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IBISBA - A Systems-oriented Research Infrastructure in Industrial Biotechnology

Michael O'Donohue

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ESCAPE - S3-o6: INDUSTRIAL BIOTECHNOLOGY (II)

IBISBA

A Systems-oriented Research Infrastructure in Industrial Biotechnology

Michael O'DONOHUE, Division Leader, INRAE and Acting
Director General IBISBA



**Funded by
the European Union**

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Industrial Biotechnology

State of Play

- Bioprocesses are widely used for the production of a variety of molecules
 - pharmaceuticals, foods and beverages, food ingredients and supplements, nutraceuticals, perfumes, monomers, solvents, and biofuels etc (Nielsen et al. <https://doi.org/10.1016/j.tibtech.2022.03.007>)
- As an underpinning technology the value of industrial biotechnology is quite hard to estimate
 - €4.32 billion (UK revenue in 2017) (Developing a Strategy for Industrial Biotechnology and Bioenergy in the UK, 2017)
 - EU28 GDP contribution of industrial biotechnology was €34.5 bn in 2018
 - Biotechnology represents approx. 930 K jobs (direct and indirect), with 223 K direct employment



Data source - Measuring the Economic Footprint of the Biotechnology Industry in Europe, Haaf and co-authors, 2020)

IB State of Play

- In the USA, the Bioscience Industry **directly** employed over 2M people in 2021 and had a total impact of over 10 million jobs and **\$3 trillion** of economic output
- September 2022, the White House announced strong measures in favour of biotechnology and biomanufacturing

Data source - TEconomy/BIO The U.S. Bioscience Industry: Fostering Innovation and Driving America's Economy Forward 2022



Data source - IBISBA policy note - <https://bit.ly/4z2mR781>

IB State of Play

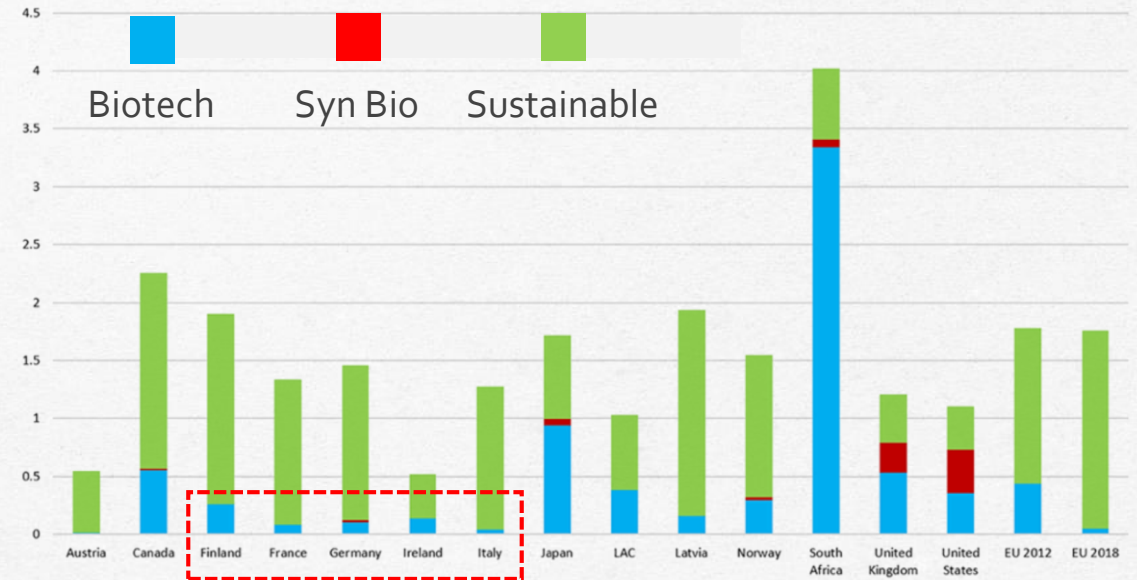
- **Biotechnology and biomanufacturing** are undergoing strong development **outside of the European Union**



