DAESUNG GROUP

6/11th Floor Dongdeok Bldg., 68 Ujeongguk-ro, Jongno-gu, Seoul, 03145 Korea

Tel : +82-2-3700-1700 | Fax : +82-2-3700-1701

70th ANNIVERSARY
DAESUNG GROUP

FEW NEXUS CONFERENCE

Mighty Microbes for the Energy Revolution

DAESUNG GROUP

Hosted by Daesung Haegang Science and Culture Foundation

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70th ANNIVERSARY
DAESUNG GROUP

FEW NEXUS CONFERENCE

Mighty Microbes for the Energy Revolution

- **Date** Thursday June 22, 2017 | 13:30~16:30
- **Venue** Ruby Room, Yeong Bin Gwan
  The Hotel Shilla, Seoul

CONTENTS

CONGRATULATORY SPEECH 02 **SCENE SETTING SPEECH** 03 **PROGRAM / OVERVIEW** 06

MODERATOR CHO, Byung Kwan Professor 09

SPEAKERS LEE, Choul-Gyun Professor 10 Mario R. Tredici Professor 12 Ioannis Ieropoulos Professor 14
Yuan Kun Lee Professor 16 LEE, Sang Yup Professor 18

CONGRATULATORY SPEECH

OH, Se-jung

Member of National Assembly
President, National Research Foundation of Korea

Global climate change is one of the greatest issues facing the mankind today. Climate change can take grave effect upon critical elements indispensable for human survival, such as energy, water and food. It is heartening, however, that recently solutions are sought for to resolve these critical issues by use of microorganisms.

Furthermore, the current research in microorganisms will be expedited in the research, advancing the outcome of research findings, by taking advantage of the tools generated by the Fourth Industrial Revolution, such as artificial intelligence, robots and Big Data.

As a physicist, who has experienced administration in science and technology field, and acting National Assembly member of South Korea, I will do my best to ensure legal, legislative, and financial systems of the Korean society to effectively support your noble endeavors for this goal.

SCENE SETTING SPEECH

Younghoon David Kim

Chairman and CEO, Daesung Group
Chair, World Energy Council

The Mighty Potential of the Microbes: Peacemakers for a Resilient FEW Nexus

Good afternoon.

Welcome everyone!

Perhaps many of you here today attending this conference are wondering why, all of a sudden, “microbes”?

Well, the reason is simple.

I believe that we must proactively make a firm commitment to a new energy future in this era of the Grand Energy Transition.

Quite simply we must leave behind our dependence on fossil fuels, which are in fact the product of dead micro-organisms. Instead we must look to living organisms, in other words, “mighty microbes” to provide the source of truly affordable, reliable and sustainable energy.

Recall that it was heat and pressure that turned dead microbes into coal, oil and gas. Because these fossil fuels need to be combusted to provide energy, this created CO2 and other pollutants. We are now living with the serious consequences of our dependence on the deposits of dead microbes. Yes, fossil fuels are relatively reliable sources of energy, but it turns out that they cannot be long term sustainable solutions. So we are forced to look for an alternative to fossil fuels.

Now, renewable energy sources such as solar and wind power are emerging as alternatives. Even though renewable energy is sustainable, it is far from being reliable, due mainly to problems with intermittence. In other words, we cannot control the sun and the wind.

The fact that for the foreseeable future, intermittence will be a lingering conundrum persuaded me to explore the possibilities of radically innovative new forms of energy. This path led me to one inevitable conclusion: we need to change our dependence on dead microbes and, instead, embrace the potential of living microbes.

To my surprise, I was glad to discover that substantial technological progress is being made in the pursuit of energy from living micro-organisms. This includes the development of the microbial fuel cell (MFC), microbial electrolysis cell (MEC), energy from algae and production of oil through metabolic engineering, to name but a few. Furthermore, MEC with power-to-gas technology can offer an alternative energy storage system which is better than a lithium-based one. That's because microbes are universally accessible whereas lithium is geographically and geologically a finite resource.

