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# KRIBB *focus*

1st Issue | 2017 No.1

**KRIBB COVER STORY**  
on a Journey to Transform Itself  
into a 'Leading Research Institute'

Strategic Research Groups beyond the Turning Point and the New Role  
of Government-Funded Research Institutions

**Developing RESEARCHER INTERVIEW**  
a New Anticancer Drug by  
Leveraging the Cellular Signaling Mechanism of Lactate

Dr. Young Il Yeom, Principal Researcher  
at Biotherapeutics Translational Research Center, KRIBB

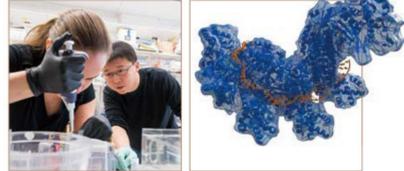


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# BIOTECH FOR ECONOMIC GROWTH AND BETTER LIVING STANDARDS

Korea Research Institute of Bioscience and Biotechnology (KRIBB) is the only Korean Government-funded Research Institute in the field of biotechnology and it is the center of excellence in leading Korea's biotechnology innovation and leveraging bioindustry.

## DOMESTIC FACILITIES

### Division of Strategic Research Groups

Resolution of national/social pending issues such as aging and rare/incurable diseases

### Division of Bioinfrastructure

Provision of industry-academia-research supports for primate materials and development of new drugs including bio organs for incurable diseases

### Division of Bio Innovation

Conduct of the technology marketing in line with supports for small and medium enterprises and technology development to commercialize biopharmaceutical materials

### Division of Biomedical Sciences

Target discovery to overcome incurable diseases and development of structure-based control technologies

### Division of Systems Biology and Bioengineering

Production of high functional food/pharmaceutical/ industrial materials and development of application technologies for such materials

### Division of Bioinfrastructure

Provision of industry-academia-research supports for primate materials and development of new drugs including bio organs for incurable diseases

### Division of Bio Innovation

Conduct of the technology marketing in line with supports for small and medium enterprises and technology development to commercialize biopharmaceutical materials

### Division of KRIBB Strategic Projects

Provision of the function of Bio Big Data infrastructure, conduct of tasks for government policy regarding BT, and development of stem cell-based technologies



## INTERNATIONAL NETWORK



- YAAS Yunnan Academy of Agricultural Sciences
- INBio Instituto Nacional de Biodiversidad
- BPPT Agency for the Assessment and Application of Technology
- IEBR The Institute of Ecology and Biological Resources

# Convergence and open Innovation

at Korea Research Institute of  
Bioscience and Biotechnology (KRIBB)

Kyu-Tae Chang, President of KRIBB

The Organization for Economic Cooperation and Development (OECD) predicted that the era of bioeconomy will arrive in 2030. Bioeconomy refers to a new economic paradigm in which biotechnology will be the key to resolving many of the humanity's challenges, including aging, serious diseases, food shortages, the depletion of energy, the destruction of the environment, and in which bioindustry will become the major engine for growth. Bioindustry is currently witnessing a dramatic transformation as many developed nations are increasing their related investments recently. Depending on the field of study, bioindustry is categorized into Red, Green, and White Bio. Red Bio, coined after the color of blood, applies biotechnology to the fields of medicine and pharmaceuticals, while Green Bio, named after the color of plants, is the field of applying biotechnology to the agriculture, livestock, and fisheries industry. Moreover, White Bio, which signifies the black smoke of factories changing into white, refers to the fields relating to biomaterial and environment-friendly energy. Among them, Red Bio accounts for 65% of the overall bioindustry market and can be broadly divided into healthcare and new drug development. This year, the World Economic Forum (WEF) has nominated Red Bio as one of the top ten future potential technologies in 2017.

To secure leading-edge status by the bio-economy era in 2030, we need to start research and development as soon as possible to reach the world's top technology. This is because, for instance, new drug development in Red Bio typically takes more than a decade from the beginning of technological development to deliver tangible results. More voices are calling for the need to build a virtuous cycle, starting from the R&D innovation of the bioindustry to secure new technologies, expand the industry, and re-investment, which can translate R&D innovations into successes in the market, and is capable of creating new technologies and industries through convergence with other technologies. To build a virtuous ecosystem of the bioindustry, definite roles shall be defined for

each stakeholder, including universities, businesses, research centers, and hospitals.

In particular, government-funded research institutions like Korea Research Institute of Bioscience and Biotechnology (KRIBB) shall serve as the hub for R&D innovation. First, KRIBB should become cradles for new growth technologies by carrying out long-term, large-scale, and high-risk R&D projects that cannot be led by universities and businesses. Additionally, KRIBB needs to act as the hub of convergence with other technologies, such as ICT and medicine, as well as the stage for converging research with related industries at the ground level. KRIBB also needs to develop innovative technologies that can resolve the pending national and social issues, such as preparing against contagious disease epidemics, ensuring food security, and preserving the ecosystem. To this end, KRIBB has established five Strategic Research Groups (Aging Research Center, Personalized Genomic Medicine Research Center, Hazards Monitoring Bionano Research Center, Anticancer Agent Research Center, and Rare Disease Research Center) to provide treatments for serious illnesses and to respond to current social issues. The 'CiM (Customized i-Medicine) Convergence Research Group' led by KRIBB is also a good example of R&D innovation, with participation from the Research Institute of Chemical Technology, Korea Basic Science Institute, hospitals, pharmaceutical companies, and universities. The objective of the CiM Convergence Research Group is to offer new lives to patients of incurable diseases by developing stem-cell based customized NK cell therapy and to stimulate the related new drug industry.

Peter Drucker once said, "The best way to predict the future is to create it." Our future depends on what we do now. For Korea to lead the world of bioeconomy in 2030, we need to start working towards building a virtuous circle of bio-ecosystem with R&D innovations, and KRIBB shall stand at the forefront of such an endeavor. [▶▶](#)



## KRIBB on a Journey to Transform Itself into a 'Leading Research Institute'

STRATEGIC RESEARCH GROUPS BEYOND THE TURNING POINT  
AND THE NEW ROLE OF GOVERNMENT-FUNDED RESEARCH INSTITUTIONS

When did Korea's industries become developed? Of course, scholars' opinions may differ, but economists consider the industrial structure has been shifted into a 'developed market model' since the late 1980s. This is because since then, the private investment in research and development (hereafter R&D) has exceeded the investment of the public sector. R&D generated economic value which was then re-invested into new technology development. This established a virtuous cycle of a sound industrial system. However, this change in status has left the public sector with a new challenge. What role should the public sector play in the ever-changing industrial field and the world of research?



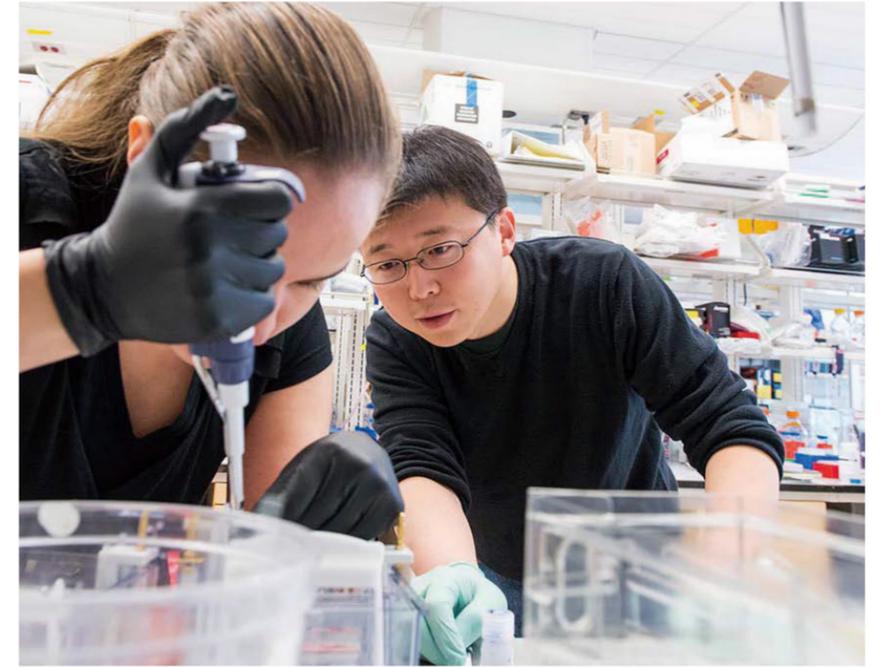
The major issue in the life sciences over the last three years has been the fight over the patent rights on CRISPR-CAS9, so-called next-generation genetic scissors. Many renowned businesses and institutions, including MIT, UC Berkeley, Google, Novartis, Bayer, and the Max Planck Institute have a stake in this area. In Korea, the Institute for Basic Science and Toolgen are involved in the CRISPR conflict. CRISPR technology is the prize for the life sciences and relevant industries since it is expected to have significant value (in the trillions of won) in the future.

In fact, unlike its popular conception as a recent advancement in technology, CRISPR has been known to the world of academia for almost 30 years now and 10 years have passed since its detailed function was known. However, back then, it might have been viewed as a mere interesting case study that CRISPR showed the 'existence of an immune system in bacteria.' Even the early researchers might not have expected the drastic change CRISPR would later bring to academia. It was only when Professors Jennifer Doudna and Emmanuelle Charpentier identified the CAS9 protein and showed that it can be used for genetic modification. So, CRISPR was reborn as a technology with tremendous potential.

### The New Role of Public Research in the Era of Technology Management

Modern research in science and technology has grown too vast to rely on a single individual genius. Most research requires significant investment such as time and money, and many researchers engage to complete one single theory. Therefore, both industry and the government, the main sources of workforce and capital, expect research in science and technology to deliver tangible benefits.

