KRIBB focus 4th Issue | 2018

Technology for Life, Our Future

www.kribb.re.kr

125 Gwahak-ro, Yuseong-gu, Daejeon 34141, Korea
Tel. : +82-42-860-4114 Fax. : +82-42-861-1759

KRIBB focus 4th Issue | 2018

KRIBB *focus*

4th Issue | 2018 No.3

COVER STORY

TREATMENT WHERE NECESSARY

PERSONALIZED GENOMIC MEDICINE RESEARCH CENTER

RESEARCHER INTERVIEW

INFORMATION INFRASTRUCTURE SUPPORTS LIFE SCIENCE RESEARCH

YONG-KYUNG CHOE, ASSOCIATE DIRECTOR OF THE KOREAN BIOINFORMATION CENTER

KRIBB focus

BIOTECH FOR ECONOMIC GROWTH AND **BETTER LIVING STANDARDS**

Korea Research Institute of Biosicence 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.

RESEARCH DIVISIONS OF **KRIBB**

DIVISION OF STRATEGIC RESEARCH GROUPS
- Rare Disease Research Center
- Personalized Genomic Medicine Research Center
- Aging Research Center
- Hazards Monitoring Bionano Research Center
- Anticancer Agent Research Center

DIVISION OF BIOMEDICAL SCIENCES
- Metabolic Regulation Research Center
- Disease Target Structure Research Center
- Biotherapeutics Translational Research Center
- Genome Editing Research Center
- Infectious Disease Research Center

DIVISION OF SYSTEMS BIOLOGY AND BIOENGINEERING
- Plant Systems Engineering Research Center
- Industrial Bio-materials Research Center
- Cell Factory Research Center
- Synthetic Biology and Bioengineering Research Center

DIVISION OF BIO INNOVATION
- Technology Transfer Center
- SME Support Center
- Biotechnology Process Engineering Center

DIVISION OF BIOINFRASTRUCTURE
- Biological Resource Center
- Laboratory Animal Resource Center
- Bio-Evaluation Center
- Korea National Primate Research Center
- Primate Resource Center
- Futuristic Animal Resource & Research Center
- International Biological Material Research Center
- ABS Research Support Center

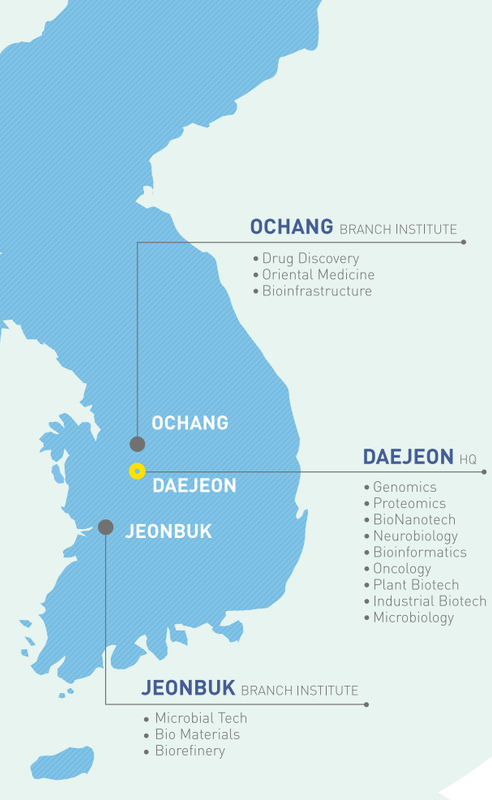
IMMUNOTHERAPY CONVERGENCE RESEARCH GROUP

DIVISION OF KRIBB STRATEGIC PROJECTS
- Korea Biosafety Clearing House
- Biotech Policy Research Center
- Korean Bioinformation Center
- National Research Safety Headquarter
- Stem Cell Research Center

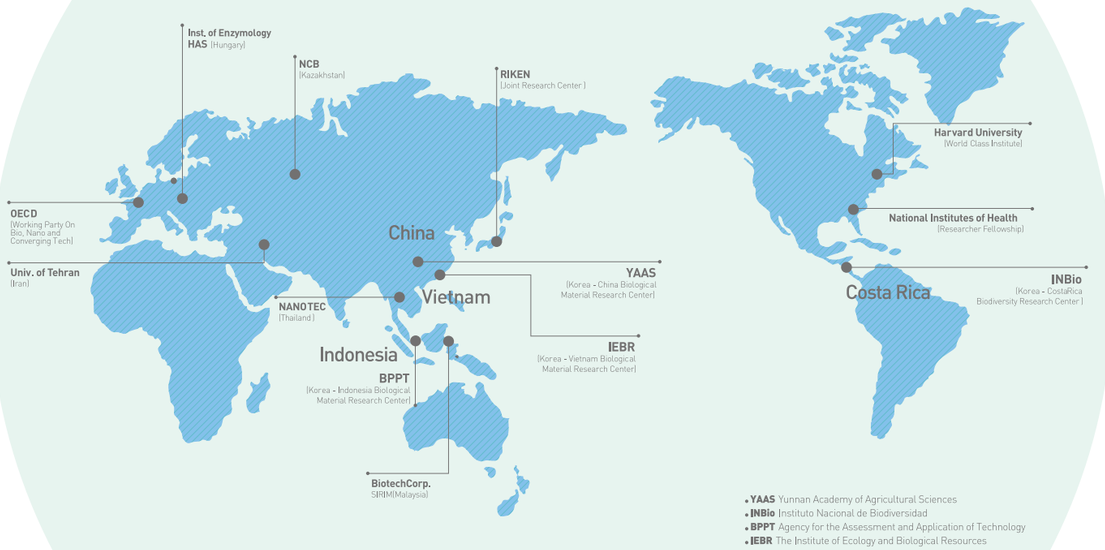
CORE FACILITY MANAGEMENT CENTER

BIODEFENSE RESEARCH CENTER

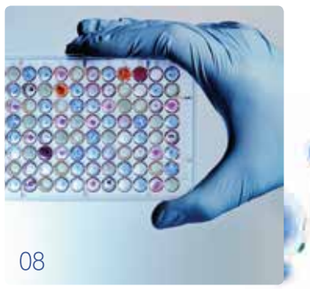
DOMESTIC

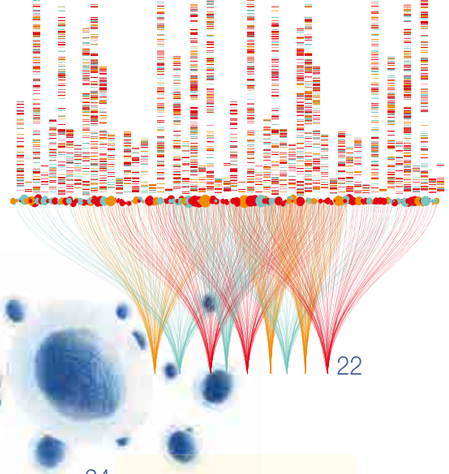


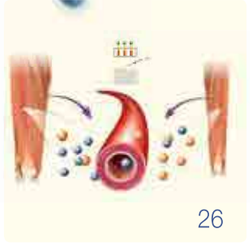
INTERNATIONAL



CONTENTS







KRIBB COLUMN

06 **The Right Treatment in the Right Place**
Personalized Medicine Realized Through Computing and Date
Jang Seong Kim, KRIBB President

COVER STORY

08 **Treatment Where Necessary**
Personalized Genomic Medicine Research Center

RESEARCHER INTERVIEW

16 **Information Infrastructure Supports Life Science Research**
Interview with Yong-Kyung Choe,
Associate Director of the Korean Bioinformation Center

RESEARCH HIGHLIGHT

22 **Curator of Biological Research Information**
Korean Bioinformation Center (KOBIC)

24 **Successful Development of Maturation Technology of an “Organoid” Similar to the Human Small Intestine**

26 **Early Diagnosis of Sarcopenia is Possible Using Blood**

LIFE IN KRIBB

28 **Enhancing Public Interest by Investigating Microbial Function**
Microbial Biotechnology Research Center; Dr. Chul Ho Kim and Dr. Baek Rock Oh

BIO ENTREPRENEUR

34 **Leading Domestic Immunotherapeutic Research and Development**
Y-Biologics; Young Woo Park (CEO) and Bum Chan Park (Vice President)

POLICY REVIEW

38 **Investment expansion for new biohealth projects in 2019**

Paradigm shift in R&D on Alzheimer’s, from treatment to diagnosis and prediction

Urgent calls for bioethics act reform to activate biohealth industry

GLOBAL NETWORK

40 **The Bridge between the European Basic Science and Korea**
Association des Scientifiques Coréens en France (ASCoF)

BIOTECH NEWS

42 **Now at KRIBB**

KRIBB *focus* **4th Issue** | 2018 No.3

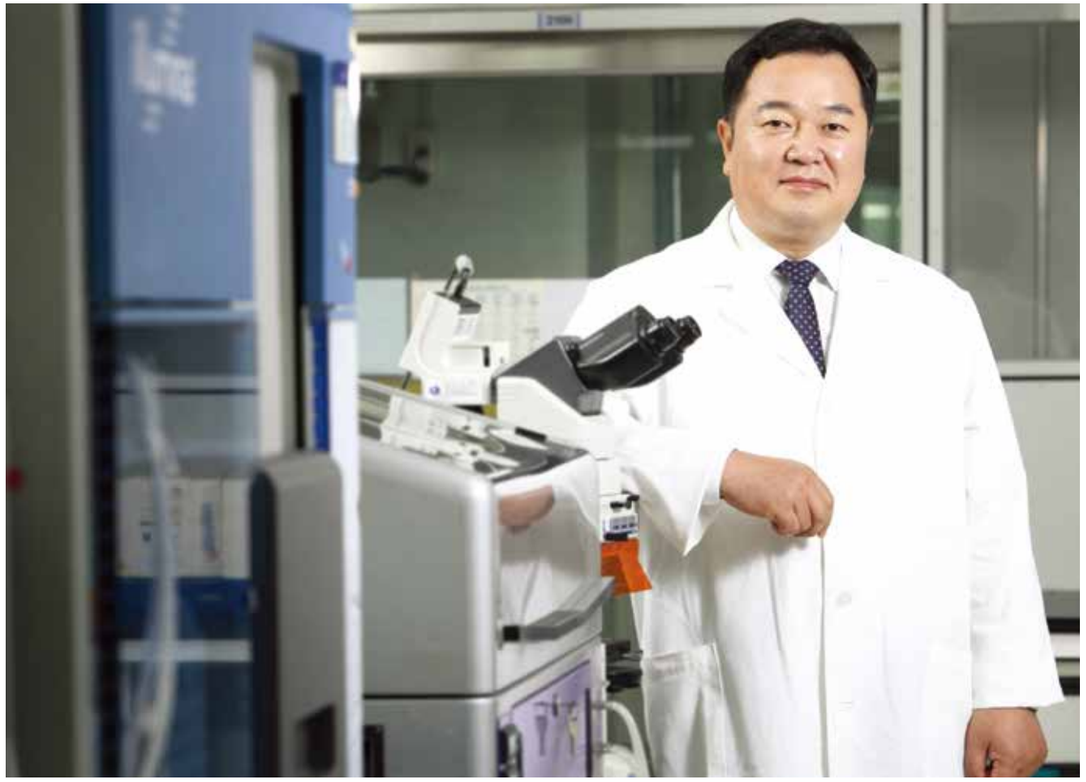
PUBLISHER Jang Seong Kim **EDITOR IN CHIEF** Doo-Byoung Oh **EDITORS** Doo-Byoung Oh, Jongwoo Lee (KRIBB) Choong-Hwan Lee, Taeckwon Kim, O-Hyun Kwon (Donga S&C)
PRODUCTION Donga Science & Communication **DESIGN** Jae-Hwan Jeong **IMAGES** KRIBB, Shutterstock

FIRST ISSUED October 31, 2017 **PUBLISHED** November 23, 2018

ADDRESSS Korea Research Institute of Bioscience and Biotechnology (KRIBB), 125 Gwahak-ro, Yuseong-gu, Daejeon 34141, Korea
TEL. +82-42-860-4114 **FAX.** +82-42-861-1759 **www.kribb.re.kr**

The Right Treatment in the Right Place

PERSONALIZED MEDICINE REALIZED THROUGH COMPUTING AND DATA



Jang Seong Kim, KRIBB President

When the Human Genome Project was completed in the early 2000s, many scientists were hopeful that a number of incurable diseases would finally be conquered. Because diseases and aging are the result of disturbed normal metabolism and the information of the enzymes mediating the metabolism is in the genome, it was believed that possessing the genomic map alone would solve the problem and every single metabolic process occurring in the human body could be identified and controlled. Unfortunately, the problem is not that simple, as we know well today.

The Human Genome Project was certainly a milestone in the history of biology and medicine, but it was not enough. The rapid advancement of biology after the year 2000 revealed that the human body is much more complex and difficult to predict than we thought. There are countless variables in almost every stages of trait expression, from transcribing of genomic information into mRNA, post-transcriptional RNA regulation producing a 'complete' map for synthesizing protein in cytoplasm, chains of amino acids forming a 3-dimensional structure to interaction between completed proteins.

Perhaps this is why the ambitious dream of 'personalized medicine' – which predicts and prevents risk factors through the analysis of an individual's genome and provides optimal treatment for every human being – lost its momentum upon completion of the Human Genome Project. The map would show where the information is located in the genes, but it was hard to understand its impact on diseases since so much information must be taken into account.

Computing was the breakthrough. Genetic analysis, which used to take days in the past, is now completed in less than half a day, with greater accuracy and precision. Acquired information has been accumulated this way and now it is possible to secure the genomic information of every individual, even each and every cell. This colossal amount of genomic information is digitalized and swiftly analyzed, helping grasp the genetic characteristics of individual cells more accurately.

The dream of personalized medicine was revived as the machine took over analysis that seemed impossible with just human hands and brains. Most laboratories today do not deal with just one gene or protein, their subjects are entire genomes composed of countless genes and proteomes of innumerable proteins. This has brought light to the relationships between genetic information and real biological phenomena and increasing number of mechanisms underlying incurable diseases are being discovered. Modern biological sciences went beyond the individual level and pioneered in analyzing and controlling the genetic differences in cells. 'Personalized medicine', which controls and cures individual diseased cells, has become a reality.

The representative example of personalized medicine is cancer research. Cancer is a disease in which cells in the system abnormally proliferate and push away normal ones. Cancer cells used to be somatic cells exist in the body and this makes it difficult for the immune system to distinguish them. Further, it is not easy to wipe them out like bacteria or viruses because cancer cells frequently mutate and resist the immune system or bypass it entirely. As it is difficult to apply general treatment and there is no standardized treatment for cancer, studies of cancer treatment are oriented toward identifying and attacking the unique characteristics of the cancer cells. An optimal personalized treatment method is developed according to the genetic characteristics of an individual patient and cancer cells.

