"International Conference On It-Bio Convergence"

February 13 (Mon) – 15 (Wed), 2023

MUJU DEOGYUSAN RESORT, SOUTH KOREA

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Organizer & Sponsor

Center for IT-Bio Convergence System Agriculture
Chonnam National University
Sunchon National University
Chosun University

National Research Foundation of Korea

Welcome Message

On behalf of Organizing Committee, I would like to extend a warm welcome to all participants of the 4th International Conference of the Brain Korea 21 FOUR Interdisciplinary Program in IT-Bio Convergence System. I also express my appreciation to all speakers for their contribution to this conference.

Three universities of Chonnam National University, Suncheon National University, and Chosun University participate in this program and involve the research area of agricultiral & life sciences and ICT. The main targets of this program are to foster high-quality human resources and to advance R&D in the field of “Smart Farm”.

A smart farm is defined as a farm that combines agriculture with ICT solutions to improve productivity. Smart farms are powered by cutting-edge technologies underlying the Fourth Industrial Revolution, such as IoT, drone technology, big data, robotics, AI, nanotechnology, and 3D printing while optimizing the human labor required. Smart Farming has a real potential to deliver a more productive and sustainable agricultural production, based on a more precise and resource-efficient approach.

This conference will provide a platform to share experience, ans to explore the state-of-the-art technologies and future directions in the field of Smart Farm. I think special topic of “Change in Future Agriculture with New Technology” is proper and timely. Especially, I’d like to express my sincere thanks to Prof. Kim, the head of the BK21 FOUR Interdisciplinary Program in IT-Bio Convergence System and the 17 distinguished lectures, even to student speakers and all members of the Organizing Committee.

I sincerely wish all participants of this conference would have a meaningful and productive time. Once again I appreciate your participation in this conference.

Thank you very much.

February 13, 2023

Youngsoo Choi, Professor, Chonnam National University

General Chair of the International Conference on IT-Bio Convergence

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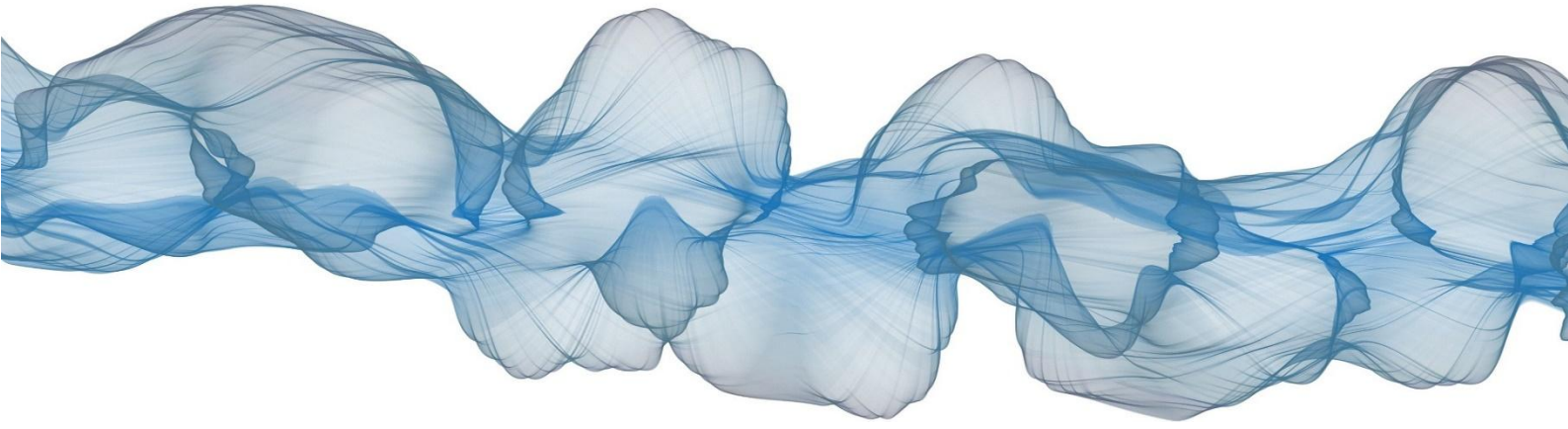


Congratulatory Address

I would like to congratulate holding the 4st International Conference of the Brain Korea 21 FOUR Interdisciplinary Program in IT-Bio Convergence System Agriculture at Chonnam National University of “confident and unconstrained CNU”

Still under this tough circumstances of COVID-19 pandemic, I deeply appreciate the greatest scholars’ passion to hold this conference for the exchange of opinions in the field of smart farm.

The world’s greatest scholars in the field of IT-Bio attend this wonderful conference, which will provide the latest advances in basic and applied research with the world-class scholars in smart farm.

Our Chonnam National University has put in a lot of energy and efforts into hosting this conference. I would like to thank Professor Yeongsoo Choi, General Chair, and Professor Jangho Kim, the head of BK 21 Four center for IT-Bio Convergence System Agriculture as well as all the related officials for opening this conference successfully.

Our Chonnam National University was established in 1952 and is one of the flagship Korean national universities, as well as a university of "Change N Unite" that explores truth and creates new knowledge.

Through this conference, I sincerely hope that it will be a good opportunity to join Chonnam National University in various cooperative measures, including research and education of the IT-Bio Convergence System Agriculture including smart farm.

Thank you to all the professors, researchers, and students around the world for joining us, today.

Finally, I would like to express my sympathy and gratitude to all of you who have worked hard to make this conference successful.

Once again, warm welcome and thank you.

February 13, 2023

Sungtaek Jung

President of Chonnam National University

축사

'당당하고 자유로운' 전남대학교에서 4번째 BK21 FOUR IT-Bio융합시스템농업 국제학술대회가 개최된 것을 진심으로 축하하고 반갑게 생각합니다.

아직 여전한 코로나19 팬데믹의 어려운 상황에서 스마트팜 분야의 석학들이 상호 의견 교류의 장을 펼치는 열정에 감사의 말씀드립니다.

BK 21 FOUR IT-Bio융합시스템농업 국제학술대회는 IT-Bio 분야의 저명한 학자들이 참석하는 국제학술대회로, 이번 학술대회에서는 관련 스마트팜 분야의 최신 지견과 논문이 발표될 것입니다.

전남대학교는 본 학회의 개최를 위하여 혼신의 힘을 쏟았습니다. 수고해주신 조직위원장 이신 최영수 교수와 IT-Bio융합시스템농업교육연구단장 김장호 교수를 비롯한 많은 관계자 분들에게 감사의 말씀을 드립니다.

1952년에 개교한 전남대학교는 대한민국의 자랑스러운 거점국립대학으로 진리를 탐구하고 새로운 문화를 창조하며, 국가와 지역사회에 봉사하는 "Change N Unite" 대학입니다.

본 학회를 통하여 미래 농업의 핵심요소인 스마트팜 연구와 교육을 비롯한 다양한 협력방안을 전남대학교와 함께 할 수 있는 좋은 계기가 되길 바랍니다.

함께 자리해 주신 전 세계의 여러 교수님, 연구원, 및 학생들에게도 감사드립니다.

끝으로, 학술대회를 준비하느라 애쓰신 관계자 여러분의 노고에 위로와 감사의 말씀을 드립니다.

환영합니다. 그리고 고맙습니다.

2023년 2월 13일

전남대학교 총장 정성택

Congratulatory Address

On the occasion of the opening of the 4st International Conference of the Brain Korea 21 FOUR Interdisciplinary Program in IT-Bio Convergence System, on behalf of the IT-Bio Convergence System Agriculture center, I would like to offer my warmest congratulations and extend my sincere welcome to everyone who are with us today.

Our Chonnam National University has 24 BK21 FOUR teams, which is top 7 throughout the nation. Especially the IT-Bio Convergence System Agriculture center who has organized this conference, has the pride as the only national level BK21 team among local universities.

Titled “Change the Future Agriculture with New Farming Technology”, the conference will bring together researchers and engineers from around the world to present their latest research accomplishments, innovations, and visions in the field of IT-Bio.

We hope that the 4st International Conference of the BK 21 FOUR Interdisciplinary Program in IT-Bio Convergence System will be a valuable, memorable and an exciting platform for the participants to exchange information and ideas for their advanced researches.

We are very grateful to the IT-Bio Converegence System Agriculture center and the conference general chair (Prof. Yeongsoo Choi) and the dean of center (Prof. Jangho Kim) for opening this conference successfully.

I want to extend a special welcome to students and to guests joining us for this conference. I would like to express gratitude to all of you who have worked hard to make this conference successful.

Warm welcome. Best wishes for a spectacular conference.

February 13, 2023

Dean of the Graduate School at Chonnam National University

Sang Hyun Kwak

축사

4번째 BK 21 FOUR IT-Bio융합시스템농업 국제학술대회 참석해주신 분들께 감사 인사드립니다.

전남대학교 4단계 BK21 교육연구단(팀)은 총 22개로 구성이 되었으며, 이는 전국 7위 규모입니다. 특히, 본 학술대회를 개최하는 IT-Bio융합시스템농업교육연구단은 지역대학으로는 유일하게 전국 단위의 BK21사업단으로 그 자부심이 있습니다.

“Change the Future Agriculture with New Farming Technology“라는 소제목의 본 학회는 스마트팜 분야의 새로운 비전을 제시하는 교류의 장이 될 것이라고 생각됩니다.

참석하신 모든 분들이 연구 교류를 하면서 각자의 진보된 연구를 위해 뜻깊고 기억에 남는 시간이 되길 바랍니다.

본 학회 개최를 위해 수고해주신 IT-Bio융합시스템농업교육연구단과 조직위원 장이신 최영수 교수와 단장이신 김장호 교수에게 감사인사 드립니다.

마지막으로, 학회에 참석해주신 초청강연자들을 환영하며, 수고해주신 모든 분들에게 감사인사 드립니다.

환영합니다. 그리고 멋진 학회가 되길 기원합니다.

2023년 2월 13일

전남대학교 대학원장 곽상현

Congratulatory Address

I would like to offer my warmest congratulations for holding the 4st International Conference of Brain Korea 21 FOUR Interdisciplinary Program in IT-Bio Convergence System Agriculture at the College of Agriculture and Life Sciences in Chonnam National University.

Based on the 114 years of history and the tradition, the College of Agriculture and Life Sciences of Chonnam National University is leading our country's agricultural development.

Chonnam National University is conducting agricultural education that combines the advanced science and technology, and is taking the lead in fostering the members of society who have the excellent field sense for preparing the 4th industrial revolution. In particular, the BK21 FOUR Interdisciplinary Program in IT-Bio Convergence System Agriculture is committed to foster the future agricultural manpower through the education and research of cutting-edge smart farms.

I would like to thank Professor Yeongsoo Choi, the general chair of the organizing committee, Professor Jangho Kim, the head of the Interdisciplinary Program in IT-Bio Convergence System Agriculture, and all the participating professors for organizing the international conference for the scholars in smart farm through online.

Through this conference, I hope that information on agriculture and young future agricultural talents can grow further, and thank you to many of you for joining us.

Once again, warm welcome and thank you.

February 13, 2023

Dean of College of Agriculture and Life Sciences

at Chonnam National University

Jae-Hak Moon

축사

전남대학교 농업생명과학대학 중심의 4번째 BK21 FOUR IT-Bio융합시스템농업 국제학술대회가 개최된 것을 진심으로 축하하고 환영합니다.

전남대학교 농업생명과학대학은 114년의 역사와 전통을 바탕으로 우리나라 농업 발전에 선도적인 역할을 수행하고 있습니다.

4차 산업혁명시대를 맞아 첨단과학기술을 접목한 농업교육을 실시하며, 현장 감각이 탁월한 사회인을 양성하는데 앞장서고 있습니다. 특히, BK21 FOUR IT-Bio융합시스템농업교육연구단은 최첨단 스마트팜의 교육과 연구를 통한 미래 농업 인력 양성에 최선을 다하고 있습니다.

이번 국제학술대회에서는 다양한 스마트팜 분야의 석학들과 함께 국제학술대회를 개최하게 되었습니다. 수고해 주신 조직위원장이신 최영수 교수와 IT-Bio융합시스템농업교육연구단 단장 김장호 교수, 그리고 참여 교수들에게 감사의 말씀을 드립니다.

본 학회를 통하여 농업의 정보와 젊은 미래 농업 인재들이 더욱더 성장할 수 있는 장이 되기를 바라며, 함께 자리해 주신 많은 분들께도 감사드립니다.

다시 한 번, 환영의 인사를 드립니다. 감사합니다.

2023년 2월 13일

전남대학교 농업생명과학대학장 문제학

축사

제4회 BK21 FOUR IT-Bio융합시스템농업 국제학술대회에 참석해 주심을 진심으로 환영합니다. 안녕하세요. 저는 BK21 FOUR IT-Bio융합시스템농업교육연구단의 단장을 맡고 있는 전남대학교 김장호 교수입니다.

저희 BK21 FOUR IT-Bio융합시스템농업교육연구단은 전남대학교, 순천대학교, 조선대학교의 훌륭하신 26분의 교수님을 포함한 연구원, 학생 및 행정직원으로 구성되어 있습니다. 특히, 국내 최초의 국립대-사립대 연합의 "스마트팜" 분야BK 연구교육단으로 미래 농업과 바이오산업을 이끌 고급인력 양성에 최선을 다하고 있습니다.

이번 저희 교육연구단에서 전남대학교 최영수 교수님을 조직위원장으로 모시고 제4회 BK21 FOUR IT-Bio융합시스템농업 국제학술대회를 개최하게 되었습니다. 아주 기쁘고 영광스럽게 생각 합니다.

본 국제학술대회를 위해서 전남대학교 정성택 총장님, 곽상현 대학원장님, 문제학 농업생명과학대학장님께서 축사를 해 주셨습니다. 이에 큰 감사의 인사를 드리며 앞으로도 많은 격려와 관심을 부탁드립니다. 또한 국내외 많은 분들께서 본 학술대회에 참여해 주심에 깊은 감사의 인사를 드립니다.

특히, 본 학술대회를 통하여 학생 여러분들께서 미래 농업 산업의 가치를 더 이해하고 함께 나아갈 수 있는 좋은 기회가 되길 진심으로 바래봅니다. 다시 한 번, 함께 자리해 주신 모든 분들께 감사와 환영의 인사를 드립니다.

2023년 2월 13일

IT-Bio융합시스템농업교육연구단장 김장호

Program Schedule

2023 4th International Conference of the Brain Korea 21 FOUR Interdisciplinary Program in IT-Bio Convergence System

"Change The Future Agriculture with New Farming Technology"

Muju Deogyusan Resort, Carnival Culture Palace (Ensemble Hall), South Korea

February 13 (Mon), 2023, 12:50 p.m. – February 15 (Wed), 2023, 18:00 p.m.

@Center for IT-Bio Convergence System Agriculture

■ Welcome Remark - Feb. 13 (Mon)

Korean time	Chair: Prof. Heegyeong Yi
12:50 - 13:00	**Congratulatory Address** President of Chonnam National University, Sungtaek Jung
	Congratulatory Address Dean of the Graduate School, Chonnam National University, Sang Hyun Kwak
	Congratulatory Address Dean of College of Agriculture and Life Sciences, Chonnam National University, Jae-Hak Moon
	Welcome Address Dean of IT-Bio Convergence System Agriculture, Chonnam National University, Jangho Kim
	Welcome Message General Chair, Chonnam National University, Youngsoo Choi

■ Session 1: Invited Lectures - Feb. 13 (Mon)

Korean time / Speaker's time	Chair: Prof. Jangho Kim
13:00 - 13:25 08:00 - 08:25 (Feb.12)	**"Immobilized Transgenic Rice Cells for Intensified Long Term Bioproduction"** Dr. Karen A. McDonald (University of California, USA)
13:25 - 13:50 13:25 - 13:50	**"From Silkroad to Bioroad"** - Dr. Enoch Y. Park (Shizuoka University, Japan)
13:50 - 14:15 05:50 - 06:15	**"Toward Robotic Aerial Co-workers in Civil Applications"** - Dr. Antonio Franchi (University of Twente, Netherlands)
14:15 - 14:40 06:15 - 06:40	**"Steering Microbiomes by Organic Amendments Towards Climate-Smart Agricultural Soils"** Dr. Paul L.E. Bodelier (Netherlands Institute of Ecology, NIOO, Netherlands)

14:40 – 15:00	**Coffee break**

■ Session 2: Invited Lectures - Feb. 13 (Mon)

Korean time	Chair: Prof. Hyoung Il Son
15:00 – 15:20	**"Agrivoltaics Research on Vegetables in Naju-si, Korea Including Kimchi Cabbage, Broccoli, Garlic, and so on: Yield, Quality, Profitability, and Sustainability"** - Dr. Kangmo Ku (Korea National University)
15:20 – 15:40	**"Yeast Metabolic Engineering to Produce Cosmetic Biomaterials for Industrial Applications"** - Dr. Soo-Jung Kim (Chonnam National University)
15:40 – 16:00	**"Molecular Mechanisms of Fungicide Resistance in Plant Pathogenic Fungi and Beyond"** - Dr. Hyunkyu Sang (Chonnam National University)
16:00 – 16:20	**"Performance Evaluation Method for Prediction of Building Cooling and Heating Load Using Granular Model"** - Dr. Chanwook Yeom (Chosun University)
16:20 – 16:40	**"Nanoengineered Cellular Behaviors for Controlling Functions of Biosystems"** - Dr. Sunho Park (Chonnam National University)
16:40 – 17:00	**"Field Robotics and Automation for Smart Agricultural System: Work in Progress"** - Dr. Chanyoung Ju (Korea Institute of Industrial Technology (KITECH))
17:00 – 17:10	**Coffee break**

■ Session 3: Student Short Talks - Feb. 13 (Mon)

