THE FIELD OF ANTIBIOTICS


Bacteria and Antibacterial Agents, one of three books in the Biochemical and Medicinal Chemistry Series published by Spektrum Academic Publishers, provides a concise introduction to the field of antibiotic chemistry and biological activities. The content is suitable for readers in both the chemical and biomedical disciplines, although it will be best appreciated by readers who have had introductory organic chemistry and some exposure to basic microbiology.

The book is divided into six chapters: microorganisms and disease; the structure of bacteria and their metabolic pathways; the sites of action of antibacterial drugs; biosynthesis and mode of action of ß-lactams; bacterial resistance to antibiotics; and new antibiotics and new strategies. It is amply illustrated with many chemical structure drawings and an electron micrograph, and it contains a list of up-to-date articles for additional reading as well as an index.

The authors begin with an interesting historical summary of the development of antibiotics, beginning in the mid-nineteenth century and including the contributions of Agostino Bassi, Louis Pasteur, M. J. Berkeley, J. L. Schönlein, Joseph Lister, Robert Koch, Paul Ehrlich, Gerhard Domagk, Donald Woods, Alexander Fleming, Charles Horey, Dorothy Hodgkin, John Sheehan, Selman Waksman, and others. This material introduces the reader to the classical antibiotics: sulfonamides, penicillins, and cephalosporins.

The next section provides a basic, generalized outline of major bacterial structures, including cell walls and membranes. It also includes information about bacterial growth and the regulation of biosynthesis.

Next comes a description of the cellular targets of antibodies and their modes of action. These mechanisms include interfering in metabolic pathways, disrupting the cytoplasmic membrane, and inhibiting protein, nucleic acid, or cell wall biosynthesis. Antibiotics mentioned in this section include compounds that interfere with metabolism (sulfonamides [sulfamethoxazole and trimethoprim], ß-aminosalicylic acid and Salvarsan), protoplast membrane binding agents (hexachlordrophenone, tyrocidin A, gramicidin S, polymyxins, vanomycin, macrolide antibiotics [monensin A and nigericin], polypeptide antibiotics [amphoterin B and nystatin]), protein biosynthesis inhibitors (aminoglycosides [streptomycin, gentamycin, neomycin, kanamycin, and kasugamycin], tetracyclines, thiopeptides, and puromycin), nucleic acid synthesis inhibitors (ansamycins [rifampicin A and streptovaricin A], streptolydigin, 3'-deoxyadenosine, nalidixic acid, novobiocin, hydroxyphenylazopyrimidines, and chloroquine), and cell wall biosynthesis inhibitors (cyclodexrine, vancomycin, rifostacin, bacitracin, and penicillins).

The following chapter is devoted to both the biochemical and chemical syntheses of the ß-lactam antibiotics (penicillins [e.g., penicillin G, penicillin V], cephalosporins [e.g., cephalosporin C, cepalexin], and cephamycins [e.g., cephemycin C]). This chapter also mentions the role and importance of the fungal Penicillium acylase and transacylase enzymes in biosynthesis of these compounds. As the authors discuss, the ß-lactam antibiotics' modes of action include the inhibition of cell wall peptidoglycan synthesis by inactivation of a bacterial transpeptidase and the inactivation of penicillin-binding proteins.

The authors devote a chapter to bacterial resistance to antibiotics. They discuss how several species of bacteria (e.g., Staphylococcus) have rapidly become resistant to several types of antibiotics and how the imputude of these compounds contributed to the evolution of resistance. The biochemical bases of resistance—modification of the target site or enzyme, prevention of antibiotic access, and the production of enzymes that destroy or inactivate the antibiotic—are described and illustrated by reference to the ß-lactamases and chloramphenicol acetyl transferase. The chapter concludes with a description of the genetic basis of antibiotic resistance, that is, the transfer of resistance genes on plasmids between bacteria via transduction or conjugation.

The book ends on an optimistic note, with examples of how the growing problem of bacterial resistance is being met by the production of new ß-lactam antibiotics and quinolones by the pharmaceutical industry and through the discovery of new types of antibiotics, such as the antimicrobial peptides. This section is weighted perhaps too heavily toward the ß-lactam antibiotics; only one paragraph mentions the recently discovered naturally occurring gene-encoded peptide antibiotics (e.g., cepropins, magamin, and defensins).

