Volume 28

Enzyme Wave

2025

AMANO
Amano Enzyme

培養肉未来創造
コンソーシアム
Consortium for Future Innovation by Cultured Meat

Enzyme Wave vol.28

CONTENTS

Trend

Latest Trends in Cultured Meat: Consortium for Future Innovation by Cultured Meat

Authors

Michiya Matsusaki

Professor, Joint Research Laboratory for Social Implementation of Cultured Meat, Graduate School of Engineering, Osaka University

[Brief background]

Michiya Matsusaki was born in Kagoshima, Japan in 1976. He received his Ph.D. degree in 2003 from Kagoshima University. He started his academic career as a Postdoctoral fellow at Osaka University in 2003. He was a visiting scientist at Lund University in 2004. In 2006, he joined the Department of Applied Chemistry in the Graduate School of Engineering at Osaka University as an Assistant Professor. He was promoted to Associate Professor in 2015 and to full Professor in 2019. He was a JST-PRESTO researcher (Concurrent position) from 2008 to 2011 and from 2015 to 2019. He was awarded 21 awards including Osaka Science Award and the Young Scientist's Prize by MEXT. His research interest is biomaterials and tissue engineering for regenerative medicine and pharmaceutical applications. His current publication number is 215 and h-index is 47.

Kazumasa Nodake

Visiting researcher, Joint Research Laboratory for Social Implementation of Cultured Meat, Graduate School of Engineering, Osaka University

Michiya Matsusaki

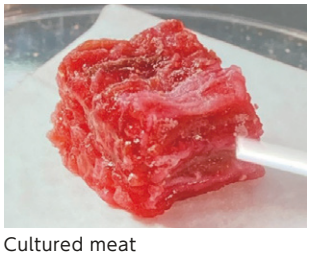
Kazumasa Nodake

In 2021, a team led by Professor Matsusaki of Graduate School of Engineering, Osaka University developed "3D-printed Kintaro candy technology" that allows for the reproduction of the complex structure of meat. The technology works by 3D printing different types of fibrous tissue, such as muscle, fat, and blood vessel, and then integrating them together like intricately designed rock candy (Nature Communications 12:5059). This technology not only allows for the reproduction of the characteristic marbling of Wagyu beef but also makes it possible to adjust the amount of muscle and fat of a piece of meat.

With the goal of further developing this technology and supporting its real-world use, Graduate School of Engineering, Osaka University, Shimadzu Corporation, Itoham Yonekyu Holdings Inc., TOPPAN Holdings Inc., and SIGMAXYZ Inc. formed an operating partnership in March 2023 and established the Consortium for Future Innovation by Cultured Meat and (ZACROS Corporation joined in May 2024). With facilities such as the Joint Research Laboratory for Social Implementation of Cultured Meat (established by Itoham Yonekyu Holdings and TOPPAN Holdings), the Joint Research Laboratory (ZACROS) for Social Implementation of Bio-Manufacturing (established by ZACROS), and the Osaka University - Shimadzu Analytical Innovation Research Laboratory on the Osaka University Suita Campus, the consortium is doing work that transcends that of any one company.

In addition to the operating partners, the consortium is also made up of R&D partners and communications partners. The former conducts joint research in specific technical fields while the latter is responsible for promoting cultured meat-related technologies and products through information sharing. So far, seventeen companies have joined the consortium (as of January 2025), however, further participation from a wider range of fields is expected.

The consortium is supporting the Osaka Healthcare Pavilion: Nest for Reborn at Expo 2025 Osaka, Kansai, Japan, and plans to exhibit cultured meats and automated cultured meat manufacturing equipment that uses 3D bioprinting technology. By exhibiting at the expo, we hope to promote awareness for cultured meat as a food of the future that will reduce environmental impact and contribute to solving the global protein shortage.



Cultured meat

培養肉未来創造
コンソーシアム
Consortium for Future Innovation by Cultured Meat

Consortium logo

Consortium establishment ceremony

Column

A Case for the Importance of Liberal Arts Today

Author

Seiichi Kondo

[Brief background]
Born in Kanagawa Prefecture in 1946. Kondo graduated from the Department of Liberal Arts at the University of Tokyo in 1971. He joined the Ministry of Foreign Affairs of Japan in 1972. He became the Deputy Secretary-General of the Organisation for Economic Co-operation and Development (OECD) in 1999. After serving as Ambassador Extraordinary and Plenipotentiary and Permanent Delegate of Japan to the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 2006 and Ambassador Extraordinary and Plenipotentiary to Denmark in 2008, he was appointed Commissioner for Cultural Affairs from 2010 to 2013. **Current positions:** President of the Professional Institute of International Fashion, Chairman of the Yokohama Arts Foundation, Co-Representative of the Jin-Bun-Chi Forum, and Director of the Shizenkan Center for Liberal Arts and Leadership, and others. **Publications:** "Seiichi Kondo: Complete Works I, II, III, VI," Kamakura Shunjusha, among many others.

