What is Industrial Biotechnology?

**Industrial Biotechnology** is a means to manufacture chemicals, pharmaceuticals, consumer products, polymers, fuels and numerous other materials, using innovative manufacturing processes and sustainable raw materials with a reduced carbon footprint.

BBSRC defines Industrial Biotechnology (IB) as ‘a set of cross-disciplinary technologies that use biological resources for producing and processing materials and chemicals for non-food applications. These resources can be derived from the tissues, enzymes and genes of plants, algae, marine life, fungi and micro-organisms.’

https://bbsrc.ukri.org/funding/grants/priorities/ibb-industrial-biotechnology/

IB is delivering new products, new functionalities in existing products, and new markets as a whole new industry sector.

Why Scotland?

Scotland’s size permits strong integration and effective collaboration between industry, academia and government.

Why Scotland? #1

Scotland CANDO Action Framework.

Network of Innovation Centres.

Scottish Government Strategies are a strategic fit for IB:

Scotland has a highly skilled workforce with strong academic capabilities based on existing industry in chemical manufacturing, engineering, biomedical technologies and refining which are highly transferrable to the bioeconomy.

Scotland has established IB active companies of all sizes engaging with the manufacturing industry and pursuing aggressive growth.

The University of Edinburgh hosts the Edinburgh Genome Foundry – a fully automated facility for the construction of engineered strains which can be used for a multitude of applications.

The University of Glasgow houses the Glasgow Polyomics facility, a world-leading facility designed to address the complex intracellular analytics of bioprocesses.

The University of St Andrews owns Guardbridge, which houses SME biotechnology companies and provides low carbon electricity, heat and cooling along with access to biomass handling facilities.

Scotland has a long history in biotechnology from fermentation of yeast and distillation of alcohol by the whisky industry to pharmaceutical manufacturing using microorganisms.

GSK manufacture their largest global product (by volume) using a fermentation process at their site at Irvine Bay.

Current expertise ranges from utilisation of biomass feedstocks and organic waste co-product materials for production of valuable materials to the engineering of microorganisms for the production of high value chemicals.

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Scotland has significant strength in synthetic biology, with both world leading academics and a growing ambitious company base.

Next generation molecular genetic engineering for the biotechnological production of:
- pharmaceuticals
- high-value chemicals
- materials
- novel therapeutic treatments
- solutions to address global sustainability and societal challenges.

Scotland’s world leading development and implementation of renewable energy means that the country has the potential to produce more energy than it needs. Biotechnology can provide a sustainable use for that additional energy.

Local companies are using Scotland’s academic base in chemistry, process engineering and biology to develop technologies for more efficient use of resources to create valuable products through biorefining of materials from biomass or through conversion of the carbohydrate fraction of biomass and other feedstocks to generate high value products.
### #4 Scotland’s unique natural resources.

#### Macro and Micro Algae
1. Globally, macroalgae (seaweed) and microalgae are a potential feedstock for a bio-based economy.
2. Potential uses include:
   - Production of nutraceuticals and pharmaceuticals
   - Sewage and waste water treatment
   - Synthetic fuel
3. Metabolic engineering (using microalgae as a vessel for producing novel products) is expected to be particularly important in pharmaceutical and chemical advances in the future.
4. Scotland has the most abundant source of macro algae in the UK, one of the most available sources worldwide, and has a long history of harvesting and utilising commercially.

#### Industrial, agricultural and municipal waste
1. Annually, Scotland produces 27 million tonnes of bioresources arising from:
   - Wastes
   - By-products
   - Agricultural residues
   - 3 million tonnes of by-product from brewing and distilling industry
2. Urban:
   - Concentration of economic activity
   - Food and Drink sector - well positioned to realise the economic benefits of biorefining - creating a new Circular Economy

### #5 Scotland’s Existing Infrastructure.

#### Forestry
1. Scotland contains:
   - Half of the UK forests
   - Two thirds of the softwood population
   - One fifth of the hardwood population
2. Timber value chain co-products and residues represent a significant resource for biorefinery feedstock
3. Tree stumps, brush and thinnings could become a valuable feedstock if they can be effectively extracted.

