Industrial Biotechnology Catalyzing the Sustainable Development --an Introduction to TIB,CAS

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Sincere thanks to Dr. S. M. Junaid Zaidi
Dr. Maj. Gen. (R) Muhammad Tahir
Mr. Tajammul Hussain

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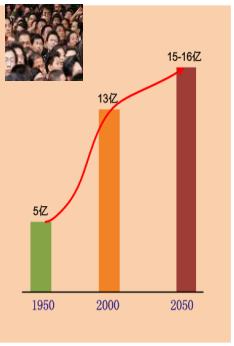
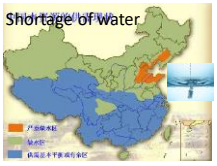
- Present statistics of the institute
- On-going programmes
- International collaborations
- Future plans
- Proposal for participation in COMSATS
- S&T cooperation requests

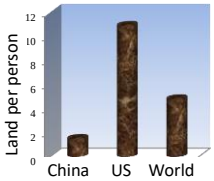
Overview and statistics

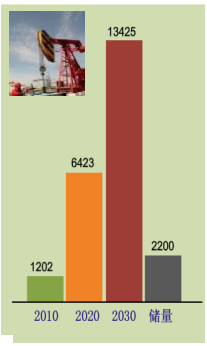
China is facing grant challenge



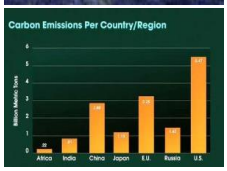
Increasing population







Shortage of resources (water, land, mineral, petroleum)



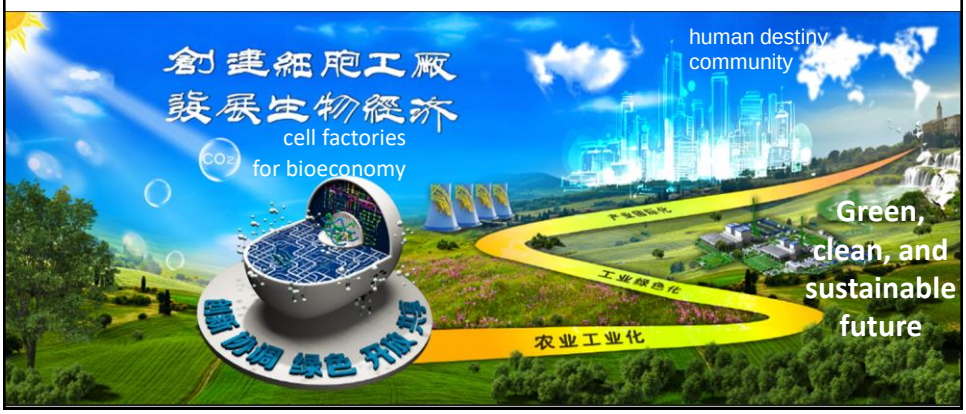
Increasing emission of CO_2 and waste

Industrial Biotechnology may provide a green strategy to support sustainable (unlimited) growth of the world

Mission of TIB,CAS

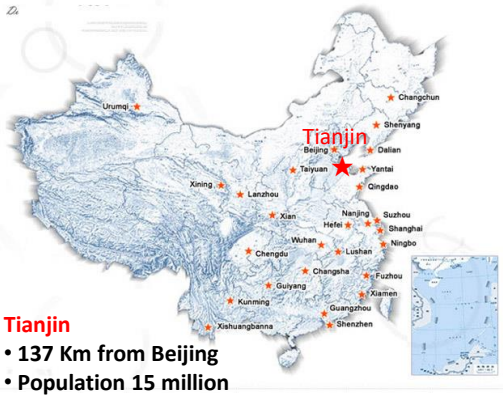
Catalyze 3 transitions by biotechnological innovation, serve for the sustainable development of the socio-economy.

