2.3.15 Laboratory : Laboratory of Metabolic Science of Forest Plants and Microorganisms

Member :	Professor	Umezawa, Toshiaki, Dr. Agric. Sci.
	Assistant Professor	Hattori, Takefumi, Dr. Agric. Sci.
	Doctor's program	3
	Master's Program	2
	Other	1
	Post-Doctoral fellow	2

A. Research Activities (2009.4-2010.3)

A-1. Main Subjects

a) Integrated mechanisms for wood formation

It is obvious that we need to move from the fossil resource based society to the renewable resource dependant society. Among renewable biomass resources, it is wood biomass that the most abundantly accumulated is. Therefore, mechanisms for wood formation provide us the basic knowledge for tree biotechnology and cell-wall metabolic engineering. Lignin is one of the major components of plant cell wall, and much attention has been focused on the regulation of its biosynthesis from the standpoints of postharvest, cellulose-based wood processing for fiber, chemical, and bioethanol production. We are working on elucidating the integrated control mechanisms, including isolation of transcription factors, for the biosynthesis of lignin and other cell wall components by gene-coexpression network analysis and by comprehensive metabolite analysis.

b) Biosynthetic mechanisms for lignans produced by woody plants

Many lignans are isolated from various parts of plants, e.g. heartwoods, and known to have various biological activities. Lignans are optically active and their biosyntheses involve enantioselective processes. However, little has been known about biosynthetic mechanisms of lignans. We have been working on elucidating the stereochemical mechanisms for dibenzylbutyrolactone lignan biosyntheses and the biosynthetic mechanisms for antitumor lignans.

c) Biosynthetic mechanisms for norlignans produced by woody plants

Norlignans are compounds which cause heartwood coloration in important woods such as

Cryptomeria japonica and Chamaecyparis obtusa. However, little has been known about biosynthetic mechanisms of norlignans. We have isolated cDNAs encoding a norlignan synthase (hinokiresinol synthase, HRS) for the first time. We are working on elucidating the reaction mechanisms for HRS cagtalyzed reactions and its gene expression mechanisms.

d) Molecular breeding of trees suitable for sustainable societies

It is extremely important to establish systems for the sustainable production of renewable biomass recources, mostly wood biomass. In our laboratory, we are working on molecular breeding of trees which are suitable for sustainable societies with respect to commercial benefits such as improved resistance to wood-rotting fungi and high production of industrial raw materials and bioethanol based on knowledges of biosynthetic mechansisms for wood components.

e) Mechanisms for organic acid metabolism of wood-rotting fungi and ectomycorrhizal fungi

Biodegradation of wood components by wood-rotting (WR) fungi including white- and brown-rot basidiomycetes is important as a first process leading to humus production, which in turn contributes greatly to sustainable forest ecosystems. On the other hand, ectomycorrhizal (ECM) fungi, symbiont of some woody plants, serve as phosphate supplying biofertilizers for host plants, which help trees in growing well in forest. Oxalate excreted from WR and ECM fungi play a wide variety of roles in these process. The purpose of this study is to elucidate regulatory mechanisms for metabolism of organic acid including oxalate in WR and ECM fungi for comprehensive understanding of possible role of the two fungi in forest at molecular level.

A-2.Publications and presentations

a) Publications

Books

- Umezawa, T.
Metabolic engineering of lignin biosynthesis for second generation biofuel production (in Japanese)
In “Second generation biofuels -Fundamentals and Application-” (Eds. M. Ueda, E. Fukuzaki, and K. Yoshida), CMC, pp.103-111 (2009)

Original Papers

- Suzuki, S., Y. Suzuki, N. Yamamoto, T. Hattori, M. Sakamoto and T. Umezawa: High-throughput determination of thioglycolic acid lignin from rice. Plant Biotechnology 26; 337-340, 2009

- Sonoda, T., Koita, H., Nakamoto-Ohta, S., Kondo, K., Suezaki, T., Ishizaki, Y., Nagai, K., Iida, N., Sato, S., Umezawa, T., Hibino, T., Increasing fiber length and growth in transgenic tobacco plants containing a gene encoding the Eucalyptus camaldulensis HD-Zip class II transcription factor driven by a CaMV35S promoter, Plant Biotechnology, 26, 115-120 (2009)
- Yamamura, M., Suzuki, S., Hattori, T., Umezawa, T., Subunit composition of hinokiresinol synthase controls enantiomeric selectivity in hinokiresinol formation, Org. Biomol. Chem., 8, 1106-1110 (2010)
- Suzuki, S., Sakakibara, N., Li, L., Umezawa, T., Chiang, V.L., Profiling of phenylpropanoid monomers in developing xylem tissue of transgenic aspen (Populus tremuloides), J. Wood Sci., 56, 71-76 (2010)