It would have been helpful if the authors had included a summary.

Chemical ecology is a biological discipline that is only now coming of age. Revealing how organisms use chemicals in their interactions with members of their own and different species, and in their responses to the physical environment, chemical ecology has roots dating back far. However, it was not until roughly 30 years ago that this venture joining ecologists, behaviorists, and physiologists, along with chemists, began to take firm hold, as evidenced by several seminal publications. Today the field continues to grow: many works and symposia appear annually, and two journals (Journal of Chemical Ecology and Chemobiology) are devoted specifically to the topic. Perhaps the surest sign that chemical ecology has matured is the recent publication of its first extensive popular account, Bombardier Beetles and Fever Trees by William Agosta of The Rockefeller University. Agosta provides an accessible introduction that—by virtue of chemical ecology's interdisciplinary character, its focus on fascinating aspects of the natural world, and its emerging importance in the campaign to preserve biodiversity—should appeal to a wide audience.

The title Bombardier Beetles and Fever Trees is reflective of two main streams that meander, often intersecting, throughout the book. The first is a discussion of organisms and their use of chemicals in ecological interactions. Here the focus is on the natural phenomena themselves; presented are the results of basic research such as that elucidating the explosive chemical defense of bombardier beetles. The second stream is more applied. It examines how we humans, for our own purposes, use chemicals derived from biological sources, and it includes examples such as the historical and continued significance of quinine—the antimalarial agent—originating from South American cinchona trees.

In examining how organisms themselves use chemicals, Agosta organizes the book around three categories of compounds, based on their ecological roles: those involved in chemical warfare, those that serve in communication, and those that play a central role in defining an organism's lifestyle. The first part deals primarily with chemical defenses used by creatures as they contend with predators, pathogens, and competitors. Plants, animals, and microbes each have a chapter devoted to their chemical protection. In the plant chapter (chapter 2), the defensive role of secondary metabolites, including photo-activated toxins and mimics of herbivore hormones, is presented, along with the notion that plants may actually recruit aid from their consumers' enemies. In the animal chapter (chapter 3), attention is paid to the de novo synthesis of the defensive compounds, but the focus is on how animals often usurp existing defensive chemicals from other organisms. While recognizing that fungi, bacteria, and other microbes are chemically rich, Agosta rightly points out that knowledge of the actual ecological roles of microbial toxins lags behind our understanding of the defenses of plants and animals. Hence, the microbial chapter (chapter 4) leans more toward applied aspects of their chemical ecology. It describes the development of antibiotics and antihelmethics from fungal metabolites, while also covering microbial toxins that adversely impact humans.

Chemicals involved in communication are examined in two chapters—chapter 7, focusing on intraspecific communication, and chapter 8, on interspecific communication. Pheromones, intraspecific molecular messengers, are introduced with chemical, behavioral, and neurophysiological discussion of moth sex attractants. The human deployment of these signals in attempts to control agricultural pests is mentioned. Further, in an examination of pheromonal communication in vertebrates, including humans, cautious attention is paid to recently developed perfumes purported to contain human pheromones. In the chapter directed at interspecific communication, topics include how predators use chemical cues to lure or otherwise locate their victims, and how mutualism and parasitism are often chemically mediated. The chapter has a strong applied bent, showing how an understanding of chemical cues is being used to develop methods of controlling two devastating parasites, witchweed (Striga spp.), a parasitic plant affecting tropical agriculture, and blood flukes that cause schistosomiasis in people.

Additionally, chapter 6 is devoted to what Agosta calls "life style" chemicals, compounds that "facilitate or sustain an organism's particular way of life." Examples addressed include the molecules behind bioluminescence, compounds serving as antifreeze in antarctic fauna, and the proteins comprising spider silk and adhesives produced by marine invertebrates. One could view this chapter as dealing with ecological materials science, and, not surprisingly, applied ramifications are considered.

Clearly, the topic of human application of nature's chemicals has emerged regularly, even through these basic chapters. However, two additional chapters (chapters 5 and 9) focus on that subject. The first deals with the long, rich history of humanity's use of medicines and drugs derived from plants. It also examines the possibility of zoopharmacognosy: Growing evidence suggests that animals, as well