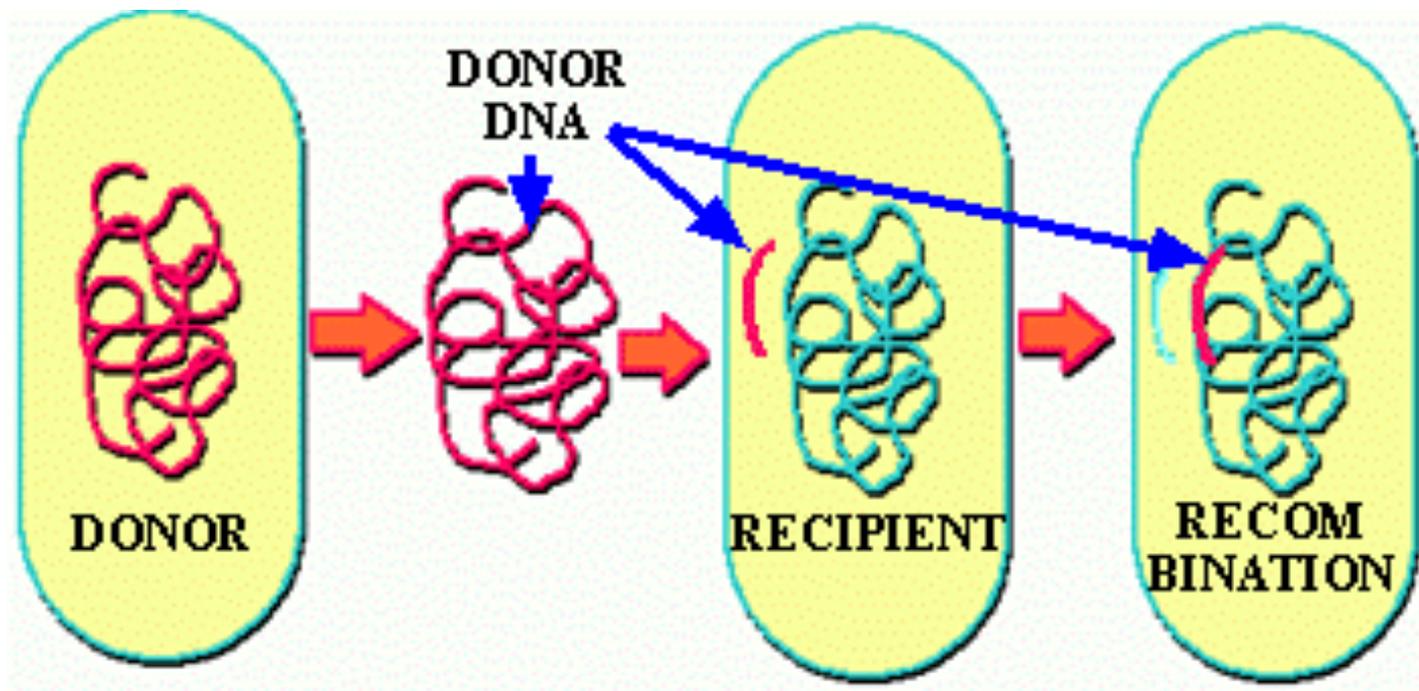


TRANSFER OF GENETIC MATERIAL IN BACTERIA

Department of Microbiology

Things to know...

- Donor bacteria (bacterium giving the genetic material),
- Recipient bacteria (Bacteria receiving the genetic material)
- Transfer could be both *in-vitro* and *in-vivo*
- Fusion with the recipient's chromosome: genetic homogeneity of bacteria (homology between DNA sequences of donor&recipient bacteria)
- The recipient bacteria can become positive in terms of the special characters carried by the gene/genes in the foreign DNA sequence integrated into its own chromosome.



Transfer of genetic material between bacteria (natural gene transfer)

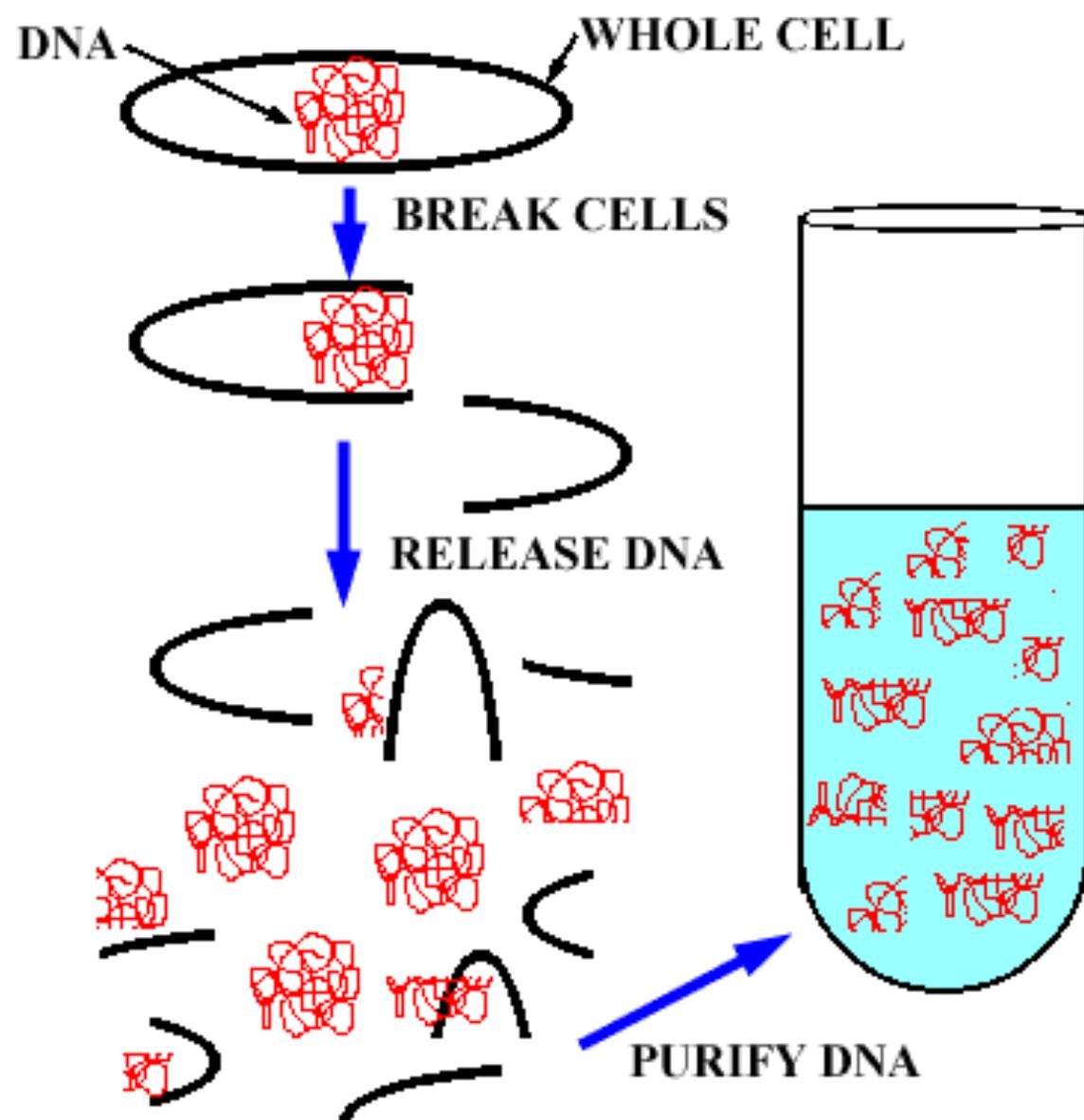
1. Transformation
2. Conjugation
3. Transduction