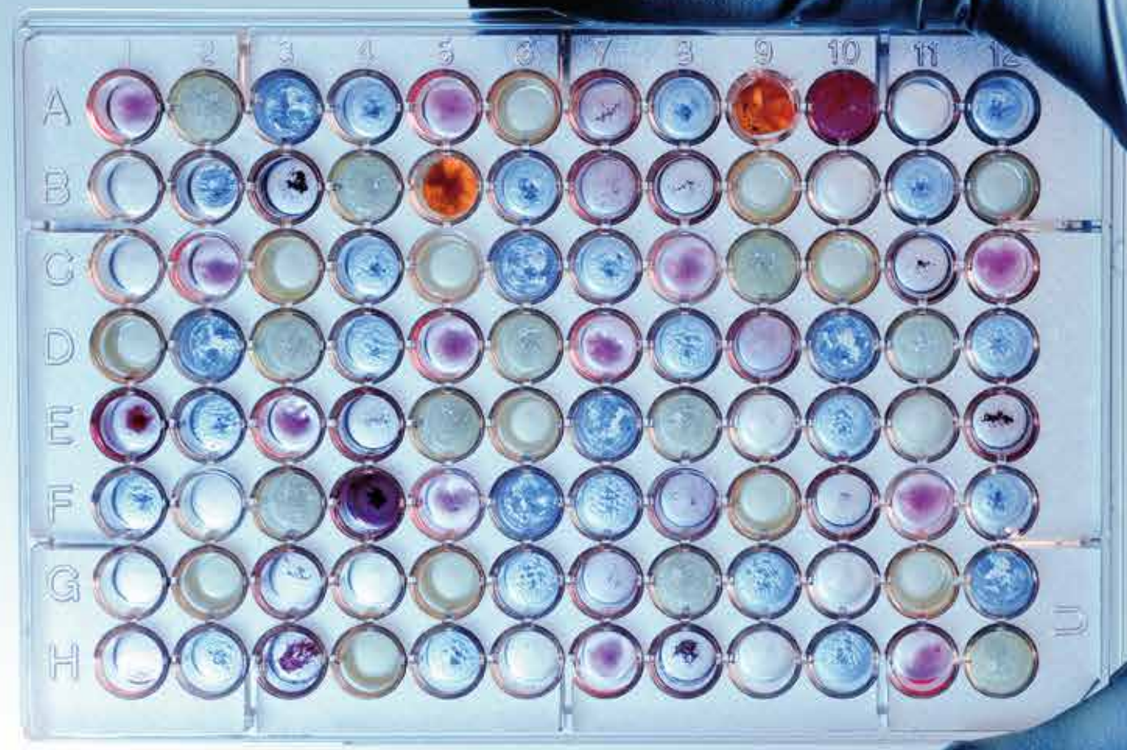
There still lies a long way ahead to realize true personalized medicine. Globally, medical research based on large-scale genetic information has just started. Researchers around the world are relentlessly racing for the finish line known as personalized medicine.

Korea Research Institute of Bioscience and Biotechnology (KRIBB) is also a participant in this race. The starting line is cancer treatment research, which will be the essence of personalized medicine. Currently, the Personalized Genomic Medicine Research Center is establishing a genomic information system to develop personalized treatments based on the genetic information of cancer cells. When the expanded Korean Bioinformation Center takes place, cancer research would be able to take a step further and establish a general methodology of personalized medicine.

The real issues here are time and policy. Genetic information-based personalized medicine is a field with great prospects and considered to be a future technology often by the governments of major developed countries. However, it will take a considerable amount of time to gain tangible profits due to the nature of medical technologies. It is necessary to establish various regulations and bioethics standards are needed for collecting and analyzing a broad range of data. This is why the role of public research institutes such as KRIBB is significant. This edition's KRIBB focus discusses and offers suggestions about how personalized medicine research, initially starting with the topic of cancer treatment, should be carried out. This is KRIBB's commitment, joining the journey of biological scientists towards a 'healthy world'.

Treatment Where Necessary, Personalized Genomic Medicine Research Center

"It's more important to know what sort of person has a disease than to know what sort of disease a person has."
"Hippocrates of Cos" of ancient Greece has been recognized as the father of Western medicine. This is because he approached medicine in terms of universal scientific theory rather than empirical wisdom for the first time. However, medicine has evolved into a sophisticated general theory and "individual," the factor that Hippocrates considered most important, still remains in the realm of experience. Fortunately, now that 2,500 years have passed, medical scientists are taking challenge in systematizing prescriptions according to the characteristics of an individual and a cell. This shows the emergence of "personalized medicine." In the center of the field, there is the Personalized Genomic Medicine Research Center at Korea Research Institute of Bioscience and Biotechnology (KRIBB).



To treat diseases or pain, the cause must be identified and eliminated. Thus, medical practice consists of two steps. The first is diagnosis that observes symptoms and speculates the cause and the second is treatment that cures the cause of disease based on the speculation. The greatest concern for doctors was the first step, diagnosis.
Doctors carefully observe individuals' characteristics, lifestyles and medical histories to find the cause. To this end, "experience" about patients beyond the general theory is important. This is also the case for modern doctors. Even if patients show the same symptoms, the cause may be different from person to person and even two people suffering from the same disease may react differently to the same treatment.

The problem is that medicine aims for diagnosis and treatment that is universally applicable for all. This has raised the level of medical care throughout the society, but the success rate of diagnosis and treatment has not improved dramatically compared to that in the past. Frankly speaking, the process in which medicine is elaborated into a universal theoretical system involves too many variables, so there had to be sacrifice in understanding the individual patient, which heavily relies on experience.

Hopes and Disappointments Presented by the Human Genome Project

"Life scientists and doctors were excited when the Human Genome Project (HGP) was completed in 2003. It was because they thought they could finally get an understanding of the individual. Proteins are made from the genetic information of the genome and proteins mediate the physiological phenomena. Therefore, they expected that analysis of the genetic map would allow them to predict more precisely about which disease the individual is vulnerable."
Kyung Chan Park, Associate Director of the Personalized Genomic Research Center, recalled that the HGP was hope and frustration for life scientists. It was particularly the case for cancer, the main research topic of the research team. Cancer arising from mutations in normal cells is greatly affected by genes. There are particularly vulnerable genetic factors for cancer, so family history is important in diagnosing cancer. They hoped that identifying vulnerable genes using a human genome map would provide a breakthrough in cancer diagnosis and treatment.
However, the result fell short of their expectation soon. The genetic map alone was insufficient to be applied to the medical field. Because of the assumption that one gene mutation could be the cause of a disease, the genetic map was thought

Hippocrates of Kos, often referred as "Father of Medicine" had emphasized the importance of patient-specific treatments.

TRADITIONAL MEDICINE

Radiation
·High-energy particles damage or destroy cancer cells

Chemotherapy
·Chmicals attack cancer

Surgery
·Operate on part of the body to diagnose or treat cancer

PRECISION MEDICINE

Genetics
·Gene sequencing
·Locate cancer causing genes

Immunotherapy
·Identify ways to customize treatment
·Find ways to turn immune system on
·Personalize treatment with immune-activating drugs

Targeted Therapies
·Drugs turn specific genes on or off

+Traditional therapies

Traditional medicine versus precision medicine. Traditionally, radiation, chemotherapy and surgery were the only means by which doctors could treat cancer. With precision medicine, doctors use a patient's genomes and proteoms to uncover clues for treating the disease.

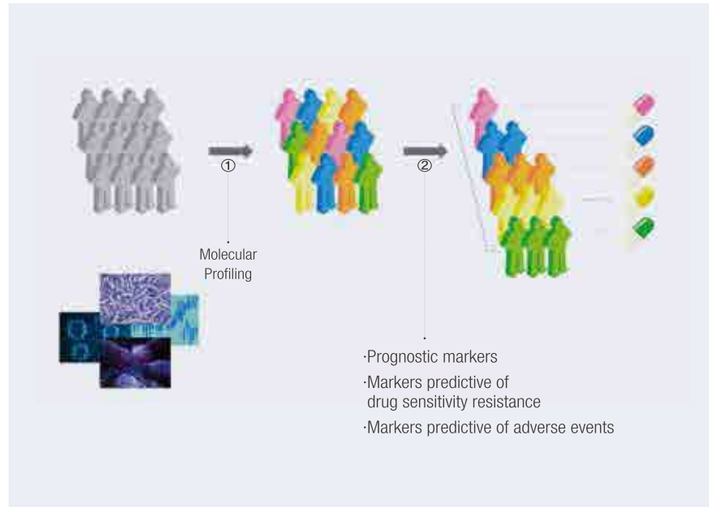
to be reliable. However, researchers have found that it is difficult to predict the gene expression and function due to the influence of other genes, regulators and proteins in the cells. In other words, what actually happens in cells are more important than the genetic map.

"This is why 'omics' research has become a core trend in life science since the mid-2000s. Omics refers to genomics or proteomics and it is a field that deals with the mutual effects of RNA and polypeptides in the actual cellular environment."

In addition to the complexity of the research subject, as genome and proteome analysis techniques evolved, the information that researchers handled literally began to "pour out." The more information, the more difficult it has been to understand the research subject. This is similar to the process of finding which thread to pull to untie the skein. It is like an unexpected thread is caught and interferes with the process or the skein clumps more tightly when pulling a thread carefully.

While researchers were struggling with too much information, the field of information science presented a new solution. The solution is big data process, a methodology for analyzing massive data chunks with machine algorithms using powerful computing capacity. Recently, there have been active research on "multi-omics," which combines genomics and proteomics. In addition, studies have been actively carried out to analyze enormous data using artificial intelligence, which replaces the human brain.

A used postage stamp from the UK, commemorating the completion of the Human Genome Project. At first, scientists thought genomic informations would unveil mysteries of human health. But not long after, it was obvious that Human Genome Project was another piece of a larger puzzle, not the last piece of smaller one. © chrisdorney / Shutterstock.com



Schematics of personalized medicine. The concept of tailoring treatments to patients dates back to the time of Hippocrates. In recent years, the growth of new diagnostic and informatics approaches, particularly genomics realized the concept.

Two Elements of Tailored Medicine, Precision Medicine and Personalized Medicine

With the help of the computer, the skein has begun to be disentangled. Then, the way to realize Hippocrates's old maxim, "humans rather than diseases" has reopened. Researchers now see cells and individuals together by identifying genes, traits, and immune systems at the same time. "Precision medicine" that accurately identifies and treats individual cells and "personalized medicine" that considers different environment of each person, began to be introduced in the field.

"Personalized medicine is a bit confusing term. People generally think that tailored medicine is to diagnose and treat patients according to their disease characteristics. However, personalized medicine also includes identifying the exact cause of the disease of the individual patient and appropriately treating the patient by considering different genetic and environmental factors of each patient. In foreign countries, the former is called personalized medicine, and the latter is called precision medicine. Of course, the two are closely related. Tailored medicine is to treat only the cells causing diseases by considering the patient's health condition and environment."

The key to tailored medicine is "biomarkers." Biomarker refers to a gene or substance that causes a disease or accurately indicates the nature of a disease. By marking the target physically, it is possible to capture only the markers accurately. Then, tailored diagnosis and treatment can be achieved using drugs that only work on the markers.

Therefore, recent medical research has focused on finding effective biomarkers. Although many companies are pursuing related research in foreign countries, such studies are mainly conducted by the universities and the public sector in Korea. This is because the pharmaceutical industry base is inadequate in Korea compared to that in advanced biotechnology countries. Therefore, it is burdensome for the industry to carry out biomarker research that takes more than five years from basic research to the preclinical stage. The Personalized Genomic Medicine Research

Dr. Kyung Chan Park(left) and his research staff at their laboratory. Personalized Genomic Medicine Research Center of KRIBB is searching various biomarkers that can diagnose and cure cancer. © Hyun Jin

A classic case of precision medicine, Glivec.

Center is also contributing to the Korean pharmaceutical industry by developing biomarkers for cancer treatment and transferring technology.

Cancer has attracted the greatest attention in the field of tailored medicine and biomarkers. Finding therapeutic targets precisely is desperately needed for cancer treatment compared to treatment of other diseases. Cancer cells originate from mutations of somatic cells present in the body, not from pathogens entering from the outside. Therefore, the treatment of removing cancer cells also damages somatic cells. Thus, chemotherapy involves severe side effects. If a mutant gene or metabolism that appears only in cancer cells is identified and used as a biomarker, it will be possible to minimize the side effects and improve the therapeutic effects by clearly distinguishing cancer cells from normal cells.

"We already know successful cancer biomarker cases. One is Glivec, a leukemia therapeutic agent. It has been well known that mutant kinase is activated in chronic myeloid leukemia where "Philadelphia chromosome" is found. Glivec targets the mutant kinase and suppresses its function. Thanks to this medicine, we can treat chronic myeloid leukemia with fewer side effects than before."

Associate Director Park explained that since the development of Glivec, a considerable number of new drugs are being developed as a targeted therapy. About 70% of currently developing anticancer drugs are targeted therapies. However, unlike expectations, drugs with fewer side effects and effective efficacy like Glivec have not appeared yet. This is because a marker, which is cancer-specific and shows a good therapeutic effect like the "Philadelphia chromosome" has not been discovered.

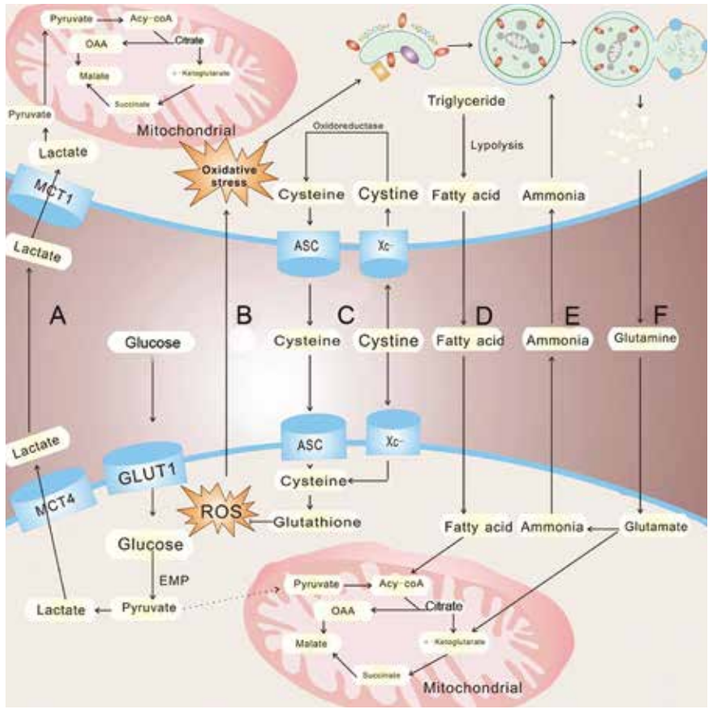
Therefore, immunotherapy has been proposed as another alternative in recent years. It prevents cancer cells from avoiding immune cells or activates T cells to strengthen the whole immune system. Thus, it helps a natural removal of cancer cells. Since this therapy utilizes the inherent defense mechanisms in the body, it is well aligned with "personalized medicine," which provides a specialized prescription for each patient.

