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Bacterial 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.

Genes are sequences of nucleotides within DNA that code for functional proteins. The genetic material of bacteria and plasmids is DNA. The two essential functions of genetic material are replication and expression. Most prokaryotic genes are carried on **bacterial chromosome** . while many bacteria contain additional genes on **plasmids**.

1-Bacterial chromosome:

most bacteria have single, covalently closed, circular chromosomes. Not all bacteria have a single circular chromosome: some bacteria have multiple circular chromosomes, and many bacteria have linear chromosomes and linear plasmids.

2- Plasmids:

Plasmids are extra-chromosomal elements found inside a bacterium. These are not essential for the survival of the bacterium but they confer certain extra advantages to the cell.

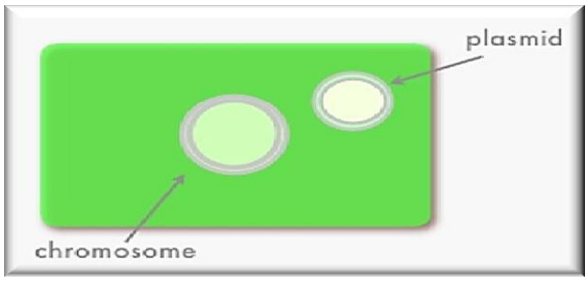
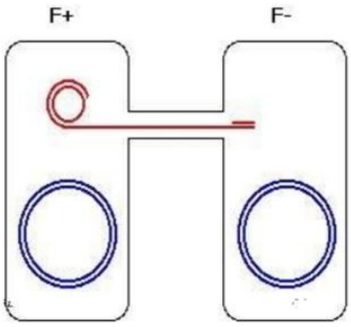


Figure 1: Bacterial genome

Types of plasmids:

- **F factor:** This is also known as **fertility factor** or **sex factor**. Most plasmids are unable to mediate their own transfer to other cells. F factor is a plasmid that codes for **sex Pilli** and its transfer to other cells. Those bacteria that possess transfer factor are called F+, such bacteria have sex pili on their surface. Those cells lacking this factor are designated F-. The F factor plasmid is transferred to other cells through conjugation. An F- cell will become F+ when it receives the fertility factor from another F+ cell.



- **R factor:** Those plasmids that code for the transmissible drug resistance are called R factor. These plasmids contain genes that code for resistance to many antibiotics. R factors may be transferred by conjugation and its transfer to other bacteria is independent of the F factor. Bacteria possessing such plasmids are resistant to many antibiotics and this drug resistance is transferred to closely related species.

- **Col Factor :** Responsible for colicin production.

Importance of plasmids:

1. Codes for resistance to several antibiotics.
2. Codes for the production of bacteriocines.
3. Codes for the production of toxins
4. Codes for resistance to heavy metals
5. Plasmids carry virulence determinant genes.
6. Codes resistance to uv light (DNA repair enzymes are coded in the plasmid).
7. Codes for colonization factors that is necessary for their attachment. Eg, as produced by the plasmids of *Yersinia enterocolitica*, *Shigella flexneri*, Enteroinvasive *Escherichia coli*.
8. Contains genes coding for enzymes that allow bacteria unique or unusual materials for carbon or energy sources. Some strains are used for clearing oil spillage.

Mutation :

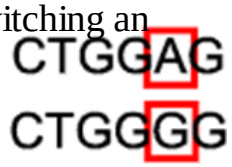
Mutation is defined as any change in base sequence of DNA. it occur in two form: **Transition** (purine replaced by purine or pyrimidine replaced by pyrimidine) or **Transversion (** purine replaced by pyrimidine or vice versa)

Mutations result from damage to DNA which is not repaired, errors in the process of replication, or from the insertion or deletion of segments of DNA by mobile genetic elements. Mutations play a part in both normal and abnormal biological processes including: evolution, cancer.

Types of Mutations:

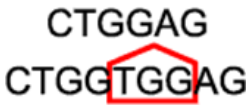
1- Substitution

- A substitution is a mutation that exchanges one base for another (i.e., a change in a single "chemical letter" such as switching an **A** to **G**).



2- Insertion:

- Insertions are mutations in which extra base pairs are inserted into a new place in the DNA.

