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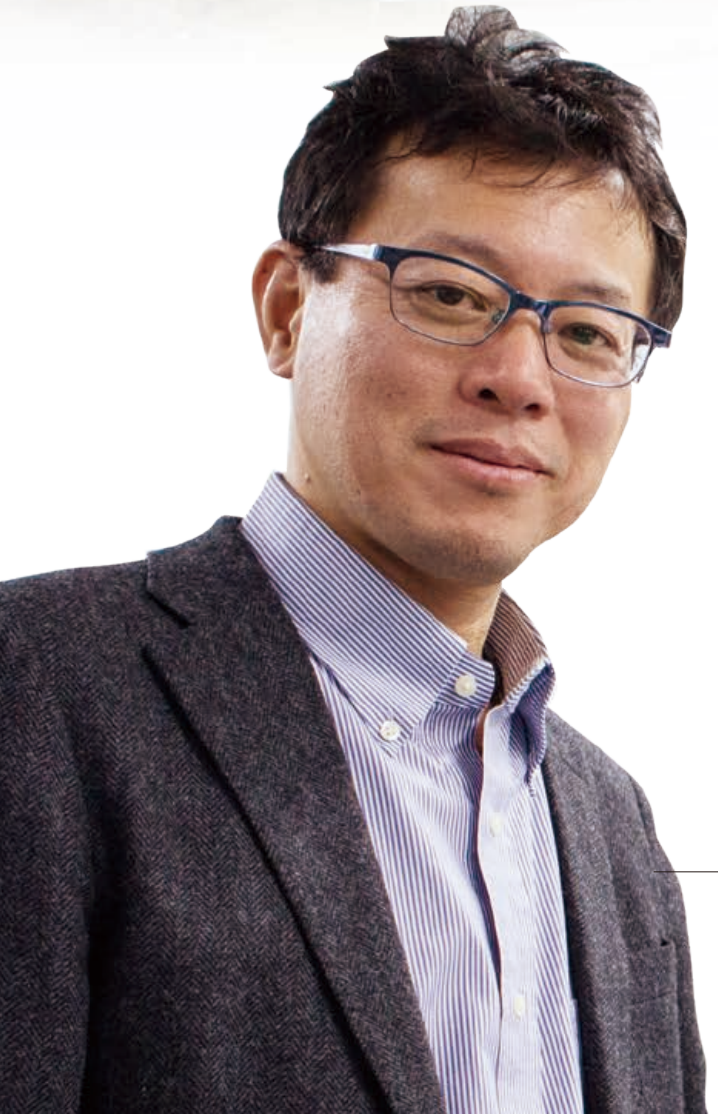
大阪大学
OSAKA UNIVERSITY

SHIMADZU

Osaka University Shimadzu
Omics Innovation Research Laboratories

WELCOME TO THE LABORATORY

In these laboratories, we aim to actively promote various kinds of collaborative research in order to tackle the issue of extending healthy and active lifespan, focused on the use of omics with metabolomics at its core. Until now, Prof. Fukusaki, who develops applications for metabolomics technology, and Prof. Matsuda, who focusses on data analysis, have been carrying out research together at the Osaka University and Shimadzu Analytical Innovation Research Laboratory. In moving to the new Omics Innovation Research Laboratories, they hope to up the pace of innovation to provide direct solutions to these types of societal problems.



Issues related to the environment, food supply, and energy are becoming commonplace in the 21st century. Now more than ever, there is a desire to use biotechnology as the key to building an environmentally-friendly and sustainable social system. Bioresource engineering is the study of biological resources at the core of biotechnology. It involves discovering techniques and technologies for evaluating their practicality, and developing applications for such resources.

With metabolomics as a core competency, we are working together with corporations to build the systems required for the next generation.

Associate Director of Osaka University and Shimadzu Omics Innovation Research Laboratories

Professor Fukusaki Eiichiro

Division of Science and Biotechnology,
Graduate School of Engineering, Osaka University

Osaka University and Shimadzu Analytical Innovation Research Laboratory

Industry on Campus

大阪大学 OSAKA UNIVERSITY + SHIMADZU

The Omics Innovation Research Laboratories will be a base for corporate research within Osaka University, and will act as a hub for the expansion of multi-faceted industry-academia research activities. Osaka University will be able to share and exchange information, technology, personnel and facilities with companies in a common research space, facilitating the incorporation of research results into industry, and aiming to cultivate a high level of research and staff expertise on both sides.

