

4. Bacterial Genetics

Faculty of Medicine

Hashemite University

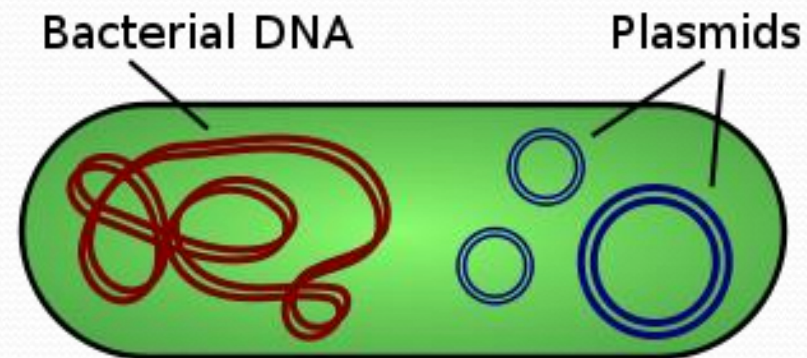
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Objectives

- DNA structure and function.
- Differentiation between genotype and phenotype
- Genetic changes in bacteria including mutations and variations
- Clinical applications of genetic studies.

Introduction

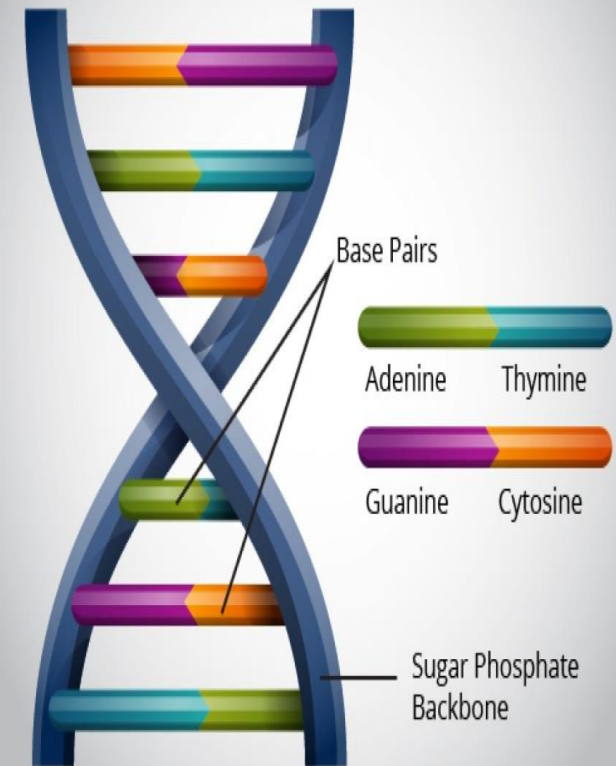
- Bacterial genome includes Chromosome & DNA Plasmid
- Gene: A segment of DNA specifies production of a particular amino acid, polypeptide chain function (Enzyme, Protein)
- Genetic information is stored in DNA sequences found in
 1. Chromosomes
 2. Plasmids



