KRIBB ANNUAL REPORT 2017

KRIBB Annual Report 2017

KRIBB

KRIBB

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CONTENTS

BIOTECHNOLOGY POLICY IN KOREA

1983
Enacted 'Biotechnology Promotion Law'

1985
Establishment of KRIBB

1993
Chosen as one of the '10 Next Generation Growth Engines'

1993
Set up 'Biotech 2000' (1994~2007)

2006
Set up 'Bio-Vision 2016' (2007~2016)

2017
Set up 'Science Technology-based Bioeconomy Innovation Strategy 2025' (2017~2026)

nature immunology

Infection-specific phosphorylation of glutamyl-prolyl tRNA synthetase induces antiviral immunity [2016]

Cell

A Lactate-Induced Response to Hypoxia [2015]

Science

Regulatory T Cells generated early in life play a distinct role in maintaining self-tolerance [2015]

nature cell biology

Amino-terminal arginylation targets endoplasmic reticulum chaperone BiP for autophagy through p62 binding [2015]

Genes & Development

miR-431 promotes differentiation and regeneration of old skeletal muscle by targeting Smad4 [2015]

nature structural & molecular biology

Molecular basis for unidirectional scaffold switching of human Plk4 in centriole biogenesis [2014]

nature commun

The strctural basis for the negative regulation of thioredoxin by thioredoxin-interacting protein [2014]

Cell metabolism

TXNIP Maintains the Hematopoietic Cell Pool by Switching the Function of p53 under Oxidative Stress [2013]

nature biotechnology

Analysis of a genome-wide set of gene deletions in the fission yeast Schizosaccharomyces pombe [2010]

nature

Genome evolution and adaptation in a long-term experiment with Escherichia coli [2009]

nature cell biology

Drosophila short neuropeptide F signalling regulates growth by ERK-mediated insulin signalling [2008]

Cancer Cell

Block of T cell development in P53-deficient mice accelerates development of lymphomas with characteristic RAG-dependent cytogenetic alterations [2006]

nature genetics

Comparative analysis of chimpanzee and human Y chromosomes unveils complex evolutionary pathway [2006]

nature medicine

E2-EPF UCP targets pVHL for degradation and associates with tumor growth and metastasis [2006]

BIOTECH FOR ECONOMIC GROWTH AND BETTER LIVING STANDARDS

From fundamental research exploring basic facts about life to cutting-edging technologies, our work is aimed at creating new engines for economic growth and bringing concrete improvements in the quality of life.

MISSION & VISION

MISSION

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

› To disseminate the results of its scientific research and technological development

VISION

Bio Korea! Global KRIBB!

- A Global Leader in the Bio Industry, KRIBB -

TECHNOLOGICAL LEADERSHIP
Creating new growth engine

CONVERGENCE
Innovation through bio-convergence

WELL-BEING
Solutions for national agenda

Innovation-based expansion of bio infrastructure

MAJOR OBJECTIVE

01 CORE DIRECTIONS FOR RESEARCH & BUSINESS DEVELOPMENT

- **Biotechnology to Create New Economic Growth Engines**
  - Development of BINT (BT, IT, NT) convergence technology
  - Development of disease controlling technologies using stem cells and antibodies
  - Identification of targets and development of candidate materials for the diagnosis and treatment of five major diseases
  - Development of the platform technology for cell factories and biomaterials
- **Biotechnology to Address the National Agenda**
  - Technology development for infection control
  - Fostering R&D on cranial nerves and the aging society
  - Development of biomass and bioenergy technology
- **National Infrastructure to Enhance National Biotechnology Competitiveness**
  - Improvement of the infrastructure for compiling, managing and utilizing bio resources and data
  - Consolidation of the infrastructure for biological assessment and GMO risk assessment

02 CORE DIRECTIONS FOR ORGANIZATIONAL MANAGEMENT

- **Improvement of the Framework to Facilitate R&D**
  - Introduction of an open innovation system and acquisition of competitive human resources
  - Strategical selection and concentration
  - Expansion of global cooperation
- **Contributions to the Society and the Country**
  - Improvement of the ability to respond to future biotechnology demands
  - Promotion of demand-based R&D and commercialization of technologies
  - Raising public awareness of biotechnology and public interest in science
- **Improvement of the Management Efficiency**
  - Promotion of result and objective-oriented management
  - Augmentation and efficient allocation of the R&D budget
  - Maintenance of an up-to-date and facility infrastructure

GENERAL INFORMATION

FOUNDATION BASIS

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

KEY FUNCTION

Develop and disseminate sophisticated core technology in bioengineering and bio-economy

- Innovative bioconvergence, creation of future growth engine, resolution of bio-based agenda

Support public infrastructure for bioengineering research and development both at home and abroad

- Supporting establishment of public infrastructure, government-sponsored Think Tank, nurturing talented human resources, supporting commercialization of small/medium sized companies

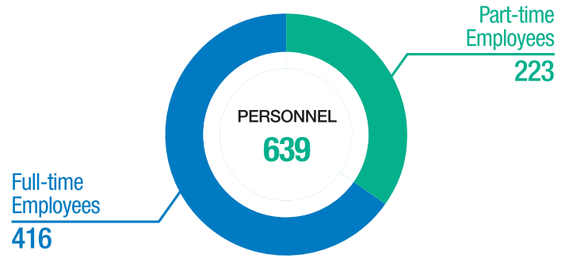
HISTORY

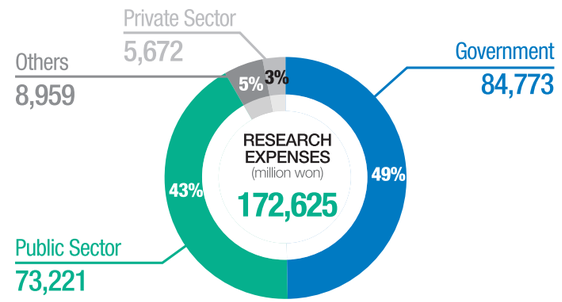
Feb.	1985	Established as a Genetic Engineering Research Center (Seoul)
Jul.	1990	Moved to Daejeon
Mar.	1995	Changed its name to Korea Research Institute of Bioscience and Biotechnology (KRIBB)
May	1999	Became an independent legal entity under the Korea Research Council of Fundamental Science & Technology (KRCF)
Sep.	2005	Established Ochang Branch Institute
Nov.	2006	Established Jeonbuk Branch Institute

FACILITY

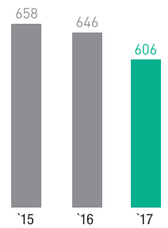
- Headquarter : 103,684 m^2
  - Human Gene Bank, Plant Extract Bank
- Ochang Branch Institute : 212,258 m^2
  - National Primate Research Center, Bio-Evaluation Center, Biotechnology Process Engineering Center
- Jeonbuk Branch Institute : 160,026 m^2
  - Eco-friendly Bio Material R&D Hub Research Center, Microbial Evaluation Center

YEARLY PROGRESS



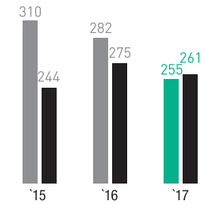


PUBLICATIONS (items)
606



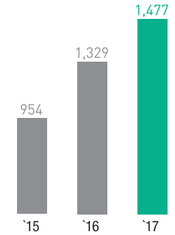
Domestic 85
Overseas 521

PATENTS (items)
255 / 261



Application 255
Registration 261

TECHNOLOGY TRANSFERS (million won)
1,477



ORGANIZATION

President

Auditor

Assistant Auditor

Immunotherapy Convergence Research Group

Biodefense Research Center

Executive Vice President

Division of KRIBB Strategic Projects

Core Facility Management Center

Ochang Branch Institute

Jeonbuk Branch Institute

Division of Bioinfrastructure

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

- Natural Medicine Research Center
- Management & Support Department

- Natural Product Research Center
- Immunoregulatory Materials Research Center
- Microbial Biotechnology Research Center

- Management & Support Department

Division of Strategic Research Groups

- Rare Disease Research Center
- Personalized Genomic Medicine Research Center
- Aging Research Center
- Hazards Monitoring Bionano Research Center
- Anticancer Agent Research Center

Division of Biomedical Sciences

- Metabolic Regulation Research Center
- Disease Target Structure Research Center
- Biotherapeutics Translational Research Center
- Infectious Disease Research Center
- Genome Editing Research Center

Division of Systems Biology and Bioengineering

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

Division of Bio Innovation

- Technology Transfer Center
- SME Support Center
- Biotechnology Process Engineering Center

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

Divison of R&D Policy

- Policy and Strategy Department
- Department of International Cooperation & PR

Planning & Management Department

- Planning and Budget Section
- R&D Management Section
- Computer and Information Section

Administration Department

- Human Resource Development Section
- General Affairs & Accounting Section
- Procurement Section
- Facilities and Securities Section

RESEARCH INFRASTRUCTURE

1985

Biological Resource Center

2003

Human Gene Bank

2005

National Primate Research Center

2006

Bio-Evaluation Center

2010

Korean Bioinformation Center

2013

· Biotechnology Process Engineering Center

· Eco-friendly Bio Material R&D Hub Research Center

2015

Microbial Evaluation Center

2012

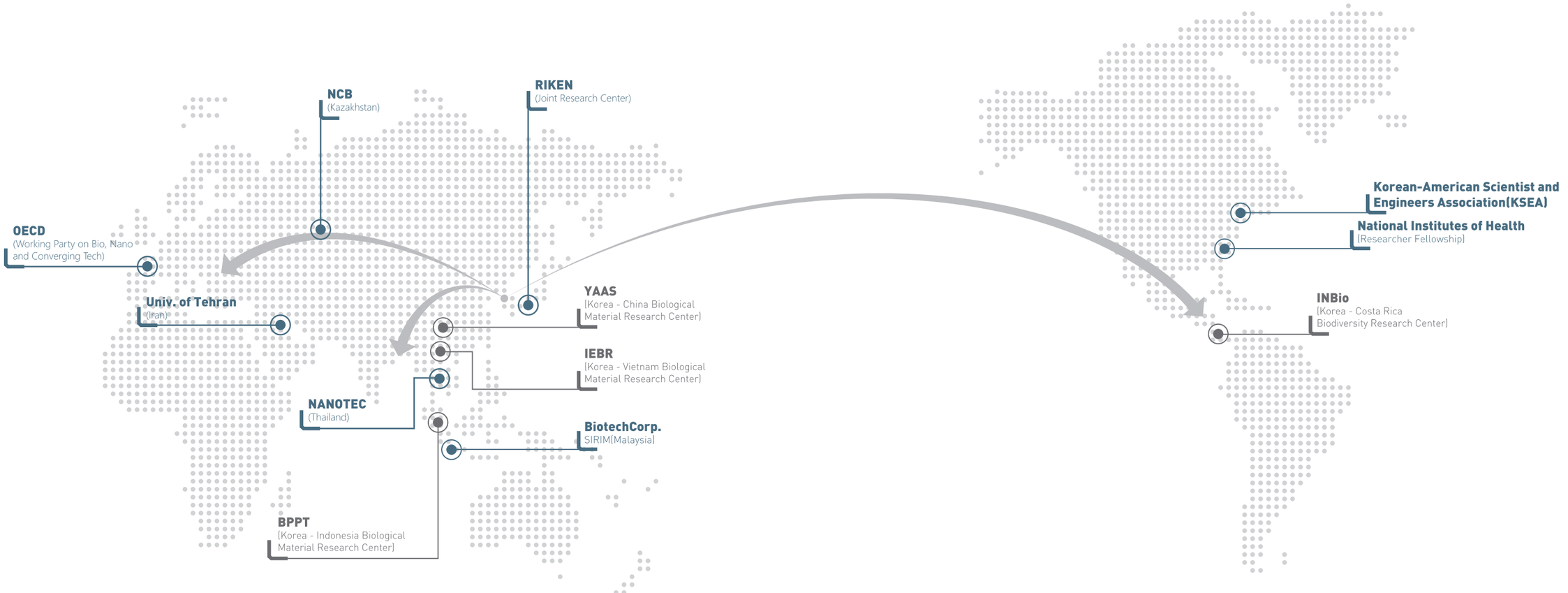
Futuristic Animal Resource Research Center

2017

Primate Resource Center

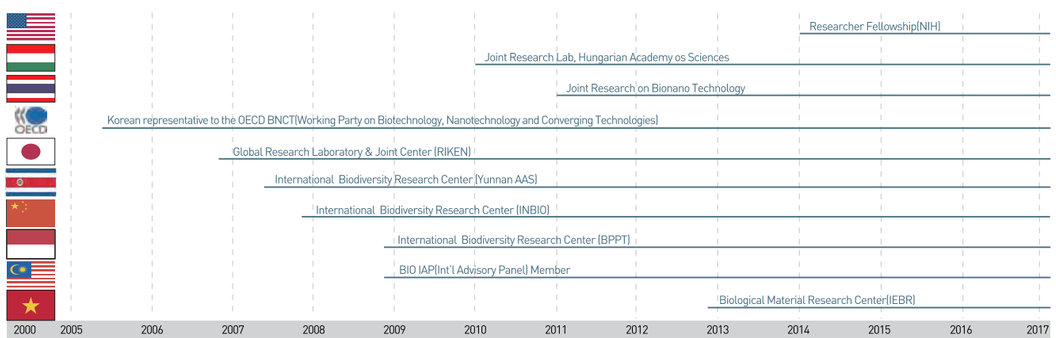
RESEARCH DIRECTION

INTERNATIONAL NETWORK



To strengthen its global cooperation in mutually beneficial relationships

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



CUTTING EDGE BIOTECHNOLOGY RESEARCH AND CREATION OF BIOECONOMY

At KRIBB, we conduct cutting-edge research of biotechnology for our society and economic growth in the field of medical healthcare, food and agriculture, and bioenergy. We are also fostering new bioindustry in Korea.

DIVISION OF STRATEGIC RESEARCH GROUPS

- Rare Disease Research Center
- Personalized Genomic Medicine Research Center
- Aging Research Center
- Hazards Monitoring Bionano Research Center
- Anticancer Agent Research Center

We are taking steps to develop technologies that address national and social issues such as aging and rare/incurable diseases. We will take the lead in developing technologies to treat incurable diseases through advancements in biotherapy.

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RARE DISEASE RESEARCH CENTER

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

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INVESTIGATORS

Nam-Soon Kim nskim37@kribb.re.kr
- Genome and functional study of rare neuronal diseases
- Functional genomics of cancer
- Management of Korea Human Gene Bank (KHGB)

Jae-Ran Lee leejr@kribb.re.kr
- Functional analysis of synaptic molecules related to rare neuronal diseases
- Discovery of biomarkers for early diagnosis of neuro developmental disorders

Kyung Sook Chung kschung@kribb.re.kr
- Development of molecular diagnostics for rare neuronal diseases
- Cancer therapies development
- Development of biomimetic 3D liver and toxicity analysis platform

Eun-Wie Cho ewcho@kribb.re.kr
- Cancer molecular cell biology and biochemistry
- Development of molecular diagnostics for rare neuronal diseases

Dae-Soo Kim kds2465@kribb.re.kr
- Genome study of neurological disorder genes using NGS
- Construction of genome analysis infrastructure for neurological disorders

Da Yong Lee daylee@kribb.re.kr
- Neuroscience
- Developmental neurobiology

Jeong Ju Lee snailee@kribb.re.kr
- Large-scale collection and distribution of human cDNA clones
- Operation of Korea Human Gene Bank (KHGB)

Yong Jae Lee tmx@kribb.re.kr
- Construction and operation of DB related to human gene cloning
- Construction and operation of DB related to rare neuronal diseases

Wantae Kim wantaekim@kribb.re.kr
- Signal transduction
- Cancer biology

RESEARCH AREAS

- Establishment of genome research infrastructure and technology platforms for rare neuronal diseases
- Construction of a genetic variants map and integrated DB for Korean rare neuronal diseases
- Large-scale screening and identification of genes related to rare neuronal diseases
- Identification of biomarkers and development of gene panel for precise diagnostics of rare neuronal diseases
- Functional validation of candidate target genes for precise therapeutics development of rare neuronal diseases
- Application of target genes onto gene therapy for precise therapeutics of rare neuronal diseases

ACHIEVEMENTS

Construction of a genetic variants map of Korean HSP & Ataxia
- Construction of a genetic variants map of Korean HSP from WES data of 88 HSP families, 116 affected individuals and 25 healthy control subjects, using bioinformatic tools.
- Construction of a genetic variants map of Korean Ataxia from WES data of 61 Korean patients with Non-Polyglutamine Ataxia using bioinformatic tools.
- These genetic variants maps revealed the genetic heterogeneity of Korean HSP and Non-Polyglutamine Ataxia.

Development of molecular diagnostics for Hereditary spastic paraplegia (HSP)
- Development of an in silico 113-gene panel for HSP consisting of five X-linked genes, 21 autosomal dominant genes and 54 autosomal recessive genes, as extracted from a genetic variants map of Korean HSP.
- Development of a digital PCR-based method for efficient and simple screening of large genomic deletion in the spastin gene (SPG4), the main causative gene in HSP.
- These molecular diagnostics for HSP were transferred to companies.

Construction of analysis pipeline of large volume NGS genome data for rare diseases
- Development of an integrated system for handling, processing and analyzing large volumes of NGS genome data and multiple bio big data with different data structure
- Identification of various SNV/INDEL candidates related to diseases using clinical samples and NGS data in Public DB
- Establishment of technology for integrated analysis of genome information and information standardization
- Construction of CNV map and DB related to diseases

Modeling of rare neuronal diseases using animal & patient derived iPSCs
- Development of animal models for rare brain diseases including Hereditary Spastic Paraplasia (HSP), Tuberous Sclerosis Complex (TSC), and a rare multisystem genetic brain developmental disorder, a genetic brain disease with a malfunction of cortical motor neurons.
- Generation of iPSCs from the blood mononuclear cells of patients with Duchenne Muscular Dystrophy (DMD), a severe type of muscular dystrophy and intellectual disability.
- Finding out that various de novo mutations in nerve cell specific KIF1A motor domain that cause intellectual developmental disorder, spastic paralysis, axon disorders and cerebellar atrophy.

SELECTED PUBLICATIONS

Elasticity-based development of functionally enhanced multicellular 3D liver encapsulated in hybrid hydrogel.
Acta Biomater. 64:67-79.
Kyung-Sook Chung and Cho Rok Jung (Co-corresponding)

Osteopontin production by TM4SF4 signaling drives a positive feedback autocrine loop with the STAT3 pathway to maintain cancer stem cell-like properties in lung cancer cells.
Oncotarget. 8(60):101284-101297.
Eun-Wie Cho (Co-corresponding)

Novel indazole-based small compounds enhance TRAIL-induced apoptosis by inhibiting the MKK7-TIPRL interaction in hepatocellular carcinoma.
Oncotarget. 8(68):112610-112622.
Nam-Soon Kim (Co-corresponding)

Autosomal dominant transmission of complicated hereditary spastic paraplegia due to a dominant negative mutation of *KIF1A*, SPG30 gene.
Sci Rep. 7:12527.
Jae-Ran Lee (Corresponding)

Ottogi inhibits Wnt/ -catenin signaling by regulating cell membrane trafficking of Frizzled8.
Sci Rep. 7(1):13278.
Nam-Soon Kim
(Co-corresponding)

PERSONALIZED GENOMIC MEDICINE RESEARCH CENTER

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

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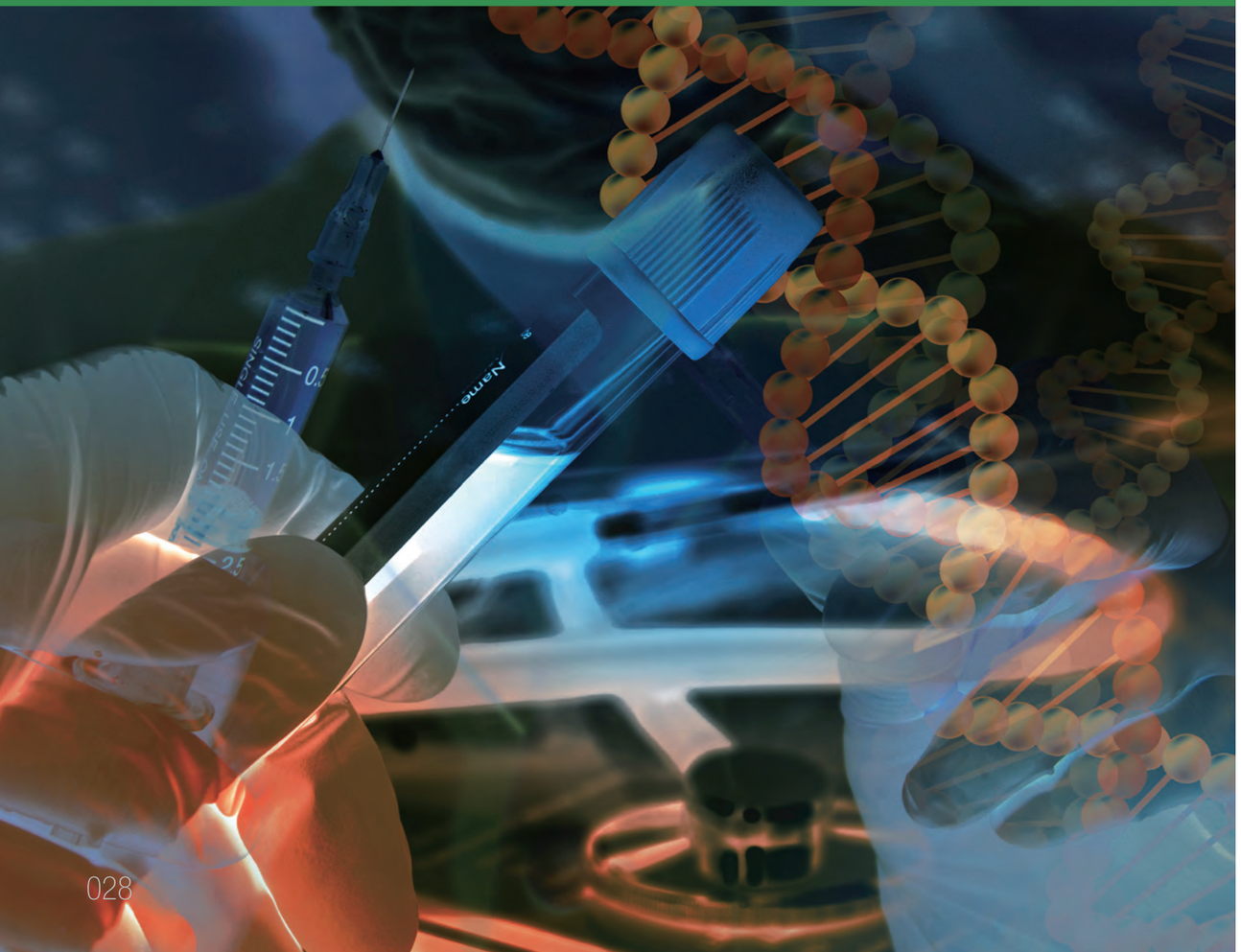

INVESTIGATORS

Kyung Chan Park kpark@kribb.re.kr
- Large-scale screening and identification of cancer related genes
- Studies on regulation of metabolic reprograming in cancer and inflammatory diseases

Mi Sun Won misun@kribb.re.kr
- Identification and functional verification of genes to develop carcinostatic substances
- Identification of mechanism of new carcinostatic substances and analysis and verification of genes to overcome resistance to therapeutics

Dong Cho Han dchan@kribb.re.kr
- Study of cancer cells' stress responses, migration, metastasis, stemness, and drug resistance using chemical biology

Mirang Kim mirang@kribb.re.kr
- Epigenomic study of stem cell differentiation and cancer development
- Genome-wide study of DNA methylation and microRNA

Bo Kyung Kim kimbk@kribb.re.kr
- Finding out the feasibility of cancer related gene expression control and treatment targets
- Analysis and verification of genes to overcome resistance to therapeutics

Jung-Ae Kim jungaekim@kribb.re.kr
- Studies on histone modifications involved in gene expression and genome stability
- Studies on the crosstalks between metabolic regulation and chromatin regulators

Seon-Kyu Kim seonkyu@kribb.re.kr
- Finding prognostic signatures based on cancer genomics/epigenomics and development of bioinformatic analysis platforms

RESEARCH AREAS

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

ACHIEVEMENTS

Prognostic signature identification based on transcriptomic profiling of multiple cancer patient cohorts

The identification of practical biomarkers to predict heterogeneous clinical behaviors in cancer patients is profoundly important. We carried out two independent investigations to identify prognostic molecules in prostate cancer and hepatocellular carcinoma (HCC). In the analysis of multiple prostate cancer patient cohorts, we showed that a higher serine peptidase inhibitor, Kazal type 1 (*SPINK1*) and lower Sp8 transcription factor (*SP8*) expression are associated with progression into castration-resistant prostate cancer. In the analysis of multiple HCC patient cohorts, we also identified Protein Arginine Methyltransferase 1 (*PRMT1*) as a novel practical marker. In the prognostic analysis, the overexpression of PRMT1 was clearly associated with poor prognoses in a number of HCC patient cohorts. Moreover, after PRMT1 knockdown, HCC cell lines exhibited cell growth and spheroid formation suppression, an increase in Sub-G1 cells by FACS analysis, and enrichment of the cell cycle pathway via functional enrichment analysis. With these results, we demonstrated that *PRMT1* could be a novel prognostic marker and therapeutic target for HCC therapy.

DDIAS suppresses TRAIL-mediated apoptosis by inhibiting DISC formation and destabilizing caspase-8 in cancer cells

We report that DDIAS protects cancer cells from tumor necrosis factor-related apoptosis-inducing ligand (TRAIL)-induced apoptosis by two distinct mechanisms in non-small cell lung cancer (NSCLC) and hepatocellular carcinoma (HCC) cells. DDIAS depletion sensitized NSCLC and HCC cells to TRAIL-mediated apoptosis. Interestingly, the N terminus of DDIAS interacted with the death effector domain of Fas-associated protein death domain (FADD) and prevented its recruitment to the death-inducing signaling complex (DISC), thereby blocking caspase-8 activation. DDIAS knockdown also suppressed epidermal growth factor-induced phosphorylation of p90 ribosomal S6 kinase (RSK) 2 and stabilized caspase-8 by preventing its ubiquitination and proteasomal degradation. Taken together, DDIAS has the dual function of inhibiting DISC formation as well as destabilizing caspase-8, thereby suppressing TRAIL-mediated apoptosis in cancer cells.

Characterizing a role of LSD1 in oxygen-deprived tumor microenvironmental stress

Oxygen deprivation induces a range of cellular adaptive responses that enable the drive to cancer progression. We report that lysine-specific demethylase 1 (LSD1) suppresses the oxygen-independent degradation of HIF-1 alpha by demethylating RACK1 protein, and consequently upregulating hypoxia responses. Further, we show that the activity of LSD1 is attenuated during prolonged hypoxia, dependently with the cellular level of flavin adenine dinucleotide (FAD). Transcriptomic analyses of patient tissues show that the HIF-1 signature is highly correlated with the expression of LSD1 target genes as well as the enzymes of FAD biosynthetic pathways in triple-negative breast cancers, reflecting the significance of FAD-dependent LSD1 activity in cancer progression. Together, our findings provide new insight into HIF-mediated hypoxia response regulation by coupling the FAD dependence of LSD1 activity to the regulation of HIF-1 alpha stability. Moreover, this study suggests a close relation between cellular metabolic statuses such as intracellular FAD level and the adaptive response to microenvironmental stress including hypoxia.

Development of small molecular inhibitor of HSF1 and OCT4

HSF1 is the master transcription regulator of the stress responses Knock-out of HSF1 protects mice from tumors initiation and progression. From the screening of HSF1 inhibitors using cell-based reporter assays, we identified KRIBB11, as an inhibitor of cancer cell metastasis. Meanwhile, OCT4 is a main transcription factor for stemness in stem cells and is reported to be involved in cancer stem cells. From the screening of OCT4 inhibitors using cell-based reporter assays, we identified KRIBB53, which binds to and enhances OCT4 degradation through the proteasome, causing apoptosis of the OCT4-positive testicular germ cell tumor.

SELECTED PUBLICATIONS

Stability of the cancer target DDIAS is regulated by the CHIP/HSP70 pathway in lung cancer cells.
Cell Death Dis. 8(1):e2554.
Mi Sun Won (Corresponding)

The novel hypoxia-inducible factor-1 inhibitor IDF-11774 regulates cancer metabolism, thereby suppressing tumor growth.
Cell Death Dis. 8(6):e2843.
Mi Sun Won (Co-corresponding)

DNA methylation : an epigenetic mark of cellular memory.
Exp Mol Med. 49(4):e322.
Mirang Kim (First)

Methyl 3-(3-(4-(2,4,4-trimethylpentan-2-yl) phenoxy)-propanamido)benzoate as a novel and dual malate dehydrogenase (MDH) 1/2 inhibitor targeting cancer metabolism.
J Med Chem. 60(20):8631-8646.
Mi Sun Won (Co-corresponding)

AGING RESEARCH CENTER

We investigate the molecular mechanisms of the aging process in the aspect of cellular changes and organ degeneration.

We are going to develop fundamental technologies in the prevention and therapeutics of healthy aging.

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INVESTIGATORS

Ki-Sun Kwon kwonks@kribb.re.kr
- Systems biology of sarcopenia and age-related diseases
- Signal transduction related to muscle aging

Yong-Kook Kang ykkang@kribb.re.kr
- Epigenetic mechanism of muscle aging

Sung Sup Park sspark@kribb.re.kr
- Understanding the pathogenesis of muscle dysfunction
- Molecular mechanisms in neuronal cell death

Eun-Soo Kwon eunsoo.kwon@kribb.re.kr
- Molecular biology and genome-wide studies on aging and aging-related diseases using Caenorhabditis elegans
- Inter-species regulation of longevity by gut microbe

Young Kyo Seo ykseo@kribb.re.kr
- Regulation of age-dependent inflammation in muscles
- Energy metabolism in muscle aging

Seok Ho Kim kims@kribb.re.kr
- Research on the aging of muscles and immunity
- Molecular mechanism of age associated Tendinosis (rotator cuff tear)

Kwang Pyo Lee kplee@kribb.re.kr
- Molecular mechanisms of myoblast (satellite cell) differentiation, dysfunction and diseases (aging and sarcopenia)

Yong Ryoul Yang dearyang@kribb.re.kr
- Age-related diseases in mouse models

Jung Sun Park jspark@kribb.re.kr
- Production of transgenic animal models related to aging

RESEARCH AREAS

- Systems biology of sarcopenia and age-related diseases
- Discovery of new genes involved in the aging process and studies on signaling pathways therein
- Discovery of rejuvenating factors to reverse the processes of aging
- Functional identification of age-related genes using model worms, flies and mice
- Development of drug candidates and biologics for the control of age-associated diseases

ACHIEVEMENTS

- Identification of muscular microRNAs that are associated with age: We study the function of miRNAs down-regulated in old muscle and their targets in order to improve muscular function in old animals.
- Development of drug candidates to treat muscle wasting disease: We found chemical compounds that improved regenerative capacity in old mice. Recently, we made a successful technology transfer of a drug candidate to a biotech company.
- Identification of the rejuvenating factors that are able to reverse aging in old animals: We analyze serum factors and gut microbes by using proteomics tools and a genome-wide library in order to slow down the aging processes in old animals.