With mass spectrometers as a core product line, Shimadzu Corporation is committed to helping resolve the growing number of social needs and issues related to mass spectrometers. By working with Osaka University to solve new and evolving societal problems, we are committed to giving back to society.

In today's complex society, scientific advances and the development of innovative cutting-edge technologies are changing the way in which research organizations and universities work with companies to deliver solutions that make a real difference.

Osaka University is actively promoting "Open Innovation". As a result, we have opened these innovative joint research laboratories between Shimadzu and Osaka University, where we aim to solve problems and search for innovative breakthroughs.

The joint research laboratories will use metabolomics as a core technology and apply metabolomics in fields such as medical research, medical treatment, and pharmaceutical sciences, as well as food and energy.

Director of Osaka University and Shimadzu
Omics Innovation Research Laboratories
Specially Appointed Professor Junko Iida

Shimadzu Corporation
Analytical & Measuring Instruments Division Senior Manager

Research and Development of A Data Analysis Platform Using Mass Spectrometry

Metabolomics is a technique for comprehensively investigating the phenomena associated with life in living organisms by detecting and analyzing all the varied metabolites generated from biological activities. Metabolites represent information about the last step in the process of genetic expression. Because they are closer to the expression of living organisms than genes and proteins, they more directly reflect the steadily changing phenomena of activities associated with life. Consequently, metabolite applications are widely used for diagnosis, biomarker discovery, and drug discovery research. In recent years, metabolomics has been used in the food industry to improve taste and quality and to develop functional foods. It is also used in the biotechnology industry to improve fermentation and biofuel productivity.

On the other hand, metabolomics, which involves a mixture of life sciences, organic chemistry, analytical chemistry, and information science, is a new field that is still in its infancy in terms of developing technologies and operating methods. The Osaka University and Shimadzu Omics Innovation Research Laboratories were established to research and develop applications that use pretreatment, analytical, or data analysis methods essential for metabolomics, including a newly developed data analysis platform.

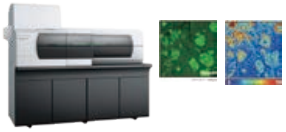
Product portfolio supports efficient and effective metabolomics from quantitative metabolomics to multi-omics analysis

Mass Spectrometers

GC-MS/MS

Q-TOF LC/MS

LC-MS/MS

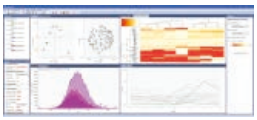


Imaging Mass Microscope

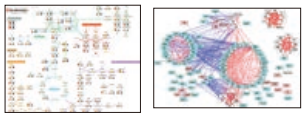
Database (Method Packages)

- Primary metabolites
- Metabolic enzymes
- D/L amino acids
- Cell culture profiling
- Lipid mediators
- Phospholipid profiling
- Short chain fatty acids
- Bile acids

Software



Multivariate Analysis



Visualization of Data

Application Fields

Medical Research

- Elucidation of physiological and pathological mechanisms
- Disease biomarker discovery
- Drug discovery support and toxicity evaluation

Plant and Food

- Analysis of flavor and fragrance components
- Functional evaluation
- Food authenticity and quality control

