HOW MICROORGANISMS ASSIST US IN OUR DAILY LIVES

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Japan is often said to be a country with few natural resources. But when it comes to microorganisms, our country is one of the most resource-rich countries in the world. Japan is extremely varied geographically; hence, an extremely wide variety of microorganisms can be found here. What’s more, these microorganisms undergo variations throughout the year as the season changes. The richness of our microbial resources is one of the reasons why in the field of applied microbiology, Japan is today one of the most advanced countries in the world. Our laboratory aims at discovering and developing the unique functions of microorganisms and creating industrial applications for them.

Leading the way to green chemistry
- for environment -

Nitrile hydratase, an enzyme discovered by our lab., efficiently performs hydration reactions with nitrile compounds. For example, it has been used since 1988 in an industrial process (with a capacity of 30,000 tons per year) for producing acrylamide from acrylonitrile. This marked the first example of the use of a biocatalyst in the production of commodity chemicals. It has been the subject of a great deal of attention worldwide as a successful example of environmentally friendly green chemistry. Many processes developed in our laboratory through collaboration with industries, are now used all over the world. They are called as microbial factories (see the map right).

Using microorganisms to produce edible oil
- for health -

Until recently no one realized that microorganisms are a promising source for abundant quantities of polyunsaturated fatty acids (PUFAs), which are used in medicines and functional food products. We discovered that a filamentous fungus, Mortierella alpina, produces prodigious quantities of oils containing PUFAs. With this discovery as a starting point, we conducted research employing methods from metabolic engineering and molecular biology for controlling cultures and breeding mutant strains. Finally, we achieved the ability to produce a variety of PUFAs containing selected oils in large quantities.
Keywords

Applied microbiology, microorganism, fermentation, screening, enzyme, microbial conversion, chiral compound, single cell oil, metabolic engineering, bio-process, environmental preservation, bio-fuel, functional food material, probiotics, plant growth enhancer

Recent Publications

β -aryl-β -amino acid aminotransferase from Variovorax sp. JH2 is useful for enantioselective β -phenylalanine production

Microbial oxidases catalyzing conversion of glycolaldehyde into glyoxal
Isobe, K., M. Kataoka, J. Ogawa, J. Hasegawa S. Shimizu

Cloning and overexpression of ketopantoic acid reductase gene from Stenotrophomonas maltophilia and its application to stereospecific production of D-pantoic acid
Si, D., N. Urano, S. Shimizu, M. Kataoka

L-Pantoyl lactone dehydrogenase from Rhodococcus erythropolis: Genetic analyses and application to the stereospecific oxidation of L-pantoyl lactone
Si, D., N. Urano, S. Nozaki, K. Honda, S. Shimizu, M. Kataoka

Characterization of Bacillus thuringiensis L-isoleucine dioxygenase toward the production of useful amino acids

Novel multi-component enzyme machinery in lactic acid bacteria catalyzing C=C double bond migration useful for conjugated fatty acid synthesis

A novel L-isoleucine metabolism in Bacillus thuringiensis generating (2S, 3R, 4S)-4-hydroxyisoleucine, a potential insulinotropic and anti-obesity amino acid

Linoleic acid isomerase in Lactobacillus plantarum AKU1009a proved to be a multi-component enzyme system requiring oxidoreduction cofactors
Kishino S., J. Ogawa, K. Yokozeki, S. Shimizu
Bioconversion of substituted naphthalenes and β-eudesmol with the cytochrome P450 BM 3 variant F87V

Improvement of aldehyde tolerance and sequential aldol condensation activity of deoxyriboaldolase via immobilization on interparticle pore type mesoporous silica
*Journal of Molecular Catalysis B: Enzymatic*, 68 (2), 181–186 (2011)

Genetic analysis around aminoalcohol dehydrogenase gene of *Rhodococcus erythropolis* MAK154: a putative GntR transcription factor in transcriptional regulation
Urano, N., M. Kataoka, T. Ishige, S. Kita, K. Sakamoto, S. Shimizu

