2024

ANNUAL REPORT

Technology for Life, Our Future

KRIBB Korea Research Institute of Bioscience & Biotechnology

TECHNOLOGY
FOR LIFE,
OUR FUTURE

ANNUAL REPORT 2024

CONTENTS

PREFACE

Over the past year, the field of biotechnology has advanced at an extraordinary pace, moving beyond academic exploration to actively address some of the most pressing challenges facing humanity. The convergence of cutting-edge technologies—such as artificial intelligence and big data—with new research methodologies has enabled deeper and more precise insights into biological phenomena, surpassing previous limitations. These advances are driving meaningful impact across society and the economy—accelerating progress in disease treatment, public health, food security, and environmental sustainability. Ultimately, they are becoming a vital foundation for a sustainable future.

As a government-funded research institute, the Korea Research Institute of Biological Science and Biotechnology (KRIBB) has played a central role across the broad landscape of biological sciences—from fundamental research and core technology development to interdisciplinary collaboration. Through our world-class infrastructure and open innovation ecosystem, we are committed to fostering scientific talent, enhancing partnerships across academia and industry, and expanding both domestic and global research networks. These efforts are not only fueling the growth of emerging industries such as biohealth but also contributing meaningfully to improving the quality of life and advancing societal sustainability.

In 2024, with a focus on building a sustainable future and a healthier society, we achieved tangible outcomes in key areas of advanced biotechnology—including the development of next-generation biopharmaceutical technologies, convergence and biomaterials, solutions to both national and global challenges, and the advancement of world-class research infrastructure. We also strengthened global collaboration with industry, academia, and medical institutions to ensure that our research delivers meaningful benefits to the public. This Annual Report highlights the progress and achievements that KRIBB has made over the past year.

KRIBB will continue to take on bold challenges and pursue creative innovation to contribute to shared global prosperity and strengthen Korea's leadership in biological sciences and biotechnology. We sincerely appreciate your continued support and interest in our ongoing journey.

Suk Yoon Kwon, Ph.D.
President
Korea Research Institute of Bioscience and Biotechnology

ABOUT KRIBB

01

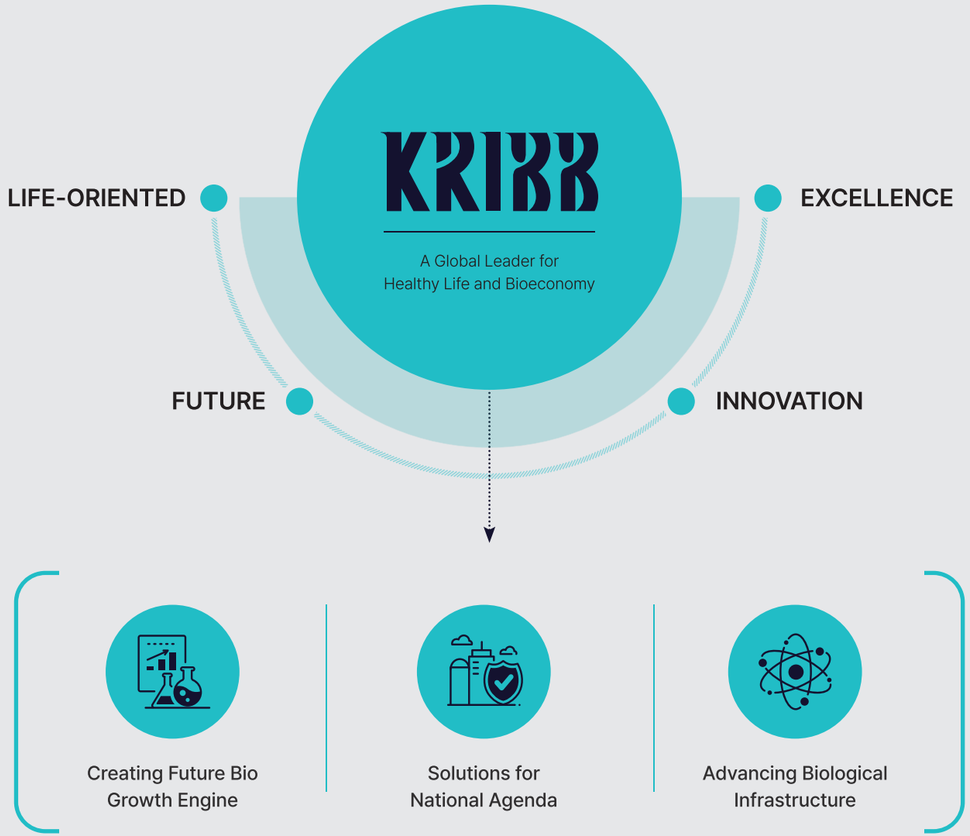
MISSION & VISION

MISSION

Develop breakthrough technologies in biological sciences and lead bioeconomy

Establish and support national infrastructure for biological sciences R&D at home and abroad

VISION



GENERAL INFORMATION

FOUNDATION BASIS

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

KEY FUNCTION

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

1985	1999	2005	2006
Established as the Genetic Engineering Research Center (Hongneung, Seoul)	Became an independent legal entity	Established Ochang Branch Institute	Established Jeonbuk Branch Institute

FACILITIES

Headquarter
100,978m²

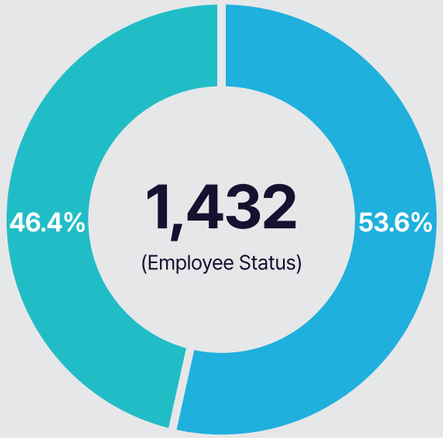
Ochang Branch Institute
212,258m²

Jeonbuk Branch Institute
126,620m²

CURRENT STATUS

PERSONNEL

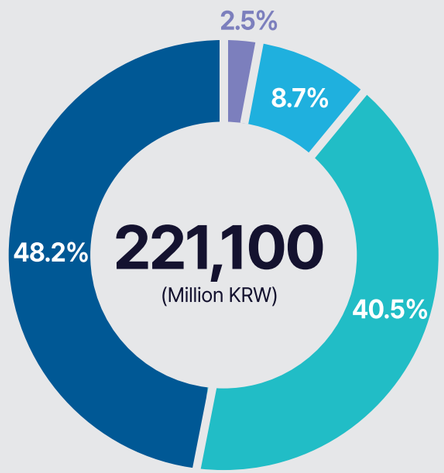
Full-time Employees
665



Part-time Employees
767

2024 BUDGET

Government Projects
106,600



Government Grant
89,600

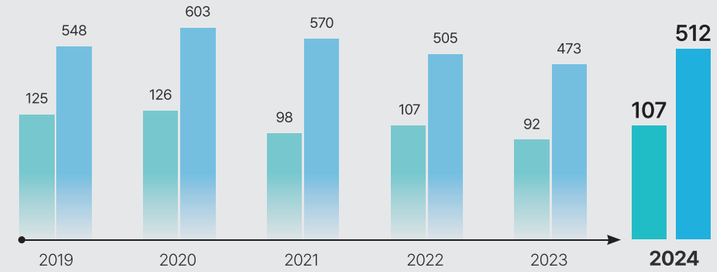
Others
19,300

Civilian Contracts
5,600

PUBLICATIONS

Domestic
107

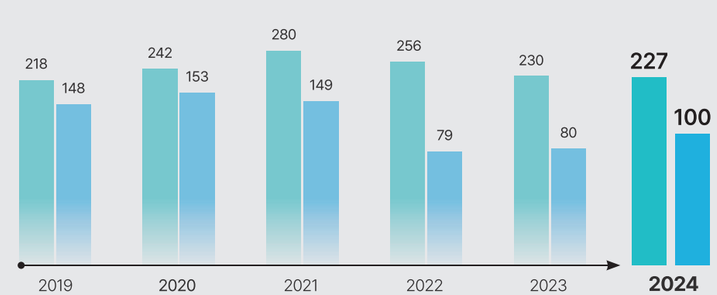
International
512



PATENTS

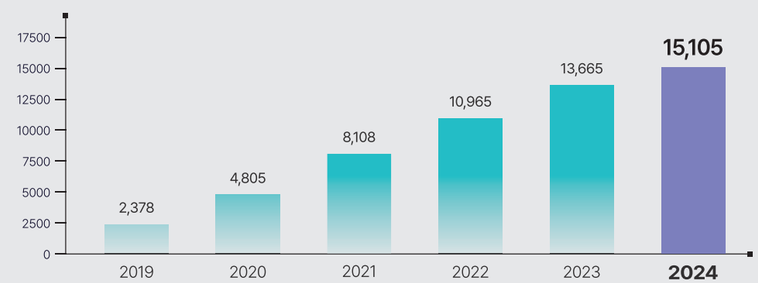
Application
227

Registration
100



ROYALTIES

2024 ROYALTIES
15,105
(Million KRW)
Accumulated Total



ORGANIZATION

KRIBB — President

- Aging Convergence Research Center
- Critical Diseases Diagnostics Convergence Research Center
- Center for Gene & Cell Therapy
- Division of Ethics and Inspection

Vice President

- Ochang Branch Institute
  - Department of Management & Operations
  - Division of National Bio-Infrastructure
    - Laboratory Animal Resource & Research Center
    - National Primate Research Center
    - Futuristic Animal Resource & Research Center
    - Bio-Resource Central Bank
    - International Biological Material Research Center
    - Korea Preclinical Evaluation Center
    - Bio-Infrastructure Policy Support Center
- Jeonbuk Branch Institute
  - Department of Management & Operations
  - Natural Product Research Center
  - Chemical Biology Research Center
  - Nucleic Acid Therapeutics Research Center
  - Functional Biomaterial Research Center
  - Microbial Biotechnology Research Center
  - Biological Resource Center
  - Primate Resources Center
- KRIBB School
  - Department of Education & Human Resource Development
- Synthetic Biology and Bioengineering Research Institute
  - Department of Research Support Services
  - Synthetic Biology Research Center
  - Genome Editing Research Center
  - Cell Factory Research Center
- Division of Biomedical Research
  - Department of Research Support Services
  - Personalized Genomic Medicine Research Center
  - Microbiome Convergence Research Center
  - Rare Disease Research Center
  - Biotherapeutics Translational Research Center
  - Immunotherapy Research Center
  - Disease Target Structure Research Center
  - Metabolic Regulation Research Center
- Korea Bioinformation Center
- Digital Biotech Innovation Center
- ABC-based Regenerative Biotherapeutics Research Center
- Division of Research on National Challenges
  - Department of Research Support Services
  - Infectious Disease Research Center
  - Environmental Diseases Research Center
  - Biodefense Research Center
  - Stem Cell Convergence Research Center
  - Bionanotechnology Research Center
  - Plant Systems Engineering Research Center
- Division of Biotechnology Innovation
  - Technology Transfer Center
  - SME Support Center
  - BioProcess Engineering Center
  - Bio-Evaluation Center
  - Core Research Facility & Analysis Center
- Division of Research Strategy
  - Biotech Policy Research Center
  - Korea Biosafety Clearing House
  - National Research Safety Headquarters
  - National Center for Technology Strategy on Advanced Life Science
  - Department of Research Policy
  - Department of Strategic Planning
  - Department of Public Relations
- Division of Planning and Management
  - Department of Planning and Budget
  - Department of Research Coordination
  - Department of Systems, Analytics and Information
- Division of Administrative Operations
  - Department of Human Resources
  - Department of Workforce Relations
  - Department of Acquisition and Contract
  - Department of Facilities
  - Department of Health and Safety

Ochang Branch Institute

[Biomedical Science & Commercialization]

• Drug Discovery • Oriental Medicine • Bioinfrastructure

Daejeon Headquarters

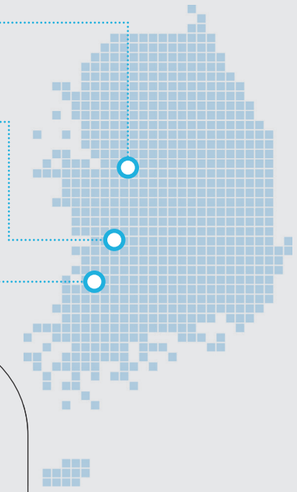
[Bio Convergence & Source Technology]

• Genomics • Proteomics • Personalized Medicine • Bionanotech • Neurobiology
• Oncology • Plant Biotech • Industrial Biotech • Microbiology • Bioinformatics

Jeonbuk Branch Institute

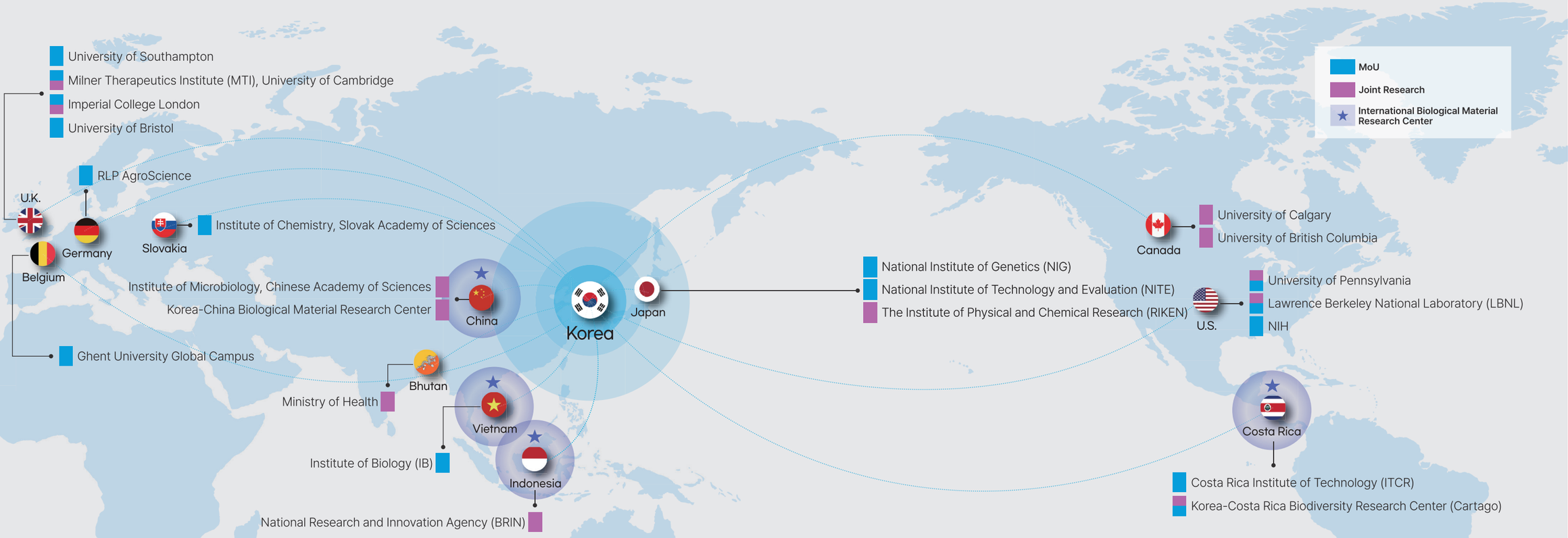
[Biomaterials & Commercialization]

• Microbial Tech • Bio Materials • Biorefinery • Bioresource



TO STRENGTHEN GLOBAL COOPERATION IN MUTUALLY BENEFICIAL RELATIONSHIPS

KRIBB engages in diverse and strategic international collaborations to lead global bio-innovation—ranging from joint research and collaboration hubs to global consortia



MoU

150 institutions in **42** countries

Signed MoUs with over **150** institutions in **42** countries

Joint Research

Collaborating with leading overseas research institutes in key areas such as synthetic biology and gene therapy

Bioresource

International Biological Material Research Center
Operates four cooperation hubs in China, Vietnam, Indonesia, and Costa Rica

Foreign researchers

A total of **42**
2 full-time staff, 13 post-docs, and 27 students and others

RESEARCH INFRASTRUCTURE

LIFE-CYCLE INFRASTRUCTURE SERVICE FROM BASIC RESEARCH TO COMMERCIALIZATION

Korean Collection for Type Culture (KCTC)

1985

National Primate Research Center

2005

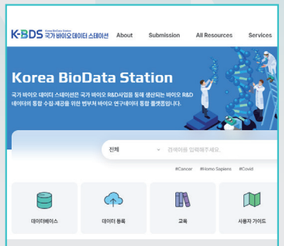
Korea Bioinformation Center

2010

BioProcess Engineering Center

Sustainable Biomaterials R&D Hub Center

2013



National Biodata Station

2022

2000

2010

2020

1986

Laboratory Animal Resource & Research Center

2006

Bio-Evaluation Center

2012

Futuristic Animal Resource & Research Center

2018

Primate Resources Center

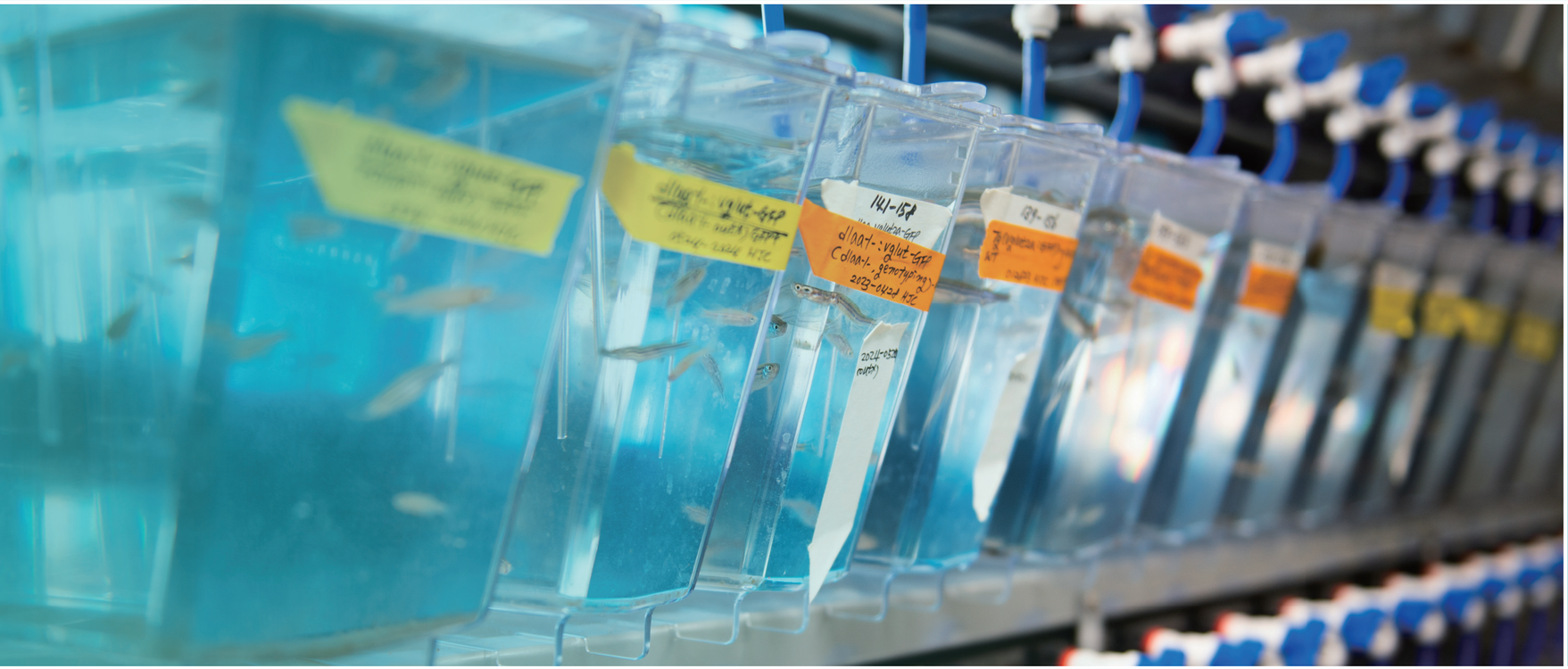
2022

National Bioresources Central Bank

- Animal Model Central Bank
- Natural Product Central Bank
- Microorganism Central Bank

RESEARCH HIGHLIGHTS

02



2024

KRIBBian

of the Month

Awardees

JANUARY

Dr. **Jin-Ho Yun**

Senior Researcher,
Cell Factory Research Center

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Toward a zero-waste microalgal biorefinery: Complete utilization of defatted Chlorella biomass as a sole heterotrophic substrate for Chlorella sp. HS2 and an improved composite filler

The concept of circular biorefinery has been promoted as a sustainable new approach for the nascent microalgae industry. In particular, solvent extraction of the lipid fraction of microalgal biomass is generally performed when aiming to recover marketable compounds from microalgae; the waste residual biomass generated by this process can provide new market opportunities for microalgae in a wide array of commercial sectors. Herein, the heterotrophic cultivation of Chlorella sp. HS2 was demonstrated using a hydrolysate recovered following the dilute acid hydrolysis of defatted Chlorella biomass (DCB). While HCl and H2SO4 in each case were found to be an effective catalyst capable of converting nearly 40% of DCB into fermentable monosugars, the results of microalgal cultivation in diluted hydrolysate indicated high cellular growth without the need for any supplemental nutrients. Notably, the highest microalgal growth was observed when neutralizing HCl- and H2SO4-treated hydrolysates with NaOH and Ca(OH)2, respectively. Furthermore, the fabrication of a polymer/residual composite using the residual material obtained after H2SO4-catalyzed hydrolysis and Ca(OH)2 neutralization suggested improved tensile capabilities, attributed to the improved dispersion of salt precipitates-containing residue in the hydrophobic polymer matrices. Considering that the leftover residual DCB could be better conditioned as an organic-inorganic filler for composite fabrication through a combined acid hydrolysis-neutralization process, the results here suggest new integrated utilization routes for underutilized byproducts from the microalgal industry. Further investigations are thus warranted with a special focus on bolstering the economic feasibility and scalability of the postulated zero-waste microalgal biorefinery.

Toward a zero-waste microalgal biorefinery: Complete utilization of defatted Chlorella biomass as a sole heterotrophic substrate for Chlorella sp. HS2 and an improved composite filler. CEJ 2024.

FEBRUARY

Dr. **Ohman Kwon**

Senior Researcher,
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Chemically-defined and scalable culture system for intestinal stem cells derived from human intestinal organoids

Three-dimensional human intestinal organoids (hIO) are widely used as a platform for biological and biomedical research. However, reproducibility and challenges for large-scale expansion limit their applicability. Here, we establish a human intestinal stem cell (ISC) culture method expanded under feeder-free and fully defined conditions through selective enrichment of ISC populations (ISC3D-hIO) within hIO derived from human pluripotent stem cells. The intrinsic self-organization property of ISC3D-hIO, combined with air-liquid interface culture in a minimally defined medium, forces ISC3D-hIO to differentiate into the intestinal epithelium with cellular diversity, villus-like structure, and barrier integrity. Notably, ISC3D-hIO is an ideal cell source for gene editing to study ISC biology and transplantation for intestinal diseases. We demonstrate the intestinal epithelium differentiated from ISC3D-hIO as a model system to study severe acute respiratory syndrome coronavirus 2 viral infection. ISC3D-hIO culture technology provides a biological tool for use in regenerative medicine and disease Modeling.

Chemically-defined and scalable culture system for intestinal stem cells derived from human intestinal organoids. nature communications 2024.

MARCH

Dr. Jungwoon Lee
Principal Researcher,
Environmental Diseases Research Center
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Development of pluripotent stem cell-derived epidermal organoids that generate effective extracellular vesicles in skin regeneration

Cellular skin substitutes such as epidermal constructs have been developed for various applications, including wound healing and skin regeneration. These cellular models are mostly derived from primary cells such as keratinocytes and fibroblasts in a two-dimensional (2D) state, and further development of three-dimensional (3D) cultured organoids is needed to provide insight into the in vivo epidermal phenotype and physiology. Here, we report the development of epidermal organoids (EpiOs) generated from induced pluripotent stem cells (iPSCs) as a novel epidermal construct and its application as a source of secreted biomolecules recovered by extracellular vesicles (EVs) that can be utilized for cell-free therapy of regenerative medicine. Differentiated iPSC-derived epidermal organoids (iEpiOs) are easily cultured and expanded through multiple organoid passages, while retaining molecular and functional features similar to in vivo epidermis. These mature iEpiOs contain epidermal stem cell populations and retain the ability to further differentiate into other skin compartment lineages, such as hair follicle stem cells. By closely recapitulating the epidermal structure, iEpiOs are expected to provide a more relevant microenvironment to influence cellular processes and therapeutic response. Indeed, iEpiOs can generate high-performance EVs containing high levels of the angiogenic growth factor VEGF and miRNAs predicted to regulate cellular processes such as proliferation, migration, differentiation, and angiogenesis. These EVs contribute to target cell proliferation, migration, and angiogenesis, providing a promising therapeutic tool for in vivo wound healing. Overall, the newly developed iEpiOs strategy as an organoid-based approach provides a powerful model for studying basic and translational skin research and may also lead to future therapeutic applications using iEpiOs-secreted EVs.

