

European Studies in Philosophy of Science

Raffaella Campaner

Explaining Disease: Philosophical Reflections on Medical Research and Clinical Practice



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Raffaella Campaner
Department of Philosophy
and Communication Studies
University of Bologna
Bologna, Italy

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Chapter 1

Scientific Explanation: Theoretical Issues and Practical Implications



This introductory chapter presents the core topic of the volume, and provides a first set of general tools serving as a guide in the general debate on scientific explanation and the tangle of issues arising at the crossroads between philosophical discourse on medical explanation, and medical discourse that pays at least some attention to philosophical – conceptual and methodological – questions.

1.1 Scientific Explanation and Explaining Disease

Medicine tackles diseases in order to promote health. Understanding why, where and when a given disease originates, how it develops over time and, possibly, what can stop or quell it, allows scientists to devise effective clinical treatment and prevention strategies. Although by no means the only epistemic goal of medical investigations, disease explanation no doubt constitutes a very relevant one. Explaining both enhances theoretical understanding of diseases and can provide sound grounds for predictions and interventions. Indeed, as we will see, different kinds of explanation can relate in different ways to our capacity to predict the course of health-related events, and effectively prevent or reduce the harm caused. Medical knowledge includes a huge amount of explanatory knowledge that is constantly being extended. New explanatory hypotheses for incompletely understood diseases are constantly being proposed by scientific papers. Complex diseases – such as cancer and psychiatric disorders – and rare conditions are especially at the centre of scientific efforts to achieve explanatory knowledge. The recent Covid-19 pandemic is a further excellent example of how some infectious diseases may also be in urgent need of explanations in order to develop the most effective ways of fighting them. Examining how genuine explanatory knowledge can be achieved and employed can serve as a preliminary step and lead to practical therapeutic and preventive scenarios at both the individual and general population level.

Even if medicine is far from being always successful in its enquiries and applications,¹ it is undeniable that significant progress continues to be made, including advances in explanatory knowledge. But what does “to explain something” exactly mean? What are the specific features of explanatory accounts, and what distinguishes explanations from other epistemic goals? Scientific explanation has been one of the core topics in philosophy of science for a long time now, with a number of works devoted to answering such questions. Since the famous Hempelian models and the so-called “received view”,² theories have proliferated, and the debate is still very lively and articulated. This long philosophical tradition includes different perspectives whose consequently different proposals at times give rise to conflicting elements while others (the majority) intersect or overlap to various extents, even being considered complementary. In these latter circumstances, intersections of views can be beneficial, continuing to foster discussion. By and large, the debate started in the late Forties with the assumption that a single philosophical reconstruction of what scientific explanations amounted to fitted all the sciences and could be applied across the board. This philosophical standpoint, however, underwent significant change in concomitance with a more general shift from philosophy of science to *philosophies of the sciences*, and with philosophical focus turning to *scientific practice* as reflections on scientific explanations increasingly tackled the distinctive features of different disciplinary fields. Awareness has grown that close attention to particular scientific contexts can provide extremely relevant hints as to the specific features of a given disease explanation. Considerations have hence concentrated on what explaining can mean with respect to certain kinds of phenomena, or even specific case studies, and certain epistemic aims. The debate has developed in terms of an increasingly closer interaction between philosophy of science and the sciences themselves. This has led to a two-fold outcome: on the one hand, many philosophical positions have been so-to-speak “tested” against cases from the sciences (mostly the special sciences), stimulated by them, and in many respects adjusted accordingly; on the other, the range of strictly scientific works referring to philosophical reflections in order to have a better understanding of explaining methodological and conceptual issues has also increased significantly.

The relations between medicine and philosophy have greatly benefitted from these general trends. These significant interactions and the relevant role played by biomedical issues have advanced the debate, overcoming the so-called “received view” put forward by Hempel and its predominant nomological character. Actually, the very history of philosophy of medicine as a disciplinary field is marked by its close relation with reflections on explanation and causation. To start with, what is regarded as the first transdisciplinary symposium on philosophy and medicine – held in Galveston in 1974 – was entitled “Evaluation and Explanation in the Biomedical Sciences”. Ever since, medicine has provided a very fertile scenario for

¹Recent works stressing some limits of medical knowledge and the effectiveness of modern medicine are Stegenga (2018) and Broadbent (2018a, b). For some critical remarks, see Gillies (2019b, 2020) and Metz (2018).

