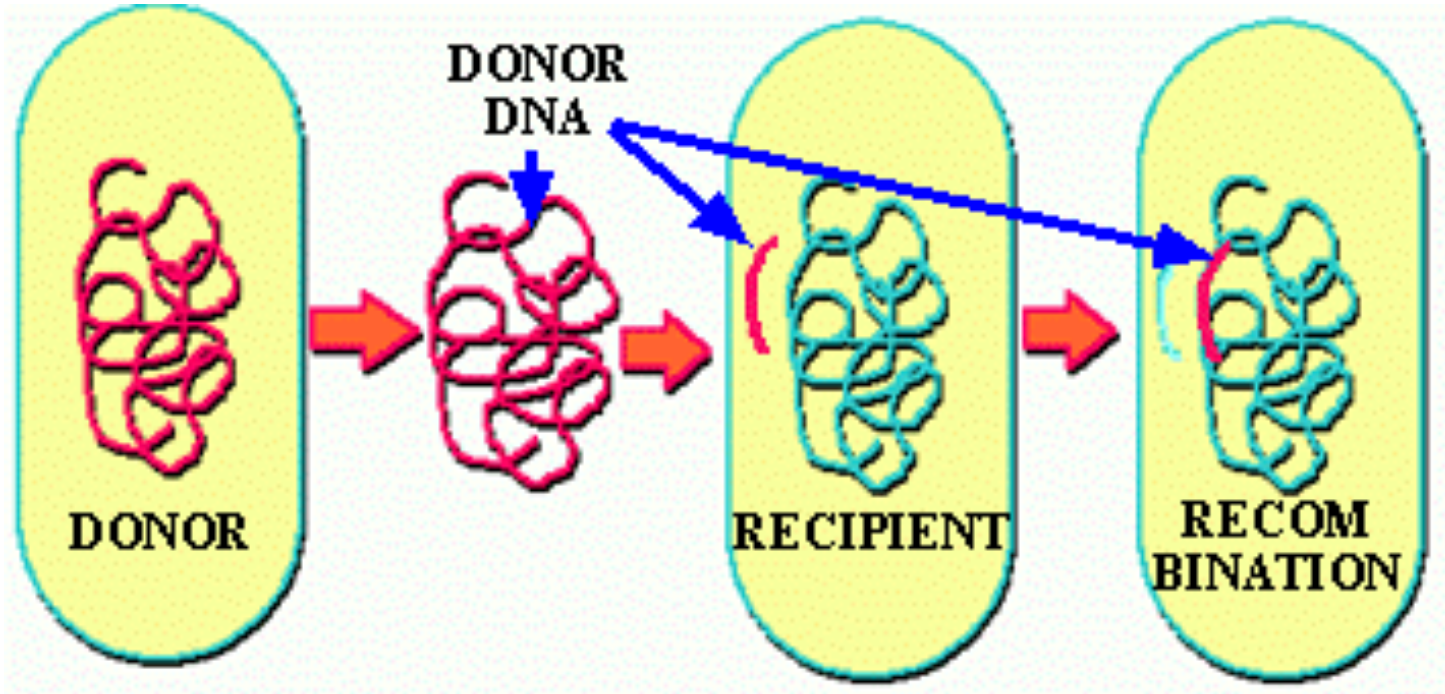
Transfer of Genetic Materials in Bacteria

Week 11

Things to Know...

- Donor (donor) bacteria, recipient (acceptor) bacteria
- in vivo and in vitro transfer
- Merging with the chromosome of the receptor: the genetic affinity of bacteria
- Homology between DNA sequences
- The recipient bacterium can become positive in terms of special characters carried by the gene / genes in the foreign DNA sequence that is integrated into its chromosome


DONOR
DONOR DNA
RECIPIENT
RECOM BINATION

Transfer of Genetic Material Between Bacteria (Natural gene transfer);

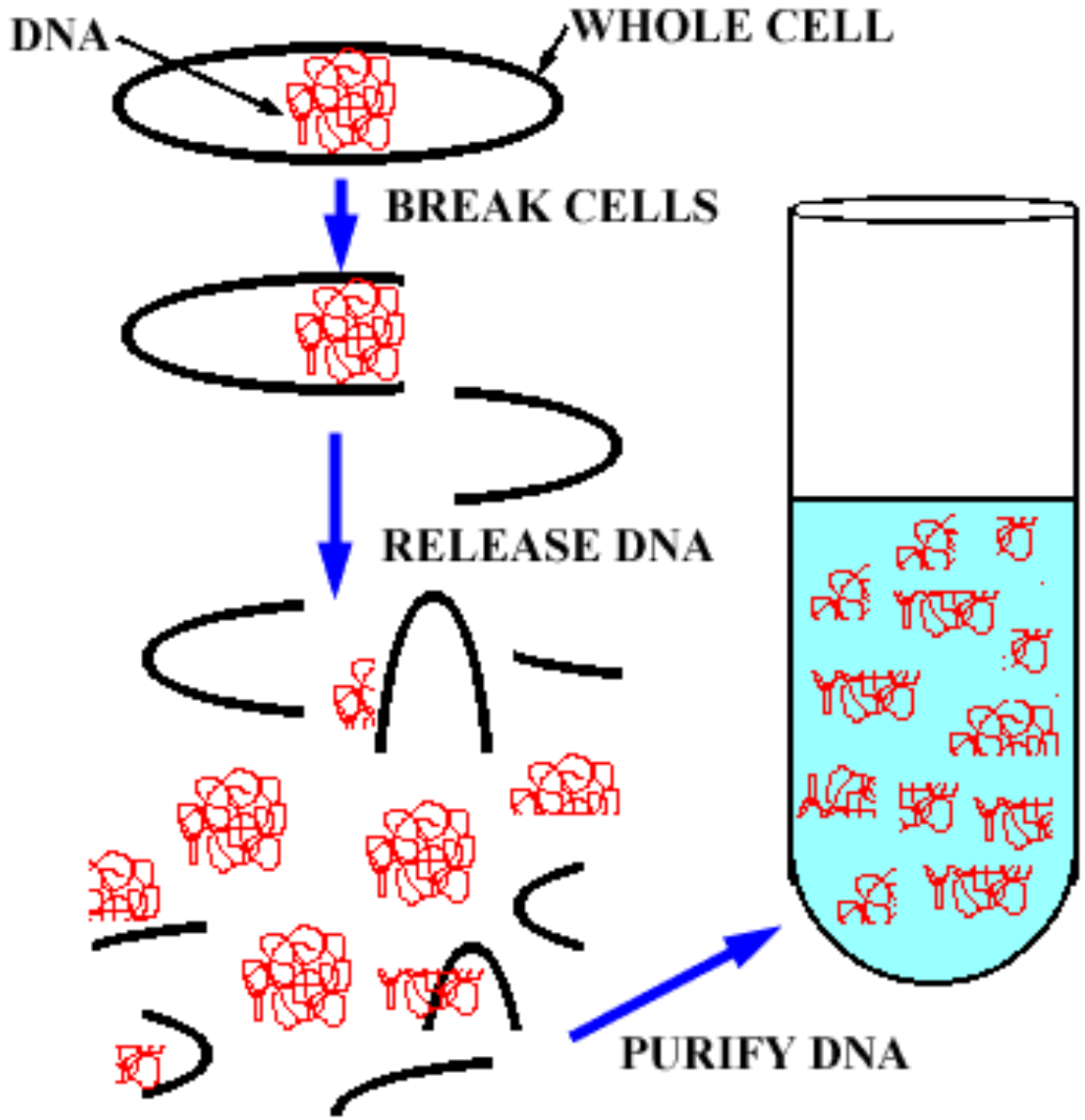
1. Transformation
2. Congugation
3. Transduction