Korean time	Chair: Prof. Hoon Seonwoo
17:10 – 17:20	**"Eggshell Membrane-Incorporated Cell Friendly Tough Hydrogels with Ultra-Adhesive Property"** - Yonghyun Gwon (Chonnam National University, Korea)
17:20 – 17:30	**"Siiding Mode Controller Design for Trajectory Tracking of a Vessel"** - Tegen Eyasu (Chosun University, Ethiopia)
17:30 – 17:40	**"Semantic Segmentation Model Applying Channel Enhancement Module of Polarization Filter Technique"** - Jinseong Kim (Sunchon National University, Korea)
17:40 – 17:50	**"Biodegradable and Flexible Nanoporous Films for Design and Fabrication of Active Food Packaging Systems"** - Woochan kim(Chonnam National University, Korea)
17:50 – 18:00	**"Artificial Intelligence for Real-time Respiratory Health Monitoring System in Swine Farming"** - Eddiemar Lagua (Sunchon National University, Philippines)
18:00 – 18:10	**"Factors of Soil Moisture on Potted Plant Quality and Life after Distribution Kalanchoe Blossfeldiana 'Queen bell"** - Seyeong Lee (Chonnam National University, Korea)

18:10 – 18:20	**“Biocompative 3D-Printing Ti6Al4V-based Implants Embedded with Equine Bone”** - Juo Lee (Sunchon National University, Korea)
18:20 – 18:30	**"Engineering Plant Growth and Development on Nanotopographical Cues”** - Safdar Mahpara (Chonnam National University, Pakistan)
18:30 -	**Banquet**

■ Session 4: Invited Lectures - Feb. 14 (Tue)

Korean time / Speaker’s time	Chair : Profs. Jangho Kim and Yeon-Ok Kim
09:00 – 09:25 05:00 – 05:25 (Feb 13)	**"Nucleus-Chloroplast Communication”** - Dr. Chan Yul Yoo (University of Utah, USA)
09:25 – 09:50 01:25 – 01:50	**"Shared Control for Tele-Manipulation and Tele-Navigation”** - Dr. Paolo Robuffo Giordano (Centre National de la Recherche Scientifique (CNRS), France)
09:50 – 10:15 09:50 – 10:15	**"Dehydrins: Stress-Responsive Intrinsically Disordered Proteins in Plants”** - Dr. Masakazu Hara (Shizuoka University, Japan)
10:15 – 10:40 07:15 – 07:40	**"Current Practice and Future Prospects of Smart Poultry Farming in Bangladesh”** - Dr. Md. Sazedul Karim Sarker (Principal Scientific Officer & Head, Poultry Research Center, Bangladesh)
10:40 – 11:05 10:40 – 11:05	**"Canopy Micrometeorology Model to Improve the Prediction of Heat Stress in Rice Under Global Warming”** - Dr. Mayumi Yoshimoto (Senior Principal Scientist, Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization (NARO), Japan)
11:05 – 11:30 07:05 – 07:30	**"Smart Farming: Innovative Tool for Sustainable Livestock Production”** - Researcher MS. Muhammad Ammar Dilawar (Institute of Professional Veterinary Training, Pakistan)
11:30 – 11:55 10:30 – 10:55	**"Bio-Signal Classification Based on Machine Learning”** - Dr. Jae-Neung Lee (SHENZHEN-BASED Southern University of Science and Technology, China)
11:55 - 13:30	**Coffee break & Luncheon seminar**

"International Conference of the BK21 FOUR on IT-Bio Convergence"

■ February 13 (Mon): Session 1, Session 2, Session 3

BK21 FOUR
IT-Bio융합시스템농업교육연구단
제 4회 국제학술대회

Zoom Meeting (Session 1, Session 2, Session 3)

February 13 (Mon), 2023 (13:00 ~ 18:30)

Zoom address

Meeting ID : 886 9842 3048

Password : 1004

■ February 14 (Tue): Session 4

BK21 FOUR
IT-Bio융합시스템농업교육연구단
제 4회 국제학술대회

Zoom Meeting (Session 4)

February 14 (Tue), 2023 (09:00 ~ 11:55)

Zoom address

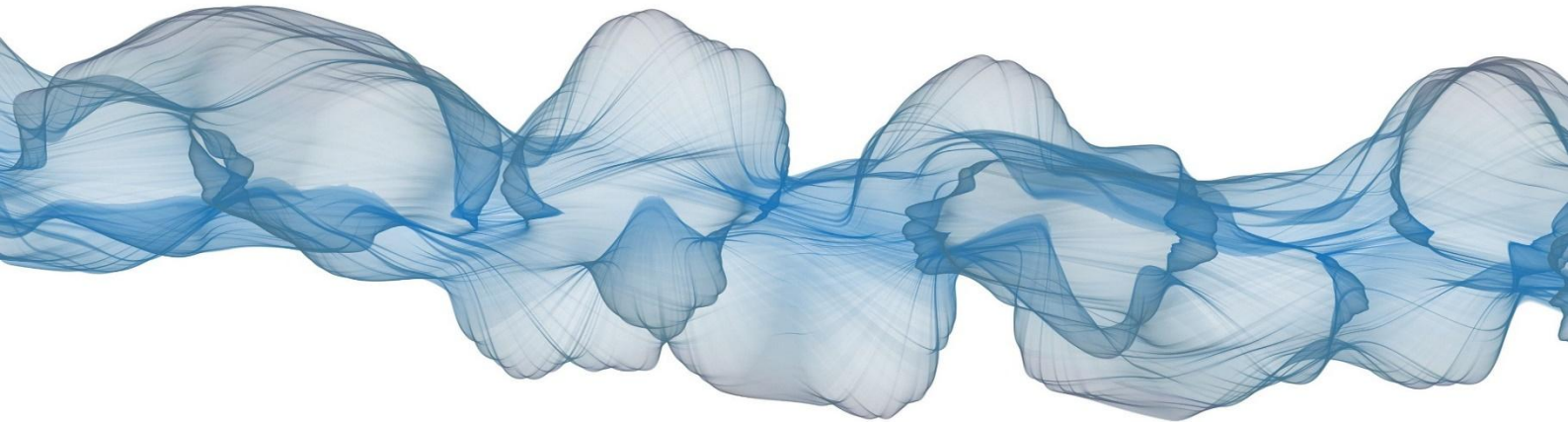
Meeting ID : 820 9647 2394

Password : 1004

ABSTRACT

Session 1 (Feb. 13):

INVITED LECTURES



Immobilized Transgenic Rice Cells for Intensified Long Term Bioproduction

Karen A. McDonald

Department of Chemical Engineering, University of California, Davis, CA, United States

Living plant cells can be engineered to produce heterologous proteins in response to a wide variety of external stimuli including chemicals, light, temperature, and biotic and abiotic stress. They are ideal controllable living systems for incorporation into nonliving matrices (polymers, gels, etc.) using either immobilization or bioprinting technologies for several reasons. First, their relatively low metabolic uptake rates reduce concerns about nutrient and oxygen mass transfer limitations within the matrices even for reasonably high seeding densities. Second, their slow growth rates allow them to be used over long time periods before reaching physical space constraints. Third, they are relatively robust and able to withstand short term perturbations in nutrient concentrations, temperature, pH, and shear stress.

In this talk I describe two approaches our laboratory has used towards bioprocess intensification using transgenic rice (Oryza sativa) cell cultures for recombinant protein production. The rice cells have been engineered to produce recombinant butyrylcholinesterase (BChE) as a prophylactic/therapeutic against organophosphate nerve agent poisoning, cocaine toxicity, and neurodegenerative diseases like Alzheimer's. BChE is a large (~340 kDa), multimeric (homotetrimer) glycoprotein (10 N-linked glycosylation sites per monomer), presenting a challenge for heterologous production. In our transgenic rice system, BChE production is controlled by a sugar-responsive promoter, the rice alpha-amylase 3D promoter, thus sugar concentration is the primary control stimulus, with high sugar levels promoting growth and sugar-free conditions leading to BChE production. The BChE gene construct includes a secretion signal peptide to target the product to the apoplast. In the first approach we use a packed bed rice cell culture in a single-use disposable membrane bioreactor over 180 days of semicontinuous operation for repeated BChE production. In the second approach we have immobilized the transgenic rice (Oryza sativa) cell aggregates in hydrogels. This work serves as a foundation for further investigation towards engineering stimulus-responsive living plant cells for intensified bioproduction, representing a simple, efficient, robust, modular, and potentially field-deployable bioreactor system for the manufacture of biologics and other products.

Curriculum Vitae – Prof. Karen A. McDonald, PhD

Department of Chemical Engineering, 1 Shields Avenue,
University of California, Davis, CA USA

Mob: (707) 548-8314
Tel: (530) 752-8314
Email: kamcdonald@ucdavis.edu

Education

- Ph.D., Chemical Engineering, Univ. of Maryland, College Park, MD (1985)
- M.S., Chemical Engineering, Univ. of California, Berkeley, CA (1980)
- B.S., Chemical Engineering, Stanford University, Stanford, CA, (1979)

Research and Teaching Positions

- 2022 - Distinguished Professor, Department of Chemical Engineering, University of California, Davis
- 2013 - 2018 Faculty Director, UC Davis ADVANCE Program
- 2001 - 2013 Associate Dean, Research and Graduate Studies, College of Engineering, University of California, Davis
- 2000 - 2001 Acting Associate Dean, Research and Graduate Studies, College of Engineering, University of California, Davis
- 1998 - present Professor, Department of Chemical Engineering, University of California, Davis
- 1993 - 1998 Associate Professor, Department of Chemical Engineering and Materials Science, University of California, Davis
- 1985 - 1993 Assistant Professor, Dept. of Chemical Engineering, University of California, Davis
- 1982 - 1985 Research Assistant, Dept. of Chemical Engineering, University of Maryland, College Park
- 1979 - 1982 Member of Technical, Sandia National Laboratories, Staff, Livermore, CA

Selected Refereed Journal Articles (last 5 years)

1. Matthew J. McNulty, Naomi Hamada, Jesse Delzio, Liber McKee, Somen Nandi, Marjorie L. Longo, and Karen A. McDonald (2022). Functionalizing Silica Sol-gel with Entrapped Plant Virus-based Immunosorbent Nanoparticles, Journal of Nanobiotechnology, 20:105, doi: 10.1186/s12951-022-01303-1.

2. Anika Varma, Hawi B. Gemeda, Matthew J. McNulty, Karen A. McDonald, Somen Nandi, and Jennifer M. Knipe (2021). Immobilization of Transgenic Plant Cells Towards Bioprinting for Production of a Recombinant Biodefense Agent, Biotechnology Journal, 16(10) e2100133, doi: 10.1002/biot.202100133.

3. Kantharakorn Macharoen, Min Du, Seongwon Jung, Karen McDonald, and Somen Nandi (2021). Production of Recombinant Butyrylcholinesterase from Transgenic Rice Cell Suspension Cultures in a Pilot Scale Bioreactor, Biotechnology and Bioengineering, 118: 1431–144, doi: 10.1002/bit.27638.

4. Kantharakorn Macharoen, Karen A. McDonald, and Somen Nandi (2020). Simplified Bioreactor Processes for Recombinant Butyrylcholinesterase Production in Transgenic Rice Cell Suspension Cultures, Biochemical Engineering Journal 163: 107751, doi: 10.1016/j.bej.2020.107751.

5. Jasmine M. Corbin, Matthew J. McNulty, Kantharakorn Macharoen, Karen A. McDonald, and Somen Nandi (2020). Techno-economic Analysis of Semicontinuous Bioreactor Production of Biopharmaceuticals in Transgenic Rice Cell Suspension Cultures, Biotechnology and Bioengineering 117(10): 3053-3065, doi:10.1002/bit.27475.

6. Jasmine M. Corbin, Muchena J. Kailemia, C. Linn Cadieux, Salem Alkanaimsh, Kalimuthu Karuppanan, Raymond L. Rodriguez, Carlito B. Lebrilla, Douglas M. Cerasoli, Karen A. McDonald, and Somen Nandi (2018). Purification, Characterization, and N-glycosylation of Recombinant Butyrylcholinesterase from Transgenic Rice Cell Suspension Cultures, Biotechnology and Bioengineering, 115(5), 1301-1310, doi: 10.1002/bit.26557.

From Silkroad to Bioroad

Enoch Y. Park

Laboratory of Biotechnology, Molecular and Biological Function Research Core, Research Institute of Green Science and Technology, Shizuoka University, 836 Ohya Suruga-ku, Shizuoka 422-8529, Japan (E-mail: park.enoch@shizuoka.ac.jp)

Silkworms have provided enormous benefits to human beings for 5000 years. Still, silk is a high-value-added product and has contributed to natural fibers, medicine, and biomimetics. Recently, the silkworm has been one of the most attractive hosts for the large-scale production of eukaryotic proteins. Several human proteins were expressed successfully in silkworm larvae or pupa using our first developed practical Bombyx mori nucleopolyhedrovirus (BmNPV) bacmid system. Virus-like particles (VLPs) among recombinant proteins are highly attractive for vaccine candidates since they induce a more specific adaptive immune response. VLPs are empty virus particles formed by the self-assembly of structural proteins without encapsulating the viral genome. Furthermore, innate immunity can be activated due to efficient capture by immune cells. In this study, we focus on the display of antigens on the surface of VLPs using SpyTag (SpT)/SpyCatcher (SpC) molecular adhesive. SpT and SpC are 13 amino acid peptides and 116 amino acid proteins isolated from Streptococcus pyogenes. The binding between SpC and SpT is based on an isopeptide bond, which can spontaneously give high yields of SpC-SpT conjugate under various pH, temperature, and buffer conditions. This system was validated in a silkworm-bacmid expression system. We constructed bacmids by fusing Venus, a type of EGFP, to the N-terminus of SpC and mCherry to the N-terminus or C-terminus of SpT and expressed them in the display. Norovirus-like particles (NoV-LPs) and Canine parvovirus-like particles (CPV-LPs) were tried for antigen display. In the NoV-LPs, linker addition is effective, and in the CPV-LPs, the structurally exposed site shows higher display efficiency. The fluorescent protein EGFP as a model antigen protein, SpC-EGFP, was prepared by inserting SpC into the N-terminus of EGFP. We investigated the best-displaying site of the surface of VLPs structurally. As a result, L1-SpT showed an efficiency of 80.3%, and immunoelectron microscopy confirmed the display of EGFP on the CPV-LP surface. This result clarified that the amount of antigen displayed could be dramatically changed depending on the displaying site of VLPs. Our strategy suggests that silkworm-expressed VLPs are promising bivalent vaccine candidates against viral infections.

Funding: Grant-in-Aid for Scientific Research (A) Grant No. 22248009; Grant No. 19360372 from the Ministry of Education, Culture, Sports, Science and Technology, Japan.

Curriculum Vitae – Dr. Enoch Y. Park

Address: 884-44, Oshika Suruga-ku, Shizuoka 422-8529, Japan

Mob: +81-80-3064-1870
Tel: +81-54-238-4887 (Office)
Email: park.enoch@shizuoka.ac.jp

Education

・1976–1979: Department of Chemical Engineering, Han-Yang University. Awarded the degree of BS.

・1980–1981: Department of Chemical Engineering, Korea Advanced Institute of Science and Technology (KAIST). Awarded the degree of MS.c in Chemical Engineering

・1987–1990: Department of Chemical Engineering, University of Tokyo. Awarded the Ph.D. in Chemical Engineering.

Research and Teaching Positions

・ 1990. 10 – 1992. 12: Assistant Professor of the Department of Biotechnology, Nagoya University

・ 1993. 1 – 1994. 3: Assistant Professor of the Department of Applied Biological Chemistry, Shizuoka University

・ 1994. 4 – 1999. 9: Associate Professor of the Department of Applied Biological Chemistry, Shizuoka University

・ 1994. 10 – 1995. 7: Visiting Professor of Rutgers University, USA

・ 1999. 10 – 2006.3: Professor of the Department of Applied Biological Chemistry, Shizuoka University

・ 2013. 4 – 2022. 3: Director of Research Institute of Green Science and Technology, Shizuoka University

・ 2022. 4 – present: Vice director of Research Institute of Green Science and Technology, Shizuoka University

Selected Refereed Journal Articles (last 5 years)

1. Boonyakida, JIrayu; Khoris, Indra Memdi; Nasrin, Fahmida; Park, Enoch Y., Improvement of Modular Protein Display Efficiency in SpyTag-Implemented Norovirus-like Particles, Biomacromolecules, 24(1), 308–318 (2023).

2. Indra Memdi Khoris, Tsuruga Kenta, Akhilesh Babu Ganganboina, Enoch Y. Park, Pt-embodiment ZIF-67-derived nanocage as enhanced immunoassay for infectious virus detection, Biosens. Bioelectron., 215, 114602 (2022).

3. Achadu, Ojodomo; Abe, Fuyuki; Li, Tian-Cheng; Khoris, Indra Memdi; Lee, Dongkyu; Lee, Jaebeom; Suzuki, Tetsuro; Park, Enoch Y., Molybdenum trioxide quantum dots-encapsulated nanogels for virus detection by surface-enhanced Raman scattering on a 2D substrate, ACS Appl. Mater. & Interfaces, 13(24), 27836–27844 (2021).

4. Robert Minkner, Jian Xu, Kenshin Takemura, Jirayu Boonyakida, Hermann Wätzig, Enoch Y. Park, Ni-modified magnetic nanoparticles for affinity purification of His-tagged proteins from the complex matrix of the silkworm fat body, J. Nanobiotechnol,, 18, 159 (2020).

5. Tatsuya Kato, Yuki Machida, Kenshin Takemura, Jian Xu, Enoch Y. Park, Preparation of divalent antigen-displaying enveloped virus-like particles using a single recombinant Bombyx mori nucleopolyhedrovirus bacmid in silkworms, J. Biotechnol. 323, 92–97 (2020).

6. Jian Xu, Rikito Hiramatsu, Hamizah Suhaimi, Tatsuya Kato, Akari Fujimoto, Toshihiro Tokiwa, Kazunori Ike, Enoch Y. Park, Neospora caninum antigens displaying virus-like particles as a bivalent vaccine candidate against neosporosis, Vaccine, 37, 6426–6434 (2019).

