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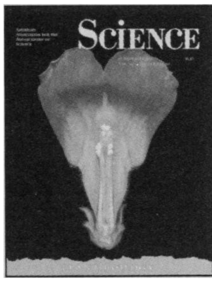

COVER Shown is a wild-type flower of *Antirrhinum majus* (snapdragon), a plant used for genetic and molecular studies of the mechanisms of flower development. Lower parts of the corrolla leaves have been removed, revealing reproductive organs (the pistil and four stamens). Z. Schwarz-Sommer *et al.* have studied homeotic genes in *Antirrhinum majus* (page 931). In this issue is a collection of articles that describe progress in understanding molecular aspects of plant biology. See pages 923 to 966. [Photograph by Dietrich Bock]

Book Reviews

Products & Materials

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Frontiers in Plant Biology

The estimated 260,000 species of plants that exist on the earth today, together with algae and photosynthetic bacteria in the ocean, convert carbon dioxide to the foodstuffs used by the 5 billion humans and other creatures currently living on the planet. Moreover, plants reduce carbon dioxide concentrations and generate the oxygen needed to preserve our ecology. Plants also offer us an opportunity to understand basic principles in biology because of their difference from, and similarity to, animals and bacteria. This special issue of *Science*, edited under the expert guidance of Pamela Hines, contains articles that address both practical questions and basic plant research.

One feature that distinguishes plants from animals is the phenomenon called totipotency, which refers to the ability of a highly differentiated vegetative plant cell to be the source for an entire new plant. In animals, a liver cell cannot be converted into a new animal, nor even into a nerve cell. Differentiation and organ formation, however, occurs throughout the lifetime of a plant and can sometimes extend many, many years. Thus, while the process of differentiation is common to both kingdoms, plants offer a different tool to study it. Homeotic mutants that perturb the differentiation process can produce the wrong organ at the wrong place in plants as well as animals. Schwarz-Sommer and co-workers used such mutants in flower development in order to understand the molecular basis of morphogenesis. The shoot system of higher plants is used as a model by Poethig to study the process of differentiation and its changes over time and space. The shoot apex passes through what might be called juvenile, adult, and reproductive phases, and these may be related to fundamental molecular properties such as DNA methylation and epigenetic cell status.

Rubisco (ribulose bisphosphate carboxylase-oxygenase), which plays a vital role in fixing the carbon dioxide from the atmosphere, is quite an inefficient enzyme and is therefore made in enormous quantities. It may be the single most abundant protein in the biosphere. Improving the properties of rubisco is of great practical value, and is the goal of much plant research. It has also been a source of theoretical understanding in regard to the assembling of protein complexes, because the role of chaperones has been uncovered and enhanced by plant studies, as described by Ellis. Transcription in plants, described by Benfey and Chua, is extraordinarily complex, and involves cis factors, transfactors, protein-protein interactions, and protein-DNA interactions suggesting that there is a combinatorial code of cis-regulating elements. These complexities suggesting domain units may be similar to those in other species of plants and animals. Differences and similarities can be seen again in the articles on nitrogen fixation, male sterility, and self-incompatibility. Nap and Bisseling discuss the way in which nitrogen-fixing nodules operate in symbiosis with their host to provide nitrogen to the plant. It is a case of infection in which the infective agent, the prokaryote *Rhizobium*, generates a response in specific activation of genes in both plant and bacteria to produce nitrogen fixation and plant growth.

A not-so-beneficial genetic trait is described by Levings, who explains the cases of male sterility and disease susceptibility, which are linked inseparably in corn genes. These diseases are traced to a single 13-kilodalton polypeptide in the mitochondria, which provides a rational basis for the linkage. A system that prevents inbreeding in plants has elements of the self-nonself recognition of the immune system, as described by Haring and co-workers. In the plant system, a different individual of the same species is necessary for fertilization. The plant also uses glycoproteins for nonself recognition to improve hybrid vigor.

Lest those who are struggling with the difficult problems of mammalian species, life and death, or benign growth versus cancer, jump to the conclusion that plants are the preferred species, two interesting reports by Malamy *et al.* and Métraux *et al.* describe the importance of salicylic acid as an endogenous signal involved in turning on various pathogenesis-related genes upon infection. The fascinating relation between plants and animals is therefore carried one step further, and philosophical questions arise as to whether plants get headaches in sympathy with their mammalian counterparts.

Our continuing pollution of the atmosphere and the problem of feeding the world's growing population will make plant biology ever more important. The articles in this issue illustrate some of the fascinating biological properties of plants purely as intellectual puzzles. Plant researchers can rejoice in knowing that the intellectual pleasure of working on these systems is matched by the relevance of such systems to other species and the enormous practical consequences for the ecosystem.—DANIEL E. KOSHLAND, JR.