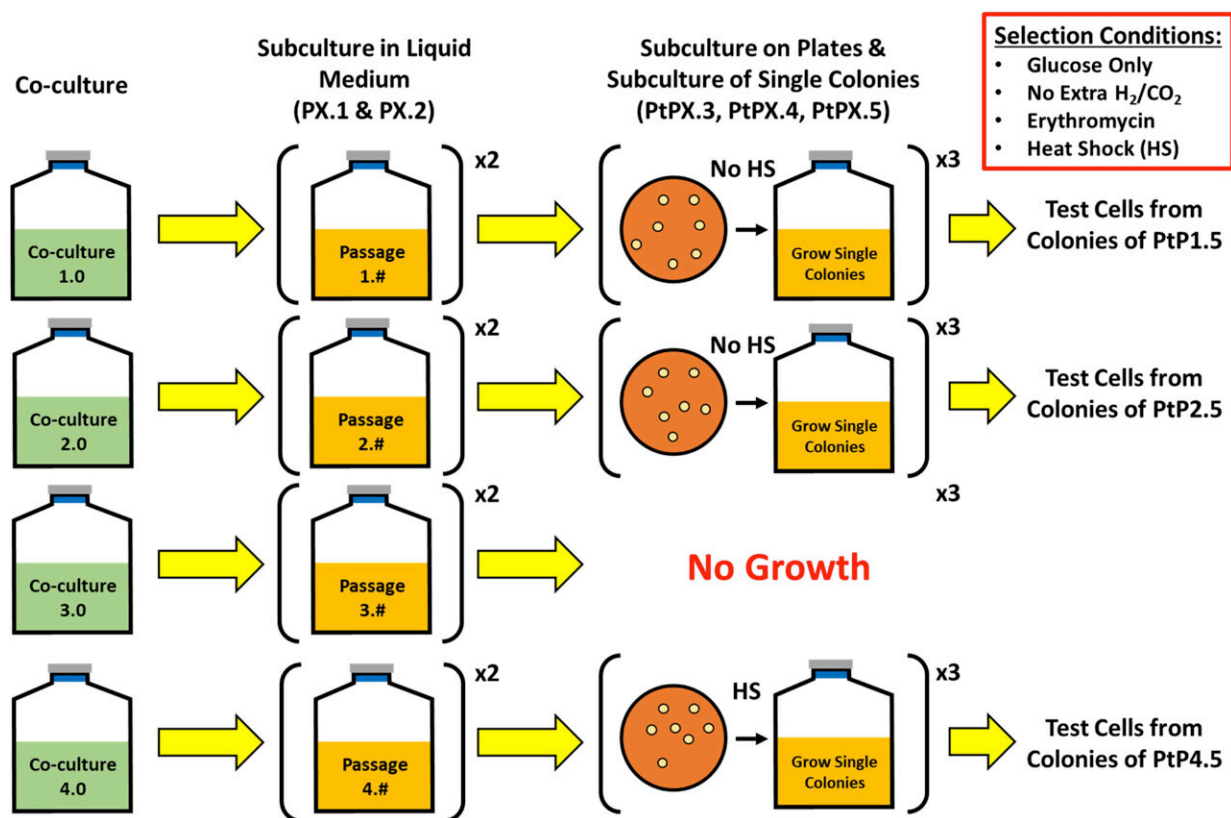


Engineers uncover new mechanism for gene transfer

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Summary of the selection procedure for isolating *C. acetobutylicum* strains, which have acquired p100ptaHalo plasmid DNA from *C. ljungdahlii*-ptaHalo cells in the coculture. Credit: *mBio* (2024). DOI: 10.1128/mbio.03133-23

If you still remember that "Dear King Phillip Came Over For Good Spaghetti," you'll likely also recall the corresponding taxonomic ranks of

biology: domain, kingdom, phylum, class, order, family, genus and species. The domains include prokaryotes, single-celled organisms such as bacteria and archaea, and eukaryotes, which include fungi, plants and animals.

Eukaryotes undergo evolution when mutations are passed down from parent to offspring, known as vertical gene transfer. For prokaryotes, evolution can take place through [horizontal gene transfer](#) (HGT for short), where [genetic information](#) is directly shared between bacteria. This process allows individual organisms, and even entire species, to quickly gain new genes, including potentially dangerous ones like those that confer antibiotic resistance.

At the University of Delaware, in the lab of Eleftherios "Terry" Papoutsakis, Unidel Eugene du Pont Chair Professor in the College of Engineering's Department of Chemical and Biomolecular Engineering, the Department of Biological Sciences and the Delaware Biotechnology Institute, researchers recently discovered a new mechanism by which HGT can occur in bacteria.

The findings in this study, led by doctoral alumnus Kamil Charubin and doctoral candidate John Hill, expand on the current understanding of evolution and survival strategies for complex microbiomes, with implications for fields ranging from ecology to biotechnology and medicine. The study was published in [mBio](#).

The research for the group's latest paper began after Charubin observed that two species of bacteria (*Clostridium acetobutylicum* and *C. ljungdahlii*) were exchanging nutrients, metabolites and cellular material at high rates when they were in close proximity to one another. They found that the cells were using a mechanism called heterologous cell fusion to transfer materials and wanted to see if bacteria could also transfer genetic information through this mechanism.

"This wasn't just a few proteins but actually encompassed most of the materials in the cytoplasm," Hill said. "These findings prompted us to determine whether or not genetic material, including plasmids, could be exchanged as well."

To see if gene transfer was also occurring when the [bacterial cells](#) were in close contact, Hill adapted the group's laboratory techniques so they could track the movement of the bacteria's genome and plasmids (circular pieces of DNA used by bacteria that are separate from their genome). The researchers also used selective subculturing techniques, isolating *C. acetobutylicum* cells after they had taken up plasmids from *C. ljungdahlii*, then confirmed gene transfer using PacBio Single-Molecule Real Time (SMRT) sequencing data.

The results of this research show that the two species of *Clostridium* can indeed share genetic information via heterologous cell fusion, a mechanism for HGT "that has not been previously contemplated or observed before," Papoutsakis said. "Through heterologous cell fusion, we found that there is exchange of DNA between the microbes and that the resulting hybrid cells contain large amounts of genomic DNA from both organisms."

The researchers said that the group's latest paper provides new insights into the processes and drivers of bacterial evolution.

"We know that [microbial life](#) has evolved in naturally occurring communities, and if there is a large number of interspecies interactions, including gene exchange, that would reveal another aspect of microbial evolution," Hill said. "These results could implicate that microbes are not evolving independently from one another but rather that there exists a multiplicity of evolutionary trajectories within local environments which are motivated by a variety of external pressures, including HGT."

Papoutsakis added that this study could also have implications in other fields as well, especially if it's another way that [bacteria](#) can confer traits such as antibiotic resistance to one another.

"There's a lot more complexity and interaction between microbes in natural microbiomes, such as those in the environment or the human gut, for example," Papoutsakis said. "This kind of mechanism for HGT can really have important physiological and medical implications."

More information: Kamil Charubin et al, DNA transfer between two different species mediated by heterologous cell fusion in *Clostridium* coculture, *mBio* (2024). [DOI: 10.1128/mbio.03133-23](https://doi.org/10.1128/mbio.03133-23)

Provided by University of Delaware

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