ANNUAL REPORT

2020

KRIBB

Korea Research Institute of Bioscience and Biotechnology

KRIBB website

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KRIBB 20

Publication Address

『We will become a research institute that leads innovation in biotechnology for the sustainable development of mankind and the realization of shared values.』

In the past year, the COVID-19 pandemic completely changed our lives, reminding us that biotechnology is more important than ever for the economy, industry, and survival of mankind and national security.

As such, biotechnology is the key technology of the fourth industrial revolution that can simultaneously achieve economic development and quality of life as a solution to the four major challenges of mankind : disease, food, environment, and energy.

Korea Research Institute of Bioscience and Biotechnology (KRIBB) is a biological R&D hub and a professional research institute leading the bioeconomy in Korea. Since its foundation in 1985, we have been leading the innovation in biotechnology and the development of the bio-industry through open innovation by conducting basic and fundamental research, constructing infrastructure, and developing bio-ecosystem in accordance with national and social R&D needs.

In particular, in the midst of the recent COVID-19 pandemic, we have successfully supported the rapid non-clinical evaluation of vaccines and therapeutic candidates using ABSL3 facilities, emerging as a national core research institute that is accepted and trusted by the people for resolving issues pertaining to human health and social welfare.

In addition, by linking KRIBB's role and responsibility (R & R) with the UN sustainable development goals (SDGs), we participate in the international community's efforts to solve global agendas. Through strategic alliance, we are actively conducting practical open cooperation and exchanges, such as joint research and information exchange, as we continuously innovate to grow into a global advanced research institute based on excellent research manpower and cutting-edge equipment and facilities.

Going forward, KRIBB will take the lead in resolving international and social issues by creating growth engines for the future of the bio-industry and securing core technologies for the national agenda.

In addition, we will continue to advance the bio-infrastructure by upgrading and opening up consumer-oriented research infrastructure, to create national utility results and design the future of mankind, leading the innovative national growth.

The annual report for 2020 contains the fruits of KRIBB's efforts, focusing on research achievements over the past year. Although physical exchange is more difficult than ever due to COVID-19, I hope this annual report will serve as an opportunity to gather the roles, responsibilities, and wisdom from all walks of life, including joint research and cooperation between countries and institutions, and building networks.

Thank you.

Jang-Seong Kim, Ph.D.

President of Korea Institute of Bioscience and Biotechnology

MISSION & VISION

MISSION

To carry out R&D activities and related projects in the field of bioscience and biotechnology in joint effort with other research institutes, academia, and industries at home and abroad

To disseminate the results of scientific research and technological development

VISION

KRIBB

A Global Leader for Healthy Life and Bioeconomy

LIFE-ORIENTED

INNOVATION

FUTURE

EXCELLENCE

Creating Future Bio Growth Engine

Solutions for National Agenda

Advancing Biological Infrasturucture

GENERAL INFORMATION

FOUNDATION BASIS

Article 8, Act on the Establishment, Management and Promotion of Government-funded Research Institutes

KEY FUNCTIONS

Develop and disseminate sophisticated core technology in bioengineering and bioeconomy

- Innovative bio convergence, creation of future growth engine, resolution of bio-based agenda Support public infrastructure for bioengineering R&D both at home and abroad
- Supporting establishment of public infrastructure, government-funded think tank, nurturing talented human resources, supporting commercialization of small/medium sized companies

HISTORY

Feb. 1985
Established as Genetic Engineering Research Center(Seoul)

Jul. 1990
Moved to Daejeon

Mar. 1995
Changed the name to Korea Research Institute of Bioscience and Biotechnology(KRIBB)

May. 1999
Became an independent legal entity under the Korea Research Council of Fundamental Science & Technology(KRCF)

Sep. 2005
Established Ochang Branch Intitute

Nov. 2006
Established Jeonbuk Branch Institute

FACILITIES

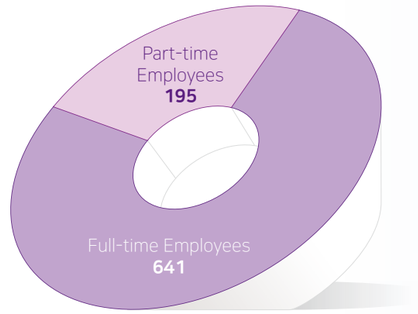
Headquarter
103,684㎡

Ochang Branch Institute
212,258㎡

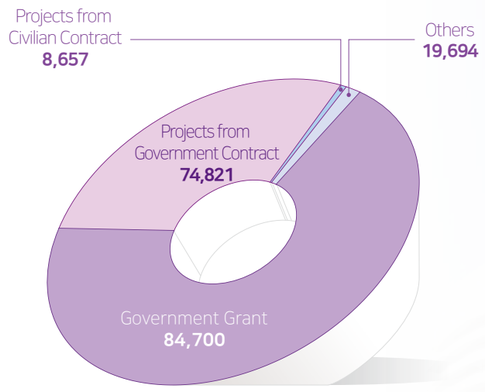
Jeonbuk Branch Institute
160,709㎡

BRIEF OVERVIEW

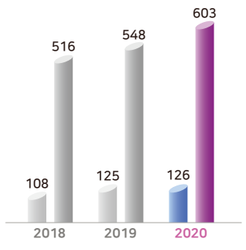
PERSONNEL
836



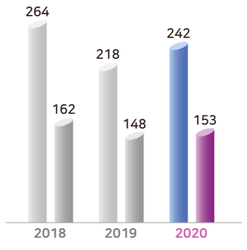
RESEARCH FUNDS
187,872
(million KRW)



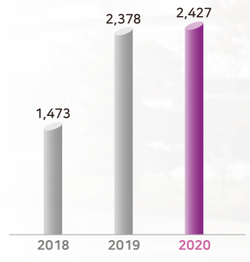
PUBLICATIONS
Domestic **126** | International **603**



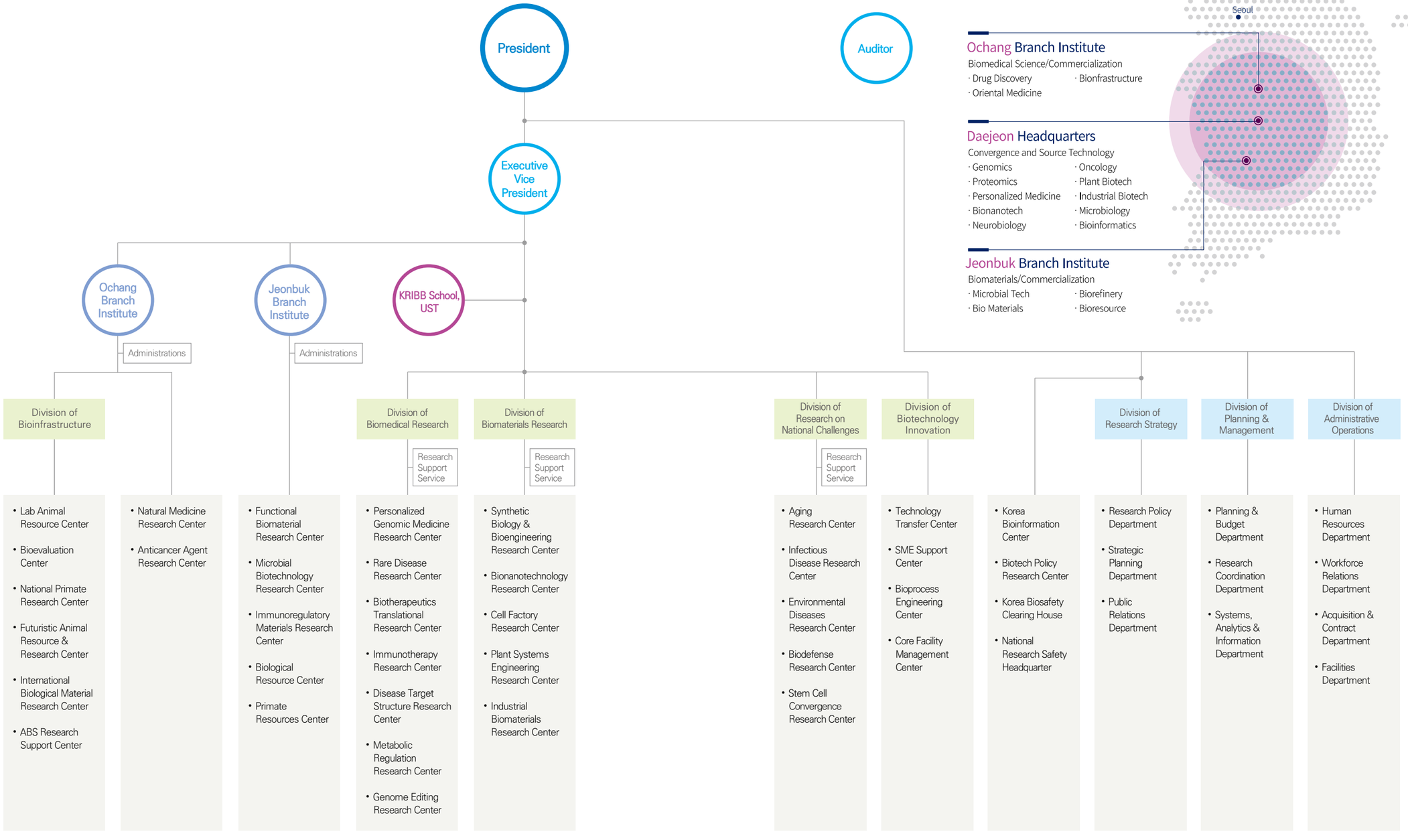
PATENTS
Application **242** | Registration **153**



TECHNOLOGY TRANSFERS
2,427(million KRW)



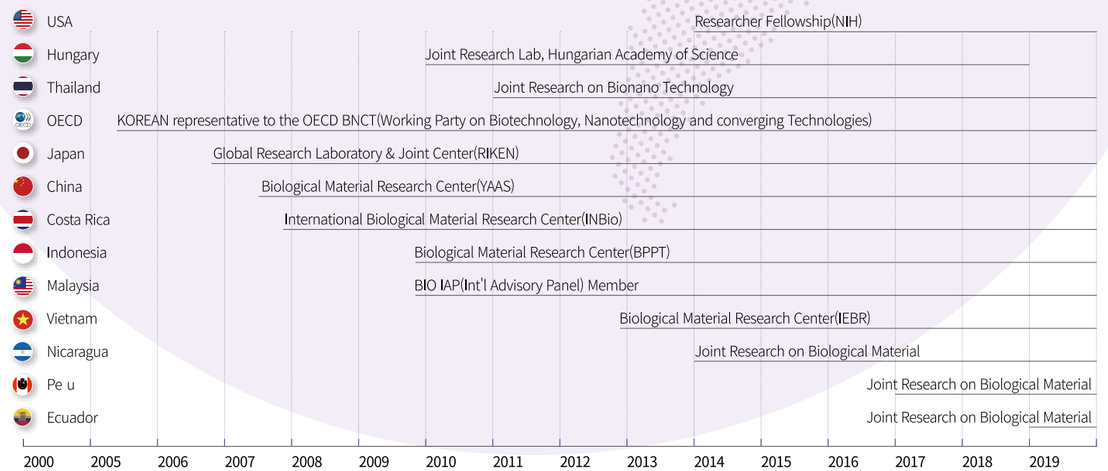
ORGANIZATION



INTERNATIONAL NETWORK

To strengthen global cooperation in mutually beneficial relationships

- R&D globalization by the Ministry of Science and ICT
- Research collaboration with world's renowned research institutes
- Establishment of network for the preservation and utilization of biolgical materials with China, Vietnam, Costa Rica and Indonesia



RESEARCH HIGHLIGHTS

(2020 'KRIBBIAN OF THE MONTH' AWARD)

- Use of network analysis for microbial interaction to find clues to the solution of cyanobacterial bloom
- Real-time monitoring of environmentally hazardous substances using nanocapsules
- Identification of novel causes of Parkinson's disease
- Development of a 3D culture structure of natural killer cells optimized for anticancer immunotherapy
- Decomposition of PET bottles using phytoplankton
- The investigation of harmful substances in the environment by identifying the functional principle of protein
- New aging-control solution by intestinal microbes
- Development of ultra-sensitive non-target detection technology
- Whether new gene scissors act on the target with accuracy has been identified
- The process of metastasis in colorectal cancer caused by high cholesterol
- Discovery of a protein that causes inflammation during lung damage caused by COVID-19
- The phenomenon of aging explained as caused by the decreased fluidity of the cellular inner membrane

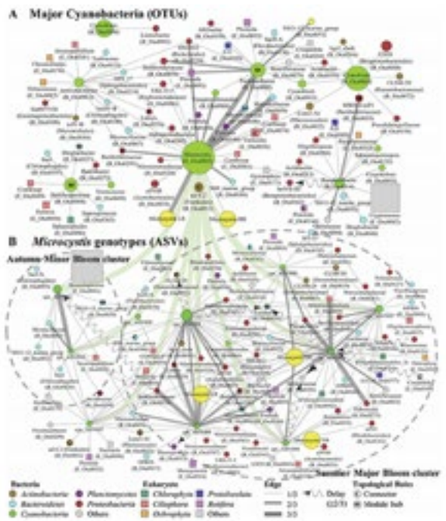
Use of network analysis for microbial interaction to find clues to the solution of cyanobacterial bloom

Dr. Chi Yong Ahn
Cell Factory Research Center

The detailed biological mechanism of the formation and decline of cyanobacterial bloom was identified through the analysis of the microbial interaction network.

The results of this study are the first to reveal the specific biological processes through which microorganisms interact and play an important role during the cyanobacterial bloom.

It is important that the widely studied microbiome and network analysis technology was applied to the study of cyanobacteria and is expected to contribute to the development of eco-friendly bloom control technology, such as by encouraging microbial communities that can inhibit cyanobacterial growth.



** Network analysis reveals succession of Microcystis genotypes accompanying distinctive microbial modules with recurrent patterns*

Water Research

Real-time monitoring of environmentally hazardous substances using nanocapsules

Dr. Oh Seok Kwon
Infectious Disease Research Center

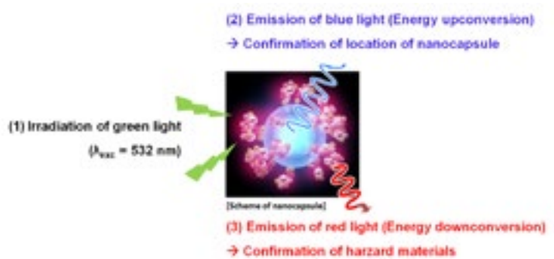
Using two types of light emitted in opposite directions with a single light source, we succeeded in developing a nanocapsule technology that enables a simultaneous real-time monitoring and tracking of hazardous substances.

In particular, the material developed in this study is the world's first system capable of simultaneous light emission using a single light source, which can overcome the disadvantages of existing detectors**

** The existing optical-based hazardous substance monitoring technology is limited by its difficulty in tracking the location of the scanned probe (a substance made to search for a specific substance), and measures the amount of hazardous substances under the assumption that the probes are evenly distributed.

A single light source is irradiated on the nanocapsule using two or more types of emitted light to overcome the disadvantages of the existing detector, and the technique allows an even distribution of nanocapsules in all parts of the sample while measuring the concentration of harmful substances.

The new technology developed herein is expected to be used as a material for small diagnostic devices that can easily detect environmental and disease hazards relevant to human health.



〈The process of checking the position of nanocapsules and harmful substances by irradiating light on nanocapsules〉

** Single-Photon-Driven Up-/Downconversion Nanohybrids for In vivo Mercury Detection and Real-time Tracking*

Journal of Materials Chemistry A

Identification of novel causes of Parkinson's disease

Dr. Kyu Sun Lee
Bionanotechnology Research Center

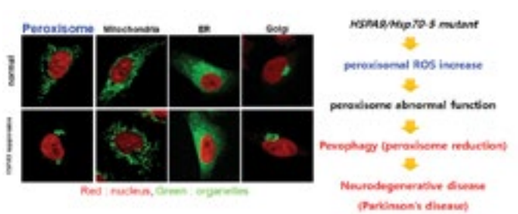
It was identified that a reduced function due to the mutation of the gene (HSPA9*) induces a significant decrease in energy metabolism and the abundance of the major organelles (peroxisomes) regulating reactive oxygen species, which can cause Parkinson's disease.

* HSPA9: mitochondria encoded by the human HSPA9 gene

Peroxisome, a single-membrane organelle, is present in most eukaryotic cells. Produced from the endoplasmic reticulum, it is a site where oxidation reactions of fatty acids mainly occur and function to regulate fatty acid degradation and cholesterol metabolism. In mammals, it plays an important role in energy metabolism in the brain, liver, heart, and lung tissues. In particular, a genetic problem in the production and degradation of peroxisomes leads to congenital cranial nervous system development disorders, such as Zellweger syndrome*.

* Zellweger syndrome: A fatal disease showing myasthenia gravis, high forehead, wide grand palate, central facial hypoplasia, glaucoma, corneal opacity, cataract, joint contracture, hepatomegaly, and punctate cartilage insufficiency in the early neonatal period (KDCA)

In this study, the importance of peroxisomes has been newly presented in the field of Parkinson's disease research, in which mitochondrial dysfunction has long been posited as one of the important causative factors. It is expected that organelle regulators will be used as new targets in the development of a treatment for Parkinson's disease.



** Loss of HSPA9 induces peroxisomal degradation by increasing pexophagy*

Autophagy

Development of a 3D culture structure of natural killer cells optimized for anticancer immunotherapy

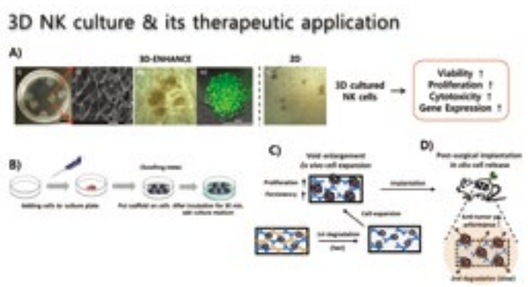
Dr. Tae Don Kim
Immunotherapy Research Center

We developed a hyaluronic acid (HA)-based cell culture scaffold* (3D-ENHANCE) with a three-dimensional porous structure that enhances the proliferation and anticancer effect of natural killer cells (NK cells). NK cells are responsible for innate immunity and known as immune cells that eliminate cancer cells or cells infected with viruses or bacteria.

* Scaffold: a structure capable of supporting cell culture, mainly composed of nano and polymer materials

The research team discovered a three-dimensional cell culture scaffold made of a bio-embedded material capable of mass proliferation of NK cells and capable of targeted treatment, and proved that it enhances the anticancer therapeutic effect of NK cells. In addition, the fusion of a 3D cell culture scaffold with CAR-NK treatment with increased specificity and killing power against cancer cells demonstrated a clear therapeutic effect in solid cancers, against whom treatment had been ineffective in the past.

The application of the newly developed immune cell culture and therapeutic scaffold provides a new concept for NK cell and CAR-NK gene therapy technology and is expected to accelerate the development of various forms of fusion technology that can be administered or treated in combination with chemotherapy and immunomodulatory therapy in the future.



** A three-dimensional hyaluronic acid-based niche enhances the therapeutic efficacy of human natural killer cell-based cancer immunotherapy*

Biomaterials

Decomposition of PET bottles using phytoplankton

Dr. Yong Jae Lee
Cell Factory Research Center

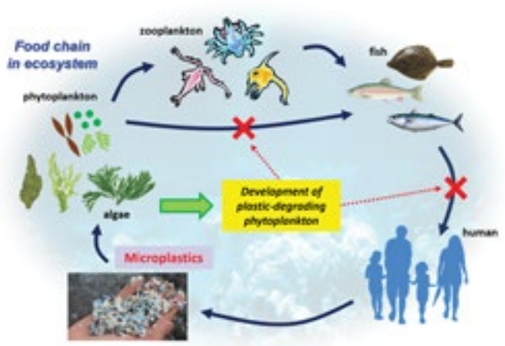
We developed phytoplankton that decomposes plastic bottles by expressing a plastic-degrading enzyme through genetic engineering.

The research team confirmed that commercial plastic bottles were decomposed into the monomers (TPA and EG) that are harmless to the human body using the lysate of phytoplankton.

In addition, the decomposition of plastic surface was observed through an electron microscope.

This technology presents a new paradigm for solving environmental pollution caused by plastics, and is expected to be widely used in various fields such as natural restoration and aquaculture.

This technology could also contribute to blocking the bioconcentration of microplastics through the food chain.



* *Functional expression of polyethylene terephthalate-degrading enzyme (PETase) in green microalgae*

Microbial Cell Factories

The investigation of harmful substances in the environment by identifying the functional principle of protein

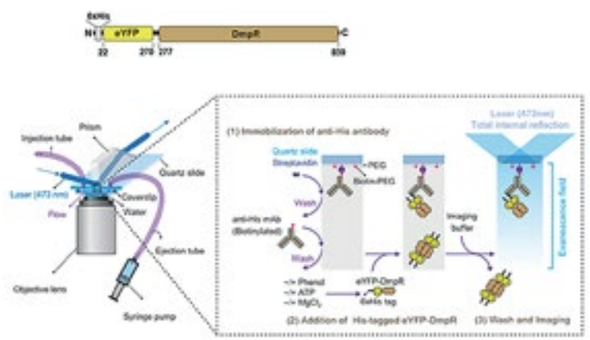
Dr. Eui Jeon Woo
Disease Target Structure Research Center

To eliminate harmful compounds (phenols) from industrial wastewater, microorganisms, such as Pseudomonas bacteria, are used in water purification methods. DmpR protein is known as a phenol degradation-promoting protein (*transcription factor) present in purified microorganisms; however, its functional importance and structural and molecular mechanisms of its activity have not been elucidated.

* Transcription factor: A protein that acts as a switch that turns the target gene on and off by binding to the DNA near the target gene

The research team investigated the principle of action and 3D structure of the protein that promotes the degradation of phenols and environmentally harmful substances (sensing transcription factor; DmpR, di-methyl phenol regulator).

This is the first report on the mechanism which promotes the decomposition of phenolic substances and is expected to greatly contribute to soil and water pollution detection and protein engineering through related research.



* *Tetrameric architecture of an active phenol-bound form of the AAA+ transcriptional regulator DmpR*

Nature communication

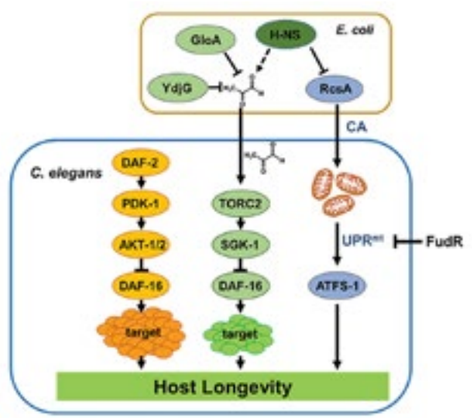
New aging-control solution by intestinal microbes

Dr. Eun Soo Kwon
Aging Research Center

Gut microbes play diverse roles in modulating host fitness, including longevity. However, its molecular mechanisms remain poorly understood. In this study, we find that gut microbe derived metabolite, methylglyoxal (MG), control host longevity through host signaling pathway.

MG is highly reactive species, causing Parkinson's disease and diabetes in human. Although MG is known to non-specifically damage proteins, lipid and genetic materials, our studies show that MG also modulate the certain signaling pathway, here, TORC2/SGK1/FOXO.

Therefore, reducing the levels of MG is expected to be a new treatment for related diseases, including geriatric diseases such as diabetes and neurodegenerative diseases.



* *Bacteria-derived metabolite, methylglyoxal, modulates the longevity of C. elegans through TORC2/SGK-1/DAF-16 signaling*

Proceedings of National Academy of Sciences of United States of America

Development of the ultra-sensitive detection technology for CRISPR malfunctions

Dr. Seung Hwan Lee
National Primate Research Center

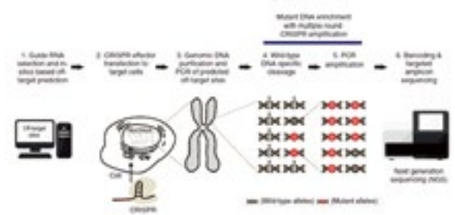
CRISPR effectors, which comprise a CRISPR-Cas protein and a guide RNA derived from the bacterial immune system, are widely used to induce double-strand breaks in target DNA and activate the in-vivo DNA repair system for target-specific genome editing.