- **BioMADE receives \$450M** budget increase from The Department of Defense, March 2023
- In the previous **decade China spent at least €65 million** on basic research in synthetic biology alone.
- China's 14th **Five-Year Plan for Bioeconomy Development'** (2021–2025) identifies biotechnology as one of the three empowering pathways*

* Zhang et al, 2022 Eng Biol. doi: [10.1049/enb2.12026](https://doi.org/10.1049/enb2.12026)

Occurrences of terms in national bioeconomy strategies



Bell et al. (2021) doi:10.1049/enb2.12008

Simultaneously, there is a danger that **biotechnology** is losing ground **in the European Union**

Intrinsic Challenges for IB Development

- Industrial chemistry
 - Physical phenomena
 - Chemical phenomena
- Industrial biotechnology
 - Physical phenomena
 - Chemical phenomena
 - Biological phenomena – genetic adaptation, metabolic plasticity

\$4.7 trillion (global)

Data source - <https://www.statista.com/statistics/302081/revenue-of-global-chemical-industry/>

\$0.3 trillion (global)

Data source - Martin, DK et al (2021) A brief overview of global biotechnology, Biotechnology & Biotechnological Equipment, 35:sup1, S5-S14, DOI:10.1080/13102818.2021.1878933

Some IB challenges

- Compared to petrochemical processes, bioprocesses display fundamental differences in economies of scale ^{*}
 - larger capital investments for the same production capacity
 - lower financial returns
- R&D efforts are too long and too costly
 - Much focus on the biocatalyst
 - Insufficient focus on intensification of bioprocesses
 - Insufficient focus on DSP
- Scale up is hazardous
 - Discover problems too late
 - Insufficient flow of knowledge from bioengineers to chemical engineers

Example of 1,4 BDO

Company (production site)	Capacity Ktonnes/year	Route
Novamont (Novara, Italy) ¹	30	Biological (succinic acid)
BioAmber (Ontario, Canada) ¹	22	Biological (succinic acid)
Dongjing Bioenvironmental Technology Ltd (Wuhai City, China)	280 (380 projected)	Chemical (alkyne aldehyde)

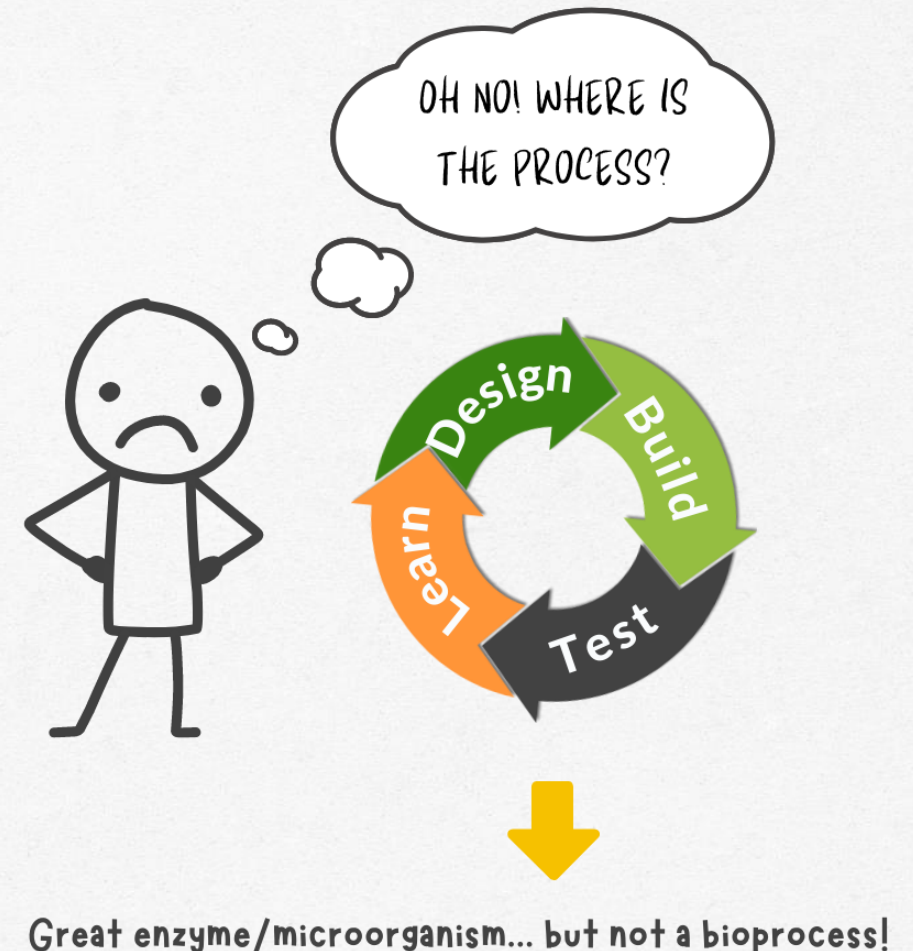
1 - Kumar et al. Crit Rev Biotechnol 2023 <https://doi.org/10.1080/07388551.2023.2176740>

