# Bacterial genetics

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# Bacterial Genetics

- The methods of gene transfer in bacteria includes
- Bacterial conjugation
- Transformation
- Transduction

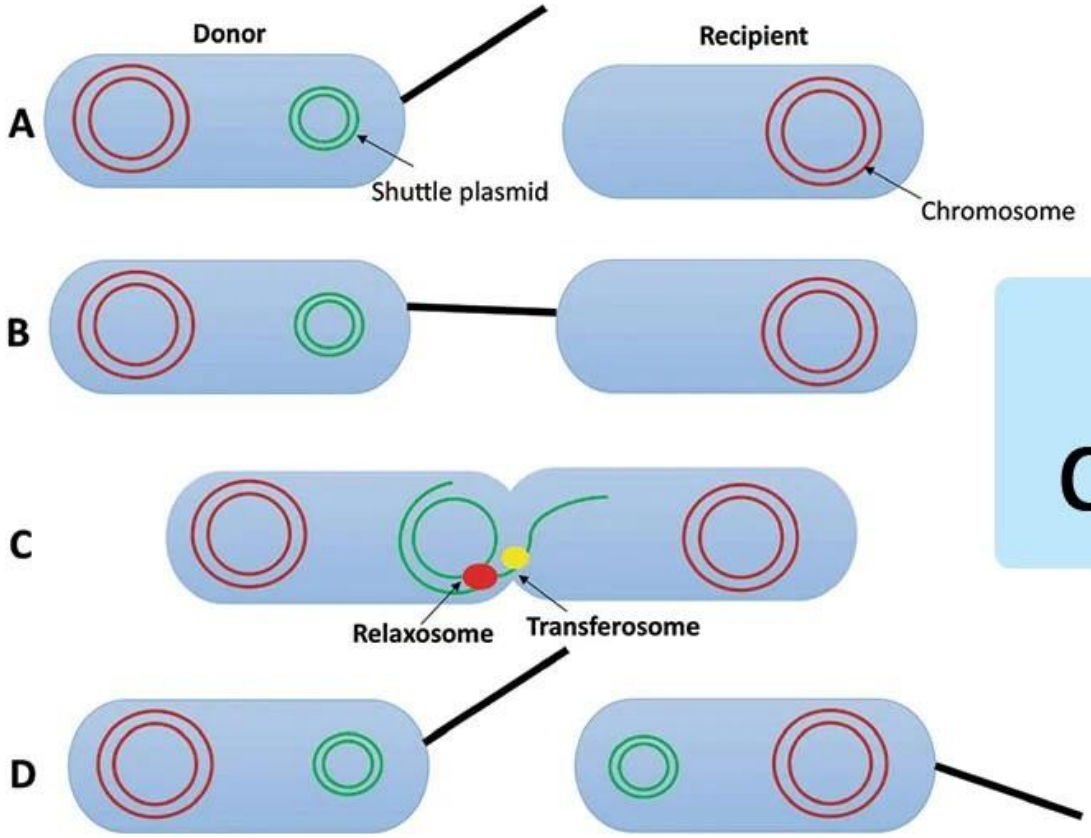
# Bacterial conjugation

- Bacterial conjugation was first demonstrated by Joshua Lederberg and Edward Tatum in 1946
- It is the transfer of genetic material from one bacterial cell to another by direct cell to cell contact through sex pili

# Different types of conjugation

- F+ x F- conjugation

- Here the transfer of F plasmid from donor cell / F+ cell to recipient / F – cells take place
- The F+ strain contains an extra chromasomal F factor carrying the genes for sex pilus formation and plasmid transfer.
- The sex pilus is used to establish contact between F+ and F- cells.
- Once the contact is made the pilus retracts bringing the cells into close physical contact
- The F factor then replicates and one strand is moved to the recepient cell through the lumen of sex pilus
- After the entry of plasmid into the recepient cell, the entering strand is copied to produce double stranded DNA
- Now the F- recipient become F+