*guide RNA: nucleic acids, which contains target sequence information, that required for target recognition of CRISPR-Cas system

When the gRNA recognizes genomic loci with sequences that are similar to the target, deleterious and often carcinogenic mutations can occur. Off-target mutations with a frequency below 0.5% remain mostly undetected by current genome-wide off-target detection techniques.

In our study, we developed a method to effectively detect extremely small amounts of mutated DNA based on predicted off-target-specific amplification. We used various genome editors, including CRISPR-Cpf1, Cas9, and an adenine base editor, to induce intracellular genome mutations.

The CRISPR amplification method detected off-target mutations at a significantly higher rate (1.6~984 fold increase) than did an existing targeted amplicon sequencing method without polymerase generated errors. In the near future, CRISPR amplification in combination with genome-wide off-target detection methods will allow to detect genome editor-induced off-target mutations with high sensitivity and in a non-biased manner.



Prediction-based highly sensitive CRISPR off-target validation using target-specific DNA enrichment

Nature Communications

Development of CRISPR gene scissors with target specificity

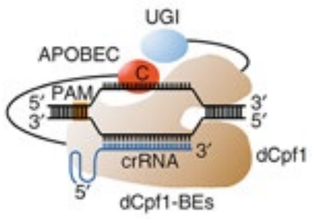
Dr. Dae Sik Kim
Genome Editing Research Center

DNA, which contains all information about living things, is made up of four bases. Adenine (A), thymine (T), cytosine (C), and guanine (G) bases pair with each other to create a sequence and three bases are combined to store genetic information as codons. The DNA sequence is important because a single mistake in a single base can cause serious illness. Cystic fibrosis and sickle cell anemia are typical genetic diseases caused by the presence of one specific incorrect base.

This research team identified the location where the nucleotide-correction gene scissors malfunctioned at a non-target location at the genome-wide level for the first time with the self-developed genome cutting analysis technique (Digenome-seq) and confirmed the accuracy.

The results of this research confirmed that the location of the malfunction in the DNA of the base-correcting gene scissors is different from that of the gene scissors, determined by the accuracy of the base-correcting gene scissor.

In this study, CRISPR DNA scissors with higher accuracy were produced by mutating the deaminase constituting the Cpf1 cytosine editing gene. As the performance of Cpf1 cytosine base-correcting gene scissors has been confirmed, this technology is expected to be widely used in the future, such as in the development of gene and stem cell therapeutics and for the improvement of high value-added agricultural and livestock products.



** Genome-wide specificity of dCpf1 cytidine base editors*

Nature Communications

The process of metastasis in colorectal cancer caused by high cholesterol

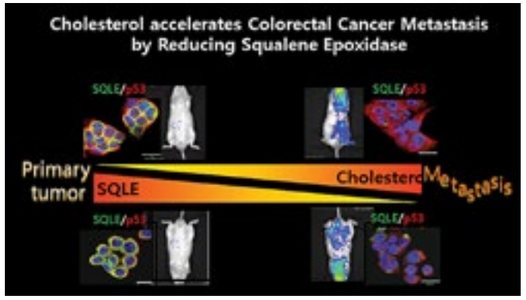
Dr. Nam Soon Kim
Rare Disease Research Center

Nevertheless, reports that the western diet, mainly comprising cholesterol, increases colorectal cancer incidence/metastasis risk, the underlying mechanisms have never been entirely determined.

This research team revealed that squalene epoxidase (SQLE) is degraded by cholesterol accumulated over a threshold point accelerates colorectal cancer metastasis.

This study demonstrates that SQLE reduction, by excess cholesterol or genetic knockdown, aggravates CRC progression via simultaneously activating the b-catenin oncogenic pathway and deactivating the p53 tumor suppressor pathway.

Our study implies that the feedback reduction of SQLE by cholesterol supports the widely accepted concept that a high-cholesterol diet increases CRC aggressiveness and provide new insights into the link between cholesterol and CRC, identifying SQLE as a key regulator in CRC aggressiveness and a prognostic biomarker.



** Reduction of squalene epoxidase by cholesterol accumulation accelerate colorectal cancer progression and metastasis*

Gastroenterology

Discovery of a protein that causes inflammation during lung damage caused by COVID-19

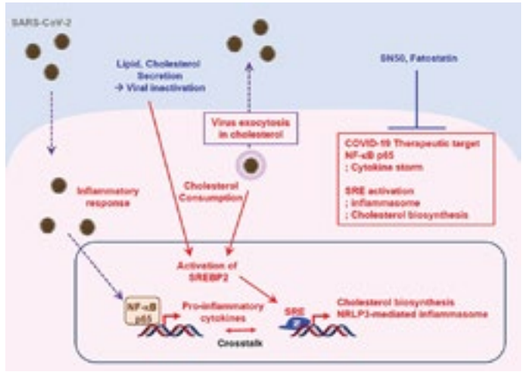
Dr. Young Gyo Seo
Aging Research Center

Regulatory protein is a key factor involved in regulating cholesterol and lipid homeostasis and enhancing the innate immune response in each living tissue, including the liver, by activating enzymes involved in the cholesterol biosynthesis pathway.

The research team discovered that the mature regulatory protein showed activity as an inflammatory transcription factor in virus-infected patients and that the protein was secreted into the blood and could be a diagnostic target.

This achievement can be developed as a target to diagnose or treat acute lung damage caused by COVID-19.

This factor is expected to contribute greatly to the development of effective anti-inflammatory drugs and therapeutic agents for seasonal acute infectious diseases and diseases related to the metabolic imbalance in the elderly.



** COVID-19-activated SREBP2 disturbs cholesterol biosynthesis and leads to cytokine storm*

Signal Transduction and Targeted Theraphy

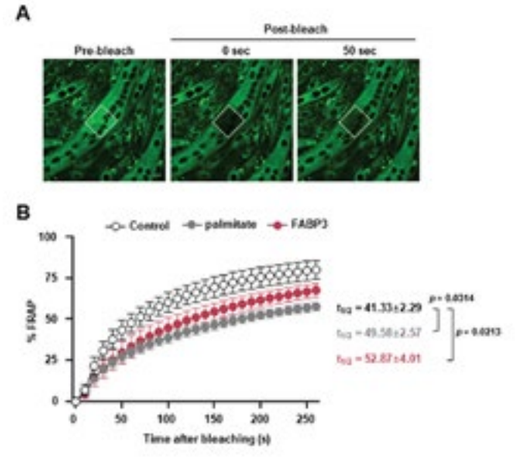
The phenomenon of aging explained as caused by the decreased fluidity of the cellular inner membrane

Dr. Seung Min Lee
Aging Research Center

The increase in the expression of a lipotransfer protein (FABP3) with aging reduces fluidity due to an increase in the saturated fatty acid chain of the membrane component, which causes stress in the endoplasmic reticulum and explains the phenomenon of aging that reduces muscle mass and strength.

The research team also proposed the “fluidity theory of aging,” which suggests that the “biological” clock of gene expression according to aging (time) induces “chemical” changes in the lipid component of the biological membrane, which in turn controls the fluidity of the “physical” membrane, ultimately contributing to “physiological” homeostasis.

In the future, this theory is expected to be applied as a principle of aging in various biological organs and in the development of new drugs that delay or reverse aging.



** FABP3-mediated membrane lipid saturation alters fluidity and induces ER stress in skeletal muscle with aging*

Nature Communications

- Director
- **Seung-Wook Chi, Ph.D.**
- Tel. +82-42-860-4100
- E-mail. swchi@kribb.re.kr

DIVISION OF BIOMEDICAL RESEARCH

- Personalized Genomic Medicine Research Center
- Rare Disease Research Center
- Biotherapeutics Translational Research Center
- Immunotherapy Research center
- Disease Target Structure Research center
- Metabolic Regulation Research Center
- Genome Editing Research Center

Personalized Genomic Medicine Research Center

The goal of the center is to develop original technologies for customized treatment of cancer based on genome-wide screening as well as genome and epigenome analysis. The center also focuses on prognostic and predictive biomarkers for lung, liver, and gastric cancers by conducting integrative analyses of the NGS genome, transcriptome, and epigenome data.

Associate Director
Kyung Chan Park, Ph.D.

Tel. +82-42-879-8115
E-mail. kpark@kribb.re.kr

RESEARCH AREAS

- Development of bioinformatics tools and databases
- Genomic characterization of various cancers for prognostic and predictive biomarker discovery
- Integrative analysis of the NGS genome, transcriptome, and epigenome in large-scale data sets derived from various cancers
- Large-scale screening and identification of cancer-related genes
- Functional validation of candidate target genes and biomarkers for the development of therapeutics and diagnostics
- Discovery and characterization of active compounds for anti-cancer, anti-metastasis, and anti-relapse therapy

MAIN PROJECTS

- **Construction of next-generation genomics analysis supporting center in Korean**
  - Construction of platform generating genomics data
  - Development of bioinformatic analysis platform
  - Biobank construction
  - Technical support and collaboration of commercial companies
- **Identification of new therapeutic targets through single cell multi-omics analysis**
  - Single cell transcriptome and epigenome analysis of patient-derived organoids
  - Single cell analysis of tumor heterogeneity and drug resistant cancer cells
  - Identification of new therapeutic targets for resistance to targeted therapies
- **Discovery and validation of novel therapeutic targets of Korean, never-smoker lung cancer by multi-genomics analyses**
  - Production and integrated analysis of multi-genomic (genome, transcriptome, methylome) data for non-smoking lung cancer tissues
  - To find targets for treating lung cancer by screening of shRNA library for genes selected from the integrated analysis of multi-genomic data.
- **Development of MDH1/2 dual inhibitor**
  - Development of a preclinal candidate suppressing MAS (Malate-aspartate shuttle) by inhibition of both MDH and MDH2
  - Preclincal analysis to prepare IND for clinical study for NSCLC.

ACHIEVEMENTS

- **Development of anti-cancer drug, MDH1/2 dual inhibitor, controlling cancer metabolism**
  - Novel MDH1/2 dual inhibitor suppresses growth of cancer cells and targets LKB1/KRAS co-mutant cancer cells
  - Technology transfer for the inhibitor to Future Medicine Co., Ltd.
- **Identification of a molecular signature of prognostic subtypes in diffuse-type gastric cancer**
  - The identification of practical biomarkers to predict heterogeneous disease behaviors is profoundly important. We aimed to identify a prognostic and predictive signature of diffuse-type GC heterogeneity. Via transcriptomic profiling of 150 gastric tissue samples obtained from 107 patients with diffuse-type gastric cancer (GC), we identified a signature which revealed distinct subtypes of diffuse-type GC: the intestinal-like (INT) and core diffuse-type (COD) subtypes. Integrative mutational and gene expression analyses demonstrated that the COD subtype was responsive to chemotherapy, whereas the INT subtype was responsive to immunotherapy with an immune checkpoint inhibitor. In conclusion, we present a molecular signature that can identify diffuse-type GC patients who display different clinical behaviors as well as responses to chemotherapy or immunotherapy.
- **PRMT1 Is Required for the Maintenance of Mature β-Cell Identity**
  - Loss of functional β-cell mass is an essential feature of type 2 diabetes, and maintaining mature β-cell identity is important for preserving a functional β-cell mass. However, it is unclear how β-cells achieve and maintain their mature identity. We demonstrate a novel function of protein arginine methyltransferase 1 (PRMT1) in maintaining mature β-cell identity. Prmt1 knockout in fetal and adult β-cells induced diabetes, which was aggravated by high-fat diet–induced metabolic stress. Deletion of Prmt1 in adult β-cells resulted in the immediate loss of histone H4 arginine 3 asymmetric dimethylation (H4R3me2a) and the subsequent loss of β-cell identity. The expression levels of genes involved in mature β-cell function and identity were robustly downregulated as soon as Prmt1 deletion was induced in adult b-cells. Chromatin immunoprecipitation sequencing and assay for transposaseaccessible chromatin sequencing analyses revealed that PRMT1-dependent H4R3me2a increases chromatin accessibility at the binding sites for CCCTC-binding factor (CTCF) and b-cell transcription factors. In addition, PRMT1-dependent open chromatin regions may show an association with the risk of diabetes in humans. Together, our results indicate that PRMT1 plays an essential role in maintaining β-cell identity by regulating chromatin accessibility.
- **DDIAS promotes STAT3 activation by preventing STAT3 recruitment to PTPRM in lung cancer cells**
  - DNA damage-induced apoptosis suppressor (DDIAS) regulates cancer cell survival. Here we investigated the involvement of DDIAS in IL-6–mediated signaling to understand the mechanism underlying the role of DDIAS in lung cancer malignancy. We showed that DDIAS promotes tyrosine phosphorylation of signal transducer and activator of transcription 3 (STAT3), which is constitutively activated in malignant cancers. Interestingly, siRNA protein tyrosine phosphatase (PTP) library screening revealed protein tyrosine phosphatase receptor mu (PTPRM) as a novel STAT3 PTP. PTPRM knockdown rescued the DDIAS-knockdown-mediated decrease in STAT3 Y705 phosphorylation in the presence of IL-6. However, PTPRM overexpression decreased STAT3 Y705 phosphorylation. Moreover, endogenous PTPRM interacted with endogenous STAT3 for dephosphorylation at Y705 following IL-6 treatment. As expected, PTPRM bound to wild-type STAT3 but not the STAT3 Y705F mutant. PTPRM dephosphorylated STAT3 in the absence of DDIAS, suggesting that DDIAS hampers PTPRM/STAT3 interaction. In fact, DDIAS bound to the STAT3 transactivation domain (TAD), which competes with PTPRM to recruit STAT3 for dephosphorylation. Thus we show that DDIAS prevents PTPRM/STAT3 binding and blocks STAT3 Y705 dephosphorylation, thereby sustaining STAT3 activation in lung cancer. DDIAS expression strongly correlates with STAT3 phosphorylation in human lung cancer cell lines and tissues. Thus DDIAS may be considered as a potential biomarker and therapeutic target in malignant lung cancer cells with aberrant STAT3 activation.
- **Comprehensive DNA Methylation Profiling Identifies Novel Diagnostic Biomarkers for thyroid cancer**
  - There are no reliable biomarkers to accurately differentiate indolent thyroid tumors from more aggressive thyroid cancers. This study aimed to develop new DNA methylation markers for diagnosis and recurrence risk stratification of papillary thyroid carcinoma. We performed a genome-wide assessment of thyroid tumor-specific differentially methylated CpG sites in the discovery set, then validated the top candidate markers in an independent set of 293 paraffin tissue samples comprised of follicular adenoma (FA, n=61), Hurthle cell adenoma (HA, n=24), NIFTP (n=56), PTC (n=120), follicular thyroid carcinoma (n=27), and Hurthle cell carcinoma (n=5), by pyrosequencing. Three selected markers (cg10705422, cg17707274, and cg26849382) differentiated nonmalignant (FA, HA, and NIFTP) tumors from differentiated thyroid cancers with area under the receiver operating characteristic curve of 0.83, 0.83, and 0.80, respectively. In conclusion, DNA methylation levels of three markers can be useful for differentiating differentiated thyroid cancer from nonmalignant follicular thyroid lesions, and may serve as prognostic biomarkers for predicting recurrent or persistent disease after surgery for differentiated thyroid cancer.
- **Ethacrynic acid inhibits STAT3 activity through the modulation of SHP2 and PTP1B tyrosine phosphatases in DU145 prostate carcinoma cells**
  - Discovery of a new STAT3 inhibitor Ethacrynic acid via a Connectivity Map database mining.
  - Connectivity Map analysis for drug repurposing is a strategy of "old drug for new use" and attractive in that the old drug can be used in the clinic with less time and lower cost than the development of new drugs. To identify novel signal transducer and activator of transcription factor 3 (STAT3) inhibitors, we generated gene expression profiles of known STAT3 inhibitors and explored gene expression signature-based strategies using a connectivity map database. From this analysis, we identified ethacrynic acid, which is currently used as a diuretic drug to treat high blood pressure. Therefore, we proposed the possibility of using ethacrynic acid, which is used as a treatment for hypertension, as an anticancer therapeutic.

Next Generation Sequencing System (DNBSEQ-T7)

Rare Disease Research Center

The goal of the center is to establish world-class genomics-based technology platforms and to apply those to biomedical research programs in order to achieve precision medicine for rare diseases based on genome big data. This will help realize the analysis of large-scale NGS data for rare neuronal diseases, as well as the high-throughput identification and global functional analysis of the genes associated with rare neuronal diseases, such as Hereditary Spastic Paraplegia (HSP), Ataxia, Malformations of Cortical Development (MCD) and Lennox-Gastaut Syndrome (LGS). We also discover targets and biomarkers in order to develop precise diagnostics and therapeutics for rare neuronal diseases.

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RESEARCH AREAS

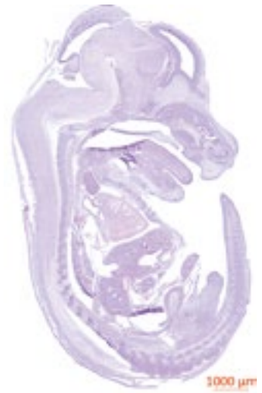
- **Establishment of genome research infrastructure and technology platforms for rare neuronal diseases**
- **Identification of biomarkers and development of gene panel for precise diagnostics of rare neuronal diseases**
- **Functional validation and application onto gene therapy of candidate target genes for precise therapeutics development of rare neuronal diseases**
- **Systematic analysis of the cellular targets of bioactive molecules using the fission yeast genome-wide gene-deletion collection**

MAIN PROJECTS

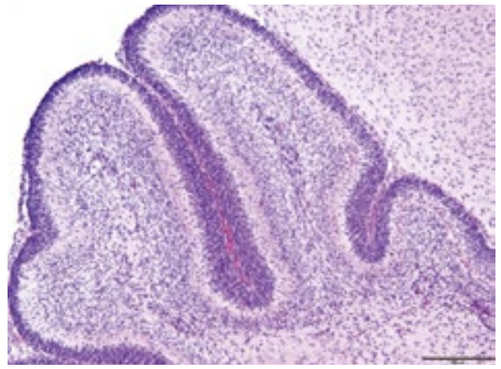
- **Analysis of WES data and validation of targets for Hereditary Spastic Paraplasia (HSP) and Lennox-Gastaut Syndrome (LGS)**
  - Generation and analysis of WES data from Korean HSP & LGS families
  - Functional study of novel targets and development of animal model for HSP
  - Construction of a genetic variants map and integrated DB for Korean HSP & LGS
- **Identification of genetic targets for the therapeutics of amyotrophic lateral sclerosis (ALS) associated with TDP-43 mutation**
  - Screening the therapeutic effects of genetic targets on cytotoxicity caused by TDP-43 mutation
  - Identification of potential candidates for ALS gene therapy according to their efficacy verified in both cell-based and animal models
- **Discovery of protein biomarkers for early treatment of brain developmental delay**
  - Identification of protein biomarkers with serums of development-delayed patients
  - Development of diagnostic technique for brain developmental delay
- **Development of therapeutic techniques for microplastic induced neurodevelopmental disorders through the identification of pathological mechanism**
  - Establishment of microplastics as risk factors for brain developmental disorder
  - Investigation of therapeutic targets for microplastic-induced developmental disorder

ACHIEVEMENTS

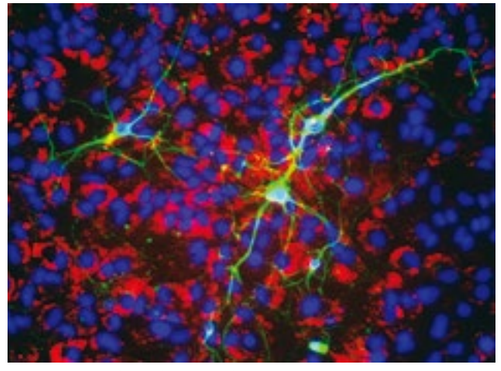
- **Reduction of SQLE accelerates colorectal cancer progression and metastasis**
  - SQLE reduction caused by cholesterol accumulation aggravates CRC progression via the activation of the b-catenin oncogenic pathway and deactivation of the p53 tumor suppressor pathway
  - These findings provide new insights into the link between cholesterol and CRC, identifying SQLE as a key regulator in CRC aggressiveness and a prognostic biomarker.
- **Characteristics of genetic variations associated with Hereditary Spastic Paraplasia (HSP) and Lennox-Gastaut syndrome (LGS) in Korean families**
  - A novel X-linked variant of IQSEC2 associated with LGS and mild intellectual disability in three generations of a Korean family
  - Coiled-coil domain containing 50-V2 protein positively regulates neurite outgrowth
  - Identification of novel candidate genetic variations and networks associated with LGS in Korean LGS Families. These results would aid in expanding the spectrum of genetic variations thereby might inform the diagnosis and management of individuals with LGS
- **Characterization of PTPRT-knockout and-mutant mice with brain developmental delay**
  - Depression-like behaviors induced by defective PTPRT activity through dysregulated synaptic functions and neurogenesis
  - Our findings show that the physiological roles of PTPRT in hippocampal neurogenesis, as well as synaptic functions, are involved in the pathogenesis of depressive disorder.
- **Establishment of econazole (antifungal drug) as a candidate anticancer drug for the treatment of gastric cancer**
  - Econazole promotes apoptosis and effectively blocks proliferation signaling in gastric cancers. Econazole could be repurposed to induce gastric cancer cell death and inhibit cancer invasion.
- **Discovery of non-invasive biomarkers for cancer**
  - Cyclic Peptide Mimotopes for the Detection of Serum Anti-ATIC Autoantibody Biomarker in HepatoCellular Carcinoma
  - This study indicates that anti-ATIC autoantibody can be a potential HCC-associated serum biomarker and suggests that autoantibody biomarker's efficiency can be improved by using antigenic mimicry to native antigens present in vivo.



〈Sagittal section of mouse embryo at embryonic day 14.5〉



〈Cerebellum of postnatal day 7 mouse〉



〈Neurons (green) differentiated from hippocampal mouse neural stem cells in vitro〉

Biotherapeutics Translational Research Center

The Biotherapeutic Translational Research Center (BTRC) is focused on fostering personalized treatment for rare and incurable diseases through development and implementation of new therapeutic platform technology and translational research studies. The primary mission of the BTRC is to stimulate high-quality clinical and translational research that seeks to enhance the care of cancer, diabetes, and cardio-neurodegenerative diseases. All BTRC faculty are dedicated to several translational projects aimed at design, discovery, and development of tailored biotherapeutics in cancer, vascular, stem cell, and metabolic research.

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RESEARCH AREAS

- **Mining of theranostic targets for vascular/metabolic diseases and cancer**
  - Validation and control technology of tumor therapeutic targets by single cell transcriptome analysis
- **Development of Biopharmaceuticals (antibody/protein) for vascular and cancer therapy**
  - Development of first in class drugs through translational research between basic and clinical research
  - Platform technology development for cancer immunotherapy
  - Development of new target efficacy evaluation system based on cancer patient-derived organoids
  - Development of antibody-drug conjugates (Biobetter)
- **Discovery of recombinant protein with high efficiency and high productivity**
  - Construction of recombinant protein-expressing cell lines with highly productivity
  - Establishment of high yield antibody library
- **Process development for the efficient biopharmaceuticals production**
  - Establishment of high antibody-producing mammalian/insect cells
  - Development of culture process for serum-free suspended mammalian cells
- **Finding out the resistance to drug and metastasis regulation and development of control technology**
  - Development of a new drug through translational research between basic and clinical research
  - Development of anti-cancer drugs regulating cancer metabolism
- **Identification and functional study of non-coding RNAs in cancer**
  - Identification of novel biomarker for anti-cancer resistant patient using exosomal non-coding RNA in gastric cancer
  - Functional study of gastritis or gastric cancer development-related microRNA
  - Identification of early diagnostic marker using exosomal non-coding RNA in hepatocellular carcinoma
- **Identification of gene related to the production of immunodeficient pigs**
  - Research on the mechanism of factors that cause immune rejection response
- **Production of disease animal and functional study- Production of transgenic and knockout animal using gene editing system.**
  - Biomolecular and physiological mechanism study using animal disease model
- **Wastewater treatment using microalgae**
  - Economic and efficient treatment of wastewater and biomass production, by cultivating microalgae
  - Production of biofuel and high-value compounds from microalgae
- **Algal bloom research**
  - Ecophysiological and metagenomic study on the mechanisms of algal bloom in freshwater (green tide) and seawater (red tide): advanced monitoring of bloom and production of algal toxins, mal-odor compounds, and their interaction with aquatic microorganisms.
- **Plant-based expression and production research**
- **In-plant cell biotechnology for invaluable biomaterials**
- **Discovery of diagnostic biomarkers for early stage of hepatocellular carcinoma (HCC) using serum exosomal microRNAs**
  - Establishment of liver disease mouse models including Non-alcoholic fatty liver disease (NAFLD), Non-Alcoholic SteatoHepatitis (NASH) and HCC
  - Identification of novel serum exosomal microRNAs for detect the early stage HCC

ACHIEVEMENTS

- **Development of tumor-specific antibody-protein conjugates for therapeutic angiogenesis & anti-cancer therapy**
  - Validation and control of vessel normalization by human Tie2-targeted antibody
- **Development of G-protein coupled receptor regulators as anti-cancer drugs**
  - Identification of repurposed drugs regulating function of G-protein coupled receptors
  - Development of diagnostic system for target G-protein coupled receptors
- **Development of liver disease mouse models and establishment of mouse liver tissue-derived organoids**
- **Finding out the factors that regulate resistance to drugs and metastasis, development of control technology and establishment of basic-clinical translational research**
- **Establishment of genetically modified cell lines to produce mini-pigs for Xenotransplantation**
  - Establishment of pig T- and B- cell knock out cell lines

MAIN PROJECTS

- **Platform technology development for high efficient targeted antibody**
  - Next generation antibodies for treatment of cancer and vascular diseases
  - Development of antibody-based immuno-cancer therapy
- **Biomarkers for bio-weapon defense**
  - Diagnostic antibody agasint biological agents
- **Development of targeted cancer drugs with companion diagnostics based on regulation of G-protein coupled receptor targetome**
  - Target validation and development of drug screening system
  - Development of drugs regulating G-protein coupled receptor

Immunotherapy Research Center

The goal of Immunotherapy Research Center (IRC) is to develop core platform technology of immune cell therapy for cancers based on the differentiation of immune cells from hematopoietic stem cells. The center is also working on the development of anti-cancer antibody therapy and cancer diagnostics.