Right now research is gathering momentum with each passing day. We are on the hunt for more efficient microbes. One place to find them may be the ocean where more than 90% of micro-organisms exist.

Further, the rapid progress in synthetic biology means that sooner or later I hope to see “designer” microbes. These microbes will offer even more efficiency and capacity that allow us to successfully scale-up and commercialize energy from microbes.

We have already benefited from these mighty microbes through the energy source called biomass. From my own experience I learned that micro-organisms are not only a reliable and sustainable source of energy, but also that they can be affordable.

Let me share with you a concrete example. In Daesung Group’s hometown of Daegu, we have a project called landfill gas, that is, LFG in short. This LFG plant not only keeps the environment clean, but also produces methane gas. This LFG project began operations over ten years ago and was quickly registered as a Clean Development Mechanism (CDM) under the UN Framework Convention on Climate Change.

Obviously I feel good about the fact that local air quality has improved and that we can sell the collected gas for a district heating plant. Yet what is more meaningful is that we have created not only an environmentally sustainable project but also a lucrative business model. In fact, this project shows that microbes can be a supplier of a reliable and sustainable as well as affordable energy resource.

So what does this mean for the future of the “mighty microbe”?

The 1st Industrial Revolution was powered by coal and the steam engine. In the case of the 2nd Industrial Revolution, petroleum and electricity were the driving forces.

Now we foresee the advent of a new energy revolution to be galvanized by mighty microbes.

Furthermore, in view of the close interconnections between the energy, food and water sectors, we can expect the water and food sectors can be positively impacted as well.

Energy as a source material for pesticides and fertilizers and as a power source for food storage and distribution are good examples of its contributions to the food sector. In the case of the water sector, its significance can be found in the processes of desalination and waste water treatment as a source of power.

Moreover, the food, energy and water sectors are not only closely linked, they together form the foundation of the global economy. Therefore, the new energy revolution brought about by mighty microbes can be a positive impetus for a global economic revolution by securing a resilient food, energy, water nexus.

In conclusion, on the occasion of Daesung Group’s 70th anniversary I have set a future course for us to become a total solution provider for a resilient food, energy, water nexus through an energy revolution led by mighty microbes.

I also hope that a more resilient global economy can be realized by the mighty power of living microbes.

I sincerely hope you find today’s conference both informative and inspirational.

Thank you very much.

PROGRAM

Time	ITEM
13:30-14:00	**Registration & Reception**
14:00-14:05	**Opening**
14:05-14:10	**Congratulatory Speech** **OH, Se-Jung** Member of National Assembly **KIM, Jung Hoe** Professor of KAIST
14:10-14:20	**Scene Setting Speech** **Younghoon David Kim** Chairman and CEO, Daesung Group
14:20-14:30	**Opening Speech** **CHO, Byung Kwan** Professor
14:30-15:20	**Panel Session** **LEE, Choul-Gyun** Professor **Mario R. Tredici** Professor **Ioannis Ieropoulos** Professor **Yuan Kun Lee** Professor **LEE, Sang Yup** Professor
15:20-15:25	Break
15:25-16:30	**Panel Discussion** **Moderator : CHO, Byung Kwan** Professor

OVERVIEW

Title	**FEW NEXUS CONFERENCE** Mighty Microbes for the Energy Revolution
Date	Thursday June 22, 2017 | 13:30~16:30
Venue	Ruby Room, Yeong Bin Gwan | The Hotel Shilla, Seoul
Participants	Daesung Group Executives & Invited Guests
Program	Reception Panel Session Panel Discussion

FOOD

ENERGY

WATER

The conference is entitled "Mighty Microbes for the Energy Revolution" and will offer fresh perspectives on solving the challenges facing the food, energy and water (FEW) nexus. The conference will focus on microbe-based technology in the context of a new era of technology-intensive energy and how this may contribute to the development of sustainable economies.

