Transformative Innovation

Pursue *Essential Research* to unleash breakthrough innovations that help realize more sustainable lifestyles by solving social issues and easing people's pains.

Social issues

The COVID-19 pandemic that has continued since 2019 has had a major impact on people's lives and society, but with the progress of vaccination, stagnant economic activity is beginning to recover. However, social changes, including destabilizing international affairs and rising prices of resources and raw materials in 2022, are greater than ever.

Consumers are also showing shifting values and consumption behavior due to the digitalization of daily life, while being affected by infectious diseases and economic conditions. The world's population is aging rapidly due to demographic changes, and efforts to reduce healthcare costs by extending healthy life expectancy are required.

In addition, the increasing frequency and severity of natural disasters around the world has raised concerns about the spread of losses and damage such as the collapse of infrastructure and ecological systems. To create a sustainable society for the future and counter global warming, companies need to work toward decarbonization, circular economy and decentralization / coexistence with nature.

Web Ministry of the Environment Annual Report on the Environment, the Sound Material-Cycle Society and Biodiversity in Japan 2022
https://www.env.go.jp/policy/hakusyo/r04/pdf.html

Based on the above changes, Kao is focusing on four issues.

- Normalization of infectious diseases: Concerns that the pandemic will be repeated on a different scale
- Environmental issues: Change in social values regarding mass production, mass consumption, and mass disposal
- Super-aging society: Increasing medical costs, shortage of nursing care workers
- Responding to changes and diversification: Rapid changes in society and the environment, diversification of consumer awareness and values

Policies

We have adopted the following three basic policies for our Research and Development activities.

1. Strengthen existing businesses: Respond to the needs and issues of consumers and customers with innovative products
2. Create new businesses: Generate the seeds of new businesses and plant them as early as possible
3. Share science and technology with society: Accelerate dissemination to society by sharing the results obtained through presentations at academic conferences and technological collaborations, etc.

Based on these fundamental policies, we swiftly identify changes in consumer lifestyles and social issues, employ science to unveil the mechanisms of phenomena, and apply technology to create products that meet diverse needs. In promoting these research and technology development activities, it is important to pursue *Essential Research* while constantly pursuing innovation.

Our activities are driven by the pursuit of *Essential Research* backed by inquisitive minds. The essence of universality, mechanisms, and root causes revealed through exhaustive investigation of objects and phenomena through the lens of science provides new evidence for solving issues faced by society and consumers, and sparks ideas for new technologies and consumer and customer value creation.

The pursuit of innovation is the embodiment of issue solving and value provision. We promote research activities from two perspectives, hoping to transform technology innovations into new products and services that will enrich the lives of consumers.

One of them is the backcasting perspective, which delves into the needs of consumers and customers, redraws the enriched lifestyles of the future, and works to realize them by making the most of the many research findings and technology assets accumulated at Kao. We will apply our core technologies, such as precise interfacial control, as our strength and combine them with new technologies to create astonishing products and services that will contribute to solving issues in the short- to medium-term, and reflect this in the development of our existing businesses.

The other is the forecasting perspective, which draws up the concept of Kirei for people, society, and the planet to address critical issues that are difficult to solve with current technology, and solves social issues through the pursuit of innovation. We will strengthen existing businesses and create new ones through new technologies that take full advantage of digital and other technologies. New businesses need to quickly roll out their obtained technology to society, improve its reliability with a lean start, and have a system to connect that technology to the business and sustain it. To this end, we will work with a variety of stakeholders to meet the challenge.

