



# **Green Biomanufacturing For Sustainable Development—Report of TIBCAS**

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**Brief Introduction to TIB**



**Science and Technology Examples for SDGs**



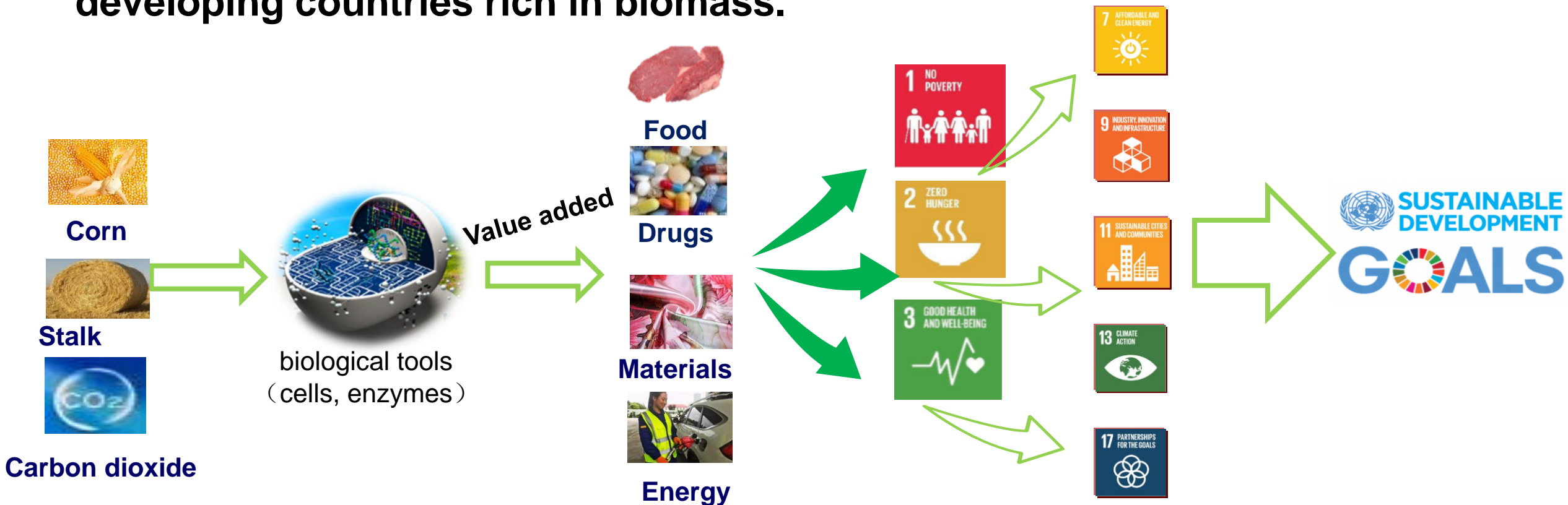
**Activities on South–South Cooperation during 2023-2024**



**Future plans for COMSATS' Network**

# Green Biomanufacturing: a perfect solution for SDGs

- uses microorganisms (or parts) to make value-added products from agricultural or other renewable resources in an efficient and clean way.
- model of hand-in-hand development of industry and agriculture, ideal for developing countries rich in biomass.



# TIB: the core institute of biomanufacturing in China

- Co-founded by Chinese Academy of Sciences and Tianjin municipality in 2012

- ~1200 employees and graduate students, including over 150 senior professionals

- 90% of faculty recruited from all over the world and have long-term research experiences in USA or Europe

- *National Key Laboratory of Engineering Biology for Biomanufacturing*

- *National Center of Technology Innovation for Synthetic Biology*

- *National Engineering Research Center of Industrial Enzymes*

- *National Intellectual Property Operation Center for Synthetic Biology*

- *National Professional Incubator for Biotechnology - BIOINN*

- *Biomanufacturing Industry (Talent) Alliance*

- *National Base for International S&T Cooperation*

- *CoE of COMSATS since 2018*

Basic Research

technical innovation

tech transfer

industry fostering

低碳合成工程生物学  
重点实验室（全国）

中国科学院（科技部）

2022

NCTI

国家合成生物技术创新中心

中华人民共和国科学技术部

2019

工业酶

国家工程研究中心

国家发展和改革委员会  
二〇二一年十二月

2021



国家知识产权局  
二〇二一年九月

2021



生物技术国家专业化众创空间

2017

京津冀食品营养健康与安全创新平台  
Jingjinji Innovation Platform for Food Nutrition, Health and Safety