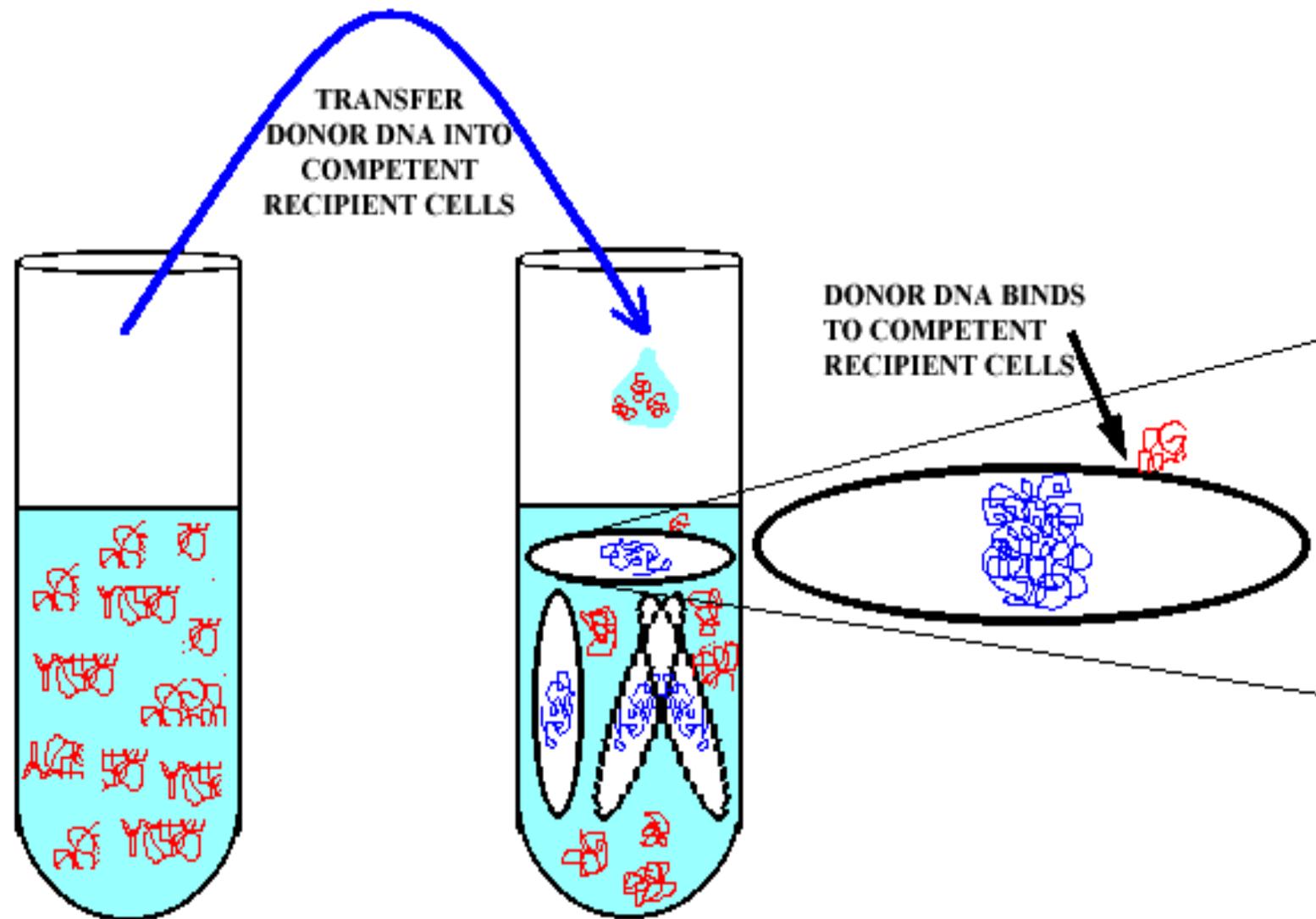
TRANSFORMATION

- Two microorganisms whose DNA composition is identical/similar to/with each other
- If one of these microorganism is produced in a medium containing genetic material from the other, the donor microorganism. The receipient microorganism can take donor's genetic material and show its physical characteristics...

In-vitro Transformation

- *Trials with II-S and II-R strains of Diplococcus pneumoniae*
- *II-S was inactivated (killed) and its DNA extracts were included into the medium.*
- *The living II-R strain received the genetic materials of the II-S strain from the medium and became positive in terms of the characteristics carried in these genetic elements (transformed into II-S).*





DNA BINDS TO CELL WALL



**DNA ENTERS
HOST CELL**



**DONOR DNA
INTERACTS WITH
HOST DNA**

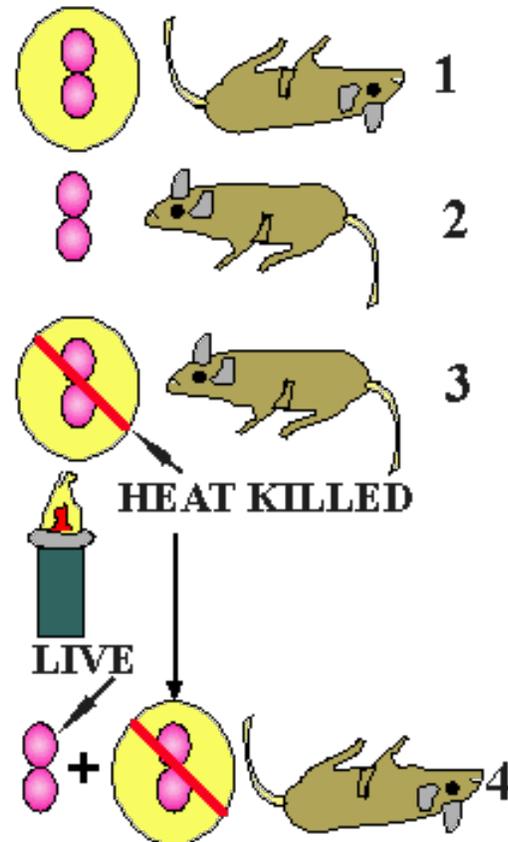


**DONOR DNA
HOST DNA
EXCHANGE**



In-vivo Transformation

- Griffith Experiment



1-Live II-S strain with capsule (virulent)