2 - <https://www.echemi.com/cms/830231.html>

** Hennigan J, et al. A Technoeconomic Evaluation of the Potential of Industrial Biotechnology for the Competitive Production of Commodity and Bulk Chemicals. ChemRxiv*

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Opportunities for Industrial Biotechnology



More than 50 countries have adopted bioeconomy strategies



The circular bioeconomy is an integral part of Europe's Green Deal



Industrial Biotechnology is to the circular bioeconomy what industrial chemistry has been to the petroeconomy



Biomanufacturing can revolutionise the way we produce and consume

Opportunities for Industrial Biotechnology

- The **digital revolution**
 - Modelling, big data, AI, ML, digital twins
- **Creativity** is required to leverage the combined power of nature and emerging technologies



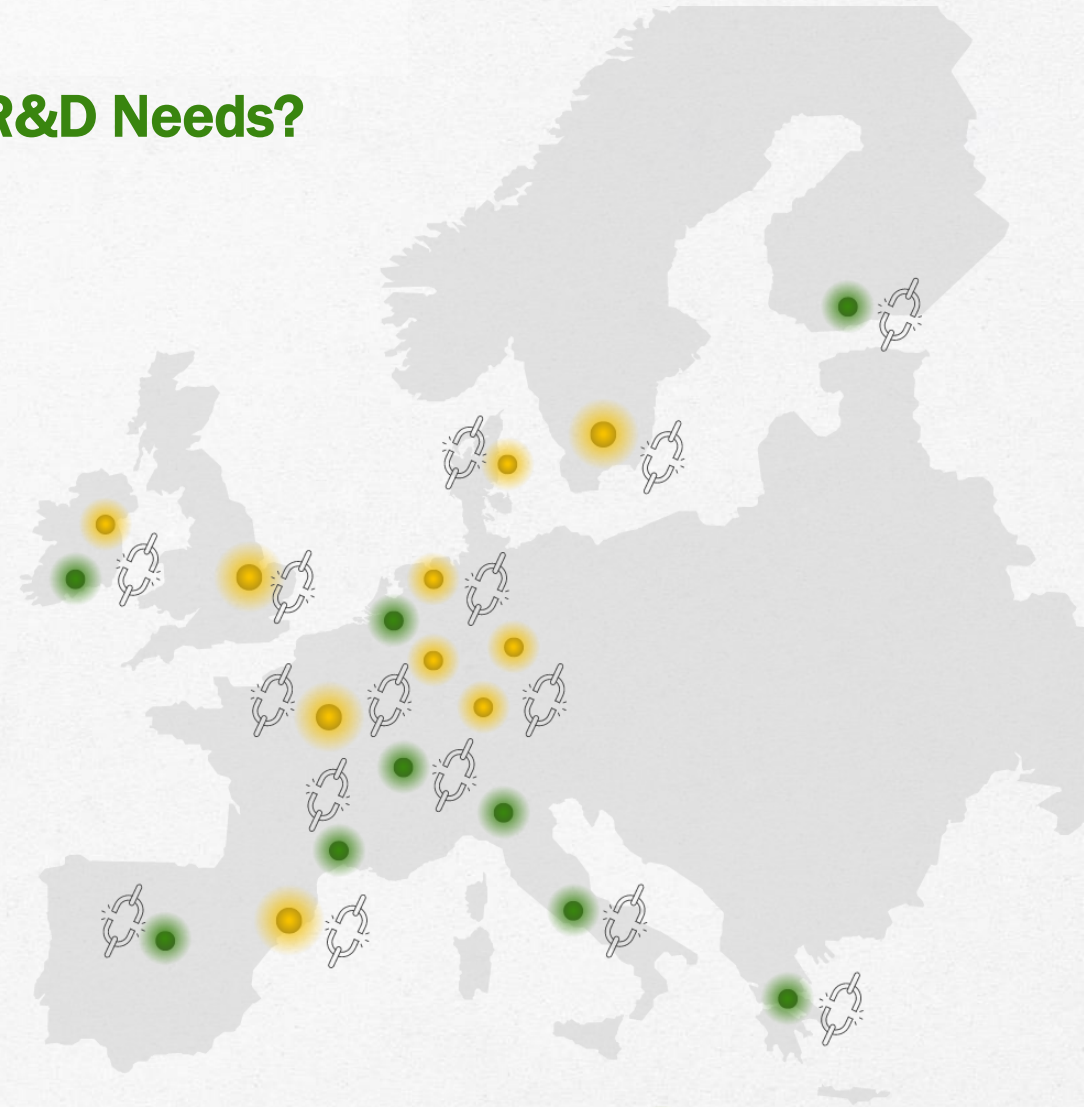
Photo by an unknown author. [CCBY-NC](#) license