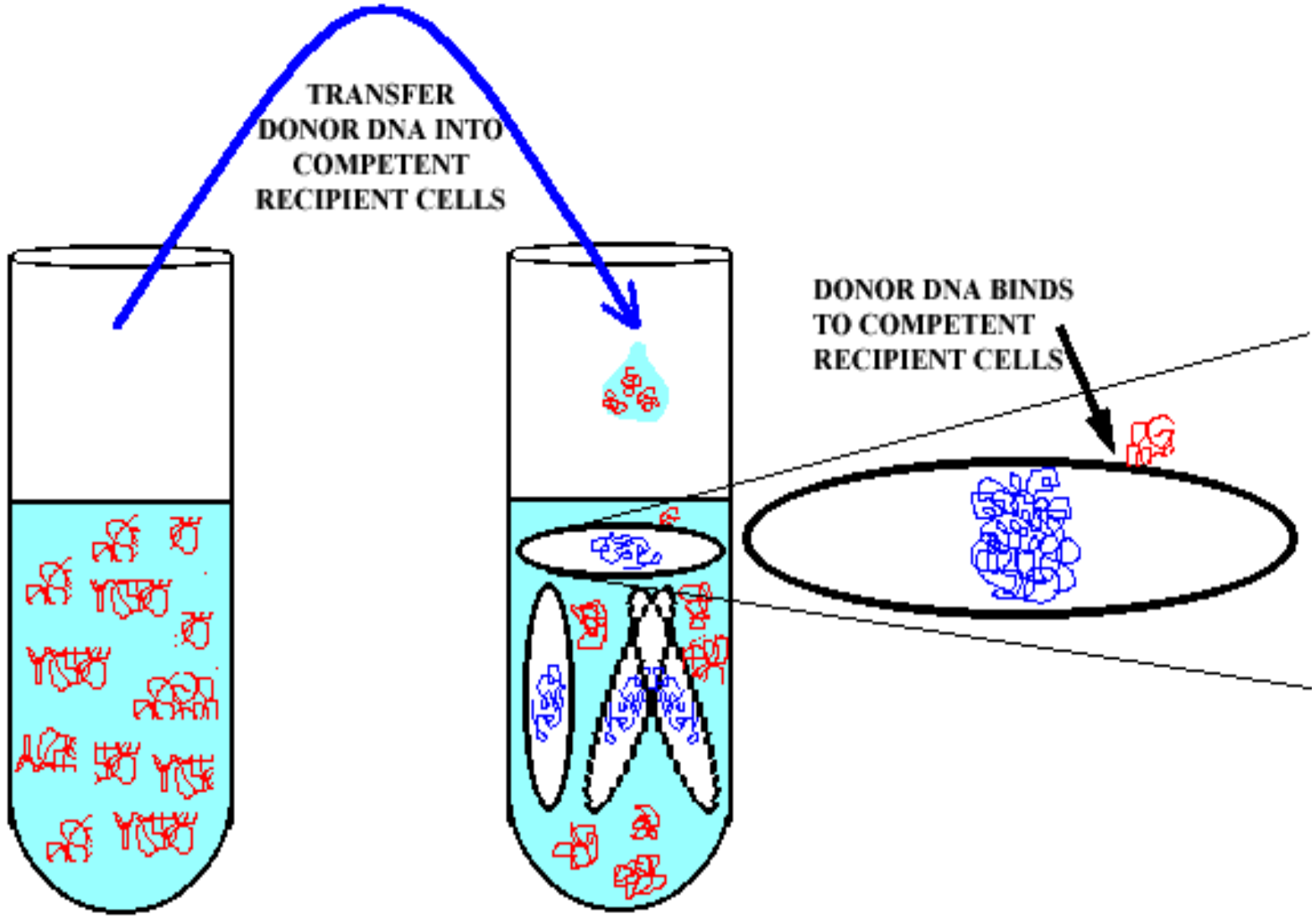
TRANSFORMATION

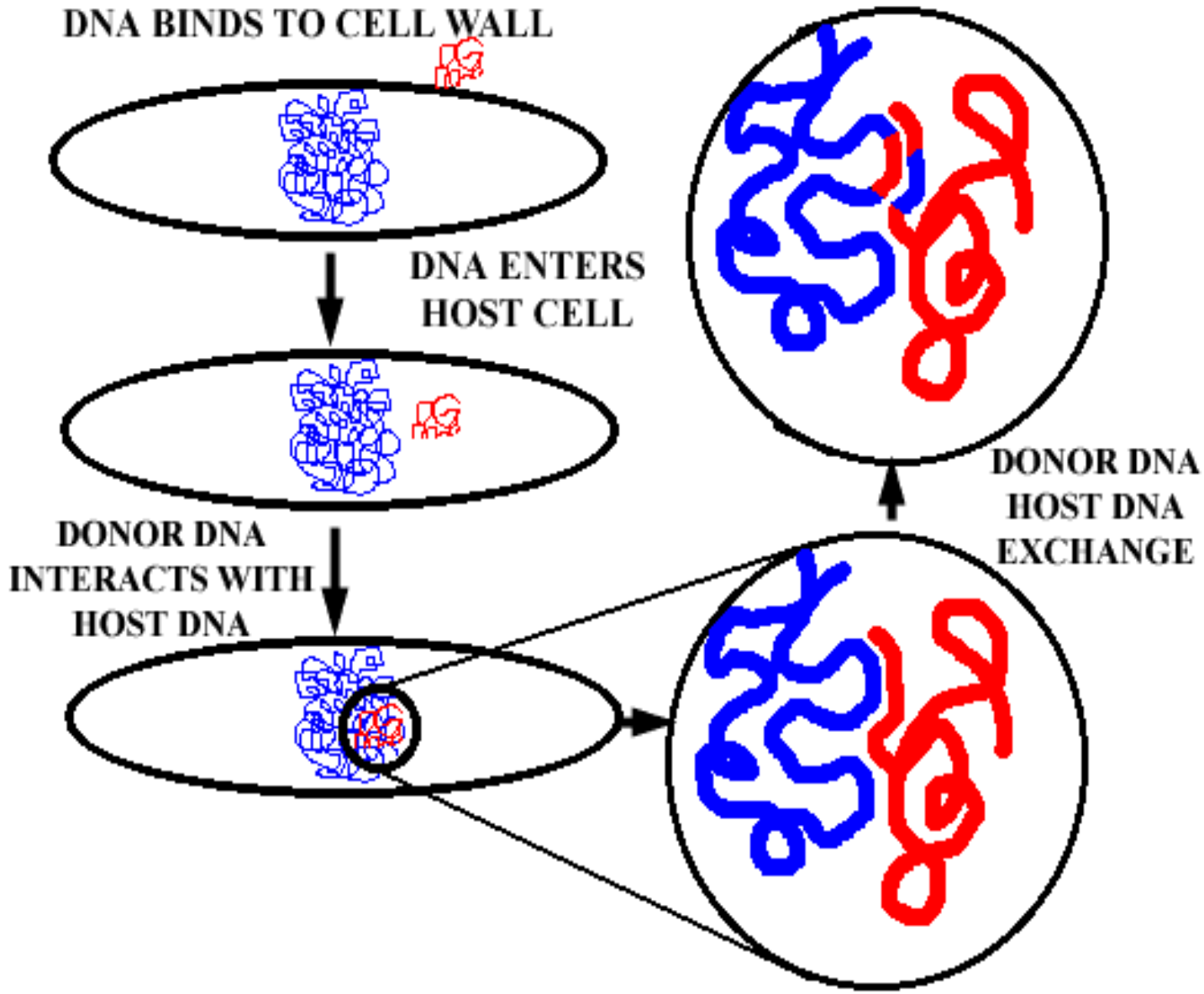
- DNA composition of two microorganisms close to each other
- If one of these m.o. is produced in an environment containing genetic material belonging to the other, the recipient m.o. the donor can take the genetic material of m.o. and show its physical characteristics.

In-vitro

- *Trials with II-S and II-R strain of D. Pneumoniae*
- *II-S killed its DNA extracts added to the medium*
- *The alive II-R strain has taken the genetic material of the II-S strain from the environment and became positive in terms of the characters carried in these elements (transformed into II-S)*

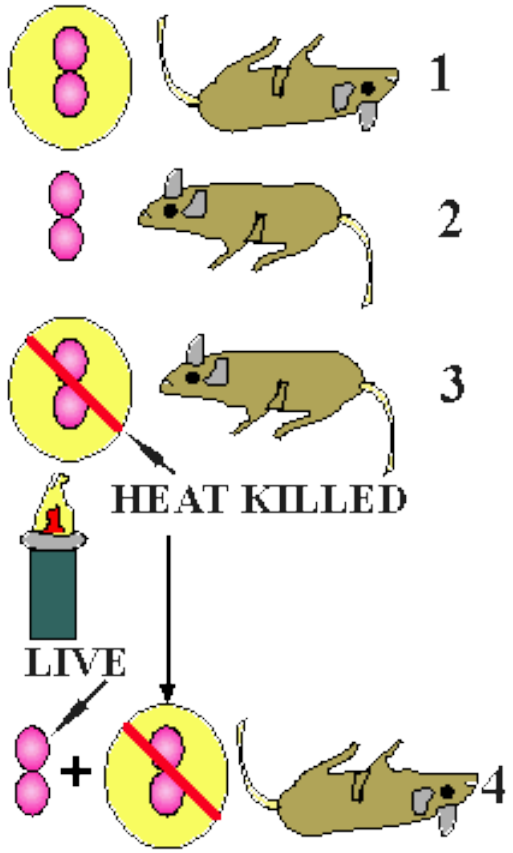

DNA
WHOLE CELL
BREAK CELLS
RELEASE DNA
PURIFY DNA


TRANSFER
DONOR DNA INTO
COMPETENT
RECIPIENT CELLS
DONOR DNA BINDS
TO COMPETENT
RECIPIENT CELLS


DNA BINDS TO CELL WALL
DNA ENTERS
HOST CELL
DONOR DNA
INTERACTS WITH
HOST DNA
DONOR DNA
HOST DNA
EXCHANGE

In-vivo

- Griffith Experiment



Encapsulated strain II-S (virulent)

Live II-R strain (unencapsulated, avirulent)

Heat inactivated strain II-S

Live strain II-R is followed by heat inactivated strain II-S

Rules for Transformation:

- Antigenic homology between bacteria
- Homology between their DNA
- The recipient cell being compotent (having the ability to take the DNA fragment, permeability)
- Molecular weight of DNA (at least 0.3-8 x 10^5 daltons) and structure (double stranded)
- Finding the necessary receptors for adsorption and penetration on the surface of the recipient cell

- The time until the DNA segment is adsorbed on the recipient cell surface and combines with competitive DNA after it enters, is called the eclipse (latent) period.
- DNA particle entering from outside to exogenous
- Recipient cell DNA fusion with endogenote, recombination