2-Live II-R strain without a capsule (avirulent)

3-Heat-inactivated (killed) II-S strain

4-Live II-R strain and then heat inactivated II-S strain

Conditions required for transformation

- Presence of antigenic similarity in bacteria
- Homology between their DNA
- The recipient cell is competent (capable of taking up a piece of DNA and/or permeability)
- Molecular weight (at least $0.3-8 \times 10^5$ daltons) and structure (double-stranded) of DNA
- Presence of receptors required for adsorption and penetration on the surface of the recipient cell

- *The time between the DNA segment adsorbing on the recipient cell surface and joining with the competent DNA after it enters the cell is called the eclipse (latent) period.*
- *DNA fragment entering from outside to inside the cell is exogenot*
- *Fusion of recipient cell DNA with endogenot is recombination*

With Transformation;

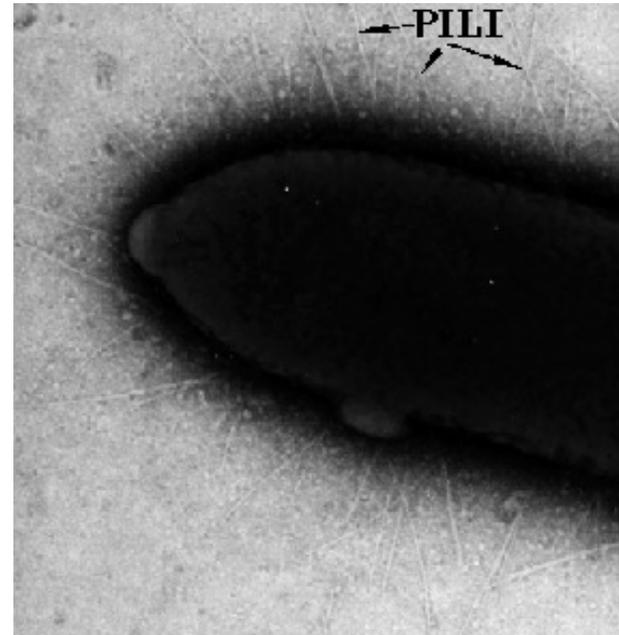
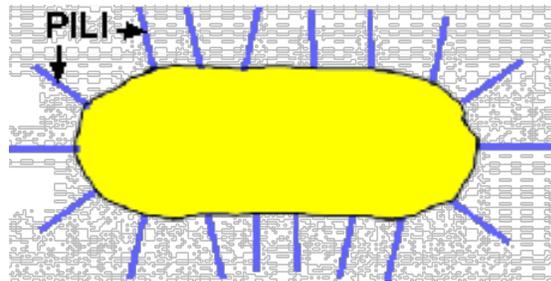
- Lactose and galactose positive genes,
- Resistance to antibacterial agents,
- Transfer of various virulence genes to recipient bacteria,
- Determination of chromosome maps of bacteria

Transfection

- Transfer of phage DNA (or plasmid) into a competent bacterial cell

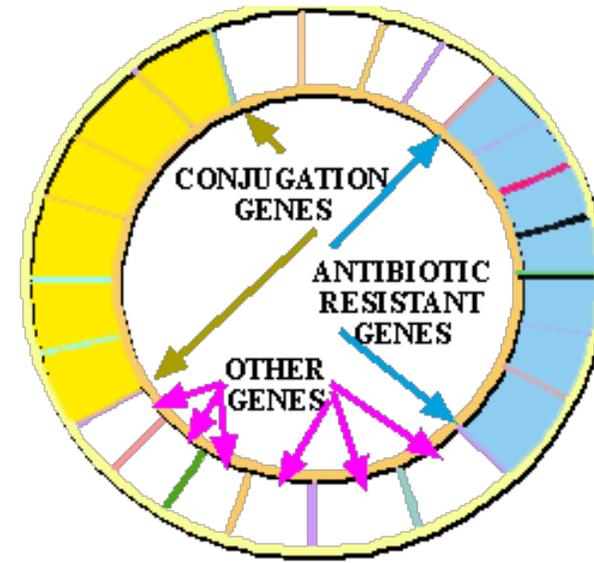
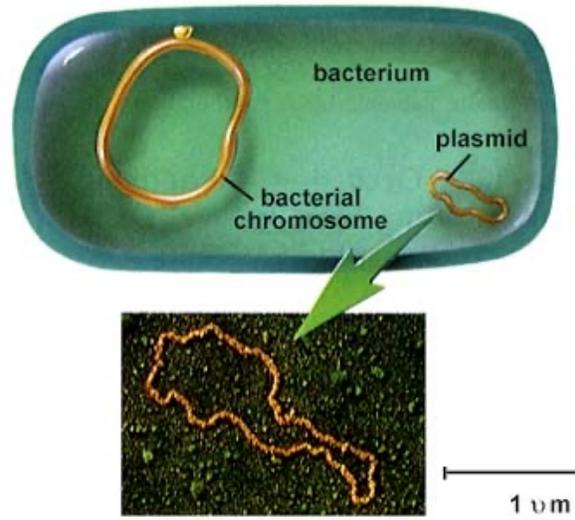
CONJUGATION

- The transfer of all or a fragment of the donor cell's DNA to the recipient by direct contact of these two cells or via sex pili