²See Hempel (1965). For some critical discussion, see Salmon (1989).

theoretical reflections, which have led, among others, to questioning the explanatory adequacy of the Hempelian models and the possibility of applying scientific laws in some strict sense to medical situations for explanatory purposes.

Arguments on differences between the nature and role of scientific laws in physics and the life sciences have intersected with arguments on the adequacy of the nomological model for the latter. The health sciences can present cases in which, as required by Hempel's approach, the explanans consists of at least one scientific law, plus the initial or antecedent conditions. For example, "why a patient's cardiac output (CO) is 4.9 l is explained by the initial conditions of a stroke volume (SV) of 70 ml and a heart rate (HR) of 70 beats per minute and by the law: $CO = SV \times HR$ " (Marcum, 2008, p. 139). Although inferential arguments along Hempelian lines can be elaborated that have diseases as explananda, their adequacy to grasp the majority of genuine explanations in medicine has been challenged for a few decades now, and wide reflections have been devoted to attempts to substitute nomological relations – held to provide, at best, "provisional surrogates" (Schaffner, 1993, p. 274) – with causal ones. As stressed also by Maël Lemoine,

...most medical explanations do not refer to laws of nature. Examining short-term potentiating in neurobiology, inheritance, and AIDS, Schaffner concludes that the general premise in the explanans is not a law of nature, but 'rather a set of causal sentences of varying degrees of generality' (Schaffner, 1993, p. 286). Some of these sentences are very general and resemble laws of nature [...] But other are very specific (Lemoine, 2016, p. 298).³

Biomedical sciences have thus significantly contributed to the dismantling of the Hempelian nomological view, and to discussions and refinements of the notion of cause as a distinctive trait of explanations in medicine – to the point of claiming that "this concept is a defining characteristic of modern western thinking about disease" (Carter, 2003, p. 1). Discussing causal explanation thus also amounts to jointly discussing approaches to causation itself, and the distance, or, vice versa, adequacy of different philosophical views on the topic with respect to the use of the notion of cause in the health sciences. While reflections on what it is to causally explain a disease, and the promises and limits of different theories of causation in different medical scenarios have largely dominated the debate on explanation in philosophy of medicine in the last two-three decades, they have by no means been alone. In particular, the explanatory role of functions and computational tools have also played a prominent part. In the following chapters of this volume, we will consider a range of theoretical approaches to explanation, outlining their distinctive traits, exploring how they have intersected, and how they can further intersect medical research and clinical practice. While far from being exhaustive, the set considered will allow us to develop reflections on a number of, partly intertwined, directions. In the first place, considerations will be elaborated on what 'explain' might mean exactly when striving for explanatory accounts in different medical situations. This

³A re-evaluation of the notion of scientific law – but not of nomological explanation – is advocated by Gillies (2019a). Gillies takes causal laws to play an absolutely fundamental role in medicine insofar as they provide the grounds for interventions – which can be meant both to cure diseases or to prevent them. We will discuss the explanatory role of interventions in Chap. 8.

goal will be pursued by devoting close attention to what the health sciences themselves present as explanations of diseases, and discussing how this might be influenced by both the particular features of the various objects of explanation, and by the purposes for which explanatory processes are enacted. These reflections will inevitably lead us to consider not only explanations as such, but also their relations with other epistemic activities, especially descriptions, predictions and interventions. The features explanations may present in situations addressing diseases will be analyzed through the lens of certain relevant portions of the philosophical debate, with the aim of shedding light on both their overall merits and limits. We will question to what extent philosophical views – and which of them – help clarify what characterizes genuine explanations in medicine, and, on the other hand, to what extent distinctive features of some medical explanations can, instead, challenge philosophical standpoints. This approach will also allow us to bring into focus the actual relations of philosophy and medicine as they have developed recently, considering what mutual fields and positions are regarded as the most interesting and challenging from the standpoint of other disciplines.