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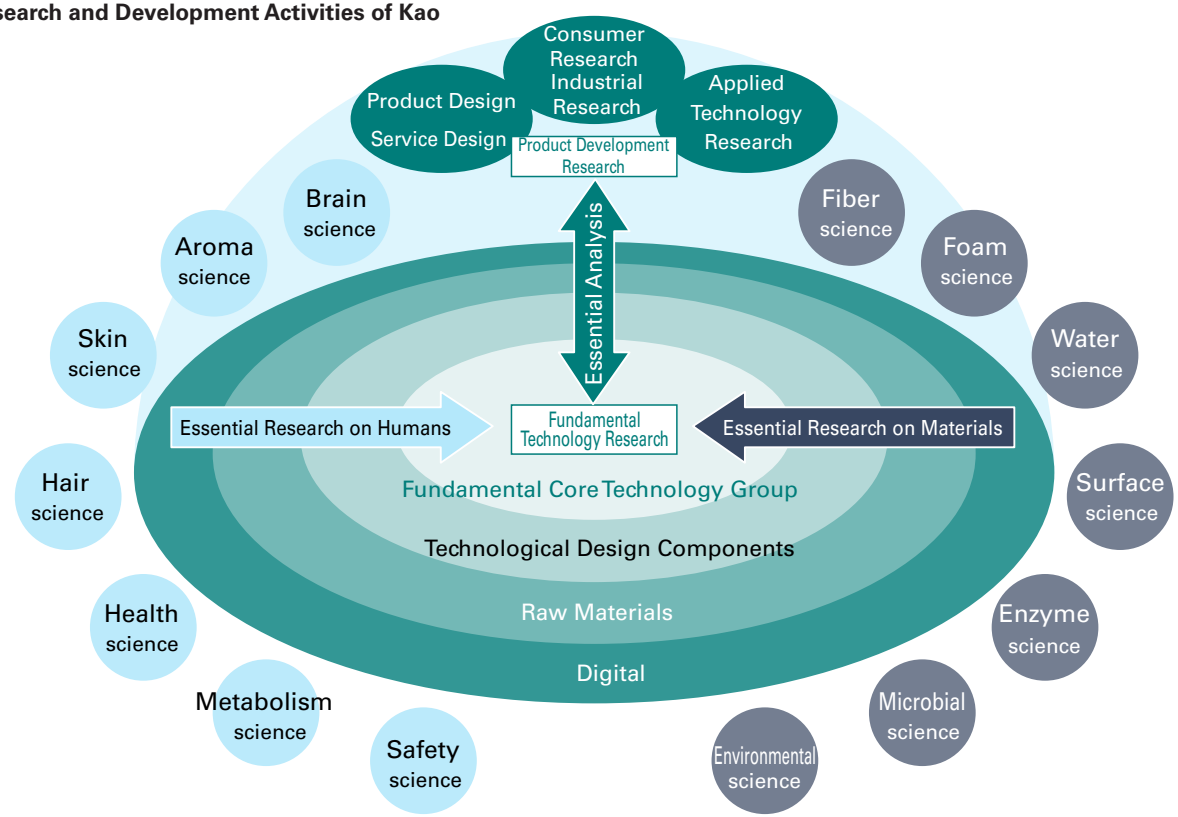
Research and Development Activities of Kao



Strategy

Risks and opportunities

Risks

Our goal is to enrich lives and realize a sustainable society in which everyone can confidently lead Kirei lives every day with vitality and peace of mind. In realizing this goal, the frequent occurrence of disasters due to climate change, environmental pollution caused by increased waste, and the super-aging society and declining birthrate are major risks not only to people's lives but also to our corporate activities, such as the impact on operations and the need to change R&D activities.

R&D activities have a nature that encompasses a wide range of risks, from product improvements for existing businesses to the development of advanced technologies with uncertain marketability. For example, if the original strategy or policy is significantly revised due to entry into a different industry or a change in policy, there is concern that the investment made up to that point will be wasted. There is also a risk that the productivity and competitiveness of R&D activities will lag behind the competitors due to the development of digital technology.

Loss of business opportunities due to damages caused by leaks or disasters involving hazardous materials handled by the R&D department or leakage of technical information on product development strategies or upcoming products prior to launch are also risks to the continuation of business activities.

Opportunities

The means to alleviate the risks are the many technology assets that we have accumulated to date. We believe that we can continue to give consumers and customers new experiences and satisfaction through our products and services. These products and services leverage our research findings and technology assets accumulated in wide-ranging business domains, as we have done with our core precise interfacial control technology, where we have built up expertise and deployed it for a diverse range of products from clothing to precision electronic components.

Strategy

Since the founding of our soap and detergent business in 1890, the company has expanded its business in the four areas of beauty in the Beauty Care and Cosmetics business, health in the Health and Life Care business,

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cleanliness in the Hygiene and Living Care business, and environment mainly in the Chemical business, with interfacial control technology as our core technology. Using our accumulated technology assets as our strength, we will promote innovation in the following three directions.

