteria and allows them to form three-dimensional colonies which are protected against things that would otherwise kill them, like antibiotics. It has been shown that biofilms are resistant to doses of antibiotics over 1000 times stronger than

those needed to kill free-floating bacteria! They also make it harder to remove the colonies with physical force, like with a toothbrush or toilet brush. Our hands-on '**Blast a Biofilm**' activity will model the differences between removing bacteria without EPS vs biofilm colonies with EPS matrix protecting them. One is much easier than the other!



Because biofilms make bacterial colonies so resilient, they can cause problems when they grow where they shouldn't be. This can happen in industrial systems like drains, pipes and other manufacturing equipment, or in biological systems like the human body, including medical hardware like heart valves, catheters and hip replacements.

However, not all biofilms are harmful. People have learned how to use biofilms for beneficial purposes, including the treatment of wastewater and even cleaning up oil spills. Because the biofilms are made up of bacteria that consume organic (carbon-based) waste, they are very good at cleaning debris and oil out of their environments.



## Health and Hygiene

The human body contains many different types of microbes, and most of these are beneficial – they help our bodies carry out the tasks it needs to in order to



function well. Sometimes, however, bacteria and other microbes grow too much and cause infection or other negative results. Though we can treat infections with antibiotics biofilm formation makes the bacteria much harder to kill, which means infections can last longer and become more serious.

Understanding how biofilms work is important so that we can treat things like catheter infections, ear infections, and diseases like cystic fibrosis.

## Biodiversity



Although you can have biofilms of just one type of bacteria it is far more common to find biofilms made up of many different types of microbes living together! Dental plaque can be made up of hundreds of different species of bacteria, just like a city is made up of lots of different types of people.

Interactions between the different species can either involve competition for resources (antagonistic) or working together (synergistic). Learning how these species interact may allow scientists to create biofilms for specific purposes such as industrial waste filtering or help them learn how to combat hard-to-treat infections.

## Communication

Because the bacteria in biofilms are packed so closely together they are able to communicate by sending chemical signals which travel from microbe to microbe, like letters sent through the post. This is called quorum sensing and it only happens when bacteria are in close proximity, like in a biofilm.

One example of quorum sensing is with the bioluminescent bacteria *Aliivibrio fischeri*, which lives on the Hawaiian bobtail squid. Because the glow given off by the bacteria is impossible to see on its own, it uses quorum sensing to communicate that there are lots of bacteria gathered together before it starts to glow, therefore not wasting effort or energy.



## **Biofilms in the classroom**

### Model a biofilm

- Make a model of a biofilm community out of creative materials – why not try jelly as the EPS matrix?

### Make a health education poster

- Biofilms affect human health in a variety of ways – help everybody stay healthy with an informational poster!

### Spot a biofilm – take a picture and tweet it!

- If you see a biofilm ‘in the wild’ (or in your house!) tweet us a picture at @bacteriacities or post on Facebook at:  
<https://www.facebook.com/bacteriacities>

### Grow your own

- Grow your own biofilms by submerging slides or plates in a pond. Pull it out and chart its growth and the biodiversity of the many species you’ll find.

### Dental plaque tablets

- See the biofilms growing on your teeth by chewing a dental plaque tablet. Have more than you like? Try brushing it off and see how well you do.

For more microbe activities visit:

<http://www.lifesci.dundee.ac.uk/impact/schools-outreach/schools-resources>

Please share your biofilm investigations and discoveries with us on Twitter or Facebook – we are keen to see your creativity and scientific knowledge at work!