DNA Structure

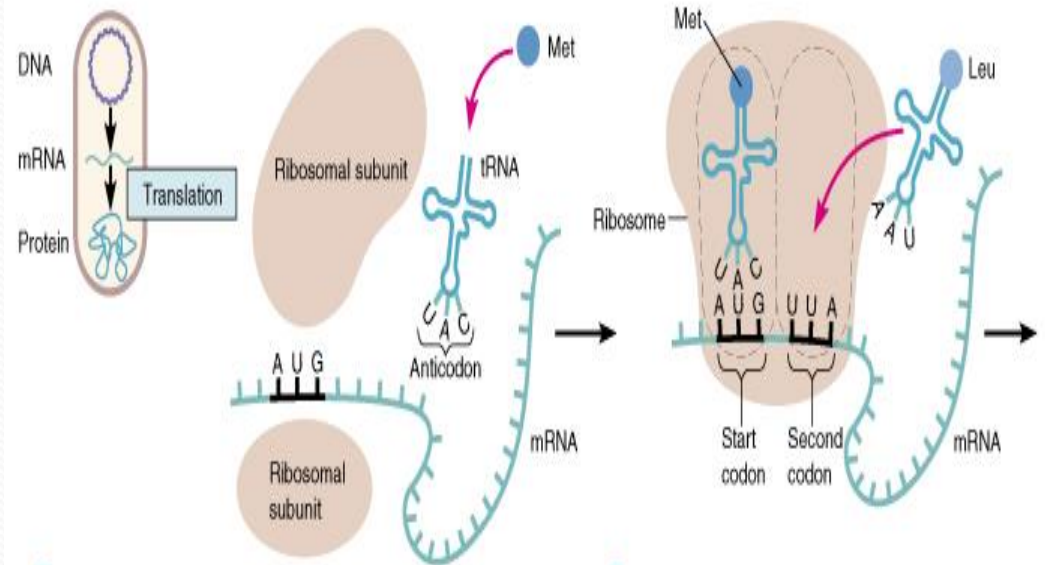
- DNA=deoxyribonucleic acid
- RNA=ribonucleic acid
- Basic building blocks:
 - Nucleotides
 - Phosphate group
 - Pentose sugar
 - Nitrogenous base
- 5' to 3' (strands are anti-parallel)
- Complimentary base pairing
 - A-T
 - G-C

DNA Structure



DNA Function

- Genetic information is encoded in DNA, transcribed into mRNA, translated on ribosomes through tRNA into various protein, polypeptides/structures and enzymes with diverse functions



1 Components needed to begin translation come together.

2 On the assembled ribosome, a tRNA carrying the first amino acid is paired with the start codon on the mRNA. A tRNA carrying the second amino acid approaches.

