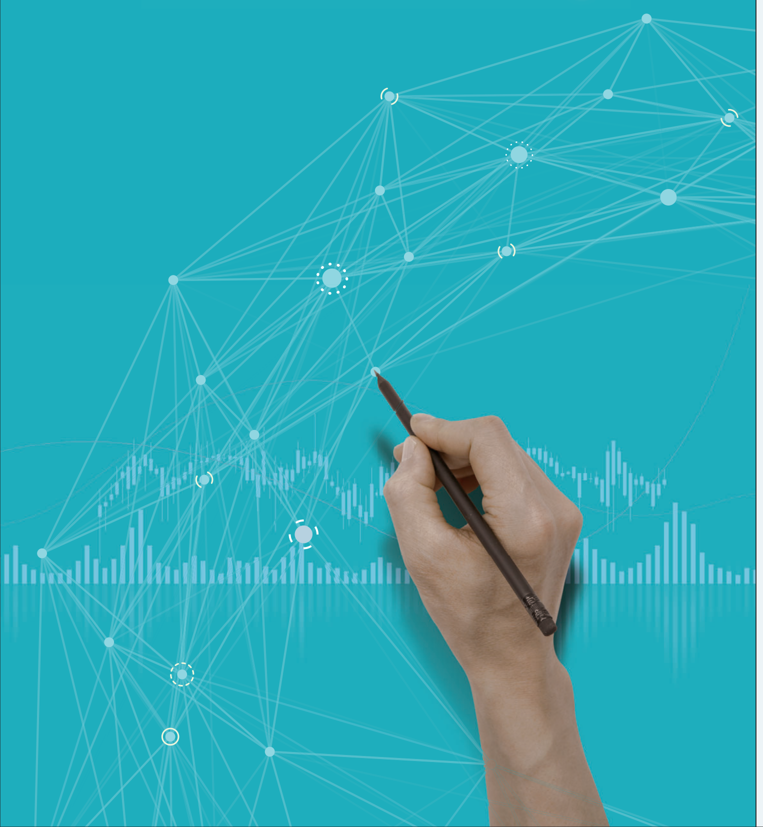
DAESUNG HAEGANG
MICROBES FORUM

Lab to Industry for Bioeconomy



Welcoming Remark

Welcome to 2019 Daesung Haegang Microbes Forum.

I am proud we are now hosting the third annual edition of this forum. This international forum brings together experts from Korea and abroad to discuss the great potential of microbes in leading just the type of appropriate breakthroughs we will need to ensure a sustainable future.

In 2018 our forum received excellent reviews for its introduction of a synthetic biology-based bio-butanal technology, a commercial fuel-producing fermentation platform using microbes, and a microbiologic conversion technology that turns greenhouse gas methane into biofuels and chemical materials.

This year, under the theme of "Lab to Industry for Bioeconomy," we hope to introduce laboratory technologies that are close to industrialization and hold in-depth discussions on how we may successfully commercialize bio-technology.

We have invited a truly renowned group of speakers. In this field Derek R. Lovley, Distinguished Professor at the Department of Microbiology at the University of Massachusetts, almost needs no introduction. Dr. Lovley has helped to create a new field of study around a microorganism he discovered and personally named, Geobacter.

I would also like to extend a warm welcome to Dr. Kristala L.J. Prather, who is the Arthur D. Little Professor of Chemical Engineering at MIT and a co-director of the MIT Energy Initiative's Low-Carbon Energy Center for Energy Bioscience Research.

In addition, I am very grateful that Professor Sung-Hoon Park of UNIST, who is recognized for his research on the economic feasibility and development of eco-friendly chemical products, and I am also delighted to have the opportunity to offer up-and-coming scientists in the field of bio-technology the opportunity to present their research. Professor Jeong-Wook Lee of POSTECH and Professor Won-Ki Cho of KAIST plan to announce the results of latest research.

I sincerely hope you find today's forum both informative and inspiring.

Thank you very much.

Younghoon David Kim
Chair, World Energy Council
Chairman & CEO, Daesung Group

Young Scientists' Speeches

Genetic devices that control life or death of living organisms

Jeong-Wook Lee
POSTECH, Korea

Genetically modified organisms can be used in various applications from degrading toxic compounds in environment to monitoring around the human body for diagnosis and/or treatment. However, to deploy such engineered organisms to our environment or human body, we need a system to control the organisms in case the organisms operate in an undesirable way. To address the issue, genetic devices that control the engineered organisms are introduced in this talk. Genetic devices are composed of gene regulatory components including transcriptional repressors and activators, which are used to precisely control gene expression and to create non-existing regulatory functions such as Boolean logic operations. By combining well-defined gene regulatory parts, genetic devices can be created that control cellular behaviors including life or death of living organisms. To do this, a bistable, genetic toggle switch is unbalanced to make a monostable switch, which contains only one stable state. Self-killing mechanisms are then coupled with the monostable toggle switch that triggers the activation of the self-killing mechanisms when the cells are placed outside their intended environment. Furthermore, the genetic circuit that efficiently kills the host strain can be readily reprogrammed to respond to other signal molecules. Such genetic devices can be applied to develop genetic biocontainment system that will prevent unauthorized release of genetically modified organisms and protect intellectual properties such as genes and strains for a variety of industrial, environmental and clinical applications.