- **Transition from agricultural plantation to industrial manufacturing**
- **Transition from chemical processing to bioprocessing**
- **Transition from fossil based resource to renewable one**



An overview of TIB,CAS

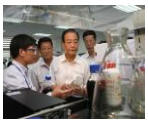
- Launched in 2007, officially established in 2012
- Leading national research institute on industrial biotechnology
- The success drawing attentions from the national leadership and the society



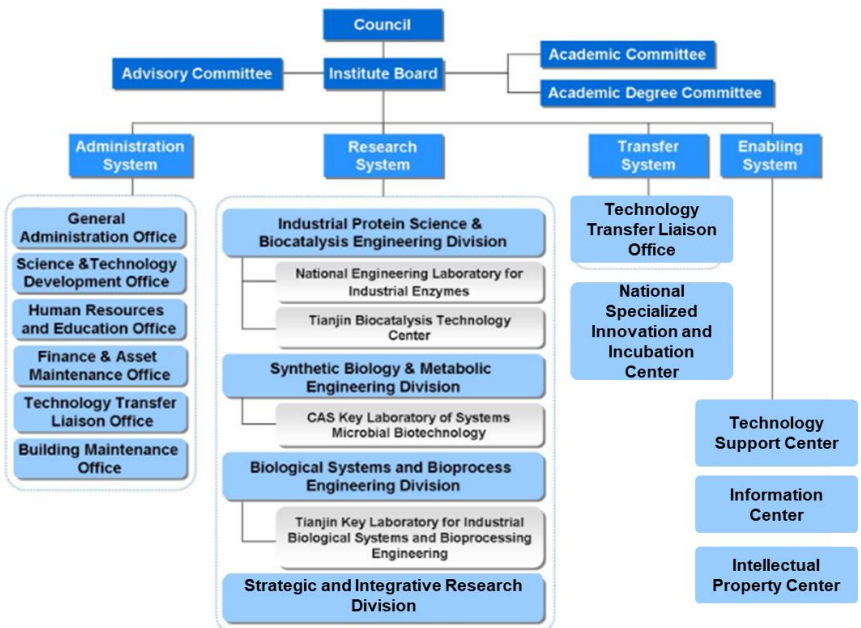
Tianjin

- 137 Km from Beijing
- Population 15 million



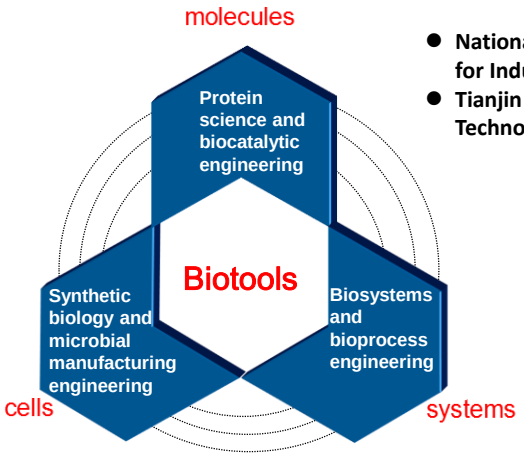



Organizational structure



3 Interconnected Research Areas

4 national/provincial labs

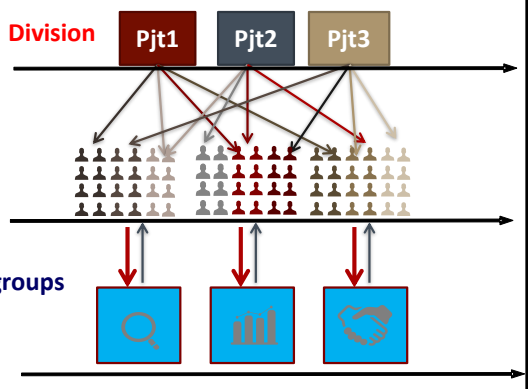


- National Engineering Lab for Industrial Enzymes
- Tianjin Biocatalysis Technology Center
- CAS Key Lab of Systems Microbial Biotechnology
- Tianjin Key Lab for Biosystems and Bioprocess Engineering

Research Organization

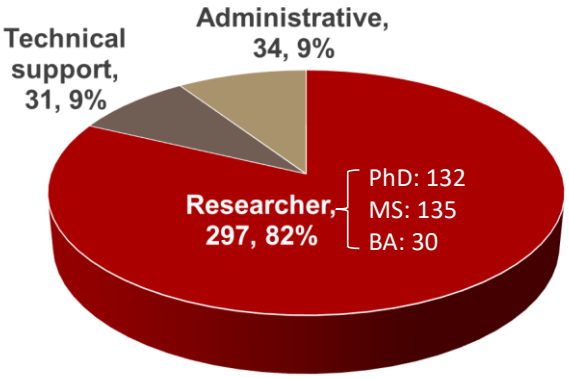
Unique three dimensional R&D organizing model