Genotype & Phenotype

- Genotype :

- Represents all potential genes of bacteria cell (Its genome).
- All Inherited essential biological features & growth patterns.
 1. Constitutive genes : gene expressed all the time
 2. Inducible genes: genes only expressed when the gene products are needed

- Phenotype:

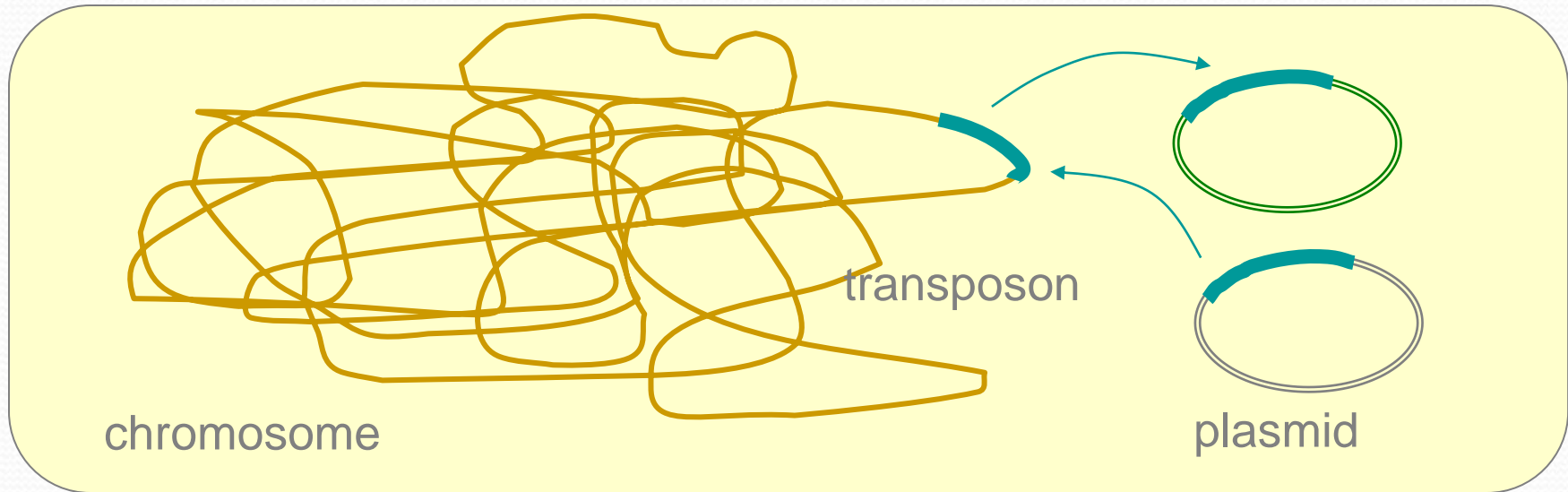
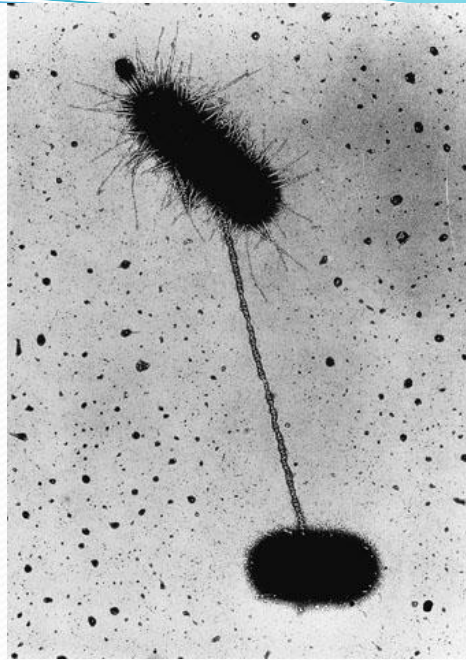
- Is all the organism's physical traits, attributes or characteristics (The expressed genes).
- The observed characteristics of the of the individual bacteria.
- Expressed by physical & biochemical properties. Growth patterns, Fermentation products, Antibiotic resistance, Toxins production. etc.

