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Editorial Overview

An eight-year government supported project investigating the control of industrial plant material production processes via genetic engineering in Japan

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A technology development project investigating industrial plant material production by genetic engineering was instigated in 2002 in Japan, and is supported by the New Energy and Industrial Technology Development Organization (NEDO) (Kanagawa, Japan). The project entitled the "*Development of Fundamental Technologies for Controlling the Material Production Process of Plants*" and abbreviated to the "*PM project*", has involved the collaboration of ten members of the private sector, three academic research institutions and over 20 Universities. The project has received budget support from the Ministry of Economy, Trade and Industry. The project will be completed at the end of the 2009 fiscal year, and has produced a wealth of results and publications to date. The purpose of the project is to develop the technical infrastructure required for genetic engineering in various industrial plant species to produce industrial materials and other useful substances. This special issue of Plant Biotechnology is arranged to report many of the major results arising from the investigations of the contributors to the PM project.

A major factor that distinguishes the PM project from previous plant-related NEDO projects is its metabolomics aspect. With the completion of the genome sequencing of the model plant *Arabidopsis thaliana* in 2000, the entire set of *A. thaliana* metabolism related genes emerged into the spotlight of plant biotechnology. When the project began in 2002, transcriptomic technologies such as microarray gene expression analysis and bioinformatic treatment of large datasets were still undergoing development. This project has succeeded at continuing to incorporate the latest transcriptomic technologies and has also successfully developed metabolomics technology, in which information from the transcriptome is integrated into that of the metabolome in order to understand the metabolite control mechanisms in plants. The outcomes of this project have had a great impact on plant metabolomic research, and are illustrated in the many published manuscripts.

In order to identify key genes involved in the regulation of metabolite production in industrial plants, the PM project is organized to incorporate the basic knowledge of plant metabolism obtained from *A. thaliana* and the legume *Lotus japonicus*, both model plants in this area of research. Such investigation is essential as genetic information and research resources involved in metabolite production in industrial plants remain scarcely available. The private sectors associated with this project are mainly interested in industrial material production research, while the academic research institutions and Universities are interested in increasing their understanding of the mechanisms underlying general metabolism control in the plant models. The generation of databases that store the enormous amount of data produced from the project, and the release of these databases to the public is also an important aim of the project.

Kazusa DNA Research Institute (Shibata lab) is a key partner in the PM project, and has been responsible for the production of genetic resources including *L. japonicus* and other industrial plant cDNA clones, a large number of genetically modified *A. thaliana* cell lines, and multiple gene-connected vectors. In addition, they have also been responsible for the development of the metabolome analysis technology that uses state-of-the-art mass spectrometry, and the integration of the transcriptome and metabolome data produced from the project into databases. The institution has provided support for the private sectors in the form of technology and resources. Two laboratories at the National Institute of Advanced Industrial Science and Technology (AIST) (Shinshi & Suzuki and Takagi labs) have been investigating the *A. thaliana* transcription factors that control metabolite production. The Shinshi and Suzuki lab focuses on the DFO gene family, while the Takagi lab applies the CRES-T technology that they developed to simultaneously control sets of transcription factor genes in the model plants. The Research Institute of Innovative Technology for the Earth (RITE) has contributed to an increased understanding of how chloroplasts control metabolism in the organelle via proteomics, molecular biol-

ogy and metabolomics. Takara Bio Inc., a member of the private sector, has developed a gene-specific cDNA microarray and the technology required for cell-specific gene expression analysis of *A. thaliana*, and has constructed the relevant databases.

The other members of the private sector who participated in the NEDO project investigated metabolites according to their own interest and industrial usefulness, and worked in tight collaboration with the academic research institutions and Universities. Ajinomoto Co. Inc. analyzed the production processes of nitrogen compounds, in particular amino acids. Oji Paper Co., Ltd and Nippon Paper Industries Co., Ltd, worked specifically on transgenic eucalyptus trees. The former identified that some genes were able to enhance growth of eucalyptus for wood biomass production, while the later produced salt tolerant eucalyptus trees in order to expand the area of potential plantation. Bridgestone Corporation worked on controlling rubber production in the rubber tree *Hevea brasiliensis*, and Hitachi Zosen Corporation investigated the control of eucommia-rubber production in the hardy rubber tree *Eucommia ulmoides*. Tokiwa Phytochemical Co., Ltd focused their investigation on the identification of genes that form the secondary metabolites of the genus *Glycyrrhiza glycyrrichines*, which are used as alternative sweeteners in food and beverages. High-level production of carotenoids by transgenic plants was challenged by the Marine Biotechnology Institute until 2008, however the project was soon taken over by Kirin Holdings. Toyobo Co. Ltd worked on the production of hyaluronic acid in plant cells, while Plantech Research Institute worked until 2006 on the control of sterol production in plants.

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