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The biophysics of infection.

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Abstract

Our understanding of the processes involved in infection has grown enormously in the past decade due in part to emerging methods of biophysics. This new insight has been enabled through advances in interdisciplinary experimental technologies and theoretical methods at the cutting-edge interface of the life and physical sciences. For example, this has involved several state-of-the-art biophysical tools used in conjunction with molecular and cell biology approaches which enable investigation of infection in living cells. There are also new, emerging interfacial science tools which enable significant improvements to the resolution of quantitative measurements both in space and time. These include single-molecule biophysics methods and super-resolution microscopy approaches. These new technological tools in particular have underpinned much new understanding of dynamic processes of infection at a molecular length scale. Also, there are many valuable advances made recently in theoretical approaches of biophysics which enable advances in predictive modelling to generate new understanding of infection. Here, I discuss these advances, and take stock on our knowledge of the biophysics of infection and discuss where future advances may lead.

Key words: Single-molecule biophysics, super-resolution

1. Introduction

This volume in the Advances in Experimental Medicine and Biology series consists of a collection of truly cutting-edge research studies, laboratory protocols, experimental and theoretical biophysical techniques and applications in use today by some of the leading international experts in the field of infection research. A key difference in emphasis with this volume compared with other earlier themed collections of infection research is on the emphasis on the utility of *interfacial methods* which increase the underlying physiological relevance of infection investigation. These developments are manifest through applying methods such as *single-molecule cellular biophysics* which strive to maintain the native physiological context through investigation of living cells (1), especially experimental methods using emerging tools of optical microscopy (2), as well as methods which combine *in vivo*, *in vitro* and computational approaches to probe biological process such as the interaction of proteins with DNA (3), such as the use of fluorescence microscopy methods to probe functional, living cells, especially so using microbial systems as model organisms (4-14). The length scale of precision of experimental protocols in this area has improved dramatically over recent years and many cutting-edge methods now utilize state-of-the-art single-molecule approaches, to enable imaging of biomolecule structure to a precision better the standard optical resolution limit (15), as well as emerging biophysics tools which use single-molecule force spectroscopy (16-20). This volume also includes more complex representative methods to investigate infection through the use of advanced mathematical analysis and computation.

It is clear is that combining pioneering molecular biology, biochemistry, structural biology and genetics methods with emerging, exciting tools from the *younger* areas of biophysics, bioengineering, computer science and biomathematics, that our understanding of the processes of infection are being transformed. Improvements in all of these fields are likely to add yet more insight over the next years in the near future into the complex interactions between multiple key molecular players involved in infection.

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