Plasmid

- Extra-chromosomal piece of circular double-stranded autonomous DNA
- Replicate by itself
- It often carries nonessential genes such as resistance to antibiotics, virulence factors (enterotoxin, adhesion factor).
- Each contains 5-100 genes..

Types of Plasmids

1. Conjugative /transferable plasmid: A plasmid capable of transferring itself between bacteria (F-plasmid).
2. Non-conjugative plasmid: are incapable of initiating conjugation, hence they can be transferred only with the assistance of conjugative plasmids.
3. Transposones / integrons: (jumping genes): Nonessential small genetic elements that can exist in two ways in the bacterial cell: Both can be integrated into the bacterial chromosome or attached to plasmid.

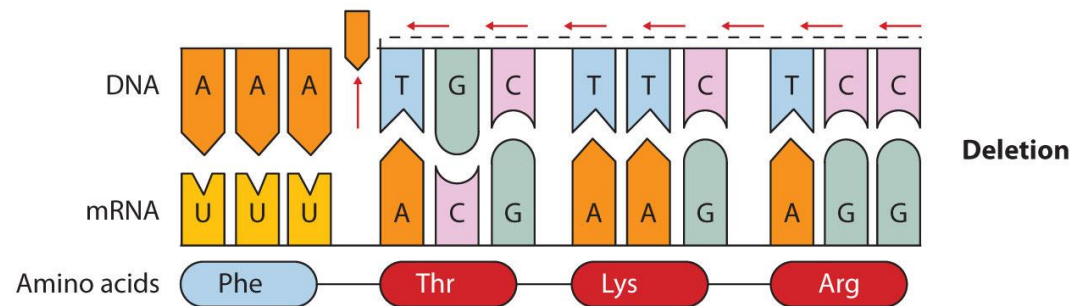
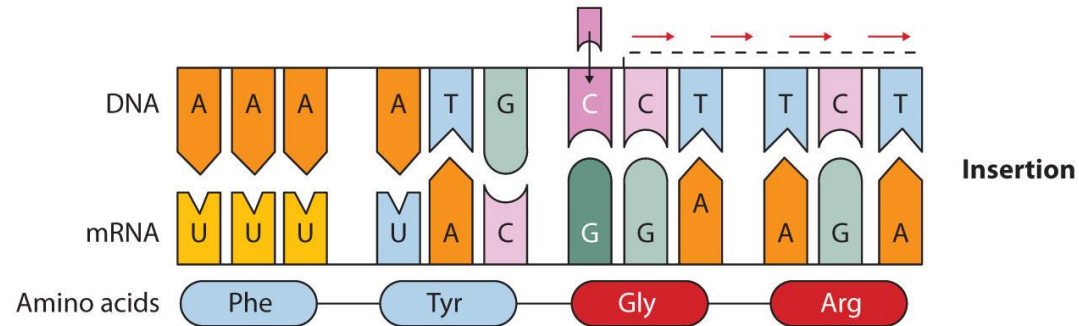
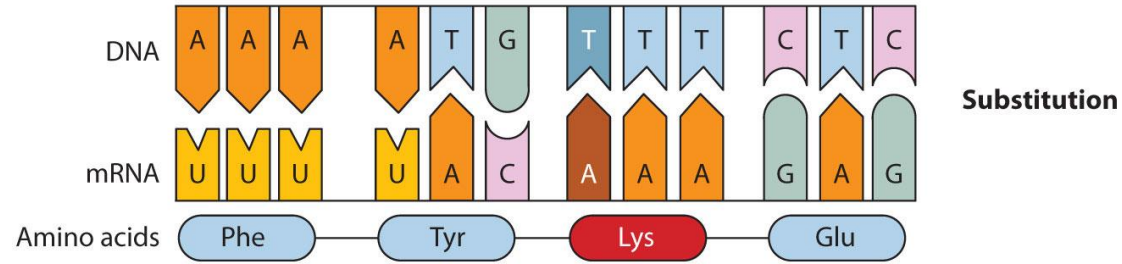
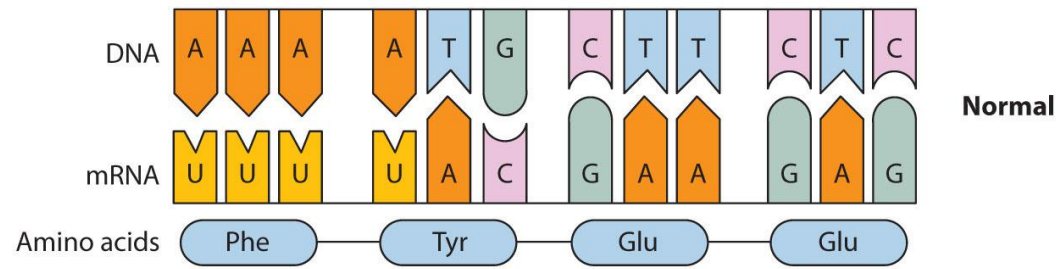


Genetic Change in Bacteria

- Genetic changes: A major mechanism for the appearance of new pathogens/toxigenic strains, Development of antimicrobial resistance and can occur and become widespread over a short period of time
- Two mechanism can be involved:
 - Mutation affects the epidemiology & virulence of a pathogen.. contribute to changes in the nature and prevalence of certain important infections.
 - Genetic variation in bacterial cell antigens (capsule, toxins) of some pathogens can seriously complicate disease & development of vaccines against those organisms.