#### Grangemouth
Grangemouth is the largest chemical manufacturing site and crude oil refinery in Scotland.

#### Guardbridge
Guardbridge, owned by the University of St Andrews, provides low carbon electricity, heat and cooling along with access to biomass material handling facilities for SME biotechnology companies.

#### Irvine Bay
Irvine Bay in North Ayrshire is home to many global companies including EDF, UPM Caledonian, GSK and DSM. The local UPM Caledonian paper mill uses wood largely from local Scottish forestry with potential to share existing infrastructure.
Phase I
Achievements:

£10M Core grant leveraged into:

£27.4M Direct activity

£23.4M Indirect activity

£100.8M Sector growth

170 New jobs

Phase I Network:

<table>
<thead>
<tr>
<th>Industry Members</th>
<th>Scottish Partner Universities and Research Institutes plus N8 partner universities</th>
<th>HND, MSc and PhD courses</th>
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</thead>
<tbody>
<tr>
<td>114</td>
<td>18</td>
<td>+</td>
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Membership Composition:

<table>
<thead>
<tr>
<th>ORGANISATION</th>
<th>LOCATION</th>
</tr>
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<tbody>
<tr>
<td>33% Micro</td>
<td>41% UK</td>
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<tr>
<td>32% SME</td>
<td>40% Scotland</td>
</tr>
<tr>
<td>28% Large</td>
<td>11% EU</td>
</tr>
<tr>
<td>7% Other</td>
<td>8% Other</td>
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</table>

Member organisations have access to the following benefits:

- IBioIC’s Technical Network, which connects members with specialist individuals whose expertise covers the vast space of industrial biotechnology.
- Access to a network of companies and events from micro to multinational to aid in potential new market opportunities for IB.
- Skills Programme, which operates from HND – PhD level, providing access to CPD opportunities and a pipeline of trained industrial biotechnologists.
- Project funding to support projects that bring industrial biotechnology closer to commercialisation.
- Use of two open access equipment centres for the provision of scale up of industrial processes.
Learning from Phase I:

**INDUSTRIAL ENGAGEMENT: ACHIEVEMENTS**

- Over 100 paying Industrial members
- Networking opportunities with over 160 events
- Raised global awareness of IB opportunities in Scotland
- Annual conference with over 450 attendees
- Government policies to support IB
- Broader investment opportunities
- Broader supply chain involvement
- Inward investment opportunities
- Greater support and nurturing of home grown start-ups
- Broader engagement with supportive technologies (Syn Bio, automation, AI, Big Data etc.)
- Horizon scanning for new opportunities

**PROJECTS: ACHIEVEMENTS**

- 48 Industry led projects in Scottish universities
- 2 equipment centres built and operational
- Technical network established with access to 22 experts in IB
- >£10m of additional funding secured
- IB National Plan gives focus to activities and targets to aim at
- Strong support given to IB companies in developmental stages of their growth
- >£10m of additional funding secured
- Strong partnership with full suite of business support facilities

**PROJECTS: NEXT STEPS**

- Greater economic impact
- Broader TRL scope in projects
- Greater support for companies directly to de-risk IB adoption
- Demonstration scale facilities
- Industry access to (underused) facilities that are not IBioIC but which directly support IB advancement and implementation
- Facilities tailored to build on Scotland’s unique IB strengths
- Direct involvement in multi-national projects that support Scottish IB
- Better use of existing capabilities

**SKILLS: ACHIEVEMENTS**

- >52 PhD Studentships awarded at decreasing cost to IBioIC
- Collaborative MSc in IB with >94 students trained over 4 cohorts
- Established HND in IB with initial cohort of 15 students
- £100.8m growth in IB industry
- 170 additional people employed in IB since starting

**SKILLS: NEXT STEPS**

- Greater awareness of IB as a career opportunity
- CPD opportunities for industry
- Learning from Phase I
- PHASE II SUMMARY
The plan for Phase II:

Key Additional Activities:

- Leverage IB awareness to drive adoption and implementation.
- Easier access to direct funding.
- Promote advancement of policies to support commercialisation of IB.
- Access to facilities to de-risk scale-up and demonstration.
- Expand community into new value chains.

