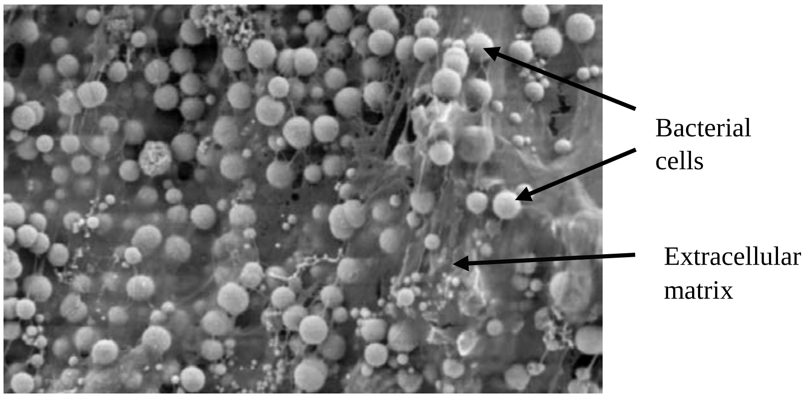
BIOFILMS- A FRIEND OR FOE?

Dinusha Kanatiwela
Board of Study in Plant Sciences

What is a biofilm?

A biofilm is basically defined as a structured community of microbial cells enclosed in a matrix of extracellular polymeric substances (EPS), growing on a biotic or abiotic substrate.

However, the best and the simplest definition given for a microbial biofilm has been put forward by Watnick and Kolter, in 2000 who have defined biofilms as "city of microbes" (Watnick and Kolter, 2000). They have described several similarities between a biofilm and our own city in terms of colonization, development, structure and function. The very first step in human colonization is the selection of a proper city which is followed by the selecting neighborhood which fulfills our requirements. Once we find a suitable place, we make our own home amongst many others and become stable. With time, a city becomes a heterogeneous complex and a stable structure which encompass various types of people, mode of transport, etc. These steps are common to the colonization of microbes, in which they first choose a suitable substrate (biotic / abiotic) in a suitable environment where they can get stabilized. This is followed by producing microcolonies, secreting different extracellular material to produce a complex, three dimensional robust structure in which they use water channels to transport nutrients and other waste products.



Scanning electron microphotograph of a bacterial biofilm
(http://dujs.dartmouth.edu/wp-content/uploads/2009/11/biofilm2_cmyk.jpg)

Where do we find biofilms?

Biofilms are ubiquitous in nature. They can be found in any place where conditions are favorable for their colonization. Living tissues, medical devices, industrial or potable water system piping, or natural aquatic systems or any other damp places are ideal residences for microbial colonization.

Biofilms – friend or foe?

<u>Friendly biofilms</u>

Biofilms play the role of 'the best friend' of engineers who develop water treatment systems. Microbial communities which comprise of bacteria, fungi, algae, and protozoa are utilized to breakdown pollutants in waste water through oxidation of organic particles and nitrification of ammonium (Nicolella *et al.*, 2000). The same phenomenon is adopted in bioremediation, such as cleaning oil spills (Tribelli *et al.*, 2012).

Farmers are benefitted by biofilms. Increased N_2 fixation in soybean has been observed when fungal-*Rhizobium* biofilms were applied than the single inoculation with *Rhizobium* sp. Phototrophic biofilms also provide benefits to the agricultural field in numerous ways. Increased water holding capacity in soil by extracellular matrix of algal and cyanobacterial biofilms, use of cyanobacterial biofilms as soil fertilizers are some of the examples (Roeselers *et al.*, 2008).

In industry, biofilm reactors are used in the production of value added products, such as ethanol, acetic acid, fumaric acid, lactic acid, citric acid cellulose, amylase and lipase (Qureshi *et al.*, 2005).

Enemy biofilms

Unwanted biofilms create enormous problems in various areas including medical, environmental and industrial fields.

In healthcare fields, microbial colonization is of great concern since a vast spectrum of hospital-acquired human infections are due to the development of either bacterial, fungal or mixed biofilms. Systemic implanted devices *viz*. intravascular or urinary catheters, endotracheal tubes, or dental prosthesis provide excellent substrates for the establishment of biofilms which lead to various secondary infections in the host body. Contact lenses and dentures are superficial devices which may harbor biofilms resulting in ocular diseases and denture stomatitis. Dental plaques, which are the yellow colour slimy deposits in the tooth surface are frequently found amongst people with poor oral hygiene. These dental plaques consist of a mixture of microbial biofilms, mucus and food material. Sometimes effects of these robust microbial communities can also be life threatening. Colonization of microbes on native heart valves is one such example which may collapse the function of the heart. The threat posed by biofilms in medicine is their high resistance to the antimicrobials making the treatment of biofilm-associated infections challenging (Cernohorska and Votava, 2002; Bryers, 2008).

Biofilms have negative effects on industrial systems such as equipment, pipe systems used to transport resources and air ventilation systems. Enhanced material deterioration (biofouling), accelerated corrosion and increased fluid frictional resistances resulted by biofilms microbial colonization in industrial ventures are responsible for a waste of over billion dollars per year. Additionally, biofilms associated with food industry, pharmaceutical industry and water filtration and transporting systems may harbor pathogenic microbes. Possible health risk to consumers due to product contamination by those pathogenic organisms cannot be ignored (Coetser and Cloete, 2005; Schlegelova and Karpiskova, 2007).

Thus, some of the biofilms which exist in nature act as friends while some act as enemies**.** Hence, currently a large number of research studies are in progress to identify the control strategies to battle with bad biofilms and also to discover possible benefits of good biofilms which still remain unexplored.

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