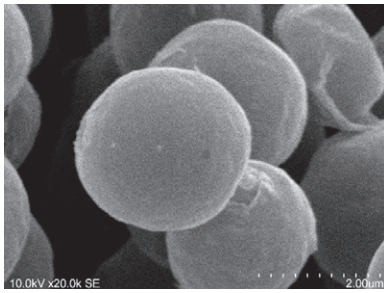
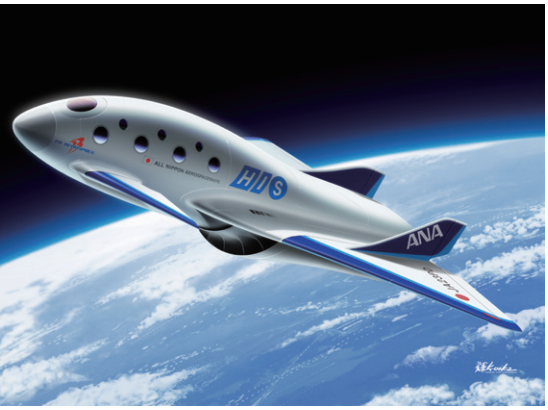
Volume 25

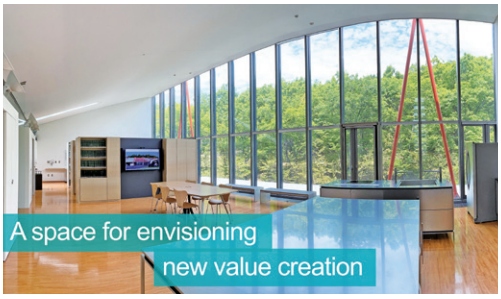
Enzyme Wave

2022

AMANO
Amano Enzyme







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Front Page:Malted rice(Ingredient for Saké)

Column

Japan's National Fungus — Koji —

Author

Eiji Ichishima

Professor Emeritus, Tohoku University / Professor Emeritus, Tokyo University of Agriculture and Technology / Director Emeritus, Noda Institute for Science Research

[Brief background]

Ichishima graduated from the Department of Agricultural Chemistry, Faculty of Agriculture, Tokyo University of Agriculture and Technology in 1957, and obtained a doctorate in agriculture from the University of Tokyo in 1967. He received the JSBBA Award for Achievement in Technological Research in 1969, an honorable mention from The Japanese Biochemical Society in 1972, the JSBBA Award for Senior Scientists in 1997, and the Achievement Award from the Brewing Society of Japan in 2008. His specialty is enzyme chemistry.

Do you know what Japan's "national fungus" is? Most Japanese people know that Japan's national flower is the cherry blossom, the national bird is the pheasant, and the national butterfly is the great purple emperor. However, it is probably not well known that the national fungus is "koji".

Koji is used in a variety of traditional Japanese foods and has helped nurture the culture of food in many parts of Japan. It wouldn't be an exaggeration to say that the Japanese diet would not be complete without koji, which is indispensable in the production of miso, soy sauce, and saké. For centuries, Japanese people have been aware of the role the invisible fungus known as koji plays and used it to produce food and saké.

Due to its inclusion in UNESCO's World Heritage List and people's growing demand for healthy, low-calorie foods, Japanese food has gained popularity around the globe. As a result, we are sure that the use of koji will only further expand around the world.

It was Dr. Eiji Ichishima, introduced above, who proposed that koji be recognized as Japan's national fungus. Dr. Ichishima has been a leading researcher on koji and enzymes produced by koji, such as proteases, for more than half a century. In addition to being a researcher on fungi and enzymes, he is also a prolific writer, with many books to his name, including "Koji" and "Saké Culture in Man'yoshu."

Now, we would like to introduce Dr. Ichishima's special commentary for Enzyme Wave, titled "Koji, the National Fungus in Saké Brewing."

Japan's flagship microorganism is the national fungus: koji, (scientific name: *Aspergillus oryzae*) (Fig. 1 and Fig. 2). In 2006, as part of its 100th anniversary celebration, the Japan Brewers Association (JBA) chose koji to be officially recognized as one of Japan's national fungi. Japan's national fungi include *A. oryzae*, *A. sojae*, and the kurokoji fungus *A. luchuensis* (Eiji Ichishima, "National Fungi of Japan," Tohoku University Press, 2017).

Since 2013, when UNESCO added "Washoku, traditional dietary cultures of the Japanese [...]" to their Representative List of the Intangible Cultural Heritage of Humanity, it shone a spotlight on the fungus essential in making Japanese food, koji/*Aspergillus oryzae*. The following is an excerpt.

In the Harima Fudoki, compiled in 713 in the Nara period (6th year of the Wado Period), there is a passage that goes back to the "Age of the Gods," where it is thought that saké was brewed using "mold" (Yuzuki Manabu, "History of Saké Brewing," Yuzankaku Shuppan, 1987).

大神の御粮(乾飯、糒)沾れて麺生えき、即ち酒を醸しめて、庭酒に献宴しき。

The great Okami's food (dried rice and dried boiled rice provisions) is wet to grow mold before being brewed into wine offered to the gods.

"Man'yoshu" — Vol. 19, 4275. Fumiyanochinu Masato —

天地と久しきまでに万世に
　仕へ奉らむ黒酒白酒を

To the heavens and earth, to all ages forever.
　Enjoy the black and white saké offered to the gods.

According to the Engi-shiki — the detailed rules for the enforcement of the Ritsuryo, which was enacted in 967 — koji shall be defined as "bara koji," written with the character "蘗" ("getsu" or "yone no moyashi") (Kinichiro Sakaguchi, Saké in Japan, Iwanami Bunko, 2007).

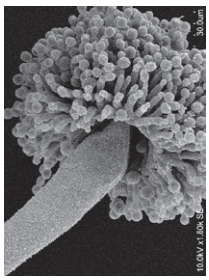


Fig.1
Electron micrographs of *Aspergillus oryzae* conidia (spores), apical sacs, and conidiophores (stalks) (courtesy of the Noda Institute for Science Research)

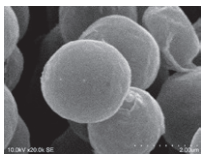


Fig.2
Electron micrographs of *Aspergillus oryzae* conidia(courtesy of the Noda Institute for Science Research)

Column

The Challenge of Developing Japan's First Manned Spacecraft

Author

Shuji Ogawa

CEO and CTO, PD AeroSpace LTD.