Directed evolution of an aminoalcohol dehydrogenase for efficient production of double chiral aminoalcohols

Two laccase isoenzymes and a peroxidase of a commercial laccase–producing basidiomycete, *Trametes* sp. Ha1

Production of geranylgeraniol on overexpression of a prenyl diphosphate synthase fusion gene in *Saccharomyces cerevisiae*
Ohto, C., M. Muramatsu, S. Obata, E. Sakuradani, S. Shimizu

Cloning, sequencing and expression analysis of a gene encoding alcohol oxidase in *Paenibacillus* sp. AIU 311

Microbial production of conjugated γ-linolenic acid from γ-linolenic acid by *Lactobacillus plantarum* AKU 1009a
Kishino, S., J. Ogawa, A. Ando, K. Yokozeki, S. Shimizu

Metabolic engineering of *Escherichia coli* to produce (2S, 3R, 4S)-4-hydroxyisoleucine
Characterization of the ubiquinone binding site in alternative NADH–quinone oxidoreductase of *Saccharomyces cerevisiae* by photoaffinity labeling
Biochemistry., 49 (13), 2973–2980 (2010)

Oils, Microbial Production
Sakuradani, E., J. Ogawa, S. Kishino, A. Ando, K. Yokozeki, S. Shimizu

Advances in the production of various polyunsaturated fatty acids through oleaginous fungus *Mortierella alpina* breeding
Sakuradani, E

Arachidonic Acid–Producing *Mortierella alpina*: Creation of Mutants, Isolation of the Related Enzyme Genes, and Molecular Breeding
Sakuradani, E. A. Ando, J. Ogawa S. Shimizu

Aldehyde reductase
Shimizu, S., M. Kataoka

Lactonohydrolase
Shimizu, S., M. Kataoka

Pantothenic Acid and Related Compounds
Shimizu, S., M. Kataoka

Retrosynthetic production of 2′-deoxyribonucleoside from glucose, acetaldehyde, and nucleobase through multistep enzyme reactions
Ogawa, J., N. Horinouchi, S. Shimizu

Establishment of *Agrobacterium tumefaciens*–mediated transformation of an oleaginous fungus, *Mortierella alpina* 1S–4, and its application for eicosapentaenoic acid producer breeding
A novel L-isoleucine hydroxylating enzyme, L-isoleucine dioxygenase from *Bacillus thuringiensis*, produces (2S,3R,4S)-4-hydroxyisoleucine

Overproduction of geranylgeraniol by metabolically engineered *Saccharomyces cerevisiae*

Screening and characterization of a phosphopentomutase useful for enzymatic production of 2′-deoxyribonucleoside

Single cell oil production by *Mortierella alpina*
Sakuradani, E., S. Shimizu

Expression, purification, crystallization and preliminary X-ray analysis of conjugated polyketone reductase C2 (CPR–C2) from *Candida parapsilosis* IFO 0708

Crystallization and preliminary X-ray analysis of the NADPH-dependent 3-quinuclidinone reductase from *Rhodotorula rubra*

Overexpression of the gene encoding HMG–CoA reductase in *Saccharomyces cerevisiae* for production of prenyl alcohols
Ohto, C., M. Muramatsu, S. Obata, E. Sakuradani, S. Shimizu

Prenyl alcohol production by expression of exogenous isopentenyl diphosphate isomerase and farnesyl diphosphate synthase genes in *Escherichia coli*
Ohto, C., M. Muramatsu, S. Obata, E. Sakuradani, S. Shimizu

Production and characterization of alcohol oxidase from *Penicillium purpureascens* AIU 063
Isobe, K., T. Takahashi, J. Ogawa, M. Kataoka, S. Shimizu

Microbial production of conjugated fatty acids
Kishino, S., J. Ogawa, K. Yokozeki, S. Shimizu
*Lipid Technology*, 21(8–9), 177–181 (2009)