
بسم الله الرحمن الرحيم

Bacterial mutation and gene transfer

Dr. bahaa Mohammed

Associate professor

Medical microbiology and immunology

Intended Learning Outcomes (ILOs)

- After this presentation, you will be able to:

1. define types of bacterial variation
2. Differentiate between genotypic and phenotypic variation
3. Explain the common type of mutations
4. Discuss common three types of gene transfer (transformation, conjugation and transduction)

Bacterial Variation

- Bacterial variation
- 1- phenotypic
- 2- genotypic variation.

- Phenotypic Variations
- changes in bacterial characters under the influence of the environment with no underlying genetic changes.
- It is reversible when the environmental cause is removed.
- It is not heritable.

- For example

  L-forms of bacteria

  Despite the absence of cellwall, L-forms survive because they were in isotonic solution

- Genotypic Variation
- A heritable
- Irreversible variation due to changes in genetic constitution.
- For example

  Mutation

Genetic variation

اكتساب الجينات

1- Mutation. 2- Gene transfer.

Phenotypic and Genotypic Variations

Phenotypic Variations	Genotypic Variations
Changes in bacterial characters under the influence of the environment with no change in genetic constitution	Change in bacterial characters due to underlying genetic changes.
Reversible (transient)	Irreversible (permanent)
Not-heritable	Heritable
Examples: 1 - Change in colony morphology from smooth to rough 2- Loss of cell wall in L-forms of bacteria. 3- Increased pigment production by staphylococci at room temperature.	Examples: 1- Mutation 2- Gene transfer a- Transformation, b- Conjugation, c- Transduction.

Genetic variation occurs through:

I- Mutation: Vertical change (within the same bacteria)

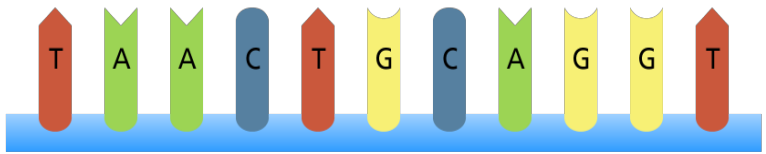
- Mutation in the DNA double helix may be due to
- 1- substitution (استبدال), deletion (محو) or insertion (إضافة) of one or more base pairs giving a new base sequence
- This causes alteration of the genetic code and hence changing the protein product of the gene .
- Mutation occurs

1- Spontaneously during replication at a rate varying between 1 in 10^7 and 1 in 10^{10} replication error.

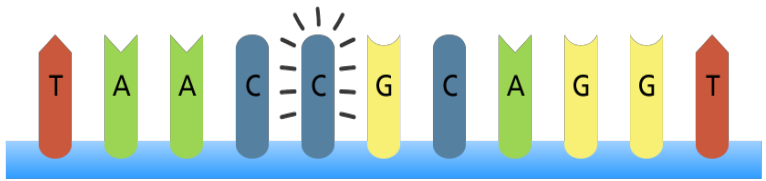
2- Induced at a higher rate by mutagenic agents as ultraviolet light (الأشعة فوق بنفسجية), Ionizing radiation (الاشعاع), chemical substances

