

When A Bacterium Acquires A Trait From Its Temperate Phage, It Is Called

When A Bacterium Acquires A Trait From Its Temperate Phage, It Is Called lysogeny, a critical process in bacterial genetics and phage biology that has significant implications for microbial evolution, pathogenicity, and biotechnology. Understanding this process provides insight into how bacteria adapt, acquire new capabilities, and sometimes become more virulent or resistant to antibiotics.

Understanding Temperate Phages and Lysogeny

What Are Temperate Phages?

Temperate phages are a class of bacteriophages (viruses that infect bacteria) capable of choosing between two life cycles upon infecting a bacterial cell:

- **Lytic cycle:** The phage hijacks the bacterial machinery to produce new phage particles, ultimately causing cell lysis and release of progeny.
- **Lysogenic cycle:** The phage integrates its genome into the host bacterial chromosome, existing as a prophage without destroying the host cells immediately.

This dual lifestyle allows temperate phages to coexist with their bacterial hosts for extended periods.

The Process of Lysogeny

Lysogeny begins when a temperate phage infects a susceptible bacterium and, instead of immediately replicating and lysing the cell, the phage genome integrates into the bacterial chromosome at specific attachment sites. The integrated phage DNA, called a prophage, remains dormant but can be induced to enter the lytic cycle under certain conditions.

Gene Transfer via Lysogeny: The Concept of

Lysogenic Conversion

What Is Lysogenic Conversion?

Lysogenic conversion refers to the process whereby a bacterium acquires new genetic traits from its prophage, leading to phenotypic changes. This process occurs because prophages often carry additional genes, known as "morons" (from "more on" genes), which are not essential for the phage's lifecycle but can influence the host's phenotype.

How Does Lysogenic Conversion Occur?

When a prophage integrates into the bacterial genome, it can introduce new genetic material that:

- Confers resistance to antibiotics
- Increases virulence factors (toxins, adhesion molecules)
- Imparts metabolic capabilities
- Provides immune evasion mechanisms

These traits can significantly alter the behavior and pathogenic potential of the host bacterium.

Examples of Traits Acquired Through Lysogenic Conversion

Virulence Factors and Pathogenicity

One of the most well-known outcomes of lysogenic conversion is the increase in bacterial virulence due to prophage-encoded toxins. Examples include:

- **Cholera toxin in *Vibrio cholerae*:** The gene for cholera toxin is carried on a prophage called CTX ϕ . When integrated, it renders the bacterium capable of causing cholera.
- **Shiga toxin in *Escherichia coli*:** The genes for Shiga toxin are carried on lambdoid phages. These toxins are responsible for severe disease manifestations in humans.

- **Diphtheria toxin in *Corynebacterium diphtheriae*:** The toxin gene is encoded by a prophage, contributing to the bacterium's pathogenicity.

Antibiotic Resistance and Survival

Some prophages carry genes that confer resistance to antibiotics, enabling bacteria to survive in antimicrobial environments. This transfer can accelerate the spread of resistance traits within bacterial populations.

Metabolic and Environmental Adaptations

Prophages can introduce genes that help bacteria adapt to specific niches, such as genes involved in:

- Utilizing unusual substrates
- Resisting environmental stresses like oxidative stress or pH changes

The Molecular Mechanisms Behind Trait Acquisition

Integration and Expression of Phage Genes

The process involves:

1. Infection of the bacterial cell by a temperate phage.
2. Integration of the phage DNA into the bacterial genome via site-specific recombination.
3. Maintenance of the prophage as part of the host genome, with phage genes expressed alongside bacterial genes.
4. Potential induction to enter the lytic cycle, which can be triggered by stress or DNA damage.

Regulation of Prophage Genes

Prophage gene expression is tightly regulated by phage-encoded repressors that keep the prophage dormant. Environmental cues can lead to derepression, inducing the lytic cycle and potentially transferring prophage-encoded traits to new hosts.

Implications of Lysogenic Conversion

Impact on Bacterial Evolution

Lysogenic conversion is a significant driver of bacterial evolution, enabling horizontal gene transfer and rapid adaptation to new environments or hosts. It contributes to genetic diversity and the emergence of new pathogenic strains.

Public Health Concerns

The acquisition of virulence factors via prophages can lead to the emergence of highly pathogenic bacterial strains, posing challenges for disease control and vaccine development.

Biotechnological and Medical Applications

Understanding lysogeny and prophage-encoded traits has applications in:

- Vaccine development, using phage-derived antigens
- Phage therapy, utilizing engineered phages to target bacterial pathogens
- Genetic engineering, employing phages as tools for gene delivery

Conclusion

When a bacterium acquires a trait from its temperate phage, it is called lysogeny, a process that exemplifies the dynamic nature of bacterial genomes and the profound influence of phages on microbial ecology and pathogenicity. Through lysogenic conversion, prophages serve as vehicles for genetic innovation, providing bacteria with new capabilities that can enhance

survival, virulence, and adaptability. As research continues to unveil the complexities of phage-host interactions, the significance of lysogeny in health, disease, and biotechnology remains ever more apparent.

