

CENTER FOR COGNITION AND SOCIALITY

COGNITIVE GLIOSCIENCE GROUP
BRAIN IMAGING AND CONTROL GROUP
SOCIAL NEUROSCIENCE GROUP



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INSTITUTE FOR BASIC SCIENCE (IBS)

IBS is a national research institute in the Republic of Korea, which was established in 2011 to conduct world-class basic science research. Currently, 33 research centers are being operated in mathematics, physics, chemistry, life science, earth science, and interdisciplinary fields. Up to 50 research centers are planned to be operational in the future according to the government plan. IBS ranked 17th among government research institutes in the world, according to the Nature Index 2020 rankings. IBS is continuing to patronize innovative research activities by supporting excellent teams of prominent researchers with state-of-the-art facilities and a research-friendly environment.



**GLIA-NEURON
INTERACTION**



**BEYOND YOUR
IMAGINATION**



DIRECTOR'S GREETING



What we call the mind is enabled by the brain. The construction of the mind by the brain is what we want to understand. How consciousness is controlled, how we learn and remember things and events, how emotions are controlled, how we make decisions when needed; these are among the questions we pursue. We particularly address these question in the context of social behavior; this is where the name Center for Cognition and Sociality comes from.

The neurocentric approach has deterred us from discovering effective treatments for psychiatric as well as neurological diseases, including neurodegenerative diseases (Alzheimer's disease, Parkinson's disease, Huntington's disease etc), traumatic brain

injuries, depression, and post traumatic stress disorders (PTSD). Hence, we aim to identify the role of glial cells, an imperative and unexplored area of brain science that has not received much attention so far.

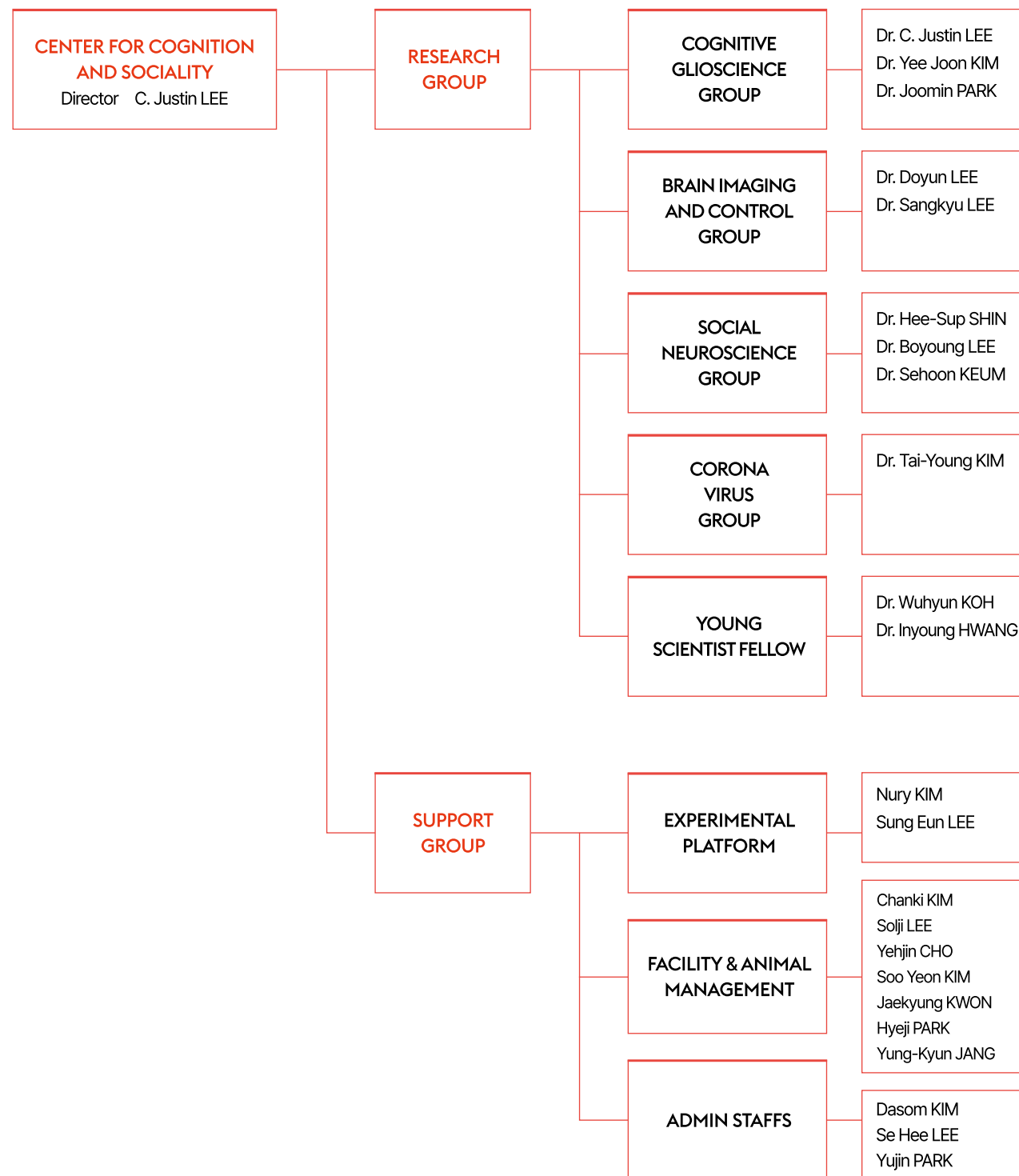
Another important aim of our Center is to help young brain scientists to grow to their fullest capacity. In the long run, we believe, accomplishing this aim will be the most rewarding experience for our Center. We will try to make our Center a place where many renowned brain scientists can later point to as the place their careers truly start.

Director
C. Justin LEE

HISTORY

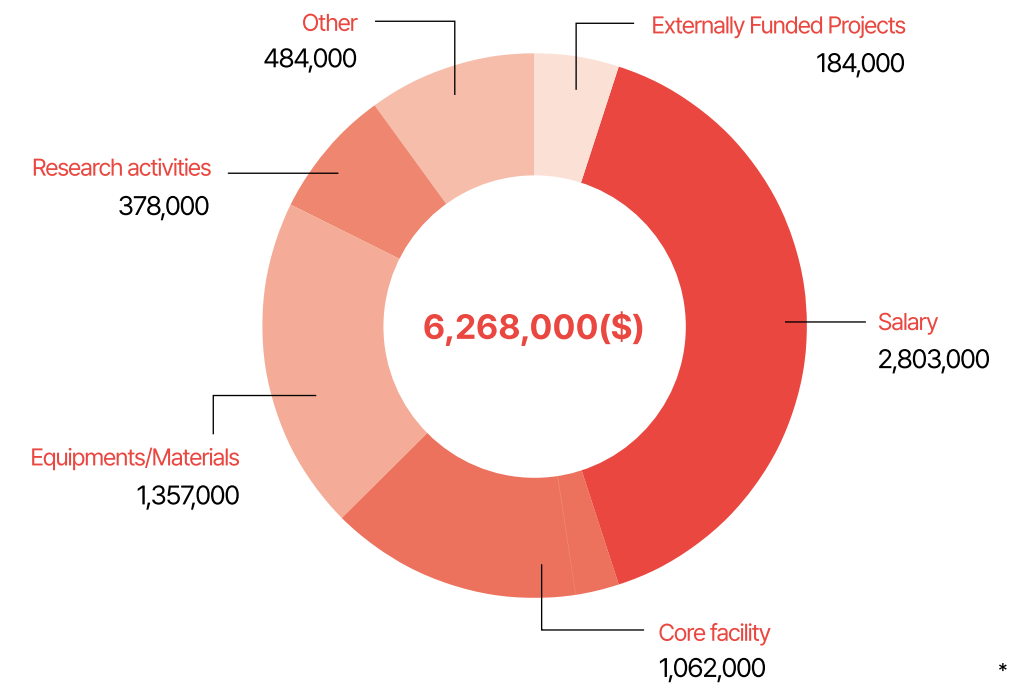


ORGANIZATION

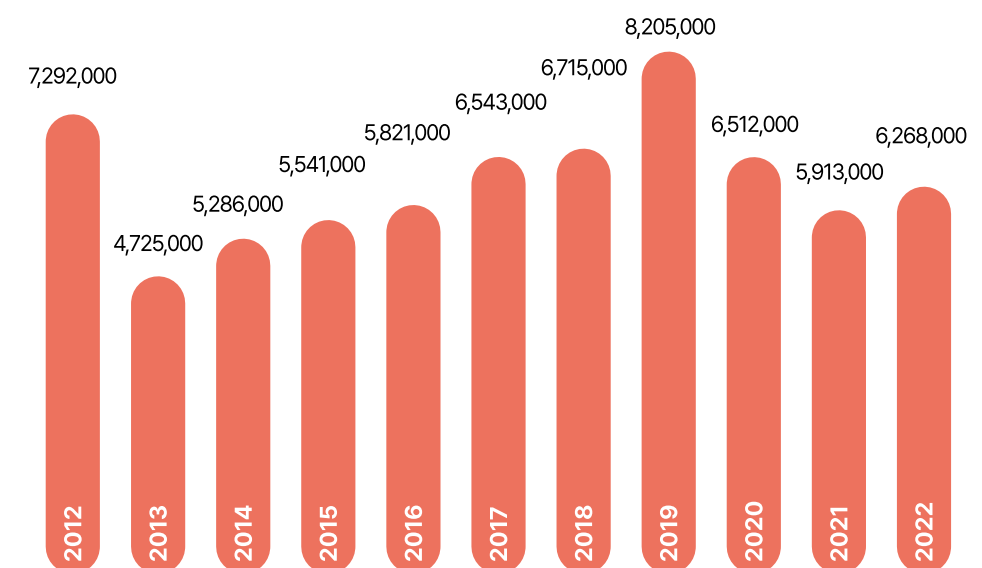


BUDGET

(as of 2022)

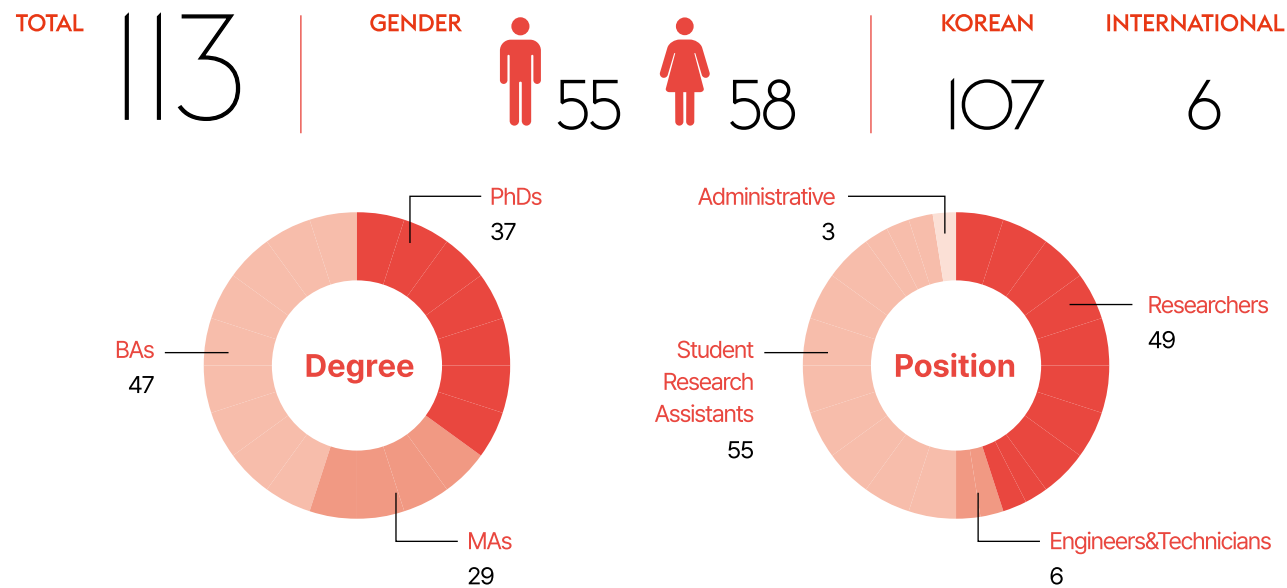


ANNUAL BUDGET



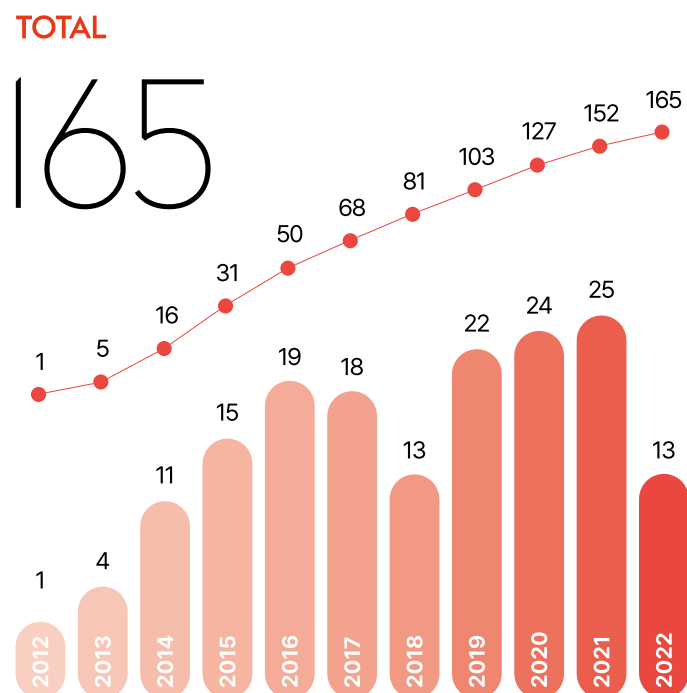
PERSONNEL

(2022. 8)

