Recombination of Genetic Material + Genetic Engineering

WHAT IS Recombination?

WHAT IS Recombinant DNA

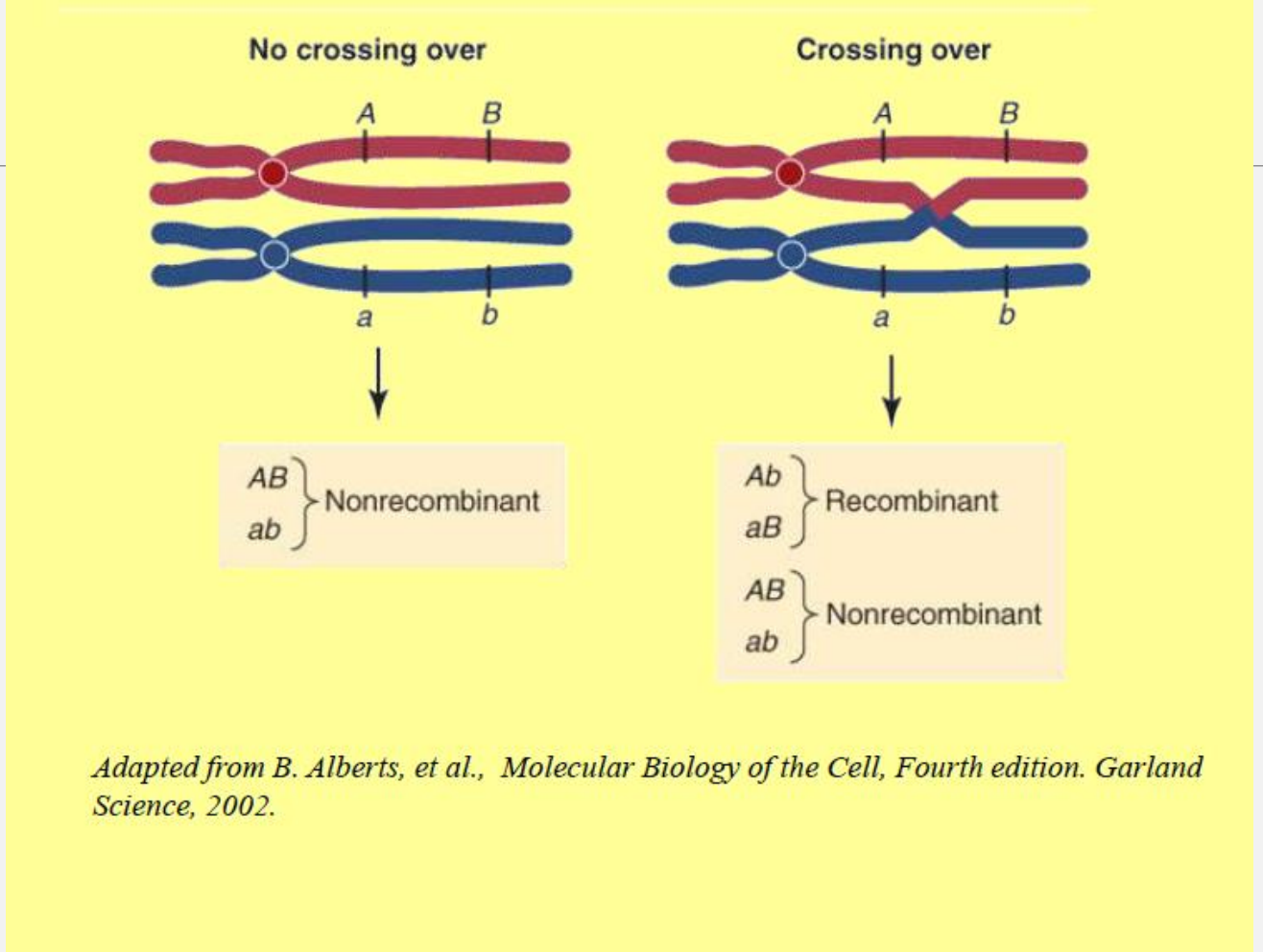
Recombination is a process by which pieces of DNA are broken and recombined to produce new combinations of alleles. This recombination process creates genetic diversity at the level of genes that reflects differences in the DNA sequences of different organisms.

