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CM Venture Capital

SEIF INNOVATION
Shanghai Emerging Industries Foundation
上海战略新兴产业发展基金会

Tong'an Holding Co.,Ltd
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Revitalize 复苏!
Discover the science behind LOHAS
大健康和可持续发展

The “Net Zero” Material World

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CM Venture Capital

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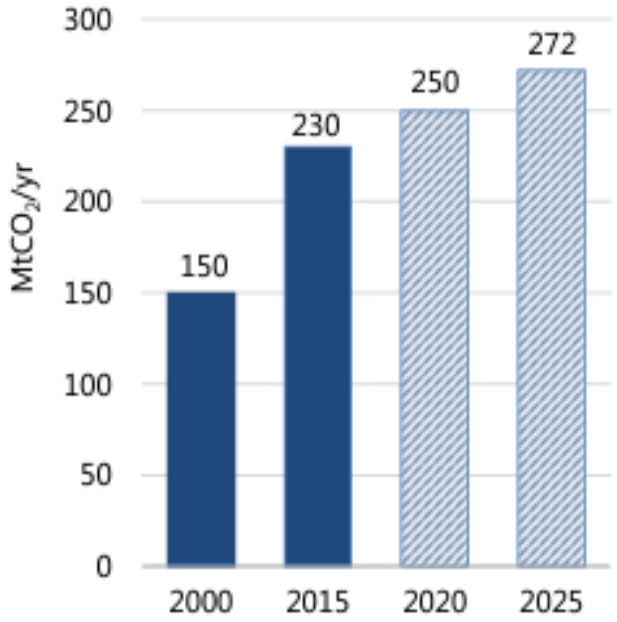
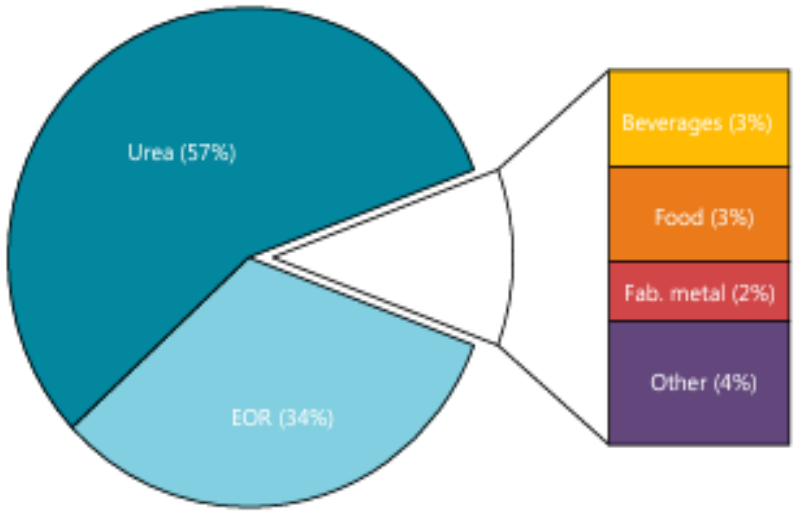
Huge gap between CO2 emission and CO2 utilization

Total CO2 emissions = 37 billion tons / year
World needs to remove from the atmosphere by 2050 = 10 billion tons of CO2 annually

Growth in global demand of CO2



Breakdown of CO2 demand (2015)



Source: IEA 2019 report “Putting CO2 to use”

Capturing and storage of CO2 is costly

CO_2 source	CO_2 concentration [%]	Capture cost [USD/tCO_2]
Natural gas processing	96 - 100	15 - 25
Coal to chemicals (gasification)	98 - 100	15 - 25
Ammonia	98 - 100	25 - 35
Bioethanol	98 - 100	25 - 35
Ethylene oxide	98 - 100	25 - 35
Hydrogen (SMR)	30 - 100	15 - 60
Iron and steel	21 - 27	60 - 100
Cement	15 - 30	60 - 120

For a power station, CCS technology uses between 10 and 40% of the energy!
(about 60% from the capture process, 30% from compression and 10% from pumps and fans)
In addition, constructing CCS units is capital intensive: large-scale CCS project costs $500M to $1.1B over lifetime

Source: IEA 2019 report “Putting CO2 to use”

CO2 is a very inert molecule

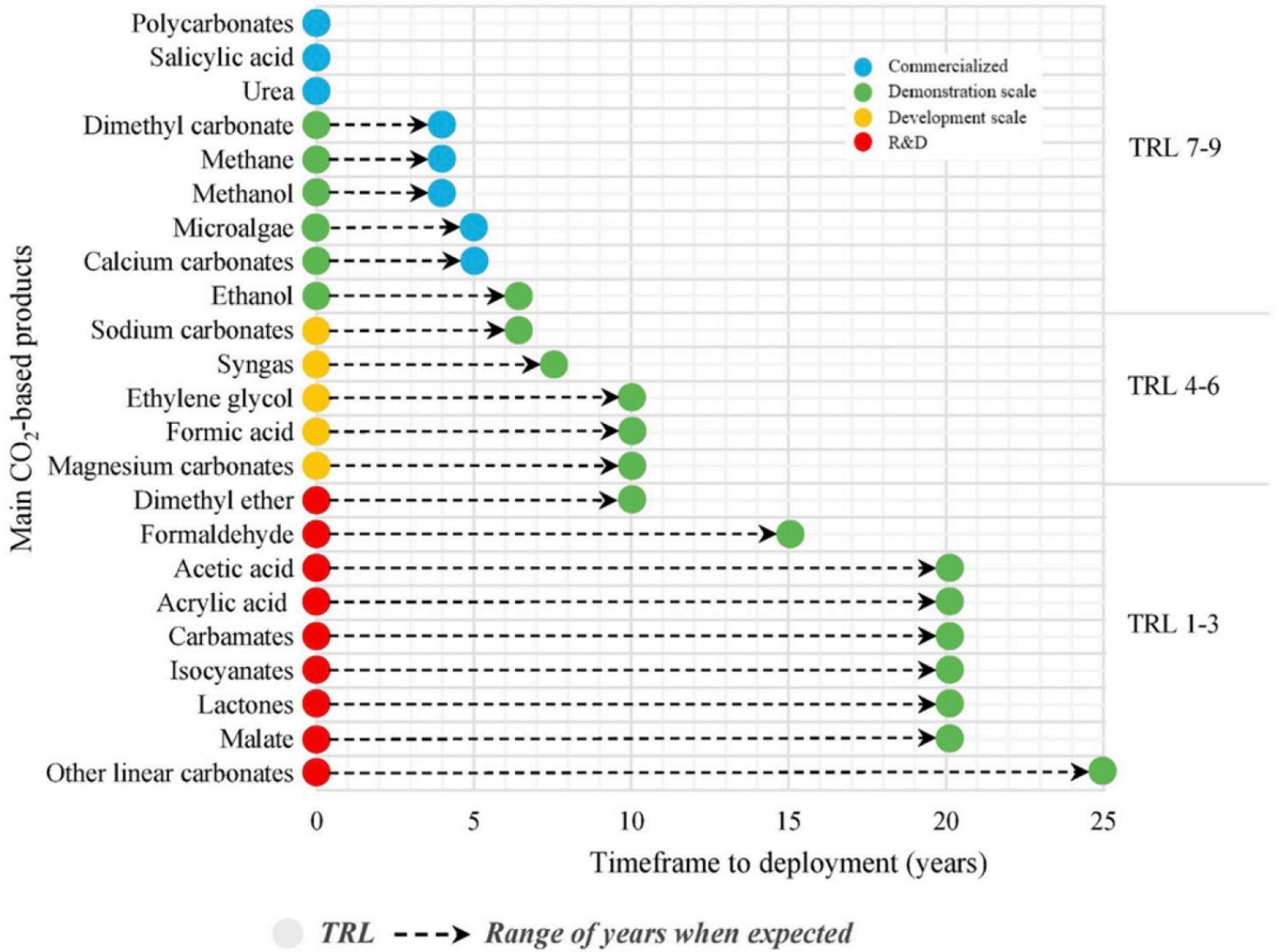
Direct Incorporation

Mineralization	Reaction with alkali to form carbonate $CO_2+Ca(OH)_2 = CaCO_3+H_2O$	Requires large amounts of alkali as raw material;
CO2-to-Polyol		Normally required high pressure