References

- Campbell, A. (2003). Lysogeny and its role in bacterial evolution. Microbiology Today.
- Penadés, J. R., & Chen, J. (2020). Phage-mediated horizontal gene transfer and its impact on bacterial evolution. Annual Review of Virology.
- Brussow, H., & Hendrix, R. W. (2002). Phage genomics: small genomes for big insights. Nature Reviews Microbiology.
- Kropinski, A. M. (2009). Lysogeny: molecular mechanisms and implications. Journal of Bacteriology.

This comprehensive overview highlights the importance of lysogeny and lysogenic conversion in bacterial genetics and pathogenicity, emphasizing the term "lysogeny" as the process when a bacterium acquires traits from its temperate phage.

Frequently Asked Questions

What is the process called when a bacterium acquires a trait from its temperate phage?

Lysogenic conversion

Which mechanism allows a bacterium to gain new traits via a temperate phage?

Horizontal gene transfer through lysogeny

What term describes the integration of phage DNA into a bacterial genome, resulting in new traits?

Prophage formation

When a bacterium acquires an antibiotic resistance gene from a temperate phage, what is this process

called?

Transduction via lysogenic conversion

How does a temperate phage influence bacterial pathogenicity through gene transfer?

By transferring virulence factors during lysogenic conversion

What is the significance of lysogenic conversion in bacterial evolution?

It introduces new genetic traits that can enhance survival and pathogenicity

Can lysogenic conversion lead to the emergence of new bacterial strains?

Yes, by incorporating new genetic traits, it can result in novel bacterial variants

What distinguishes lysogenic conversion from other forms of horizontal gene transfer?

It involves the integration of a prophage into the bacterial genome, conferring new traits

Is lysogenic conversion permanent, and what effect does it have on the bacterium?

Yes, it is permanent; it can alter bacterial phenotype by introducing new genetic traits

Additional Resources

When A Bacterium Acquires A Trait From Its Temperate Phage, It Is Called lysogeny, a fundamental concept in microbiology and genetic exchange. This process exemplifies the intricate relationships between bacteria and viruses, revealing mechanisms of horizontal gene transfer that significantly influence bacterial evolution, pathogenicity, and adaptability. Understanding this phenomenon not only enriches our grasp of microbial genetics but also has profound implications for medicine, biotechnology, and ecology.

Introduction to Bacteriophage and Lysogeny

Bacteriophages, commonly known as phages, are viruses that infect bacteria. They are the most abundant biological entities on Earth and play crucial roles in regulating bacterial populations and facilitating genetic exchange. Phages exhibit two primary life cycles: the lytic cycle and the lysogenic cycle.

In the lytic cycle, the phage infects a bacterium, hijacks the host's machinery to produce new phage particles, and ultimately causes host cell lysis, releasing progeny phages. Conversely, in the lysogenic cycle, the phage integrates its genetic material into the bacterial genome and remains dormant as a prophage. This dormant state can persist through multiple bacterial generations without immediate destruction of the host.

Lysogeny is the process by which a temperate phage establishes this dormant, integrated state within the bacterial genome. This integration can lead to the transfer of genetic traits from the phage to the bacterium, often conferring new capabilities that can be advantageous or, in some cases, pathogenic.

Definition and Mechanism of Lysogeny

Lysogeny is a form of horizontal gene transfer where the genetic material of a temperate phage incorporates into the bacterial genome, creating a lysogen. The key steps involved include:

1. Attachment and Injection: The phage attaches to specific receptors on the bacterial surface and injects its DNA.
2. Decision Between Lytic and Lysogenic Cycle: The phage's genetic circuitry determines whether it proceeds to lysis or integrates into the host genome.
3. Integration: For lysogeny, the phage DNA integrates into the bacterial chromosome via site-specific recombination, facilitated by integrase enzymes.
4. Prophage Maintenance: The integrated prophage replicates passively with the host DNA during bacterial cell division.
5. Induction: Under certain stress conditions (e.g., UV radiation, chemical agents), the prophage can excise itself and enter the lytic cycle, producing new phages and lysing the host.

This process results in the stable inheritance of phage DNA within bacterial populations, which can include genes that alter bacterial traits.

Genetic Traits Acquired from Temperate Phages

When a bacterium acquires genetic material from a temperate phage, it often gains new traits that can dramatically influence its phenotype. These traits include:

1. Virulence Factors

Many pathogenic bacteria acquire toxins and other virulence determinants through lysogenic conversion. For example:

- *Corynebacterium diphtheriae* gains the diphtheria toxin gene via a prophage.
- *Vibrio cholerae* acquires the cholera toxin gene from a phage.
- *Clostridium botulinum* can harbor toxin genes from phage integration.