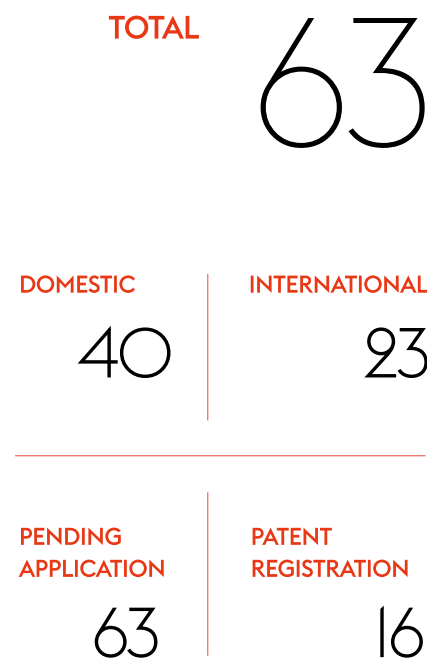


PUBLICATIONS

(2012~2022. 7)



PATENTS



COLLABORATIONS

MAP OF PARTNERS



DOMESTIC

- | | | |
|--|--|---|
| ① Catholic Univ. of Korea | ⑧ Inje Univ. | ⑮ Mokpo Univ. |
| ② Cha medical group | ⑨ KAIST Korea Advanced Institute of Science and Technology | ⑯ POSTECH Pohang University of Science and Technology |
| ③ Chungnam Nat'l Univ. | ⑩ KBRI Korea Brain Research Institute | ⑰ SNUH Seoul Univ. Bundang Hospital |
| ④ Dankook Univ. | ⑪ KIST Korea Institute of Science and Technology | ⑱ Soonchunhyang Univ. |
| ⑤ Ewha Womans Univ. | ⑫ Korea Univ. | ⑲ Sungkyunkwan Univ. |
| ⑥ GIST Gwangju Institute of Science and Technology | ⑬ Kyunghee Univ. | ⑳ Yonsei Univ. |
| ⑦ Hanyang Univ. | ⑭ kyungpook Univ. | |

INTERNATIONAL

- | | | |
|---------------------------------|----------------------------------|---|
| ① Australian National Univ. | ⑧ University of Southern Denmark | ⑮ MIT Massachusetts Institute of Technology |
| ② Chinese Academy of Sciences | ⑨ University of Tübingen | ⑯ Mayo Clinic |
| ③ Hungarian Academy of Sciences | ⑩ Emory Univ. School of Medicine | ⑰ New York Univ. |
| ④ Osaka Univ. | ⑪ Harvard Univ. | ⑱ Stanford Univ. |
| ⑤ Universite de Paris | ⑫ HHMI Janelia Research Campus | ⑲ Univ. of Alabama at Birmingham |
| ⑥ UCL University College London | ⑬ Johns Hopkins Medicine | ⑳ UCLA Univ. of California, Los Angeles |
| ⑦ University of Hong Kong | ⑭ Louisville Univ. | ㉑ Univ. of Toronto |



COGNITIVE GLIOSCIENCE GROUP

Cognitive Glioscience group has contributed to the field of gliotransmission by creating several seminal publications on the channel-mediated gamma-Aminobutyric acid (GABA) and glutamate release from astrocytes. They later identified the biosynthetic pathway for astrocyte GABA and found monoamine oxidase B to be the key enzyme for GABA production which raised the possibility that astrocytes can directly participate in cognitive processes via astrocytic GABA. The group also found a connection with GABA and H₂O₂ from reactive astrocytes and impaired memory in mouse models of Alzheimer's disease, leading them to propose astrocytic GABA- and H₂O₂-related pathways might be a diagnostic tool, biomarker, and therapeutic target for both neurological diseases Alzheimer's and Parkinson's. The research is notable as it revealed that astrocytes, like neurons, play a significant role in cognitive processes. The findings also resulted in a technology transfer to Neurobiogen which will be prepared for a phase I clinical trial in 2022. Thus, the group continues to investigate the cognitive functions of 1) GABA synthesis and release from glia, 2) molecular mechanisms of glutamate and d-serine release from glia, 3) astrocytic volume transient and brain plasticity, and 4) reactive astrogliosis and neurodegeneration.



BRIEF RESUME

2022	Managing Director, Institute for Life Sciences, IBS
2019	Director, Center for Cognition and Sociality, IBS
2017	Presidential Medal of Honor, Korea Science & Technology Development
2016	The Kyung Ahn Prize in Arts & Sciences
2014	The Korean Academy of Science and Technology, FILA Basic Science Award
2014	Jang Jin Award, Korean Society for Brain and Neuroscience
2013	Star Professor Award, The University of Science & Technology
2011	Scientist of the Year Award, KIST
2010	Outstanding Researcher Award, Prime Minister of Korea
2010	Scientist of the Month Award, Ministry of Science & Technology, Korea
2010	Scientist of the Month Award, KIST
2009	Outstanding Project Award, Outstanding Researcher Award, KIST
2009	Outstanding Teacher Award, The University of Science & Technology(UST)
2000, 2003	Outstanding Researcher Award, Association of Korean Neuroscientists(AKN)

RESEARCH TOPIC

1. GABA synthesis and release from glia
2. Molecular mechanisms of glutamate and d-serine release from glia
3. Astrocytic volume transient and brain plasticity
4. Reactive astrogliosis and neurodegeneration

Director

Chang
joon
Justin

LEE



RESEARCH INTERESTS

Astrocyte, Reactive astrocyte, Astrocyte-neuron interaction, GABA, Glutamate, D-serine, ATP release, Metabolism, Synaptic transmission and plasticity, Memory, Alzheimer's disease, Parkinson's disease, Spinal cord injury, Depression, PTSD

PUBLICATIONS

- Astrocytic urea cycle detoxifies A β -derived ammonia while impairing memory in Alzheimer's Disease, *Cell Metabolism*, 2022
- Astrocytes Render Memory Flexible by Releasing D-Serine and Regulating NMDA Receptor Tone in the Hippocampus, *Biol Psychiatry*, 2021
- Opto-vTrap, an optogenetic trap for reversible inhibition of vesicular release, synaptic transmission, and behavior, *Neuron*, 2021
- A nonsense TMEM43 variant leads to disruption of connexin-linked function and autosomal dominant auditory neuropathy spectrum disorder, *Proc Natl Acad Sci USA*, 2021
- Severe reactive astrocytes precipitate pathological hallmarks of Alzheimer's disease via H₂O₂-production, *Nature Neurosci*, 2020
- Astrocytes Control Sensory Acuity via Tonic Inhibition in the Thalamus, *Neuron*, 2020
- Aberrant Tonic Inhibition of Dopaminergic Neuronal Activity Causes Motor Symptoms in Animal Models of Parkinson's Disease, *Curr Biol*, 2020



RESEARCH TOPIC

Neural basis of perceptual awareness and statistical perception. We aim to better understand brain mechanisms of various perceptual, cognitive, and conscious processes by deploying multiple techniques ranging from behavioral methods such as psychophysics and eye tracking to brain imaging techniques such as ECoG, EEG, and MRI. We also use machine learning techniques and bio-inspired computational modeling to probe the spatiotemporal pattern dynamics of brain imaging data and develop a mechanistic model of consciousness.

RESEARCH INTERESTS

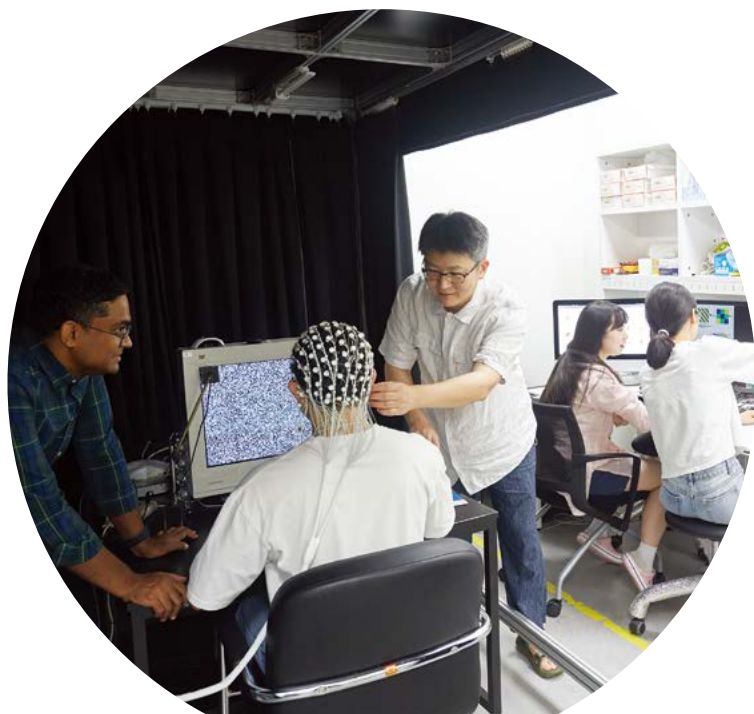
Cognitive neuroscience, Predictive coding, Statistical perception, Abstraction, General intelligence, Attention, Consciousness, Brain-imaging, Bio-inspired neural modeling

PUBLICATIONS

- Representational dynamics of sequential perceptual averaging, *Journal of Neuroscience*, 2022
- Induced astigmatism biases the orientation information represented in multivariate electroencephalogram activities, *Human Brain Mapping*, 2021
- Effect of spatiotemporally changing environment on serial dependence in ensemble representations, *Biorxiv*, 2021
- Ensemble representations reveal distinct neural coding of visual working memory, *Nature Communications*, 2019
- Attention to multiple objects facilitates their integration in prefrontal and parietal cortex, *Journal of Neuroscience*, 2017

BRIEF RESUME

- 2020 – present Associate professor, University of Science and Technology
- 2014 – present Research Fellow, IBS
- 2010 – 2014 Postdoc, Smith-Kettlewell Eye Research Institute, San Francisco, USA
- 2008 – 2010 Postdoc, Center for Neural Science, NYU, USA
- 2008 PhD in Brain, Behavior, and Cognition Program, Northwestern University, USA



BRIEF RESUME

[EDUCATION & PROFESSIONAL APPOINTMENTS]

- 2022 – present Adjunct Professor, IBS-UNIST Neuroscience program
- 2017 – present Professor, Basic Science, University of Science and Technology
- 2015 – present Research Fellow/Principal Investigator, IBS, Korea
- 2012 – 2015 Assistant Professor, Dept. Physiology, Jeju National University School of Medicine, Korea
- 2004 – 2012 Postdoctoral Fellow/Research Associate, Dept. Neuroscience, Johns Hopkins University School of Medicine, USA
- 2004 Ph.D. Dept. Physiology, Seoul National University College of Medicine, Korea

[HONORS AND AWARDS]

- 2014 – 2015 The distinguished Scientist Support program funded by Jeju National University

RESEARCH TOPIC

My current research interest centers upon the development of new non-invasive ultrasonic neuromodulation techniques for clinical translation and alternative approaches to treat neurological and psychiatric diseases. In addition, to address activity-dependent neural plasticity and synaptic dysfunction in the brain, we have performed multiple electrophysiology and behavioral assays such as whole-cell patch configuration, brainwave (EEG) recording, high resolution fluorescence microscopy, optogenetics, and behaviors modelling aspects of impaired sensorimotor gating

RESEARCH INTERESTS

Cognitive and behavioral neuroscience, Cellular and molecular neurophysiology, Learning and memory

PUBLICATIONS

- Homer1a Regulates Shank3 Expression and Underlies Behavioral Vulnerability to Stress in a Model of Phelan-McDermid Syndrome, *Cell Reports*, 2021
- Excitatory synapses and gap junctions cooperate to improve Pv neuronal burst firing and cortical social cognition in Shank2-mutant mice, *Nature Communications*, 2021
- Histone demethylase PHF2 activates CREB and promotes memory consolidation, *EMBO Reports*, 2019
- A Prolyl-isomerase Mediates Dopamine-dependent Plasticity and Cocaine Motor Sensitization, *Cell*, 2013
- Homeostatic scaling requires group I mGluR activation mediated by Homer1a, *Neuron*, 2010



02

BRAIN IMAGING
AND CONTROL
GROUP

The structure and function of brain circuits are finely controlled in space and time to generate diverse brain functions. Understanding the dynamic nature of brain activity and its underlying circuit and molecular mechanisms requires tools to monitor and control specific parts of the brain (e.g. regions, circuits, cells, synapses, or molecules). Our group monitors brain activity by employing a variety of approaches, including in vivo fluorescence imaging, neuropixels, and molecular engineering. We also design optogenetic tools and synthetic proteins to control specific cellular and molecular functions in the brain with high spatiotemporal precision. In conjunction with efforts to develop novel behavior paradigms in animals, we seek to identify important operating mechanisms at the molecule-circuit-organism level that underlie cognition and social interaction.

RESEARCH TOPIC

Within a close-knit social group, recognizing an individual as a unique identity and associating and retrieving individual-specific information during social interactions are fundamental abilities for living as a member of the group. Although individual recognition has been reported in many different species, including rodents, its neural underpinnings remain unclear. We have been developing simplified and precisely controlled individual discrimination paradigms in which subject mice distinguish between stimulus mice based on their individually-unique characteristics. Together with quantitative behavioral measures, we use multiple state-of-art techniques, including two-photon calcium imaging, miniscope imaging, and Neuropixels recordings, to reveal neural mechanisms of social recognition.