7. Ankan Dutta Chowdhury, Kenshin Takemura, Tian-Cheng Li, Tetsuro Suzuki, Enoch Y. Park, Electrical pulse-induced electrochemical biosensor for hepatitis E virus detection, Nat. Commun., 10:3737 (2019).

In addition, 87 papers were published since 2018 year.

Toward robotic aerial co-workers in civil applications

Antonio Franchi

University of Twente

In this seminar I will provide an overview of the designs, control and planning methods that my group developed in the last years in order to increase the stability and performance in aerial tasks involving physical contact and manipulation. In particular I will show how multi-directional thrust — when properly mastered — may confer a superior level of accuracy and robustness to the physical task execution, when compared to standard platforms with an underactuated base.

Our group has been an early promoter of multi-directional thrust aerial platforms for physical contact and manipulation. Multi-directional thrust has since then been adopted as one of the most powerful way to face many of the challenges of aerial physical interaction.

However, the field has still several challenges remain still to be addressed. I will introduce and briefly discuss some of them, and in particular the ones related to the extended capabilities, energy efficiency, robustness, and human physical interaction. Furthermore, I will discuss how the increased size of the state and the need for an accurate control calls for the use of motion planning and predictive control algorithms that can exploit at best the redundancy and dynamic capabilities of the system while respecting the real actuation and sensing limits of the platform.

Curriculum Vitae – Antonio Franchi, PhD

Full Professor, University of Twente, The Netherlands –
Affiliated Researcher, LAAS-CNRS, France – IEEE Fellow

Address: University of Twente, EEMCS, Carr´e 3609, P.O. Box 217, 7500 AE Enschede, TheNetherlands
Email: a.franchi@utwente.nl

Education

- Nov. 2006 – Feb. 2010: PhD in System Engineering, University of Rome "La Sapienza"
- 2007: Habilitation of the Professional Association of Engineers Italian: "Abilitazione alla Professione di Ingegnere"
- 2005: MasterDegree in Electronic Engineering, University of Rome "La Sapienza"

Research and Teaching Positions

- From Jan. 2022 Full Professor at the University of Twente, The Netherlands, and Affiliated Researcher at LAAS-CNRS, France
- Dec.2019 - Dec.2021: Associate Professor at the University of Twente, The Netherlands, and Affiliated Researcher at LAAS-CNRS, France
- Jan.2014 – Nov.2019: Permanent Researcher (CR1) at CNRS (Centre National de la Recherche Scientifique). Member of: LAAS (Laboratoire d'Analyse et d'Architecture des Systemes), Toulouse, France; Guest Scientist atMax-Planck Institute for Biological Cybernetics
- Nov.2012 – Jan.2014: Head of the Autonomous Robotics and Human Machine Systems group atMax-Planck Institute for Biological Cybernetics, T¨ubingen, Germany
- Feb.2010–Nov.2012: Research Scientist, associate leader of the Human-Robot Interaction Group atMax-Planck Institute for Biological Cybernetics, T¨ubingen, Germany.
- 2009: Visiting Scholar at University of California at Santa Barbara, CA, USA. Center for Control, Dynamica

Steering microbiomes by organic amendments towards climate-smart agricultural soils

Paul L.E. Bodelier

Netherlands Institute of Ecology (NIOO-KNAW), Wageningen, the Netherlands

Increasing carbon sequestration while lowering GHG-emissions and maintaining crop yields is one of the biggest societal and scientific challenges. The use of organic fertilizers is one of the most important management measures to make agriculture more sustainable by closing cycles and minimizing the use of artificial mineral fertilizer. However, it is also a way of steering microbiomes towards higher contribution to carbon sequestration and lowering of GHG emissions. In this talk, examples will be discussed where organic amendments modulate microbial communities in agricultural soils towards e.g. favorable GWP, by e.g enhanced uptake of atmospheric methane.

Curriculum Vitae – Dr. Paul L.E. Bodelier

Address: NIOO-KNAW, droevendaalsesteeg 10, 6708PB, Wageningen, the Netherlands

Mob: 31 657269346
Tel: 31 317473485
Email: p.bodelier@nioo.knaw.nl

Education

- MSc degree. Biology, Ecology and Microbiology, University of Nijmegen, 1991.
- PhD degree. University of Nijmegen, 1997.

Research and Teaching Positions

- 1991 – 1992 Research assistant, Netherlands Institute of Ecology, Centre for Terrestrial Ecology, Heteren, The Netherlands.
- 1992 – 1997 PhD student, Netherlands Institute of Ecology, Centre for Terrestrial Ecology (Heteren, The Netherlands).
- 1997 – 1999 Post-doctoral research fellow, Max-Planck Institute for Terrestrial Microbiology Marburg, Germany.
- 1999 – 2007 Post-doctoral research fellow, Netherlands Institute of Ecology, Centre for Limnology Nieuwersluis, the Netherlands.
- 2008 – Senior Researcher Netherlands Institute of Ecology, the Netherlands.

Selected Refereed Journal Articles (last 5 years)

1. Rob J. M. van Spanning, Qingtian Guan, Chrats Melkonian1, James Gallant, Lubos Polerecky, Jean-Francois Flot, Bernd W. Brandt, Martin Braster, Paul Iturbe Espinoza, Joost W. Aerts, Marion M. Meima-Franke, Sander R. Piersma, Catalin M. Bunduc, Roy Ummels, Arnab Pain, Emily J. Fleming, Nicole N. van der Wel, Vasile D. Gherman, Serban M. Sarbu, Paul L. E. Bodelier, and Wilbert Bitter. (2022). Methanotrophy by a Mycobacterium species that dominates a cave microbial ecosystem. Nature Microbiology, 7:2089-2100.

2. Brenzinger, K., Costa, O. Y. A., Ho, A., Koorneef, G., Robroek, B. J. M., Molenaar, D., Korthals, G., & Bodelier, P. (2021). Steering microbiomes by organic amendments towards climate-smart agricultural soils. Biology and Fertility of Soils, 57:1054-1071. https://doi.org/10.1007/s00374-021-01599-5

3. Adrian Ho, Hyo Jung Lee, Max Reumer, Marion Meima-Franke, Ciska Raaijmakers, Hans Zweers, Wietse de Boer, Wim H. Van der Putten, Paul L.E. Bodelier. (2019). Unexpected role of canonical aerobic methanotrophs in upland agricultural soils. Soil Biol Biochem 171:1-8.

4. Drost, S. M., Rutgers, M., Wouterse, M., De Boer, W., & Bodelier, P. (2020). Decomposition of mixtures of cover crop residues increases microbial functional diversity. Geoderma, 361, 4060]. https://doi.org/10.1016/j.geoderma.2019.114060

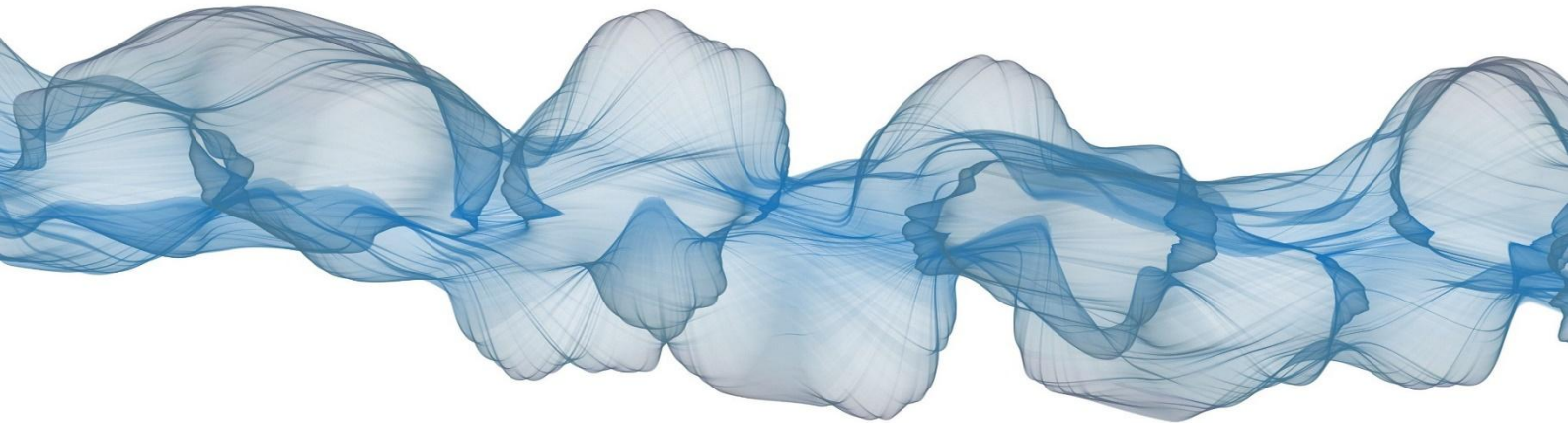
5. Adrian Ho, Hyo Jung Lee, Max Reumer, Marion Meima-Franke, Ciska Raaijmakers, Hans Zweers, Wietse de Boer, Wim H. Van der Putten, Paul L.E. Bodelier. (2019). Unexpected role of canonical aerobic methanotrophs in upland agricultural soils. Soil Biol Biochem 171:1-8.

6. AJ Veraart, P Garbeva, F van Beersum, A Ho, CA Hordijk, M Meima-Franke, H Zweers, PLE Bodelier. Living apart together – Volatile organic compounds influence methanotrophic growth and activity. ISME J 12:1163-1166.

ABSTRACT

Session 2 (Feb. 13):

INVITED LECTURES



Agrivoltaics research on vegetables in Naju-si, Korea including Kimchi cabbage, broccoli, garlic, and so on: yield, quality, profitability, and sustainability

Kang-Mo Ku

Department of Plant Biotechnology, Korea University

Growing need on sustainable energy and crop production exist in South Korea just like other countries. Among various sustainable energy production systems, Agriphotovoltaics or agrivoltaics is suggested as high land use efficient energy production systems as well as crop production system. In agrivoltaics solar panel is elevated to higher than 3 meter for crop production and machinery operation. Previous study has reported that bi-facial solar panel is higher electronic generation efficiency than mono-facial solar panel. For agrovoltaics, crops with low photosynthesis saturation point are ideal to cultivated including Kimchi cabbage, cabbage, broccoli, radish and so on. However, it has not been investigated on yield, quality, sustainability, and profitability of bi-facial agrivoltaics on these horticultural crops. To test effect of agrivoltaics on frequently cultivated Korean crops, yield, phytochemicals, land use efficiency, profitability were investigated. Among various crops, agrivoltaics grown broccoli showed greener color than conventional open-field grown one although yield of broccoli was tend to decreased under agrivoltaics. In addition, in broccoli case, we tried additional shading treatment using agrovoltaic structure. The additional shading treatment make broccoli greener than open-field grown one but yield also significantly decreased. For tested crops, crop yields under agrivoltaics was consistently decreased compared to open-field grown crops. However, it is possible to minimize this yield by controlling the agricultural practices.

Funding: This study is supported by GS construction

Curriculum Vitae – Prof. Kang-Mo Ku

Address: 145 An-nam, Songbook-gu, Seoul, Korea

Mob: 010-9624-3699
Tel: 02-3290-3063
Email: ku_km@korea.ac.kr

Education

- Ph. D. Crop Sciences, University of Illinois at Urbana-Champaign (USA), 2013.
- M.S. Horticulture, Kyungpook National University, 2008.
- B.A. School of Plant Biosciences, Kyungpook National University, 2006.

Research and Teaching Positions

- Associate Professor, Dept. of Plant Biotechnology, Korea Univ. (2022 ~)
- Associate Professor, Dept. of Horticulture, Chonnam National Univ. (2021-2022)
- Assistant Professor, Dept. of Horticulture, Chonnam National Univ. (2019-2021)
- Assistant Professor, Division of Plant and Soil Sciences, West Virginia Univ. (2015-2019)
- Researcher in Functional Metabolomics Lab, KonKuk Univ., (2008-2009)

Selected Refereed Journal Articles (last 5 years)

1. Impact of an Agriphotovoltaic System on Metabolites and the Sensorial Quality of Cabbage (Brassica oleracea var. capitata) and Its High-Temperature-Extracted Juice. Moon HW, KM Ku. Foods. 2022, 11 (4), 498

2. Agrivoltaic Systems Enhance Farmers' Profits through Broccoli Visual Quality and Electricity Production without Dramatic Changes in Yield, Antioxidant Capacity, and Glucosinolates. SH Chae, HJ Kim, HW Moon, YH Kim, KM Ku, Agronomy 12 (6), 1415

3. Optimization of allyl isothiocyanate sanitizing concentration for inactivation of Salmonella Typhimurium on lettuce based on its phenotypic and metabolome changes. Song HJ, Ku KM. Food Chemistry. 2021, 130438.

4. Differing Precision Irrigation Thresholds for Kale (Brassica oleracea L. var. acephala) Induces Changes in Physiological Performance, Metabolites, and Yield. Barickman TC, Ku KM*, Sams CE. Environmental and Experimental Botany. 2020, 104253

5. Methyl jasmonate treated broccoli: impact on the production of glucosinolates and consumer preferences. Chiu YC, Matak K, Ku KM. Food Chemistry. 2019. 125099

6. Untargeted and targeted metabolomics analyses of blackberries-understanding postharvest red drupelet disorder. Kim MJ, Lee MY, Shon JC, Kwon YS, Liu KH, Lee CH, Ku KM. Food Chemistry. 2019. 125169

Yeast metabolic engineering to produce cosmetic biomaterials for industrial applications

Soo-Jung Kim

Department of Integrative Food, Bioscience and Biotechnology, Chonnam National University, Gwangju, 61186, Republic of Korea

Yeast systems have numerous advantages for industrial applications such as easy culture, high tolerance to harsh fermentation condition and resistance to bacteriophage. Recent metabolic engineering is often harnessed to efficiently produce cosmetic biomaterials using yeasts. In this talk, I will present yeast metabolic engineering to produce 2,3-butanediol (2,3-BDO) with high titer and yield for industrial applications. First, high titer was obtained in Saccharomyces cerevisiae by intensifying 2,3-BDO biosynthetic pathway and eliminating ethanol pathway for redirection of carbon fluxes toward 2,3-BDO instead of ethanol. Second, cofactor engineering and employment of industrial brewing yeast were attempted to reduce glycerol as a by-product and increase yield of 2,3-BDO, respectively. Additionally, I will talk about metabolic engineering to produce enantiopure meso-2,3-BDO with 99.8% of theoretical yield of 2,3-BDO. As another cosmetic biomaterial, I will present sustainable production of mycosporine-like amino acids, especially shinorine, from lignocellulosic biomass by metabolically engineered S. cerevisiae. These results will support that metabolically engineered S. cerevisiae might be a good host to produce cosmetic biomaterials for industrial applications.

Curriculum Vitae – Prof. Soo-Jung Kim

Address: 77, Yongbong-ro, Buk-gu, Gwangju, 61186, Korea

Mob: 010-7340-7795
Tel: 062-530-2146
Email: bioksj@jnu.ac.kr

Education

- Ph. D. (2009.09.01. – 2014.02.28.) Department of Agricultural Biotechnology, Seoul National University, Korea
- M. Sc. (2003.03.01. – 2005.02.25.) Department of Agricultural Biotechnology, Seoul National University, Korea
- B. Sc. (1999.03.01. –2003.02.14.) Department of Biological and Environmental Science, Dongguk University, Korea (Multiple Majors: Department of Food Science and Biotechnology)

Research and Teaching Positions

- Assistant Professor (2019.09. – Present) Division of Food Technology and Biotechnology, Chonnam National University, Korea
- Postdoctoral Researcher (2018.08. – 2019.08) Synthetic Biology & Bioengineering Research Center, Korea Research Institute of Bioscience & Biotechnology (KRIBB), Korea
- Postdoctoral Researcher (2017.03. – 2018.07.) Department of Energy, Environmental and Chemical Engineering, Washington University in St. Louis, USA

Selected Refereed Journal Articles (last 5 years)

1. SR Kim, M Cha, T Kim, S Song, HJ Kang, Y Jung, JY Cho, SH Moh and SJ Kim*, Sustainable production of shinorine from lignocellulosic biomass by metabolically engineered Saccharomyces cerevisiae, Journal of Agricultural and Food Chemistry, 70, 50, 15848-15858.

2. HS Lim†, SK Kim†, SG Woo, TH Kim, SJ Yeom, W Yong, YJ Ko, SJ Kim*, SG Lee* and DH Lee*, (−)-α-Bisabolol production in engineered Escherichia coli expressing a novel (−)-α-bisabolol synthase from the globe artichoke, Cynara cardunculus var. scolymus, Journal of Agricultural and Food Chemistry 69, 30, 8492-8503.

3. YG Lee†, JM Bae† and SJ Kim*, Enantiopure meso-2,3-butanediol production by metabolically engineered Saccharomyces cerevisiae expressing 2,3-butanediol dehydrogenase from Klebsiella oxytoca, Journal of Biotechnology 354, 1-9.

Molecular mechanisms of fungicide resistance in plant pathogenic fungi and beyond

Hyunkyu Sang

Department of Molecular Biotechnology, Chonnam National University

Fungal species include economically important plant pathogens and some can cause diseases in human and animal populations. To control plant pathogens, different classes of fungicides have been applied but fungicide resistance of pathogenic fungi has been increasingly reported. Understanding molecular mechanisms of fungicide resistance is essential to managing plant diseases. In this presentation, molecular mechanisms of fungicide resistance in plant pathogenic fungi including Aspergillus flavus, Fusarium virguliforme, and Botrytis cinerea will be discussed. The main molecular mechanisms of the fungal species are mutation(s) in fungicide target gene(s) and overexpression of efflux transporters such as ATP-binding cassette (ABC) or major facilitator superfamily (MFS) transporters. To control these fungicide resistant pathogens, a Bacillus strain showing strong antifungal activity was selected and characterized. The bacterial strain only or in combination with fungicide azoxystrobin successfully controlled fungal diseases. The approach potentially reduces fungicide application rates and fungicide resistant fungal populations.