“... I think the biggest innovations of the twenty-first century will be the intersection of biology and technology. A new era is beginning”
(Steve Jobs, 2011)

IBISBA

A Creative Response to IB R&D Needs?

- Europe's **public R&D** efforts are:
 - Numerous
 - Extremely diverse and rich
 - Scattered across the continent, with several hotspots
- **Research infrastructures** are:
 - largely reserved for national communities
 - duplicated
 - sometimes under-used
 - disconnected
- The mobilisation of **comprehensive support for ambitious R&D** projects encounters numerous obstacles:
 - Overcome to some extent in EC-funded projects



Hotspots identified by Le Deu, F. and Santos da Silva, J. (McKinsey report), August 23, 2019

IBISBA

A Creative Response to IB R&D Needs?

We envision a world where Europe's industrial biotechnology sector drives the global circular bioeconomy transition

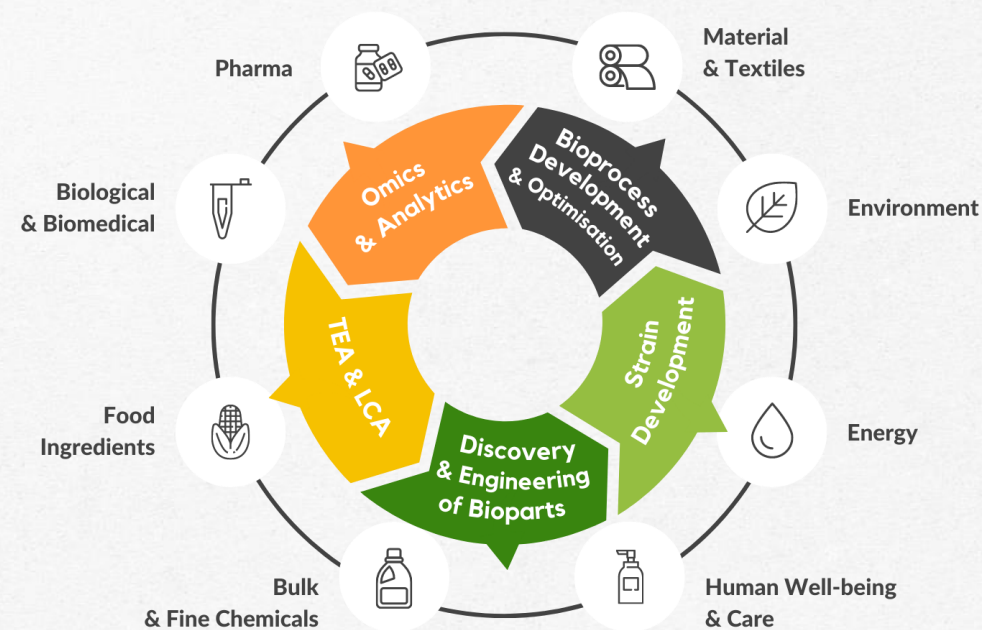
- IBISBA is:
 - a distributed **European research infrastructure**
 - a **business alliance** involving Universities, RTOs and other partners in different countries
- A **future non-profit legal entity**
 - coordinates the alliance and provides a permanent **governance framework** for collaboration
 - provides **shared tools** and promotes best business standards (creates **interoperability**)
 - confers the community with a unique ability to engage in common **strategic planning**