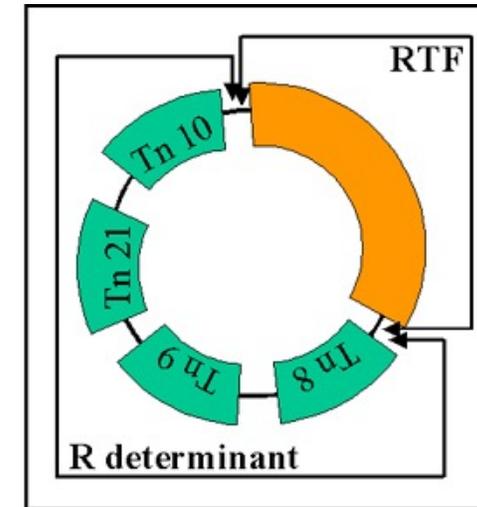
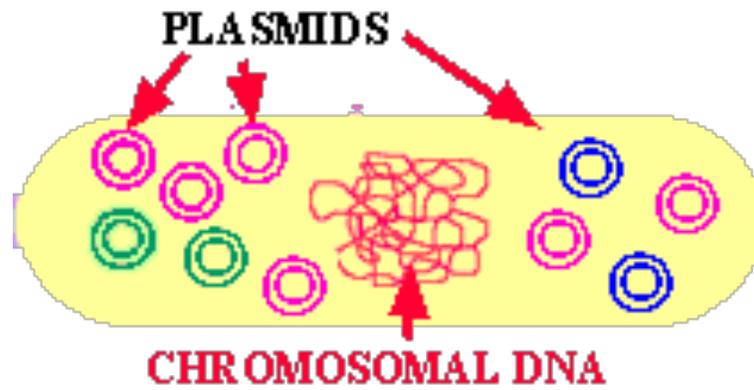


For Conjugation;

- Direct contact
- *The ability to be a donor is determined by plasmids (transfer factor or sex factor), which is a transmissible genetic element in the cell.*
- *Cells that receive this factor become positive for transported characteristics.*
- *The sex pilus (fimbria) is synthesized by special genes in the sex factor (plasmid) inside the cell*



CIRCULAR PLASMID DNA



Extrachromosomal genetic elements that can be transferred by conjugation

- Fertility factor (F-factor)
 - Resistancy factors (R-factors)
 - Colisin factor (Col-factor)
-
- Cells with an F factor on the chromosome (Hfr, high frequency recombination) have a higher F+ transmission frequency than cells with an independent F factor.

F factor

- circular, double-stranded DNA segment
- 32 nm long (1.2% of bacterial DNA)
- can encode 40-60 proteins

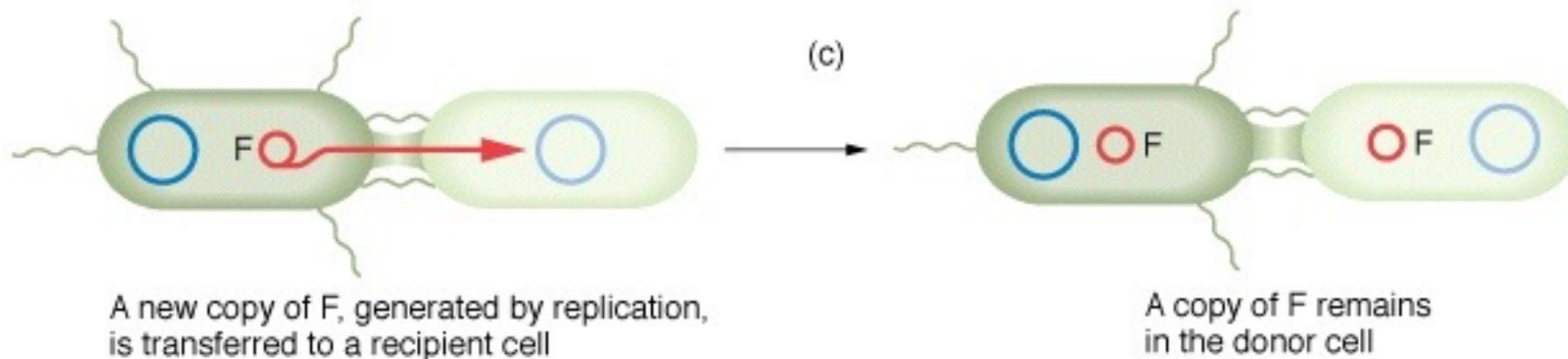
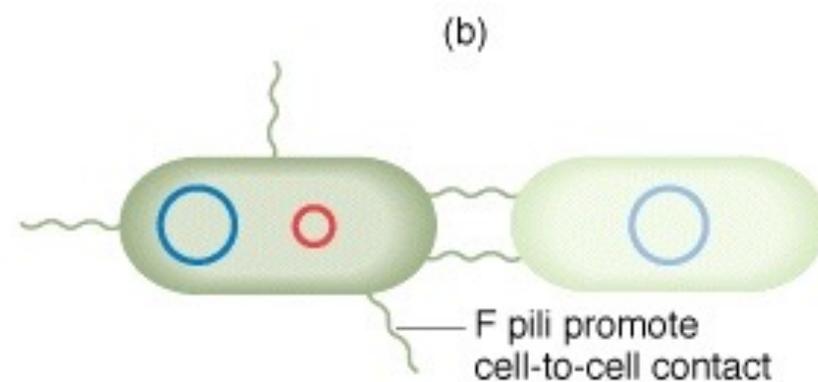
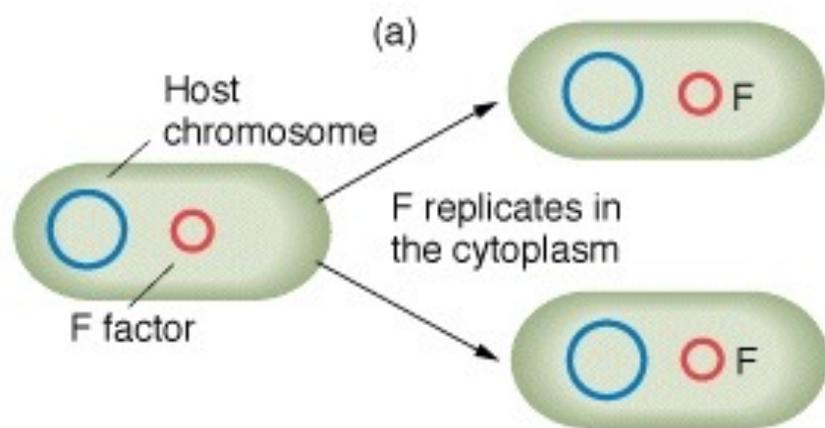
F factor can be found in 3 different forms in a cell

1. Independent genetic element (F+), plasmid
2. Integrated to the host DNA (Hfr), the episome
3. Independent but as part of host DNA, F' prime

- In order for the circular F factor to integrate into the recipient's cell chromosome, homologous regions must be found.
- Before integration, the F factor takes a linear state and approaches next to the homologous region on the bacterial chromosome. The fusion occurs with a single cross-over between homologous regions and Hfr cells are formed.
- After Hfr cell formation, this factor activates the synthesis mechanism by stimulating the cell for the formation of the sex pilus.