· Assistant Professor, Department of Chemical Engineering, Pohang University of Science and Technology (POSTECH)

Young Scientists' Speeches

Shedding light on the cell using super-resolution microscopy

Won-Ki Cho
KAIST, Korea

DNA contains genetic information for a cell. In the cell, DNA is highly coiled and packed in a small nucleus. We have understood how the genetic information of DNA is expressed. The first step of gene expression is transcription that copies DNA information into mRNAs. By the way, the detailed mechanism of transcription is not fully solved yet. To directly observe the process in a living cell nucleus we used fluorescence microscopy, labeling RNA Polymerase II and Mediator which are essential proteins for transcription. Since the nucleus is very crowded space, we used super-resolution microscopy to achieve high-resolution. We found RNA Polymerase II forms clusters in a cell nucleus, along with Mediator. Further experiments with lattice-light sheet microscopy unveiled physical property of the protein clusters, that of liquid-droplets. By labeling a specific gene fluorescently, we also found the protein clusters are transcription-related. In conclusion, we set a new model for transcription regulation.

· Assistant Professor, Department of Biological Sciences, Korea Advanced Institute of Science and Technology (KAIST)

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June 20, 2019
The Westin Chosun Seoul

Host
Daesung Haegang Science and Culture Foundation

Co-organizers
Korean Society for Microbiology and Biotechnology
C1 Gas Refinery R&D Center
KAIST Department of Biological Sciences
Intelligent Synthetic Biology Center

Sponsor
Daesung Group

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Program

12:00 - 13:00	**Registration & Reception**
13:00 - 13:05	**Opening**
13:05 - 13:15	**Congratulatory Remark** Se-Jung Oh President, Seoul National University
13:15 - 13:35	**Welcoming Remark** Younghoon David Kim Chair, World Energy Council Chairman & CEO, Daesung Group
13:35 - 15:05	**Plenary Speeches** Derek R. Lovley University of Massachusetts-Amherst, USA Sung-Hoon Park UNIST, Korea Kristala L. J. Prather MIT, USA
15:05 - 16:05	**Panel Discussion** Theme Lab to Industry for Bioeconomy Moderator Byung-Kwan Cho KAIST, Korea Panelists Derek R. Lovley University of Massachusetts-Amherst, USA Sung-Hoon Park UNIST, Korea Kristala L. J. Prather MIT, USA
16:05 - 16:25	Coffee Break
16:25 - 16:45	**Industry Speech** Jörg Fischer CFO, EnviTec Biogas
16:45- 17:15	**Young Scientists' Speeches** Jeong-Wook Lee POSTECH, Korea Won-Ki Cho KAIST, Korea
17:15 - 17:20	**Closing**

Plenary Speeches

Electromicrobiology solutions for sustainable energy

Derek R. Lovley
University of Massachusetts-Amherst, USA

Electromicrobiology refers to microorganisms that can exchange electrons with their external environment. Electrically active bacteria, as well as materials harvested from these bacteria, offer multiple novel opportunities in sustainable energy generation. For example, electrically conductive protein nanowires harvested from the microorganism Geobacter are a revolutionary 'green' electronic material produced from renewable feedstocks with low energy inputs and no toxic components. Remarkably, devices comprised of thin films (< 10μm) of the protein nanowires harvest electricity from the ambient environment, literally producing current 'out of thin air' with scalable, robust, long-term performance. Protein nanowires also perform well in other nano-electronic devices, including flexible films for biomedical and environmental sensing. The conversion of organic waste to methane, known as anaerobic digestion, is one of the few successful large-scale bioenergy processes. Study of the microbiology of anaerobic digestion revealed that microorganisms that express protein nanowires 'wire' themselves to methane-producing microbes providing the electrons for the conversion of carbon dioxide to methane. This new microbiological understanding has led to strategies to accelerate and stabilize anaerobic digestion, greatly improving the process. Electrically active bacteria can also wire themselves to electrodes, leading to new bioenergy strategies, such as microbial electrosynthesis, in which sustainably produced electricity powers microbial conversion of carbon dioxide to fuels and other organic commodities. Electrically active bacteria are also useful agents for remediating environments contaminated with organic and metal pollutants associated with traditional fossil fuel and nuclear energy options. Additional emerging concepts on the application of electromicrobiology to a sustainable energy future will be discussed.

· Distinguished Professor, Department of Microbiology, University of Massachusetts-Amherst

Plenary Speeches

Biological production of 3-hydroxypropionic acid from glycerol

Sung-Hoon Park
UNIST, Korea

3-Hydroxypropionic acid (3-HP) is an important platform chemical which has diverse applications in paint, polymer and diaper industries. It can be produced from crude glycerol, an abundant byproduct of biodiesel production, by two enzymatic reactions. To develop suitable microbial cell factories, we studied various host strains, genes, pathway, toxicity, cell physiology, etc. for last~15 years. The work includes selection of proper host microorganisms, optimization of gene expression, enzyme engineering, deletion of competing and 3-HP degradation pathways, optimization of energy and cofactor metabolisms, transport, adaptive evolution, etc. Many strains have been developed and transferred to a collaborating company, and the company has been working on bioreactor-scale fermentation, downstream processing and scale-up for commercialization. This lectures summarizes and discusses our journey with 3-HP.

· Professor, School of Energy and Chemical Engineering, Ulsan National Institute of Science and Technology (UNIST)

Plenary Speeches

Building microbial chemical factories

Kristala L. J. Prather
MIT, USA

Biological systems have the potential to produce a wide array of compounds with uses that include fuels, materials, bulk chemicals, and pharmaceuticals. Our group is focused on applying principles from metabolic engineering and biocatalysis towards the design and construction of novel biosynthetic pathways for specified target compounds. This "retro-biosynthetic design" approach is aided by advancements in the development of new tools under the umbrella of synthetic biology that facilitate re-engineering of biological systems. As new pathways are designed and constructed, typical challenges such as low product yields and titers can hamper development of commercially-relevant processes. In this talk, I will review our group's sustained efforts to both produce novel compounds through biological synthesis and develop strategies to address its inherent limitations.

· Arthur D. Little Professor, Department of Chemical Engineering, Massachusetts Institute of Technology (MIT)

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