Arena of Competition for Tailored Medicine, from Cancer Research to Data

The Personalized Genomic Medicine Research Center has been making notable achievements in the field of cancer-tailored medicine. A paper published in Cell in 2015 presents a new possibility for cancer-targeted therapy. The research team noted that cancer cells, unlike normal cells, gain energy from lactic acid fermentation even in oxygen-enriched environments. In general, human cells produce energy from mitochondria when oxygen is present and lactic acid fermentation occurs only in specific situations where mitochondrial energy alone is insufficient. The research team is exploring ways to use genes that contain information about enzymes that cause lactic acid fermentation as biomarkers.

"We could make such an achievement due to screening analysis technique at the genome level. It is a method of analyzing various genes at once in the whole genome. In the past, we could only analyze one gene at a time. With the advancement of technology, life science research has accelerated."

In recent years, the research team has taken a step further to attempt a single-cell genomic analysis. One of the reasons why targeted therapy for cancer cells is difficult is because mutations in cancer cells occur frequently. Normal cells correct or even destroy genes with errors while replicating genes. This process maintains gene consistency during numerous cell divisions.



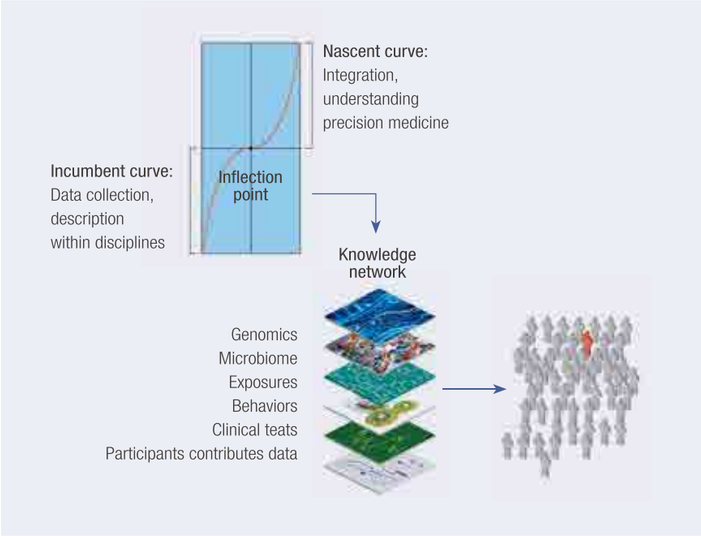
Summary of the role of the tumor microenvironment in the regulation of cancer cell metabolism, where biomarkers are around as diagnostic index and cure for cancer. (A) Tumor cells, under hypoxic conditions, secrete lactate via MCT4. In response, cancer-associated fibroblasts (CAFs) and oxygenated tumor cells take up the tumor-extruded lactate. (B) Cancer cells induce ROS production in CAFs, leading to the onset of stromal oxidative stress, which in turn, drives autophagy and provides recycled nutrients via catabolism and aerobic glycolysis to feed the appetite of adjacent cancer cells. (c) Tumor stromal cells are able to take up cystine, convert it to the amino acid cysteine, and then secrete it. Tumor cells then use cysteine to produce glutathione, resulting in increased ROS resistance and survival. (D) Adipocytes provide tumor cells with fatty acids supplying the energy needs of rapid tumor growth. (E) Glutamine can be hydrolyzed as ammonia in tumor cells and reused by CAFs. (F) CAFs secrete glutamine into the tumor microenvironment to meet the glutamine needs of the cancer cells. MCT4, monocarboxylate transporter 4; GLUT1: Glucose transporter 1; ASC: Neutral amino acid transporter A; XC-: Cystine/glutamate transporter; ROS: Reactive Oxygen Species; OAA: Oxaloacetate.

However, cancer cells do not correct this gene error. In other words, there is a high probability that a mutation would appear in the cell division.

Thus, although cancer tissue is formed by the proliferation of a single cell, the genetic makeup of the cells constituting the cancer is very diverse. Due to this diversity, cancer cells can easily avoid the immune system or chemotherapy. Even if a specific biomarker is targeted for treatment, some cells acquire the ability to avoid the target biomarker inhibiting effect due to mutation. Although it seems that significant cancer cells are destroyed by the targeted therapy and the symptoms are improved, this targeted therapy does not work if the mutant cancer cells survive from the treatment, proliferate, and cause cancer recurrence. According to the mechanism of evolution, the cancer cell population adapts to the environmental pressure (treatment).

Therefore, to completely treat cancer, it is necessary to find what genetic characteristics are present in each cancer cell constituting the cancer tissue of the patient and to combine therapies effective for each type of cancer cell. If the cancer cell with A target and the cancer cell with B target are mixed in an analysis of the cancer tissue of the patient, then A targeted therapy and B targeted therapy should be administered together. In the conventional method of extracting genetic materials from whole cancer tissues and then analyzing them, the characteristics of each cell are not distinguished. Therefore, it is necessary to analyze the genomes of individual cancer cells. This method is a single-cell genome analysis.

"True tailored medicine is a 'cocktail.' Diseases are as complex as life. In many cases, there are many causes of diseases even in one patient. All of these causes should be controlled for effective treatment.



Precision medicine aims to integrate large-scale, diverse datasets reflecting the inherent complexity of biological systems and their role in health or underlying disease.
© Hagwood et al. / Science Translational Medicine

Therefore, it is necessary to use various markers to find out all the causes of the disease of an individual and to combine appropriate targeted therapies for prescription. It is a true tailored medicine, which combines both precision medicine and personalized medicine."

The challenge is data. To realize the ideal of tailored medicine, the following items are necessary: a massive storage space that collects vast amounts of data accumulated separately for each cell, a high-speed network that collects and exchanges information in real time in various research institutes and clinical facilities and artificial intelligence that processes large amounts of information quickly and accurately. To this end, it is important to recruit more bioinformatics experts majoring in artificial intelligence, big data and expand related infrastructure. As precision medicine at the cellular level is still at the beginning stage in the world, there is a chance of success. How to establish a partnership with the research organization that deals with data will be the key.

The kernel of 'omics' research is data. KRIBB holds data center for massive informations from various researches.© Hyun Jin

A Mini-Interview

Dr. Kyung Chan Park

Associate Director of the Personalized Genomic Medicine Research Center

I would like to know why the Personalized Genomic Medicine Research Center focuses specifically on cancer.

A. Cancer research was decisive moment for me to build my career as a researcher. Originally, I had mainly studied proteolysis and cellular motility mechanisms, which were rather classic research topics. When I joined KRIBB after completing the post-doctoral course, I encountered cancer research. At the time I joined, the "Human Genome Research Center" was just established, and the topic that the center was studying was genome-based cancer research. The Human Genome Research Center has developed into the Personalized Genomic Medicine Research Center, which means that the element of the research team was cancer research.

However, in 2004, when we belonged to the center, we used a rudimentary genome analysis method such as a DNA chip. The study progressed slowly because of little experimental data and lack of clinical data. On the other hand, now we have achieved more than we expected because of the accumulation of vast amounts of data, which cannot be handled with only nine researchers. We have definitely benefited from the advanced analytical techniques.

A massive amount of clinical data would be required for studying treatment. But I guess it may not be easy to collect medical information because it belongs to personal information.

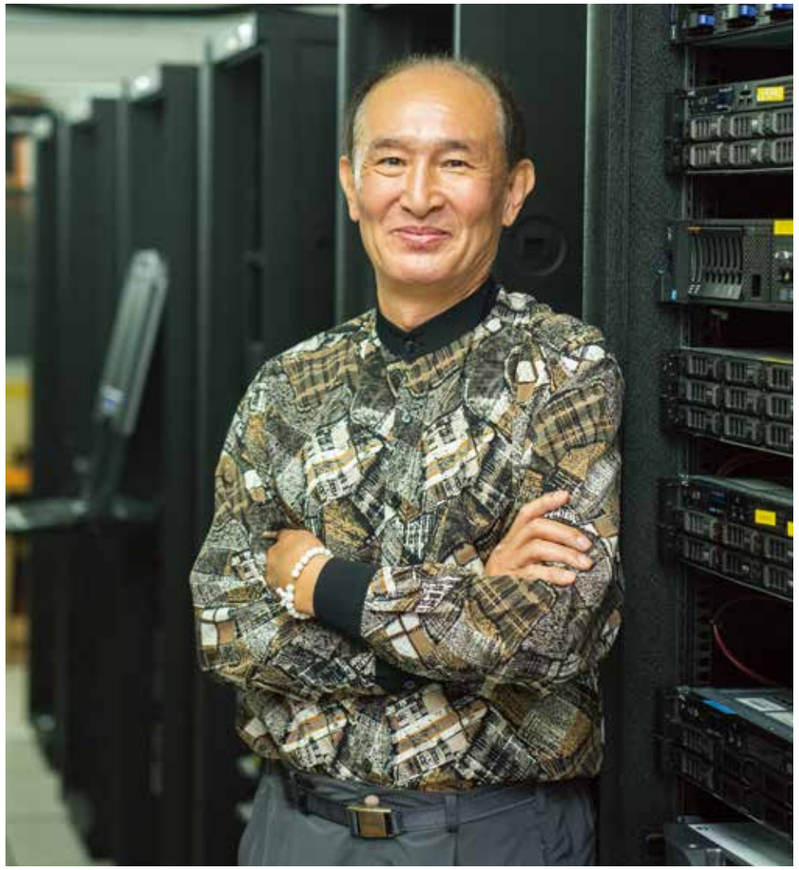
A. In fact, medical technology deals with a wide range of diseases, but there is not much information about the cases of each disease. Since patient information is personal information, administrative procedures are complicated, and it is not easy to obtain information-use consent. What makes us concern the most is that the targeted therapy targets patients who cannot undergo surgery, the most obvious way to treat cancer is to physically remove the tumor. However, in the case of those patients, this cannot be done, so only drugs are used to attack cancer cells. However, to analyze the cancer cells of a patient, it is necessary to obtain cancer tissue by surgical treatment. In other words, the patient must undergo surgery for research purposes, not for treatment. This is not allowed according to medical ethics or research ethics, so we are making efforts to obtain as many cancer tissues as possible without ethical issues.

Life science and new drug research seem to be competing for more data. What should be improved in the Korean research environment in line with this global trend?

A. For research purposes, I hope that there is a way to collect various disease cases easily. Our recent study aimed at collecting and analyzing more than 150 cancer tissues. However, research has been delayed because it is difficult to collect them. Patient's tissues belong to a field of personal information, thereby involving strict regulations. Since clinical treatment is urgently needed at the hospital site, tissue collection for research purposes naturally becomes a lower priority. Therefore, to facilitate related research, it is necessary to establish professional clinical institutes that can cooperate closely with the research department, to code the patient's tissue samples in a way that makes personal identification impossible and to relax regulations or hurdles for research sample collection according to the research purpose. Although bioethics is important and researchers also think that it is dangerous to collect samples indiscriminately, we are worried, as we have to compete with research groups in the world at the front.

How do you plan to lead the research team in the future?

A. Data analysis is more urgent than sample collection. The amount of data generated in life science worldwide is increasing exponentially. Therefore, the demand for bioinformatics researchers is increasing, leading to a shortage of a skilled workforce. We plan to expand experts in the field of big data and artificial intelligence by finding or retraining talented individuals. On the other hand, the scope of tailored medicine is too broad for small research groups like ours to handle. We will choose an area to be concentrated according to the current workforce structure to achieve a solid research achievement. Based on current genome research, we are exploring a number of anticancer agent-resistance inducing markers in lung cancer tissues and examining whether these can be used as targets for overcoming resistance. We will also try to find useful markers for precision medicine in the treatment of lung cancer, liver cancer and stomach cancer, which do not have any proper therapy.



© Hyun Jin

Information Infrastructure Supports Life Science Research

INTERVIEW WITH YONG-KYUNG CHOE,
ASSOCIATE DIRECTOR OF THE KOREAN BIOINFORMATION CENTER

In the past, the field of life science was described with people dressed in laboratory gowns carrying Petri dishes and pipettes, handling various reagents or culturing microorganisms. However, since 2000, life science laboratories have changed. Now, life scientists are struggling with a massive volume of data than researchers in any other field. The collection and management of data have become core activities in life science. In Korea, the Korean Bioinformation Center (KOBIC) collects and manages bioinformation. We met Yong-Kyung Choe, Associate Director of KOBIC, the center of Korea's life science research, to hear about the present and the future situations of biological research resources.

Data: Basic Infrastructure of Modern Life Sciences

Q.

KOBIC is known as the institute that manages biological research resources. The term "research resources" stands out. What do "research resources" mean?

A. In the past, we were collecting and managing genomic information at an individual level. However, since 2007, genome-related research has been active and the volume of information has surged, leading to a situation where data has to be systematically managed for research. Therefore, in Korea, we have established the concept of "research resources" for the first time in the world. The result is the Secondary Biological Research Resource Management Plan. According to this plan, KOBIC has been developed into the institute that integrates and manages research resource information.

Q.

So, in other words, KOBIC is the system in which genomic information for research is unified.

A. Not necessarily. KOBIC does not cover all genomes and related information. Some information is managed by different institutes depending on the type. This is because there is a massive amount of genetic information and such information is used in different fields depending on its purpose and nature. For example, the Korean Collection for Type Cultures, which is located at KRIBB Jeonbuk Branch Institute, manages genomic information of living organisms at an individual level. Additionally, Korea Research Institute of Chemical Technology deals with the information regarding compounds produced from genes or chemically resynthesized compounds. Thus, there are several institutes that are responsible for specific information, so related institutes regularly hold meetings and workshops to exchange ideas.

Q.

You have been involved in many activities in terms of research policy and management. I believe that you have a broad perspective of research field due to your experience. How does KOBIC's data contribute to life science research?

