

# Chapter 1

## Introduction

The goal of this book is to provide an understanding of an important element of contemporary biological research practice, namely of *explanatory reduction*, or more precisely, of *reductive explanations*.<sup>1</sup> My central question is: What makes an explanation in the biological sciences reductive and distinguishes it from non-reductive explanations?

The topic of reduction(ism) was and still is a much discussed issue in fields such as general philosophy of science, philosophy of mind, and philosophy of biology. Most notably, it belongs to the classical issues that were discussed when philosophy of biology emerged as a distinct discipline in the 1960s and 1970s. The general topic I am concerned with in this book is thus not new. But the specific question that I address, the way in which I approach this question, and the answer I give are novel. Most discussions about reduction in philosophy of biology have focused on two issues: on the one hand, on the question of whether *reductionism* or *antireductionism* is ultimately correct, for instance, whether it is in principle possible to adequately explain each biological phenomenon in molecular or in physical terms. On the other hand, discussions about reductionism centered on a particular understanding of reduction, namely on Ernest Nagel's (1961) formal model of *theory reduction*. In the last third of the twentieth century philosophers put a lot of effort into defending or criticizing the application of Nagel's model to the biological sciences (in particular to the relation between Mendelian genetics and molecular biology).

My analysis in this book differs from these classical disputes in both respects: my aim is neither to defend a certain version of reductionism or antireductionism with respect to biology, nor is it to discuss the topic of reduction within the narrow boundaries of Nagel's model of theory reduction (cf. Kaiser 2012). Instead, I focus on answering a question that I think is prior to discussions about explanatory reduc-

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<sup>1</sup>I assume that there are four types of reduction that one should keep apart: ontological reduction and three kinds of epistemic reduction, namely theory, methodological, and explanatory reduction (this difference is spelled out in Chap. 3).

tionism (see Chap. 3, Sect. 1), namely what does it mean to explain a biological phenomenon in a reductive manner? I offer an extensive and (hopefully) persuasive answer to this question by developing my account of explanatory reduction in biology. This account presents an alternative way of thinking about epistemic reduction in biology, which does not remain within the Nagelian framework that reconstructs reduction as a relation of logical derivation between theories.

In the last two decades several philosophers have responded to the shortcomings of Nagel's model of theory reduction by abandoning the concept of reduction or the focus on reduction altogether (e.g., Craver 2005, 2007a; Mitchell 2003, 2009; Mitchell and Dietrich 2006; Darden 2005; Bechtel and Richardson 2010). In my view, this is not the right strategy. Reductions – more precisely, reductive methods and reductive explanations – were and remain important elements of biological practice. This is not to say that reductive research strategies do not have crucial limitations and that the attempt to explain the behavior of some biological objects or systems in a reductive way may not result in serious inadequacies. But despite their shortcomings reductive methods and explanations also have certain merits, which is why they still do play an important role in contemporary biological practice. This is supported by the fact that current biological research papers show a continuous attention to the topic of reduction(ism). In particular, biologists discuss questions such as “Under which conditions is the application of reductive methods a permissible and profitable research strategy?” and “Can a particular biological phenomenon be adequately explained in a reductive manner?” (for further details see Chap. 6, Sect. 1.3). Thus, I think we should adhere to the concept of epistemic reduction because it is an important conceptual tool for capturing significant aspects of biological research practice. What we need is a better understanding of what epistemic reduction in biology is, not the removal of the concept of reduction from philosophy of biology altogether.

My aim in this book is to develop such a better understanding of epistemic reduction. Precisely speaking, I am concerned with a specific type of epistemic reduction, namely with explanatory reduction, respectively with reductive explanation (this focus will be justified in Chap. 3). The central question that I seek to answer in my analysis is: what are the features of biological explanations that determine their reductive character? In other words, which characteristics are common to all (or to most) reductive explanations in the biological sciences and allow one to clearly distinguish reductive from non-reductive explanations? What is crucial to my account of explanatory reduction is that the answer I give to this question emerges from a critical reconstruction of biological research practice itself. That is, my answer does not reflect a philosophical ideal of reduction. Rather, it captures paradigmatic and important cases of explanatory reduction from contemporary biological practice, and it accounts for the way biologists currently discuss the merits and “limits of reductionism” (Ahn et al. 2006a, 709; Mazzocchi 2008, 10; see also Kaiser 2011) or call for a move “beyond reductionism” (Gallagher and Appenzeller 1999, 79). By taking actual biological practice seriously my analysis provides several novel insights into the central characteristics of reductive explanations. That way, it clarifies and specifies what it means to explain a biological phenomenon reductively.