Recombinant DNA (rDNA) molecules are DNA molecules formed by laboratory methods of genetic recombination (such as molecular cloning) to bring together genetic material from multiple sources, creating sequences that would not otherwise be found in the genome.

In eukaryotic cells, which are cells with a nucleus and organelles, recombination typically occurs during meiosis.

Meiosis is a form of cell division that produces gametes, During the first phase of meiosis, the arms of the chromosomes can overlap and temporarily fuse, causing a crossover.

Crossovers result in recombination and the exchange of genetic material between the maternal and paternal chromosomes. As a result, offspring can have different combinations of genes than their parents. Genes that are located farther apart on the same chromosome have a greater likelihood of undergoing recombination, which means they have a greater recombination frequency.



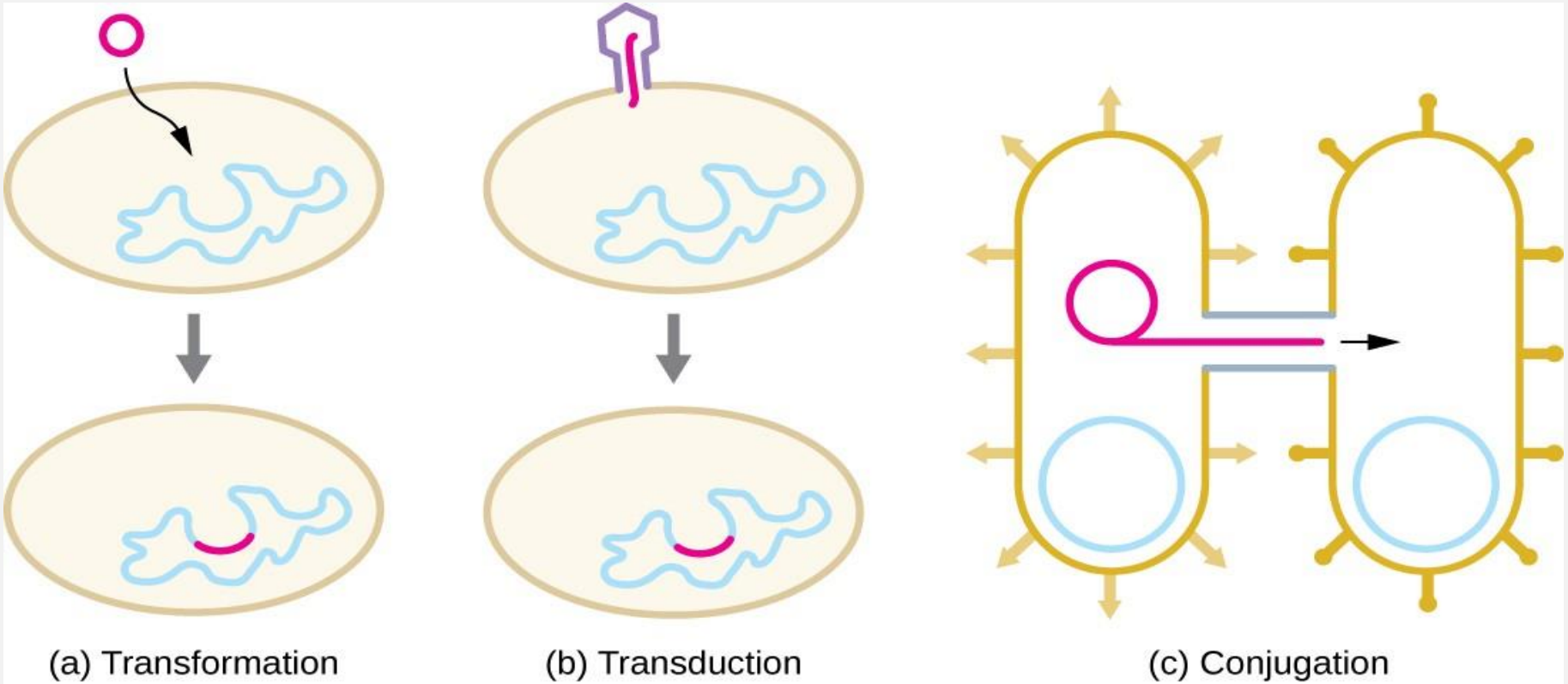
Adapted from B. Alberts, et al., Molecular Biology of the Cell, Fourth edition. Garland Science, 2002.