SELECTED PUBLICATIONS

Age-associated chromatin relaxation is enhanced in Huntington's disease mice.
Aging. 9(3):803-822.
Yong-Kook Kang (Co-corresponding)

STAT5A-mediated NOX5-L expression promotes the proliferation and metastasis of breast cancer cells.
Exp Cell Res. 351(1):51-58.
Ki-Sun Kwon (Co-corresponding)

Comprehensive miRNA profiling of skeletal muscle and serum in induced and normal mouse muscle atrophy during aging.
J Gerontol A. 72(11):1483-1491.
Kwang Pyo Lee (Co-first)

Forebrain-specific ablation of phospholipase C 1 causes manic-like behavior.
Mol Psychiatry. 22(10):1473-1482.
Yong Ryoul Yang (First)

Memory and synaptic plasticity are impaired by dysregulated hippocampal O-GlcNAcylation.
Sci Rep. 7:44921.
Yong Ryoul Yang (First)

HAZARDS MONITORING BIONANO RESEARCH CENTER

Our goal is to develop original technology to detect/analyze biological and chemical hazards based on the concept of nano-bio convergence. To accomplish this goal, we develop new biocontents, nanobiomaterials and an integrated system thereof for highly sensitive detection and related technologies, thereby enabling the continuous monitoring of hazards. Combining these efforts will contribute to the creation of new businesses and realize our dream of prolonging human life.

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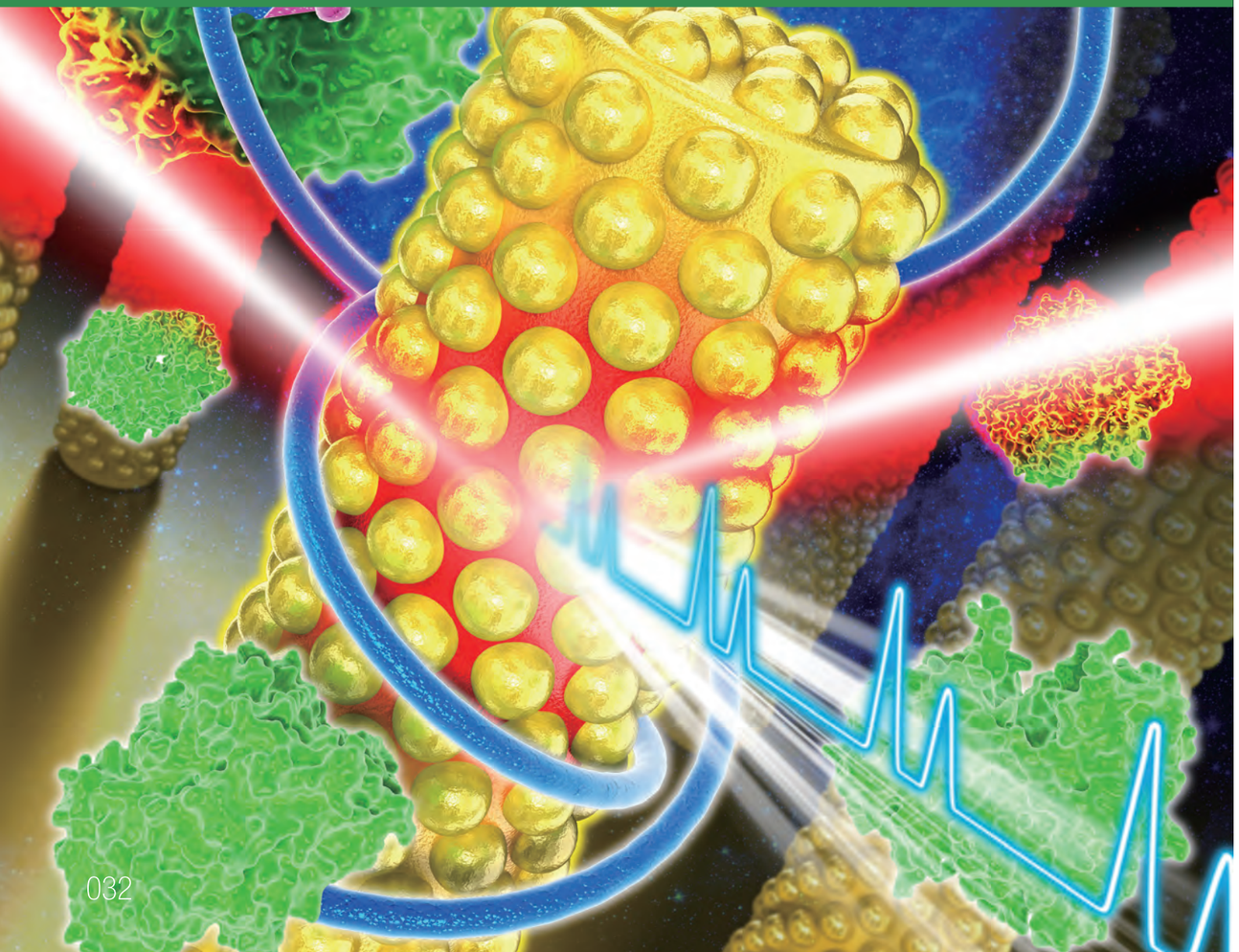

INVESTIGATORS

Tai Hwan Ha taihwan@kribb.re.kr
- Nanobiomaterials for biosensor and biochips, DNA/RNA aptamer biosensors

Moonil Kim kimm@kribb.re.kr
- Bioelectronics, Living Biosensor

Myung Kyu Lee mklee@kribb.re.kr
- Bionanotechnology, Biochemistry

Im Sik Chung cis123@kribb.re.kr
- Nano-polymer Chemistry

Kyu-Sun Lee ekuse74@kribb.re.kr
- Development of a Drosophila model system for studying age-related diseases such as diabetes and neurodegenerative diseases

Juyeon Jung jjung@kribb.re.kr
- Antibody engineering for infectious diseases

Chang-Soo Lee cslee@kribb.re.kr
- Development of fluorescent probes for small molecules

Taejoon Kang kangtaejoon@kribb.re.kr
- Development of SERS biosensor for cancer diagnosis

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- Development of nanomaterials for biosensors, Bionanomedicine

Eun-Kyung Lim eklim1112@kribb.re.kr
- Development of nanomedicine for "Theragnosis"

Oh Seok Kwon oskwon79@kribb.re.kr
- Electrical Bionanosensors for small molecules

Ju Young Byun bjy8349@kribb.re.kr
- Bionanosensors based on paper-chip

RESEARCH AREAS

Bio contents technology to detect and analyze biological hazards (infectious germs and viruses) and chemical hazards (toxicity, shellfish toxins, pesticides, heavy metals, etc.)

- Development of highly efficient biomaterials (antibodies, peptides, oligonucleotides etc.) for the detection/analysis of hazards
- Biological and chemical engineering to apply to hazard detection and analysis system
- Establishment of bio contents library for hazards and effective analysis

New concept nano structure and bio contents interfacing technology to detect/analyze hazards

- New manufacturing technology for functional nanostructure to detect hazards
- Highly efficient interfacing technology between bio contents and nano structures
- Highly sensitive hazard detection/analysis technology based on bio contents/nano structure

Integrated monitoring system technology to detect/analyze hazards

- Bio element and signal transducer technology to detect hazards
- Highly efficient bio interfacing technology to integrate bio/nano elements
- Signal amplification technology for biosensors to detect hazards
- Integrated hazards detection/analysis system for both bio contents and nano materials/elements

ACHIEVEMENTS

Development of a field-effect transistor (FET) biosensor harboring membrane protein as signal transducer

- Development of ultra-sensitive FET biosensors fabricated by loading membrane protein (dopamine receptors) as a crucial signal transducer that can be widely employed in the diagnosis of neuro-degenerative disease

In this study, we proposed an approach for studying receptor agonism and antagonism by combining the roles of FETs and GPCRs in a dopamine receptor D1 (DRD1)-conjugated FET system, which is a suitable substitute for conventional cell-based receptor assays. The real-time responses from the DRD1-nanohybrid FET were highly sensitive and selective for dopamine agonists/antagonists.

Development of SERS-based biosensors for early cancer diagnosis

- Development of a nanogap-rich surface enhanced Raman scattering (SERS) biosensor that is fabricated from single crystalline Au nanowires

The nanogap-rich Au NWs are constructed by deposition of nanoparticles on single-crystalline Au NWs and provided highly reproducible SERS spectra. The telomeric substrate (TS) primer-attached nanogap-rich Au NWs can detect telomerase activity. This sensor enables us to detect telomerase activity from various cancer cell lines with a detection limit of 0.2 cancer cells mL−1.

Development of highly sensitive aptamer biosensor for Salmonella

- Development of a simple scheme using a hairpin DNA aptasensor to detect Salmonella Typhimurium (S. Typhimurium)

The hairpin DNA aptasensor was a single-stranded oligonucleotide including both a target-binding sequence and a reporting DNAzyme called horseradish peroxidase-mimicking G-quadruplex.

SELECTED PUBLICATIONS

Graphene-embedded hydrogel nanofibers for detection and removal of aqueous-phase dyes.
ACS Appl Mater Interfaces. 9(12):10768-10776.
Oh Seok Kwon (Co-corresponding)

Dopamine receptor D1 agonism and antagonism using a field-effect transistor assay.
ACS Nano. 11(6):5950-5959.
Oh Seok Kwon (Co-corresponding)

Nanogap-rich Au nanowire SERS sensor for ultrasensitive telomerase activity detection : application to gastric and breast cancer tissues diagnosis.
Adv Funct Mater. 27(37):1701832.
Taejoon Kang (Co-corresponding)

A multivalent structure-specific RNA binder with extremely stable target binding but reduced interaction to nonspecific RNAs.
Angew Chem Int Ed Engl. 56(50):15998-16002.
Taejoon Kang (Co-corresponding)

3D hydrogel scaffold doped with 2D graphene materials for biosensors and bioelectronics.
Biosens Bioelectron. 89(1):187-200.
Oh Seok Kwon (Co-first)

A near-infrared "turn-on" fluorescent probe with a self-immolative linker for the In vivo quantitative detection and imaging of hydrogen sulfide.
Biosens Bioelectron. 89(2):919-926.
Chang-Soo Lee and Oh Seok Kwon (Co-corresponding)

A facile, rapid and sensitive detection of MRSA using a CRISPR-mediated DNA FISH method, antibody-like dCas9/sgRNA complex.
Biosens Bioelectron. 95:67-71.
Juyeon Jung and Eun-Kyung Lim (Co-corresponding)

A highly sensitive and widely adaptable plasmonic aptasensor using berberine for small-molecule detection.
Biosens Bioelectron. 97:292-298.
Ju Young Byun (Co-first)

Surfactant-free vapor-phase synthesis of single-crystalline gold nanoplates for optimally bioactive surfaces.
Chemi Mater. 29(20):8747-8756.
Taejoon Kang (Co-corresponding)

Energy efficient capacitors based on graphene/conducting polymer hybrids.
J Ind Eng Chem. 51:1-11.
Chang-Soo Lee (Co-corresponding)

An electrochemical nanofilm sensor for determination of 1-hydroxypyrene using molecularly imprinted receptors.
J Ind Eng Chem. 51:106-112.
Chang-Soo Lee (Co-first)

Nanostructured mesophase electrode materials : modulating charge-storage behavior by thermal treatment.
Nanoscale. 9(44):17450-17458.
Oh Seok Kwon (Co-corresponding)

Attomolar detection of extracellular microRNAs released from living prostate cancer cells by a plasmonic nanowire interstice sensor.
Nanoscale. 9(44):17387-17395.
Taejoon Kang (Co-corresponding)

Polyamidoamine (PAMAM) dendrimers modified with cathepsin-B cleavable oligopeptides for enhanced gene delivery.
Polymers. 9(6):224.
Tai Hwan Ha (Co-corresponding)

Improved sensing characteristics of dual-gate transistor sensor using silicon nanowire arrays defined by nanoimprint lithography.
Sci Technol Adv Mater. 18(1):17-25.
Yong Beom Shin (Co-corresponding)

Top-down fabrication and enhanced active area electronic characteristics of amorphous oxide nanoribbons for flexible electronics.
Sci Rep. 7:5728.
Yong Beom Shin (Co-corresponding)

ANTICANCER AGENT RESEARCH CENTER

Our center strives to discover new anticancer agents derived from microorganisms and chemical libraries and to identify their cellular targets for the development of novel front-line chemotherapeutic agents. Our research utilizes chemical biology techniques based on metabolomics, genomics, proteomics and cellulomics technology combined with our expertise in N-end rule mediated protein degradation, PLK-linked cytokinesis and tumor cell specific metabolism to develop medicinal and bio-functional compounds.

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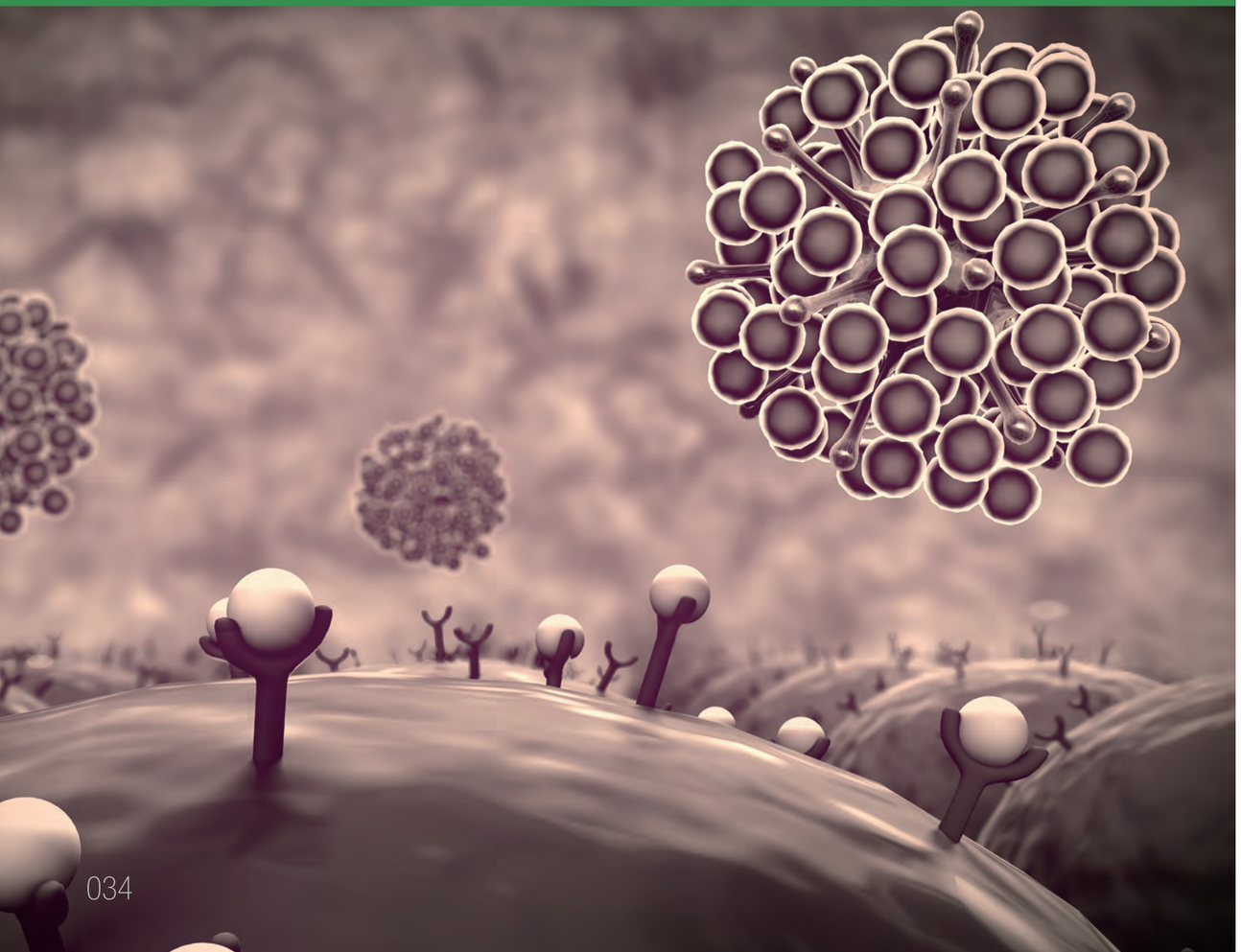

INVESTIGATORS

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- Microbiology and cell biology
- Chemical biology

Bo Yeon Kim bykim@kribb.re.kr
- Cancer molecular cell biology
- N-end rule pathway and protein degradation, autophagy

Sangku Lee sangku@kribb.re.kr
- Organic chemistry
- Organic synthesis, Medicinal Chemistry

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- Natural product biosynthesis and engineering
- Genome mining for new bioactive molecule discovery

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- Microbial natural products chemistry
- Marine natural products chemistry
- Chemical biology

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- Virology of oncogenic viruses
- Drug discovery and validation

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- Cancer cell biology
- Cell division, anticancer drug discovery

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- Chemical biology
- Target protein identification and target molecule interaction

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- Molecular cell biology
- N-end rule pathway, autophagy and protein arginylation

Kyung Ho Lee leekh@kribb.re.kr
- Molecular cell biology
- Cell division, metastasis, ciliogenesis, spermatogenesis

In-Ja Ryoo ijryoo@kribb.re.kr
- Natural product chemistry
- Bio-assay system

RESEARCH AREAS

Anticancer agent screening
- Screening new bioactive compounds regulating tumor cell proliferation and metastasis
- Identifying their cellular targets.

Cancer target discovery and functional mining of anticancer targets
- Research on cancer cell division and its regulatory proteins, polo-like kinase (PLK) and mTOR
- Identification of centrosomal protein Cep131, a key molecule for cancer cell division.
- HEF1 mediated Wnt signaling for cell cycle and metastasis
- Regulation of cilia formation in association with cancer

Research on protein degradation based on the N-end rule pathway
- N-end rule pathway linked with cancer therapeutic drug development
- Protein arginylation mediated cancer development
- Cancer-specific proteolytic signaling mediated by the N-end rule pathway

Autophagy
- Development of bioactive compounds modulating autophagy and cellular microorganelle function

Tumor cell specific metabolism regulator
- Screening of bioactive compounds inhibiting indole 2,3-oxygenase (IDO) and MTH

Virus-associated cancers
- Epstein-Barr virus (EBV)-associated gastric cancer
- Kaposi's sarcoma-associated herpesvirus (KSHV)

Construction of microbial secondary metabolites
- Discovery of bioactive secondary metabolites from microorganisms
- Compilation of a library of microbial secondary metabolites

Combinatorial and Synthetic Biotechnology
- Generating structurally complex bioactive secondary metabolites and their analogues in microorganisms employing their biosynthetic genomes

ACHIEVEMENTS

Discovery of bioactive secondary metabolites from microorganism

Structurally unique and diverse secondary metabolites from microorganisms have been an invaluable source of drugs and molecular probes over the decades. We focus our attention on the exploration of less chemically studied microorganisms, which are potentially prolific sources of novel chemistry. We have isolated 1,200 Actinomycetes and fungal strains from soil samples collected from such places as Ulleung Island and screened their secondary metabolites. Our preliminary chemical screening of EtOAc extracts by LC-MS suggests that Streptomyces sp. produces unusual metabolites, which are rare in public and in-house databases. These metabolites were identified as polyketides, anthranilic acid possessing 6-Deoxy- -L-talopyranose, ulleungoside, and two new chlorinated cyclic hexapeptides, ulleungmycins A and B.

Construction of artificial biosynthetic pathway of polyketides in Escherichia coli

Biological synthesis of plant-specific polyketides has attracted increasing attention due to their proven beneficial properties and health-promoting effects. Engineered E. coli containing artificial phenylpropanoid biosynthetic pathways were established for the production of plant-specific metabolites. Our lab is interested in studying the biosynthesis of various pharmaceutically important natural products, including but not limited to plant-specific polyketides and bacterial type III polyketides.

Virus-associated cancers

We focus our efforts on the discovery of therapeutic candidates for the efficient treatment of Epstein-Barr virus (EBV)-associated gastric cancers. To achieve this goal, we successfully established a robust assay system quantitatively measuring lytic induction of EBV and utilized this system to screen various synthetic chemical and natural resource libraries. Recently, we identified a Euphorbia extract from medicinal plant extracts as a strong lytic inducer of latent EBV and further revealed its active constituents.

Development of potent and selective inhibitors of DYRK1A

Dual specificity tyrosine-phosphorylation-regulated kinase 1A (DYRK1A) has recently drawn increasing attention as a less explored kinase target with diverse therapeutic applications including cancer treatment. In recent years, we identified novel chemotypes of a DYRK1A inhibitor with extraordinarily high potency and reasonable selectivity using computer-aided virtual screening and validated their effectiveness in various assay systems. These inhibitors and related technologies were successfully transferred to two Korean pharmaceutical companies resulting in contracts worth billions of won. In addition, KRIBB will receive royalties on each sale.

Autophagic proteolysis modulated by the N-end rule pathway

The N-end rule pathway whose function used to be associated only with the ubiquitin-proteasome system (UPS) is now emerging as a crossroad between cellular stress sensing and autophagy through our groundbreaking research. Our findings shed light on how cells sense proteotoxic stress manifested as ubiquitinated protein accumulation in cytoplasm and relay the information to induce autophagy. Our results clearly demonstrate that N-terminal arginylation of cytosolic BiP/GRP78 is induced under proteotoxic stress, indicating a stress sensing role of arginyltransferase 1 (ATE1), an important regulator of the N-end rule pathway. Using its Nt-arginine, BiP binds to the ZZ domain of p62/sqstm1, a critical autophagic cargo receptor, which facilitates p62 aggregation, autophagosome biogenesis and autophagic co-delivery and degradation of p62 with BiP and ubiquitinated cargo. Utilizing this mechanism, cells promote their survival in response to devastating cellular stresses such as proteotoxic stress.

SELECTED PUBLICATIONS

Glioma-derived cancer stem cells are hypersensitive to proteasomal inhibition.
EMBO Rep. 18(1):150-168.
Bo Yeon Kim (Co-corresponding)

Octaminomycins A and B, cyclic octadepsipeptides active against *Plasmodium falciparum*.
J Nat Prod. 80(1):134-140.
Jong Seog Ahn (Co-corresponding)

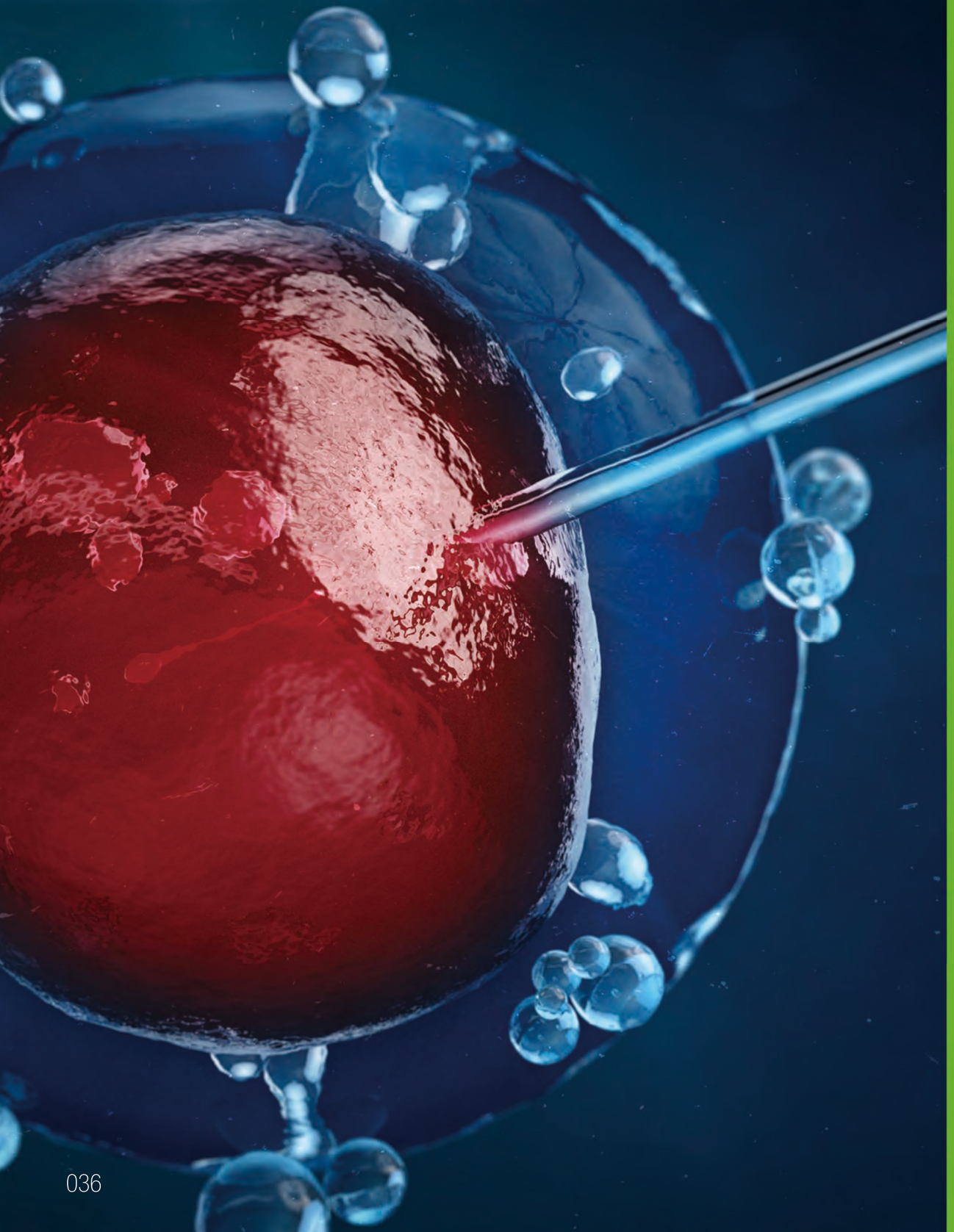
Polyketides and anthranilic acid possessing 6-deoxy- α -L-talopyranose from a *Streptomyces* species.
J Nat Prod. 80(5):1378-1386.
Jong Seog Ahn and Jae-Hyuk Jang (Co-corresponding)

Genomics-driven discovery of chlorinated cyclic hexapeptides ulleungmycins A and B from a *Streptomyces* species.
J Nat Prod. 80(11):3025-3031.
Jong Seog Ahn and Jae-Hyuk Jang (Co-corresponding)

Ginsenoside Re promotes osteoblast differentiation in mouse osteoblast precursor MC3T3-E1 cells and a zebrafish model.
Molecules. 22(1):e42.
Nak-Kyun Soung and Bo Yeon Kim (Co-corresponding)

p62/SQSTM1/Sequestosome-1 is an N-recognin of the N-end rule pathway which modulates autophagosome biogenesis.
Nat Commun. 8(1):102.
Bo Yeon Kim (Co-corresponding)

Gemcitabine, a broad-spectrum antiviral drug, suppresses enterovirus infections through innate immunity induced by the inhibition of pyrimidine biosynthesis and nucleotide depletion.
Oncotarget. 8(70):115315-115325.
Sungchan Cho (Co-corresponding)



DIVISION OF BIOMEDICAL SCIENCES

- Metabolic Regulation Research Center
- Disease Target Structure Research Center
- Biotherapeutics Translational Research Center
- Infectious Disease Research Center
- Genome Editing Research Center

We are making an effort to identify targets and develop structure-based control technologies to overcome incurable diseases. In addition, we aim to conduct clinical trials on control substances related to incurable diseases through clinical and translational studies. We will contribute to the generation of core technologies for metabolic diseases by playing the role as the hub of biotechnology and medical science in Korea.

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METABOLIC REGULATION RESEARCH CENTER

The Metabolic Regulation Research Center (MRRC) is designed to conduct basic science research and translational research to control metabolic diseases including diabetes, obesity, neurodegenerative disease, and cancer. We aim to understand the cellular mechanism as well as metabolic network between organs (fat, liver, muscle, cranial nerve, etc.) through omics analysis and in vivo analysis. We also support and promote multidisciplinary research to develop the core technology to control metabolic diseases.