RESEARCH INTERESTS

Social information processing and memory formation, Episodic information processing, Ensemble perception

PUBLICATIONS

- Reward learning improves social information processing in the medial prefrontal cortex of autism model mice (In preparation), 2022
- Dynamic and stable representations of social identity and reward value in the dorsal CA1 hippocampus (Submitted), 2022
- Transient effect of mossy fiber stimulation on spatial firing of CA3 neurons in familiar and novel environments, *Hippocampus*, 2020
- Transient effect of mossy fiber stimulation on spatial firing of CA3 neurons, *Hippocampus*, 2019
- Whole-cell recording in the awake brain, *Cold Spring Harb Protoc*, 2017

BRIEF RESUME

2020 – present Senior Research Fellow, IBS
 2020 – present Associate professor, University of Science and Technology
 2015 – 2020 Tenure-Track Research Fellow, IBS
 2008 – 2015 Postdoc, Janelia Research Campus, HHMI, USA
 2007 Ph.D., Physiology, Seoul National University College of Medicine, Korea

PI
Do
yun

LEE



BRIEF RESUME

[Professional Experience]

2020 – present	Senior Research Fellow, IBS, Korea
2018 – 2020	Tenure-Track Research Fellow, IBS, Korea
2013 – 2017	Non-tenure track research fellow, IBS, Korea
2011 – 2013	Post-doc, KAIST, Korea

[Honors and Awards]

2020 –	A person of merit in the development of biological sciences, Ministry of Science and ICT, Korea
2016 –	Best Young Scientist Member(IASSF)
2014 – 6 th	'Bioneer Young Investigator Award' – Korea Society for Molecular and Cellular Biology (KSMCB), Korea

RESEARCH INTERESTS

Synthetic biology, Protein engineering, Molecular optogenetics, Molecular and cellular interaction

RESEARCH TOPIC

Communication across various scales of biological systems, from molecules to organisms, is essential for sharing information among members of society. At the molecular level, communication among a particular set of molecules is important not only to determine the functions and fates of individual cells but also to create harmonious and complex multicellular actions such as brain circuit activity that can ultimately change organisms' behaviors. Therefore, understanding the nature of molecular communication and its impact on higher-level communication is a fundamental step toward explaining how the brain works as a whole. To achieve this, we design a variety of synthetic molecules by employing and combining naturally occurring or engineered proteins to visualize or control molecular and cellular communication in living organisms. During the last decade, we have developed genetically encoded fluorescent sensors to assess molecular interactions in live cells and visualize protein activity at the subcellular level in the brain of behaving animals. Besides molecular sensors, we have also developed a series of optogenetic tools to control diverse intracellular molecules including calcium channels, receptor tyrosine kinases, cytoskeleton proteins, and mRNAs.

We are now moving towards focusing on intercellular communication in the brain to elucidate the role of cell-cell interaction in various brain functions such as cognition, learning and memory, and social behaviors. To this end, we are developing novel molecular tools to visualize or control different types of cell-cell interactions or their molecular mediators (e.g. neuro/gliotransmitters, peptides, or proteases). We believe that these technologies will open new avenues to deepen our understanding of how molecular communication can be translated into higher-level function in the brain and how its dysfunction causes various brain disorders.

PUBLICATIONS

- Optogenetic control of mRNA localization and translation in live cells, *Nature Cell Biology*, 2020
- Non-invasive optical control of endogenous Ca²⁺ channels in awake mice, *Nature Communications*, 2020
- Intensiometric biosensors visualize the activity of multiple small GTPases in vivo, *Nature Communications*, 2019
- Optogenetic control of endogenous Ca²⁺ channels in vivo, *Nature Biotechnology*, 2015
- Reversible protein inactivation by optogenetic trapping in cells, *Nature Methods*, 2014

PI

Sang
kyu

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03

SOCIAL NEUROSCIENCE GROUP

The goal of social neuroscience group is to understand how the brain controls emotion and cognition in the context of social behavior, and how maladaptive changes in brain circuits relate to various psychiatric disorders such as autisms and psychopaths. Our research focuses on 1) the neural mechanisms of empathic ability to share and understand the emotions of others, 2) individual recognition and memory formation to understand conspecifics others, 3) development of novel empathy models and brain rhythms, and 4) structure and function of glycosylation enzymes and glycans involved in social behavior and mental disorders, which has been unexplored so far. Focusing on the neurobiological mechanisms of comprehensive brain activities underlying these social behaviors, our group will identify mechanisms of the cognition and sociality at the levels of spanning from molecules to systems. These studies will contribute to the understanding of the brain mechanisms for social cognition in humans, which will ultimately benefit the treatment of mental disorders.



RESEARCH TOPIC

1. Emotional salience driving empathy of negative affection
2. Brain rhythmic oscillation in affective empathy
3. Behavioral paradigm for studying empathy of positive affection

RESEARCH INTERESTS

Empathy, Genetics, Phospholipase C beta-1, Rhythmic oscillation, Theta rhythm, Anterior cingulate cortex, Amygdala, Attention

PUBLICATIONS

- Neural circuits underlying a psychotherapeutic regimen for fear disorders, *Nature*, 2019
- A missense variant at the Nr3x3 locus enhances empathy fear in the mouse, *Neuron*, 2018
- Mice in conflict show rule-observance behavior enhancing long-term benefit, *Nature Communications*, 2017
- Observational fear learning involves affective pain system and Cav1.2 Ca²⁺ channels in ACC, *Nature Neuroscience*, 2010

BRIEF RESUME

[Professional Experience]

- 2018 – 2022 Chair, Organizing Committee, Keystone Symposium on Neurocircuitry of Social Behavior
- 2012 – 2020 Director, Center for Cognition and Sociality, IBS
- 2005 – 2011 Director, Center for Neural Science, KIST
- 1991 – 2001 Associate Professor/Professor, Dept. Life Science, POSTECH
- 1985 – 1991 Assistant Professor, Dept. of Biology, MIT

[Honors and Awards]

- 2005 MOST, Korea
- 2004 Order of Civil Merit (Dongbaeg), President of Korea
- 2004 Hoam Prize, Hoam Foundation

[Academic Activities]

- 2021 Fellow, International Union of Physiological Sciences(IUPS) Academy of Physiology
- 2021 Francine Shapiro Award-2020, EMDR-Europe Society
- 2018 AAAS Fellow, American Association for Advancement of Science
- 2010 Member, National Academy of Sciences, Republic of Korea
- 2009 Foreign Member, National Academy of Science, USA



BRIEF RESUME

[Professional Experience]

2021 – Present Associate Professor, Basic Science, IBS campus, UST
2020 – Present Senior Research Fellow, IBS
2019 – 2020 Associate Research Scientist, Department of Psychiatry, Yale University, USA
2018 – 2019 Postdoctoral Associate, Department of Psychiatry, Yale University, USA
2013 – 2018 Research Fellow (non-tenure track), Center for Cognition and Sociality, IBS
2010 – 2013 Postdoctoral Fellow (KRCF young scientist fellow), KIST, Korea
2009 – 2010 Postdoctoral Associate, Department of Psychiatry, Yale University, USA
2007 – 2008 Postdoctoral Researcher, Department of Neuroscience, College of Medicine, The Ohio State University, USA

[Fellowships]

2011 – 2013 Young Scientist Fellowship, Korea Research Council of Fundamental Science and Technology
2005 – 2007 Predoctoral fellowship, American Heart Association (0515170B)
2001 – 2002 Intern fellowship, Korea Science and Engineering Foundation (KOSEF)

RESEARCH INTERESTS

Glycosylation, Neuropsychiatric disorders, Social behaviors, Glycomics, Proteomics, Schizophrenia, PTSD, Depression, Autism

RESEARCH TOPIC

Glycosylation is a common posttranslational modification, in which a carbohydrate consisting of several sugar molecules, which is sometimes also referred to as a glycan is attached to a protein, lipid, or glycan substrate. Nearly 2% of the human genome encodes glycosyltransferases, glycosidases, or other glycan-modifying enzymes, and approximately half of all mammalian proteins are glycosylated, suggesting the importance of glycosylation in cellular function. The glycan structures on glycoproteins expressed in the central nervous system (CNS) play key roles in regulating cellular recognition, adhesion, signal transduction and trafficking that are important for normal brain function. More importantly, differential glycan expression has been found at multiple stages of CNS cellular differentiation and in diseases and pathological conditions such as Alzheimer's disease, Parkinson's disease, Huntington's disease, multiple sclerosis, schizophrenia and brain cancer. However, the roles of glycan structural alterations in glycoproteins and the functions of glycoproteins in different brain regions and variable cell types, including neurons and glia, have not yet been adequately addressed, particularly as they pertain to social behaviors and neuropsychiatric disorders closely related to abnormal social behaviors. Therefore, my research group will focus on identification of the role of glycosylation in social behaviors and behaviors associated with neuropsychiatric disorders and other brain diseases and will also focus on investigation on diagnostic tools and therapeutic strategy through studies on physiological, biochemical and molecular mechanisms underlying altered protein glycosylation in different cell types including glia and neurons.

PUBLICATIONS

- Depression in adolescence and BDNF, *Frontiers in Molecular Neuroscience*, 2022
- Deletion of Phospholipase C β 1 in the Thalamic Reticular Nucleus Induces Absence Seizures, *Exp Neurol*, 2022
- Positive modulation of N-methyl-D-aspartate receptors in the mPFC reduces the spontaneous recovery of fear, *Mol Psychiatry*, 2022
- NMDAR modulators as rapid antidepressants: Converging and distinct signaling mechanisms, *Integrative Clinical Medicine*, 2020
- Stress-induced changes in social dominance are scaled by AMPA-type glutamate receptor phosphorylation in the medial prefrontal cortex, *Sci. Rep.*, 2018
- The Possible Role of Neurobeachin in Extinction of Contextual Fear Memory, *Sci. Rep.*, 2018
- mTOR-dependent synapse formation underlies the rapid antidepressant effects of NMDA antagonists, *Science*, 2010

PI

Bo
Young



LEE





BRIEF RESUME

[Education and Professional experience]

2020 – Present Research fellow, IBS Associate professor, UST
 2018 – 2020 Tenure-track Research Fellow, IBS
 2013 – 2018 Research fellow (Non-tenure), IBS
 2012 – 2013 Postdoctoral researcher, UCSF, USA
 2010 – 2012 Postdoctoral researcher, Duke Univ., USA
 2005 – 2010 PhD in Genetics & Genomics, Duke Univ., USA

[Honors and Awards]

2022 Merit award for basic science by the Minister of Science and ICT, Korea
 2021 Merit award for the 10th anniversary of the institute, IBS
 2008 American Heart Association (AHA) Pre-doctoral Fellowship

RESEARCH TOPIC

My laboratory seeks to understand how the brain controls social affective behaviors, and how dysfunction in brain circuits relate to psychiatric disorders such as autism and psychopaths. In particular, we are interested in how the anterior cingulate cortex (ACC) integrates multiple sensory and emotional information to induce vicarious social fear and how the affective pain signal is processed in thalamic circuits in observational fear, a rodent model of affective empathy. To resolve these neural mechanisms comprehensively, we combine mouse genetics, optogenetics, and in vivo calcium imaging techniques. In addition, we aim to identify novel genes and underlying signaling pathways to probe synaptic and circuit dysfunctions that cause abnormal emotional recognition and empathic behaviors.

RESEARCH INTERESTS

Social affective behavior, Empathy, Observational fear learning, Emotion recognition, Psychopathy, Psychiatric disorder

PUBLICATIONS

- Observational Fear Learning as A Potential Model of Affective Empathy, *Neuron*, 2019
- A Missense Variant at the Nr1n3 Locus Enhances Empathy Fear in the Mouse, *Neuron*, 2018
- Variability in empathic fear response among 11 inbred strains of mice, *Genes Brain Behav*, 2016
- Natural Genetic Variation of Integrin alpha L (Itgal) Modulates Ischemic Brain Injury in Stroke, *PLoS Genet*, 2013
- A QTL (LSq-1) on mouse chromosome 7 is linked to prevention of tissue loss following surgical hind-limb ischemia, *Circulation*, 2008

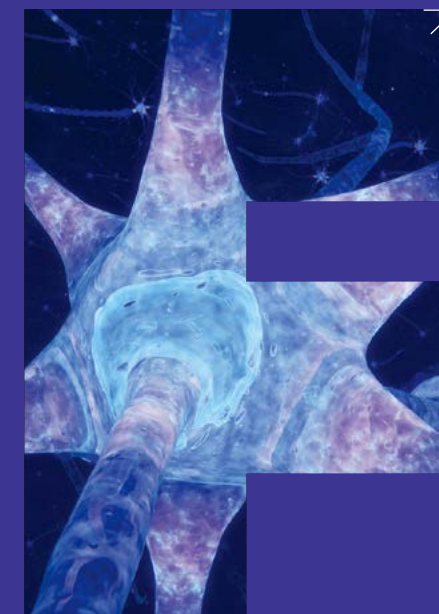


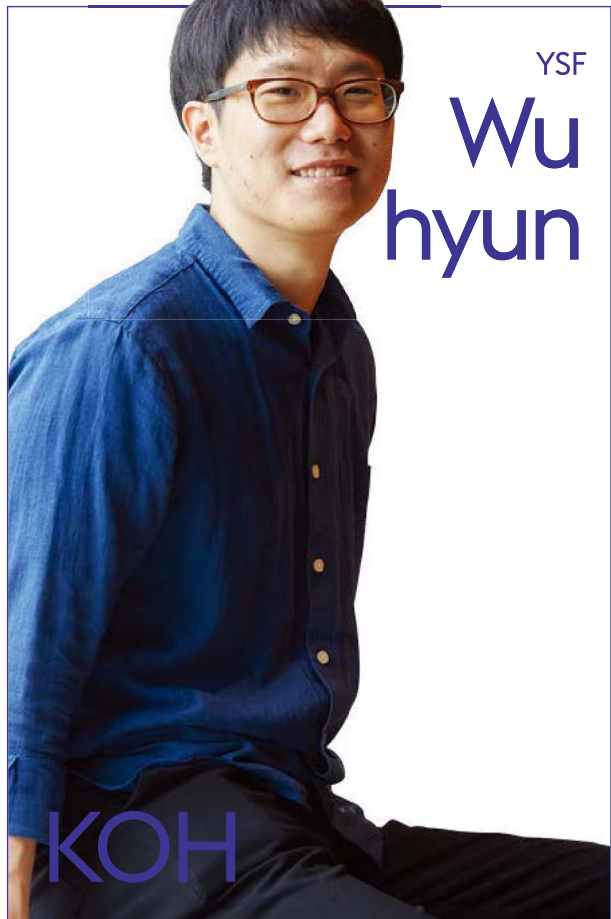
04

YOUNG SCIENTIST FELLOWSHIP



IBS offers opportunities to young researchers through a variety of programs. YSFs are researchers within seven years after obtaining a Ph.D. or are under the age of 40 and receive support for up to five years. YSFs operate their own group with a budget of KRW 150 million to KRW 300 million per year.





