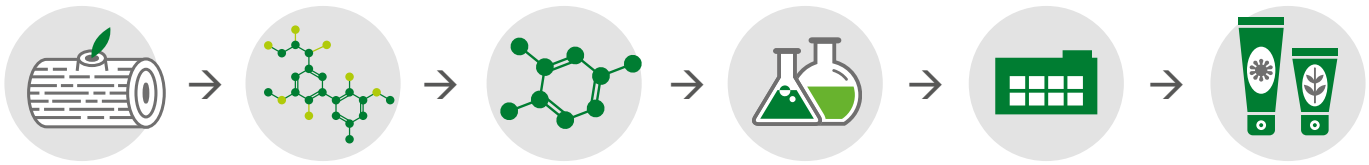
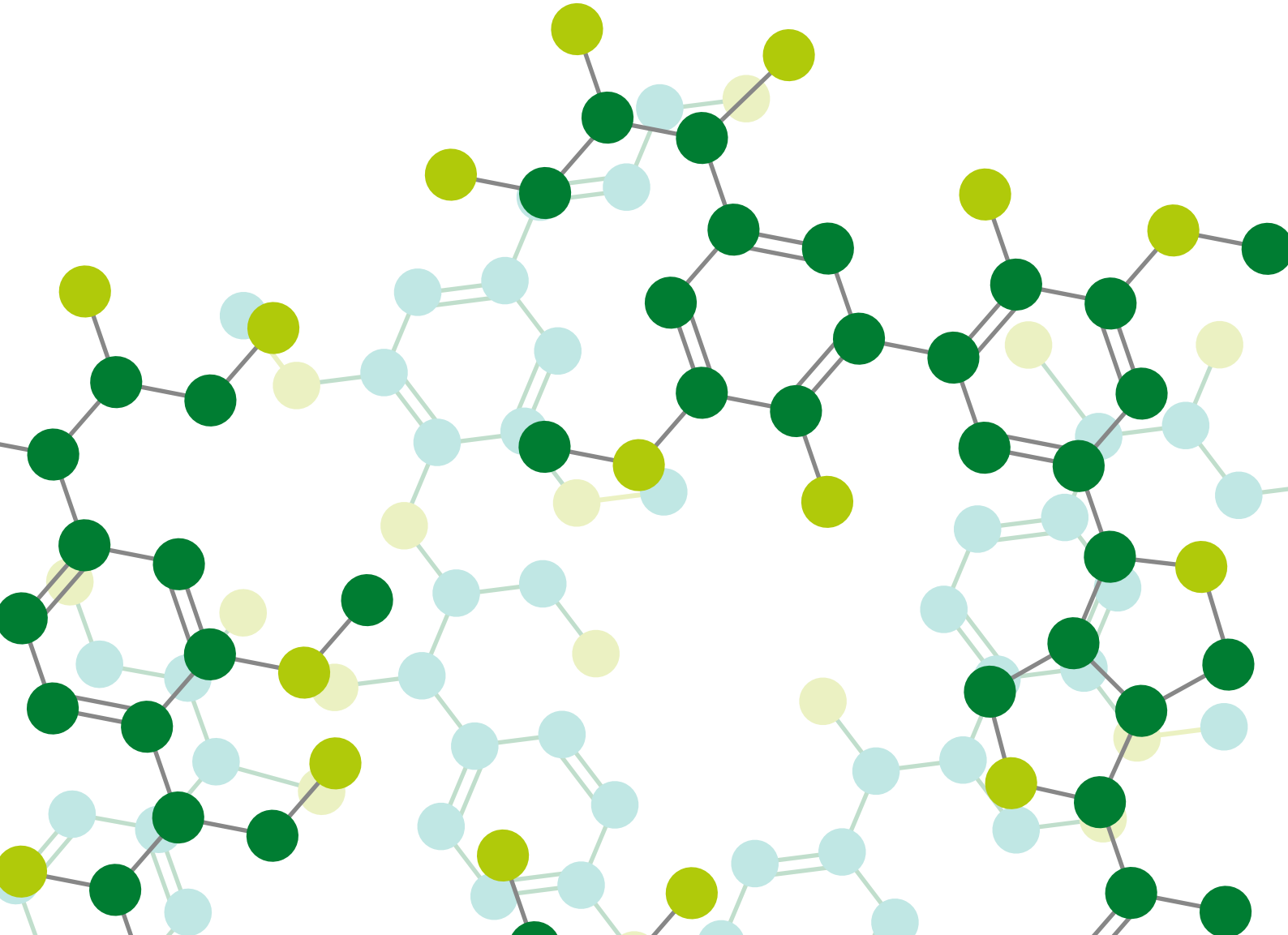
biome bioplastics

Biome Bioplastics
An Exploration of Lignin





Biome Bioplastics
An Exploration of Lignin

Biome Bioplastics is the UK's leading developer of intelligent, natural plastics. Our diverse product portfolio demonstrates the wide range of applications where bio-based, biodegradable alternatives can replace traditional oil-based plastics.

