Epigenetic Regulation of Genes Mediated by Satellite DNA

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Satellite DNA is a highly repetitive DNA, organized in long tandem arrays, located in the heterochromatic regions of chromosomes. Repeats of satellite DNAs can be excised from their heterochromatin loci and integrate into euchromatin. This scenario was proposed to describe euchromatic dispersion of TCAST1, the species-specific major satellite DNA of beetle Tribolium castaneum, which is associated with numerous protein-coding genes. Dispersed repeats of TCAST1 (dTcast1) were present as monomeric or multimeric repeat units in intragenic (introns), as well as, intergenic regions. Our assumption was that dTcast1can influence the expression of associated genes.

Our results show that dTcast1 affects the adjacent genes under physiological condition by inducing a slight downregulation of gene expression. The effect is more pronounced after heat stress when transient increase of satellite DNA transcripts processed into TCAST1-siRNAs is induced. We showed that a temporary formation of heterochromatic state characterized by increased level of H3K9met2/3 at dTcast insertion sites and their spreading to the proximal regions is responsible for downregulation of nearby genes. In conclusion, dTcast1 satellite elements influence the level of expression of their associated genes through RNA interference-based „heterochromatinization“ and the level of suppression is positively correlated with the amount of transcripts of TCAST1 satellite DNA. Insertion of satellite DNA repeats within euchromatin provides genes with regulatory elements that modulate their activity in particular in response to environmental stress. Variation in satellite repeats insertion among individuals can in some cases provide phenotypic variation that could be acted upon by selection enabling satellite DNA to contribute to the evolution of gene regulatory networks.