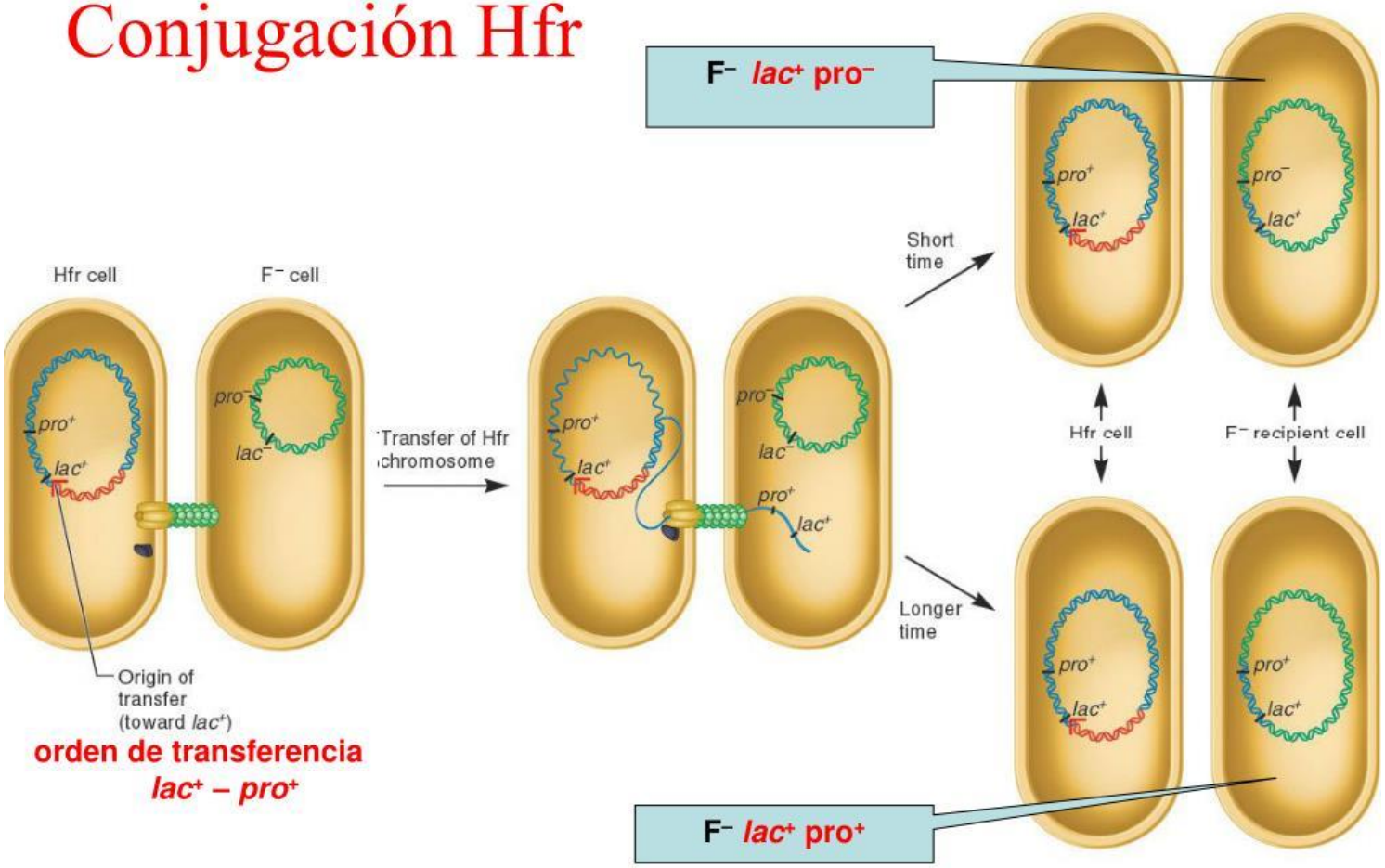

# Bacterial Conjugation

The Biology Notes

# HFR CONJUGATION

- It is called high frequency conjugation because of high frequency of recombinants produced by this mating.
- In Hfr starins the F factor is integrated into the bacterial chromosome rather than free in the cytoplasm
- So these plasmids also known as episomes
- After integration also these plasmids can produce pili carry out replication and transfer of genetic material to F- recipient.
- But here rather than transferring itself , the F factor directs the transfer of host chromosome
- Here only part of F factor is transferred to the recipient cell, so the F- recipient cells remain F- itself