The Commercial Challenge

The main barriers to the widespread adoption of bioplastics are cost of production and performance. In recognition of these challenges, our commercial and development focus is on our existing high performance product ranges. These products give us access to markets where profit margins are greater and the higher cost of bioplastics is outweighed by demand for sustainability credentials and end-of-life performance.

In the longer term, it is our intention to produce bioplastics that can challenge the dominance of oil-based plastics, and ultimately replace them completely. In this ambition we recognise that our existing technology platform can take us only so far.

Research and Development

Responding to the challenges of cost and performance will enable Biome to accelerate the adoption of innovative, natural plastics across a range of markets. In order to achieve this, we need to undertake research and development activities that tackle the intrinsic synthesis of bioplastics that currently keeps costs high and limits performance.

One such area of focus is the oil-based chemicals that are widely used in the manufacture of bioplastics to convey properties including mechanical strength, tear resistance and durability. These high performance chemicals contain aromatic rings and therefore can currently only be sourced from oil. The range of these chemicals that is suitable for bioplastics is limited and expensive. Deriving aromatic chemicals from a plentiful, natural source could significantly reduce costs, expand functionality and increase performance.

Aromatic chemicals in plastics

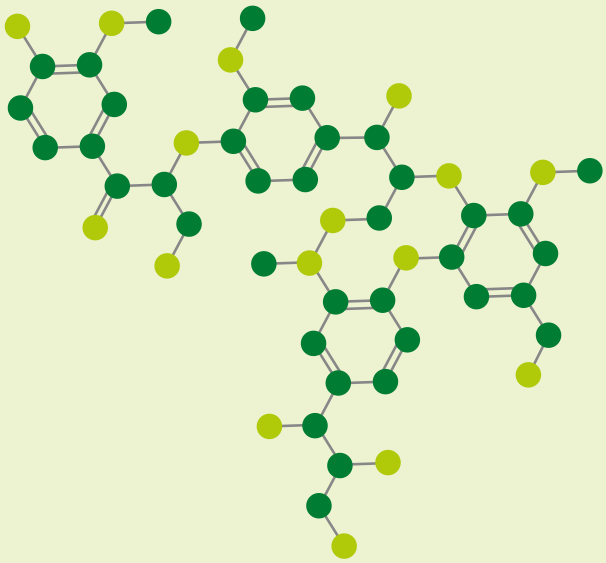
Aromatic compounds play key roles in the biochemistry of all living things. An aromatic hydrocarbon has alternating double and single bonds between carbon atoms, forming rings. Chemicals containing these rings are inherently more stable.

In the manufacture of bioplastics, aromatic chemicals are added to convey functionality including strength, flexibility and temperature resistance. Currently, these aromatic chemicals can only be sourced from oil, limiting the range of possible functions and increasing the cost of manufacture.

What is lignin?

Lignin is a naturally occurring complex hydrocarbon. It is what makes plants 'woody', and is vital in providing structural support and protection against environmental stresses. Lignin differs from the hydrocarbons derived from sugars, starches and cellulose as it contains aromatic rings rather than long molecular chains.

After cellulose, lignin is the most abundant renewable carbon source that is readily available, with substitution potential that may extend to many products currently sourced from petrochemical substances. Lignin is a natural branched and crosslinked network polymer that lends itself to use in materials.



Lignin

One of the most likely sources of bio-based aromatic chemicals is lignin, the naturally occurring complex hydrocarbon that helps to provide structural support in plants and makes them 'woody'. Lignin is available as a waste product of the pulp and paper industry, providing an abundant feedstock. If lignin can be broken down under the right controlled conditions, and the resultant chemicals can be extracted at scale, the process could provide the foundation for a new generation of bioplastics.

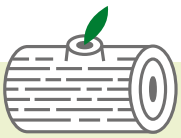
To explore this concept, Biome Bioplastics has partnered with the University of Warwick's Centre for Biotechnology and Biorefining that is pioneering academic research into lignin-degrading bacteria. Led by Professor Tim Bugg, the group has already identified novel lignin-degrading bacteria and their enzymes, and studied the breakdown process these follow. In these pathways, Biome has identified the presence of aromatic feedstock chemicals that would be suitable for bioplastic production. Biome Bioplastics is now working with the Warwick team to develop methods to control the breakdown process to determine whether these chemicals can be extracted in significant quantities.