RESEARCH TOPIC

Humans and other social animals are not born with sociality. After birth, sociality is developed through interaction with mother, father, and sibling. Our lab is studying the mechanism by which "social brain" is formed. In particular, we investigate whether maternal attachment affects social brain development, and to find various methods and drugs to treat autism spectrum disorder (ASD) and other neurodevelopmental diseases.

RESEARCH INTERESTS

Maternal attachment, Sociality, Neurodevelopment, Glia-neuron interaction, Cognition, Autism spectrum disorder (ASD), Neurodevelopmental disorders

PUBLICATIONS

- Astrocytes Render Memory Flexible by Releasing D-Serine and Regulating NMDA Receptor Tone in the Hippocampus, *Biol Psychiatry*, 2022
- The Tripartite Glutamatergic Synapse, *Neuropharmacology*, 2021
- Astrocytes Control Sensory Acuity Via Tonic Inhibition in the Thalamus, *Neuron*, 2020
- AAV-Mediated Astrocyte-Specific Gene Expression under Human Aldh1l1 Promoter in Mouse Thalamus, *Exp Neurol*, 2017

BRIEF RESUME

[Professional Experience]

- | | |
|----------------|--|
| 2021 – Present | Young Scientist Fellow, IBS |
| 2021 – | Post-Doctoral Fellow, IBS |
| 2018 – 2021 | Technical Research Personnel (Mandatory military service in the Korea) |
| 2013 – 2021 | Ph.D. in Neuroscience, University of Science and Technology, Korea |

[Honors and Awards]

- | | |
|------|---|
| 2022 | Best poster award at the Annual Glia Conference of the Korean Society for Brain and Neural Science (KSBNS), Korea |
| 2021 | Researcher of the Year Award in IBS, Korea |
| 2020 | Best poster award at KSBNS, Korea |

[Academic Activities]

- | | |
|----------------|---|
| 2021 – present | Reviewer for journals: Frontiers in Cellular Neuroscience, Experimental Neurobiology, Molecular and Cellular Toxicology |
|----------------|---|

RESEARCH TOPIC

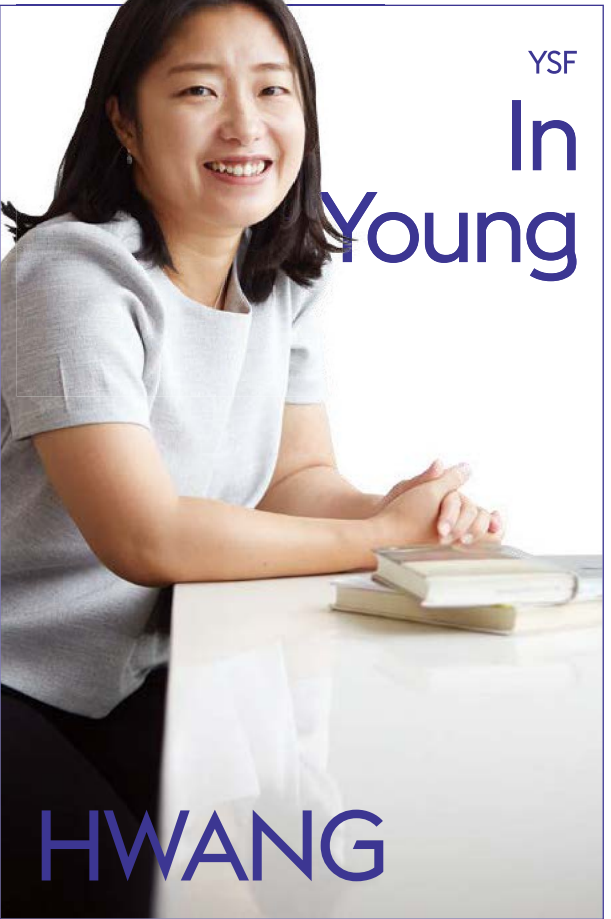
We want to explore how epigenomic regulation determines brain cell fate and function, and its relevance to neurological disorders. As the most abundant cell population in our brain, astrocytes are found in various neurological conditions. However, our understanding of astrocytic chromatin regulation is far beyond complete. We propose to employ the hiPSC-derived model system with multi-omics approaches (e.g., epigenomics, transcriptomics) to dissect underlying mechanisms of the astrocyte identity and function. In the long run, our goal is to lay the foundation for potential biomedical applications in treating neurological diseases.

RESEARCH INTERESTS

Epigenomics, Astrocyte, hiPSC, Tripartite synapse, Neural activity, Single-cell RNA/ATAC-sequencing, Neurological disorder

PUBLICATIONS

- Comparative chromatin accessibility upon BDNF-induced neuronal activity delineates neuronal regulatory elements, *Molecular Systems Biology*, 2022
- The neurodevelopmental disorder-linked PHF14 complex that forms biomolecular condensates detects DNA damage and promotes repair, *bioRxiv*, 2021
- Zinc finger proteins orchestrate active gene silencing during embryonic stem cell differentiation, *Nucleic Acids Res*, 2018
- Psat1-Dependent Fluctuations in α -Ketoglutarate Affect the Timing of ESC Differentiation, *Cell Metabolism*, 2016



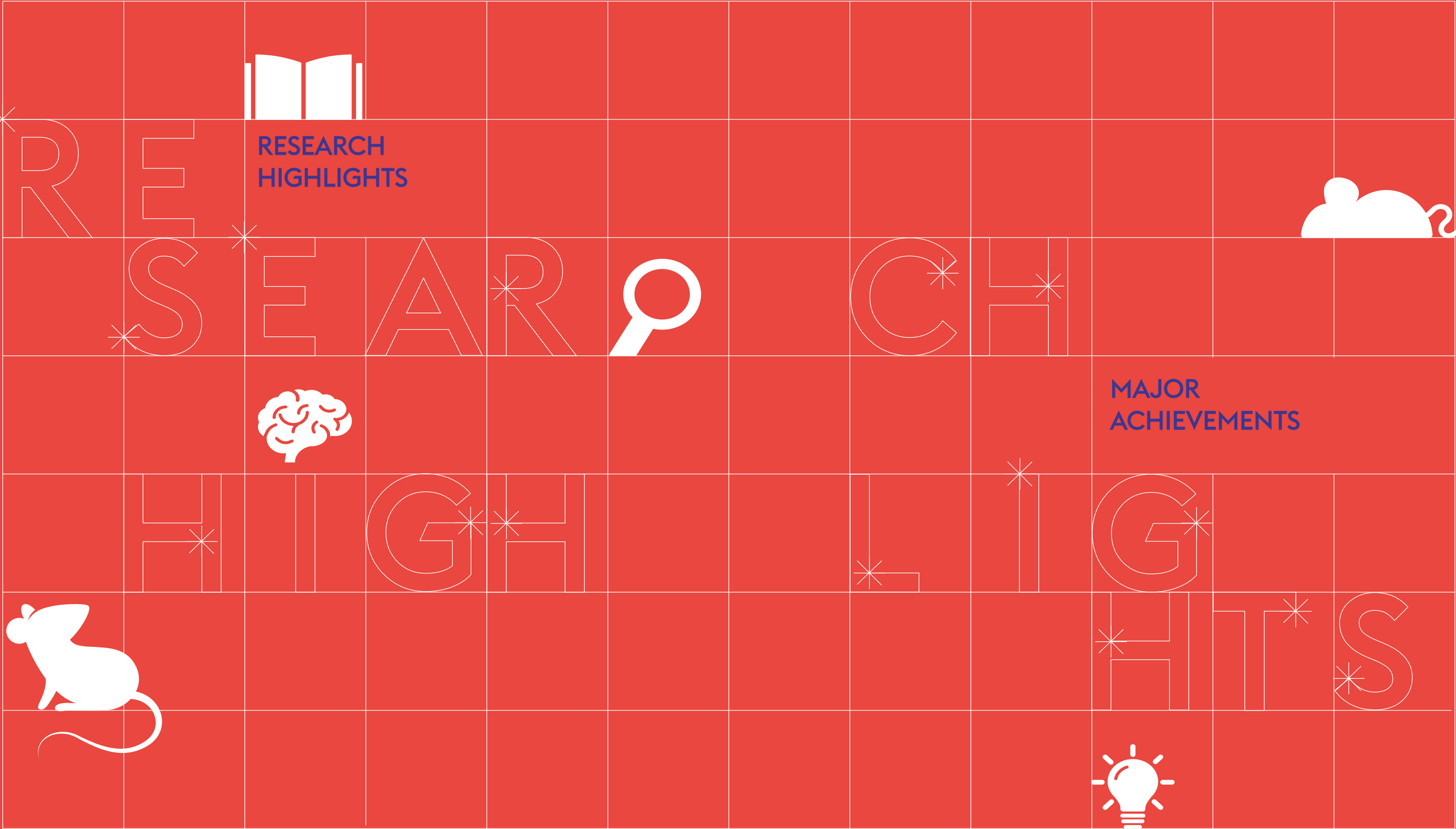
BRIEF RESUME

[Professional Experience]

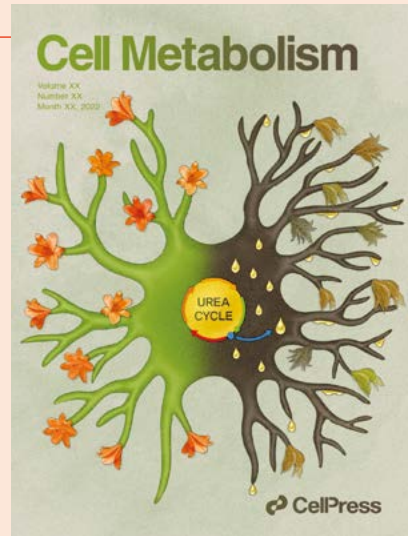
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|----------------|---|
| 2022 – Present | Young Scientist Fellow, IBS |
| 2019 – 2022 | EIPOD Post-doctoral fellow in Genome Biology and Structural Biology Unit, EMBL, Germany |
| 2016 – 2018 | Post-doctoral fellow in Seoul National University, College of Medicine, Korea |
| 2009 – 2016 | Ph.D. in Unified Master's and Doctor's Course in Department of Biomedical Sciences, Seoul National University, College of Medicine, Korea |

[Honors and Awards]

- | | |
|-------------|--|
| 2019 – 2022 | EIPOD (EMBL Interdisciplinary Post Doctoral) fellowship, funding from the European Union's Horizon 2020 research and innovation programme under Marie Skłodowska Curie Actions |
| 2018 | Post-doctoral fellowship supported by Basic Science Research Program through National Research Foundation of Korea funded by the Ministry of Education |
| 2016 | Outstanding Graduate Award - Department of Biomedical Sciences, Graduate School of Seoul National University |



RESEARCH



Identification of the urea cycle within reactive astrocytes in the brain as a new cause of Alzheimer's disease

(Cell Metabolism, 2022)

Through joint research with the Neuroscience Research Institute (KIST, Seoul), we uncovered the existence and role of urea cycle in reactive astrocytes of Alzheimer's disease. Enzyme ODC1 belonging to this pathway was found to be the key switch between beneficial and detrimental role of reactivity. This suggested the possibility of a new therapeutic target to rescue memory in AD.

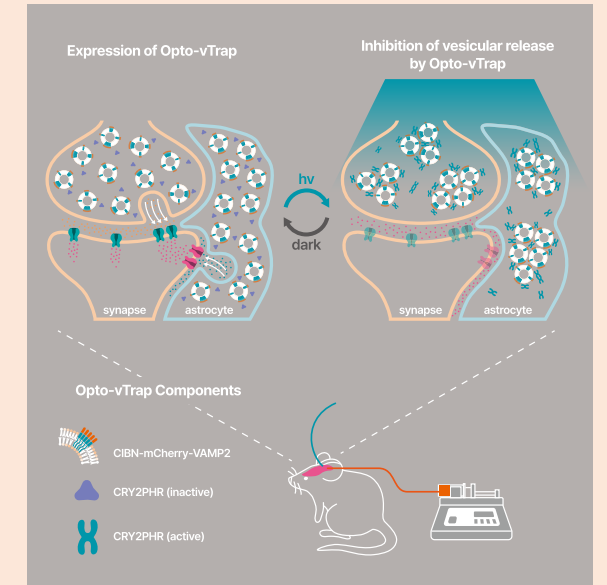


03

Freely regulate brain functions, behaviors, and emotions using light

(Neuron, 2021)

In joint research with KAIST, our Center developed 'Opto-vTrap', an optogenetic technology that can freely control brain functions and behaviors using light. Opto-vTrap can freely modulate brain activity by directly controlling the secretion of vesicles. Furthermore, it was confirmed through animal experiments that not only brain cell signal transduction but also memory, emotion, and behavior can be regulated using this approach. As Opto-vTrap can be used on various cells in addition to brain cells, it is expected to contribute to various areas in neuroscience such as mapping of the human brain and epilepsy treatment, as well as muscle spasm and skin muscle expansion technology.