A. In my view, the true mission of KOBIC is not to collect and archive research resource information. KOBIC aims to produce information based on data, create knowledge based on such information, and eventually gain insight and wisdom that will penetrate core areas of life science based on that knowledge. Numerous information in precision medicine, one of the most spotlighted field of research in modern life science, has been generated based on data. I would like to apply my favorite figure of speech. In other words, many restaurants across the country are data; words of mouths about good restaurants are information; restaurants that appear on the TV among the good restaurants are knowledge; and, the restaurants that have reached the master level among those that appeared on TV level are wisdom.

Q.

So, it means that the data accumulated in KOBIC is successful data that yields to knowledge.

A. For now, yes. However, I think it is necessary to accumulate "failed data." Most of research involves trial and error. Research is the process of taking a wrong pathway, realizing the wrong pathway and then taking a right pathway again. Here, the wrong pathway -failed data- shows what should not be done, greatly reducing time taken in trial and error. But now the failed data is still not appreciated. Therefore, researchers do not disclose unsuccessful information.

Q.

Don't researchers personally share failure cases with each other?

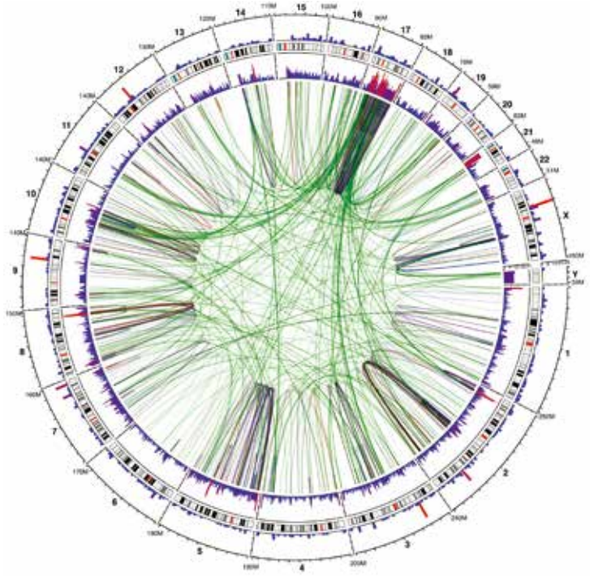
A. Of course, they share important failure cases within the lab. However, this should spread throughout the research community without staying in the limited space of the laboratory to help the development of life science. This is not a problem for individual researchers, but a problem of how our society and research community deal with failures.

Applying the Global Sense to KOBIC

Q.

It seems that a broad perspective is necessary for leading a research support organization. You have worked in the OECD. How has such experience helped your current job?

A. The experience at the OECD has allowed me to view life science from various perspectives. Since 2003, I have been working as a Korean delegate in the working party of each research division. In modern industry, science and technology are very important. Therefore, the OECD organizes a "working party" consisting of researchers and private experts who represent each country in the field of research closely related to industry. The



Recurrent rearrangements in the genomes of pediatric medulloblastomas investigated in the ICGC PedBrain project. Green lines represent inter- or intrachromosomal translocations, blue lines deletions, red lines duplications, and black lines inversions. The outer circles indicate hotspots of single nucleotide variants and genomic breakpoints, respectively. © dkfz.de

working party selects issues for each research field and presents directions that are shared by the world, including the OECD member countries.

Q. _____

In which working group are you involved?

A. I belonged to a Working Party on Biotechnology for 10 years since 2003. Then, according to the restructure of organization, Working Party on Biotechnology and the Working Party on Nanotechnology have been combined. Therefore, I now belong to Bio-, Nano-and Converging Technology (BNCT) working party. Since 2015, I have served as Vice Chairman.

Q. _____

What is your working party currently working on?

A. We work on technology, policy and system. We are currently discussing research resource sharing and international research support for mutual growth of countries around the world, including OECD member countries. We also establish research protocols for fair and ethical research and check if research is conducted in accordance. In particular, partnership between private and public sectors is the major agenda lately.

Q. _____

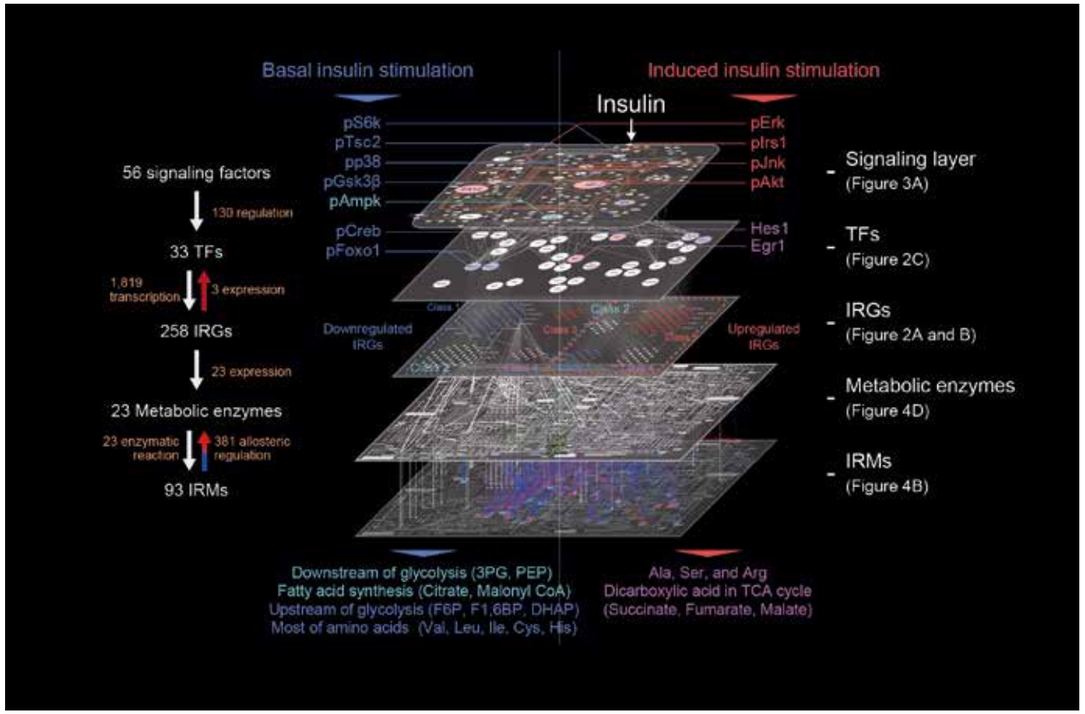
Why is partnership important in the bio sector?

A. The market in bio sector is unique. Most markets consist of providers and consumers and consumers who pay money are beneficiaries. However, bio market is different. The person who benefits directly from biotechnology is the patient, but the primary consumer is the doctor. In addition, there are some entities that introduce and implement technology like public health and unspecified people may also receive benefits. Thus, providers, consumers paying money and beneficiaries are different, and several groups are intricately intertwined. Because of these characteristics, we think that partnership between private and public sectors is important.

Q. _____

What are the characteristics of each country's bio sector based on your experience in international conferences?

A. Whenever having an OECD working party meeting, I feel subtle differences by country. This is obvious due to different industrial structure and environment of each country.



The example of utilizing bioinformation to research. Construction of the Trans-omic Network by Insulin Stimulation. The trans-omic network contains 5 layers and the regulatory relationships among them. The colors of molecules and metabolic terms on the trans-omic network indicate the classes classified by the EC50 and T1/2 values of the IRGs. The representative molecules in the selective transomic network by induced (right, red) or basal insulin stimulation (left, blue) are shown. © Kentaro Kawata et al. / Cell

North American countries such as US and Canada view bioinformation as a useful intellectual asset for industrial technology. On the other hand, Western Europe, including France and Germany and Northern European countries, deal with bioinformation in terms of natural resources and ecosystem conservation. These various perspectives are good stimulus for me to run KOBIC.

Q. _____

Is there any particularly impressive experience while interacting with overseas researchers?

A. I talked to the Dutch representative at the OECD meeting. He was interested in exchanging plant specimens and genetic information. In fact, I had never been to the Netherlands, so I only thought of it as a country consisted of reclaimed land and actively engaged in trades. Therefore, I wondered why the representative was interested in plant resources. Later, when I learned that the Netherlands was an agricultural powerhouse with highly developed agricultural technologies, I was surprised and understood his interest. I realized that the Netherlands considers agriculture as a high technology industry because agricultural products are major export items, so they are enthusiastically collecting the plant research resources to be used for agriculture. I also thought that this method of the Netherlands, applying grass and arbor materials to agriculture, would contribute to the development of Korean agriculture.

Attempting to Complement Expertise and Systems Based on Policy Experience

Q.

As you pointed out, biological research resources can be utilized in various areas. However, it seems that the research resources are not being utilized evenly. What should be improved to make such research resources widely utilized?

A. To create a case like that in the Netherlands I mentioned above, the information provided by institutes, such as KOBIC, must be reliable. In addition, researchers also need to select and use information. Therefore, KOBIC is promoting education for researchers and students. We are almost completed with the development of an online curriculum with the commissioned agency. We are also conducting offline information utilization lectures for researchers at universities across the country. Recently, we gave a lecture on solving problems using research resource information data at Chungnam National University.

Q.

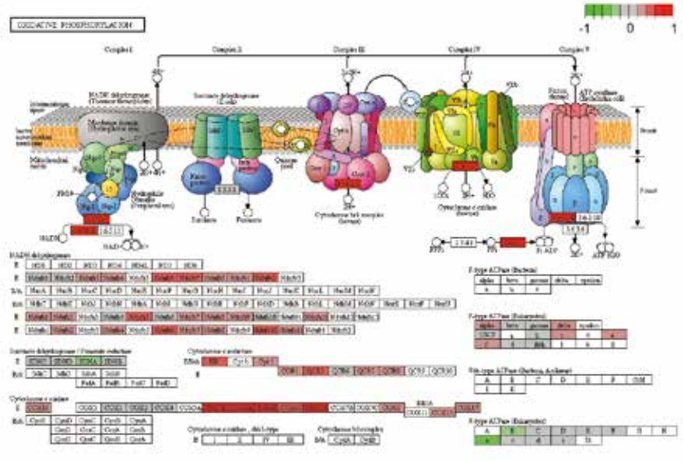
It seems like using the network is also a very important task in terms of dealing with data.

A. Of course. So, now we are providing a genome analysis service, so-called Bio-Express. When a user uploads a genomic information, this service contrasts and compares it with other genetic information. Since we launched the service in 2017, this service has already performed more than 1,000 analyses. Moreover, we have developed a specialized platform for analyzing omics data and we are internally testing it. We hope that the activation of these services will help to improve the life science research environment.

Q.

As you have been engaged in the science policy field for a long time, you may have discovered something to be improved in terms of system and policy.

A. KOBIC's role only involves information services. The popularity of the field of bioinformatics suggests that biological research resource is a specialized field which requires further studies. We need to establish system for classifying data, develop utilization plan, and carry out big data analysis so that data can be effectively applied to actual research. Nevertheless, researchers at KOBIC still cannot afford to collect and manage data.



An example on processing bioinfomatics data to easily recognizable diagram. This image explains impact factors of various genes involving oxidative phophorylation based on KEGG graph. © MDI

Q.

Wouldn't biological research resource management agencies in other countries experience a similar situation?

A. Advanced countries in terms of life science have significantly specialized research resource information field. The representative world-class genetic information centers are NCBI in US, EBI in Europe, and DDBJ in Japan. Among them, I have visited DDBJ. At DDBJ, experts with long research experience curate the bioinformation database. DDBJ does not just deliver the data requested by a researcher passively, but it recommends the relevant data for the researcher or suggests research based on the data. What was impressive was that DDBJ researchers spend only 30% of their working time on data services and the remaining 70% on their own research. On the other hand, we are still focused on services, so the researchers spend only 10% of their working time for personal research.

Q.

Perhaps we need to further acknowledge the expertise of biological research resource information management.

A. In modern life science, data management and services are research support activities that require high level of expertise. If biological resource information management, classification and services are sufficiently specialized and the appropriate evaluation indices are established, the expertise of biological resource information will be improved, thereby contributing to the development of life science greatly. At a glance, the problem of evaluating the performance of an infrastructure employee seems to be an issue of individual researchers' interests, but it is a problem that must be solved in the research community.

Q.

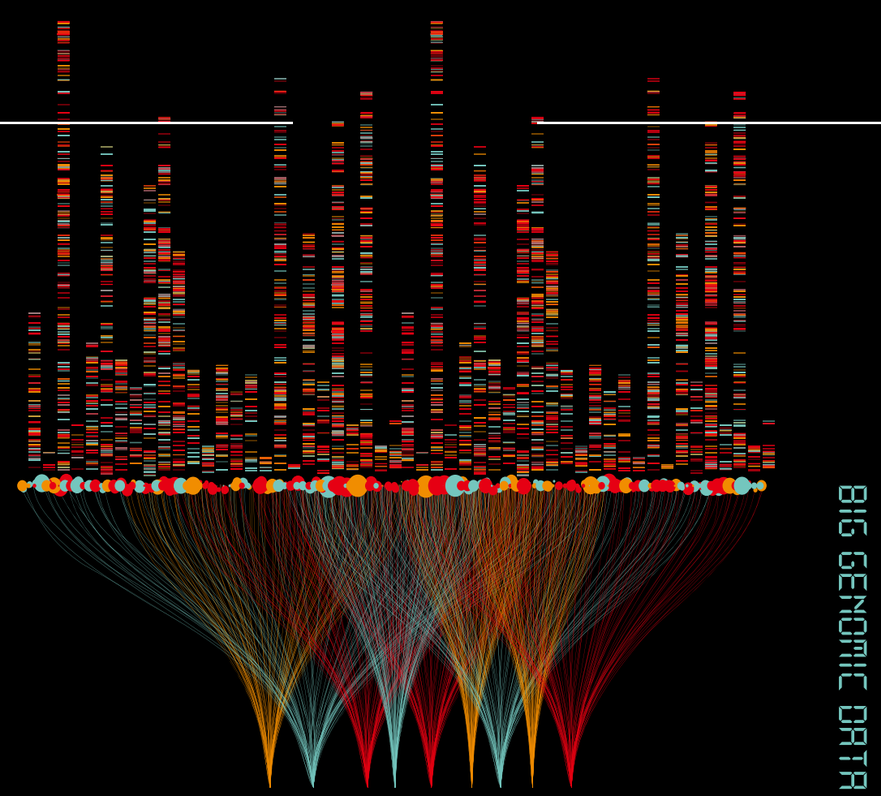
Lastly, how do you plan to lead KOBIC as Associate Director?