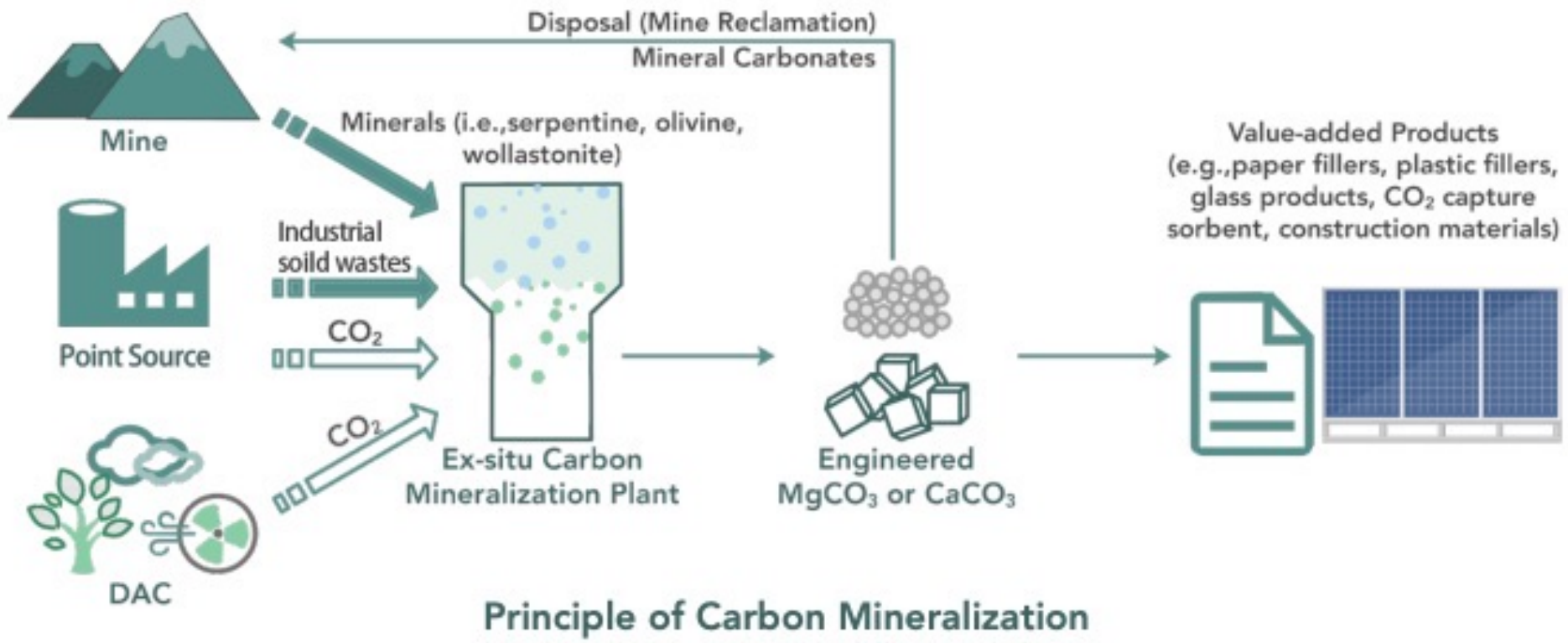
CO2 Splitting

Thermochemical conversion	Heating (with catalyst) to chemicals $CO_2+H_2 = (CHO)_n$	Requires large amount of hydrogen, high cost of hydrogen source required
Redox method	Reaction with reducing agent to produce chemicals $CO_2+C = 2CO$	Additional heat required, conversion rate needs to be increased
Electrochemical method	Electrolysis of carbon dioxide and water to produce syngas $CO_2+H_2O = CO+H_2+O_2$	High cost of electrolyzer
Photochemical conversion	Photochemical decomposition of carbon dioxide $CO_2+H_2O+solar = (CHO)_n$	Low light conversion efficiency, no large scale promotion capability