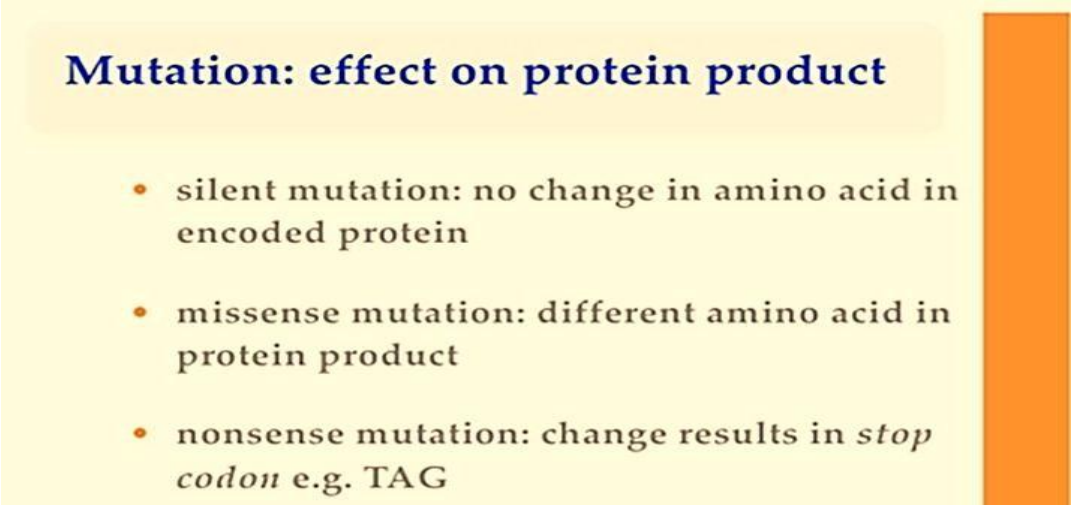


3- Deletion:

- Deletions are mutations in which a section of DNA is lost, or deleleted.

Frame shift:

Since protein-coding DNA is divided into codons three bases long, insertions and deletions can alter a gene so that its message is no longer correctly parsed. These changes are called **frame-shifts**.



Exchange of Genetic Information:

1- Transformation

Transformation is gene transfer resulting from the uptake by a recipient cell of naked DNA from a donor cell. Certain bacteria (e.g. *Bacillus*, *Haemophilus*, *Neisseria*, *Pneumococcus*) can take up DNA from the environment and the DNA that is taken up can be incorporated into the recipient's chromosome.

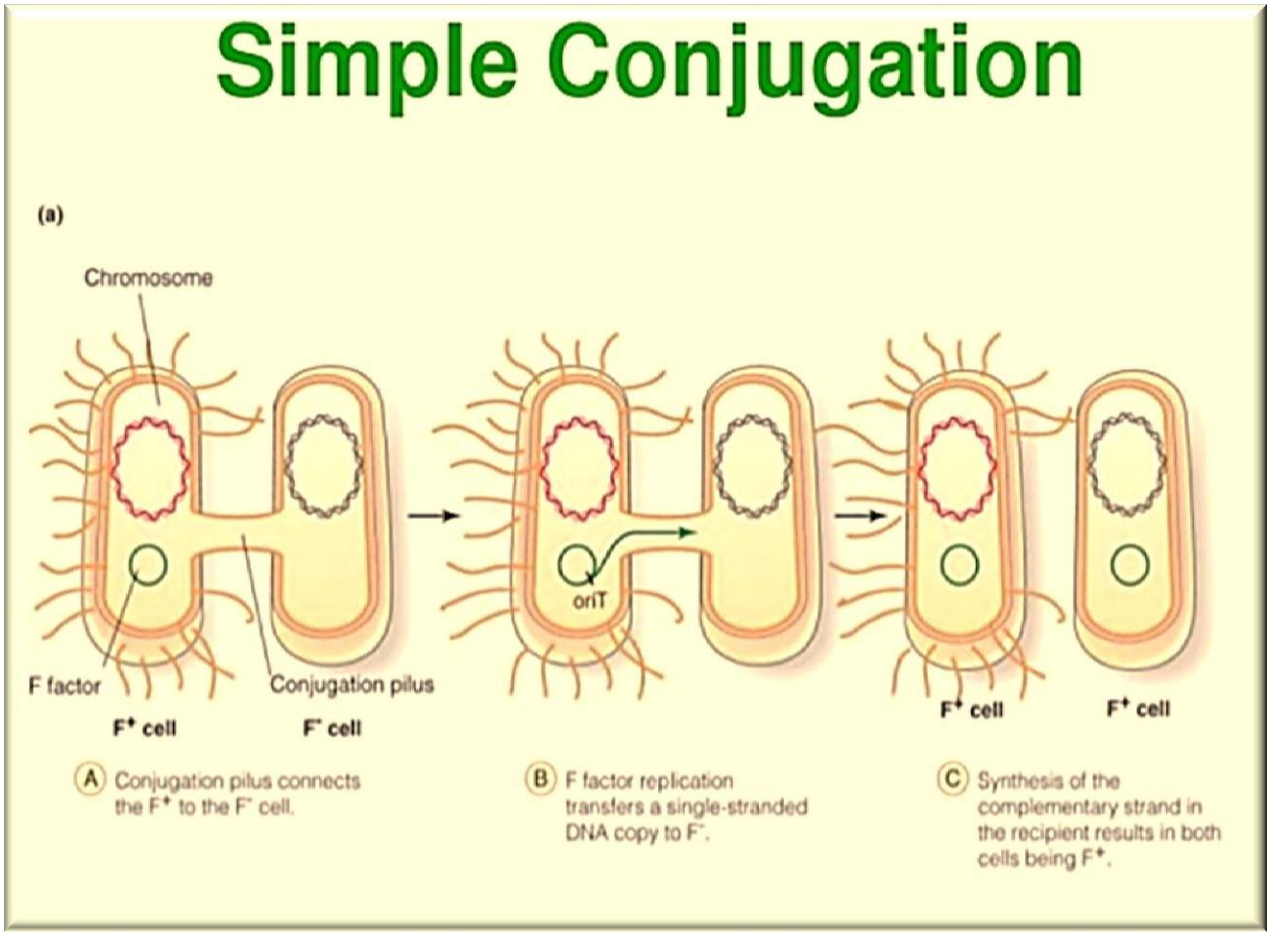
2- Transduction

Transduction is the transfer of genetic information from a donor to a recipient by way of a bacteriophage.