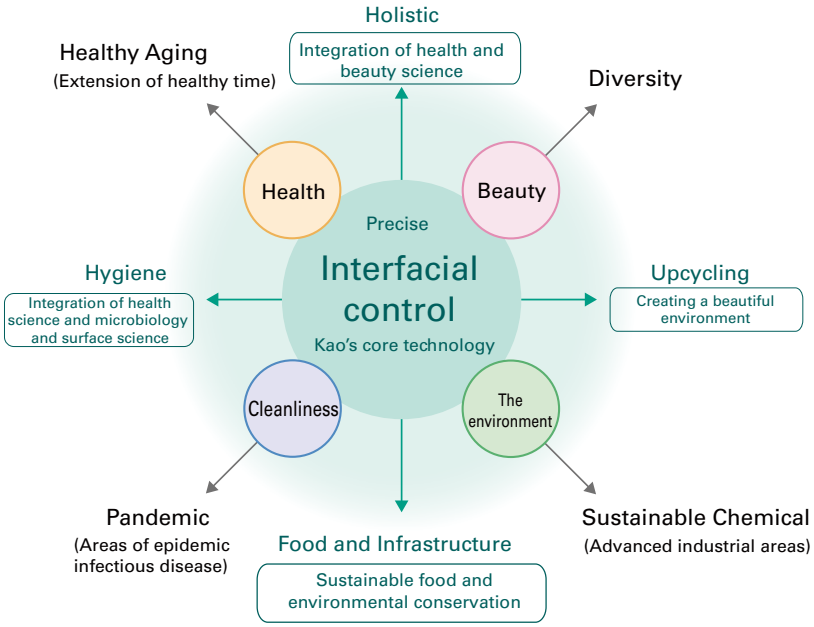
1. Strengthen existing businesses by deepening existing technologies (short-term)

We will accelerate product development by continuously improving and utilizing our technology assets to meet the diversifying values and needs of consumers. We will promote "Maximum with Minimum ESG *Yoki-Monozukuri*," which provides maximum value with minimum use, by selecting raw materials that minimize environmental impact while adding value to products, substituting rare raw materials, and developing technologies to reduce CO_2 emissions while conserving water and energy when consumers use our products.

2. Expand existing business in borderline areas (by 2025)

We will provide products and services that bring unprecedented value by rethinking conventional technologies from the perspectives of Environmental, Social and Governance (ESG) and QOL, and by creating new innovations at the boundaries of existing businesses.

- Hygiene: Safe and secure products and services that protect consumers from infectious diseases and unpleasant environments in daily life through technology to control bacteria and viruses
- Holistic: Products and services that provide a daily life rich in health and beauty both physically and mentally by considering beauty and health as a whole
- Upcycling: Recycling technology that transforms plastic containers and other waste into new resources and asphalt modifiers, etc. that make use of plastic waste
- Food and Infrastructure: Adjuvants that increases food production with the least possible usage of agrochemicals and solutions / services, etc. to strengthen infrastructure



3. Creation of new businesses by backcasting from future society (by 2030)

We envision a future society where no one is left behind in the face of global warming, climate change, and a super-aging population, and create new businesses through early implementation of new technologies and business models.

- Infectious diseases: Infection prevention technologies, etc. that can help everyone live safely amid the normalization of infectious diseases
- Population aging: Health care services, etc. to prevent geriatric syndrome and extend healthy life expectancy as we approach the super-aging society
- Diversity: Precision Life Care, etc. that supports and responds to the issues and differences of each individual
- Sustainable Chemicals: Resource-circulating society that recycles waste, CO_2 recycling, etc. instead of wasteful society

Social impact

We will solve environmental and social issues by offering distinctive technologies and innovative businesses and products in line with our strategy to

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enrich people's lives, and help to realize a resource-circulating society as well as safer, more reliable, and healthier lifestyles. We aim to become a needed presence for people around the world by continuing to create and offer technology solutions and value.

Contributions to the SDGs

Business impact

Research and Development activities will lead to increased sales of new and improved products, higher earnings and brand loyalty, as well as the creation of new businesses.

Governance

Framework

Risk management in relation to transformative innovation is carried out by the Internal Control Committee and opportunity management is conducted by the ESG Managing Committee, under the supervision of the Board of Directors. These committees are both headed by the President & CEO.