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INVESTIGATORS

Won Kon Kim wkkim@kribb.re.kr
- Research on the regulation of adipocyte differentiation and thermogenesis
- Research on trans-differentiation of adipocytes
- Research on metabolic diseases

Kwang-Hee Bae khbae@kribb.re.kr
- Identification of metabolic disease treatment targets and functional research using proteomics
- Identification of stem cell differentiation and de-differentiation related protein and functional research

Sang Chul Lee lesach@kribb.re.kr
- Research on the mechanism of metabolism regulation related to stem cell differentiation
- Identification of the protein related to metabolic disease based on the omics approach and investigation of its function

Myung Hee Kim mhk8n@kribb.re.kr
- Research on the mechanism and control of molecular pathology based on convergence technology

Byoung-Chan Kim bckim@kribb.re.kr
- Research on the isolation and identification of anaerobic human microorganisms and their clinical application

Jungwon Hwang jwhwang@kribb.re.kr
- Research on the pathogen-specific biochemical mechanism based on structural and cell biological approaches

Baek-Soo Han bshan@kribb.re.kr
- Exploration of treatment for degenerative neural diseases, research on metabolic functions and identification of neural cell differentiation regulation factors

Hyun Seung Ban banhs@kribb.re.kr
- Identification of new anticancer target molecules using chemical biology and development of function regulation materials

Young-Jun Park pyj71@kribb.re.kr
- Research on metabolic control and control of infectious disease using the macrophage, which is involved in innate immunity

Kyung Jin Oh kjoh80@kribb.re.kr
- Understanding the insulin signal delivery system and energy metabolism of type 2 diabetes and obesity, and researching regulations

Eun-Woo Lee ewlee@kribb.re.kr
- Research on the ubiquitin pathways in metabolic disease and cancer metabolism
- Research on cell death pathways including apoptosis, necroptosis and ferroptosis

RESEARCH AREAS

Research on the regulation of metabolic diseases
- Identification of the metabolic energy system and regulatory mechanism of type 2 diabetes and obesity
- Identification of regulatory material related to the transition from white adipose tissue to brown adipose tissue and research on function
- Screening and functional research of metabolic disease regulatory material based on low molecular compound or natural product
- Analysis of the functional change of major metabolic organs and signal delivery system under the metabolic abnormality and improvement condition using animal models
- Identification and functional research of network regulation factors among metabolic organs through omics analysis

Metabolic control research related to neurodegenerative diseases
- Research on metabolomics and animal models related to neuron function and neurodegenerative diseases

Research on the mechanism of deterring diabetes and macular degeneration by macrophage
- Research on the mechanism of controlling metabolism by macrophage
- Identification of the mechanism for deterring infectious diseases and signaling control by macrophage

Research on the mechanism of cancer metabolism regulation
- Identification of target molecules related to cancer metabolism using compound and function regulation
- Ubiquitination/Deubiquitination-mediated control of cancer metabolism

Development of metabolic disease regulation technology utilizing microbiome analysis
- Development of treatment for obesity and diabetes utilizing intestinal microbiota

ACHIEVEMENTS

Research on the regulatory mechanism of adipocyte differentiation
- Discovery of the regulatory mechanisms and functions of white/brown adipocyte differentiation by protein phosphorylation and acetylation
- Identification of factors that control white/brown adipocyte differentiation of adipocyte adipose tissue using proteomic analysis and discovering its mechanism
- Identification of protein that controls the conversion of white adipose tissue to brown adipose tissue and research on its function

Research on the in vivo function of white and brown adipose tissue
- Understanding the role of novel regulatory proteins including phosphatase in the function of adipose and obesity using knock-out mice
- Identification of new targets for brown adipocyte differentiation control and study on its mechanism and function

Identification of new drug target protein to treat neurodegenerative diseases
- Identification of new drug target protein to treat neurodegenerative diseases by analyzing changes of phosphorylated protein during the destruction of neurons

Finding out the mechanism of infectious disease control through iNOS control
- Finding out the mechanism of iNOS control by TXNIP
- Finding out the deterrent effect of inflammation by iNOS control

Research on the possibility of controlling obesity and diabetes by controlling TXNIP
- Finding out the role of TXNIP in obesity and diabetes
- Finding out the signaling system of TXNIP in obesity and diabetes

Identification of new antivibriosis agent and investigation of related mechanism
- Identification of a sustainable antivibriosis agent, QStatin by target-based high-throughput screening
- Understanding the functional mechanism of QStatin by structural and biochemical analyses

SELECTED PUBLICATIONS

Synthesis and biological evaluation of kresoxim-methyl analogues as novel inhibitors of hypoxia-inducible factor (HIF)-1 accumulation in cancer cells.
Bioorg Med Chem Lett. 27(13):3026-3029.
Hyun Seung Ban (Co-corresponding)

Metabolic adaptation in obesity and type II diabetes : myokines, adipokines and hepatokines.
Int J Mol Sci. 18(1):e8.
Kwang-Hee Bae and Sang Chul Lee (Co-corresponding)

Ginsenoside Rg3 ameliorated HFD-induced hepatic steatosis through downregulation of STAT5-PPAR γ.
J Endocrinol. 235(3):223-235.
Young-Jun Park, Jeong Ki Min and Hee Gu Lee (Co-corresponding)

HDAC11 inhibits myoblast differentiation through repression of MyoD-dependent transcription.
Mol Cells. 40(9):667-676.
Sang Chul Lee (Co-corresponding)

Shiga toxins induce apoptosis and ER stress in human retinal pigment epithelial cells.
Toxins. 9(10):e319.
Young-Jun Park and Moo-Seung Lee (Co-corresponding)

DISEASE TARGET STRUCTURE RESEARCH CENTER

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

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

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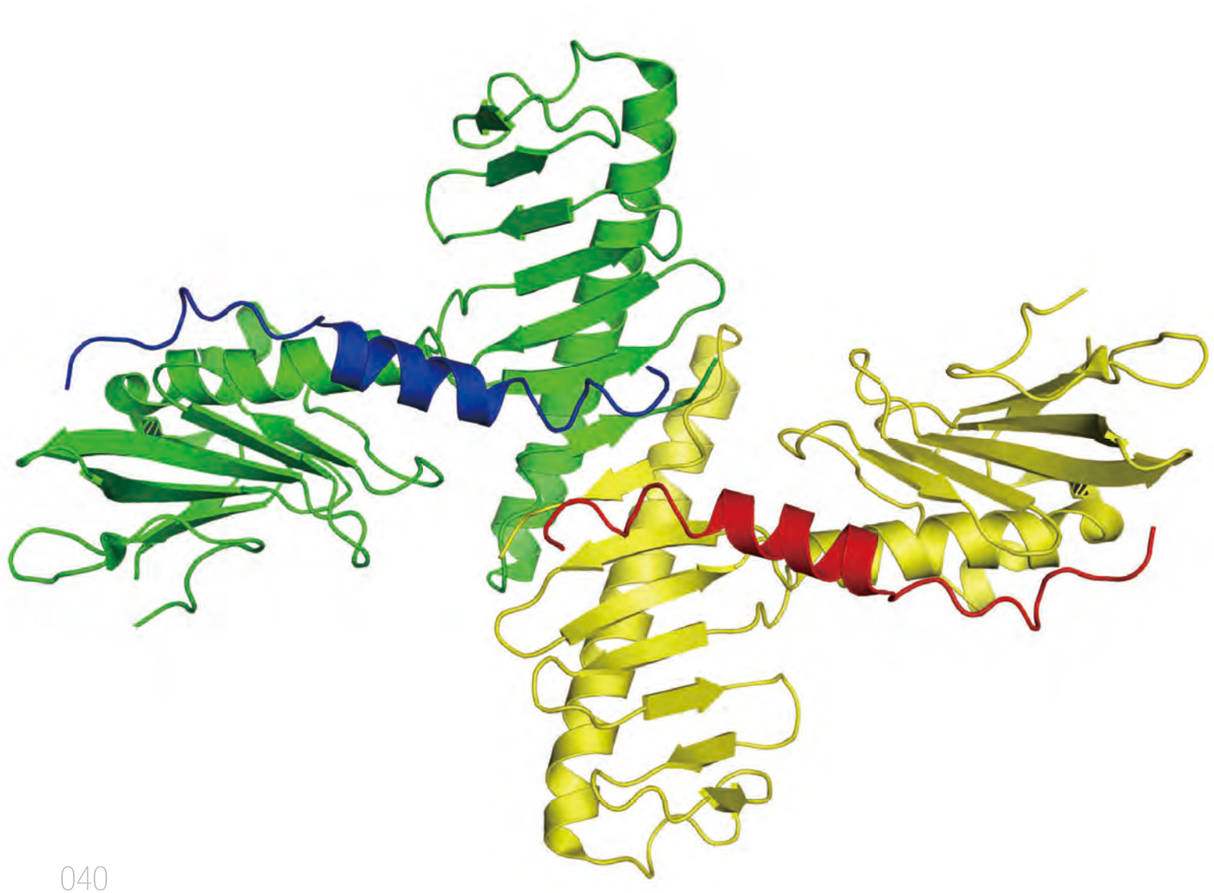

INVESTIGATORS

Seung-Wook Chi swchi@kribb.re.kr
- Nanopore sensor technology development, protein design and engineering
- Structure-based drug development, structural biology of apoptosis-regulating anticancer proteins

Sunghyun Kang skang@kribb.re.kr
- Proteomics and mass spectrometry

Sunhong Kim sunhong@kribb.re.kr
- Cell Signal Transduction in cell and C. elegans model
- Drug Discovery

Seung Jun Kim ksj@kribb.re.kr
- Structural studies on anti-oxidant proteins and protein tyrosine phosphatases
- Drug development using 3-D structural information

Jeong Hee Moon jhdal@kribb.re.kr
- Mass spectrometry, Proteomics, Protein Dynamics, Protein Quantification

Byoung Chul Park parkbc@kribb.re.kr
- Target mining and validation using proteomics, Signal transduction
- Translational research on immune diseases

Sung Goo Park sgpark@kribb.re.kr
- Mechanism and functions of apoptosis-related proteins, Protease degradomics

Eui-Jeon Woo ejwoo@kribb.re.kr
- Research on the structure and function of nucleic acid-binding proteins and Crispr system
- Development of functional control technology using structure-based protein engineering

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- Molecular genetics research on metabolic and neurodegenerative diseases using the Drosophila Model

Tae-Sung Yoon yoonts@kribb.re.kr
- Neutron & X-ray crystallography, structural proteomics, astrobiology

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- Protein X-ray crystallography
- Structural studies on signaling-regulatory proteins

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- Studies on the regulatory mechanisms of chromatin modifiers

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- Structural and dynamics studies using NMR spectroscopy
- Analysis of biomolecule using solid-state and protein nanopores

Jeong-Soo Lee jeongsoo@kribb.re.kr
- Research on neurology, blood vessel development, and nanotoxicity using zebrafish

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- Protein X-ray crystallography
- 3D structural studies and antibody development of protein tyrosine phosphatases

RESEARCH AREAS

Research on the structures and functions of disease target proteins
- Elucidation of structures and functions of therapeutic proteins involved in apoptosis, cell division, and carcinogenesis using X-ray crystallography and NMR spectroscopy
- Structure-based drug discovery against disease targets

Proteomics-based discovery and validation of disease target proteins
- Proteomics-based analysis of apoptosis interactome
- Identification and validation of biomarkers related to atopic skin disease, asthma, and rheumatoid arthritis

Animal model-based research for treatment of degenerative diseases
- Development of animal models (Drosophila and zebrafish) for phenotypic screening of neurodegenerative diseases
- Animal model-based discovery and validation of new drug candidates for neurodegenerative disease

Drug discovery by cellular signaling research
- Research on cellular signaling mechanism in various pathways including GPCR, Wnt, mTOR
- Discovery of hits and leads using various activity evaluation assays

Development of nanopore sensor technology for detecting proteins and nucleic acids
- Development of nanopore sensor platform technologies for drug screening and disease diagnosis

ACHIEVEMENTS

Elucidation of structures and functions of kinases and phosphatases
- Determination of three-dimensional structures and functional mechanisms of over 20 phosphatases involved in cellular signaling including apoptosis, cell division, and carcinogenesis.

Determination of structures of apoptosis-regulating proteins and development of structure-based multi-targeting strategy
- Determination of three-dimensional structures of apoptosis-regulating anticancer target proteins using NMR spectroscopy, Structure-based development of multi-targeting anti-cancer therapeutics

Elucidation of growth-regulating microRNA
- Discovery of growth-regulating microRNA9a by microRNA library screening
- Elucidation of growth-regulating role of microRNA9a as a new target of sNPFR/NPYR

Development of a novel screening technology for protein-protein interaction inhibitors using nanopore

Research for treatment of Alzheimer's disease using photoactivated porphyrins

High-resolution real-time imaging analysis on the effect of graphene oxide nanoparticles on blood vessel development

SELECTED PUBLICATIONS

Acoustic wave-driven functionalized particles for aptamer-based target biomolecule separation.
Anal Chem. 89(24):13313-13319.
Tae-Sung Yoon (Co-corresponding)

The cellular basis of dendrite pathology in neurodegenerative diseases.
BMB Rep. 50(1):5-11.
Sunhong Kim (Co-first)

RNA activation-independent DNA targeting of the Type III CRISPR-Cas system by a Csm complex.
EMBO Rep. 18(5):826-840.
Eui-Jeon Woo (Co-corresponding)

Two-track virtual screening approach to identify both competitive and allosteric inhibitors of human small C-terminal domain phosphatase 1.
J Comput Aided Mol Des. 31(8):743-753.
Seung Jun Kim (Co-corresponding)

Zebrafish knockout of Down syndrome gene, *DYRK1A*, shows social impairments relevant to autism.
Mol Autism. 8:50.
Jeong-Soo Lee (Co-corresponding)

Uracil DNA glycosylase (UDG) activities in *Bradyrhizobium diazoefficiens* : characterization of a new class of UDG with broad substrate specificity.
Nucleic Acids Res. 45(10):5863-5876.
Eui-Jeon Woo (Co-corresponding)

Development of zebrafish medulloblastoma-like PNET model by TALEN-mediated somatic gene inactivation.
Oncotarget. 8(33):55280-55297.
Jeong-Soo Lee (Co-corresponding)

Pharmacological intervention of early neuropathy in neurodegenerative diseases.
Pharmacol Res. 119:169-177.
Jeong-Hoon Kim (Co-first)

BIOTHERAPEUTICS TRANSLATIONAL RESEARCH CENTER

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

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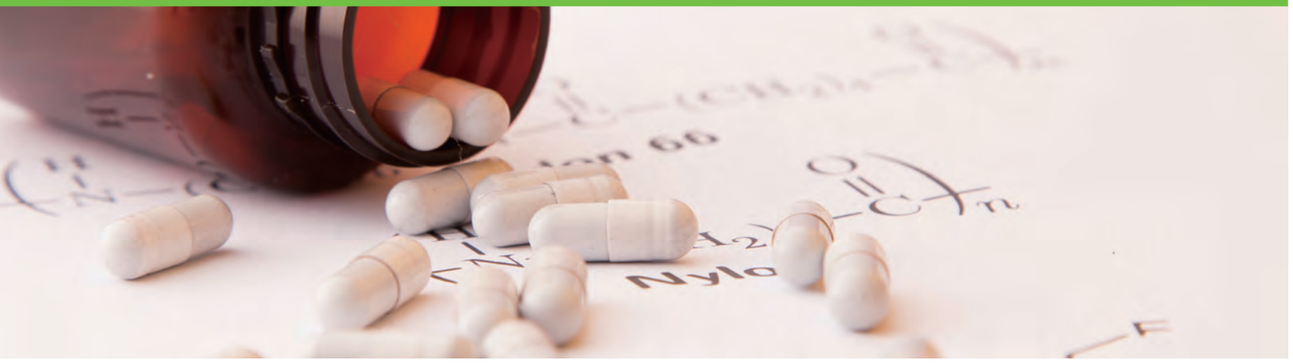

INVESTIGATORS

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- Translational research for treatment of vascular-related diseases & cancer
- Studies on vascular development & inflammation, new anticancer drug targets, and stem cell differentiation

Jang-Seong Kim jangskim@kribb.re.kr
- Translational research for anti-cancer drugs
- Cancer biology (metastasis research)

Young Il Yeom yeomyi@kribb.re.kr
- Identification of cancer therapeutic targets

Jeong-Woong Lee jwlee@kribb.re.kr
- Production of cloned pig
- Functional study of animal disease models

Dong Uk Kim kimdongu@kribb.re.kr
- Systematic analysis of the cellular targets of bioactive molecules using the fission yeast genome-wide gene-deletion collection
- Studies on the cell biology underpinning protein-misfolding diseases using fission yeast as a model system
- Research on degenerative brain disease using a yeast model
- Development of anti-cancer drugs based on synthetic lethality

Yeon-Gu Kim ygkim@kribb.re.kr
- Development of high therapeutic protein-producing mammalian cells
- Process development for therapeutic protein production in mammalian cells

Dong Chul Lee dclee@kribb.re.kr
- Identification of cancer therapeutic targets
- Functional study of disease-related biomarkers

Sang-Hyun Lee leesh@kribb.re.kr
- Validation and control technology of therapeutic targets by multifunctional protein antibody library based
- Translational research for development of cancer control technology
- To understand the role of microglia chemotaxis and activation in neuroinflammation

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- Validation of therapeutic targets for cardiovascular diseases
- Regulation of metabolic disorders

Jangwook Lee jlee@kribb.re.kr
- Development and application of therapeutic biomacromolecules- on-demand for patients
- Targeted macromolecule delivery system for disease theragnosis(diagnosis and therapy)

Tae Su Han tshan@kribb.re.kr
- Identification and functional study of non-coding RNAs in cancer

Chi-Yong Ahn cyahn@kribb.re.kr
- Ecophysiology of microalgae and cyanobacteria (control of algal bloom)
- Optimization of mass cultivation of microalgae using wastewater

Hyun-Soon Kim hyuns@kribb.re.kr
- Studies on plant-based expression system for sustainable production of invaluable bio-materials

Suk Yoon Kwon sykwon@kribb.re.kr
- Structural and functional genomics of plants
- Transformation of crop plants for enhancing agricultural traits

RESEARCH AREAS

Identification of target that adjusts cancer/angiogenesis and blood vessel inflammation and development of control technology
- Identification of target based on multi-function antibody library system and development of antibody
- Regulating endothelium differentiation based on stem cell

Development of Biopharmaceuticals (antibody/AAV) for therapeutic angiogenesis & anti-cancer therapy
Mining of Diagnostic/therapeutic targets for vascular/metabolic diseases and cancer
Finding out the resistance to drug and metastasis regulation and development of control technology
- Development of a new drug through translational research between basic and clinical research

Identification of non-coding RNAs as biomarkers for diagnosis and prognosis of cancer
Development of treatment targeting cancer specific cell metabolism-signals and development of application technology
- Role of cancer cell metabolome lactic acid and research on mechanism
- Research on therapeutic technology through controlling lactic acid signaling system

Drug Target identification
- Target identification and mechanism of action in drug discovery
- Target deconvolution using yeast gene-deletion collection

Targeted therapeutic biomacromolecules (antibody/protein/gene)
- Development of antibody-drug conjugates (Biobetter)
- Establishment of targeted drug delivery system

Identification of gene related to the production of immunodeficient pigs
- Research on the mechanism of factors that cause immune rejection response

Production of disease animal and functional study- Production of transgenic and knockout animal using gene editing system.
- Biomolecular and physiological mechanism study using animal disease model

Wastewater treatment using microalgae
- Economic and efficient treatment of wastewater and biomass production, by cultivating microalgae
- Production of biofuel and high-value compounds from microalgae

Algal bloom research
Ecophysiological and metagenomic study on the mechanisms of algal bloom in freshwater (green tide) and seawater (red tide): advanced monitoring of bloom and production of algal toxins, mal-odor compounds, and their interaction with aquatic microorganisms.

Plant-based expression and production research
In-plant cell biotechnology for invaluable bio-materials

ACHIEVEMENTS

Providing cancer/blood vessel treatment technology through finding out the function of a new protein that regulates angiogenesis and functions
- Technology that activates/controls angiogenesis based on antibody
- Cell treatment technology by establishing endothelium differentiation regulation platform

Identification of phosphatase enzyme that regulates blood vessel inflammation/permeability and finding out mechanism for new inflammation regulation
Finding out the new function of lactate in tumor cell metabolism
- Finding out the new signaling mechanism in hypoxic tumor microenvironment
- Finding out the major factors that regulate the function of lactate, which is a cancer specific metabolic product

Finding out the factors that regulate resistance to drugs and metastasis, development of control technology and establishment of basic-clinical translational research
Development of EC-specific receptor agonistic antibodies, tumor-specific antibody-protein conjugate for therapeutic angiogenesis & anti-cancer therapy
- Development of antibodies to surface proteins and for isolation of pluripotent stem cells
- Mining of Diagnostic/therapeutic targets for biliary tract cancer, insulin resistance and steatosis

Development of biocompatible drug delivery system that can address adverse drug reactions and achieve targeted therapeutic success
Establishment of pig T- and B- cell knock out cell lines
Establishment of genetically modified cell lines to produce mini-pigs for Xenotransplantation
Development of disease mouse models
Advanced cultivation of microalgae and wastewater treatment
- Collection of Korean algal strains with high productivity of useful materials
- Development of cultivation systems, optimizing environmental conditions

Mechanism of algal bloom and its control
The genetic diversity of microalgae and their interactions with other microorganisms are being studied using metagenomic and ecoinformatics tools, to understand the detailed biological mechanisms of bloom formation. Environment-friendly methods are being developed to control algal bloom, based on ecological principles.

High-efficiency production of useful recombinant protein by transient expression plant cell suspension culture system
Establishment of plant cell & tissue culture for the over-production of secondary metabolites derived from native herbal plants
The high quality reference genomes of Cucurbit crops
Viral vectors for expression of foreign proteins in plants

SELECTED PUBLICATIONS

Regulation of hypoxia responses by flavin adenine dinucleotide-dependent modulation of HIF-1 protein stability.
EMBO J. 36(8):1011-1028.
Young Il Yeom, Jung-Ae Kim and Kyung Chan Park (Co-corresponding)

Fluorescent nanoswitch for monitoring specific pluripotency-related microRNAs of induced pluripotent stem cells : development of polyethyleneimine-oligonucleotide hybridization probes.
Nano Res. 110(8):2545-2559.
Jeong Ki Min (Co-corresponding)

L1 increases adhesion-mediated proliferation and chemoresistance of retinoblastoma.
Oncotarget. 8(9):15441-15452.
Jeong Ki Min (Co-corresponding)

Improvement of anti-cancer drug efficacy via thermosensitive hydrogel in peritoneal carcinomatosis in gastric cancer.
Oncotarget. 8(65):108848-108858.
Tae Su Han (Co-first)

Investigation of relationship between EBNA-1 expression level and specific foreign protein productivity in transient gene expression of HEK293 cells.
Process Biochem. 55:182-186.
Yeon-Gu Kim (Co-corresponding)

INFECTIOUS DISEASE RESEARCH CENTER

Infectious diseases have become a serious medical and social problem in recent times. Bacteria resistant to major antibiotics are evolving into untreatable 'superbacteria' and acute viral diseases such as influenza and MERS are threatening public health with high morbidity and mortality. Therefore, it is necessary to formulate plans to counter current and future infectious diseases. Being motivated by new insights gained from small RNA, induced resistance, the genomic library and novel antibacterial lead compounds, we are actively engaged in identifying novel antibacterial targets and innovative antibacterial leads. We are also investigating microbe-host interactions to better understand and manage bacterial pathogenesis. For the prophylactic measure against viral diseases, we are developing new vaccines and adjuvant technologies and antiviral strategies based on virology, immunology, and structural biology.

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INVESTIGATORS

Choong-Min Ryu cmryu@kribb.re.kr
- Bacteria-bacteria communication, Bacteria-plant interactions, plant immunity

Soo-Keun Choi sookeun@kribb.re.kr
- Genetics and genomics of Gram-positive bacteria

Dae Gwin Jeong dgjeong@kribb.re.kr
- Structure-based development of recombinant viral protein vaccines
- Proteomic analysis of virus-host interaction

Haeyoung Jeong hyjeong@kribb.re.kr
- High-throughput sequencing and analysis of microbial genomes
- Genomic epidemiological study of nosocomial infection-related bacteria

Won-Gon Kim wgkim@kribb.re.kr
- Discovery and development of new antibacterials
- Microbial natural product chemistry/biosynthetic engineering

Jae Gu Pan jgpan@kribb.re.kr
- Molecular microbial physiology and antimicrobial genomics

Seung-Hwan Park shpark@kribb.re.kr
- Functional genomic study of Bacillus spp. and peptide antibiotics

Haryoung Poo haryoung@kribb.re.kr
- Development of vaccine adjuvants and study of their immune mechanism
- Development of a cervical cancer vaccine using lactobacillus as a vehicle

Doo-Jin Kim golddj@kribb.re.kr
- DNA vaccines against acute respiratory viral diseases (influenza and MERS)
- Mechanisms of action of immunomodulatory vaccine adjuvants
- Immunomodulatory function of viral proteins

Moo-Seung Lee msl031000@kribb.re.kr
- Characterization of enterohaemorragic E.coli Shiga toxins to cause acute renal failure
- Efficient production of recombinant antimicrobial hybrid peptides and therapeutic proteins to prevent pathogens from infecting host
- Understanding microbial toxin-host interaction

Sun-Woo Yoon syoon@kribb.re.kr
- Pathogenesis and genetic characterization of influenza viruses
- Development of influenza vaccine technologies using the reverse genetics system

Hye Kwon Kim khk1329@kribb.re.kr
- Viral infectious diseases in animals
- Identification and characterization of novel viruses

Ji Hyung Kim kzh81@kribb.re.kr
- Antibiotic-resistance & virulence on aquatic pathogens
- Zoonotic bacterial diseases in animals

Jun-Seob Kim junkim83@kribb.re.kr
- Control of multi-drug resistance (superbacteria)
- Bacterial persistence (Non-inherited antibiotic resistance)

Sung-Kyun Park skpark@kribb.re.kr
- Stage-specific control of B cell development and function
- Development of therapeutic antibody for viral infectious diseases

RESEARCH AREAS

- Antibacterials discovery and target identification with genomic library
- Microbial genome analysis and recombineering for enhanced antibiotics production
- Small RNA biology and induced resistance related to pathogenic bacteria
- Bacterial display of enzymes and antigens: directed evolution
- Bacterial acetylproteomes
- Bacteria-host interactions
- Development of high throughput protein expression system
- Development of new vaccines against infectious diseases including influenza and MERS
- Development of novel vaccine adjuvants and the investigation of their immunomodulatory mechanisms
- Basic research on pandemic influenza, including surveillance and genetic characterization
- Research on Emerging and re-emerging viral infectious diseases

ACHIEVEMENTS

- Dissecting probiotic Paenibacillus –plant interactions and their genome analysis
- Understanding and applying Paenibacillus elicited plant growth promotion and induced resistance.
- Engineering of NRPS gene clusters from Paenibacillus polymyxa and over-producing strains of peptide antibiotics
- High expression of polymyxin and fusaricidin biosynthetic gene clusters and engineering to generate novel derivatives.
- Discovery of new anti-Gram negative compounds with new mode of action from a microbial library
- Generation of new analogues by biosynthetic engineering of Streptomyces gene clusters
- Construction of libraries for monitoring functions of small RNAs
- Vector-based library construction for analyzing the function of small RNAs and related proteins in the metabolic pathways of bacteria.
- Role of volatile organic compounds on bacterial communications
- Understanding the mechanistic basis of bacterial interactions by volatile organic compounds in developing drug resistance.
- Spore display system for enzymes and vaccines
- Developing novel display systems for enzymes and antigens in Bacillus spores.
- Bacterial acetylproteomes
- Systematic identification of post-translationally acetylated proteins in bacteria.
- Genome engineering of Bacillus subtilis
- Developing a highly-efficient microbial genome engineering method using CRISPR/Cas9 system
- Development and technology transfer of a novel avian influenza vaccine
- Investigation on the immunomodulatory and antiviral functions of bacterial outer membrane vesicles (OMVs)
- Molecular mechanisms of development of intraepithelial lymphocytes
- Isolation and characterization of influenza viruses from domestic wild birds, dogs, horses, and human patients.
- Development and clinical studies of a cervical cancer vaccine
- Precision sequencing and analysis of microbial reference genomes using contemporary genome sequencing technologies in light of genealogy and evolution

SELECTED PUBLICATIONS

Chatting with a tiny belowground member of the holobiome : communication between plants and growth-promoting rhizobacteria.
Adv Bot Res. 82:135-160.
Choong-Min Ryu (Corresponding)

Biological and chemical strategies for exploring inter- and intra-kingdom communication mediated via bacterial volatile signals.
Nat Protoc. 12(7):1359-1377.
Choong-Min Ryu (Corresponding)

Foliar application of the leafcolonizing yeast *Pseudozyma churashimaensis* elicits systemic defense of pepper against bacterial and viral pathogens.
Sci Rep. 7:39432.
Choong-Min Ryu (Corresponding)

Poly- ɣ -glutamic acid/chitosan nanogel greatly enhances the efficacy and heterosubtypic cross-reactivity of H1N1 pandemic influenza vaccine.
Sci Rep. 7:44839.
Haryoung Poo (Corresponding)

Seed defense biopriming with bacterial cyclodipeptides triggers immunity in cucumber and pepper.
Sci Rep. 7:14209.
Choong-Min Ryu (Corresponding)

Experimental infection of clade 1.1.2 (H5N1), clade 2.3.2.1c (H5N1) and clade 2.3.4.4 (H5N6) highly pathogenic avian influenza viruses in dogs.
Transbound Emerg Dis. 64(6):1669-1675.
Dae Gwin Jeong (Co-corresponding)

Are circular RNAs New Kids on the Block?
Trends Plant Sci. 22(5):357-360.
Choong-Min Ryu (Corresponding)

Outer membrane vesicles harboring modified lipid A moiety augment the efficacy of an influenza vaccine exhibiting reduced endotoxicity in a mouse model.
Vaccine. 35(4):586-595.
Doo-Jin Kim (Co-corresponding)

GENOME EDITING RESEARCH CENTER

Genome editing is a type of genetic engineering in which DNA is inserted, deleted or corrected in the genome of a living organism using engineered nucleases, or "molecular scissors." These nucleases create site-specific double-strand breaks (DSBs) at desired locations in the genome, and the induced double-strand breaks are repaired through nonhomologous end-joining or homologous recombination, resulting in targeted mutations. Three distinct types of engineered nucleases are being used; zinc finger nucleases (ZFNs), transcription activator-like effector-based nucleases (TALEN), and the CRISPR-Cas system. The development of alternative genome engineering tools is also being attempted. These genome-engineering tools are used for genetic functional study, generation of model organisms and gene therapy. The related techniques can be applied to various research and development fields including gene delivery, stem cells, nanotechnology, and cell therapy.

