Understanding How Science Explains the World

All people desire to know. We want to not only know what has happened, but also *why* it happened, *how* it happened, whether it *will* happen again, whether it can be *made* to happen or not happen, and so on. In short, what we want are explanations. Asking and answering explanatory questions lies at the very heart of scientific practice. The primary aim of this book is to help readers understand how science explains the world. This book explores the nature and contours of scientific explanation, how such explanations are evaluated, and how they lead to knowledge and understanding. As well as providing an introduction to scientific explanation, it also tackles misconceptions and misunderstandings, while remaining accessible to a general audience with little or no prior philosophical training.

Kevin McCain is Professor of Philosophy at the University of Alabama at Birmingham. His academic research interests lie in epistemology and philosophy of science, focusing on the role of explanatory reasoning in the production of scientific knowledge. He is the author of numerous articles and books, including *Uncertainty: How It Makes Science Advance* (Oxford University Press, 2019), *What Is Scientific Knowledge?* (Routledge, 2019), and *The Nature of Scientific Knowledge* (Springer, 2016).

The ***Understanding Life*** series is for anyone wanting an engaging and concise way into a key biological topic. Offering a multidisciplinary perspective, these accessible guides address common misconceptions and misunderstandings in a thoughtful way to help stimulate debate and encourage a more in-depth understanding. Written by leading thinkers in each field, these books are for anyone wanting an expert overview that will enable clearer thinking on each topic.

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"This engaging book effectively introduces a wide range of philosophical ideas about scientific explanation in an accessible way. It's attentive to nuances but avoids getting bogged down in details and debates."

Angela Potochnik, Professor of Philosophy and Director of the Center for Public Engagement with Science, University of Cincinnati

"Kevin McCain's excellent book zooms in on the role of *explanation* in science and links it with scientific *understanding*. McCain has the enviable gift to write a gentle introduction for the novice reader that also provides a fresh perspective that is interesting for the specialist. Overall, this book is an accessible and illuminating contribution to the literature on scientific explanation."

Olaf Dammann, Professor of Public Health and Community Medicine, Tufts University

"In this concise and elegant book, McCain provides a superb overview of current thinking about the nature of explanation in science, correcting common misunderstandings and providing a clearly written, entertaining, and insightful guide to the enterprise of understanding the world."

Michael Strevens, Professor of Philosophy, New York University

"*Understanding How Science Explains the World* is a very impressive achievement. It draws on and develops some of the most important philosophical views on the nature of explanation, while carefully engaging throughout with important examples from the history of science (including quite recent history, which takes into account scientific attempts to explain and understand COVID-19). Highly recommended."

Stephen R. Grimm, Professor of Philosophy, Fordham University

For Declan

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Foreword

Why do birds have wings? Why do offspring resemble their parents? Why did the nonavian dinosaurs become extinct? How do organisms develop? How do species evolve? How do ecosystems remain stable despite perturbations? These and other "why?" and "how?" questions are very common in science – in fact, these are the kinds of questions that scientists usually ask. When the answers to such questions provide accounts of why and how something occurred in the past or regularly occurs, and these accounts in turn provide understanding of the respective phenomena, then these answers are more than that: they are explanations. In this philosophically informed book, Kevin McCain provides a clear and accessible introduction to some core issues in the philosophy of science. He explains what makes explanations different from descriptions, what is the role of causes in explanations, how explanations contribute to understanding, what is the structure of scientific explanations, their potential but also their limits. McCain provides a comprehensive introduction to scientific explanation that is at the same time comprehensible; and these are features that do not always go together when it comes to the philosophy of science. In the end, reading this book will be a rewarding experience: you will come to understand what scientific explanation is, as well as why philosophy is absolutely necessary for doing science – and for understanding life.

Kostas Kampourakis, Series Editor

Preface

The ancient Greek philosopher Aristotle began his *Metaphysics* by stating "all men by nature desire to know." He was right, but there's much more to the story than that. For one thing, it's not just men who desire to know. All people desire to know. For another thing, we don't want to know in general; we want to know specific things. In particular we want to not only know what has happened, but also *why* it happened, *how* it happened, whether it *will* happen again, whether it can be *made* to happen or not happen, and so on. In short, what we want are explanations. Anyone who has spent even a moderate amount of time around young children knows that two of their first, and favorite, things to ask are "why?" and "how?" This practice isn't something that we abandon as we grow older. In fact, asking and answering "why" and "how" questions lies at the very heart of scientific practice.

How do we answer such questions? By giving explanations. In order to answer why plants need sunlight to survive and how they make use of sunlight to survive, we need to know about photosynthesis, which explains why and how plants make use of sunlight. Natural selection explains why particular traits are present in populations and how particular traits have become predominant in a given population. Molecular polarization explains why and how certain molecules bond to one another. And so on. In each of these cases, we are trying to provide an account of why things are the way they are (and perhaps why they are not some other way).

Explanation is a key aim of science. We seek to explain the world around us because doing so allows us to come to know about the world and to better understand it. The primary aim of this book is to help readers understand how

science explains the world. More specifically, the book explores the nature and contours of scientific explanation, how such explanations are evaluated, as well as how they lead to knowledge and understanding. Science helps us understand the world by giving us explanations of the phenomena we encounter. This book is broader in scope than many of the others in the *Understanding Life* series as it is focused on features that one finds in all scientific domains. Nevertheless, as fitting for a book in this series, issues from the life sciences will be given pride of place as the book seeks to facilitate an understanding of how it is that science explains the world.

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