[Brief background]

Born in Nagoya City, Aichi Prefecture.

Graduated from Fukui University, Faculty of Engineering, Department of Mechanical Engineering, and Tohoku University, Graduate School of Aerospace Engineering. Worked at Mitsubishi Heavy Industries for four years in the development of next generation support fighter jets, and at Aisin Corporation for seven years in the development of automobile-related parts. Established PD AeroSpace in 2007 and became the representative director. Started development of spaceplane and engine. Served two terms as a member of Cabinet Office Space Strategy Space Policy Committee (Space Transportation System Subcommittee).

In the "Biotechnology in Japan" series, we share contributions on Japanese tradition and culture.

There is a traditional culture of manufacturing in Japan, which has had a lot of impact on industrial technology.

In this third installment, we have a piece from Shuji Ogawa of PD AeroSpace LTD., who is taking on the dream of creating a manned spacecraft from Japan.

The year 2021 would later be known as the "first year of space tourism." A total of 29 civilians, who were not selected by their countries to be astronauts, went into or stayed in space. Our relationship with space, especially the way we go to space, is beginning to see a dramatic shift. This is manifested not only in changes in the attributes of the people who are on board the spacecraft, but also in changes in the organizations who launch them not only governments but also private companies as well as in changes in the appearance and flying style of the spacecraft themselves.

However, Japan's development of manned space travel is limited only to stays in the International Space Station (ISS) and lunar surface development for the Artemis program, and there are no plans for the development of manned space transportation (manned rockets) seen anywhere.

Our company, PD AeroSpace, is championing the development of a manned spaceplane and manned space transportation businesses, including space tourism, due in part to these facts. However, in this piece, I would like to explain how a private, a one-person venture company started the reckless challenge of developing a manned spaceplane, and how we have reached where we are today.

There were four major "triggers." 1) My father was an inventor and we had a laboratory at home. From a young age, I helped my father with experiments, and I naturally gained the ability to create new things and come up with ideas. 2) Longing to become a pilot, I learned engineering design on the job at an aircraft manufacturer. 3) When I was in graduate school, I suddenly came up with the idea of "a single engine switching between jet and rocket combustion." 4) I witnessed the accomplishment of a company of only 50 people in the U.S. building, a manned rocket flying it to space reaching and landing.

Combined, these four triggers made me think I could do it and that I wanted to try. At that time, I was 37 years old. I started by setting up a roughly 16 m² prefab building in the parking space of my parents' home. The laboratory was also located there. I crafted my own ideas, gave them shape, and repeatedly experimented with them. However, I was certainly not swimming in money, so I had to push one engine to its limits

and find a way to gather every ounce of knowledge I had when making measurements. 15 years ago, the situation was completely different from what it is now. When I would explain about "rocket development" and "space business," people would simply say, "That's some dream," and wouldn't invest. With no funds, I couldn't hire anyone, so I had to fight alone for ten years.

It was in 2015 that the tide turned. Venture companies building small satellites or working to remove space debris had raised large sums of money — some as much as 2, 3 billion yen. 15 years after the U.S., risk money (investments) began to enter the "space business" in Japan. In response to this, I changed the way I thought and moved to fundraising. That is when I met with Mr. Sawada of HIS and Mr. Katanozaka of ANA and received seed money.

Four years have passed since then and our company has raised about 1.2 billion yen in funding and grown to organization of 40 people with an R&D center in Hekinan City, Aichi Prefecture, and a flight test base on Shimoji Island in Okinawa Prefecture. Currently, while repeating combustion tests of the new engine, we are developing our sixth unmanned flight test vehicle. If all goes well, we plan to conduct a test flight in April this year. (This aircraft does not yet have the capability to go into space and can only fly at an altitude of about 10 km.)

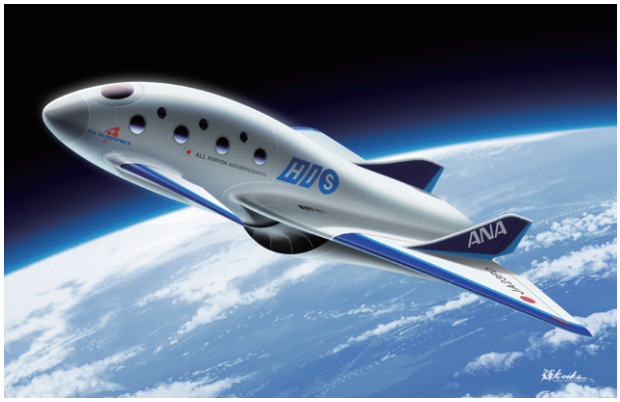
Our efforts are not limited to the development of airframes and engines but also include the development of laws and medical standards, operation methods, ticket sales, and the study and maintenance of spaceports. As a manufacturer, we have graciously been told that we are overextending ourselves as this is not our original domain. However, in order to begin "space tourism," this is unavoidable, and someone has to make it happen. People are so ready to tell you things, but they aren't as ready to get their hands dirty and help. So we had to do it ourselves. However, as a result, we were able to ascertain our "goal" and what our business actually is, and we are now able to respond to jabs from any direction.

It has been 15 years since I started my reckless challenge. The seeds that have been sown so far have sprouted and some of them have begun to take shape. The moment you think you can't do something, you lose the ability to do it. Thinking, instead, "How can I do it?" is where things start. I believe that any big thing is a collection of these small starts. Once you start moving, keep moving and keep going, and even if the steps are small, you will find your way. Or at least that is what I believe. It is "a battle."

If you too are working on a "challenge," I hope you remember that some idiot is out there foolishly working in the field of space when you get stuck or hit a wall and feel like giving up.

We, too, have not yet reached space, and we are far behind the Americans. Now comes the real battle. I hope that you will continue to keep an eye on us and our future.

https://pdas.co.jp/
https://www.facebook.com/PDAeroSpace



Trend

The Next Phase in Global Alternative Protein Source Development

Author

Nobu Kumagai

Founding Managing Partner, Wildcard Incubator; Partner, addlight Inc.

[Brief background]

Graduated from the Faculty of Economics, Keio University. MBA from Cornell University.