- *E. coli* K 12 strain can conjugate with other bacterial genus in Enterobacteria (*Shigella*, *Salmonella*, *Serratia*, *Proteus*, etc.)...
- Conjugation frequency and integration into the recipient cell chromosome are directly proportional to the homology between bacteria.
- In cases where there is no integration, the F factor is found in a free state (in the form of a plasmid) in the cell.

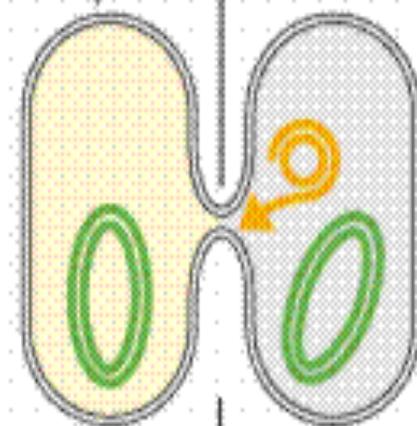
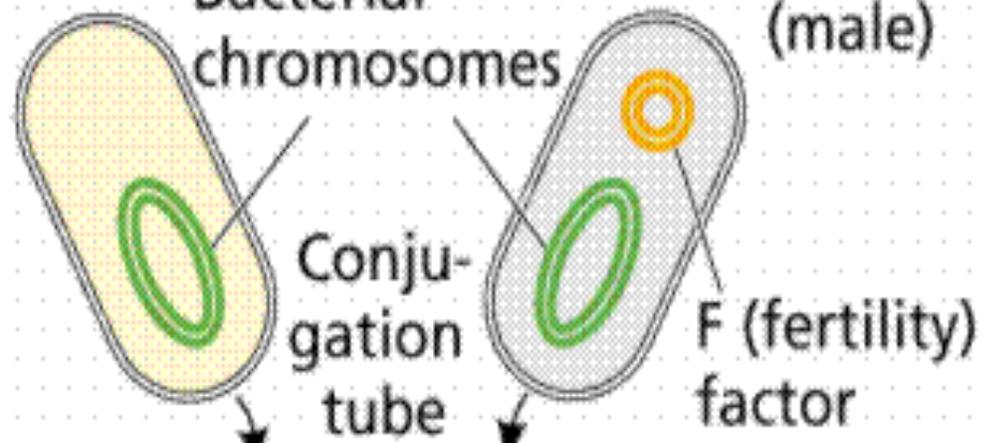
- Replicates synchronously and simultaneously with cell DNA
- The F factor containing the foreign genome fragment is called the F-prime factor (F') and the recipient cell is called the F genode.
- Sometimes, while the F factor is in the cell DNA, it is next to the galactose or lactose genes, and when it leaves, it can become an extrachromosomal genetic element by taking one of these genes with it. When this plasmid is transferred to another cell, they can transform those cells into gal⁺ and lac⁺. These cells are called secondary F'-cells, and this phenomenon is called sexduction.
- In some cases, the F factor can be separated by leaving the host cell. Such cells become F⁻, which event (Hfr---F+---F⁻) is called release or healing.



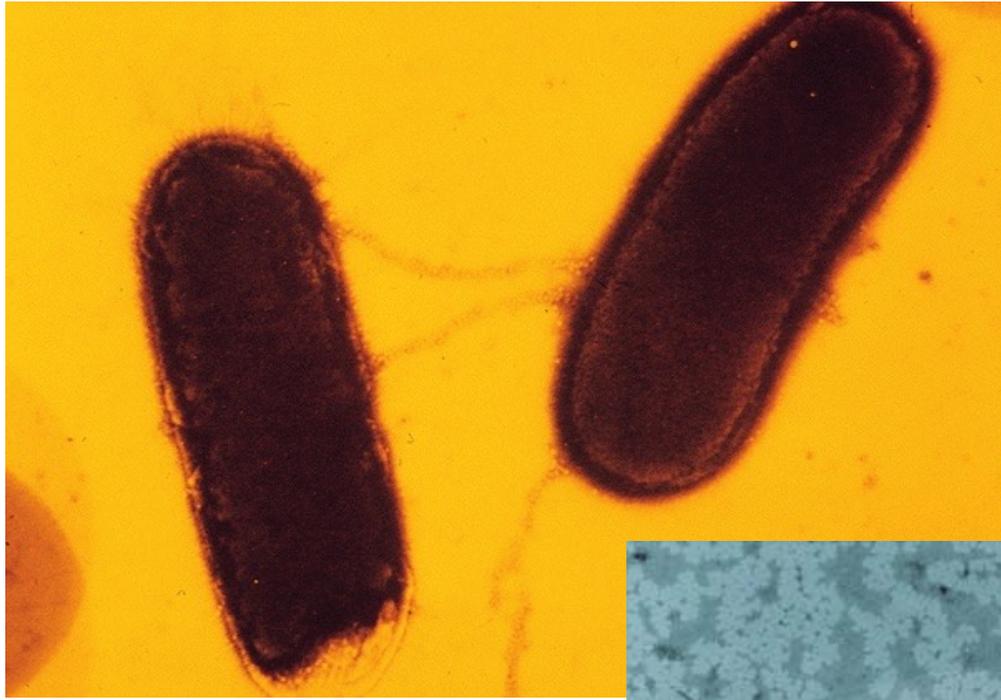
F^- *E. coli*
(female)

