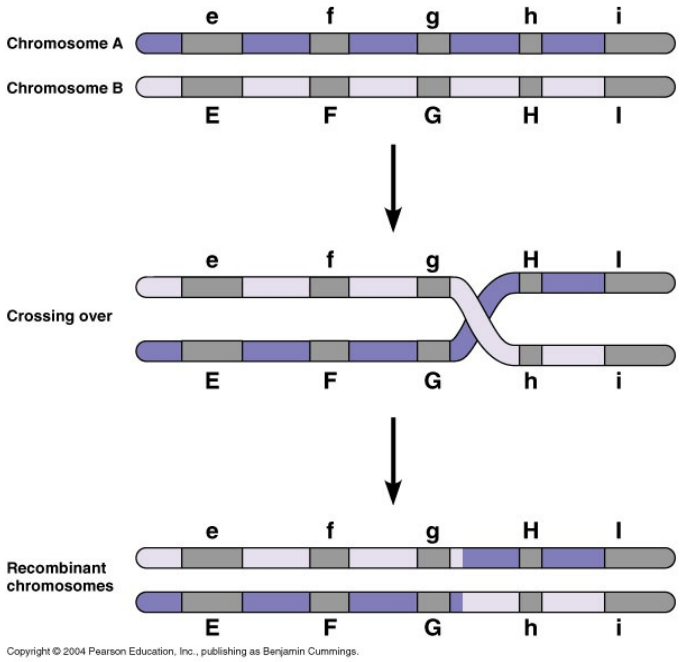
Chapter 7 B Highlights

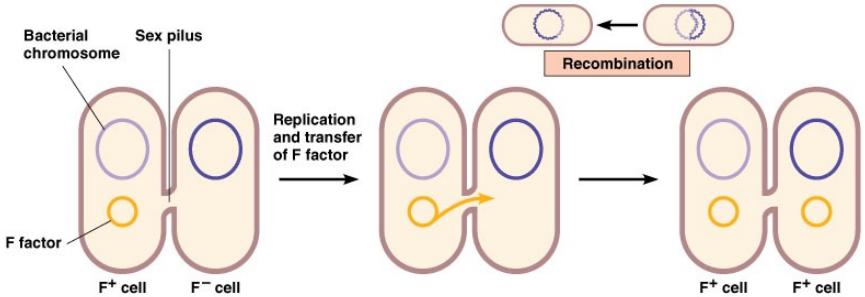
Microbial recombination and Plastids

Homologous recombination (also known as general or reciprocal recombination): Pairs of chromosomes containing the sate gene locus join and exchange allelic portions of the same chromosome.



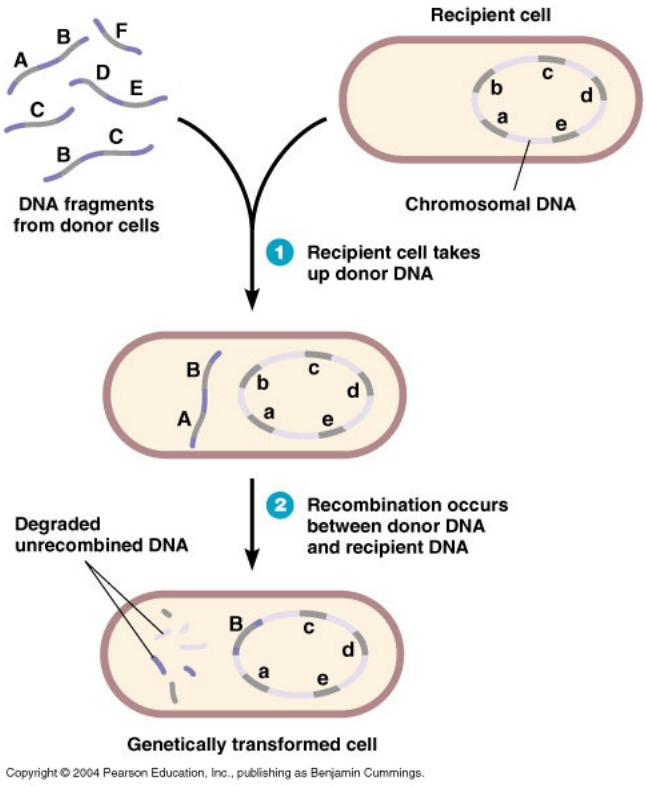
Non reciprocal general recombination of homologous genes occurs an bacteria.

