Preface

All living organisms are in a constant battle against their environment. Since uncontained microorganisms would simply overgrow all higher animals, from the beginning of the evolution of multicellular organisms the need was clearly evident for adequate and efficient defense mechanisms to protect their own integrity and to ensure their own survival. Usually, the first encounter with pathogens occurs at epithelial interfaces, which present the first barrier against invading pathogens and already comprises a number of mechanical and chemical defense mechanisms. However, in addition to these passive mechanisms an arsenal of active weapons also evolved. As it turned out, some of them were so efficient that basically all organisms rely at least partly on them: there is no known species that does not produce antimicrobial peptides, which represent very likely the most ancient immune defense molecules and the most common effector molecules of the innate immune response.

Over recent decades, the appreciation of the innate immune system has vastly increased. A pivotal event and possibly the beginning of the modern era of innate immunity was Charles Janeway's opening lecture at the annual Cold Spring Harbor Symposium of Quantitative biology in 1989. He hypothesized that recognition of certain patterns or characteristics of infectious microorganisms through pattern recognition receptors whose specificity is "hard-wired" into the genome is vitally important for the immune response. However, it took about seven years before the involvement of the *Drosophila* Toll protein in the immune response was discovered by Jules Hoffmann's group in Strasbourg. One year later, the first human counterpart was discovered by Medzhitov and Janeway and the era of mammalian Toll-like receptors and the search for their ligands began.

Finally, people began to understand just how specific the so-called "unspecific" innate immune response really is. Since then, these receptors has been found and investigated in many species. It became clear that in higher animals the innate and the adaptive immune system is strongly intertwined and that the activation of the innate immune system is required for the activation of adaptive immune system. However, one has to remember that for many species the innate immune system is the sole active defense system and that it comprises many more mechanisms than only the detection of pathogen-associated molecular patterns through Toll-like receptors.

This book wants to give an overview of our current knowledge about the innate immune system of plants, animals and humans. In the first six chapters, the innate immune mechanisms and responses of so diverse organisms such as plants, Cnidaria, *Drosophila*, urochordates and zebrafish are presented and reviewed in great detail. Shunyuan Xiao presents an overview about the evolution of plant resistance genes, which evolved as a response to the recognition of pathogen effector proteins in plants. The next chapters cover organisms that are at critical places on the evolutionary tree. First, Thomas C.G. Bosch et al. provide fascinating information about one of the earliest multicellular species, the ancient group of Cnidaria, which diverged from the so-called Bilateria long before insects and worms evolved. Since the innate immune system of the fruitfly *Drosophila melanogaster* is among the best studied of all species, two chapters cover the field. Neal Silverman's group discusses the molecular mechanisms of pathogen recognition and signal transduction that leads to the elimination of invading microbes, whereas the group of Louisa Wu further elucidates two very important aspects of the cellular innate immunity: the encapsulation and phagocytosis of pathogens by *Drosophila* hemocytes. Next, Konstantin Khalturin et al. present an overview of the innate immune responses of the urochordates, which present the vertebrates closest relatives and thus provide insight into innate immune mechanisms just before the sudden appearance of adaptive immunity. Moving along the evolutionary tree, Con Sullivan and Carol H. Kim provide a review about innate immune responses of the zebrafish, *Danio reo*. In contrast to all species covered so far, the zebrafish is the first species that in addition to its innate immune defenses also contains an adaptive immune system.

The last four chapters deal with different aspects of the mammalian innate immune system: Andrei Medvedev and Stefanie Vogel provide detailed information about the human and mouse Toll-like receptor (TLR) family including their ligands and signal transduction. Besides the family of TLRs that all are expressed on cell or endosomal membranes, a new family of intracellular and cytosolic pattern recognition receptors has recently emerged. Named after the unifying expression of the nucleotide oligomerization domain (NOD) and with respect to the TLRs the members of this family are called NOD-like receptors. This family consists of 22 members and a number of mutations have been found in these proteins that are surprisingly often linked to inflammatory diseases.

Finally, two chapters present the major effector mechanisms of the innate immune system: Regine Gläser, Jürgen Harder, and Jens-Michael Schröder provide an up-to-date overview about human antimicrobial peptides; and Bob Sim et al. review the complement system.

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