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Opinion Article

How do asexual prokaryotes manage to maintain genetic diversity?

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DESCRIPTION

Vertical gene transfer, or the transmission of genetic information from generation to generation, is what most people think of when they think of genetic transfer. Vertical gene transfer is by far the most common mechanism of genetic information transmission in all cells. Crossing-over events and the autonomous assortment of individual chromosomes during meiosis contribute to genetic variation in sexually reproducing organisms. When the genetic information from two parents, each with different complements of genetic information, is mixed, unique combinations of parental genotypes are produced in the diploid offspring, introducing genetic variety. The presence of mutations also contributes to a population's genetic diversity. Offspring genetic variety is beneficial in changing or inconsistent circumstances, and it may be one explanation for sexual reproduction's evolutionary success.

When prokaryotes and eukaryotes reproduce asexually, they use vertical gene transfer to pass on a nearly identical copy of their genetic material to their offspring. Asexual reproduction generates more offspring faster, but the benefits of diversity among those offspring are lost. So, how do species with an asexual reproduction mechanism generate genetic diversity? Horizontal gene transfer (HGT), which involves the transfer of genetic material from one organism to another within the same generation, is an important means for prokaryotes to add genetic variety. Even distantly related species can share genes, altering their phenotypes, according to HGT. HGT is expected to be more common in prokaryotes, but only a tiny portion of the prokaryotic genome can be transferred at any given moment. As the phenomenon is examined further, it may be discovered to be even more widespread. Many scientists believe that HGT and mutation are important sources of genetic variety in prokaryotes, providing the raw material for natural selection. HGT is more prevalent among evolutionarily related creatures, but it can happen between any two species living in the same natural population.

The prokaryote transforms by absorbing naked DNA from its surroundings, which is derived from other cells that have lysed and discharged their contents, including their genome, into the environment. Many bacteria are inherently competent, which means they actively bind to ambient DNA, transfer it into their cytoplasm, and single-strand it. Nucleases often degrade double-stranded foreign DNA within cells as a protection against viral infection. However, because these nucleases are weak against single-stranded DNA, the single-stranded DNA within the cell can recombine into the bacterial genome. Recombinant DNA is a DNA molecule that comprises fragments of DNA from many organisms (Recombinant DNA will be covered in greater depth in Microbes and Genetic Engineering Tools.) The bacterial cell may obtain new phenotypic features if the additional DNA is incorporated into its own genome through recombination. If a nonpathogenic bacteria takes up DNA from a pathogen's toxin gene and inserts it into its chromosome, it may become pathogenic as well. Competent bacteria can also take up plasmid DNA and provide the cell new properties.

In a process known as transduction, viruses that infect bacteria (bacteriophages) can transmit tiny fragments of chromosomal DNA from one bacterium to another. Remember that in generalised transduction, any portion of chromosomal DNA can be accidentally packaged into a phage head during phage assembly and transported to a new host cell. Specialized transduction, on the other hand, occurs when a lysogenic prophage is imprecisely excised from the bacterial chromosome, resulting in the phage carrying a fragment of the bacterial chromosome from either side of the phage's

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integration site to a new host cell. As a result, the host may be able to purchase more homes. This is known as lysogenic conversion. A virulence gene may be carried by a lysogenic phage to its new host, which has medical implications. Once incorporated into the chromosome of the new host, the new host may become pathogenic. Because of the introduction of toxin-encoding genes by lysogenic bacteriophages, several pathogenic bacteria, including *Corynebacterium diphtheriae* (the causative agent of diphtheria) and *Clostridium botulinum* (the causative agent of botulism), are virulent, demonstrating the clinical relevance of transduction in the exchange of genes involved in infectious disease. Archaea have their own viruses that transfer genetic material from one person to the next.