Lemoine, who stresses how a very strict link holds between the fact that medicine is a scientific enterprise and the elaboration of explanations in medical contexts, has stated:

The scientific part of medicine seeks explanations. [...] A satisfactory account of explanations in medicine should: 1. encompass all types of medical explanations (molecular, epidemiological, psychiatric, pathophysiological, social, ...) or explicitly define a more limited target; 2. state what is specific to medical explanation, if anything, as opposed to non-medical explanation; 3. account for the function of explanation as opposed to other activities such as providing evidence (2016, p. 296).

What Lemoine lists as the goals that a satisfactory account of explanation should pursue will be tackled in the present volume with a specific focus on a few points. With respect to 1., specific issues arising within particular medical fields of investigation – e.g., mental health sciences and cancer studies – will be addressed, questioning to what extent we should strive to find a single account of explanation that can encompass all kinds of medical explanation across all medical fields and contexts. The commitment to such an enterprise, in fact, should not run the risk of neglecting or underestimating relevant explanatorily differences between, e.g., the features of explanation in molecular medicine and those in psychiatry. Indeed, cases from different fields should rather be seen as helping to unravel both common traits and distinctive problems in medical explanations in different disciplines. With regard to the second goal mentioned by Lemoine, our standpoint will be slightly different. Rather than focusing on what is specific to medical explanation as opposed to non-medical explanation, we will stress what issues emerging from medical cases may be relevant for rethinking or deepening reflections on explanation in other fields as well. Point 3 in Lemoine's list will be frequently considered throughout the volume, with reflections on different conceptions of explanation, highlighting both how they differ from other epistemic goals and how they relate to them, being, for instance, inextricably linked to descriptions, and at times providing a useful guide to therapeutic interventions and prevention strategies. Here too, focus will be given

to the differences in activities in the different medical fields since the weight of various epistemic activities can significantly differ from one discipline to another. The attention will be confined to differences and possible overlaps or reconciliations between different understandings of explanatory procedures – with each approach setting its own boundaries with respect to non-explanatory accounts.

Although the common thread of this volume will be the close dialogue between theoretical positions in philosophy of science – and, more specifically, philosophy of medicine – and medical practice, it should be noted that not all relevant intersections between philosophy of health and disease and explanatory issues in medicine will be covered by this volume. The chapters that follow will not illustrate differences between explanations in medicine and explanations elsewhere, either in commonsensical discourse or in other sciences, nor will they be able to provide an exhaustive account of explanatory views that may be of some relevance in medical fields. Furthermore, the reflections presented in the following chapters will not be oriented by the preliminary adoption of some specific stance on what a disease exactly is. Even if the debate on the nature and/or definition of health and disease is extremely large and interesting, without doubt revealing crucial intersections with what is presented in the following pages, no specific, naturalist, normativist or hybrid view will be here assumed as the privileged point of departure of the discussions. Rather than starting from a specific conception of what a disease is, on a few occasions it will be stressed how the adoption of a given explanatory perspective can provide reasons for preferring one standpoint on a given matter over another. The focus will be on explanatory practices, and theoretical approaches to diseases will be recalled insofar as they accompany explanatory practice and/or are influenced by purported explanations.

Having provided the general scenario and overall goals of the volume, and before entering the core of the debate and tackling particular theories and specific issues, let us briefly consider certain general structural features of explanation. In the next section, I introduce a few crucial conceptual distinctions that are essential in order to grasp what any explanatory process consists in.

1.2 Explanatory Questions and Explanatory Relations: What We Explain, and How

Discussing explanations, how they are formulated and what sort of information they convey, requires some preliminary clarification and conceptual distinctions in order to disentangle the very structure of any explanatory account. Any explanation stems from a question, requires an answer, picks an object of investigation, and provides some information which, to have explanatory relevance, must regard the object of explanation itself. All such elements need to be recognized, adequately specified, and not conflated when considering whether an explanation is adequate and what epistemic gains it provides us with.