The issue with research in basic sciences, which requires extensive investment of both time and capital, is that it is sometimes considered as 'a costly field without much concrete performance.' This statement is especially true for government-funded research institutions in Korea which have been contributing to research outcomes



Feng Zhang at his research lab. He was the first winner of CRISPR patent dispute. © MIT

that lead to direct impacts on industry and economic development. As the economic benefits of private research institutions began to outweigh government-funded institutions since the 1990s, the image of these government-funded institutions as public institutions was considered as low performance compared to high investment. Indeed, 2006 report by the Ministry of Science and Technology shows that the cost in government-funded research increased by 114% from 1998 to 2004, while the number of patents registered by such government-funded research institutions decreased by 12.9%.

Of course, it is only natural to expect concrete results when the available resources are limited. However, unlike in the past when technological advances were new, we now need to consider the roles that best fit the research or institutions under the current complex environment where a single institution or researcher may not easily consider all aspects of technological developments and their applications. The example of CRISPR highlights the roles

that public institutions should play. The reason behind CRISPR gaining the spotlight as a genetic editing technology with tremendous economic value lies in the numerous studies performed even before the research published by Professor Doudna. It was Dr. Yoshizumi Ishino of Japan who first discovered the CRISPR sequence from the genes of *E. coli*, and after the completion of genome map in 1994, it was confirmed that the sequence is common in many bacteria. Dr. Rodolphe Barrangou and Dr. Philippe Horvath confirmed that CRISPR played an important role in the immune system of the bacteria. It was only possible to catch the big fish of the '3rd generation genetic engineering technology' as the research continued over a long period of time, which in the past seemed so distant from genetic engineering.

Many theories must be supported in order to deliver research performances that can be used in industrial settings. These theories need a substantial amount of time to offer tangible outcomes, and it may be difficult to expect

direct economic benefits from them. With the time required to recover investment capital and with uncertainty over the possibility of such a recovery, there are high risks for businesses to commit themselves to such research despite its necessity.

This 'niche' is where the new role of government-funded research institutions lies. To carry out research in fields that require industrial and social applications which is not easy for businesses to engage in, in fields that may have significant economic benefits despite the time needed and uncertainty, and in fields that are typically characterized by a 'High Risk, High Return' nature, the sources of funding must be stable so as not to be susceptible to the market response or the desire for value creation. Against such a background, it shall be the role of the public research institutions to take the lead, which places emphasis on the intent of the policy or the establishment of the institution rather than on the changes in the market.

#### The New Role of the Government-Funded Research Institutions: Incubators for Leading Research

Nonetheless, there is a major challenge that must be overcome for public research institutions to

faithfully carry out long-term and large-scale research. This challenge is to change the research environment which currently focuses on the mass production of short-term results.

The negative attitude towards public research, including that conducted by government-funded research institutions, is due to the 'lack of change in the research demanded despite the change in circumstances.' At the moment, the research activities of government-funded institutions are evaluated on a quarterly basis, with a heavy bias towards short-term assignments that span one or two years. The number of technology transfers and examples of business developments are also key performance indicators. In short, the current operation model is optimized towards research that can deliver quick industrial applications.

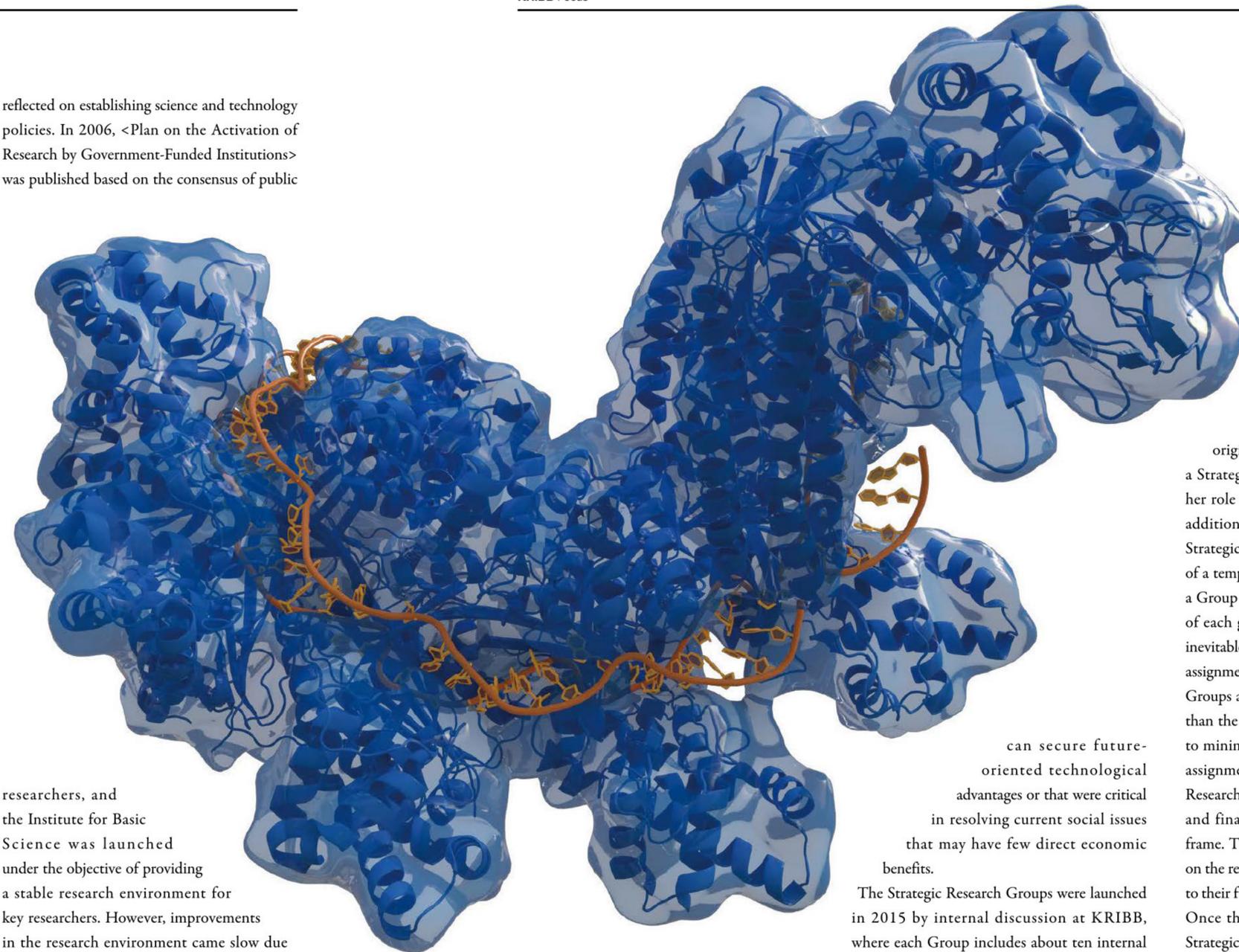
Such an environment makes it difficult to carry out creative research. Short-term projects tend to require less research costs and conducts numerous studies simultaneously to secure more research funding, which results in a lower level of concentration and efficiency. More than anything, the issue lies in not being able to take on creative research activities that strive to look for various methods and undergo repeated trials and errors.

Such shortcomings were recognized during the previous participatory administration and were

reflected on establishing science and technology policies. In 2006, <Plan on the Activation of Research by Government-Funded Institutions> was published based on the consensus of public

researchers, and the Institute for Basic Science was launched under the objective of providing a stable research environment for key researchers. However, improvements in the research environment came slow due to administrative and legal issues around government-funded research institutions. This was not easy to resolve as both assessments of the institutions and relevant legislation had to be revised.

Even so, each of the government-funded research institutions considered many ideas to improve the research environment within the boundaries of current laws and regulations. One well-known example of this was the launch of the Strategic Research Groups of KRIBB. These Strategic Research Groups were established to support research assignments in the basic sciences that



Molecular structure of Type-I CRISPR-surveillance-complex, bound with the target DNA. Without prerequisite researches in public sector, it may have taken more time to use CRISPR. © Thomas Spletstößer

can secure future-oriented technological advantages or that were critical in resolving current social issues that may have few direct economic benefits.

The Strategic Research Groups were launched in 2015 by internal discussion at KRIBB, where each Group includes about ten internal and external researchers with clear objectives. This was based on the lessons learned from previous experiences in operating research centers or strategic research institutes. While KRIBB in the past operated separate centers for different fields of research, some pointed out that this model was not adequate in carrying out modern research assignments which involve collaboration among various fields of studies. Thus, KRIBB was restructured into a 'mission-oriented' institution conducting research by specific objectives. However, this too was not sustainable as the organizational structure of

each individual center grew extensively. Once again, the framework has been revised to provide stable support for long-term research by maintaining small-scale groups of key researchers to work on selected objectives.

The characteristic feature of the Strategic Research Groups can be seen in the 'double-hatting' of roles by the members, where they

maintain their positions in the original teams. The researcher assigned to a Strategic Research Group will not lose his/her role in the original team but will take the additional role as a member researcher in the Strategic Research Group. The Group is more of a temporary task force. The members within a Group work on the theme set by the director of each group for three years. Of course, it is inevitable to engage in a certain level of external assignments to secure research funding, but the Groups are supported by funding that is greater than the general average budget within KRIBB to minimize the burden on externally financed assignments. The assessments of the Strategic Research Groups are also simplified to interim and final reports within the three-year time frame. This allows the members to concentrate on the research set by the director of each Group to their full potential.

Once the three-year time period is over, the Strategic Research Groups will be evaluated on whether they should be continued or dismissed after presenting the results. However, as the Strategic Research Groups are operated under a 'sunset approach' that allows the researchers to focus on their desired area of research, the core performance results of the three-year research are transferred over to relevant teams or external research institutions or partners to collaborate and continue through follow-up research. Thus, the Strategic Research Groups function as 'incubators' of long-term assignments. Once the groups are dismissed, the researchers will return to their original teams.