- **Strategic and Integrative Research Division**
  industrialization-oriented, driven by large projects
- **Disciplinary research groups**
  discipline and technological oriented
- **Core Facilities/enabling research groups**
  facility and technology integrated

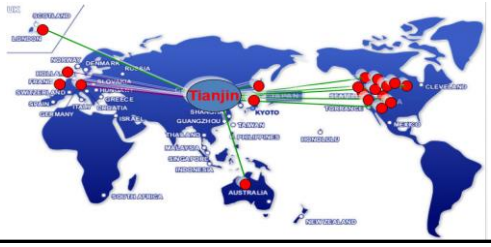


To avoid the fragmentation and isolation of activities of research groups;
To coordinate innovative resource for big target
To deliver ready-to-use technology package for industry

Staff: 362 in total



■45 Professors recruited from all over the world



Students: 297 in totoal

✓ PhD student: ca. 50
✓ Master students: ca. 250

In three majors:

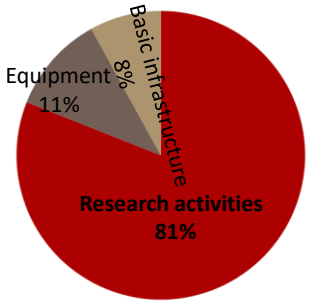
- Biology (PhD, MS)
- Chemical Engineering and Technology (PhD, MS)
- BioEngineering (MS)

Annual budget. ~ $ 23 M

- Basic budget from CAS per year: ~$5 M
- + Projects from the central government (mainly MOST and NSFC), CAS, local government (Tianjin) and industries as well.
- + Technology transfer
- = Annual budget ~$23M all together, ~$77K /person
- Almost all the budget used for development directly or indirectly.

Year	Budget
2017	$27million
2016	$23 million
2015	$23 million
2014	$20million
2013	$23 million
Total	$116 million

Annual budget during the past five years



Allocations of the budget

Research output

Publications (~500)

360+ indexed by SCI
- ~25 cover stories

Patents (~540)

Invention patents: >96%
- Granted:136
- Patent transferred /applied: >30%
- Average license fee: >$1million/patent

Awards (12)

- National/Provincial:10

On-going programmes

Capacity building conferences

Iconic conferences initiated and regularly organized by TIB

China Summit Forum on Industrial Biotechnology Development

- Supported by CAS, NDRC, MOST, etc
- The national namecard forum on Industrial Biotechnology
- Annually
- 400+ participants

China Bioindustry & Capital Conference

- Initiated by TIB since 2016
- Recognized as the investment indicator in bioindustry
- Biannually
- 300+ participants

Capacity building conferences

International conferences

Sino–Canada Workshop on Biomass Transformation and Commercial Opportunities(2014, 2016)
- Supported by MOST, China
- 60+participants

