WHAT EPIGENESIS CAN DO

Lenny Moss, *What Genes Can't Do*. Cambridge, Mass.: MIT Press, 2003. Pp. 228. US$34.95 HB.

By Karola C. Stotz

Lenny Moss's historically informed philosophical analysis, rhetorical criticism and empirical–scientific discussion of the gene concept and some of its empty promises arrives in a timely fashion for the fiftieth anniversary of the discovery of the molecular structure of DNA, a time when almost everybody else seems happy to join a big party in celebration of the subsequent advances in molecular genetics (with the notable exception, despite its title, of Evelyn Fox Keller's *The Century of the Gene*, Cambridge, Mass., 2000). Moss, as a cell biologist turned philosopher, is uniquely equipped for this task, and is motivated by a concern with the intellectual, ethical, and social implications of our understanding of biology. Philosophically speaking, he hopes to gives a 'naturalised' explanation of organised life forms (including humans) without the need to fall back up on some kind of preformationist entities as a shortcut for not yet fully understood natural processes, and "thereby better to allow for the re-embedding of the self-understanding of human language and knowledge in contingent social and developmental processes" (p. xiv). This important project fits well with similar recent efforts to counterbalance the long preoccupation of philosophers with evolutionary, and more recently molecular, biology (see for instance David Moore's *The Dependent Gene*, New York, 2002).

Moss's primary concern is with the widespread notion that genes contain information-specifying phenotypic traits, or a blueprint for the organism. He highlights the historical debate between epigenesis and preformationism over the explanation of biological form as the background to modern debates over the correct understanding of the gene (and he opposes the ubiquitous idea in modern philosophy of biology that Darwinian evolution and Creationism have been the only two basic organising principles in the study of life). The rise of the gene concept in the first half of the twentieth century marked a 'phylogenetic turn' away

Metascience **12:** 414–417, 2003.

from an ontogenetic understanding of adaptation, in the sense that the genetic program became the principal means by which adaptive changes were believed to be acquired over the course of multiple generations, i.e. phylogenies. This in turn cemented the dominant position of genetic determinism, following the preformationist tradition, and pushed epigeneticists (by then called developmentalists) to the margins. Contrary to most standard histories of biology, Moss does not see Darwin as the central figure separating two traditions. The first historical phase in Moss's account takes place well before Darwin, which shows how much earlier debates in biology played (and continue to play) a critical influence in shaping the concepts through which biologists understand life. It would also be wrong to identify Darwin as the key player in initiating the second, phylogenetic, phase, which in fact did not commence before the dawn of the twentieth century and the emergence of the so-called 'neo-Darwinists'.

At the heart of the book stands Moss's claim that in current scientific and clinical usage there are two distinctly different meanings of 'gene' in play, Gene-D and Gene-P, each heir to one of his two major historical schools, preformation and epigenesis. The preformationist gene (Gene-P), which also came to underlie the phylogenetic turn, is not actually a physical entity but is rather an instrumental device for predicting a phenotype. The epigenetic gene (Gene-D), defined by its molecular structure, is supported by an ontogenetic approach and is just one among many developmental resources. At root each concept is legitimate and empirically accountable within its 'native' disciplinary context but these two senses of the gene, for lack of clarification, are prone to blend into one another (especially in cross-disciplinary, public, and other disciplinary contexts, such as, perhaps, psychology). Hence, and this is the most important claim made in this book, it is not these two concepts in themselves, but their conflation into a single 'informational gene' that causes many of the wrongheaded ideas about what genes are (e.g. blueprints, engine of life, a 'giant epic written in three billion runes') and what genes can do (e.g. determining a phenotypic outcome). Moss attempts to provide the needed clarification to prevent this conflation.

The hardest part of Moss's theory to grasp is perhaps his concept of Gene-P. A Gene-P is not a gene for function, nor is it merely the embodiment of a 'top-down' approach to studying genetics (because on reaching 'down' there is no Gene-P). Instead, Gene-P allows us to track the transmission of phenotypes 'as if' they were caused by discrete atomic units – even though they are not. Gene-P is an instrumental device that reflects 'something' about the biology of complex multicellular organisms, but something we don't yet understand very well.

Moss suggests that genes for phenotypes (Gene-P) have to be understood as explanatory entities completely different from any of the entities also referred to as 'a gene', but which using some stretch of DNA as a point of departure. Only once the Gene-P sense of the gene is identified and isolated is it possible to consider the meaning of genes that are specified by their nucleic acid sequence, without the burden of additional phenotypic responsibilities, obligations or presuppositions. This is what the author tries to achieve with his Gene-D concept. Once the preformationist baggage is dropped, one can examine the new menagerie of DNA-based players on their own terms: promoters, enhancers, various binding motifs, introns, exons, sequences that play more than one molecular role, repetitive sequences, and sequences that have transposon characteristics that may occasionally serve to reorganise the architecture of chromosomes. A Gene-D provides coding resources, nothing less; but – since it does not determine the outcome of any cellular process – nothing more either.

According to Moss, our currently largely preformationist gene concept, encapsulated in metaphors like the genome as the 'book of life', is the result of the illegitimate conflation of these two senses of gene, held together by the rhetorical glue of the 'gene-as-text' metaphor. In some cases we can legitimately talk of 'genes for' a trait, but these are simply not physical entities. In other cases we can equally legitimately identify genes with a particular stretch of DNA, but the genes thus identified will not be linked to a particular phenotype. The gene concept foisted upon us by conflating these two is the idea of a gene as a physical entity that also codes for traits. This gene does not exist: no gene is simultaneously a Gene-P and a Gene-D.

A large part of Moss's book is spent defending the view that increased understanding of developmental and molecular biology is going to reveal important deficiencies in the reductionistic paradigm of contemporary genetics, deficiencies that will constrict future research. He argues that new conceptual approaches are needed to tackle the enormous complexity of living cells or the whole organisms (for similar views, see e.g. Gilbert and Sarkar's "Embracing Complexity: Organicism for the 21st Century", *Developmental Dynamics*, 2000; and Strohman's "Ancient Genomes, Wise Bodies and Unhealthy People", *Perspectives in Biology and Medicine*, 1993). Moss exemplifies this thesis in an extended discussion of a topic new to the philosophy of science, the biology of cancer. Research in this field has been shaped throughout the twentieth century by the 'somatic mutation hypothesis'. The empirical shortcomings of oncology's emphasis upon genetic susceptibility to cancer and the conflated preformationist view that caused it, Moss argues, is gradually leading the mainstream of

oncology toward a more epigenetic view of cancer etiology. At the end of the book, Moss looks ahead to "the nature of molecularized biology *after the gene*" (p. 184). Here the author reveals his ultimate goal: since he holds the conflated contemporary gene concept empirically accountable for the scientific and cognitive consequences he discusses in his book, he aims to replace it with an epigenetic theory of the molecular and multi-modular constituents of the cell.

Moss raises significant and uncomfortable questions about the gene-centred orientation in contemporary biology and medicine and the impact of metaphors used to ascribe, and more often than not, over-ascribe, certain power to the genes. He conveys a wealth of historical and cell-biological information, and employs an array of alternative metaphors to talk about what genes can – and can't – do (e.g. 'regulatory lawyers and politicians', 'complex constituent committees'). His book does not, however, make for easy reading, and for some of the very urgent questions raised at the beginning, the author does not (and probably cannot) offer satisfying answers. He needn't do so to justify writing this fascinating book, however, since very often the questioning of truisms, received views, and entrenched myths is just what drives science and society towards deeper understanding.

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