With Transformation;

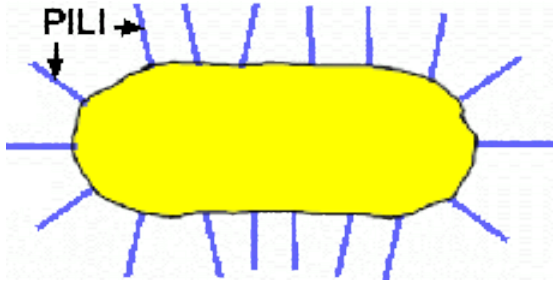
- Lactose and galactose positive genes,
- Resistance to antibacterial agents,
- Transfer of various virulence genes to the recipient bacteria,
- Determination of the chromosome maps of bacteria

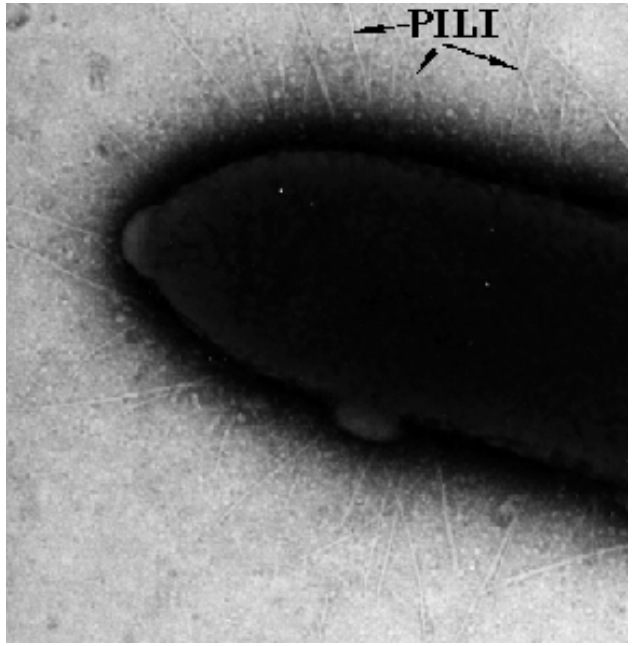
Transfection

- Transfer of phage DNA (or plasmid) to the component bacterial cell

CONJUGATION

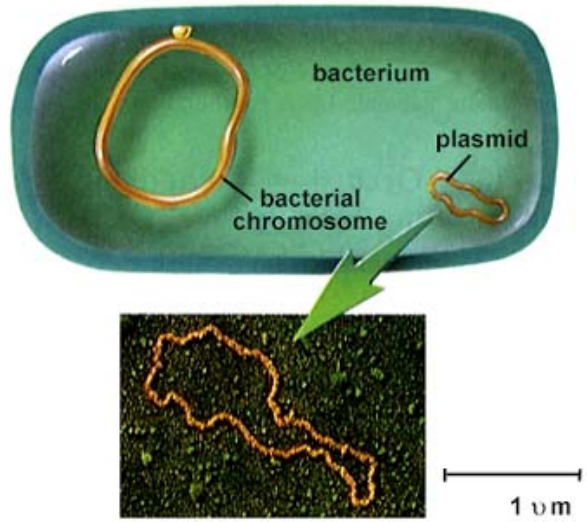
The event of transferring all or a segment of the donor cell DNA to the recipient through direct contact of these two cells or through sex piluses

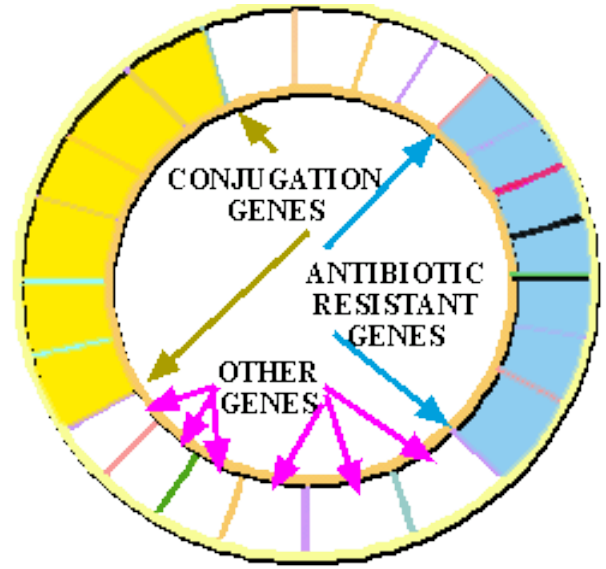




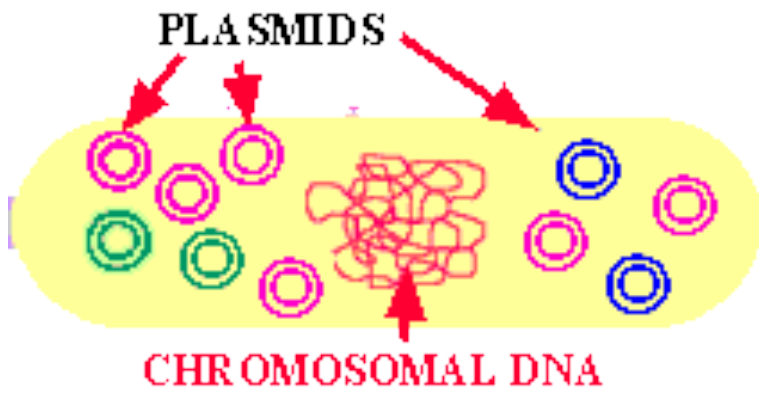
For Conjugation;

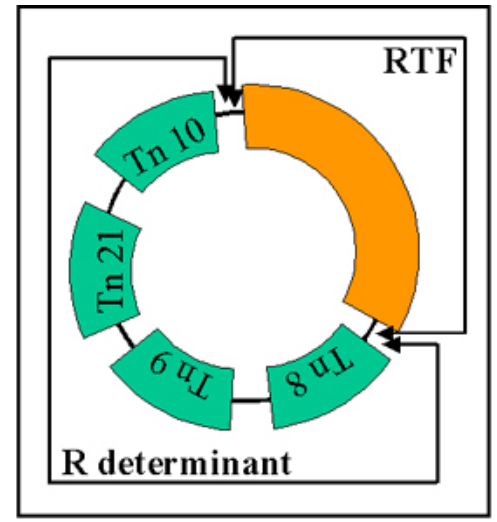
- Direct contact
- The ability to be in a donor state is determined by plasmids (transfer factor or sex factor), which are a transferable genetic element in the cell.
- Cells that take this factor become positive in terms of the characters carried.
- sex pilus (fimbria) synthesized by specific genes in the sex factor (plasmid) inside the cell





CIRCULAR PLASMID DNA





Extrachromosomal genetic elements that can be transferred by conjugation

- Fertility factor (F-factor)
- Resistance factors (R-factors)
- Colisin factor (Col-factor)