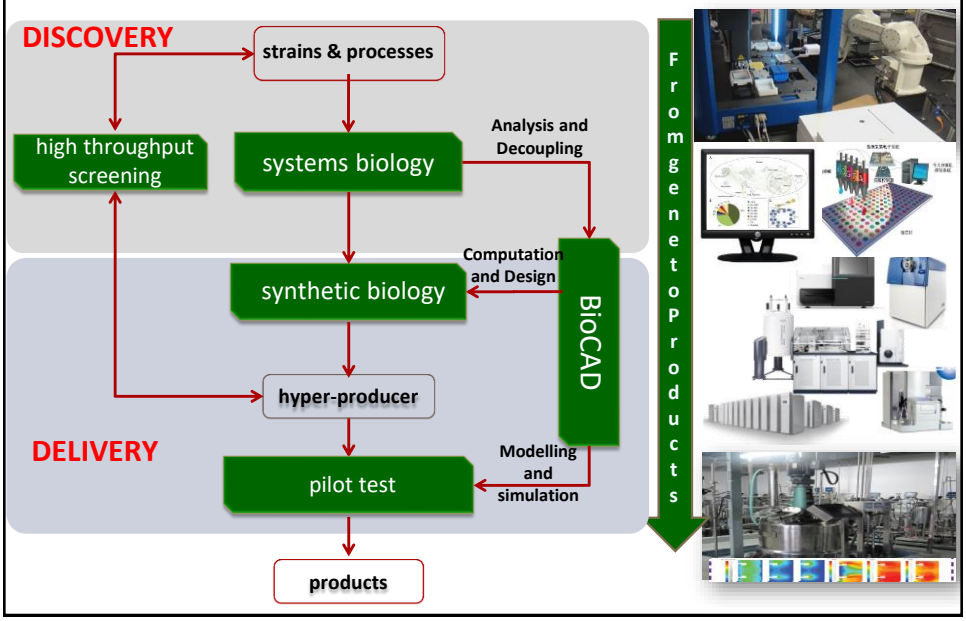
2015 International Conference for Bioeconomy
- Supported by MOST, China
- >300 Participants from 7 countries

International Summit Forum on Amino Acid Industry (2015, 2017)
- Supported by CFIA, China
- 300+participants

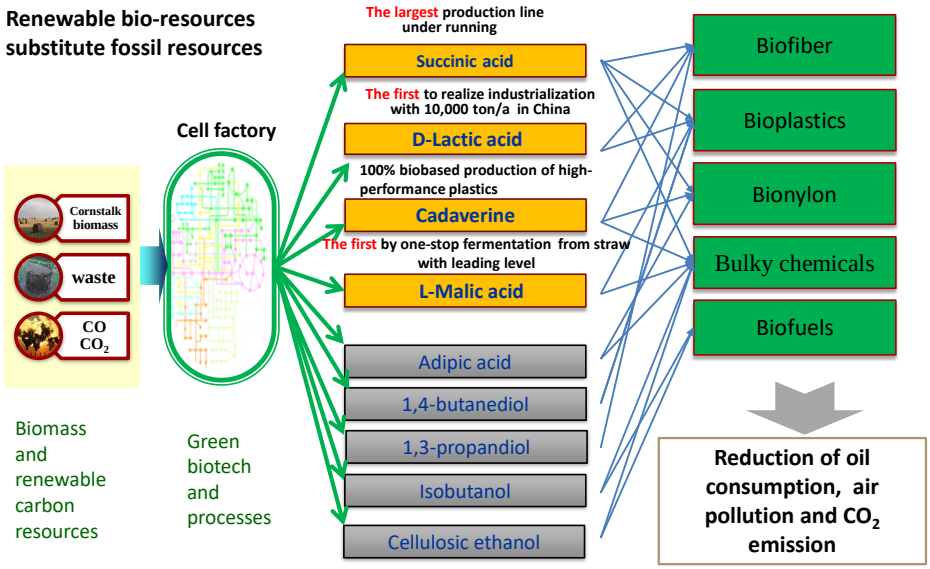
China-UK Workshop on Synthetic Biology (2017)
- Supported by NSFC
- >30 Participants

Core Facilities

■ Total investment >$25M



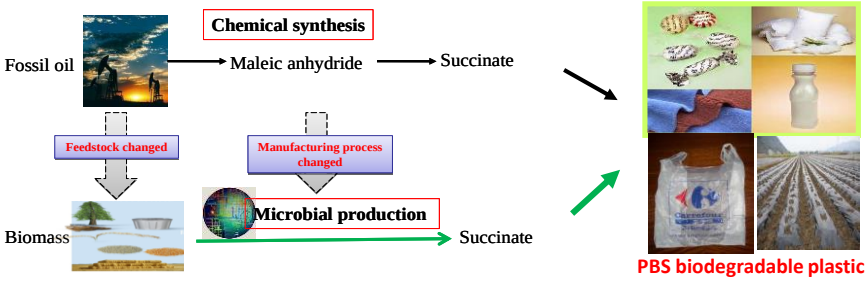
Cell factories for material industry



Succinate

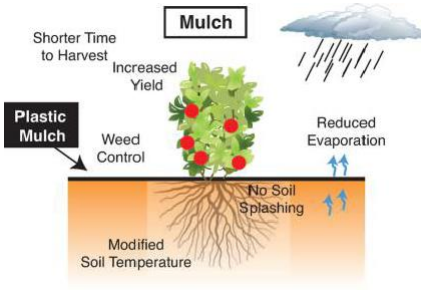
山东兰典公司

- Monomer for synthesis biodegradable plastic PBS and bionylon (polyamide) PAx4
- Potential global market $16B per year
- Currently produced mainly from fossil oil