Whenever addressing explanatory issues, we should start by clarifying *what sort of question* we are asking. In the case of health conditions, we may be interested, for instance, in explaining why a given pathology has started, looking for what brought it about, or why it started at a given moment rather than at some other time, or why it affects somebody rather than somebody else within a given population, or what differences hold between two or more individuals affected by what is regarded as the same pathology, or, rather, to what extent a given condition in a given individual can be representative of a general condition, why a given drug is/is not working in a certain case, and so on. The identification of the precise question orients the precise identification of the *explanandum* as well – which without doubt is one of the crucial steps in the elaboration of any explanation. What exactly we are considering is to be made explicit and very clearly circumscribed. It is important to make clear what kind of phenomenon it is, what its boundaries are, through the lens of which scientific fields it is presented as an object of explanation, at what level of detail it is described as the target of our investigation, whether what the explanation is tackling is a disease as such, or the present conditions of a particular diseased individual, or his/her evolving conditions, or the incidence of a pathology within a certain population. The explanandum, that is, what is to be explained, constitutes the target of the explanatory activity, and thus dictates its boundaries and contents, and set the grounds for its evaluation.

The precise definition of the explanandum impacts not only the form that the explanation will take in the end, but its very content, that is, what will be identified as the *explanans*. Once we have determined what question we are raising, and what the object of our explanatory investigation is, we have to group and combine all and only the relevant explanatory information, which will build up the answer to our question – the explanation itself. The explanans is called to explain the explanandum by virtue of some relation holding between them. An explanation qualifies as a response to a why-request exhibiting some form or other of dependence of the explanandum on the explanans. The explanans can be related to its explanandum in different ways, and different conceptions of explanation take different stances on what exactly count as *explanatory relations*. An adequate explanation will then identify an explanans that entertains what is regarded as the right relation to the explanandum. According to where we think that the explanatory power actually resides, explanantia will hence include laws, or invariant generalizations, mathematical relations, productive causes, or functions performed, etc. The selection of the relevant content to be included in the explanans will thus depend on what one takes to be the explanatory relation. At the same time, the same information – e.g., the same bodily features, or biochemical processes, or socio-economic variables – can be included in what are de facto different explanations in cases in which the relations holding between them and the explanandum are interpreted differently. The interest the explanation might have for a given audience will also depend on how a given approach – i.e., a given standpoint on what to explain exactly amounts to – relates to other epistemic activities. This is a core point when discussing explanatory relations. Some different understanding of causal nexus, or the import of generalizations/laws/computational relations, functions or mechanisms, will also bring

with it a different understanding of the relation between explanation and describing, predicting, intervening and controlling.

Medicine is no doubt characterized by a strong practical vocation: theoretical knowledge in any medical field is to be ultimately translatable into practice, cure or prevention. This raises interesting issues regarding the relation between the elaboration of general knowledge and its application to single cases, that is, the relation in medical contexts between an explanatory model of the disease and its use to treat the individual patient. Moreover, explanatory investigations can get particularly puzzling in the case of complex diseases, such as cardiovascular diseases, diabetes, cancer, psychiatric disorders, ..., which derive from a very large number of diverse intertwined factors, interacting with each other and *probabilistically* responsible for the pathology.⁴ Different kinds of variables act and interact, mutually affecting each other and affecting the probability of the disease occurring. Identifying all and only the variables which are genuinely explanatorily relevant, understanding different possible configurations and joint behaviours and, at the same time, disentangling variables from one other, is a very thorny enterprise, and different theoretical approaches try to tackle it. Discussing explanatory procedures, and different ways to conceive of them, thus proves extremely relevant to disentangling both connections and distances between different kinds of epistemic access to the phenomena of interest, each driven by some interest and striving for some goal, which might have to do with the features of a given disease, the health of a population, or single individual. An adequate in-depth clarification of the epistemic issues arising from explanations will hence have to start from a proper conceptual toolbox, unraveling the different elements that make up explanatory accounts.

