

BIOTECHNOLOGY

The word biotechnology was coined in 1919 by Karl Ereky to apply to the interaction of biology with human technology. Today, it comes to mean a broad range of technologies from genetic engineering (recombinant **DNA** techniques), to animal breeding and industrial **fermentation**. Accurately, biotechnology is defined as the integrated use of **biochemistry**, microbiology, and engineering sciences in order to achieve technological (industrial) application of the capabilities of **Microorganisms**, cultured tissue cells, and parts thereof. The nature of biotechnology has undergone a dramatic change in the last half century greatly based on recent developments in **molecular biology**, especially those in genetic engineering. Organisms from **bacteria** to cows are being genetically modified to produce pharmaceuticals and foods. Also, new methods of disease **gene** Isolation, analysis, and detection, as well as gene therapy, promise to revolutionize medicine. In theory, the steps involved in genetic engineering are relatively simple. First, scientists decide the changes to be made in a specific DNA molecule. It is desirable in some cases to alter a human DNA molecule to correct errors that result in a disease such as diabetes. In other cases, researcher might add instructions to a DNA molecule that it does not normally carry: instructions for the manufacture of a chemical such as insulin, for example, in the DNA of bacteria that normally lack the ability to make insulin. Scientists also modify existing DNA to correct errors or add new information. Such methods are now well developed. Finally, scientists look for a way to put the recombinant DNA molecule into the organisms in which it is to function. Once inside the organism, the new DNA molecule

give correct instructions to cells in humans to correct genetic disorders, in bacteria (resulting in the production of new chemicals), or in other types of cells for other purposes. Genetic engineering has resulted in a number of impressive accomplishments. Dozens of products that were once available only from natural sources and in limited amounts are now manufactured in abundance by genetically engineered microorganisms at relatively low cost. Insulin, human growth hormone, tissue plasminogen activator, and alpha interferon are examples. In addition, the first trials with the alteration of human DNA to cure a genetic disorder began in 1991. Molecular geneticists use molecular **cloning** techniques on a daily basis to replicate various genetic materials such as gene segments and cells. The process of molecular cloning involves isolating a DNA sequence of interest and obtaining multiple copies of it in an organism that is capable of growth over extended periods. Large quantities of the DNA molecule can then be isolated in pure form for detailed molecular analysis. The ability to generate virtually endless copies (clones) of a particular sequence is the basis of recombinant DNA technology and its application to human and medical genetics. A technique called positional cloning is used to map the location of a human disease gene. Positional cloning is a relatively new approach to finding genes. A particular DNA marker is linked to the disease if, in general, family members with certain nucleotides at the marker always have the disease, and family members with other nucleotides at the marker do not have the disease. Once a suspected linkage result is confirmed, researchers can then test other markers known to map close to the one found, in an attempt to move closer and closer to the disease gene of interest. The gene can then be cloned if the DNA sequence has the characteristics of a gene and it can be shown that particular **mutations** in the gene confer disease. Embryo cloning

is another example of genetic engineering. Agricultural scientists are experimenting with embryo cloning processes with animal embryos to improve upon and increase the production of livestock. The first successful attempt at producing live animals by embryo cloning was reported by a research group in Scotland on March 6, 1997. Although genetic engineering is a very important component of biotechnology, it is not alone. Biotechnology has been used by humans for thousands of years. Some of the oldest manufacturing processes known to humankind make use of biotechnology. Beer, wine, and bread making, for example, all occur because of the process of fermentation. As early as the seventeenth century, bacteria were used to remove copper from its ores. Around 1910, scientists found that bacteria could be used to decompose organic matter in sewage. A method that uses microorganisms to produce glycerol synthetically proved very important in the World War I since glycerol is essential to the manufacture of explosives.

See also Fermentation; Immune complex test; Immunoelectrophoresis; Immunofluorescence; Immunogenetics; Immunologic therapies; Immunological analysis techniques; Immunosuppressant drugs; *In vitro* and *in vivo* research