MODERATOR

CHO, Byung Kwan

KAIST
Professor

Prof. Cho is an associate professor at the department of biological sciences of Korea Advanced Institute of Science and Technology (KAIST) since 2010, Korea. Before joining the KAIST, he has been a project scientist in the Palsson lab at the department of bioengineering of University of California San Diego. He completed his Ph.D. in the molecular biotechnology and biomaterials laboratory at the Seoul National University, Korea. His research has focused on the systems and synthetic biology of microorganisms, in particular he has contributed on the understanding of microbial transcriptional and translational regulatory networks at a genome-scale using high-through put technologies. He is highly interested in the determination of bacterial meta-structure, which consists of numerous cis- and trans-genetic (or genomic) elements such as transcription start sites, promoters, ribosome-binding sites, and non-coding RNAs. Recently, he is also focusing on (1) development of the microbial gas fermentation systems to convert carbon dioxide to multicarbon products using acetogenic bacteria, (2) design of the minimal genome to provide a chassis for the synthetic biology applications, (3) understanding of the microbiome related with aging process, and (4) elucidation of the production of diverse antibiotics to treat super bacteria using Streptomyces species. As of October 2016, he has published over 80 scientific papers and gave about 300 presentations at the international conferences and the invited seminars. He has appointed as a young scientist from World Economic Forum (WEF) 2012 and Korea Academy of Science and Technology (KAST) 2013.

SPEAKERS

LEE, Choul-Gyun

INHA University
Professor

Dr. LEE, Choul-Gyun is currently an Inha Fellow Professor in Department of Biological Engineering, Inha University, Korea. His field of expertise is on culture of microalgae in various types of photobioreactors and on molecular/biotechnological studies of the microalgae based on whole cell genome-scale in silico modeling. On top of his research work, he has held a number of administrative positions in the University, in the Korean Government and in academic societies. He is the leader (Director) of National Marine Bioenergy R&D Consortium funded by Korean Government and is the Head of Institute of Industrial Biotechnology as well as Lipidomics Research Center. He served as the President of the Korean Society of Marine Biotechnology and will serve as the President of The Asia-Pacific Society for Applied Phycology. He got his Ph.D. in the Department of Chemical Engineering at University of Michigan in Ann Arbor, USA in 1994 and he worked for NASA, Kennedy Space Center in Advance Life Support Team before joining Inha University.

01

Critical Criteria for Successful Biofuels from FEW Point of View

A successful bioenergy must be produced much cheaper than the most of the biologically-driven products. Critical criteria for sustainable biofuels should include (i) lower CAPEX; (ii) no freshwater usage; (iii) no fertilizer; (iv) no pesticide; (v) rely on solar (and other natural) energy; (vi) larger area to deploy without competing with food production; and so on. Some possible solutions will be discussed.

SPEAKERS

Mario R. Tredici

University of Florence
Professor

Prof. Tredici is full professor at the University of Florence where he holds courses on Agricultural Microbiology and Microbial Biotechnology. His research topics include design of novel photobioreactors and microalgal biomass production for food and feeds, nutraceuticals and bioactives, biofuels and CO_2 biofixation.

He has been technical advisor for several companies and institutions, among which the Hawaii Natural Energy Institute, the International Energy Agency, Eni SpA (Italy), AlgaeFuels Biotechnology (Chile), Roquette Freres (France), Aurora Algae (USA), SABIC (Saudi Arabia) and the International Network on Biofixation of CO_2 and Greenhouse Gas Abatement with Microalgae. He has been member of the Technical Advisory Panel of the Algae Biofuels Challenge (Carbon Trust - UK) and chair of the ESBF (European Sustainable Biofuel Forum).

He has been one of the founders (and President from 2002 to 2005) of the International Society of Applied Phycology (ISAP). He founded (in 2009) the European Algae Biomass Association (EABA).

In 2004 he founded Fotosintetica & Microbiologica S.r.l., a spin-off company of the University of Florence.

His research group has participated and participates in several European projects, among these the FP7th projects AQUAFUELS, GIAVAP and BIOFAT, and the H2020 projects NOMORFILM (Novel marine biomolecules against biofilm. Application to medical devices) and PHOTOFUEL (Biocatalytic solar fuels for sustainable mobility in Europe). He has been the scientific coordinator of the Italian project MAMBO (MicroAlgae, starting Material for BioOil), and of the FP7th projects AQUAFUELS (Algae and Aquatic Biomass for a Sustainable Production of 2nd Generation Biofuels) and BIOFAT (Biofuel From Algae Technologies).