Although all these aspects are fundamental for a proper understanding of what explaining amounts to, how explanations are elaborated, what forms they can take, and how they can be evaluated, explanans, explananda and explanatory relations will not be addressed equally in this volume. Our focus will be mostly on explanatory relations: what the relations holding between explanans and explananda are, by virtue of which the former genuinely explain the latter? Why should some sort of relations be preferred over others as endowed with explanatory power? What should such preference – if any – be based on and justified by? In what sense can some evidence be deemed relevant from an explanatory point of view? How can different sorts of explanatory links relate to one another? This kind of concerns will drive the discussion that follows, which will rely on work in philosophy of science.⁵ We will consider both the arguments supporting different views, and the possible shortcomings various specific proposals encounter in medical contexts. As will be seen, no

⁴For extensive reflections on probability and probabilistic causation in medicine, see Gillies (2019a).

⁵This differs, for instance, with the recent volume “Explaining Health Across the Sciences” (Sholl & Rattan, 2020), which, while presenting extremely relevant material for what is also discussed here, assumes another standpoint, i.e., mainly that of medicine itself – in fact, a range of different disciplines in the health sciences, in a strongly interdisciplinary perspective – and focuses on a multifaceted and multi-dimensional notion of health.

single proposal seems immune to problems and possible counterexamples – or, at least, devoid of problematic aspects worthy of further discussion. Epistemological investigations on these issues easily translate, once referred to the health sciences, into reflections on features of medical research, diagnoses, treatments, prognoses, and prevention, thereby proving not only their clear relevance for an analysis of the advancement of medical knowledge, but also their potential impact on clinical practice. It is also with respect to the various possible uses and goals of explanations in medicine that reflections on the topic have fruitfully intersected with wider philosophical reflections on the roles contextual elements play in explaining, as we will see in the next section.

1.3 Explanations and Their Contexts

1.3.1 *Plurality and Pluralisms*

As is currently largely accepted in the philosophical literature – and partly discussed in some medical works as well – explanations can take various forms, and can be related to one another in different ways. As remarked above, whereas at its origins the philosophical debate on explanation intended to single out what *the* logic of scientific explanation was, views have begun to differentiate one from another, and the idea that there is no principled reason to prefer one account over all the others has found increasing consent. In the larger framework of pluralistic stances in philosophy of science, so-called *pluralistic* accounts of explanation have been developed, especially in the last couple of decades or so, usually stressing both the complexity of phenomena such as those addressed in the life and social sciences, and the role of the context in elaborating and evaluating any given explanation. Even if not confined to explanation, philosophical pluralistic views concern a number of issues, and directly impinge also on *explaining*, that is, on the idea that we need more than one perspective to account for explanatory practices in the sciences.

Contemporary philosophy of science has actually witnessed a proliferation of pluralistic positions – so much so that it has become more appropriate to talk of *pluralisms*. Explanatory pluralism is accompanied by, and intertwined with, forms of evidential pluralism, causal pluralism,⁶ and pluralism about scientific theories and models. In order to understand why investigating different sorts of explanation might not imply picking one over the others, but, rather, discussing their possible mutual relations in depth, we will dwell here a little on different forms of pluralism. Far from addressing all kinds of pluralism, I will only provide some core indications on a few. This is necessary to better clarify what is really at stake in the current

⁶A plethora of positions on causal pluralism is available. E.g., Cartwright (2004); Campaner (2006); Williamson (2006); Campaner and Galavotti (2007); Hitchcock (2007); Galavotti (2008); Psillos (2009); Godfrey-Smith (2009); Illari and Russo (2014).

scenario of approaches to explanations, what motivates the major positions, and what epistemological implications there are when kept separate or, rather, intersected. Some disentangling of various views that currently fall under the heading of “pluralism” is also necessary to properly appreciate their differences in terms of their motivations and supporting arguments.

Before qualifying the varieties of pluralism, a preliminary distinction should be made to free the ground of a possible source of confusion, namely that between *plurality* and *pluralism*. Both notions frequently figure in large portions of current philosophical work on the scientific enterprise, the search for causes, and the elaboration of explanations – both causal or otherwise. Although strictly related insofar as it is undoubtedly from different sorts of plurality that pluralisms stem, it must be stressed that the two terms must not be confused. Philosophers of science as well as philosophers of biology and medicine have long highlighted that complex phenomena result from a plurality of causal interacting (mostly probabilistic) factors, that a plurality of heterogeneous entities that can be described at different levels are involved, and that a plurality of disciplinary and methodological standpoints are needed to tackle them. Pluralist positions stem from an acknowledgement that scientific knowledge is constructed from such pluralities of elements, but they do *not* coincide with a simple acknowledgment of extant plurality in its various versions. Although pluralistic views differ from one another, in general terms the elaboration of *pluralistic* positions has specifically to do with *taking a philosophical stance* over the *implications* that various sorts of *pluralities* might have with respect to the way in which science runs, and, with respect to the way in which we think it should run. Pluralities – it is maintained – do not have to be somehow “absorbed” and dissipated into unitary frameworks; multiplicity of points of view to address them actually provide *epistemic added value*.

