seem to form small clusters within the host crystals. Michl and his group are now looking for ways to keep guest molecules isolated from one another. "If we can get the molecules singly isolated," says Michl, "it creates a very unusual environment for these molecules." Benzene, for instance, surely doesn't want to be in the middle of a highly polar, ionic environment like that, he says. The researchers want to study the photochemical properties of molecules under these conditions.

Michl, who already has a patent on this technique, is also considering possible applications. Using salt as a way of storing organic compounds, he says, could be a convenient way of getting drugs to cows, which like licking salt but often dislike medicinal preparations.

This method could also be used to generate "molecular imprints" on surfaces. Any guest molecules that evaporate from a surface may leave behind a hollow. "If this footprint is stable," says Michl, "you'll have a shape that will presumably accept the same sort of molecule that left and not others that are bigger." This could lead to useful detectors for specific compounds. *– I. Peterson*

Firefly gene sets tobacco plants aglow

Live tobacco plants that glow before they're lit may sound like a promotion for a cigarette company, but they actually are a demonstration of a powerful new tool in the field of genetics. Using the gene responsible for the firefly's glow, scientists from the University of California at San Diego (UCSD) have developed a glowing genetic tag.

Until now, the standard procedure for marking and monitoring gene activity has involved radioactivity, which, aside from posing the danger of accidental exposure, can be costly and time consuming. The new procedure not only solves all these problems, says UCSD plant biologist Stephen H. Howell, but also is "100 to 1,000 times more sensitive" in detecting gene expression.

The key to the process is luciferase, a firefly enzyme that catalyzes a chemical reaction between luciferin, a small organic molecule, and adenosine triphosphate (ATP), the cell's energy storage molecule. When all three are present, luciferin reacts with ATP and emits light.

Last year, the UCSD team isolated the gene that codes for luciferase and transplanted it into bacteria. This year, in the Nov. 14 SCIENCE, they report success in growing luciferase-producing plants by inserting the luciferase gene into the plants' DNA.

What makes this gene such an attractive tool is the ease of detecting the luciferase; and it is just as easy to detect in a whole plant as it is in a single cell. On the single-cell level, Howell and his colleagues inserted the luciferase gene into cultured carrot cells. After 24 hours they ground up the cells and added luciferin and ATP. A flash of light announced the presence of luciferase, which meant that the cells had been producing the firefly enzyme.

The researchers also grew whole tobacco plants containing the firefly gene. To test for luciferase production, they "watered" the plants with a luciferin solution. Several hours later they had glowing plants – proof that the plants were expressing the luciferase gene.

Many applications await this gene, especially in the study of gene expression. Biologists have long been puzzled by differential gene expression: Why, for example, don't liver cells produce kidney cells, when every cell within a single organism contains the same genetic material? To study such phenomena, scientists can physically link a "reporter" gene, in this case the luciferase gene, to a "target" gene. Testing for luciferase will then reveal which cells are expressing the target gene and whether this gene is turning on and off in response to environmental cues.

Presently the standard reporter gene codes for chloramphenicol acetyltransferase (CAT). However, to assay the CAT gene, scientists must grind up – and consequently destroy – the sample. This aspect, coupled with the radioactivity involved in the CAT assay, taints the CAT gene's usefulness as a reporter gene, says Keith V. Wood, another member of the UCSD team, which also included Marlene DeLuca, Donald R. Helinski, David W. Ow and Jeffrey R. de Wet, who is now at Stanford University.

Howell told SCIENCE NEWS that at the outset of the experiment, "we thought what we were going to have to do was grind up parts of the plant. . . . But it was a real bonus when we found out that we could actually observe this [glowing] in the plant itself."

The luciferase assay also shows promise as a quick, cheap and nondestructive test for inherited plant traits, says DeLuca. One such application would be in the development of disease-resistant crops. "If you had a gene coding for the disease-resistant trait and you linked that to the luciferase gene, then it would be possible to determine whether the resistance had been maintained by successive generations, or whether it had been lost by segments of the population," says DeLuca. She adds that scientists could perform this test by simply dunking young seedlings into a luciferin solution. They could weed out those that don't light up and plant those that do.

Helinski, DeLuca, de Wet, Wood and Suresh Subramani have also induced monkey cells to produce luciferase; a report on their work should appear next year. Wood says that, as in plants, the luciferase gene will be a powerful new reporter gene for multicelled animal systems. However, don't expect to see any glowing Marlboro men.

– R. Monastersky

Photos: Wood

Researchers created a glow-in-the-dark tobacco plant (right) by inserting a firefly gene into the plant DNA. At left is the same plant in ordinary light.

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