Development of pluripotent stem cell-derived epidermal organoids that generate effective extracellular vesicles in skin regeneration.
Biomaterials 2024.

APRIL

Dr. Hyun Ji Park
Researcher,
Plant Systems Engineering Research Center
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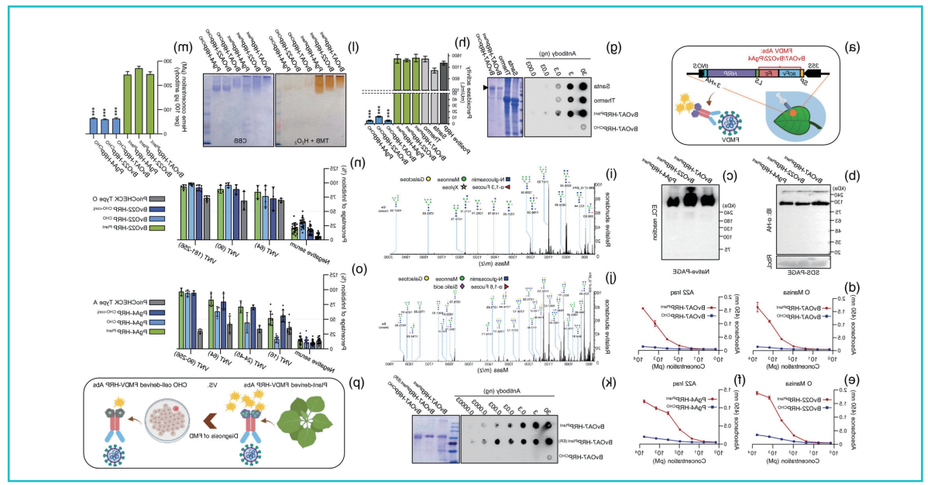
Plant-derived foot-and-mouth disease virus antibodies fused to horseradish peroxidase are efficient diagnostic reagents

Our findings suggest that the production of plant-derived antibodies fused to HRP supports the development of a SPCE with high heme content that is critical for HRP activity, offering simplicity and high sensitivity compared to comparable HRP-antibody fusions produced in CHO cells (Figure 1p). Our platform should be widely applicable to the design and production of reagents for the detection of diseases, providing a promising application potential in future clinical serum detection.



Plant-derived foot-and-mouth disease virus antibodies fused to horseradish peroxidase are efficient diagnostic reagents.
Plant Biotechnology Journal 2024.

MAY

Dr. **Youngjeon Lee**

Principal Researcher,
National Primate Research Center

neurosci@kribb.re.kr

Hypothalamic neuronal activation in non-human primates drives naturalistic goal-directed eating behavior

Maladaptive feeding behavior is the primary cause of modern obesity. While the causal influence of the lateral hypothalamic area (LHA) on eating behavior has been established in rodents, there is currently no primate-based evidence available on naturalistic eating behaviors. We investigated the role of LHA GABAergic (LHAGABA) neurons in eating using chemogenetics in three macaques. LHAGABA neuron activation significantly increased naturalistic goal-directed behaviors and food motivation, predominantly for palatable food. Positron emission tomography and magnetic resonance spectroscopy validated chemogenetic activation. Resting-state functional magnetic resonance imaging revealed that the functional connectivity (FC) between the LHA and frontal areas was increased, while the FC between the frontal cortices was decreased after LHAGABA neuron activation. Thus, our study elucidates the role of LHAGABA neurons in eating and obesity therapeutics for primates and humans.

Hypothalamic neuronal activation in non-human primates drives naturalistic goal-directed eating behavior.
Neuron 2024.

JUNE

Dr. **Chul-Ho Lee**

Principal Researcher,
Laboratory Animal Analysis Team

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The secreted protein Amuc_1409 from Akkermansia muciniphila improves gut health through intestinal stem cell regulation

Akkermansia muciniphila has received great attention because of its beneficial roles in gut health by regulating gut immunity, promoting intestinal epithelial development, and improving barrier integrity. However, A. muciniphila-derived functional molecules regulating gut health are not well understood. Microbiome-secreted proteins act as key arbitrators of host-microbiome crosstalk through interactions with host cells in the gut and are important for understanding host-microbiome relationships. Herein, we report the biological function of Amuc_1409, a previously uncharacterised A. muciniphila-secreted protein. Amuc_1409 increased intestinal stem cell (ISC) proliferation and regeneration in ex vivo intestinal organoids and in vivo models of radiation- or chemotherapeutic drug-induced intestinal injury and natural aging with male mice. Mechanistically, Amuc_1409 promoted E-cadherin/β-catenin complex dissociation via interaction with E-cadherin, resulting in the activation of Wnt/β-catenin signaling. Our results demonstrate that Amuc_1409 plays a crucial role in intestinal homeostasis by regulating ISC activity in an E-cadherin-dependent manner and is a promising biomolecule for improving and maintaining gut health.

The secreted protein Amuc_1409 from Akkermansia muciniphila improves gut health through intestinal stem cell regulation.
nature communications 2024.

JULY

Dr. **Won Gon Kim**

Principal Researcher,
Infectious Disease Research Center

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Tyrosol blocks E. coli anaerobic biofilm formation via YbfA and FNR to increase antibiotic susceptibility

Bacteria within mature biofilms are highly resistant to antibiotics than planktonic cells. Oxygen limitation contributes to antibiotic resistance in mature biofilms. Nitric oxide (NO) induces biofilm dispersal; however, low NO levels stimulate biofilm formation, an underexplored process. Here, we introduce a mechanism of anaerobic biofilm formation by investigating the antibiofilm activity of tyrosol, a component in wine. Tyrosol inhibits E. coli and Pseudomonas aeruginosa biofilm formation by enhancing NO production. YbfA is identified as a target of tyrosol and its downstream targets are sequentially determined. YbfA activates YfeR, which then suppresses the anaerobic regulator FNR. This suppression leads to decreased NO production, elevated bis-(3′–5′)-cyclic dimeric GMP levels, and finally stimulates anaerobic biofilm formation in the mature stage. Blocking YbfA with tyrosol treatment renders biofilm cells as susceptible to antibiotics as planktonic cells. Thus, this study presents YbfA as a promising antibiofilm target to address antibiotic resistance posed by biofilm-forming bacteria, with tyrosol acting as an inhibitor.

Tyrosol blocks E. coli anaerobic biofilm formation via YbfA and FNR to increase antibiotic susceptibility. **nature communications** 2024.

AUGUST

Dr. **Hana Lee**

Researcher,
Stem Cell Convergence Research Center

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Long-Term Culture of Human Pluripotent Stem Cells in Xeno-Free Condition Using Functional Polymer Films

Human pluripotent stem cells (hPSCs), encompassing human embryonic stem cells (hESCs) and human induced pluripotent stem cells (hiPSCs), hold immense potential in regenerative medicine, offering new opportunities for personalized cell therapies. However, their clinical translation is hindered by the inevitable reliance on xenogeneic components in culture environments. This study addresses this challenge by engineering a fully synthetic, xeno-free culture substrate, whose surface composition is tailored systematically for xeno-free culture of hPSCs. A functional polymer surface, pGC2 (poly(glycidyl methacrylate-grafting-guanidine-co-carboxylic acrylate)), offers excellent cell-adhesive properties as well as non-cytotoxicity, enabling robust hESCs and hiPSCs growth while presenting cost-competitiveness and scalability over Matrigel. This investigation includes comprehensive evaluations of pGC2 across diverse experimental conditions, demonstrating its wide adaptability with various pluripotent stem cell lines, culture media, and substrates. Crucially, pGC2 supports long-term hESCs and hiPSCs expansion, up to ten passages without compromising their stemness and pluripotency. Notably, this study is the first to confirm an identical proteomic profile after ten passages of xeno-free cultivation of hiPSCs on a polymeric substrate compared to Matrigel. The innovative substrate bridges the gap between laboratory research and clinical translation, offering a new promising avenue for advancing stem cell-based therapies.

Long-term culture of human pluripotent stem cells in xeno-free condition using functional polymer films. **ADVANCED MATERIALS** 2024.

SEPTEMBER

Dr. **Youngjin Lee**

Researcher,
Microbiome Convergence Research Center

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Dissemination of pathogenic bacteria is reinforced by a MARTX toxin effector duet

Multiple bacterial genera take advantage of the multifunctional autoprocessing repeats-in-toxin (MARTX) toxin to invade host cells. Secretion of the MARTX toxin by Vibrio vulnificus, a deadly opportunistic pathogen that causes primary septicemia, the precursor of sepsis, is a major driver of infection; however, the molecular mechanism via which the toxin contributes to septicemia remains unclear. Here, we report the crystal and cryo-electron microscopy (EM) structures of a toxin effector duet comprising the domain of unknown function in the first position (DUF1)/Rho inactivation domain (RID) complexed with human targets. These structures reveal how the duet is used by bacteria as a potent weapon. The data show that DUF1 acts as a RID-dependent transforming NADase domain (RDTND) that disrupts NAD+ homeostasis by hijacking calmodulin. The cryo-EM structure of the RDTND-RID duet complexed with calmodulin and Rac1, together with immunological analyses in vitro and in mice, provide mechanistic insight into how V. vulnificus uses the duet to suppress ROS generation by depleting NAD(P)+ and modifying Rac1 in a mutually-reinforcing manner that ultimately paralyzes first line immune responses, promotes dissemination of invaders, and induces sepsis. These data may allow development of tools or strategies to combat MARTX toxin-related human diseases.

Dissemination of pathogenic bacteria is reinforced by a MARTX toxin effector duet. **nature communications** 2024.

OCTOBER

Dr. **Taejoon Kang**

Principal Researcher,
Bionanotechnology Research Center

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Amplifying mutational profiling of extracellular vesicle mRNA with SCOPE

Sequencing of messenger RNA (mRNA) found in extracellular vesicles (EVs) in liquid biopsies can provide clinical information such as somatic mutations, resistance profiles and tumor recurrence. Despite this, EV mRNA remains underused due to its low abundance in liquid biopsies, and large sample volumes or specialized techniques for analysis are required. Here we introduce Self-amplified and CRISPR-aided Operation to Profile EVs (SCOPE), a platform for EV mRNA detection. SCOPE leverages CRISPR-mediated recognition of target RNA using Cas13 to initiate replication and signal amplification, achieving a sub-attomolar detection limit while maintaining single-nucleotide resolution. As a proof of concept, we designed probes for key mutations in KRAS, BRAF, EGFR and IDH1 genes, optimized protocols for single-pot assays and implemented an automated device for multi-sample detection. We validated SCOPE's ability to detect early-stage lung cancer in animal models, monitored tumor mutational burden in patients with colorectal cancer and stratified patients with glioblastoma. SCOPE can expedite readouts, augmenting the clinical use of EVs in precision oncology.

Amplifying mutational profiling of extracellular vesicle mRNA with SCOPE. **nature biotechnology** 2024.

NOVEMBER

Dr. **Mirang Kim**

Principal Researcher,
Aging Convergence Research Center

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DNA methylome analysis reveals epigenetic alteration of complement genes in advanced metabolic dysfunction-associated steatotic liver disease

Blocking the complement system is a promising strategy to impede the progression of metabolic dysfunction–associated steatotic liver disease (MASLD). However, the interplay between complement and MASLD remains to be elucidated. This comprehensive approach aimed to investigate the potential association between complement dysregulation and the histological severity of MASLD.

Liver biopsy specimens were procured from a cohort comprising 106 Korean individuals, which included 31 controls, 17 with isolated steatosis, and 58 with metabolic dysfunction–associated steatohepatitis (MASH). Utilizing the Infinium Methylation EPIC array, thorough analysis of methylation alterations in 61 complement genes was conducted. The expression and methylation of nine complement genes in a murine MASH model were examined using quantitative RT-PCR and pyrosequencing.

Methylome and transcriptome analyses of liver biopsies revealed significant ($P<0.05$) hypermethylation and downregulation of C1R, C1S, C3, C6, C4BPA, and SERPING1, as well as hypomethylation ($P<0.0005$) and upregulation ($P<0.05$) of C5AR1, C7, and CD59, in association with the histological severity of MASLD. Furthermore, DNA methylation and the relative expression of nine complement genes in a MASH diet mouse model aligned with human data.

Our research provides compelling evidence that epigenetic alterations in complement genes correlate with MASLD severity, offering valuable insights into the mechanisms driving MASLD progression, and suggests that inhibiting the function of certain complement proteins may be a promising strategy for managing MASLD.

DNA methylome analysis reveals epigenetic alteration of complement genes in advanced metabolic dysfunction-associated steatotic liver disease HEPATOLOGY 2024.

DECEMBER

Dr. **Nak-Kyun Soung**

Principal Researcher,
Chemical Biology Research Center

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HIF-1α inhibition by MO-2097, a novel chiral-free benzofuran targeting hnRNPA2B1

Hypoxia-inducible factor 1 (HIF-1) is a transcriptional activator mediating adaptive responses to hypoxia. It is up-regulated in the tumor microenvironment and recognized as an effective anticancer drug target. Previously, we discovered that the natural compound moracin-O and its synthetic derivative MO-460 inhibited HIF-1α via hnRNPA2B1.

This study aimed to develop novel HIF-1 inhibitors for cancer chemotherapy by harnessing the potential of the natural products moracins-O and P.

In an ongoing search for novel HIF-1 inhibitors, a series of nature-inspired benzofurans with modifications on the chiral rings of moracins-O and P were synthesized. They showed improved chemical tractability and were evaluated for their inhibitory activity on HIF-1α accumulation under hypoxic conditions in HeLa CCL2 cells. The most potent derivative's chemical-based toxicities, binding affinities, and in vivo anti-tumorigenic effects were evaluated. Further, we examined whether our compound, MO-2097, exhibited anticancer effects in three-dimensional cultured organoids.

Herein, we identified a novel synthetic chiral-free compound, MO-2097, with reduced structural complexity and increased efficiency. MO-2097 exhibited inhibitory effects on hypoxia-induced HIF-1α accumulation in HeLa CCL2 cells via inhibition of hnRNPA2B1 protein, whose binding affinities were confirmed by isothermal titration calorimetry analysis. In addition, MO-2097 demonstrated in vivo efficacy and biocompatibility in a BALB/c mice xenograft model. The immunohistochemistry staining of MO-2097-treated tissues showed decreased expression of HIF-1α and increased levels of apoptosis marker cleaved caspase 3, confirming in vivo efficacy. Furthermore, we confirmed that MO-2097 works effectively in cancer patient-based organoid models.

MO-2097 represents a promising new generation of chemotherapeutic agents targeting HIF-1 α inhibition via hnRNPA2B1, requiring further investigation.

HIF-1α inhibition by MO-2097, a novel chiral-free benzofuran targeting hnRNPA2B1. Journal of Advanced Research 2024.

RESEARCH DIVISION

03

- Synthetic Biology and Bioengineering Research Institute
- Division of Biomedical Research
- Division of Research on National Challenges
- Division of Biotechnology Innovation
- Ochang Branch Institute
- Division of National Bio-Infrastructure
- Jeonbuk Branch Institute
- Convergence Research Centers
- Office of the Vice President
- Division of Research Strategy

Research Divisions

Director

Dr. Seung-Goo Lee

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Synthetic Biology and Bioengineering Research Institute

- Synthetic Biology Research Center
- Genome Editing Research Center
- Cell Factory Research Center

Synthetic Biology Research Center

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INTRODUCTION

The Synthetic Biology Research Center (SBRC) integrates engineering principles into the life sciences to design standardized biological parts and construct novel biological systems. SBRC is composed of a multidisciplinary team of experts dedicated to advancing synthetic biology through the Design–Build–Test–Learn (DBTL) cycle, a core framework in the field.

To accelerate this cycle, SBRC has established a Biofoundry Beta Platform, enabling high-throughput and automated workflows that drive innovation. Leveraging this infrastructure, SBRC is achieving key milestones across diverse areas, including AI-assisted bio-design, development of standardized bio-parts, construction of genetic circuits, artificial genome engineering, microbial consortium design, and sustainable biomaterial production. Since 2025, SBRC has been entrusted with the critical national mission of establishing K-Biofoundry, Korea's official biofoundry platform. This effort builds upon the knowledge, operational experience, and technical capacity accumulated through the Biofoundry Beta Platform. By translating these insights into a national-scale infrastructure, SBRC is faithfully leading the development of an integrated biofoundry ecosystem that will serve as the foundation for Korea's synthetic biology innovation.

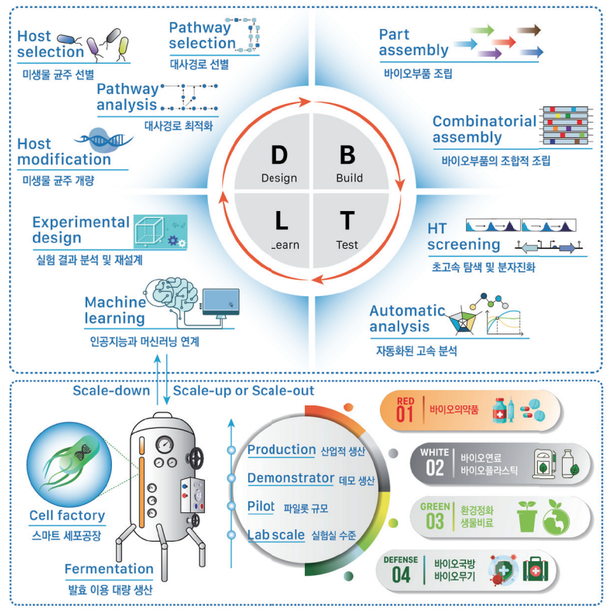
Through these initiatives, SBRC not only contributes to the advancement of synthetic biology but also plays a pivotal role in fostering the bioeconomy and addressing global challenges in health, environment, and sustainability.

RESEARCH AREAS

- **Advancements in synthetic biology core technologies**
  - Establishing a robust synthetic biology platform focused on smart genetic circuit and genome synthesis for practical applications.
  - Employing structure-based enzyme design and molecular evolution techniques to engineer industrially valuable enzymes.
  - Engineering artificial cells via CRISPR-based genome manipulation and the introduction of genetic circuits.
  - Engineering metabolic pathway and cell factory through bio-system design by utilizing artificial intelligence and computational methodologies.
- **Establishing a biofoundry infrastructure**
  - Constructing parallel and high-speed biofoundry technology to accelerate the synthetic biology DBTL (Design-Build-Test-Learn) cycle.
  - Innovating DNA design software and workflows to minimize errors during DNA assembly processes.
  - Pioneering artificial genome synthesis using advanced genome design and module assembly techniques.
  - Advancement of biofoundry technology through standardization efforts and the establishment of a web-based part-bank for biological parts.

RECENT ACHIEVEMENTS

- **Development of biofoundry workflows for efficient engineering of proteins and cells**
  - Automated construction of a yeast-based multigene library via homologous recombination in a biofoundry workflow (ACS Synthetic Biology).
  - Cell-free biosensor with automated acoustic liquid handling for rapid and scalable characterization of cellobiohydrolases on microcrystalline cellulose (Synthetic Biology).
  - Dsembler-DNA assembly designer: a tool for facilitating assembly of oligomers (Journal of Microbiology and Biotechnology).
- **Engineering microbes for diagnosis and treatment of diseases**
  - RiboJ-assisted non-repeated sgRNA arrays for enhanced CRISPR multiplex genome engineering in Escherichia coli (Chemical Engineering Journal).
  - Novel signal peptides and episomal plasmid system for enhanced protein secretion in engineered Bacteroides species (ACS Synthetic Biology).
  - Engineering probiotic E. coli for inflammation-responsive indoleacetic acid production using RiboJ-enhanced genetic circuits (Journal of Biological Engineering).
- **Sustainable production of value-added chemicals for biomanufacturing**
  - Compositional and temporal division of labor modulates mixed sugar fermentation by an engineered yeast consortium (Nature Communications).
  - Engineered Methylococcus capsulatus Bath for efficient methane conversion to isoprene (Bioresource Technology).
  - Unlocking synergies: Harnessing the potential of biological methane sequestration through metabolic coupling between Methylomicrobium alcaliphilum 20Z and Chlorella sp. HS2 (Bioresource Technology).



Genome Editing Research Center

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INTRODUCTION

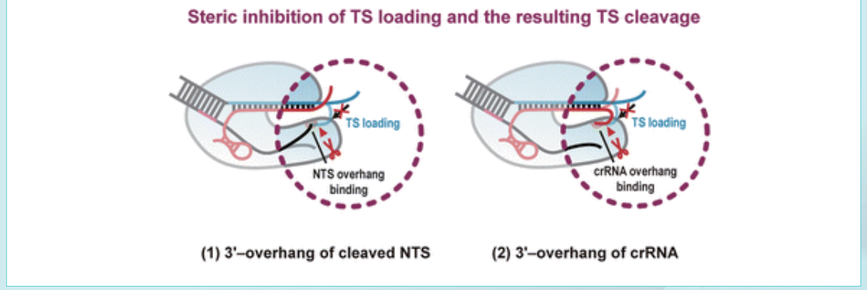
The genome editing research center as a pioneering department committed to driving innovation within the domain of gene editing technologies. This research center is endeavoring to a multifaceted exploration, including the refinement of genome editors, the advancement of gene therapy modalities, and the establishment of mouse models through gene-editing techniques.

RESEARCH AREAS

- **Advancement of gene editing technologies**
  - Development of ultra-small Cas enzyme engineered for enhanced efficacy and safety.
  - Development of technology to verify the accuracy of prime editors.
  - Improvement of efficiency in homology-directed repair to insert large gene fragments.
- **Development of gene therapy based on new genome editing technologies**
  - Development of novel genome editing tools for gene therapy applications.
  - Integration of genome editing technology into diagnostic platforms.
  - Validation of gene therapy through the utilization of gene-edited medium-sized animal models.
- **Development of glycan-humanized mouse model using glyco-gene editing technology**
  - Verification of the effectiveness of glycan-humanized mouse model.
  - Functional study of the role of non-human glycosyltransferase in human cancer.
- **Discovery of cancer biomarkers based on aberrant glycosylation**
  - Establishment of aglycosylated antibody-producing mice enabling quantification of tumor markers through aglycosylated antibody- lectin coupled immunoassays.
  - Discovery and validation of liver cancer marker based on aberrant glycosylation using aglycosylated antibody.

RECENT ACHIEVEMENTS

- **Unveiling Cas12j trans-cleavage activity for CRISPR diagnostics: application to miRNA detection in lung cancer diagnosis**
  - Cas12j1, 2, and 3 variants display strong trans-cleavage activity, particularly on short single-stranded DNA.
  - The newly developed EXP-J assay enables rapid and highly sensitive detection of miRNAs using Cas12j.
  - The EXP-J system successfully detects oncogenic miRNAs in plasma from lung cancer patients with high accuracy.
  - Effects of steric hindrance from single-stranded overhangs on target-strand loading into the Cas12a active site.
  - Cas12a cleaves the target strand (TS) after the non-target strand (NTS), but 3′ single-stranded overhangs from either crRNA or cleaved NTS sterically hinder TS loading into the catalytic site.
  - Using smFRET-ALEX, the study shows that removing 3′ overhangs.
  - These findings provide mechanistic insights into Cas12a's sequential cleavage with a single catalytic site and inform the development of improved genome editing and diagnostic applications.



- **Transgenic mouse for aglycosylated antibody production and its application in disease biomarker detection**
  - Transgenic Mouse for Producing Aglycosylated Antibody and Uses of Aglycosylated Antibody prepared Thereof. Patent Registration (No: US 12,048,296).

