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THE EVOLVING DEFINITION OF A GENE IN THE CONTEXT OF MODERN PLANT BREEDING

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The laws of inheritance that are the great legacy of Gregor Mendel were derived from the analysis of diploid pea individuals that could be either homozygous or heterozygous for the specific gene controlling one of the 7 traits analysed. The definition of gene, however, has profoundly changed since Mendel's pioneering work. The coining of the term gene is not to be attributed to Mendel who rather talked about cell elements but to the Danish botanist Wilhelm Johansen in 1909 when he first used it to describe the units of inheritance. Since then, its definition has changed multiple times as our knowledge of the structure of genes and genomes increased. Stadler in 1954 talked of an operational and a hypothetical gene concept and this is a signal of the difficulties that have always been encountered in defining what is one of the basic concepts of genetics, which went from being abstract hereditary factors in Mendel and Johansen views to being physically defined entities grounded in the DNA sequence and defined by precise boundaries to being again rather undefined entities that today we cannot completely identify in all their components in the genome. The deepening of our knowledge about the intricacies of gene regulation makes the identification of all the elements that compose a gene very difficult and we cannot identify even in fully sequenced genomes where each gene starts and ends. The accurate identification of all regulatory elements that together with the transcribed region make up a gene is, however, a prerequisite for the effective utilization of genome editing technologies in future breeding endeavours because the improvement of complex traits will often require the fine tuning of gene expression either spatially or temporally. We will discuss possible approaches to obtain a more accurate

depiction of the complete structure of plant genes.