# Conjugación Hfr




**orden de transferencia**

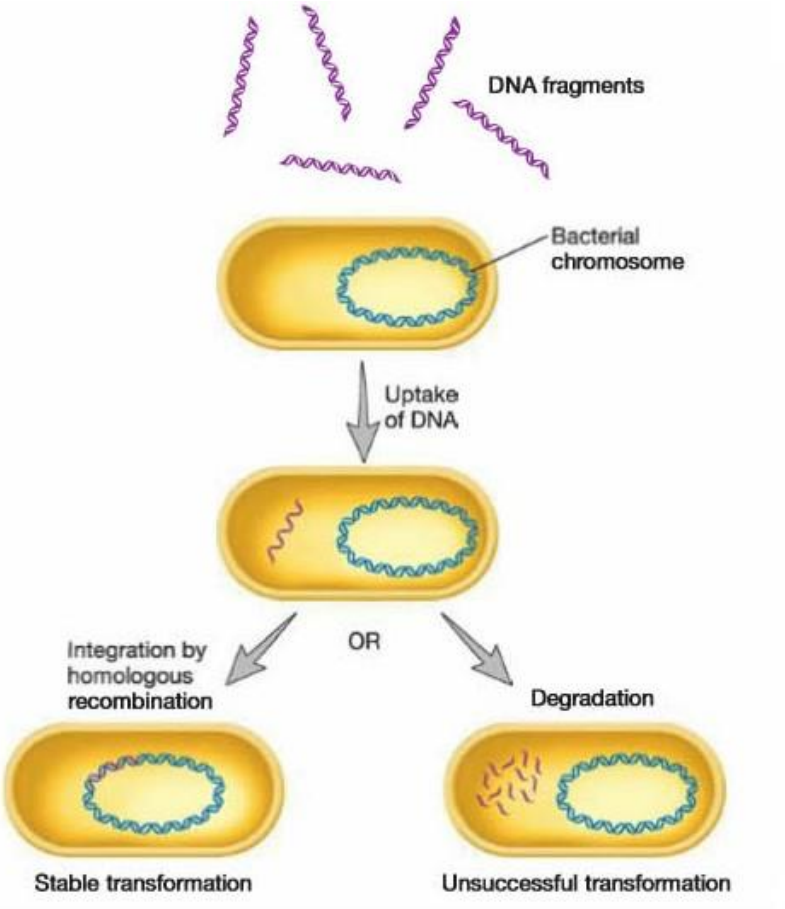
***lac⁺ – pro⁺***

# F' CONJUGATION

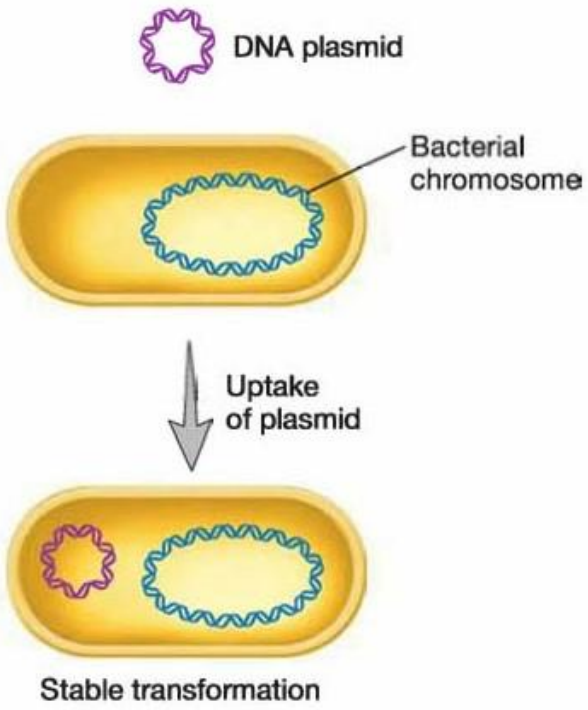
- The F factor is an episome when leaves the bacterial chromosome,, pick up a portion of bacterial chromosome along with it.
- Since it contains bacterial DNA also it is known as F' plasmid. Then it conjugate with F- recepient
- F'x F- conjugation is similar to F+ x F- mating and the recipient become F' +ve
- Conjugation occur mainly in E. coli and other Gram- negative bacteria.