In the "Biotechnology in Japan" series, we share contributions on Japanese culture and traditions. In this sixth installment, Seiichi Kondo writes about why liberal arts are necessary in this modern world of advanced science, based on his years of experience in official roles at the forefront of Japanese cultural diplomacy and a subsequent post as Commissioner for Cultural Affairs.

The concept of "liberal arts" used to mean the two years of general education students spend at university before entering their major. Recently, however, the concept is gaining renewed attention as the number of specialized academic disciplines continue to increase and our lives become ever more permeated by advanced technologies such as artificial intelligence. This is because the liberal arts are considered important for mastering small but particular areas of expertise or skill to ensure that they can contribute to the betterment of humankind from a broader perspective. It is regarded as something needed for living a fulfilled life, in both one's work and private life.

However, that begs the larger question, what exactly are liberal arts?

This concept originated in ancient Greece and became widely discussed at universities in medieval Europe. In a society where slavery was the norm, liberal arts were considered necessary for those who wanted to live as a free man. The "seven liberal arts" were the subjects thought to best exemplify the field those days. They were grammar, dialectic, rhetoric, arithmetic, geometry, astronomy, and music.

What is important when discussing liberal arts today, however, is not which specific subjects one picks up, but rather upholding a commitment to free thinking and action. Our thoughts and actions ought not to be swayed by particular areas of expertise or bound by external constraints. In modern-day society, where there is no slavery and where we can study anything we like, you may be wondering why we are talking about liberal arts at all.

However, although we may seem free, we must pay attention to how we are unconsciously being kept enslaved by prejudices and fixed ideas. Prime examples of this are conviction that the economy must grow infinitely, and optimism that science and technology are all powerful and will eventually solve all the problems that arise during that process. There is also the assumption that in order to win in business, it is important to increase efficiency and achieve results in the short term, and that such things must be quantified and evaluated using such criterion as price and time performance. Behind this are the ideas of modern Western rationalism.

It is true that science and technology, as well as economic growth, have made a great contribution to the achievements of civilization. But as a result, we humans have become arrogant in thinking that we are the masters of the planet. It is clear to see

that not only has this led to the worsening of climate change and the destruction of ecosystems, but it has also created disparity and division within our own societies, and brought the possibility of a great catastrophe through war before us. Even so, we are unable to find a fundamental solution to these issues, even with our vaunted science and technology. Instead, we continue to turn a blind eye to the worsening state of the world and settle for stopgap measures.

Liberal arts can provide useful hints for eliminating this arrogance people in modern-day society have fallen prey to and for regaining the freedom to think about and implement long-term policies. It taps into not only the findings from analytics of the natural sciences, social sciences, and humanities but also the intellectual activities—including the classics, history, culture and the arts—that humans have created over the centuries.

It is impossible for a single person to be an expert in all fields. However, while pursuing further knowledge in one's own field, people can familiarize themselves with the classics, history, culture and the art, as well as engage in free, creative discussions with experts in other fields. Such pursuits then allow us to gain unexpected insights and inspiration.

The Bible seems to teache us to reflect on the fact that humanity's failure to properly use the science and technology it acquired by eating the "forbidden fruit" has led to a divergence from nature, or in other words, to the "expulsion from paradise." The Tower of Babel is another story that warns against human arrogance. The famous opening sentence of the Buddhist reflection on solitude, Hojoki, touches on the nature of life that science has yet to unravel (*).

No matter how busy we may be, if we are able to remain curious about things outside our fields of expertise, engage in discussions with other experts, familiarize ourselves with the classics and history, enjoy our hobbies, and create opportunities to stay in touch with nature, both the individual and society as a whole will naturally benefit from the power of the liberal arts.

* *The flow of the river is incessant and yet its water is never the same, while along the still pools foam floats, now vanishing, now forming, never staying long: So it is with men and women and all their dwelling places here on earth.*
Kamono-chomei Hojhoki (Iwanamibunko)

The Garden of Eden with the Fall of Man

The Tower of Babel

Symposium

The 2nd Asia-Pacific Enzyme Technology Symposium - jointly organized with The 2024 HUS Symposium on Life Science and Biotechnology

On October 25, 2024, the 2nd Asia-Pacific Enzyme Technology Symposium – jointly organized with The 2024 HUS Symposium on Life Science and Biotechnology was held in Hanoi, Vietnam, in collaboration with the Vietnam National University Hanoi University of Science (VNU-HUS). The aim of the symposium was to promote the development of science and technology related to enzyme technologies and biotechnology in the Asia-Pacific region, as well as the development of a circular economy.

The symposium featured 13 lectures from four fields: Advanced technology, industry, food and agriculture, and environmental technology. Posters by VNU-HUS students were also displayed for a total of 34 research presentations. Approximately 30 Vietnamese companies and 234 people from universities and research institutions were in attendance. Many passionate and lively discussions could be heard, further reaffirming the interest in the potential of enzymes and biotechnology.

At this year's symposium, we were honored to be joined by Mr. Duy, Deputy Minister of the Ministry of Science and Technology of Vietnam, and Mr. Ishikawa, Deputy Head of Mission of the Embassy of Japan in Vietnam. Southeast Asia's ASEAN members have achieved remarkable economic development and each possesses a wealth of biodiversity and superb talent. We believe that holding the symposium in Vietnam, one of the ASEAN countries, will help to promote an exchange of technologies between Japan and Vietnam going forward.