Risk management related to transformative innovation is conducted by the Internal Control Committee (meets twice a year) and its subordinate organization, the Risk & Crisis Management Committee (meets four times a year). These committees are headed by the Executive Officer Responsible for Corporate Strategy.

Opportunity management related to transformative innovation is conducted by the ESG Managing Committee (meets six times a year). Comprising outside experts, the ESG External Advisory Board provides advice and suggestions on issues raised by the ESG Managing Committee and offers outside viewpoints to be reflected into management, and the ESG Promotion Meeting executes the strategies.

The R&D Division is in charge of promoting transformative innovation. In R&D, each laboratory is positioned as an organization directly under R&D. A system is in place for product development (vertical axis in the figure) and fundamental technology (horizontal axis in the figure) laboratories to accumulate wisdom and organically collaborate with each other. We set R&D strategies in line with our management and business strategies to transform science into technology and technology into unique products and services, thereby contributing to business by solving issues faced by consumers and society.

In the existing business domains of beauty, health, cleanliness, and the environment, our product development laboratories view issues faced by consumers and customers from a scientific angle, collaborate with business divisions to define the policy for the value we will provide at an early stage, and continue to provide innovative products by evolving and making the most of technology assets. In addition, in the new business domains, our research institute for technology development plays a central role in creating technology innovations to address social issues from a future perspective, and we are considering early social implementation and commercialization through collaboration inside and outside the company.

These Research and Development activities are shared with management, including the head of the R&D Division, on a monthly and semi-annual basis to confirm progress.

In order to respond quickly and flexibly to changes in the business and social environment, the R&D Strategy Group acts as an intermediary and sets up a forum in the annual plan for reporting to operational and business management, including Executive Officers, so that policies, strategy implementation, and progress in Research and Development activities are shared. Members of this forum verify progress and revise strategies as necessary, speeding up decision-making and accelerating global growth.

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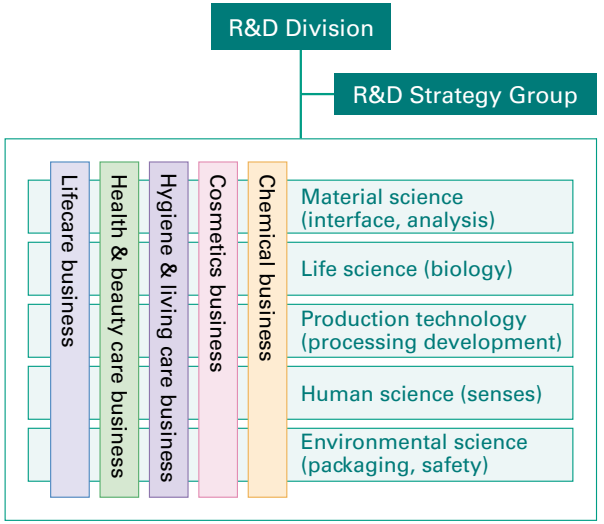

Education and promotion

To advance our Research and Development activities, we must develop individual researchers' advanced specialization, creativity and originality as well as foster a culture in which many researchers work together to take on challenges in new fields.

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For this purpose, we have established a research report database that all researchers can access to independently browse internal research findings, technology assets and the latest research results. We also provide opportunities to engage with leading-edge science and technology through lectures and technical guidance provided by outside experts.

In addition, we hold presentation sessions with participation and discussion open to all researchers to create opportunities for collaboration where new discoveries can be made through the exchange of ideas. Through the use of online conferencing tools, researchers, including those outside Japan, participate and interact with each other. We emphasize dialogue as well as efficiency through the use of digital technology, leading to innovation through the fusion of different types of knowledge.

Collaboration with stakeholders

Multi-faceted linkage and collaboration between industry, government and universities are necessary to solve challenging environmental and social issues. Open innovation is one example of this approach. New value is created when two or more parties mutually supplement and combine their technology strengths, and this enables products and services to be quickly delivered to consumers. Especially when it comes to realizing a sustainable society, collaborating with companies that are tackling the same social issues is necessary. To establish a resource-circulating society, we are working together to establish technologies to recycle packaging containers and address methods to newly utilize used diapers through demonstration experiments, with the aim of early social implementation.

By presenting important knowledge gained through Research and Development activities at academic conferences and through publications, we strive to propagate science and technology. This has earned us high recognition, including awards for various discoveries and technologies.