# DNA TRANSFORMATION

- The transformation is the uptake of Naked DNA molecule/ fragment from the medium and incorporation of these molecule into the recipient chromosome in a heritable form
- Transformation was discovered by Frederich Griffith in 1928
- Natural transformation was discovered in Streptococcus, Bacillus and Pseudomonas
- A cell that is able to take up DNA and get transformed are called competent cells
- The mechanism of transformation has been intensively studied in Streptococcus pneumoniae




(a) Transformation with DNA fragments

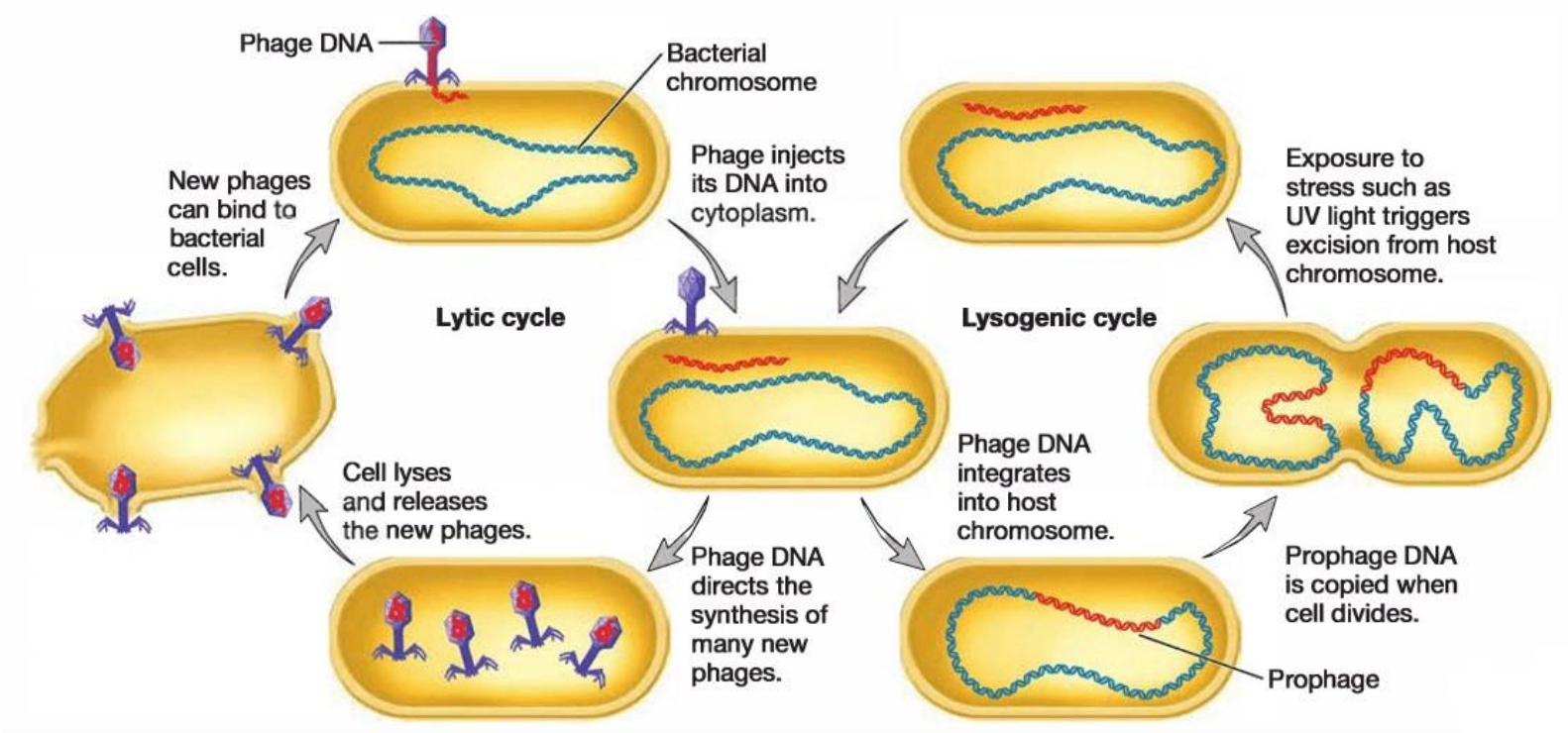



(b) Transformation with a plasmid

- The competent cells bind with double stranded DNA fragments, if the fragment is moderately large.
- Then the DNA is cleaved by endonucleases to double stranded fragments of 5 to 15 kilo bass
- It is an energy dependant procedure and one strand is hydrolyzed by exonuclease and the other strand associates with small protein and move through the plasma membrane
- Then the single stranded fragment get integrated to the bacterial genome
- We can artificially makes the cells competent by electrical shock and treatment with Calcium chloride

# TRANSDUCTION

- Transduction is the bacteriophage mediated transfer of genes from one bacteria to other .
- It is discovered by Joshua Lederberg and Zinder in 1951 in *Salmonella enterica* serovar Typhimurium
- Viruses that infect bacteria are called bacteriophages
- Some phage replicate in their bacterial host immediately after entry
- After the number of replicated phages reaches a certain number , they cause the host cell to lyse and infect new host cells
- These phages are called virulent phages and the process is called lytic cycle