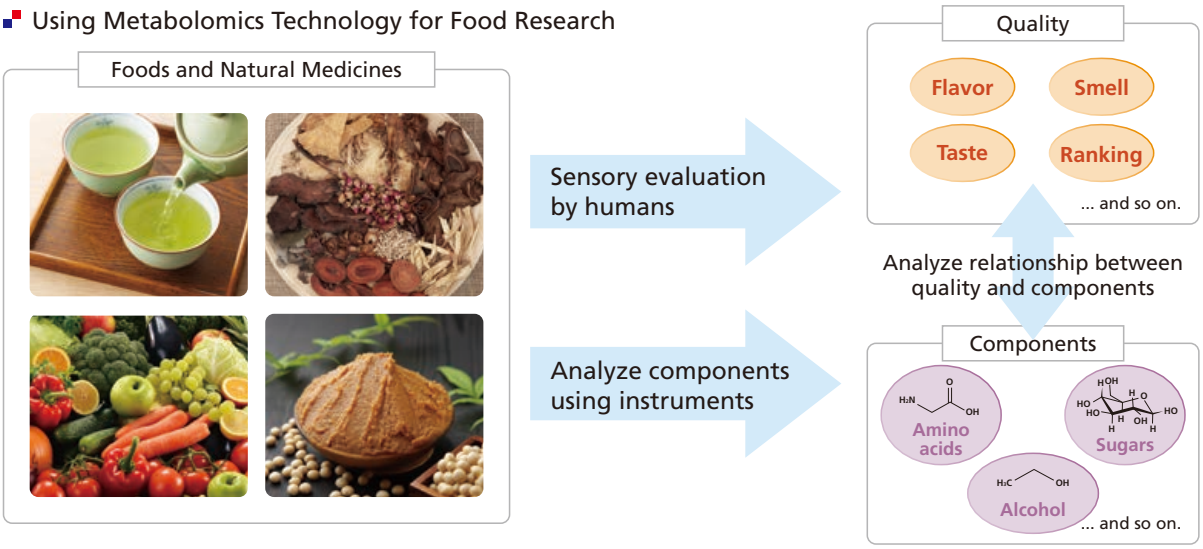
Biotechnology

- Improvement and optimization of fermentation process
- Biofuel productivity improvement

Using Metabolomic Profiling for Food Research

In the food industry, metabolomics is used for a wide range of applications, such as to improve the taste or smell of foods, develop new functional foods, improve the quality of fermented foods, or develop more sophisticated technologies for raw materials, processing, storage, and distribution. Research activities address issues with advanced technologies and techniques, such as how to pretreat samples, how to measure samples with analytical instruments, how to analyze data, and how to analyze the relationship between quality and components. The aim of the Omics Innovation Research Laboratories is to promote the widespread use of metabolomics in the food industry by developing a spectrometer-based data analysis platform and researching the use of the platform to improve and control the quality of foods.

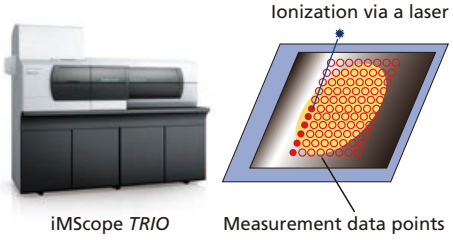
Using Metabolomics Technology for Food Research



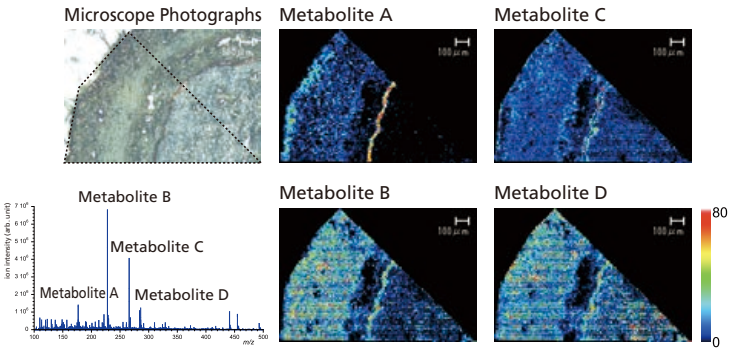
Applied Research Using Imaging Mass Spectrometry

With normal metabolome measurements, it is impossible to obtain detailed spatial information about the interior of a sample. Using an imaging mass microscope (iMScope *TRIO*) for the surface analysis of the target sample provides information on spatial distribution, i.e. what the metabolites are, where they are, and in what quantity, a technique known as imaging metabolomics. If ionization has occurred on the sample surface, the entirety can then be visualized. Accordingly, there is no limit to the application scope of this technology. In this research course, we are developing techniques for visualizing samples and molecules that are very difficult to see with typical imaging methods.

