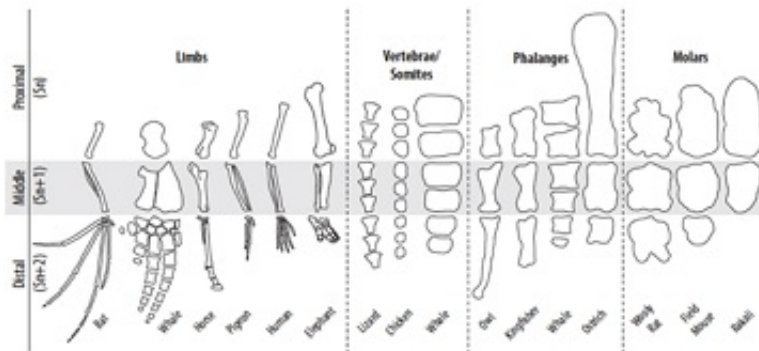


Research demonstrates shared rules of development can predict patterns of evolution in different species

April 2 2015



The evolution and development of structures as diverse as limbs, fingers, teeth, somites and vertebrae may have more in common than once believed, according to a new study by UMass Dartmouth Biology faculty member Kathryn Kavanagh, PhD, and UC San Francisco (UCSF) School of Medicine Assistant Professor Nathan Young, PhD.

The study, "Shared Rules of Development Predict Patterns of Evolution in Vertebrate Segmentation," was published in the research journal *Nature Communications* on April 1, 2015. UMass Dartmouth's Benjamin Winslow, PhD, and Endeavor Scholar and Biology student Sowmya Takkellapati are co-authors on the study.

The study uses experimental results in avians and comparative analysis of more than 1,200 mammal, avian and reptile species to offer potential insight into a universal design principle.

"In all these species, very different parts of the skeleton, such as fingers, teeth, limbs or [vertebrae](#), evolve variations in size proportions in the same way—even with clearly different genes involved," Kavanagh said. "This essential similarity among diverse structures seems to be a result of species using a similar style of developing skeletal segments in sequence as an embryo."

The results suggest that skeletons of different animals may use common self-organizing principles independent of specific genetic underpinnings.

"The signal is so strong and so widespread," Kavanagh said. "We have uncovered a law of nature."

The collaborative study finds that developmental programs governing segmentation create particular size variations that channel evolution in highly predictable ways.

"These results are exciting because they show that structures we think of as having much different evolutionary and developmental origins may utilize a similar inherited genetic 'logic,' which in turn appears to have a direct and measurable impact on how they can vary and evolve," Young said.

Numerous biology textbooks display a figure that contrasts the homology of segmented structures with dramatic evolved differences in their proportions and associated functions. Although these contrasts are known to have their roots in genetic patterning events shared from birds to mice, neither a universal rule linking the mode of development across different structures nor a mechanism for how this might impact how

they evolve has been previously identified.

Most notably, the UMass Dartmouth and UCSF study highlights that middle segments in a variety of species are consistently a third of the total size, while the first and last segments are highly variable and trade off in their proportions. According to the researchers, this pattern is consistent with predictions of a simple activator-inhibitor system.

Moreover, while past research offers insight into how segments of the skeleton form in different species, UMass Dartmouth and UCSF demonstrate that the effect of these early developmental patterning events are crucial to the generation and patterning of size and proportions, which has implications for the etiology of disease processes.

This developmental design rule has a number of new and important implications. This study provides crucial experimental and comparative evidence for a shared developmental "logic" and demonstrates the utility of high-level modeling independent of molecular identity. It provides a developmental explanation for why skeletons of different species evolve the way they do that may operate independent of function. The study also shows how simple rules of animal design may be reused in a range of structures to produce diverse outcomes.

The results of the study show how outcomes from comparative and experimental data are informative of the kinds of developmental interactions that are possible, providing explicit predictions that will help inform future models of development and [evolution](#). The research provides a potential common framework for a variety of developmental contexts to predicting both short-term responses to selection in population-level variation and long-term evolutionary patterns in a diverse set of species.

More information: "Shared rules of development predict patterns of

evolution in vertebrate segmentation." *Nature Communications* 6, Article number: 6690 [DOI: 10.1038/ncomms7690](https://doi.org/10.1038/ncomms7690)

Provided by University of Massachusetts Dartmouth

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