国家卫生健康委员会  
二〇二三年二月

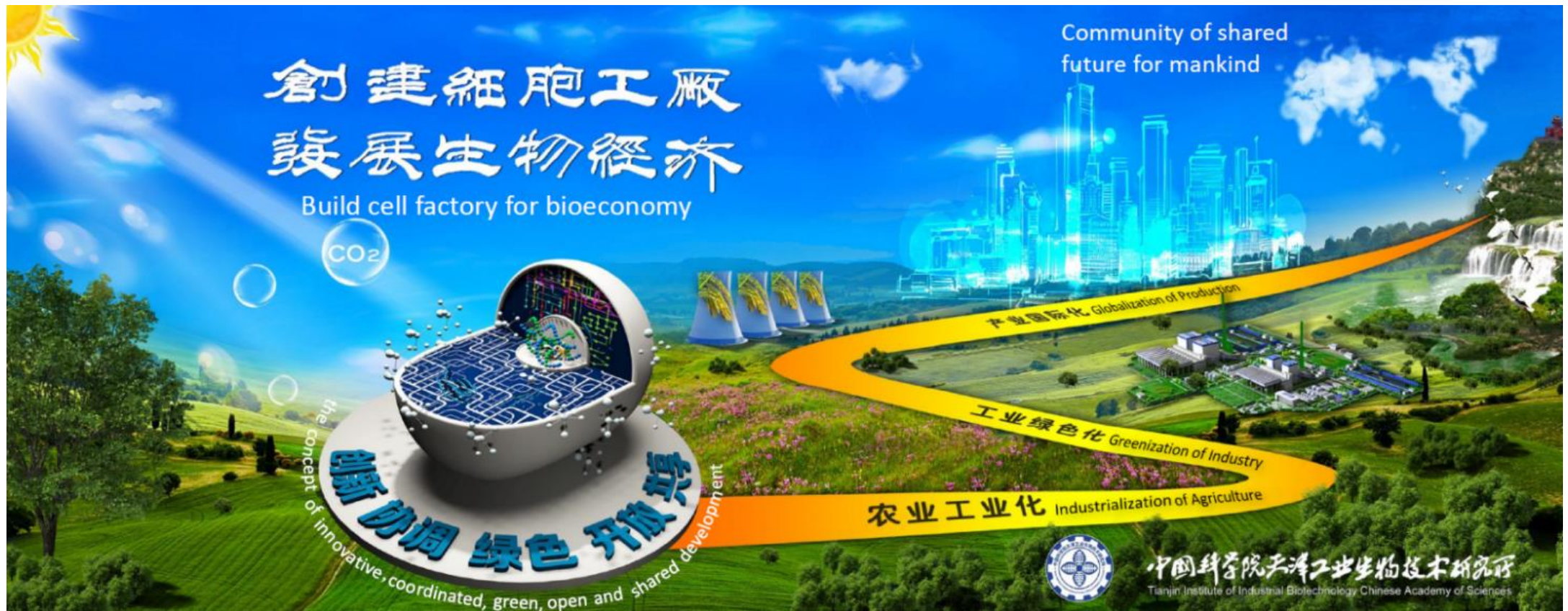
2023



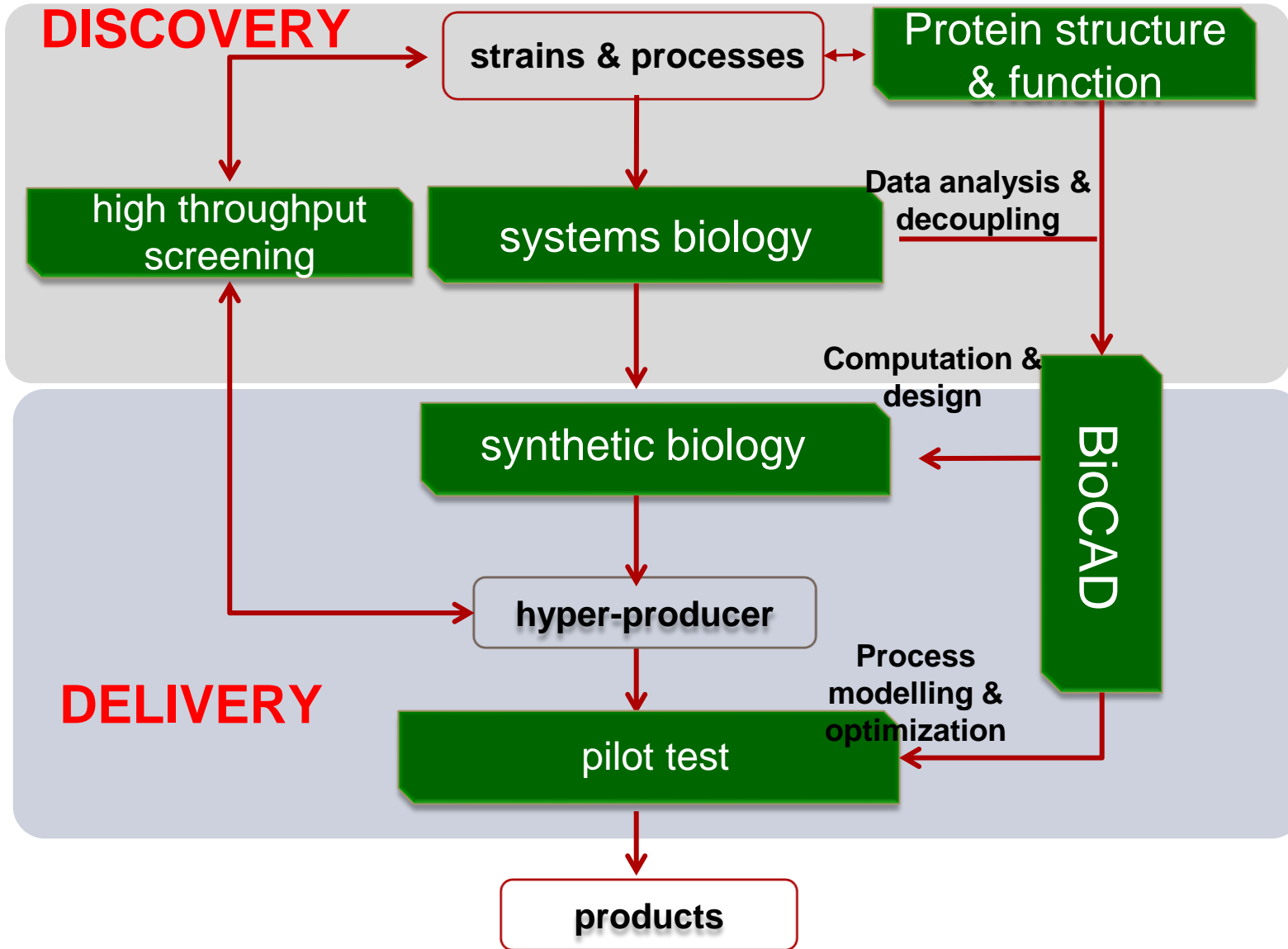
# Missions

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

agricultural farming → industrial manufacturing  
chemical processing → green bioprocessing  