Amano Enzyme will continue to hold symposiums in the Asia-Pacific region and make every effort to further develop the industry and achieve a sustainable society through enzyme technology.

Venue photo

Group photo

Session 1: Advanced Technology		
Kiyohiko Igarashi	The University of Tokyo	70 years of debate on enzymatic degradation of cellulose
Nguyen Thi Hong Loan	VNU-HUS	Proteases: an old or new topic for research and application
Pimchai Chaiyen	VISTEC	Enzyme Catalysis and Engineering for Green Synthesis and Food Safety
Session 2: Industry		
Tomohiro Fujita	CHITOSE GROUP	CHITOSE's Strategies and Implementation in the Bioeconomy Trend
Kazuhiro Furukawa	Amano Enzyme Asia Pacific Co.,Ltd.	World industrial enzymes and Amano specialty enzymes for the circular society
Session 3: Food & Agriculture		
Francisco Elegado	University of the Philippines Los Baños	Linamarase-producing lactic acid bacteria for the reduction of toxic cyanogenic glycosides in cassava and bamboo shoots
Siti Aishah Hasbullah	The National University of Malaysia	Development of Biosensor Technology for Environmental and Food Monitoring
Tran Van Tuan	VNU-HUS	Development of food-grade expression systems for recombinant enzyme/protein production in filamentous fungi and medicinal mushrooms
Md. Mahabubur Rahman Talukder	A*STAR	Non-GMO Fungus-Derived Cellulolytic Enzyme Cocktails for Valorizing Agri-Food Sidestreams into Prebiotic, Bioactive Protein, and Functional Lipid
Session 4: Environment & Technology		
Do Thi Huyen	Vietnam Academy of Science and Technology	Application of Metagenomic technology in mining lignocellulolytic enzymes and understanding the role of bacterial communities
Kazuhito Fujiyama	Osaka University	Lipid production using a basidiomycetous yeast, Rhodotorula toruloides
Ahmad Fathoni	BRIN	Fostering an Advanced Biodiversity Utilization Through Structural Biology Collaboration Platform in Indonesia
Nguyen Duc Quang Tien	Hue University	Mutation-enabled thermal stability and functionality boost of expressed recombinant 42 kDa chitinase from Nicotiana benthamiana

Report

AI & Fermentation Technology

Fermentation is a process that utilizes microorganisms to produce materials that are good for humans. Companies that produce such materials using fermentation need skilled engineers who can expertly design and manage the microbial cultivation. These engineers rely on information from sensors in the cultivation tanks, analysis, and their own senses to resolve issues that may arise. However, there remain some issues that have yet to be resolved.

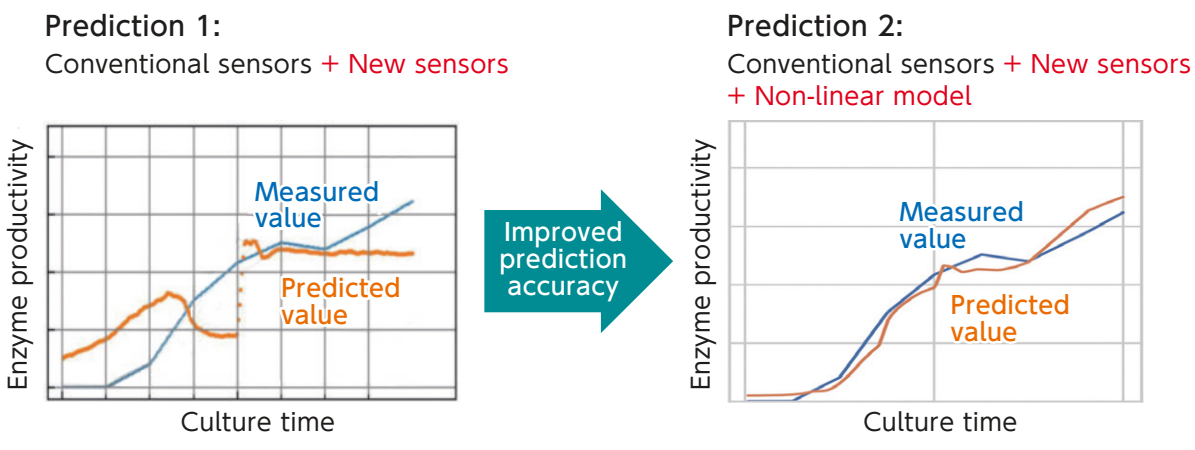
The first is that the methods for standardizing cultivation differ between engineers due to the reliance on individual knowledge and experience. The second is that even skilled engineers require time to identify the causes of poor cultivation and optimize the process. The third is that when creating cultivation at scale, engineers may not fully understand how to use all of the equipment required, resulting in low yields.