Groundbreaking ceremony for Korea Institute of Science and Technology(KIST). During industrialization period(1960s~1970s), the development of science and technology was led by public sector. © National Archives of Korea

### From Cancer Treatment to Social Safety ... A New Challenge to Become the Best Bio R&D Institution

Currently, Korea Research Institute of Bioscience and Biotechnology (KRIBB) operates the five Strategic Research Groups — Aging Research Center, Personalized Genomic Medicine Research Center, Hazards Monitoring Bionano Research Center, Anticancer Agent Research Center, and Rare Disease Research Center. The basic research on aging for diagnosis and treatment, as well as the research on contagious diseases for securing public safety, are all fields of basic research required for industry and society in a longer-term perspective rather than for immediate benefits.

The Aging Research Center focuses mainly on research on musculoskeletal disorders associated with aging out of the wide range of aging studies. The reason for not tackling all aspects of aging is because it is a very complex phenomenon that encompasses many diverse fields. And sarcopenia, gradual decline of muscle function and mass with aging, is emerging field of interests, which began to be recognized as “disease” by World Health Organization (WHO) in 2016. Aging Research Center is working on developing diagnosis of sarcopenia as well as interventions using natural compounds, chemical drugs and biologics. For the same reason, there are active collaborations and divisions of research with external institutions. The Center has built a wide and robust collaborative research framework with medical institutions including Seoul National University Hospital and Eulji University Hospital, the US National Institute on Aging, and businesses like Gyeonggi Bio and Dong-A ST Pharm.

The Personalized Genomic Medicine Research Center carries out research on treatments for incurable cancer using genome-wide technology. As such cancer research is a global issue, collaborations are in progress with Severance Hospital, UC San Francisco of the US, and University of Tokyo School of Medicine and Dentistry of Japan.

The Hazards Monitoring Bionano Research Center is engaged in research on detecting and

analyzing biohazard materials. The Center focuses on fighting contagious diseases and responding to bioterror threats by combining bioscience with nanotechnology. With its heightened importance in the public sector, the Center was nominated as a 'frontier project group.' The Center currently collaborates with the National Nanotechnology Center of Thailand.

The Anticancer Agent Research Center carries out research on the identification of anticancer agents from various sources. The Center works with RIKEN of Japan, NCI of USA and is collaborating in various fields.

The Rare Disease Research Center intends to provide solutions for rare diseases that specifically afflict Koreans. Currently, the Center is building an integrated database to find the genetic solution to 'hereditary paraplegia' and is closely working with Samsung Hospital, Chungnam University, and KAIST.

The five Strategic Research Groups finished their interim assessment last June and will have their

final assessment at the end of 2018. They have already passed their mid-way point. While there are still many areas for improvement as this is the first run of such groups, KRIBB will continue to refine the framework of the Strategic Research Groups with the advice of external experts.

We cannot predict whether the new framework of KRIBB will result in meaningful future outcomes like CRISPR. In fact, considering the intent and purpose of the Strategic Research Groups, it might not even be meaningful to think in advance of the future applications of the research, as was the case with the CRISPR genetic engineering technology. This is because the purpose of the Strategic Research Groups is to concentrate on research that cannot be measured for its actual benefits but to generate leading research findings, which is the new role of public sector research. The reason for public and private interest in this new attempt by KRIBB is that it provides a glimpse to the direction forward for public sector research under Korea's current circumstances. **KR**



Entrance view of Korea Research Institute of Bioscience and Biotechnology (KRIBB) Ochang Branch Institute.

### Interview with Vice President Jang-Seong Kim of KRIBB

KRIBB had been discussing about the Strategic Research Groups for quite some time. The debate over the new role of government-funded institutions and the organizational structure for this new role has continued since the new millennium. However, it took much effort from many individuals for the Strategic Research Groups framework to really take shape. Vice President Jang-Seong Kim is a key person behind the agenda. Since he took office as Vice President, the first initiative was to launch the Strategic Research Groups. As a key individual who was involved from the early stages of establishing the framework, we interviewed Vice President Kim on the philosophy behind the management of the Strategic Research Groups.

#### The Strategic Research Groups are new structures that were rare at existing government-funded research institutions. What is background of their establishment?

There has been a lot of debate on what roles government-funded research institutions should play. In particular, there was consensus that the roles of government-funded research institutions are to connect the academic research of universities with the technologies required by businesses and to resolve nation-wide challenges. These roles are too complicated and difficult for individual researchers to take on. Thus, the idea of forming a group of researchers by a given mission led to the establishment of Strategic Research Groups. On top of that, there was intent to concentrate support on research that may result in good performances.

#### There seems to be similarities with the intent for launching the Institute for Basic Science.

The scope of research performed by government-funded research institution is beyond the basic sciences. As government-funded research institutions are research institutions and public institutions at the same time, they have to take on the role of resolving issues demanded by society. Therefore, KRIBB has a very different role from that of the Institute of Basic Science, which focuses on the research work of individual researchers. The format of the Strategic Research Groups is more aligned with the structure of the

#### you planning to continue with the performances of the Strategic Research Groups?

The Strategic Research Groups were initially started under the sunset approach. Rather than producing the final results within the three-year time frame, the framework intends to focus on generating results that can be continued for in-depth follow-up research. Even when a Strategic Research Group is dismissed, the research in progress and the group's performances will be transferred to various research teams and external institutions if necessary. That is, the Strategic Research Groups will be planting the seeds, so to speak.

#### As you have been involved since the establishment of the Strategic Research Groups, please share your views on the way forward.

The core value of the Strategic Research Groups is 'excellence.' These are not just outstanding performances, but performances that can have practical contributions to our society which may not be easily produced by other

institutions. This is why I think that the performances of the Strategic Research Groups should not stay within the walls of KRIBB but to be shared with businesses, medical institutions, and the government because it is the duty of government-funded research institutions to provide the source technology to places that require technology to ultimately deliver useful services.



#### The three-year period seems short for the assignments of Strategic Research Groups. How are

## Developing a New Anticancer Drug by Leveraging the Cellular Signaling Mechanism of Lactate

DR. YOUNG IL YEOM, PRINCIPAL RESEARCHER  
AT BIOTHERAPEUTICS TRANSLATIONAL RESEARCH CENTER, KRIBB

Dr. Young Il Yeom, Principal Researcher at Biotherapeutics Translational Research Center at KRIBB, was awarded the Ungbi Medal, the Order of Science and Technology Merit, for his contributions on the Day of Science and ICT last April. Dr. Yeom discovered that lactic acid, previously known as a byproduct that causes fatigue, plays a key role in signal transduction for cell growth and angiogenesis. It is expected that his finding will make a significant contribution to the development of treatments for cancer and inflammatory diseases by regulating the cellular signaling mechanism of lactate. On April 16, 2015, the results of his research were published in the online version of the world-renowned biology journal Cell. In November of the same year, Dr. Yeom won the Science and Technology Award of the Month from the National Research Foundation of Korea for his finding and its applications in the treatment of cancer by regulating lactate-induced signaling inside the human body.

### 'A New Discovery with an Unexpected Twist'

"Lactic acid is prevalent in the human body because it is produced when we exercise or when we are ill. In fact, there has not been much research on lactate until recent years as it was regarded mostly as a fatigue agent or a waste product of the metabolism of our body. However, as we now know that lactate regulates the expression of carcinogenic genes, it has given us a whole new perspective on how we view lactate."

In his own words, Dr. Yeom explained the discovery of the new functions of lactate as 'a new discovery with an unexpected twist.' The team of researchers led by Dr. Yeom elucidated that lactate, a key metabolite of cancer cells, promotes the expression of the carcinogenic gene NDRG3. This finding can be said to have established the key role of lactate as a crucial cellular signaling agent that facilitates the growth and malignancy of cancer cells.

The concept of cell signaling was introduced only after the field of molecular biology started to grow in the 1980s, and thereafter we have been able to carry out experimental research for its verification. Cells grow or move by adequately responding to stimuli or signals generated when interacting with other cells or their environment. They can only carry out their proper functions when such stimuli or signals are passed on to the desired destinations. As such, a number of cells exist together as a signal transduction system.

At first, Dr. Yeom started his research on how genetic traits were passed down in single organisms or groups, just like in the study of Mendelian Genetics. In the process, his curiosity about their cellular mechanism of action grew and later became interested in cellular signaling studies. He explained that he "screened many genes that were related to diseases, such as cancer, out of about 30,000 human genes and focused on the functions of certain genes that are improperly activated in the cancer cells" and



“

We introduced a foundation for developing new therapies with the discovery of a new carcinogenesis mechanism, and contributed to advances in biotechnology by building on its infrastructure and developing new professional talents.

”



Dr. Yeom at his laboratory with a post doctoral researcher.

that he “found that normal cells developed into cancer cells when abnormal signals were given by such genes.” In particular, he discovered that lactate controlled the expression of a newly found oncogenic gene NDRG3. Currently, Dr. Yeom is fully engaged in research for the development of a cancer treatment that targets the lactate-induced signal transduction mechanism of NDRG3.

**Three Roles of KRIBB**

“Compared to 23 years ago, Korea has witnessed a major advancement in its science

and technology and now stands on par with the leading nations in many areas. Today, the country has expertise in diverse fields in an organized manner and has a competitive edge in the global market.” This was what Dr. Yeom said, comparing the science and technology landscape in Korea today to 1994 when he first came to KRIBB. He also explained that “we are living in a time of paradigm shift, where we used to carry out research and introduce policies in the past to keep up with the developed nations, we are now entering a new creative R&D era to lead the world by creating something new.”

Dr. Yeom explained that R&D results go through the stages of discovery, in-depth research, development, commercialization (industrialization) and production for their benefits to be shared with the public and that government-funded research institutions must take on the roles of the in-depth research and development phases. Dr. Yeom summarized the three roles that can be played by the government-funded institutions (KRIBB) against this backdrop.