A. Modern life science is developing rapidly. As the amount of research information is increasing, convergence with ICT field, as shown in data analysis using artificial intelligence and deep learning, is being achieved. On the other hand, as the concept of precision medicine targeting single cells has been established, studies related to nano or materials fields have been active. As Associate Director, I will try to support this trend and prevent the life science industry in Korea from falling behind in the global trend. In particular, if Korea, China, and Japan establish cooperation systems through information exchange and ASEAN countries join the system, East Asian countries may become another major cluster of life science. There are, of course, sensitive issues such as ownership and security of information, but I think these issues should be wisely solved for the development of life science.

The Server room of Korean Bioinformation Center. © Hyun Jin

Curator of Biological Research Information

KOREAN BIOINFORMATION CENTER (KOBIC)



Recently, press such as Bloomberg has reported that IBM will restructure organization of the Watson Health business. The move to introduce Watson at medical institutions has eventually stopped. Watson, which made a brilliant debut in the US quiz show "Jeopardy!" in 2011 was expected to replace human physicians. But it is found to have inadequate diagnostic skills.

According to a recent study by the Asian Congress of the European Society for Medical Oncology, the average concordance rate between medical staff and Watson was only 60% for cancer diagnosis (out of 1,000 patients) at Manipal Hospital in India. In a domestic study by Gachon University Gil Hospital, only 55.9% of the cases that Watson's recommended treatment agreed with the medical staff's opinion. Watson showed a message to put additional information about patients and even stopped operation.

Watson's disappointing performance resulted from insufficient data. Artificial intelligence, like Watson, learns accumulated data from deep learning and sets its own rules. This is why Watson was expected to be crucial for "personalized medicine" where vast amount of data has to be considered. However, it is difficult to establish a reliable rule if the data and the cases of diseases are insufficient. Artificial intelligence cannot accurately diagnose any diseases involving poor prognosis or insufficient cases due to rarity.

This suggests that it is still too early to diagnose a disease using artificial intelligence. On the other hand, it is apparent that enough information must be accumulated to make artificial intelligence to work properly in the medical field. According the medical records of Manipal Hospital in India, the diagnostic concordance rates of rectal cancer and non-metastatic breast cancer, both having low mortality and high incidence rates, exceeded 80%. However, metastatic breast cancer and lung cancer, which have poor prognosis, showed 45% and 17.8% of concordance rates, respectively. For cancer with difficulty to accumulate cases, a low diagnosis rate was shown. Of course, this is also the case for human physicians. It is difficult to make an accurate judgment if there is little information about diseases and patients.

Ultimately, data is the key. The reason why North American life science research is conducted through a strong link with hospitals, why China is collecting patient information by minimizing regulations and why European countries are jointly promoting personalized medical projects, is because they want to collect as many cases as possible and accumulate data to gain significant information. As more data is collected and categorized, more accurate analysis is possible and new information is generated.

In Korea, the Korean Bioinformation Center (KOBIC) collects and organizes data. KOBIC was established with the completion of the Human Genome Project (HGP) in 2001. Following the completion of HGP, studies based on genetic information have been actively conducted. As a result, various data have been generated and variables to be considered in research have increased. Therefore, it has become necessary to systematically manage research information. KOBIC was established based on the bill prepared according to the request of the research community at that time because it needed an institute dedicated to genomic information.

At that time, KOBIC introduced the concept of "research resources," unlike other countries' genomic information service organizations. Until the mid-2000s, genomic information was collected and managed at the individual or species level, regardless of purpose or utilization. This is similar to each country separately keeping a large detailed topographic map. However, as the volume of information in life science research has surged, it has become necessary to systematically and separately manage the data necessary. If maps are categorized into cadastral maps in urban areas, farmland in rural areas, and weather maps in the sea, people would easily find information they need and compare according to their use. This is the reason why the concept of "research resources" was presented in Korea for the first time in the world.

The major difference between existing biogenetic information and research resource information is "purpose." Research focus more on individual genes that show a particular trait than on the entire genome. They are interested in gene mutations and how genes are processed and expressed as proteins. Thus, genomic information for such research should contain countless information for individual genes.

For example, in the case of government research projects, each department has different interests even with the same genomic information. The Ministry of Agriculture, Food and Rural Affairs is interested in information related to varieties of food resources, vegetation of forest resources and livestock products. The Ministry of Environment approaches biodiversity and genetic diversity of the whole ecosystem. The Ministry of Oceans and Fisheries uses genetic information to improve diversities for fish resources and aquaculture and the Ministry of Health and Welfare requires human genome information for disease prevention and treatment. Because different genetic information is needed for each purpose, there are many cases dealing with different types of the same gene. Sometimes, there are some cases where genetic information to be researched is overlapped. Therefore, KOBIC was established as an organization that efficiently combines and manages such genetic information.

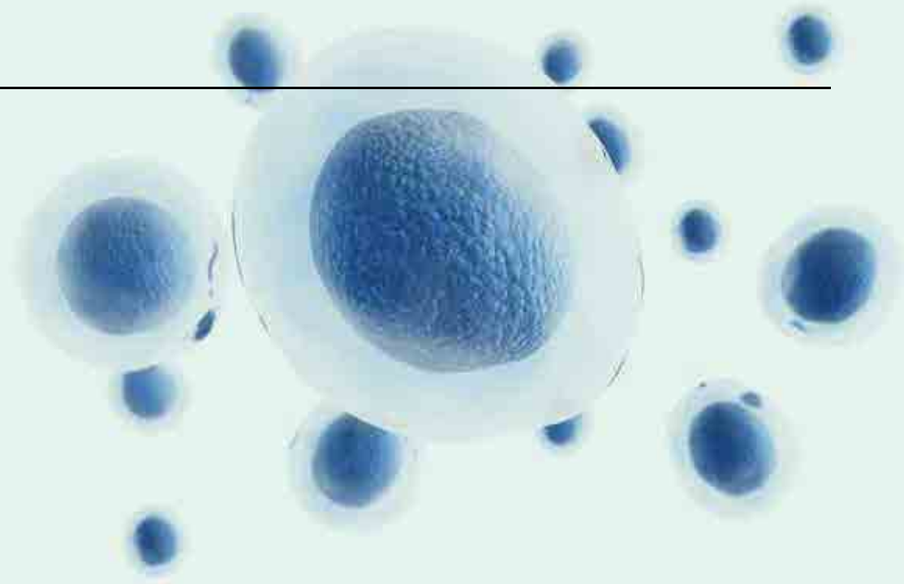
Like any research information management organization, KOBIC is collecting data to utilize. As of July 2018, KOBIC has collected data on a server with a capacity of 3,100 CPU core and storage capacity of 10.7 PB (Peta Bytes). It is currently operating four types of services based on this data.

The most basic service is the Korean Bio-resource Information System (KOBIS, http://kobis.re.kr), which provides unified search, statistics, and related information on biological research resources. KOBIS is an integrated search service for information collected by KOBIC. As of July 2018, KOBIS provides information search of 13,104,341 cases for 78,496 species. Through links with the National Science & Technology Information Service (NTIS), KOBIC has improved its utilization by providing papers, patents and reports on biological research resources. In addition, researchers can also directly register their research achievements. To this end, KOBIC is operating bioinformation research achievement registration system (Biodata, http://biodata.re.kr).

In addition to basic services such as search and registration, it also provides a cloud-based bulk information analysis system. This system (Bio-Express, http://bioexpress.re.kr) provides a high-performance hardware analysis program and pipeline for efficient utilization of research resources even in small laboratories lacking computerized infrastructure and analytical experts.

Bio-Express has a Hadoop-based big data platform that is easily accessible from a web browser. On the other hand, it also provides a linkage system for searching and utilizing genome information collected from various departments. The Genome-InfraNet (http://gins.kr), a multi-department genome information linkage system, integrates and manages data owned by five departments' genome information centers. The genomic information, which is generated by the Ministry of Science and ICT (has jurisdiction over Korea Research Institute of Bioscience and Biotechnology), the Ministry of Agriculture, Food and Rural Affairs (Rural Development Administration, Korea Forest Service), the Ministry of Trade, Industry and Energy, the Ministry of Health and Welfare, and the Ministry of Oceans and Fisheries can be integrated, searched and downloaded.

The characteristics of modern biology and related industries are enormous and accumulation of information. The surge in data triggered by 'omics' studies has enabled artificial intelligence analysis and personalized medicine research. What is essential here is the ICT that manages increased data. Life science can be said to be an academic field that benefits most from advanced ICT. KOBIC serves as a repository and curator that enables various data to be utilized where needed at a contact point between biotechnology and ICT.



Successful Development of Maturation Technology of an “Organoid” Similar to the Human Small Intestine

Dr. Mi-Young Son’s research team in the Stem Cell Research Center at Korea Research Institute of Bioscience and Biotechnology developed *in vitro* maturation technology of intestinal organoids of human small intestine for the first time in the world by applying a new three-dimensional (3D) differentiation protocols combined with co-culture techniques. This 3D intestinal organoid model solved the issues that cells differentiated from human pluripotent stem cells (hPSCs) generally have poor functions and are immature, thereby being appraised as raising the level of human-like model development technology.

Although hPSCs can differentiate into various tissue-specific cells or organoids, most of the cells differentiated from hPSCs are at a fetal maturity level. In particular, there have been no successful cases of *in vitro* maturation of intestinal organoids and only a few cases have succeeded in *in vivo* maturation by transplanting intestinal organoids into the mouse kidney capsule.

However, *in vivo* maturation process in mice is time-consuming and costly. It relies on empirical and uncharacterized methodology. The biggest problem is that there is no way to identify what factors are involved in maturation in the mice. Therefore, it is necessary to develop a maturation protocol with clearly defined additives *in vitro*.

To overcome this issue, Dr. Mi-Young Son’s research team simulated the human intestinal environment by co-culturing the existing 3D intestinal organoids with immune cells. As a result, the mature intestinal organoids showed all four enteric cells: enterocytes, goblet cells, paneth cells and enteroendocrine cells. All cell types within mature intestinal organoids expressed markers representing the function of each cell types. The next generation sequencing (NGS)-based transcriptome analysis also confirmed that the overall gene expression levels were similar to those in the adult human small intestine.

They also analyzed whether the intestinal organoids could function well at the cellular level to verify similarity with actual human small intestine. As a result, it was confirmed that the drug absorption and glucose uptake through enterocytes of the mature intestinal organoids and the expression and function of proteins are related to cystic fibrosis disease (CFTR assay). Mucin-production ability of mature goblet cells and hormone secretion activity of enteroendocrine cells within mature intestinal organoids were upregulated, demonstrating that intestinal organoids undergoing *in vitro* maturation were more functionally mature than conventional intestinal organoid models.

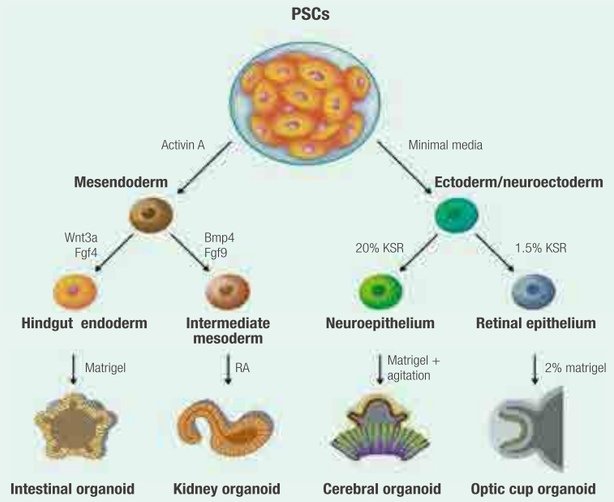
Dr. Mi-Young Son’s research team’s intestinal organoids have remarkably similar gene expression patterns to their *in vivo* adult human small intestine counterparts compared to the existing immature intestinal organoids. By reproducing the main functions of the small intestine, they demonstrated the efficacy and applicability of *in vitro* maturation technology of hPSC-derived intestinal organoids.

Because newly developed intestinal organoids have similar physiological characteristics with adult human small intestines, the responsiveness to drugs and the phenotypes of the disease can be better recapitulated by using these organoids. Furthermore, the organoids can be used as an alternative technology for animal experiments in the development of new drugs. Therefore, *in vitro*-matured organoids are expected to be applied to various fields, such as development of disease models and drug screening platforms, intestinal microorganism research and cell therapy.

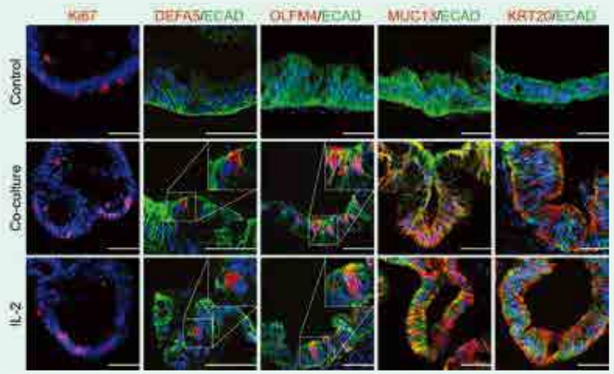
“The most challenging and important goals in the field of stem cell research is to generate mature differentiated cell or organoid models that are more similar to the human body. Our highly functional intestinal organoid that has undergone *in vitro* maturation is the world-class functional human small intestine model. As it has a high degree of similarity to the human body, it will contribute to the development of new drugs by more accurately predicting human body responses,” said Dr. Mi-Young Son.

This study was published at Nature Communications online on August 2.