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INVESTIGATORS

Yong-Sam Kim omsys1@kribb.re.kr
- Development of a new gene editing technology
- Research on the advancement of a gene editing technology

Yong Sung Kim yongsung@kribb.re.kr
- Exploration of epigenetic target genes related to cancer and stem cell differentiation
- Development of epigenetic gene editing technology for a target gene

Byoung-Mog Kwon kwonbm@kribb.re.kr
- Exploration of genes related to diseases utilizing biochemical and chemical genomics and identification of the function, utilizing gene editing technology

Jeong-Heon Ko jhko@kribb.re.kr
- Research on the function of glucide genes and development of glucide gene editing technologies

Dae-Yeul Yu dyyu10@kribb.re.kr
- Production of transformation mouse model and research on its function

Namshin Kim deepreds@kribb.re.kr
- NGS-based Genome Platform by Assessment of Genome Variant and Genic Intolerance
- Development of Genomic Prediction Algorithm & Software by Artificial Intelligence
- Development of Open Source Platform for High-Density Genotyping Technologies

Seon-Young Kim kimsy@kribb.re.kr
- Research on the understanding of cancer in the human body through the functional genome approach
- Bioinformatics and computational biology

Yoonkyung Kim ykim@kribb.re.kr
- Biocompatible polymer, dendrimer, nano-medicine (diagnosis, drug delivery), organic/supramolecular/medicinal chemistry

Jeong Gu Kang kang@kribb.re.kr
- Development of method to regulate epigenetic target genes utilizing a gene editing technology

RESEARCH AREAS

Research on the advancement of gene editing technologies
- Research on the increase of efficiency of CRISPR/Cas9 and CRISPR/cpf1 gene editing technologies
- Establishment of target regulation system of genes related to stem cells, disease and aging

Development of human mimicking mouse model utilizing glucide gene editing technology
- Selection of glucide gene that causes differences in glucides between humans and mice and development of a mouse model editing the selected gene.
- Verification of non-clinical appropriateness of human mimicking mouse model

Development of new gene editing technologies
- Development and effect verification of the 4th generation gene editing technology

Development of mouse disease models utilizing animal transformation technology

Research on the mechanism of antioxidant enzymes in the process of cancer development

Identification of biological activation mechanism of intrinsically disordered protein and mechanism of causing diseases

Design, compounding and application of new organic/polymer/nano compounds for diagnosis and treatment of incurable diseases

ACHIEVEMENTS

Leading selective expression of a target gene using gene editing technology
- Development of gene expression regulation system based on TALEN targeting promoter of E-cadherin

Development of epigenetic regulation method for a target gene
- Development and verification of technology that induces change of epigenetic gene in a certain chromatin body

Development of mouse disease models for a number of diseases including liver cancer and lung cancer

Invention and spread of the activated part of prestructured motif of intrinsically disordered protein in a world's first

Development of new nano compounds for diagnosis of cancer and retinal disease

SELECTED PUBLICATIONS

The mechanism of p53 rescue by SUSP4.
Angew Chem Int Ed Engl. 56(5):1278-1282.
Kyou Hoon Han (Corresponding)

Geranylnaringenin (CG902) inhibits constitutive and inducible STAT3 activation through the activation of SHP-2 tyrosine phosphatase.
Biochem Pharmacol. 142:46-57.
Byoung-Mog Kwon and Dong Cho Han (Co-corresponding)

Variability in chromatin architecture and associated DNA repair at genomic positions containing somatic mutations.
Cancer Res. 77(11):2822-2833.
Seon-Young Kim (Corresponding)

Toward redesigning the PEG surface of nanocarriers for tumor targeting : impact of inner functionalities on size, charge, multivalent binding, and biodistribution.
Chem Sci. 8(7):5186-5195.
Yoonkyung Kim (Co-corresponding)

Potential forensic application of DNA methylation to identify individuals in a pair of monozygotic twins.
Forensic Sci Int - Genet. 6:e456-e457.
Yong Sung Kim (Corresponding)

Epigenetic regulation of RNA polymerase III transcription in early breast tumorigenesis.
Oncogene. 36(49):6793-6804.
Seon-Young Kim (Co-corresponding)

Lectin from Sambucus sieboldiana abrogates the anoikis resistance of colon cancer cells conferred by N-acetylglucosaminyltransferase V during hematogenous metastasis.
Oncotarget. 8(26):42238-42251.
Yong-Sam Kim and Jeong-Heon Ko (Co-corresponding)

Transcriptomic features of primary prostate cancer and their prognostic relevance to castration-resistant prostate cancer.
Oncotarget. 8(70):114845-114855.
Seon-Young Kim (Co-corresponding)

DIVISION OF SYSTEMS BIOLOGY AND BIOENGINEERING

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

We are making an effort to develop technologies for the production and utilization of high functional food, pharmaceutical and industrial materials. In addition, we are aiming to realize the industrialization of a cell factory based on synthetic biology. We are committed to opening a new global bioindustry era in the 21st century, which is led by plant biotechnology.

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PLANT SYSTEMS ENGINEERING RESEARCH CENTER

We focus on the development of important platform technology for plant biotechnology and industrial transgenic plants. These include studies on plant genomes and transcriptome, finding functionally important genes, developing transgenic plants and analyzing their characteristics. Furthermore, we generate industrial transgenic plants with enhanced tolerance to environmental stresses in marginal lands, to develop plant-based global green technology and establish a global cooperation network. We also currently focus on the development of In-Plant cell biotechnology for invaluable bio-pharmaceuticals and bio-materials. Our endeavor is to research these organisms and associated processes, and develop sustainable technologies/products from these resources.

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INVESTIGATORS

Hyun Soon Kim hyuns@kribb.re.kr
- Establishment of plant-based expression system for sustainable production of invaluable bio-materials

Sang-Soo Kwak sskwak@kribb.re.kr
- Development of industrial plants (sweet potato, alfalfa, poplar etc.) with enhanced tolerance to multiple stresses for sustainable agriculture in global marginal lands

HyeRan Kim kimhr@kribb.re.kr
- Genetics and genomics for crop improvement
- Development of crop molecular markers for genomics assisted breeding

Sung Ran Min srmin@kribb.re.kr
- Development of transgenic plants for agricultural traits by nuclear and plastid transformation
- Establishment of optimal culture system for in vitro large scale production of medicinal plants

Stephen Beungtae Ryu sbryu@kribb.re.kr
- Lipid-based signaling of plants in response to abiotic and biotic stresses
- Production of natural rubber using Russian dandelion

Haeng-Soon Lee hslee@kribb.re.kr
- Molecular breeding of crops with enhanced tolerance to abiotic stresses

Suk Yoon Kwon sykwon@kribb.re.kr
- Structural and functional genomics of plants
- Transformation of crop plants to enhance agricultural traits

Jae Sun Moon jsmoon@kribb.re.kr
- Molecular plant-microbe interactions
- Development of oligo chips for pathogen diagnosis

Jeong Mee Park jmpark@kribb.re.kr
- Molecular mechanisms of pathogens - induced cell death
- Plant immunity to viruses

Hye Sun Cho hscho@kribb.re.kr
- Studies on roles and fine-tuning mechanism of post-translational regulation (PPIase) in response to environmental stress and application of genes to improve crop productivity

Won-Joong Jeong wonjoong@kribb.re.kr
- Regulation of gene expression for improvement of algal biomass

Jae Heung Jeon jeonjh@kribb.re.kr
- Development of optimal mass production system of the seeds or seedling of useful vegetative-propagation crops

Jeongyeo Lee leejy@kribb.re.kr
- Functional characterization of the genes associated with the content of bioactive compounds and plant nutrients using molecular genetics approaches

Hyo-Jun Lee hyojunlee@kribb.re.kr
- Studies on molecular mechanisms of plant adaptation to environmental changes

RESEARCH AREAS

- Studies on structural and functional genomics of plants
- Studies on post-translational modification in plants
- Generation of biotech plants with enhanced tolerance to multiple stresses
- Studies on omics to increase the storage ability of the sweet potato
- Functional studies on IbOrange gene in terms of abiotic stress tolerance
- Studies on plant-microbe interaction and its utilizable technology
- Studies on light and circadian clock signaling networks in plants
- The cooperative study of plant-based global green technology with China, Kazakhstan, etc.
- Establishment of sustainable Biomass
- Development of high-efficiency production system
- Biomaterials research
- Lipid signaling network and production of natural rubber

ACHIEVEMENTS

Research on the regulatory mechanism of adipocyte differentiation

Development of transgenic plants with enhanced tolerance to multiple environmental stresses
- We characterized the tolerance to drought, high salt, low temperature and oxidative stress using the transgenic sweet potato overexpressing *IbOrange, IbCBF3* and *AtP3B* etc. In addition, transgenic poplar plants with increased plant growth and salt stress tolerance were generated by down-regulation of *GIGANTEA-like* genes.

Functional studies of the IbOrange gene involved in accumulation of carotenoids
- Transgenic sweet potato plants overexpressing the *IbOrange* gene showed a strong heat stress tolerance at 47 . IbOrange with high chaperone activity regulates photosynthesis under heat stress by stabilizing IbPsbP in addition to stabilizing IbPSY protein, one of the most important genes in the carotenoid biosynthetic pathway of the sweet potato.

Development of salt tolerance transgenic plant
- We developed transgenic tobacco plants enhanced salt stress tolerance by introducing an alcohol dehydrogenase gene (ADH) from *Synechocystis* PCC6906

Investigating the cell death mechanism of plants related to disease resistance
- Isolation of novel leaf-inhabiting endophytic bacteria that showed antagonistic activities against phytopathogens.
- We have characterized genes related to the cell death mechanism of plants that were involved in resistance to bacterial and viral-disease using virus induced gene silencing technology.

Development of genomics assisted breeding tools
- Commercialization of backcross selection markers for cabbage breeding program
- Development of cabbage F1 purity test marker set
- Establishment of classification and genetic diversity assessment systems for strawberry cultivars

Increased lipid productivity in microalgae for biofuel production
- Three prong strategy for achieving high lipid productivity with enhanced growth
- Collection of strains from Korean wilderness with high lipid productivity
- Ecosystem engineering of algal production systems using beneficial bacteria
- Genetic engineering of algal metabolic and signaling pathways

Construction of omics information and genetic network
- The whole genome of two novel microalgae has been sequenced. Genomic information will provide valuable clues to drive commercialization of microalgae for the maximum production of lipid and carotenoids through genetic modification.

Establishment of transcriptome database in Jerusalem artichoke
- We took advantage of RNA-Seq technology from the Illumina platform to investigate the metabolic pathways and tissue-specific functional genomics in a non-model plant species. The assembled transcriptome sequences and additional data make a substantial contribution to the existing genomic resources for Jerusalem artichoke and will serve to enable research on differentially-expressed genes and functional genomics in Jerusalem artichoke. Further, our work supports a global view and provides resources for future research on the Jerusalem artichoke species.

Investigation of fine-tuning mechanism of immunophilins to adapt to environmental stress in *Arabidopsis* and rice
- Classification of rice immunophilin genes (29 FKBPs and 26 CYPs belonging to the PPIase family) for the first time in monocot and identification of a number of immunophilins related to environmental stresses
- Molecular characterization and physiological roles of novel immunophilins in environmental stress adaptation
- Development of breeding materials and crops against future climate change using immunophilins
- RNA-guided genome editing in immunophilins for functional genomics

Lipid signaling and production of natural rubber
- Lipid-derived signaling in plant systemic acquired resistance
- Commercialization of lipid signals for multiple resistance of crops
- New variety of Russian dandelion with 3 fold increase in yield of rubber

SELECTED PUBLICATIONS

Overexpression of *Arabidopsis P3B* increases heat and low temperature stress tolerance in transgenic sweetpotato.
BMC Plant Biol. 17(1):139.
Sang-Soo Kwak (Corresponding)

***IbOr* regulates photosynthesis under heat stress by stabilizing *IbPsbP* in sweetpotato.**
Front Plant Sci. 8:989.
Sang-Soo Kwak (Corresponding)

Overexpression of golgi protein CYP21-4s improves crop productivity in potato and rice by increasing the abundance of mannosidic glycoproteins.
Front Plant Sci. 8:1250.
Hye Sun Cho and Hyun Soon Kim (Co-corresponding)

A transcriptome approach toward understanding fruit softening in persimmon.
Front Plant Sci. 8:1556.
Stephen Beungtae Ryu (Corresponding)

An alcohol dehydrogenase gene from *Synechocystis sp*. confers salt tolerance in transgenic tobacco.
Front Plant Sci. 8:1965.
Sung Ran Min (Co-corresponding)

***Nicotiana benthamiana Matrix Metalloprotease 1 (NMMP1)* gene confers disease resistance to *Phytophthora* infestans in tobacco and potato plants.**
J Plant Physiol. 218:189-195.
Hyun Soon Kim (Co-corresponding)

Transcriptome analysis of the oriental melon (*Cucumis melo* L. var. makuwa) during fruit development.
PeerJ. 5:e2834.
Suk Yoon Kwon (Corresponding)

Down-regulation of *GIGANTEA*-like genes increases plant growth and salt stress tolerance in poplar.
Plant Biotechnol J. 15(3):331-343.
Sang-Soo Kwak (Corresponding)

First report of impatiens flower break virus infecting impatiens walleriana in South Korea.
Plant Dis. 101(2):394.
Jae Sun Moon (Corresponding)

Silencing of an α -dioxygenase gene, *Ca-DOX*, retards growth and suppresses basal disease resistance responses in Capsicum annum.
Plant Mol Biol. 93(4-5):497-509.
Jeong Mee Park (Corresponding)

Recombinant human acidic fibroblast growth factor (aFGF) expressed in *Nicotiana benthamiana* potentially inhibits skin photoaging.
Planta Med. 83(10):862-869.
Hyun Soon Kim (Corresponding)

INDUSTRIAL BIO-MATERIALS RESEARCH CENTER

Based on the bio-diversity of insects, microorganisms, plants and marine organisms, this team is trying to figure out and build new platform technology that can support new biomaterials, diverse enzymes (including feed enzymes and saccharification enzymes), nutraceuticals, cosmeceuticals and biopesticides.

- Microbial enzymes from insect symbiotic environment
- Nutraceuticals and cosmeceuticals from natural products
- Biopesticide ingredients from natural sources
- Microbial (Bacteria, Actinomycetes, Fungi and Yeast) library
- Business build-up from biodiversity information

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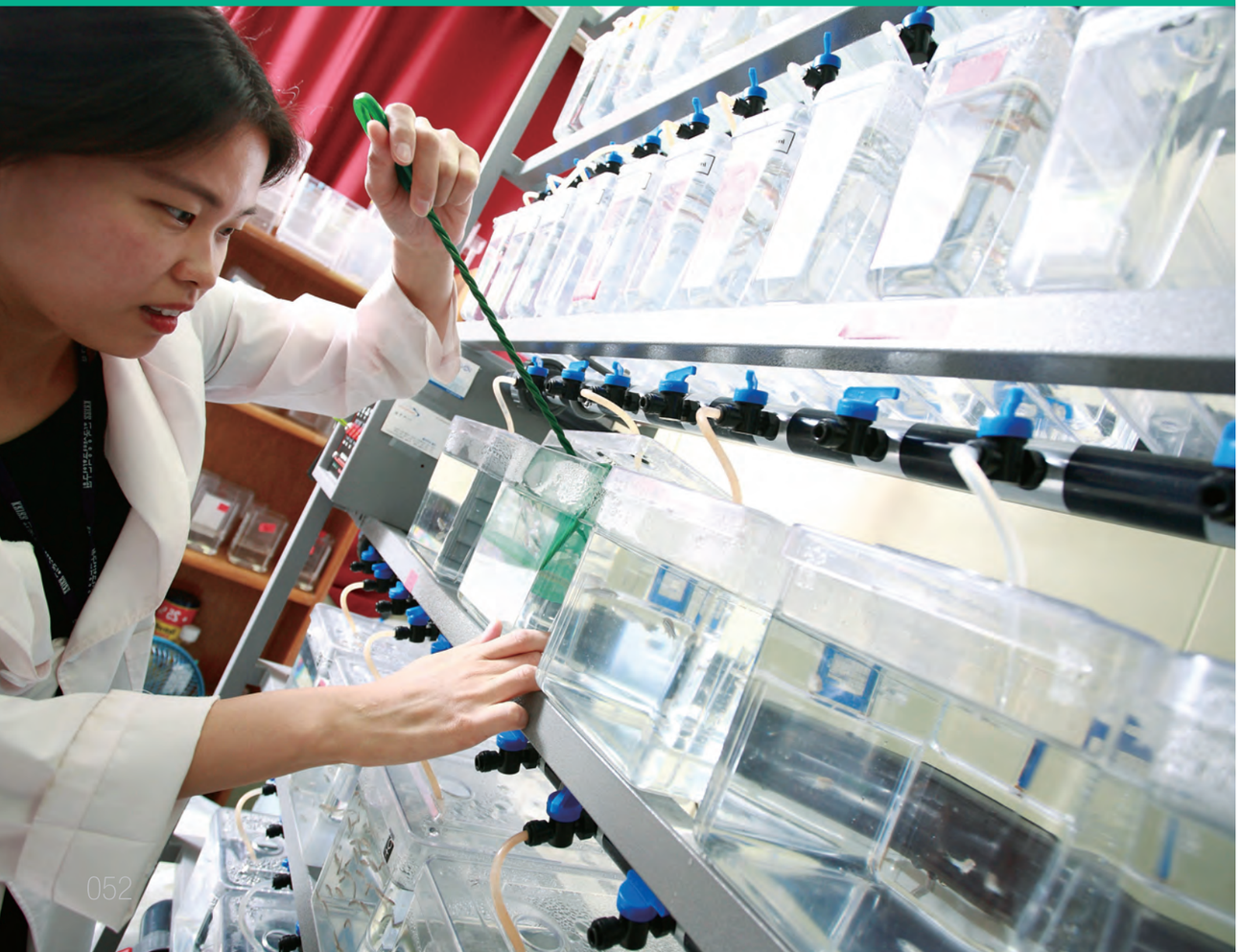

INVESTIGATORS

Kwang-Hee Son sonkh@kribb.re.kr
- Enzymes for industrial uses from biodiversity.
- Microbial genomics and bioinformatics.
- Plant natural products for skin whitening agents.

Tae-Sook Jeong tsjeong@kribb.re.kr
- Screening, in vivo efficacy testing, and mechanism study of bioactive materials and substances for prevention and treatment of metabolic syndrome (including obesity, diabetes, hyperlipidemia, atherosclerosis, and inflammation) and using these in the development of functional foods and nutraceuticals

Ho-Yong Park hypark@kribb.re.kr
- Highly active enzymes and bio-materials from invertebrates & microbes for industrial application
- Development of bio-insecticides for the control of agricultural insects by insect pathogens

Sung Uk Kim kimsu@kribb.re.kr
- Search and development of bio-materials for agriculture including biological control agents, fungicides, and signaling modulators from natural resources

Do Young Kim kdy119@kribb.re.kr
- Development of industrially valuable biocatalysts, bioactive compounds, and biopolyesters
- Metagenomic analysis of the invertebrate gut microbiome

Chang-Jin Kim changjin@kribb.re.kr
- Exploitation of microbial resources (Actinomycetes)
- Screening of secondary metabolites and development of useful biomaterials

Kee-Sun Shin ksshin@kribb.re.kr
- Studies on the value of evaluating microbial resources for industrial applications
- Identification and phylogeny of yeasts

RESEARCH AREAS

Development of bio-materials based on biodiversity and FT (fusion technology)
- Unique enzymes from insect and related (symbiotic for example) microorganisms.
- Bio-catalysts to resolve bio-recalcitrance of biomass.
- Environmentally friendly bio-pesticides using entomopathogenic microorganisms.

Development of anti-virus drugs to cure virus originated hepatitis B
- Isolation of 3 new materials from plant natural products in Korea (Alleviate drug resistance caused by a mutation).

Development of nutraceuticals for metabolic syndrome control
- Development and mechanism study of health functional foods, nutraceuticals or active components from natural and edible sources for preventing and treating metabolic syndrome

Search and development of bio-materials inhibiting microbial functions from natural resources
- Search and development of signaling modulators from natural resources
- Improvement of antagonistic microorganism to enhance the productivity of biological control agents
- Search and development of biopesticides from microbial metabolites

Construction of mass utilization system of value-created microbial resources for industrial applications
- Investigation of the production of useful microbial enzymes, antimicrobial activities and Plant growth-promoting activities, etc.
- Production of microbial broths, extracts, and proteomes
- Generation of LC/MS profiles for microbial metabolomes
- Construction of DB for information on microbial characterization and products

ACHIEVEMENTS

Protein degrading enzyme, Arazyme
- From the gut-bacteria pool of the Korean black widow spider, a salt tolerant and cold tolerant enzyme, Arazyme, was developed. Core technology with the protein producing strain was transferred to a biospecific company and resulted in the creation of various industrial materials, biocosmetics and feed enzymes.

NSP (non starch polysaccharides) degrading enzymes
- Although wooden components (including cellulose, hemicellulose and lignin) are known to be major biomasses on earth, their usage is limited because of their recalcitrance. As a biocatalyst to cut and degrade the NSP, our team developed a xylanase system and its related products to gain a share of the feed market.

Discovery of signaling modulators using the wild type and a calcineurin mutant of Cryptococcus neoformans
- Using specific signal mutants of C. neoformans for Hog1 MAPK and calcineurin, a screening system for signaling modulators was established targeting the two-component system of *C. neoformans*, based on the counter-regulatory action of these pathways. Three compounds from plant extracts were isolated and their structures and biological activities were determined.

Development of functional materials from soy leaf extracts for prevention and treatment of obesity and diabetes, and investigation of their molecular mechanism
- Extracts of soy (Glycine max (L.) Merr.) leaves (ESL) are enriched in flavone glycosides and pterocarpans. ESL exhibits anti-obesity effects via inhibition of lipid accumulation and stimulation of fat oxidation, and ESL also enhances insulin sensitivity and pancreatic -cell proliferation in disease mouse models. We first demonstrated the anti-obesity and anti-diabetic effects of ESL in a clinical study with overweight and prediabetes individuals. ESL has potential as a safe and effective supplement against obesity and type 2 diabetes.

Technology transfer of *Aspergillus niger* F22 and its applications for biological control of *Meloidogyne incognita*
- Plant-parasitic nematode infection is a major problem in crop production. In the course of screening of nematode biological control agents, we isolated a fungal strain, A. niger F22, exhibiting strong nematocidal activity on M. incognita. We later devised a suitable formulation for the industrial application and handling of the bio-agent with increased efficacy.

SELECTED PUBLICATIONS

Biocatalytic characterization of an endo- β -1,4-mannanase produced by *Paenibacillus* sp. strain HY-8.
Biotechnol Lett. 39(1):149-155.
Kwang-Hee Son (Corresponding)

Isotrifoliol inhibits pro-inflammatory mediators by suppression of TLR/NF- B and TLR/MAPK signaling in LPS-induced RAW264.7 cells.
Int Immunopharmacol. 45:110-119.
Tae-Sook Jeong (Corresponding)

Soy-leaf extract exerts atheroprotective effects via modulation of Kruppel-like factor 2 and adhesion molecules.
Int J Mol Sci. 18(2):e373.
Tae-Sook Jeong (Corresponding)

***Mesonia maritimus* sp. nov., isolated from seawater of the South Sea of Korea.**
Int J Syst Evol Microbiol. 67(8):2574-2580.
Kee-Sun Shin (Corresponding)

Conifer diterpene resin acids disrupt juvenile hormone-mediated endocrine regulation in the Indian meal moth *Plodia interpunctella*.
J Chem Ecol. 43(7):703-711.
Hyun Woo Oh (Co-corresponding)

CELL FACTORY RESEARCH CENTER

The world market is embracing ecofriendliness, healthcare, and sustainability, in the truest sense. Slowly but surely, bioproducts with a sustainable life cycle, are being preferred. Hence, this center identifies and develops a cell-factory system able to produce bioresources for a whole host of industries including energy, environment, nutraceuticals, pharmaceuticals and cosmetics. We currently focus on the production of these products from yeast and microalgae using process, genetic and ecological engineering. Our endeavor is to research these organisms and associated processes, and develop novel and highly efficient technologies/products from these resources.

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- Algal biology, metabolism and ecology
  · Research on microalgal biofuels and other bioproducts
  · Algal-bacterial interactions and their impending applications

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- Ecophysiological, genomic research of microalgae and cyanobacteria for cyanobacterial bloom control and algal biofuel production

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- Yeast secretory production of recombinant proteins
- Yeast-based platform technology for bioenergy and biochemicals
- Lipase engineering for eco-friendly production of biodiesel

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- Establishment of external factors that are involved in bio regulation and immunity activation related to disease and securing candidate materials

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- Ecophysiology of microalgae and cyanobacteria (control of algal bloom)
- Optimization of mass cultivation of microalgae using wastewater

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- Yeast metabolic engineering
- Recombinant protein production

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- Microbial taxonomy and genetic engineering of microalgae
- Omics studies for phylogenetic identification and adaptive evolution of microalgae and bacteria

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- Protein engineering and recombinant protein expression in microorganisms
- Genetic engineering and directed evolution of microorganisms

RESEARCH AREAS

Development of functional-oil-producing microalgal cell factory
- Testing both genetic and ecological engineering for strain improvement
- Omics studies on metabolism, signaling and regulation
- Development of high-efficiency production system based on exploring novel engineered systems for cultivation and harvesting of microalgae

Microalgae biofuel/biomaterial research
- Economic and efficient production of biodiesel and high-value materials from microalgae, based on physiological, genetic, and omics research
- Screening of novel pharmaceutical, cosmetic and nutraceutical compounds from microalgae

Algal bloom research
Ecophysiological and metagenomic study on the mechanisms of algal bloom in freshwater (green tide) and seawater (red tide). Advanced monitoring of bloom and production of algal toxins, mal-odor compounds, and their interaction with aquatic microorganisms.

Yeast cell and protein factory
- Novel expression systems with yeast and bacteria to produce pharmaceutical proteins, antimicrobial peptides and industrial enzymes
- Microbial cell engineering and synthetic biology for sustainable biochemicals including biopolymers and bioplastics

Discovery and engineering of enzymes for industrial biocatalyst
- Lipase engineering for eco-friendly production of biodiesel
- Carbohydrate-related enzymes for high-value polysaccharides
- Enzyme engineering for artificial photosynthesis

ACHIEVEMENTS

Increased lipid productivity in microalgae for industrial application. A three-pronged strategy for achieving high lipid productivity with enhanced growth.
- Collection of strains from Korean wilderness with high lipid productivity
- Ecosystem engineering of algal production systems using beneficial bacteria
- Genetic engineering of algal metabolic and signaling pathways

Construction of omics information and genetic network
The whole genomes of two novel microalgae have been sequenced. Genomic information will provide valuable clues to driving the commercialization of microalgae for the maximum production of lipid and carotenoids through genetic modification.

Mechanism of algal bloom and its control
Genetic diversity of microalgae and their interactions with other microorganisms are being studied using metagenomic and ecoinformatics tools, to understand the detailed biological mechanisms of bloom formation. Environment-friendly methods are being developed to control algal bloom, based on ecological principles.

Construction of a yeast protein factory for the efficient production of recombinant proteins for therapeutics and bio-based industries
Genome-wide screening of the TFP library and efficient secretion of difficult-to-express proteins and enzymes.

Development of bio-refinery processes
Enzymatic production of biodiesel and consolidated bioprocessing for bio-based chemical production from various feedstock.

SELECTED PUBLICATIONS

Lipid turnover between membrane lipids and neutral lipids via inhibition of diacylglyceryl *N,N,N*-trimethylhomoserine synthesis in *Chlamydomonas reinhardtii*.
Algal Res. 27:162-169.
Hee-Mock Oh and Hyung-Gwan Lee (Co-corresponding)

***Pusillimonas caeni* sp. nov., isolated from a sludge sample of a biofilm reactor.**
Antonie Van Leeuwenhoek. 110(1):125-132.
Hyung Gwan Lee and Chi-Yong Ahn (Co-corresponding)

Higher production of C-phycocyanin by nitrogen-free (diazotrophic) cultivation of *Nostoc* sp. NK and simplified extraction by dark-cold shock.
Bioresour Technol. 227:164-170.
Chi-Yong Ahn (Corresponding)

Light intensity as major factor to maximize biomass and lipid productivity of *Ettlia* sp. in CO2-controlled photoautotrophic chemostat.
Bioresour Technol. 244:621-628.
Hee-Mock Oh (Corresponding)

Floating rice-culture system for nutrient remediation and feed production in a eutrophic lake.
J Environ Manage. 203(1):342-348.
Hee-Mock Oh (Corresponding)

1-palmitoyl-2-linoleoyl-3-acetyl-rac-glycerol ameliorates arthritic joints through reducing neutrophil infiltration mediated by IL-6/STAT3 and MIP-2 activation.
Oncotarget. 8(57):96636-96648.
Jae-Wha Kim (Co-corresponding)

Abundant iron and sulfur oxidizers in the stratified sediment of a eutrophic freshwater reservoir with annual cyanobacterial blooms
Sci Rep. 7:43814.
Hee-Mock Oh (Co-corresponding)

Microalgal diversity fosters stable biomass productivity in open ponds treating wastewater.
Sci Rep. 7:1979.
Hee-Sik Kim (Co-corresponding)

Co-fermentation using recombinant *Saccharomyces* cerevisiae yeast strains hypersecreting different cellulases for the production of cellulosic bioethanol.
Sci Rep. 7:4428.
Jung-Hoon Sohn (Corresponding)

Periphyton effects on bacterial assemblages and harmful cyanobacterial blooms in a eutrophic freshwater lake : a mesocosm study.
Sci Rep. 7:7827.
Chi-Yong Ahn (Corresponding)

SYNTHETIC BIOLOGY AND BIOENGINEERING RESEARCH CENTER

Synthetic Biology and Bioengineering Research Center (SBBRC) is to develop and advance novel biological systems and assemble them into a practical and useful engineering discipline. The key is the development of sensing devices using synthetic bio-parts, designed genetic circuits, and CRISPR technology. The range of potential applications encompasses but is not limited to: diagnostics, therapeutics, sensors, and biofuel/chemical production.