The project of developing an account of explanatory reduction in biology is valuable by itself because the question of what makes an explanation reductive has not received sufficient philosophical attention so far. Moreover, it is beneficial because it has the potential to advance debates about explanatory reductionism. Any fruitful discussion about the truth of explanatory reductionism must be based on a clear understanding of what explanatory reduction is. Otherwise misunderstandings and people talking at cross purposes are a daily occurrence. My analysis also yields an understanding of what the merits and limitations of applying reductive strategies and developing reductive explanations in biological practice are. This knowledge, not only about what reductive explanations are but also about the conditions under which they succeed and fail to be adequate, is of great value to discussing the plausibility of different versions of explanatory reductionism (at least if one is interested in in-practice kinds of explanatory reductionism; see Chap. 3, Sect. 1).

The general structure of my book is the following. Chapter 2 serves to disclose the meta-philosophical assumptions that underlie my analysis of explanatory reduction. This includes explicating (and justifying) the aim of my analysis, the philosophical methodology by which I develop my account, and the criteria of adequacy that I accept. I will characterize my own account as being descriptive and bottom-up but critical, as being as universal as possible and as specific as necessary, as being normative in a certain way but not in another, and as being potentially useful for science.

The purpose of Chap. 3 is to introduce the previous debate about reduction(ism) in the philosophy of biology. But this introduction will not be a mere overview. Rather, I present what I conceive as the most crucial lessons one should learn from this debate. In doing so, I introduce and specify important concepts and distinctions. Moreover, I show the reader the path I will run in the remaining part of this book. That is, I adduce reasons for why I develop an account of explanatory reduction, rather than an account of ontological reduction, methodological reduction, or theory reduction.

In Chap. 4 I critically discuss the two perspectives on explanatory reduction that have been proposed in the philosophy of biology so far, namely Rosenberg's thesis that explanatory reduction is a relation between a higher-level and a lower-level explanation of the same phenomenon and Sarkar's, Hüttemann's, and Love's approach to focus on individual reductive explanations. The result of my critical examination will be that Rosenberg's perspective on explanatory reduction in biology has several shortcomings and that, even though Sarkar's, Hüttemann's, and Love's encounters objections, too, it seems to be the more promising path to run.

If one decides to analyze epistemic reduction by examining the reductive character of individual explanations, as I do, the question arises how entangled the issue of reduction becomes with the issue of explanation. I will address this question in Chap. 5. In particular, there are two questions that need to be answered differently: first, does the question of what determines the reductive character of a biological explanation (the question of reduction) boil down to the question of what characterizes an adequate explanation (the question of explanation), and second, do debates

about the truth of explanatory reductionism depend on specific discussions about explanation (and if yes, on which)?

The results of these four chapters constitute the ground on which I can then, in Chap. 6, develop my own account of explanatory reduction in biology. I will start with briefly specifying two concepts that occupy center stage in my account: the concept of a biological part (or of a part-whole relation) and the concept of levels of organization. On the basis of these conceptual clarifications I can then answer the central question of my book, namely what are the characteristics that determine whether a biological explanation is reductive or not. The main result of my analysis of biological practice will be that reductive explanations in biology possess three features (two of which are necessary conditions, one of which is only a typical feature that most reductive explanations exhibit): they display a lower-level character, focus on factors that are internal to the biological object of interest, and describe the biological parts of this object only as parts in isolation.

This account deviates from previous discussions not only insofar as it does not discuss the truth or falsity of reductionism and is not concerned with reduction as a relation among theories. Moreover, it is innovative because it reveals three specific criteria of the reductivity of biological explanations, which have not been discussed in the literature in this way before. These three criteria point out very clearly what the reductive character of an explanation consists in, also because they trace the reductivity of explanations back to specific relations that exist in the world and that are represented in a certain way by reductive explanations. This is why I characterize my account as an *ontic* account of explanatory reduction.<sup>2</sup>

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<sup>2</sup>Note that this understanding of the term ‘ontic’ deviates from how Craver and Strevens understand it. I do not claim, as they do, that explanations are entities in the world, rather than representations of entities in the world (more on this in Chap. 5, Sect. 2 and Chap. 6, Sect. 6).