Curriculum Vitae – Prof. Hyunkyu Sang

Address: 77, Yongbong-ro, Buk-gu, Gwangju, 61186, Korea

Mob: 010-530-2168
Tel: 062-530-2160
Email: hksang@jnu.ac.kr

Education

- University of Massachusetts, Amherst — Plant and Soil Sciences — Ph.D. 2017
- Chungnam National University — Plant Pathology and Plant Cell Technology — M.S. 2011
- Chungnam National University — Applied Biology — B.S. 2009

Research and Teaching Positions

- Assistant Professor, Chonnam National University — 2019 - Present
- Postdoctoral Researcher, Michigan State University — 2017 – 2019

Selected Refereed Journal Articles (last 5 years)

1. Lee G, Choi H, Liu H, Han YH, Paul NC, Han GH, Kim H, Kim PI, Seo SI, Song J, Sang H*. 2023. Biocontrol of the causal brown patch pathogen Rhizoctonia solani by Bacillus velezensis GH1-13 and development of a bacterial strain specific detection method. Frontiers in Plant Science 13:1091030

2. Sang H*, Chang HX, Choi S, Son D, Lee G, Chilvers MI*. 2022. Genome-wide transcriptional response of the causal soybean sudden death syndrome pathogen Fusarium virguliforme to a succinate dehydrogenase inhibitor fluopyram. Pest Management Science 78:530-540

3. Paul NC, Park SW, Liu H, Choi S, Ma J, MacCready JS, Chilvers MI, Sang H*. 2021. Plant and fungal genome editing to enhance plant disease resistance using the CRISPR/Cas9 System. Frontiers in Plant Science 12:700925

4. Sang H, Popko J, Jung G*. 2019. Evaluation of a Sclerotinia homoeocarpa population with multiple fungicide resistance phenotypes under differing selection pressures. Plant Disease 103:685-690

5. Sang H, Chang HX, Chilvers MI*. 2019. A Sclerotinia sclerotiorum transcription factor involved in sclerotial development and virulence on pea. mSphere 4: e00615-18

Performance Evaluation Method for Prediction of Building Cooling and Heating Load Using Granulation Model

Chan-Uk Yeom

Center for IT-Bio Convergence System Agriculture

Granular computing (GrC) is a computational model that builds a computational model using data, called information granulation, and is used in various fields. Pedrycz proposed a GM (Granular Model) using CFCM (Context-based Fuzzy C-Means) clustering method. GM may represent a relationship between information granulation generated by the CFCM clustering method. Therefore, instead of the root mean square error (RMS), which is a general performance evaluation method, a performance evaluation method using coverage and specificity of the fuzzy number of the GM output value should be used. In this paper, a study was conducted to confirm the validity of the performance evaluation method using coverage and specificity.

The granular model was constructed by the CFCM clustering method. Unlike the FCM clustering method, the CFCM clustering method can cluster information granulation more accurately in consideration of the characteristics of the input space and the output space. Figure 1 shows the structure of GM and the output value. Input layer, layer 1, layer 2, layer 3, output layer consists of a total of five layers. Layer 1 and layer 2 are connected. Layer 1 refers to a set of activation levels of CFCM clustering. Layer 2 is a conditional clustering of linguistic contexts, and given a context, clustering is performed in each context. Layer 3 calculates the final output of the GM and the output is expressed as a fuzzy number in the form of a triangle, not a numerical value.

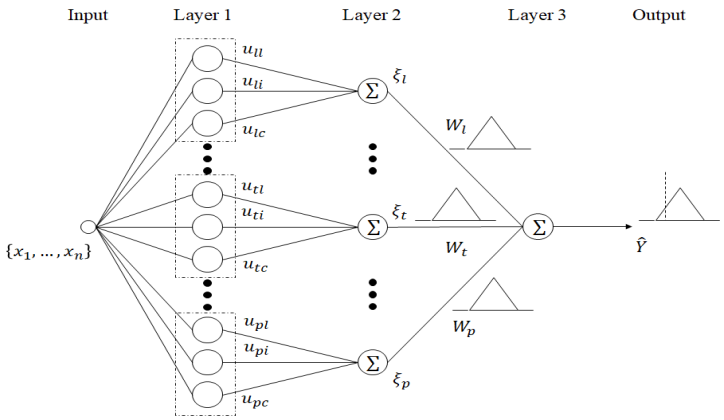


Figure 1 Concept of granular model

When evaluating the performance of a model, accuracy and clarity are important factors. The general performance evaluation method is the RMSE method. The RMSE method is a measure of the error between the output value of the model and the actual value, and is a good way to express precision. For the performance evaluation method using coverage and specificity of fuzzy number mentioned in this paper, we use fuzzy number which is the final output of GM. Fuzzy numbers are represented in the form of triangles, with both ends at the lower and upper values. The center of the triangle is the modal value. Figure 2 shows coverage and specificity. The coverage of the fuzzy number is affected by the number of linguistic contexts and the number of clusters to be created in each context, and represents the full range of output. Specificity is influenced by the interval of fuzzy numbers and represents the interval of both end points of the fuzzy number. Finally, the performance is evaluated by calculating the PI (Performance Index) by multiplying the coverage and specificity. Coverage and specificity are trade-offs.

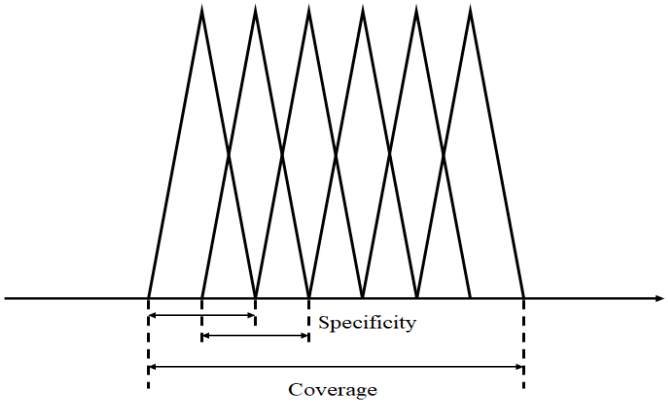
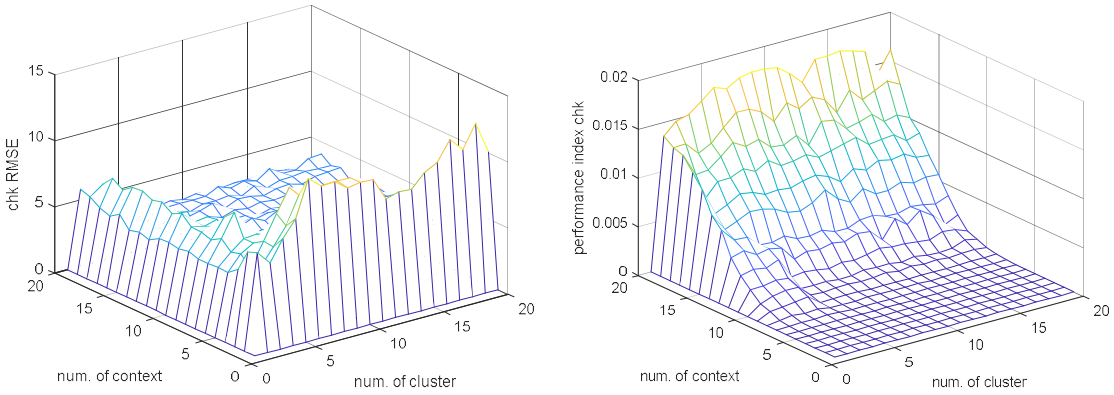


Figure 2 Concept of coverage and specificity



(a) (b)

Figure 3 GM predictive performance results: (a) RMSE method, (b) PI method

Table 1 RMSE Method, PI Method Predictive Performance Results

Performance method	Number of context	Number of cluster	Performance (using training data)	Performance (using training data)
RMSE	20	6	2.8194	2.8041
PI	20	9	0.0173	0.0177

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Curriculum Vitae – Dr. Chan-Uk Yeom

Address: 65, Chosundae 5-gil, Dong-gu, Gwangju, Republic of Korea

Mob: 010 – 9622 - 4129
Tel: 010 – 9622 - 4129
Email: walt18@naver.com

Education

・2022.02. Department of Control and Instrumentation Engineering, Graduate School of Chosun University, doctor's degree

・2017.08. Department of Control and Instrumentation Engineering, Graduate School of Chosun University, master's degree

・2016.02. Department of Control and Instrumentation Robot Engineering, College of IT Convergence, Chosun University, bachelor's degree

Research and Teaching Positions

・ 2022.06.~ Design of hierarchical interval and fuzzy granular model and performance evaluation based on information granule, researcher

・ 2020.04.~2022.02. Development of brain-body interface technology using AI-based multi-sensing, researcher

・ 2018.06.~2022.02. Design and application of knowledge-based autoencoder using particle computing, researcher

・ 2017.04.~2022.02. Solar Power-based Quarterly Heat Storage System Optimization Technology Advanced Track, researcher

・ 2016.06.~2022.02. User authentication technology using multiple biological signals based on wearable devices, researcher

Selected Refereed Journal Articles (last 5 years)

1. C. U. Yeom, K. C. Kwak, 'A Design and Optimization of a CGK-Based Fuzzy Granular Model Based on the Generation of Rational Information Granules,' Symmetry, Vol. 10, No. 12, 2022.

2. C. U, Yeom, K. C. Kwak, 'A Design of CGK-Based Granular Model Using Hierarchical Structure,' Applied Sciences, Vol. 12, No. 6, 2022.

3. C. U. Yeom, M. W. Lee, K. C. Kwak, 'Performance Index of Incremental Granular Model with Information Granule of Linguistic Intervals and Its Application,' Applied Sciences, vol. 10, no. 7, 2020.

4. C. U. Yeom, K. C. Kwak, 'Adaptive Neuro-Fuzzy Inference System Predictor with an Incremental Tree Structure Based on a Context-Based Fuzzy Clustering Approach,' Applied Sciences, Vol. 10, No. 23, 2020.

5. C. U. Yeom, K. C. Kwak, 'Performance Evaluation of Automobile Fuel Consumption Using a Fuzzy-Based Granular Model with Coverage and specificity,' Symmetry, Vol. 11, No. 12, 2019.

6. C. U. Yeom, K. C. Kwak, 'Incremental Granular Model Improvement Using Particle Swarm Optimization,' Symmetry, Vol. 11, No. 3, 2019.

7. C. U. Yeom, K. C. Kwak, 'Performance Comparison of ANFIS Models by Input Space Partitioning Methods,' Symmetry, Vol. 10, No. 12, 2018.

Nanoengineered Cellular Behaviors for Controlling Functions of Biosystems

Sunho Park

Department of Convergence Biosystems Engineering, Chonnam National University, Gwangju, 61186, Republic of Korea

Department of Rural and Biosystems Engineering, Chonnam National University, Gwangju, 61186, Republic of Korea

Interdisciplinary Program in IT-Bio Convergence System, Chonnam National University, Gwangju 61186, Republic of Korea

Biosystems are constructed of cells, which can be unicellular or multi-cellular, and the cells are self-contained complex from numerous macromolecules and biophysical cues that responds to and interactions with its microenvironments. Based on this scientific observation, the controlling of the cellular behavior is a fundamental to improve functions of biosystems, and it has directly and indirectly affect on biosystems-based applications. As applied to biosystems, the scale-related factor is often ignored to control the cellular behavior in spite of the essential fact that cells have a size from 100 nm to 100 μm (i.e., ultra-tiny scale; from nanoscale to microscale), and it is very important to provide the proportional nanoengineering as scale-related factor to maximize controlling of the cellular behaviors. In this study, we proposed engineering in nanoscale to control the cellular behaviors for controlling functions of biosystems and strategically suggested their use in plant and animal biosystems. In other words, we tried to reveal the effects of the proposed nanoengineering on cellular behaviors and sequential effects on tissue-organ-biosystem level. Using proposed nanoengineering, we reveal the importance of nanoscale-based factor for engineering of cellular behaviors, and we hope that the potential use of the developed nanoengineering for improving the functions of biosystems in the near future.

Funding: This work was supported by the National Research Foundation of Korea (NRF) grants funded by the Korean government (NRF-2022R1A6A3A01087689).

Curriculum Vitae – Dr. Sunho Park

Address: Chonnam National University, CALS 1, Rm 401

Mob: 82-10-5674-9330
Tel: 82-530-0724
Email: preference9330@gmail.com

Education

- Ph.D. (2018-2022) Rural and Biosystems Engineering, Chonnam National University - Thesis: Engineering cellular behaviors for improving functions of biosystems in ultra-tiny scale (Advisor: Prof. Jangho Kim)
- M.S. (2016-2018) Rural and Biosystems Engineering, Chonnam National University - Thesis: Development of eggshell membrane-based nanoengineered platforms (Advisor: Prof. Jangho Kim)
- B.S. (2012-2016) Rural and Biosystems Engineering, Chonnam National University (Advisor: Prof. Jangho Kim)

Research and Teaching Positions

- Adjunct Instructor, Department of Convergence Biosystems Engineering, Chonnam National University, 2022.
- Researcher, Department of Convergence Biosystems Engineering, Chonnam National University, 2022~.

Selected Refereed Journal Articles (last 5 years)

1. S. Park*, H.H. Park*, K. Sun, Y. Gwon, M. Seong, S. Kim, T.E. Park, H. Hyun, J. Kim#, H.E. Jeong#. Hydrogel nanospike patch as a flexible anti-pathogenic scaffold for regulating stem cell behavior. ACS NANO, 2019 [*co-first author, #corresponding author]. [IF: 18.027, JCR: 7%]

2. S. Park*, Y. Gwon, W. Kim, J. Kim#. Rebirth of the eggshell membrane as a bioactive nanoscaffold for tissue engineering. ACS Biomaterials Science & Engineering, 2021. [IF: 5.13]

3. S. Park*, Y. Jeon, T. Han, S. Kim, Y. Gwon, J. Kim#. Nanoscale manufacturing as and enabling strategy for the design of smart food packaging systems. Food Packaging and Shelf Life, 2020. [IF: 8.749, JCR: 6%]

4. S. Park, K.S. Choi, S. Kim, Y. Gwon, J. Kim #. Graphene oxide-assisted promotion of plant growth and stability. Nanomaterials, 2020. [IF: 5.719]

5. S. Park*, T. Kim*, Y. Gwon, S. Kim, D. Kim, H.H. Park, H.E. Jeong#, K. Kim#, J. Kim#. Graphene-layered eggshell membrane as a flexible and functional scaffold for enhanced proliferation and differentiation of stem cells. ACS Applied Bio Materials, 2019 [*co-first author, #corresponding author]. (Selected as a Cover Article)

6. S. Park, K.S. Choi, D. Kim, W. Kim, D. Lee, H.N. Kim, K.T. Lim, J.W. Kim, Y.R. Kim, J. Kim#. Controlled extracellular topographical and chemical cues for acceleration of neuronal development. Journal of Industrial and Engineering Chemistry, 2018. [IF: 6.76, JCR: 16%]

Field Robotics and Automation for Smart Agricultural System: Work in Progress

Chanyoung Ju

Automotive Materials & Components R&D Group, Korea Institute of Industrial Technology, Gwangju, 61012, Republic of Korea

In agriculture, robots and automation systems are promising technologies to solve the problems of low labor and food shortages. This talk aims to briefly overview the progress of the ongoing projects. First, I introduce the development of an intelligent agriculture robot for a smart greenhouse. In this work, we are designing an unmanned ground vehicle (UGV) platform and a controller to perform agricultural tasks such as transplantation, defoliation, and cleaning. In detail, we design a UGV mechanism capable of mounting transportation, spraying, and lifting modules and develop a ROS-based middleware system for autonomous navigation. The second part focuses on developing a robotic fulfillment agricultural products processing center for fresh agricultural products. Here, we develop the logistics automation system for supply chain management, sorting, packaging, and loading agricultural products. Most processes, such as packaging, loading, and wrapping, are carried out manually. Therefore, machines and manipulator-based automation are significant issues in agricultural systems. The proposed field robots and automation system are expected to improve the performance of crop production, processing, and distribution in a digital transformation of the agricultural environment.

Keywords: field robotics, automation, smart agricultural system, smart greenhouse, agricultural products processing center

Funding: This work was supported by the Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry (IPET) through the Smart Farm Innovation Technology Development Program and Smart Agri Products Flow Storage Technology Development Program, funded by the Ministry of Agriculture, Food and Rural Affairs (MAFRA) under Grants 421032-04 and 322054-5.

Curriculum Vitae – Dr. Chanyoung Ju

Address: Automotive Materials & Components R&D Group, Korea Institute of Industrial Technology, Gwangju, 61012, Republic of Korea
Mob: +82-10-5837-6145
Tel: +82-62-600-6450
Email cyju@kitech.re.kr

Education

- Ph.D. in Rural and Biosystems Engineering, Chonnam National University (2022)
- M.S. in Rural and Biosystems Engineering, Chonnam National University (2019)
- B.S. in Rural and Biosystems Engineering, Chonnam National University (2017)

Research and Teaching Positions

- Senior Researcher, Automotive Materials & Components R&D Group, Korea Institute of Industrial Technology (2022-present)
- Postdocotral Fellow, Industrial Engineering and Operations Research Department, University of California, Berkeley (2022)

Selected Refereed Journal Articles (last 5 years)

1. 1. C. Ju and H. I. Son†, "A Hybrid Systems-based Hierarchical Control Architecture for Heterogeneous Field Robot Teams," IEEE Transactions on Cybernetics, accepted (doi: 10.1109/TCYB.2021.3133631).

2. C. Ju, J. Kim, J. Seol, and H. I. Son†, "Review on Multirobot Systems in Agriculture," Computers and Electronics in Agriculture, vol. 202, pp. 107336, 2022.

3. C. Ju and H. I. Son†, "Human-centered Evaluation of Shared Teleoperation System for Maintenance and Repair Tasks in Nuclear Power Plants," International Journal of Control, Automation and Systems, vol. 20, no. 10, pp. 3418-3432, 2022.