Pluralistic perspectives thus tend not to be confined to descriptive claims but make clear commitments with respect to how scientific research *should* be pursued. Pluralistic standpoints are associated with some *positive* evaluation of extant pluralities of approaches, methods and notions, which are held to convey some epistemic gain. When referring to explanation, the general idea is that different kinds of explanation of a given explanandum can be admitted that, for instance, realize different explanatory virtues (such as, for example, necessity, generality, unification, ...), or that preferably address either the macro- or the micro-level, according to the explanatory question and the context: “A good scientific explanation sometimes requires macro causes, sometimes micro causes, and sometimes a combination of the two. When it comes to scientific explanation, we should be pluralists” (Lipton, 2008, p. 124), and “a genuine explanation with certain virtues cannot be replaced by an explanation of another type with those very same virtues” (Pincock, 2018, p. 39).

Possible taxonomies of pluralism have been presented by, among others, Kellert et al. (2006); Mitchell (2009); van Bouwel (2014); Ruphy (2016). Let us just recall here some of the most successful views that have stressed relevant aspects of explanations.

One of the authors who has been more active in the debate on pluralism is Sandra Mitchell. In the Nineties (Mitchell, 1992; Mitchell et al., 1997), she distinguished between *competitive* and *compatible pluralism*. The *competitive* approach takes the competition between different theories or research programs as the best strategy to test them rigorously and, through such testing, contribute to enhancing scientific progress: through competition we can get some constructive confrontation, which can help scientific communities face problems related to choices between alternative theories and evaluate them in the light of available evidence. What the competitive approach stresses is that competition always implies some sort of assessment that is to be done in the light of the evidence and methodological tools *available in a given context*. Competitive pluralism thus highlights the role of the context in considering evidence: currently accepted theories are not necessarily those that will still deserve the highest epistemic trust in the future, since future assessment may be grounded on further evidence coming to light in the meantime that might support different evaluations.⁷ This is not to say that agreement cannot eventually be reached after confrontation. In this sense, competitive pluralism can be regarded as a *temporary* mode of addressing scientific knowledge, which might work just as a strategy to possibly achieve the acceptance of some single theory in the long run.

Competitive pluralism is different from compatible pluralism, which does not see alternatives as mutually exclusive and which has been largely discussed especially when dealing with different explanatory accounts and different levels of analysis in the biological sciences. While on the one hand, compatible pluralism no doubt grasps some real features of explanatory accounts, both in biology and elsewhere, on the other, it has been considered as running some risks too. First and foremost, it might fail to entertain a crucial insight of pluralism, namely the appreciation of the role of various alternatives in tackling *one and the same* feature of a given phenomenon. Concerns can be expressed that the different perspectives are compatible insofar as they actually address different facets and features of a given phenomenon under investigation. If so, it is debatable whether we might deem different views as genuinely alternative, or whether, in the end, compatible pluralism in fact stresses how different views identify certain levels and focus on them – hence running the risk of turning into *isolationist pluralism*: by stressing compatible aspects, compatible pluralism might isolate single levels of analysis, considering them one at a time and neglecting the wealth of mutually interacting processes, in the end – and this is the worry – separating disciplinary fields, research groups and programs rather than integrating them.⁸ From the standpoint of isolationist pluralism, each explanatory perspective has its own autonomous sphere of influence. While an explanatory account tackling one of the levels in the description of the explanandum at the time, addressing it separately from the others, might certainly

⁷See Kitcher (1990).

⁸The notion of “level” is in turn problematic and has been addressed in different ways. We will address this in the following chapters.

allow for the compatibility of a range of views, it will be unlikely to foster much epistemic interaction between such views.