First, unlike universities, where an individual professor takes on his or her own research, government-funded institutions should carry out large-scale convergence research by leveraging the organized structures of departments, centers, and operational subunits. This means that government-funded institutions should play the main role in creating new technologies for the next decades to come. Second, government-funded institutions shall take on leadership roles in resolving nationwide challenges by collaborating with experts in the fields relevant to science and technology as well as experts in social sciences such as law, regulations, humanities and religion. KRIBB, in particular, should actively take the lead in forming organizations and resolving nationwide bio-issues (such as SARS, MERS, and foot-and-mouth disease). Lastly, KRIBB shall inject public funds to build large bio-related infrastructure and to provide it to universities, small institutions or small and medium-sized enterprises.

**“Time to Give Back to the Public”**

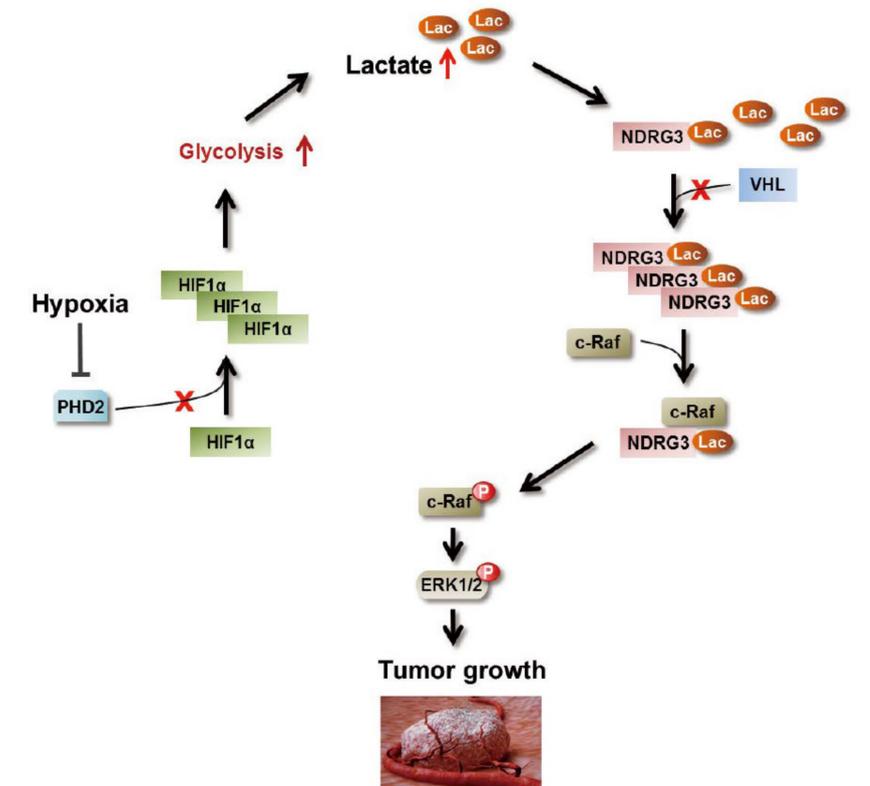
“Now it is time for us to contribute to improving quality of human lives or build up intellectual capacity for business development. KRIBB must do this as well. As taxpayers’ money is being invested, it is obvious that we must think more about how we can repay what we were given,” Dr. Yeom commented on the future direction of KRIBB.

Bio-engineering, the technology related to medicine in particular, has gained attention of many, but research in bio-engineering requires a lot of time and money. Dr. Yeom explained, “technology in medicine is related to the health

and lives of people, requiring caution under legal and social limitations as well as mid- to long-term investments,” and added, “that is why communication among the people, the government and researchers is needed, so we can establish mutual understanding for the need and effects of research.” This means that building a consensus based on communication will lead to the establishment of policies that will result in the necessary mid- to long-term support.

The field of cellular signaling, Dr. Yeom’s main area of research, can also lead to active industrialization of its research outcomes.

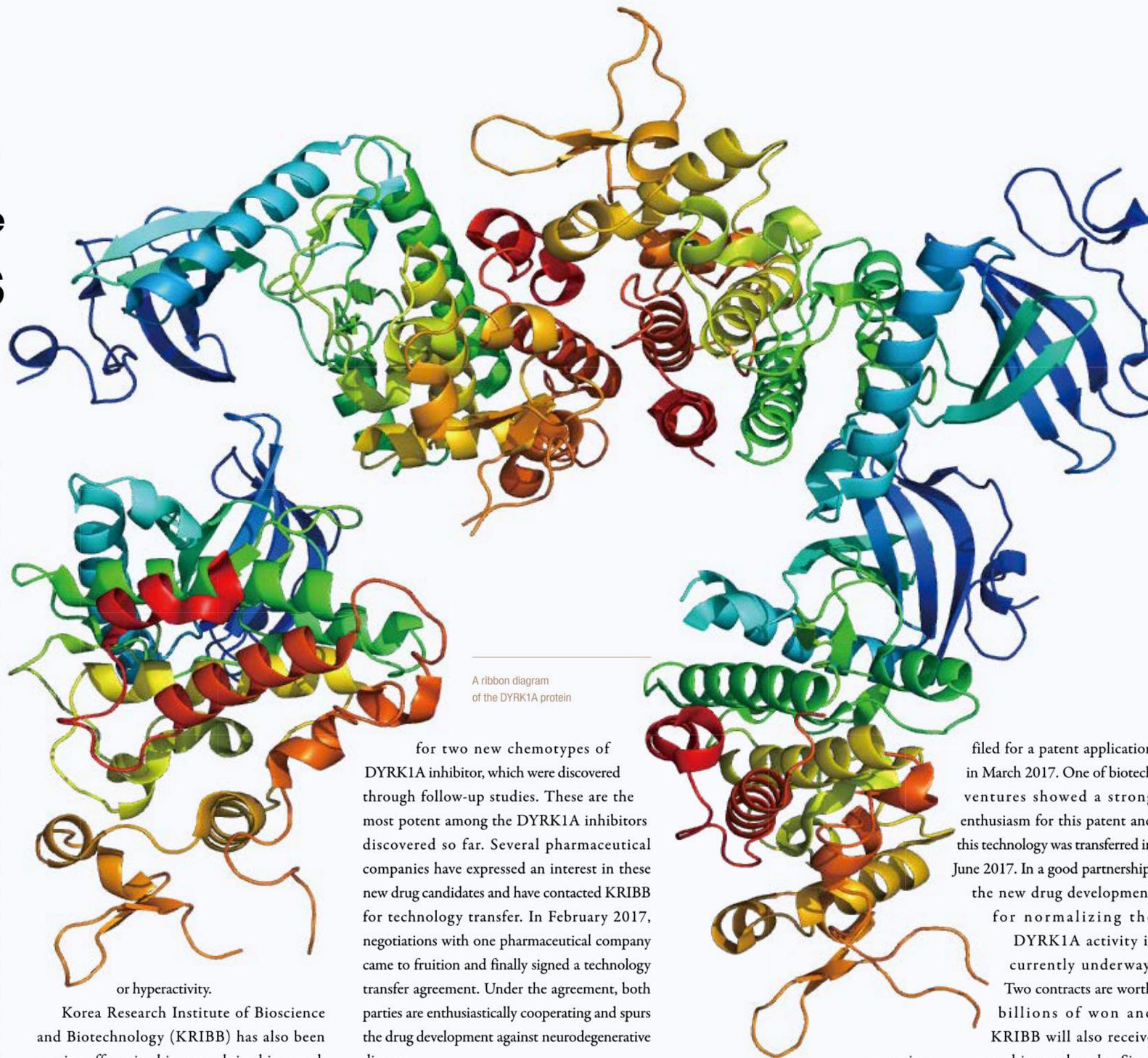
He stated, “deregulation in the cellular signal mechanism can lead to diseases,” and “we can diagnose them by monitoring closely to develop new drugs that can target the points of concern.” What is his aspiration as a researcher? He replied “we hope our research outcomes can eventually reach the people who supported us.” He added that he is “currently developing new drugs by leveraging lactate-induced signaling” and working closely with the Graduate School of New Drug Discovery and Development of Chungnam National University and the New Drug Development Center of Daegu Medical Innovation Foundation. [\[X\]](#)



Modulation of angiogenesis and cell growth by the lactate-induced cell signaling in the hypoxic tumor microenvironment.

## KRIBB's Discovery, the First Step to Treating Intractable Diseases

Down Syndrome (DS) is the most common genetic disorder, with an incidence of 1 in 800 live births, and is caused by a complete or partial trisomy of human chromosome 21. DS is characterized by various symptoms, including mental retardation and congenital heart defects, as well as by defects in immune and endocrine systems. As studies on Down Syndrome have advanced, it has been revealed that the DYRK1A (Dual-specificity tyrosine phosphorylation-regulated kinase 1A) protein has an important role in brain development. Moreover, all adults with DS develop brain pathology similar to that of Alzheimer's disease (AD), a representative neurodegenerative disease. At the neuropathological level, DS and AD share several features that are characterized by the presence of amyloid plaques and neurofibrillary tangles, the formation of which is affected by the aberrant phosphorylation of Tau (for neurofibrillary tangles), as well as of amyloid precursor protein (APP) and presenilin 1 (PS1) (for amyloid plaques). In addition, it has been reported that DYRK1A directly phosphorylates Tau, APP and PS1. These observations provide a plausible link between DS and AD that could explain the early onset of AD-like symptoms in the majority of people with DS and further indicate that DYRK1A could be a promising therapeutic target for treating diseases such as DS and AD that involve DYRK1A overexpression



A ribbon diagram of the DYRK1A protein

or hyperactivity.