Cell Factory Research Center

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INTRODUCTION

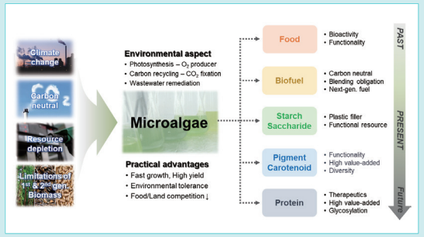
In the era of climate crisis, new technological breakthroughs to mitigate greenhouse gases and bolster environmental sustainability remain imperative not just for the sake of stewarding ecosystem services, but seizing new market opportunities. The center leads key initiatives in this core area with a primary goal of advancing microalgae-based carbon capture and utilization (CCU) technologies to enable effective transition to carbon-neutral bioeconomy. The center is also actively involved in major research efforts aimed at mitigating harmful algal blooms (HABs) as well as enabling effective biological treatment of plastic wastes. Furthermore, the center is dedicated to identifying and engineering a cell factory system capable of synthesizing valuable metabolites and proteins for a variety of industrial applications, including energy, environmental management, nutraceuticals, cosmetics, and pharmaceuticals. Through our multi-faceted endeavors, the center aspires to disseminate groundbreaking technologies and bioproducts in both the environmental and industrial sectors with a global reach.

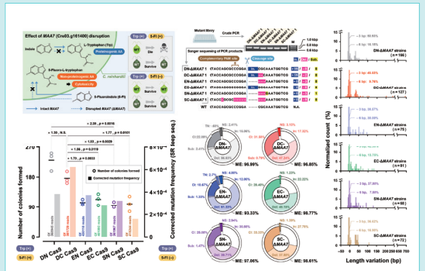
RESEARCH AREAS

- **Development of microalgal cell factories**
  - Screening of novel pharmaceutical, nutraceutical, and cosmetic ingredients from microalgae and microbes.
  - Synthetic biology-based cellular and metabolic engineering of microalgae for high-value biomaterial production.
  - Development of a high-performance clustered regularly interspaced short palindromic repeats (CRISPR) RNA-guided nucleases system for the efficient gene editing of microalgae.
  - Omics research of microalgae to modulate biosynthetic pathways.
- **Advancement of microalgae-based carbon capture and utilization (CCU) technology**
  - Development of microalgal strains with high carbon fixation capability under different facility operation scenarios.
  - Enabling lab-to-field translation of microalgae-based CCU technology through bioprocess engineering, process integration, and techno-economic assessment.
  - Improvement of biorefinery technology to construct circular bioeconomy system based on microalgae product portfolio.
  - Trophic conversion of microalgae for valorization of various carbon sources.
  - Development of microalgae-derived methane- and nitrous oxide-reducing animal feed.
- **Microalgae-based environmental engineering**
  - Development of plastic-degrading microalgae and their application for mitigating the trophic transfer of microplastics.
  - Phytoremediation: Microalgae-based pollutant removal from wastewaters.
  - Synthetic communities: Assembling synergistic microbial consortium for environmental remediation.
- **Microalgae-related microbiome research**
  - Study of microbiome and their interaction networks during cyanobacterial blooms and development of novel methods for bloom control.
  - Freshwater ecosystem health assessment based on multi-meta-omics of microbiome.
  - Microbiome on aquatic plants and their interaction with cyanobacteria.

RECENT ACHIEVEMENTS

- **The patent assignment for anti-wrinkle cosmetics application assigned to ASKLabs (2023, total amount: $1,000,000)**
  - Novel microalgae having high productivity for lutein (Korean Patent No. 10-2023-0023614).
- **Designer microalgal biorefinery**
  - Toward a zero-waste microalgal biorefinery: Complete utilization of defatted Chlorella biomass as a sole heterotrophic substrate for Chlorella sp. HS2 and an improved composite filler Chem. Eng. J. 480:147998 (2024).
- **Harmful algal bloom microbiome**
  - Microcystis abundance is predictable through ambient bacterial communities: A data-oriented approach. J. Environ. Manage. 368:122128 (2024).
- **Microalgae nutraceutical productions**
  - Enhancement of ketocarotenoid production via heterologous expression of orange protein from Ipomoea batatas in indigenous microalga Ettlia Algal Res. 84 (2024).
  - Heterologous overexpression of the cyanobacterial alcohol dehydrogenase sysr1 confers cold tolerance to the oleaginous alga Nannochloropsis salina Front. Plant Sci. 14 (2023).
- **Improvement of gene editing frequency in microalgae**
  - Cas9-mediated gene-editing frequency in microalgae is doubled by harnessing the interaction between importin α and phytopathogenic NLSs Proc. Natl. Acad. Sci. USA 122:10 (2025).
  - Patent applications include: KR10-2023-0061795, PCT/KR2023/006493, WO 2023/224327 A1.





Improvement of gene editing frequency
in microalgae through optimization of CRISPR-Cas9 system

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Division of Biomedical Research

- Personalized Genomic Medicine Research Center
- Microbiome Convergence Research Center
- Rare Disease Research Center
- Biotherapeutics Translational Research Center
- Immunotherapy Research Center
- Disease Target Structure Research Center
- Metabolic Regulation Research Center

Personalized Genomic Medicine Research Center

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INTRODUCTION

This research center is discovering novel biomarkers that can diagnose/ control primary and metastatic cancers based on the genome, and developing anticancer treatment technologies through functional analysis. We are producing multi-genomics data by using next-generation sequencing platform and also developing targeted anticancer drugs through bio big data-based biomarker discovery and validation.

RESEARCH AREAS

- Development of bioinformatics tools and databases
- Multiomics analyses of various cancers to develop prognostic and predictive biomarkers and therapeutic targets
- Genome assembly and pan-genome construction for precision and personalized medicines
- Maintenance and upgrade of NGS platform generating multiomics data
- Large-scale screening and identification of cancer-related genes
- Research on cancer dormancy
- Functional validation of candidate target genes and biomarkers for development of treatments and diagnostics for various cancers
- Development of innovative treatments and effective therapeutics for cancers

RECENT ACHIEVEMENTS

- **Proteogenomic Characterization Reveals Estrogen Signaling as a Target for Never-Smoker Lung Adenocarcinoma Patients without EGFR or ALK Alterations**
  - Never-smoker lung adenocarcinoma (NSLA) is prevalent in Asian populations, and is even more in women. EGFR mutations and ALK fusions are major alterations observed in NSLA.
  - Genome analysis revealed that TP53 (25%), KRAS (22%), ROS1 fusion (14%), and SETD2 (11%) were the most frequently mutated genes in NENA patients.
  - Through DNA copy-number alteration analysis, we identified 22 prognostic proteins, influencing transcriptomic and proteomic changes. Gene set enrichment analysis revealed that the estrogen signaling emerged as the key pathway activated in NENA.
  - Saracatinib, an Src inhibitor, was suggested as a potential drug for targeting activated estrogen signaling in NENA, and was experimentally validated in vitro using cell line model.
  - In this study, we enhanced our understanding of the etiology of NENA NSLA through the proteogenomic landscape, based on which we proposed saracatinib as an effective drug.
- **CYB5R3 functions as a tumor suppressor by inducing ER stress- mediated apoptosis in lung cancer cells via the PERK-ATF4 and IRE1α-JNK pathways**
  - Cytochrome b5 reductase 3 (CYB5R3) is involved in various cellular metabolic processes, including fatty acid synthesis and drug metabolism.
  - We showed that CYB5R3 expression is downregulated in human lung cancer cell lines and tissues. Overexpression of CYB5R3 suppresses lung cancer cell growth in vitro and in vivo. However, CYB5R3 deficiency promotes tumorigenesis and metastasis in mouse models.
  - Transcriptome analysis revealed that apoptosis- and endoplasmic reticulum (ER) stress-related genes are upregulated in CYB5R3-overexpressing lung cancer cells. Metabolomic analysis revealed that CYB5R3 overexpression increased the production of nicotinamide adenine dinucleotide (NAD+) and oxidized glutathione (GSSG).
  - Ectopic CYB5R3 is mainly localized in the ER, where CYB5R3-dependent ER stress signaling is induced via activation of protein kinase RNA-like ER kinase (PERK) and inositol-requiring enzyme 1 alpha (IRE1α).
  - In addition, CYB5R3 induces the generation of reactive oxygen species and caspase-9-dependent intrinsic cell death.
  - Our findings highlight the importance of CYB5R3 as a tumor suppressor for the development of CYB5R3-based therapeutics for lung cancer.
- **A 23-gene prognostic index predicts progression and BCG response in non-muscle-invasive bladder cancer (NMIBC)**
  - To enhance NMIBC prognostication, we used deep learning for an analysis of long-term follow-up data to develop a prognostic index (PI) for NMIBC progression.
  - We identified 23 core genes and a network of interactions driving tumor cell invasion, proliferation, and migration.
  - The 23-gene PI effectively predicts NMIBC progression and responses to intravesical BCG therapy, and addresses challenges in identifying diverse responders to standard treatment.
  - Unlike established predictors with limited BCG response predictability, the PI identifies patients with high-risk disease who may benefit the most from BCG, allowing patients with low-risk disease to explore alternative treatments such as targeted biologics for better outcomes.
  - Our study introduces a promising PI that can accurately identify patients with high-risk NMIBC with distinct clinical behaviors and treatment responses. This PI overcomes current limitations in NMIBC prognosis and may provide valuable guidance for therapeutic decision making.

- **Identification and characterization of target molecule of 2′- Hydroxy cinnamaldehyde (HCA), a component of the commonly used spice cinnamon**
  - HCA induced reactive oxygen species (ROS) and apoptosis in cancer cells and treating cancer cells with antioxidants abolished HCA-mediated ROS production and apoptosis.
  - We identified peroxiredoxin 1 (PRX1) and peroxiredoxin 2 (PRX2) as target proteins of HCA using affinity chromatography, and further confirmed these association using a cellular thermal shift assay (CETSA).
  - Down-regulation of target proteins PRX1 and PRX2 significantly reduced HCA-mediated ROS induction, supporting that PRX1 and PRX2 are targets of HCA for ROS elevation.
  - Additionally, HCA inhibited SW620 tumor growth. CETSA analysis of tumor tissues showed that PRX1 and PRX2 were bound and thus inactivated by HCA in a mouse xenograft model.
- **CRHBP, a novel multiple cancer biomarker connected with better prognosis and anti-tumorigenicity**
  - Little is known about the role of CRHBP, a major regulator of neuroendocrine, autonomic, and stress adaptation, in tumors.
  - This study provides a comprehensive summary of the systemic role of CRHBP expression in various types of tumors, highlighting the prognostic importance and clinical significance of tumors.
  - Furthermore, CRHBP decreases cell proliferation and mobility in cancer cell lines associated with OS and DFS.
  - Thus, our study contributes to clarifying the role of CRHBP from various perspectives.
- **DNA methylome analysis reveals epigenetic alteration of complement genes in advanced metabolic dysfunction-associated steatotic liver disease**
  - Blocking the complement system is a promising strategy to impede the progression of metabolic dysfunction-associated steatotic liver disease (MASLD). However, the interplay between complement and MASLD remains to be elucidated.
  - Liver biopsy specimens were procured from a cohort comprising 106 Korean individuals, which included 31 controls, 17 with isolated steatosis, and 58 with metabolic dysfunction-associated steatohepatitis (MASH). Utilizing the Infinium Methylation EPIC array, thorough analysis of methylation alterations in 61 complement genes was conducted.
  - Methylome and transcriptome analyses of liver biopsies revealed significant hypermethylation and downregulation of C1R, C1S, C3, C6, C4BPA, and SERPING1, as well as hypomethylation and upregulation of C5AR1, C7, and CD59, in association with the histological severity of MASLD. Furthermore, DNA methylation and the relative expression of nine complement genes in a MASH diet mouse model aligned with human data.
  - Our research provides compelling evidence that epigenetic alterations in complement genes correlate with MASLD severity, offering valuable insights into the mechanisms driving MASLD progression, and suggests that inhibiting the function of certain complement proteins may be a promising strategy for managing MASLD.

Microbiome Convergence Research Center

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INTRODUCTION

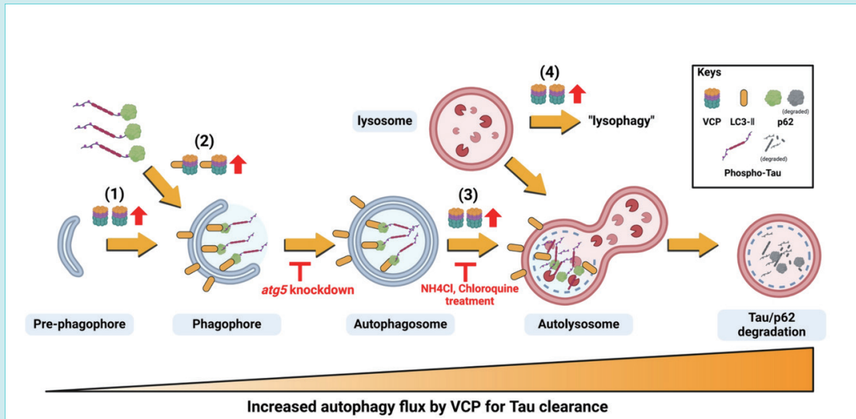
The Microbiome Convergence Research Center (MCRC) is dedicated to studying how the human microbiome impacts health and disease while developing microbiome-targeted therapeutics. We now recognize that our bodies integrate the biology of our human cells and genome with the trillions of bacteria inhabiting us. Notably, a significant portion of disease can be traced back to these microbial communities. Unraveling the processes and events influenced by our microbiota offers new insights into disease mechanisms and uncovers relationships that govern the natural history of human disease. The goals of MCRC are to elucidate the roles of the microbiome in modulating human/host physiology by regulating immunity and metabolism, ultimately linking this knowledge to the development of novel therapeutics and approaches for treating and preventing disease.

RESEARCH AREAS

- **Uncovering the molecular mechanisms by which gut microbiota coordinate signaling pathways to modulate immunometabolic circuits**
  - Identifying gut microbiota-derived molecules beyond metabolites and assigning their host targets through proteomics-based interactome analysis and biochemical approaches.
  - Analyzing these molecules at the molecular level using cryo-EM technologies.
  - Elucidating the mechanisms by which these molecules function as immunometabolic mediators to modulate host physiology.
  - Investigating therapeutic approaches for treating inflammatory diseases, including IBD.
- **Investigating the microbiome-neuro-immune axis using zebrafish as an animal model**
  - Exploring host immune responses through host-microbiome interactions as well as bacteria-bacteria interactions.
  - Ameliorating the neurodegenerative phenotypes associated with Alzheimer's disease and Parkinson's disease through a deeper understanding of the microbiome-gut-brain axis.

RECENT ACHIEVEMENTS

- **Providing mechanistic insights into how Vibrio vulnificus utilizes its MARTX toxin to suppress ROS generation, ultimately paralyzing first-line immune responses and inducing sepsis**
  - Findings reveal that the DUF1-RID effector duet within the MARTX toxin hijacks calmodulin (CaM) and Rac1 in infected host cells.
  - Crystal and cryo-EM studies of the effector duet complexed with CaM and Rac1, along with biochemical and immunological analyses, provide key insights into a concerted invasion strategy that promotes sepsis (Choi et al., Nature Communications, 2024).
- **Identification of VCP/p97 as a key factor in a zebrafish tauopathy model**
  - Induced expression of VCP/p97 leads to the degradation of excessive Tau protein via the autophagy-lysosomal pathway (Giong et al., Acta Neuropathologica, 2024).
  - The zebrafish tauopathy model can be utilized to identify novel classes of small molecules and signaling pathways that mitigate tauopathy phenotypes through in vivo high-content screening.



(Source: Giong et al., Acta Neuropathologica, 2024)

Rare Disease Research Center

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INTRODUCTION

Precision medicine for rare neuronal disease based on omics big data considered to be a better option for next generation. To develop technologies related to these, this research center is focusing on the construction of genomics-based technology platforms, identification of the therapeutic target genes and diagnostic biomarkers, and application to diagnosis and treatment for rare neuronal disease.

RESEARCH AREAS

- **Identification of therapeutic target genes and diagnostics biomarkers for Precision medicine of rare neuronal diseases**
  - Establishment of genome research infrastructure and technology platforms for rare neuronal diseases.
  - Functional validation and application onto gene therapy of candidate target genes for precise therapeutics development of rare neuronal diseases.
  - Identification of biomarkers and development of gene panel for precise diagnostics of rare neuronal diseases.
  - Construction of animal model to infer the cause of rare neuronal diseases.
- **Investigation of the effects of microplastics on the brain and metabolism**
  - Establishment of microplastics as environmental risk factors in developmental disorder.
  - Investigation of the effects of microplastic exposure on metabolic changes and related phenotypes.
- **Identification of therapeutic targets for incurable diseases and development of specific antibodies**
  - Identification of therapeutic targets in cancers and viral infections, and development of specific response antibodies.
  - Development of diagnostics and therapies based on target-specific antibodies.

RECENT ACHIEVEMENTS

- **Characteristics of genetic variations and identification of a novel therapeutic target in Korean families with rare neurological diseases**
  - The emerging genetic diversity of hereditary spastic paraplegia (HSP) in Korean patients.
  - Identification of novel candidate genetic variations and networks associated with LGS in Korean LGS Families.
- **Investigation of the effects microplastics on overweight and obesity in mice (Environ. Int. 2024. 185:108522)**
  - Identification of obesity-like phenotypes following nanoplastic exposure, including weight gain, elevated blood cholesterol levels and increased body fat accumulation.
- **Age-related cholesterol and colorectal cancer progression: Validating squalene epoxidase for high-risk cases (Aging Cell. 2024. 23:e14152)**
  - Identification of valuable biomarkers, including SQLE and GSK3βpS9, for older patients at an elevated risk of CRC.
- **Development of next-generation SARS-CoV-2 vaccine using glycan-free S2 peptide-conjugated virus-like particles for broad protection against variants (Vaccines (Basel). 2024. 12(6):676)**
  - A new vaccine using glycan-free S2 peptides on virus-like particles (VLPs) was developed to provide broad protection against SARS-CoV-2 variants.

Biotherapeutics Translational Research Center

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INTRODUCTION

The Biotherapeutic Translational Research Center (BTRC) is dedicated to advancing personalized treatments for rare and intractable diseases through the development of innovative therapeutic platform technologies and translational research. The primary mission of BTRC is to promote clinical and translational research aimed at overcoming diseases and improving the management of cancer, diabetes, and cardio-/neurodegenerative disorders. BTRC faculty members lead multiple translational projects focused on the design, discovery, and development of customized biotherapeutics in cancer, vascular, and metabolic diseases.

RECENT ACHIEVEMENTS

- Stilbenoid derivatives as potent inhibitors of HIF-1α-centric cancer metabolism under hypoxia(Biomedicine & Pharmacotherapy)
- Coactivation of Tie2 and Wnt signaling using an antibody-R-spondin fusion potentiates therapeutic angiogenesis and vessel stabilization in hindlimb ischemia(Mabs)
- Development of a novel sandwich immunoassay based on targeting recombinant Francisella outer membrane protein A for the diagnosis of tularemia(Frontiers in Cellular and Infection Microbiology)
- Machine learning powered detection of biological toxins in association with confined lateral flow immunoassay (c-LFA) (Analyst)
- Effects of autophagy-inhibiting chemicals on sialylation of Fc-fusion glycoprotein in recombinant CHO cells (Applied Microbiology and Biotechnology)

RESEARCH AREAS

- **Mining of therapeutic targets for cancer and vascular/metabolic diseases**
  - Discovery, validation, and regulation of therapeutic targets through transcriptomic and genomic analyses.
  - Evaluation of targets and therapeutic agents for atherosclerosis, aortic aneurysm, type 2 diabetes, non-alcoholic fatty liver disease (NAFLD), and obesity using in vitro and in vivo models.
- **Development of Biopharmaceuticals (antibody/protein) for cancer and vascular/metabolic diseases**
  - Discovery of disease-specific, target-binding antibodies.
  - Development of bispecific antibodies, fusion proteins, and antibody-drug conjugates (ADCs).
- **Process development for efficient biopharmaceutics production**
  - Establishment of high-yield antibody-producing mammalian cell lines.
  - Development of serum-free suspension culture processes for mammalian cells.
- **Development of antibody/exosome-based molecular diagnostic system**
  - Discovery of novel antibodies targeting disease-specific antigens.
  - Identification of early diagnostic biomarkers using exosomal microRNAs.
- **Research on drugs targeting tumor microenvironment**
  - Platform technology development for cancer immunotherapy.
  - Discovery of therapeutics targeting HIF-1-centered cancer metabolism.
- **Exosome engineering for therapeutics and diagnostics**
  - Engineering of exosome surface molecules and cargo contents.
  - Development of hybrid exosomes via membrane fusion with liposomes.

Immunotherapy Research Center

Dr. **Suk Ran Yoon**

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INTRODUCTION

Gene-engineered immune cell therapies have emerged as advanced treatments for cancer. Natural killer (NK) cells are innate immune cells that play a unique role in cancer immune surveillance. This research center has been dedicated to the development of anti-tumor NK cell therapy since the early 2000s. Our research focuses on the development of chimeric antigen receptor (CAR)-NK cells, T cells, immune cell reprogramming, and antibody therapies. We have expanded the research to include hematopoietic stem cell (HSC) aging, rejuvenation, platelet differentiation, and cytokine production. We are committed to advancing diverse technologies in immune and blood cell-based therapies.

RECENT ACHIEVEMENTS

- **METHOD FOR PRODUCING CAR GENE-INTRODUCED NK CELLS AND USE THEREOF (Patent Registration No. ZL202080038941.8, 2024.05.10)**
  - This invention enables direct reprogramming of human somatic cells into CAR-expressing iNK cells, without using stem cells or differentiation steps.
  - The method is efficient, cost-effective, and applicable to various starting cell types.
- **Paulownin elicits anti-tumor effects by enhancing NK cell cytotoxicity through JNK pathway activation. Front. Pharmacol. 15:1439079, 2024**
  - Elucidation of a novel anticancer mechanism of Paulownin via enhancement of natural killer cell cytotoxicity.
- **PLK1 phosphorylates RhoGDI1 and promotes cancer cell migration and invasion. Cancer Cell International, 24(1):73, 2024**
- **Deficiency of thioredoxin-interacting protein (TXNIP) results in age-related thrombocytopenia due to megakaryocyte oxidative stress. Journal of Thrombosis and Haemostasis, 22(3):834–850, 2024**

RESEARCH AREAS

- **Natural Killer (NK) cell immunotherapy for refractory cancer**
  - Establishment of anti-cancer immunotherapy platform based on NK cell differentiation.
  - Advancement of NK cell therapy through the regulation of the tumor microenvironment.
  - Development of a cryopreservation method for NK cell therapy.
- **Development of chimeric antigen receptor (CAR)-NK cell and gene therapy**
  - Establishment of cell culture method for NK cell expansion.
  - Development of NK cell specific CAR construct for NK cell activation.
  - CAR-NK cell therapy using gene delivery system.
  - Preclinical studies with high efficient NK cell.
- **Novel therapeutic candidates for anti-tumor immunotherapy**
  - Development of molecules to enhance the anti-cancer efficacy of NK cell therapy.
  - Development of fusion cytokine for NK cell activation.
  - Investigation of immunomodulatory substances for therapeutic candidates.
  - Development of human and humanized antibodies for cancer treatment.
- **Hematopoietic stem cell (HSC) differentiation and aging**
  - Molecular hematopoiesis and blood disorders.
  - Development of platform for stem cell-derived platelet generation.
  - HSC aging mechanism and rejuvenation.
  - Novel approaches for development of immune cell targeting senescent cell.
- **Cell fate reprogramming**
  - Cell fate conversion to immune cells.
  - Characterization of reprogrammed cells.
  - Evaluation of Efficacy and safety of reprogrammed cells.