After working at Lehman Brothers Holdings Inc. and HSBC Securities (Japan) Limited, he became the head of Japan-Asia Investment's Japan-US Advanced Technology Investment Fund in 2007 and was a board member of one of its portfolio companies, a software development startup in Silicon Valley. Founded Wildcard Incubator in the US in 2013. Became a partner of addlight Inc. in 2020. He is currently working on several projects in Japan and the US on the topic of food, well-being and tech, primarily in Silicon Valley.

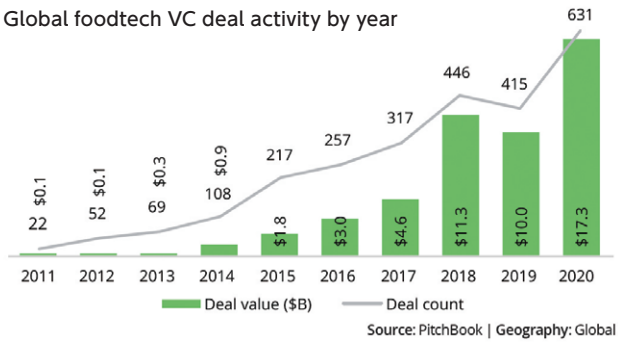
In the food tech industry, major social issues and changes in the value people place on food have led to a number of innovations in the global food value chain by global titans of industry and startups alike.

Nobu Kumagai wrote this piece for us about global food tech trends with a focus on alternative protein sources.

Global "Food Tech" Enters New Growth Phase

The concept of "food tech" began gaining traction around the world, particularly in Western industries, when in 2013 — almost 10 years ago — when Professor Mark Post of Mosa Meat unveiled the world's first cell-cultured meat hamburger, with a price tag of $325,000. Nowadays, major companies and startups around the globe are competing with each other through a wide range of food value chains (production sites - labs - production plants - distributions - retail - delivery - food loss/upcycling), including meat alternatives. Since 2019, previously unthinkable major investments into food technology have also been making headlines.

As the following graph shows, investment by venture capital firms and others in leading food tech startups through major markets around the world, including Japan, took a giant leap forward in 2020. The total investment amount is driven by projects that have already passed the development phase to some extent and are now in the late phase (Series B and above), attracting investments of billions to tens of billions of yen, such as Beyond Meat (see below), and JUST Egg and Clara Foods, which are developing egg substitutes.



Source: Finistere Ventures 2020 AgriFood Tech Investment Review (US).

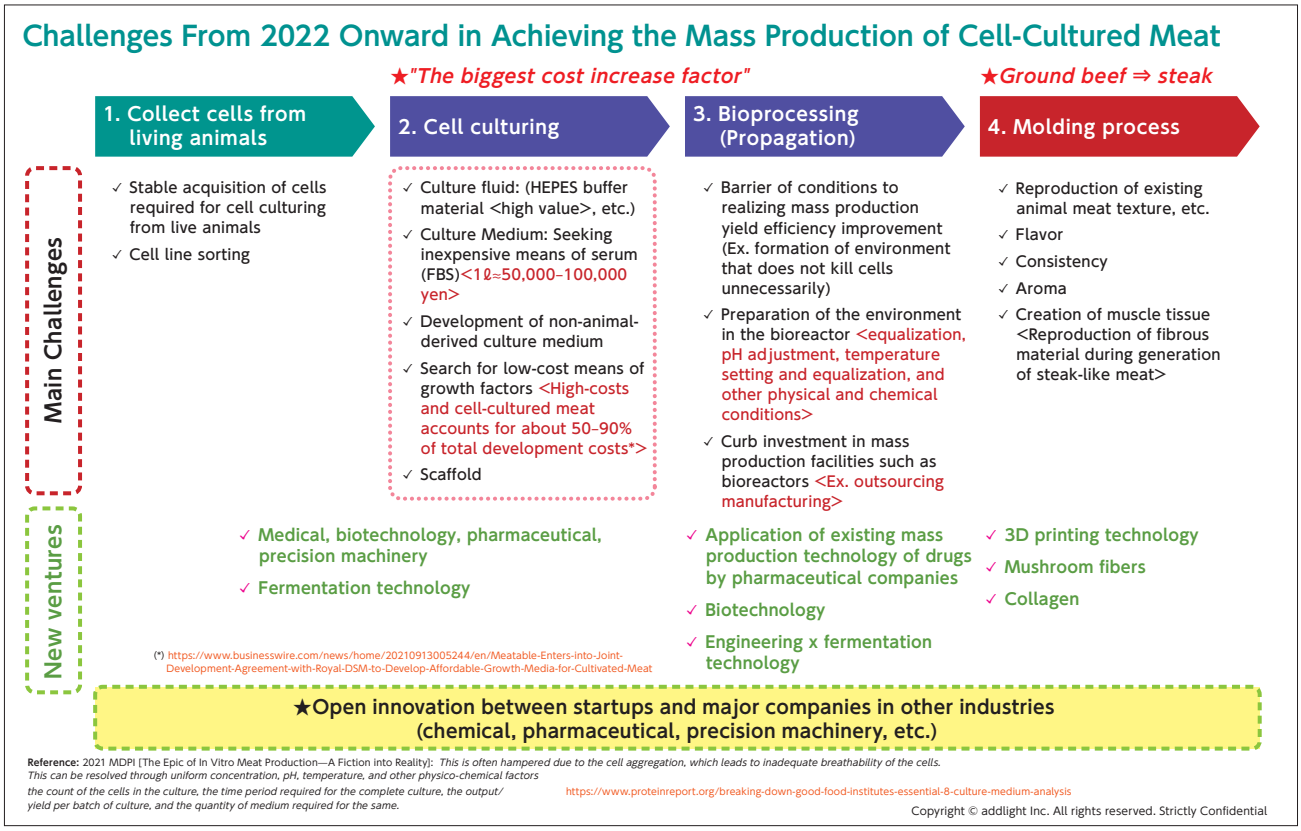
The next trend expected in the development of alternative protein sources after 2022

In the development of alternative protein sources, Impossible Foods (plant-based meat) and Beyond Meat (cell-cultured meat) are currently the best-known brands, and investments have reached tens of billions of yen in Series B and C funding rounds. In 2021, the global market for the development of alternative protein sources will be worth approximately

US$5.7 billion(approx. 600 billion yen), including NotCo, a Chilean company that develops alternative dairy products, and Motif Foodworks, which develops unique protein sources that give plant-based food groups the unique texture and flavor of animal-based food. The vast frontier that is alternative protein source development ranges from cell-cultured meats to plant-based alternatives, dairy products, and beverages, each of which is undergoing technological development to replicate conventional animal proteins in a variety of applications, including nutritional value, texture, flavor, and shelf life. It is thought that in these, there are a wealth of opportunities for enzymes to play an active role.