Initial Feasibility Project

The initial focus of this work is to "isolate" an aromatic chemical from lignin to replace the oil-derived equivalent currently used in the production of a polymer that conveys strength and flexibility in some of Biome's products. The production of such a bio-based polymer would reduce the cost and further enhance the sustainability of these products. The intention of this feasibility project, which is backed by a grant from the government's Technology Strategy Board (TSB), is to establish whether such chemicals might be extracted economically and at scale.

Possibilities for the Future

Starting with the successful production of a bio-based polymer will allow us to integrate this development directly into our existing product range. Building on this work, Biome will explore the possibilities for deriving a wide selection of bio-based aromatic chemicals from lignin, further reducing cost and expanding bioplastic functionality. This work will be fundamental in moving the performance and cost balance away from conventional oil-derived polymers and will position Biome Bioplastics at the very forefront of the market for intelligent, natural plastics.



The pulp and paper industry

Worldwide consumption of paper has risen by 400% in the past 40 years, and today over 100 million tonnes of paper and paperboard is produced in Europe alone.

Wood and other plant materials used to make pulp contain three main structural components: cellulose fibres, which are desired for papermaking, hemicelluloses and lignin (the latter two are removed in the pulping process). As lignin makes up around 30% of wood, a large amount is produced as waste.

Finding an enzyme to break down lignin

Termites are notorious for their ability to eat wood. Bacteria in the termite's gut are vital in the process of breaking down the lignin in the wood.

Tim Bugg and his team at Warwick University have been studying lignin-degrading enzymes for 5 years, identifying 12 new lignin-degrading bacteria and associated enzymes.

Warwick Centre for Industrial Biotechnology and Biorefining

The newly opened centre is a one stop shop for academics and industrialists covering the full range of industrial biotechnology activities from plant science and genetics, through biochemistry and fermentation, to product synthesis and manufacturing.

The centre is run my Professor Tim Bugg who is leading on the lignin project with Biome Bioplastics.

Technology Strategy Board funding

Biome Bioplastics and the University of Warwick have secured a grant of approximately £150k from the Technology Strategy Board (TSB) to fund part of this research.

The grant was given as part of the TSB's Collaborative R&D fund, which aims to help companies tackle technical challenges by working collaboratively to create new products and services. The programme co-funds innovative projects that involve partnerships between business and academia, aimed at driving high quality academic work out of the laboratory and into commercialisation.

Technology Strategy Board
Driving Innovation

Industrial Biotechnology

Industrial biotechnology is the use of biological material as a catalyst or feedstock to make industrial products. It offers novel solutions that will benefit many UK industry sectors including chemicals, renewable energy, materials, and health. Innovation in this field has the potential to help move our economy away from a dependency on fossil resources.

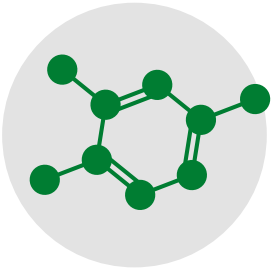
> "Robust estimates of the global IB market by 2025 range from £150 billion to £360 billion; similar estimates for the UK IB market range from £4 billion to £12 billion"
>
> **Industrial Biotechnology Innovation and Growth Team, IB 2025 Report**

The UK government firmly supports industrial biotechnology, believing it will open up new, emerging and established markets to develop less carbon intensive products and processes. Industrial biotechnology poses a significant opportunity for the UK's chemical sector to maintain and increase its competitiveness through the development of new, efficient and sustainable ways of satisfying a significant proportion of our chemical and material needs. Bioplastics are key to this sector and are leading the way for other manufacturers to move into this space.

> "The full climate change mitigation potential of industrial biotechnology ranges between 1 billion and 2.5 billion tons of CO_2 per year by 2030"
>
> **WWF, Industrial biotechnology: More than green fuel in a dirty economy?**

Synthetic Biology

If bioplastics are to truly compete with oil-derived polymers they will need to make use of new lower-cost feedstocks and processes derived from biological sources. Biome Bioplastics' lignin project utilises synthetic biology to control the activity of lignin-degrading bacteria. Synthetic biology is an area of industrial biotechnology that involves the design and construction of novel biological components, systems and processes.



Key advances in genetic engineering are allowing new technologies to be produced at ever increasing speeds and ever reducing cost. Potential products and services to come out of synthetic biology include: new systems for energy, materials and chemicals production; medical diagnostics, therapeutics and vaccines; and innovative approaches to the clean up of hazardous waste.

> "Synthetic biology could provide solutions to the global challenges we face and offers significant growth opportunities in a range of important sectors from health to energy"
>
> **David Willets, Minster of State for Universities and Science**

Biome Bioplastics Limited
North Road, Marchwood
Southampton, United Kingdom
SO40 4BL

Tel: +44 (0) 2380 867100
Fax: +44 (0) 2380 867070
Email: info@biomebioplastics.co.uk
www.biomebioplastics.com

biome bioplastics