Disease Target Structure Research Center

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INTRODUCTION

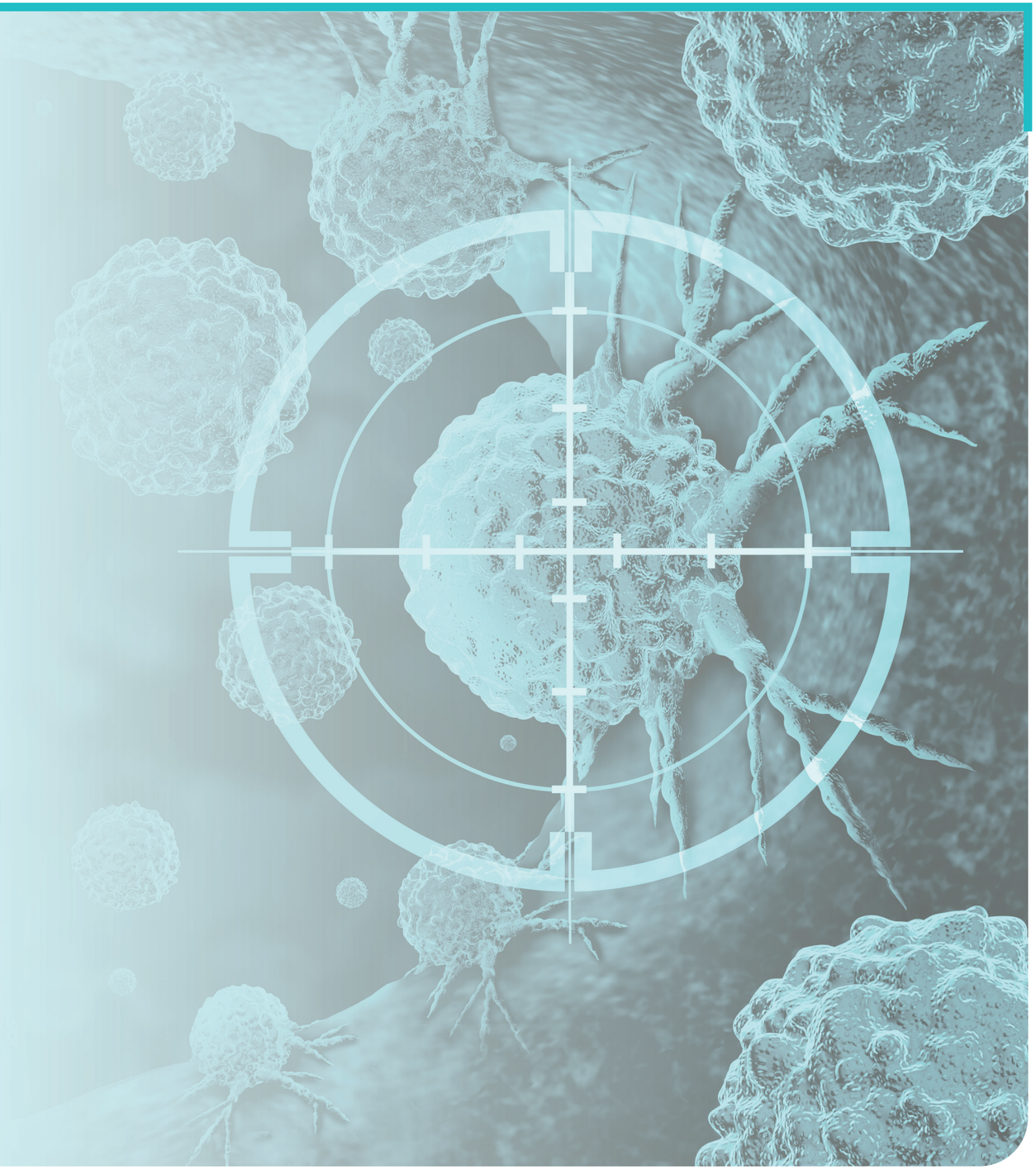
This research center has been focused on the development of new drugs by the basis of protein 3-D structure oriented screening of disease targets and biological validation of screened targets.

RESEARCH AREAS

- **Target identification & validation for drug discovery**
  - Drug discovery using targeted protein degradation (PROTAC and molecular glue).
  - Protein X-ray crystallography.
  - Structural studies on signaling-regulatory proteins.
  - Development of nanopore sensor technology for detection of protein-protein interaction, protein-nucleic acid interaction, proteins, peptides, and small molecules.
  - Development of nanopore sensor platform technologies for drug screening and disease diagnosis.
  - Development of new drugs regulating Wnt signal through artificial protein.
  - Development of hypersensitivity immunosuppressants through artificial cytokine.

RECENT ACHIEVEMENTS

- **Histone lysine methylation modifiers controlled by protein stability (Exp Mol Med, 2024, 56(10):2127-2144)**
  - Comprehensive review of histone lysine methylation modifiers and their regulatory mechanisms.
- **Discovery of a novel molecular glue degrader targeting GSPT1/2 with a non-IMiD based CRBN binder (Eur J Med Chem, 2025, 291:117642)**
  - Development and characterization of a novel GSPT1/2 degrader with antitumor activity.



Metabolic Regulation Research Center

Dr. **Won Kon Kim**

Associate Director

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INTRODUCTION

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, 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.

RESEARCH AREAS

- Identification of metabolic energy system and regulatory mechanism of type 2 diabetes and obesity
- Identification of regulatory mechanism associated with the transition from white adipose tissue to brown adipose tissue
- Screening and functional research of metabolic disease regulatory material based on the generation of a low molecular weight compound or natural product
- Elucidating the pathophysiological mechanism of Metabolic dysfunction-associated fatty liver disease (MAFLD) and Metabolic dysfunction–associated steatohepatitis (MASH)
- Elucidating the pathophysiological mechanism of the entire liver diseases in Metabolic dysfunction-associated steatohepatitis (MASH) to liver fibrosis to hepatocellular carcinoma (HCC)
- 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
- Research on lipid metabolism and ferroptosis in cancer and cardiovascular diseases

RECENT ACHIEVEMENTS

- **Novel protein identification involved in regulation of brown fat thermogenesis (Nat. Commun. 2023, 14:3746)**
  - Identification of Letmd1, a new factor that can regulate energy homeostasis in brown fat.
  - Confirmation of new location of Letmd1 protein in mitochondria.
- **Identification of new targets for metabolic dysfunction-associated fatty liver disease (MAFLD) (Diabetologia 2023, 66:931-954)**
  - First research report and intellectual property rights acquisition on the occurrence and progression of metabolic abnormality-related fatty liver disease (MAFLD) due to regulation of expression of diabetes gene TCF7L2.
- **Generation of preclinical animal models and discovery of new targets related to the progression from MAFLD/MASH**
  - Generation of a mouse model that ensures predictability and rapidity of liver cancer formation for research on progression from MAFLD/MASH to Hepatocellular carcinoma (HCC).
- **Elucidating the role of phospholipid recycling by lipoprotein-associated phospholipases A2 (Lp-PLA2) in ferroptosis through metabolomics analysis (Nat. Commun. 2023, 14:1578)**
  - Identification of darapladib, an Lp-PLA2 inhibitor that was tested in phase III clinical trial for cardiovascular diseases, as a ferroptosis-sensitizing drug.
  - Elucidating the role of Lp-PLA2 that cleaves pro-ferroptotic phospholipids through metabolomic and biochemical approaches.

Research Divisions

Director

Dr. Mi-Young Son

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Division of Research on National Challenges

- Infectious Disease Research Center
- Environmental Diseases Research Center
- Biodefense Research Center
- Stem Cell Convergence Research Center
- Bionanotechnology Research Center
- Plant Systems Engineering Research Center

Infectious Disease Research Center

Dr. **Choong-Min Ryu**

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INTRODUCTION

Infectious diseases, including antibiotic-resistant superbacteria and acute viral diseases such as influenza and COVID-19, pose significant health challenges. To address these threats, Infectious Disease Research Center focuses on studying bacterial resistance mechanisms and uncovering novel interactions between viruses and the host immune system. Based on this basic knowledge, we are also attempting to identify new antibacterial agents and develop new viral vaccines, adjuvants, and therapeutic options.

RESEARCH AREAS

- **Asia Pacific Infectious Disease Shield (APIS) networking for rapid response and preparedness of infectious diseases in Asia and Pacific region**
- **Discovery and development of anti-bacterial compounds**
  - New drugs against multidrug-resistant bacteria and persister cells.
  - Lipid and gold nanoparticle-based antimicrobials.
  - In vivo model for efficacy evaluation.
- **Interaction between respiratory viral proteins and host innate immunity**
- **Development of biomaterials and strategies to control viral infection**
  - Development of vaccine and adjuvants for improving vaccine efficacy and cross-protective immunity.
  - Development of viral antigen-specific monoclonal antibodies.
  - Identification of viral gene related to zoonotic potential.
- **Antigenicity and biological characteristics of influenza virus with zoonotic potential**
- **Development of mRNA vaccines, therapeutics, and probes via nano- and supramolecular organic chemistry**
  - High-performance ionizable lipids for mRNA vaccine and gene therapy.
  - Modified LNPs for tissue-specific targeting.
  - Reversibly photoswitchable probes for high-precision fluorescence imaging in living systems.
- **Mechanisms of regulating antibody immunity in B cells**

MAIN PROJECTS

- Establishment of APIS network and global infectious disease network (GloPID-R)
- Development of synthetic compounds against bacterial persister
- Development of fundamental technology for prevention and therapy of viral disease
- Development of antimicrobial strategies through host immune control
- Discovery and mechanistic study of novel antibiofilm compounds for the treatment of multidrug-resistant bacteria
- Development of new high-performance multivalent mRNA nanocarriers
- Pilot study on the development of lipid nanoparticle-based gene delivery platform for ocular administration
- High-efficiency organic supramolecular reversible fluorescence photoswitch for high-resolution imaging in living systems

RECENT ACHIEVEMENTS

- **Antimicrobial resistance**
  - Tyrosol blocks E. coli anaerobic biofilm formation via YbfA and FNR to increase antibiotic susceptibility (Nat Commun 2024).
  - 3-O-substituted quercetin: an antibiotic-potentiating agent against multidrug-resistant Gram-negative Enterobacteriaceae through simultaneous inhibition of efflux pump and broad-spectrum carbapenemases (ACS Infect Dis 2024).
  - Facemask acne attenuation through modulation of indirect microbiome interactions (npj Biofilms Microbiomes 2024).
  - Lipid Nanoparticle-Mediated CRISPR-Cas13a Delivery for the Control of Bacterial Infection (Adv Healthc Mater 2024).
- **Vaccine and viral infection**
  - A low pathogenic avian influenza A/Mallard/South Korea/KNU2019-34/2019 (H1N1) virus has the potential to increase the mammalian pathogenicity (Virol Sin 2024)
  - Modulating lipid nanoparticles with histidinamide-conjugated cholesterol for improved intracellular delivery of mRNA (Adv Healthc Mater 2024).
  - S2 peptide-conjugated SARS-CoV-2 virus-like particles provide broad protection against SARS-CoV-2 variants of concern (Vaccines-Basel 2024).
- **Immunity**
  - Dynamic O-GlcNAcylation governs long-range chromatin interactions in V(D)J recombination during early B-cell development (Cell Mol Immunol 2024).

Environmental Diseases Research Center

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INTRODUCTION

Welcome to the Environmental Diseases Research Center. Our ultimate mission is to unravel the mechanism of multi-organ failure triggered by environmental pollutants, such as fine dust, and to craft defense technologies to mitigate this damage. Our commitment is to enhance the quality of life for our citizens. Our core responsibilities include safeguarding public health by investigating the accumulation of fine dust within the human body. We analyze the diseases it causes and research control strategies. Our work involves the creation of disease models induced by fine dust, the standardizing of analyses on its impact within the body, and the identification of new damage prediction factors for each organ due to fine dust. We are also engaged in the study of disease network mechanisms and the development of pioneering technologies to control damage.

In addition, we clarify the interrelationship between harmful environmental factors, including air pollution and exposure to pollutants, and human health. We actively collaborate with international institutions to share knowledge and technologies that can solve new challenges related to environmental disease-causing substances.

Through our research endeavors, we aim to establish efficient disaster response research and development policies for diseases caused by fine dust. We strive to be the driving force for the nation's next-generation growth by developing control technologies for multi-organ damage. We are working towards enhancing our competitiveness in the prevention, diagnosis, and treatment of diseases related to multi-organ damage, as well as in the development of related product technologies.

RESEARCH AREAS

- **Combined toxicity of microplastics and environmentally hazardous substances**
  - Analysis of bioaccumulation of microplastics and environmentally hazardous substances such as PAH.
  - Analysis of multi-organ damage induced by microplastics and environmentally hazardous substances in zebrafish as laboratory animal model.
- **Discovery of regulatory targets and therapeutic candidates for controlling**
  - diseases caused by PMs.
  - Discovery of candidate substances for regulating macrophage inflammatory responses induced by PMs.
  - Verification of medicinal samples capable of controlling inflammatory responses caused by PMs.
- **Discovery of molecular targets for the diagnosis/treatment of diseases caused by PMs**
  - Analysis of harmful genes induced by PMs through single-cell genomic analysis of lung tissue.
  - Analysis of damage prediction/diagnostic markers and transcription factor expression patterns for respiratory diseases mediated by PMs.
- **Analysis of multi-organ damage and elucidation of mechanisms based on disease models induced by PMs**
  - Analysis of signal transduction regulatory mechanisms in intestinal diseases induced by PMs.
  - Analysis of candidate substances for regulating Caspase-1 activity and mechanisms after exposure to PMs.
- **Analysis of the significance and safety of disease control substances based on animal models**
  - Construction of animal models for cancer metastasis due to various types of cancer caused by PMs.
  - Analysis of genomic changes and significance in stem cell-based models under the influence of PMs.
  - Discovery of respiratory microbiomes controlling opportunistic pathogens induced by PMs.

RECENT ACHIEVEMENTS

- **The development of diagnostic markers for the particulate matter-related disease**
  - Specific upregulation of extracellular miR-6238 in particulate matter-induced acute lung injury and its immunomodulation (J. Hazard. Mater. 2023, 445, 130466).
- **Finding of particulate matter-induced cancer metastasis mechanisms**
  - Particulate matter promotes cancer metastasis through increased HBEGF expression in macrophages (Exp. Mol. Med. 2022, 54(11), 1901-1912).
- **Physical and chemical properties of PMs and 3D shape analysis**
  - Combined effects of microplastics and benz[a]anthracene on cardiotoxicity in zebrafish (Danio rerio) larvae: Size matters, Chemosphere 2023, 138723.
- **Analysis of the impact of PMs accumulation in the body & the possibility of control regulation**
  - Differential particle and ion kinetics of silver nanoparticles in the lungs and biotransformation to insoluble silver sulfide (J. Hazard. Mater. 2023, 452, 131223).
- **Analysis of the characteristics of bacteria carried by PMs & host damage mechanism**
  - P. stutzeri PM101005 inhaled with atmospheric particulate matter induces lung damage through inflammatory responses (Environ. Pollut. 2023, 317, 120741).

Biodefense Research Center

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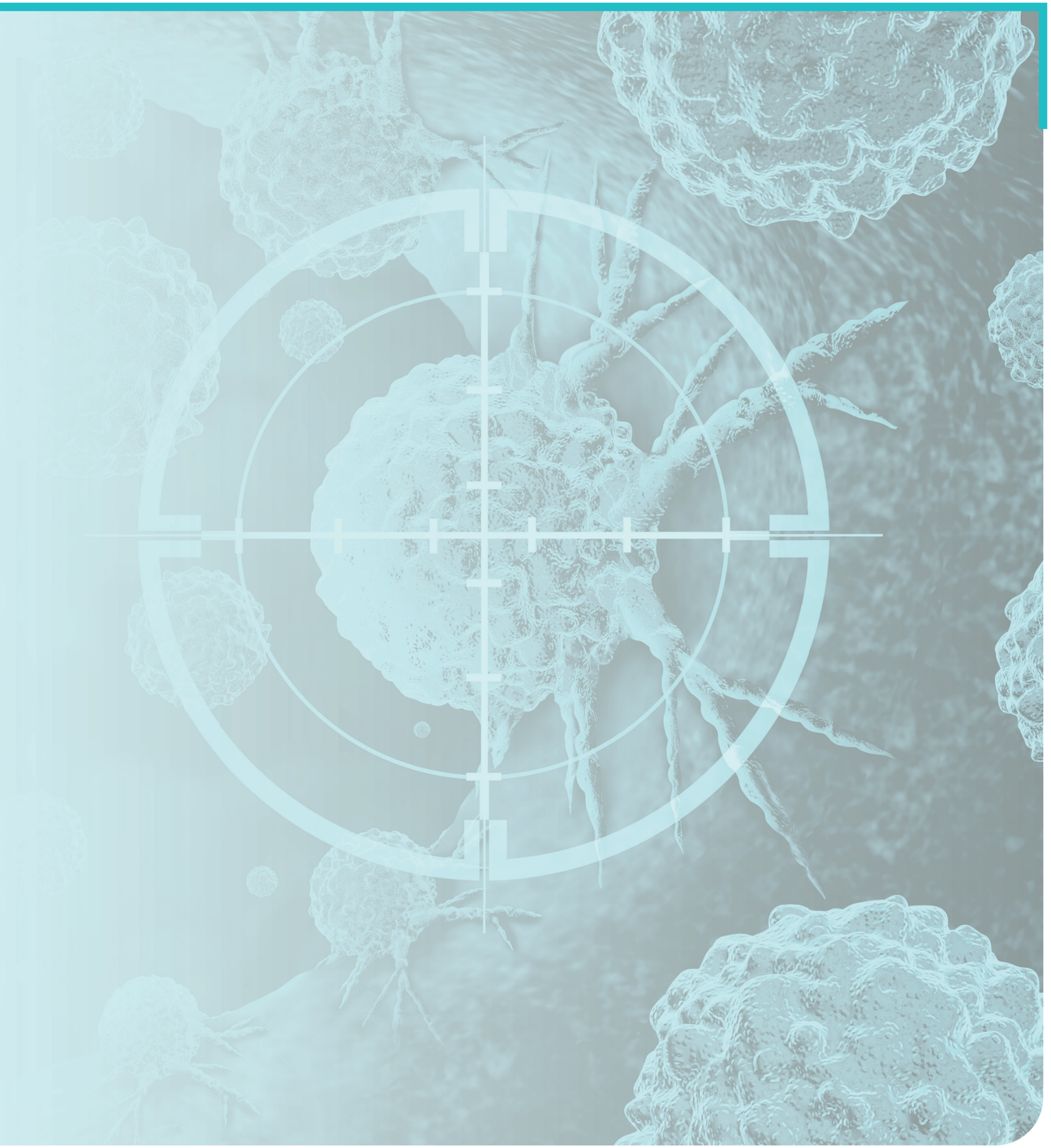
INTRODUCTION

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.

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



Stem Cell Convergence Research Center

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INTRODUCTION

The research goal of this center is to conduct fundamental research that includes investigations into differentiation mechanisms by utilizing various differentiated cells and organoids derived from pluripotent stem cells, as well as applied research for various purposes such as disease modeling, drug development, personalized therapy, and tissue regeneration.

RESEARCH AREAS

- **Development of regenerative therapies based on stem cell-derived organoids**
  - Human intestinal organoid-based regenerative therapy with the enhanced in vivo engraftment and regeneration by microenvironment modulation- Non-clinical safety and efficacy evaluation using animal models with various intestinal diseases.
- **Development of biomimetic 3D human tissue and networking platform for predicting drug toxicity and efficacy**
  - Establishment of biomimetic network circulation culture system (NOCS).
  - Modeling 3D human diseases based on stem cells and organoid technology for personalized therapeutics.
  - Development of in silico prediction systems for the differentiation or functional status of organoids.
  - Technology for PK/PD assessment based on NOCS.
- **Development of advanced biopharmaceuticals**
  - Functional mechanism research of genetic diseases and development of gene therapy treatments.
  - Development of cell therapy technology through cell fate conversion techniques.
  - Advancement of gene delivery techniques for gene therapy.

MAIN PROJECTS

- **Development of personalized disease model based on the networking organoid circulating culture system**
  - 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.
- **Development of organoid platform for safety evaluation**
  - Development of drug safety evaluation platform using liver- and intestine organoids.
  - Validation of organoid-based drug safety evaluation platform and development of test guideline for hepatotoxicity prediction.
- **Establishment of an organoid-based alternative animal resource bank and development of an operating system**
  - Establishment of a standardized and internationally harmonized operation systems and foundational infrastructure for the organoid resource bank (intestine, liver, kidney, heart, lung, skin, brain, etc).
- **International standardization of organoids (ISO, OECD)**
  - Requirements for endpoint quality assessment of intestinal organoids (ISO/TC276/WG4, ISO/NP 25772).
  - Standardization of liver organoid: NP ballot in progress for endpoint quality assessment of human liver organoids (ISO/NP 25893).
  - Standardization of liver organoid-based toxicity testing: SPSF for Detailed Review Paper (DRP) approved in 2024, and a proposal for test guideline under development (OECD/TGP 4.176).
  - Genomics informatics - Procedures for gene expression panel-based similarity calculation for human pluripotent stem cell-derived organoids (ISO TC215/SC1, ISO/CD TS24932).

RECENT ACHIEVEMENTS

- Long-Term Culture of Human Pluripotent Stem Cells in Xeno-Free Condition Using Functional Polymer Films (Adv. Mat. 2024)
- Positive regulation of cell proliferation by the miR-1290-EHHADH axis in hepatocellular carcinoma. Cancer Communications (Cancer Commun. 2024)
- Xenogeneic-free culture of human intestinal stem cells on functional polymer-coated substrates for scalable, clinical-grade stem cell therapy (Nat. Comm. 2024)
- Chemically-defined and scalable culture system for intestinal stem cells derived from human intestinal organoids (Nat. Comm. 2024)
- A multicellular liver organoid model for investigating hepatitis C virus infection and nonalcoholic fatty liver disease progression (Hepatology, 2024)
- Helicobacter pylori VacA-induced mitochondrial damage in the gastric pit cells of the antrum and therapeutic rescue (Biomaterials. 2024)
- ARL6IP1 gene delivery reduces neuroinflammation and neurodegenerative pathology in hereditary spastic paraplegia model (J Exp Med, 2024)

Bionano technology Research Center

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INTRODUCTION

The Bionanotechnology Research Center is dedicated to advancing biomedical technologies through the integration of novel biomarker discovery and cutting-edge bionano-contents. By harnessing convergence technologies, the center develops state-of-the-art biosensors for the diagnosis of infectious diseases, chronic and intractable conditions, and environmental hazards as well as theragnostic platforms that link diagnosis and treatment. Through these efforts, the center is committed to enabling personalized and precision medicine, contributing to the realization of a healthier and more sustainable future society.

RESEARCH AREAS

- **Advanced Bio-Nano Convergence Technologies**
  - Discover disease-specific biomarkers and targets to power personalized therapies.
  - Engineer nano-bio interfaces for optimal biocompatibility and performance.
  - Build ultra-sensitive sensing platforms for early detection and continuous monitoring.
  - Innovate across electrochemical, optical, magnetic, and image-based diagnostics.
- **Translating Innovation into Clinical Solutions**
  - Create multifunctional nanocomposites uniting imaging and targeted drug delivery.
  - Harness precision delivery systems for site-specific therapy and visualization.
  - Drive research-to-clinic pipelines from discovery to commercialization.
  - Design scalable platforms for infectious, oncologic, and rare diseases.
  - Integrate in vitro and in vivo diagnostics for seamless, end-to-end care.

RECENT ACHIEVEMENTS

- **Amplifying mutational profiling of extracellular vesicle mRNA with SCOPE (Nat. Biotechnol., 2024. PMID: 39375445)**
  - Development of the SCOPE platform for ultrasensitive and specific detection of extracellular vesicle (EV) mRNA using CRISPR-Cas13-based amplification.
  - Successful application of SCOPE in identifying oncogenic mutations (KRAS, BRAF, EGFR, IDH1) and monitoring tumor burden and patient stratification in lung, colorectal, and glioblastoma models.
  - Demonstration of sub-attomolar sensitivity and single-nucleotide resolution with a single-pot, automated system, advancing the clinical utility of EVs in precision oncology.
- **Advancing SARS-CoV-2 variant detection with high affinity monoclonal antibodies and plasmonic nanostructure (Adv. Funct. Mater., 2024, 34, 2405340)**
  - Development of a nanoplasmonic biosensor combining SERS-optimized gold nanostructures and highly selective monoclonal antibodies for accurate detection of SARS-CoV-2 and its variants.
  - Demonstrated feasibility of airborne virus detection by integrating the sensor into face masks, suggesting practical utility for real-time COVID-19 monitoring and prevention.
- **All-in-one fusogenic nanoreactor for the rapid detection of exosomal microRNAs for breast cancer diagnosis (ACS Nano, 2024, 18, 26297-26314)**
  - Development of an all-in-one fusogenic nanoreactor system containing DNA-fueled molecular machines for single-step, nonenzymatic amplification-based detection of extracellular vesicle (EV)-associated miRNAs.
  - Rapid (< 30 min), noninvasive molecular profiling of breast cancer through direct analysis of EV miRNAs in various biofluids (cell culture, urine, plasma) and 95.4% diagnostic accuracy in distinguishing breast cancer patients, highlighting its potential in personalized cancer care.
- **Empowering the on-site detection of nucleic acids by integrating CRISPR and digital signal processing (Nat. Commun., 2024, 15, 6271)**
  - Introduction of the CreDiT (CRISPR Enhanced Digital Testing) platform for rapid, low-cost, on-site nucleic acid detection, aiming at addressing global disparities in cervical cancer screening.
  - Integration of a one-pot CRISPR-based amplification system into fluorescent digital encoding/decoding technology, enabling sensitive detection of viral DNA down to single-copy levels within 35 min.
- **Self-assembled multicolor fluorescent nanoparticles derived from dopamine analogues: A versatile platform for biomedical applications (Chem. Eng. J., 2024, 495, 152739)**
  - Development of multicolor, pH-responsive fluorescent polydopamine nanoparticles for broad-spectrum bioimaging and targeted theranostic applications.
  - Integration into tissue-adhesive PDMS sheets enabling long-term (15-day) in vivo fluorescence monitoring for improved adhesion and functionality for internal tissue diagnostics.

