

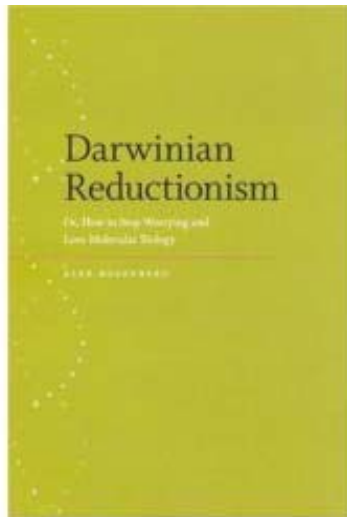
Book Review

Darwinian Reductionism

Or how to Stop Worrying and Love Molecular Biology

Alex Rosenberg

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Could the *science of life* be considered an independent research field? What about the promising successes achieved by molecular biology during the last fifty years? The massive recourse to methodologies derived from physics and chemistry that characterize the recent biological development calls into question its own autonomy from a more basic level of knowledge, giving rise – within the scientific and philosophical community – to both *enthusiasm* for renewed reductive perspectives and *alarm* for the loss of independence of our conception of life.

After the molecular revolution – which took place in 1953 when *Nature* published the famous Watson & Crick's article about the structure of Deoxyribose Nucleic Acid (DNA) –, it

has become clear that we need to determine whether biology should be considered an independent research field or, rather, only a complex conceptual construction quickly reducible to some more basic knowledge.

This condition has promoted a sort of ideological dualism, represented by the conflict between *reductionists* and *anti-reductionists*. The former convinced of the possibility and desirability of a complete translation of all biological knowledge into a more basic framework, the latter contrary to a conception of biology that does not recognize its intrinsic autonomy.

With his book, Alex Rosenberg tries to defend the reductionist paradigm against the anti-reductionist challenge; by analyzing in detail some of the most important problems for a molecular approach to the domain of the natural phenomena of life, he tries to solve the puzzle represented by the reductive strategy for an evolutionary formulation of biology.

Besides the epistemic limits concerning the actual development of our knowledge, the reductionist project – as reminded in the first chapter – suffers from another important limit, which is very well expressed by Dobzhansky's dictum "Nothing in biology makes sense except in the light of evolution". How could it be possible, in fact, to re-define the evolutionary theory and its central Darwinian core represented by natural selection into a more basic scientific framework only through the aid of physical, or chemical, concepts? This is the question that moves Rosenberg's work toward the definition of a non-naïve reductive strategy, capable of considering the evolutionary epistemic peculiarity of biology.

Unlike Nagel's, Rosenberg's reductive strategy does not seek for bridge laws between biology and other sciences, because he assumes in the first place that there is a *structural diversity* between physics and the science of life. For Rosenberg, the absence of a functional



formulation of biology does not allow the implementation of a “classical” reductionist procedure based on the translation of a law to another more basic law, or set of laws.

To reconfigure the debate about reduction is the main aim of the eight chapters of Rosenberg’s book. Once avoided the functionalist neo-positivist conception of reductionism, what the author is interested in is to defend an explicative conception of molecular biology, considered as the best research program capable of providing a deeper and complete explanation of all biological phenomena. Introducing the analysis of developmental biology, Rosenberg rejects the claim that satisfying the reductionist project leads necessarily to some loss of biological understanding. Within Rosenberg’s analysis, developmental biology appears to be the main field of research, where the success of the molecular approach shows all its explicative power. Historical *mysteries* concerning, for example, the process of multi-cellular fertilization, embryogenesis and maturation, find in the molecular approach a new experimental and scientific dimension. Molecular biology allows the identification of the micro-mechanisms whereby cells manifest their developmental capacities, and it does this without having to attribute intentional properties to non-intentional systems like cells or biological processes.

The surprising results obtained in the study of the fruit flies’ *eyeless gene*¹ and of its homologue (found in mice) show how the role of molecular genetics is important for the explanation of developmental processes. The inexplicability, within a macro-biological domain, of several experiments on the process of eye formation and localization, as well as the puzzling presence of genetic homologues among different species, are, for Rosenberg, an indisputable evidence of the major explicative power of a molecular approach to the phenomena of life.

