Understanding Metaphors in the Life Sciences

Covering a range of metaphors from a diverse field of sciences, from cell and molecular biology to evolution, ecology, and biomedicine, *Understanding Metaphors in the Life Sciences* explores the positive and negative implications of the widespread use of metaphors in the biological and life sciences.

From genetic codes, programs, and blueprints, to cell factories, survival of the fittest, the tree of life, selfish genes, and ecological niches, to genome editing with CRISPR's molecular scissors, metaphors are ubiquitous and vital components of the modern life sciences. But how exactly do metaphors help scientists to understand the objects they study? How can they mislead both scientists and laypeople alike? And what should we all understand about the implications of science's reliance on metaphorical speech and thought for objective knowledge and adequate public policy informed by science?

This book will *literally* help you to better understand the *metaphorical* dimensions of science.

Andrew S. Reynolds is Professor of Philosophy at Cape Breton University, Canada. He is the author of *The Third Lens: Metaphor and the Creation of Modern Cell Biology* (University of Chicago Press, 2018) and *Peirce's Scientific Metaphysics: The Philosophy of Chance, Law and Evolution* (Vanderbilt University Press, 2002). He has a PhD in the philosophy of science from the University of Western Ontario.

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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"What a timely book this is! It is precisely because biology has made such striking advances in recent years that its stock of metaphors is due for a clinical check-up. Reynolds offers a reliable and perceptive diagnosis of the framing narratives of the life sciences, sympathetically examining their strengths and weaknesses. This book should be an essential accompaniment to any study course in the biological sciences."

Philip Ball, science writer and author of *How to Grow a Human*

"In this beautifully written, highly accessible, and captivating work, Reynolds reveals the incredible extent to which scientific methods and descriptions in biology, the life sciences, and medicine are infused with metaphors. Interweaving the rich history and philosophy of the uses of these metaphors over time, their many implications for scientific reasoning, understanding, and the ethical and political dimensions of science itself are perceptively explored, with wonderful clarity and across an encyclopedic range of examples. Metaphors afford telling insight, opening doors to further inquiry and closing others. Is your genome software? Are enzymes molecular machines? Does nature select some traits over others, thereby constructing the tree of life? The fascinating world of metaphors in science comes to life on every page."

Anjan Chakravartty, University of Miami, USA

"I read Lakoff and Johnson's book *Metaphors We Live By* in the 1980s, and it was eye opening. Andrew Reynolds' book, which should be called *Metaphors Science Lives By*, is equally eye opening. Metaphors shape the way we live in the world. In science, they shape the way we understand the world. This can have huge implications for our lives, for better or for worse. How does this process of understanding work, especially in the life sciences? This book deals with the essential role of metaphors in this process. Written in an admirably clear style, Reynolds makes us aware of the power of metaphor, but also its dangers and pitfalls. It is an essential read for everybody interested in understanding how science and science communication work with and through metaphors. Importantly, it also dispels some common misunderstandings about the role of metaphors in science."

Brigitte Nerlich, University of Nottingham, UK

"*Understanding Metaphors in the Life Sciences* takes us from genes to cells, and up to the vast evolutionary tree of life, showing how science depends overwhelmingly on metaphor for understanding, for advance, for communication. A very important book."

Michael Ruse, Florida State University, USA

To my older siblings: Tina, Rhys, Anne, and Peter; for perpetually spoiling your baby brother while also molding me into a reasonably responsible and productive human being.

Contents

Foreword

The title of this book might seem strange to you, *Metaphors in the Life Sciences*. Science is supposed to provide an "objective" account of nature, and so metaphors have no place in it, you may think. Perhaps metaphors are used to communicate findings to non-experts, in order to help them understand something complex by presenting it in terms of something they are more familiar with. But this is it. Metaphors are just tools for communicating complex ideas, so why is this book about metaphors "in" the life sciences? Well, because metaphors are inherent in the language of science and are not used for communication purposes only. As Andrew S. Reynolds shows in this eye-opening book, most – perhaps even all – scientific concepts are metaphors, because this is how science is done. In their quest to understand nature, scientists need to describe and represent the phenomena they study, and metaphors are the best – if not the only – way of doing this. In order for scientists themselves to make sense of their objects of study, it is necessary to develop mental representations in terms of something else they are familiar with. But there is more. The choice of metaphors not only affects the representation of phenomena, but also guides research: We currently talk about genome "editing" only because the genome has long been perceived as a "book." Reynolds brilliantly shows not only the metaphorical nature of many scientific concepts, but also the implications for their scientific and public understanding. Your perception of science is likely to change forever after reading this book.

Kostas Kampourakis, Series Editor

Preface

Even if you are not a working scientist or someone who studied much science in university or high school, you no doubt have some familiarity with biology and the life sciences. In this age of the Internet and pervasive communication, it is difficult not to at least passively soak up some knowledge about genetics, evolution, ecology, or medicine. Here's a sample (in my own words) of what most people probably think they understand about biology and the modern life sciences:

> Genes or DNA provide the code or instructions or program or blueprint or whatever for building organisms, which are made from tiny cells that contain proteins and things that are like machines or factories, and they got that way through evolution because nature selected only the strongest organisms to survive and reproduce, which explains why they all fit perfectly into their little niches in the environment. But when humans mess up this balance of nature we make ecology unhealthy, which can lead to illnesses like cancer. Fortunately, scientists are now experimenting with molecular scissors like CRISPR to do gene-editing that will reprogram or rewire cells to switch the cancer off.

