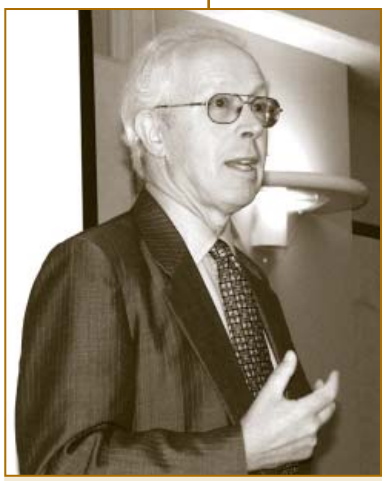
SDCMA

San Diego Center *for* Molecular Agriculture

The San Diego Center for Molecular Agriculture (SDCMA) is an alliance of plant biologists from basic research institutions who are engaged in the discovery of genetic traits that can be used to create improved crops. The center was established in 1999 to foster interactions between these scientists and their counterparts in the agricultural biotechnology industry. By combining the powerful tools of molecular biology and genomics with genetics and plant breeding, they will help create improved crop varieties that will raise agricultural productivity while at the same time making agriculture more sustainable.



Maarten Chrispeels, director of the SDCMA, lectures about GM crops for UCSD-TV.

Agriculture has been at the center of human activities ever since our aboriginal ancestors began to manage their food crops some 10,000 years ago. As the population of the earth rose—quite slowly for many centuries, but very quickly in the past fifty years—crop management had to become more intense as well. In the second half of the twentieth century, most of the available arable land was put to the plow and plant breeders produced superior varieties of many crops, allowing us to feed this burgeoning human population. Yields of our three most important staples—rice, wheat, and corn—rose four- to fivefold between 1950 and 2000. This remarkable achievement of human ingenuity was made possible by the use of genetically improved crop varieties in combination with new crop management techniques.

What is molecular agriculture?

Agriculture, like medicine, is an applied science that relies heavily on discoveries in the basic sciences. For example the basis for all plant breeding—an applied science—is genetics, a basic science. Plant breeding didn't really get underway until about 1900, when the importance of Mendel's laws of inheritance became clearly understood. Biological pest control provides another example of this synergy between the basic and applied sciences. Biological pest control—a management tool—took off when we understood pest ecology: the relationship between the population size of a pest, its food resources and the organisms that normally keep the population in check. Understanding pest ecology led to remarkable improvements in pest control. Each time new scientific discoveries are made, scientists working at the interface of the basic and applied sciences exploit them for agriculture's benefit. Now, molecular techniques and genomics are revolutionizing all of biology and promise to have a tremendous impact on applied sciences like medicine and agriculture.

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Providing food security for 9 billion people by 2150 will require a doubling of food production. This can only be accomplished if plant breeders generate more productive crop varieties and if our management practices make agriculture more sustainable.

Joanne Chory and Joe Ecker from the Salk Institute for Biological Studies in a greenhouse where some of the Arabidopsis plants for the Arabidopsis genome project are being grown.

Molecular agriculture aims to create a set of tools that will allow plant breeders to do their part of the job. By finding new solutions for pathogens and pests it will also make crop management more environmentally friendly. This set of tools includes among others the genome sequences of crop plants and crop pathogens, methods to carry out gene therapy in plants, and procedures to identify individual genes as well as multigene chromosomal segments that carry important agronomic traits. The most ambitious goal of molecular agriculture is the identification of the function of all of the 25,000 genes in a plant.

Molecular technologies will help make agriculture more sustainable. During the twentieth century, the Earth's ecosystems underwent very significant ecological change. The expansion of agriculture, required by the need to feed the evergrowing human population, has been the major driver of this change. There is no denying that our present practices are not sustainable. We have been successful in adequately feeding a large proportion of humanity, but at the expense of slowly eroding the resource base. The answer to this problem is not "organic" agriculture, because its productivity is too low. The answer is sustainable agriculture using genetically improved plants and better management techniques. This quest for sustainability will be greatly aided by the tools that molecular agriculture will provide. Molecular plant breeding is the wave of the future. Using the molecular tools of genomics, genes will be shuffled between elite varieties and wild relatives more rapidly than is now possible, cutting the time to produce improved elite varieties in half. Genome projects are now under way for a number of important crops, including corn, soybean, tomato, and rice. Only by applying a systems approach that integrates the use of all the tools at our disposal, can we come to grips with the formidable challenge of feeding 9 billion people.

