# *Chapter 8 Bacterial Genetics*

## *Summary Outline*

8.1 Diversity in Bacteria: the properties of bacteria can change through **mutations**, changes in the chemical structure of DNA, or by changes in gene expression.

**Gene mutation**

8.2 **Spontaneous mutations** are changes in the nucleotide sequences in DNA, which occur without the addition of agents known to cause mutations.

2. **Base substitution** usually occurs during DNA replication.
3. **Point mutations** occur when only one base pair changes.
4. **Frame shift mutations** involve the **addition** or **deletion** of nucleotides resulting in all genes downstream of a stop codon and in the same operon becoming nonfunctional.
5. **Transposable elements (transposons)** have the ability to move to any other location in the genome.

8.3 **Induced mutations**

A. Chemical **mutagens** alter hydrogen-bonding properties of purines and pyrimidines such that there is an increase in the frequency of mutations.

1. **Base analogs** with different hydrogen bonding properties can be incorporated into DNA in place of usual purines and pyrimidines.
2. **Intercalating agents** are planar molecules, which insert into the double helix and push nucleotides apart resulting in a frameshift mutation.

B. **Transposition**—An insertion mutation results when a transposon integrates into a recipient cell genome.

C. Radiation

1. **Ultraviolet irradiation** results in the formation of thymine dimers due to the formation of covalent bonds between adjacent thymine molecules on the same strand of DNA.
2. **X-rays** cause single strand breaks, double strand breaks, and alterations to the DNA bases.

8.4 **Repair of damaged DNA**

A. **Repair of errors in base incorporation**—DNA polymerase has a proofreading function.

B. **Repair of thymine dimers**

1. In **light repair** a photoreactivating enzyme breaks the bonds of the thymine dimer, thereby restoring the original molecule.
2. In **excision or dark repair**, the damaged segment is excised by an endonuclease. A new strand is synthesized by DNA polymerase.

C. **SOS repair** is a last ditch repair mechanism in which enzymes are induced by damaged DNA resulting in DNA polymerase bypassing the damaged part of the strand, but without proofreading the DNA product.

8.5 **Mutations and their consequences**

A. Genes mutate **independently** of one another.

B. Mutations provide a mechanism for **natural selection**.

C. Mutations are **expressed rapidly in bacteria** because bacteria are **haploid**.

8.6 **Mutant selection**

A. **Direct selection** involves inoculating cells on a medium on which the mutant but not the parent can grow.

B. **Indirect selection** is required when the mutant being sought does not grow on a medium on which the parent grows.

C. **Replica plating** involves the simultaneous transfer of all the colonies on one plate to another and the comparison of the growth of individual colonies on both plates.
D. **Penicillin enrichment** will increase the proportion of **auxotrophic mutants** in the population.
E. **Conditional lethal** mutations cannot be overcome by adding growth factors to the medium.
F. The **Ames test** measures whether a suspected carcinogen increases the frequency of reversion; a positive test indicates the suspected carcinogen is a mutagen and therefore a likely carcinogen.

**Mechanisms of gene transfer**

8.7 **DNA-mediated transformation** involves the transfer of "naked" DNA.
A. **Horizontal (lateral) gene transfer** is the transfer of genes from one bacterium to another.
B. **Vertical gene transfer** is transfer of genes from the parent cell to daughter cells in DNA replication.
C. **Natural competence** is the ability of a cell to take up DNA
D. **Artificial competence**—Cells can be made artificially competent by electroporation, a process whereby the cells are treated with an electric current that makes holes in the cell envelope through which DNA can pass.

8.8 **Transduction** involves the transfer of bacterial DNA by a bacterial virus or bacteriophage.

8.9 **Conjugation** requires cell-to-cell contact by means of a sex pilus encoded on an F plasmid.

8.10 **Plasmids** are extrachromosomal pieces of DNA that code for nonessential information.
A. **R plasmids** code for antibiotic resistance

8.11 Genetic Transfer of Virulence Factors
A. Genes coding for virulence factors are transferred between bacteria by **transformation**, **transduction**, and **conjugation**.
B. Genes coding for virulence factors may be grouped together in **pathogenicity islands**.

8.12 **Gene movement within the same bacterium—transposable elements**
A. Transfer of genes to unrelated bacteria
1. Transposable elements often transfer antimicrobial-resistance genes from a chromosome to a plasmid.
2. Plasmids can be transferred by conjugation to unrelated bacteria.
B. Structure of transposons – There are different types of transposons that differ in complexity.

8.13 **Barriers to gene transfer**
A. Restriction of DNA -DNA entering unrelated bacteria is recognized as foreign and is degraded by a class of deoxyribonucleases.
B. Modification enzymes methylate potential cleavage sites and prevent the DNA from being cleaved.

8.14 Importance of Gene Transfer to Bacteria - **Gene transfer** allows bacteria to survive changing environments by providing cells with a set of new genes.