Rosenberg analyzes another important argument against the reductionist project by distinguishing the reductive program from the eliminativist thesis. Far from sustaining the elimination of terms referring to a non-molecular level of description, Rosenberg instead claims that reductionism is a research field rooted in a piecemeal and opportunistic fashion, capable of providing more explicative and predictive solutions than other strategies. Here, probably, Rosenberg’s conception “falls” into an ideological formulation of reductionism, without clarifying the actual epistemic role assigned to a non-molecular biology. If what Rosenberg’s reductionism denies is that there are distinct causal properties that are not open to identification at a (macro) molecular level, what is not perfectly clear is the specific kind of knowledge that a non-molecular biology could bring within a reductionist framework. So, why not trying to extend the reductionist program to all biological terms? This doubt still remains after Rosenberg’s analysis of the epigenetic challenge to genetic-centrism. If in all cases it’s the stability of genes, at a molecular level of description, that explains phenomena concerning the interaction between an organism and its environment, then there are no grounds for contributions from a non-molecular context.

Another fundamental target of Rosenberg’s work is to defend the legitimacy of the notion of gene. Assuming that the concept of gene is not a “natural kind”, the author proceeds with his pragmatic approach, according to which the absence of a list of natural features permits a

¹ The *eyeless gene* is a control-gene whose activation is necessary and sufficient to activate some groups of other genes and start the production of a cascade of proteins involved in the formation of a fly’s eye.



relational definition of the notion of gene. Is the role of natural selection – that Rosenberg considers to be crucial here – influencing the methods for individuating genes as local outcomes of a continuative evolutionary process?

For Rosenberg, natural selection appears to be of primary importance in biology also for another reason. Recognizing natural selection as the only and fundamental law of biology is, in fact, for him, the main way to contrast the challenge of anti-reductionism, consisting in the claim that biology embodies no laws, or other generalizations, suitable for a reductive explanation. By defining the Principle of Natural Selection (PNS) as the assumption for which *if there is random variation among replicators, then there will be selection for differences between them, or between their interactors*, Rosenberg intends to demonstrate the historical and explicative nature of biology. He takes PNS as the unique and fundamental law of biology, that is: he claims that biology became an historical discipline when the laws of progressive chance were found and codified in the Darwinian theory of natural selection. For Rosenberg, the defense of a reductionist approach depends on whether or not we are able to reduce PNS to a molecular level of description. As observed by Rosenberg himself, if the anti-reductionists can show that the PNS by itself demands an approach to biology which is not compatible with the reductive project, then that would make reductionism an indefensible perspective.

The strategy adopted by Rosenberg consists of showing how it is possible to conceive Natural Selection as a physical process describable at a macro molecular level, and how this can be physically explained. Starting with the description of a set of atoms, interacting according to the laws of chemistry, to compose other more complex molecules, Rosenberg is able to retrieve a notion of a natural selected system, drawing the attention to the *stability* of the molecular system compared to the environment. Moreover, increasing the complexity of the molecular interaction makes it possible to predict the formation of self-replicant macro-molecules, that maintain a proper selective character, some of which approximate an optimal environmental combination of stability and replication. The result is for Rosenberg the spontaneous selection of the fittest molecules, permitted only by laws of chemistry no further reducible.

What's important to notice here is that Rosenberg's reductionism does not require that PNS should be explained by a process of selection at the immediately lower level, instead, what Rosenberg does require is only that, wherever selection operates, it could be eventually explained at some level in the succession of the reductive process, and that a description of the natural selective process at the macro-molecular level is possible, in principle.

In the last part of his book, while defending his reductive stance, Rosenberg also faces – besides the epistemological issues – some of the most salient problems that genetic reductionism involves. If on the one hand he shows a moderate approach to socio-deterministic properties ascribable to genetics, on the other hand he attributes the fundamental power of shedding light and guiding the research on how some aspects of our social behavior emerge to the genetics analysis. Examples concerning social instincts present in animals without linguistic abilities, or the hypothesis concerning a genetic involvement in cases of socio-cognitive deficits, appear, to Rosenberg, evidence of how the influence of genetics shapes the organization of our social life.



In the past few years, the general increase of endorsement for reductive strategies – for example from developmental biology, physiology and medicine – has given rise to several problems in bioethics, which appear to be of great importance to the public opinion, and that, for Rosenberg, risks to generate confusion about the real aims of genetic and molecular biology. Questions concerning the actual availability of genetic deterministic-diagnoses, or the naïve hypothesis of a one to one correlation between specific human features and specific genetic situ, are the challenges that the community of biologists is called to face today, and upon which the future development of molecular biology may depend.

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