In order to address these issues, Amano Enzyme and Chitose Laboratory collaborated in the NEDO project* to create a system for visualizing enzyme productivity in real time. The project was comprised of five steps: (1) Obtaining culture data using Amano Enzyme's enzyme-producing bacteria, (2) processing said data, (3) developing an AI prediction model, (4) inference, and (5) control testing. In addition to conventional sensors (pH, dissolved oxygen, etc.), new sensors for real-time monitoring of culture conditions (potential, color, smell, wavelength, etc.) developed by Chitose Laboratory specifically for AI learning were used to better follow the progress of the culture.

Our findings showed that the accuracy of the AI prediction model was greatly improved when the data set from the new sensor was added to the data from the conventional sensor. Furthermore, by introducing a non-linear model, the actual enzyme productivity values and the predicted values from the AI prediction model were almost identical (Figure 1). For the production of enzymes using microorganisms, we successfully built an AI prediction model that allows the visualization of enzyme productivity in real time.

As a result of this project, it will be possible to try and achieve automatic operation via AI that would show the conditions of the culture in factories in real time and compare with past data to control the culture appropriately. Amano Enzyme hopes to continue utilizing a wide variety of microorganisms, as well as advanced technologies, such as AI, and traditional technologies, such as breeding and cultivation, to create products with new, never-seen-before value.

Figure 1: Newly built AI prediction model that predicts enzyme productivity



* The results of this study were obtained as part of a project consigned by NEDO, "Bio-Based Product Production Technology Development for the Acceleration of Carbon Recycling Realization."

Report

Controlling Sweetness in Plant-Based Milk Substitutes Using Enzymes

Due to the rise in environmental awareness and health consciousness, plant-based milk substitutes are growing in popularity around the globe. Currently, there are three main types of milk substitutes. These are: those derived from beans, such as soy milk and pea milk; those derived from grains, such as oat milk and rice milk; and those derived from seeds, such as almond milk and coconut milk (or so-called nut milks). Of these, consumption of oat milk has been growing especially rapidly in recent years, particularly in Europe and the United States. In addition to being a good alternative for people who are lactose intolerant or have a soy allergy, oat milk also contains nutrients such as B vitamins and dietary fiber, and lacks the strong bean-like flavor that some other types of milk have, making it more pleasant to drink—all of which contributes to oat milk's growing popularity.

Generally, oat milk is made by grinding oats, adding water, heating to gelatinize the starch, then adding alpha-amylase to partially break down the starch and reduce the viscosity of the mixture, turning it into a liquid. While adding only alpha-amylase reduces the viscosity, it results in a milk with few low-molecular-weight sugars that form the basis of sweetness, making it not very sweet. As the milk would be unpleasant to drink with such a low level of sweetness, saccharification enzymes are used to add sweetness. There are multiple types of saccharification enzymes (Figure 1), including glucoamylase, which isolates sugars in glucose; β-amylase, which isolates sugars in maltose; maltotriohydrolase, which produces maltotriose; and transglucosidase, which produces isomaltooligosaccharide through glycosyl transfer. The sugars produced by these enzymes each have a different type of sweetness (Figure 2). Glucose is used in products such as candy and has a pleasant sweetness, maltose has a mild sweetness like that of baked sweet potatoes, maltotriose has a clean, clear sweetness, and isomaltooligosaccharide has a complex sweetness like that of mirin rice wine. By appropriately using different saccharification enzymes, it is possible to produce oat milk with a variety of different flavors.

While we used oat milk as the example here, this technology can also be applied to other grain-derived milk substitutes as well, such as rice milk. We are also in the midst of developing technology to similarly add value to non-grain-derived milk substitutes, such as bean and seed milks, as well. At Amano Enzyme, we work tirelessly to enhance the value of foods using the power of enzymes.

Figure 1: Responses of different saccharification enzymes

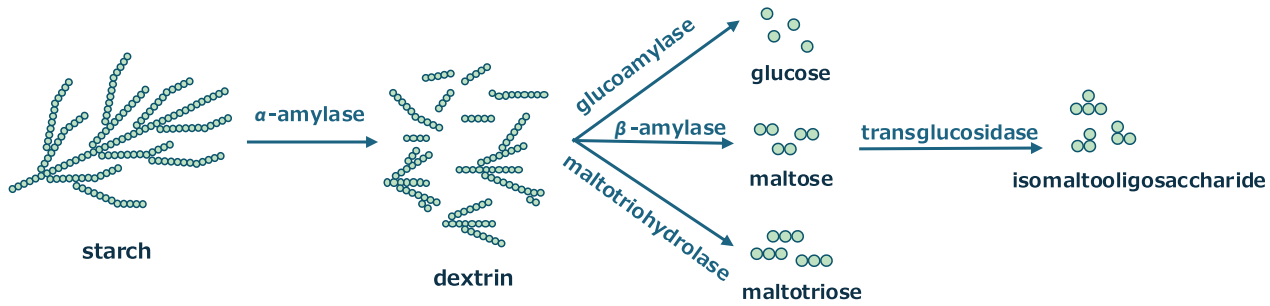
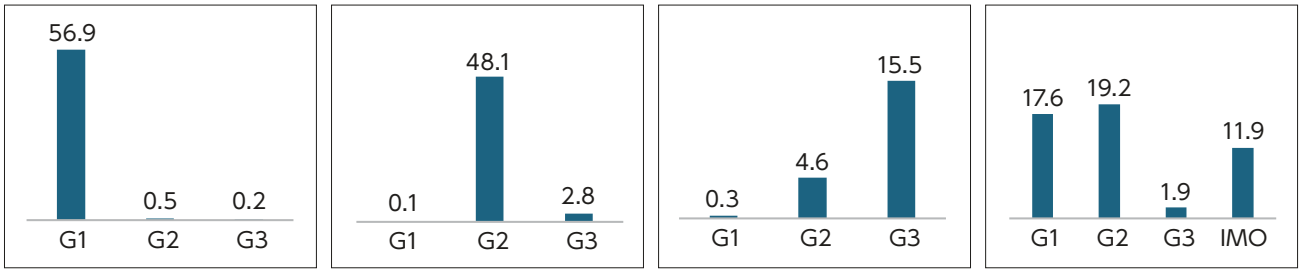