IBISBA's Strategy

- Federate experts and research infrastructure across Europe
 - Create a permanent **interdisciplinary community** - Bioengineers, Chemical engineers, Computer scientists
 - Nurture interoperability and promote knowledge sharing - A **repository for biotech knowledge assets** (<https://hub.ibisba.eu/>), data standards
 - Accelerate R&D and knowledge transfer - « At the beginning, keep the end in mind » (put P into DBTL)

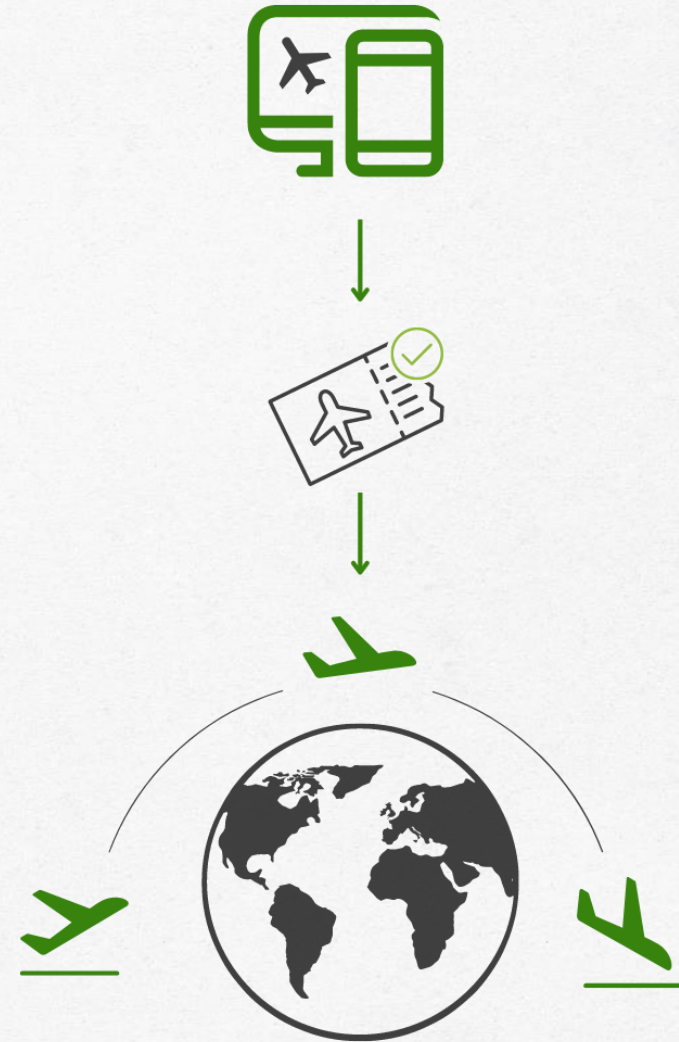
Provide **greater access** to European infrastructure capabilities offering a range of **interoperable R&D services**



