13-4 Applications of Genetic Engineering

Standards Bio 5.c

Vocabulary: transgenic, clone

Genetic engineering makes it possible to transfer DNA sequences, including whole genes, from one organism to another. Does this mean that genes from organisms as different as animals and plants can be made to work in each other? American researcher Steven Howell and his associates provided the answer in 1986. They isolated the gene for luciferase, an enzyme that allows fireflies to glow, and inserted it into tobacco cells. When whole plants were grown from the recombinant cells and the gene was activated, the plants glowed in the dark. The gene for luciferase, which comes from an animal, can specify a trait in a plant. This shows that the basic mechanisms of gene expression are shared by plants and animals.

Transgenic Organisms

The universal nature of genetic mechanisms makes it possible to construct organisms that are transgenic, meaning that they contain genes from other species. Using the basic techniques of genetic engineering, a gene from one organism can be inserted into cells from another organism. These transformed cells can then be used to grow new organisms. Genetic engineering has spurred the growth of biotechnology, which is a new industry that is changing the way we interact with the living world.

Transgenic Microorganisms Because they reproduce rapidly and are easy to grow, transgenic bacteria now produce a host of important substances useful for health and industry. The human forms of proteins such as insulin, growth hormone, and clotting factor, which are used to treat serious human diseases and conditions, were once rare and expensive. Bacteria transformed with the genes for human proteins now produce these important compounds cheaply and in great abundance. People with insulin-dependent diabetes are now treated with pure human insulin produced by human genes inserted into bacteria. In the future, transgenic microorganisms may produce substances designed to fight cancer, as well as the raw materials for plastics and synthetic fibers.

Transgenic Animals Transgenic animals have been used to study genes and to improve the food supply. Mice have been produced with human genes that make their immune systems act similarly to those of humans. This allows scientists to study the effects of diseases on the human immune system. Some transgenic livestock now have extra copies of growth hormone genes. Such animals grow faster and produce leaner meat than ordinary animals. Researchers are trying to produce transgenic chickens that will be resistant to the bacterial infections that can cause food poisoning.

In the future, transgenic animals might also provide us with an ample supply of our own proteins. Several labs have engineered transgenic sheep and pigs that produce human proteins in their milk, making it easy to collect and refine the proteins.

Transgenic Plants Transgenic plants are now an important part of our food supply. In the year 2000, 52 percent of the soybeans and 25 percent of the corn grown in the United States were transgenic, or genetically modified (GM). Many of these plants contain genes that produce a natural insecticide, so the crops do not have...
to be sprayed with synthetic pesticides. Other crop plants have genes that enable them to resist weed-killing chemicals. These genes allow crop plants to survive while weeds are still controlled.

Transgenic plants may soon produce human antibodies that can be used to fight disease, plastics that can now be produced only from petroleum, and foods that are resistant to rot and spoilage. One of the most important new developments in GM foods is a rice plant that contains vitamin A, a nutrient that is essential for human health. Since rice is the major food for billions of the world's people, this rice may improve the diets and health of many people by supplying an important nutrient.

**Cloning**

A *clone* is a member of a population of genetically identical cells produced from a single cell. Cloned colonies of bacteria and other microorganisms are easy to grow, but this is not always true of multicellular organisms, especially animals. For many years, biologists wondered if it might be possible to clone a mammal—to use a single cell from an adult to grow an entirely new individual that is genetically identical to the organism from which the cell was taken. After years of research, many scientists had concluded that this was impossible.

In 1997, Scottish scientist Ian Wilmut stunned biologists by announcing that he had cloned a sheep. How did he do it? The figure below shows the basic steps. In Wilmut's technique, the nucleus of an egg cell is removed. The cell is fused with a cell taken from another adult. The fused cell begins to divide and the embryo is then placed in the reproductive system of a foster mother, where it develops normally. The sheep, which Wilmut named Dolly, is shown in below. Cloned cows, pigs, mice, and other mammals have been produced by similar techniques. Researchers hope that cloning will enable them to make copies of transgenic animals and even help save endangered species. On the other hand, the technology is controversial for many reasons, including studies suggesting that cloned animals may suffer from a number of genetic defects and health problems.
The use of cloning technology on humans, while scientifically possible, raises serious ethical and moral issues that have caused many people to oppose such work. As techniques improve, these important issues will become even more pressing.

13-4 Section Assessment

1. List one practical application for each of the following: transgenic bacteria, transgenic animals, transgenic plants.
2. What is a transgenic organism?
3. What basic steps were followed to produce Dolly?
4. List reasons you would or would not be concerned about eating genetically modified food.