Non-homologous recombination also known as non-reciprocal recombination: an example of at F plastid integration into E. coli chromosome. Inverted repeats of DNA are involved as well as direct repeats may happen. In Bacteria, insertion of F plastid DNA into chromosome or insertion of bacteraophage chromosome into bacterial chromosome involves non-homologous recombination mechanism.

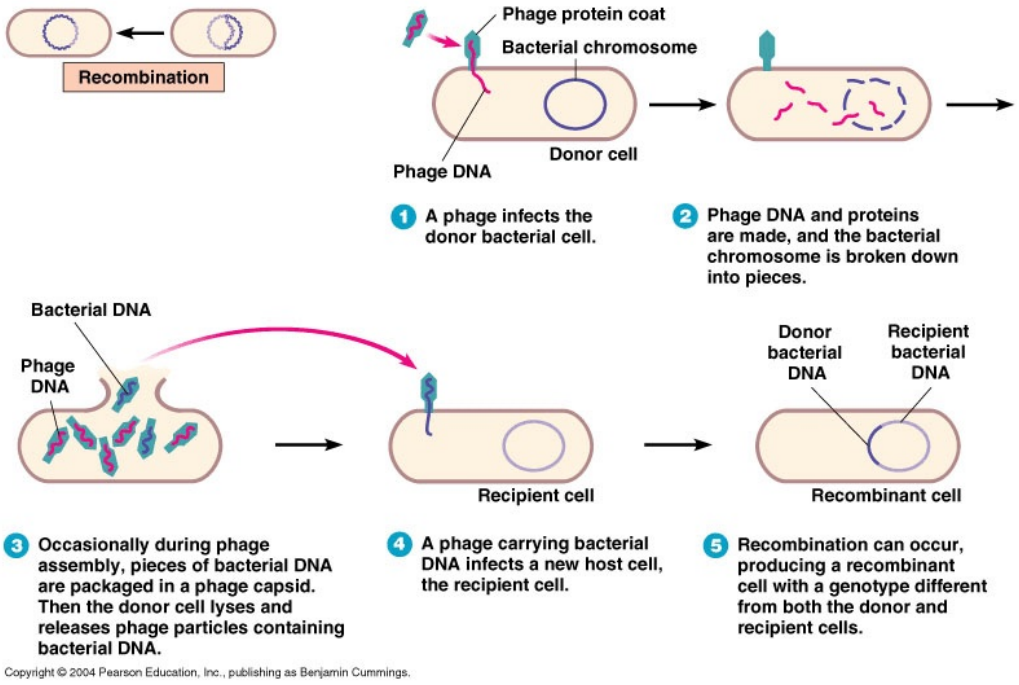


(a) When an F factor (a plasmid) is transferred from a donor (F^+) to a recipient (F^-), the F^- cell is converted into an F^+ cell.

Transposable genetic elements (transposones). These are stretches of DNA, which have sequences for a few enzymes including enzymes for maintenance, recombination and resistance to antibiotics. Non-homologous recombination or insertion, via direct or inverted repeats, may insert this DNA from a location in a plasmid into a location in the chromosome of a bacterium. Or, the move may be from the chromosome into a plasmid.



Lysogeny is a state of cell chromosome where a bacteriophage genome has been inserted into the bacterial chromosome by nonreciprocal recombination occurring between the phage chromosome and the bacterial chromosome. This insertion occurs at specific locations in each of chromosomes where there in homology of sequences in the two chromosomes.



Lysogenic conversion is the state of a cell that shows new properties like ability to form cytotoxins. The *tox* gene, coding for a toxic protein affecting eukaryotic cells, is on the phage genome that is expressed in the bacterium without causing lysis of the bacterial cell and production of more phage. The *tox* gene that is located in a corynephage chromosome codes for diphtheria toxin that kills susceptible human cells. When this phage chromosome becomes inserted into chromosome of the bacterium Corynebacterium diphtheriae, human infection with this microbe leads to formation and release of diphtheria toxin in the human host producing symptoms of diphtheria.

Three distinct mechanisms of gene transfer from a donor bacterium to a recipient bacterium have been described.

