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Biological Complexity and Integrative Pluralism

This fine collection of essays by a leading philosopher of science presents a defense of integrative pluralism as the best description for the complexity of scientific inquiry today. The tendency of some scientists to unify science by reducing all theories to a few fundamental laws of the most basic particles that populate our universe is ill-suited to the biological sciences, which study multicomponent, multilevel, evolved complex systems. This integrative pluralism is the best way to understand the different and complex processes – historical and interactive – that generate biological phenomena.

This book will be of interest to students and professionals in the philosophy of science.

Sandra D. Mitchell is Professor in the Department of History and Philosophy of Science at the University of Pittsburgh.

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For Joel Murray Smith, my inspiration

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Preface and Acknowledgments

This collection of essays defends integrative pluralism as the best description of the relationship of scientific theories, models, and explanations of complex biological phenomena. Complexity is endemic in biology, but it is constituted by various features of multicomponent, multilevel, evolved systems. The types of scientific representations and the very methods we use to study biological systems must reflect both that complexity and variety. Developing models of single causal components, such as the effects of genetic variation, or of single-level interactions, such as the operation of selection on individuals, give valuable, if partial, accounts. These explanations need to be integrated in order to understand what historical, proximal, and interactive processes generate the array of biological phenomena we observe.

Clearly, the way the world is dictates what we can say about it. The way our representations are structured also plays a significant role in the scientific accounts we develop. Theories and models are idealized, partial descriptions, couched in the conceptual frameworks of the day, framed in a language that carries meanings from the broader social context. The suggestion that our current best theories of the nature of nature exactly capture the world in all its details is hubris. The idealized and partial character of our representations suggest that there will never be a single account that can do all the work of describing and explaining complex phenomena. Different degrees of abstraction, attention to different components of a system, are appropriate to our varying pragmatic goals and conceptual and computational abilities. In short, both the ontology and the representation of complex systems recommend adopting a stance of integrative pluralism.

I have developed the ideas and arguments in this book over a period of fifteen years. There are many people who have had important influences on the way I think about these issues. Naturally, my early teachers in philosophy of science – Jim Bogen, Imre Lakatos, and Peter Machamer – get some of the

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blame. In addition, Nancy Cartwright has been both friend and mentor. The philosophical work of John Dupré, Elliott Sober, and Bill Wimsatt have also been stimulating.

My deepest thanks must go to Rob Page. We met in the 1980s at the Ohio State University where he was in the Department of Entomology. Rob has enormous enthusiasm for his science, astuteness in his research, and a desire to get it right. He has opened the door for me to get an inside look at biology at its best, and I have learned a great deal from him. Indeed, Rob is coauthor of Chapter 3, section 3.1, “The Evolution of Division of Labor,” and also of “Idiosyncratic Paradigms and the Revival of the Superorganism,” one of the papers on which Chapter 2, section 2.1, is based. The other scientists whose ideas have been important to my approach are Steve Gould and Stuart Kauffman.

I am grateful for the support and challenge provided by my colleagues and students at the University of Pittsburgh and previously at the University of California. In addition, the years I spent at the Center for Interdisciplinary Research in Bielefeld, Germany, and at the Wissenschaftskolleg in Berlin provided intellectual opportunities for which I am grateful. The Santa Fe Institute has also been a place for new ideas and new collaborations.

I thank Megan Delehanty, Dennis Pozega, and Melissa Wurster for help in the production of the book, and Michael Ruse for suggesting it in the first place.

I have dedicated this book to Joel Smith, my husband, my friend, and the best critic and supporter one could wish for.

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The introductions to each of the chapters have not been previously published. Also new for this volume is the first section of Chapter 1 and Chapter 6, section 6.1, “Critics of Unity of Science.” There are two sections that are the result of merging two previously published articles. Chapter 2, section 2.1, “Compositional Complexity and the Superorganism Metaphor,” is from Sandra Mitchell, “The Superorganism Metaphor: Then and Now,” in S. Maasen, E. Mendelsohn, and P. Weingart, eds., *Biology as Society, Society as Biology: Metaphors*, Yearbook in the Sociology of Science

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