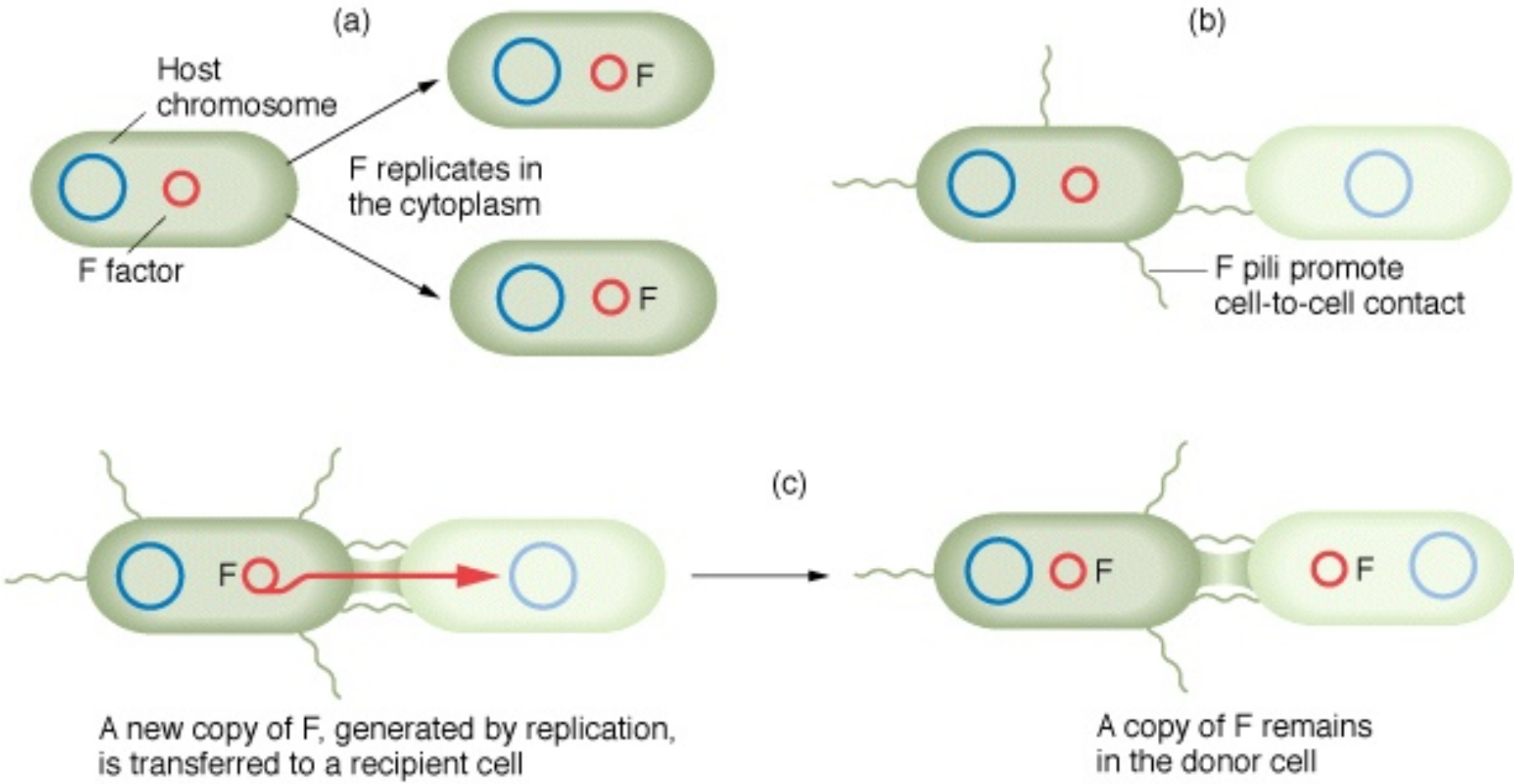
F factor

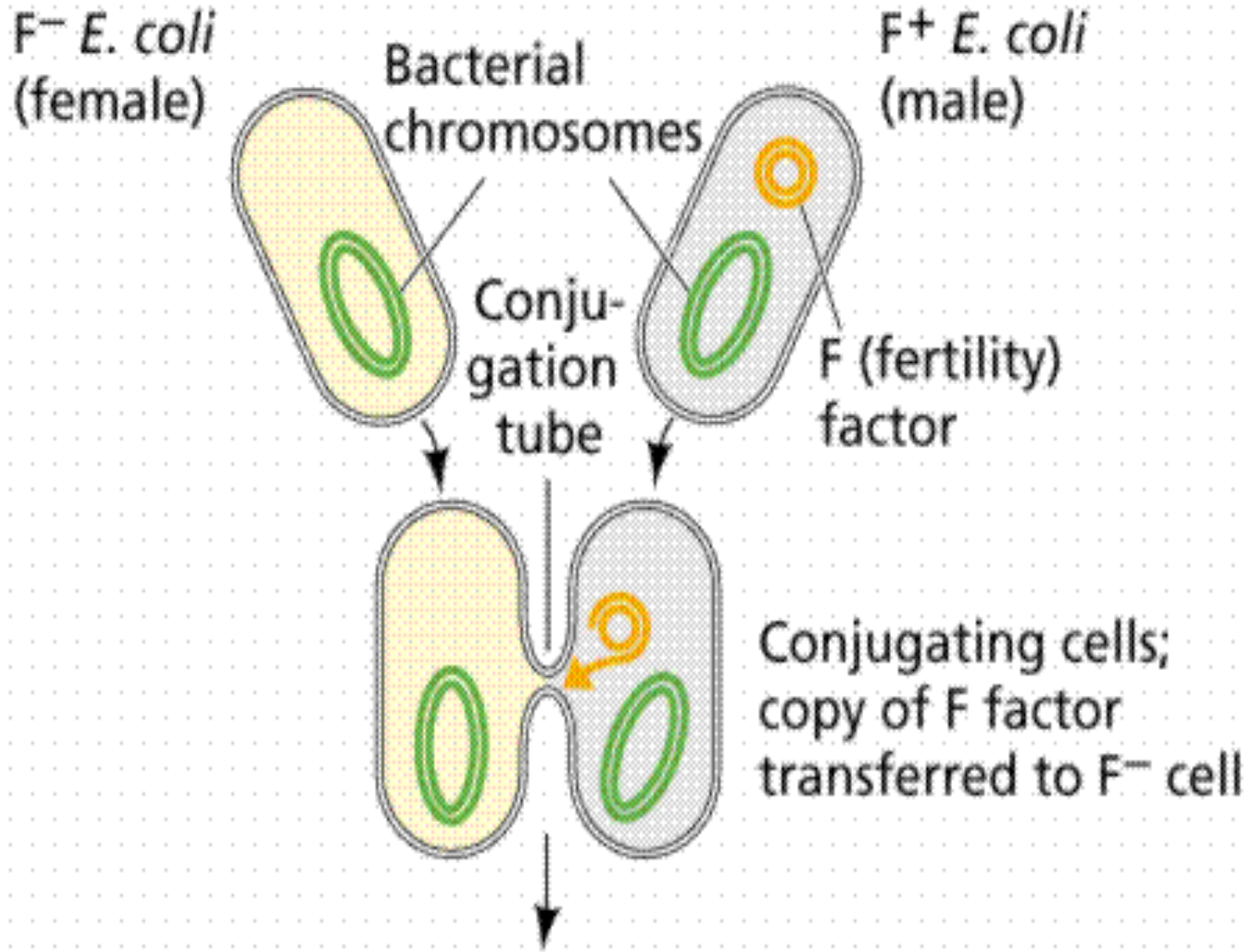
- Circular, double-stranded DNA segment
- 32 nm long (1.2% of bacterial DNA)
- Can encode 40-60 proteins

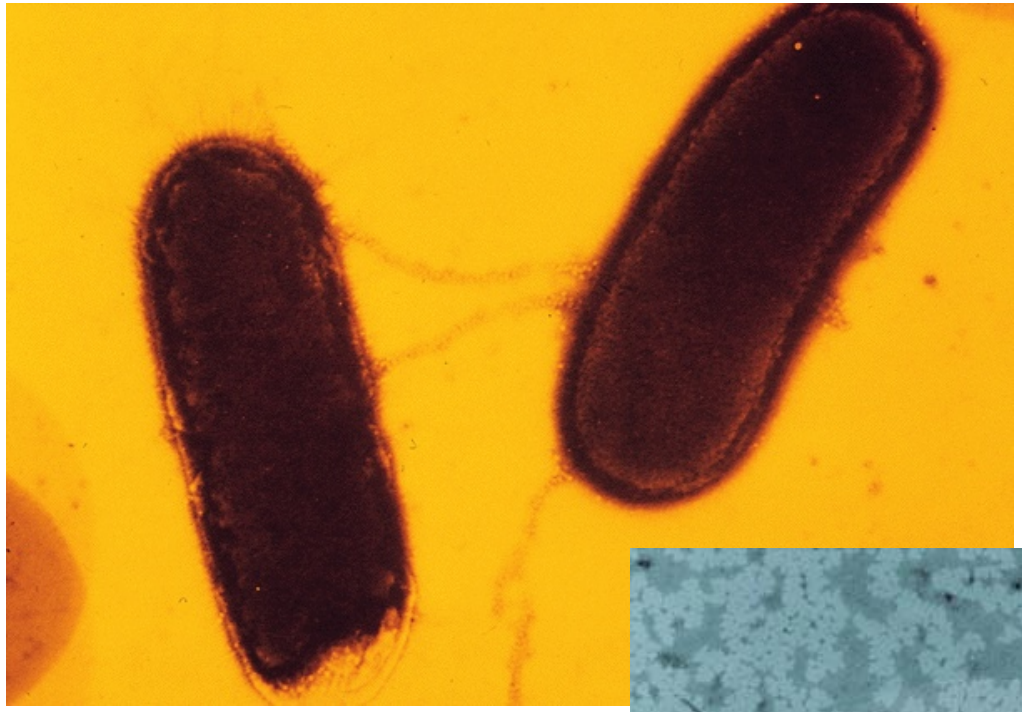
Within a cell F factor;

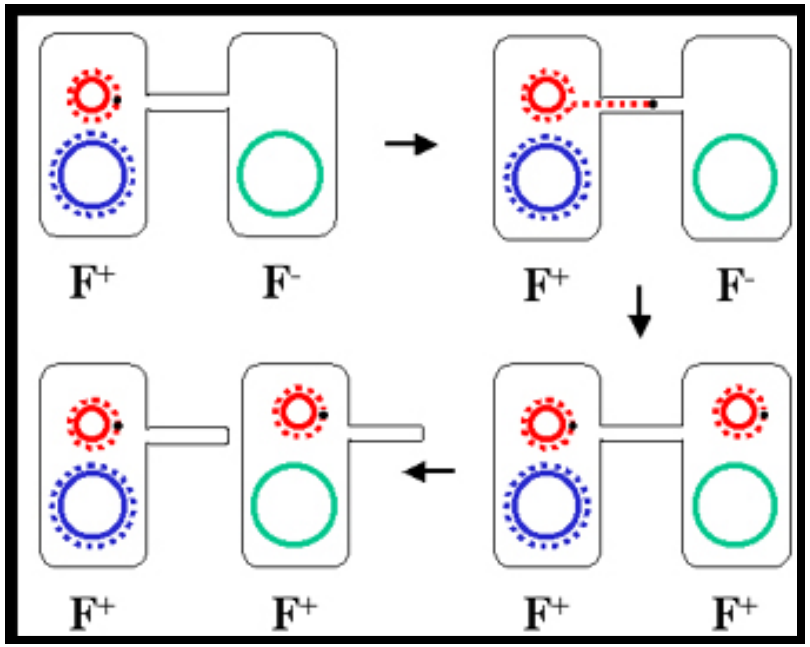
1. Independent genetic element (F +), plasmid
2. Fused with host DNA (Hfr), episome
3. Independently but as part of the host DNA, the F 'prime