Basic Principles of Imaging Mass Spectrometry and Measurement Example



Ion Production and Detection Using a UV Laser Via the iMScope *TRIO*



Direct Mass Spectrometry and the Ion Intensity Distribution on the Sample Surface

This product may not be sold in your country. Please contact us to check the availability of this product in your country.

Contributes to Various Fields Such as Fermented Foods, Clinical and Antiaging Research

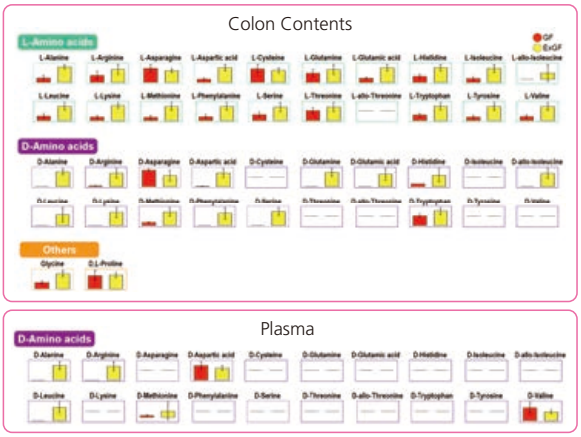
The 20 amino acids that form the structure of proteins exist as mirror image optical isomers: the D-amino acids (D-form) and the L-amino acids (L-form) (chiral amino acids). The L-form of amino acids exists in large quantities in foods and in the body as the structural elements of proteins and as nutritional sources. As food ripens or the body ages, a portion of these is known to change to the D-form. Assessing the amounts of the D- and L-forms is a focus of interest in a variety of areas. Examples include the evaluation of fermented foods, physiological functional analysis of the cranial nerve system, searches for biomarkers, and the health and beauty fields. However, with conventional chiral amino acid analysis, it is necessary to perform derivatization or use very long run times.

With the LC/MS/MS Method Package for D/L Amino Acids, derivatization is not necessary, and high-sensitivity analysis can be performed in a short period of time, bringing efficiency to the chiral separations.

List of Registered Amino Acids		
D/L-Alanine	D/L-Histidine	D/L-Serine
D/L-Arginine	D/L-Isoleucine	D/L-Threonine
D/L-Asparagine	D/L-allo-Isoleucine	D/L-allo-Threonine
D/L-Aspartic acid	D/L-Leucine	D/L-Tryptophane
D/L-Cysteine	D/L-Lysine	D/L-Tyrosine
D/L-Glutamine	D/L-Methionine	D/L-Valine
D/L-Glutamic acid	D/L-Phenylalanine	
Glycine	DL-Proline	

Analysis example: D/L amino acid analysis in colon contents and plasma

A comprehensive analysis of chiral amino acids in mouse colon contents and plasma was conducted to investigate D-amino acids produced by intestinal flora. Concentrations of 12 D-amino acids were significantly higher in normal colonized mice (Ex-GF) than in sterile mice (GF), which indicates that these D-amino acids are produced by the intestinal flora.

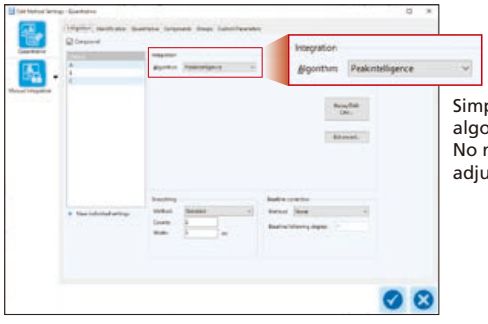


* The analysis method of this method package was developed based on the research results of the Fukusaki Lab, Division of Science and Biotechnology, Graduate School of Engineering, Osaka University. Reference: Nakano, Y., Konya, Y., Taniguchi, M., Fukusaki, E., Journal of Bioscience and Bioengineering, 123, 134–138 (2016)