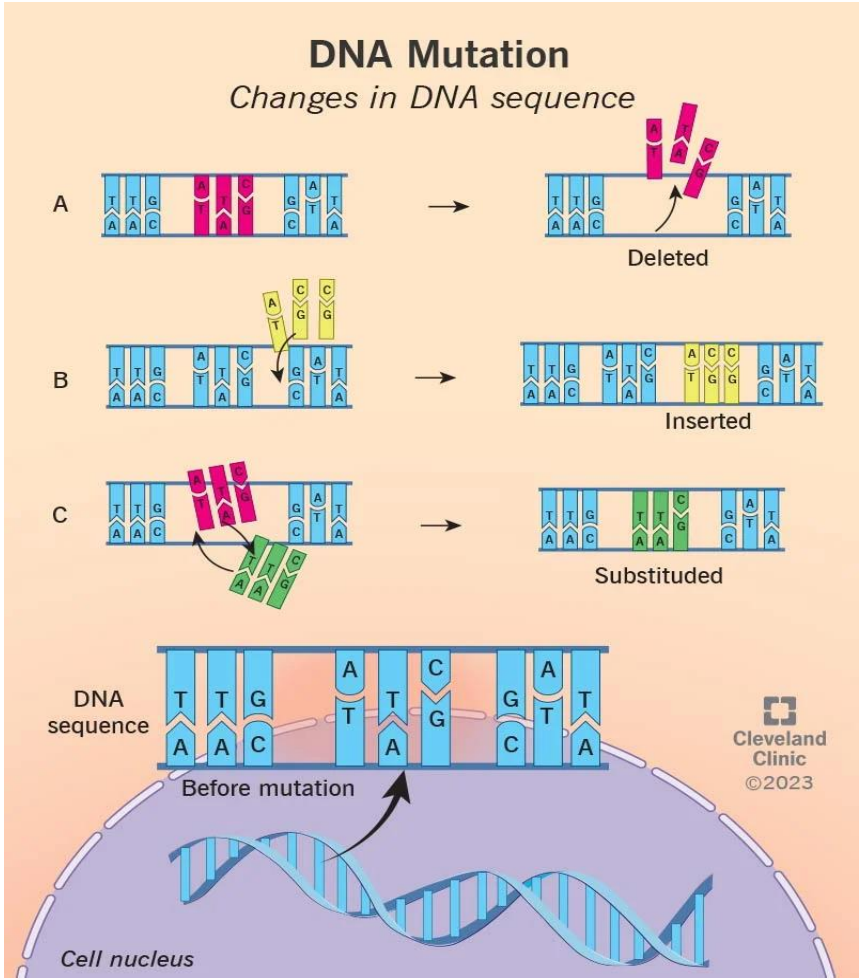
Gene mutation

Original sequence



Point mutation → change in one base only





change between 2 bacteria

II- Gene Transfer: Horizontal ,3 types of gene transfer

Transformation, conjugation and transduction

* ركز على التعريفات!!

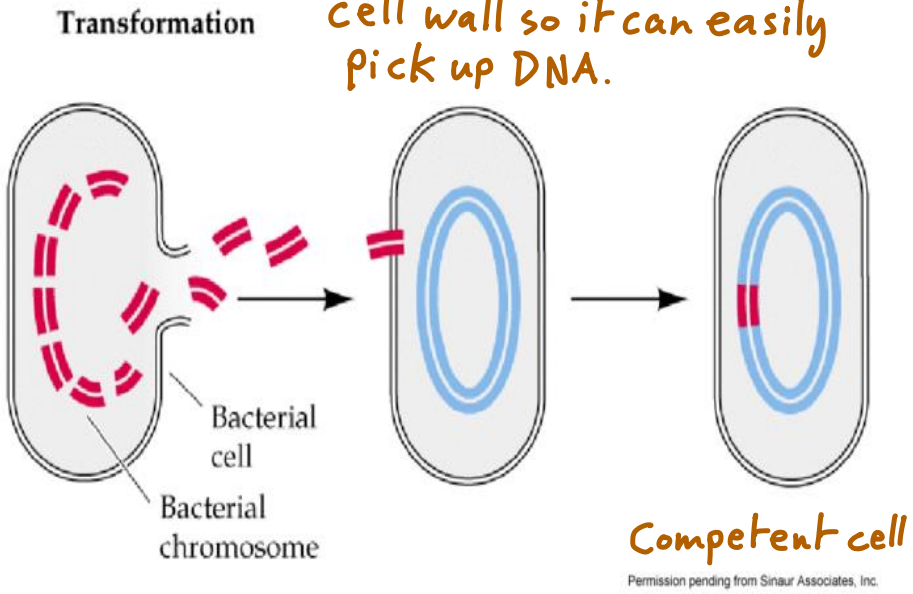
1- Transformation :

- This occurs when a recipient cell takes up a fragment of bacterial DNA, present free in the surrounding medium.
- This DNA fragment recombines with the bacterial chromosome and the new genes are expressed leading to changes in characters of recipient cells.
- In transformation with plasmid DNA, it becomes re-established in the recipient cell and autonomously replicates.

independantly of chromosomes & other plasmids.

- Some species can undergo natural transformation and easily incorporate foreign DNA into their chromosome.
- These are very useful in genetic engineering uses → ↑↑ # of transformed gene = synthesis of it's protein e.g: Synthesis of insulin.
- Transformation can be induced in the laboratory by treatment of cells with calcium chloride or heat shock, → unstabilizing bacterial cell wall so it can easily pick up DNA.