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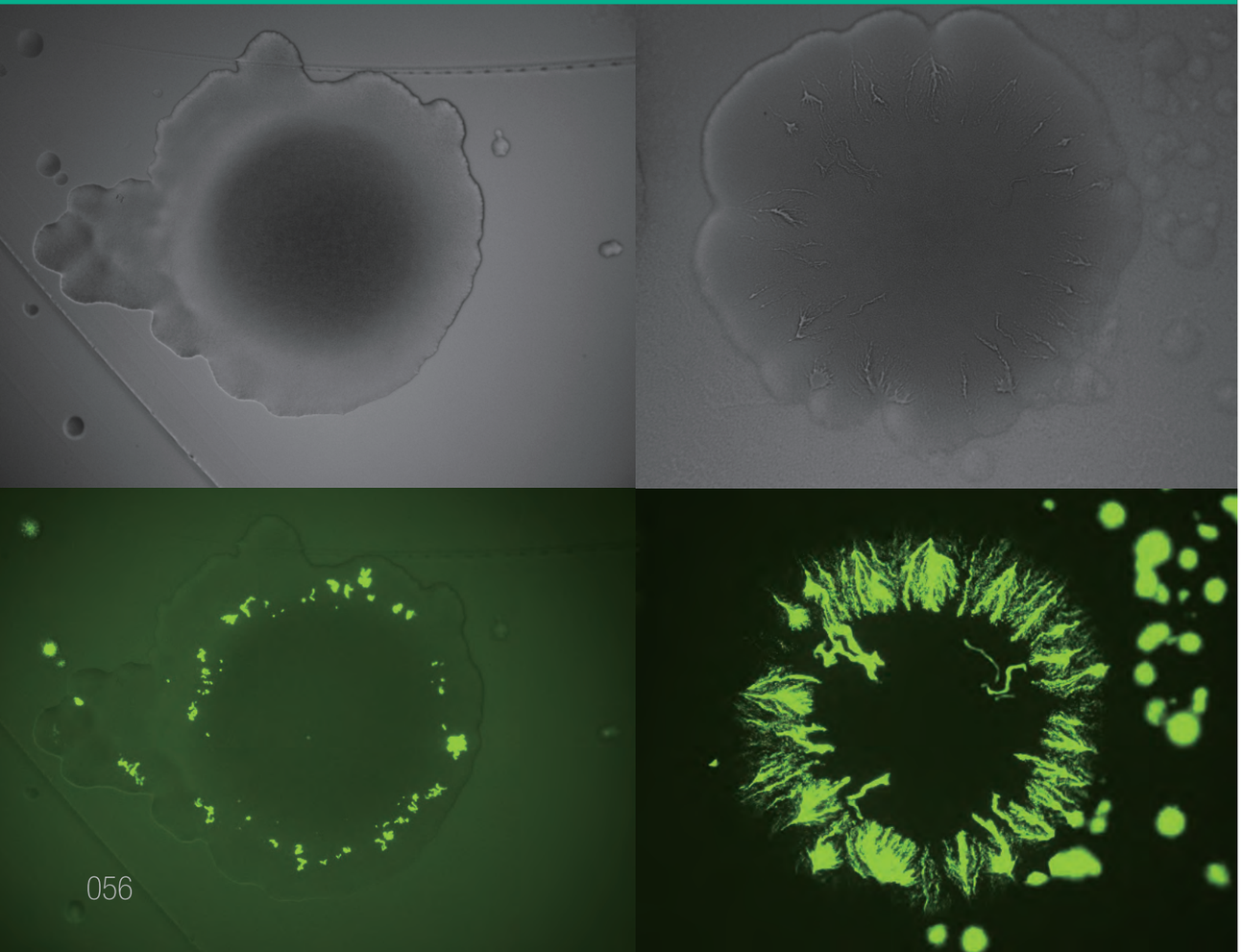

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- Bioimaging, Biosensors and Biochips

RESEARCH AREAS

Synthetic biology
- Development of synthetic genetic circuits for high-throughput screening and evolution of enzymes
- Development of microbial cell factories through CRISPR interference-based intelligent control of cellular networks

Systems biology
- In silico modeling and simulation of biological networks

Bioengineering
- Design and synthesis of customized proteins
- Synthetic biology-based production of high-value natural compounds

ACHIEVEMENTS

Development of platform technologies of intelligent genetic circuits
- Intelligent genetic circuit-based high-throughput screening of enzymes and microbes
- Characterization of biosynthetic pathways of novel enzymes to produce natural compounds

Development of intelligent metabolic control devices
- CRISPR interference-based metabolic control of microbial cells to produce natural compounds
- CRISPR interference-guided multiplex repression of endogenous competing pathway genes to redirect metabolic flux
- Artificial metabolon-equipped microbial cell factory to improve biochemical production

Development of novel protein expression system
- Development of antibiotics-free protein expression system for long-term stability and tightly controlled production
- Controlled aggregation and increased stability of enzymes by cellulose binding domain fusion
- Tunable control of an *E. coli* expression system for the overproduction of membrane proteins by titrated expression of a mutant *lac* repressor

SELECTED PUBLICATIONS

Efficient transcriptional gene repression by type V-A CRISPR-Cpf1 from *Eubacterium eligens*.
ACS Synth Biol. 6(7):1273-1282.
Seung-Goo Lee and Dae-Hee Lee (Co-corresponding)

Tunable control of an *Escherichia coli* expression system for the overproduction of membrane proteins by titrated expression of a mutant lac repressor.
ACS Synth Biol. 6(9):1766-1773.
Dae-Hee Lee (Co-first)

Synthetic vaccine nanoparticles target to lymph node triggering enhanced innate and adaptive antitumor immunity.
Biomaterials. 130:56-66.
Doo-Byoung Oh (Co-corresponding)

Leucine zipper-mediated targeting of multienzyme cascade reactions to inclusion bodies in *Escherichia coli* for enhanced production of 1-butanol.
Metab Eng. 40:41-49.
Seung-Goo Lee and Dae-Hee Lee (Co-corresponding)

CRISPR interference-guided multiplex repression of endogenous competing pathway genes for redirecting metabolic flux in *Escherichia coli*.
Microb Cell Fact. 16(1):188.
Seung-Goo Lee and Dae-Hee Lee (Co-corresponding)

DIVISION OF BIO INNOVATION

- Technology Transfer Center
- SME Support Center
- Biotechnology Process Engineering Center

The Bio-Innovation Business Division is composed of a Technology Transfer Center, SME (Small-to-medium enterprises) Support Center and Biotechnology Process Engineering Center.

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TECHNOLOGY TRANSFER CENTER

The mission of the Technology Transfer Center(TLC) is to support and encourage the dissemination of technology-related IP resulting from the KRIBB's scientific and technical programs and to have a potential for further development and commercial exploitation. TLC is responsible for the identification and protection of technological assets. Once these technologies are properly protected, marketing initiatives are triggered to facilitate their adoption and market uptake. The main dissemination channel is done through licensing. The terms and conditions of the licensing agreements are adapted on a case by case basis depending on the specific situation of the licensee, the maturity of the technology and the expected market. In specific cases, if the technology arising from a research project has a business potential, the TLC also supports the creation of a start-up. To support biotechnology innovation in Korea, TLC also carries out the analysis and valuation of Biotech-related intellectual property to support the creation of start-up or technology transfer. TLC also conducts the technological evaluation of new biotech companies for KOSDAQ(Korea Securities Dealers Automated Quotation) list.

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MAIN FUNCTIONS

Intellectual Property Management: Building a strong patent portfolio
- Consulting on intellectual property filling / office action / maintenance
- Screening of excellent ideas / know-how / technology
- Scientific affairs to internal and external collaboration

Technology Transfer
- Technology valuation / marketing
- Technology licensing-out

Technology commercialization
- Support joint ventures (Institute Enterprise)
- Analysis and valuation of Biotech-releated IP
- Technological evaluation for KOSDAQ list

ACHIEVEMENTS

Creating/Securing Superior Technology
- Number of Registered Patents (accumulated, 2013~2017)

Year	Domestic	Overseas	Total
2017	1,081	494	1,575

Technology Transfer Commercialization
- 348 intellectual property transfers have gone to industry as at 2017
  - Established an in-house venture, 'Nano Biotech' in November 2015 as a joint venture between KRIBB, Natural F&P Inc. and Next BT Inc.
  - Established an in-house venture, 'DK Bio' in May 2016 as a joint venture between KRIBB and DAMY Chemical Inc.
  - Established an in-house venture, 'Huvet' in November 2017 as a joint venture between KRIBB and Huvet Inc.

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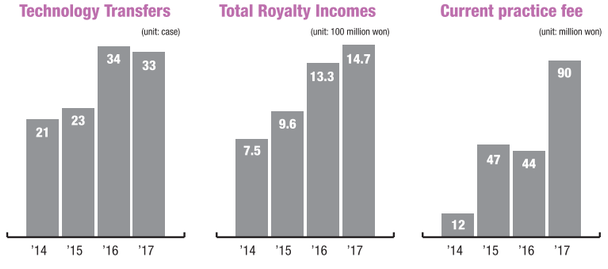

Technology Transfer Status at 2017

SME SUPPORT CENTER

In Korea, Biotech Startups and small-to-medium enterprises (SMEs) compete on a level playing field with large companies, make inroads into the global market, and are at the forefront of efforts to drive the nation's economic growth and high-quality job creation. However, Biotech SMEs have to overcome various barriers at every stage of growth.
The primary goals of SME Support Center (Small and Medium Enterprise Support Center) are to establish Biotech Business Ecosystems for the mutual growth of participating large and small-to-medium sized biotech enterprises, to support Biotech SMEs to consolidate their technological and developmental competence, and to incubate Biotech Startups. To achieve these goals, SME Support Center develops and implements various strategies, programs, and networks, based on the human resources, infrastructure, and funds of KRIBB.

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MAIN FUNCTIONS

Establishment of Biotech Business Ecosystems
- Building Biotech Business Ecosystems focusing on Ecofriendly biomaterials, Bio-medicine, and Bio-convergence
- Exchange of technology and business information, generation of common agendas, and development of B2B business models among participants
- Building a KRIBB Bio-Mentoring System with a technical mentor group (70 Ph.D.), investment mentor group (35 VC investment specialists) and Business growth mentor group (35 business management specialists)

Operation of Growth Stage Specific Support Programs (to foster 50 global future leader biotech companies)
- 5 Global hidden champions with annual sales of 50B KRW
- 15 Pre-global hidden champions with annual sales of 10B KRW
- 30 Techin-Biz companies with annual sales of 2B KRW

Operation of demands-based support programs for Biotech SMEs
- Demands-Based KRIBB-Biotech Cooperative R&BD Program to accelerate technology commercialization by Biotech SMEs
- KRIBB Research Center - Biotech SME Partnership Program to strengthen technology competitiveness of Biotech SMEs
- KRIBB Biotechnology Mentoring Program to provide solutions for technology difficulties of Biotech SMEs

Acceleration of Biotech Startups
- Customized Researcher Startup Support Program including entrepreneurship education, business plan preparation, inauguration, and business incubation
- Operation of Bio-Venture Center to accelerate inauguration of Biotech Startups and their success (designated space and Startup Incubation Programs for Technology Business Incubator, Technology Innovation Center, and KRIBB Cooperation Company)

ACHIEVEMENTS

Creating/Securing Superior Technology
Operation of Biotech business ecosystems
- Eco-friendly biomaterials in Jeollabuk-do, Bio-medicine in Chungcheongbuk-do, and Bio-convergence in Daejeon with 250 Biotech SMEs
- Generation of common agendas and development of B2B business models
- Operation of KRIBB Bio-Mentoring System: Technology innovation and problem solving (31 cases), Investment attraction and financing (40 cases)

Operation of Growth Stage Specific Support Programs
- Global Hidden Champion program (4 projects)
- Pre-global hidden champion program (10 projects)
- Techin-Biz program (20 projects)

Operation of demands-based support programs for Biotech SMEs
- Demands-Based KRIBB-Biotech Cooperative R&BD Program (12 projects)
- KRIBB Research Center-Biotech SME Partnership Program (74 companies with 25 KRIBB research centers)

Acceleration of Biotech Startups
- Bio-Venture Center (3-story building with a total of 2,970 m2 and 35 business incubation units)
- 62 Biotech Startups graduated since 2000 (10 listed on the KOSDAQ)
- 19 Biotech Startups in Bio-Venture Center achieved total annual sales of 18.8B KRW in 2017

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BIOTECHNOLOGY PROCESS ENGINEERING CENTER

The Biotechnology process engineering center (BPEC) is a skill division which provides engineering solutions for technical issues in biological processes. Since being founded in 1995, our center plays a unique role in Korea's industrial biotechnology R&D ecosystem by transforming scientific proof of concepts into value propositions in the field, including microbial fermentation, biotransformation, and downstream processing for biochemical materials.
In addition, we have established animal cell culture research facilities to efficiently respond to the recent explosive growth in the biopharmaceutical industry. We have been carrying out mass production and commercialization of protein drugs using animal cells while expanding advanced biotechnology. Nowadays, our center is providing a range of support services to strengthen domestic bio-industry capabilities, for example research support for industrialization of research results, equipment utilization support, and professional manpower training.

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- Animal cell culture/Separation and purification

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- Support for biological pilot-scale downstream equipment

RESEARCH AREAS

Microbial fermentation and scale-up research for biomaterials production
- Development of novel expression system for biomaterials.
- Development of industrial strain for biomaterials.
- Process development and scale-up research for biomaterials.

Mammalian cell culture for biopharmaceuticals production
- Development of stable cell line producing biopharmaceuticals.
- High-cell-density culture for mammalian cells.
- Process design for quality control.

Separation and purification technology
- Optimization of chromatography and membrane processes.
- Protein/Organic acid purification.
- Scale-up in separation and purification process.

ACHIEVEMENTS

New cell line development for antibody-producing CHO cells

Chinese hamster ovary (CHO) cells are one of the most widely used host cells for therapeutic protein production. For a large number of analytes from clonal variation, it is necessary to develop an efficient high-throughput cell screening system. Recently, we developed an efficient screening method based on reconstitution of split GFP to select high antibody producing CHO cells using a FACS analysis. On the basis of a correlation between antibody production and fluorescence intensity by reconstituting GFP, the fragment complementation system for split GFP has potential as a powerful tool for antibody production in CHO cells.

Process development of mammalian cells for biopharmaceuticals production

Mammalian cell culture has become the dominant system for biopharmaceuticals production including therapeutic proteins and live virus vaccines. We are currently developing a cell line adapted in serum-free suspension culture, the serum-free medium with hydrolysates, and feeding strategies for fed-batch cultures in a number of mammalian cell lines such as CHO cells, baby hamster kidney (BHK) cells, and human embryonic kidney (HEK)-293 cells. Furthermore, we have developed chromatographic purification technologies and high-throughput precision analysis based on design of experiment (DOE) analysis.

Microbial engineering for recombinant proteins production

The demand for recombinant proteins has increased as more applications in several fields have become a commercial reality. We have developed microbial strains producing industrial enzymes, antigenic proteins and virus-like particles for veterinary vaccines, growth factors for cosmetics, and bioreceptors for diagnostic kits. In order to nurture a commercially viable process for final products, we have optimized microbial fermentation and protein purification processes at the pilot-plant scale.

Yeast biotechnology for polymeric bio-monomers production from plant oil

Growing environmental concerns have stimulated attention on efforts to produce bio-based plastics from renewable sources. However, past efforts mostly focused on short-chain polymeric monomers based on sugars. Plant oils represent renewable sources of medium to long-chain hydrocarbons, many of which are able to emulate the properties of petrochemicals, or to enable new industrial chemicals. We have developed n-alkane-assimilating diploid Candida tropicalis for biotransformation of plant oil-derived fatty acids into dicarboxylic acid (dodecanedioic acid and sebacic acid) as polymeric monomers. Subsequent fed-batch processes with this engineered strain allowed a molar yield of above 98% and a final titer of above 100 g/L at the pilot scale. In addition, we developed *de novo* biosynthetic pathways for medium- to long-chain α , ω -diols, α , ω -diamines and ω -amino fatty acids from plant oil-derived fatty acids and their derivatives in the cheese-ripening yeast *Yarrowia lipolytica*. This has made it possible for yeast to produce all the long chain monomers for polyamide and polyester according to the corresponding substrates.

SELECTED PUBLICATIONS

Characterization of the newly isolated ω -oxidizing yeast *Candida sorbophila* DS02 and its potential applications in long-chain dicarboxylic acid production.
Appl Microbiol Biotechnol. 101(16):6333-6342.
Hong-Weon Lee (Corresponding)

Enhanced performance of the methylerythritol phosphate pathway by manipulation of redox reactions relevant to IspC, IspG, and IspH.
J Biotechnol. 248:1-8.
Eui Sung Choi (Co-corresponding)

One-step purification of melittin derived from *Apis mellifera* bee venom.
J Microbiol Biotechnol. 27(1):84-91.
Eun-Gyo Lee (Corresponding)

Complete genome sequence of the sulfur-oxidizing chemolithoautotrophic *Sulfurovum lithotrophicum* 42BKT^T.
Stand Genomic Sci. 12:54.
Jung-Oh Ahn (Corresponding)

DIVISION OF KRIBB STRATEGIC PROJECTS

- Korea Biosafety Clearing House
- Biotech Policy Research Center
- Korean Bioinformation Center
- National Research Safety Headquarter
- Stem Cell Research Center
- Immunotherapy Convergence Research Group
- Biodefense Research Center

A division of KRIBB Strategy Projects, responsible for national agenda programs, conducts important research at the national level, which includes research on viral infectious diseases and stem cells. The Division also extends policy support for biotechnology by providing biosafety information and undertaking biotechnology policy research.

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KOREA BIOSAFETY CLEARING HOUSE

The Korea Biosafety Clearing House(KBCH) is dedicated to promoting public awareness and exchange of information, undertaking surveys and research, and garnering international cooperation on issues regarding Living Modified Organisms(LMOs), while implementing the legal duties on LMO related information as per the “Cartagena Protocol on Biosafety” and the “Act on Transboundary Movements, etc. of LMOs”.
The KBCH is also functioning as a Korean national focal point of the Biosafety Clearing-House installed under the “Cartagena Protocol on Biosafety” and is now expanding its overseas activities to particularly promote subregional cooperation on biosafety.

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INVESTIGATORS

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- Establishment of KBCH strategies and monitoring of Living Modified Organisms, Biosafety and related topics

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- Management of adherence to Conventions on Biological Diversity, Access to Genetic Resources and Benefit-Sharing(ABS) information

Wonhee Kim whkim7@kribb.re.kr
- Information sharing, Monitoring of adherence to LMO regulations, management of information regarding biosafety

Jeongsuk Jo chojs@kribb.re.kr
- Analysis of trends and Promotion of public awareness and participation regarding LMOs and biosafety

Gookche Jeon bobos302@kribb.re.kr
- Collection of information regarding LMO related industries especially focusing on White(or Industrial) biotechnology, Publication of “Trends in White Biotech”

Mihee Jeon mhjeon@kribb.re.kr
- Management of budget and affairs

RESEARCH AREAS

Implementation of the Biosafety Protocol & LMO Act
- Performance of information-related duties such as collection and dissemination
- Implementation of administrative matters(preparation of Country Reports, analysis of major issues in COP-MOP, management of Expert Forums for discussion of major issues, etc.)
- Support for developing countries’ capacity-building efforts
- Implementation of the LMO Act(operation of Biosafety Committee, support for implementation of the LMO Act to attain purpose and achieve further improvements)
- Industrial LMO safety management(operation of Industrial LMO Risk Assessment Committee, as consigned by The Ministry of Trade, Industry & Energy according to government guidelines)

Improvement of Public Awareness & Communication
- Management of Biosafety Portal and family sites
- Publications such as the ‘Biosafety Whitepaper’ (biennial), ‘Biosafety’ Journal(semiannual), etc.
- Hosting of communication activities(LMO forums, international seminars, debate competitions, KBCH reporters, etc.)

Survey & Research
- Survey on public perceptions
- Establishment of database for holding LMOs and BIO related statistics
- LMOs and bioindustry trend analysis
- Analysis of the industrial impact of the ABS Protocol

ACHIEVEMENTS

Compliance with the LMO Act and the Biosafety Protocol

KBCH officially started its work in January 2008 when the LMO law and the Biosafety Protocol took effect in Korea, even though its actual work in the management of LMO information began a decade or more back. KBCH’s primary mission is to undertake duties mandated by the LMO Act and Biosafety Protocol so far as they relate to information management regarding the transfer, handling and use of LMOs. These duties include the collection and distribution of unbiased information on LMOs, as well as efforts to increase public awareness and participation in activities related to LMOs.

Promotion of Public Awareness and Participation

To promote awareness and participation, especially with regard to the public, KBCH does its best in order to ensure biosafety, as stipulated in the Protocol. Above all, KBCH is trying to ensure that both positive and negative views on LMOs find their way to the public arena, through the promotion of open public discussion about all LMO-related issues.
To this end, it operates the “Korean Biosafety Portal”, participates in discussions on high-profile Internet sites, and distributes materials published by the KBCH, such as the semiannual “Biosafety”, a biennial “White Paper on Biosafety”, and various booklets and pamphlets. Its other activities include seminars(LMO forums, etc.), which are events where anyone can attend and share his or her opinion, and the “Biosafety Debate Competition” among high school students, which attracts hundreds of applicants nationwide every year.

Implementation of the Korea Biosafety capacity-building Initiative

At COP-MOP7 in 2014, Korea had proposed the Korea Biosafety Capacity Building Initiative with a view to contributing to BCH capacity building with developing country Parties and Parties with economies in transition.
Two main programs are set to be implemented by KBCH, under the Initiative. One is about assisting Parties in Asia to build capacities for their national BCH operation and reach full compliance with the Protocol. In this endeavor, KBCH held the ‘5th Asia Regional BCH Workshop in partnership with UN Environment’(Daejeon) in 2017 where 17 countries participated and KBCH was once more able to consolidate its leader status of the so-called Asia BCH Family. The other is to explore collaborative areas on Biosafety among Asian countries. In 2017, KBCH held the ‘1st Asia Forum on Environmental Release & Safety Management of LMOs’ in Jeju, in which 16 participants from 8 countries took part as either speakers or moderators. This Forum was comprised of two Themes: 1) National experience in safety management of LMOs for intentional introduction into the environment; 2) Public participation in issues regarding environmentally released LMOs. Participants agreed to continue to share experiences in overcoming challenges around LMOs and try to develop a regional cooperation system that can improve the level of safety management.

BIOTECH POLICY RESEARCH CENTER

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

① To provide government officers with accurate, relevant, and timely information on biotech trends.
② As a think tank, to develop biotech R&D strategy to help government officers.
③ To build networks with opinion leaders as an idea platform.

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

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생명공학정책연구센터 Biotech Policy Research Center

BioIN 미래를 선도하는 정보 인프라인 Biotech Information Portal

INVESTIGATORS

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- Policy planning and policy research
- BT industrial trends research
- International cooperation (OECD)

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- BT emerging technologies & statistics
- BT policy website (www.bioin.or.kr)
- Information System on Bio Discovery to Market Acceleration

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- Policy planning and policy research
- Bio-Infrastructure Issue Analysis

June Hyuck Yang yangjh@kribb.re.kr
- BT Policy Planning & tech trends Research
- BT R&D Project Planning
- Korea BT White Book project

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, and institutional policy information and to conduct relevant statistics, patent maps, and bibliometric analysis.

Information (Issue) Gathering/Disseminating
To provide systematic information 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.

ACHIEVEMENTS

Policy Planning
- Planning for the third Biotechnology Fostering Basic Plan-Science Technology-based Bioeconomy Innovation Strategy 2025.
- Planning of large-scale projects for Survey and analysis of national R&D programs.
- Analysis of Portfolio and positioning of National R&D project.
- Establishing a strategy for innovation in the bio-infrastructure sector that forms the basis of bio-research activities such as life research resources, facilities, equipment and research support services
- Research on BT regulatory issues and operation of “bio regulatory sinmungo”

Emerging Technology Forecast and Statistical Development
- Discover promising and emerging BT technologies that will affect the industrial and technological fields in the next 5 to 10 years
- The center has published annual reports on domestic and overseas statistical data on biotechnologies categorized by investment, human resources, industry, and technology.

Information System on Bio Discovery to Market Acceleration
- Establishment and service of comprehensive information system to promote national bio R&D industrialization through supporting the R&D and technology commercialization of small and medium-sized bio venture companies and researchers

Expert Network & International Collaboration
- To operate the “BIO FUTURE FORUM”, BT Seminars and BT expert discussions
- To participate in the annual Session of the OECD Working Party on Biotechology, Nanotechnology and Converging technology(BNCT).

Policy Website
- A one-stop website was created with regard to BT policies to assist policy makers’ understanding of detailed data on domestic and overseas BT policies.
- The site currently has 100,000 pieces of data.

KOREAN BIOINFORMATION CENTER

The Korean Bioinformation Center (KOBIC) is the national center for bioinformatics and bioresource information, designated by the Act on the Acquisition, Management, and Utilization of Biological Resources.
In the field of bioinformatics, we serve as the national center for omics data produced by national R&D grants and operate the data repository called BioData. From the Post-Genome Multi-Ministry Genome Project in Korea, we also collect data and provide a cloud computing-based genome analysis system called Bio-Express. We also carry out R&D to develop various bioinformatics databases and tools, and do scientific research on genomics. For collaborative and outreach activities, we support various genomics projects in Korea, and provide bioinformatics data analysis services and bioinformatics education programs.
In the field of bioresource information, we collect and link nationwide bioresource and biodiversity information across institutions and ministries to facilitate sharing and utilization of bioresource data. As the heart of this activity, we operate the Korean Bioresource Information System (KOBIS), the hub database for Korean bioresource information.

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RESEARCH AREAS

Bioresource Information Division
- Operation of Korean Bioresource Information System (KOBIS)
- Nationwide bioresource data integration across institutions and ministries
- Strategic planning of national management of bioresource information

Computing Infrastructure and Development Division
- Development of core software and systems (KOBIS, BioData, Bio-Express)
- Construction and management of computing hardware infrastructure

Bioinformatics Division
- Bioinformatics data analysis service
- Bioinformatics education service
- Development of various bioinformatics databases, tools, and pipelines

ACHIEVEMENTS

As the national Biological Research Resource Information Center in Korea, we operate the Korean Bioresource Information System (KOBIS), which integrates nationwide bioresource and biodiversity information across institutions and ministries. To fulfill the role as the national bioresource hub for expanding the impact of data sharing and utilization, we have been continuously improving the data quantity and content of the KOBIS since its construction in 2008.

The genomics research field has been continuously producing a huge amount of data, often more than individual research labs can feasibly interrogate. Therefore, infrastructure is needed to allow the analysis and sharing of bio-big data to maximize its scientific potential and value. As the national bioinformatics center, KOBIC operates BioData, a repository of genomics data produced from research supported by national R&D funds.

KOBIC also assists genomics research activities in Korea, both large- and small-scale. The most notable example of large-scale national genomics research activities is the Post-Genome Multi-Ministry Genome Project in Korea. For this project, we developed and operated a cloud computing-based genome analysis system called Bio-Express to provide a comprehensive genomics data analysis environment. Through the KOBIC research support program, we also assist individual researchers who are in need of expert bioinformatics support for their small-scale projects. In addition, we offer bioinformatics education programs in the form of workshops and online programs.

Over last decade, KOBIC collaborated with the research community and pioneered the development of public resources for data-sharing, databases, analysis pipelines, and research, as evident in many published works, including the first Korean genome sequence in 2009. All the aforementioned activities were made possible by our ever-expanding computing infrastructure, the largest among bioinformatics research centers in Korea.

SELECTED PUBLICATIONS

Genome analysis of *Hibiscus syriacus* provides insights of polyploidization and indeterminate flowering in woody plants.
DNA Res. 24(1):71-80.
Ryan W Kim (Corresponding)

Bioinformatic identification of prognostic signature defined by copy number alteration and expression of CCNE1 in non-muscle invasive bladder cancer.
Exp Mol Med. 49(1):e282.
In-Sun Chu (Corresponding)

Effect of Cd2+ on tyrosinase : integration of inhibition kinetics with computational simulation.
Int J Biol Macromol. 94:836-844.
Jinhyuk Lee (Co-first)

Inhibitory effect of hesperetin on α -glucosidase : molecular dynamics simulation integrating inhibition kinetics.
Int J Biol Macromol. 101:32-39.
Jinhyuk Lee (Co-corresponding)

The effect of oxaloacetic acid on tyrosinase activity and structure : integration of inhibition kinetics with docking simulation.
Int J Biol Macromol. 101:59-66.
Jinhyuk Lee (Co-first)

Hydrogen peroxide (H2O2) irreversibly inactivates creatine kinase from *Pelodiscus sinensis* by targeting the active site cysteine.
Int J Biol Macromol. 105:1595-1601.
Jinhyuk Lee (Co-first)

The effect of alpha-ketoglutaric acid on tyrosinase activity and conformation : kinetics and molecular dynamics simulation study.
Int J Biol Macromol. 105:1654-1662.
Jinhyuk Lee (Co-first)

Inhibition of tyrosinase by fumaric acid : integration of inhibition kinetics with computational docking simulations.
Int J Biol Macromol. 105:1663-1669.
Jinhyuk Lee (Co-first)

NATIONAL RESEARCH SAFETY HEADQUARTER

National Research Safety Headquarter is responsible for evaluation and management of biological safety under the Act on the Establishment of Safe Laboratory Environment and the Transboundary Movement, Etc. of Living Modified Organisms Act and contributes to the prevention of safety accident at a laboratory and improvement of R&D productivity by establishing a professional and systematic safety management system at domestic laboratories.

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- Culture and Information Team

In-Ja Song injasong@kribb.re.kr
- LMO Policy Team/LMO Education and Research Team

RESEARCH AREAS

Bioresource Information Division

Field guidance and inspection at research facilities
- Strengthen safety management through field inspection including inspection on the current state of safety management.
- Operate accident investigation squad, analyze accident statistics, conduct online survey, report the designation of laboratory safety environment manager, etc.

Develop safety management policies and conduct business for a laboratory
- Support the enactment and revision of act on laboratory safety, develop policy and provide support.
- Good laboratory accreditation, safety environment support project, development of laboratory safety standards

Conduct laboratory safety training
- Develop policies and institutions on laboratory safety training.
- Develop and operate customized laboratory safety training.
- Develop and utilize on/offline training contents for each laboratory safety area.
- Provide on-offline training service through laboratory online training system.

National Research Safety Information System
- Provide information on laws and institutions related to Act on the Establishment of Safe Laboratory Environment
- Report the execution of act and appointment and change of safe laboratory environment manager
- Inform training and events related to laboratory safety management
- Provide information related to laboratory safety (safety issues, Q&A)

Field guidance and inspection in LMO research facilities
- Conduct field guidance and inspection in LMO research facilities considering the characteristics of LMO and organizational structure.

Improve LMO laws and institutions and develop policies
- Improve LMO laws and institutions and provide follow-up support
- Develop safety management policies on LMO for test and research purpose and manage safety of new research area

Provide training on LMO safety
- Newly establish or expand training programs in line with revised act on LMO.
- Conduct mandatory training, provide training to nurture responsible researchers and professional instructors in accordance with revised notice.

Establishment and operation of LMO online training system
- Provide on/offline training on LMO safety.
- Inquire the status of training completion and issue certificate.

Information system for LMO for test and research purpose
- Inform laws and institutions related to Safe Laboratory Environment and the Transboundary Movement, Etc. of Living Modified Organisms Act.
- Receive online registration including LMO research facility registration and LMO import registration.
- Conduct training and events on LMO safety management.
- Provide information on LMO safety (publications, Q&A).

