Uncovering evolutionary secrets

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Elephant. Credit: Picture by Yathin S Krishnappa. Licensed under CCBY-SA3.0

How did the elephant get its trunk? Or the turtle its shell? How, in general, did the seemingly infinite diversity of complex animal forms on our planet arise? The scientific pursuit of how such "evolutionary novelties" come about is one of the big mysteries that biologists are trying to tease apart.

The University of Pittsburgh's Mark Rebeiz and colleagues provide some answers in a paper published today in the journal *Developmental Cell*.

Even in the most complex organisms, the genetic repertoire is limited. If creatures don't evolve by acquiring new genes, how do new anatomical structures arise? Physical structures—organs, limbs, etc.—are encoded during development through the actions of collections of genes that work together in "networks." Connections between genes in these networks take form primarily via gene products binding and controlling gene activation at regulatory sequences known as "switches." These switches function as a blueprint for how to build an organism. They represent information that can be exploited to understand a network's evolutionary beginnings.

Rebeiz, an assistant professor of evolutionary development in Pitt's Department of Biological Sciences within the Kenneth P. Dietrich School of Arts and Sciences, used these switches to uncover the origins of a recently evolved structure called the posterior lobe—part of the genitalia of a certain kind of male fruit fly. Other fruit flies lack these lobes, making it a simple test system to study how an anatomical structure originated.

How does a particular structure, and its network, originate without the evolution of new genes? The answer is to reuse, or "co-opt" a network that was already being used at another time and place during development.

Rebeiz and colleagues found that a switch that activates a critical factor of the posterior lobe's network could be traced to another network active during an earlier life stage. This led his team to find that several genes of the network that makes the posterior spiracle, a structure that connects the larval breathing system to the outside world, were redeployed during genital development through their posterior spiracle switches.

"How do you make something completely new?" asks Rebeiz. The answer, it seems, is to use something old. "By tracing the evolution of a network's switches," he says, "we can see how new structures are built from networks we never would have imagined to be related."

Provided by University of Pittsburgh

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