Prokaryotic cells can undergo recombination through one of these three processes:

Conjugation: is where genes are donated from one organism to another after they have been in contact. What the offspring ends up having is a mix of traits from different strains of bacteria.

Transformation: This is where the organism acquires new genes by taking up naked DNA from its surroundings. The source of the free DNA is another bacterium that has died, and therefore its DNA was released to the environment.

Transduction: is gene transfer that is mediated by viruses. Viruses called bacteriophages attack bacteria and carry the genes from one bacterium to another.

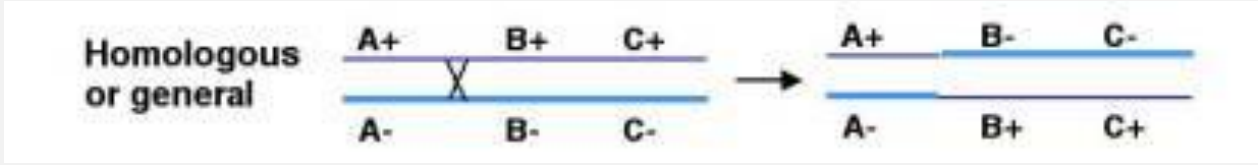

(a) Transformation
(b) Transduction
(c) Conjugation

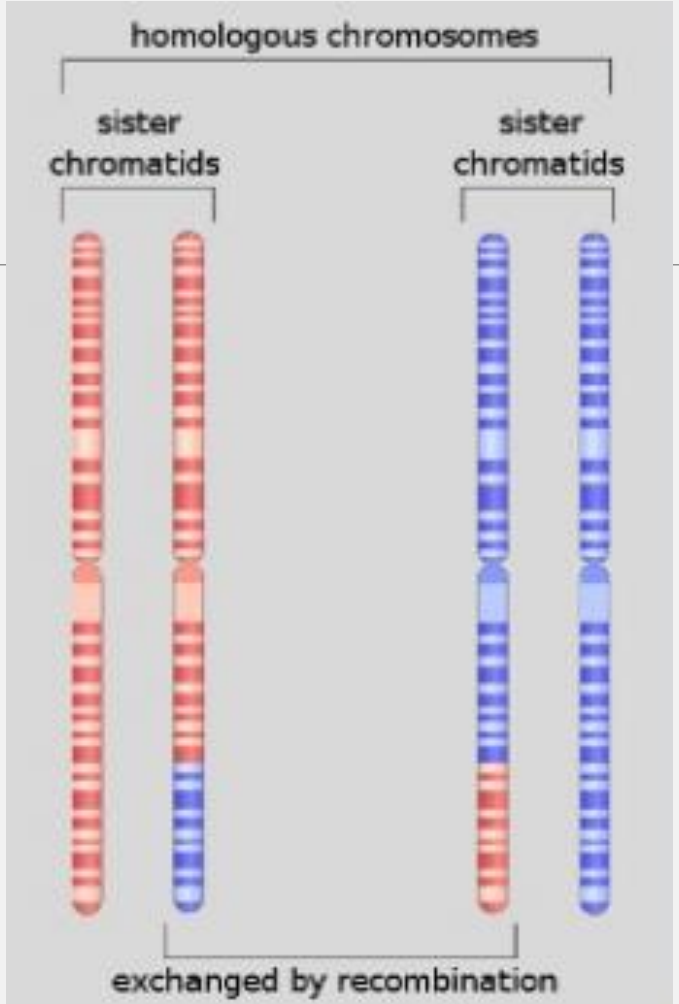
Types recombination

Four types of naturally occurring recombination have been identified in living organisms

1. Homologous or General Recombination

Occurs between DNA molecules of very similar sequence, such as homologous chromosomes in diploid organisms. General recombination can occur throughout the genome of diploid organisms, using one or a small number of common enzymatic pathways