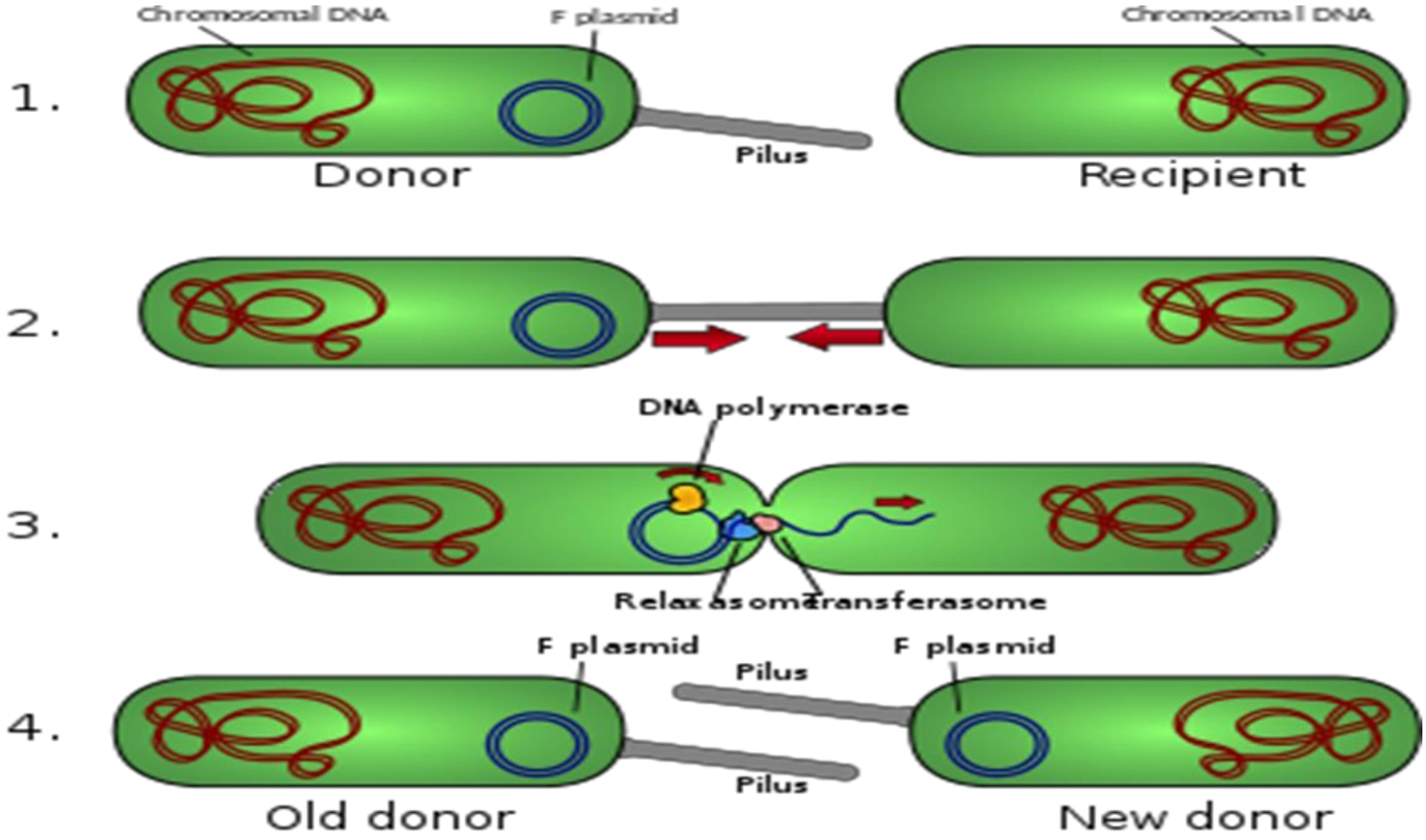
  these cells called Competent cell → cells in which the extracellular DNA has been succesfully incorporated in the bacterial chromosome



2- Conjugation (Mating):

- Mating of 2 bacterial cells, of the same or different species
- The process is controlled by conjugative F (fertility) plasmid which carries the genes that code for formation of sex pilus.
- As the cells come in contact, one strand of the plasmid separates and passes from **F+** donor cell to the **F-** recipient cell (does not contain F plasmid) through the conjugation tube formed by the sex pilus.
- At the same time, a complementary strand is formed by both cells.
- Now each cell becomes **F+.**

Conjugation



3- Transduction

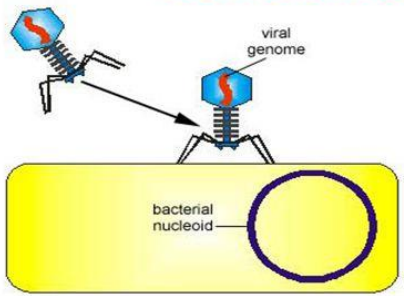
- Fragments of chromosomal DNA can be transferred into another bacterium by bacteriophage. a virus which infects bacteria, depends on cellular machinary for it's replication & gene expression
- There are 2 types of transduction:
- 1- Generalized transduction:
- During the lytic cycle of phage , a piece of bacterial DNA by accident, enclosed within a phage particle instead of the normal phage DNA.
- When this phage infects a second bacterium, the DNA from the first bacterium is released and recombines with the chromosome of the second bacterium.
- Plasmid DNA can also be transferred to the second bacterium by transduction .