Mutations

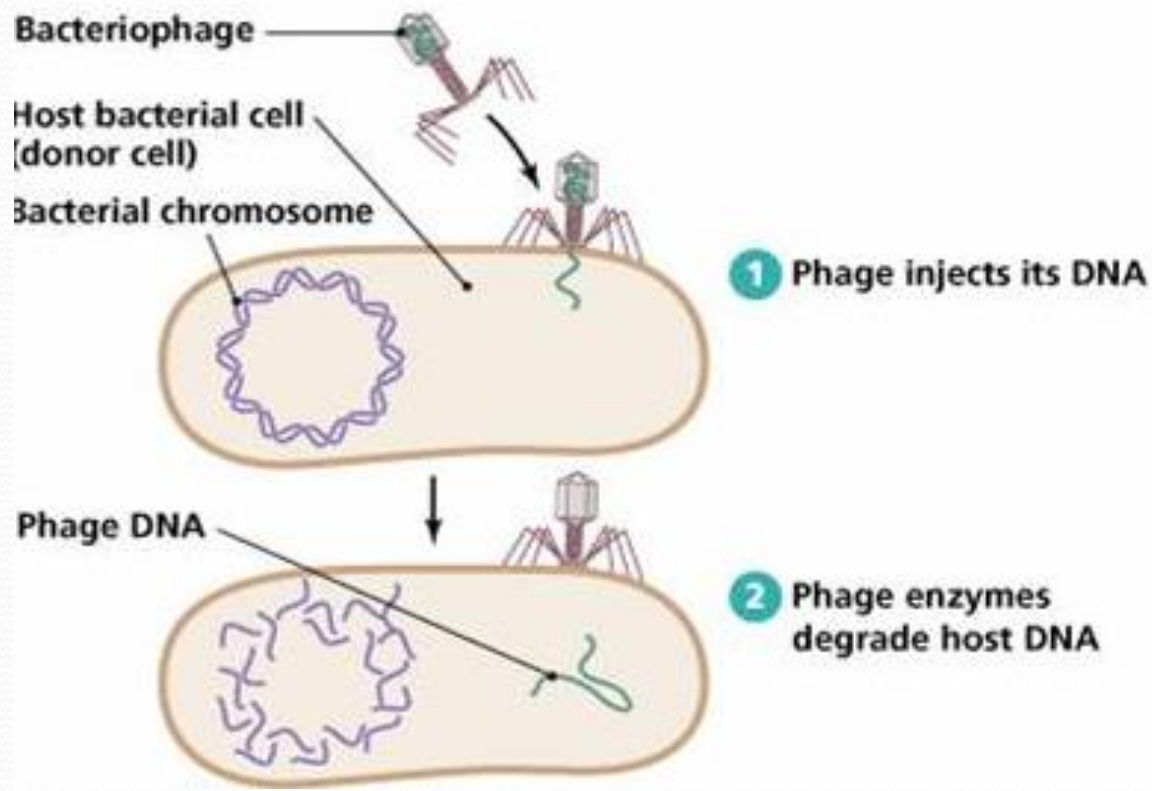
- Random, heritable, undirected variation due to a change in the nucleotide sequence of DNA
- Addition, deletion or substitution of a base pair
 1. Spontaneous mutation
 2. Induced mutation -mutagens



