

**Springer Series on Biofilms**  
Volume 6

Series Editor: J. William Costerton  
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Editors

# **Biofilms and Veterinary Medicine**

 Springer

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ISBN 978-3-642-21288-8 e-ISBN 978-3-642-21289-5  
DOI 10.1007/978-3-642-21289-5  
Springer Heidelberg Dordrecht London New York

Library of Congress Control Number: 2011935431

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*Steven L. Percival would like to dedicate this book to a number of people who have provided support, guidance and reassurance throughout the 20 years he has been studying and researching microbiology and biofilms. These include Carol, Alex, Tom, Mum, Dad, Nigel, Emma, Jorge, Sam, Elisha and Kara.*

*Christine A. Cochrane would like to dedicate this book to Paul (for your constant support and encouragement), our sons Paul and Mark and grandchildren Jennifer and Callum. Finally, to my Mother Betty who never doubted my ability to become a scientific researcher.*



# Preface

Imagination should give wings to our thoughts but we always need decisive experimental proof, and when the moment comes to draw conclusions and to interpret the gathered observations, imagination must be checked and documented by the factual results of the experiment. (Pasteur L)

Louis Pasteur (1822–1985) was an amazing, persevering, perceptive and determined scientist who today is widely regarded as the father of the “Germ Theory” and bacteriology. He is revered for possessing the most important qualities of a scientist: he had an unrivalled ability to scrutinise data on almost any subject and then to develop profound and often fundamental questions from them. He had an uncanny ability to identify the solutions to problems based on analytical scrutiny of data – even without any of the sophisticated statistical tools we have today. He possessed an almost unique and certainly an enviable reputation for patience and drive to research under strictly controlled conditions regardless of the contemporary scepticism that accompanied the current dogma. These are also the characteristics of the scientists who have taken on the needs associated with biofilm research in the modern era. While Pasteur was not the first to propose that disease was the result of pathogenic microorganisms, he developed the principals and theories and conducted the experiments that clearly indicated their relevance.

Since the advent of the antibiotic age man has sought to find “chemical” strategies to overcome pathogens in particular. These have also involved the “devious” manipulation of the immune system through the development of vaccines and hyperimmune sera. The immune stimulating approach to disease is “super-efficient” in that the various cascades of the cellular and humoral immune systems are mobilised specifically at target organisms and in this process, there are a few adverse side effects. The organisms have difficulty overcoming the amazing versatility and target accuracy of the immune system. This results in prevention of disease in the case of vaccine production and/or the limitation of a disease to the extent that the pathogen causes mild or sub-clinical changes. In the event that a pathogen is introduced into a totally susceptible host, there is a race between the immune system and its attempts to both overcome and to eliminate the pathogen and the pathogen’s own ability to trigger inflammatory, cytopathic, toxic or other

damaging processes. Viruses, bacteria, fungi, yeasts, protozoa and parasites are all capable of causing disease and the survival of any species is surely a testament to the “innate” and “acquired” immune systems that through evolution have developed strategies to at least limit the damage and in many cases to prevent any effect whatever. However, when an infection challenges a naive host, there is a significant delay in the mobilisation of the immune systems resources. During this time, disease can develop and so the objective of modern medicine (including the veterinary and related science and biological professions) is to try to limit the effects of the infection without harming the host animal. Having been exposed to a disease the immune system will react in a co-ordinated fashion to ensure that the disease is as short and as mild as possible and so antimicrobial drugs in these situations would become largely unnecessary.

It is widely accepted that antimicrobial drugs (whether antiviral, antibacterial, antifungal, or antiprotozoal or antiparasitic) are inherently flawed as a long-term strategy for controlling and treating disease because of the evolutionary pressure that will inevitably result in resistance. The concept that “there is an antibiotic that will work if the dose is high enough” is definitely counter to all principles of antimicrobial therapy, and yet it is one of the commonest approaches. It is born out of frustration and lack of understanding as to why bacteria can survive against all the odds. It is surely far better to understand the reasons for failures of efficacy and to address these specifically than it ever is to simply add more and more antibacterial drugs! Whilst there is no doubt at all that antimicrobial strategies have reduced the incidence of disease and reduced the duration of illness associated with infections, the rate of new-molecule development has not kept pace with the ability of the microorganisms to resist them. In many circumstances, failure of efficacy is simply blamed on “resistance” but it is clear from biofilm research that there is much more to “resistance” than meets the eye. The spectrum of drugs used in veterinary species is relatively narrow – a few antibiotics (largely those that are not used in human’s medicine!) are used widely. Veterinarians have taken their responsibility for rational use seriously and it is unfair to blame the veterinary profession for the development of antibiotic resistance. There are certainly specific circumstances when antibiotics and the hosts’ own immune and reparative processes fail to control infections and one of the most interesting of these is the development of biofilms that protect and “shield” the organisms from potentially damaging environmental and host defences. Biofilms are the most common mode of bacterial growth in nature and are highly resistant to antibiotics.

Biofilms are implicated in many common medical problems including urinary tract infections, catheter infections, middle-ear infections, dental plaque, gingivitis, and some less common but more lethal processes, such as endocarditis, infections in cystic fibrosis. However, biofilms have only recently been given their true importance in the overall process of disease pathogenesis. Bacterial biofilms are one of the fundamental reasons for incipient wound healing failure in that they may impair natural cutaneous wound healing and reduce topical antimicrobial efficiency in infected skin wounds. Their existence explains many of the enigmas of microbial infection and a better grasp of the process may well serve to establish a different



approach to infection control and management. Biofilms and their associated complications have been found to be involved in up to 80% of all infections. A large number of studies have been performed targeted at the bacterial biofilms and many of these are referred to in this book, which is the first of its kind. These clinical observations emphasise the importance of biofilm formation to both superficial and systemic infections and the inability of current antimicrobial therapy to “cure” the resulting diseases even when the *in vitro* tests suggest that they should be fully effective.

In veterinary medicine, the concept of biofilms and their role in the pathogenesis of disease has lagged seriously behind that in human medicine. This is the more extraordinary when one considers that much of the research has been carried out using veterinary species in experimental situations. The clinical features of biofilms in human medicine are certainly mimicked in the veterinary species but there is an inherent, and highly regrettable indifference to the failure of antimicrobial therapy in many veterinary disease situations and this is probably at its most retrograde in veterinary wound management.

Leahurst, UK  
March 2011

Derek C. Knottenbelt



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