New study pinpoints why some microbial genes are more promiscuous than others

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A new study of more than three dozen bacteria species — including the microbes responsible for pneumonia, meningitis, stomach ulcers and plague — settles a longstanding debate about why bacteria are more likely to steal some genes than others.

While most organisms get their genes from their parents just like people do, bacteria and other single-celled creatures also regularly pick up genes from more distant relatives. This ability to 'steal' snippets of DNA from other species — known as lateral gene transfer — is responsible for the rapid spread of drug resistance among disease-causing bacteria.

"By understanding why some genes are more likely to spread from one species to the next, we can better understand how new virulent bacterial strains emerge," said co-author Tal Pupko, a visiting scientist at the National Evolutionary Synthesis Center in Durham, NC.

Scientists have proposed several theories to explain why some bacterial genes are more likely to jump into other genomes. One theory, Pupko explained, is that it depends on what the gene does in the cell.

Genes involved in core functions, like converting RNA into protein, are much less likely to make the leap. "If a species already has the basic molecular machinery for transcription and translation, there's no advantage to taking in another set of genes that do the same thing," Pupko said.

Other studies suggest it's not what the gene does that matters, but how many proteins it interacts with – a network researchers have dubbed the 'interactome.' Genes involved in transcription and translation, for example, must work in concert with many partners to do their job.

To find out which factor was more important — what a gene does, or how connected it is — the researchers looked for evidence of gene transfer in more than three dozen bacteria species, including a number of pathogens known to cause illness in people.

When they compared proteins with similar degrees of connectivity, the importance of gene function disappeared. "The reason some proteins are rarely acquired is because of how connected they are, not because of their function," said co-author Uri Gophna of Tel Aviv University.

Genes whose protein products rely on many partners to do their job are less likely to work properly in a new host, Gophna said. Transferring a highly connected gene into a new host is like importing a fax machine into a remote village, he explained. "While the machine itself is potentially useful, it needs a number of additional connections to work – electricity, a phone line, a supply of paper, possibly a technician. If one of these is missing the machine becomes useless and ends up as junk."

Bacteria are more likely to adopt 'loner' genes than genes that are well-connected, the authors added. "If you think of the cell like a machine, it's much more difficult to exchange the hub of a machine than some of its accessories," Pupko said.

The scientists describe their findings in the April 2011 issue of *Molecular Biology and Evolution*.

More information: Cohen, O., U. Gophna, et al. (2011). "The complexity hypothesis revisited: connectivity rather than function

constitutes a barrier to horizontal gene transfer." *Molecular Biology and Evolution* 28(4): 1481-1489. First published online December 13, 2010 doi:10.1093/molbev/msq333