Plant Systems Engineering Research Center

Dr. **Hye Sun Cho**

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INTRODUCTION

To address the urgent challenges posed by climate change, our center is pioneering the development of core technologies for next-generation crop improvement. We integrate cutting-edge research on plant environmental responses with advanced gene regulation and genome editing techniques. Our vision is to lead innovation in crop trait design by combining expertise in plant regeneration, molecular biology, multi-omics approaches, and protein modeling, ultimately establishing a global platform for sustainable agriculture.

RESEARCH AREAS

- **Deciphering Molecular Mechanisms of Plant Environmental Responses**
  - Unraveling key physiological and molecular processes that govern plant adaptation to abiotic stresses.
  - Mining and characterizing novel genetic resources for stress resilience enhancement.
- **Advancing Plant Regeneration Technologies**
  - Identifying molecular drivers of plant cell totipotency and regeneration.
  - Developing universal, highly efficient regeneration protocols applicable across diverse crop species.
- **Establishing a Plant Systems Biology Platform for Bio-innovation**
  - Building comprehensive omics resources and advanced bioinformatics pipelines
  - Engineering plant metabolic pathways to enhance the production of valuable biomaterials.
  - Designing and optimizing synthetic genetic circuits for precision reprogramming of plant functions.

RECENT ACHIEVEMENTS

- **Proposing a New Paradigm in Plant Stress Regulation (The Plant Cell, 2024, accepted)**
  - For the first time globally, we identified that the dephosphorylation of spliceosomal components, such as PRP18a, plays a critical role in pre-mRNA splicing and heat stress adaptation. This discovery overcomes the limitations of traditional stress research that has predominantly focused on gene expression regulation.
- **Establishing a Protease Inhibition Strategy via SlCYS8-EGF Fusion for Enhanced Protein Stability (Journal of Integrative Plant Biology, 2024, accepted)**
  - By fusing SlCYS8 with EGF, we successfully developed a novel protease inhibition system that dramatically reduces protein degradation in plants. This approach enabled the production of physiologically active proteins at significantly higher levels compared to conventional systems.
- **Establishment of a Plant-Based Production System for Functional Activin A (Rice, 2024)**
  - We developed a stable and efficient plant-based platform for producing biologically active mature activin A, demonstrating its full functional activity in cancer cells and highlighting its potential as a research tool for cancer therapeutics.
- **Demonstration of the Superior Diagnostic Performance of Plant-Derived FMDV Antibody-HRP Fusion Proteins (Plant Biotechnology Journal, 2024)**
  - We successfully demonstrated that HRP-fused FMDV antibodies produced in plants exhibit significantly enhanced HRP enzymatic activity compared to those produced in CHO cells, highlighting the superior potential of plant-based platforms for the development of highly efficient diagnostic reagents.
- **MicroRNA396 Identified as a Key Inhibitor of Shoot Regeneration in Tomato (Hortic. Res., 2024)**
  - Suppression of microRNA396 (miR396) significantly enhanced shoot regeneration efficiency in tomato by upregulating GROWTH-REGULATING FACTORs (GRFs), providing a new strategy to improve plant transformation and genome editing in low-regeneration genotypes.
- **High-Quality Chromosome-Level Genome Assembly of Nicotiana benthamiana (Sci Data, 2024)**
  - We generated a high-quality, chromosome-level genome assembly of the N. benthamiana LAB strain from Korea (NbKLAB), achieving 99.5% BUSCO completeness and significantly improving sequence accuracy, providing a crucial genomic resource for plant research and comparative genomics.

Director
Dr. Hong-Weon Lee
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Division of Biotechnology Innovation

- Technology Transfer Center
- SME Support Center
- BioProcess Engineering Center
- Bio-Evaluation Center
- Core Research Facility & Analysis Center

Technology Transfer Center

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INTRODUCTION

The Technology Transfer Center (TTC) at the Korea Research Institute of Bioscience and Biotechnology (KRIBB) is dedicated to enhancing the applicability and commercial value of KRIBB's intellectual property (IP). TTC supports the development and transfer of both tangible and intangible assets through a range of structured programs.

RESEARCH AREAS

- **KRIBB's Technology Transfer Center (TTC) offers several programs to support the development and commercialization of its intellectual property (IP)**
  - IP-INNO : Facilitates the creation of robust IP by supporting the full lifecycle from initial research planning to patent application.
  - TECH-UP : Bridges the gap between research and market needs by refining technologies with input from industry experts.
  - IP Biz : Focuses on successful commercialization through services such as marketing, negotiation and technical support.
  - Technology Valuation and IP Management: Ensures informed commercialization by managing research records and performing detailed IP evaluations.

RECENT ACHIEVEMENTS

- **Significant Growth in Licensing and Contracts:**
  - Technology licensing revenue rose 60%, from 7.6 billion KRW (2015–2019) to 12.2 billion KRW (2020–2024).
  - Technology transfer contract value increased more than tenfold, from 25 billion KRW to 254 billion KRW over the same periods.
- **Major Technology Transfer Deals:**
  - OnecureOOO Co., Ltd (May 2023): 18.7 billion KRW.
  - TSOOO Co., Ltd (July 2023): 11.7 billion KRW.
  - TSOOO Co., Ltd (August 2023): 10 billion KRW.
- **High Return on Investment:**
  - Technology transfer contracts totaling 13.83 billion KRW were secured, achieving returns over 17 times the original investment of 0.8 billion KRW through follow-up R&D and commercialization support.

SME Support Center

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INTRODUCTION

The SME Support Center was established to foster the bioindustry in Korea by providing both technical and business support to small and medium-sized enterprises (SMEs). Our mission is to facilitate the creation and growth of new biotechnology ventures by offering the essential resources needed for their development.

To achieve this, we design and operate a variety of programs that leverage our budget, equipment, facilities, and research personnel.

We also implement government-funded projects and actively build networks within both domestic and global bio-business ecosystems by engaging with key stakeholders, including experienced business professionals, venture capital firms, and partners from both the public and private sectors.

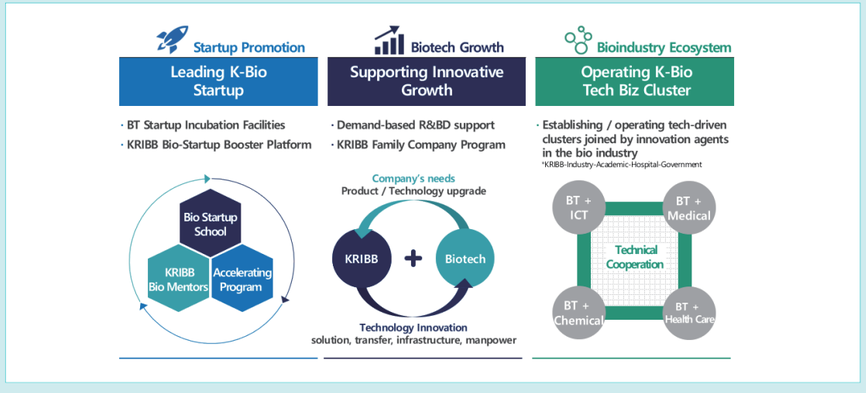
RESEARCH AREAS

- **Creation and Acceleration of Bio-Ventures**
  - The Center operates Bio-Venture Center (BVC), a biotech-focused business incubator that supports early-stage bio-ventures by providing dedicated space along with administrative and entrepreneurial services.
- **We also run the K-Bio Startup Booster Program, a comprehensive initiative that supports the successful launch and growth of bio-ventures through**
  - Tech-Mining: Identifying potential business ideas and entrepreneurs
  - Startup School: Entrepreneurial training
  - Startup Consulting: Business model development and growth/exit strategy planning
  - Incubation: Providing workspace and infrastructure
  - Accelerating: Supporting investment attraction and product development
  - Open Innovation for Bio-Venture Creation: We facilitate the joint creation of bio-ventures by connecting KRIBB researchers with external business experts
  - Bio-Venture Center (BVC): Accelerates the establishment and growth of early-stage bio-startups through dedicated space, infrastructure, and tailored incubation programs
- **Coordination of R&BD Collaboration**
  - Since 2015, we have coordinated R&BD (Research and Business Development) collaboration programs between KRIBB researchers and innovative biotech companies. Participating companies receive customized R&BD support tailored to their growth stages and business goals.
  - Hidden Champions Program: Supports the development of new products aimed at entering the global market.
  - Technology Innovation Program: Provides technical solutions for early-stage bio-startups and companies located near KRIBB branch campuses.
- **Strengthening the Bioindustry Ecosystem**
  - To promote the exchange of ideas and mutual growth, we organize networking events and collaboration programs with biotech companies.
  - K-Bio Tech-Biz Clusters: We partner with companies, universities, research institutes, hospitals, and government agencies across various sectors of the bioindustry.
  - Support for KRIBB Family Companies*: We support 244 companies through R&D collaboration, technology licensing, and technical/business mentoring.

  * KRIBB Family Company: firms with close collaborative relationships with KRIBB

RECENT ACHIEVEMENTS

- **Creation and Acceleration of Bio-Ventures**
  - 20 startups are currently incubated at Bio-Venture Center and 86 startups have graduated since 2000.
  - 16 of these companies are listed on KOSDAQ (as of 2024).
  - Combined sales reached 21.1 billion KRW in 2024.
  - 321 billion KRW in venture capital investments secured between 2015 and 2024.
- **R&BD Collaboration**
  - 6 biotech SMEs are currently in R&BD collaboration with KRIBB: 2 in the Hidden Champions Program and 4 in the Technology Innovation Program.
- **Strengthening Bioindustry Ecosystems**
  - Bio Tech-Biz Clusters established in various regions:
    · Daejeon Metropolitan City: Bio-ICT convergence
    · Chungcheongbuk-do Province: Biopharmaceuticals
    · Jeollabuk-do Province: Eco-friendly biomaterials
    · Gyeonggi-do Province: Diagnostics and medical devices



BioProcess Engineering Center

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INTRODUCTION

Established in 1995, the BioProcess Engineering Center (BPEC) has played a pivotal role in advancing industrial biotechnology in Korea. The center specializes in microbial fermentation, biotransformation, and downstream processing, while also conducting cutting-edge research in animal cell culture for biopharmaceutical production. BPEC supports the large-scale manufacturing of therapeutic proteins and is actively expanding its scope to next-generation biologics, including mRNA-based therapeutics and cell and gene therapies (CGT). It further strengthens the domestic bioindustry by facilitating technology transfer, optimizing bioprocess equipment, and providing professional training programs.

RESEARCH AREAS

- **Advancing Global Technological Competitiveness in Biomanufacturing**
  - Development of Core process technologies for the commercialization of biomedical/chemical products.
  - Support for Process Development and Prototype Production tailored to industry needs.
- **Establishment and supporting of Industry-Academia-Research Infrastructure for biotechnology industrialization**
  - Operation and service provision of Pilot-Scale Production Facilities for Microbial Fermentation, Purification, and Animal Cell Culture.
  - Workforce Training and Education programs for Workforce for the biotechnology sector.
  - Facilitation of collaborative research and dissemination of internal and external R&D outcomes.
  - Standardization of Production Technologies to ensure quality and scalability.

RECENT ACHIEVEMENTS

- **Design of Bioprocesses for Bio-based Material Production Using Fermentation Process Simulation**
  - Stoichiometry-based design of fermentation media.
  - Development and packaging of fermentation process simulation models.
  - Optimization of bioprocess parameters using model-based approaches.
- **Development of a Chemically Defined Media-Based Manufacturing Process for CAR-T Cell Therapy**
  - Comparative analysis of T cell proliferation across commercial chemically defined media and selection of optimal medium.
  - Optimization of CAR-T cell culture conditions and validation of antitumor efficacy.
- **Tailored Industrial Process Development for Client Companies**
  - Development of production technology for EGF protein raw material using yeast extract.
  - Development of natural cosmetic ingredients using yeast fermentation metabolites.
  - Development of production and purification technology for canine-derived antigen proteins.
  - Comparative performance evaluation of imported bioreactors using protein-producing cell lines.
- **Prototype Production Based on Corporate Demand**
  - Scale-up of fermentation-based production and development of separation/purification technology for functional cosmetic ingredients.
  - Pilot-scale production of human-like collagen protein.
  - Prototype production of high-concentration vitamins for cost-effectiveness.
  - High-yield production technology for precursor peptides used in liraglutide biosimilar manufacturing.
- **Bioprocess Equipment Utilization Support : 502 cases**
- **Professional Training in Biochemical and Pharmaceutical Manufacturing : 20 trainees**

Bio-Evaluation Center

Dr. **Chang-Gi Kim**

Associate Director

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INTRODUCTION

The Bio-Evaluation Center serves as a central hub assisting the industrialization of emerging new organisms, including living modified organisms (LMOs) and genome-edited organisms by continuously developing technologies for and supporting genetic analysis and for human and environmental risk assessment using secured human resource and infrastructure. Furthermore, the Bio-Evaluation Center provides end-to-end support for the entire process from development to commercialization. This positions the Center as a key institution for evaluating the safety of domestic bio-products.

RESEARCH AREAS

- **Development and establishment of evaluation techniques for living modified organisms**
  - Broadening the range of host types and introduced gene formats in living modified organisms, including plants and microorganisms.
- **Assistance with the development and regulatory approval of living modified organisms for commercialization**
  - Providing support for genetic analysis, as well as human and environmental risk assessment, for domestically developed living modified organisms.
- **Incorporating cutting-edge techniques into the risk assessment of living modified organisms**
  - Introducing and applying state-of-the-art technologies, such as Digital PCR and Next-Generation Sequencing, into the risk assessment processes for living modified organisms.

RECENT ACHIEVEMENTS

- **Bio-Evaluation Support for living modified organisms**
  - Living modified microorganisms, with support from the Bio-Evaluation Center, successfully received risk assessment approval from the Ministry of Food and Drug Safety (Korea) for food use (2 events) and from the Ministry of Trade, Industry and Energy (Korea) for industrial use (1 event).
  - Continual support in securing domestic regulatory approval for living modified microorganisms intended for food use (1 event) or industrial use (2 events).
  - Continual support in securing international regulatory approval for living modified microorganisms intended for industrial use.
- **LMO Policy Support (backed by the Ministry of Trade, Industry and Energy and the Rural Development Administration)**
  - Assistance in developing guidelines for the environmental risk assessment of LMOs intended for food, feed, and processing.
  - Support in establishing risk assessment standards and guidelines for industrial LMOs.
  - Assistance in creating a system for Excellent Safe Organisms under the revised LMO Act (regulatory simplification).
  - Support for the development of a new risk assessment model based on NGS (simplification of assessment processes and cost reduction).
  - Participation in meetings of the Parties to the Cartagena Protocol.
  - Development of policies to address the pre-review system for gene-edited plants.

Core Research Facility & Analysis Center

Dr. **Hyun Woo Oh**

Associate Director

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INTRODUCTION

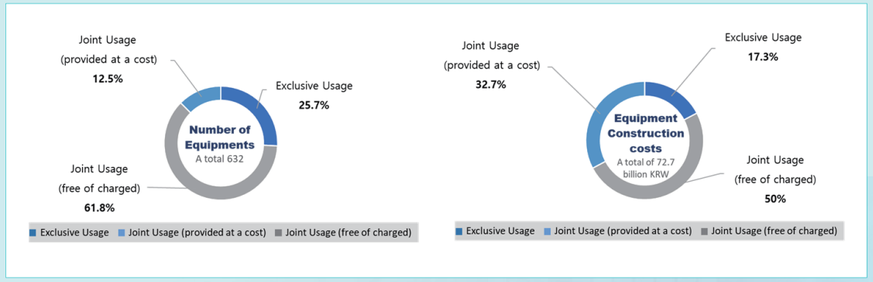
The Core Research Facility & Analysis Center is dedicated to establishing and operating shared research infrastructure tailored to the researcher's need. By building and managing high-end scientific instruments, the center enables efficient joint utilization of costly equipment across internal research divisions. It also provides proximity-based technical support to facilitate seamless access to these resources. Furthermore, the center is expanding its role by integrating diverse analytical platforms from various departments, with the goal of creating a comprehensive research support system.

RESEARCH AREAS

- Operation of integrated research equipment room and common equipment room for efficient joint-usage of research equipment
- Establishment and operation of joint utilization system to enhance shared usage of research equipments
- Survey and asset inspection for the shared research equipments (once a year)
- Implementation of projects linked to the integrated portal (ZEUS) for National research facility equipment utilization
- Increase joint-usage research equipments and improve management efficiency
  - Stabilization of a mobile app(Biocore) that can be accessed in real-time at the research site.
  - Implementation of additional function for research equipment location map.
- Enable to identify the status of research equipment for joint-usage
  - 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 research equipments
  - Establishment of Central Analysis Laboratory (in Ochang subdivision) at the basement of Biomedical Building.
- Supports proteome and structural data analysis of biosamples using common equipment
  - Identification of proteins and compounds by Mass Spectrometry (MS).
  - Structural analysis of proteins and various biomolecules using Cryo-TEM.

RECENT ACHIEVEMENTS

- Comprehensive survey of jointly used research equipment(as of 2024)



- Facilitating outstanding research outcomes through advanced Cryo-TEM & Mass Spectrometry analysis
  - Dissemination of pathogenic bacteria is reinforced by a MARTX toxin effector duet (Nat Commun, 2024).
  - Angiotensin-converting enzyme inhibition prevents l-dopa-induced dyskinesia in a 6-ohda-induced mouse model of Parkinson's disease (Eur J Pharmacol, 2024).
  - Microbiome-Derived Lipid Nanoparticles for Improved Immunogenicity of mRNA Vaccines (ACS Materials Letters, 2024).

Research Divisions

Branch Director

Dr. Sei-Ryang Oh

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Ochang Branch Institute

- Natural Product Research Center
- Chemical Biology Research Center
- Nucleic Acid Therapeutics Research Center

Natural Product Research Center

Dr. **Sei-Ryang Oh**

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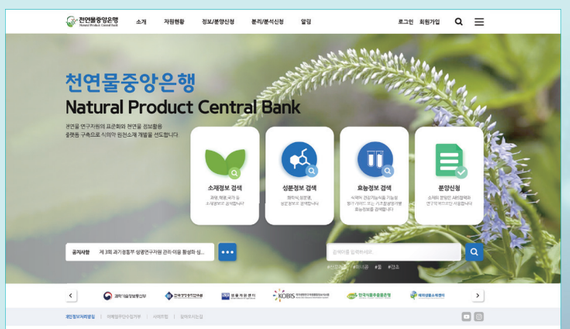
INTRODUCTION

- Plant-derived natural products have been used traditionally as medicine since ancient times, and are currently being actively utilized as raw materials for new drugs, natural medicines, health functional foods, and functional cosmetics.
- The Natural Products Research Center operates the largest domestic natural product extract bank (Natural Products Central Bank) of native/foreign plant resources, to provide standard extracts and natural product information, discovers plant-derived natural products that are effective for chronic diseases, and conducts research to develop effective raw materials that can be used in the food and pharmaceutical industries.

RESEARCH AREAS

- Management of Natural Product Central Bank
  - Securing natural materials derived from domestic/overseas plants and manufacturing standard extracts.
  - Establishment of integrated information on materials/analysis/efficacy of domestic native plants.
  - Provision of standard extracts and information and searching program.
- Development of raw materials for treatment of chronic diseases
  - Research for effective targets of respiratory/metabolic diseases, evaluation of efficacy of natural products, and efficacy mechanism.
  - Research on separation and structural analysis of active natural compounds.
  - Discovery of food and drug source materials and standardization of raw materials from domestic/foreign plants.



RECENT ACHIEVEMENTS

- **Establishment of a specialized portal for natural products and establishment of an information utilization platform**
  - Establishment of an integrated distribution system for standard extracts of domestic and overseas strategic materials.
  - Establishment of an integrated information utilization platform for plant materials, extract profiles/phytochemical analysis and biological efficacy.
- **Research on the physiological activity of natural products and standardization of raw materials**
  - Daphnetin alleviates allergic airway inflammation by inhibiting T-cell activation and subsequent JAK/STAT6 signaling (Eur. J. Pharm. (2024) vol. 979 p176826).
  - Effect of isoscopoletin on cytokine expression in HaCaT keratinocytes and RBL-2H3 basophils: preliminary study (Int. J. Mol. Sci. (2024) vol. 25 p6908).
  - Regional comparison study of Epimedium koreanum using UHPLC-QTOF/MS-based metabolomics approach (Appl. Biol. Chem. (2024) vol. 67, p54).
  - A metabolomics approach to identify factors influencing their alpha-glucosidase and hDPP-IV activity relative to chemical marker in adzuki bean (Vigna angularis (Willd.) Ohwi & H. Ohashi) cultivars (J. Appl. Biol. Chem. (2024) vol. 67, p105).
  - Rotundifuran induces ferroptotic cell death and mitochondria permeability transition in lung cancer cells (Biomedicines (2024) vol.12, p576).

Chemical Biology Research Center

Dr. **Jae-Hyuk Jang**

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INTRODUCTION

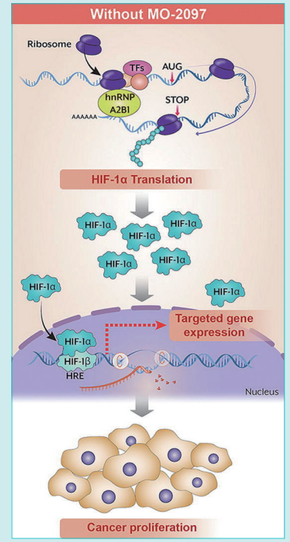
The research goal of the center is to develop next-generation innovative new drug based on chemical biology research techniques. To this end, we discover pharmaceutical active substances from various biological resources, especially microorganisms, which are important resources for new drug development, interpret their functional mechanisms and identify cellular target proteins, and use them to understanding life phenomena and to develop novel drugs for various diseases such as cancer, metabolic diseases, infectious diseases, and immune diseases.

RESEARCH AREAS

- **Discovery of bioactive novel microbial secondary metabolites for drug development**
  - Through enforced activation of biosynthetic cryptic gene clusters.
  - Studying the enzymatic machinery for the biosynthesis of secondary metabolites and development of new drugs candidates.
  - Construction of artificial biosynthetic pathway for useful bioactive compounds.
  - Construction of microbial secondary metabolites library.
- **Discovery of First-In-Class Anticancer Agents through Innovative Cancer Target Strategy**
  - Identification of bioactive compounds regulating tumor cell proliferation, apoptosis, autophagy, and metastasis.
  - Modulation of Cancer Associated Fibroblasts(CAF) for cancer therapeutics development.
  - Regulation of anticancer drug resistance by primary cilia.
  - Development of anticancer agents for inhibition mechanism of RNA binding protein, hnRNPA2B1.
  - Establishment of patient-derived cancer organoid and development of drug efficacy test system using cancer organoid.
  - Development of fluorescent probes to detect specific environmental changes within cells.
  - Development of anti-cancer candidates by inhibiting CSE1L to block tumor cell invasion and metastasis.
  - Development of inspired chiral-free benzofuran anti-cancer agents.