IBISBA Service Families and Application Areas

IBISBA in a Nutshell

- A **single access point** for R&D services
- **Harmonised procedures** and business standard
- Like airline alliances, IBISBA **takes its users to their R&D destination**
- Permanent **cooperation** leading to strong, shared ambitions and **coordinated** investments



IBISBA Progress and Current Activities

- IBISBA is part of the ESFRI strategic roadmap for research infrastructure
 - It is progressing towards the creation of a legal entity (Horizon Europe project PREP-IBISBA)
- IBISBA already actively contributes to the European RI landscape



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canSERV
providing cutting edge
cancer research services
across europe

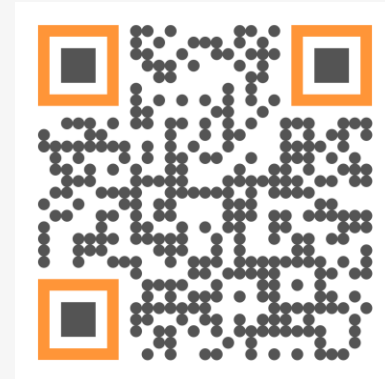




An IBISBA Coordinated Project



<https://www.linkedin.com/showcase/bioindustry4/>



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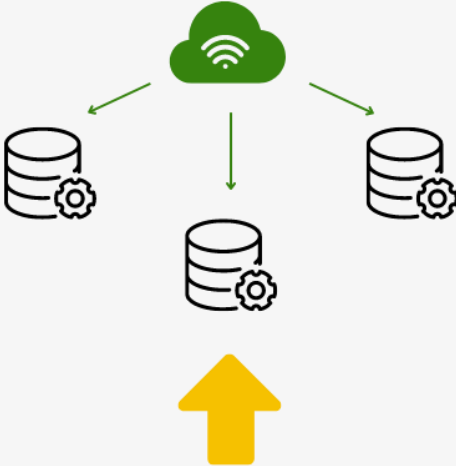
Devising Creative Solutions for Industrial Biotechnology

Imagine.....Alexa, design me an
automated bioprocess to make 100
tonnes of 1,4 BDO

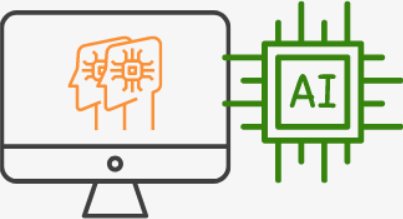


Expected Outcomes from BIOINDUSTRY 4.0

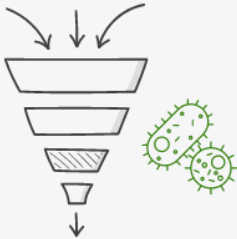
Trusted research network federated
AI-learning and data exchange



AI-driven enhanced digital twins for
bioprocess design and control



Use cases for data
provision and showcasing



Advanced DSS for
industrial exploitation
of microbial diversity

Metadata framework and data fabric for
bioprocess data quality, reuse and AI-learning

Advanced PAT devices
and data analytics

IBISBA – take home messages

- Biotechnology is on the verge of making a **difference** in manufacturing
- Europe has the ability to be competitive if it capitalizes on its assets – **no single Member State is equipped to go it alone**
- Europe can seize the opportunities of converging bio- and digital technologies only if it is able to propose **permanent, obstacle-free organizations to support R&D**

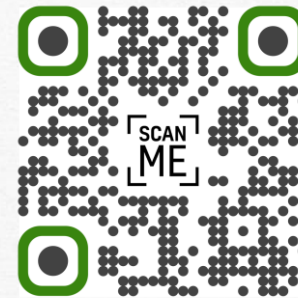
IBISBA does that and provides the basis to be ambitious and think BIG TOGETHER



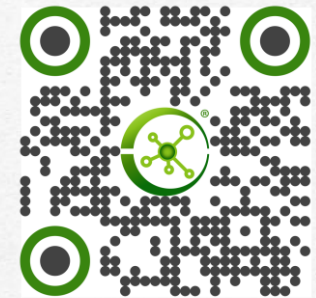
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