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2nd symposium on engineering biology and BioFoundry

1. Background

In the annals of biological sciences, synthetic biology (also known as engineering biology) has emerged as the third paradigm shift, succeeding the molecular biology revolution sparked by the discovery of DNA double helix and the genomic revolution by the Human Genome Project. Synthetic biology epitomizes an interdisciplinary subject encompassing biology, chemistry, physics, mathematics, and engineering, enabling precise and innovative design of biological systems for user-defined behavior. With inspirations from natural processes and electronic engineering principles, these artificial lives have been programmed to deliver real-world products (e.g., medicine, fuel, material, and fertilizer[1]) and tackle global challenges (e.g., healthcare,[2] environmental pollution,[3] food shortage, data storage, and energy crisis[4]).

The tremendous accomplishments of synthetic biology counted on the endeavors to improve our capabilities to design and analyze biological systems computationally. In recent years, a wealth of computational strategies, tools, and platforms have been employed in synthetic biology, catalyzing the convergence of biotechnology (BT) and information technology (IT). A landmark of the BT/IT integration is AlphaFold,[5] a neural network-based model that accurately predicts protein structures of the human proteome. Other machine learning approaches have also led to sequence-to-function predictions of DNA, RNA, and protein regulators[6,7] and automatic forward-engineering of novel biological parts[8,9] and genetic circuits.[10]

The establishment of biofoundries also contributed to the flourishing of synthetic biology by accelerating the iterative "design-build-test-learn" cycles. Biofoundries integrate high-throughput experimental pipelines and computer-aided design automation to empower large-scale, cost-effective construction and characterization of artificial biological systems.[11,12] Examples of the most successful biofoundries so far are iBioFAB at the University of Illinois at Urbana-Champaign, Edinburgh Genome Foundry at the University of Edinburgh, and iBioFoundry at Zhejiang University (ZJU)-Hangzhou Global Scientific and Technological Innovation Center (ZJU-HIC). To facilitate the cooperation and coordination of global biofoundries, a Global Biofoundry Alliance (GBA)[12] was launched in 2019, now joined by at least 35 biofoundries, including five from China.

To foster the development of synthetic biology in China, the College of Chemical and Biological Engineering (CBE) of ZJU and the Institute for Intelligent Bio/Chem Manufacturing of ZJU-HIC co-organized the 2nd Symposium of Engineering Biology and BioFoundry (SEBB) in Hangzhou from from 20th to 22nd October, 2023. The symposium aimed to underline and address challenges in creating and applying artificial biological systems by combining biofoundry with BT/IT integration, to promote the disruptive innovations of synthetic biotechnology and the biomanufacturing industry. To this end, four structured sessions were set to present advancements in genetic part and circuit design, synthetic biomanufacturing, BT/IT integration, and biofoundry.

2. Conference organization

2.1. Introduction of conference organizer and iBioFoundry

With the breakthrough development of synthetic biology technologies, synthetic biology is rapidly advancing toward practicality and industrialization. Guided by government policies and favorable capital investments, the synthetic biology industry is experiencing robust growth and vibrant diversity.

On July 14, 2022, ZJU-HIC successfully hosted the 1st SEBB with over 250 participants. The 2nd symposium, co-organized by ZJU-CBE and ZJU-HIC, was hosted on October 20–22, 2023 (Fig. 1). The conference theme was "Synthetic Biology: Forging the Future," focusing on innovation and industrialization in synthetic biotechnology. The conference featured rich and diverse content, including plenary sessions, keynote speeches, and various activities that gathered experts and professionals from various fields, facilitating the exchange of high-level intellectual resources and discussions on the path of synthetic biology technology and industry development. This conference concentrated on four major themes: genetic part and circuit design, synthetic biomanufacturing, BT/IT integration, and biofoundry. Representatives from the fields of technology, education, and industry in the synthetic biology sector actively participated in this event.

The iBioFoundry, built by ZJU-HIC, is an automated scientific facility for synthetic biology, integrates all equipment and operations under central software control through an orbital robotic arm. This system enables full-process automation in synthetic biology, including intelligent sample retrieval, DNA part assembly, strain construction, cultivation, and screening, as well as product detection, ensuring high-throughput experiments with excellent efficiency and standardization levels. This system could serve as the foundational platform for genetic part and circuit design and BT/IT interdisciplinary integration, ultimately expediting advanced synthetic biomanufacturing.

2.2. Introduction of conference organizing committee

The conference was co-chaired by Prof. Huimin Zhao from the University of Illinois at Urbana-Champaign and Prof. Lirong Yang from ZJU-CBE/ZJU-HIC. Serving as the executive conference chairs were Prof. Baojun Wang and Prof. Jianping Wu, both from ZJU-CBE/ZJU-HIC. The Conference Secretaries were Principal Investigators Jiazhang Lian, Haoran Yu, and Yuan Yao, all from ZJU-CBE/ZJU-HIC. A total of 45 experts and scholars delivered academic presentations during the conference, with attendance exceeding 300 participants (Fig. 2, Top Panel).