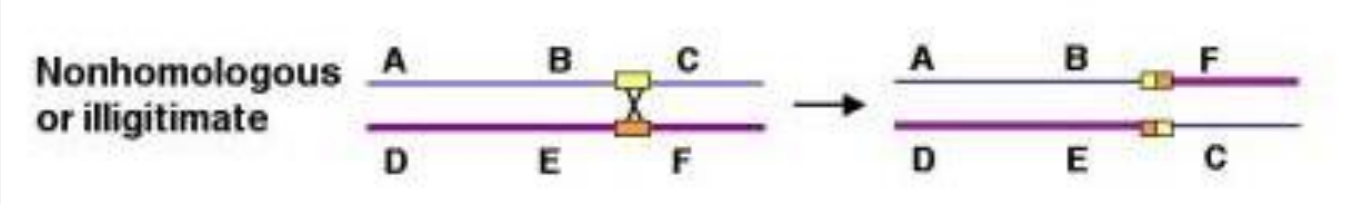


During meiosis, homologous recombination can produce new combinations of genes as shown here between similar but not identical copies of human chromosome 1

Types recombination

2. Non-homologous Recombination

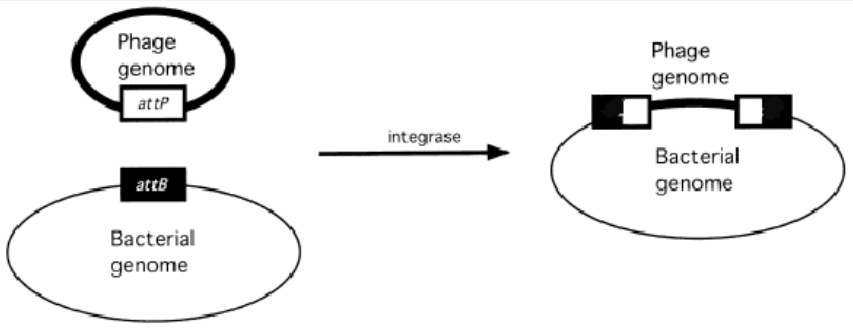
Is the process by which two unrelated double stranded segments of DNA are joined. This insertion of genetic material which is not meant to be adjacent tends to lead to genes being broken causing the protein which they encode to not be properly expressed.

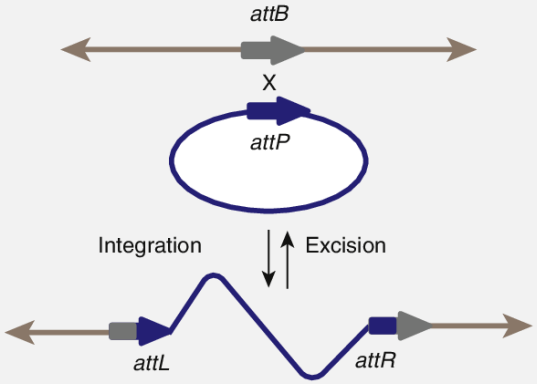


Types recombination

3. Site-specific Recombination

Occurs between particular short sequences (about 12 to 24 bp) present on otherwise dissimilar parental molecules. Site-specific recombination requires a special enzymatic machinery, basically one enzyme or enzyme system for each particular site. Good examples are the systems for integration of some bacteriophage, such as l, into a bacterial chromosome.