Kwang Bo Jung et al., "Interleukin-2 induces the *in vitro* maturation of human pluripotent stem cell-derived intestinal organoids", Nature Communications, 2018, DOI: 10.1038/s41467-018-05450-8

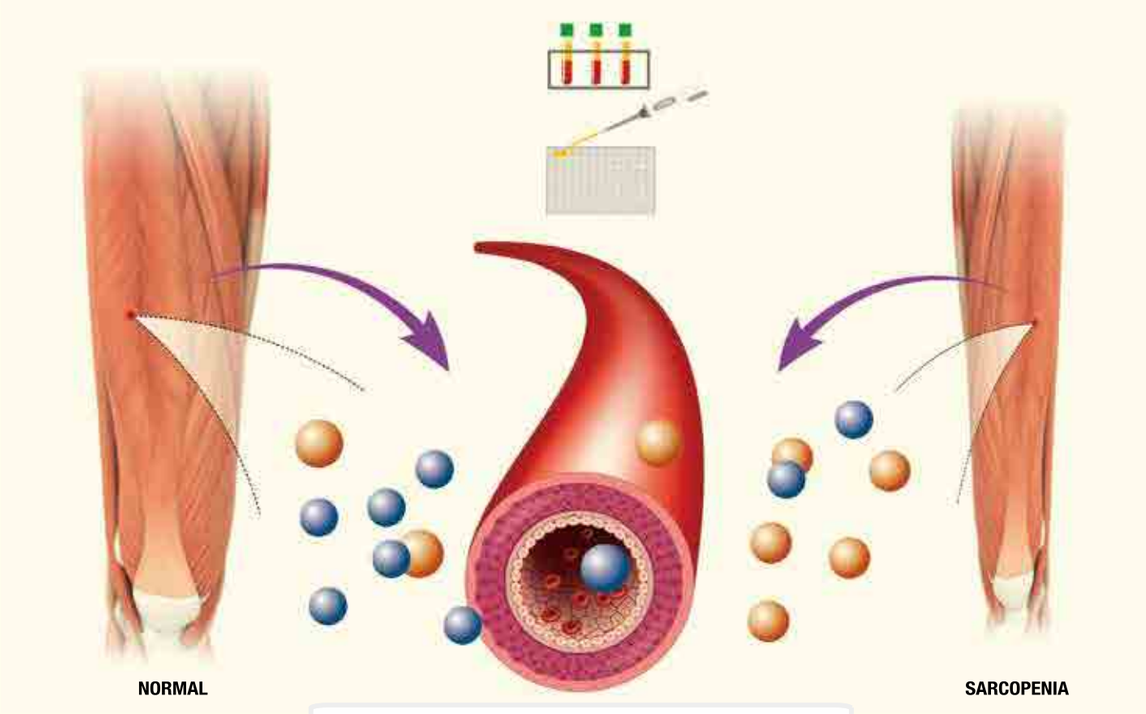


Overview of organoid methodologies. Organoid differentiation strategies developed so far from human PSCs. Conditions and growth factors are indicated for the derivation of progenitor identities. © Madeline A. Lancaster et al. / Science



Expression of mature intestinal markers in control and *in vitro*-matured human intestinal organoids © Jung et al. / Nature Communications

Early Diagnosis of Sarcopenia is Possible Using Blood



Biomarkers are differently secreted between normal and sarcopenia muscle.

Dr. Ki-Sun Kwon's research team in the Aging Research Center at Korea Research Institute of Bioscience and Biotechnology and the Seoul National University Hospital jointly developed a diagnosis technology with high accuracy by discovering a blood biomarker for sarcopenia and combining multiple biomarkers.

Sarcopenia is a disease in which the muscle mass gradually decreases with aging. It occurs mainly in the fifties and about 20% of the people aged 65 years or older are patients with sarcopenia who need active treatment. The prevalence rate of senile sarcopenia is rapidly increasing due to global population aging. Decreased muscle mass due to sarcopenia is a major cause of restricting the independent life of the elderly. It also lowers the basal metabolic rate, raising the risk of hypertension and cardiovascular disease up to five times.

Sarcopenia is diagnosed by measuring muscle mass and physical activity ability (such as grip strength and walking speed). The most accurate measurements of muscle mass are currently magnetic resonance imaging (MRI) and computed tomography (CT), but these are uneconomical and CT involves a radiation hazard.

An alternative is the dual energy X-ray absorptiometry scans (DXA), which is relatively economical and has a low radiation hazard. However, it overestimates muscle mass up to 8% in the case of muscle edema or fat deposition within the muscle. The bioelectrical impedance analysis (BIA), which is easy to move and can measure muscle mass quickly and conveniently, is less accurate because muscle mass value varies depending on race, gender, age and degree of dehydration.

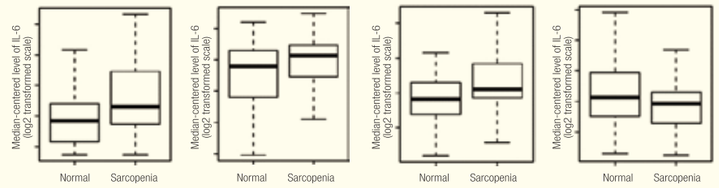
Thus, diagnosis through measurement of muscle mass and physical activity is uneconomical and inefficient. The diagnosis can be also made after a certain degree of sarcopenia has progressed. In addition, since it does not reflect the pathophysiological aspects of an individual, it is difficult to determine the correct treatment method. Therefore, it has been urgent to develop an early diagnosis method of sarcopenia that reflects the biological characteristics of an individual using blood biomarkers.

Dr. Ki-Sun Kwon's research team conducted a comparative analysis of the blood of an elderly group with normal muscle mass and that of an elderly group with sarcopenia, regarding 21 sarcopenia biomarker candidates to find a sarcopenia blood biomarker. As a result, they identified four biomarkers (IL-6, SPARC, MIF and IGF-1) that were different between the two groups.

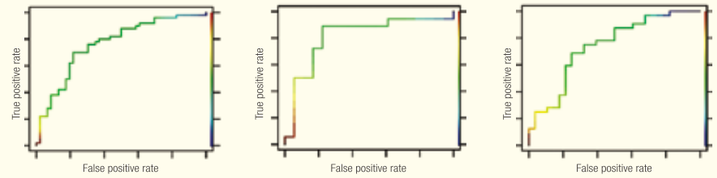
The individual diagnostic accuracy of the biomarkers identified is less than 0.7, which is low for actual clinical use. Thus, the research team calculated the risk index by combining four biomarkers with logistic regression and increased the diagnostic accuracy to 0.763 through this combination. They also confirmed that a most accurate diagnosis was possible within a significant range with 70% sensitivity and 78.3% specificity. In recent years, two new biomarkers have been discovered. As a result, the diagnostic accuracy increased up to 0.877.

Diagnosis of sarcopenia using biomarkers in the blood is very economical, quick and safe. Moreover, it can be used not only for the diagnosis of sarcopenia, but also for the effective evaluation of clinical classification, prognosis, and drug response. It is expected to dominate the market for the *in vitro* diagnostic medicine for sarcopenia where there has been no blood diagnostic technique.

"Early diagnosis of sarcopenia is essential for a healthy life during old age, because muscle aging is a major cause of poor quality of life. I would like to contribute to a healthy aged society through this diagnostic technique," said Dr. Ki-Sun Kwon, who led the research.



Comparison of serum protein levels between normal and sarcopenic aged subjects.
IL-6 (A), SPARC (B), MIF (C) and IGF-1 (D) protein levels in human serum were measured using sandwich ELISA. Box plots were used to visualize distribution of each serum protein level. P-values were obtained with two sample t-tests.



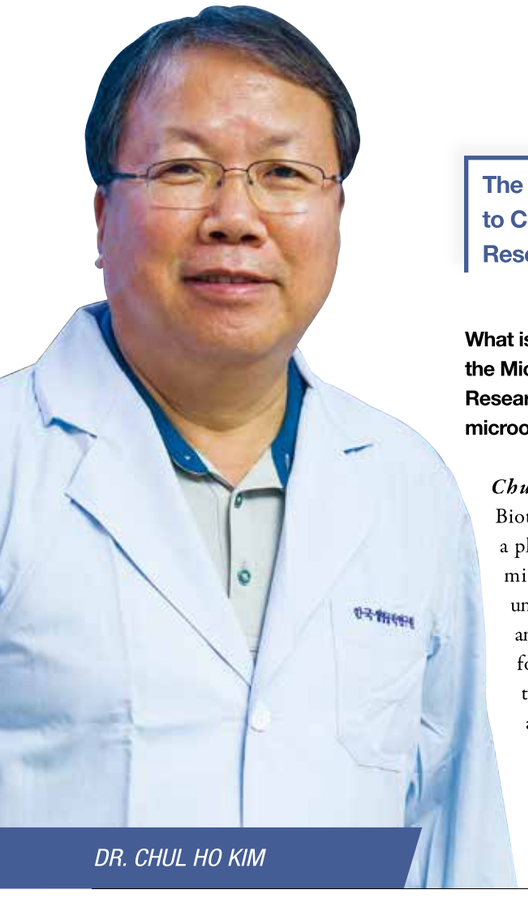
Significance of risk score based on multiple biomarkers for diagnosis of sarcopenia.
Receiver operating characteristic (ROC) curves for each group. Whole population (A), Men (B), Women (C). The area under the ROC curve (AUC) was calculated for each group to determine the significance of multiple biomarkers in predicting sarcopenia.

Ju Yeon Kwak et al., "Prediction of sarcopenia using a combination of multiple serum biomarkers", Scientific Reoprts, 2018, DOI:10.1038/s41598-018-26617-9

Enhancing Public Interest by Investigating Microbial Function

MICROBIAL BIOTECHNOLOGY RESEARCH CENTER;
DR. CHUL HO KIM AND DR. BAEK ROCK OH

The world around us and our bodies are full of invisible organisms. As far as quantity goes, these microorganisms are like Earth's conquerors. As described in the word "conquerors," microorganisms might be thought as terrifying warmongers which cause infectious diseases and destroy populations. However, we have been using microorganisms in useful ways for a long time. Penicillin, made of blue mold, has saved many lives and fermented food has enriched our dietary lives. Microorganisms are ambivalent. We still do not know all about microorganisms. The possibility of microorganisms saving human lives is endless. The Microbial Biotechnology Research Center at Jeonbuk branch of Korea Research Institute of Bioscience and Biotechnology (KRIBB) is a place to realize the infinite possibilities of microorganisms. Let's enter the world of microbial function through an interview with Dr. Chul Ho Kim and Dr. Baek Rock Oh at the Microbial Biotechnology Research Center.



DR. CHUL HO KIM

The Main Goal is to Commercialize Research Outcomes

What is the specific goal of the Microbial Biotechnology Research Center in terms of microorganism research?

Chul Ho Kim: The Microbial Biotechnology Research Center is a place to study the application of microorganisms. We explore the unique functions of microorganisms and study the technologies necessary for the production of products that promote human utility such as pharmaceutical materials, cosmetic materials, food materials, and probiotics. We have also continuously researched bio-refinery that produces chemical materials through microbial fermentation. Thus, we are trying to replace chemical materials with environment friendly microbial materials.

Baek Rock Oh: In other words, we focus on developing industrially applicable microorganism-based technologies. Identifying useful microorganisms and characterizing them are not enough. It is a key to establish a commercialization process so that a specific function of microorganisms is mass produced and used. The staffs and resources at the Microbial Biotechnology Research Center are prepared for commercialization.

Research on microbial function seems to have set the social utility of scientific research as its important value. Do you care about utility more than your personal curiosity when conducting research?

Chul Ho Kim: I think that nowadays, not only microorganism field, but also all other fields have to consider about the economic effects. For government projects, even basic research should consider applicability. This may discourage research activities but we cannot consider that social utility is less important than personal curiosity. When I assume that my research is going to be used and contribute somewhere, I find it interesting. The research recognized by many people for its value is meaningful, isn't it?

Baek Rock Oh: Even a new discovery that amazes everyone and an innovative technology that is admired eventually dies out unless it has economic feasibility. As our center frequently carries out joint research with companies, we cannot help but consider how much our technology will help to solve various social issue. Utility is the core value shared by all researchers at the Microbial Biotechnology Research Center.

What are the special difficulties of investigating microbial function?

Baek Rock Oh: The basic aspect of research is to cultivate microorganisms and produce materials. Since microorganisms grow day and night, I have to check whether they are growing well and how much they have produced useful substances constantly. Our center is well-coordinated, so the researchers check them by turn, but sometimes we have to stay up all night. However, the researchers check other colleagues' microorganisms while carrying out their research at dawn, which I really appreciate.

What is the key that makes the Microbial Biotechnology Research Center cooperate with each other? How do you communicate?

Baek Rock Oh: We frequently have small gatherings. In informal situations, our members sometimes come up with good research ideas and we also advise each other about the life as a researcher.

Chul Ho Kim: Most of our researchers live in dormitories. Therefore, it is relatively easy to gather and Dr. Baek Rock Oh, responsible for the administrative work of the research, is young. He gathers together with his students often and carry out informal conversations with them. Of course, they do share valuable opinions during regular lab meetings and seminars, but it seems that many insights come up while sharing research stories in a comfortable place.

What are the benefits of having researchers with distinct individuality in the name of the Microbial Biotechnology Research Center?

Chul Ho Kim: The field of microbial function research is divided into various sections. The researchers at our center, including those majoring in separating microorganisms, improving microorganisms and cultivating micro-organisms, have their

DR. BAEK ROCK OH

© Hyun Jin

own unique roles. No one can carry out research alone, without working with others. Moreover, our research center focuses on industrialization, so we need a vessel that can contain all stages, from microorganism cultivation and development to industrialization. The Microbial Biotechnology Research Center is such a vessel.

Dr. Kim, in your opinion, what is your role in the Microbial Biotechnology Research Center?

Chul Ho Kim: Since I am a principal researcher, I am trying to serve as a bridge between our center and companies that care about the market. The perspectives of those engaged in the industry are different from those of researchers. Therefore, I would like to deliver ideas from different perspectives and be the voice of the field to young researchers.

Baek Rock Oh: Dr. Kim gives helpful comments on the ideas at the beginning stage and provides a lot of help to conduct joint research with companies. I would like to develop our research with researchers based on Dr. Kim's opinions.

Chul Ho Kim: Young researchers have little opportunity to participate in seminars and interact with people working in the industry because they solely focus on research. I want to help researchers to meet with those working for companies as often as possible.

Microbial Function is Still an Unexplored Area

I am curious about your research background. I would like to know what made you study microbial function and how your interests have changed.

Chul Ho Kim: I started studying microbial function with bioenergy. Bioenergy is a field of studying technologies to improve biological resources and convert them into energy sources. As in other studies, bioenergy is heavily influenced by market situations. When the price of petroleum energy increases, the demand for research increases. But in the opposite case, it is not easy to lead the research. Nowadays, we are dedicated to researching cosmetic materials and microbiome, a human intestinal microbiota.

Baek Rock Oh: I also have similar a background and interest with Dr. Kim. We have been working together in the same center for a long time, so our research history seems to match. I am currently spending a lot of time in producing cosmetic preservatives and moisturizers. I am also studying intestinal microorganisms. The opportunity that led me to study microorganisms is simple, I found microorganism cultivation that can produce useful materials amazing and interesting.

How did you start your research at KRIBB?

Chul Ho Kim: I started my research career at KRIBB and I have continued researching until now. Dr. Oh worked in a company before working at KRIBB. I am also wondering about the difference between working at KRIBB and working in a company.