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Fig. 1. Participants of the 2nd SEBB

2.3. Plenary session

Prof. Yingjin Yuan from Tianjin University, Prof. Huimin Zhao from the University of Illinois at Urbana-Champaign, Prof. Anping Zeng from Westlake University, Professor He Huang from ZJU, Prof. Tianwei Tan from Beijing University of Chemical Technology, and Prof. Zixin Deng from Shanghai Jiao Tong University successively delivered plenary speeches at the conference on topics "Synthetic biology and its applications", "From C1 to Cx and catalytic soft matter in synthetic biology: green compound and biomanufacturing of artificial meat", "Synthetic biology 2.0: the dawn of a new era", "Research and clinical translation of synthetic biology in cellular immunotherapy", "Genome-scale models for the design of cell factories", and "Driving forces for synthetic biotechnology based on breakthroughs in dna sulfur modification", respectively. They passionately discussed industry trends and explored the forefront of synthetic biology and biomanufacturing.

Fig. 2. Wonderful moments of the 2nd SEBB. Top: Snapshot of the plenary session. Bottom Left: Poster session. Bottom Right: Onsite visit to iBioFoundry at ZJU-HIC.

2.4. Thematic sessions

Thirty-nine experts delivered insightful presentations in the four thematic sessions: Genetic Part and Circuit Design, Synthetic Biomanufacturing, BT/IT Integration, and Biofoundry.

I. Genetic Part and Circuit Design
1. Prof. Bangce Ye, East China University of Science and Technology, Regulation of protein acylation for efficient biosynthesis.
2. Prof. Ye Chen, Shenzhen Institute of Advanced Technology, Quantitative design of eukaryotic transcriptional regulatory systems.
3. Prof. Ziyi Yu, Nanjing University of Technology, Process intensification for biomanufacturing.
4. Prof. Zibo Chen, Westlake University, A synthetic protein-level neural network in mammalian cells.
5. Prof. Quanjiang Ji, Shanghai University of Science and Technology, Mechanisms and development of mini-CRISPR editors.
6. Prof. Qian Li, Hubei University, Engineering of hydroxylases for steroid drug synthesis.
7. Prof. Sheng Yang, Shanghai Institute of Plant Physiology, Chinese Academy of Sciences, Pentose-fermenting yeast.
8. Prof. Yong Lai, Hong Kong University of Science and Technology, Advancing living medicines and microbiome engineering with synthetic biology.
9. Prof. Yuan Yao, ZJU-HIC, Data-driven design of programmable immunomodulatory peptides.
10. Prof. Ying Zhou, East China University of Science and Technology, Genetically engineered bacteria for ultra-sensitive detection of blood markers.
11. Prof. Shuai Fu, Zhejiang Lab, AI-driven mining of proteases and post-translational modification enzymes.

II. Synthetic Biomanufacturing
1. Prof. Chun Li, Tsinghua University, Microbial production of plant terpenoid natural products.
2. Prof. Xueli Zhang, Tianjin Institute of Industrial Biotechnology, Chinese Academy of Sciences, Metabolic regulatory mechanisms and industrial applications of microbial cell factories.
3. Prof. Shihui Yang, Hubei University, Optimization and application of *Zymomonas mobilis* cell factories.
4. Prof. Zhen Kang, Jiangnan University, Regulation of glycosaminoglycan biosynthesis.
5. Dr. Kai Li, Shanghai Jiao Tong University, Construction of a formate-utilizing *Corynebacterium glutamicum* cell factory for succinic acid production.
6. Prof. Huimin Yu, Tsinghua University, Genome editing and biosynthesis of specialty chemicals in *Rhodococcus* chassis.
7. Prof. Chun You, Tianjin Institute of Industrial Biotechnology, Chinese Academy of Sciences, Construction and optimization of *in vitro* multi-enzyme molecular machines.
8. Prof. Mingtao Huang, South China University of Technology, Screening, construction, and mechanism exploration of *Saccharomyces cerevisiae* strains with efficient protein secretion.
9. Prof. Shangxian Xie, Huazhong University of Science and Technology, Microbial synthesis of bioplastics from lignin: designing an intelligent regulatory hub system for the metabolism of lignin-derived aromatic substrates.
10. Prof. Hongtao Zhang, Jiangnan University, Efficient and uniform synthesis of human milk oligosaccharides by high-density consortia fermentation.