CO2 splitting or conversion have years to commercialization



Carbon mineralization

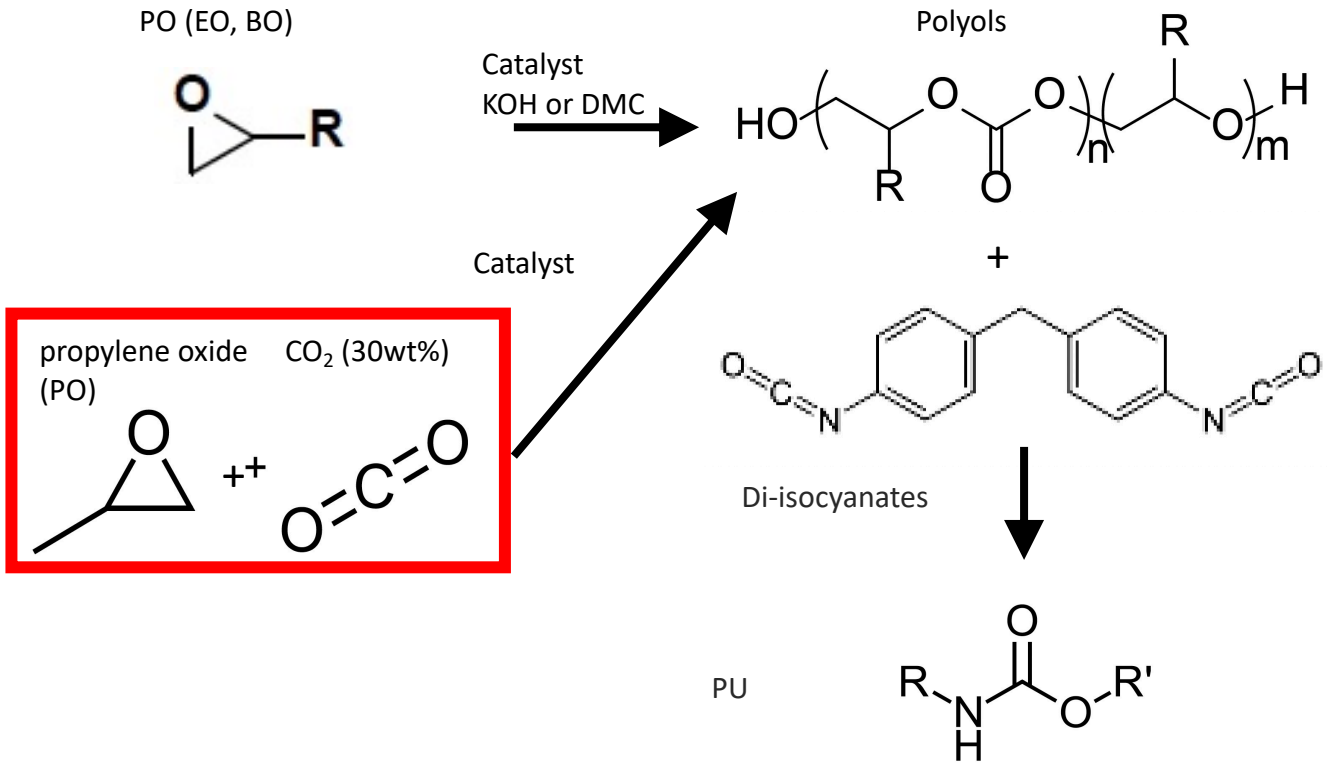


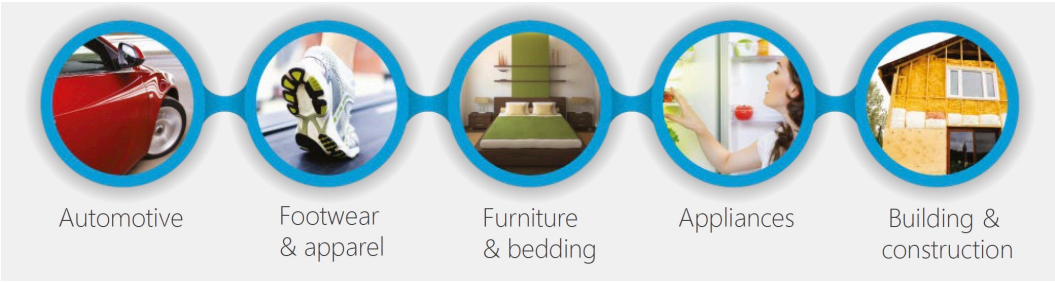
Principle of Carbon Mineralization

Start-up companies in the field of CO2-incorporation-into-cement

	CARBON CURE	SOLIDIA	CARBONBUILT	GREENORE	Geopoly	CLEAN CO_2 清洁捕获
Location	Nova Scotia, Canada	New Jersey, United States	California, United States	Shanghai, China	Shanghai, China	Beijing, China
Funding	$12 MUSD	$105 MUSD	$10 MUSD	N/A	$12M USD	Unknown
Year Founded	2007	2008	2020	2018	2013	2021
Technology readiness (TRL)	commercial	commercial	demonstration	demonstration	commercial	demonstration
Product spec.	Cement	Cement	Cement	Cement	Cement	Cement

CO2-to-Polyol

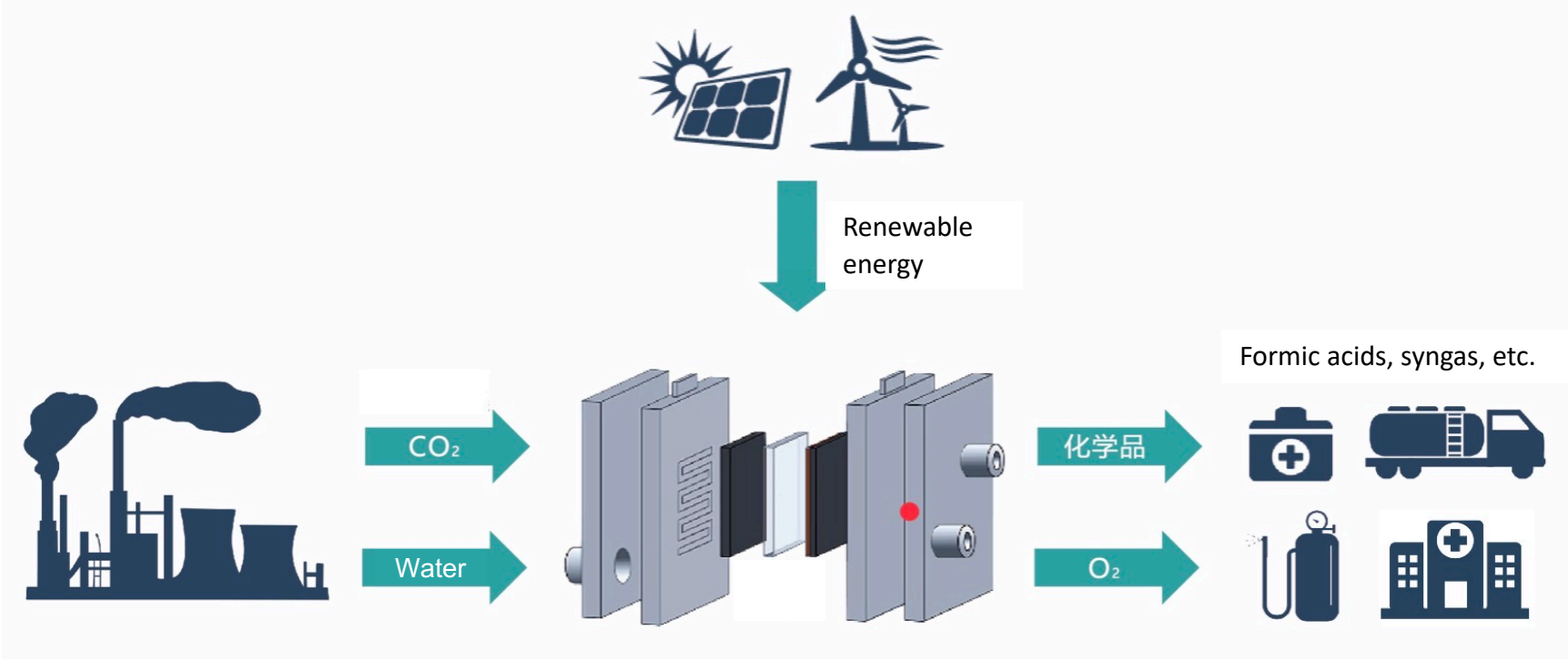




Companies in CO2-to-Polyol

	covestro	aramco	ECONIC	POLYx MATERIAL TECHNOLOGY
Location	Leverkusen, German	Saudi Arabic	London, England	Zhejiang, China
Funding			$ 47 MUSD	~ $ 4 MUSD
Founded year	2015	1933	2011	2017
Carbon source	CO_2	CO_2	CO_2	CO_2
Technology readiness	commercial	demonstration	commercial	demonstration
Pressure	50 bar	20 bar	10 bar	15 bar