Already, plant-based meat alternatives are beginning to appear on the market in Japan, with startups like Next Meats and other major food manufacturers offering similar products. As for cell-cultured meat, over eight years have passed since the aforementioned Professor Mark Post announced his unbelievably priced hamburger in 2013. As prices finally fall below $100 per piece, it is expected that the establishment of a mass production system for the popularization of cell-cultured meat will pick up steam with the cooperation of numerous industrial sectors.

Specifically, the development of technologies that make it possible to reduce the price of the culture medium and growth factors in the lab, which are seen as the biggest factors driving up the cost of cell-cultured meat production, and the improvement of the environment for the realization of mass production (e.g., improvement in various physical and food chemical conditions in the bioreactor, water treatment technology, etc.).



Source: Prepared by the author based on various published papers.

Looking at the movement toward cell-cultured protein sources making their way into the mass market, we believe that players from various industries, including food, chemical, semiconductor, precision machinery, and pharmaceutical manufacture, will create boundary-transcending open innovation. It is almost certain that in the 2020s, the food systems of the future will begin rooting themselves in society at an ever-accelerating pace on a global scale as major companies and startups utilize their respective areas of expertise to build systems for the social implementation of a new food value chain. With this in mind, enzymes, which are highly applicable as a technology for food, medical, and industrial use, will play an increasingly important role in the diversification of food development, and not only in the development of cell-culture protein sources.

Report

Introduction of the new product "Glucose Oxidase AC"

Amano Enzyme recently launched a novel carbohydrate oxidase, Glucose Oxidase AC (GO-AC).

Glucose oxidase is generally known as an enzyme that oxidizes glucose to produce gluconic acid and hydrogen peroxide. It is also a rare enzyme in that both the substrate sugar and oxygen, and the product sugar acid and hydrogen peroxide can be used for industrial purposes. It can be used for reducing of sugar, for consuming of oxygen, for production of sugar acids as functional food materials, and for generation of hydrogen peroxide to strengthen the gluten network in bread.

In addition to glucose, GO-AC has the ability to act on malt-oligosaccharides and non-starch sugars (such as lactose and cellobiose). As a result, it is expected to be applicable to and developed for a variety of applications, and we have already received numerous inquiries from customers. For example, in the fermentation of yogurt, the effect of deoxygenation on promoting anaerobic fermentation of lactic acid bacteria has been confirmed. This is an effect that could not be obtained with conventional glucose oxidase, which does not act on lactose.

In addition, GO-AC will be available in both genetically modified (GMO) and non-genetically modified (non-GMO) enzymes to meet the diverse needs of our customers. GMO enzyme is based on the enzyme gene from *Acremonium chrysogenum* using *Aspergillus oryzae* as a host, and it has been succeeded in the mass production at an industrial level. In August 2021, the Ministry of Health, Labor and Welfare in Japan confirmed that the production shall be performed by the meeting "Standards for manufacturing of Foods and Food Additives produced by Recombinant DNA Techniques". Amano Enzyme has manufactured more than 20 GMO enzymes for diagnostic and synthetic applications, but this is the first GMO enzyme to be approved for production for food applications.

Amano Enzyme has one of the top microbial libraries in the private sector (approximately 20,000 strains as of the end of 2021). We will continue to develop unique enzymes from a variety of strains.

Glucose Oxidase AC Application

Makes low carbohydrate foods

Surpresses the coloration of the Maillard reaction

Sugar reduction

Supports the growth of lactic acid bacteria

Shortens the production time of fermented milk

Deoxygenation

Functional food materials

Are produced as sugar acids

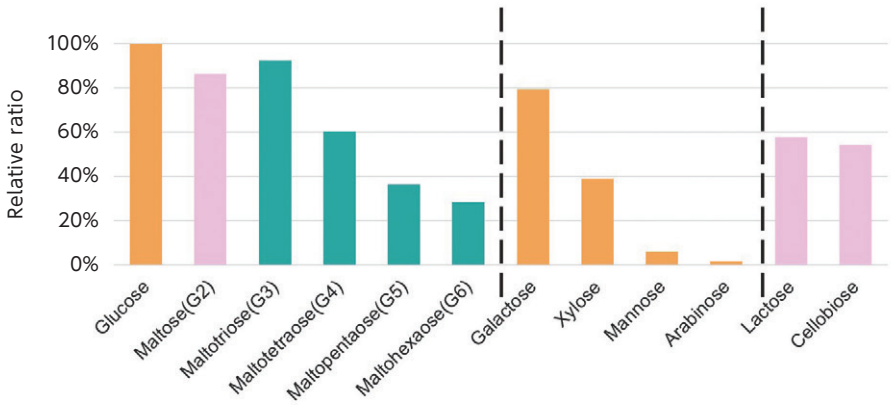
Strengthening the gluten network

Extends the shelf life of frozen dough

Increases the volume of bread

Glucose Oxidase AC from *Acremonium chrysogenum*

Broad substrate specificity, acts on more than just glucose



Report

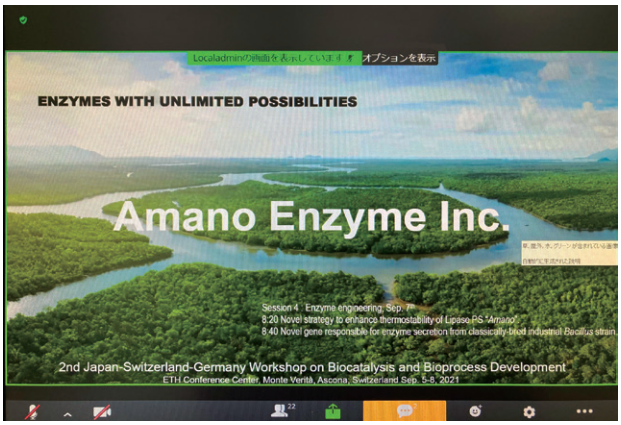
2nd Japan-Switzerland-Germany Workshop on Biocatalysis and Bioprocess Development

The second meeting of the "Japan-Switzerland-Germany Workshop on Biocatalysis and Bioprocess Development" was held online and in Ascona, a tourist town in southern Switzerland. Amano Enzyme Inc. sponsored the workshop, and two of our researchers participated and presented online.