This process enhances bacterial pathogenicity, leading to more severe or novel disease profiles.

2. Antibiotic Resistance

Although less common than other mechanisms, some phages can carry resistance genes, contributing to multidrug resistance in bacterial populations.

3. Metabolic Capabilities

Some prophages carry genes that enable bacteria to utilize new nutrients or survive under specific environmental conditions, enhancing bacterial adaptability.

4. Surface Structures and Surface Antigens

Acquiring phage-encoded genes can alter bacterial surface antigens, impacting immune evasion and vaccine effectiveness.

Examples of Lysogenic Conversion in Pathogenic Bacteria

The phenomenon of lysogenic conversion has been well-documented in numerous pathogenic bacteria, illustrating its importance in bacterial evolution and disease emergence.

Diphtheria and the Diphtheria Toxin

The causative agent of diphtheria, *Corynebacterium diphtheriae*, acquires the diphtheria toxin gene (tox gene) from a lysogenic phage called β -phage. This

prophage carries the tox gene, and its presence transforms a benign bacterium into a pathogenic one capable of producing potent toxin, leading to severe respiratory disease.

Cholera and the Cholera Toxin

Vibrio cholerae strains responsible for cholera outbreaks often harbor a prophage known as CTX ϕ , which encodes the cholera toxin. The acquisition of this toxin gene through lysogenic conversion is a key factor in the bacterium's virulence.

Shiga Toxin-Producing *Escherichia coli*

Certain strains of *E. coli*, notably EHEC (enterohemorrhagic *E. coli*), acquire Shiga toxin genes via prophages. The toxin production is responsible for severe disease manifestations like hemorrhagic colitis and hemolytic uremic syndrome.

Implications of Lysogenic Conversion

The process of lysogeny and the associated trait acquisition has significant biological and clinical implications.

Advantages for Bacteria

- Increased Virulence: Acquisition of toxins and other virulence factors enhances pathogenicity.
- Environmental Adaptability: Genes for metabolic versatility or stress resistance can improve survival.
- Genetic Diversity: Phage-mediated gene transfer accelerates bacterial evolution and diversity.

Disadvantages

- Lytic Induction Risks: Under stress, prophages can induce lysis, killing the host cell.
- Metabolic Burden: Maintaining additional genetic material can impose a fitness cost.
- Potential for Unwanted Traits: Acquisition of resistance or virulence genes can complicate treatment strategies.

Public Health Concerns

Lysogenic conversion can lead to the emergence of hypervirulent or antibiotic-resistant strains, posing challenges for disease control and vaccine development.

Detection and Study of Lysogenic Conversion

Understanding whether bacteria harbor prophages and the traits they carry is crucial for microbiological research and public health.

Methods

- PCR and Genomic Sequencing: Detect specific phage genes within bacterial genomes.
- Induction Assays: Use agents like mitomycin C to induce prophage excision and observe phage production.
- Electron Microscopy: Visualize phage particles released from bacteria.
- Phenotypic Assays: Assess changes in virulence, toxin production, or antibiotic resistance.

Challenges

- Differentiating between integrated prophages and extrachromosomal plasmids.
- Determining the functional expression of phage-encoded traits.

Evolutionary and Ecological Significance

Lysogeny is a strategy that enhances bacterial adaptability and evolution. It facilitates rapid acquisition of beneficial traits, sometimes conferring selective advantages in specific environments.

- Horizontal Gene Transfer (HGT): Lysogeny is a key mechanism of HGT, alongside conjugation and transformation.
- Microbial Community Dynamics: Phages influence bacterial population structure and gene flow.
- Evolution of Pathogenicity: The transfer of toxin genes can lead to the emergence of new pathogenic strains.

In ecological contexts, lysogeny contributes to genetic diversity and resilience among microbial communities, impacting nutrient cycles and ecosystem stability.

Conclusion

When A Bacterium Acquires A Trait From Its Temperate Phage, It Is Called lysogeny, a process that exemplifies the complex interplay between viruses and bacteria. This phenomenon is a cornerstone of bacterial evolution, facilitating the spread of virulence factors, resistance genes, and other adaptive traits. While it confers advantages such as increased pathogenicity and environmental adaptability, it also poses challenges for disease control and antibiotic therapy. Ongoing research continues to unravel the mechanisms, consequences, and applications of lysogeny, underscoring its importance in microbiology, medicine, and biotechnology. Understanding lysogenic conversion not only illuminates the dynamic nature of microbial genomes but also highlights the importance of phages as drivers of genetic innovation and evolution in the microbial world.

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