Baek Rock Oh: I worked for about a year in a company that develops food materials after earning my Ph.D. KRIBB has many advantages compared to the company. First, it has a well-established research infrastructure that a company cannot build. Moreover, there are many researchers from various fields of study. So, if I face obstacles while researching, I can immediately get advice from experts in each field.

Microbiome affects one's mental and physical health. Particularly, fecal microbita transplantation, a theraphy that transplants microbiome extracted from feces of healthy person to the guts of patient with enteric disease, yields good results.
© shutterstock.com

Chul Ho Kim: I agree with what he mentioned. Companies prioritize profits, so they focus on short-term performance. Therefore, it is difficult for companies to have detailed research infrastructure and human resources. Since we have laid all the grounds for microorganism research, we can accept most of research requests.

If so, please describe the research achievements including technology transfer that have been carried out by the Microbial Biotechnology Research Center.

Baek Rock Oh: The representative case is the technology for biologically producing 1,3-propanediol. The 1,3-propanediol, which is usually used as a raw material for making fibers, is produced using microorganisms, and it replaces chemical raw materials. It can be applied as a moisturizer or preservative in cosmetics. We studied it for more than 10 years to commercialize it. As a result, we successfully transferred this technology to a cosmetic raw material company. Since then, we received a research project for demonstrating this applied research from the Ministry of Environment, so we are carrying out joint research currently.

To Dr. Kim and Dr. Oh, the focus of research is the "social value." They put the practicality and utility over the value as knowledge. Thus, those two researchers ever interact with corporate practitioners to draw inspirations for their research. © Hyun Jin

Chul Ho Kim: There are many technologies that have become the basis of current commercialized products. The technology to produce DHA, generally extracted from fish, by cultivating microalgae, the microorganism technology for feed and the microorganism technology for fertilizer have all been successfully transferred and commercialized.

Baek Rock Oh: Since we carry out many studies with companies, we have more technology transfer cases compared to other research centers.

At what level is the field of healthcare using an intestinal microbiome?

Chul Ho Kim: Microbiome is a collective term for microorganisms and proteins produced by microorganisms. Basically, it is not an unfamiliar field for microbiologists. However, the field of healthcare using intestinal microorganisms requires strict clinical trials, so it is difficult to industrialize microbiome soon. In particular, fecal microbiota transplantation has shown prominent results. The United States has already established a fecal bank, refined the major microorganisms in the feces and supplied them to those suffering from intestinal diseases. In Korea, some hospitals are carrying out fecal microbiota transplantation. Perhaps, as more companies become interested in this area, there will be more research investment activities.

Baek Rock Oh: Intestinal microorganisms are diverse and different for individuals, so it is too early to apply them for treating diseases only based on some successful cases. However, data on the effectiveness of treatment with intestinal microorganisms have been accumulated and many researchers have become interested and are participating in this field. Therefore, it is expected that microorganisms will be appropriately used for the treatment of actual diseases.

Chul Ho Kim: The most difficult part results from the peculiarities of microorganism research. Even if disease treatments using microorganisms are found to be effective, we should discover the mechanism. However, the effects of microbial populations are very complex, so there are many cases in which a clear mechanism is not explained. Currently, we are studying intestinal microorganisms that have a positive effect on skin improvement, which does not involve demanding clinical procedures.

Discovering the Utility of Microorganisms Is the Joy of Research

How would you describe your research style? Where and from what do you come up with ideas?

Chul Ho Kim: I get a lot of ideas about research when talking to people in different environments, especially people working for companies. Having only developed fabric materials, I began to study cosmetic materials because I keenly realized the necessity and economic feasibility when talking with an employee from a cosmetic company.

Baek Rock Oh: When determining the research and method I should conduct, I think a lot about how this affects the market and demand. I also strive to have a conversation often with corporate executives for ideas.

Have you ever had a "discovery," "A-ha!" or "Eureka!" moment that made you feel fulfilled?

Baek Rock Oh: I felt happier and more fulfilled when I obtain desired data rather than the moment of discovery. Useful substances produced by microorganisms have a standard production amount and when I achieved it, I couldn't feel happier. After that, I was pleased as a researcher when there was technology transfer for a beneficial product.

Chul Ho Kim: The successful domestic production of cosmetic materials made from white jelly fungus extract remains in my memory. Before then, all white jelly fungus extract was imported from China. Mushrooms are also microorganisms as they are fungi. Therefore, we thought that we definitely could cultivate white jelly fungus. After many experiments with Dr. Oh, we finally succeeded in cultivating white jelly fungus. This was the moment I felt happy.

I would like to ask you about the future of microorganism research you are dreaming of.

Chul Ho Kim: I do not have a great ambition because I will retire soon. I would like to finish my research life by laying well-established foundation of microbiome research for our center.

Baek Rock Oh: We are currently conducting studies to produce beneficial substances using safety-proven lactic acid bacteria. We are trying to apply a programmable nuclease technology to maximize the substance production of lactic acid bacteria. For now, I want to concentrate on this research.

© Hyun Jin

Leading Domestic Immunotherapeutic Research and Development

Y-BIOLOGICS; YOUNG WOO PARK (CEO) AND BUM CHAN PARK (VICE PRESIDENT)

As the Nobel Prizes 2018 in Physiology and Chemistry were awarded to scientists who have developed the cancer immunotherapy and phage-display technology, interest in immunotherapy using antibodies has been increasing more than ever. Seven of the top ten drugs, which currently account for the highest volume of sales in the global market, are therapeutic antibodies. It is not exaggerated to say that the future direction of the pharmaceutical industry depends on therapeutic antibodies. We met Young Woo Park, CEO and Bum Chan Park, Vice President of Y-Biologics, which has the most solid core technology among platform antibody drug R&D companies and asked them about the future.

Y-Biologics is a biotechnology venture company with antibody discovery technology that discovers effective antibody drugs, selects therapeutic targets and examines the effects. Currently, we have discovered a new antibody drug that inhibits immune checkpoint, which is at the pre-clinical stage. Y-Biologics developed an "antibody-like cell engager (ALiCE)," a bispecific antibody technology that activates immune cells directly to kill cancer cells. Y-Biologics is aiming to launch antibody drugs produced with platform technology and ultimately contribute to improving the quality of human life.

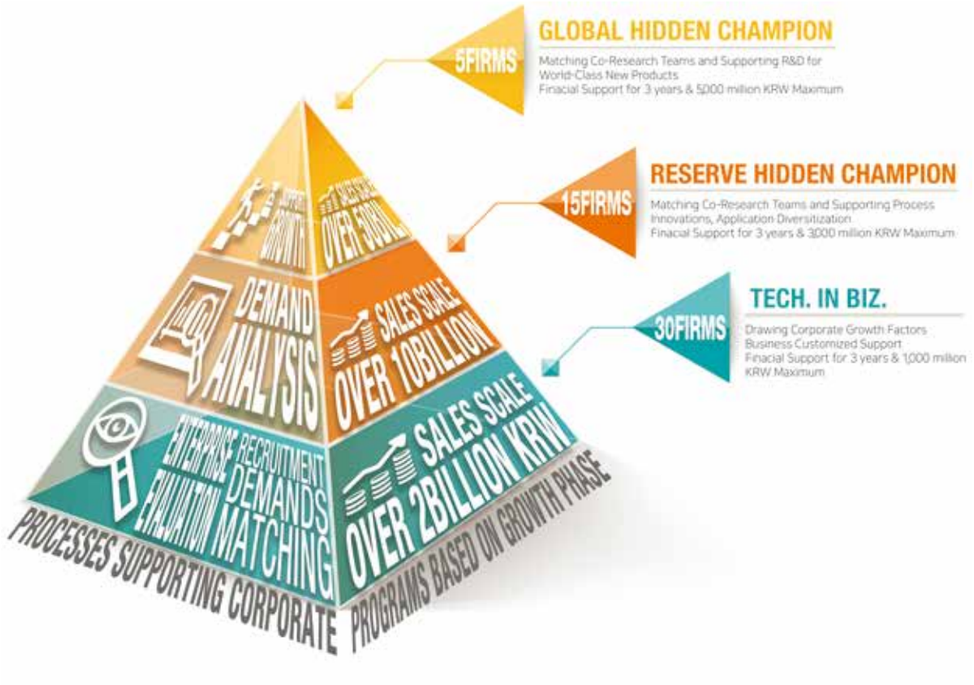
New Drug Development is Not an Outcome of an Individual Company

CEO Park is an entrepreneur who used to be a researcher with this goal in his mind. "I was a therapeutic antibody researcher for 20 years in LG Life Science Ltd., and then carried out a number of government research projects for antibody drug development at Korea Research Institute of Bioscience and Biotechnology (KRIBB). However, I keenly realized that there was a lack of manpower and investment for developing new drugs in the global market. I had thought about how to solve this issue for a long time, and then I decided to run my business to secure professional manpower and funds."

Therapeutic antibodies for immune-oncology are new paradigm that activates the immune system of the human body and target the disease-causing substances on cancer cells. Unlike conventional therapies such as chemo- or radiotherapy, therapeutic antibodies have fewer side effects and higher potency. In addition, successful development of therapeutic antibodies will create tremendous economic value added. However, there are many obstacles in achieving this development. CEO Park said that the support from KRIBB helped him overcome barriers. "To develop immunotherapeutic agents effectively, it is essential to assess the efficacy of antibodies using animal models which have a similar immune system to humans'. These animal models are costly and require a high level of skills. The only place that could establish an animal model in Korea was the Laboratory Animal Resource Center at KRIBB. Therefore, we participated in the Pre-hidden Champion program that helps technological innovations for technology-based biotechnology companies."

Vice President Park emphasized that the cooperation between enterprises and government-funded research institutes creates positive feedback to promote research and development. "Programs such as the Pre-hidden Champion do not only support Y-Biologics. Having a platform for producing animal models at KRIBB would

The Antibody research lab of Y-biologics. The most valuable assets of Y-biologics are zest and creativity from young staffs. © Hyun Jin



Schematic diagram of enterprise support programs serviced by KRIBB. Y-Biologics received 'Reserve Hidden Champion,' the second stage program.

enable companies that are trying to develop immunotherapeutic agents to take a great leap forward. This close cooperation would eventually lead to a new drug development that leads the global market.

A Step Towards Advanced Immunotherapeutic Agents

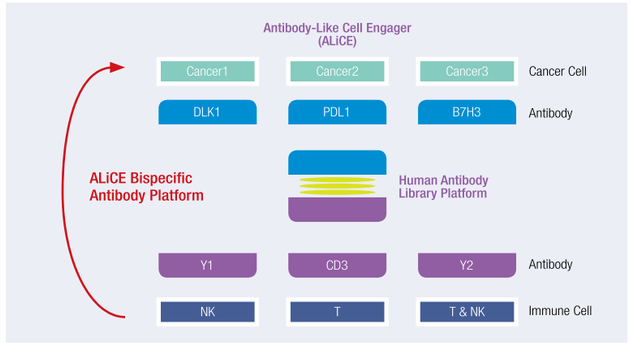
Y-Biologics is working on creating a new product (an improved version of the immunotherapeutic agents that are distributed in the market) through the Pre-hidden Champion program. In particular, CEO Park mentioned that bispecific antibody technology is important. "Although immune checkpoint inhibitors such as anti-PD-1 or anti-PDL-1 antibodies have shown a great progress in cancer treatment, it has a clear limitation in applying it to all patients. The rate of complete recovery is also not high. In addition, CAR-T, which targets cancer cells by gene manipulation of immune cells, shows much higher potency, so the rate of complete recovery is high. However, it has limitations of personalized treatment and its cost is too high. ALiCE is a bispecific antibody technology that overcomes these two disadvantages and activates immune cells while attacking cancer cells.

Therapeutic antibodies produced by ALiCE technology can be applied to many patients and show higher potency at cheaper prices. Its commercialization would save many domestic and international patients from suffering. CEO Park stressed that what makes this research possible is the core technology like the human antibody library possessed by Y-Biologics. "Y-Biologics is the only company in Korea with an automated system that can screen more than 10,000 human antibodies a day. The technology that identifies the disease target and finds the right antibody is the best in the world."

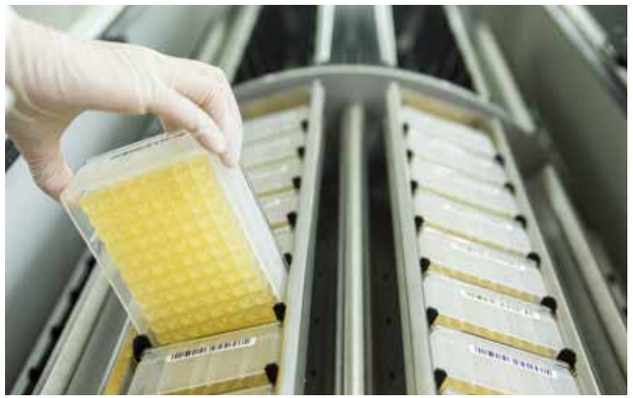
More Support and Cooperation Needed to Guarantee Future Life Rights and Economic Growth

It had taken a lot of time and trials until Y-Biologics acquired this technology. It is difficult for biotechnology companies to obtain achievements in a short period of time due to research nature. For this reason, CEO Park said that more institutional support for biotechnology companies is needed. "The technology level of Y-Biologics is globally competitive, but to be validated by the world regulatory institutions, we need to secure reliable animal experimental data and publish papers in prestigious journals. Companies need to use limited manpower and funds as efficiently as possible. Therefore, I believe that it would be a great help if KRIBB supports the academic verification field by dividing the roles. I also hope that companies with excellent research capabilities, despite of their low sales, can apply for a variety of programs created by KRIBB considering the characteristics of each company."

CEO Park has been able to run his biotechnology company continuously due to his belief that he would produce effective new drugs with platform technology and guarantee the people's right to life without relying on global pharmaceutical companies. In addition, new drug development can contribute to economic growth and job creation in Korea. CEO Park spoke of his aspiration, "I would like to make Y-Biologics as the leader in biotechnology and industry together with KRIBB. As I have served as a researcher at KRIBB, I often meet with researchers and get a lot of insights. I believe that using bispecific antibody technology, Y-Biologics can carry out collaborative research with Customized i-Medicine which has the NK cell therapy technology. Therefore, we plan to receive consultation for the development of a NK bispecific antibody."



Schematic diagram of ALiCE. ALiCE(Antibody-Like Cell Enger) is the company's proprietary bispecific antibody format that redirects activated T cells to specific cancer cells. CD3/PD-L1 ALiCE, namely ACE-5, targets T cells onto PD-L1 on cancer cells. It has shown very strong potency in NHSLC cell-driven Xenograft tumor model.