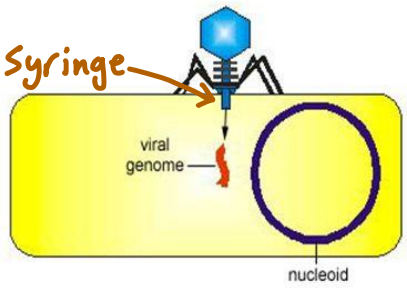
- 2- Specialized transduction occurs when prophage released from the lysogenic bacteria to infect another cell.
- It may carry with it a fragment of the adjacent genetic material of the bacterial chromosome, and pass it to another bacterium.

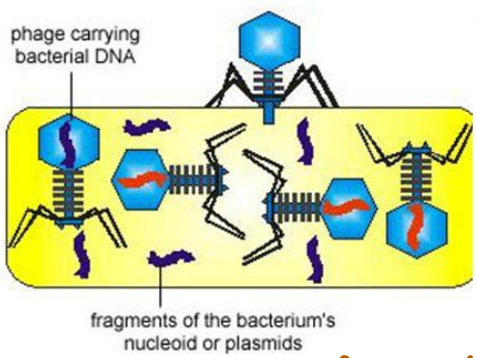
- Micro fact:
- Plasmid can be transferred by 3 types of gene transfer

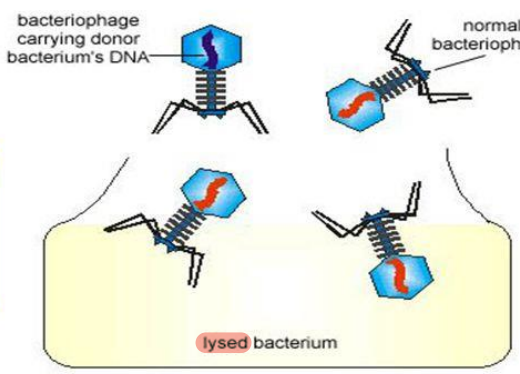
سبب التسمية ← the genome inside the bacteriophage is bacterial in general not viral.

Generalized Transduction





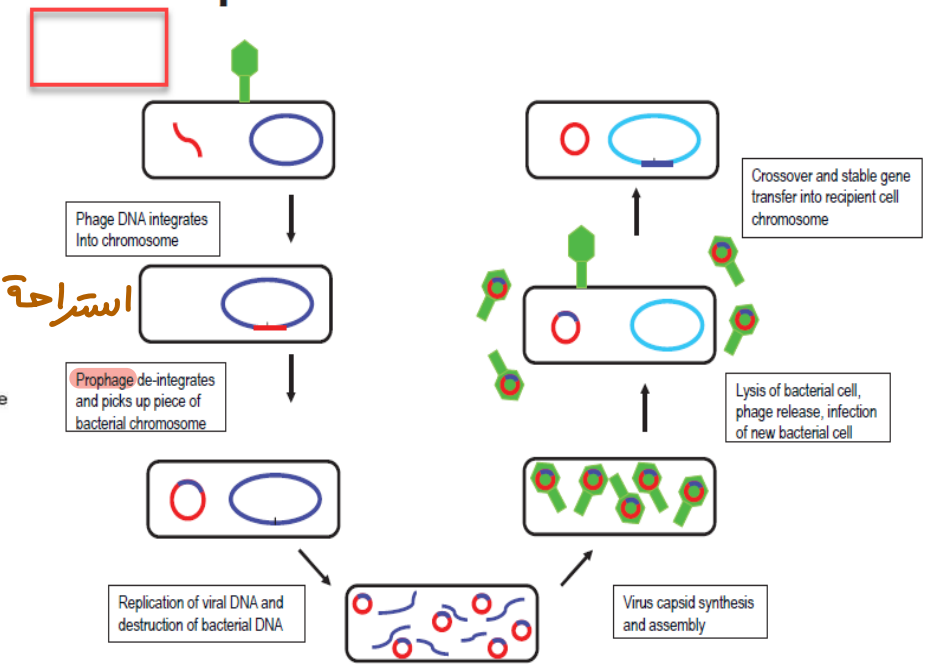




* Viral genome & viral capsid are produced seperatly.

- then the process of filling the capsid with the genome occurs.

Specialized transduction



Courtesy of M. Mulks (MSU)

Differences between Generalized & Specialized transduction

Generalized transduction	Specialized transduction
1. Any gene of donor bacterium can be transduced into recipient.	1. Only bacterial genes close to the attachment site of the prophage can be transduced.
2. Transducing phage carries only the bacterial genes.	2.Transducing phage carries both bacterial and phage genes

Generalized and Specialized Transduction

	Generalized	Specialized
Types of phage	Lytic (virulent) phage	Temperate (lysogenic) phage
Replication cycle	Lytic cycle	Lysogenic cycle
Mechanism	Error in assembly (filling)	Error in excision ✂
What genes may be transferred?	Any genes . (chromosomal or Plasmid)	Only chromosomal genes next to the insertion site of prophage


Thank You