Overview of Thailand Synthetic Biology Roadmap

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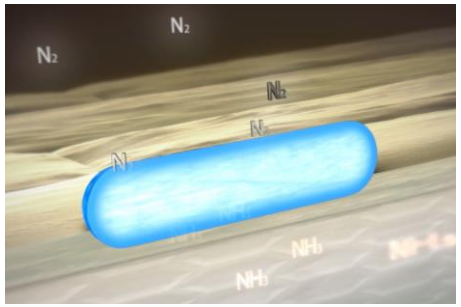
11 November 2024

SynBio Consortium 2024

Pullman King, Bangkok

SynBio Solutions & Market Opportunities



Biofertilizers

- Demand increase for sustainability & self-care products
- Chemical fertilizers are harmful for environment & human health

60,000 M Baht (11.5%)
(Research & Markets)
Import 100,000 M Baht
(Fertilizers, Trademap)

Technology

Genome remodeling
Engineered plant-associated bacteria to turn on the gene that fix nitrogen

Sweetener & Prebiotic: IMO

- Functional food global trends
- IARC classified aspartame as possibly carcinogenic to humans
- Sugar-tax increase across countries

25,000 M Baht (5.7%)
(Future Market Insights)
Import 36,000 M Baht
(Functional ingredients, Trademap)

Technology

Cell factory engineering
Genetically modified microorganisms to produce flavors for plant-based meat

Second Generation Biofuel for SAF

- Production of CORSIA SAF should promote food security
- IATA's roadmaps accelerate the transition to net zero by 2050

20,000 M Baht (60%)
(Future Market Insights)
2024-2032F:
75,000 M Baht
(DEDE)

Technology

Hybrid algae innoculation
to produce ethanol:
16 times higher ethanol yield achieved from corn & >6 times from sugar cane

Cell Therapy: CAR-T cell

- High-efficacy therapy
- High-value product
- Thailand medical tourism attracts international patients

89,000 M Baht (6.9%)
(Future Market Insights)
Import 245,000 M Baht
(Cell therapy products, Trademap)

Technology

Genetic circuit design
Genetically modified T-cells ss a chimeric antigen receptor (CAR)