4. B. Kim*, C. Ju*, and H. I. Son†, "Field Evaluation of UAV-Based Tracking Method for Localization of Small Insects," Entomological Research, vol. 52, no. 3, pp. 135–147, 2022.

5. C. Ju and H. I. Son†, "Localization and Autonomous Tracking of Micro-sized Radio-tagged Flying Insects," IEEE Access, vol. 10, pp. 4048–4062, 2022.

6. C. Ju and H. I. Son†, "Modeling and Control of Heterogeneous Field Robots under Partial Observation," Information Sciences, vol. 580, pp. 419–435, 2021.

7. C. Ju and H. I. Son†, "Autonomous Tracking of Micro-Sized Flying Insects Using UAV: A Preliminary Results," Journal of the Korean Society of Industry Convergence, vol. 23, no. 2 1, pp. 125–137, 2020.

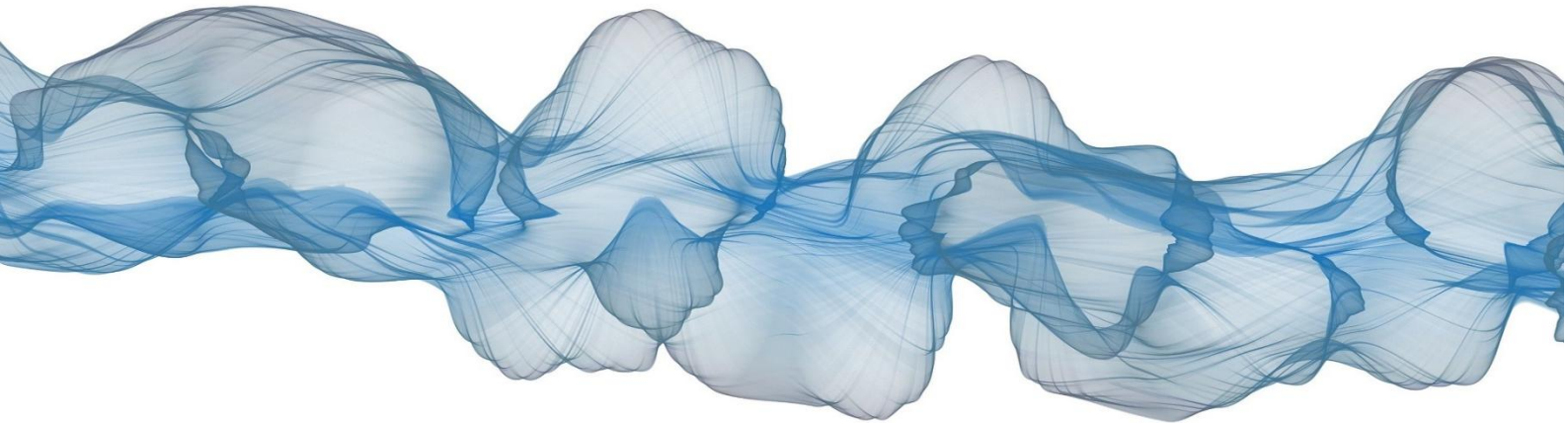
8. C. Ju and H. I. Son†, "Modeling and Control of Heterogeneous Agricultural Field Robots based on Ramadge-Wonham Theory," IEEE Robotics and Automation Letters, vol. 5, no. 1, pp. 48–55, 2020.

9. S. Kim*, C. Ju*, J. Kim, and H. I. Son†, "A Tracking Method for the Invasive Asian Hornet: A Brief Review and Experiments," IEEE Access, vol. 7, pp. 176998–177008, 2019.

ABSTRACT

Session 3 (Feb. 13):

STUDENT SHORT TALK



Eggshell Membrane-incorporated Cell Friendly Tough Hydrogels with Ultra-Adhesive Property

Yonghyun Gwon[1, 2, 3], Sunho Park[1, 2], Woochan Kim[1,2,3], Hyoseong Kim[1, 2, 3], Jangho Kim[1, 2, 3, *]

[1] Department of Convergence Biosystems Engineering, Chonnam National University, Gwangju 61186, Republic of Korea

[2] Department of Rural and Biosystems Engineering, Chonnam National University, Gwangju 61186, Republic of Korea

[3] Interdisciplinary Program in IT-Bio Convergence System, Chonnam National University, Gwangju 61186, Republic of Korea

*Corresponding author: Jangho Kim (rain2000@jnu.ac.kr)

Adhesive and tough hydrogels have received increased attention for their potential biomedical applications. However, traditional hydrogels have limited utility in tissue engineering because they tend to exhibit low biocompatibility, low adhesiveness, and poor mechanical properties. Herein, the use of the eggshell membrane (ESM) for developing tough, cell-friendly, and ultra-adhesive hydrogels is described. The ESM enhances the performance of the hydrogel network in three ways. First, its covalent cross-linking with the polyacrylamide and alginate chains strengthens the hydrogel network. Second, it provides functional groups, such as amine and carboxyl moieties, which are well known for enhancing the surface adhesion of biomaterials, thereby increasing the adhesiveness of the hydrogel. Third, it is a bioactive agent and improves cell adhesion and proliferation on the constructed scaffold. In conclusion, this study proposes the unique design of ESM-incorporated hydrogels with high toughness, cell-friendly, and ultra-adhesive properties for various biomedical engineering applications.

Sliding Mode Controller Design for Trajectory Tracking of a Vessel

Tegen Eyasu Derbew [1], Prof. Nak Yong Ko[*]

[1] Dept. of Electronic Engineering, Graduate School, Gwangju, 61452, Korea

(eyasuderbew2008@gmail.com)

* Dept. of Electronic Engineering, Graduate School, Gwangju, 61452, Korea

(nyko@chosun.ac.kr)

Many classical control algorithms were extensively applied for marine vessel control. Nonetheless, the performance of these conventional control schemes is degraded due to the presence of model uncertainties and external disturbances, such as wind, ocean current, wave. A robust controller is needed to overcome these shortcoming of classical control methods. Hence, this paper aims at designing a sliding mode controller for reference trajectory tracking of a marine vessel. The three degree of freedom mathematical model of the vessel is developed and the proposed control law is also implemented using MATLAB Simulink software. The results demonstrated the effectiveness of the designed controller.

Funding: This work was supported by the National Research Foundation of Korea (NRF) grants funded by the Korean government (NRF-2021R1A4A3025206, NRF-2019M3A9H1103737, NRF-2021M3E5E7026407, and NRF-2019R1I1A3A0106345).

Semantic segmentation model using channel attention module of polarized filter technique

Jinseong Kim

Sunchon National University

Semantic segmentation is one of the key tasks in computer vision. Since Fully Convolutional Networks(FCN), models in which all neural networks are composed of convolutional products have become mainstream. However, since most of the FCN-based models form a pyramid shape, information loss occurs in the feature extraction process. To alleviate this problem, various information emphasize modules have been published.

In this study, in order to reduce the loss of channel information rich in pixel class information in the feature extraction process, a channel enhancement module with a polarized filter technique is inserted into each convolution block unit constituting HRNet. In order to emphasize channel information, it is important to include global information by compressing information of each channel into one. The channel emphasizing module compresses each channel into one piece of information using 1x1 convolution and reshape filter, passes softmax to obtain similarity, and then multiplies with the input feature map again. Finally, the importance of the channel is reset by passing through the sigmoid, so that important information is further emphasized and unimportant information is less important. The activation function used in the channel emphasis module uses GELU to increase the calculation speed.

As a result of the PASCAL Context 59 data set experiment, mean intersection over union(mIoU) achieved 50.21%, the same as the existing model, and mean pixel accuracy(MPA) increased by 0.19% to 60.97%. From the results, it was confirmed that the channel enhancement module had an effect on improving the class classification performance rather than the boundary segmentation performance.

Biodegradable and Flexible Nanoporous Films for Design and Fabrication of Active Food Packaging Systems

Woochan Kim[1, 2, 3], Taeseong Han[1, 2, 3], Yonghyun Gwon[1, 2, 3], Sunho Park[1, 2, 3], Hyoseong Kim[1, 2, 3], Jangho Kim[1, 2, 3, *]

[1] Department of Convergence Biosystems Engineering, Chonnam National University, Gwangju 61186, Republic of Korea

[2] Department of Rural and Biosystems Engineering, Chonnam National University, Gwangju 61186, Republic of Korea

[3] Interdisciplinary Program in IT-Bio Convergence System, Chonnam National University, Gwangju 61186, Republic of Korea

* Corresponding author: Jangho Kim (rain2000@jnu.ac.kr)

Nanotechnology has facilitated the development of active food packaging systems with functions that could not be achieved by their traditional counterparts. Such smart and active systems can improve the shelf life of perishable products and overcome major bottlenecks associated with the fabrication of safe and environmentally friendly food packaging systems. Herein, we used a plasma-enabled surface modification strategy to fabricate biodegradable and flexible nanoporous polycaprolactone-based (FNP) films for food packaging systems. Their capacity for preserving tomatoes, tangerines, and bananas at room and refrigeration temperatures was tested by analyzing various fruit parameters (mold generation, appearance changes, freshness, weight loss, firmness, and total soluble solids contents). Compared with commonly used polyethylene terephthalate-based containers, the proposed system enhanced the fruit storage quality (i.e., retained appearance, reduced weight loss, better firmness, and sugar contents) by controlling moisture evaporation and inhibiting mold generation. Thus, the FNP film represents a new active food packaging strategy.

Funding: This work was supported by National Research Foundation of Korea (NRF) grant funded by the Korea government (MSIT) (No. 2020R1A5A8018367, NRF-2021R1A4A3025206, NRF-2019M3A9H1103737, NRF-2021M3E5E7026407, and NRF-2022M3A9E4017151).

ARTIFICIAL INTELLIGENCE FOR REAL-TIME RESPIRATORY HEALTH CONDITION MONITORING IN SWINE

Eddiemar B. Lagua[1], Hong-Seok Mun[1,2], Keiven Mark B. Ampode[1], Veasna Chem[1], Young-Hwa Kim[3], Chul-Ju Yang[1,4]

[1] Animal Nutrition and Feed Science Laboratory, Department of Animal Science and Technology, Sunchon National University, Suncheon 57922, Republic of Korea

[2] Department of Multimedia Engineering, Sunchon National University, Suncheon 57922, Republic of Korea

[3] Interdisciplinary Program in IT-Bio Convergence System (BK21 Plus), Chonnam National University, Gwangju 61186, Republic of Korea

[4] Interdisciplinary Program in IT-Bio Convergence System (BK21 Plus), Sunchon National University, 255, Jungangno, Suncheon 57922, Republic of Korea

The porcine respiratory disease complex is a major concern for the swine industry that resulted in significant economic losses. Thus, early detection of and response to the disease at the farm level is essential to prevent and minimize the potential damage that it may cause. In this study, the authors reviewed the latest studies on the application of artificial intelligence (AI) in the detection and control of respiratory disease in swine. Audio technology is mostly used for the detection of respiratory disease by coughing recognition. Visual technology is also used but its application is at the experimental stage. The technology available commercially used audio technology that can monitor and evaluate the herd's respiratory health status and with temperature and humidity sensors to monitor environmental conditions. However, some limitations of the existing technology were identified. Substantial effort must be exerted to surmount the limitations to have a smarter AI technology for monitoring respiratory health status in swine.

Funding: This work was supported by the Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry(IPET) and Korea Smart Farm R&D Foundation through the Smart Farm Innovation Technology Development Program, funded by the Ministry of Agriculture, Food and Rural Affairs(MAFRA) and Ministry of Science and ICT(MSIT) and Rural Development Administration(RDA) (421023-04).

Factors affecting Potted Plant Quality and Life of Kalanchoe blossfeldiana by Soil Moisture in Export Distribution

Se Young Lee and Young Boon Lee*

Department of Horticulture, Chonnam National University, Gwangju, 61186, Korea

This study investigates the relationship between soil moisture environment, morphological and physiological factors, and shelf life in the export distribution of potted kalanchoe. The soil moisture of the potted plant was treated optimum (50%) and low (< 20%). The quality of potted plants was analyzed by morphological factors including plant height, width, fresh or dry weight of shoot and root, number of inflorescence, flowers, flower buds, and leaves, and leaf thickness or physiological factors inculding chlorophyll contents, Fv/Fm, stomatal size change rate of leaves, and plant temperature of petals and leaves. The shell life of low soil moisture was 11.8 days shorter than the optimum and decreased by 36%. In consumer after 4 weeks stage, plant height, width, fresh and dry weight, number of flowers, and flower buds were numerically low in low soil moisture. The chlorophyll content and chlorophyll fluorescence of the leaves were decreased in low soil moisture at auction in the Japan stage. The difference between air and petal or leaf surface temperature was greater in low soil moisture before export transport. The correlation with shelf life by soil moisture before export transport was positive correlation with plant height and a negative with plant width. Therefore, there was a difference in the potted plant's quality of kalanchoe by soil moisture after distribution, and it was found that soil moisture was an important factor in the potted plant's quality after transport.

Funding: This work was supported by Korea Institute of Planning and Evaluation for Technology in Food, Agriculture and Forestry (IPET) through Smart Agri Products Flow Storage Technology Development Program, funded by Ministry of Agriculture, Food and Rural Affairs (MAFRA) (322053-03)

Engineering Plant Growth and Development on Multiscale topographical Cues

Mahpara Safdar[1, 2, 3], Sunho Park[1, 2, 3], Woochan Kim[1,2,3], Yonghyun Gwon[1, 2, 3], Yeon-Ok Kim[3], Jangho Kim[1, 2, 3, *]

[1] Department of Convergence Biosystems Engineering, Chonnam National University, Gwangju 61186, Republic of Korea

[2] Department of Rural and Biosystems Engineering, Chonnam National University, Gwangju 61186, Republic of Korea

[3] Interdisciplinary Program in IT-Bio Convergence System, Chonnam National University, Gwangju 61186, Republic of Korea

* Corresponding author: Jangho Kim (rain2000@jnu.ac.kr)

Seed germination and root development are important indicators of plant development. Here, we propose a new multiscale technology to guide plant growth and development. We developed polymer-based soil platforms with micro and nanoscale topographical features that were used to explore the impact on plant development, including phenotypic aspects and gene regulation. The fabricated micro and nanotextured surfaces showed the good mechanical stability, biocompatibility, strong adhesion, non-toxicity as well as super hydrophobicity. Our new Arabidopsis root system had the abundant molecular genetic resources according to the unique multiscale structure designs, controlling the plant growth, which can be used as a new platform for investing the phenotype and gene networks. Finally, we showed some examples that our unique multiscale topographical platforms have the potential to promote plant growth and development by providing specific roadmap and transport genes.

Funding: This work was supported by the National Research Foundation of Korea (NRF) grants funded by the Korean government (NRF-2021R1A4A3025206, NRF-2019M3A9H1103737, NRF-2021M3E5E7026407, and NRF-2019R1I1A3A0106345).

Biocompative 3D-Printing Ti6Al4V-based Implants Embedded with Equine Bone

Juo Lee[1, ‡], Sangbae Park[2, ‡], Jong-Jin Kim[3, ‡], and Hoon Seonwoo[4, *]

[1] Department of Animal Science & Technology, Sunchon National University, Suncheon 57922, Republic of Korea

[2] Research Institute for Agriculture and Life Sciences, Seoul National University, Seoul 08826, Republic of Korea

[3] Department of Biology, Sunchon National University, Suncheon 57922, Republic of Korea

[4] Department of Convergent Biosystems Engineering, College of Life Science and Natural Resources, Sunchon National University, Suncheon 57922, Republic of Korea

*Corresponding author: Hoon Seonwoo (uhun906@gmail.com)

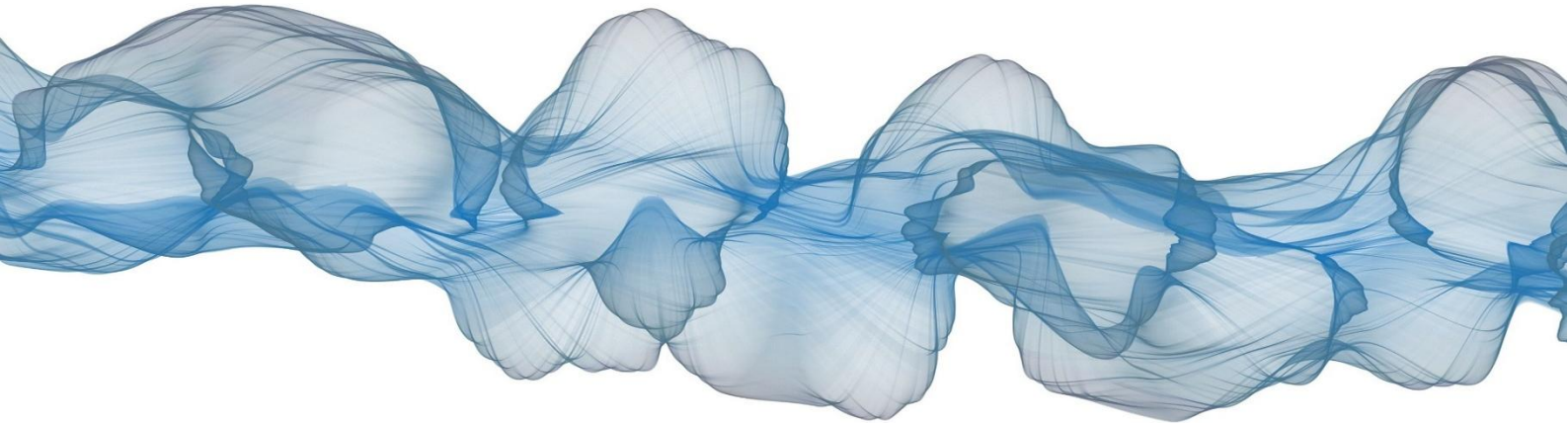
Although hydroxyapatite play a vital role in modulating the physicochemical properties and biocompatibility of implants, their unfavorable mechanical properties and innate immune responses impede clinical success of implants. In this study, we report a novel strategy to develop Ti6Al4V (Ti) implants embedded with natural hydroxyapatite derived from equine bones (EB), which overcomes the limitations of conventional hydroxyapatite-coated Ti implants. Selective laser melting technique was employed for the facile fabrication with flexible fusing feedstock and regular EB distribution. The developed Ti/EB implants not only exhibited higher hydrophilicity and protein adsorption but also enhanced the crystalline structure (β-Ti) suitable for implantation. The proposed platform significantly promoted the attachment, proliferation, osteogenic differentiation, and anti-inflammatory effects in vitro. Furthermore, the bone regeneration capability and alleviated inflammatory responses of Ti/EB implants contributing to the successful implantation were confirmed by in vivo studies. The proposed study could be utilized to design advanced tissue-engineered implants and, consequently, the Ti/EB implant would be a promising candidate to replace conventional dental or orthopedic implants.