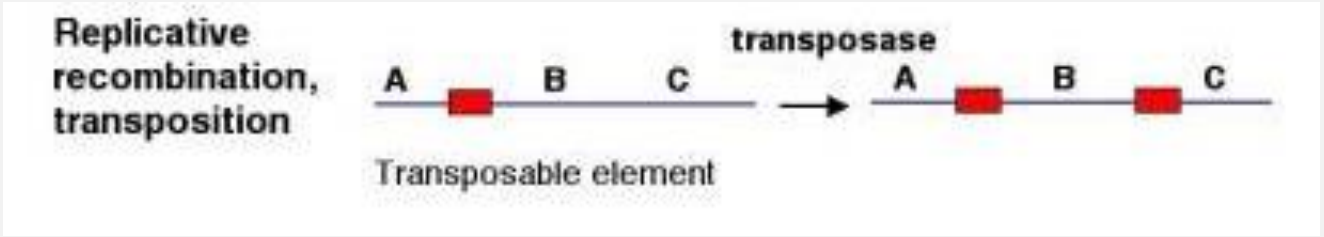


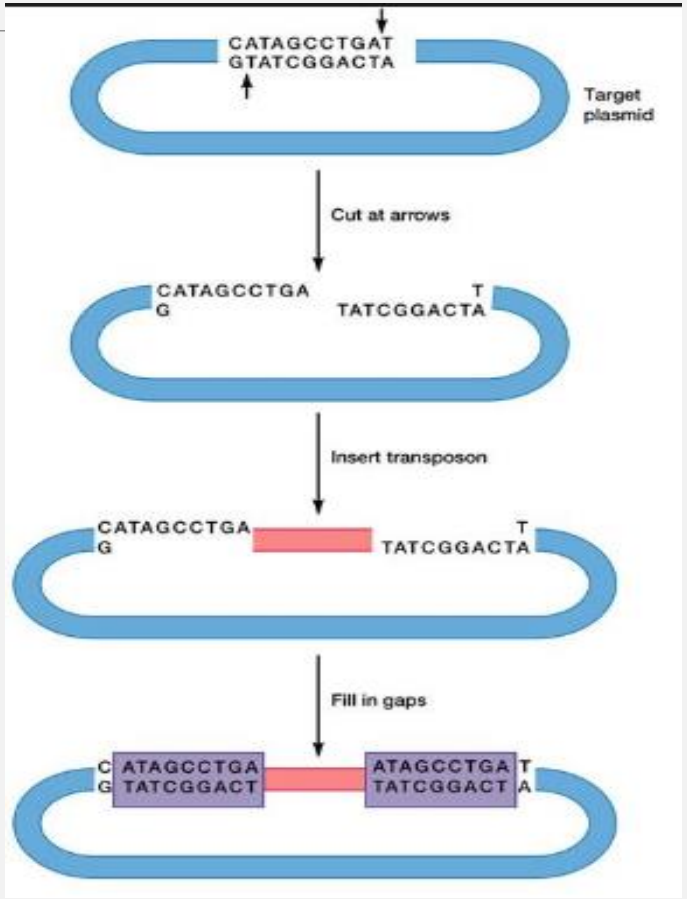


Types recombination

4. Replicative Recombination

Which generates a new copy of a segment of DNA. Many transposable elements use a process of replicative recombination to generate a new copy of the transposable element at a new location.