Thailand's status & key challenges

Publication

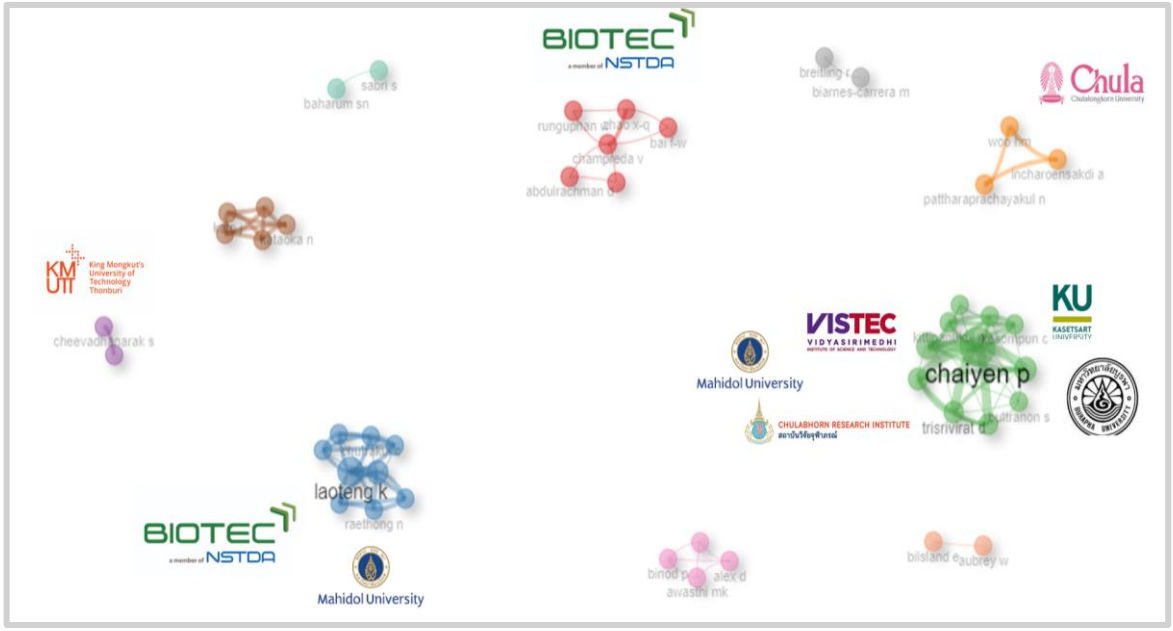
Improve quantity and quality is needed

- Thailand rank 2nd in ASEAN, 7th in Asia, and 24th in world publication number. Improved 7 ranks during the past ten years.
- Field-weighted Citation Impact is below 1.0 (0.7)
- Synbio related R&D Investment = 200 MB (5yrs)

Multidisciplinary platform should be set out to promote collaboration between system biologist - computational scientist – bioprocess engineer

- Publication in metabolic engineering -- which is an important foundation of synthetic biology are found. However, there is no research publication on tools development such as using gene circuit and deep learning or AI to create host cell.

Synbio related research network in Thailand



Thailand’s status & key challenges

Patent

Research to reach higher TRL must be accelerated to demonstrate market opportunity, registration process should be clear to foster industry adoption

- No synbio related patent is found both from Thai inventor nor foreign application
- Imply that technological capability in commercial application is not yet mature, and Thailand is still not yet strategic market of the region.
- Most of Thai patents are in modern biotechnology/genetic engineering, with applications in biofuel, natural product and biocatalyst. while global innovators file application on host cell, promoter and vector development, fermentation process, gene circuit and AI.

Human resource

Career pathway must be secured for talents to remain in the fields

- 12 universities have synthetic biology related courses (35%), and other 6 universities are developing their curriculum

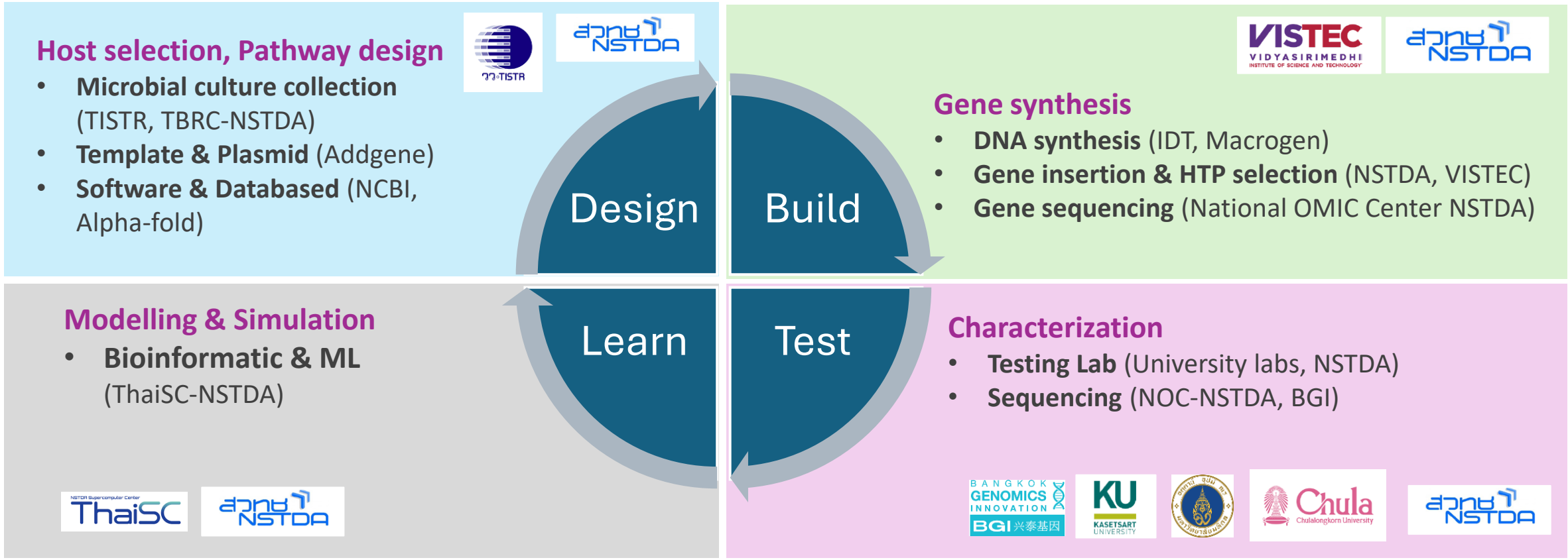
Graduates can be upskilled to work with synthetic biology or machine learning and AI