As this was only the second ever workshop, it may seem quite new. However, it is actually an amalgamation of the previous bilateral meetings that were held every other year since 1978 between Japan and Germany, and since 1988 between Japan and Switzerland. In recent years, biocatalysts, or enzymes, have been the focus of attention in the SDGs, however, this workshop has focused on, maintained, and developed them for the past 40 years.

At the workshop, a wide range of discussions were held, from enzyme development itself to their new applications, including reports on new enzyme applications for resource recycling and the expansion of enzyme applications through the use of cutting-edge AI technology.

The workshop was an opportunity for us to reaffirm the incredible potential of enzymes, a substance that has long attracted researchers in Japan and Europe. Held every other year, the next one is scheduled to be held in Japan in two years. As a Japanese enzyme manufacturer, we will continue to work on current and new product development to be able to contribute to this historic workshop.



Received the 2021 Actinomycete Society of Japan Corporate Award

Amano Enzyme received a Corporate Award titled "Contribution to the production and stable supply of industrial enzymes derived from actinomycetes" at the award ceremony of the 2021 Annual Meeting of the Society for Actinomycetes Japan held on September 18 and 19, 2021.

The Society for Actinomycetes Japan is a historied academic society that follows in the footsteps of Dr. Hamao Umezawa, who was awarded the Order of Culture for the development of the antibiotic kanamycin, and Dr. Satoshi Omura, who was awarded a Nobel Prize for the development of ivermectin.

We are involved in several products derived from actinomycetes, and among them, the protein cross-linking enzyme transglutaminase, which was jointly developed with Ajinomoto, has had a major impact on the global food industry. This award is mainly in recognition of the stable supply of the product for 30 years.

Encouraged by this award, we will continue to provide products that will contribute even more to society moving forward.


表彰状

企業賞

（放線菌由来の産業用酵素の製造と安定供給の貢献）

天野エンザイム株式会社殿

貴殿は放線菌に関する優れた研究開発成果を挙げられ放線菌応用研究領域の進歩と発展に貢献をなさいましたここにその業績を讃え日本放線菌学会企業賞を贈ります

令和三年九月十八日

日本放線菌学会

会長 大利 徹

Symposium

The 6th Sino-Japan Joint Symposium on Enzyme Technology

The 6th Sino-Japan Joint Symposium on Enzyme Technology was held on January 7, 2022. This symposium has gathered every other year since 2011 by Jiangnan University (Wuxi, Jiangsu, China) and Amano Enzyme with the aim of "contributing to the promotion of enzyme applications in Asia through exchanges between Japanese and Chinese researchers related to enzymes." With the pandemic still going on, this year's symposium was held for the first time in an online-offline hybrid format with Jiangnan University's Future Food Science Center, built last summer, as the main venue.

Held on the theme of "alternative proteins and enzyme technology," the symposium saw 52 participants from universities, research institutes and companies in China attend in person and 206 online, with Amano Enzyme connecting from Japan via the web too. Alternative proteins are gaining attention as an alternative to animal proteins, the production of which has a large environmental impact, due to the growing awareness of the need for a sustainable society, and interest in foods containing them. A total of eight lectures were given by speakers from Japan and China. From Japan, Professor Takeuchi (The University of Tokyo) and Professor Matsumura (Kyoto University) gave online presentations. Speakers and lecture titles are listed in the table below.

The panel discussion at the end of the session was particularly lively, with a lot of questions and answers, indicating the high level of interest in this field and enthusiasm among the participants.

By continuing to hold this symposium for years to come, Amano Enzyme will do its best to deepen the technical exchange between Japan and China, and to develop the enzyme industry.

Jian Chen (Jiangnan University)	Protein Alternative Production : Missions and Challenges of Fermentation industry
Shoji Takeuchi (The University of Tokyo)	Meat 3.0 - The Challenge for Cultured Steak Meat
Yasuki Matsumura (Kyoto University)	Enzymes as a tool modulating structure, interactions and functional properties of food materials
Bin Li (Huazhong Agricultural University)	Research on the construction and processing characteristics of plant-based egg
Xinqi Liu (Beijing Technology and Business University)	Development innovation of soy protein production processing and application technology
Masamichi Okada (Amano Enzyme Inc.)	Enzymes for plant-based protein and development of new enzyme preparations
Yapeng Fang (Shanghai Jiao Tong University)	Texture design of plant-based meat by molecular engineering
Yan Xue (AgFood Future)	Protein innovation and advanced accurate fermentation technology

Main venue (Chinese participants)


Professor Takeuchi (The University of Tokyo)


Professor Matsumura (Kyoto University)

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

The foundation continued its activities during the COVID-19 pandemic though 2021. Although the usual lectures at educational institutions such as junior high schools and universities in the Hokuriku region were postponed, related events and lectures were held in Kanazawa and Takaoka in November. In Kanazawa, a lecture was held on Dr. Takamine's birthday (November 3) at a shopping center built on the site of his former residence. In Takaoka, the venue was the Chamber of Commerce and Industry building where the relocated Shofuden stand, bringing "time, places, and topics" together. In addition, the unknown relationship between Dr. Takamine and Eiichi Shibusawa, the protagonist of the historical drama "Reach Beyond the Blue Sky," has also been slowly receiving more attention. We will continue to provide more accurate information in books and media.

Lecture at the Great People of Kanazawa Memorial Museum

Topic Eiichi Shibusawa and Jokichi Takamine

From the time they met in 1886 until Dr. Takamine's death in 1922, they had a 37-year relationship that included the establishment of Japan's first artificial fertilizer company, the development of Kurobe River power facilities, the founding of RIKEN, and the success of Shibusawa's business team in the United States. Shibusawa acted as a collaborator and mentor in bringing Takamine's ideas to fruition, while Takamine was Shibusawa's greatest collaborator and adviser in private diplomacy, especially in diplomacy with the United States. For more information, visit their website. https://npo-takamine.org/

History up to the foundation:
From the RIKEN 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/

Seeing the invisible

The World's Easiest and Most In-Depth Enzyme Website, Created by Amano Enzyme. Today, we will delve into the unseeable world of enzymes and explore the future and possibilities of enzymes with experts from a range of fields.

https://mienaimono.jp/en/

I want to recreate the workings of nature in a single dish.