RECENT ACHIEVEMENTS

- HIF-1α inhibition by MO-2097, a novel chiral-free benzofuran targeting hnRNPA2B1 (Journal of Advanced Research, 2024, Dr. Nak-Kyun Soung)
- Mining biosynthetic gene clusters in Paenibacillus genomes to discover novel antibiotics (BMC Microbiology, 2024, Dr. Jae-Hyuk Jang)
- Naphthalamide-biotin-based fluorescent probe: A sensitive tool for CO detection in cancer cells and zebrafish (Dyes and Pigments, 2024, Dr. Sung-Kyun Ko)
- New autophagy-modulating lanostane-type triterpenoids from a hallucinogenic poisonous mushroom Gymnopilus orientispectabilis (Archives of Pharmacal Research, 2024, Dr. Sung-Kyun Ko)
- Protective effect of hygrolansamycin C against corticosterone-induced toxicity and oxidative stress-mediated via autophagy and the MAPK signaling pathway (Pharmacological Reports, 2024, Dr. Sung-Kyun Ko, Dr. Jae-Hyuk Jang)
- Inhibitory effect of human indoleamine 2,3-dioxygenase 1 (hIDO1) by kazinols of 1,3-diphenylpropane derivatives (Applied Biological Chemistry, 2024, Dr. Sung-Kyun Ko)
- Transport of Golgi-localized β-catenin p-S47 by KIF11 or KIFC3 induces primary ciliogenesis (Molecules and Cells, 2024, Dr. Kyung Ho Lee)



Nucleic Acid Therapeutics Research Center

Dr. **Hyunjoo Cha**

Associate Director

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INTRODUCTION

The Nucleic Acid Therapeutics Research Center at KRIBB develops next-generation RNA vaccines and therapeutics to address infectious, oncologic, rare, and neurodegenerative diseases. By combining proprietary RNA designs—including mRNA, saRNA, and circular RNA—with advanced lipid nanoparticle (LNP) delivery systems, we aim to achieve targeted and durable therapeutic effects. Our innovations include organ- and mucosa-targeted LNPs, BBB-penetrating formulations, and AI-guided target discovery. Through global collaborations with institutions such as the University of Pennsylvania and University of British Columbia, we are advancing RNA platforms with strong translational potential.

RESEARCH AREAS

- **Next-generation RNA structure design**
  - Development of proprietary mRNA, saRNA, and circRNA constructs with improved translation efficiency, stability, and persistence.
- **Scalable RNA production platform**
  - Establishment of GMP-compatible large-scale in vitro transcription and purification protocols for various RNA modalities.
- **Advanced lipid nanoparticle (LNP) delivery systems**
  - Design and screening of novel ionizable lipids; development of LNPs for intramuscular, intranasal, and organ-specific (CNS, lung, retina, inner ear, tumor) delivery.
- **Mucosal and systemic vaccine development**
  - Development and preclinical evaluation of COVID-19, pan-sarbecovirus and universal influenza mRNA/saRNA vaccines via intramuscular and nasal routes.
- **RNA therapeutics for rare and intractable diseases**
  - Evaluation of RNA/LNP formulations in models of glioblastoma, Alzheimer's, spinal muscular atrophy, and hereditary deafness.

RECENT ACHIEVEMENTS

- **Development of KRB1-7, KRIBB's first-generation COVID-19 mRNA vaccine**
  - Engineered by combining proprietary mRNA structures (KRB1–4) with high-efficiency ionizable lipid H9T6 for enhanced immunogenicity and durability (KRB1–4 PCT: PCT/KR2024/018416, H9T6 LNP: 10-2024-015562).
- **Establishment of a novel intranasal mRNA/saRNA vaccine platform (Molecular Therapy. 2025. 25:00269-2)**
  - Developed in collaboration with the University of Pennsylvania and University of British Columbia to enable mucosal delivery against respiratory viruses.
- **Construction of a high-throughput ionizable lipid library (>2,000 candidates) (ACS Applied Materials & Interfaces. 2025. doi: 10.1021/acsami.5c06464)**
  - Applied for organ-specific RNA delivery, including CNS-penetrating LNPs for glioblastoma and neurodegenerative disease models.
- **Design of AI-guided universal influenza and pan-sarbecovirus antigens (ACS Materials Letters. 2024. 6:1557-1563)**
  - Structure-based vaccine antigens targeting conserved viral regions, integrated into next-generation mRNA vaccine platforms.
- **Patent filings for lipid nanoparticles**
  - Multiple domestic patent applications were submitted in 2024, including those covering asymmetrical tail lipids and tumor-delivery formulations (10-2024-0057790 and 10-2024-0125965).

Director
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Division of National Bio-Infrastructure

- Laboratory Animal Resource & Research Center
- National Primate Research Center
- Futuristic Animal Resource & Research Center
- Bio-Resource Central Bank
- International Biological Material Research Center
- Korea Preclinical Evaluation Center
- Bio-Infrastructure Policy Support Center

Laboratory Animal Resource & Research Center

Dr. **Ki Hoan Nam**

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INTRODUCTION

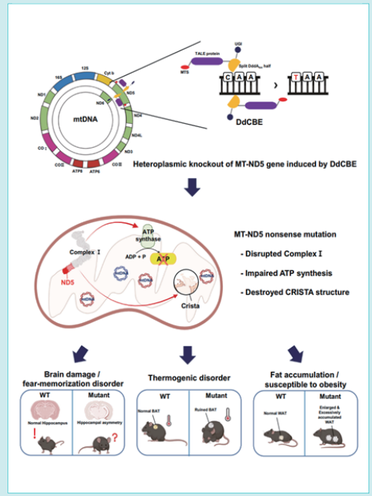
The goals of the center are to establish a national infrastructure for laboratory animal resources and a public/intramural service core for animal experiments. For these purposes, we have been collecting mouse resources, developing quality control technologies, generating animal models for human diseases, 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 and Central Bank of Model Animal Cluster by Ministry of Science and ICT in 2019 and 2020, respectively.

RESEARCH AREAS

- Collection, maintenance, production 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
- Establishment of infrastructure for non-clinical evaluation of drug candidates
- Efficacy evaluation of drug candidates
- Pharmacokinetic study in drug development

MAIN PROJECTS

- **KRIBB Initiative Program**
  - Running of the mouse resource bank.
  - Establishment of animal models for cancers (humanized, orthotopic) and acute lung injury.
  - Research Support for Animal Experiments.
  - Establishment of animal models for non-clinical evaluation of new drug candidates and research support for industry, academy and research institute.
- **[NRF] Studies on the regulation of arthritis by orphan nuclear receptor**
  - Promotion of the model animal central bank.
  - Functional analysis of orphan nuclear receptors in osteoarthritis.
- **[MOTIE] High-Throughput 3D Multifunctional Tissue-based Screening Service of Efficacy and Safety for Drug Discovery**
  - Organoid-based pharmacokinetic evaluation platform.
- **[Industry-Sponsored Research & Self-Supporting Account System] Research support for industry, academy and research institute**
  - Technical assistance for efficacy evaluation of drug candidates (small molecules, therapeutic antibodies, cell therapeutics etc.).



RECENT ACHIEVEMENTS

- **Running an Exclusive Center for Mouse Resource in Korea**
  - Designated as a Central Bank for Model Animal Cluster by MSIT since 2020.
- **The largest laboratory animal resource bank in Korea**
  - Deposits of laboratory animal resources exceed 2,300 strains, and their distribution amounts to more than 6,000 animals.
- **Center for quality control of laboratory animals**
  - Health monitoring covers more than 6,000 animals, and animal clearing involves more than 140 strains.
- **Research supports for animal experiments**
  - IACUC-approved animal experiments number 142 items, and pathological experiments comprise 1,053 cases with 14,994 specimens.
- **Technical assistance for non-clinical evaluation of new drug candidates**
  - Efficacy evaluation of new drug candidates comprises 822 cases, and pharmacokinetic studies in drug development comprise 226 cases.
- **Development of animal models with targeted mitochondrial gene mutation**
  - Technology development for precise base editing in mitochondrial DNA.

National Primate Research Center

Dr.**Jae-Won Huh**

Associate Director

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INTRODUCTION

The National Primate Research Center (NPRC) has established specialized facilities for primate-based research in accordance with international standards. These efforts include the securing and maintenance of primate resources, expansion of advanced equipment and professional personnel, and enhancement of its research management system. NPRC supports collaborative efforts across industry, academia, and research institutions by providing access to advanced imaging equipment such as 3T MRI, PET-CT, and Micro PET-CT. It also facilitates research on novel drugs, stem cells, and gene therapy through a dedicated support system.

In addition, NPRC aims to develop disease models and construct efficacy evaluation systems through joint research initiatives. The Center is positioned to serve as a key infrastructure hub for responding to urgent public health challenges by operating an Animal Biosafety Level 3 (ABL-3) facility. Through this, NPRC supports research focused on the prevention and treatment of serious infectious diseases—including COVID-19, Middle East Respiratory Syndrome (MERS), Severe Acute Respiratory Syndrome (SARS), Zika virus disease, and other zoonoses—that have caused significant global health crises.

RESEARCH AREAS

- **Establishment of a System for Securing SPF Primate Resources**
  - Establish a stable system for securing Specific Pathogen-Free (SPF) primate resources essential for the development of new biologic medical products, regenerative cell therapies, and research on neurological and infectious diseases.
  - Develop a research framework based on SPF primate resources to support collaborations among industry, academia, and research institutions.
- **Management and Standardization of SPF Primate Resources**
  - Construct an internationally accredited SPF primate breeding facility and develop a management system to establish national Standard Operating Procedures (SOPs).
  - Standardize health monitoring systems to ensure the continued maintenance of SPF primate resources.
  - Build a comprehensive management system for efficient oversight of SPF primate resources.
- **Research on Primate Models for Efficacy Evaluation**
  - Establish an efficacy evaluation system based on SPF primate resources to support the discovery of new drugs, biomaterials, and vaccines.
  - Develop evaluation methodologies using imaging, molecular biology, histopathology, behavioral analysis, and cognitive function assessments.
- **Development of Primate Disease Models**
  - Develop induced disease models using SPF primate resources, including models for neurodegenerative diseases, drug addiction, aging, obesity, and infectious diseases.
  - Conduct research on efficacy evaluation systems for drug, biomaterial, and vaccine candidates utilizing these primate disease models.
- **Animal Biosafety Level 3 (ABL-3) Facility for Research Support**
  - Provide research support for studies on infectious diseases, zoonoses, bioterrorism, and antimicrobial-resistant superbacteria that pose national disaster-level threats.
- **Provision of Expertise and Technology Related to Primate-Based Research**
  - Offer researchers specialized knowledge, training, and technical support related to primate care and associated research facilities.

RECENT ACHIEVEMENTS

- **Establishment of Primate Models for COVID-19 Research**
  - Achieved the world's fourth successful development of a COVID-19 primate infectious disease model (following the United States, China, and the Netherlands).
  - Established technologies for the acquisition, isolation, purification, and amplification of the SARS-CoV-2 virus.
  - Supporting the development of vaccines and therapeutics for COVID-19 through the use of ABL-3 facilities and the COVID-19 primate model.
- **Enhancement of Breeding Environment and Management System with Consideration for Animal Welfare**
  - Developed an advanced breeding environment incorporating social housing to promote primate social interaction.
  - Provided living spaces that meet international standards in accordance with U.S. and EU animal welfare guidelines.
- **Development of Primate Disease Models and Support for Industry, Academia, and Research Institutes**
  - Established and supported primate models for Alzheimer's disease (AD), Parkinson's disease (PD), and stroke.
  - Developed evaluation systems for new drug candidates using primate models.
- **First in the world to identify the cerebrospinal fluid drainage pathway (Nature. 2024 Jan;625(7996):768-777)**
  - Nasopharyngeal lymphatic plexus is a hub for cerebrospinal fluid drainage.
- **First in the world to control feeding behavior through modulation of neural circuits in the brain (Neuron. 2024 Jul 3;112(13):2218-2230)**
  - Hypothalamic neuronal activation in non-human primates drives naturalistic goal-directed eating behavior.

Futuristic Animal Resource & Research Center

Dr. **Sun-Uk Kim**

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INTRODUCTION

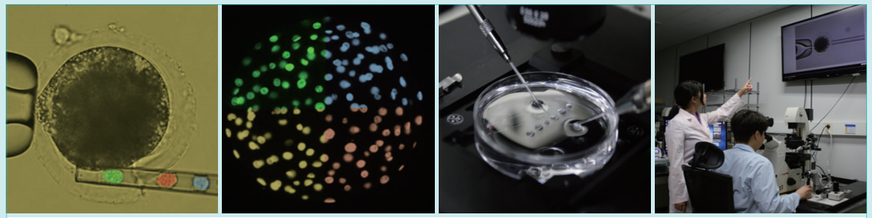
Futuristic Animal Resource & Research Center, a core infrastructure for mini-pig resources, was established with the purpose of establishing a national high-tech infrastructure with world-class resources, materials, equipment, facilities, technology, information, and manpower and supporting/leading research and development activities related to rapid response/resolution of current and future issues in science and technology, national society, and industrial economy, thereby contributing to securing/preempting national competitiveness in advanced biotechnology, promoting/expanding universal public healthcare/welfare, and revitalizing/fostering industrial ecosystems.

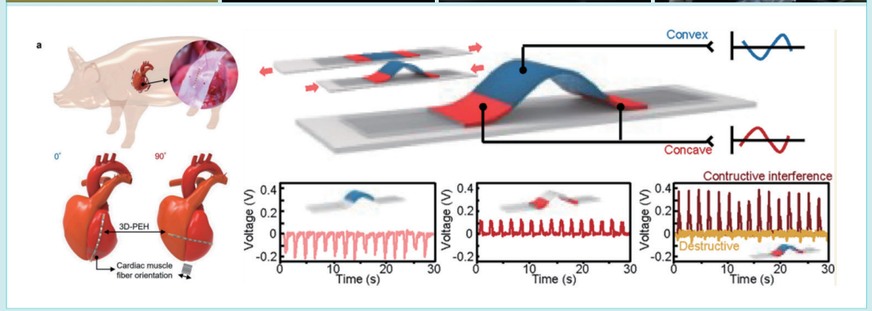
RESEARCH AREAS

- **Establishment of a system to secure, standardize, value-enhance and support mini-pig resources/materials/technologies/information**
  - Promoting the establishment of a comprehensive management system for mini-pig resources, materials, and data.
- **Promotion of the creation, evaluation, and utilization of mini-pig models for biomedical research and development**
  - Supporting transgenic/induced model mini-pigs and non-clinical evaluations.
- **Establishment and support of (advanced) regenerative medicine/biotechnology R&D support systems and non-clinical platforms**
  - Establishment of advanced regenerative medicine R&D infra/technology for artificial blood, artificial organs, etc.
  - Activation of support for (advanced) biotechnology R&D, including gene therapy, cell therapy, and new drugs.
- **Establishment and support of non-clinical evaluation platforms for (advanced/convergent) medical devices, equipment and techniques**
  - Promotion of support for non-clinical evaluation of (advanced/convergent) medical devices, equipment, and techniques based on minipig models.
- **Establishment and operation of a consumer needs-driven/lead support system**
  - Enhancement of demand research/needs-based support.
  - Establishment of forward-looking/demand-driven support system.

RECENT ACHIEVEMENTS

- Achieved maximum annual performance in support of mini-pig resource industry-academia (50 heads as of 2024.10)
- Non-clinical success in developing three-dimensional inorganic piezoelectric nanogenerators using mini-pigs (2024, ACS nano, IF=15.8)
- Global-top level of cloned mini-pig production efficiency (2021-2024)
- Patent application and technology transfer for development of a fluorescent reporter to measure real-time apoptosis and autophagy (2024)
- Advancing embryology/cloning-based technology (2024, J Anim Sci Biotech, JCR<5%)





Bio-Resource Central Bank

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INTRODUCTION

The Bio-Resource Central Bank Center deals with three clusters of the model animals, plants and microbes. Functioning as a central repository for bio-resources, it plays a pivotal role in the development of the infrastructure for the bio-resources through close collaboration with other bio-banks and relevant centers.

RESEARCH AREAS

- **Model Animal Central Bank**
  - As a central bank of physical resources/model animals, it engages in roles of resource standardization and maintains exclusive oversight of mouse resources.
- **Microorganism Central Bank**
  - Its objective is to explore novel microbial resources, emphasizing their inherent value, and furthering their utilization across the red, white, and green bio sectors.
- **Natural Product Central Bank**
  - It endeavors to create a hub-and-spoke type of cluster model, connecting a central bank, other bio-banks and relevant centers, and offers standardized natural raw materials and customized information utilization services.

International Biological Material Research Center

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INTRODUCTION

We aim to legally procure biological materials from four overseas regional centers and neighboring countries under international collaborative research frameworks. Our mission is to supply researchers with diverse resources, including indigenous medicinal knowledge, and to build national infrastructure for the development of natural pharmaceuticals, nutraceuticals, and other high-value bio-based products.

RESEARCH AREAS

- **Global Biological Material Research**
  - Operation and management of four international collaborative centers dedicated to the collection, preparation, and preliminary processing of biological materials from diverse ecological regions worldwide.
- **Integrated Resource Management System**
  - Establishment and operation of a comprehensive system and database for managing biological materials and associated traditional medicinal knowledge collected through the four regional centers and their neighboring partner countries.
- **Standardization of High-Value Bioresources**
  - Research on the standardization of highly active biological materials, including large-scale cultivation techniques and quality control measures, to build a reliable supply platform for leading research groups within project-defined frameworks.
- **Phylogenetic Analysis and DNA Barcoding**
  - Molecular phylogenetic studies and development of DNA barcodes to accurately identify and classify medicinal plant species, supporting both conservation and applied research.
- **Information Resource Studies for Cooperation and Utilization**
  - Investigation of access and benefit-sharing (ABS) systems, related laws and regulations, and region-specific information to facilitate international collaboration and responsible utilization of biological resources.

RECENT ACHIEVEMENTS

- **Establishment and operation of the International Biological Material Research Center (IBMRC)**
  - IBMRC was established in 2006 by the Korean government as a national infrastructure to support biotechnology research. IBMRC provides biological materials and related information to industry, academia, and research institutes through an open-access platform, facilitating the generation of high-quality research outcomes.
  - Retention of biological materials: 40,900 specimens (accumulated).
  - Deposits of voucher specimens: 103,000 herbarium specimens (accumulated).
  - Distribution of extracts (2024): 265,959 materials provided to research organizations (universities, research institutes, and private companies).
  - Support for bulk materials for industrialization candidates (2024): 10 cases.
  - Discovery of taxa closely related to highly active materials (2024): 2 cases.
  - Establishment of cooperation systems with industry (2024): 3 cases.
  - Technology transfer to companies (2024): 1 case.
- **Operation and management of four collaborative biological material research centers**
  - Korea-China Biological Material Research Center (Kunming).
  - Korea–Costa Rica Biodiversity Research Center (Cartago).
  - Korea-Indonesia Biological Material Research Center (Tangerang).
  - Korea-Vietnam Biological Material Research Center (Hanoi).
- **International collaborative research**
  - Status of International Partnership (2024): 12 countries, 12 Institutions.
  - 39 countries, 55 Institutions (accumulated).
  - Joint research consultations with overseas local research institutes (2024): 12 institutes.
  - Exchange program (2024): 3 scientists from the USA and Mongolia.
- **Selected Publications**
  - Intracellular gene transfer (IGT) events from the mitochondrial genome to the plastid genome of the subtribe Ferulinae Drude (Apiaceae) and their implications, BMC Plant Biology, 24(1), 1172. Sangjin Jo, J.H. Paik and Sangho Choi.

Korea Preclinical Evaluation Center

Dr. **Kyong-Cheol Ko**

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INTRODUCTION

The Korea Preclinical Evaluation Center (KPEC) is a mission-driven national center dedicated to providing a continuous, preemptive, and rapid response to emerging and re-emerging infectious diseases (EIDs). KPEC establishes and operates a one-stop support system for preclinical research, providing a critical foundation for accelerating the development of vaccines and therapeutics. The center is also developing a digital preclinical platform to enhance predictive modeling and translational research based on preclinical infectious disease data. Through close collaboration with industry, academia, and research institutes, and by tailoring its services to their needs, KPEC contributes to strengthening the national ecosystem for infectious disease R&D.

RESEARCH AREAS

- **Development of preclinical evaluation support systems for vaccines and therapeutics targeting EIDs**
  - Efficacy assessment conducted under Biosafety Level 3 (BL3) and Animal Biosafety Level 3 (ABL3) conditions, encompassing in vitro and in vivo models
    - · Cell-based basic efficacy evaluation.
    - · Efficacy evaluation using small animal models (mouse, hamster, ferret).
    - · Efficacy evaluation using non-human primate models (Rhesus macaque, Cynomolgus macaque).
    - · Efficacy evaluation using human organoid models (e.g., lung organoids).
  - Safety assessment of vaccine and therapeutic candidates through GLP-compliant toxicity studies.
  - Pharmacokinetic (PK) evaluation of vaccine and therapeutic candidates:
    - · Proof of Concept (POC) and ADME (Absorption, Distribution, Metabolism, and Excretion) assessment using radioisotopes.
    - · PK evaluation using small animal and non-human primate models.
- **Development and advancement of infection models and testing methodologies**
  - Preemptive development and refinement of infection models and testing methodologies, focusing on priority infectious diseases selected through KPEC's Blueprint List of Priority Diseases (KPD*)
    - · Development of infection models across various platforms, including cell-based assays, human organoid systems, small animal models (mice, hamsters, ferrets), and non-human primate models.
    - · Advancement of evaluation and analytical methods for the testing of vaccine and therapeutic candidates.

* KPD : COVID-19, Influenza, SARS, MERS, SFTS, Zika, Dengue fever

- **Advancement of rapid evaluation platforms using new approach methodologies (NAMs)**
  - We are establishing and refining efficacy evaluation models while also exploring various New Approach Methodologies (NAMs).
  - These NAMs include both human organoid-based models and in silico approaches that leverage the Digital Preclinical Platform (DPP) through computer modeling and Artificial Intelligence (AI), aiming to accelerate preclinical evaluation by supplementing or potentially replacing traditional testing methods.
- **Establishment of the Digital Preclinical Platform (DPP)**
  - Establishment of the DPP through the production and utilization of high-quality infectious disease preclinical data, including digital in vitro analysis.
  - Advancement of clinical predictive technologies using real-time modeling and simulation tools based on preclinical data.
- **Enhancement of Research Infrastructure for EID Response**
  - Expansion of ABL3 facilities to strengthen non-human primate research capacity for high-risk infectious diseases.
  - Introduction of state-of-the-art biomedical research instruments, including PET-CT systems, to support advanced preclinical studies.
- **Establishment of the Pandemic Emergency Bank (PEB) for securing a library of candidate molecules**
  - Stockpiling of candidate molecules, adjuvants, and control drugs verified through KPEC's preclinical evaluation, to enable rapid deployment in response to future infectious disease threats.

RECENT ACHIEVEMENTS

- **Establishment of a one-stop preclinical support platform for EIDs and support for therapeutic and vaccine candidate development through industry-academia-research collaborations during the COVID-19 pandemic and beyond**
  - In 2024, preclinical evaluation support was provided for 84 studies across 29 institutions, covering 51 therapeutic and vaccine candidates.
  - In 2024, reflecting the needs of infectious disease R&D researchers, new preclinical study categories were established to support human organoid-based studies and PK studies using small animals.
- **Publication of multiple SCIE-indexed papers through infection model development and preclinical evaluation support**
  - Chemically-defined and scalable culture system for intestinal stem cells derived from human intestinal organoids (Nature Communications, 2024).
  - Synchronous Diagnosis of Respiratory Virus Variants via Receptonics Based on Modeling Receptor—Ligand Dynamics (Advanced Materials, 2024).
  - Strategy to develop broadly effective multivalent COVID-19 vaccines against emerging variants based on the Ad5/35 platform (Proceedings of the National Academy of Sciences of the United States of America, 2024).
  - Broad-Spectrum Antiviral Agents against SARS-CoV-2 Variants Inhibit the Conserved Viral Protein Nsp1-RNA Interaction (Angewandte Chemie International Edition, 2024).
- **Development of a prototype for digital PK analysis to establish the groundwork for the DPP**
  - Extraction of PK data from publications, image files, and datasets to build a dedicated database and development of a web-based prototype platform for PK evaluation.
- **Establishment of partnerships with affiliated institutions and hosting of forums, symposiums, and seminars to enhance collaboration networks and research capacity**

Bio-Infrastructure Policy Support Center

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INTRODUCTION

Bio-Infrastructure Policy Support Center is the secretariat of Division of National Bio-Infrastructure, which is the “Competent Authority for Biological Research Resources of the Ministry of Science and ICT (MSIT)”, and supports the establishment and execution of policies related to Biological Research Resources. As a designated center for responding to and supporting the Nagoya Protocol (ABS) of the MSIT, we also operate ABS Help-Desk for researchers. Another primary responsibility is to manage the following three committees with institutional authority, in terms of legal regulations for ensuring bio-safety: Institutional Review Board (IRB), Institutional Animal Care and Use Committee (IACUC), and Institutional Bio-safety Committee (IBC). We also research taxonomy and culture of probiotic anaerobic bacteria to cope with the ABS issues.