Electrochemical splitting of CO2

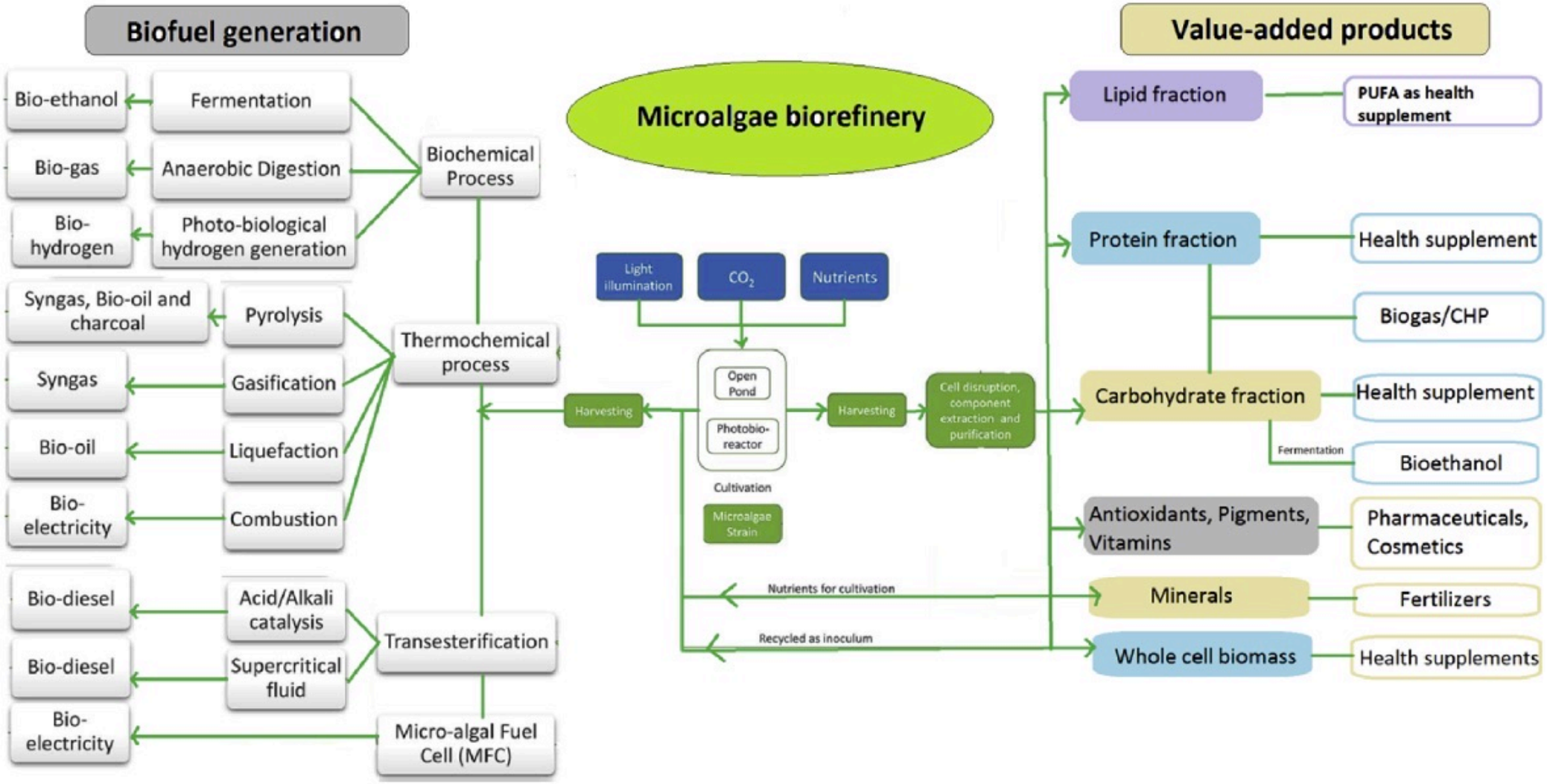


Membrane Electrode Assembly (MEA)

Electrochemical conversion companies

Location	Illinois, USA	Oslo, Norway	New Jersey, United States	British Columbia, Canada	Beijing, China	Anhui, China
Funding	< $1 MUSD	Unknown	$33 MUSD	N/A	$ 15 MUSD	$ 5 MUSD
Founded year	2009	1864	2009	2007	2015	2021
Technology readiness	lab scale	lab scale	lab scale	lab scale	demonstration	demonstration
Product spec.	Formic acid, syngas	Formic acid	Formic acid, Oxalic acid	Formic acid	Syngas	Formic acid, syngas
Conversion efficiency	38%	35%	42%	41%	52%	48%

Microalgae carbon capture and utilization



Flow diagram of a microalgae biorefinery in summarized form

Microalgae carbon capture and utilization companies

	LanzaTech	cellana	MANGO MATERIALS	Electrochaea	Lyxia | Xiaozao Tech	DMT 德默特	PROTOGA 元育生物
Location	Illinois, USA	San Diego, USA	San Francisco, USA	Planegg, Germany	Guangdong, China	Guangdong, China	Beijing, China
Funding	~ 280m USD	14.4m USD	Unknown	~6m USD	Unknown	~ 20m USD	~ 5m USD
Founded year	2005	2004	2010	2010	2016	2019	2021
Carbon source	CO	CO_2	CH_4	CO_2	CO_2	CO_2	CO_2
Technology readiness (TRL)	commercial	demonstration	demonstration	10 MWe biome-thanation plant	commercial	demonstration	demonstration
Product spec.	Ethanol, protein, biomass	DHA oils, protein/ carbohydrates, biomass	PHA pellets	Biomethane generation	EPA &DHA oils, biomass	Fucoxanthin, EPA oil, protein	Astaxanthin, EPA oil, protein
Potential applications	Aviation fuels, daily chemical packaging, perfumes, etc.	Animal feed. biofuels nutritional omega-3 oil	Polymer, fibers for textiles	Energy storage, power generation	nutritional omega-3 oil	Pharmaceuticals, Cosmetics, animal feed, nutritional omega-3 oil	Cosmetics, animal feed, nutritional omega-3 oil

Big goals for biomanufacturing

Climate: in 20 years, convert bio-based feedstocks into polymers that can displace **90%** of today's plastics and other commercial polymers

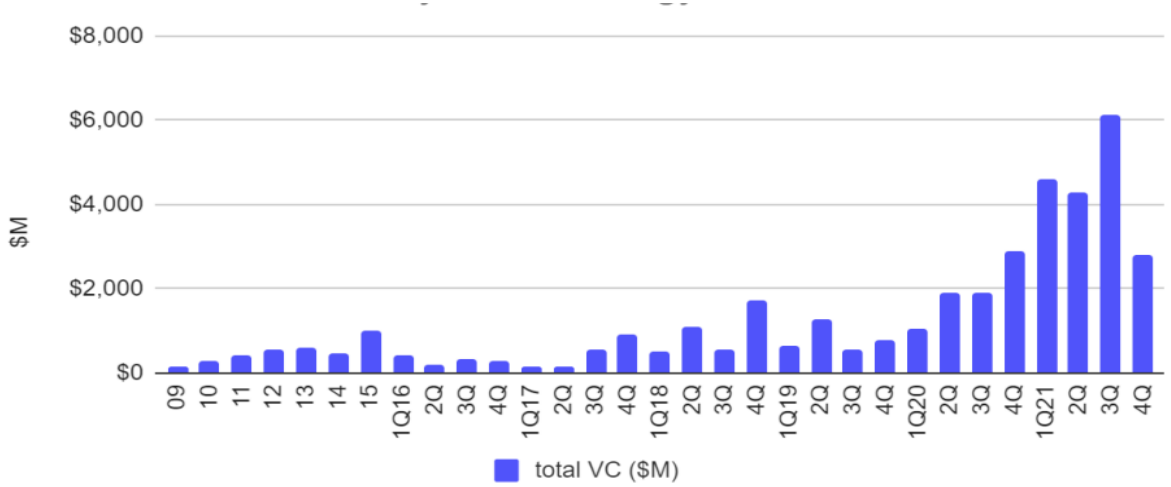
Food and agriculture: By 2030, reduce greenhouse gas emission by **50%** in the US and 30% globally

