

# CHAPTER (6)

## BACTERIAL VARIATION

• Bacterial variations are **changes in bacterial characters**

• **May be phenotypic or genotypic variations:**

① Phenotypic variation	② Genotypic variation
Occurs in response to <b>changes in environmental conditions without change in genetic constitution</b>	Occurs as a result of <b>change in the underlying genetic constitution</b>
<b>Reversible (transient)</b>	<b>Irreversible (permanent)</b>
<b>Not-heritable</b>	<b>Heritable</b>
<b>Examples:</b> ① L-forms of bacteria ② Loss of flagella upon exposure to phenol	<b>It occurs through:</b> ① Mutation ② Gene transfer: ① Transformation    ② Transduction    ③ Conjugation

### ① Mutation

• **It results from change in nucleotide sequence of DNA that may occur:**

- ① Spontaneously as replication error (at rate of **once every  $10^6 - 10^7$  cells**), or
- ② Induced by radiation or chemical agents (at higher rate → **once every  $10^3 - 10^4$  cells**)

• **Mutation can be classified according to nucleotide substitution, insertion or deletion into:**

#### ① Single-base (point) mutations

Involve replacement (substitution) of single nucleotide in coding sequence → this may result in:

##### ① Same sense (silent) mutations:

Occur when the **resulting base triplet (codon) codes for the same amino acid** as the original triplet

##### ② Mis-sense mutations:

- \* Occur when the **mutant base changes the coding sequence** → so, **different amino acid is produced**
- \* The **resulting protein may be functioning or not** → depending on the importance of the area affected by mutation

#### ② Frame-shift mutations

Occur when **nucleotide is inserted into, or deleted from the coding sequence** → resulting in **shift of the reading frame**, e.g. insertion of transposable element

Induced mutations may be used to manipulate viral genomes for vaccine production & gene therapy

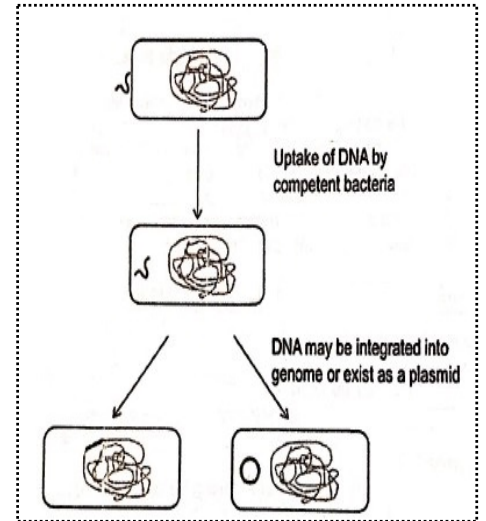
## ② Gene Transfer

There are 3 methods for gene transfer among bacteria:

① Transformation	② Transduction	③ Conjugation
Uptake of short fragments of naked DNA by naturally transformable bacteria	Transfer of DNA from one bacterium to another via bacteriophage	Transfer of DNA via sex pilus & requires cell-to-cell contact

### ① Transformation

- Dying bacteria release DNA which can be taken up by other bacteria
- Such DNA may be chromosomal or plasmid in origin, and may carry genes that "transform" the recipient bacterium
- The transforming DNA may become:
  - ① Integrated with bacterial chromosome, or
  - ② Re-established extra-chromosomally in the recipient cell
- Transformation depends on competence → ability of recipient bacterial cell to take up DNA
- Competence depends on presence of proteins in cell membrane that have special affinity to bind DNA & transport it into cytoplasm
- Artificial competence can be induced during recombinant DNA techniques by treating recipient bacteria with calcium chloride → which alters cell membrane permeability, enabling uptake of DNA



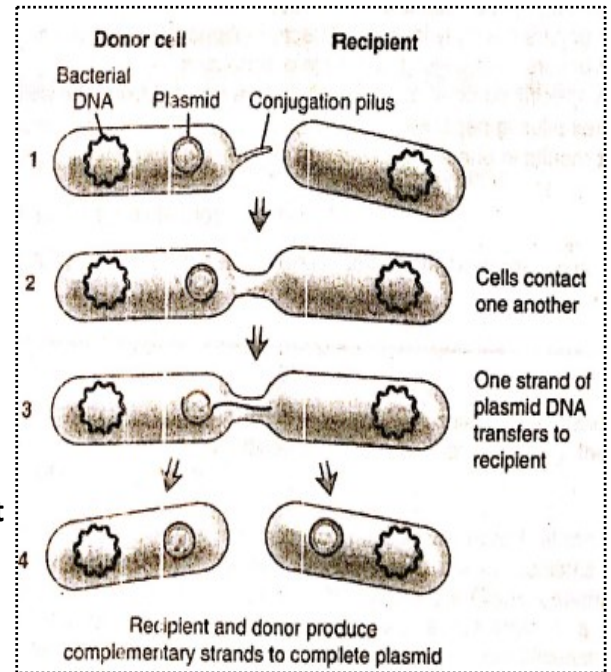
### ② Transduction

- Transfer of DNA from one cell to another by means of bacteriophage
- There are 2 types of transduction:

	① Generalized transduction	② Specialized transduction
	* During lytic phage cycle, bacterial DNA is fragmented & any fragment of DNA (whether chromosomal or plasmid) may be incorporated into phage head  * Phage particle can then transfer the incorporated bacterial DNA into another bacterial host	* It takes place when prophage contained in lysogenized bacterial cell is induced to detach  * Such prophage may carry with it the adjacent piece of chromosomal DNA & transfer it to another bacterial cell
Type of phage	Lytic (virulent) phage	Temperate (lysogenic) phage
Replication cycle	Lytic cycle	Lysogenic cycle
The transferred DNA fragments	Any piece of bacterial DNA (chromosomal or plasmid)	Specific piece of chromosomal DNA → adjacent to the site of insertion of prophage

### ③ Conjugation

- It is the most frequently observed mechanism of DNA transfer
- It involves 2 cell types:
  - ① Donors ( $F^+$ ) → which possess fertility (F) factor
  - ② Recipients ( $F^-$ ) → which lack (F) factor
- (F) factor carries genes for synthesis of sex pilus which acts as conjugation tube between donor & recipient bacterial cells
- The 2 DNA strands of (F) factor are then separated → & one strand is transferred from donor to recipient cell
- Each strand forms complementary strand → thus, the recipient cell acquires copy of (F) plasmid & becomes ( $F^+$ ) cell



### Test Yourself

**1) Transformation in bacteria depends on:**

- a- F factors
- b- R factors
- c- Bacteriophages
- d- Cosmids
- e- Competence of bacteria

**2) One of the following requires cell to cell contact:**

- a- Transformation
- b- Conjugation
- c- Transduction
- d- Transcription
- e- Transposition

**3) Which of the following is mediated by a bacteriophage that carries host cell DNA:**

- a- Transformation
- b- Conjugation
- c- Transduction
- d- Translation
- e- Transcription

**4) Regarding generalized transduction:**

- a- It occurs during lytic cycle of bacteriophage
- b- It occurs during lysogenic cycle of prophage
- c- Specific piece of bacterial DNA is transferred from one cell to another
- d- Sex pilus is necessary
- e- It results in phenotypic variation of bacterial character