RESEARCH AREAS

- Support for establishing policies for Biological Research Resources and develop institutional policies for Division of National Bio-Infrastructure
- Research on ABS laws and regulations in line with global trends or emerging issues
- Provision of consulting services on the access and use of domestic and foreign genetic resources
- Management of three KRIBB ethics boards (IRB, IACUC and IBC)
- Research on taxonomy of anaerobic bacteria to cope with ABS and develop authentic probiotics of Korean origin

RECENT ACHIEVEMENTS

- **Organization of public events for the Division of National Bio-Infrastructure**
  - Joint promotion at Korean Society for Biochemistry and Molecular Biology (May 2024/KSBMB), etc.
  - KRIBB Conference (October 2024)
  - Bio-Infrastructure Advisory Committee meeting (June & October 2024)

- **Holding policy seminars in response to current issues of the Nagoya Protocol**
  - (4th)‘ABS Cases and International Trends for Researchers’ (June 2024, Daejeon)
  - (5th)‘Prospects for the Establishment of DSI Benefit-Sharing Mechanism from the Perspective of Researchers’ (September 2024, Daejeon)

- **Holding and presenting at an international symposium**
  - ‘7th Korea-Japan Symposium on the Nagoya Protocol’ (February 2024, Seoul)
  - ‘2nd Asian Academic ABS Forum – ABS Symposium 2024’ (November 2024, Bangkok)

- **Holding three KRIBB ethics boards**
  - IRB: 2 annual meetings (28 reviews conducted by the public IRB of the MOHW)
  - IACUC: 27 meetings with 378 reviews
  - IBC: 4 meetings with 7 reviews

Research Divisions

Branch Director

Dr. Cha Young Kim

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Jeonbuk Branch Institute

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

Functional Biomaterial Research Center

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INTRODUCTION

The goal of Functional 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).

RESEARCH AREAS

- **Development and commercialization of functional biomaterial-based foods and drugs in response to the current fast-changing era**
  - Discover and evaluate the efficacy of functional biomaterial in response to the fast-changing era.
  - Establishment of food and drug evaluation models and the development of appropriate biomaterial (immune response, metabolic disease, etc.).
  - Identification and profile of functional biomaterials by using spectroscopic instrumental analysis (NMR, MSMS, etc.).
  - Isolation of extracellular nano-like vesicles from natural resources and evaluation of their biological effectiveness.

- **Evaluation and support of ABL3-facility-based responses to national disasters and novel infectious diseases**
  - Efficacy assessment of COVID-19 vaccine/treatment using small-animal models for infection (hamster, ACE2-TG mouse, etc.).
  - Secure new variations of infectious pathogens and ABL3 facility operation and maintenance.

Microbial Biotechnology Research Center

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INTRODUCTION

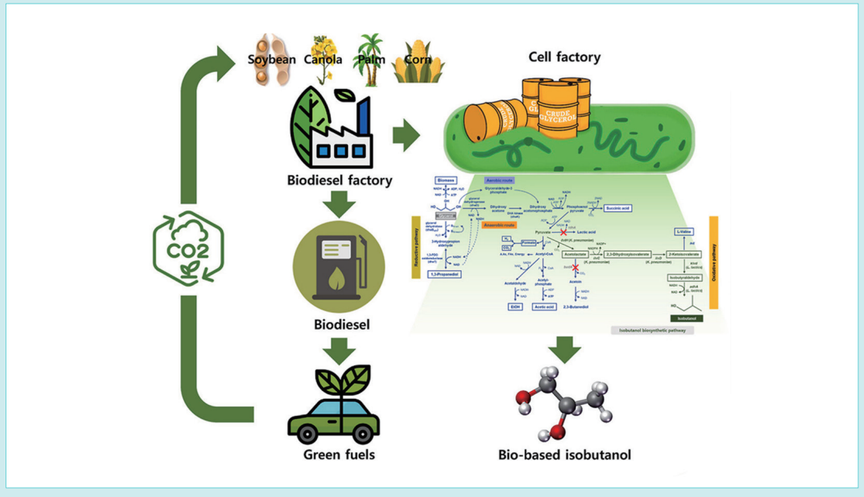
The emphasis of the Center for Microbial biotechnology research center is to develop novel technology for improving the efficiency and quality of industrial microorganisms and microbial processes in the production of food and feed ingredients, and bio-agro-products to ensure eco-friendly and sustainable BIOeconomy. Our activities are centered on both fundamental and applied biotechnology, with the view to establishing a basis for effective microbial cell factories for the development of microbial control materials and biochemicals in the field of industrial biotechnology.

RESEARCH AREAS

- **Microbial metabolic engineering**
  - Production of microbial metabolites and antimicrobial materials.
  - Metabolic engineering of industrial microorganisms.
- **Bioconversion technology**
  - High throughput screening of novel biocatalysts.
  - Directed evolution of industrial enzymes.
- **Gut microbiome research**
  - Development of novel methodologies for evaluation of gut microbiome.
  - Evaluation of prebiotics and probiotics resources for human and animal health.
- **Biochemical and bioprocess engineering**
  - Production of biochemicals for sustainable materials.
  - Development of green technologies from renewable sources.

RECENT ACHIEVEMENTS

- **Evaluation of the efficacy of prebiotics in gut microbiome consortia**
  - Short-chain fatty acids (acetic acid, propionic acid, and butyric acid) produced by the breakdown of prebiotic dietary fiber by gut microbiota directly or indirectly affect morphological differentiation and mucus secretion of HT-29 human intestinal epithelial cells (Foods, 2024, 13(19), 3194).
  - Low-molecular-weight exopolysaccharides of Cordyceps militaris (LCMP) may provide positive effects for the host by promoting probiotics to inhibit the growth of pathogens and increase the production of metabolites related to anticancer activity (LWT, 2024, 210: 116845).
- **Evaluation of the efficacy of bio-products produced by bioconversion technology**
  - A lipid mediator (LM, namely, 17S-monohydroxy docosahexaenoic acid, resolvin D5, and protectin DX in a ratio of 3:47:50) produced by soybean lipoxygenase from DHA attenuates arthritis severity, restores serum imbalances, and modifies joint damage. Thus, LM represents a promising therapy for relieving RA symptoms (Biomedicine & Pharmacotherapy, 2024, 171, 116153).
- **Research on the production of biochemicals produced through bioprocess engineering from renewable sources**
  - The Klebsiella pneumoniae Cu ΔldhAΔbudA, pUC-tac-BN-ISO strain produced 2.56-fold more isobutanol from glycerol, an abundant and inexpensive resource. This demonstrated enhanced production of isobutanol from glycerol and provides insights for future research on isobutanol production from renewable feedstock (Renewable Energy, 2024, 223, 120010).
  - Using a K. pneumoniae strain in which the budC gene was inactivated and the dhaD gene was overexpressed, the titer of 89.47 g/L of (R,R)-2,3-BDO (1.69 g/L of meso-2,3-BDO), productivity of 1.24 g/L/h, and yield of 0.35 g/g consumed crude glycerol was achieved by a two-step agitation speed control strategy (adjusted from 500 to 400 rpm after 24 h) while maintaining a purity of 98% or higher (Microbial Cell Factories, 2024, 23(1), 205).



Biological Resource Center

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INTRODUCTION

The Biological Resource Center, also known as the Korean Collection for Type Cultures (KCTC) is a nationally and internationally accredited biological resource center dedicated to the systematic management and distribution of microbial and cell resources. Since its approval as a gene bank project by the Ministry of Science and Technology in 1985, KCTC has joined WFCC and WDCM and was designated as an International Depositary Authority (IDA) by WIPO in 1990. It has since obtained ISO 9001:2015 and KS J ISO 20387:2018 certifications, meeting global standards for quality and biobanking. As Korea's national microbial bank, KCTC continues to support global scientific and industrial communities through resource sharing and international collaboration.

RESEARCH AREAS

- **Acquisition and Management of Biological Resources**
  - Collection and long-term preservation of essential biological resources to support scientific research.
  - Distribution of biological materials to academia, research institutes, and industries.
- **Development of Core Technologies for Biological Resources**
  - Advancement of platform technologies for the isolation, stable preservation, and practical application of valuable biological materials.
- **International Depositary Authority (IDA) Services**
  - Official support for the deposit, maintenance, and international distribution of patent-related microorganisms under the Budapest Treaty framework.
- **Infrastructure Development and Support for Networks and Education**
  - Establishment of regional and international collaborative networks for biological resource sharing.
  - Organization of training programs, workshops, academic conferences, and consultation services for capacity building.
- **Microbial Infrastructure for Human and Animal Health Industries**
  - Construction of a microbiome resource bank including probiotics and gut microbial strains from humans and animals.
  - Support for R&D in food additives, healthcare solutions, and gut microbiome-based industrial applications.
- **Plant Cell Resource Development and Management**
  - Collection, development, and preservation of plant cell lines such as callus, adventitious roots, shoots, and micro-tubers.
  - Large-scale production of high-value plant cell lines using bioreactor systems.
  - Enhancement of metabolite yields through elicitation and optimization of cell culture conditions.
- **Core Technologies for Plant Cell Differentiation and Regeneration**
  - Innovation in plant tissue culture technologies for the differentiation and regeneration of commercially and scientifically important plants.
  - Establishment of a national platform for genome editing and precision breeding of target plant species.
- **Localization Technology for Medical Cannabis**
  - Development of elite cell lines for the mass production of bioactive compounds from medical cannabis.
  - Implementation of metabolite farming techniques to increase cannabinoid content in plant cell cultures and controlled-environment farms.

RECENT ACHIEVEMENTS

- **In 2024, KCTC expanded its collection to 46,378 biological resources and distributed 6,468 strains to universities, research institutes, and private companies**
- **Biological resources of KCTC include 9,502 patent strains, 8,455 pseudomonadota, 5,569 molds, 5,886 actinomycetota, 5,502 bacillota, 3,123 yeasts, 1,961 microalgae, 334 archaea, 918 plant cell lines, 226 animal/human cell lines, and 4,902 other resources**
- **KCTC provides workshops and training courses on the cultivation, preservation, and management of biological resources for domestic users of bioresources as well as international researchers who are ACM members. Last year, 20 domestic workshops and 2 conference booths were provided**
- **"Advancement of Central Microbial Resource Center of the Ministry of Science and ICT" supported by the Bio&Medical Technology Development Program of the National Research Foundation(NRF) has been launched**
- **Researchers at KCTC have published 61 scientific papers, including descriptions of 21 microbial taxa in 2024**
- **KCTC acquired 295 novel type strains that were reported in international taxonomy journals in 2024**

Primate Resources Center

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INTRODUCTION

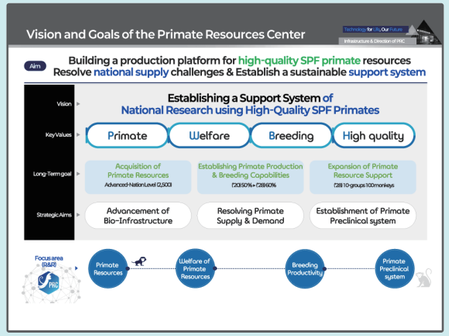
Recently, non-human primate (NHP) resources have become a very valuable resource internationally. Primate Resources Center (PRC) intends to introduce SPF primate resources for bio (medicine and vaccine) research and establish its production base. High-quality primate colonies through the breeding primate group, and establish group breeding SOP to establish a cross-ministerial support infrastructure for primate research through the establishment of a cooperative network at home and abroad.

RESEARCH AREAS

- **Maintenance, production, and distribution of non-human primate resources**
  - Establishment and preservation of laboratory non-human primate resources.
  - Constructing a 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, environmental enrichment.
  - 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 non-human primate models.
- **Collaboration and support for industrial-academic-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

- Infrastructures for securing and supporting primate resources
- Primate resources biobank for biomedical and basic science
- Creating and verifying monkey and pig models of human genetic diseases using advanced genome editing tools



RECENT ACHIEVEMENTS

- **Establishment of production system for non-human primate resources**
  - Production of two macaque species (cynomolgus monkey, rhesus monkey).
- **Creation of natural/artificial nursing environment for pregnant macaques**
  - Achieved 50% production rate of macaca monkeys (Cynomolgus monkey and Rhesus monkey) through its own breeding system in Primate Resources Center.
- **Research support of non-human primate resources/materials to national partners of industry, university, institute and hospitals (PK, PD, Organ transplantation research etc.)**
  - We supported macaque monkeys (weight, age, sex etc.) that customers needed through a strict quarantine process.
  - We supported macaque monkey materials (blood-derived cell lines, tissues) for various research.
- **Development of in vitro fertilization (IVF) monkey production and gene-targeted monkey production technology through assisted reproductive technology (ART)**
  - Development of superovulation and surrogate mother synchronization technology by checking hormone (E2, P4 etc.,) levels in serum.
  - Establishment of primate derived IVF embryos production and in vitro culture technology.
  - Development of primate embryo transplantation and pregnancy diagnosis (ultrasonic diagnostics) technology.
  - Production of genetically modified monkeys by base-editing technology.

Research Divisions

Convergence Research Centers

- Aging Convergence Research Center
- Critical Diseases Diagnostics Convergence Research Center
- Center for Gene & Cell Therapy

Aging Convergence Research Center

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INTRODUCTION

The Aging Convergence Research Center (ACRC) focuses on understanding the biology of aging and developing innovative strategies to delay or reverse age-related decline. Aging is a major risk factor for chronic diseases, yet its molecular mechanisms at the systems level remain elusive. ACRC integrates epigenetics, single-cell multiomics, and translational models to identify key regulators of aging and develop diagnostics and interventions.
In 2024, ACRC has expanded efforts in building DNA methylation-based aging clocks, identifying rejuvenating plasma factors, and mapping senescent cells in vivo using single-cell and spatial profiling. In parallel, the center is developing targeted senolytics and rejuvenation strategies for hematopoietic stem cells, aiming to improve healthspan and immune resilience.

RESEARCH AREAS

- **Development of Epigenetic Biomarkers and Aging Clocks**
  - Construction of human and mouse DNA methylation clocks using high-resolution epigenome data.
  - Multi-omics modeling of biological age to improve diagnostic accuracy for aging and frailty.
- **Discovery of Blood-Derived Rejuvenating Factors**
  - Identification of plasma proteins, miRNAs, and metabolites with systemic anti-aging effects.
  - Integration of microbiome-host interaction data to uncover novel longevity mechanisms.
- **In vivo Senescent Cell Mapping and Mechanisms of Senescence**
  - High-resolution mapping of senescent cells via spatial transcriptomics and proteogenomics.
  - Dissection of gene regulatory networks driving senescence using single-cell multiome analysis.
- **Development of Targeted Senolytics and Immune-based Therapies**
  - Design of antigen-targeted senolytics for precision clearance of senescent cells.
  - Co-culture-based screening platforms for restoring immune recognition of senescent cells.
- **Hematopoietic Stem Cell (HSC) Aging and Rejuvenation**
  - Mechanistic dissection of HSC fate decisions during aging.
  - Drug screening and validation for rejuvenation of aged HSCs via single-cell platforms.

RECENT ACHIEVEMENTS

- **Epigenetic Alteration of Complement Genes in Advanced Liver Disease**
  - "DNA methylome analysis reveals epigenetic alteration of complement genes in advanced metabolic dysfunction-associated steatotic liver disease" (Clinical and Molecular Hepatology, 2024).
  - The study identified age-related epigenetic reprogramming of complement genes in MAFLD patients, implicating immune-metabolic crosstalk in liver aging and disease progression.
- **Non-coding RNAs as Regulators of Muscle Aging**
  - "The role of non-coding RNAs in muscle aging: regulatory mechanisms and therapeutic potential" (Frontiers in Molecular Biosciences, 2024).
  - This review outlines the regulatory roles of miRNAs, lncRNAs, and circRNAs in age-related muscle decline and highlights their potential as therapeutic targets for sarcopenia.
- **Gut Microbiota-Based Anti-Aging Patent Applications**
  - (PCT) Novel Bifidobacterium and/or Lactobacillus strains or their combinations and use thereof.
  - The invention proposes novel gut microbiota strains with beneficial effects on muscle health and systemic aging, demonstrating improvement in muscle function in aged mice. These strains are expected to serve as live biotherapeutics for age-related muscle dysfunction.
- **CRLS1 Regulates Age-Related Myopathy and Muscle Regeneration**
  - "Age-dependent loss of CRLS1 causes myopathy and skeletal muscle regeneration failure" (Experimental and Molecular Medicine, 2024).
  - This study revealed that age-related decline in cardiolipin synthase 1 (CRLS1) disrupts mitochondrial structure and function in skeletal muscle, leading to impaired myogenesis and regeneration. Modulation of CRLS1 expression using AAV vectors rescued muscle repair in aged or injured models, suggesting CRLS1 as a therapeutic target for age-related sarcopenia.

Critical Diseases Diagnostics Convergence Research Center

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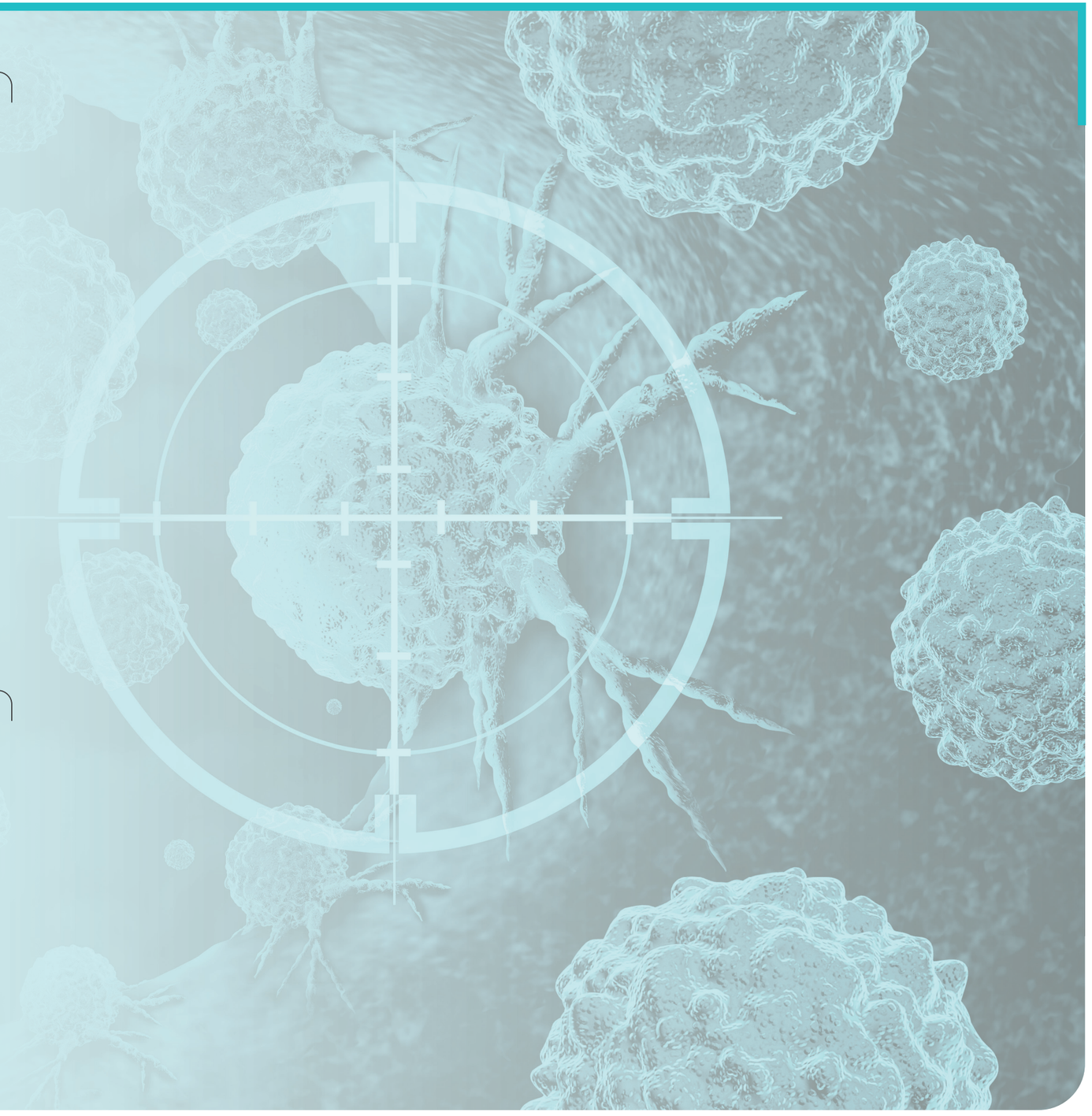
INTRODUCTION

In modern society, with the increasing survival rates through early detection of cancers and critical diseases, the paradigm of healthcare is transitioning from treatment to health management through diagnosis and prevention, and the market size of advanced technology-integrated diagnostic devices is rapidly expanding. The Critical Diseases Diagnostics Convergence Research Center aims to address the current major healthcare situation and overcome the limitations of existing critical disease diagnoses by developing the UnTACT (Non-invasive Technology-oriented Autonomous Convenient Test) system. This system is designed to enable minimally or non-invasive early diagnosis technology, on-site diagnosis, and continuous monitoring capabilities. Our research center is currently progressing in the development of a next-generation healthcare system, the Smart Self-Diagnosis System, through the integration of BT, NT, and ICT. This includes the development of technology such as breath-based bio-nano sensor development, artificial protein redesign for ultra-precise detection of disease biomarkers, CRISPR-based gene multiplex detection technology, nanopore-based single-molecule sensing technology for biomarker detection, and the development of an AI-based smart diagnostic analysis system.

RESEARCH AREAS

- **Discovery of non/low-invasive virus target biomarkers**
  - Discovery of at least 6 types of disease target biomarkers including 4 types of cancer (pancreatic cancer, biliary tract cancer, renal cancer, lung cancer), SARS-CoV, and novel/infectious variant viruses.
- **Development of ultra-precision/rapid biomarker detection technology**
  - Development of ultra-precision/rapid sensing technology for early diagnosis and prevention of diseases such as cancer, infectious diseases, etc.
  - Development of sensors for biomarker detection (quantum sensors, nanopore sensors, artificial protein sensors).
- **Establishment of portable self-diagnostic device and data integration management system**
  - Establishment of portable self-diagnostic equipment and data integration management system to enhance the portability and usability of self-diagnostic equipment, ensuring the accuracy and reliability of detection results.



Center for Gene & Cell Therapy

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INTRODUCTION

Our research group's goal is to develop innovative gene and cell therapies that address unmet medical needs across a range of complex diseases.

We focus on enhancing the safety, efficacy, and precision of treatments through advanced techniques such as novel vector design, immune-evasive gene delivery systems, and optimized production processes. By utilizing cutting-edge technologies and preclinical models, we aim to ensure the successful transition of these therapies to clinical application.

Our work spans multiple therapeutic areas, including genetic disorders, retinal diseases, liver and neurological disorders, and cancer. Through targeted therapies, we seek to improve patient outcomes by offering more effective, personalized treatment options. Ultimately, our mission is to contribute to the advancement of precision medicine, bringing transformative therapies from the laboratory to the clinic to meet the diverse needs of patients.