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RESEARCH AREAS

- **Natural Killer (NK) cell immunotherapy for refractory cancer**
  - Development of anti-cancer immunotherapy based on NK cell differentiation
  - Development of platform technology for the regulation of NK cell differentiation
  - Development of anti-cancer immunotherapy utilizing microbiome metaplatform
- **Development of chimeric Antigen Receptor (CAR)-NK cell and gene therapy**
  - Establishment of 3D cell culture method for NK cell expansion
  - Development of NK cell specific CAR construct for NK cell activation
  - CAR-NK cell therapy using mRNA delivery system
- **Hematopoietic stem cell (HSC) differentiation and aging**
  - Molecular hematopoiesis and blood disorders
  - HSC aging mechanism and rejuvenation
  - HSC fate decision
- **Novel therapeutic targets for cancer immunology**
  - Development of therapeutic target antigens
  - Development of human and humanized antibodies for cancer treatment
  - Evaluation of therapeutic antibodies
- **Enhancement of anti-tumor efficacy with immunotherapy**
  - Development of mutein for NK cell activation
  - Production of super agonist for NK cell activation
- **Cell fate reprogramming**
  - Cell fate conversion to immune cells
  - Nonclinical and clinical application of reprogrammed cells
  - Human pluripotent stem cell-derived blood cell production for disease modeling, drug discovery, and cell and gene therapy

MAIN PROJECTS

- **Development of NK cell therapy for refractory cancer**
  - Generation of hematopoietic stem cell (HSC)-derived functional immune cells
  - Molecular mechanisms of immune cell aging and rejuvenation
  - NK cell exhaustion by tumor microenvironment
- **Development of Next-generation CAR-NK cell therapy using gene editing**
  - Development of NK cell-specific CAR construct for treating refractory cancer
  - Identifying single-chain variable fragment (scFv) against novel tumor antigen
  - Preclinical studies with high efficient CAR-NK cell
- **Investigation of novel therapeutic targets for cancer immunotherapy**
  - Researches on NK cell immune checkpoint and molecular mechanisms
  - Identifying novel cancer therapeutic targets and development of therapeutic antibody
  - Mechanism of action of drug candidates
- **Enhancement of anti-tumor efficacy with immunotherapy**
  - Development of an efficient production system for reprogrammed NK cells
  - Discovery of modulating molecule to improve anticancer efficacy of NK cells
  - Development of synthetic cytokine for anticancer therapy of NK cells

ACHIEVEMENTS

- A method for producing natural killer cells and uses thereof. *Technology transfer*
- Three-dimensional hyaluronic acid-based niche enhances the therapeutic efficacy of human natural killer cell-based cancer immunotherpay.
- TXNIP regulates natural killer cell-mediated innate immunity by inhibiting IFN-γ production during bacterial infection.
- The *Gata1*^{low} murine megakaryocyte-erythroid progenitor cells expand robustly and alter differentiation potential.
- Dysregulation of Rho GTPases in human cancers.

Disease Target Structure Research Center

Determination of three-dimensional structures of disease targets and development of highly efficient drug discovery platform technology for disease targets.

- Determination of structures and functions of disease target proteins
- Development of a drug discovery platform technology for disease targets
- Proteomics-based discovery and validation of disease targets
- Animal model-based research for the treatment of degenerative diseases
- Development of nanopore sensor technology

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RESEARCH AREAS

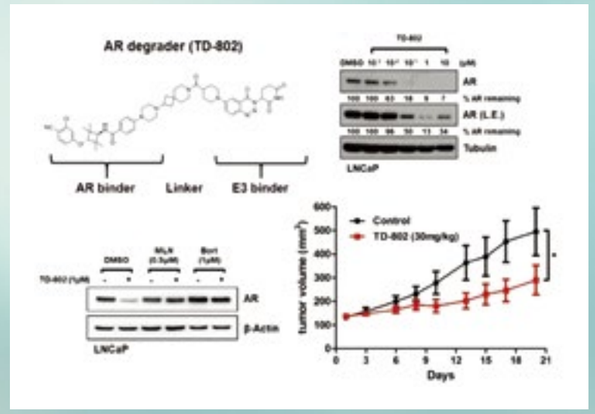
- Target identification & validation for drug discovery
- Drug discovery using targeted protein degradation (PROTAC and molecular glue)
- Cell signaling in cancers
- Protein X-ray crystallography
- Study of Tau aggregates causing Alzheimer's disease
- Development of nanopore sensor technology for detection of protein-protein interaction, protein-nucleic acid interaction, proteins, peptides, and small molesules
- Development of nanopore sensor platform technologies for drug screening and disease diagnosis.

MAIN PROJECTS

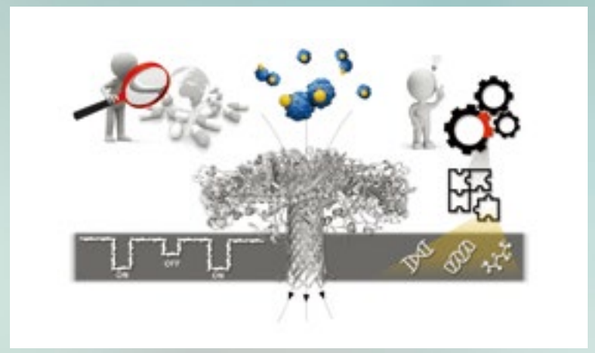
- **Development of nanopore platform technology for drug discovery**
  - Development of sensing platform for discovering low-cost, high-efficiency new drugs by developing monomolecular analysis technology for disease targets based on the new nanopore sensing principles
- **Target validation of artificial intelligence-based repositioned drugs**
  - Development of an artificial intelligence-based drug repositioning platform and a combination validation model for cancer disease core targets toward feed-back to building validating platform of the target validity of the repositioning drug candidates.
- **Validation of mechanism of action for repurposed drugs and feedbak into platform**
- **Elucidation of structures and functions of phosphatases**
  - Determination of three-dimensional structures and functional mechanisms of drosophila-derived noncanonical enzymes targeting phosphoarginine
  - Identification of functional mechanisms of tyrosine phosphatases in a complex with cancer-associated viral proteins

ACHIEVEMENTS

- Probing the neuraminidase activity of influenza virus using a cytolysin A protein nanopore
- Tumour-derived Dilp8/INSL3 induces cancer anorexia by regulating feeding neuropeptides via Lgr3/8 in the brain
- Design and characterization of cereblon-mediated androgen receptor proteolysis-targeting chimeras.
- Structural and biochemical characterization of the two *drosophila* low molecular weight-protein tyrosine phosphatases DARP and Primo-1
- Nanopore analysis on the drug-induced conformation change of a p53-linker-mouse double minute 2 protein complex



〈AR degraducer development by PROTAC technology〉



〈Drug discovery using nanopore technology〉

Metabolic Regulation Research Center

Metabolic Regulation Research Center (MRRC) is designed to conduct basic scientific and translational research to control metabolic diseases, including diabetes, obesity, neurodegenerative disease, and cancer. The center aims to understand the mitochondria and cell signaling as well as metabolic network between organs (fat, liver, muscle, cranial nerve and, etc.) through omics analysis and in vivo analysis.

Further, the center also supports and promotes multidisciplinary studies to develop the core technology for controlling metabolic diseases.

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RESEARCH AREAS

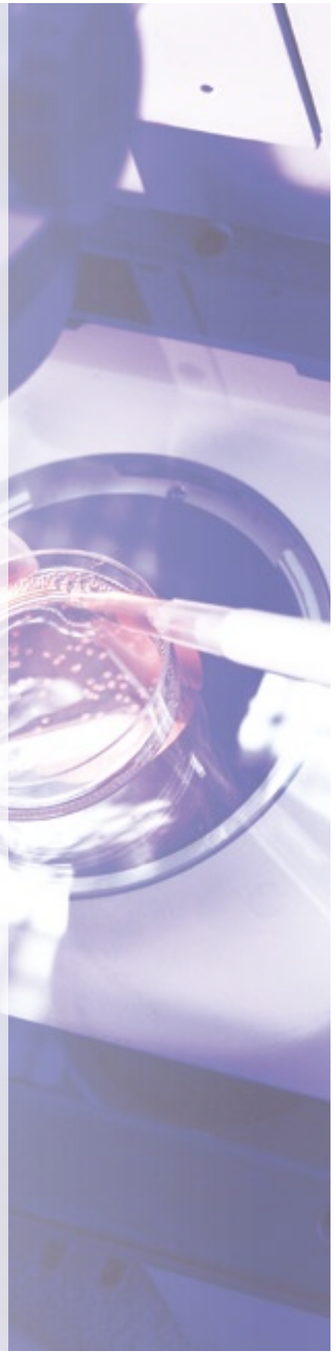
- Identification of metabolic energy system and regulatory mechanism of type 2 diabetes and obesity
- Identification of regulatory material associated with the transition from white adipose tissue to brown adipose tissue and determine their functions
- Screening and functional research of metabolic disease regulatory material based on the generation of a low molecular weight compound or natural product
- Elucidation of the pathophysiological mechanism of non-alcoholic fatty liver disease (NAFLD) and nonalcoholic steatohepatitis (NASH)
- Pathophysiology and energy metabolism in skeletal muscle
- Analysis of the functional change in major metabolic organs and signal delivery systems under the metabolic abnormality and improvement conditions using animal models
- Identification and functional research of network regulation factors among metabolic organs through omics analysis
- Inter-kingdom signaling between gut microbiota and host immune that promotes homeostasis
- tRNA synthetase biology covering system development and immune homeostasis
- Studying on virulence mechanisms caused by bacterial pathogens based on structural and cell biological approaches
- Research on pathogenic mode of action caused by emerging virus derived proteins
- Research on the isolation and identification of anaerobic human microorganisms and their clinical application
- Research on the ubiquitin pathways in metabolic disease and cancer metabolism
- Research on lipid metabolism and ferroptosis in cancer and cardiovascular diseases

MAIN PROJECTS

- Development of Mitochondria and Energy Metabolism based Therapeutics for the Treatment of Metabolic Disease
  - Development of mitochondrial control technology through the regulation of mitochondrial function and cellular metabolism
  - Development of mitochondrial control technology by mitochondria transplantation
  - Development of original technology for metabolic disease treatment based on mitochondrial function control/transplantation
- **Discovery of therapeutic targets for improving liver failure associated with type 2 diabetes and obesity**
  - Discovery of new therapeutic targets for non-alcoholic fatty liver disease (NAFLD) and non-alcoholic steatohepatitis (NASH)
  - Discovery of the targets for controling the progression from NAFL/NASH to HCC
  - Discovery of the targets for regulating hepatic glucose metabolism
- **Development of the human immune system-based therapeutic agents against RNA viruses**
  - Development of a broad-spectrum RNA virus-targeting antiviral peptide
  - Development of a vaccine adjuvant that drives effective immune responses and improves immune responses to vaccine antigens
- **Understanding metabolic pathway of chemo-refractory group through proteome analysis and finding the appropriate drug combination**
  - Identification of proteins and modified proteins through proteomic analysis using chemoresistant and chemosensitive cancer cell lines
  - Identification of new drug combinations targeting cancer metabolism for the treatment of chemoresistant tumors
  - Elucidating the novel target and the pathophysiological mechanism for treatment of non-alcoholic fatty liver disease (NAFLD) and non-alcoholic steatohepatitis (NASH)
  - Elucidating the novel target and the pathophysiological mechanism for regulating hepatic gluconeogenesis, one of main causes in type 2 diabetes
- **Uncovering a inter-kingdom signaling between gut microbiota and host immune mediated by a bacterial tRNA synthetase**
  - Discovery of a gut bacterial tRNA synthetase that regulates host immunity and improves immune homeostasis
- **Elucidating the role of polyunsaturated fatty acid (PUFA) biosynthesis pathway in ferroptosis in chemoresistant gastric cancer cells.**
  - Identification of the essential role of ELOVL5 and FADS1 in ferroptosis, a novel form of regulated cell death induced by lipid peroxidation

ACHIEVEMENTS

- Identifying novel targets for treatment of obesity by regulation of WAT browning
- Discovery of novel targets for regulation of brown adipogenesis and themogenic energy expenditure
- Discovery of therapeutic targets for improving liver failure associated with type 2 diabetes and obesity



Genome Editing Research Center

Genome editing is a type of genetic engineering in which DNA is inserted, deleted, or corrected in the genome of a living organism using engineered nucleases or "molecular scissors." These nucleases create site-specific double-strand breaks (DSBs) at a desired locus, and the induced double-strand breaks are repaired through nonhomologous end-joining or homologous recombination, which results in targeted gene corrections and ablations. The center aims to develop a new genome-editing platform and improve CRISPR system to provide a sophisticated tool for genome engineering. These genome-engineering tools are used for basic research, including the functional study of genetics, generation of model organisms, and gene therapy. The associated techniques can also be applied to various research and development fields, including gene delivery, stem cells, nanotechnology, and cell therapy.

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RESEARCH AREAS

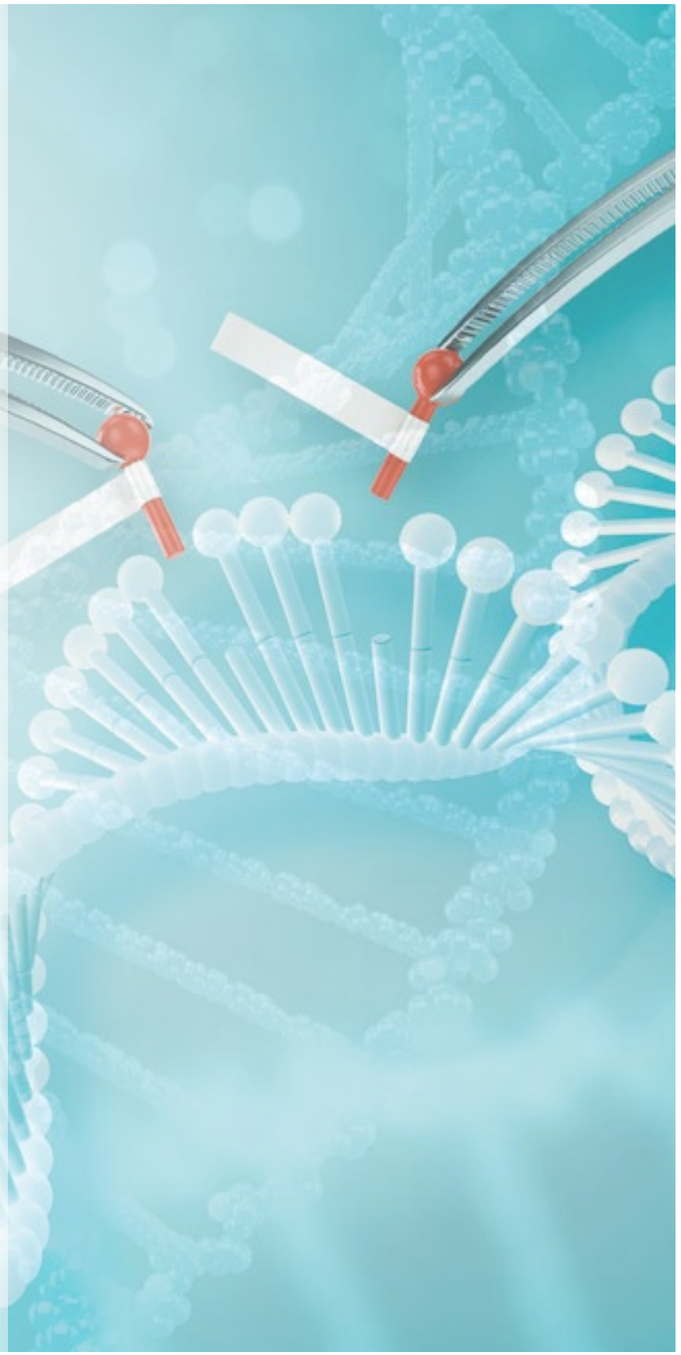
- Research on the advancement of gene editing technologies
- Development of the humanized mouse model using glyco-gene editing technology
- Development of the first-in-class drug
- Development of nano-sized therapeutics and imaging agents for biological applications
- Evolution and adaptation of organisms living in chemosynthetic hydrothermal vent ecosystems based on whole genomes

MAIN PROJECTS

- **Generation of glycan-humanized model mouse for non-clinical study**
  - Development of the humanized mouse model using glyco-gene editing technology
  - Validation of glycan homogeneity in humanized mice based on mass spectrometry
  - Verification of the usefulness of humanized mice for non-clinical study
- **Development of ARPC2 inhibitor for anti-tumor and –metastasis agent**
  - Development of clinical candidates that only inhibit cancer cell migration and growth through ARPC2 inhibitors
  - Verification of ARPC2 inhibitor and profiling of target products
- **Development of precise cancer diagnostics through engineering aglycosylated antibody production system**
  - Development of the aglycoylated antibody-producing mice using gene editing technology
  - Development of the alglycosylated antibody-lectin coupled immunoassay for the quantification of tumor markers
- **Biocompatible and stimuli-responsive fluorescence switches with their contrast amplified through the programmed polymeric assembly**
  - Design, synthesis, analysis and performance verification of the reversible fluorescence switches based on dendrimer nanoclusters
  - Design, synthesis, analysis and performance verification of polyrotaxene-based fluorescence switches

ACHIEVEMENTS

- **Development of technology to verify the accuracy of prime editors**
  - Verify the efficiency and accuracy of prime editors via nickase-based Digenome-seq
  - Improve the specificity of prime editor by incorporating mutations from engineered Cas9 variants, particularly eSpCas9 and Sniper Cas, into prime editors
- **Identification of genome-wide off-target sites of Cpf1 base editors**
  - Develop an unbiased in vitro method for identifying genome-wide off-target sites of Cpf1 base editors via whole-genome sequencing
- **Development of preclinical candidates for the first-in-class drug**
  - Patent applications in six countries (USA, EU, Japan, China, Cananda, Australia)
  - Licensing out preclinical candidate based on the patent applications
- **Development of nano-sized therapeutics for retinal diseases**
  - Provide useful guidelines for the rational design of intravitreal nanocarriers to treat vision-threatening retinal diseases, including age-related macular degeneration
- **Biodiversity on chemosynthetic hydrothermal vents**
  - Description of barnacle new species and completion of its mitochondrial genome
  - Competitive interaction among sympatric species based on symbiotic bacteria



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DIVISION OF BIOMATERIALS RESEARCH

- Synthetic Biology and Bioengineering Research Center
- Bionanotechnology Research Center
- Cell Factory Research Center
- Plant Systems Engineering Research Center
- Industrial Bio-Materials Research Center

Synthetic Biology and Bioengineering Research Center

Synthetic Biology and Bioengineering Research Center (SBBRC) develops biological parts/devices and assembles them into practical and useful engineering tools. The key is the development of artificial genetic circuit devices using bio-parts, modeling/simulation and CRISPR technology. The range of potential applications encompasses, but is not limited to, biocatalyst/enzyme engineering, biofuel/chemical production, diagnostics and therapeutics. SBBRC recently became a member of Global Biofoundries Alliance (https://biofoundries.org) by establishing K-Biofoundry (https://kbiofoundry.org/index.html) to develop a robust and integrated biomanufacturing platform accessible to researchers across the private and public sectors.

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RESEARCH AREAS

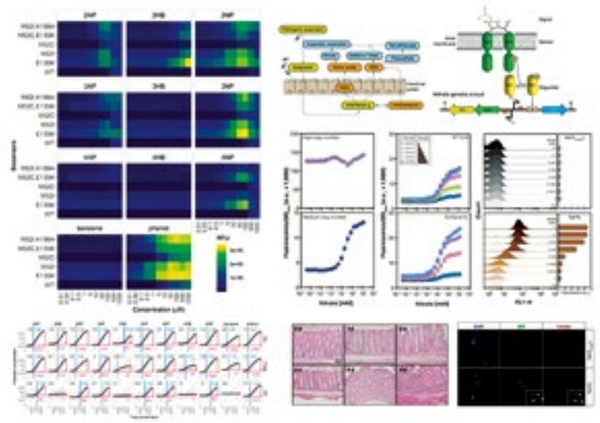
- Synthetic biology and genome engineering
- Microbial cell factory and biocatalyst engineering for industrial applications
- Bioinformatics and artificial intelligence with genetic devices

MAIN PROJECTS

- **Platform technologies for synthetic biology and genome engineering**
  - Development of practical synthetic biology technologies for smart genetic circuit and genome synthesis
  - Development of high-speed and mass-volume biofoundry technologies to cope with climate change issues emerging as new threats
  - Development of machine learning linked genetic devices to improve its specificity and stability
- **Development of synthetic biology technology for controlling microbial community**
  - Development of artificial genome synthesis technology through genome design and modular assembly
  - Intestinal microbial consortium control by smart genetic circuits for diagnosis of inflammatory bowel disease
- **Development of plastic degradation and bio-plastic synthesis technologies**
  - Discovery of biological resources degrading PET using genetically encoded biosensors
  - Discovery and characterization of novel plastic degrading enzymes and microbes
  - Mass production of degradable plastic monomers using acid-tolerant microorganisms
- **Development of microbial systems for the production of biochemicals from greenhouse gas**
  - Development of synthetic consortium of methanotrophs and heterotrophs to produce C4-chemicals from methane by mimicking the natural methane ecosystem
  - Development of CRISPR system for engineering methanotroph and partner microbe

ACHIEVEMENTS

- **Machine learning linked evolutionary biosensor array for highly sensitive and specific molecular identification**
  - A novel molecular fingerprinting technique by employing multiple mutant transcription factors along with machine learning technique capable of capturing highly specific substrate signals
- **A designed whole-cell biosensor for live diagnosis of gut inflammation through nitrate sensing**
  - A designed probiotics using nitrate-responsive genetic circuit for non-invasive diagnostics of inflammation-associated diseases
- **Yeast-based recombinant protein production and its application technology**
  - Screening of highly secreted proteins and their use as fusion partners for production of recombinant proteins
- **Biocatalyst technology for the production of pharmaceutical amino acids**
  - Novel D-threonine aldolase and its application for stereospecific production of D-threonine
- **Highly efficient genetic tools for methanotroph to convert methane, a potent greenhouse gas, into value-added biochemicals**
  - Tunable recombinant protein expression in methanotroph without cell-to-cell variations
  - CRISPR base editor systems for methanotroph with high editing efficiency



〈Machine learning linked biosensor array(left) and whole-cell biosensor for live diagnosis of gut inflammation(right)〉

Bionanotechnology Research Center

Bionanotechnology Research Center aims to develop effective biosensor technology for hazard detection and disease diagnosis based on interfacing bio-contents and nanomaterials. For enabling continuous and convenient detection of hazards and human diseases, the center develops new biomarkers, innovative nanomaterials, and integrated system. The center also focuses on development of theragnostic nanotechnology to achieve precision medicine development for healthy future.

