Biotech In focus

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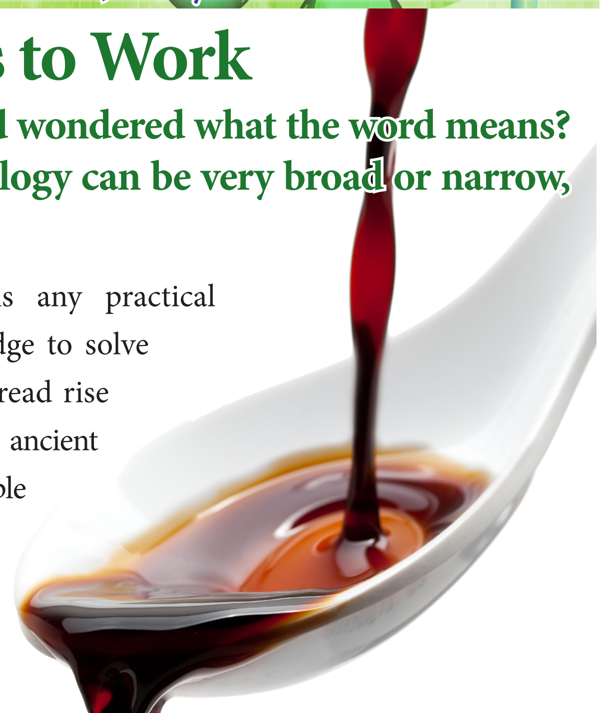
Biotechnology Basics: DNA Goes to Work

Have you ever heard or read about "biotechnology" and wondered what the word means? If so, you're not alone, because definitions of biotechnology can be very broad or narrow, depending upon who is speaking.



In one sense, biotechnology is any practical application of biological knowledge to solve problems. Using yeast to make bread rise or mold to ferment soy sauce are ancient biotechnologies. More recently, people have used microorganisms and plants to clean polluted water and soil.

About 60 years ago, scientists learned that genes (DNA) contain the instructions to make proteins and that different combinations of DNA's four chemical nucleotides, symbolized by the letters A, C, T, and G, produced different proteins. As DNA-based technologies have become more widespread, the popular meaning of biotechnology has narrowed, so that today people use the word to describe how knowledge of DNA and its protein products are put to work in many aspects of life.

Biotechnology also includes the use of products from living things. For example, rennet proteins from calf stomach have long been used in making cheese. In the 1920s, extraction of the protein insulin from animal pancreases made it possible to treat childhood (Type I) diabetes, which before then had always been fatal. Other types of biological products, such as sugars and oils from plants and algae, are being used to develop biofuels for renewable energy.

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DNA In Medicine

Many medically useful proteins—including human insulin for diabetes patients, human antibodies that help the immune system fight cancer, and anti-viral vaccines—are produced in genetically modified (GM) yeast and bacteria to which genes from other organisms have been added.

Some diagnostic tests are based on DNA sequencing (the order of nucleotides); others rely on antibodies, which have traditionally been made in mice but can now be made (painlessly to mice!) in GM yeast.

With advances in genomics, the study of an organism's complete set of DNA, doctors are gaining the ability to tailor therapies to an individual patient's genes and proteins; this personalized medicine is expected to expand dramatically in coming decades.

DNA & Industry

An enzyme is a protein that speeds up a chemical reaction. Enzymes made by GMOs are used to process food and make biofuels, bioplastics, and detergents. For example, rennet from calf stomach has largely been replaced by the enzyme chymosin, which is produced in GM bacteria and fungi; the resulting hard cheeses can be considered kosher, hallal, and vegetarian.

The Environment

DNA sequences, antibodies, and whole GMO cells have been used as biosensors to test wastewater and other environmental samples for the presence of pollutants and pathogens (disease-causing microorganisms).

In polluted environments, GM bacteria can break down solvents or pesticides that resist decay and can concentrate toxic metals, making them easier to remove.

Public Safety

Since the late 1980s, DNA evidence has resulted in thousands of criminal convictions and the release of more than 300 wrongly convicted individuals from prison.

Biosensors have been designed to detect chemicals and pathogens that can be used as weapons.

DNA and Agriculture

Many centuries before the discovery of DNA, farmers used selective breeding to improve the quality of crop plants. Now that DNA technology allows plant breeders to add genes from a wide range of plants and non-plant sources, crop plants have been genetically modified to tolerate herbicides, kill insect pests, and resist plant viruses. We'll focus on this topic next.

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