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DEVELOPMENT

Parental influences on plant development

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Two ways in which parental genomes may influence the development of the early embryo are through the inheritance of maternal transcripts and through altering gene expression by genomic imprinting. In two recent studies, the authors have dissected the parental effects on early development in plants and found quite a different story to that in animals.

In animals, early development is controlled by maternal transcripts that are translated before the zygotic genome is activated. In a recent study, Nodine and Bartel set out to determine whether this was also the case in *Arabidopsis thaliana* using a transcriptomic approach. They crossed two polymorphic accessions of *A. thaliana* and performed RNA sequencing (RNA-seq) on poly(A)$^+$ RNA isolated from the hybrid embryos at the 1-to-2-, 8- or 32-cell stage. The polymorphisms allowed them to identify whether transcripts were derived from the paternal or the maternal genome. They also analysed the transcriptome of the embryos of reciprocal crosses to control for any inherent expression differences between the lines.

Nodine and Bartel showed that at each stage, the maternal and paternal ratios of the transcripts were equal, indicating that at these early stages, there is widespread transcription in the zygote. This is contradictory to the story in animals and indicates that zygotic genome activation occurs much earlier in plants: before the 1-to-2-cell stage. GFP reporter experiments in which the reporter and activator were located in the same embryo but on chromosomes of different parental origin confirmed active transcription from both maternal and paternal chromosomes before the first embryonic cell division. The authors also identified a small subset of transcripts in early embryos for which the expression patterns suggested a form of imprinting, but this did not affect the overall striking equal contribution of the male and female genomes to early transcripts.

In another paper, the role of an imprinted plant gene was investigated by Gutierrez-Marcos and colleagues. In order to develop, embryos need to obtain nutrients from the surrounding maternal tissue. In maize plants, the second fertilization product — the endosperm — acts as an interface between the embryo and the mother plant to facilitate maternal nutrient uptake into the seed via its specialized transfer tissue. The authors knocked down the maternally expressed imprinted gene *maternally expressed gene1* (*Meg1*), which encodes a signalling peptide, and showed that this peptide is necessary for transfer cell differentiation and sugar homeostasis during seed development. A further experiment to test the dosage effects of the gene in the endosperm was performed by generating transgenic maize containing a *Meg1* transgene linked to imprinted and non-imprinted promoters. By genetically crossing these lines, the authors showed that increased dosage of *Meg1* promoted transfer cell function and seed size, whereas imprinting served to regulate this process. These findings are in contrast to the situation in mammals, in which maternally expressed imprinted genes that affect nutrition generally limit the distribution of nutrients to the developing embryo.

The variation in parental effects on embryonic development highlighted by these studies will no doubt spark further research into the parental control of early embryonic development in these and other organisms.

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Image courtesy of J. F. Gutierrez-Marcos, School of Life Sciences, University of Warwick, UK.

ORIGINAL RESEARCH PAPERS Nodine, M. D. & Bartel, D. P. Maternal and paternal genomes contribute equally to the transcriptome of early plant embryos. *Nature* 22 Jan 2012 (doi:10.1038/nature10756) | Costa, L. M. *et al.* Maternal control of nutrient allocation in seeds by genomic imprinting. *Curr. Biol.* 12 Jan 2012 (doi:10.1016/j.cub.2011.11.059)