3-Conjugation

Transfer of DNA from a donor to a recipient by direct physical contact between the cells. In bacteria there are two mating types a donor (male) and a recipient (female) and the direction of transfer of genetic material is one way; DNA is transferred from a donor to a recipient.

The ability of a bacterium to be a donor is a consequence of the presence in the cell of an extra piece of DNA called the **F factor or fertility factor or sex factor**. The F factor has genes on it that are needed for its replication and for its ability to transfer DNA to a recipient. One of the things the F factor codes for is the ability to produce a sex pilus (F pilus) on the surface of the bacterium. This pilli is important in the conjugation process.



Recombinant DNA Technology:

Recombinant DNA technology procedure by which DNA from different species can be isolated , cut and spliced together . The new recombinant molecules are then multiplied in quantity in population of rapidly dividing cells (e.g. bacteria ,yeast). Currently it is relatively easy to cut out a specific piece of DNA produce a large number of copies , determine its nucleotide sequence , slightly alter it and then as a final step transfer it back in to cell in .

Recombinant DNA technology is based on a number of important things :

1- Bacteria contain extra chromosomal molecules of DNA called plasmids which are circular

Bacteria also produce enzyme called restriction endonuclease that cut DNA molecules at specific places in to many smaller fragments called restriction fragments. each enzyme cuts DNA at specific site defined by sequence of bases in the DNA called recognition site.

2- Restriction enzyme cuts only double helical segments that contain a particular sequence and it makes its incisions only within that sequence to give sticky end and blunt end.

3- Insertion DNA fragment in appropriate plasmid (vector) to generate recombinant molecule .

4- Introduce recombinant molecule in to new host.

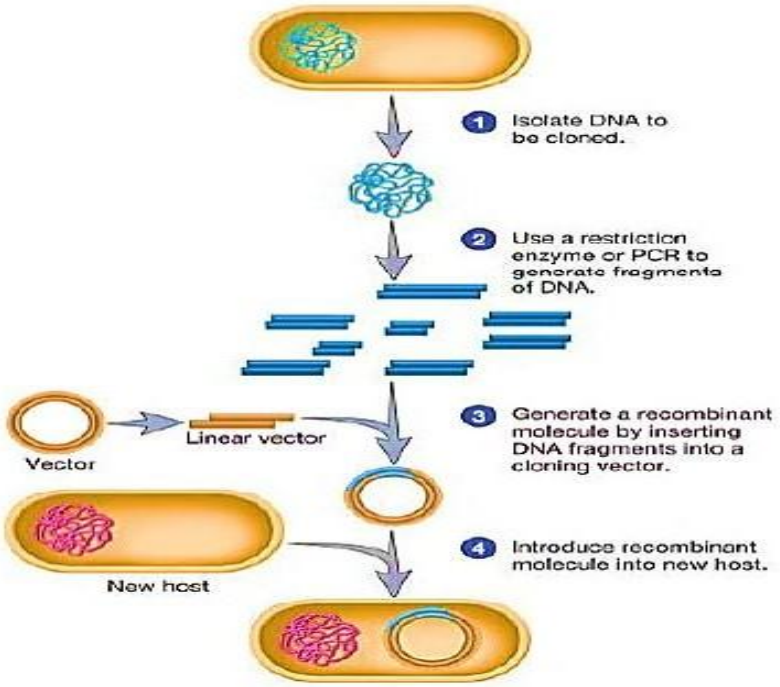
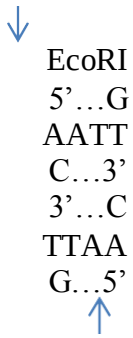


Figure : Steps in recombinant DNA techniques .

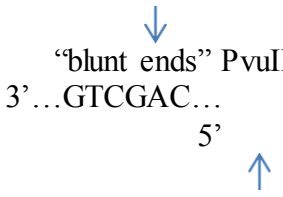
Restriction Enzymes :

They are proteins produced in a bacteria cell that cut DNA at a specific site. Also known as restriction endonucleases . This enzyme are primarily found in bacteria and given abbreviations based on genus and species of the bacteria . one of the first to be isolated was **Eco R1** it was isolated from *Escherichia coli* strain called RY13.

Some enzymes cut in a staggered fashion - "sticky ends"



Some enzymes cut in a direct fashion –



H.W.// *Why don't bacteria destroy their own DNA with their restriction enzymes?*