MAIN PROJECTS

- Advancing Global TOP K-Gene Therapy Technology to Overcome Rare and Incurable Disease (2024. 06~2029. 05)
- Development of advanced biomedical technology for orphan diseases (2021. 01 ~ 2030. 12)
- Investigating proof-of-concept for GSD1 gene therapy and advancing the development of a secure and liver-specific AAV platform (2024. 04~2029. 03)
- Establishment and cooperation of a joint Korea-UK research center to secure global leadership in ATMPs
- ABC-based regenerative Biotherapeutics (2024. 05~2030. 04)
  - Developing technologies for organ-specific ABC-like cell formation and control through in vivo reprogramming.
- Mechanism of immunity control via a novel class of immune synapse regulator NgR1 (2024. 05 ~ 2027. 03)
- Development of anti-cancer ASO targeting cancer-specific and cancer-critical splicing (2025. 03 ~ 2029. 02)

RESEARCH AREAS

- **AAV Capsid Engineering for Targeted and Immune-Evasive Gene Therapy**
  - Development of novel AAV capsids for tissue-specific and efficient gene delivery.
  - Structure-guided capsid engineering based on Cryo-EM and protein-protein interactions.
  - Incorporation of microRNA target sites for immune evasion.
  - Optimization of engineered capsids through hit-to-lead screening for clinical application.
- **Retinal, Liver, Neural Disease Models and Therapeutic Evaluation**
  - Development of disease models using iPSC-derived organoids and genetically engineered mice and minipig.
  - Preclinical evaluation of ATMPs for inherited retinal, liver, and neurological disorders.
- **Clinical-Grade AAV Vector Development**
  - Optimization of AAV production and purification for IND submission.
  - Ex vivo and in vivo AAV delivery protocol standardization.
  - Quality assurance and characterization of clinical-grade vectors.
- **NK Cell-Based Immunotherapy and CAR-NK Platform Development**
  - Mathematical modeling and mechanistic studies of NK cell cytotoxicity and immune checkpoints.
  - Development of NK-specific CAR constructs and discovery of novel tumor antigens.
  - Preclinical evaluation of CAR-NK therapies using 3D culture and tumor microenvironment (TME) assay systems.
- **RNA Biology and Nucleic Acid Therapeutics**
  - Functional analysis of noncoding RNAs and RNA modifications (e.g., m6A) in gene regulation.
  - Target discovery and validation for nucleic acid drug development.
  - RNA structure design for RNA-based gene therapies.
  - Development of mRNA, ASO, and other nucleic acid platforms for vaccines and therapeutics.
- **Lipid Nanoparticle (LNP) Platforms for RNA Delivery**
  - Discovery of bio-inspired or bio-derived LNPs to enhance mRNA delivery and efficacy.
  - Development of organ-selective LNP systems for therapeutic applications.
- **Clinical Translation and Commercialization of Biologics and ATMPs**
  - GMP production and clinical approval of ATMP therapies for ocular and neurodegenerative diseases.
  - Development of direct-conversion cell and immune cell therapies for CNS diseases.
- **Activated Blastema Cell (ABC)-Based Regenerative Medicine**
  - Study of ABC generation during Yamanaka factor-induced reprogramming.
  - Development of ABC-based technologies for regenerative cell and gene therapies.

RECENT ACHIEVEMENTS

- **Establishment of a Korea-UK Joint Research Center for Global Leadership in Advanced Biopharmaceuticals (2025)**
  - Joint development of next-generation biopharmaceuticals in collaboration with the Cambridge Milner Institute.
  - Promotion of global excellence in stem cell and gene therapy research through international partnership with the Cambridge Milner Institute.
- **Development of Tissue-Specific Gene Therapy Platforms Using Engineered AAV Capsids and Vector systems for Retinal, Liver and Neural Targeting (Domestic and International Patents Filed and Secured, 2021~2025)**
  - Development of AAV capsids and vector systems with enhanced tissue tropism for precise and efficient gene delivery to the retina, liver, and nervous system.
- **Platform for CAR-NK Gene Therapy and Clinical Translation (licensing-out, 2023)**
  - Establishment of an integrated manufacturing pipeline for innovative CAR-NK therapies.
  - Commercialization and licensing-out of CAR-NK products targeting T cell malignancies.
- **Identification of a Novel Immune Checkpoint in immunity (Nat. Immunol., 2023)**
  - Discovery of NgR1 as a key inhibitory receptor and development of blocking antibodies for cancer immunotherapy.
- **Development of a High-Performance mRNA Platform (PCT patent application, 2024)**
  - Enabling high and sustained expression of disease genes or antigens.
- **Discovery of Novel Antiviral Targets and Diagnostic Platforms**
  - Identified a novel PLK1–miR-122 signaling axis critical for HCV proliferation and discovered rigosertib as a potential anti-HCV drug candidate (PNAS, 2022).
  - Developed a simple and versatile cell culture medium-based biosensor for detecting SARS-CoV-2 spike–ACE2 interactions (Biosensors & Bioelectronics, 2023).
- **Phase I clinical trials for autoimmune diseases**
  - Transferred DYRK1A-selective inhibitor technology to Fresh Track Therapeutics Corp. (2021).
- **Development of Microbiome-Derived Lipid Nanoparticles for Enhanced mRNA Vaccine Immunogenicity (ACS Materials Letters, 2024)**
  - Incorporated microbiome metabolites into lipid nanoparticles to boost mRNA vaccine-induced adaptive immunity for COVID-19 and cancer.
- **Exploring Activated Blastema Cells (ABCs) Potential for Next-Generation Precision Regenerative Therapies (Int. J. Stem Cells, 2025)**
  - Investigated cross-capacity of blastema and proposed mammalian applications.
  - Suggested novel gene and cell therapy strategies using reprogramming factors.

Research Divisions

Office of the Vice President

Korea Bioinformation Center

Digital Biotech Innovation Center

ABC-based Regenerative Biotherapeutics Research Center

Korea Bioinformation Center

Dr. **Haeyoung Jeong**

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INTRODUCTION

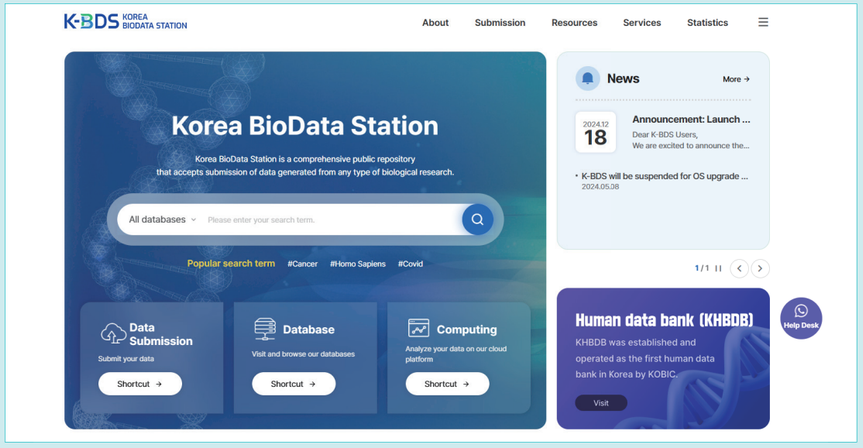
Korea Bioinformation Center (KOBIC) is a national center for biological research resource information. We establish research environment infrastructure to facilitate data-driven research in biology.

RESEARCH AREAS

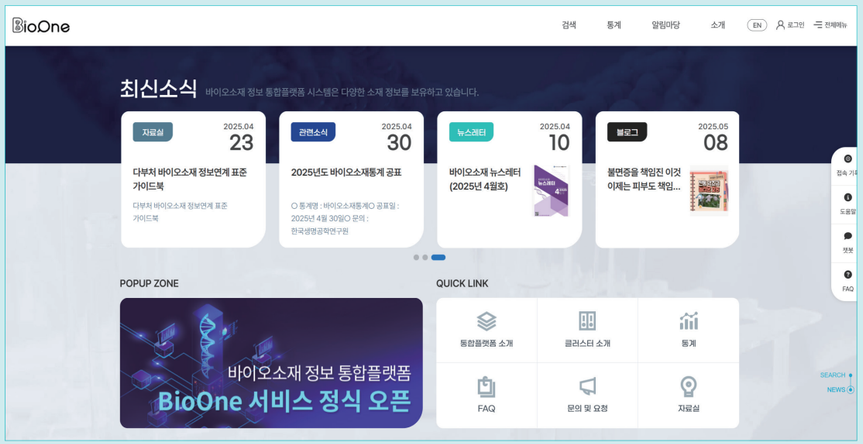
- **Establishing infrastructure for collecting, distributing, and utilizing data generated from biological research**
  - Construction and operation of an integrated platform (K-BDS; Korea BioData Station) to collect and distribute biological research data.
  - Support for utilization of biological research data by providing cloud-computing service, data analysis service, and training courses.
  - Collaboration and alignment with biological data management centers in both Korea and abroad.
- **Participating in the Korea National Genome Project**
  - Participating in the Korea National Genome Project, which constructs a large-scale clinical and genomic data bank as a nationwide R&D infrastructure.
  - Responsible for generating and analyzing genomics and other omics data.
- **Establishing national cluster of biological resources**
  - Development and implementation of the strategies related to biological resources.
  - Construction and operation of the information integration platform for biological resources (BioOne).

RECENT ACHIEVEMENTS

- **Upgrade of Korea BioData Station (K-BDS)**
  - Upgraded and launched the year 2024 version of Korea BioData Station (K-BDS) in December 2024.
  - Major upgrades include improvement of data type-specific sub-homepages, improvement of interface, advancement of the procedures for submission, management, and provision of data.



- **Initiation of the first phase of the Korea National Genome Project**
  - Began the first phase (2024-2028) of the project.
  - Generating and analyzing genome, transcriptome, proteome, and metabolome data from the participants.
- **Development and launch of the pilot version of BioOne**
  - Developed and launched the official version of BioOne platform in March 2024, which integrates biological resource information and enables search and distribution applications.



Digital Biotech Innovation Center

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INTRODUCTION

Recently, research in biohealth utilizing bio-big data is actively progressing. This research center is constructing a bio-healthcare platform through the utilization of bio-big data to create a human organ map. This platform can be utilized for precision diagnosis, therapeutic development, and prognosis research.

The goal of the Digital Biotech Innovation Center is to develop algorithms utilizing artificial intelligence (AI) technologies for precision diagnosis, therapeutic development, and prognosis prediction, based on bio-big data. Through AI-driven analysis, we aim to advance more accurate and predictive medical technologies in the field of bio-healthcare.

RESEARCH AREAS

- **Development and commercialization of functional biomaterial-based foods**
- **Development of Bio-GPT for Drug Discovery Based on the E-Human Organ Atlas**
  - Development of Bio-GPT leveraging the E-Human Organ Atlas to enable applications in precision medicine.
- **Development of artificial intelligence-based genome analysis programs**
  - Developing algorithms to discover genes with high diagnostic and therapeutic potential by integrating and analyzing bio-big data.
- **Identification of biomarkers and development of gene panel for precise diagnostics of metabolic diseases and cancer**
  - Identification of biomarkers for precision diagnostics through integrative analysis of bio-big data.
- **Development of an artificial intelligence-based computational framework for drug-target prioritization**
  - Development of AI-based drug discovery technologies utilizing protein structure modeling to enhance the efficiency of therapeutic development for target genes.
- **Integrative analysis of the whole genome, transcriptome, and epigenome in large-scale datasets derived from metabolic diseases and cancer**
  - Establishment of a system for analyzing genetic feature changes through integrative analysis of omics data from normal to disease states.
- **Artificial intelligence-based analysis of pathological/diagnostic imaging data**
  - Artificial intelligence-driven analysis of pathological and diagnostic imaging data.

RECENT ACHIEVEMENTS

- **Development of a quantitative prediction algorithm for target organ specific similarity of human pluripotent stem cell-derived organoids and cells**
  - The study aimed to develop a quantitative prediction algorithm to evaluate the target organ-specific similarity between human pluripotent stem cell (hPSC)-derived organoids and cells. The algorithm was designed based on the RNA sequencing data from hPSC-derived organoids and the corresponding human tissue samples. The algorithm was validated using different hPSC-derived organoids and showed high accuracy in predicting the target organ-specific similarity.
- **Characterization of signature trends across the spectrum of non-alcoholic fatty liver disease using a deep learning method**
  - The study aimed to identify differentially expressed genes (DEGs) in non-alcoholic fatty liver disease (NAFLD) patients to determine different stages of the disease. The study found 103 DEGs in NAFLD patients, with 75 genes gradually increasing or decreasing in the NAFLD stage and 28 genes showing differences only in non-alcoholic steatohepatitis (NASH). The identified genes were used for deep-learning method with a subset of features from lasso regression to obtain reliable determination performance in NAFLD and NASH. The study also found significant differential expression of several candidate genes in liver cancer (LIHC), suggesting a potential relationship between NAFLD and hepatocellular carcinoma (HCC). The identified biomolecular signatures may improve clinical diagnosis and prognosis of NAFLD and enable therapeutic intervention.
- **Uncovering gene expression signatures and diagnostic biomarkers in hepatocellular carcinoma through multinomial logistic regression analysis**
  - The study aimed to identify diagnostic and prognostic molecular signatures associated with the progression of hepatocellular carcinoma (HCC). It sought to classify HCC developmental stages based on gene expression data using a multinomial logistic regression (MLR) model. The model was validated in multiple independent patient cohorts. Additionally, the study aimed to uncover key genes involved in cell cycle regulation and tumor proliferation, and evaluated their prognostic value through Cox regression analysis. These findings contribute to a better understanding of HCC progression and support the development of precision medicine approaches for improved diagnosis, prognosis, and treatment.

ABC-based Regenerative Biotherapeutics Research Center

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INTRODUCTION

Due to global population aging, there has been a rapid increase in degenerative brain diseases, cardiovascular conditions, joint disorders, and diabetic complications—ailments that require regenerative intervention. Many of these conditions cannot be effectively treated with conventional drugs or surgery, leading to a growing demand for regenerative therapies capable of replacing, regenerating, and restoring the original functions of human cells, tissues, and organs. As a result, the regenerative medicine market is expected to continue expanding.

Globally, mainstream regenerative therapies include cell therapy, gene therapy, tissue engineering, and organoid-based approaches. Compared to other cell-based therapies, there is a growing need for more economical and scalable regenerative treatments that carry a lower risk of tumorigenesis. In this context, during processes such as partial reprogramming via transient expression of OSKM factors or direct reprogramming, researchers have identified cell populations that exhibit similarities to blastema cells—undifferentiated cell masses capable of regenerating organs or body parts in certain species. This discovery opens new possibilities for achieving amphibian-like complete regeneration in mammals.

Artificial blastema cells refer to cell populations that resemble naturally regenerative blastema cells found in amphibians, but are induced in mammals, including humans. Our consortium aims to identify novel factors capable of inducing artificial blastema cells through in vivo regeneration and to develop non-cell-based regenerative therapies inducing these cells.

RESEARCH AREAS

- **Identification of Human ABCs and their Inducing Factors**
  - Discovery of ABC-inducing factors and substances: Identification of novel ABC-inducing factors and elucidation of their mechanisms of action → Investigation of in vivo safety mechanisms of newly discovered ABC-inducing factors.
  - Development of in vivo ABC induction and regulation technologies: Exploration of organ-specific blastema-like cell formation through in vivo reprogramming → Optimization and control of organ-specific blastema-like cell formation.
- **Development of ABC-mediated Regenerative Therapies**
  - Development of ABC induction and therapeutic technologies by tissue/disease type: Establishment of disease models to validate ABC-based therapies → Development of tissue- or disease-specific therapeutic techniques using ABC-inducing factors.
  - Development and validation of ABC-based therapies for liver diseases: Establishment of liver disease models and analysis of liver-specific ABC induction mechanisms → Preclinical validation of ABC-based regenerative therapies for liver conditions.
- **Development of Therapeutics Based on Artificial Blastema Cells (ABCs)**
  - Development of ABC-inducing therapeutics: Identification of candidate ABC-type regenerative therapeutics and execution of preclinical studies→ IND approval of at least one ABC-type regenerative therapeutic and initiation of follow-up preclinical studies.

Research Divisions

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Division of Research Strategy

- Biotech Policy Research Center
- Korea Biosafety Clearing House
- National Research Safety Headquarters
- National Center for Technology Strategy on Advanced Life Science

Biotech Policy Research Center

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INTRODUCTION

Nominated and established by the Ministry of Science and ICT in 2004, the National Biotech Policy Research Center is a non-profit organization devoted to the research and development of biotech policy and policy alternatives. And in April 2021, our center was designated as a specialized institution for biotechnology policy based on Article 24 of the Biotechnology Support Act. Our mission is mainly threefold: to provide government officers with accurate, relevant, and timely information on biotech trends, as a think tank, to develop biotech R&D strategy to help policy makers, and to build networks with opinion leaders as an idea platform. We run a portal site (BIOIN, www.bioin.or.kr) to enhance public understanding of biotechnology and biotechnology policies and also a BT innovative linkage platform (BICS, www.bics.or.kr) to facilitate Bio Discovery to Market activities.

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.

RECENT ACHIEVEMENTS

- **Policy Planning**
  - Formulation of the Advanced Biotechnology Initiative Strategy.
  - Formulation of the “Korea Bio Transformation Strategy”.
  - Formulation of the AI-Bio Diffusion Strategy.
  - Enactment of the Synthetic Biology Promotion Act.
  - Revision of the Biotechnology Promotion Act.
  - Planning for Digital- Biotechnology Strategy.
  - Planning for National Synthetic Biology Initiative.
  - Planning for the fourth Biotechnology Fostering Basic Plan – Science Tech based.
  - Planning of large-scale projects for Survey and analysis of national R&D programs.
  - Research on BT regulatory issues and operation of “Bio Regulatory SINMUNGO”.
  - Supporting the establishment of Biotechnology Fostering Implementation Plan.
  - Research on tracking for the bio-industry achievements (technology, industry, investment) of vitalization.
  - Analysis of the status of small and medium-sized bio venture companies to monitor the bio-industry ecosystem.
- **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.
  - Publishing annual reports on domestic and overseas statistical data on biotechnologies categorized by investment, human resources, industry, and technology.
- **Expert Network & International Collaboration**
  - Co-hosting of the OECD–Korea Synthetic Biology Workshop.
  - To OECD Korea Workshop “Policy directions for critical health technology innovation and access”.
  - To organize the “BIO Future Forum(BT Forum)”.
  - To participate in the annual Session of the OECD Working Party on Biotechnology, Nanotechnology and Converging technology(BNCT).
  - To support the Council for Comprehensive Biotechnology Policy.
  - To support the Bio-regulatory TF.
- **Policy information portal (Website)**
  - BioIN : A one-stop portal website to provide Bio information related to various technology, industry trends and policies. (https://www.bioin.or.kr).
  - BICS (Biotechnology Innovation Connect Service) : Bioeconomy monitoring and networking platform (https://www.bics.re.kr).
  - SBKIH (Synthetic Biology Knowledge Information Hub) : Synthetic Biology monitoring and networking platform (https://www.bics.re.kr/synbio_korea).

Korea Biosafety Clearing House

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INTRODUCTION

Based on Cartagena Protocol on Biosafety(CPB) and LMOs Act, Korea Biosafety Clearing House carries out professionally the collection and exchange of the information on living modified organisms(LMOs) and Biotechnology to promote and facilitate public awareness, education and participation concerning the safe transboundary movements, handling and use of LMOs, contributing to the sound development of bioindustry in Korea.

RESEARCH AREAS

- **Implementation 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.
- **Safety Management for LMOs for Industrial Use**
  - Risk Review for LMOs for Industrial Use and Safety Management for Related Facilities.
  - Awareness-Raising and Capacity Building of Safety Management in the industry.
- **Establishment of Industry Support System related to the Nagoya Protocol**

RECENT ACHIEVEMENTS

- **Submitting LMOs information to BCH Central Portal**
  - Uploading Domestic Decisions and Risk Assessment information etc (10 cases).
  - Collecting and Managing domestically generated LMOs Information.
- **Actively Producing LMOs information and Communicating with Stakeholders**
  - Publishing KBCH Briefings and National Reports (44 cases).
  - Operating the YouTube Channel(GMO TV) (Upload: 59 cases) .
  - Operating the GMO Portal (https://www.biosafety.or.kr).
  - Operating Public Panel, and KBCH Forum Seminar(3 times), SMART LMO Reporters, Publications(Webzine 4 cases) etc.
- **Operating Biosafety Management for LMOs for Industrial Use**
  - Holding the LMO Risk Review Committee (2 times).
  - Revision of the Consolidated Notification on Industrial LMOs.
  - Operating the Industrial LMOs Safety Information Service.
- **Revising the LMO Act and Operating the Association of Related Agencies**
  - Support for Laying a Revised LMO Act to the National Assembly.
  - Holding the National Biosafety Committee and Research meetings (11 times).
- **Strengthening the Asia cooperation network(Asia Biosafety Family)**
  - Implementing the BCH Capacity Building Project.
  - Operating the ABF Portal.
- **Establishment of Industry Support System related to the Nagoya Protocol**
  - Investigation and Analysis of Overseas Biological Resources Usage Status in Bio-Industry.
  - Analysis of Bio-Industry by Sector related to DSI Benefit-Sharing.
  - Operating the ABS Website and Publishing the Legal Guidebook for the Nagoya Protocol to Provide Information and Raise Awareness in the Industry.

National Research Safety Headquarters

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INTRODUCTION

National Research Safety Headquarters 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.

RESEARCH AREAS

- **Ensuring a safe research environment and preventing accidents**
  - Identifying and improving factors contributing to safety in LMO research through facility inspections and comprehensive surveys.
  - Conducting on-site inspection of laboratories in the field of science and technology to identify safety management vulnerabilities and guide improvement measures.
  - Supporting the establishment of autonomous safety management systems at research sites.
- **Support for establishing a safety management system of LMOs for R&D (Especially in the operation of governmental compliance procedures and the development of policy & standards, etc.)**
  - Assistance in the operation of the license system related to research facilities and import & export of LMOs for R&D.
  - Establishment and dissemination of biosafety standards for LMO research facilities and biological materials (microorganisms, animals, plants, etc.).
- **Development of safety management policies and systems for science and technology laboratories**
  - Legal operation and policy support for Act on the Establishment of Safe Laboratory Environment.
  - Establishment of national laboratory safety management policy and system.
  - Development of laboratory-specific safety standards and guidelines.
  - Supporting the establishment of an organization dedicated to lab safety and the improvement of lab environment, and operating certification system for exemplary labs.
- **Conduct safety training (online and offline) and develop educational content**
  - Operate statutory safety training and training by target, research material, and field.
  - Development and distribution of educational contents (e-learning, textbooks, videos).
- **Fostering a culture of safety by hosting lab & LMO-related occasions and public relations**
  - Planning and operating programs(content contests, conference, safety events, etc.) to promote a culture of safety.
  - Conduct promotional activities through online communication tools, such as social media(YouTube, Instagram, etc.) and newsletters.
- **Establishment and operation of an information system to provide intelligent safety information**
  - Development and provision of LMO administrative information portal, chatbot, LMS (Lab Management System), and mobile app.

National Center for Technology Strategy on Advanced Life Science

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INTRODUCTION

National Center for Technology Strategy on Advanced Life Science is a government-affiliated organization in Korea dedicated to developing national R&D investment strategies in the field of advanced biotechnology. Following a pilot phase in 2024, the Center was officially designated in February 2025 by the Ministry of Science and ICT as the national strategic agency supporting R&D strategy and budget coordination in the life science sector. It now serves as the Ministry's official "R&D Investment Strategy Support Agency" for the life science sector.

RESEARCH AREAS

- **Support for R&D Investment Strategy Formulation**
  - Develop mid- and long-term R&D investment directions and strategies based on systematic monitoring of advanced biotechnology trends and in-depth analysis of key investment issues and promising technologies.
- **Support for R&D Budget Allocation and Coordination**
  - Facilitate cross-ministerial R&D budget allocation and coordination through comprehensive analysis of technologies, investments, projects, and outcomes across subfields of advanced biotechnology.
- **Operation of an Expert Collaboration Network in R&D**
  - Operate a pool of R&D experts from industry, academia, and research institutes in the field of biotechnology to provide ongoing advisory support for investment strategies and analysis.

RECENT ACHIEVEMENTS

- **Formulated R&D Investment Directions for the Government's G3 Initiatives "Advanced Biotechnology as a National Game Changer"**
  - Developed strategic R&D investment directions aligned with the G3 Initiatives, identifying advanced biotechnology as a key national transformation agenda.
  - Provided support for the government in allocating and coordinating R&D budgets based on the defined investment directions.
- **Enhancing Strategic and Efficient Government R&D Investments**
  - Supported budget coordination based on an analysis of the alignment between policy goals and project objectives as well as the competitiveness of investments in advanced biotechnology, contributing to improved efficiency and stronger strategic alignment in national R&D investments.
- **Supported the Early Formulation of the 2026 Bio R&D Investment Plan**
  - Assisted the government in formulating the 2026 Bio R&D Investment Plan ahead of schedule, strengthening inter-program linkages and enhancing the strategic planning of new initiatives by relevant ministries.

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Technology for Life, Our Future