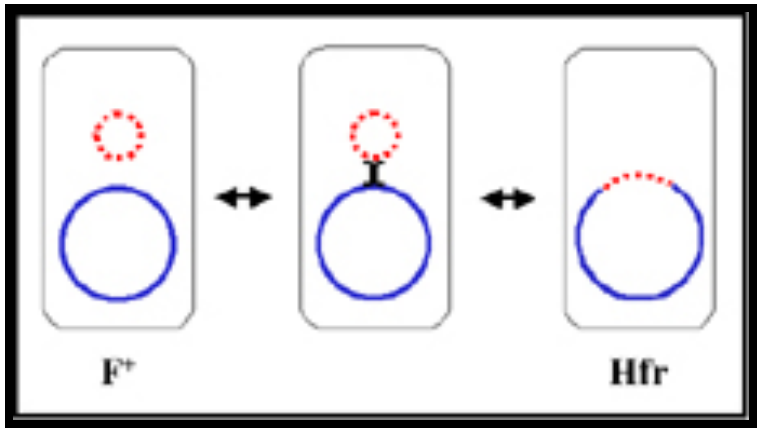
can be found as.

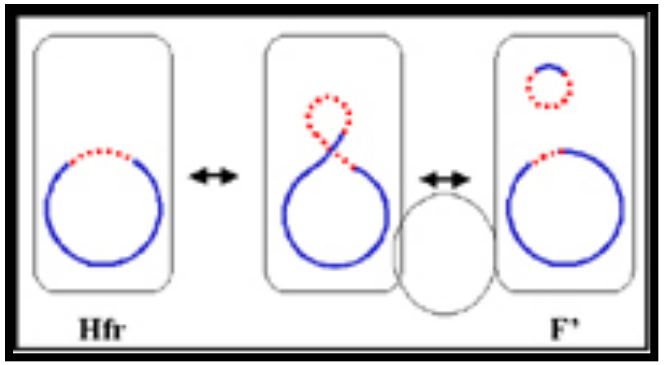

(a)
Host chromosome
F factor
F replicates in the cytoplasm
F
F
(b)
F pili promote cell-to-cell contact
(c)
F
F
F
A new copy of F, generated by replication, is transferred to a recipient cell
A copy of F remains in the donor cell

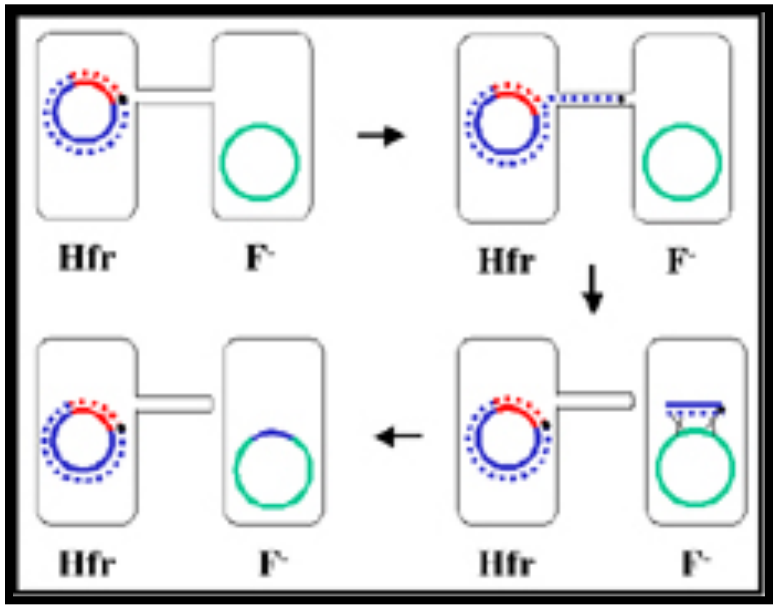

F⁻ E. coli
(female)
Bacterial
chromosomes
F⁺ E. coli
(male)
Conju-
gation
tube
F (fertility)
factor
Conjugating cells;
copy of F factor
transferred to F⁻ cell

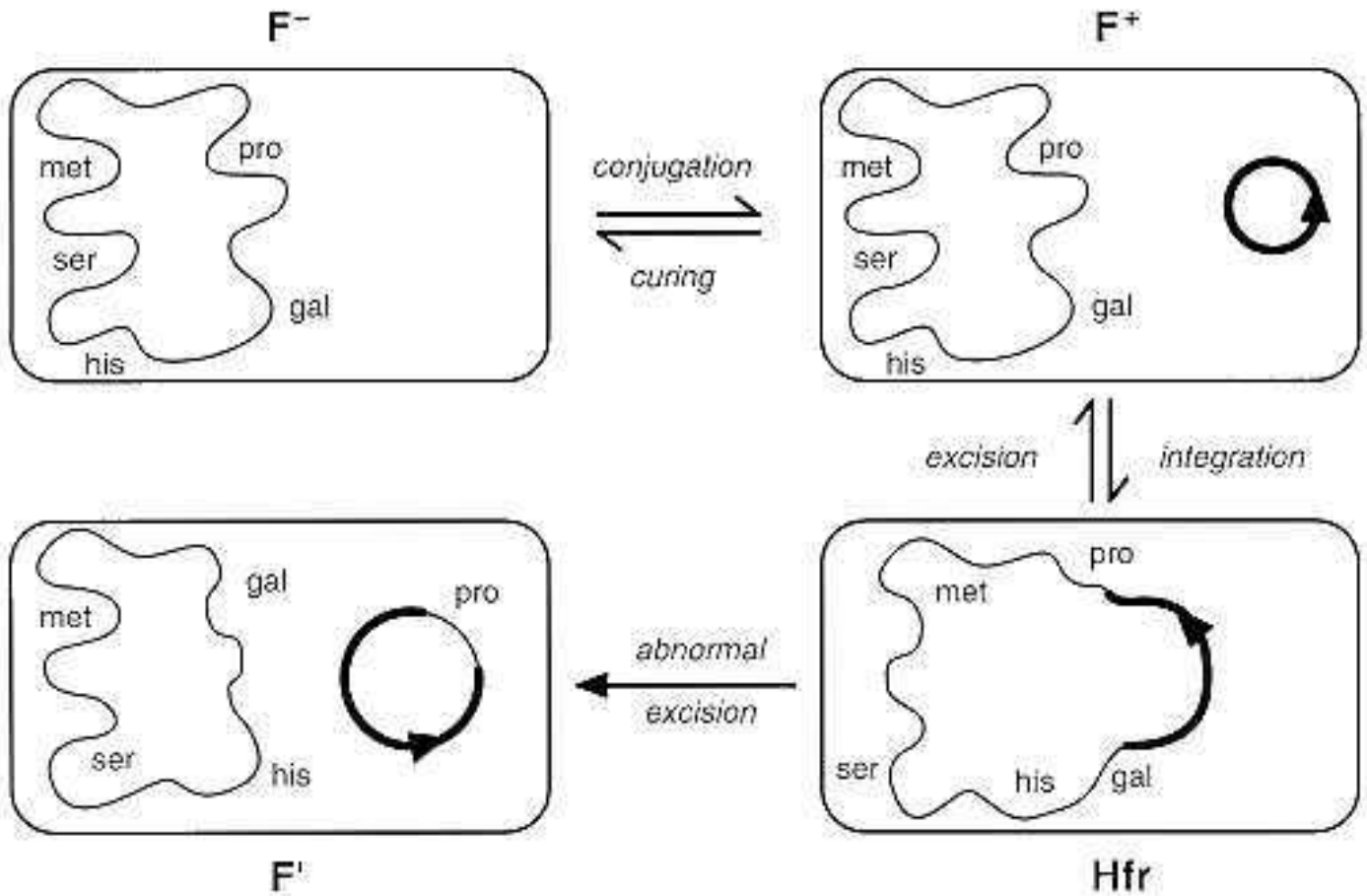



F+
F-
F+
F-
F+
F+
F+
F+


F+
Hfr


Hfr
F'


Hfr
F-
Hfr
F-
Hfr
F-
Hfr
F-


F⁻
F⁺
met
pro
ser
gal
his
conjugation
curing
excision
integration
abnormal
excision
F'
Hfr

TRANSDUCTION

The transfer of genetic material from a donor bacterium to a recipient bacterium via phages is called transduction.