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RESEARCH AREAS

- **Bio-contents and nano structure interfacing technology for detecting biological hazards (infectious germs and virus including Sars-CoV-2) and diagnostics of cancer and age-related diseases**
  - Development of highly efficient biomaterials (antibodies, peptides, oligonucleotides etc.) for the detection of hazards and genetic mutations
  - Optimizing bio-contents for the detection of infectious and genetic diseases
- **Highly efficient interfacing technology between biocontents and nano structures**

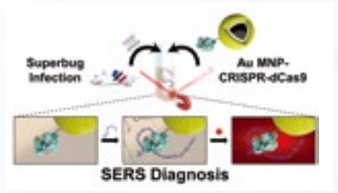
  Integrated monitoring system technology to detect hazards and diseases
  - Sensor and signal transducer technology to detect hazards
  - Signal amplification technology for detecting hazards using biosensors
  - Bioelectronics, bionanosensor, and optic-based platform for the detection of hazards and diseases
- **Innovative nanomaterials for drug delivery and disease diagnostics**
  - Highly sensitive detection system for chronic, infectious, and genetic diseases based on nanotechnology
  - Development of nanomaterials for a highly efficient drug delivery system

MAIN PROJECTS

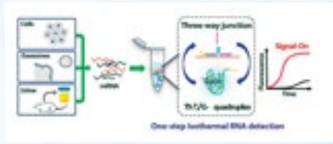
- **Development of Theragnosis platforms based on bionanotechnology**
- **Provide and optimization of bio- and nano-contents for developing diganosis and therpeutics**
- **Development of new technology on applicating in vitro diagnostics for COVID-19**
- Development of H-GUARD system and world-class platform technologies for the detection and monitoring of biohazardous substances including new and mutant viruses, superbacteria, etc.

ACHIEVEMENTS

- **Clustered Regularly Interspaced Short Palindromic Repeats-Mediated Surface-Enhanced Raman Scattering Assay for Multidrug-Resistant Bacteria**
  - We report a clustered regularly interspaced short palindromic repeats (CRISPR)-mediated surface-enhanced Raman scattering (SERS) assay for multidrug-resistant (MDR) bacteria species Staphylococcus aureus, Acinetobacter baumannii, and Klebsiella pneumoniae, without purification or gene amplification steps.



- **Development of A4 antibody for detection of neuraminidase I223R/H275Y-associated antiviral multidrug-resistant influenza virus**
  - The emergence and spread of antiviral drug-resistant viruses have been a worldwide challenge and a great concern for patient care. We report A4 antibody specifically recognizing and binding to the mutant I223R/H275Y neuraminidase and prove the applicability of A4 antibody for direct detection of antiviral multidrug-resistant viruses, allowing fast, simple, and reliable point-of-care assays of antiviral multidrug-resistant influenza viruses.
- **Loss of HSPA9 induces peroxisomal degradation by increasing pexophagy**
  - Quality control of peroxisomes is essential for cellular homeostasis. However, the mechanism underlying pexophagy is largely unknown. We identified HSPA9 as a novel pexophagy regulator. Downregulation of HSPA9 increased macroautophagy/autophagy but decreased the number of peroxisomes in vitro and in vivo. In addition, we developed in vivo fluorescence reporters for mitochondria and peroxisomes for monitoring disease-sepcific organellar dynamics.
- **Urinary exosomal mRNA detection using novel isothermal gene amplification method based on three-way junction**
  - We report a rapid one-step isothermal gene amplification reaction based on three-way junction (3WJ) formation and the successful detection of urinary exosomal mRNA from tumor-bearing mice. The 3WJ structure can be formed by the association of 3WJ probes (3WJ-template and 3WJ-primer) in the presence of target RNA.



Cell Factory Research Center

Transitioning to sustainable consumption and production is no longer an option, but our responsibility to ensure a healthy and prosperous future. Hence, the center identifies and develops a cell factory system that is capable of producing useful metabolites and proteins in a wide range of sectors, including energy, environment, nutraceutical, cosmetic, and pharmaceutical industries. The center currently focuses on the production of these products from microalgae using genetic, ecological, and fermentation engineering approaches. By investigating this group of photosynthetic microbes and their cell factory applications, the center aims to develop highly efficient industrial technologies as well as active bioproducts from renewable resources.

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RESEARCH AREAS

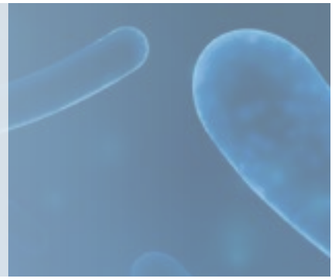
- **Development of microalgal cell factory**
  - Genetic and ecological engineering for strain improvement and cultivation
  - Omics studies on metabolism, signaling, and regulation
  - Development of high-efficiency production system based on exploring novel engineered systems for cultivation and harvest of microalgae
- **Production of microalgae-based biofuel/biomaterials**
  - Screening of novel pharmaceutical, cosmetic, and nutraceutical compounds obtained from microalgae
  - Economic and efficient production of biodiesel and high-value biomaterials from microalgae based on physiological, genetic, and omics research
- **Algal bloom research**
  - Ecophysiological and metagenomic study of harmful algal blooms (HABs) in freshwater (green tide) and seawater (red tide)
  - Elucidation of microbial interaction network contributing to the formation and decline of HABs and development of novel methods for bloom control

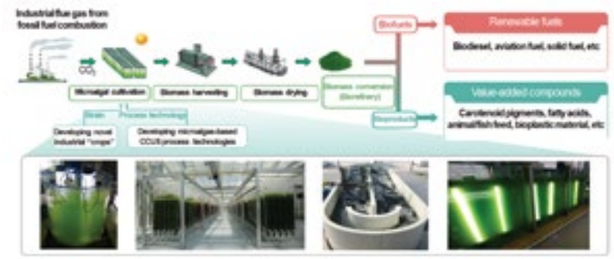
MAIN PROJECTS

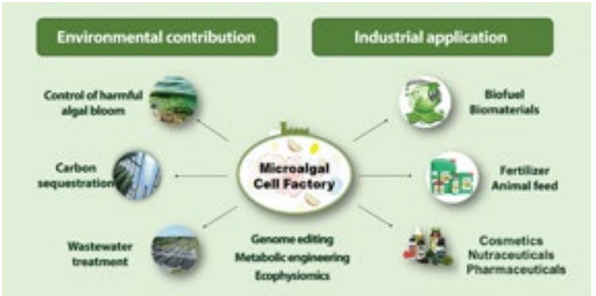
- **Development of microalgae strains and cultivation optimization for the efficient production of phyto-conversion plastic**
  - Isolation of suitable microalgal strain for phytoconversion plastic production and its optimization of cultivation process.
  - Development of low-lipid/high-protein microalgal strain via directed evolution and metabolic engineeirng
- **Interaction and network analysis between harmful algae and algaecidal microbes**
  - Diversity analysis, isolation and identification of microbes regulating microalgal growth in different habitats/depths/seasons
  - Investigation of interaction mechanisms between microalgae and microbial community by omics approaches
  - Demonstration of developed HAB control technique by using mesocosm studies
- **Development of microalgal pigment-based high-value materials and its application technology**
  - Development of 1,000-L scale high efficiency photobioreactor (PBR) for the mass production of microalgae
  - Development of cosmetic materials using microalgal pigments and industrialization of functional materials
- **Development of microalgae-based carbon capture, utilization, and storage (CCUS) technology**
  - Developing a group of novel microalgal strains suitable for treating carbon dioxide-rich flue gas from fossil fuel-fired power plant or industry via direct injection
  - Systematization of microalgal production and post-production processes for industrial-scale deployment of microalgal CCUS technology

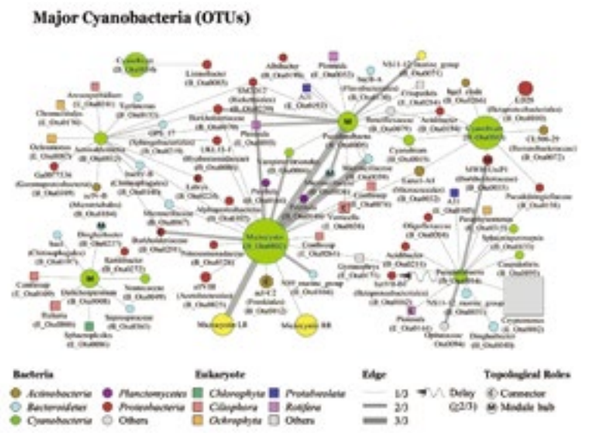
ACHIEVEMENTS

- **Two patents assignments for hair-cosmetical application to RIMAN KOREA**
  - Novel microalgae having high productivity for loliolide
  - Composition for preventing of hair loss or promoting hair growth comprising loliolide or *Scenedesmus* sp. HS4
- **Microbial interaction network during red tide (marine HAB)**
  - *Cochlodinium polykrikoides* bloom is concomitant with distinct microbial communities, contributing to the rise and fall of the bloom, and finally determining the local microbial community structures.
- **Succession of *Microcystis* genotypes revealed by network analysis**
  - The transition patterns of cyanoHAB-related modules and their key microbes could be crucial in the succession of *Microcystis* genotypes.
- **The biodegradation of polyethylene terephthalate (PET) by engineered microalgae**
  - Functional expression of polyethylene terephthalate -degrading enzyme (PETase) in green microalgae
- **Development of genetic-tool box for indigenous microalgae**
  - Development of a species-specific transformation system using the novel endogenous promoter calreticulin from oleaginous microalgae *Ettlia sp.*









〈Microbial network analysis about cyanoHAB-related modules and their key components〉

Plant Systems Engineering Research Center

The center focuses on development of important platform technology for plant biotechnology and industrial transgenic plants. These include studies on plant genomes and metaboloms, determining functionally important genes, and developing molecular tools to improve plant traits. Furthermore, the center generates industrial transgenic plants with an enhanced tolerance to environmental stresses in marginal lands, to develop a plant-based global green technology and establish international cooperation network. Further, the center currently focuses on development of in-plant cell biotechnology for the production of invaluable bio- pharmaceuticals and bio-materials. The goal is to investigate these organisms and associated processes, and develop sustainable technologies/products from these resources.

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RESEARCH AREAS

- Studies on structural and functional genomics of plants
- Development of genomic tools to improve plant useful traits
- Generation of biotech plants with an enhanced tolerance to multiple stresses
- Studies on sweetpotato biotechnology ensuring food and nutrition security in the face of climate crisis
- Development of sweetpotato plants with enhanced tolerance to multiple stresses for sustainable agriculture in global marginal lands
- Enhancing plant secondary metabolite contents in Brassica oleracea
- Genomic studies on the regulation of phytochemical contents
- Regulation of gene expression for improvement of algal biomass and bioactive compounds
- Lipid signaling network and production of natural rubber
- Studies on molecular mechanisms of plant regeneration
- Investigation of wound-induced events in plants
- Effects of climate changes on potato tuberization
- Research on gene functions related to major crop traits through genomic analysis

MAIN PROJECTS

- Plant engineering for adaptation to climate change
- Omics-based regulation of biosynthesis pathway of plant bio-materials and core-technology
- Establish marine reference genomes and their utilization platform
- Mining the useful functional genes and study their mechanism
- **Studies of key factors involved in the storage ability of sweetpotato by omics approach**
- **Elucidation of signaling network initiated by a natural lipid, plant defense inducer and development of commercialization technology using the lipid**

- Isolation and identification of unknown SAR mobile signal substances
- Discovering natural material VHC2 that treats plant virus disease

ACHIEVEMENTS

- **Functional studies of genes involved in tolerance of environmental stresses**

- We characterized genes (*IbINH, IbDHAR3, IbERF4, swpa4*) involved in various abiotic stresses such as drought, high salt, low temperature and oxidative stress in transgenic sweetpotato plants.

- **Functional studies of *IbOr* gene involved in accumulation of carotenoids and stress tolerance**

- A single amino acid change at position 96 (Arg to His) of the sweetpotato Orange (IbOr) protein leads to marked increase of carotenoid accumulation and abiotic stress tolerance in transgenic sweetpotato. In addition, IbOr protein showed interaction with carotenoid cleavage dioxygenase 4 (IbCCD4) protein in terms of carotenoids homeostasis under severe stress conditions.

- **Activation of Carbon Concentration Machinery (CCM) increase algal biomass and lipid productivity**

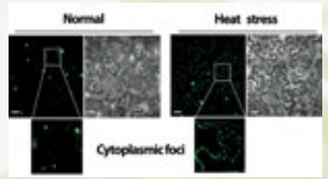
- We found that *CrLCIA* expression in N. salina increased intracellular Ci and carbonic anhydrase (CA) activity, resulting in increased growth (30%) and biomass (2-fold). These research will be useful to improve the CCM function for high biomass and lipid production using genetic modification tools in Nannochloropsis species, contributing to improved biodiesel production.

- **Identification of OsFKBP20-1b-mediated RNA processing under environmental stress conditions in rice**

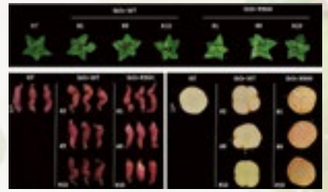
- We report the molecular function of the unique OsFKBP20-1b gene in rice, one of the most stress-responsive immunophilins, to investigate the mechanism of plant-specific stress adaptation. OsFKBP20-1b affected pre-mRNA splicing of abiotic stress-responsive genes in rice and stabilized OsSR45, which is a plant-specific splicing factor. Our results reveal that OsFKBP20-1b interacts with OsSR45 and affects the stability of OsSR45 that is directly involved in pre-mRNA splicing in rice.

- **Uncovering molecular mechanisms on flood-induced inhibition of plant defense against herbivores**

- We found that submergence deactivates wound-induced defense responses in plants by supression of jasmonic acid biosynthesis. Submergence-activated ethylene signaling is involved in these responses. Our findings suggest that submergence inactivates defense systems in plants, which would explain the proliferation of herbivores after flooding.



〈Cytoplasmic mRNP (mRNA-protein complex) localization of OsFKBP20-1b in response to heat stress〉



〈Phenotypic analysis of transgenic sweetpotato plants overexpressing IbOr-WT and IbOr-R96H〉

Industrial Bio-Materials Research Center

Recently, the eco-friendly functional bio-materials is considered to be a better option for next generation. This research center is focusing on the novel biomaterials, including enzymes, functional foods, pharmaceuticals, cosmeceuticals, bio-pesticides as shown belows.

- Microbial enzymes from diverse organisms, including insect gut microbiota
- Natural resources for functional foods and cosmeceuticals
- Bio-pesticide candidates from natural resources
- Microbial libraries (bacteria, actinomycetes, fungi, and yeasts)
- Business build-up based on biodiversity information
- Technologies to solve the social issues such as plastic and malodor

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RESEARCH AREAS

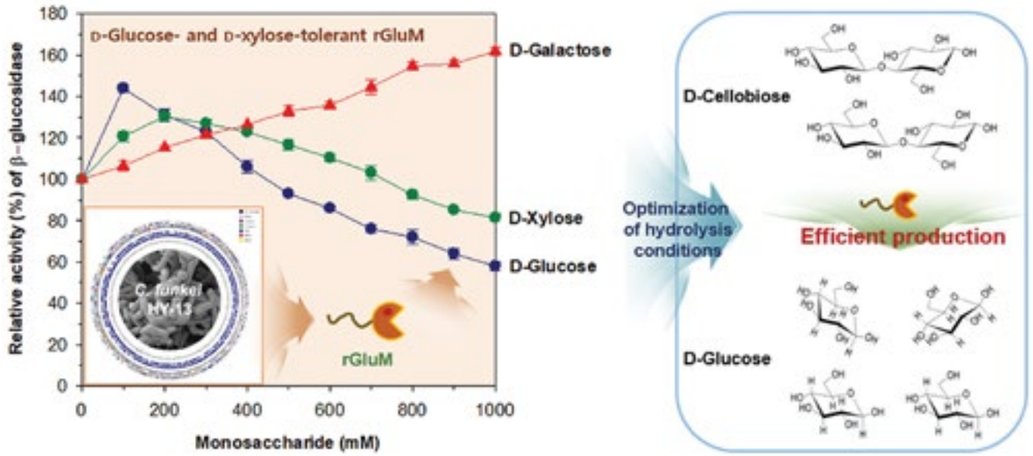
- **Microbial library build-up (bacteria, actinomycetes, fungi, and yeasts)**
  - Eco-friendly biological control agents
  - Symbiotic microbiota (probiotics)
  - Strain improvement with conventional and synthetic biology-based skills
  - Industrial enzymes (protease, carbohydrolase)
  - Biodegradable polymer technology
  - Functional natural products

MAIN PROJECTS

- **Discovery of industrial biomaterials using natural resources**
- **Research on the value enhancement and utilization of microorganisms**
- **Next-Generation Value Enhancement for Microbial Resources**
- **Microorganism-based harmful soil nematode control technology development and empirical research.**
- **Development of microbial and biochemical herbicides**
- **Improving the living environment by reducing the odor of the livestock farmers in Chonnam Korea.**
- **Biosynthesis of versatile and biodegradable microbial polyesters**
- **Microbial degradation of recalcitrant synthetic polymers**

ACHIEVEMENTS

- **Constructions of the microbial and extract libraries for research and industrial application**
  - Provision of the microbial natural products and strains
  - LC/MS-based microbial metabolic profile production
  - Development of the information database on microbial characteristics
- **Identification and functional characterization of a D-glucose and D-xylose-tolerant GH1 β-glucosidase**
  - A gut bacterium of *Eisenia fetida*, *Cellulosimicrobium funkei* HY-13 was found to have a novel D-glucose and D-xylose-tolerant GH1 β-glucosidase that can be exploited as a potential biocatalyst to generate D-glucose molecules in D-cellobiose degradation
- **Reduction of the odor of the livestock farmers in Chonnam**
  - To reduce the odor of the livestock farmers, some animal feed additives consisting of biomaterials and/or microorganisms were developed and subjected to multiple living labs in different sites to evaluate their odor-reducing effects.
- **Pine tree nematode control technology**
  - To replace the chemical pesticides for the control of pine tree nematode, our team developed the eco-friendly biological tools based on the microbial diversity.



〈Development of industrial enzymes originated from natural biodiversity pool〉

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DIVISION OF RESEARCH ON NATIONAL CHALLENGES

- Aging Research Center
- Infectious Disease Research Center
- Environmental Diseases Research Center
- Biodefense Research Center
- Stem Cell Convergence Research Center

Aging Research Center

Aging Research Center investigates the molecular mechanisms of the aging processes with regard to cellular changes and organ degeneration.

The center is also responsible for developing fundamental technologies for the prevention of aging, aging-associated diseases and generation of therapeutics, using a multi-omics analysis, followed by functional validation.

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RESEARCH AREAS

- Discovery of rejuvenating factors to reverse the processes of aging
- Functional identification of age-related genes using animal models
- Characterize *in vivo* cellular senescence using animal models
- Development of drug candidates and biologics for the control of age-associated diseases

MAIN PROJECTS

- Identification of the rejuvenating factors that can reverse aging in old animals

- Analysis of serum factors and gut microbes by using proteomics tools and a genome-wide library, in order to achieve the slowing down of the aging process in old animals.

- Discovering blood factors that change after exercise by multi-omics analysis in human and animal models

- The study of the function of miRNA which is changed after exercise, in order to extend healthspan

- Identification of new genetic factor leading to muscle aging

- Analysis of lipid composition by lipidomic analysis, in order to find the cause of muscle aging

- Discovering transcriptomic signature of *in vivo* cellular senescence

- Analysis of transcriptomic changes with aging exploiting single-cell mRNA sequencing analysis

ACHIEVEMENTS

- FABP3-mediated membrane lipid saturation alters fluidity and induces ER stress in skeletal muscle with aging
- Bacteria-derived metabolite, methylglyoxal, modulates the longevity of C. elegans through TORC2/SGK-1/DAF-16 signaling
- A subset of microRNAs in the Dlk1-Dio3 cluster regulates age-associated muscle atrophy by targeting Atrogin-1
- COVID-19-activated SREBP2 disturbs cholesterol biosynthesis and leads to cytokine storm
- Dnmt1 binds and represses genomic retroelements via DNA methylation in mouse early embryos

Infectious Disease Research Center

Infectious diseases have become a serious medical and social problem recently. Bacterial resistance against major antibiotics is causing bacteria to evolve into untreatable 'superbacteria.' Additionally, acute viral diseases such as SARS-CoV-2, influenza virus, and MERS-CoV, which are associated with high morbidity and mortality, are posing a threat to public health. Therefore, it is necessary to formulate plans to counter current and future infectious diseases. To combat superbacteria using the new insights gained by the study of induced resistance, the genomic library, small RNAs, and novel antibacterial lead compounds, the center is actively engaged in identifying novel antibacterial targets and innovative antibacterial compounds. For taking prophylactic measures against viral diseases, our center is developing new vaccines, adjuvant technologies, and anti-viral strategies based on virology, immunology, and structural biology. Further, our center also investigates microbe-host interactions to understand and manage viral/bacterial pathogenesis better.

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RESEARCH AREAS

- Development of animal models for COVID-19 research
- Genetic and mucosal vaccines against viral infectious diseases and immunological mechanism and pathogenesis of influenza virus
- Establishment of global infectious disease network during COVID-19 crisis
- Discovery and development of new anti-superbaterial compounds from natural resources
- Development of superbacteria diagnosis methodologies by nano-biotechnology system
- Research on mechanisms controlling antibody diversity and productivity in B cells and enhancing host immunity against microbial infection through metabolic regulation
- Biocontrol of antimicrobial resistant bacteria using bacteriophage
- Surveillance of potential zoonotic pathogens in animals

MAIN PROJECTS

- Advancement of research consortium by global network system
- Development of fundamental technologies for prevention and therapy of viral disease
- Management of superbacteria infection based on intergenomics studies
- In-situ virus detection and analysis diagnostic new technology for future pandemic preparation

ACHIEVEMENTS

- Establishment of SARS-CoV-2 infection animal model
  - Infection and rapid transmission of SARS-CoV-2 in ferrets.
- Novel diagnoses tools for superbacteria
  - Clustered regularly interspaced short palindromic repeats-mediated surface-enhanced Raman scattering assay for multidrug-resistant bacteria.
  - High-performance portable graphene field-effect transistor device for detecting Gram-positive and –negative bacteria.
- Discovery of a new antibiofilm target, nitrite transporter, in *Pseudomonas aeruginosa*.
  - Identification of a novel target anti-biofilm chemical, complestatin.
- Scientific overview of COVID-19 animal model and vaccine researches
- Pathogenomic feature of white shrimp
  - Genomic and histopathological characteristics of *Vibrio* parahaemolyticus isolated from an acute hepatopancreatic necrosis disease outbreak in Pacific white shrimp (*Penaeus vannamei*) cultured in Korea.

Environmental Diseases Research Center

Exposure to environmental pollutants and living in unhealthy environments contribute to a wide range of adverse health outcomes in our community, leading national recognition. The primary objective of the Environmental Disease Research Center is to conduct reasearch on the pathogenesis mechanism by which environmental factors cause or influence human diease and development for innovative methods for early detection, prevention, and control of environmentally-related diseases. The proposed center focuses on studying analysis of essential biomarkers of diseases induced by environmental pollutants and establishing validation or control system of various environmental disease. In particular, we are promoted to study for developing of novel targets and therapeutic candidates specific for particulate matters-mediated cell.

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RESEARCH AREAS

- Assessment of Ecotoxicological Effects of Particulate Matter in Human Organs by establishing multiomics, cell, *in vivo*-based infrastructure and platform technologies for ameliorating environmental diseases
- Development of particulate matter-induced pulmonary disease in mouse model and validation of novel therapeutic targets
- The regulatory and functional study of autophagy and genes involving pathogenesis of environmental-related disease
- Research on metabolic control and control of infectious disease using the macrophage, which is involved in innate immunity
- Bioinformatics: Gene Expression Profiling Interactive Analysis and Integrative Analysis of Genome by Next Generation Sequencing Platform
- The molecular regulatory mechanisms of cell death including apoptosis and non-apoptotic cell death;Protein therapeutics, Glycan analysis and remodeling
- Environmental and toxicological effect of nano- and micro-materials
- Environmental influences on stem cells in development, regeneration, and disease
- Study on immune cell type and function according to the change of tissue environment
- Understanding microbial toxin-host interaction

MAIN PROJECTS

- Investigation of particulate matter(PM10/2.5)-mediated multiorgan failure
  - reasearch on the pathogenesis mechanism by which environmental factors cause or influence human diease and development for innovative methods for early detection, prevention, and control of environment-related diseases.
- Development of novel eco-friendly biomaterials or biosynthesized reagents for particulate matter(PM10/2.5)-mediated disease
  - study for developing of novel targets and therapeutic candidates specific for particulate matters-intoxicated cells.
- Discovery analysis of essential biomarkers of diseases induced by environmental pollutants and establishment of validation assays or control system in various environmental diseases.