- Efficient engineered *E. coli* with International leading fermentation level
- Production cost cut by 25% , CO_2 cut by 94% ➔ PBS competitive to PET plastics
- Plant in operation@20,000 tons/a, world largest production line

Benefits of Plastic Mulch

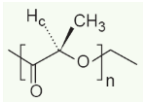


White Pollution

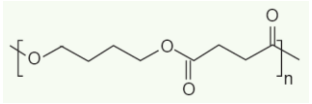
➔Yield decrease!

Biodegradable Plastic Mulch

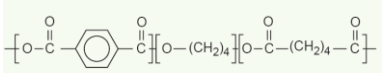
Biodegradable Polymer



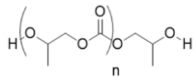
Polylactide (PLA)



Poly(Butylene Succinate) (PBS)



Poly(Butylene Adipate-Terephthalate) (PBAT)



Poly(Propylene Carbonate) (PPC)

Application of Biodegradable Mulch in Xinjiang Uygur Autonomous region

Biodegradable Mulch

Polyethylene Mulch

Crops	Year			
	2014	2015	2016	2017
Cotton	-8.5	-5.8	-5.3	-3.1
Maize	+0.46	+0.53	+2.65	+4.32
Sugar beet	+5.31	+3.32	+2.94	+4.35
Tomato	+1.31	+2.66	+1.15	+2.07

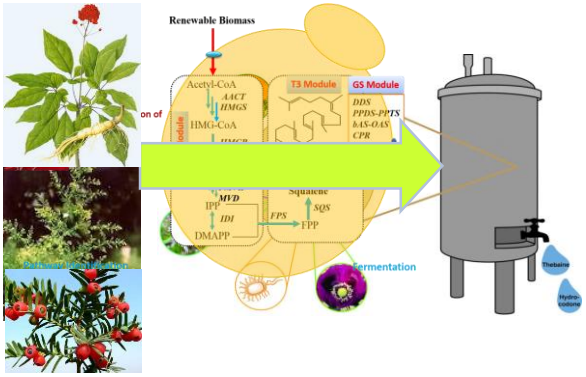
Yield enhanced!

Natural products from plants

Natrual products for medicine, fragrance, pigment for healthcare, food additives, cosmetics.
But, shortage of resources, plantation and extraction causes pollution

Tranditional:
Plantation and extraction

Now:
Metabolic engineering and fermentation



Benefits:

- **No resource limitation**
- **Global.herb medicine**
- **Beneficial for poors**
- **New industry**

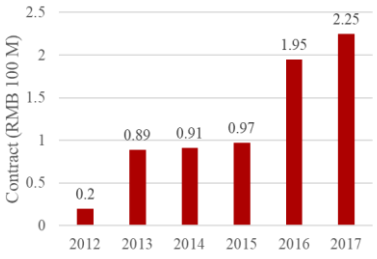
Plant natural products by microorganisms

30+ Cell factories for plant natural products for Chinese medicine, fragrance, pigment for healthcare, food additives, cosmetics

	Strain dev.	Process dev.	Pilot test	Industrialization
Ginsenosides	1K m^2 = 10K ha, the first yeast cell factory			
lycopene	1Km^2 = 6K ha, 20 ton/a under construction			
β-carotene	Highest titer, 30 ton/a under construction			
Salidroside	The first *E. coli* cell factory,1/40 cost of plant extraction			
Gastrodin	The first *E. coli* cell factory,1/200 cost of plant extraction			
Breviscapine	1/2 cost of plant extraction			
Rosemaric acid				
Apigenin				
Costunolide				

Industrial collaboration

- Every 8-10 days, a commercial cooperation agreement is signed with the enterprise.
- Established partnership with > 140 companies via 190 projects of 24 provinces
- Total contract fund $120 million, occupying >60% of the institute revenue.
- Ranked top 10 among >100 CAS institutes judged by technology transfer
- 20 joint labs with the companies
- 4 industrialization bases with the local governments and enterprises



Well-connected to industry

Social-economic impact

30

Technologies industrialized in various industris such as pharmacy, chemical, textile, fermentation, biomaterials and enzyme.