Figure 2: Sugar composition in oat milk by saccharification enzyme

G1:glucose、**G2**:maltose、**G3**:maltotriose、**IMO**:isomaltooligosaccharide(g/L)



Symposium

The 5th Japan-China Symposium on Biocatalysis and Biotransformation

Amano Enzyme holds the Japan-China Symposium on Biocatalysis and Biotransformation every other year in collaboration with Zhejiang University in China. The symposium aims to connect Chinese companies interested in enzyme-based sustainable industrial processes with professors from Japanese and Chinese universities and public research institutions conducting cutting-edge research in the field, and to contribute to the development of the field.

Marking 10 years, the fifth symposium was held on November 16, 2024, in Hangzhou, Zhejiang Province, China. This year's symposium was the first to be held entirely in person since the second symposium in 2018, due to the impact of the COVID-19 pandemic. Approximately 130 people from business and academia were in attendance. A total of 11 lectures were given (see below), including two guest speakers from Japan, Professor Hiroshi Shimizu (Osaka University) and Professor Michihiko Kobayashi (University of Tsukuba). The lectures covered a wide range of topics, but primarily focused on the results of studies on the functional modification of enzymes using AI technology and their practical application. The insightful lectures spurred lively discussions with the attendees. To commemorate the 10th year of the symposium, a special round-table discussion was held. Representatives from Japanese and Chinese companies and academia joined to discuss recent trends in enzyme-based processes, as well as future prospects.

Green chemistry using enzymes will be an essential technology in the realization of a sustainable society. As a Japanese enzyme producer, we hope to continue to contribute to the development of the field.

Group photo


Round-table discussion


Symposium

Lecture topics

Hiroshi Shimizu	Osaka Univ.	*In silico* design and experimental analysis of metabolic pathways for microbial bioproduction of valuable compounds
Qi Wu	Zhejiang Univ.	Directed evolution and application of stereoselective enzymes for precision synthesis
Michihiko Kobayashi	Univ. of Tsukuba	Microbial enzymes and metabolism: Traditional biotechnological research
Special program for 5th anniversary conference – A review of progress in biocatalysis and biotransformation, and prospects for the future		
Kazunori Yoshida	Amano Enzyme Inc.	Application of microdroplet technology to industrial enzyme development
Jing Wu	Jiangnan Univ.	Creating new functional enzyme based on enzyme promiscuity
Zhiqi Cong	Chinese Academy of Sciences	Rational design of unnatural P450 peroxizymes for catalytic applications
Yajie Wang	Westlake Univ.	Expanding the repertories of biocatalysis by AI-BT-Chem
Hui Chen	Shandong Univ.	The biotransformation of inert chemicals driven by electrical energy
Xiaoqing Mu	Jiangnan Univ.	Molecular modification of α-amino acid dehydrogenase based on analysis of substrate recognition mechanism mediated by steric hindrance
Huiying Luo	Chinese Academy of Agricultural Science	Green innovation in enzyme production
Zhiguang Zhu	Chinese Academy of Sciences	Construction of bioelectrocatalytic systems by integrating synthetic biology and electrochemistry

Information

Jokichi Takamine Study Group, NPO

Dr. Jokichi Takamine

Dr. Jokichi Takamine lived through the dramatic period of time from the end of the Tokugawa shogunate, Meiji era, and Taisho era. He left a great legacy as a scientist, entrepreneur, and an international goodwill ambassador. Dr. Takamine is called the father of modern biotechnology for his research and development of amylolytic enzymes derived from microorganisms, mainly Taka-Diastase.

Dr. Jokichi Takamine
(photo courtesy Great People of Kanazawa Memorial Museum)

Jokichi Takamine Study Group, NPO

The NPO, Dr. Jokichi Takamine Study Group, is engaged in educational activities, such as publishing journals and holding lectures, in order to make more people aware of Dr. Takamine, who made a great contribution to the development of science and technology in modern Japan, its commercialization, and goodwill between Japan and the United States.