ACHIEVEMENTS

- Research on the disease mechanism of cancer
  - p38 stabilizes snail by suppressing DYRK2-mediated phosphorylation that is required for GSK3β-βTrCP-induced snail degradation
- Gene selection tool (GST): A R-based tool for genetic disorders based on the sliding-window proportion test using whole-exome sequencing data
  - A deep learning and similarity-based hierarchical clustering approach for pathological stage prediction of papillary renal cell carcinoma
- Finding the mechanism of phagocytosis in bacterial infection
  - Thioredoxin-interacting Protein Promotes Phagosomal Acidification Upon Exposure to Escherichia coli Through Inflammasome Mediated Caspase-1 Activation in Macrophages.
- Discovery of novel therapeutic cancer target molecules
  - Epsilon-globin HBE1 enhances radiotherapy resistance by down-regulating BCL11A in colorectal cancer cells.,
- Found the novel cell death mechanism of necroptosis factor
  - Beclin 1 functions as a negative modulator of MLKL oligomerisation by integrating into the necrosome complex

Biodefense Research Center

Recently, there has been a global epidemic of new and transformed infectious diseases, and the possibility of bio-terrorism has been increasing. Futurists are expecting the spread of pandemic disease and biological terrorism using high-risk pathogens to be a major cause of human catastrophes. Terrorism can occur with the aid of biochemical weapons worldwide, regardless of the time of exposure and it takes a lot of time to check the presence of infections and prepare after their occurrence. In particular, somewhat inadequate level of scientific and technological knowledge is required in the domestic chemical, biological, and radiological fields for the development of small and remote alarms for detection and identification, which should enhance the level of protection biological warfare. Therefore, Biodefense Research Center is planning and conducting the following studies:

- Development of preventive, diagnostic, and therapeutic technologies to preemptively respond to biological agent threats
- Development of a wearable integrated biological defense system for the future soldier and its validation through a primate model

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RESEARCH AREAS

- Development of biomarkers for early and rapid response of biological agents and establishment of basic technology for micro human simulation for hazard identification,
- development of wearable sensors for monitoring the physical condition of future soldiers
- Research on the development of the point-of-care diagnosis device for detecting biochemical and toxic materials using bionanoelectronics
- development of drug delivery system for detoxification of biochemical agents
- the effectiveness of wearable sensors and drug delivery systems can be validated through primate-based animal models

MAIN PROJECTS

- **Next-Generation Biodefense Research Laboratory**
  - Development of core source technologies necessary for the development of next generation prevention, diagnosis and treatment system and future wearable integrated biodefense system to respond to future biological weapon threat and bioterrorism threat
- **Development of Nuclear, weapon for mass destruction response technology**
  - Joint research and project planning with ADD, Army and Defense Acquisition Program Administration
  - Development of defense technology for biological agents
- **Diagnostic technology development for bio-weapon defense**
  - Design and production of antigens for biological agents
  - Diagnostic antibody against biological agents
  - Development of antibody-based bio-defensive diagnosis and therapy

ACHIEVEMENTS

- **Development of immune cell differentiation technology with human embryonic stem cells**
  - Investigation of characteristics of differentiated immune cells and development and confirmation of QA/QC techniques
- **[KEIT-Alchemist] Development of in-situ virus monitoring using all-in-one systems**
  - Development of state-of-the-art sensing technologies for overcoming alchemists in the field of infectious disease monitoring industries
- **Building diverse DNA nanostructures for nanobio-sensors and molecular computational elements**
  - Fabricating platforms to facilitate a novel 3-input algorithmic self-assembly for advanced molecular computation
  - Visualizing heterogeneous DNA/nanoparticle structures via electron microscopy without chemical staining
- **The molecular, phylogenetic, and evolutionary characteristics of Korean DV-1 and DV-4 isolates were evaluated for the first time.**
  - We sought to characterize the molecular and evolutionary features of DV-1 and DV-4 isolated from Korean overseas travelers. We used phylogenetic analysis based on the full coding region to classify isolates of DV-1 in Korea into genotype I (43251, KP406802), genotype IV (KP406803), and genotype V (KP406801). In addition, we found that strains of DV-4 belonged to genotype I (KP406806) and genotype II (43257). Evidence of positive selection in DV-1 strains was identified in the C, prM, NS2A, and NS5 proteins, whereas DV-4 showed positive selection only in the non-structural proteins NS2A, NS3, and NS5. The substitution rates per site per year were 5.58 × 10-4 and 6.72 × 10-4 for DV-1 and DV-4, respectively, and the time of the most recent common ancestor was determined using the Bayesian skyline coalescent method.

〈Opening of Next-generation Bio-defense Research Lab〉

Stem Cell Convergence Research Center

The research goal of the center is to understand stem cell functions and disease mechanisms, in order to develop therapeutics for the treatment of human diseases. The center focuses on the generation of 3D human disease model systems using reprogrammed cells such as patient-derived induced pluripotent stem cells (iPSCs) for developing personalized and in vivo-mimetic disease models. In addition, the center developed an alternative method for animal testing, named as the 'Networking Organoid Culture System (NOCS),' which involves different types of organoids, such as the intestine, liver, heart, brain, etc.

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RESEARCH AREAS

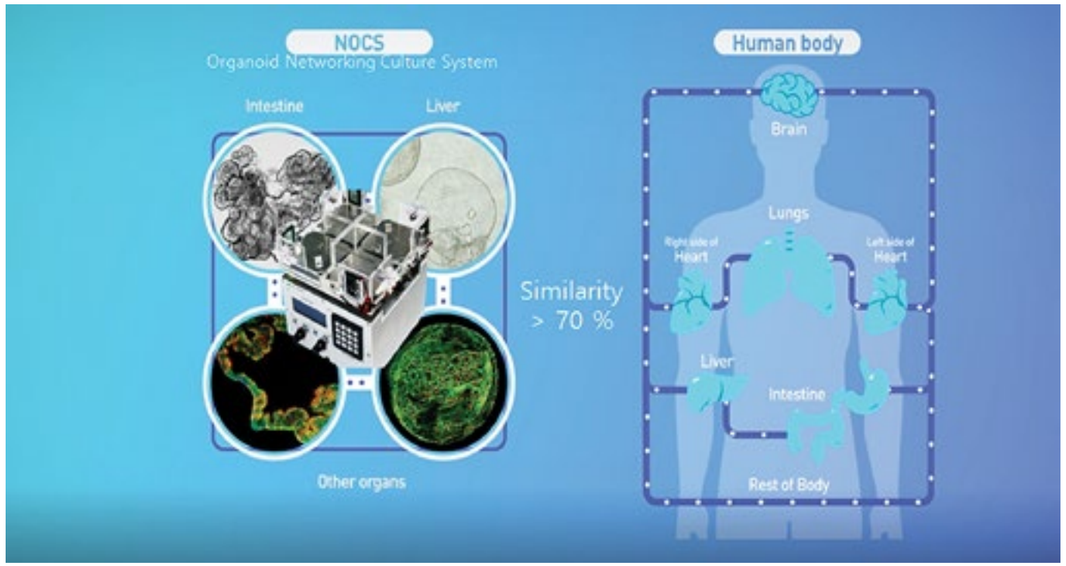
- Development of core technologies in cell fate change between somatic cells and stem cells
- Modeling 3D human diseases based on stem cells, reprogramming, and organoid technology
- Development of *in silico* prediction systems for the differentiation or functional status of in vitro models
- Development of biomimetic 3D human tissue and networking platform for predicting drug toxicity and efficacy
- Functional study of various disease-related genes for therapeutic approach
- Development of advanced biopharmaceuticals such as regenerative cell and gene therapy drug

MAIN PROJECTS

- **Development of personalized disease model based on the networking organoid circulating culture system (NOCS)**
  - Establishment of in vivo mimicking drug evaluation platform to study accurate human drug response using highly matured organoids/ engineered tissues and NOCS
  - Development of new PK/PD assay based on NOCS for the alternative preclinical test
- **Development of human gut organoid based microbiome research platform and microbiome therapeutics**
  - Establishment of a research platform based on human gastrointestinal organoids to study the entire human microbiota
  - Development of novel microbiome therapeutics for the treatment of non-alcoholic steatohepatitis and GI disorders using human organoid-based screening platform
- **Discovery of novel regeneration- and reprogramming -inducing factors**
  - Comparison between in vitro reprogramming and in vivo regeneration.
  - Discovery of common & early cell-fate-changing factors and application of thereof
- **Development of mini-lung and mini-liver for early response to major disease**
  - establishment of lung or liver organoid batteries and to create organoid-based infectious disease models
  - Developing immunized human organoids for infectious disease models for the respiratory or liver pathogens by co-culture of iPSC-drived macrophage and lung/liver organoids.

ACHIEVEMENTS

- **Systematic identification of a nuclear receptor-enriched predictive signature for erastin-induced ferroptosis**
  - Identification of biomarkers for therapeutic drugs is critical for patient stratification. Through analysis of pharmacogenomic datasets, we constructed an effective model for prediction of erastin sensitivity. This approach would be useful for identifying patients who could potentially respond to erastin treatment.
- **Low-dose interleukin-2 alleviates dextran sodium sulfate-induced colitis in mice by recovering intestinal integrity and inhibiting AKT-dependent pathways.**
  - Ulcerative colitis (UC) is a chronic inflammatory condition of the colon that lacks satisfactory treatment. In this study, we aimed to determine the effects of low-dose IL-2 as a therapeutic for UC on dextran sulfate sodium (DSS)-induced colitis. Low-dose IL-2 was effective in ameliorating the disruption of epithelial barrier integrity in DSS-induced colitis tissues by restoring tight junction proteins and mucin production and suppressing apoptosis, suggesting that low-dose IL-2 has therapeutic effects on DSS-induced colitis and potential clinical value in treating UC.
- **A new experimental model to study human drug responses**
  - New networking and circulating cell culture system (NCCS) is mimicking the circulatory system and interaction of organs for studying the PK and PD of oral drugs in vitro. NCCS generated absorption and metabolism data showed 〉70% similarity to human data.
- **Connectivity map-based drug repositioning of bortezomib to reverse the metastatic effect of GALNT14 in lung cancer**
  - Considering poor-druggability of novel molecular target, computational drug repositioning based on altered transcriptome could be a feasible approach to reverse the response. In this research, through in silico approach, we identified BTZ as a potent inhibitor of GALNT14 induced metastasis and revealed underlying mechanism.
- **Ubiquitination of PPAR-gamma by pVHL inhibits ACLY expression and lipid metabolism, is implicated in tumor progression**
  - VHL plays role in cellular lipid metabolism via regulating mitochondria and targeting PPARγ, a transcription factor for ACLY independent of hypoxia-inducible factor 1α. A novel VHL-PPAR γ-ACLY axis and its implication in fatty liver disease and cancer were uncovered.



〈In vivo mimicking organoid and NOCS to study human drug response〉

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DIVISION OF BIOTECHNOLOGY INNOVATION

- Technology Transfer Center
- SME Support Center
- BioProcess Engineering Center
- Core Facility Management Center

Technology Transfer Center

Technology Transfer Center(TTC) is to support and encourage the dissemination of technology related intellectual property of KRIBB and carry out research for further development and commercial exploitation. TTC is responsible for the identification and protection of technological assets. Once these technologies are protected effectively, marketing initiatives are used to facilitate their adoption and commercial uptake. Dissemination is mainly carried out after licensing. The terms and conditions of the licensing agreements are adapted on a case-by-case basis, depending on the specific situation of the licensee, maturity of the technology, and expected markets. In specific cases, if the technology of research project has business potential, the TTC also supports the creation of a start-up. To support biotechnological innovation in Korea, TTC also analyzes and valuates external intellectual property, to support the creation of start-up or technology transfer. TTC also conducts the technological evaluation of new biotech companies on the KOSDAQ list.

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FUNCTIONS

- **Copyrighted Management(Strengthening of Records for IP)**
  - Management of Laboratory Notebook
  - Management of Researcher's Article DB
  - Management of Copyrighted Public Records
- **IP-Inno.(Creation of Competitive Patents)**
  - Administration of IP-R&D
  - Plaining IP-R&D
  - Annual Review for Inventions and Patents
- **Tech-up(Enhancement of Demand-based Technology)**
  - Evaluation of Current Technology
  - Discovering Promising Technology for Commercialization
  - Demand-based R&D support
- **IP-Value(Active Implementation of Value Evaluation for Public Research Results)**
  - Evaluation of Technology
  - Evaluation and Quality Control of BT Research Results
- **IP-Biz. (Technology Transfer and Commercialization)**
  - Strategic Technology Marketing
  - Technology Transfer
  - Acceleration and Support of Technology Commercialization

MAIN PROJECTS

- **Construction of University-Institute cluster for commercialization of bio-convergence technology based on the 4th industrial revolution(Ministry of Science and ICT)**

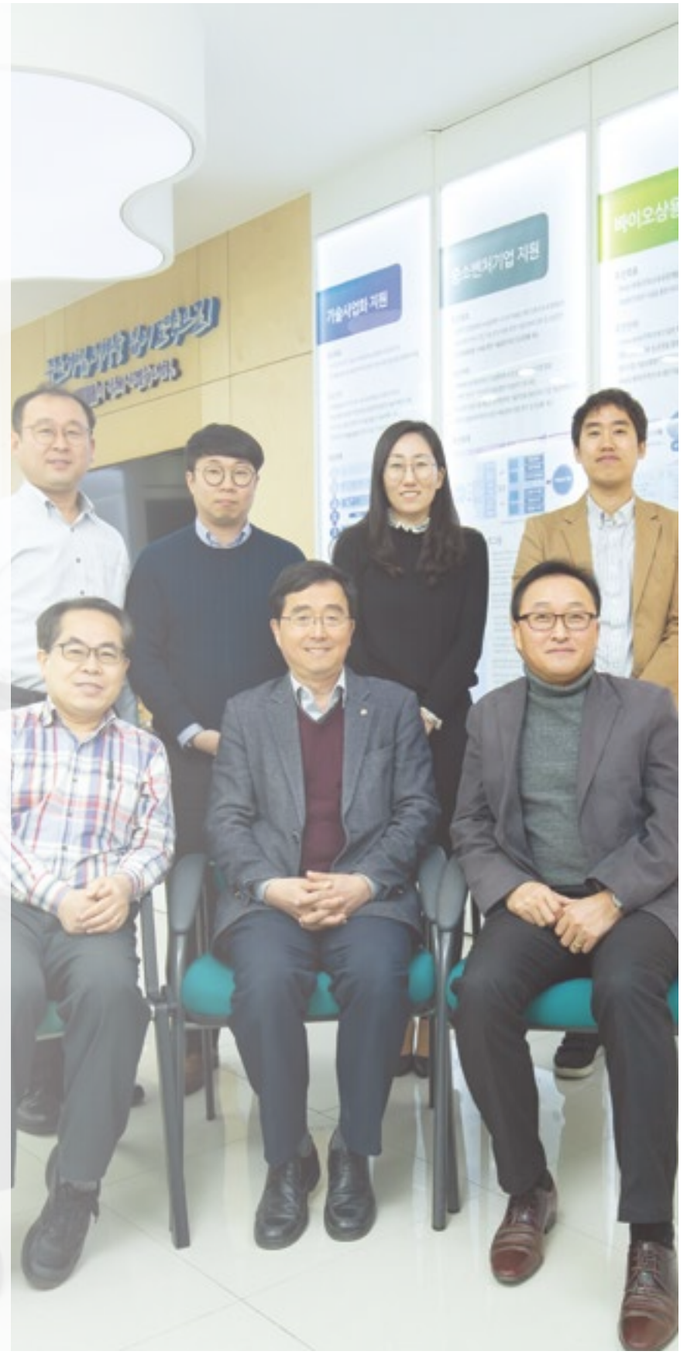
- **Supporting commercialization of bio-innovation technology**
- **Support project to promote technology transfer**

ACHIEVEMENTS

- **Creating/Securing Superior Technology**
  - Number of Registered Patents (accumulated, 2016-2020)

Year	Domestic	International	Total
2020	848	503	1351

- **203 technology license out have gone to industry as at 2020**
  - Established an Research Institute Spin-off Company, 'KPROTECH INC.' in January 2020 and'OneCureGEN(1000th)'in August 2020
  - Established an in-house venture,'AVENTI'and CuePEAKbio in March 2020
  - Listed on KOSDAQ an Mico BioMed in October 2020



SME Support Center

The SME Support Center was established to foster bioindustry in Korea through providing technical and business support to SMEs. We aim to ensure creation and scale-up of new biotechnology ventures, and to provide the necessary supports for the growth of these SMEs. To achieve our vision and mission, we develop and operate various programs based on budgets, equipment and facilities, and researchers in KRIBB. We also run governmentally funded projects and employ networks with various players in the Korean and global business ecosystems such as talented business people, venture capitals, and public and private sector players.

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FUNCTIONS

- Creation and Acceleration of Bio-Ventures
- Coordination of R&BD Collaboration
- Support for KRIBB Family Company
- Strengthening Bioindustry Ecosystems

MAIN PROJECTS

- Creation and Acceleration of Bio-Ventures
  The Center operates the biotech-specialized business incubator Bio-Venture Center (BVC) to foster early-stage bio-ventures by providing space as well as administrative and entrepreneurial services. In addition, the Center runs the KRIBB Bio-Startup Booster Program to accelerate the growth of bio-ventures.

- The KRIBB Bio-Startup Booster Program: Total solution program to support successful creation and growth of bio-ventures, including Tech-Mining (Discovering of business items and potential entrepreneurs), Startup School (Entrepreneurial training), Startup Consulting (business model development and growth/ exist planning), Incubation (supporting space/ infrastructure), Accelerating (supporting for investment attraction and product development)
- Open innovation for bio-venture creation : Arrangement and support for joint bio-venture creation between KRIBB researchers and outside business experts
- Bio-Venture Center (BVC) : Accelerating the settlement and growth of early stage bio-startups by providing designated space/ infrastructure and startup incubation programs

- Support for R&BD Collaboration
  Since 2015, the Center has been coordinating R&BD collaboration program between the innovative biotech companies and KRIBB researchers. Participating companies receives R&BD support from KRIBB research team based on their growth stage and business target.

- Hidden Champions Program : Support for new product development to enter the global market
- Pre-Hidden Champions Program : Support for product diversification to lead the domestic market
- Techin-Biz Program : Support for process and manufacturing innovation of early stage bio-startups
- Leading Regional Innovation Companies Program : Support for strengthening technology competitiveness of early stage bio-startups located in the regions with KRIBB branch campus

- Support for KRIBB Family Company Membership
  Since 2017, the KRIBB has designated innovative leading biotech companies as a KRIBB Family Company. In 2020, 52 companies were newly added, which gives rise to totally 156 ones. The center support the KRIBB Family Companies through various activities such as R&D collaboration, licensing of KRIBB technologies, and technical and business mentoring.

- Strengthening Bioindustry Ecosystems
  In order to stimulate the business idea exchange and shared business growth, the Center promotes networking events and programs with biotech enterprises
- KRIBB Tech-Biz Partnering Program : Partnering events with regional biotech SMEs consists of seminars for technology and support program, mentoring for technical and business problem, and networking
- KRIBB Tech-Bridge Program : Biotech company visiting program by KRIBB delegation with administrators and researchers to exchange ideas for in-depth collaboration

ACHIEVEMENTS

- Creation and Acceleration of Bio-Ventures
- 2 Startups created in 2020 (27 Startups since 1990) : 7 listed in KOSDAQ(~2020)
- 25 Startups currently incubated in Bio-Venture Center (72 startups graduated since 2000) : 13 listed in KOSDAQ (~2020), 83.6B KRW Sales in 2020, 93.6B KRW VC Investment (2015~2020)
- Expansion of Bio Open Innovation Lab(132 ㎡) : Co-working spaces fully equipped with 56 instruments for cell culture, DNA manipulation and microbial fermentation
- **19 biotech SMEs in R&BD collaboration with KRIBB**
- 2 companies with Hidden Champions Program, 2 companies with Pre-Hidden Champions Program, 10 companies with Techin-Biz Program

BioProcess Engineering Center

BioProcess Engineering Center (BPEC) is a skilled division that provides engineering solutions for technical issues in biological processes. Since 1995, the center plays a unique role in Korea's industrial biotechnological R&D ecosystem, by transforming scientific proof of concepts into value propositions in the field, including the microbial fermentation, biotransformation, and downstream processing of biochemical materials. In addition, the center established research facilities for animal cell culture, to efficiently respond to the recent explosive growth in the biopharmaceutical industry. The center has been carrying out the mass production and commercialization of protein drugs using animal cells, while gaining more knowledge about advanced biotechnology. Nowadays, the center is providing a range of support services to strengthen domestic bio-industry capabilities, for example, it provides support for the industrialization of results obtained during research and equipment utilization, in addition to professional manpower training.

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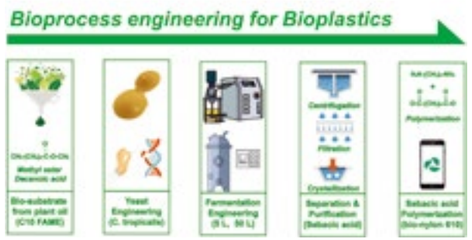
RESEARCH AREAS

- **Microbial fermentation technology and Scale-up research**
- **Technology support for industrialization of microbial bioprocess**
- **Animal cell culture and advanced purification technology for therapeutics**
- **Technology Support for preclinical sample preparation**

MAIN PROJECTS

- **Development of core process technologies for commercialization of biomaterials**
  - Fermentation and downstream processes for human growth factors in E. coli
  - Development of an enhanced mammalian transient expression system
- **Support for process development and prototype production for biocompany demand**
  - Microbial platform technology for anti-IFN-γ antibody fragment
  - Culture process of human NK cell using serum-free medium
  - Production process of *E. coli*-based whole-cell biocatalyst
  - Pilot-scale 500L fermentation process of retinoid
  - Purification process for recombinant NP protein from COVID-19 in E. coli (Biocompany: Bore Da Biotech)
  - Production and separation process of Taq polymerase in E. coli
- **Support of bioprocess equipment utilization**
  - 506 cases
- **Training of biochemical and pharmaceutical industry experts**
  - 20 trainees

〈Bioprocess engieering center〉



〈Schematic representation of microbial sebacic acid (SA) production, purification, and polymerization. Bio-polyamide 610 was produced bypolymerization of hexamethylenediamine with the purified SA〉

ACHIEVEMENTS

- **Technology transfer: Construction technology of CHO expression platform for the production of therapeutic antibody**
  - Cell lines for the production of therapeutic antibody
  - Production technology of enzymes used in gene therapy
- **Whole-cell biocatalysis using cytochrome P450 monooxygenases for biotransformation of sustainable bioresources (fatty acids, fatty alkanes, and aromatic amino acids)**
- **Enhaced mating-type switching and sexual hybridization in heterothallic yeast *Yarrowia lipolytica***

Core Facility Management Center

The Joint Equipment Operation Center was established to facilitate the joint use of key expensive research equipment in the field of biology owned by KRIBB in an attempt to promote the exchange and cooperation among industry, academia, and research field by providing a platform for information exchange.

