Industrial Biotechnology Catalyzing the Sustainable Development
——Annual Report of TIB

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Mission of TIB

catalyze 3 transitions by biotechnological innovation, serve for the sustainable development of the socio-economy.

Research divisions

- National Engineering Lab for Industrial Enzymes
- Tianjin Biocatalysis Technology Center
- CAS Key Lab of Systems Microbial Biotechnology
- Tianjin Key Lab for Biosystems and Bioprocess Engineering

➢ 600 staff and graduates
➢ 46 professors
Core Facility

- Total investment >$25M

DISCOVERY
- strains & processes
  - high throughput screening
  - systems biology
    - Data analysis & decoupling
    - Computation & design

DELIVERY
- synthetic biology
  - hyper-producer
    - pilot test
      - products

BioCAD
- Process modelling & optimization

From gene to Products

Progresses in 2018

- Projects • 45 with ~$ 7 mn from MoST, CAS, NSFC and local government
- Publications • 154 (SCI: 141, 15 with IF>10)
- Patents • 74 applied while 49 issued
- Awards • 2 (National/Provincial)
- TechTrans • 28 projects with~$ 15 mn
Highlights--microbial production of breviscapine

- Used to treat cardio- and cerebrovascular diseases
- Produced mainly by plant extraction
- Market value: 5 billion RMB.

Liu et al., Nature Communication 2018

Highlights--de novo biosynthesis of vitamin B$_{12}$

- Widely used in medicine, feed, food and cosmetics
- Current microbial production: long fermentation time, high production cost

- The first E.coli strain to produce VB$_{12}$ by expressing 28 heterologous genes from 5 different species
- Fermentation efficiency enhanced 10 folds

Fang et al., Nature Communication 2018
**Highlights—commercialization**

- **D-Lactic acid**
  - Monomer for synthesis of PLA
  - Built the first production line with an annual output of 10,000 tons
  - Became the new World dominant provider

- **L-alanine**
  - Fine chemicals/intermediate
  - Industrialized at 20,000-ton scale in 2018, occupied 70% of world market
  - Cumulative profit ~ $50M since commercialization
  - The only supplier to BASF

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**Highlights—NC SynBio**

**National Technology Innovation Center for Synthetic Biology**

- Introduction of major social capital (>$5 Bn)
- Construction of buildings of 170K m²
- International Scientific Advisory Board & ~30 International talents
- Setup of innovation network of 31 coordinative nodes
Collaborations with other CoEs

Initiated collaboration with ICCBS

➢ Prof. Dr. Iqbal Choudhary and Dr. Atia-tul Wahab visited TIB on 8-9 January, 2019
➢ Symposium to share information and prepare future collaborations

Signed MoU with ICCBS

➢ Extensive collaborations especially in natural products
➢ Co-establish China-Pakistan Joint Research Center for Natural Products
Collaborations with other CoEs

8 scientists joined ITRGs

➢ 5 scientists join ITRG on Natural Products Sciences led by ICCBS, Pakistan

Prof. Huifeng Jiang  Prof. Tao Liu  Prof. Meng Wang  Dr. Zhubo Dai  Dr. Jinhui Feng

➢ 2 scientists join ITRG on Agriculture, Food Security, and Biotechnology led by IRCC, Sudan

Dr. Yan Zeng  Dr. Guoxia Liu

➢ 1 Professor joins the ITRG on Renewable Energy led by IROST, Iran

Prof. Zhiguang Zhu

Collaborations with other CoEs

TIB PIs attended conferences hosted by the CoEs

➢ Prof. Huifeng Jiang delivered a lecture during “2nd International Symposium on Natural Products for the Future and “14th International Symposium on Natural Product Chemistry” hosted by ICCBS “Synthesis of plant natural products by synthetic biology in yeast”

➢ Prof. Hui Song made a speech at the “4th International Conference on Agriculture, Food Security, and Biotechnology” hosted by ISESCO, COMSATS and INIT “Green Production of Enzymatic Gelatin”
Activities on South – South Cooperation

Joint research projects

➢ A project named “Research and development on the processing and production of functional food ingredients from agricultural biomass resources in Asia and Africa” with developing countries including COMSATS’ member countries such as Egypt and Pakistan

➢ Supported by “International Partnership Program of Chinese Academy of Sciences” (IPP) to serve for the BRI

