Mother controls embryo's gene activity

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Frog embryos do not fully control which genes they can turn on or off in the beginning of their development – but their mother does, through specific proteins in the egg cell. Molecular developmental biologists at Radboud University publish these results in *Nature Communications* on December 18.

Frog embryos do not only receive half of the genetic information from their mother, but also the instructions on how to use that DNA. That is what molecular developmental biologist Saartje Hontelez and her colleagues, led by Gert Jan Veenstra at the Radboud Institute for Molecular Life Sciences, have discovered. For a long time, scientist believed that the gene regulation is not inheritable.

Mother's tools

How does the influence of the mother work exactly? Hontelez explains: 'The mother delivers all kinds of tools like proteins and RNA which control the gene regulation of the embryo. And because these tools are very specific, the embryo is limited in its possibilities. The mother sets strict boundaries regarding which genes can be turned on and which cannot. It is only after the twelfth cell division that the embryo can produce its own RNA and thus have some influence on the gene regulation. But this process is still largely controlled by the mother until much later in the embryonic development.'

Surprise

'The amount of influence the mother has, surprised us. We always thought that gene regulation is not inheritable and therefore expected that the embryo is in control of it. But when we shut down the embryo's RNA production, this had surprisingly little effect. That was not only the case for important genes during early embryonic development, but also much later, well into the stages of organogenesis. This shows very clearly that the mother is responsible for the early stages of embryonic development, and that her influence is still strongly present in later stages as well.'

Fast development

For this publication, Hontelez and her colleagues investigated embryos of the western clawed frog (Xenopus tropicalis), because their embryonic development occurs very rapidly: there are only six hours between fertilization and the moment that the embryo's RNA production starts. For comparison: mammal embryos start producing their own RNA after twenty-four hours.

'When you consider the amount of eggs a frog lays, and how many of those eggs successfully develop into frogs, it is not surprising that embryos get a little help from their mother', Hontelez explains. 'It is a pre-programmed system, making sure that early embryonic development usually succeeds.' Can these results now be compared to the development of mice, or even humans? 'Yes, it probably works roughly the same. The biggest difference is that mammalian embryos start producing their own RNA after the first cell division. But the time until that moment takes much longer than in frogs. It is also worth noting that the genes involved in setting up the epigenome are all involved in human cancer.'

More information: Saartje Hontelez et al. Embryonic transcription is controlled by maternally defined chromatin state, *Nature Communications* (2015). DOI: 10.1038/NCOMMS10148

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