He is Chair of the Scientific Committee of the European Conference “AlgaEurope” since its first edition in 2014.

In June 2014 Prof. Tredici was awarded by the ISAP the “Distinguished Applied Phycologist Award” and in October 2015 was nominated by the Florence Municipality “Ambasciatore di Firenze”.

Prof. Tredici is member of the Accademia dei Georgofili of Florence.

02

Marine Microalgae for Bioenergy and Food

Nutrition of the growing population is an urgent global problem. The food crisis is not only a matter of calories, but mainly of lack of proteins and other essential nutrients (vitamins, minerals and fatty acids). World’s oceans have been almost depleted and heavily polluted. Fertile soils have been overexploited. Climate change is decreasing crop production almost everywhere. Intensive agriculture is among the first causes of GHG emissions, loss of soil, ocean dead zones, desertification and consumption of dwindling freshwater resources. Marine microalgae offer a sustainable option to provide the essential amino acids and nutrients that the world population requires. They have enormous potential and several advantages over traditional crops (e.g., they do not need fertile soils and freshwater). However, many critical barriers still hinder the widespread use of microalgae as food and, especially, bioenergy sources. Some approaches and technological innovations developed at the University of Florence, which can help lifting these obstacles, will be discussed.

SPEAKERS

Ioannis Ieropoulos

University of the West of England
Professor

Ioannis Ieropoulos, Director of the Bristol BioEnergy Centre, is a Professor of Bioenergy and Self-Sustainable Systems and an EPSRC Career Acceleration Fellow (EP/I004653/1; EP/L002132/1) at UWE, Bristol. He has produced EcoBots I and II for his PhD (2002, 2005) and was the lead Researcher for the EU FP6 Integrated project "Integrating Cognition, Emotion and Autonomy (ICEA)", contract number 027819, FP6: IST, which successfully resulted in the development of EcoBot-III. For the last 14 years he has been working on autonomous robotics and further improving MFC technology, both as a power generator and also a waste and wastewater treatment technology. He is the P.I. on the Bill and Melinda Gates Foundation-funded project Urine-tricity (grant nos. OPP1094890, OPP1149065), which is looking to develop the MFC technology for Developing World Countries and he also leads UWE in a an EU H2020 project investigating living architecture (grant. no. 686585), EU FP7 FET project, EVOBLISS (grant no. 611640) and a Leverhulme Trust grant, joint with the University of Bristol that is looking into biodegradable robots powered by biodegradable MFCs (RPG362). He has published >100 peer reviewed journal papers and has been invited to present at numerous conferences and workshops. He is a member of the EPSRC Peer Review College and he is also the Associate Editor for the Journal of Sustainable Energy Technologies and Assessments (Elsevier).

Project management expertise

Ieropoulos has developed into a manager of projects and personnel in the course of his Career Acceleration Fellowship. The result of this has been the establishment of the Bristol BioEnergy Centre (BBiC) at the University of the West of England, of which he is the Director, with 17 core and 4 affiliated members of staff. All of the recent and current projects, Ieropoulos has been/is the PI with direct management responsibility and accountability.

03

Self-Sustainable Systems – from robots to homes

We live in a world of two extremes: on the one hand, societies in the Developed World consume vast amounts of natural resources and energy for comfort and improved quality of life; on the other hand, people in countries of the Developing World lack the very basics for water, sanitation and hygiene with millions of deaths annually, resulting from poor conditions of life. In nature, all examples of living systems are self-sustainable in the right environment and under the right conditions and we have an obligation of studying and understanding these systems in order to change our way of living. In this talk, the general principle of self-sustainability will be described with examples of how it may be implemented using the Microbial Fuel Cell technology.