Main Activities

In 2024, we were fortunate to receive many opportunities to teach people about Dr. Takamine and his work through activities, such as lectures held in Kanto, Chubu, and Hokuriku regions in Japan, a magazine book titled "Takamine Jokichi ga Wakaru" (Insights on Jokichi Takamine) published through Mainichi Shimbun Publishing, and an informational TV program broadcast on NHK centered around Dr. Takamine. Interest in Dr. Takamine continues to grow and we hope to provide even more accurate information and educational opportunities in 2025 and beyond.

A talk held at a junior high school in Takaoka City, Toyama Prefecture. This marks the 16th year of talks given at schools.

Topic Achievements in connecting Japan and the United States

Along the banks of the Potomac River in Washington, D.C. is a line of famous cherry trees. Near the trees, a plaque explaining Japanese and American figures involved in the cherry tree donation project includes none other than Dr. Takamine. Over the years, the plaque had worn down due to being exposed to the elements, however, the restoration was completed in just six months after the project began, thanks to the swift cooperation of the Japanese and American authorities involved. From spring 2024, visitors will once again be able to clearly read about the historic event.

Additionally, in May of 2024, Dr. Takamine was inducted into the National Inventors Hall of Fame of the United States. This is a non-profit organization sponsored by the United States Patent and Trademark Office that honors great inventors. The induction recognizes Dr. Takamine's contributions to medicine and industry through the extraction of adrenaline and the invention of Takadiastase, as well as his efforts to promote friendly relations between Japan and the United States. As a Japanese organization, we feel deeply proud to see that even after 100 years, his achievements are still being recognized and celebrated in the United States today.

From left to right: Eliza Scidmore, the woman behind the idea for the cherry tree project; botanist David Fairchild; Tokyo Mayor Yukio Ozaki; and Jokichi Takamine.

Induction to the National Inventors Hall of Fame is not limited to living people. Historical inventors, including Thomas Edison, Nikola Tesla, and Steve Jobs, have been inducted in previous years.

Scan the QR code ▶ to visit the Study Group's website.

Notification of the recruitment of new members

The Jokichi Takamine Study Group is accepting supporting members.

Supporting members will receive publications related to Dr. Takamine and regularly issued newsletters. They also receive information about lectures, events, and news.

If you would like to join us, please write your name (if you are a corporate body, company/organization name and department), postal code, address, phone number (no cell phone number accepted), occupation, age, and sex on a letter or a postcard and mail it to us. We will return a bank transfer form to pay the initiation fee and the annual membership fee.

Address

Jokichi Takamine Study Group, NPO Office
1-15-11 5th floor of Daini Meiwa Building, Toranomon, Minato-ku, Tokyo 105-0001 Japan

*For more details, please visit our website.
https://npo-takamine.org/membership/

Conference presentation

Amano Enzyme has decided academic presentations such as the following.

Conference/Meeting	Date	Title	Speaker
The 3rd Green Symposium	April 24th-25th , 2024 (Surabaya, Indonesia)	Amano Speciality Enzymes towards a greener and safer bioeconomy	Shotaro Yamaguchi
2024 AOCS ANNUAL MEETING & EXPO	April 28th- May 1st, 2024 (Montreal, Canada)	Moo-ving Towards Sustainability: Enzymatic Enhancement in Plant-Based Dairy Ingredients	Monica Henry
		Unlocking Flavor Frontiers: Enzymatic Innovations with Amano Enzyme in Plant-Based Foods	Nickolas Broches
		Advancement of Physical Properties in Hard-Type Textured Plant-based Cheese with the Use of Enzymatic Treatment	Monica Henry
109th Brewed Seasoning Food Seminar	July 1st - Sep. 30th, 2024 (Online)	Enhanced functional properties of food by industrial enzymes - Focusing on soy-based foods -	Kiyota Sakai
3rd Indonesia Research and Innovation Expo (InaRI Expo) 2024	Aug. 8th, 2024 (Jakarta, Indonesia)	Industrial Enzymes contributing to the society	Shotaro Yamaguchi
The 71st Annual Meeting of Japanese Society for Food Science and Technology	Aug. 31st, 2024 (Nagoya, Japan)	Enzyme application for improving the functionalities of plant-based meat analogs	Kiyota Sakai
Japan Society for Bioscience, Biotechnology, and Agrochemistry 199th Chubu branch's Regular Meeting	Sep. 28th, 2024 (Nagoya, Japan)	Enzyme applications: Improving the functionalities of plant-based meat analog products	Kiyota Sakai
35th Food Hydrocolloid Symposium	Oct. 8th, 2024 (Tokyo, Japan)	Improved functionalities of plant-based meat analogs by enzymes	Kiyota Sakai
The 2nd Asia-Pacific Enzyme Technology Symposium / The 2024 HUS Symposium on Life Science and Biotechnology	Oct. 25th, 2024 (Hanoi, Vietnam)	World Industrial Enzymes and Amano Specialty Enzymes for the Circular Society	Kazuhiro Furukawa
5th Sino-Japan Symposium on Biocatalysis and Biotransformation	Nov. 16th, 2024 (Hangzhou, China)	Application of microdroplet technology to industrial enzyme development	Kazunori Yoshida
International Scientific Conference on Cultured Meat 10	Nov. 17th-19th, 2024 (Maastricht, The Netherlands)	Preliminary Findings on the Production of Active hTGFb3 in Food-Grade Enzyme Strains for Cultured Meat Applications	Hirotaka Matsubara
4th Amano Enzyme Research Grant Presentation	Nov. 19th, 2024 (Nagoya, Japan)	Enzyme Applications in Beverage Industry	Keita Okuda
Wellness Tokyo 2024	Nov. 29th, 2024 (Tokyo, Japan)	Enzyme applications for improving functionalities of food	Keita Okuda
2024 Sakura-Bio Meeting in OKINAWA	Dec. 17th, 2024 (Okinawa, Japan)	The global industrial enzyme market and speciality enzymes towards a greener bioeconomy	Satoru Ishihara