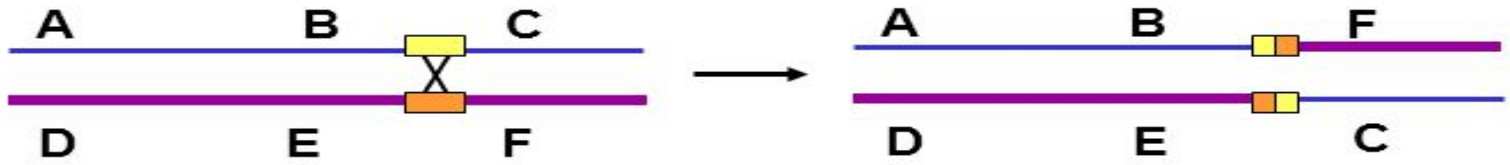




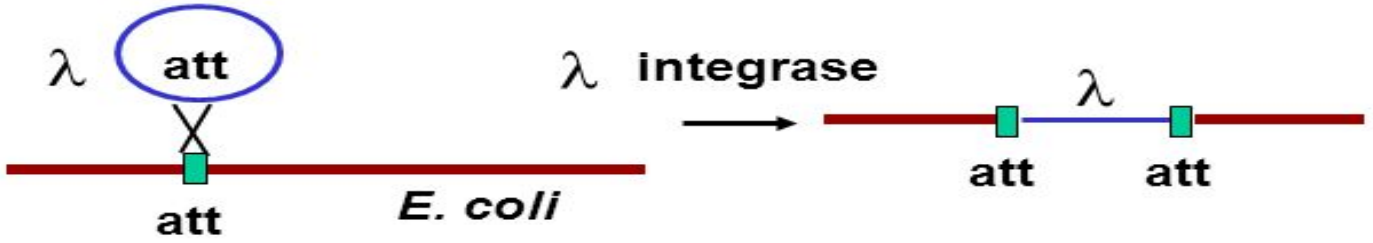
Types of recombination

Homologous or general

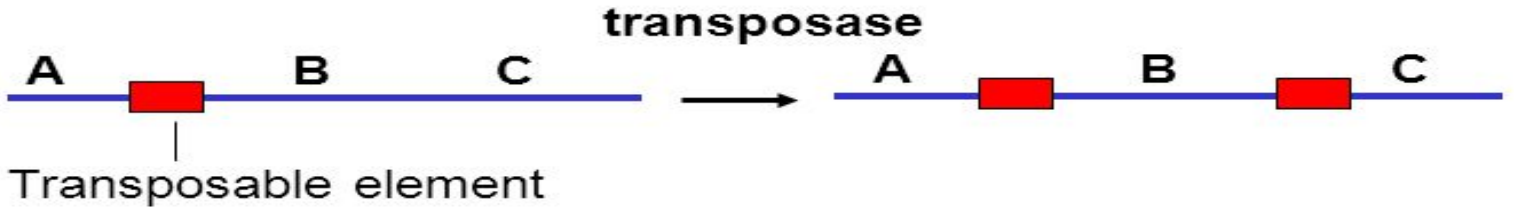
Nonhomologous or illigitimate



Site-specific



Replicative recombination, transposition



Recombinant DNA technology

Recombinant DNA technology refers to the joining together of DNA molecules from two different species that are inserted into a host organism to produce new genetic combinations that are of value to science, medicine, agriculture, and industry.

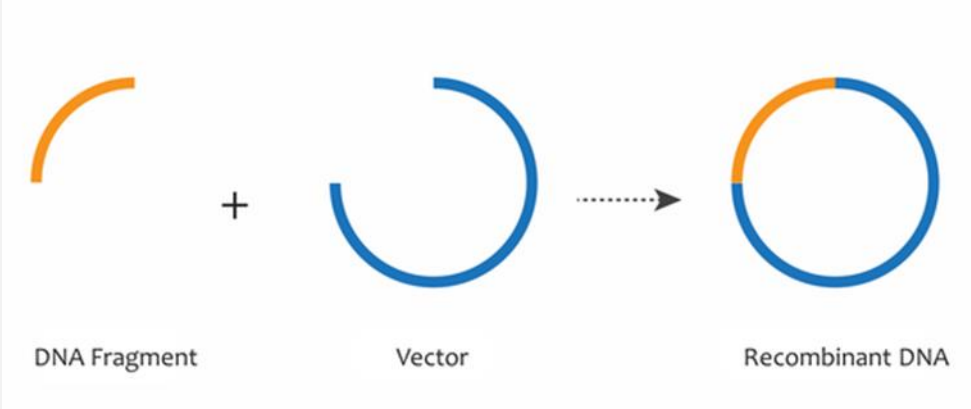
Recombinant DNA (rDNA), on the other hand is the general name for a piece of DNA that has been created by the combination of at least two strands.