Risk management

We address a wide range of risks in our R&D activities, prioritizing risks with the greatest business impact. In order to respond promptly to risks in line with business changes, it is necessary to visualize the degree of progress and risk of research themes, to optimize the allocation of R&D expenses and personnel, and to make modifications according to the situation. It is also important to prepare for changes in the business environment by co-creating with governments and various stakeholders to keep abreast of the latest developments.

Furthermore, while enhancing the serendipity of researchers through experience, we are taking the initiative to incorporate simulation, artificial intelligence, machine learning, and other digital technology to improve the speed of Research and Development by, for example, narrowing down experimental targets.

With regard to risks related to continuing business activities, the Risk & Crisis Management Committee and the Responsible Care Promotion Committee within the Internal Control Committee work together to identify risks such as technical information leaks and chemical substance releases, and conduct self-audits to ensure that all researchers are aware of these risks.

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Risks related to transformative innovation are managed within the corporate risk management framework.

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Targets and metrics

Mid- to long-term targets and 2022 results

We will advance innovation, aiming to strengthen existing businesses and create new businesses. In our existing businesses, we will meet the expectations of consumers and customers and realize a sustainable society by providing safe and reliable quality as well as environmentally friendly products and services. In new businesses, we aim to make new proposals for social issues such as infectious diseases, hygiene and population aging.

2030 long-term targets

We have prepared concrete activity plans for two research objectives to ensure that all researchers conduct Research and Development activities with a high level of awareness.

1. Propose products with a major positive impact on lifestyles

Propose ten or more product releases by 2030 incorporating innovations capable of causing major positive change with respect to lifestyles, society or the environment (cumulative beginning in 2019)

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2. Propose businesses and systems with major positive impact on lifestyles

Propose ten or more businesses or schemes by 2030 incorporating innovations capable of causing major positive change with respect to lifestyles, society or the environment (cumulative beginning in 2019)

2022 results

To strengthen existing businesses, we are releasing products that solve an even wider range of consumer issues by leveraging our technology assets and combining them with new technologies. In addition, in order to enhance the QOL of consumers in an aging society that will gray even further as time passes, we have launched functional food products that partially assist walking and cognitive functions, and offer health support services using gait monitoring technology in collaboration with external companies.

As an example of expanding the boundaries of existing business, we are promoting *NEWTLAC 5000*, which uses proprietary technology to transform waste PET into an asphalt modifier to improve pavement durability as part of our upcycling* efforts. Given its capability to also reduce CO_2, the company's technological capabilities and social usefulness have been recognized by The Association for Resilience Japan at its 8th Japan Resilience Awards, which granted the company the runner-up grand prize and gold prize.

As the COVID-19 pandemic continued worldwide, we expanded our offering of hygiene products both within and outside Japan in 2022, while mosquito-borne malaria and dengue fever are also remaining major social issues. Using a method different from conventional repellents, we developed a technology that protects against bites by making it difficult for mosquitoes to perch on the skin, and launched it as *Bioré GUARD Moss Block Serum* in Thailand, where dengue fever is common.

Furthermore, in creating new businesses, we are working to commercialize a sebum RNA monitoring technology that enables precise visualization of daily changes in the condition of the skin and body. Based on Kao's technologies such as RNA collection and analysis as well as skin knowledge and databases, we are in the midst of building a business model to propose optimal solutions tailored to each individual through collaboration with external ventures and platforms.

* To give new value to something that would otherwise be discarded and configure it into a different product

Reviews of 2022 results

At the Kao Group Technology Innovation session in November 2018, we announced our new technologies in five domains: skin, health, hair, surface chemistry and environment.

In the surface chemistry domain, Bio IOS is an environmentally friendly surfactant derived from natural raw materials that are hard to compete with food applications, and is being expanded into a variety of products because it can reduce carbon dioxide emissions through product formulation. For the hair domain, a naturally occurring source of black hair melanin (coloring ingredient: dihydroindole) that supplements blackness in gray hair is being developed in products ranging from hair color to shampoos and conditioners. In the environment domain, we are collaborating with various stakeholders to conduct demonstration experiments on recycling film packaging, while at the same time, continue to develop technologies for horizontal material recycling to convert the material back into containers.