- 30 courses with 700 graduates who have foundation in system biology and metabolic engineering and bioinformatic

Thailand's status & key challenges

Research Infrastructure

Research ecosystem and supply chain need to be improved to shorten R&D cycle
Key labs must be strengthened, high throughput facilities should be accessible for all research community



Host selection, Pathway design

- **Microbial culture collection** (TISTR, TBRC-NSTDA)
- **Template & Plasmid** (Addgene)
- **Software & Databased** (NCBI, Alpha-fold)

Gene synthesis

- **DNA synthesis** (IDT, Macrogen)
- **Gene insertion & HTP selection** (NSTDA, VISTEC)
- **Gene sequencing** (National OMIC Center NSTDA)

Modelling & Simulation

- **Bioinformatic & ML** (ThaiSC-NSTDA)

Characterization

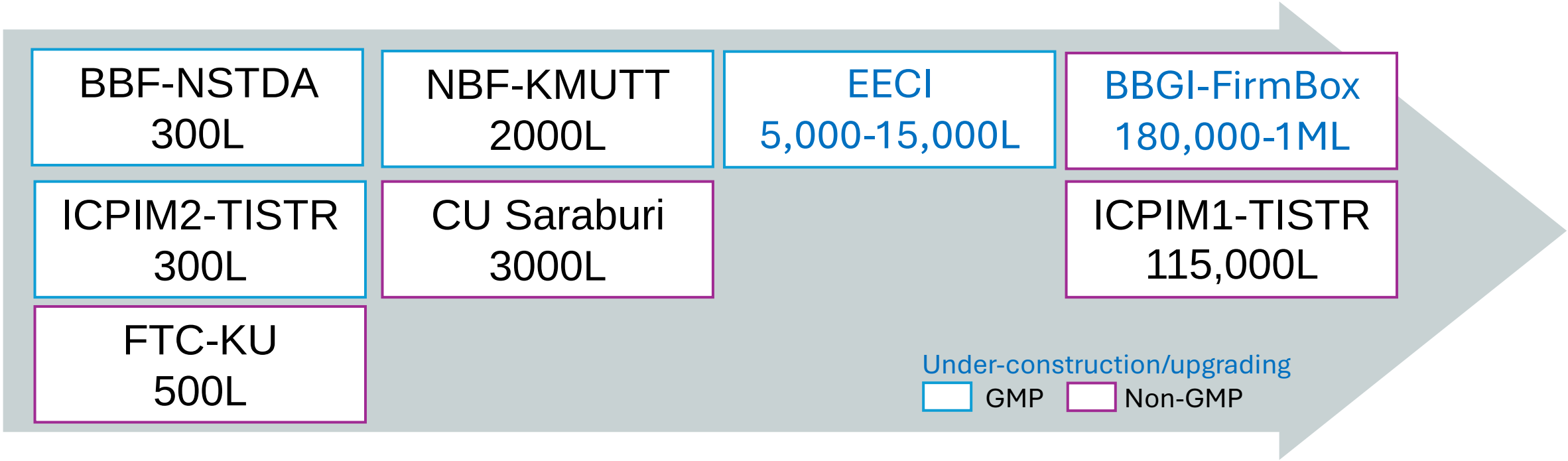
- **Testing Lab** (University labs, NSTDA)
- **Sequencing** (NOC-NSTDA, BGI)