fossil based resources → renewable resources



# Core Facility

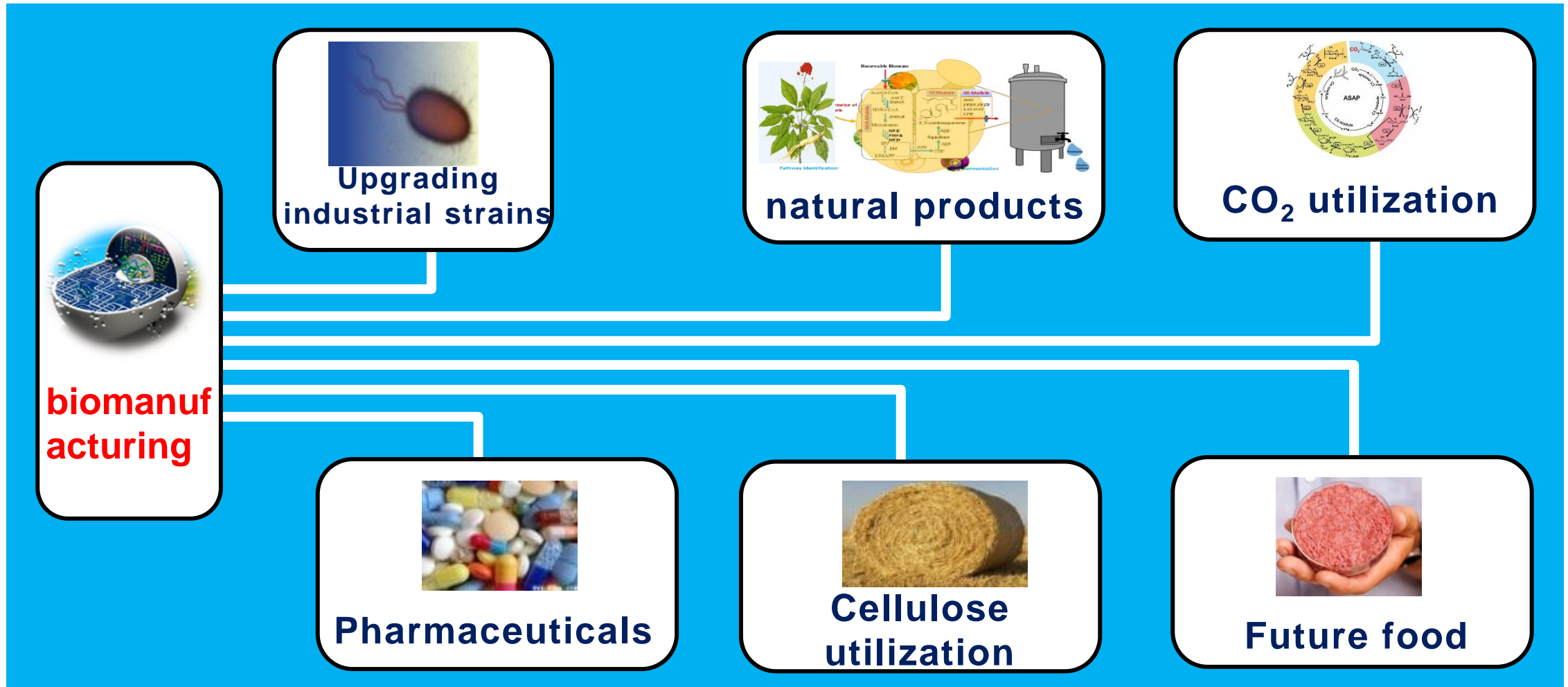


From gene to Products



# key research areas

Targeting at the low-carbon and sustainable development demands, six key research directions are set up.