- Making 2 private enterprises listed on the stock market NEEQ by our single tech
- Helping 35 small and medium-sized enterprises with >$17 million output value become technology innovation-driven enterprises
- Promoting 10 large enterprises with >$170 million output value upgraded
- Engaged in 2 industry clusters in biomaterials and biochemical
- Creating new output value>$2 billion while indirect industry scale> $10 billion

International collaboration

International network/connections

+30 **Collaborative R&D Universities from >20 countries**

- University of Minnesota
- University of California, Berkeley
- UIUC
- Harvard University
- University of Kentucky
- TUHH
- TU Berlin
- TU Braunschweig
- RWTH Aachen
- The University of Edinburgh
- The University of Manchester
- Kagawa University,Japan
- The University of Auckland
- Politehnica University of Bucharest
- Monash University
- Mansoura University
- University of Tehran
- .....

~10 **Moreover, established partnership with ~10 organizations**

NRC·CNRC IBioIC RSE The Royal Society of Edinburgh CLIB 2021 iap SCIENCE RESEARCH HEALTH the interacademy partnership ICGEB twas TYAN ICAAS International Council on Amino Acid Science

International Collaboration

Scholars exchange	Training graduate students	Collaborative R&D projects	Joint partnership labs	Symposia & Seminars
➢ ~ 60+ foreign scholars /a visit TIB ➢ ~50 Staff of TIB per year go abroad ➢ 20+ visiting scholars with the support of PIFI, CAS	➢ 3 PhD students from Pakistan, Nigeria, Rwanda	➢ ~20 programs in bio-energy, biomass transformation, functional food, synthetic biotechnology… ➢ Supported by MOST, CAS, NSFC	➢ Joint laboratory of Systems Biotechnology	➢ ~10 International workshops ➢ Such as "The Belt & Road" Industrial Biotechnology Symposium

Director-General, ICGEB visited TIB

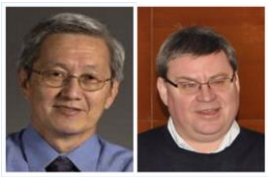
Coordinator of IAP and TWAS visited TIB

Pakistan Enterprise Delegation visited TIB

Symposia with CLIB Delegation

TIB signed collaborative agreement with NRC, Canada

Distinguished/visiting professorship



Peter Lau　　Igor Goryanin

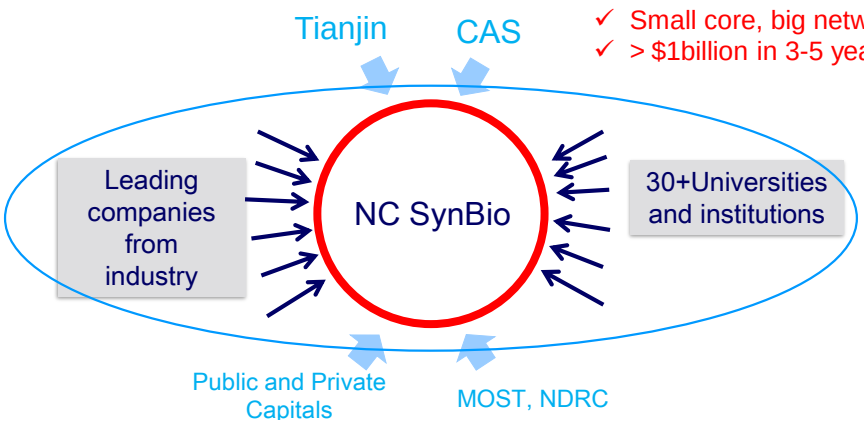
Manfred T. Reetz　　Vera Meyer

Base for International Science & Technology Cooperation in 2013 by MOST of China

Future plans

National Technology Innovation Centre for Synthetic Biology (NC SynBio)

