Does evolution select for faster evolvers?

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It's a mystery why the speed and complexity of evolution appear to increase with time. For example, the fossil record indicates that single-celled life first appeared about 3.5 billion years ago, and it then took about 2.5 billion more years for multi-cellular life to evolve. That leaves just a billion years or so for the evolution of the diverse menagerie of plants, mammals, insects, birds and other species that populate the earth.

New studies by Rice University scientists suggest a possible answer; the speed of evolution has increased over time because bacteria and viruses constantly exchange transposable chunks of DNA between species, thus making it possible for life forms to evolve faster than they would if they relied only on sexual selection or random genetic mutations.

"We have developed the first exact solution of a mathematical model of evolution that accounts for this cross-species genetic exchange," said Michael Deem, the John W. Cox Professor in Biochemical and Genetic Engineering and professor of physics and astronomy.

The research appears in the Jan. 29 issue of *Physical Review Letters*.

Past mathematical models of evolution have focused largely on how populations respond to point mutations – random changes in single nucleotides on the DNA chain, or genome. A few theories have focused on recombination – the process that occurs in sexual selection when the genetic sequences of parents are recombined.

Horizontal gene transfer (HGT) is a cross-species form of genetic

transfer. It occurs when the DNA from one species is introduced into another. The idea was ridiculed when first proposed more than 50 years ago, but the advent of drug-resistant bacteria and subsequent discoveries, including the identification of a specialized protein that bacteria use to swap genes, has led to wide acceptance in recent years.

"We know that the majority of the DNA in the genomes of some animal and plant species – including humans, mice, wheat and corn – came from HGT insertions," Deem said. "For example, we can trace the development of the adaptive immune system in humans and other jointed vertebrates to an HGT insertion about 400 million years ago."

The new mathematical model developed by Deem and visiting professor Jeong-Man Park attempts to find out how HGT changes the overall dynamics of evolution. In comparison to existing models that account for only point mutations or sexual recombination, Deem and Park's model shows how HGT increases the rate of evolution by propagating favorable mutations across populations.

Deem described the importance of horizontal gene transfer in the work in a January 2007 cover story in the *Physics Today*, showing how HGT compliments the modular nature of genetic information, making it feasible to swap whole sets of genetic code – like the genes that allow bacteria to defeat antibiotics.

"Life clearly evolved to store genetic information in a modular form, and to accept useful modules of genetic information from other species," Deem said.

Source: Rice University