III. BT/IT Integration
1. Prof. Liang Hong, Shanghai Jiao Tong University, Universal artificial intelligence model for protein engineering.
2. Prof. Baishan Fang, Xiamen University, Artificial intelligence system for the optimization of synthetic biomanufacturing.
3. Prof. Ruibo Wu, Sun Yat-sen University, Dry-Wet iteration and mathematical integration: Computational assistance in terpenoid biosynthesis.
4. Prof. Binju Wang, Xiamen University, Understanding the catalysis of P450 from computational investigation.
5. Prof. Hongwu Ma, Tianjin Institute of Industrial Biotechnology, Chinese Academy of Sciences, Biocomputation design based on AI and mechanism models.
6. Prof. Zhuojun Dai, Shenzhen Institute of Advanced Technology, Living fabrications by engineered bacteria.
7. Prof. Long Qian, Peking University, Exploring practical DNA storage.
8. Prof. Lujia Zhang, East China Normal University, Intelligent design system for substrate selectivity of enzymes.
9. Prof. Keyan Ding, ZJU-HIC, Scientific discovery driven by language and knowledge models.

IV. Biofoundry
1. Prof. Liming Liu, Jiangnan University, Microbial chemical factories for reduced emission and sequestration of carbon dioxide.
2. Prof. Zongbao Zhao, Dalian Institute of Chemical Physics, Chinese Academy of Sciences, Synthetic biology based on non-natural coenzyme NCD.
3. Prof. Fan Jin, Shenzhen Institute of Advanced Technology, Automated engineering of microbial gene circuits.
4. Prof. Meng Wang, Tianjin Institute of Industrial Biotechnology, Chinese Academy of Sciences, Tiangong No. 1 biofoundry and automated genome editing.
5. Prof. Tiangang Liu, Shanghai Jiao Tong University, Innovative discovery of terpenoids.
6. Dr. Jim Lalonde, Bota Biosciences, Engineering enzymes as highly efficient catalysts for organic synthesis: A perspective on the state of the art.
7. Prof. Yongqin Lv, Beijing University of Chemical Technology, Enhanced biocatalysis via microenvironment modulation based on functional carriers.
8. Dr. Yan Zhang, MEGAROBO, Development and application of automated intelligent laboratories.
9. Dr. Ran Cao, LifeFoundry, Establishing the abstraction level for biological systems.

2.5. Poster session

The conference also received more than 30 poster submissions from various institutes with outstanding young scholars showcasing their research achievements (Fig. 2, Bottom Left Panel), representative topics include “Manipulation of energy metabolism in *Pichia pastoris* for enhanced protein production”, “Preventing autosomal-dominant hearing loss in Bth mice with CRISPR-CasRx-based RNA editing”, “TIR1 regulates the IFNγR1-JAK/STAT-CXCL9 axis mediating tumor immune evasion in liver cancer”, “Complete biosynthesis of sanguinarine and its halogenated derivatives in yeast”, “Mutator-driven continuous genome evolution of *Saccharomyces cerevisiae*”, and “Construction and mechanism of conversion pathway for electro-synthetic reduction of carbon dioxide by *Shewanella*”. The conference organizing committee concurrently conducted the selection process for outstanding poster awards, resulting in the presentation of 1 first prize, 2 second prizes, and 3 third prizes.

3. Impact of the conference

The 2nd SEBB centered on innovative, interdisciplinary technologies,

and industrialization of engineering biology. This symposium engaged many distinguished scientists and academicians proficient in diverse areas (e.g., metabolic engineering, biochemistry, biomedicine, biomaterial, DNA storage, synthetic genomics, bioinformatics, and quantitative biology) from various universities, institutes, and companies (e.g., Tsinghua University, Peking University, Shanghai Jiao Tong University, Xiamen University, East China University of Science and Technology, Jiangnan University, Westlake University, Shanghai Institutes for Biological Sciences, Dalian Institute of Chemical Physics, Shenzhen Institute of Advanced Technology, Tianjin Institute of Industrial Biotechnology, Bota Bio, MegaRobo, and LifeFoundry). Forty-five scientists, including two international speakers, presented the state-of-the-art research of cutting-edge areas of synthetic biology, discussed the future challenges, and exchanged ideas for advancing the field. Many GBA members (e.g., iBioFAB, Tianjin Biofoundry, Tianjin University Biofoundry, SIAT Biofoundry, SJTU SynBio Biofoundry, and iBioFoundry) also attended the conference. This symposium promoted collaborations among scientists, institutes, and industries. Moreover, it also augmented the national and global reputation of the host organization, ZJU-CBE and ZJU-HIC: the attendants highly acknowledged the achievements of ZJU-HIC and visited iBioFoundry at ZJU-HIC on site (Fig. 2, Bottom Right Panel), marking the successful culmination of the symposium. In the near future, this symposium will be developed into an international conference with an expanded impact on global synthetic biology research and industry.

4. Summary

The 2nd SEBB was an academic feast. The topics covered various fields, including genetic part and circuit design, synthetic biomanufacturing, BT/IT integration, biofoundry, and several globally trending issues. We earnestly hope the knowledge exchange, brainstorming, and collaboration offered by the symposium will catalyze high-quality research and disruptive technologies to revolutionize the manufacturing and healthcare industries and tackle global challenges in health, resource, energy, and the environment. We also sincerely look forward to the 3rd SEBB next year.

Declaration of competing interest

The authors declare no competing financial interest.

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