Biologists find genetic explanation for evolutionary change: Location

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A gene's location on a chromosome plays a significant role in shaping how an organism's traits vary and evolve, according to findings by genome biologists at New York University's Center for Genomic and Systems Biology and Princeton University's Lewis-Sigler Institute for Integrative Genomics. Their research, which appears in the latest issue of the journal *Science*, suggests that evolution is less a function of what a physical trait is and more a result of where the genes that affect that trait reside in the genome.

Physical traits found in nature, such as height or eye color, vary genetically among individuals. While these traits may differ significantly across a population, only a few processes can explain what causes this variation—namely, mutation, natural selection, and chance.

In the Science study, the NYU and Princeton researchers sought to understand, in greater detail, why traits differ in their amount of variation. But they also wanted to determine the parts of the genome that vary and how this affects expression of these physical traits. To do this, they analyzed the genome of the worm *Caenorhabditis elegans* (*C. elegans*). *C. elegans* is the first animal species whose genome was completely sequenced. It is therefore a model organism for studying genetics. In their analysis, the researchers measured approximately 16,000 traits in *C. elegans*. The traits were measures of how actively each gene was being expressed in the worms' cells.

The researchers began by asking if some traits were more likely than

others to be susceptible to mutation, with some physical features thus more likely than others to vary. Different levels of mutation indeed explained some of their results. Their findings also revealed significant differences in the range of variation due to natural selection—those traits that are vital to the health of the organism, such as the activity of genes required for the embryo to develop, were much less likely to vary than were those of less significance to its survival, such as the activity of genes required to smell specific odors.

However, these results left most of the pattern of variation in physical traits unexplained—some important factor was missing.

To search for the missing explanation, the researchers considered the make-up of *C. elegans*' chromosomes—specifically, where along its chromosomes its various genes resided.

Chromosomes hold thousands of genes, with some situated in the middle of their linear structure and others at either end. In their analysis, the NYU and Princeton researchers found that genes located in the middle of a chromosome were less likely to contribute to genetic variation of traits than were genes found at the ends. In other words, a gene's location on a chromosome influenced the range of physical differences among different traits.

The biologists also considered why location was a factor in the variation of physical traits. Using a mathematical model, they were able to show that genes located near lots of other genes are evolutionarily tied to their genomic neighbors. Specifically, natural selection, in which variation among vital genes is eliminated, also removes the differences in neighboring genes, regardless of their significance. In *C. elegans*, genes in the centers of chromosomes are tied to more neighbors than are genes near the ends of the chromosomes. As a result, the genes in the center are less able to harbor genetic variation.

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