Funding: This research was supported by “Development of 3D Bioprinting Inks for Tissue Regeneration Using Marine Bacteria Cellulose” of Korea Institute of Marine Science & Technology Promotion (KIMST) funded by the Ministry of Oceans and Fisheries (KIMST- 20220232).

ABSTRACT

Session 4 (Feb. 14):

INVITED LECTURES

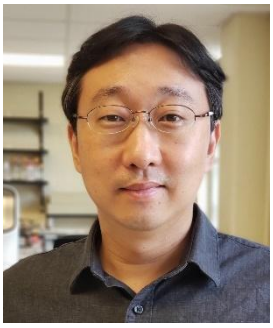


Light-dependent Greening in Plants: Alternative Promoter Selection as a Mechanism of Nucleus-Chloroplast Communication

Chan Yul Yoo

School of Biological Sciences, University of Utah, Salt Lake City, UT, 84112

Chloroplast is an essential organelle in green plants for establishing photoautotrophic life as a site of photosynthesis. In angiosperms (flowering plants), chloroplast biogenesis is initiated by light that is sensed by a suite of photoreceptors including red and far-red light-sensing phytochromes. Light-activated phytochromes translocate from the cytoplasm to the nucleus and form subnuclear membraneless foci called photobodies. The formation of photobodies in the nucleus leads to the subsequent assembly of the plastid-encoded RNA polymerase (PEP) complex in chloroplasts. Recent genetic screen has identified NUCLEAR CONTROL OF PEP ACTIVITY (NCP) as a phytochrome-dependent dual switch in the nucleus and chloroplasts. However, the mechanism of nucleus-chloroplast communication to initiate chloroplast biogenesis is still unknown. Here, we propose that light-dependent alternative promoter selection on NCP promoter is the key mechanism of nucleus-chloroplast communication for initiating chloroplast biogenesis in angiosperms.of poultry, along with challenges and future perspectives of this technique



Curriculum Vitae – Dr. Chan Yul Yoo

257 S 1400 E, #201, School of Biological Sciences
University of Utah, Salt Lake City, UT 84112

Mob: (707) 548-8314
Tel: 801-585-1929
Email: chanyuly.yoo@utah.edu

Education

- Ph.D., Purdue University
- B.Sc., Yonsei University

Research and Teaching Positions

- Assistant Professor, University of Utah (2022-Current)
- Adjunct Assistant Professor, Oklahoma State University, (2020-2021)
- Assistant Project Scientist, University of California Riverside (2015-2020)
- Hargitt Postdoctoral Fellow, Duke University (2013-2015)
- Postdoctoral Associate, Purdue University (2012)

Selected Refereed Journal Articles (last 5 years)

1. Hwang Y*, Han S*, Yoo CY*, Hong L, You C, Le BH, Shi H, Zhong S, Hoecker U, Chen X, Chen M (2022) Anterograde signaling controls plastid transcription via sigma factors separately from nuclear photosynthesis genes. Nature Commun 13:7440

2. Yoo CY, He J, Sang Q, Qiu Y, Long L, Kim RJ, Chong E, Hahm J, Morffy N, Zhou P, Strader L, Nagatani A, Mo B, Chen X, Chen M (2021) Direct photoresponsive inhibition of a p53-like transcription activation domain in PIF3 by Arabidopsis phytochrome B. Nature Commun 12:5614

3. Qiu Y*, Pasoreck EK*, Yoo CY*, He J, Wang H, Bajracharya A, Li M, Larsen H, Cheung S, Chen M (2021) RCB initiates Arabidopsis thermomorphogenesis by stabilizing the thermoregulator PIF4 in the daytime. Nature Commun 12:2042

4. Yoo CY, Han S, Chen M (2020) Nucleus-to-plastid phytochrome signaling in controlling chloroplast biogenesis. Annu Plant Rev 3:251-280

5. Yoo CY, Pasoreck EK, Wang H, Cao J, Blaha GM, Weigel D, Chen M (2019) Phytochrome activates the plastid-encoded RNA polymerase for chloroplast biogenesis via nucleus-to-plastid signaling. Nature Commun 10:2629

6. Yang EJ*, Yoo CY*, Liu J*, Wang H, Cao J, Li F, Pryer K, Sun T, Weigel D, Zhou P, Chen M (2019) NCP activates chloroplast transcription by controlling light-dependent dual nuclear and plastidial switches. Nature Commun 10:2630

Shared Control for Tele- manipulation and Tele-navigation

Paolo Robuffo Giordano

IRISA, Campus Universitaire de Beaulieu 35042 Rennes cedex, France

Nowadays and future robotics applications are expected to address more and more complex tasks in increasingly unstructured environments and in co-existence or co-operation with humans. Achieving full autonomy is clearly a "holy grail" for the robotics community: however, one could easily argue that real full autonomy is, in practice, out of reach for years to come, and in some cases also not desirable. The leap between the cognitive skills (e.g., perception, decision making, general ”scene understanding”) of us humans w.r.t. those of the most advanced nowadays robots is still huge. In most applications involving tasks in unstructured environments, uncertainty, and interaction with the physical word, human assistance is still necessary, and will probably be for the next decades. These considerations motivate research efforts into the (large) topic of shared control for complex robotics systems: on the one hand, empower robots with a large degree of autonomy for allowing them to effectively operate in non-trivial environments. On the other hand, include human users in the loop for having them in (partial) control of some aspects of the overall robot behavior. In this talk I will then review several recent results on novel shared control architectures meant to blend together diverse fields of robot autonomy (sensing, planning, control, machine learning) for providing a human operator an easy "interface" for commanding the robot at high-level. Applications to the control of single/multiple mobile robots for remote navigation, and of manipulation systems for remote telemanipulation will be illustrated.

Curriculum Vitae – Dr. Paolo Robuffo Giordano

IRISA, Campus Universitaire de Beaulieu
35042 Rennes cedex, France

Tel: +33 (0)2 99842545
Email: prg@irisa.fr
Website: https://team.inria.fr/rainbow/team/prg

Education

・Habilitation `a Diriger des Recheches (HDR), Universit´e de Rennes 1, France (2016)

・Ph.D., in Systems Engineering (Dottorato di ricerca in Ingegneria dei Sistemi), University of Rome "La Sapienza", Rome, Italy (2004-2008)

・M.Sc., in Computer Science Engineering (Laurea in Ingegneria Informatica) University of Rome "La Sapienza", Rome, Italy (1995-2001)

Research and Teaching Positions

・ Head of the EPC Rainbow group at IRISA and Inria Rennes Bretagne Atlantique, Rennes, France (2018-Current)

・ CNRS Research Director (DR2), head of the Rainbow team at IRISA and Inria Rennes Bretagne Atlantique, Rennes, France (2016-Current)

・ CNRS Researcher (CR1) in the Lagadic team at Irisa and Inria Rennes Bretagne Atlantique, Rennes, France (2012-2016)

・ Project Leader (Senior Research Scientist – Head of the Human-Robot Interaction group) at the Max Planck Institute for Biological Cybernetics, B¨ulthoff Department, T¨ubingen, Germany (2008-2012)

・ Research Scientist at the Institute of Robotics and Mechatronics, German Aerospace Center (DLR), Oberpfaffenhofen, Germany (2007-2008)

・ Research assistant, University of Rome "La Sapienza", Italy (2002)

Dehydrins: Stress-Responsive Intrinsically Disordered Proteins in Plants

Masakazu HARA

Graduate School of Science and Technology (GSST)

Research Institute of Green Science and Technology (RIGST), Shizuoka University

Late embryogenesis abundant (LEA) proteins are abiotic stress responsive proteins which are widely distributed in the plant kingdom. LEA proteins are categorized into several groups according to their amino acid sequences. Among them the group #2, also known as "dehydrins", are the most common LEA proteins in land plants. Dehydrins are not only accumulated in the mature seeds but also expressed in vegetative tissues of plants exposed to dehydration and cold. Since dehydrins are rich in hydrophilic amino acids and Gly, the proteins have highly disordered structures and are soluble in aqueous solution even under high temperature. Considering that the gene expression of dehydrins remarkably responded to environmental stimuli, dehydrins have been thought to protect bio-macromolecules such as proteins and membranes in stressed cells. However, detail mechanisms, such as how the target biomolecules are protected by dehydrins, have not been determined. Recently, we have focused on the cryoprotective activities for cryosensitive proteins. The cryoprotective activities of dehydrins were remarkably higher than those of traditional cryoprotectants. Biochemical and biophysical analyses demonstrated that dehydrins are highly disordered in solution and efficiently protected cryo-sensitive proteins via specific hydrophobic amino acids in the conserved segments (Ksegs) without binding to the target proteins. During the freezing and thawing process, dehydrins are likely to protect the target proteins via the multiple mechanisms including both molecular shield effects and chaperone activities. Since dehydrins inhibited cryoaggregation of lipid nanoparticles and antibodies, dehydrins may be used for the storage of biofunctional materials and pharmaceutical proteins.

Funding: This work was supported by Grants-in-Aid (nos. 18H02222 and 19K22274) for Scientific Research from the Ministry of Education, Culture, Sports, Science, and Technology of Japan.

Curriculum Vitae – Prof. Masakazu HARA

Graduate School of Science and Technology, Shizuoka University, 836 Ohya, Suruga-ku, Shizuoka, 422-8529 Japan

Tel: +81-54-238-5134
Email: hara.masakazu@shizuoka.ac.jp

Education

- Ph.D., Chemical Engineering, Univ. of Maryland, College Park, MD (1985)
- M.S., Chemical Engineering, Univ. of California, Berkeley, CA (1980)
- B.S., Chemical Engineering, Stanford University, Stanford, CA, (1979)

Research and Teaching Positions

- 2020 – Dean of Graduate School of Science and Technology, SU
- 2013 – Research Institute of Green Science and Technology, SU
- 2001 - 2013 Associate Dean, Research and Graduate Studies, College of Engineering, University of California, Davis
- 2006 – Graduate School of Science and Technology, SU
- 2005 – Professor of Faculty of Agriculture, SU
- 2003 – 2005 Associate professor of Faculty of Agriculture, SU
- 1997 – 2003 Assistant professor of Faculty of Agriculture, Shizuoka University (SU)

Selected Refereed Journal Articles (last 5 years)

1. Osuda H, Kimura Y, Hara M (2023) Freeze-thaw-induced aggregation of bovine gamma globulin was efficiently inhibited by an intrinsically disordered plant protein dehydrin. Food Hydrocolloids for Health, 3, 100108.

2. Kimura Y, Ohkubo T, Shimizu K, Magata Y, Park EY, Hara M (2022) Inhibition of cryoaggregation of phospholipid liposomes by an Arabidopsis intrinsically disordered dehydrin and its K-segment. Colloids and Surfaces B: Biointerfaces 211, 112286

3. Osuda H, Sunano Y, Hara M (2021) An intrinsically disordered radish vacuolar calcium-binding protein (RVCaB) showed cryoprotective activity for lactate dehydrogenase with its hydrophobic region. International Journal of Biological Macromolecules 182: 1130-1137.

4. Yokoyama T, Ohkubo T, Kamiya K, Hara M (2020) Cryoprotective activity of Arabidopsis KS-type dehydrin depends on the hydrophobic amino acids of two active segments. Archives of Biochemistry and Biophysics 691: 108510.

5. Ohkubo T, Kameyama A, Kamiya K, Kondo M, Hara M (2020) F-segments of Arabidopsis dehydrins show cryoprotective activities for lactate dehydrogenase depending on the hydrophobic residues. Phytochemistry 173: 112300.

6. Matsuoka E, Kato N, Hara M (2019) Induction of the heat shock response in Arabidopsis by heat shock protein 70 inhibitor VER-155008. Functional Plant Biology 46: 925-932.

Current practice and future prospects of smart poultry farming in Bangladesh

Sazedul Karim Sarker

Poultry Research Center, Bangladesh Livestock Research Institute, Savar, Dhaka

2Bangladesh Jute Research Institute, Manik Mia Avenue, Dhaka

The concept of smart poultry farming can be expressed as the application of cutting-edge technologies, including artificial intelligence (AI), the internet of things (IoT), and high-speed wireless network into poultry farming practices to enhance poultry production in an economic and sustainable trend. The 2050 goal of sustainable farming is to increase agricultural yield including poultry to meet the food demand of 10 billion people. The use of AI, IoT, wireless networks (WLN), and responsible leadership in this sector in Bangladesh may install both the effectiveness and efficiency of smart poultry farming. These days IT has connected to every step of our daily life and even in the poultry farm operation in many countries of the world. It is now a time-demand issue from the rearing of poultry birds from day old to their production stage (egg or meat). This sector is becoming more commercialized rather than subsistence farming in Bangladesh compared to the last 20 years. To improve poultry growth by using the most modern technology we are proposing a complete wireless sensor network solution for poultry farming. The challenges in poultry farm operations are the emission of ammonia gas, an optimal temperature that is required for egg production, and also broiler growth, feeding, hatching, processing of birds, etc. Although commercial poultry farms have started IT-based poultry operations in our country but is very minimum as per requirement. Automation is essential for the upliftment of the poultry sector in Bangladesh as we are dreaming to reach a developed country by 2041. Initially, through our project funding, we are planning to start some activities related to IT here in Bangladesh and plan to collaborate with some developed countries including South Korea.

Keywords: Smart farming, sustainable agriculture, artificial intelligence, internet of things

Curriculum Vitae – Dr. Md. Sazedul Karim Sarker

Principal Scientific Officer and Head, Poultry Research Center, Bangladesh

Mob: +88-01712223635
Tel: +88-02224491679
Email: sazdulkarim@yahoo.com

Education

- Ph.D., (Awarded) from Sunchon National University, Jeollanam do, Suncheon, South Korea, 2010
- M.S., in Poultry Science (First Class) from Bangladesh Agricultural University, Mymensingh, 1999
- B.Sc., in Animal Husbandry (First Class) from Bangladesh Agricultural University, Mymensingh in 1999
- Higher Secondary Certificate (HSC) from Rajshahi Board, Bangladesh
- Secondary School Certificate (SSC) from Rajshahi Board, Bangladesh

Research and Teaching Positions

- Principal Scientific Officer & Head, Poultry Research Center, Bangladesh Livestock Research Institute (BLRI), Savar, Dhaka 1341
- Project Director, Strengthening of Poultry Research and Development Project, BLRI, Savar, Dhaka 1341
- Former Head, Poultry Production Research Division, BLRI, Savar, Dhaka 1341
- Former Station In-charge, BLRI Regional Station, Baghabari, Shazadpur, Sirajhgonj

Selected Refereed Journal Articles (last 5 years)

1. Farhana Sharmin, Md. Sazedul Karim Sarker, Md. Abdur Rashid, Shakila Faruque (2022). Effect of feeding Spirulina platensis, Trigonella foenum-graecum seed as a functional feed ingredient on growth performance and oxidative stability in turkey meat. Glob J Nutri Food Sci. 3(5): DOI:10.33552/GJNFS.2022.03.000573.

2. M.M. Rana, C.I. Lim, M.S.K. Sarker, A.A. Bhuiyan and K.S. Ryu (2022). Effect of dietary phosphorus and restricted feeding on performance, egg quality and serum biochemical traits of laying hens at the second production phase. Bangladesh J. Agri. 2022, 47(2): 119-132

3. Farhana Sharmin, Md. Sazedul Karim Sarker, Nathu Ram Sarker, Shakila Faruque (2021). Dietary effect of Moringa oleifera on native laying hens' egg quality, cholesterol and fatty acid profile. Ital. J. Anim. Sci., doi: 10.1080/1828051X.2021.1987846

4. F. Sharmin, N. R. Sarker, M.S.K. Sarker (2020). Effect of using Moringa oleifera and Spirulina platensis as feed additives on performance, meat composition and oxidative stability and fatty acid profiles in broiler chicken. Journal of Nutrition & Food Sciences, 10 (3): 772, 1-8.

5. F. Sharmin, M.S.K. Sarker, N.R. Sarker, K.S. Huque, S.M.J. Hossain and M.K. Bashar (2019). Taxonomical identification, biomass production and nutrient composition of Moringa sp. as a fodder crop. Bangladesh Journal of Livestock Research, 26(1&2), 61-72.

6. M. A. Rashid, M.S.K. Sarker, H. Khatun, N. R. Sarker, M. Y. Ali and M. N. Islam (2018). Detection of heavy metals in poultry feed, meat and eggs. Asian-Australasian Journal of Food Safety and Security, 2(1): 1-5

Canopy Micrometeorology Model to improve the prediction of heat stress in rice under global warming

Dr. Mayumi Yoshimoto

Institute for Agro Environmental Sciences, NARO, Japan

Rice is well adapted to a wide range of climates, but is highly susceptible to heat during flowering. However, there are uncertainties in assessing the occurrence of heat-induced spikelet sterility (HISS) and the impact of climate change. One reason is the gap between the ambient air temperature and the panicle temperature, which determines the magnitude of HISS in field studies. To improve our understanding of this gap, we established a multi-site monitoring network (MINCERnet) to measure canopy micrometeorology and heat stress in the major rice growing regions (Sub-Saharan Africa; South, Southeast, and East Asia; and the USA). By using the MINCERnet data in the canopy heat-balance model (IM^{2}PACT), we confirmed that the canopy and panicle transpiration and the resulting evaporative cooling strongly affected the gap between the ambient air temperature and the panicle temperature, and that the HISS rate in open fields could be predicted accurately even in diverse climates by using the mean panicle temperature during the flowering hours. Based on these results, this talk will show how to reduce uncertainties caused by gaps between global scale and the micrometeorology inside the plant canopy, and also the importance of microclimate models in predicting the future of heat stress and evaluating the effectiveness of adaptation measures under climate change.