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RESEARCH AREAS

- Operate research equipment integration room and common equipment room for efficient use of the joint-use research equipment
- Establishment and operation of a joint utilization system for shared use of research equipment
- Survey on-demand and asset inspection for the shared research equipment (once a year)
- Implementation of projects linked to the integrated portal (ZEUS) for National research facility equipment utilization

MAIN PROJECTS

- Increase the utility of the joint use of research equipment and improve management efficiency
  - Stabilization of a mobile app (Biocore) that can be accessed in real-time at the research site
- Identify the status of research equipment for joint use
  - Survey the demand for jointly used equipment and perform an on-site survey of assets
- Expand the integration room and common equipment room for efficient use of jointly used research equipment
  - Establishment of Ochang Central Analysis Laboratory in the basement of Biomedical Building, Ochang Plant
  - Construction of a common equipment room in the basement of the research building of the main building (moved and installed 30 freezers)

ACHIEVEMENTS

- Comprehensive survey of jointly used research equipment

- Establishment of central analysis laboratory in Ochang plant
  - Establishment of integrated research and analysis equipment for joint use on B1 of the Biomedical Building

- Stabilization of mobile app to increase access to shared use of research equipment for joint use

- Installation and planning of the latest high-cost research equipment for joint use
  - Next-generation genomic analysis system, hybrid orbitrap mass spectrometer
  - Cryo-TEM to be built (2021)

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OCHANG BRANCH INSTITUTE

- Natural Medicine Research Center
- Anticancer Agent Research Center

DIVISION OF BIOINFRASTRUCTURE

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

Natural Medicine Research Center

The center aims to develop a big-data platform based on digital-based analytics of natural products in Korean medicinal plants and investigates natural drug candidates against chronic/rare diseases such as asthma/COPD, cancers and spinal muscular atrophy from plant sources.

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RESEARCH AREAS

- **Establishment of Natural Product Bank**
  - Establishment of database for bio-active constituent profiles of medicinal plants using HPLC/UPLC-MS
  - Elucidation of natural compound structure using NMR and QTof-MS
  - Management of plant extract bank with standard plant extracts and phytochemicals from domestic & foreign plant sources
- **Discovery of bio-active compounds from plant sources against chronic diseases**
  - Screening plant extracts using cell-based targets of chronic respiratory diseases such as asthma, COPD and pulmonary fibrosis
  - Screening plant extracts using cell-based obesity & diabetes system
  - Screening plant extracts regulating tumor cell proliferation, autophagy, metastasis and immunogenic cell death
  - Identification of active compounds that could correct the defect of SMN splicing
  - Pharmacologica vaidation of active compounds in SMA-induced murine model
  - Isolation of active constituents in the screened plant extracts and identification of structures of natural compounds
  - Investigation of molecular mechanisms of bio-active compounds on the diseases
  - Evaluation of therapeutic effects of natural products in murine disease models

MAIN PROJECTS

- **Construction of natural product central bank based on plant sources**
  - Establishment of big-data platform for natural product source & information
  - Development of application program for plant origin, chemical & biological information of medicinal plants for pharmaceutical & nutraceutical candidates
- **Developement of drug candidates for chronic inflammatory diseases form natural products.**
  - Research on major protein regulating the inflammatory responses in the lungs
  - Confirmation of molecular mechanisms of bioactive compounds
  - Evaluation of bio-active compounds for pulmonary fibrosis *in vitro* and *in vivo*
  - Developement of novel drug candidates and neutraceuticals for anti-atherosclerotic activity *in vitro* and *in vivo*.
- **Discovery of drug candidate for the treatment of spinal muscular atrophy (SMA)**
  - Identification of bioactive compounds correcting the defect of SMN splicing through HTS
  - Pharmacological validation of bioactive compounds in SMA mouse model
- **Development of the active substances that have anti-cancer and anti-fibrotic efficacy**
  - Setup of in vitro & in vivo screening systems for drug discovery
  - Validation of drug target, efficacy evaluation, and mechanism study of compounds

ACHIEVEMENTS

- Metabolomics approach to identify the active substances influencing the antidiabetic activity of Lagerstroemia species.
- Longifolioside A inhibites TLR-4-mediated inflammatory responses by blocking PKCδ activation in LPS-stimulated THP-1 macrophges.
- Developement of a candidate for anti-atherosclerotic drug and developement of a neutracetical for atherosclerosis patients.
- Tilianin attenuates HDM-induced allergic asthma by suppressing Th2-immune responses via downregulation of IRF4 in dendritic cells.
- Improvement of spinal muscular atrophy via correction of the SMN2 splicing defect by *Brucea javanica* (L.) Merr. extract and Bruceine
- Acacetin enhances glucose uptake through insulin-independent GLUT4 translocation in L6 myotubes.

Anticancer Agent Research Center

Anticancer Agent Research Center is committed to the discovery of new anticancer agents derived from natural and chemical compound libraries and to the identification of novel anti-disease targets for developing cutting edge therapeutic approaches to cancer and other age-related diseases. To accomplish these goals, we utilize our expertise in N-end rule mediated protein degradation, wnt signaling, PLK-linked cytokinesis and tumor metabolism along with state-of-the-art techniques including in silico drug screening, metabolomics, genomics, proteomics, and cellulomics.

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RESEARCH AREAS

- **Innovative cancer specific therapeutic strategy through CAF regulation on malignant cells**
- **Tumorigenesis regulated by cancer-specific proteolytic signaling (the N-end rule pathway)**
- **Wnt signaling-related primary ciliogenesis in cancer cells**
- **Polo-like kinase 1 (Plk1) function in cancer cell division**
- **Construction of microbial secondary metabolites**
  - Discovery of bioactive secondary metabolites from microorganisms
  - Compiling a library of microbial secondary metabolites
- **Bio-active secondary metabolites screening and target identification**

  Screening new bioactive compounds from microbial secondary metabolites regulating tumor cell proliferation, metastasis, autophagy and cellular microorganelle function, and identification of their cellular targets
- **Microbial Natural Product Biosynthesis and Engineering**

  The study of biosynthetic pathways to natural products will facilitate the production of target molecules including commercial drugs and key intermediates for their chemical derivatives. Our lab is interested in studying the enzymatic machinery for the biosynthesis of secondary metabolites and their functional network will promote the development of new drugs candidates. Additionally, we are interested in unveiling hidden secondary metabolites from microbial genome.

MAIN PROJECTS

- **Identification of N-degron pathway components as new anticancer targets and the development of novel therapeutic agents**
- **Investigation into the role of wnt signaling-induced primary ciliogenesis in cancer cells**
- **Identification of novel anticancer molecules using human cancer organoids**
- **Discovery of novel microbial secondary metabolites through enforced activation of biosynthetic cryptic gene clusters**
- **Identification of bioactive compounds regulating tumor cell proliferation, apoptosis, autophagy, and metastasis**

ACHIEVEMENTS

- **Identification of Wnt3a-induced primary ciliogenesis pathway**
  - Primary cilium is an antenna-like microtubule-based cellular sensing structure. Abnormal regulation of the dynamic assembly and disassembly cycle of primary cilia is closely related to ciliopathy and cancer. Wnt signaling pathway plays major roles in embryonic development and tissue homeostasis, and defects in Wnt signaling are associated with a variety of human diseases, including cancer. In this study, we provide direct evidence of Wnt3a-induced primary ciliogenesis, which includes a continuous pathway showing that the stimulation of Wnt3a, a canonical Wnt ligand, promotes the generation of β-catenin p-S47 epitope by CK1δ, and these events lead to the reorganization of centriolar satellites resulting in primary ciliogenesis. We have also confirmed the application of our findings in MCF-7/ADR cells, a multidrug-resistant tumor cell model. Thus, our data provide a Wnt3a-induced primary ciliogenesis pathway and may provide a clue on how to overcome multidrug resistance in cancer treatment.
- **Kushenol E inhibits autophagy and impairs lysosomal positioning via VCP/p97 inhibition**
  - Autophagy plays a major role in cell survival and has therefore been exploited as an important strategy in cancer therapy. In this study, we evaluated the autophagy-regulatory effects of kushenol E (KE), a bi-prenylated flavonoid isolated from *Sophora flavescens* and inhibited autophagosome maturation. It also reduced lysosomal activity and cathepsin maturation by disrupting lysosomal positioning, subsequently inducing apoptosis. Further, we identified valosin-containing protein (VCP)/p97 as a potential target protein of KE. Thus, KE may possess autophagy-regulating properties mediated by binding to VCP/p97.
- **Highly oxygenated angucycline from *Streptomyces* Sp. KCB15JA014**
  - LC/MS-based chemical screening of culture extract led to a new highly oxygenated angucycline derivative, grecocycline D (1) from Streptomyces sp. KCB15JA014, isolated from a soil sample of Oedolgae in Jeju Island, Korea. The planar structure was determined on the basis of spectroscopic analysis, including 1D and 2D NMR techniques as well as HRESIMS and comparisonwith data from the literature. A relative and absolute configuration of 1 was assigned by ROESY experiment and electronic circular dichroism calculation. Compound 1 showed weak inhibitory activity against indoleamine 2,3-dioxygenase.
- **Microbial Natural Product Biosynthesis and Engineering**
  - The study of biosynthetic pathways to natural products will facilitate the production of target molecules including commercial drugs and key intermediates for their chemical derivatives. Our lab is interested in studying the enzymatic machinery for the biosynthesis of secondary metabolites and their functional network will promote the development of new drugs candidates. Additionally, we are interested in unveiling hidden secondary metabolites from microbial genome.

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DIVISION OF BIOINFRASTRUCTURE

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

Laboratroy Animal Resource Center

The goals of the center are to establish a national infrastructure for laboratory animal resources and a public/intramural service core for animal experimentations. For these purposes, we have been collecting mouse resources, developing quality control technologies, generating animal models for human diseases, and providing animal resources and services to researchers in biomedical research fields since 1984. Recently, we started running a broad-based primary mouse phenotyping system which was established in cooperation with Korea Mouse Phenotyping Consortium (KMPC) and International Mouse Phenotyping Consortium (IMPC). In addition, we have established infrastructure for non-clinical evaluation and lead optimization of drug candidates using laboratory animals and have been providing research support to bio-health companies and researchers. Especially, our center has been designated as the exclusive center for mouse resources by Ministry of Science and ICT in 2019.

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RESEARCH AREAS

- Collection and maintenance of laboratory animal resources
- Production, expansion and distribution of laboratory animal resources for research communities
- Permanent preservation of laboratory animal resources as frozen resource
- Quality control of laboratory animals (microbiological and genetic monitoring, microbiological clearing of animals contaminated with pathogens)
- Phenotyping of mutant mice
- Development of animal models for human diseases and animal experiment support
- Production and archiving of cancer organoid derived tumor xenograft
- Establishment of infrastructure for non-clinical evaluation of new drug candidates
- Efficacy evaluation of new drug candidates
- Drug metabolism and pharmacokinetics in drug development

MAIN PROJECTS

- **KRIBB Initiative Program**
  - Running of the mouse resource bank
  - Establishment of animal models for cancers (humanized, orthotopic, etc.) and acute lung injury
  - Research Support for Animal Experiments
- **Korea Mouse Phenotyping Center Project**
  - Archiving KMPC mutant mice and proving quality control service to KMPC program
  - Broad-based mouse basic phenotyping of KMPC mouse
- **Studies on the regulation of liver toxic stresses by orphan nuclear receptor**
  - Functional analysis of orphan nuclear receptors in acute and chronic liver diseases
- **High-Throughput 3D Multifunctional Tissue-based Screening Service of Efficacy and Safety for Drug Discovery**
  - Organoid-based pharmacokinetic evaluation platform
- **Research support for industry, academy and research institute**
  - Technical assistance for efficacy evaluation of anti-cancer drug candidates (small molecules, therapeutic antibodies, cell therapies etc.)

ACHIEVEMENTS

- **Running Exclusive center for mouse resource in Korea**
  - Designated as an Exclusive center for mouse resource by MSIT since 2019
- **The largest laboratory animal resource bank in Korea**
  - Deposits of laboratory animal resources: 1,448 strains
  - Distribution of laboratory animal resources: 6,007 animals
- **Center for quality control of laboratory animals**
  - Health monitoring: 4,493 animals
  - Animal clearing: 177 strains
- **Research supports for animal experiments**
  - IACUC-approved animal experiments: 175 items
  - Pathological experiments: 55 cases/1,782 specimens
  - Hematological and biochemical analyses: 82 cases/1,959 specimens
- **Technical assistance for non-clinical evaluation of new drug candidates**
  - Efficacy evaluation of new drug candidates: 854 cases
  - DMPK evaluation of new drug candidates: 216 cases

Bio-Evaluation Center

The mission of Bio-Evaluation Center is to support development and commercialization of organisms, which were developed using biological engineering tools (gene transformation or genome editing, etc.). To achieve this goal, the center has established human and physical infrastructure for research and bio-evaluation, consisting of molecular genetic analysis techniques, human and environment-risk assessment techniques, facilities, and experts. The benefits and risks of organisms for industrialization (living modified organisms, genomeedited organisms, and introduced species, etc.) are evaluated through the entire process from development to commercialization using the established infrastructure, in order to acquire approval from the regulatory authority. The center also advises industries to carry out the optimization and standardization of the process at the developmental stage.

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RESEARCH AREAS

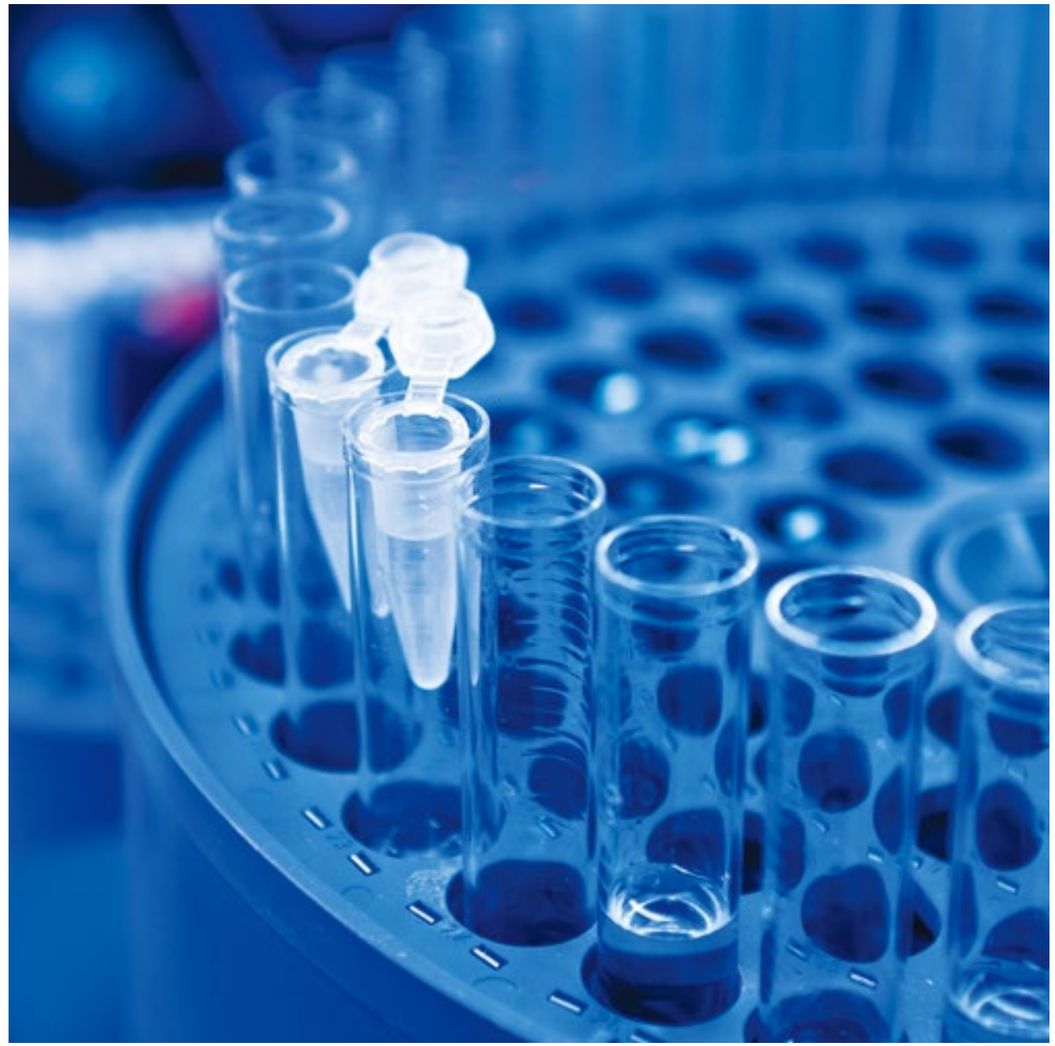
- Molecular genetic characterization of living modified organisms for commercialization
- Environment risk assessment of living modified organisms for commercialization
- Human risk assessment of living modified organisms for commercialization

MAIN PROJECTS

- Development of risk assessment techniques of novel organisms for commercialization
- Support risk assessment process of novel organisms for commercialization
- Risk assessment of transgenic soybean producing cosmeceutical protein
- Evaluation of agronomic characteristics of herbicide-resistant transgenic soybean

ACHIEVEMENTS

- **Designated LMO Risk Assessment Institution by Ministry of Trade, Industry and Energy of Korea**
  - The first LMO Risk Assessment Institution designated by Korea Ministry of Trade, industry and Energy
- **Bio-Evaluation Support for industrial living modified organism**
  - Support to acquire approval from the regulatory authority of 2 events of living modified microorganisms for industrial use and food and medical equipment.
- **Genetic analysis and evaluation technique development**
  - Development of evaluation techniques for genetic analysis, human and environment risk assessment for domestically developed living modified organisms



National Primate Research Center

National Primate Research Center (NPRC) was established as a major national non-human primate infrastructure to support industry/academia/research institute, including those involved in xenotransplantation, regenerative medicine, and new-drug discovery for incurable diseases.

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RESEARCH AREAS

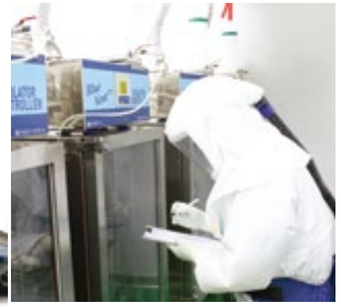
- **Construction of a system to secure SPF primate resources**
  - Establishing a system to secure stable SPF primate resources essential to discover new biologic medical products, regenerative cell therapy and research neurological and infectious diseases
  - Development of research system based on SPF primate resources for industry·academia·research institute support
- **Management and standardization of SPF primate resources**
  - Construction of an international-grade SPF primate breeding facility and development of management system to establish national standard operating procedure (SOP)
  - Standardization of health monitoring system to maintain SPF primate resources
  - Construction of a comprehensive SPF primate resource management systems
- **Research on primate model for efficacy evaluation**
  - Establishing an efficacy evaluation system to discover new drugs, biomaterials, and vaccines based on SPF primate resources
  - Developing evaluation system using imaging / molecular biological / histopathological / behavioral / cognitive functional assay
- **Development of primate disease models**
  - Development of induced disease model based on SPF primate resources (neurodegenerative disease, drug addiction, aging, and infectious disease)
  - Research on the efficacy evaluation system for drug, biomaterial, and vaccine candidates using primate disease models
- **Animal Biosafety Level 3 (ABL3) facility for research support**
  - Support for research on infectious diseases, animal diseases, bioterrorism, and super bacteria on a national disaster scale
- **Providing expertise and technology related to primates-based research**
  - Providing researchers with specialized skills and information on primate care and related-facilities

MAIN PROJECTS

- **Establishing primate research infrastructure and facilitate cooperation with industries, academia and research institutes**
  - Developing research infrastructure for preclinical primate model, standadization and quality improvement of primate care, and facilitating cooperation with industry, academia, and research institutes
- **Developing non-human primate models of human infectious disease required for the industry·academia·research institute**
  - Establishing primate model system for infectious diseases research
  - Establishing the efficacy evaluation system for diagnosis/treatment agents and vaccines development using primate models of infectious diseases
- **Establishment of customized drug efficacy evaluation platform based on comparative analysis of primate degenerative brain**
  - Developing the platform for the generation, analysis, and utilization of comparative medical data for degenerative brain diseases
  - Supporting for development of degenerative brain disease models for customized healthcare technology and establishing effective verification platform
- **Development of animal models of neurodegenerative diseases**
  - Establishment of neurodegenerative disease primate model and related efficacy evaluation system

ACHIEVEMENTS

- **Establishment of primate models for COVID-19 research**
  - World's fourth development of COVID-19 Primate Infectious Disease Model (USA, China, Netherlands, South Korea)
  - SARS-CoV-2 virus acquisition, isolation, purification and amplification technology establishment
  - Support for development of vaccine and medicine targeting COVID-19 using the ABL3 research facility and the COVID-19 primate model
- **Improvement of the breeding environment and management program of primate resources in consideration of animal welfare**
  - Establishing an advanced breeding environment with social housing for primate social interaction
  - Providing living space conforming to international standards in accordance with EU guidelines
- **Certification of ISO 9001: 2015 quality management system (QMS) and establishment of the Primate Resource Management System (PRMS)**
  - Certification of ISO 9001: 2015 about acquisition, preservation, distribution and research infrastructure services of biological resources
  - Development of an integrated primate resource management system for primate research infrastructure at international level and advanced resource management
- **Establishing a primate model system for efficacy evaluation**
  - Establishment of imaging (MRI, PET-CT) / molecular biological / histopathological / immunological / behavioral (gait analysis, hand motor function, activity analysis) / cognitive function evaluation (finger maze test, CANTAB test) system
  - Research on molecular mechanism of primate disease models using genome, transcriptome, epigenome, and microbiome analysis
- **Support of primate-related resources and techniques to national partners of industry·academia·research institute**
  - Providing various substances such as blood, nucleic acids, and various tissues derived from primates
  - Providing various specialized technologies such as information, facilities, breeding, microbiological monitoring, quarantine, and experiments related to primates and support for education and training



Futuristic Animal Resource & Research Center

Futuristic Animal Resource & Research Center (FARRC) has been established for contributing to the vitalization of future bio-industries, including new bio-drug discovery, xenotransplantation and regenerative medicine. Further, the center works to address national/social issues, such as blood deficiency, low birthrate, rapidly aging population, etc, by developing research support system that could be utilized across the government ministries, based on national mini-pig infrastructure that combines the world's best resources, materials, technologies, instruments, facilities, and specialists.

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RESEARCH AREAS

- **Obtainment and standardization of specific pathogen free (SPF) mini-pig resources**
  - Obtainment of mini-pig resources and development of a new breed
  - Standardization of mini-pig resources by SPF/health monitoring
- **Supply of mini-pig resources/materials/techniques/information**
  - Development and support transgenesis techniques in minipigs
  - Generation and support transgenic/cloned mini-pigs
  - Generation and support an induced/transgenic disease model using mini-pigs
  - Development and support mini-pig research resources, including tissues, cells, bloods, nucleic acids, etc.
- **Industry/academia/research institute support**
  - Basic biomedical research: neuroscience, genomics, bioinformatics, developmental biotechnology, etc.
  - Advanced biotechnology: new bio-drug discovery, xenotransplantation, stem cell medication, regenerative medicine, etc.
  - National/social issues: blood deficiency, low birth rate, rapidely aging population, national-wide infectious diseases, bioterrorism, chronic incurable diseases, etc.
- **Establishment of research needs-customizing/leading infrastructure**
  - Establishment of user-customizing infrastructure after the analysis of on/off-line research needs
  - Establishment of infrastructure based on expectations from future research fields

MAIN PROJECTS

- **Development of core-infrastrucure/technologies for artificial blood research**
- **Establishment of national mini-pig infrastructure for industrial/ academical/ institutional cooperation support**
- **Establishment of male-infertility large-medium animal model for preclinical evaluation of artificial spermatozoa therapeutics**
- **Establishment of large-medium animal cell lines as core-components of preclinical evaluation platform for vatalization of biomedial industry**

ACHIEVEMENTS

- **Reproduction and maintenance of SPF mini-pigs**
  - Optimal number of mini-pigs was successfully obtained through indoor inbreeding and maintenance, under a stable SPF environment.
- **Derivation of research resources from SPF mini-pigs**
  - Support industry/academia/research institute demands and establish somatic cell nuclear transfer methodsomatic cell lines were established from a variety of mini-pig tissue and organs.
- **Generation of transgenic/cloned mini-pigs for biomedial research support**
  - Transgenic mini-pigs were successfully generated by the production of cloned embryos, embryo transfer into foster mothers, delivery by caesarian section and artificial nursing.
  - Phenotype analyses of the transgenic mini-pigs were conducted based on molecular/histological/serological/bahavioural/image-medial techniques.
- **Development of transgenic core-technologies based on genome-editing system**
  - Development of guide RNA engineering method with high on-target-specificity.

International Biological Material Research Center

We are aiming at procuring biological materials from four overseas regional centers and their neighboring countries through legal routes within the scope of international collaborative research projects. Our mission is to provide researchers with a various of materials, including indigenous medicinal knowledge, and also to establish the nation's core infrastructure for developing new natural drugs and nutraceuticals, along with other commercially important natural products.