Integrative pluralism is meant to answer this sort of concern, taking seriously the high variety of natural phenomena and their features, and, especially, complexity in the biological world. Mitchell (2002, 2003) has successfully supported the idea that, given the plurality of models of the same phenomenon we often encounter, an analysis of their relations and, whenever possible, some integration of accounts is the way to go to make the most of the knowledge they convey. According to Mitchell, to re-enforce pluralistic stances different stages in the construction of scientific knowledge are to be distinguished from one another. In acknowledging the relevance of integrating portions of obtained knowledge, we also need to be aware of the difference between being engaged in *theoretical modeling*, and the *application of models* to specific complex phenomena. The attitude toward pluralism might be different when pursuing theoretical investigations and when carrying out practical activities – as we will discuss in Chap. 9. “At the theoretical level pluralism is sanctioned,” while “at the concrete explanatory level ... integration is required,” since “however many contributing causes participated, there is only one causal history that, in fact, has generated a phenomenon to be explained” (Mitchell, 2002, p. 66). Given such a distinction, which plays a crucial role, the core of integrative pluralism is that it demands some *joint* work to bring together positions that happen not to contradict each other, but, rather, are capable of covering each other’s blind spots. Pluralism will continue to hold in modeling potential contributing causes, but not in the application of such models in specific explanations, where they must be integrated: “pluralism with respect to models can and should coexist with integration in the generation of explanations of complex and varied biological phenomena” (*ibid.*, p. 68). Integration does not, however, have just a theoretical import. It is meant to bring with it also effects in scientific practice, insofar as it can promote collaboration between disciplines, encouraging multiple perspectives not just to cohabit but to share epistemological tools, and, by so doing, enrich one another.

Integrative pluralism has encountered broad consent, but criticisms have been expressed as well. They regard, in particular, a central issue in any debate on pluralism, that is, whether a view that deems itself pluralist can be regarded as *genuine* pluralism, in the sense of a position stressing *permanent* features of scientific enterprise, rather than just a provisional contingent character that will later be discarded in the long run. If integrative pluralism really aims at the *integration* of explanatory approaches, then – the criticism goes – its ultimate target is some sort or another of *integrated*, joint and unique, explanation for a given explanandum. In other words, the pursuing of an integrative account could amount to the promotion of some single explanatory account arising from a combination of a certain set of other explanations. Would this lead to a sort of – so-to-speak – “super-explanation” in a given context, resulting in integrative pluralism reaching its aims and, hence, not being pursued any longer? Integration cannot just be assumed as an uncontroversial starting point, something to necessarily aim at, but needs to be argued for. Various concerns can be raised. How can we combine the idea – at the core of pluralistic views – that we are not striving for a single unified theory, yet at the same time argue

for an epistemic pluralism the benefit of which is given by the integration of different approaches? What would a “more integrated view” consist of exactly, and with respect to what aims should it be measured (e.g., would integration lead to a more inclusive account, a more detailed one, one with higher predictive power, ...?) In sum, if, on the one hand, the integrative stance is considered in the positive, the approach is appreciated for stressing compatibility and consilience among fields, and for fostering inter-disciplinary and trans-disciplinary collaboration among fields. On the other hand, worries are expressed regarding whether the implementation of an integrative attitude brings with it the overcoming, in the long run, of pluralism itself, thereby implying that plurality would eventually be dissolved into unity.

Another view of pluralism that stresses both scientific practice and collaborative work among fields is discussed by Stephanie Ruphy as “foliated pluralism”, which is presented as a view meant to “capture essential features of contemporary scientific practice, such as the transdisciplinary and cumulative ways of proceeding to gain new knowledge, resulting from the simultaneous use of different styles of reasoning” (Ruphy, 2016, p. xvi). Ruphy presents this approach as far from any appeal to “patchwork” forms of disunity of science, which might just be based on the recognition that different methods are to be applied when addressing specific types of objects; rather, ontological-methodological foliated pluralism is characterized by transdisciplinarity, synchronicity, non-exclusiveness, and cumulateness. Ruphy stresses that “there do not exist different things of things that can be known only in different ways, precisely because several styles may be mobilized to study a given type of objects [...], and the domain of application of a style is not ontologically marked out; on the contrary, it is open and revisable” (*ibid.*, p. 33). In this perspective, it is remarked that philosophical understanding of scientific situations in which plurality is given should foster cooperation between the different approaches involved, “having compatible pluralism as our epistemic horizon” (*ibid.*, p. 135).