Thomas Frebel (chef)

Awarded two stars in the Michelin Guide Tokyo 2020, his restaurant INUA supervised the cooking in the drama "La Grande Maison Tokyo" starring Takuya Kimura. Thomas is the head chef at INUA. The restaurant features a variety of cooking methods that make full use of fermentation and ingredients discovered through his travels throughout Japan that are woven into Japan's four distinct seasons. One of Thomas's dreams was to use the power of enzymes to turn food waste into nutritious soil or edible paste that could be sent to starving countries.

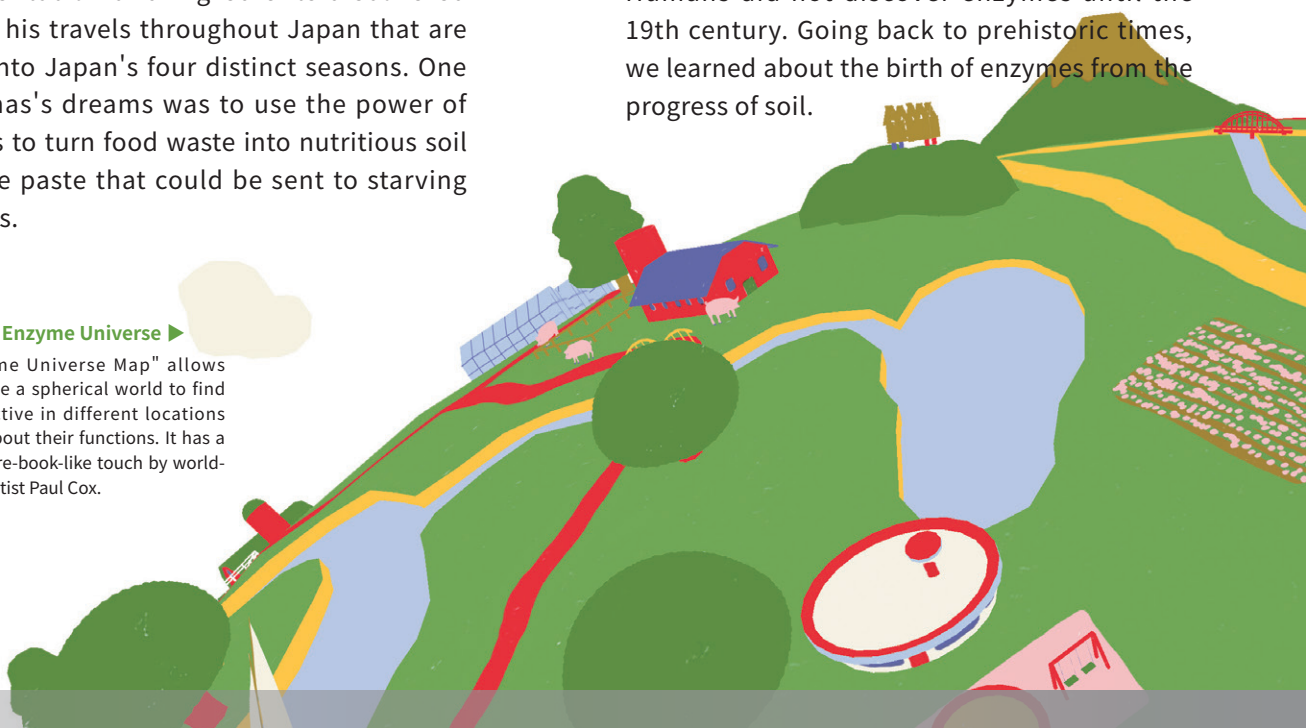
In Search of Soil to Feed 10 Billion People

Kazumichi Fujii (soil researcher)

The world's population is expected to reach nearly 10 billion by 2050. Fujii, who has written several books including "Soil: The Last Mystery of the Earth" and "Five Hundred Million Years of the Earth," travels the world with shovel in hand to confront the predicted food problems. Studying soil for many years, Fuji says, "Enzymes are related not only to growing crops, but also to cattle breeding and energy issues," and comments that the function of microorganisms in soil is incredibly complex. Humans did not discover enzymes until the 19th century. Going back to prehistoric times, we learned about the birth of enzymes from the progress of soil.

Map of the Enzyme Universe ▶

The "Enzyme Universe Map" allows you to rotate a spherical world to find enzymes active in different locations and learn about their functions. It has a warm, picture-book-like touch by world-renowned artist Paul Cox.



Elucidate the World Mechanism with Imagination

Masayuki Ishikawa (manga artist)

Ishikawa authored the popular manga "Moyasimon: Tales of Agriculture," which was turned into an anime twice. He successfully took on the challenge of conveying the mysterious world of fermentation in a fun way by giving the main character the ability to see bacteria normally invisible to the human eye as he attends school at an agricultural university. In addition, his latest title features a planet as the protagonist and makes readers use their imagination to figure out how the world works. He said that enzymes are "full of possibilities," and expressed his hopes and encouragement for future research, saying, "I feel that the more we learn, the easier life will become."

Can We Realize a Zero Waste World?

Akira Sakano (Representative of Zero Waste Japan)

For about five years since 2015, Sakano served as the president of the Zero Waste Academy, a non-profit organization based in Kamikatsu, Tokushima Prefecture. In 2019, she was selected as the Co-Chair of the World Economic Forum (Davos), and is also taking her message to the international stage. We asked Sakano, who has been practicing a solution for the garbage problem from the standpoint of an environmental policy, how to create a "garbage free society." She also taught us about the potential of enzymes, the importance of being low-tech as well as high-tech, the basics of recently much-talked-about ocean plastics and bioplastics, and the answer to the simple question of what is "garbage" in the first place. progress of soil.

Message from Enzo

So many people from different fields are taking an interest in enzymes, it makes me so happy! Enzymes manipulate the magic of "fermentation," are indispensable in the maturation of soil and the decomposition of garbage, and everyone is finally starting to take notice. I think if everyone learns about the possibilities of the "world of invisible things" in which enzymes do their work, we can realize a better future for all.