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RESEARCH AREAS

- Operation and management of four collaborative biological material research centers for the collection and preparation of biological materials worldwide
- Establishment and operation of a comprehensive system and database to manage biological materials and related traditional medicinal knowledge procured from four regional centers and their neighboring countries
- A study on the standardization of highly active biological materials (massive cultivation and quality control) for the establishment and operation of a supply system for leading research groups within the scope of the assigned project
- Phylogenetic Analysis and Development of DNA barcode for the identification of Medicinal plants
- A study of the information resources (biological resource access and benefit-sharing, related laws, and system, local information) for the promotion of cooperation and utilization

ACHIEVEMENTS

- **Establishment and operation of the International Biological Material Research Center (IBMRC)**
  - IBMRC was established in 2006 by the Korean government as an infrastructure to support biotechnology research in Korea. Through the operation of an open website, IBMRC is actively providing information and materials to industry, academia, and research institutes to support the creation of high-quality research results.
    - · Retain Biological Materials: 38,032 no.
    - · Deposits of voucher specimens: 102,000 herbarium specimens
    - · Distribute 267,312 no. of materials to research organizations, such as universities, research institutes, and private companies (2020)
    - · Support for bulk materials for industrialization candidates: 9 cases
    - · Discovering of taxa closely related to highly active materials: 2 cases
    - · Establishment of cooperation system with industry: 4 cases
- **Operation and management of four collaborative biological material research centers**
  - Korea-China Biological Material Research Center (Kunming)
  - Korea-Costa Rica Biological Material Research Center (Heredia)
  - Korea-Indonesia Biological Material Research Center (Tangerang)
  - Korea-Vietnam Biological Material Research Center (Hanoi)
- **Establishment and operation of a massive sample supply system**
  - *Pistacia weinmannifolia* massive cultivation farm (Kunming, China)
  - *Diospyros blancoi* massive cultivation farm (Guacimo, Costa Rica)
  - *Lagestroemia ovalifolia, Ficus villosa* massive cultivation farm (Lampung, Indonesia)
  - *Desmodium sequax* massive cultivation farm (Hanoi, Vietnam)
- **International collaborative research**
  - Status of International Partnership (2020): 15 countries, 18 Institutions
  - 38 countries, 50 Institutions (accumulated)
  - Joint research consultations with overseas local research institutes: 12 institutes
  - Exchange program of 3 scientists from Ecuador, Mongolia, and Uzbekistan

ABS Research Support Center

ABS Research Support Center, an executive office of the Competent National Authority for biological resources management, plays a main role in the provision of comprehensive services for obtaining "access to genetic resources and benefit-sharing (ABS)" under the supervision of the Ministry of Science and ICT (MSIT). The center operates the 'ABS Help-Desk,' to provide valuable information about Nagoya Protocol issues and the 'Advanced bioResource Information System (ARIS)' for the convenient utilization of biological resources and information. The Center also studies taxonomy and cultures probiotic anaerobic bacteria to cope with ABS. Another primary responsibility is to manage the following three committees with institutional authority, in terms of legal regulations for ensuring biosafety: Institutional Review Board (IRB), Institutional Animal Care and Use Committee (IACUC), and Institutional Biosafety Committee(IBC).

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RESEARCH AREAS

- Research on laws, regulations and current international trends about ABS
- Capacity building and awareness raising of ABS through public presentations and seminars
- Consultation of the access and use of domestic and foreign genetic resources
- Taxonomic study and development of probiotic anaerobic bacteria to cope with ABS
- Operation of Biological Research Resources Information Center of Ministry of Science and ICT (MSIT)
- Management of Institutional Boards (IRB, IBC, and IACUC)

MAIN PROJECTS

- **Consigned affairs of the Ministry of Science and ICT for their role as Competent National Authority & Checkpoint under the Nagoya Protocol**
  - Receiving and processing a submission of 'Report on Access to Domestic Genetic Resources'
  - Receiving and processing a submission of 'Report on Procedural Compliance for Foreign Genetic Resources'
  - Managing 'ABS Help-Desk'(online and telephone consultation)
- **Activities for raising awareness of the Nagoya Protocol**
  - Publishing book series of 'ABS Guide for Researchers'
  - Publishing and distributing 'ABS Brief' online every month
  - Holding public seminars to raise awareness of the Nagoya Protocol
- **Establishment of Bio Resource Information Service**
  - Operating'Advanced bioResource Information System (ARIS)' to facilitate utilization of biological resources and information
- **Management of three institutional boards**
  - IRB : 3 annual meetings (30 review cases by the public IRB in contract)
  - IBC : 8 meetings with 26 review cases
  - IACUC : 25 meetings with 338 review cases

ACHIEVEMENTS

- Publication of 'ABS Guide series No. 9 - Code of Conduct & Best Practice for Access and Benefit-Sharing'
- Online publication and distribution of twelve 'ABS Brief'(every month)
- An online public seminar convened under the title of "Current Status and Prospect of Implementing the Nagoya Protocol"
- Amendment of regulations/guidelines related to institutional boards (IRB, IBC, and IACUC)
  - 'Biosafety Management Guidelines' ('20.07.02)
  - 'Institutional Review Board Standard Operating Procedure' ('20.07.23)
  - 'Regulation on the Management and Use of Laboratory Animals' ('20.09.30)
  - Distribution of 'Biosafety Manual for Researchers ver.2'

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JEONBUK BRANCH INSTITUTE

- Functional Biomaterial Research Center
- Microbial Biotechnology Research Center
- Immunoregulatory Materials Research Center
- Biological Resource Center
- Primate Resources Center

Functional Biomaterial Research Center

The goal of Funtional Biomaterial Research Center is to develop natural biomaterials with a broad range of biological activities against human or livestock diseases caused by infectious/contagious pathogens, aging, inflammatory, and immune-mediated responses from natural resources (plants, microorganisms, and marine sources).

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RESEARCH AREAS

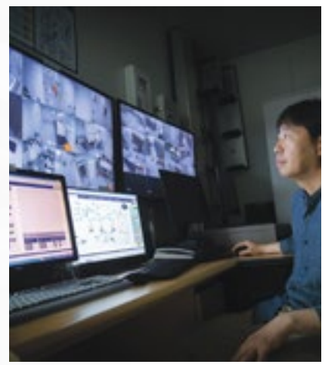
- **Construction of a natural product fraction library**
  - Construction and utilization of both fractions from plant and microbial culture extracts and a natural compound library
  - Isolation and identification of bioactive compounds from natural resource extracts
  - Quantitative and qualitative analysis of components from natural resources
  - The role of LC-MS in metabolism and pharmacokinetics studies of natural products
- **Development of bioresource related to neutraceutices and cosmeceutics**
  - Establishment of bioassay and system for screening such biologically active extracts/compounds in target items
  - Target items include individuals exhibiting metabolic disease, anti-inflammation, immune regulation, andropause, menopause, benign prostatic hyperplasia, dysmenorrhea, anti wrinkle, whitening, atopic dermatitis, etc
- **Construction of bioassay system related to infectious and immune diseases**
  - Establishment of in vitro/-in vivo model system for antiviral drug such as SARS-CoV, HPAI, etc., based on ABL-3 facility.
  - Establishment of bioassay and screening system to search for biomaterials or compounds that have a therapeutic effect against pathogen-mediated inflammatory and immune diseases
  - Development of active compounds or materials inhibiting inflammatory or immune-mediated responses and improving the disturbance of immune functions
- **Development of mass-production technologies for useful biological compounds and research into practical technologies via field applications**
  - Development of mass-production technologies for generating useful biological compounds using pilot plants
  - Development of technologies for field applications and the commercialization of useful compounds

MAIN PROJECTS

- **Development and commercialization of high valuable healthe bio-materials**
- **Covid-19 Emergency utilization support project for industry-academic-association**
- **Development of biomaterials to improve prostatic hypertrophy using natural resources at home and abroad**
- **High-risk coronavirus efficacy biomaterial discovery and efficacy verification system construction**
- **Development of functional cosmetics material using plant stem cells**

ACHIEVEMENTS

- **Evaluation of natural products for use thereof Natural products are chemical compounds or substances isolated from living organisms. A study of the chemistry of natural products includes the investigation of their biosynthesis, extraction, identification, quantification, structural elucidation, physical and chemical properties, and reactivity. They are produced via pathway for primary or secondary metabolism. Plant secondary metabolites can be found in leaves, stem, root, or bark of plant, depending on the type of secondary metabolite that is being produced. The most bioactive secondary metabolites include alkaloids, tannins, flavonoids, and phenolic compounds. The study of these natural products has played a major part in development of medicinal chemistry and functional foods/cosmetics, and the center is now starting to understand the important role of these compounds/extracts.**
  - Isolation of secondary metabolites in natural products.
  - Chemical and spectroscopic strategies for structure elucidation (UV, IR, and NMR)
  - Performing quantitative/qualitative analysis using HPLC and an ultra high-performance liquid chromatography-high-resolution tandem mass spectrometric method (UPLC-HRMS-MS/MS), which was developed for the standardization of secondary metabolites in extracts
  - In addition, the center has built a natural product fraction library, and collecting plant resources, and utilizing both plant extracts through open column chromatography in addition to natural product library.
- **Animal model establishment and research using animal disease model**
  - Development of animal models for efficaciously generating neutraceutical biomaterials in vivo
  - Development of animal models for studying high pathogen-mediated diseases animal model in animal biosafety level 2/3 facility
  - Efficacy evalution of biomaterials on high pathogenic virus/bacteria-mediated diseases using animal biosafety level 2/3 facility
- **Identification of biological targets and pharmacological properties:**
  - Development of active compounds showing inhibitory effects on pathogen-related enzymes related to internalization, replication, and release (such as SARS 3CL, PL, influenza neuraminidase etc.)
  - Development of active compounds showing inhibitory effects on human disease-related enzymes (such as alpha-glucosidase, tyrosinase, etc.)
  - Development of active compounds showing anti-inflammatory activity through the inhibition of NF-kB signaling, JNK/AP-1 signaling, and TLRs



Microbial Biotechnology Research Center

The goal is to develop biotechnologies and bioprocesses for the production of microbial metabolites, proteins, industrial enzymes, and bioenergy, all of which are useful for pharmaceutical, nutraceutical, dietetic, cosmetic, feed, fine chemical, and other industries.

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RESEARCH AREAS

- **Microbial metabolic engineering**
  - Production of microbial metabolites
  - Metabolic engineering of industrial microorganisms
- **Bioconversion technology**
  - High throughput screening of novel biocatalysts
  - Directed evolution of industrial enzymes
  - Production of useful biomaterials by bioconversion
- **Animal microbiome**
  - Microbiome taxonomic profile (MTF) analysis of animals
  - Development of pre/probiotic materials for industrial animals
- **Molecular bioprocess engineering**
  - Production of therapeutic recombinant proteins
  - Development of bio-refinery technologies

MAIN PROJECTS

- **Development and commercialization of well-aging biomaterials based on agro-bio microbiome**
- **Useful Agricultural Life Resources Industry Technology Development Program**
  - Development of high-value microbial and animal cell culture media materials using protein enzyme decomposition products of animal blood
- **Development of microbial systems metabolic engineering platform technology for biorefinery**
  - Development of high-throughput toolbox from metagenomic resources for systems metabolic engineering
- **Encouragement Program for The Industries of Economic Cooperation Region**
  - Development of sensitive skin improvement cosmetics using natural products and biotechnology

ACHIEVEMENTS

- Regulation of lipid accumulation using nitrogen for microalgae lipid production in *Schizochytrium* sp. ABC101.
- Ricin B-like lectin orthologues from two mushrooms, *Hericium erinaceus* and *Stereum hirsutum*, enable recognition of highly fucosylated N-glycans.
- Enhancement of 1,3-propanediol production from industrial by-product by *Lactobacillus reuteri* CH53.
- Synthesis of two new lipid mediators from docosahexaenoic acid by combinatorial catalysis involving enzymatic and chemical reaction.
- Identification and characterization of a cocoon degradable enzyme from the isolated strain *Bacillus subtilis* Bs5C.

Immunoregulatory Materials Research Center

The goal of Immunoregulatory Materials Research Centerl is to develop natural biomaterials with a broad range of biological activity against infectious/contagious diseases of human beings or livestock, immunological synapse, inflammatory and immune-mediated diseases from the natural resources (plants, microorganisms, and marine sources).

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RESEARCH AREAS

- **Construction of a bioassay system related to immune diseases**
  - Establishment of a bioassay and screening system searching biomaterials or compounds which have a therapeutic effect against immune diseases including infectious and inflammatory diseases.
  - Development of active compounds such as inhibitors of cell adhesion molecules, inflammatory cytokine and chemokine.
  - Development of active materials or compounds regulating the innate immune system including Toll-like receptor family.
  - Development of active materials or compounds boosting immunity such as a Type I interferon family.
- **Development of mass-production technologies for useful biological compounds and research into practical technologies via field applications**
  - Development of mass-production technologies for useful biological compounds using pilot plants.
  - Development of technologies for field applications and the commercialization of useful compounds.
- **Construction of a natural product fraction library**
  - Construction and utilization of both fractions from plant and microbial culture extracts and a natural compound library.

MAIN PROJECTS

- **Development and commercialization of high value added health biomaterials**
- **Development of materials for the prevention and treatment of immune diseases by using Ampelopsis brevipedunculata**
- **Development of post-biotics functional food materials by applying lactic acid bacteria fermentation technology to enhance high value of Actinidia arguta**
- **Development of technology for controlling black rot disease of cruciferous crops**
- **Development of in vitro screening system and Mechanism study for improving of women's menopausal symptoms from marine biological resources**
- **Development and commercialization of functions materials for joint health using red bean(*Vigna angularis*)**

ACHIEVEMENTS

- **Development and utilization of cell-based screening system for new active substrates with anti-inflammatory activity**
  - Screening system for the inhibitor of IL-6 signaling.
  - Screening system for the inhibitor of Toll-like receptors and NO.
  - Exploring the efficacy of skin health functional materials using human keratinocyte.
- **Evaluation of therapeutic effect on several animal model for immune disease**
  - Vigna angularis ameliorated atopic dermatitis, osteoarthritis, and osteoporosis.
  - KR-600 inhibited bone loss on ovariectomized osteoporosis mice model.
- **Purify active compounds from natural resources and determine the structure of the compounds**
  - Development of active compounds showing anti-inflammatory activity through inhibition of cell adhesion molecules, TLRs and IL-6 signaling.
- **Identify biological target and pharmacological properties**
  - Diterpenoids from Celastrus orbiculatus showed anti-inflammatory activity through downregulation of MAPK and NF-kB signaling cascade.
  - Eleocharis kuroguwai Ohwi Ameliorates LPS-mediated Inflammation by Suppressing MAPKs Signaling.
  - AGK2 ameliorates mast cell-mediated allergic airway inflammation and fibrosis by inhibiting FcϵRI/TGF-β signaling pathway
  - Retrofractamide C Derived from Piper longum Alleviates Xylene-Induced Mouse Ear Edema and Inhibits Phosphorylation of ERK and NF-B in LPS-Induced J774A.1.
  - Rugosic acid A, derived from Rosa rugosa Thunb., is novel inhibitory agent for NF-κB and IL-6/STAT3 axis in acute lung injury model
- **Verify in vivo anti-inflammatory activity**
  - Rugosic acid A ameliorated LPS-mediated ALI by decreasing MPO concentration and inhibiting phosphorylation of STAT3 and p65 NF-κB.

Biological Resource Center

Biological Resource Center or Korean Collection for Type Cultures (KCTC) is very well known both domestically and internationally. KCTC joined the World Federation of Culture Collections (WFCC) in 1985 and the World Data Center for Microorganisms (WDCM) in 1986. It also gained the status of an International Depositary Authority (IDA) from the World Intellectual Property Organization (WIPO) in 1990, under the Budapest Treaty. KCTC currently collects, preserves, and distributes biological resources, including archaea, aerobic, or anaerobic bacteria, molds, yeasts, plant cell lines, animal/human cell lines, and patent strains. All biological resources are extensively qualitycontrolled. KCTC also endeavors to construct collaborative networks with other BRCs to support both scientific and industrial communities.

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RESEARCH AREAS

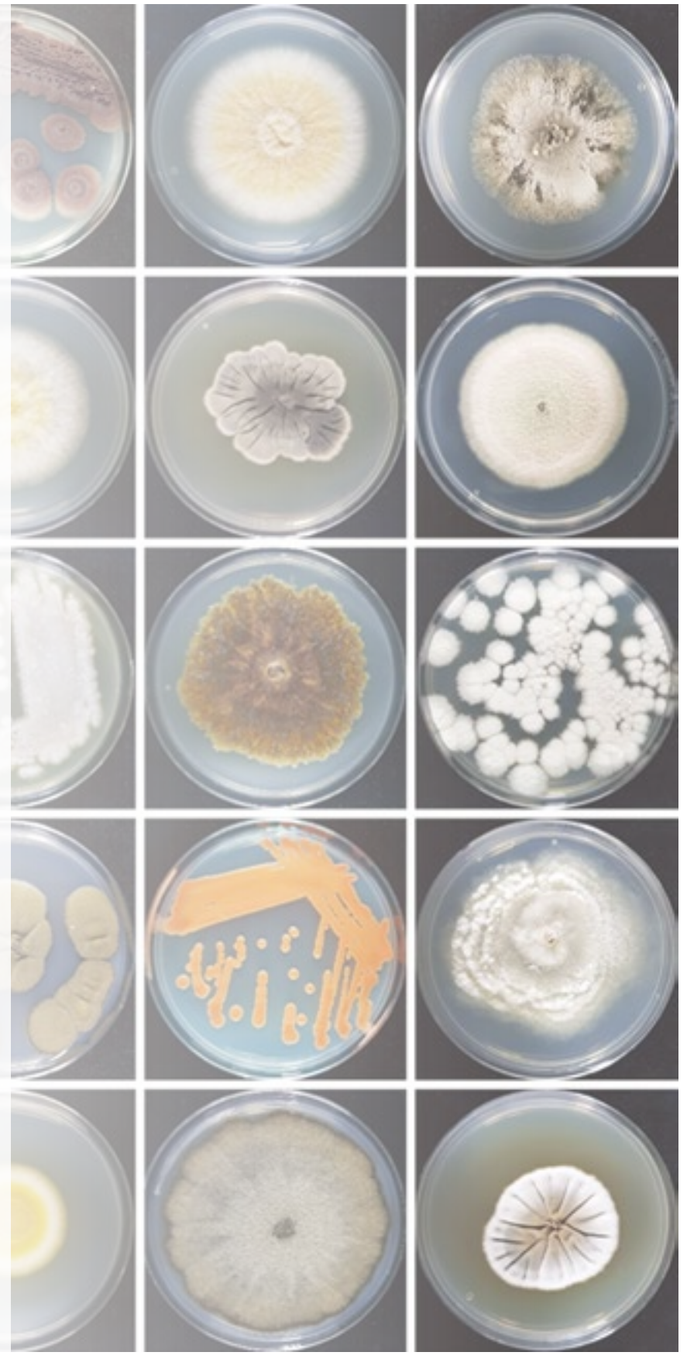
- **Aquisition and management of biological resources**
  - Collection and preservation of core biological resource for research activities
  - Distribution of biological resources to academia, research institutes, and industries
- **Development of core technologies for biological resources**
  - Development of platform technologies for isolation, long-term preservation, and application of useful biological resources
- **Construction of infrastructure for networks and support for services and education related to biological resource**
  - Construction of local and global networks for biological resource
  - Support training workshops, conference, and consultations
- **Construction and application technology development of the infra-system for Korean gut microbiome**
  - Establishment of the Korean gut microbiome bank
  - Support Korean gut microbiome research and industry
- **Development and management of valuable plant cell resources**
  - Development, collection, preservation, and distribution of plant cell resources (callus, adventitious roots, shoot and micro-tubes)
  - Mass production of valuable plant cell resources using bioreactors
  - High-level production of useful metabolites by eliciting response from plant cells
- **Development of core technologies for plant cell differentiation and plant regeneration**
  - Development of core technologies for cell differentiation and regeneration of useful plant resources
  - Establishment of a national platform for the genome editing of useful plant resources
- **Biotechnological application of plant-associated microbes**
  - Molecular ecology approaches for a better understanding of plant-associated microbe interactions
  - Improving the ability of plant-associated microbes for stress alleviation in crops based on a better understanding of plant-microbiome interactions

MAIN PROJECTS

- **Enhancement of infrastructure for biological resources and customized service thereof**
- **Establishment of plant cell resources and its application**
- **Constructions and application technology development of the infra-system for Korea gut microbime**
- **Development of the establishment and support of animal gut microbiome bank**

ACHIEVEMENTS

- *Lactococcus kimchi* sp. nov., a new lactic acid bacterium isolated from kimchi
- *Senegalimassilia faecalis* sp. nov., an anaerobic actinobacterium isolated from human faeces, and emended description of the genus *Senegalimassilia*
- The synergistic effect of co-treatment of methyl jasmonate and cyclodextrins on pterocarpan production in *Sophora flavescens* cell cultures
- Maturation of human intestinal organoids in vitro facilitates colonization by commensal lactobacilli by reinforcing the mucus layer
- Temporal and spatial expression analysis of shoot–regener ation regulatory genes during the adventitious shoot formation in hypocotyl and cotyledon explants of tomato(CV.Micro-Tom)
- Development of a squaraine-based molecular probe for dual-modal in vivo fluorescence and photoacoustic imaging
- *Sutterella faecalis* sp. nov., isolated from human faeces
- Homeobox proteins are essential for fungal differentiation and secondary metabolism in *Aspergillus nidulans*



Primate Resources Center

Primate Resources Center (PRC) is the largest non-human primate infrastructure in Korea. Non-human primates in PRC are extensively quality-controlled by means of health monitoring (e.g., infectious viruses and bacteria) in order to maintain specific pathogen free (SPF) non-human primate resources. In addition, PRC endeavors to construct collaborative networks to support industry, academia, institute for non-human primate research, including for neurodegenerative disease models, regenerative medicine, and new-drug discovery related to incurable diseases.