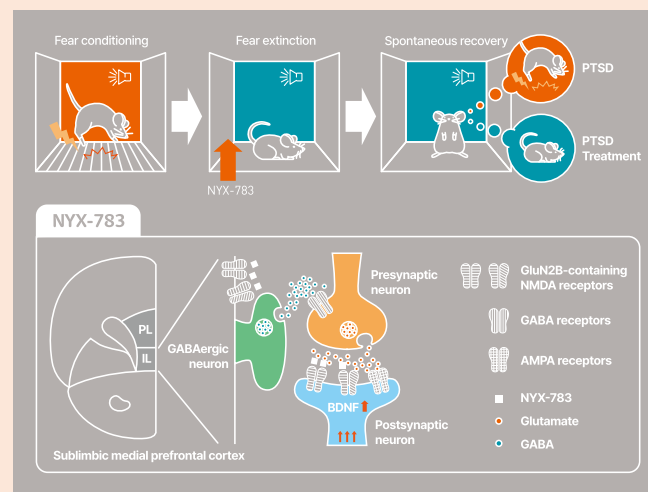
HIGHLIGHTS

02

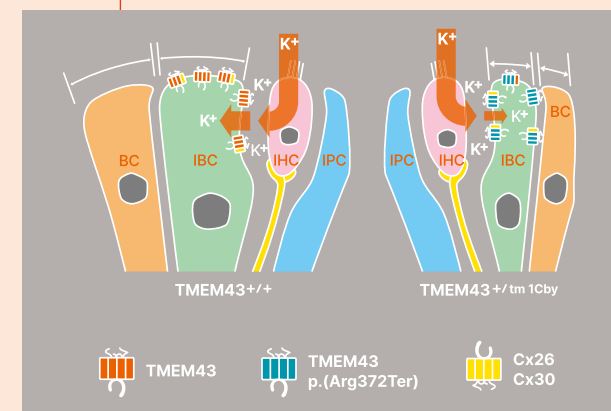
First identification of the treatment mechanism for post-traumatic stress disorder (PTSD)

(Molecular Psychiatry, 2022)

NYX-783, a novel PTSD drug under clinical development, was applied to a PTSD mouse model to study the molecular mechanism of its therapeutic effect. It was found that the drug suppressed fear memory by acting on the NMDA receptors, specifically on the GluN2B subunit protein in excitatory neurons in the sublimbic medial prefrontal cortex. It laid the theoretical foundation for the development of a treatment for PTSD, and at the same time presented a strategy that targets the NMDA protein.



Through joint research with Seoul National University Bundang Hospital, Mokpo University, Central South University of China, and the University of Miami, USA, our Center identified a new deafness gene TMEM43, which is expressed in cochlear support cells, and investigated the mechanism of auditory neuropathy. Prescription of cochlear implant in three deaf patients with defective TMEM43



protein was able to successfully restore their hearing ability. This research is significant in that it has identified the molecular and physiological role of glial cells in the cochlea of the peripheral nervous system, which has been not been studied extensively to date.

A new gene responsible for hearing loss was discovered

(PNAS, 2021)





05

Excessive generation of hydrogen peroxide in severely reactive astrocytes is the cause of dementia

(Nature Neuroscience, 2020)

Through a joint study with the Brain Science Research Institute, our Center revealed for the first time the mechanism of neuronal cell death and induction of dementia caused by reactive astrocytes that occur in the early stages of the disease. The results of this study prove that severe reactive astrocytes rather than amyloid beta plaques are key to neuronal apoptosis. Furthermore, it was confirmed that it was possible to suppress the progression of dementia merely by targeting astrocytes to reduce their hydrogen peroxide production.

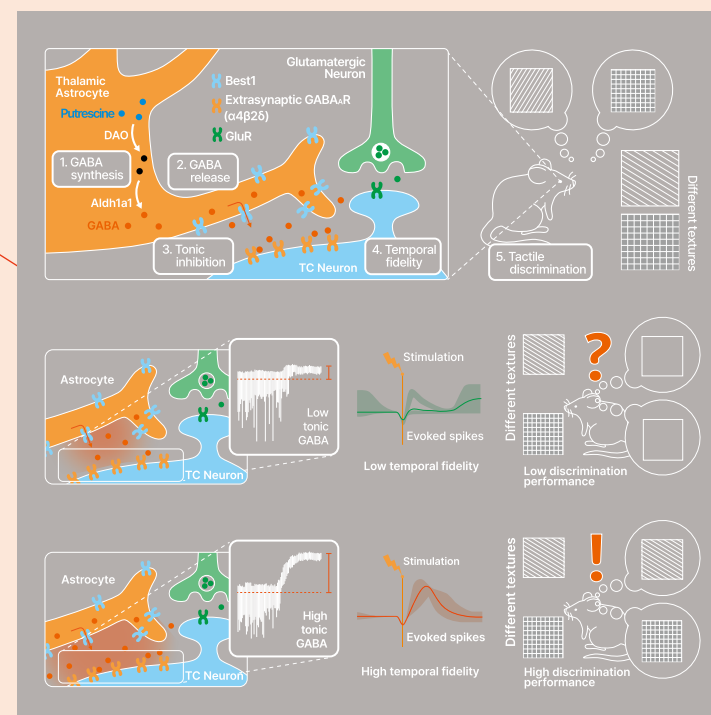
RESEARCH

06

Astrocytes regulate tactile sensitivity

(Neuron, 2020)

Joint research between our Center and Yonsei University revealed how astrocytes in the brain's thalamus regulate tactile perception through the secretion of GABA. It is expected to lay the foundation for the treatment of sensory disorders by providing an understanding of how the transmission of sensory information is regulated. On the other hand, the study also showed that not only neurons but also astrocytes can play a central role in cognitive function.



The exact mechanism of eye movement desensitization and reprocessing (EMDR), a psychotherapeutic therapy for the treatment of post-traumatic stress disorder (PTSD), was elucidated through animal experiments. It was confirmed that the reduction of the fear response is regulated by a neural circuit that starts in the superior colliculus where the visual stimulus is received and eventually reaches the amygdala via the mediodorsal thalamic nucleus. These findings are expected to contribute to the treatment of PTSD by explaining how the circuits related to fear memory are regulated and suppressed.



07

Removing fear memories with visual stimulation

(Nature, 2019)

HIGHLIGHTS

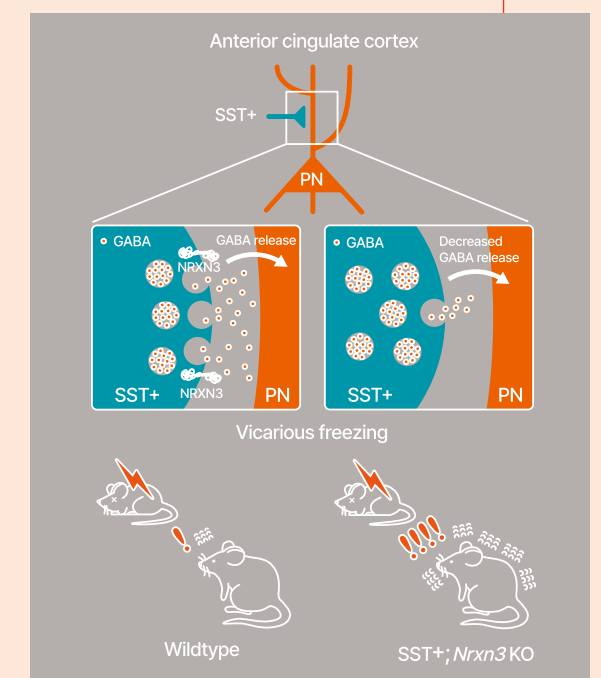


08

Identification of the gene and neural circuit controlling empathy

(Neuron, 2018)

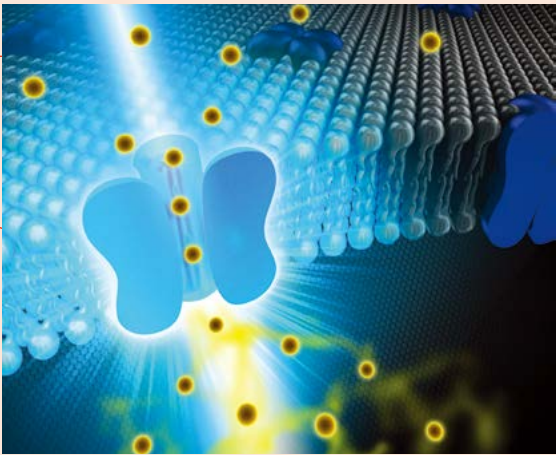
This study discovered that the *Nrxn3* gene dependent inhibitory synaptic transmission in somatostatin-expressing (SST+) interneurons in the anterior cingulate cortex controls the degree of observational fear learning, a rodent model of affective empathy. These findings contribute to development of effective treatments of various mental disorders such as autism, depression, schizophrenia, and psychopaths, all of which manifest in impairment of empathy.



Using light to control calcium concentration and improve memory

(Nature Biotechnology, 2015)

We have developed the world's most efficient 'optical remote control' that can control calcium ion concentrations in living organisms. Application of this technology in the mouse's brain resulted in successful induction of calcium channel opening, which resulted in a doubling of the mouse memorization capacity. This is expected to contribute to the treatments for diseases with calcium ion metabolic defects, such as Alzheimer's disease and cardiac arrhythmia.



RESEARCH

09



HIGHLIGHTS



Our Center developed a 'Light-Activated Reversible Inhibition by Assembled Trap (LARIAT)', which is a new technology that can remotely control the function of specific proteins using light. Using LARIAT, important life phenomena such as cell movement and division can be controlled very easily and reversibly without drug treatment, simply by switching the light on and off. In particular, it is expected that it will be usefully used for cancer cell research and cancer signal transduction research in the future, where this technology can be used to block the division of cancer cells.

Controlling protein function with light to block cancer cell division

(Nature Methods, 2014)



10

PUBLICATION LIST

(2019-2022.7)

JOURNAL	TITLE	YEAR	MONTH
Genes, Brain and Behavior	Experience of a hierarchical relationship between a pair of mice specifically influences their affective empathy toward each other	2022	06
Glia	Longitudinal intravital imaging of cerebral microinfarction reveals a dynamic astrocyte reaction leading to glial scar formation	2022	05
Molecular Psychiatry	Positive modulation of N-methyl-D-aspartate receptors in the mPFC reduces the spontaneous recovery of fear	2022	05
Molecular Brain	Antiallodynic effects of KDS2010, a novel MAO-B inhibitor, via ROS-GABA inhibitory transmission in a paclitaxel-induced tactile hypersensitivity model	2022	05
International Journal of Molecular Sciences	Revisiting the Role of Astrocytic MAOB in Parkinson's Disease	2022	04
Biological Psychiatry	Astrocytes render memory flexible by releasing D-serine and regulating NMDAR tone in the hippocampus	2022	04
Molecules and cells	Role of Hypothalamic Reactive Astrocytes in Diet-Induced Obesity	2022	02
Journal of Neuroscience	The representational dynamics of sequential perceptual averaging	2022	02
Neuron	Opto-vTrap, an optogenetic trap for reversible inhibition of vesicular release, synaptic transmission, and behavior	2022	02
CRISPR Journal	CRISPR-Cas9 Gene Editing Protects from the A53T-SNCA Overexpression-Induced Pathology of Parkinson's Disease in Vivo	2022	02
Glia	Inhibition of monoamine oxidase B prevents reactive astrogliosis and scar formation in stab wound injury model	2022	02
Biosensors and Bioelectronics	Interference-free, lightweight wireless neural probe system for investigating brain activity during natural competition	2022	01
Molecular Oncology	Platycodin D inhibits autophagy and increases glioblastoma cell death via LDLR upregulation	2022	01
Molecular Brain	Retina-attached slice recording reveals light-triggered tonic GABA signaling in suprachiasmatic nucleus	2021	11
Cell Reports	Homer1a regulates Shank3 expression and underlies behavioral vulnerability to stress in a model of Phelan-McDermid syndrome	2021	11
Nature Communications	Structural insights into the clustering and activation of Tie2 receptor mediated by Tie2 agonistic antibody	2021	11
Neuropharmacology	The tripartite glutamatergic synapse	2021	11
Neurotherapeutics	KDS2010, a Newly Developed Reversible MAO-B Inhibitor, as an Effective Therapeutic Candidate for Parkinson's Disease	2021	10
Experimental Neurobiology	A Deafness Associated Protein TMEM43 Interacts with KCNK3 (TASK-1) Two-pore Domain K+ (K2P) Channel in the Cochlea	2021	10
Human Brain Mapping	Induced astigmatism biases the orientation information represented in multivariate electroencephalogram activities	2021	09