Y-biologics has procured world-class antibody library valuable for development of new therapeutic antibody. © Hyun Jin

Investment expansion for new biohealth projects in 2019

R&D projects for bio and health will be largely increased from 2019. According to '2019 National R&D Project Budget' released by the Ministry of Science and ICT, 8 major biohealth R&D projects will be newly launched. The initiative includes the core industries of the 4th industrial revolution such as building an AI-based drug development platform, developing omics-based precision medicine technologies, and establishing the infrastructure for precision medicine industry.

Drug development is one of the lucrative representative of biohealth sectors, but tremendous time and costs incurred in R&D are its serious drawbacks. For instance, 'Humira', the medication used to treat autoimmune diseases such as rheumatoid arthritis and Crohn's disease, has sales of about 7 trillion KRW annually in the European market alone. The development of 'Humira' was initially launched in 1993, but it was finally approved in 2002 after a series of strict clinical tests.

Developing new drugs requires enormous resources such as time, costs and human capital, which sets high entry barriers for the Korean pharmaceutical companies to enter the global pharmaceutical market. The rate of new drugs released by Korean pharmaceuticals recorded only at 0.01% last year. To tackle this challenge, the Korean government suggested establishing an AI platform, which will eventually shorten the period of drug development by half (7 to 8 years) and minimize the number of trials and errors.

The process of new drug development is classified into 4 stages – discovery of candidate compounds, preclinical trial, clinical trial and sales. AI big data analysis can investigate all data used in each of the four stages and suggest the optimal lead compounds. Furthermore, AI that analyzes medical data can shorten the clinical trial period by suggesting an optimal patient population and contribute to minimizing side effects through its automatic post-sale tracking of effects and toxicity.

More concretely, AI collects and learns open-access information of compound structures available in Korea and abroad, as well as information from papers and patents that present the effects of each compound. It then suggests the structure of the new drug target that the researcher on the platform wants to analyze. Once AI predicts the optimal compound combination corresponding to the new drug target and its expected effect, the researcher can test the predicted effects through trials. 27.7 billion KRW will be invested in establishing a new AI drug development platform over the next 3 years.

Paradigm shift in R&D on Alzheimer's, from treatment to diagnosis and prediction

The governmental support for Alzheimer's R&D, chiefly focused on medication development, will be expanded to cover diagnosis and prediction. A budget of 700 billion KRW will be invested to achieve this goal over the next 10 years.

The Ministry of Science and ICT (MSIT, Minister Young Min You) announced the 'National Alzheimer's R&D Strategies' at the 'Hankyung Biohealth Industry Conference 2018' which took place on September 5. "The response to Alzheimer's so far has been largely focused on alleviating symptoms. It is extremely difficult to treat Alzheimer's in this manner because brain damage has already significantly progressed," said Gyeongchun Seo, head of the Bioscience Technology Division of MSIT. He added, "we will shift the direction of our support towards the early diagnosis and response."

Seo further explained, "we are planning to announce a comprehensive plan reflecting this policy shift in the second half of the year."

The most urgent challenge in the early Alzheimer's diagnosis is developing a convenient technology to swiftly diagnose Alzheimer's disease using biomarkers in blood, urine and saliva. Once an Alzheimer's biomarker-based diagnostic kit is commercialized, it can replace costly PET and CSF analysis and patients with mild cognitive impairments will be able to prevent Alzheimer's disease.

This endeavor also leads to expanding the scope of Alzheimer's-related industries and creating new business models. In the wake of the global era of an aging population, the Alzheimer's market is expected to be valued at 15 billion USD in 2026. Therefore, more sophisticated classification of patient groups according to biomarkers and the development of an early Alzheimer's diagnostic kit suitable for each group will certainly generate tremendous economic value added. In addition, the AI new drug development platform will advance the development of Alzheimer's mediation as well.

Urgent calls for bioethics act reform to activate biohealth industry

There are growing demands for bioethics act reform to vitalize the biohealth industry. The Bioethics Act was established in 2004 to prevent bioscience technologies from undermining the human dignity and value and to ensure bioscience technologies be used for prevention and treatment of diseases for human. However, there has been a constant appeal that the extremely rigid Bioethics Act holds back the development of biohealth industry where time is the key. The Bioethics Act is a 'positive' system which only allows what the law stipulates, so it is difficult to develop new ideas or undertake creative endeavors. Expecting innovative research outcomes under this system is hard because most of the researchers spend their time preparing documents that support their work and convincing the authorities.

Recognizing the issue, the Ministry of Health and Welfare and the Ministry of Science and ICT jointly hosted the 'Seoul Bioeconomy Forum 2018' on September 13 at KBIZ Korea Federation of SMEs (small and medium-sized businesses), Seoul. The forum was held for the first time this year to identify urgent challenges and strategies for the development of biohealth industry, the key driver for innovative growth.

"The current Bioethics Act is not catching up with technologies in this progressive era of convergence," said Jang Seong Kim, the President of Korea Research Institute of Bioscience and Biotechnology. He emphasized that it is necessary to distinguish basic research from clinical trials. "We have to allow limited extent for basic research that does not undermine the human dignity and bioethics," argued Kim.

This does not mean a complete abolishment of regulations, but they should be reformed to facilitate the application of bioscience technologies for disease treatment. There was also an idea that the researchers need to consult with regulatory authorities from the initial stage of R&D to promote innovations in biohealth sector. Some proposed regulations should be tailored for different companies because the regulatory barriers are higher for small and medium-sized companies than they are for big companies. Bioethics act reform in line with global standards will provide biohealth industry with greater momentum.

© ASCoF

The Bridge between the European Basic Science and Korea

ASSOCIATION DES SCIENTIFIQUES CORÉENS EN FRANCE (ASCOF)

International cooperation in scientific-technological research has been actively pursued for a long time. Particularly, the relationship between Korea and France is special. Korea has cultivated experts in science and technology by concluding agreements with France in areas such as nuclear power, high-speed railroads and space research and development. The Association des Scientifiques Coréens en France (ASCoF) is striving to strengthen the exchange and cooperation in science and technology between Korea and France.

ASCoF was established in 1976 to promote academic exchange and relationship among its members and to contribute towards the exchange of science and technology between Korea and France. In 1975, nonprofit preparatory committee was formed and Dr. Sunsik Min, the first Asian professor at a French university, was appointed as the Chairman. On January 31, 1976, the rules of the association were established at ASCoF inaugural assembly with 36 founding members. Dr. Youngchul Lee was appointed as the first President. In 1977, ASCoF's exchange with Korea began when its delegation participated in comprehensive domestic and foreign academic lectures for Korean scientific technicians (equivalent to the current academic conferences hosted by ASCoF) in Seoul.

ASCoF plays a role not only as a hub for Korean scientists in France but also as a liaison connecting European scientists and Korea through regular academic conferences, special conferences and Europe-Korea Conference on Science and Technology (EKC), where scientists and engineers both in Europe and Korea gather and exchange knowledge and ideas.

Two regular academic conferences are conducted annually, which are open to all members of ASCoF: (1) the spring conference, held in a non-metropolitan area and (2) the fall general meeting, held in Paris, France. The academic conferences include not only a keynote speech but also present opportunities for families of ASCoF members to learn about members' activities in sharing their academic and expert knowledge. In addition, special lecture programs are arranged featuring various invited experts from diverse fields beyond the natural science, including anthropology, economics, business management, the humanities, history, and art.

ASCoF has eight solid regional assemblies and holds at least one local academic conference per year. As of 2018, 268 members are registered from Paris, Provence, Lyon, Grenoble, Toulouse, Strasbourg, Bordeaux, Troyes, and three southern European countries. ASCoF also operates eight specialized academic departments and registered members are required to join one of the departments. The eight specialized academic departments are (1) basic science, (2) bio-life science, (3) earth-ocean science, (4) computer science, (5) energy and the environment, (6) machines and aircraft, (7) electronic computing and (8) material science.

ASCoF pursues multi-dimensional cooperation, such as conclusion of agreements, collaborative research, international scientific-technological seminars, technical advice and student exchange programs for promoting cooperation among companies, public organizations, and universities in both Korea and France.

Notably, because France recently has implemented innovative scientific-technological programs, channels for integrating such models have begun operation in Korea. In France, foreign students and researchers are guaranteed with the same social security benefits as the French. Also, researchers can dedicate themselves fully to their research without having to take on any administrative duties or projects. Such environment helps researchers to improve their creativity and insight. Accordingly, many Korean scientists working at universities or national research institutes in France are actively improving research environments and are developing cooperative R&D programs while performing mutual exchanges with Korean universities, in addition to cultivating talented individuals by implementing student exchange programs and joint doctoral degree systems.

ASCoF is strengthening several programs in support of the new generation of scientists (i.e., Korean college students, graduate students and post-doctoral researchers). The association also holds some smaller networking events and regular academic conferences with senior scientists to allow young scientists in France and other European countries to connect with one another, share their research directions, and pursue new directions. Furthermore, ASCoF actively participates in several cooperative programs with the associated organizations in Korea and scientists in France to allow small- and medium-sized enterprises to enter the European markets.

France has achieved outstanding results in the area of health and medical treatment and, in particular, leads innovations in the pharmaceutical and beauty industries. The Institut Pasteur currently has a number of Korean scientists conducting research. There is also a researcher who established a business in Korea after studying at the school of pharmacy in France and conducting research at the L'Oréal research center. Life science researchers and companies in the biotechnology field have an invaluable opportunity to cooperate with France, which is home to the world's leading bio-cluster in the areas of new drug development, immunotherapy, protein engineering and diagnostic medicine.

The 2018 spring conference held by ASCoF. The conference is a forum where Korean scientists make cultural and academic exchange with French. © ASCoF

The Nagoya Protocol information session hosted by the Ministry of Science and ICT and Korea Research Institute of Bioscience and Biotechnology

The Ministry of Science and ICT (MSIT, Minister Young Min You) and Korea Research Institute of Bioscience and Biotechnology (KRIBB, President Jang Seong Kim) jointly hosted the 'MSIT Nagoya Protocol Information Session' on August 7 at Korea Science and Technology Center prior to the enforcement of the Nagoya Protocol (enforce since August 18).

ABS Research Support Center (Associate Director Yeong Hyo Chang) at KRIBB was commissioned with the tasks of national responsible organization and national monitoring organization by the MSIT prior to the enforcement of the Genetic Resources Act for the implementation of the Nagoya Protocol on August 18. The information session was held in order to explain practical response measures of the Nagoya Protocol and the Genetic Resources Act for researchers who are still using the existing biological resources and to minimize confusion.

The session consisted of 2 sections. Section 1 briefly introduced the Nagoya Protocol and the reporting process in accordance with the Genetic Resources Act and procedure. Further, frequently asked questions among 200 inquiries were shared with the participants. In Section 2, participants had their questions answered. After this Q&A session, private one on one meetings were arranged as well. Approximately 200 researchers from various organizations in industries, academia and research institutes took part in the information session and expressed great interest and concerns about the Nagoya Protocol.

Seung Jun Kim, the Executive Vice President of KRIBB stated, "the Nagoya Protocol will have a tremendous impact on bioengineering R&D. This information session will certainly help researchers to prepare for the Nagoya Protocol and prevent unexpected problems."

KRIBB hosted the '5th KRIBB Technology Transfer Information Session 2018' to create a bio industry ecosystem

Korea Research Institute of Bioscience and Biotechnology (KRIBB, Pesident Jang Seong Kim) hosted the '5th KRIBB Technology Transfer Information Session 2018' on September 20 at Coex, Seoul to promote growth of bio ecosystem in Korea through reinforcing cooperation with bio venture startups and other related companies.

In the information session, KRIBB presented outstanding research cases selected from its accumulated bio and medical research expertise. KRIBB also provided one on one meeting sessions to encourage 'coexistence and cooperation' and 'shared growth' with bio companies.

For this session, KRIBB selected 14 basic technologies with great commercial growth potential among patent applications from the past 10 years. These include anti-cancer drugs, new anti-metabolic drug candidates, technologies for skin cancer and so on. In particular, programs run by the Biotechnology Process Engineering Center were introduced to enhance capability and competence in the biotechnology, the key area for the 4th industrial revolution.

KRIBB is planning to provide programs such as 'Biopharmaceuticals/Material Industrialization Process Development Project' to support the growth of the Korean bio industry ecosystem continuously. "We are planning to host this technology transfer information session regularly to increase the competitiveness of the bio sector. In this event, KRIBB will have an opportunity to provide a new momentum for growth through our technology transfer in the short term and vitalize the industrial bio ecosystem by supporting innovative growth of the bio sector in the long term," said the President Jang Seong Kim.

KRIBB jointly-hosted the '16th Korea-Japan-China Bioinformatics Symposium 2018'

The Korean Bioinformation Center (KOBIC, Associate Director Yong-Kyung Choe) of Korea Research Institute of Bioscience and Biotechnology (KRIBB, President Jang Seong Kim) jointly hosted the '16th Korea-Japan-China Bioinformatics Symposium' with Japan and China, from August 30 to 31 in SOKENDAI (The Graduate University for Advanced Studies) located in Hayama, Japan.

The Korea-Japan-China Bioinformatics Symposium is jointly hosted every year and the bioinfomation institutes in participating countries have taken turns hosting the annual bioinformatics symposium. These are the Korean Bioinformation Center (KOBIC) of Korea, the National Institute of Genetics (NIG) of Japan, and the Shanghai Center for Bioinformatics Technology (SCBIT) of China. The objectives of this symposium are to establish an international cooperation network in Northeast Asia in the field of bioinformatics and to discover shared R&D agenda.

A total of 30 presentations were given at the symposium. Prof. Gojobori Takashi, Distinguished Professor at the King Abdullah University of Science and Technology (KAUST) located in Saudi Arabia, represented Japan to present on 'a big data analysis of the genome of living communities in the Red Sea'. Prof. Runsheng Chen at the Institute of Biophysics of the Chinese Academy of Sciences representing China, presented about 'genome, big data, precision medicine, and artificial intelligence'. Finally, Prof. Doug Woo Nam, special lecturer from the Ulsan National Institute of Science and Technology representing Korea, presented on the topic 'improving the power of genome-wide association study through biological circuit and metaanalysis'.

This symposium will expand the horizon of bioinformatics, which analyzes genomic data through computer science. It will also contribute to consolidating the foundation of research cooperation for the latest bioinformation agenda including big data, the 4th industrial revolution and precision medicine.

"This international cooperation network of bioinformatics between Korea, Japan and China will lay a foundation for close research cooperation and contribute to identifying new R&D issues common for Northeast Asia," said Yong-Kyung Choe, Associate Director of KOBIC.

Answering Questions to Life

KRIBB

Korea Research Institute of Bioscience & Biotechnology