Korea Research Institute of Bioscience and Biotechnology (KRIBB) has also been putting efforts in this research in this regard. Research team, led by Dr. Sungchan Cho, has recently reported CX-4945 as an inhibitor of DYRK1A with a high potency, which its patent has been applied in May 2015. In December 2016, Dr. Cho filed further patent applications

for two new chemotypes of DYRK1A inhibitor, which were discovered through follow-up studies. These are the most potent among the DYRK1A inhibitors discovered so far. Several pharmaceutical companies have expressed an interest in these new drug candidates and have contacted KRIBB for technology transfer. In February 2017, negotiations with one pharmaceutical company came to fruition and finally signed a technology transfer agreement. Under the agreement, both parties are enthusiastically cooperating and spurs the drug development against neurodegenerative diseases.

Meanwhile, the third chemotype of DYRK1A inhibitor discovered by the successful collaboration between the research teams in KRIBB and Daegu-Gyeongbuk Medical Innovation Foundation (DGMIF) has been

filed for a patent application in March 2017. One of biotech ventures showed a strong enthusiasm for this patent and this technology was transferred in June 2017. In a good partnership, the new drug development

for normalizing the DYRK1A activity is currently underway. Two contracts are worth billions of won and KRIBB will also receive

running royalties on the sales. Since the search for an Alzheimer's disease treatment has been unsuccessful for the past two decades, these accomplishments of KRIBB will provide a new therapeutic approaches to tackle this devastating disease. 

## Efficacy of Red Beans revived as a New Drug

The *Phaseolus angularis* seed, also known as red bean, has been regarded as a "miraculous" food from ancient times. According to folklore, the red color of the bean is believed to ward off bad luck. Traditional medicine describes the red beans as non-poisonous, with a diuretic effect, and good for treating swelling in the body. The current Oriental medicine prescribes a *Phaseolus* seed decoction, which is prepared by infusing red bean and mulberry bark together, to reduce swelling.

The efficacy of red beans has been further elucidated by modern science. In modern medicine, red beans are recommended for angina and diabetes. It also has the ability to relieve renal toxicity.

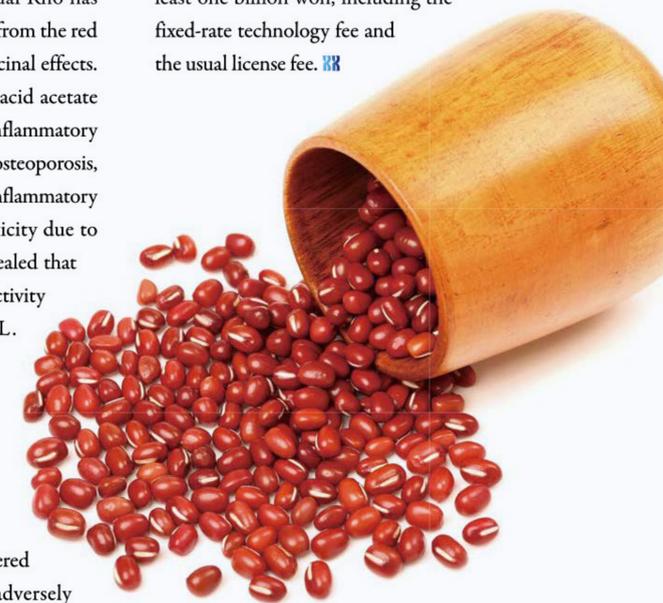
The research led by Dr. Mun-Chual Rho has been the extraction of constituents from the red bean extract to understand its medicinal effects. Studies have shown that oleanolic acid acetate present in the red beans alleviates inflammatory diseases such as arthritis, atopy, and osteoporosis, which are induced by activation of inflammatory factors, as well as reduces renal toxicity due to drugs. The studies have further revealed that oleanolic acid acetate inhibits the activity of STAT3, TLRs and RANKL. STAT3 is a protein involved in cell growth and death, TLRs are a protein involved in immune response activation, and RANKL is a protein involved in immune responses and bone formation.

The inflammatory response is triggered by the immune system, which is adversely

affected by oleanolic acid acetate. Therefore, oleanolic acid acetate promotes effective inhibition of inflammation.

The studies by KRIBB have shown that oleanolic acid acetate reduces kidney toxicity, when co-administered with the anticancer drug cisplatin. Such efficacies of oleanolic acid acetate enable it to be used as an adjuvant in the treatment of cancer and immune diseases.

KRIBB filed a patent application for this discovery in 2012. In April 2017, KRIBB signed a technology transfer agreement with a pharmaceutical company in Korea. The technology transfer contract is an exclusive license agreement that will be maintained until the expiration of the patent. It is valued at least one billion won, including the fixed-rate technology fee and the usual license fee. 



# Understanding Bacterial behavior through Odor

METHOD FOR SYSTEMATIC ANALYSIS OF THE ODORS OF BACTERIAL SIGNALING MOLECULES

Areas with large amounts of bacteria emit distinctive and nauseating odors; from the musty smell of yogurt or cheese to the stinky stench of an old laundry, various odors are generated. These odors play an important role as signaling molecules that help bacteria interact with other organisms, and allow the prediction of the bacterial type and quantity. However, the relevant study methods have not been sufficiently systematized.

The research team headed by Dr. Choong-Min Ryu at KRIBB has successfully developed a standardized protocol for the bacterial odor analysis in cooperation with American, French, and Egyptian scientists. The study was funded by the Global Frontier, the Woo Jang-Choon project by the Rural Development Administration, and KRIBB, as a major project.

In 2003, the research team of Dr. Ryu was the first to prove that bacterial odors are important molecules for signal transduction in plant-bacteria and bacteria-bacteria interactions. Nevertheless, a significant challenge arose as experimental results varied between laboratories owing to the lack of standardization of accurate study methods. The latest study results of the team are highlighted because they propose a method to obtain accurate data, regardless of the researcher or place, which therefore provides a foundation for further investigations of bacterial odors.

This new protocol analyzes bacterial odors, which are difficult to capture owing to their high volatility, through the combination of gas chromatography-mass spectrometry (GC-MS). It is characterized by its quantitative capabilities, even with an extremely small amount of gas. GC facilitates the visual verification of specific substances and MS allows the calculation of the mass composition even of an extremely small amount of sample.

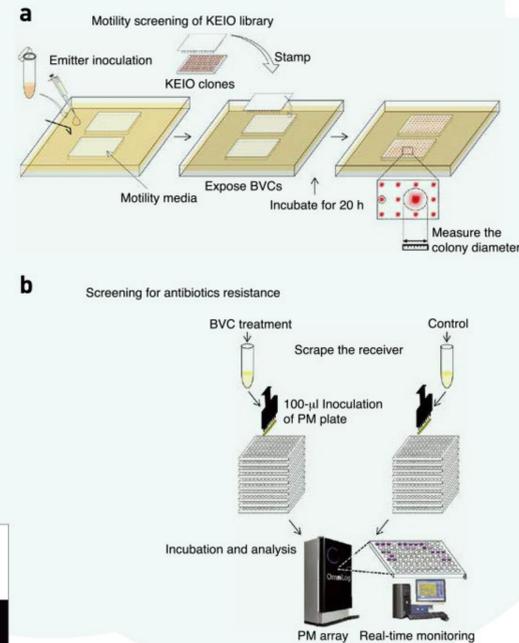
Furthermore, Dr. Ryu's research team suggested various methods to utilize bacterial odors. Bacterial odors also function as signaling molecules, which activate the growth stimulating factor of plants, and can be used as



an 'invisible gas fertilizer.' They also function as means of inter-bacteria (inbetween bacteria) communication; thus, they can be applied in the field of medicine to restrict the growth of specific pathogenic bacteria. His team was previously listed among the "10 most important science news of the year 2016" for their development of a new substance that was highly effective for the prevention of drug resistance bacteria. Dr. Ryu stated that "our study established a platform for the study participation, which is available simply on the internet worldwide. We expect that future studies on bacterial odors for agricultural or medical applications will make a great contribution to addressing global food and public health problems." Their study results were published in the July edition of *Nature Protocols* (IF=10.03) which is one of the world's most prestigious journals in the field of protocols as the cover article.

#### Information related to the article:

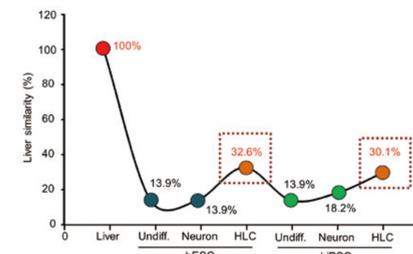
Farag et al., "Biological and chemical strategies for exploring inter- and intra-kingdom communication mediated via bacterial volatile signals", *Nature Protocols*, 2017, DOI: 10.1038/nprot.2017.023



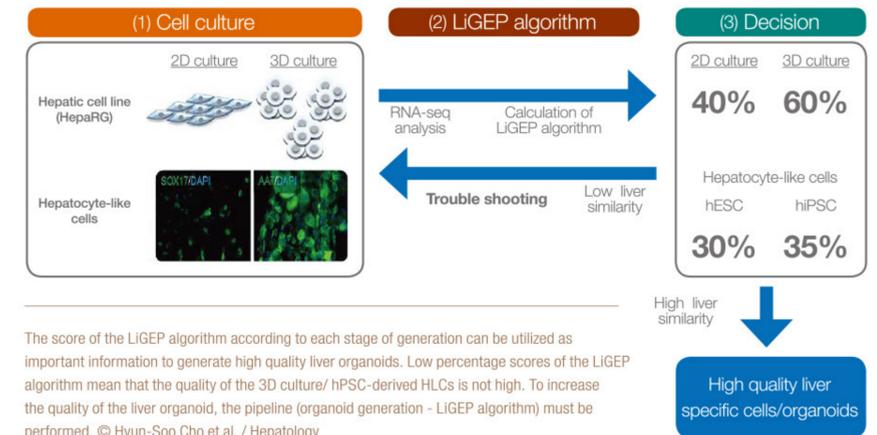
KEIO collection screening and assessment of antibiotic resistance using microtiter plates. (a) A 1-ml suspension of *B. subtilis* 168 (OD<sub>600</sub> = 0.1) was spread on square dishes (245 × 245 mm) containing TSA medium and incubated for 3 h. The KEIO collection was replica-plated onto LB medium containing 50 μg/mL kanamycin and 5% soft agar 3 h after inoculation of *B. subtilis* 168. (b) Antibiotic resistance of *E. coli* cells in the presence of VOCs was analyzed by phenotype microarray (PM, plates 11–20) after incubation. A 100 μl suspension of receiver cells was inoculated onto PM plates and incubated. © Geun Cheol Song et al. / *Nature Protocols*

One of the biggest challenges in medical and pharmaceutical studies is the difficulties associated with experimentation and testing. Animal testing and clinical testing are required to verify the effects of medication in human tissues and organs, and these entail an enormously long time and high costs. This is one of the factors that impedes the development of new drugs and increases drug prices, and is one of the top priorities that must be addressed in terms of public health. Recent advances in the field of biotechnology have facilitated the establishment of a technology that simulates the development of a specific organ, and that could serve as a useful reference for related studies.