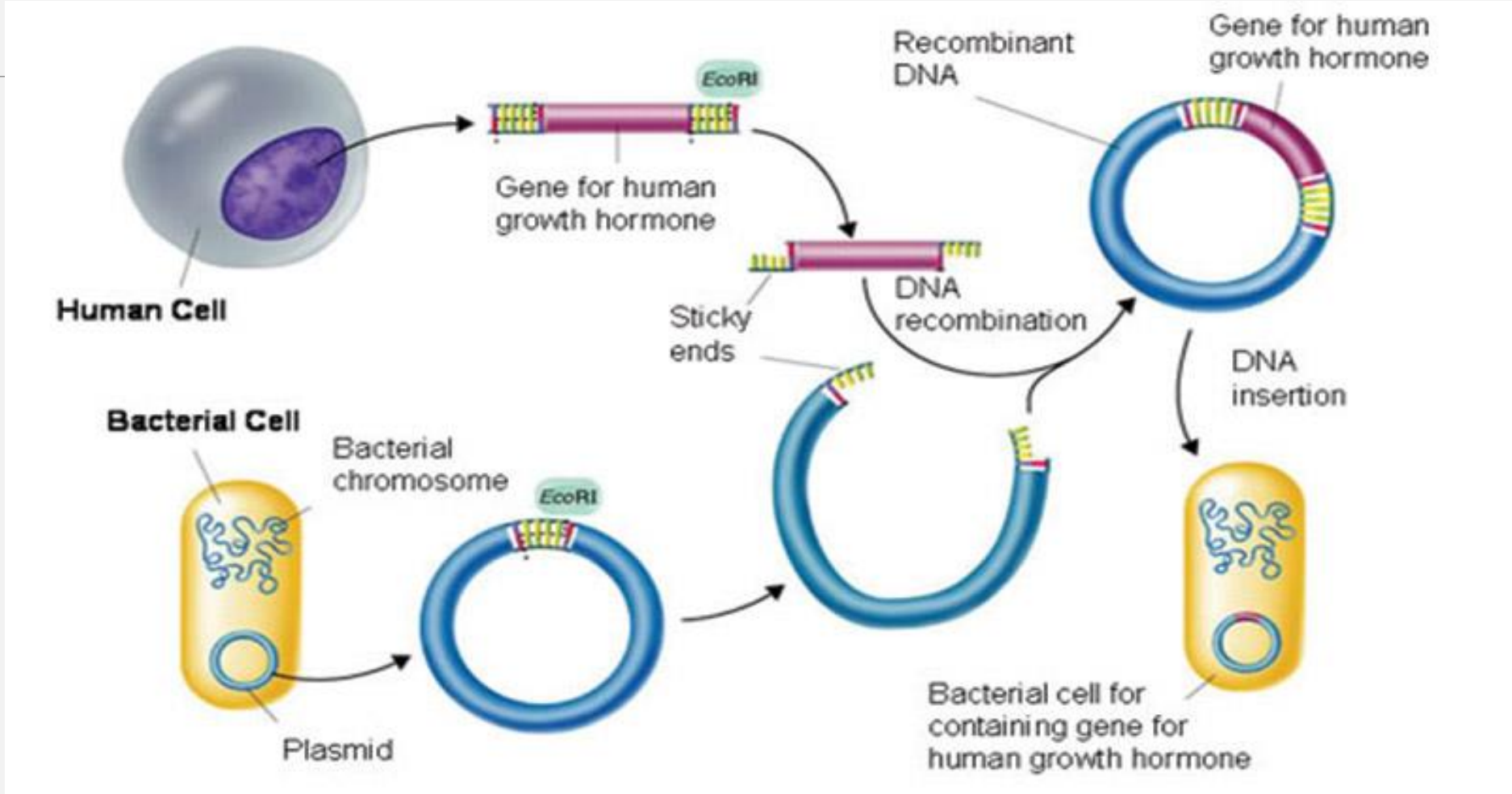
They are DNA molecules formed by laboratory methods of genetic recombination (such as molecular cloning) to bring together genetic material from multiple sources, creating sequences that would not otherwise be found in the genome.

Recombinant DNA technology also referred to as molecular cloning is similar to polymerase chain reaction (PCR) in that it permits the replication of a specific DNA sequence. The fundamental difference between the two methods is that molecular cloning involves replication of the DNA in a living microorganism, while PCR replicates DNA in an in vitro solution, free of living cells.

In standard molecular cloning experiments, the cloning of any DNA fragment essentially involves seven steps

1. Choice of host organism and cloning vector
2. Preparation of vector DNA
3. Preparation of DNA to be cloned
4. Creation of recombinant DNA
5. Introduction of recombinant DNA into host organism
6. Selection of organisms containing recombinant DNA
7. Screening for clones with desired DNA inserts and biological properties




Human Cell
EcoRI
Gene for human growth hormone
Sticky ends
DNA recombination
Recombinant DNA
Gene for human growth hormone
DNA insertion
Bacterial Cell
Bacterial chromosome
EcoRI
Plasmid
Bacterial cell for containing gene for human growth hormone

Application of Recombinant DNA technology