Project Activities:

**Phase I:**

- TRL 3 - 5

**Phase II:**

- TRL 3 - 8

Proposed Development Facilities:

- Marine Bioprocessing Centre.
- Engineering Biology Innovation Centre.
- Industrial Biotechnology Demonstration Centre.
5 key themes:
IBioIC Phase II Themes
Existing and Extended Services

Providing Strategic Leadership

EXISTING SERVICES
- Lead and attend events, conferences, and workshops
- Promote Scotland on an international scale
- Raise awareness of Scotland’s IB activity
- Represent company members at European level through BIC SME cluster membership

EXTENDED SERVICES
- Advocate for industry to influence IB friendly Government policy
- Provide continued horizon scanning for new opportunities and emerging technologies that meet Scotland’s industrial and academic strengths
- Lead the development and delivery of the National Plan for IB with the SBIO
- Lead on IB partnership development/relationship management with SE/HE/Scottish Gov/UK Gov agencies, relating to the National Plan
- Develop and deliver an international strategy for IB, liaising with SDI as appropriate, including company targeting activity
- Lead all future IB propositions for indigenous and inward investment opportunities, liaising with SDI as appropriate
- Lead for IB in Scotland at International Events, Trade missions, and similar activities as needs emerge

Accelerating Commercialisation

EXISTING SERVICES
- Provide access and support to strain optimisation through the IBioIC Rapid Bioprocess Prototyping Centre
- Provide access and support to process development at the IBioIC Flexible Bioprocessing Centre
- Coordinate access to all UK facilities through BioPilotsUK

EXTENDED SERVICES
- Support marine biotechnology company development through access to scale-up facilities, primarily through the development of the Marine Bioprocessing Centre within the Highlands and Islands region
- Support the exploitation and development of synthetic biology strengths within Scotland
- Support the construction of bespoke demonstration plants to accelerate commercialisation

Developing New Value Chains

EXISTING SERVICES
- Increase the awareness of IB through the Network Integrator Project
- Expand IBioIC’s reach into new sectors
- Attend and participate in events outside the mainstream scope of IBioIC

EXTENDED SERVICES
- Design and manage awareness events for industry interested in engaging with the IB community
- Extend value chain activity and technology scope to develop complete value chains from feedstock to market application
- Connect to European and Global value chains and webs
- Extend coverage of the product life cycle to work at higher TRLs
- Identify potential start-up companies and support
- Provide support packages for FDI targets

Investing in Value Chains using Biotechnology

EXISTING SERVICES
- Provide project calls for industry/academic projects with funding secured and made available for the academic contribution
- Provision of mentoring and support for growing businesses
- Provide access to the IBioIC Technical Network ensuring the best expertise and advice for members

EXTENDED SERVICES
- Secure and provide funding support to industry to de-risk technology investment, commercialisation and adoption, TRL 5-8
- Catalyse the establishment of an IB incubator/accelerator to support new ventures and spin-out companies
- Enable the setting-up of an IB investment fund
- Become an expert in and champion for public sector support programmes
- Enable “proof of application” of new technologies/processes

Skilling the Necessary Workforce

EXISTING SERVICES
- Support and sponsor a collaborative MSc in IB
- Maintain an industry driven PhD programme
- Support an HND in IB through Scotland’s FE Colleges
- Contribute to STEM learning and provide school support for early adoption of IB