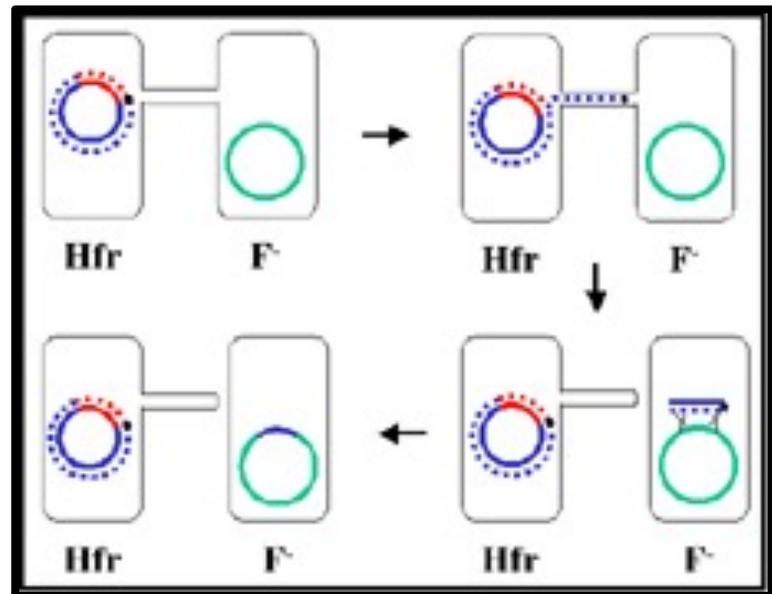
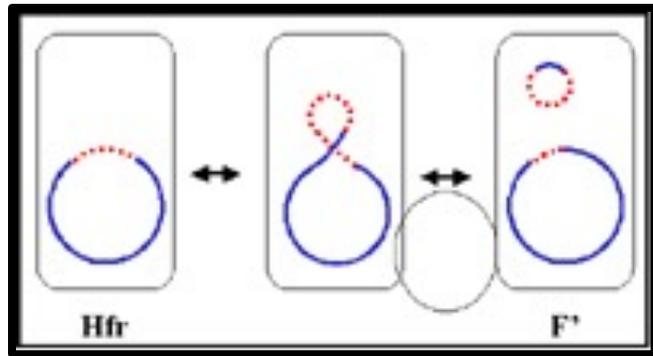
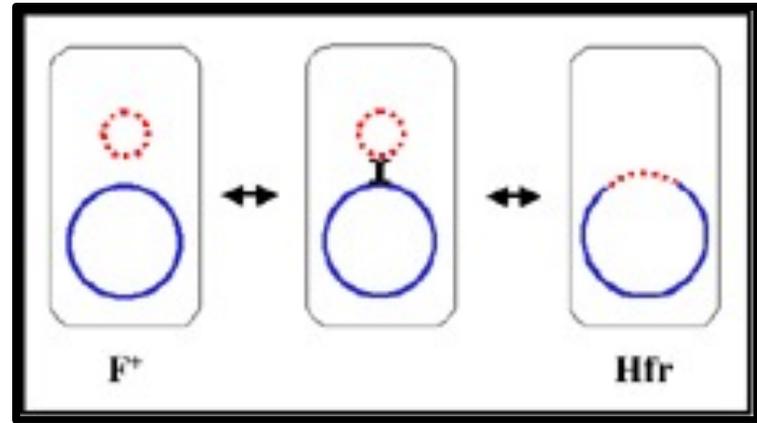
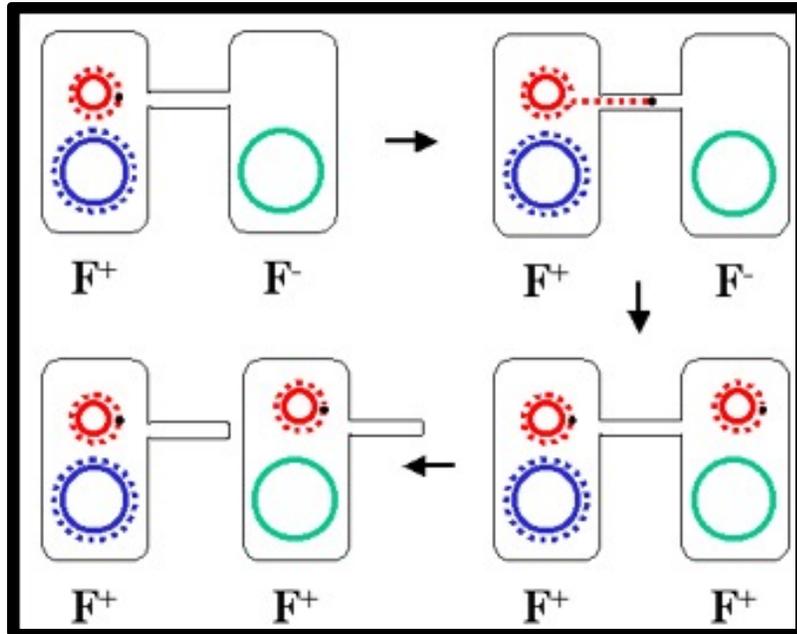
Bacterial
chromosomes

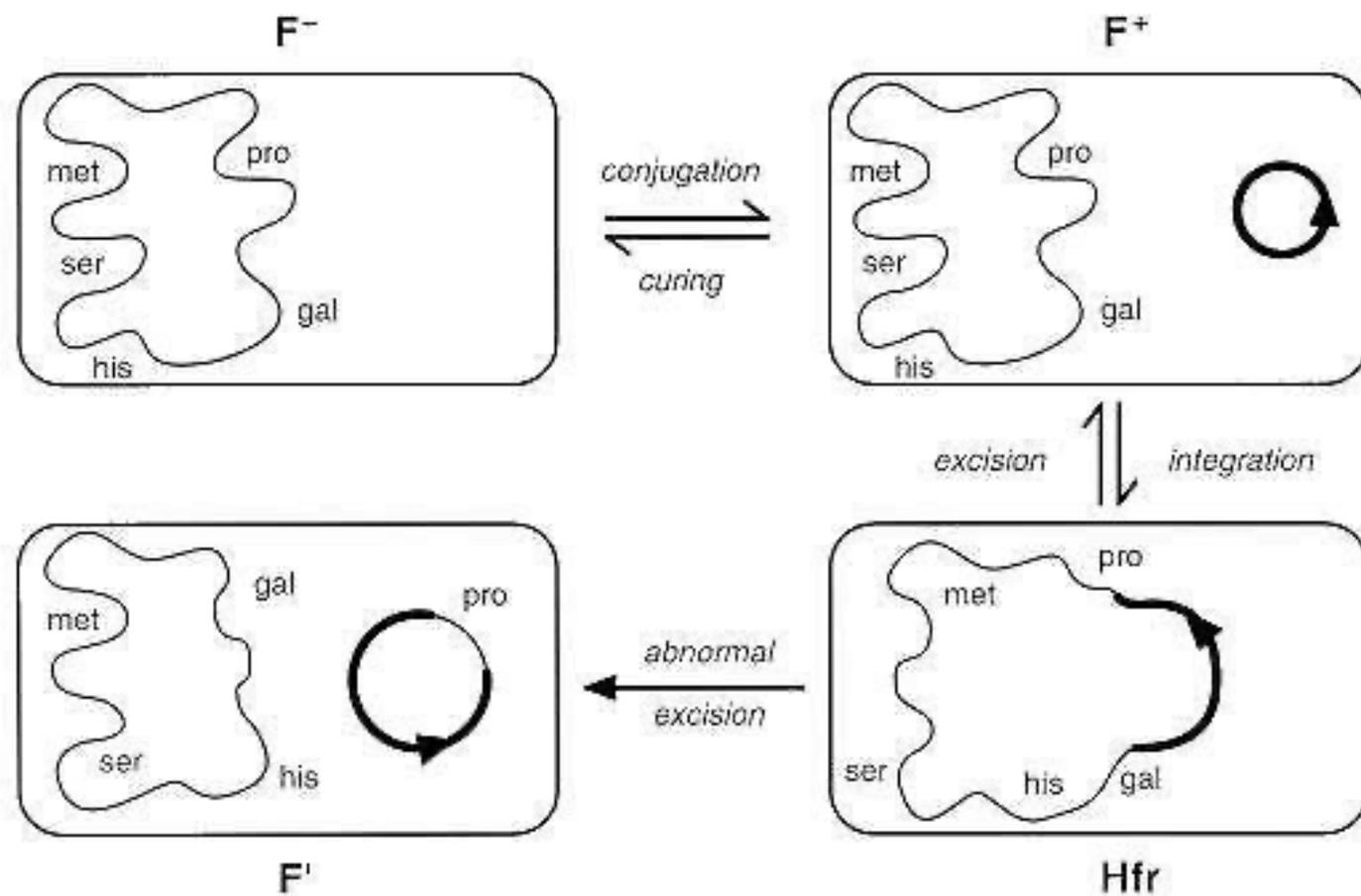
F^+ *E. coli*
(male)