Interactive pluralism, between integrative and isolationist pluralism, has been advocated to avoid the risks both run. As a sort of intermediate view between the two, it claims that “satisfactory explanations can also be obtained without integration of multiple levels” and which, while *not* establishing an integration *imperative*, “does not discourage interaction as, in some instances, interaction and integration do lead to better explanations” (van Bouwel, 2014, p. 109). *Interaction* is presented as the most plausible, constructive and fruitful epistemological option to be adopted to make different positions actively foster useful exchanges between one another and cross-fertilize fields. Exchanges, while encouraged, are not forced in any particular, pre-established direction – as integration, vice versa, might hint – and interactions are considered in the positive *per se*; integration is admitted, but not pursued as the necessary target of pluralism.

Compatibility and possible mutual interactions are certainly always worth testing, but integration is not to be assumed uncontroversially as the preferred strategy from the very beginning. At the same time, stressing that exchange and interactions are needed to address plurality brings with it the idea that different disciplines, or

sub-disciplines or research groups are to collaborate.⁹ In this sense, pluralism is also related to the social nature of scientific investigations, to wide and open debate, interfield work, peer review processes, transparent methodologies and, ultimately, democratic science, driving collective knowledge production. Discussing pluralism implies discussing also whole research programs, explanatory standards and – more or less shared – values and interests. An enduring pluralism concerns a whole range of aspects in scientific investigation:

The particular research program that occasions an explanation [...] determines which causal patterns explains the focal phenomenon. And so, by influencing which research programs are pursued, individual and shared interests, concerns, and values shape the content of our explanations – not just what we aim to explain, but in what in fact explains those things. [...] Research program emphasizing different causal patterns is simple what is meant for them to have different epistemic purposes. The epistemic acceptability of even the same posit will be judged differently when the focus is on different causal patterns (Potochnik, 2017, p. 200).¹⁰

Overall, as already remarked in presenting integrative pluralism, all views addressing plurality by advocating one version or another of pluralism have to deal with a crucial issue: is pluralism a permanent option, or is it related to some provisional feature of our construction of knowledge, to be eventually surpassed in the long run? Answers can differ. Embracing some moderate form of pluralism might imply the advocacy of just a *temporary* co-presence of alternative theories, ultimately aimed at achieving some form of unity in the long run. Differently, pluralism can be held to persist, being not contingent features of research or a symptom of the allegedly immature character of investigations, but rather due to the inherent complexity of the systems under enquiry, and hence of the epistemic activity to be entertained to deal with them. If so, pluralism is a *permanent* feature of scientific endeavor we should all, normatively, strive for. As stressed by Chang's (2012) *active normative epistemic pluralism*, different approaches must be enhanced insofar as they address different epistemic aims and satisfy different – sometimes divergent – epistemic values (such as, e.g., simplicity and completeness). According to Chang, pluralism offers twofold benefits, conveyed through, first, *toleration* and, then, *interaction*. Toleration amounts to “insurance against unpredictability, compensation for the limitations of each system, and multiple satisfaction of any given aim,” while interaction includes “the integration of different systems for specific purposes, the co-optation of beneficial elements across systems, and the productive competition between systems” (Chang, 2012, p. 253). Far from dissipating resources, normative epistemic pluralism is very careful not to admit of *any* simultaneous contribution whatsoever, thus avoiding ending up in relativism. It must be strongly stressed that pluralistic science is not the pursuit of some “*anything goes*” kind of endeavor, but the commitment to promote a motivated and justified “*many things can go*” attitude. Pluralism does not imply relativism, and relativism, in turn, does not per se imply

⁹On the appeal to different disciplinary fields in the endorsement of different kinds of explanations, see Brigandt (2013).

¹⁰My discourse is confined here to *epistemological* pluralism.