Preface

For more than 100 years, the morphogen concept has captured the imagination of experimental and theoretical biologists alike. The possibility that a single diffusible molecule could specify and pattern many different cell fates was attractive for its simplicity and promised to open the door to a quantitative understanding of development. However, for many years, morphogens remained abstract concepts. Quantitative studies were impossible and although the ideas continued to be discussed, they had limited practical use. Thanks in large part to the revolution brought about by molecular genetics, this situation changed in the late 1980s and early 1990s, when the molecular identities of several morphogens were revealed. With specific molecules in hand, biologists began to design rigorous tests of morphogen action, and were able to confirm many predictions from the past. Further developments in molecular biology and imaging have bolstered our ability to observe morphogens and to measure their effect on target gene expression and cellular responses. Consequently, the field now spans the whole biological scale, from experiments that track single molecules to tissue-wide analyses of cell behavior and even genomic screens.

Three main questions have been the focus of much work during the past decade: What are the mechanisms that ensure the formation of stable and reliable morphogen gradients? How do cells within a field assess their position by reading the local morphogen concentration? How are the graded responses of cells transformed into differential gene expression to control the fate and behavior of cells? These questions are the main subjects of this collection. The latest thinking about a variety of tissues patterned by morphogens is described and several authors have taken this opportunity to set these ideas in the historical context of the field. State-of-the-art experimental approaches in different model systems are introduced. We hope these will provide a reader new to the subject a sense of the field's diversity and also offer fresh inspiration to the seasoned morphogen researcher. In addition, we have taken advice from mathematically minded scientists who have made important contributions to our understanding of morphogens. Several contributions describe quantitative analyses of the formation and interpretation of morphogen gradients. Although these are sophisticated and rigorous, they are also accessible. Indeed, one of our aims has been to identify common ground for experimentalists and theoreticians, thus stimulating further exchanges between the two cultures. We believe such an active dialogue is now essential for further progress. It is only through these interactions that we will gain a better understanding of how the exquisitely patterned tissues that are the hallmark of embryogenesis are produced so reliably by the action of morphogens.

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James Briscoe
Peter A. Lawrence
Jean-Paul Vincent
London and Cambridge
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