# Biomanufacturing of Future Food

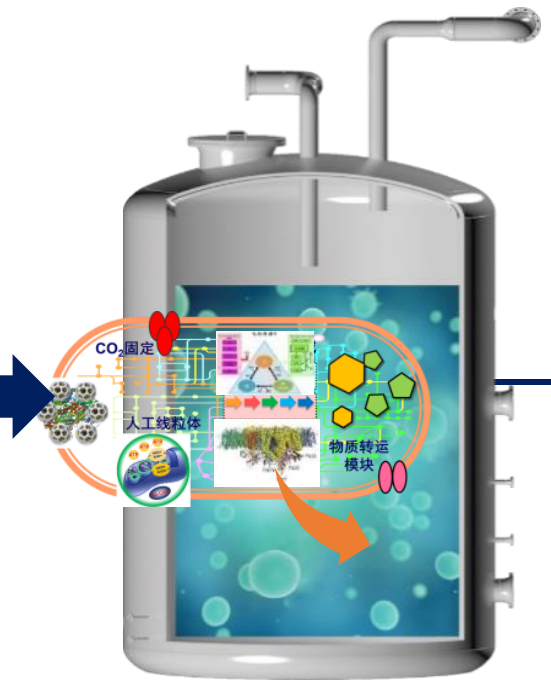


Less land/water demand  
no pesticide/fertilizer  
high output w. less labor input

## Stable supply of food, independent of agriculture



Farming  
transforming  
Livestock



**Biomanufacturing  
Factory**

**Starch**

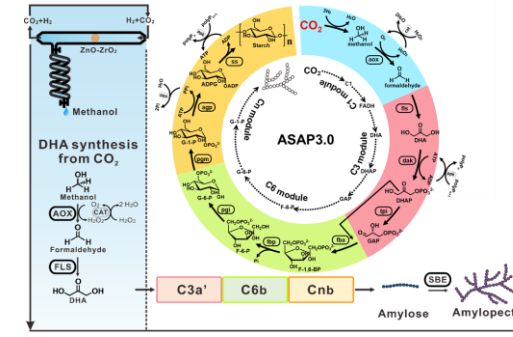
$\text{CO}_2 \rightarrow \text{starch}$

**Healthy sugars**

$\text{Starch} \rightarrow \text{healthy sugar}$

**Proteins**

$\text{Starch} + \text{ammonium} \rightarrow \text{Proteins}$



Artificial pathway for  
synthesis of starch from  
 $\text{CO}_2$  (*Science* 2021)  
and tons' pilot under  
built



Allulose at kilo-ton  
industrial scale



Foods made of  
microbial proteins



# Biomanufacturing of pharm chemicals

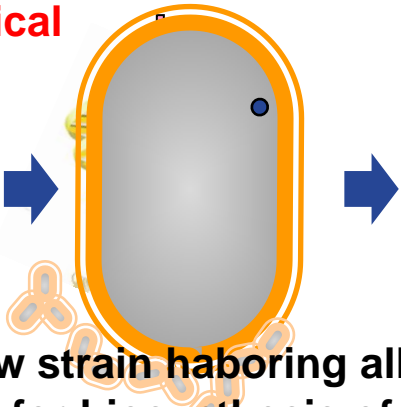


Clean process  
Cost effective

## Address safety and environmental issues of the pharm chemical industry

**One-pot biological process**

raw materials



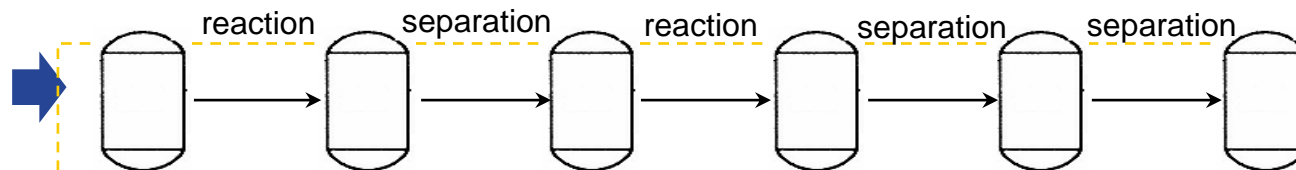
New strain harboring all genes for biosynthesis of the target chemical

- ✓ Steroid hormone
- ✓ L-Alanine
- ✓ Inositol
- ✓ 5-Aminolevulinic acid
- ✓ Levodopa

- ✓ Reduce waste water release 30-90%
- ✓ Reduce energy consumption 30-70%
- ✓ Reduce the cost 30-80%
- ✓ Disruptive tech—market reshuffled