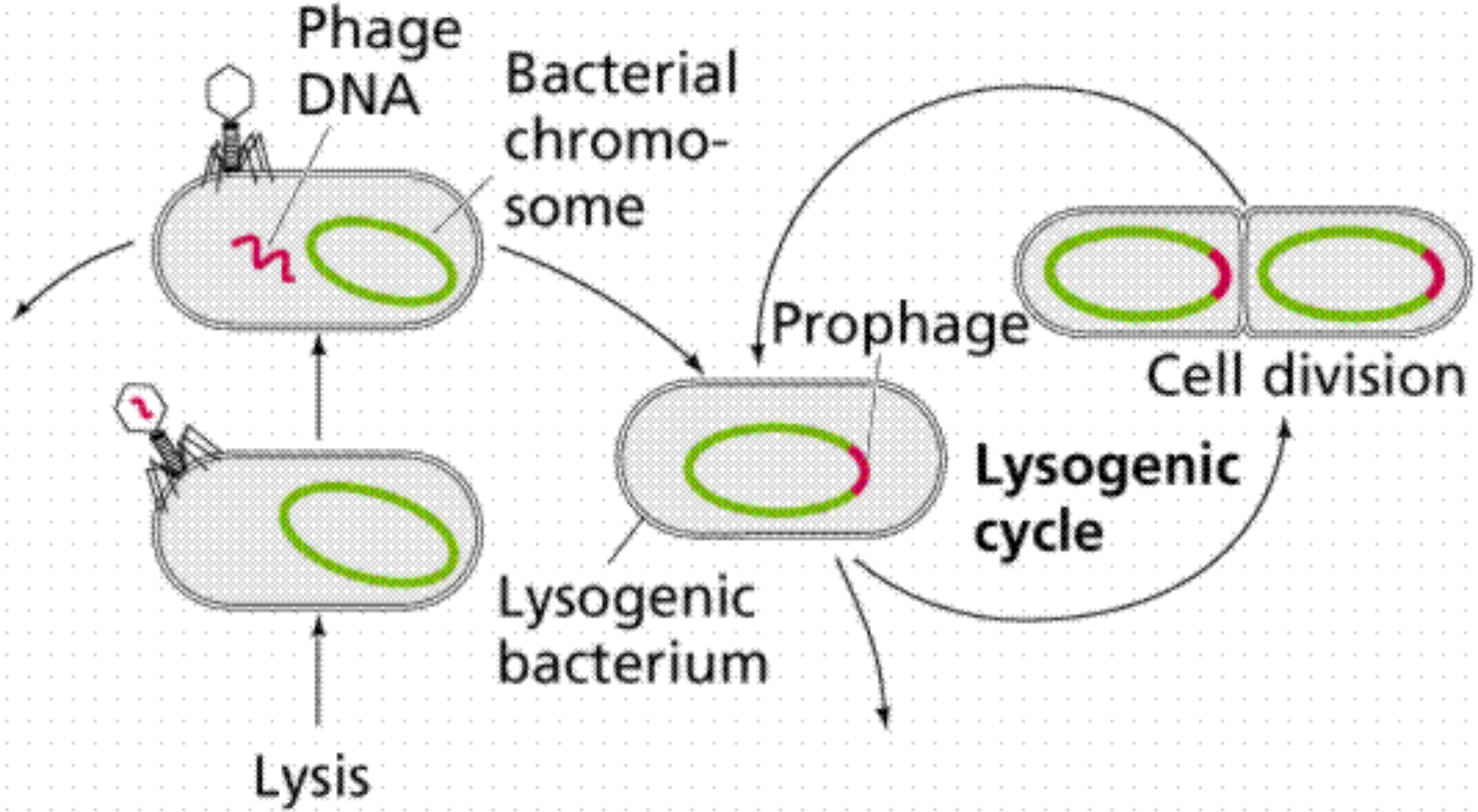
Gene transfer by transduction in Gram negative (Salmonella, E. coli, Shigella, Proteus, Vibrio, P. aeruginosa) and Gram positive m.o. (staphylococcus and bacilli)

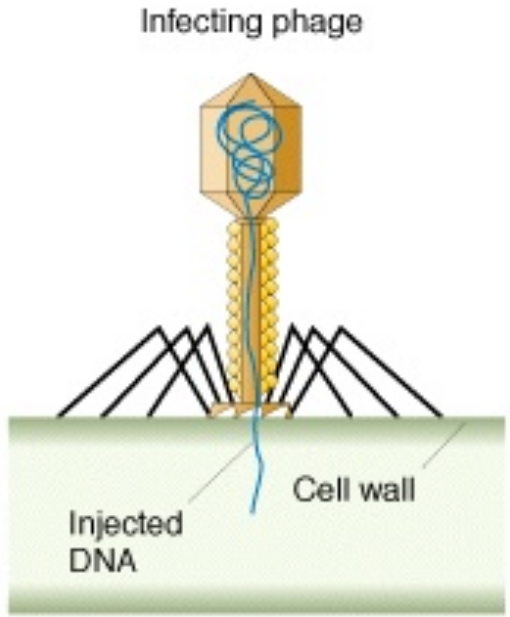
Phages are viruses (bacteriophage) that break down or lyse bacteria.

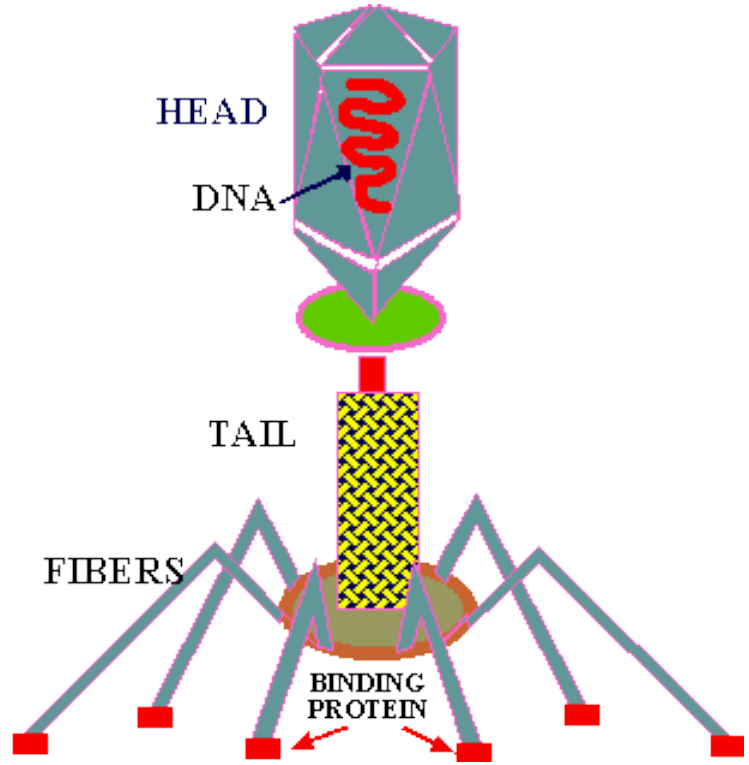
It is host specific and has a species specificity among bacterial phages.

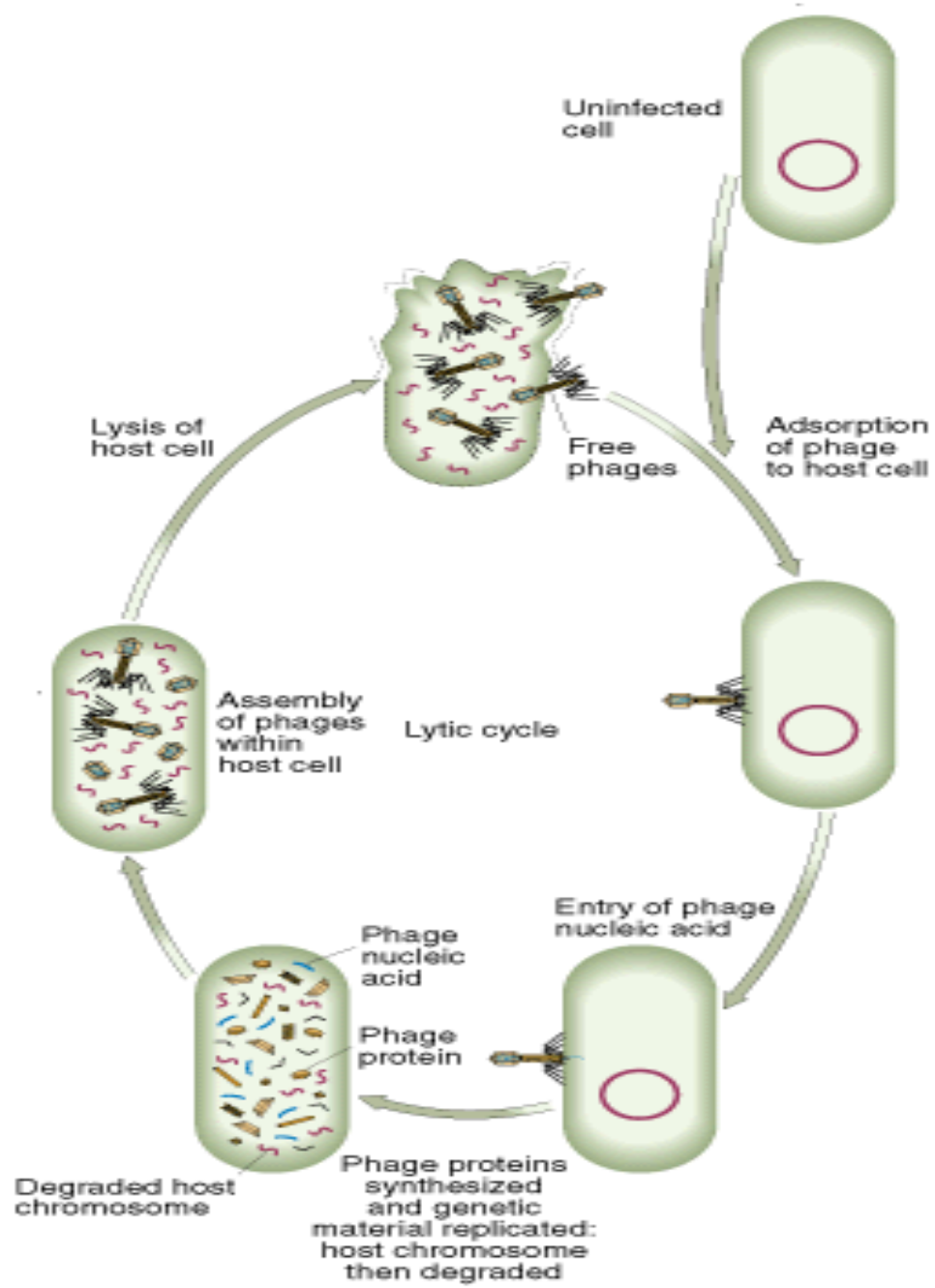
Phages;

