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# What mechanism generates our fingers and toes?

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Dr. Marie Kmita and her research team at the IRCM contributed to a multidisciplinary research project that identified the mechanism responsible for generating our fingers and toes, and revealed the importance of gene regulation in the transition of fins to limbs during evolution. Their scientific breakthrough is published today in the prestigious scientific journal *Science*.

By combining genetic studies with mathematical modeling, the scientists provided experimental evidence supporting a theoretical model for pattern formation known as the Turing mechanism. In 1952, mathematician Alan Turing proposed mathematical equations for pattern formation, which describes how two uniformly-distributed substances, an activator and a repressor, trigger the formation of complex shapes and structures from initially-equivalent cells.

"The Turing model for pattern formation has long remained under debate, mostly due to the lack of experimental data supporting it," explains Dr. Rushikesh Sheth, postdoctoral fellow in Dr. Kmita's laboratory and co-first author of the study. "By studying the role of Hox genes during limb development, we were able to show, for the first time, that the patterning process that generates our fingers and toes relies on a Turing-like mechanism."

In humans, as in other mammals, the embryo's development is controlled, in part, by "architect" genes known as Hox genes. These genes are essential to the proper positioning of the body's architecture,

and define the nature and function of cells that form organs and skeletal elements.

"Our genetic study suggested that Hox genes act as modulators of a Turing-like mechanism, which was further supported by mathematical tests performed by our collaborators, Dr. James Sharpe and his team," adds Dr. Marie Kmita, Director of the Genetics and Development research unit at the IRCM. "Moreover, we showed that drastically reducing the dose of Hox genes in mice transforms fingers into structures reminiscent of the extremities of fish fins. These findings further support the key role of Hox genes in the transition of fins to limbs during evolution, one of the most important anatomical innovations associated with the transition from aquatic to terrestrial life."

**More information:** www.sciencemag.org/content/338/6113/1476

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