**Multi-step chemical process**

raw materials



~~Inflammable and explosive  
Environmental pollution~~



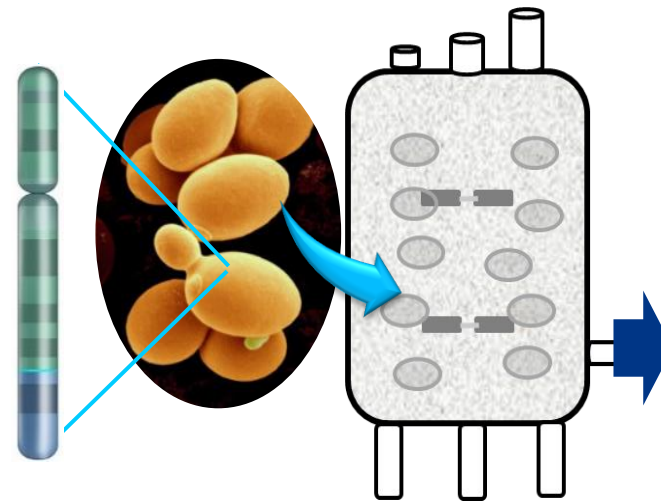
The smart factory for key steroid drug intermediates

# Biomanufacturing of natural products



Indep. resource  
Cost effective  
Globalization

- Address the challenges for herbal plant natural products useful as drugs/healthcare: standardization, low availability, low content, toxicity



- Ginsenosides**
- lycopene
- $\beta$ -carotene
- Salidroside
- Gastrodin
- Breviscapine
- Rosemaric acid
- Apigenin
- Costunolide

- ~100 microbial cell factories being developed.
- Ginsenoside, scutellarin, gastrodin, salidroside, geraniol, lycopene and etc. are ready for industrialization

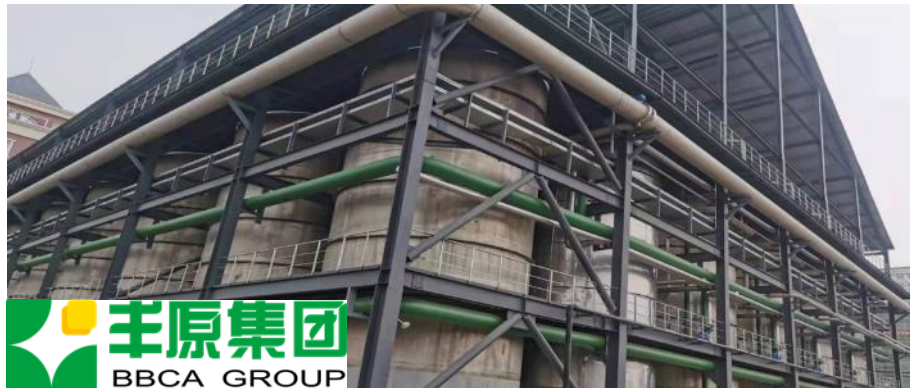
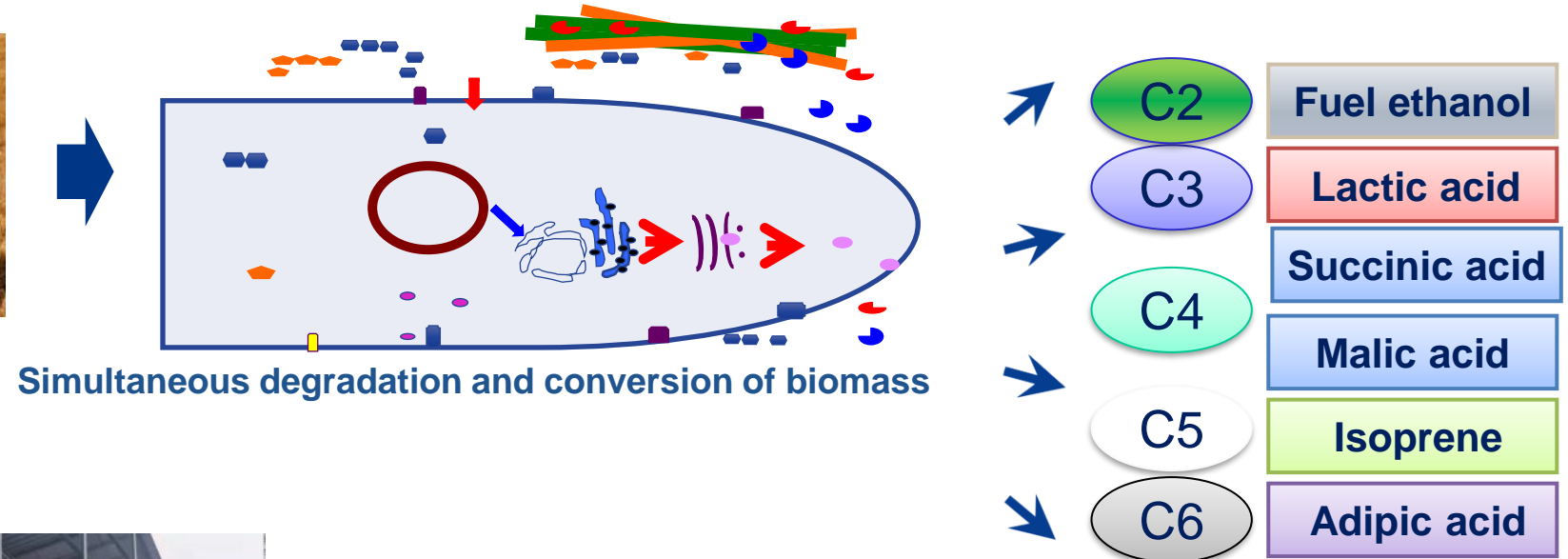
- Identify genes; 2. pathway reconstruction;
- cell optimization ; 4.production

