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# Repetitive DNA: An Important Source of Variation in Eukaryotic Genomes

In the last few decades, the architecture of the three genomes of a eukaryotic cell (i.e., nuclear and mitochondrial DNA and chloroplast DNA) has been explored in great detail. These studies have originated with the determination of complete DNA sequences for the organelles and/or nuclear genomes of a handful of model organisms. The first two plant species, for which all three genomes have been sequenced, are the model organisms *Arabidopsis thaliana* and *Oryza sativa*.

The basic organization of the three genomes present in plant cells is fundamentally different. The chloroplast DNA (cpDNA) molecule, typically ranging from 15 to 160 kb in size, is packed into grana and thus resembles the streamlined configuration of its cyanobacterial ancestral genome.<sup>1,2,3</sup> In contrast, the nuclear genome of plants (and other eukaryotes) can be viewed as a huge ocean of largely noncoding DNA with some bits of thousands of genes and gene clusters scattered throughout. A significant portion of non-coding DNA is repetitive DNA, which consists of tandemly repeated units and may be considered as part of the cpDNA genome.<sup>4,5,6,7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup>

The plant mitochondrial DNA (mtDNA) exhibits a number of features with both the nuclear and the chloroplast genomes. Thus, plant mtDNA genes have polycistronic promoters just like cpDNA genes, but introns are more common.<sup>21</sup> With about 170–200 kb, the three higher plant mtDNAs are among the largest of any eukaryotic genome, but only about 10% of these sequences represent protein-coding genes.<sup>22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Another 10% is thought to be made up of repetitive DNA, including retrotransposons.<sup>21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup> Thus, the majority of plant mtDNA sequences lack obvious features of eukaryotic genes. The mitochondrial genome also reveals a dynamic and ongoing horizontal exchange of DNA between the three different genomes, resulting in a net import of genes of genes from the organelles to the nucleus.<sup>21,22,23,24,25,26,27,28,29,30,31,32,33,34,35,36,37,38,39,40,41,42,43,44,45,46,47,48,49,50,51,52,53,54,55,56,57,58,59,60,61,62,63,64,65,66,67,68,69,70,71,72,73,74,75,76,77,78,79,80,81,82,83,84,85,86,87,88,89,90,91,92,93,94,95,96,97,98,99,100</sup>

Repetitive DNA elements comprise the largest part of the nuclear genome in eukaryotic organisms, and various types of repetitive DNA are also found in