● Who is Enzo?
An original character that serves as a guide to the website. He shows off the various functions of enzymes, such as "degradation" and "synthesis," and works as a navigator for enzyme talks.

https://mienaimono.jp/en/

Report

Introduction to the "Enzyme Application Studio"

In May 2021, Amano Enzyme opened the "Enzyme Application Studio" in our research and development base, the Innovation Center.

The Enzyme Application Studio is a place where you can experience first-hand the effects of enzymes, allowing visitors to feel the benefits of enzymes through their senses. Our staff, skilled in the handling of enzymes, assist visitors with the experience and answer any questions they may have about enzymes.

The studio consists of three facilities: an "Application Laboratory" equipped with a kitchen, a "Co-Creation Space" for meetings with visitors, and an "Enzyme Museum" that holds the collected wisdom of those who came before.

We hope customers will use the "Enzyme Application Studio" as a place to help develop their products.

In addition to the "Enzyme Application Studio," Amano Enzyme also provides a variety of external webinars to help customers learn more about enzymes. We will continue to provide information on the use of enzymes into the future.

Application Laboratory	We have cooking equipment such as stoves and steam convection ovens, where you can cook enzyme-treated ingredients and foods to test the effects of enzymes.
Co-Creation Space	In a space away from everyday life, surrounded by nature, our skilled staff help visitors create new ideas and values.
Enzyme Museum	The Enzyme Museum displays valuable materials related to enzymes and enzyme utilization, as well as materials and panels showing the historical development of enzymes and enzyme utilization.

Conference presentation

Amano Enzyme has decided academic presentations such as the following.

Conference/Meeting	Date	Title	Speaker
The 51st Annual Meeting of Japan Pancreats Society	Jan. 8th, 2021 (Hyogo, Japan, Web)	Effective power of digestive enzyme preparations for medical use with low pH in the duodenum such as chronic pancreatitis - Second Report -	Kuroda, M., Ishigaki, Y., Nishio, K., Ko, S.
		Evaluation of digestive enzymes in the digestive tract by the human gastric digestion simulator	Nishio, K., Takahashi, A., Kuroda, M., Ko, S.
The 2021 Annual Meeting of the Japan Society for Bioscience, Biotechnology, and Agrochemistry	Mar. 20th, 2021 (Web)	The challenge of reproduction with human gastric digestion: The approach used a simulator and Future prospects	Kobayashi, I., Nishio, K.
Plant-Based Foods & Proteins Value Chain Americas 2021	Apr. 14th, 2021 (Web)	Enzymatic Solution for Plant-Based Food Innovation	N, Broches.
The 107th General Meeting of the Japanese Society of Gastroenterology	Apr. 15th, 2021 (Tokyo, Japan, Web)	Evaluation of digestive enzymes in the digestive tract by the continuous type of human gastric digestion simulator	Nishio, K., Ishigaki, Y., Takahashi, A., Ko, S.
		Comparative study of pharmaceutical formulation of digestive enzyme with intestinal low pH model	Ishigaki, Y., Takahashi, A., Nishio, K., Ko, S.
Technical Forum on the Application of Protein - Glutaminase in Plant - based Food	Apr. 15th -16th, 2021 (Wuxi, China, Web)	Application of Amano Protein Glutaminase in Plant-based drink	Yamaguchi, S., Wang, P.
The 86th symposium on enzyme engineering	Apr. 23th, 2021 (Web)	Enzyme engineering of FAD-GDH by circular permutation.	Ishihara, S.
Virtual 2021 AOCS Annual Meeting & Expo	May. 3th, 2021 (Web)	Enzymatic clean label processing for plant-based meat ~Improvement of binding property of textured vegetable protein~	Takahashi, A., Obara, T., Okada, M., Yamaguchi, S.
		Industrial Protein Modification Enzymes as a tool for clean labeled plant based protein foods	Yamaguchi, S.
		Improvement of Plant Protein Functionality by Protein Glutaminase	Okuda, K., Fujioka, Y., Yamaguchi, S.
		Enzymatic editing of vegetable oils to obtain a low diglyceride (DG) oil by two methods – specific hydrolysis of DG and conversion of DG to TG by using an unique lipase –	Kimura, T., Shinoda, T., Kojima, Y., Yamaguchi, S.
ifia/HFE JAPAN2021	May. 14th, 2021 (Kanagawa, Japan)	Enzyme-based food for the elderly that looks delicious and easy to digest	Ishigaki, Y.
IFT 21	Jul. 20th, 2021 (Web)	Develop a more savory vegan product with Amano's Umamizyme Pulse	T, Arledge.
2nd Japan-Switzerland-Germany Workshop on Biocatalysis and Bioprocess Development	Sep. 5th-8th, 2021 (Ascona, Switzerland, Web)	Identification of useful mutation from industrial Bacillus amyloliquefaciens	Matsubara, H., Onishi, Y., Koikeda, S.
		Creation of thermostable industrial lipase by three consecutive mutations using loop-walking method and machine learning	Yoshida, K., Kawai, S., Fujitani, M., Koikeda, S., Kato, R., Ema, T.
The 2021 Annual Meeting of the Society for Actinomycetes Japan	Sep. 18th-19th, 2021 (Web)	Industrial production of enzymes derived from Actinomycetes and contribution to their stable supply (SAJ Award for Corporation)	Yamaguchi, S.
Food-Tech Webinar Fall 2021 ~powered by addlight, Inc.	Sep. 22th, 2021 (Web)	Enzymes that creates new values for alternative proteins	Furukawa, K.
Approaching the 7th Nutrient –Academic Exchange Conference on Dietary Fiber	Oct. 15th, 2021 (Shanghai, China, Web)	Exploring the application of enzymes in dietary fiber	Zhao, S.
Pacifichem 2021	Dec. 16th-21th,2021 (Web)	Development of novel stereoselective esterase catalyzing (1R,3S)-ethyl crythanthemate by semi-rational-design	Ono,A., Koikeda, S.
		Development of Industrial Enzymes Using Molecular Dynamics Simulations	Ishihara, S., Yoshida, K., Ohno, A. Koikeda, S.

