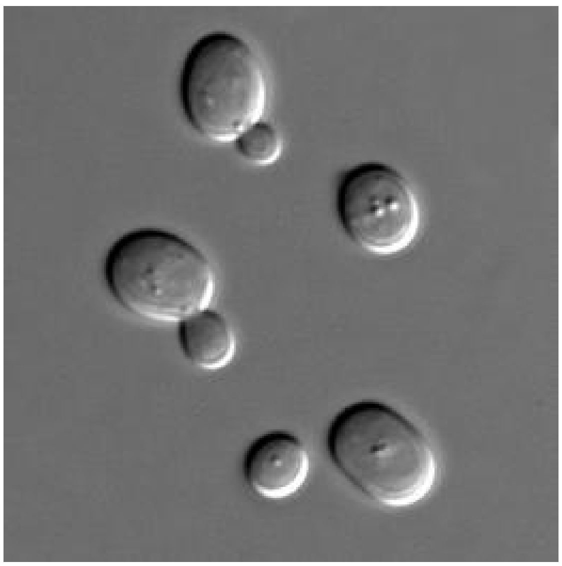
Yeast study yields insights into longstanding evolution debate

October 27 2020



Sacharomyces cerevisiae cells in DIC microscopy. Credit: Wikipedia.

In the past two decades, researchers have shown that biological traits in both species and individual cells can be shaped by the environment and inherited even without gene mutations, an outcome that contradicts one of the classical interpretations of Darwinian theory.

But exactly how these epigenetic, or non-genetic, traits are inherited has been unclear.

Now, in a study published Oct. 27 in the journal *Cell Reports*, Yale scientists show how epigenetic mechanisms contribute in real time to the evolution of a gene network in yeast. Specifically, through multiple generations yeast cells were found to pass on changes in gene activity induced by researchers.

The finding helps shed light on a longstanding question in evolutionary biology; scientists have long debated whether organisms can pass on traits acquired during a lifetime.

"Do genetic mutations have to be the sole facilitator of gene network evolution or can epigenetic mechanisms also lead to stable and heritable gene expression states maintained generation after generation?" asked Yale's Murat Acar, associate professor of molecular, cellular & developmental biology, a faculty member at the Yale Systems Biology Institute, and senior author of the paper.

During much of the last half of the 20th century, biology students were taught that mutations of genes that helped species adapt to the environment were passed on through generations, eventually leading to tremendous diversity of life. However, this theory had a problem: advantageous mutations are rare, and it would take many generations for physiological changes caused by the mutation to take root in a population of any given species.

Scientists in the last century have found that certain regions of DNA do not code for genes but regulate gene activity in the face of environmental change. The concept of passing on stable gene expression states to offspring resurrected the once widely discredited theories of 18th century French scientist Jean-Baptiste Lamarck, who first proposed inheritance of traits acquired during a lifetime.

For the new study, Acar lab graduate students and co-first authors Xinyue Luo and Ruijie Song wanted to investigate the role of epigenetic inheritance in the evolution of gene network activity in individual yeast cells, which reproduce asexually about every 100 minutes. As their experimental model, they investigated a gene network known as the galactose utilization network, which regulates use of the sugar-like molecule galactose, in the yeast. Through daily cell-sorting, they segregated the cells that had lowest levels of gene expression in the population and grew these cells in the same environment over a period of seven days.

Ultimately, they found expression level reductions persisted for several days and multiple generations of reproduction after the 7-day segregation period. Genetic causes alone could not explain the expression reduction; inheritance of epigenetic factors contributed to the observed change, the Yale team found.

Acar said the findings show a clear Lamarckian epigenetic contribution to gene network evolution and the classic Darwinian interpretation of evolution alone cannot explain our observations. "The findings support the idea that both genetic and epigenetic mechanisms need to be combined in a 'grand unified theory of evolution,'" he said.

Provided by Yale University

Citation: Yeast study yields insights into longstanding evolution debate (2020, October 27) retrieved 20 April 2024 from https://phys.org/news/2020-10-yeast-yields-insights-longstanding-evolution.html