Supply chain: In 20 years, **> 30%** US chemical demand via sustainable and cost-effective biomanufacturing

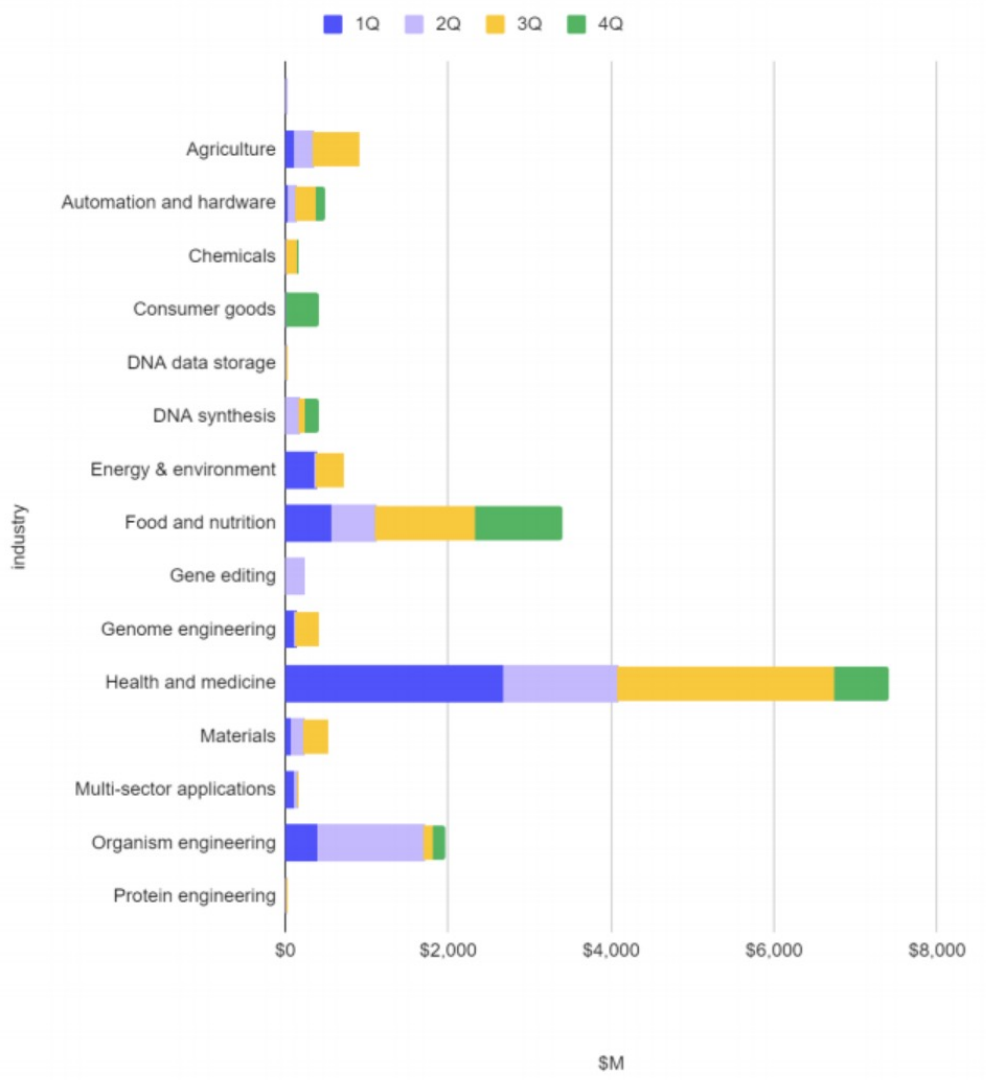
Health: in 20 years, reduce manufacturing cost of cell-based therapies **10 fold**

Cross-cutting advantages: in 5 years, sequence the genomes of **1 million microbial species** and understand the functions of **> 80%** newly discovered genes