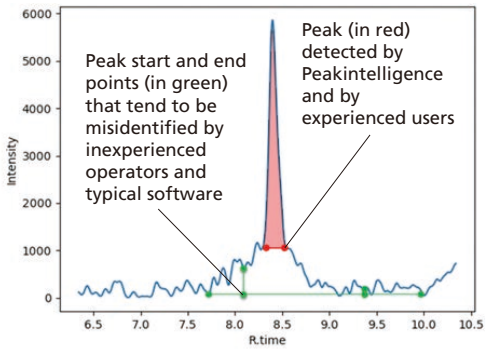
Simplifies Data Analysis and Enables a More Productive Laboratory

As mass spectrometers have evolved, the amount of data obtained from them has become massive. As a result, when analyzing the data, the procedure known as peak picking has become a bottleneck because it requires visual confirmation of multiple peaks. Further, the accuracy of data analysis varies from operator to operator and the falsification of data is a possibility. At research sites in the life sciences dealing with medical treatments and drug discovery, for example, the automation of high-accuracy peak picking, which would eliminate dependency on operator expertise, has been a highly sought-after development.

Peakintelligence software for LC-MS/MS is a algorithm incorporating artificial intelligence (AI) assistance to search for chromatography peaks. Having learnt peak processing skills from experienced users, the AI can process data with the same skill level. The software replaces the conventional process of visual confirmation by the operator, thereby reforming the work environment at research sites.



Simply select the algorithm to use.
No need for parameter adjustment!