Among the organoids that were artificially cultured through biotechnology, artificial liver holds the greatest



The scores for the LiGEP algorithm in undifferentiated hPSCs and hPSC derived Hepatocyte  
© Hyun-Soo Cho et al. / *Hepatology*



The score of the LiGEP algorithm according to each stage of generation can be utilized as important information to generate high quality liver organoids. Low percentage scores of the LiGEP algorithm mean that the quality of the 3D culture/ hPSC-derived HLCs is not high. To increase the quality of the liver organoid, the pipeline (organoid generation - LiGEP algorithm) must be performed. © Hyun-Soo Cho et al. / *Hepatology*

importance. The liver is responsible for detoxification, and thus, studies on this organ are fundamental for examining the effects of new drugs and their toxicity. Currently, a liver cell differentiation technology using various types of human cells, including the human pluripotent stem cells (hPSCs), is being used for the production of an artificial liver.

Evaluation is the most important step in artificial organ production. In order to secure the reliability of artificial organ testing for replacing clinical testing, it should be objectively guaranteed whether the organ has been formulated through cellular differentiation as intended. Nonetheless, current testing methods only include liver-specific protein extraction or qualitative evaluation that tests liver tissue-specific enzyme activities. In other words, objective evidence that helps judge whether an artificial liver is similar to a real human liver is highly insufficient.

Fortunately, a domestic research team developed

## First Leap Towards the Development of Three-Dimensional Artificial Organs

DEVELOPING AN ALGORITHM THAT MEASURES THE MATURITY OF ARTIFICIAL LIVER ORGANIDS

a quantitative prediction algorithm for assessing the status of human liver cell differentiation, and is expected to make a substantial contribution to artificial liver development. The research team for the development project on individual custom disease model based on biomimetic culture systems headed by Dr. Dae-Soo Kim, Dr. Jae Woon Ryu, and Dr. Mi Young Son at KRIBB used the next-generation sequencing technique (NGS). Their research group analyzed the transcriptomes of 20 human tissues and established an evaluation panel and algorithm for the liver organoids. NGS is a sequencing analysis method developed in 2006. This technique reads a single dielectric as a small fragment, and combines it based on a biotechnological methodology. This technique rapidly decodes a tremendous amount of dielectric information in a quantitative manner, and thus, is highly useful to objectively measure the differentiation status of the liver organoids.

The research team explained that "the replacement organs or organoids for external evaluation is an area which is currently being actively investigated. Our achievement is what we developed based on the basic technology for measuring its quantitative differentiation and maturity". They added that "the application of our new quantitative evaluation system will largely contribute to the development of cell treatment drugs based on stem cells and replacement tissue models for drug screening." Their study was published online on June 23 in *Hepatology* (IF = 13.246), a prestigious international journal in biology.

#### Information related to the article:

Dae-Soo Kim et al., "A liver-specific gene expression panel predicts the differentiation status of in vitro hepatocyte models", *Hepatology*, 2017, DOI: 10.1002/hep.29324

Aging is another aspect of the current advances in medical technology. Longevity has been a long-awaited dream since the beginning of human history. However, as soon as increases in longevity were possible as a result of the advances in medical technology, the quality of life of the aged who comprise the majority of society emerged as a social problem. In particular, cells degenerate or malfunction along with the process of aging, which results in geriatric diseases. Studies on aging are therefore highly important for the treatment of intractable and degenerative diseases that frequently occur.

Owing to their importance, various countries around the world have continued to invest in the task as a subject area of national importance, but the progress is very slow. So far, researchers have achieved certain outcomes, such as the identification of the aging factor or the discovery of medication against stem cell aging, based on studies of the aging of stem cells. However, the method of "reverse aging" to restore the functions of already aged cells faces endless challenges.

The research team at KRIBB has recently been the subject of much attention, as they were the world's first researchers to induce a reverse aging reaction in hematopoietic stem cells. Hematopoietic stem cells are adult stem cells that produce cells in blood, including leukocytes and erythrocytes, and form the basis of the circulatory system and the immune system of human body. Hematopoietic stem cells lose their stem cell function as aging progresses, which causes various conditions and diseases, including weakened immunity, anemia, and cancer. KRIBB research team successfully identified the gene that controls the aging of hematopoietic stem cells and, based on this finding,

achieved the rejuvenation of aged, underperforming hematopoietic stem cells.

The team led by Dr. Inpyo Choi and Dr. Haiyoung Jung focused on the function of the protein TXNIP in hematopoietic stem cells. p38 MAPK, a stress-activated kinase, increases the concentration of reactive oxygen in cells, thereby stimulating cell aging. TXNIP directly combines with p38 MAPK to restrain its activity and subsequently postpone the aging process. Potentially, it can reverse aging and eliminate its negative effects. The team developed a p38 MAPK-specific peptide that reduces the activity of p38 MAPK based on the function of TXNIP and induced the reverse aging of hematopoietic stem cells.

Dr. Inpyo Choi, the study supervisor, stated that "drugs for immunocyte treatment can be developed, which helps maintain haematopoietic stem cell healthily if we continue to work on the development of reverse

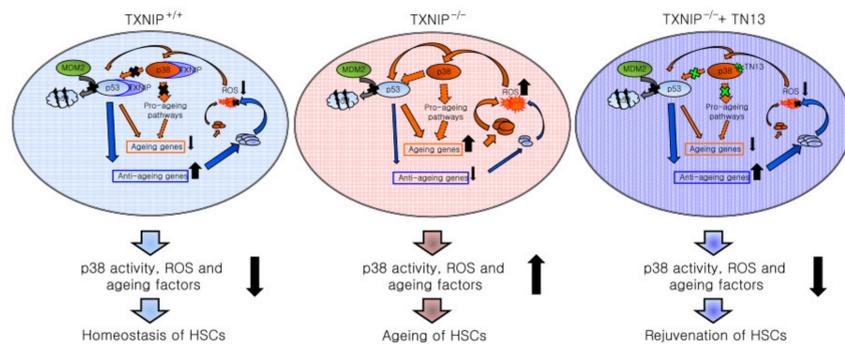
aging technology based on our findings." He added, "we expect that our findings will provide a crucial foundation for overcoming diseases such as immune disorders or cancer." This study was conducted with the support of the convergence studies project by the National Research Council of Science and Technology. It was published in the online edition of *Nature Communications* in November 2016 (IF=11.329 / 5-year average IF=12.001). [📄](#)

**Information related to the article:**

Haiyoung Jung et al., "Thioredoxin-interacting protein regulates haematopoietic stem cell ageing and rejuvenation by inhibiting p38 kinase activity", *Nature Communications*, 2016, DOI: 10.1038/ncomms13674

## Running the Cell Clock in Reverse: Will It Be the Key to Overcoming Intractable Diseases?

RESEARCHERS DEVELOP A TECHNOLOGY THAT REJUVENATES AGED HEMATOPOIETIC STEM CELLS



A cartoon for the regulation of ageing of TXNIP<sup>+/+</sup> or TXNIP<sup>-/-</sup> HSCs by TXNIP or TAT-TN13. TXNIP-derived peptide, TAT-TN13, rejuvenates aged HSCs by inhibiting p38 activity, ROS production and ageing factors. © Haiyoung Jung et al. / Nature

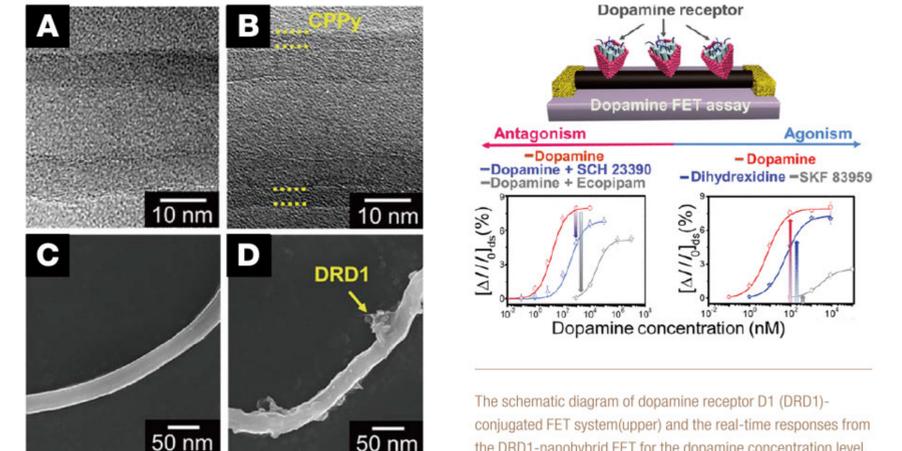
## Convergent Technologies for Improved Efficiency of New Drug Development

DEVELOPMENT OF A PROTEIN-BASED BIOELECTRONIC SENSOR FOR NEW DRUG SCREENING

New drug development requires extensive time and money; frequently, the majority of drug costs involves research and development expenses. Because of the huge scale of research and development needed, only a few pharmaceutical companies in the world develop new drugs and the pharmaceutical industry is perceived as a representative high value-added industry.