ACHIEVEMENTS

<Laboratory Policy>
- Revision of Act on the Establishment of Safe Laboratory Environment for field-focused safety management (Jan. 2017)
- Revised "Compensation Standard for Accidents in Laboratories" to strengthen protection for researchers (Mar. 2017)
- Published and distributed Manual on Laboratory Installation and Operation (Jul. 2017) and Book with explanation on Act on the Establishment of Safe Laboratory Environment (Dec. 2017)

<Laboratory Training>
- Conducted laboratory safety training for those who demanded the training (classroom training: 111 times for 9977 audiences, online training for 274,550 people)
- Established the system to nurture professional instructors and ran expert committee on laboratory safety training (2 times), established ways to develop training policies and institutions (Dec. 2017)
- Developed and used customized laboratory safety training contents (standard textbook, training plan: 7 kinds, e-learning contents: 20 sessions, 2 video clips for training)(Dec. 2017)

<Laboratory Inspection>
- Conducted survey on the status of laboratory safety management (targeting 4,307 organizations) and field inspection (420 organizations/ 2714 sample laboratories) (Apr. to Oct. 2017)

<LMO Policy>
- Published LMO export notification user manual (Apr. 2017)
- Published LMO separate packing facility registration manual (May 2017)
- Published handbook on LMO act (Sep. 2017)
- Published test and research purpose LMO online registration system user manual (Sep. 2017)
- Published LMO import procedure guidance (Dec. 2017)
- Published book with explanation on test and research purpose LMO safety management (Dec. 2017)

<LMO Training>
- Published test and research purpose LMO FAQ Vol.1(Jan. 2017) and Vol.2 (Dec. 2017)

<LMO Inspection>
- Conducted field guidance and inspection for LMO research facility (407 facilities, 137 institutions), survey on safety management status (886 facilities, 142 institutions) and whole LMO research centers (460 centers).
- Developed guideline for operation and practice of Institutional Biosafety Committee (Sep. 2017)
- Developed guideline for handling of major equipment and devices for biological research (Nov. 2017)
- Published manual for registration and approval process of Institutional Biosafety Committee for LMO researchers (Nov. 2017)

<Information System>
- Improved functions focusing on users including reorganizing menus in the National research Safety Information System
- Involved in upgrade of systems including LMO law and institution implementation inspection system, LMO expert review system development.

<Presentation at Symposiums>
- "The Korean Society of Safety, Spring Symposium 2017" Development of Predictive System to Prevent Electrical Fire Caused by Partial Disconnection and Arc in Laboratories (May, 2017)
- "ACSEL 2017" The Biosafety Management System and the Law of Living Modified Organisms for Tests and Research in South Korea (Jul. 2017)
- "ACSEL 2017" An analysis of the severity of laboratory accident injury by research institute, research area and accident type (Jul. 2017)
- "ACSEL 2017" The Development of a Fuzzy Prediction System with Overcurrent and Arc as Input Variables for Indoor Wiring in Laboratories(Jul. 2017)
- "ACSEL 2017" Improvement of On-site Examination Through Comparison of ACT ON THE ESTABLISHMENT OF SAFE LABORATORY ENVIRONMENT and safety-related laws(Jul. 2017)
- "ACSEL 2017" A Study on Classification and Report Criteria For Laboratory Safety Accident(Jul. 2017)
- "The 5th Korean Institute of Hazardous Materials Symposium" Result of THE 1st Survey on the Safety Management in Laboratories and Its Implications (Aug. 2017)
- "The 5th Korean Institute of Hazardous Materials Symposium" Study on the Improvement of Accident Management through Analysis of Accidents in Laboratories (Aug. 2017)
- "The 5th Korean Institute of Hazardous Materials Symposium" Major Contents and Future Development Direction of Act on the Establishment of Safe Laboratory Environment (Aug. 2017)
- "The Korean Institute of Chemical Engineers, Autumn Symposium 2017" Desirable Ways to Manage Safety in Chemical (engineering) Laboratories through Safety Inspection (Oct. 2017)
- "The Korean Institute of Chemical Engineers, Autumn Symposium 2017" Development of Guideline on Safety Management in Chemical Laboratories to Protect Future Talented People (Oct. 2017)

STEM CELL RESEARCH CENTER

Our research goal is understanding stem cell functions and disease mechanisms to develop novel therapeutics to treat human diseases. We focus on the generation of 3D human disease model systems using reprogrammed cells such as patient-derived induced pluripotent stem cells (iPSCs) for developing personalized and in vivo-mimic disease models. In addition, we develop alternative methods to animal testing, called 'Networking Organoid Culture System (NOCS)' which involves a different kind of organoid such as an intestine, liver, cardiac, brain, etc. We hope it increases the fidelity of in vitro testing and decreases the sacrifice of research animals.

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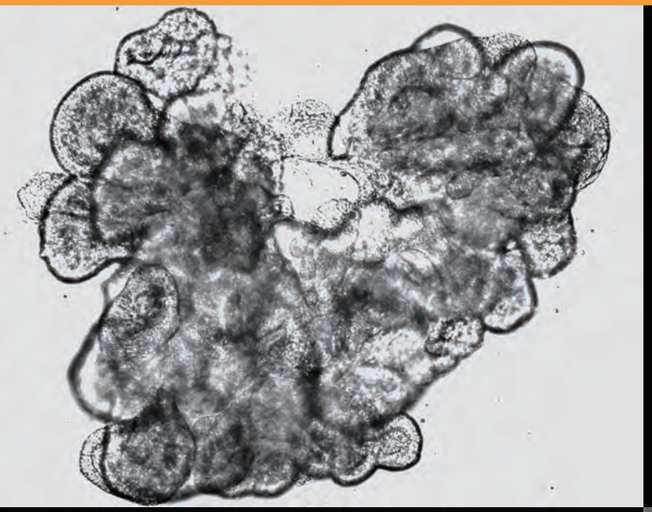

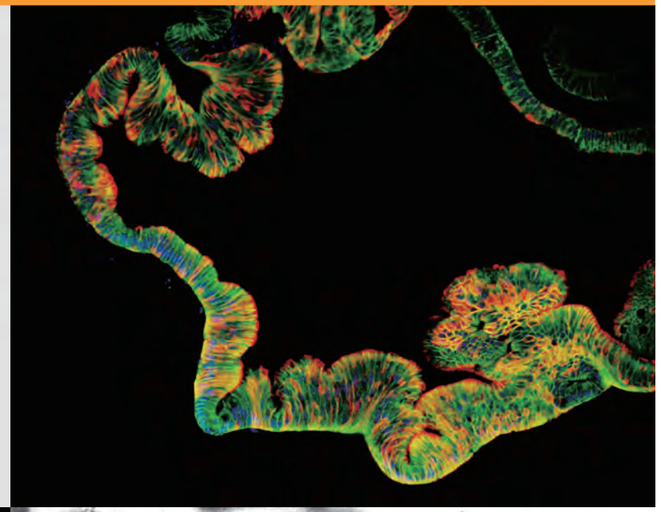

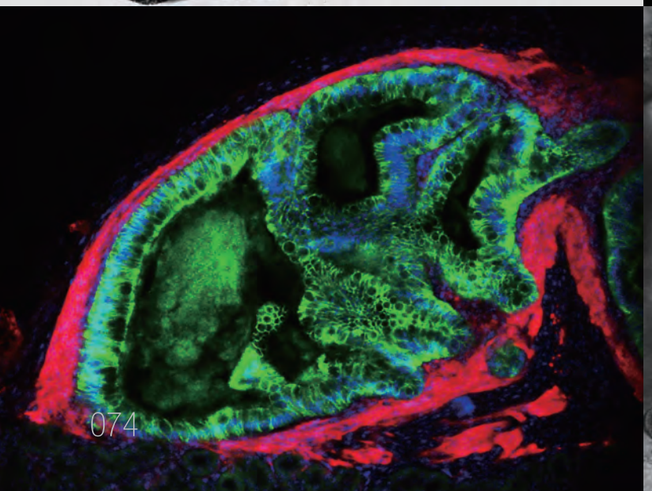

INVESTIGATORS

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- Differentiation and transdifferentiation into neural cells
- Disease modeling and development of therapeutics
- Common mechanism of reprogramming

Cho Rok Jung crjung@kribb.re.kr
- Functional validation of disease related genes and development of therapeutics
- Development of 3 dimensional cell based disease model

Mi-Young Son myson@kribb.re.kr
- Disease modeling based on induced pluripotent stem cells
- Stem cell-based 3D gastrointestinal organoids as models of human development and disease

Myung Jin Son mjson@kribb.re.kr
- Metabolic and mitochondrial regulation in cell fate transition
- Modeling normal- and disease-state livers using organoid system

Hyun-Soo Cho chohs@kribb.re.kr
- Development of prediction pipeline for hPSC-derived cells
- Functional analysis of epigenetic modifiers in hPSC-derived cells

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- Functional Analysis of disease related genes
- Development and evaluation of small molecule cancer drug
- Evaluation of therapeutic gene transfer for genetic disease

Hyun Mi Kang hmkang@kribb.re.kr
- Development of disease model based on 3-dimensional cells
- Research on generation/differentiation of kidney organoids

Kyung Hee Noh trollius@kribb.re.kr
- Novel mechanism for ubiquitination enzyme
- Development of novel oral bioavailability method

Young-Joo Jeon jeonyj@kribb.re.kr
- Molecular analysis of disease targets identified using patient iPSCs
- Proteomic analysis and identification of novel drug targets

RESEARCH AREAS

- Development of core technologies in cell fate change between somatic cells and stem cells
- Modeling 3D human diseases based on stem cells, reprogramming, and organoid technology
- Development of biomimetic 3D human tissue and networking platform for predicting drug toxicity and efficacy
- Characterization of genes related to various diseases including cancer and development therapeutic interventions such as small molecules, gene therapy, regenerative cells and tissues

ACHIEVEMENTS

Distinctive gene expression changes in intestinal organoids differentiated from Parkinson's disease (PD) specific iPSCs.

PD is the second most common neurodegenerative disease after Alzheimer's disease. Although PD is a neural disease, gastrointestinal phenotypes are often found in early PD progression. To investigate the pathogenesis, we differentiated familial PD (LRRK2 G2019S) iPSCs into both neural and intestinal organoids then analyzed the changes in gene expression. Surprisingly, we found distinctive and significant changes in PD-intestinal organoids compared to normal. These changes are even greater than the changes in neural organoids. Based on these results, we hope to find diagnosis markers for early PD and to develop an advanced disease model for PD with 3D organoids.

Cell Spheroids with Enhanced Aggressiveness to Mimic Human Liver Cancer In Vitro and In Vivo.

We fabricated a spheroid-forming unit (SFU) for the efficient and economic production of cell spheroids and then optimized the protocol for generating large and homogenous liver cancer cell spheroids using Huh7 hepatocellular carcinoma (HCC) cells. The large Huh7 spheroids showed apoptotic and proliferative signals in the centre and at the surface, respectively. In particular, hypoxia-induced factor-1 alpha and ERK signal activation were detected in the cell spheroids. umbilical vein endothelial cells (HUVECs) promoted the proliferation and gene expression of HCC-related genes and cancer stem cell markers in the Huh7 spheroids by activating cytokine signaling, mimicking gene expression in liver cancer. Our large cell spheroid provides a useful in vitro HCC model to enable intuitive observation for anticancer drug testing.

Upregulation of mitochondrial NAD+ levels impairs the clonogenicity of SSEA1+ glioblastoma tumor-initiating cells.

Emerging evidence has emphasized the importance of cancer therapies targeting an abnormal metabolic state of tumor-initiating cells (TICs) in which they retain stem cell-like phenotypes and nicotinamide adenine dinucleotide (NAD+) metabolism. However, the functional role of NAD+ metabolism in regulating the characteristics of TICs is not known. We provide evidence that targeting the maintenance of healthy mitochondria with increased mitochondrial NAD+ levels and SIRT3 activity could be a promising strategy for abolishing the development of TICs as a new therapeutic approach to treating aging-associated tumors.

In vitro and in vivo **imaging and tracking of intestinal organoids from human induced pluripotent stem cells.**

Human intestinal organoids (hIOs) derived from human pluripotent stem cells (hPSCs) have immense potential as a source of intestines. Therefore, an efficient system is needed for monitoring the *in vitro* differentiation and tracking the *in vivo* localization of hIOs. Here, two fluorescent biosensors were developed based on human induced pluripotent stem cell (hiPSC) lines that stably expressed fluorescent reporters driven by intestine-specific gene promoters ($KLF5^{mCherry}$ and ISX^{eGFP}). Then hIOs were efficiently induced from these transgenic hiPSC lines in which mCherry- or eGFP-expressing cells, which were identified in intact living cells in real-time. Transplanted hIOs under the kidney capsule were tracked using fluorescence imaging and confirmed histologically. Our study contributes to the further improvement of cell-based therapies and preclinical screenings in the intestinal field.

A Liver-specific Gene Expression Panel Predicts the Differentiation Status of in vitro Hepatocyte Models

Differentiated liver cells and three- dimensional (3D) organoids are expected to provide new cell sources for clinical therapies. However, conventional experimental methods confirming the expression levels of liver-specific lineage markers cannot provide complete information regarding differentiation status between liver and differentiated cell sources. Therefore, to overcome several issues in the assessment of differentiated/ 3D culture liver cells, we developed a LiGEP (Liver-specific Gene Expression Panel) algorithm, representing liver similarity as a "percentage". Our LiGEP can provide useful information and insight regarding the differentiation status of *in vitro* liver models.

SELECTED PUBLICATIONS

Differential effects of EGFL6 on tumor versus wound angiogenesis.
Cell Rep. 21(10):2785-2795.
Kyung Hee Noh (First)

A liver-specific gene expression panel predicts the differentiation status of In vitro hepatocyte models.
Hepatology. 66(5):1662-1674.
Mi-Young Son(Frist), Cho-Rok Jung and Hyun-Soo Cho (Co-corresponding)

Distinctive genomic signature of neural and intestinal organoids from familial Parkinson's disease patient-derived induced pluripotent stem cells.
Neuropathol Appl Neurobiol. 43(7):584-603.
Janghwan Kim, Cho Rok Jung and Mi-Young Son (Co-corresponding)

Cell spheroids with enhanced aggressiveness to mimic human liver cancer *In vitro* and *In vivo*.
Sci Rep. 7(1):10499.
Cho Rok Jung and Jung Hwa Lim (Co-corresponding)

IMMUNOTHERAPY CONVERGENCE RESEARCH GROUP

Our goal is to identify the differentiating factors between adult stem cells and immune cells, to develop core platform technology for immune cell therapies that target cancer by researching their functions, and to develop the platform technology for anti-cancer antibody therapy and cancer diagnostics.

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- Anti-tumor NK cell therapy based on NK differentiation

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- Role of NK cells in reproduction

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- Development of CAR-NK cell therapy

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- Functional validation of novel therapeutic targets and development of molecular targeted therapy

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Seon-Jin Lee sjlee@kribb.re.kr
- The regulatory and functional study of autophagy and disease-related genes

Hee Jun Cho hjcho@kribb.re.kr
- Cancer progression and chemoresistance

Yee Sook Cho june@kribb.re.kr
- Pluripotency, reprogramming, differentiation, disease modeling

Jungwoon Lee jwlee821@kribb.re.kr
- Molecular mechanisms of induced pluripotency
- Disease modeling using patient-derived iPSCs

Mi-Ok Lee molee@kribb.re.kr
- Differentiation of human pluripotent stem cells
- Disease modeling with hPSCs and genome editing technique

RESEARCH AREAS

NK cell therapy
- Developing platform technology for the differentiation of stem cells.
- Developing platform technology for the regulation of NK cell differentiation.
- Developing NK cell therapy for cancer treatment.
- Developing CAR (chimeric antigen receptor)-NK cell therapy.

Antibody therapy
- Development of therapeutic target antigens.
- Development of human and humanized antibodies for cancer treatment.
- Evaluation of therapeutic antibodies.

Hematopoietic stem cell (HSC) aging
- HSC fate decision
- HSC aging mechanism and rejuvenation

Stem cell tech-based NK differentiation & production

Cellular reprogramming
- Reprogramming technologies for producing therapeutically- or disease-relevant human cells

Human pluripotent stem cells
- Human pluripotent stem cell-derived human cell production for disease modeling, drug discovery, and cell therapy

ACHIEVEMENTS

Molecular profiling of NK cell differentiation from stem cells

NK cells develop from hematopoietic stem cells (HSCs) in the bone marrow. In order to understand the molecular regulation of NK cell development and activation, serial analysis of gene expression (SAGE), microarray, and NGS data of mRNA and noncoding RNAs have been established from stage-dependent NK cell differentiation and activation. These big data have been extensively used for the elucidations of basic roles, mechanistic insights, and molecular networks of differentially expressed genes in NK cell development and activation.

Development of immune therapy techniques utilizing NK cells

Based on the observations in NK differentiation, immunotherapy for cancer has been designed. The platform technology of NK cell therapy for cancer treatment was established and has been used in clinical trials of incurable cancers. Recently, CAR-NK cell therapy has been developed in order to be applied to biomarkers-expressing solid tumors in the level of preclinical trials.

Molecular mechanism of HSC aging and stress

The functions of HSCs are changed under stress and aging. Reactive oxygen species are major players for aging and stress response of HSCs. The molecular targets for HSC stress and aging have been identified and the functions of them have been investigated.

Stem cell technology-based NK cell production

We have generated human induced pluripotent stem cells (iPSC) from peripheral blood cells and are developing the differentiation protocol for the efficient production of the functional and cytotoxic NK cells. Further optimization of our protocol will help to generate scalable cytotoxic NK cells to treat different types of cancer and provide a genetically interchangeable platform to investigate causes and potential targets for cancer therapy.

SELECTED PUBLICATIONS

Cystatin SN inhibits auranofin-induced cell death by autophagic induction and ROS regulation via glutathione reductase activity in colorectal cancer.
Cell Death Dis. 8(3):e2682.
Hee Gu Lee (Corresponding)

miR-150-mediated Foxo1 regulation programs CD8$^+$ T cell differentiation.
Cell Rep. 20(11):2598-2611.
Tae-Don Kim (Co-corresponding)

Upregulation of mitochondrial NAD$^+$ levels impairs the clonogenicity of SSEA1$^+$ glioblastoma tumor-initiating cells.
Exp Mol Med. 49(6):e344.
Yee Sook Cho and Myung Jin Son (Co-corresponding)

Vitexin confers HSF-1 mediated autophagic cell death by activating JNK and ApoL1 in colorectal carcinoma cells.
Oncotarget. 8(68):112426-112441.
Hee Gu Lee (Co-corresponding)

MicroRNA-150 modulates intracellular Ca 2$^+$ levels in naive CD8$^+$ T cells by targeting TMEM20.
Sci Rep. 7:2623.
Inpyo Choi (Co-corresponding)

Suppressor of cytokine signaling 2 negatively regulates NK cell differentiation by inhibiting JAK2 activity.
Sci Rep. 7:46153.
Inpyo Choi and Haiyoung Jung (Co-corresponding)

Schwann cell precursors from human pluripotent stem cells as a potential therapeutic target for myelin repair.
Stem Cell Reports. 8(6):1714-1726.
Yee Sook Cho (Corresponding)

Biomarker discovery by modeling Behcet's disease with patient-specific human induced pluripotent stem cells.
Stem Cells Dev. 26(2):133-145.
Yee Sook Cho (Corresponding)

Anti-cancer activity of novel TM4SF5-targeting antibodies through TM4SF5 neutralization and immune cell-mediated cytotoxicity.
Theranostics. 7(3):594-613.
Semi Kim and Sang Jick Kim (Co-corresponding)

BIODEFENSE RESEARCH CENTER

The Biodefense Research Center was established to respond more systematically to the growing importance of biodefense, including the threat of biological weapons. The center conducts research and development on biodefense technology and related policies for biological weapons and bioterrorism. It also designs R&D projects and exchanges technical information with organizations associated with the military.

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INVESTIGATORS

Kwang-Hee Bae khbae@kribb.re.kr
- Identification of metabolic disease treatment targets and functional research using proteomics
- Identification of stem cell differentiation and de-differentiation related protein and functional research

Choong-Min Ryu cmryu@kribb.re.kr
- Bacteria-bacteria communication, Bacteria-plant interactions, plant immunity

Sang-Rae Lee srlee@kribb.re.kr
- Development of brain disease models (Stroke, Dementia, Parkinson's disease) with nonhuman primates
- Establishment of efficacy test system with brain disease models
- Development of infectious disease models with nonhuman primates

Tai Hwan Ha taihwan@kribb.re.kr
- Developing nanobiomaterials for biosensor and biochip applications
- Developing optical transducers for biochemical warfare
- Devising a smart transdermal drug delivery system to load antidotes

Sun-Woo Yoon syoon@kribb.re.kr
- Pathogenesis and genetic characterization of influenza viruses
- Development of influenza vaccine technologies using the reverse genetics system

Doo-Jin Kim golddj@kribb.re.kr
- DNA vaccines against acute respiratory viral diseases (influenza and MERS)
- Mechanisms of action of immunomodulatory vaccine adjuvants
- Immunomodulatory function of viral proteins

RESEARCH AREAS

Research and Development of BioDefense
- Development of wearable sensor technologies for soldiers in the future
- Development of new biological materials for national defense
- Development of bio-markers and diagnosis/vaccine technologies to respond to biological weapons
- Development of an animal evaluation model to build protection against biological weapons
- Development of a platform technology of biomimetics for the military

ACHIEVEMENTS

Development of highly sensitive aptasensors for pathogens and wearable sensor platforms
- Development of ultra-sensitive FET biosensor platforms that can be adapted to wearable, privatized, and integrated sensor systems for futuristic soldiers

OCHANG BRANCH INSTITUTE

- Natural Medicine Research Center

Division of Bioinfrastructure

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

Ochang Branch Institute conducts research activities to build up the pipeline and platform for new bio-drugs at the national level. Its major research areas include medicinal resources assessment based on metabolomic analysis of natural products and the establishment of systems to discover new physiologically active substances. The Institute is also involved in identifying inhibitors and clinical candidates targeting diseases. The Branch Institute has also carried out support activities for researchers with the provision of bio-resource infrastructures such as laboratory mice, miniature pigs and primates, and a bio-evaluation system of drug efficacy and GMO safety tests.

BRANCH DIRECTOR Jang-Seong Kim / TEL +82-43-240-6001 / FAX +82-43-240-6009 / E-MAIL srlee@kribb.re.kr

NATURAL MEDICINE RESEARCH CENTER

Our aim is to develop natural product candidates for natural/synthetic pharmaceuticals from plant sources that are effective against chronic diseases such as asthma/COPD, metabolic diseases, viral diseases and cancers.

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INVESTIGATORS

Sei-Ryang Oh seiryang@kribb.re.kr
- Identification of biologically active compounds from natural resources
- Evaluation of natural products and/or extracts against chronic diseases
- Metabolomic research of medicinal plants for origin discrimination and standardization of natural drugs.

Hyeong-Kyu Lee hykylee@kribb.re.kr
- Identification of new molecular targets related to immune diseases
- Development of active compounds for pharmaceuticals from natural products
- Construction of natural product library

Kyung-Seop Ahn ksahn@kribb.re.kr
- Evaluation of anti-inflammatory and anti-asthmatic activity of natural products
- Identification of new bio-markers for asthma/COPD

Jong-Pyung Kim kimjp@kribb.re.kr
- Isolation/evaluation of anti-oxidative compounds from mushrooms
- Development of nutraceuticals and drug candidates for prevention/ treatment of neurological disorders

Hyun-Jun Lee hjlee@kribb.re.kr
- Control of inflammation by innate and adaptive immune mechanisms
- Identification of bio-markers in vivo for asthma/COPD treatment

Dur Han Kwon dhkwon@kribb.re.kr
- Screening natural sources showing anti-viral activity
- Evaluation of anti-viral effects and development of preventive materials from natural sources.

Mun-Ock Kim mokim@kribb.re.kr
- Validation of molecular targets involved in metabolic diseases
- Development of in vitro & in vivo screening systems for drug discovery

Hyung Won Ryu ryuhw@kribb.re.kr
- Isolation of active constituents from medicinal plants
- Elucidation of natural compound structure using analytical instruments

RESEARCH AREAS

Natural product Chemistry
- Isolation of bioactive materials from plant sources.
- Elucidation of natural product structure using analytical instruments (HPLC/UPLC, LCMS, NMR).
- Management of domestic plant extract banks.

Molecular targets related to chronic respiratory diseases and metabolic diseases
- Identification of molecular targets involved in chronic respiratory diseases and metabolic diseases.
- Establishment of bioassay/screening systems using the molecular targets of chronic diseases such as asthma/COPD and obesity/diabetes.
- Evaluation of natural products as candidates of natural drugs and/or functional foods for chronic diseases in vivo.

ACHIEVEMENTS

Identification of natural products against chronic diseases

We have isolated active natural compounds as therapeutic candidates from plant sources and evaluated the biological activities of them in inflammation, asthma/COPD, cancer and metabolic disorder.

Construction of plant extract bank

We manage a plant extract bank (extracts of over 5,000 samples from domestic plants) and provide the extracts to researchers for screening active materials and service a massive extraction/fractionation/purification process.

Industrial research

We have licensed out two natural drug candidates (asthma/COPD: Yungjin Pharm Co. Ltd, 2011.05.16., atherosclerosis: Korea Bio Medical Sciences Institute, 2015.03.23.) and one lead compound of synthetic pharmaceuticals for chronic inflammation (A-ju Pharmaceutical Co. Ltd, 2015.07.02). The natural drug candidate for COPD successfully completed phase IIa (U.S.A. FDA 2017.08.01). For nutraceuticals, the original candidates (compounds from *Pistacia weinmannifolia*) were licensed out to a company (BTC Co. Ltd, 2016.06.29.).

SELECTED PUBLICATIONS

Comparison of secondary metabolite changes in *Camellia sinensis* leaves depending on the growth stage.
Food Control. 73:916-921.
Sei-Ryang Oh (Co-corresponding)

***Artemisia argyi* attenuates airway inflammation in ovalbumin-induced asthmatic animals.**
J Ethnopharmacol. 209:108-115.
Hyung Won Ryu (Co-first)

Protective effect of polyacetylene from *Dendropanax morbifera* Leveille leaves on pulmonary inflammation induced by cigarette smoke and lipopolysaccharide.
J Funct Foods. 32:358-366.
Sei-Ryang Oh (Corresponding)

Protective effects of coumestrol on lipopolysaccharide-induced acute lung injury via the inhibition of proinflammatory mediators and NF-κB activation.
J Funct Foods. 34:181-188.
Hyung Won Ryu and Sei-Ryang Oh (Co-corresponding)

Potential anti-inflammatory effects of the fruits of *Paulownia tomentosa*.
J Nat Prod. 80(10):2659-2665.
Sei-Ryang Oh (Co-corresponding)

Melatonin suppresses fibrotic responses induced by cigarette smoke via downregulation of TGF-β 1.
Oncotarget. 8(56):95692-95703.
Kyung-Seop Ahn (Co-corresponding)

Lepistatins A-C, chlorinated sesquiterpenes from the cultured basidiomycete *Lepista sordida*.
Phytochemistry. 143:111-114.
Jong-Pyung Kim (Corresponding)

DIVISION OF BIOINFRASTRUCTURE

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

The Division of Bioinfrastructure has a key function to promote national biotechnology R&D and industries. It has three infrastructure activities: as a biological resource, for industrial support, and to research safety and offer policy support. As a biological resource, the primary activity involves establishing support systems for biotechnology R&D and practical utilizations of research outcomes through the acquisition and utilization of bio-resources including plant, animal, microorganisms, and human-derived resources. The industrial support infrastructure provides customized services for the commercialization of research outcomes such as bio-evaluation, preclinical trial, and process development to the industrial process. The policy and Safety infrastructure manages the utilization of living modified organisms (LMOs) and the implementation of access and benefit sharing(ABS).

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BIOLOGICAL RESOURCE CENTER

The Biological Resource Center (BRC) of South Korea, or KCTC (Korean Collection for Type Cultures), is very well known both at home and abroad. KCTC joined the World Federation of Culture Collections (WFCC) in 1985 and the World Data Center for Microorganisms (WDCM) in 1986. It also gained the status of an International Depositary Authority (IDA) from the World Intellectual Property Organization (WIPO) in 1990 under the Budapest Treaty.
KCTC currently collects, preserves and distributes over 32,903 biological resources including archaea, bacteria, molds, yeasts, plant cell lines, animal/human cell lines and patent strains. All biological resources are extensively quality-controlled. KCTC also endeavors to construct collaborative networks with other BRCs in support of both the scientific and industrial communities.

Major functions of KCTC :
- Collection, preservation and distribution of biological resources
- Development of core technologies to foster valuable biological resources
- Construction of collaborative networks and support of services and education related to biological resources

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INVESTIGATORS

Cha Young Kim Kimcy@kribb.re.kr
- Metabolic engineering and molecular farming for high-level production of valuable metabolites and proteins (vaccines etc.) in microbe and plant systems
- Development of plant cell and organ culture systems for the production of valuable metabolites using bioreactors

Suk Weon Kim kimsw@kribb.re.kr
- General curator for plant cell resources
- Development and commercialization of plant cell resources (calluses, adventitious roots, shoots, and micro-tubers)

Jung-Sook Lee jslee@kribb.re.kr
- General curator for microbial resources
- Microbial diversity, taxonomy and ecology
- Research for human gut microbiome

Doo-Sang Park dspark@kribb.re.kr
- Development of lactic acid bacteria resources
- Host-microbe interaction research

Song-Gun Kim sgkim@kribb.re.kr
- Taxonomy and characterization of novel bacteria from oxic and anoxic conditions
- Biotransformation and production of natural products using microbial enzymes
- Microbial diversity of environment and human related ecosystem

Jae Cheol Jeong jcjeong@kribb.re.kr
- Management of patent resources
- Understanding of the epigenetic regulatory mechanisms involved in modulating the embryogenesis process in plant cultured cells
- Comparative transcriptomic analysis of plants in response to abiotic and biotic stimuli

Ju Huck Lee juhuck@kribb.re.kr
- Isolation and identification of gut microbiota in humans and animals
- Development of gut microbiota resources
- Molecular study of bacterial pathogenesis

Seung-Hwan Park biopark@kribb.re.kr
- Isolation and identification of gut microbiota in humans and animals
- Study of bacteria-mediated cancer therapy
- Imaging analysis and application for theranostics

Jiyoung Lee jiyoung1@kribb.re.kr
- Isolation and characterization of plant growth-promoting endophytes
- Exploration of the potential of endophytes from medicinal plants as sources of natural compounds
- Understanding plant-pathogen interaction

Se Won Kang bioksw@kribb.re.kr
- Bioinformatic analysis of genome and transcriptome in animals, plants and microbiota
- Metagenomic analysis of the gut microbiome in humans and animals
- Phylogenetic study of biological resources

Mi-Kyung Lee miklee1010@kribb.re.kr
- Curation for fungal and yeast strain resources
- Collection and commercialization of fungal and yeast strain resources for research activities
- Research for regulation of fungal development

Kang Hyun Lee khlee@kribb.re.kr
- Support for gram-negative bacterial resources

Moon Soo Rhee msrhee@kribb.re.kr
- Support for actinobacterial resources

Keun Chul Lee kclee@kribb.re.kr
- Support for archaea, extremophiles, and gram-positive bacterial resources

Min Ok Jun ksmino@kribb.re.kr
- Management of patent resources
- Support for gram-negative α - and β -bacterial resources
- Arrangements for Asian Consortium for the Conservation and Sustainable Use of Microbial Resources (ACM)
- Support for workshops

RESEARCH AREAS

Acquisition and Management of biological resources
- Collection and preservation of core biological resources for research activities
- Distribution of biological resources to academia, research institutes and industries

Development of core technologies for biological resources
- Development of platform technologies for isolation, long-term preservation, and application of useful biological resources

Construction of infrastructure networks and support for services and education related to biological resources
- Construction of local and global networks for biological resources
- Support for training workshops, conferences and consultations

Construction and application technology development of the infra-system for Korean gut microbiome
- Establishment of the Korean gut microbiome bank
- Support for Korean gut microbiome research and industry

Development and management of valuable plant cell resources
- Development, collection, preservation and distribution of plant cell resources (calluses, adventitious roots, shoots, and micro-tubers)
- Mass production of valuable plant cell resources using bioreactor
- High-level production of useful metabolites by elicitation of plant cells

Development of core technologies for plant cell differentiation and plant regeneration
- Development of core technologies for cell differentiation and regeneration of useful plant resources
- Establishment of national platform for genetic transformation and gene editing of useful plant resources

Biotechnological application of plant-associated microbes
- Collection, isolation and identification of plant-associated microbes
- Application of useful natural products from plant-associated microbes

ACHIEVEMENTS

- KCTC has retained 32,903 biological resources from home and abroad, and KCTC has distributed 8,305 strains in 2017 to research organizations such as universities, research institutes and private companies.
- The biological resources include 6,092 patent strains, 5,359 proteobacteria, 4,584 molds, 4,462 actinobacteria, 3,885 firmicutes, 2,694 yeasts, 1,657 microalgae, 250 archaea, 667 plant cell lines and 182 animal/human cell lines.
- KCTC provides education and training courses on cultivation, preservation and management of biological resources for domestic users of bioresources as well as overseas researchers who are ACM members. Last year, 11 domestic workshops were provided and the 7th international training course on microbial taxonomy was held for 6 weeks in KCTC with 6 international ACM members from Indonesia, Malaysia, Mongolia, The Philippines, Thailand, and Vietnam.
- KCTC is conducting 'The Korean Gut Microbiome Bank (KGMB) Project," which includes metagenomic analysis of the human gut microbiome and the isolation of real bacterial resources like anaerobic bacteria, from Korean people.
- KCTC is currently developing a database for the rapid identification of fungal species by matrix assisted laser desorption/ionization time of flight mass spectrometry (MALDI-TOF MS).
- KCTC members published 23 scientific papers including descriptions of 20 microbial taxa in 2017.
- KCTC acquired 349 novel type strains that were reported in international taxonomy journals (KCTC: 349; DSMZ: 276; JCM: 240). KCTC currently holds a total of 2,783 type strains.
- In addition, the citation number of microbial resources of KCTC continued to grow over 15% annually during 2015-2017 (Scopus).
- KCTC and WDCM are collaborating on the project GCM* 2.0 related to sequencing for type strains. KCTC also takes an active part in ACM proceedings for discussion of collaborative plans of conservation and sustainable use of biological resources with BRC in Asian countries.