SPEAKERS

Yuan Kun Lee

National University of Singapore
Professor

Department of Microbiology & Immunology, Yong Loo Lin School of Medicine, National University of Singapore, Singapore

Prof. Yuan Kun Lee research interests include the effect of diet on the cross-talk between the gastrointestinal microbiota and the host, the recycling or removal of carbon dioxide by photosynthetic algae, and microbial fermentation processes in the production of food and pharmaceuticals and in the treatment of waste products. Prof. Lee has published 131 papers in international peer reviewed scientific journals, contributed 29 chapters in books, and authored 5 monographs. In addition, he has 3 patents to his name. He is currently President of the International Union of Microbiological Societies (IUMS). Prof. Lee is also President of the Singapore Society of Microbiology and Biotechnology, and the Asian Federation of Societies for Lactic Acid Bacteria. Prof. Lee received his Ph.D from the University of London, UK. He serves on the editorial board of the Critical Reviews in Microbiology (Associate Editor), Scientific Reports, Beneficial Microbes, Bioscience of Microbiota, Food & Health.

04

Sustainable clean water supply inspired by nature

The global human population will reach equilibrium at around 2100. Except water starved Middle East, the per capita water availability in different regions across the globe exceeds per capita water consumption by 3 (Africa and Asia Pacific) to 113 (Latin America) folds. The availability of clean water is however a concern, Asia being ranked high in Water Poverty, in particular in regions of intensive industrial activities and concentrated human population. Most of the current water treatment and re-cycling systems are microbe-based depending on naturally occurring microbes, which have reached their systemic limitation in urban and industrial regions. The water biotechnology would need to be upgraded to that of pharmaceutical and food biotechnology to cope with the increasing demand for clean water.

SPEAKERS

LEE, Sang Yup

KAIST
Professor

Dr. LEE, Sang Yup is Distinguished Professor at the Department of Chemical and Biomolecular Engineering, Korea Advanced Institute of Science and Technology (KAIST). He is currently the Dean of KAIST Institutes, Director of BioProcess Engineering Research Center, and Director of Bioinformatics Research Center. He served as a Founding Dean of College of Life Science and Bioengineering. He has published more than 550 journal papers, 75 books/book chapters, and more than 610 patents, many of which licensed. He received numerous awards, including the National Order of Merit, National Science Medal, Ho-Am Prize, POSCO TJ Park Prize, James Bailey Award, International Metabolic Engineering Award, Marvin Johnson Award, US Presidential Green Chemistry Challenge Award, Charles Thom Award, and Elmer Gaden Award. Professor Lee also delivered numerous named lectures around the world. He is currently Fellow of American Institute of Chemical Engineers, American Association for the Advancement of Sciences, American Academy of Microbiology, American Institute of Medical and Biological Engineering, Society for Industrial Microbiology and Biotechnology, the World Academy of Sciences, Korean Academy of Science and Technology, and National Academy of Engineering Korea. He is also Foreign Member of National Academy of Engineering USA and National Academy of Sciences USA. He is honorary professor of University of Queensland, Shanghai Jiao Tong University, Wuhan University, Hubei University of Technology, and Beijing University of Chemical Technology. He is Editor-in-Chief of Biotechnology Journal, and Associate Editor and board member of numerous journals. He has served as the Chairman of the Global Agenda Council on Emerging Technologies and also Biotechnology, and is currently Chair of Global Future Council on Biotechnology at the World Economic Forum. He founded the World Council on Industrial Biotechnology in 2010 and served as a Founding Chair for two years. He is a member of the Presidential Advisory Council on Science and Technology of Korea and a member of Government Performance Evaluation Committee.

05

Microbial biotechnology for nutrition, chemicals, fuels and materials

Microorganisms can be employed for providing solutions to better nutrition, which will become increasingly important. In particular, various natural compounds can be produced by metabolically engineered microorganisms without being affected by weather condition. Microorganisms are already playing important roles in producing chemicals, fuels and materials from renewable non-food biomass. Here, the cell factories need to be successfully established through metabolic engineering to achieve highest possible titer, yield and productivity. In this lecture, I will describe general strategies of metabolic engineering and showcase some examples on producing nutritional compounds, chemicals, fuels and materials.

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