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Contributions to Microbiology

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Bacterial Sensing and Signaling

Volume Editors

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Contents

VII  Foreword  
Collin, M. (Lund); Schuch, R. (New York, N.Y.)

1  Chemical Interactions between Organisms in Microbial Communities  
Duan, K. (Calgary, Alta./Xian, Shaanxi); Sibley, C.D. (Calgary, Alta.); Davidson, C.J. (East Lansing, Mich.); Surette, M.G. (Calgary, Alta.)

18  Autoinducer-2-Based Chemical Communication in Bacteria: Complexities of Interspecies Signaling  
Federle, M.J. (Chicago, Ill.)

33  The Molecular Basis of Excitation and Adaptation during Chemotactic Sensory Transduction in Bacteria  
Rao, C.V.; Ordal, G.W. (Urbana, Ill.)

65  Bacterial PEP-Dependent Carbohydrate: Phosphotransferase Systems Couple Sensing and Global Control Mechanisms  
Lengeler, J.W. (Magdeburg); Jahreis, K. (Osnabrück)

88  Correlations between Carbon Metabolism and Virulence in Bacteria  
Poncet, S.; Milohanic, E.; Mazé, A.; Nait Abdallah, J.; Aké, F. (Thiverval-Grignon); Larribe, M.; Deghmane, A.-E.; Taha, M.-K. (Paris); Dozot, M.; De Bolle, X.; Letesson, J.J. (Namur); Deutscher, J. (Thiverval-Grignon)

103  Stand-Alone Response Regulators Controlling Global Virulence Networks in Streptococcus pyogenes  
McIver, K.S. (College Park, Md.)

120  The Heme Sensor System of Staphylococcus aureus  
Stauff, D.L.; Skaar, E.P. (Nashville, Tenn.)

136  Bacterial Sensing of Antimicrobial Peptides  
Otto, M. (Bethesda, Md.)

150  RNA Thermosensors in Bacterial Pathogens  
Johansson, J. (Umeå)

161  Prevailing Concepts of c-di-GMP Signaling  
Römling, U.; Simm, R. (Stockholm)

182  Magnetosomes and Magneto-Aerotaxis  
Frankel, R.B. (San Luis Obispo, Calif.); Bazylinski, D.A. (Las Vegas, Nev.)
194 Engineering Bacterial Signals and Sensors
   Salis, H.; Tamsir, A.; Voigt, C. (San Francisco, Calif.)

226 Author Index
227 Subject Index
Foreword

Over the last 10–15 years, the study of how bacteria sense their environment and respond accordingly has emerged as a focal point in the field of microbiology. Not surprisingly, the bacterial adaptive response is now described by a panoply of interesting mechanisms, signals, behaviors, etc., involving everything from the movement of flagella to the formation social groupings. *Bacterial Sensing and Signaling*, a volume of the Karger book series *Contributions to Microbiology*, was initiated with the hope of introducing the results of state-of-the-art research from internationally recognized experts.

Chemical communication is undoubtedly the best-studied mechanism for passing information between bacterial organisms and coordinating their behavior. As such, Duan et al. begin the first section of this book with an introduction to the distinct array of chemical signals that shape bacterial community relationships. Michael Federle then follows with a description of his work on one such signal, termed autoinducer-2, with a focus on its role in cell-cell communication (or quorum sensing) among different bacterial species and the mechanism by which such a signal is transduced across the bacterial membrane.

In keeping with the theme of signal transduction, Rao and Ordal next present a comprehensive review of the molecular mechanisms by which individual bacteria sense environmental attractants and repellents and transduce this information to the flagellar motor to evoke a locomotive response (chemotaxis). Chemotaxis is the most thoroughly understood bacterial adaptive behavior, and its description serves to introduce the roles of bacterial two-component and phosphotransferase systems (PTSs) systems in signal transmission and the processes of receptor multimerization and methylation that allow response adaptation. The importance of PTSs in the coupling of sensory and regulatory mechanisms is further pursued by Lengeler and Jahreis, who describe both the rapid chemotactic responses to carbohydrates and the delayed responses associated with catabolite repression, as well as the concepts adaptation, memory, and learning associated with these signaling systems.
The next several chapters are devoted to studies of bacterial virulence and in particular, the mechanisms of host detection, nutrient acquisition and host-defense avoidance. Poncet et al. begin with a description of how the PTS-mediated carbohydrate signaling pathway responds to host-specific conditions and drives virulence factor expression in both Gram-positive and Gram-negative pathogens. Kevin McIver follows with a review of the so-called stand-alone response regulators of the human pathogen Streptococcus pyogenes that serve to fine-tune virulence factor expression at appropriate times during infection. Stauff and Skaar then detail a heme-sensing two-component system that communicates with transmembrane channel proteins (ABC transporters) in pathogenic staphylococci and related Gram-positive bacteria. This mechanism allows bacteria to acquire essential iron from host hemoglobin and avoid the toxic effects of heme. In the subsequent chapter, Michael Otto covers how bacterial pathogens adapt to the human host by responding to human antimicrobial peptides (AMPs). Here, the author discusses how two-component systems induce expression of resistance mechanisms against AMPs and how antimicrobial compounds are themselves signaling molecules.

The next three chapters present some of the more unusual and novel aspects of bacterial signaling and sensing processes identified this far. In his chapter, Jörgen Johansson introduces RNA thermosensors and the principles by which environmental temperature controls access to RNA expression signals and regulates virulence gene expression in a variety of human pathogens. Römling and Simm describe the current knowledge about the signaling molecule cyclic-di-GMP (in fact a small cyclic RNA) required for many bacterial responses including virulence regulation and the transition between sessility and motility in bacteria. Next, Frankel and Bazylinski review the intriguing field of magneto-aerotaxis which is based on the use of magnetic nanoparticles (magnetosomes) in the bacterial cytoplasm that serve to orient bacteria and ensure migration within geomagnetic fields and maintenance of positions within favorable oxygen concentrations.

The last chapter, by Salis et al., describes how the individual abilities of bacteria to sense and alter their environment can be harnessed for bioengineering applications. By incorporating these capabilities into synthetic gene networks, bacteria can actually be ‘programmed’ for specific interactions and functions in the physical world.

We thank all of the authors who contributed to this volume. They have provided us with comprehensive, interesting, and well-written chapters despite numerous other duties and engagements. We further thank the series editor Dr. Heiko Herwald for initiating this volume and Mr. Thomas Nold from Karger Publishers for helpful assistance and encouragement.

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