Journal/Book	Date	Title	Author
A Technical Journal on Food Chemistry & Chemicals, Vol.37 No.3	Mar. 2021	Enzyme-based food for the elderly that looks delicious and easy to digest	Ishigaki, Y., Morita, M., Nishio, K.
Seibutsu-kogaku kaishi 99 (4), 195	Apr. 2021	Is it possible to predict the future of proteins by AI?	Ishihara, S.
Scientific reports 2021, Vol.11, 11883	Jun. 2021	Enhancement of protein thermostability by three consecutive mutations using loop-walking method and machine learning	Yoshida,K., Kawai, S., Fujitani, M., Koikeda, S., Kato, R., Ema, T.
Scientific reports 2021, Vol.11, 16631	Aug. 2021	Improved functional properties of meat analogs by laccase catalyzed protein and pectin crosslinks	Sakai, K., Sato, Y., Okada, M., Yamaguchi, S.
Fermentation 2021, Vol.7, 294	Dec. 2021	Supplemental Aspergillus Lipase and Protease Preparations Display Powerful Bifidogenic Effects and Modulate the Gut Microbiota Community of Rats	Yang, Y., Kumrungsee, T., Kato, N., Fukuda, S., Kuroda, M., Yamaguchi, S.
Molecular Catalysis 2022, Vol.517, 112054	Jan. 2022	Enhanced activity and stability of protein-glutaminase by Hofmeister effects	Sakai, K., Sato, Y., Okada, M., Yamaguchi, S.
Scientific reports, 2022, Vol.12, 1168	Jan. 2022	Synergistic effects of laccase and pectin on the color changes and functional properties of meat analogs containing beet red pigment	Sakai, K., Sato, Y., Okada, M., Yamaguchi, S.

2022 Exhibitions

Date	Exhibition	Location
March 15-17	Food Ingredients China 2022	Shanghai (China)
April 8-10	Specialty Coffee Expo 2022	Boston (USA)
May 18-20	ifia Japan 2022	Tokyo (Japan)
June 21-22	FFT- Future Food Tech Alternative Proteins	New York (USA)
June 21-23	CPhI China 2022	Shanghai (China)
July 10-13	IFT 22	Chicago (USA)
September 7-9	Food Ingredients Asia 2022	Jakarta (Indonesia)
October 4-6	AOCS Sustainable Protein Forum	Chicago (USA)
October 25-26	2022 Protein Trends & Technologies Seminar	Itasca (USA)
October 31-November 3	Supply Side West & Food Ingredients North America	Las Vegas (USA)

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

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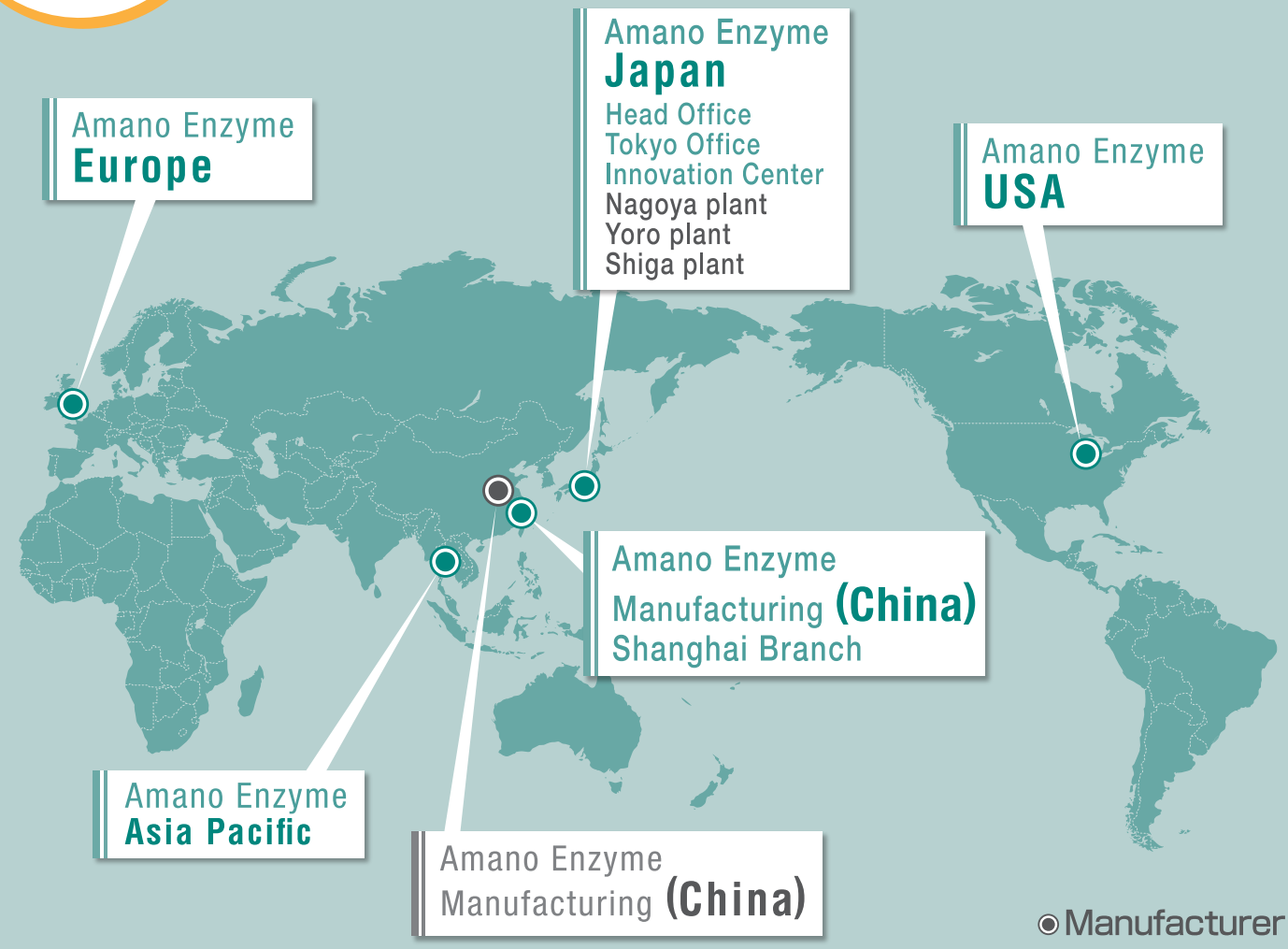
Amano Enzyme

World Network



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