Journal/Book	Date	Title	Author
Food Science and Technology Research 2024, Vol.30, No.2	Mar. 2024	Reaction products in the browning system of plant-based meat analogs by laccase and betanidin	Kiyota Sakai, Masamichi Okada, and Shotaro Yamaguchi
Handbook of Plant-Based Meat Analogs Innovation, Technology and Quality ISBN: 978-0-443-21846-0	May 2024	Chapter 17 - Functional properties of meat analog products consisting of plant-derived proteins	Kiyota Sakai
Food Science and Technology Research 2024, Vol.30, No.4	July 2024	Enhanced textural properties of plant-based patties treated using crosslinking-catalyzed enzymes compared with those of beef patties	Kiyota Sakai, Masamichi Okada, and Shotaro Yamaguchi
Foods & Food Ingredients J. Jpn., 2024, Vol.229, No.3	July 2024	Development of Enzymes for Plant-Based Foods, with a Focus on Protein-Glutaminase	Masamichi Okada
Frontiers in Nutrition 2024, Vol.11, 1436113	Aug. 2024	Umami and Saltiness Enhancements of Vegetable Soup by Enzyme-Produced Glutamic Acid and Branched-Chain Amino Acids	Kiyota Sakai, Masamichi Okada, and Shotaro Yamaguchi
OISHISA Science 2024, Vol.38, No.10	Oct. 2024	Improved textural properties of plant-based meat analogs by enzymes and polysaccharides	Kiyota Sakai
Food, Nutrition and Health 2024, Vol.1, 4	Oct. 2024	Plant-based meat analogs: color challenges and coloring agents	Haizhou Wu, Kiyota Sakai, Jingnan Zhang, David Julian McClements

2025 Exhibitions

Date	Exhibition	Location
January 22-23	Florida Section IFT	Orlando (USA)
March 4	SCIFTS Suppliers Night Expo	Garden Grove (USA)
March 17-19	Food Ingredients China 2025	Shanghai (China)
March 19	Food Focus Thailand Roadmap 2025	Nonthaburi (Thailand)
March 25-28	Novel Enzymes 2025	Budapest (Hungary)
March 26-27	Dairy Innovation Strategies 2025	Copenhagen (Denmark)
March 31-April 2	AmineBioCat 2025	Aachen (Germany)
April 8-11	China International Medical Equipment Fair 2025	Shanghai (China)
April 15	NY IFT	Edison (USA)
May 8-10	FBIF 2025	Shanghai (China)
May 21-22	PPIC Annual Research Spotlight Meeting	St Paul (USA)
May 21-23	Active Pharmaceutical Ingredient China 2025	Guangzhou (China)
June 3-5	Bridge2Food EUROPE 2025	Hague (Netherlands)

Date	Exhibition	Location
June 24-26	CPHI China 2025	Shanghai (China)
June 29-July 3	BIOTRANS 2025	Basel (Switzerland)
July 14-16	IFT FIRST 2025	Chicago (USA)
September 17-19	Fi Asia Thailand 2025	Bangkok (Thailand)
September 24-25	Plant Based World Expo	New York (USA)
October 8-9	The Food Tech Summit & Expo 2025	Mexico City (Mexico)
October 15-17	FiT Japan 2025	Tokyo (Japan)
October 17	Food Focus Thailand Roadmap 2025	Nonthaburi (Thailand)
October 27-30	Fi North America	Las Vegas (USA)
November 5	Chicago Section IFT	Chicago (USA)
November 8	Longhorn Section IFT	Frisco (USA)
December 2-4	Fi Europe 2025	Paris (France)

For details and the latest information, please refer to our website or each exhibition website.