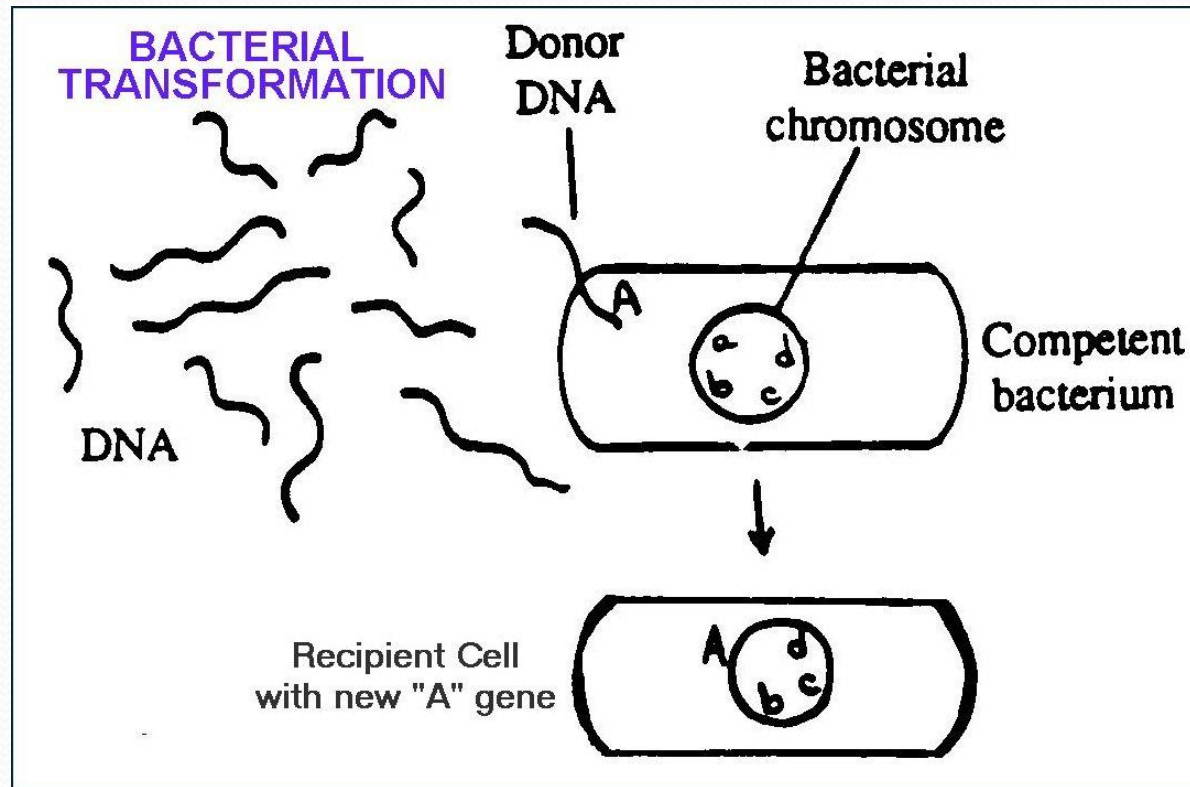
Genetic Recombination

- Three processes bring bacterial DNA from different individuals together:
 - Transduction: Bacteriophages (bacterial viruses) transfer bacterial genes from one host cell to another
 - Transformation: Alteration of a bacterial cell's genotype and phenotype by the uptake of naked, foreign DNA from the surrounding environment
 - Conjugation: Direct transfer of DNA between live bacterial cells that are temporarily joined

