

## Microbial Genetics

**Genetics** is the study of genes including the structure of genetic materials, what information is stored in the genes, how the genes are expressed and how the genetic information is transferred.

- Genetics is also the study of heredity and variation . The arrangement of genes within organisms is its genotype and the physical characteristics an organism based on its genotype and the interaction with its environment, make up its phenotype .

- The order of DNA bases constitutes the bacterium's genotype. A particular organism may possess alternate forms of some genes , such alternate forms of genes are referred to as alleles.

- **Microbial genetics** is a branch of genetics concerned with the transmission of hereditary characters in **microorganisms** . Microbial genetics has played a unique role in developing the fields of molecular and cell biology and also has found applications in medicine, agriculture, and the food and pharmaceutical industries .

### Characteristics of Prokaryotic Genomes .

- \* Main portion of DNA , along with associated proteins and RNA .
- \* Prokaryotic cells are haploid (single chromosome copy) .
- \* Typical chromosome is circular molecule of DNA in nucleoid .
- \* The length of a DNA molecule is usually expressed in thousands of base pairs, or **kilobase pairs (kbp)** .

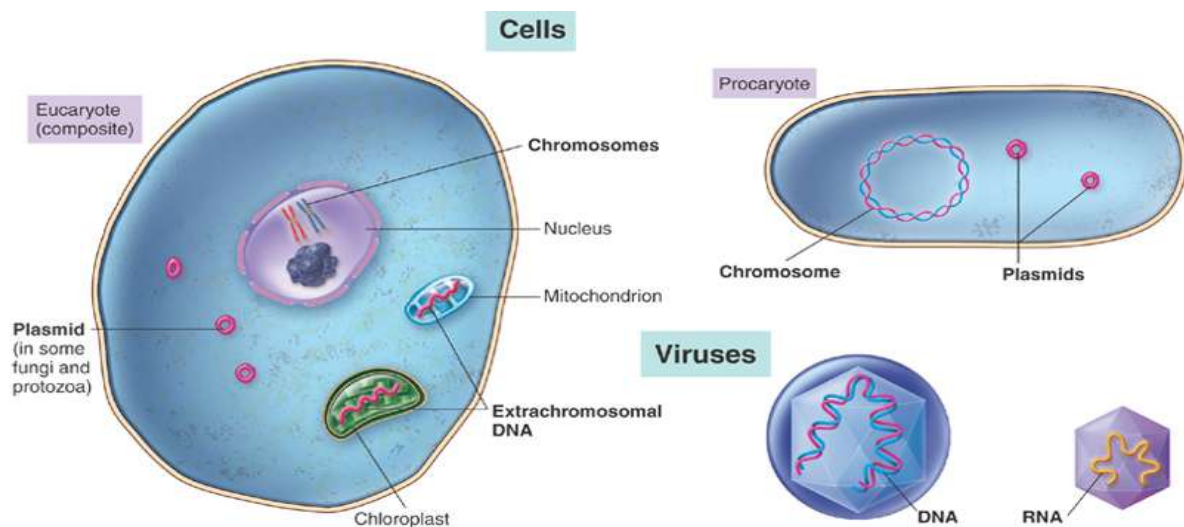
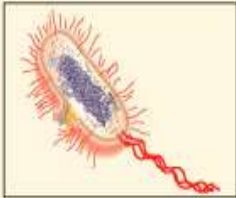
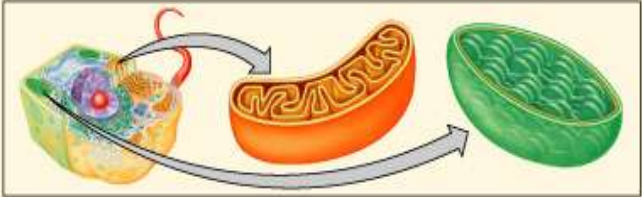


TABLE 10.2		Prokaryotic Cells and Eukaryotic Organelles Compared	
	Prokaryotic Cell	Eukaryotic Cell	Eukaryotic Organelles (Mitochondria and Chloroplasts)
<b>DNA</b>	Circular	Linear	Circular
<b>Histones</b>	No	Yes	No
<b>Ribosomes</b>	70S	80S	70S
<b>Growth</b>	Binary fission	Mitosis	Binary fission

## Genetic Recombination in Prokaryotes .

- Genetic recombination :- occurs when an organism acquires and expresses genes that originated in another organism .
- Genetic information in prokaryotes can be transferred vertically and horizontally .
  - Vertical gene transfer (VGT)
    - transfer of genetic material from parent cell to daughter cell.
  - Horizontal gene transfer (HGT)
    - transfer of DNA from a donor cell to a recipient cell .