This invented statement is only meant to summarize what I believe to be fairly common opinions people have about issues in the life sciences, based on my own 20+ years of experience of teaching university courses on science and society and research in the history and philosophy of science. The ideas expressed in the made-up passage are not all entirely false or off-base, but they do suggest a less-than-firm grasp of what the terms employed really

mean. Part of the problem from the non-scientist's perspective is that science, when it's not using a lot of incomprehensible mathematical equations and technical jargon, contains a lot of metaphorical language. And that's because scientists actually do use a lot of metaphors, not only when they are communicating with laypeople outside of their profession, but also when they are actually doing their science. In many cases, the metaphors actually help them to think about their research questions, how to set up their experiments, and how to interpret the results.

In the prologue to his book *How to Grow a Human* (2019), science writer Philip Ball describes his growing awareness of how much science is "driven by stories" or narratives that inform our interpretation of what the science means. The metaphors scientists use to describe the things they study in particular influence how they think about them and implicitly suggest stories or narratives through which they may be understood; and although science is commonly portrayed as providing an objective account of the world, close inspection reveals that it is replete with and reliant on metaphorical language and concepts. Because metaphors create bridges between two ostensibly dissimilar topics, this makes them powerful facilitators of analogical reasoning, which allows scientists to apply what they already know about one type of entity or process to others more novel and poorly understood. For instance, thinking of biological cells in analogy with factories has permitted scientists to apply insights into how factories are organized and operate to the structure and function of cells.

It can be challenging, however, for non-scientists or anyone unfamiliar with the precise details of how scientists use and interpret these metaphors to understand exactly what their pronouncements do and do not mean. In many cases, scientists use metaphors like "chemical bond" or "genetic code" as a kind of shorthand that covers a whole range of quite specific and well-understood ideas, phenomena, and techniques. But not always. Sometimes the scientists themselves are as uncertain as any of us what precisely the metaphors mean, even though they may find them quite useful for some purpose. But even when the scientists do understand the metaphors in quite specific ways that are well accepted within their professional community, they can be misleading and confusing to those on the outside. Just as anyone

can look through a microscope without knowing how to make sense of what they see, knowing how to interpret a scientific metaphor requires a little instruction. This book aims to provide such instruction in brief and accessible language.

As Brendon Larson, a conservation biologist who has written on the relationship between metaphor and science, says: "Scientists are responsible for their metaphoric choices and citizens are responsible for learning to interpret scientific metaphors." And as the image on the cover of this book suggests, metaphors consist in the recycling of ideas from one domain of discourse to another. Frequently, ideas from domains outside of science are transferred into a scientific topic, as, for example, when the ideas of codes, information, and computer programs were injected into the field of genetics. But the ideas, once established in a scientific domain, can then be recycled and transferred back into non-scientific conversation, as when we ask whether we should edit our genomes as a means of treating disease or disability. This entrenches the idea that both the cause and solution are biological and located inside our bodies, rather than perhaps implicated in a broader network of relations extending beyond our genomes to the natural and social environments in which we live.

In this respect, metaphors are like viral vectors that carry ideas (and habits of thought) bi-directionally between science and society. And like a virus, once a metaphor has settled in (as a conventional or "dead" metaphor), we may no longer recognize we are speaking and thinking under its influence, and we may uncritically replicate and perpetuate its existence to the exclusion of other potentially more useful modes of speech and thought.

The purpose of this book is to help everyone – non-scientists and scientists too, I hope – to think more clearly about the many functions of metaphors in science, and to understand better the meaning and roles (both positive and negative) of a selection of specific metaphors drawn from the various life sciences. Think of it as a kind of booster shot for your critical thinking response system.

Chapter 1 provides a basic introduction to metaphor and to ideas about its relationship and relevance to science. Chapter 2 explains how and why a small set of rather general sorts of metaphors have been so common in

science, both past and present. In Chapters 3 through 8, I discuss a select set of metaphors specific to a particular area or field in the life sciences, covering genetics, proteins, cells, evolution, ecology, and biomedicine. Each of these chapters begins with a brief account of the metaphors to be discussed, followed by a short history of why scientists began using these metaphors in the first place, explaining why they have been helpful for the investigations and theories in which they occur, after which the deficiencies and reasons why the metaphors have been criticized are discussed.

In short, we will be asking questions such as

- Are genes blueprints?
- Are cells factories?
- Are proteins machines?
- Does nature select which organisms get to survive and reproduce?
- What exactly is the tree of life and what kind of tree is it?
- Is there such a thing as the balance of nature?
- How do scientists go about editing a genome?
- Will they really be able to switch off or reprogram cancer cells?

The literature on metaphor and its relation to science is vast, and I have benefitted from a great number of authors and publications. I have tried to draw attention to those examples that I think are particularly helpful for understanding the select set of metaphors discussed in this book. I do not pretend to offer the final word on the topic of science and metaphor; this is rather a snapshot of some of the interesting topics and research to date. To those whose work I have not mentioned or have missed in my own reading, I extend my apology.

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