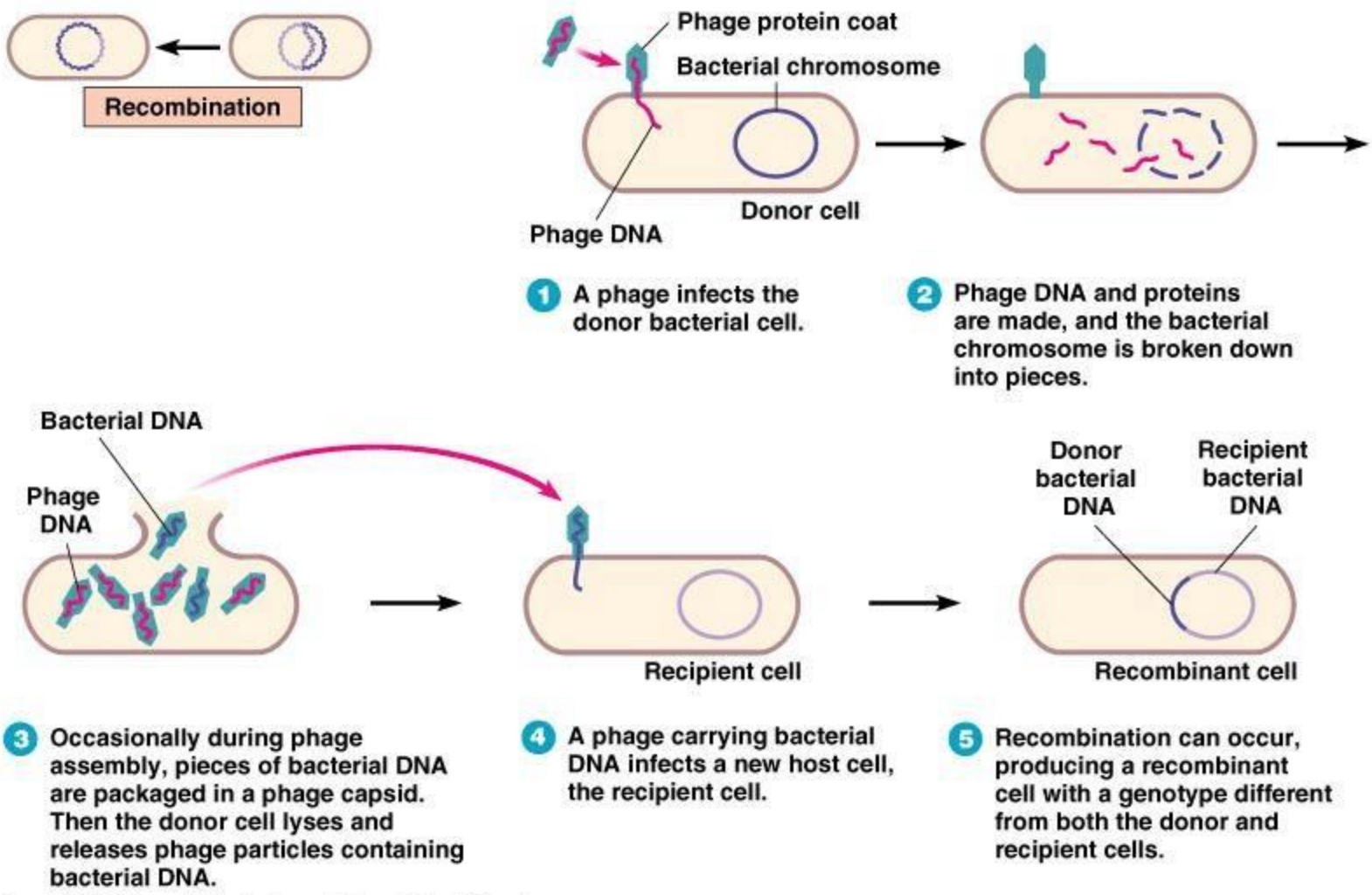

Phage DNA
Bacterial chromosome
Phage injects its DNA into cytoplasm.
New phages can bind to bacterial cells.
Lytic cycle
Lysogenic cycle
Exposure to stress such as UV light triggers excision from host chromosome.
Cell lyses and releases the new phages.
Phage DNA integrates into host chromosome.
Phage DNA directs the synthesis of many new phages.
Prophage DNA is copied when cell divides.
Prophage

- Other bacteriophage after entry into the bacterium, instead of replicating insert their genome into the bacterial chromosome
- Phage DNA inserted into the bacterial genome is called prophage
- The host bacterium is not harmed by this
- Here the phage genome also replicate along with the bacterial genome
- These bacteriophages are called temperate phages and the relationship between the virus and host is called lysogeny
- The bacteria that have been lysogenised are called lysogens

- These temperate phages can be induced to switch to a lytic cycle of growth under certain condition such as UV irradiation
- Here the prophage excise from the bacterial genome and enter into the lytic cycle