*GCM: Global Catalogue of Microorganisms

SELECTED PUBLICATIONS

***Lacinutrix chionocetis* sp. nov., isolated from gut of a red snow crab.**
Arch Microbiol. 199(4):597-603.
Doo-Sang Park (Corresponding)

***Paucibacter oligotrophus* sp. Nov., isolated from fresh water, and emended description of the genus Paucibacter.**
Int J Syst Evol Microbiol. 67(7):2231-2235.
Song-Gun Kim (Corresponding)

***Sphingomonas gotjawalisoli* sp. nov., isolated from soil of a lava forest.**
Int J Syst Evol Microbiol. 67(8):2975-2979.
Jung-Sook Lee (Corresponding)

Complete genome of a metabolically-diverse marine bacterium *Shewanella japonica* KCTC 22435^T.
Mar Genomics. 35:39-42.
Kyung Mo Kim (Corresponding)

LABORATORY ANIMAL RESOURCE CENTER

The goals of our center are to establish national infrastructure for laboratory animal resources and a public/intramural service core for animal experimentations. For these purposes, we have been collecting mouse resources, developing quality control technologies, generating animal models for human diseases, and providing animal resources and services for researchers in biomedical research fields since 1984. Recently, we started producing genetically engineered mice (GEM) and 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). We have also constructed infrastructure for the non-clinical evaluation and optimization of drug candidates and have been providing services for biotech companies and researchers.

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INVESTIGATORS

Hyoung-Chin Kim hckim@kribb.re.kr
- Experimental Animal Medicine,
- Toxicology of Drug Development
- Health Safety of LMOs

Chul-Ho Lee chullee@kribb.re.kr
- Development and functional validation of animal models for human diseases
- Genetic quality control of laboratory animals

Ki-Hoan Nam namk@kribb.re.kr
- Laboratory Animal Science/Immunology
- Reproductive engineering/Phenotyping of mutant mice

Won-Kee Yoon wkyoon@kribb.re.kr
- Veterinary Pathology
- Genetic monitoring of laboratory animals
- Health Safety of LMO

Young-Suk Won yswon@kribb.re.kr
- Bacteriology
- Health monitoring of laboratory animals

Jung Hwan Hwang coccs99@kribb.re.kr
- Development of genetically altered laboratory animal models
- Phenotyping of functional genes associated with metabolic diseases

Kyung-Shim Kim kskim@kribb.re.kr
- Development and phenotyping of animal models for brain and neurological diseases
- Discovery of bioactive materials for human brains and neurological diseases

Yong-Hoon Kim milknut@kribb.re.kr
- Support for veterinary care and histopathological diagnosis
- Functional phenotyping of cardiovascular and liver disease models

Hoyoung Ghang kangho@kribb.re.kr
- Genome and phenome association study with model animals
- Bioinformatics

Jong Soon Kang kanjon@kribb.re.kr
- Molecular Pharmacology
- Efficacy evaluation of drug candidates

Kyeong-Ryoon Lee kyeongrlee@kribb.re.kr
- Drug Metabolism and Pharmacokinetics (DMPK)
- PK-PD modeling and simulation

RESEARCH AREAS

- Collection and maintenance of laboratory animal resources.
- Production, expansion and distribution of laboratory animal resources for research communities.
- Permanent preservation of laboratory animal resources as frozen resources.
- Establishment of a laboratory animal database.
- 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
- Research support for animal experiments
- Functional validation of the genes associated with human diseases
- Provision of the basics of laboratory animal experimentation techniques to animal technicians and researchers
- Establishment of infrastructure for non-clinical evaluation of new drug candidates
- Efficacy evaluation of new drug candidates
- DMPK evaluation of new drug candidates

ACHIEVEMENTS

The largest laboratory animal resource bank in Korea
- Deposits of laboratory animal resources: 1,050 strains
- Distribution of laboratory animal resources: 12,387 animals

Center for quality control of laboratory animals
- Health monitoring: 5,175 animals
- Mouse genotyping: 4,644 animals
- Animal clearing: 124 strains

Training workshop for laboratory animal techniques
- The 40th Laboratory Animal Workshop was held on November 21-22, 2017.

International cooperation with ICLAS, RIKEN and IMPC
- ICLAS: International Council for Laboratory Animal Science.
- RIKEN BRC: RIKEN BioResource Center
- IMPC: International Mouse Phenotyping Consortium.

Support for animal experiments
- IACUC-approved animal experiments: 134 cases
- Service for pathological diagnosis: 92 cases
- Service for hematology and blood biochemistry: 118 cases

Non-clinical evaluation of drug candidates
- Efficacy evaluation of drug candidates: 3.948 cases
- DMPK evaluation of drug candidates: 87 cases

SELECTED PUBLICATIONS

An injectable collagen/poly(γ -glutamic acid) hydrogel as a scaffold of stem cells and α -lipoic acid for enhanced protection against renal dysfunction.
Biomater Sci. 5(2):285-294.
Chul-Ho Lee (Co-corresponding)

Hepatocyte toll-like receptor 4 mediates lipopolysaccharide-induced hepcidin expression.
Exp Mol Med. 49(12):e408.
Chul-Ho Lee (Co-corresponding)

Blue light effect on retinal pigment epithelial cells by display devices.
Integr Biol. 9(5):436-443.
Jong Soon Kang (Corresponding)

***Humulus japonicus* inhibits the progression of Alzheimer's disease in a APP/PS1 transgenic mouse model.**
Int J Mol Med. 39(1):21-30.
Kyoung-Shim Kim and Chul-Ho Lee (Co-corresponding)

BIO-EVALUATION CENTER

The mission of Bio-Evaluation Center (BEC) is to support the efficient and successful development and commercialization of biotech products. To achieve this goal, we have established a range of collective and specific infrastructures, consisting of detection and analysis techniques, facilities, and manpower. These infrastructures aim to evaluate the benefits and risks of LMOs (Living Modified Organisms) from development to commercialization. We support analyzing, optimizing, and standardizing the process at the development stage. For commercialization, we assess the benefit and risks of LMOs on the environment and human beings and release useful and safe biotech products to market and our society.

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INVESTIGATORS

Soon-Chun Jeong scjeong@kribb.re.kr
- Molecular genetic characterization of LMOs
- Soybean genomics

Chang-Gi Kim cgkim@kribb.re.kr
- Environmental risk assessment of LMOs
- Plant ecology

Jung-Ho Park jungho@kribb.re.kr
- Human risk assessment of LMOs
- Protein engineering

Ju Seok Lee juseoklee@kribb.re.kr
- Molecular genetic analysis of LMOs
- Soybean population genetics

In-Soon Pack bis74@kribb.re.kr
- Molecular genetic characterization of LMOs

RESEARCH AREAS

Living modified organisms (LMOs)
- Genetic analysis of LMOs
- Environmental risk assessment of LMOs
- Human risk assessment of LMOs

ACHIEVEMENTS

We have established and developed infrastructure for genetic analysis and risk assessments of LMOs.

Genetic analysis and evaluation technique development

We have developed evaluation techniques for genetic analysis, environmental and human risk assessment for domestically developed transgenic crops (soybean, tobacco, and microorganisms).

Bio-Evaluation Support

We provide support for companies to conduct genetic analysis and evaluate the environment and human risk from various transgenic organisms (cabbage, lettuce, water melon, poplar, soybean, rice, and microorganisms).

SELECTED PUBLICATIONS

Translation-dependent mRNA cleavage by YhaV in *Escherichia coli*.
FEBS Lett. 591(13):1853-1861.
Jung-Ho Park (Co-corresponding)

Preferential use of minor codons in the translation initiation region of human genes.
Hum Genet. 136(1):67-74.
Jung-Ho Park (Co-corresponding)

Salinity affects metabolomic profiles of different trophic levels in a food chain.
Sci Total Environ. 599:198-206.
Chang-Gi Kim (Corresponding)

Genetic analysis of the *Lf1* gene that controls leaflet number in soybean.
Theor Appl Genet. 130(8):1685-1692.
Soon-Chun Jeong (Co-corresponding)

NATIONAL PRIMATE RESEARCH CENTER

The NPRC was established within KRIBB as a major national nonhuman primate infrastructure to support industries/ academia/research institutes including those involved in xenotransplantation, regenerative medicine and new-drug discovery for incurable diseases.

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INVESTIGATORS

Yeung Bae Jin ybjin@kribb.re.kr
- Pathologic diagnosis and veterinary clinical care for nonhuman primates
- Development and preclinical evaluation of nonhuman primate models for human disease

Kyu-Tae Chang changkt@kribb.re.kr
- Acquisition and establishment of support system for utilization of primate / mini-pig resources
- Technical advancement of developmental biotechnology using primate / mini-pig.
- Development of transgenic and cloned animal models using primate / mini-pig

Sang-Rae Lee srlee@kribb.re.kr
- Development of brain disease models (Stroke, Dementia, Parkinson's disease) with nonhuman primates
- Establishment of efficacy test system with brain disease models
- Development of infectious disease models with nonhuman primates

Youngjeon Lee neurosci@kribb.re.kr
- Neuroscience and behavioral science
- Development and preclinical evaluation of nonhuman primate models for Alzheimer's disease and Parkinson's disease

Jae-Won Huh huhjw@kribb.re.kr
- Human and nonhuman primate comparative genomics
- Molecular genetics & Primatology
- Identification and molecular characterization of nonhuman primate genes

Young-Hyun Kim kyh@kribb.re.kr
- Maintaining quality standards of nonhuman primate resources by SPF health monitoring
- Comparative analysis of human and nonhuman primate genome
- Identification and molecular characterization of nonhuman primate genes

Jung Joo Hong hong75@kribb.re.kr
- Comparative immunology of human and nonhuman primates
- Understanding the immunologic mechanisms in immunization and vaccination using infectious model of nonhuman primate
- Analyzing the safety and efficacy of immune modulator in vitro and in vivo nonhuman primate model

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- Virus monitoring of SPF primate
- Molecular genetics of human and nonhuman primates
- Quantitative analysis of various species' genes

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- Veterinary preventive medicine
- Veterinary clinical diagnosis and care for nonhuman primates and minipigs
- Pathologic and molecular characterization of infectious agents using in vitro and in vivo systems including minipigs and nonhuman primates
- Biosafety management of animal biosafety level 3 facility

Jong-Hee Lee jonglee@kribb.re.kr
- Stem cell biology of nonhuman primates and minipigs
- Understanding of developmental and disease mechanisms and provision of new therapeutics using stem cell technology from nonhuman primate and minipig models

Seung Hwan Lee lsh080390@kribb.re.kr
- Development of an effective transgenic animal model with target-specific genome engineering
- Development of disease model and therapeutic agent by using nonhuman primates and minipigs
- Development of minipig models for heterologous organ transplantation

Kang-Jin Jeong nemo9426@kribb.re.kr
- Reproduction and maintenance of SPF primates
- Quarantine of nonhuman primates
- External support service

Seung-Ho Baek bsh82@kribb.re.kr
- Molecular imaging using PET-CT

Chang-Yeop Jeon jcy7959@kribb.re.kr
- Bio-medical engineering & radiology
- MR imaging in development of brain disease models (Stroke, Alzheimer's disease and Parkinson's disease) with nonhuman primates

Hwal-Yong Lee lhy3650@kribb.re.kr
- Reproduction and maintenance of SPF primates

RESEARCH AREAS

Acquisition, propagation and distribution of specific pathogen free (SPF) nonhuman primate resources

Acquiring and distributing SPF nonhuman primate resources to industrial, academic and research institutions

Standardization in handling of and regulating lab requirements for nonhuman primate research
- Maintaining quality standards of nonhuman primate resources by monitoring bacteria, viruses and other general health parameters.
- Establishing a standard operating procedure (SOP) by providing guidelines for the breeding and management of nonhuman primate resources at the international level.

Xenotransplantation research

Transplanting organs (e.g. pancreatic islets, hearts) from transgenic germ-free minipigs into SPF nonhuman primates and analyzing the efficacy and safety of the organs transplanted.

Regenerative medical research and applications

Using nonhuman primate disease models in cell therapy and gene therapy research, and evaluating their efficacy and safety for the treatment of incurable diseases.

Preclinical efficacy assessments of newly developed drug candidates

Applying various biodrugs and biomaterials to SPF nonhuman primates to evaluate efficacy.

Evaluation of immunogenicity and safety of vaccine candidates

Testing and assessing the immunogenicity, efficacy and safety of AIDS and various other vaccines.

Development of disease models
- Constructing disease models for incurable nonhuman primate diseases, which have metabolic pathways most similar to man, and thus developing new drugs and applications for organ and regenerative research.
- Developmental biotechnologies and applications.
- Establishing cell resources, including embryonic stem cells and a variety of tissue cells, and applying them to cell therapies, nuclear transfers, and the study of molecular mechanisms.

Genome research and the establishment of a genomic database Construction and support for Animal Biosafety Level 3(ABL 3) research facilities

Support for infection experiments in nonhuman primates/minipigs/rodents in preparation for national disaster-level infections/diseases/zoonoses/bio-terror attacks/super bacterial infections.

Collaboration and support for nationwide non-institutional research involving nonhuman primates

Providing specialized technologies and information about nonhuman primate care and facilities to researchers, and conducting collaborative research for the development of related technologies.

ACHIEVEMENTS

Procurement of SPF nonhuman primate resources, maintenance and breeding of healthy SPF animals, and preclinical evaluation of biomedical technologies

The NPRC currently houses SPF nonhuman primates: rhesus monkeys, cynomolgus monkeys.

Transfer of nonhuman primate-related resources and techniques to national partners of industrial, academic and research institutions

The NPRC shares its nonhuman primate-related expertise with researchers nationwide, in fields such as neuroscience, pharmacokinetics, etc. We provide services for the upkeep of SPF nonhuman primates, including microbiological monitoring, quarantine and maintenance workshops, and train the personnel (e.g. veterinarians and breeders) who work with nonhuman primates.

Establishment of disease models using nonhuman primates

Establishment of production technology for three brain disease models (Stroke, Alzheimer's disease, and Parkinson's disease). For the establishment of a non-invasive evaluation system for nonhuman primate brain disease models, the MRI and PET-CT system is equipped in NPRC.

Collaboration with national and international research teams

We have conducted collaborative studies in various fields, including xenotransplantation and the pharmacokinetic evaluation of therapeutic drugs against aplastic anemia. We are currently collaborating with world-renown researchers in embryo implantation and development. We are also working with domestic companies for the development of minipigs useful in organ xenotransplantation.

Construction of self-sustaining nonhuman primate resource research facilities to prepare for a turbulent supply of primate resources (Jeonbuk Jeongeup Science-Industry Town)

SELECTED PUBLICATIONS

Early initiation of antiretroviral treatment post-SIV infection does not resolve lymphoid tissue activation.
AIDS. 31(13):1819-1824.
Jung Joo Hong (First)

Sustained diffusion reversal with in-bore reperfusion in monkey stroke models : confirmed by prospective magnetic resonance imaging.
J Cereb Blood Flow Metab. 37(6):2002-2012.
Kyu Tae Chang (Co-corresponding)

Isothiocyanates suppress the invasion and metastasis of tumors by targeting FAK/MMP-9 activity.
Oncotarget. 8(38):63949-63962.
Sang-Rae Lee (Co-corresponding)

Role of melatonin combined with exercise as a switch-like regulator for circadian behavior in advanced osteoarthritic knee.
Oncotarget. 8(57):97633-97647.
Kyu Tae Chang (Co-corresponding)

Iloprost supports early development of In vitro-produced porcine embryos through activation of the phosphatidylinositol 3-kinase/AKT signalling pathway.
Reprod Fertil Dev. 29(7):1306-1318.
Kyu Tae Chang and Sun-Uk Kim (Co-corresponding)

PRIMATE RESOURCE CENTER

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

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INVESTIGATORS

Ji-Su Kim kimjs@kribb.re.kr
- Development of transgenic animal models in Xeno-transplantation research and support
- Establishment of developmental biotechnology and regenerative medicine in non-human primates
- Development and derivation of research resources from non-human primates

Seung-Bin Yoon ellysbin@kribb.re.kr
- Production of early monkey embryos with high developmental competence
- Research of molecular mechanism on early embryogenesis in monkeys
- Support for SPF monkey mass production system

Yeonghoon Son sonyh@kribb.re.kr
- Veterinary clinical diagnosis for non-human primates
- Support for veterinary care and histopathological diagnosis
- Behavioral analysis of group-housed primates

Dong-Ho Lee luckyberry@kribb.re.kr
- Veterinary clinical diagnosis and care for non-human primates
- Establishment of environment enrichment strategies for non-human primates

Ja-Rang Lee jrlee@kribb.re.kr
- Health monitoring of SPF non-human primate resources
- Comparative genomics of human and non-human primates
- Functional genomics of non-human primate model

Sangil Lee sangil0120@kribb.re.kr
- Reproduction and maintenance of SPF non-human primates
- Handling and training of non-human laboratory primates
- Support for experiments using non-human primates

Ki Jin Kim kj0211@kribb.re.kr
- Reproduction and maintenance of SPF non-human primates
- Handling and training of laboratory primates

RESEARCH AREAS

Maintenance, production, and distribution of non-human primate resources
- Establishment and preservation of laboratory non-human primate resources.
- Construction of stable breeding colony for non-human primate 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, and environment enrichments
- Establishing a standard operating procedure (SOP) by providing guidelines for the veterinary care and welfare assessment of non-human primate resources at the international level.

Behavioral analysis of non-human primate disease models
- Constructing disease models for incurable non-human primate diseases, which have metabolic pathways most similar to man, 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-academical-institutional research groups using non-human primates
- Provision of external researchers with expertise and information on care methods and facilities for large-scale reproduction of non-human primates, and conduct of collaborative research to develop specific related technologies in industry, universities, institutes and hospitals.

ACHIEVEMENTS

Maintenance and breeding of healthy SPF animals, and preclinical evaluation of biomedical technologies
- The PRC currently houses two types of macaques: Macaca mulatta (rhesus monkeys) and *Macaca fascicularis* (cynomolgus monkeys).

Distribution of non-human primate-related resources and techniques to national partners in industry, universities, institutes and hospitals.
- The PRC shares its non-human primate-related expertise with researchers nationwide. We provide services for the upkeep of SPF non-human primates, including microbiological monitoring, quarantine and maintenance workshops, and training of personnel (e.g., veterinarians and breeders) who work with non-human primates.

Collaboration with national and international research teams
- We conduct collaborative studies in various fields, including xenotransplantation and the pharmacokinetic evaluation of therapeutic drugs against aplastic anemia. We are currently collaborating with world-renowned researchers in embryo implantation and development.

SELECTED PUBLICATIONS

Establishment and characterization of immortalized minipig neural stem cell line.
Cell Transplant. 26(2):271-281.
Seung-Bin Yoon and Sang-Rae Lee (Co-first)

Superovulatory responses in cynomolgus monkeys (Macaca fascicularis) depend on the interaction between donor status and superovulation method used.
J Reprod Dev. 63(2):149-155.
Ji-Su Kim and Seung-Bin Yoon (Co-first)

FUTURISTIC ANIMAL RESOURCE & RESEARCH CENTER

The FARRC was established to contribute to the vitalization of future bio-industries in areas such as new bio-drug discovery, xenotransplantation and regenerative medicine, and the settlement of national/social issues, such as artificial blood and foot-and-mouth disease. It achieves this through the development of a research support system able to be utilized across government ministries based on national mini-pig infrastructure that combines the world's best resources, materials, technologies, instruments, facilities and specialists.

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INVESTIGATORS

Sun-Uk Kim sunuk@kribb.re.kr
- Establishment of developmental biotechnology and regenerative medicine in mini-pigs
- Development and derivation of research resources from mini-pigs
- Establishment of phenotyping system in mini-pigs

Bong-Seok Song sbs6401@kribb.re.kr
- Establishment of developmental biotechnology for generation of transgenic mini-pigs
- Production of early porcine embryos with high developmental competence

Young-Ho Park pyh2877@kribb.re.kr
- Development of vector system for transgenesis in mini-pigs
- Establishment of molecular phenotyping system in mini-pigs

Bo-Woong Sim embryont@kribb.re.kr
- Establishment of micromanipulation system for generation of transgenic mini-pigs
- Development of advanced cloning technology in mini-pigs

Kyung-Seob Lim dvmlim96@kribb.re.kr
- Veterinary clinical diagnosis and care for large-medium experimental animals
- General surgery of large-medium experimental animals
- Support for veterinary services and preclinical testing for biomedical research using large-medium experimental animals

Phil-Yong Kang gt1300@kribb.re.kr
- Reproduction and maintenance of SPF mini-pigs

RESEARCH AREAS

Obtainment and standardization of specific pathogen free (SPF) mini-pig resources
- Obtainment of mini-pig resources and development of new breeds
- Standardization of mini-pig resources by SPF/health monitoring

Supply of mini-pig resources/materials/techniques/information
- Development and support for transgenesis techniques in minipigs
- Generation and support for transgenic/cloned mini-pigs
- Generation and support for induced/transgenic disease models from mini-pigs
- Development and support for mini-pig research resources, including tissues, cells, blood, nucleic acid, etc.

Industrial-academical-institutional support
- Basic biomedical research: Neuroscience, Genomics, Bioinformatics, Developmental biotechnology, etc.
- Advanced biotechnology: New Bio-drug discovery, Xenotransplantation, Stem cell medication, Regenerative medicine, etc.
- National/social Issues: Nation-wide infectious diseases, Bioterror, Chronic incurable diseases, etc.

Establishment of research need-customizing/leading infrastructure
- Establishment of user-customizing infrastructure by on/off-line research needs analysis
- Establishment of user-leading infrastructure by expected future research fields.

ACHIEVEMENTS

Reproduction and maintenance of SPF mini-pigs
- Our center has obtained mini-pigs by breeding and maintenance under a stable SPF environment.

Derivation of research resources from SPF mini-pigs
- To support the industrial-academical-institutional research demands and to establish the somatic cell nuclear transfer method, somatic cell lines were established from a variety of mini-pig tissues.

Establishment of transgenesis/cloning system in mini-pigs
- Transgenic mini-pigs were successfully generated by production of cloned embryos, embryo transfer into foster mothers, delivery by cesarian section and artificial nursing, indicating the successful establishment of an overall transgenesis/cloning system in mini-pigs.

SELECTED PUBLICATIONS

Abnormal gene expression in regular and aggregated somatic cell nuclear transfer placentas.
BMC Biotechnol. 17(1):34.
Bo-Woong Sim (First)

Ganglioside GM3 induces cumulus cell apoptosis through inhibition of epidermal growth factor receptor-mediated PI3K/AKT signaling pathways during *In vitro* maturation of pig oocytes.
Mol Reprod Dev. 84(8):702-711.
Sun-Uk Kim (Co-corresponding)

INTERNATIONAL BIOLOGICAL MATERIAL RESEARCH CENTER

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

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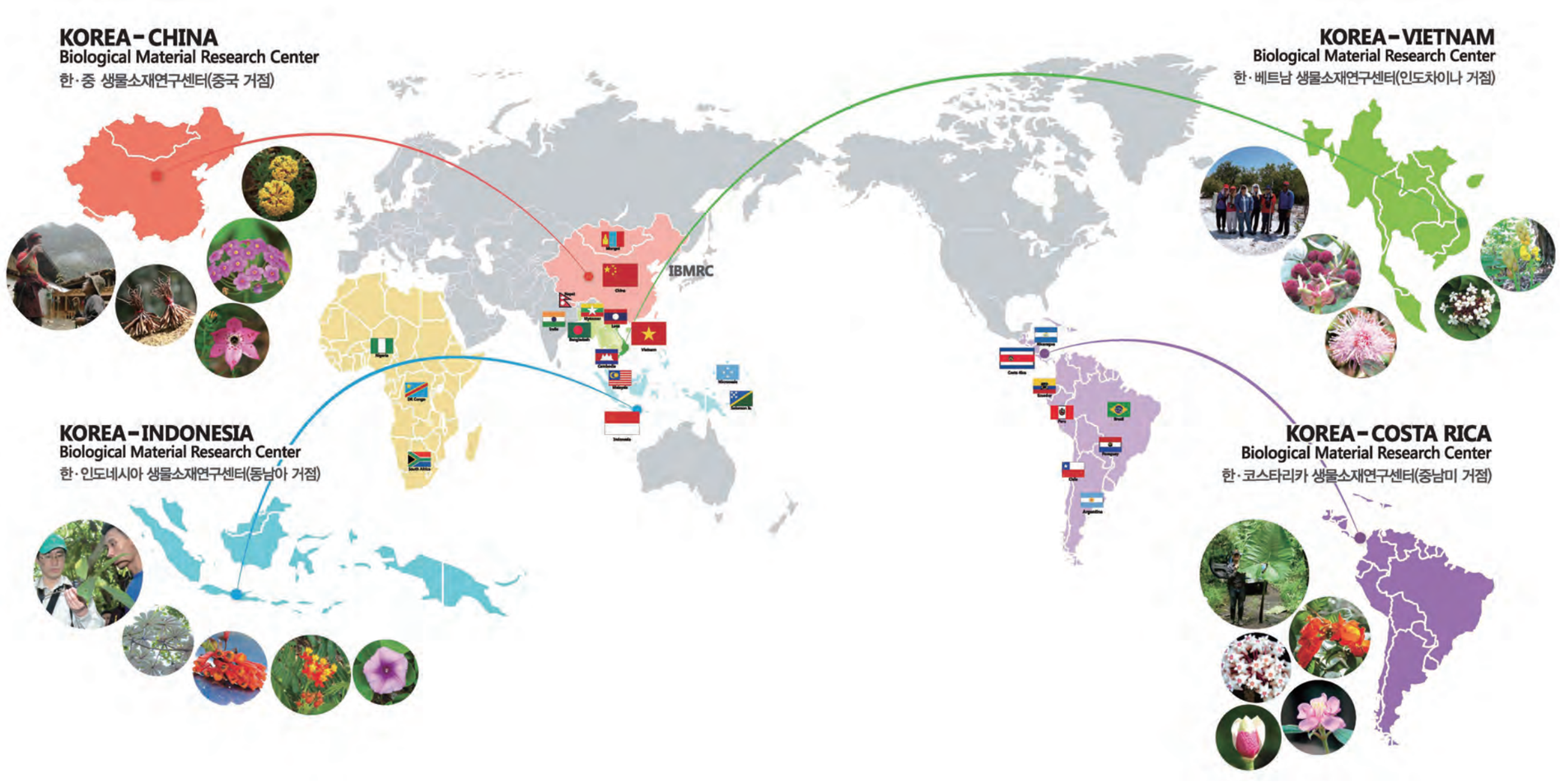

INVESTIGATORS

Sangho Choi decoy0@kribb.re.kr
- Biodiversity, Environmental Science

Sangwoo Lee ethnolee@kribb.re.kr
- Ethnobotany, Biodiversity

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- Plant Taxonomy, Biodiversity

Soo-Yong Kim soodole@kribb.re.kr
- Plant Molecular Biology

Sangmi Eum eomsm@kribb.re.kr
- Plant Taxonomy, Biodiversity

Dong-Keun Yi lydian78@kribb.re.kr
- Plant Systematics, Bioinformatics, Biodiversity

Seung-Hyun Cho shcho@kribb.re.kr
- Plant Taxonomy, Biodiversity

Mijin Park mjpark@kribb.re.kr
- Management of Four Regional Research Centers and extract supply

RESEARCH AREAS

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

ACHIEVEMENTS

Establishment and operation of the International Biological Material Research Center (IBMRC)

IBMRC was established in 2006 by the Korean government as an infrastructure to support biotechnology research in Korea. Through the operation of an open website, IBMRC is actively providing information and materials to industry, academia, and research institutes to support the creation of high-quality research results.
- Retained Biological Materials: 33,800 no.
- Deposits of voucher specimens: 100,000 herbarium specimens
- Distribution of plant extracts: 337,000 no. (2017)

Operation and management of four collaborative biological material research centers
- Korea-China Biological Material Research Center (Kunming)
- Korea-Costa Rica Biological Material Research Center (Heredia)
- Korea-Indonesia Biological Material Research Center (Tangerang)
- Korea-Vietnam Biological Material Research Center (Hanoi)

Establishment and operation of massive sample supply system
- *Pistacia weinmannifoli*amassive cultivation farm (Kunming, China)
- *Diospyros blanco*imassive cultivation farm open (Guacimo, Costa Rica)

International collaborative research
- Status of International Partnership (2017): 15 countries, 17 Institutions

Exchange program
- Host 'A Symposium for the Promotion of International Biological Material's Utilization' (6th April 2017, KRIBB) 100 participants from industry, academia and research institutes including 8 scientists from China, Costa Rica, Indonesia and Vietnam

Books and Reports
- Herbal Plants of Bangladesh
- Policy study report on utilization of overseas biomaterials

SELECTED PUBLICATIONS

***Capparis dongvanensis* sp. nov. (Capparaceae) from Vietnam.**
Nord J Bot. 35(3):272-275.
Sangmi Eum (Corresponding)

***Impatiens bokorensis* (Balsaminaceae), a new species from Cambodia.**
PhytoKeys. (77):33-39.
Seong-Hyun Cho (First)

ABS RESEARCH SUPPORT CENTER

As an executive office of a competent national authority for biological resources management, ABS Research Support Center plays a main role in the project of comprehensive services for Access to genetic resources and Benefit-Sharing(ABS) rules under the supervision of the Ministry of Science and ICT. ABS Research Support Center also operates the 'ABS Help-Desk' to provide valuable information on ABS issues and 'Advanced bioResource Information System(ARIS)' for convenient utilization of biological resources and information. The other primary responsibility is managing three committees with institutional authority in terms of legal regulations on biosafety; Institutional Review Board(IRB), Institutional Animal Care and Use Committee(IACUC) and Institutional Biosafety Committee(IBC).