Reviews

- Umezawa, T., The cinnamate/monolignol pathway, Phytochemistry Reviews, 9, 1-17 (2010)

b) Conference and seminar papers presented

- 60th Annual Meeting of Japan Wood Res. Soc. (Matsumoto): 5 papers
- The 27th Annual Meeting of the Japanese Society of Plant Cell and Molecular Biology (Fujisawa): 4 papers
- 54th Lignin Symposium, (Shizuoka): 1 paper
- The 459th Meeting of Japan Society for Biosciece, Biotechnology and Agrochemistry, Kansai, (Kyoto): 1 paper
- 49th Annual Phytochemical Society of North America Meeting and Symposia, Towson, USA: 1 paper
- RIKEN PSC Seminar, RIKEN, Yokohama: 1 paper
- 1st International Symposium of Indonesian Wood Research Society, Jakarta, Indonesia: 1 paper
- The 7th Meeting of Japan Applied Cell Biology Society, Kyoto: 1 paper

A-3.Off-campus activities

Membership in academic societies

- Umezawa, Toshiaki, D.Agric.Sci : The Japan Society for Bioscience, Biotechnology, and Agrochemistry, Kansai (councillor), The Japan Wood Research Society (Committee Member of Future Planning, Committee Member of International Academic Exchange, Program

Committee Member, Coordinator of Program Committee), International Academy of Wood Science (Fellow)

- Hattori, Takefumi, D.Agric.Sci : The Japan Wood Research Society (Editorial Board)

Research grants

1. Grants-in-aid for Scientific Research(KAKENHI)

- Scientific Research (B) (2) : Umezawa, Toshiaki, D.Agric.Sci : Molecular breeding of lignocellulosics based on metabolic network control
- Scientific Research (C): : Hattori, Takefumi, D.Agric.Sci : Elucidation of the mechanisms for solubilization of insoluble phosphate salt by mycorrhizal fungi.

2.Other Research Grants

- Institute of Sustainability Science, Kyoto University, Grant-in-Aid for Exploratory Research : Umezawa, Toshiaki, D.Agric.Sci : Systembiological analysis of Thujopsis dolabrata var. hondae
- A grant from the Ministry of Agriculture, Forestry and Fisheries of Japan (Genomics for Agricultural Innovation GMA-0006) : Umezawa, Toshiaki, D.Agric.Sci : Metabolic engineering of lignin biosynthesis
- R&D Project of Industrial Science and Technology Frontier Program supported by New Energy and Industrial Technology Development Organization : Umezawa, Toshiaki, D.Agric.Sci : Integrative data base construction of metabolisms and gene expression of energy plants

A-4.International cooperation and overseas activities

Membership in academic societies

- Toshiaki Umezawa, Dr. Agr. : Phytochemical Society of North America, Phytochemical Society of Europe, International Academy of Wood Science (Fellow), Lignobiotech (Organizing Committee)

International meetings(country,roles)

- Toshiaki Umezawa, Dr. Agr. : The 11th International Congress of Biotechnology in the Pulp and Paper Industry (Lignobiotech One) (program committee), 1st International Symposium of Indonesian Wood Research Society (Peer reviewer)

International joint research, overseas research surveys

- Metabolic engineering of phenylpropanoid biosynthesis (North Carolina State Univerity, USA)
- Biotechnology of Acacia mangium (Indonesian Institute of Sciences, Indonesia)

- Sustainable production and utilization of tropical plantation trees (Indonesian Institute of Sciences, Indonesia)

Visiting Research Scholars

- Researcher　1（Bangradesh）

B.Educational Activities(2009.4-2010.3)

B-1.On-campus teaching

a) Courses given

- Undergraduate level：Cyclic Utilization of Bio-based Resources of the Humanosphere (Umezawa), Introduction to mushroom science (Hattori), Muschroom science (Hattori), Plant biochemistry II (Umezawa), Renewable biomass resources (Umezawa)
- Graduate level：Metabolic Science of Forest Plants and Microorganisms (Advanced Course) (Umezawa), Experimental Course of Metabolic Science of Forest Plants and Microorganisms (Umezawa and Hattori), Seminar on Metabolic Science of Forest Plants and Microorganisms (Umezawa and Hattori), Science for Diagnostics and Control of Humanosphere (Umezawa)

B-2.Off-campus teaching etc.

Open lectures, etc.

- Toshiaki Umezawa: 2009 Kyoto University Open Seminar, Foresty, Earth, and Human, Research Institute for Sustainable Humanospere, Kyoto Univeristy, Division of Forest and Biomatgerials Science, Graduate School of Agriculture, Kyoto University, Organizing Committee, Lecturer

B-3.Overseas teaching

International students

- International students :　Doctral　1　(Indonesia)