- virulent or vegetative phages that replicate after entering the host cell and break down bacteria
- Does not lyse the infected cell; temperate phages
- Those combined with the host DNA; prophages
- cells containing a prophage bacteriophage; lysogenic cells


Phage
DNA
Bacterial
chromo-
some
Prophage
Cell division
Lysogenic
cycle
Lysogenic
bacterium
Lysis

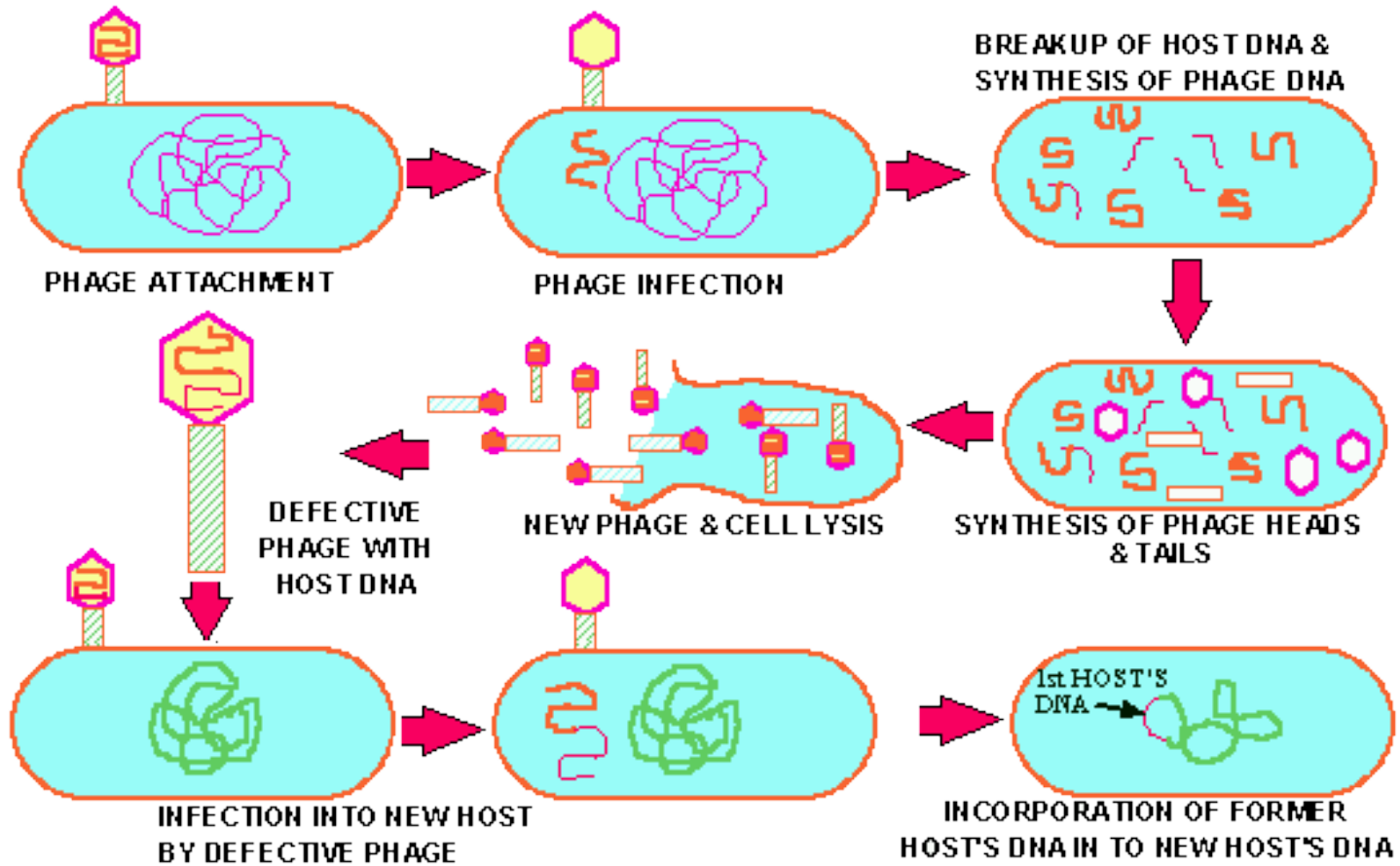

Infecting phage
Injected
DNA
Cell wall

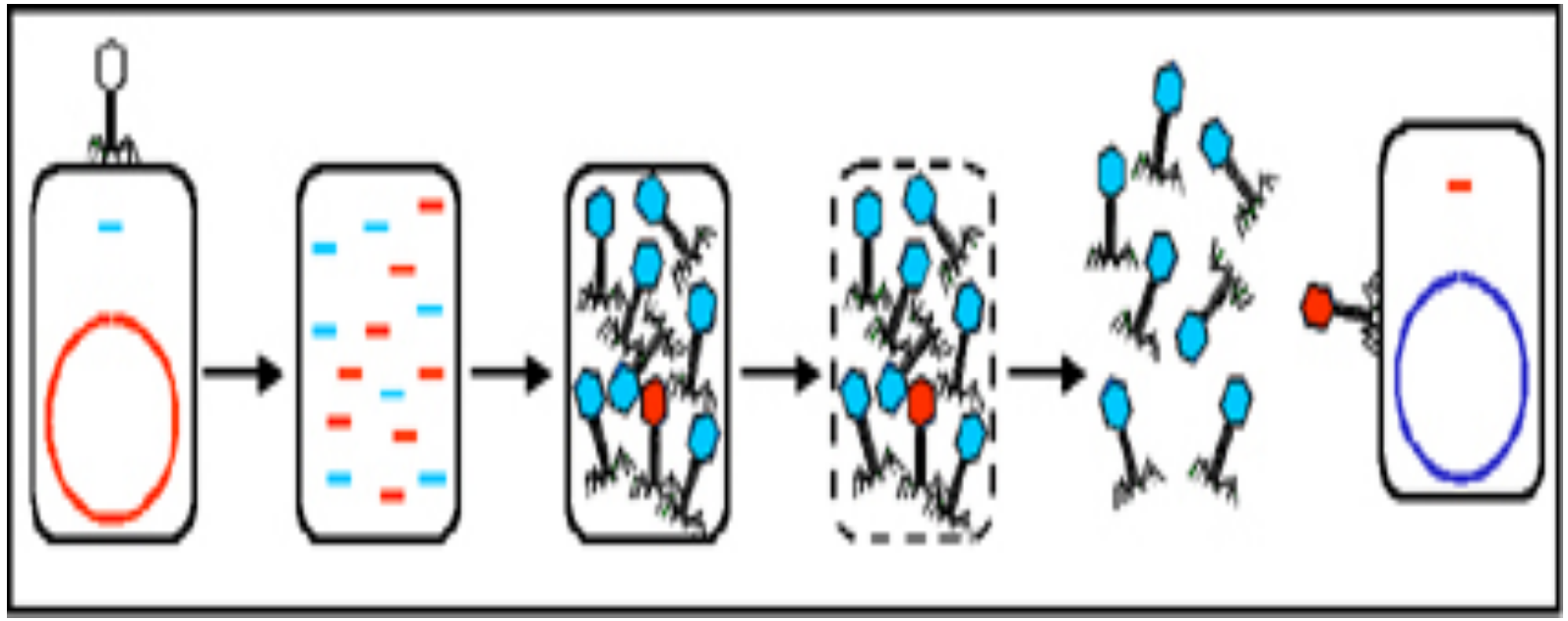

HEAD
DNA
TAIL
FIBERS
BINDING
PROTEIN

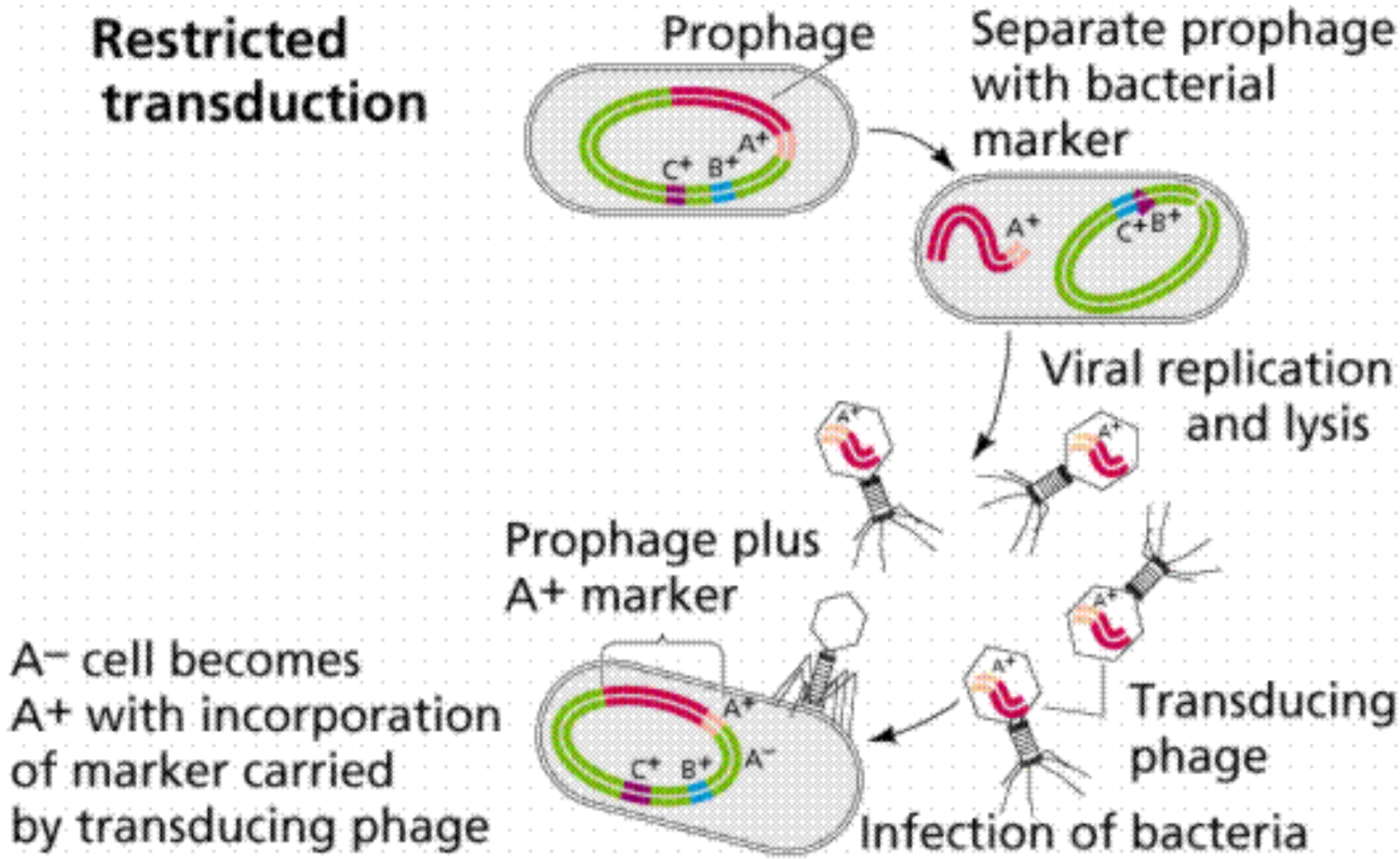

Uninfected cell
Adsorption of phage to host cell
Free phages
Lysis of host cell
Assembly of phages within host cell
Lytic cycle
Entry of phage nucleic acid
Phage nucleic acid
Phage protein
Degraded host chromosome
Phage proteins synthesized and genetic material replicated: host chromosome then degraded

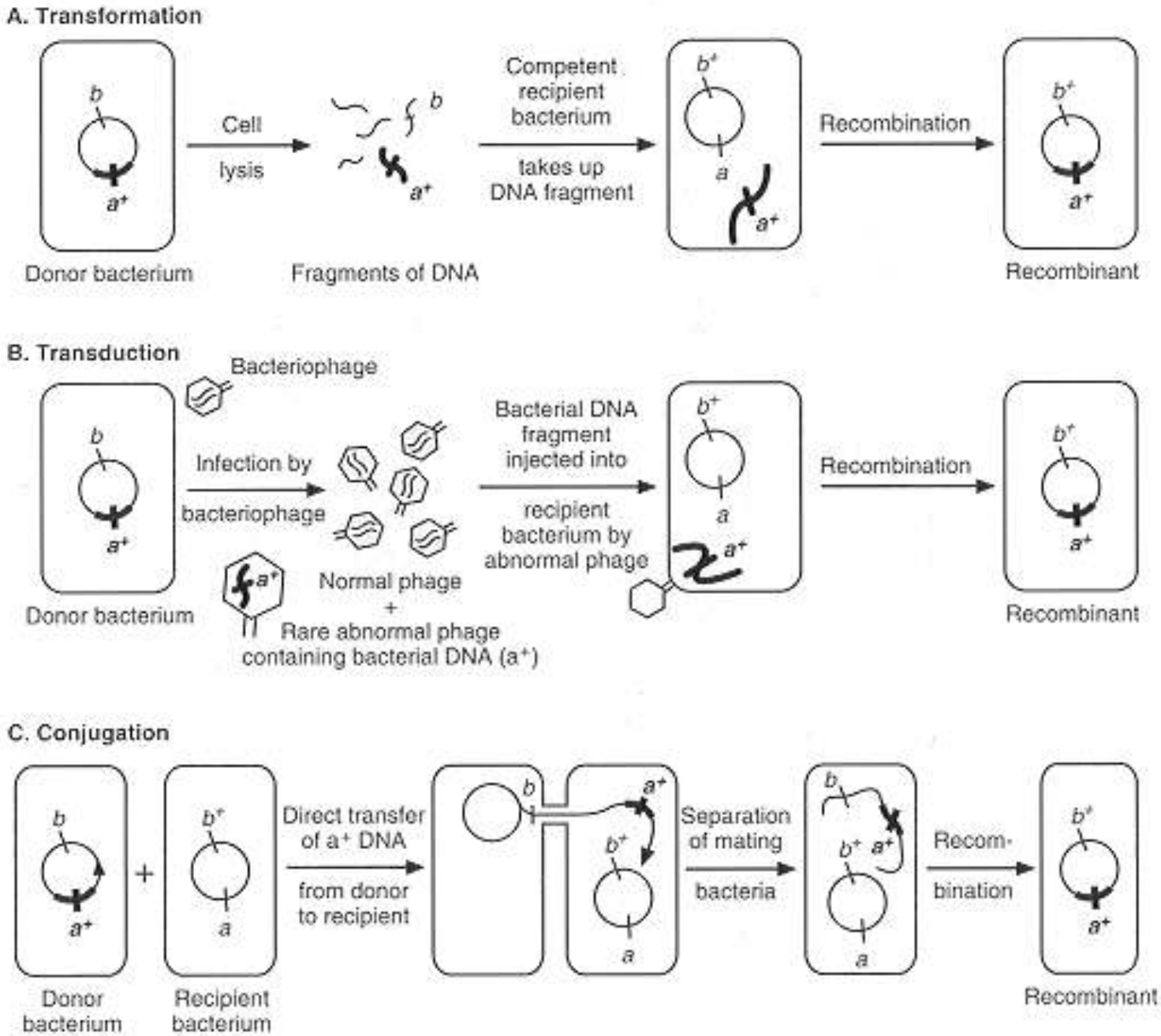
Types of Transduction

1. Generalised transduction
2. Special transduction
3. Abortive transduction


PHAGE ATTACHMENT
PHAGE INFECTION
BREAKUP OF HOST DNA &
SYNTHESIS OF PHAGE DNA