JOURNAL	TITLE	YEAR	MONTH
Cell Proliferation	Fine-tuning of dual-SMAD inhibition to differentiate human pluripotent stem cells into neural crest stem cells	2021	09
Nature Communications	Excitatory synapses and gap junctions cooperate to improve Pv neuronal burst firing and cortical social cognition in Shank2-mutant mice	2021	08
Experimental and Molecular Medicine	Redefining differential roles of MAO-A in dopamine degradation and MAO-B in tonic GABA synthesis	2021	07
Proceedings of the National Academy of Sciences of the United States of America	A nonsense TMEM43 variant leads to disruption of connexin-linked function and autosomal dominant auditory neuropathy spectrum disorder	2021	06
Biological Psychiatry	Persistently Elevated mTOR Complex 1-S6 Kinase 1 Disrupts DARPP-32-Dependent D1 Dopamine Receptor Signaling and Behaviors	2021	06
Experimental Neurobiology	Adenovirus-induced Reactive Astrogliosis Exacerbates the Pathology of Parkinson's Disease	2021	06
Experimental Neurobiology	Differential Proximity of Perisynaptic Astrocytic Best1 at the Excitatory and Inhibitory Tripartite Synapses in APP/PS1 and MAOB-KO Mice Revealed by Lattice Structured Illumination Microscopy	2021	06
Current Opinion in Neurobiology	Affective empathy and prosocial behavior in rodents	2021	06
Nature Communications	Tanc2-mediated mTOR inhibition balances mTORC1/2 signaling in the developing mouse brain and human neurons	2021	05
Experimental and Molecular Medicine	Platycodin D, a natural component of Platycodon grandiflorum, prevents both lysosome- and TMPRSS2-driven SARS-CoV-2 infection by hindering membrane fusion	2021	05
Experimental Neurobiology	The pathological role of astrocytic MAOB in parkinsonism revealed by genetic ablation and over-expression of MAOB	2021	04
Experimental Neurobiology	Tumor spheroids of an aggressive form of central neurocytoma have transit-amplifying progenitor characteristics with enhanced EGFR and tumor stem cell signaling	2021	04
FASEB Journal	Cyclophilin A is an endogenous ligand for the triggering receptor expressed on myeloid cells-2 (TREM ₂)	2021	04
American Journal of Chinese Medicine	Quercetin Induces Apoptosis in Glioblastoma Cells by Suppressing Axl/IL-6/STAT3 Signaling Pathway	2021	03
Nature Neuroscience	Reactive astrocyte nomenclature, definitions, and future directions	2021	03
Experimental Neurobiology	Ultimate COVID-19 Detection Protocol Based on Saliva Sampling and qRT-PCR with Risk Probability Assessment	2021	02
Journal of Enzyme Inhibition and Medicinal Chemistry	High-yield synthesis and purification of recombinant human GABA transaminase for high-throughput screening assays	2021	01
Cellular and Molecular Life Sciences	Signaling mechanisms of μ-opioid receptor (MOR) in the hippocampus: disinhibition versus astrocytic glutamate regulation	2021	01
Animal Cells and Systems	Inhibitors of synaptic vesicle exocytosis reduce surface expression of postsynaptic glutamate receptors	2020	12
Scientific Reports	Platycodin D enhances LDLR expression and LDL uptake via down-regulation of IDOL mRNA in hepatic cells	2020	11

JOURNAL	TITLE	YEAR	MONTH
Nature Neuroscience	Severe reactive astrocytes precipitate pathological hallmarks of Alzheimer's disease via H ₂ O ₂ -production	2020	11
Proceedings of The National Academy of Sciences of The United States of America	Spatial and temporal diversity of glycome expression in mammalian brain	2020	11
Neuron	Astrocytes Control Sensory Acuity via Tonic Inhibition in the Thalamus	2020	11
Journal of Neuroscience	Excitation-inhibition imbalance leads to alteration of neuronal coherence and neurovascular coupling under acute stress	2020	11
Journal of Physiology-London	The molecular mechanism of synaptic activity-induced astrocytic volume transient	2020	10
Hippocampus	Transient effect of mossy fiber stimulation on spatial firing of CA3 neurons in familiar and novel environments	2020	07
Cell Reports	Excessive Astrocytic GABA Causes Cortical Hypometabolism and Impedes Functional Recovery after Subcortical Stroke	2020	07
Acs Chemical Neuroscience	PyrPeg, a Blood-Brain-Barrier-Penetrating Two-Photon Imaging Probe, Selectively Detects Neuritic Plaques, Not Tau Aggregates	2020	06
Experimental and Molecular Medicine	Optimization of primer sets and detection protocols for SARS-CoV-2 of coronavirus disease 2019 (COVID-19) using PCR and real-time PCR	2020	06
Biochemical and Biophysical Research Communications	Optogenetic tools for dissecting complex intracellular signaling pathways	2020	06
Glia	Bestrophin1-mediated tonic GABA release from reactive astrocytes prevents the development of seizure-prone network in kainate-injected hippocampi	2020	05
Experimental Neurobiology	Sleep-enhancing effects of phytoncide via behavioral, electrophysiological, and molecular modeling approaches	2020	04
Science Advances	Dynamic Fas signaling network regulates neural stem cell proliferation and memory enhancement	2020	04
IEEE Access	Predicting Trial-by-Trial Variation in Oculomotor Behavior Using Multivariate Electroencephalography Theta Phase	2020	04
Scientific Reports	Serial optical coherence microscopy for label-free volumetric histopathology	2020	04
Molecules and Cells	Dynamic Changes in the Bridging Collaterals of the Basal Ganglia Circuitry Control Stress-Related Behaviors in Mice	2020	04
Experimental Neurobiology	Development of a Laboratory-safe and Low-cost Detection Protocol for SARS-CoV-2 of the Coronavirus Disease 2019 (COVID-19)	2020	04
Biochemical and Biophysical Research Communications	An inducible system for in vitro and in vivo Fas activation using FKBP-FRB-rapamycin complex	2020	03
Journal of Molecular Biology	Optogenetic Modulation of TrkB Signaling in the Mouse Brain	2020	02
Nature Cell Biology	Optogenetic control of mRNA localization and translation in live cells	2020	02
Current Biology	Aberrant Tonic Inhibition of Dopaminergic Neuronal Activity Causes Motor Symptoms in Animal Models of Parkinson's Disease	2020	01
Nature Communications	Non-invasive optical control of endogenous Ca ²⁺ channels in awake mice	2020	01

JOURNAL	TITLE	YEAR	MONTH
Nature Communications	Ensemble representations reveal distinct neural coding of visual working memory	2019	12
Journal of Neuroscience	Neurovascular coupling under chronic stress is modified by altered GABAergic interneuron activity	2019	12
Cell Chemical Biology	Locally Activating TrkB Receptor Generates Actin Waves and Specifies Axonal Fate	2019	12
Neuroimage	Motion direction representation in multivariate electroencephalography activity for smooth pursuit eye movements	2019	11
Neuropharmacology	Genetic factors associated with empathy in humans and mice	2019	11
Nature Methods	Optogenetic activation of intracellular antibodies for direct modulation of endogenous proteins.	2019	11
Nature Communications	The rostroventral part of the thalamic reticular nucleus modulates fear extinction	2019	10
Experimental Neurobiology	3-Carene, a Phytoncide from Pine Tree Has a Sleep-enhancing Effect by Targeting the GABA(A)-benzodiazepine Receptors	2019	10
Neuron	Neural Basis of Observational Fear Learning: A Potential Model of Affective Empathy	2019	10
Current Biology	Ultrasonic Neuromodulation via Astrocytic TRPA1	2019	10
Embo Reports	Histone demethylase PHF2 activates CREB and promotes memory consolidation	2019	09
Hippocampus	Transient effect of mossy fiber stimulation on spatial firing of CA3 neurons	2019	07
Cell Reports	Activation of Astrocytic μ -Opioid Receptor Causes Conditioned Place Preference	2019	07
Experimental Neurobiology	Tweety-homolog (Ttyh) Family Encodes the Pore-forming Subunits of the Swelling-dependent Volume-regulated Anion Channel (VRAC(swell)) in the Brain	2019	04
Korean Journal of Physiology & Pharmacology	Neuroprotective mechanisms of dieckol against glutamate toxicity through reactive oxygen species scavenging and nuclear factor-like 2/heme oxygenase-1 pathway	2019	03
Science Advances	Newly developed reversible MAO-B inhibitor circumvents the shortcomings of irreversible inhibitors in Alzheimer's disease	2019	03
Nature	Neural circuits underlying a psychotherapeutic regimen for fear disorders	2019	02
Experimental Neurobiology	Pharmacological Dissection of Intrinsic Optical Signal Reveals a Functional Coupling between Synaptic Activity and Astrocytic Volume Transient	2019	02
Journal of Neuroscience	Association of mGluR-Dependent LTD of Excitatory Synapses with Endocannabinoid-Dependent LTD of Inhibitory Synapses Leads to EPSP to Spike Potentiation in CA1 Pyramidal Neurons	2019	01
Nature Communications	Intensiometric biosensors visualize the activity of multiple small GTPases in vivo	2019	01
Nature Communications	Noninvasive optical activation of Flp recombinase for genetic manipulation in deep mouse brain regions	2019	01
Genes Brain and Behavior	Observational fear behavior in rodents as a model for empathy	2019	01

PATENT LIST

NO.	APPLICATION DATE	INVENTION TITLE	APPLICANTS	CONDITION
1	2022	Pharmaceutical compositions for the prevention or treatment of attention deficit hyperactivity disorder	PCT	pending application
2	2022	Triterpenoid saponin derivatives for the prevention and treatment of Enveloped viruses (proof reading)	U.S.A.	pending application
3	2022	Triterpenoid saponin derivatives the prevention and treatment of Enveloped viruses	U.S.A.	pending application
4	2022	Dopamine-hyaluronic acid complex for the treatment of Parkinson's disease	KOREA	pending application
5	2022	Antisense Oligomers Against Monoamine oxidase B and Use Thereof	KOREA	pending application
6	2022	Pharmaceutical composition for the prevention and treatment of Enveloped viruses comprising Codonopsis, Aster and/or Polygala extracts	KOREA	pending application
7	2021	An Optogenetic system for reversible inhibition of vesicular release	KOREA	pending application
8	2021	Use of GAT-3 for the diagnosis of attention deficit / hyperactivity disorder	KOREA	pending application
9	2021	Pharmaceutical compositions for preventing or treating attention deficit hyperactivity disorder comprising SNAP5114 as an active ingredient	PCT	pending application
10	2021		KOREA	pending application
11	2021	Methods and systems for modifying empathy by modulating type 2 theta oscillations	PCT	pending application
12	2020		U.S.A.	pending application
13	2021	Novel aminoaromatic compounds or pharmaceutically acceptable salt thereof and pharmaceutical composition for prevention or treatment of neurodegenerative diseases comprising the same as an active ingr	PCT	pending application
14	2021		KOREA	pending application
15	2020		KOREA	pending application
16	2021	Pharmaceutical composition for the prevention and treatment of coronavirus infection comprising Trifluoperazine or analogue thereof	KOREA	pending application
17	2020		KOREA	pending application
18	2020	Brain Plasticity Control Device and Method Using Theta-Burst Ultrasound	KOREA	pending application
19	2021	Pharmaceutical composition for the prevention and treatment of Enveloped viruses comprising taining Platycodon grandiflorus root extracts	KOREA	patent registration
20	2020		KOREA	pending application
21	2021	Pharmaceutical composition for the prevention and treatment of coronavirus infection comprising phytoncide	KOREA	pending application
22	2020		KOREA	pending application
23	2020	Composition for prevention or treatment of rheumatoid arthritis	KOREA	pending application
24	2021	Composition For Inducing Synthetic Intercellular Interaction and Method for Inducing Synthetic Intercellular Interaction Using the Same	PCT	pending application
25	2021		KOREA	pending application
26	2020		KOREA	pending application
27	2021	Dynamic Fas signaling network regulates neural stem cell proliferation and memory enhancement	KOREA	pending application
28	2020		KOREA	pending application
29	2021	A Contrast Agent Composition for Detecting Lesional Margin of Astrocytosis-Related Disease Comprising C11-Acetate as an Active Ingredient	PCT	pending application
30	2020		KOREA	patent registration
31	2021	A Contrast Agent Composition for Detecting Lesional Margin of Dementia Caused by Degenerative Brain Disease Comprising Quinoline Derivatives as Active Ingredients	PCT	pending application
32	2020		KOREA	pending application
33	2021	A Contrast Agent Composition for Detecting Lesional Margin of Astrocytosis-Related Disease Comprising Quinoline Derivatives as Active Ingredients	PCT	pending application
34	2020		KOREA	patent registration
35	2021	A Contrast Agent Composition for Detecting Lesional Margin of Dementia Caused by Degenerative Brain Disease Comprising C11-Acetate as an Active Ingredient	PCT	pending application
36	2020		KOREA	pending application
37	2020	Development of a Laboratory-safe and Low-cost Detection Protocol for SARS-CoV-2 of the Coronavirus Disease 2019 (COVID-19)	KOREA	patent registration
38	2020		KOREA	pending application

