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Gene Concepts in Higher Education Cell and Molecular Biology Textbooks

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ABSTRACT: Despite being a landmark of 20th century biology, the 'classical molecular gene concept,' according to which a gene is a stretch of DNA encoding a functional product, which may be a single polypeptide or RNA molecule, has been recently challenged by a series of findings (e.g., split genes, alternative splicing, overlapping and nested genes, mRNA edition, etc). The debates about the gene concept have important implications on biology teaching, and, thus, it is important to investigate whether and how these are addressed in this context. In this paper, we report results of an investigation relating to the treatment of genes in higher education cell and molecular biology textbooks. These results indicate that, despite several findings challenging time-honored ideas about genes, these ideas continue to be widely used in textbooks, even though the textbooks themselves discuss part of those findings. Textbooks also harbor a proliferation of meanings about genes that may make the concept look vague and confused, and even lead to ideas that are at odds with our current knowledge about genomes.

KEYWORDS: Biology teaching, gene, higher education, textbooks.

Introduction

The term "gene" was created by the geneticist Wilhelm L. Johannsen in 1909 and has certainly been a landmark in the history of biology in the 20th century. Snustad, Simmons, and Jenkins (2005, p. 381) argue that "the gene is to genetics what the atom is to chemistry" (see, also, Keller 2000, 2005). Indeed, few would disagree that the gene was (and still is) the central unifying theme of genetics, even though it is, at present, a "concept in tension" (Falk, 2000) or "in trouble" (Keller, 2000). This situation results from a series of findings during the last three decades that posed important challenges to our usual understanding of the gene concept, such as, split genes, alternative splicing, overlapping and nested genes, mRNA edition, alternative translation modes, etc. (see, e.g., Fogle, 1990, 2000; Falk, 1986, 2000; Pardini & Guimarães, 1992; Griffiths & Neumann-Held, 1999; Keller, 2000; Moss 2001, 2003; El-Hani, Queiroz, & Emmeche, 2006; El-Hani, 2007; Neumann-Held & Rehmann-Sutter, 2006).

In the philosophical literature, the usual way of understanding 'genes' has been designated as the "classical molecular gene concept" (Griffiths & Neumann-Held, 1999; Stotz, Griffiths, and Knight, 2004). According to this concept, a gene