**Case Ginsenoside, 1k m<sup>2</sup> fermentation facility= $\sim$ 700 ha land plant**

# Conversion of straw cellulose



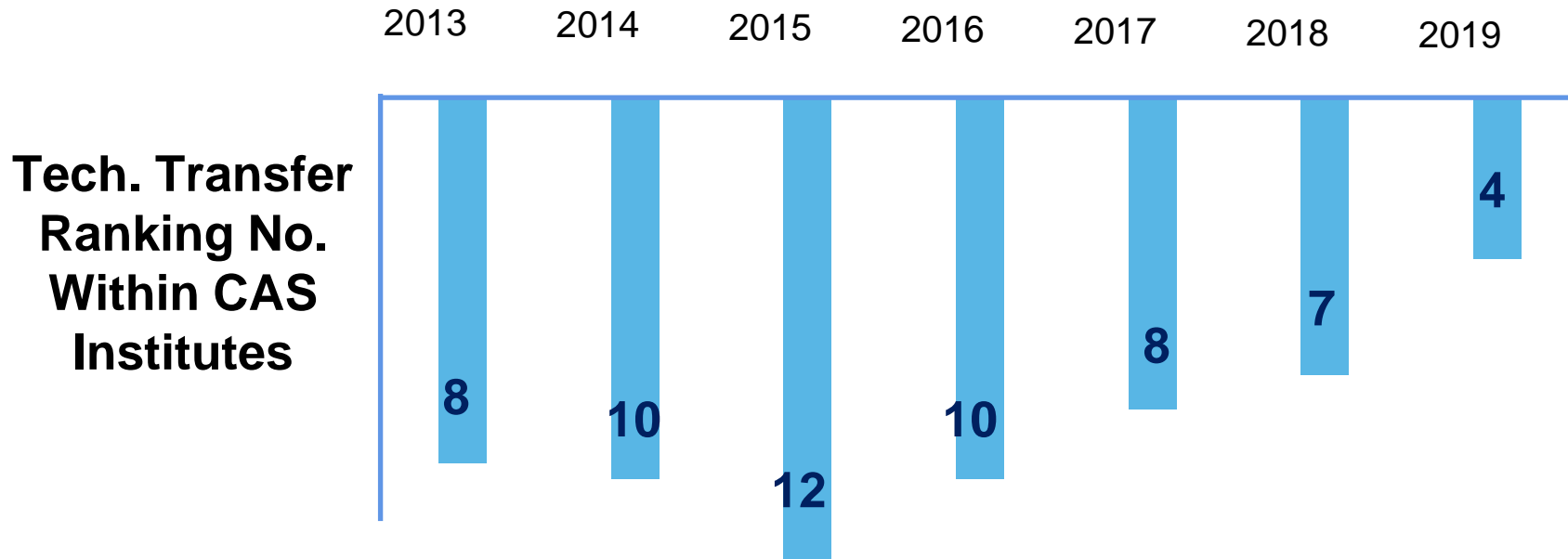
- Focus on the challenges of straw disposal and straw bioconversion
- One step microbial conversion of cellulose and semi-cellulose to useful products



- ✓ 2 tons of biomass to 1 ton malic acid
- ✓ Production cost is significantly lower than petrochemical routes
- ✓ **The world's first** 20,000-ton L-malic acid production line has been put into operation

# Strong collaboration with industry

- Partnership with **> 250** companies from all over the China
- **1 patent /3 days; 1 contract with industry/10 days**
- TechTransfer rate: pending patent **25.3%**; authorized patent **44.5%**



Technology transfer **top 10** among over 100 CAS institutes in past years



**TOP 1% among 3554 Chinese universities and institutions**

- "The 2022 Annual Report on the Transformation of Scientific and Technological Achievements in China" (Institutions of higher learning and scientific research institutions)



# CCIB: South-South Cooperation Platform for Biomanufacturing

- To promote industrial biotechnology cooperation and bio-industry development among countries in the south, the COMSATS Joint Center for Industrial Biotechnology (CCIB) was formally established by TIB and COMSATS in April 14, 2021.