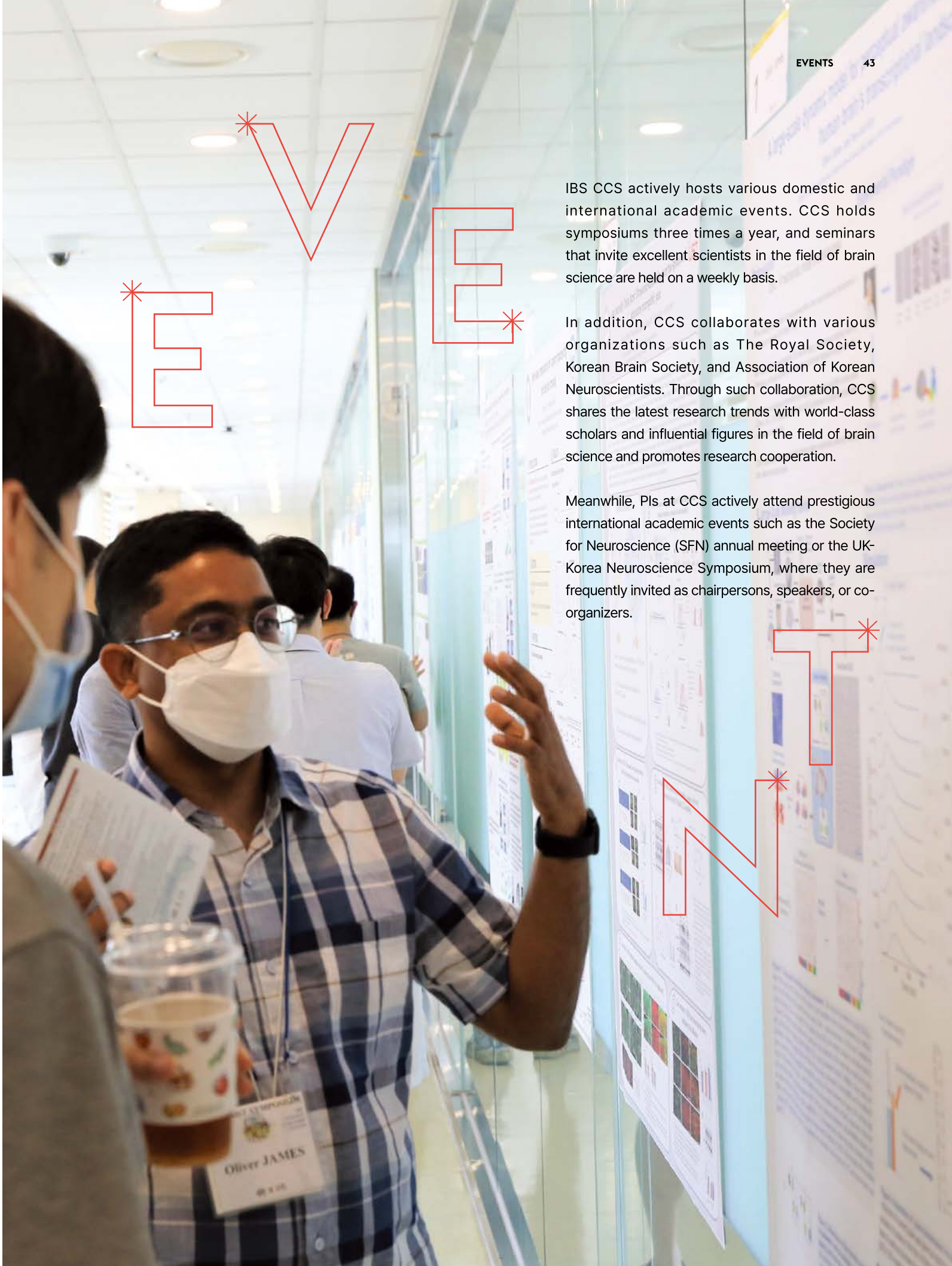
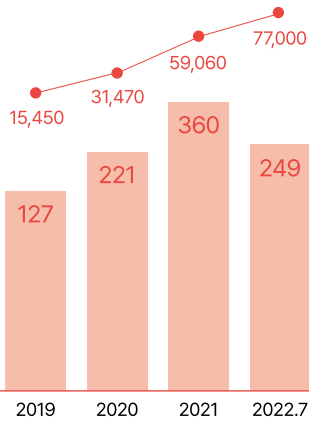
No.	APPLICATION DATE	INVENTION TITLE	APPLICANTS	CONDITION
39	2020	Neural Plasticity Control Device and Method Using Theta-Burst Ultrasound	KOREA	pending application
40	2021		U.S.A.	pending application
41	2019	Modified CRY2 with high photosensitivity and use of the same	PCT	pending application
42	2019		KOREA	patent registration
43	2018	Non-invasive optogenetics for control of cellular function in vivo system	KOREA	pending application
44	2019	Two-photon Probe and Tracer for PET Specific to Amyloid-beta Oligomers and Plaques	KOREA	patent registration
45	2017	Method and Device for Improving of the Consolidation of Memory During Sleep Using Stimulation of Thalamic spindles	KOREA	pending application
46	2017	Optogenetic protein clustering through fluorescent protein tagging and extension of CRY2	KOREA	patent registration
47	2018	A Stimuli activated Flp recombinase and Uses thereof	PCT	pending application
48	2017		KOREA	patent registration
49	2019		U.S.A.	pending application
50	2019		JAPAN	patent registration
51	2019	Brain stimulating device and use thereof	E.P.O	pending application
52	2019		CHINA	patent registration
53	2017		PCT	pending application
54	2017		KOREA	patent registration
55	2016		KOREA	pending application
56	2021		U.S.A.	pending application
57	2018	Antibody analogue capable of being activated reversibly and uses thereof	U.S.A.	patent registration
58	2016		PCT	pending application
59	2016		KOREA	patent registration
60	2014	test method of sociality of target	KOREA	patent registration
61	2014	Test apparatus and method of recognition function of target	KOREA	patent registration
62	2014	cell culture vessel and the method for cell culture	KOREA	pending application
63	2013	Pharmaceutical composition comprising N1-cyclic amine-N5-substitued bigunide derivatives as an ingredient for preventing or treating aging-induced cognitive decline	KOREA	patent registration

TECHNOLOGY
TRANSFER

CONTRACT DATE	TECHNOLOGY TITLE
2019.3	Brain stimulating device and use there of
2019.5	Antibody analogue capable of being activated reversibly and uses there of
	Non-invasive optogenetics for control of cellular function in vivo system

VIRUS
FACILITY
OPERATIONAL
RECORD

● distribution(\$)
■ times utilized



IBS CCS actively hosts various domestic and international academic events. CCS holds symposiums three times a year, and seminars that invite excellent scientists in the field of brain science are held on a weekly basis.

In addition, CCS collaborates with various organizations such as The Royal Society, Korean Brain Society, and Association of Korean Neuroscientists. Through such collaboration, CCS shares the latest research trends with world-class scholars and influential figures in the field of brain science and promotes research cooperation.

Meanwhile, PIs at CCS actively attend prestigious international academic events such as the Society for Neuroscience (SFN) annual meeting or the UK-Korea Neuroscience Symposium, where they are frequently invited as chairpersons, speakers, or co-organizers.

WORKING



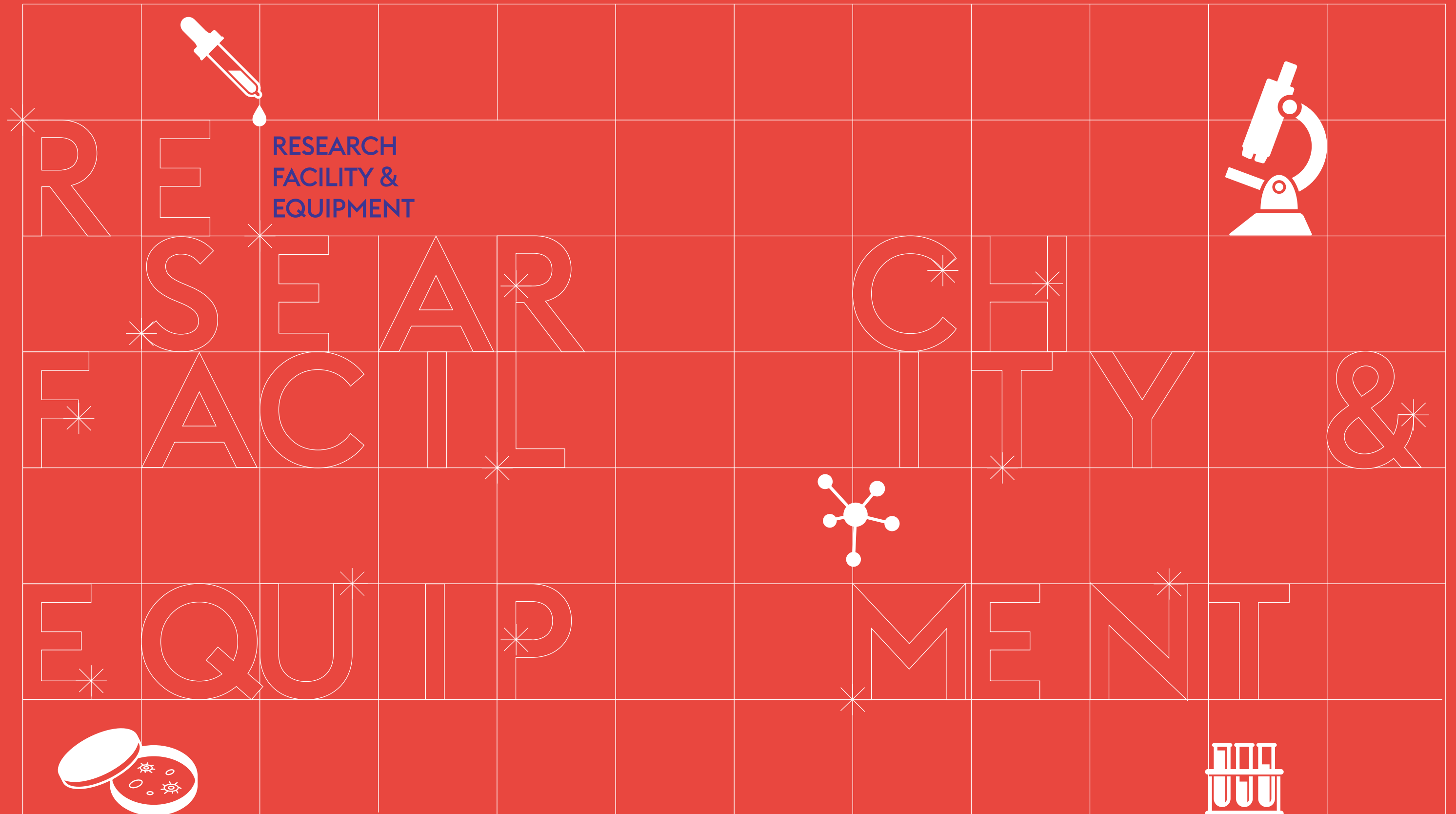
WORKING
AT
CCS

IBS CCS provides a creative open research environment and excellent welfare for all researchers regardless of their nationality, gender, or age.

AT
CCS

									
									
WORKING AT CCS		IBS boasts the highest proportion of international researchers among Korean research institutes, and it is equipped with various support services such as a bilingual system and a global help desk.						It also promotes gender equality as a key policy and provides a friendly environment for researchers with children. Researchers alone or with their families can live in the dormitory and use the on-campus daycare center.	
									

		WORKING AT CCS											
													
										Specialized educational institutions such as science high schools and foreign schools are also nearby, and through agreements with some institutions, they offer discounts on tuition for children of IBS employees.			
													
CCS is located in the middle of downtown Daejeon which has various cultural, recreational, and commercial infrastructures.													
													



RESEARCH FACILITY & EQUIPMENT



Lightsheet microscope (LSFM or SPIM)

#imaging
#3D_imaging
#service

Available Systems
- Lightsheet 7, Zeiss

Fluorescence microscopy technique with an intermediate-to-high optical resolution, but good optical sectioning capabilities and high speed. In contrast to epifluorescence microscopy only a thin slice (usually a few hundred nanometers to a few micrometers) of the sample is illuminated perpendicularly to the direction of observation. For illumination, a laser light-sheet is used, i.e. a laser beam which is focused only in one direction (e.g. using a cylindrical lens). As only the actually observed section is illuminated, this method reduces the photodamage and stress, also the background signal. Because LSFM scans samples by using a plane of light instead of a point (as in confocal microscopy), it can acquire images at speeds 100 to 1000 times faster than those offered by point-scanning methods.

Single Cell NGS

#sequencing

Available Systems

- CI, Fluidigm
- BioMark HD Reader, Fluidigm
- MiSeq, Illumina



Massive sequencing tool to describe and analyze genome / transcript information. Seeks for quantified data from DNA, RNA, methylation / epigenetics. Aids research in cancer biology, neuroscience, complex (genomic) disease.

Animal facility

#service
#animal



4,836m²



The animal facility is heavily equipped with various animal behavior test tools, including customized instruments for testing learning & memory, cognition and sociality tasks. Can be used to address instinctive behaviors (fear) to high cognitive functions (empathy). As the core facility for life science research at IBS, the Laboratory Animal Resource Facility(LARF) ensures optimal support for animal experiments with proper care and management of animals. LARF has the capacity to house up to 30,000 mice and 6,000 cages over an area of 4,836m².