Thailand's status & key challenges

Scaleup facility

Increase utilization and accessibility of the facilities as well as GMP/CDMO upgrade are needed

- Both government and private sector invested in scaleup facilities and its services resulting in bringing biotech research to commercialization as well as human resource development



Thailand 10yrs Synthetic Biology Strategy

SynBio be strong foundation for innovative products/services and national sustainable growth

Approx. Economic Value of Bio-industry 3% GDP (450,000 MB)

Capability
1,000 Synbio talents
Av. Field-weight citation >1.3
World top 20 in publication no.

Process, product & service
Agro: crop traits/biofertilizer/biopesticide
Food: fn ingredients and fn food
Med: biologics (human & animal)
Fuel & Chemicals: biochemicals, biomaterial, enzymes

Users & Firms
1,500 Synbio-user firms
100 Synbio startups
3 Global synbio firms
1 Private R&D Center

S2: Building strong knowledge foundation

Talent
- Multidisciplined degree course
- Scholarship, fellowship, contest *to attract talents to the fields*
- Synbio short course

Research system
- 10 key labs *frontier research grant, equipment upgrade & researcher career pathway*
- 1 National bio-foundries
- Upgrade bio-resource data services
- Synbio conference

S3: Upgrading industry tech cap & market expansion

Bridging & Scaleup
- Grant for scaleup research & infra utilization
- CDMO's network
- IP&FTO support program

Business Support
- Pre-competitive R&D grant
- Synbio incubator
- Tech assessment & scouting services
- Market expansion support

S1: Ecosystem that nurture research capacity, and increase industry adoption

Policy & Budgetary
- Announce "Synbio as National Targeted Technology"
- Secure 500MB x 10yr for frontier & foundation research

Awareness
- Increase dynamism of consortium activities to engage public

Regulation & Standard
- Develop Synbio's product & process registration guidelines
- Develop Bioethics Guidelines
- Develop NQI & Technical standards

Global Partnership
- Attract global Synbio firm investment
- Co-project with Synbio global network

Thailand 10yrs Synthetic Biology Roadmap

	1-2 yrs	3-5yrs	5-10yrs
Strategic Direction	**Mastering the tools & Demonstrating commercial opportunity**	**S&T critical mass and scaleup success**	**Creates new tools & Growth through scaling market**
Strategic Product/Service	**Enzyme, Plant traits Bioprocess improvement service**	**Fn ingredients, specialty chems CDMO & Research services**	**Biologics Mass synbio-products**
Research Program	**Frontier & Platform technology** *Genome engineering, Protein design* *Cellular pathway & Circuit design* *Host and consortia engineering,* *AI & modelling* *Standard & measurement*	**Translational research** *Scaleup cell culture* *Downstream process* *Purification technique* *Process optimization* *Toxicity test & Clinical trial*	**Pre-competitive tech platform** *Future industry disruption*
Research infra	**Key labs network** **Culture data collection network** *Foster collab research with domestic & int'* *Microbes, Plant, Medical, Animal*	**National biofoundry & Bioresource data center** *Host genome, Omics data + Software & Standards* **GMP pilot plants** **CDMO utilization grant**	
Talent	**Multidisciplined researcher pool** *System biologist & synthetic biologist (machine learning) & bioprocess engineer* **Bio-business professional pool** *Standard & registration, bioethics, bio-entrepreneurship*		
Ecosystem	**Policy & Budgetary** *Frontier research excellence* **User community & awareness** *Potential products identification* **Registration guidelines**	**Synbio business incubator** *Co-lab space & tech advisory* *Business advisory board & mentor* *Bio-venture fund & network* *IP & FTO support & Reg sandbox*	**Investment & Market expansion** *Private R&D center* *CDMO & other research business* *Synbio product manufacturers*

Source: NXPO, adapted from Thailand Academy of Science and Technology (TAST), 2 024

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SCIENCE RESEARCH
AND INNOVATION POLICY COUNCIL

THANK YOU