## DNA Recombination Events :-

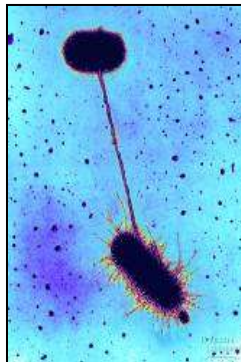
- 3 means for exogenous genetic recombination in bacteria :-
  1. Bacterial Conjugation
  2. Transformation
  3. Transduction.

## Transmission of Exogenous Genetic Material in Bacteria .

Conjugation	requires the attachment of two related species & formation of a bridge that can transport DNA .
Transformation	transfer of naked DNA .
Transduction	DNA transfer mediated by bacterial virus .

### 1. Conjugation

- Transfer of a plasmid or chromosomal fragment from a donor cell to a recipient cell via **direct connection** .
- Gram-negative .
  - cell donor has a **fertility plasmid**
    - (F plasmid, F' factor)
    - allows the synthesis of a conjugation (sex) pilus
  - Recipient cell is a related species or genus without a fertility plasmid .
  - Donor transfers fertility plasmid to recipient through pilus .

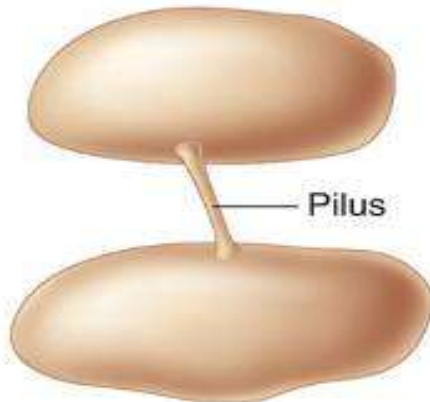


**Pilus** :- are bacterial particles found on the surface of some types of bacteria, the diameter of single hair is approximately 6-7 nm. The hairs help the bacteria to attach to a hard surface and mainly role in bacteria conjugation .

## Physical Conjugation .

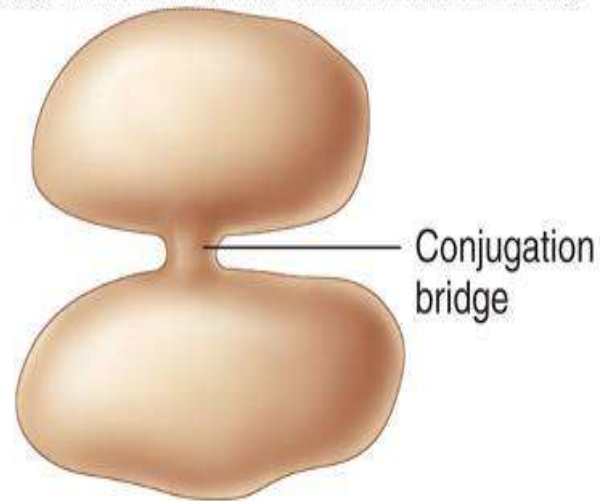
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### Physical Conjugation



(a) The pilus of donor cell (top) attaches to receptor on recipient cell and retracts to draw the two cells together. This is the mechanism for gram-negative bacteria.

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(b) An opening or pore forms between the cell walls, thereby creating a bridge to transmit genetic material. This is presumably how gram-positive bacteria conjugate.

## 2. Transformation .

- Chromosome fragments from a lysed cell are accepted by a recipient cell.
- Genetic code of DNA fragment is acquired by recipient
- Donor and recipient cells can be unrelated .
- Useful tool in recombinant DNA technology .