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RESEARCH AREAS

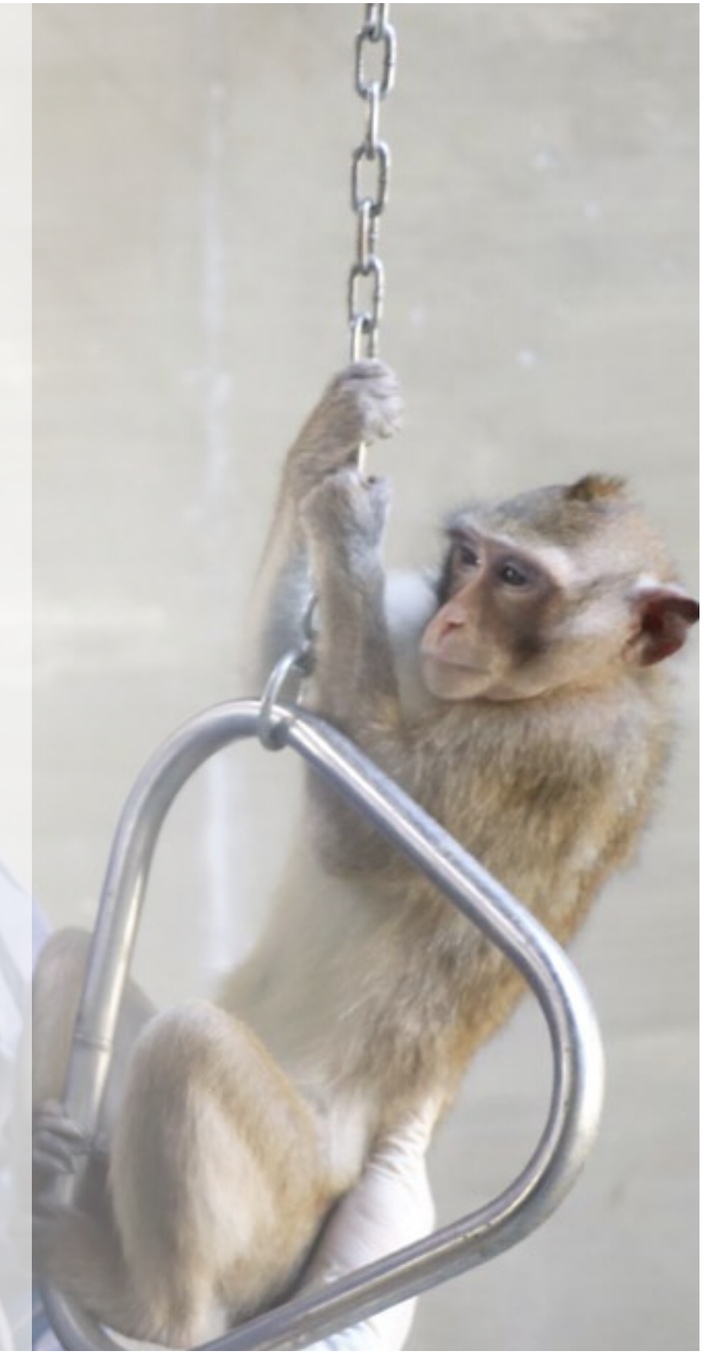
- **Maintenance, production, and distribution of non-human primate resources**
  - Establishment and preservation of laboratory non-human primate resources
  - Constructing stable breeding colony for non-human primates resources
- **Establishment and development of SPF non-human primate resources**
  - Quality control of laboratory non-human primates (infectious viruses and bacterial monitoring)
  - Acquiring and distributing SPF non-human primate resources to industrial, academic and research institutions
- **Standardization in non-human primate accommodation, care and use for non-human primate research**
  - Maintaining quality standards for non-human primate breeding, handling, training, environment enrichments
  - Establishing a standard operating procedure (SOP) by providing guidelines for the veterinary care and welfare assessment of non-human primate resources at the international level
- **Behavioral analysis for non-human primate disease models**
  - Constructing disease models for incurable non-human primate diseases, which have metabolic pathways most similar to human, and thus developing new drugs and applications for organ and regenerative research
  - Establishing methods for analyzing behavioral patterns in a non-human primate models
- **Collaboration and support for industrial-academical-institutional research groups using non-human primates**
  - Provide other researchers with expertise and information on care methods and facilities for large-scale reproduction of non-human primates, and conducting collaborative research to develop related specific technologies in industry, university, institute and hospitals

MAIN PROJECTS

- **Acquisition and introduction of non-human primate resources**
  - Introduction of macaque monkeys through a strict quarantine process according to the quarantine SOP of the Primate Resources Center
- **Establishment of screening techniques for breeding macaques**
  - Maintenance and breeding of healthy SPF animals through annual health monitoring
  - Establishment of system for infrastructure support services of macaques derived materials (cells, tissues, etc.)
  - Establishment of resource selection criteria by species/age to efficiently support non-human primate resources
- **Establishment of optimal breeding environment for macaques**
  - Creating an environmental enrichment program and facility for macaques
  - Introduction of diagnostic equipment by medical department and establishment of disease diagnosis and treatment system
  - Establishing a breeding system to establish an own breeding environment and establishing an artificial nursing system

ACHIEVEMENTS

- **Acquisition and introduction of non-human primate resources**
  - Introduction of cynomolgus monkeys through a strict quarantine process according to the quarantine SOP of the Primate Resources Center
- **Distribution of non-human primate resources to national partners of industry, university, institute and hospitals (COVID-19 research etc.)**
- **Creation of natural/artificial nursing environment for pregnant macaques**
  - Achieved 50% production rate of cynomolgus monkeys throughout an own breeding system in Primate Resources Center



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DIVISION OF RESEARCH STRATEGY

- Korea Bioinformation Center
- National Biotech Policy Research Center
- Korea Biosafety Clearing House
- National Research Safety Headquarter

Korea Bioinformation Center

Korea Bioinformation Center (KOBIC) has been designated as the National Information Center of Biological Research Resources by the act for the acquisition, management, and utilization of biological research resources. KOBIC plays the following major roles: In the field of bio-resource information, it collects and integrates information about bio-resources and biodiversity observed nationwide, across institutions and ministries, to facilitate sharing and utilization of bioresource data. To achieve this, Korean Bioresource Information System (KOBIS), the database for Korean bio- resource information, is also operated.

In the field of bioinformatics, the center serves as the national center for omics data produced by studies funded with national R&D grants, and operate data repository known as BioData. From the Post-Genome Multi-Ministry Genome Project in Korea, the center also collects data and provides a cloud computing-based genome analysis system known as Bio-Express. The center carries out R&D to develop various bioinformatics databases and tools, and carries out scientific genomics studies. For conducting collaborative and outreach activities, various genomics projects in Korea are supported, bioinformatics data analysis services and bioinformatics education programs are provided by the center.

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RESEARCH AREAS

- **Establishing bio infrastructure core research environment for a virtuous cycle system of biological research resources**
  - Preparing integrative management system for acquisition·management·utilization of biological research resources
  - Supply Integrative analysis and utilization environment of bio research data
  - Design, development, construction and management of an automated system concerning biological research resources
  - Assistance for and training of research institutes related to biological research resources and biological resource centers for information management
  - Cooperation with information management institutions of biological research resources in Korea and abroad
  - Other matters necessary for the integrated management and distribution of biological research resources

MAIN PROJECTS

- **The advanced utilization of biological research resources**
  - Bio-economic realization infrastructure building through vitalization of the sharing of biological research resource information
  - Building a National Bio Data Station for integrated collection and supply of bio research data and supply an environment for integrated analysis and utilization of bio research data

- **Construction of infrastructure for genome big data**
  - Supporting construction and utilization of big-data consisting of 20,000 clinical Information and genomic with the aim of imporving quality of healthcare, future precision healthcare lead and securing the growth engines for the bio-health Industry
- **Next-generation Genome-InfraNET for the advancement of genome research and service**
  - The public information service providing and system advanced using an open genomic information analysis system
- **Construction of infra-structure for genome data utilization and supporting system**
  - Pan-ministry genomic information quality management and curation system development, supply user-customized genomic information utilization system development and service

ACHIEVEMENTS

- **Bio research data standard registration format establishment (`20.12)**

- Composition a working group of experts for each research field, such as new drugs, medical devices, and food with relevant ministries
- Supplementation domestic opinions on 7 internationally accepted modalities such as genomes and proteins
- Preparing toxic efficacy data, brain scanning images, livestock characteristic information, etc. new 44 formats

- **Establishment 3rd master plans for management, utilization of biological research resources (`20.7)**

- Establishment of master plans in the field of biological research resources in accordance with 「ACT ON THE ACQUISITION, MANAGEMENT, AND UTILIZATION OF BIOLOGICAL RESEARCH RESOURCES」 Article 5 and 7 for infrastructure building to support bio research and industrial innovation
- **International standard NGS genomic raw data registration system(KoNA, Korean Nucleotide Archive) building and operation (`20.10)**

- Building and operation of international standard NGS genomic raw data registration system(KoNA)
- When submitting paper by domestic researchers, so that can citing KoNA registration numbers international recognition propulsion
- **COVID-19 research information portal building and operation (`20.4)**

- Building and operation of a portal that provides various latest data and news, such as research data(genomic data, mutation, etc.) related to the COVID-19 virus, research trends, papers, analysis tools, etc.
- **Operating and advancement of massive genomic data analysis service(Bio-Express) (Always)**

- User convenience enhancement and big data-based solution addition
- Equipped GATK-based massive genomic analysis pipeline and AI-based analysis program

National Biotech Policy Research Center

Nominated and established by the Ministry of Science and ICT in 2004, the Biotech Policy Research Center is a non-profit organization devoted to the research and development of biotech policy and policy alternatives. Our mission is mainly threefold

① To provide government officers with accurate, relevant, and timely information on biotech trends.

② As a think tank, to develop biotech R&D strategy to help government officers.

③ To build networks with opinion leaders as an idea platform.

- We also run a portal site(BIOIN, www.bioin.or.kr) to enhance public understanding of biotechnology and biotechnology policies.

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RESEARCH AREAS

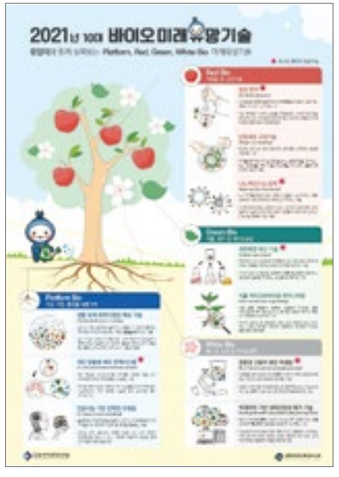
- **Policy Planning**
  - To plan comprehensive national policy and strategies to foster the research and development of biotechnology.
- **Policy Research**
  - To investigate technology, industry, infra and institutional policy information and to conduct relevant statistics, patent maps, and bibliometric analysis.
- **Dissemination of Knowledge and Issues**
  - To provide systematic knowledge and issues regarding biotechnology and biotechnology policy at large through portal sites (www.bioin.or.kr).
- **Public Relations**
  - To publish biotechnology white papers and to organize public workshops to enhance public understanding of biotechnology.

MAIN PROJECTS

- **Supporting Program for Biotechnology Information Service and Policy**
  - By securing and analyzing biotechnology information and supporting strategic national BT policies, and by strengthening and revitalizing policy information infrastructure, it contributes to creating new growth engines, expanding the base of biotechnology policies, and enhancing global competitiveness.
- **Information Project on Bio Discovery to Market Acceleration**
  - Establishment of a comprehensive national bio R&D industrialization information system and service to support R&D and technology commercialization of bio small and medium-sized venture companies and researchers.

ACHIEVEMENTS

- **Policy Planning**
  - Planning for the third Biotechnology Fostering Basic Plan-Science Technology-based Bioeconomy Innovation Strategy 2025.
  - Research on BT regulatory issues and operation of "Bio Regulatory SINMUNGO"
  - Supporting Amendment of 'Biotechnology Support Act'
  - Establishment of government support system from the perspective of R&D for vitalization of the bio-industry
  - Research on continuous research methods for achievements (technology, industry, investment) for vitalization of the bio-industry
  - Analysis of the status of small and medium-sized bio venture companies to discover ways to revitalize the bio-industry ecosystem
  - Planning of large-scale projects for Survey and analysis of national R&D programs.
  - Analysis of Portfolio and positioning of National R&D project.
- **Emerging Technology Forecast and Statistical Development**
  - Discovery promising and emerging BT technologies that will affect the industrial and technological fields in the next 5 to 10 years
  - The center has published annual reports on domestic and overseas statistical data on biotechnologies categorized by investment, human resources, industry, and technology.
- **Expert Network & International Collaboration**
  - To operate the "BIO FUTURE FORUM", BT Seminars and BT expert discussions
  - To participate in the annual Session of the OECD Working Party on Biotechology, Nanotechnology and Converging technology(BNCT).
  - To support Special Committee on Biotechnology
- **Policy Website**
  - BioIN : A one-stop website was created with regard to BT policies to assist policy makers' understanding of detailed data on domestic and overseas BT policies.
  - BICS(Biotechnology Innovation Connet Service) : Online services to promote industrialization of Bio R&D outcomes



Korea Biosafety Clearing House

Korea Biosafety Clearing House (KBCH) is dedicated to the promotion of public awareness and exchange of information regarding living modified organisms (LMOs). While implementing the legal duties associated with LMO related information, as per the "Cartagena Protocol on Biosafety" and the "Act for Transboundary Movements, etc. of LMOs"(LMO Act), KBCH also functions as the national focal point of the biosafety clearing-house, installed under the "Cartagena protocol on biosafety," and is now expanding internationally to particularly promote Asia cooperation with regard to biosafety.

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RESEARCH AREAS

- **Implementation of the Cartagena Protocol & LMO Act**
- **Improvement of Public Awareness & Communication**
- **Risk Review for Industrial LMOs**
- **Implementation of the Nagoya Protocol & Genetic Resources Act**

MAIN PROJECTS

- **Implemetation of the Cartagena Protocol and Operation of the Biosafety Clearing House**
  - Implementation of the Cartagena Protocol on Biosafety
  - Implementation of LMO Act and Policy Support
  - Public Communication and Information Management
  - Establishment of Industrial Support for the Implementation of Nagoya Protocol
- **Safety Management for Industrial LMOs**
  - Risk Review for Industrial LMOs and Safety Management for Related Facilities
  - Promotion of Public Awareness and Capacity Building on Safety Management

ACHIEVEMENTS

- **Actively Producing LMO information and Communicating with Stakeholders**
  - Publishing KBCH Briefings and National Reports (48 cases)
  - Opening the Youtube Channel(LMO TV) (Upload: 17 postings)
  - Redesigning the Biosafety Portal (https://www.biosafety.or.kr)
  - Operating Publications(2 cases), Debate Contest and University Student reporters, etc
- **Operating the Safety Management for Industrial LMOs**
  - Holding the Risk Review Committee for Industrial LMOs
  - Holding the Capacity Building Programs for the Safety Management Experts
  - Designating an Risk Assessment Institution(Oct.) : Bio Evaluation Center at KRIBB
  - Planning the R&D Project for Upgrading Risk Assessment and Risk Review for Industrial LMOs and Securing Infrastructure
- **Revising the LMO Act and Operating the Association of Related Agencies**
  - Revising the Notification under the LMO Act(Nov.) : Simplifying the Process of Risk Review
  - Holding the National Biosafety Committee and Research meetings (12 cases)
- **Strengthening the Asia cooperation network(Asia Biosafety Family)**
  - Holding 6th Asia BCH Workshop with UNEP (Feb., New Deli)
  - Preparing for BCH Capacity Building Project (Scheduled to apply for the GEF Project by the First Half of the Year)
- **Securing budgets for the Implementation of Nagoya Protocol and Genetic Resources Act**
  - Supporting the bio-Industries using biological resources (2021~)

National Research Safety Headquarter

National Research Safety Headquarter is responsible for the evaluation and management of biological safety under the act for the establishment of a safe laboratory environment and the transboundary movement, etc. of the Living Modified Organisms Act. Further, the center contributes to the prevention of accidents at laboratories and improvement of R&D productivity, by establishing a professional and systematic safety management system within domestic laboratories.

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RESEARCH AREAS

- **Field inspection in LMO research facilities**
- **Improve LMO laws, institutions and develop policies**
- **Provide education and training on LMO safety, online education system operation**
- **Information system construction for LMO**
- **Site inspection of laboratory safety management**
- **Develop safety management policies and operate support policies**
- **Conduct laboratory safety education and training, operate online education system**
- **Establishment and operation of national research safety information system**

MAIN PROJECTS

- **Research safety management**
  - Conduct field inspection of laboratory and LMO research facilities & the survey on the status of safety management
  - Establishment of an accident management system by operating an accident investigation team and preparing accident statistics standards
- **Law and policy development**
  - Revision of Act on LMO for R&D and the establishment of safe laboratory environment
  - Development of the safety evaluation technology and the research safety management criteria specialized in research field
- **Safety education and culture spread**
  - Operation of training courses for each target(manager, laboratory director, etc.), development of educational contents, and dissemination through online education system
  - Planning and operation of programs to spread safety culture such as LMO workshop, Lab safety week, LMO & Lab safety content contest, LMO SAFETY reporters and laboratory safety supporters, etc.
  - Establishment of a network for the exchange of information about LMO & Lab safety management
- **Information system construction**
  - Establishment of an integrated safety management system for LMO & Lab and promotion of the enhancement of functions
  - Development and distribution of customized information provision tools

ACHIEVEMENTS

- **Legal and institutional improvements**
  - Revision of the LMO Act and subordinate laws(to improve regulations and establish a safety management system according to material characteristics
  - The first full revision of "Act on the Establishment of Safe Laboratory Environment" to improve the legal structure and strengthen the protection of researchers
- **Development of detailed technological standards and guidelines for LMO and laboratory safety**
  - Guidelines for laboratory safety response to prevent the spread of COVID-19
  - LMO safety management standards for research sites such as verification of Level 3 LM Plant Research Facilities for Environmental Hazards, Methods of using chemical disinfectants
  - Detailed safety standards for each area of research, such as safety management of electrochemical laboratories, precautions for handling and management of nanomaterials
- **Education and Training**
  - Activation of online education by development of smart learning system (micro-learning content, flipped learning, etc.), co-utilization of educational contents and development on-line contents(LMO 37 sessions, Laboratory 152 sessions)
  - Diversification of LMO education targets reflecting changes in the educational environment due to COVID-19 (researcher, research manager, person in charge of biosafety management officer, etc.)
- **Safety culture diffusion**
  - Implementation of participatory safety culture events such as public contest for LMO/laboratory safety(1,699 participants) and online safety week event(10,119 participants)
  - romotion of various public relations, such as media public relations, operation of LMO safety reporters(8 people), laboratory safety supporters(55 people) and activation of SNS
- **Advancement of LMO/Laboratory safety information provision system**
  - Establishment of a full-cycle history management system of LMO facilities and institutions
  - Integration of LMO safety management information(On-site inspection history, LMO education information, and reporting status by institution)
  - Establish intelligent safety information providing service plans using massive data (status of harmful factors in 4,075 institutions, education and training, field inspection, etc.)

PHOTO NEWS

January

2020 New Year Ceremony | *02*

Visit to the National Cemetery | *03*

Executive Vice President Seung Jun Kim, elected as the 14th President of the Korean Biophysical Society | *09*

Visit of the National Assembly Budget Office | *10.*

Visit of Articled Deputy Directors of the Ministry of Science and ICT | *15.*

Lunar New Year Celebration | *22.*

KRIBB Network Seminar | *29.*

February

35th Annual Foundation Ceremony | *01.*

Publication of KRIBB Bioinfra Utilization Guide | *11.*

2020's Top 10 Technologies with Great Prospects | *12.*

Oustanding Graduates of UST KRIBB School, 2020 Spring | *27.*

March

Visit to Ochang Branch by the Vice Minister I of Science and ICT | *06.*

Opened COVID-19 Research Information Portal | *18.*

April

(Online lecture) The story of COVID-19 and Viruses | *02.*

Meeting with Nationwide Science and Technology Research Institutes on COVID-19 | *16.*

Science Day Commemorative Award
① Executive Vice President Seung-Jun Kim, Merits Science and Technology Promotion Merits
② Director of Division of Research Strategy, Doo-Byoung Oh, Presidential Citation
③ Dr. Jeong Ki Min, Prime Minister Citation | *22.*

May

Online Outreach Education Service | *07.*

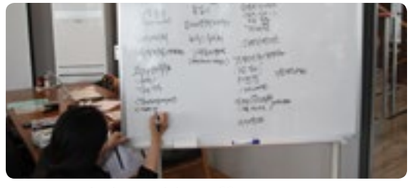
MOU with Korea In Vitro Diagnostics Association | *12.*

KRIBB Tech Bridge Program - Bioneer Inc.

Sugentech, Inc. | *20.*

2020's New Training Program of Emerging Technologies | *25~29.*

June



Organizational Culture Workshop | *09.*

(Online Lecture) Microplastics and COVID-19 | *24.*

Visit of the Minister of Science and ICT | *24.*

July

(Conference) Advanced Biopharmaceuticals | *03.*

2020 UST KRIBB School Graduation Thesis Presentation | *08.*

Published Bio-startups and Innovative Growth & Performance | *14.*

Invitational Meeting with the Presidents of Bio-related Academic Societies to Promote the Creation of a National Biodata Station | *29.*

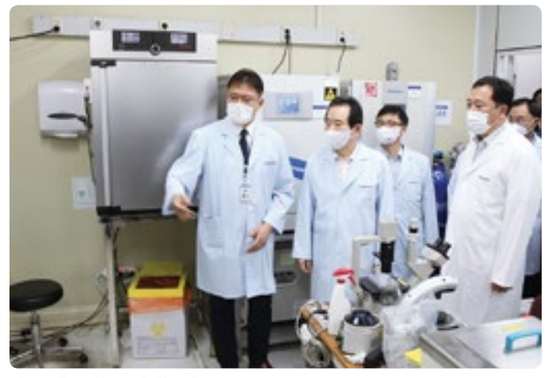
August

Supported the Supply of Antigen for the Development of COVID-19 Antibody Diagnostic Device | *04.*

The 11th National Biosafety/Bio Industry Debate Competition for High School Students | *28.*

Visit of a group from the Presidential Council on Intellectual Property | *07.*

UST Commencement | *24.*



Visit of Prime Minister Se-Kyun Chung | *29.*

(Conference) Hazardous Factors from Environmental Pollution and Future Human Health | *25.*

Organizational Culture Event

September

Signboard hanging ceremony for the 1000th research company (Onecurezen) | *02.*

Visit of Seung-Rae Cho, member of the National Assembly | *04.*

Visit of Jeong-sook Yang, member of the National Assembly | *09.*

Visit of a Director from the Ministry of Science and ICT | *10.*

Introduction of Robotic Process Automation (RPA) | *11.*

KRIBB Network Seminar | *17.*

MOU with Korea Invention Promotion Association | *23.*

Visit of the Members from the Parliament | *28.*

October

MOU with Government Institutes Nationwide on the field of Life Science | *06.*

(KRIBB Conference) Prospects for Protein Drug Development and Target Protein Control Technology | *15.*

November

Public Hearing on National Bio Bigdata Projects | *03.*

Conference with COVID-19 Mutation Characteristics Research Consultative Group | *23.*

Briefing session on the outcome of Korean Bio Lab Central establishment plan | *24.*

December

2020 UST KRIBB School Graduation Thesis Presentation | *07.*

2020 KRIBB Annual Conference | *9-10*

Opening address

Precision Medicine Session

Metabolic Engineering Session

December

Plenery Lecture

COVID-19 Session | *10.*

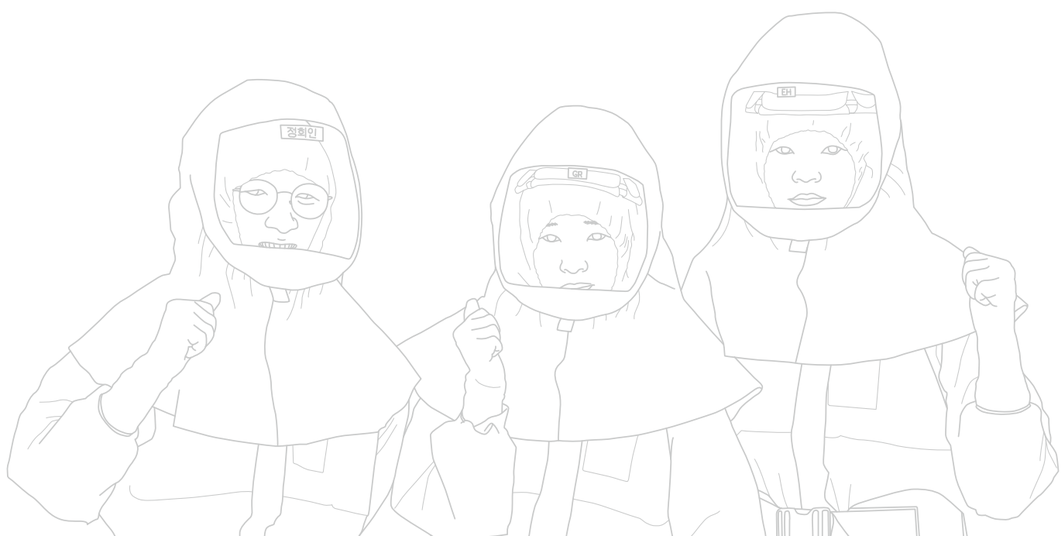
Poster Festival

Presentation by Young Researchers

KRIBB Family Company Networking

Executive Vice President Seong Jun Kim, Elected as the Vice Chairman of the OECD BNCT Working Group | *14.*

The first President of KRIBB Moon-hi Han, Selected for 2020 Persons of Science & Technology Merits | *20.*



Korea Research Institute of Bioscience and Biotechnology (KRIBB) carries out full-cycle life science research from basic, fundamental research as well as commercialization while providing national infrastructure for the efficient allocation of research resources and information.
For further information, please refer to the below and website.

KRIBB Homepage
www.kribb.re.kr

Korea Human Gene Bank
genbank.kribb.re.kr

Korean Collection for Type Cultures
kctc.kribb.re.kr

Biological Resources Portal
biorp.kribb.re.kr

Laboratory Animal Resource Center
mouse.kribb.re.kr

International Biological Material Research Center
www.ibmrc.re.kr

Korea ABS Research Center
www.abs.re.kr

Advanced Bioresource Information System
www.aris.re.kr

Korea Bioinformation Center
www.kobic.re.kr

Korea Bio-resource Information System
www.kobis.re.kr

Bioinformation Research Results Registration System
www.biodata.kr

Korea Biosafety Clearing House
www.biosafety.or.kr

INdustrial Genome Information Cente
www.ingic.or.kr

National Research Safety Information System
www.labs.go.kr

Test·Research LMO Information System
www.lmosafety.or.kr

Lab·LMO Safety Education System
edu.labs.go.kr

Biotech Information Potal
www.bioin.or.kr

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library.kribb.re.kr

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https://oak.kribb.re.kr

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