Our research was financially supported by the Global Environmental Research Coordination System from Ministry of the Environment of Japan (MAFF1531 and MAFF1842), and by a Japan Society for the Promotion of Science KAKENHI Grant Number JP15H02650.

Curriculum Vitae – Dr. Mayumi Yoshimoto

Institute for Agro-Environmental Sciences, National Agriculture and Food Research Organization (NARO)
3-1-3 Kannondai, Tsukuba, Ibaraki 305-8604 Japan

Tel: +81-29-838-8205
Email: yoshimot@affrc.go.jp

Education

- Ph.D., 1997, Environmental Sciences and Technology, Osaka Prefecture University, Japan
- M.A., 1991, Geophysics, University of Tokyo, Japan
- B.A., 1989, Geophysics, University of Tokyo, Japan

Research and Teaching Positions

- Senior Principal Scientist, Institute for Agro-Environmental Sciences, NARO, 2016-Present
- Senior Researcher, National Institute for Agro-Environmental Sciences (NIAES), 2001-2016
- Researcher, NIAES, 1991.10-2001.3
- Researcher, Tohoku National Agricultural Experimental Station, 1991.4-1991.9

Selected Refereed Journal Articles (last 5 years)

1. Yoshimoto, M., Fukuoka, M., Tsujimoto, Y. et al. (2022) Monitoring canopy micrometeorology in diverse climates to improve the prediction of heat-induced spikelet sterility in rice under climate change. Agricultural and Forest Meteorology, 316, 108860

2. Zhang, G., Ujiie, K., Yoshimoto, M. et al. (2022) Daytime warming during early grain filling offsets the CO2 fertilization effect in rice. Environmental Research Letters, 17, 114051

3. Ishimaru, T., Sasaki, K., Lumanglas, P.D., Cabral, C.L.U., Ye, C., Yoshimoto, M., Kumar, A., Henry A. (2022) Effect of drought stress on flowering characteristics in rice (Oryza sativa L.): a study using genotypes contrasting in drought tolerance and flower opening time. Plant Production Science, 25(3), 359-370

4. Tang, S., Yuan, P., Tawaraya, K., Tokida, T., Fukuoka, M., Yoshimoto, M., Sakai, H., Hasegawa, T., Xu X., Cheng, W. (2022) Winter nocturnal warming affects the freeze-thaw frequency, soil aggregate distribution, and the contents and decomposability of C and N in paddy fields. Science of The Total Environment, 802, 149870

5. Yoshimoto., M., Sakai, H., Ishigooka, Y. et al. (2021) Field survey on rice spikelet sterility in an extremely hot summer of 2018 in Japan. Journal of Agricultural Meteorology, 77(4), 262-269

6. Tsujimoto, Y., Fuseini, A., Inusah, I.Y., Dogbe, W., Yoshimoto M., Fukuoka, M. (2021) Different effects of water-saving management on canopy microclimate, spikelet sterility, and rice yield in the dry and wet seasons of the sub-humid tropics in northern Ghana. Field Crops Research, 260, 107978

Smart Framing: Innovative Tool for Sustainable Livestock Production

Muhammad Ammar Dilawar

Instructor and Researcher at MS Institute of Professional Veterinary Training

Smart livestock farming uses the efficient digital technologies for better production, and sustainable farm operations. Smart livestock production and increased animal welfare have the potential to reduce the impact of animal farming on natural resources. The approach of smart livestock farms is leveraging new techniques such as predictive analysis, big data, and internet of things (IoT). The important aspect of smart livestock farming is the individual monitoring and analyses of animals, which is referred to as precision livestock farming (PLF). In PLF, different automatic and continuous sensors are used to check the important productive parameters of animal health, environmental factors, and productivity. Smart farming uses IoT based advanced technologies and solutions for better farm operational efficiency, increase yield, and reduce wastage by incorporating real-time farm data collection, data analysis, and implementation of control mechanism. The objectives of the livestock farming must be to meet future demands of livestock products, maintain consistent quality, and to accomplish this in a sustainable manner without exceeding global resources and causing irreparable environmental damage.

Keywords: smart livestock farming; precision livestock farming; sustainable; internet of things; sensors

Curriculum Vitae – Ph. D. Muhammad Ammar Dilawar

House 515C, Street 49, I-8/2 Islamabad

Mob: (707) 548-8314
Tel: +92-3465945829
Email: ammar_dilawar@yahoo.com

Education

- Ph.D., in Animal Science (Poultry Nutrition), Sunchon National University, Republic of Korea (2018-2022)
- Doctor of Veterinary Medicine (DVM), PMAS- Arid Agriculture University, Pakistan (2011-2016)

Research and Teaching Positions

- Post-doc Researcher at Animal Nutrition Lab, Sunchon National University.
- Working as a Researcher in different industry collaborated projects since 2018.
- 6 months of working experience at Poultry Feed Mill.
- 6 months of working experience at a commercial broiler farm.

Selected Refereed Journal Articles (last 5 years)

1. Dilawar, M.A., Mun, H.S., Rathnayake, D., Yang, E.J., Seo, Y.S., Park, H.S., Yang, C.J. Egg Quality Parameters, Production Performance and Immunity of Laying Hens Supplemented with Plant Extracts. Animals 2021, 11, 975.

2. Dilawar, M.A., Saturno, J.F.L., Mun, H.S., Kim, D.H., Jeong M.G., Yang, C.J. Influence of Two Plant Extracts on Broiler Performance, Oxidative Stability of Meat and Odorous Gas Emissions from Excreta. Ann Anim Sci 2019, 19, 1099-1113.

3. Dilawar, M.A., Mun, H.S., Rathnayake, D., Jeong, M.G., Yang, E.J., Park, H.S., Yang, C.J. Influence of Combination of Two Plant Extracts and Liquid Minerals Supplementation in Drinking Water on Growth Performance and Meat Quality in Pigs. Ind J Anim Res 2020, 1-6.

4. Yang, E.J., Seo, Y.S., Dilawar, M.A., Mun, H.S., Park, H.S., Yang, C.J. Physico-chemical attributes, sensory evaluation and oxidative stability of leg meat from broilers supplemented with plant extracts. J Anim Tech 2020, 62, 730-740.

5. Mahfuz, S., Mun, H.S., Dilawar, M.A. and Yang, C.J. Applications of Smart Technology as a Sustainable Strategy in Modern Swine Farming. Sustainability 2022, 2607.

6. Mun, H.S., Rathnayake, D., Dilawar, M.A., Jeong, M.G. and Yang, C.J. Effect of ambient temperature on growth performances, carcass traits and meat quality of pigs. J App Anim Res 2022, 50, 103-108.

7. Mun, H.S., Dilawar, M.A., Kim, C.D., Ryu, S.B., Moon, J.P. and Yang, C.J.. Geothermal Heat Pump as an Environmental Friendly, Renewable Energy Source for Sustainable Pig Production. Environ Asia 2022, 15(1).

8. Mun, H.S., Dilawar, M.A., Kim, C.D., Ryu, S.B., Moon, J.P. and Yang, C.J.. Geothermal Heat Pump as an Environmental Friendly, Renewable Energy Source for Sustainable Pig Production. Environ Asia 2022, 15(1).

Bio-signal classification based on machine learning

Jae-Neung Lee

Department of Electrical and Electronic Engineering, SUSTECH,1088 Xueyuan Blvd, Nanshan, Shenzhen, Guangdong Province, China, 518-055, China

In this paper, we propose a PICANet model based on PPCA and ICA. The existing PCANet has a smaller computational complexity and is faster than deep learning. However, any modification such as changing a scale and adding a noise in the data decreases the performance, which is a limitation The PICANet algorithm has thus been proposed to solve this problem. To eliminate the correlation between the PPCA feature vectors, the ICA algorithm is used to determine the vectors that are statistically independent. The feature values obtained from the final histogram are vectorized and serve as input to the classifier. We use the BIDMC-PPG and CU-ECG and employ noise data to verify the performance of the proposed method. A PICANet demonstrates better experimental performance than a PCANet about 2% in terms of recognition rate. In addition, when noise PPG and ECG data are used, the PICANet achieved better performance than the PCANet. The experiment results show that the proposed model plays an effective role in terms of simplicity and efficiency.

Curriculum Vitae – Dr. Jae-Neung Lee

1088 Xueyuan Blvd, Nan Shan Qu, Shen Zhen Shi, Guang Dong Sheng, China, 518055

Mob: +86-13823530487
Tel: +86-13823530487
Email: jnlee@sustech.edu.cn

Education

・Ph.D., major in Machine learning, motion analysis, ECG biometrics, face recognition, Chosun University, South Korea (2013)

・M.S., major in deep learning, motion analysis, ECG biometrics, Chosun University, South Korea

・B.S., major in Machine learning, Chosun University, South Korea

Research and Teaching Positions

・ 2021 - 2023 Post-Doctoral Research Assistant, PPG classification, SHENZHEN-BASED Southern University of Science and Technology

・ 2020 - 2021 Post-Doctoral Research Assistant object detection, CITY University of Hong Kong

・ 2015 - 2017 Research assistant, circuit design, Chosun University, South Korea

Selected Refereed Journal Articles (last 5 years)

1. Jae-Neung Lee, Keun-Chang Kwak, "ECG-Based Biometrics Using a Deep Network Based on Independent Component Analysis", IEEE Access, vol. 10, pp. 12913–12926, Feb 2022. DOI: 10.1109/ACCESS.2022.3147807

2. Jae-Neung Lee, Keun-Chang Kwak, "Personal identification using a robust EigenECG network based on time-frequency representations of ECG signals", IEEE Access, vol. 7, pp. 48392–48404, March 2019. DOI: 10.1109/ACCESS.2019.2904095

3. Jae-Neung Lee, Yeong-Hyeon Byeon, Sum Bum Pan, and Keun-Chang Kwak, An EigenECG network approach based on PCANet for personal identification from ECG signal", Sensors. vol. 18, no. 11, pp. 1–25, Nov 2018. DOI: 10.3390/s18114024

4. Jae-Neung Lee, Yeong-Hyeon Byeon and Keun-Chang Kwak, "Design of Ensemble Stacked Auto-Encoder for Classification of Horse Gaits with MEMS Inertial Sensor Technology", Micromachines, vol. 9, no. 8, pp. 1-17, Aug 2018. DOI: 10.3390/mi9080411

Guide for Zoom Meeting Attendance
Zoom 설치 및 회의 참가 가이드

"International Conference of the BK21 FOUR on IT-Bio Convergence"

■ February 13 (Mon): Session 1, Session 2, Session 3

Zoom Meeting (Session 1, Session 2, Session 3)

February 13 (Mon), 2023 (13:00 ~ 18:30)

Zoom address

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February 14 (Tue), 2023 (09:00 ~ 11:55)

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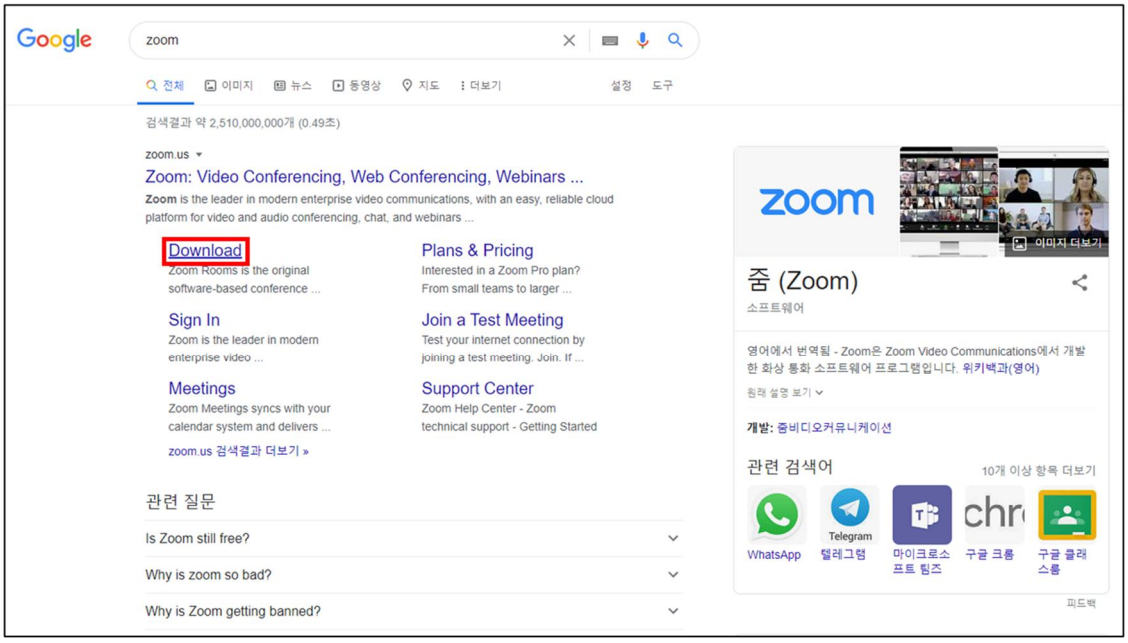

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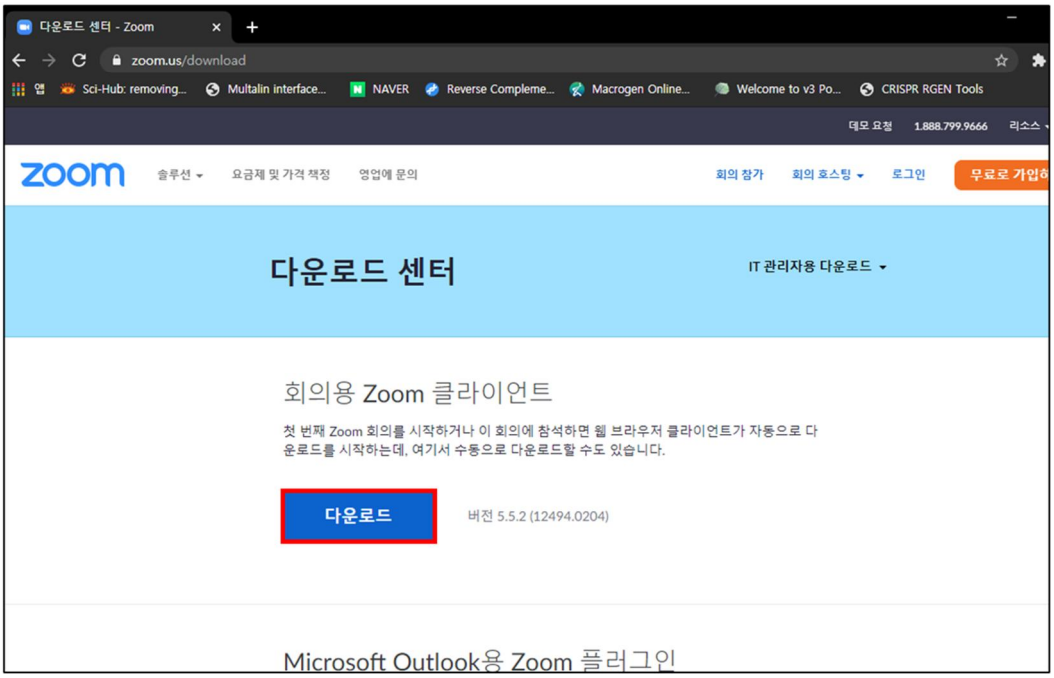

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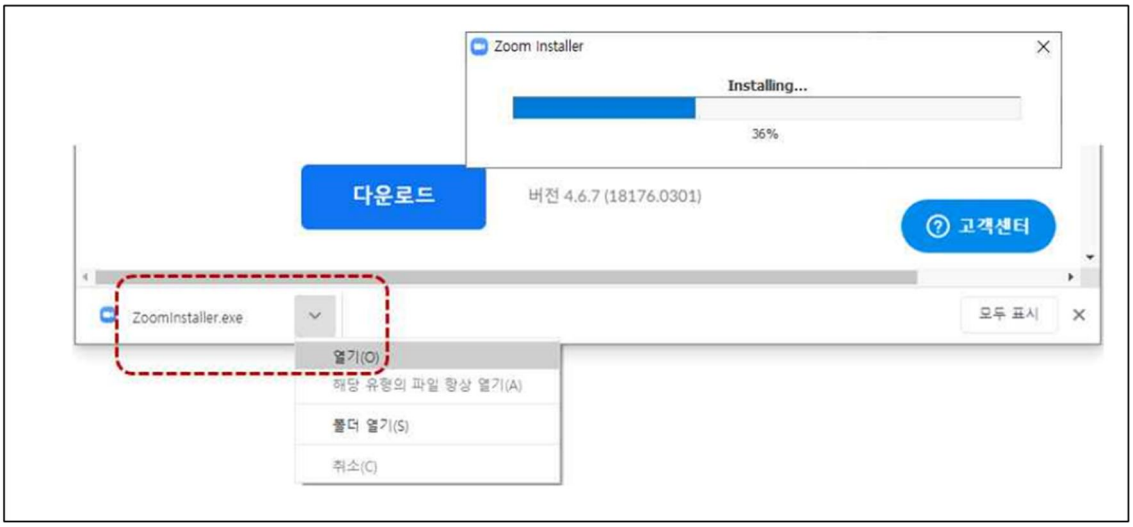
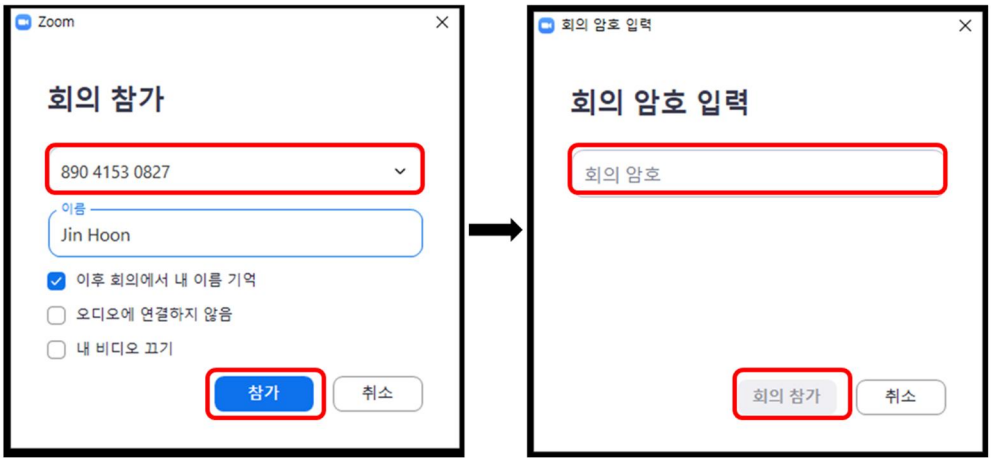
   Open the zoom installation file > Install the zoom program



