SCIENCE

# The Emerging World of Plant Science

## FRONTIERS IN BIOTECHNOLOGY



STASKAWICZ *ET AL.*

Plants surround us. We use them for food and for decoration, and they help sustain our ecosystems. In this special issue we have collected News stories, Articles, Reports, and a Perspective that highlight some of the dramatic recent advances in our knowledge of the inner workings of plants and how the tools of biotechnology are being applied to plants to produce new, as well as improved, crops.

Researchers are coming to a better understanding of the processes plants use to deal with both beneficial and harmful influences. Light is one beneficial influence, and Quail *et al.* discuss how the phytochromes detect light of certain wavelengths, allowing plants to make appropriate responses, such as changing their growth patterns to help seedlings grow out from the shade of overbearing plants nearby. Plants also need to be able to cope with factors that can cause harm, such as pathogenic viruses and bacteria. As discussed by Staskawicz *et al.*, plants employ similar molecules, and perhaps pathways, to defend against a remarkable variety of pathogens. And still other factors, such as atmospheric carbon dioxide, may be good or bad, depending on the circumstances. As described by Culotta, recent research shows that rising atmospheric carbon dioxide concentrations may benefit many agricultural crops, while the overall effects on plants in natural ecosystems are far less clear.

Responses of many sorts must be integrated throughout the plant. The hormone ethylene, which controls, among other things, the ripening of some of your favorite fruits, induces a complex series of molecular responses in the cell. Ecker describes what is known about the ethylene receptor and the propagation of its signals. Within any given cell, physiologic responses must also be coordinated. Levings and Siedow discuss one of these mechanisms, known as "redox poise," which takes place in chloroplasts and adjusts production of a certain protein in accordance with the plant's needs. Gene transcription is also coordinated with other responses and seems to grow ever more complex. As described by Jorgensen, the phenomenon of cosuppression, which first became apparent when certain transgenic plants failed to produce the expected results, hints at posttranscriptional mechanisms of gene control.

The advent of biotechnology and gene transfer has given researchers a new ability: They can engineer crop plants to produce natural components more effectively and even to produce unexpected materials. Töpfer *et al.* discuss how this technology is being used to induce plants to make lipids for nutritional and industrial applications, while Moffat surveys the current status of some of these novel plants. And Reports by Haq *et al.* and Ma *et al.* and a related News story by Moffat describe the possibility of applying plant biotechnology to a perennial public health problem—the production and delivery of safe and effective vaccines against human disease. Finally, these developments have made plants valuable commodities in the biotech community, and Stone discusses recent battles that have flared up over the patent rights to genetically engineered plants.

**–Pamela J. Hines and Jean Marx**