# Two types of tranduction

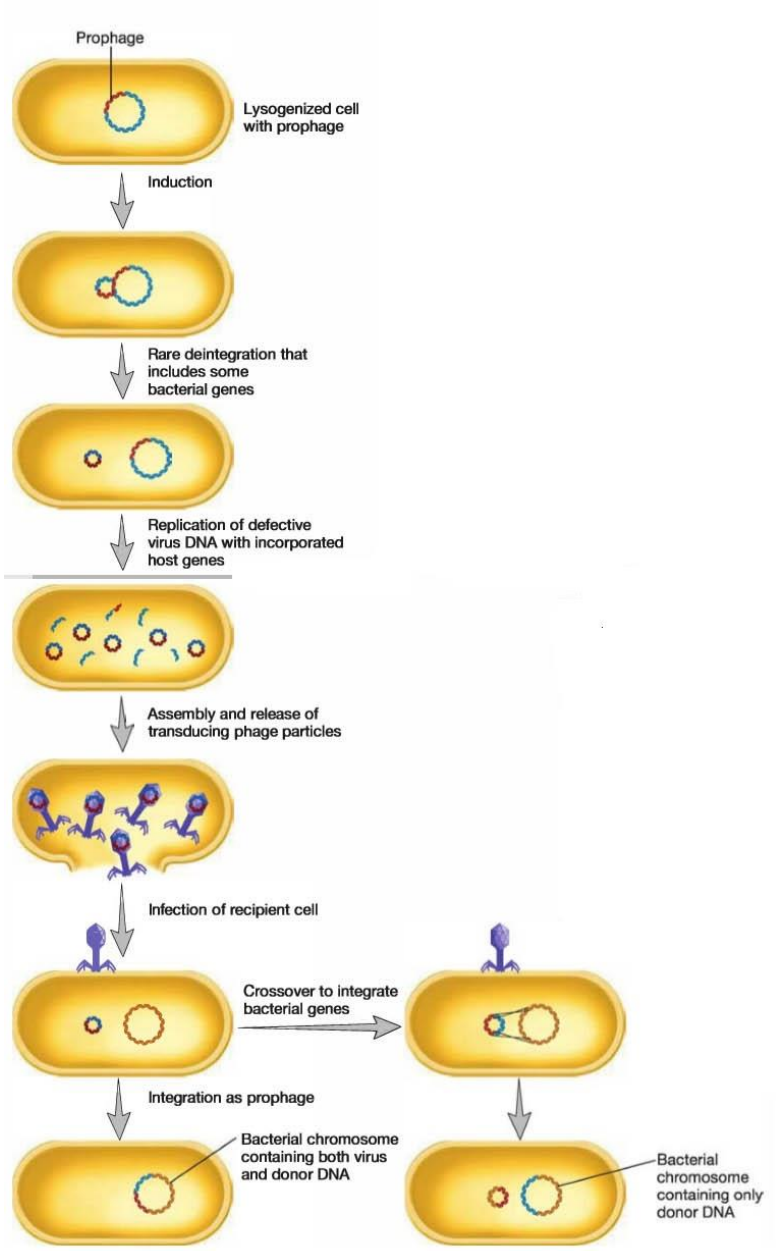
- Generalized transduction
- Generalized transduction occur during the lytic cycle of virulent phage and some temperate phages can transfer any part of the bacterial genome
- Here during the assembly stage when viral chromosomes are packed into the protein capsids, random fragments of partially degraded bacterial chromosome also may be packed by mistake
- Because the capsid can contain only a limited quantity of DNA, the viral DNA is left behind



- The resulting viral particle often injects DNA into other bacterial cell, but can not initiate a lytic cycle
- As in transformation, one DNA has been injected, it must be incorporated into the recipient cells chromosome for stable transduction