4. Zoom 프로그램 실행 후 '회의참가' 버튼 클릭
   After running zoom program, click the 'participation in meeting' button

- **Zoom 설치 및 회의 참가 가이드**
  Guide of Zoom program setup

5. Meeting ID를 입력하고 '참가' 버튼을 클릭 > 회의 암호 입력 후 '회의 참가' 클릭
   Enter the Meeting ID and click the'Join' button
   > Enter the meeting password and click'Join the Meeting'



- **Zoom 설치 및 회의 참가 가이드**
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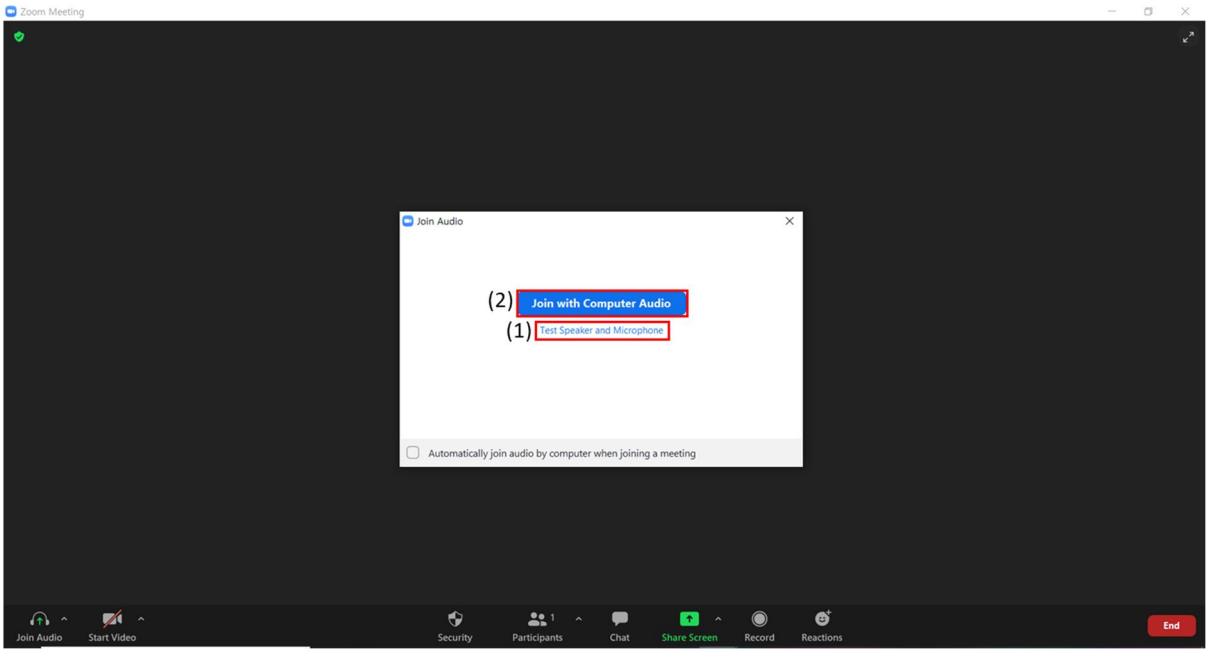
6. (1) 스피커, 마이크 테스트 버튼을 눌러서 작동 유무를 확인한다
   Before join the meeting, Please check the speaker and microphone (click the **'Test Speaker and Microphone'** button
   (2) 컴퓨터 오디오로 참가 버튼을 누르면 회의 화면을 볼 수 있다.
   Click the 'Join with computer audio' button > You can see the meeting



- **Zoom 설치 및 회의 참가 가이드**
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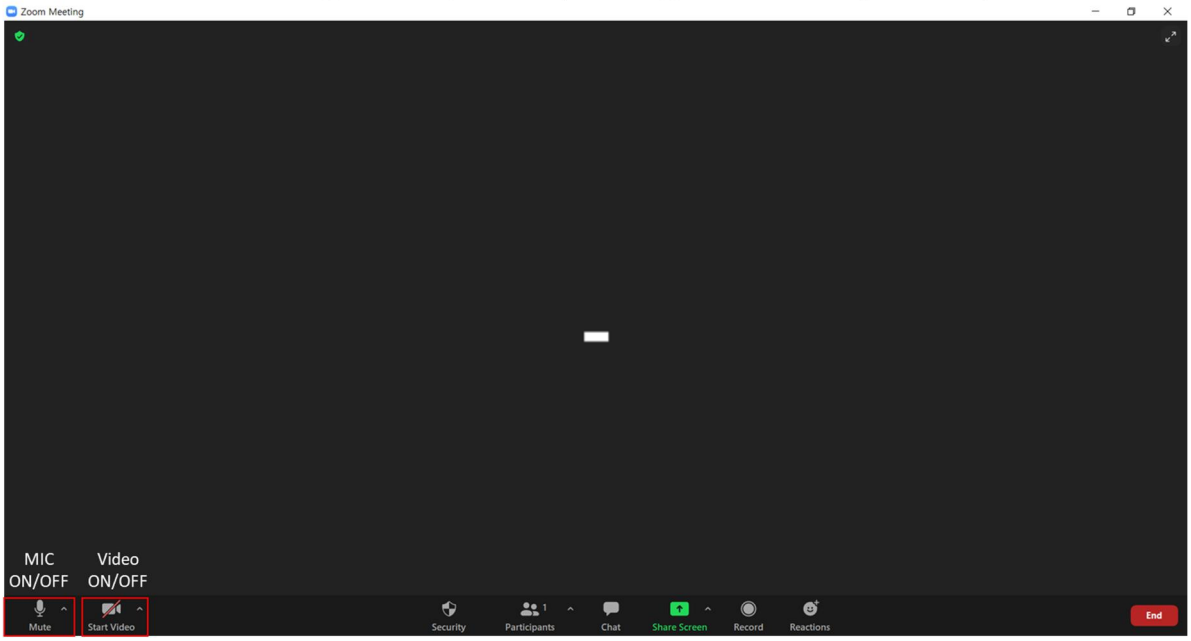
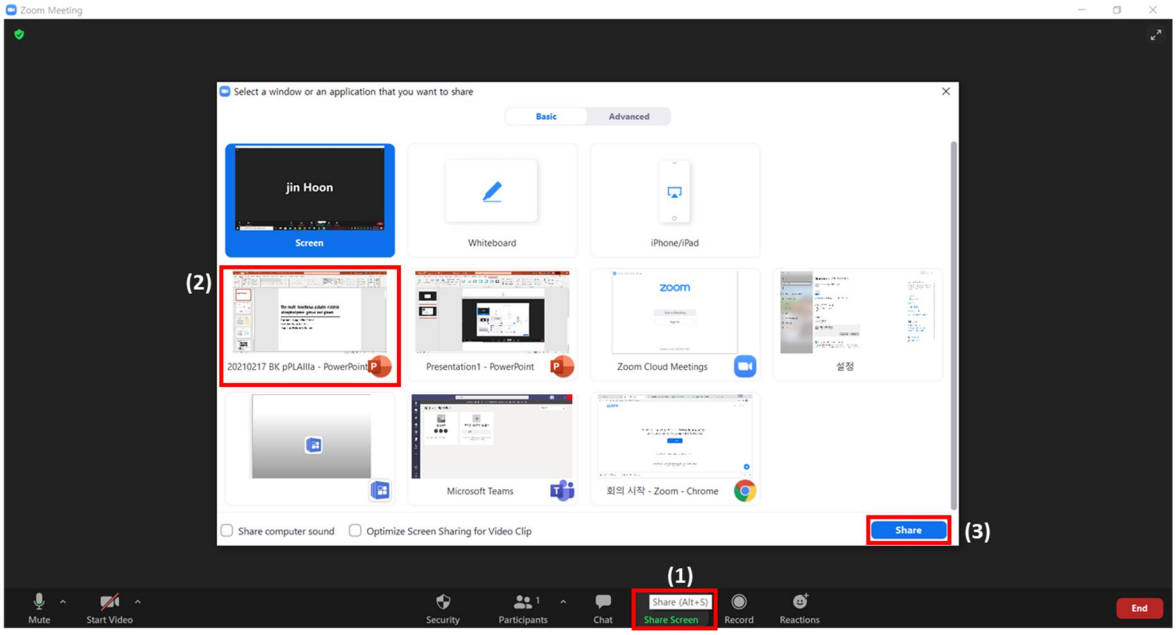
7. (1) 미팅에 참여한 뒤, 음소거 버튼으로 마이크를 ON/OFF 할 수 있다. **(필요시에만 마이크를 켜 주시길 바랍니다.)**
   After joining the meeting, you can turn the microphone ON/OFF with the mute button. **(Please turn on the microphone only when necessary.)**
   (2) 비디오 시작 버튼을 클릭하면 웹캠 (얼굴 화면)을 보여줄 수 있습니다. **(가급적 비디오를 켜 주시길 바랍니다.)**
   Click the **'start video button'**, you can show your webcam (face screen) **(We recommend turning on the video.)**



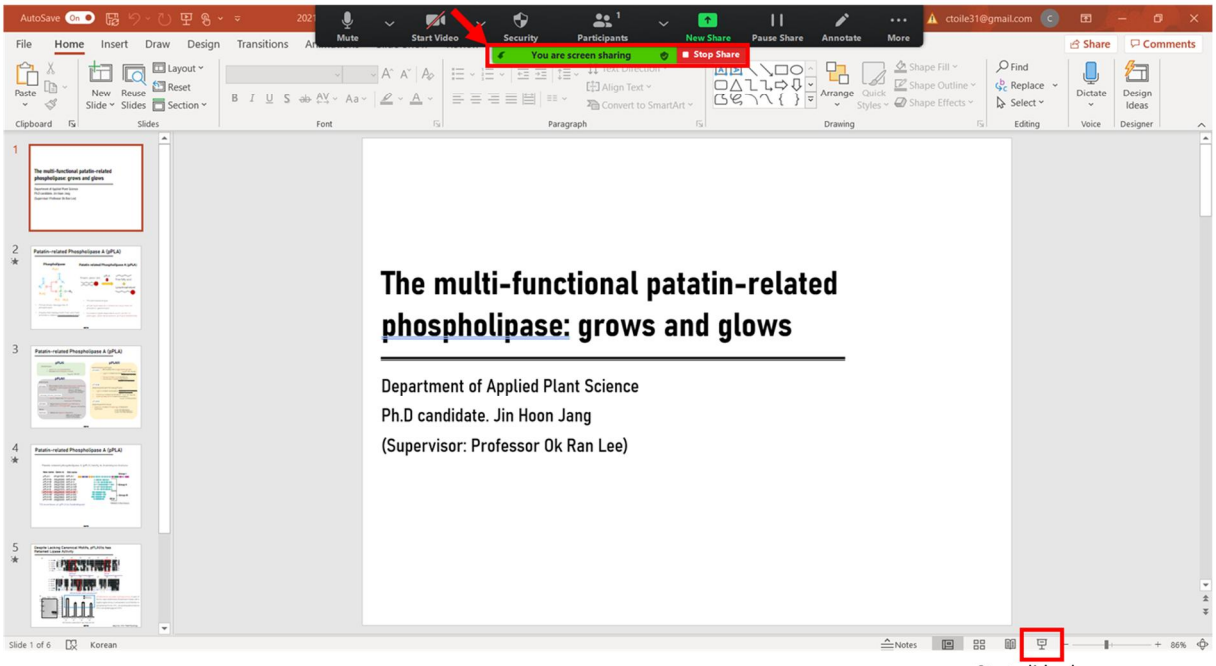
- **Zoom 설치 및 회의 참가 가이드**
  Guide of Zoom program setup
  발표자 화면공유 (Speaker's screen sharing)

8. (1) 화면 공유 버튼을 클릭 > (2) 공유할 창 (ex, ppt 파일)을 클릭 > (3) '공유' 버튼을 클릭
   (1) Click the **'Share Screen'** button > (2) Click the screen you want to share. > (3) Click the **'Share'** button



- **Zoom 설치 및 회의 참가 가이드**
  Guide of Zoom program setup
  발표자 화면공유 (Speaker's screen sharing)

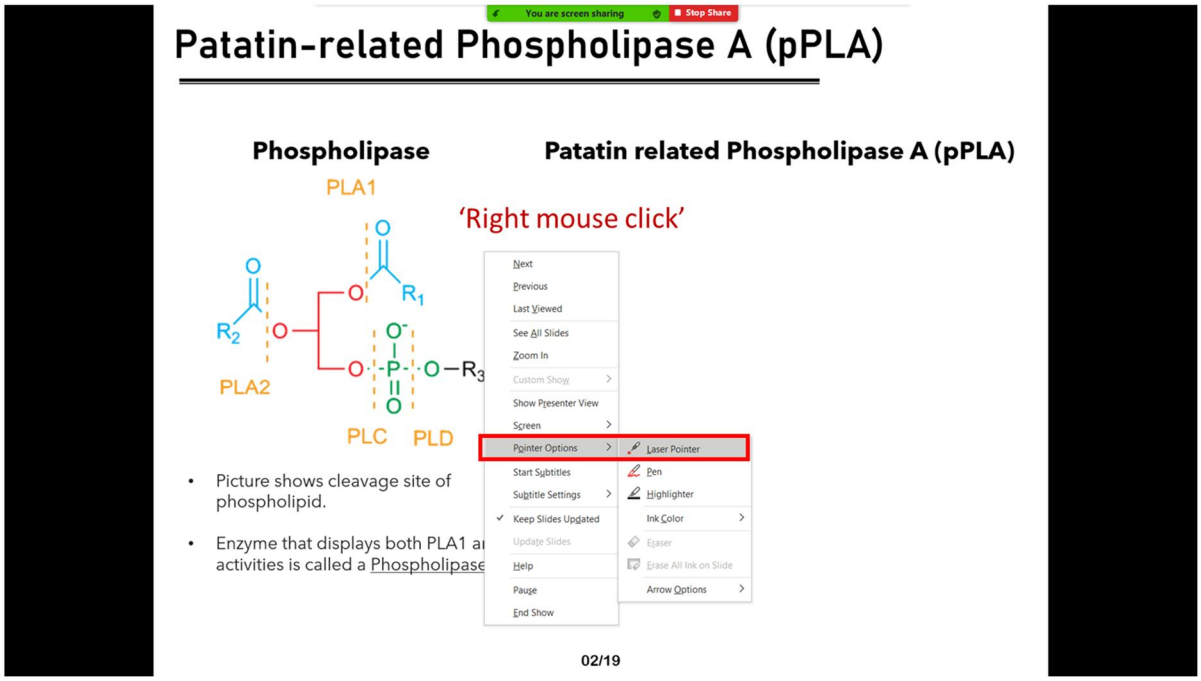
9. 화면공유가 되었다면, **화면공유중 이라는 안내문구**를 확인할 수 있다. > 슬라이드 쇼 버튼을 누르고 발표 시작
   If the screen is shared, you can check the message that **'You are screen sharing'** > Start to presentation

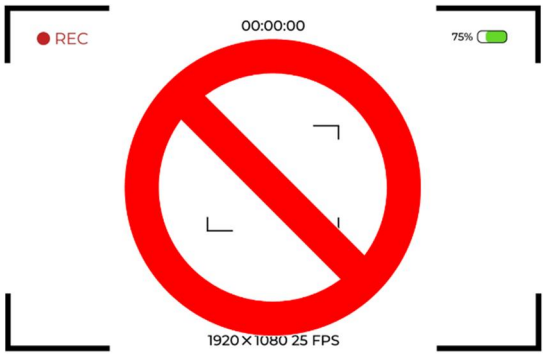


Start slide show

- **Zoom 설치 및 회의 참가 가이드**
  Guide of Zoom program setup
  발표자 화면공유 (Speaker's screen sharing)

10. 파워포인트 발표 (슬라이드쇼) 중 마우스 우클릭 > 포인터 기능 사용가능
    Right mouse click on ppt slide > You can use the pointer



 'https://kor.pngtree.com/so/음소거'	 'https://kor.pngtree.com/so/카메라
발표자를 제외한 모든 참가자들 음소거 해주세요. **Please press the mute button.**	실시간 온라인 강의(ZOOM) 시, 별도의 기기를 이용하여 녹화하는 행위 금지 (저작권 및 초상권 침해 가능성) **Do not recording**

BK21 FOUR IT-Bio융합시스템농업교육연구단 제 4회 국제학술대회

"Change The Future Agriculture with New Farming Technology"

February 13 (Mon) – 15 (Wed), 2023

MUJU DEOGYUSAN RESORT, SOUTH KOREA