Screening, the process of repeating several experiments and tests to verify the efficacy of a drug and to identify its toxicity, demands a significant proportion of the resources invested in the new drug development. The process is time-consuming and requires large numbers of samples, as it is necessary to conduct tests in the maximum variety of environments.

Currently, the most widely used screening techniques are cell-based. However, the application of drugs to artificially cultured cells and the analysis of their responses has limitations with respect to time and

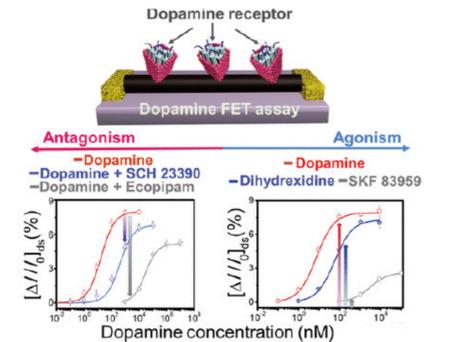


(A) the bare CNT and (B) ultrathin CPPy-coated CNT hybrids and SEM images of (C) a bare nanohybrid and (D) a DRD1-conjugated nanohybrid. The dotted yellow line indicates the thickness of the CPPy layer in C, and the arrow in E indicates DRD1 with detergent.

economic efficiency. Thus, many researchers are seeking various methods to overcome the disadvantages of cell-based screening.

A joint research team from KRIBB and Seoul National University proposed a method to dramatically increase the screening efficiency of new drugs by using biosensors. To screen dopamine, a neurotransmitter, the research team obtained high-purity dopamine receptor proteins and attached them onto conductive nanotubes.

The research team has two main achievements. The mass production of dopamine receptors is difficult because they are complicated structures that are not well expressed in xenogeneic cells. However, the research team succeeded in isolating and purifying dopamine receptors after mass production using *E. coli*. Although dopamine can be directly attached onto conductive nanotubes, which detect and transmit the signals of the purified proteins, quantitative detection remains difficult. Using a low-molecular thin-film forming technique, the research team applied a conductive polymer onto the surface of carbon nanotubes in the form of nanotubes to prevent the



The schematic diagram of dopamine receptor D1 (DRD1)-conjugated FET system (upper) and the real-time responses from the DRD1-nanohybrid FET for the dopamine concentration level.

possibility of malfunctions that result from the direct binding of dopamine.

The research team developed a screening platform that could eventually detect dopamine through combination of the prepared dopamine receptor with a polymeric nanohybrid substrate. Such a platform is more efficient than cell-based screening, because it is easy to control the variables and quantitatively identify the responses to the drug.

Dr. Oh Seok Kwon, who participated in the research, said, "If this novel technology for the manufacture of biosensors based on nanohybrid transistors coupled with highly purified receptors is commercialized, the technology will replace the existing cell-based drug screening method, reducing the time and cost of new drug development. The technology will be useful for strengthening the international competitiveness of the Korean pharmaceutical industry."

The study was published on June 8 in the online edition of *ACS Nano* (IF = 13.334), a world-renowned academic journal in the nanoscience field. [📄](#)

**Information related to the article**

Seon Joo Park et al., "Dopamine receptor D1 agonism and antagonism using a field-effect transistor assay", *ACS Nano*, 2017, 11, 5950-5959

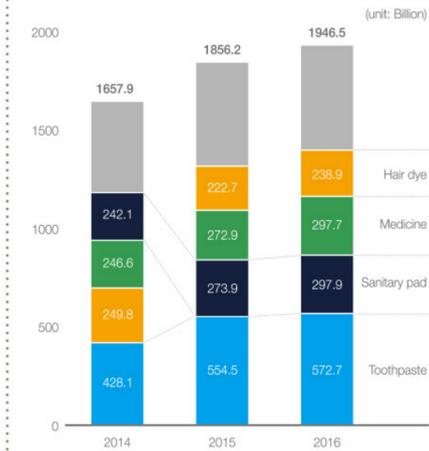


### National R&D budget is rising in the support for basic research

It is shown that the national budget for R&D in 2016 is similar to R&D budget of the previous year. It is confirmed that the support for basic research, SMEs and enterprises in middle standing have continued to increase significantly. The Ministry of Science, ICT and Future Planning (present Ministry of Science and ICT) analyzed like this in the presentation "Analysis on national R&D project survey and analysis in 2016" to the 29th National Science and Technology Council held in June 26. Ministry of Science, ICT and Future Planning analyzed 562 projects and 54,927 tasks conducted by 35 ministries, administrations, agencies and committees in 2016 and showed that 19.44 trillion KRW, which is increase by 0.7% from the previous year was executed. It is analyzed that R&D investment has been stagnant but increased by 4.5% on annual average for the past 5 years. The Ministry of Science, ICT and Future Planning invested the largest amount, spending 34.3% of total R&D budget. The Ministry of Trade, Industry and

Energy spent 18.0% and the Defense Acquisition Program Administration spent 13.2% of total R&D budget respectively. Share of investment in basic research showed increasing trend in 2016. The investment in basic research in 2016 amounted to 5.1 trillion KRW, which accounts for 38.9% of the total. The figure is increase by 2.6% from 36.3% in 2014. By area, information technology and biotechnology received intensive support and significant investment was made also for energy. What is noteworthy is that investment in SMEs and enterprises in middle standing is not less. In 2016, half of R&D budget was allocated to government-sponsored research institutes and universities but investment in SMEs and enterprises in the middle standing increased significantly to 3.6 trillion KRW, which is 19.2% of total R&D budget. This is equivalent to R&D budget invested in universities, indicating that the amount for those companies increased by 8.5% on annual average for the past 4 years. By region, the investment was more even

compared to the previous years. Investment in regions except for metropolitan cities and Daejeon was 6.3 trillion KRW in 2016, accounting for 34.5% leading continuous increasing trend for the past 5 years. However, it is shown that the average increase rate of research budget per research task does not catch up with total increase in R&D budget. Research budget per task in 2016 was 350 million KRW, which is 2.1% increase on average for the past 5 years. In particular, the number of researchers per task increases continuously but the increase cannot be followed by research budget support. As a result, the increase in research budget per researcher is a mere 0.9% for 5 years. Overall, it is a positive change that share of basic research, SMEs and enterprises in the middle standing increased among 2016 R&D budget but research budget per capita has been stagnant, indicating areas for improvement. The result of the survey will be disclosed national science and technology information service (<http://www.ntis.go.kr>) and national statistics portal (<http://www.kosis.kr>) reflecting the review result of the National Science and Technology Council.



### Domestic production of over the counter drugs reached to 1.9 trillion KRW in 2016

Production of domestic over the counter has achieved annual average growth of 10.2% for the past 5 years. Ministry of Food and Drug Safety (Minister Youngjin Ryu) announced that domestic over the counter production increased by 4.9% from 2015 to record 1.95 trillion KRW. Trade balance increased more than production. According to the statistics obtained by the Ministry of Food and Drug Administration, trade balance for over the counter was 171.3 billion KRW with 36.5% from the previous year. On the contrary, market volume increased only by 2.6% recording at 1.78 trillion KRW. It shows the share of overseas market in domestic over the counter industry is increasing. Last year, export of over the counter was 3.553 trillion KRW, which is increased by 21.9% from 2015 and import increased by 15.0% recording 27.64 million KRW. In terms of export destination, China accounted for 33.0% of total export

recording 111.72 million dollars of export followed by Vietnam with 43.61 million dollars and Japan with 39.41 million dollars. What is noteworthy is that export to European countries increased significantly. Export volume to European countries increased significantly by 193.8%, 351.6%, 150.6%, 152.2% and 503.9% respectively for Germany, UK, Italy, Ukraine and France from 2015, indicating that over the counter export market is being diversified. In the meantime, production increase seems to be attributed by increased fear of consumers regarding sanitary and hygiene such as new infectious diseases like ZIKA and increased concentration of particles. In particular, the consumption of sanitary related goods such as insecticide and sterilizer, as well as toothpaste increased. Hand sterilizer and other sanitary related goods have showed continued growth since 2012. It is related to the growing interest in personal sanitary and sterilization of living spaces with fear of ZIKA virus and MERS outbreak in 2015. Masks achieved 18.7 billion production, which is similar level of 2015 when demand for mask increased significantly due to MERS outbreak. The production of each country showed similar composition with 2015. There has been no change in the ranking in terms of production volume among top 5 companies. AMORE PACIFIC ranked top by recording production volume of 323.1 billion KRW followed by DONG-A PHARM (291.8 billion KRW), LG Household & Health Care Ltd.(288.4 billion KRW), Yuhan Kimberly (117.6 billion KRW), and Aekyung (111.2 billion KRW). Those top five companies accounted for 58.2% of the total. However, the fact that Henkel Homecare Korea achieved 36.5 billion KRW, which is increased by 54.7% from 2015 thanks to increased demand for household insecticide, is outstanding. The Ministry of Food and Drug Safety announced that it would strengthen safety standard of over the counter and improve regulation related to safety in a reasonable manner considering the situation that public interest in the safety of chemical products in our lives is increasing and social environment is changing with increasing number of new infectious diseases.



## How did the government fund contribute to the venture ecosystem?

In the venture capital market, bio medicine is one of the hot potatoes. As the area is related to health and public health which can naturally become an issue where people exist and the potential for growth is high with the development of life science. The investment in domestic bio medicine increased gradually to record 102.3 billion KRW as of May 2017. Among them, 11.8 billion KRW or 11% is found to be funded by the government. The government share is higher than general expectation.