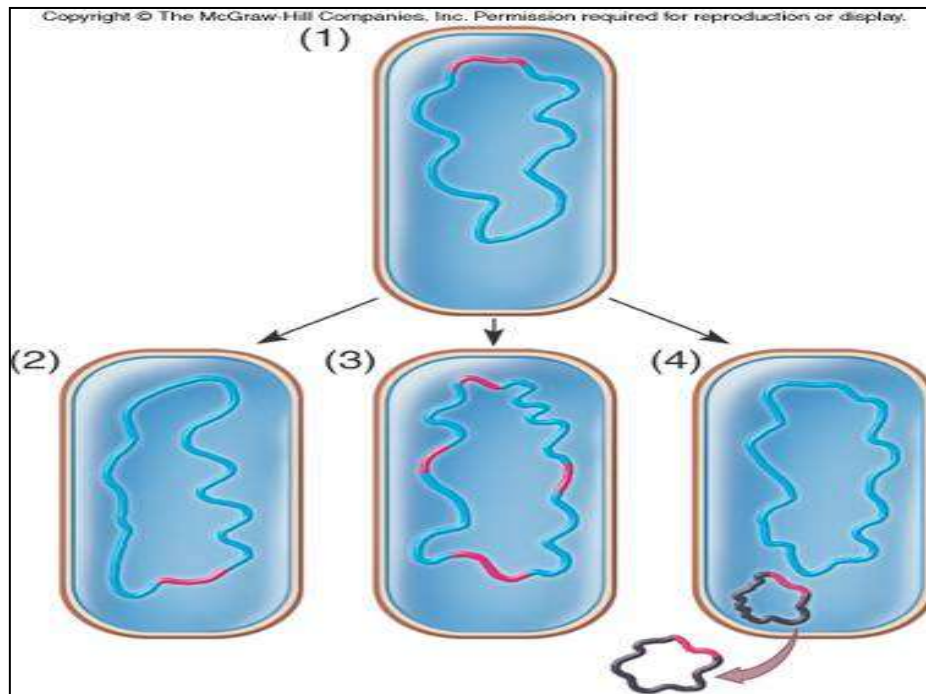
### Other ways genetics can change :-

- Transposons
- Mutations

### Transposons

- Special DNA segments that have the capability of moving from one location in the genome to another . (“jumping genes”)
- Can move from :-
  - one chromosome site to another .
  - chromosome to a plasmid .
  - plasmid to a chromosome .
  -

- May be beneficial or harmful :-
  - Changes in traits
  - Replacement of damaged DNA
  - Transfer of drug resistance .



## Mutations .

The term “mutation” was coined by Hugo deVries, which is derived from Latin word meaning “to change”. Mutations are heritable changes in genotype that can occur spontaneously or be induced by chemical or physical treatments.

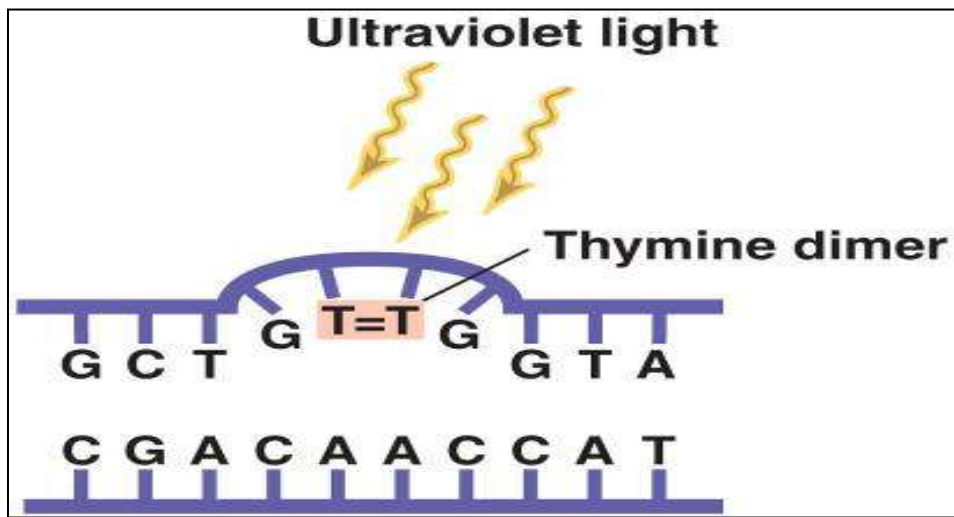
(Organisms selected as reference strains are called wild type, and their progeny with mutations are called mutants.) The process of mutation is called mutagenesis and the agent inducing mutations is called mutagen. **Changes** in the sequence of template DNA (mutations) can affect the type of protein end product produced .

### ■ Mechanisms of mutation are :-

- (A) Substitution of a nucleotide
- (B) Deletion or addition of a nucleotide .

### ■ Result of natural processes or induced :-

- Spontaneous mutations
  - heritable changes to the base sequence in DNA
  - result from natural phenomena such as radiation or uncorrected errors in replication.
- UV light is a physical mutagen that creates a dimer that cannot be transcribed properly.



## Transduction

- DNA is transferred from one bacterium to another by a virus .
- Bacteriophages .
  - Virus that infects bacteria .
  - consist of an outer protein capsid enclosing genetic material .
  - serves as a carrier of DNA from a donor cell to a recipient cell .