Synbio has attracted increasing VC investments

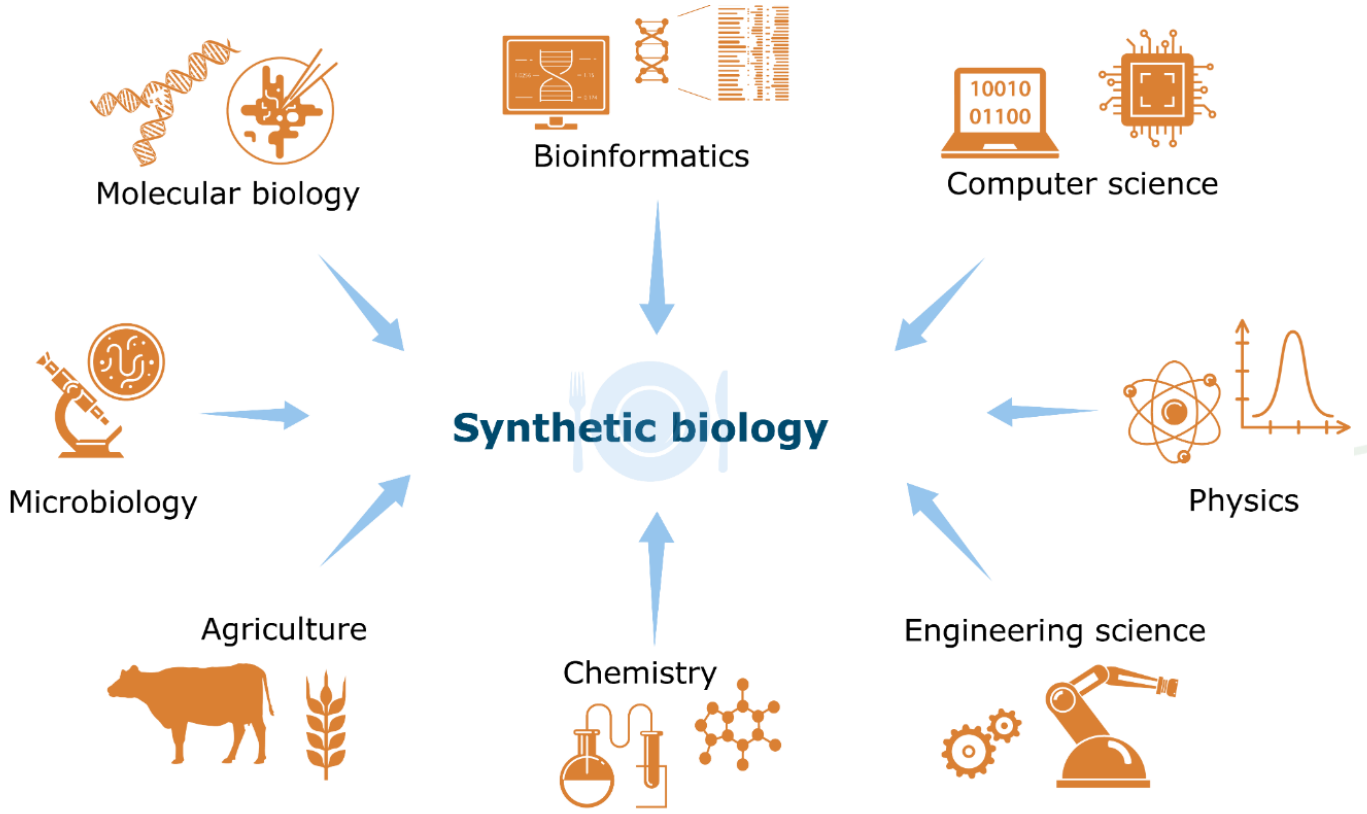


Overall investment in synthetic biology

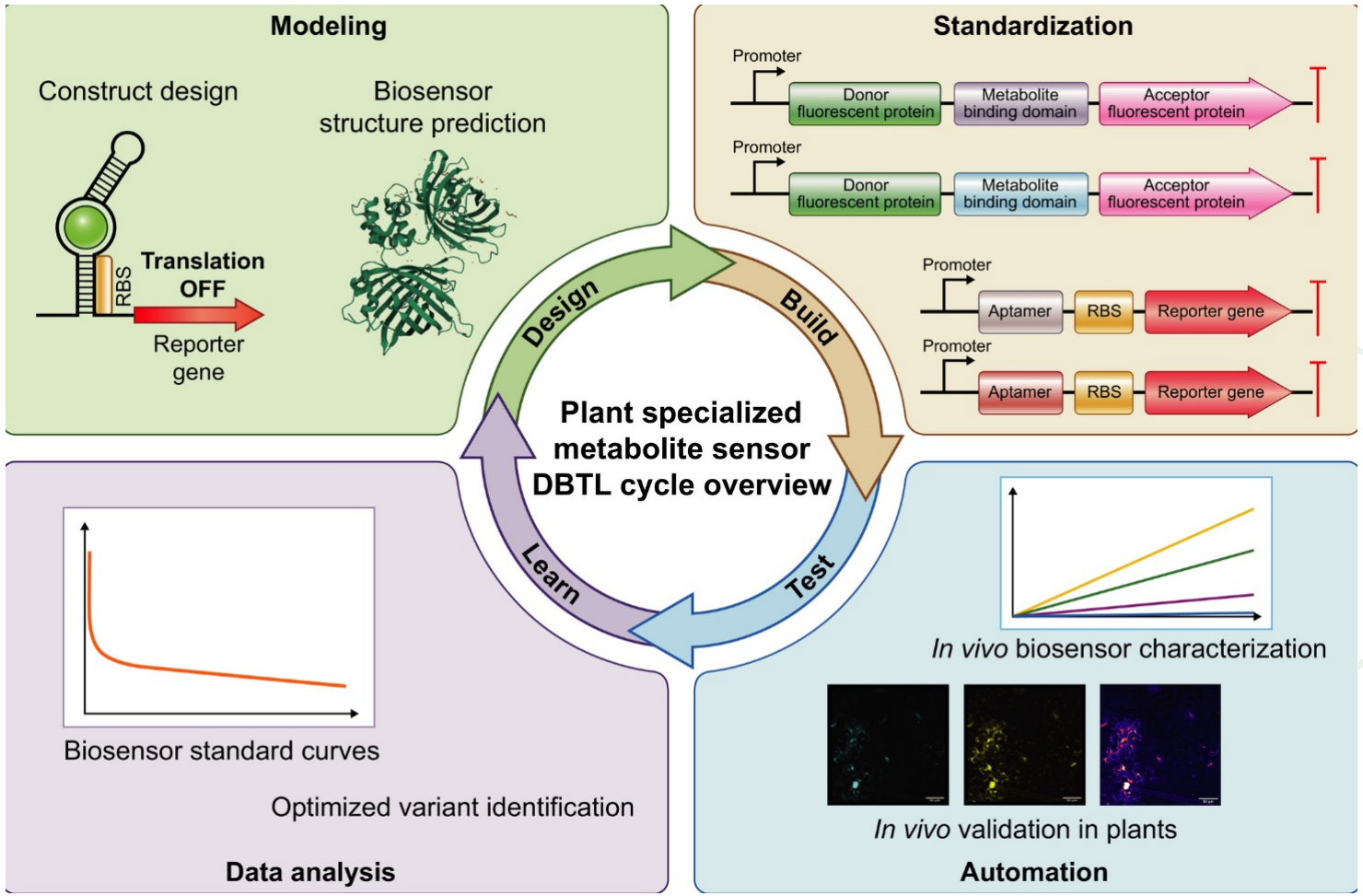


Synthetic biology investments in different sectors in 2021

Synthetic Biology has come of age due to advance in informatics



Design > Build > Test > Learn reiteration cycle



The biological system can be seen as consisting of two parts: “hardware” and “software”

Synbio has many startups in the West

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Food and Agriculture

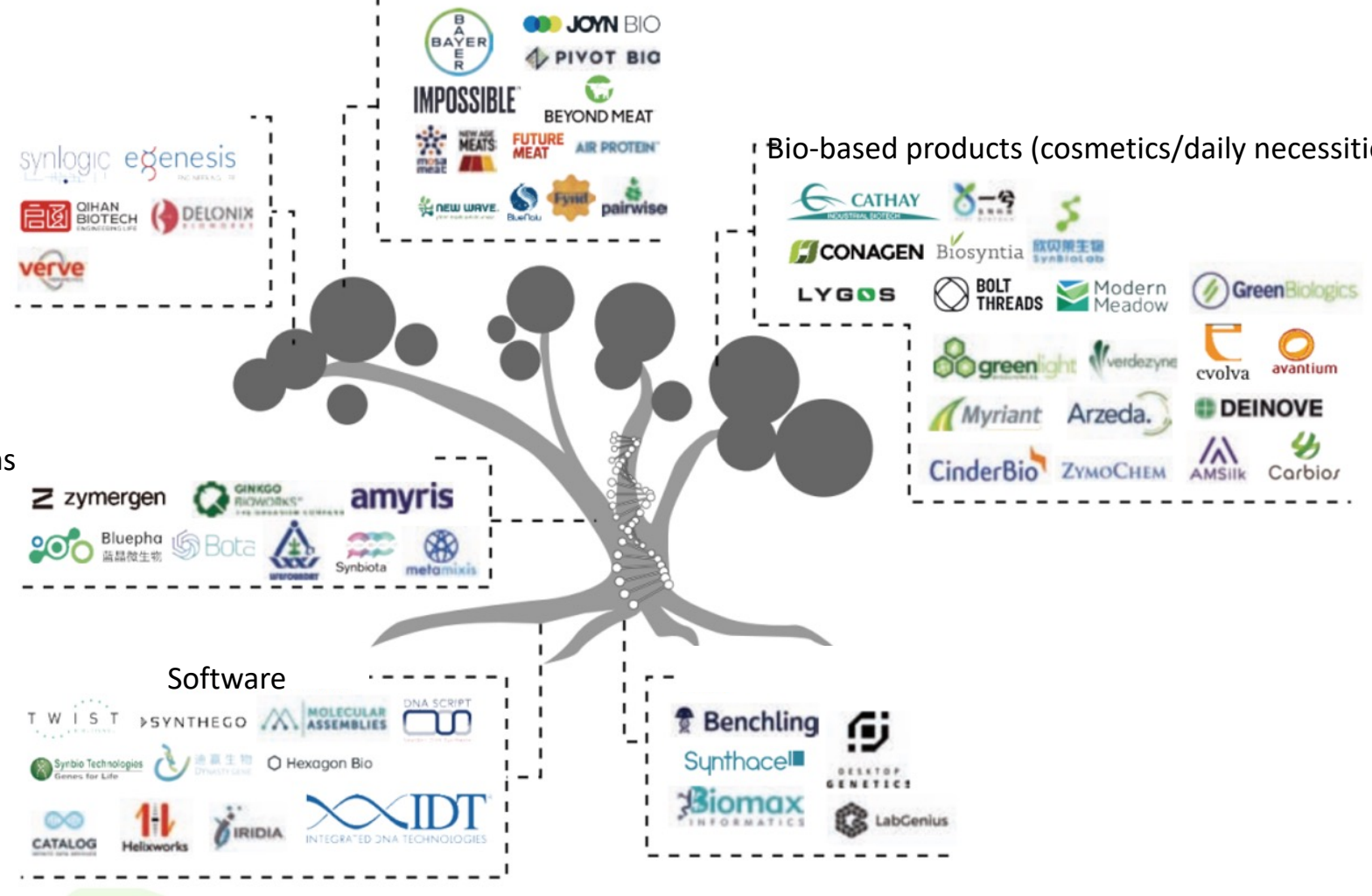
Health and Wellness

Bio-based products (cosmetics/daily necessities)