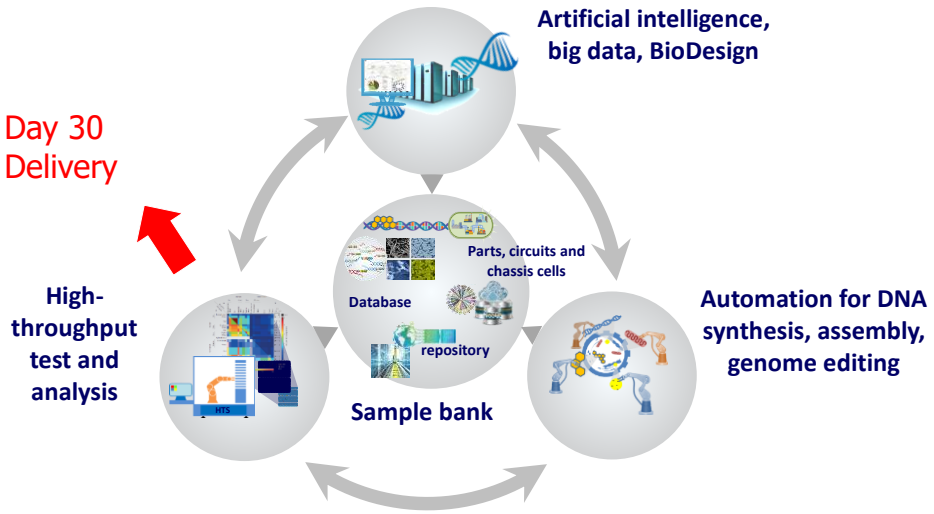
Comprehensive, integrated and open-access platform to boost the development of disruptive technologies in synthetic biology for material synthesis, energy supply, intelligent healthcare and environment protection.



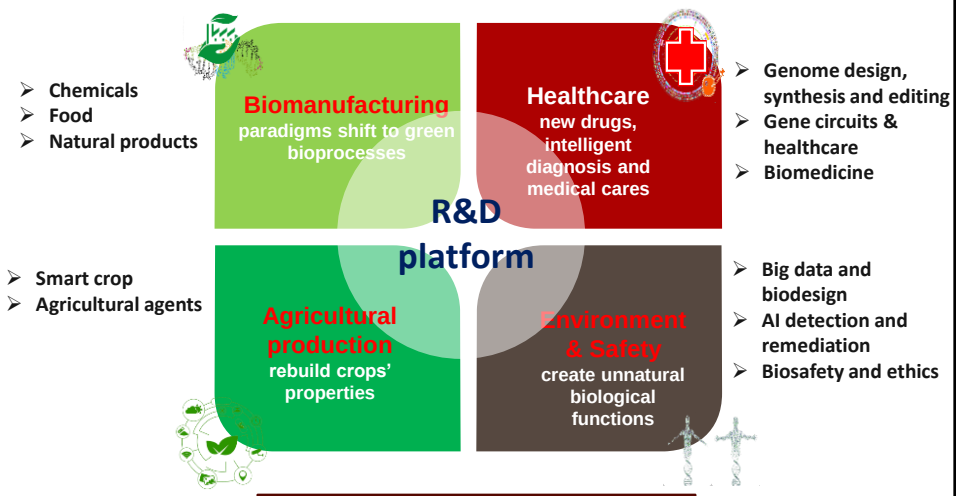
Market-oriented research under the guidance of social capital