Conjugating cells;
copy of F factor
transferred to F^- cell





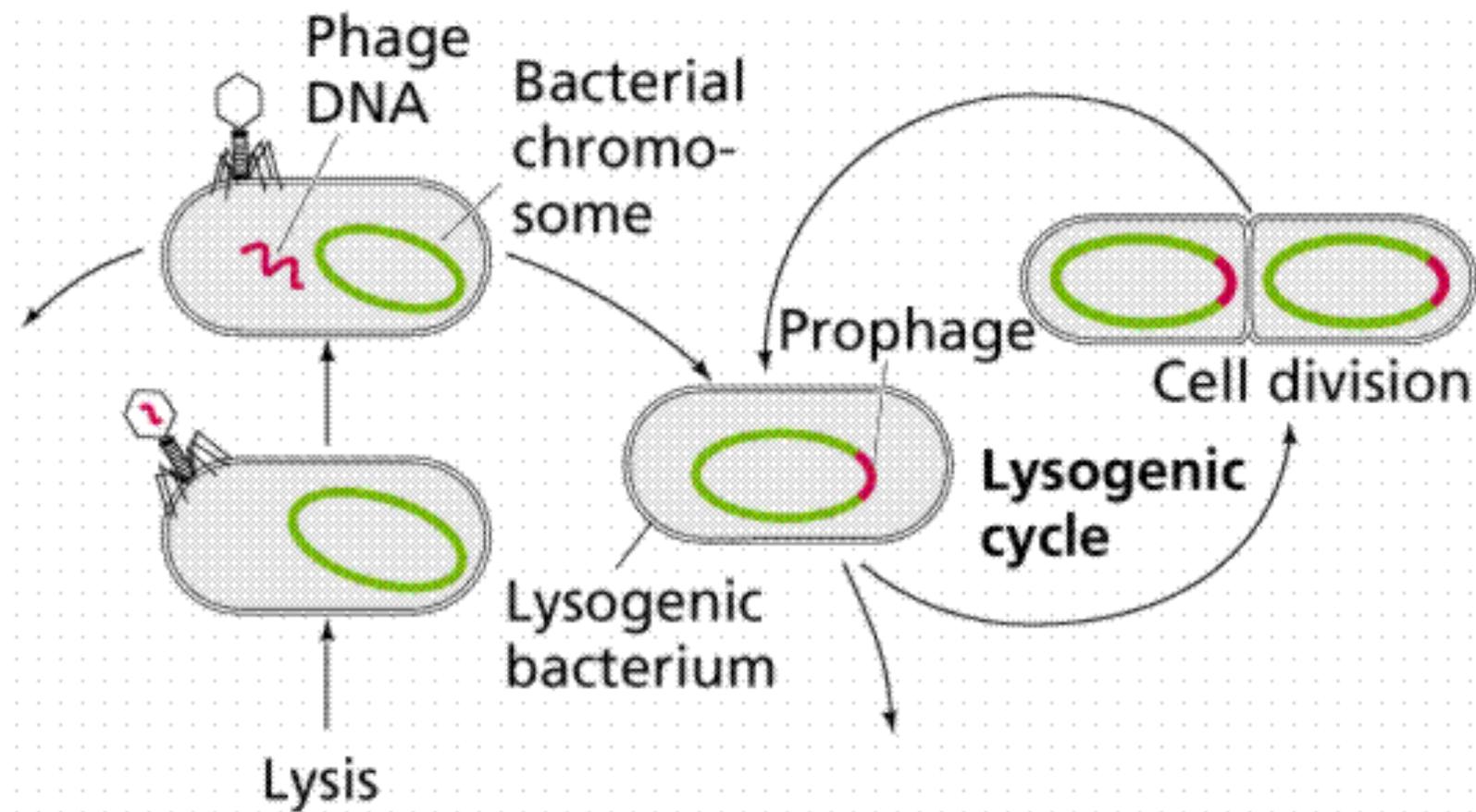


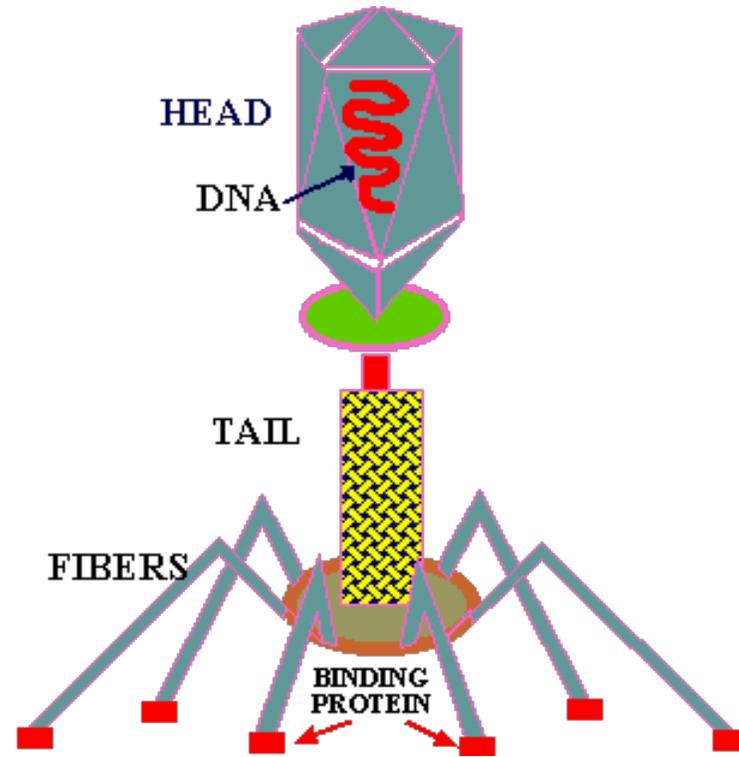
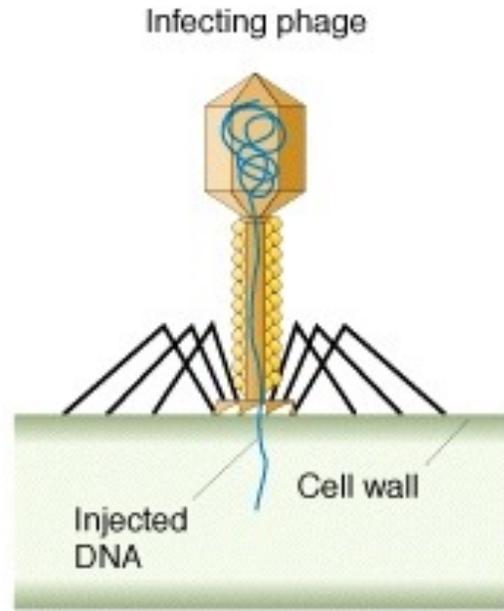
TRANSDUCTION

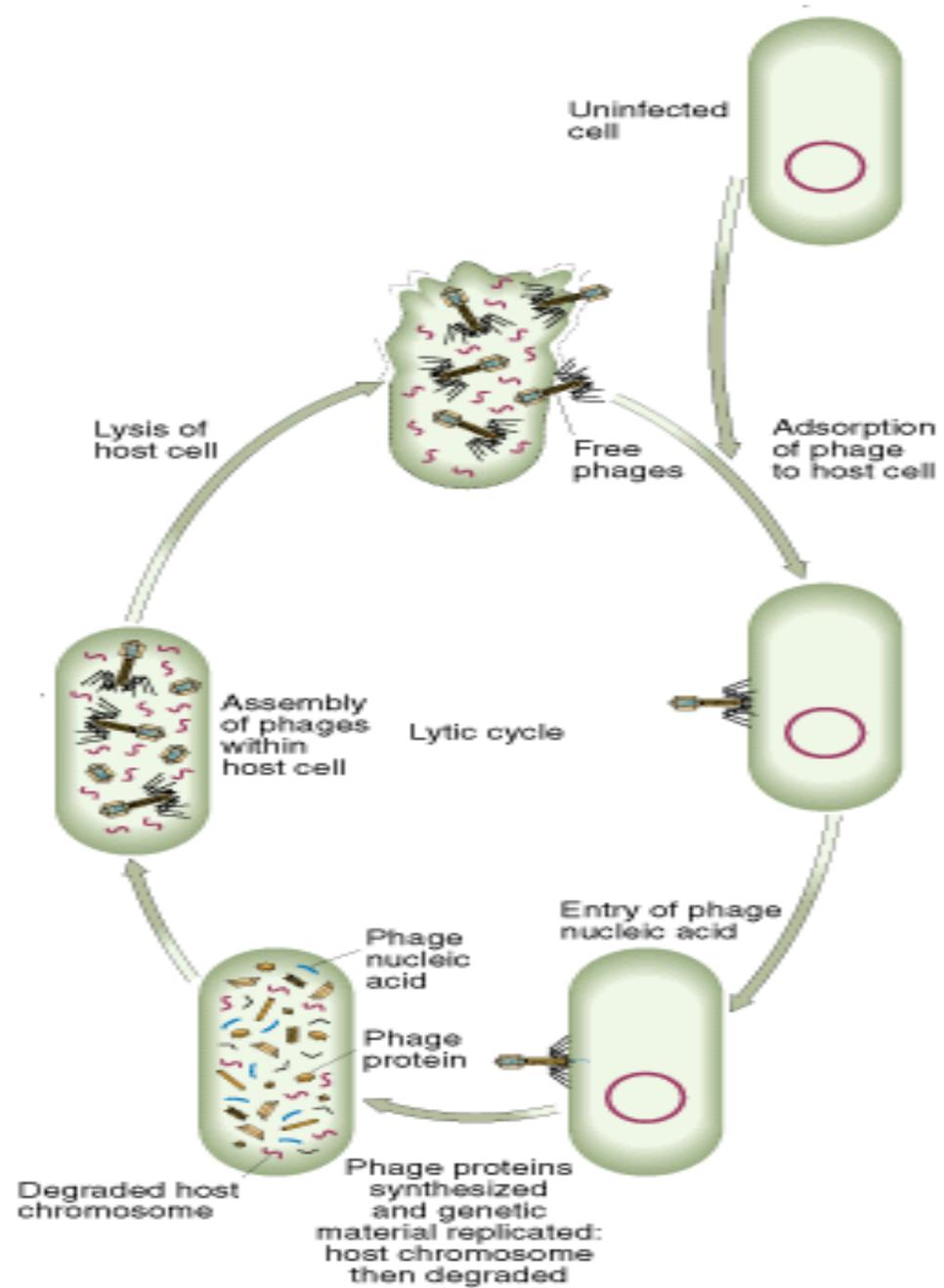
- The transfer of genetic material from a donor bacterium to a recipient bacterium via phages is called transduction.
- Gene transfer by transduction could be seen both in Gram-negative (*Salmonella*, *E. coli*, *Shigella*, *Proteus*, *Vibrio*, *P. aeruginosa*) and Gram-positive microorganisms (staphylococci and bacilli)
- Phages are viruses (bacteriophages) that break down or lyse bacteria. It is host specific and has species specificity among bacterial phages.

Bacteriophages Types

- *virulent or vegetative phages that replicate after entering the host cell and lyse the bacterium*
- *Bacteriophages those do not lyse the infected cell; temperate phages*
- *Those that combine with the host DNA; prophages*
- *cells containing bacteriophages as prophages; lysogenic cells*









**Thank you for your
patience&interest.**