

CHAPTER 2

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THE CLASSICAL GENE: ITS NATURE AND ITS LEGACY

1. INTRODUCTION

Much has been written in recent years by biologists, historians, and philosophers of biology about the gene concept and its evolving meaning over time (Burian, 1985; Darden, 1991; Falk, 1986, 1995; Kitcher, 1982; Portin, 1993; Gifford, 2000; Rheinberger, 2000). These studies have provided a useful review of the literature tracing the term through almost a century of its changing meaning (Portin, 1993) and various philosophical usages. The terms 'classical gene,' 'developmental gene,' 'biochemical gene,' and 'molecular gene' all have appeared in the recent historical and philosophical literature. But it has not always been clear how these terms differ from one another, whether they map onto specific chronological periods, or the extent to which they overlap in meaning (e.g., how similar or different are the 'classical' and the 'developmental' gene?). Few contemporary geneticists or historians/philosophers of science would deny that the concept of the 'gene,' referring to the material basis of heredity, has undergone significant changes in the course of its evolution during the past century. The key question is: what is the nature of that change? Is it quantitative or qualitative? Has there been divergence into competing gene concepts either in the past or in recent times? How can the history of gene concepts help to illuminate some of the current questions and problems scientific and ethical confronting modern researchers and policy makers about issues such as genetic manipulation, privacy rights, patenting of genes, and the medicalization of social behaviors that are claimed to have a "genetic" basis?

In this chapter, I explore one facet of this complex history: the development of the 'classical,' or what I will call the 'derived Mendelian gene,' from the rediscovery

of Gregor Mendel's work through the mid-1930s. My major thesis is that this view of the gene, especially as it became codified in biology and genetics textbooks and in popular literature (both genetic and the associated eugenical writings of the time), contained many connotations and implications that are still associated with the term 'gene' as it is understood today. I argue further that these connotations developed out of two related movements in the early decades of the century:

- (1) the attempt to fashion a new image of biology as a hard, experimental science, akin to, and based on, physics and chemistry, put forward by a younger generation of investigators (born after, roughly, 1860); and
- (2) the adherence by this same younger generation to a strong mechanistic materialism that became both the foundation and rationale for the new science.

In this paper, I focus particularly on the influence of mechanistic materialism on biology and genetics during the early decades of the twentieth century.

Mechanistic materialism, or the mechanical philosophy, was hardly new to biology at the turn of the twentieth century. In one way or another it had been a cornerstone of much of Western science since the scientific revolution. It had been imported into areas of the life sciences in the seventeenth century by René Descartes, William Harvey, Robert Boyle, and Giovanni Borelli (among others); in the eighteenth century by Stephen Hales, Joseph Priestley, Luigi Galvani, and others; and in the mid-nineteenth century by Hermann von Helmholtz, Emil Du Bois-Reymond, and the Berlin medical materialists. It also formed a focal point for the "new" biology of the early twentieth century. Even among researchers familiar with the more subtle developments in the field of genetics in the last half-century, especially popularizers of genetics and textbook writers, the mechanistic notions surrounding the concept of the gene persist and influence the very way we conceptualize our understanding of the hereditary process. Because of my own interest in the way genetics has evolved in the area of medical and social policy, I will focus the last part of this chapter on the implications of the mechanistically-conceived gene for present-day research into the supposed inheritance of many personality and behavioral traits in human beings.

For the purposes of convenience and clarity I will follow Petter Portin's chronological division of the history of genetics since 1900 into three periods (Portin, 1993, pp. 173-4):

- (1) the period of the 'classical gene,' based on Mendel's original work up through the work of the Morgan and Emerson "schools," as well as that of Barbara McClintock, Theodosius Dobzhansky, and H.J. Muller (1900-1930);
- (2) the period of the biochemical or developmental gene, including the work of Boris Ephrussi, George Beadle, Edward Tatum, Conrad Waddington, and to some extent, that of Richard Goldschmidt (1930-1955); and
- (3) the period of molecular genetics, beginning with discovery of the structure of DNA and continuing through to the Human Genome Project (HGP) and beyond,

and including the work of James Watson and Francis Crick, Matthew Meselsohn and Frank Stahl, Severo Ochoa, Joshua Lederberg, Sydney Brenner, Marshall Nirenberg, Jonathan Beckwith, Scott Gilbert, and many more concerned with the molecular structure of the gene and its functioning in transcription and translation (1955-present).

I am tempted to add a fourth period, one which we may be just entering at the present time, which could be termed the period of 'molecular/developmental genetics,' characterized by what many see as the concrete prospects of returning to the century-old problem of embryonic development in terms of genetic regulatory elements such as signal transduction pathways between the developing embryo and its external environment (e.g., in the work of Shaun Carroll, Christiane Nüsslein-Vollhard, and Eric Wieschaus, among others). It is, however, primarily the first period that I examine in this chapter, largely because I think the paradigm of the gene laid down during that time is the one that has persisted in the conceptualization of genetics by all but those working directly in the laboratory—and even many of those—studying inheritance in complex (eukaryotic) organisms.

2. THE CONCEPTUAL AND PROFESSIONAL TRANSFORMATION OF BIOLOGY, 1880-1930

The field of biology (not including the medical/physiological sciences as they are currently defined) underwent a major transition in the late nineteenth and early twentieth centuries. In 1880 biology was a descriptive enterprise, dominated by areas such as comparative anatomy, the classical embryology of Francis M. Balfour and Carl Gegenbaur, taxonomy, and, with the growing acceptance of an evolutionary framework, areas of natural history such as biogeography and phylogeny. By the 1930s however, a new generation of biologists considered their discipline to be radically different: more experimentally-based, more rigorous, and concerned more with fundamental—even universal—principles and less with merely describing the structural, functional, and taxonomic relationships of organisms. As I have discussed this transformation at length in a number of previous publications (e.g., Allen, 1983, 1991), I will only summarize here the broad features of what I think it involved. In the sense of professionalizing the field for the current century, however, this transitional period may be characterized as "the coming of age of biology."

Long dominated by concerns of descriptive natural history and taxonomy, biology had experienced its first major paradigm shift with the introduction of Darwin's theory of evolution by natural selection during the latter half of the nineteenth century. As it replaced the older theory of the origin of species by special creation, Darwin's paradigm showed that the most profound concerns of natural history, the origin of life's immense diversity, could be accounted for by natural laws derived, in the best sense of the term, by the process of consilience—the

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