8.3.5. Transposons: Internal Gene Transfer

Previously, we discussed the presence of *insertion elements* on the chromosome. A closely related phenomenon is a *transposon*, which refers to a gene or genes that have the ability to "jump" from one piece of DNA to another, or to another position on the original piece of DNA. The transposon integrates itself into the new position independently of any homology with the recipient piece of DNA. Transposons differ from insertion sequences in that they code for proteins. Transposons appear to arise when a gene becomes bounded on both sides by insertion sequences. Many of the transposons encode antibiotic resistance.

Transposons are important because (1) they can induce mutations when they insert into the middle of a gene, (2) they can bring once-separate genes together, and (3) in combination with plasmid- or viral-mediated gene transfer, they can mediate the movement of genes between unrelated bacteria (e.g., multiple antibiotic resistance on newly formed plasmids). Transposon mutagensis can be a very powerful tool in altering cellular properties.

8.4. GENETICALLY ENGINEERING CELLS

Our description of DNA replication, mutation, and selection and the natural mechanisms for gene transfer provide the reader with a knowledge of all the tools necessary to genetically engineer a cell. The purposeful, predetermined manipulation of cells at the genetic level, an idea that was farfetched before 1970, is easily within the grasp of beginning college students.

Genetic engineering is a set of tools and not a scientific discipline. Although difficult to define precisely, it involves the manipulation of DNA outside the cell to create artificial genes or novel combinations of genes with predesigned control elements. Because many of these manipulations can be done outside the cell, *we can circumvent species limitations* that limit the age-old techniques of mutation and selection and breeding (e.g., we can express a human protein in *E. coli*). Learning how to use these tools is the basis of modern biotechnology.

8.4.1. Basic Elements of Genetic Engineering

An overview of the strategy typically employed in genetic engineering is given in Fig. 8.7. The strategy makes use of *recombinant DNA* techniques, the ability to isolate genes from one organism and recombine the isolated gene with other DNA that can be propagated in a similar or unrelated host. Most of our discussion will be drawn from approaches for genetically engineering bacteria.

The first step is obtaining the gene of interest. A simple, brute-force approach is *shotgun cloning*. Here the DNA from the donor organism is cut into fragments using *restriction enzymes*. If an efficient screening procedure is available, large numbers of host cells with random fragments of DNA can be screened for those with a property related to the desired gene.