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INVESTIGATORS

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- Management of ABS Research Support Center
- Operation of ABS Help-Desk
- Research on laws, regulations and current international trends on ABS agenda

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- Operation of ABS Help-Desk
- Research on laws, regulations and current international trends on ABS agenda

Han Chul Lee hanchul@kribb.re.kr
- Operation of IRB, IACUC, and IBC

A Rum Cheon arum415@kribb.re.kr
- Institutional operations for bio-safety and bio-security

RESEARCH AREAS

Project on comprehensive services for ABS agenda
- Researching laws, regulations and current international trends on ABS
- Capacity building and raising awareness through international conferences and presentations
- Consulting on access to and utilization of domestic and foreign genetic resources

ACHIEVEMENTS

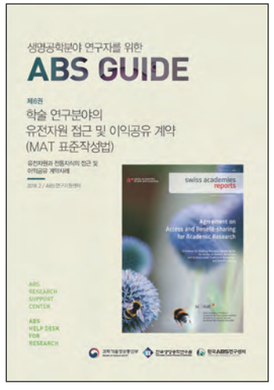
Capacity building and raising public awareness for ABS
- Publication and distribute of ABS newsletter; ABS Brief (monthly)
- ABS guidebook 6th. MAT on access and benefit-sharing for academic research ('18.2)
- ABS guidebook 7th. National ABS Regulatory Frameworks in Viet Nam and Central America ('18.2)

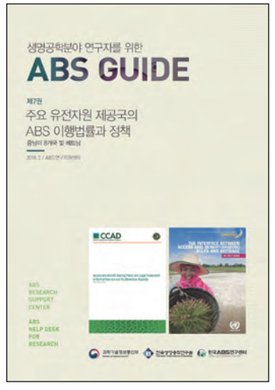
Management of institutional IRB, IACUC, and IBC

SELECTED PUBLICATIONS

Description of *Absiella argi* gen. nov., sp. nov., and transfer of *Eubacterium dolichum* and *Eubacterium tortuosum* to the genus *Absiella* as *Absiella dolichum* comb. nov. and *Absiella tortuosum* comb. nov.
Anaerobe. 48:70-75.
Young Hyo Chang (Corresponding)

***Bacteroides koreensis* sp. nov. and *Bacteroides kribbi* sp. nov., two new members of the genus *Bacteroides*.**
Int J Syst Evol Microbiol. 67(11):4352-4357.
Young Hyo Chang (Corresponding)





JEONBUK BRANCH INSTITUTE

- Natural Product Research Center
- Immunoregulatory Materials Research Center
- Microbial Biotechnology Research Center

Jeonbuk Branch Institute was established with the core objective of developing functional materials through the application of biotechnology techniques, such as the development of functional materials, mass production of biomaterials, metabolic engineering, and bioprocess engineering. Finally, our goal is to industrialize these biomaterials for applications in energy, food, agriculture, livestock, marine, and the environment.

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NATURAL PRODUCT RESEARCH CENTER

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

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INVESTIGATORS

Young Bae Ryu ybryu@kribb.re.kr
- Isolation and structural identification of bioactive compounds from natural products
- Performance of metabolite profiling and analysis
- Disease target enzyme inhibition and kinetic study

Woo Song Lee wslee@kribb.re.kr
- Identification of infection related target molecules and establishment of screening systems for infectious diseases
- Isolation and structure elucidation of bioactive compounds

Su-Jin Park sjpark@kribb.re.kr
- Development of active biomaterials by studies of in vitro and in vivo antiviral activity and action mechanisms
- Molecular genetic analysis and pathogenesis of viruses causing enteritis & pneumonia (Coronavirus, Rotavirus, Influenza virus, etc.) in cows, pigs and poultry
- Histopathologic, immunohistochemical, and electromicroscope studies

Hyung-Jun Kwon hjkwon@kribb.re.kr
- Animal model establishment and research using animal disease model
- Development of anti-virus drug to cure veterinary viral infectious diseases and antiviral study
- Development of active biomaterials via studies on in vitro and in vivo antiviral activity and action mechanisms

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- Establishment of a library and securing bio-materials through the establishment of an effective search system for bioactive substances
- Purification of bioactive substances from natural materials

In-Chul Lee leeic@kribb.re.kr
- Development of animal models for viral/bacterial diseases and evaluation of in vivo efficacy using infectious models
- Evaluation of the general toxicity of natural biomaterials or bioactive substances
- Evaluation of the efficacy of active biomaterials using animal models for human diseases (metabolic syndrome and inflammatory diseases)

RESEARCH AREAS

Construction of a natural product fraction library
- Construction and utilization of both fractions from plant and microbial culture extracts and a natural compound library.
- Isolation and identification of bioactive compounds from natural resource extracts.
- Performance of quantitative and qualitative analysis of components from natural resources.
- The role of LC-MS in metabolism and pharmacokinetic studies of natural products.

Construction of a bioassay system related to infectious and immune diseases
- Establishment of a bioassay and screening system for such compounds against infectious diseases (virus and bacteria).
- Establishment of a bioassay and screening system searching biomaterials or compounds which have a therapeutic effect against pathogen mediated-inflammatory and immune diseases.
- Development of active compounds or materials inhibiting inflammatory- or immune-mediated responses and improving the disturbance of immune functions.
- Development of active compounds or materials which have a therapeutic effect against aging- and metabolism-related diseases.

Development of mass-production technologies for useful biological compounds and research into practical technologies via field applications
- Development of mass-production technologies for useful biological compounds using pilot plants.
- Development of technologies for field applications and the commercialization of useful compounds.

Animal model establishment and research using animal disease model
- Development of animal models for viral/bacterial diseases and evaluation of in vivo efficacy using infectious models
- Animal model-based research for treatment of respiratory and gastrointestinal disease

ACHIEVEMENTS

Evaluation of Natural product for use thereof

Natural products are chemical compounds or substances isolated from living organisms. The chemistry of natural products includes their biosynthesis, extraction, identification, quantification, structural elucidation, physical and chemical properties and reaction. They are produced via the pathway of primary or secondary metabolism. Plant secondary metabolites can be found in the leaves, stem, root or bark of a plant depending on the type of secondary metabolite that is being produced. The most bioactive secondary metabolites are alkaloids, tannins, flavonoids and phenolic compounds. The study of these natural products has played a major part in the development of medicinal chemistry and functional foods/cosmetics and we are now starting to understand the important application role that these compounds/extracts have.
- Isolation of secondary metabolites in natural products chemistry.
- Chemical and spectroscopic strategies in structure elucidation (UV, IR and NMR)
- A Performance of quantitative/qualitative analysis by HPLC and an ultra performance liquid chromatography-high-resolution tandem mass spectrometric method (UPLC-HRMS-MS/MS), which was developed for the standardization of secondary metabolites in extracts.
- Also, we have built a natural product fraction library, and are collecting plant resources and utilizing both plant extracts through open column chromatography and a natural products library.

Identification of new molecular targets related to infectious diseases

By conducting research into molecular targets such as proteomics and genomics, new target candidates for viral infectious diseases have been identified. We have established assay and screening systems for viral diseases.

In vitro and in vivo antiviral evaluations

We have identified methods of culture and quantitative titration for several viruses including the influenza virus, porcine reproductive and respiratory syndrome virus, rotavirus, coronavirus, rhinovirus, and enterovirus; and we are developing new active biomaterials and immune-therapies against viruses by investigating mechanisms of action, in vitro antiviral assays and in vivo animal models based on virology.

Identification of biomaterials against inflammatory diseases

Development and utilization of cell-based screening system for new active substrates with anti-inflammatory activity:
- Screening system for inhibitor of NF-kB signaling.
- Screening system for inhibitor of JNK/AP-1 signaling.
- Screening system for inhibitor of COX-2/PGE2.

Identification of biological targets and pharmacological properties:
- Development of active compounds showing anti-inflammatory activity through inhibition of NF-kB signaling, JNK/AP-1 signaling, and TLRs.
- Development of active compounds showing inhibitory effects on human disease-related enzymes (such as alpha-glucosidase, tyrosinase, etc.)
- Development of active compounds showing anti-oxidative activity through scavenging highly reactive oxygen radicals and elevating intrinsic anti-oxidants.
- Development of active compounds showing inhibitory effects on pathogen-related enzymes related to internalization, replication, and release (such as 3CLSP, neuraminidase, helicase, etc.)

SELECTED PUBLICATIONS

Sialidase inhibitory activity of diarylnonanoid and neolignan compounds extracted from the seeds of *Myristica fragrans*.
Bioorg Med Chem Lett. 27(14):3060-3064.
Woo Song Lee and Young Bae Ryu (Co-corresponding)

Protective effect and mechanism of action of diallyl disulfide against acetaminophen-induced acute hepatotoxicity.
Food Chem Toxicol. 109(1):28-37.
In-Chul Lee (Co-corresponding)

Evaluation of polyphenols from *Broussonetia papyrifera* as coronavirus protease inhibitors.
J Enzyme Inhib Med Chem. 32(1):504-512.
Woo Song Lee and Young Bae Ryu (Co-corresponding)

IMMUNOREGULATORY MATERIALS RESEARCH CENTER

Our research goal is to develop natural biomaterials that possess a broad range of biological elements that combat inflammatory and immune-mediated diseases in human beings or livestock, as well as infectious inflammatory responses and immunological synapses. These biomaterials will be derived from natural resources (plants, microorganisms, and marine sources).

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INVESTIGATORS

Mun-Chual Rho rho-m@kribb.re.kr
- Isolation of active fractions or compounds from natural products such as plants and microbes and the identification of structures for active compounds
- Identification of new target molecules related to several immune diseases and the establishment of a screening system to develop biomaterials or compounds that combat inflammation and several immune diseases

Seung Woong Lee lswdoc@kribb.re.kr
- Activity-guided isolation of bioactive constituents from natural products
- Chemical structure determination of natural products

Soyoung Lee sylee@kribb.re.kr
- Evaluation of efficacy and immunotoxicity of nature products and underlying mechanisms
- Development of animal models for immune diseases (Inflammatory Bowel Disease, hypersensitivity, allergic inflammation)

Seung-Jae Lee seung99@kribb.re.kr
- Development of functional material including animals and plants from natural products
- Evaluation of inflammatory diseases using in vitro screening system

Kyungsook Jung jungks@kribb.re.kr
- Therapeutic mechanism of the active materials and compounds in experimental animal models for immune diseases

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- Microorganism screening, sequencing and application

RESEARCH AREAS

Construction of a bioassay system related to immune diseases
- Establishment of a bioassay and screening system seeking biomaterials or compounds which have a therapeutic effect against immune diseases including infectious and inflammatory diseases.
- Development of active compounds such as inhibitors of cell adhesion molecules, inflammatory cytokine and chemokine.
- Development of active materials or compounds regulating the innate immune system including the Toll-like receptor family.
- Development of active materials or compounds that boost immunity, such as the Type I interferon family.

Development of mass-production technologies for useful biological compounds and research into practical technologies via field applications
- Development of mass-production technologies for useful biological compounds using pilot plants.
- Development of technologies for field applications and the commercialization of useful compounds.

Construction of a natural product fraction library
- Construction and utilization of both fractions from plant and microbial culture extracts and a natural compound library.

ACHIEVEMENTS

Identification of biomaterials for modulating immune responses using in vitro and in vivo system

Development and utilization of cell-based screening system for new active substrates with anti-inflammatory activity:
- Screening system for inhibitors of cell adhesion molecules like VCAM-1/VLA-4 and sialic glycosaminoglycan/P-selectin.
- Screening system for the inhibitor of IL-6 signaling.
- Screening system for the inhibitors of Toll-like receptors.

Purification of active compounds from natural resources and determination of the structure of such compounds:
- Development of active compounds showing anti-inflammatory activity through inhibition of cell adhesion molecules, TLRs and IL-6 signaling.

Identification of biological targets and pharmacological properties:
- Norkurarinol showed anti-viral activity through activation of IRF-3, followed by IFN-beta induction.
- The anti-viral effect of KR-200 was demonstrated after coxsackievirus A21 infection:KR-200 inhibited NF-kB and AP-1 activation and inflammatory cytokine production induced by coxsackievirus A21 infection.
- KR-300 and the active compounds showed inhibition of IL-6 signaling.

Verification of in vivo anti-inflammatory activity:
- KR-200 and KR-300 inhibited expression of pro-inflammatory cytokines (IL-1beta, IL-6, and TNF-alpha) and mRNA of inflammatory genes in mice with inflammation.

Evaluation of therapeutic effect on several animal models for immune diseases
- KR-300 ameliorated atopic dermatitis, osteoarthritis, and rheumatic arthritis and inflammatory bowel disease (IBD).
- KR-600 inhibited bone loss in the ovariectomized osteoporosis mice model.

Natural product fraction library

We have built a natural product fraction library, and are collecting plant resources and utilizing both plant extracts through open column chromatography and a natural products library.

SELECTED PUBLICATIONS

Association between perfluorooctanoic acid exposure and degranulation of mast cells in allergic inflammation.
J Appl Toxicol. 37(5):554-562.
Soyoung Lee (Co-first)

Anti-inflammatory activity of eudesmane-type sesquiterpenoids from Salvia plebeia.
J Nat Prod. 80(10):2666-2676.
Mun-Chual Rho and Seung Woong Lee (Co-corresponding)

Effect of sunlight radiation on the growth and chemical constituents of Salvia plebeia R.Br.
Molecules. 22(8):1279.
Mun-Chual Rho and Seung Woong Lee (Co-corresponding)

Acyclic triterpenoids from *Alpinia katsumadai* inhibit IL-6-Induced STAT3 activation.
Molecules. 22(10):1611.
Mun-Chual Rho and Seung Woong Lee (Co-corresponding)

MICROBIAL BIOTECHNOLOGY RESEARCH CENTER

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

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INVESTIGATORS

Jae Jun Song jjsong@kribb.re.kr
- Development of platform technologies for massive screening and the commercialization of industrially valuable enzymes using the HTS system
- Development of the technology to prepare genomic library from single unculturable microorganisms sorted from nature

Jeong-Woo Seo jwseo@kribb.re.kr
- Development of microbial strains and bioprocess for integrated biorefinery
- Development of biotechnology for bio-oil production and utilization using microorganisms

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- Biorefinery and Bioenergy, Functional biomaterials, Bioprocess

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- Development of functional food ingredients using microbial strains

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- Development of platform technologies for screening useful enzymes/metabolic pathways using high throughput technology
- Development of the tool box applicable to white biotechnology based on synthetic biotechnology

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- Glycoengineering and glyco(bio)technology
- Development of sugar platform technologies using renewable bioresources

Baek Rock Oh baerkock.oh@kribb.re.kr
- Development of bioprocess engineering
- Biofuels and biochemicals production

Ji Young Kang jiyoka@kribb.re.kr
- Development of microbial strains for biorefinery and bioenergy

RESEARCH AREAS

Microbial metabolic engineering
- Production of microbial metabolites.
- Metabolic engineering of industrial microorganisms.

Bioconversion technology
- High throughput screening of novel biocatalysts.
- Directed evolution of industrial enzymes.
- Production of useful biomaterials by bioconversion.

Molecular bioprocess engineering
- Production of therapeutic recombinant proteins.
- Development of bio-refinery technologies.

ACHIEVEMENTS

Microbial strains and processes to produce chemicals

Microbial strains and processes optimized to produce valuable chemicals (1,3-propanediol, 2,3-butanediol, 3-hydroxypropionic acid and etc.) using crude glycerol derived from the biodiesel industry were developed through genetic and metabolic engineering. These can have applications as platform chemicals for eco-friendly biochemical industries such as bio-plastics, textiles and so on.

Production and utilization of microbial oil

Oleaginous heterotrophic microalgal strains to produce lipids containing functional substances such as poly-unsaturated fatty acids were isolated and the optimal process was developed. The microbial oil can be valuable as a feedstock source for biofuel, chemicals and active substances (drugs, food and feed ingredients).

Bioenergy

Lignocellulosic biomass is a renewable bioresource for second generation bioethanol production. These potential sugar resources, derived from various agricultural residuals, containing cellulose, hemicellulose, and lignin can be hydrolyzed or enzymatically degraded to sugars, and then be fermented to produce bioethanol. Also these sugar plat form technologies may be applied to various biorefinery processes to create an environmentally friendly process.

High-Throughput Screening System and Biotechnological Applications

We developed mass screening methods for various enzymes from metagenomic libraries using an HTS system based on robots. We were able to screen new enzymes such as cellobiohydrolases, glycosyltransferases, BVMO, cold-adapted esterase and deoxyribose 5-phosphate aldolase(DERA) based on fluorescence intensity.

These new strategies, combined with the HTS system, were able to screen various new enzymes faster, and with greater sensitivity and ease than previously reported screening methods. This approach may be applied to other useful enzymes and metabolic pathway screenings from metagenomic resources.

Screening enzyme from single cell based polymerase Fosmid cloning

A new method was developed for the enrichment of minor bacteria from environmental samples. And single cell based fosmid libraries were generated from these minor bacterial pools. This method is based on Fluorescence in situ hybridization (FISH), Fluorescence associated cell sorter (FACS), and Multiple displacement amplification (MDA). We have demonstrated enrichment of minor bacteria from an artificial microbial community and single cell based MDA followed by fosmid library construction for activity screening.

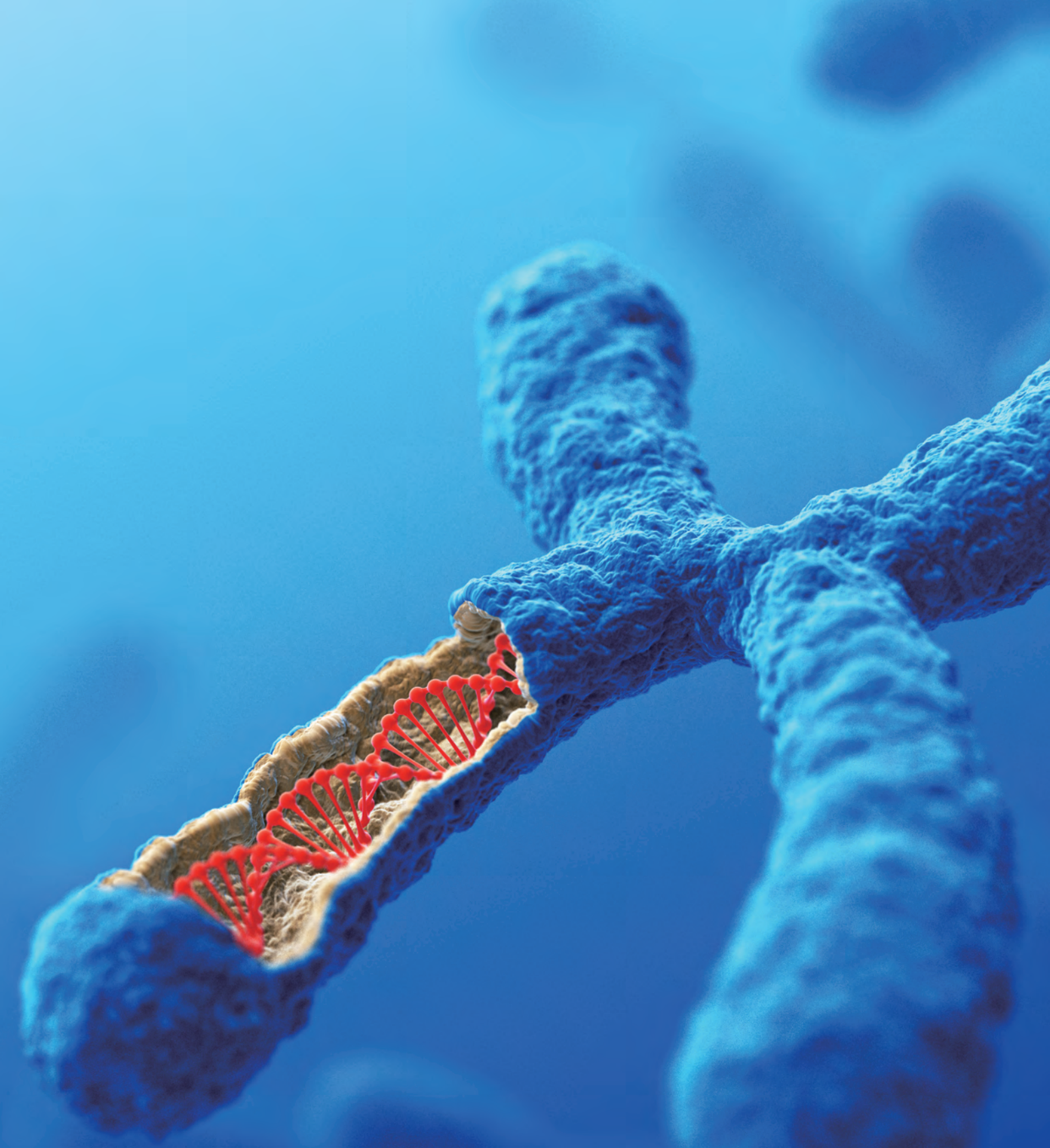
SELECTED PUBLICATIONS

***Gemmobacter straminiformis* sp. Nov., isolated from an artificial fountain.**
Int J Syst Evol Microbiol. 67(12):5019-5025.
Ji Young Kang (First)

Enhancement of 2,3-butanediol production from Jerusalem artichoke tuber extract by a recombinant Bacillus sp. strain BRC1 with increased inulinase activity.
J Ind Microbiol Biotechnol. 44(7):1107-1113.
Chul Ho Kim (Co-corresponding)

APPENDIX

- SOCIAL CONTRIBUTION
- DONATION FOR EDUCATION
- OUTSTANDING RESEARCH ACHIEVEMENTS
- INVESTIGATOR INDEX



SOCIAL CONTRIBUTION

The KRIBB will spare no effort to create a better world where all people live a happy life under the notion that it values the human the most.
It has been doing its best to create a healthier and happier society where a culture of sharing blooms between people by implementing social contribution activities. The sharing culture is our solemn responsibility and the noblest thing we should fulfill in our daily lives.
The KRIBB promises to become an institute together with neighbors by devoting itself to making all people healthy and happy and to embracing socially excluded or marginalized people with love.

DONATION FOR EDUCATION

We specifically focus on educating and nurturing the growing children. The KIRBB will be committed to fostering an environment where all gifted and talented students can have equal opportunity to fulfill their potential regardless of where they come from through "donation for education" which is a creative culture of sharing.

The KRIBB has actively conducted and participated in donation activities for education to realize science and technology in daily lives and to create an environment where people get more familiar with science and technology. It was designated as the certified organization of donation for education from KOFAC(Korea Foundation for the Advancement of Science and Creativity) in 2012, and has provided a variety of information on biotechnology to teachers and students through a wide range of donation activities for education.

OUTSTANDING RESEARCH ACHIEVEMENTS

Development and technology transfer of candidate compounds for treatment of Alzheimer's disease

Sungchan Cho [Feb. 2017]

Two classes of candidate compound for treatment of Alzheimer's disease were discovered from a new approach targeting DYRK1A kinase, which has been closely associated with onset of Alzheimer's disease. The candidate compounds and their related technologies were successfully transferred to a Korean pharmaceutical company because of a distinctive strategy based on a new molecular target, superior efficacy, and potential applicability to other diseases (Down syndrome, diabetes, and malignant tumors).

Development of bio electronic sensor based on protein for new drug screening

Oh Seok Kwon [ACS Nano, Jun. 2017]

A joint research team composed of KRIBB and Seoul National University successfully developed conducive nanotube based new bio electronic sensor that combines protein (dopamine receptor).

The research explored new methods through nano bio convergence technology. New bio electronic sensor that would existing cell-based new drug screening analysis methods was developed utilizing protein (dopamine receptor) mass production and high purity separation and refining technology as well as nano-hybrid manufacturing original technology.

Standardization of protocol visualizing smell of bacteria

Choong-Min Ryu [Nature Protocols, Jun. 2017]

Smell of bacteria, which is one of the representative bad odor, has been recognized as an important signal material of interaction among same kind/ and different kind bacteria but research method has not been systematic. To overcome this problem, a team led by domestic researchers and composed of scientists from the US, France and Egypt has completed a standardized protocol.

The research team also provided various methods for using bacteria odor. The bacteria odor makes plants grow well, opening the possibility of using it as invisible gas fertilizer. In addition, it can be developed into a gas antibiotics based on the study result that shows the odor deters the growth of pathogen.

Development of new algorithm measuring the completeness of artificial liver organoid

Hyun-Soo Cho [Hepatology, Jun. 2017]

A research team made of domestic researchers developed quantitative prediction algorithm to evaluate the differentiation level of human hepatocyte. It is expected that the development of well-differentiated liver organoid will be accelerated by evaluating the differentiation level of 3D liver organoid made from various human cells.

Identification of new protein function activating the harmful protein dissolution in the cell

Bo Yeon Kim [Nature Communications, Jul. 2017]

A domestic research team and research team from University of Pittsburgh presented a new way for the treatment of cancer, neurodegenerative diseases and cardiovascular diseases by identifying a new mechanism to activate protein dissolution.

this study found that if the proteasome path is blocked or protein aggregate is accumulated, the autophagy path is activated through p62 protein to dissolve waste protein. Therefore, the study can be applied to the development of treatment for aging and metabolism related diseases including cancer as it is possible to activate the processing of protein aggregates accumulated in the cell by controlling p62 and relevant proteins.

Identification of new micro RNA controlling the differentiation of immune cells in bowels

Inpyo Choi, Tae-Don Kim [JACI, Aug. 2017]

The research team identified micro RNA called miR-150 which influence the expression of protein of TGF- β receptor II, that is signal transmission medium for IEL cell differentiation and found that miR-150 plays an important role in IEL cell differentiation.

It is expected that the discovery will contribute to the development of immunotherapy for bowel diseases by controlling differentiation of IEL cell which is known to have close relationship with immune system in bowel inflammatory diseases.

Development of 3D in-vitro liver cancer model similar to human liver cancer

Cho Rok Jung, Jung Hwa Lim [Scientific Reports, Sep. 2017]

Korea Research Institute of Bioscience & Biotechnology research team successfully produce in-vitro liver cancer model which is more similar to human liver cancer. It is the development of spheroid forming unit similar to human liver cancer. In addition, the team successfully achieved result more similar to human liver cancer model than existing 2D cultivation by using the technology in the evaluation of efficacy of carcinostatis substance.

Identification of gene function causing autism

Jeong-Soo Lee [Molecular Autism, Sep. 2017]

A research group composed of researchers from Korea Research Institute of Bioscience & Biotechnology (KRIBB), Chungnam National University and Augusta University, US verified that DYRK1A gene, which has been known as the gene that causes Down syndrome, also causes autism utilizing zebrafish animal model for the first time.

The research team developed a simple and rapid new verification method to measure sociality, which is key to ASD research by producing knock-out mutant of zebrafish against DYRK1A utilizing gene scissor technology and utilizing behavior of fish (shoaling). By using the model, the team verified that the sociality of individuals becomes lowered significantly if the DYRK1A function is harmed and relevant gene expression in the neuron system was changed.

Development of multivalent protein based optical sensor enabling detection of genes with high sensitivity

Taejoon Kang [Angewandte Chemie International Edition, Oct. 2017]

Domestic researchers successfully synthesize multivalent protein that combines double stranded genes selectively and apply it to wire nano wire optical sensor to detect genes with high sensitivity.

The research team synthesized multivalent protein which combines with double stranded genes selectively for the first time through protein engineering process and found that the protein has very high coherence with double stranded genes. However, the team found problems of detecting genes as non-specific coherence with single stranded genes increases. To solve this problem, the research team developed optimized multivalent protein which is combined with target genes specifically and does not combine with non-target genes by adjusting surface electric charge of multivalent protein developed.

A new compound with chemical structure and antibacterial activity that deters cancer metastasis

Jong Seog Ahn [Journal of Natural Products, Nov. 2017]

Anti-cancer Agent Research Center of the Korea Research Institute of Bioscience & Biotechnology successfully found new microbial metabolites called Ulleungamide A, B, ulleunmycin A, B, and Ulleungoside which have new chemical structure and have anti-cancer and antibacterial activity characteristics that have not known in the natural system from native antinomyctes in Uleungdo soil.

Identification of the mechanism of apoptosis gene resistant to cancer treatment

Mi Sun Won [Oncogene, Dec. 2017]

Identified the mechanism of deterring apoptosis by new lung cancer treatment target gene (DDIAS) which is involved in the resistance to cancer treatment.

The research team, which has developed proprietary technology by identifying DDIAS as cancer treatment target genes, presented new mechanism of extrinsic apoptosis through identification of DDIAS functions to deter extrinsic apoptosis.

The research team presented DDIAS as a way to overcome resistance to TRAIL (Tumor necrosis factor-related apoptosis-inducing ligand) which is grabbing the attention as the next generation anti-cancer drugs.

INVESTIGATOR INDEX

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