2021. 10. 7(THU), 09:10 - 09:50

# PLENARY LECTURE I

## Synthetic Biology: Life Redesigned

**Prof. James J. COLLINS**

Institute for Medical Engineering & Science Department of Biological Engineering Massachusetts Institute of Technology; Broad Institute of MIT and Harvard; Wyss Institute, Harvard University

Synthetic biology is bringing together engineers, physicists and biologists to model, design and construct biological circuits out of proteins, genes and other bits of DNA, and to use these circuits to rewire and reprogram organisms. These re-engineered organisms are going to change our lives in the coming years, leading to cheaper drugs, rapid diagnostic tests, and synthetic probiotics to treat infections and a range of complex diseases. In this talk, we highlight recent efforts to create synthetic gene networks and programmable cells, and discuss a variety of synthetic biology applications in biotechnology and biomedicine.

2021. 10. 7(THU), 09:50 - 10:30

# PLENARY LECTURE II

## The Coming of Age of De Novo Protein Design

**Prof. David BAKER**

Department of Biochemistry,
University of Washington, Seattle, USA

Proteins mediate the critical processes of life and beautifully solve the challenges faced during the evolution of modern organisms. Our goal is to design a new generation of proteins that address current-day problems not faced during evolution. In contrast to traditional protein engineering efforts, which have focused on modifying naturally occurring proteins, we design new proteins from scratch based on Anfinsen's principle that proteins fold to their global free energy minimum. We compute amino acid sequences predicted to fold into proteins with new structures and functions, produce synthetic genes encoding these sequences, and characterize them experimentally. SARS-CoV-2 provided a test of the relevance of these methods to real-world challenges. In this talk, I will describe the de novo design of SARS-CoV-2 candidate diagnostics, therapeutics, and vaccines: designed switches that luminesce in the presence of antiviral antibodies, designed 55 residue proteins that bind to the viral Spike with picomolar affinity and block infection, and nanoparticle immunogens which elicit much higher yields of neutralizing antibodies in animals than the Spike trimer that is the basis of most current vaccine trials. I will close by describing the status of getting these into the clinic, and lessons for combatting future pandemics."

2021. 10. 7(THU), 15:00 - 15:40

# PLENARY LECTURE III

## Systems Biology of Yeast Metabolism

**Prof. Jens NIELSEN**

Department of Biology and Biological Engineering,
Chalmers University of Technology, Gothenburg, Sweden

Metabolic Engineering relies on a thorough understanding of how the many different metabolic reactions in the cell to be engineered interacts. Genome-scale metabolic models offers a very strong tool for performing quantitative analysis of how the many different reactions in the metabolic network interacts, and through the addition of kinetic and proteome constraints to these models their predictive strength has significantly improved. However, these models can also be used for integrative analysis of quantitative data, e.g. proteomics and metabolomics data. In the lecture there will be presented progress on how kinetic and proteome constraints can improve the predictive strength of genome-scale metabolic models for use in metabolic engineering. Examples will be given of both identification of novel metabolic engineering designs and of using these models for gaining novel insight into the functioning of metabolism.

2021. 10. 7(THU), 15:40 - 16:20

# PLENARY LECTURE IV

## Conversion of Escherichia coli to Generate All Biomass Carbon from $CO_2$

**Prof. Ron MILO**

Dept. of Plant and Environmental Sciences,
Weizmann Institute of Science, Rehovot, Israel

The living world is largely divided into autotrophs that convert CO2 into biomass and heterotrophs that consume organic compounds. In spite of wide-spread interest in renewable energy storage and more sustainable food production, the engineering of industrially relevant heterotrophic model organisms to use CO2 as their sole carbon source has so far remained an outstanding challenge. I will describe the achievement of this transformation on laboratory timescales with the help of rational design making use of constraint-based modeling. We constructed and evolved Escherichia coli to produce all its biomass carbon from CO2. Reducing power and energy, but not carbon, are supplied via the one-carbon molecule formate, which can be produced electrochemically. Rubisco and phosphoribulokinase were co-expressed with formate dehydrogenase to enable CO2 fixation and reduction via the Calvin-Benson-Bassham cycle. Autotrophic growth was achieved following several months of continuous laboratory evolution in a chemostat under intensifying organic carbon limitation and confirmed via isotopic labeling.

2021. 10. 8(FRI), 09:00 - 09:40

# PLENARY LECTURE V

## Engineering biology to solve global challenges

**Prof. Jay D. KEASLING**

Univ. of California, Berkeley, USA

TBA

# PLENARY LECTURE VI

## Bioelectronic Nose for Odor Standardization

**Prof. Tai Hyun PARK**

School of Chemical and Biological Engineering, Institute of Chemical Processes, Seoul National University, Seoul, Korea

Communication about odors among persons is very difficult because their perceptions are not exactly same and their vocabularies for odors are different. These make us more difficult to classify and standardize odors. More than one hudred years ago, Alexander Graham Bell, who invented the telephone, said that we have very many different kinds of smells, but until you can measure their likenesses and differences you can have no science of odor. However, it is still difficult to measure odors. Why is it so difficult? Because we have not understood the identity of 'odor' until Robert Axel and Linda Buck discover the mechanism of smell sensing on the molecular basis. Now we know that information of an odor is the combinatorial pattern made of the olfactory receptors activated by the odor molecules. A bioelectronic nose using human olfactory receptors mimics human olfactory system and can make the combinatorial pattern of the activated olfactory receptors as in human nose. In this sense, a bioelectronic nose will play an important and useful role as a tool for odor standardization. In this presentation, I will discuss the principles and methods for the development of bioelectronic nose and its application for odor standardization.