San Diego has a prominent position in molecular agriculture research. In the past ten years plant biologists in San Diego working at three major public research institutions—the University of California, San Diego (UCSD), the Salk Institute, and The Scripps Research Institute—have made startling discoveries in the field of plant molecular biology that are directly applicable to agriculture. **San Diego**, the home of a major research university, numerous private biomedical research institutes, and over 200 biotechnology companies, is one of the world's unique centers of biological and biotechnological research and development. Plant biotechnology is well represented by major research groups led by world-renowned plant biologists in the public and private

Governor Paul E. Patton and a delegation from Kentucky visit the SDCMA in June 2001.

sector. Agricultural applications of basic research are being pursued by Dow AgroSciences (formerly Mycogen), Dow Chemical, the Torrey Mesa Research Institute (formerly the Novartis Agricultural Research Institute), Cibus Genetics, Epicyte, and other companies. Small groups of researchers interested in agricultural applications of specific biotechnologies work in other companies as well. The interactions between the scientists at all these institutions, facilitated by the SDCMA, create an exciting research environment for this new branch of applied biological research. Some SDCMA researchers are heavily involved in the plant genome project, and the recent completion of the first genome of a flowering plant has opened the door for new molecular and genetic discoveries that will allow us to understand how plants grow and develop, how they acquire nutrients and water, how they respond to stressful environments, and how they interact with pests and pathogens. Those are the basic processes that underlie crop growth and they are the processes in which the San Diego scientists are interested.

What are the goals of the SDCMA? The SDCMA has three major goals. The first one is to increase the level of intellectual activity in plant molecular biology and other disciplines that relate to molecular agriculture in the San Diego region. This we do by organizing monthly research meetings for young scientists, holding symposia, and inviting seminar speakers. We also provide a conduit for information about various events in the region. The idea is to get scientists from different institutions to talk to one another and to share ideas and technologies. The second goal is to organize outreach activities for non-scientists in San Diego and to raise people's awareness of the contributions that basic scientists in San Diego are making to molecular agriculture. These outreach activities take the form of workshops, furnishing speakers for small meetings, and the publication of brochures that help lay people understand the science that underlies agriculture. The third goal, now under development, is to create an endowment and research support for molecular agriculture. In 2000, Novartis established an endowed chair in plant science that is occupied by Professor J. Schroeder, a member of SDCMA.

Gene Discoveries and Technology Development by SDCMA members.

The research laboratories of the SDCMA members have developed a number of exciting technologies, some of which have been licensed to industry. These discoveries include:

- discovery of hormone regulated genes that reduce water loss by plants
- identification of a large family of water channel proteins and isolation of their genes
- discovery of soil nutrient transporters and their genes
- isolation of genes involved in fruit growth and fruit ripening
- discovery of genes necessary for seed dispersal in wild plants
- generation of the first insect resistant seeds through genetic engineering
- identification of genes that control the timing of flower development
- discovery of genes that control protein accumulation in corn seeds
- identification of genes that make nematodes resistant to the popular Bt toxins
- identification of genes that permit plants to take up toxic heavy metals and decontaminate soils

A sampling of SDCMA activities in 2000 and 2001

- Spring Symposium 2000: Proteomics
- Fall Symposium 2000: Molecular Tools for Plant Biology
- Workshop for media commentators and legislative aides on genetically modified (GM) crops and foods (February 2001)
- Publication of a16-page color brochure: "Foods from Genetically Modified Crops"
- Host to Governor Paul Patton and a delegation from Kentucky to discuss agricultural biotechnology (June 2001)
- Production of TV Programs with UCSD-TV (Spring 2001)
- Host to a delegation from the Netherlands to discuss public perception of agricultural biotechnology (June 2001)
- Publication of a 16-page color brochure: "Foods from Genetically Improved Crops in Africa"
- Fall Symposium 2001: How do plant cells transduce environmental and hormonal signals?
- Agricultural Biotechnology Inventor/Investor Showcase in collaboration with UCSD Connect (October 2001)

Members of the SDCMA

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How is the SDCMA funded?

As an organized research unit of UCSD, the SDCMA receives a small subsidy from UCSD to hire a half-time assistant. Specific projects are funded by grants from foundations, biotechnology companies, or public agencies such as the UC Biotechnology Research and Education Program. A list of those stakeholders is at our Web site: www.sdcma.org.

Plants can be selected to utilize less water. Compare the mutant plant (abcap) on the left, with the control (WT) on the right. Water was withheld from both plants for the same length of time (Laboratory of Professor Julian Schroeder).

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Get in touch!

- If you want to participate in our monthly meetings
- If you have ideas for collaborative activities or projects
- If you would like to support the SDCMA financially
- If your program needs a speaker to explain molecular agriculture or agricultural biotechnology
- If you want a copy of our brochure "Foods from Genetically Modified Crops"

You can contact us by writing directly to the director, Professor Maarten J. Chrispeels, Division of Biology, University of California, San Diego, 9500 Gilman Drive, La Jolla CA 92093-0116 or mchrispeels@ucsd.edu
If you want to be notified of our activities, send a message to Milda Simonaitis at milda@ucsd.edu

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