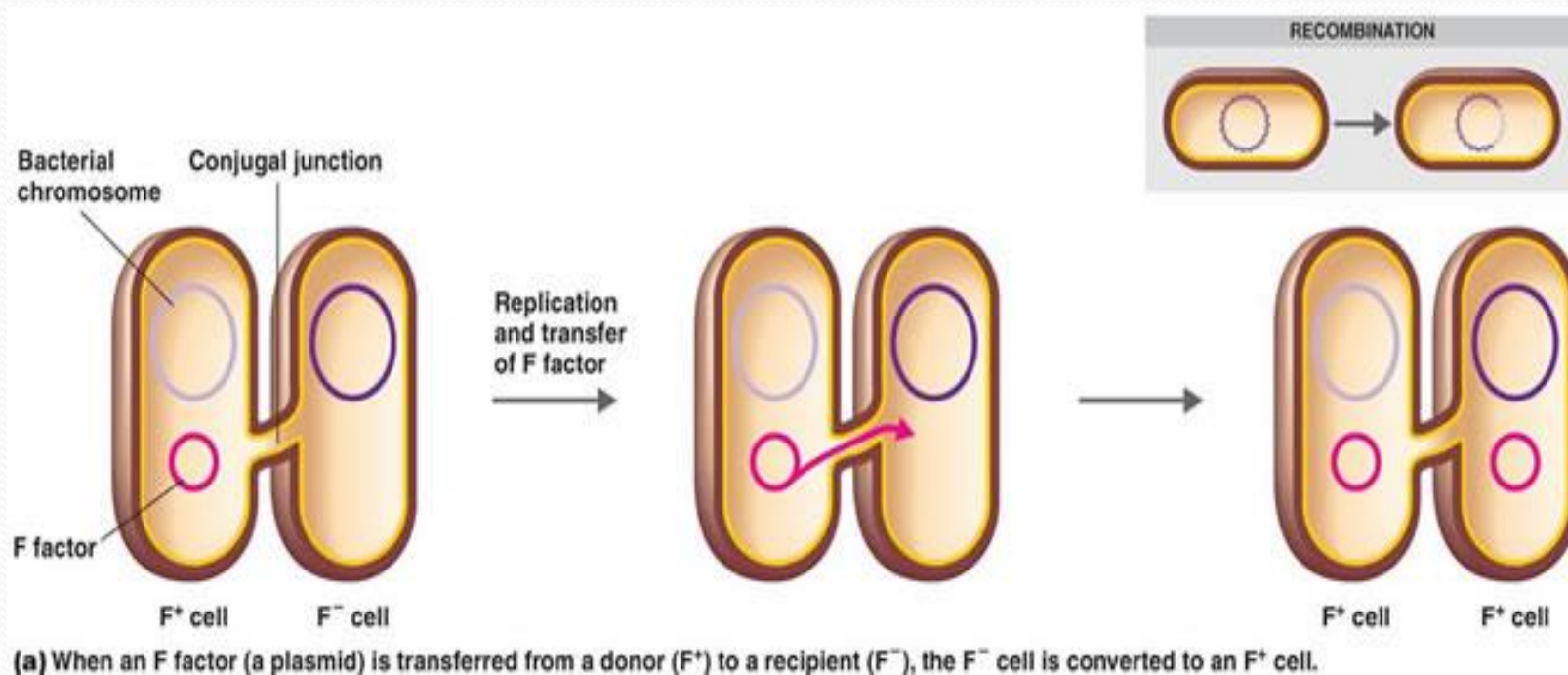
1. Transduction



2. Transformation

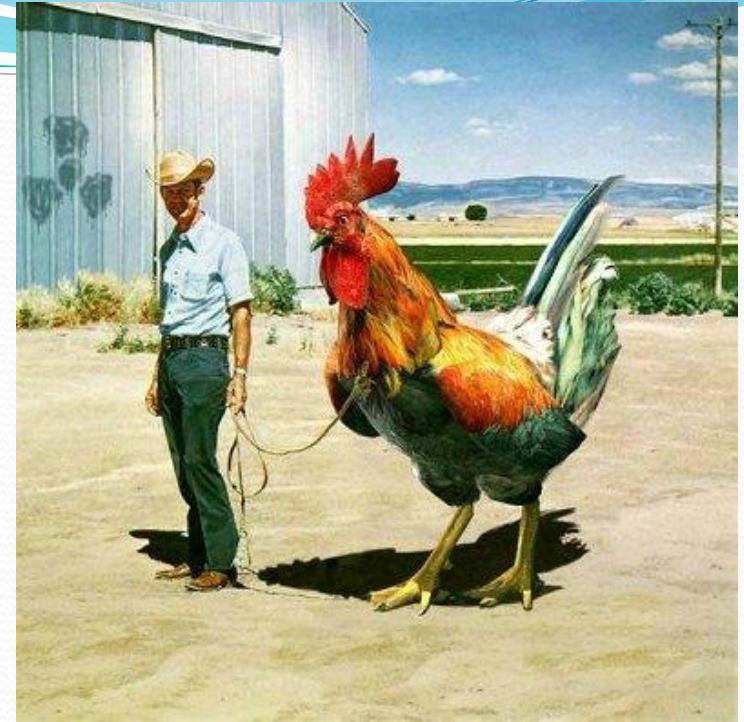


3. Conjugation



Applications

- Genetic engineering
- Drug resistance
- Identification of new species
- Diagnosis of pathogens



Genetic diagnosis of pathogens:

- Polymerase Chain Reaction (PCR technique):
- allows amplification of specific region of DNA to detect few number of organism/ cell DNA in clinical specimens.. Blood, Urine.. identify cause of Disease .. Bacteria, Viruses & others
- 16S ribosomal RNA gene (16srRNA) is highly stable in most bacterial types