SYNTHESIS OF PHAGE HEADS
& TAILS
NEW PHAGE & CELL LYSIS
DEFECTIVE
PHAGE WITH
HOST DNA
INFECTION INTO NEW HOST
BY DEFECTIVE PHAGE
1st HOST'S
DNA
INCORPORATION OF FORMER
HOST'S DNA IN TO NEW HOST'S DNA




Restricted transduction
Prophage
Separate prophage with bacterial marker
Viral replication and lysis
Prophage plus A+ marker
A– cell becomes A+ with incorporation of marker carried by transducing phage
Transducing phage
Infection of bacteria


A. Transformation
b
a+
Donor bacterium
Cell
lysis
b
a+
Fragments of DNA
Competent
recipient
bacterium
takes up
DNA fragment
b+
a
a+
Recombination
b+
a+
Recombinant
B. Transduction
Bacteriophage
b
a+
Donor bacterium
Infection by
bacteriophage
Normal phage
+
a+
Rare abnormal phage
containing bacterial DNA (a+)
Bacterial DNA
fragment
injected into
recipient
bacterium by
abnormal phage
b+
a
a+
Recombination
b+
a+
Recombinant
C. Conjugation
b
a+
Donor
bacterium
+
b+
a
Recipient
bacterium
Direct transfer
of a+ DNA
from donor
to recipient
b
a+
b+
a
Separation
of mating
bacteria
b
b+ a+
a
Recom-
bination
b+
a+
Recombinant