The inauguration Meeting of the CCIB

An open and shared platform to promote Joint R&D, capacity building and technical demonstration



Recognized by the UN

# Collaborations with COMSATS

## Jointly held the *International Forum on Innovative Development of Biomanufacturing* in Nov. 2023

- Over 400 participants including government officials, diplomatic envoys, experts, scholars, and entrepreneurs from nearly 20 countries attended
- provide a high-level platform for cross-boarder exchanges of technologies, talents, resources and information.
- Played a positive role in promoting global industry-university-research cooperation on biomanufacturing.



The opening ceremony



Address by Ambassador Dr. Mohammad Nafees Zakaria



Keynote Lectures

# Collaborations with COMSATS

## Jointly held the *Fourth International Training Course on Industrial Synthetic Biotechnology* in Nov. 2023

- Training for 15 days from November 1 to 16, 2023. focused on the theory, practice and application of the Industrial Synthetic Biotechnology.
- 20 young researchers from 11 developing countries, among them **8 are from COMSATS members** countries including Egypt, Pakistan, Kazakhstan, Nigeria, Iran, Yemen, Zimbabwe, Sri Lanka



Technical courses



Experimental courses



Visit to leading biomanufacturing enterprise



# Collaboration with Kazakh National University (KazNU)

KazNU



Bolatkhon Zayadan  
Professor



Assemgul Sadvakassova  
Associate Professor

TIB



Zhiyong Huang  
Professor



Jingjing Wang  
Associate Professor

KazNU



Jenis Janar  
Professor

TIB



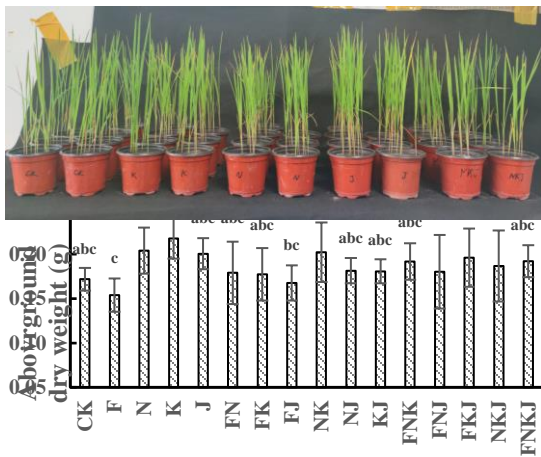
Haixia Xiao  
Professor



Yibin Zhuang  
Associate Professor

- Jointly developed biofertilizer and finished field experiment in Kazakhstan with good results.
- Jointly published **2** SCI.
- Jointly applied for **3** projects and **1** project was approved.

- Joint study on active ingredients of medicinal plants in Central Asia



laboratory experiments



field experiment in Kazakhstan



mutual visits





# Collaboration with Kazakh National University (KazNU)

## ➤ Academic Exchanges & Talents Cultivation



7 young talents from KazNU were funded to carry on collaborative research or Postdoc work, or get trained at TIB



TIB delegates visited KazNU in Sept. 2023



KazNU scientists attended the forum held by TIB and delivered speeches in Nov. 2023



KazNU young researchers conducted research at TIB during 2023-2024



TIB delegates attended the forum held by KazNU and delivered speeches in April 2024



KazNU young researchers attended training courses held by TIB in Nov. 2023

# Collaboration with Iranian Research Organization for Science & Technology (IROST)

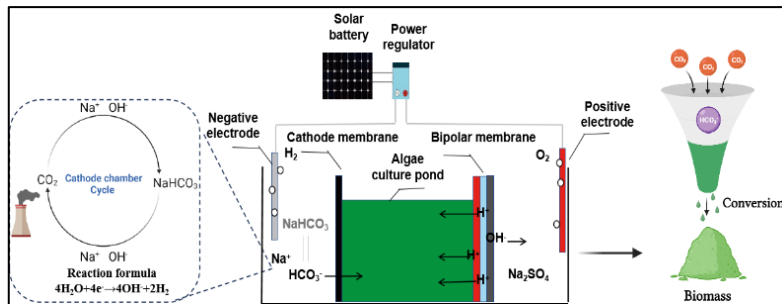


Prof. Maliheh Safavi  
IROST



Prof. Lei Zhao  
TIBCAS

- Joint research on the development of Microalgae active components funded by TIB's program. 3 SCI have been published.
- Jointly applied for the project in Iran and was approved.



Established efficient microalgal carbon capture and utilization (EIMs) systems enable carbonate (hydrogen) enrichment and utilization in the culture pond, increasing inorganic carbon sources by 50%.