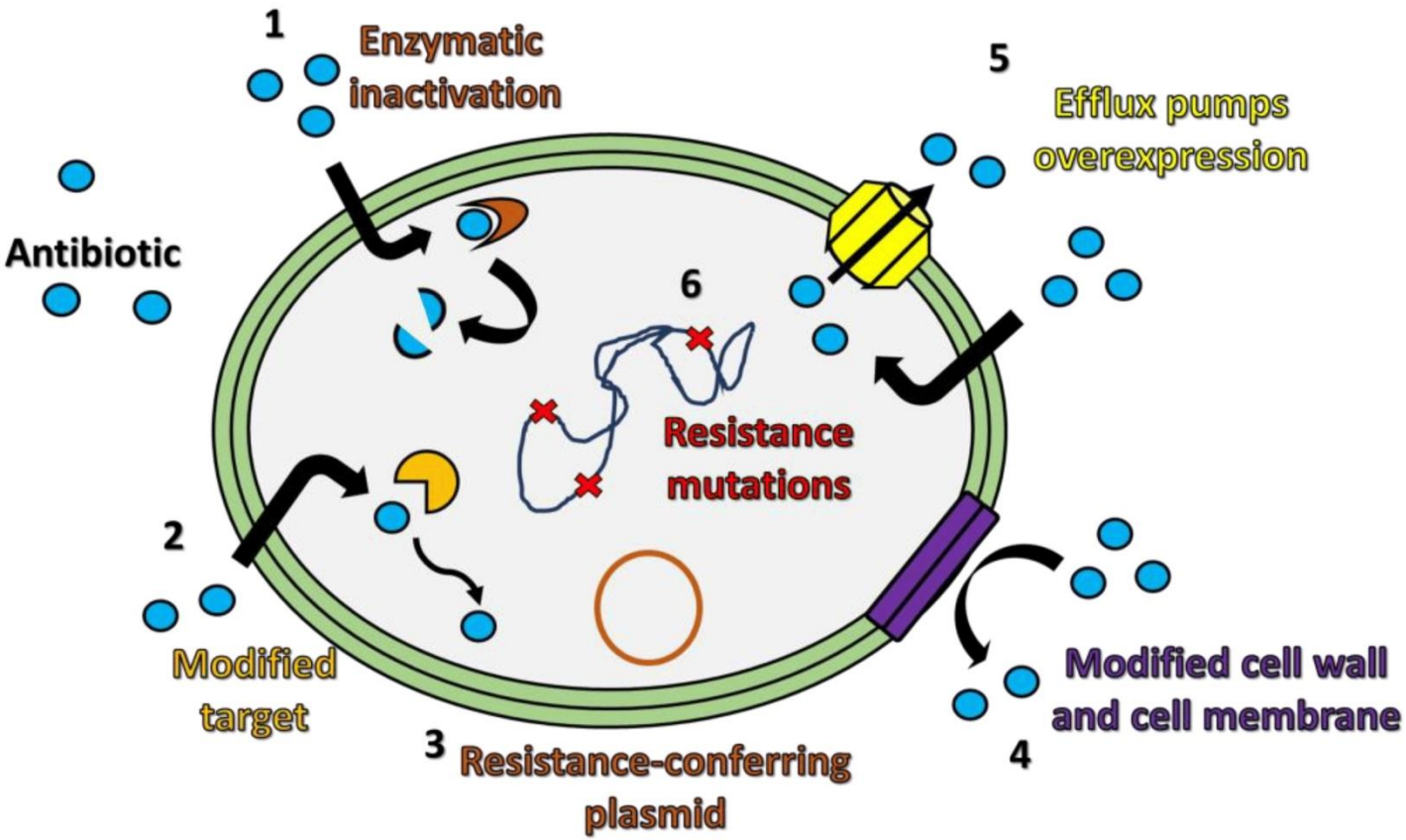
# Specialised transduction

- In specialized transduction the transducing particle carries only specific portion of the bacterial genome
- It occurs in the lysogenic life cycle of temperate phage
- Here when a prophage is induced to leave the bacterial genome, it will carry some portion of bacterial gene next to the integration site
- The transducing phage will inject bacterial genes into another bacterium and get incorporated into the recipients genome


Prophage
Lysogenized cell with prophage
Induction
Rare deintegration that includes some bacterial genes
Replication of defective virus DNA with incorporated host genes
Assembly and release of transducing phage particles
Infection of recipient cell
Crossover to integrate bacterial genes
Integration as prophage
Bacterial chromosome containing both virus and donor DNA
Bacterial chromosome containing only donor DNA

# Antibacterial resistance

- Resistanceto antibiotics occur as a result of drug inactivation, drug target modification or decreased intracellular accumulation associated with reduced membrane permeabilityor increaes drug efflux
- In broad terms resistance ca be
- Innate (intrinsic)
- Aquired (extrinsic)
- Innate resistance is chromasomally encoded and is due to cell wall complexicity, efflux mechanism or enzyme inactivation of antibiotic
- Acquired resistance can arise from a mutation of gene/ transfer of genetic material encoding resistance gene *via* conjugation, transformation and transduction


1
Enzymatic inactivation
Antibiotic
2
Modified target
3
Resistance-conferring plasmid
4
Modified cell wall and cell membrane
5
Efflux pumps overexpression
6
Resistance mutations