The Ministry of Trade, Industry and Energy made such announcement at the meeting with 15 bio venture companies held in Korea Technology Center on July 13. At the meeting, participants checked the outcome of running initial bio fund and introduced government R&D project for venture companies. In the meantime, difficulties and ways for improvement for startups were discussed.

Bio startup development fund (hereinafter initial bio fund) is a policy fund intended to make bio venture companies overcome capital shortages in the early stage of startup. The fund was mobilized with 10 billion KRW from the Ministry of Trade, Industry

and Energy and 28.5 billion KRW from private investors in Nov. 2016. Since initial bio fund, 16.3 billion KRW was invested in 9 bio companies until the first half of this year and 42% of total fund was invested. The 7 out of 9 companies which received bio fund are less than 5 years of business operation and investment for those 7 companies is 13.5 billion KRW accounting for 80% of investment attracted by those companies.

It takes much time to recover investment for bio industry, R&D period is long and market uncertainty is high. Accordingly, most investors prefer companies which have run their business for a certain time with less uncertainty. As a result, there are many companies in financial difficulties at the initial stage when investment should be concentrated. By providing capital to bio companies at the initial stage, it is possible to compose investment portfolio for the whole life cycle of bio companies.

In the meantime, many companies with innovative business model participated at the meeting and the entrepreneurs' background was diverse, ranging from the youth, researcher at large companies, professors and doctors. Representative of participating companies proposed that "it takes long time from starting business to achieve growth as bio technology is difficult and licensing is rigorous. Continued interest in regulation improvement such as promotion of technology trade, receiving condition for listing and simplification of exit plan is necessary."

Seon-ki Kim, Head of Bionano Division of the Ministry of Trade, Industry and Energy said government R&D investment for newly started bio venture companies based on innovative technologies will expand further such as promising bio IP commercialization project to establish open innovative ecosystem for bio industry. The initial bio fund management is not just for securing fund but also for mentoring established venture companies on experience and knowhow on growth. As such we will accelerate growth through business incubation program of KoreaBio and provide support to make sure that investment recovery is not that difficult by promoting technical exchange, joint marketing among companies invested and technical exchange with overseas companies."



## KRIBB supports startup bio companies as economic growth driver

Korea Research Institute of Bioscience and Biotechnology (President Kyu-Tae Chang, hereinafter referred to as KRIBB) held 2017 KRIBB bio company ecosystem technical exchange meeting at KRIBB on July 13. At the meeting, about 200 people including CEOs of bio companies participated and 4 companies related to Tech in Biz were selected to provide designation certificate for KRIBB family companies. Concentrated support for business innovation and entry into global market will be provided until 2019 for those selected as a family company.

KRIBB has provided supports to promote cooperation and strengthen R&D capabilities among bio companies under the goal of technology innovation and support for startups for joint growth based on KRIBB bio company ecosystem where 250 bio companies participate. The technical exchange meeting is part of these efforts to nurture 50 future leading companies, manage KRIBB bio mentor group and provide field-focused technical support and support venture startup and corporate growth.

After the selection of family companies, there was a session for sharing commercialization strategy for common technology. In relation to this, ways to make life cycle corporate growth model, promote industry-research center technical cooperation and strengthen capability of commercialization were discussed. In addition, ways for strategic technical cooperation to identify future promising bio technology and respond to global market change to lead in the 4th industrial revolution were checked. KRIBB's program to link industry and research center has achieved tangible outcome. The global

hidden champion and potential hidden champion nurturing program, which is a customized support program starting from 2015, achieved outcome of 5 new products launch at the end of 2017 by supporting new product development and product upgrade. The number of technology transfer was 4 as of 2016 increased to the extent that the number is 3 only in the first half of 2017.

Recently, 23.3 billion KRW support was provided to 4 companies for 2 years by running KRIBB bio investment mentor group. In the meantime, with the support of KRIBB for business incubation and commercialization, 10 companies were listed in KOSDAQ and 2 companies were registered in KONEX.

President Kyu-Tae Chang of KRIBB said "KRIBB bio business ecosystem is a life cycle company growth support platform intended to strengthen technology innovation capabilities of bio SMEs and promote growth in the global market. KRIBB will provide support for bio companies to lead the global technology market."



## Venue for debate and learning for future life scientists

The 8th national high school debate on biosafety and bioindustry which is jointly held by Korea Biosafety Clearing House of KRIBB (director Homin Jang) and Gyeongsang National University (president Sang Kyung Lee) was completed successfully at BNIT Industry and Academia Cooperation Building on July 28.

The debate was held under the theme of "is it desirable to apply a genome editing technology for the advancement of the bioindustry?" The debate

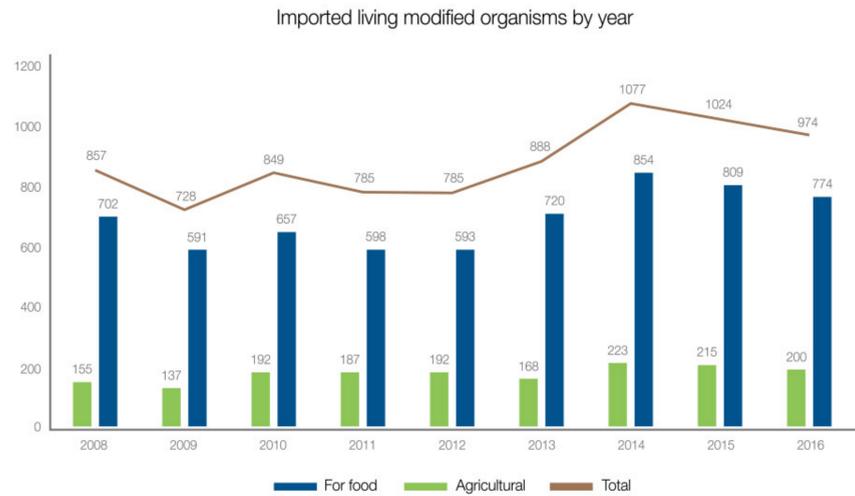
video and discussion outline were received from national high school students for 2 months starting from April 20 and a total of 98 teams (196 students, 2 students work as one team) participated. 24 teams were short listed after reviewing video and preliminary competition was held on a league basis in the morning of the debate. After applying tournament method, 8 teams completed and award winning video and winning team were selected in the final match.

At the final, "Gilmul ppaaja Team (Sang-seong Kim, Seok-hyeon Lee)" from Daegu Il Science High School won the grand prize from the Minister of Trade, Industry and Energy (certificate of merit, prize money of 1 million KRW) and "Songlim Ihyeon Team (Chae-hyeon Lim, Seung-woo Roh)" from Gimcheon High School, which made up to the final round where fierce discussion was held with Gilmul ppaaja Team won the gold award by KRIBB (certificate of merit, prize money of 0.8 million KRW). Excellent speaker award was given to Chae-hyeon Lim (2nd grade of Gimcheon Highschool) and good speaker award was given to Hee-heon Kim (10th grade of Korea International School).

As this year's debate is held jointly by Gyeongsang National University, students were provided with an opportunity to participate in "special lecture on life science and experience" led by Gyeongsang National University. The opportunity was provided to make sure that the debate is not just for competition but for an opportunity the growth of all participants.

Students participating in the competition said "it was not easy to search information and prepare debate on genome editing, which is the latest biotechnology but we learned ways to look at the problem from various perspective. At every debate, we could learn more to grow further by accepting different opinion of other teams and advice from examiners."

President Kyu-Tae Chang of KRIBB said to participants, "this debate served as an opportunity to learn and criticize both positive and negative aspects of genome editing technology. I hope that all of you can be a talent in the bio industry who can coordinate communication and social consensus based on communication skills and knowledge on science."



### Approval for imports of living modified organisms for food has decreased by 5% for 2 consecutive years

It is found that the amount of living modified organisms for food and feed approved for import to Korea in 2016 was 9.74 million tons (79% for agriculture and 21% for food) and 2.1 billion dollar. The LMOs imported mostly from the US (4.74 million tons, 49%) and Brazil (2.57 million tons, 26%).

According to the major statistics on 2016 LMO released by biosafety portal (<http://www.biosafety.or.kr>) of Korea Biosafety Clearing House of KRIBB (director Ho-min Jang) on June 13, the LMO imports for food and feed peaked in 2014 and have continued to decrease by 5% for 2 consecutive months. This is attributed by keeping high level of corn inventory by food and feeding companies and decreased number of stock rising due to AI and foot-and-mouth disease.

In the meantime, LMO imports for test and research purpose increased significantly. The number of LMOs registered for import in 2016 was 3575, increased by more than 65% from

2015. The number of LMOs exported to other countries increased significantly to 159. The number of registered research facilities was 1249, 49% increase from the previous year. This is attributed by further understanding of LMO related laws among researchers with expansion of research infrastructure.

Korea Biosafety Clearing House of KRIBB (director Ho-min Jang) said "there were many developments in R&D and safety management related to LMO in 2016. I hope that the statistics can serve as a good information to see the domestic and overseas trend and statistics of LMO in 2016 and execute policy decision related to LMO."

The major statistics on LMO are the summary of documents related to LMO released by Korea Biosafety Clearing House in the previous year and disclosed to the public every year under the Transboundary Movement, Etc. of Living Modified Organisms Act. 

# UST

## World-Class National Research University

### GERMANY



IMPRS(1999)  International Max Planck Research School in Max Planck Society

### REPUBLIC OF KOREA



UST(2003)  University of Science and Technology of National Research Institutes

### USA



Watson School of Biological Sciences (1999)  Watson School of Biological Sciences in Cold Spring Harbor Lab.

### CHINA



UCAS(1978)  University of Chinese Academy of Sciences in Chinese Academy of Science

### JAPAN



SOKENDAI(1988)  Inter-University Research Institutes participating in SOKENDAI, The Graduate University for Advanced Studies