On the other hand, for the skin domain, fine-fiber technology is characterized by the formation of a natural ultra-thin film by blowing ultra-fine fibers onto the skin, and we are continuing to study applications for it while expanding various research findings. In the health domain, since sebum RNA monitoring technology is new and unique, we aim to commercialize it through social implementation in cooperation with various stakeholders while building consumer value and business models.

Currently, we have set a certain number of innovations as our mid- to long-term targets, aiming to change consumers' lifestyles and enrich society. We are also considering the need to measure the impact of this initiative on both existing and new businesses.

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Main initiatives

Development of foam cleaning products by refining precise interfacial control technology (short-term)

Kao has been developing a variety of products by fine-tuning the performance of foam.

Until now, the cleaning power of foam has been considered irrelevant, although its fluffy texture is pleasing. By controlling this foam at a high density, we have found that it spontaneously absorbs oil (dirt) and enhances cleaning power, while little of it is adsorbed into the skin, as the foam cannot easily penetrate the stratum corneum. These characteristics of dirt removal and gentleness to the skin are widely applied to face washes and body cleansers. By increasing foam volume and lather retention, we provide a comfortable, frictionless wash.

In addition, by dispensing the product as foam, even children and the elderly, who have had difficulty working up a lather, can easily spread the cleansing ingredients and thoroughly remove dirt. This property of firm and easy spreading is also applied to hair coloring.

In addition, as improvements to foam breaking helps to conserve water by reducing the amount of water used for rinsing, this technology is also being used for dishwashing detergents.

The act of washing has been around for a long time, but we expect that refining interfacial control technology will expand the world of washing for everyone, enhance the quality of life for increased comfort, and is environmentally friendly.

Protecting Future Lives Technology to prevent mosquito-borne infectious diseases (medium-term)

Mosquito-borne infectious diseases such as malaria and dengue fever are problems that pose a threat worldwide. To combat them, insect repellents and other agents are commonly used. By carefully observing mosquito behavior, Kao has developed a technology that prevents mosquito bites through application of a low-viscosity silicone oil to create a skin surface that mosquitoes dislike. This is due to the oil quickly wetting and spreading on the mosquito's legs, and applies Kao's core technology of precise interfacial control technology. Furthermore, when combined with a lower concentration of repellent, the number of mosquito landings was markedly reduced. *Bioré GUARD Moss Block Serum*, which employs this technology, was launched in Thailand in June 2022. We plan to promote activities that protect future lives through awareness-raising and research activities related to dengue fever.

Biochemical production using cassava residue from inedible biomass (long-term)

Bioethanol derived from biomass is anticipated to be applied as an industrial material as well as a substitute for petrochemical fuels. However, since most of them are made from edible biomass such as corn and sugarcane, the issue is to utilize non-edible biomass that does not compete with food sources. Focusing on the residue of cassava, a type of potato cultivated in the tropics and subtropics, Kao has developed an enzyme technology that converts the inedible part, consisting of sugar, to ethanol, after starch extraction. Development of this saccharification enzyme is the result of many years of working on detergent enzyme technology, and features a compact on-site production system that produces and supplies enzymes at the same plant site through a multi-enzyme production system that uses filamentous fungi to simultaneously produce multiple types of enzymes. Kao Corporation and Kao Industrial (Thailand) Company Limited have launched joint efforts to conduct a demonstration study on a manufacturing system after being selected by the New Energy and Industrial Technology Development Organization (NEDO) at its first public contest for an International Demonstration Project on Japan's Energy Efficiency Technologies (Study of Suitability of Demonstration Requirements) in FY2022. Our goal is to establish and commercialize an integrated production system for environmentally friendly bio-chemical products.

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Employees' opinions

We want to deliver new hygiene practices to the world through *Genba*-driven innovation.

Kohei Takeuchi
R&D - Sensory Science Research 4,
Kao Corporation

Our experts in various fields discussed in detail how consumers can protect themselves from infectious diseases spread by mosquitoes from various angles with the aim to become a company that protects lives, and created *Mos Block Serum* as a solution. While deepening the technology developed from the core technology of Kao, namely interface science, in our laboratories, we made numerous trips to Southeast Asia, where the dengue fever challenge is a big problem, and went through repeated trial and error until we were sure that this product would become a new practice to prevent mosquito-borne infection. The launch of this product opened up an opportunity to widen our scope to governments and third-party partners. We will also promote awareness-raising and research activities to further accelerate this activity.