Cooperative Extension Service
Biotechnology Outreach Program
College of Tropical Agriculture and Human Resources
University of Hawai'i at Manoa

Biotech In focus

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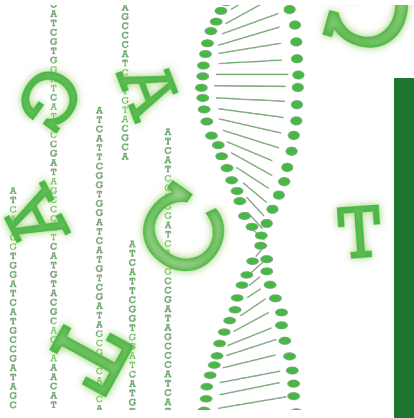
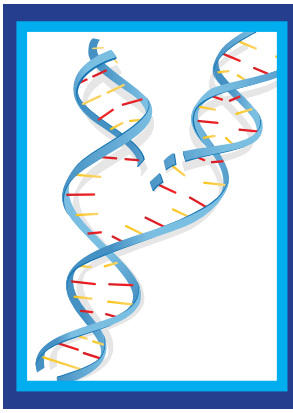
Genetic Engineering: Adding New Recipes to the DNA Cookbook

One morning, our farm family finds that their young tomato plants are being gobbled up by a caterpillar that they haven't seen before. This new pest came from somewhere else and has no natural predators nearby.

If their current pest management strategies aren't working, should they spray more or use a stronger insecticide to kill the caterpillar? Will spraying affect the bees they rely on to pollinate some of their other crops? What will become of the natural enemies of other pests, will they also be killed? What about the insecticides and practices used in organic agriculture? How much will these different options cost? Does plant breeding have a new tool to offer?

As we learned in Bulletin #1, the four DNA letters—A, C, T, and G—group together in three-letter DNA "codons" to spell out the recipes for proteins. These recipes written in DNA are called genes. All living things, from bacteria to plants and animals, share the same genetic code. This means that all types of cells can translate the same sequence of codons into the same protein.





To make a new protein, the cell turns to its DNA cookbook, called a **genome**. The cell first copies the DNA recipe, just like we might copy a recipe onto an index card and cook using the copy to protect a favorite cookbook. Next, the cell reads the copied codons and strings together amino acids in the exact order dictated by the recipe. Copying the DNA recipe is called **transcription**, and using the copied recipe to make a protein is called **translation**. Transcription plus translation is sometimes called gene expression.

For more information and past issues, please visit our website at www.ctahr.hawaii.edu/biotechinfocus

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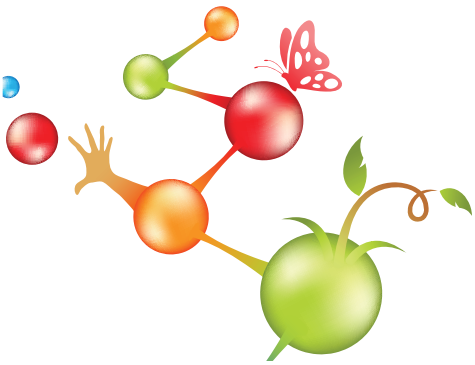
Genetic Engineering

Broadly speaking, **genetic engineering** is the process of taking a gene from the DNA cookbook of one organism and adding it to the cookbook of another organism. There are so many different terms to describe this process that it's easy to lose track. For example, genetic engineering can also be called **genetic modification**, **transgenic manipulation** or **transformation**. The gene being moved from one genome to another is a **transgene**, and the organism to which the new gene is added is described as being **transformed**, **transgenic**, a **genetically engineered organism (GEO)** or a **genetically modified organism (GMO)**.

Transferring Genes

This process of transferring genes or whole genomes from different organisms has occurred many time in nature and has been involved in the evolution of many organisms.

Unique Events



In genetic engineering, each transfer event is unique. Even if the same transgene is added to the same organism in a separate transformation, the results will be somewhat different, because the transgene will enter its new host genome at a different place.

New Recipes

We can think of this as a new recipe being added to the cookbook at a random page number.

For the tomato farmers, genetic engineering means that tomato plants can be bred not only with good tomato traits for yield, fruit size, flavor and taste, but also with useful traits from any other organism. If there's a DNA recipe anywhere for a protein that kills the new caterpillars, a plant breeder can now move the gene for that trait into tomato plants. Since 1994, genetically engineered crops have been grown by farmers in the United States. We'll discuss which crops contain which genetically engineered traits in our next bulletin.