EXTENDED SERVICES
- Increase the technical and commercial capabilities of Scotland’s workforce by providing continued professional development (CPD)
- Develop a part-time option of the current MSc to allow greater uptake as part of CPD

Engagement Activities

NEXT
# Table of Engagement Activities

Table 6: Summary of Industry Engagement Activities

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<th>Activity</th>
<th>Year 18/19</th>
<th>Year 19/20</th>
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## Logic Model: IBioIC Phase II

Key milestones and KPIs
Key milestones and KPIs:

**Input:**
- **DIRECT FINANCIAL INPUT**
  - SFC: Scottish Enterprise
  - Highlands and Islands Enterprise
- **Academia**
- **INDIRECT FINANCIAL INPUT**
  - Innovate UK
  - BBSRC
  - H2020
- **EXPERTISE**
  - Technical
  - Financial/funding
  - Commercial
  - Operational
- **NETWORKS**
  - Industry
  - Academic
  - Public funders
- **FACILITIES**
  - Rapid Bioprocess Prototyping Centre
  - Flexible Downstream Bioprocessing Centre
  - Access to BioPilotsUK

**Activities:**
- **DEVELOPING VALUE CHAINS USING BIOTECHNOLOGY**
  - 78 Collaborative industry-led projects
  - 5 Core projects
  - 25 Fact-finding projects
  - 190 Technical Network projects
  - 35 Higher TRL support projects
  - 77 Signposts to other organisations and funding opportunities
  - £37.5m Challenge funds/UKRI funds and H2020 projects
- **SKILLING THE NECESSARY WORKFORCE**
  - 75 PhD students
  - 165 MSc students
  - 150 HND students
  - 35 Higher TRL support projects
- **ACCELERATING COMMERCIALISATION**
  - Access to BioPilots equipment centres
  - Coordinate access to BioPilotsUK
  - 210 Equipment Centre Projects
  - 3 Development facilities
  - Support company demonstration facilities
- **CROSS CUTTING ENGAGEMENT**
  - Grow industry membership
  - Further develop academic engagement
  - Effective Centre marketing
  - Establish BioPilots legal entity
  - Deliver National Plan for IB

**Outputs:**
- **CONNECTIONS**
  - 435 Unique enquiries to the Centre
  - 1500 Unique contacts initiated by the Centre
  - 1050 Industrial attendees at Centre events
  - 18 HEIs engaged
  - 4 Further Education Colleges engaged
- **FOLLOW-ON FROM COMPLETED PROJECTS**
  - 39 Signposted to SE/HIE
  - 32 Signposted to other public bodies
  - 11 Signposted to private investment
  - 20 New IC projects supported
  - 49 Projects not taken forward
  - 3 Taken forward to commercialisation
- **INDIVIDUALS GAINING QUALIFICATION**
  - 44 PhD graduates
  - 139 MSc graduates
  - 78 completed HND
- **NEW FACILITIES**
  - Marine Bioprocessing Centre
  - Engineering Biology Innovation Centre
  - Demonstration Centre
  - IB Incubator and Investment Hub
- **COMMERCIAL**
  - 250 Industry members
  - 100 Scottish companies actively involved in IB
  - 20 New spin out companies
  - 120 New products, processes, services, business models delivered to market
- **KNOWLEDGE AND SKILLS**
  - 93 HEI Research posts supported/created
- **WIDER BENEFITS**
  - Regional development
  - Reduced CO2 emissions
  - Societal benefits

**Outcomes:**
- **GVA SUPPORTED/CREATED**
  - £89m by 2021
  - £120m by 2023
  - £130m by 2025
- **JOBS SUPPORTED/CREATED**
  - 900+ by 2021
  - 1200+ by 2023
  - 1400+ by 2025
- **SCOTTISH COMPANIES ENGAGED IN IB**
  - 73+ by 2021
  - 100+ by 2023
  - 115+ by 2025