
The molecular gene concept in the post-genomic era

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Abstract

Genome-wide analyses of transcriptomes have revealed that the vast majority of the eukaryotic genome is transcribed, mostly as non-coding RNAs. Besides, the extensive overlap of transcriptional units and regulatory elements reveals that genomic architecture is not linear, but highly interleaved. Altogether, the pervasive transcription and the complex genomic organization challenge the concept of the gene. Despite multiple attempts, biologists did not reach a consensus on a molecular definition of the gene. Neither did they clarify whether sequences transcribed in non-coding RNAs should be or not considered as genes. But, more importantly, post-genomic analyses urge to reconsider the status of the gene concept. If the gene concept is to survive the crisis it currently faces, it will have to depart from three historical commitments associated with the classical molecular gene. First, the post-genomic molecular gene concept will have to take into account the great structural diversity of functional genetic elements in eukaryotic genomes. Second, it will have to pay more attention to the long evolutionary history of these genomes, which has resulted in a highly complex genomic organization. Finally, the gene can no longer be the privileged level to characterize the relations between genotype and phenotype. Therefore, the post-genomic era prompts to reexamine the explanatory value of the gene concept. The gene may lose some of its theoretical power, but, instead, a richer and finer representation of the structural and functional properties of the genome will emerge.

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