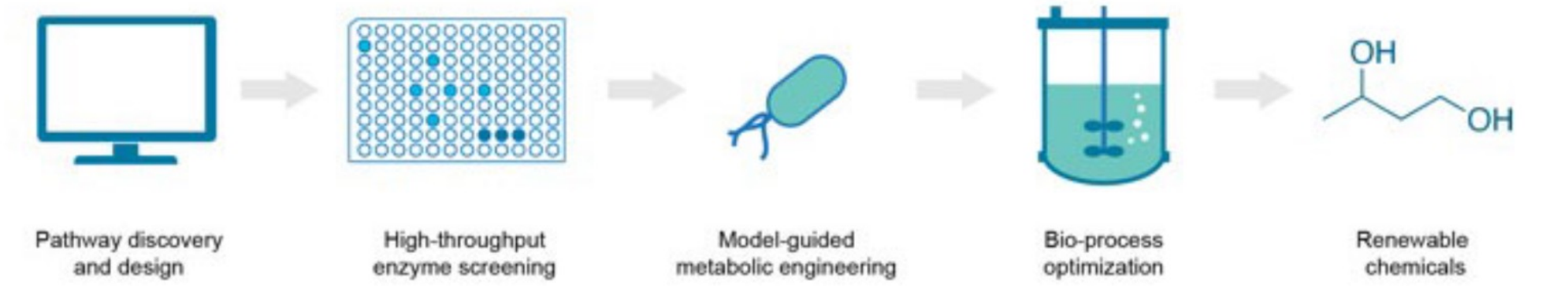
Synthetic Biological Platforms

DNA, RNA synthesis

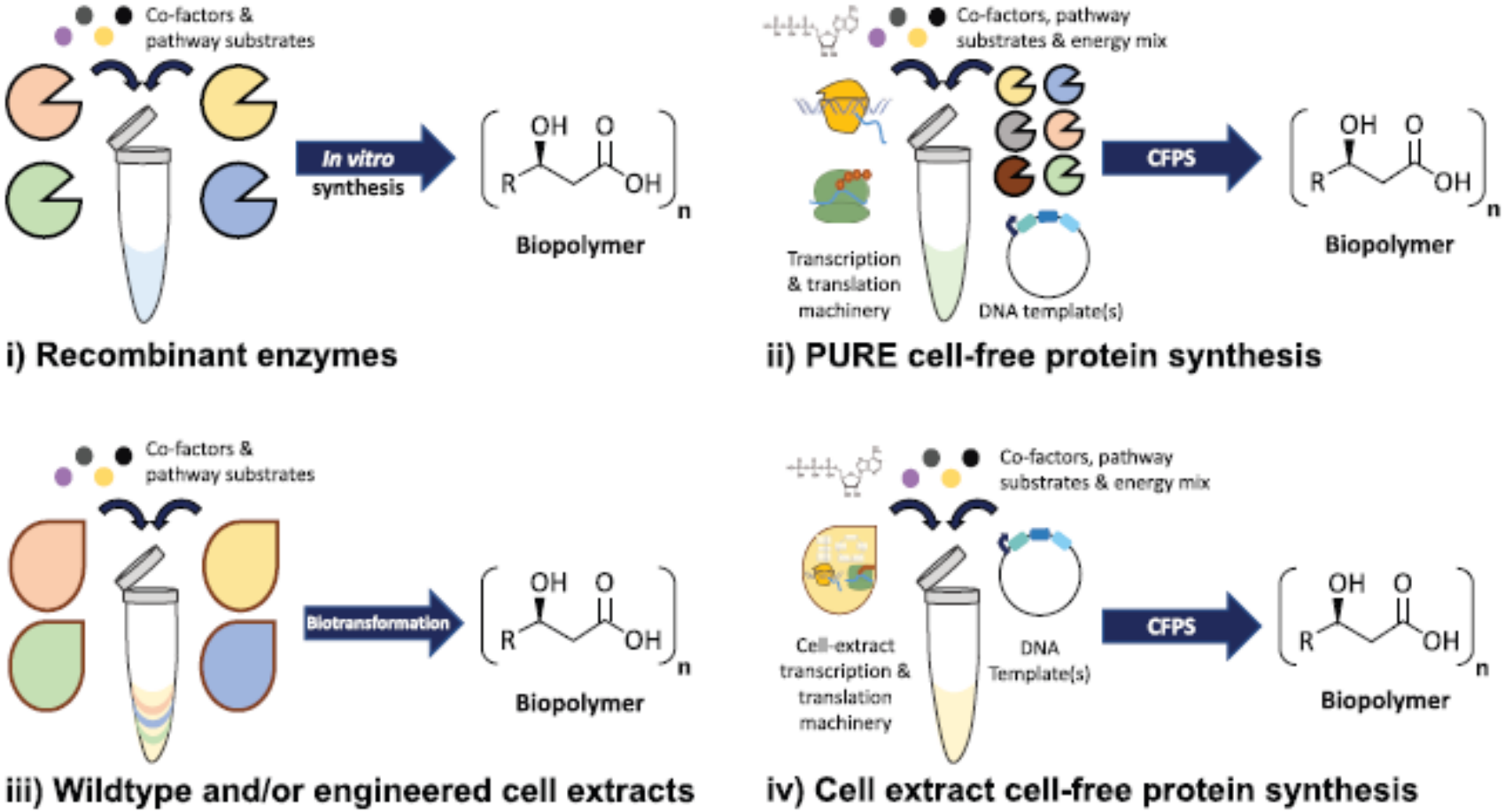
Software



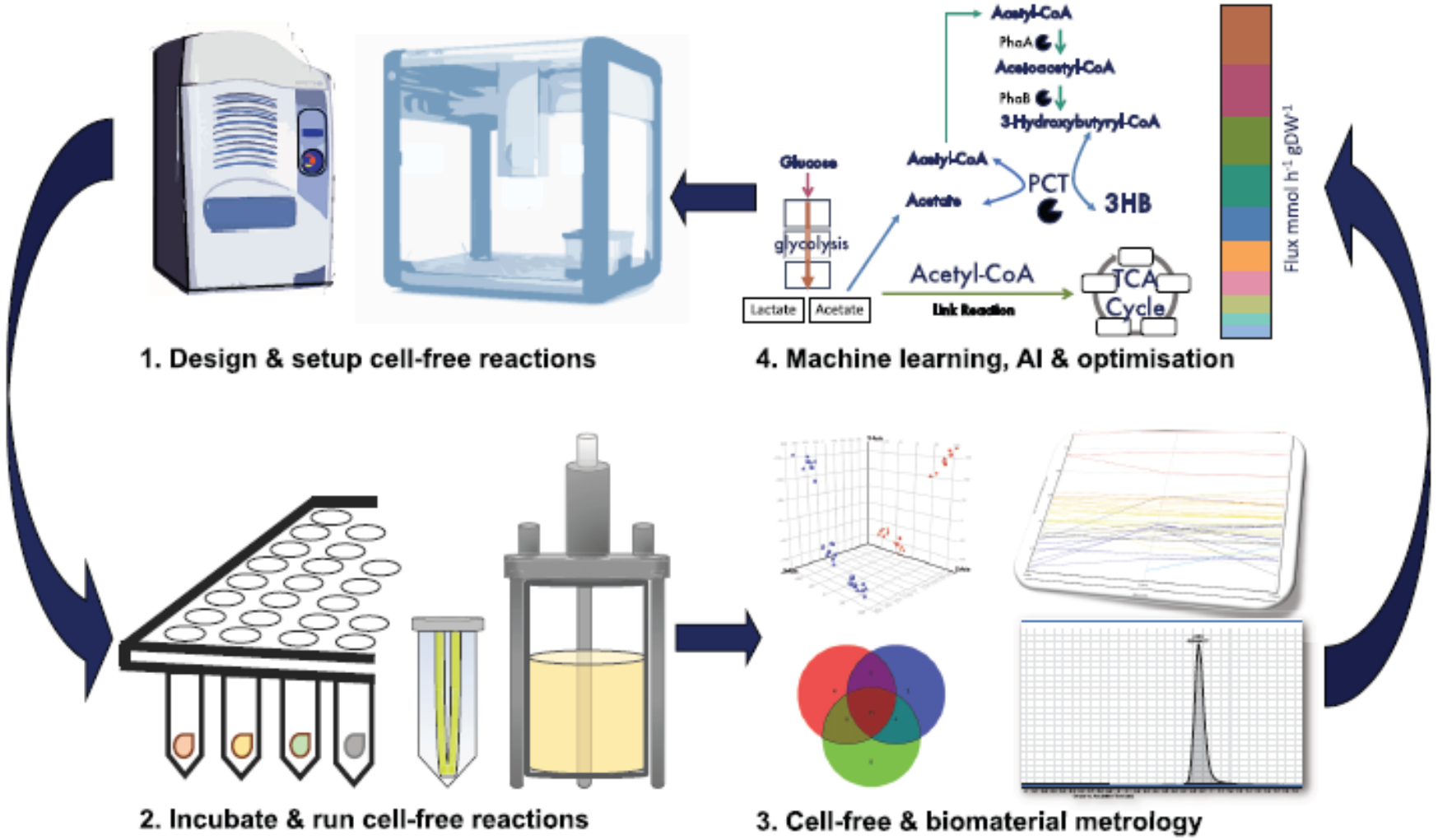
Traditional fermentation process



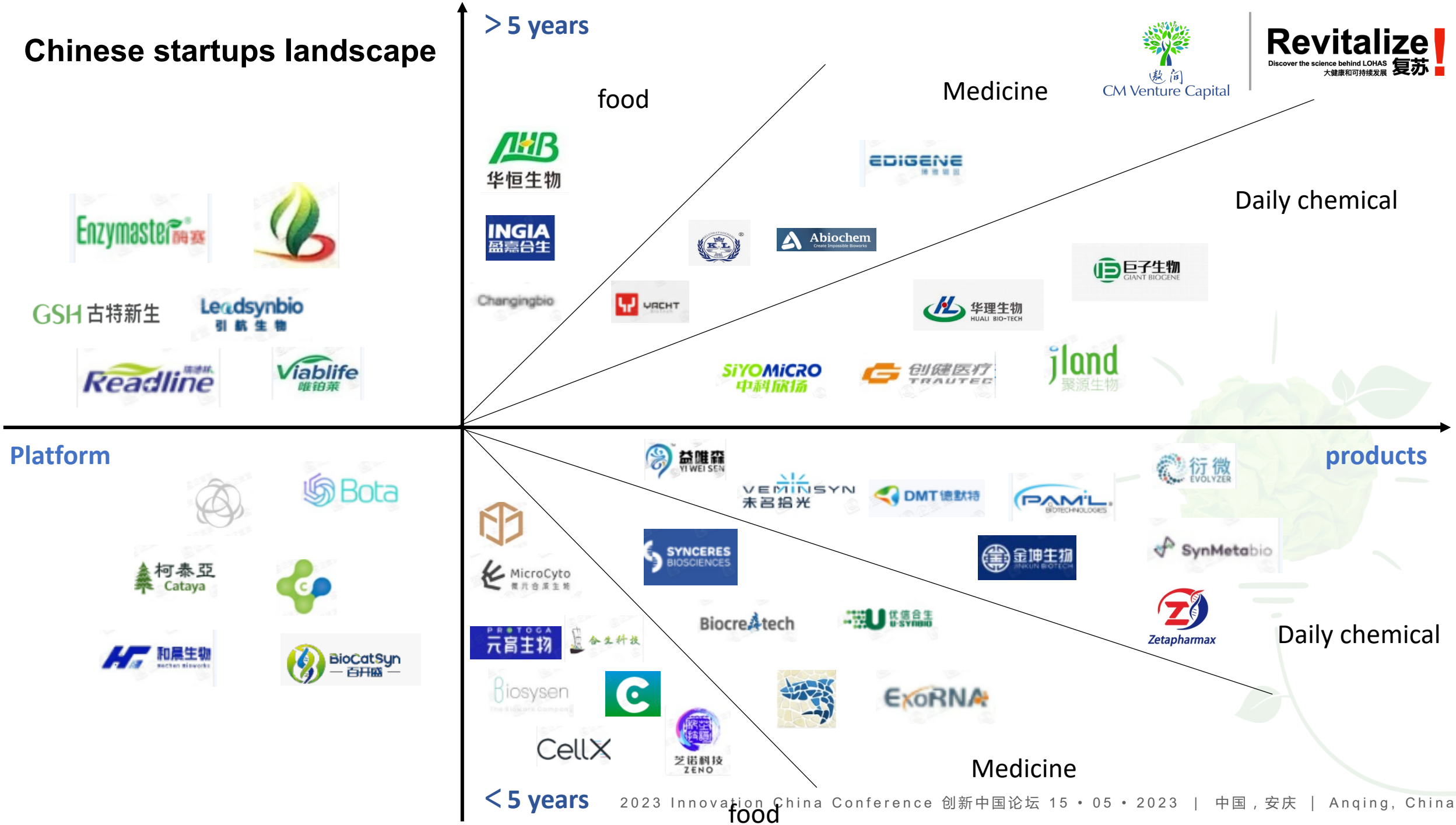
The next frontier: cell-free



The same Design > Build > Test > Learn reiteration cycle



Chinese startups landscape



Chinese start-ups landscape

> $500M market product

Cell-free

Full-cell

< $500M market product

CM Investment Strategies

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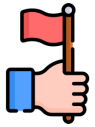
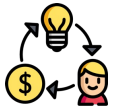
1 INFLECTION POINT 

2 TAKE SIGNIFICANT POSITIONS 

3 LEADERS & DISRUPTORS 

 OPEN ENTREPRENEURSHIP 4

 CAPITAL EFFICIENCY 5

 WORLD VIEW 6