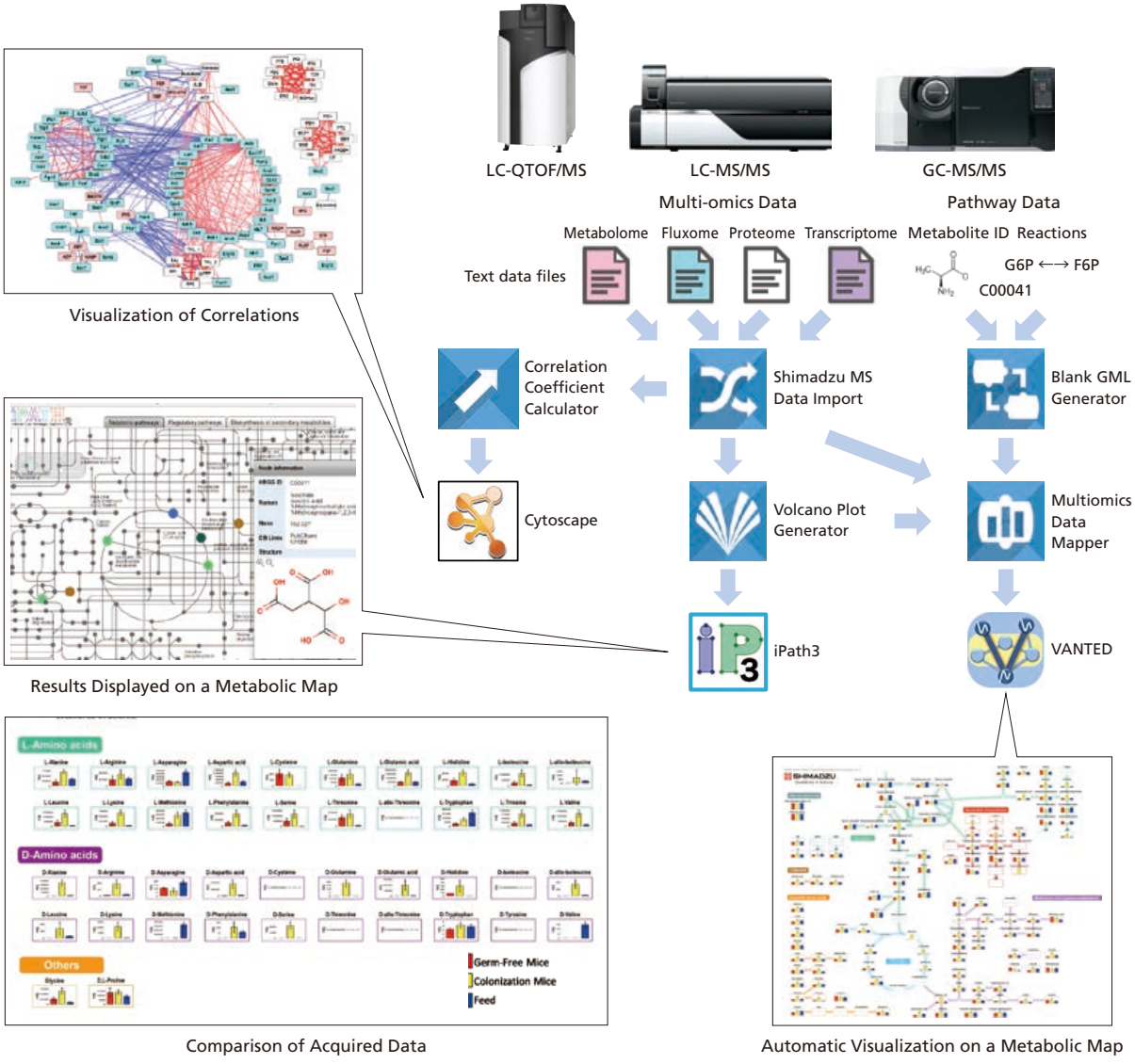


* R&D for this product was carried out as a collaboration between Shimadzu Corporation and Fujitsu Ltd.

Support for Drug Discovery, Bioengineering and Other Life Science Research Applications

Multi-omics is a cutting-edge research area in the field of life sciences. It involves the integrated analysis of changes in genes, proteins, metabolites and other substances, towards a holistic elucidation of biological activities at cellular level. Multi-omics is expected to be useful in a variety of fields such as drug discovery, diagnostics, and biofuel research. Mass spectrometers are indispensable for multi-omics research. In recent years, with the emergence of ultra-fast mass spectrometers, the amount of data that can be obtained has grown enormously. As a result, the data analysis process has become a research bottleneck. Creating charts from quantitative trend data on each metabolites and proteins and rendering the results visible on a metabolic map, takes over ten hours even for experienced analysts.

The Multi-omics Analysis Package, developed for metabolic engineering applications, provides the ability to automatically generate metabolic maps and perform a variety of data analysis for the vast data generated in fields like metabolomics, proteomics and flux analysis. Dramatically reduces the amount of work required for bottleneck processes of analyzing and visualizing data, such as displaying data on a metabolic map and analyzing correlations.



The Multi-omics Analysis Package is based on software tools (called gadgets) that have been released on the GARUDA™ platform – an open research platform, developed by the GARUDA Alliance led by The Systems Biology Institute, Japan (SBI).

Data Analysis Tools Used in the Multi-omics Analysis Package

Volcano Plot
A tool that combines a t-test (statistically significant difference) and a fold-change (Example: Difference in mean value such as 2 times or 1/2) to visualize the differences between the two groups.

iPath
Data analysis tool can be used for visualization of diverse metabolic pathways or data mapping and customization.

VANTED
Tool maintained at University of Konstanz, Germany, for visualization and analysis of networks across different data sets.

Cytoscape
Bioinformatics tool used to visualize metabolic pathways, to integrate gene expression profiles with related data, and so on.

* GARUDA is a trademark of The Systems Biology Institute.

Articles on Metabolomics

In addition to this brochure, a list of articles related to metabolomics is available on our website.

https://www.shimadzu.com/an/industry/pharmaceuticallifescience/n9j25k00000nga0n.html

Applications in Various Organizations

- Records
  - S&B Foods Inc.
  - TSUMURA & CO.
  - Hakutsuru Sake Brewing Co., Ltd.
  - Kyodo Milk Industry Co., Ltd.
  - Keio University
  - National University of Singapore, etc.

Collaborative Research is Expanding Worldwide

As part of our collaborative research activities, we are actively promoting cooperation between industry and academia overseas through joint workshops and other events.

- Thailand (Participation by Mahidol University, Kasetsart University, etc., 2015)
- Indonesia (Cohosted with Institut Teknologi Bandung, 2016)
- United Kingdom (Cohosted with the University of Manchester, 2019)

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https://www.shimadzu.com/labcamp/