Core facility

Day 1 Request



R&D platforms for key technological areas

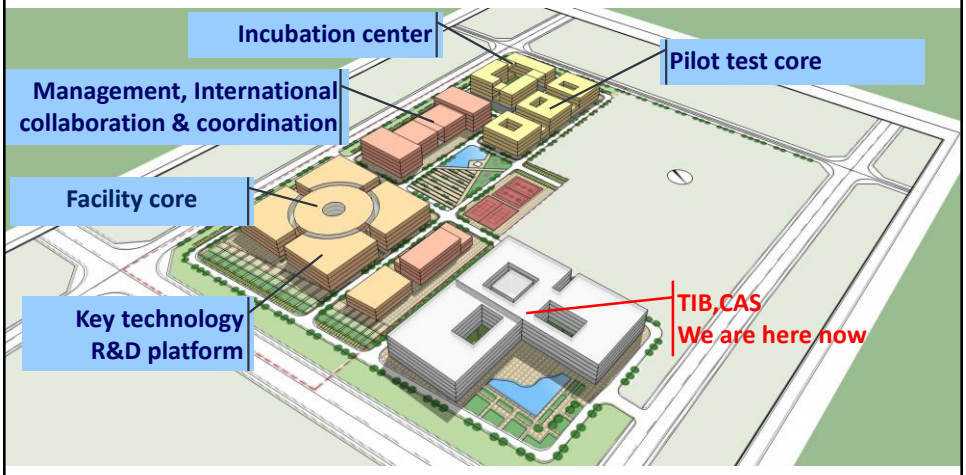


12 platform labs/functions

Incubation and service platform

New Campus

120K m^2 to host 2500 people
3 years construction period



Functional operation in 2020

Proposal for participation in COMSATS activitites

Participation in COMSATS' programmes

- Participation in the ITRGs in particular:
  - Natural products –understanding and advanced use of biological information
  - Agriculture, food security and biotechnology
  - Renewable Energy

Participation in COMSATS' programmes

- **New proposal as ITRGs:**
  - **Biodegadable plastics**

Reuse local waste resources: agricultural debris, urbon waste water

Products: primary biodegradable materials such as PHA, PBS, PLA, etc, and secondary products such as fibers, textile, plastic bag, agr. Mulch

Benefits:

- ✓ Decrease in oil dependence (less consumption, less import)
- ✓ Decrease CO2 emission (less greenhouse gas, less carbon trading)
- ✓ Decrease white pollution (better crop yield)
- ✓ More income for the farmer and local government
- ✓ More job opportunity (full chain of industry and markets, multidisciplinary)
- ✓ New mode for self-dependent, sustainable development (Agr+Ind)

Opportunity:

Fast technology advancement

Already tested in some places

Vision and inspection for publication

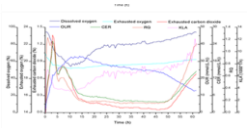
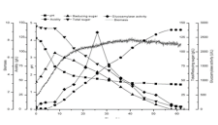
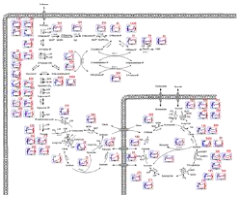
Other collaboration potentials

1. COMSATS Center as international collaboration hub in NC SynBio, to be better connected to the academia and industry, to share the core facilities and laboratories
2. Scholarship of COMSATS-Chinas, supported by CAS, CSC, NSF, MOST, Post doc and PhD students, to be supported by UCAS or TWAS
3. Regular training courses (annually), supported by COMSAST and TIB
4. Symposium and conferences: invite COMSATS members, or joint launch new symposiums with focus on biotechnology and sustainable development
5. Joint R&D projects supported by "The Belt and Road" Program, or by social capitals and industry
6. Technology transfer, bi-directional

Under the framework of the COMSATS with the support of MOST, and CAS

S&T cooperation requests

- **Modelling** of industrial microorganisms at molecular level
  - Comprehensive quantitative data for process, strains, intra/extracellular molecules
  - Aiming at fully understanding the life and higher predictability on engineering life.
- **Natural products**
  - Identifying interesting targets, and producing it efficiently as drug or healthcare products
- **CO2 biotransformation**
- **Technology transfer** in the area of production of food, feed, drug, healthcare products, chemical and materials, solution for environmental protection (waste water, gas, solid; soil remediation)

In Conclusion

- In the past ten years, TIB built great capacities in the area of Industrial Biotechnology including infrastructure, team, R&D model, and achieved big success in technology invention, innovation and transfer.
- In the future, the NC SynBio will be a unique platform for technology innovation, substantially contribute to the sustainable development of China. NC SynBio serves a good opportunity for international cooperation under the roof of COMSATS.

The future is green,
the future is bio.

Thank you for your attention!
Looking forward to collaborating with you!

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