

Study: How life generates new forms

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Credit: Stephen Alfred Forbes via Wikimedia Commons

When organisms change during the course of evolution, often what drives new forms is not genes themselves, but gene regulation —what turns genes on and off. A new study identifies the kind of gene regulation most likely to generate evolutionary change.

Most modern organisms store genetic information in DNA and transcribe the information from DNA into RNA. Protein "transcription

factors" that inhibit or enhance transcription of [genes](#) in the DNA are said to regulate [gene expression](#).

In a March paper in PNAS, a team at ETH and the University of Zürich demonstrated that [gene regulation](#) by protein transcription factors more readily powers [evolutionary change](#) than another form of gene [regulation](#) that works at the RNA level.

"That really surprised us," said senior author Andreas Wagner, SFI External Professor and Chairman of the Institute of Evolutionary Biology and Environmental Studies at the University of Zürich. "It's not self-evident. It's one of those things you just don't know before you look."

"New forms of regulation are crucial for a lot of new features of life," said Wagner. "What distinguishes the body plan of humans from that of sea urchins or fruit flies is new kinds of regulation—turning the right genes on and off at the right time."

Previous work by the same team showed that transcription factors show high levels of two key evolutionary traits—robustness and evolvability. A robust system functions relatively normally even when mutations occur. In contrast, an evolvable system is able to generate new forms or traits in response to new mutations.

Added lead author Joshua Payne (ETH Zurich, Swiss Institute of Bioinformatics) "We find that transcription factor binding sites are highly evolvable because mutations often create binding sites for other transcription factors. In this way, mutations to [transcription](#) factor binding sites can readily bring forth phenotypic variation."

The evolvability of transcriptional regulation may help explain why organisms switched from using RNA to store information some 4 billion

years ago, to using DNA and proteins, Wagner said.

"RNA mediated gene regulation is less evolvable than transcriptional regulation," is published in *PNAS* (March 26, 2018).

More information: Joshua L. Payne et al. RNA-mediated gene regulation is less evolvable than transcriptional regulation, *Proceedings of the National Academy of Sciences* (2018). [DOI: 10.1073/pnas.1719138115](https://doi.org/10.1073/pnas.1719138115)

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