1. **Transformation:** Free, naked DNA (chromosomal or plasmid) is released from a donor bacterium when the bacterium lyses. This DNA is taken up into the recipient cell. The recipient cell must be competent; the DNA must be compatible and survive in the recipient cell's progeny. The insertion is by nonreciprocal general recombination. This process was first describes in Pneumococcus pneumoniae which was transformed from a non-capsulated strain to a capsulated strain. Note that plasmid DNA uptake need not be followed by recombination whereas chromosomal DNA pieces must go through the

process of reciprocal recombination in the recipient cell to become part of the progeny cells DNA.

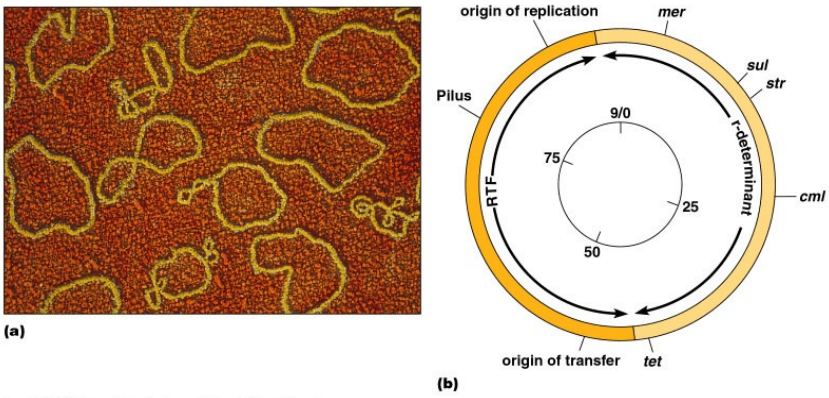
2. **Transduction**. The donor cell's DNA is wrapped in a bacteriophage protein capsid. In this method of gene transfer cellular DNA of the donor cell may be packaged into a bacteriophage capsid as the phage replicates in the donor cell. The donor cell eventually lyses and releases many phages. The phages that are carrying host DNA in the phage capsid in place of phage DNA are defective for phage replication because they do not have all of the phage DNA needed for their replication; instead they have bacterial DNA in their capsid. When such transforming phage infects a new bacterium, it inserts the donor cell's DNA into the recipient cell. Thus, the recipient cell now has new genes donated from the previous bacterium. If the in-coming DNA is a plasmid, it has to be compatible with the new host cell to survive in this host and to be present in all cells' progeny. If the DNA of the donor bacterium is chromosomal, it has to go through reciprocal recombination with this new host's DNA for new traits to appear in the progeny cells. This piece of chromosomal DNA, incapable of replicating in the new bacterium is diluted out and disappears if it is not incorporated into the bacterial genome.

3. **Conjugation** involves cell-to-cell contact. Both cells have to be viable and able to synthesize DNA. The common example is the F plasmid system of E. coli. F plasmid is a conjugative plasmid of E. coli. When mating occurs between a F+ donor cell and an F- recipient cell via F plasmid, the donor cell makes a copy of the F plasmid and the copy is transferred into the F- cell as the F plasmid is being made The cells must remain in contact. At the conclusion of conjugation, the F- cell becomes F+ cell, that is, it carries a copy of F plasmid. F plasmid can spread in a population of susceptible F- cells converting them to F+ cells.

Special circumstance

Conjugation between Hfr cell and F- cell. Hfr cell is an E. coli bacterium in which the F plasmid has become inserted into the bacterial chromosome. When conjugation takes place, chromosomal genes are transferred into the recipient cell. The F- cell remains F- because not all portions of F plasmid can transfer. The F- bacterium becomes a partial zygote or merozygote for a short while. Reciprocal recombination between the recipient cell's chromosome and the donor cell's partial chromosomal DNA needs to take place for genuine recombinants (showing new phenotypic traits) to appear in progeny cells. Note that the recipient cell remains F-. Different Hfr strains of E.coli were used many years ago to experimentally show that the genetic linkage in E. coil was continuous and circular. i.e. one chromosome in circular form was present.

To study genetics of bacteria, **metabolic mutants** are often used. For example we might try mating an Hfr cell type able to synthesize tryptophan with an F- cells that are not able to make this amino acid. We can then look for recombinants that have most of the genetic traits of F- cells but now are also able to make tryptophan.



In addition to F plasmids (conjugative plasmid and also an episome) other plasmids are seen in E.coli and also in many other bacteria these are metabolic plasmids, resistance transfer factors (R-plasmids) Pathogenic plasmids

M:\Microbiology\Micro works\Micro Chap 7 B.wpd