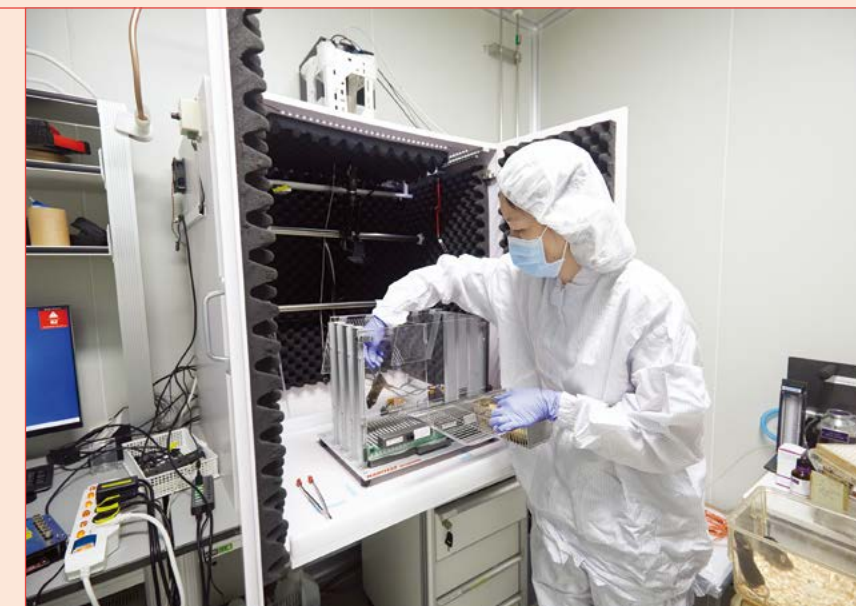


Animal behavior

#Animal
#behavior_test

Available Systems

- Observational Fear
- Barnes maze
- Field test / object test
- Rotarod
- Ultrasound Vocalization
- Tube test
- 3 chamber
- Attention behavior
- Y maze
- Rule observance
- Sleep analysis



The timsTOF fleX is a full-featured, high-speed, high-sensitivity electrospray ionization (ESI) instrument for multi-omics analysis with an integrated matrix-assisted laser desorption/ionization (MALDI) source for fast MALDI imaging. This instrument is best suited for MALDI imaging of thousands of molecules, such as lipids, peptides, proteins, glycans, and metabolites with higher spatial resolution, improved image acquisition, speed and better molecular specificity. In addition, collisional cross section (CCS) values generated with trapped ion mobility spectrometry (TIMS) device at the front of a quadrupole time-of-flight (QTOF) mass spectrometer enable the detection and separation of isobaric or isomeric ions at low concentration levels that are difficult to separate with other commercially available MALDI imaging instruments.



timsTOF fleX

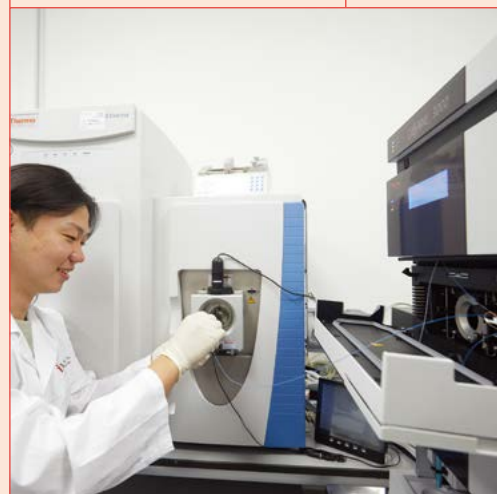
#Core facilities
#Services
#tims-TOF pro2
#MALDI imaging
#Spatial multiomics

05

06

Orbi-Trap

#mass_analysis



Mass Spectrometer

#mass_analysis

Available Systems

- Q Exactive, Thermo

The injection flatapole transmits ions from the source to the quadrupole, which works as ion transmission device with the possibility to filter the transmitted ion according to its mass-to-charge ratios. The ions are transferred into the C-Trap and then injected into the Orbitrap mass analyzer to get mass spectra.

Q Exactive hybrid quadrupole-Orbitrap mass spectrometer mainly includes an ion source, a stacked-ring ion guide (S-lens), a quadrupole mass filter, a curved linear trap (C-trap), a Higher Energy Collisional Dissociation (HCD) cell, and an Orbitrap mass analyzer.

HPLC is an abbreviation for High Performance Liquid Chromatography. "Chromatography" is a technique for separation, "chromatogram" is the result of chromatography, and "chromatograph" is the instrument used to conduct chromatography. Among the various technologies developed for chromatography, devices dedicated for molecular separation called columns and high-performance pumps for delivering solvent at a stable flow rate are some of the key components of chromatographs. As related technologies became more sophisticated, the system commonly referred to as High Performance Liquid Chromatography, simply became referred to as "LC". Nowadays, Ultra High Performance Liquid Chromatography (UHPLC), capable of high-speed analysis, has also become more wide-spread.

UHPLC / NLC

#mass_analysis

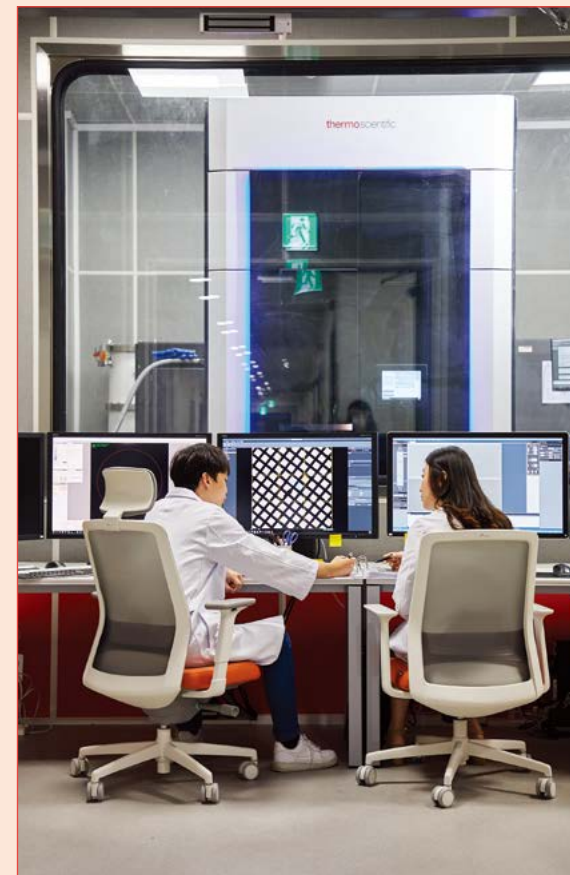
Available Systems

- UltiMate3000, Thermo
- EasyNLC 1000, Thermo
- 1260 Infinity, Agilent

Electron Microscopy Facility

#structure_analysis
#imaging

07



Available Systems

- Glacios, Thermo Fisher
- Krios G4, Thermo Fisher

Uses a beam of electrons as a source of illumination, whose wavelength can be up to 100,000 times shorter than that of visible light photons. Has a higher resolving power, about 250 pm resolution and up to about 1,000,000× magnification.

Selected Publications

Nat. Med. 2014 Aug;20(8):886-96,
Cell. 2012 Sep 28;151(1):25-40

This system expands access to high-performance imaging and analytics to all levels of microscopy expertise. With ColorSEM Technology, a unique live elemental imaging capability, compositional information is available. Eliminating all the hassle associated with typical EDS implementations, ColorSEM Technology offers unprecedented time to result and ease of use.

08

FE-SEM

#structure_analysis
#imaging

Available Systems

Apreo2S, Thermo Fisher



09

Confocal Microscopy

#imaging

Available Systems

- AIR, Nikon
- AI, Nikon
- C2, Nikon
- LSM 700, Zeiss
- LSM 880 Airyscan, Zeiss
- LSM 900, Zeiss

An optical imaging instrument for enhanced optical resolution and contrast by means of using a spatial pinhole to block out-of-focus light in image formation. Broadly used to see the detailed structure of objects within specimen.



12

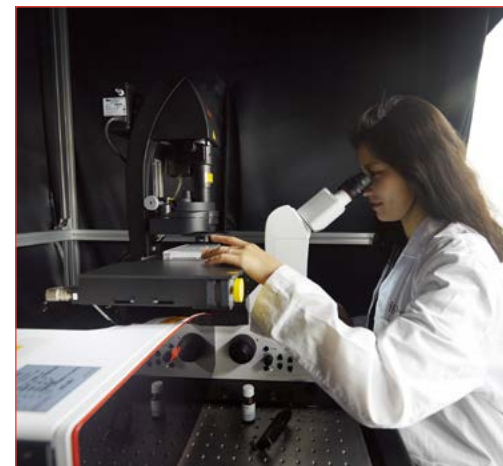
Leica Thunder

#imaging

Available Systems

- Thunder Imager 3D, Leica

Thunder Imagers use an integrative holistic approach to overcome the limitations of camera-based imaging systems. Detects and removes the unwanted signals from out-of-focus regions of the specimen, distinguishes between the out-of-focus and in-focus signals via the difference in size of the features.



10

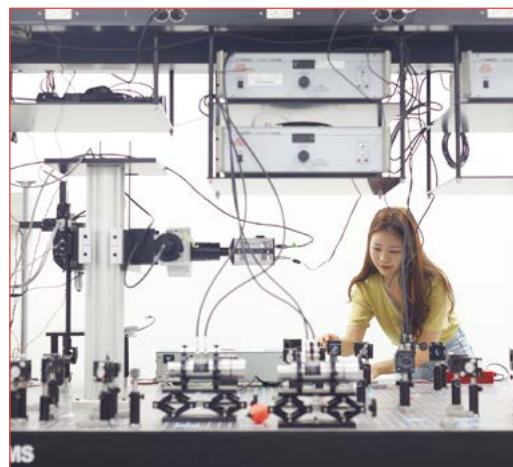
Multi-photon Microscopy

#imaging

Available Systems

- AIR-MP, Nikon
- MOM, Sutter
- Scientifica

Enhances the ability to observe complex and dynamic biological processes from deeper within living tissue with minimal invasion and photodamage. This gives a much more effective way for imaging thick specimen.



13

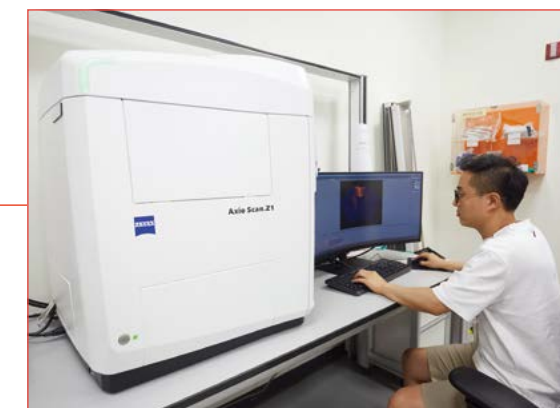
Slide Scanner

#imaging

Available Systems

- Axioscan ZI., Zeiss

The tissue slide scanner automatically obtains image of multiple slides and helps analysis & management of a large amount of data. Equipped with modular tray: can digitize glass slide of any type.



11

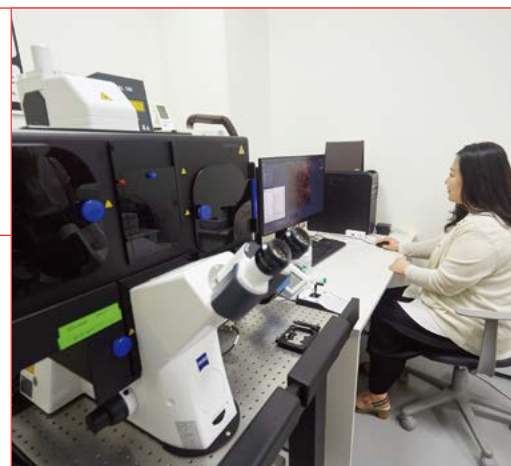
SUPERRESOLUTION MICROSCOPY

#imaging

Available Systems

- N-SIM, Nikon
- Lattice SIM, Zeiss
- N-STORM, Nikon

Structured Illumination Microscopy (SIM) is a super-resolution fluorescence optical microscope imaging technique that increases resolution by patterned light. Stochastic optical reconstruction microscopy (STORM) relies on the sequential activation and time-resolved localization of fluorophores to generate high-resolution images.



14

FACS

#cell_sorting

Available Systems

- Fortessa, BD
- Cantoll, BD
- Astrios, Thermo Fisher

Analyze expression of molecules in heterogeneous cell population or particles. Measures physical and chemical characteristics particles using light (laser) and used to determine cell characteristics / function, state of differentiation, and for diagnostic purpose.



15

AI assisted
behavior
analysis

#animal
#behavior_test

A real-time 3D motion reconstruction system to detect whole freely moving behavior in open-field without any marker. The AVATAR system consist of multi-vision hardware and object detection deep learning algorithm that can be used for various mice experiment. This system precisely identifies motion units, a set of body posture/frame, enabling the real-time motion sequencing with sub-millisecond resolution, opening new avenue toward the unsupervised behavioral analysis.



Available Systems
- AVATAR

16

Virus
facility

#service
#virus

Provide services of
viral vector design,
cloning, and virus
production for gene
of interest to the
worldwide basic
science researchers.



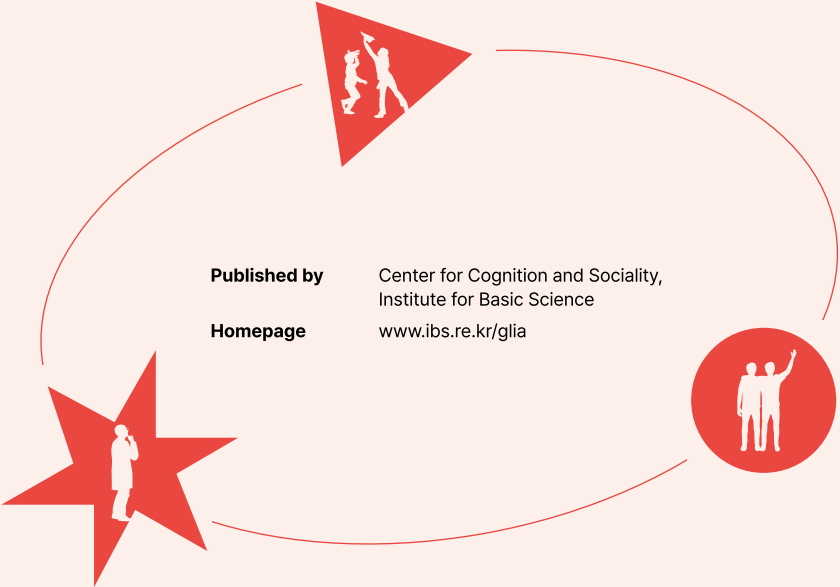
17

Data Center

#data_processing

Available Systems
- ALEPH

The ALEPH is a super-computer in IBS ranked in 3rd in Korea / 445th in worldwide with maximum performance of 1.43 Pflops. This will give you a great opportunity to deal with a large dataset, or train the AI you made.





CCS
Homepage

55 Expo-ro, Yuseong-Gu, Daejeon, South Korea