"The extraction of mycosporine-like amino acids (MMAs) from microalgae in the 25 L reactor and evaluation of UV-protective activity against skin cells"



## ➤ Mutual visits and Academic Exchanges



TIB delegates attended the congress hosted by IROST and visited IROST in Sept. 2023



IROST delegates attended the forum held by TIB and visited TIB in Nov. 2023

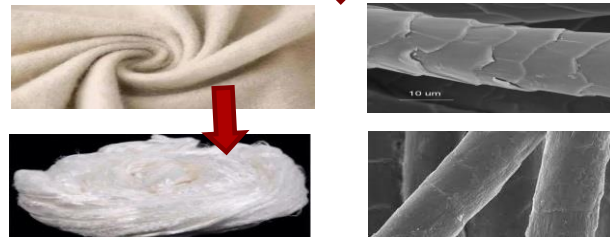
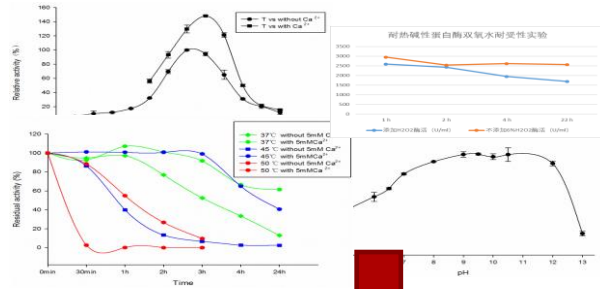


# Collaboration with National Research Centre, Egypt (NRC)

- Joint research on Biological-treatment processes before fabric-dyeing of textile



Prof. BAI Wenqin  
TIB



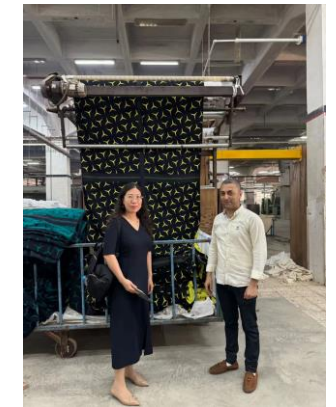
Prof. Hosam El-Sayed  
Vice President, NRC

Completed the experiments of enzyme activity, hydrogen peroxide tolerance and wool enzymatic modification with good results

- Mutual Visits and academic exchanges



NRC delegates visited TIB and delivered a speech at the forum held by TIB in Nov. 2023



TIB delegates visited NRC and local textile companies in Aug. 2024

# Collaboration with COMSATS University, Pakistan (CUI)

➤ Joint research on Anaerobic bio treatment of organic waste



Demao Li, Professor  
TIB, CAS



Athar Hussain, Prof  
COMSATS University



Dr. FARRUKH RAZA AMIN  
COMSATS University



Quintech Sciences  
Agriculture Technology  
company in Pakistan



Technical demonstration

finished postdoctoral study at TIB under the support of Tianjin  
Synthetic Biotechnology Innovation Capacity Improvement Project



Webinar on technical demonstration

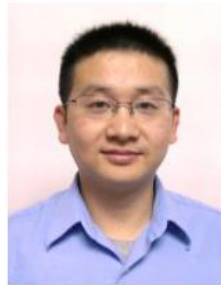
In Pakistan, DHA biomanufacturing has been demonstrated.



# Collaboration with International Center for Chemical and Biological Sciences, Pakistan (ICCBS)



M. Iqbal Choudhary  
Director/Distinguished  
National Professor  
ICCBS



Huifeng Jiang  
Professor  
TIB

➤ Academic Exchanges & Talents Cultivation

➤ Joint research on Heterogenous biosynthesis for the natural plant products' bioproduction



Prof. M. Iqbal Choudhary delivered keynote lecture at the forum held by TIB in Nov. 2023



Nida Ahmed from ICCBS, has finished master work at TIB and back to ICCBS in Jan. 2024

# Set up program to fund young researchers

- 12 young scholars from developing countries have been funded to carry two months or 2-year joint research work at TIB.
- 11 of them are from COMSATS member states.



Pakistan  
Dr. Muneer Ahmed  
Qazi



Pakistan  
Dr. Muniza Shaikh



Pakistan  
Dr. Sadia Naz



Kazakhstan  
Dr. Assemgul  
Sadvakassova



Pakistan  
Dr. Junaid Haider



Iran  
Dr. Pezhman  
SHIRI



Pakistan  
Dr. Farrukh Raza Amin



Pakistan  
Dr. Habiba Khalid



Kazakhstan  
Dr. Bauyenova Meruyert



Kazakhstan  
Dr. Bekzhan Kossalbayev



Malaysia  
Dr. Maxine Yew



Iran  
Dr. Atefeh Roosta

# Future Plans for COMSATS Network

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- Consolidate and strengthen the cooperation with other CoEs in the field of industrial biotechnology under the framework of COMSATS
- Exert the advantages of CCIB as a comprehensive, integrated, open and shared platform to promote industrial biotechnology cooperation and bio-industry development among developing countries
- Strengthen south-south/triangular cooperation to promote sustainable development of bioeconomy



Thanks for your attention and Look forward to more collaborations!

# 創建細胞工廠 發展生物經濟

Build cell factory for bioeconomy

CO<sub>2</sub>

the concept of innovative, coordinated, green, open and shared development

創新 協調 綠色 開放 共享

Community of shared future for mankind

产业国际化 Globalization of Production

工业绿色化 Greenization of Industry

农业工业化 Industrialization of Agriculture



中国科学院天津工业生物技术研究所  
Tianjin Institute of Industrial Biotechnology Chinese Academy of Sciences