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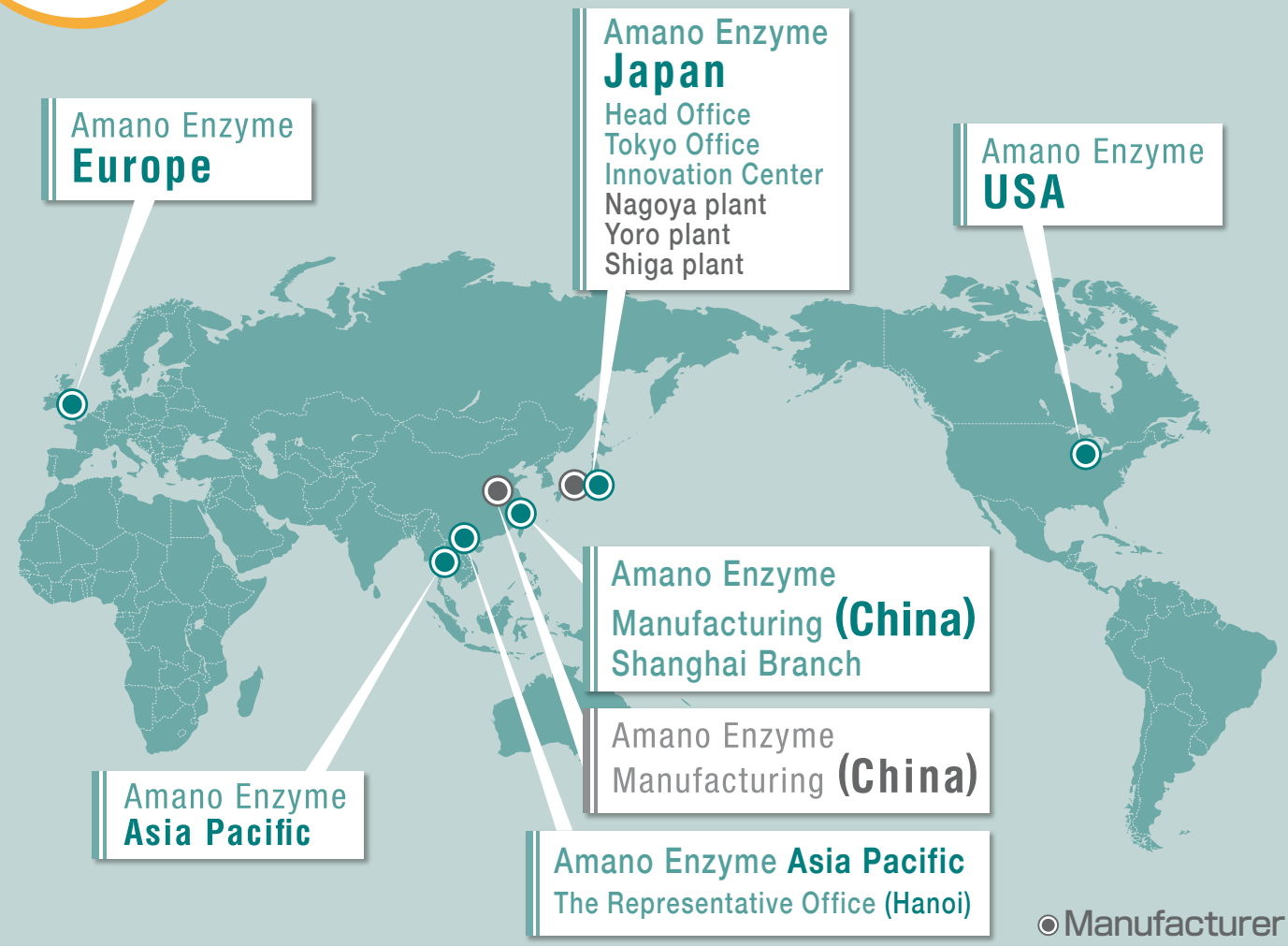
Amano Enzyme

World Network



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https://www.amano-enzyme.com

AMANO ENZYME INC. (Publisher)

Head Office:
2-7, 1-chome,
Nishiki, Naka-Ku, Nagoya,
460-8630 Japan

Tel : +81-(0) 52-211-3032
Fax: +81-(0) 52-211-3054
E-mail: sales@amano-enzyme.com

Tokyo Office:
8F AMANO Shibakoen Building,
2-8, 1-chome, Shibakoen,
Minato-ku, Tokyo,
105-0011 Japan

Tel : +81-(0) 3-6452-8970
Fax: +81-(0) 3-6452-8971

AMANO ENZYME U.S.A. CO., LTD.
1415 Madeline Lane, Elgin, IL 60124 U.S.A.
Tel : +1-847-649-0101
Fax: +1-847-649-0205

AMANO ENZYME EUROPE LTD.
Second floor West, 25 Western Avenue,
Milton Park Abingdon, Oxfordshire, OX14 4SH, U.K.
Tel : +44-(0) 1608-644677

AMANO ENZYME MANUFACTURING (CHINA), LTD. SHANGHAI BRANCH
C3-5F "800SHOW", No.800,
ChangDe Road, Shanghai 200040, P.R.China
Tel : +86-(0) 21-6249-0810
Fax: +86-(0) 21-6248-7026

AMANO ENZYME ASIA PACIFIC CO., LTD.
Room No.1116, Innovation Cluster 2 Building, Tower D,
141 Thailand Science Park, Phahonyothin Road,
Khlong Nueng, Pathum Thani 12120, Thailand
Tel : +66-(0) 2-117-8390
Fax: +66-(0) 2-117-8392

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