COMSATS Joint Center for Industrial Synthetic Biotechnology

a facility to host and strengthen the connections with COMSATS

Prof. Jibin Sun, the Executive Director

Prof. Yanhe Ma, the Director

Ms. Qianqian Chai, COMSATS Liaison officer
Activities on South – South Cooperation

Students from developing countries

➢ 3 students for PhD degree
  ● 2 supported by UCAS Scholarship for 3 years, free tuition fee, monthly stipend of RMB 2,500
  ● 1 supported by CAS-TWAS President’s Fellowship Programme for 3-4 years, free tuition fee, RMB 7,000 or RMB 8,000

Science and Technology for achieving SDGs

Mission of TIB:
catalyze 3 transitions by biotechnological innovation,
serve for the sustainable development of the socio-economy.
Science and Technology for achieving SDGs

Industrial Biotechnology

An Industrial Biotechnology Solution for SDGs
Science and Technology for achieving SDGs

- Unification of agriculture and industry

⇒ Fermentative production of silk as example

Silk are protein fibers; Silk products are luxury goods

Traditional:

- 225-300 kg of raw silk from mulberry leaves by silkworm culture per ha
- Production cycle: >1 month, limited by season and location

• starch sugar as raw material
• ~ 3000 kg silk protein per ha
• Production cycle: 2-3 days, at any time any location

Unification of agriculture and industry

Products from agriculture

Industrial Biotechnology

healthcare
foods
materials
energy
environment

Value added

GOALS

SUSTAINABLE DEVELOPMENT
Science and Technology for achieving SDGs

- Industrialization of agricultural products
  Produce foods by factory instead of crops

Strategy 1: Biomass to starch

- straw → starch

Strategy 2: CO₂ to starch

Working on future foods with no need of farming:
Meat, eggs, milk, oils,...

Science and Technology for achieving SDGs

- Industrialization of agricultural products
  Microbial production of herb effective component

- Ginsenoside, active components Asian ginseng and American ginseng
- anti-cancer
- Mainly extracted from ginseng currently

>60 natural plant products by microbes @TIB

1,000 m² (0.1 ha) fermentation factory = 10,000 ha ginseng plantation!
Science and Technology for achieving SDGs

- Industrialization of agricultural products

![Agriculture → Industrial Biotechnology](image1)

- Less area
- Less fertilizer
- Less pesticide
- Less labor
- High output

Science and Technology for achieving SDGs

- Greenization of industry

**Biocatalytic production of inositol**

- Inositol (vitamin B8), used in the drug, cosmetic, food & feed industries.
- 10,000 tons per year, potential global market $60 million per year.

**Traditional**

- Corn steep liquor → Phytate → Inositol
- Alkaline, Acid
- High pressure hydrolysis
- +Pi waste water

**Biotransformation**

- Starch → Inositol
- zero Pi waste water
- Cost reduced 70%
- Pilot verification passed @ 1000 ton.
- Production line of 10,000 ton under construction
Science and Technology for achieving SDGs

- Greenization of industry

Industrial Biotechnology

- Less organic solvents
- Less heavy metals
- Less waste water
- High yield
- Clean process

Thousands reactions in one cell

Chemical Industry

- Multiple reaction tanks, multiple separation steps

Future Programs

International Training Workshop on Industrial Synthetic Biotechnology

- Designed for capacity building in the south
- 20 trainees for 20 days
- Sponsored by MoST and CAS
- Free round-trip ticket and local hospitality
- Tentative programs:
  - technical theoretical knowledge
  - experimental training in the laboratories
  - site visit to the enterprises
  - free to attend the international Metabolic Engineering Summit 2019
- Oct 14-Nov 2, 2019 in Tianjin, China

Contact Ms. Chai: chai_qq@tib.cas.cn
Future Programs

➢ International Joint Center of Industrial Synthetic Biotechnology for COMSATS member countries
  • A framework to host collaborations with COMSATS members
  • A platform for scientists and engineers from COMSATS to stay, learn and collaborate in China

Future Programs

Joint R&D projects supported by “The Belt and Road” Programs, social capitals and industry
Symposium and conferences
Joint talent training (researchers exchange, MS and PhD scholarships, Post-doctoral fellowships)
Technology transfer, bi-directional

Under the framework of the COMSATS with the support of MOST, and CAS
Thank you for your attention!
Looking forward to collaborating with you!

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